YAKEEN 2.0

FOR NEET 2025

Lecture- 1 | Physics

Basic Maths and Calculus

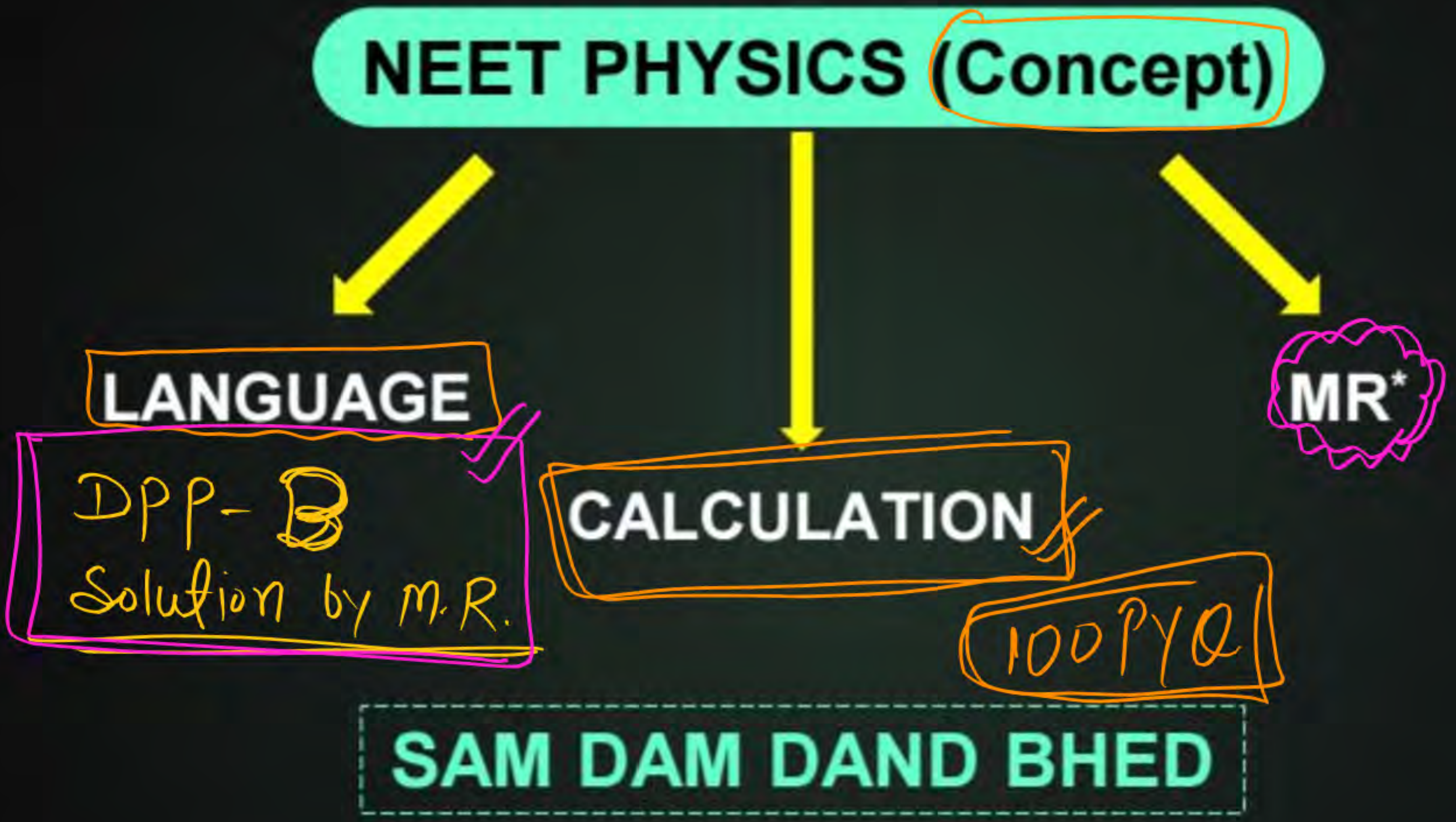
By- Dr. Manish Raj (MR SIR)



Topics to be covered

1. concept of Power
2. Basic calculation
3. P.Y.Q
4.




NEET PHYSICS (Concept)
LANGUAGE
DPP- B
Solution by M.R.
CALCULATION
100 PYQ
MR*
SAM DAM DAND BHED

BASIC MATH

- Basic calculation ✓✓
- logarithmic ✓✓
- Trigonometry ✓✓
- GP and AP series ✓✓
- Graph → All type of Graph ✓✓
- Differentiation ✓✓
  Maxima min
- Integration ✓✓
- Binomial, Quadratic

Last Day

18 F.E.B

JEE main
90% PYQ
Will discuss
in class

100+ PYQ.

20% Prepration

RULE OF POWER (EXPONENT)

$e = 2.71$

1. If power of any non-zero number is zero then result will be 1.

$8^0 = 1$ $10^0 = 1$ $e^0 = 1$

$6^0 = 1$ $4^0 = 1$ $2^0 = 1$

2. Negative Property of exponent (x is non-zero number)

$x^n = \frac{1}{x^{-n}}$ $\frac{1}{x^n} = x^{-n}$ $\frac{1}{10^2} = 10^{-2}$

Ex $2^4 = \frac{1}{2^{-4}}$

$10^{-4} = \frac{1}{10^{+4}}$

3. **Product property of exponent** (If Base is same then Power will add)

$x^n \cdot x^m = x^{n+m}$

$x^4 \times x^6 = x^{10}$

$2^4 \times 2^3 = 2^{12}$ ✗

$= 2^7$ ✓

4. **Division property of exponent**

$\left(\frac{x^n}{x^m}\right) = x^{n-m}$

$x^n x^{-m} = x^{n-m}$ ✓

$\frac{10^4}{10^3} = 10^{4-3} = 10^1$ ✓

5. **Power of a power :**

$$(x^n)^m = x^{n \times m}$$

$$(2^3)^4 = 2^{12}$$

Ex $(8)^{2/3} = (8)^{2 \times \frac{1}{3}}$

$= (64)^{1/3}$

$= 4^{3 \times \frac{1}{3}} = 4$

$4^3 = 64 = 4 \times 4 \times 4$

6. **Fractional exponent :**

$$(x)^{3/2} = (x^3)^{1/2} = \sqrt[2]{x^3}$$

$$(x)^{\frac{3}{2}} = (x)^{3 \times \frac{1}{2}} = (x^3)^{\frac{1}{2}} = \sqrt[2]{x^3}$$

QUESTION

Find value of $10^2 + 10^3$? ??

$10^2 \times 10^3 = 10^5$ ✓

$10^2 + 10^3 = 100 + 1000$ ✓

A 10^5 (44%) wrong

B 10^6

C 1.1×10^3 ✓ (47%)

D 101

$10^2 + 10^3 = 100 + 1000$

$= 1100$

$= \frac{1100}{1000} \times 1000$

$= 1.1 \times 10^3$ (47%)

find value of $2^3 + 2^2 + 2^1$??

$8 + 4 + 2 = 14$ ✓

(a) 64

(b) 16

(c) 14 ✓ (92% correct)

(d) 32

$10^2 \times 10^3 = 10^5$





- $2^2 = 2 \times 2 = 4$
- $2^3 = 2 \times 2 \times 2 = 8$
- $2^4 = 2 \times 2 \times 2 \times 2 = 16$
- $2^5 = 2 \times 2 \times 2 \times 2 \times 2 = 32$
- $2^6 = 64$
- $2^7 = 128$
- $2^8 = 256$

$2^9 = 512$

$2^{10} = 1024$

$3^0 = 1$ ✓

$3^1 = 3$

$3^2 = 9$

$3^3 = 3 \times 3 \times 3 = 27$

$3^4 = 81$

$3^5 = 243$

$4^1 = 4$

$4^2 = 16$

$4^3 = 64$

$4^4 = 256$

$4^5 = 256 \times 4$
$= 1024$

$6^2 = 36$

$6^3 = 36 \times 6 = 216$

$5^1 = 5$

$5^2 = 25$

$5^3 = 5 \times 5 \times 5 = 125$

QUESTION

$3^2 =$

$3^3 =$

$3^4 =$

$3^5 =$

$3^6 =$

$\sqrt{2} = 1.41$ ✓

$\sqrt{3} = 1.73 \simeq 1.71$ ✓

$\sqrt{5} = 2.23$ //

$\pi = \frac{22}{7} = 3.14$ //

$\pi^2 = 10$

$3.14 \times 3.14 \cong 10$

NEET → 22

NEET - 24

QUESTION

$0.4 = 0.40 = 0.400$

$\underset{a}{0.4} = \underset{b}{0.40} = \underset{c}{0.400}$

$0.4 = \frac{4}{10} = \frac{4}{10}$

$0.40 = \frac{40}{100} = \frac{4}{10}$

$0.400 = \frac{400}{1000} = \frac{4}{10}$

✓ (a) $a = b = c$

✗ (b) $a > b > c$

(c) $a < b < c$

(d) can't say

$$\Rightarrow \quad 0.431 = \frac{431}{1000} = \frac{431}{10^3} = 431 \times 10^{-3}$$ ✓

$$\Rightarrow \quad 4.36 = 436 \times 10^{-2}$$ ✓

$$\Rightarrow \quad 4.36 = 0.436 \times 10^{1}$$

$$\Rightarrow \quad 234.78 = 0.23478 \times 10^{3}$$ ✓

$$\Rightarrow \quad \boxed{4.389 = 438.9 \times 10^{-2} = 0.04389 \times 10^{2}}$$ ✓

Maha-Basic

$$\frac{1}{10} = 0.1$$

$$\frac{1}{100} = 0.01 = 10^{-2}$$

$$\frac{1}{1000} = \frac{1}{10^3} = 10^{-3} = 0.001 = 1 \times 10^{-3}$$

Maha-Basic

$0.2 = \frac{2}{10} = \frac{1}{5}$

$0.4 = \frac{4}{10} = \frac{2}{5}$

$0.50 = \frac{1}{2}$

$0.60 = \frac{6}{10} = \frac{3}{5}$

$0.75 = \frac{75}{100} = \frac{3}{4}$

$0.33 = \frac{33}{100} \approx \frac{1}{3}$

$0.66 = \frac{2}{3}$

$25 \times 0.6 = 25 \times \frac{3}{5}$

$= 15$ ✓

$45 \times 0.2 = 45 \times \frac{2}{10}$

$= 4.5 \times 2$

$= 9$ ✓

Maha-Basic

$0.66 = \frac{2}{3}$

$0.25 = \frac{25}{100} = \frac{1}{4}$

$1.33 = \frac{133}{100} \approx \left(\frac{4}{3}\right)$

$1.5 = \frac{3}{2}$

$4.33 = (4 + 0.33)$

$2.5 = \frac{5}{2}$

$6.75 \times 16 =$

$(6 + 0.75) \times 16 = \left(6 + \frac{3}{4}\right) \times 16$

$= \frac{27}{4} \times 16$

$= 108$

$4.33 \times 9 = ??$

$(4 + 0.33) \times 9$

$\left(4 + \frac{1}{3}\right) \times 9$

$= \frac{13}{3} \times 9 \approx 39$

$$\Rightarrow \quad \frac{1}{a} + \frac{1}{b} = \left(\frac{b+a}{ab}\right)$$

$$\Rightarrow \quad \frac{1}{4} + \frac{1}{3} = \frac{3+4}{12} = \frac{7}{12}$$

$$\checkmark \quad \frac{4}{1} + \frac{1}{8} = \frac{32+1}{8} = \frac{33}{8}$$

$$8 \times \frac{4}{8} + \frac{1}{8} = \frac{33}{8} \ \checkmark$$

$$\frac{\overset{3}{\cancel{4}}\ 1}{3 \times 2} + \frac{1}{6} = \left(\frac{4}{6}\right)$$

$$\frac{1}{2} + \frac{1}{6} = \frac{6+2}{12} = \frac{8}{12}$$

$$= \frac{4}{6}$$

Maha-Basic

$0.66 = 0.67 = \frac{2}{3}$

$12 \times 0.67 = \overset{4}{\cancel{12}} \times \frac{2}{\cancel{3}} = 8$

$15 \times 0.67 = \overset{5}{\cancel{15}} \times \frac{2}{\cancel{3}} = 10$

$0.125 \times 24 = \frac{125}{1000} \times 24$ ✓

find x

$2.33 = \frac{x}{3}$

$(2 + 0.33) = \frac{x}{3}$

$\left(2 + \frac{1}{3}\right)3 = x$

$\frac{7}{\cancel{3}} \times \cancel{3} = x$

$x = 7$

- $7.4 \times 25 = \left(7 + \frac{2}{5}\right) \times 25 = \frac{37}{5} \times 25 = 37 \times 5 = 185$ ✓

- $2.66 \times 15 = \left(2 + \frac{2}{3}\right) \times 15 = \frac{8}{3} \times 15 = 40$

- $8.75 \times 8 =$ H/W

- $6 \times 4.33 =$ H/W

- $25 \times 0.6 =$ H/W

$\Rightarrow$ $3.75 \times 1.33 = ??$

$\left(3 + \frac{3}{4}\right) \times \left(\frac{4}{3}\right) =$

$\frac{15}{4} \times \frac{4}{3} = 5$

$2^3 \times 2^2 =$

$(2^3)^2 =$

$2^3 + 2^3 =$

Maha-Basic

Find x in given expansion:

$(x)^{\frac{1}{3}} = 4$

$x^{1/3} = 4$

$x = 4^{3/1}$

$\Rightarrow x = 4^3 = 4 \times 4 \times 4 = 64$

$x^2 = y$

$x = y^{\frac{1}{2}}$

$1.33 = \frac{4}{3}$

find x

$(x)^{\frac{2}{3}} = 9$

$x = 9^{3/2} = (9^{\frac{1}{2}})^{\times 3} = 3^3 = 27$

Maha-Basic

Find x in given expansion:

$(x)^{\frac{3}{4}} = 27$

$x = (27)^{4/3} = 3^{3 \times \frac{4}{3}} = 3^4 = 81$

$(x)^{\frac{3}{2}} = 8$ ⟶ H/W

$x = (8)^{2/3} = 2^{3 \times \frac{2}{3}} = 2^2 = 4$

- $(8)^{2/3} = 4$
- $(4)^{4/3} =$ H/W
- $(64)^{2/5} =$

$(32)^{2/5} = (2^5)^{2/5} = 2^2 = 4$

- $(1/2)^{-3} = \left(\frac{1}{2}\right)^{-3} = (2^{-1})^{-3} = 2^3 = 8$ ✓
- $(4)^{-3/2} = \frac{1}{(4)^{3/2}} = \frac{1}{(2^2)^{\times\frac{3}{2}}} = \frac{1}{8}$
- $(2)^{-4} = \frac{1}{2^4}$

- $(125)^{2/3} =$ $(125)^{2/3} = (5^3)^{2/3} = 5^2 = 25$ ✓
- $(216)^{2/3} = (6^3)^{2/3} = 36$
- $(64)^{2/3} =$

H/w

$125 = 5^3$

$r = r_0 A^{1/3}$

Area of Nucle $\propto A^{2/3}$

↑ mass no.

$6^3 = 6 \times 6 \times 6 = 216$

Maha-Basic

find x

$$\frac{4}{(1/x)} = 3$$

$$\frac{4}{1/x} = 3$$

$$4x = 3$$

$$x = \frac{3}{4} = 0.75$$

$$\frac{y}{(1/3)} = 4$$

$$\frac{y}{(1/3)} = 4$$

$$3y = 4$$

$$y = \frac{4}{3} = 1.33 \quad 1.34$$

$$\frac{x}{(1/y)} = 8$$

$$xy = 8$$

$$\frac{2}{3} = \frac{1}{\left(\frac{3}{2}\right)}$$

QUESTION (Level up)

1. If $3^{6-x} = 27$, find value of x.

$$3^3 = 3 \times 3 \times 3 = 27$$

$$3^{6-x} = 3^3$$

$$6 - x = 3$$

$$6 - 3 = x$$

$$x = 3$$

2. If $2^{y-4} = 64$, find value of y.

$$2^{y-4} = 2^6$$

$$2^6 = 2^3 \times 2^3 = 8 \times 8 = 64$$

$$y - 4 = 6$$

$$y = 10 \text{ Ans.}$$

- $4^{x/2} = 8$, find x

$4^{x/2} = 8$

$4^x = 8^2 = 64 = 4^3$

Powr a.

$x = 3$

- $10^{x/3} = 10^5$, find x

$\frac{x}{3} = 5$

$x = 15$

- $\frac{10^7}{10^{x/2}} = 10^6$, find x H/w

(9) $x^{-\frac{2}{5}} = \frac{1}{9}$

Soln

$\frac{1}{x^{\frac{2}{5}}} = \frac{1}{9}$

$9 = x^{2/5}$

$x = (9)^{5/2}$

$= 3^{2 \times \frac{5}{2}} = 3^5$

$= 3 \times 3 \times 3 \times 3 \times 3$

$= 243$

QUESTION (Level up)

4. If $(x-4)^{2/3} = 4$. Find x.

$$(x-4)^{2/3} = 4$$

$$x-4 = (4)^{3/2}$$

$$x-4 = (2^2)^{3/2} = 8$$

$$\boxed{x = 4+8 = 12}$$ ✓

QUESTION

Moving charges and magn PYQ NEET

Find value of x for given expression

$$27 = (5 + x^2)^{3/2}$$

Sol^n

$$27 = (5+x^2)^{3/2}$$

$$(27)^{2/3} = 5+x^2$$

$$(3^3)^{2/3} = 5+x^2$$

$$9 = 5+x^2$$

$$9-5 = x^2$$

$$4 = x^2$$

$$x = \sqrt{4} = \pm 2$$

MR* Type

QUESTION (Level up)

5. If $\left(\frac{a}{b}\right)^{x-1} = \left(\frac{b}{a}\right)^{x-3}$. Find x.

Sol^n

$$\left(\frac{a}{b}\right)^{x-1} = \left(\frac{b}{a}\right)^{x-3}$$

$$\left(\frac{b}{a}\right)^{1-x} = \left(\frac{b}{a}\right)^{x-3}$$

Base same then Power will be equal

$$1-x = x-3$$

$$1+3 = x+x$$

$$4 = 2x$$

$$x = 2$$

QUESTION (Level up) YPQ

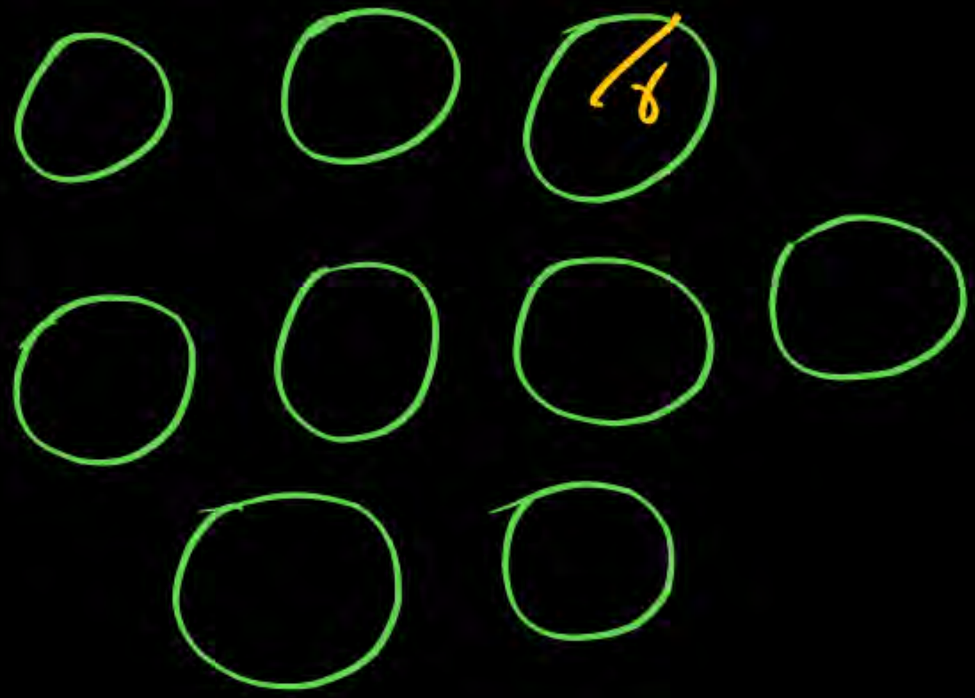
6. If rod of length l, is bended to form a coil of n-turns then find radius of coil.



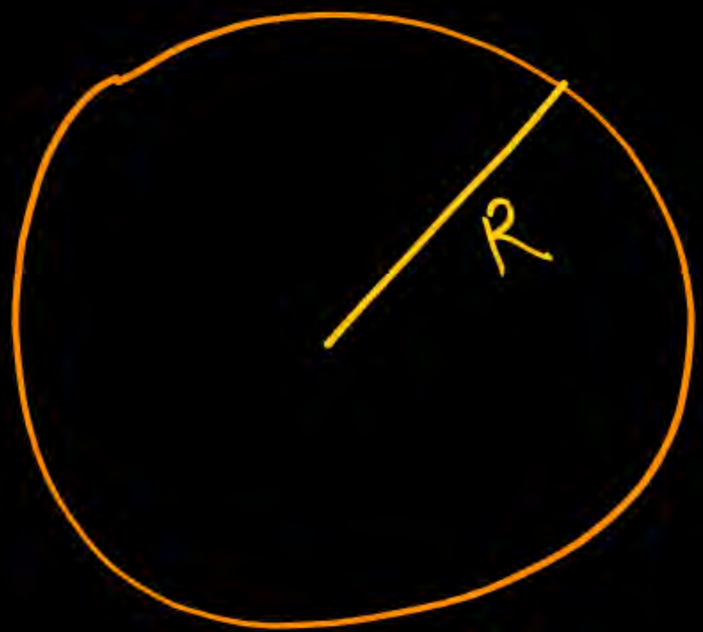
$$n(2\pi R) = l$$

$$R = \left(\frac{l}{2\pi n}\right)$$

PhD on Basi Math



mass = const^n
density = const^n
→
volume = const^n



(Q) there are n-sphere of radius r combine to form a bigger sphere then find its radius

Volume initial = volume final

$$n\left(\frac{4}{3}\pi r^3\right) = \frac{4}{3}\pi R^3$$

$$n \cdot r^3 = R^3$$

$$R = (n r^3)^{1/3} = n^{1/3} r^{3 \times \frac{1}{3}}$$

MR Rafta $\boxed{R = n^{1/3} r}$

- Capacitance
- fluid
- Terminal velo
- Potential
- atom

QUESTION

$\sqrt{2}\times\sqrt{2}=2$ ✓

$\frac{2}{\sqrt{2}}=\sqrt{2}$ $\Rightarrow \frac{2}{\sqrt{2}}=\frac{\sqrt{2}\times\sqrt{2}}{\sqrt{2}}=\sqrt{2}$

$\frac{\sqrt{2}}{2}=\left(\frac{1}{\sqrt{2}}\right)$

$\frac{12}{\sqrt{3}}=\frac{4\times 3}{\sqrt{3}}=4\sqrt{3}$

$\frac{24}{\sqrt{4}}=\frac{6\times 4}{\sqrt{4}}=6\sqrt{4}$

$\sqrt{2}\times\sqrt{2}=2^{1/2}\times 2^{1/2}$

$=2^{\left(\frac{1}{2}+\frac{1}{2}\right)}=2^{1}=2$ Ans

$(8)^{2/3}$ =

$(4)^{5/2}$ =

$(16)^{3/2}$ = already done

H/w

$\sqrt{8} = \sqrt{4 \times 2} = 2\sqrt{2}$

$\sqrt[3]{8} = (8)^{1/3} = (2^3)^{1/3} = 2$

$\sqrt[3]{27} = (27)^{1/3} = 3$

$\sqrt{27} = \sqrt{9 \times 3} = 3\sqrt{3}$

Level up

QUESTION

Find value of $16^{-1/4} + 4^{-2}$?

$$16^{-\frac{1}{4}} + 4^{-2} = \frac{1}{16^{1/4}} + \frac{1}{4^2}$$

$$= \frac{1}{(2^4)^{\frac{1}{4}}} + \frac{1}{16}$$

$$= \frac{1}{2} + \frac{1}{16} = \frac{8+1}{16} = \frac{5}{16}$$

QUESTION

Find value of n; if $\frac{2}{n} = 4 + \frac{6}{7}$.

Sol^n

$$\frac{2}{n} = \frac{7 \times 4}{7} + \frac{6}{7} = \frac{28+6}{7}$$

$$\frac{2}{n} = \frac{34}{7}$$

$$\frac{1}{n} = \frac{17}{7}$$

$$n = \frac{7}{17}$$

QUESTION (Level up)

3. If $x = \frac{d}{\sqrt{3}-1}$. Simplify this.

Sol^n

$$x = \frac{d}{(\sqrt{3}-1)} \times \left(\frac{\sqrt{3}+1}{\sqrt{3}+1}\right)$$

$$= \frac{d(\sqrt{3}+1)}{(\sqrt{3})^2-(1)^2}$$

$$\boxed{x = \frac{d(\sqrt{3}+1)}{2}}$$ Ans

$(a+b)^2 = a^2+b^2+2ab$

$(a-b)^2 = a^2+b^2-2ab$

$$\boxed{(a+b)(a-b) = a^2-b^2}$$

QUESTION

Taking 2 common from the given expression :

$(4+x) = 4\left(1+\frac{x}{4}\right)$

fed

(i) $(2+x)^2 = 2(1+x)^2$ ✗

$\left\{\left(2+\frac{x \cdot 2}{2}\right)\right\}^2 = \left\{2\left(1+\frac{x}{2}\right)\right\}^2 = 4\left(1+\frac{x}{2}\right)^2$

(ii) $\sqrt{4+x} = (4+x)^{1/2}$

$= \left[4\left(1+\frac{x}{4}\right)\right]^{1/2} = 2\left(1+\frac{x}{4}\right)^{1/2}$

$= 2\sqrt{\left(1+\frac{x}{4}\right)}$

QUESTION

$P = \sqrt{2m\, K.E}$

From given relation, if K.E. becomes on fourth then, find final momentum.

QUESTION

If $E = \frac{2KP}{r^3}$; distance becomes double then, find ratio of final to initial electric field.

QUESTION

If $y = \frac{2x^2}{z}$ if x becomes double and z becomes half then y will be

QUESTION

If $S = \frac{V_0^2}{2a}$; if speed becomes half and retardation becomes double then, find ratio of stopping distance.

QUESTION

A bob is whirled in a horizontal plane by means of a string with an initial speed of ω rpm. The tension in the string is T. If speed becomes 2ω while keeping the same radius, the tension in the string becomes:

A $T/4$

B $\sqrt{2}T$

C T

D $4T$

QUESTION

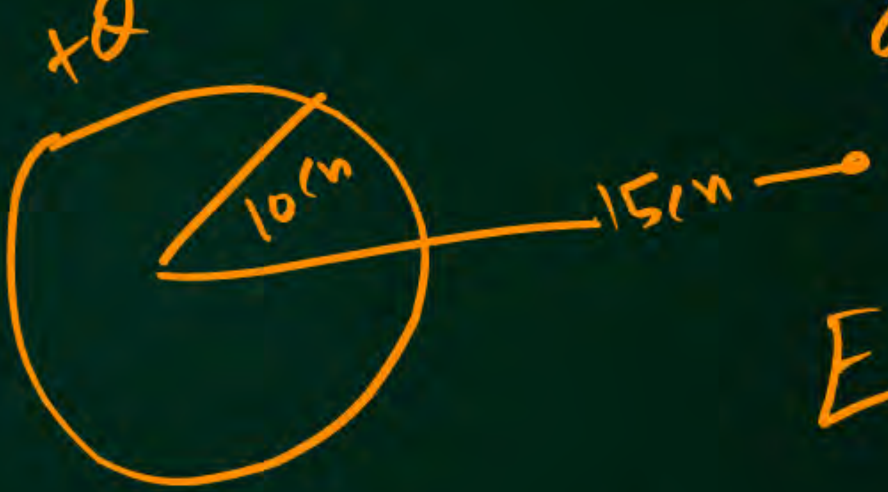
A spherical conductor of radius 10 cm has a charge of 3.2×10^{-7} C distributed uniformly. What is the magnitude of electric field at a point 15 cm from the centre of the sphere? $\left(\frac{1}{4\pi\varepsilon_0} = 9 \times 109\ \text{N m}^2/\text{C}^2\right)$ **[NEET 2020]** PYQ

(A) 1.28×10^4 N/C

(B) 1.28×10^5 N/C

(C) 1.28×10^6 N/C

(D) 1.28×10^7 N/C



given

$E = \frac{KQ}{r^2} = \frac{9\times10^9 \times 3.2\times10^{-7}}{(15\times10^{-2})^2}$

$E = \frac{9\times3.2\times10^2}{225\times10^{-4}}$

$= \left(\frac{28.8}{225}\right)\times10^6 = \left(\frac{288}{225}\right)10^{-1}\times10^6$

QUESTION

An electron is rotating around an infinite positive linear charge in a circle of radius 0.1 m, if the linear charge density is 1 μC/m, then the velocity of electron in m/s will be

A 0.562×10^7

B 5.62×10^7

C 562×10^7

D 0.0562×10^7

H/W

QUESTION

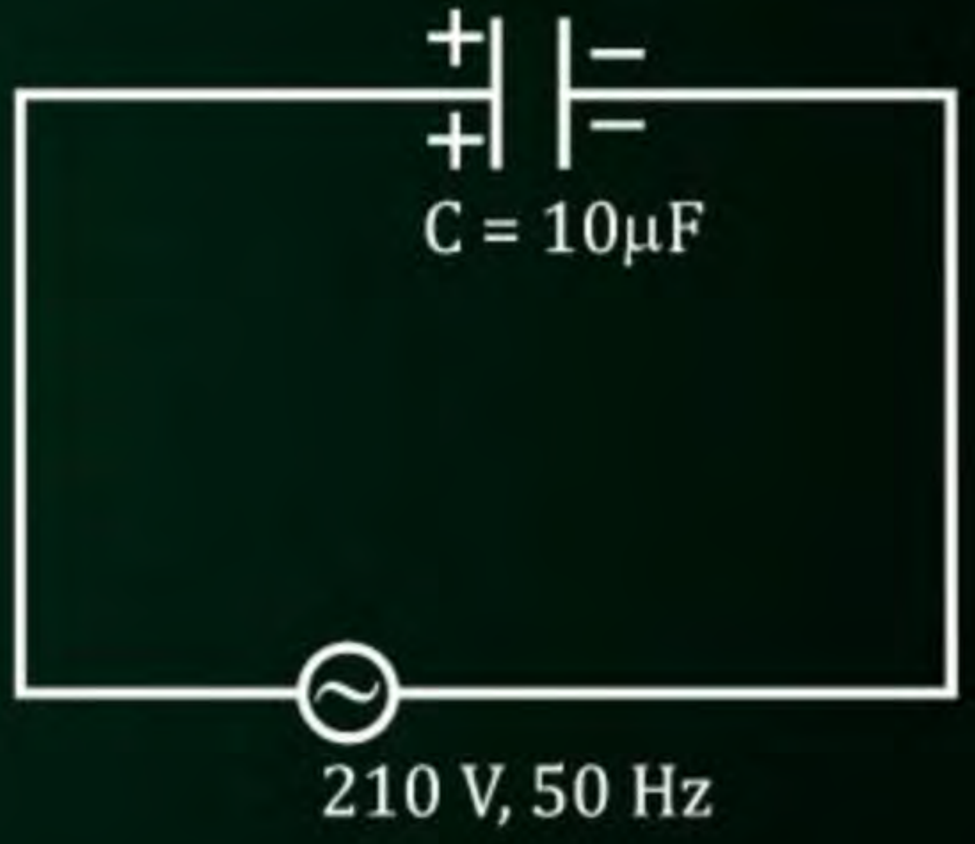
A 10 μF capacitor is connected to a 210 V, 50 Hz source as shown in figure. The peak current in the circuit is nearly ($\pi = 3.14$):

A 1.20 A

B 0.35 A

C 0.58 A

D 0.93 A



H/W

QUESTION

If the mass of the bob in s simple pendulum is increased to thrice its original mass and its length is made half its original length, then the new time period of oscillation is $\frac{x}{2}$ times its original time period. Then the value of x is:

A $2\sqrt{3}$

B 4

C $\sqrt{3}$

D $\sqrt{2}$

H/W

QUESTION

A metallic bar of Young's modulus, 0.5×10^{11} N m^{-2} and coefficient of linear thermal expansion 10^{-5} °C^{-1} length 1 m and area of cross-section 10^{-3} m^2 is heated from 0°C to 100°C without expansion or bending. The compressive force developed in it is:

A) 100×10^3 N

B) 2×10^3 N

C) 52×10^3 N

D) 50×10^3 N

H/W

QUESTION

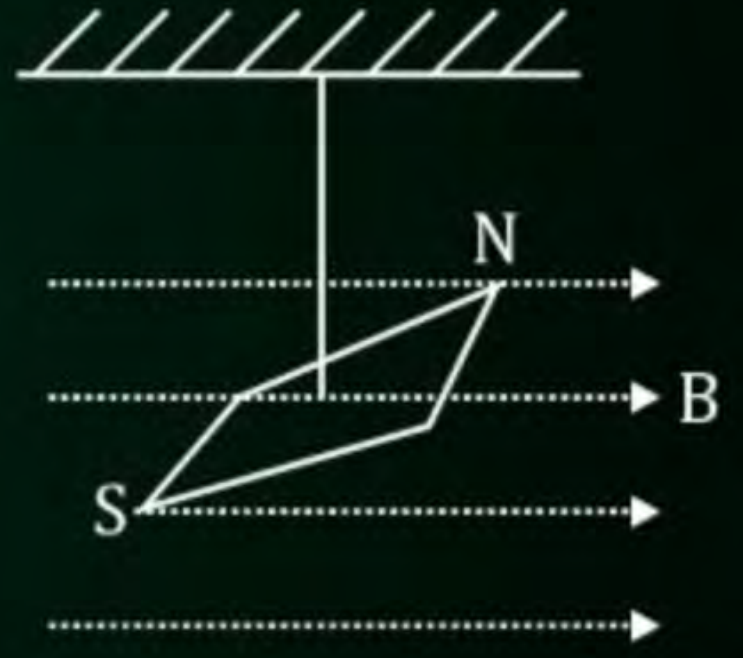
In a uniform magnetic field of 0.049 T, a magnetic needle performs 20 complete oscillations in 5 seconds as shown. The moment of inertia of the needle is 9.8×10^{-6} kg m^2. If the magnitude of magnetic moment of the needle is $x \times 10^{-5}$ Am^2, then the value of 'x' is:

A $50\pi^2$

B $1280\pi^2$

C $5\pi^2$

D $128\pi^2$



H/W

QUESTION

A thin flat circular disc of radius 4.5 cm is placed gently over the surface of water. If surface tension of water is 0.07 Nm^{-1}, then the excess force required to take it away from the surface is:

(A) 1.98 mN

(B) 99 N

(C) 19.8 mN

(D) 198 N

H/W

QUESTION

Find value of

(i) $10^2 - (-10^3) =$ ________

(ii) $9^0 + 9 =$ ________

(iii) $27 + 7^0 =$ ________

(iv) $4^3 - 4^2 =$ ________

(v) $3 - 1^2 =$ ________

(vi) $(8)^{2/3} =$ ________

(vii) $(4)^{5/2} =$ ________

(viii) $(27)^{2/3} =$ ________

H/W

(ix) $t^2t^3 =$ ________

(x) $\frac{1}{x^2\sqrt{x}} =$ ________

(x) $(27)^{1/3} =$ ________

(xi) $(9)^{5/2} =$ ________

$0.4 \times 25 =$

$0.75 \times 25 =$

$0.67 \times 12 =$

$0.33 \times 15 =$

$$\frac{1.33}{0.25} =$$

QUESTION

$\sqrt{2} \times \sqrt{2} = 2$

$\frac{2}{\sqrt{2}} = \sqrt{2}$

$\frac{\sqrt{2}}{2} = \frac{1}{\sqrt{2}}$

$\frac{12}{\sqrt{13}} =$

$\frac{24}{\sqrt{4}} =$

H/W


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture-02 | **Physics**

Basic Maths and Calculus



By- Dr. Manish Raj (MR SIR)

Topics to be covered

1. H/W complete
2. feel of Trigonometry
3. [redacted]
4. [redacted]



QUESTION

Find value of

(i) $10^2 - (-10^3) = 10^2 + 10^3 = 1100$ ✓

(ii) $9^0 + 9 = 1 + 9 = 10$ ✓

(iii) $27 + 7^0 = 27 + 1 = 28$ ✓

(iv) $4^3 - 4^2 = 64 - 16 =$

(v) $3 - 1^2 = 3 - 1 = 2$ ✓

(vi) $(8)^{2/3} = (2^3)^{\frac{2}{3}} = 4$ ✓

(vii) $(4)^{5/2} = (4)^{\frac{1}{2}\times 5} = 2^5 = 32$

(viii) $(27)^{2/3} = 9$ ✓

(ix) $t^2 t^3 = t^5$ ✓

(x) $\frac{1}{x^2\sqrt{x}} = \frac{1}{x^2 \cdot (x)^{1/2}} = \frac{1}{x^{5/2}} = x^{-5/2}$ ✓

(x) $(27)^{1/3} = (3^3)^{\frac{1}{3}} = 3$

(xi) $(9)^{5/2} = (3^2)^{5/2} = 3^5 = 243$

QUESTION

$$\sqrt{2} \times \sqrt{2} = 2$$

done

$$\frac{2}{\sqrt{2}} = \sqrt{2}$$

$$\frac{\sqrt{2}}{2} = \frac{1}{\sqrt{2}}$$

$$\frac{12}{\sqrt{3}} = \frac{4 \times 3}{\sqrt{3}} \sqrt{3} = 4\sqrt{3}$$

$$\frac{24}{\sqrt{4}} =$$

$0.4 \times 25 = \frac{4}{10} \times 25 = 10$ ✓

$0.75 \times 25 = \frac{3}{4} \times 25 = \frac{75}{4}$

$0.67 \times 12 = \frac{2}{3} \times 12 = 8$ ✓

$0.33 \times 15 = \frac{1}{3} \times 15 = 5$ ✓

$$\frac{1.33}{0.25} = \frac{\frac{4}{3}}{\frac{1}{4}} = \frac{4 \times 4}{3 \times 1} = \frac{16}{3}$$

Ae

$0.4 = \frac{4}{10} = \frac{2}{5}$

$0.75 = \frac{75}{100} = \frac{3}{4}$

$0.67 = \frac{67}{100} \approx \frac{2}{3} = 0.66$

H|W

➤ $7.4 \times 25 = (7+0.4)\times 25 = \left(7+\frac{2}{5}\right)\times 25 = 175+10=185$ ✓

➤ $2.66 \times 15 = \left(2+\frac{2}{3}\right)\times 15 = 30+10=40$ (max) ✓

➤ $8.75 \times 8 = \left(8+\frac{3}{4}\right)\times 8 = 64+6=70$

➤ $6 \times 4.33 = 6\times\left(4+\frac{1}{3}\right) = 24+2=26$

➤ $25 \times 0.6 = 25 \times \frac{3}{5} = 15$

$$\begin{array}{r} 25 \\ 7.4 \\ \hline \end{array}$$

$8.75\times 8 = \left(8+\frac{3}{4}\right)\times 8$

$= 64+6 = 70$ ✓

$6\times 4.33 = 6\times\left(4+\frac{1}{3}\right)$

$= 24+2=26$

QUESTION

given Relⁿ b/w momentum & K.E.

$P = \sqrt{2m\, K.E}$

From given relation, if K.E. becomes onefourth then, find final momentum.

मजदूरी

The MR*

$P \propto \sqrt{K.E} = \frac{1}{2}$

Solⁿ

$P = \sqrt{2m\, K.E}$

(2m → const)

$P \propto \sqrt{K.E}$

$P' \propto \sqrt{\frac{K.E}{4}} = \frac{1}{2}\sqrt{K.E} = \frac{P}{2}$

moment becomes half

$P_i = \sqrt{2m\, K.E_i}$ — (I)

$P_f = \sqrt{2m\, K.E_f} = \sqrt{2m \frac{K.E_i}{4}}$ — (II)

(I)/(II)

$\frac{P_i}{P_f} = \frac{\sqrt{2m\, K.E_i}}{\sqrt{2m \frac{K.E}{4}}} = \sqrt{4} = 2$

$\frac{P_i}{P_f} = 2$

$P_f = \frac{P_i}{2}$

QUESTION

If $E = \frac{2KP}{r^3}$; distance becomes double then, find ratio of final to initial electric field.

direct use

$$E_i = \frac{2KP}{r_i^3} \quad \text{—(i)}$$

$$E_f = \frac{2KP}{(2r)^3} = \frac{2KP}{8r^3} \quad \text{—(ii)}$$

(i)/(ii)

$$\left[\frac{E_i}{E_f} = \frac{2KP}{r^3} \times \frac{8r^3}{2KP} = \frac{8}{1}\right]$$

$$\frac{E_f}{E_i} = \frac{1}{8}$$

Ans

QUESTION

If $S = \frac{V_0^2}{2a}$; if speed becomes half and retardation becomes double then, find ratio of stopping distance.

direct formula

$$S_1 = \frac{V_0^2}{2a}$$ ← speed (numerator), ← retart (denominator)

$$S_2 = \frac{\left(\frac{V_0}{2}\right)^2}{2(2a)} = \frac{V_0^2}{4 \times 2 \times 2a} = \frac{V_0^2}{16a}$$

$$\frac{S_1}{S_2} = \frac{V_0^2}{2a} \times \frac{16a}{V_0^2} = \left(\frac{8}{1}\right)$$

The MAT

$$S' = \frac{V_0^2}{2a} = \frac{1}{4 \times 2} = \frac{1}{8}$$

$$\frac{S_1}{S_2} = \frac{8}{1}$$

QUESTION

NEET-24

A bob is whirled in a horizontal plane by means of a string with an initial speed of ω rpm. The tension in the string is T. If speed becomes 2ω while keeping the same radius, the tension in the string becomes:

A) $T/4$

B) $\sqrt{2}T$

C) T

D) $4T$ ✓

given in question

$T = m\omega^2 R$

given → $T = m\omega^2 R$ ← use this directly

const

$T \propto \omega^2$ — (1)

$T' \propto (2\omega)^2 = 4\omega^2$

$T' = 4T$

QUESTION

If $y = \frac{2x^2}{z}$ if x becomes double and z becomes half then y will be

16y

$$y = \frac{2x^2}{z} \quad \text{--- (1)}$$

$$y' = \frac{2(2x)^2}{\left(\frac{z}{2}\right)} = \frac{2 \times 4\, x^2 \times 2}{z} = \frac{2\, 8x^2}{z} = 8y$$

QUESTION

question नहीं समझना है।
only focus on calculation using formula. NEET/JEE

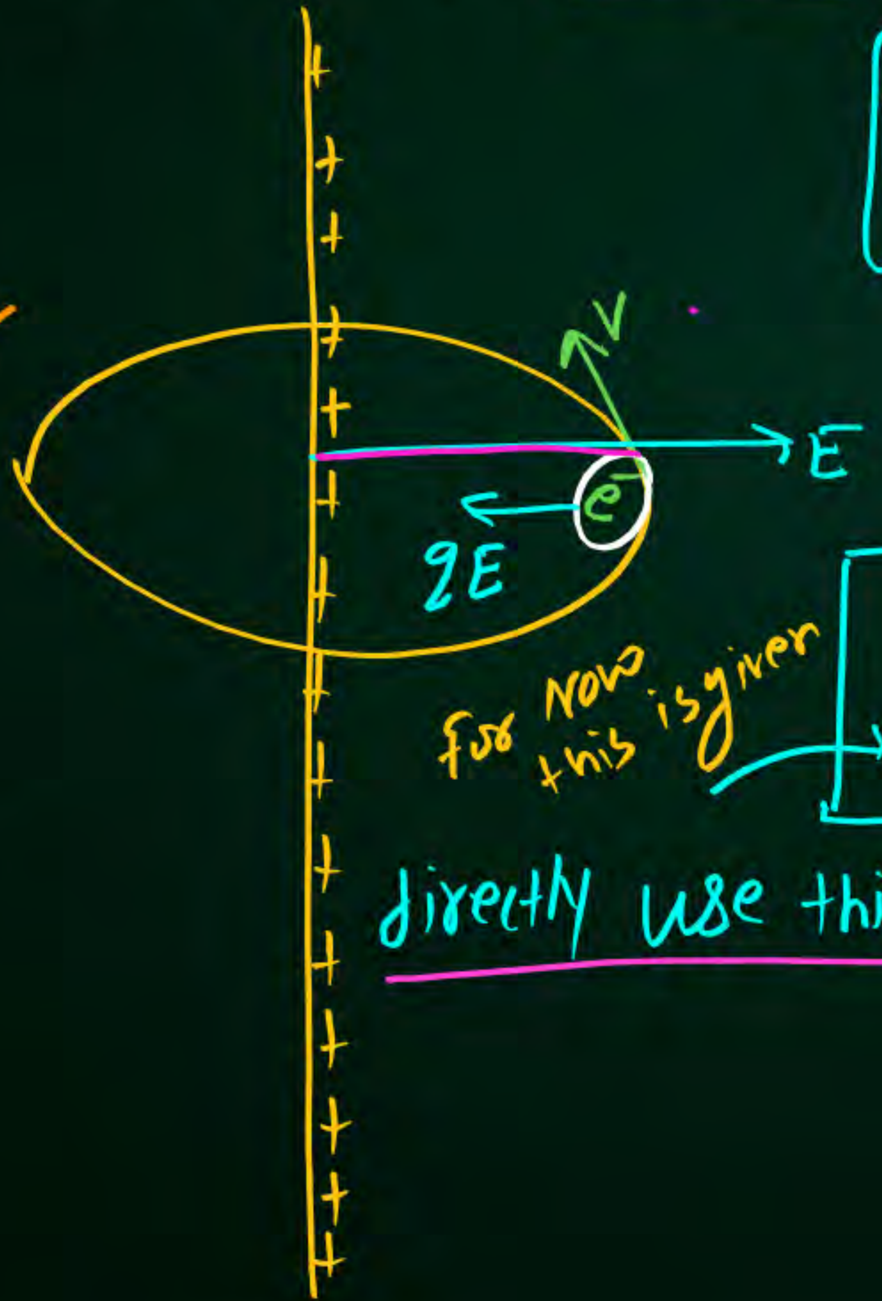
An electron is rotating around an infinite positive linear charge in a circle of radius 0.1 m, if the linear charge density is 1 μC/m, then the velocity of electron in m/s will be ??

(A) 0.562×10^7

(B) 5.62×10^7

(C) 562×10^7

(D) 0.0562×10^7



$$\frac{mv^2}{R} = qE = e\frac{2k\lambda}{R}$$

$$\frac{m_e v^2}{R} = \frac{2k\lambda e}{R}$$

for Now this is given → $V = \sqrt{\frac{2k\lambda e}{m_e}}$

directly use this formula Now

main Part

$$V = \sqrt{\frac{2\times 9\times 10^9 \times 10^{-6}\times 1.6\times 10^{-19}}{9.1\times 10^{-31}}}$$

$$V = \sqrt{3.2\ \frac{10^{-6}\times 10^{-10}}{10^{-21}}}$$

$$V = \sqrt{\frac{3.2}{10^{-15}}} = \sqrt{3.2\times 10^{15}}$$

$$= \sqrt{32\times 10^{14}}$$

$$= \sqrt{32}\times 10^7$$

$$\sqrt{10^{14}} = 10^{14 \times \frac{1}{2}} = 10^{7}$$

$$\sqrt{25} = 5$$

$$\boxed{\sqrt{32} = 5.6}$$

$$\sqrt{36} = 6$$

QUESTION

NEET-24

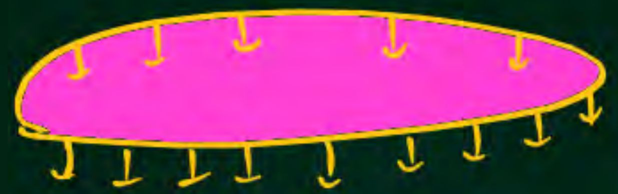
A thin flat circular disc of radius 4.5 cm is placed gently over the surface of water. If surface tension of water is 0.07 Nm^{-1}, then the excess force required to take it away from the surface is:

(A) 1.98 mN

(B) 99 N

(C) 19.8 mN

(D) 198 N



given (use this directly) $F = S(2\pi R)$ ← S: surface Tension

$F = 0.07\left[2 \times \frac{22}{7} \times 4.5 \times 10^{-2}\right]$

$= 7 \times 10^{-2} \times \frac{44}{7} \times \frac{9}{2} \times 10^{-2}$

$= 198 \times 10^{-4}$ N

$= 198 \times 10^{-1}$ mN

Main Pair

$10^{-4} = 10^{-3} \times 10^{-1}$

$= 10^{-1}$ m

mili (10^{-3})

QUESTION

A metallic bar of Young's modulus, $0.5 \times 10^{11}\ N\ m^{-2}$ and coefficient of linear thermal expansion $10^{-5}\ °C^{-1}$ length 1 m and area of cross-section $10^{-3}\ m^2$ is heated from 0°C to 100°C without expansion or bending. The compressive force developed in it is:

(A) 100×10^3 N

(B) 2×10^3 N

(C) 52×10^3 N

(D) 50×10^3 N

$$\frac{F}{A} = Y(\alpha \Delta\theta)$$

Y: Young modulus; $\alpha\Delta\theta$: thermal expansion

use this directly

main part calculate

$$F = A Y \alpha \Delta\theta$$
$$= 10^{-3} \times 0.5 \times 10^{11} \times 10^{-5} \times 100$$
$$= 0.5 \times 10^{3} \times 100$$
$$= \frac{5}{10} \times 100 \times 10^{3}$$
$$= 50 \times 10^{3}\ N$$

NEET-2024

QUESTION

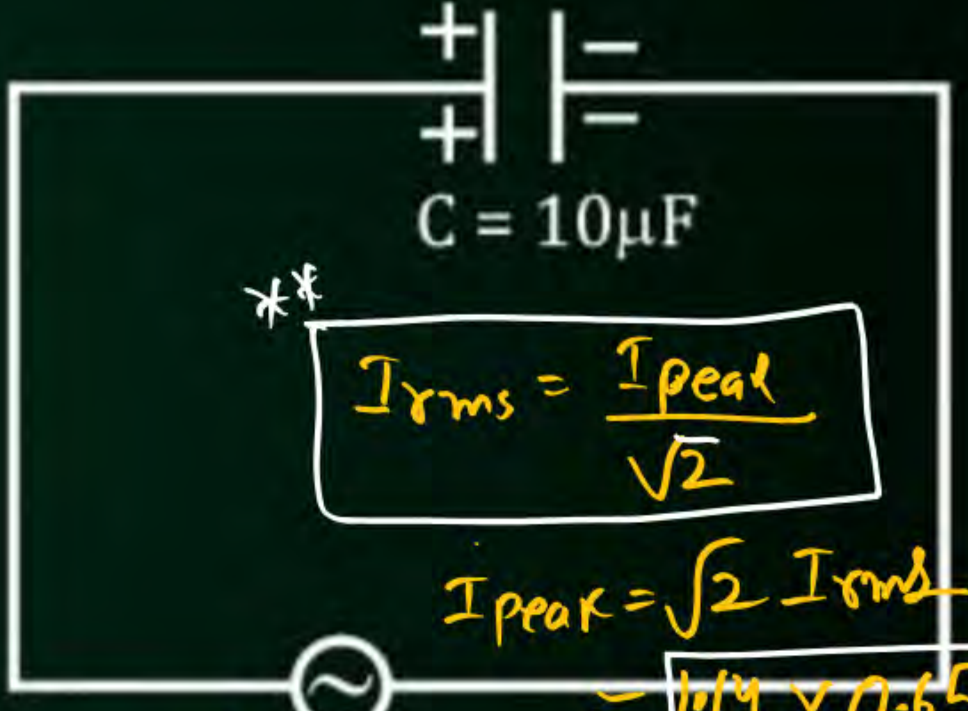
A 10 μF capacitor is connected to a 210 V, 50 Hz source as shown in figure. The peak current in the circuit is nearly ($\pi = 3.14$):

(A) 1.20 A

(B) 0.35 A

(C) 0.58 A

(D) 0.93 A



Use this directly

$I_{rms} = \frac{V_0}{X_C} = V_0 \omega C$

$I_{rms} = V_0 (2\pi f) C$

We will understand this, when study A/C chapter

$I_{rms} = 210 \times 2 \times 3.14 \times 50 \times 10 \times 10^{-6}$

$= 21 \times 3.14 \times 10^{4} \times 10^{-6}$

$= 21 \times 3.14 \times 10^{-2}$

$I_{rms} = 0.21 \times 3.14 = 0.65$

$I_{rms} = \frac{I_{peak}}{\sqrt{2}}$

$I_{peak} = \sqrt{2}\, I_{rms}$

$= 1.14 \times 0.65$

$V_0 = 210$ V, 50 Hz

QUESTION

NEET-2024

In a uniform magnetic field of 0.049 T, a magnetic needle performs 20 complete oscillations in 5 seconds as shown. The moment of inertia of the needle is 9.8×10^{-6} kg m^2. If the magnitude of magnetic moment of the needle is $x \times 10^{-5}$ Am^2, then the value of 'x' is:



(A) $50\pi^2$

(B) $1280\pi^2$

(C) $5\pi^2$

(D) $128\pi^2$

use this directly → $T = 2\pi\sqrt{\frac{I}{MB}}$ (I: moment of inertia; M: magnetic moment; B: mag. moment)

$T = \left(\frac{5}{20}\right)$ sec

$\frac{5}{20} = 2\pi\sqrt{\frac{9.8\times10^{-6}}{x\times10^{-5}\times0.049}}$

$\left(\frac{1}{8\pi}\right)^2 = \frac{9.8\times10^{-1}}{x(0.049)}$

$\Rightarrow x = \frac{64\pi^2 \times 9.8\times10^{-1}}{49/10^3} = \frac{64\times10^2\times 9.8\times\pi^2}{49} = 1280\pi^2$

QUESTION

NEET-24

If the mass of the bob in *s* simple pendulum is increased to thrice its original mass and its length is made half its original length, then the new time period of oscillation is $\frac{x}{2}$ times its original time period. Then the value of x is:

$$T = 2\pi\sqrt{\frac{l}{g}}$$

(A) $2\sqrt{3}$

(B) 4

(C) $\sqrt{3}$

(D) $\sqrt{2}$

M | ω

Not for all only for daddy ji

$1\ fm = 1$ fermi metre $= 10^{-15} m$ ✓

1 PC $= 10^{-12}$ (Pico) C

1 ηc $= 10^{-9}$ (nano) c

1 μF $= 10^{-6}$ (micro) f

1 mm $= 10^{-3}$ (milli) m

1 KJ $= 10^{3}$ (Kilo) J

1 MW $= 10^{6}$ (Mega) W

1 GN $= 10^{9}$ (Giga) N

$1 Å = 10^{-10} m$

Physics by lalu Ram

Sabka kar de kam Tamam

What is infinity ?

➤ Is one divided by zero is Infinite??

$\frac{1}{0} = \infty$ (undefined)

$\Rightarrow \frac{1}{1} = 1$

$\frac{1}{2} = 0.5 \downarrow$

$\frac{1}{4} = 0.25 \downarrow\downarrow$

$\frac{1}{5} = 0.2 \downarrow\downarrow\downarrow$

$\frac{1}{10} = 0.1$

$\frac{1}{100} = 0.01$

$\frac{1}{1000} = 0.001$

$\frac{1}{(10000)} = 0.0001$

$\frac{1}{0.1} = 10$

$\frac{1}{0.01} = 100$

$\frac{1}{0.001} = 1000$

1m length is infinitly larger than radius of atom (10^{-10} m)

* 1m length is infinitly smaller than radius of earth

$\frac{1}{\infty} = \text{zero}$ ✓ feel.

$\frac{1}{0} = \text{infini..}$ ✓

$\frac{1}{\infty} = \text{zero}$

$\frac{1}{0} = \text{infinity}$

$2^0 = 1$

$\Rightarrow 2^{\infty} = \text{infinite}$

$\Rightarrow 2^{-\infty} = \frac{1}{2^{\infty}} = \frac{1}{\infty} = 0$



exponetial

$e = 2.71$

$e^0 = (2.71)^0 = 1$

$e^1 = e$

$e^{\infty} = \text{infinite}$

$e^{-\infty} = \text{zero}$ ✓

QUESTION

Find value of x at $\theta = 90°$. from a given expresion ✓

$$\tan\theta = \frac{4}{x^2-4}$$

$$\tan\theta = \frac{4}{x^2-4}$$

at $\theta = 90°$

$$\tan 90° = \frac{1}{0} = \frac{4}{x^2-4}$$

$$x^2-4 = 4\times 0$$

$$x^2-4=0$$

$$x^2=4$$

$$x = \sqrt{4} = \pm 2$$

QUESTION

Find of 3.87×0.4

A 1.584

B 1.548

C 3.851

D 1.845

3.87
0.4
1.548
fixed

QUESTION

Find value of $\frac{1514}{489}$

A. 3.096

B. 3.000

C. 2.879

D. 3.414

$$\frac{1514}{489} = \frac{1514}{(500)} \text{ Let} \quad 3.1$$

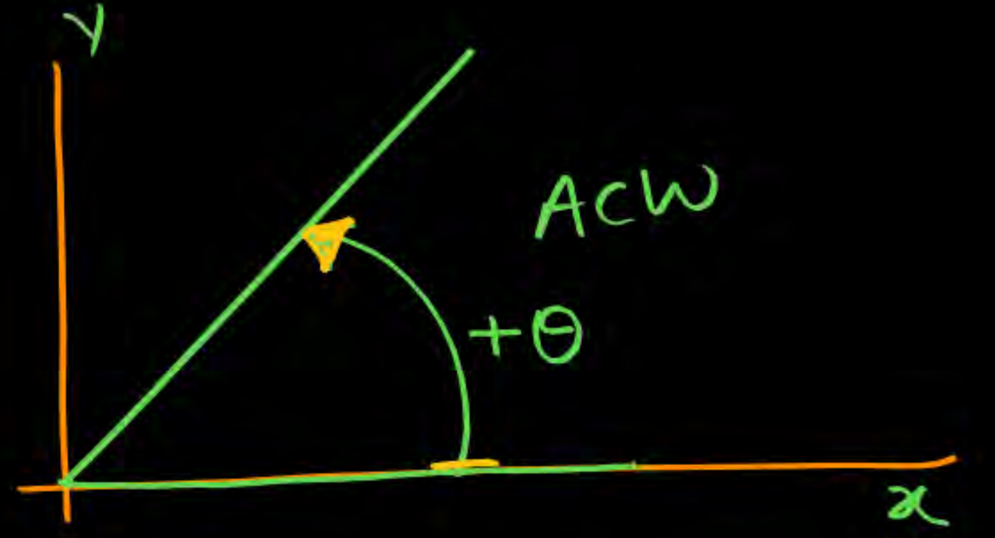
$$\frac{1514}{489} = \frac{1514}{500} \text{ (माना)} \quad 3.01$$

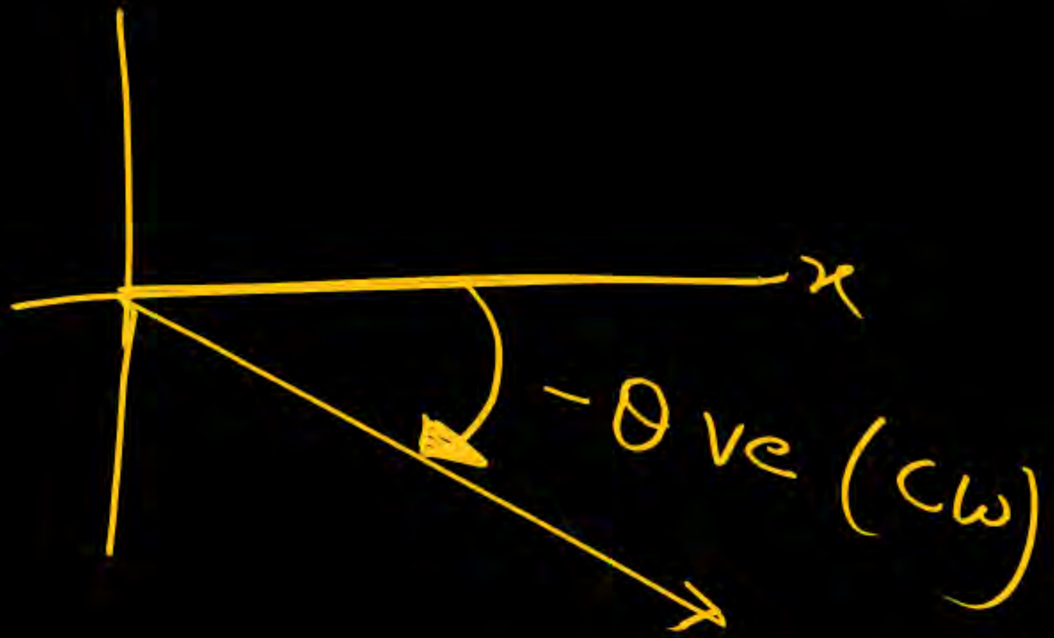
Trigonometry

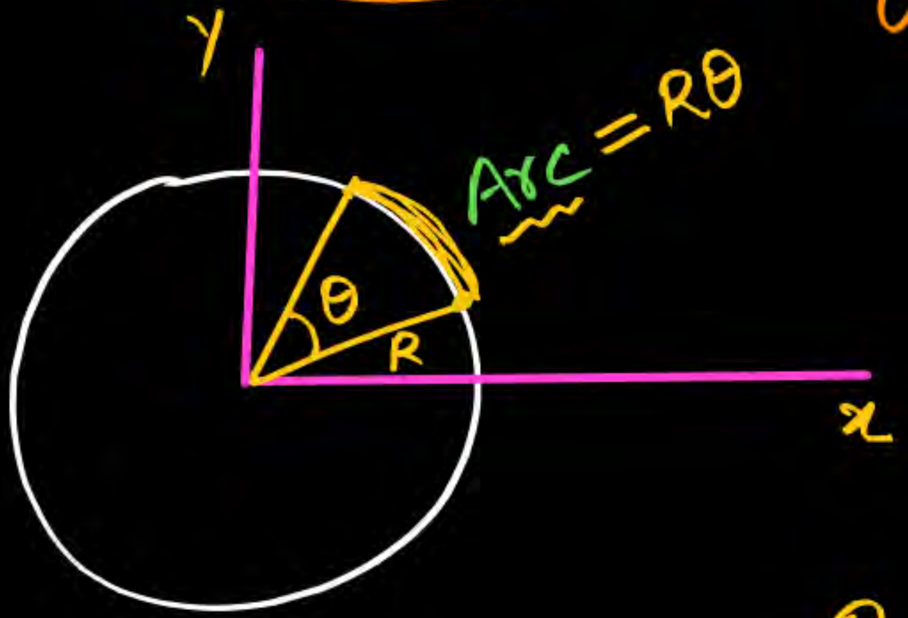
→ θ (Angle) ← (algebric function)

→ sinθ / cosθ, tanθ → Trigonometric functio

Trigonometric ratio







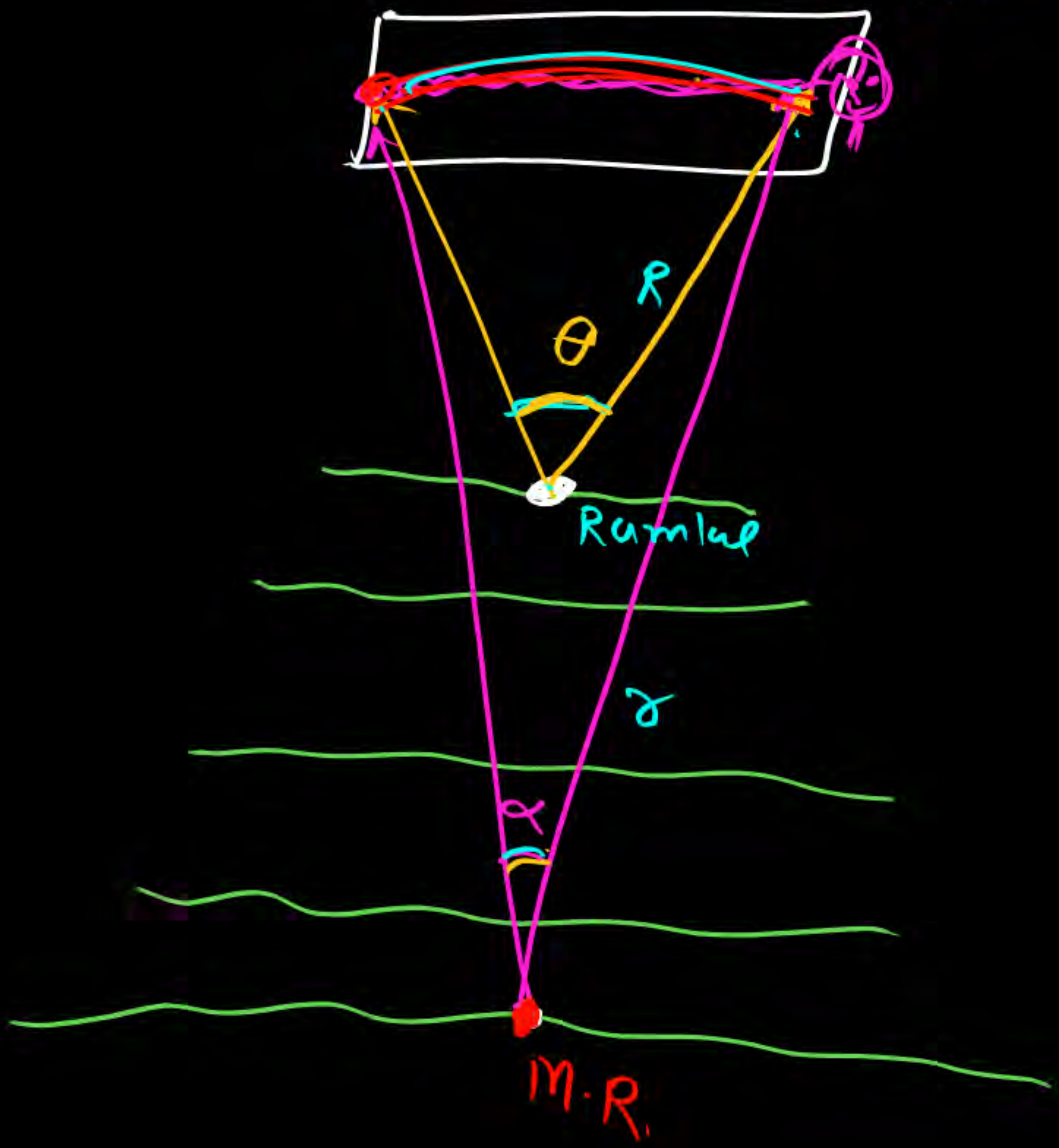
$Arc = R\,\theta$

Arc → unit metre; R → metre; θ → radian

θ → dimensionless but have unit

S.I unit radian

$$Arc = R\theta$$



QUESTION

Ball is dropped from height 122.5, then find time of flight

$$T = \sqrt{\frac{22H}{g}}$$

UNIT OF ANGLE

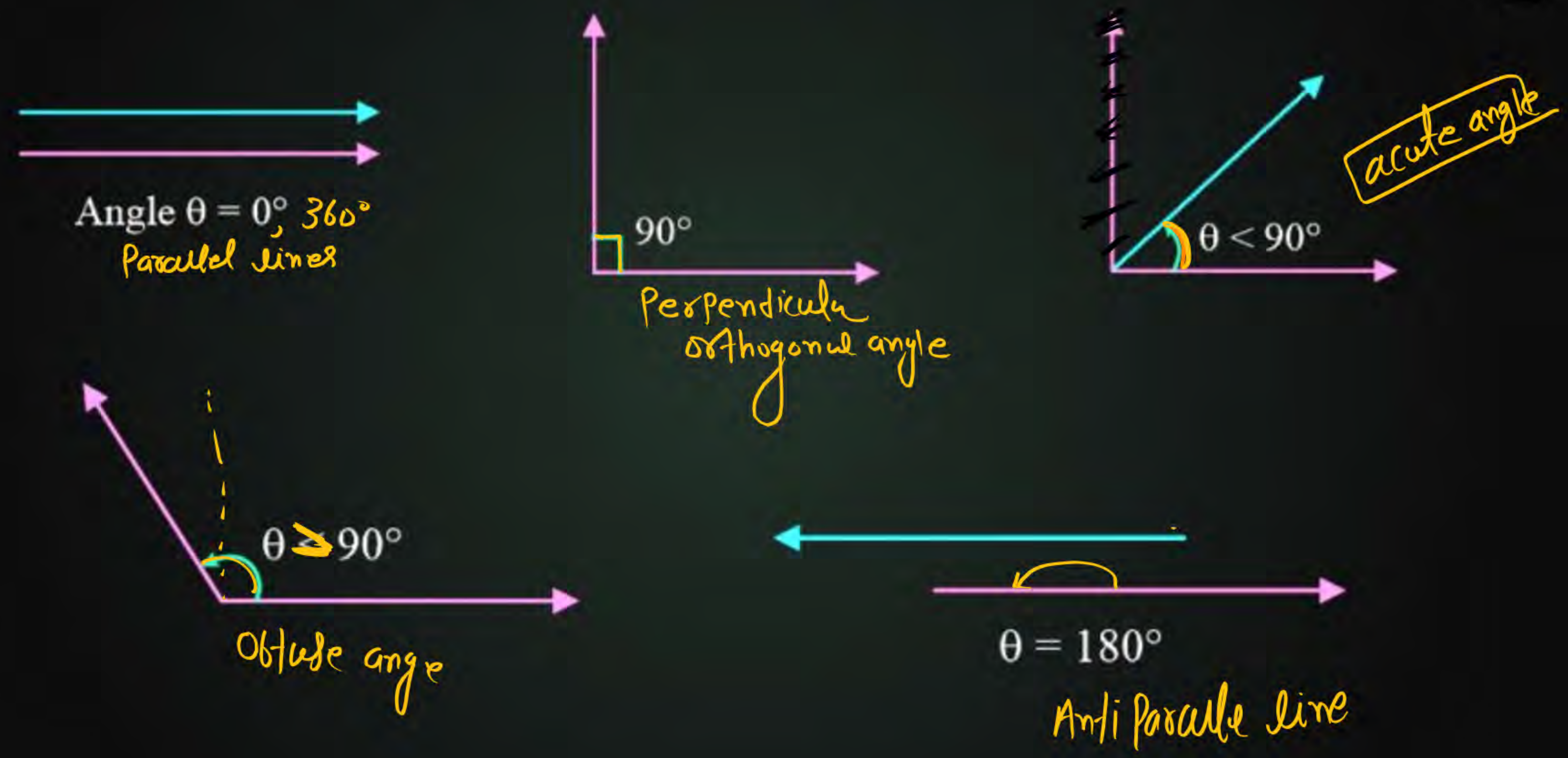
S.I. units (of Angle) = Radian

Other unit (Practical unit) = degree, minute, second (for small angle)

For algebraic function (θ) we always use radian. for trigonometric ratio we can use both degree or radian

$Arc = R\theta$ ← Must be in radian

$\sin\theta$ / $\cos\theta$ ← may be in rad or degree



Angle θ = 0°, 360°
Parallel lines
90°
Perpendicular
orthogonal angle
θ < 90°
acute angle
θ > 90°
Obtuse angle
θ = 180°
Anti Parallel line

MR Rafte

$$\pi \text{ rad} = 180^\circ$$

$$1 \text{ rad} = \frac{180^\circ}{\pi}$$



$$1^\circ = \frac{\pi \text{ rad}}{180}$$

QUESTION

Convert following radian into degree

(i) $\frac{\pi}{2}$ rad $= \frac{\pi}{2}\left(\frac{180°}{\pi}\right) = 90°$

(ii) $\frac{\pi}{4}$ rad $= \frac{180}{4} = 45°$

(iii) $\frac{\pi}{3}$ rad $= \frac{180}{3} = 60°$

(iv) $\frac{5\pi}{6}$ rad $= \frac{5}{6} \times 180 = 150°$

(v) $\frac{2\pi}{3}$ rad $= \frac{2}{3} \times 180 = 120°$

(vi) $\frac{4\pi}{3}$ rad $= \frac{4}{3} \times 180 = 240°$

MR*

$\frac{\pi}{2}$ rad $= \frac{180}{2} = 90°$

QUESTION

Convert following into radian

(i) 45° $= \frac{45}{180} \times 180° \rightarrow \frac{45}{180} \times \pi \text{ rad} = \frac{\pi}{4}$

(ii) 60° $= \frac{60}{180} \pi \text{ rad} = \frac{\pi}{3}$

(iii) 120° $= \frac{120}{180} \times \pi \text{ rad} = \frac{2\pi}{3} \text{ rad}$

(iv) 30°

(v) 150°

(vi) 90°

(vii) π

(viii) 270°

(ix) 135°

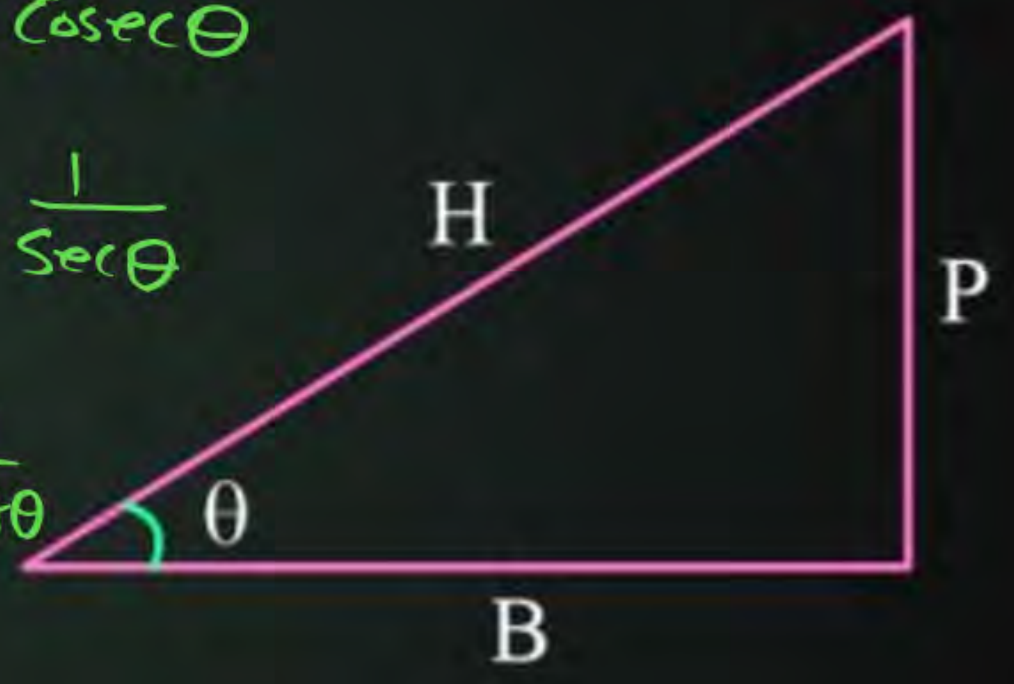
TRIGONOMETRIC RATIO

$$P^2 + B^2 = H^2$$

$$\sin\theta = \frac{P}{H} = \frac{1}{\operatorname{cosec}\theta}$$

$$\cos\theta = \frac{B}{H} = \frac{1}{\sec\theta}$$

$$\tan\theta = \frac{P}{B} = \frac{1}{\cot\theta}$$



$\Rightarrow \tan\theta = \frac{2}{1} = \frac{P}{B}$

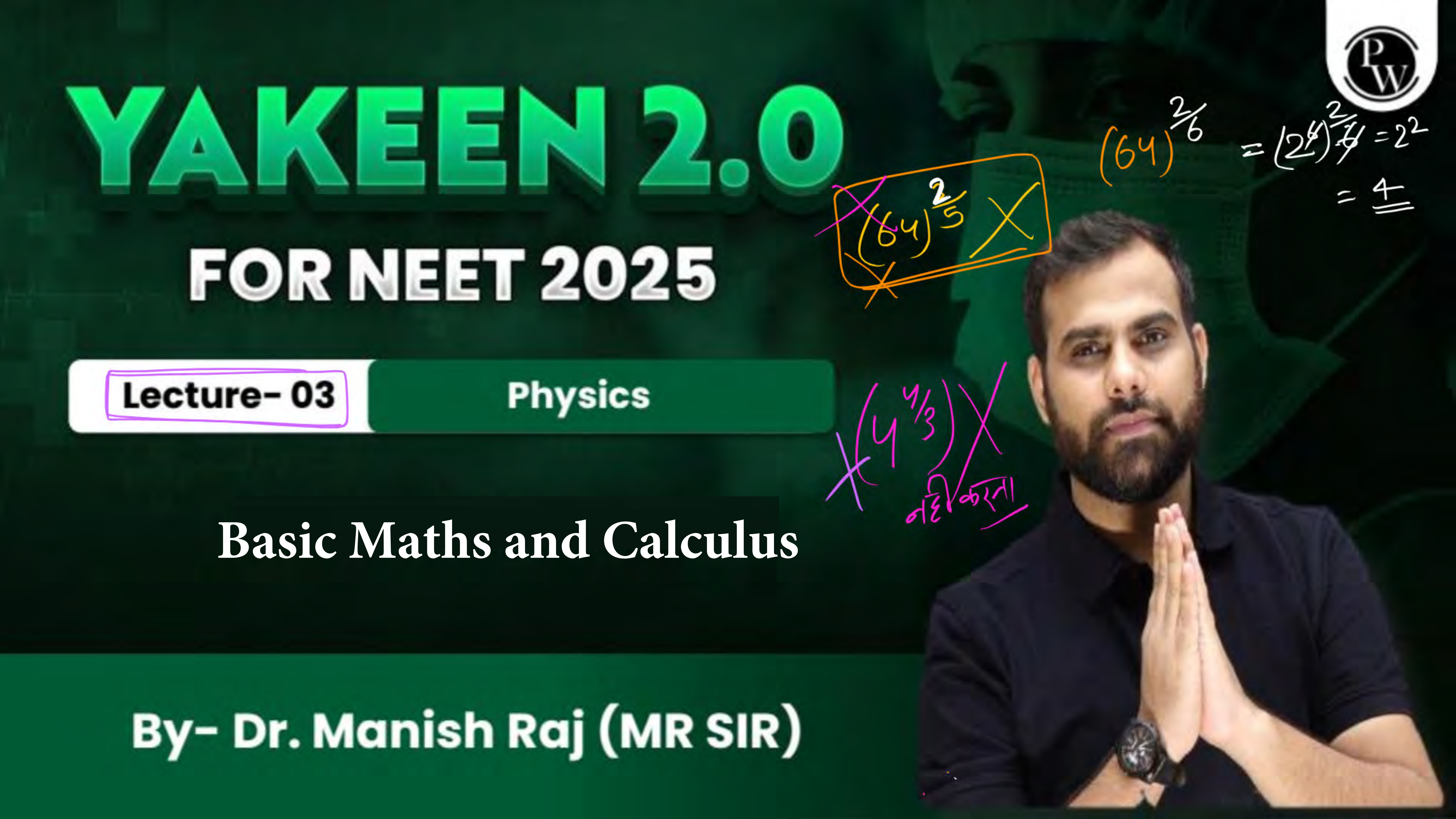
$\sin\theta = ?? = \frac{P}{H}$

$P = 2$

$B = 1$

$H^2 = P^2 + B^2$


THANK YOU


YAKEEN 2.0
FOR NEET 2025
Lecture- 03
Physics
Basic Maths and Calculus
By- Dr. Manish Raj (MR SIR)
(64)^2/6 = (2^6)^2/6 = 2^2
= 4
(64)^2/5
(4^4/3)
नहीं करना

Topics to be covered

1. PhD. on Trigonometry
2. [redacted]
3. [redacted]
4. [redacted]

\+ Vector → S.H.M, Laws of moti., Kinematics, Relⁿ m, Rotⁿ, Work, Wave, Optics



QUESTION

wave optics / Sound wave / SHM ✓

If $\frac{A_1}{A_2} = \frac{7}{3}$ then find $\frac{A_1 + A_2}{A_1 - A_2}$ $= \frac{7+3}{7-3} = \frac{10}{4} = \frac{5}{2}$ Ans ✓

→ $A_1 = 7$ when $A_2 = 3$

QUESTION

If $\frac{\sqrt{I_1}+\sqrt{I_2}}{\sqrt{I_1}-\sqrt{I_2}}=\frac{5}{3}$ then find $\frac{I_1}{I_2}$. = ??

one leg stand for next 5 mint

$\Rightarrow \frac{\sqrt{I_1}+\sqrt{I_2}}{\sqrt{I_1}-\sqrt{I_2}}=\frac{5}{3}$

$\Rightarrow$ Let $\sqrt{I_1}=x$ & $\sqrt{I_2}=y$

$\frac{x+y}{x-y}=\frac{5}{3}$

$3x+3y=5x-5y$

$5x-3x=3y+5y$

$2x=8y$

$\frac{x}{y}=\frac{8}{2}=4$

$\frac{\sqrt{I_1}}{\sqrt{I_2}}=4$

$\frac{I_1}{I_2}=\frac{16}{1}$ (Ans)

Componendo & divido

$\frac{A+B}{A-B}=\frac{x}{y}$

$\left(\frac{A}{B}\right)=\frac{x+y}{x-y}$

If $\frac{A_1}{A_2} = \left(\frac{3}{5}\right)$ then find $\frac{A_1^2 + A_2^2}{A_1^2 - A_2^2} = ??$

Sol^n

$A_1 = 3$

if $A_2 = 5$

$$\frac{9+25}{9-25} = \frac{34}{-16} = -\frac{34}{16} = -\frac{17}{8}$$

If $x + y = 10$ and $2x - y = 2$ then find x and y.

Soln

$$x + y = 10 \quad \text{— (i)}$$

$$2x - y = 2 \quad \text{— (ii)}$$

$$3x = 12$$

$$x = \frac{12}{3} = 4$$

Puting value of x in eqn (1)

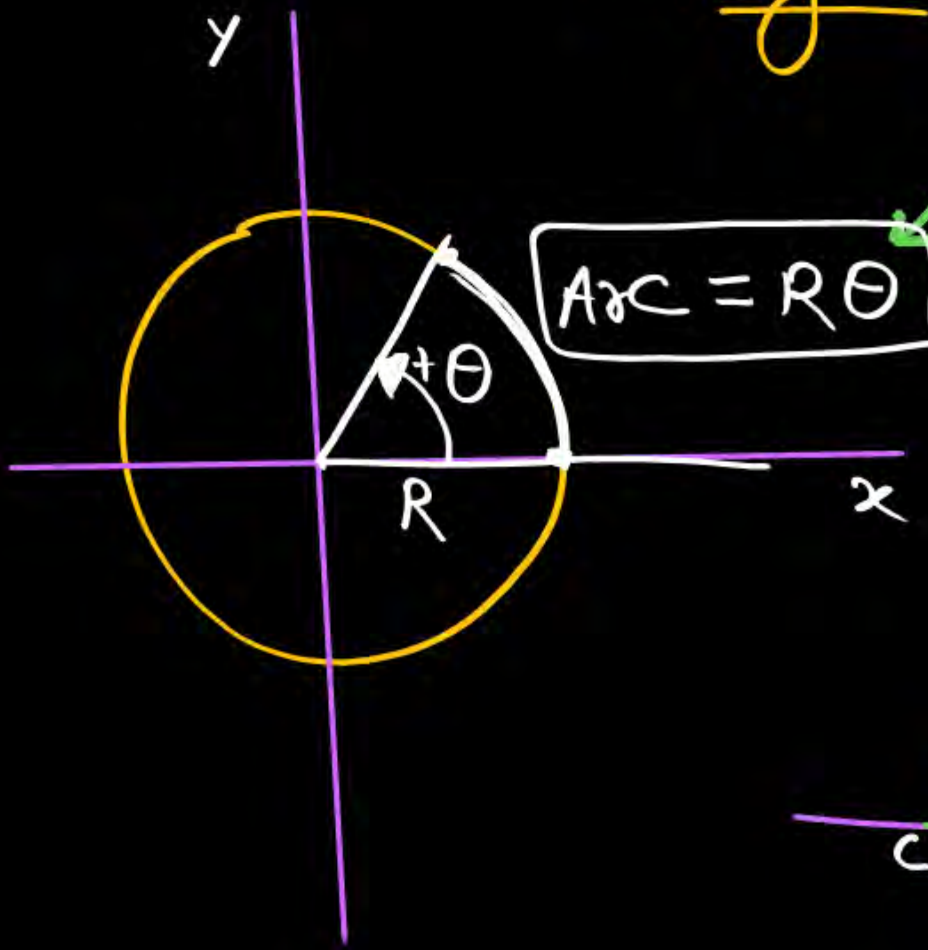
$$x + y = 10$$

$$y = 10 - 4 = 6$$

Feel से PhD

Trigonometry

→ Angle



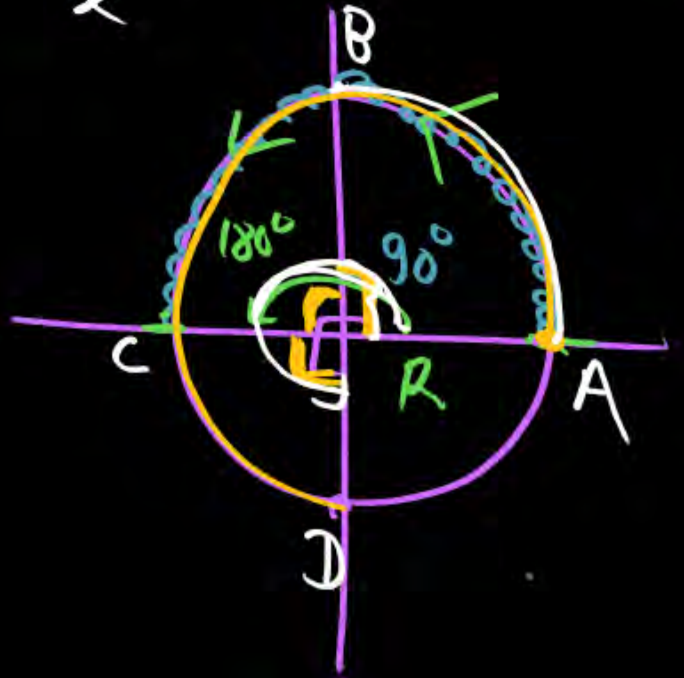
$Arc = R\theta$ — S.I unit rad.

$180^\circ = \pi\, rad$ ← MR Rafte

$1^\circ = \dfrac{\pi\, rad}{180}$ ✓

$1\, rad = \dfrac{180^\circ}{\pi}$

(Q) When object moves from Point 'A' to 'C' on the circle the find total distance moved by object



- $(Arc)_{A\to C} = R\theta = R\,180^\circ$ ✗
  $= \pi R$ metre

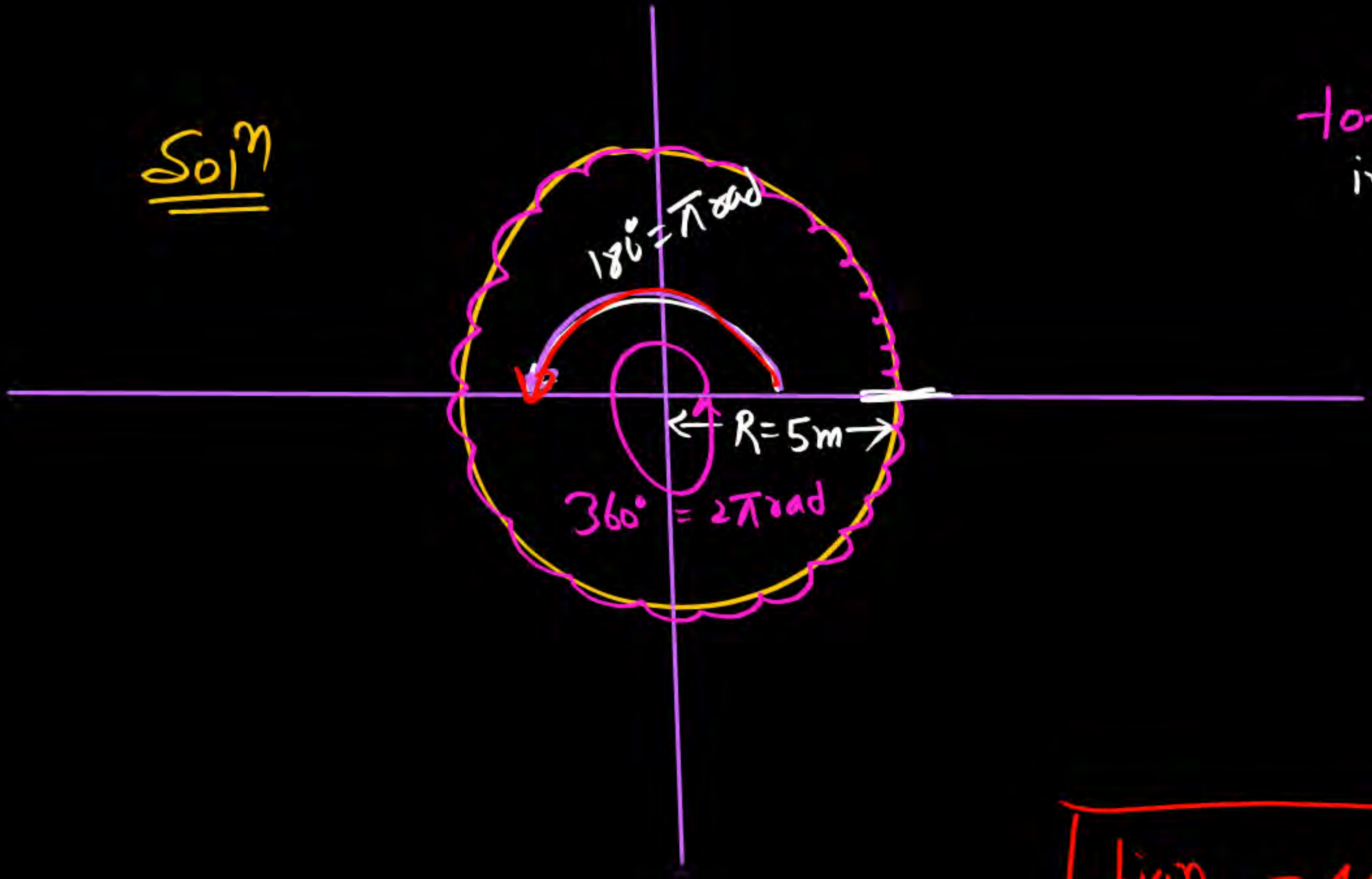
  $(Arc)_{A\to A} = (2\pi R)$

- $(Arc)_{A\to B} = R\theta = \dfrac{\pi R}{2}$

- $(Arc)_{A\to D} = R\,(270^\circ) = R \times \dfrac{270 \times \pi\, rad}{180} = \dfrac{3\pi R}{2}$ m

Total distⁿ moved by object on the circle of Radius 5m in 3 and half Rotation (IIT)(NEET).

Solⁿ



total distⁿ in 1 Rotⁿ $= R\theta = (2\pi R)\,m$

Total distⁿ in 3 rotⁿ $= 3(2\pi R)$
$= 6\pi R$

Half Rotⁿ $= (\pi R)$

3 and half Rotⁿ $= (6\pi R + \pi R)$
$= 7\pi R = 7\pi \times 5$
$= 35\pi = 35 \times \frac{22}{7}$

distⁿ = 110m

QUESTION

$180° = \pi \text{ rad}$

Convert following radian into degree ??

(i) $\frac{\pi}{2}$ rad $= 90°$ ✓

(ii) $\frac{\pi}{4}$ rad $= 45°$ ✓

(iii) $\frac{\pi}{3}$ rad $= 60°$ ✓

(iv) $\frac{5\pi}{6}$ rad $= \frac{5}{6} 180° = 150°$ ✓

(v) $\frac{2\pi}{3}$ rad $= \frac{2}{3} \times 180° = 120°$ ✓

(vi) $\frac{4\pi}{3}$ rad $= 240°$ ✓

MR Rafte

(vii) $\frac{3\pi}{5}$ rad $= \frac{3}{5} \times 180° = 108°$ ✓

(viii) 5π rad $= 5 \times 180 = 900°$ ✓

(ix) $\frac{2\pi}{5}$ rad $= \frac{2 (\pi \text{ rad})}{5}$ 180 $= 72°$ ✓

(x) $\frac{7\pi}{12}$ rad $= \frac{7}{12} 180° = 105°$

(xi) $\frac{5}{2} \pi$ rad $= \frac{5}{2}(\pi \text{ rad}) = 450°$ ✓

(xii) $3(\pi \text{ rad}) = 540°$ ✓

(xiii) $\frac{\pi}{6}$ rad $= 30°$

(xii) $2\pi \text{ rad} = 360°$

QUESTION

$180^\circ = \pi\ rad$

Convert following into radian

(i) $45^\circ = \frac{\pi}{4}\ rad$

(ii) $60^\circ = \frac{\pi}{3}\ rad$

(iii) $120^\circ = 120 \times \frac{\pi\ rad}{180} = \frac{2\pi}{3}\ rad$

(iv) $30^\circ = \frac{\pi}{6}\ rad$

(v) $150^\circ = \frac{5\pi}{6}\ rad$

(vi) $90^\circ = \frac{\pi}{2}\ rad$

(vii) $300^\circ = 300 \times \frac{\pi}{180} = \frac{30\pi}{18}\ rad = \frac{5\pi}{3}\ rad.$

(viii) $270^\circ = \left[\frac{3\pi}{2}\ rad\right]$

(ix) $135^\circ = \frac{3\pi}{4}\ rad$

(x) $720^\circ = 4\pi\ rad.$

(xi) $36^\circ = 36 \times \frac{\pi\ rad}{180} = \frac{\pi\ rad}{5}$

(xii) $450^\circ = 90^\circ \times 5 = \frac{5\pi}{2}\ rad$

(xiii) $240^\circ = 60 \times 4 = \frac{4\pi}{3}\ rad.$

(xiv) $330^\circ = 330 \times \frac{\pi\ rad}{180} = \left[\frac{11\pi}{6}\right] = 30 \times 11 = \frac{11\pi}{6}$

$30^\circ \times 11 = 330^\circ = \frac{11\pi}{6}$

(xv) $57^\circ = 57 \times \frac{\pi\ rad}{180} = 1\ rad$ (π = 3.14)

(xvi) $360^\circ = 2\pi\ rad$

$$\pi\, rad = 180^\circ$$

$$1^\circ = 60' = 60 \text{ miniut}$$

$$1' = 1 \text{ minikte} = \frac{1^\circ}{60}$$

QUESTION

Convert 1 radian into minute ??

$$180^\circ = \pi \text{ rad}$$

$$1 \text{ rad} = \frac{180^\circ}{\pi} = \frac{180}{\pi} \times 1^\circ$$

$$= \frac{180 \times 60'}{\pi}$$

$$= \left[\frac{10800}{\pi}\right] \text{ minute}$$

(Q) Convert 2° in miniute ??

Sol^n $2^\circ = 2(1^\circ) = 2(60')$

$= 120'$ (minute)

QUESTION

When a clock shows 4 O'clock, how much angle do its minute and hour hand make.



$12\alpha = 2\pi \text{ rad} = 360^\circ$

$\alpha = \frac{2\pi \text{ rad}}{12} = \frac{360^\circ}{12}$

$\theta = 4\alpha = 4\left(\frac{2\pi \text{ rad}}{12}\right) = \left(\frac{2\pi}{3} \text{ rad}\right) = 120^\circ$

TRIGONOMETRIC RATIO = Ratios of sides of right angle Triangle.

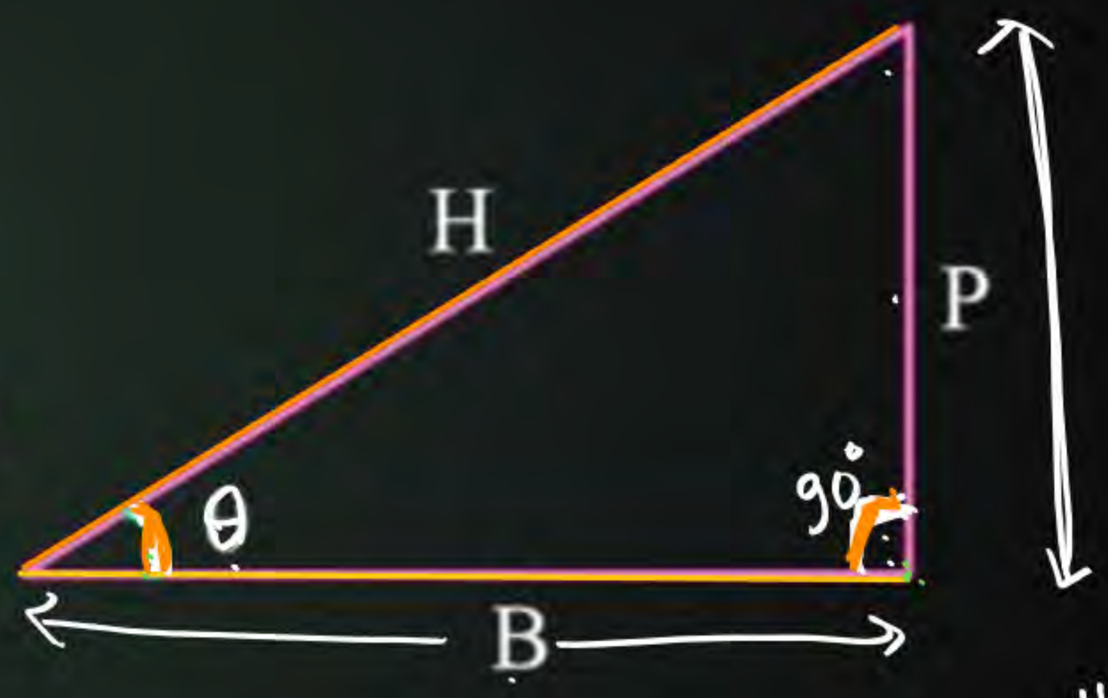
$\sin\theta = \frac{P}{H}$ $\quad \cos\theta = \frac{B}{H}$ $\quad \tan\theta = \frac{P}{B}$

$\operatorname{cosec}\theta = \frac{H}{P}$ $\quad \sec\theta = \frac{H}{B}$ $\quad \cot\theta = \frac{B}{P}$

$\sin\theta \cdot \operatorname{cosec}\theta = 1 \Rightarrow \sin\theta = \frac{1}{\operatorname{cosec}\theta}$

$\tan\theta \cdot \cot\theta = 1 \Rightarrow \tan\theta = \frac{1}{\cot\theta}$

$\cos\theta \cdot \sec\theta = 1 \Rightarrow \cos\theta = \frac{1}{\sec\theta}$



$P < H$
$B < H$ } → Is this true??

Yes

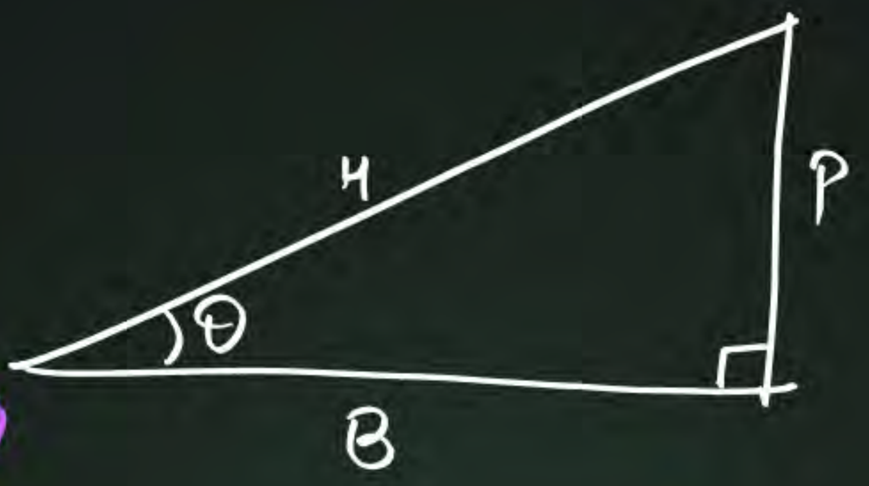
QUESTION

$(P^2 + B^2 = H^2)$

(If divided by P^2 both size.)

$$\frac{P^2}{P^2} + \frac{B^2}{P^2} = \frac{H^2}{P^2}$$

$\frac{P}{H} = \sin\theta$

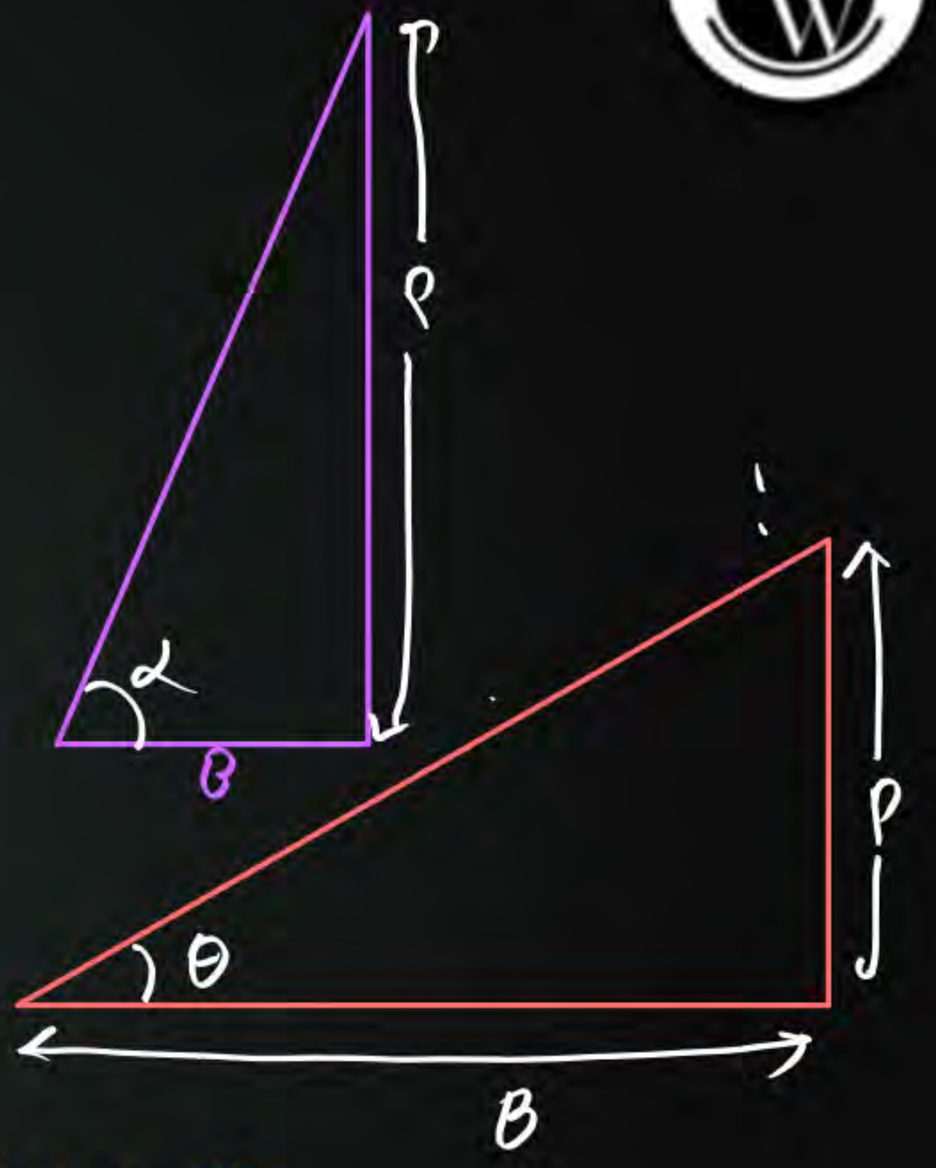


** $1 + \cot^2\theta = \operatorname{cosec}^2\theta$

$H^2 = P^2 + B^2$

$H = \sqrt{P^2 + B^2}$

MR Rafta



$\Rightarrow P^2 + B^2 = H^2$

divided by H^2 both side.

$$\frac{P^2}{H^2} + \frac{B^2}{H^2} = \frac{H^2}{H^2} \; 1$$

$\sin^2\theta + \cos^2\theta = 1$

MR Rafta

divided y $\cos^2\theta$ both side

$\tan^2\theta + 1 = \sec^2\theta$

$\frac{\sin\theta}{\cos\theta} = \tan\theta$

MR Rafta

$$\boxed{\sin^2\theta + \cos^2\theta = 1}$$ MR Raftr

$$\sin^2\theta = 1 - \cos^2\theta$$

$$\sin\theta = \sqrt{1 - \cos^2\theta}$$

$$\cos\theta = \sqrt{1 - \sin^2\theta}$$

$$(\sin\theta)^2 = \sin^2\theta \quad ✓$$

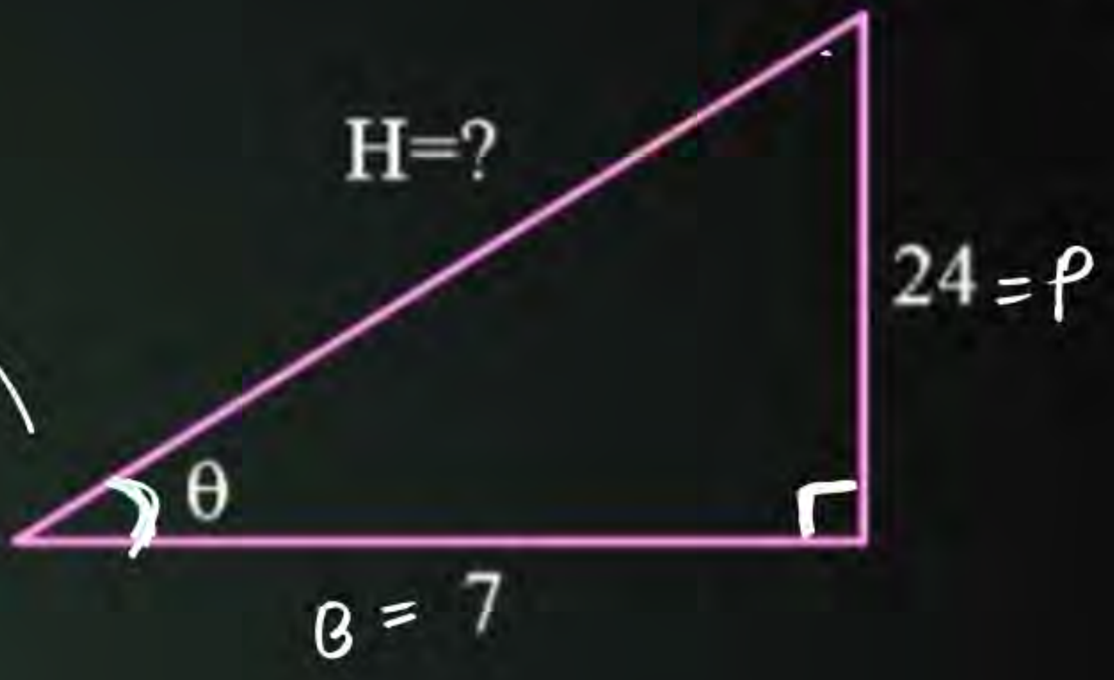
$$= \sin^2\theta^2 \quad ✗$$

$$= \sin(\theta^2) \quad ✗$$

$$\boxed{\sin^2\theta = (\sin\theta)^2} \quad ✓$$

QUESTION

Find angle and H.



$\sin\theta = \frac{P}{H}$

$\sin\theta = \frac{24}{25}$

$\theta = \sin^{-1}\left(\frac{24}{25}\right)$

$\tan\theta = \frac{P}{B} = \frac{24}{7}$

* $\boxed{\theta = \tan^{-1}\left(\frac{24}{7}\right)}$

$H^2 = B^2 + P^2$

$= 7^2 + (24)^2$

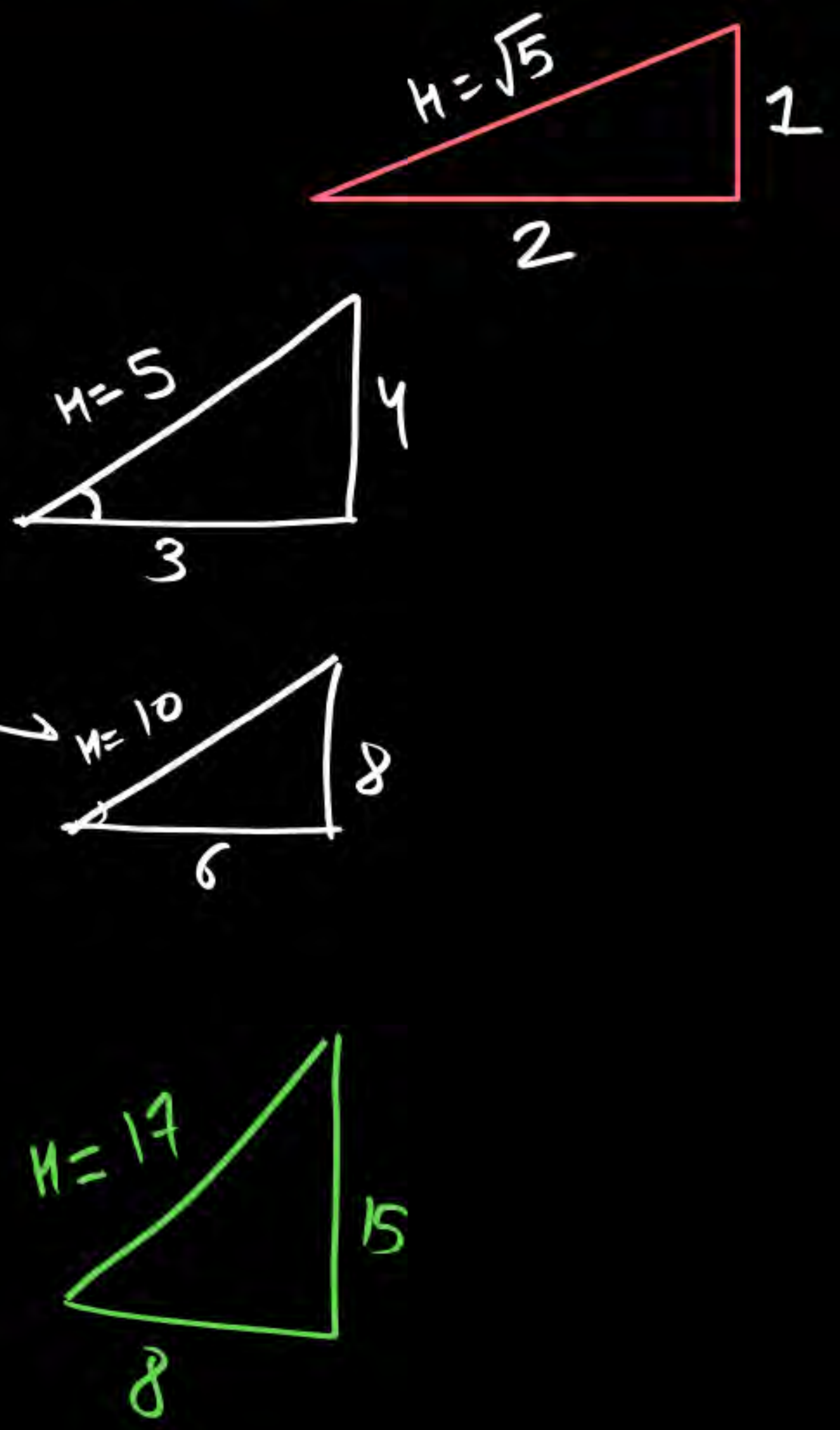
$H^2 = 49 + 576 = 625$

$H = \sqrt{625} = \underline{\underline{25}}$

Important Pythagoras Relation

P, B, H
1, 2, $\sqrt{5}$
3, 4, 5
6, 8, 10
5, 12, 13
7, 24, 25
8, 15, 17

MR Rafta

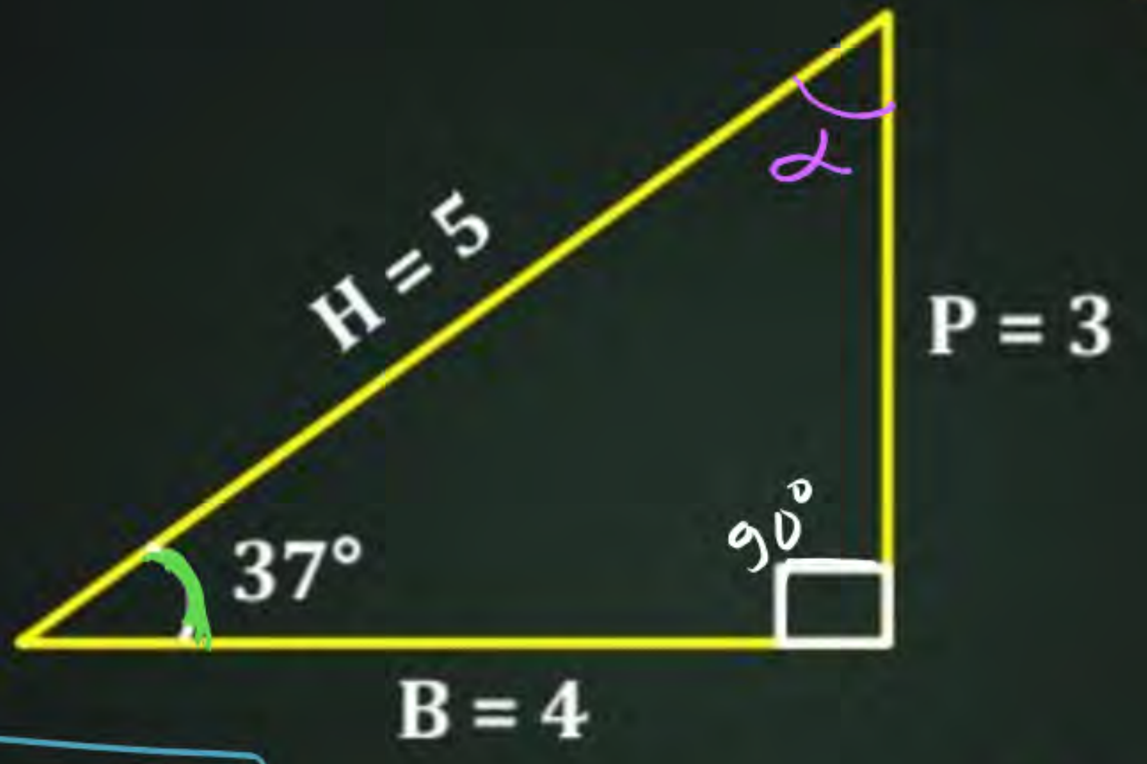


$H = \sqrt{(1)^2 + (2)^2} = \sqrt{1+4} = \sqrt{5}$

QUESTION

Find

$\tan\theta = \dfrac{\sin\theta}{\cos\theta}$





$90 + 37 + \alpha = 180$

$\alpha = 180 - 90 - 37$

$\alpha = 53°$

$\sin 37° = \dfrac{P}{H} = \dfrac{3}{5}$

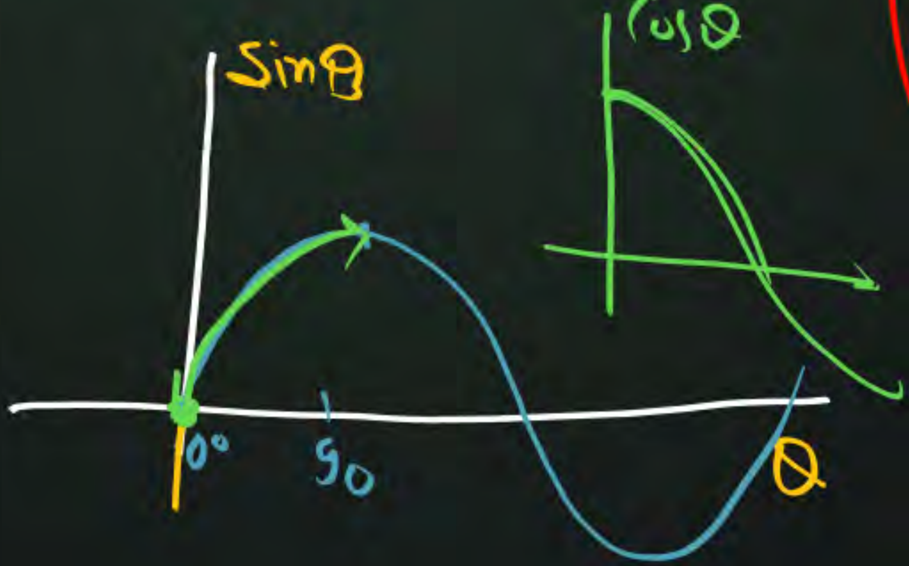
$\cos(37°) = \dfrac{B}{H} = \dfrac{4}{5}$

$\tan(37°) = \dfrac{P}{B} = \left(\dfrac{3}{4}\right)$

$\sin 53° = \dfrac{4}{5}$

$\cos 53° = \left(\dfrac{3}{5}\right)$

$\tan(53°) = \dfrac{4}{3}$



MR*

QUESTION

For given triangle, Find value

$\sin\theta = \frac{P}{H} = \frac{6}{10} = \frac{3}{5}$

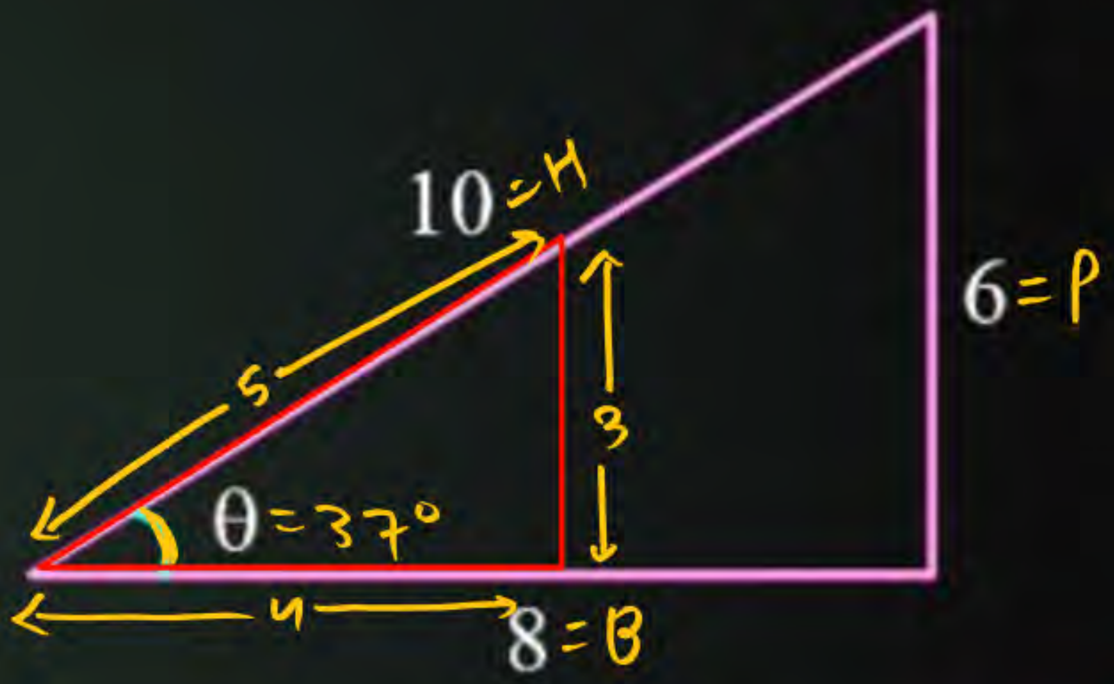
$\cos\theta = \frac{B}{H} = \frac{8}{10} = \frac{4}{5}$

$\tan\theta = \frac{P}{B} = \frac{6}{8}$

$\operatorname{cosec}\theta = \frac{H}{P} =$

$\sec\theta = \frac{H}{B} =$

$\cot\theta = \frac{B}{P} =$





QUESTION

If value of $\sin\theta = \frac{3}{4}$, then find value of $\cos\theta$ and $\tan\theta$.

Sol^n

$\sin\theta = \frac{P}{H} = \frac{3}{4}$

$P = 3$

$H = 4$

$B = ??$

$H^2 = P^2 + B^2$

$16 = 9 + B^2$

$B^2 = 16 - 9 = 7$

$B = \sqrt{7}$

$\cos\theta = \frac{B}{H} = \frac{\sqrt{7}}{4}$

$\tan\theta = \frac{P}{B} = \frac{3}{\sqrt{7}}$ ✓

QUESTION

If $\sin\theta = 3/5$ then find $\cos\theta$ ✓, $\tan\theta$. ✓

$\sin\theta = \frac{P}{H} = \frac{3}{5}$

$B = 4$

(Q) If $\sin\theta = \frac{4}{3}$ then find $\cos\theta$ and $\tan\theta$??

Soln $\sin\theta = \frac{P}{H} = \frac{4}{3}$

Not Possible

$\sin\theta = \frac{4}{3} = 1.33$

$\sin\theta > 1$

Value of $\sin\theta$ can't Possible greater than 1

QUESTION

If $\tan\theta = 2$ then find $\sin\theta$ and $\cos\theta$.

$$\tan\theta = \frac{2}{1} = \frac{P}{B}$$

$P = 2$

$B = 1$

$H = \sqrt{5}$

$$\sin\theta = \frac{P}{H} = \frac{2}{\sqrt{5}}$$

$$\cos\theta = \frac{B}{H} = \frac{1}{\sqrt{5}}$$

If $\frac{\sin\theta + \cos\theta}{\sin\theta - \cos\theta} = \frac{11}{5}$ then find Value of $\tan\theta$.

$$\frac{\sin\theta}{\cos\theta} = \frac{11+5}{11-5}$$

$$\tan\theta = \frac{16}{6} = \frac{8}{3}$$

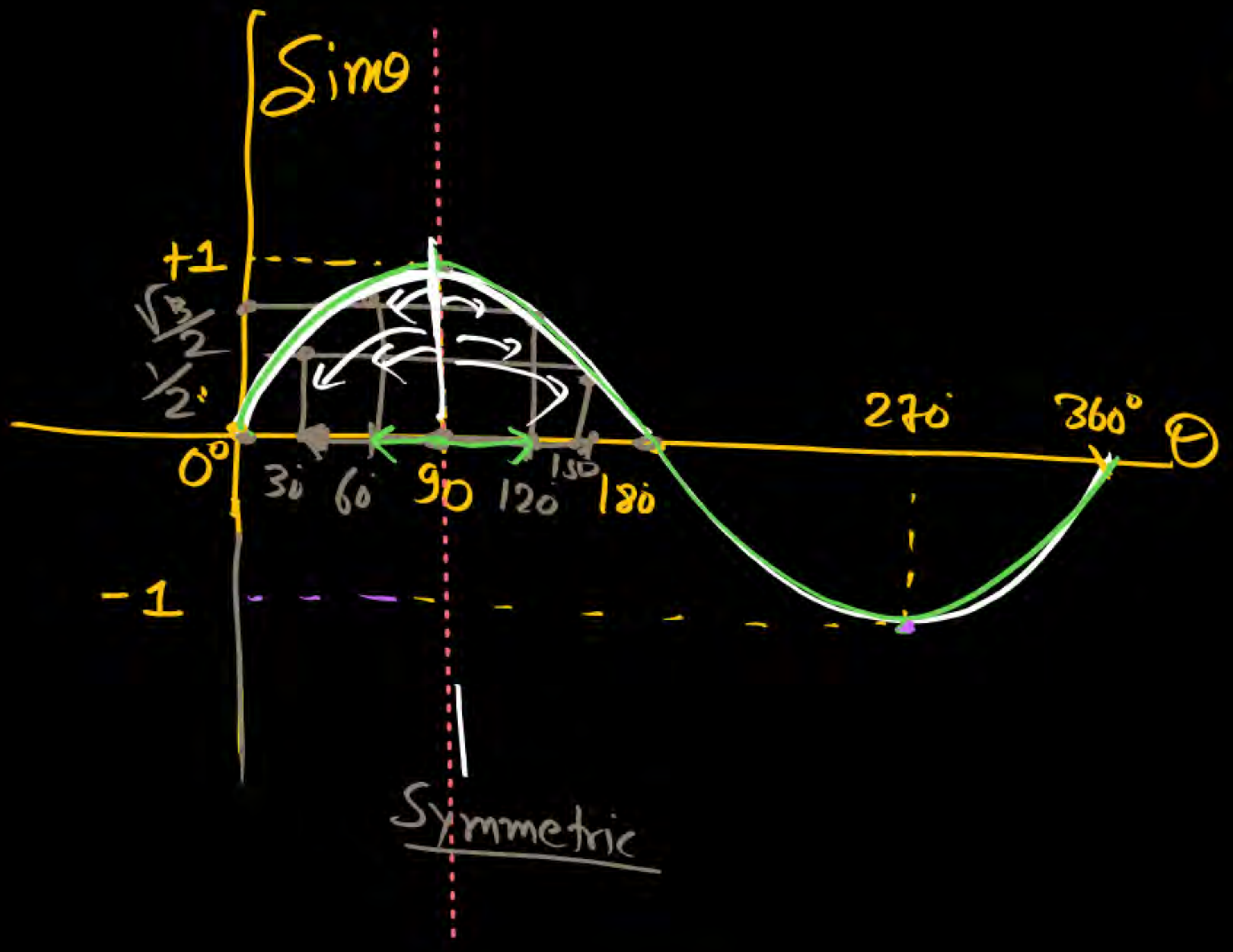
Ans

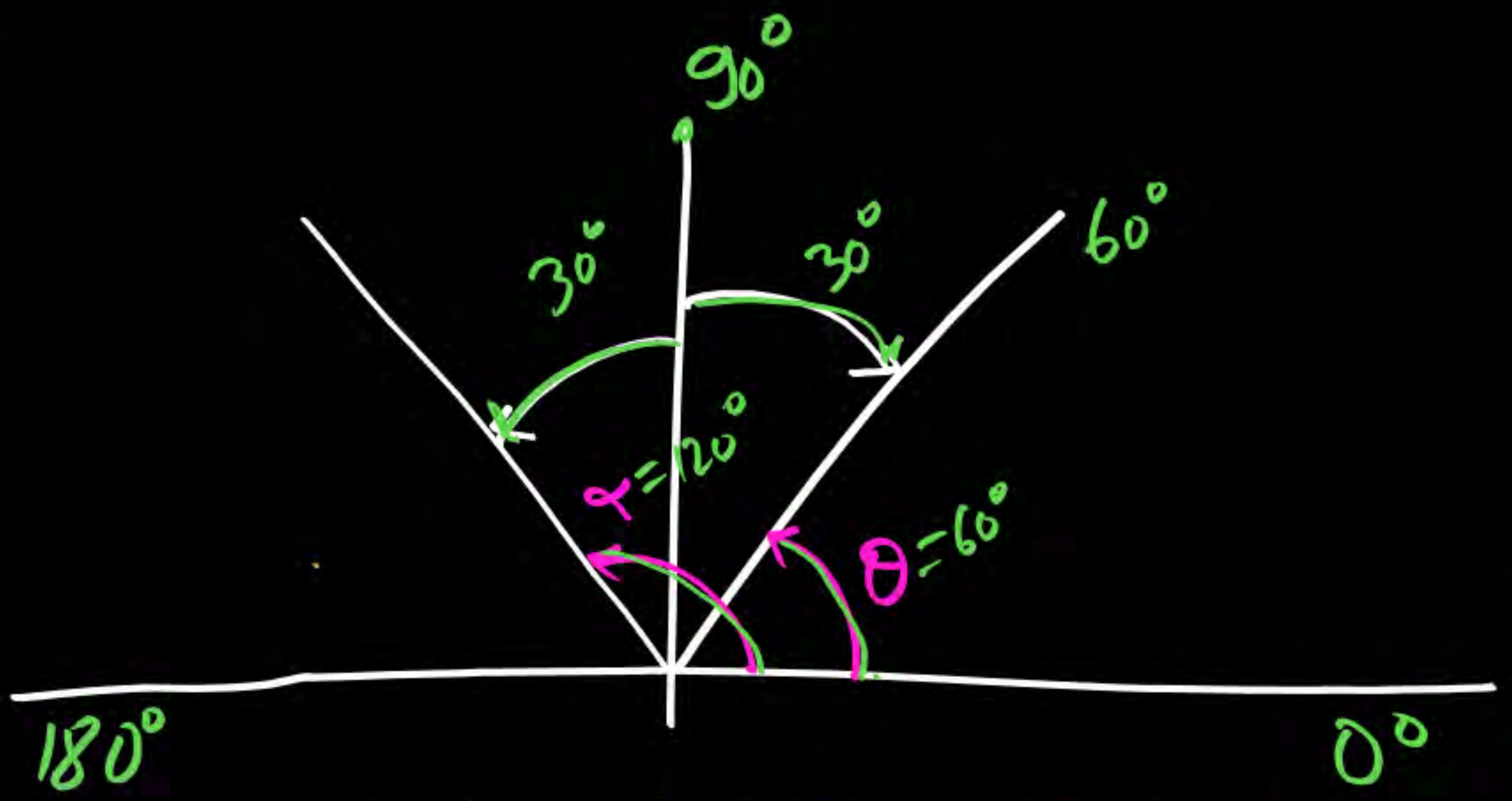
$$5\sin\theta + 5\cos\theta = 11\sin\theta - 11\cos\theta$$

$$16\cos\theta = 6\sin\theta$$

$$\frac{16}{6} = \frac{\sin\theta}{\cos\theta} = \tan\theta$$

MR feel





*

$$\sin\theta_{max} = +1$$

$$\sin\theta_{min} = -1$$

Value of trigonometric function will be same at θ and α.

Value of all trigonometric function are Periodic

Angle	0°	30°	37°	45°	53°	60°	90°	120°	127°	135°	143°	150°	180°
$\sin\theta$	0	$\frac{1}{2}$	$\frac{3}{5}$	$\frac{1}{\sqrt{2}}$	$\frac{4}{5}$	$\frac{\sqrt{3}}{2}$	1	$\frac{\sqrt{3}}{2}$	$\frac{4}{5}$	$\frac{1}{\sqrt{2}}$	$\frac{3}{5}$	$\frac{1}{2}$	0
	0	0.5	0.6	$\frac{1}{1.414} = 0.7$	0.8	0.86	1						
$\cos\theta$	1	$\frac{\sqrt{3}}{2}$	$\frac{4}{5}$	$\frac{1}{\sqrt{2}}$	$\frac{3}{5}$	$\frac{1}{2}$	0	$-\frac{1}{2}$	$-\frac{3}{5}$	$-\frac{1}{\sqrt{2}}$	$-\frac{4}{5}$	$-\frac{\sqrt{3}}{2}$	-1
$\tan\theta = \frac{\sin\theta}{\cos\theta}$	0	$\frac{1}{\sqrt{3}}$	$\frac{3}{4}$	1	$\frac{4}{3}$	$\sqrt{3}$	∞ Inf	$-\sqrt{3}$	$-\frac{4}{3}$	-1	$-\frac{3}{4}$	$-\frac{1}{\sqrt{3}}$	0

$\sin(45°) = \sin(135°) = \frac{1}{\sqrt{2}}$

$\sin(150°) = \sin(30°) = \frac{1}{2}$

mirror

$0° = 2\pi = 4\pi = 6\pi = 8\pi = 10\pi$

$\pi = 3\pi = 5\pi = 7\pi = 9\pi$

$\tan(135^\circ) = -1$

$\sin(120^\circ) = \frac{\sqrt{3}}{2}$ ✓

$\cos(150^\circ) = -\frac{\sqrt{3}}{2}$

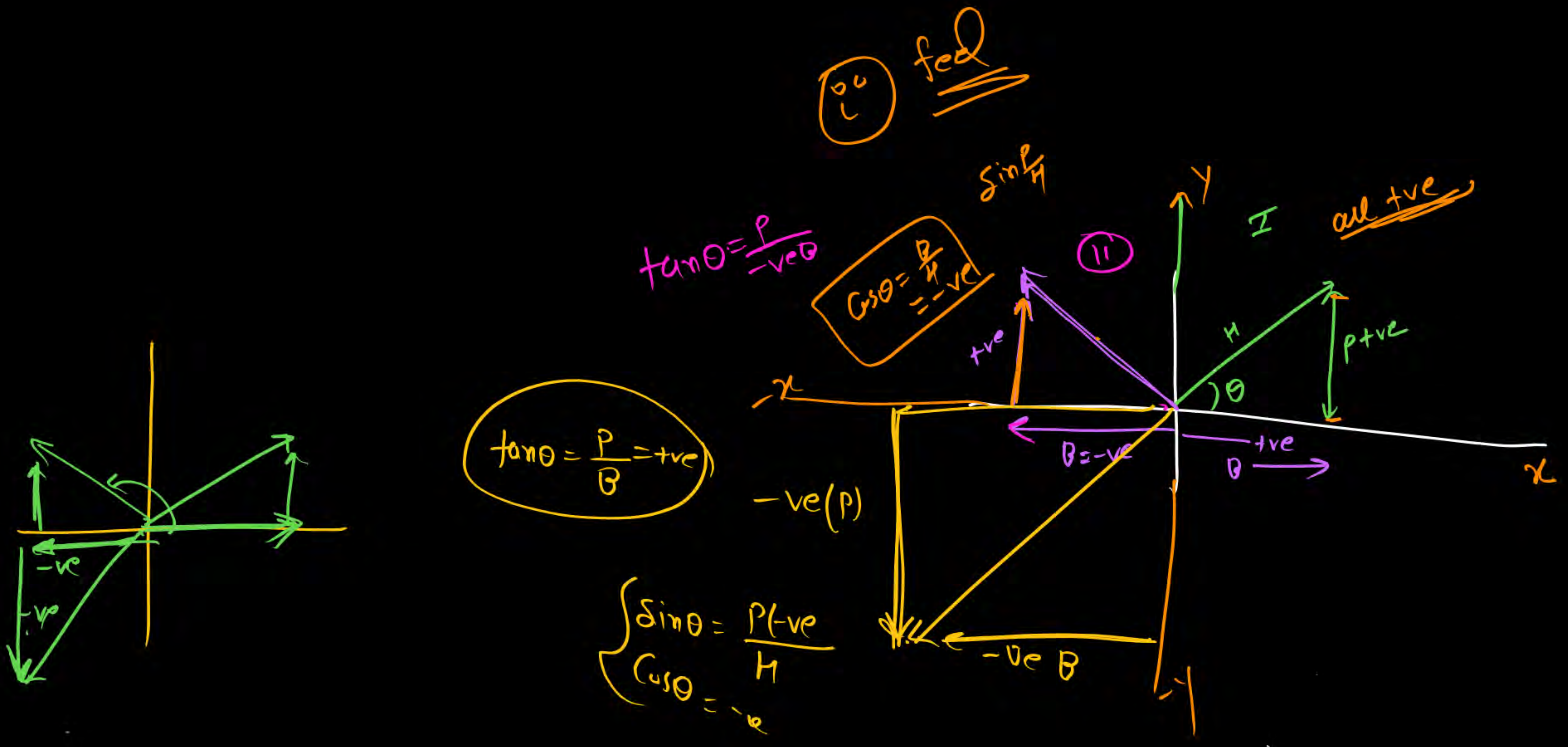
$\sin(-60^\circ)$

↳ we will disw in next cul (dpp solve मत करना)

$\sin(127^\circ) = \sin(90+37)$

$= \frac{4}{5}$ ✓

$\cos(135^\circ) = -\frac{1}{\sqrt{2}}$



feel
sin P/H
tanθ = P/-veB
Cosθ = B/H = -ve
II
y
I
all +ve
+ve
H
p+ve
θ
-x
tanθ = P/B = +ve
B = -ve
+ve
B
x
-ve(P)
sinθ = P(-ve)/H
Cosθ = -ve
-ve B
-y
-ve

QUESTION

If angle increases from 0° to 90°, then value $\sin\theta$ and $\cos\theta$

(A) Increases, decreases

(B) decreases, Increases

(C) both decrease

(D) both Increase

H/W

QUESTION

Find value of $\sin(53^\circ) \times \operatorname{cosec}(53^\circ)$

H/W

QUESTION

Find value of $\sin^2(40°) + \cos^2(40°)$

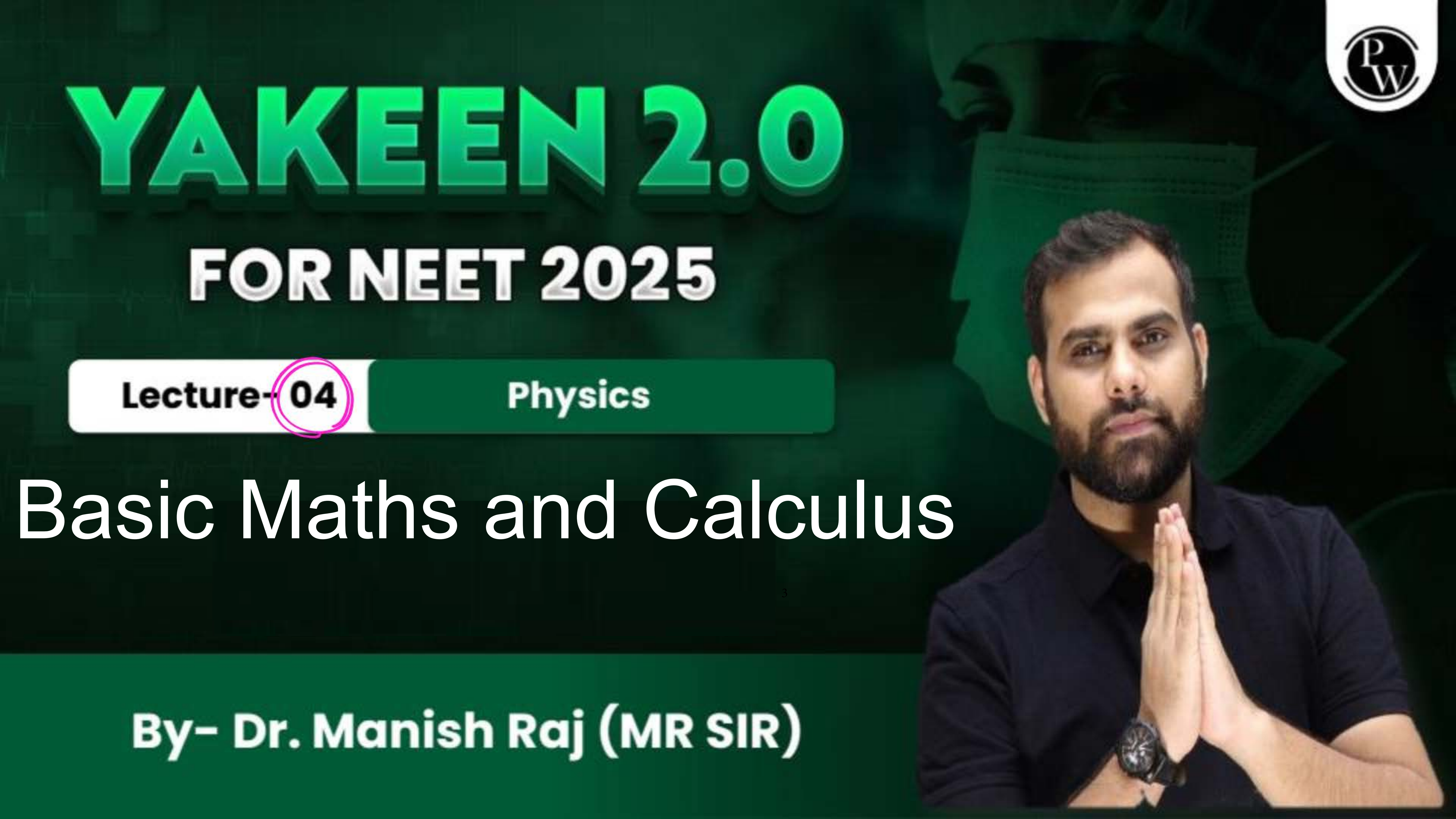
H/W

QUESTION

Find value of $\sin(180^\circ)\cos(135^\circ)\tan(120^\circ)$

H/W


THANK YOU



Basic Maths and Calculus

Topics to be covered

1. Value of Trigonometric Ratio at diff^n angle
2. gmp. formula of Trigonometr
3. function change
4. Phasor diagram

feel के साथ

Phasor diagram → Vector → 20%, SHM → 20%, Sound wave → 20%, A/C → 70%, EM wave → 20%, wave optics → 20%

excess comment ∝ 1 / selection.

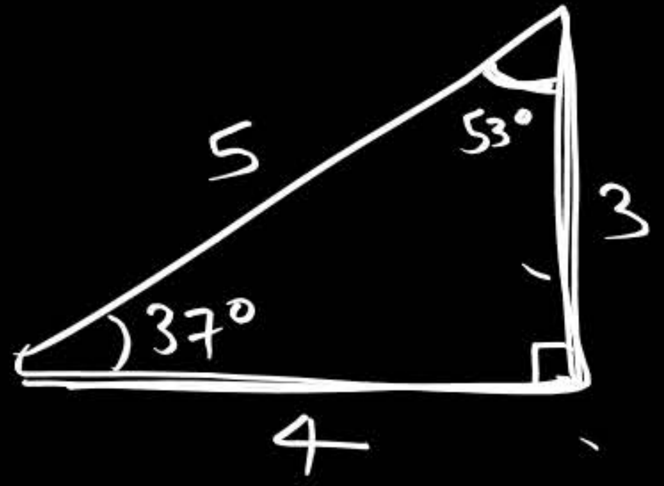
Section (marks) ∝ 1 / (excess comment)

Newtons



$$\frac{1}{2} = 0.5$$

$$\frac{1}{\sqrt{2}} = \frac{1}{1.41} = 0.7$$



$$\tan 53^\circ = \frac{4}{3}$$

$$\tan 37^\circ = \frac{3}{4}$$

−45° +45°
−30° +30°

Angle →	0°	30°	37°	45°	53°	60°	90°	120°	127°	135°	143°	150°	180
$\sin\theta$	0	$\frac{1}{2}$	$\frac{3}{5}$	$\frac{1}{\sqrt{2}}$	$\frac{4}{5}$	$\frac{\sqrt{3}}{2}$	1	$\frac{\sqrt{3}}{2}$	$\frac{4}{5}$	$\frac{1}{\sqrt{2}}$	$\frac{3}{5}$	$\frac{1}{2}$	0
$\cos\theta$	1	$\frac{\sqrt{3}}{2}$	$\frac{4}{5}$	$\frac{1}{\sqrt{2}}$	$\frac{3}{5}$	$\frac{1}{2}$	0	$-\frac{1}{2}$	$-\frac{3}{5}$	$-\frac{1}{\sqrt{2}}$	$-\frac{4}{5}$	$-\frac{\sqrt{3}}{2}$	−1
$\tan\theta = \frac{\sin\theta}{\cos\theta}$	0	$\frac{1}{\sqrt{3}}$	$\frac{3}{4}$	1	$\frac{4}{3}$	$\sqrt{3}$	∞	$-\sqrt{3}$	$-\frac{4}{3}$	−1	$-\frac{3}{4}$	$-\frac{1}{\sqrt{3}}$	0

MR* ↓ ↓

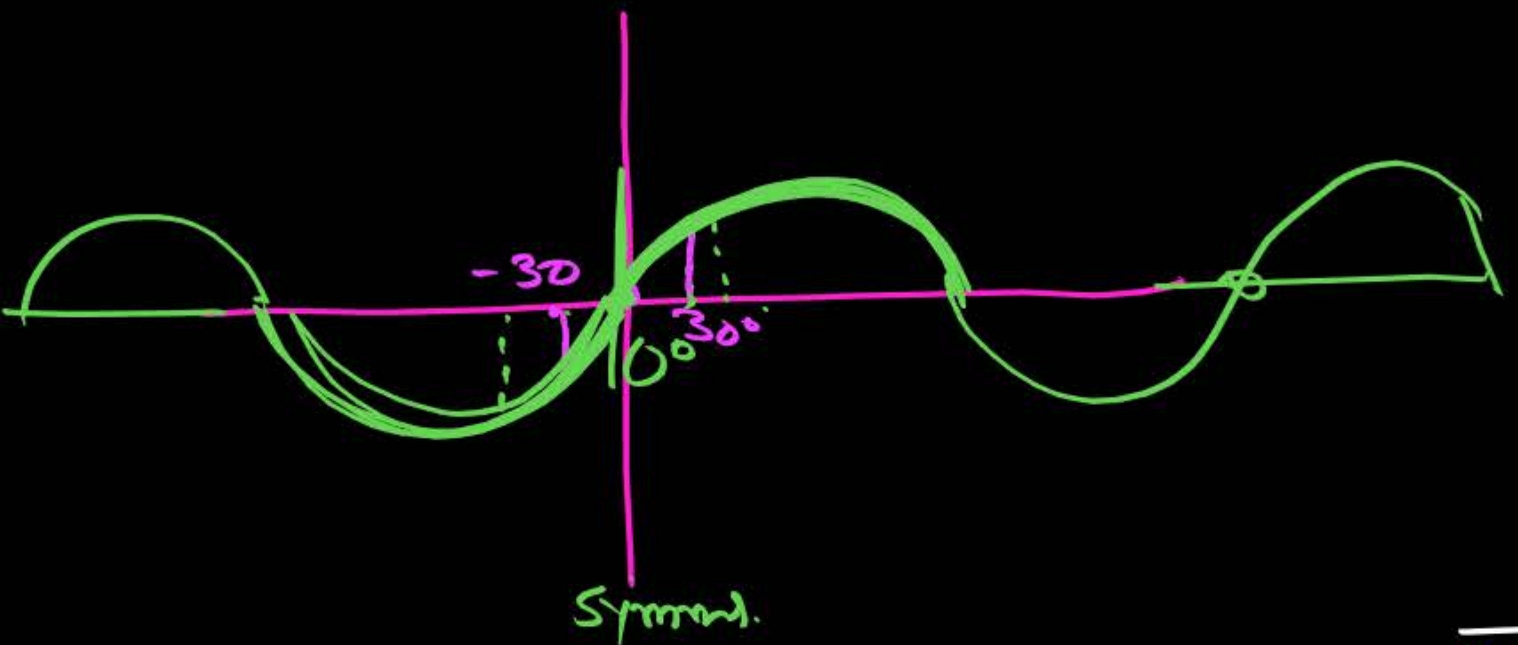
$\alpha + \theta = 180^\circ$

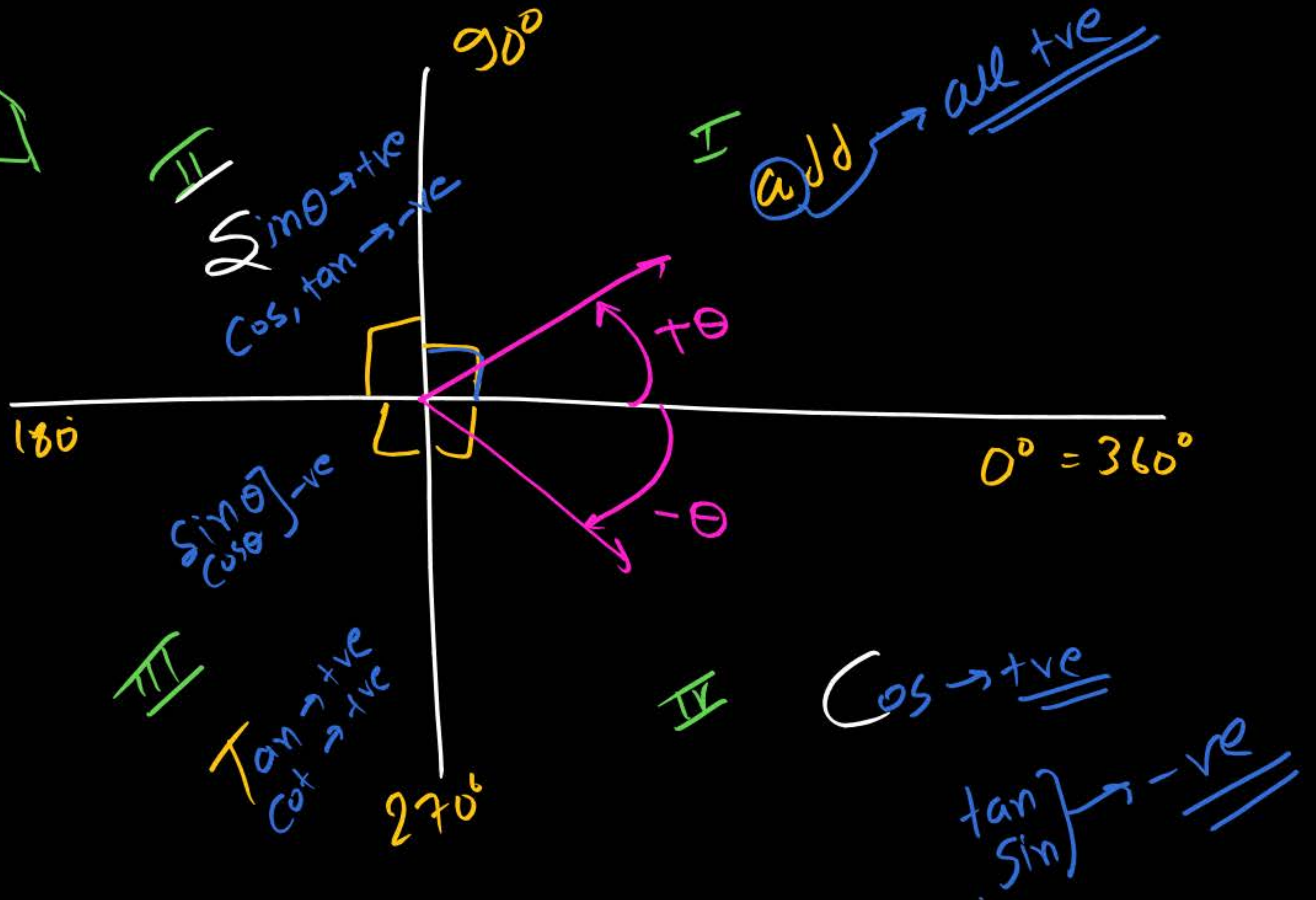
$30^\circ + 150^\circ = 180^\circ$ $\quad$ $135 + 45^\circ = 180^\circ$

$60^\circ + 120^\circ = 180^\circ$

Angle (θ) ↑ from 0° to 90° ⟶ $\sin\theta$ ↑ $\quad \cos\theta$ ↓

$\tan\theta$ ↑





* $\sin(-\theta) = -\sin\theta$

* $\sin(-30^\circ) = -\frac{1}{2}$

* $\cos(-60^\circ) = \frac{1}{2}$

$\sin(120^\circ) = \sin(60^\circ) = \frac{\sqrt{3}}{2}$

$\sin(135^\circ) = \sin 45^\circ = \frac{1}{\sqrt{2}}$

$\sin(-30^\circ) = -\frac{1}{2}$

$\cos(60^\circ) = \frac{1}{2}$

* $\sin(150^\circ) = \sin 30^\circ = \frac{1}{2}$

* $\tan(135^\circ) = -1$

$\cos(150^\circ) = -\frac{\sqrt{3}}{2}$

$\sec(120^\circ) = \frac{1}{\cos(120^\circ)} = \frac{1}{-\frac{1}{2}} = -2$

* $\tan(143^\circ) = -\left(\frac{3}{4}\right)$

* $\sin(127^\circ) = \sin 53^\circ = \frac{4}{5}$

$\sec\theta = \frac{1}{\cos\theta}$

$\cos(150^\circ) = -\frac{\sqrt{3}}{2}$

* $\tan(127^\circ) = -\frac{4}{3}$

QUESTION

Suggest suitable match between function given in the first column and its description given in the second column.

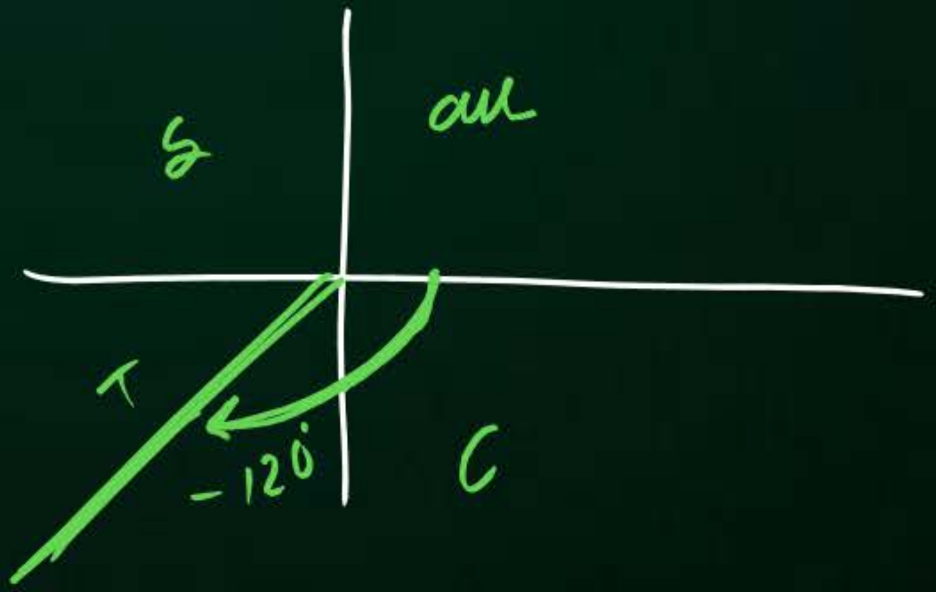
Column-I	Column-II
(A) sin (390°)	(P) Positive
(B) sin (–30°)	(Q) Negative
(C) cos 120°	(R) Zero
(D) tan (–120°)	(S) Modulus is greater than one
	(T) Modulus is less than one

A A→PT, B→QT, C→QT, D→PS

B A→PT, B→QS, C→QT, D→PS

C A→QT, B→QS, C→PT, D→PS

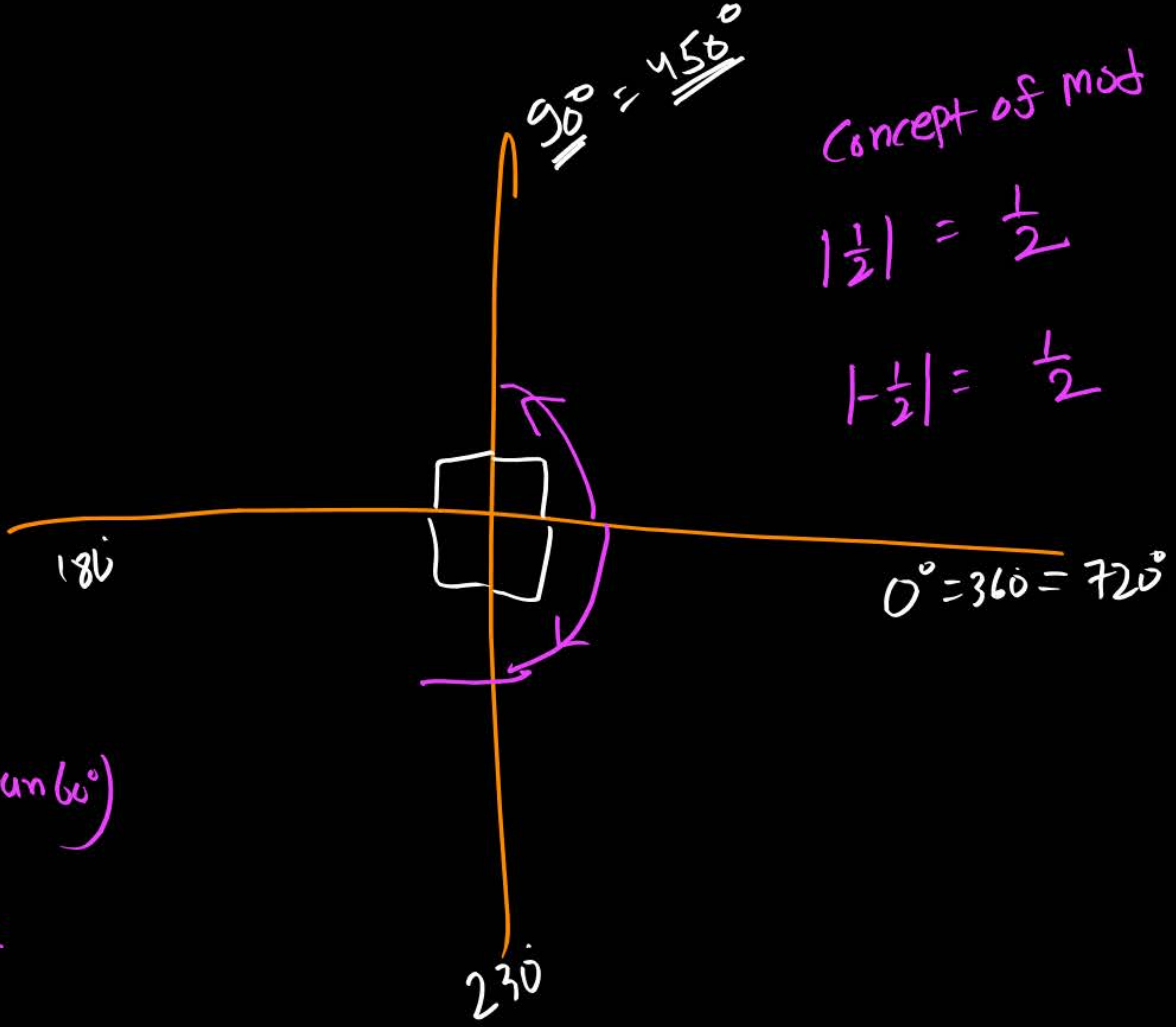
D A→QS, B→PT, C→QT, D→PS



Concept of mod

$\left|\frac{1}{2}\right| = \frac{1}{2}$

$\left|-\frac{1}{2}\right| = \frac{1}{2}$



$\tan(-120°) = +ve\ (\tan 60°)$

$= +\sqrt{3}$

3rd Quadrant ↑

QUESTION

If angle increases from 0° to 90°, then value $\sin\theta$ and $\cos\theta$

A. Increases, decreases (Ans)

B. decreases, Increases

C. both decrease

D. both Increase

QUESTION

Find value of $\sin(53°) \times \text{cosec}(53°) = 1$

$\sin(53°) \times \frac{1}{\sin(53°)} = 1$

$\cos\theta \cdot \sec\theta = 1$

$\sin\theta \cdot \text{cosec}\,\theta = 1$

QUESTION

Find value of $\sin(180°) \cdot \cos(135°) \cdot \tan(120°)$

$0 \text{ (zero)} \cdot \left(-\frac{1}{\sqrt{2}}\right) \cdot -\sqrt{3} = 0$

$60° + 120° = 180$

$30° + 150° \rightarrow 180°$

$45° + 135° \rightarrow 180°$

QUESTION

If $\left[y = \dfrac{\sin\theta}{\theta}\right]$ then find value of y if $\theta = 30°$.

Sol^n

$$y = \frac{\sin(\theta)}{\theta} \leftarrow \text{SI unit rad.}$$

$$y_{\theta=30°} = \frac{\sin 30°}{30°} = \frac{1}{60} \quad \times$$

$$y = \frac{\sin 30°}{(\pi/6)} = \frac{1}{2 \cdot \frac{\pi}{6}} = \frac{3}{\pi}$$

Ans

QUESTION

Find value of $\sin^2(40°) + \cos^2(40°) = 1$

$\sin^2\theta + \cos^2\theta = 1$

SMALL ANGLE APPROXIMATION

MR Rafta

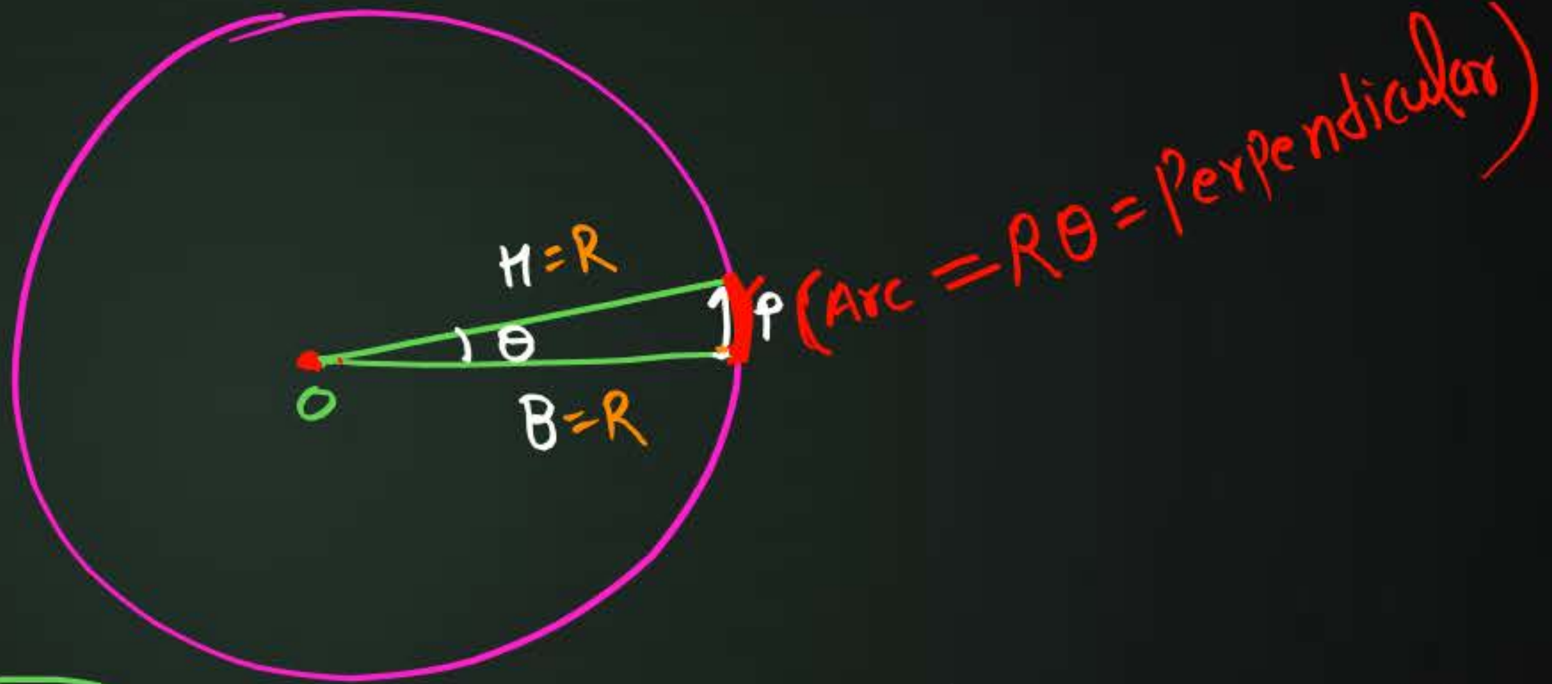
$\sin\theta = \frac{P}{H} = \frac{R\theta}{R} = \theta$ ← SI unit rad

↑ for small angle

Ex $\sin 2^\circ = 2^\circ$

$= 2\left(\frac{\pi \text{ rad}}{180}\right)$

$= \left(\frac{\pi}{90}\right) \text{rad} \simeq 0.034$



MR Rafta

$\cos\theta = \frac{B}{H} = 1$

$\theta \to$ small

Ex $\cos 1^\circ = 1$

$\cos 3^\circ = 1$

$\cos (4^\circ) = 1$

$B \simeq H$ ($P \simeq$ very small)

$\Rightarrow$ for small angle ($\theta \lesssim 7^\circ$)

$$\sin 5^\circ = \boxed{5^\circ} = 5\left(\frac{\pi \text{ rad}}{180}\right) = 0.0872$$ ✱✱

(small) — Practical unit → $\frac{\pi}{36}$

#

$$\tan\theta = \frac{\sin\theta}{\cos\theta} = \frac{\theta}{1} = \theta$$

$\theta \to$ small

→ hence $\sin\theta = \tan\theta$ for small angle

$$\theta \to 0^\circ \ (\text{small}) \quad \frac{\sin\theta}{\theta} = 1$$

QUESTION

SI unit

Find value :

(i) $\sin 2^\circ = 2^\circ = \left[2 \times \frac{\pi}{180}\right] = \frac{\pi}{90}$

(ii) $\tan 3^\circ = 3^\circ = 3 \times \frac{\pi}{180} = \frac{\pi}{60}$ ✓

(iii) $\cos 3^\circ = 1$

(iv) $\sin (88.5^\circ) \simeq \sin 90^\circ \simeq 1$

Aiims

[redacted]

QUESTION

Which of the following option is correct for the value of tan (2°)

(A) 2°

(B) π/90

(C) π/30

(D) 2 rad

$\tan 2^\circ = 2^\circ = 2 \times \frac{\pi \text{ rad}}{180}$

90

$\tan\theta = \theta$ ← must be in rad.

unit → degree, rad

QUESTION

Two diff^n angle

Find value

(i) $\sin(A + B) = \sin A \cdot \cos B + \cos A \sin B$

(ii) $\sin(A - B) = \sin A \cdot \cos B - \cos A \cdot \sin B$

(iii) $\cos(A + B) = \cos A \cdot \cos B - \sin A \cdot \sin B$

(iv) $\cos(A - B) = \cos A \cdot \cos B + \sin A \cdot \sin B$

(v) $\tan(A + B) = \dfrac{\tan A + \tan B}{1 - \tan A \cdot \tan B}$

Ex- $\sin(120^\circ) = \sin(90 + 30)$

$= \sin 90^\circ \times \cos 30^\circ + \cos 90^\circ \cdot \sin 30^\circ$

$= 1 \times \frac{\sqrt{3}}{2} + 0 \times \frac{1}{2} = \frac{\sqrt{3}}{2}$

$\cos(150^\circ) = \cos(90 + 60^\circ)$

$= \cos 90^\circ \cos 60^\circ - \sin 90^\circ \sin 60^\circ$

$= 0 - 1 \times \frac{\sqrt{3}}{2} = -\frac{\sqrt{3}}{2}$

QUESTION

[redacted]

$$\sin(A+B) = \sin A \cdot \cos B + \cos A \cdot \sin B$$

If $A = B = \theta$ *

$$\sin(2\theta) = \sin\theta \cdot \cos\theta + \cos\theta \cdot \sin\theta$$

MR Ref *

$$\sin(2\theta) = 2\sin\theta \cdot \cos\theta$$

half angle

$2\theta = \alpha$ (let)

$$\sin\alpha = 2\sin\left(\frac{\alpha}{2}\right) \cdot \cos\left(\frac{\alpha}{2}\right)$$

$$\cos(A+B) = \cos A \cdot \cos B - \sin A \cdot \sin B$$

If $A = B = \theta$

MR Ref

$$\cos(2\theta) = \cos^2\theta - \sin^2\theta$$

Let $2\theta = \alpha$

$$\cos(\alpha) = \cos^2\left(\frac{\alpha}{2}\right) - \sin^2\left(\frac{\alpha}{2}\right)$$

→ half angle

mR Ratta

$$\cos(2\theta) = \cos^2\theta - \sin^2\theta$$

$$\cos(2\theta) = \cos^2\theta - [1 - \cos^2\theta]$$

$$\cos 2\theta = \cos^2\theta - 1 + \cos^2\theta$$

$$1 + \cos(2\theta) = 2\cos^2\theta$$

$$\cos^2\theta = \frac{1 + \cos(2\theta)}{2}$$

$$\sin^2\theta + \cos^2\theta = 1$$

$$\sin^2\theta = 1 - \cos^2\theta$$

QUESTION

Find value of

(i) $\sin(75°) = \sin(45° + 30°) = \sin 45° \cdot \cos(30°) + \cos(45°) \cdot \sin(30°)$

$= \frac{1}{\sqrt{2}} \times \frac{\sqrt{3}}{2} + \frac{1}{\sqrt{2}} \times \frac{1}{2} = \left(\frac{\sqrt{3}+1}{2\sqrt{2}}\right)$

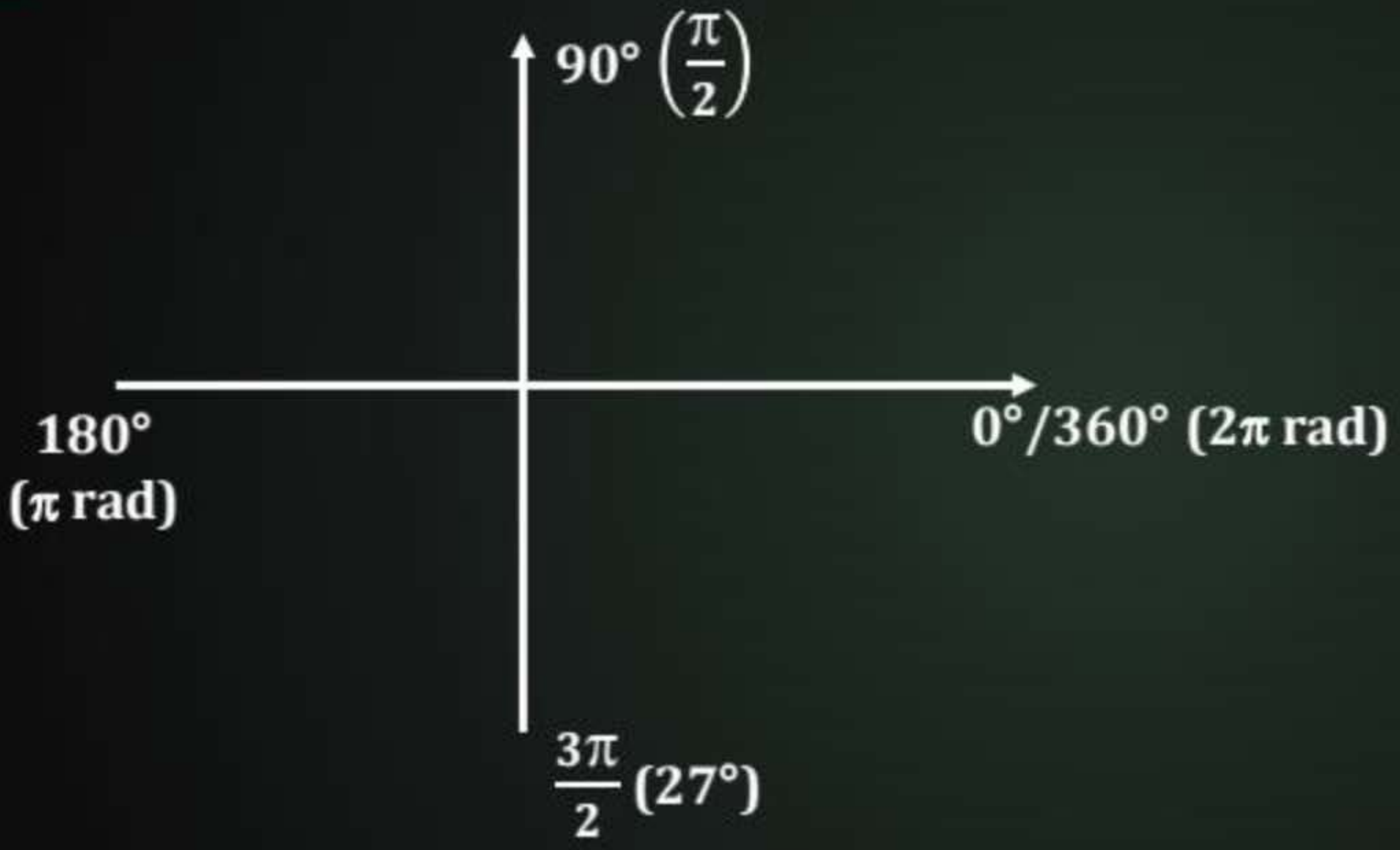
(ii) $\sin(105°) = \frac{\sqrt{3}+1}{2\sqrt{2}}$

(iii) $\cos(120°) = -\left(\frac{1}{2}\right)$

$\sin(105°) = \frac{\sqrt{3}+1}{2\sqrt{2}}$

$(105° + 75) = 180$

TRIGONOMETRY FUNCTION CHARGE



$\sin(90° - \theta) =$

$\cos(90° - \theta) =$

$\sin(90° + \theta) =$

$\cos(90° + \theta) =$

$\sin(180° - \theta) =$

$\cos(180° - \theta) =$

$\sin(90 - \theta) =$

$\cos(90 - \theta) =$

$\sin(90 + \theta) =$

$\cos(90 + \theta) =$

$\sin(180 - \theta) =$

$\cos(180 - \theta) =$

QUESTION

Find value of

(i) $\sin(-30^\circ)$

(ii) $\cos(-60^\circ)$

(iii) $\sin(120^\circ)$

(iv) $\sin(390^\circ)$

[redacted]

$\sin(360°) =$

$\sin(450°) =$

$\sin(-90°) =$

$\sin(120°) =$

$\sin(-150°) =$

$\cos(300°) =$

$\cos(330°) =$

$\tan(240°) =$

$\cos(-30°) =$

$\tan(-60°) =$

$\cot(-45°) =$

$\sin\theta_{max} = 1$
at $\theta = 90^\circ$

$\sin\theta_{min} = -1$
$\theta = 270^\circ$

Range of $\sin\theta$

$-1 \leq \sin\theta \leq +1$

\# $\cos\theta_{max} = +1$
at $\theta = 0^\circ$

\# $\cos\theta_{min} = -1$
at $\theta = 180^\circ$

Range of $\cos\theta$

$-1 \leq \cos\theta \leq +1$

$y = 4\sin\theta$ then max^m value of y"

$y_{max} = 4(\sin\theta)_{max} = 4$ (with $(\sin\theta)_{max} = 1$)

at $\theta = 90^\circ$

$y = 4\sin(2\theta)$.

find max^m value of y and also find Angle at which y will be max^m.

$y = 4\,[\sin(2\theta)]_{max}$ → 1

$$\boxed{y_{max} = 4}$$

$2\theta = 90^\circ$

$$\boxed{\theta = 45^\circ}$$

Ans

QUESTION

If $y = 3\cos(3\theta)$, then find angle at which y will be zero.

Sol^n

$$y = 3[\cos(3\theta)] \to 0$$

$$3\theta = 90^\circ$$

$$\theta = \frac{90}{3} = 30^\circ$$

QUESTION

If $y = A\sin\theta + B\cos\theta$ then find maximum value of y.

Sol^n $y = A\sin\theta + B\cos\theta$

$$y_{max} = +\sqrt{A^2+B^2}$$

Rememb it

$$y_{min} = -\sqrt{A^2+B^2}$$

Ex $y = 3\sin\theta + 4\cos\theta$

$$y_{max} = +\sqrt{3^2+4^2}$$

$$= \sqrt{9+16} = \sqrt{25}$$

$$= +5$$

$y = A\sin\theta + B\sin\theta$

$$y_{max} = (A+B)$$

QUESTION

If $y = 3\cos\theta + 4\cos\theta$ then find maximum value of y.

$y_{max} = (3+4)\cos\theta_{max}$

$y_{max} = 7$

$y_{min} = -7$

Trigonometric Function	Maximum / Minimum Value
$Y = 3\sin(2\theta)$	$Y_{max} = 3$ $\quad Y_{min} = -3$
$Y = 3\sin\theta + 4\cos\theta$	$Y_{max} = 5$ $\quad Y_{min} = -5$
$Y = 5\cos\theta + 4\cos\theta$	$Y_{max} = 9$ $\quad Y_{min} = -9$
$Y = 5 - 3\sin(2\theta)$	$Y_{min} = 5 - 3\sin(2\theta)$, max $= 1$

$Y_{min} = 2$

$Y = 5 - 3\,(\sin(2\theta))$, min $= -1$

$Y_{max} = 5 + 3 = 8$

Ex $\quad Y = 2 + \sin\theta$

$Y_{max} = 3$

$Y_{min} = 1$

Phase difference → diff^n in Angle b/w two same Tringonometric function is called phase diff^n.

$A = \sin(\theta)$

$B = \sin(\alpha)$

Phase diff^n $= \theta - \alpha$

QUESTION

Phase difference → difference in angle between two same trigonometric function. Find phase difference between A & B.

is called phase diffⁿ.

(i) $A = 4\sin(\theta + \pi/4)$ → [redacted] $B = 3\sin(\theta - \pi/4)$ ⟹ $\phi = \theta + \frac{\pi}{4} - \theta + \frac{\pi}{4}$

$\phi = \frac{\pi}{4} + \frac{\pi}{4}$

$= \frac{\pi}{2}$

(ii) $A = 4\sin(\theta + \pi/3)$ $B = 3\sin(\theta + \pi/6)$

(iii) $A = 3\cos(\omega t + \pi/2)$ $B = 3\sin(\omega t)$

(iv) $A = 3\sin(\omega t)$ $B = 3\cos(\omega t - \pi/2)$

→ This is not a H/W
We will discuss in
next class.

→ $\phi = \theta + \frac{\pi}{3} - \theta - \frac{\pi}{6}$

$= \frac{\pi}{3} - \frac{\pi}{6}$

$= \frac{2\pi - \pi}{6} = \frac{\pi}{6}$


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 5 | Physics

Basic Maths and Calculus

By- Dr. Manish Raj (MR SIR)



Topics to be covered

1. Function change
2. Phase diagram
3. A/P G/P series
4. straight line graph



Function change

$\sin(90^\circ + \theta) =$

$\sin(90 - \theta) =$

$\cos(180 + \theta) =$

$\cos(90 - \theta) =$

$\cos(90 + \theta) =$

$\tan(90 + \theta) =$

$\sin(270 + \theta) = ??$

$\cos(270 - \theta)$

How To do it ??



ACST

Prob^{m} hai isme ??

(a) Yes ✓ 72%

(b) NO ✓ 27%

$$\sin(A+B) = \sin A \cdot \cos B + \cos A \cdot \sin B$$

$$\cos(A+B) = \cos A \cdot \cos B - \sin A \cdot \sin B$$

Function change

$\sin(90^\circ+\theta) = \sin 90^\circ \cdot \cos\theta + \cos 90^\circ \cdot \sin\theta = \cos\theta$

A ↑, B ↑

Ex: $\sin(90^\circ+30^\circ) = \cos 30^\circ$

$\sin(90-\theta) = \sin 90^\circ \cdot \cos\theta - \cos 90^\circ \cdot \sin\theta = \cos\theta$

$\sin(90-60^\circ) = \cos 60^\circ$

$\cos(180+\theta) = \cos 180^\circ \cdot \cos\theta - \sin(180^\circ) \cdot \sin(\theta) = -\cos\theta$

$\cos(180+30) = -\cos 30^\circ$

$\cos(210) = -\frac{\sqrt{3}}{2}$

$\cos(90-\theta) = \cos 90^\circ \cos\theta + \sin 90^\circ \sin\theta = \sin\theta$

$\cos(90^\circ+\theta) = \cos 90^\circ \cdot \cos\theta - \sin 90^\circ \sin\theta = -\sin\theta$

$\tan(90+\theta) = \frac{\sin(90+\theta)}{\cos(90+\theta)} = \frac{\cos\theta}{-\sin\theta} = -\cot\theta$ ✓

$$\# \begin{cases} \sin(180+\theta) = \sin 180^\circ \cdot \cos\theta + \cos 180^\circ \cdot \sin\theta = -\sin\theta \\ \sin(180-\theta) = \sin 180^\circ \cos\theta - \cos(180^\circ)\cdot\sin\theta = +\sin\theta \\ \sin(270^\circ+\theta) = \sin 270^\circ \cos\theta + \cos(270^\circ)\cdot\sin\theta = -\cos\theta \end{cases}$$

(In the first two lines $\sin 180^\circ$ is struck through and marked 0; in the third line $\cos(270^\circ)$ is struck through and marked 0. The result $-\cos\theta$ is underlined and marked ✗.)

$\cos 180^\circ = -1$

$\sin 180^\circ = 0$

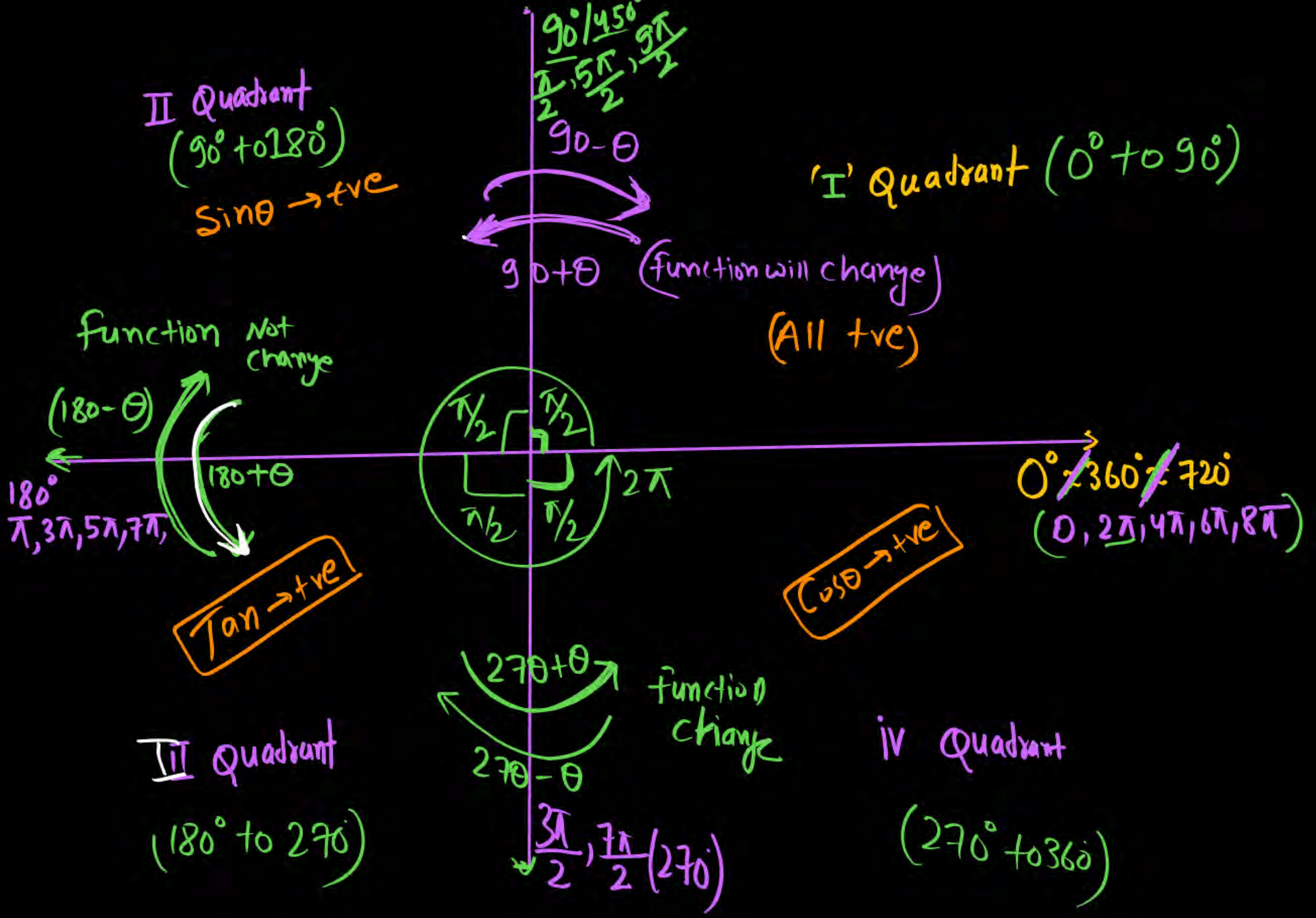
$\cos(270^\circ) = 0$

$$\left.\begin{aligned} \sin(270^\circ-\theta) &= \\ \cos(270^\circ+\theta) &= \end{aligned}\right\} \text{H/W}$$

$\sin(360^\circ+\theta) = \sin(0^\circ+\theta) = \sin\theta$ ✓

$\sin(360^\circ-\theta) = \sin(0-\theta) = \sin(-\theta)$

$\cos(360^\circ+\theta) = \cos\theta$



$\sin 0° = \sin 360° = 0$

$\sin\theta \rightleftarrows \cos\theta$

$\tan\theta \rightleftarrows \cot\theta$

$\sec\theta \rightleftarrows \csc\theta$

Function change

$\sin(90^\circ + \theta) = + \cos\theta$

$\sin(90 - \theta) = + \cos$

\# $\cos(180 + \theta) = - \cos\theta$

\# $\cos(90 - \theta) = + \sin\theta$

\# $\cos(90^\circ + \theta) = - \sin\theta$

\# $\tan(90 + \theta) = - \cot\theta$

Step → 1

→ 1st look it is
$90+\theta$, $90-\theta$, $180+\theta$, $180-\theta$

Step → 2
function is in which quadrant.

#

$$\sin(180+\theta) = -\sin\theta$$

$$\sin(180-\theta) = +\sin\theta$$

$$\sin(270+\theta) = -\cos\theta$$

$$\sin(270-\theta) = -\cos\theta$$

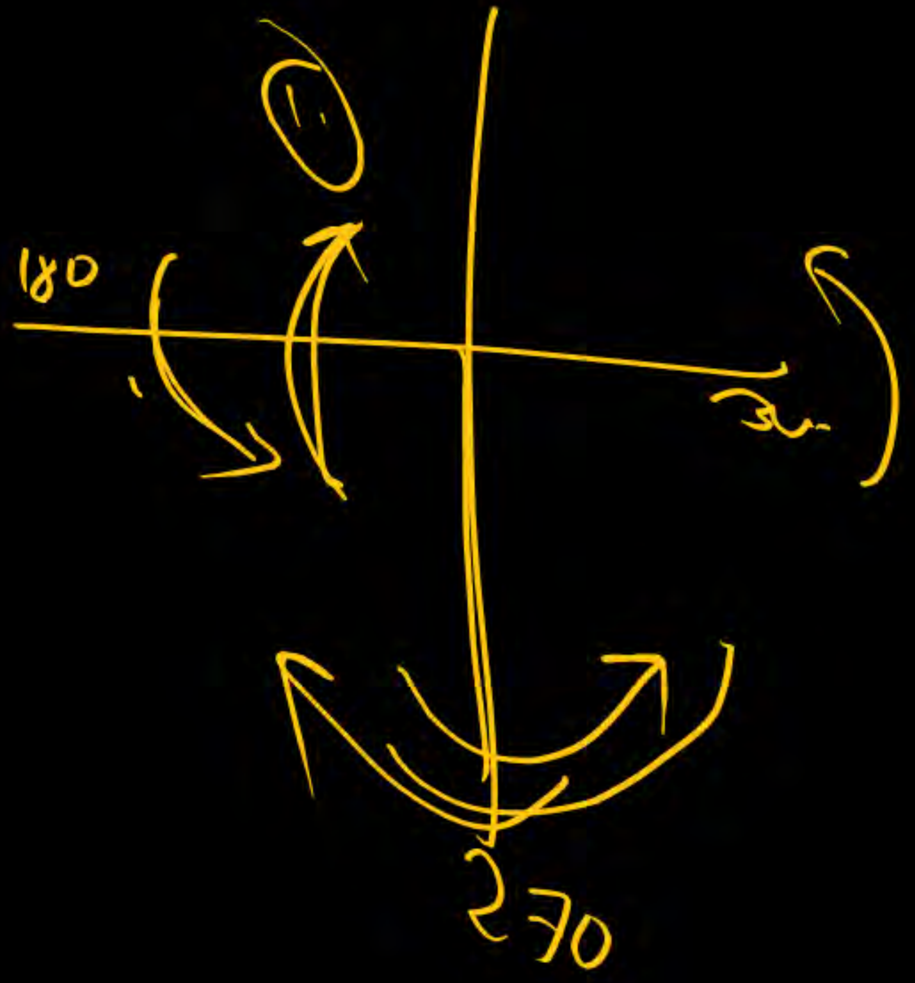
$$\cos(270+\theta) = +\sin\theta$$

**

$$\sin(360+\theta) = +\sin\theta$$

$$\sin(360-\theta) = -\sin\theta$$

$$\cos(360+\theta) = +\cos\theta$$



$\sin(360°) = 0$

$\sin(180) = 0$

$\sin 90 = 1$

$\sin(270) = -1$

$\cos(0°) = 1$

$\cos(180) = -1$

$\cos(90) = 0$

$\cos(270) = 0$

$\sin(450°) = 1 = \sin(360° + 90°) = \sin 90°$

$\sin(-90°) = -\sin 90° = -1$

$\sin(120°) = \sin(90 + 30) = \cos 30° = \frac{\sqrt{3}}{2}$

$\sin(-150°) = -\sin(150°) = -\frac{1}{2}$

$\cos(-\theta) = \cos\theta$

$\tan(-\theta) = -\tan\theta$

$\sin(-\theta) = -\sin\theta$

$\cos(300^\circ) = \cos(270+30) = +\sin 30^\circ = \frac{1}{2}$

$\cos(360-60) = \cos 60^\circ = \frac{1}{2}$

$\cos(-60) = \cos 60^\circ = \frac{1}{2}$

$\cos(330^\circ) = \cos(360^\circ - 30) = \cos(-30) = \cos 30^\circ = \sqrt{3}/2$

\# $\sin(240^\circ) = \sin(180+60) = -\sin 60^\circ = -\frac{\sqrt{3}}{2}$

$\tan(240^\circ) = \tan(180+60) = +\tan 60^\circ = \sqrt{3}$

$\cos(-30^\circ) = \cos 30^\circ = \frac{\sqrt{3}}{2}$

$\tan(-60^\circ) = -\tan 60^\circ = -\sqrt{3}$

$\cot(-45^\circ) = -\tan 45^\circ = -1$



Phasor diagarm →

$$y = A \sin(\omega t + \phi)$$

(labels on the equation: 1 → ϕ, 2 → ωt, 3 → $\sin(\omega t + \phi)$, 4 → $(\omega t + \phi)$)

which term will represent Phase

→ '4' No will represent hase

* ϕ = Initial Phase (when $t=0$)

Phase difference → diffⁿ in Angle b/w Two same trigonometric function.

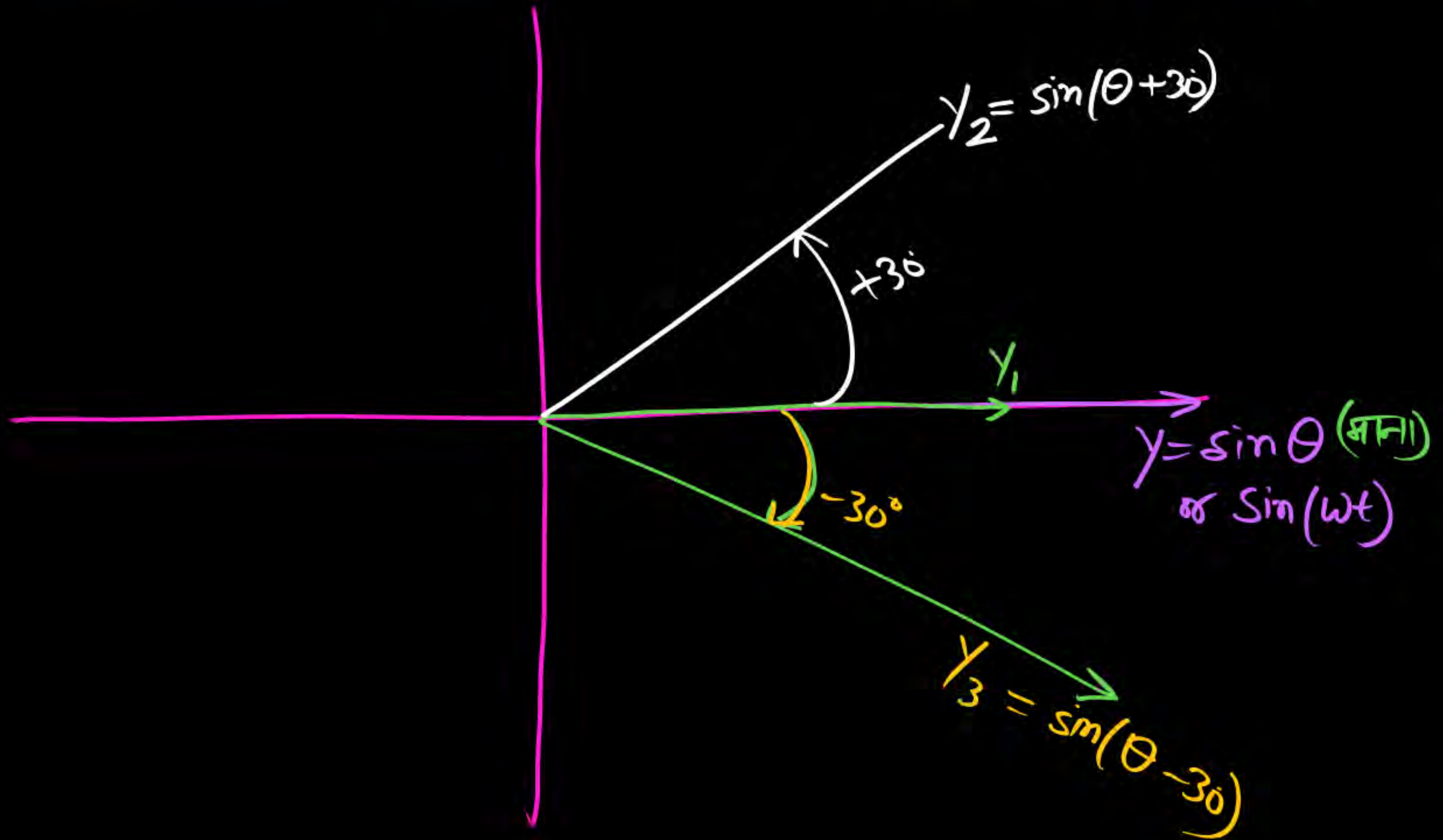
$$A = \sin(\underbrace{\omega t + \phi + \pi/3}_{\theta})$$

$$B = \sin(\underbrace{\omega t + \pi/6}_{\theta})$$

⊛ Phase diffⁿ b/w A & B $= \left(\omega t + \phi + \frac{\pi}{3}\right) - \omega t - \frac{\pi}{6} = \phi + \left(\frac{\pi}{3} - \frac{\pi}{6}\right) = \phi + \frac{2\pi - \pi}{6}$

$$= \left(\phi + \frac{\pi}{6}\right)$$

Phasor diagram → representation of Trigonometric function with Phase *.

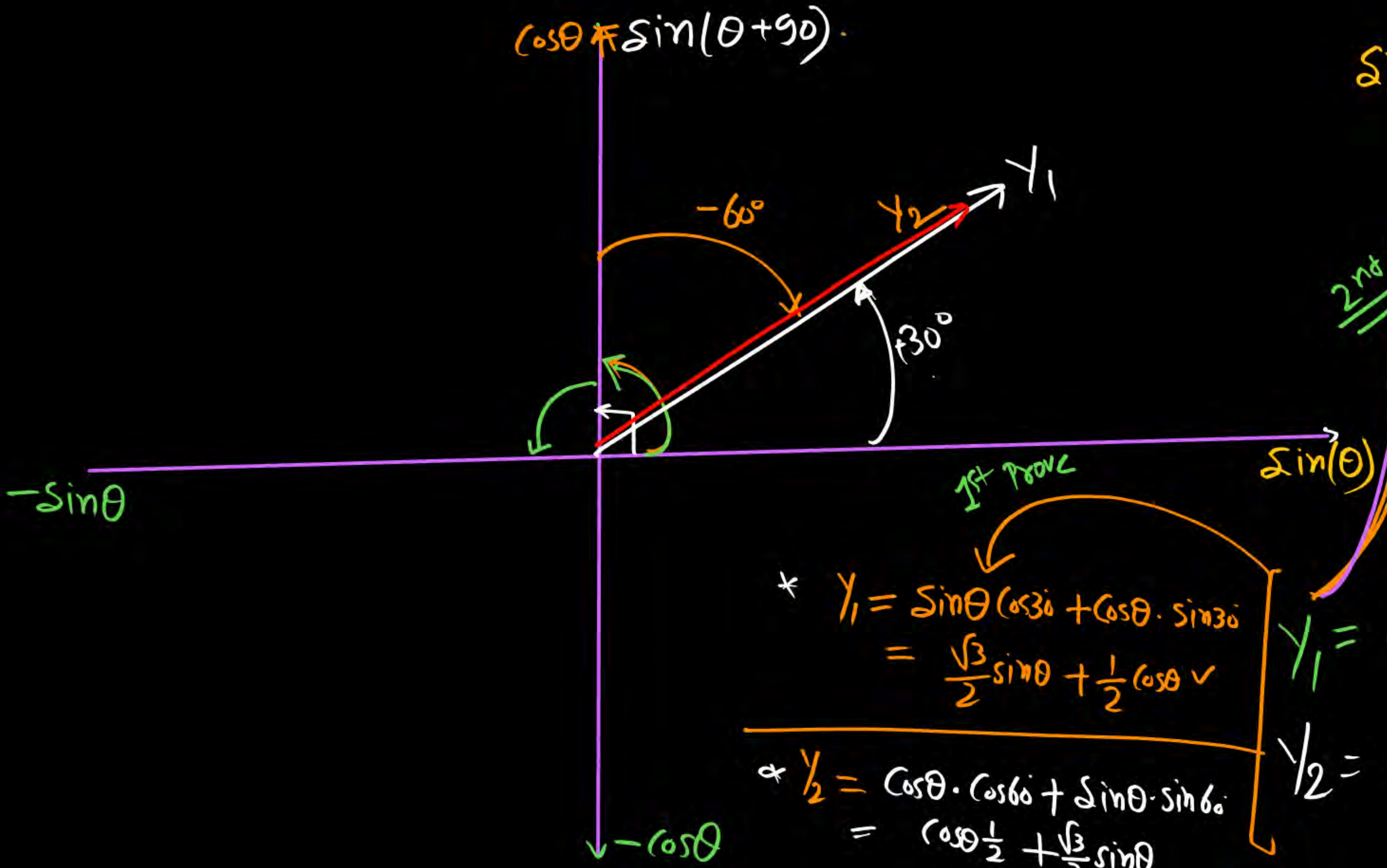


$y = \sin(\theta)$

$y_1 = 4\sin\theta$

$y_2 = \sin(\theta + 30°)$

$y_3 = \sin(\theta - 30°)$



$\sin(\theta + 90^\circ) = \cos\theta$

↑ anti-clock

2nd prove

$Y_1 = \sin(\theta + 90 - 60)$

$= \sin(90 + \theta - 60)$

$= \cos(\theta - 60)$

* $Y_1 = \sin\theta \cos 30^\circ + \cos\theta \cdot \sin 30^\circ$

$= \frac{\sqrt{3}}{2}\sin\theta + \frac{1}{2}\cos\theta$ ✓

* $Y_2 = \cos\theta \cdot \cos 60^\circ + \sin\theta \cdot \sin 60^\circ$

$= \cos\theta \frac{1}{2} + \frac{\sqrt{3}}{2}\sin\theta$

$Y_1 = \sin(\theta + 30^\circ)$

$Y_2 = \cos(\theta - 60^\circ)$

$$Y_1 = \sin(\omega t - 30)$$

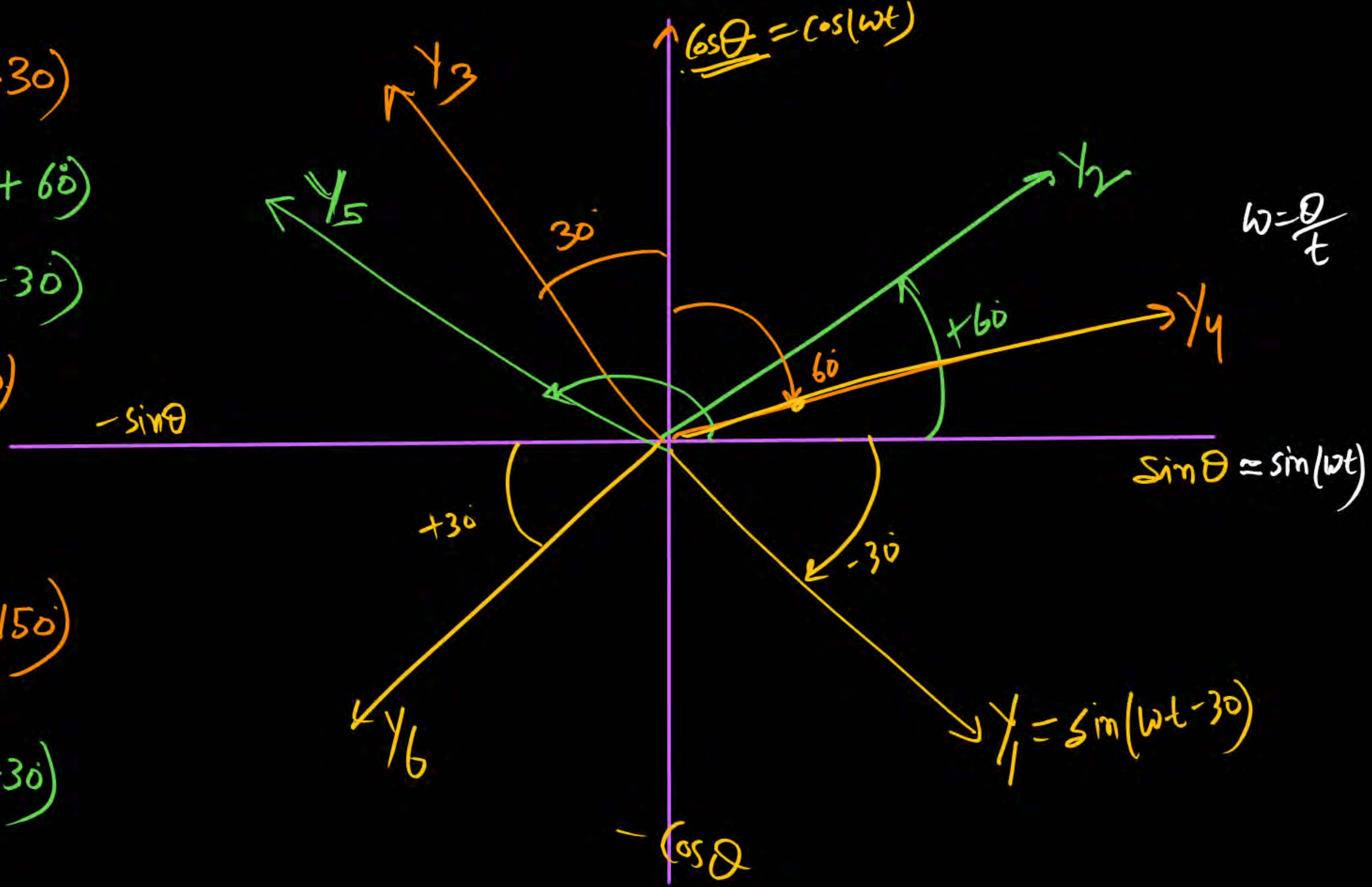
$$Y_2 = \sin(\omega t + 60^\circ)$$

$$Y_3 = \cos(\omega t + 30^\circ)$$

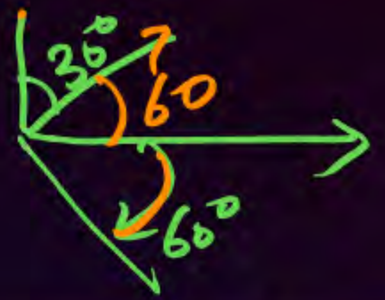
$$Y_4 = \cos(\omega t - 60^\circ)$$

$$Y_5 = \sin(\theta + 150^\circ)$$

$$Y_6 = -\sin(\theta + 30^\circ)$$



vector / S.H.M / wave / wave optics / EM wave / A/C



Equation – 1	Equation – 2	Phase difference	Resultant
$I_1 = I_0 \sin(\theta + \pi/3)$	$I_2 = I_0 \sin(\theta - \pi/6)$	90° ($\frac{\pi}{2}$ rad)	$\sqrt{2} I_0$
$I_1 = I_0 \sin(\theta + \pi/3)$	$I_2 = I_0 \cos(\theta + \pi/3)$	90°	$\sqrt{2} I_0$
$I_1 = 4 \sin(wt)$	$I_2 = 4 \cos(wt + \pi/3)$	$\frac{\pi}{2} + \frac{\pi}{3} = \frac{5\pi}{6}$	(Not required)
$I_1 = 3 \sin(wt + \pi/2)$	$I_2 = 5 \cos(wt)$	0°	8
$I_1 = 4 \cos(wt - \pi/2)$	$I_2 = 4 \sin(wt + \pi/2)$	90°	$4\sqrt{2}$
$I_1 = 3 \sin(wt + \pi/3)$	$I_2 = 3 \cos(wt)$	$\pi/6$	(Not required)
$I_1 = 4 \sin(\theta - 60°)$	$I_2 = 4 \cos(\theta - 30°)$	120° ($\frac{2\pi}{3}$ rad)	4

QUESTION

Equation of a.c. current $I = -I_0 \cos(\omega t)$ and a/c voltage is $V = V_0 \sin(\omega t - \pi/6)$ then find phase difference between current and voltage:

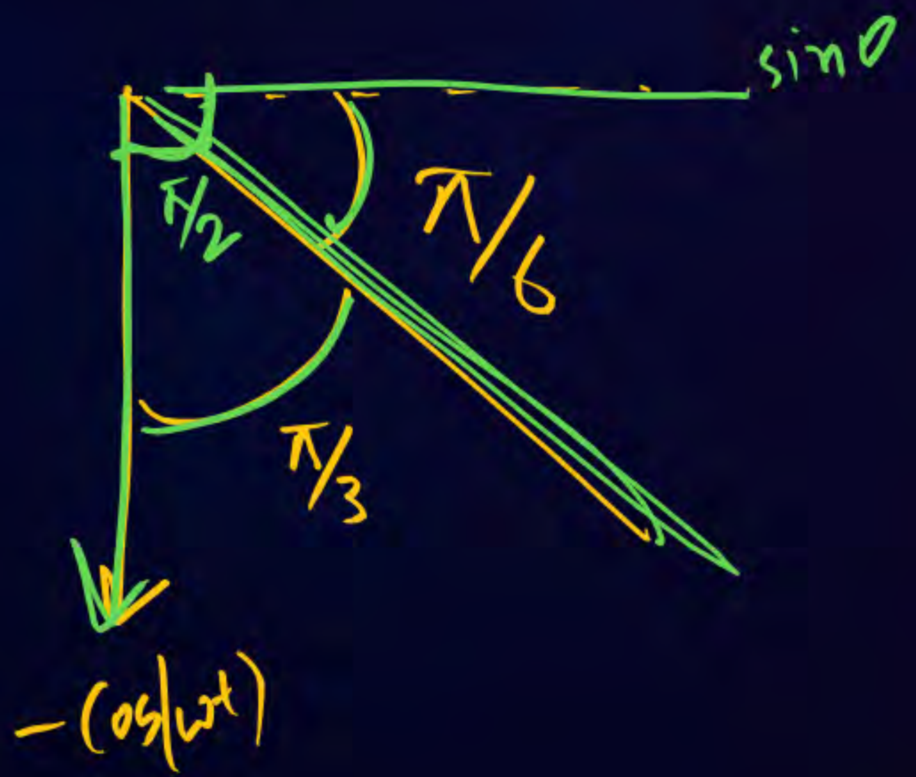
NEET

(A) $\frac{2\pi}{3}$

(B) $\frac{\pi}{3}$

(C) $\frac{\pi}{6}$

(D) $\frac{5\pi}{6}$

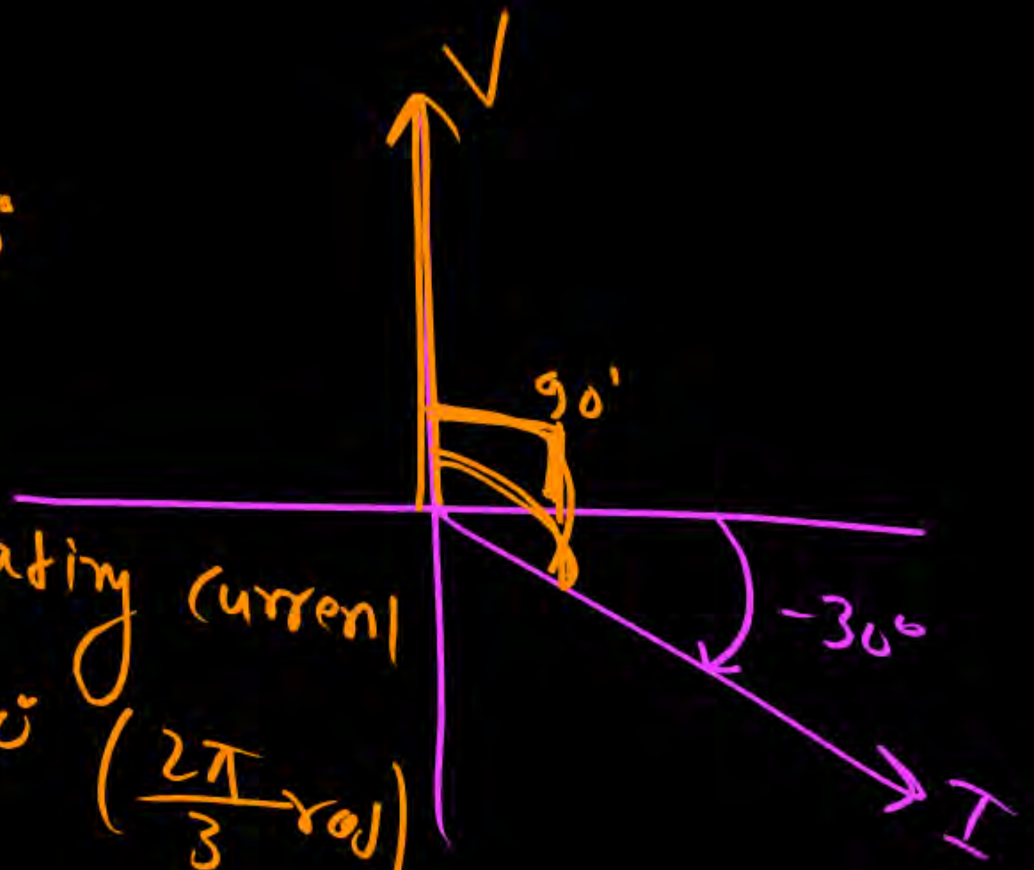


Q) Current in A/C circuits is $I_1 = I_0 \sin(\omega t - 30^\circ)$ and volage across it $V = V_0 \cos(\omega t)$.

find phase diffⁿ

Solⁿ

$\phi = 120^\circ$



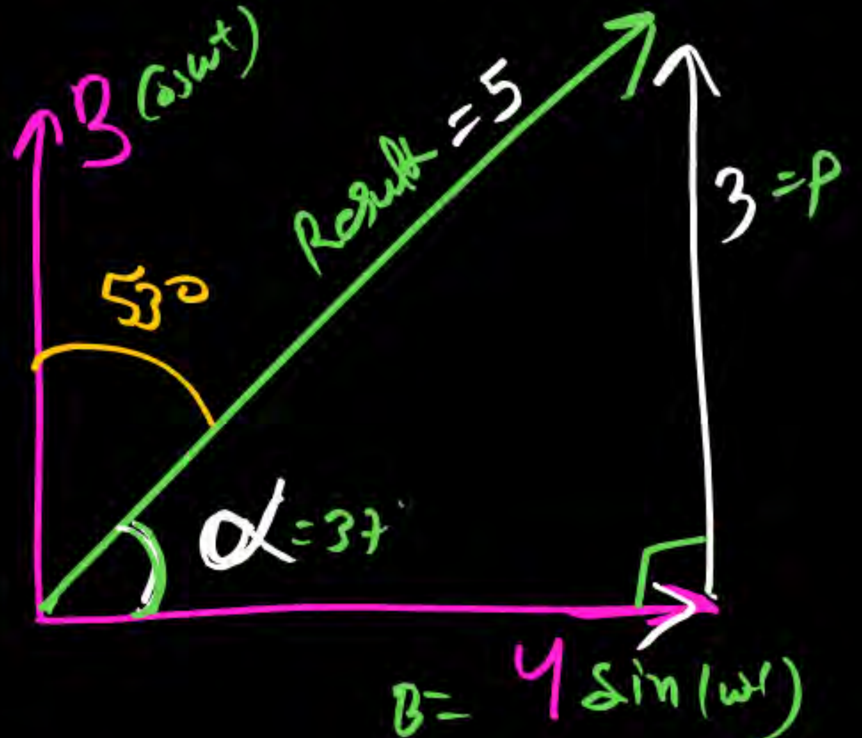
Voltage is leading current by 120° $\left(\frac{2\pi}{3} \text{ rad}\right)$

eq^n of Two osscilating Particle $x_1 = 4\sin(\omega t)$, $x_2 = 3\cos(\omega t)$ find eq^n of Superimposed SHM

Sol^n

$$x = x_1 + x_2$$

$$= 4\sin(\omega t) + 3\cos(\omega t)$$



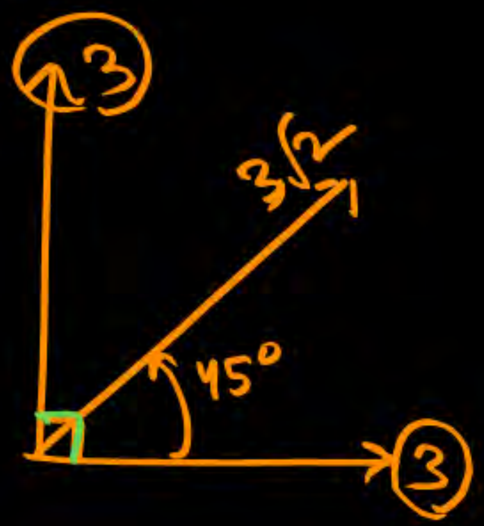
$$\tan\alpha = \frac{P}{B} = \frac{3}{4}$$

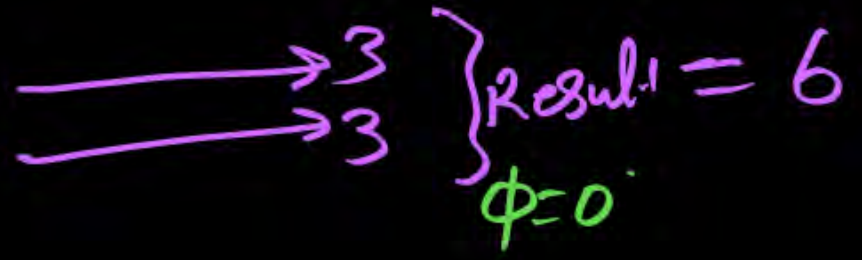
$$\boxed{\alpha = 37°}$$

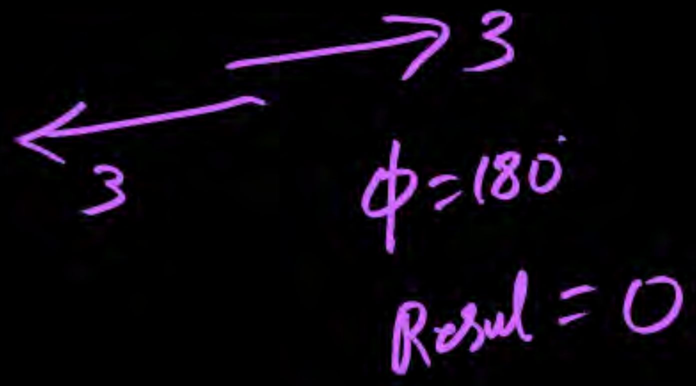
$$x = 5\sin(\omega t + 37°)$$

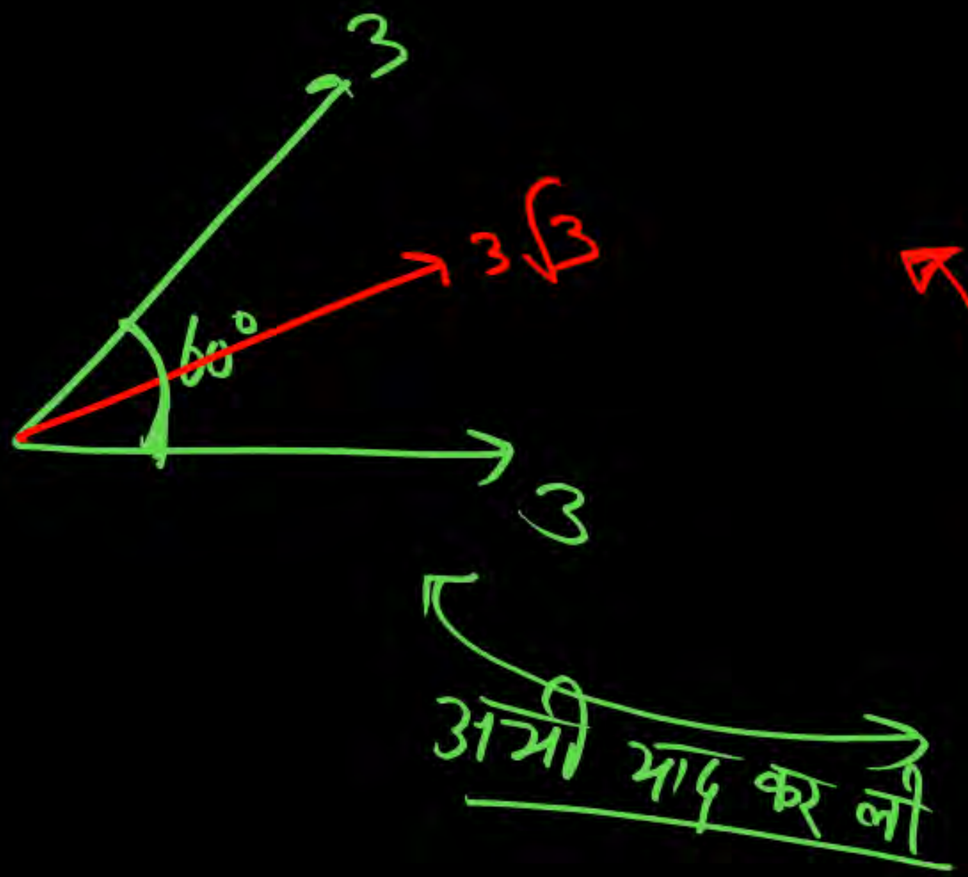
Same

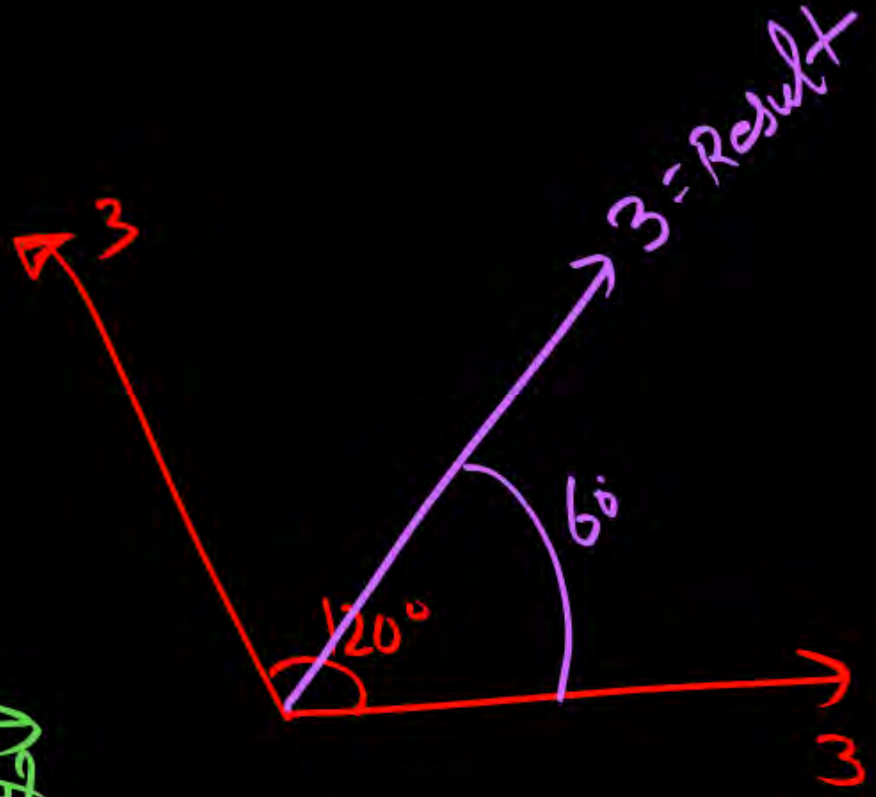
$$x = 5\cos(\omega t - 53°)$$


3
$3\sqrt{2}$
45°
3


3
3
Result = 6
$\phi = 0°$


3
3
$\phi = 180°$
Resul = 0


3
$3\sqrt{3}$
60°
3
अभी याद कर लो

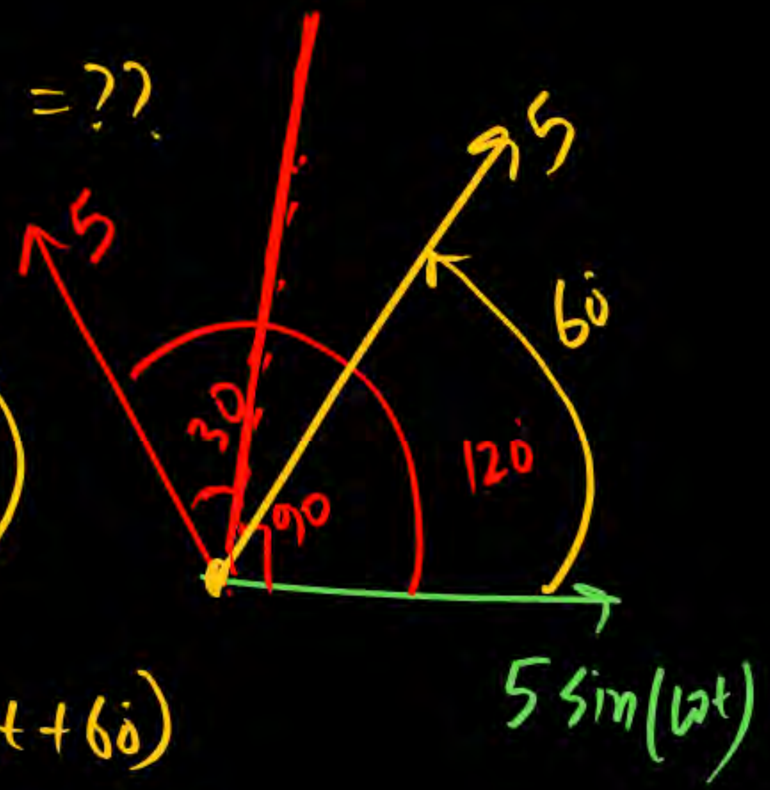

3
3 = Result
60°
120°
3

JEE main

A/c current $I_1 = 5\sin(\omega t)$

$I_2 = 5\cos(\omega t + 30^\circ)$

find $I_1 + I_2 = ??$



$I_{net} = 5$

$I_1 + I_2 = 5\sin(\omega t + 60^\circ)$

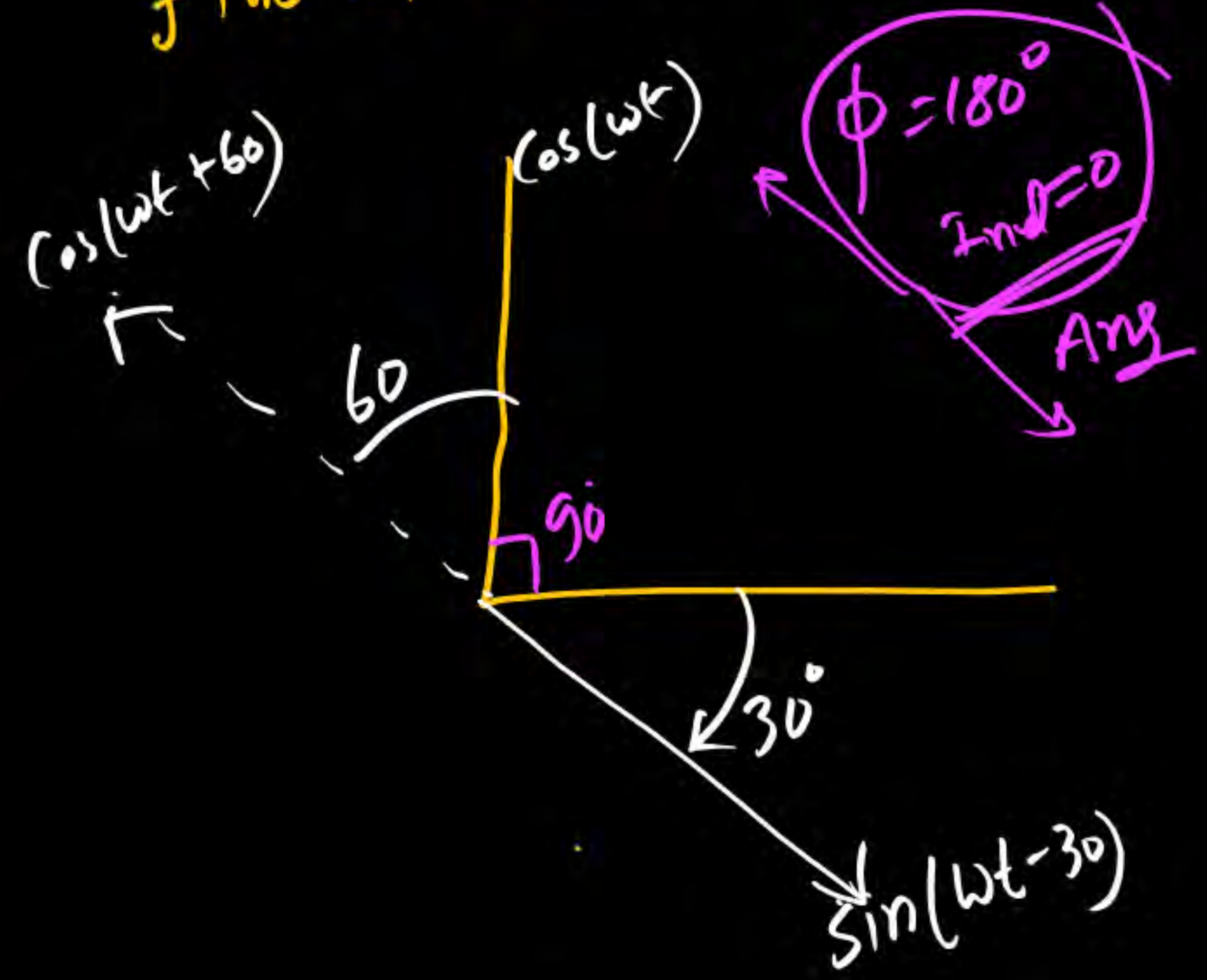
(Ans)

A/C current

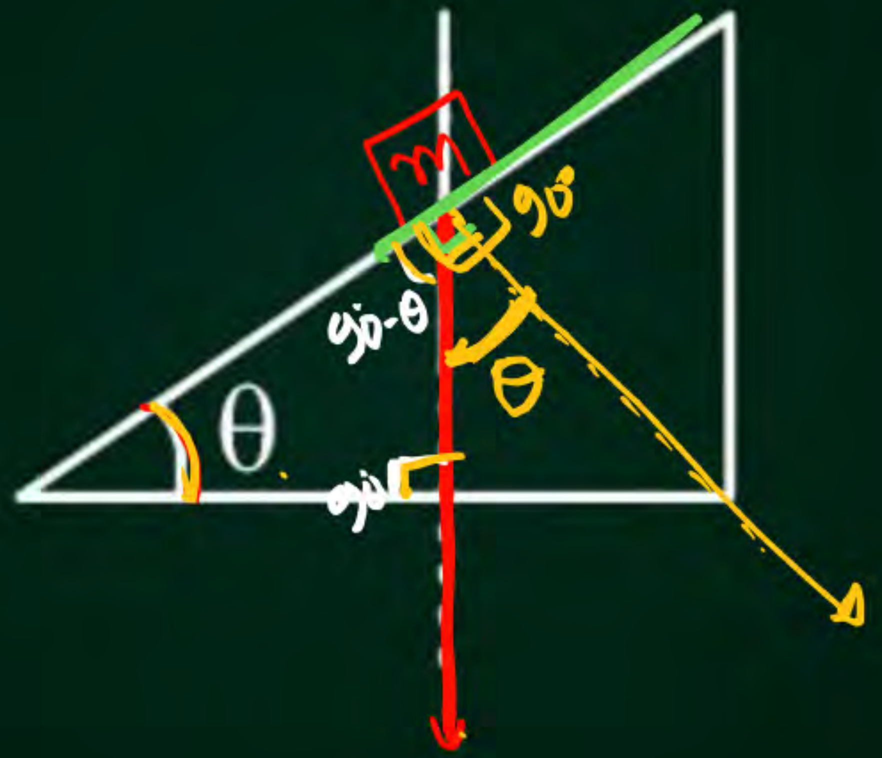
$I_1 = 4\sin(\omega t - 30)$

$I_2 = 4\cos(\omega t + 60^\circ)$

find $I_1 + I_2$.

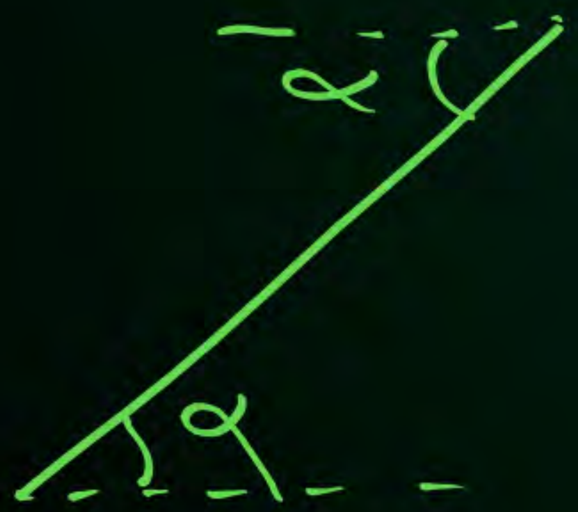


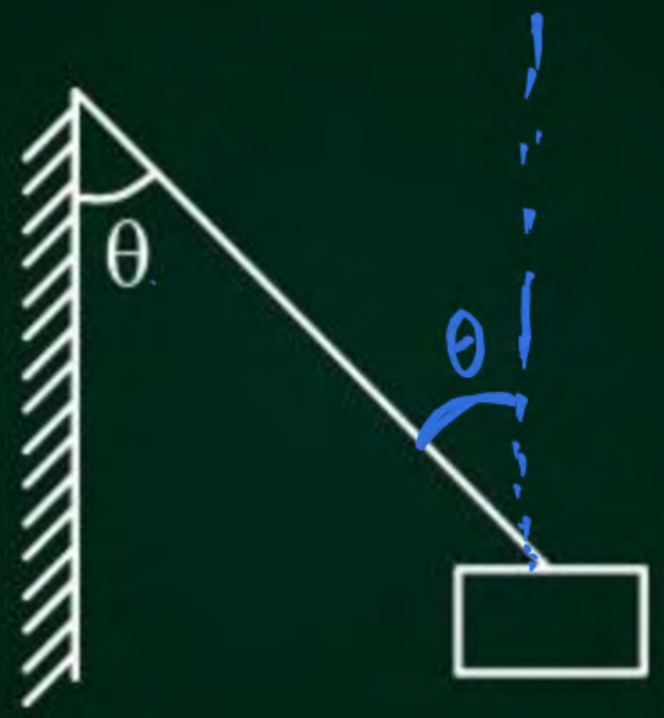
More concept of Trigonometry required in physics


m
90°
90-θ
θ
θ
90°

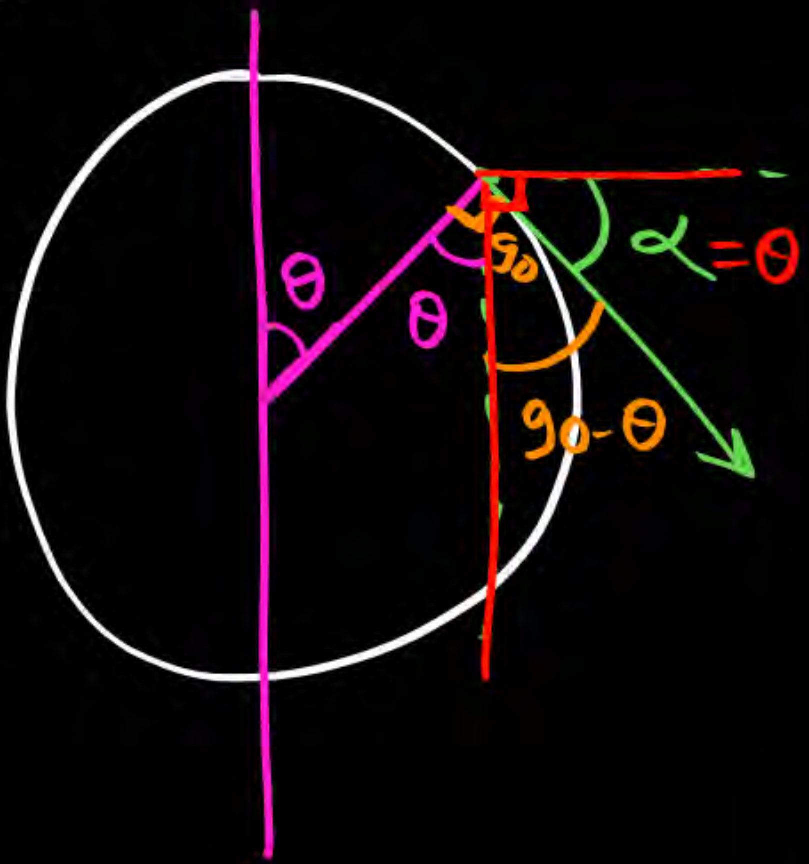
find α and β



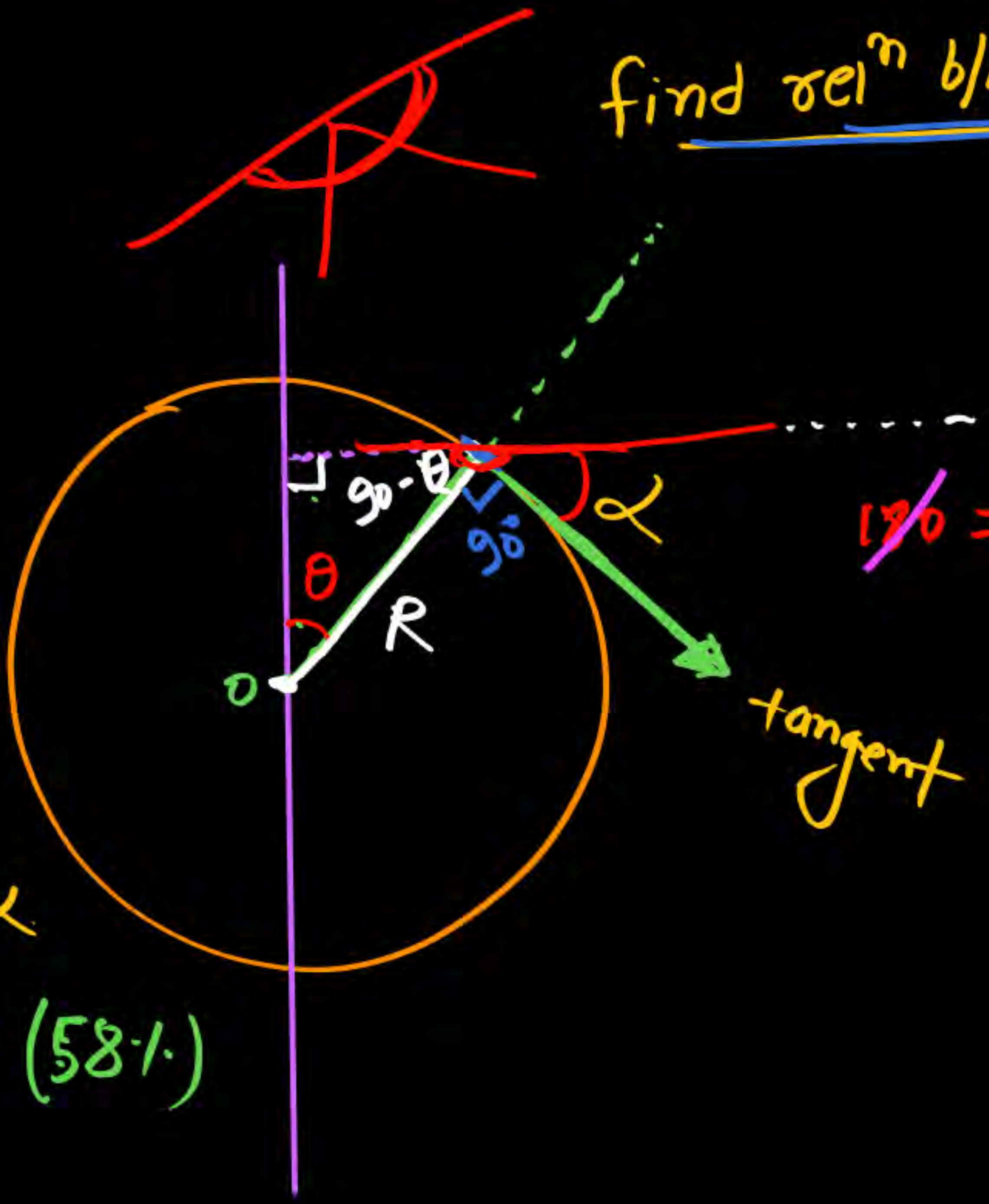



θ
θ

2nd method



find rel^n b/w θ and α



$1\cancel{8}0 = \cancel{9}0 - \theta + \cancel{9}0 + \alpha$

$\boxed{\theta = \alpha}$

R

Value of α

(a) 90 - θ (58%)

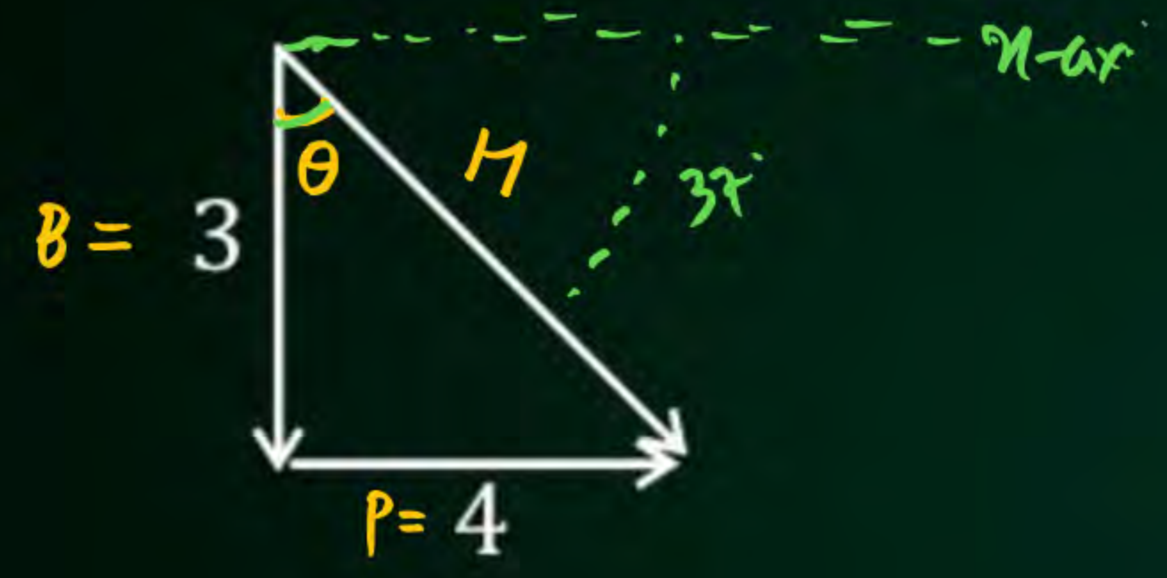
(b) 90°

(c) θ (20%)

(d) 90 + θ

QUESTION

Find direction of hypotenus from x-axis. $= 37^\circ$ (Ans)



$\tan\theta = \frac{4}{3}$

$\theta = 53^\circ$

Feel of Direction

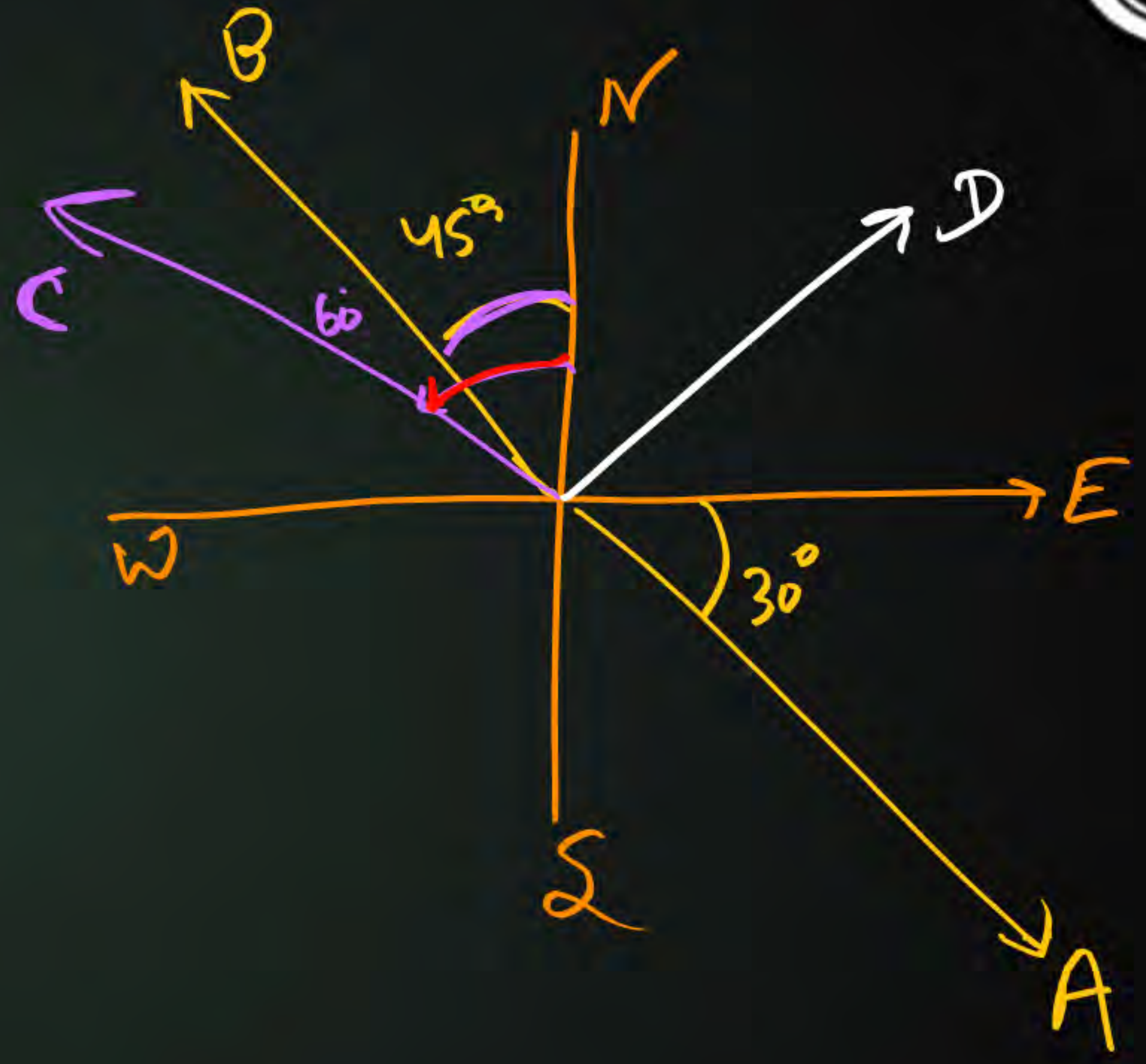
⇒ Velocity along 30° south of east (A)

⇒ Force along North West (B)

⇒ Force is acting 60° West of North. (C)

⇒ Force along east 30° North (D)

↳ way of representation




THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 6 | Physics

Basic Maths and Calculus



By- Dr. Manish Raj (MR SIR)

Topics to be covered

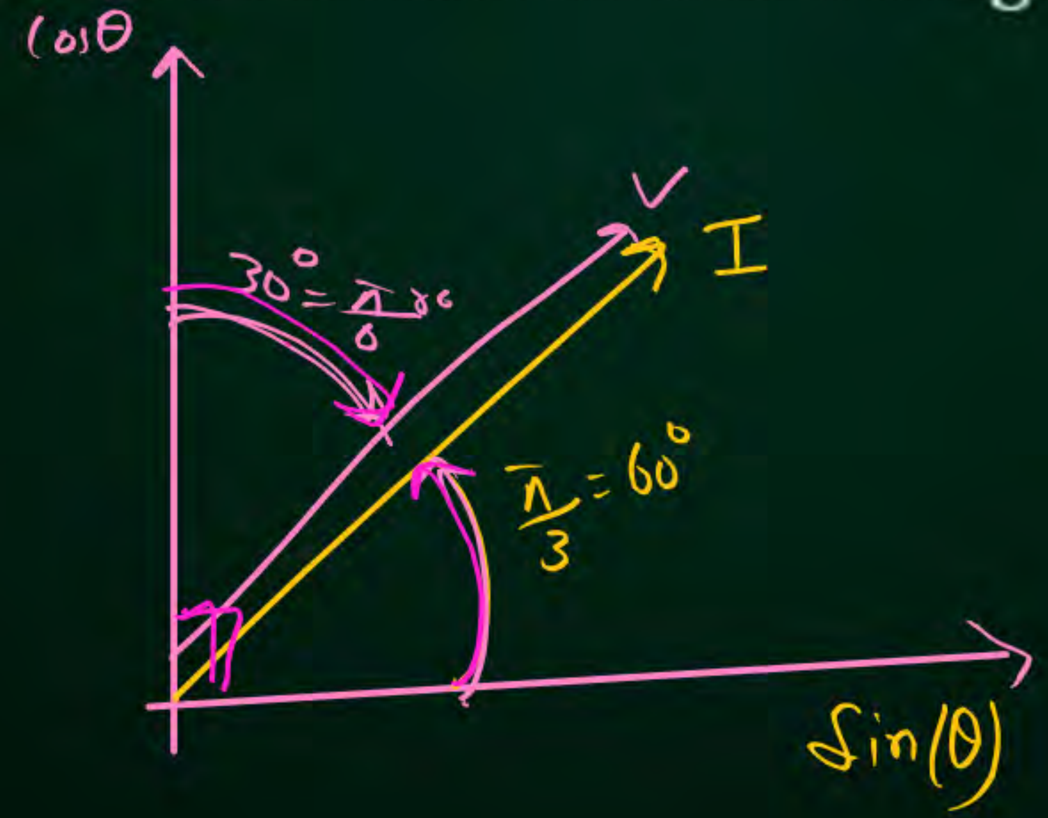
1. Type topic here K.B.D
2. Type topic here A/P
3. Type topic here ** G/P (Important)
4. Type topic here Co-ordinate Geometry & Graph



1. Equation of current and voltage

$$I = 10\sin\left(\theta + \frac{\pi}{3}\right) \text{ and } V = 10\cos\left(\theta - \frac{\pi}{6}\right)$$

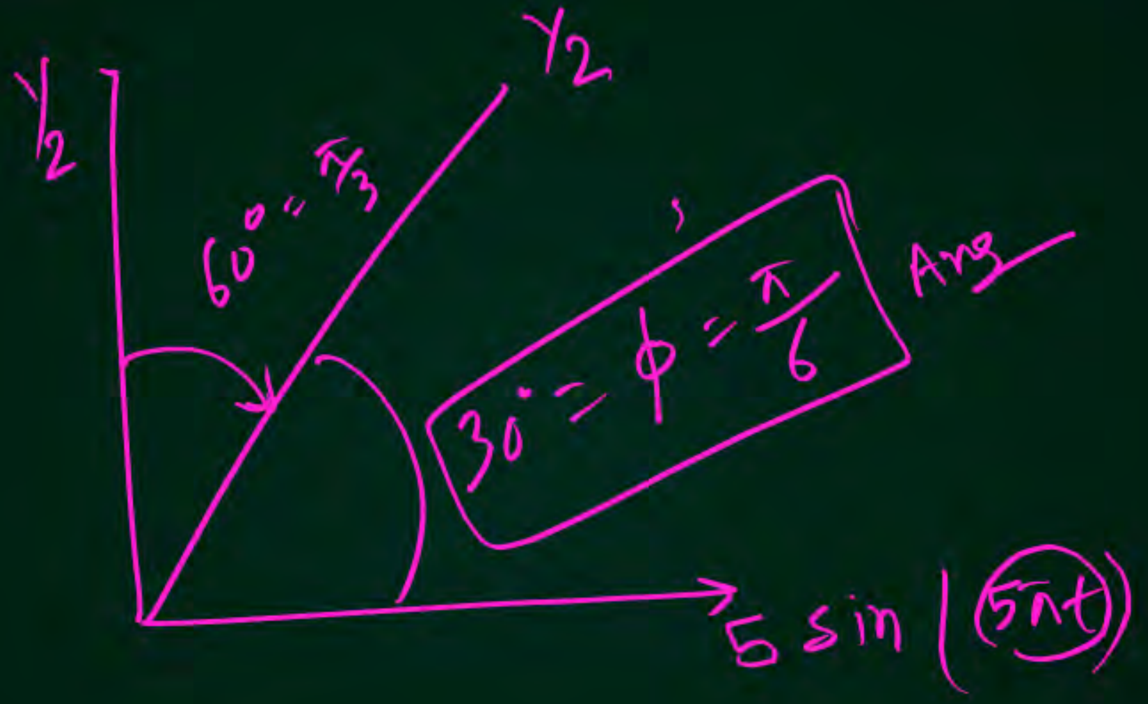
then phase difference between current and voltage. (NEET)



$\phi = 0$

QUESTION

If $y_1 = 2\sin(5\pi t)$ and $y_2 = 2\cos(5\pi t - \pi/3)$, what is the phase difference between the two waveforms ?



QUESTION

NEET/IIT

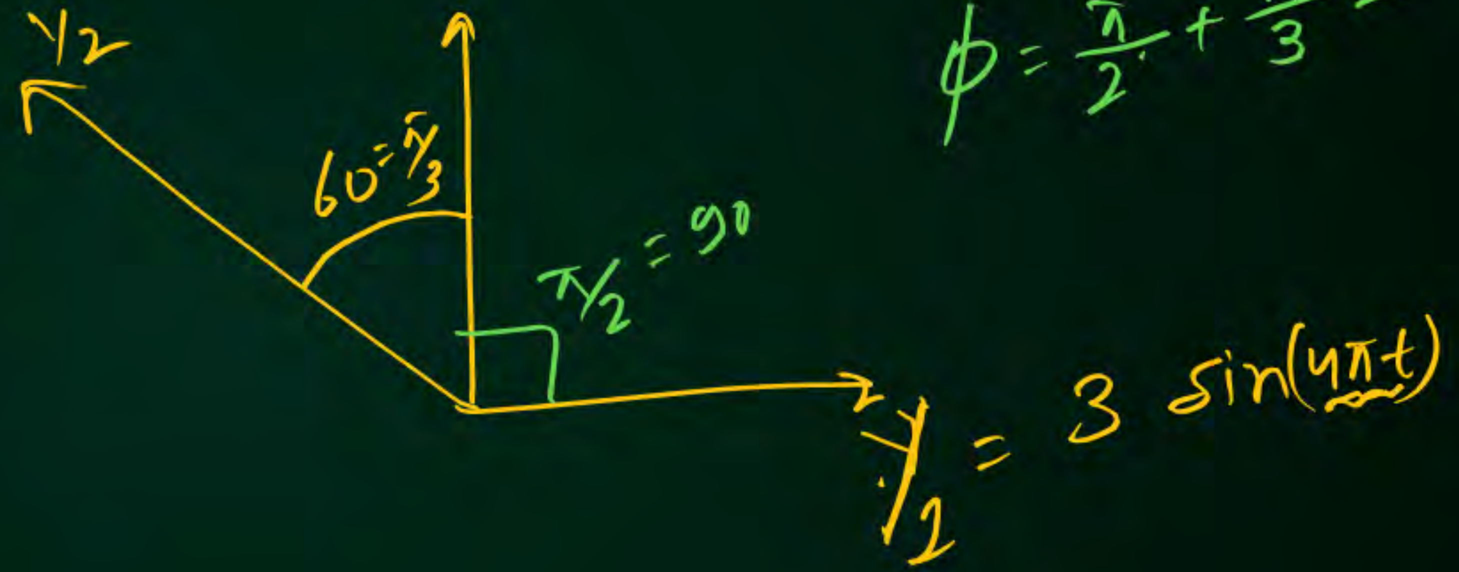
Two waves are represented by the equations $y_1 = 4\sin(3t)$ and $y_2 = 4\sin(3t + \pi/2)$. Determine the phase difference between the two waves.

$\phi = \frac{\pi}{2} = 90^\circ$

QUESTION

The equation of two waves are given as $y_1 = 3 \sin(4\pi t)$ and $y_2 = 3 \cos(4\pi t + \pi/3)$. Determine the phase difference between the two waves.

$$\phi = \frac{\pi}{2} + \frac{\pi}{3} = \frac{5\pi}{6} \text{ rad} = 150^\circ$$



QUESTION

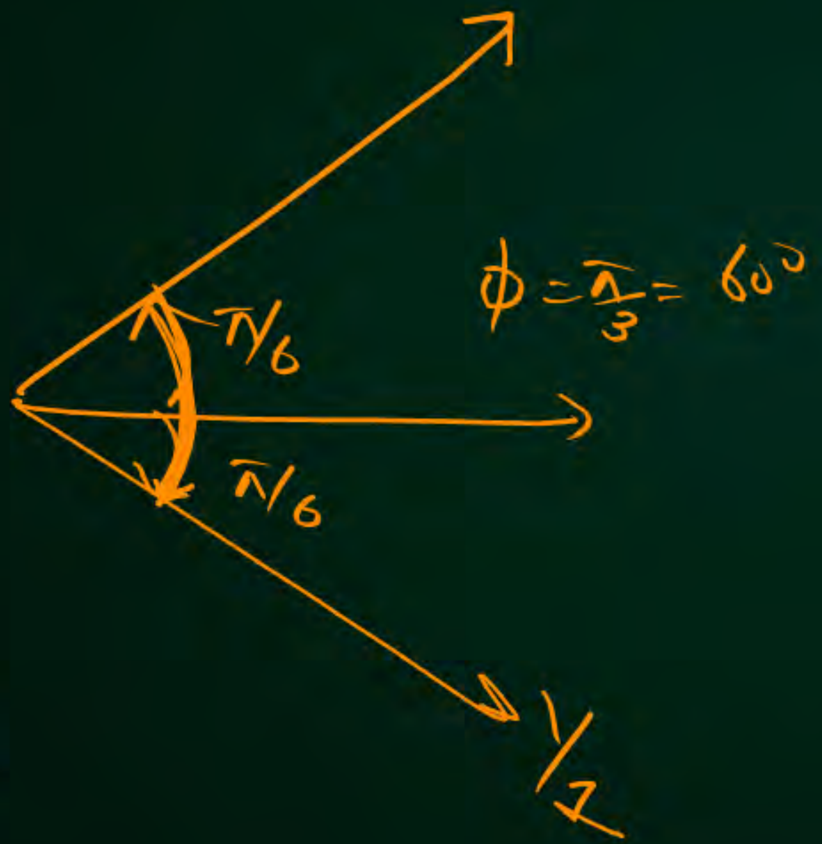
If $y_1 = 4 \sin(\omega t - \pi/6)$ and $y_2 = 4 \sin(\omega t + \pi/6)$, what is the phase difference between the two waveforms ?

(a) $\frac{\pi}{6}$

(b) $\pi/3$

(c) $\pi/2$

(d) 3π



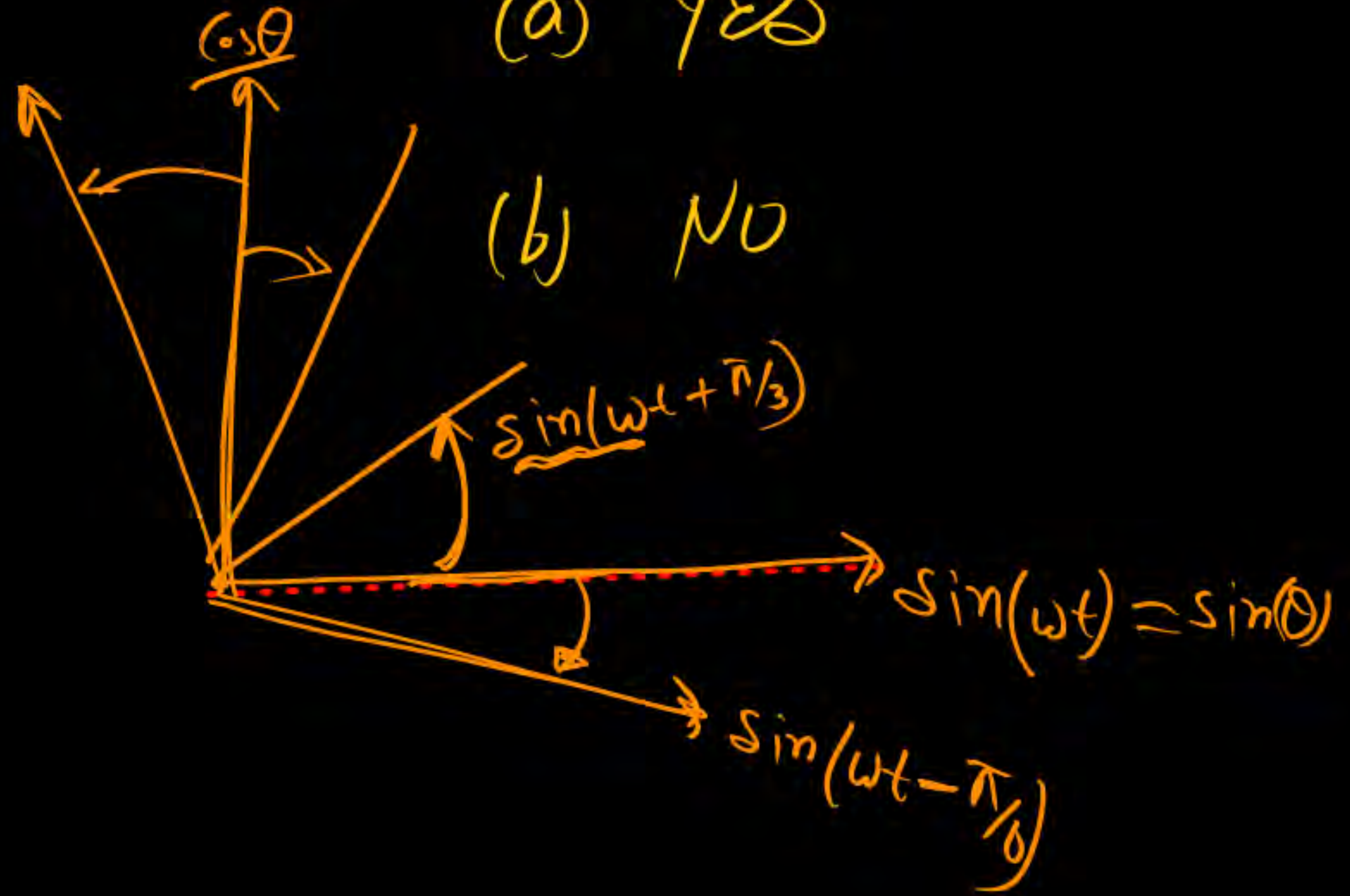
Kitne logo ko phase samajh aaya??

(a) Yes

(b) NO

95%

5%



2, 6, 10, 14, 18, 21, 25, 29, . . . ✗

3, 7, 12, 14, 20, 21 → Random Pattern

+4 +4 +4 +4

2, 6, 10, 14, 18, 22, 26, 30. . . .

→ additive Pattern (AP series)

→ 1^{st} term

d = common diffⁿ = n^{th} term − $(n-1)^{th}$ term
= $(n+1)^{th}$ − n^{th} term
= $14 - 10 = 4$

→ same

$$n^{th} \text{ term} = a + (n-1)d$$

QUESTION

Which of the following series is not arithmetic progression.

(A) 2, 8, 15, 21 27, _ _ _ Not AP series

+6 +7

(B) 3, 6, 12, 24, _ Not AP Ser

+3 +6 +12

(C) 4, 1, –2, –5, –8, _ A/P series ✓ ($d = 1 - 4 = -3$)

(–3) –3 –3 –3

(D) –5, –3, –1, 1, 3 _ A/P series ✓ $d = -3 - (-5) = -3 + 5 = 2$

+2 +2 +2 +2

$-5 + 2 = -3$

QUESTION

Find 10th term and sum of 1st 10 term.

7, 11, 15, 19, 23, 27, 31, 35, 39, 43, 47, 51

+4 +4

1st term

10th term

$d = 19 - 15 = 4$

$n^{th}\text{ term} = a + (n-1) \times d$

$10^{th}\text{ term} = 7 + (10-1) \times 4$

$= 7 + 36$

$= 43$

$$\text{Sum of } n\text{-term} = \frac{n}{2}\left(1^{st}\text{ term} + n^{th}\text{ term}\right)$$

$$= \frac{n}{2}\left[a + a + (n-1)d\right]$$

$$\text{Sum} = \frac{n}{2}\left[2a + (n-1)d\right]$$

$$\text{Sum of } 1^{st}\ 10^{th}\text{ term} = \frac{10}{2}(7 + 43) = 5 \times 50$$

$$= 250$$

⟹ 1, 3, 5, 7, 9, 11, 13, 15, 17, 19, - - - A/P series ($d = 2$)

↑ 1st term

Series of odd no is A/P

⟹ 2, 4, 6, 8, 10, 12, 14, 16, 18, - - - - - - (A/P series) ($d = 2$)

Series of even no is A/P

⟹ 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 - - - - - (A/P series)

Series of natural no is A/P.

QUESTION

Sum of 1st n-natural number 1 + 2 + 3 + ... n.

(A) $\frac{n^2}{2}$

(B) $\frac{n(n+1)}{2}$

(C) $\frac{n(n-1)}{2}$

(D) $\frac{n^2(n+1)}{6}$

QUESTION

Which term of AP 27, 24, 21, 18, 15, 12, 9, 6, 3, 0 so on......... is zero.

1st term = 27

$d = 24 - 27 = -3$

n^{th} term $= a + (n-1)d$

$0 = 27 + (n-1) \times -3$

$27 = 3(n-1)$

$9 = n - 1$

$n = 10$ th term

Sum of n term $= \frac{n}{2}[1^{st} \text{ term} + n^{th} \text{ term}]$

$= \frac{n}{2}[a + a + (n-1)d]$

Sum of n term $= \frac{n}{2}[2a + (n-1)d]$

QUESTION

28, 22, x, y, 4 is an AP then value of x and y is :



Sol^n

$28, 22, x, y, 4, -2 \ldots$

$22-6 = x = 16$

$d = 22-28$
$= -6$

$y = 10$

QUESTION Applicatn of AP in NEET

25 tuning fork are arranged in increasing order of frequency. Frequency difference is 10 then find frequency of 1st tuning fork if frequency of 25th is 400 Hz.



$f_1 = x$ (let) $f_2 = x+10$ $f_3 = x+20$ $f_{25} = 400$

↑ माना

→ 25th term = 400 $= x + (25-1)10$

→ $d = 10$ $400 = x + 240$

→ a = 1st ter = ?? $x = 400 - 240$

$= 160$ Hz

2, 4, 8, 16, 32, 64, 128, 256, ...

1st term

→ multiplying pattern (Geometric Progradi)

G/P series

$$\text{Common ration} = \frac{n^{th} \text{ term}}{(n-1)^{th} \text{ term}}$$

$$\text{Sum of all item} = \frac{a}{1 - c.r} \quad (c.r < 1)$$

Ex

$1, \frac{1}{2}, \frac{1}{4}, \frac{1}{8}, \frac{1}{16}, \frac{1}{32} \ldots$

G.P serie $\quad c.r = \frac{1}{8 \times \frac{1}{4}} = \left(\frac{1}{2}\right)$

QUESTION

NEET/JEE

$V = \frac{Kq}{r}$

Find potential at origin ??
due to all the charges

	+q	+q	+q	+q	+q	+q
(0, 0)	(1, 0)	(2, 0)	(4, 0)	(8, 0)	(16, 0)	(32, 0)

$$V = \frac{Kq}{1} + \frac{Kq}{2} + \frac{Kq}{4} + \frac{Kq}{8} + \frac{Kq}{16} + \cdots$$

$$= Kq\left(1 + \frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \frac{1}{16} + \cdots\right) = Kq\left[\frac{1}{1 - \frac{1}{2}}\right] = Kq\left[\frac{1}{\left(\frac{1}{2}\right)}\right] = 2Kq$$

Ans

G.P. series

1st term

C.r $= \frac{1}{2}$

QUESTION

NEET/JEE

$V = \frac{Kq}{r}$

Find potential at origin ??

due to all the charges

	+q	−q	+q	−q	+q	−q
(0, 0)	(1, 0)	(2, 0)	(4, 0)	(8, 0)	(16, 0)	(32, 0)

Impt feel

$$V = \frac{Kq}{1} - \frac{Kq}{2} + \frac{Kq}{4} - \frac{Kq}{8} + \frac{Kq}{16} - \frac{Kq}{32} - \cdots$$

$$= Kq\left[1 - \frac{1}{2} + \frac{1}{4} - \frac{1}{8} + \frac{1}{16} - \frac{1}{32} + \cdots\right]$$

G.P. Ser

$$C.r = \frac{-\frac{1}{2}}{1} = -\frac{1}{2}$$

$$= Kq\left[\frac{1}{1-\left(-\frac{1}{2}\right)}\right] = \frac{Kq}{3/2} = \frac{2Kq}{3}$$

Ans

QUESTION

5-resistance connected in series, resistance of each Resistor is half of previous resistance if 1st resistance of value 10Ω then value of 5th resistance.

G.P Series

$10\Omega, 5\Omega, 2.5, 1.25, 0.625\Omega$

$10, \frac{10}{2}, \frac{10}{4}, \frac{10}{8}, \frac{10}{16}\Omega$

n^{th} term $= 5^{th}$ term $= 10\Omega\left(\frac{1}{2}\right)^{5-1} = 10\left(\frac{1}{2}\right)^4 = \frac{10}{16}\Omega$

$a, a \times r, a \times r^2, a \times r^3, ar^4 \ldots$

GP series

$a = 1^{st}$ term

$r =$ common ration

n^{th} term $= a(r)^{n-1}$

QUESTION

$$F = \frac{K q_1 q_2}{r^2}$$

Charge q is placed on x-axis of co-ordinate (1, 0), (2, 0), (4, 0), (8, 0) and so on then find force on charge q_0 which is at origin.

q_0 (0,0) — q (1,0) — q (2,0) — q (4,0) — q (8,0) — q (16,0) — q (32,0)

$$F = \frac{Kqq_0}{(1)^2} + \frac{Kqq_0}{2^2} + \frac{Kqq_0}{4^2} + \cdots$$

$$F = Kqq_0\left[1 + \frac{1}{4} + \frac{1}{16} + \cdots\right] = Kqq_0\left[\frac{a}{1 - \text{c.r}}\right] = Kqq_0\left[\frac{1}{1-\frac{1}{4}}\right] = \frac{Kqq_0}{\frac{4-1}{4}} = \frac{4Kqq_0}{3}$$

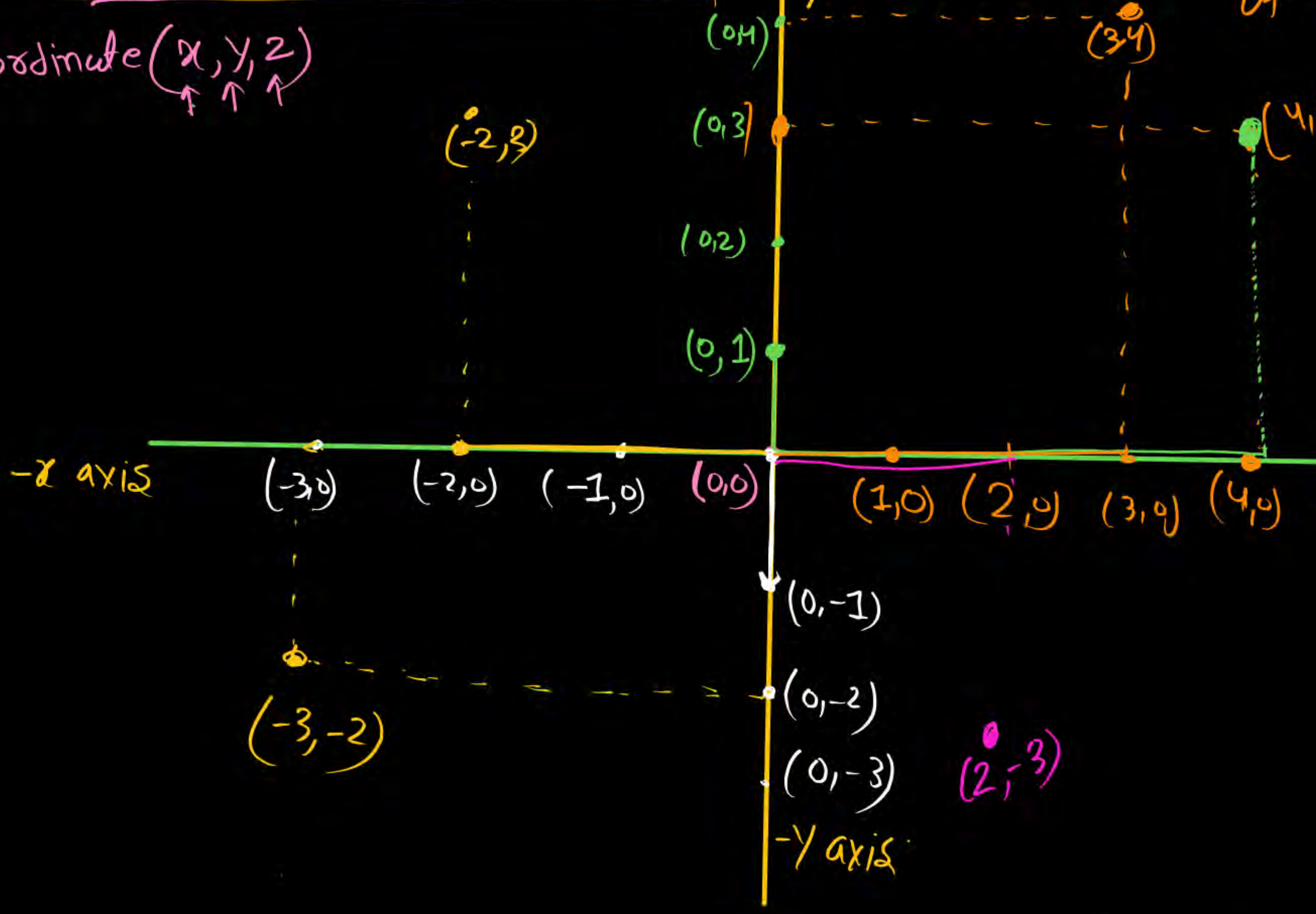
G.P series

$a = 1$, c.r $= \frac{1}{4} = \frac{1}{4\times1} = \frac{1}{4}$

Co-ordinate Geometry

Coordinate (x, y, z)

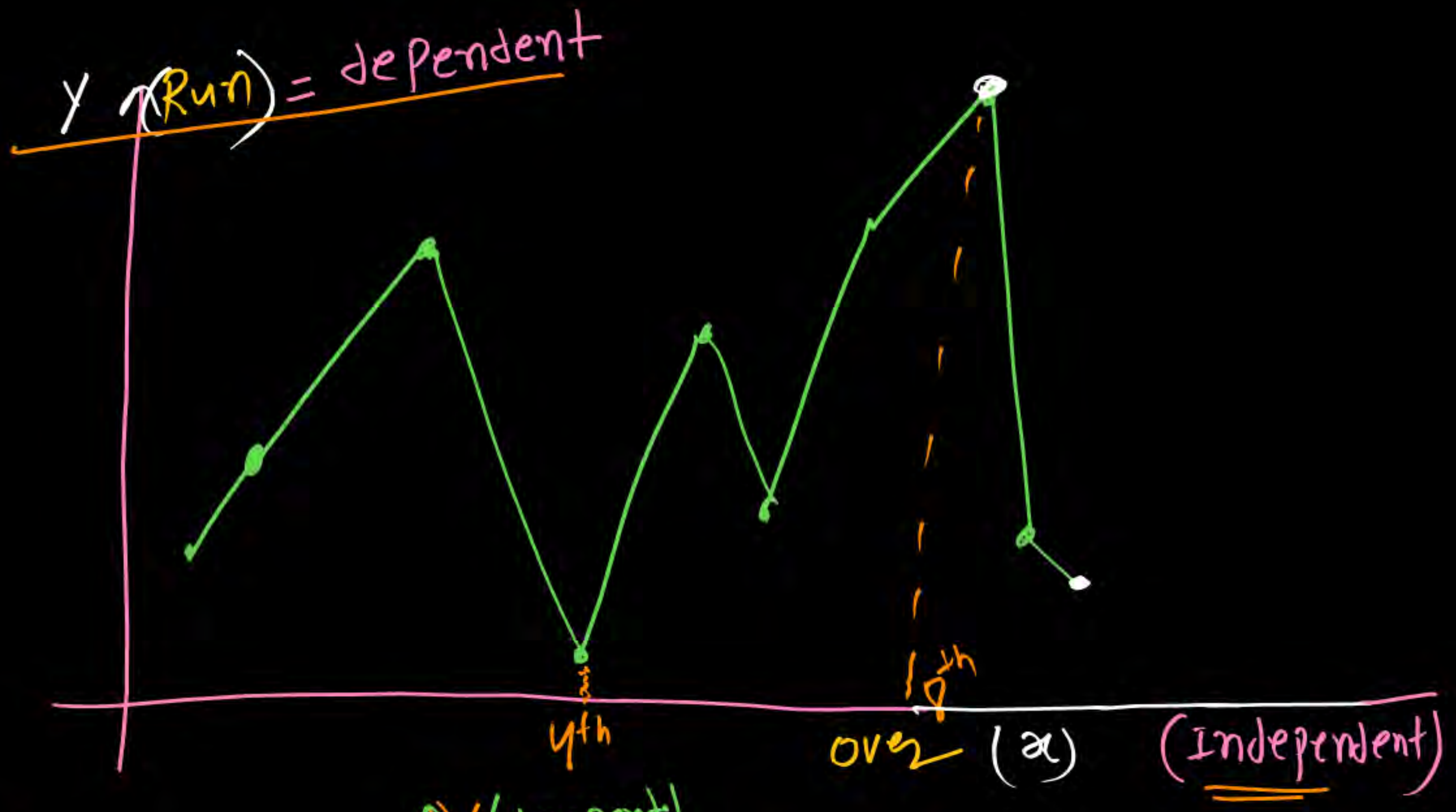
y-axis = vertical line on which value of x is zero.



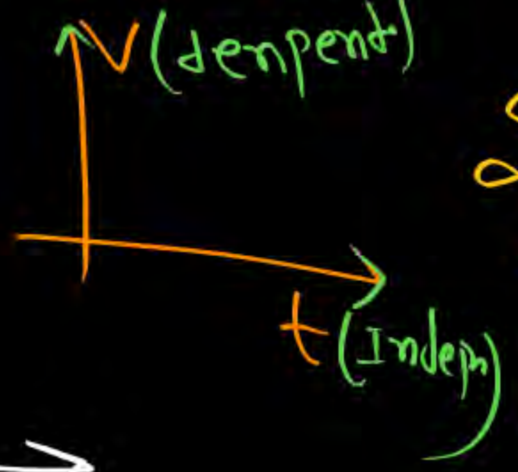
x-axis = Horizontal line on which value of y is always zero

over	Run
1	3
2	4
3	8
4	1
5	7
6	5
7	9
8	13
9	3
10	2

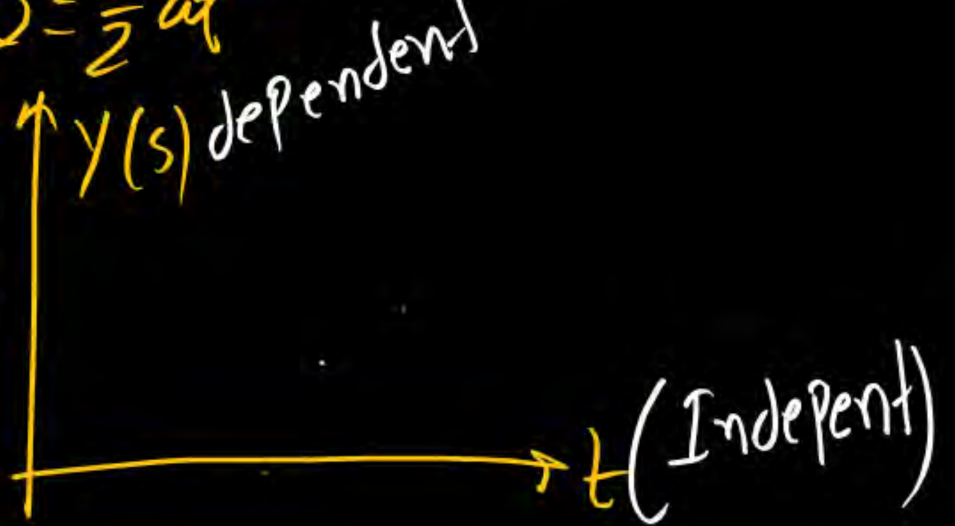
max^m Run







$S = \frac{1}{2} at^2$

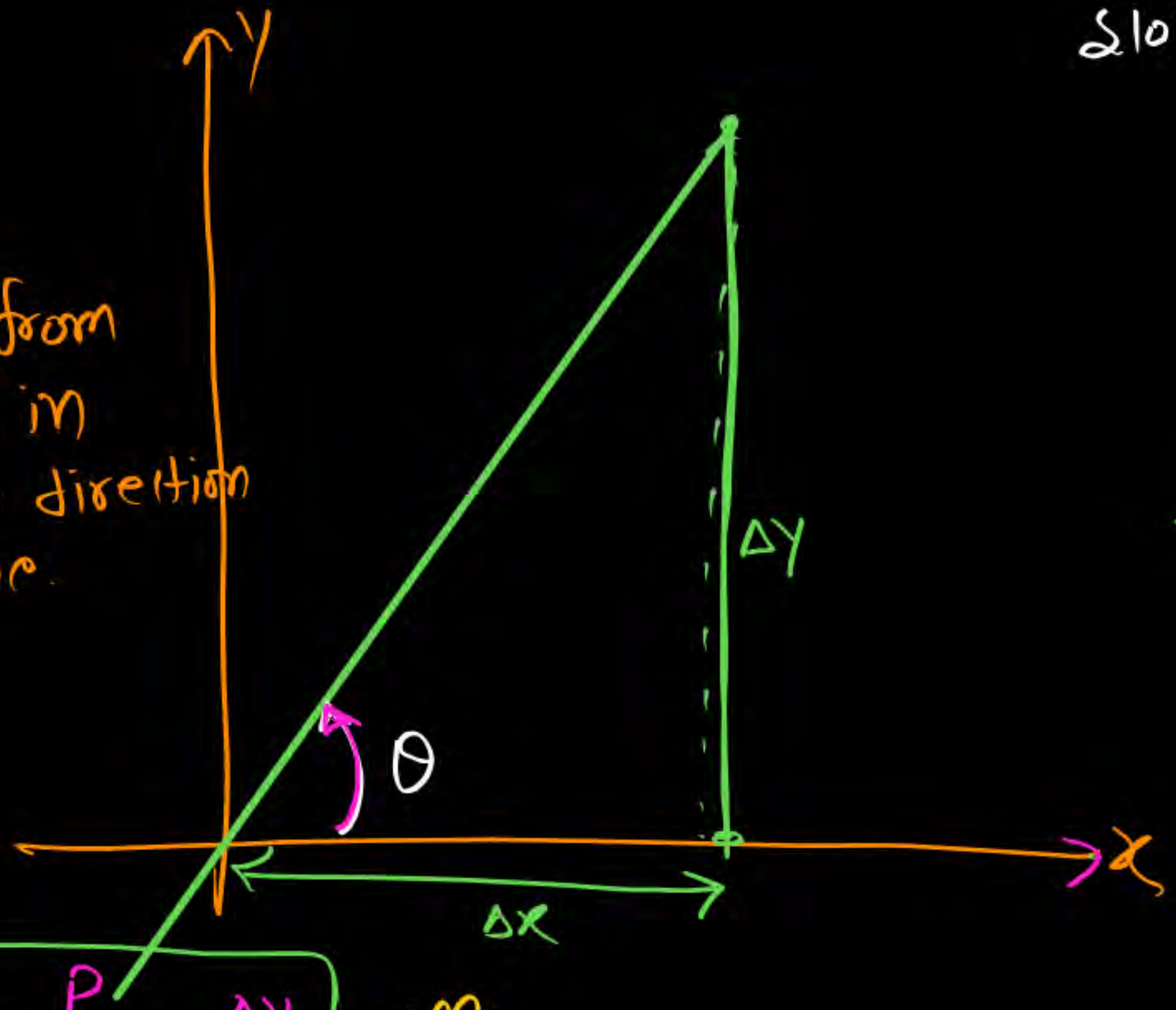


Straight line (सिधी रेखा)

slope = Inclination = $\tan\theta$

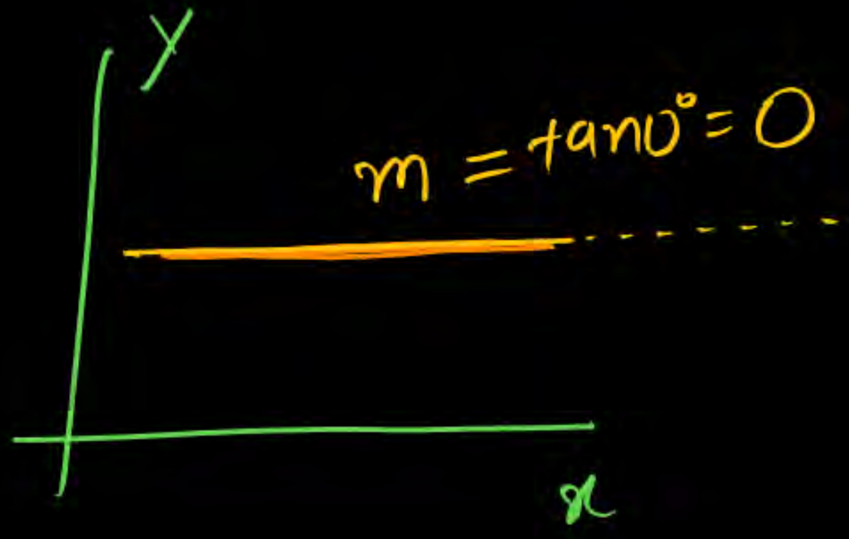
Step-1

Take angle from +ve x-axis in Anti-clock direction to the line.



Step-2

$$\tan\theta = \text{slope} = \frac{P}{B} = \frac{\Delta y}{\Delta x} = m$$



$P = mV$

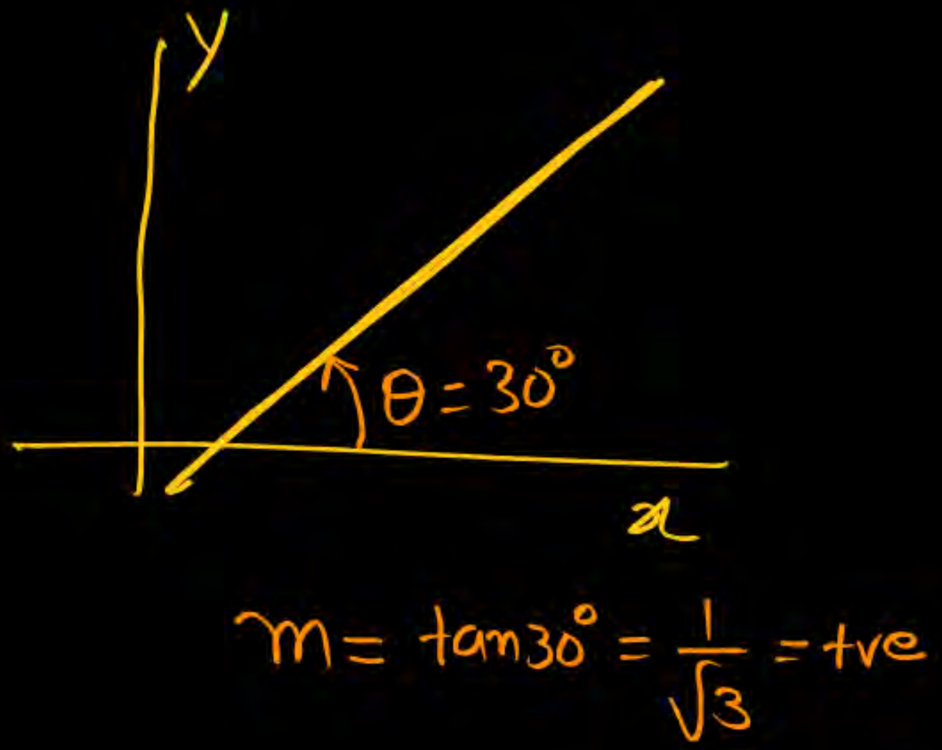
$S = \frac{1}{2}at^2$

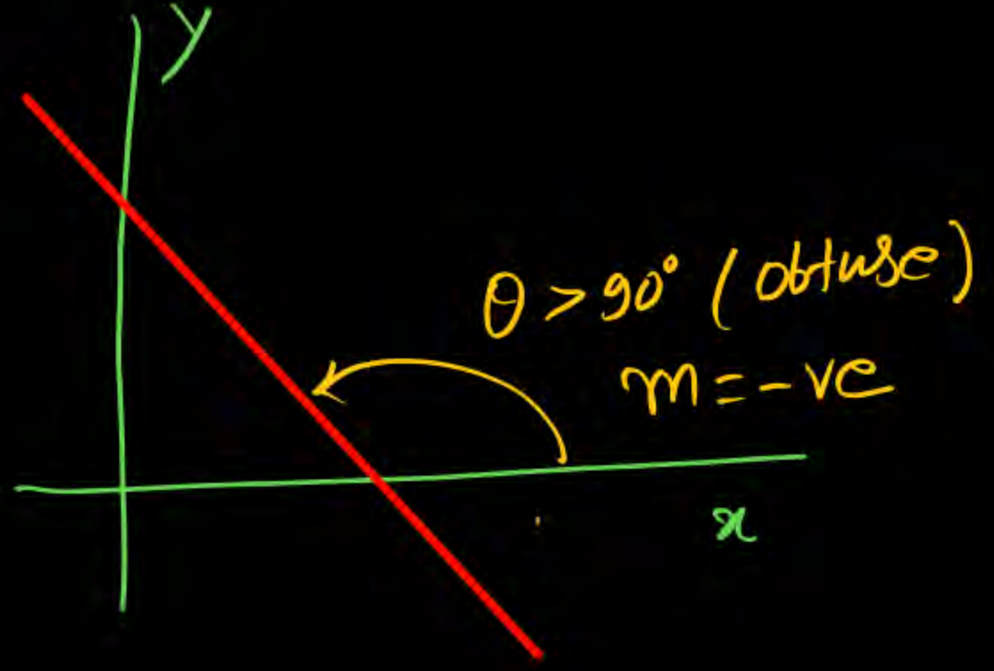
$K.E = \frac{1}{2}mv^2$

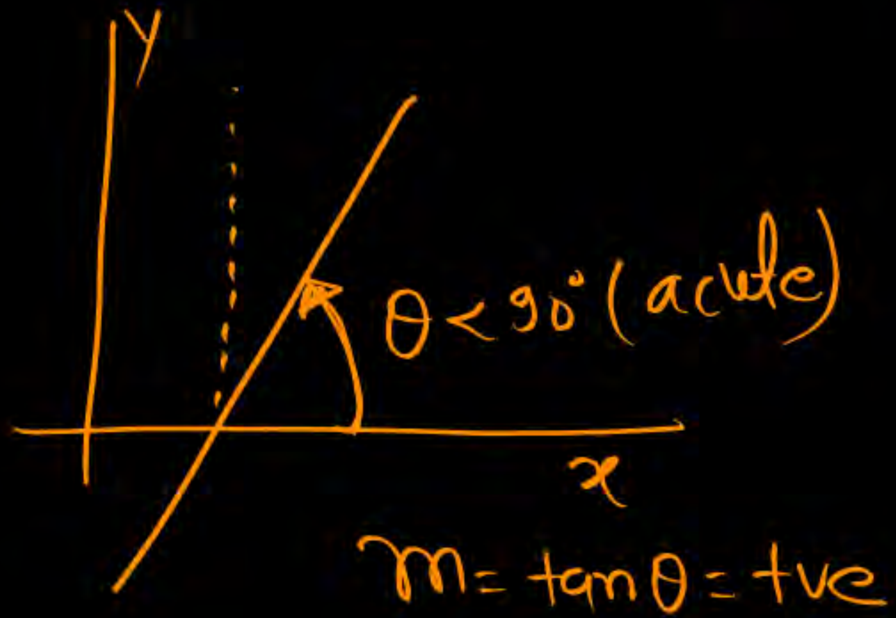
$F = ma$

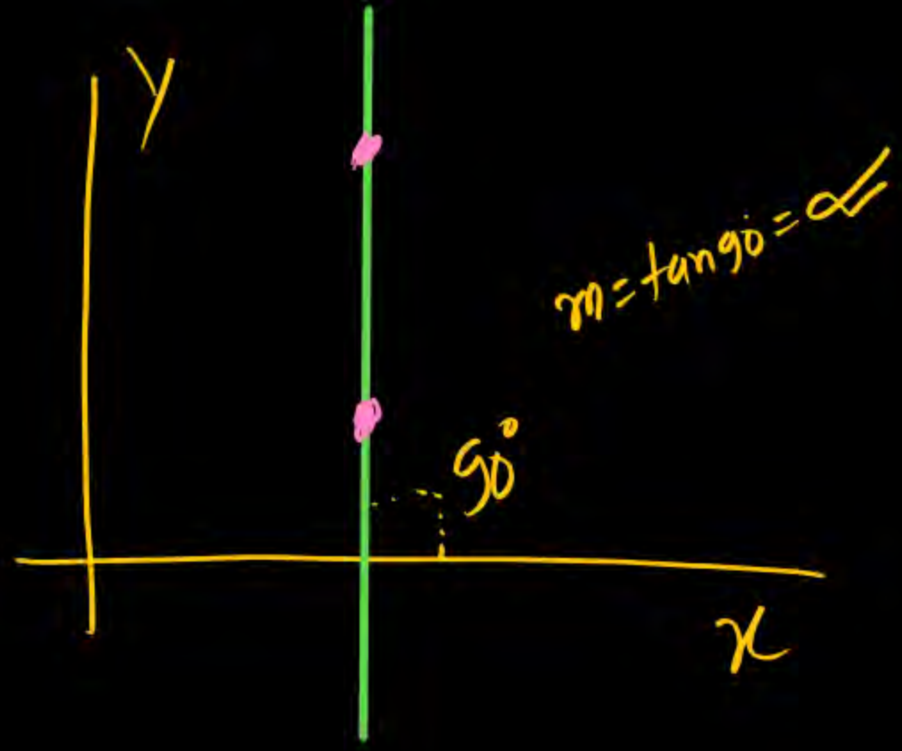
→ graph always B/w Two physical quantity.

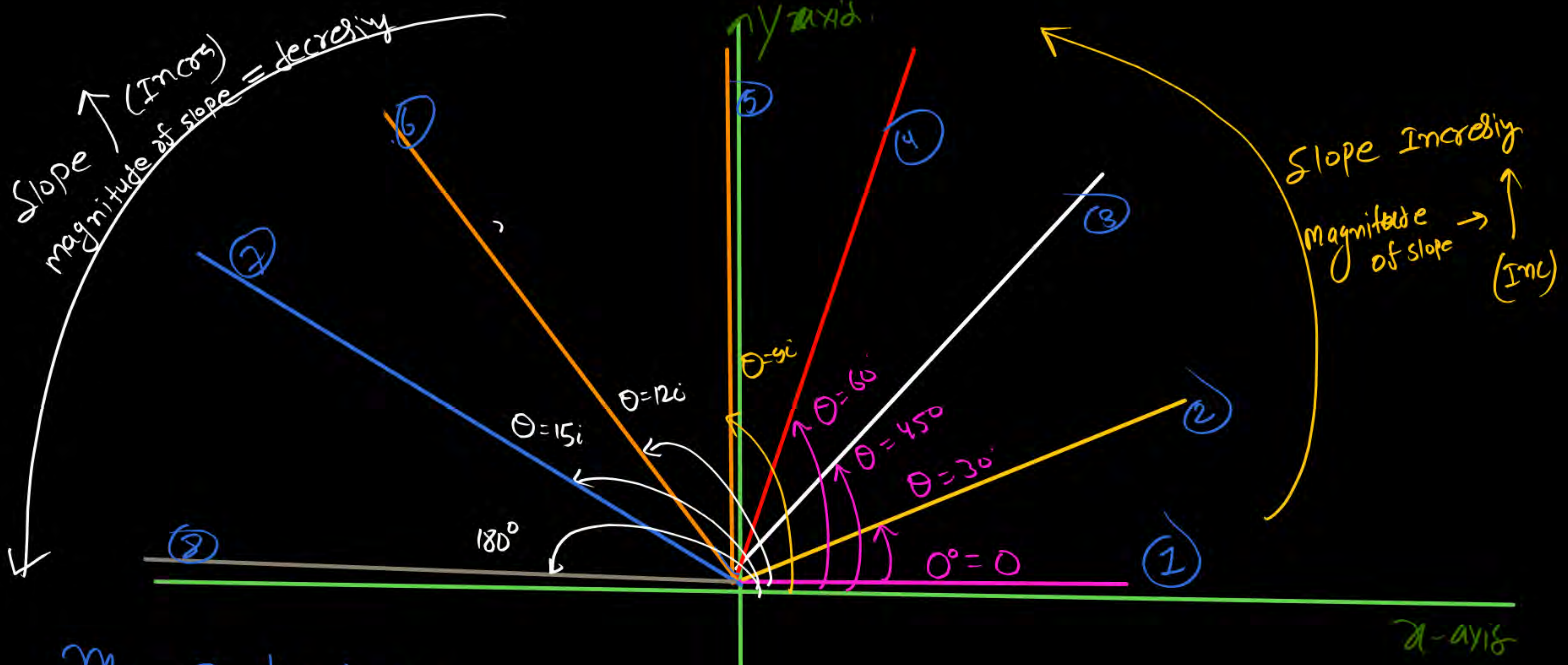
(3rd will be remains const^n)


y
θ = 30°
x
m = tan30° = 1/√3 = +ve


y
θ > 90° (obtuse)
m = -ve
x


y
θ < 90° (acute)
x
m = tanθ = +ve


y
m = tan90 = ∞
90°
x



$m_1 = 0 = \tan 0^\circ = m_8$

$m_2 = \frac{1}{\sqrt{3}}$

$m_3 = 1$

$m_4 = \tan 60 = \sqrt{3}$

$m_5 = \infty$

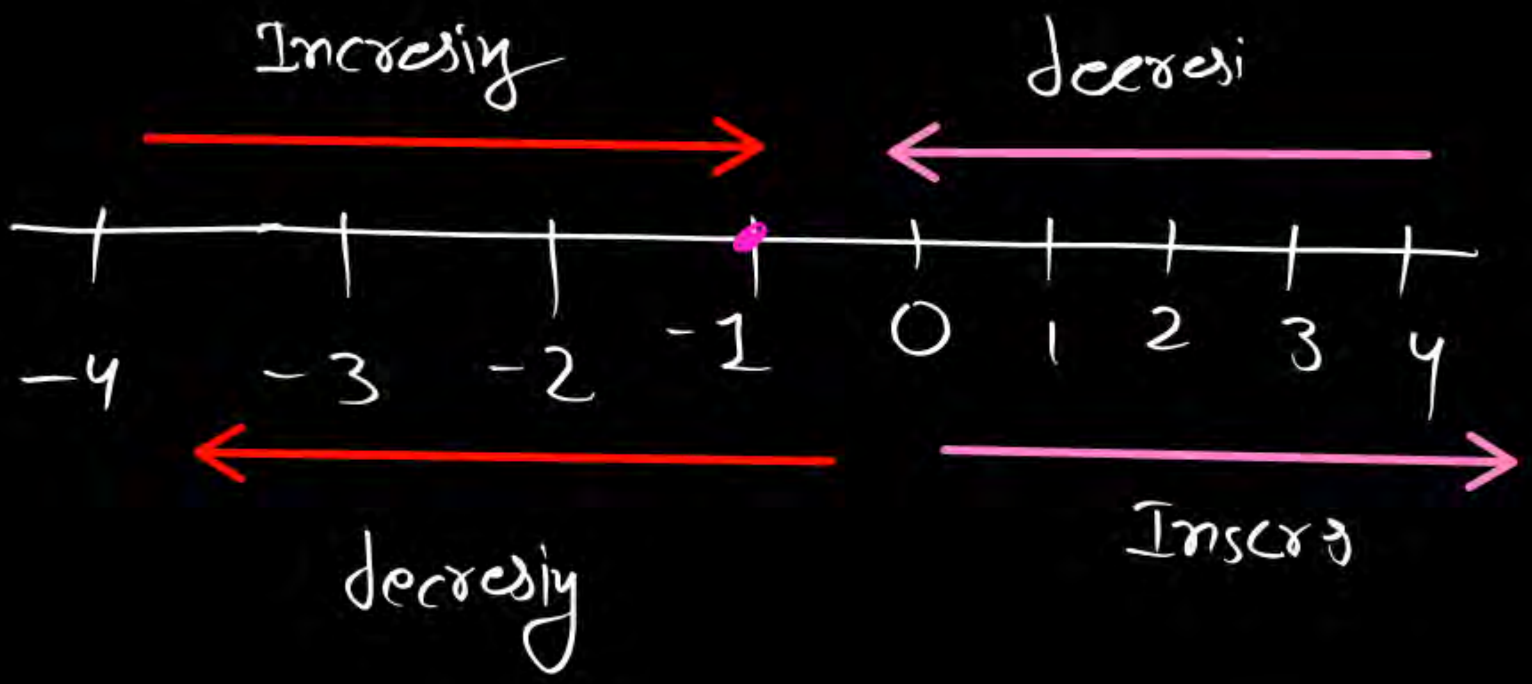
$m_6 = -\sqrt{3}$

$m_7 = -\frac{1}{\sqrt{3}}$

$m_8 = 0$

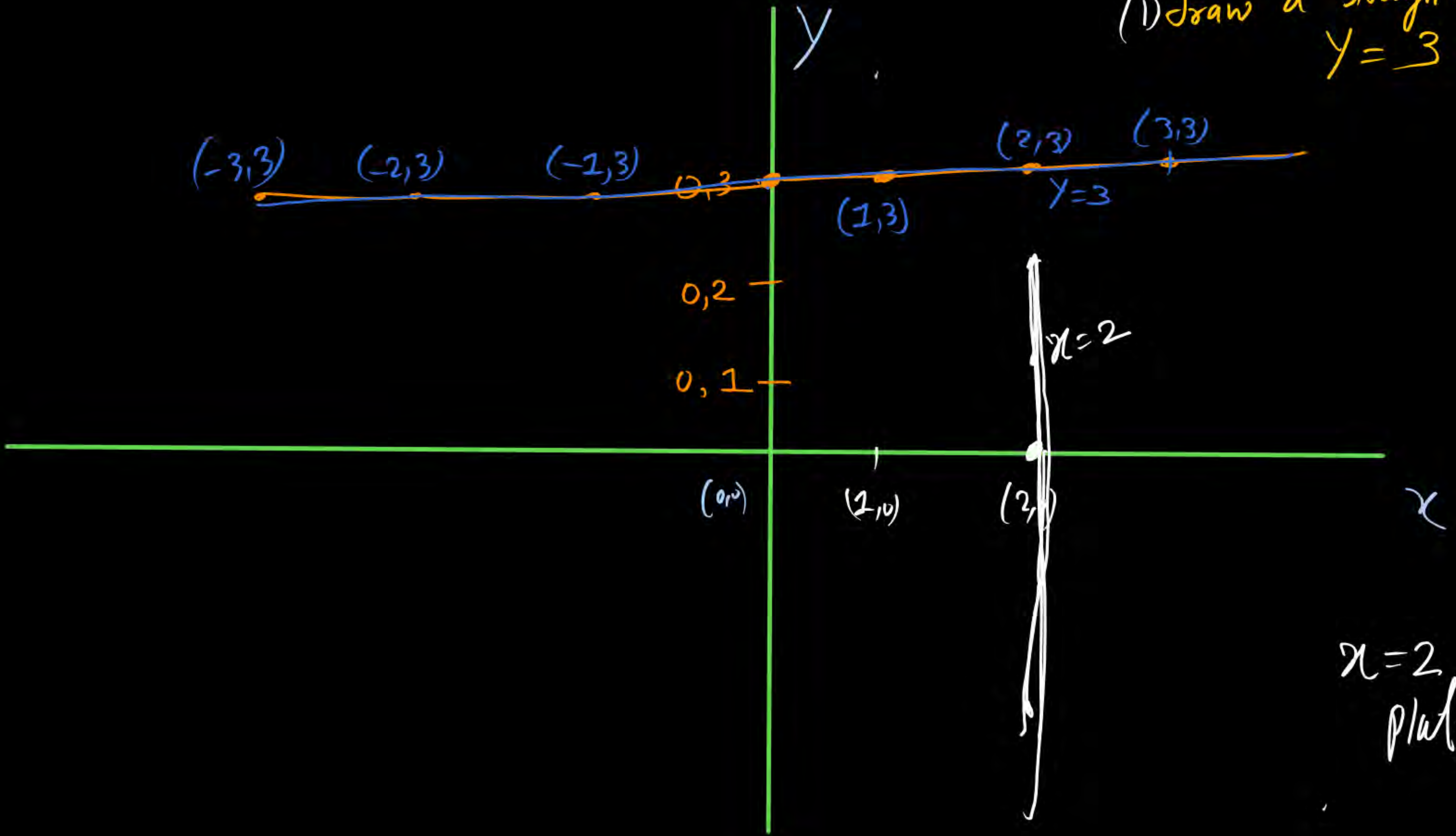
Magnitude = +ve / -ve Ignore करो

सिर्फ value



(1) draw a straight line

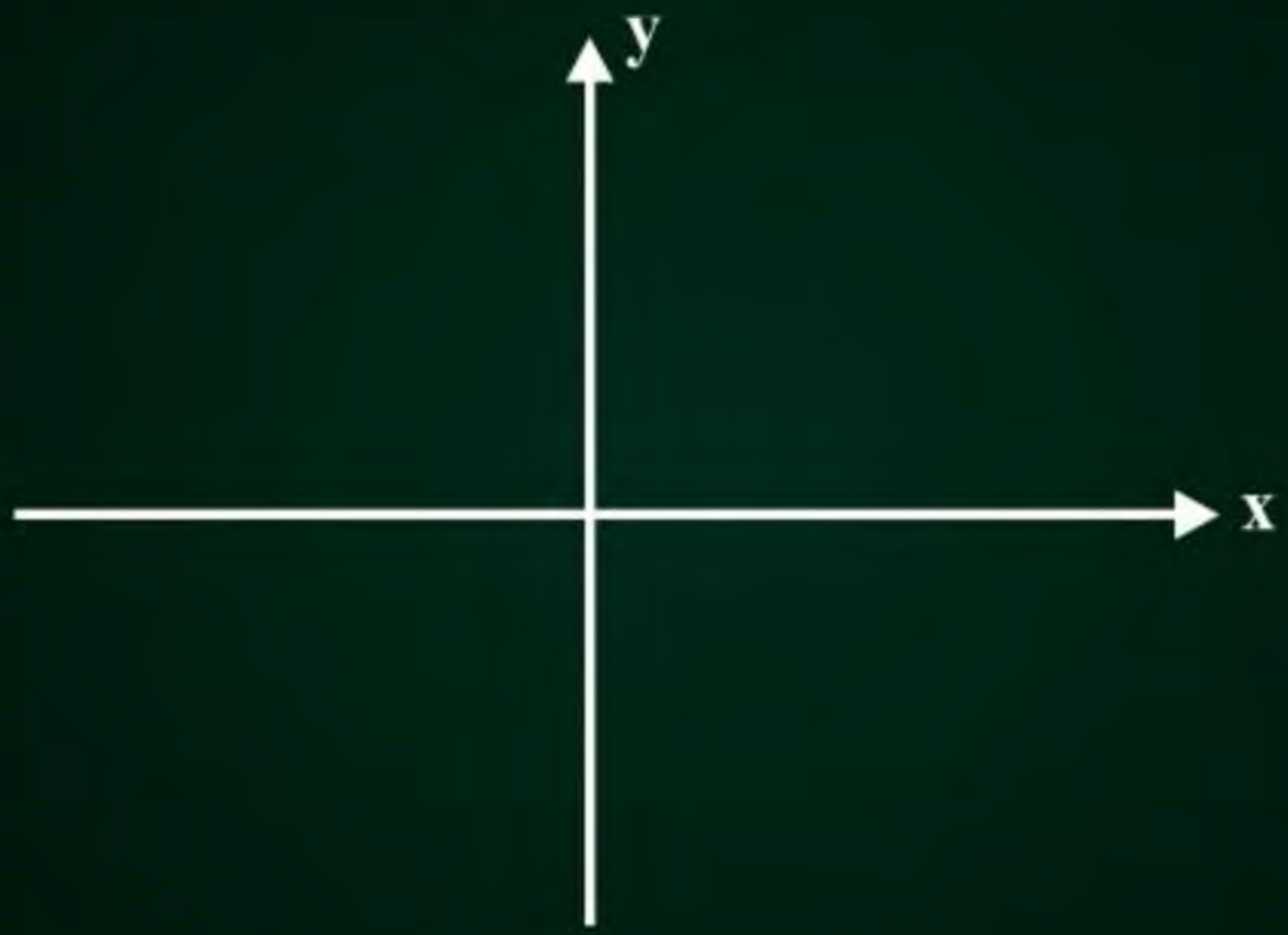
$y = 3$ ✓

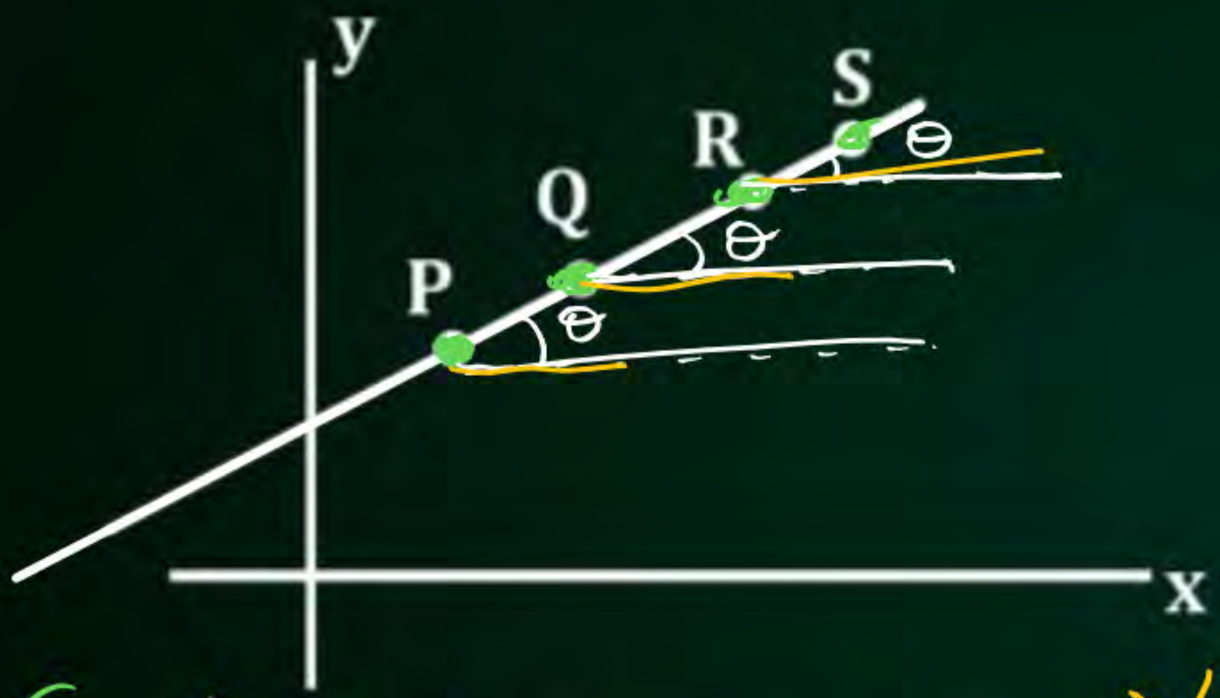


$x = 2$

plote this

Graph of straight line [linear relation between two physical quantity]:

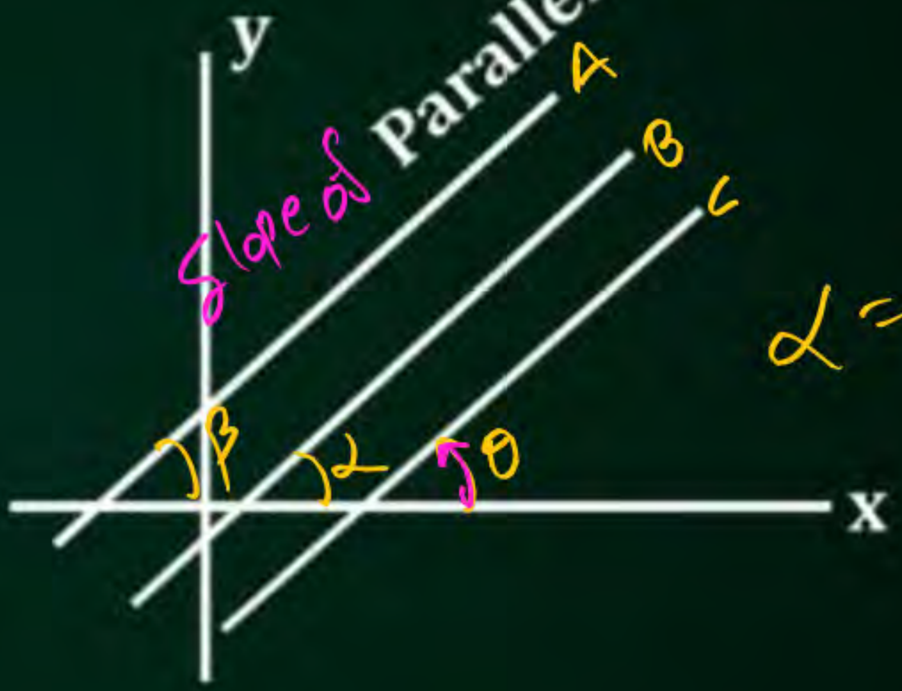




(1) $m_P < m_Q < m_R < m_S$ ✗

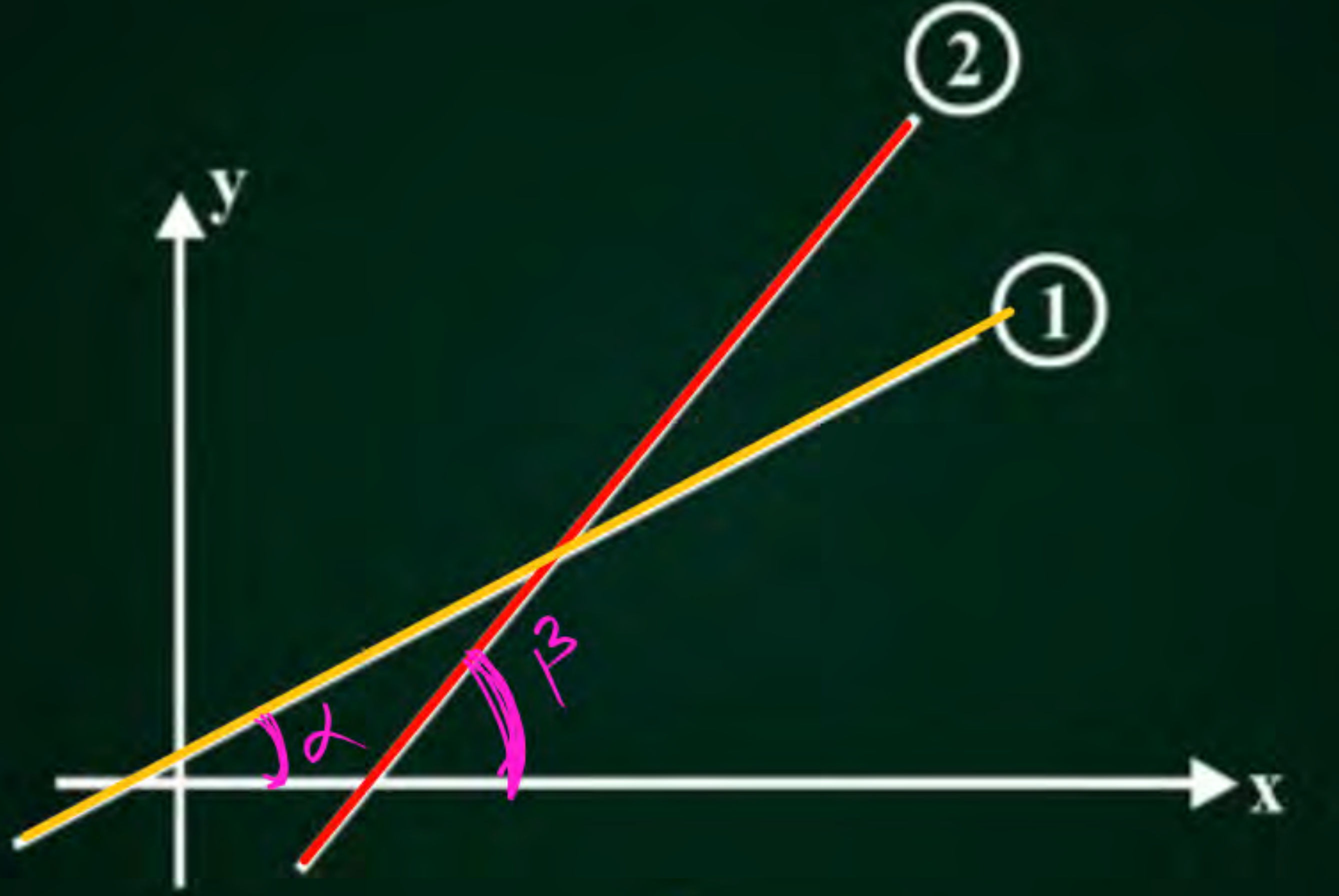
(2) $m_P = m_Q = m_R = m_S$ ✓

(3) $m_P > m_Q > m_R > m_S$



Slope of **Parallel lines** is Same

$\alpha = \theta = \beta$ = Slope = Same

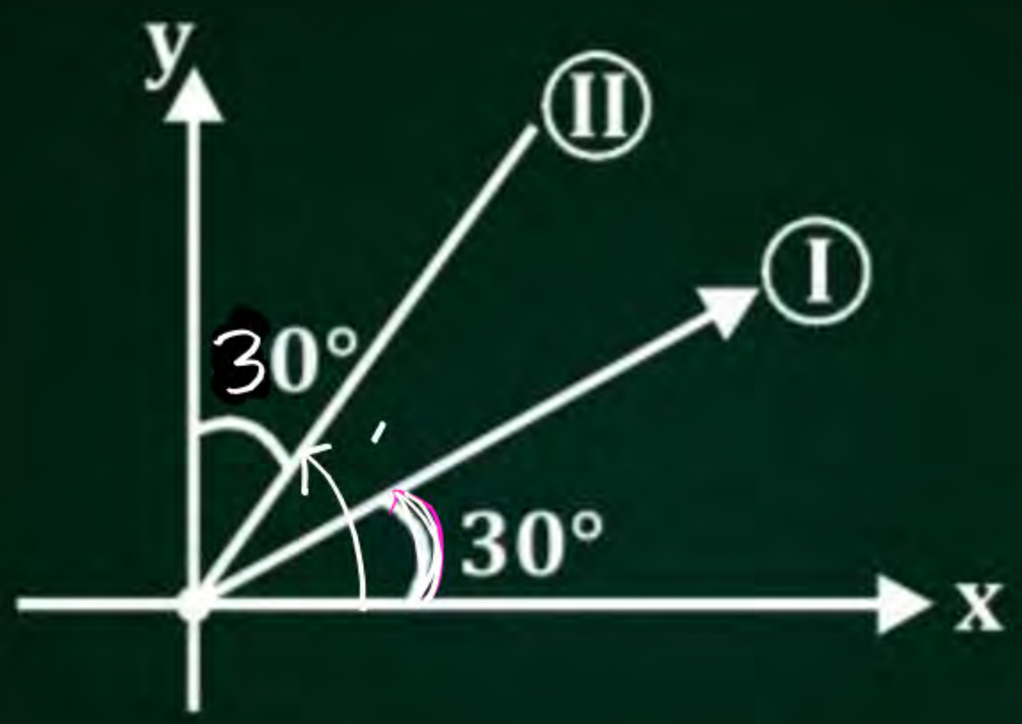


$\beta > \alpha$

Slope(2) > Slop(1)

QUESTION

Find $(\text{slope})_{I}/(\text{slope})_{II} =$



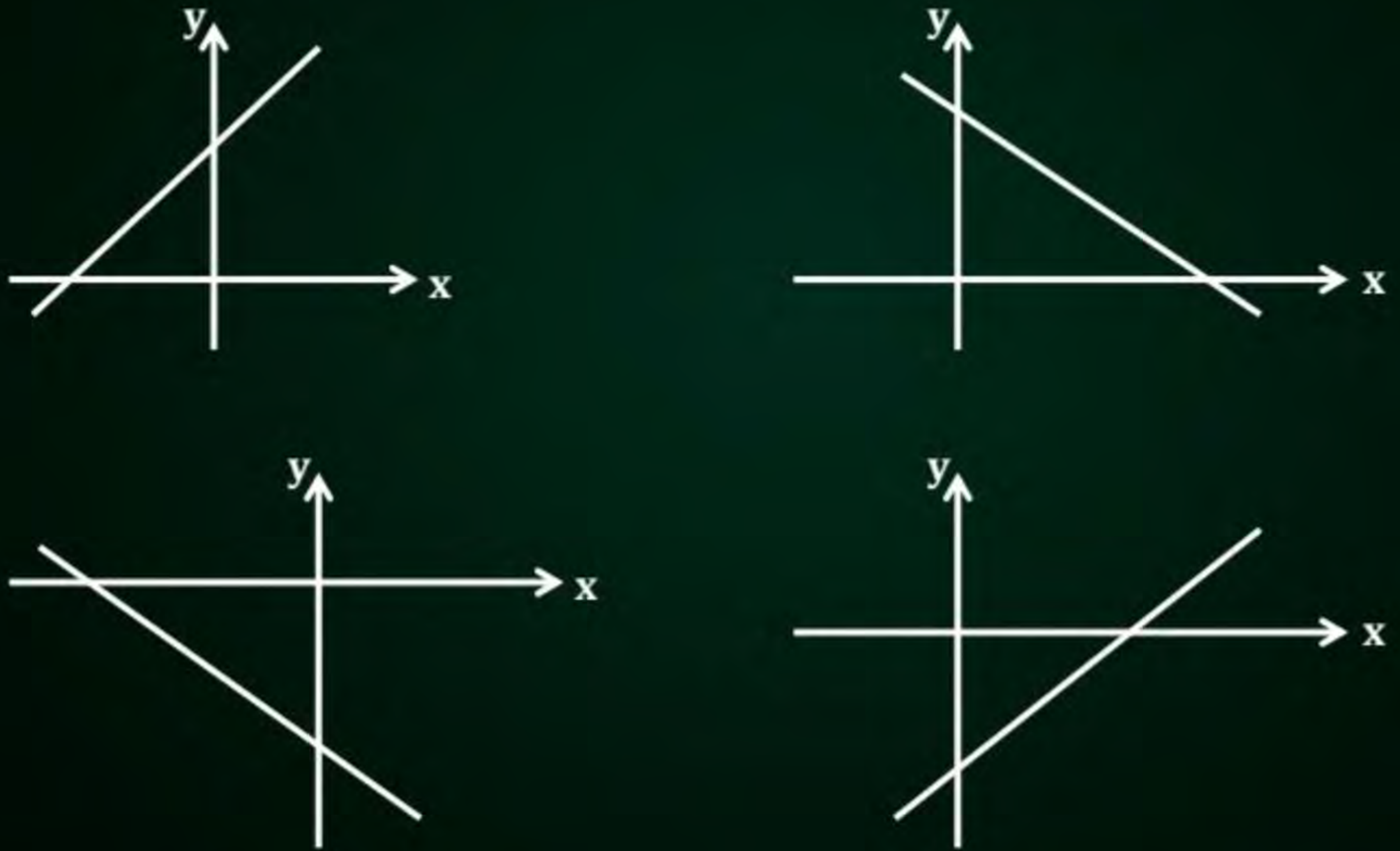
$$\frac{\text{Slope}_1}{\text{Slope}_2} = \frac{\tan 30^\circ}{\tan 60^\circ} = \frac{1}{\sqrt{3} \times \sqrt{3}}$$

$$= \frac{1}{3}$$

QUESTION

Comment on slope [redacted]

H/w



DPP → B
Assignment → 1


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 07 | **Physics**

Basic Maths and Calculus



By- Dr. Manish Raj (MR SIR)

Topics to be covered

1. PhD on straight line
2. Rectangular hyperbola
3. Parabola
4. Circle / ellipse



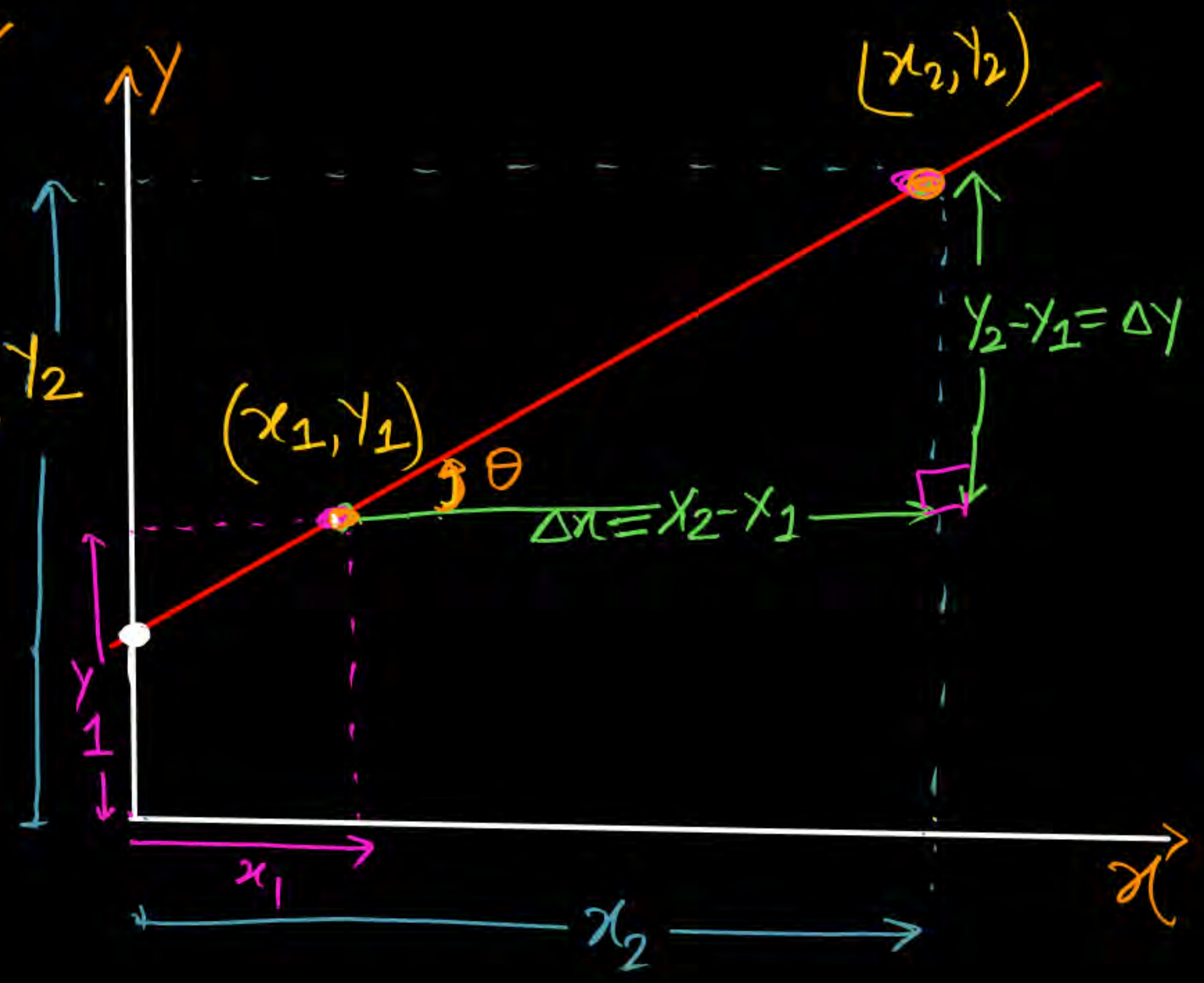
Distance formula

\# dist^n b/w two Point $= \sqrt{(x_2-x_1)^2 + (y_2-y_1)^2}$ ✓

\# If these two Point in 3-D space.

$$\text{dist}^n = \sqrt{(x_2-x_1)^2+(y_2-y_1)^2+(z_2-z_1)^2}$$ ✓

$$\text{Slope} = \tan\theta = \frac{y_2-y_1}{x_2-x_1} = m$$ ✓



$$m = \frac{y_2-y_1}{x_2-x_1}$$

(If intial Point (x_1, y_1) on y axis)

then $(x_1, y_1) = (0, c)$ — let

c is y intercept

c is value of y when $x=0$

$$m = \frac{y_2-c}{x_2}$$

$$m x_2 = y_2 - c$$

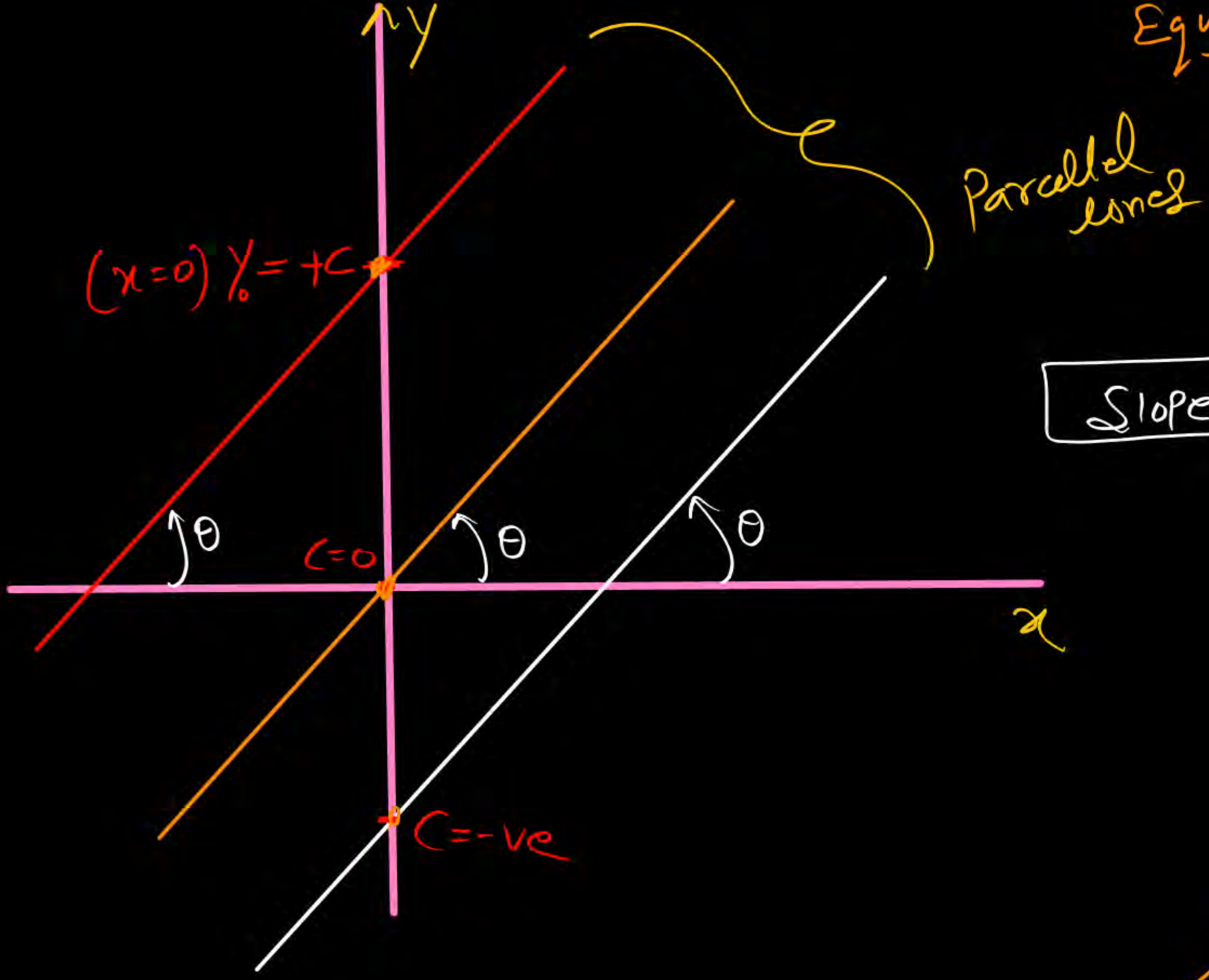
$$y_2 = m x_2 + c$$

eqn of straight line ← $$y = mx + c$$

Slope (fixed)

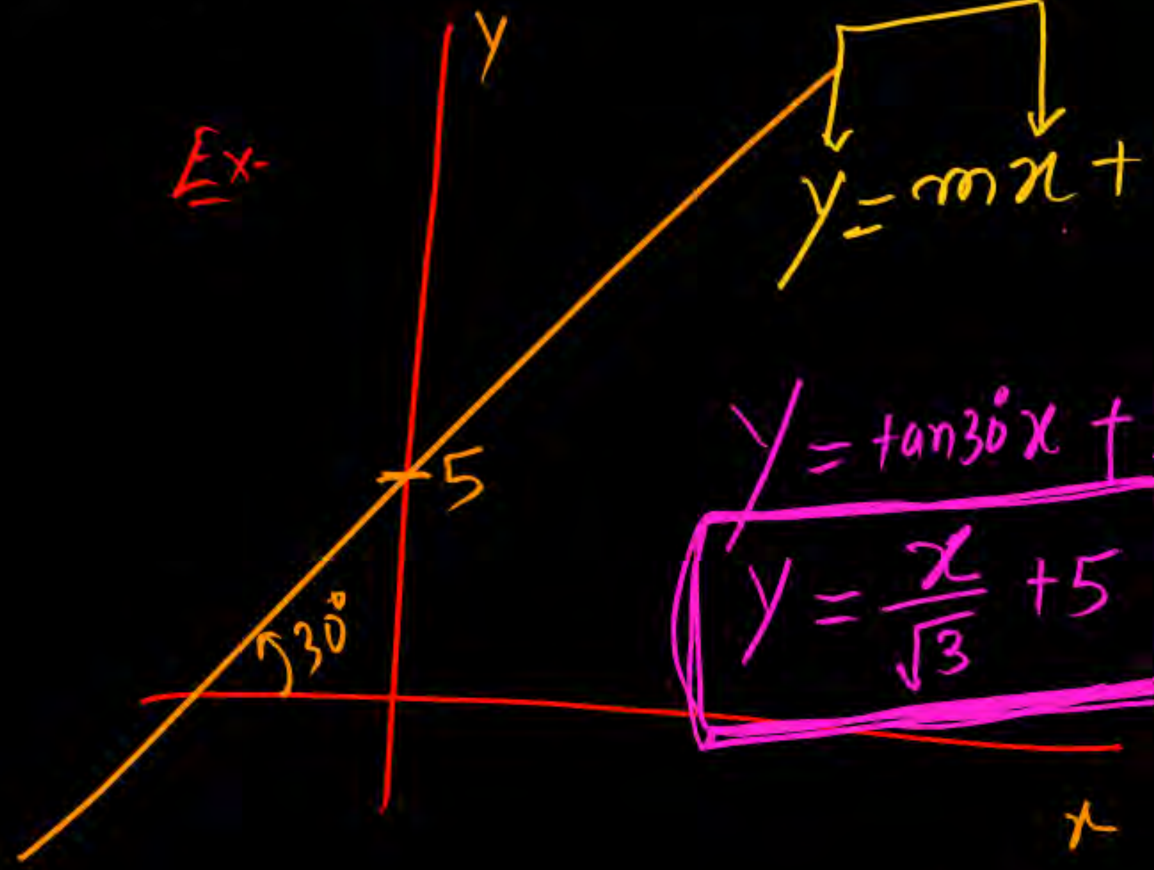
fixed (y-Intercept)

Equation of straight line



Slope equal for all three graph

Ex-



$y = mx + c$

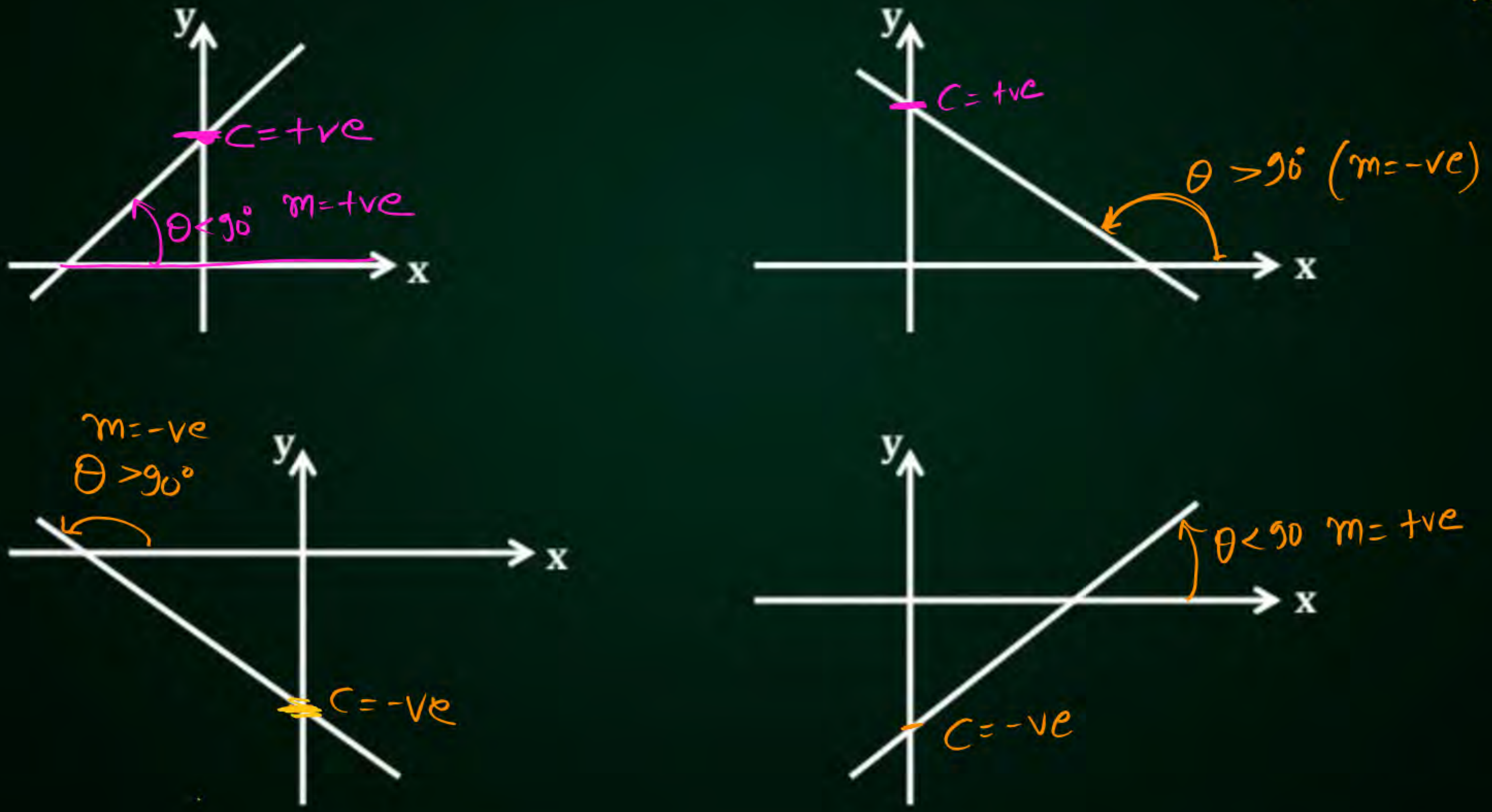
$y = \tan 30^\circ x + 5$

$$y = \frac{x}{\sqrt{3}} + 5$$

QUESTION

Comment on slope and intercept.





QUESTION

Find equation of a straight line passing through point (3, 4) and (2, 6).

(x_2, y_1)

$\tan\theta = m = \frac{6-4}{2-3} = \frac{y_2-y_1}{x_2-x_1} = \frac{2}{-1} = -2$

$y = mx + c$

$y = -2x + c$

Using one co-ordinate $(x, y) = (3, 4)$

$y = -2 \times 3 + c$

$y = -6 + c$

* $c = 10$

$y = -2x + 10$

QUESTION

Draw graph having Y-intercept 4 and passing through (2, 6).

(x, y)

$x = 0$

$y = c = 4$

$y = mx + c$

$y = mx + 4$

using co-ordinate $(2, 6)$

$6 = m2 + 4$

$2 = m \times 2$

$m = 1$

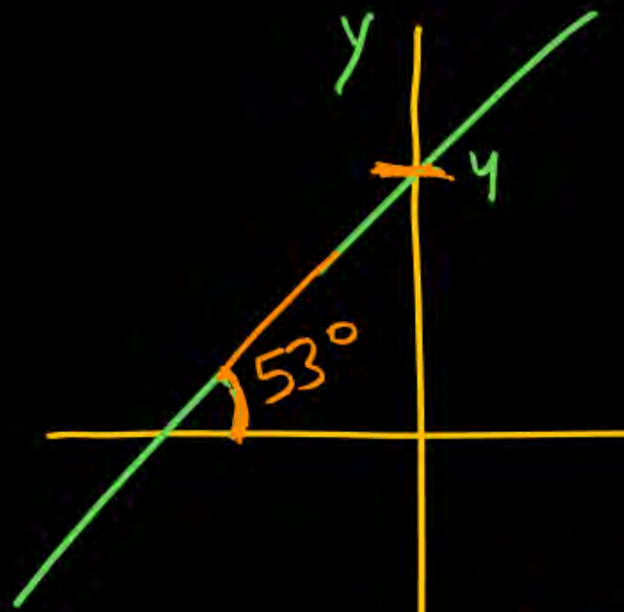
$y = mx + c$

$y = 1x + 4$

$\tan\theta$



write eqn for given graph#



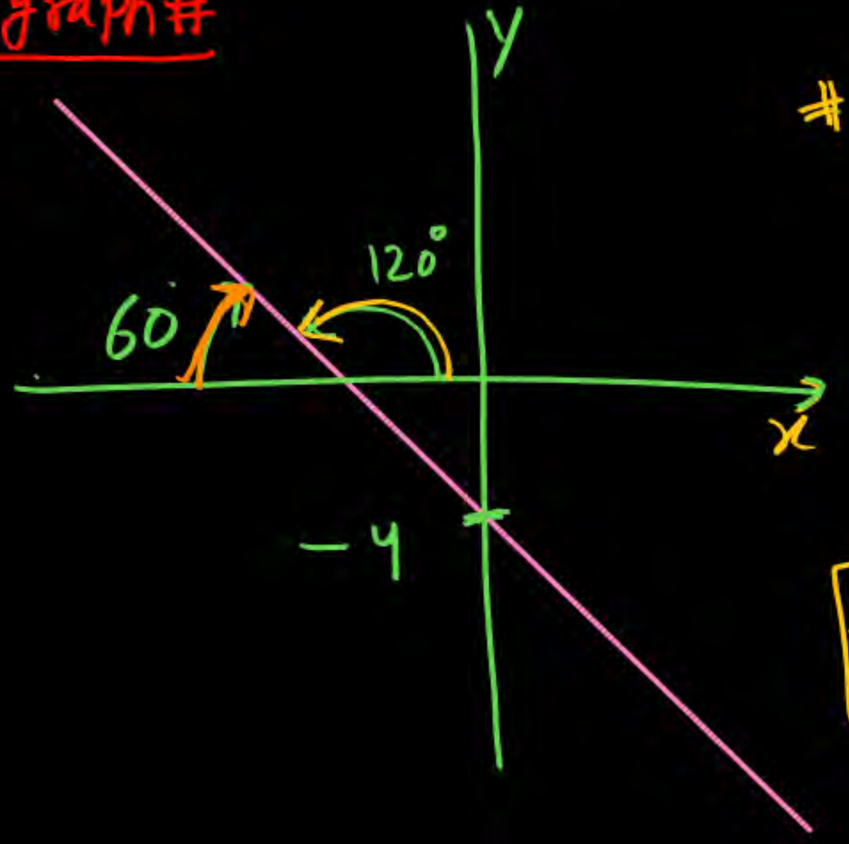
$$y = mx + c$$

$$y = \frac{4}{3}x + 4$$ Ans

x

$c = 4$

$m = \tan 53° = \frac{4}{3}$



$c = -4$

$m = \tan 120°$
$= -\sqrt{3}$ (*)(*)

$y = mx + c$

$$y = -\sqrt{3}x - 4$$

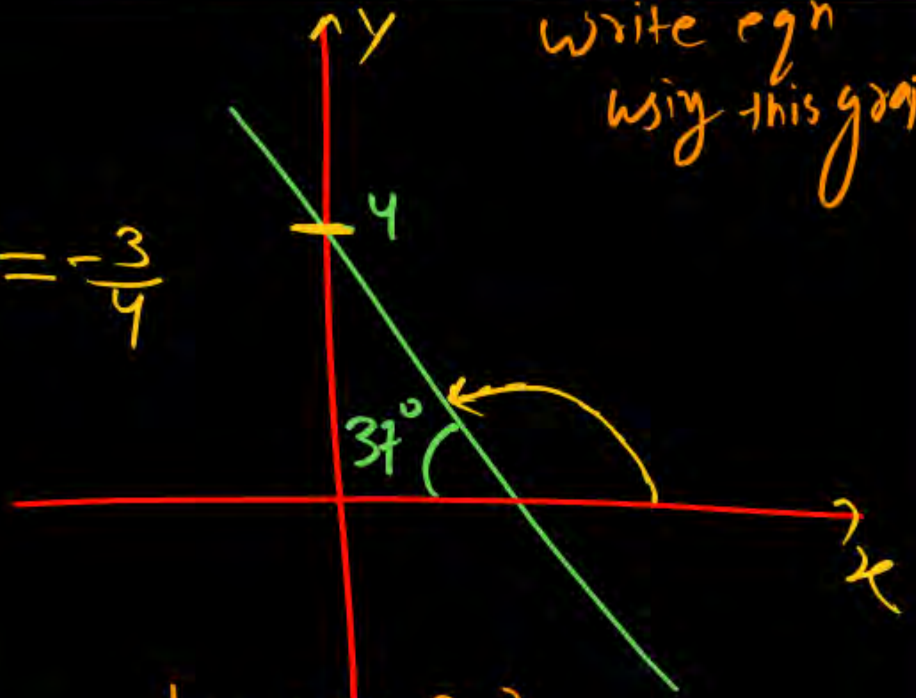
$c = 4$

$m = -\tan 37° = -\frac{3}{4}$

$y = mx + c$

$$y = -\frac{3x}{4} + 4$$

Ans



write eqn using this graph.

$\tan 37° = \frac{3}{4}$
$\tan 53° = \frac{4}{3}$



$c = -2$

$m = \tan 30°$
$= \frac{1}{\sqrt{3}}$

$$y = \frac{1}{\sqrt{3}}x - 2$$

QUESTION

Draw graph passing through (2, 3) and slope 1.

$m = \tan\theta = 1$

$y = mx + c$

$y = 1x + c$

using co-ordinate (2, 3)
(x, y)

$3 = 2 + c$

$c = 3 - 2 = 1$

$y = mx + c$

$y = x + 1$

QUESTION

Find equation of the line which makes intercept +4 and 5 on the x and y-axis.

(A) $5x + 4y + 20 = 0$

(B) $4y + 5x - 20 = 0$

(C) $4y - 5x = -20$

(D) $4x + 5y + 20 = 0$

$4x + 5y = -20$

$x = 0$, $y = c = -5$

(x intercept: $y = 0$)

(y - Intercept: $x = 0$)

2nd equation

$4y + 5x - 20 = 0$

$x = 0, y = c$

$4c - 20 = 0$

$c = \frac{20}{4} = +5$

$y = 0$, $x = c$

$5c_1 - 20 = 0$

$5c_1 = 20$

$c_1 = +4$

x - Intercept.

QUESTION

Draw graph between y and x for given equation :

(i) $y = \sqrt{3}x + 4$

(ii) $y = -x$

(iii) $y = x$

(iv) $\frac{x}{3} + \frac{y}{4} + 1 = 0$

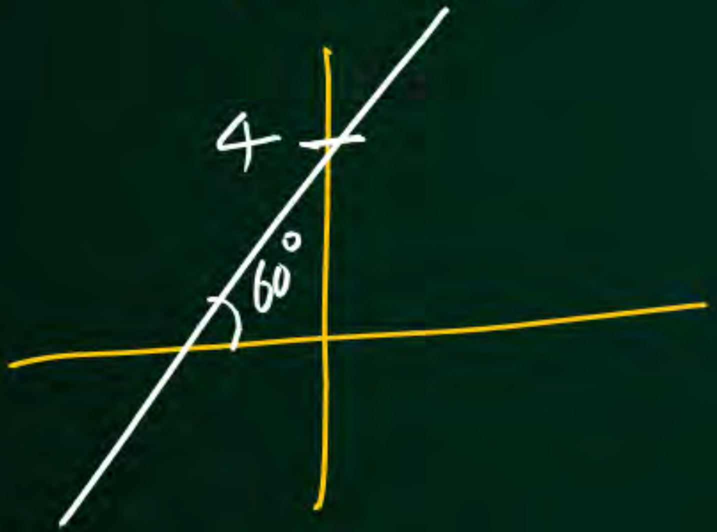
$\frac{y}{4} = -\frac{x}{3} - 1$

$y = -\frac{4}{3}x - 4$

Sol^n (i) $y = \sqrt{3}x + 4$

$\tan\theta = m = \sqrt{3}$ | $c = 4$

$\theta = 60^\circ$



(ii) $y = -x$

$y = mx + c$

$c = 0$ | $m = \tan\theta = -1$

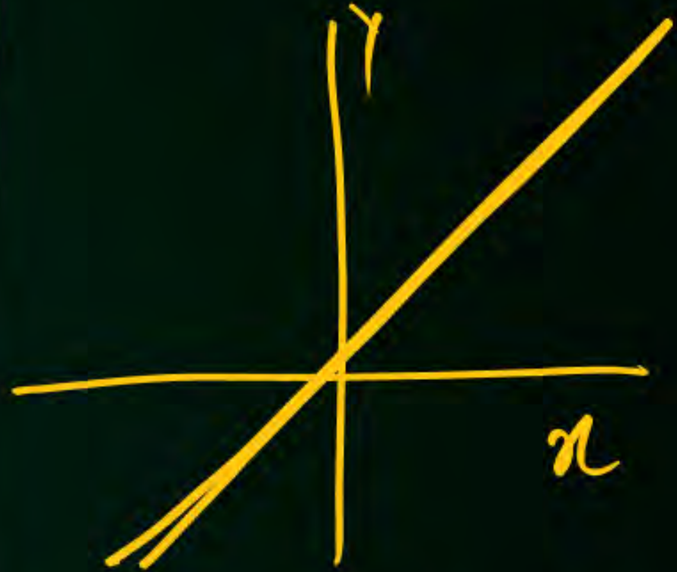
$\theta = 135^\circ$



(iii) $y = x$

$c = 0$ $\tan\theta = m = 1$

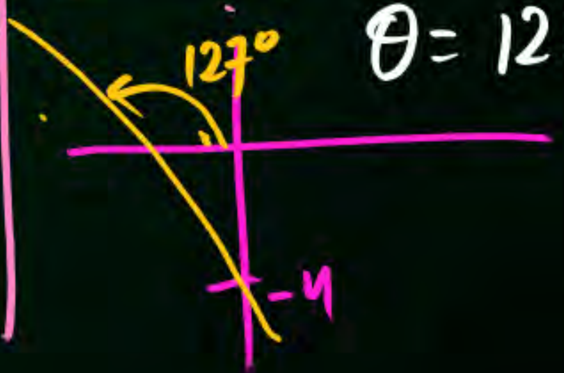
$\theta = 45^\circ$



(iv) $y = -\frac{4}{3}x - 4$

$c = -4$ $\tan\theta = -\frac{4}{3}$

$\theta = 127^\circ$



find velocity of object at $t = 4\,sec$.

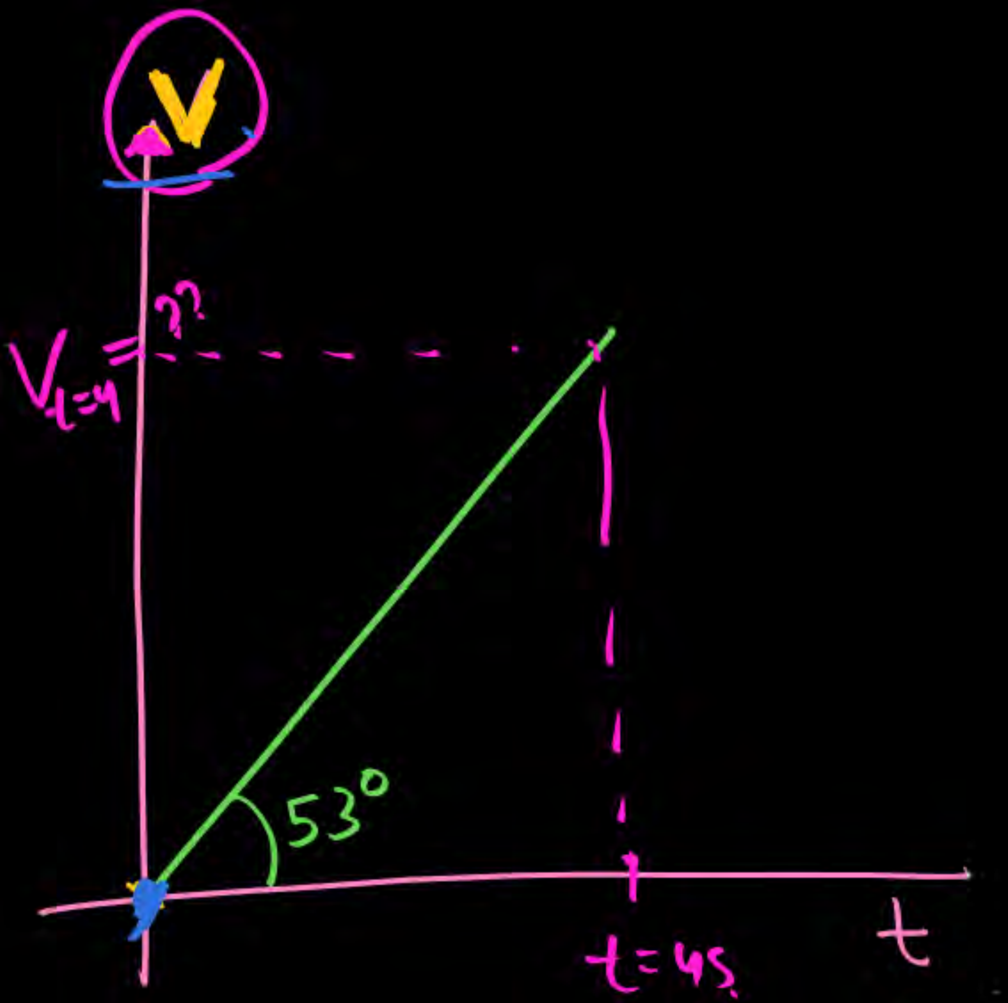
$$\{\; y = mx + c \;\}$$

$$V = \tan 53^\circ \times t + 0$$

$$V = \frac{4}{3} t$$

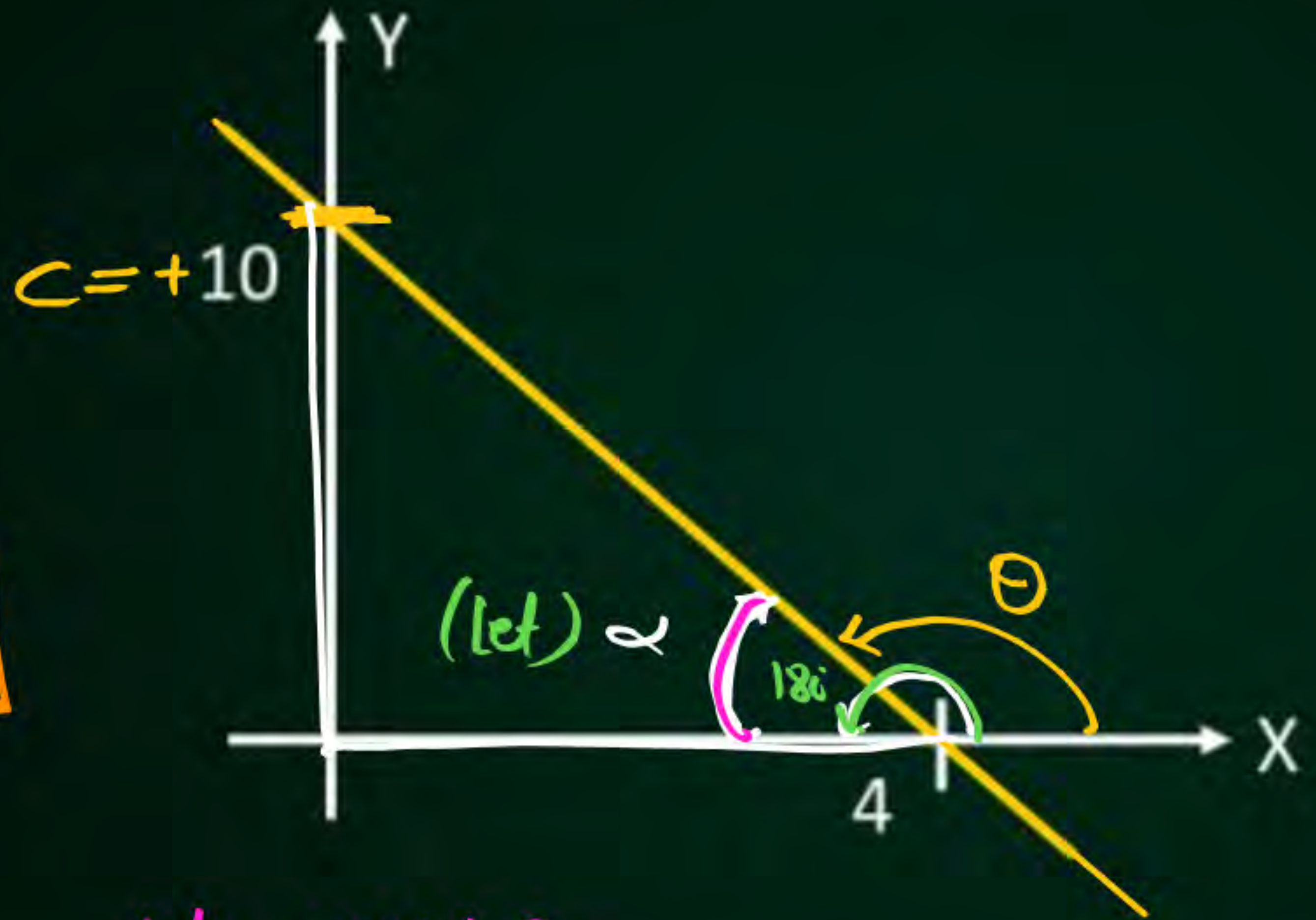
$$V_{t=4\,sec} = \frac{4}{3} \times 4 = \frac{16}{3}\ m/s$$

y intercep is value of y when $x = 0$ in eqn



QUESTION

Find slope of graph and value of y at $x = 2$.



$C = 10$

$m = \tan\theta = \tan(180 - \alpha)$

$m = -\tan\alpha = -\frac{10}{4}$

$m = -\frac{5}{2}$

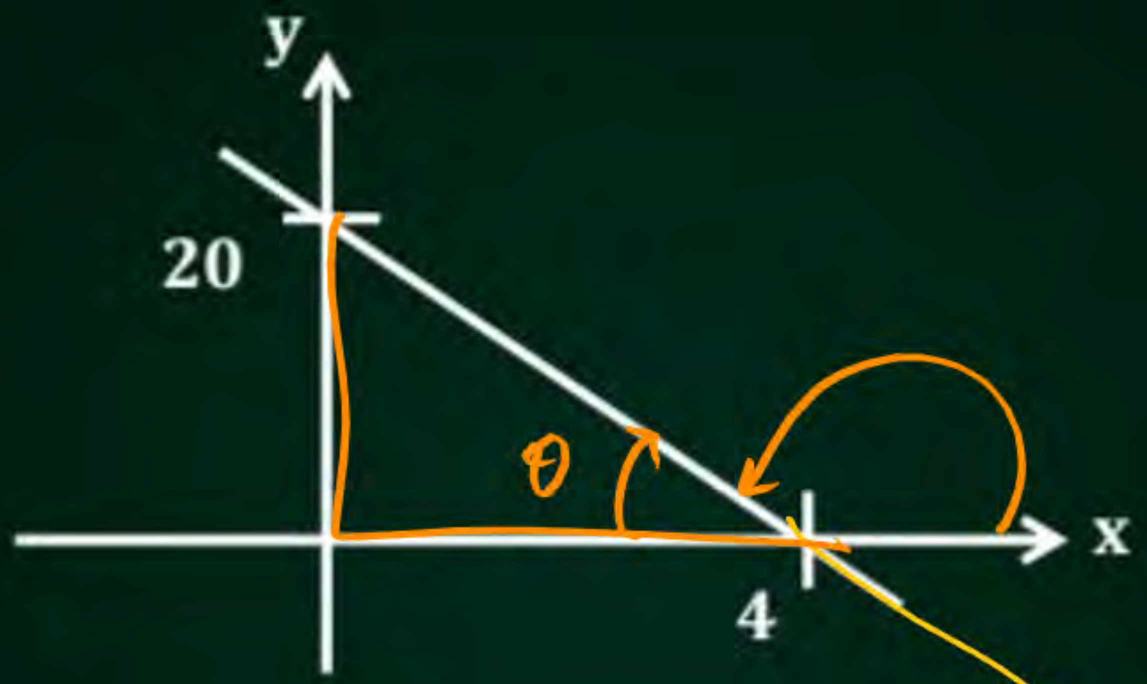
$y = mx + c$

$y = -\frac{5}{2}x + 10$

$y = -\frac{5}{2} \times 2 + 10 = 5$

QUESTION

Find value of y at $x = 8$



$c = +20$

$m = -\tan\theta = -\frac{20}{4} = -5$

$m = -5$

$y = mx + c$

$y = -5x + 20$

$y = -5 \times 8 + 20$

$y = -40 + 20$

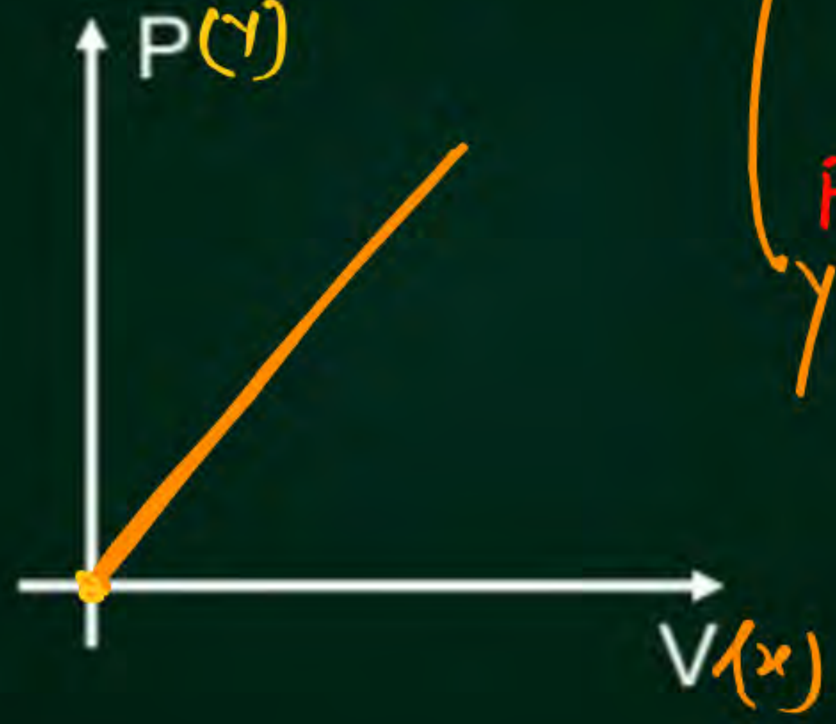
$y = -20$

GRAPH

Draw graph between momentum and velocity P = mV.

$P = mu$

$y \propto x$



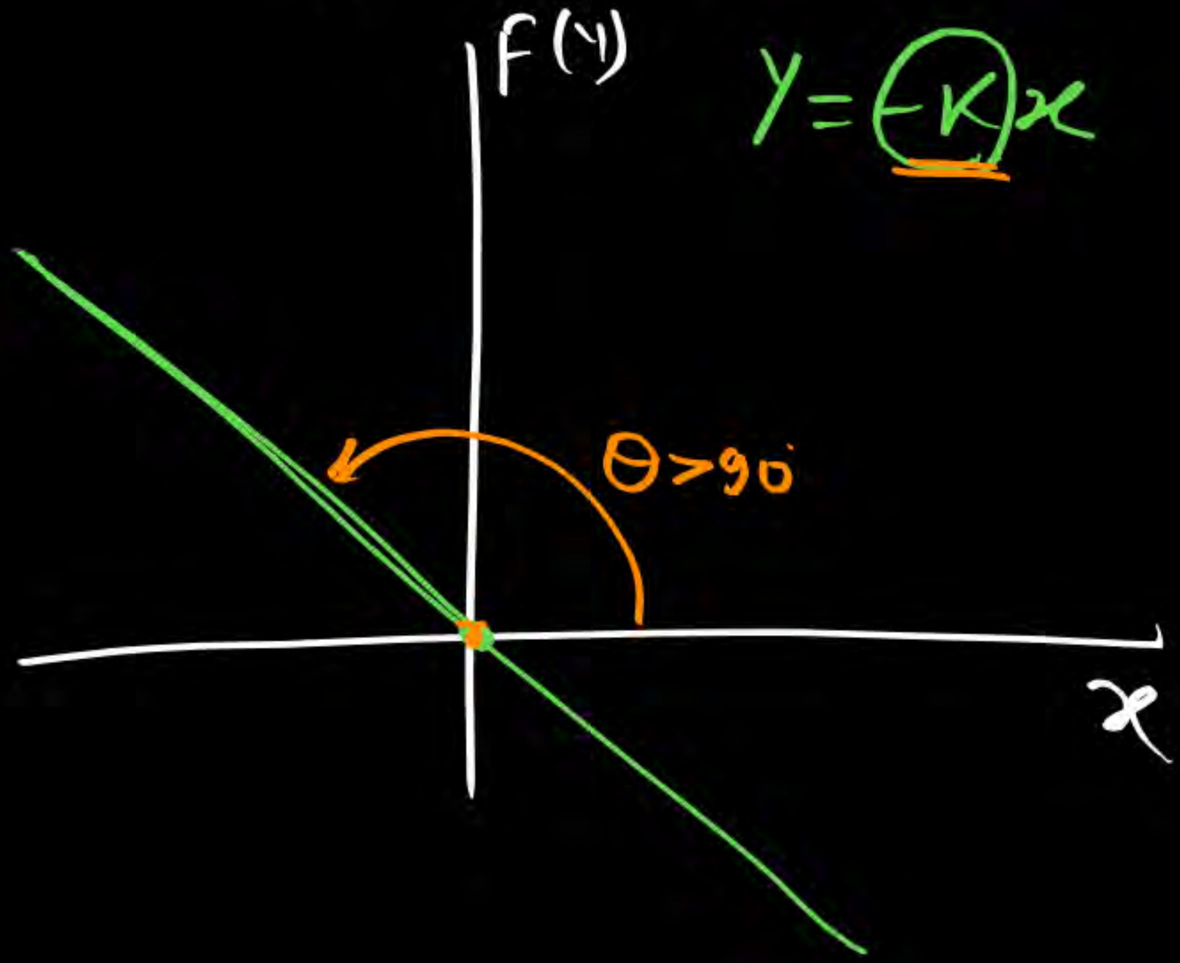
$m \rightarrow$ const^n

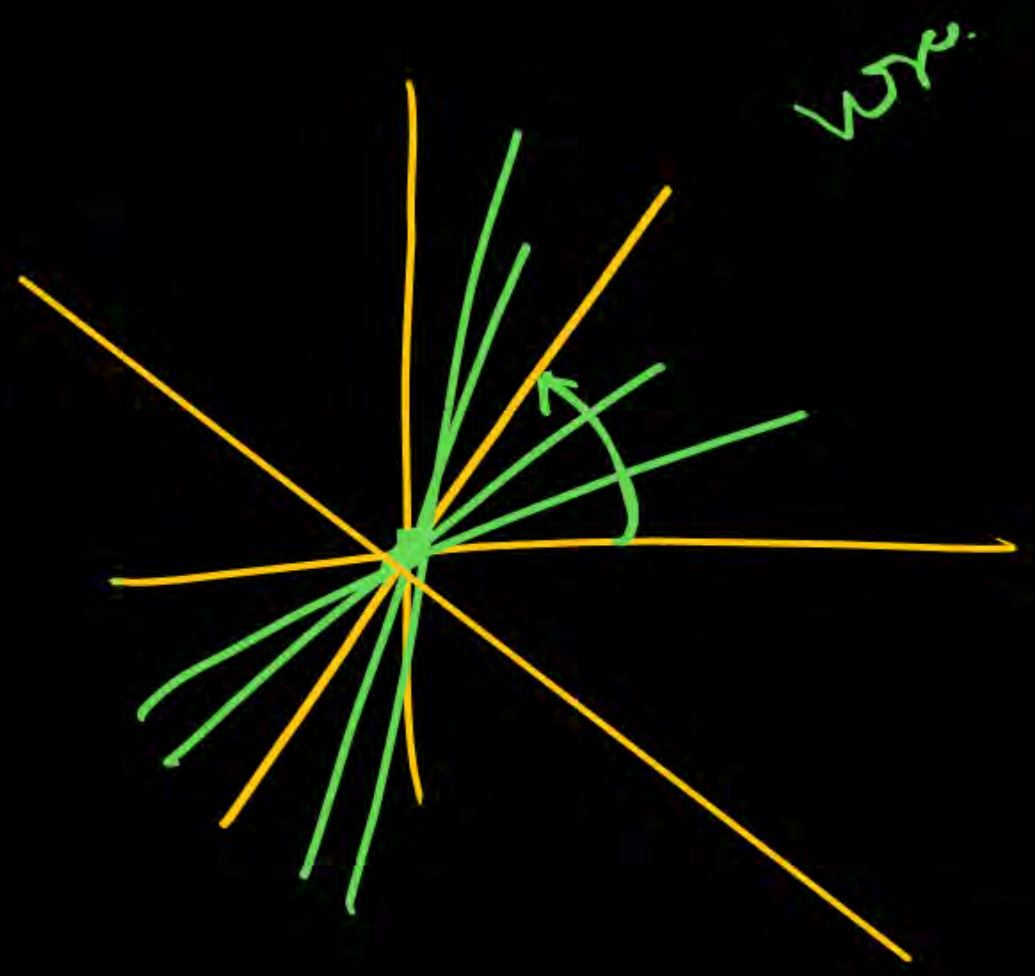
$P \propto V$

$y = mx + 0$

Draw graph b/w spring force & elongation.

$$F = -Kx$$





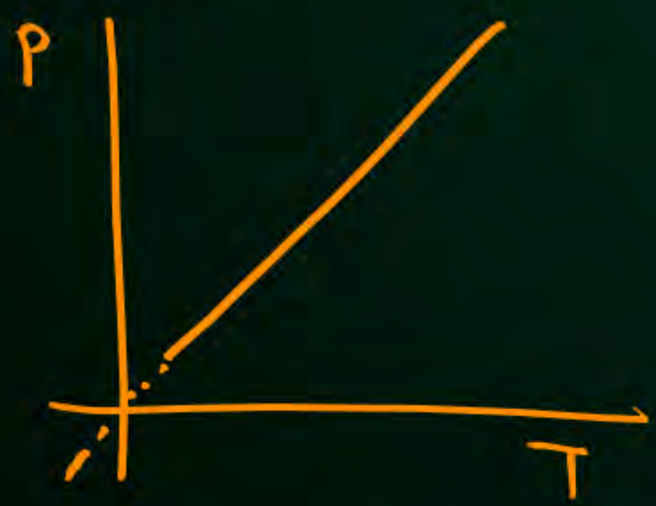
QUESTION

$PV = nRT$

Draw graph between pressure temptation for constant volume.

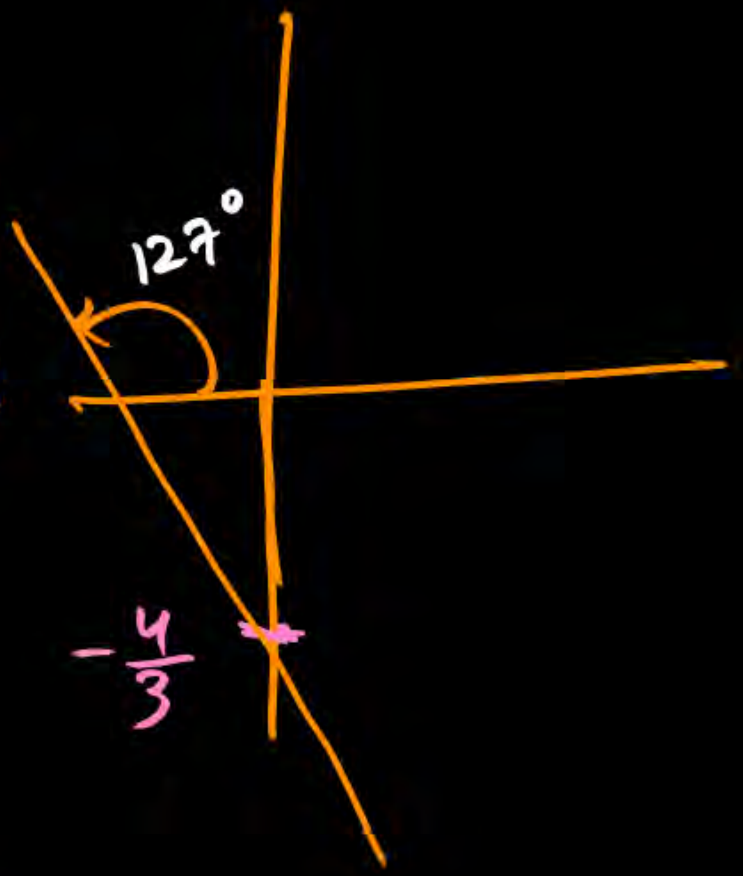
$PV = nRT$ (V, nR → const)

$P \propto T$



(i) $4x + 3y + 4 = 0 \Longrightarrow 3y = -4x - 4$

$$\boxed{y = -\frac{4}{3}x - \frac{4}{3}}$$



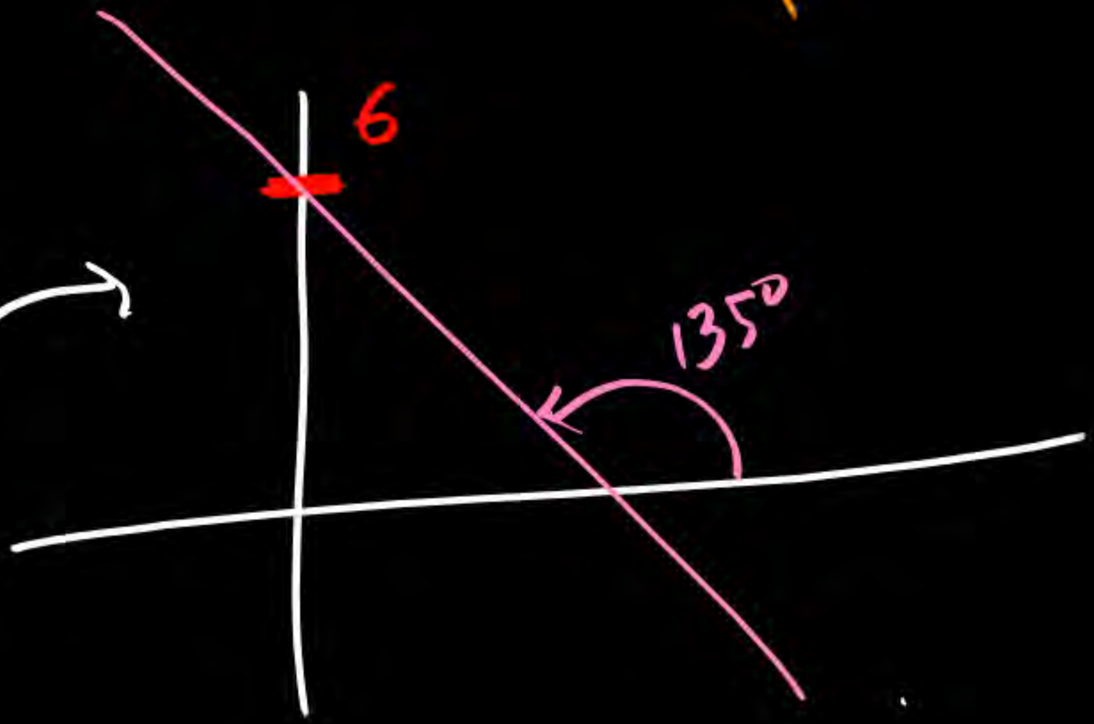
(ii) $(x-4) + (y+3) = 5$

Sol^n $x - 4 + y + 3 = 5$

$y + x = 5 + 4 - 3 = 6$

$$\boxed{y = -x + 6}$$

$\tan\theta = -1$

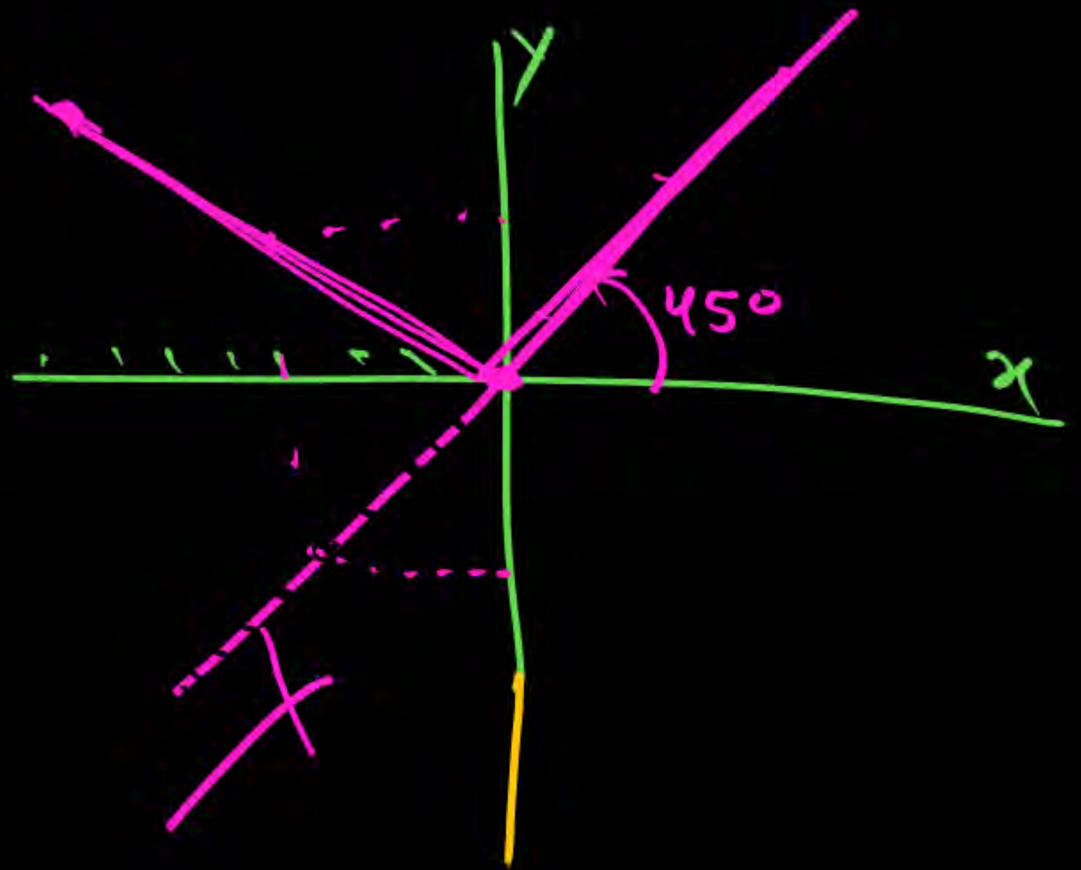


(iii) $y = |x|$

MP*
Step-1 Remove Mod & Draw simple graph ✓

$y = x$

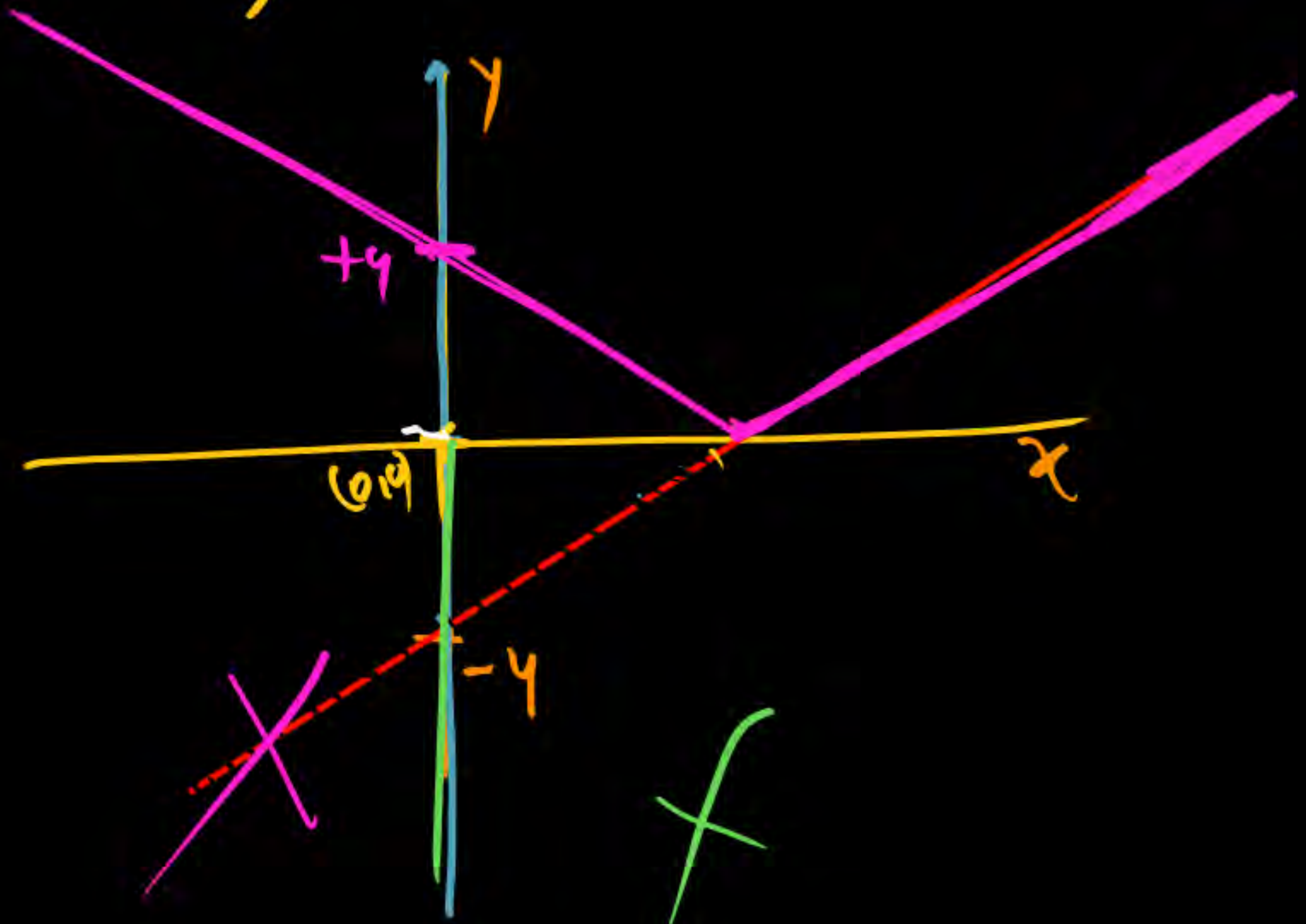
Step-2 where y is negative in graph take its mirror Image along x-axis



$y = |x-4|$

→ step-1 (Remove mod)

$$y = x-4$$



QUESTION

Draw graph between stopping potential V_0 and energy of photon for given equation $E = \phi + eV_0$

E ↑ energy of Photon

V_0 ↑ stopping Potential

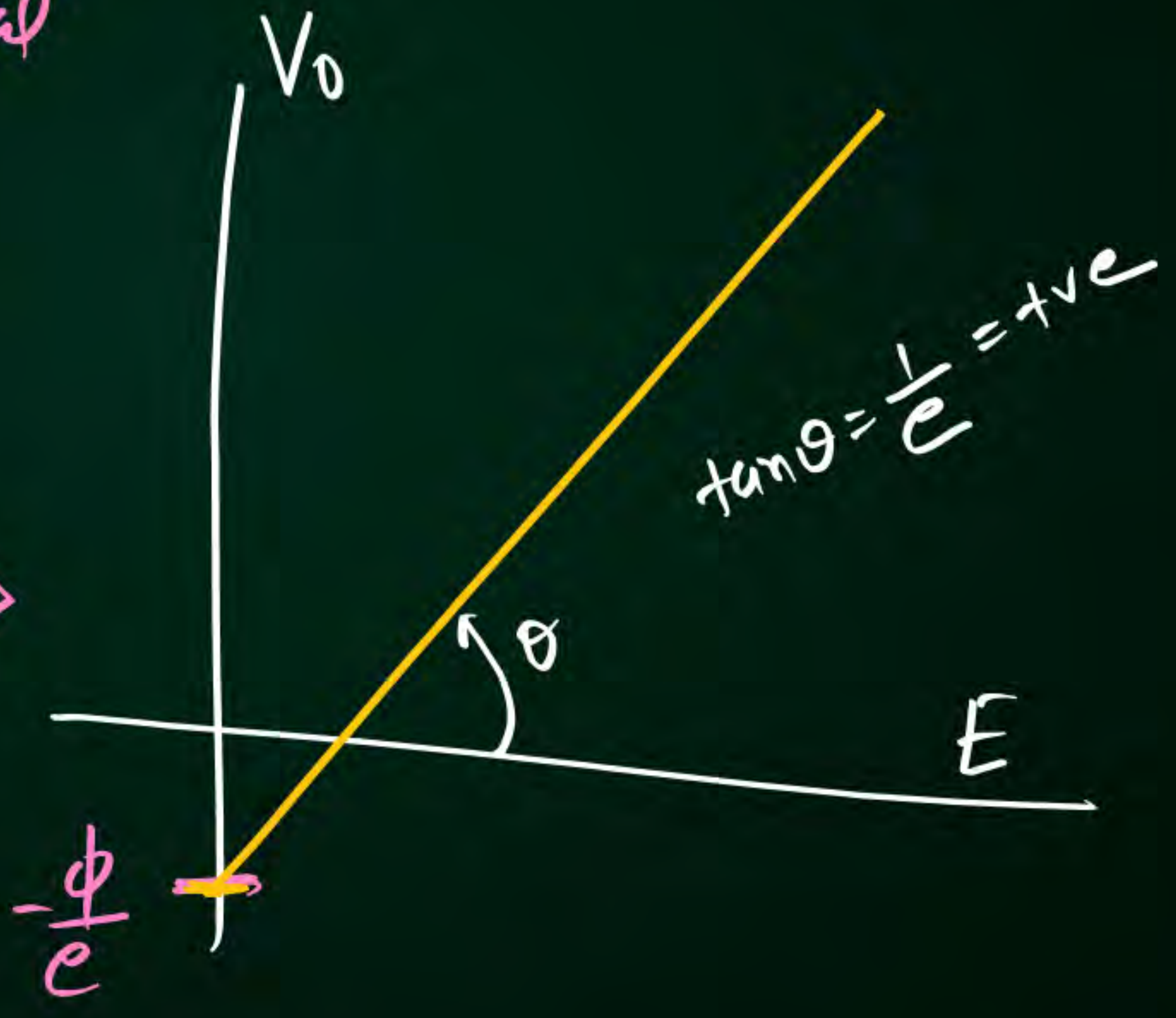
$$E = \phi + eV_0$$

$$eV_0 = E - \phi$$

$$V_0 = \frac{E}{e} - \frac{\phi}{e}$$

$$y = \frac{x}{e} - \frac{\phi}{e}$$

$y = mx + c$



Level up

$$\frac{C-0}{100-0} = \frac{K-273}{373-273}$$

given in question

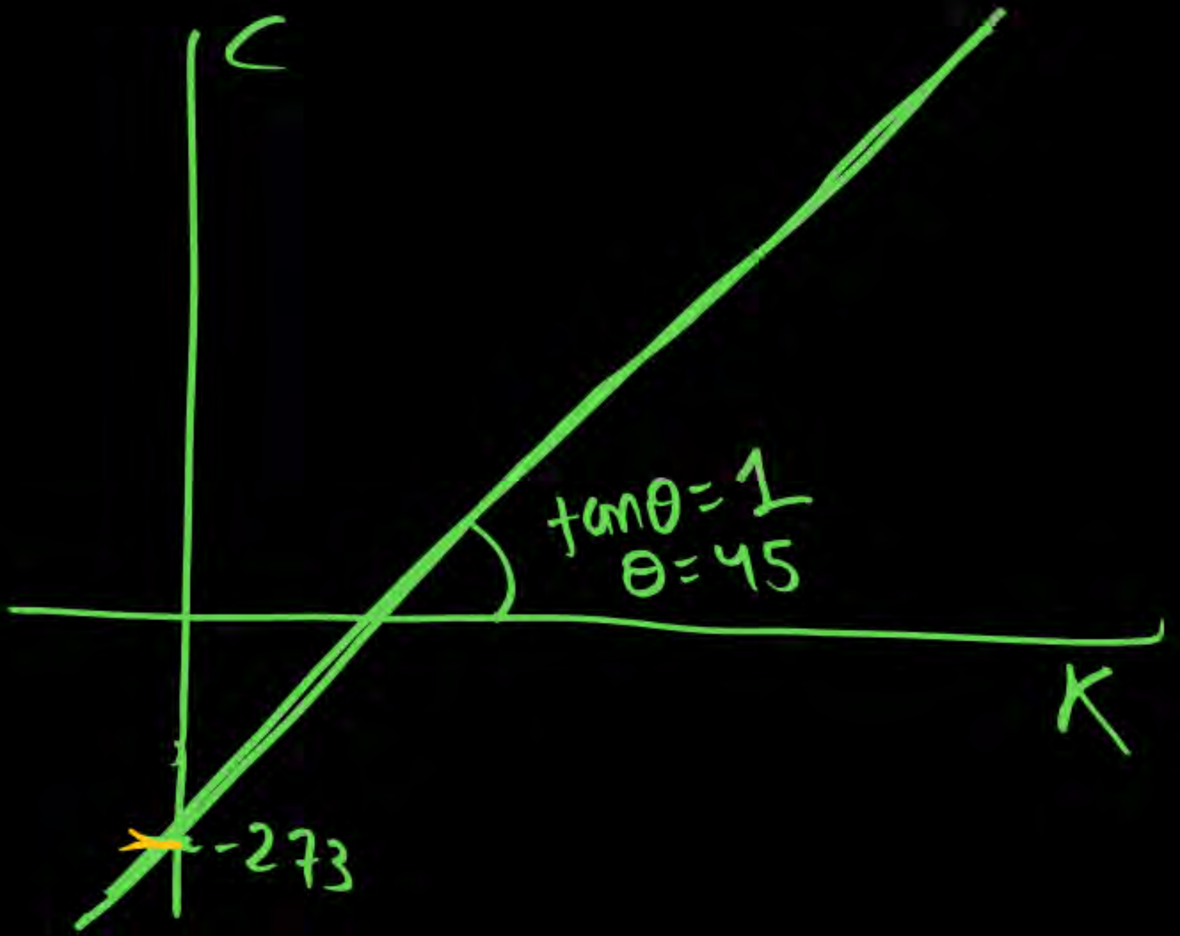
Draw grap B/w C & K.

Sol^n

$$\frac{C}{100} = \frac{K-273}{100}$$

$$C = K - 273$$

$$y = mx + c$$



$y = mx + c$ (directly Propotional)

(linear equation)

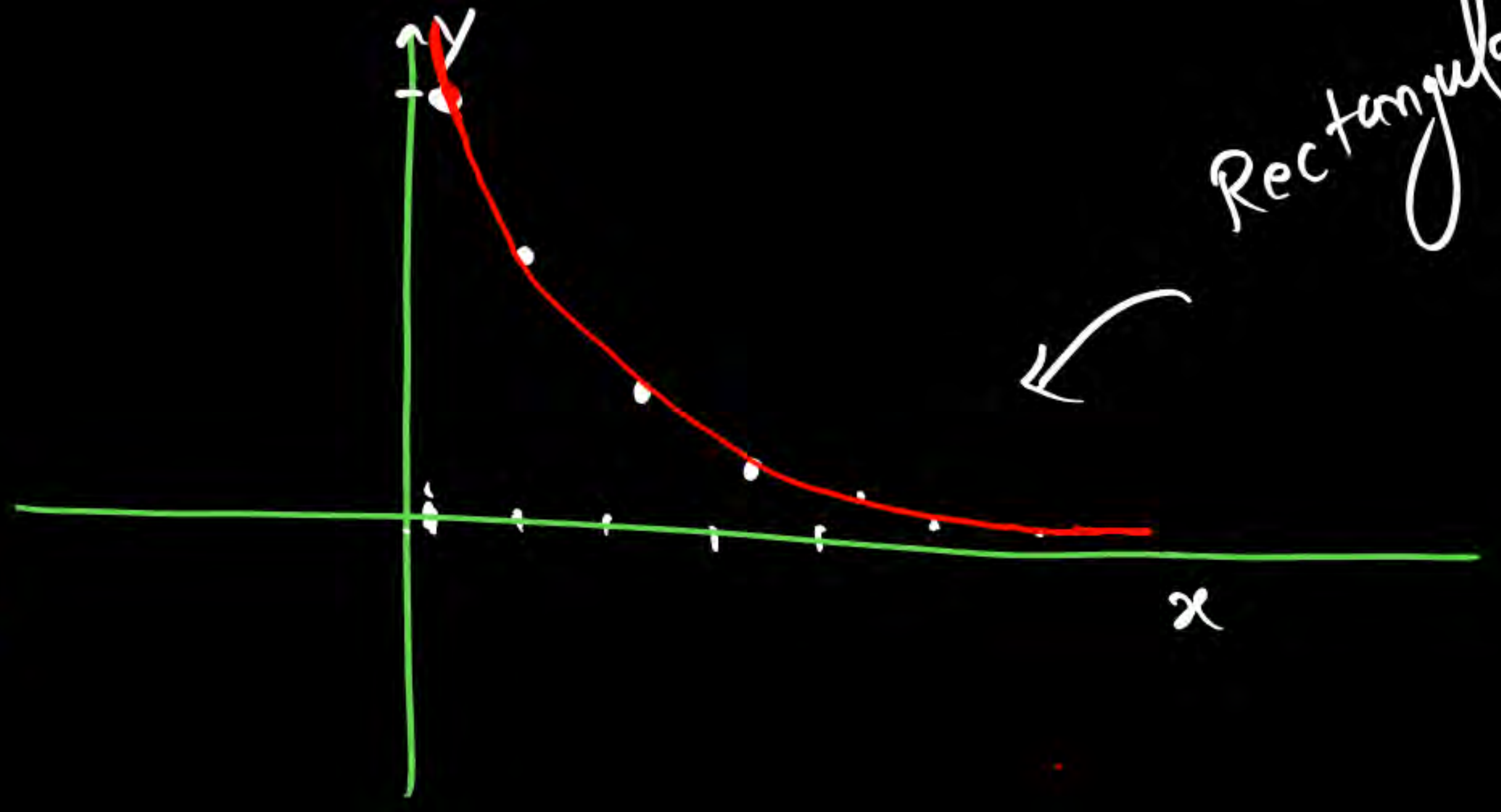
$y = \frac{K}{x}$ (K = const^n^)

If $K = 1$

$$y = \frac{1}{x}$$ (Inversly Propotional) (Non-linear variation)

y	x
100	0.01
10	0.1
5	0.2
2	0.5
1	1
0.5	2
0.2	5
0.1	10
0.01	100

x increasing & y is decreasing

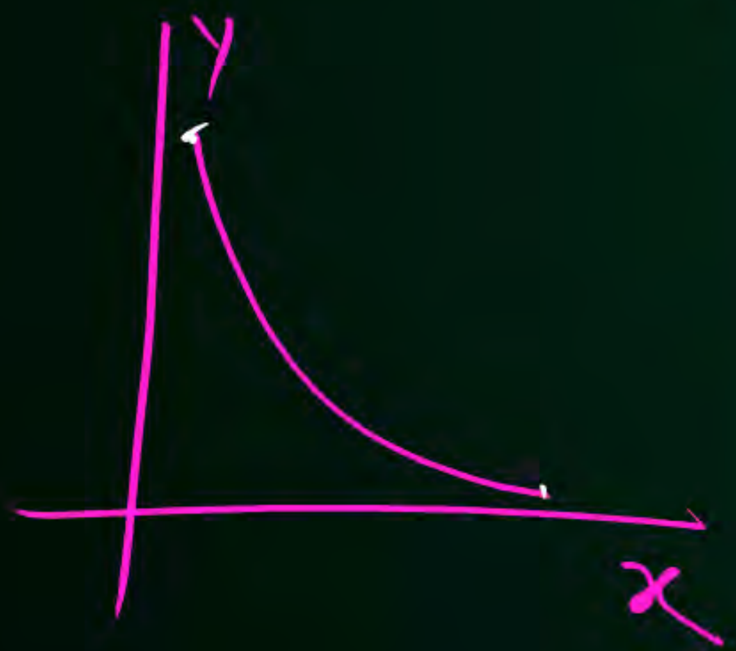


Rectangular hyperbola

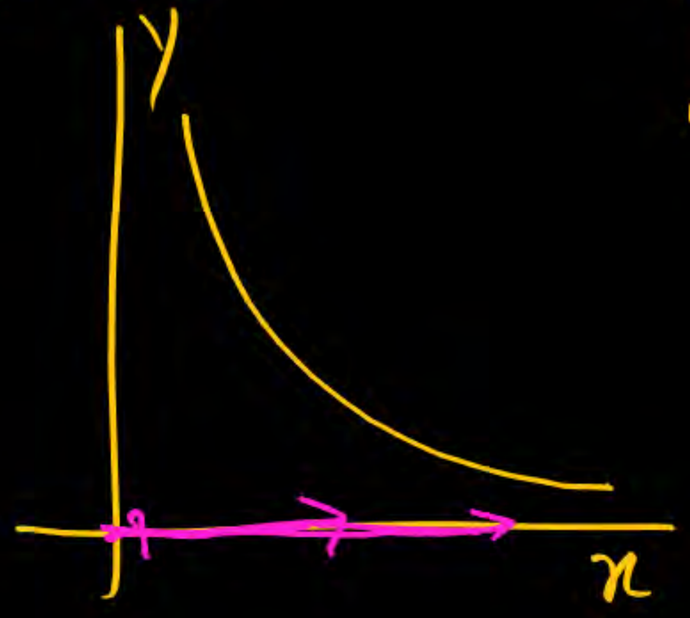
RECTANGULAR HYPERBOLA

Inverse Relations

$y = \frac{1}{x}$



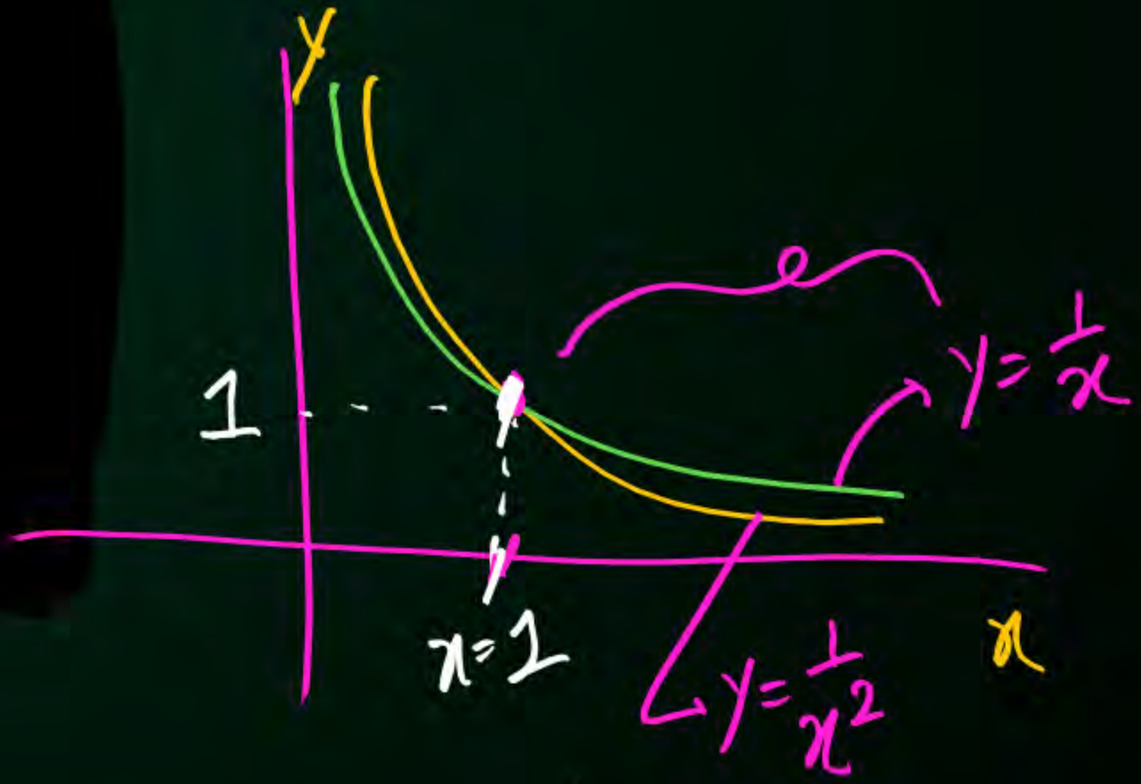
$y = \frac{1}{x^2}$

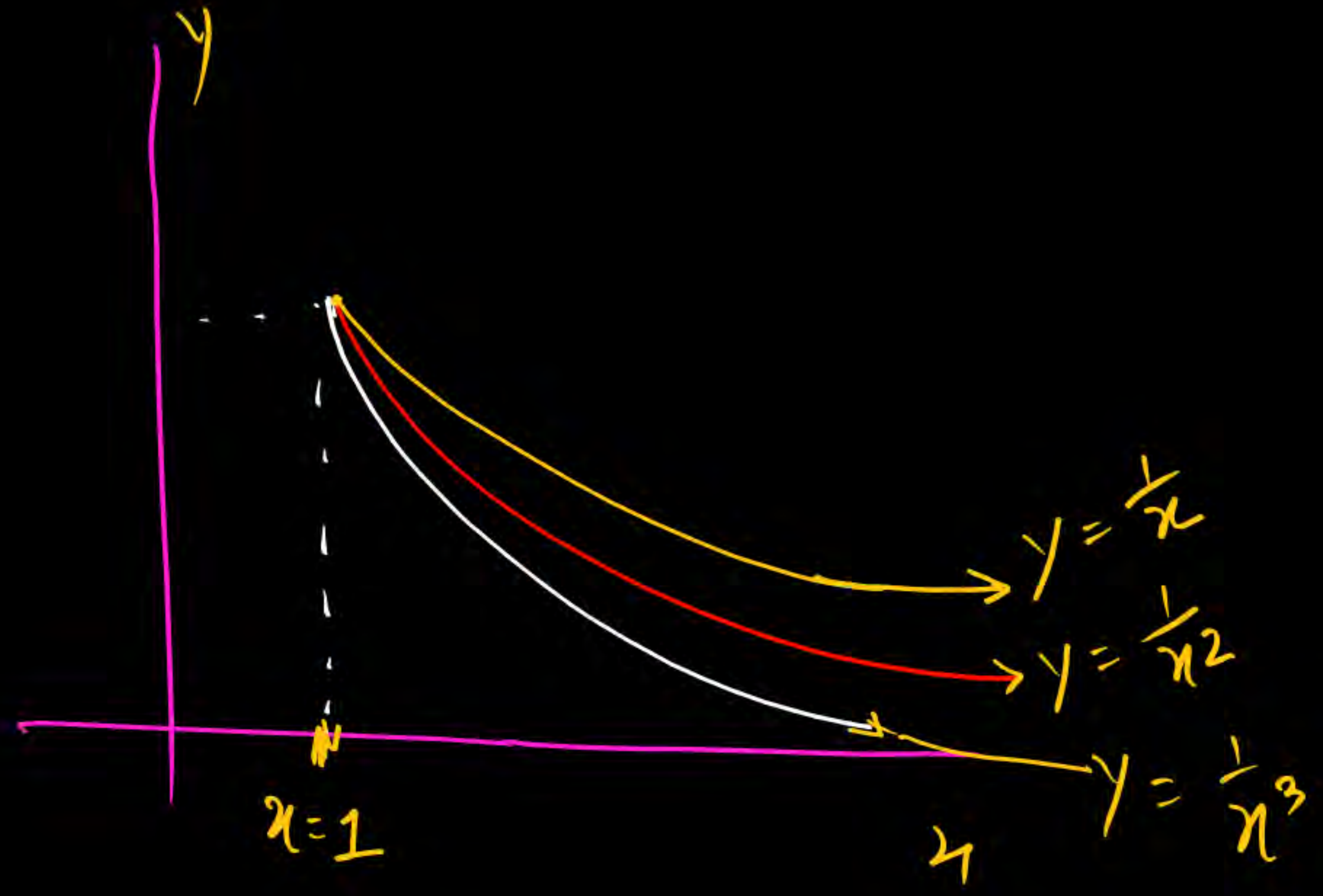


y	x
100	0.1
1	1
0.25	2
0.04	5
0.01	10
0.0001	100

$\downarrow y = \frac{1}{x\uparrow}$

$\downarrow\downarrow y = \frac{1}{x^2\uparrow}$

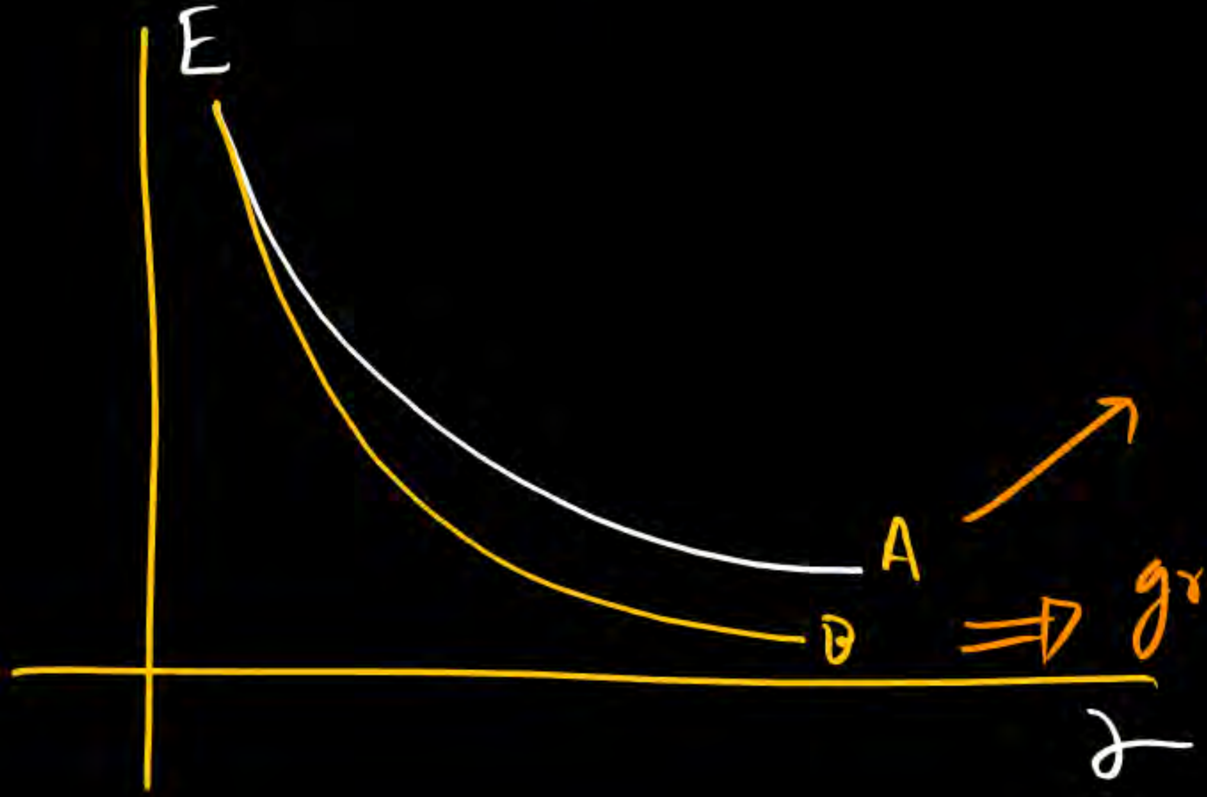



y
$y = \frac{1}{x}$
$y = \frac{1}{x^2}$
$y = \frac{1}{x^3}$
$x = 1$
4

Ex –

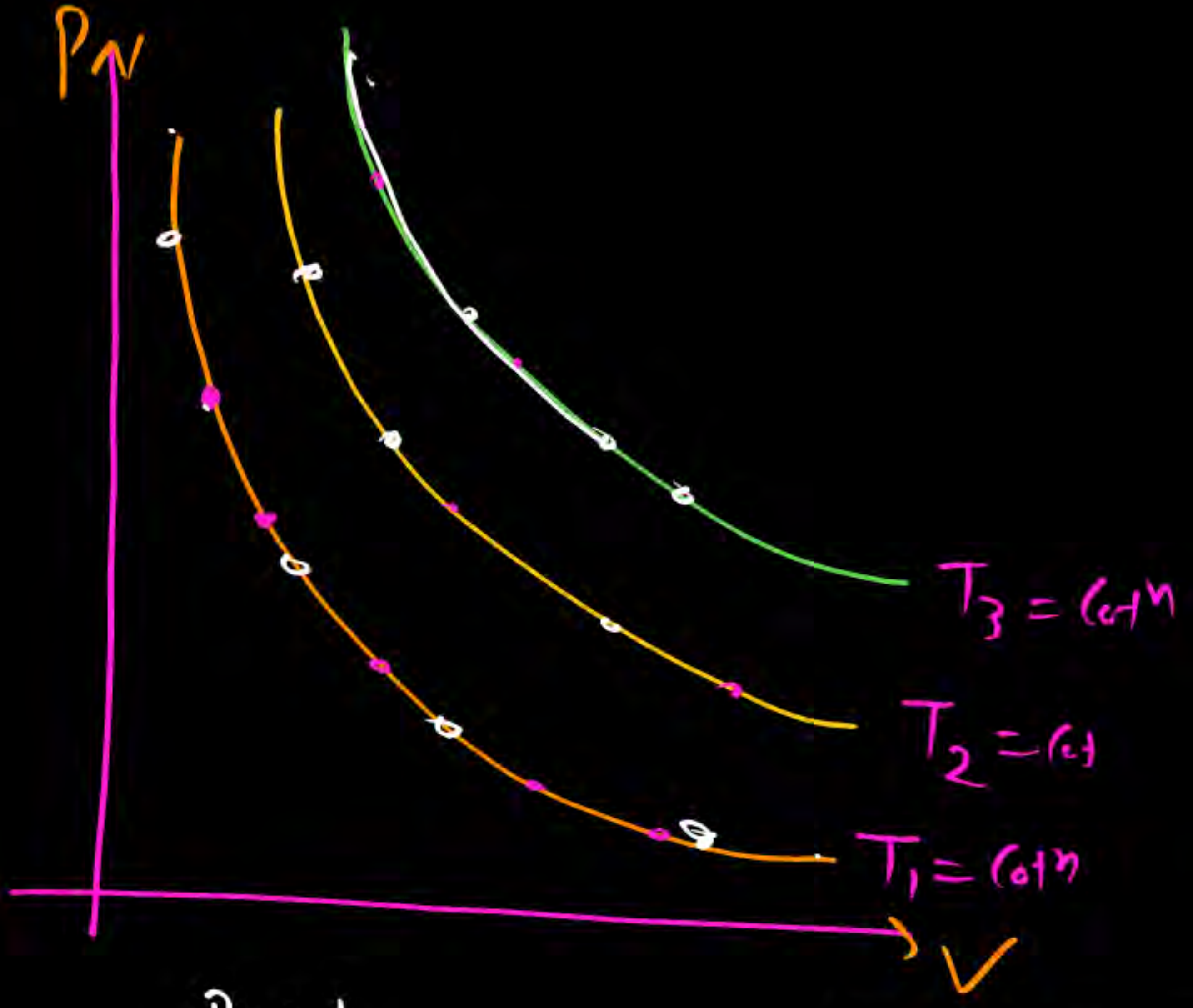
$$E_{\text{Point charge}} = \frac{KQ}{r^2} \quad \text{(KQ circled — Cst)}$$

$$E_{\text{dipole}} = \frac{2KP}{r^3}$$



A → Electric field due to point chg

graph B → for Electric field due to dipole



$P \propto \frac{1}{V}$

$PV = \text{Cot}^n = \boxed{nRT}$

$\boxed{T_3 > T_2 > T_1}$

$y = \frac{1}{x}$

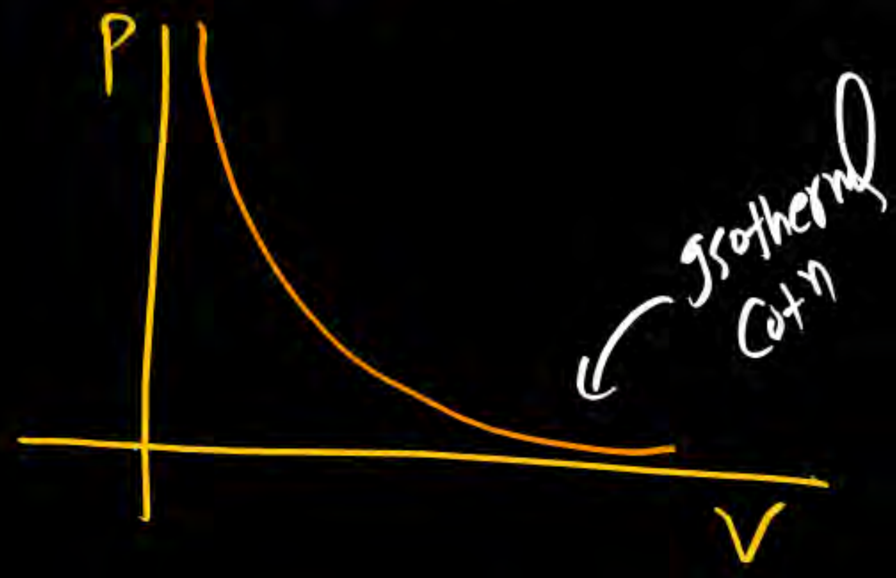
$\boxed{yx = \text{Cot}^n}$ ✓

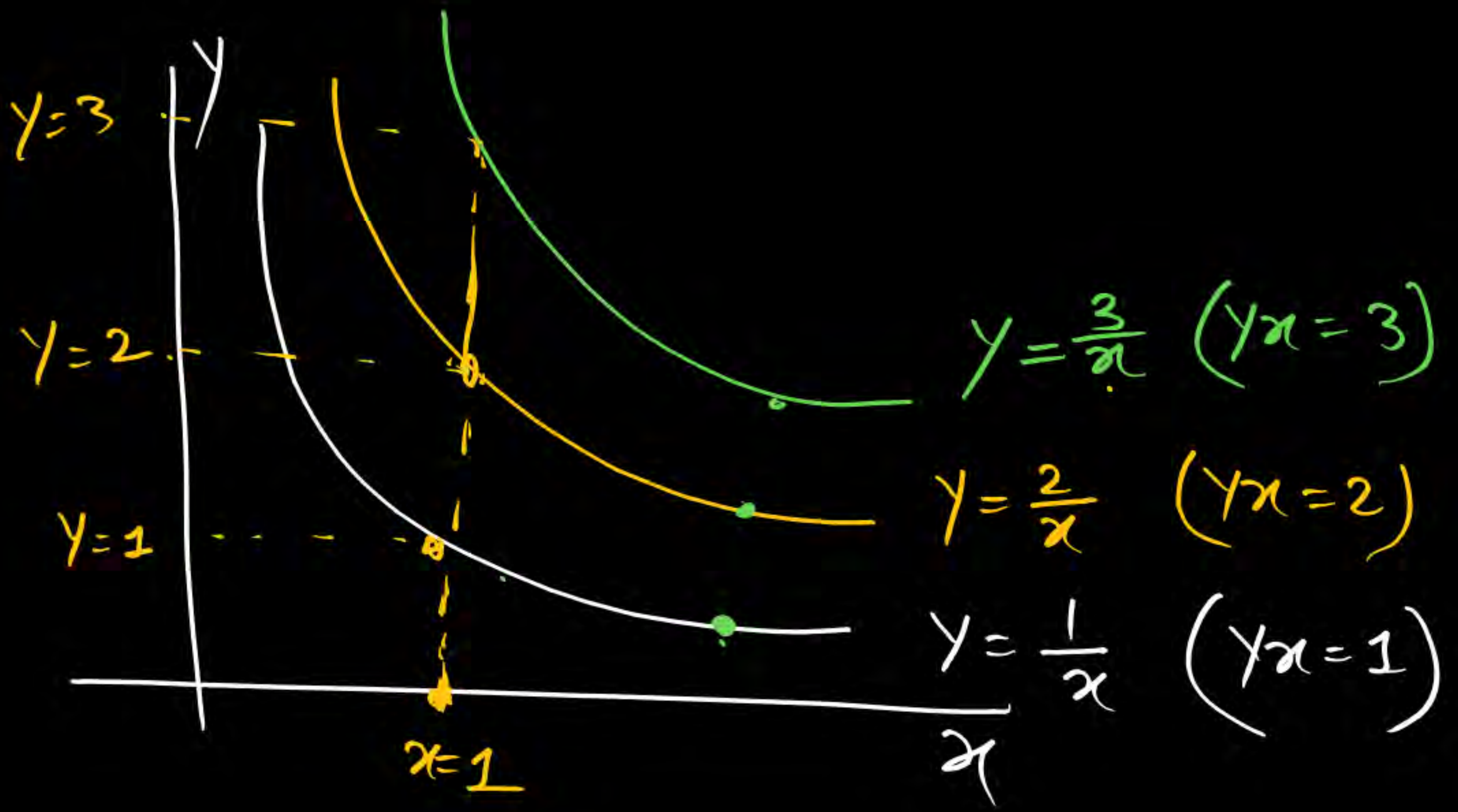
Ex $PV = \boxed{nRT} \rightarrow \text{Cot}^n$

$T = \text{Cot}^n$

$PV = \text{Cot}^n$

$P \propto \frac{1}{V}$





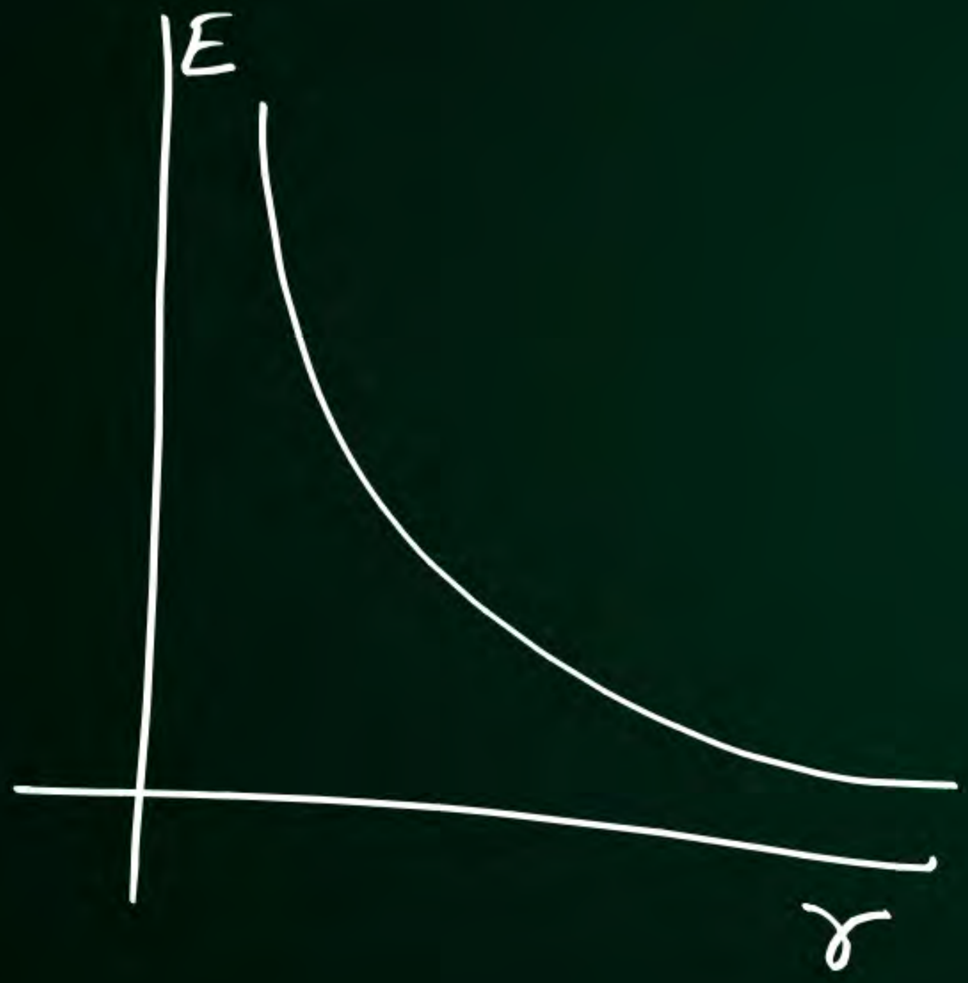
all three are Rectangul hyperbola

but at diff^n lo.

$f = \frac{1}{T}$

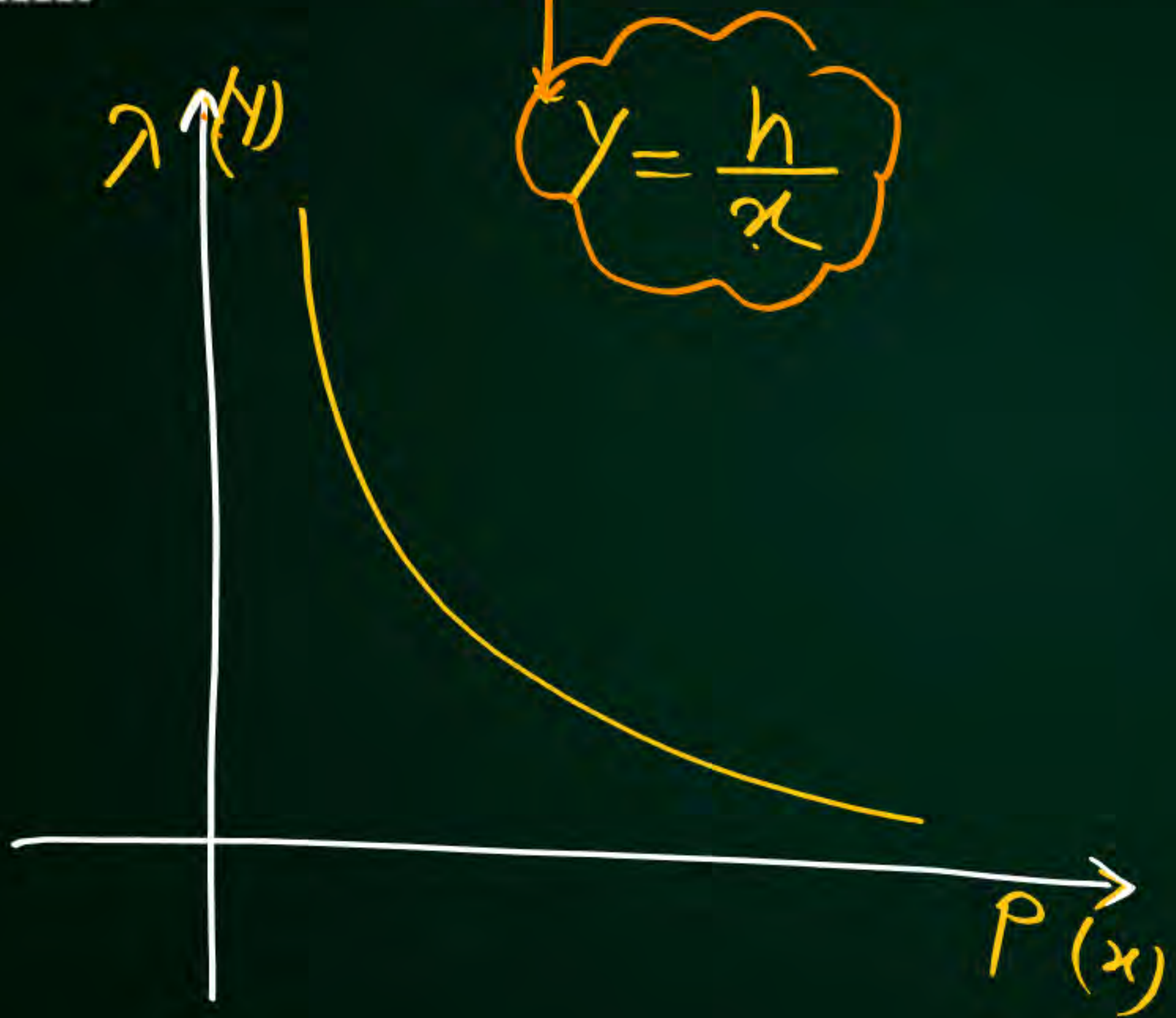


We know electric field due to point charge $E = \frac{k\theta}{r^2}$ then, draw electric field distance graph.

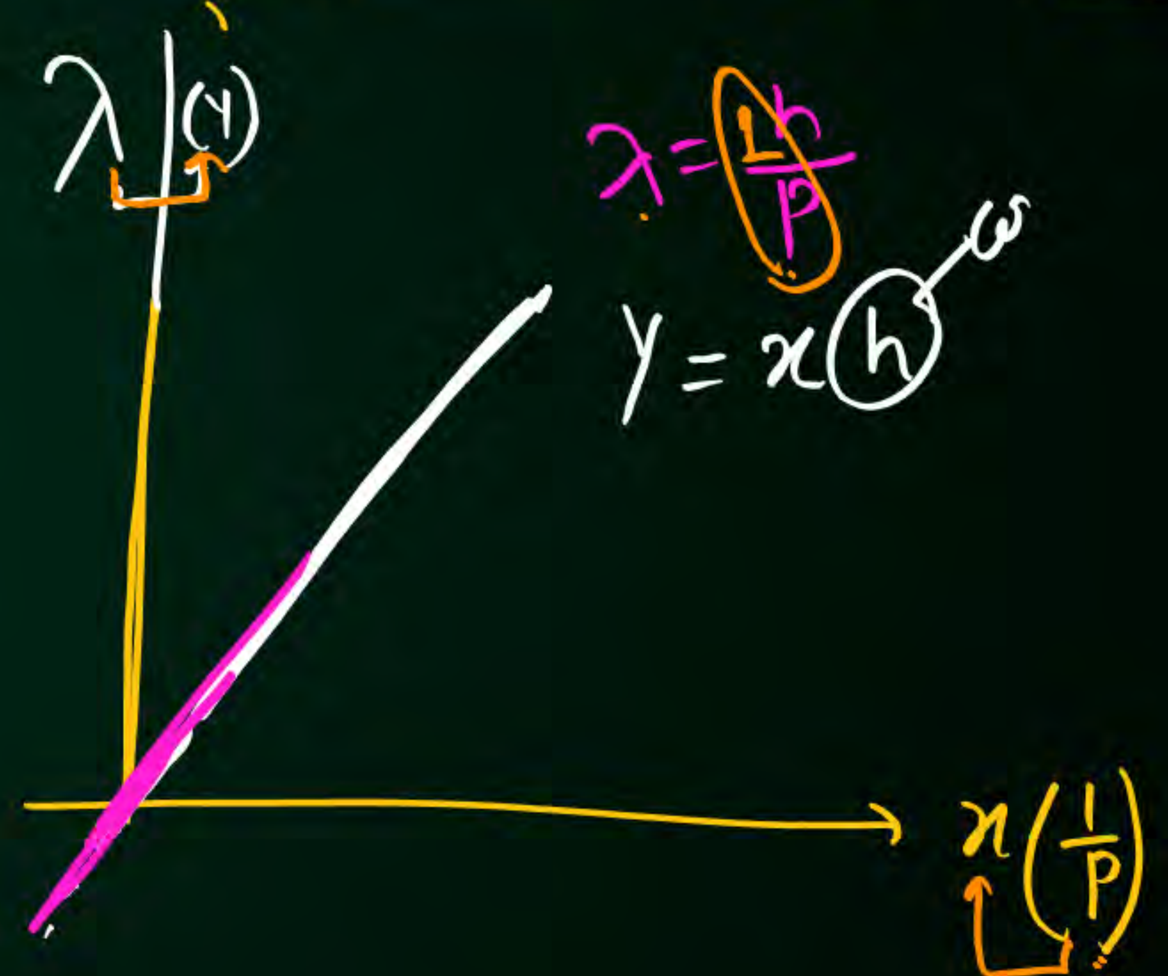


NEET-2024

De-Broglie wavelength $\lambda = \dfrac{h}{P}$. Draw graph between wavelength and momentum.



Draw graph B/W λ and 1/P



“$PV = nRT$”

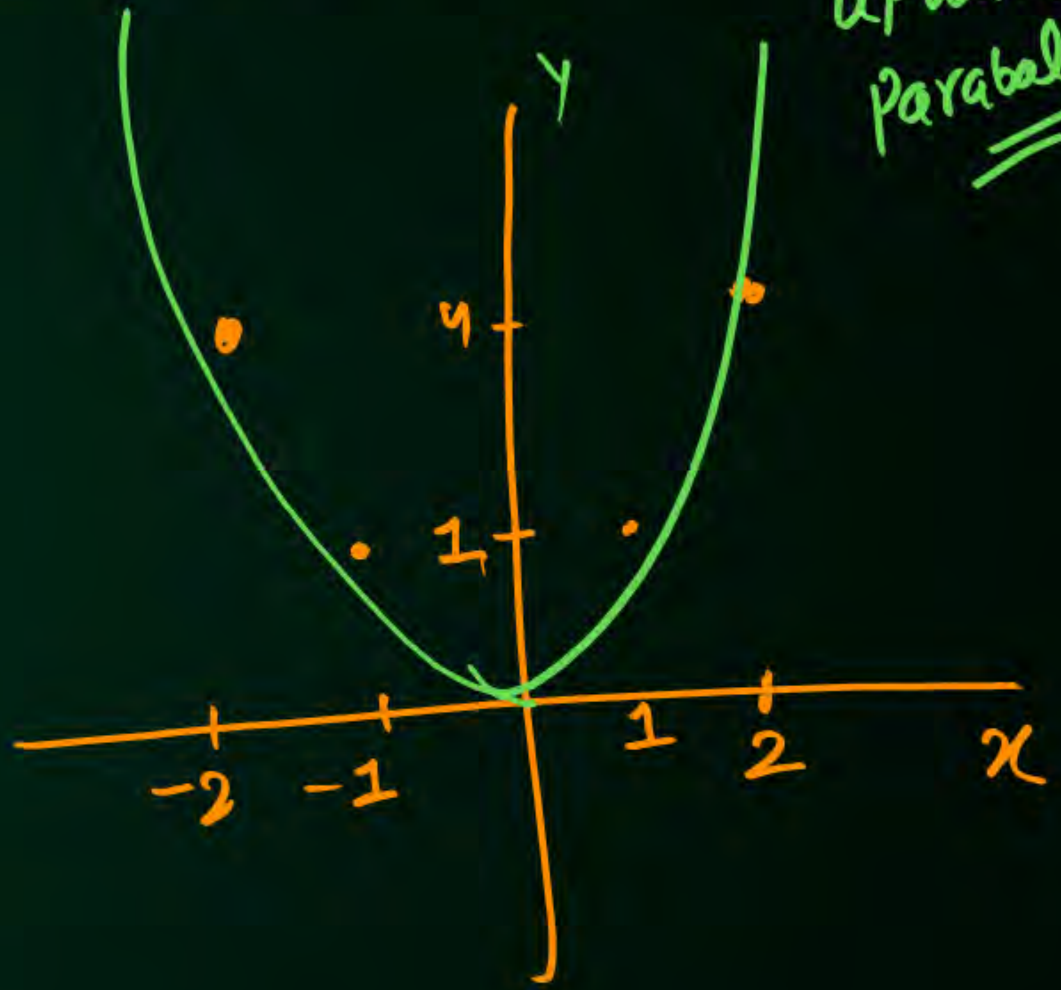
If temperature is constant then draw graph between pressure and volume for constant temperature.

Parabola

$y = x^2$

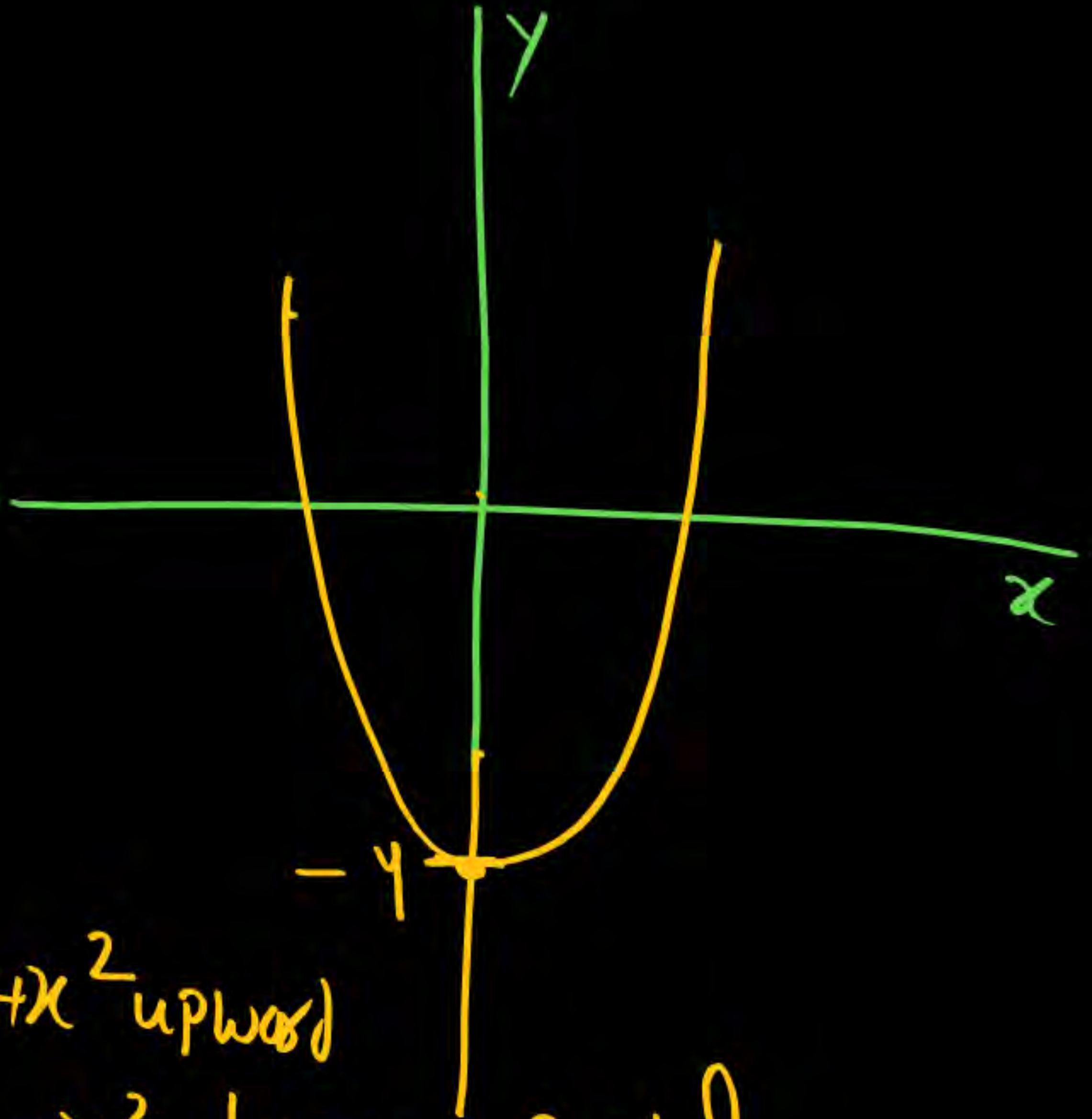
Parabola ($y = x^2$) ← Non linear Relation

Y	X
0	0
1	∓ 1
4	± 2
9	∓ 3
16	∓ 4
25	5

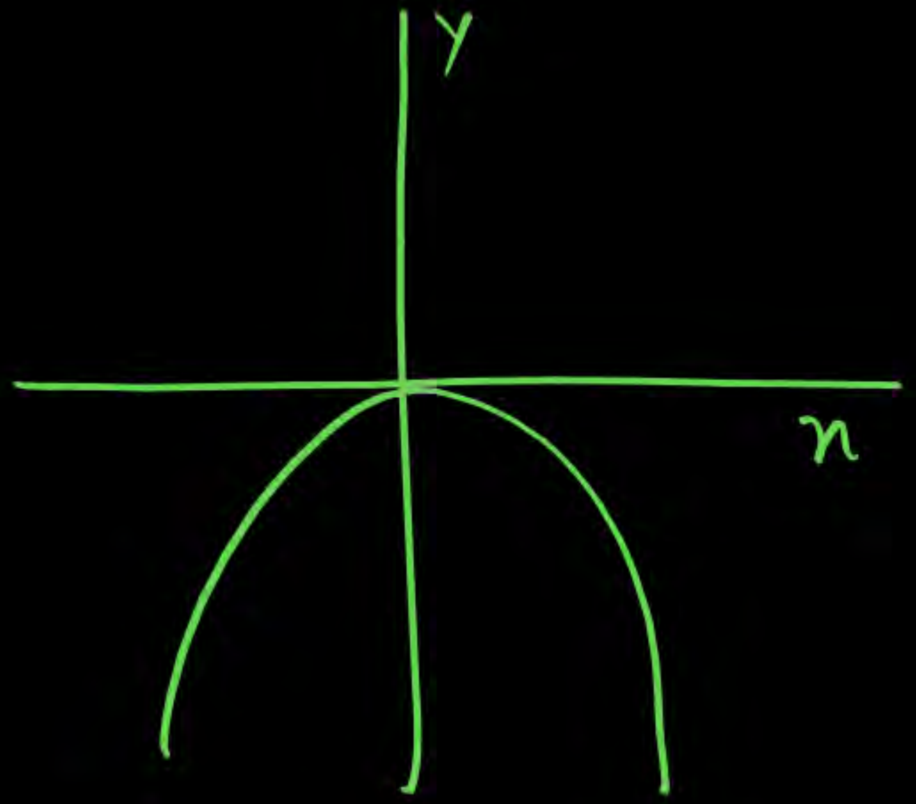


upward Parabola

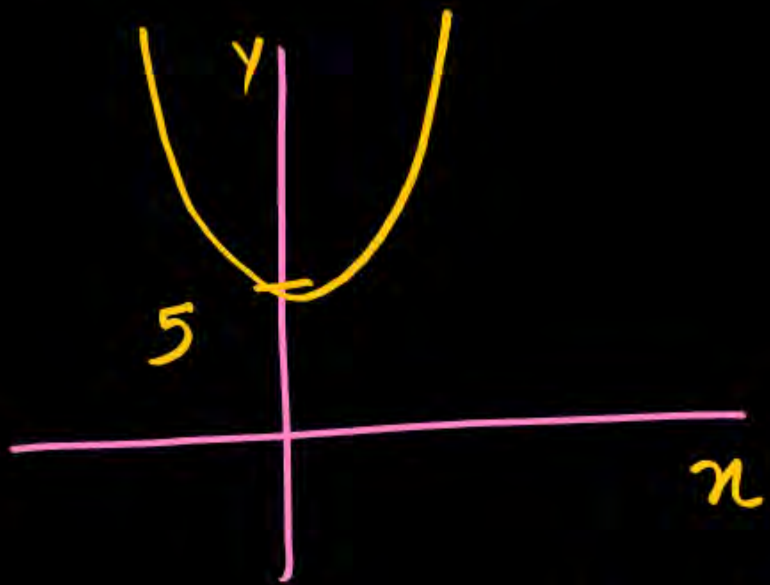
$y = x^2 - 4$



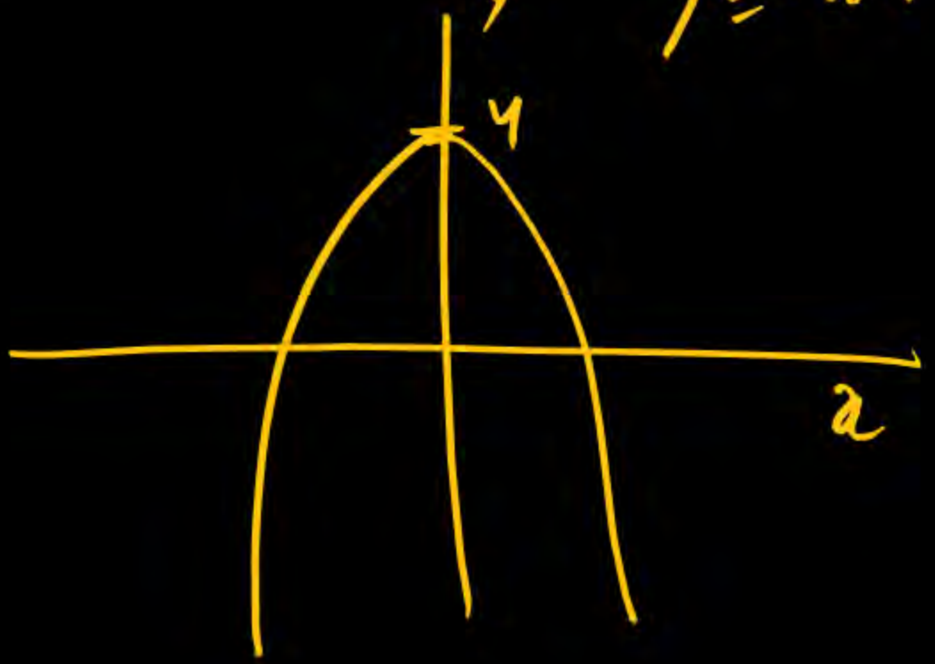
$y = -(x^2)$



$y = x^2 + 5$



$y = -x^2 + 4$

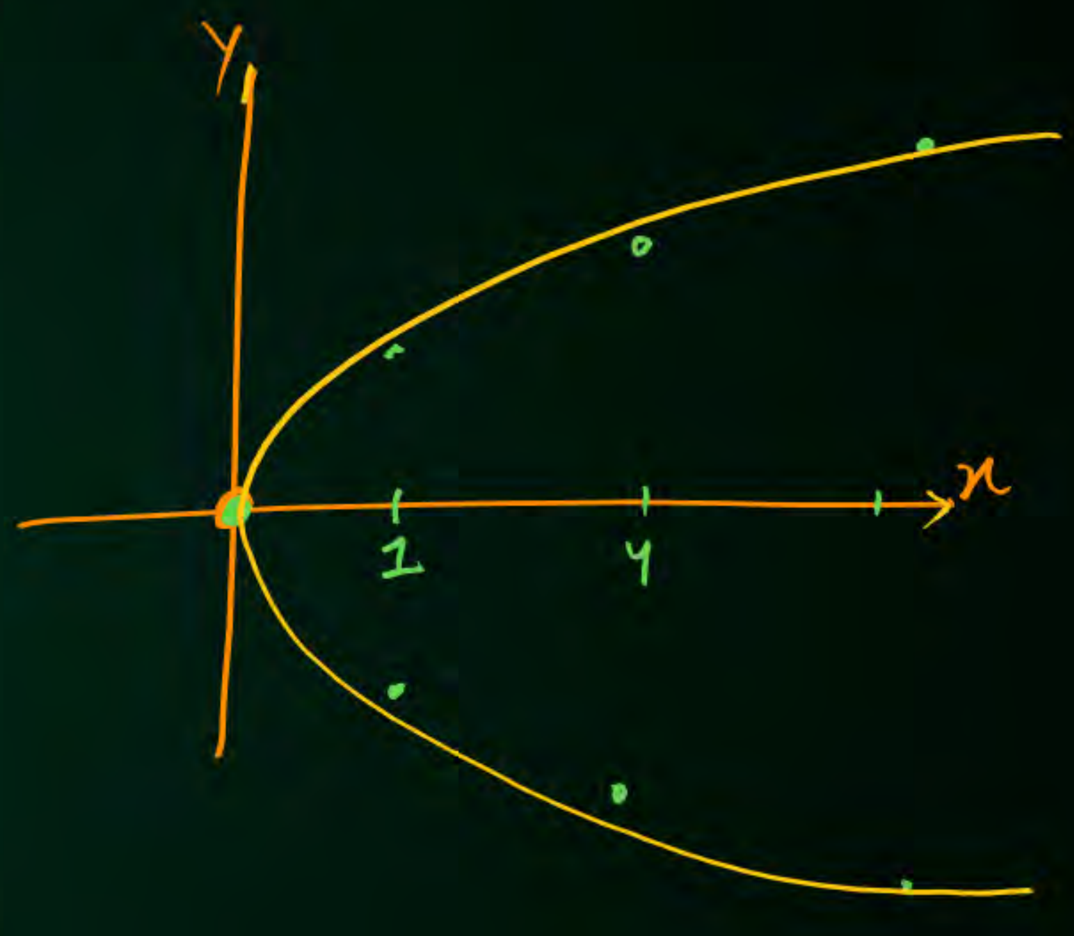


$y = +x^2$ upword

$y = -x^2$ downword Parabol

[redacted] $y = \sqrt{x}$ #

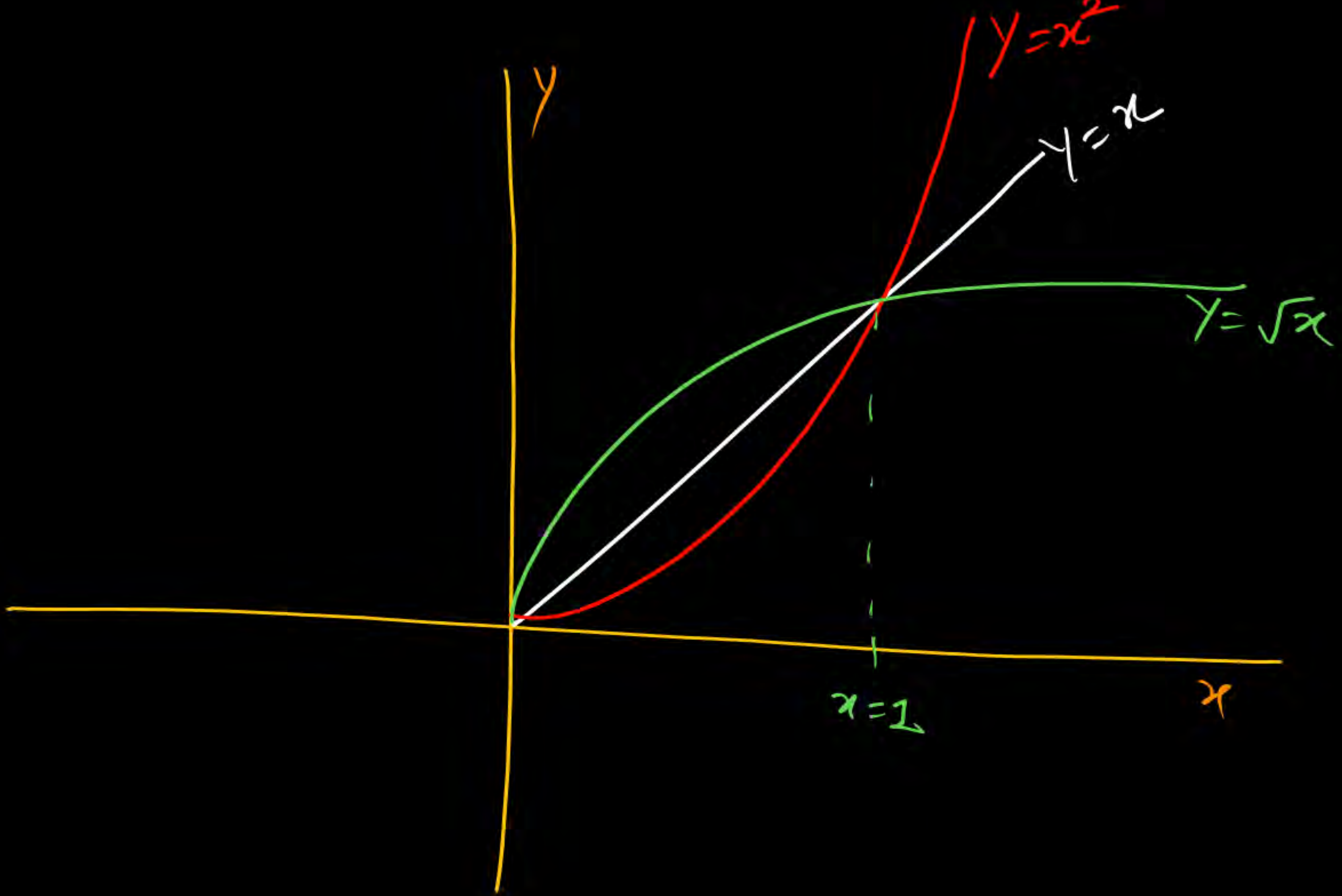
Y	X
0	0
±1	1
±2	4
±3	9
±4	16



$\sqrt{4} = \pm 2$

$\sqrt{9} = \pm 3$

$\sqrt{16} = \pm 4$



MRx

$y = x^n$

$n = 1$
Straight

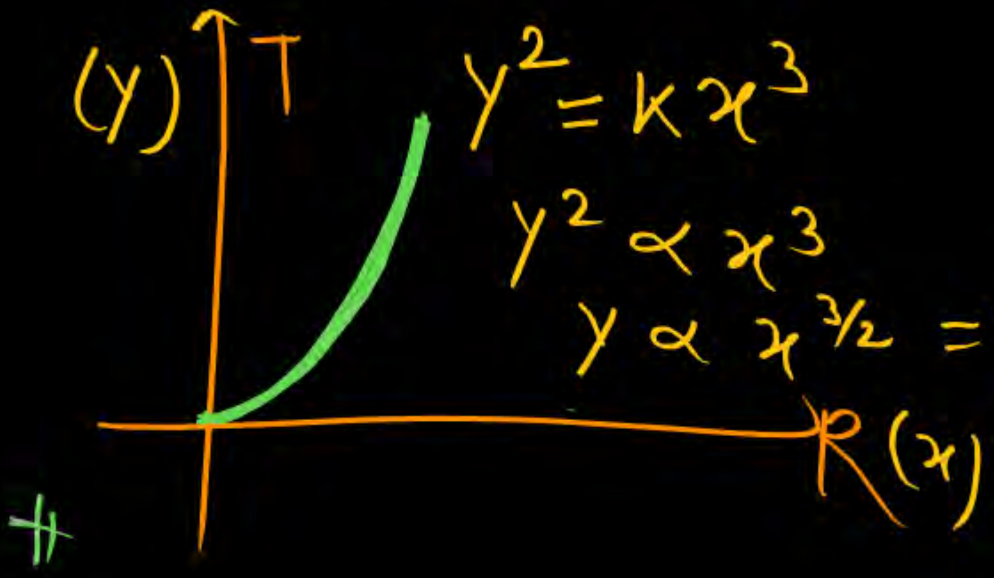
$n > 1$ (upwar)
y की तरफ Bend

$n < 1$

n → तरफ Bend
होगा

Kepplers law

$T^2 = KR^3$ (IIT)



$y^2 = kx^3$

$y^2 \propto x^3$

$y \propto x^{3/2} = x^{1.5}$


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 8 | Physics

Basic Maths and Calculus

By- Dr. Manish Raj (MR SIR)



Topics to be covered

1. PhD on Graph
2. Variation of slope
3. Differentiation
4.



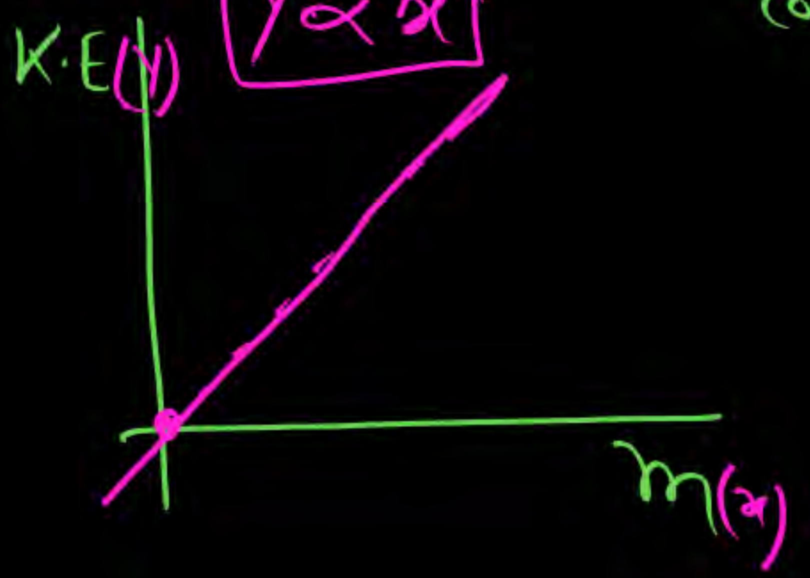
$y = mx + c$

- y → dependent varible
- m → co^n
- x → Independent Varia.
- c → co^n

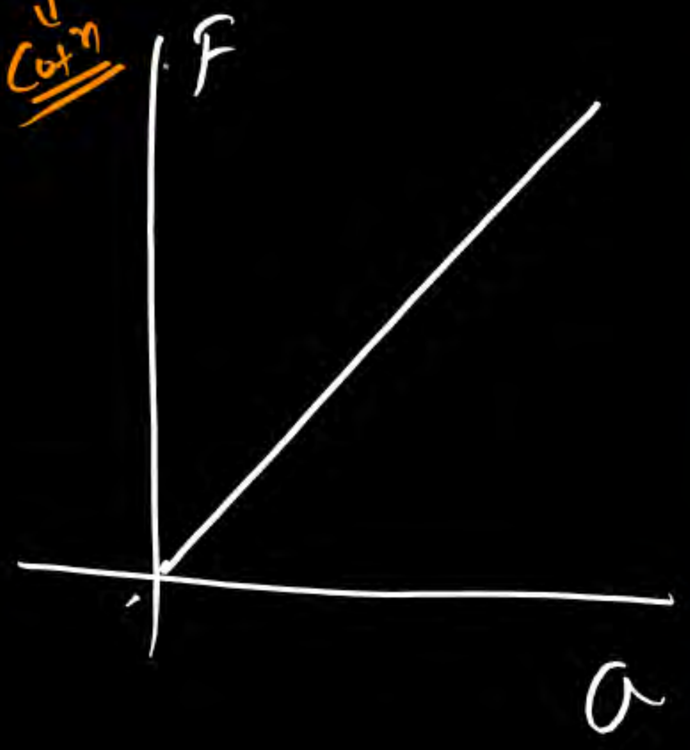
Ex

$K.E = \frac{1}{2} m v^2$ (v^2 → co^n)

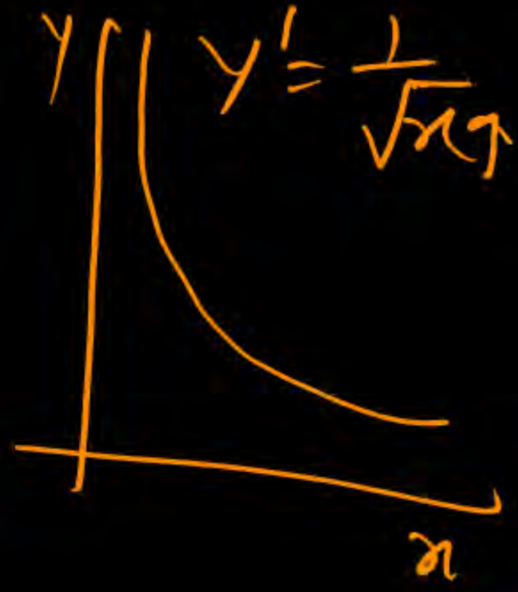
$y \propto x$



$F = ma$ (m → co^n)



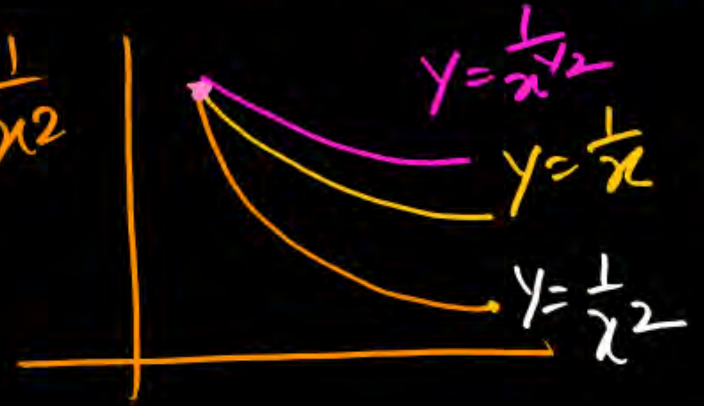
$y = \frac{1}{\sqrt{x}}$



$y = \frac{1}{x}$

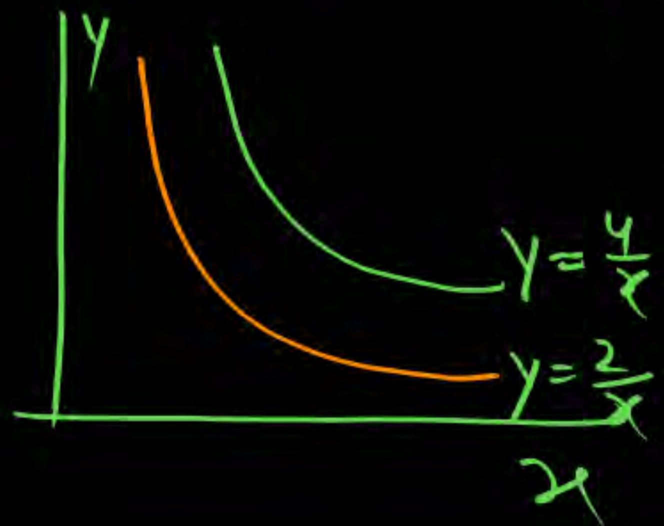


$y = \frac{1}{x^2}$

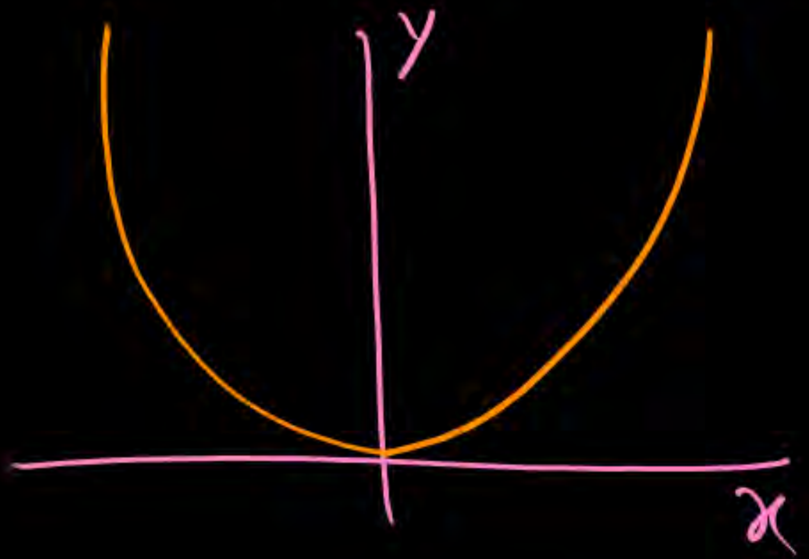


(A) $yx = 2 \rightarrow y = \frac{2}{x}$

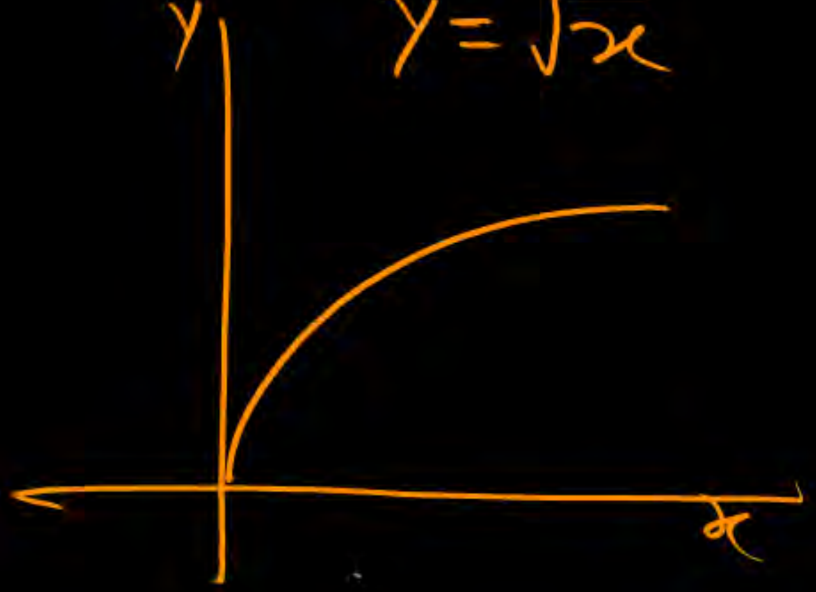
(B) $yx = 4 \rightarrow y = \frac{4}{x}$



$y = x^2$

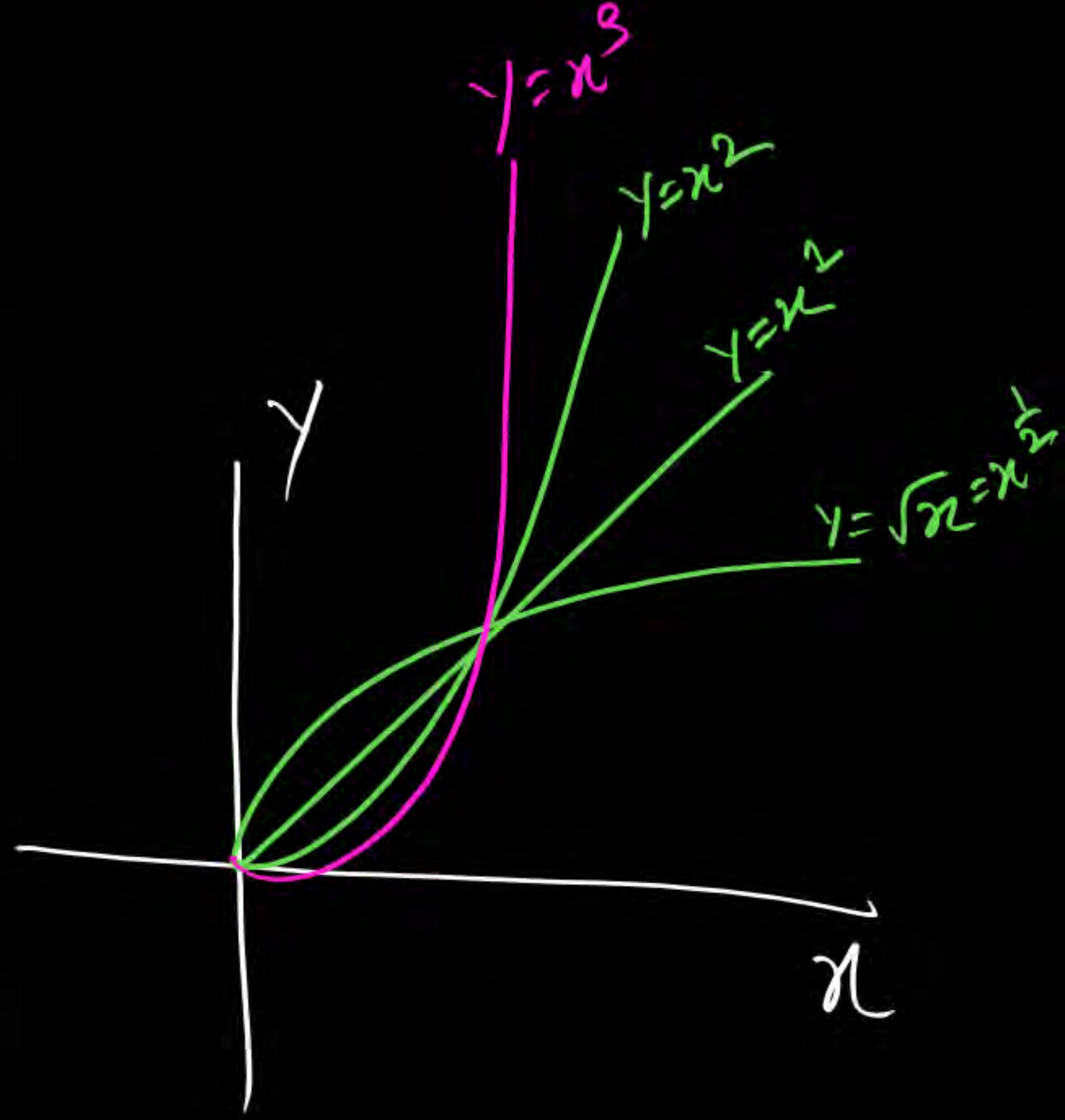


$y = \sqrt{x}$

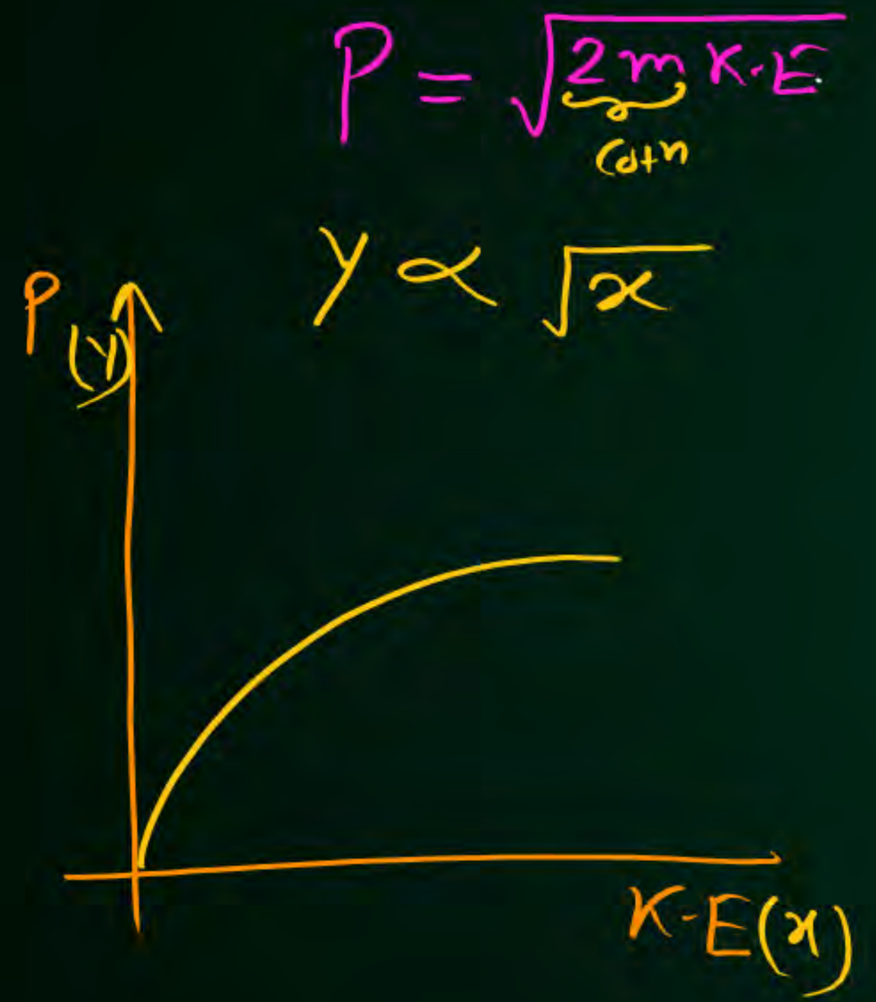


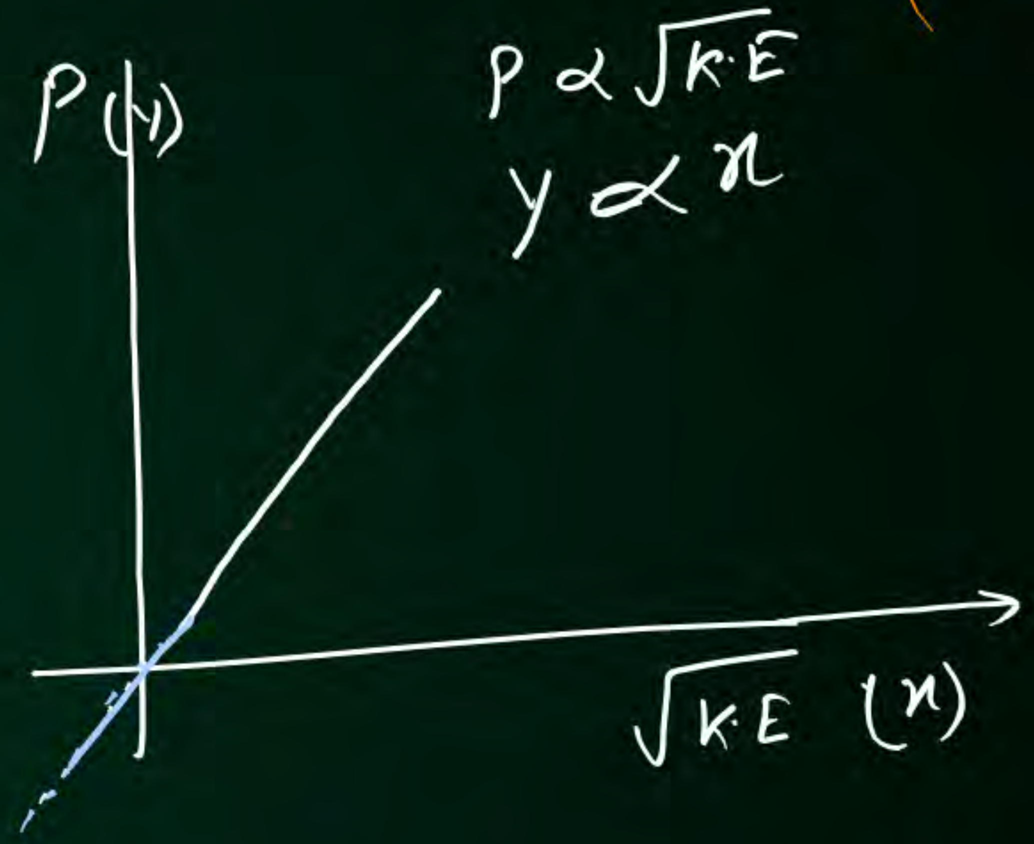
$y = -x^2$





We know K.E. and momentum relation $P = \sqrt{2m\,K.E.}$ Draw graph between P and K.E.

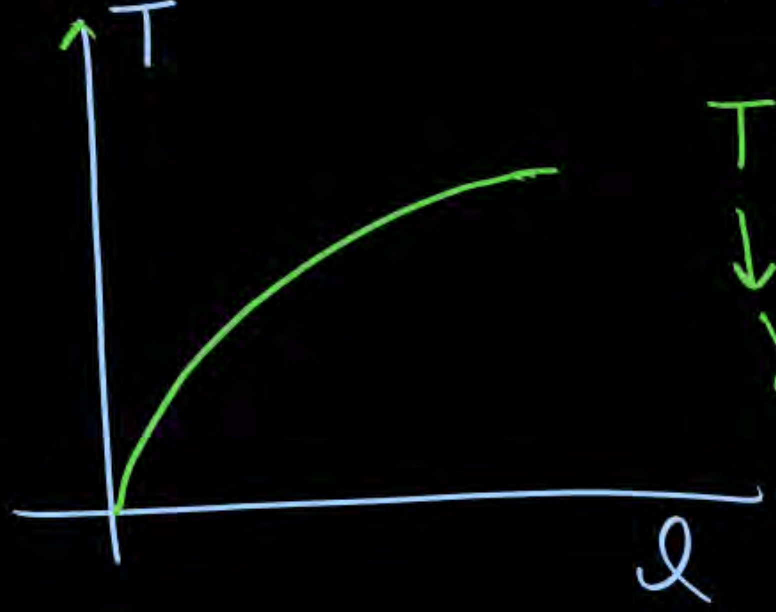




Time period of simple pendulum $T = 2\pi\sqrt{\frac{l}{g}}$

Draw graph b/w Time Period and length.

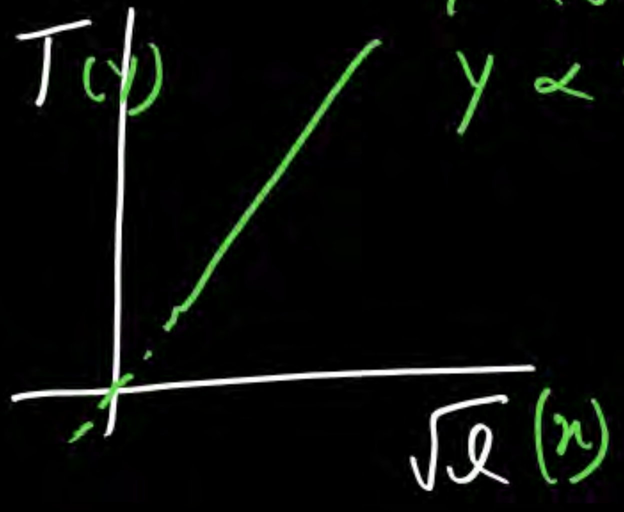
Step-1 (ignore all const)



$T \propto \sqrt{l}$

↓

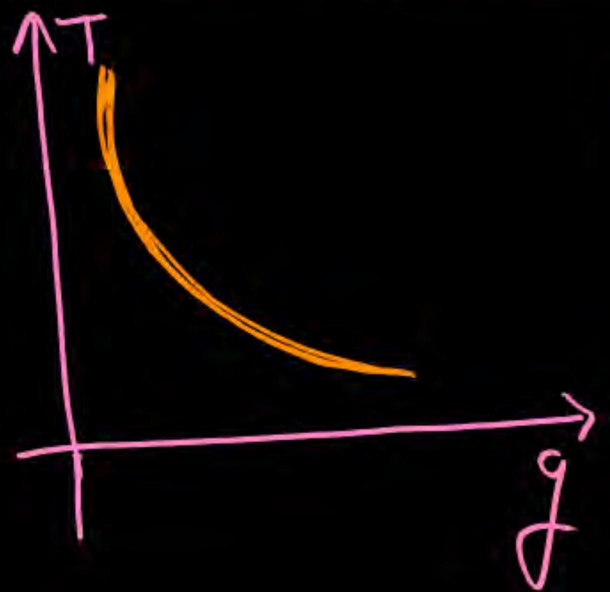
$y \propto \sqrt{x}$



$T \propto \sqrt{l}$

$y \propto x$

Rectangular hyperbola



$T \propto \frac{1}{\sqrt{g}}$ $(l = \text{const})$

$T \propto \frac{1}{g^{1/2}}$

$y \propto \frac{1}{x^{1/2}}$



$T = 2\pi\sqrt{\frac{l}{g}}$

$T \propto \sqrt{l}$

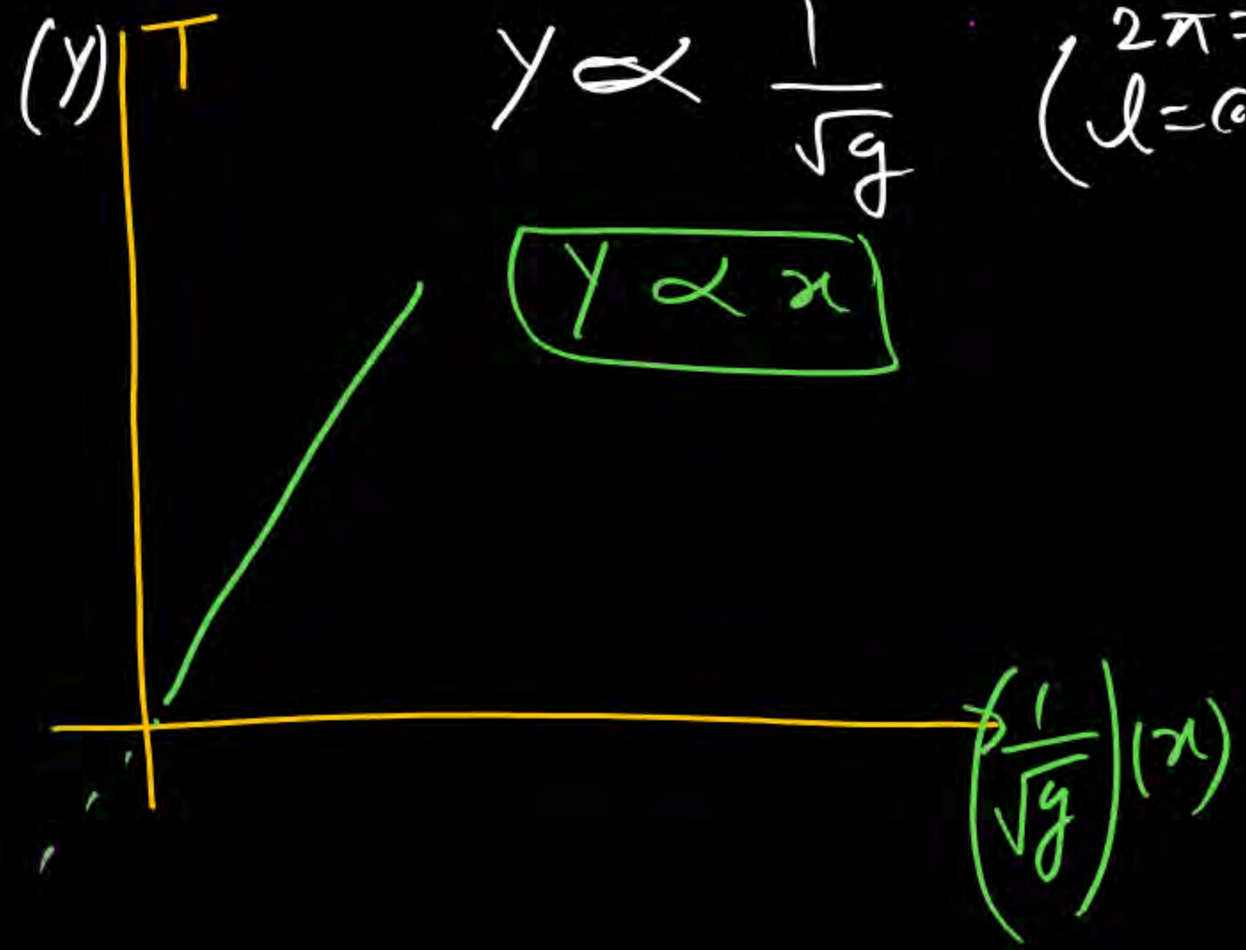
$T^2 \propto l$

$y \propto x$

$T = 2\pi\sqrt{\frac{l}{g}}$ Draw graph b/w (T) and $\left(\frac{1}{\sqrt{g}}\right)$

$y \propto \frac{1}{\sqrt{g}}$ $\left(\begin{matrix} 2\pi = \text{const} \\ l = \text{const} \end{matrix}\right)$

$y \propto x$

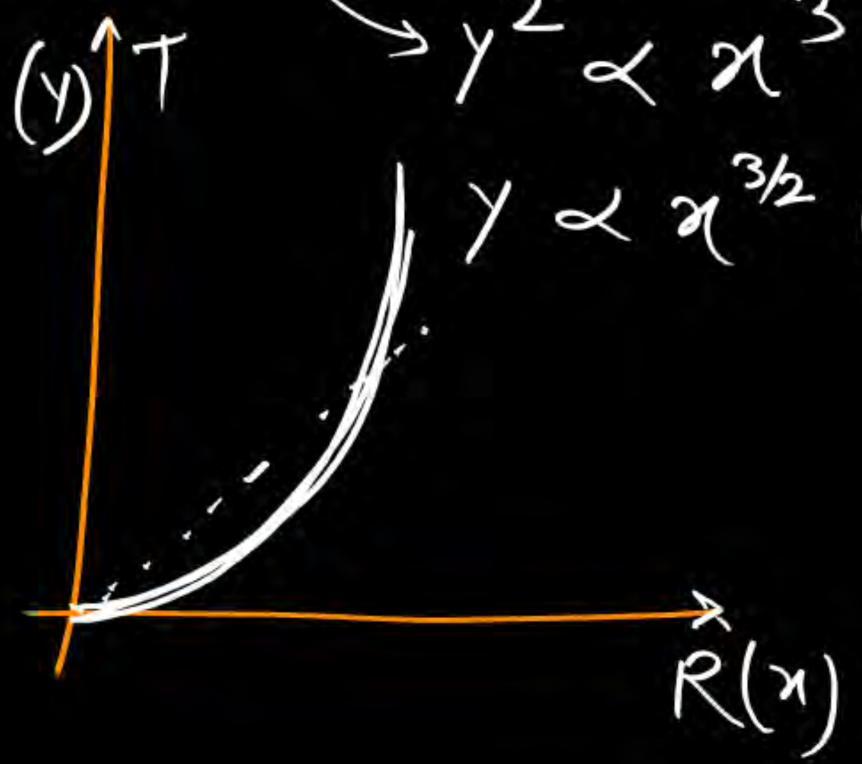


$$T^2 = KR^3$$

Kepple Law

$$y^2 \propto x^3$$

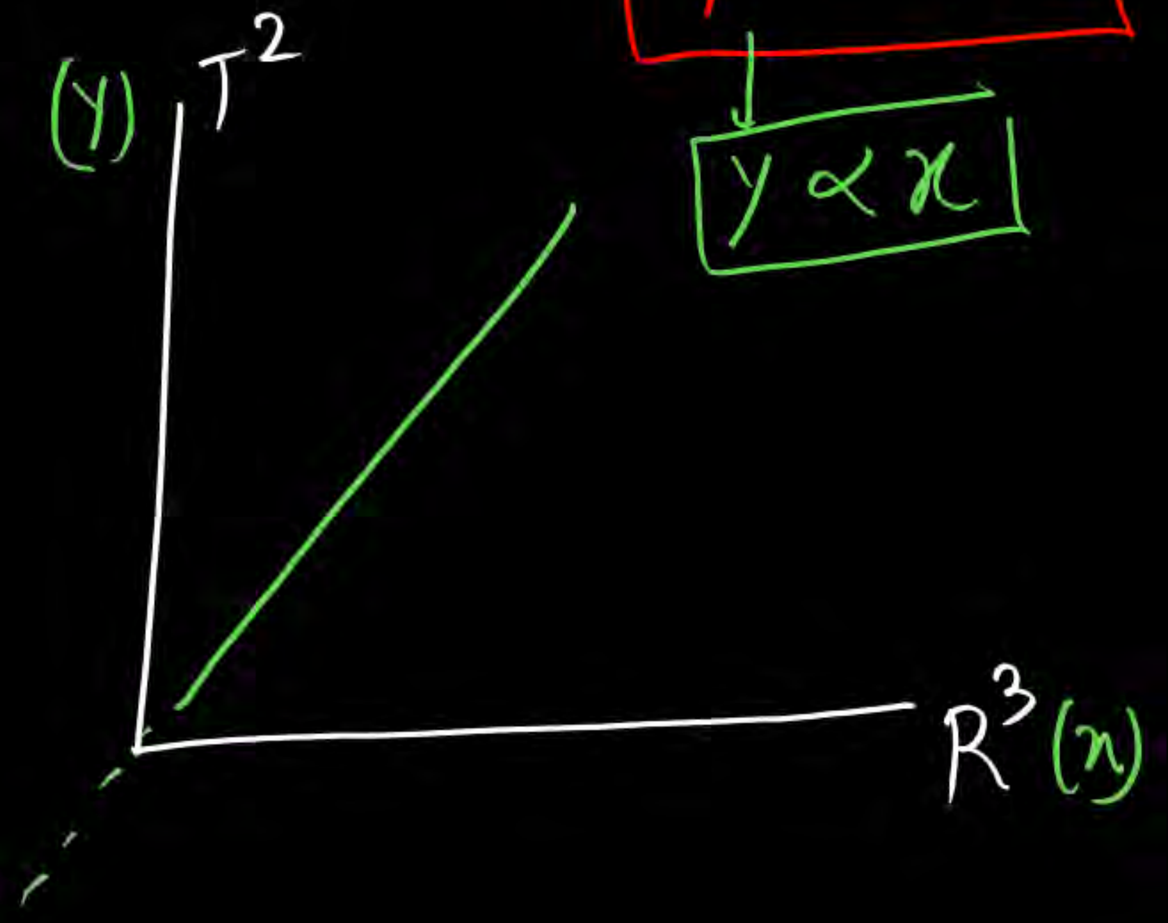
$$y \propto x^{3/2} \quad (x^{1.5})$$



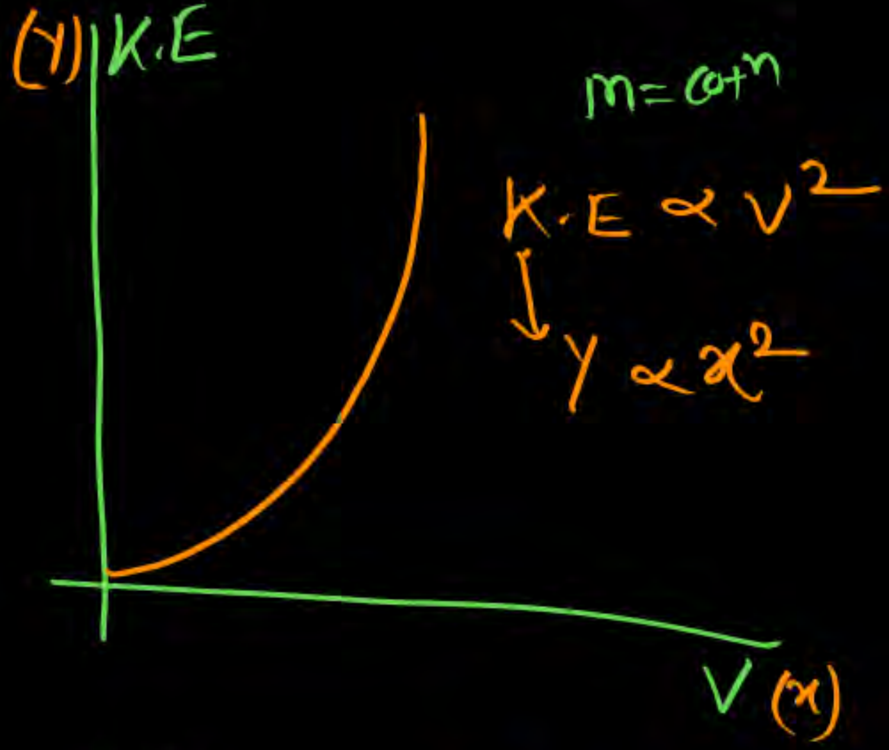
IIT

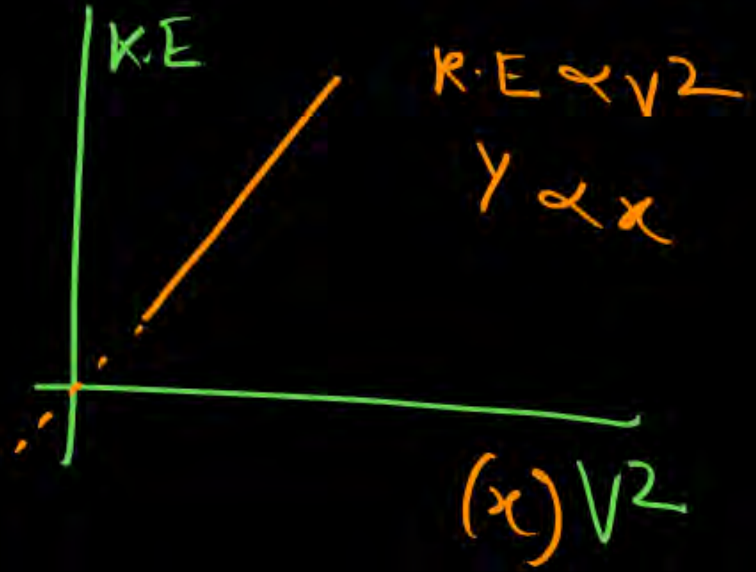
$$T^2 = KR^3$$

$$y \propto x$$



$$K.E = \frac{1}{2} m v^2$$





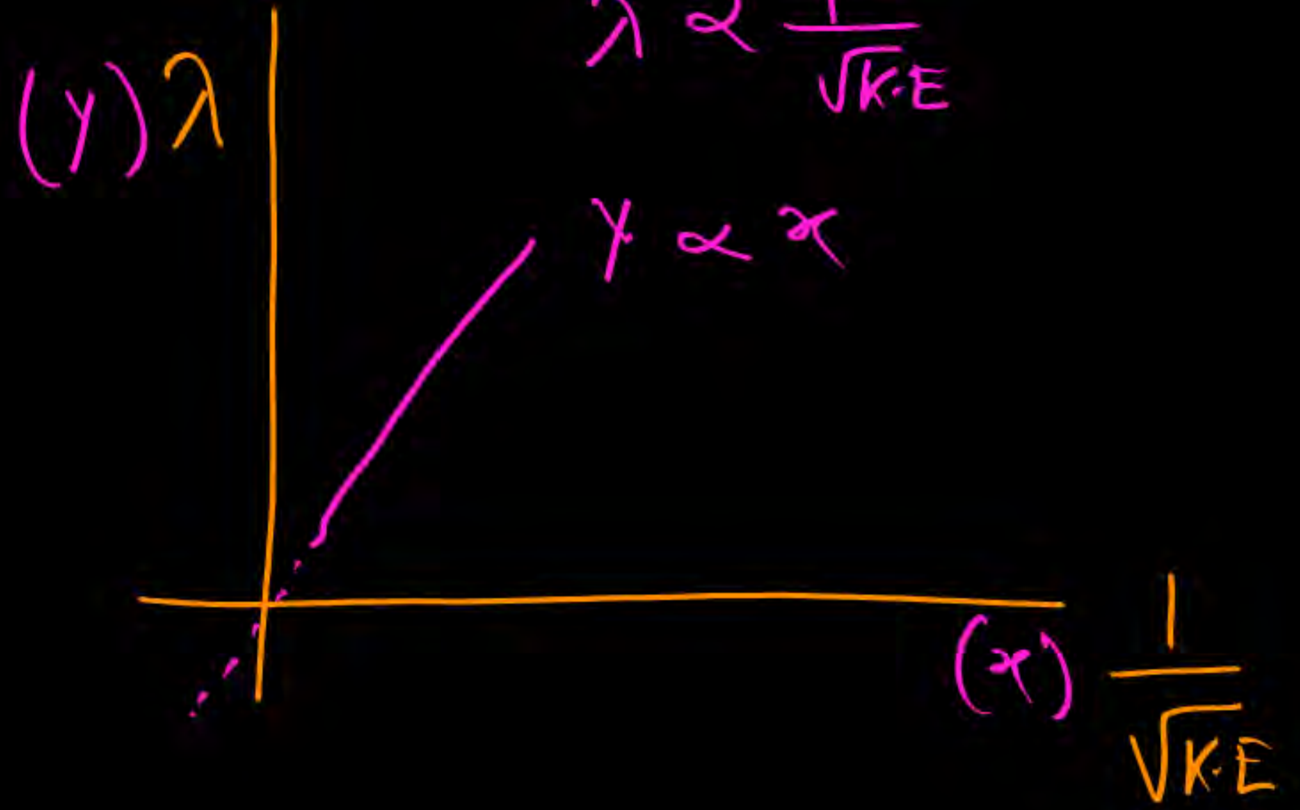
$$\lambda = \frac{h}{p} = \frac{h}{\sqrt{2mK.E}}$$

[NEET-2024]

↳ De-brglice wavelength

$$\lambda \propto \frac{1}{\sqrt{K.E}}$$

$$y \propto x$$



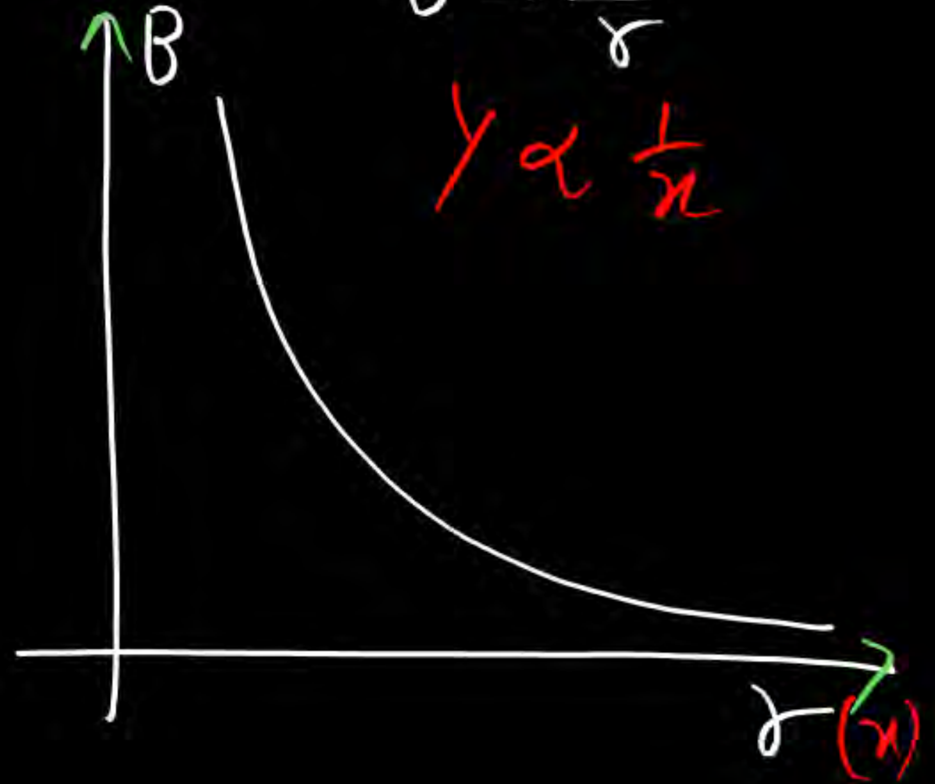
$$B = \frac{\mu_0 I}{2\pi r}$$

B → magnetic field

r → dist

$$B \propto \frac{1}{r}$$

$$y \propto \frac{1}{x}$$



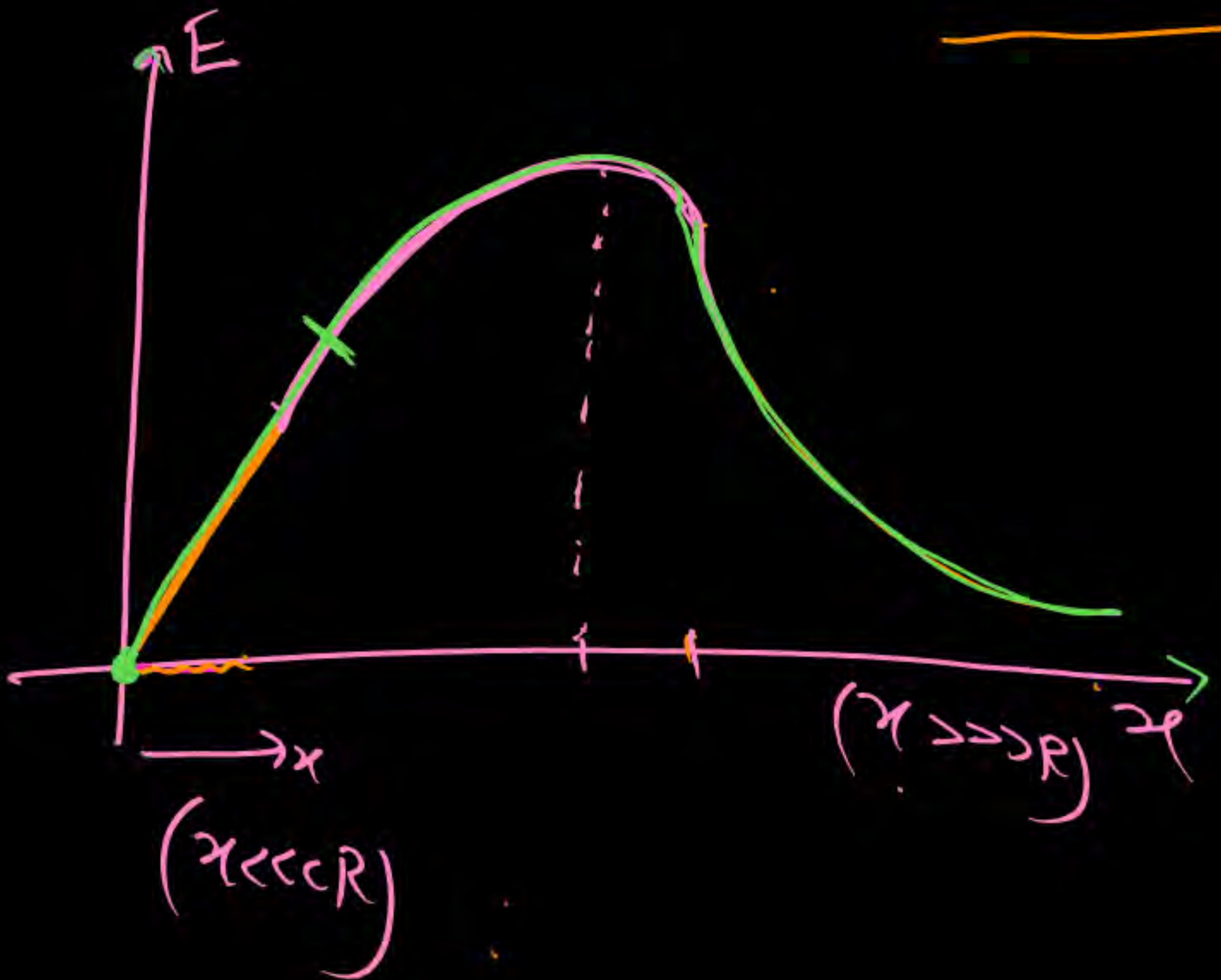
$E = \frac{KxQ}{(R^2+x^2)^{3/2}}$

Draw graph b/w "E" an "x"



electric field on the axis of Ring:-

→ (mixed graph)



If $x=0$

$$E = \frac{QK\times 0}{(R^2+0)^{3/2}} = 0$$

If $x<<<R$

$$E = \frac{KxQ}{(R^2)^{3/2}} = \frac{KxQ}{R^3}$$

$E \propto x$

If $x>>>R$

$$E = \frac{KxQ}{(R^2+x^2)^{3/2}}$$

$$E = \frac{KQx}{x^3 x^2}$$

$E \propto \frac{1}{x^2}$

apporoximation

$$3 \times 0.0001 \neq 3$$

$$3 + \underbrace{0.0001}_{0} = 3 \checkmark$$

gf $y = 2^x$ Draw graph b/w y and x

$2^{-x} = 0$

exponential functi·

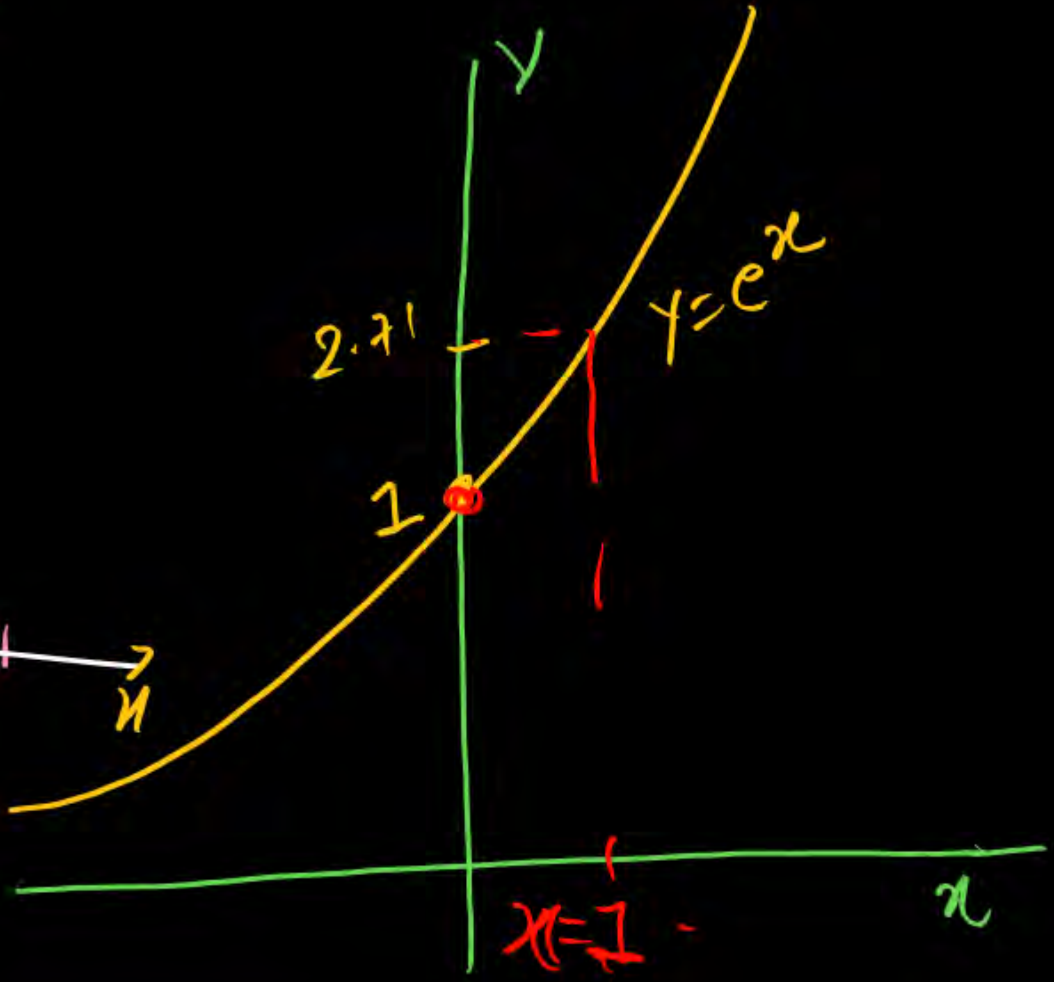
$y = e^x = (2.71)^x$

$y \propto x$ ✓
$y \propto x^2$ ✓
$y \propto \sqrt{x}$ ✓
$y = \frac{1}{x}$ ✓

$y = 2^x$

y	x
1	0
2	1
4	2
8	3
16	4
32	5
0.5	-1
0.25	-2
0	$-\infty$

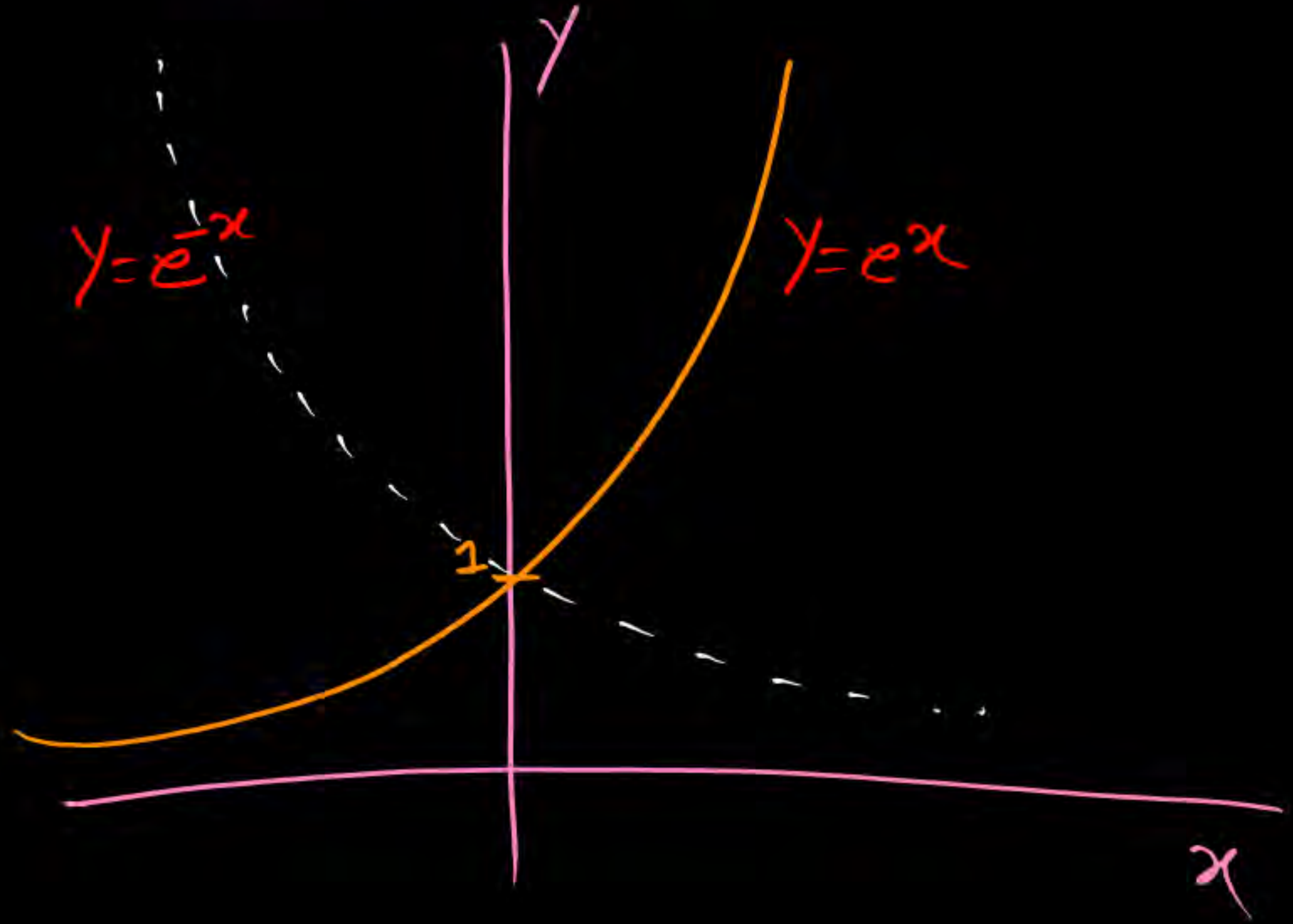




$y = 2^{-1} = \frac{1}{2} = 0.5$

$y = 2^{-2} = \frac{1}{4} = 0.25$

$$y = e^{+x}$$

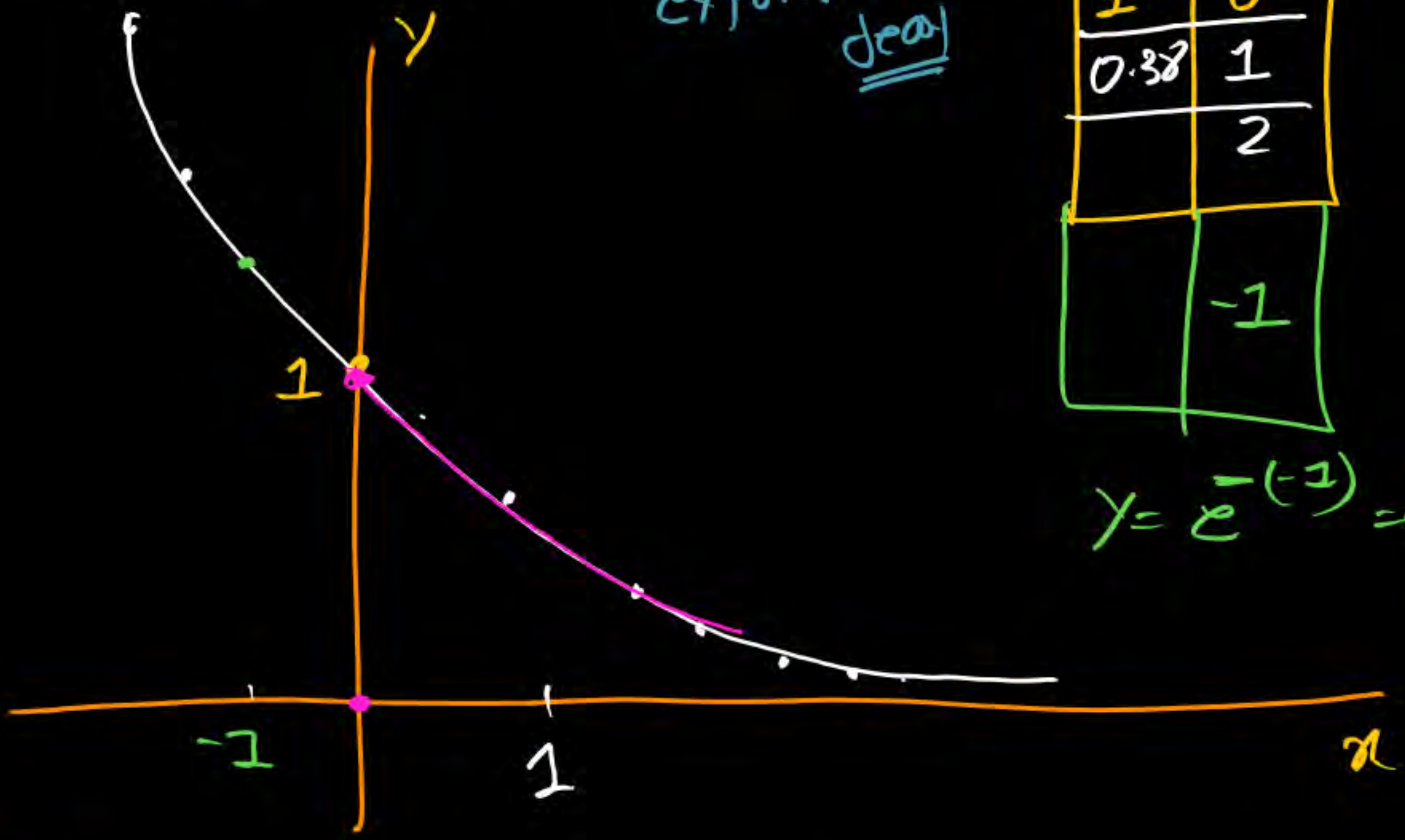


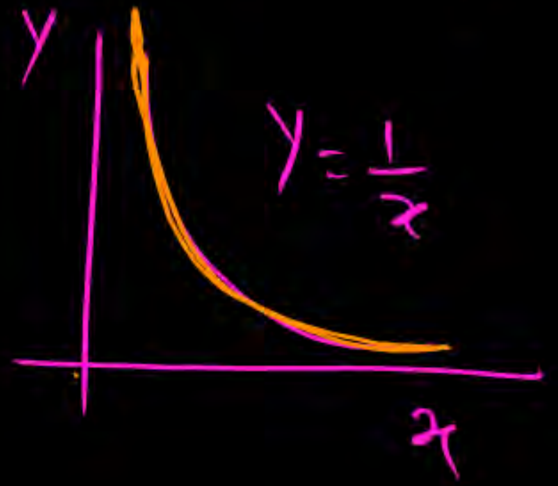
$$y = e^{-x} = \frac{1}{e^{x}} = \frac{1}{2.71}$$

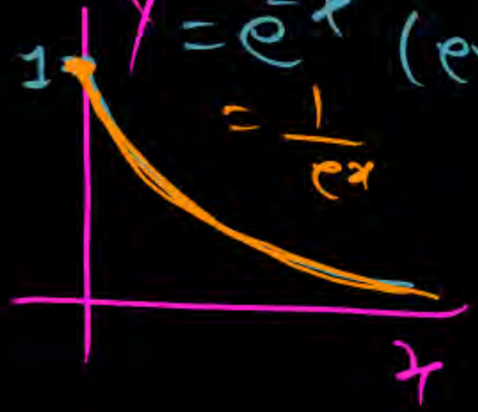
exponential decay

y	x
1	0
0.38	1
	2
	-1

$$y = e^{-(-1)} = e^{1} = 2.71$$







$$y = e^{-x} = \frac{1}{e^{x}}$$ (exponential decay)

$$Q = Q_0 e^{-t/RC}$$

$$Q \propto e^{-t}$$



circular graph

$$R^2 = (x - x_0)^2 + (y - y_0)^2$$

(centre ... centre)

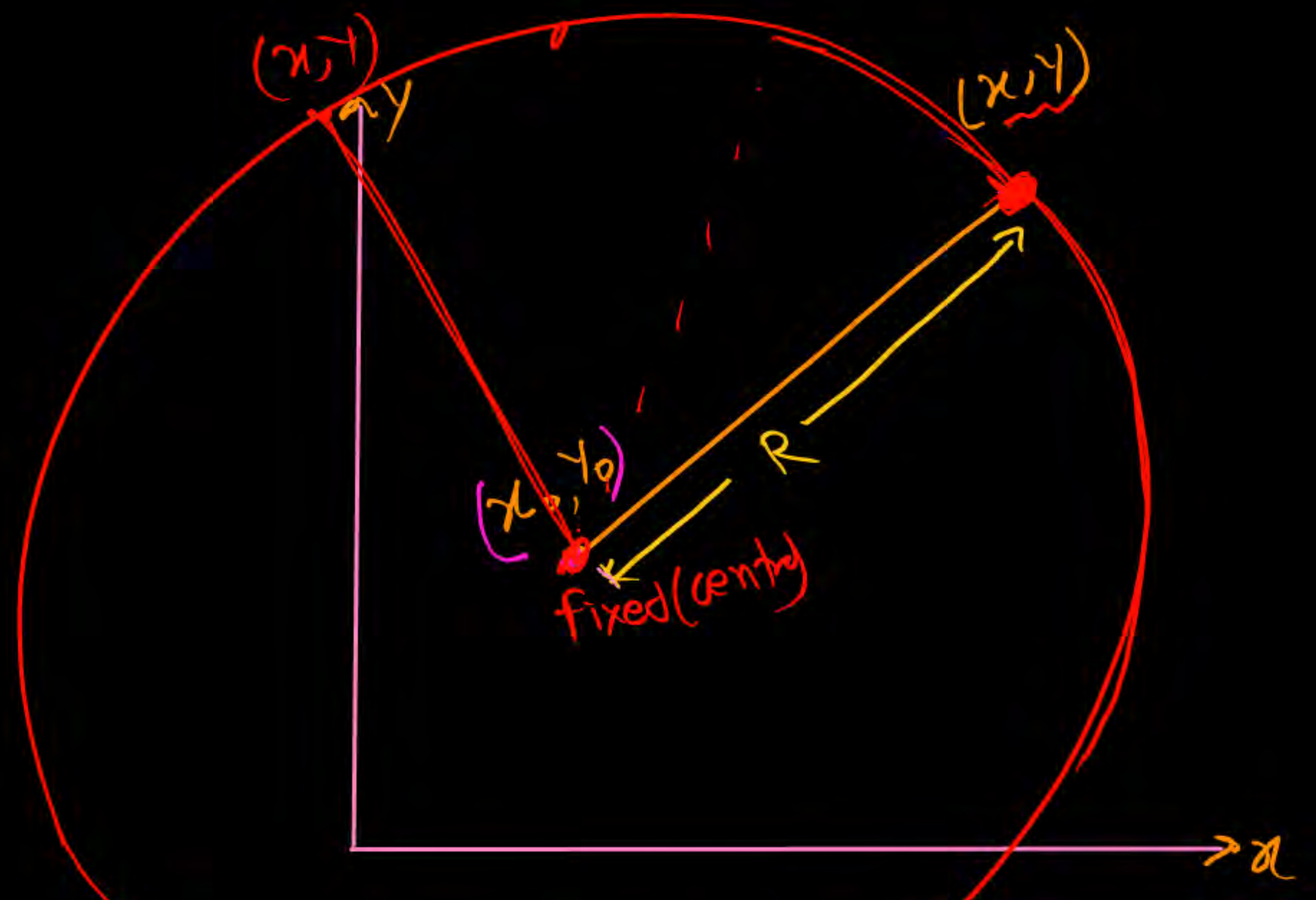
↑ Radius

$(x_0, y_0) \longrightarrow (0,0)$

centre at origin

$$R^2 = x^2 + y^2$$

→ centre is at origin



$$\text{dist}^n = \sqrt{(x - x_0)^2 + (y - y_0)^2}$$

$$R^2 = (x - x_0)^2 + (y - y_0)^2$$

Radius

$(x_0, y_0) \rightarrow$ (centre)

$$(x-4)^2+(y-3)^2=25$$

find radius and centre of circle.

eqn of circle

$$(x-x_0)^2+(y-y_0)^2=R^2$$

$$(x_0, y_0)=(4,3)$$

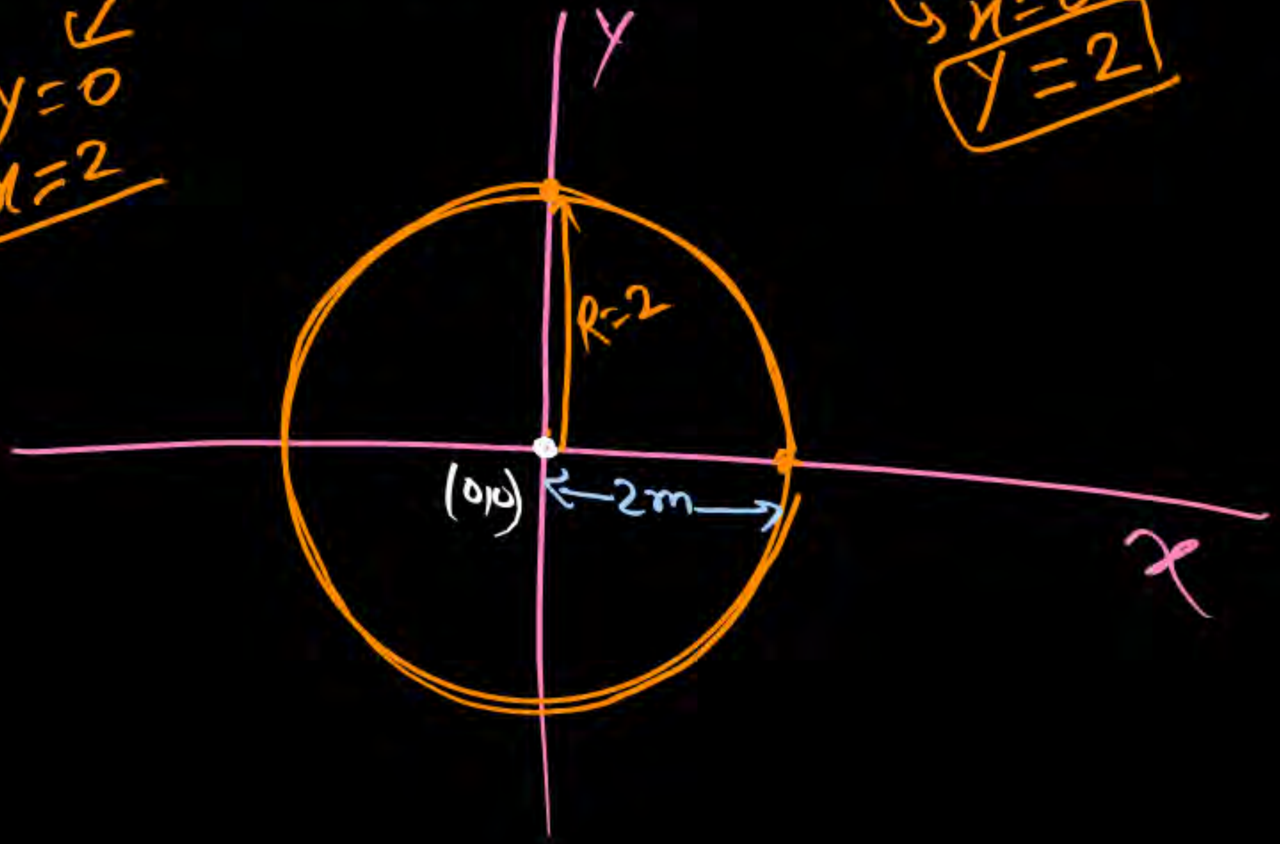
$$R=5m$$

$$\Rightarrow x^2+y^2=4$$

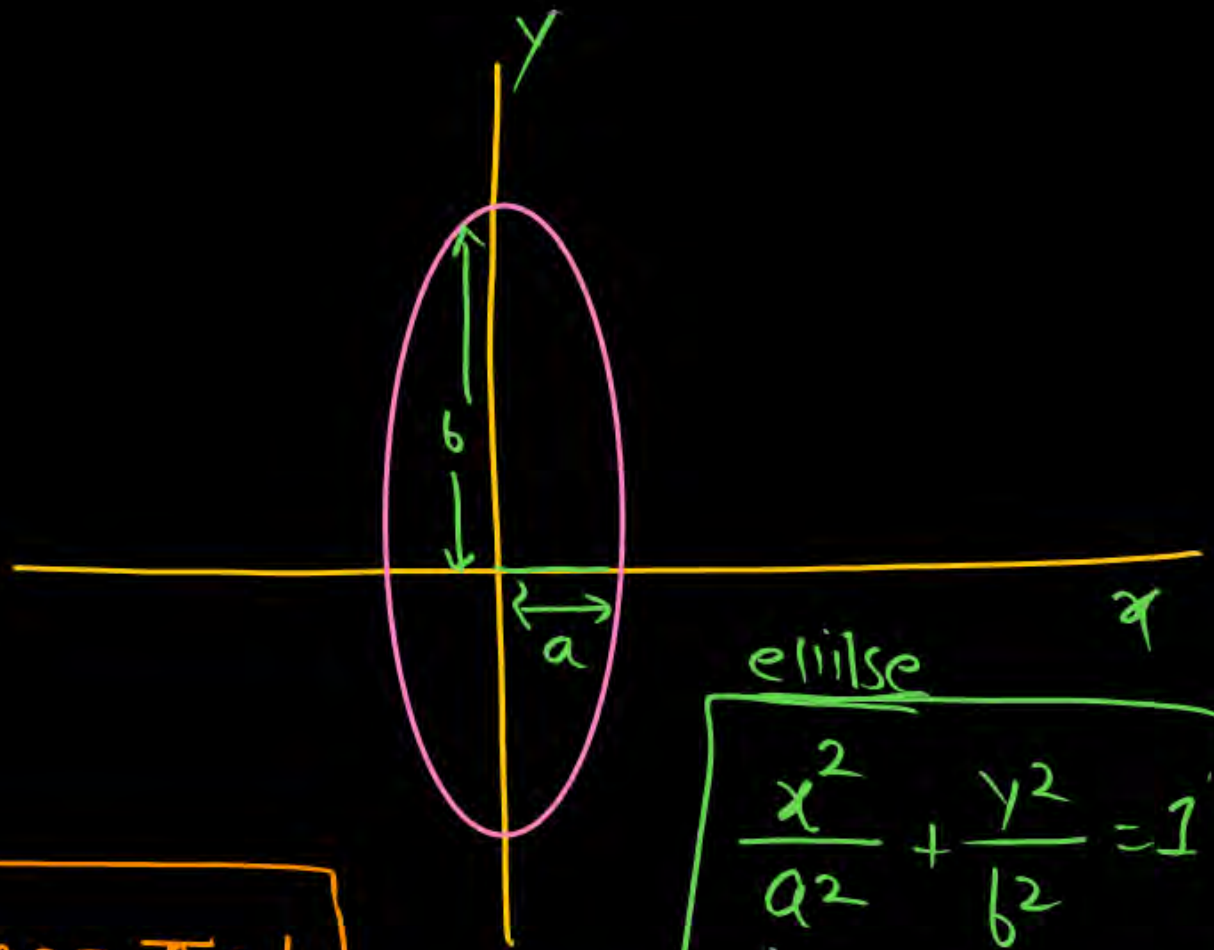
$$x^2+y^2=2^2$$

$y=0$
$x=2$

$x=0$
$y=2$



ellipse → खराब circle



ellilse

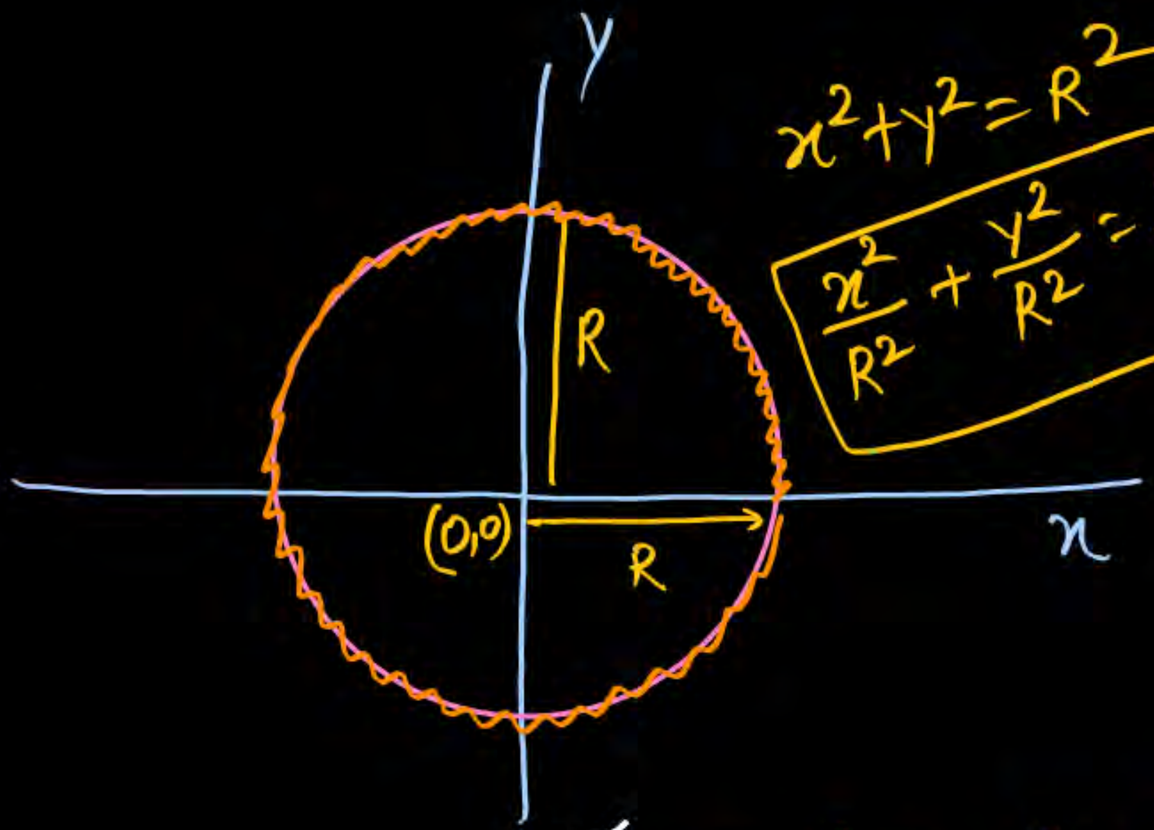
$$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$$

→ $a = b = R$ (circle)

$$\frac{x^2}{R^2} + \frac{y^2}{R^2} = 1$$

Area $= \pi ab$

Circw $= \pi(a+b)$



$x^2 + y^2 = R^2$

$$\frac{x^2}{R^2} + \frac{y^2}{R^2} = 1$$

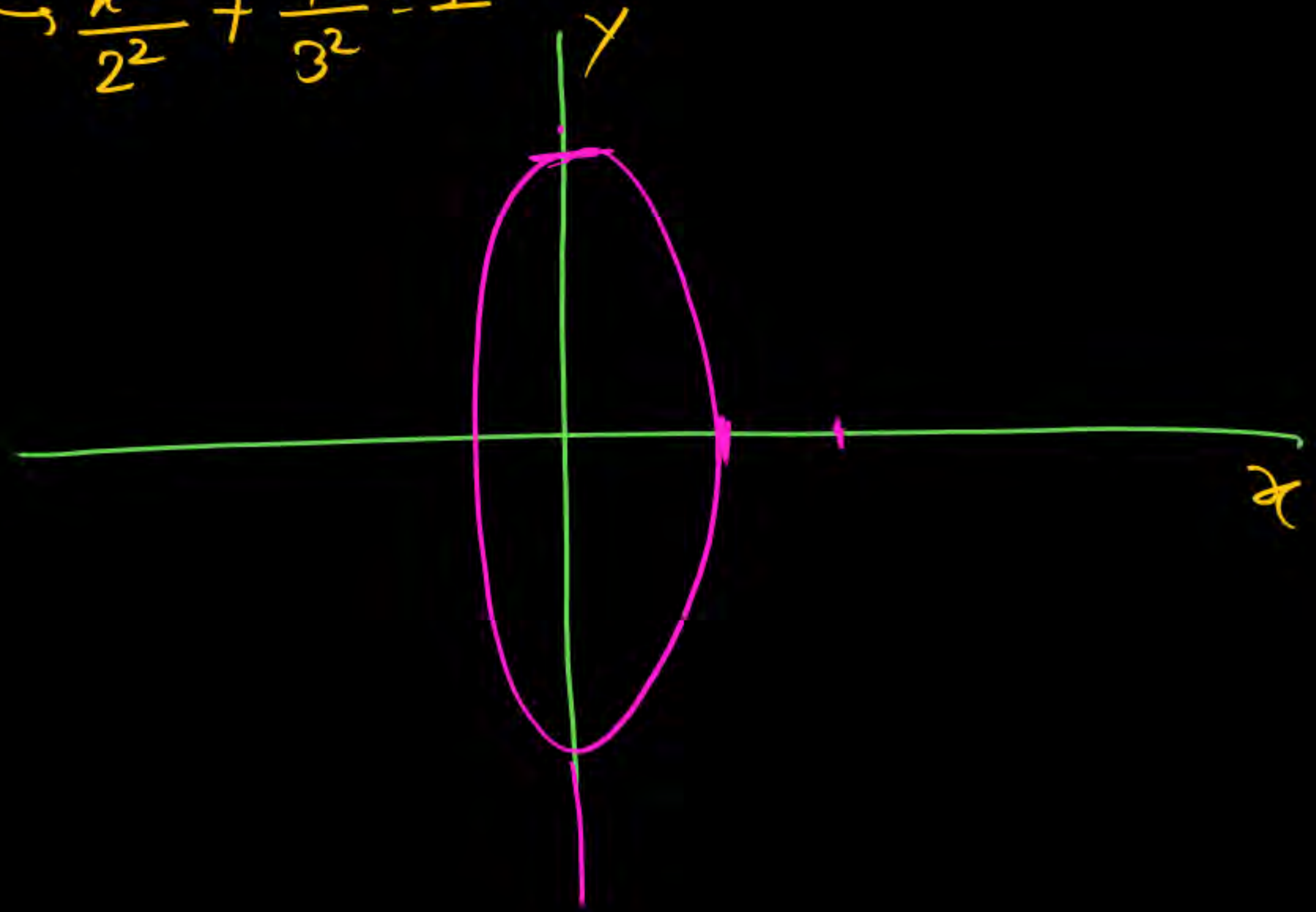
Circumfera $= 2\pi R$

Area $= \pi R^2$

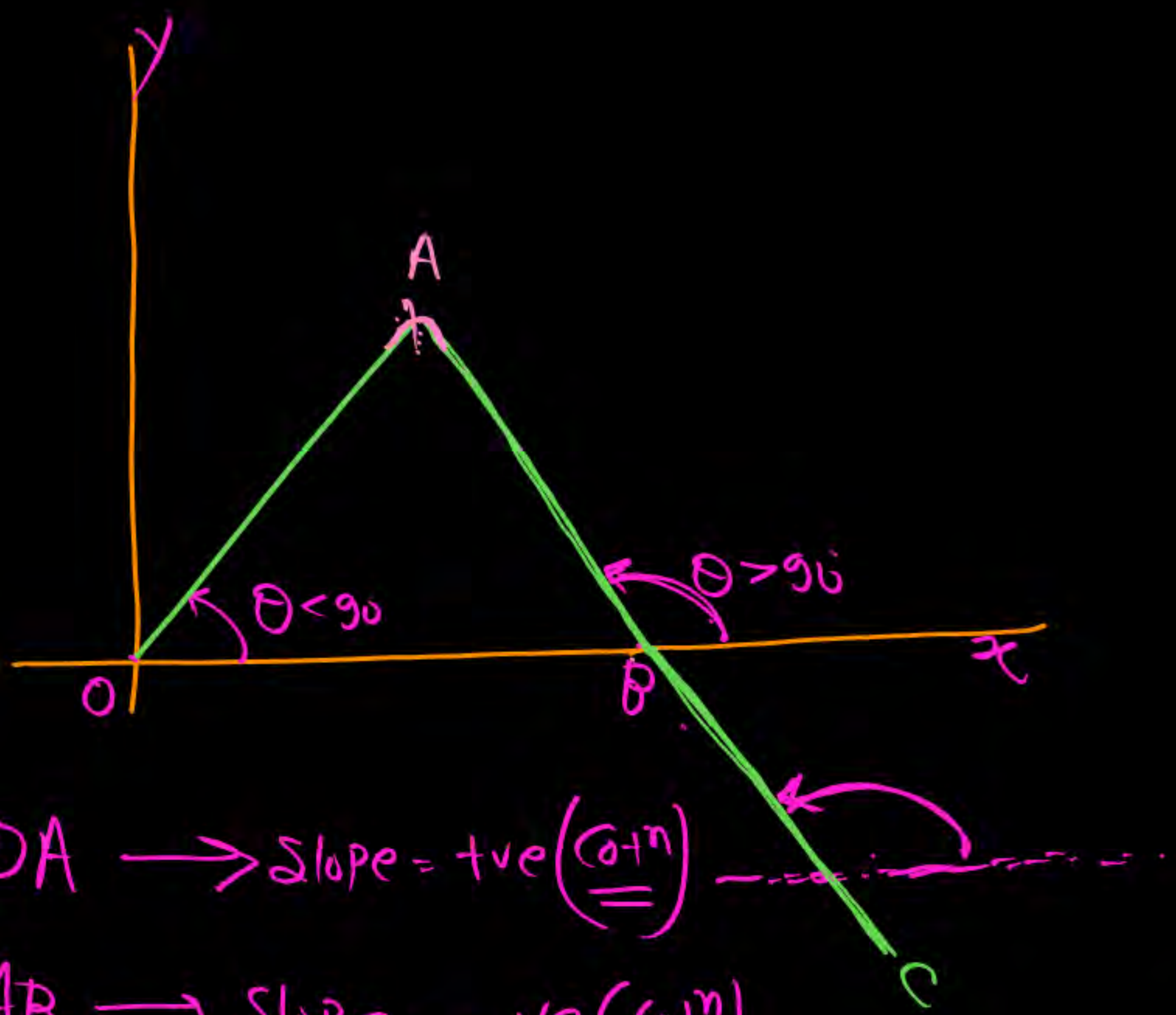
$$\frac{x^2}{4} + \frac{y^2}{9} = 1$$

Draw graph b/w x & y

$$\frac{x^2}{2^2} + \frac{y^2}{3^2} = 1$$



Variation of slope

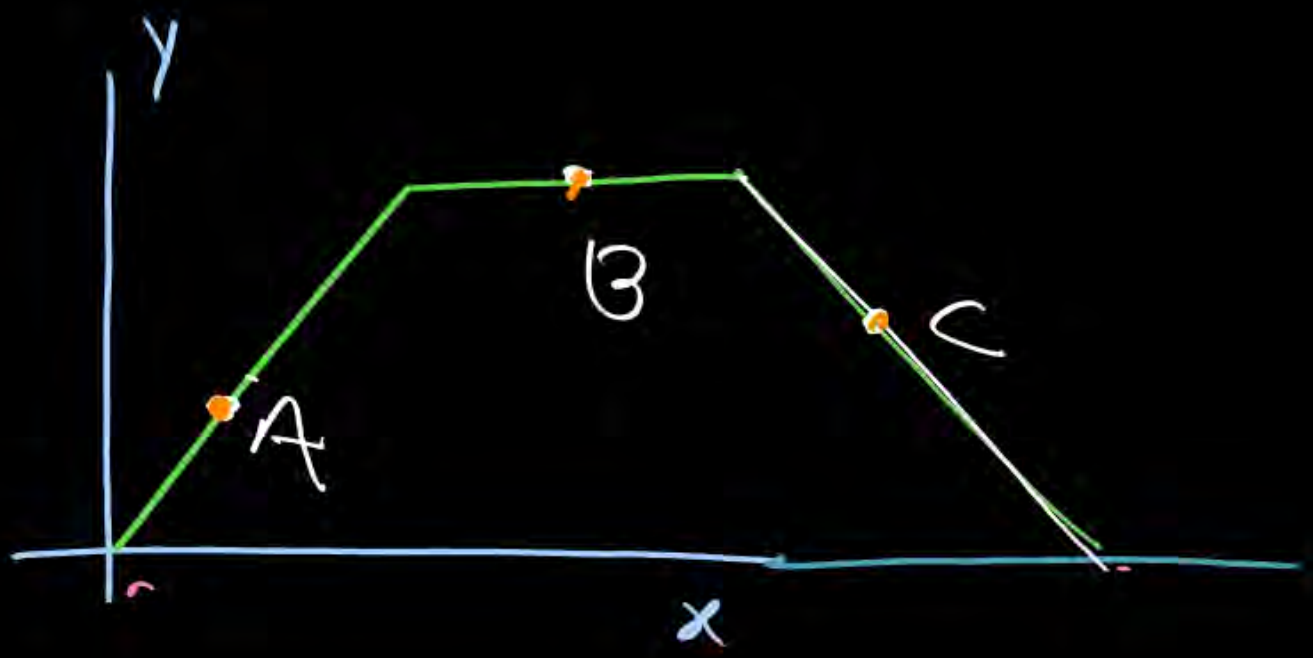


OA ⟶ slope = +ve (cot^n)

AB ⟶ Slope = −ve (cot^n)

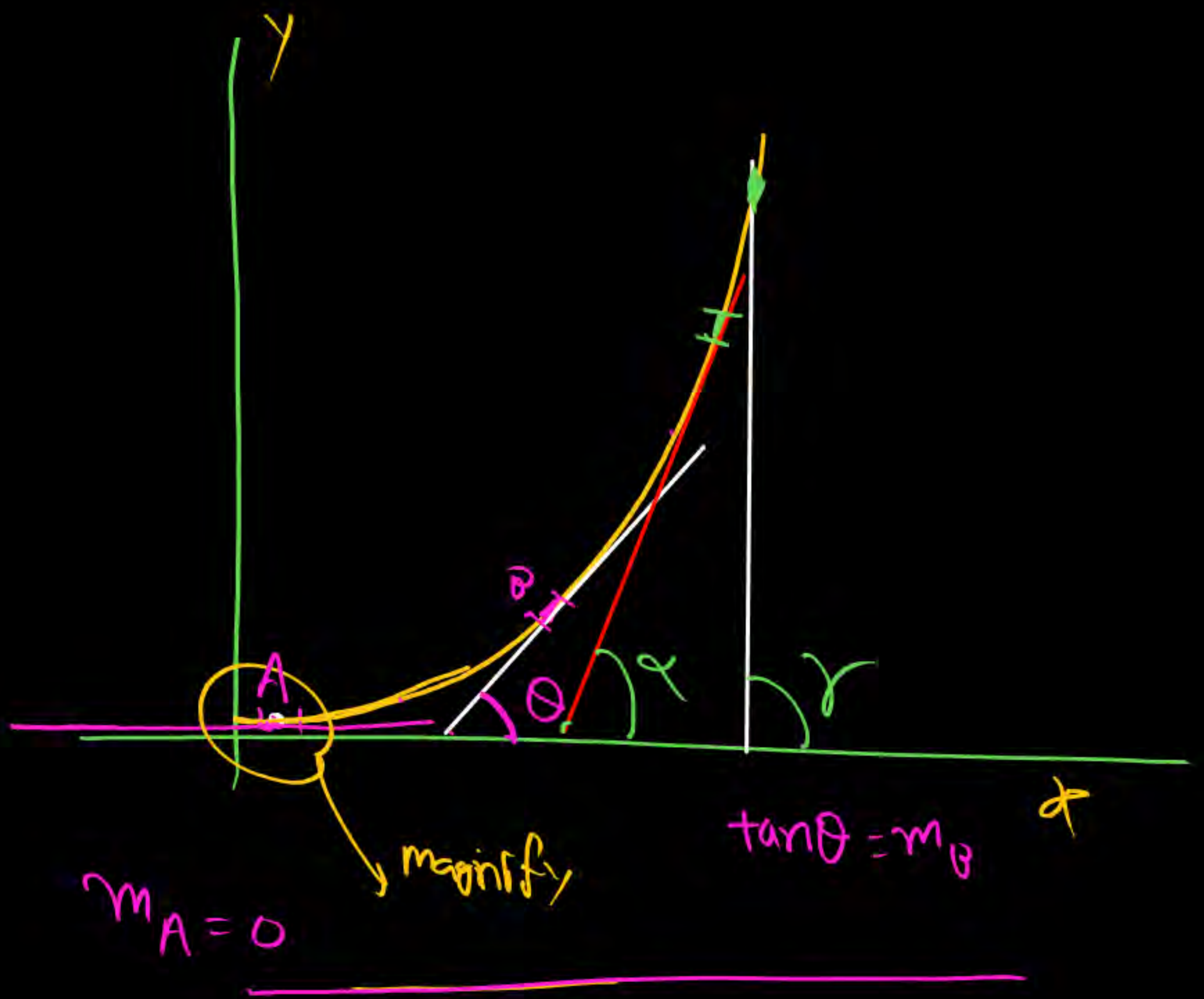
BC ⟶ slope = −ve cot^n

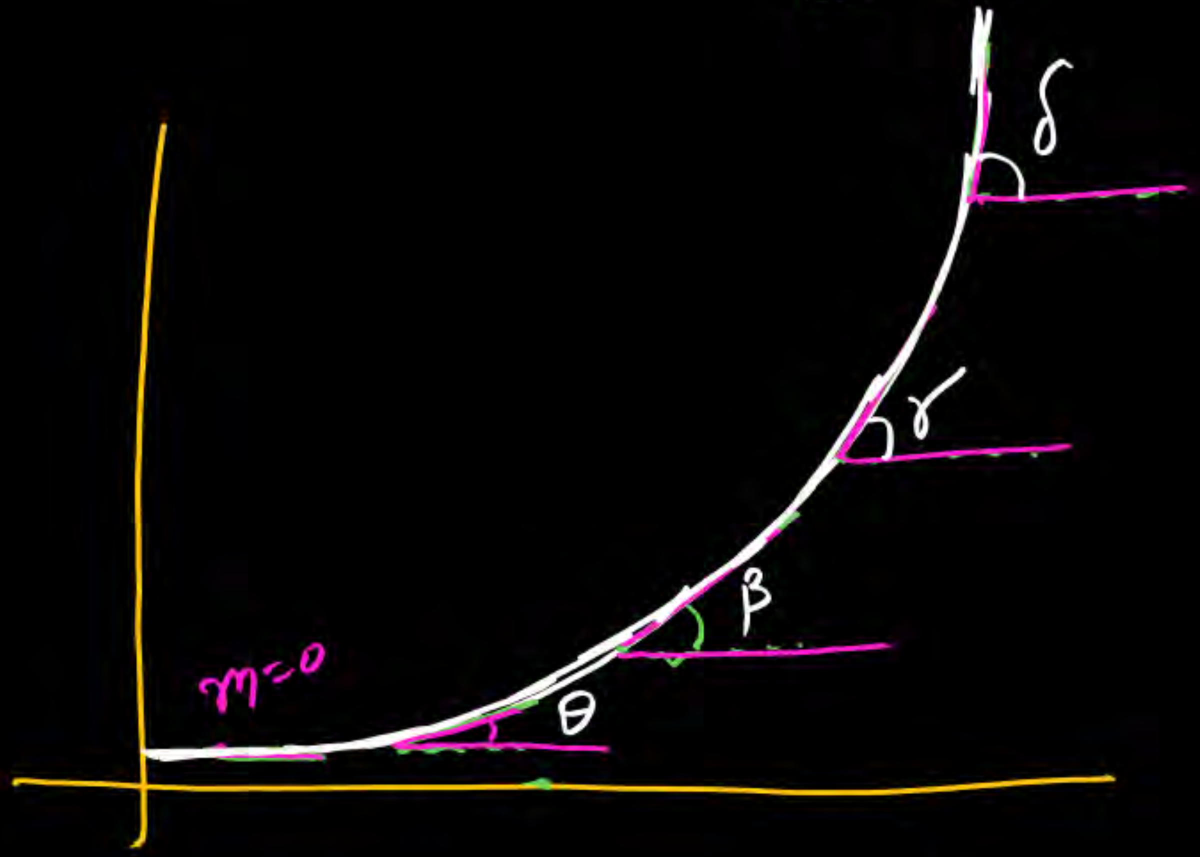
$$m_{AB} = m_{BC} = [-ve \ cot^n]$$



$$\begin{cases} m_A = +ve \\ m_B = zero \\ m_C = -ve \end{cases}$$

Slope of curve → We will draw a Tangent on a curve where we have to find slope.

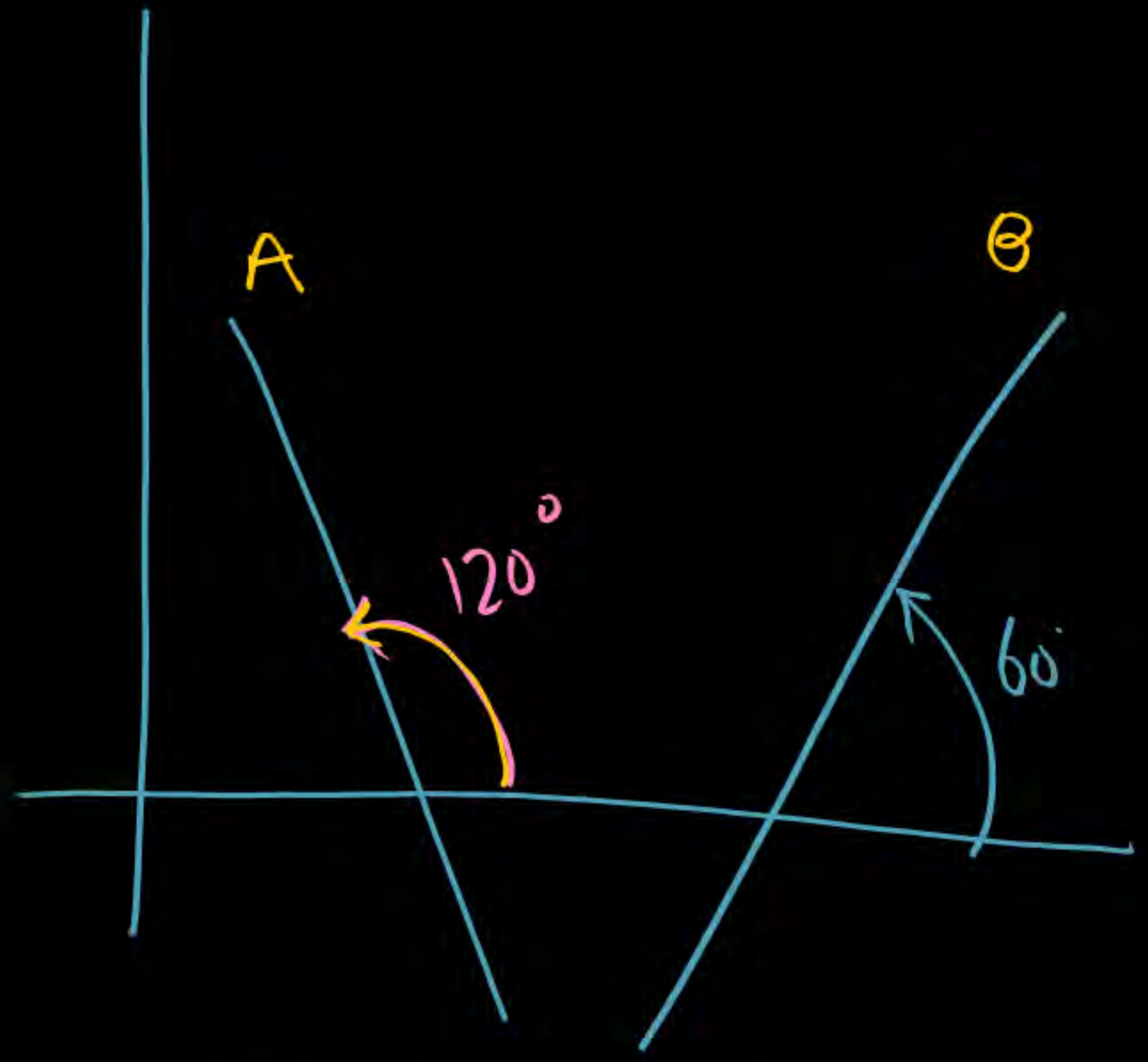




$\theta < \beta < \gamma < \delta$

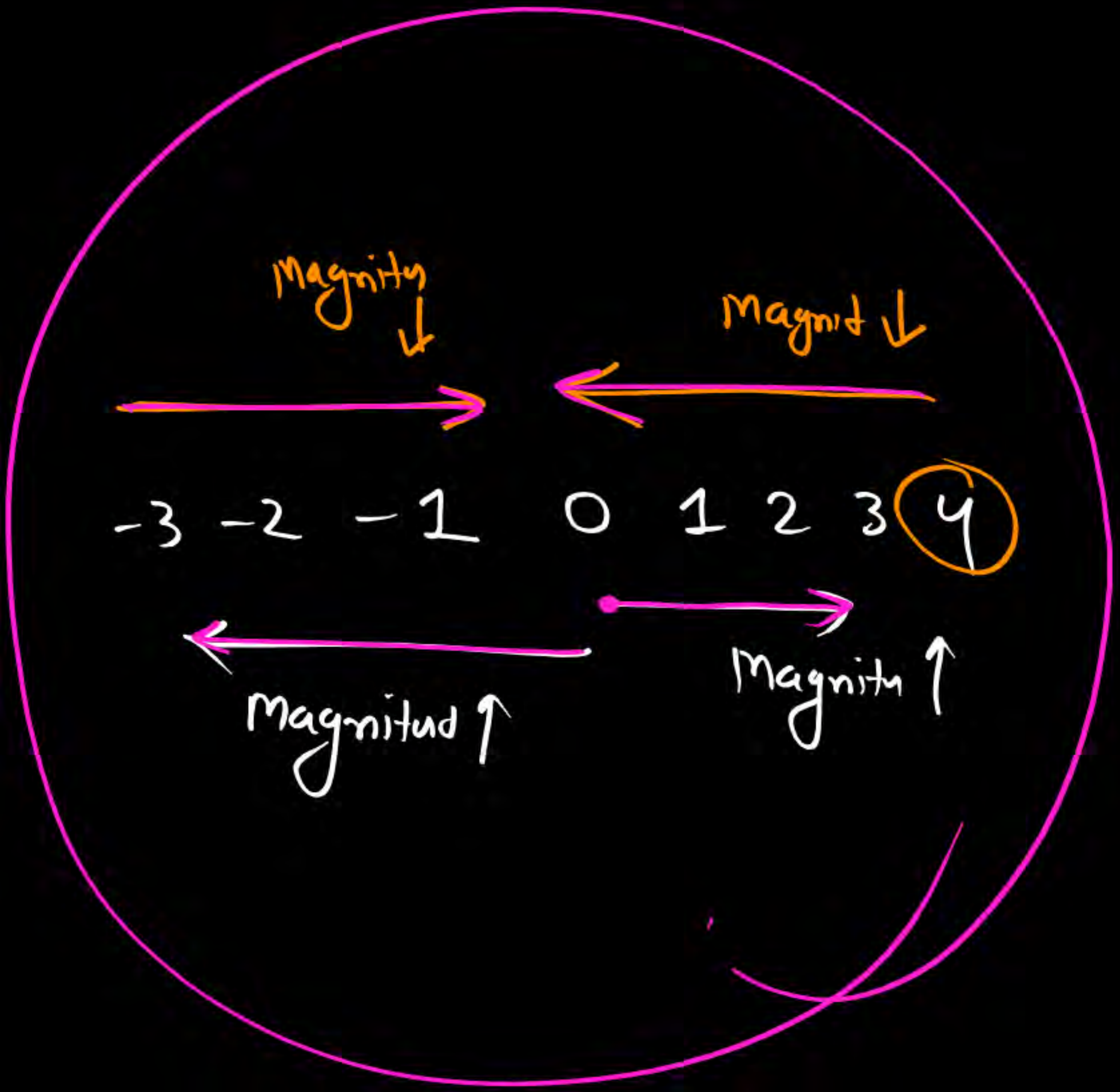
Slope ↑ (Increase)

Magnitude of slope

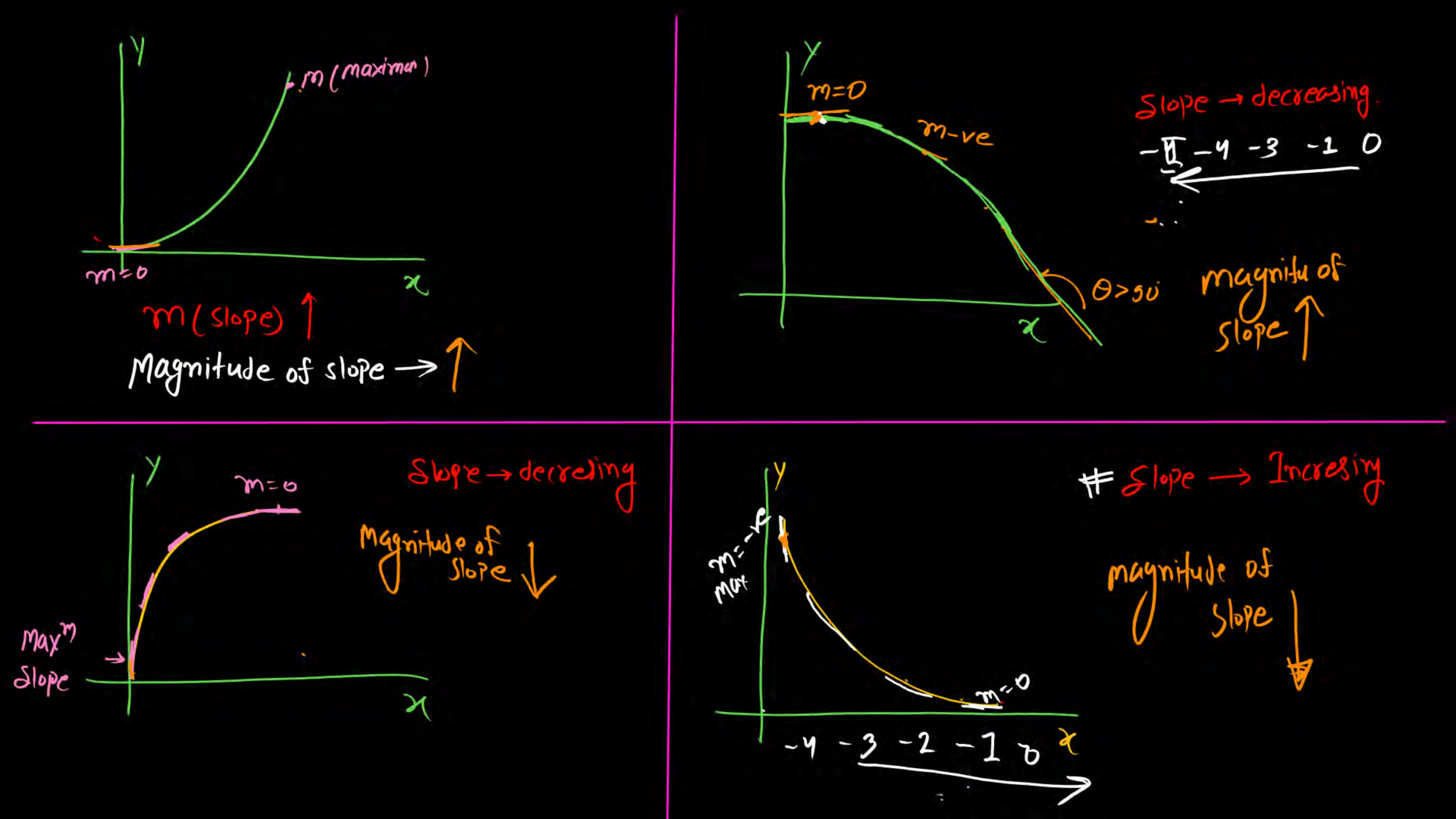


$m_A = \tan(120°) = -\sqrt{3}$; $m_B = \tan 60° = \sqrt{3}$

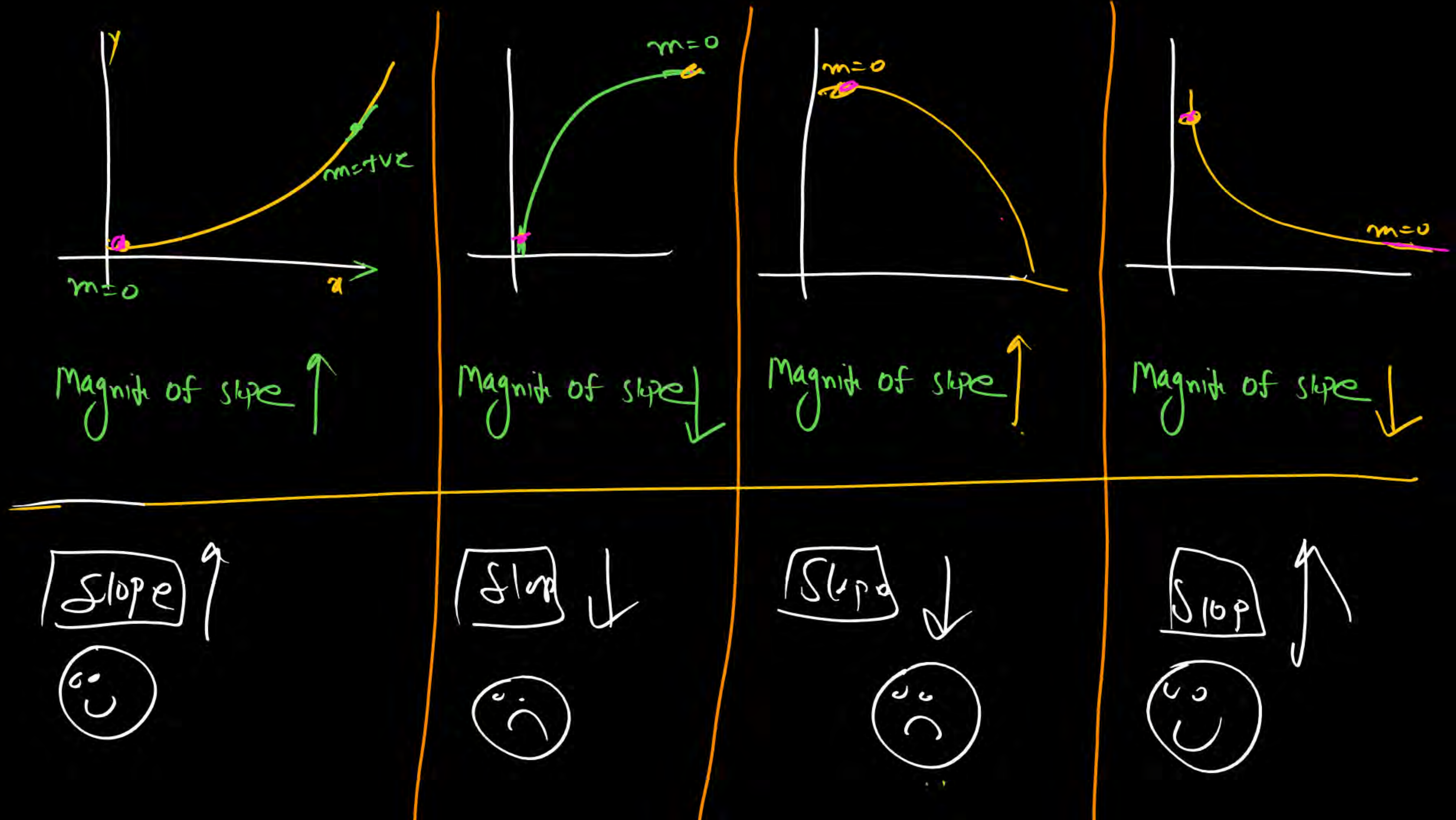
Magnitude of slope: $|m_A| = \sqrt{3} = |m_B|$


Magnitu ↓
Magnit ↓
-3 -2 -1 0 1 2 3 4
Magnitud ↑
Magnitu ↑


Slope ↑ →
हसता हुआ रामलाल
Slope ↓ →
रोता हुआ रामलाल



y
m (maximum)
m=0
x
m (slope) ↑
Magnitude of slope → ↑
y
m=0
m-ve
x
θ>90
Slope → decreasing
-4 -3 -1 0
magnitude of slope ↑
y
m=0
Max^m slope
x
Slope → decreasing
Magnitude of slope ↓
y
m=-ve max
m=0
-4 -3 -2 -1 0 x
Slope → Incresing
magnitude of slope ↓

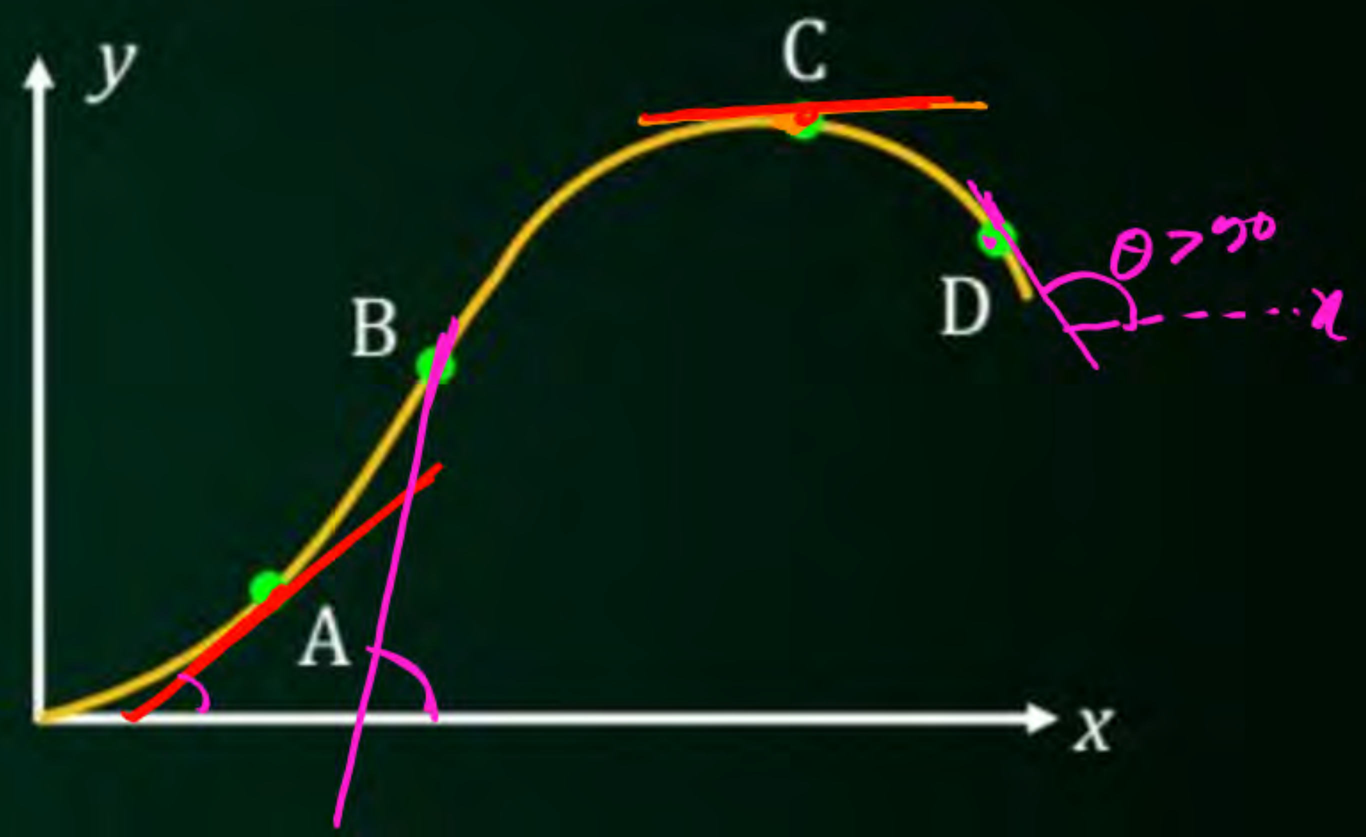


y
m=+ve
m=0
x
m=0
m=0
m=0
Magnit of slope
Magnit of slope
Magnit of slope
Magnit of slope
Slope
Slop
Slop
Slop

QUESTION

Match the matrix :

Point	Slope
A	Zero
B	negative
C	Maximum
D	Positive



If $y = 2x+4$ find change in y w.r.t x. when x changes from $x_1 = 1$ to $x_2 = 3$.

(y depends on x)

Sol^n

If $x_1 = 1$

$$y_1 = 2(1)+4 = 6$$

If $x_2 = 3$

$$y_2 = 2(3)+4 = 10$$

$$\frac{\Delta y}{\Delta x} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{(10-6)}{3-1} = \frac{4}{2} = 2$$

(Q) If $y = 2x+4$ find Rate of change in y w.r.t x at $x = 3$??

Sol^n Not possible because at one value of x we will get one value of y then how we will calculate change in y.




THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 09 | Physics

Basic Maths and Calculus



By- Dr. Manish Raj (MR SIR)

Topics to be covered

1. All rules of Differentiation
2.
3.
4.



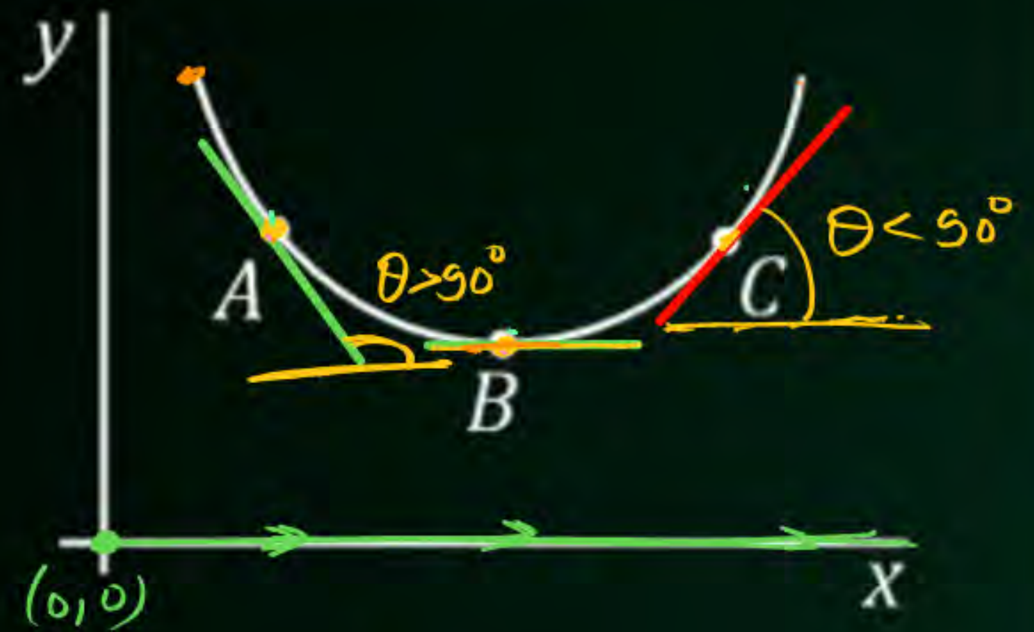
PhD on Differentiation

85% → calculation

physics

Basic Math

Comment on slope and Variation of Slope



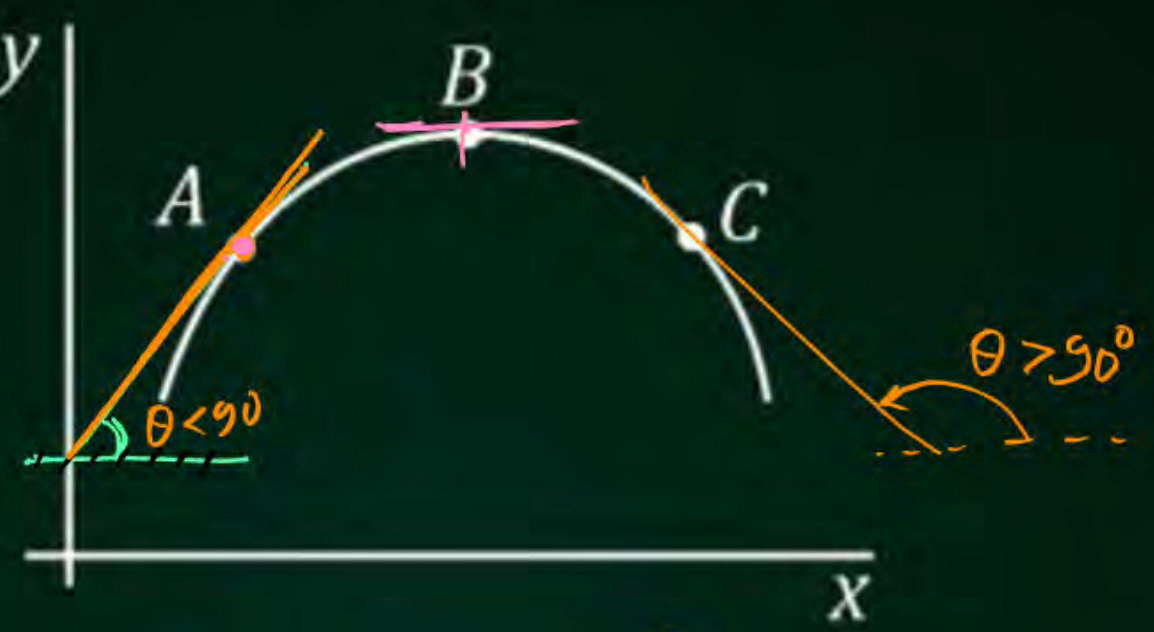
$A \rightarrow (\text{slope})_A = -ve$

$B \rightarrow (\text{slope})_B = 0$

$C \rightarrow (\text{slope})_C = +ve$

→ Slope → always Increasing

→ Magnitude of slope → 1st dec. then Inc.



$m_A \rightarrow +ve$

$m_B \rightarrow zero$

$m_C \rightarrow -ve$

$(\text{slope})_{A \text{ to } C}$ → Always decreasing

(Steepness) Magnitude of slope → 1st decreasing then Increasing

m / slope

magnitude of slope → zero slope

Differentiation

$\frac{d\square}{dx}$ = Differential operator

= Rate of change in $\square$ w.r.t. 'x'. ✓

$\frac{d\boxed{y}}{dt}$ = Rate of charge in y w. r. t. time

$2+4=6$

$3-1=2$

$6\div2=3$

$\frac{d\square}{dx}$ = diffⁿ operat.

If $y=2x^2+3$

find change in y w.r.t change in x when x changes from $\boxed{x_1=2}$ to $\boxed{x_2=2.0001}$.

$\to y_1$

• Normal method से नही कर सकते Newton बाबा ने diffⁿ दिया

$\lim_{\Delta x\to 0}\frac{\Delta y}{\Delta x}=\frac{dy}{dx}=\frac{d\boxed{y}}{dx}$

Rule: (1)

Differentiation of any constant is zero. $Y = C$ const^n

diff^n → $\frac{d\square}{dx}$ = Change in $\square$ w.r.t x

universal gravit const^n $G = 6.67\times10^{-11}\ Nm^2/kg$

$\frac{d5}{dx} = 0$

$\left[\frac{d[G]}{dt} = 0\right]$

$\sin\theta$ ← Variable

$\sin 90° = 1$ ⇒ const^n

$\frac{d\pi}{dt} = 0$

$\frac{d(\sin 90°)}{dt} = \frac{d1}{dt} = 0$

$\frac{dx^\circ}{dx} = \frac{d1}{dx} = 0$

$\frac{d[\sin^2\theta + \cos^2\theta]}{d\theta} = 0$

$\frac{d(\cos\theta\cdot\sec\theta)}{d\theta} = 0$

QUESTION

If $\frac{dy}{dx} = 0$ then y is?

A. Zero

B. Variable

C. Constant

D. Non-zero number

must constn.

$\frac{d[y]}{dx} = 0$

$\frac{d\pi}{dx} = 0$

$\frac{d0}{dx} = 0$

$\frac{d5}{dx} = 0$

$\frac{d6}{dx} = 0$

Rule: (2)

Differentiation of algebraic function $y = f(x) = x^n$

n = constant

$$\frac{dx^n}{dx} = nx^{n-1}$$

Rule

Ex- $y = x^2$

$y = x^5$

$$\frac{dy}{dx} = \frac{dx^2}{dx} = 2x^{2-1}$$

$= 2x$

$$\frac{dy}{dx} = \frac{dx^5}{dx} = 5x^{5-1} = 5x^4$$

Example:

$$\frac{dx^3}{dx} = 3x^2$$

$$\frac{dt^{4/3}}{dt} = \frac{4}{3}t^{\frac{4}{3}-1} = \frac{4}{3}t^{1/3}$$

\# $$\frac{d\sqrt{x}}{dx} = \frac{dx^{1/2}}{dx} = \frac{1}{2}x^{\left(\frac{1}{2}-1\right)}$$

$$= \frac{1}{2}x^{\frac{1-2}{2}}$$

$$= \frac{1}{2}x^{-1/2} = \frac{1}{2x^{1/2}} = \frac{1}{2\sqrt{x}}$$

$$\frac{dx^{+9}}{dx} = 9x^8$$

$$\frac{dx^{3/2}}{dx} = \frac{3}{2}x^{\frac{3}{2}-1} = \frac{3}{2}x^{1/2} = \frac{3}{2}\sqrt{x}$$

\# $y = \frac{1}{x} = x^{-1}$

$$\frac{d\left(\frac{1}{x}\right)}{dx} = \frac{dx^{-1}}{dx} = -1x^{-1-1} = -1\left[x^{-2}\right] = \frac{-1}{x^2}$$ ✓

$\frac{d(x^4)}{dt}$ = Not Possible

$\frac{dt^3}{dx}$ = Not Pos

Example:

$y = \frac{1}{\sqrt{x}}$ find $\frac{dy}{dx}$

$$\frac{d\left(\frac{1}{\sqrt{x}}\right)}{dx} = \frac{dx^{-\frac{1}{2}}}{dx} = -\frac{1}{2}x^{-\frac{1}{2}-1}$$

$$= -\frac{1}{2}x^{-3/2}$$

$$\frac{dx^{-\frac{1}{3}}}{dx} = -\frac{1}{3}x^{-\frac{1}{3}-1} = -\frac{1}{3}x^{-4/3}$$

$$\frac{d\left(\frac{1}{x^2}\right)}{dx} = \frac{dx^{-2}}{dx} = -2x^{-3}$$

$$= \frac{-2}{x^3}$$

$$\frac{dx^{-7}}{dx} = -7x^{-8}$$

$$\frac{d\frac{1}{x^3}}{dx} = \frac{-3}{x^4}$$

Rule: (3)

If any constant number is multiplied with variable then it comes out from differentiation.

$y = c\,f(x)$ → $\frac{dy}{dx} = c\frac{df(x)}{dx}$

Example:

const

$y = 3x^2$

$\frac{dy}{dx} = \frac{d[3x^2]}{dx} = \frac{3d(x^2)}{dx} = 3[2x] = 6x$

$y = 4x^3$ $\quad \frac{dy}{dx} = 4\frac{dx^3}{dx} = 4[3x^2]$

$= 12x^2$

$y = 4\sqrt{x} = 4x^{1/2}$

$\frac{dy}{dx} = 4\frac{dx^{1/2}}{dx} = 4\cdot\frac{1}{2}[x^{\frac{1}{2}-1}] = 2x^{-\frac{1}{2}} = \frac{2}{\sqrt{x}}$

$y = \frac{2}{x^3} = 2x^{-3}$ → $\frac{dy}{dx} = 2\frac{d(x^{-3})}{dx} = -6x^{-4}$

Diffⁿ of Trigonometric / exponential / log · function

$$\frac{d\sin(x)}{dx} = \cos x$$

$$\frac{d\cos(\theta)}{d\theta} = -\sin\theta$$

$$\frac{d\tan(x)}{dx} = \sec^2 x$$

→ mR Ratta

(*) $$\frac{d\cot\theta}{d\theta} = -\operatorname{cosec}^2\theta$$

→ Not Weff.

$$\frac{d[e^x]}{dx} = e^x$$

← mR Ratta

* $$\frac{d\sec\theta}{d\theta} = \sec\theta \cdot \tan\theta$$

← Not useful ✗

$$\frac{d\log_e x}{dx} = \frac{1}{x}$$

← mR Ratta

$y = A \cdot \sin x$

(const)

$$\frac{dy}{dx} = A\frac{d(\sin x)}{dx}$$

$$\frac{dy}{dx} = A\cos x$$

$y = 4e^x$

$$\frac{dy}{dx} = 4\frac{de^x}{dx} = 4e^x$$

$$\frac{d\sin(45^\circ)}{d\theta} = 0$$

$y = 5 \times \log_e x$

$$\left[\frac{dy}{dx} = 5\frac{d\log_e x}{dx} = \frac{5}{x}\right]$$

Ans

# Addition Rule	# Subtraction Rule	# Multiplication Rule	# Division Rule
$Y = A + B$	$Y = A - B$	$y = A \cdot B$	$y = \frac{A}{B}$
$\frac{dy}{dx} = \frac{d(A+B)}{dx}$	$\frac{dy}{dx} = \frac{dA}{dx} - \frac{dB}{dx}$	$\frac{dy}{dx} = \left(\frac{dA}{dx}\right)B + \left(\frac{dB}{dx}\right)A$	$\frac{dy}{dx} = \frac{\left[\frac{dA}{dx}B\right] - \left[\frac{dB}{dx}A\right]}{B^2}$
$\frac{dy}{dx} = \frac{dA}{dx} + \frac{dB}{dx}$			
Ex $y = x^2 + \sin x$	$y = \cos x - e^x$	$y = x^2 \cdot \log_e^x$	$y = \frac{\sin x}{x}$
$\frac{dy}{dx} = 2x + \cos x$	$\frac{dy}{dx} = -\sin x - e^x$	$\frac{dy}{dx} = \frac{dx^2}{dx}\log_e^x + \frac{d\log^x}{dx}x^2$	$\frac{dy}{dx} = \frac{x\frac{d(\sin x)}{dx} - \sin x\frac{dx}{dx}}{x^2}$
		$= 2x\log x + \frac{1}{x}x^2 x$	$= \frac{x\cos x - \sin x}{x^2}$
		$= 2x\log x + x$	

$$\frac{dx^1}{dx} = 1x^{1-1} = 1x^0 = 1$$

$$y = \frac{\cos(x)}{x^2}$$

$$\frac{dy}{dx} = \frac{x^2 \frac{d\cos x}{dx} - \frac{dx^2}{dx}\cos(x)}{[x^2]^2} = \frac{-x^2 \sin x - 2x\cos(x)}{x^4}$$

QUESTION

$y = \tan x \cdot \log x$

$$\frac{dy}{dx} = \frac{d \tan x}{dx} \log x + \tan x \frac{d \log x}{dx}$$

$$= \sec^2 x \log x + \frac{\tan x}{x}$$

$$y = \sin x \cdot e^x$$

$$\frac{dy}{dx} = \frac{d \sin(x)}{dx} \cdot e^x + \sin x \frac{de^x}{dx}$$

$$\frac{dy}{dx} = \cos x \, e^x + \sin x \, e^x$$

QUESTION

$y = x^2 - 4x + 3$, then find value of $\frac{dy}{dx}$ at $x = 2$

$$\frac{dy}{dx} = \frac{d(x^2 - 4x + 3)}{dx} = \frac{dx^2}{dx} - 4\frac{dx}{dx} + \frac{d(3)}{dx}$$

$$= 2x - 4 \times 1 + 0$$

$$\left[\frac{dy}{dx}\right] = 2x - 4$$

$\left(\frac{dy}{dx}\right)_{x=2} = 2 \times 2 - 4 = 0$

QUESTION

$$y = x(2-x^2)$$

find $\frac{dy}{dx}$ (??)

Sol^n

$$y = 2x - x^3$$

$$\frac{dy}{dx} = 2\frac{dx}{dx} - \frac{dx^3}{dx}$$

$$\frac{dy}{dx} = \left[2 - 3x^2\right]$$

$$y = \sqrt{x} + \frac{1}{\sqrt{x}}$$

$$\frac{dy}{dx} = \frac{d\sqrt{x}}{dx} + \frac{dx^{-1/2}}{dx}$$

$$= \frac{1}{2}x^{\frac{1}{2}-1} - \frac{1}{2}x^{-\frac{1}{2}-1}$$

$$= \left[\frac{1}{2\sqrt{x}} - \frac{x^{-3/2}}{2}\right]$$

$$y = \left(\sqrt{x} + \frac{1}{\sqrt{x}}\right)^2$$

$$y = x + \frac{1}{x} + 2\sqrt{x}\times\frac{1}{\sqrt{x}}$$

$$y = x + \frac{1}{x} + 2$$

$$\frac{dy}{dx} = 1 - \frac{1}{x^2}$$

QUESTION

$$y = \cos x + \frac{2}{x^3}$$

$$\frac{dy}{dx} = \frac{d\cos x}{dx} + 2\frac{dx^{-3}}{dx}$$

$$= -\sin x + 2\left[-3x^{-4}\right]$$

$$= -\sin x - \frac{6}{x^4}$$

Level up

$$y = \frac{4}{(x^3+1)}$$

Division Rule

$$\frac{dy}{dx} = \frac{\frac{d(4)}{dx}(x^3+1) - 4\frac{d(x^3+1)}{dx}}{(x^3+1)^2}$$

(the term $\frac{d(4)}{dx}$ is struck through and marked $\to 0$)

$$= \frac{-4\left[3x^2+0\right]}{(x^3+1)^2} = \frac{-12x^2}{(x^3+1)^2}$$

AB

$$y = \frac{x+1}{x-1}$$

division Rule

$$\frac{dy}{dx} = \frac{\frac{d(x+1)}{dx}(x-1) - (x+1)\frac{d(x-1)}{dx}}{(x-1)^2} = \frac{(1+0)(x-1) - (x+1)(1-0)}{(x-1)^2}$$

$$= \frac{(x-1) - (x+1)}{(x-1)^2} = \frac{x-1-x-1}{(x-1)^2}$$

$$= \frac{-2}{(x-1)^2}$$

H/W

$$y = \frac{A}{x^6} - \frac{B}{x^5}$$; then find x where $\frac{dy}{dx} = 0$

NEET-3 Times.

$$y = Ax^{-6} - Bx^{-5}$$

$$\frac{dy}{dx} = A\frac{dx^{-6}}{dx} - B\frac{dx^{-5}}{dx}$$

$$= -6Ax^{-6-1} + 5Bx^{-5-1}$$

$$\frac{dy}{dx} = -6Ax^{-7} + 5Bx^{-6}$$

$$0 = \frac{-6A}{x^7} + \frac{5B}{x^6}$$

$$\frac{6A}{x^7} = \frac{5B}{x^6}$$

$$\frac{6A}{5B} = x$$

Ans

add 10 in 10 two times ??

$10 + + 10 = $ ✗

$(10 + 10) + 10 = 30$ ✓

Double diffⁿ = 1 diffⁿ + 1 diffⁿ

Ex $y = x^3$

$$\left[\frac{dy}{dx}\right] = \frac{dx^3}{dx} = \left[3x^2\right]$$

diffⁿ one more time

$$\frac{d}{dx}\left[\frac{dy}{dx}\right] = \frac{d^2(y)}{dx^2} = \frac{d\,3x^2}{dx} = 3\frac{dx^2}{dx} = 3 \times 2x = 6x$$

Ex $y = \sin x$

$$\frac{dy}{dx} = \cos x$$

$$\frac{d^2y}{dx^2} = -\sin x$$

$$\frac{d^3(y)}{dx^3} = -[\cos x]$$

$$\frac{d^4y}{dx^4} = -[-\sin x] = +\sin x$$

$\frac{dy}{dx}$ = 1st order differentiation.

$$\frac{d}{dx}\left(\frac{dy}{dx}\right) = \frac{d^2(y)}{dx^2}$$ = 2nd order diffn = Double diffn

QUESTION

Double Differentiation

$$y = 1x^5 + 2x^4 + 3x^3 + 4x^2 + 5x^1 + 6x^0$$

$$\frac{dy}{dx} = 5x^4 + 2(4x^3) + 3[3x^2] + 4[2x] + 5(1) + 0$$

$$\frac{d^2y}{dx^2} = 5[4x^3] + 8[3x^2] + 9(2x] + 8[1] + 0$$

$$\frac{d^3y}{dx^2} = 20[3x^2] + 24[2x] + 18(1) + 0$$

$$\frac{d^4y}{dx^4} = 60[2x] + 48\times1 + 0$$

$$\frac{d^5y}{dx^5} = 120\times1 + 0 = 120$$

$$\frac{d^6y}{dx^5} = 0$$

QUESTION

Find 5th order differentiation of given function:

$y = e^x$

$\frac{dy}{dx} = e^x$

$\frac{d^2y}{dx^2} = e^x$

$\frac{d^3y}{dx^3} = e^x$

$\frac{d^4y}{dx^4} = e^x$ $\quad \frac{d^5y}{dx^5} = e^x$

$y = \sin x$

Function of a Function

$y = \sin x \cdot e^x$

multiplical

$y = \sin x + \cos(x)$

addition Rule

$y = \sin(e^x)$ अज्ञात

$y = \sin(x^2 + 2x)$

सरल Trigo algerbic

$y = \log x \cdot (x^5) \rightarrow \frac{dy}{dx} = \frac{(x^5)}{x} + \log x (5x^4)$

Product Rule

$= x^4 + \log x \, 5x^4$

$= x^4 [1 + 5 \log x]$ Ans

$y = x^5 - \tan x$

Subtra Rule

$y = e^{(4x)}$

expo algebric स्वर ला

$y = (x^2 + 4)^4$

~~Chain Rule~~

खराब funct → Function of a function

(Outside)-(Inside) Rule (MR*)

$y = \sin(e^{x})$

↑ outer (sin), Inner (e^{x})

$y = e^{(4x^2)}$ ← Inner function ($4x^2$)

↑ exponetia is outer

$y = (x^2-3)^4$ ← outer

Inner (x^2-3)

$\frac{dy}{dx}$ = [Differentian of outer function w.r.t Inner (Keep Inside as it is)] × [diffⁿ of Inner function w.r.t x]

$\frac{d\sin(\theta)}{d\theta} = \cos\theta$

$\frac{d\,\sin(M.R)}{d(M.R)} = \cos(M.R)$

$\frac{d\,\sin(Kallua)}{d(Kallua)} = \cos(Kallua)$

$\frac{d\,\sin(x^2)}{dx} = \cos(x^2) \times \frac{dx^2}{dx}$

$= \cos(x^2) \times 2x$



$\frac{d\,\cos(R.L)}{d(R.L)} = -\sin(R.L)$ ✓

$$y = A\cos(Kx)$$

$$\frac{dy}{dx} = A\frac{d\cos(Kx)}{dx}$$

$$= A\left[-\sin(Kx) \times \left(\frac{dKx}{dx}\right)\right]$$

$$= -A\sin(Kx)\, K \frac{dx}{dx} \to 1$$

$$\frac{dy}{dx} = -AK\sin(Kx)$$

$$y = 5e^{3x}$$

$$\frac{dy}{dx} = 5\frac{de^{3x}}{dx}$$

$$= 5e^{3x}\left(\frac{d3x}{dx}\right)$$

$$= 5e^{3x}\left[3\frac{dx}{dx}\right]$$

$$= 15e^{3x}$$

$$y = e^{-x}$$

$$\frac{dy}{dx} = e^{-x} \times \left[\frac{d{-x}}{dx}\right]$$

$$\frac{dy}{dx} = -e^{-x}$$

$$y = 3\sin(x^2+2)$$

$$\frac{dy}{dx} = 3\left[\cos(x^2+2) \times \frac{dx^2+2}{dx}\right]$$

$$= 3\cos(x^2+2) \times [2x+0]$$

$$= 6x\cos(x^2+2)$$

H/W

Partial differentiation

If $y = x^2$ find $\frac{dy}{dx}$??

If $y = x^2$ find $\left(\frac{dy}{dt}\right)$??

H/W


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 10 | Physics

Basic Maths and Calculus

By- Dr. Manish Raj (MR SIR)



Topics to be covered

1. Outside-Inside Rule (Chain Rule)
2. Partial differential
3. application of $diff^n$
4. Quadratic equation

* Maxima/minima



$\frac{dy}{dx}$ = differentiation of 'y' w.r.t 'x'
= Rate of change in 'y' w.r.t. 'x'

$\left|\frac{dy}{dx}\right|$ = Magnitude of Rate of change in y w.r.t 'x'
(Mod. of $\frac{dy}{dx}$)

$\frac{d|y|}{dx}$ = Rate of change in magnitude of y. w.r.t (x)

$\frac{d(y^2)}{dx}$ = Rate of change in y^2 w.r.t x.

$\frac{d^2y}{dx^2}$ = The Rate of change in $\left[\frac{dy}{dx}\right]$ w.r.t x

$\frac{d^2(y)}{dx^2} = \frac{d}{dx}\left(\frac{dy}{dx}\right)$
= double diff^n

(Q) If $y = \sin(x^2+3x)$ then find $\frac{dy}{dx}$??

Imp* $\frac{dy}{dx}$ = (diffⁿ of outer function keep inside as it is) × (diffⁿ of Inner function)

Solⁿ मजदूरी (chain Rule)

$y = \sin(x^2+3x)$

Let (माना) ⇒ $x^2+3x = t$ —①

$y = \sin(t)$

diffⁿ of y w.r.t to 't'

$\frac{dy}{dt} = \cos(t)$

→ $dy = \cos t \; dt$

divided by dx both side.

$\left(\frac{dy}{dx}\right) = \cos t \left(\frac{dt}{dx}\right)$ —(II)

→ diffⁿ eqⁿ ① w.r.t x

$\frac{d(x^2+3x)}{dx} = \frac{dt}{dx}$

$2x+3 = \frac{dt}{dx}$ → Putting value of $\frac{dt}{dx}$ in eqⁿ (II)

$\frac{dy}{dx} = \cos(x^2+3x) \times (2x+3)$

$$y = \sin(x^2 + 3x)$$

outside — Inside

$$\frac{dy}{dx} = \cos(x^2 + 3x) \times [2x + 3]$$

$y = e^{\alpha x^2}$ where α is constⁿ find $\left(\frac{dy}{dx}\right)$

Solⁿ

Let $\alpha x^2 = t$ — (1)

diffⁿ w.r.t 'x'

$\alpha[2x] = \frac{dt}{dx}$

$y = e^t$

diffⁿ w.r.t time

$\Rightarrow \frac{dy}{dt} = e^t$

$dy = e^t \, dt$

divided by dx both side

$\left(\frac{dy}{dx}\right) = e^t \left[\frac{dt}{dx}\right]$

$$\frac{dy}{dx} = e^{\alpha x^2} \times (\alpha 2 x]$$

mpˣ

$y = e^{\alpha x^2}$

$\frac{dy}{dx} = e^{\alpha x^2} \times \left[\frac{d(\alpha x^2)}{dt}\right]$

$= e^{\alpha x^2}[\alpha 2x]$

$$\frac{dy}{dx} = \left(\text{diff}^n \text{ of outer function Keep inside as it is}\right) \times \left(\text{diff}^n \text{ of Inside w.r.t } x\right)$$

$y = (x^2+4)^3$ → aJib Hai

Sol^n Let $(x^2+4) = t$ — (1)

diff^n w.r.t 'x'

$\frac{d(x^2+4)}{dx} = \frac{dt}{dx}$

$2x + 0 = \frac{dt}{dx}$

$2x = \frac{dt}{dx}$ — (ii)

$y = t^3$

diff^n w.r.t 't'

$\frac{dy}{dt} = \frac{dt^3}{dt}$

$\frac{dy}{dt} = 3t^2$

$\frac{dy}{dx} = 3t^2 \frac{dt}{dx}$

$= 3(x^2+4)^2 2x = 6(x^2+4)^2 x x$

MR^x

$\frac{dy}{dx} = 3(x^2+4)^{3-1} \times 2x$

$= 6x(x^2+4)^2$

QUESTION

$y = \alpha \sin(\beta t)$ find $\frac{dy}{dt}$ where α and β are constant.

MR* (outside Inside)

$y = \alpha \sin(\beta t)$

$\frac{dy}{dt} = \alpha \left[\cos(\beta t) \times \beta\right]$

$\frac{dy}{dt} = \alpha \beta \cos(\beta t)$

Ex $y = 4 \sin(3t)$ Inside

$\frac{dy}{dt} = 4\left[\cos(3t) \times 3\right]$

$\frac{dy}{dt} = 12 \cos(3t)$

Ans

QUESTION

Find double differentiation

$$y = e^{\alpha x}$$

$$y = e^{\alpha x}$$

$$\frac{dy}{dx} = e^{\alpha x} \times \frac{d(\alpha x)}{dx}$$

$$= e^{\alpha x}[\alpha]$$

$$\frac{dy}{dx} = \alpha e^{\alpha x}$$

$$\frac{d^2y}{dx^2} = \alpha\left[e^{\alpha x} \times [\alpha]\right]$$

$$\frac{d^2y}{dx^2} = \alpha^2 e^{\alpha x}$$

$$\frac{d^3y}{dx^2} = \alpha^2\left[e^{\alpha x} \times \alpha\right] = \alpha^3 e^{\alpha x}$$

(iii) $y = e^{(\sin x)}$ $\longrightarrow$ $\frac{dy}{dx} = e^{\sin x}\left[\frac{d\sin(x)}{dx}\right] = e^{\sin x} \times \cos x$

(iv) $y = \cos(x^2 + 4x)$ (inside: $x^2 + 4x$) $\longrightarrow$ $\frac{dy}{dx} = -\sin(x^2+4x) \times [2x + 4\times 1]$

$= -\sin(x^2+4x)\times(2x+4]$ Ans.

(v) $y = 4\sin(8x)$ (inside: $8x$)

$\longrightarrow$ $\frac{dy}{dx} = 4\left[\cos(8x) \times 8\right] = 32\cos(8x)$

(vi) $y = (x^2 + 4x)^2$

$\hookrightarrow$ $\frac{dy}{dx} = 2(x^2+4x)^{2-1} \times [2x+4] = 2(x^2+4x)[2x+4]$ Ans

QUESTION

$y = 4e^{3t}$ find $\frac{dy}{dt}$

$y = 4e^{3t}$

$\frac{dy}{dt} = 4\left[e^{3t} \times \frac{d(3t)}{dt}\right] = 4e^{3t} \times 3$

$= 12e^{3t}$ ✓

QUESTION

$y = 5\sin(4 + 3t)$ find $\frac{dy}{dt}$

Inside

$$\frac{dy}{dx} = 5\left[\cos(4+3t)\right] \times (0 + 3 \times 1)$$

$$= 5\cos(4+3t) \times 3$$

$$= 15\cos(4+3t)$$

QUESTION

$$y = \cos x - \frac{4}{x^2}$$

Sol^n

$$y = \cos(x) - \frac{4}{x^2}$$

$$\frac{d\left(\frac{1}{x^2}\right)}{dx} = \frac{dx^{-2}}{dx} = -2x^{-2-1}$$

$$= \frac{-2}{x^3}$$

$$\frac{dy}{dx} = -\sin(x) - 4\left(\frac{-2}{x^3}\right)$$

$$= -\sin x + \frac{8}{x^3}$$

QUESTION

$y = e^{-\alpha^2 t}$ find $\frac{dy}{dt}$ α is constant.

$y = e^{-\alpha^2 t}$

diff^n $\frac{dy}{dt} = e^{-\alpha^2 t}\left[\frac{d(-\alpha^2 t)}{dt}\right]$

$= -\alpha^2 e^{-\alpha^2 t}$

$y = e^{-\alpha^2 t}$

$\frac{dy}{dt} = e^{-\alpha^2 t} \times [-\alpha^2]$

$= -\alpha^2 e^{-\alpha^2 t}$

QUESTION

Find differentiation of

(i) $y = \log(3x+4)$

(ii) $y = \sin^2 x = (\sin x)^2$

$y = \log(\overbrace{3x+4}^{\text{Insid}})$

$$\frac{dy}{dx} = \frac{1}{(3x+4)} \times [3 \times 1 + 0]$$

$$= \frac{3}{(3x+4)} \text{ Ans}$$

$$\frac{d \log(m.R)}{d(m.R)} = \frac{1}{(m.R)}$$

Sol^n $y = (\underbrace{\sin x}_{\text{Inside}})^2$

Chain Rule

$\sin x = t$

diff^n w.r.t (x)

$\cos x = \frac{dt}{dx}$

$y = t^2$

$\frac{dy}{dt} = 2t$

$\frac{dy}{dx} = 2t \frac{dt}{dx}$

$\frac{dy}{dx} = 2(\sin x)\cos x$

MR*

$\frac{dy}{dx} = 2(\sin x)^{2-1} \times \cos x$

$= 2 \sin x \cdot \cos x$

$\frac{dy}{dx} = \sin(2x)$

QUESTION

H/W?

Find differentiation of

(i) $y = e^{-\alpha x}$ → $\frac{dy}{dx} = -\alpha e^{-\alpha x}$

(ii) $y = e^{(4x-3)}$ → $\frac{dy}{dx} = e^{4x-3} \times (4)$

(iii) $y = e^{(x^2+2)}$ → $\frac{dy}{dx} = e^{(x^2+2)}(2x)$

QUESTION

Find differentiation of y w.r.t x

$$y = A\sin(\omega t - kx)$$

$$y = A\sin(\underbrace{\omega t - kx}_{\text{Insin}})$$

$$\frac{dy}{dx} = A\left[\cos(\omega t - kx) \times \frac{d(\omega t - kx)}{dx}\right]$$

$$= A\cos(\omega t - kx) \times (0 - k1)$$

$$\left[\frac{dy}{dx} = -kA\cos(\omega t - kx)\right]$$

If $y = x^2$; find $\frac{dy}{dx} = ??$

diffn w.r.t. 'x'

$$\frac{dy}{dx} = \frac{dx^2}{dx} = 2x$$

If $y = x^2$ find $\frac{dy}{dt}$; where x depends on time.

मजदूरी

Soln

$y = x^2$

diffn w.r.t 't'

$$\frac{dy}{dt} = \frac{dx^2}{dt} \times \frac{dx}{dx} = \frac{dx^2}{dx} \times \frac{dx}{dt}$$

$$\frac{dy}{dt} = 2x \times \frac{dx}{dt}$$

MR

$y = x^2$

$$\frac{dy}{dt} = 2x\left(\frac{dx}{dt}\right)$$

$$y = \frac{2}{3}\pi x^2$$

find $\frac{dy}{dt} = ??$

$$\left[\frac{dy}{dt}\right] = \frac{2\pi}{3}(2x)\frac{dx}{dt}$$

QUESTION

Volume of sphere

If $V = \frac{4}{3}\pi R^3$; find rate of change in volume w. r. t. time $\left(\frac{dV}{dt}\right) = ??$

$V = \frac{4}{3}\pi R^3$

Sol^n

$$\frac{dV}{dR} = \frac{4\pi}{3}\left[\frac{dR^3}{dR}\right]$$

$$\frac{dV}{dt} = \frac{4\pi}{3} 3R^2 \times \frac{dR}{dt}$$

$$= 4\pi R^2 \frac{dR}{dt}$$

Ans

QUESTION

If radius of circle is increasing $\frac{1}{\pi}$ m/s then find rate of change in area when radius is 4m.

$\frac{dR}{dt} = \frac{1}{\pi}$ m/s

$\frac{dA}{dt} = ??$ $(R = 4m)$



$A = \pi R^2$

diffn w.r.t. time

$\frac{dA}{dR} = \pi 2R$

$\frac{dA}{dt} = 2\pi R \frac{dR}{dt}$

$\frac{dA}{dt} = 2\pi \times 4 \times \frac{1}{\pi} = 8$

QUESTION

If $y = x^2 e^x$ then find $\left(\frac{dy}{dx}\right)$.

$y = x^2 e^x$

use Product Rule

QUESTION

Find differentiation of $y = (x^4 - 1)^{50}$.

$$y = (x^4 - 1)^{50}$$

Inside

$$\frac{dy}{dx} = 50\left[x^4 - 1\right]^{50-1} \times (4x^3 - 0)$$

$$= 200\left[x^4 - 1\right]^{49} \times x^3$$

Ans

QUESTION

If $y = \sin\theta$ then find $\left(\frac{dy}{d\theta}\right)$ at $\theta = 30°$.

$y = \sin\theta$

$\frac{dy}{d\theta} = \frac{d\sin\theta}{d\theta} = \cos\theta$

$\left.\frac{dy}{d\theta}\right|_{at\ \theta=30} = \cos 30° = \frac{\sqrt{3}}{2}$

$\frac{d(\sin 30°)}{dt} = \frac{d\frac{1}{2}}{dt} = 0$

QUESTION

If $y = e^x$ then find $\left[\frac{dy}{dx}\text{ at } x = 2.\right]$

$$y = e^x$$

$$\left.\frac{dy}{dx}\right|_{x=2} = e^x = e^2$$

Partial diffrentiation

$U = f(x, y, z)$

↓ Partial diff^n of 'U'

$\Rightarrow \left[\frac{\partial U}{\partial x}\right]\hat{i} + \left[\frac{\partial U}{\partial y}\right]\hat{j} + \left[\frac{\partial U}{\partial z}\right]\hat{k}$

y & z are const^n ; x, z = const^n ; y & x = const^n.

If $U = xyz$

find Partial diff^n

$\left[\frac{\partial U}{\partial x}\right]_{y\,\&\,z\ \text{const}^n} = \frac{\partial (xyz)}{\partial x} = yz\frac{\partial x}{\partial x} = yz\,\hat{i}$

$\left(\frac{\partial U}{\partial y}\right)_{xz} = \frac{\partial (xyz)}{\partial y} = xz\frac{\partial y}{\partial y} = xz\,\hat{j}$

$\frac{\partial U}{\partial z} = xy\frac{\partial z}{\partial z} = xy\,\hat{k}$

QUESTION

If $V = x^2y + y^2z + z^2x$ find $\frac{\partial V}{\partial x}$

Sol^n $\left[\frac{\partial V}{\partial x}\right]_{yz = \text{const}} = \frac{\partial(x^2y + y^2z + z^2x)}{\partial x} = \frac{\partial x^2 y}{\partial x} + \frac{\partial (y^2 z)}{\partial x} + \frac{\partial z^2 x}{\partial x}$

$= y(2x) + 0 + z^2\left(\frac{\partial x}{\partial x}\right)$

$= (2xy + z^2)$ Ans.

$\frac{\partial V}{\partial y} = x^2 \times 1 + z(2y) + 0 = (x^2 + 2zy)$

If $4x - 3 = 12$ find value of x.

Simple linear eqn

Soln

$4x - 3 = 12$

$4x = 15$

$x = \frac{15}{4}$

Yakeen 2.0

Home tuition.

If $4x - 12 = 0$

find 'x'.

Soln $4x - 12 = 0$

$4x = 12$

$x = \frac{12}{4} = 3$

Quadratic equation → Maximum Power of x is 2

Ex → $ax^2+bx+c=0$ where a, b and c are constant.

$ax^2+bx+c=0$ → Two value of x will satisfy this eqn; that two value of x is called Two roots of this eqn

MR Rafte

$$x_1 = \frac{-b+\sqrt{b^2-4ac}}{2a}$$

$$x_2 = \frac{-b-\sqrt{b^2-4ac}}{2a}$$

$$x_1+x_2 = -\frac{b}{2a}-\frac{b}{2a} = \frac{-2b}{2a} = \frac{-b}{a}$$ ✓

Sum of roots

$$x_1 x_2 = \frac{c}{a}$$

Ex $2x^2+3x-6=0$

$a=2$

$b=3$

$c=-6$

$x^2 - 4x + 12 = 0$

$a = 1$
$b = -4$
$c = 12$

$\to x^2 - 6x + 2x + 12 = 0$ → wrong

$$x_1 = \frac{-b + \sqrt{b^2 - 4ac}}{2a}$$

$$\sqrt{-16} = \text{Not real value}$$

$$x_1 = \frac{-(-4) + \sqrt{16 - 4 \times 1 \times 12}}{2 \times 1}$$

→ does not have real values

QUESTION

Find roots of the equation: $x^2 - 5x + 6 = 0$

$\rightarrow a = 1, \ b = -5 \quad c = 6$

$$x_1 = \frac{-b + \sqrt{b^2 - 4ac}}{2a} = \frac{5 + \sqrt{25 - 4 \times 1 \times 6}}{2 \times 1}$$

$$= \frac{5 + \sqrt{25 - 24}}{2} = \frac{5+1}{2} = 3$$

$$x_2 = \frac{5-1}{2} = \frac{4}{2} = 2$$

*

$x^2 - 5x + 6 = 0$

$x^2 - 3x - 2x + 6 = 0$

$x(x-3) - 2[x-3] = 0$

$(x-3)(x-2) = 0 \quad x = 3, \ x = 2$

QUESTION

$x^2 - 4x = 0$, find roots of this equation.

$x^2 - 4x = 0$

$x^2 = 4x$

$x = 4$

$x = 4, x = 0$

$$x^2 - 4x + 3 = 0$$

H/W

QUESTION

$x^2 + 7x + 12 = 0$, then find the root of 'x'.

$x^2 + 5x + 2x + 12 = 0$ ✗

$x^2 + 4x + 3x + 12 = 0$ ✓

H/w

QUESTION

$2t^2 + 3t - 2 = 0$; find roots of equation.

H/W

Double differentiation of 'y'

$\frac{dy}{dx}$ = differentiation of y w.r.t. = slope

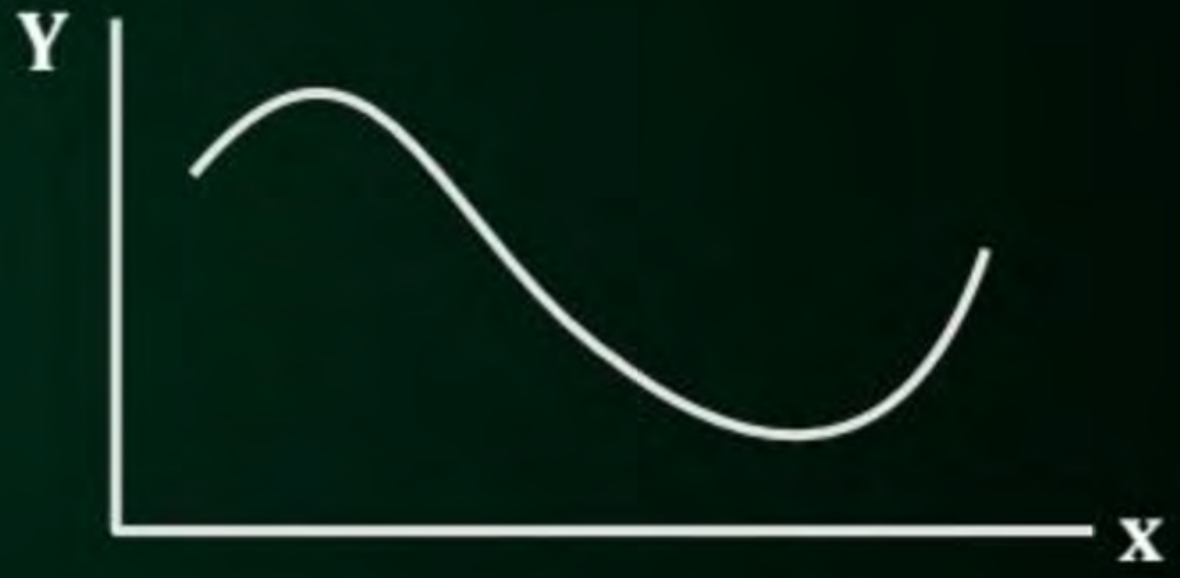
= Rate of change in y w.r.t. x

$\frac{d}{dx}\left(\frac{dy}{dx}\right) = \frac{d^2y}{dx^2}$ = Rate of change in $\frac{dy}{dx}$ w.r.t. x

= slope of slope = change in slop

Maxima Minima

at maxima | at minima



QUESTION

If $y = x^2 - 4x + 5$ then find maxima and minima of 'y'.

QUESTION

If velocity $V = t^3 - 6t^2 + 12$ then find maxima and minima value of velocity.


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Piyush Jha

615 → 705

Yakeen 2.0

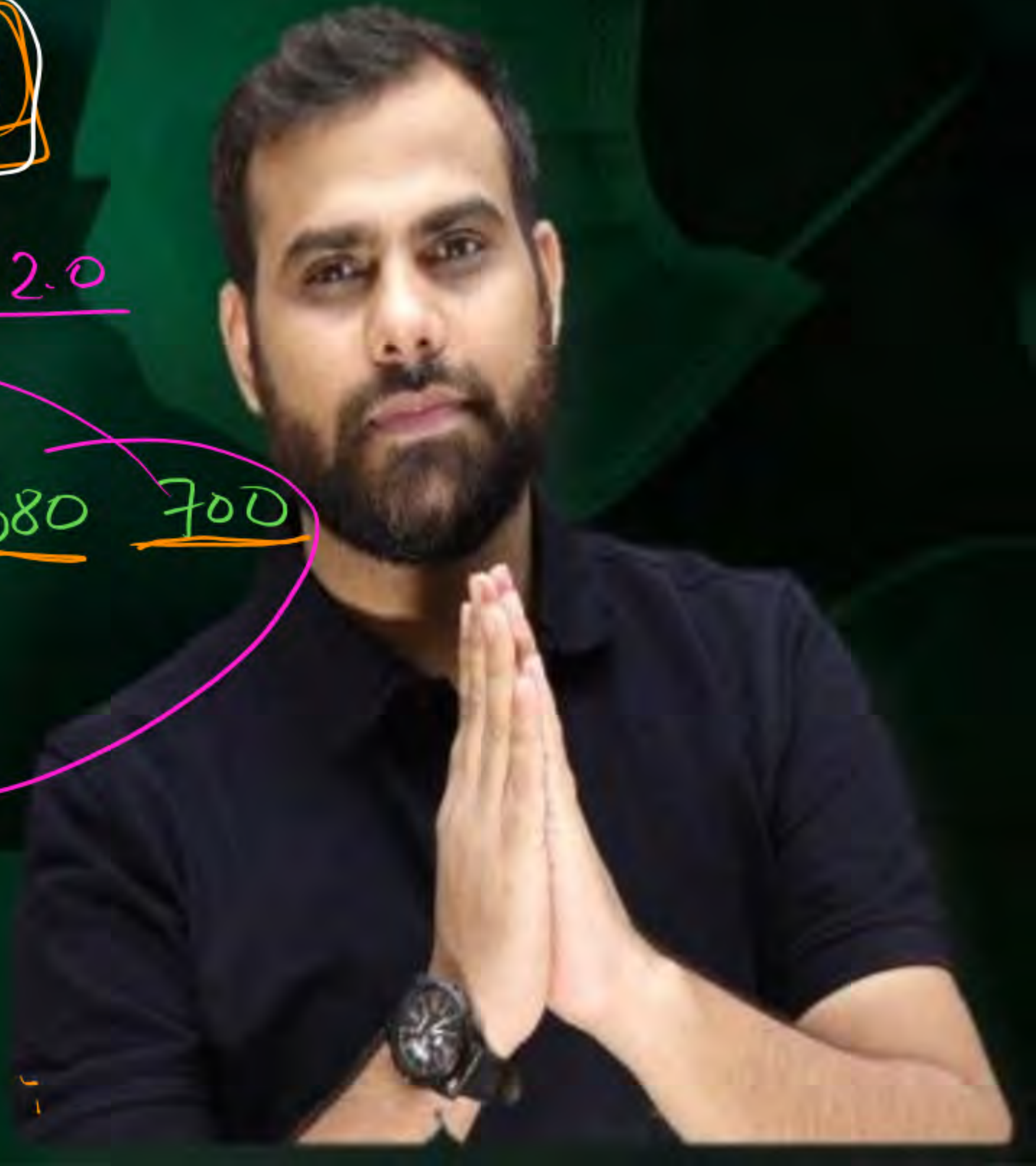
Lecture- 11 | Physics

AIR-24

610 645 680 700

660

Basic Maths and Calculus



By- Dr. Manish Raj (MR SIR)

Topics to be covered

1. Quadratic eqn
2. Maxima/minima
3. Integration ~~Type topic here~~
4. Type topic here



H/W

$$x^2 + 7x + 12 = 0$$

find roots of 'x'.

$$x^2 + 4x + 3x + 12 = 0$$

$$x(x+4) + 3(x+4) = 0$$

$$(x+4)[x+3] = 0$$

$$x = -4$$

$$x = -3$$

QUESTION

$2t^2 + 3t - 2 = 0$, find roots of equation.

$ax^2 + bx + c = 0$

$a = 2 \quad b = 3 \quad c = -2$

$$t_1 = \frac{-3 + \sqrt{9 - 4 \times 2(-2)}}{2 \times 2}$$

$$= \frac{-3 + \sqrt{9 + 16}}{4}$$

$$= \frac{-3 + \sqrt{25}}{4} = \frac{5 - 3}{4} = \frac{2}{4} = \frac{1}{2}$$

$$t_1 = \frac{-3 - 5}{4} = \frac{-8}{4} = -2$$

$t_1 = \frac{1}{2}$

$t_2 = -2$

Maxima/ Minima

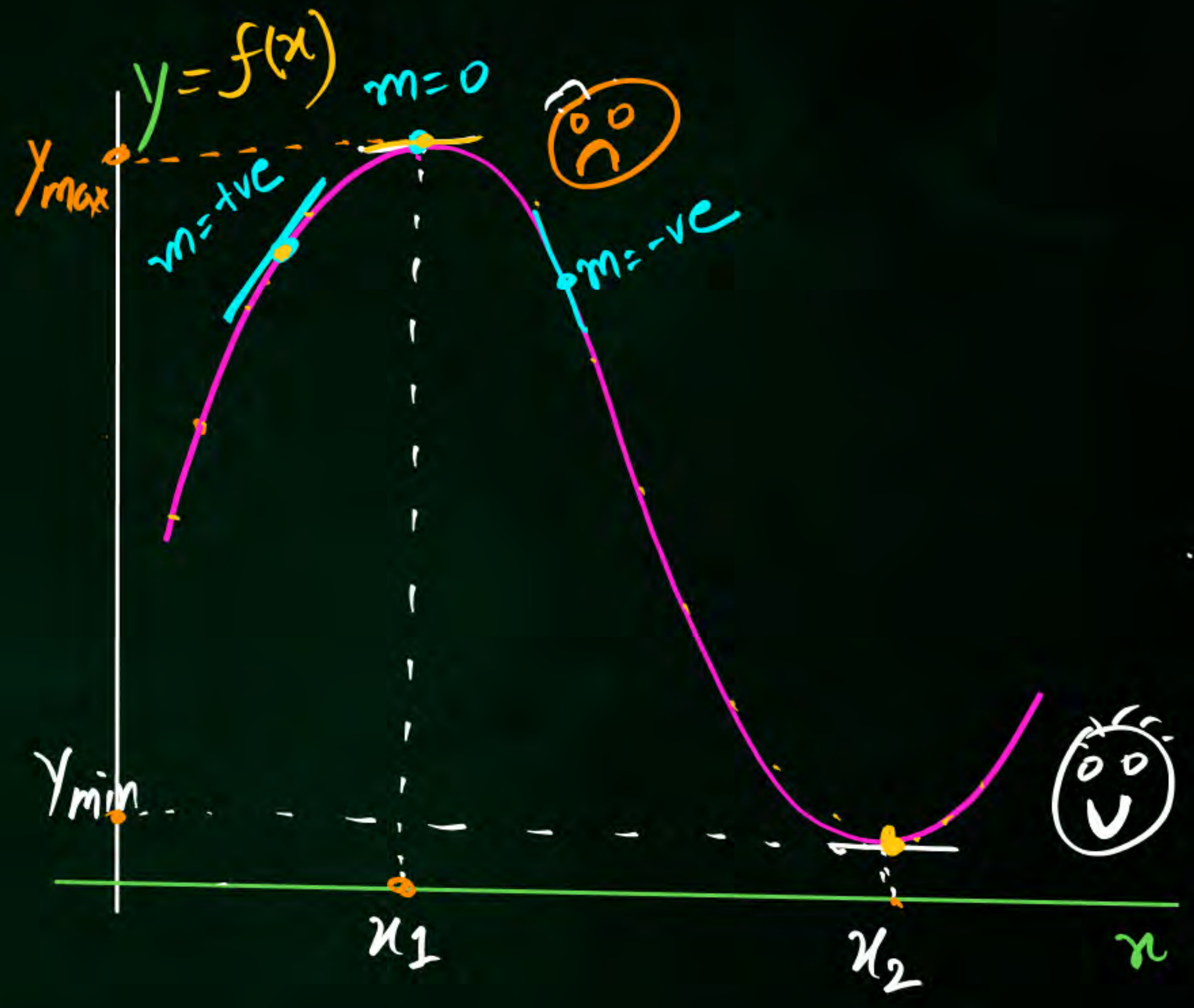
Maxima/minima of y at diffⁿ x

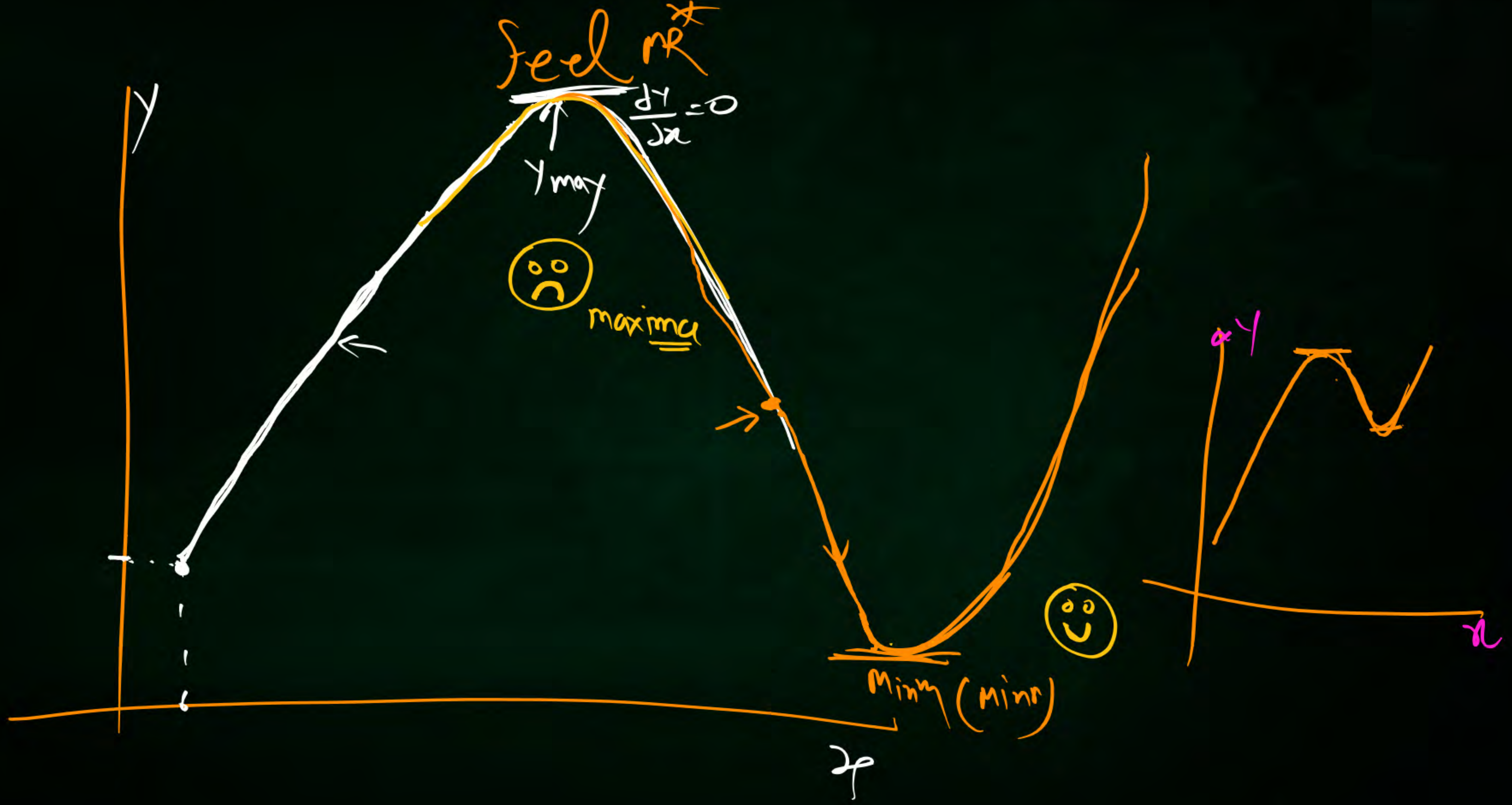
Maxima	minima
at maxᵐ	at minima
* Slope$\left(\frac{dy}{dx}\right) = 0$	* slope$\left(\frac{dy}{dx}\right) = 0$
* around maxᵐ	around minim
Slope decreasing	Slope Increasing

$$\frac{d}{dx}\left(\frac{dy}{dx}\right) = \frac{d^2y}{dx^2} = \text{slope of slope} = -ve$$

= change in slope

$$\left(\frac{d^2y}{dx^2}\right)_{min(x_2)} = +ve$$




Feel
y
dy/dx = 0
y max
maxima
x

QUESTION

Find maxima and minima of $y = x^2 + 5$



$y = x^2 + 5$ → MR*

→ मजदूरी

at Max^m and min^m slope must be zero

$\text{Slope} = \left(\frac{dy}{dx}\right) = 2x + 0 = 0$

$2x = 0$

$x = 0$ → at $x = 0$ there is max^m or min^m.

$\left[\frac{d^2y}{dx^2}\right] = +2$ → there is a minima because double diffn is +ve

$\left|y_{min}\right|_{(x=0)} = x^2 + 5 = 5$

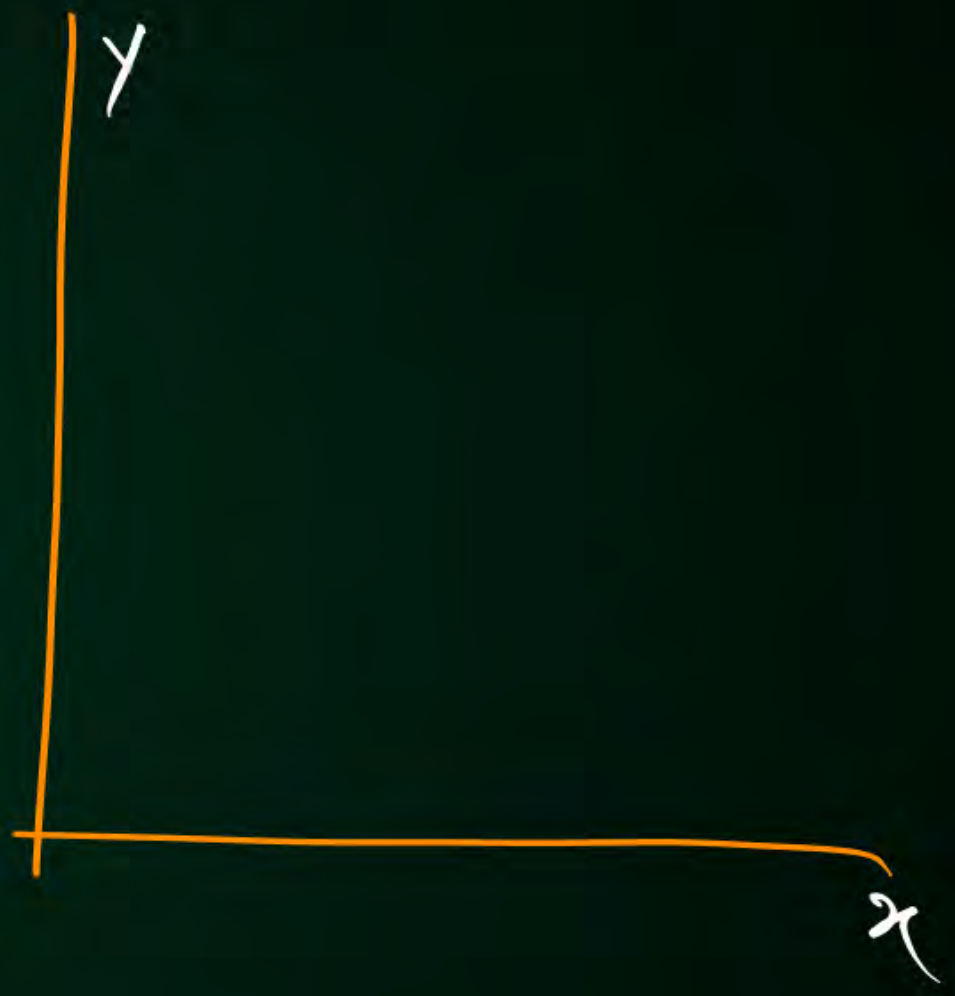
$y_{min} = 5$

QUESTION

Find maxima and minima of $y = 4x - x^2$

at max^m & min^m

Max



With the One and Only

MR

QUESTION

If $y = x^2 - 4x + 5$, then find maxima and minima of 'y'.

QUESTION

If velocity $V = t^3 - 6t^2 + 12$, then find maxima and minima value of velocity.

QUESTION

If $y = x^2 - 4x + 5$, then find x where y will be maxima or minima and find, maximum or minimum value of y.

QUESTION

$y = x^3 - 3x^2 + 4$, find maximum and minimum value.


THANK YOU

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FOR NEET 2025

Lecture- 13 | Physics

Basic Maths and Calculus



By- Dr. Manish Raj (MR SIR)

Topics to be covered

Questions on Integration

logrithmic



LOGARITHMIC

Natural log

$\log e^{x} = \text{In } x$

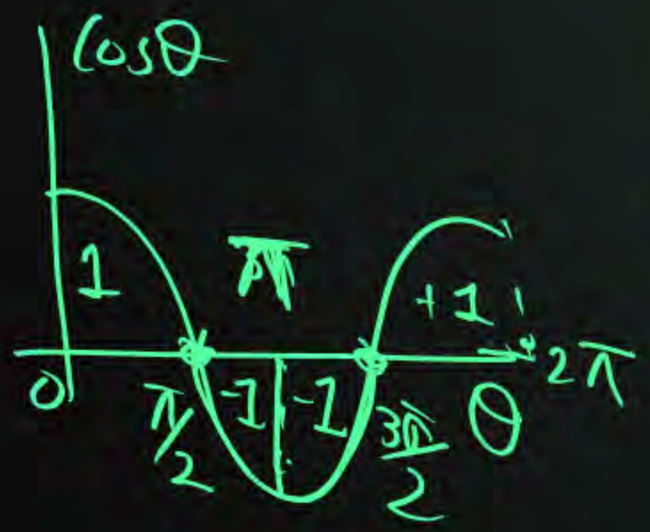
Common log

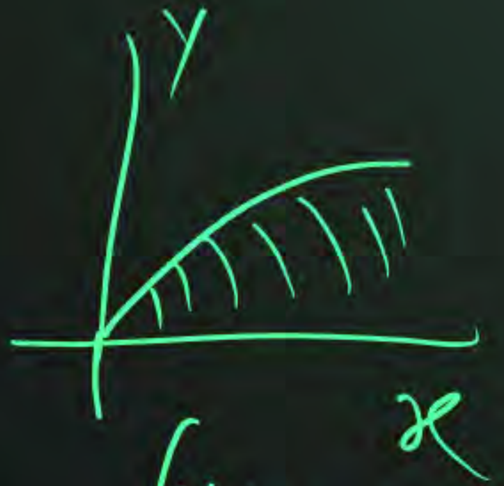
$\log 10^{x}$

$$\log e^{x} = 2.3.3.\ \log 10^{x}$$

QUESTION

$$\int_{\theta_i = \frac{\pi}{2}}^{\theta_f = \frac{3\pi}{2}} \cos\theta \, d\theta = -2$$





$\int y\,dx$ = Area of g

Integration

$$\int x^n dx = \frac{x^{n+1}}{n+1} + C$$

but not valid for $n = -1$

$$\int \frac{1}{x} dx = \int x^{-1} dx = \frac{x^{-1+1}}{-1+1} = \frac{x^0}{0} = \infty$$

undef.

$$\int \sin\theta \, d\theta = -\cos\theta + C$$

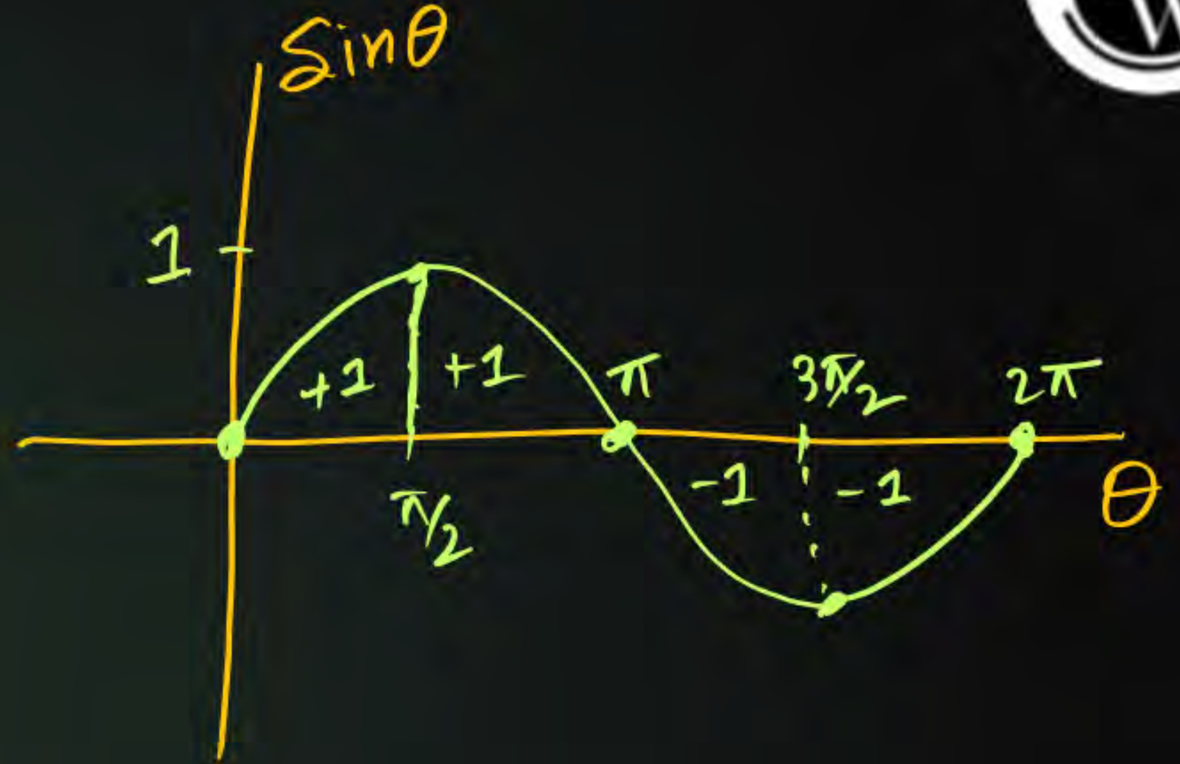
$$\int e^x dx = e^x$$

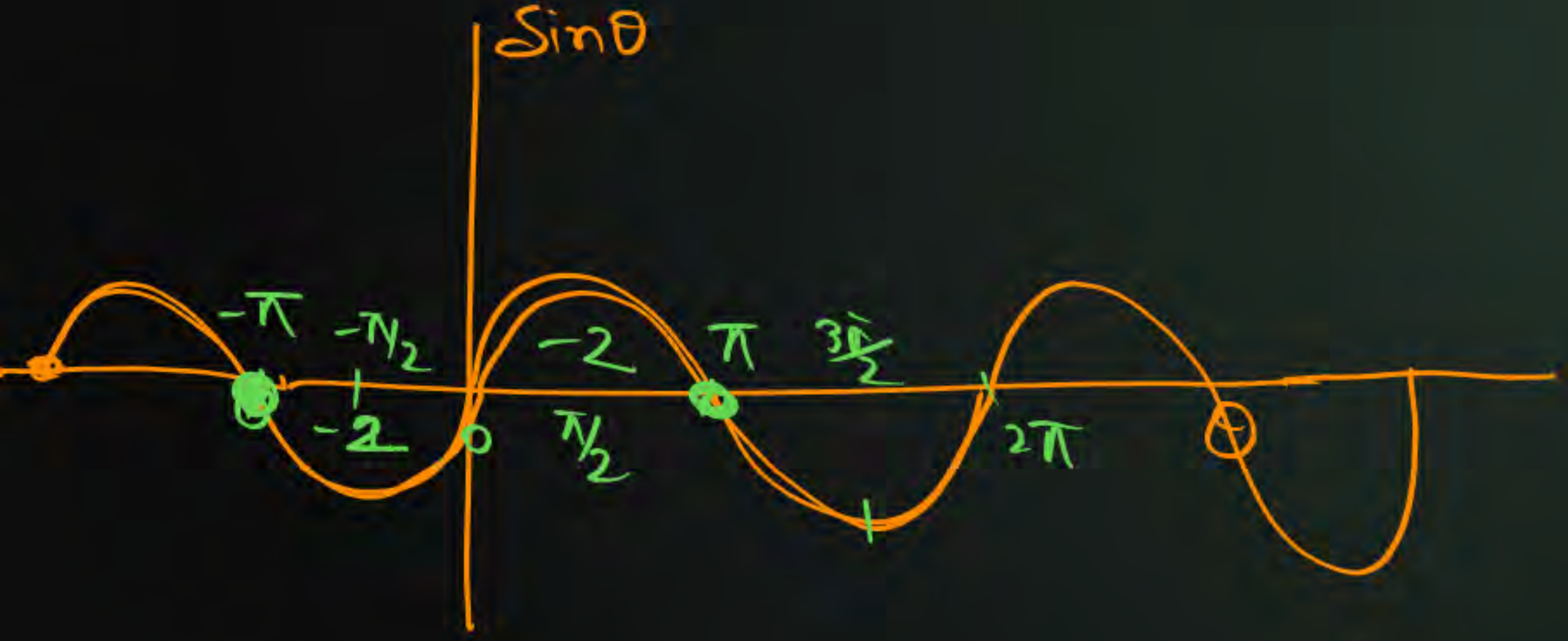
$$\int \cos\theta \, d\theta = \sin\theta$$

$$\int \frac{1}{x} dx = \log x$$

QUESTION

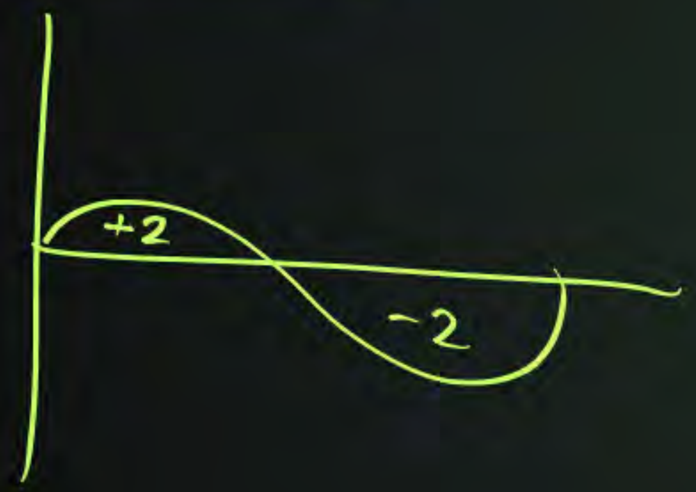
$$\int_{-\pi}^{+\pi} \sin\theta \, d\theta = 0$$





QUESTION

$$\int_0^{2\pi} \sin\theta \, d\theta = 0$$



$$\int \sin\theta \, d\theta = \left[-\cos\theta\right]_0^{2\pi} = -\left[\cos(2\pi) - \cos 0\right]$$

$$= -\left[1 - 1\right] = 0$$

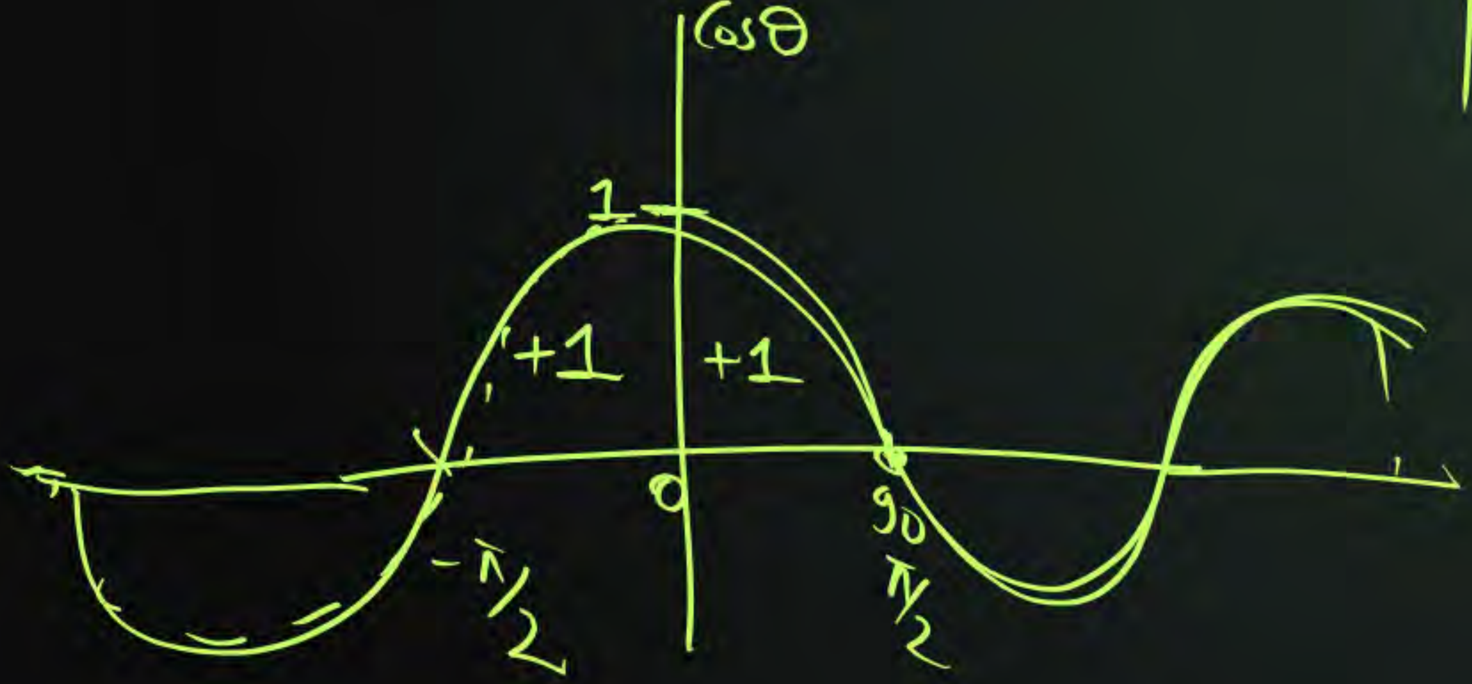
QUESTION

$$\int_{-\pi/2}^{+\pi/2} \cos\theta \, d\theta = 2$$

$$\int_{-\pi/2}^{+\pi/2} \cos\theta \, d\theta = [\sin\theta]_{-\pi/2}^{+\pi/2} = \sin(\pi/2) - \sin(-\pi/2)$$

$$= 1 - [-1]$$

$$= 2$$



QUESTION

$$\int_0^1 e^x \, dx = \left[e^x\right]_0^1$$

$$= e^1 - e^0$$

$$= e - 1$$

$$= (e-1)$$

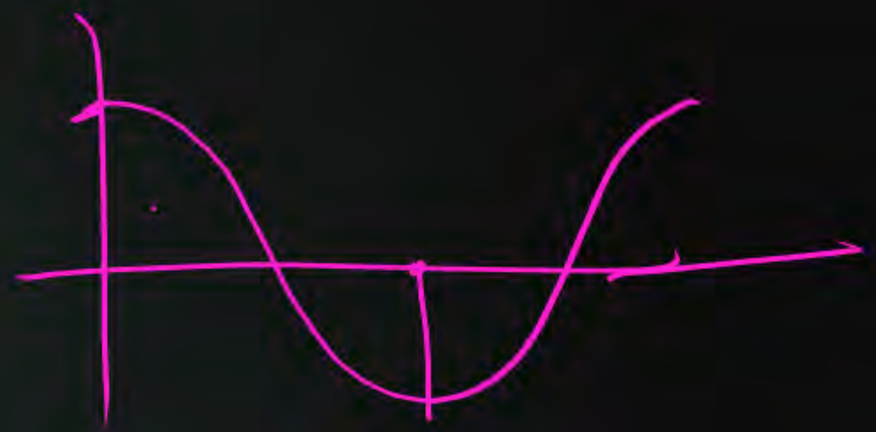
QUESTION

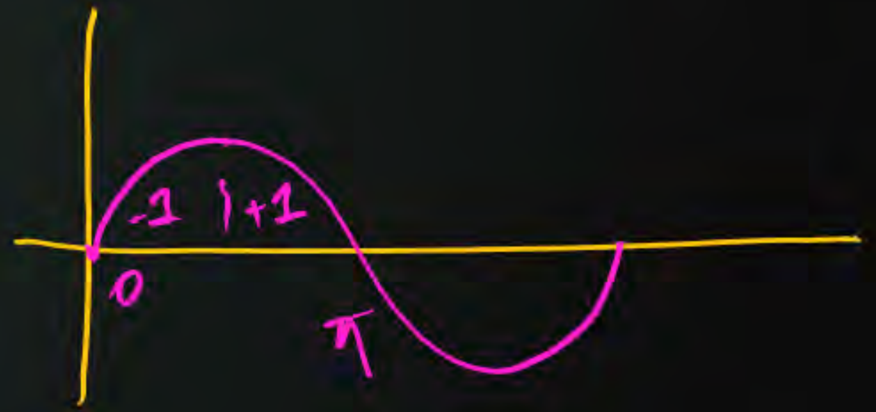
$$\int_0^{\pi/2} (\sin x + \cos x)\, dx = \int_0^{\pi/2} \sin x\, dx + \int_0^{\pi/2} \cos x\, dx = 1 + 1 = 2$$

QUESTION

$$\int_0^{\pi} (\sin x + \cos x)\, dx = \int_0^{\pi} \sin x \, dx + \int_0^{\pi} \cos x \, dx$$

$$= 2 + 0 = 2$$





QUESTION

$$\int_{\alpha}^{r} \frac{K q_1 q_2}{r^2}\, dr$$

Find value of this integration where K, q_1 and q_2 are constant.

$$\int_{\alpha}^{r} \frac{K q_1 q_2}{r^2}\, dr = K q_1 q_2 \int_{\alpha}^{r} \frac{1}{r^2}\, dr = K q_1 q_2 \left[\frac{r^{-2+1}}{-2+1}\right]_{\alpha}^{r} = K q_1 q_2 \left[\frac{r^{-1}}{-1}\right]_{\alpha}^{r}$$

$$= K q_1 q_2 \left[-\frac{1}{r}\right]_{\alpha}^{r}$$

$$= -K q_1 q_2 \left[\frac{1}{r} - \frac{1}{\alpha}\right] = \frac{-K q_1 q_2}{r}$$

$$\frac{1}{-2} = -\left(\frac{1}{2}\right)$$

Outside - Inside Rule

$$\int \sin(ax+b)\,dx = \left(\frac{\text{Integration of outer function, keep Inner function as it is}}{\text{Coefficit of } (x)}\right)$$

Inner: $(ax+b)$; outer functio: $\sin$

- Where a and b are const^n

- $\int \sin(ax+b)\,dx = -\frac{\cos(ax+b)}{a}$

- $\int e^{5x}\,dx = \frac{e^{5x}}{5} + c$

- $\int \cos(3x+4)\,dx = \frac{\sin(3x+4)}{3} + c$

$\int x^4\,dx = \frac{x^5}{5} + c$

$\int (ax+b)^4\,dx = \frac{(ax+b)^5}{5 \times a} + c$

QUESTION

$$\int_0^1 e^{-x}\,dx = \left[\frac{e^{-x}}{-1}\right]_0^1$$

$$= -1\left[e^{-1} - e^{-0}\right]$$

$$= -\left[\frac{1}{e} - 1\right]$$

$$= -\left[\frac{1-e}{e}\right] = \frac{e-1}{e}$$ R

$$\int e^{-x}\,dx = \frac{e^{-x}}{-1} + c$$ *

QUESTION

$$\int (4-3x)^2 dx = \frac{(4-3x)^{2+1}}{(2+1)\times(-3)} = \frac{(4-3x)^3}{-9}$$

$$\int (a+bx)^2 dx = \frac{(a+bx)^3}{3\times b}$$


THANK YOU

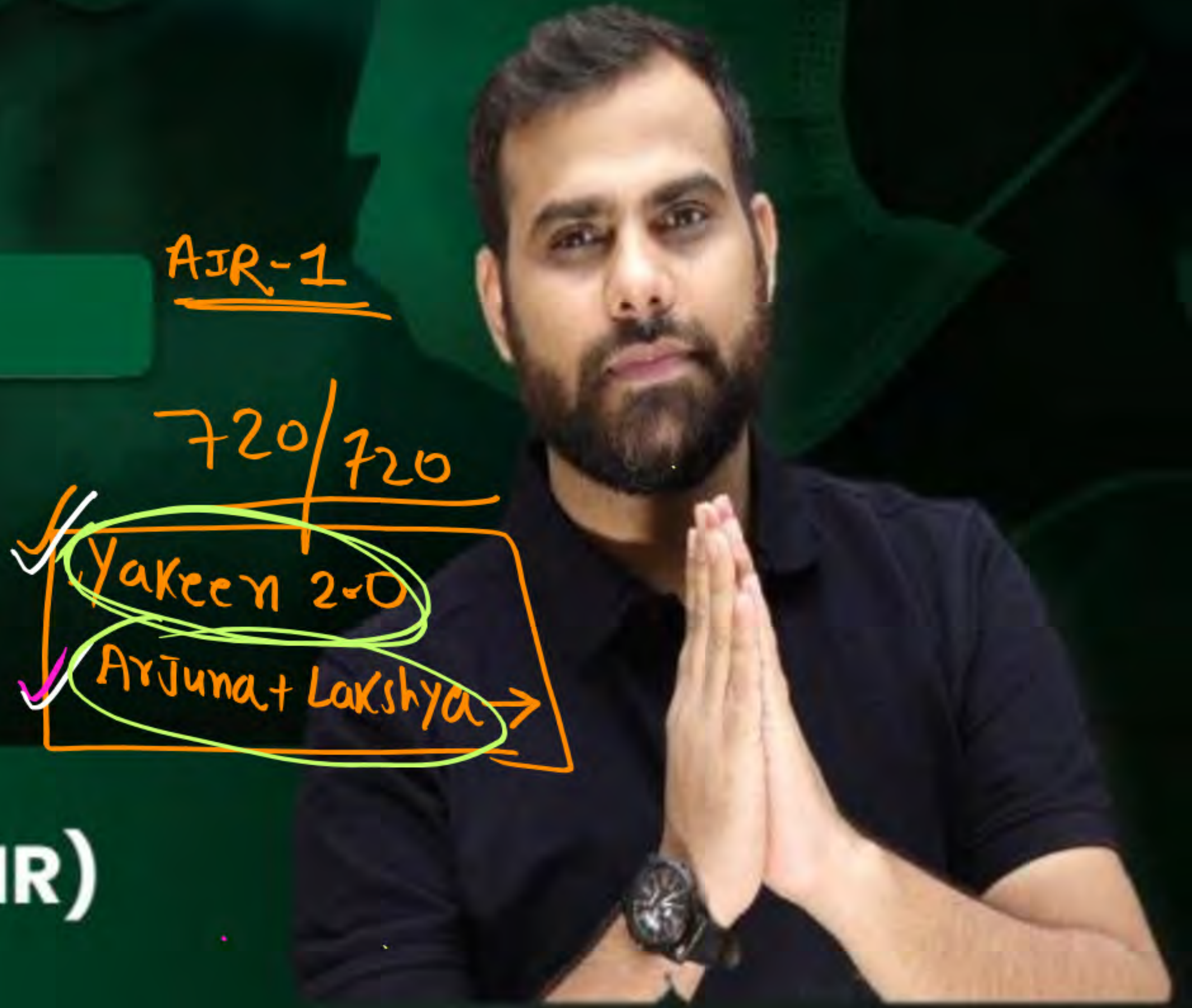
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FOR NEET 2025

Lecture- 12 | Physics

Basic Maths and Calculus

By- Dr. Manish Raj (MR SIR)



Topics to be covered

1. Max^m / minima
2. [redacted]
3. [redacted]
4. [redacted]

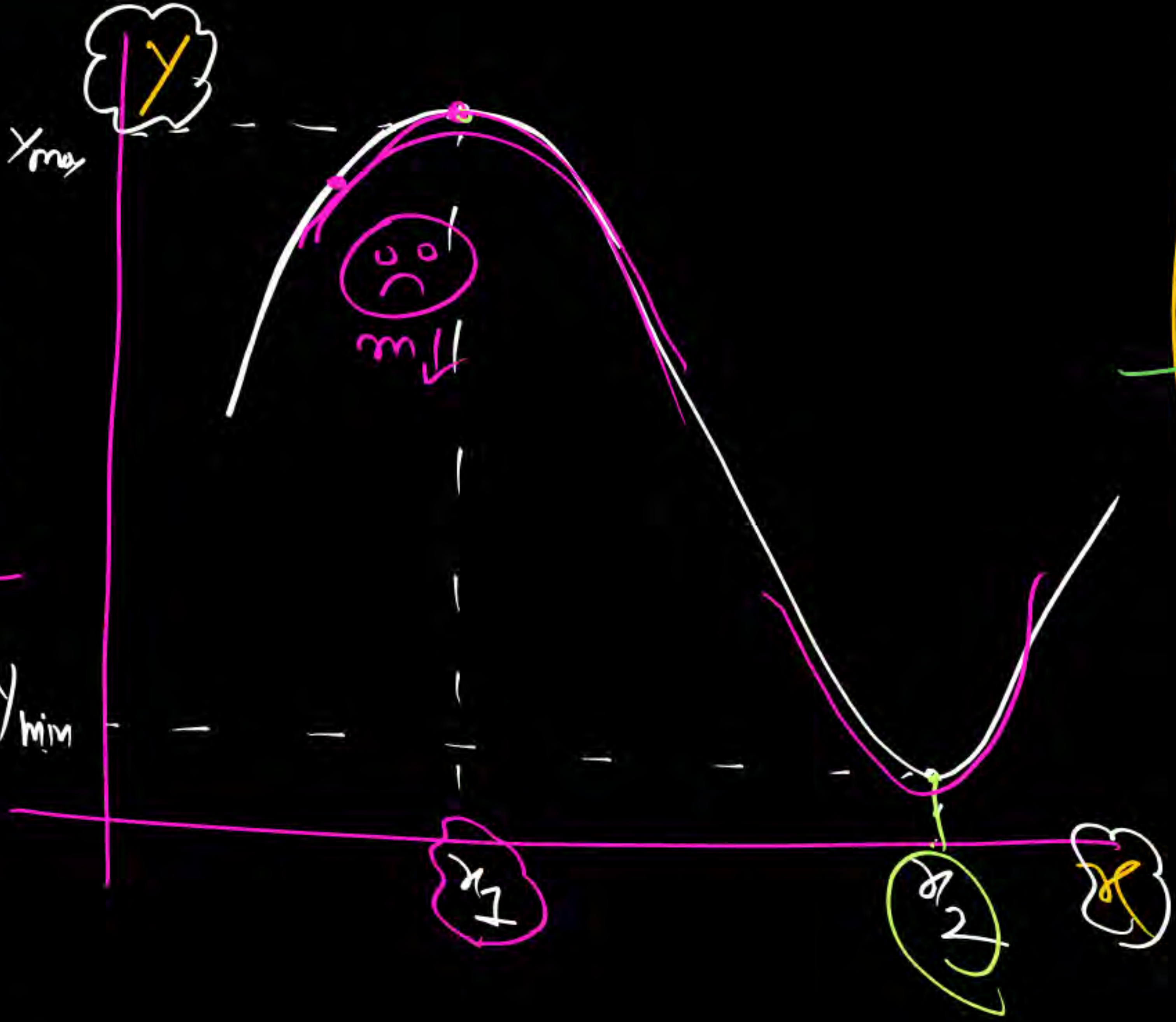


Revision

at max^m

$$\frac{dy}{dx} = 0$$

$$\frac{d^2y}{dx^2} = -ve$$



min^m

$$\frac{dy}{dx}\ (\text{slope}) = 0$$

$$\frac{d^2y}{dx^2} = +ve$$

* E [electric field] will be max^m/min at $\frac{dE}{dx} = 0$

F (force) will be max^n/min^n at $\frac{dF}{dt} = 0$

QUESTION

If $y = x^2 - 4x + 5$, then find maxima and minima of 'y'.

मजूरी

Sol^n $\quad y = x^2 - 4x + 5$

y will be max^m or min at $\frac{dy}{dx} = 0$

Slope $= \left(\frac{dy}{dx}\right) = 2x - 4 \times 1 + 0 = 0$

$2x - 4 = 0$

$\boxed{x = 2}$

Max^m / min^m me se ek hi hoga.

$y = 2x - x^2 + 6$

↳ MR^x $\boxed{\text{y will be max}^n}$

$\frac{d^2y}{dx^2} = +2$

↳ at x = 2, y will be minin

$y_{(x=2)} = (2)^2 - 4 \times 2 + 5$

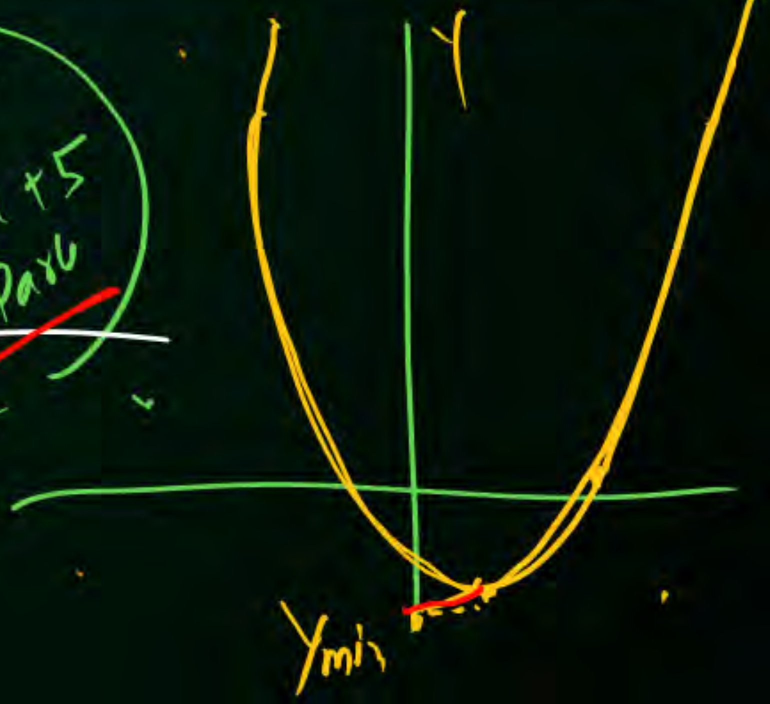
$= 4 - 8 + 5$

$= 9 - 8 = \underline{1}$

MR^x

$y = x^2 - 4x + 5$

up ward para



QUESTION

$y = x^3 - 3x^2 + 4$, find maximum and minimum value.

Sol^n $y = x^3 - 3x^2 + 4$

y will be maximum or minimum at $\frac{dy}{dx} = 0$

$\frac{dy}{dx} = 3x^2 - 3[2x] + 0$

$= 3x^2 - 6x = 0$

$= 3x[x-2] = 0$

$x_1 = 0$

$x_2 = 2$

The MR*

$y_{(x=0)} = 0 - 3\times 0 + 4 = 4$ ← maxm

$y_{(x=2)} = 2^3 - 3(2)^2 + 4$

$= 8 - 3\times 4 + 4$

$y_{min} = 12 - 12 = 0$

QUESTION

If velocity $V = t^3 - 6t^2 + 12$, then find maxima and minima value of velocity.

Sol^n

V will be max^m or min^m $\frac{dv}{dt} = 0$

$$\frac{dv}{dt} = 3t^2 - 6[2t] + 0$$

$$= 3t^2 - 12t = 0$$

$$= 3t[t - 4] = 0$$

$t_1 = 0$ | $t_2 = 4$

$V_{t=0} = 0 - 0 + 12 = 12$ Ans

$V_{max} = 12$

$V_{t=4} = 4^3 - 6(4)^2 + 12$

$= 64 - 6 \times 16 + 12$

$= 64 - 96 + 12$

$= 76 - 96$

$V_{min} = -20$

QUESTION

Find force between two point mass m_1 and m_2 which is at distance 'r'.

m_1 ——— r ——— m_2

Newtons law of gravition

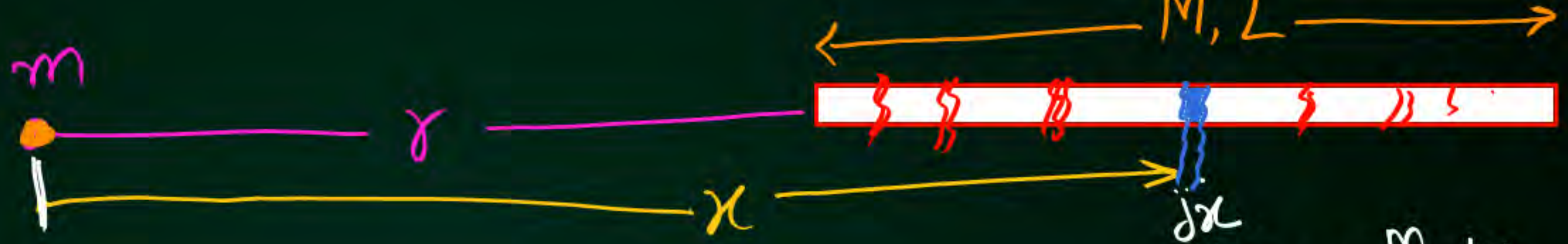
$$F = \frac{G m_1 m_2}{r^2}$$

- Valid for Point mass & spherical mass symmetry.

QUESTION

Find force between point mass and rod.

Newtons Law of gravitation is not Valid



Mass of L-length is M

" " unit length $= \frac{M}{L}$

" " dx length $= \frac{M}{L}dx$ (feel)

$dm = \frac{M}{L}dx$

$$dF = \frac{G\,m\,dm}{x^2} = \frac{G\,m\,M\,dx}{L\,x^2}$$

taking integration

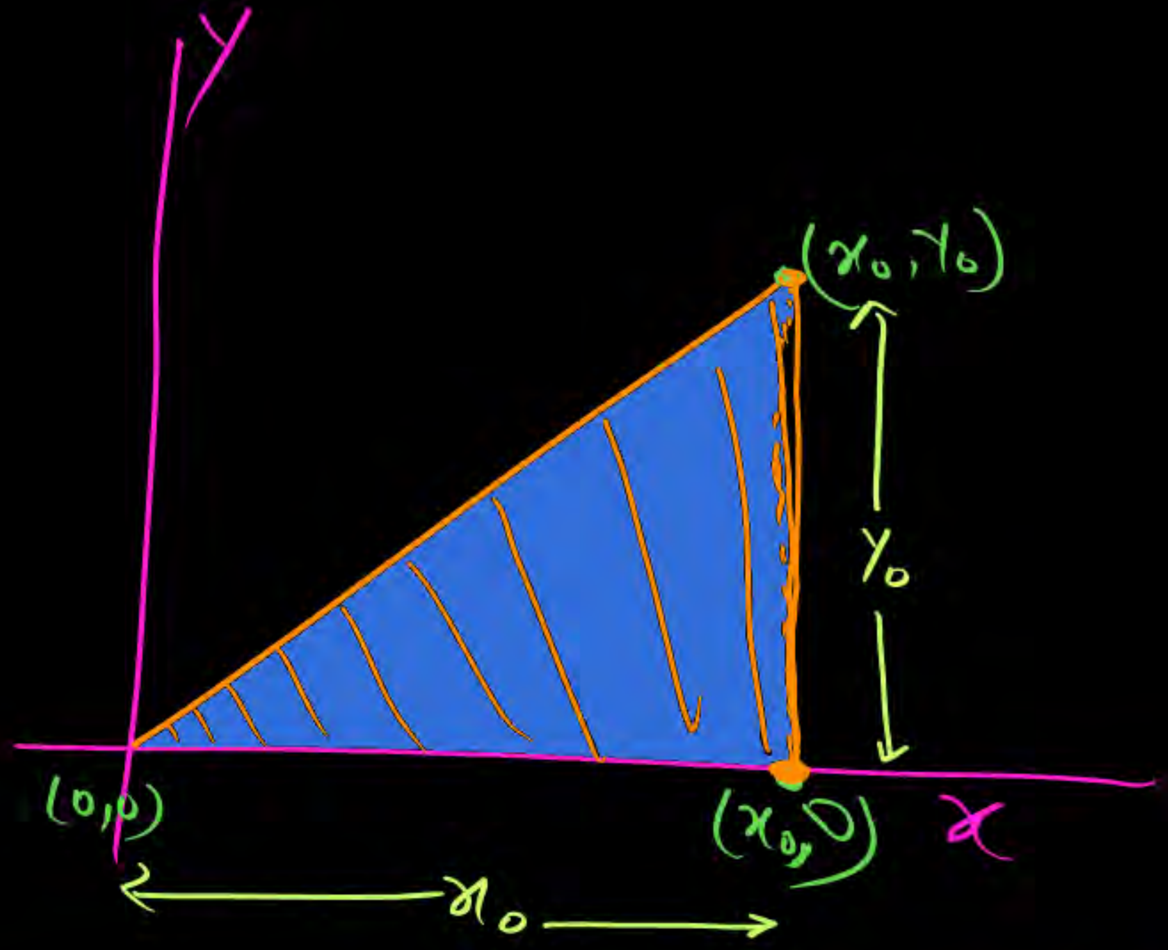
$$\int dF = \int \frac{G\,m\,M\,dx}{L\,x^2}$$

Need of Integral ka feel hai

Newtons चाचा

* Integration = addition of small terms

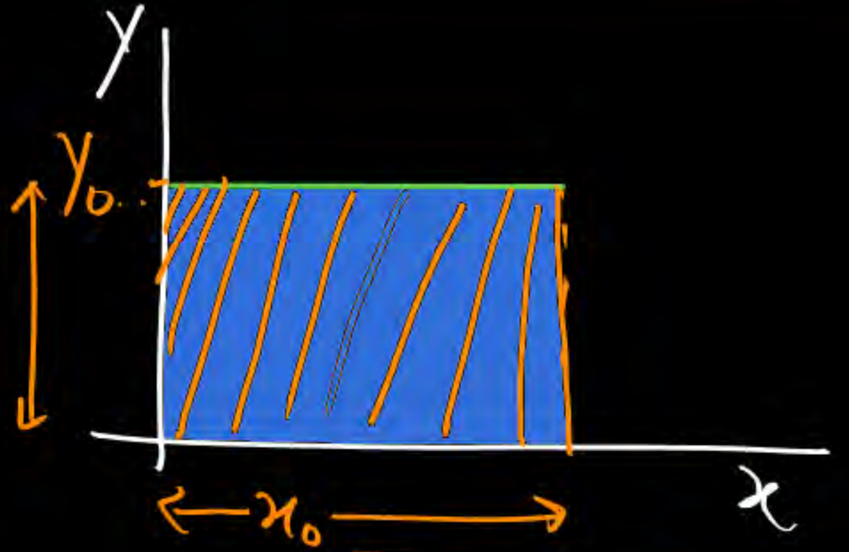
$\int \boxed{Y}\,dx$ = integration of $\boxed{Y}$ w.r.t. x



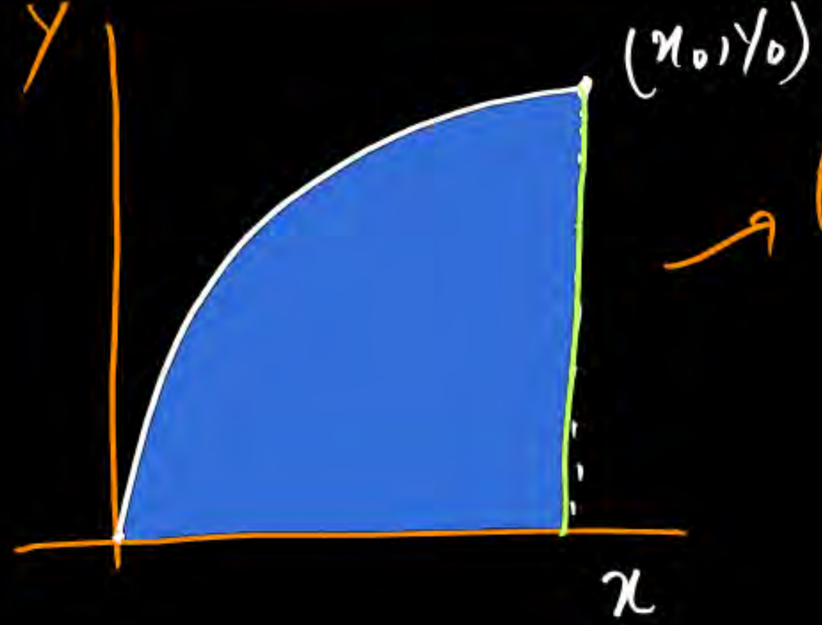
Slope of graph $= \frac{dy}{dx} =$ diff^n of y w.r.t. x

find Area under the curve (graph) with x-axis ?

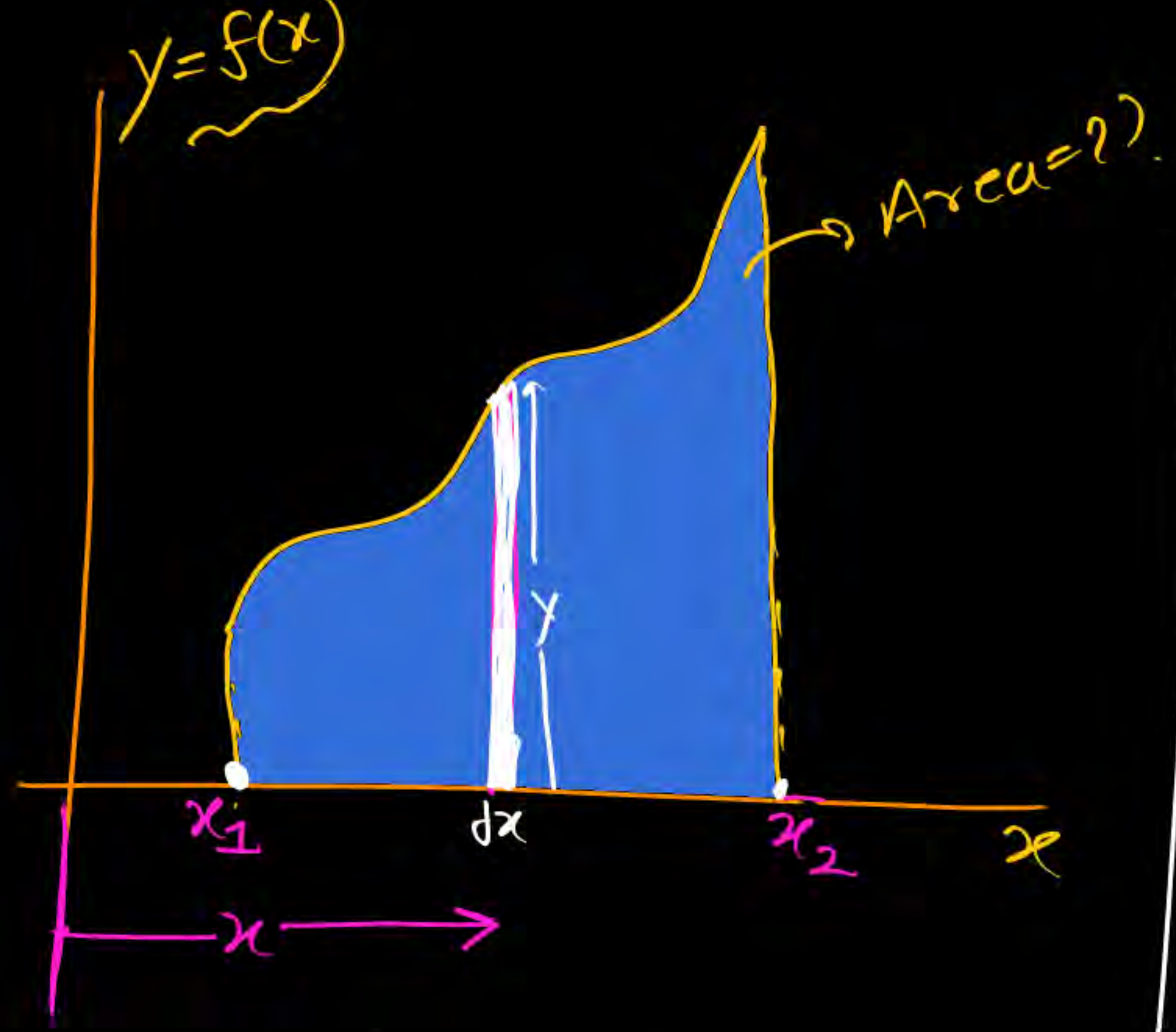
$$\text{Area} = \frac{1}{2} \times x_0 y_0$$



$$\text{Area} = y_0 x_0$$



→ Area calculation is not easy



$dA = y\,dx$

taking Integration

$$\int dA = \int y\,dx = \int f(x)\,dx$$

Area = $\int f(x)\,dx$ = Integration gives Area of graph.

Integration

- Indefinite Integration
- definite Integration

$\int y\,dx$ = No limit

$$\int_{x_1}^{x_2} y\,dx$$

x_2 ← upper limit

x_1 ← lower limit

Rule of Integation

$y = x^n$ (algebric function)

$$\int x^n \, dx = \frac{x^{n+1}}{n+1} + c$$

Not valid for $n = -1$

differentiation w.r.t x

$$\frac{d\left(\frac{x^{n+1}}{n+1}\right) + c}{dx} = \frac{1}{n+1}(n+1)x^{n+1-1} + 0$$

$$= x^n$$

$$\frac{dx^n}{dx} = nx^{n-1}$$

Valid for all value of n

- Integration Is Inverse Process of differentiation

QUESTION

Find integration of

(i) $y = x^5$

(ii) $y = 1/x^2$

$\int y\,dx = \int x^5\,dx = \frac{x^{5+1}}{5+1} + c = \frac{x^6}{6} + c$

$\int \frac{1}{x^2}\,dx = \int x^{-2}\,dx = \frac{x^{-2+1}}{-2+1} = \frac{x^{-1}}{-1} + c$

$= -\frac{1}{x} + c$

diff^n w.r.t. x

$\frac{1}{6} 6x^5 + 0 = x^5$

Ans

$$\int \sin\theta \, d\theta = -\cos\theta + c$$

Integra (arrow from $\sin\theta$ to $-\cos\theta$)

differen. (arrow from $-\cos\theta$ back to $\sin\theta$)

$$\int \sin x \, dx = -\cos x + c$$

$$\int \cos x \, dx = \sin x + c$$

differentiation (arrow from $\sin x$ back to $\cos x$)

$\int \tan\theta \, d\theta$ → Not in syllabus

$$\int \sec^2\theta \, d\theta = \tan\theta$$ ← no need

$$\int e^x \, dx = e^x + c$$

$$\int \frac{1}{x} \, dx = \log x + c$$ ✓

differentiation (arrow from $\log x$ back to $\frac{1}{x}$)

Wrong

$$\int \log x \, dx = \frac{1}{x}$$

$\int \log x \, dx$ = Not in syllabus

QUESTION

(i) $y = x^3$ $\Rightarrow$ $\int x^3\,dx = \frac{x^4}{4} + c$

(ii) $y = \sqrt{x}$ $\longrightarrow$ $\int \sqrt{x}\,dx = \int x^{1/2}\,dx = \frac{x^{\frac{1}{2}+1}}{\frac{1}{2}+1} = \frac{x^{3/2}}{\frac{3}{2}} = \frac{2}{3}x^{3/2} + c$

[redacted]

Constant Rule of Integration

$$y = c\,f(x) \quad \text{where } c = \text{const}^n$$

$$\int y\,dx = \int c\,f(x)\,dx = c\int f(x)\,dx$$

Ex $y = 5x^2$

$$\int 5x^2\,dx = 5\int x^2\,dx = 5\left[\frac{x^{2+1}}{2+1}\right] + c = \left[5\,\frac{x^3}{3} + c\right]$$

$$y = 3\sin(x)$$

$$\int y\,dx = 3\int \sin(x)\,dx$$

$$= 3\left[-\cos x\right] + C$$

$$y = 5x$$

$$\int y\,dx = \int 5x\,dx = 5\int x^1\,dx = 5\frac{x^2}{2}$$

$$= \frac{5x^2}{2} + c$$

$y = 1$ find Integration of y ($\int$)

$$\Rightarrow \int y\,dx = \int 1\,dx = \int x^0\,dx = \frac{x^{0+1}}{0+1} = x$$

feel

$\int dx = x$	$\int dF = F$
$\int dA = A$	$\int d(M\text{-}R) = M\text{-}R$

$y = 5$ integration of y

$$\int y\,dx = \int 5\,dx = 5\int 1\,dx$$

$$= 5\int x^0\,dx = 5\left[\frac{x^{0+1}}{0+1}\right]$$

$$= 5x + c$$

$$\int d(xy) = xy$$

$$\int dp = p$$

$$\int dm = m$$

$$\int dE = E$$

addition and subtraction Rule of Integration

$y = x^2 + \cos x + e^x$

find Integ^n of y.

$$\int y\,dx = \int (x^2 + \cos x + e^x)\,dx = \int x^2\,dx + \int \cos x\,dx + \int e^x\,dx$$

$$= \frac{x^3}{3} + \sin x + e^x + C$$

$$y = 4e^x + \frac{1}{x} - 3x^2 - 5\sin x$$

$$\int y\,dx = \int 4e^x\,dx + \int \frac{1}{x}\,dx - 3\int x^2\,dx - 5\int \sin x\,dx$$

$$= 4e^x + \log x - 3\left[\frac{x^3}{3}\right] + 5\cos x + C$$

Ans

definite Integration.

upper limit

$$\int_{x_1}^{x_2} y(x)\,dx = \left[y'(x)\right]_{x_1}^{x_2} = y'(x_2) - y'(x_1)$$

lower limit

$y = x^2$ find integration from $x_1 = 1$ to $x_2 = 3$

$$\int y\,dx = \int_1^3 x^2\,dx = \left[\frac{x^3}{3}\right]_1^3 = \frac{1}{3}\left[(3)^3 - (1)^3\right] = \frac{1}{3}\left[27 - 1\right] = \frac{26}{3}$$

QUESTION

If $y = x^2 + 2$ then find integration from $x_1 = 1$ to $x_2 = 3$.

$$\int y\,dx = \int (x^2+2)\,dx = \int_1^3 x^2\,dx + \int_1^3 2\,dx = \left(\frac{x^3}{3}\right)_1^3 + 2\int_1^3 dx$$

$$= \frac{(3)^3 - (1)^3}{3} + 2\left[x\right]_1^3$$

$$= \frac{26}{3} + 2\left[3-1\right]$$

$$= \frac{26}{3} + 4 = \frac{38}{3}$$

QUESTION

If $y = 5$ then integrate if from $x_1 = 2$ to $x_2 = 1$.

$$\int y\,dx = \int_2^1 5\,dx = 5[x]_2^1 = 5[1-2] = 5(-1) = -5$$

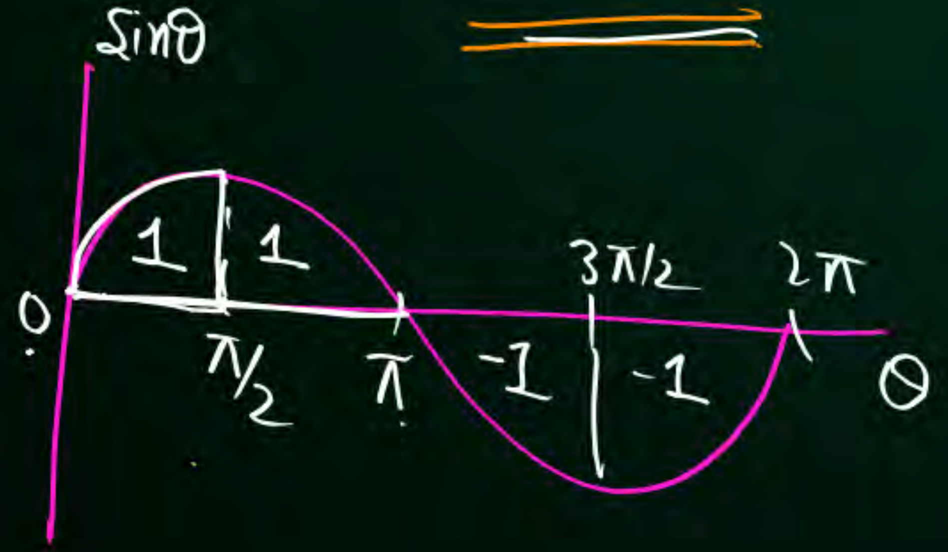
$$\int_0^{\pi/2} \sin\theta\, d\theta = \left[-\cos\theta\right]_0^{\pi/2}$$

$$= -\left[\cos\frac{\pi}{2} - \cos 0^\circ\right]$$

$$= -\left[0 - 1\right]$$

$$= +1$$

MR

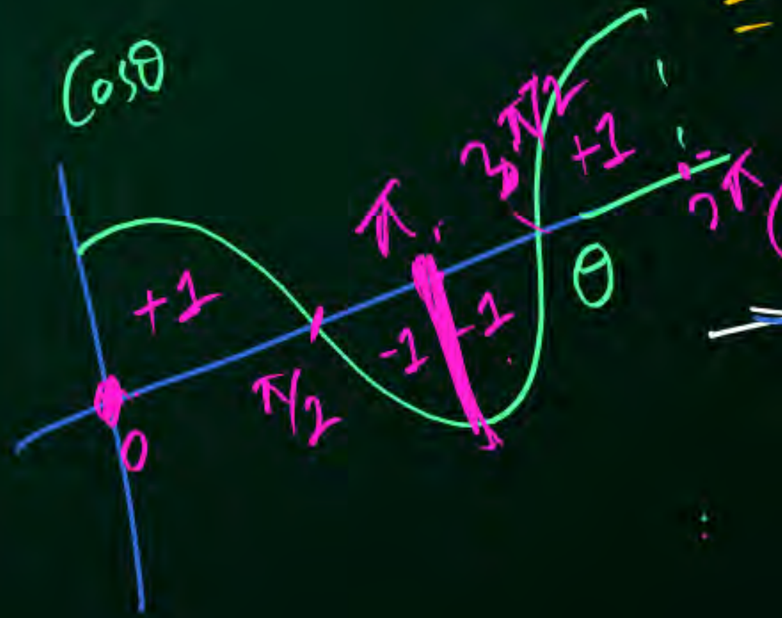


$$\int_0^{\pi} \sin\theta\, d\theta = \left[-\cos\theta\right]_0^{\pi}$$

$$= -\left[\cos\pi - \cos 0\right]$$

$$= -\left[-1 - 1\right]$$

$$= -\left[-2\right]$$



$$= +2$$ (Answer)

$$\int_0^{\pi} \cos\theta\, d\theta = \left[\sin\theta\right]_0^{\pi}$$

$$= \sin\pi - \sin 0$$

$$= 0 - 0$$

$$= 0$$

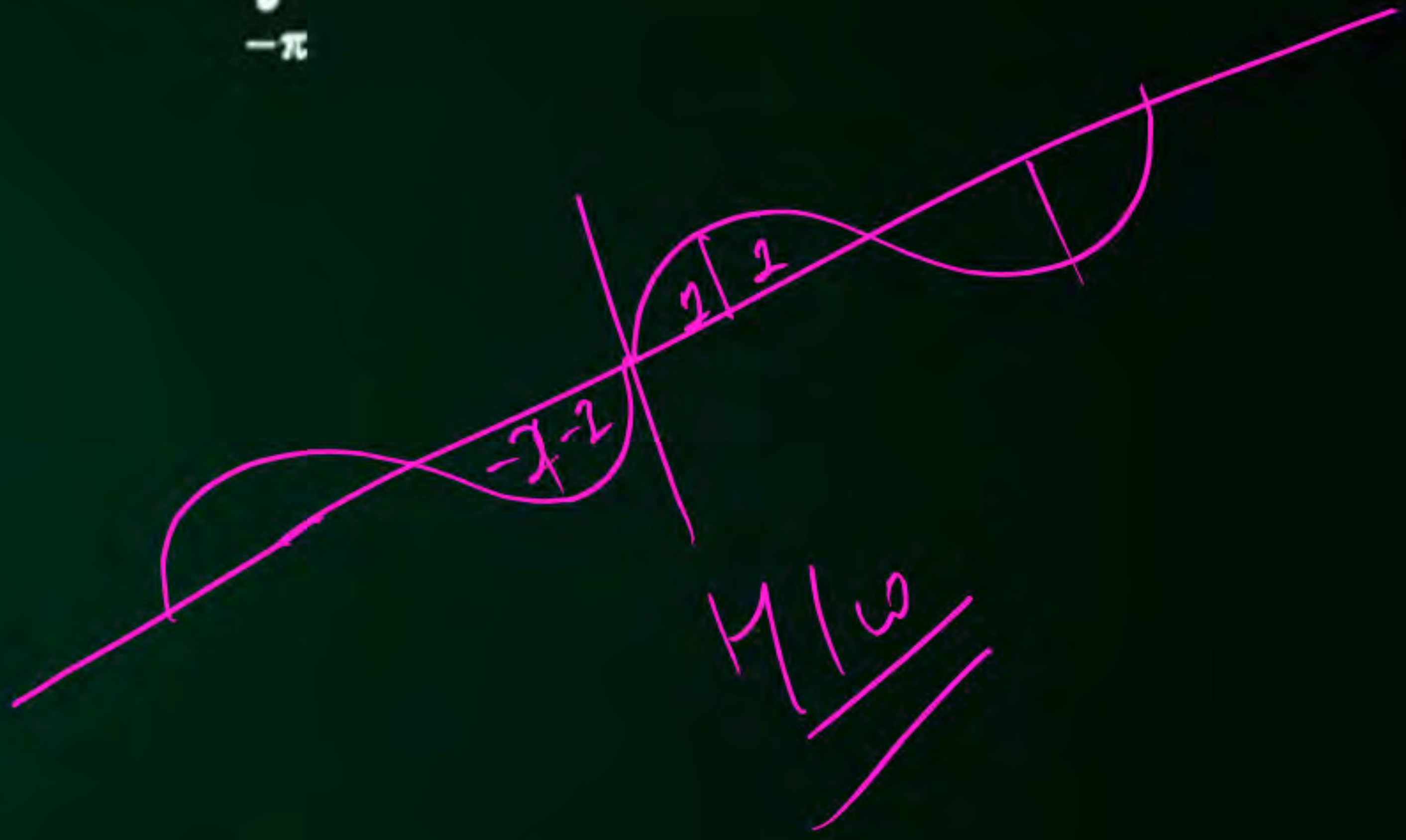
$$\int_{\pi}^{2\pi} \cos\theta\, d\theta = \left[\sin\theta\right]_{\pi}^{2\pi} = 0$$

$$\int_0^{\pi} \sin\theta\, d\theta = 2$$



$$\int_{0}^{1} e^{x}\,dx =$$

$$\int_{-\pi}^{2\pi} \sin\theta\,d\theta =$$




THANK YOU

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FOR NEET 2025

Lecture-13 Part-B | Physics

Basic Maths and Calculus

By- Dr. Manish Raj (MR SIR)



Topics to be covered

Questions on Integration. ✓

1. # LOGARITHMS & BINOMIAL EXPRESSION
2. [redacted]
3. [redacted]



QUESTION

$$\int (4-3x)^2 dx = \frac{(4-3x)^3}{3(-3)} = \frac{(4-3x)^3}{-9} + c$$

$$\int \sin(4-3x)\, dx = \frac{-\cos(4-3x)}{-3} = \frac{\cos(4-3x)}{3}$$

$$\int x^2 dx = \frac{x^3}{3} + C$$

QUESTION

$$\int_0^{\pi} \sin(2x)\,dx = \frac{-\cos(2x)}{2}$$

$$= -\frac{1}{2}\left[\cos 2x\right]_0^{\pi}$$

$$= -\frac{1}{2}\left[\cos(2\pi) - \cos 0\right]$$

$$= -\frac{1}{2}\left[1 - 1\right] = 0$$

$\int (ax+b)^3 dx = \frac{(ax+b)^4}{4 \times a} + c$ ✓

$\int \frac{1}{(ax+b)^2} dx = \int (ax+b)^{-2} dx = \frac{(ax+b)^{-2+1}}{(-2+1)a} = \frac{(ax+b)^{-1}}{-a} = -\frac{1}{a(ax+b)} + c$

$\int \frac{1}{(ax+b)} dx = \frac{\log(ax+b)}{a} + c$

→ $\int \frac{1}{x} dx = \log x + c$

QUESTION

$$\int\left(\frac{x^3+2}{x^3}\right)dx = \int\left(\frac{x^3}{x^3}+\frac{2}{x^3}\right)dx$$

$$= \int\left(1+\frac{2}{x^3}\right)dx$$

$$= \int 1\,dx + \int \frac{2}{x^3}\,dx$$

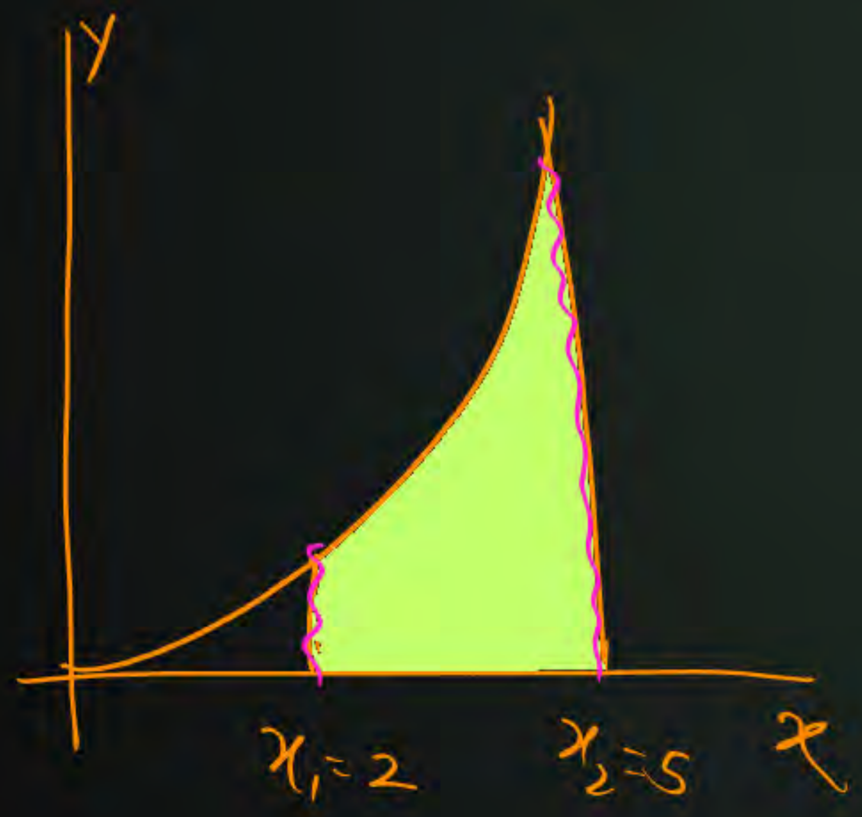
$$= x + 2\left[\frac{x^{-3+1}}{-3+1}\right]$$

$$= x + 2\left[\frac{x^{-2}}{-2}\right]$$

$$= x - \frac{1}{x^2} + c$$

QUESTION

Find area of curve $y=x^2$ from $x_1 = 2$ to $x_2 = 5$.



$$\text{Area} = \int y\,dx = \int_2^5 x^2\,dx = \left[\frac{x^3}{3}\right]_2^5$$

$$= \frac{1}{3}\left[5^3 - 2^3\right]$$

$$= \frac{1}{3}\left[125 - 8\right] = \frac{117}{3}$$

$$= 39$$

value of length is discrete

Finding of Average value of continual varible

$$L_{Avg} = \frac{L_1 + L_2 + L_3 + L_4}{4}$$

$$L_{Avg} = \frac{L_1 + L_2 + L_3 + \cdots L_n}{n}$$

$$\langle L \rangle_{Avg} = \frac{\int L\,dt}{\int dt}$$

$$\langle \square \rangle = \frac{\int \square\,dt}{\int dt}$$

$$\langle v \rangle_{Avg\ velocity} = \frac{\int v\,dt}{\int dt}$$

If Velocity of object $V = 2t + 1$ then find Avg-velocity in 2-sec.

$t_i = 0$ to $t_f = 2$ sec

Sol^n

$$\langle v \rangle_{Avg} = \frac{\int v\,dt}{\int dt} = \frac{\int_0^2 (2t+1)\,dt}{\int_0^2 dt} = \frac{\int_0^2 2t\,dt + \int_0^2 1\,dt}{\int_0^2 dt}$$

$$= \frac{\left[2\frac{t^2}{2} + t\right]_0^2}{(t)_0^2} = \frac{4+2}{2} = \frac{6}{2} = 3 \text{ m/s}$$

Concept of Power

$1^0 = 1$
$1^2 = 1$
$1^3 = 1$
$1^4 = 1$
$1^5 = 1$
$1^6 = 1$
$1^7 = 1$
$1^8 = 1$

$2^0 = 1$
$2^1 = 2$
$2^2 = 4$
$2^3 = 8$
$2^4 = 16$
$2^5 = 32$
$2^6 = 64$

$3^0 = 1$
$3^1 = 3$
$3^2 = 9$
$3^3 = 27$
$3^4 = 81$
$3^5 = 243$

$4^0 = 1$
$4^1 = 4$
$4^2 = 16$
$4^3 = 64$
$4^4 = 256$

$5^0 = 1$
$5^1 = 5$
$5^2 = 25$
$5^3 = 125$

log ka roop

$2^5 = 32$ (2 = Base, 5 = Power, 32 = Result)

When we convert Power into a form of log then Base remains same but power & result interchange their position.

$\log_2 32 = 5$ (5 = Power)

$4^3 = 64$

$\log_4 64 = 3$
power

पानी →

$4^3 = 64$

पानी मारो



$\log_x 8 = 3$

↑ base ↑ power

find value of x.

→ घो लो concept

$(x)^3 = 8$

$x^3 = 2^3$

$\boxed{x = 2}$

$\log_2 x = 4$

find x

Sol

Sol^n घो लो concept

$2^4 = x$

$\boxed{x = 16}$

Ac

Concept of Power. ⇄ Concept of log

$2^3 = 8$ (2 ← Base, 3 ← Power)

↓ log

$\log_2 8 = 3$

$3^4 = 81$

↓

$\log_3 81 = 4$ (81 ← Result)

$\log_{(e)} x$ = log e to the Power x ← wrong

$\log_e x$ = log x on the base e

Property of log #1

⇒ log and it Base is Same then Rusul Will be 1

$\log_e e = 1$

$\log_a a = 1$

$a^1 = a$ (Power, Result, Base)

$\log_{10} 10 = 1$ (Power)

$10^1 = 10$ (Base)

$\log_2 2 = 1$

$\log_4 4 = 1$

Property # 2

$10^0 = 1$

$4^0 = 1$

$e^0 = 1$

$\log_{10} 1 = 0$

$\log_4 1 = 0$

$\log_e 1 = 0$ (Base, Power)

$\log_a 1 = 0$

$a^0 = 1$

log 1 on the base any number not equal to zero or 1 then its Result will be zero

$\log_0 1$ = Not defined

$\log_1 1 = 1$

$\log_e (x)^n = \log x$ to the power n on the base e

Property #3

$$\log_e x^n = n \log_e x$$

Ex

$$\log_2 8 = \log_2 (2)^3 = 3 \log_2 2 = 3$$

$$\log_{10} 1000 = \log_{10} (10)^3 = 3 \log_{10} 10 = 3$$

$$\log_{10} \left(\frac{1}{100}\right) = \log_{10} 10^{-2} = -2$$

$$\log_2 64 = \log_2 (2)^6 = 6 \log_2 2 = 6$$

$$\log_3 \left(\frac{1}{27}\right) = \log_3 \left(\frac{1}{3^3}\right) = \log_3 3^{-3} = -3 \log_3 3 = -3$$

Property 4

$\log_{e^n}(x) = \log x$ on the base e to the power (n)

$$\log_{e^n} x = \frac{1}{n}\log_e x$$

$\Rightarrow$ $\log_{100} 10 = \frac{1}{2}$ (Result; 100 = Base)

$100^{\frac{1}{2}} = 10$

$\Rightarrow$ $\log_{100} 10 = \log_{(10^2)} 10 = \frac{1}{2}\log_{10} 10 = \frac{1}{2}$

$\log_{27} 3 = \log_{(3)^3} 3 = \frac{1}{3}\log_3 3 = \frac{1}{3}$

$\log_{125} 5 = \log_{(5^3)} 5 = \frac{1}{3}\log_5 5$
$= \frac{1}{3}$

$\log_8 64 = 2$

$\log_{(2)^3} (2)^6 = \frac{6}{3}\log_2 2 = 2$

$\log_8 32 = \log_{2^3} 2^5 = \frac{5}{3}\log_2 2$
$= \frac{5}{3}$

$\log_9 27 = \log_{3^2} 3^3 = \frac{3}{2}\log_3 3$
$= \frac{3}{2}$

$\log_{10}(x+y)$ ✗

Property #5

$$\log_e(x \cdot y) = \log_e x + \log_e y$$

Property #6

$$\log_e\left(\frac{x}{y}\right) = \log_e x - \log_e y$$

Ex

$\log_{10} 6 = \log_{10}(2\times 3) = \log_{10} 2 + \log_{10} 3$

$= 0.30 + 0.48$

$= 0.78$

$\log_{10} 5 = \log_{10}\left(\frac{10}{2}\right) = \log_{10} 10 - \log_{10} 2$

$= 1 - 0.30 = 0.70$

from log table:–

$\log_{10} 7 = 0.84$

MR Rattu ✓

$\log_{10} 2 = 0.3010$

$\log_{10} 3 = 0.47 \approx 0.48$

$\log_{10} 4 = \log_{10} 2^2 = 2\left[\log_{10} 2\right]$

$= 0.60$

Property # 7

$$\log_y x = \frac{1}{\log_x y}$$

$\log_2 8 = 3$ ✓

$\log_8 2 = \log_{(2^3)} 2 = \frac{1}{3}\log_2 2 = \frac{1}{3} = \frac{1}{\log_2 8}$

$\log_y x \cdot \log_x y = 1$

$100^{1/2} = 10$

$10^{2 \times \frac{1}{2}} = 10$ ✓

Property 8 $\log_y x = \log x$ on the base y

$$\log_y x = \frac{\log_e x}{\log_e y}$$

LOGARITHMIC

- **Natural log**

$\log e^x = \ln x$ = $\log x$ on the base e

- $\log_e x = \ln x$
- $\int \frac{1}{x} dx = \ln x = \log_e x$

$\log_e x = 2.303 \log_{10} x$

Common log

$\log_{10} x = \log x$

→ when base of log is not given then we will take base 10.

Prove that

$$\log_e^x = \log_{10}^x \times (2.303) \leftarrow \text{MR Rahul}$$

$$\log_e^{10} = 2.303 \times \log_{10}^{10}$$

✓ $\log_e^{10} = 2.303$

Using Property #8

$$\log_e^x = \frac{\log_{10}^x}{\log_{10}^e} = \frac{\log_{10}^x}{(0.43)}$$

$$\log_e^x = 2.303 \log_{10}^x$$

$$\log_e 2 = 2.303 \times \log_{10} 2$$

$$= (2.303 \times 0.30)$$

$$\log_e 10 = 2.303 \log_{10} 10 = 2.303$$

$$\log_e 3 = \log_{10} 3 \times 2.303 = 2.303 \times 0.48$$

$$\log_e 100 = 2.303 \log_{10} 100$$

$$= 2 \times 2.303$$

$$= 4.606$$

➢ $\log e^{25} + \text{Log } e^{4} - \log e^{10} = \log_e\left[\frac{25\times 4}{10}\right] = \log_e 10$

$= 2.303$

$$\log_e(xy) = \log_e x + \log_e y$$

QUESTION

Find value of given expression :

$$\log_{10}(4 \times 10^{-4})$$

$\log_{10}(4\times10^{-4}) = \log_{10}4 + \log_{10}10^{-4}$

$= 2\log_{10}2 - 4\log_{10}10$

$= 0.60 - 4$

$= -3.4$

QUESTION

Find value of x In the given expression.

(i) $\log_2 x = -4$ ⟶ को पे → $2^{-4} = x$

$\frac{1}{2^4} = x$

$\boxed{x = \frac{1}{16}}$ Ans

(ii) $\log_3 (x)^2 = 18$ ⟶ $2\log_3 x = 18$ 9

$\log_3 x = 9$

को पे $\boxed{3^9 = x}$ ✓

[redacted]

- $\log_{10}(\sin\theta \cdot \operatorname{cosec}\theta) = 0$ ✓

$\sin\theta \cdot \operatorname{cosec}\theta = 1$

- $\log_{10} 25 + \log_{10} 40 = \log_{10} 25\times40 = \log_{10} 10^3 = 3$

- $\log_{10} 200 - \log_{10} 2 = \log_{10}\left(\frac{200}{2}\right) = \log_{10} 100 = 2$

- $\log_{10} 200 = \log_{10} 100\times2 = \log_{10} 100 + \log_{10} 2$

$= 2 + 0.3$

$= 2.3$

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

$$\log_8 16 = \log_{2^3} (2)^4 = \frac{4}{3}\log_2 2 = \frac{4}{3}$$

$$\log_{27} 3 = \log_{(3^3)} 3 = \frac{1}{3}\log_3 3 = \frac{1}{3}$$

$$\log_{100} 1000 = \log_{(10^2)} 10^3 = \frac{3}{2}\log_{10} 10 = \frac{3}{2}$$

$$\log_{10} (0.0001) = \log_{10} 10^{-4} = -4\log_{10} 10 = -4$$

$$\log_{0.01} 10 = \log_{10^{-2}} 10 = -\frac{1}{2}\log_{10} 10 = -\frac{1}{2}$$

QUESTION

Loudness of sound at a point is 50 dB then find intensity at that point if $L = 10\log_{10}\left(\frac{I}{I_0}\right)$ dB where $I_0 = 10^{-12}\ \text{w/m}^2$

loudness

(A) $10^{-7}\ \text{w/m}^2$

(B) $10^{-5}\ \text{w/m}^2$

(C) $10^{8}\ \text{w/m}^2$

(D) $10^{7}\ \text{w/m}^2$

$L = 50\,\text{dB}$

$$L = 10\log_{10}\left(\frac{I}{I_0}\right)\text{dB}$$

$$50\,\text{dB} = 10\log_{10}\left(\frac{I}{I_0}\right)\text{dB}$$

$$5 = \log_{10}\left(\frac{I}{I_0}\right)$$

concept

anti-log

$$10^5 = \frac{I}{I_0}$$

$$I = I_0 \times 10^5 = 10^{-12} \times 10^5$$

$$= 10^{-7}$$

hint $\log_e\left(\frac{x}{y}\right) = \log_e x - \log_e y$

QUESTION

Loudness at a point is 16 dB where intensity is I then find loudness at a point where Intensity is I/4.

where $$L = 10\log_{10}\left(\frac{I}{I_0}\right)\text{dB}$$

$$16\,dB = 10\log_{10}\left(\frac{I}{I_0}\right)dB \quad -(1)$$

$$L = 10\log_{10}\left(\frac{I}{I_0 4}\right)dB \quad -(11)$$

(11) − (1)

$$L - 16\,dB = 10\left[\log_{10}\left(\frac{I}{I_0 4}\right) - \log_{10}\left(\frac{I}{I_0}\right)\right]$$

$$= 10\left[\log_{10}\left[\frac{I}{I_0 4} \times \frac{I_0}{I}\right]\right]$$

$$= 10\log_{10} 4^{-1}$$

$$= -10\left[\log_{10} 4\right]$$

$$= -10 \times 0.6 = -6$$

$$L - 16\,dB = -6$$

$$L = 16\,dB - 6\,dB$$

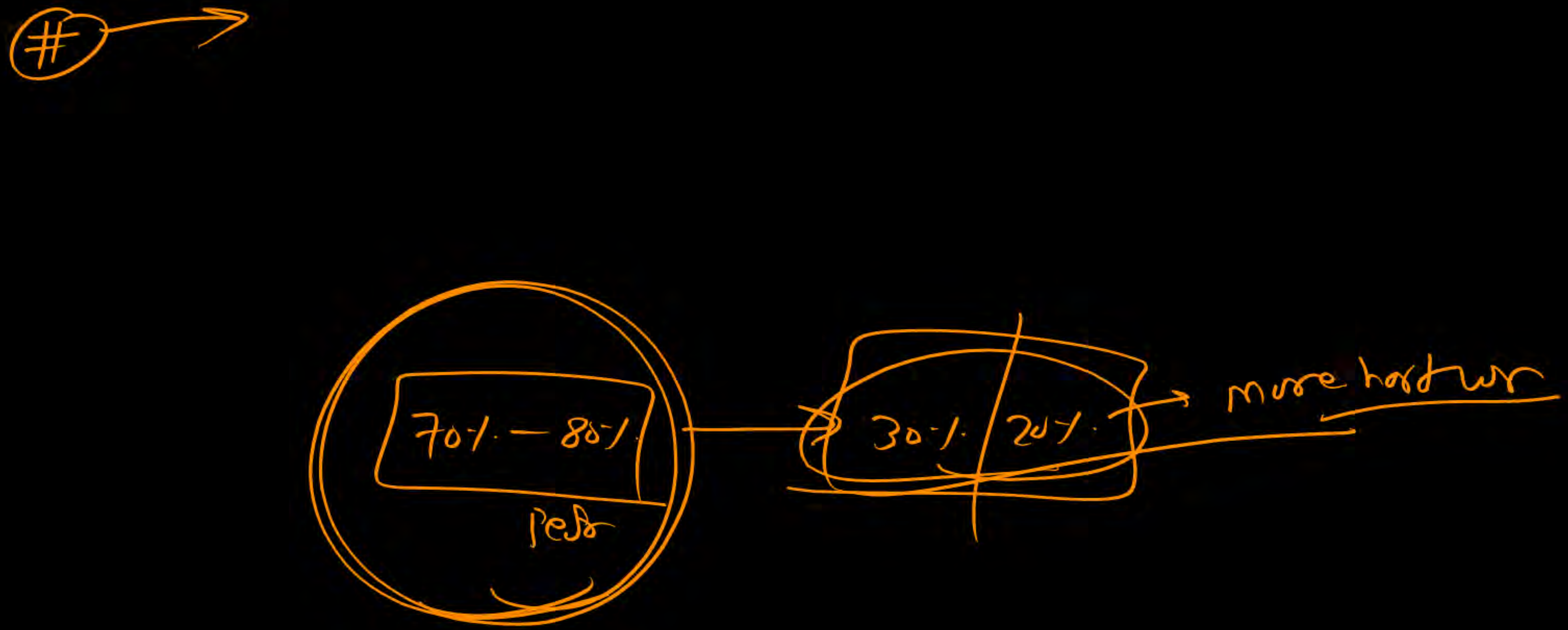
$$= 10\,dB$$

$$\log_{10}\frac{1}{4} = \log_{10} 4^{-1}$$

$$= -1 \log_{10} 4$$

$$= -1 [0.6]$$

$$= -0.6$$


#
70% — 80%
Perf
30% | 20%
more hardwr

Concent of Anti-log

$\log_e x = y$

(taking anti-log) — crossed out

(धी-धी concept) ✓

anti-log

$e^y = x$

$\log_e 10 = x$

↑ Base.

(धी धी conet anti-lg)

$e^x = 10$

QUESTION

If current flowing through wire is $I = 20\ e^{-\lambda t}$ find the time when current becomes 10 Amp. Where λ is 2.303.

$$I = 20\,e^{-\lambda t}$$

$$10 = 20\,e^{-\lambda t}$$

$$\frac{1}{2} = e^{-\lambda t}$$

$$2^{-1} = e^{-\lambda t}$$

$$2 = e^{\lambda t}$$

taking $\log_e$ both side

$$\log_e 2 = \log_e e^{(\lambda t)}$$

$$2.303 \log_{10} 2 = \lambda t$$

$$t = \log_{10} 2 = 0.30$$

Binomial theorem

$(x+y)^2 = x^2 + y^2 + 2xy$ ✓✓

$(1+x)^2 = 1 + x^2 + 2\times 1\times x$

→ If $1 >>>>> x$

$x^2 \to$ neglige

$(1+x)^2 = 1 + 2x$

$(1+x)^n = 1 + nx$

$x <<<< 1$

$(1+x)^n = 1 + nx$ ✓

mr feel

$(\text{carrier} + \text{Love})^2 = [\text{carrier} + 2\,\text{love}]$

If carrier >>> love (Binominal)

$$(1+x)^{-n} = 1-nx$$

$$(x \lll 1)$$

$$(1-x)^{n} = 1-nx$$

$$(1-x)^{-n} = 1-x(-n)$$

$$= 1+nx$$

$$(100)^2 = 10^4 = 10000$$

$$(101)^2 = (100+1)^2$$

$$= \left[100\left(1+\frac{1}{100}\right)\right]^2$$

$$= 100^2\left(1+\frac{1}{100}\right)^2$$

$$= (100)^2\left(1+\frac{2}{100}\right)$$

$$= 10^4 + 2 \times \frac{10^4}{100} 10^2$$

$$= 10^4 + (200)$$

$$= 10000 + 200 = 10200$$

$\sqrt{99} = (99)^{1/2} = (100-1)^{1/2}$

$$= \left[100\left(1-\frac{1}{100}\right)\right]^{1/2}$$

$$= 10\left(1-\frac{1}{100}\right)^{1/2}$$ Binomial

$$= 10\left[1-\frac{1}{100\times 2}\right]$$

$$= 10\left[1-\frac{1}{200}\right]$$

$$= 10-\frac{10}{200} = \frac{200-1}{20} = \frac{199}{20} = \frac{19.9}{2}$$

$$= 9.95$$

application in physics

$$\left(1 - \frac{h}{R}\right)^2$$

If $h <<<< R$

→ Binomial thm

$$\left(1 - \frac{h}{R}\right)^2 = \left(1 - \frac{2h}{R}\right)$$

$$\frac{2}{10} = 0.2$$

$$\frac{2}{(10000)} = 0.00002$$

$$\left(1 - \frac{1}{200}\right)^y = \left[1 - \frac{y}{200}\right]$$

→ Binomial thm


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 01 | Physics

we will discuss question on binominal in assignment

VECTORS

Basic strong

Level up



By- Dr. Manish Raj (MR SIR)

Topics to be covered

1. Basic of vector
2. Angle b/w vector
3. Type of Vector
4. addition of vector

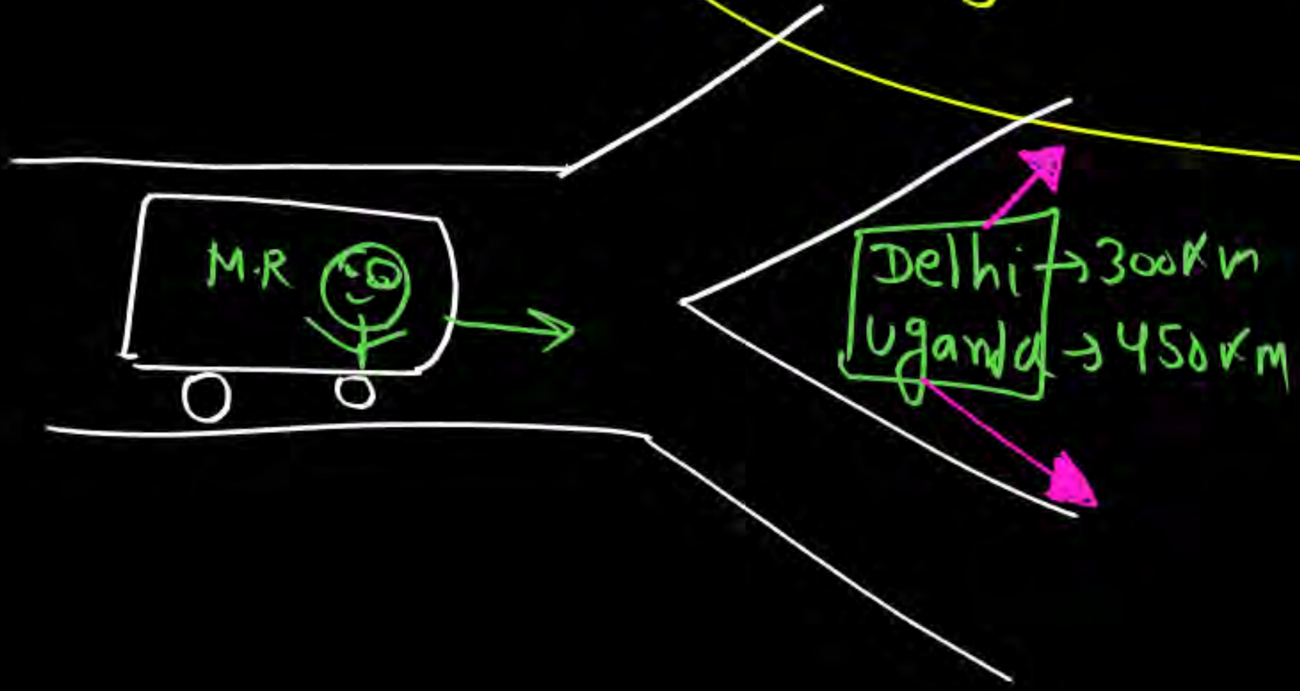


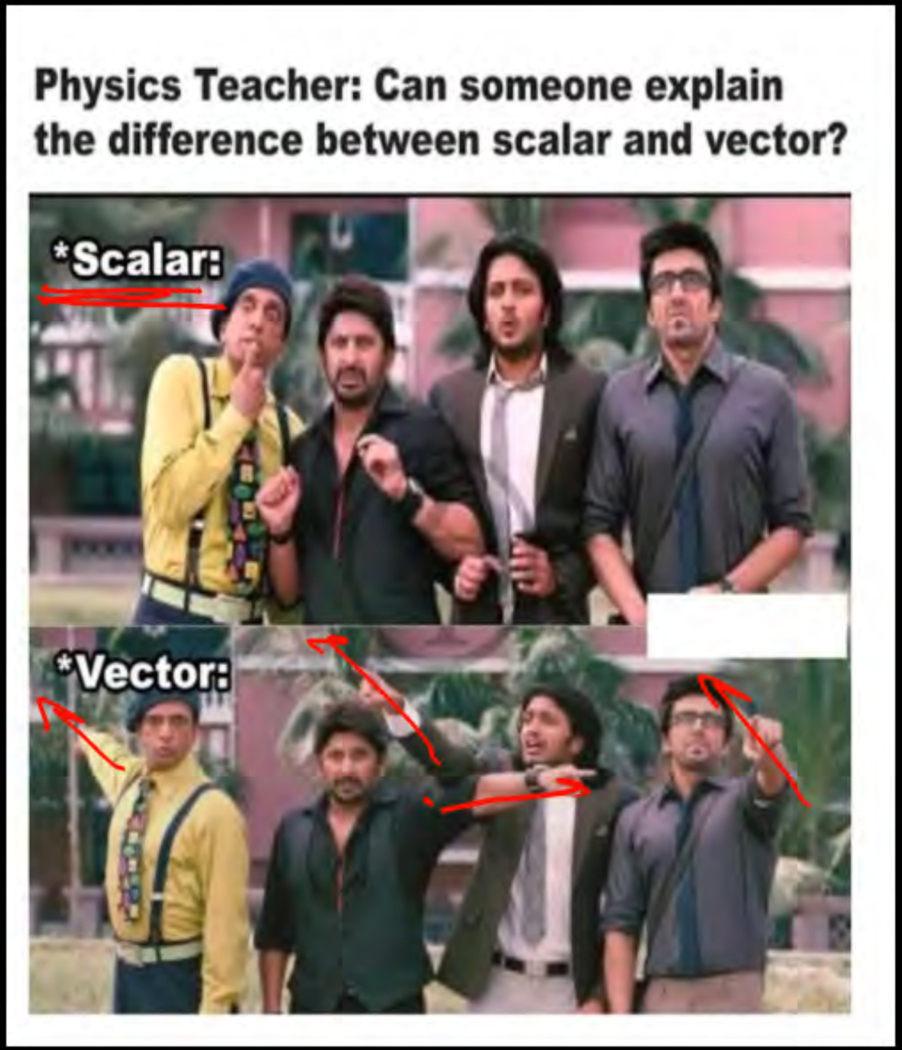
Physical quantity → quantity that can be measure is called P.Q.

Ex → mass, velocity, density, volume, Temprature
Intensity
moment of Inertia.

Non-P.Q. →

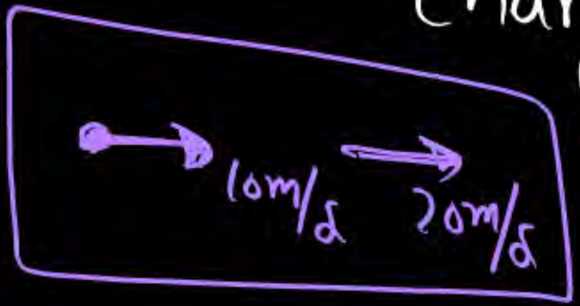
Ex → Inertia, Love, hate
→ goodness, Light,




Physics Teacher: Can someone explain the difference between scalar and vector?
*Scalar:
*Vector:

Scalar

- → A P.Q. which have magnitude only is called Scalar
- → follows simple addition
- → Ex - mass, speed (How fast)
  Tempr, electric current
  work, energy, volume.
- → Scalar can be change by changing its (magnitude only)





Vector

Vector → A P.Q. which have magnitude as well as direction and also follow Triangle law of vector addition.

Ex- dispm, velocity (How fast/where)
force, Current density
Torque, electric field
(Area)

Vector can be change by changing it Magnitude only or by (changing its direction only) or by by changing by both.

Represtation of vector

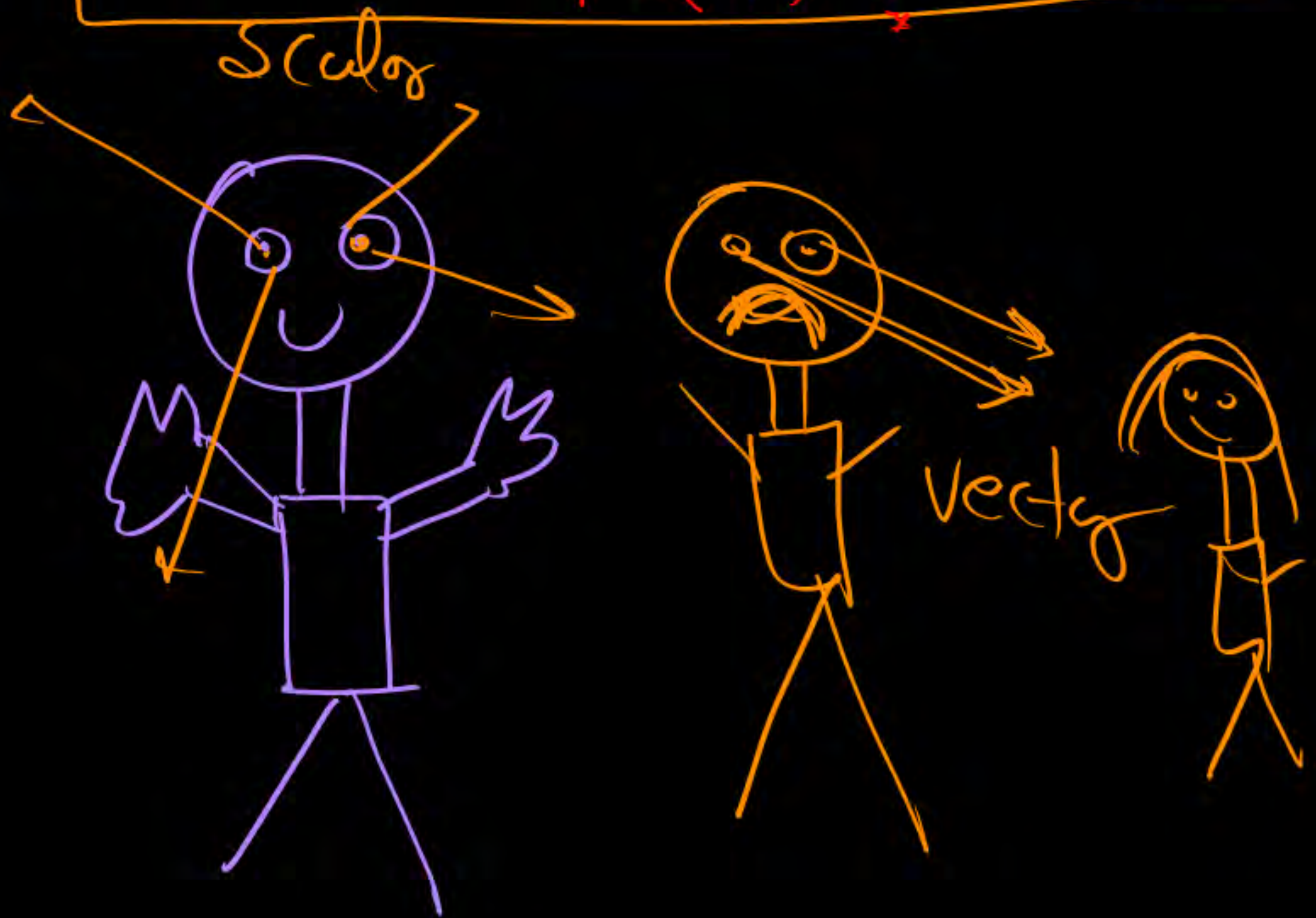
$$\vec{A} = A\,\hat{A}$$

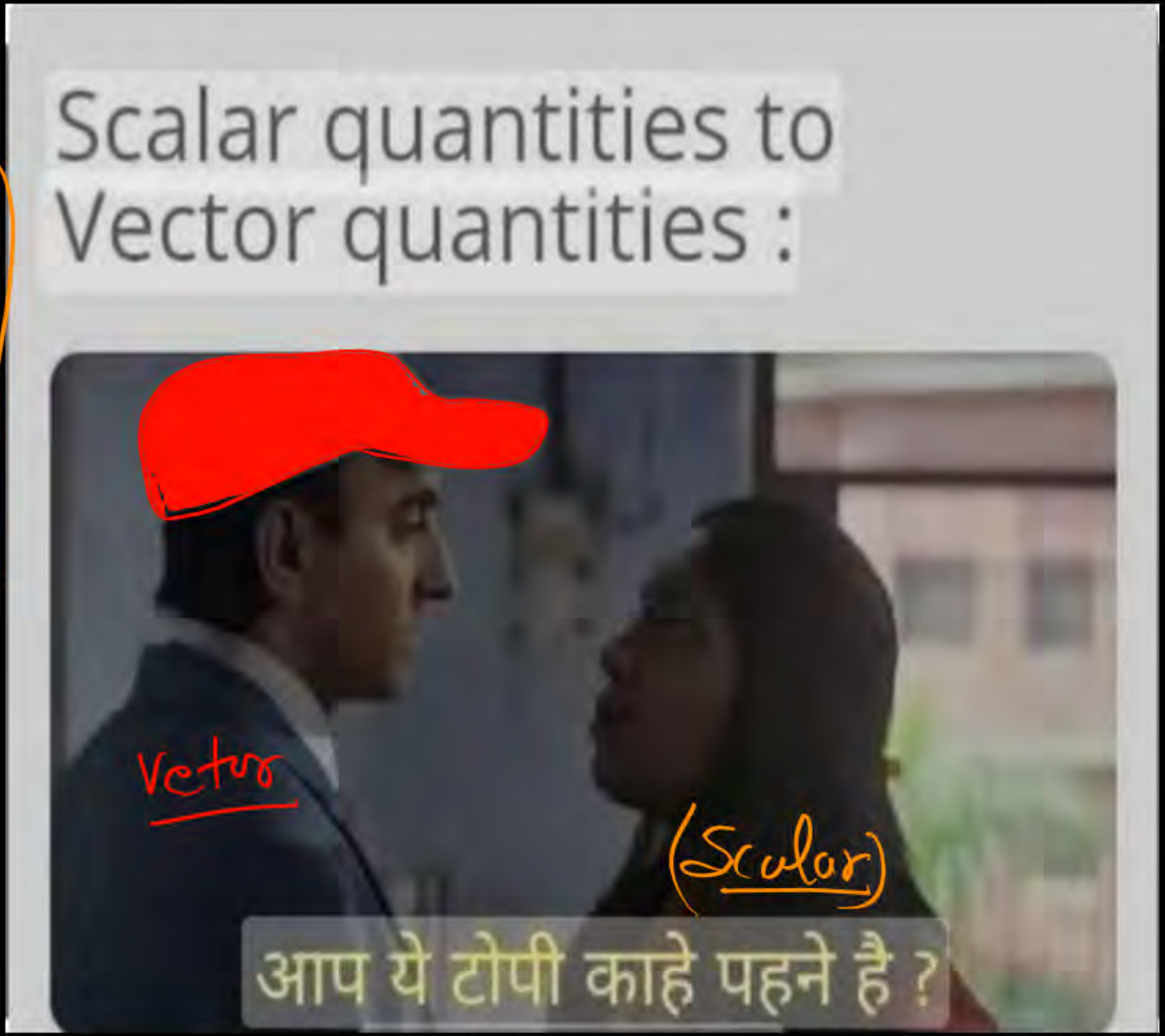
A ↑ magnitude

$\hat{A}$ ↖ direction (unit vetor)

$$\vec{A} = |\vec{A}|\,\hat{A}$$

$$\vec{F} = (10\,N)\,\hat{i}$$





A unit vector does not have any unit → (a) True ✓

(b) False ✗

$\vec{A} = A \times \hat{A}$

$\hat{A}$ → have only direction

Unit vector (dirⁿ) of x axis → $\hat{i}$

" " (dirⁿ) of y axis → $\hat{j}$

" " (dirⁿ) " z-axis → $\hat{k}$

Ex $\vec{V} = 10m/s \times \hat{i}$

1. which of the following is vector??

(a) electromotive force (58%) → e.m.f (Potential difference) scalar

(b) surface Tension (17%) → scalar $\left(S = \frac{F}{l}\right)$

(c) weight (13%) → $\vec{F} = m\vec{g}$ (vector)

(d) focal length. (11%)

87% Yakeenian are जाहिल ||

② Which of the following representation is correct??

✗ (a) Work ($\vec{W}$)

(b) ✗ Force (F)

✓ (c) Energy (E)

✗ (d) all of these.

QUESTION

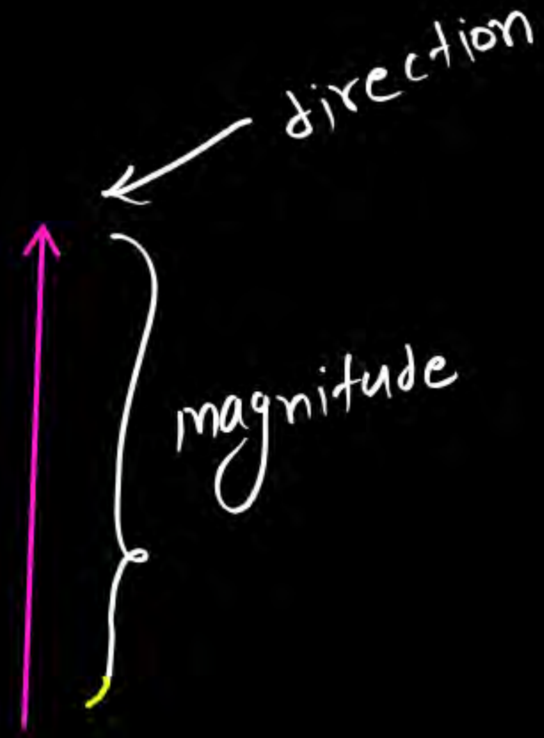
A. Physical quantity which does not have direction must be scalar.

B. Physical quantity which have direction must be vector.

1. Both are true
2. Both are false
3. A true B false
4. A false B true

graphical represantation of vector



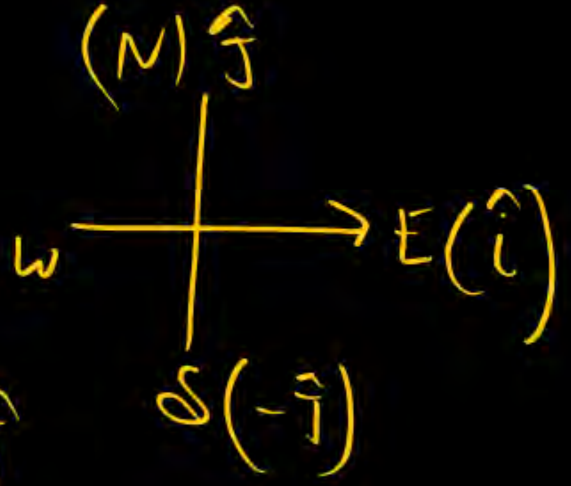


$\vec{F} = 10N\, i$

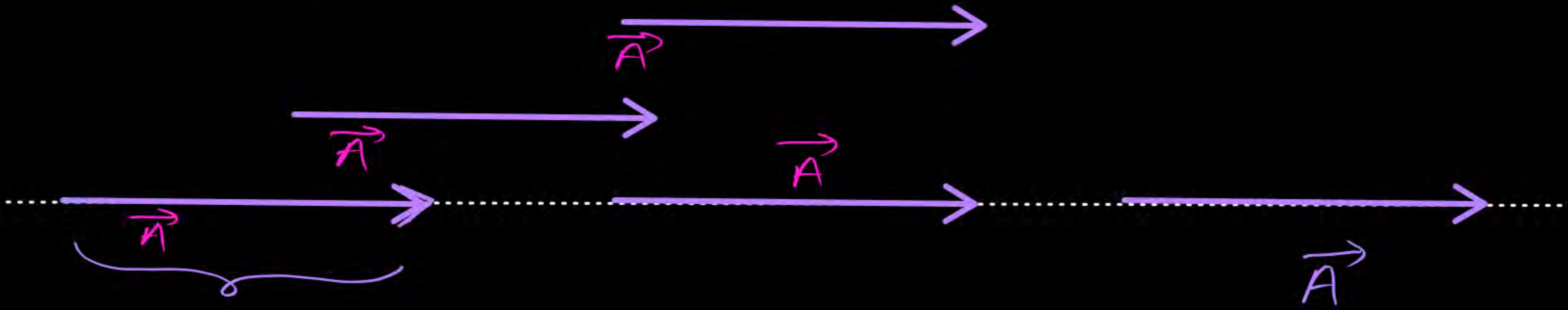
$\vec{F} = 20N\, \hat{i}$

$f = 5N\, \hat{i}$

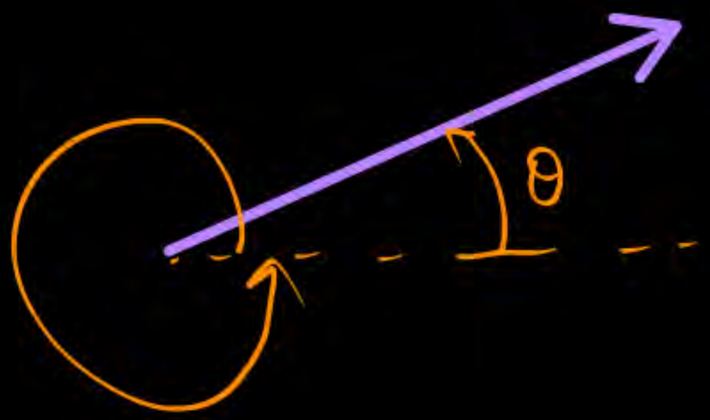
$F = 5N\, \hat{j}$



vector can be shifted Parallel to itself keeping its magnitude and direction same.

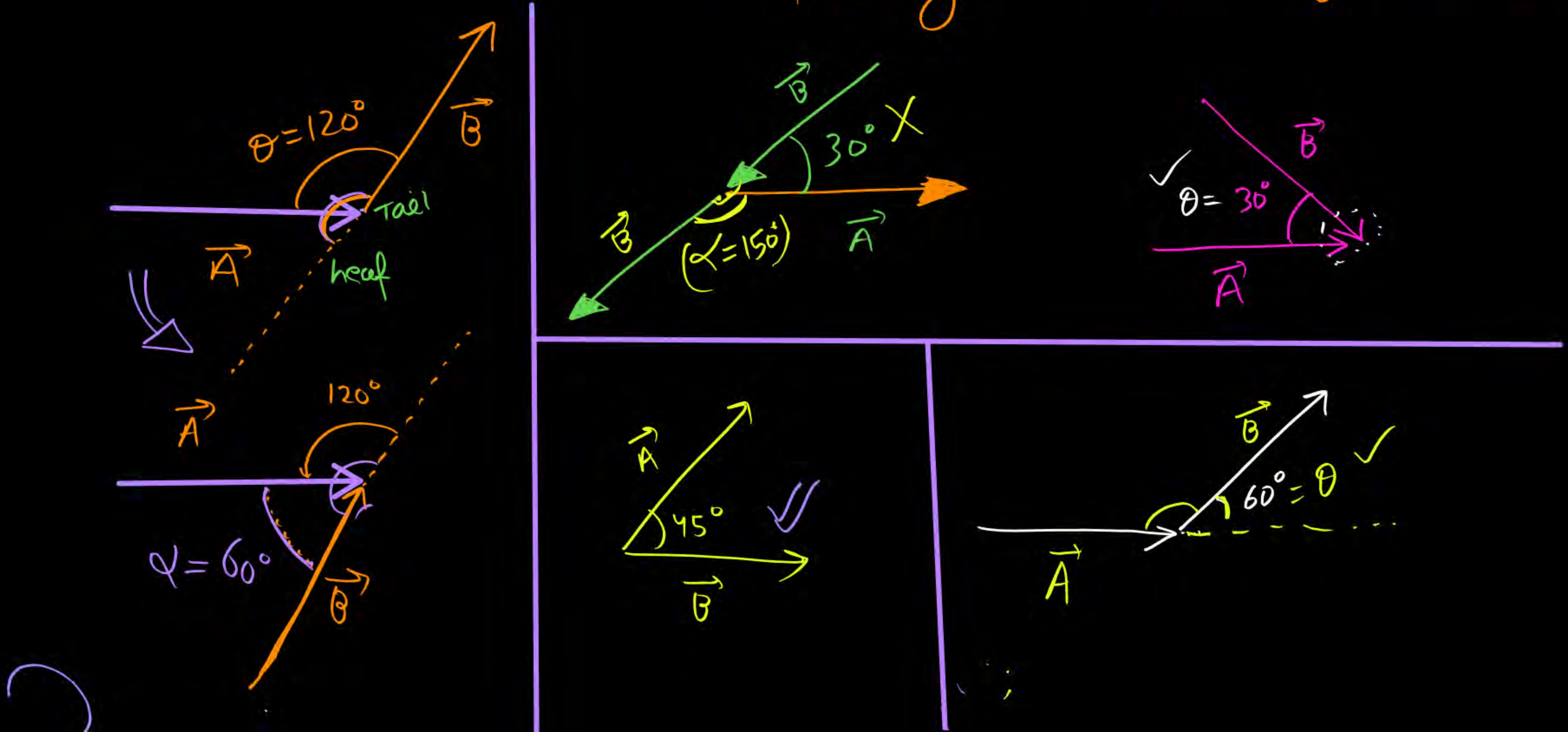


but Rotion of vector other than $(\theta = 2\pi, 360^\circ)$ is not allowed



Angle B/w vector

→ Smaller angle b/w two vector when they are place head togather or tail tail togather is called angle b/w Vectors



Type of vector

(A) **Equal vector** :→ Two vector having same magnitud and same direction of (same Nature).

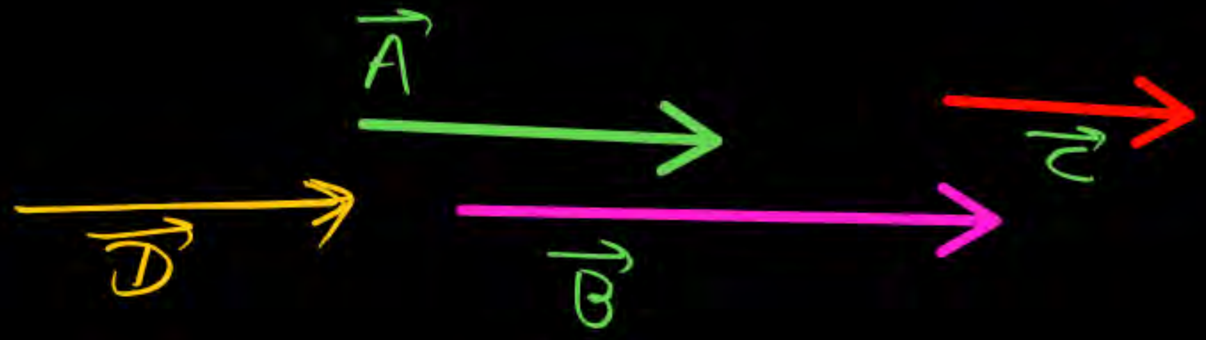


$F = 10\,N\ \hat{i}$

$\tau = 10\,Nm\ \hat{i}$

→ not a equal vector

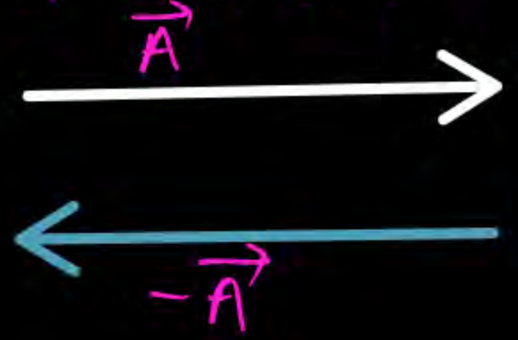
(B) **Parallel vector** :- magnitude may or may not equal, but dir^n must be same.



\# all equal vectors are Parallel. ✓

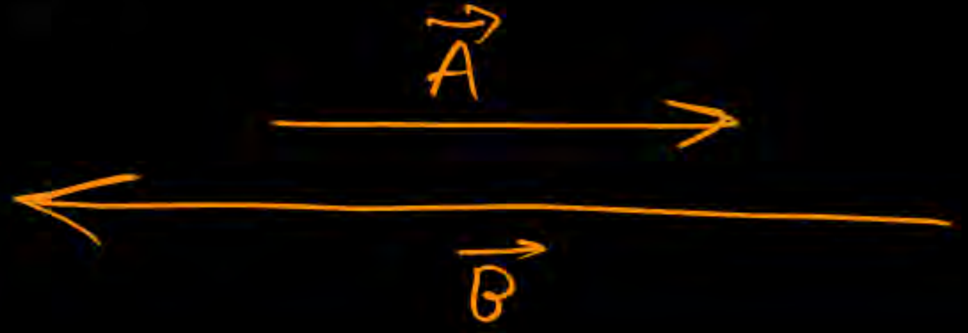
\# all parallel Vector may, or may not equal vector

(C) **Negative vector** → magnitude must be same, direction exactly opposite.



(D) anti-Parallel vector :-

Magnitude may or may not equal but director oppostion.



all -ve vectors are anti-Parallel.

all Anti-Paralle may or may not be negative of each other.



(E) unit vector

A vector having unit magnitude & repersent only direction, does not have unit.

$$\vec{A} = A\hat{A}$$

$\hat{A} = \frac{\vec{A}}{A} = \frac{\vec{A}}{|\vec{A}|}$

Unit vector

(F) **Zero vector** (Null vector) → A vector having zero magnitude.

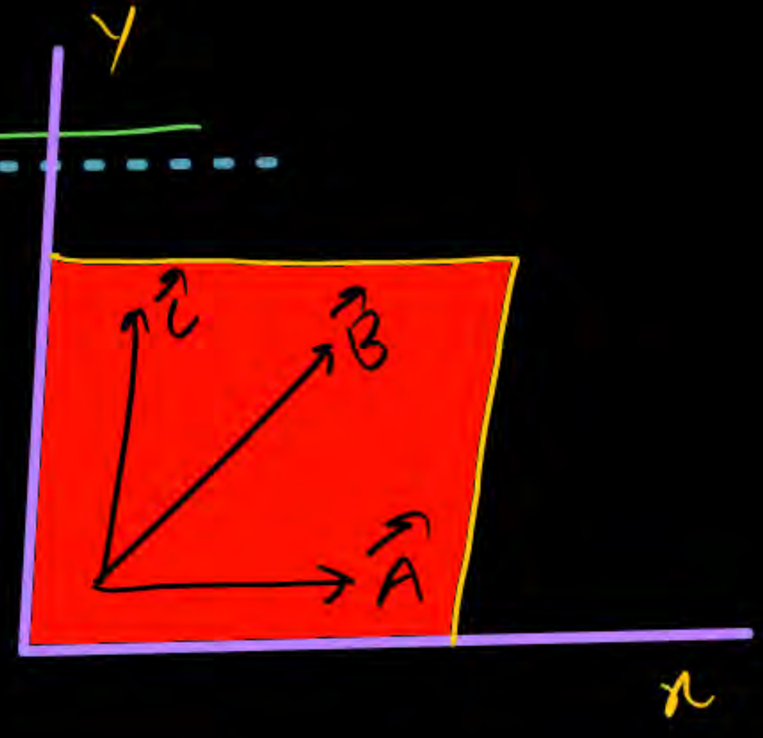
Ex. velocity of CAR which is at rest.

$$\vec{u} = 0$$

(G) **Coliner vector** → All vector are called coliner when they are along the same line.



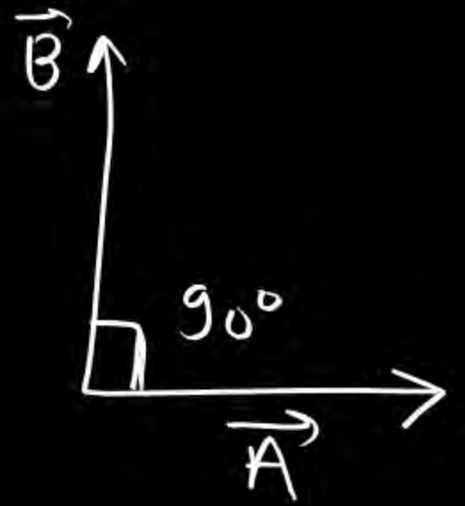
(H) **Coplaner vector** → vectors are in same plane



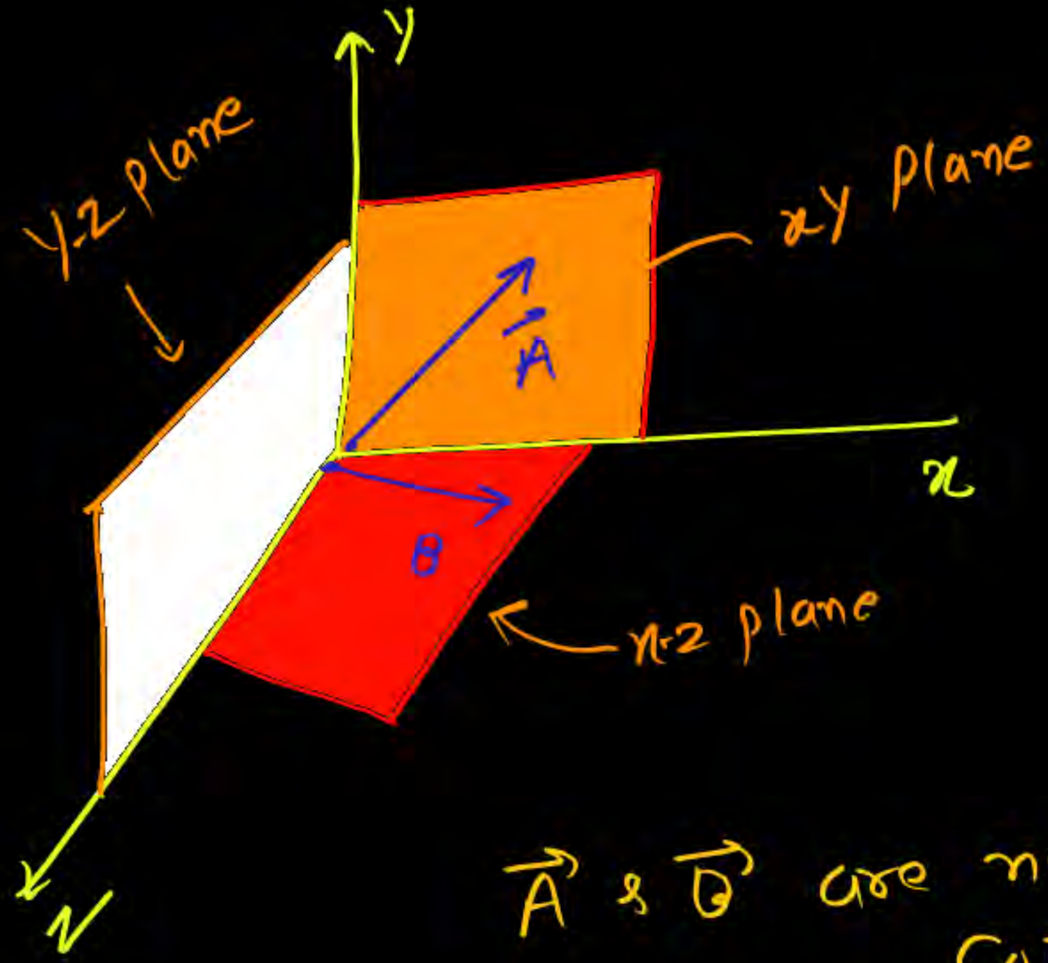
$\vec{A}, \vec{B}$ & $\vec{C}$ are co-plane

I) orthogonal vector (Perpendicular vector)

→ magnitude may or may not same, Angle must be 90°,



x- axis, y-axis & z-axis are orthogonal to each other.

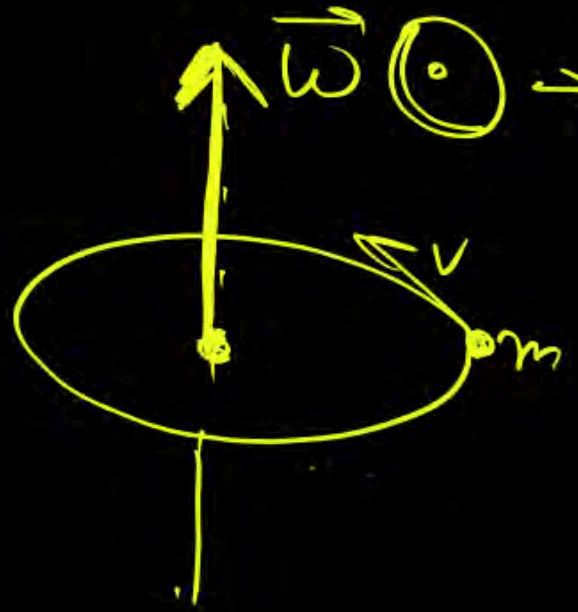


$\vec{A}$ & $\vec{B}$ are not coplanar

(J) concurrent vector :→ magnitude & direction may or may not be same, but point of action is at "same point"



(K) axial vector → A Vector having direction along axis of Rotation.
(angular vector)

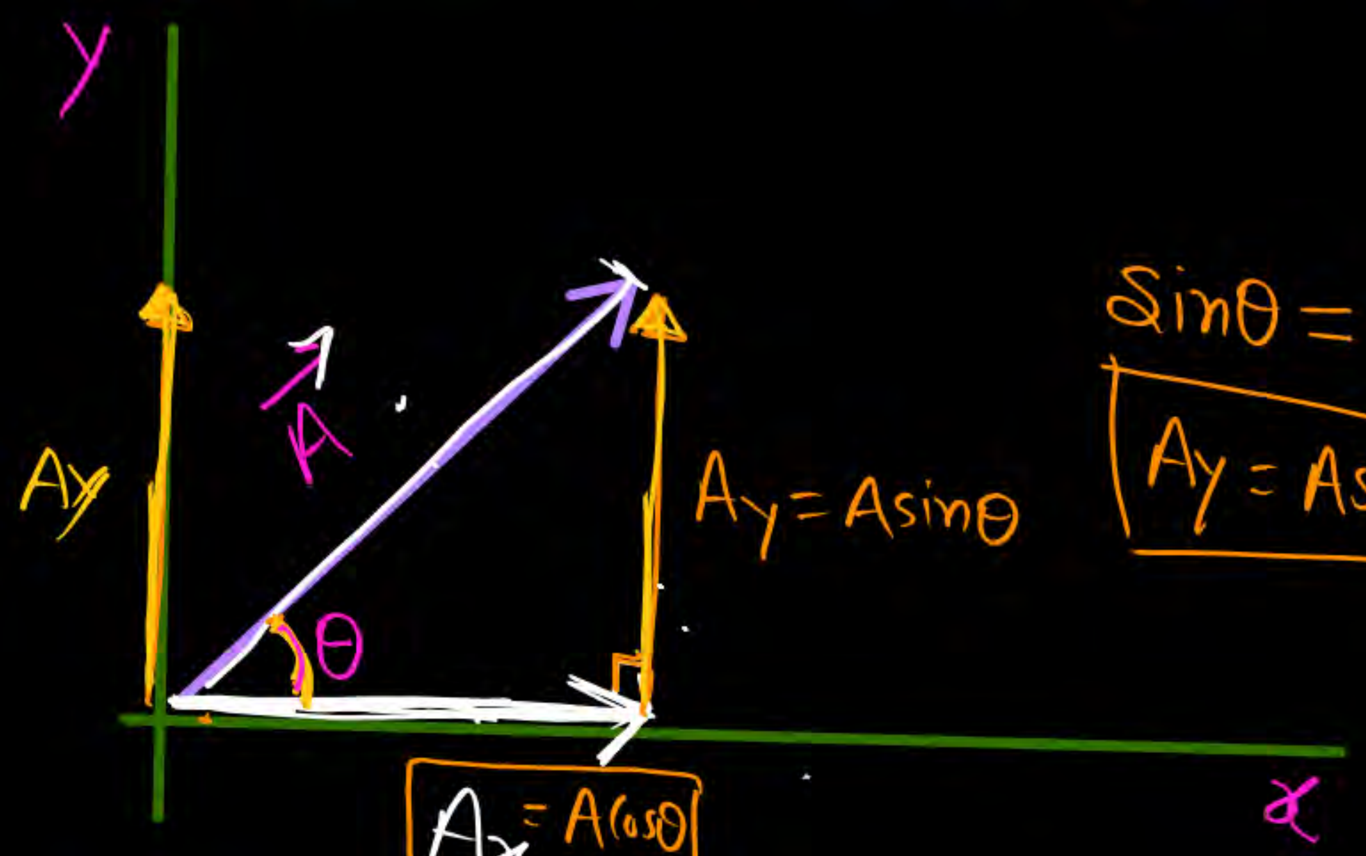


$\odot$ → axis vector

Ex → Angular velocity, angular acc^n, Torque

Vector ⟶ Kinematics, Newtons Law, WEP, Rotation × grav
$w = \vec{F} \cdot \vec{S}$, $\tau = \vec{r} \times \vec{F}$
SHM, wave
magnitsm ($F = qv \times B$)
(electrostation)

Component of vector (vector ko Todna)



$A_y = A\sin\theta$

$\sin\theta = \frac{A_y}{A}$

$A_y = A\sin\theta$

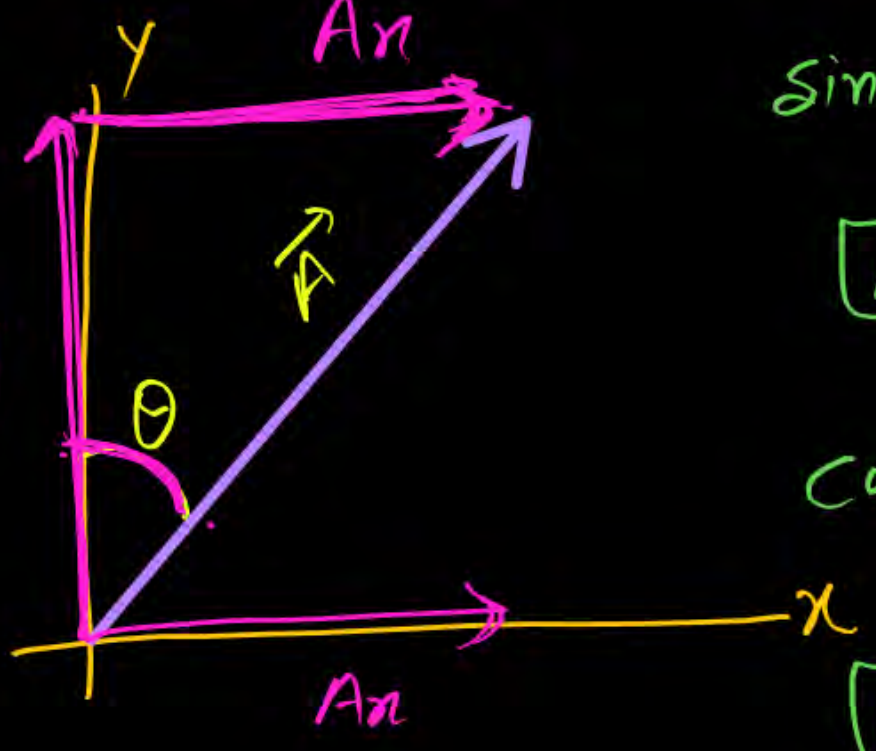
$A_x = A\cos\theta$

$\cos\theta = \frac{A_x}{A}$

$A_x = A\cos\theta$

#

$A\cos\theta = A_y$

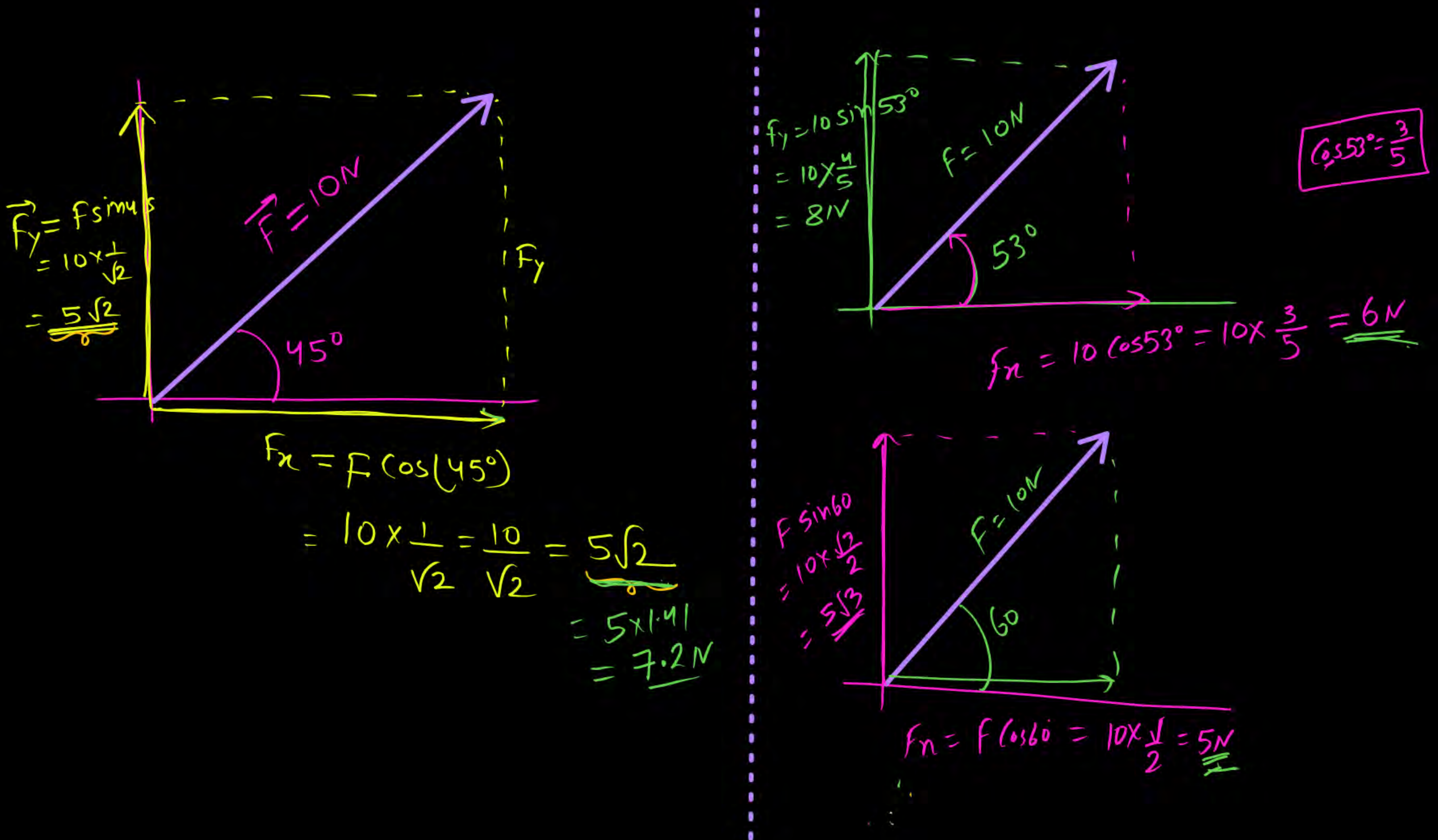


$\sin\theta = \frac{A_x}{A}$

$A_x = A\sin\theta$

$\cos\theta = \frac{A_y}{A}$

$A_y = A\cos\theta$

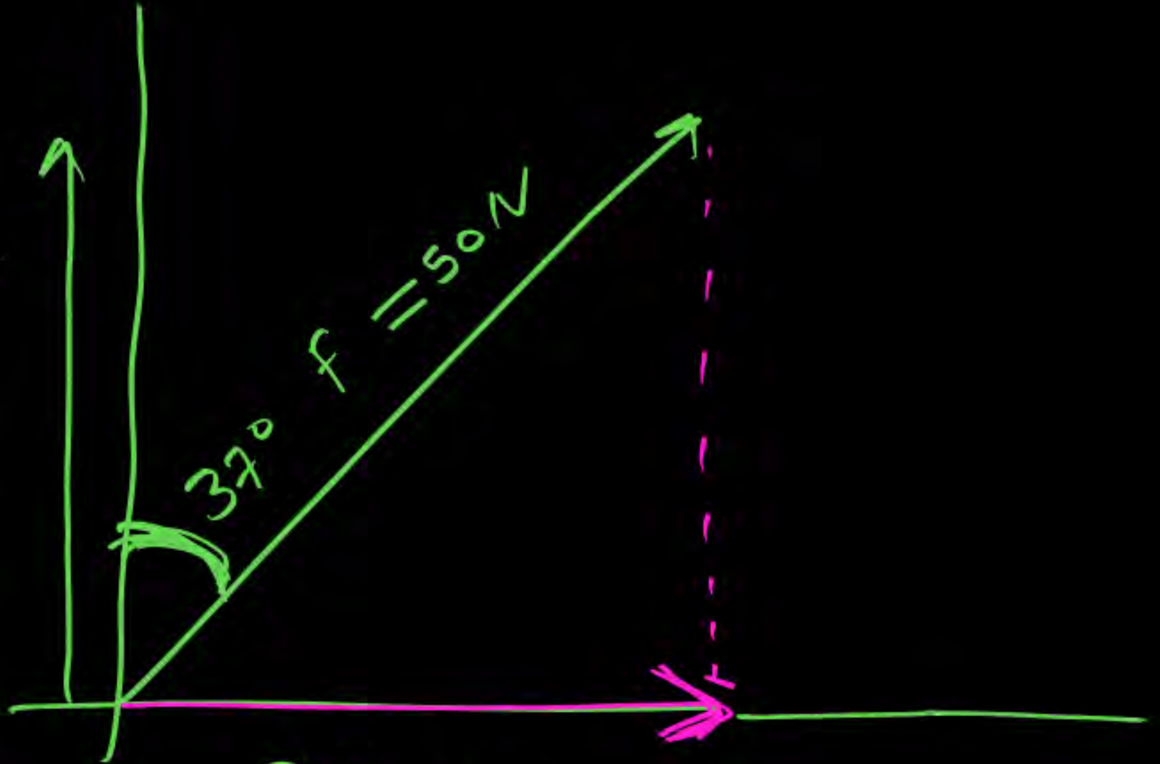


F = 10N
45°
Fy
Fy = F sin45
= 10 × 1/√2
= 5√2
Fx = F cos(45°)
= 10 × 1/√2 = 10/√2 = 5√2
= 5 × 1.41
= 7.2 N
Fy = 10 sin 53°
= 10 × 4/5
= 8N
F = 10N
53°
Cos53° = 3/5
Fx = 10 cos53° = 10 × 3/5 = 6N
F sin60
= 10 × √3/2
= 5√3
F = 10N
60
Fx = F cos60 = 10 × 1/2 = 5N

$F_y = F\cos 37°$

$= 50 \times \frac{4}{5}$

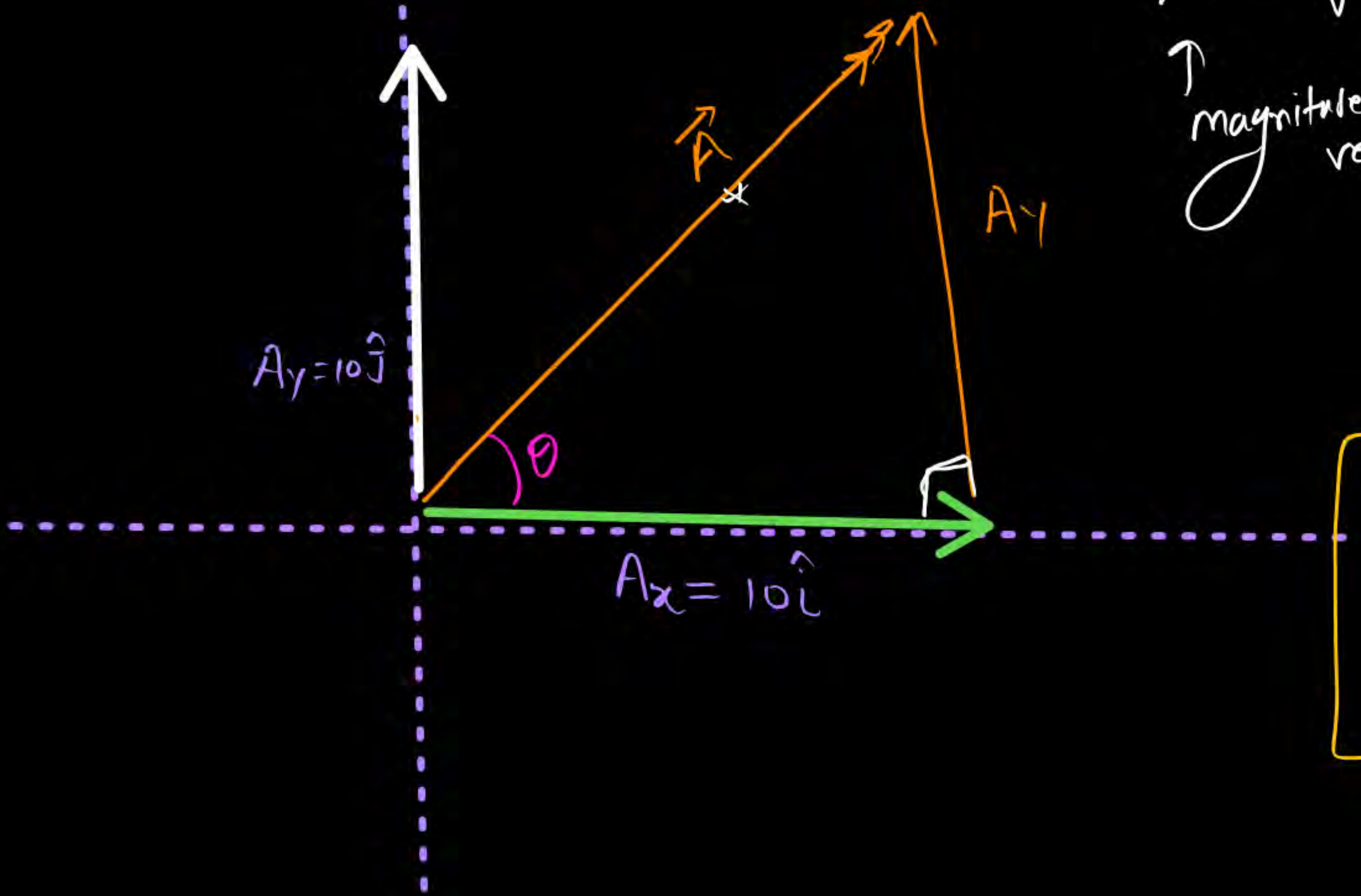
$F_y = 40\hat{j}$



$F_x = F\sin 37°$

$F_x = 50 \times \frac{3}{5} = 30N\,\hat{i}$

Magnitude of vector :→ (addition of Vector)



$A = \sqrt{A_x^2 + A_y^2} = \sqrt{(10)^2 + (10)^2}$

$= \sqrt{200}$

$= \sqrt{100 \times 2}$

$= 10\sqrt{2}$

↑ magnitude of vector

3-D vector

$$A = \sqrt{A_x^2 + A_y^2 + A_z^2}$$ *

find magnitude of vector

$\vec{A} = 2\hat{i} + 3\hat{j} \longrightarrow A = \sqrt{(2)^2 + (3)^2} = \sqrt{4+9} = \sqrt{13}$

$\vec{B} = 3\hat{i} + 4\hat{j} \longrightarrow A = \sqrt{(3)^2 + (4)^2} = \sqrt{9+16} = \sqrt{25} = 5$

$\vec{C} = 3\hat{i} + 4\hat{j} + 5\hat{k} \longrightarrow A = \sqrt{9+16+25} = \sqrt{50} = \sqrt{25\times 2} = 5\sqrt{2}$

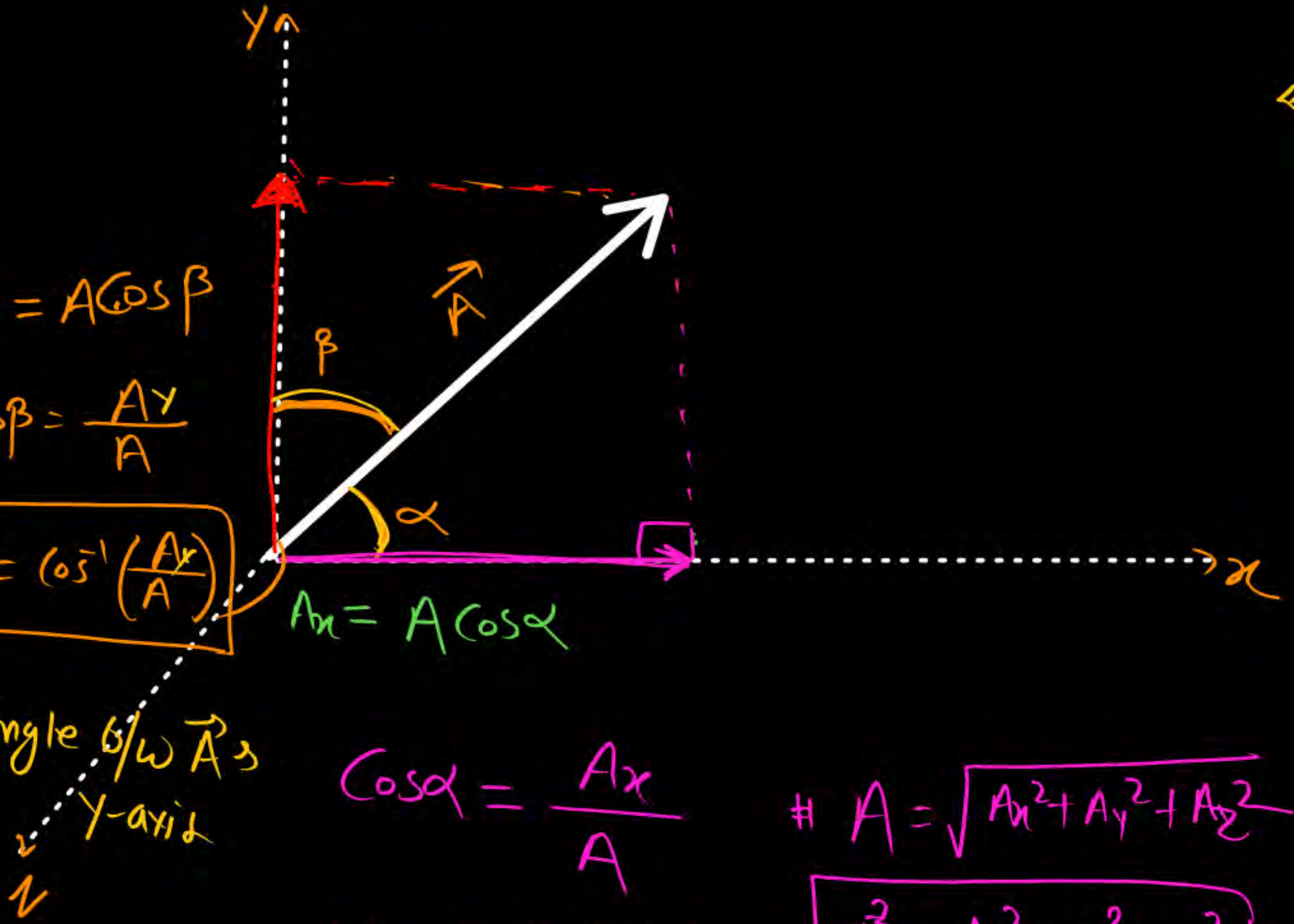
$\vec{D} = \hat{i} - \hat{j} + \hat{k} \longrightarrow A = \sqrt{(1)^2 + (-1)^2 + (1)^2} = \sqrt{1+1+1} = \sqrt{3}$ Ans

$\vec{E} = 6i - 8\hat{j} + 10\hat{k} \longrightarrow A = \sqrt{6^2 + (-8)^2 + (10)^2} = \sqrt{36+64+100} = \sqrt{200} = 10\sqrt{2}$

$\vec{F} = 10i - 10\hat{j} - 10\hat{k} \longrightarrow A = \sqrt{(10)^2 + (10)^2 + (10)^2} = \sqrt{100+100+100} = \sqrt{300} = 10\sqrt{3}$

(*)

vector cosine



$A_y = A\cos\beta$

$\cos\beta = \frac{A_y}{A}$

$\beta = \cos^{-1}\left(\frac{A_y}{A}\right)$

↳ Angle b/w $\vec{A}$ & y-axis

$\cos\alpha = \frac{A_x}{A}$

$\alpha = \cos^{-1}\left(\frac{A_x}{A}\right)$

↑ Angle b/w $\vec{A}$ & x-axis.

$A = \sqrt{A_x^2 + A_y^2 + A_z^2}$

$$A^2 = A_x^2 + A_y^2 + A_z^2$$

$\cos\alpha = \frac{A_x}{A}$ — (I) $\quad$ α = Angle b/w $\vec{A}$ & x-axis

$\cos\beta = \frac{A_y}{A}$ — (II) $\quad$ β = Angle b/w $\vec{A}$ & y-axis

$\cos\gamma = \frac{A_z}{A}$ — (III) $\quad$ γ = Angle b/w $\vec{A}$ & z-axis

$(I)^2 + (II)^2 + (III)^2$

$$\cos^2\alpha + \cos^2\beta + \cos^2\gamma = \left(\frac{A_x}{A}\right)^2 + \left(\frac{A_y}{A}\right)^2 + \left(\frac{A_z}{A}\right)^2$$

$$= \frac{A_x^2 + A_y^2 + A_z^2}{A^2}$$

$$\cos^2\alpha + \cos^2\beta + \cos^2\gamma = 1$$

Ans.

H/w If $\vec{A}$ making an angle α, β and γ with x-axis, y-axis & z-axis respectivity then find $\sin^2\alpha + \sin^2\beta + \sin^2\gamma = ??$

Soln

$$\sin^2\alpha + \sin^2\beta + \sin^2\gamma = 1 - \cos^2\alpha + 1 - \cos^2\beta + 1 - \cos^2\gamma$$

$$= 3 - [\cos^2\alpha + \cos^2\beta + \cos^2\gamma]$$

$$= 3 - 1 = 2$$

$\vec{A} = 10\hat{i} + 10\hat{j}$ find Angle B/w $\vec{A}$ & x-axis ??

Soln

$$\cos\alpha = \frac{A_x}{A} = \frac{10}{\sqrt{10^2+10^2}} = \frac{10}{10\sqrt{2}} = \frac{1}{\sqrt{2}}$$

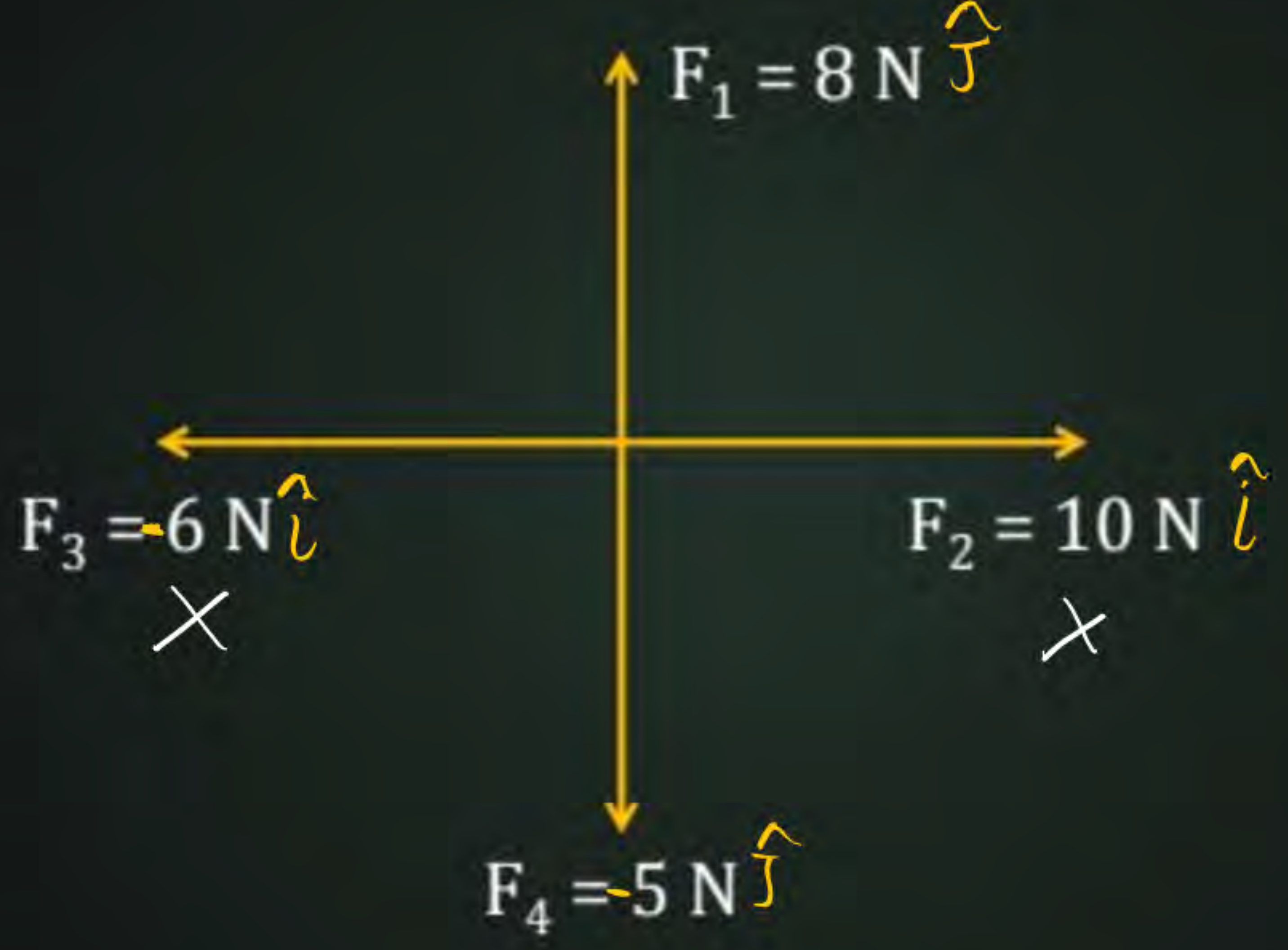
$$\cos\alpha = \frac{1}{\sqrt{2}}$$

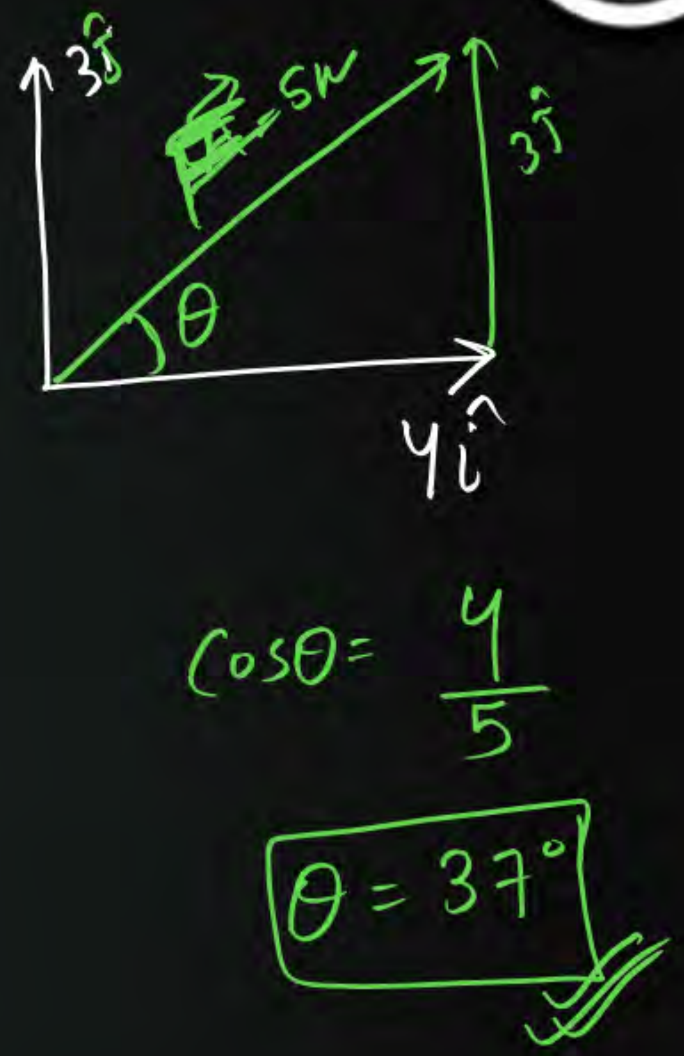
$$\alpha = 45^\circ$$

Ans

QUESTION

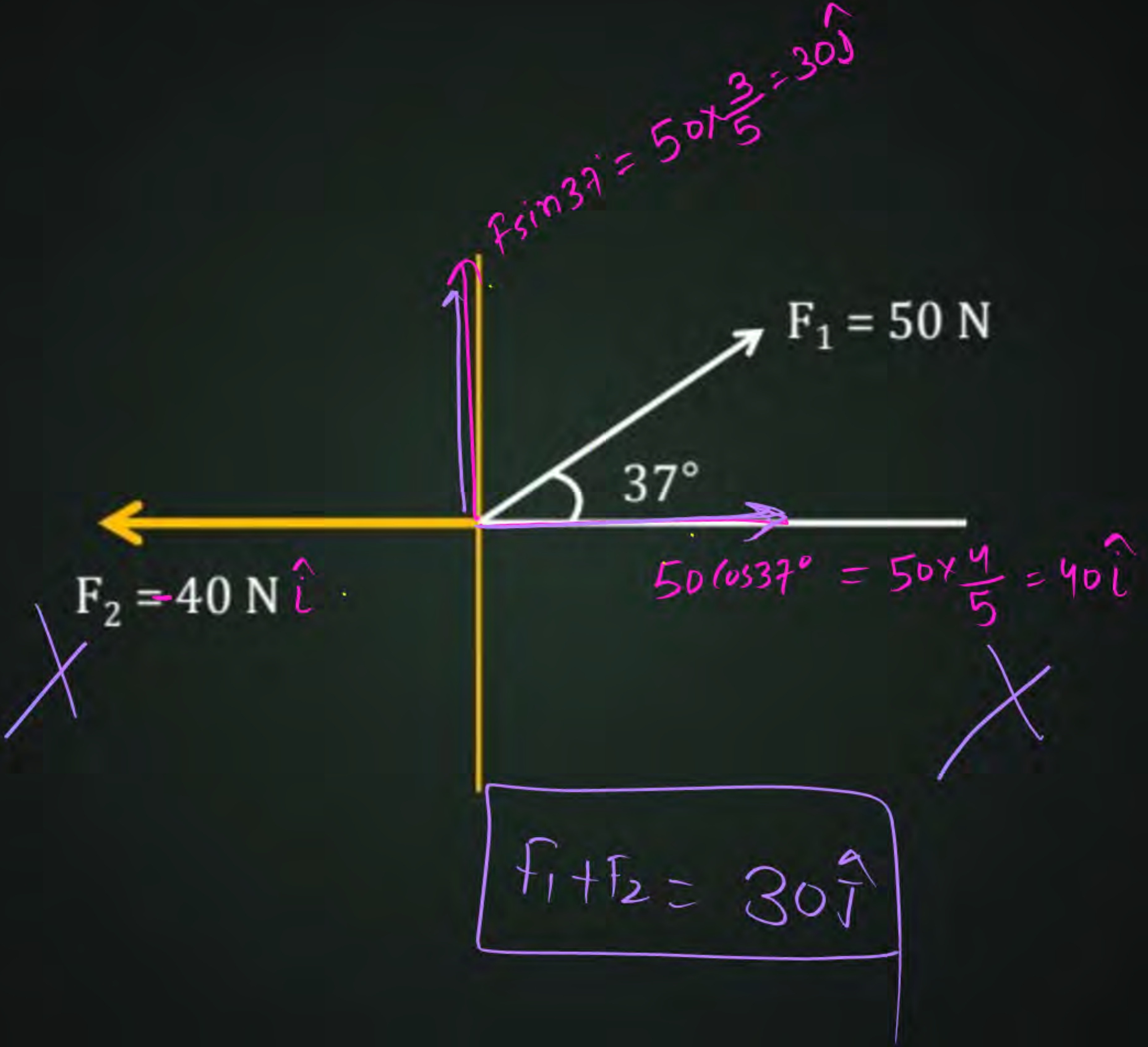
Find $\overrightarrow{F_1} + \overrightarrow{F_2} + \overrightarrow{F_3} + \overrightarrow{F_4} = ?$



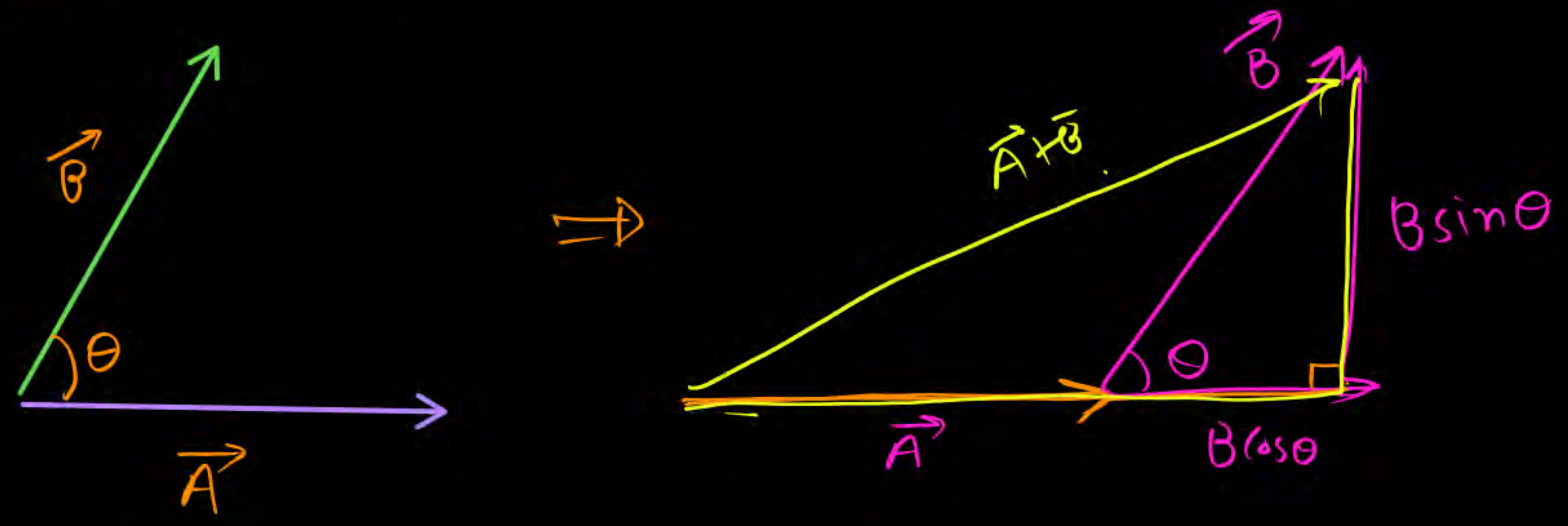


QUESTION

Find $\overrightarrow{F_1} + \overrightarrow{F_2} = ?$



Triangle law of vector addition → Addtion of Two vector



Next Class


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 02 | Physics

VECTORS

By- Dr. Manish Raj (MR SIR)



Topics to be covered

1. # Questions
2. finding of unit vector
3. # Triangle law of vector addition
4. [redacted]

$$\vec{A} = A_x\hat{i} + A_y\hat{j} + A_z\hat{k}$$

$\cos\alpha = \frac{A_x}{A}$

$\cos\beta = \frac{A_y}{A}$

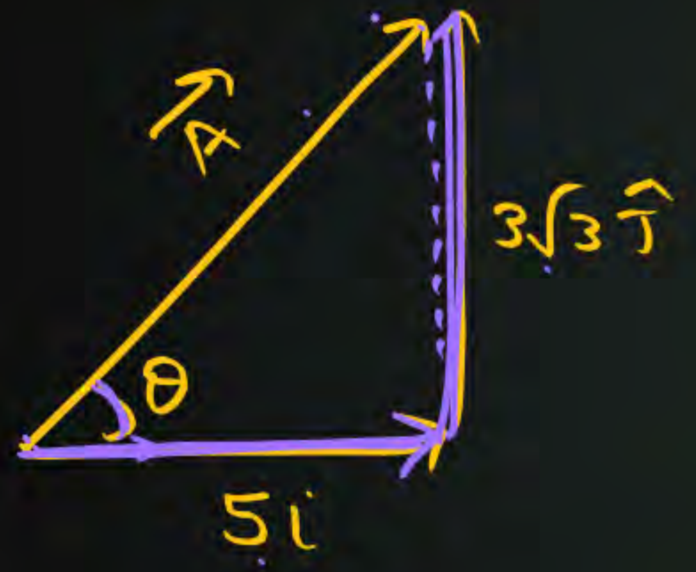
$$\cos^2\alpha + \cos^2\beta + \cos^2\gamma = 1$$



QUESTION

Vector $\vec{A} = 5\hat{\imath} + 5\sqrt{3}\hat{\jmath}$ then find angle of vector $\vec{A}$ from x-axis.

$$\cos\theta = \frac{A_x}{A}$$

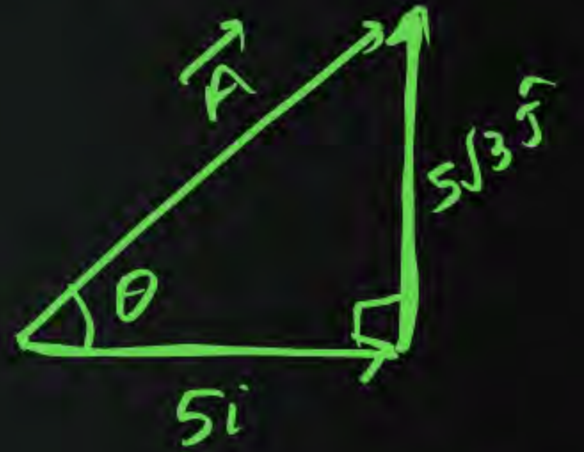


$$\cos\theta = \frac{5}{\sqrt{5^2+(5\sqrt{3})^2}} = \frac{5}{\sqrt{25+25\times 3}} = \frac{5}{\sqrt{100}} = \frac{5}{10} = \frac{1}{2}$$

$$\theta = 60^\circ$$

MR feel

$$\vec{A} = 5i + 5\sqrt{3}\hat{j}$$



$$\tan\theta = \frac{5\sqrt{3}}{5} = \sqrt{3}$$

$$\theta = 60^\circ$$ Ans

QUESTION

The angles which a vector $\hat{i} + \hat{j} + \sqrt{2}\,\hat{k}$ makes with X, Y and Z axes respectively are

(1) $60°, 60°, 60°$

(2) $45°, 45°, 45°$

(3) $60°, 60°, 45°$

(4) $45°, 45°, 60°$

Same ques.

QUESTION

Force $\vec{F} = \sqrt{2}\hat{i} + \hat{j} + \hat{k}$ then, angle made by this force from x-axis, y-axis and z-axis.

$|\vec{F}| = \sqrt{(\sqrt{2})^2 + (1)^2 + (1)^2}$

$= \sqrt{2+1+1} = \sqrt{4} = 2$

$\cos\alpha = \frac{\sqrt{2}}{2\sqrt{2}}$

$\cos\alpha = \frac{1}{\sqrt{2}}$

$\alpha = 45^\circ$ ✓

$\cos\beta = \frac{A_y}{A} = \frac{1}{2}$

$\beta = 60^\circ$ ✓

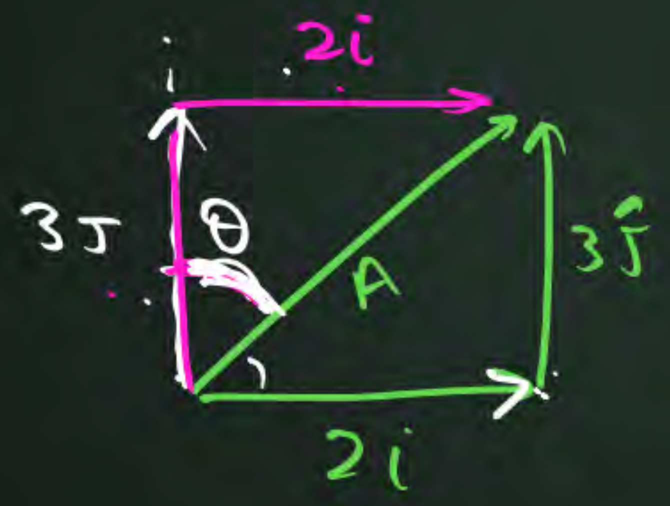
$\cos\gamma = \frac{1}{2}$

$\gamma = 60^\circ$ ✓

QUESTION

Given $\vec{A} = 2\hat{i} + 3\hat{j}$, the angle between $\vec{A}$ and Y-axis is

1. $\sin^{-1}\frac{2}{3}$
2. $\cos^{-1}\frac{2}{3}$
3. $\tan^{-1}\frac{2}{3}$
4. $\tan^{-1}\frac{3}{2}$



$\tan\theta = \frac{2}{3}$

$\theta = \tan^{-1}(2/3)$

Y-axis

$\cos\theta = \frac{A_y}{A} = \frac{3}{\sqrt{13}} = \frac{B}{H}$

by solving $P = 2$

$\tan\theta = \frac{P}{B} = \frac{2}{3}$

Adding of two vector in terms of its component

$\vec{A} = A_x\hat{i} + A_y\hat{j}$

$\vec{B} = B_x\hat{i} + B_y\hat{j}$

$$\vec{A}+\vec{B} = (A_x+B_x)\hat{i} + (A_y+B_y)\hat{j}$$

Ex $\vec{A} = 2\hat{i}+3\hat{j}$

$\vec{B} = 6i+2\hat{j}$

$\vec{A}+\vec{B} = 8i+5\hat{j}$

Ex $\vec{A} = 3i-4\hat{j}$

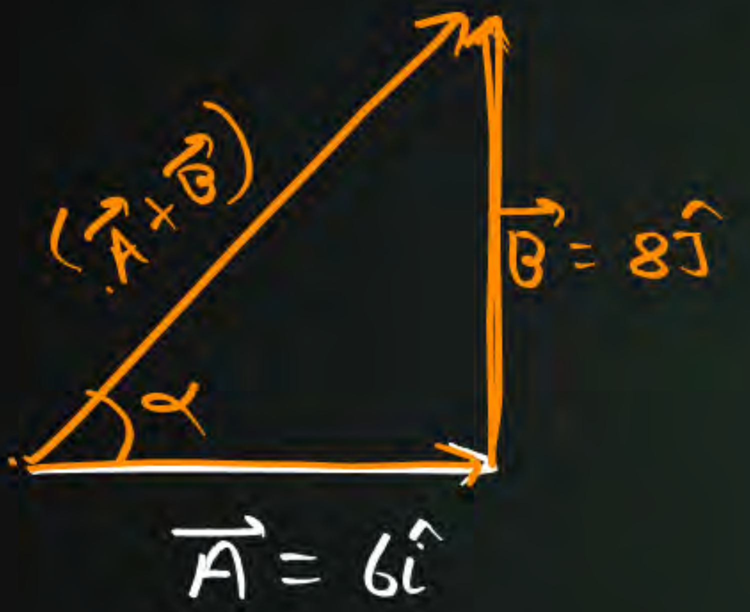
$\vec{B} = -4i+3\hat{j}$

$\vec{A}+\vec{B} = (3i-4i) - 4\hat{j} + 3\hat{j}$

$= (-\hat{i} - \hat{j})$

QUESTION

Two vector $\vec{A} = 6\hat{i}$ and $\vec{B} = 8\hat{j}$ then find $\vec{A} + \vec{B}$, direction of $\vec{A} + \vec{B}$ from $\vec{A}$.



$$\cos 37^\circ = \frac{4}{5}$$
$$\cos 53^\circ = \frac{3}{5}$$

$$(\vec{A} + \vec{B}) = 6\hat{i} + 8\hat{j}$$

$$\cos\alpha = \frac{6}{\sqrt{6^2+8^2}} = \frac{6}{\sqrt{36+64}} = \frac{6}{10} = \frac{3}{5}$$

$$\alpha = 53^\circ$$

finding of unit vector

$\vec{A} = \hat{i} + \hat{j}$ ← This is not a unit vector

$|\vec{A}| = \sqrt{1^2 + 1^2} = \sqrt{2}$

find Unit vector.

$\hat{A} = \frac{\vec{A}}{|\vec{A}|} = \left(\frac{\hat{i} + \hat{j}}{\sqrt{2}}\right)$

Unit vector of x-axis $(\hat{i})$
" " " y-axis $(\hat{j})$
" " " z-axis $(\hat{k})$

$\vec{A} = A\hat{A}$ ← unit vector

$\hat{A} = \frac{\vec{A}}{A}$

↑ Unit vector (Magnitude 1)

QUESTION

If $\vec{A} = 0.6\hat{\imath} + \beta\,\hat{\jmath}$ is a unit vector then, find value of ‘β’?

1. 0.4
2. 0.8 (56%)
3. 0.6
4. 0.7

$(0.6)^2 = \left(\frac{6}{10}\right)^2 = \frac{36}{100} = 0.36$

$|\vec{A}| = \sqrt{(0.6)^2 + \beta^2} = 1$

$0.36 + \beta^2 = 1^2$

$\beta^2 = 1 - 0.36 = .64$

$\beta = \sqrt{0.64} = \sqrt{\frac{64}{100}} = \frac{8}{10} = 0.8$

$\sqrt{0.64} = \sqrt{\frac{64}{100}} = \frac{8}{10} = 0.8$

$(0.6)^2 = \left(\frac{6}{10}\right)^2 = \frac{36}{100} = 0.36$

QUESTION

Find value of β if $\vec{A}$ is *a* unit vector $\vec{A} = 0.4\hat{\imath} + 0.3\hat{\jmath} + \beta\hat{k}$.

$0.46 = \frac{46}{100}$

$\vec{A} = 0.4\hat{i} + 0.3\hat{j} + \beta\hat{k}$

Soln

$|\vec{A}| = 1$

$\sqrt{(0.4)^2 + (0.3)^2 + \beta^2} = 1$

$0.16 + 0.09 + \beta^2 = 1$

$\beta^2 = 1 - 0.25$

$\beta = \sqrt{0.75}$

$(0.4)^2 = \left(\frac{4}{10}\right)^2 = \frac{16}{100} = 0.16$

$(0.3)^2 = \left(\frac{3}{10}\right)^2 = \frac{9}{100} = 0.09$

Soln $|\vec{A}| = 1$

$0.4 + 0.3 + \beta = 1$

$0.7 + \beta = 1$

$\beta = 1 - 0.7$

$\beta = 0.3$

QUESTION

If $\vec{A} = 2\hat{i} + \hat{j} + 2\hat{k}$ and $\vec{B} = \hat{i} + \hat{j} + 2\hat{k}$ then find vector $\vec{C}$ magnitude same as $\vec{A}$ and direction along $\vec{B}$.

$|\vec{C}| = |\vec{A}|$
$\hat{C} = \hat{B}$

cond^n given in question

$|\vec{A}| = \sqrt{4+1+4} = \sqrt{9} = 3$

$|\vec{B}| = \sqrt{1^2+1^2+2^2} = \sqrt{6}$

$\vec{C} = C\hat{C}$

$\vec{C} = |\vec{A}|\hat{B}$

$= |\vec{A}| \dfrac{\vec{B}}{|\vec{B}|}$

$= \dfrac{3}{\sqrt{6}}(\hat{i} + \hat{j} + 2\hat{k})$

QUESTION

Three forces given by vectors $2\hat{\imath} + 2\hat{\jmath}$; $+2\hat{\imath} - 2\hat{\jmath}$ and $-4\hat{\imath}$ are acting together on a point object at rest. The object moves along the direction

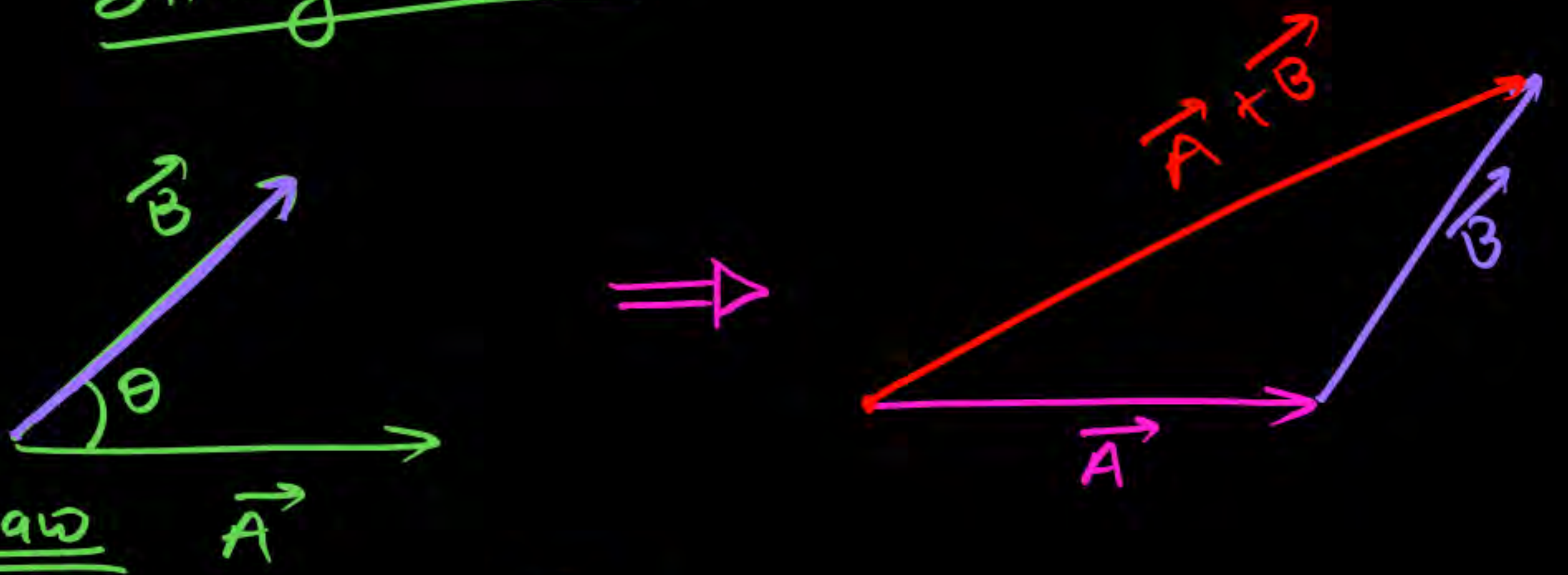
(NEET)

1. x-axis
2. y-axis
3. z-axis
4. Object does not move

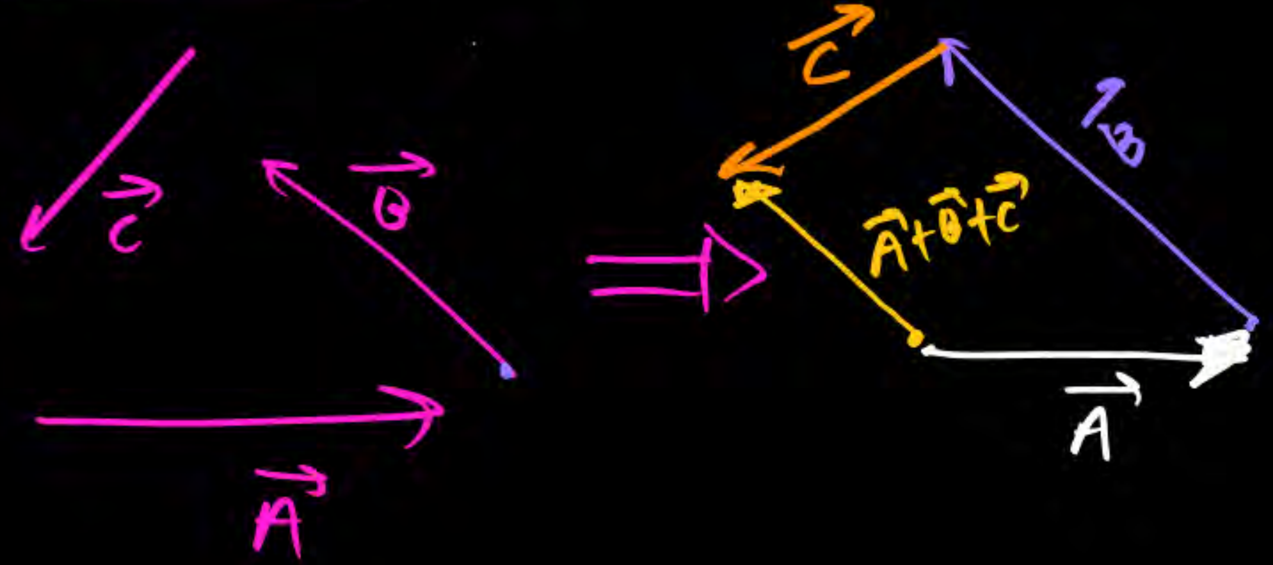
$F_1 + F_2 + F_3 = 2i + 2j + 2i - 2j - 4\hat{i}$

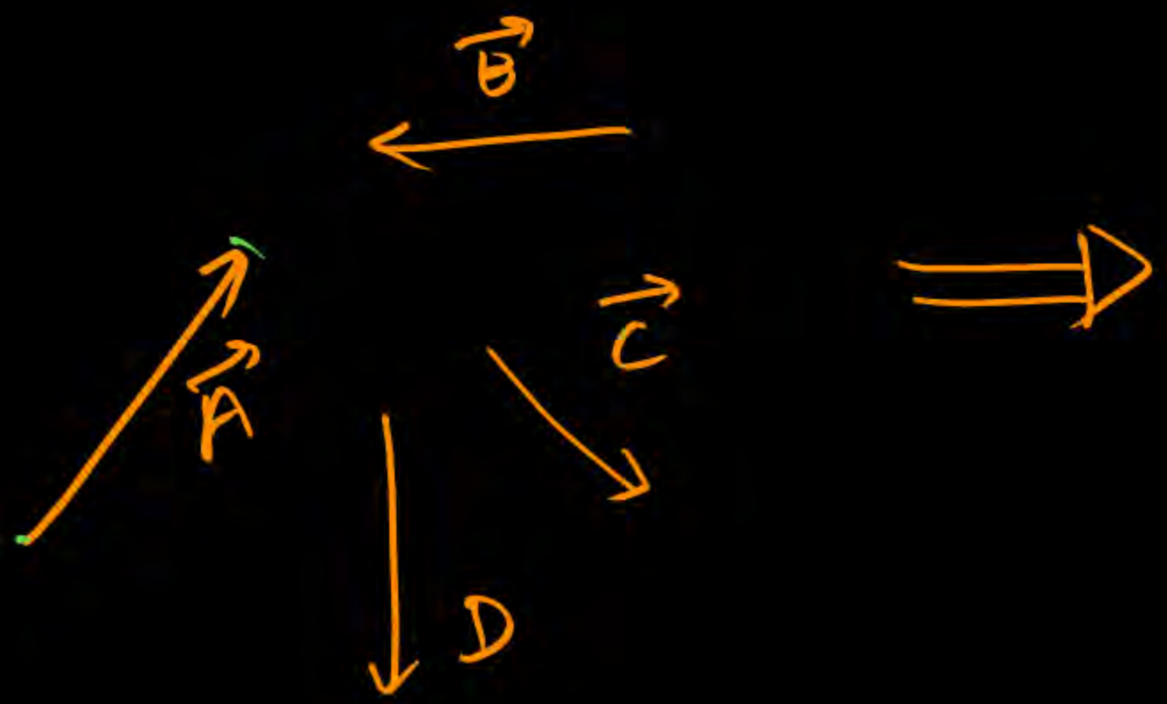
$= 4i - 4i = 0$

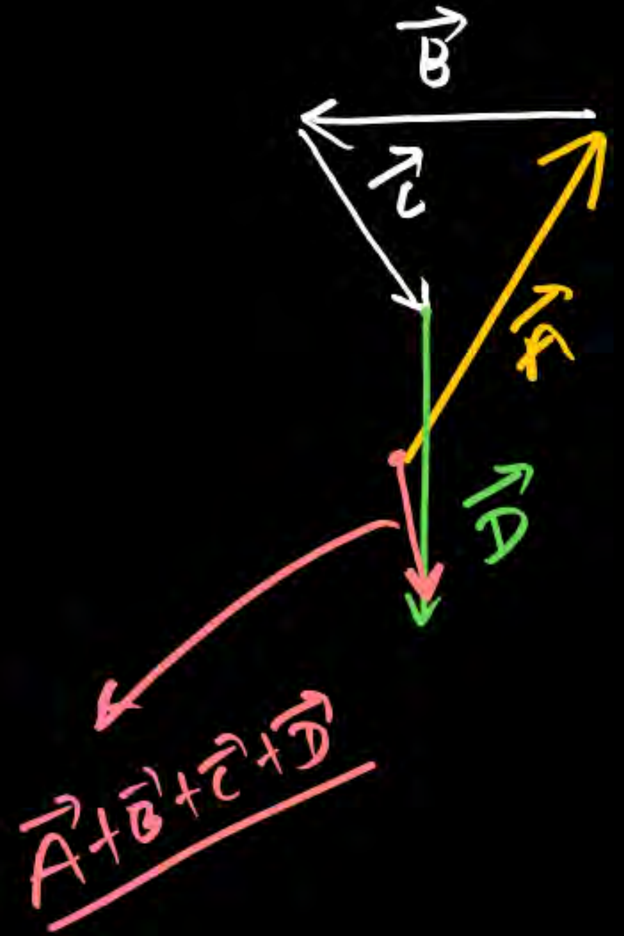
Sitting concept



Polygon law

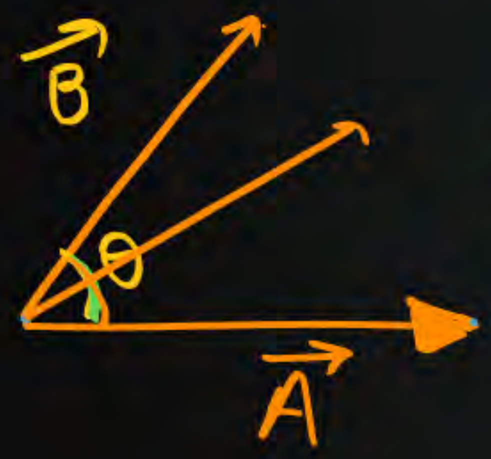



B
A
C
D

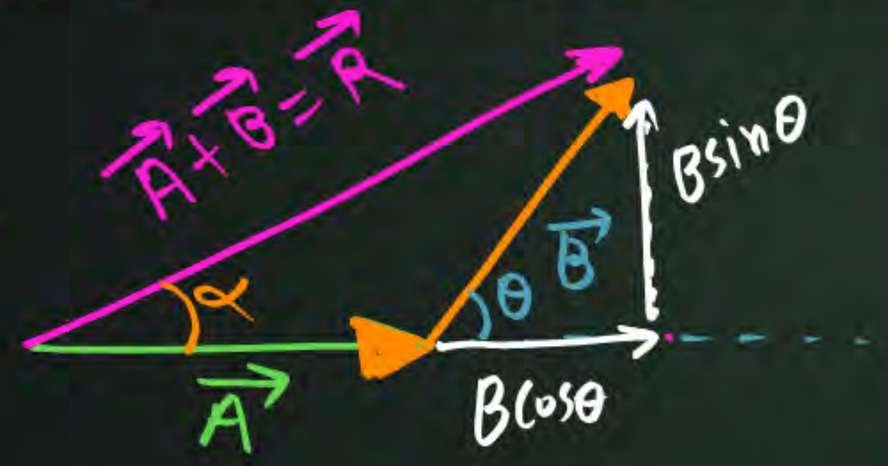

B
C
A
D
A+B+C+D

TRIANGLE LAW OF VECTOR ADDITION

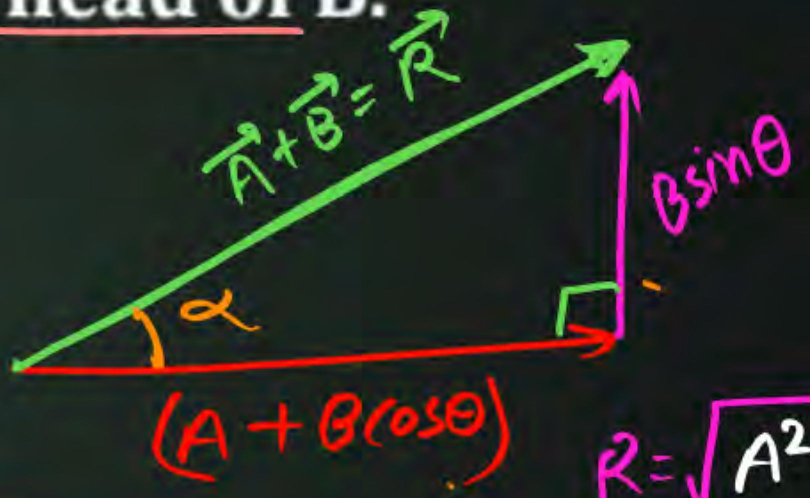
To add two vector $\vec{A}$ and $\vec{B}$ shift any of two such that tail of $\vec{B}$ at the head of $\vec{A}$ then sum of $\vec{A}$ and $\vec{B}$ is $\vec{R}$. Which is from tail of A to head of $\vec{B}$.



⇒



⇒



$$R = \sqrt{(A + B\cos\theta)^2 + (B\sin\theta)^2}$$

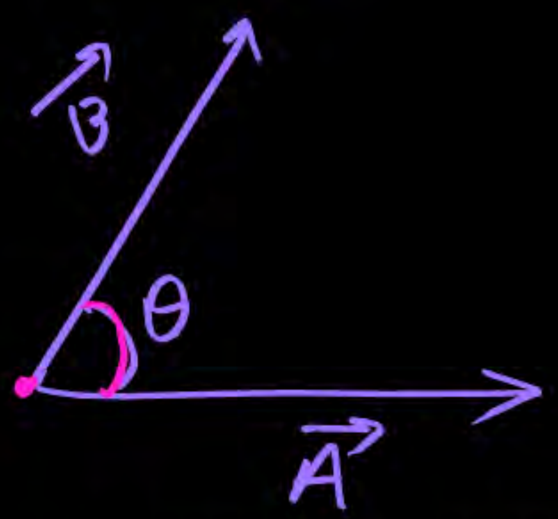
$$R = \sqrt{A^2 + 2AB\cos\theta + (B\cos\theta)^2 + (B\sin\theta)^2}$$

$$R = \sqrt{A^2 + 2AB\cos\theta + B^2(\cos^2\theta + \sin^2\theta)}$$

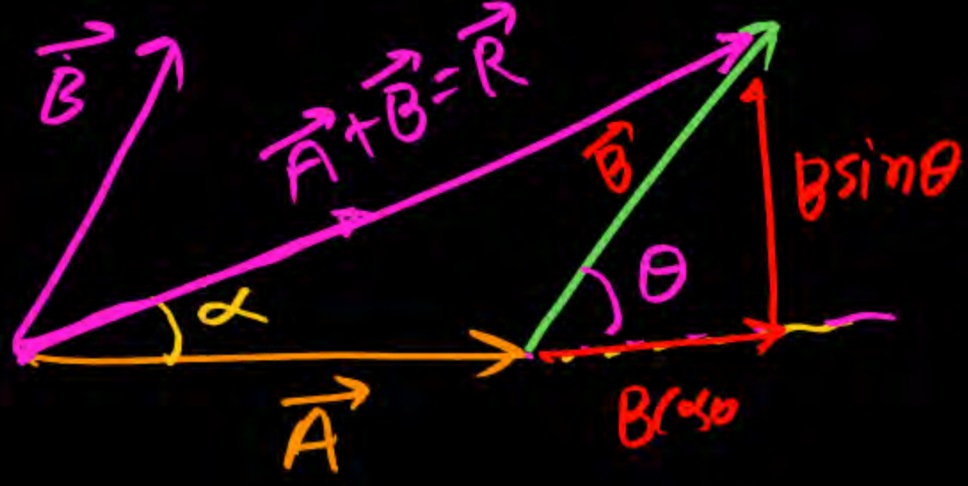
$$R = \sqrt{A^2 + B^2 + 2AB\cos\theta}$$

$$\Rightarrow \tan\alpha = \frac{B\sin\theta}{A + B\cos\theta}$$

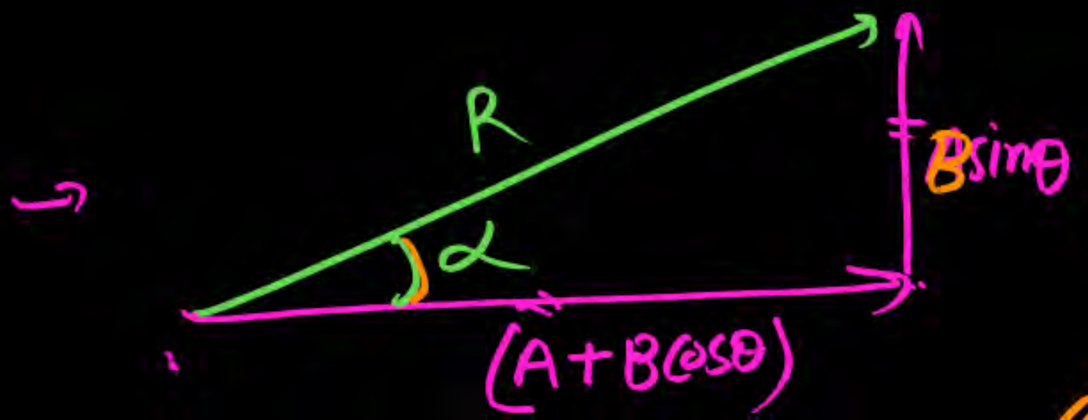
$$R = \sqrt{A^2 + B^2 + 2AB\cos\theta}$$



⇒



→

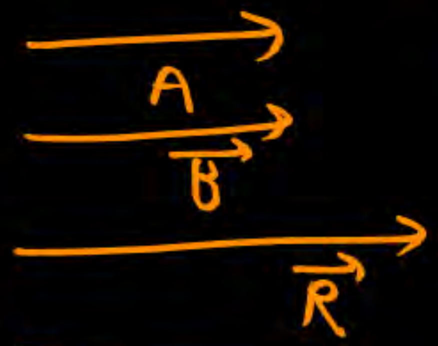


$$\tan\alpha = \frac{B\sin\theta}{A+B\cos\theta}$$

↳ Angle b/w $\vec{R}$ & $\vec{A}$

$$R = \sqrt{A^2+B^2+2AB\cos\theta}$$

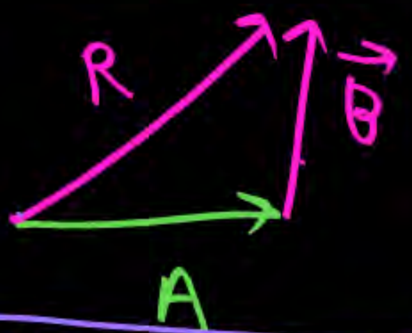
θ = 0°



$$R_{(max)} = A+B$$

θ = 90°

$R = \sqrt{A^2+B^2}$



$$R = \sqrt{A^2+B^2}$$

θ = 180°



$$R_{min} = A - B$$

$$R = \sqrt{A^2+B^2+2AB\cos 180} = \sqrt{A^2+B^2-2AB}$$

$$= \sqrt{(A-B)^2} = A-B = R_{min}$$

$$R = \sqrt{A^2+B^2+2AB\cos\theta}$$ ✓

↑ Magnitude of Resulu.

$$(A-B)^2 = (B-A)^2$$

QUESTION

Two vector of magnitude 3 and 4 acting at different angle

(i) 0°

(ii) 60°

(iii) 90°

(iv) 120°

(v) 180°

Then find resultant

$A - B \le R \le A + B$

Sol^n $\theta = 0°$

$|\vec{A}| = 3 \quad |\vec{B}| = 4$

(i) $R = \sqrt{3^2 + 4^2 + 2 \times 3 \times 4 \cos 0°}$

$R_{max} = \sqrt{9 + 16 + 24} = \sqrt{49} = 7$

(ii) $\theta = 60°$

$R = \sqrt{9 + 16 + 2 \times 3 \times 4 \cos 60}$

$= \sqrt{12 + 25} = \sqrt{37}$

$R \simeq 6.1$

(iii) $\theta = 90°$

$R = \sqrt{3^2 + 4^2 + 2 \times 3 \times 4 \cos 90°}$

$= \sqrt{9 + 16} = \sqrt{25} = 5$

(iv) $\theta = 120°$

$R = \sqrt{9 + 16 + 2 \times 3 \times 4 \cos(120°)}$

$= \sqrt{25 - 2 \times 12 \times \frac{1}{2}}$

$= \sqrt{13} \cong 3.5$

(v) $\theta = 180°$ $R = 3 - 4 = -1$

$R = 1$

QUESTION

PW

Two forces of magnitude 8 N and 15 N respectively act at a point. If the resultant forces is 17 N, the angle between the forces has to be

1. 60°
2. 45°
3. 90° ✓
4. 30°

$$R^2 = A^2 + B^2 + 2AB\cos\theta$$

$$(17)^2 = 8^2 + 15^2 + 2 \times 8 \times 15 \cos\theta$$

$$289 = (64) + (225) + 240\cos\theta$$

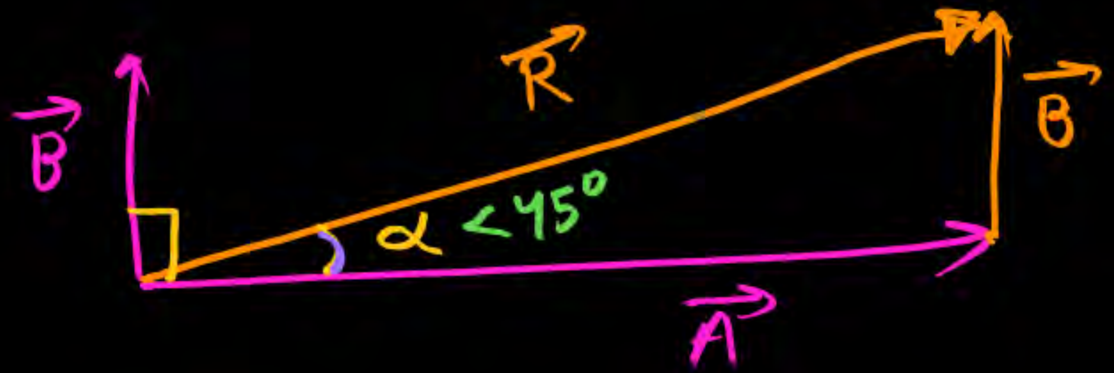
$$289 = 289 + 240\cos\theta$$

$$0 = 240\cos\theta$$

$$\cos\theta = 0$$

$$\theta = 90^\circ$$

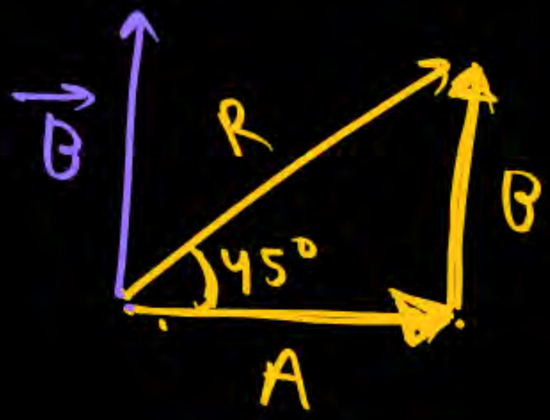
$$17 \times 17 = 119 + 170 = 289$$



$\vec{B}$
$\vec{R}$
$\alpha < 45°$
$\vec{B}$
$\vec{A}$



$\vec{B}$
$\vec{R}$
α
$> 45°$
$\vec{A}$



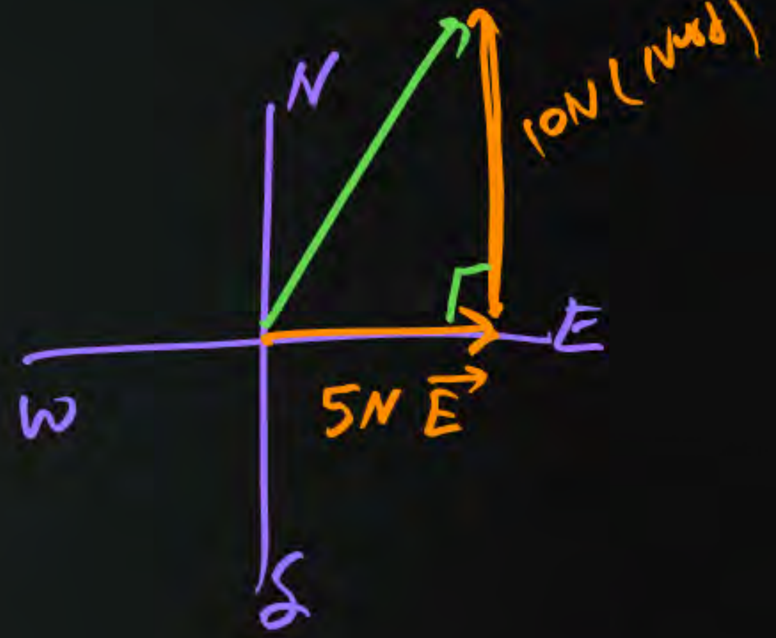
$\vec{B}$
R
B
45°
A

$|\vec{A}| = |\vec{B}|$

QUESTION

Two force $\vec{F}_1 = 5\text{N}$ due east and $F_2 = 10\text{ N}$ due north then resultant of these two force is

1. $5\sqrt{5}\text{ N}$
2. 15 N
3. 5 N
4. $\sqrt{5}\text{ N}$



$$R = \sqrt{5^2 + (10)^2}$$
$$= \sqrt{25 + 100} = \sqrt{125}$$
$$= \sqrt{25 \times 5}$$
$$= 5\sqrt{5}$$

If Two vector of (equal magnitude) acting at angle θ then its resultant will be ??

$$1 + \cos\theta = 2\cos^2 \theta/2$$

$|\vec{A}| = |\vec{B}| = A$

$$R = \sqrt{A^2 + A^2 + 2A \cdot A \cos\theta}$$

$$= \sqrt{2A^2 + 2A^2 \cos\theta}$$

$$= \sqrt{2A^2 [1 + \cos\theta]}$$

$$= \sqrt{2A^2 [2\cos^2 \theta/2]}$$

$$R = \sqrt{A^2 \times 4 \times \cos^2 \theta/2}$$

$$R = 2A\cos(\theta/2)$$

MR start

$\theta = 0°$

$R = 2A$



$\theta = 60$

$$R = 2A\cos\left(\frac{60}{2}\right) \quad (30)$$

$$= 2A \times \frac{\sqrt{3}}{2}$$

$$R = \sqrt{3}A$$

$\theta = 90°$

$$R = 2A\cos\left(\frac{90}{2}\right)$$

$$= 2A\frac{1}{\sqrt{2}}$$

$$R = \sqrt{2}A$$

$\theta = 120$

$$R = 2A\cos\left(\frac{120}{2}\right) \quad (60)$$

$$R = 2A \times \left(\frac{1}{2}\right)$$

$$R = A$$

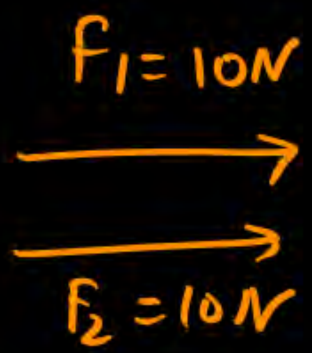
$\theta = 180°$

$R = 0$



$$R = 2A\cos(\theta/2)$$

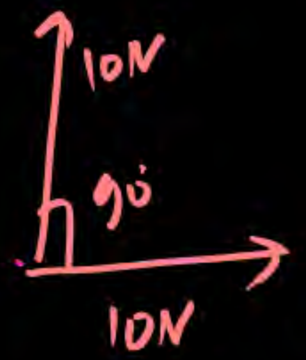
$\theta = 0°$	$\theta = 60°$	$\theta = 90$	$\theta = 120$	$\theta = 180°$
$R = 2A$	$R = \sqrt{3}A$	$R = \sqrt{2}A$	$R = A$	$R = 0$



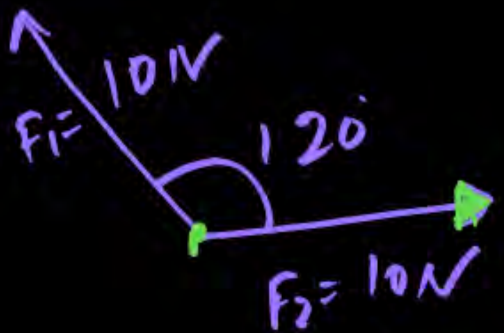
$F_{net} = 20$



$F_{net} = (\sqrt{3} \times 10)\,N$



$F = \sqrt{2}(10)\,N$



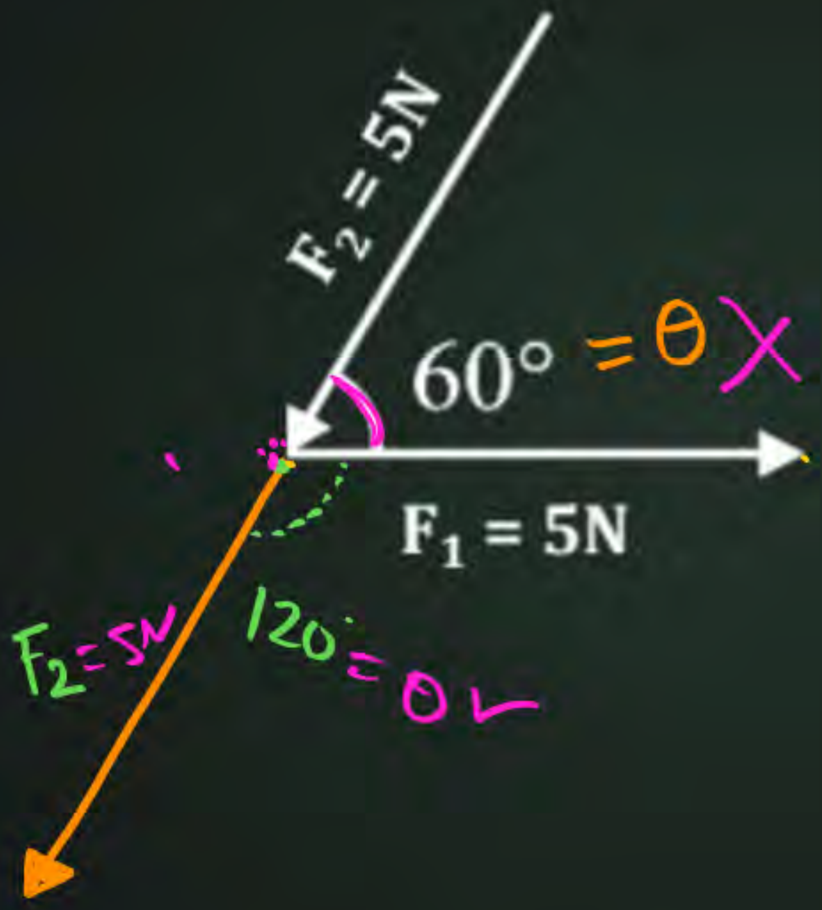
$F_{net} = 10N$



$F_{net} = 0$

QUESTION

Find net force $(\vec{F}_1 + \vec{F}_2.) = ??$



(a) 5 N (95 %) ✓

(b) $5\sqrt{3}$ N (50 %)

(c) $5\sqrt{2}$ N

(d) 0

QUESTION

Two forces of 10 N and 6 N act upon a body. The direction of the forces are unknown. The resultant forces on the body may be

1. 15 N
2. 3 N
3. 17 N
4. 2 N

$\alpha = (10+6) = 16N$

$\beta = 10-6 = 4N$


KoBoD

QUESTION

If $\vec{R} = \vec{A} + \vec{B}$ and $R = A + B$ then angle between $\vec{A}$ and $\vec{B}$ must be

1. 90°
2. 60°
3. 0°
4. 180°

Cond^n b/w A, B, R

$\vec{R} = \vec{A} + \vec{B}$

0°: $R = A + B$

90°: $R = \sqrt{A^2 + B^2}$

180°: $R = A - B$

QUESTION

If $\vec{R} = \vec{A} + \vec{B}$ and $R^2 = A^2 + B^2$ then angle between $\vec{A}$ and $\vec{B}$ may be

1. 90°
2. 60°
3. 120°
4. 80°

QUESTION

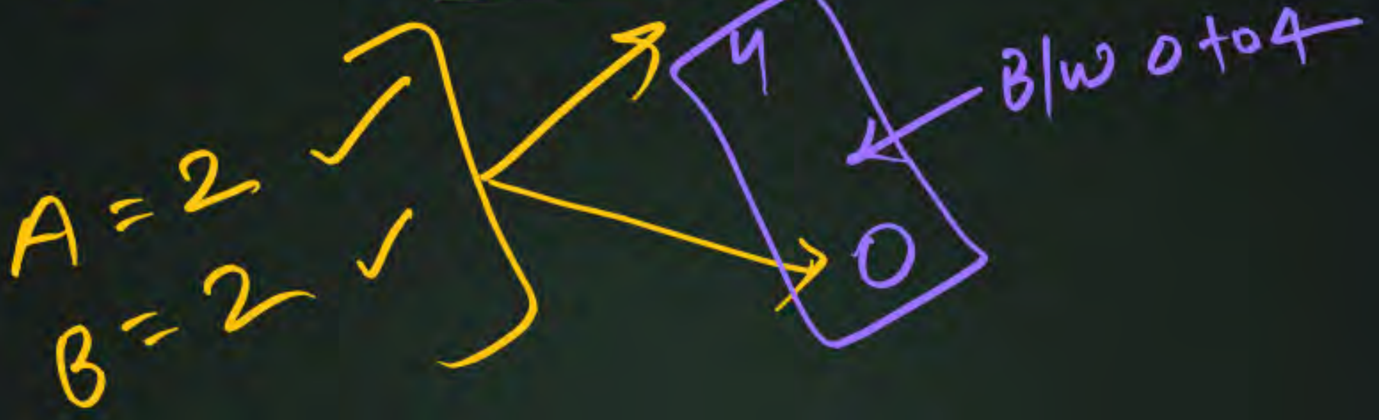
Two vector of magnitude 2 then resultant of these two vector may be ?

(1) 2

(2) 8

(3) 5

(4) 6




THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 03 | **Physics**

VECTORS



By- Dr. Manish Raj (MR SIR)

Topics to be covered

K.B.D....

1. KOIN BANEGA DR...... (25 question)
2. Vector subtraction
3. [redacted]
4. [redacted] 25

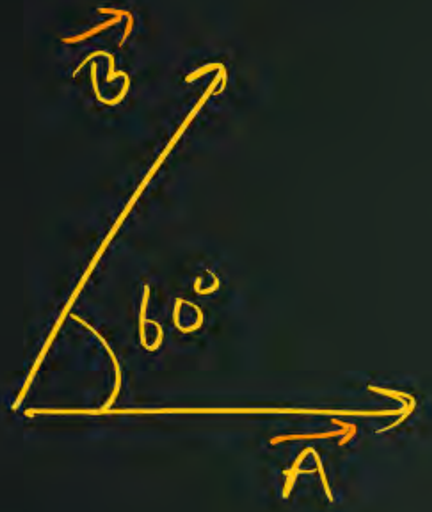


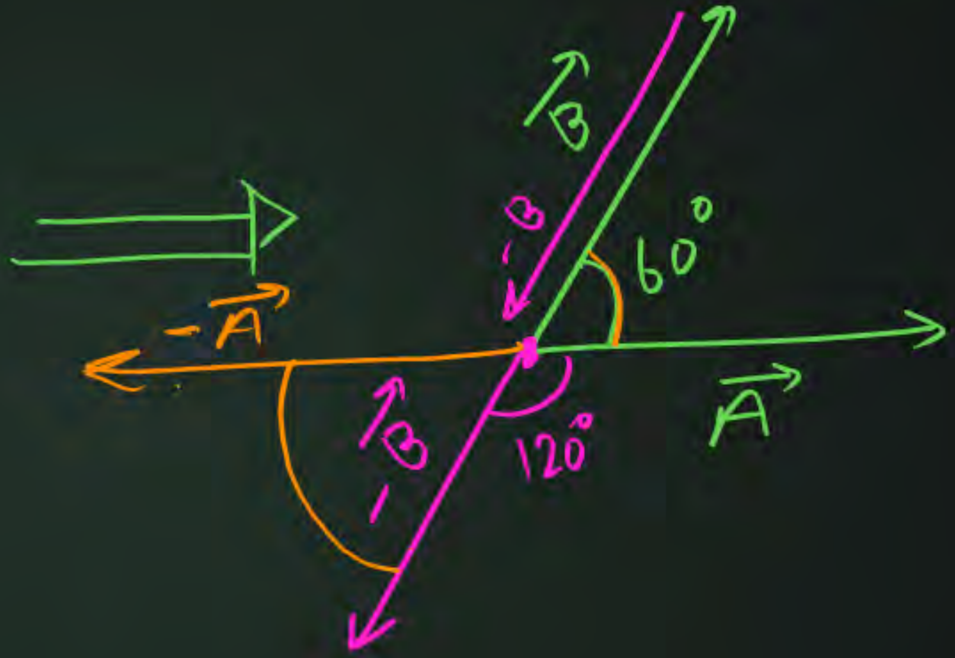
QUESTION



If angle between $\vec{A}$ and $\vec{B}$ is 60°, then find angle between $\vec{A}$ and $-\vec{B}$ & $-\vec{A}$ and $-\vec{B}$.

1. 30°, 60°
2. 120°, 30°
3. 120°, 60°
4. 120°, 120°





QUESTION

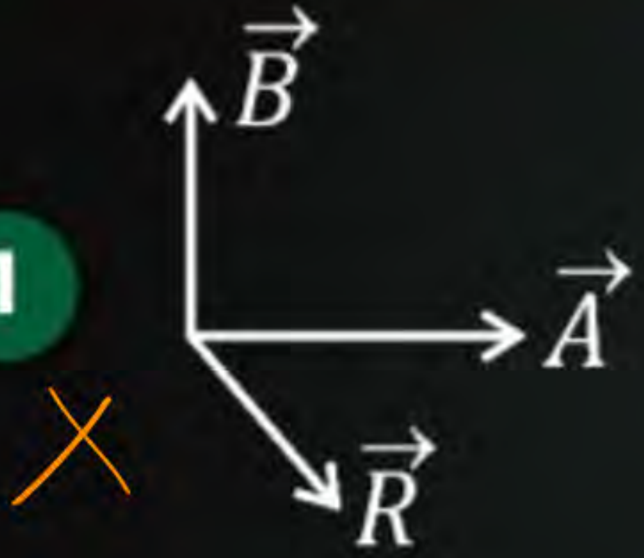
2. **Which of the following pair of vector can't give resultant of magnitude 4.**

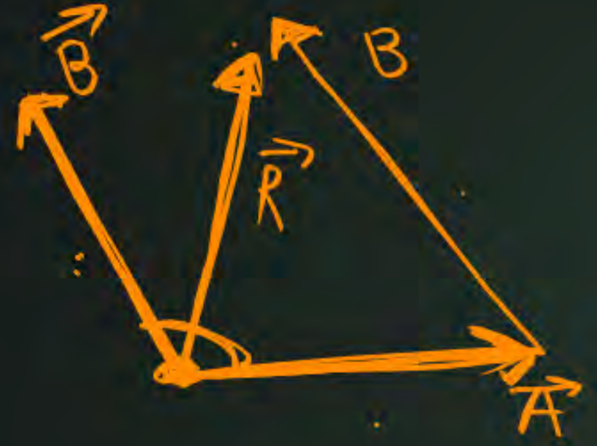
1. 2, 4 → $R_{max} = 6$, $R_{min} = 2$
2. 4, 4 → $R_{max} = 8$, $R_{min} = 0$
3. 4, 9 → $R_{min} = 5$, $R_{max} = 13$
4. 1, 5 → $R_{max} = 6$, $R_{min} = 4$

QUESTION

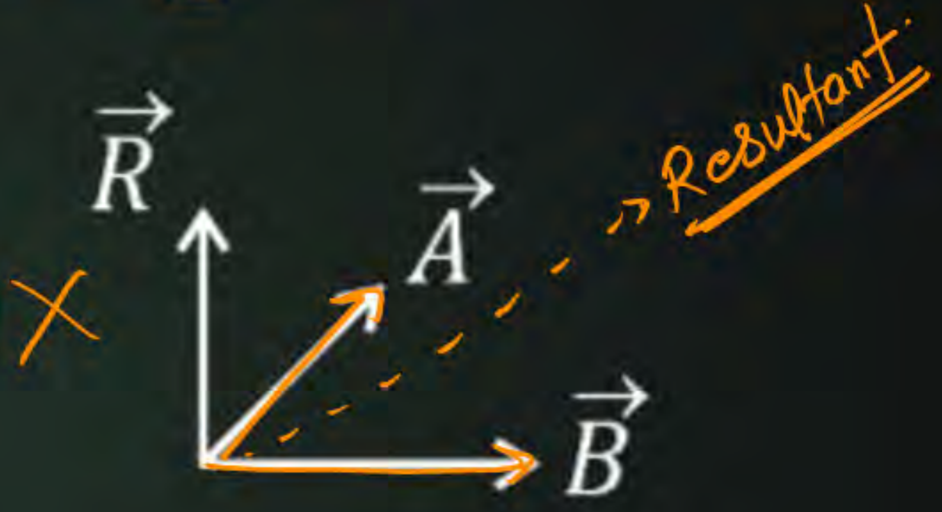
3 **Which of the following diagram is correct for $\vec{A} + \vec{B} = \vec{R}$**

1

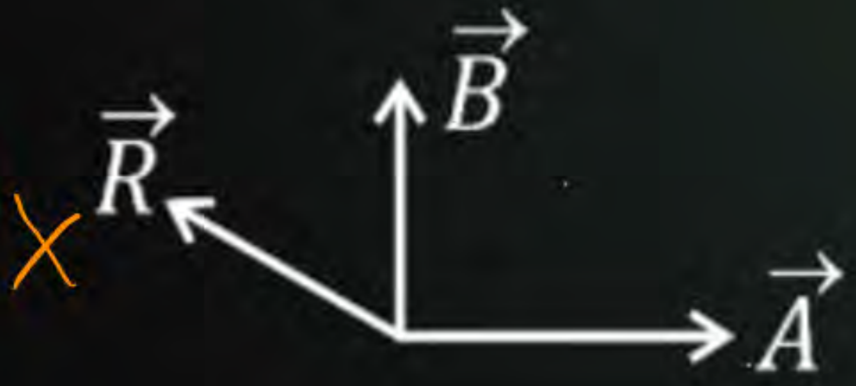




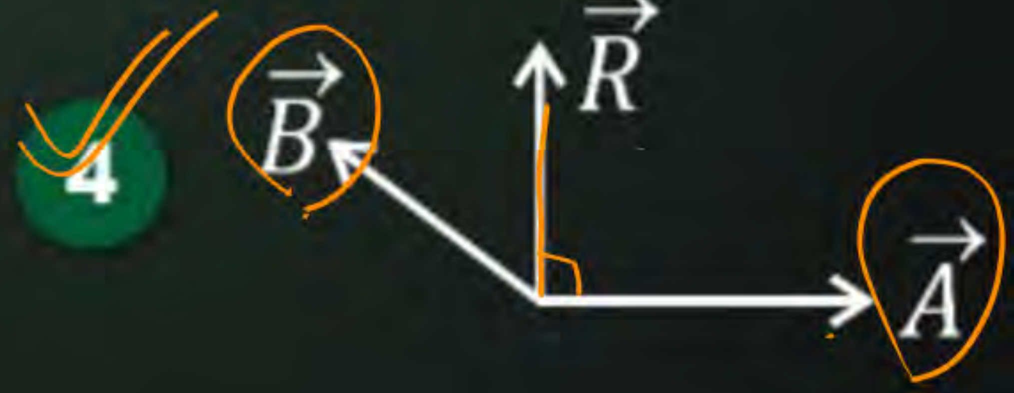
2



3



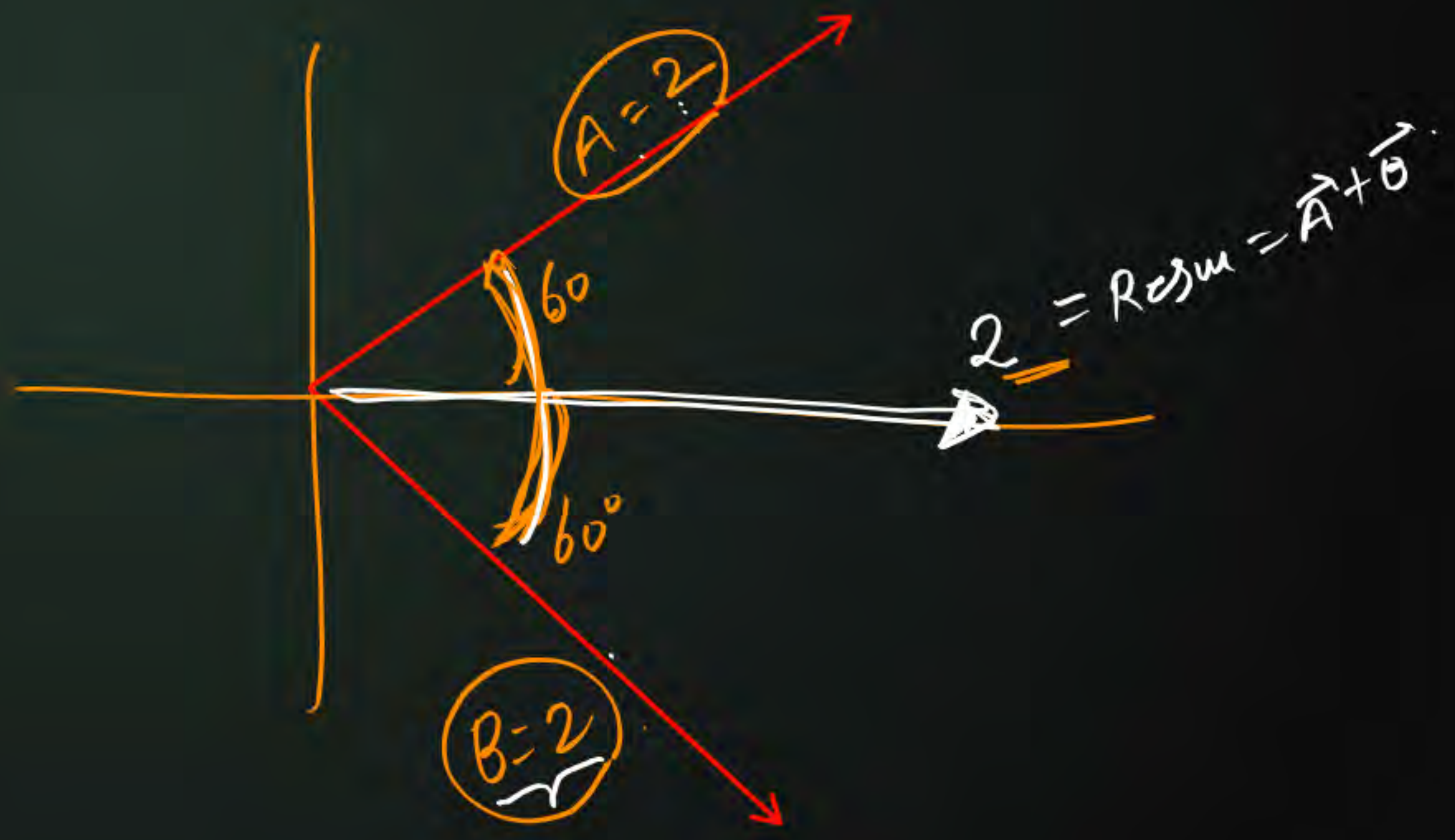
4



QUESTION

Vector $\vec{A}$ is 2 cm long and is 60° above the x-axis in the first quadrant. Vector $\vec{B}$ is 2 cm long and 60° below the x-axis in the fourth quadrant. The sum $\vec{A} + \vec{B}$ is a vector of magnitude

1. 2 along + y-axis
2. 2 along + x-axis
3. 1 along – x-axis
4. 2 along – x-axis



QUESTION

5 If vector sum of two unit vector is unit then angle between them is: ??

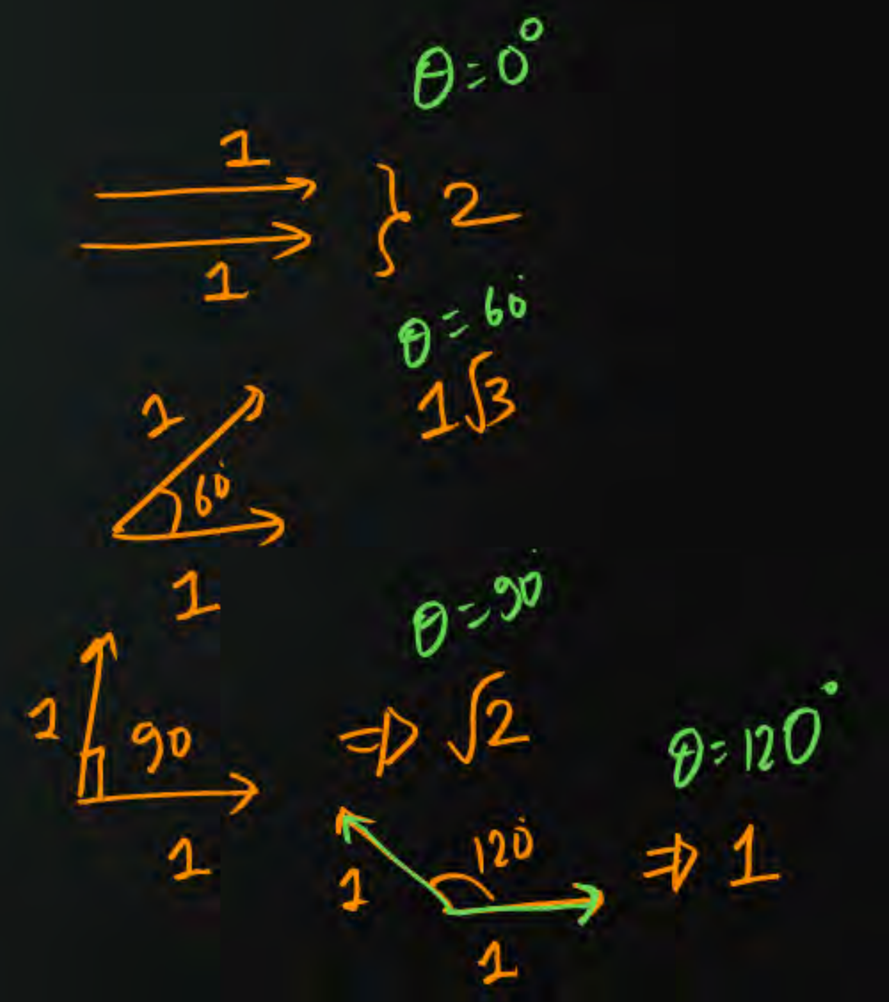
1. 90°
2. 60°
3. 120°
4. 0°

Magnitude = 1

$|\vec{A}| = 1$

$|\vec{B}| = 1$

$|\vec{A} + \vec{B}| = 1$



QUESTION

6. Which of the following is unit vector

1. $\sin\theta\,\hat{\imath} - \cos\theta\,\hat{\jmath}$ → $\sqrt{(\sin\theta)^2 + (-\cos\theta)^2}$ $= \sqrt{\sin^2\theta + \cos^2\theta} = 1$

2. $\frac{1}{\sqrt{2}}\hat{\imath} + \frac{1}{\sqrt{2}}\hat{\jmath}$ → $\sqrt{\left(\frac{1}{\sqrt{2}}\right)^2 + \left(\frac{1}{\sqrt{2}}\right)^2}$ $= \sqrt{\frac{1}{2} + \frac{1}{2}}$ $= \sqrt{1} = 1$

3. $\hat{\imath} - \hat{\jmath}$ → $\sqrt{(1)^2 + (-1)^2}$ $= \sqrt{2}$

4. Both (1) and (2) ✓

QUESTION

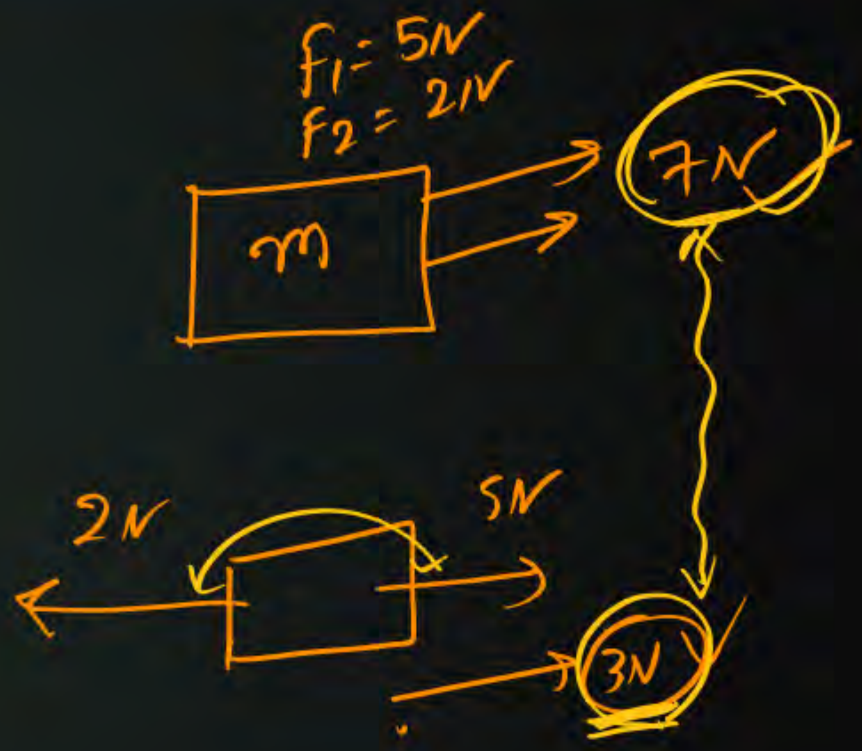
7. Two force 5N and 2N acting on the object then net force on object must not be

(1) 2 N

(2) 1 N

(3) 6 N

(4) both (1) & (2)



QUESTION

8. Two vector of magnitude is same A and resultant of these two vector is also A then angle between these two vector must be

1. 45°
2. 90°
3. 120°
4. 180°

does not write

QUESTION

9. The ratio of maximum and minimum magnitudes of the resultant of two vectors $\vec{a}$ and $\vec{b}$ is 3 : 1 Now, $|\vec{a}\,|$ is equal to :

1. $|\vec{b}|$
2. $2|\vec{b}|$
3. $3|\vec{b}|$
4. $4|\vec{b}|$

$$\frac{a+b}{a-b} = \frac{3}{1}$$

$$a+b = 3a-3b$$

$$4b = 2a$$

$$a = 2b$$

QUESTION

10 At what angle should the two forces 2P and $\sqrt{2}$P act so that the resultant force is P$\sqrt{10}$?

1. 45°
2. 60°
3. 90°
4. 120°

$R^2 = a^2 + b^2 + 2ab\cos\theta$

$10P^2 = 4P^2 + 2P^2 + 2 \times 2P\sqrt{2}P\cos\theta$

$10 - 6 = 4\sqrt{2}\cos\theta$

$4 = 4\sqrt{2}\cos\theta$

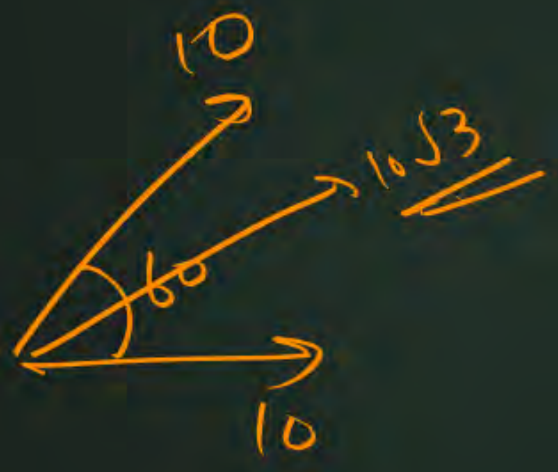
$\cos\theta = \frac{1}{\sqrt{2}}$

$\theta = 45°$

QUESTION

11. Two vector of magnitude equal to each other and 10 then resultant of these two vector at 60° is

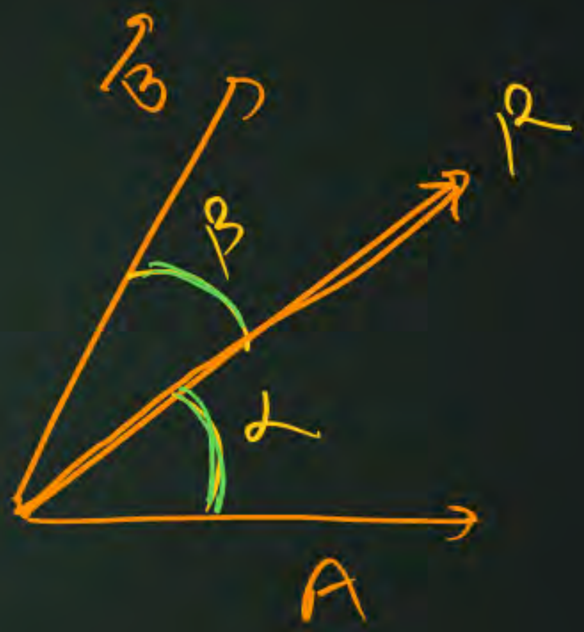
1. $10\sqrt{3}$
2. 10
3. 0
4. 20



QUESTION

12. The resultant of $\vec{A}$ and $\vec{B}$ makes an angle α with $\vec{A}$ and β with $\vec{B}$ then correction option is

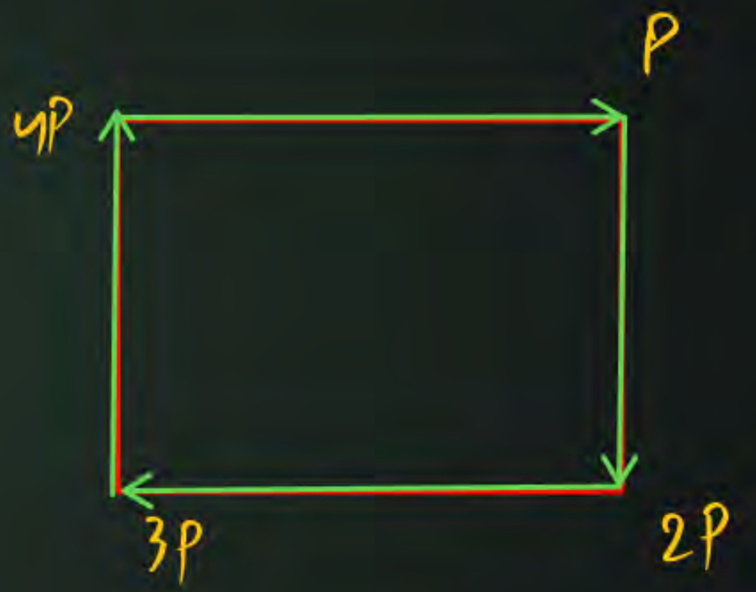
1. $\alpha > \beta$
2. $\beta < \alpha$
3. $\alpha < \beta$ if $A > B$
4. $\alpha = \beta$

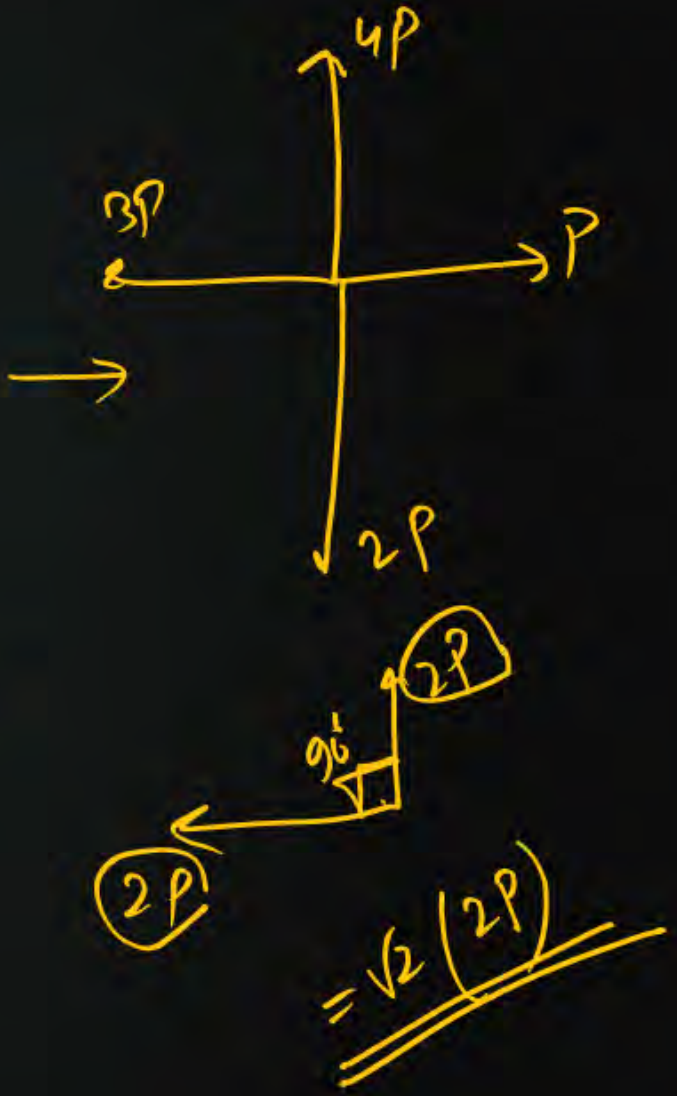


QUESTION

13. Four forces of magnitude P, 2P, 3P and 4P act along the four sides of a square ABCD in cyclic order. Find the resultant force :

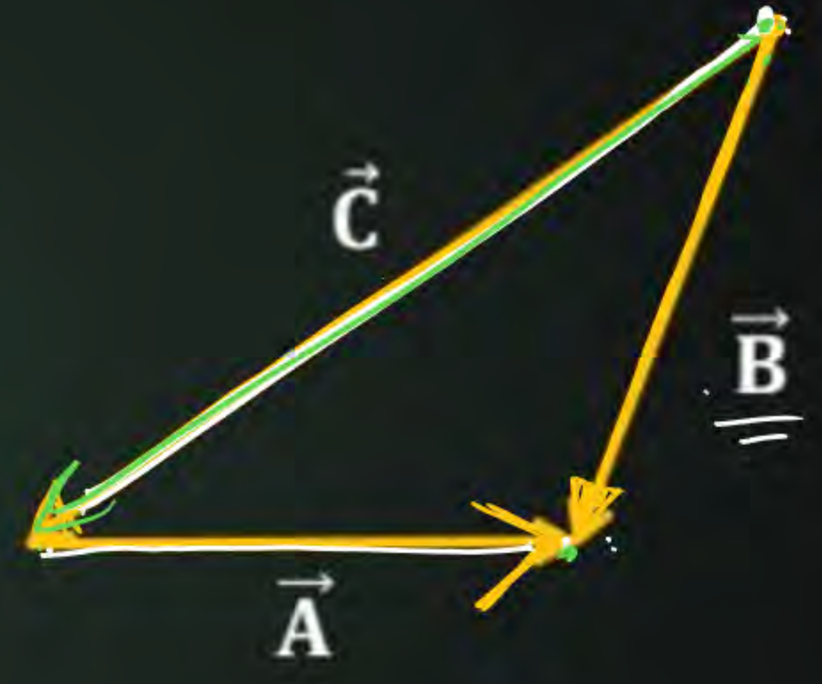
1. 2P
2. $3\sqrt{2}$ P
3. 0
4. $2\sqrt{2}$ P



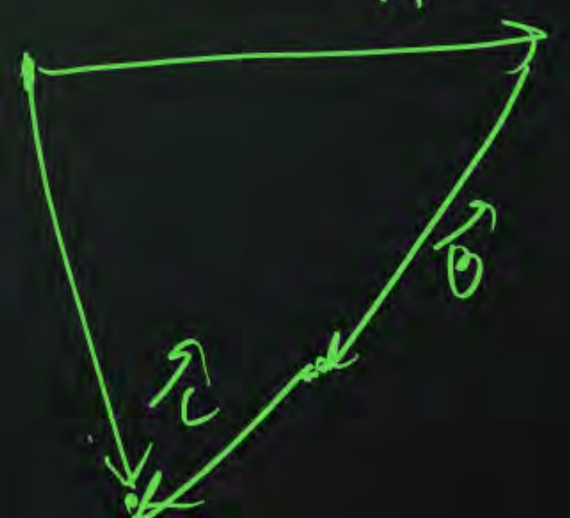


QUESTION

14. For the figure, $\vec{A}$, $\vec{B}$ and $\vec{C}$,



1. $\vec{A} + \vec{B} = \vec{C}$
2. $\vec{B} + \vec{C} = \vec{A}$
3. $\vec{C} + \vec{A} = \vec{B}$
4. $\vec{A} + \vec{B} + \vec{C} = 0$



QUESTION

(Anticlokwise)

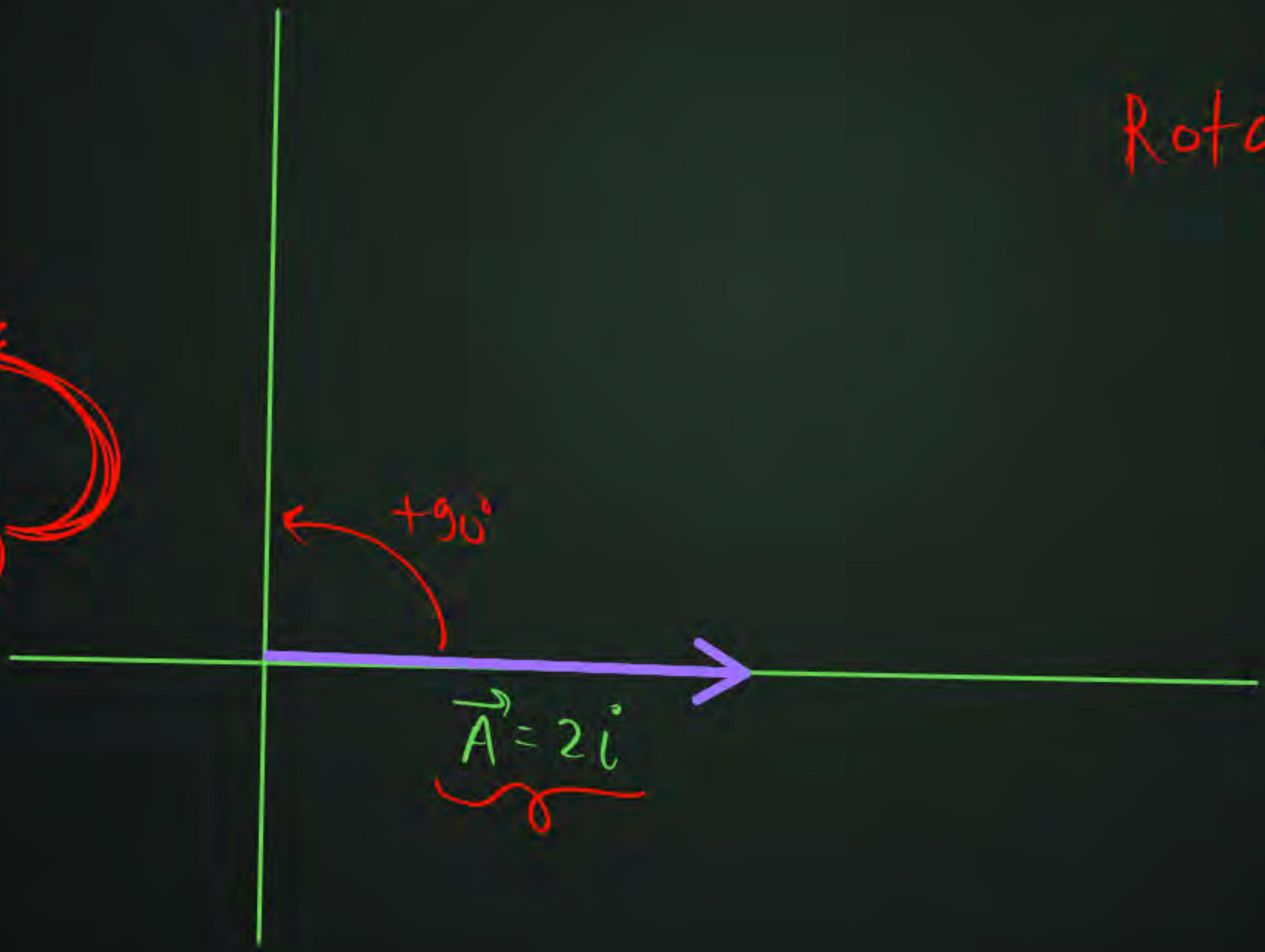
15. A vector $\vec{A} = 2i$ rotated by 90° then new vector becomes.

(a) $2\hat{i}$

(b) $2i + 2\hat{j}$

(c) $2\hat{j}$ (80%)

(d) $\sqrt{2}i + \sqrt{2}\hat{j}$

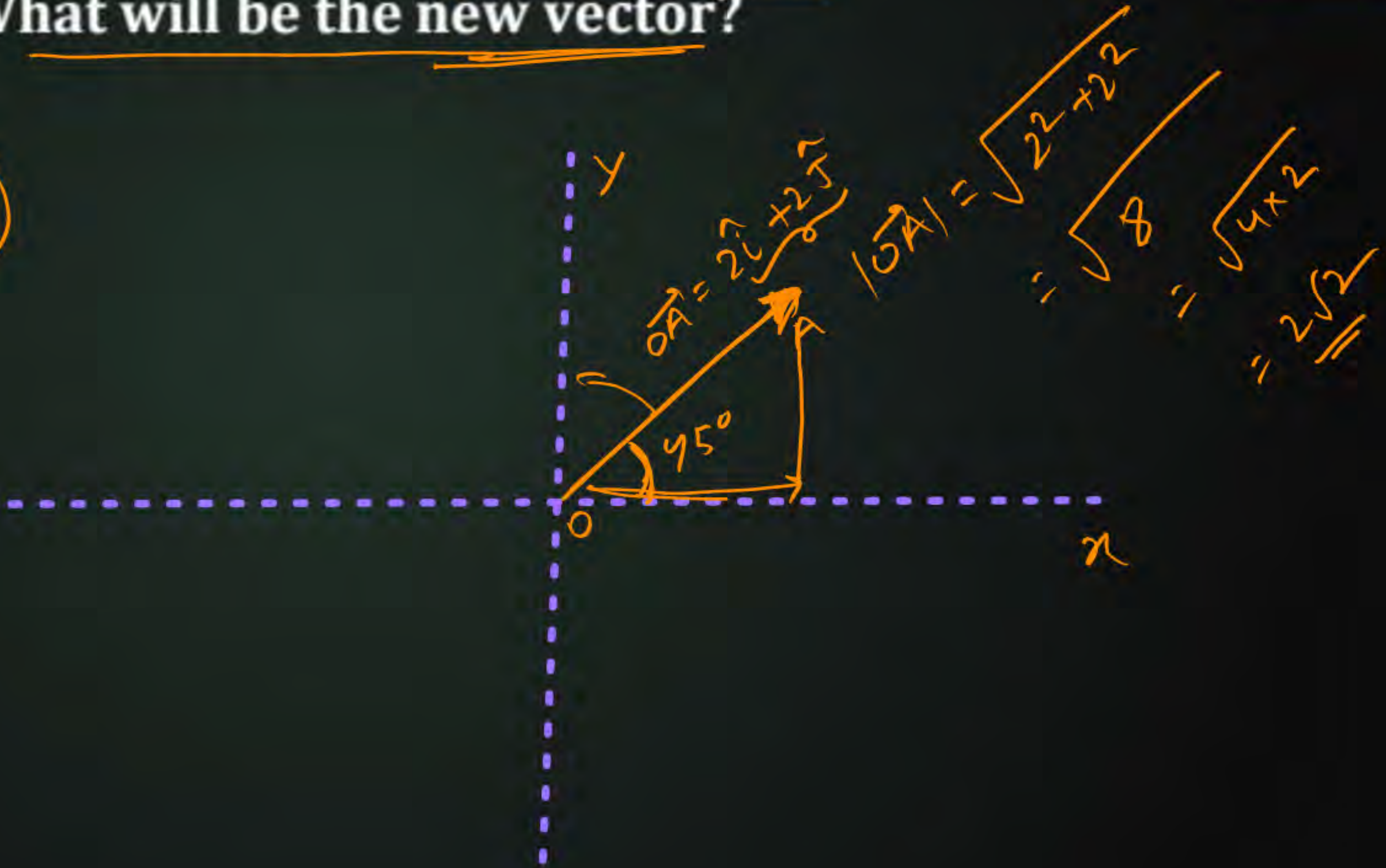


Rotation of vector will change direction only.

QUESTION

16. The vector $\overrightarrow{OA}$ where O is origin is given by $\overrightarrow{OA} = 2\hat{\imath} + 2\hat{\jmath}$. Now its is rotated by 45° anticlockwise about O. What will be the new vector?

1. $2\sqrt{2}\hat{\jmath}$
2. $2\hat{\jmath}$
3. $2\hat{\imath}$
4. $2\sqrt{2}\hat{\imath}$



QUESTION

find

17. **Magnitude of Vector**

1. $2\hat{i} + 2\hat{j} + 2\hat{k}$ = ??

   ↳ $\sqrt{(2)^2+(2)^2+(2)^2} = \sqrt{12} = \sqrt{4\times3} = 2\sqrt{3}$

2. $3\hat{i} - 4\hat{j} + 5\hat{k} = 5\sqrt{2}$

   ↳ $\sqrt{3^2+(-4)^2+5^2} = \sqrt{9+16+25} = \sqrt{50} = \sqrt{25\times2} = 5\sqrt{2}$

3. $7\hat{i} - 24\hat{j} + 25\hat{k} = 25\sqrt{2}$

4. $10i + 10j = 10\sqrt{2}$

5. $5\hat{k} + 12j \Rightarrow \sqrt{5^2+(12)^2} = \sqrt{25+144} = 13$

6. $\sqrt{2}\hat{i} + \sqrt{2}\hat{j} = \sqrt{2}(\sqrt{2}) = 2$

   unit vector $= \frac{\sqrt{2}i + \sqrt{2}\hat{j}}{2} = \frac{1}{\sqrt{2}}i + \frac{1}{\sqrt{2}}\hat{j}$

7. $i - j + \hat{k} \Rightarrow \sqrt{3}\times1 = \sqrt{3}$

8. $6i - 8j + 10\hat{k} = 10\sqrt{2}$

9. $i + \sqrt{3}j + 2\hat{k} \Rightarrow \sqrt{1^2+(\sqrt{3})^2+(2)^2} = \sqrt{1+3+4} = \sqrt{8} = 2\sqrt{2}$

(10) $5i + 5\hat{j} - 5\hat{k} \Rightarrow 5\sqrt{3}$

When we multiply A vector with a scalar then it magnitude will change but dir^n remains same. (if scalar is +ve)

$\vec{A} = 2\hat{i}$

$3\vec{A} = 3(2\hat{i}) = 6i$

$2\vec{A} = 2(2\hat{i})$
$= 4i$

$\frac{\vec{A}}{2} = \frac{2i}{2} = \hat{i}$

$\vec{A} = 2i$

find $-2\vec{A} = ??$

$-2[2\hat{i}) = -4i$

$-4\hat{i}$

QUESTION

18. $\vec{A}$ is a vector of magnitude 2.7 units due east. What is the magnitude and direction of vector $4\vec{A}$?

1. 4 units due east
2. 4 units due west
3. 2.7 units due east
4. 10.8 units due east

$4\vec{A} = 4(2.7)\text{ east}$

$= 10.8 \text{ east}$

QUESTION

19. Which of the following relation is correct between $\vec{A}$, $\vec{B}$ and $\vec{C}$ if $\vec{C} = \vec{A} + \vec{B}$

1. $B + A < C < B - A$
2. $A \leq C \geq B$
3. $A - B \leq C \leq A + B$
4. $A - B < C < A + B$

$\vec{C} = \vec{A} + \vec{B}$

$C_{max} = A + B$

QUESTION

(20) $\vec{A} = 2\hat{\imath} + 2\hat{\jmath} - 3\hat{k}$ and $\vec{B} = 3\hat{\imath} - 3\hat{\jmath} - 2\hat{k}$ find $\vec{A} - \vec{B}$.

$$(\vec{A}) - (\vec{B})$$

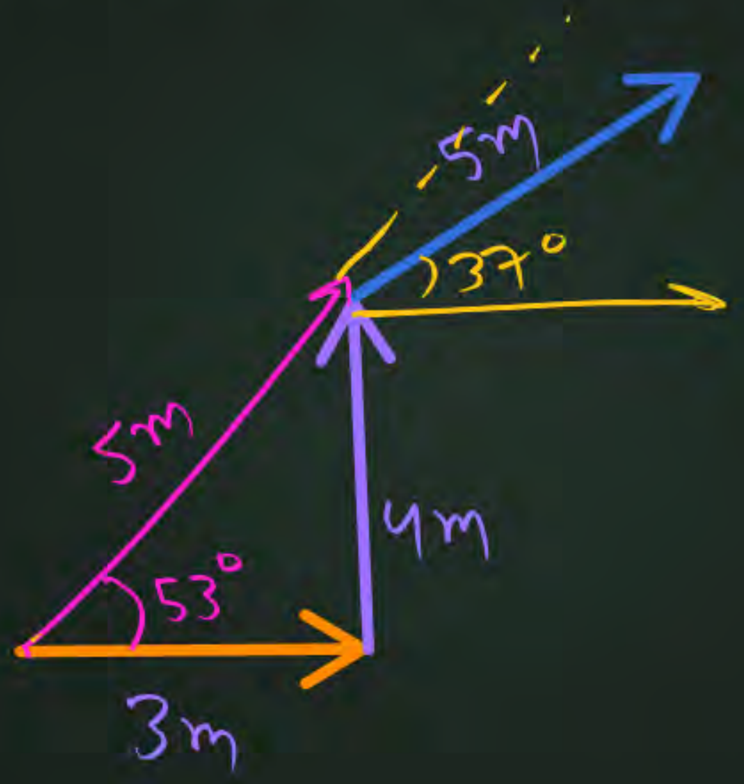
$$= 2\hat{i} + 2\hat{j} - 3\hat{k} - 3\hat{i} + 3\hat{j} + 2\hat{k}$$

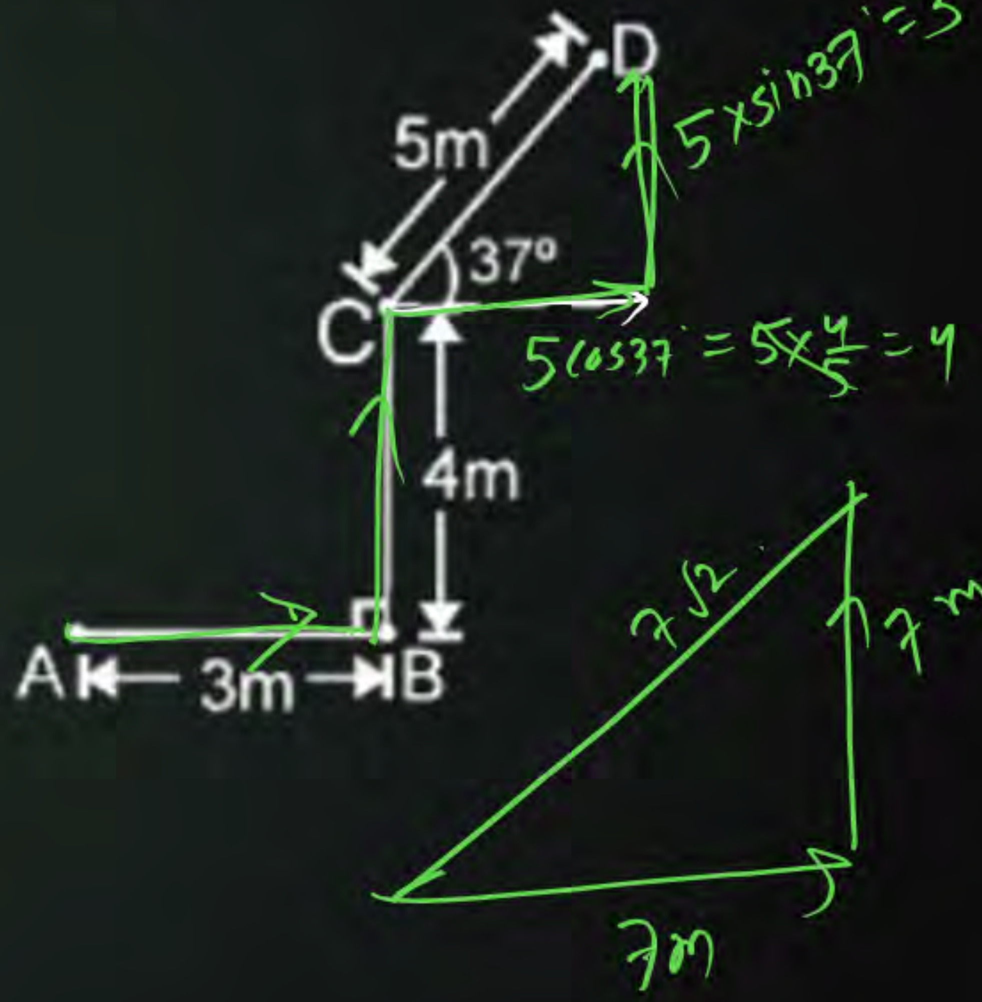
$$= -\hat{i} + 5\hat{j} - \hat{k}$$

QUESTION

A particle moves along a path ABCD as shown in the figure. Then the magnitude of net displacement of the particle from position A to D is:

1. 10 m
2. $5\sqrt{2}$ m
3. 9 m
4. $7\sqrt{2}$ m





QUESTION

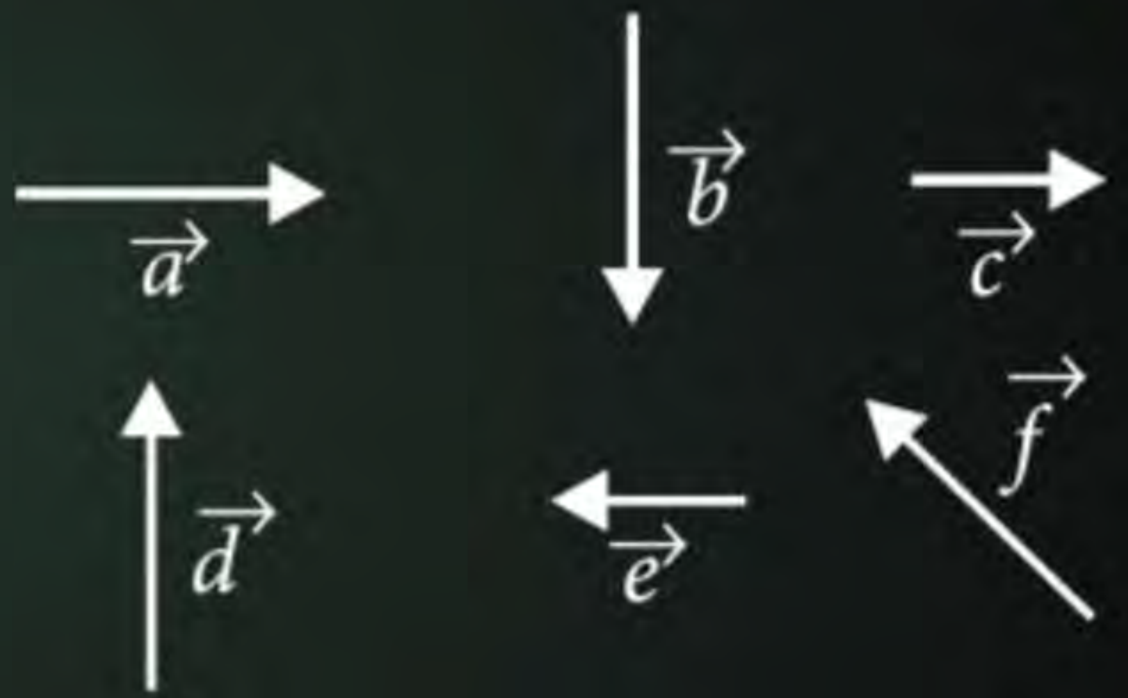
Six vectors, $\vec{a}$ through $\vec{f}$ have the magnitudes and directions indicates in the figure. Which of the following statements is true? (2010)

(1) $\vec{b}+\vec{c}=\vec{f}$

(2) $\vec{d}+\vec{c}=\vec{f}$

(3) $\vec{d}+\vec{e}=\vec{f}$

(4) $\vec{b}+\vec{e}=\vec{f}$

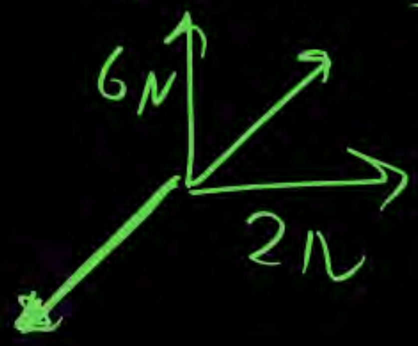


(23) (A) Resultant of two vector must be in the plane of Two vector.
(True)

(B) minimum no. of unequal vectors can give zero resultant is 2.
false



Minimum No. of Unequal vector Can give zero resultant is zero.
⟹ 3-vector //



Minimum of vectors can give zero resultant is Two

↳ equal magnitude ke vectr



(24) Two vector $\vec{a}$ & $\vec{B}$ acting ⊥r to each other then find relⁿ b/w magnitude of $\vec{A}$ & $\vec{B}$ so that their result will be zero ??

Solⁿ {Not Possible}



$$R = \sqrt{A^2 + B^2 + 2AB\cos 90^\circ}$$

$$R = \sqrt{A^2 + B^2}$$

(24) Which of the following combination of three force can give zero resultant ??

(a) [2, 4, 7] → (min 3, max 11)

(b) [3, 1, 5] → (2, 4)

(c) [2, 8, 11] → (3, 19) ✓

(d) [3, 4, 2]

QUESTION

(25)

A vector $\vec{A} = 2\hat{\imath} + 3\hat{\jmath} - 4\hat{k}$, then find $-3\vec{A}$ and $\frac{\vec{A}}{2}$.

$$-3\vec{A} = (2\hat{i} + 3\hat{j} - 4\hat{k})(-3)$$

$$-3\vec{A} = -6\hat{i} - 9\hat{j} + 12\hat{k}$$

(27) If $\vec{A} = 2i - 4\hat{j} + 3\hat{k}$ & $\vec{B} = 4\hat{i} - 8\hat{j} + 6\hat{k}$

find Angle b/w $\vec{A}$ & $\vec{B}$.

(a) Zero (53%)

(b) 90

(c) 60

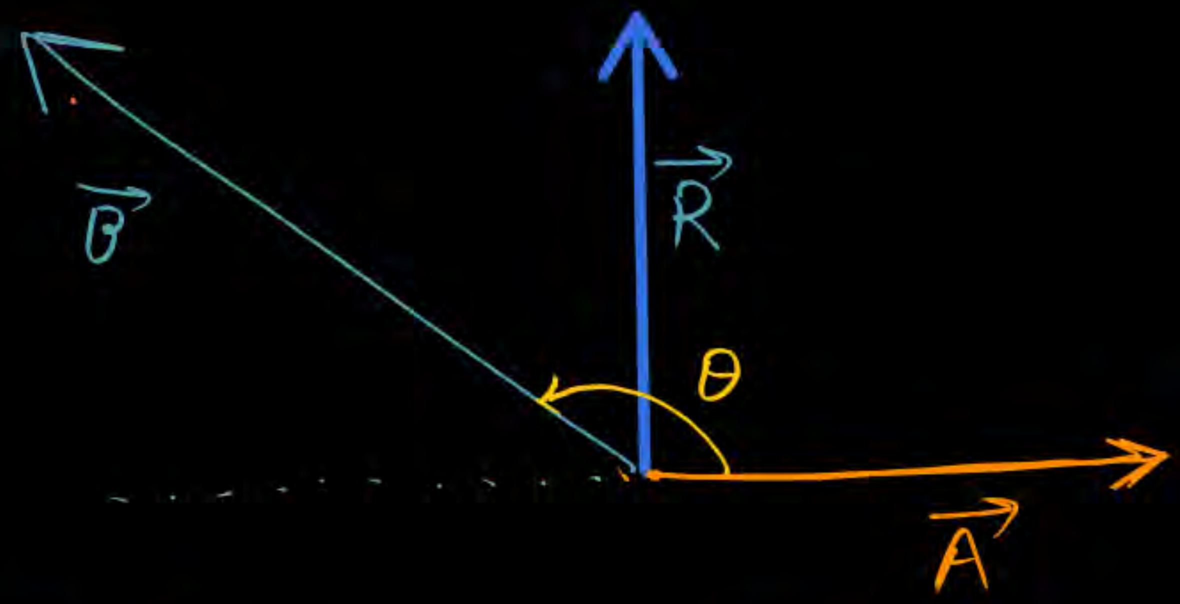
(d) Cant find (30%)

$\vec{A} = 2i - 4\hat{j} + 3\hat{k}$

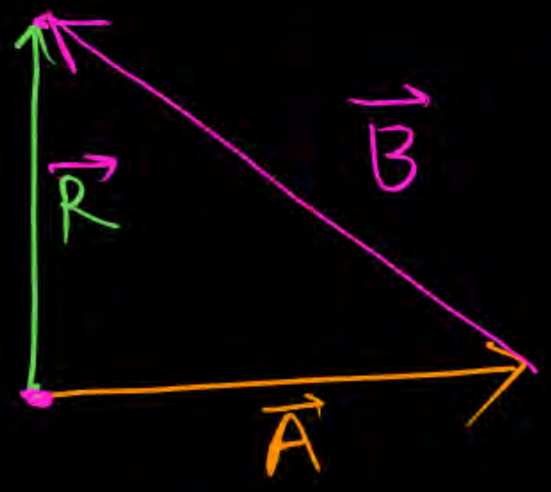
$\vec{B} = 4i - 8j + 6\hat{k} = 2[2i - 4\hat{j} + 3\hat{k}]$

$\vec{B} = 2 \times \vec{A}$

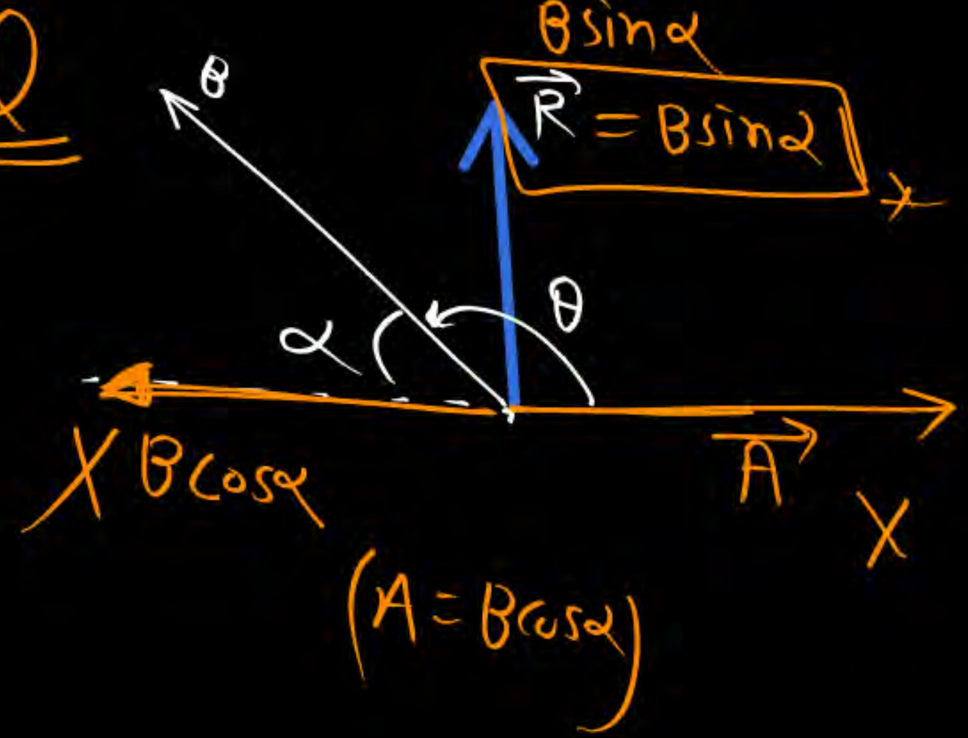
$$\vec{A}+\vec{B}=\vec{R}$$



Triangle law of vector add^n



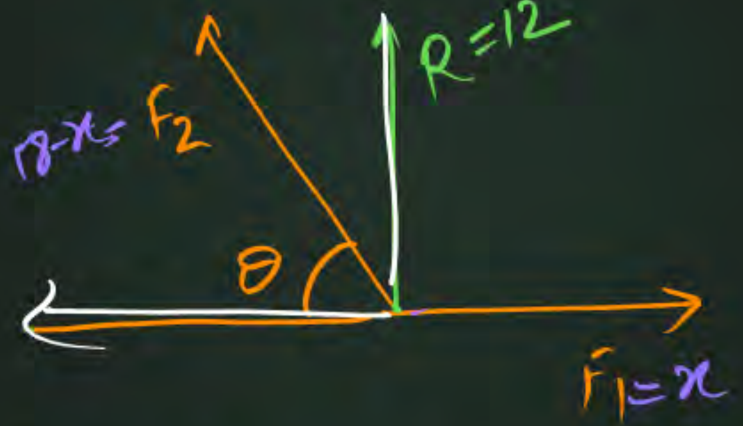
MR* feel



QUESTION

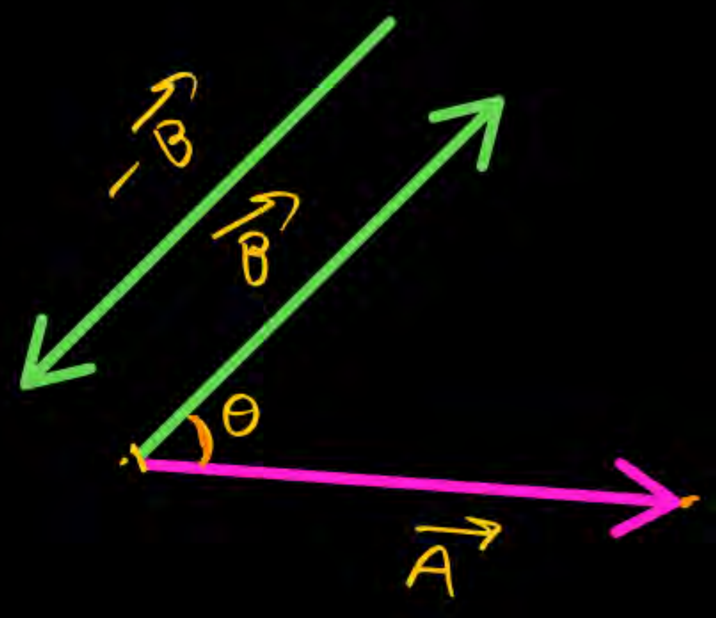
(26) The sum of the magnitudes of two forces acting at point is 18 and the magnitude of their resultant is 12. If the resultant is at 90° with the force of smaller magnitude, what are the magnitudes of forces?

1. 12, 5
2. 14, 4
3. 5, 13
4. 10, 8

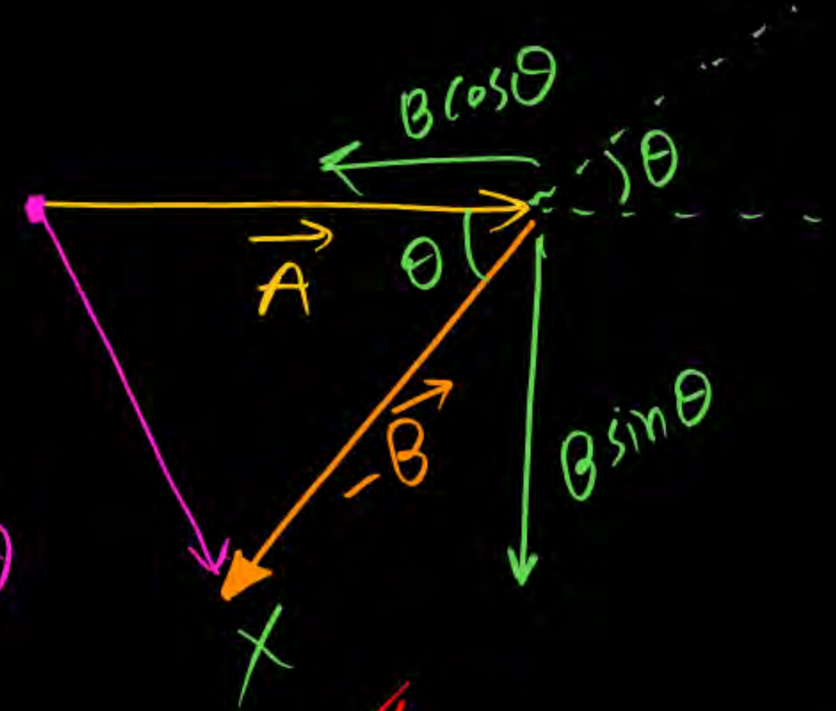


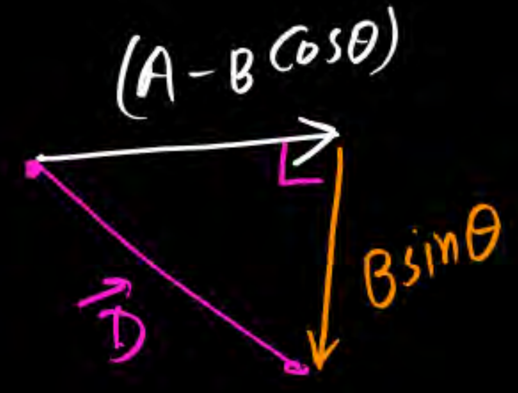
Vector Subtraction

$\vec{D} = \vec{A} - \vec{B} = \vec{A} + (-\vec{B})$



⇒





$\vec{D} = \vec{A} - \vec{B} = \vec{A} + (-\vec{B})$

$D = \sqrt{A^2 + B^2 + 2AB\cos(180 - \theta)}$

$D = \sqrt{A^2 + B^2 - 2AB\cos\theta}$

$D = \sqrt{(A - B\cos\theta)^2 + (B\sin\theta)^2}$

$= \sqrt{A^2 + B^2\cos^2\theta - 2AB\cos\theta + (B\sin\theta)^2}$

$D = \sqrt{A^2 + B^2 - 2AB\cos\theta}$

$$\vec{D} = \sqrt{A^2 + B^2 - 2AB\cos\theta}$$

$\theta = 0°$

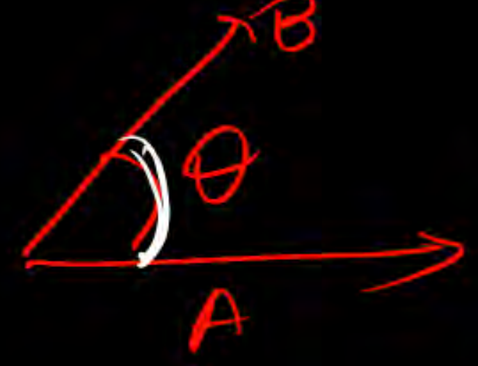
$D = A - B$

$\theta = 90°$

$D = \sqrt{A^2 + B^2}$

$\theta = 180°$

$D_{max} = A + B$



$$R = \sqrt{A^2 + B^2 + 2AB\cos\theta}$$

$\theta = 0$

$R_{max} = A + B$

$\theta = 90$

$R = \sqrt{A^2 + B^2}$

$\theta = 180$

$R_m = A - B$



If $|\vec{A}| = |\vec{B}|$

$$D = 2A\sin(\theta/2)$$

$\theta = 0°$	$\theta = 60$	$\theta = 90$	$\theta = 120$	$\theta = 180$
$D = 0$	$D = A$	$D = \sqrt{2}A$	$\sqrt{3}A$	$D = 2A$

If $|\vec{A}| = |\vec{B}| = A$

$$R = 2A \times \cos(\theta/2)$$

$\theta = 0°$	$\theta = 60$	$\theta = 90$	$\theta = 120$	$\theta = 180$
$2A$	$\sqrt{3}A$	$\sqrt{2}A$	A	0

If $|\vec{A}| = 6$ & $|\vec{B}| = 8$ then find $|\vec{A} - \vec{B}| = |\vec{D}|$

(i) $0°$

(ii) $60°$

(iii) $90°$

(iv) $180°$

H/W

QUESTION

For two vector $\vec{A}$ and $\vec{B}$ vector addition $\vec{R} = \vec{A} + \vec{B}$ and vector subtraction $\vec{D} = \vec{A} - \vec{B}$ then angle between $\vec{A}$ and $\vec{B}$.

Condition **Angle** = ??

(i) $|\vec{A} + \vec{B}| = |\vec{R}| = |\vec{A}| = |\vec{B}|$ $\rightarrow$

(ii) $|\vec{A}| = |\vec{B}| = |\vec{A} - \vec{B}|$ $\rightarrow$

(iii) $A^2 + B^2 = |\vec{A} - \vec{B}|^2 = D^2$ $\rightarrow$

(iv) $A^2 + B^2 = R^2$ $\rightarrow$

QUESTION

Condition		Angle
(v) $|\vec{A}+\vec{B}| = |\vec{A}-\vec{B}|$	$\rightarrow$	
(vi) $|\vec{A}+\vec{B}| = |\vec{A}|+|\vec{B}|$	$\rightarrow$	
(vii) $|\vec{A}-\vec{B}| = |\vec{A}|+|\vec{B}|$	$\rightarrow$	
(viii) $|\vec{A}+\vec{B}| = |\vec{A}|-|\vec{B}|$	$\rightarrow$	
(ix) $|\vec{A}-\vec{B}| = |\vec{A}|-|\vec{B}|$	$\rightarrow$	


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 04 | Physics

VECTORS

By- Dr. Manish Raj (MR SIR)



Topics to be covered ;

1. [redacted] K.B.D. ---- Notes
2. [redacted] H/W

*. PhD. on

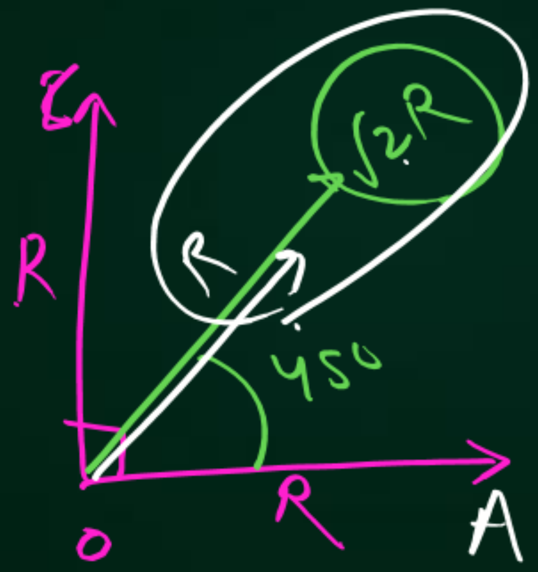
3. [redacted] vector subtraction
4. [redacted] Lamis Theorem

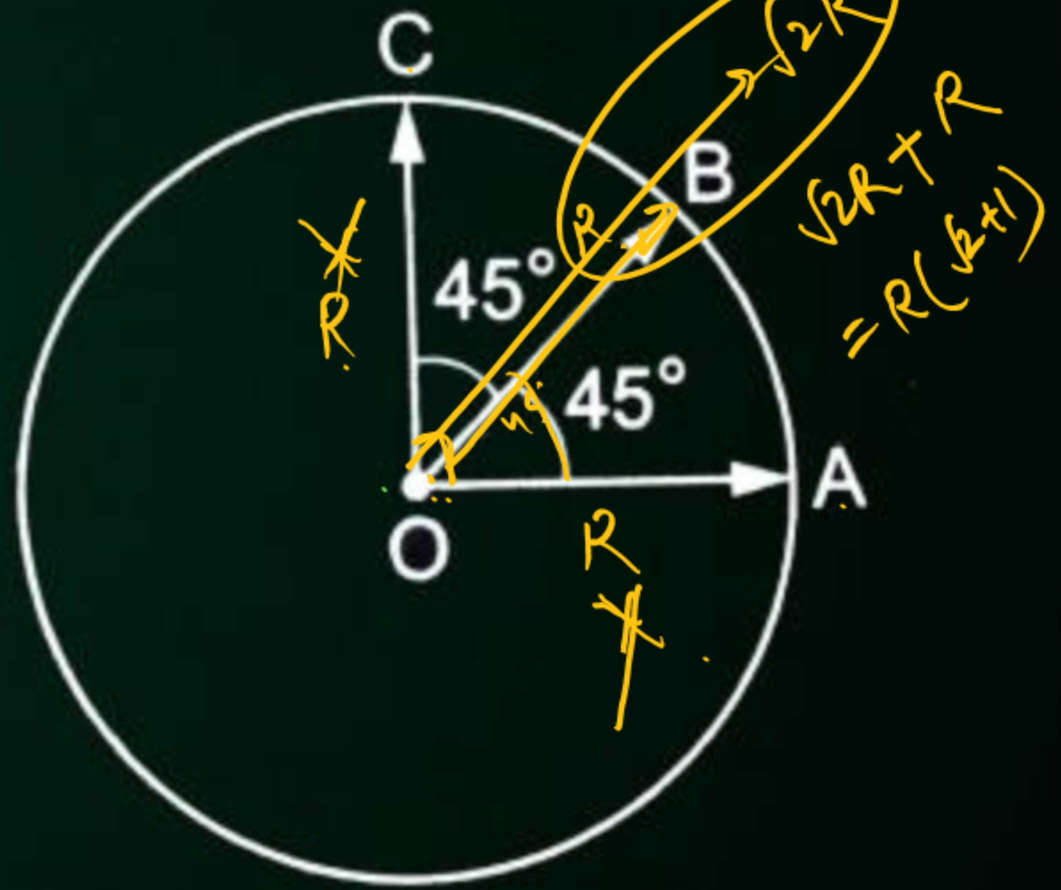
Dot Product



QUESTION

Find the resultant of there vectors $\overrightarrow{OA}$, $\overrightarrow{OB}$ and $\overrightarrow{OC}$ shown in the following figure. Radius of the circle is R.



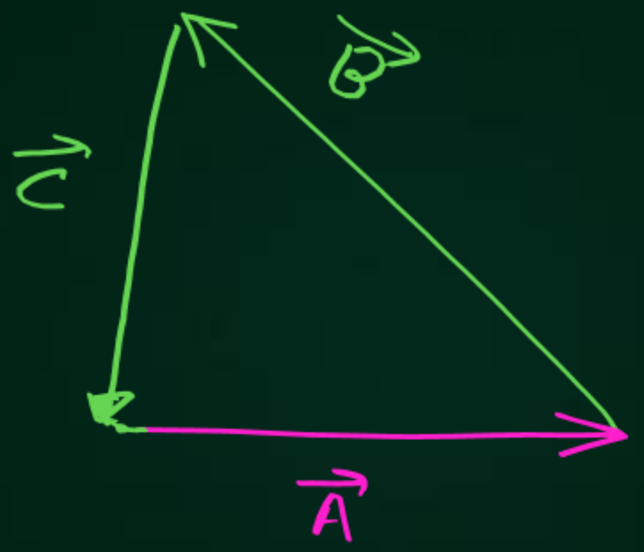


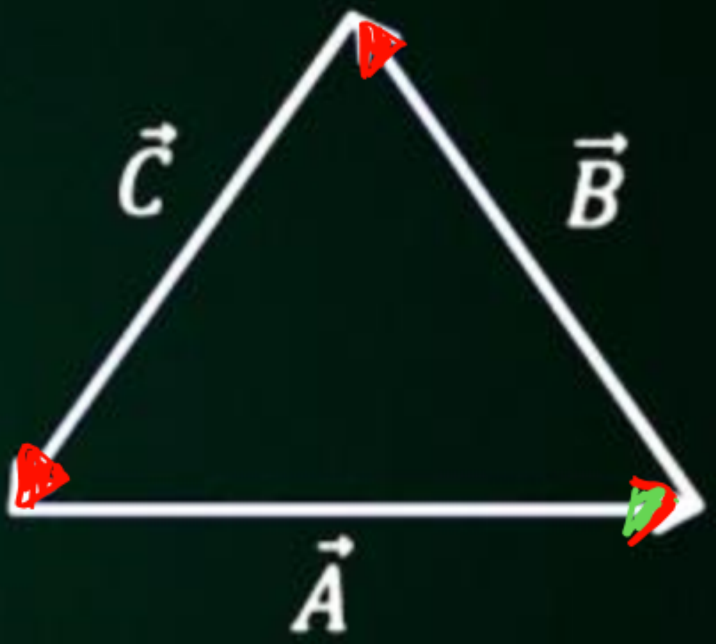
1. $2R$
2. $R(1+\sqrt{2})$
3. $R\sqrt{2}$
4. $R(\sqrt{2}-1)$

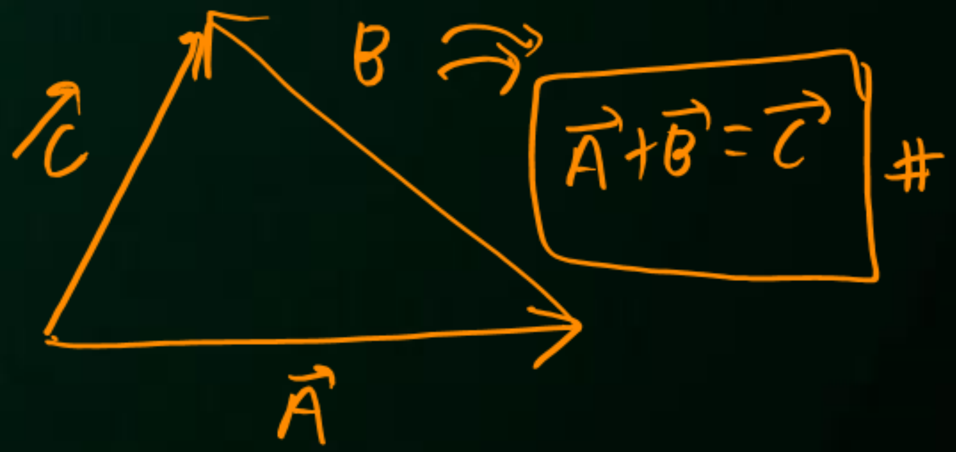
QUESTION

Which of the following option is correct for given figure?

1. $\vec{A} = \vec{B} + \vec{C}$
2. $\vec{B} = \vec{A} + \vec{C}$
3. $\vec{C} = \vec{A} + \vec{B}$
4. $\vec{A} + \vec{B} + \vec{C} = \vec{0}$







QUESTION



Assertion: Minimum number of vectors having unequal magnitude in a plane required to give zero resultant is three.

Reason: If vector addition of three vectors is zero, then they must lie in a plane.

1. If both Assertion & Reason are True & the Reason is a correct explanation of the Assertion.

2. If both Assertion & Reason are True but Reason is not a correct explanation of the Assertion.

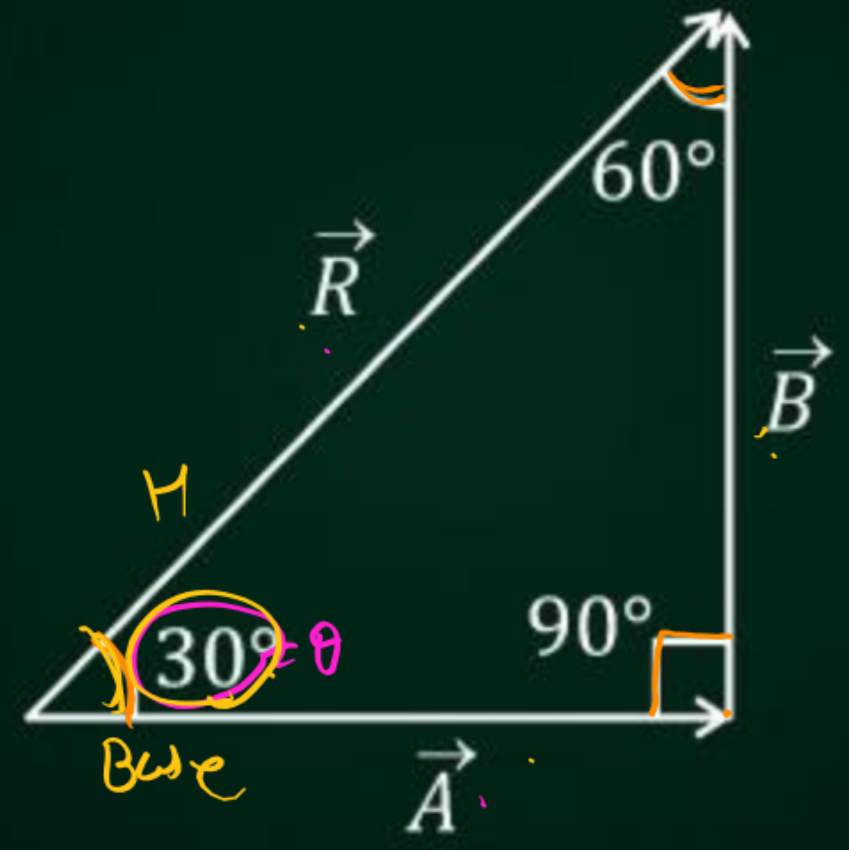
3. If Assertion is True but the Reason is False.

4. If both Assertion & Reason are false.

(#) minimum no. of Non-Coplanar vectors can gives zero Result is → 4

QUESTION

If resultant of two vector makes 30° and 60° with these vectors and has a magnitude of 40 units, then find magnitude of these vectors.



$\cos 30° = \frac{A}{R}$

$\frac{\sqrt{3}}{2} = \frac{A}{40}$

$A = 20\sqrt{3}$

$\sin 30° = \frac{B}{R}$

$\frac{1}{2} = \frac{B}{40}$

$B = 20$

QUESTION

Which of the following set of 3 force can keep the object in equilibrium?

1. 3, 4, 8
2. 2, 5, 1
3. 7, 3, 11
4. 4, 5, 8

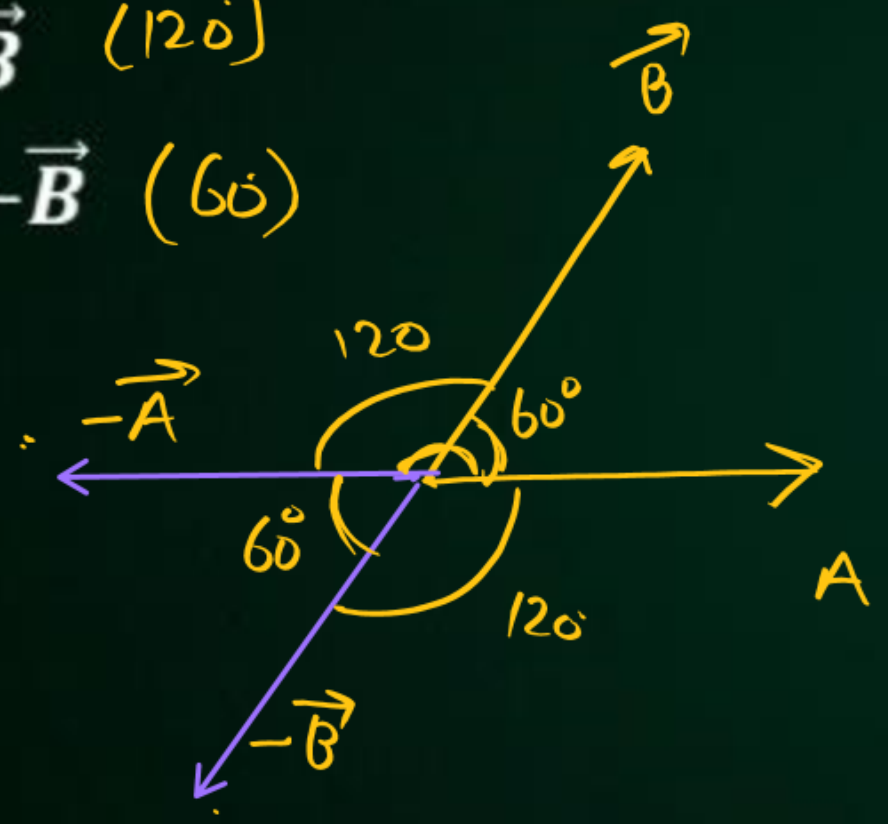
QUESTION

Angle between $\vec{A}$ & $\vec{B}$ is 60° then find angle between

(i) $\vec{A}$ & $-\vec{B}$ (120°)

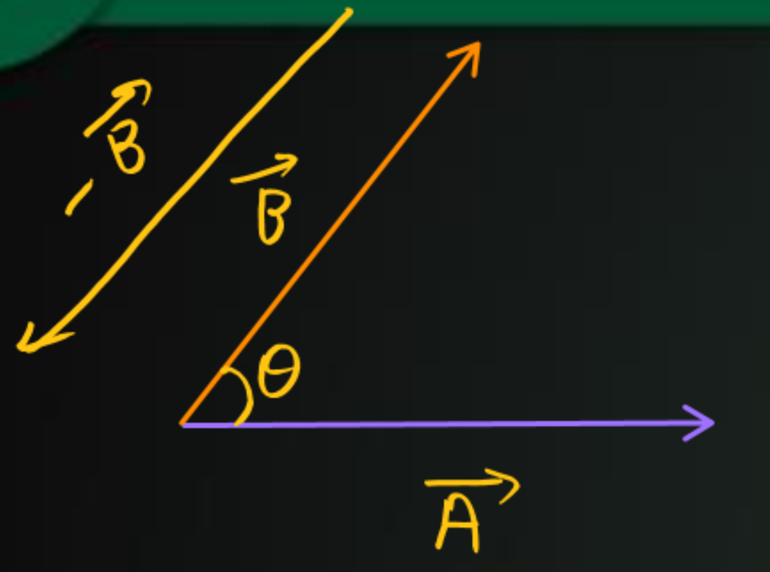
(ii) $-\vec{A}$ & $\vec{B}$ (120°)

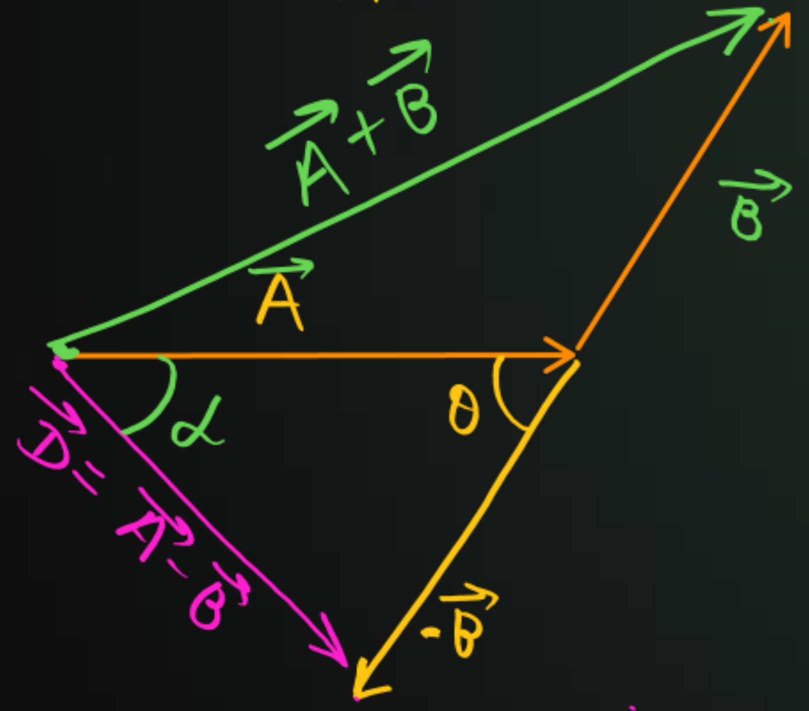
(iii) $-\vec{A}$ & $-\vec{B}$ (60°)



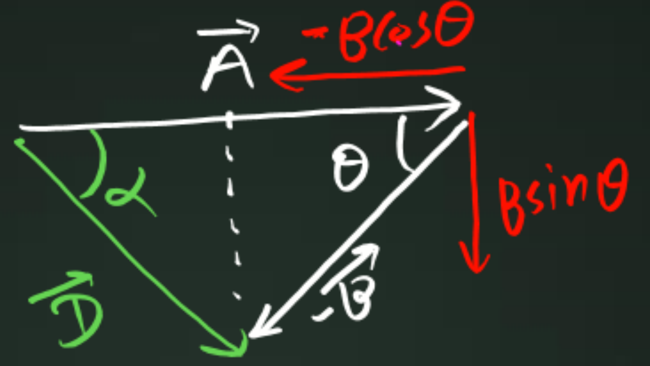
VECTOR SUBTRACTION

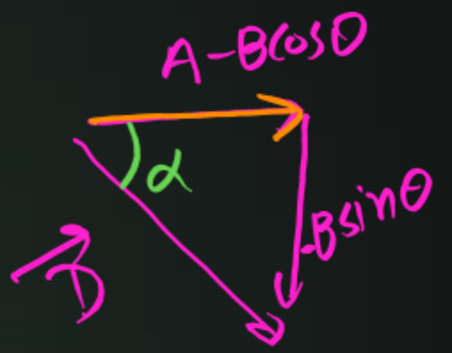
$$\vec{A} - \vec{B} = \vec{A} + (-\vec{B})$$





$\vec{A} - \vec{B}$





Angle b/w $\vec{D}$ & $\vec{A}$

$$\tan\alpha = \frac{B\sin\theta}{A - B\cos\theta}$$

$$|D| = \sqrt{(A - B\cos\theta)^2 + (-B\sin\theta)^2}$$

$$= \sqrt{A^2 + B^2\cos^2\theta - 2AB\cos\theta + B^2\sin^2\theta}$$

$$D = \sqrt{A^2 + B^2 - 2AB\cos\theta}$$

$\vec{R} = \vec{A} + \vec{B}$

$$|\vec{R}| = \sqrt{A^2 + B^2 + 2AB\cos\theta}$$

$\theta = 0^\circ$: $R_{max} = A + B$

$\theta = 90^\circ$: $R = \sqrt{A^2 + B^2}$

$\theta = 180^\circ$: $R_{min} = A - B$

If Two vectors of same magnitude

$R = 2A\cos(\theta/2)$

$\theta = 0$	$\theta = 60^\circ$	$\theta = 90^\circ$	$\theta = 120$	$\theta = 180$
$R = 2A$	$R = \sqrt{3}A$	$R = \sqrt{2}A$	$R = A$	$R = 0$

The imp*

उलटा copy करदो

$\vec{D} = \vec{A} - \vec{B} = \vec{A} + (-\vec{B})$

$$D = \sqrt{A^2 + B^2 + 2AB\cos(180 - \theta)}$$

$$D = \sqrt{A^2 + B^2 - 2AB\cos\theta}$$

$\theta = 0^\circ$ ($\vec{A}$, $\vec{B}$): $D_{min} = A - B$ or $= B - A$

$\theta = 90^\circ$: $D = \sqrt{A^2 + B^2}$

$\theta = 180^\circ$ (B, A): $D_{max} = (A + B)$

feel. Relative velocity

* $D = 2A\sin(\theta/2)$

$\theta = 0^\circ$	$\theta = 60^\circ$	$\theta = 90^\circ$	$\theta = 120$	$\theta = 180$
$D = 0$	$D = A$	$D = \sqrt{2}A$	$D = \sqrt{3}A$	$D = 2A$

QUESTION

Two vector of same magnitude and angle between them is θ then find magnitude of vector subtraction.

$$D = 2A\sin(\theta/2)$$

$$\vec{A} = A\hat{A}$$

$$|\vec{A}| = A$$

$$\vec{A} + \vec{B} = \vec{R}$$

$$\# \quad |\vec{A} + \vec{B}| = |\vec{R}| = R$$

$$|\vec{A}| + |\vec{B}| = A + B \quad \times$$

$$|\vec{A} - \vec{B}| = |\vec{D}| = D$$

$$|\vec{A}| - |\vec{B}| = A - B \quad \times$$

QUESTION

The vectors $\vec{A}$ and $\vec{B}$ are such that $|\vec{A}+\vec{B}| = |\vec{A}-\vec{B}|$. The angle between the two vectors is

1. 45°
2. 90°
3. 60°
4. 75°

$|\vec{A}| = 6$ find $\vec{A} - \vec{B}$ at $\theta = 0^\circ$

$|\vec{B}| = 8$

$\theta = 60^\circ$

$\theta = 90^\circ$

$\theta = 180^\circ$

Soln

$\vec{A} - \vec{B} = \vec{D}$

$\theta = 0^\circ$

$D = \sqrt{A^2 + B^2 - 2AB\cos\theta}$

$= \sqrt{6^2 + (8)^2 - 2 \times 6 \times 8 \times \cos 0^\circ}$

$= \sqrt{36 + 64 - 96}$

$= \sqrt{100 - 96} = \sqrt{4} = 2$

$\theta = 60^\circ$

$D = \sqrt{36 + 64 - 2 \times 6 \times 8 \times \cos 60^\circ}$

$= \sqrt{100 - 48 \times 2 \times \frac{1}{2}}$

$= \sqrt{100 - 48} = \sqrt{52}$

$\theta = 90^\circ$

$D = \sqrt{A^2 + B^2}$

$= \sqrt{64 + 36}$

$= \sqrt{100} = 10$

$\theta = 180$

$D = A + B$

$= 6 + 8 = 14$

QUESTION

If the sum of two unit vectors is a unit vector, then the magnitude of their difference is:

1. $\sqrt{3}$
2. $\sqrt{2}$
3. $\sqrt{5}$
4. $1/\sqrt{2}$

QUESTION

4 PYQ of NEET
5 PYQ of JEE Main

For two vector $\vec{A}$ and $\vec{B}$ vector addition $\vec{R} = \vec{A} + \vec{B}$ and vector subtraction $\vec{D} = \vec{A} - \vec{B}$ then angle between $\vec{A}$ and $\vec{B}$.

Condition		Angle
(i) $\lvert\vec{A}+\vec{B}\rvert = \lvert\vec{R}\rvert = \lvert\vec{A}\rvert = \lvert\vec{B}\rvert$	$\rightarrow$	$\theta = 120^\circ$ ✓
(ii) $\lvert\vec{A}\rvert = \lvert\vec{B}\rvert = \lvert\vec{A}-\vec{B}\rvert$ (vectr sub.)	$\rightarrow$	$\theta = 60^\circ$ ✓
(iii) $A^2 + B^2 = \lvert\vec{A}-\vec{B}\rvert^2 = D^2$	$\rightarrow$	90°
(iv) $A^2 + B^2 = R^2$	$\rightarrow$	90°

QUESTION

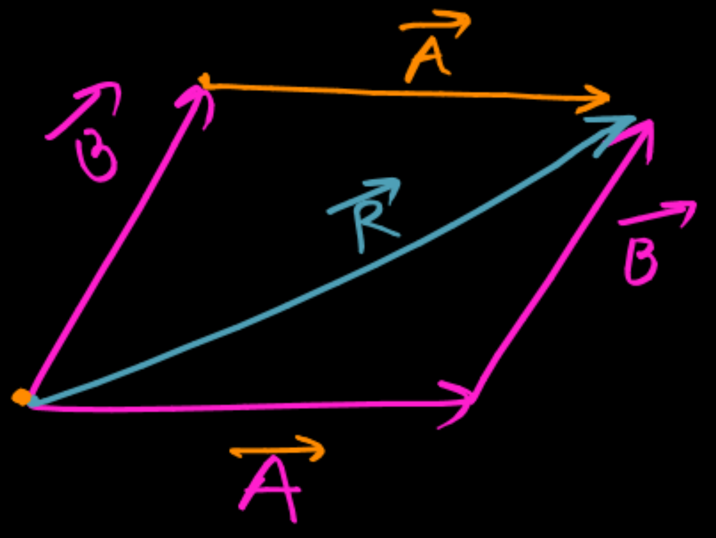
Condition		Angle
(v) $\lvert\vec{A}+\vec{B}\rvert = \lvert\vec{A}-\vec{B}\rvert$	$\rightarrow$	$90^\circ = \theta$
(vi) $\lvert\vec{A}+\vec{B}\rvert = \lvert\vec{A}\rvert + \lvert\vec{B}\rvert$ $R = A + B$	$\rightarrow$	0°
(vii) $\lvert\vec{A}-\vec{B}\rvert = \lvert\vec{A}\rvert + \lvert\vec{B}\rvert$ $\lvert\vec{B}\rvert = A + B$	$\rightarrow$	180°
(viii) $\lvert\vec{A}+\vec{B}\rvert = \lvert\vec{A}\rvert - \lvert\vec{B}\rvert$ $R = A - B$	$\rightarrow$	180°
(ix) $\lvert\vec{A}-\vec{B}\rvert = \lvert\vec{A}\rvert - \lvert\vec{B}\rvert$	$\rightarrow$	$\theta = 0^\circ$

QUESTION

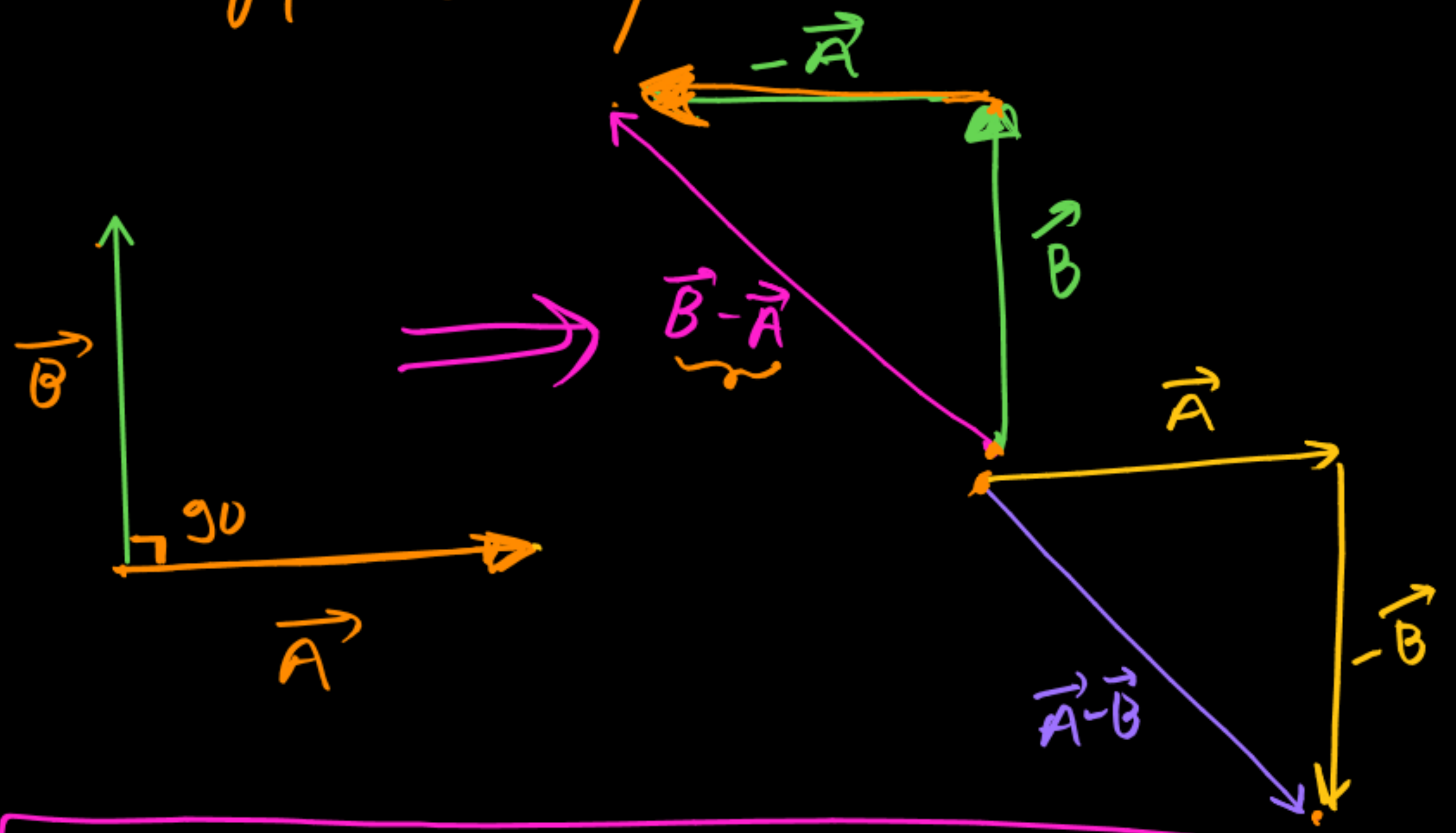
The vectors $\vec{A}$ and $\vec{B}$ are such that $|\vec{A}+\vec{B}| = |\vec{A}| = |\vec{B}|$, then $|\vec{A}-\vec{B}|$ may be equated to

1. $\frac{\sqrt{3}}{2}\vec{A}$
2. $\vec{A}$
3. $\sqrt{2}\,|A|$
4. $\sqrt{3}\,|A|$

$\vec{A}+\vec{B}=\vec{B}+\vec{A}$ ✓



$\vec{A}-\vec{B} \neq \vec{B}-\vec{A}$



Angle b/w $\vec{A}-\vec{B}$ & $\vec{B}-\vec{A}$ is 180°

object is moving with speed V on circular Path then find change is Speed when it is at diametric opposite point

How fast

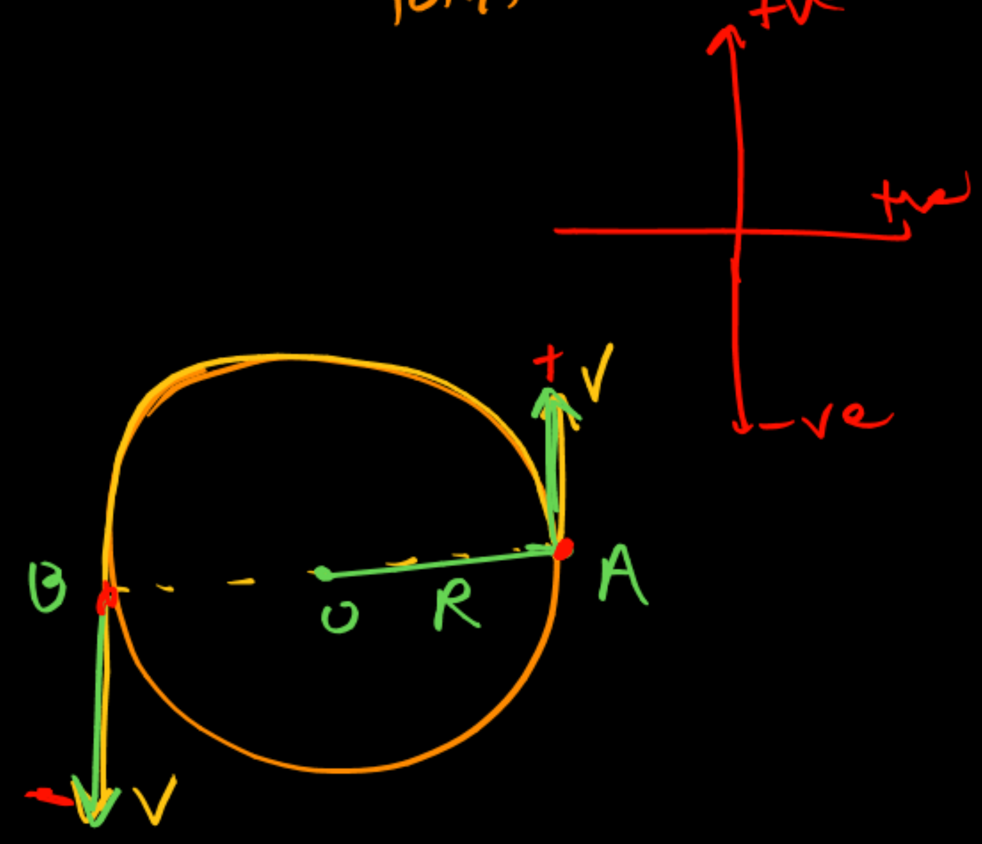
(i) change in speed = 0

(ii) change in velocity $= \vec{V}_f - \vec{V}_i$

$= -V - V$

Change in velocity $= -2V$

Magnitude of change in velocity $= 2V$



Initial velocity of object is 10 m/s east after some time its velocity becomes 10 m/s North then find change in velocity is ??

Sol^n change in velocity $= \vec{V_f} - \vec{V_i}$

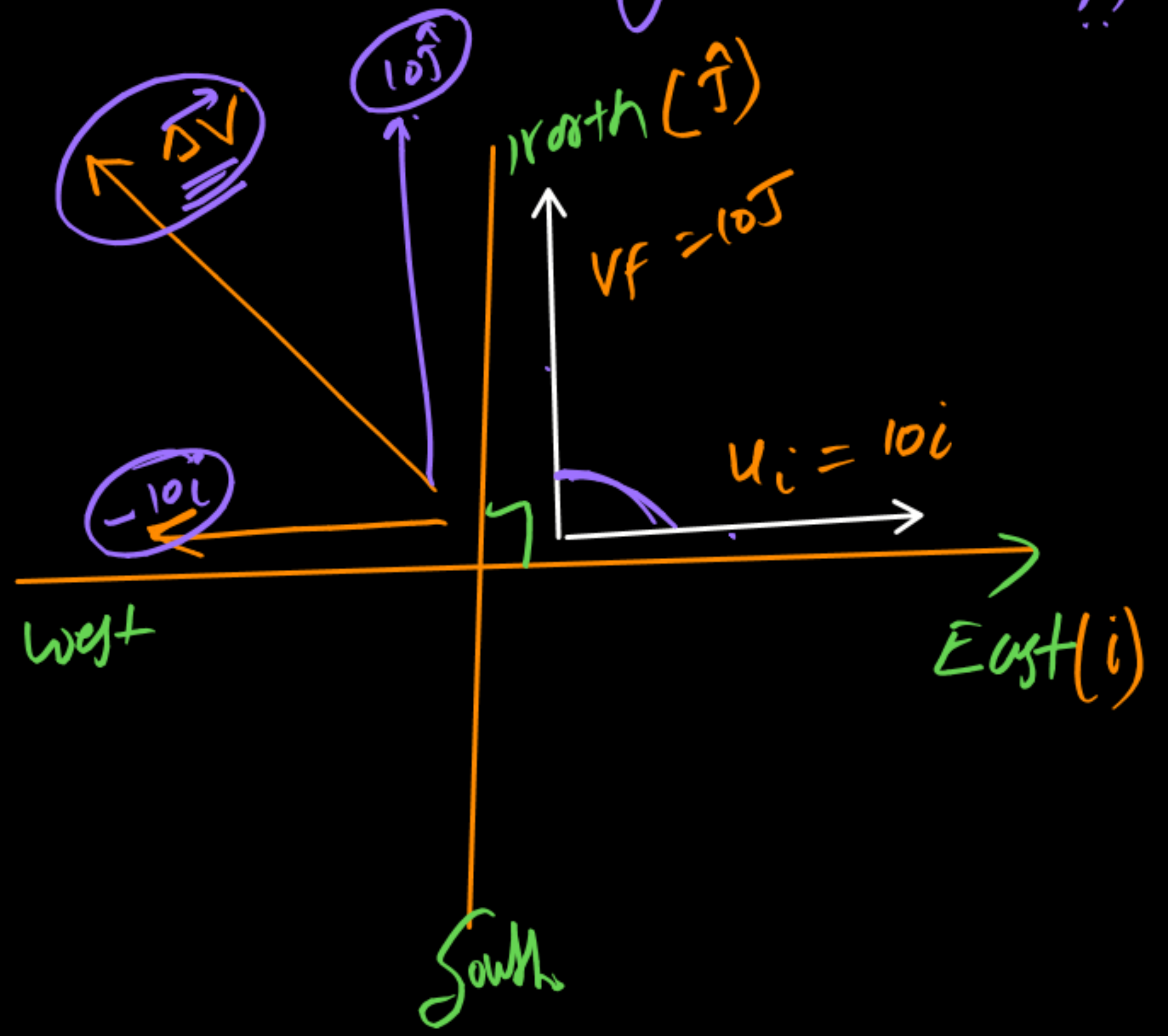
$= \vec{V_f} - (\vec{V_i})$

$= 10\hat{j} - 10\hat{i}$

$= 10[\hat{j} - \hat{i}]$ (North-west)

$= 10\sqrt{2}$ (North-west)

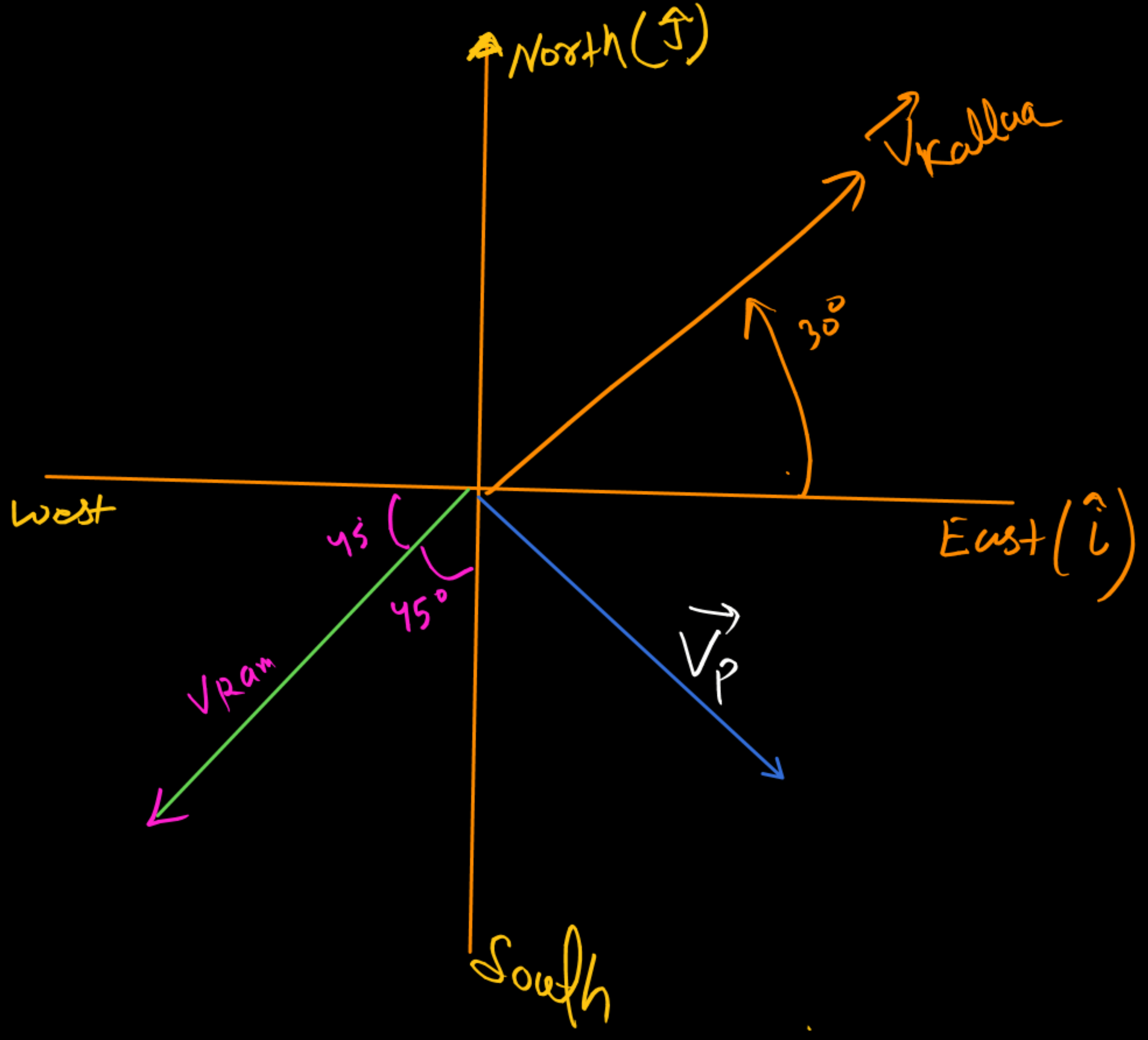
NEET-2022/23



$\vec{V}_{Ram} = 10 m/s$ (south west)

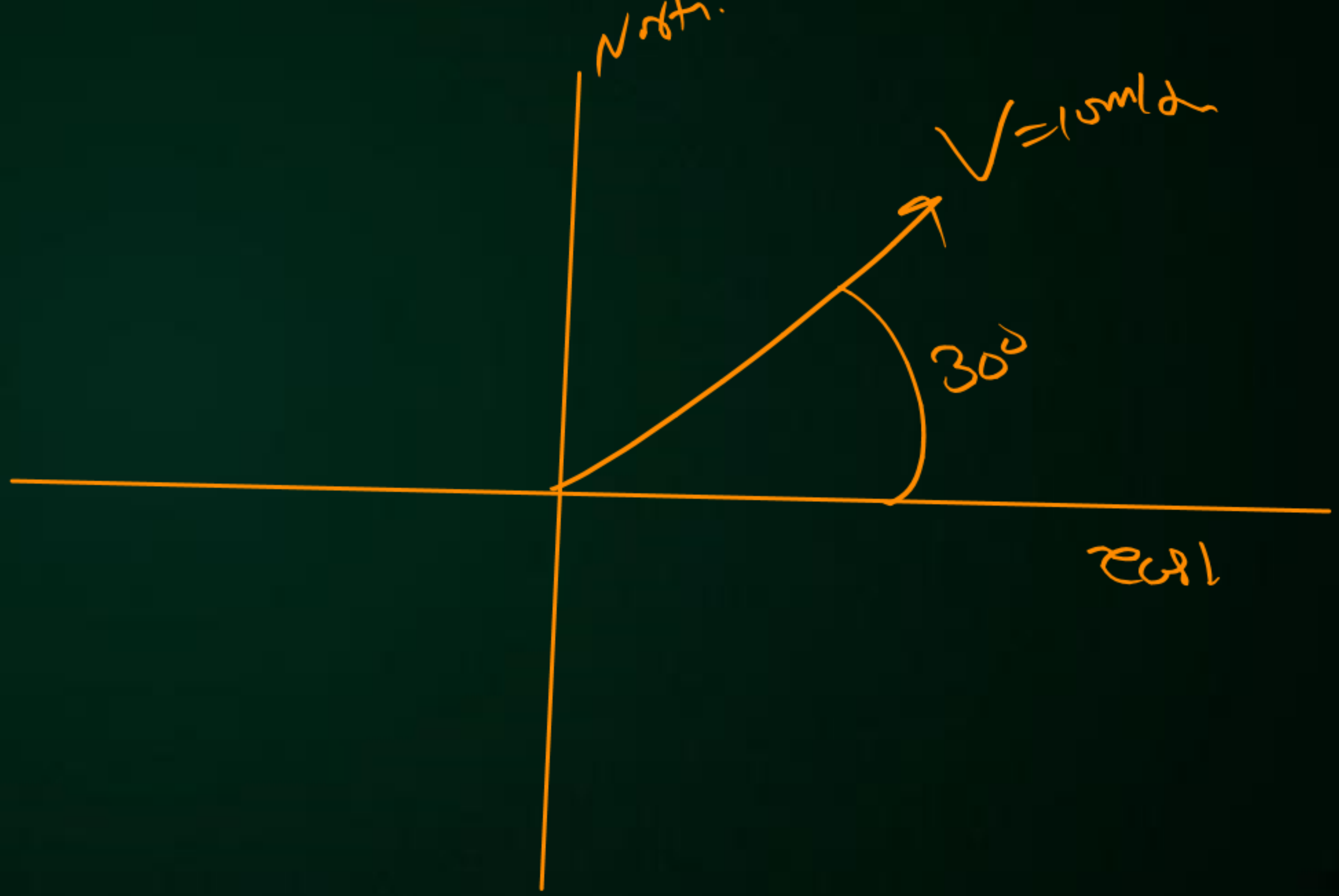
$\vec{U}_p = 10 m/s$ (south east)

$\vec{U}_{Kalua} = 10 m/s$ at 30° North of east



QUESTION

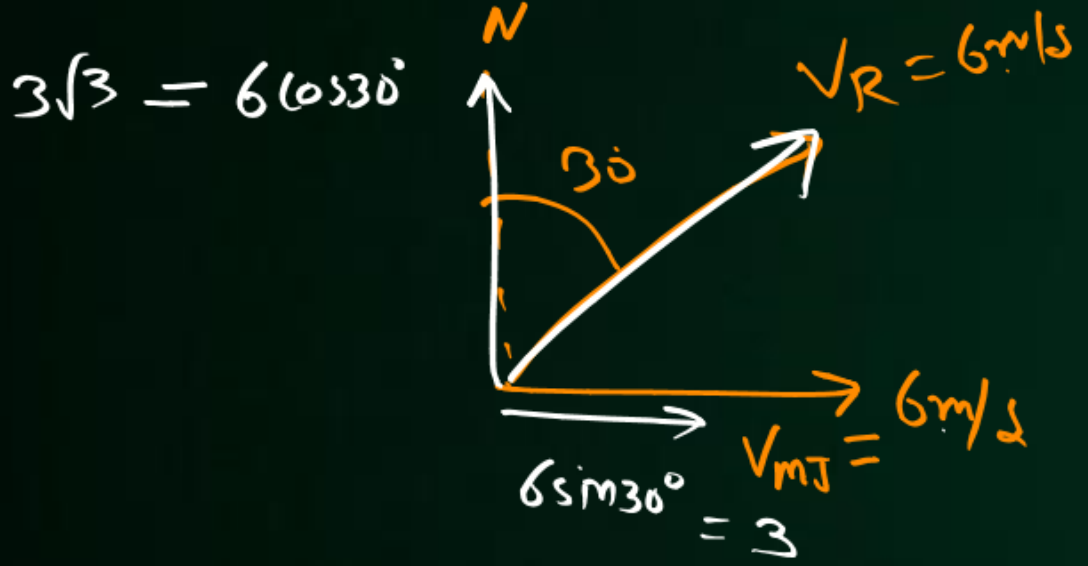
Velocity of object 10 m/s at 30° North of East. Draw in vector form.



QUESTION

feel

Majnu Majedar is moving with 6 m/s in east and Ramlal is moving with 6 m/s at 30° east of North, then find relative velocity of Ramlal w.r.t. MM.



$$\vec{v}_{R(MJ)} = \vec{v}_R - \vec{v}_{MJ}$$

$= 6$ m/s (30° E of N) $- 6$ m/s (E)

$= 6$ Ans

$$\vec{v}_R - \vec{v}_{MJ} = (3\hat{i} + 3\sqrt{3}\hat{j}) - 6\hat{i}$$

$$\vec{v}_R - \vec{v}_{MJ} = (-3\hat{i} + 3\sqrt{3}\hat{j}) \text{ Ans}$$

$$|v_{R(MJ)}| = \sqrt{(-3)^2 + (3\sqrt{3})^2} = \sqrt{9 + 9\times 3} = \sqrt{36} = 6$$

QUESTION

Initial velocity of Ramlal is 5 m/s in north after some time it is moving 5 m/s in east then find

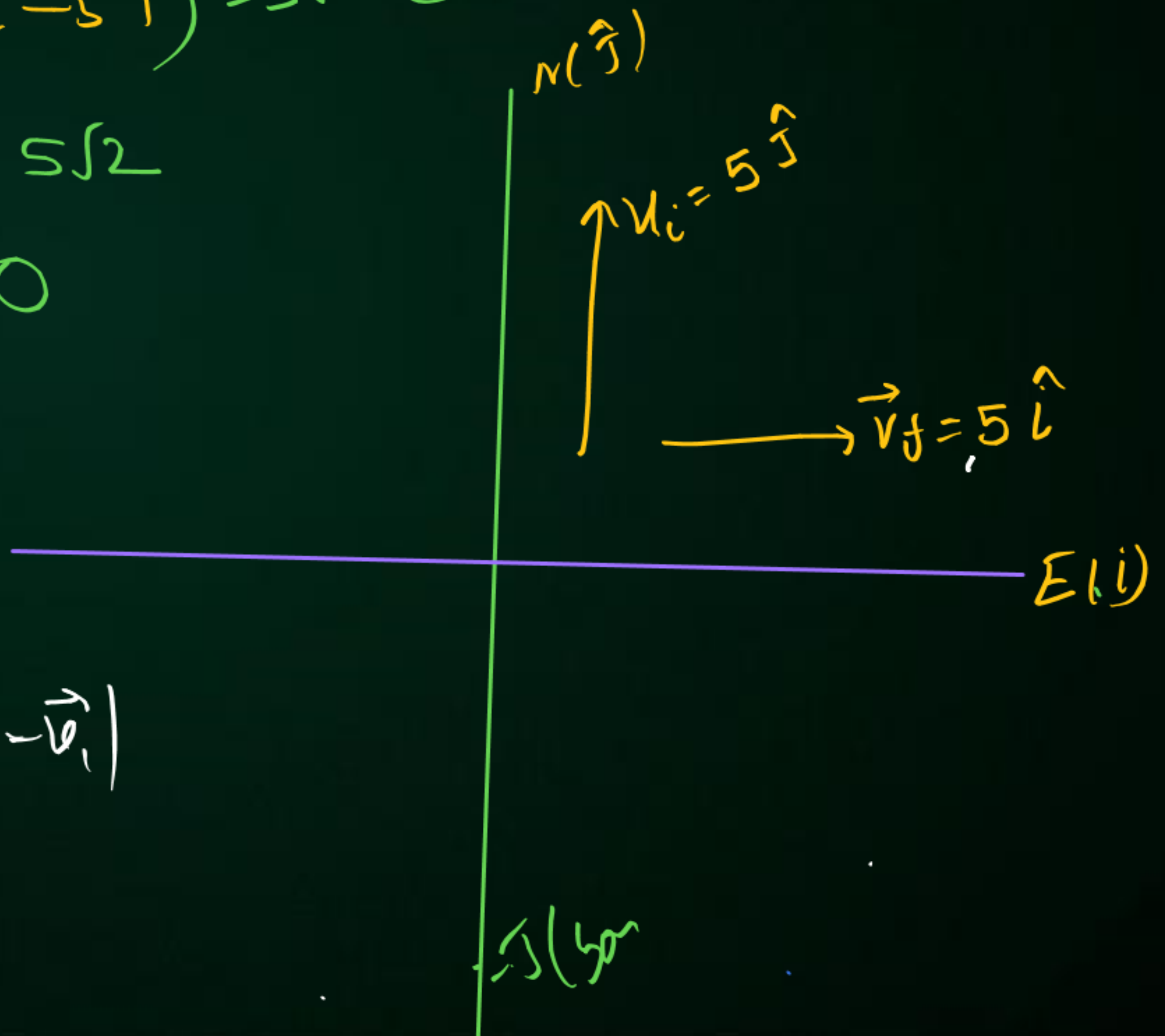
(i) Change in velocity $= \vec{v}_f - \vec{v}_i = (5\hat{i} - 5\hat{j}) = 5\sqrt{2}$ (South east)

(ii) Magnitude of change in velocity $= 5\sqrt{2}$

(iii) Change in magnitude of velocity $= 0$ (speed)

Change in magnitude of velocity $= 0$ (speed)

Magnitude of change in velocity $= |\vec{v}_f - \vec{v}_i|$

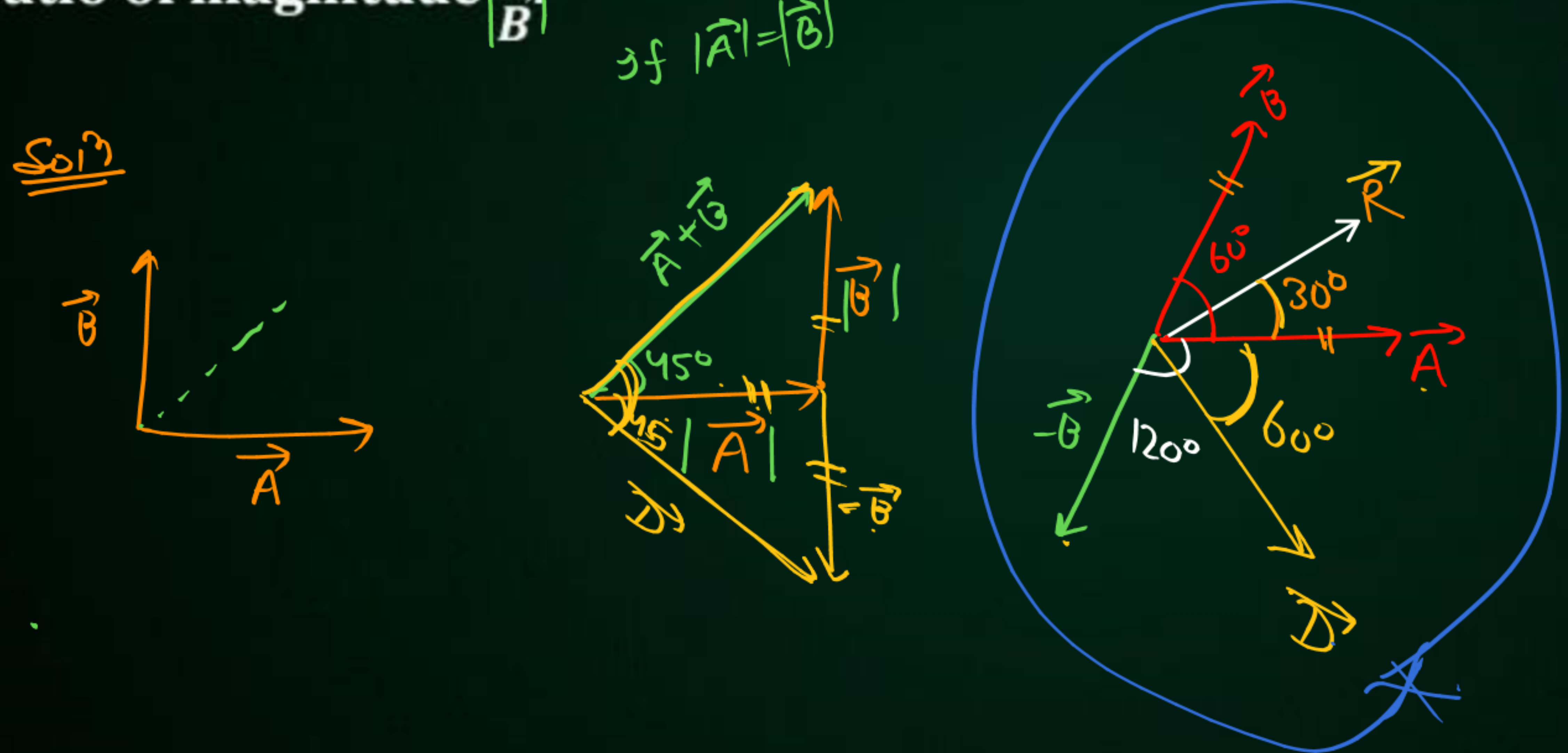


QUESTION

If two vector $\vec{A}$ & $\vec{B}$ such that $\vec{A} + \vec{B}$ is perpendicular to the difference $\vec{A} - \vec{B}$ then ratio of magnitude $\frac{|\vec{A}|}{|\vec{B}|} = ??$

If $|\vec{A}| = |\vec{B}|$

Sol^n



You cant find ratio of Two vector → True.

(Division of vector is not allowed)

Not for all

QUESTION

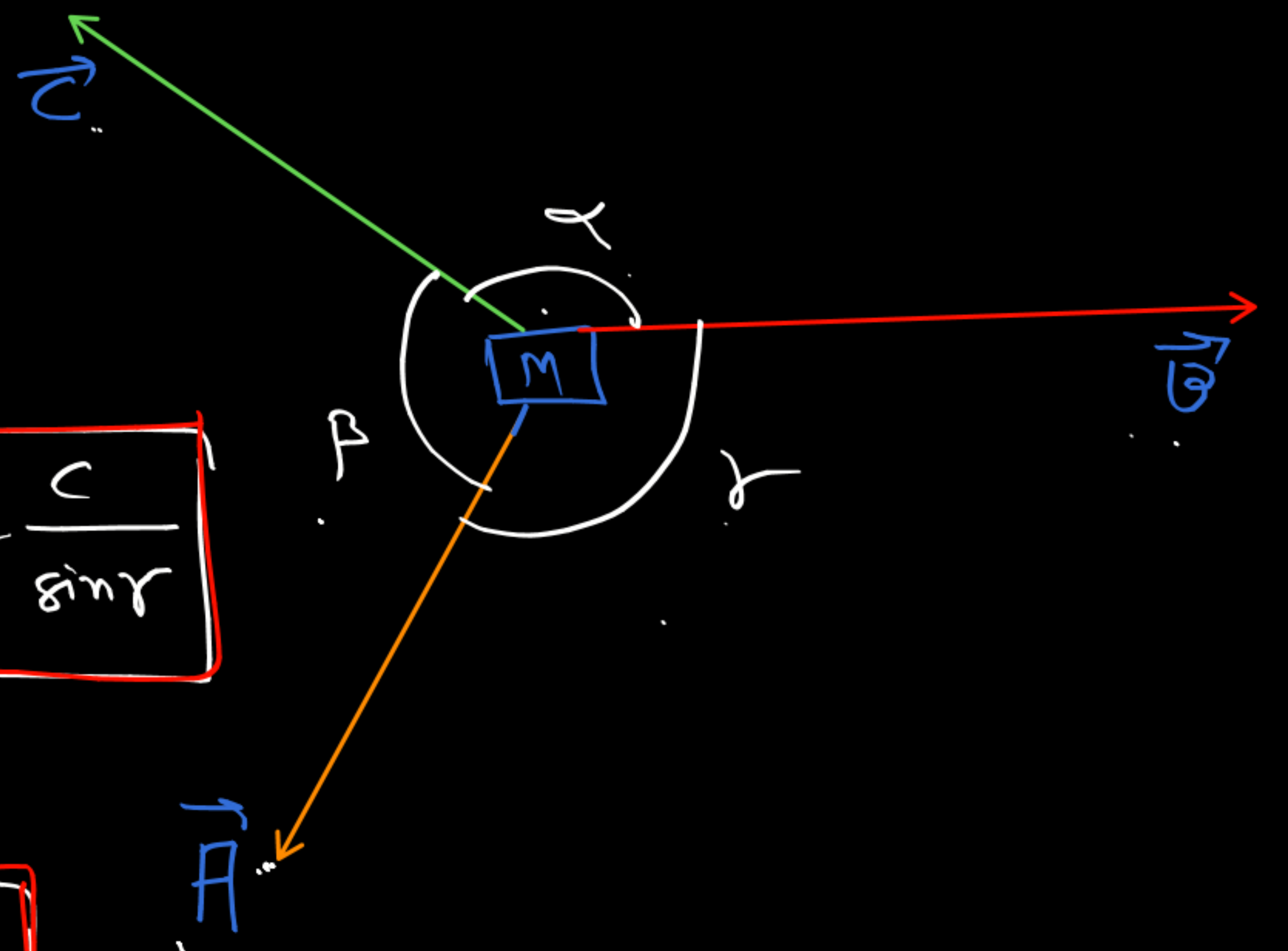
If $|\vec{A} - \vec{B}| = \sqrt{2}$ then calculate the value of $|\hat{A} + \sqrt{3}\hat{B}|$?

H/W
Level up

1. 1
2. 2
3. $\sqrt{2}$
4. $\sqrt{3}$

Lamis Theorms (Laws of motion). for (3-vector)

$$\vec{A}+\vec{B}+\vec{C}=0$$



When Condition

$$\# \quad \frac{A}{\sin\alpha} = \frac{B}{\sin\beta} = \frac{C}{\sin\gamma}$$

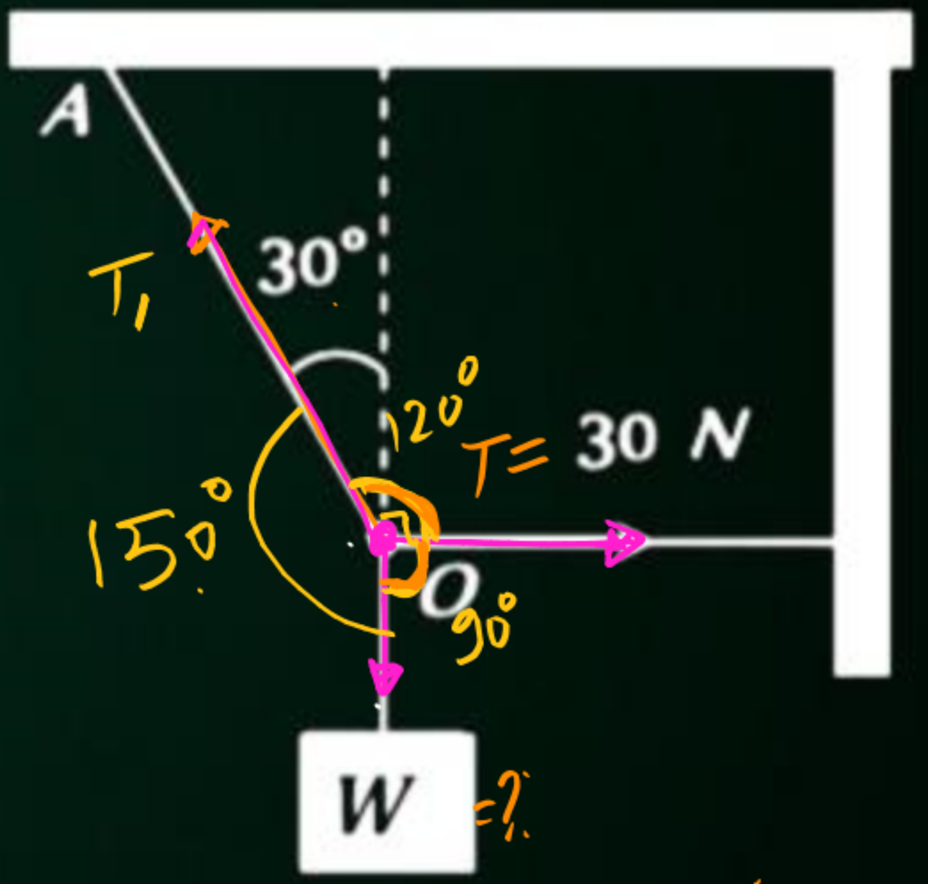
then

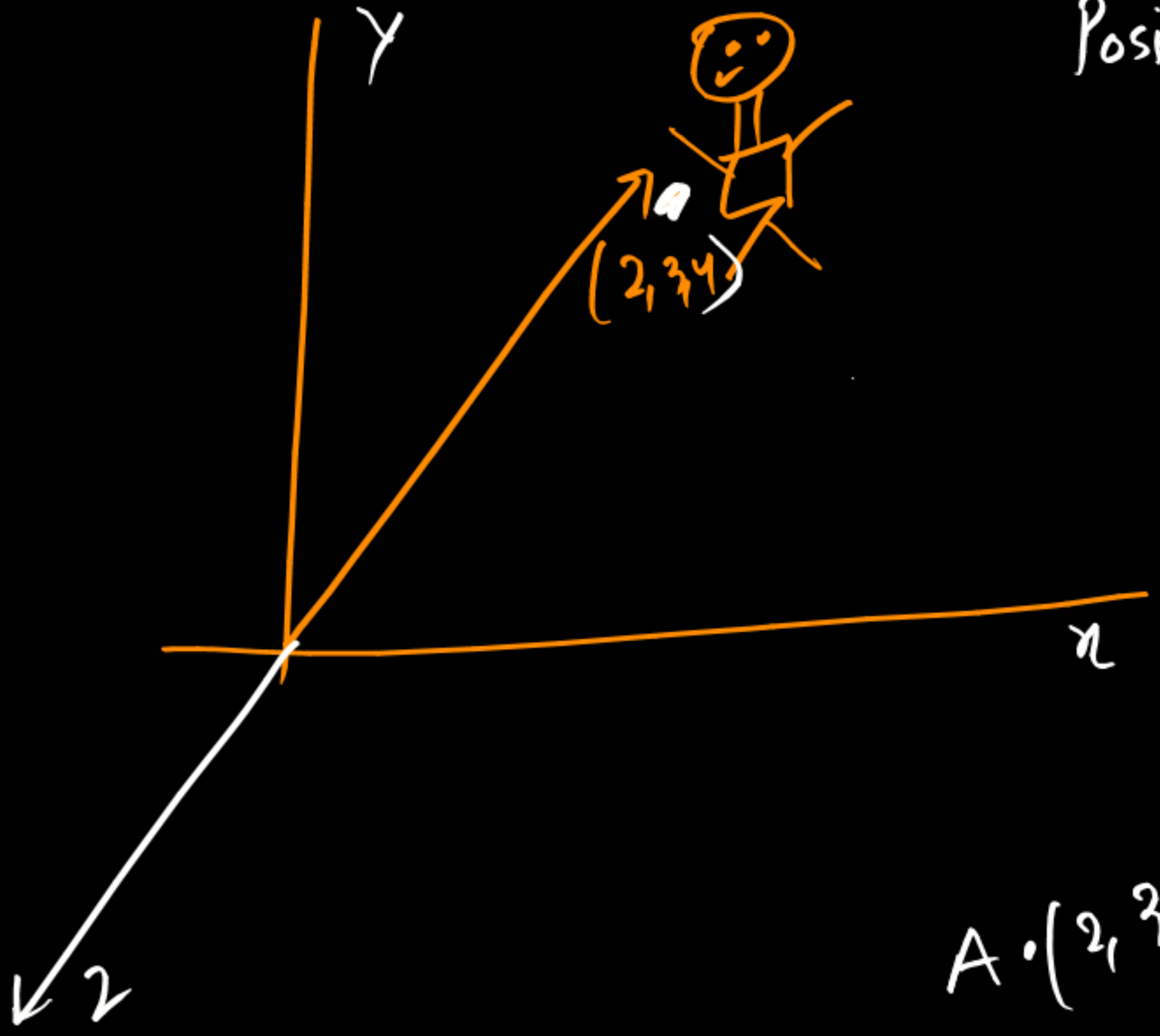
$$\vec{A}+\vec{B}+\vec{C}=0$$

QUESTION

As shown in figure tension in the horizontal cord is 30 N. The weight W and tension in the string OA in Newton are

1. $30\sqrt{3}, 30$
2. $30\sqrt{3}, 60$
3. $60\sqrt{3}, 30$
4. None of these





Position vector (2,3,4)

$$\vec{s} = 2i + 3\hat{j} + 4\hat{j}$$

$$|s| = \sqrt{(2)^2 + (3)^2 + (4)^2}$$

A $(2,3,5)$

B $(6,7,9)$

Position of 'B' w.r.t. 'A'

$$\vec{r}_{BA} = \vec{r}_B - \vec{r}_A$$

$$= (6\hat{i} + 7\hat{j} + 9\hat{k}) - \vec{r}_A$$

$$r_{BA} = 4i + 4\hat{j} + 4\hat{k}$$

$$|r_b| = 4\sqrt{3}$$

QUESTION

Find position vector of A(1, 2, 1) w.r.t. point B(–1, 2, 0)?

H/w

$$\vec{r}_{AB} = \vec{r}_A - \vec{r}_B$$

QUESTION

A particle is moving in a circular path with constant speed v. Then, find magnitude of change in velocity when it rotate by an angle of $60°$.

H.W

QUESTION

If $\vec{A} + \vec{B} = \vec{A} - \vec{B}$ then which of the following option will be corret?

1. Magnitude of $\vec{A}$ may be zero.
2. Magnitude of $\vec{B}$ must be zero.
3. Angle between $\vec{A}$ and $\vec{B}$ must be $90°$
4. Angle between $\vec{A}$ and $\vec{B}$ may be $90°$

H/W

QUESTION

If a student moves as given below:

(i) 50m in East

(ii) 20m in North

(iii) $40\sqrt{2}$m in S-E direction. Find net Displacement?

(IIT - 2016)

H/w


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 5 | Physics

VECTORS



By- Dr. Manish Raj (MR SIR)

Topics to be covered

1. H/W
2. Scalar Product (Dot Product)
3. vector Product. ×
4.

DPP-B (Assignment)



QUESTION

If $|\hat{A} - \hat{B}| = \sqrt{2}$ then calculate the value of $|\hat{A} + \sqrt{3}\hat{B}|$?

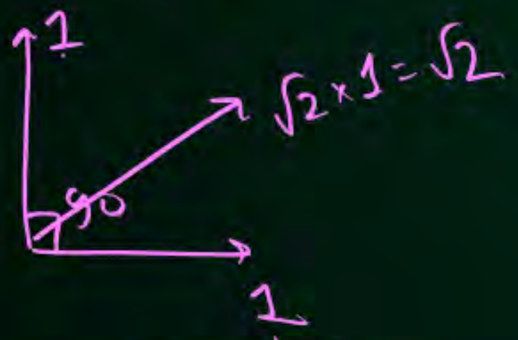
1. 1
2. 2
3. $\sqrt{2}$
4. $\sqrt{3}$

H/W

Sol^n

$\hat{A} = 1$

$\hat{B} = 1$



$\hat{A} = 1$ $\hat{B} = 1$

$\theta = 0° \rightarrow D = 0$

$\theta = 60° \rightarrow D = 1$

$\theta = 90° \rightarrow D = \sqrt{2}$

$\theta = 120° \rightarrow D = \sqrt{3}\times 1$

$\theta = 180°$ $D = 2$

$1 + \sqrt{3}\hat{B}$, $\theta = 90°$

$R = \sqrt{1^2 + (\sqrt{3})^2 + 2\times 1\sqrt{3}\cos 90°}$

$= \sqrt{1+3} = \sqrt{4} = 2$

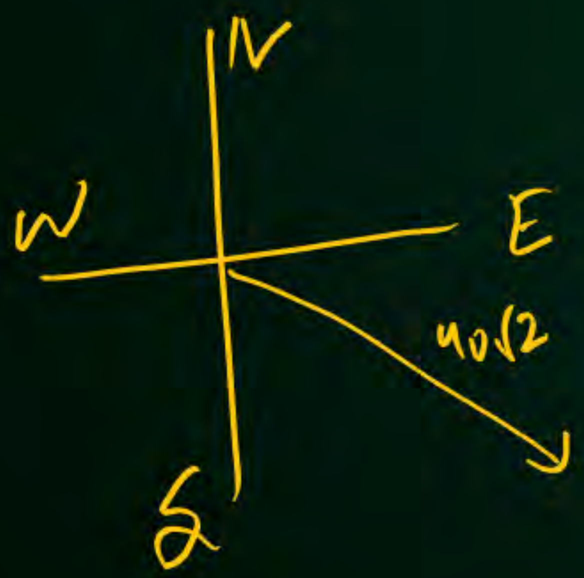
QUESTION

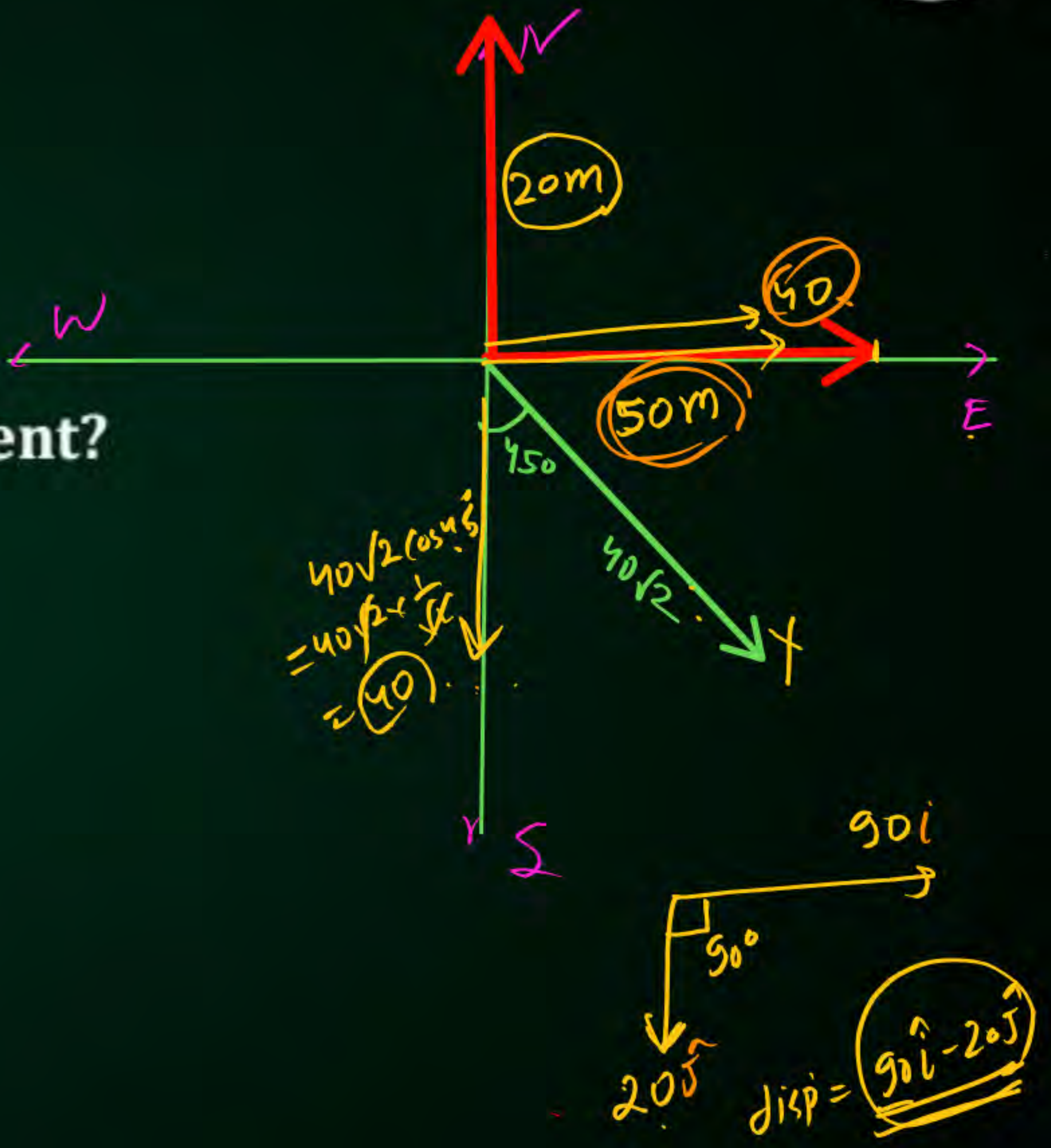
If a student moves as given below:

(i) 50m in East

(ii) 20m in North

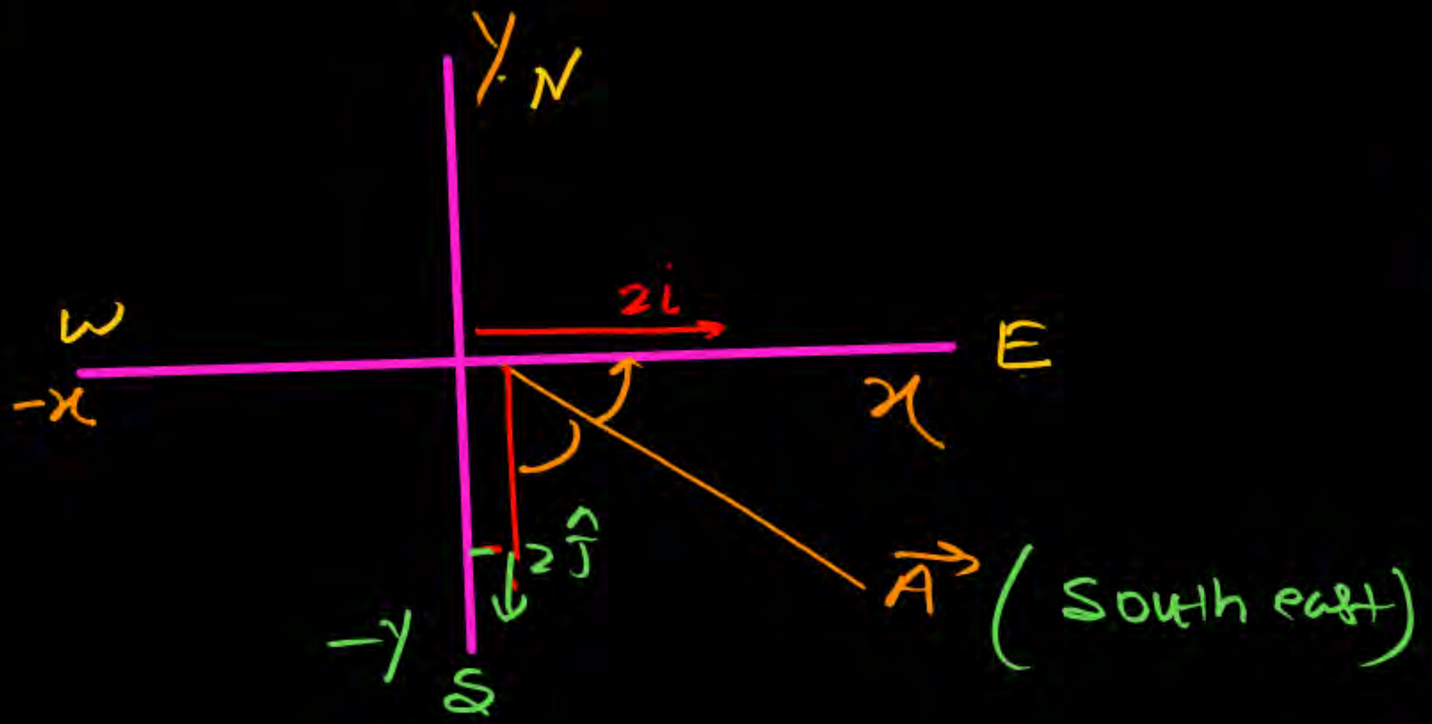
(iii) $40\sqrt{2}$m in S-E direction. Find net Displacement?

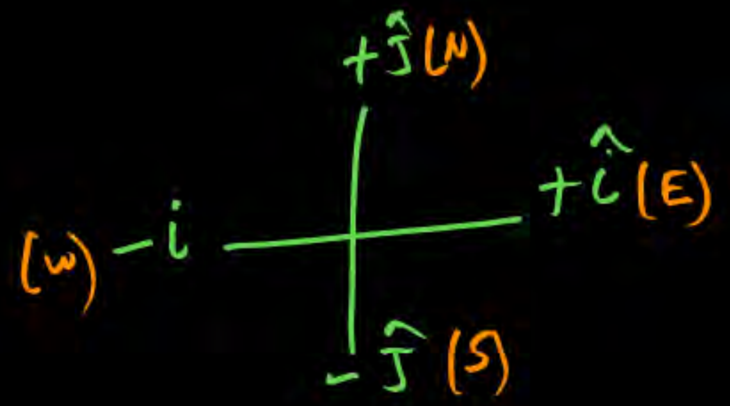




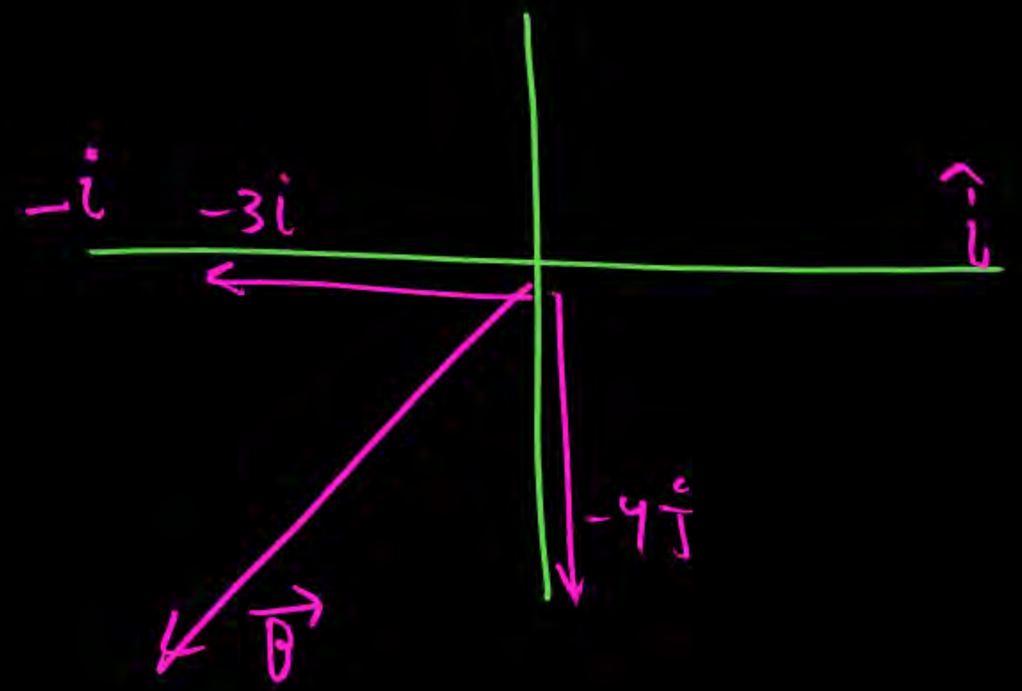
Draw given vector

$\vec{A} = 2\hat{i} - 2\hat{j}$



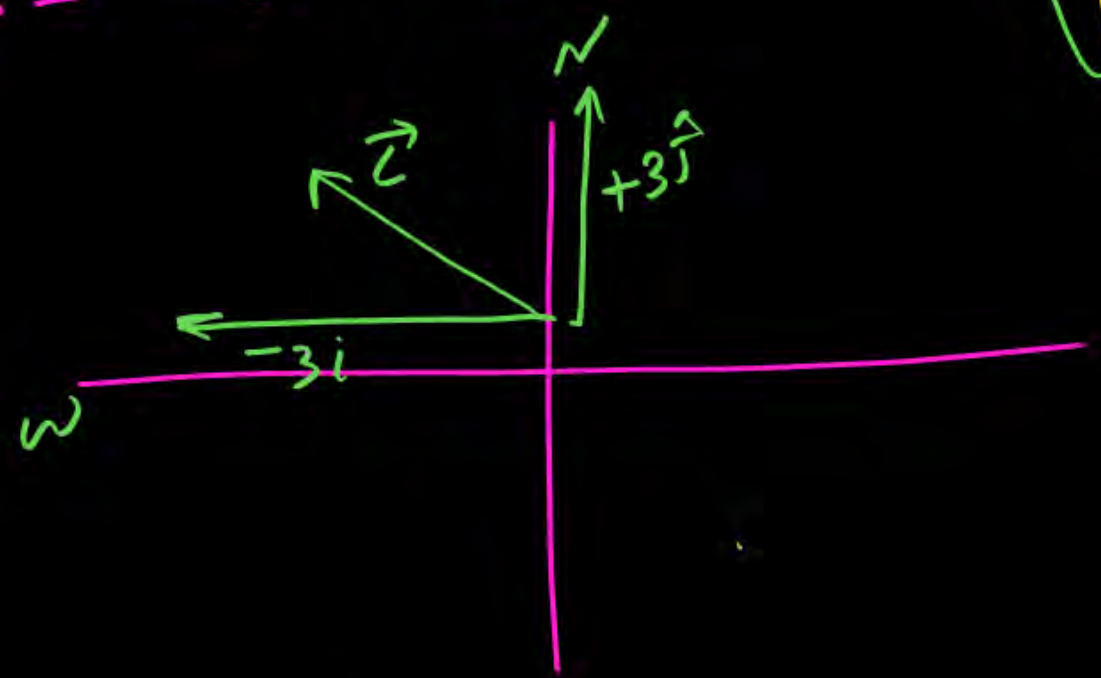


$\vec{B} = -3\hat{i} - 4\hat{j}$





$\vec{C} = -3i + 3\hat{j}$



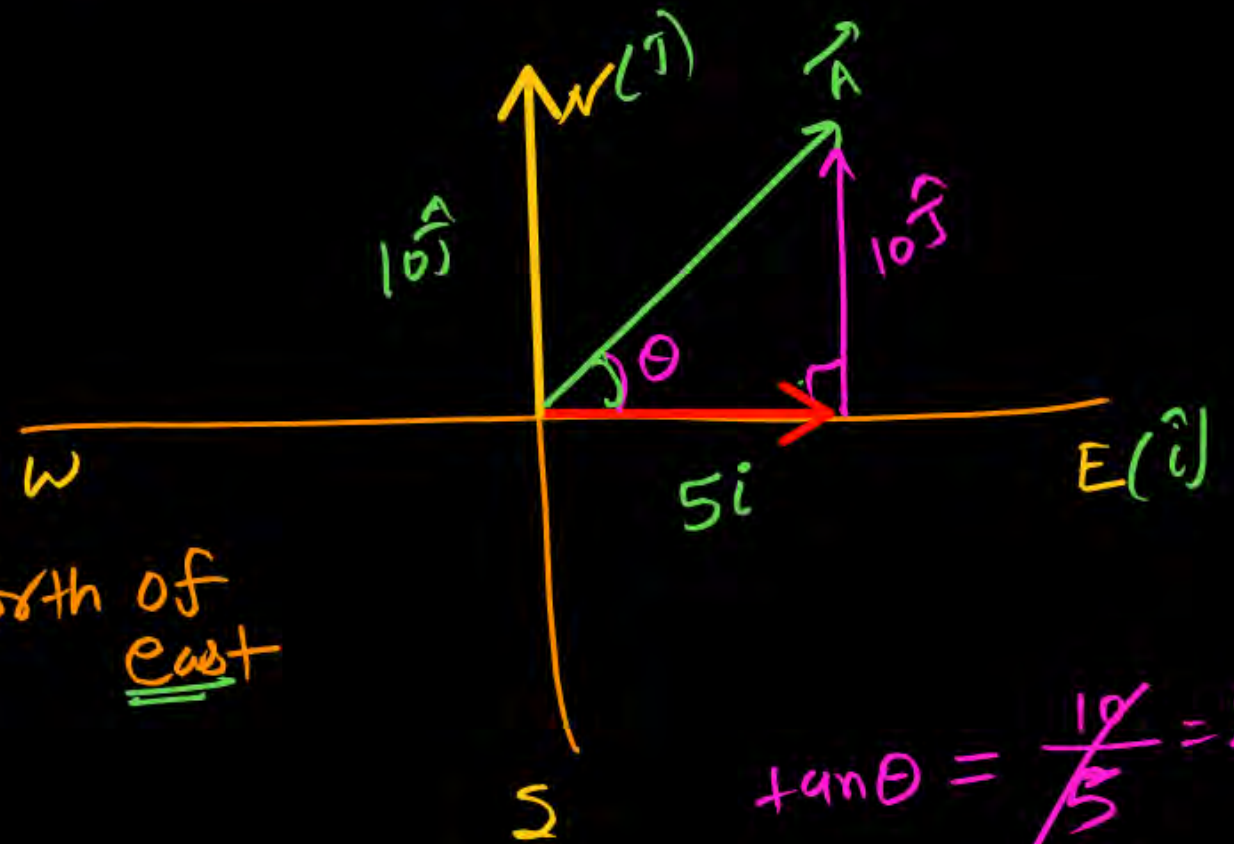
$\vec{A} = 5\hat{i} + 10\hat{j}$ Draw & write with direction

$|A| = \sqrt{5^2 + (10)^2} = \sqrt{125}$

$= \sqrt{25 \times 5}$

$|\vec{A}| = 5\sqrt{5}$

→ at an angle $\tan^{-1}(2)$ North of east

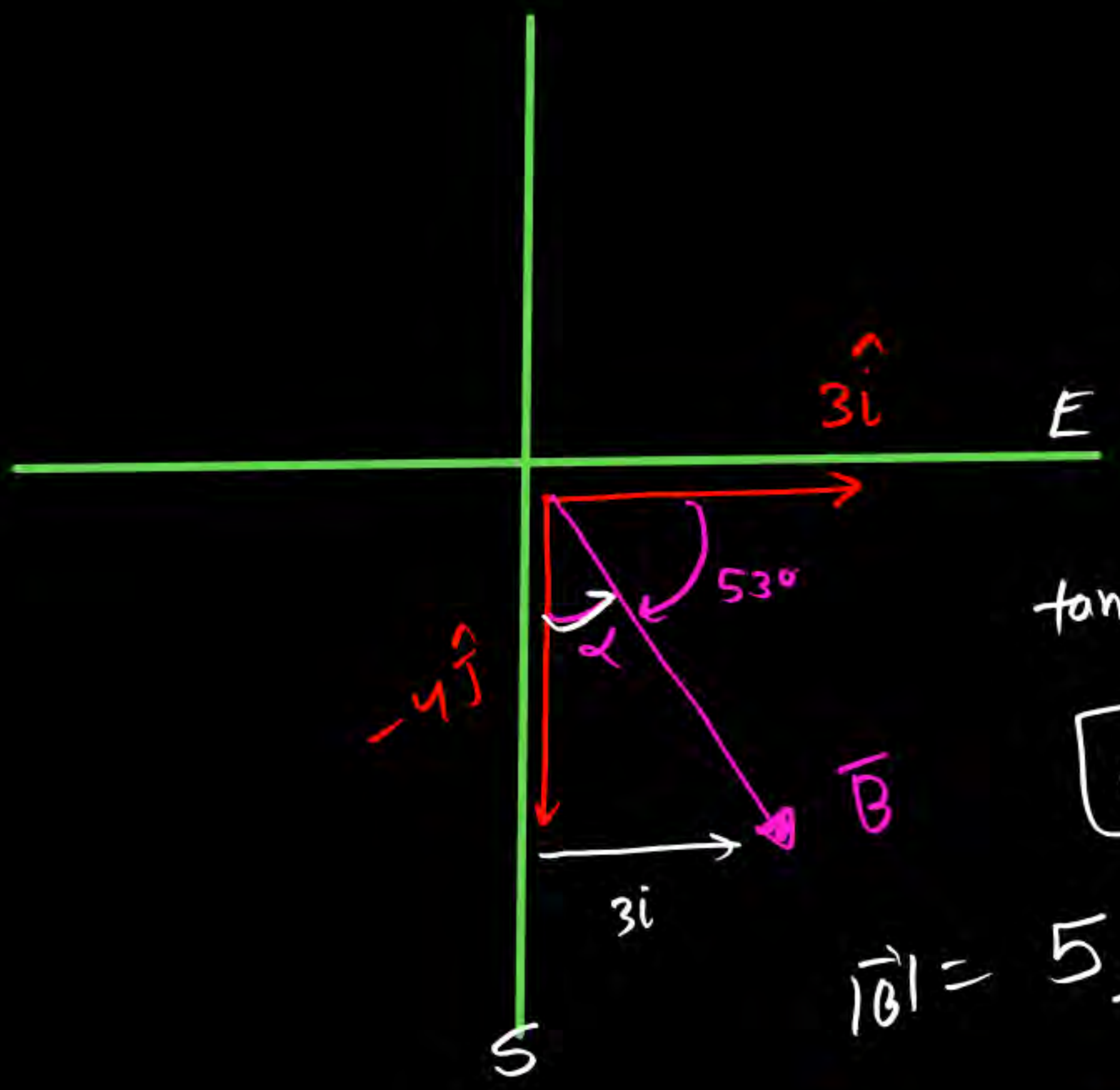


$\tan\theta = \frac{10}{5} = 2$

$\theta = \tan^{-1}(2)$

↑ Angle b/w $\vec{A}$ & (East) x-axis

$\vec{B} = +3\hat{i} - 4\hat{j}$ draw & write with direction ??



$\tan\alpha = \frac{3}{4}$

$\alpha = 37°$

$|\vec{B}| = 5$, at 37° east of south

$\vec{B} = 5$ at 53° South of east

displacement $= \vec{r}_f - \vec{r}_i$

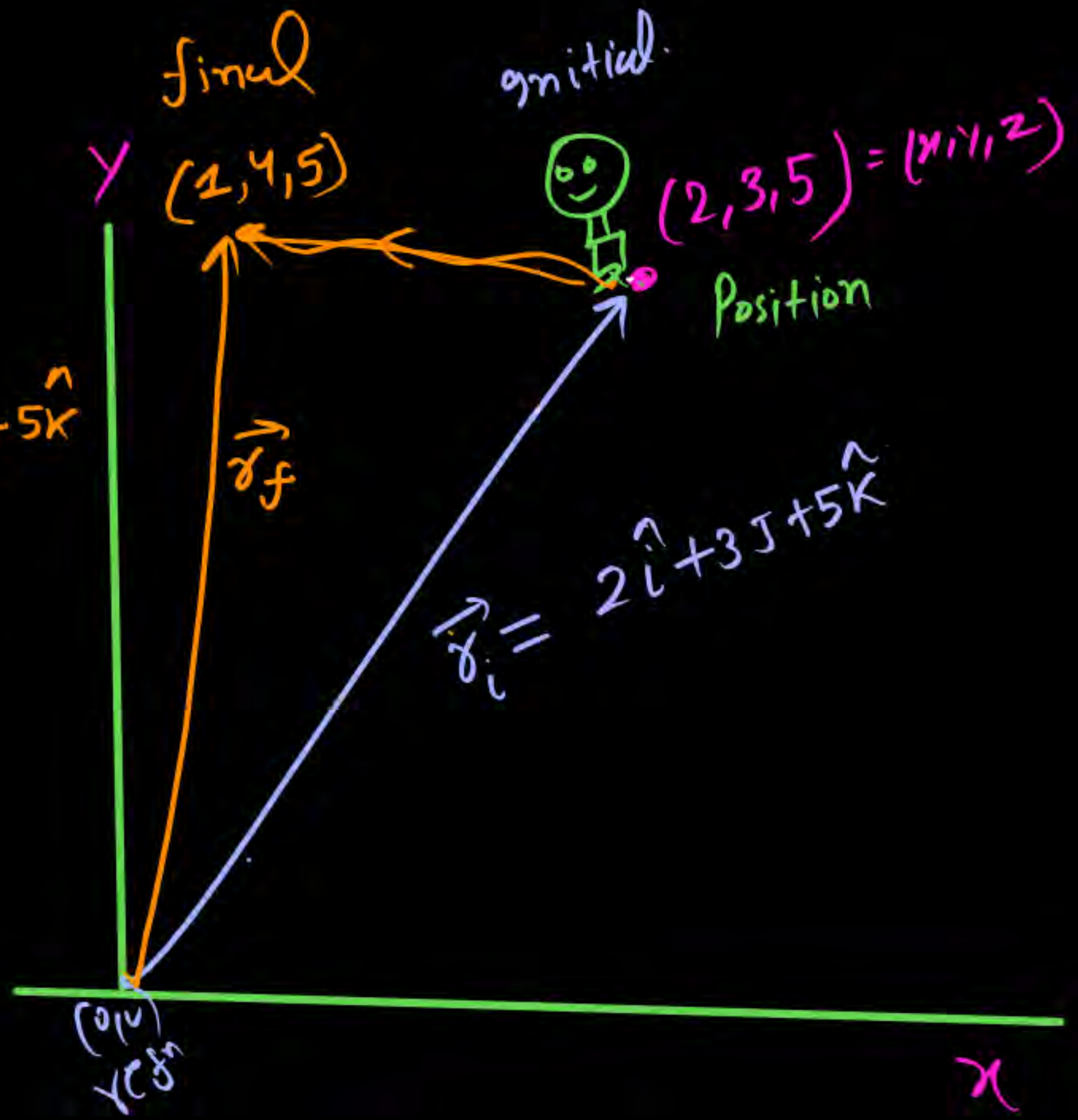
$$= (1\hat{i} + 4\hat{j} + 5\hat{k}) - (2\hat{i} + 3\hat{j} + 5\hat{k})$$

$$= -\hat{i} + \hat{j} + 0$$

$$\overrightarrow{\text{disp}} = -\hat{i} + \hat{j}$$

$$|\text{disp}^n| = \sqrt{(-1)^2 + (1)^2}$$

$$= \sqrt{2} \quad \text{Ans}$$



QUESTION

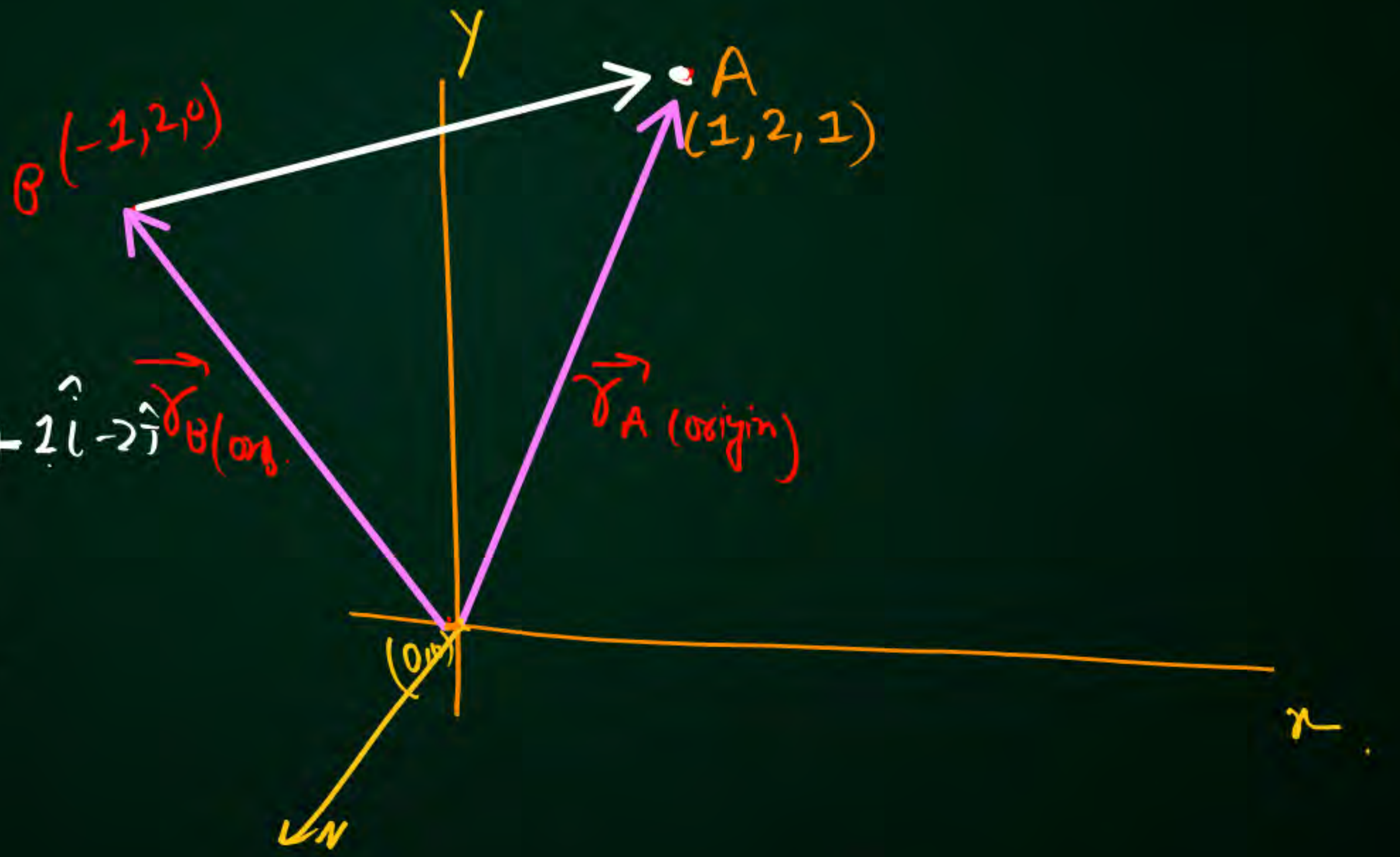
Find position vector of A(1, 2, 1) w.r.t. point B(–1, 2, 0)?

$$\vec{r}_{AB} = \vec{r}_A - \vec{r}_B$$

$$= \hat{i}+2\hat{j}+\hat{k}+\hat{i}-2\hat{j}$$

$$\boxed{\vec{r}_{AB} = 2\hat{i}+\hat{k}}$$

$$|\vec{r}_{AB}| = \sqrt{5}$$



QUESTION

Object is moving on circular path with constant speed then find magnitude of change in velocity. When it is rotated by an angle θ.

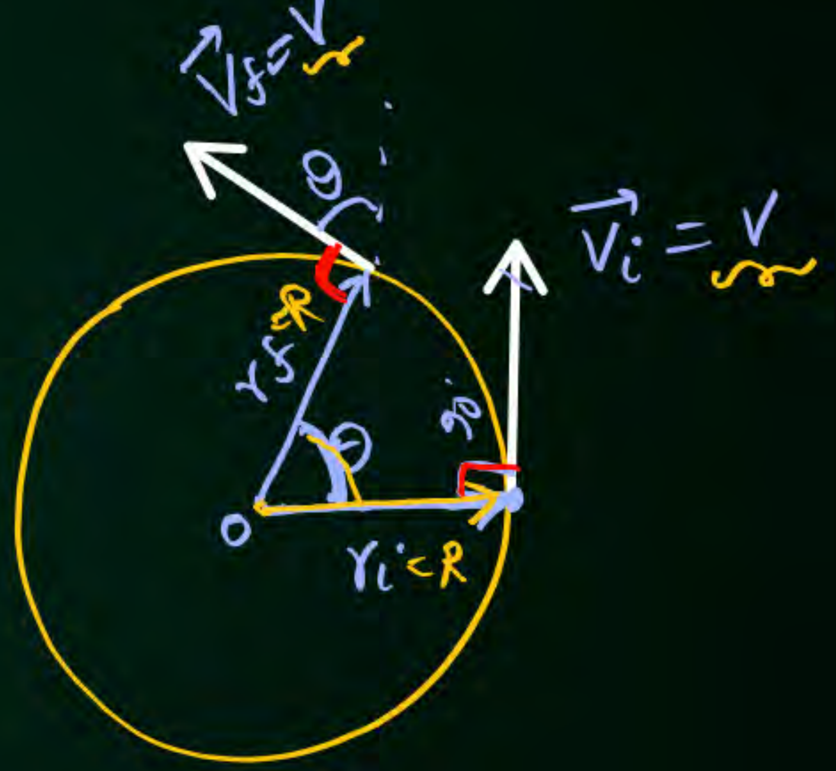
change in velocity $= \vec{V_f} - \vec{V_i}$

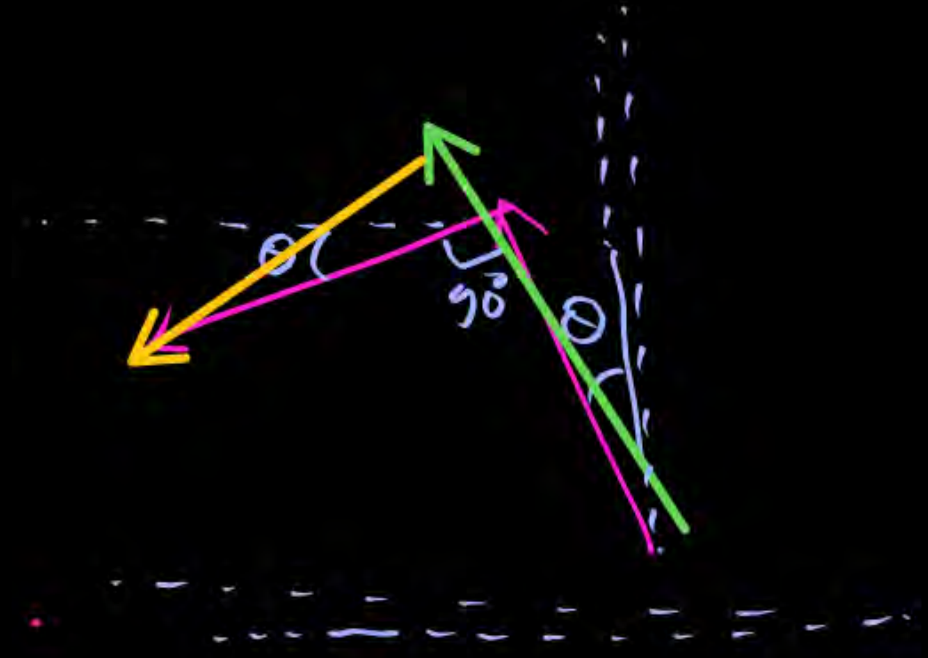
$= 2v\sin(\theta/2)$



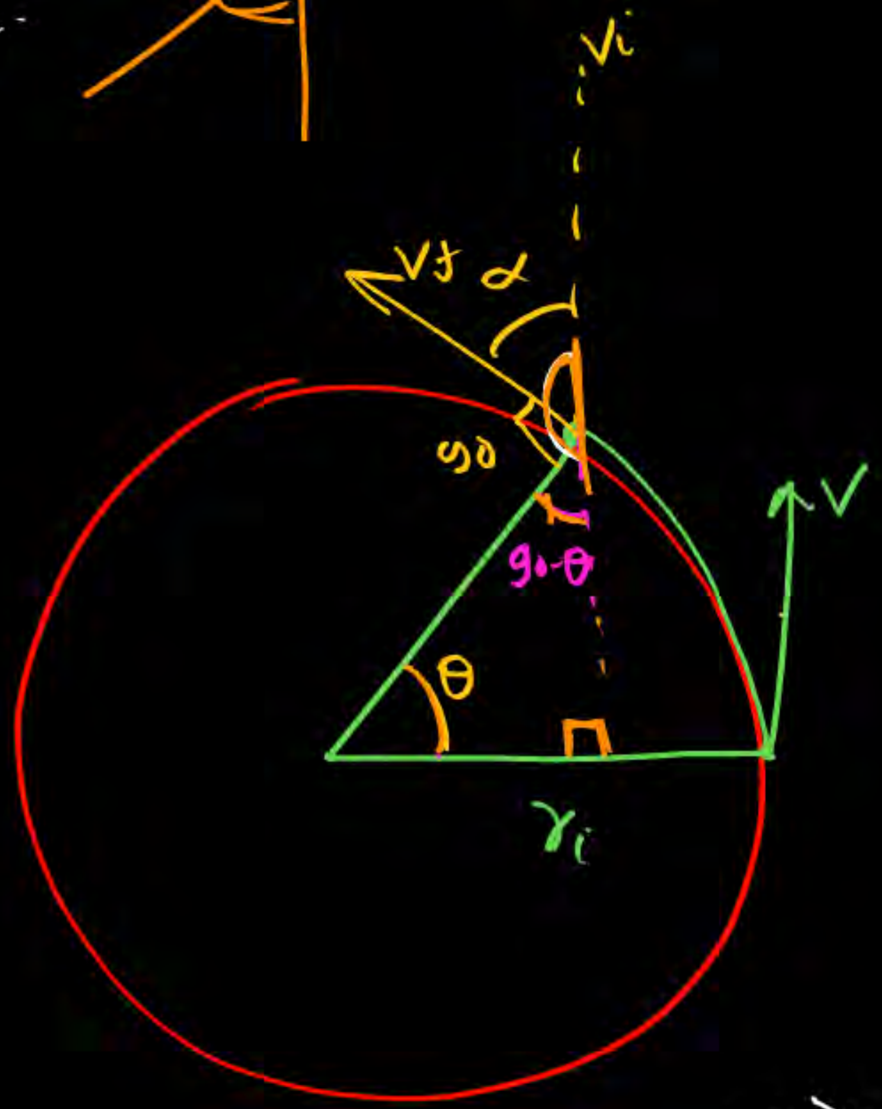
dispm = Change in Position $= \vec{r_f} - \vec{r_i}$

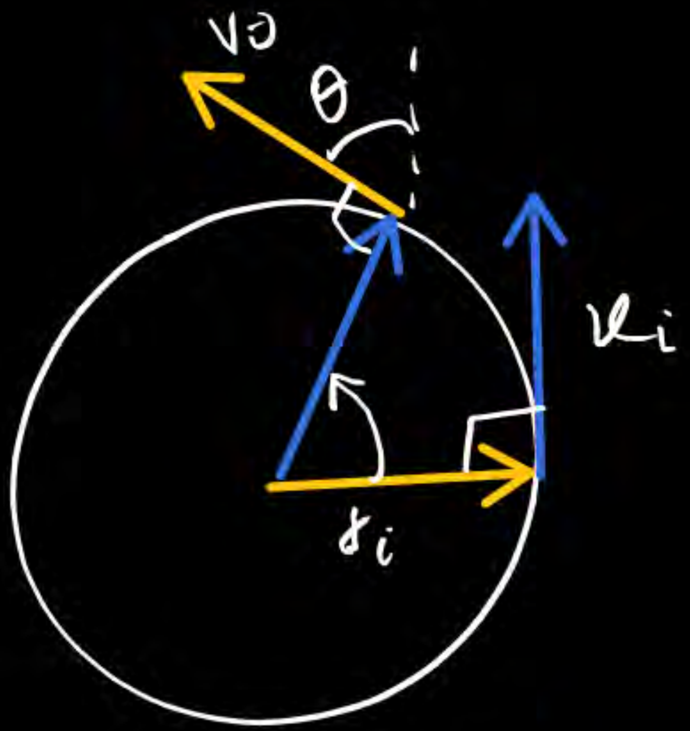
$= 2R\sin(\theta/2)$











$$\alpha + 90 + 90 - \theta = 180$$

$\boxed{\theta = \alpha}$

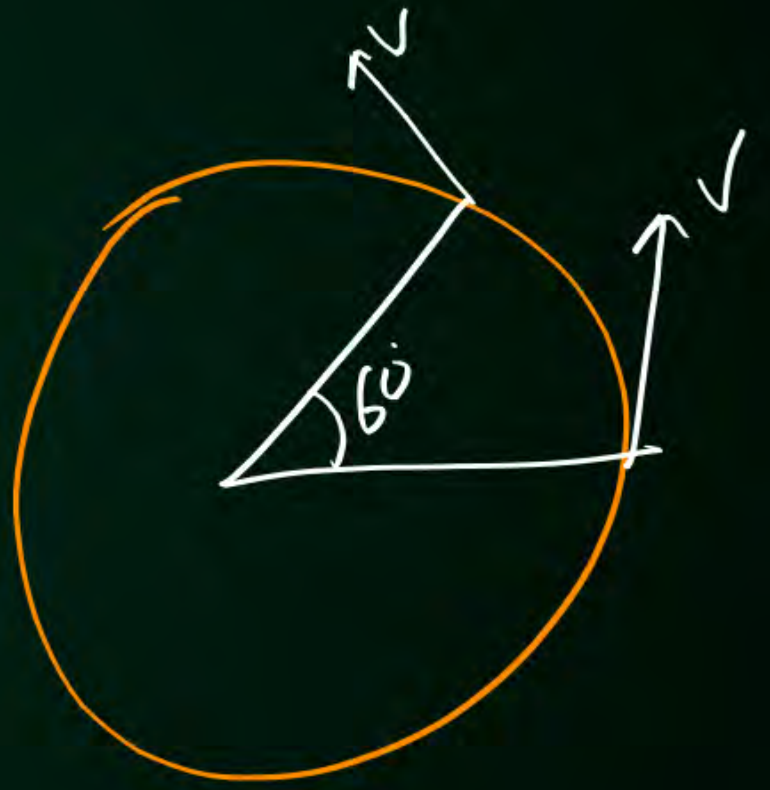
QUESTION

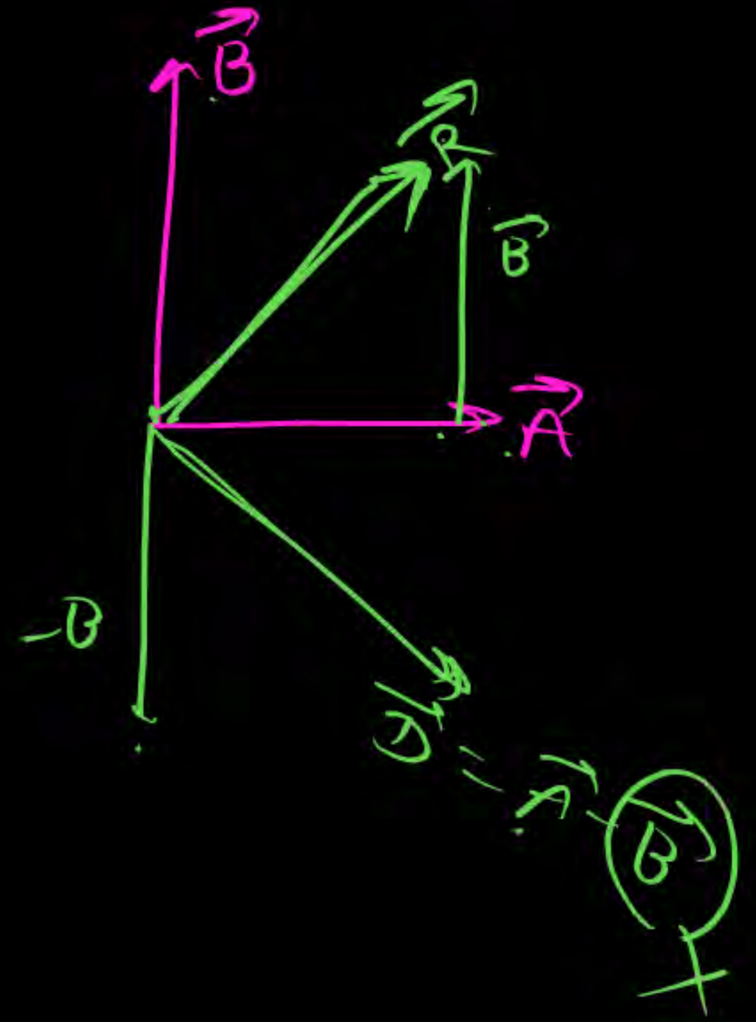
A particle is moving in a circular path with constant speed v. Then, find magnitude of change in velocity when it rotate by an angle of 60°.

$$\overrightarrow{\Delta v} = 2v \sin\theta/2$$

$$= 2v \sin\left(\frac{60°}{2}\right) \quad (30°)$$

$$|\overrightarrow{\Delta v}| = v$$





$$\vec{A} + \vec{B} = \vec{A} - \vec{B}$$

different

$\vec{B} = 0$ only possible when $\vec{B} = 0$

$$|\vec{A} + \vec{B}| = |\vec{A} - \vec{B}|$$

when Angle b/w $\vec{A}$ & $\vec{B}$ is 90°

QUESTION

If $\vec{A} + \vec{B} = \vec{A} - \vec{B}$ then which of the following option will be corret?

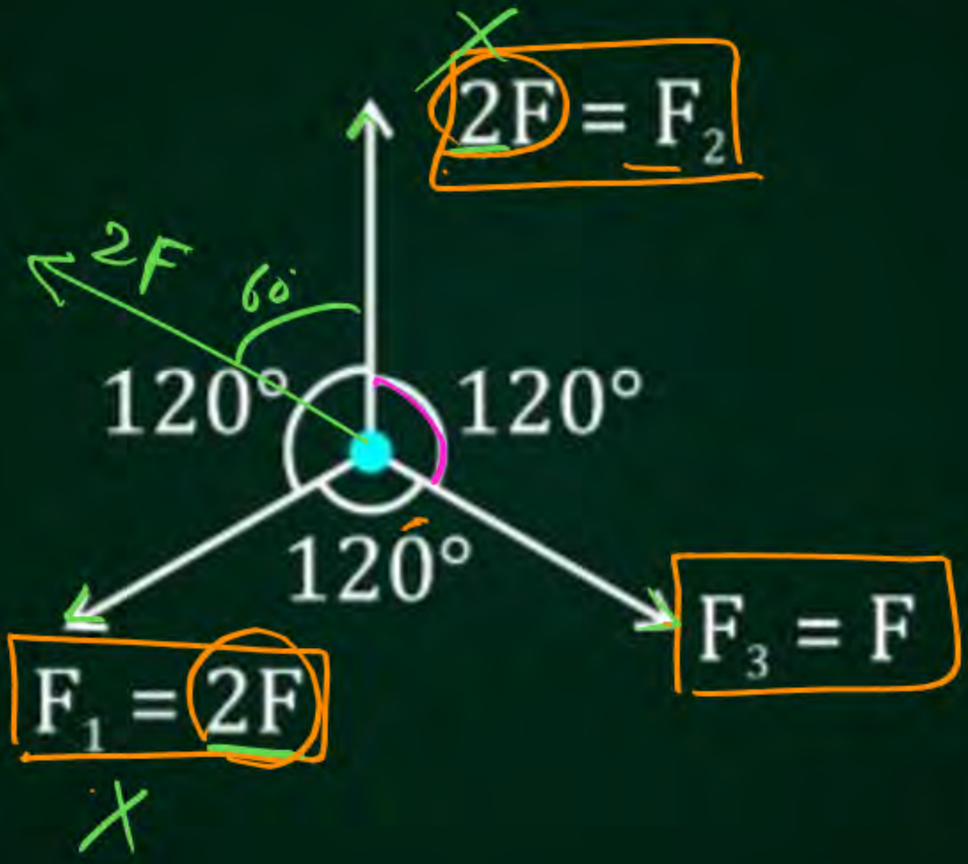
1. Magnitude of $\vec{A}$ may be zero.
2. Magnitude of $\vec{B}$ must be zero.
3. Angle between $\vec{A}$ and $\vec{B}$ must be 90°
4. Angle between $\vec{A}$ and $\vec{B}$ may be 90°

QUESTION

If three force acting on the object as shown in figure. Then find net force on object.

Net force on this Object(Point)



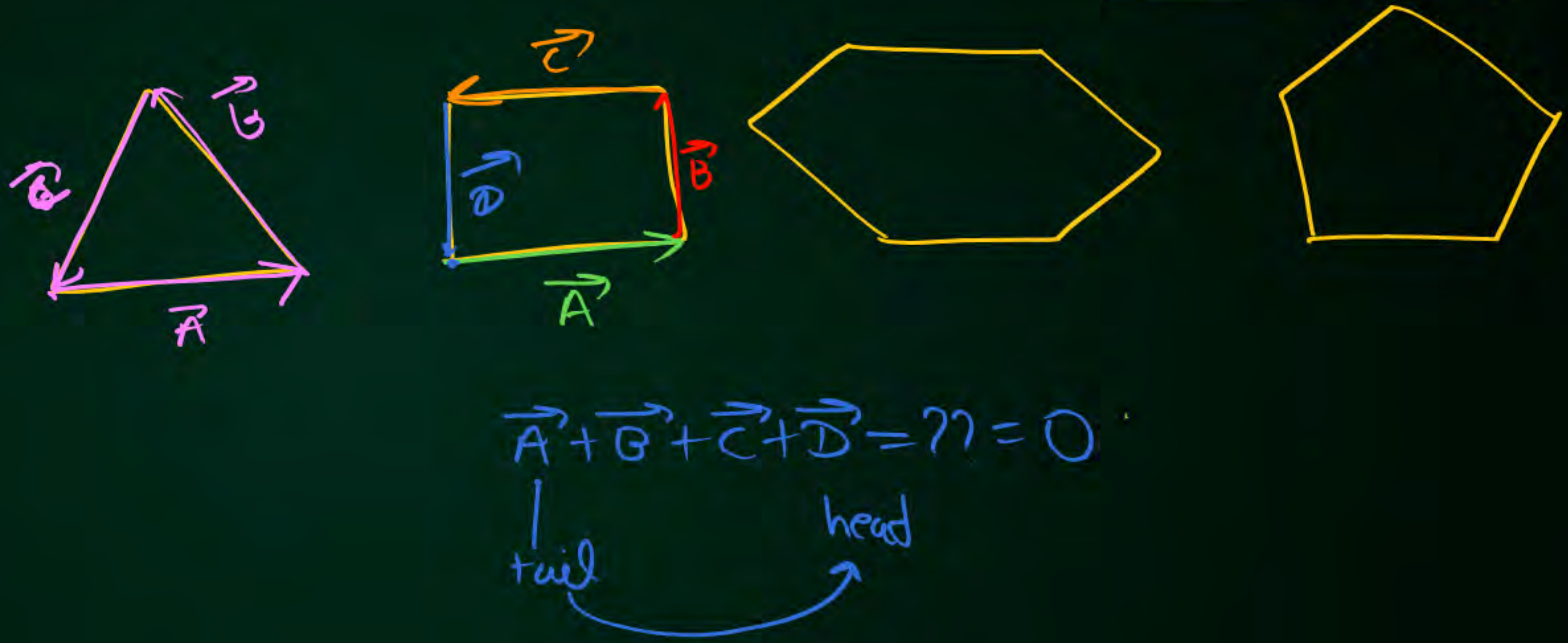


$F_{net} = 2F - F = F$

QUESTION

A set of vectors taken in a cyclic order gives a close polygen, then resultant of these vector is:

1. Unit vector
2. Null vector
3. Axial vector
4. Parallel vector



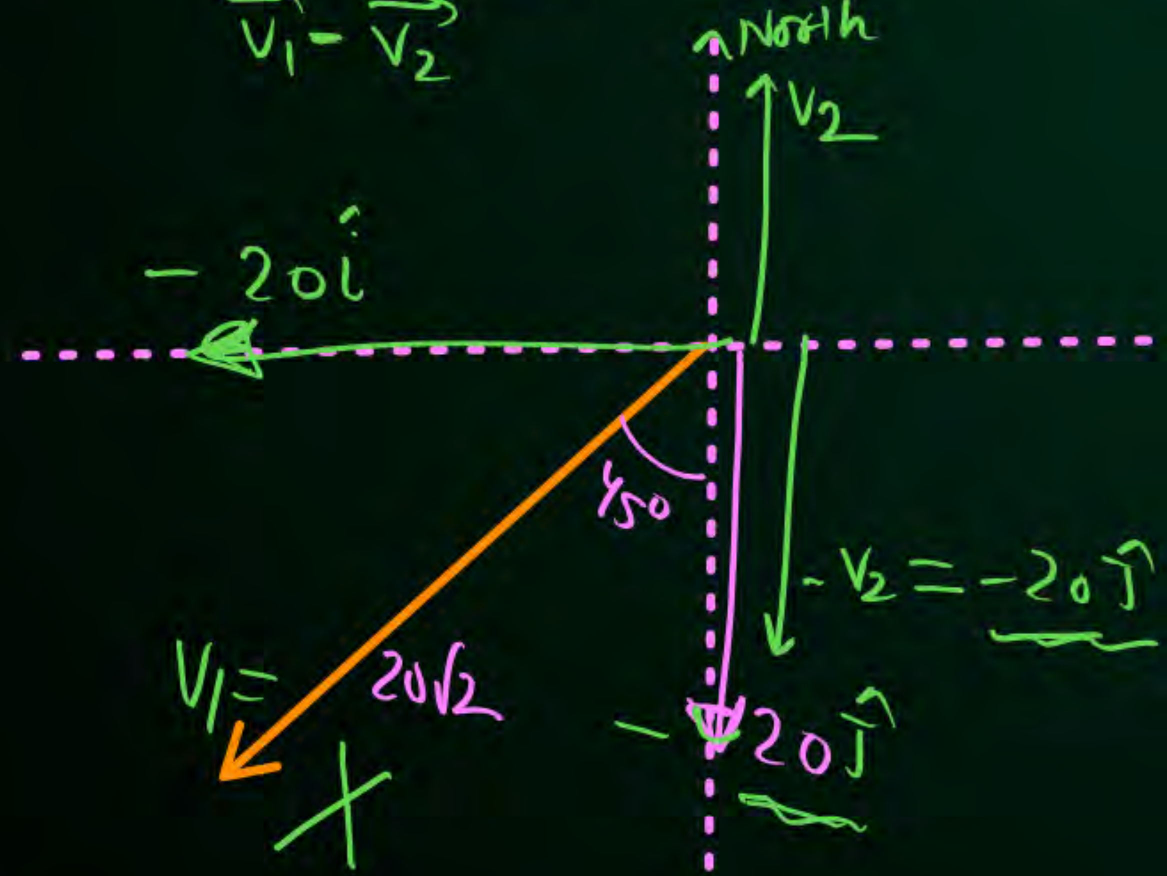
QUESTION

Two object moving with velocity $V_1 = 20\sqrt{2}$ South-West and $V_2 = 20$ m/s North then $\vec{V}_1 + \vec{V}_2 = ?$ = 20 m/s west

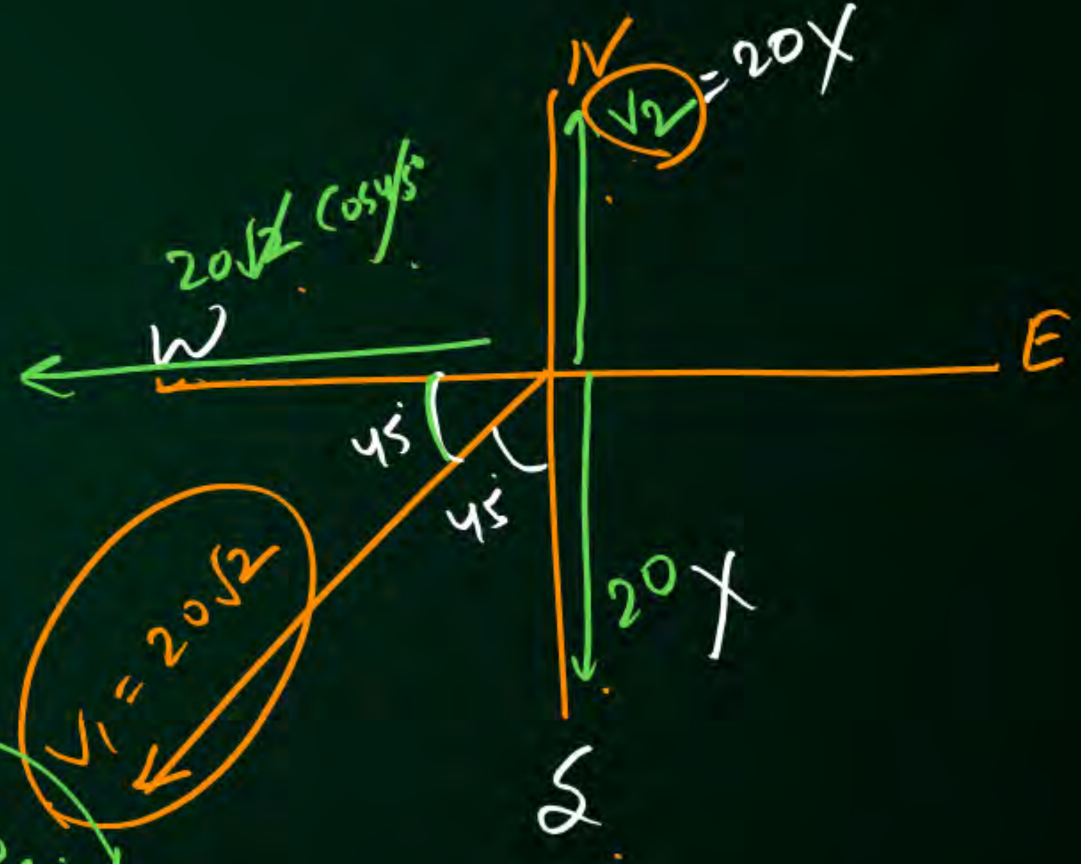
& $\vec{V_1} - \vec{V_2} = ??$

Sol^n $\vec{V_1} + \vec{V_2}$ = 20 m/s west $= -20\hat{i}$

$\vec{V_1} - \vec{V_2}$



$\vec{V_1} - \vec{V_2} = -40\hat{j} - 20\hat{i}$



QUESTION

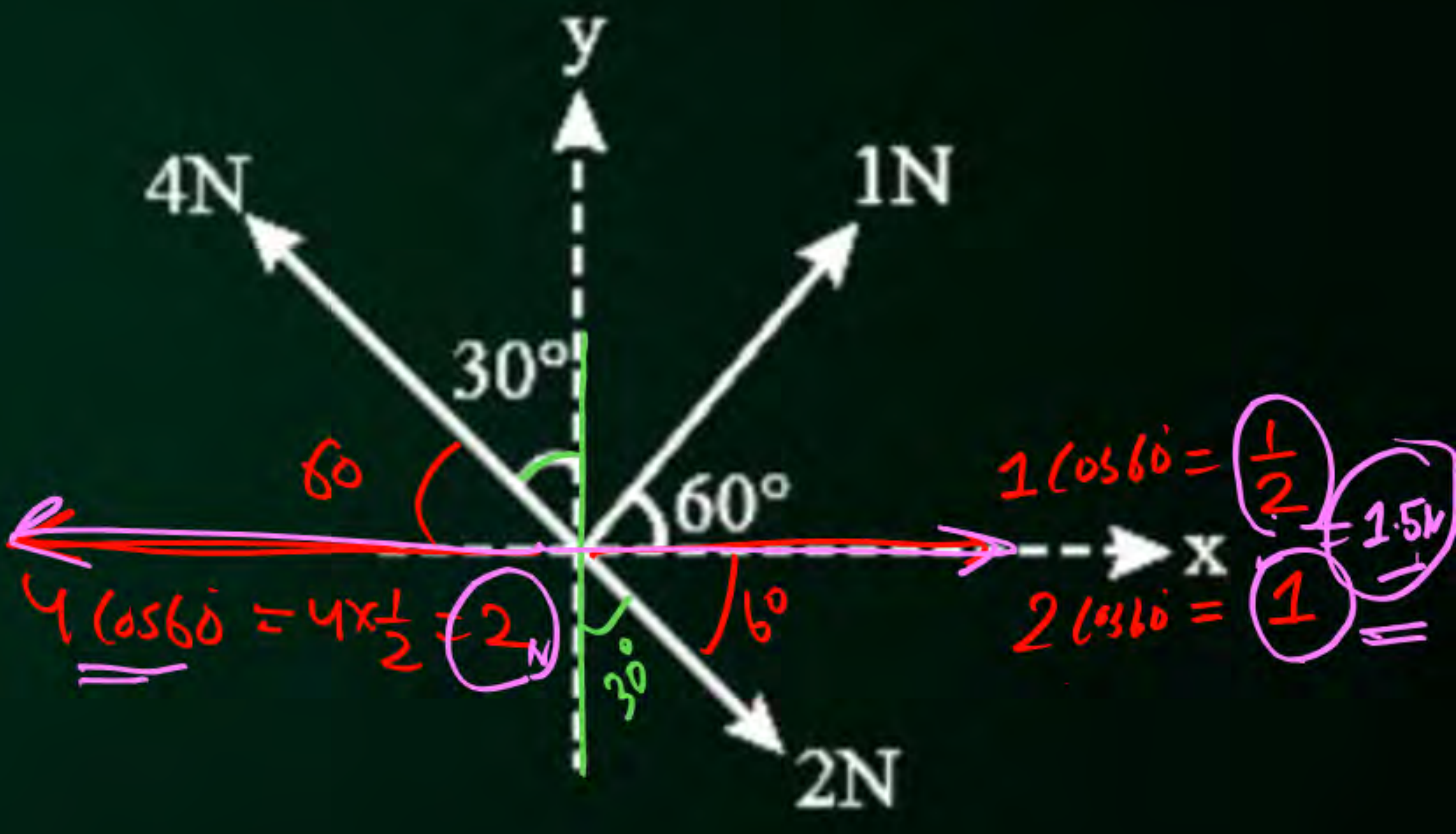
Three force acting on the body as shown in figure. To have resultant force only along y-axis, magnitude of minimum additional force needed is?

(1) $\sqrt{3}$ N

(2) $\frac{\sqrt{3}}{2}$ N

(3) 1.5 N

(4) $\frac{1}{2}$ N



$\vec{A} = 2\hat{i} + 3\hat{j}$

$\vec{B} = 2\hat{i} - 3\hat{j}$

$\frac{\vec{A}}{\vec{B}}$ = Not Possive

= Division of vector is Not Possible

$\frac{F_1 = 4 \text{ east}}{F_2 = 5 \text{ east}}$

$\frac{\text{east}}{\text{south}}$ ✗

$\frac{|\vec{A}|}{|\vec{B}|}$ = This is Possible $= \frac{1}{1}$

Multiplication of Vector with Scalar:

(i) If Scalar is Positive:

Direction remains same magnitude will change

$\vec{A}$ vector λ is scalar then $\lambda\vec{A}$ is product of vector and scalar

(Q) $\vec{A} = 2\hat{i} - 4\hat{j}$
Find Angle B/w $\vec{A}$ & $4\vec{A}$??

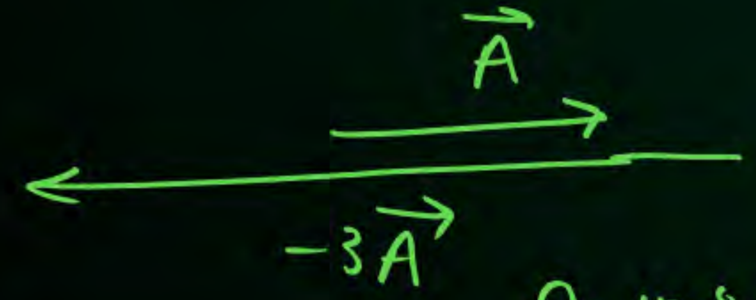
Sol^n 0°



(ii) If ~~Vector~~ Scalar is Negative:

Direction becomes opposite and magnitude will same.

$\vec{A}$, $-3\vec{A}$



$\theta = 180^\circ$ (B/w $\vec{A}$, $-3\vec{A}$)

QUESTION

If $\vec{A}$ and $\alpha\vec{A}$ will be parallel to each other then α must be

(a) Positive

(b) Negative

(c) Zero

Addition of Vector with Scalar is not allowed.

Subtract

$4 + 4N$ = Not defined

force + mass ✗

$\lambda \vec{A}$ ✓

$\lambda + \vec{A}$ ✗

$4 + 4N$ → ✗

Division of two vector is not allowed. ✓

$$\frac{\vec{A}}{\vec{B}} = \frac{4N\hat{i}}{6N\hat{j}} = \frac{2}{3}\frac{\hat{i}}{\hat{j}}$$ ✗

$\vec{A} = 3\hat{i} + 4\hat{j}$

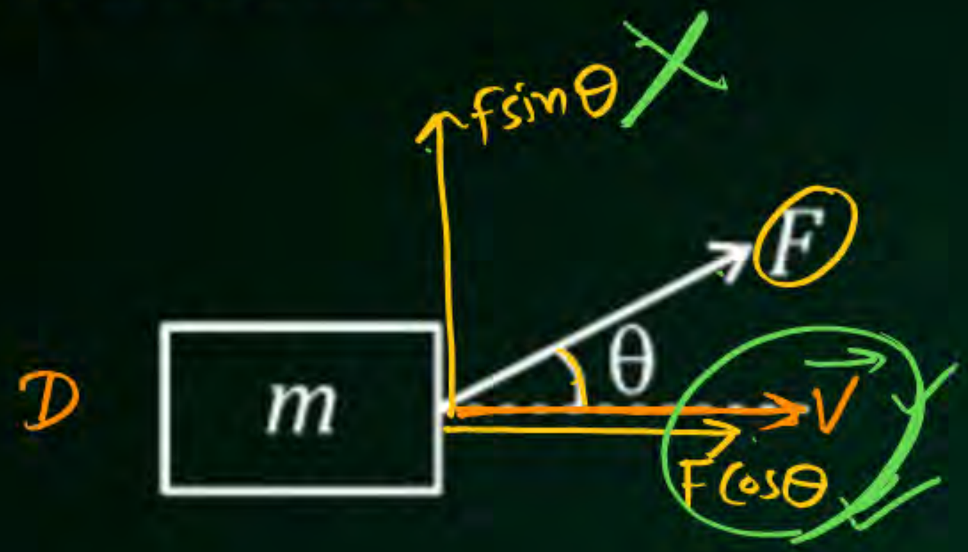
find $3 + \vec{A} = 3 + 3\hat{i} + 4\hat{j}$

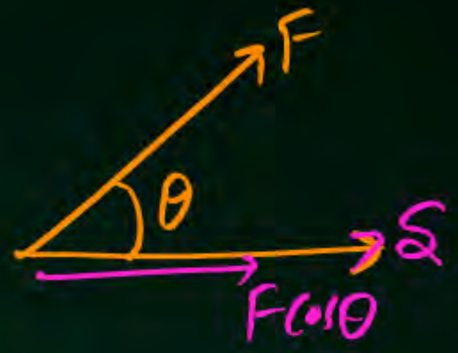
wrong

9th class physics

1) Kinemat
2) work energy
3) gravitat
4) Sound

Feel of work done:

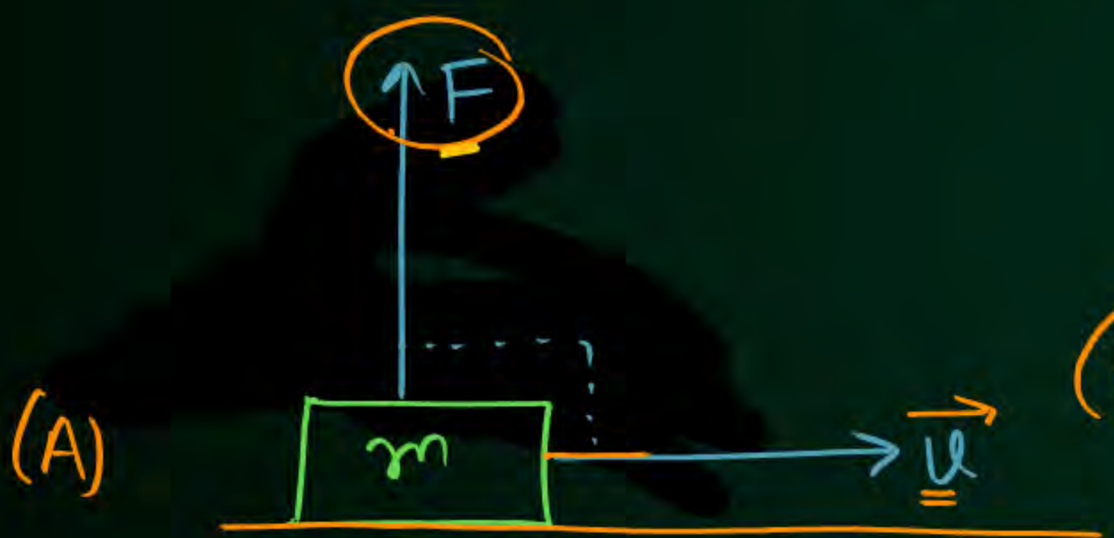




$W = S F\cos\theta$

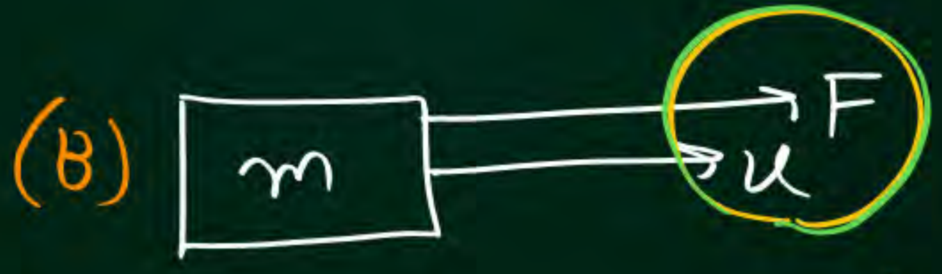
$= \vec{F}\cdot\vec{S}$

$W = |F|\cdot|\vec{S}|\cos\theta$

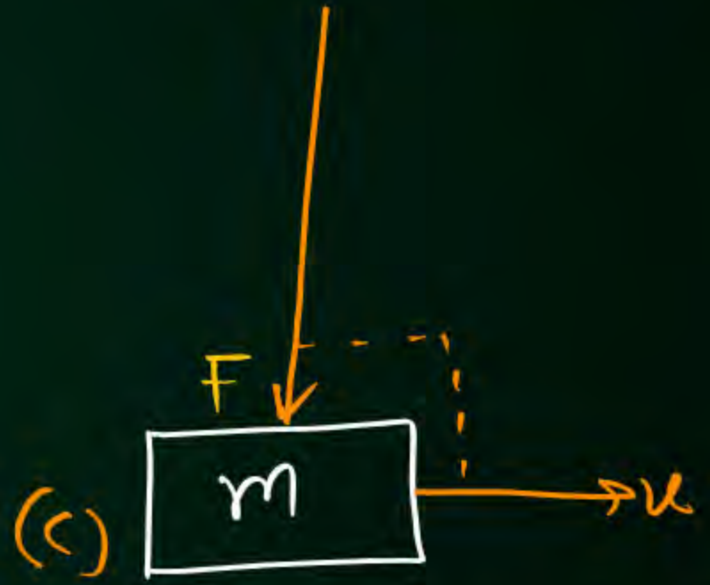


effect of force on the velocity along x-axis is zero.

$W_{(force)} = 0$



force will Increse this velocity



effect of force on velocity x-axis is zero.



$\vec{A}\cdot\vec{B} = |\vec{A}||\vec{B}|\cos\theta$

$= A B \cos\theta$

$C = \vec{A}\cdot\vec{B} = A B \cos\theta$ ← Angle θ b/w $\vec{A}$ & $\vec{B}$

dot Product

Scalar Product

$\hat{i}\cdot\hat{i} = 1\cdot 1 \cos 0^\circ = 1$

$\hat{i}\cdot\hat{j} = 1\times 1 \cos 90 = 0$

$\hat{i}\cdot\hat{k} = 0$

$\hat{k}\cdot\hat{j} = 0$

$\hat{j}\cdot\hat{j} = 1$

$\hat{k}\cdot\hat{k} = 1$

$-6\hat{i}\cdot(2\hat{i}) = -12\times 1 = -12$

$2\hat{i}\cdot 4\hat{j} = 8(\hat{i}\cdot\hat{j}) = 0$

$4\hat{k}\cdot(2\hat{k}) = 8$

$3\hat{i}\cdot 4\hat{k} = 0$

$-2\hat{i}\cdot(-4\hat{i}) = 8$

$$\vec{A} = A_x \hat{i} + A_y \hat{j} + A_z \hat{k}$$

$$\vec{B} = B_x \hat{i} + B_y \hat{j} + B_z \hat{k}$$

$$\vec{A} \cdot \vec{B} = (A_x \hat{i} + A_y \hat{j} + A_z \hat{k}) \cdot (B_x \hat{i} + B_y \hat{j} + B_z \hat{k})$$

$$\boxed{\vec{A} \cdot \vec{B} = A_x B_x + A_y B_y + A_z B_z}$$

QUESTION

If $|\vec{A}| = 2$ and $|\vec{B}| = 4$, $\theta = 60°$ then find $\vec{A}.\vec{B}$.

$$\vec{A}\cdot\vec{B} = 2 \times 4 \cos 60°$$
$$= 8 \times \frac{1}{2} = 4$$

$$\vec{A} = 2\hat{i} + 3\hat{j} - 4\hat{k}$$

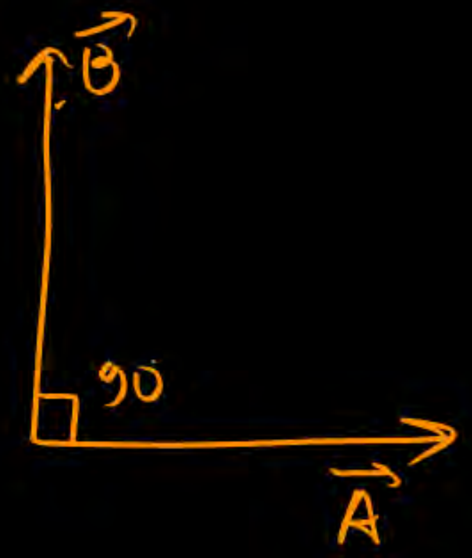
$$\vec{B} = -2\hat{i} + 4\hat{j} + 2\hat{k}$$

$$\vec{A} \cdot \vec{B} = -4 + 12 - 8$$

$$= -12 + 12 = 0$$

If $\vec{A}$ & $\vec{B}$ is ⊥r to each orther (orthogonal) then find their dot product :-

$$\vec{A} \cdot \vec{B} = AB \cos 90^\circ = 0$$ *



(iv) To check perpendicular vectors:

application

$\vec{A}\cdot\vec{B} = 0$ $\vec{A} \perp r \vec{B}$

$\vec{A}\cdot\vec{B} \neq 0$ $\vec{A}$ is Not $\perp r$ $\vec{B}$



APPLICATION OF DOT PRODUCT

To find

(i) Angle between vectors:

Angle b/w $\vec{A}$ & $\vec{B}$

$$\vec{A}\cdot\vec{B} = AB\cos\theta$$

$$\cos\theta = \frac{\vec{A}\cdot\vec{B}}{AB}$$

Angle b/w $\vec{A}$ & $\vec{B}$

$\vec{A} = \hat{i} + \hat{j}$

& $\vec{B} = \hat{i} - \hat{j}$ find Angle b/w $\vec{A}$ & $\vec{B}$.

$$\vec{A}\cdot\vec{B} = (\hat{i}+\hat{j})\cdot(\hat{i}-\hat{j}) = AB\cos\theta$$

$$= 1 - 1 = AB\cos\theta$$

$$\cos\theta = \frac{0}{AB} = 0$$

$$\theta = 90^\circ$$

Ans.

$\vec{A} = \hat{i}$

$\vec{B} = \hat{i} + \sqrt{3}\hat{j}$

Angle B/w $\vec{A}$ & $\vec{B}$

$$\vec{A} \cdot \vec{B} = AB\cos\theta$$

$$(\hat{i}) \cdot (\hat{i} + \sqrt{3}\hat{j}) = 1 \times 2\cos\theta$$

$$1 + 0 = 2\cos\theta$$

$$\cos\theta = \frac{1}{2}$$

$$\boxed{\theta = 60^\circ}$$

QUESTION

If $\vec{A} = 2\hat{\imath} + 2\hat{\jmath}$ and $\vec{B} = -2\hat{\imath} + 2\hat{\jmath}$ then find angle between $\vec{A}$ and $\vec{B}$.

$\theta = 90^\circ$ Ans

(ii) To check unit vector:

$\vec{A}$ = unit vector = 1

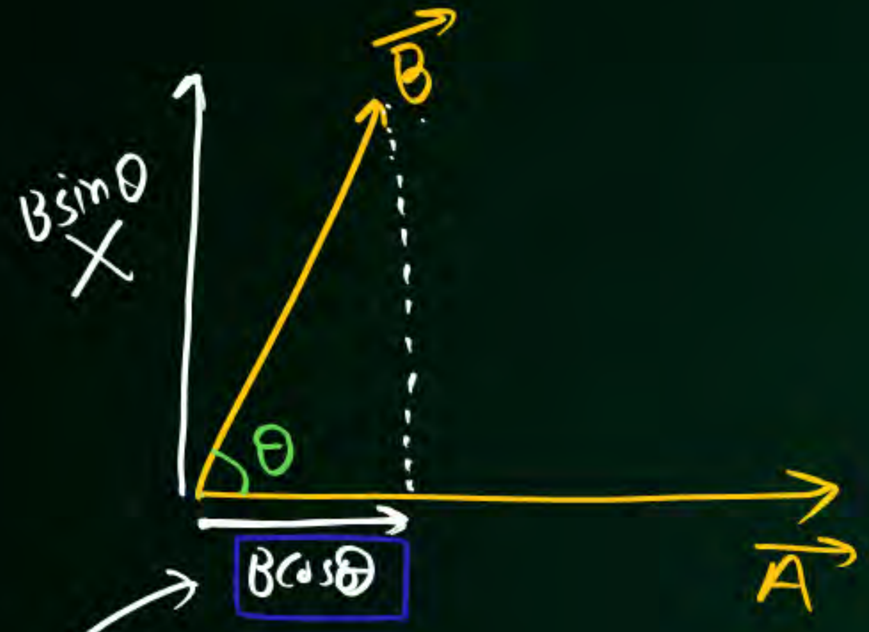
$\vec{A}\cdot\vec{A} = A\cdot A\cos 0^\circ$

$\vec{A}\cdot\vec{A} = A^2$

If A is unit vector

$\vec{A}\cdot\vec{A} = 1$

(iii) Projection (Component of $\vec{A}$ and $\vec{B}$):



Component of B along $\vec{A}$

$$\vec{A}\cdot\vec{B} = A\,B\cos\theta$$

$$= B\cos\theta = \left[\frac{\vec{A}\cdot\vec{B}}{A}\right]$$

Component of B along $\vec{A}$ $= \dfrac{\vec{A}\cdot\vec{B}}{A}$

Projection of $\vec{A}$ along $\vec{B}$ = Component of $\vec{A}$ along B $= \dfrac{\vec{A}\cdot\vec{B}}{B}$

QUESTION

If $\vec{A} = 0.5\hat{i} + 0.4\hat{j} - \alpha\hat{k}$ then find α if $\vec{A}$ is unit vector.

$\vec{A} \cdot \vec{A} = 1$

$0.25 + 0.16 + \alpha^2 = 1$

fin α

2nd

$|\vec{A}| = 1$

$\sqrt{(0.5)^2 + (0.4)^2 + (-\alpha)^2} = 1$

$(0.5)^2 + (0.4)^2 + \alpha^2 = 1$

QUESTION

If $\vec{A} = \sin\theta\,\hat{\imath} + \cos\theta\,\hat{\jmath}$ then prove that $\vec{A}$ is a unit vector.

QUESTION

If $\vec{A} = 2\hat{\imath} + 3\hat{\jmath} + \alpha\hat{k}$ and $\vec{B} = \hat{\imath} - 2\hat{\jmath} + 4\hat{k}$ find α. If $\vec{A}$ is perpendicular to $\vec{B}$.

$$\vec{A} \cdot \vec{B} = 0$$

$$2 - 6 + 4\alpha = 0$$

$$-4 + 4\alpha = 0$$

$$4\alpha = 4$$

$$\alpha = 1$$

QUESTION

If $\vec{A} = 2\hat{\imath} + 6\hat{\jmath} + 3\hat{k}$ and $\vec{B} = 4\hat{\imath}$. Find angle between $\vec{A}$ and $\vec{B}$.

$\vec{A} \cdot \vec{B} = AB\cos\theta$

$8 + 0 + 0 = \sqrt{4+36+9} \times 4 \cos\theta$

$8 = \sqrt{49} \times 4 \cos\theta$

$\frac{2}{7} = \cos\theta$

$\theta = \cos^{-1}(2/7)$

QUESTION

If vector $\vec{A} = \cos\omega t\,\hat{\imath} + \sin\omega t\,\hat{\jmath}$ and $\vec{B} = \cos\frac{\omega t}{2}\,\hat{\imath} + \sin\frac{\omega t}{2}\,\hat{\jmath}$ are function of time, then the value of t is at which they are orthogonal to each other is [2005]

Perpendicular

1. $t = \pi/\omega$
2. $t = 0$
3. $t = \pi/4\omega$
4. $t = \pi/2\omega$

$\vec{A}\cdot\vec{B} = 0$

$\cos(\omega t)\cdot\cos\left(\frac{\omega t}{2}\right) + \sin(\omega t)\cdot\sin\left(\frac{\omega t}{2}\right) = 0$

$\cos\left(\omega t - \frac{\omega t}{2}\right) = 0$

$\cos\left(\frac{\omega t}{2}\right) = 0$

$\frac{\omega t}{2} = \frac{\pi}{2}$

$t = \frac{\pi}{\omega}$

QUESTION

If a vector $2\hat{i} + 3\hat{j} + 8\hat{k}$ is perpendicular to the vector $3\hat{j} - 4\hat{i} + \alpha\hat{k}$, then the value of α is [2005]

1. 1/2
2. −1/2
3. 1
4. −1

$\vec{A}\cdot\vec{B}=0$

QUESTION

The angle between the two vectors $\vec{A} = 3\hat{i} + 4\hat{j} + 5\hat{k}$ and $\vec{B} = 3\hat{i} + 4\hat{j} - 5\hat{k}$ will be

[1994]

1. $90°$
2. $180°$
3. zero
4. $45°$

QUESTION

If Resultant of $\vec{A}$ and $\vec{B}$ is perpendicular to $\vec{A}$ then angle between $\vec{A}$ and $\vec{B}$ will be:

QUESTION

A body, constrained to move in y-direction, is subjected to a force given by $\vec{F} = \left(-2\hat{i} + 15\hat{j} + 6\hat{k}\right)$ N. The work done by this force in moving the body through a distance of along $10\hat{j}$ m y-axis, is

1. 150 J
2. 20 J
3. 190 J
4. 160 J

Work = $\vec{F} \cdot \vec{S}$

DPP

QUESTION

A particle moves from (0, 2, 4) and (3, 6, 9), application of force $F = \hat{\imath} - 2\hat{\jmath} + 2\widehat{k}$ then find work done.

QUESTION

Two forces $\vec{F}_1 = \hat{\imath} + 2\hat{\jmath} - 2\hat{k}$ and $\vec{F}_2 = 2\hat{\imath} + 2\hat{\jmath} + 3\hat{k}$ are acting on a particle and it's displacement is $-\hat{\imath} + 2\hat{\jmath} + \hat{k}$. Find work done on the particle

1. 2J
2. 6J
3. -3J
4. zero


THANK YOU


YAKEEN 2.0
FOR NEET 2025
Lecture- 6
Physics
VECTORS
By- Dr. Manish Raj (MR SIR)

Topics to be covered

Vector → Lecture No → 6

Todays Goal

→ H/W

→ dot Product Ka revision

→ Cross Product



This is Possible operation or, not??

(i) $(\vec{A}\cdot\vec{B})\cdot\vec{C}$ → wrong

(ii) $\dfrac{\vec{A}\cdot\vec{B}}{\vec{C}} = \dfrac{\text{Scalar}}{\text{vector}}$ → wrong

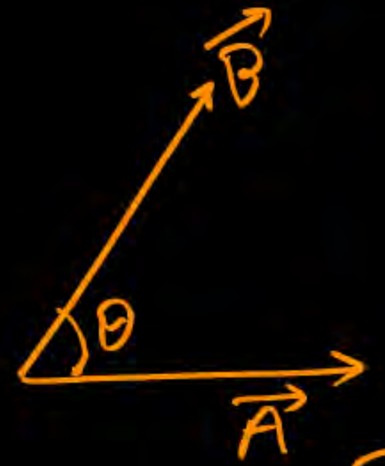
(iii) $\dfrac{\vec{A}}{(\vec{B}\cdot\vec{C})} = \left(\dfrac{\text{vector}}{\text{scalar}}\right)$ ✓ Possible

(iv) $\vec{A}\cdot B$ → Not Possible

Vector Scalar

(iii) $\vec{A} = 4\hat{i}+3\hat{j}$ find $\dfrac{\vec{A}}{3}$

$\dfrac{\vec{A}}{3} = \dfrac{4\hat{i}+3\hat{j}}{3}$



$\vec{A}\cdot\vec{B} = AB\cos\theta$

Angle b/w $\vec{A}$ & $\vec{B}$

$W = \vec{F}\cdot\vec{S}$

$\text{Power} = \vec{F}\cdot\vec{V}$

Scalar

$m\cdot\vec{F}$ ✗

dot Product b/w Scalar & vector is not Possible

$\dfrac{2}{\vec{A}}$ ✗ $\dfrac{\vec{A}}{2}$ ✓ $\left(\dfrac{\vec{F}}{3}\right)$ ✓

APPLICATION OF DOT PRODUCT

To find,

(i) **Angle between vectors:**

$$\vec{A}\cdot\vec{B} = AB\cos\theta$$

$$\cos\theta = \frac{\vec{A}\cdot\vec{B}}{AB}$$

$$\theta = \cos^{-1}\left(\frac{\vec{A}\cdot\vec{B}}{AB}\right)$$

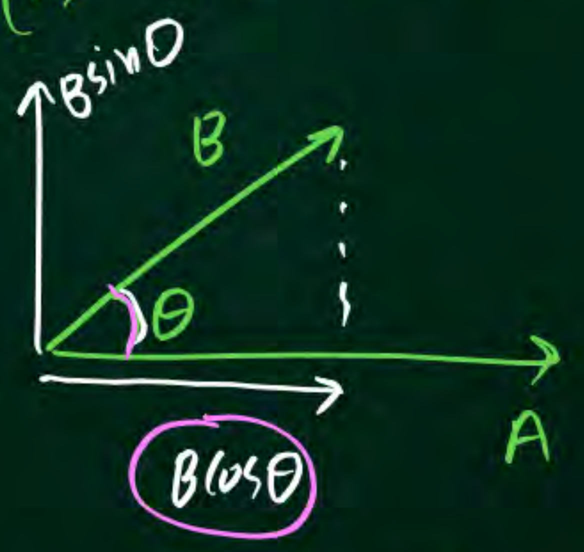
(ii) To check Perpendicular vector:

$$\vec{A}\cdot\vec{B} = 0 \quad \left(\vec{A} \perp_r \vec{B}\right) \quad \theta = 90^\circ$$

(iii) To check unit vector:

$$\hat{A}\cdot\hat{A} = 1$$

(iv) To Take Component of one vector along other vector



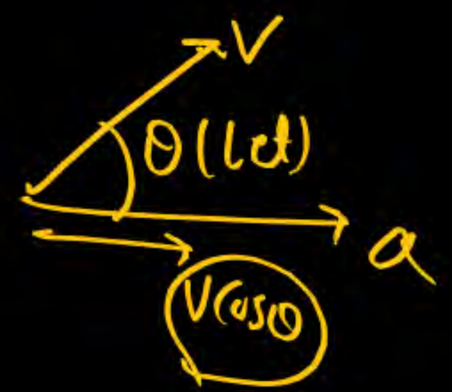
$$\vec{A}\cdot\vec{B} = A\,B\cos\theta$$

Component of B along A $= \left\{\frac{\vec{A}\cdot\vec{B}}{A}\right\}$

If Velocity $\vec{V} = \hat{i} - 2\hat{j} + \hat{k}$
and acceleration $\vec{a} = 2\hat{i} + \hat{j} + 2\hat{k}$
then find Component of
Velocity along acceleration

$\vec{V} = \hat{i} - 2\hat{j} + \hat{k}$

$\vec{a} = 2\hat{i} + \hat{j} + 2\hat{k}$ → $|a| = \sqrt{4+1+4} = \sqrt{9} = 3$



$\vec{a} \cdot \vec{u} = a\, V\cos\theta$

$V\cos\theta = \dfrac{\vec{a} \cdot \vec{u}}{|\vec{a}|} = \dfrac{2 - 2 + 2}{3} = \dfrac{2}{3}$ m/s

QUESTION

If a vector $2\hat{i} + 3\hat{j} + 8\widehat{k}$ is perpendicular to the vector $3\hat{j} - 4\hat{i} + \alpha\widehat{k}$, then the value of α is [2005]

1. 1/2
2. -1/2
3. 1
4. $\frac{-1}{8}$

$(2i + 3j + 8k) \cdot (3\hat{j} - 4i + \alpha\hat{k}) = 0$

$-8 + 9 + 8\alpha = 0$

$1 + 8\alpha = 0$

$8\alpha = -1$

$\alpha = -\frac{1}{8}$

QUESTION

The angle between the two vectors $\vec{A} = 3\hat{\imath} + 4\hat{\jmath} + 5\hat{k}$ and $\vec{B} = 3\hat{\imath} + 4\hat{\jmath} - 5\hat{k}$ will be

[1994]

1. 90°
2. 180°
3. zero
4. 45°

$\cos\theta = \frac{\vec{A}\cdot\vec{B}}{AB} = \frac{9+16-25}{AB} = 0$

$\theta = 90°$

QUESTION

Find the projection of $\vec{A} = 2\hat{\imath} - \hat{\jmath} + \hat{k}$ along the vector $\vec{B} = \hat{\imath} + \hat{\jmath} + \hat{k}$.

1. $\frac{1}{\sqrt{3}}$
2. $\frac{2}{\sqrt{3}}$ ✓
3. $\frac{4}{\sqrt{3}}$
4. 0

Comp^n of A alg B $= \frac{\vec{A} \cdot \vec{B}}{B}$

$= \frac{2 - 1 + 1}{\sqrt{3}} = \frac{2}{\sqrt{3}}$

QUESTION

A particle moves from (0, 2, 4) to (3, 6, 9), application of force $\vec{F} = \hat{i} - 2\hat{j} + 2\hat{k}$ then find work done.

initial → final

From To

Sol^n

$\text{disp}^m = \vec{r_f} - \vec{r_i}$

$= (3\hat{i} + 6\hat{j} + 9\hat{k}) - (0\hat{i} + 2\hat{j} + 4\hat{k})$

$\text{disp}^m = 3\hat{i} + 4\hat{j} + 5\hat{k}$

given for Now → $W = \vec{F} \cdot \vec{S} = (\hat{i} - 2\hat{j} + 2\hat{k}) \cdot (3\hat{i} + 4\hat{j} + 5\hat{k})$

$= 3 - 8 + 10 = 5$ Joule

QUESTION

A body, constrained to move in y-direction, is subjected to a force given by $\vec{F} = (-2\hat{i} + 15\hat{j} + 6\hat{k})$ N. The work done by this force in moving the body through a distance of along $10\hat{j}$ m y-axis, is

1. 150 J
2. 20 J
3. 190 J
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QUESTION

Two forces $\vec{F}_1 = \hat{\imath} + 2\hat{\jmath} - 2\hat{k}$ and $\vec{F}_2 = 2\hat{\imath} + 2\hat{\jmath} + 3\hat{k}$ are acting on a particle and it's displacement is $-\hat{\imath} + 2\hat{\jmath} + \hat{k}$. Find work done on the particle

1. 2J
2. 6J
3. -3J
4. zero

(15%)

diff^n

$F_{net} = \vec{F_1} + \vec{F_2}$

$F_{net} = 3\hat{i} + 4\hat{j} + \hat{k}$

$W = (\vec{F}_{net}) \cdot \vec{S}$

$= -3 + 8 + 1$

$= 9 - 3 = 6J$

QUESTION

A vector perpendicular to $\hat{i}+\hat{j}-\hat{k}$ and $\hat{i}-\hat{j}-\hat{k}$ is:

1. $\hat{i}+\hat{j}+\hat{k}$
2. $\hat{i}+\hat{k}$
3. $-\hat{i}+\hat{j}+\hat{k}$
4. $\hat{j}+\hat{k}-2\hat{i}$

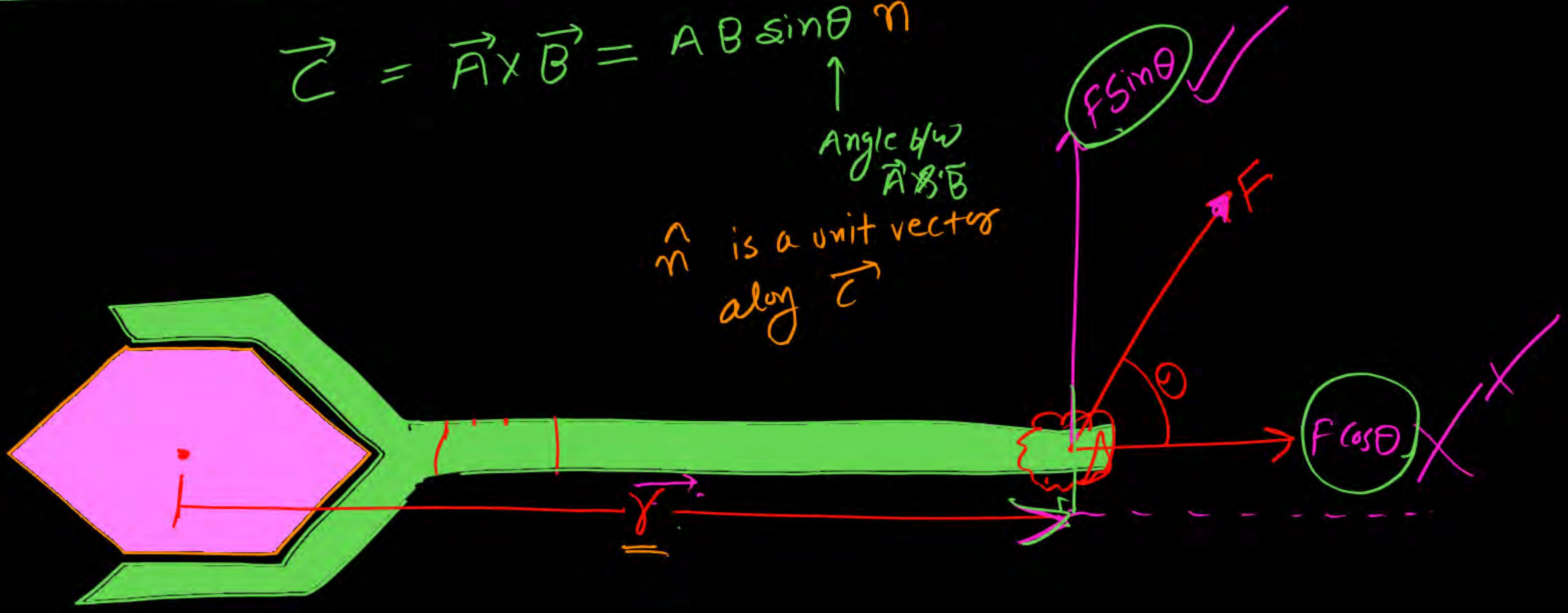
Two vector PerPendicul → dot Product must be zero

Cross vector (vector product)

$$\vec{C} = \vec{A} \times \vec{B} = AB\sin\theta\,\hat{n}$$

↑ Angle b/w $\vec{A}$ & $\vec{B}$

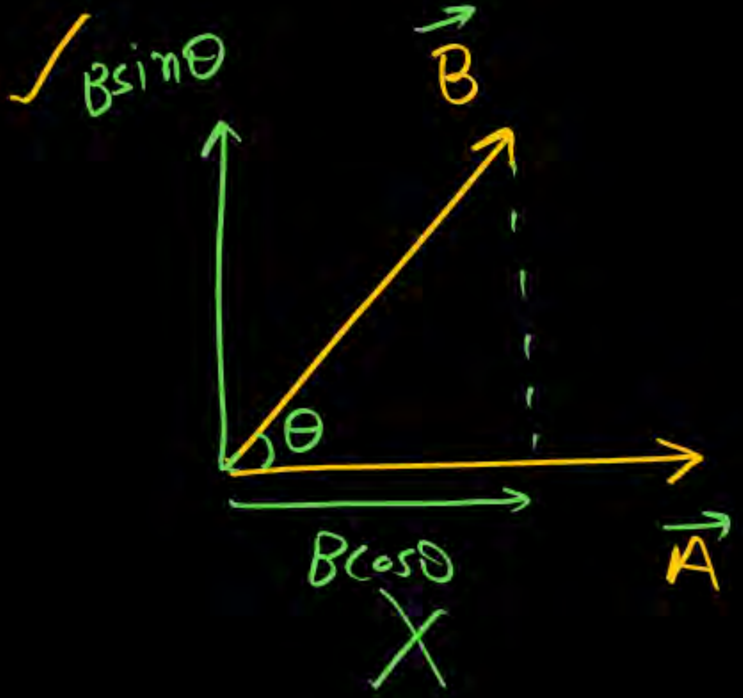
$\hat{n}$ is a unit vector along $\vec{C}$



$$\vec{\tau} = rF\sin\theta = \vec{r} \times \vec{F}$$

(Rotational effect) Torque

Cross product



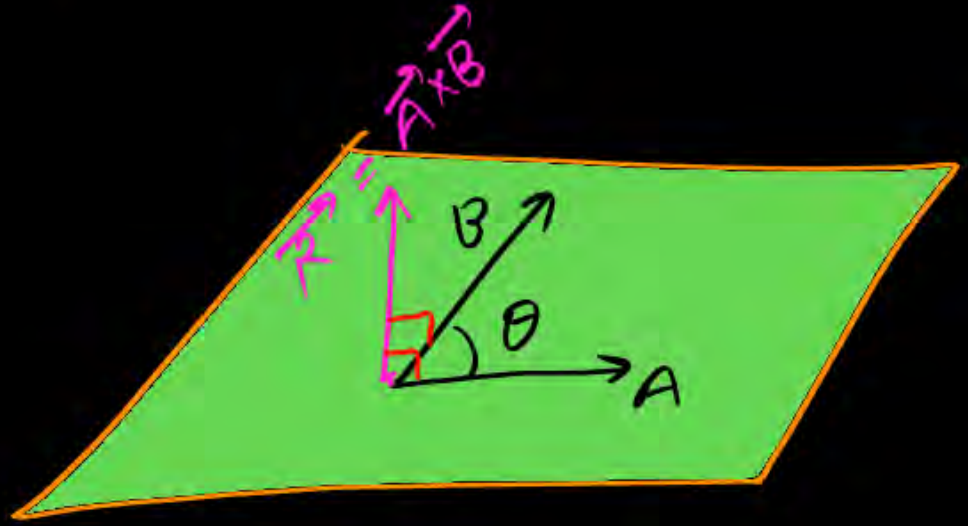
$C = \vec{A} \cdot \vec{B} = AB\cos\theta$

$\vec{R} = \vec{A} \times \vec{B} = AB\sin\theta\,\hat{n}$

(#) direction of $\vec{R}$ $(\vec{A} \times \vec{B})$ is perpendicular to $\vec{A}$ and perpr to $\vec{B}$

(#) Angle b/w $\vec{A}$ & $\vec{A} \times \vec{B}$ is 90°

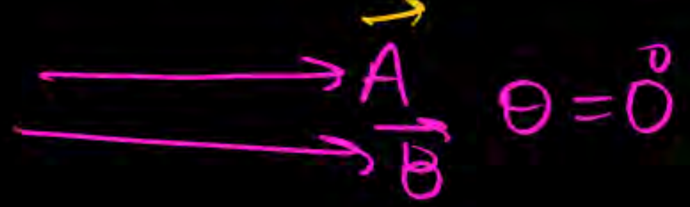
(+) Angle b/w $\vec{B}$ $\vec{A} \times \vec{B}$ is 90°

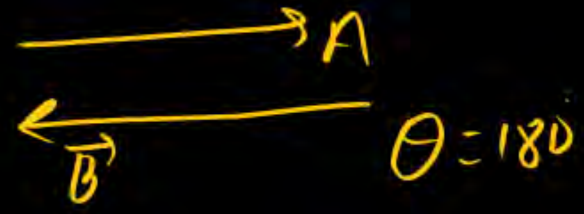


$\theta = 0^\circ, 180^\circ$

$\vec{A} \times \vec{B} = AB\sin\theta = 0$

If two vector Parallel or Anti-Parallel to each other then their cross product will be zero





$\vec{A} \times \vec{B} = 0$

$\theta = 90^\circ$

$(\vec{A} \times \vec{B})_{max} = AB\sin 90 = AB$

$\Rightarrow \hat{i} \times \hat{i} = 1 \times 1 \sin 0 = 0$

$\Rightarrow i \cdot i = 1$

$\begin{cases} \hat{j} \times \hat{j} = 0 \\ \hat{j} \cdot \hat{j} = 1 \end{cases}$

$\begin{cases} \hat{k} \times \hat{k} = 0 \\ \hat{k} \cdot \hat{k} = 1 \end{cases}$



MR*

$\hat{i} \rightarrow \hat{j} \rightarrow \hat{k} \rightarrow \hat{i}$

$\hat{i} \times \hat{j} = \hat{k}$

$\hat{j} \times \hat{i} = -\hat{k}$

$\hat{j} \times \hat{k} = +\hat{i}$

$\hat{k} \times \hat{j} = -\hat{i}$

$\hat{k} \times \hat{i} = +\hat{j}$

$i \times \hat{k} = -\hat{j}$ ✓

$\hat{i} \times \hat{j} = +\hat{k}$

$\hat{j} \times \hat{i} = -\hat{k}$

$\hat{i} \times \hat{k} = -\hat{j}$

$\hat{k} \times \hat{i} = +\hat{j}$

$\hat{j} \times \hat{k} = \hat{i}$

$\hat{k} \times \hat{j} = -\hat{i}$

$\hat{i} \rightarrow \hat{j} \rightarrow \hat{k} \rightarrow i$

MR* पहले Result लिखतो

$\hat{i} \times \hat{j} = \hat{k}$

$\hat{j} \times \hat{k} = \hat{i}$

$\hat{k} \times \hat{i} = \hat{j}$

$i \times \hat{k} = -\hat{j}$

$\hat{k} \times i = \hat{j}$

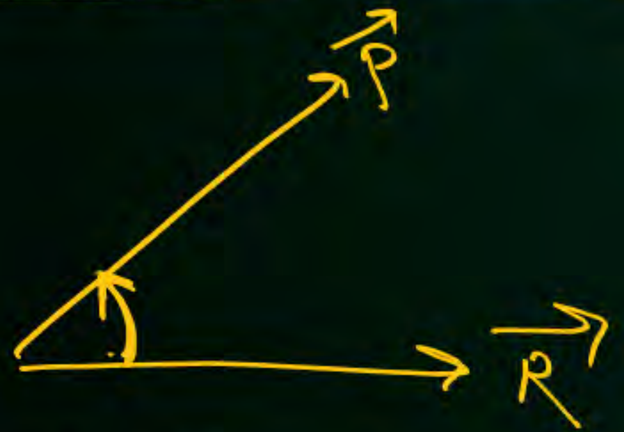
$\hat{j} \times i = -\hat{k}$

Direction of $\vec{A} \times \vec{B}$:

$$\vec{R} = \vec{A} \times \vec{B}$$

$\vec{R}$	$\vec{A}$	$\vec{B}$
↑	↑	↑
result	1st vector	2nd vector

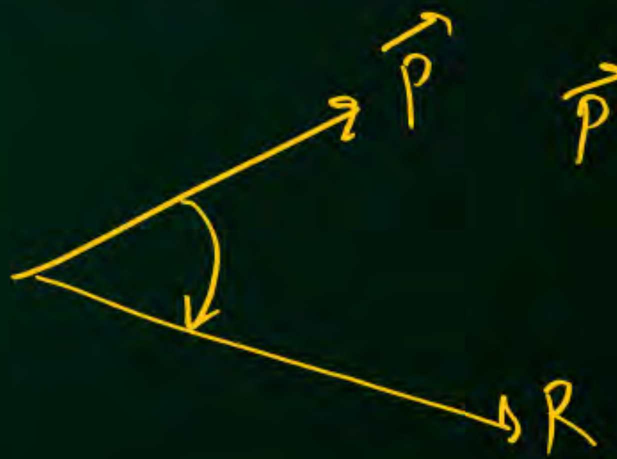
Place four finger in the director of 1st vector and then slap in the direction of $\vec{B}$ (2nd vector) then thumb represent direction of $(\vec{A} \times \vec{B})$



(dirn) $\vec{R} \times \vec{P}$ = ⊙ outwa

The MR (Anti-clu) ⊙

clock → ⊗



$\vec{P} \times \vec{R}$ ⊗

Compt Rotn
magnetism
EM wave

Ans

$\vec{A} \times \vec{A} = ?? \longrightarrow 0$

$\theta \rightarrow$ Angle b/w $\vec{A}$ & $\vec{B}$

$\vec{A} \times (\vec{A} \times \vec{B}) = ??$

$\vec{A} \times (\vec{A} \times \vec{B}) = \vec{A} \times (\overrightarrow{AB\sin\theta}) = A\,(AB\sin\theta)\,(\sin 90^\circ)$

$\overrightarrow{AB\sin\theta}$ ⊥r to $\vec{A}$

$= A^2B\sin\theta$

$(\vec{A} \times \vec{B}) \cdot \vec{A} = ?? \Rightarrow 0$ (zero)

$\vec{A} \times \vec{B}$ ⊥r of $\vec{A}$

$(\vec{A} \times \vec{B}) \cdot (\vec{A} + \vec{B}) = ?? \Rightarrow 0$ (zero)

$(\vec{A} \times \vec{B})$ ⊥r to to Plane of $\vec{A}$ & $\vec{B}$

$(\vec{A} + \vec{B})$ In the Plane of $\vec{A}$ & $\vec{B}$

$\theta = 90$

QUESTION

If $|\vec{A} \times \vec{B}| = \sqrt{3}\,(\vec{A} \cdot \vec{B})$ then find angle between $\vec{A}$ and $\vec{B}$.

$AB \sin\theta = \sqrt{3}\, AB \cos\theta$

$\tan\theta = \sqrt{3}$

$\theta = 60°$

QUESTION

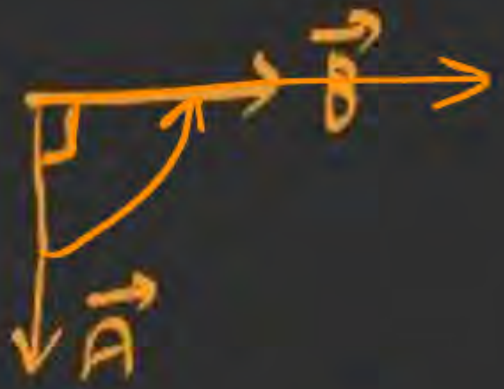
last question ($\theta = 60$)

If $|\vec{A} \times \vec{B}| = \sqrt{3}\,\vec{A}\,.\,\vec{B}$, then the value of $|\vec{A} + \vec{B}|$ is: **[AIPMT 2007]**

$\sqrt{A^2 + B^2 + 2AB\cos 60}$

$= \left(A^2 + B^2 + AB\right)^{1/2}$

1. $\left(A^2 + B^2 + \frac{AB}{\sqrt{3}}\right)^{1/2}$
2. $A + B$
3. $\left(A^2 + B^2 + \sqrt{3}AB\right)^{1/2}$
4. $\left(A^2 + B^2 + AB\right)^{1/2}$ ✓



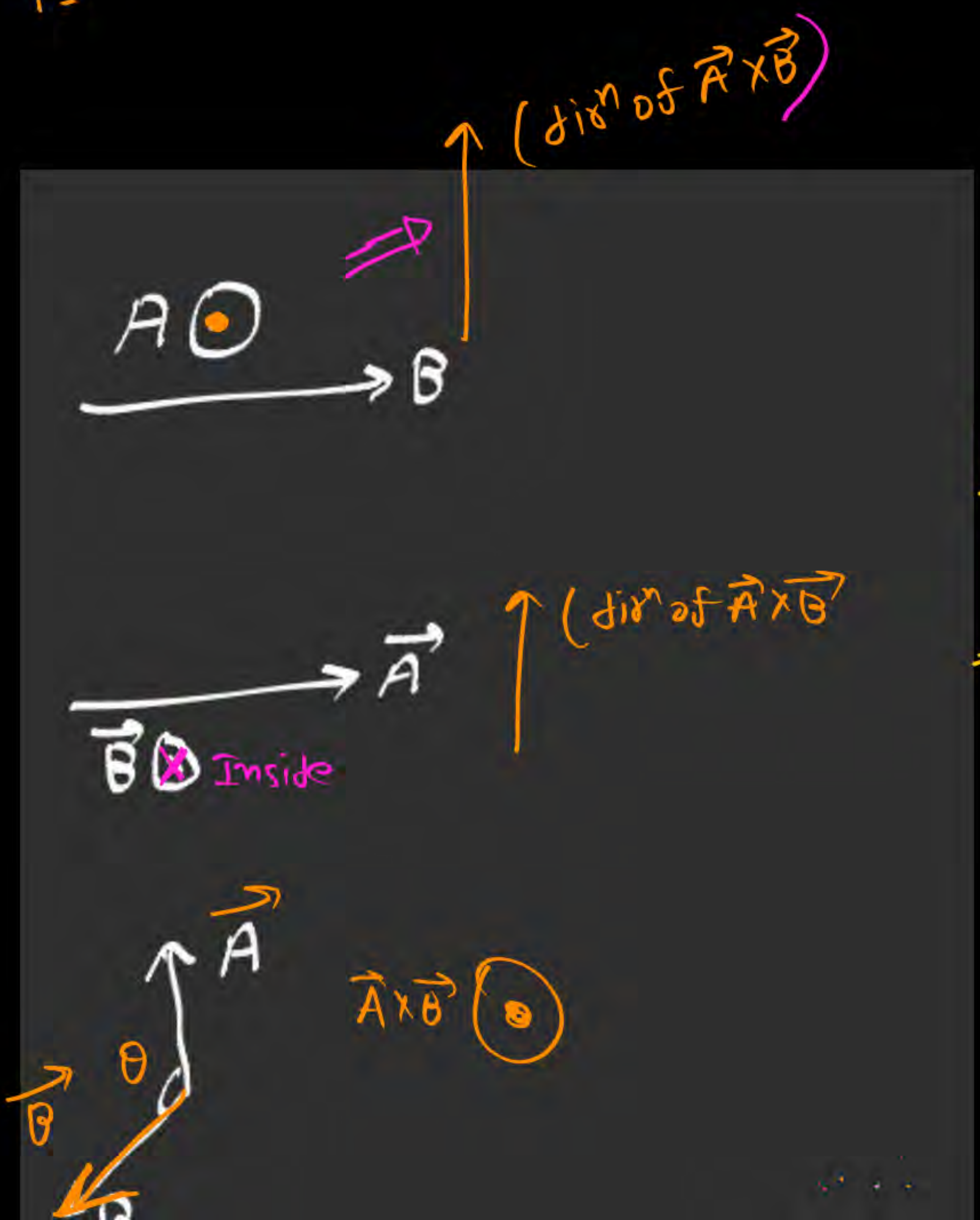


$\text{dir}(\vec{A}\times\vec{B}) = \odot$ outward

$\vec{A}\times\vec{B} = \odot$



$\vec{A}\times\vec{B}$ $\otimes$ Inwn



⊙ गद्दे कि तरफ

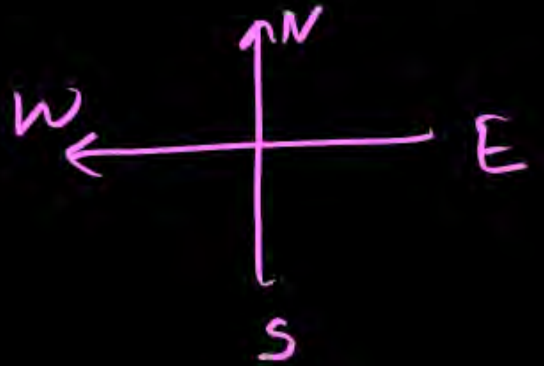
⊗ गद्दे से दूर

A ⊙
B ⊗

$\vec{A} \times \vec{B} = 0$

Angle B/w $\vec{A} \times \vec{B}$ & $\vec{B} \times \vec{A}$ is 180°

⊛ $\vec{A}$ (east)
⊛ $\vec{B}$ (south)



dir^n $(\vec{A} \times \vec{B})$ ⊗ Inward

$\vec{B}$ ←
A ⊙

dir^n $(\vec{B} \times \vec{A})$ ↑

dir^n $(\vec{A} \times \vec{B})$ = ↓

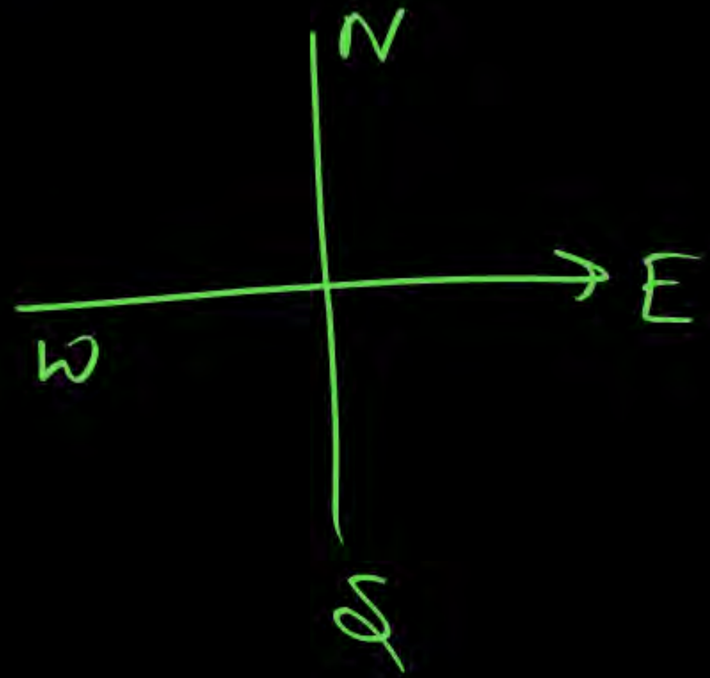
$\vec{A}$ (west)
$\vec{B}$ (North)

$\vec{A} \times \vec{B}$ = ⊗

$\vec{A}$ $\otimes$

$B = $ east

$dir(\vec{B} \times \vec{A}) = $ North



$\vec{A} = $ west

$\vec{B}$ $\odot$

$dir(\vec{B} \times \vec{A}) = $ South

$\vec{B} = $ west

$\vec{A} = $ North.

$dir(\vec{B} \times \vec{A}) = \otimes$

$\vec{A} = A_x\hat{i} + A_y\hat{j} + A_z\hat{k}$ and $\vec{B} = B_x\hat{i} + B_y\hat{j} + B_z\hat{k}$

$$\vec{A}\times\vec{B} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ A_x & A_y & A_z \\ B_x & B_y & B_z \end{vmatrix} = \hat{i}\left(A_yB_z - A_zB_y\right) + \hat{j}\left(A_zB_x - A_xB_z\right) + \hat{k}\left(A_xB_y - A_yB_x\right)$$

$i \rightarrow j \rightarrow k - i$

$$\vec{A} \times \vec{B} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ A_x & A_y & A_z \\ B_x & B_y & B_z \end{vmatrix} = i\left(A_y B_z - A_z B_y\right) + \hat{j}\left(A_z B_x - A_x B_z\right) + \hat{k}\left(A_x B_y - A_y B_x\right)$$

QUESTION

Find torque ($\vec{\tau} = \vec{r} \times \vec{F}$) of a force $\vec{F} = -3\hat{\imath} + \hat{\jmath} + 5\hat{k}$ acting at the point $\vec{r} = 7\hat{\imath} + 3\hat{\jmath} + \hat{k}$. [AIIMS 2009]

1. $14\hat{\imath} - 38\hat{\jmath} + 16\hat{k}$
2. $4\hat{\imath} + 4\hat{\jmath} + 6\hat{k}$
3. $-14\hat{\imath} + 38\hat{\jmath} - 16\hat{k}$
4. $-21\hat{\imath} + 3\hat{\jmath} - 5\hat{k}$

$$\vec{r} \times \vec{F} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 7 & 3 & 1 \\ -3 & 1 & 5 \end{vmatrix} = \hat{i}(15-1) + \hat{j}(-3-35) + \hat{k}(7+9)$$

$$= 14\hat{i} - 38\hat{j} + 16\hat{k}$$

QUESTION

The torque of force $5\hat{\imath} + 3\hat{\jmath} - 7\hat{k}$ about the origin is τ. If the force acts on a particle whose position vector is $2\hat{\imath} + 2\hat{\jmath} + \hat{k}$ then the value of τ will be: [NEET 2022]

1. $11\hat{\imath} + 19\hat{\jmath} - 4\hat{k}$ ✗
2. $-11\hat{\imath} + 9\hat{\jmath} - 16\hat{k}$ ✗
3. $-17\hat{\imath} + 19\hat{\jmath} - 4\hat{k}$ ✓
4. $17\hat{\imath} + 9\hat{\jmath} - 16\hat{k}$ ✗

$$\vec{\tau} = \vec{r} \times \vec{F} = \begin{vmatrix} i & j & k \\ 2 & 2 & 1 \\ 5 & 3 & -7 \end{vmatrix} = \hat{i}(-14-3) + \hat{j}(5+14) + \hat{k}(6-10)$$

$$= -17\hat{i} + \hat{j}\,19 - 4\hat{k}$$

QUESTION

If the angle between the vector $\vec{A}$ and $\vec{B}$ is θ, the value of the product $(\vec{B} \times \vec{A}) \cdot \vec{A}$ is equal to

$\theta = 90$

1. Zero
2. $BA^2 \sin\theta \cos\theta$
3. $BA^2 \cos\theta$
4. $BA^2 \sin\theta$

QUESTION

Find the torque of force $\vec{F} = 5\hat{i} + 3\hat{j} - 7\hat{k}$ about origin if the force acts on the particle whose position vector is $2\hat{i} + 2\hat{j} + \hat{k}$. (use torque = $\vec{r} \times \vec{F}$)

[JEE Main 2022]

1. $11\hat{i} + 19\hat{j} - 4\hat{k}$
2. $-11\hat{i} + 9\hat{j} - 16\hat{k}$
3. $-17\hat{i} + 19\hat{j} - 4\hat{k}$
4. $-17\hat{i} + 9\hat{j} + 16\hat{k}$

(Q) If $\vec{A}+\vec{B}=\vec{R}$ and $|\vec{A}|=|\vec{R}|$ and $\vec{R}$ is perpendicular to $\vec{A}$ then find Angle between $\vec{A}$ and $\vec{B}$.

H/W

QUESTION

The angle between vectors $(\vec{A} \times \vec{B})$ and $(\vec{B} \times \vec{A})$ is

1. zero
2. π = 180° ✓
3. $\pi/4$
4. $\pi/2$

QUESTION

Find the torque about the origin when a force of $3\hat{j}$ N acts on a particle whose position vector is $2\hat{k}$ m. [NEET 2020]

1. $6\hat{i}$ Nm
2. $6\hat{j}$ Nm
3. $-6\hat{i}$ Nm ✓
4. $6\hat{k}$ Nm

$F = 3\hat{j}$

$\vec{r} = 2\hat{k}$

$\tau = \vec{r} \times \vec{F} = 2\hat{k} \times 3\hat{j}$

$= -6\hat{i}$

QUESTION

For a plane electromagnetic wave propagation in x-direction, which one of the following combination gives the correct possible directions for electric field (E) and magnetic field (B) respectively?

1. $\hat{j} \times \hat{k}, \hat{j} + \hat{k}$

2. $-\hat{j} \times \hat{k}, -\hat{j} - \hat{k}$

3. $\hat{j} \times \hat{k}, -\hat{j} - \hat{k}$

4. $-\hat{j} \times \hat{k}, -\hat{j} + \hat{k}$

QUESTION

The moment of the force, $\vec{F} = 4\hat{i} + 5\hat{j} - 6\hat{k}$ at (2, 0, −3), about the point (2, −2, −2), is given by [NEET 2018]

1. $-8\hat{i} - 4\hat{j} - 7\hat{k}$

2. $-4\hat{i} - \hat{j} - 8\hat{k}$

3. $-7\hat{i} - 8\hat{j} - 4\hat{k}$

4. $-7\hat{i} - 4\hat{j} - 8\hat{k}$


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture No . 7 | Physics

Revision lecture of vectors

Vector

Vector

VECTORS



By- Dr. Manish Raj (MR SIR)

To days Goal → complete revision of Vector

& Assignment – 2 solution

In scalar P.Q →

{ +ve / −ve } mine

large / small

Scalar

No dirⁿ

→ follow simple addⁿ / subⁿ

→ Mass, work

→ Speed = 10m/s → How fast

Tempʳ = 303 K.

e.m.f = Potential

length / Volume

↓ Current / density

energy

v = 10m/s

Have dirⁿ + follow Triangle of addⁿ → vector

Velocity = How fast / where

* force ⇒ 5N î

⊛ dispᵐ, accⁿ

electric field

Current density

Area (dirⁿ)

In vector +ve, −ve repres dirⁿ

→ follow Triangle law vect addⁿ

→ vector can be change by dirⁿ
or by mag
or by mag & dirⁿ

Ex

$m_1 = 2kg$, $m_2 = 4kg$ → $m_1 + m_2 = 6kg$

$f_1 = 10N$, $f_2 = 20N$ → $f_1 + f_2 = 30N$ ✓, 25N ✓, = 20N, 15 ✓, f_{m} = 10N ✓

→ 10N, → 20N } 30N

→ 20, ← 10N } 10N

representation

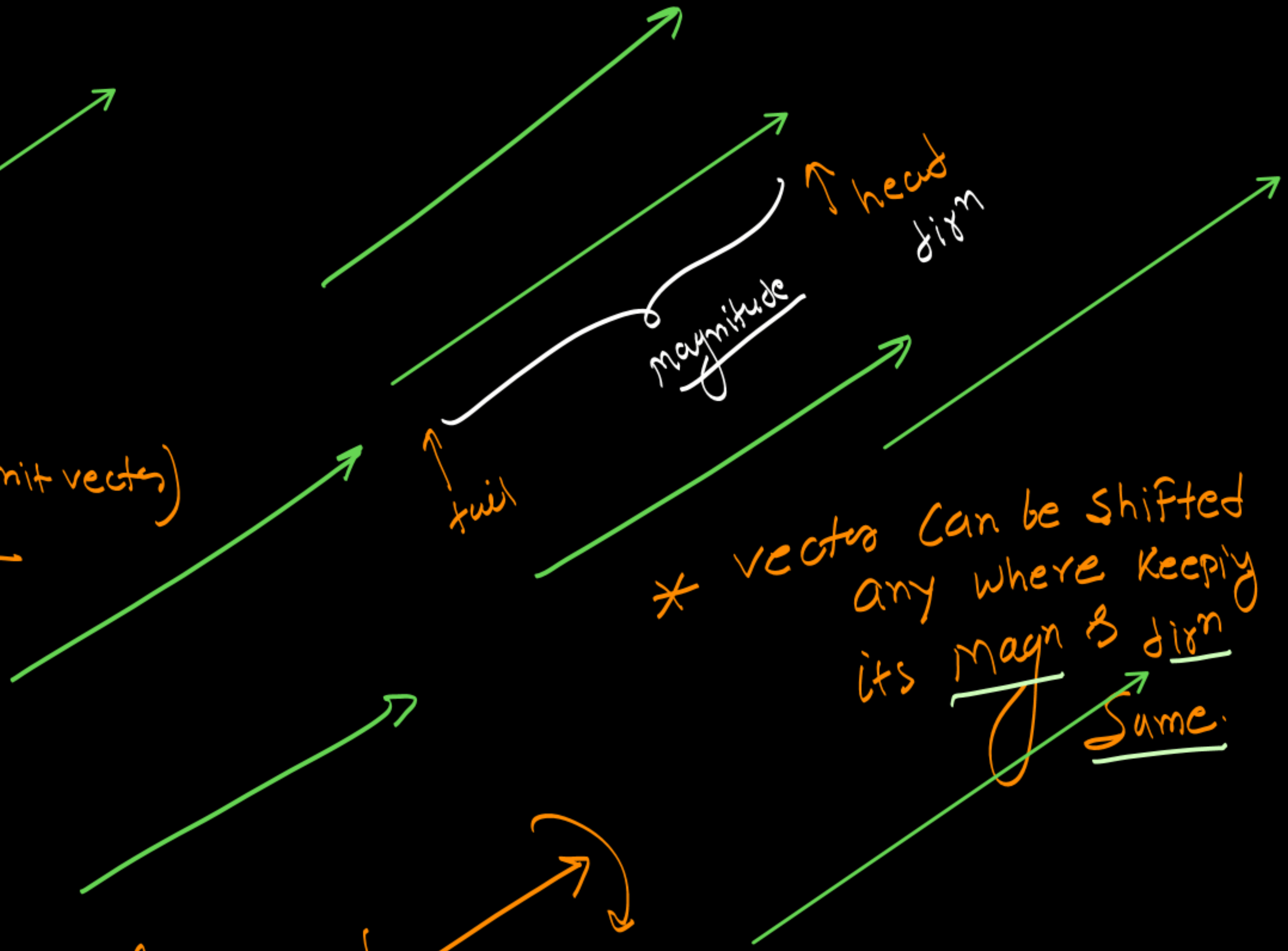
Mathmatics

$$\vec{A} = A\hat{A}$$

A → Magnitude

$\hat{A}$ → dirn vector (unit vector) → magni = 1

$$\hat{A} = \frac{\vec{A}}{A}$$



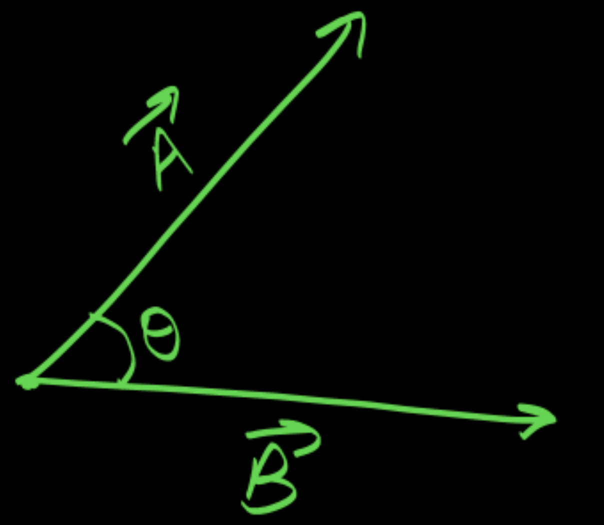
* vector can be shifted any where keeping its magn & dirn same.

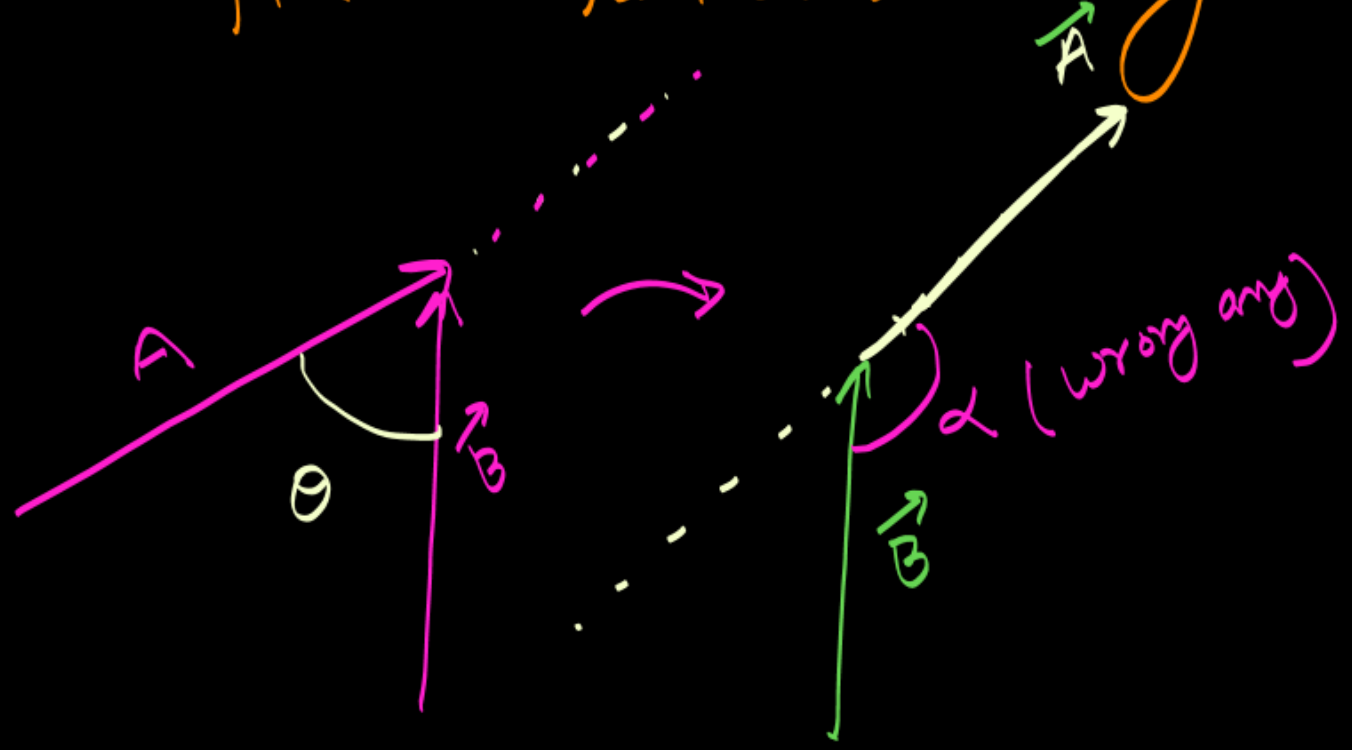
Rotn ($\theta \neq 360°$) is Not allowed

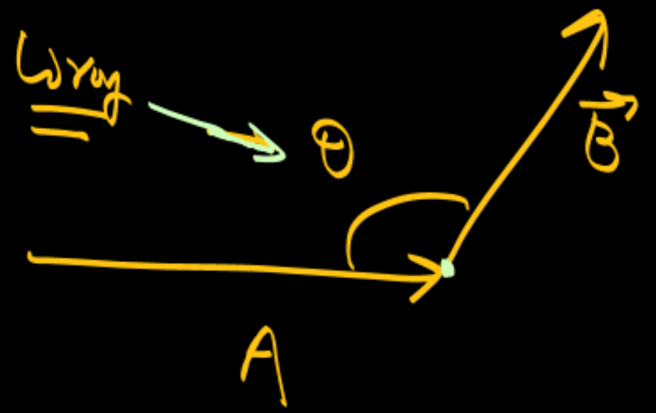
$\theta = 360° \rightarrow$ vector Rotn is allowed

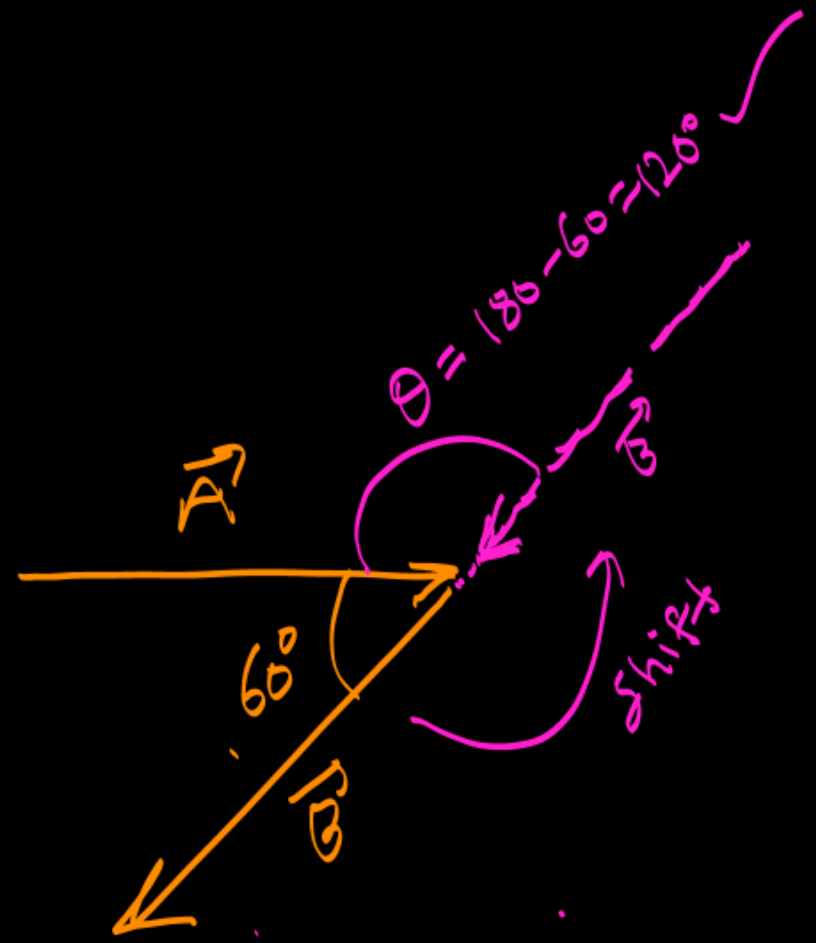
A ✗

Angle b/w Vector → Smaller angle b/w the vector when they placed tail or tail together or head-head together



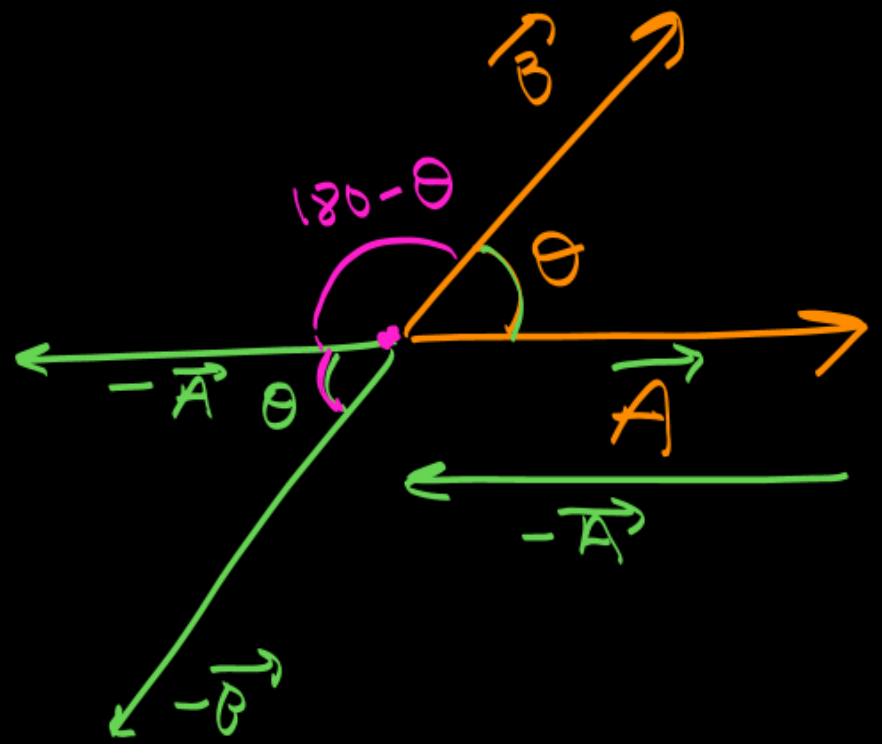


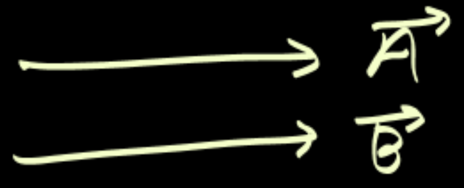
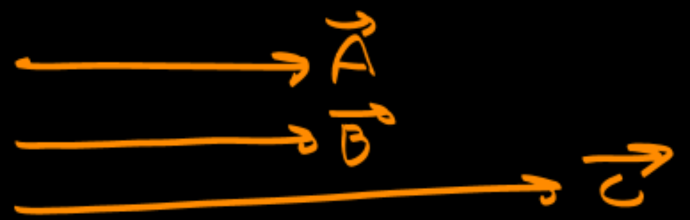
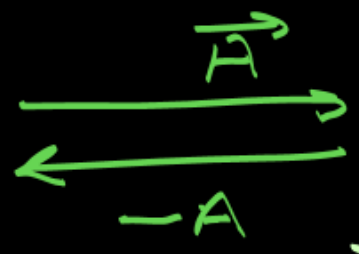
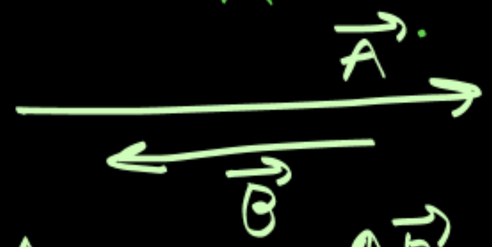
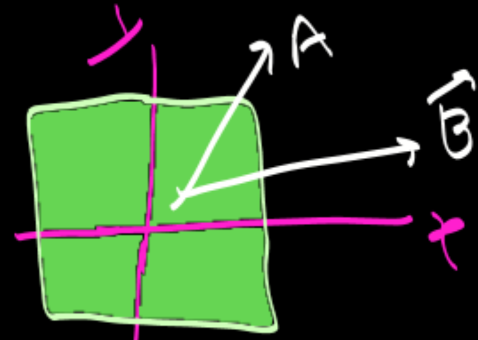
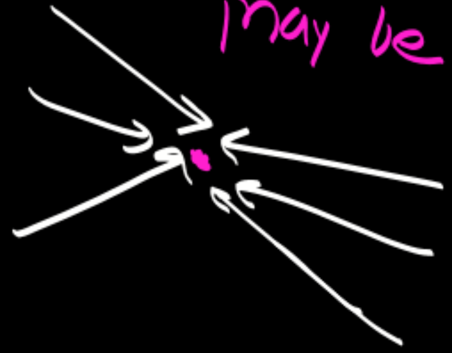




If Angle b/w $\vec{A}$ & $\vec{B}$ is θ then Angle b/w $\vec{A}$ & $-\vec{B}$ is $180-\theta$.

& $-\vec{A}$ & $-\vec{B}$ is θ

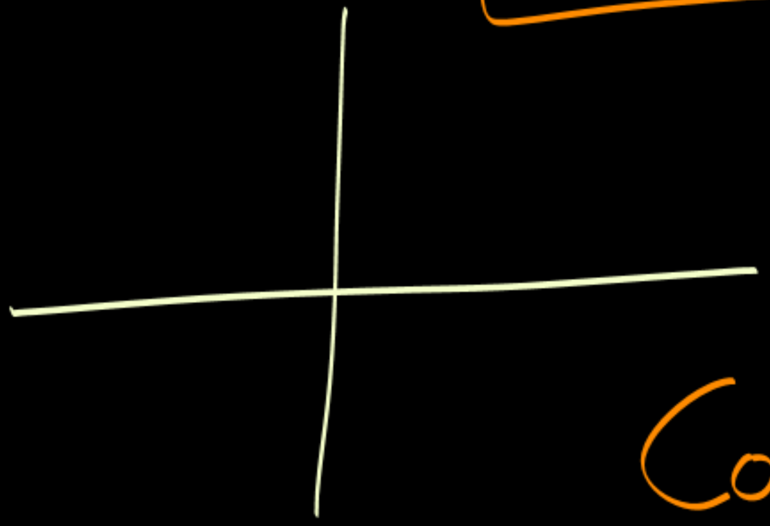


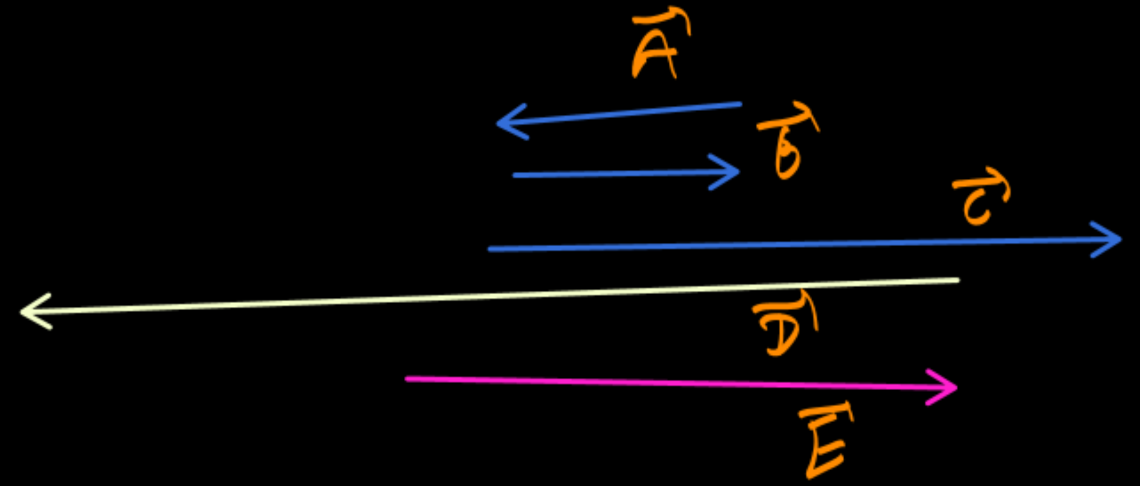
Type of vector	magnitude	dir^n	diagram
(A) equal vector	Same	Same ($\theta=0$)	
(B) Parall vectors	may be same or not	Same ($\theta=0$)	
(c) −ve vector (opposite vector)	Same	opposite ($\theta=180$)	
(d) anti Parallel vector	May be same or diff	$\theta=180$	
(e) orthogonal	May be sae	$\theta=90$	
(f) Unit vector	1 (one)	$\hat{A}=\frac{\vec{A}}{A}$	
(g) zero vector (null vector)	zero	may be any where	Ex velocity of CAR at rest.
(h) Co-Plane vector	may be same	Same Plane में 2-D space	
(I) Concurrent vector		⟸ Point of action same (may be say)	

axial vector

Rot^n → $\vec{\omega}, \vec{\alpha}, \vec{\tau}, L$

dir^n along axis of Rot^n





Colinear → along the same line

Equal vector

→ $(\vec{C}, \vec{D})$

−ve vector

$(\vec{A}, \vec{H})$ $(\vec{C}, \vec{F})$

Parallel vector

→ $(\vec{A}, \vec{B})$, (C, D)

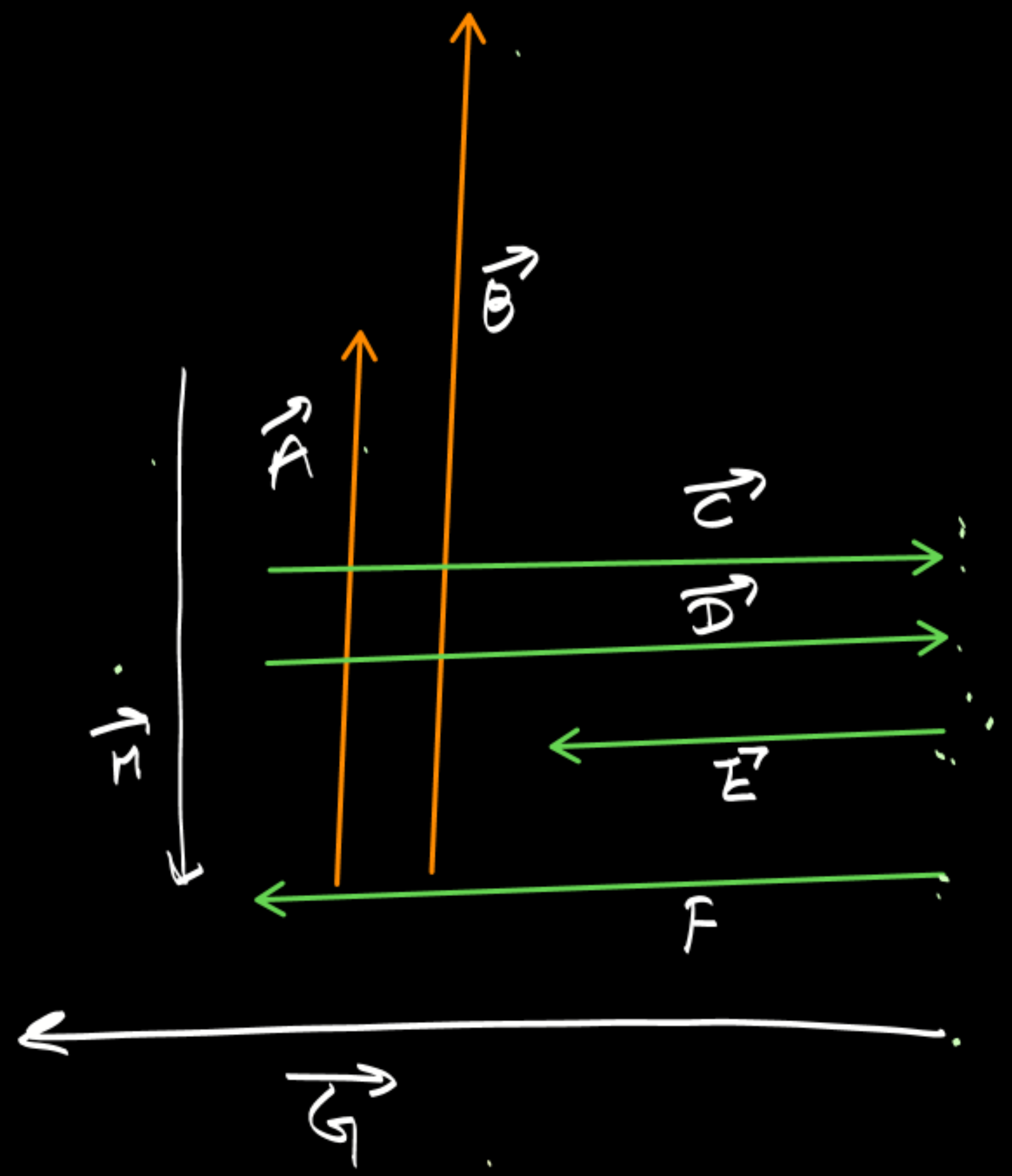
(E, F) (E, G) $(G\ F)$

Anti Parall

(A, H), $(B\ H)$, (C, E) (D, E) (F, C) (F, D) (G, C), (G, D)

Orthognl

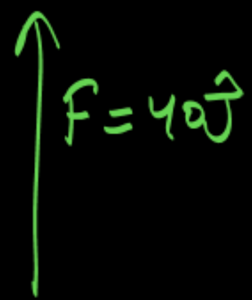
(H, C) (H, D) H, E, H, F HG AC AD AE B, F A ...

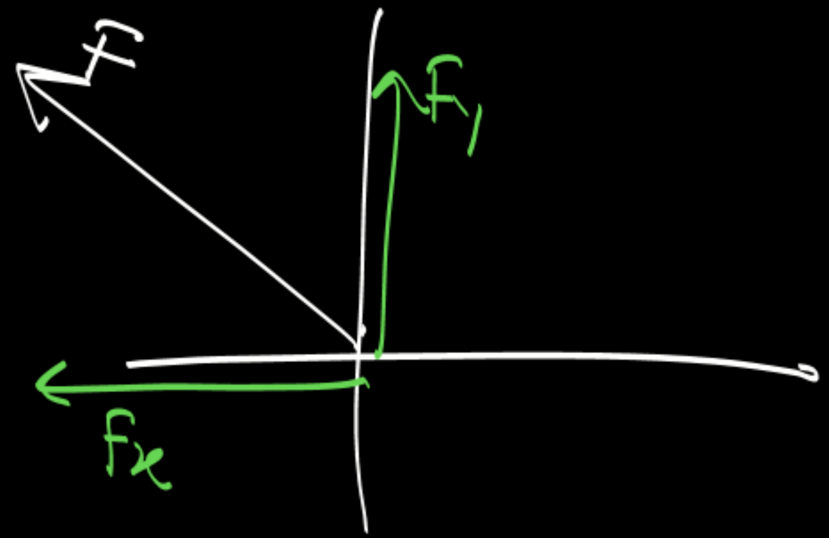


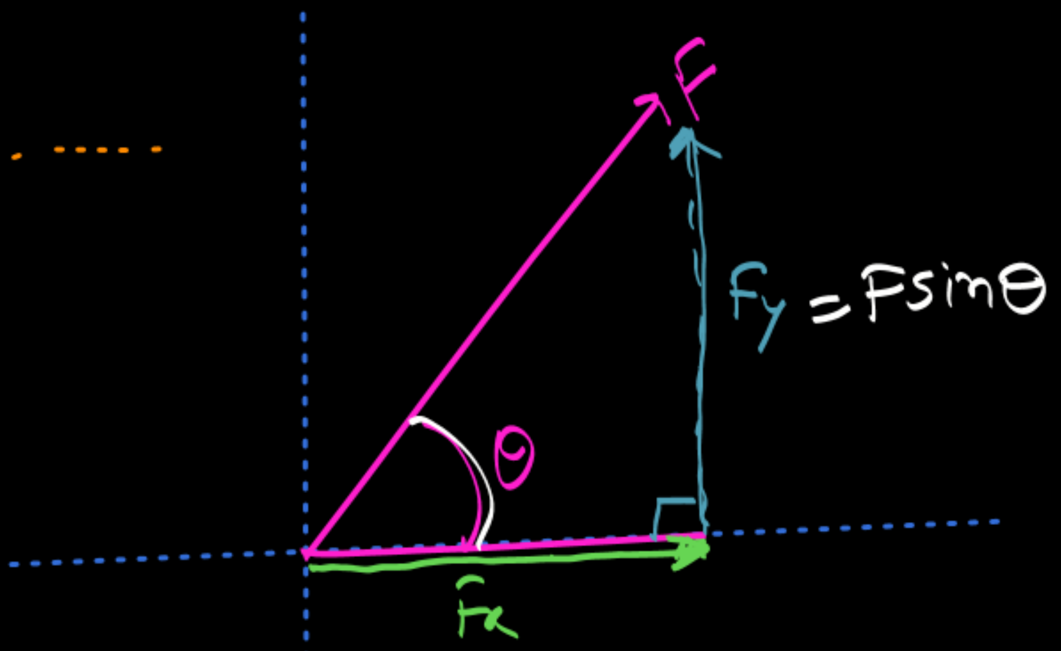
Component of vector

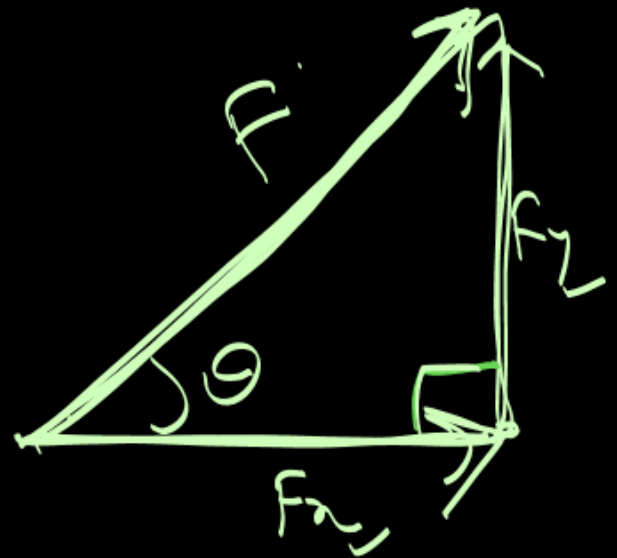
effect of vector → vector को तोड़ना





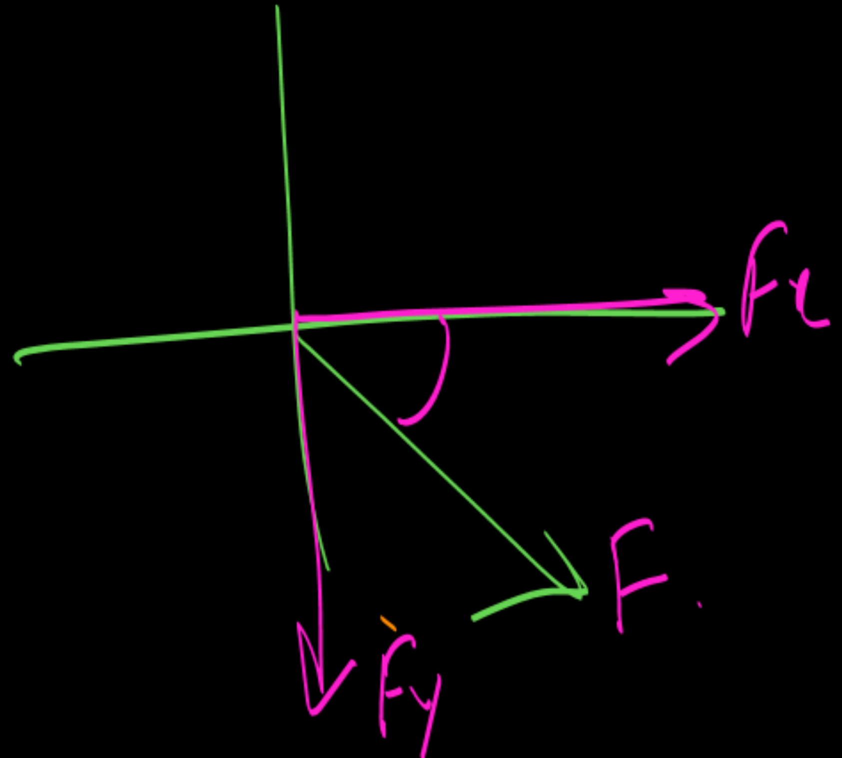


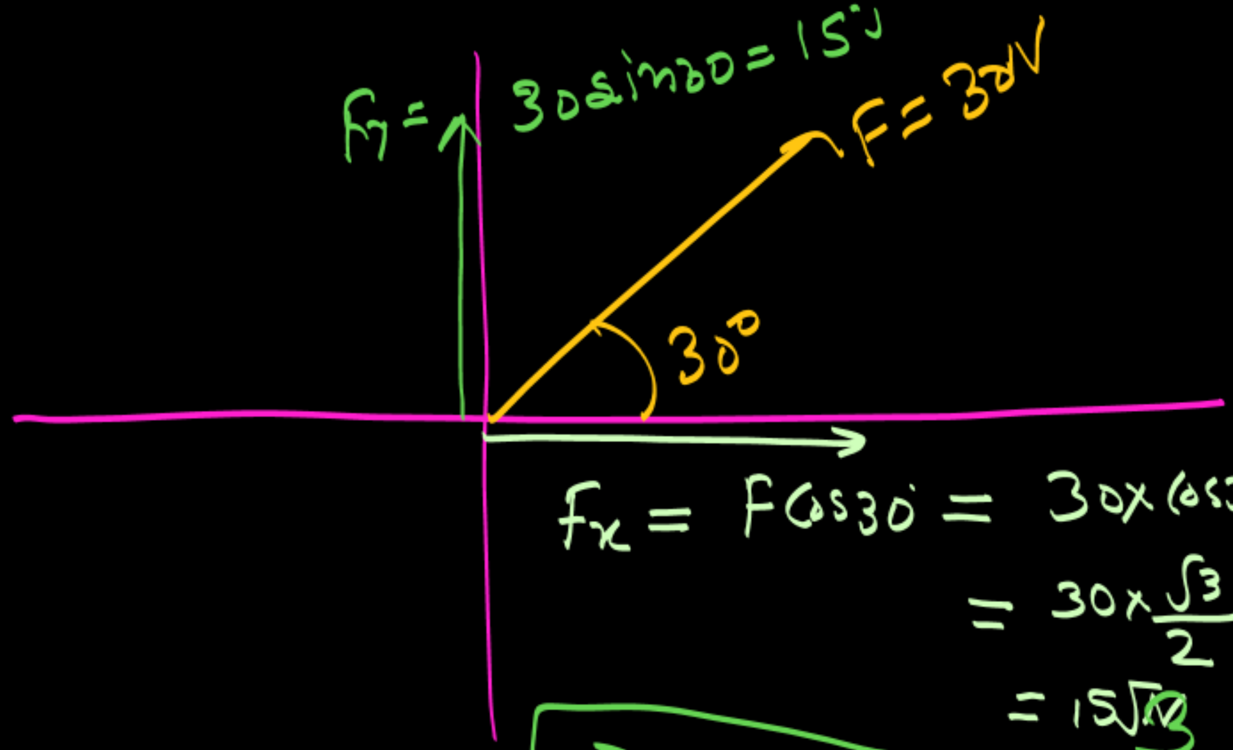




$$\cos\theta = \frac{F_x}{F}$$

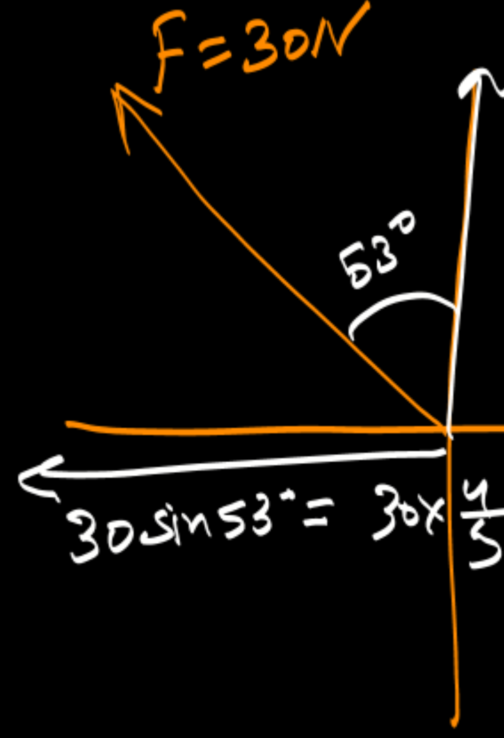
$$\boxed{F_x = F\cos\theta}$$





$F_x = F\cos 30 = 30\times\cos 30° = 30\times\frac{\sqrt{3}}{2} = 15\sqrt{3}\, i$

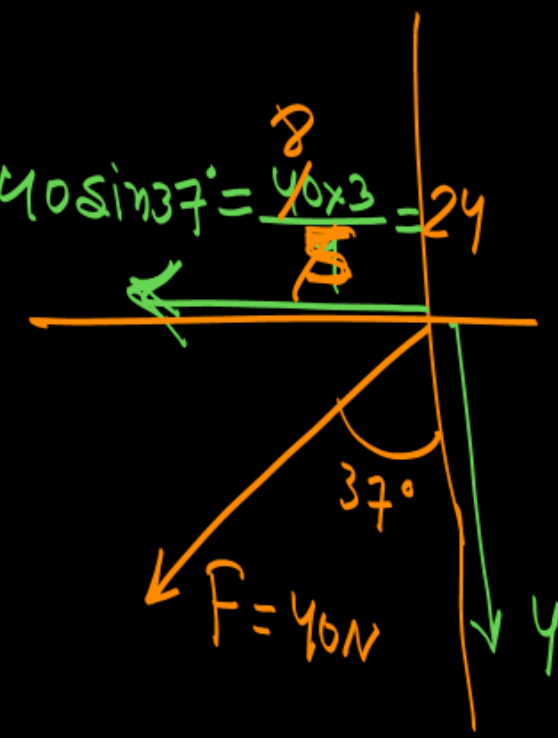
$\vec{F} = 15\sqrt{3}\, i + 15\hat{j}$



$F\cos 53° = 30\times\frac{3}{5} = 18\hat{j}$

$30\sin 53° = 30\times\frac{4}{5} = -24\hat{i}$

$F = -24\hat{i} + 18\hat{j}$



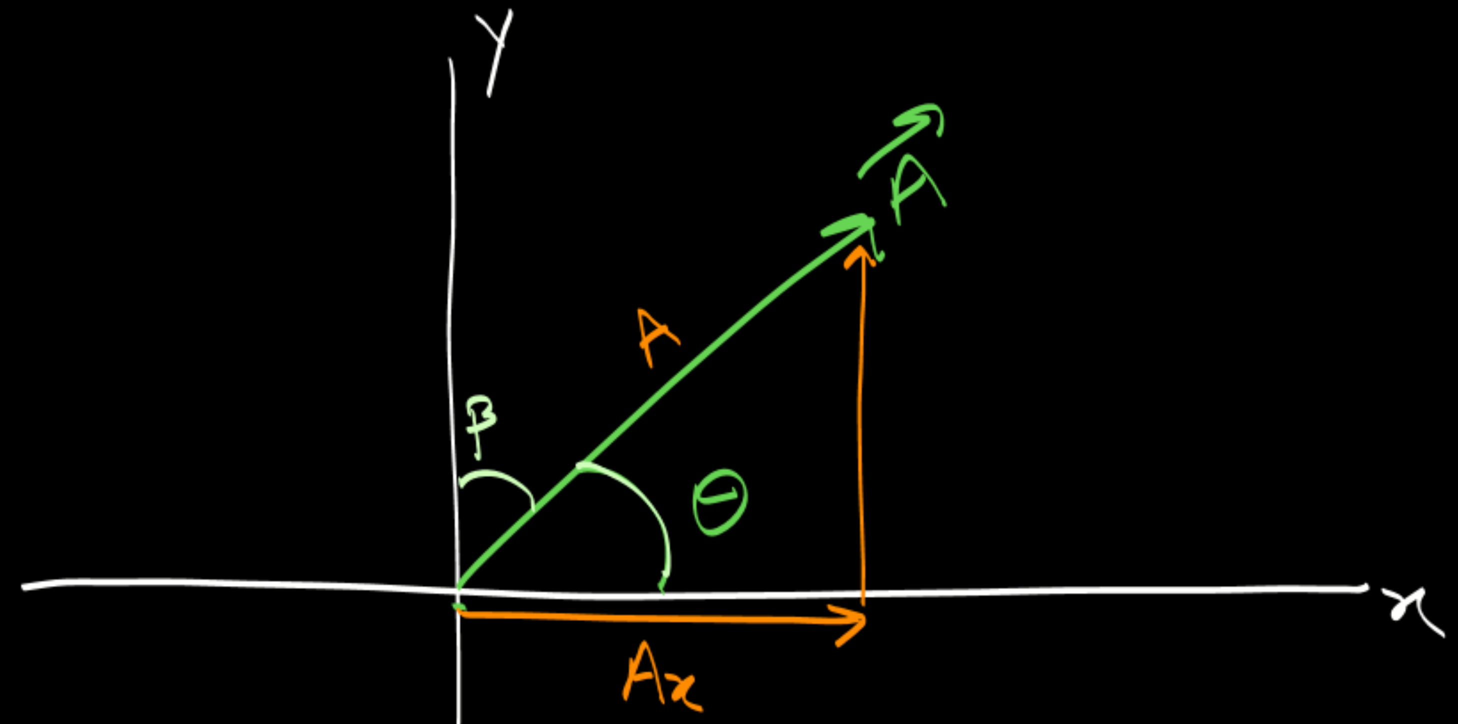
$40\sin 37° = \frac{40\times 3}{5} = 24$

$40\cos 37° = 40\times\frac{4}{5} = \frac{160}{5} = 32$

$F = -24\hat{i} - \frac{160}{5}\hat{j}$

$= -24\hat{i} - 32\hat{j}$

Cosine (dir^n of vector from diff^n axis)



Angle B/w $\vec{A}$ & Y

$$\cos\beta = \frac{A_y}{A}$$

$\vec{A}$, $\vec{z}$

$$\cos\gamma = \frac{A_z}{A}$$

$$\cos\theta = \frac{A_x}{A}$$

Angle B/w $\vec{x}$ & $\vec{A}$

$$\cos^2\theta + \cos^2\beta + \cos^2\gamma = \frac{A_x^2 + A_y^2 + A_z^2}{A^2} = 1$$

$$\sin^2\theta + \sin^2\beta + \sin^2\gamma = 2$$

$$\vec{A} = A_x\hat{i} + A_y\hat{j} + A_z\hat{k}$$

$|\vec{A}| = A_x + A_y + A_z$ ✗

$$A = \sqrt{A_x^2 + A_y^2 + A_z^2}$$

$$\vec{F} = 3\hat{i} + 4\hat{j} + 5\hat{k}$$

Angle b/w $\vec{F}$ & $\vec{z}$ axis

Sol^n

$$\cos\gamma = \frac{5}{\sqrt{3^2 + 4^2 + 5^2}} = \frac{5}{\sqrt{9 + 16 + 25}} = \frac{5}{\sqrt{50}} = \frac{5}{5\sqrt{2}} = \frac{1}{\sqrt{2}}$$

$$\cos\gamma = \frac{1}{\sqrt{2}}$$

$$\gamma = 45$$

$$\vec{A} = A_x\hat{i} + A_y\hat{j} + A_z\hat{k}$$

$$A = \sqrt{A_x^2 + A_y^2 + A_z^2}$$

$$\vec{F} = 20\hat{i} + 20\hat{j} \Rightarrow 20\sqrt{2} = F$$

$$\vec{F} = -10\hat{i} + 10\hat{j} \Rightarrow 10\sqrt{2}$$

$$\vec{F} = \hat{i} - \hat{j}$$

$$|F| = \sqrt{1^2 + (-1)^2}$$

$$= \sqrt{2}$$

$$F = i + j + k$$

$$|F| = \sqrt{3}$$

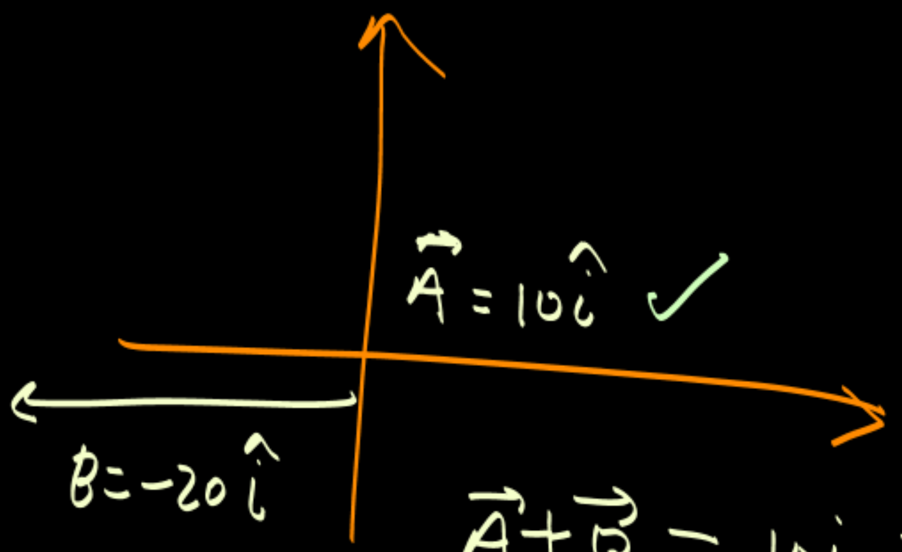
Simple law of vector add^n

$$\vec{A}\cdot\vec{B} = A_xB_x + A_yB_y + A_zB_z$$

$$\vec{A} = A_x\hat{i} + A_y\hat{j} + A_z\hat{k}$$

$$\vec{B} = B_x i + B_y j + B_z \hat{k}$$

$$\vec{A}+\vec{B} = (A_x+B_x)\hat{i} + (A_y+B_y)\hat{j} + (A_z+B_z)\hat{k}$$



$$\vec{A}+\vec{B} = 10i - 20\hat{i} = -10\hat{i}$$

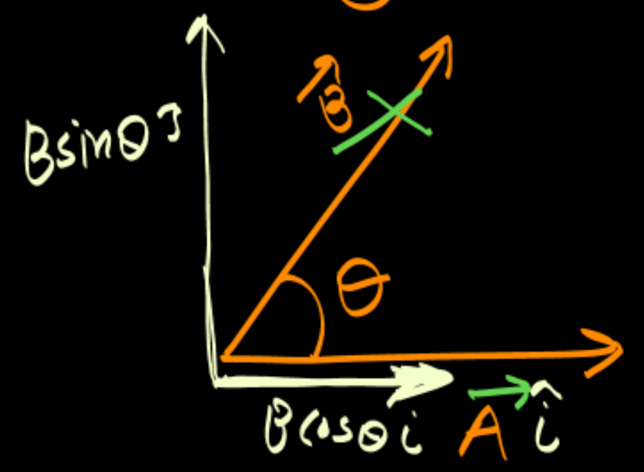
$A = 10\hat{i}$

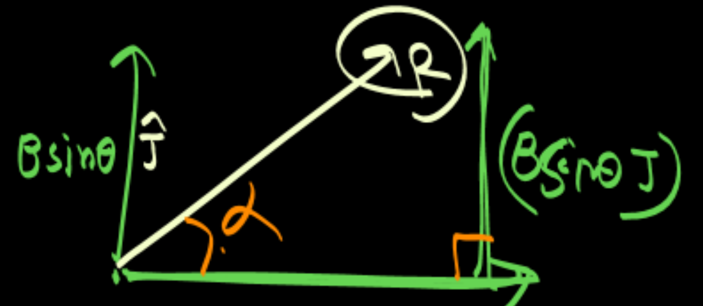
$\vec{B} = 10\hat{j}$

$\vec{A} = 10i + 10\hat{j}$

$|A| = \sqrt{10^2+10^2} = 10\sqrt{2}$

Triangle law of vector addition





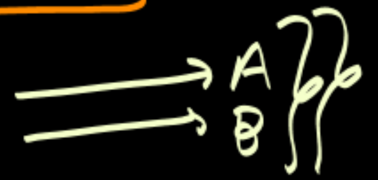
✓

$$R = \sqrt{(A + B\cos\theta)^2 + (B\sin\theta)^2}$$

$$R = \sqrt{A^2 + B^2 + 2AB\cos\theta}$$

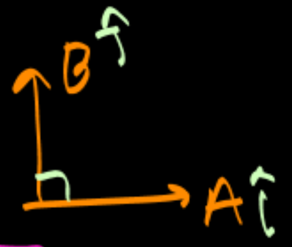
$$\tan\alpha = \frac{B\sin\theta}{A + B\cos\theta}$$

If $\theta = 0^\circ$



$$R_{max} = A + B$$

If $\theta = 90^\circ$



$$R = \sqrt{A^2 + B^2}$$

If $\theta = 180^\circ$

$$R_{min} = A - B$$



$A = 4, \; B = 5$

$|\vec{A} + \vec{B}| \Rightarrow 9$

$= \sqrt{5^2 + 4^2}$

$|\vec{A} + \vec{B}|_{min} = 1$

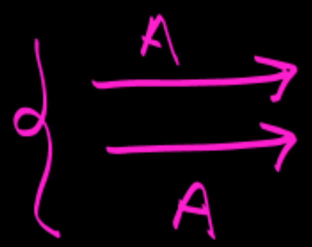
Two vectors of same magnitude

$$|\vec{A}| = |\vec{B}| = A$$

$$R = 2A\cos(\theta/2)$$

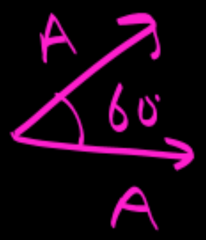
$\theta = 0$

$R = 2A$



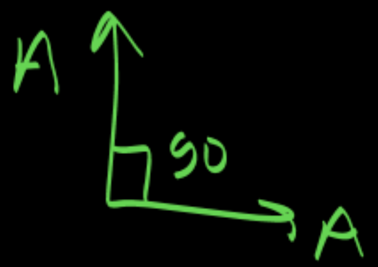
$\theta = 60°$

$R = \sqrt{3}A$



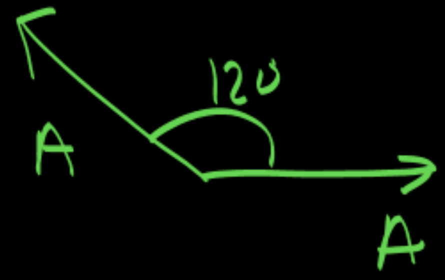
$\theta = 90°$

$R = \sqrt{2}A$



$\theta = 120°$

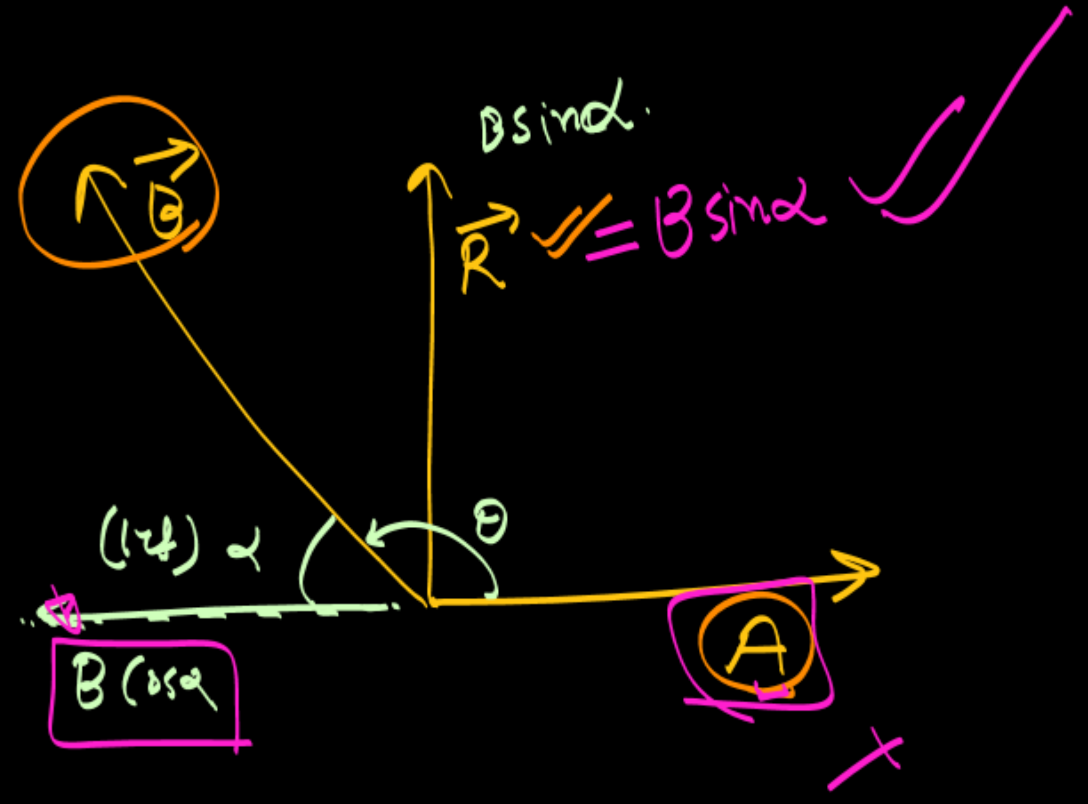
$R = A$



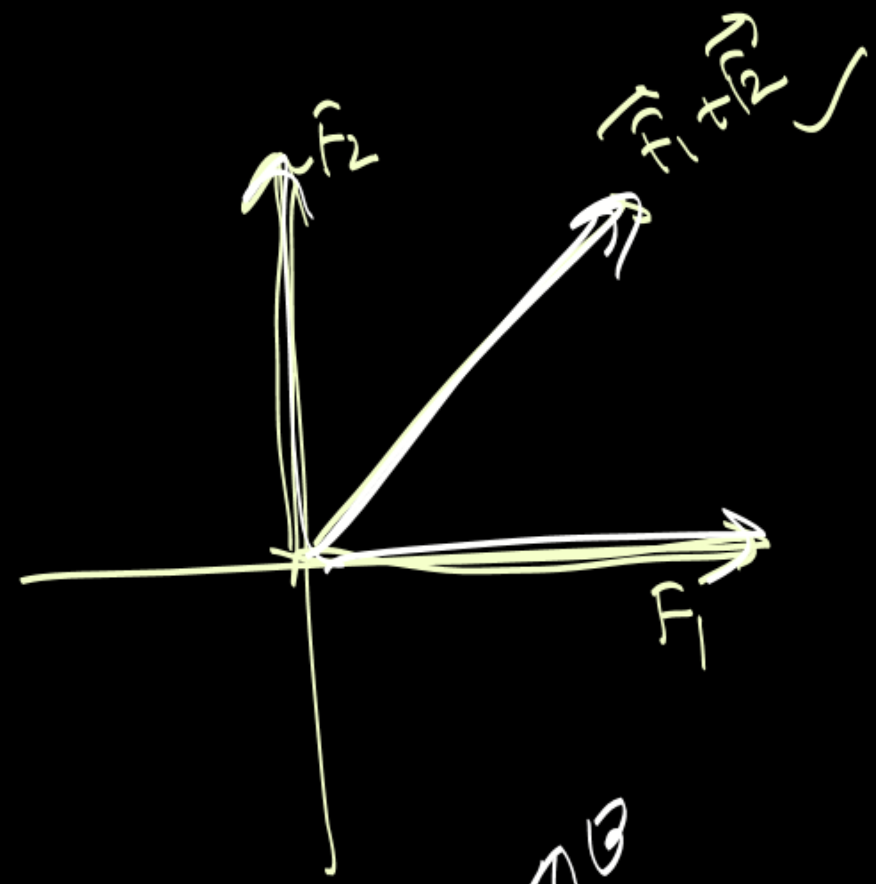
$\theta = 180$

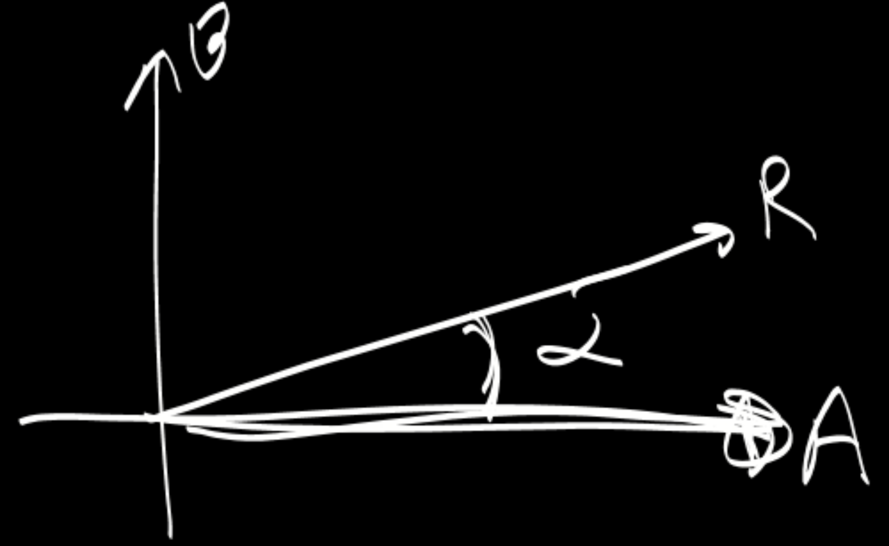


$R = 0$



$$B\cos\alpha = A$$





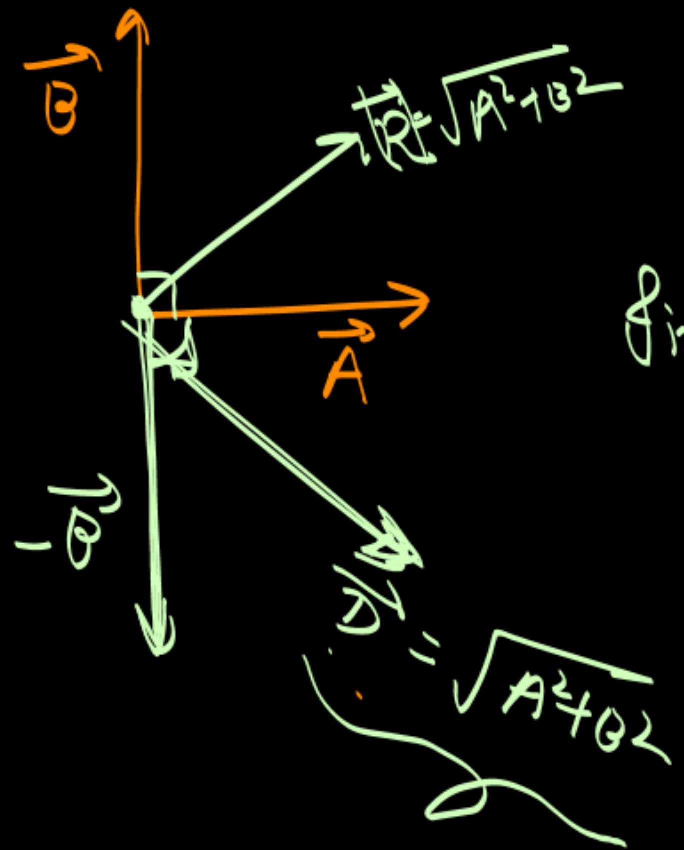
Vector subtraction ⇒ जिसको घटाना है उसको उलटा कर के add कर दो

$\vec{D} = \vec{A} - \vec{B}$

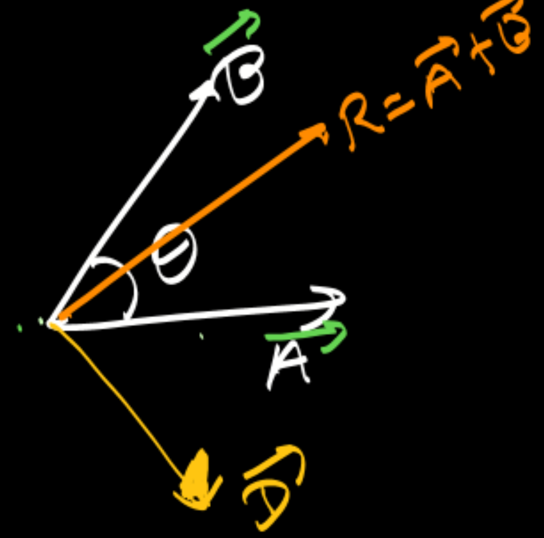
$= \vec{A} + (-\vec{B})$

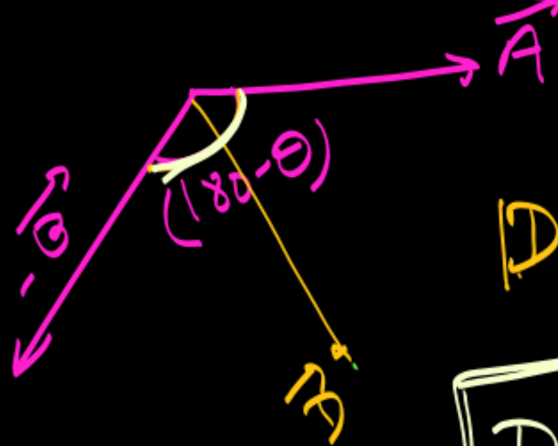
Vector addⁿ b/w $\vec{A}$ & $-\vec{B}$

$D = \vec{A} - \vec{B}$



find $\vec{A} - \vec{B} = \vec{D}$





$\vec{D} = \vec{A} - \vec{B}$

$|D| = \sqrt{A^2 + B^2 + 2AB\cos(180-\theta)}$

$D = \sqrt{A^2 + B^2 - 2AB\cos\theta}$

$\theta = 0°$

$D = A - B$

$\longrightarrow A$

$\longrightarrow B$

$\theta = 90°$

$D = \sqrt{A^2+B^2}$

$|\vec{A} + \vec{B}| = |\vec{A} - \vec{B}|$

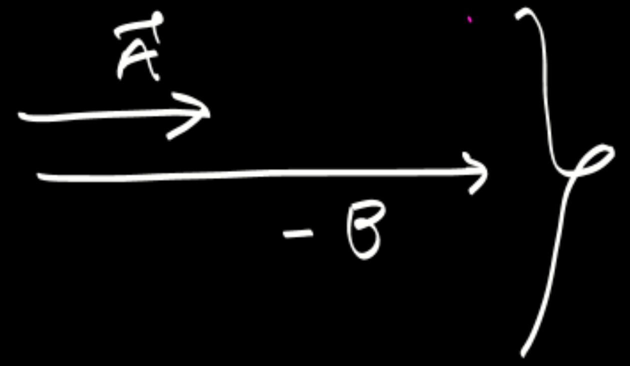
$\theta = 90°$

$\theta = 180°$

$D = A + B$



$$\vec{A} - \vec{B} = \vec{A} + (-\vec{B})$$



QUESTION-01

Two vectors acting through a point are in the ratio 3 : 5. If the angle between them is 60° and the magnitude of their resultant is 35, find the magnitude of vectors.

(add)

$$\frac{A}{B} = \frac{3}{5}$$

$\theta = 60°$

$\vec{A} + \vec{B} = 35$

$B = \frac{5A}{3}$

$R = \sqrt{A^2 + B^2 + 2AB\cos\theta}$

$35 = \sqrt{A^2 + \left(\frac{5A}{3}\right)^2 + 2A\,\frac{5A}{3}\cos 60°}$

$= A\sqrt{1 + \frac{25}{9} + \frac{5}{3}} = A\sqrt{\frac{9 + 25 + 15}{9}}$

$35 = A\sqrt{\frac{49}{9}}$

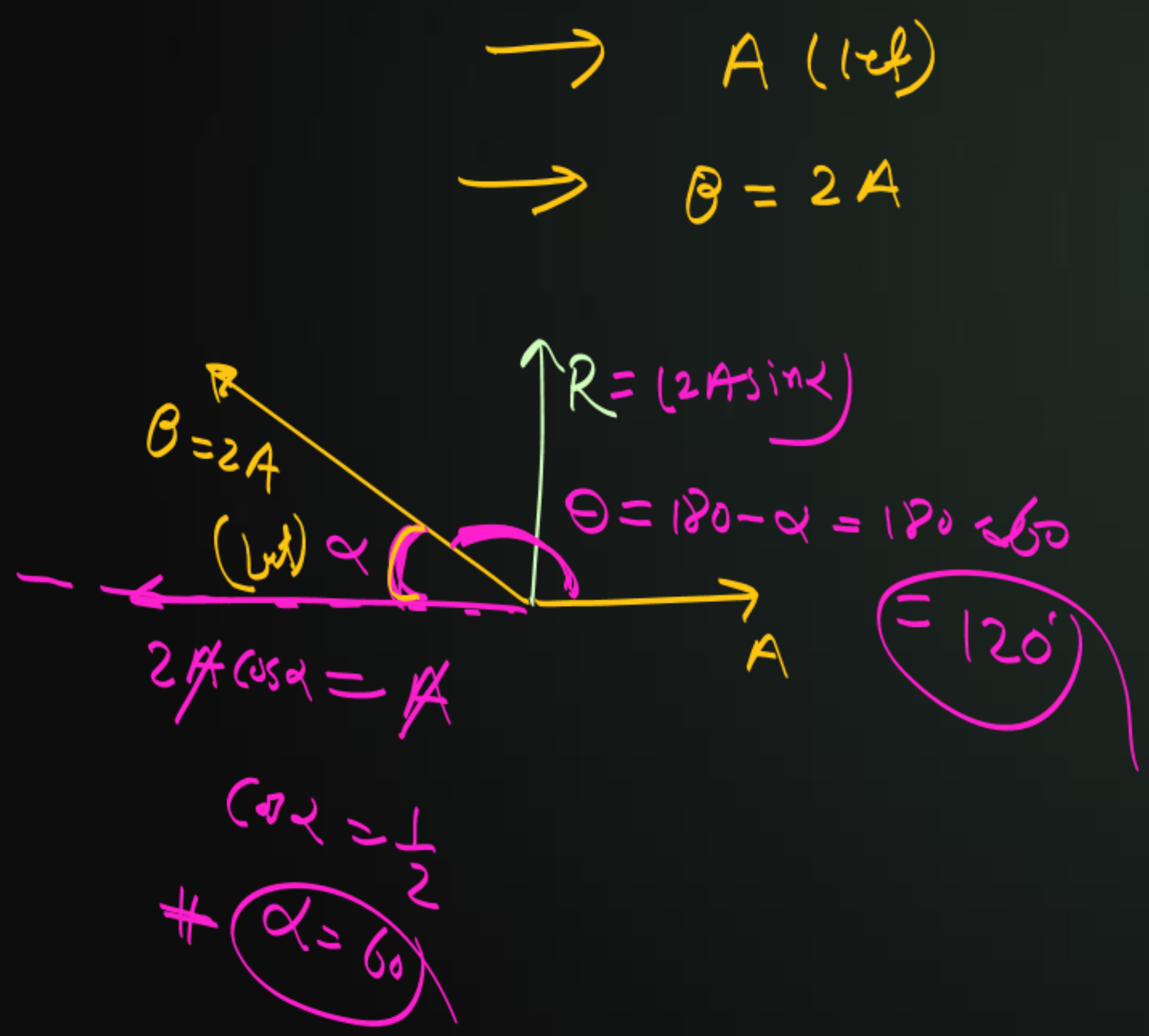
$35 = A\,\frac{7}{3}$

$A = 15$

$B = \frac{5A}{3} = \frac{5 \times 15}{3} = 25$

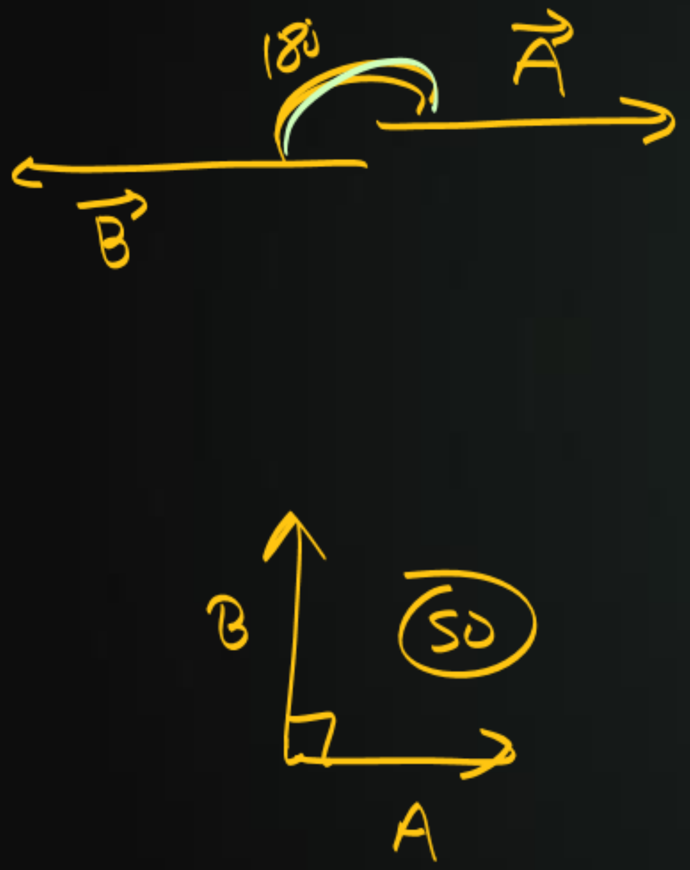
QUESTION-02

The resultant of two forces, one double the other in magnitude, is perpendicular to the smaller of the two forces. Find the angle between the forces.



QUESTION-03

Two forces acting in opposite direction have resultant 10 N and when acting perpendicularly have resultant 50 N. Find the magnitude of forces.



$\Rightarrow 40 = A - B$

$A = 40 + B$

$50 = \sqrt{A^2 + B^2}$

$50 = \sqrt{(40+B)^2 + B^2}$

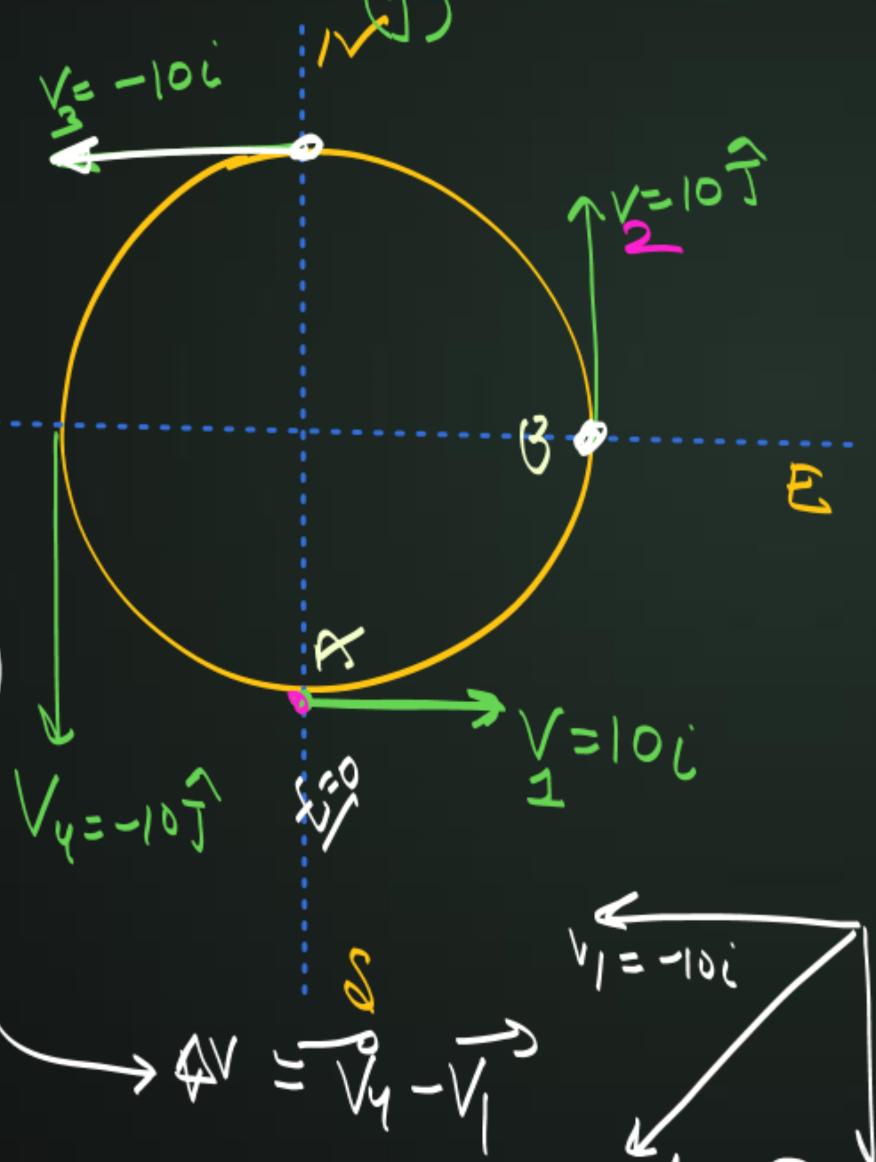
$A = 30$

$B = 40$

QUESTION-04

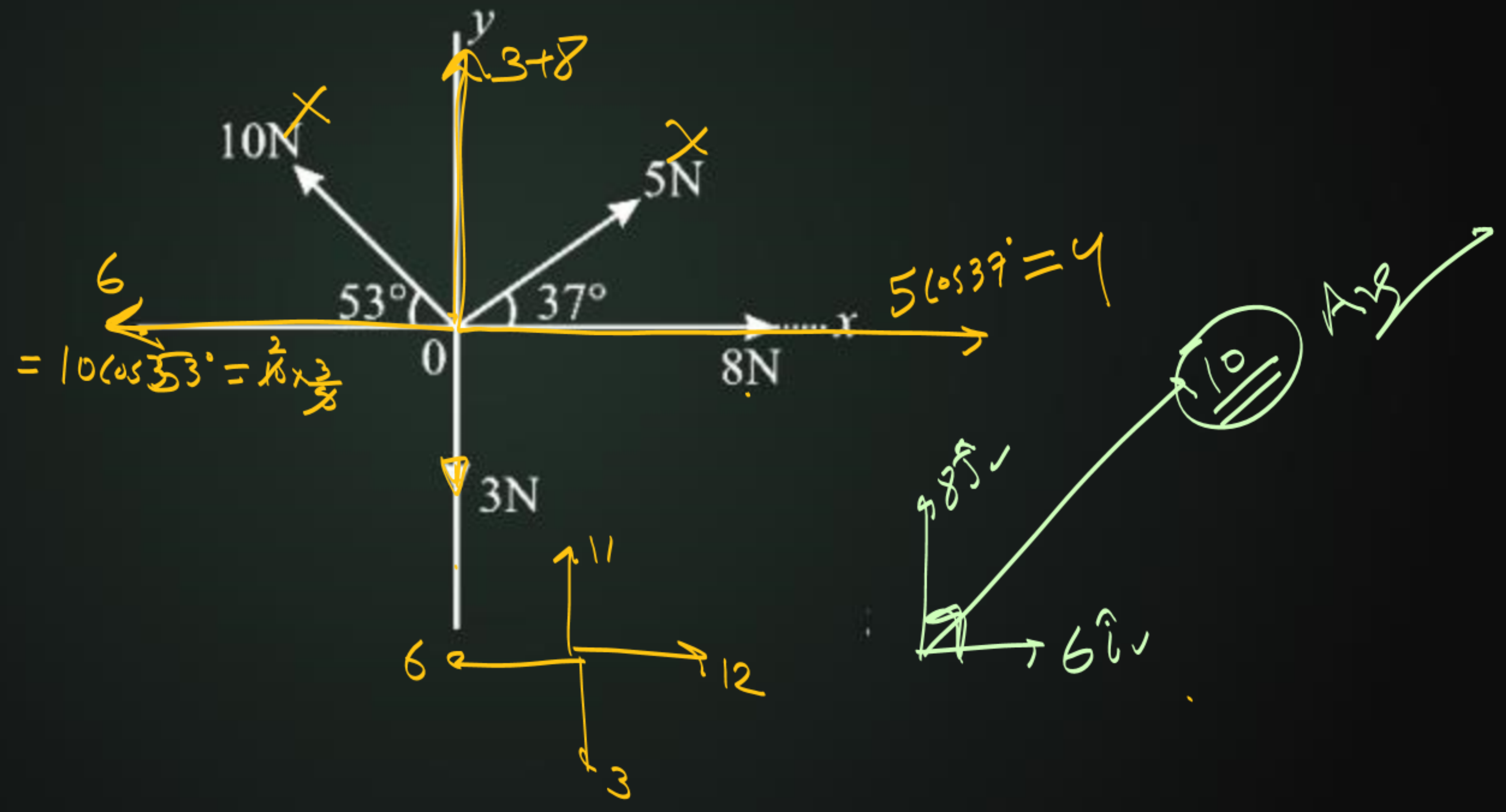
A particle is moving along a circle with a uniform speed 10 m/s. At $t = 0$, the particle is moving along east. Find the change in velocity (magnitude and direction) in

1. $1/4^{th}$ revolution
2. $1/2$ revolution
3. $3/4^{th}$ revolution
4. 1 revolution



QUESTION-05

Find the resultant of the following forces.



QUESTION-06

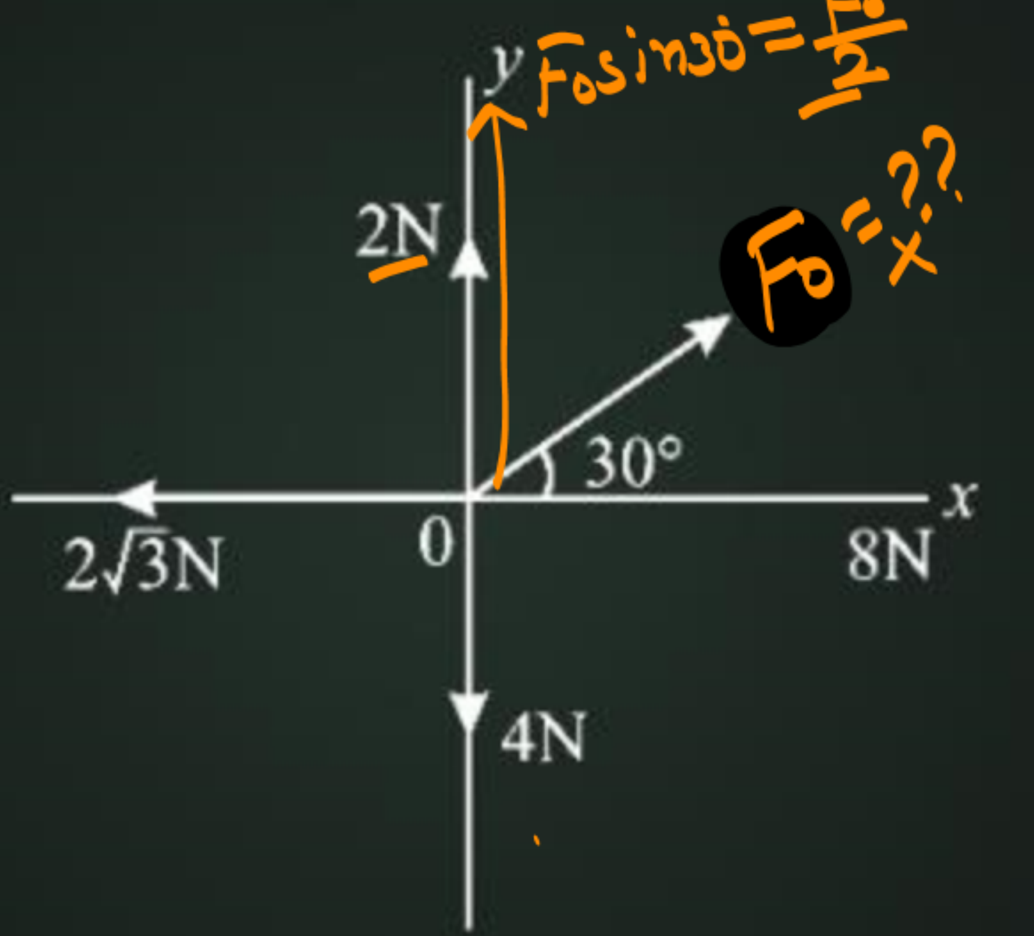
If the resultant of the following forces is zero, find the value of F_0.

$F_y = 0$

$2 + \frac{F_0}{2} = 4$

$\frac{F_0}{2} = 2$

$F_0 = 4N$



QUESTION-07

If $\vec{a} = 2\hat{\imath} + 2\hat{\jmath} + \hat{k}$, $\vec{b} = -\hat{\imath} + \hat{\jmath} + 2\hat{k}$ and $\vec{c} = 3\hat{\imath} + \hat{\jmath}$ such that $\vec{a} + \lambda\hat{b}$ is perpendicular to $\vec{c}$, find λ.

$$\vec{a} + \lambda\vec{b} = 2\hat{i} + 2\hat{j} + \hat{k} + (-\lambda\hat{i} + \lambda\hat{j} + 2\lambda\hat{k})$$

$$\vec{a} + \lambda\vec{b} = (2-\lambda)\hat{i} + (2+\lambda)\hat{j} + (1+2\lambda)\hat{k}$$

$$(\vec{a} + \lambda\vec{b}) \cdot \vec{c} = \left((2-\lambda)\hat{i} + (2+\lambda)\hat{j} + (1+2\lambda)\hat{k}\right) \cdot (3\hat{i} + \hat{j}) = 0$$

$$3(2-\lambda) + 2+\lambda = 0$$

$$6 - 3\lambda + 2 + \lambda = 0$$

$$8 = 2\lambda$$

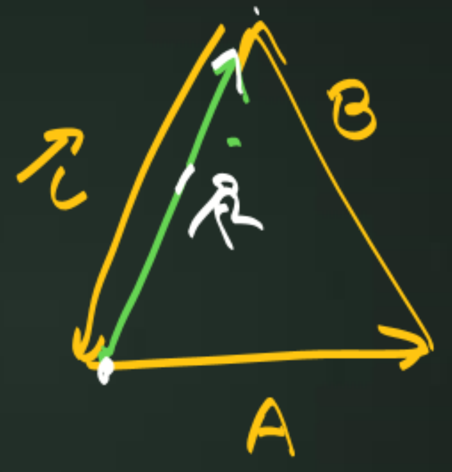
$$\boxed{\lambda = 4}$$

QUESTION-08

If $\vec{a}$, $\vec{b}$ and $\vec{c}$ be three vectors such that $\vec{a}+\vec{b}+\vec{c}=0$ and $|\vec{a}|=3$, $|\vec{b}|=5$, $|\vec{c}|=7$, find the angle between $\vec{a}$ and $\vec{b}$.

$\vec{a}+\vec{b}+\vec{c}=0$

$\Rightarrow \vec{a}+\vec{b}=-\vec{c}$ (7)



$\vec{A}+\vec{B}=-\vec{C}$

$\vec{A}+\vec{B}=\vec{R}$

$\sqrt{a^2+b^2+2ab\cos\theta}=7$

a = 3, b = 5

$\theta = 60°$

QUESTION-09

If $|\vec{a}| = \sqrt{26}$, $|\vec{b}| = 7$ and $|\vec{a} \times \vec{b}| = 35$. Find $\vec{a} \cdot \vec{b}$.

$x = \vec{a} \cdot \vec{b} = ab\cos\theta$

$35 = a \times b = ab\sin\theta$

$x^2 + (35)^2 = a^2b^2$

$x^2 = 7^2 \times 26 - 35^2$

$x = \sqrt{7^2 \times 26 - 35^2} \rightarrow 7$

$ab\sin\theta = 35$

$7 \times \sqrt{26}\,\sin\theta = 35$

$\sin\theta = \frac{5}{\sqrt{26}} = \frac{P}{H}$ $\quad B = \sqrt{26 - 25} = 1$

$\vec{a} \cdot \vec{b} = ab\cos\theta$

$= \sqrt{26} \times 7 \, \frac{1}{\sqrt{26}}$

$\vec{a} \cdot \vec{b} = 7$

QUESTION-10

Scalar triple product

$\vec{a} = 3\hat{\imath} + 2\hat{k}$, $\vec{b} = 3\hat{\jmath} - 4\hat{k}$ and $\vec{c} = \hat{\imath} + \hat{\jmath} + \hat{k}$. Find $(\vec{a} \times \vec{b}) \cdot \vec{c}$.

$$\vec{a} \times \vec{b} = \begin{vmatrix} i & \hat{j} & k \\ 3 & 0 & 2 \\ 0 & 3 & -4 \end{vmatrix} = i(-6) + \hat{j}(+12) + \hat{k}(9-0)$$

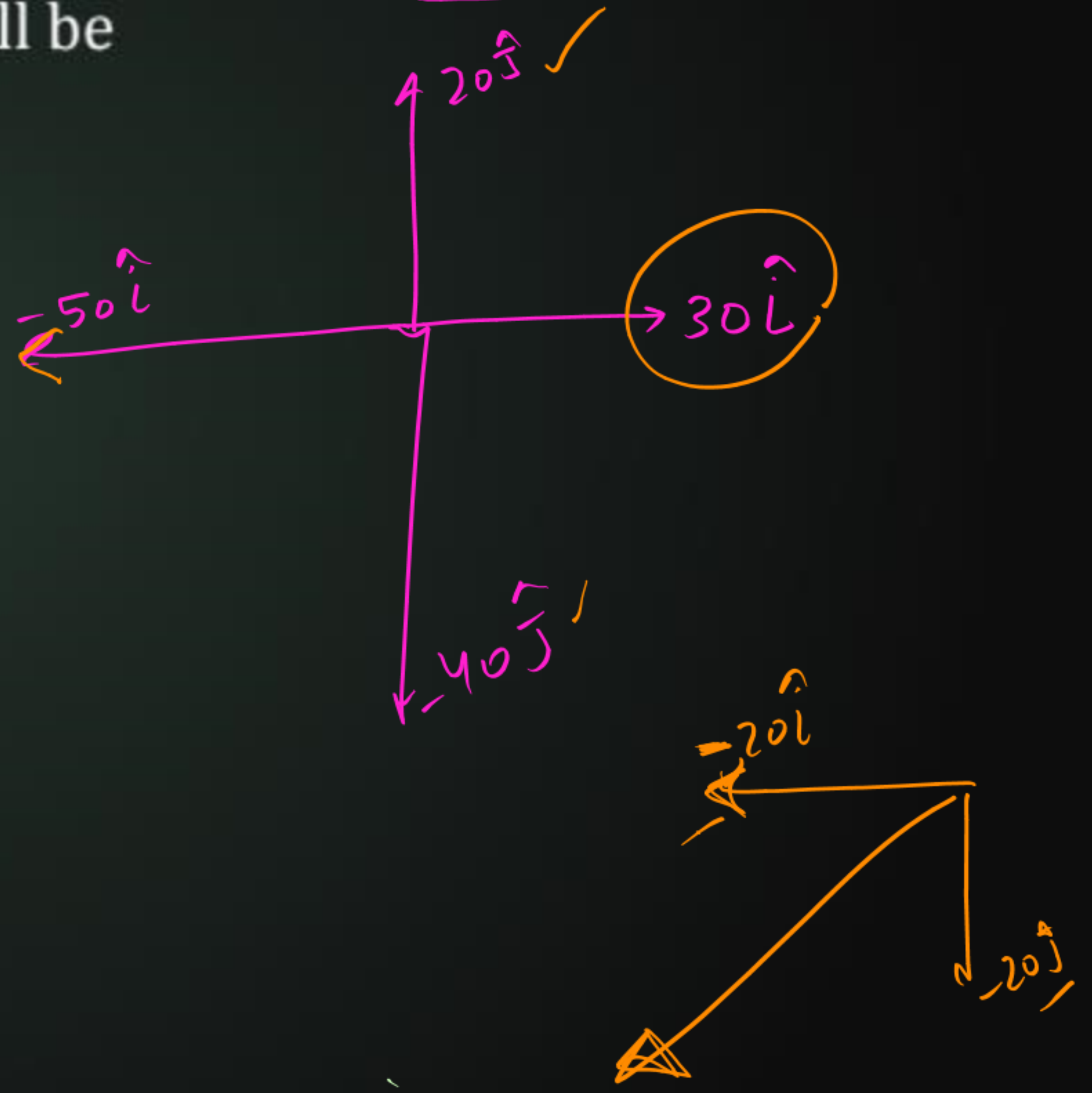
$$= (6i + 12j + 9k) \cdot (i + j + k)$$

$$= 21 - 6 = 15$$

QUESTION-11

A particle is being acted upon by four forces of 30 N due east, 20 N due north, 50 N due west and 40 N due south. The resultant force will be

1. $20\sqrt{2}$ N, 60° south to west
2. $20\sqrt{2}$ N, 45° south west
3. $20\sqrt{2}$ N, 45° north to east
4. $20\sqrt{2}$ N, 45° south to west



QUESTION-12

Two adjacent sides of a parallelogram are represented by the two vectors $\hat{\imath} + 2\hat{\jmath} + 3\hat{k}$ and $3\hat{\imath} - 2\hat{\jmath} + \hat{k}$. What is the area of parallelogram?

(1) 8

(2) $8\sqrt{3}$

(3) $3\sqrt{8}$

(4) 192

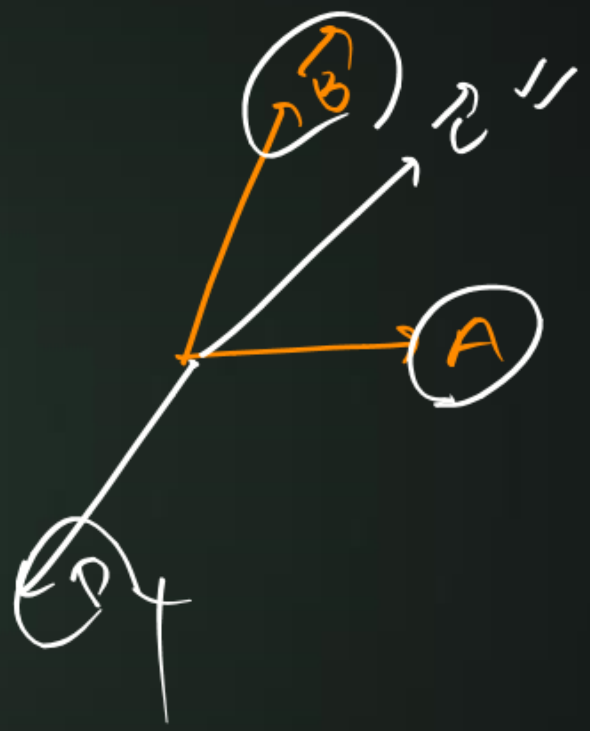
$$\vec{A} \times \vec{B} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & 2 & 3 \\ 3 & -2 & 1 \end{vmatrix} = \hat{i}(8) + \hat{j}(8) + \hat{k}(-8)$$

$8\sqrt{3}$

QUESTION-13

How many minimum numbers of non-zero vectors in different planes can be added to give zero resultant?

1. 2
2. 3
3. 4
4. 5

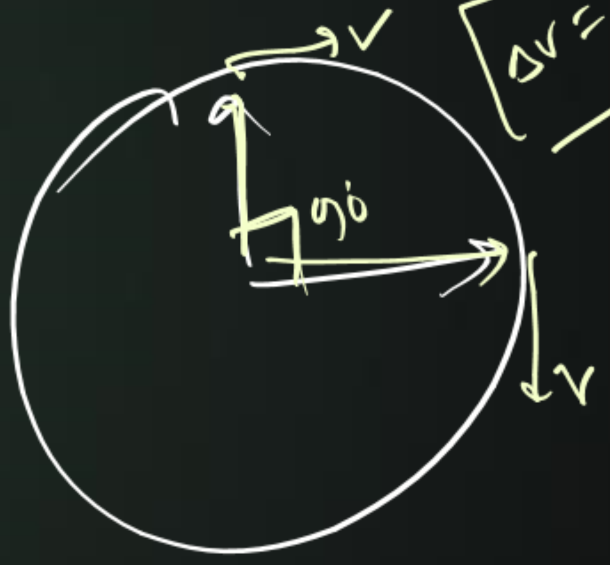


QUESTION-14

The length of the second's hand in a watch is 1 cm. The magnitude of the change in the velocity of its tip is 15 s is

1. Zero
2. $\pi/30$ cm/s
3. $(\pi/30)\sqrt{2}$ cm/s
4. $\pi/30\sqrt{2}$ cm/s

Circular motion not in this chapter



$\Delta v = 2v \sin \theta/2$

$= 2v \times \sin\left(\frac{90}{2}\right)$

$= 2v \times \sin 45$

$= 2v \times \frac{1}{\sqrt{2}}$

$\Delta v = \sqrt{2}v$

QUESTION-15

A particle moving with a speed of v changes direction by an angle θ, without change in speed.

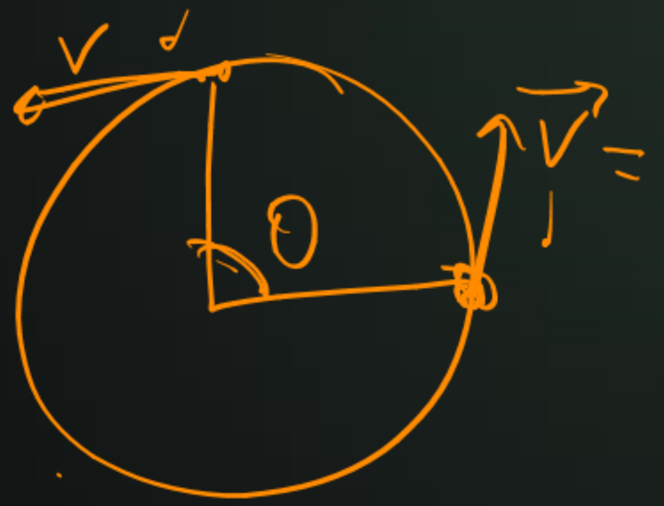
(i) The change in the magnitude of its velocity is zero.

(ii) The change in the magnitude of its velocity is $2v \sin \theta/2$.

(iii) The magnitude of the change in its velocity is $2v \sin \theta/2$.

(iv) The magnitude of the change in its velocity is $v(1 - \cos \theta)$.

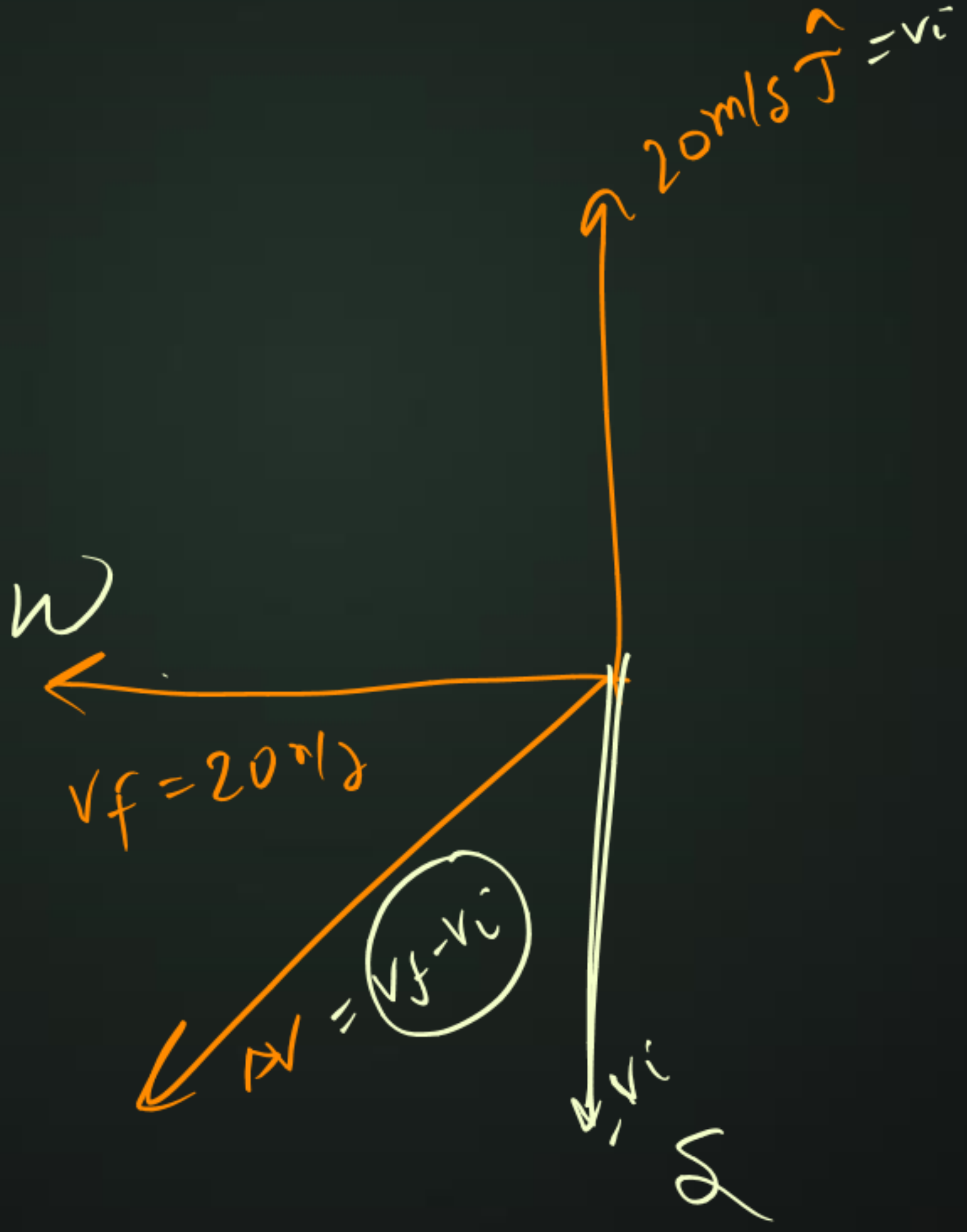
1. (i), (ii)
2. (i), (iii)
3. (i), (ii), (iii)
4. All



QUESTION-16

A truck travelling due north at 20 m/s turns west and travels at the same speed. What is the change in the velocity?

1. 40 m/s NW
2. 40 m/s SW
3. $20\sqrt{2}$ m/s NW
4. $20\sqrt{2}$ m/s SW



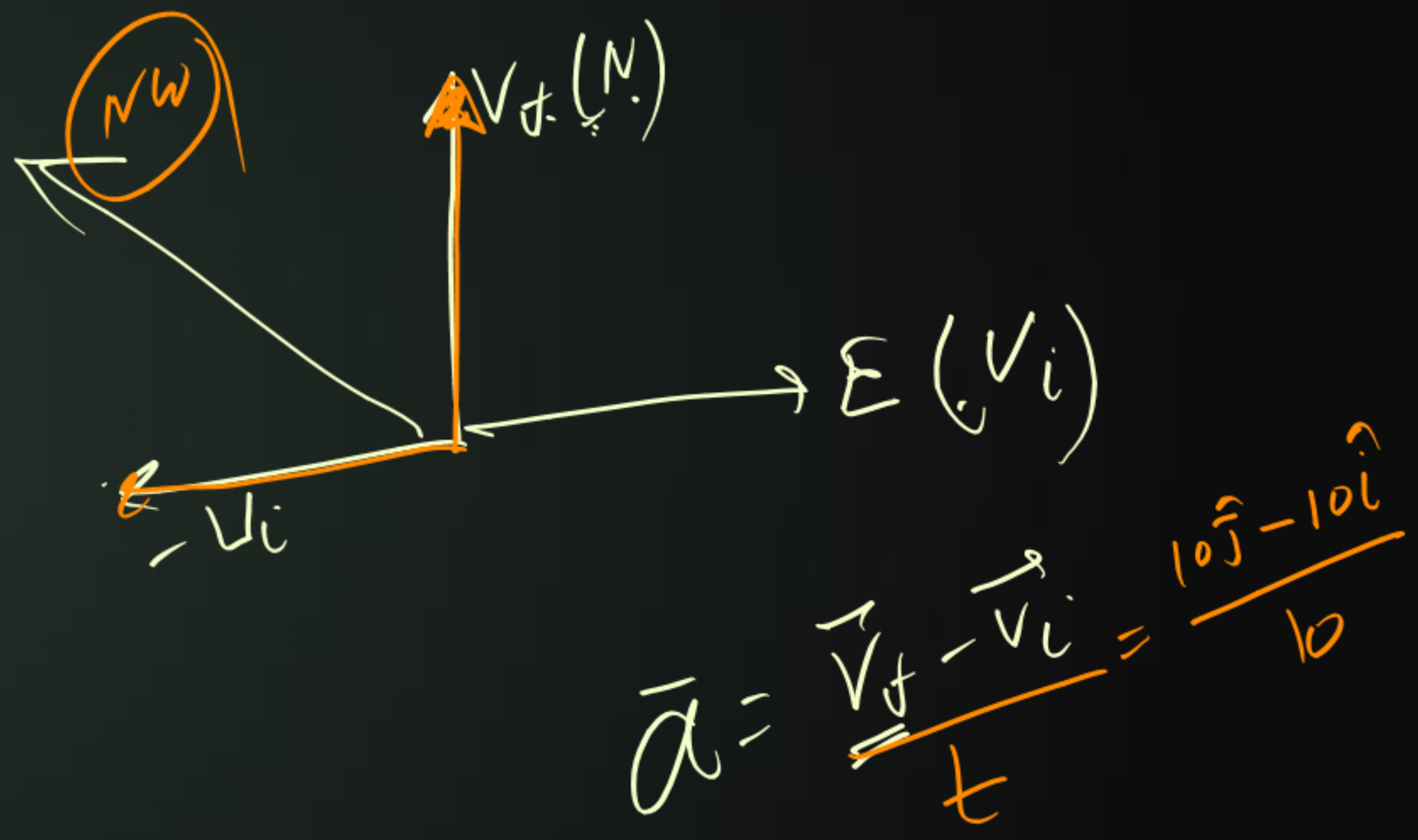
$\Delta v = \vec{v}_f - \vec{v}_i$

$= -20\hat{i} - 20\hat{j}$

QUESTION-17

A particle moves towards east with a speed 5 m/s. After 10 s its direction changes towards north with the same speed. The average acceleration of the particle is

1. Zero
2. $\frac{1}{\sqrt{2}}$ m/s^2 N-W
3. $\frac{1}{\sqrt{2}}$ m/s^2 N-E
4. $\frac{1}{\sqrt{2}}$ m/s^2 S-W



QUESTION-18

Which of the following vectors is/are perpendicular to the vector $4i - 3j$?

1. $4i + 3j$ $(4\hat{i} + 3\hat{j}) \cdot (4\hat{i} - 3\hat{j}) = 16 - 9$ ✗
2. $6i$
3. $7k$ ✓
4. $3i - 4j$ ✗

$(4\hat{i} - 3\hat{j}) \cdot (3\hat{i} - 4\hat{j}) = 12 + 12 = 24$

QUESTION-19

If $\vec{A} = 2i + j - k$, $\vec{B} = i + 2j + 3k$ and $\vec{C} = 6i - 2j - 6k$, then the angle between $(\vec{A} + \vec{B})$ and $\vec{C}$ will be

1. $30°$
2. $45°$
3. $60°$
4. $60°$

$\vec{A} + \vec{B} = \vec{D}$

$\vec{D} \cdot \vec{C} = DC \cos\theta$

Ang btw $\vec{C}$ $\vec{D}$

QUESTION-20

If $\vec{A} \times \vec{B} = \vec{C}$, then which of the following statements is wrong

1. $\vec{C} \perp \vec{A}$
2. $\vec{C} \perp \vec{B}$
3. $\vec{C} \perp (\vec{A} + \vec{B})$
4. $\vec{C} \perp (\vec{A} \times \vec{B})$

QUESTION-21

The magnitude of the vector product of two vectors A and B may not be

1. greater than AB
2. equal to AB
3. Less than AB
4. equal to zero

$\vec{A} \cdot \vec{B} = AB\cos\theta$

QUESTION-22

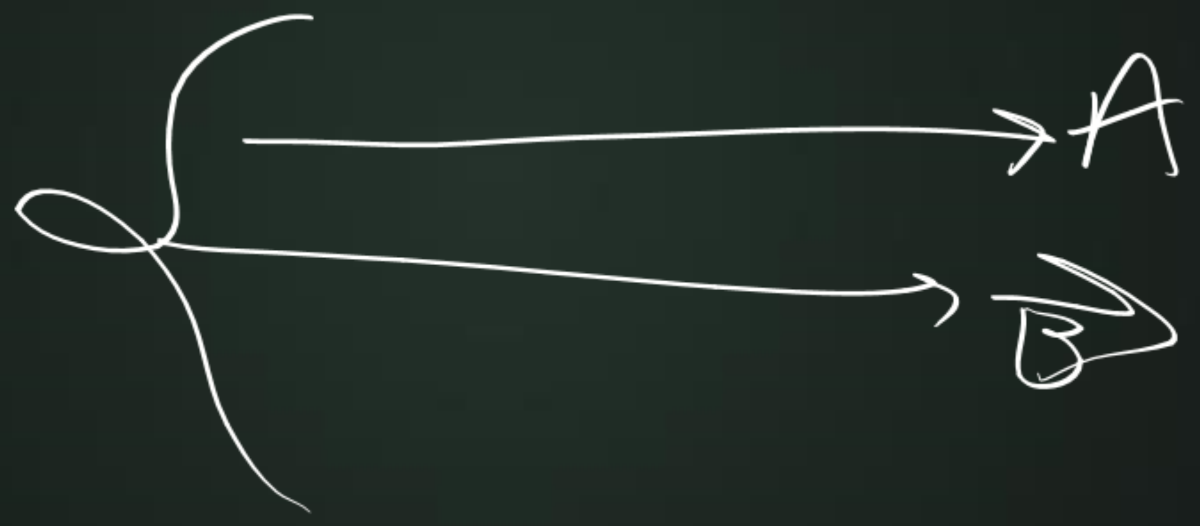
Three vectors $\vec{A}$, $\vec{B}$ and $\vec{C}$ satisfy the relation $\vec{A}.\vec{B} = 0$ and $\vec{A}.\vec{C} = 0$. The vector A is parallel to

1. $\vec{B}$
2. $\vec{C}$
3. $\vec{B}.\vec{C}$
4. $\vec{B} \times \vec{C}$

QUESTION-23

A vector $\vec{A}$ is along the positive x-axis. If B is another vector such that $\vec{A} \times \vec{B}$ is zero, then B could be

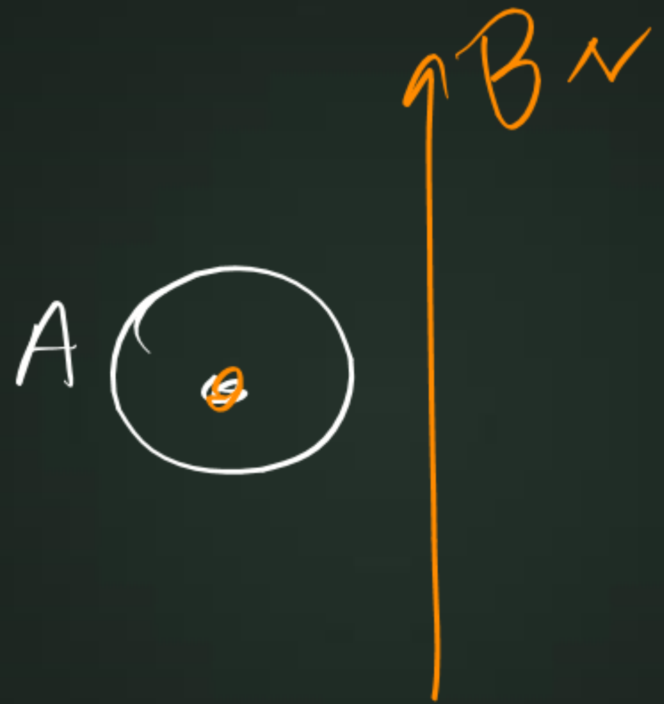
1. $4\hat{j}$
2. $-4\hat{i}$
3. $-(\hat{i}+\hat{j})$
4. $(\hat{j}+\hat{k})$



QUESTION-24

A vector $\vec{A}$ points vertically upward and $\vec{B}$ points towards north. The vector product $\vec{A} \times \vec{B}$ is

1. Zero
2. Along west
3. Along east
4. Vertically downward



QUESTION-25

The value of $(\vec{A}+\vec{B})\times(\vec{A}-\vec{B})$ is

1. 0
2. $A^2 - B^2$
3. $\vec{B}\times\vec{A}$
4. $2(\vec{B}\times\vec{A})$

$i \times i = 0 \quad \vec{A}\times\vec{A} = 0$

$0 + B\times A - 0 + BA = B\times A$

$2(\vec{B}\times\vec{A})$

$(\vec{A}+\vec{B})\times(\vec{A}-\vec{B}) = \vec{A}\times\vec{A} - \vec{A}\times\vec{B} + \vec{B}\times\vec{A} - \vec{B}\times\vec{B} =$

$-\vec{A}\times\vec{B} + \vec{B}\times\vec{A} =$

$\vec{B}\times\vec{A} + \vec{B}\times\vec{A} = 2(\vec{B}\times\vec{A})$

QUESTION-26

The scalar product of two vectors is $2\sqrt{3}$ and the magnitude of their product is 2. The angle between them is

1. 30°
2. 45°
3. 60°
4. 90°


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 01 | **Physics**

Units and Measurements



By- Dr. Manish Raj (MR SIR)

Topics to be covered

1. # H/W
2. # Unit of diffⁿ quantity (Unit conversion)
3. # feel of Dimension.
4. #

$10^a \times 10^b = 10^{a+b}$

$\frac{10^a}{10^b} = 10^{a-b}$

$2^4 \times 2^{-3} = 2^{4-3} = 2^1$

$3^6 = \frac{1}{3^{-6}}$



(Q) If $\vec{A}+\vec{B}=\vec{R}$ and $|\vec{A}|=|\vec{R}|$ and $\vec{R}$ is perpendicular to $\vec{A}$ then find angle between $\vec{A}$ and $\vec{B}$.

$|\vec{A}|+|\vec{B}| = x$

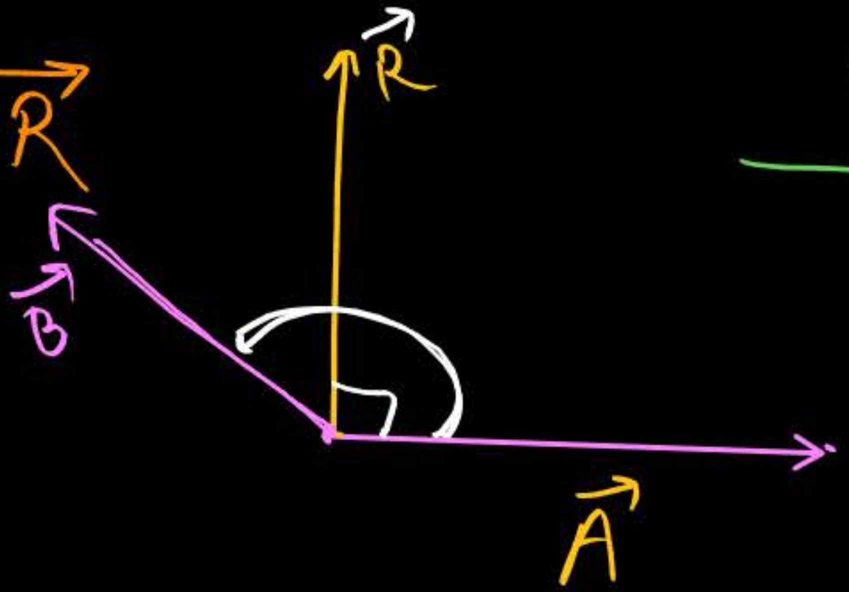
addition of magnitude of vector

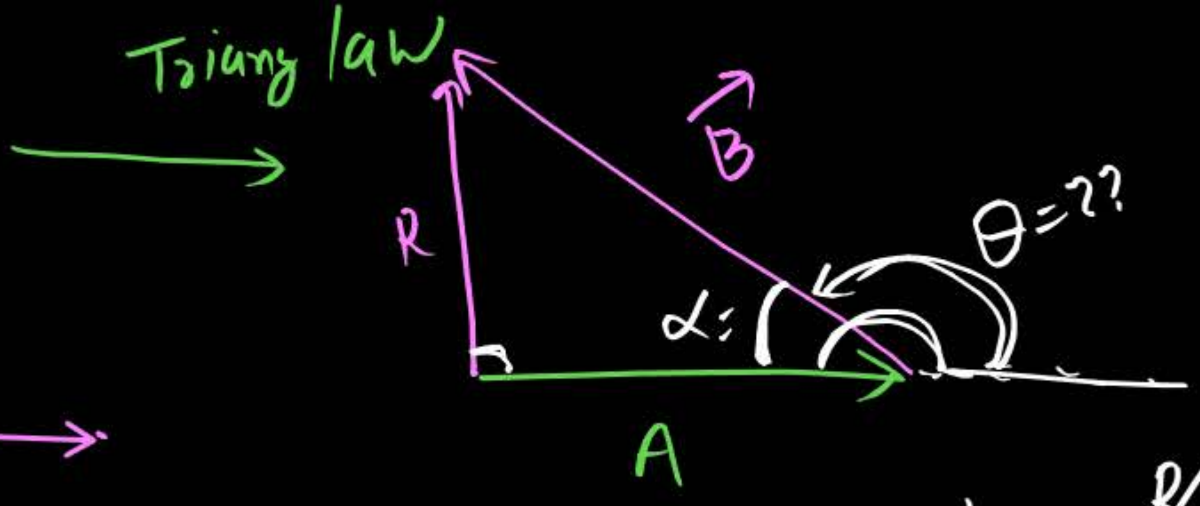
H/W

$\vec{A}+\vec{B}=\vec{R}$

$|\vec{A}|=|\vec{R}|$

$\vec{R} \perp_r \vec{A}$



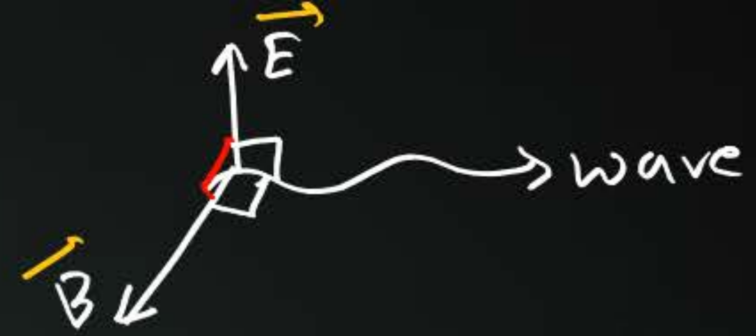


$\tan\alpha = \frac{R}{A} = 1$

$\alpha = 45^\circ$

$\theta = 180-45$
$= 135^\circ$

QUESTION H/w



For a plane electromagnetic wave propagation in x-direction, which one of the following combination gives the correct possible directions for electric field (E) and magnetic field (B) respectively?

NEET-2022

$\vec{E} \perp r \ \vec{B}$ (for Em wave)

$\vec{E} \cdot \vec{B} = 0$

1. $\hat{j} + \hat{k}, \hat{j} + \hat{k}$ ✗
2. $-\hat{j} + \hat{k}, -\hat{j} - \hat{k}$ $= 1 - 1 = 0$ ✓
3. $\hat{j} + \hat{k}, -\hat{j} - \hat{k}$ $= -1 - 1 = -2$ ✗
4. $-\hat{j} + \hat{k}, -\hat{j} + \hat{k}$ ✗

QUESTION

The moment of the force $\vec{F} = 4\hat{\imath} + 5\hat{\jmath} - 6\hat{k}$ at (2, 0, –3), about the point (2, –2, –2), is given by [NEET 2018]

1. $-8\hat{\imath} - 4\hat{\jmath} - 7\hat{k}$
2. $-4\hat{\imath} - \hat{\jmath} - 8\hat{k}$
3. $-7\hat{\imath} - 8\hat{\jmath} - 4\hat{k}$
4. $-7\hat{\imath} - 4\hat{\jmath} - 8\hat{k}$

Torque

Position of force ($\vec{r}$)

(ref^n point)

$r_{F\,ref} = (2\hat{i} - 3\hat{k}) - (2\hat{i} - 2\hat{j} - 2\hat{k})$

$\vec{r} = 0\hat{i} + 2\hat{j} - \hat{k}$

Position vector of force w.r.t ref point.

$$\vec{r} \times \vec{F} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 2 & -1 \\ 4 & 5 & -6 \end{vmatrix}$$

$= \hat{i}(-12 + 5) + \hat{j}(-4 - 0) + \hat{k}(0 - 8)$

$= -7\hat{i} - 4\hat{j} - 8\hat{k}$

QUESTION

For a body $\overrightarrow{W} = \hat{\imath} - 2\hat{\jmath} + 3\hat{k}$ and radius $\vec{r} = \hat{\imath} + \hat{\jmath} + \hat{k}$ then find velocity where $(\vec{v} = \vec{w} \times \vec{r})$.

(given in question)

$$\vec{V} = \vec{\omega} \times \vec{r} = \begin{vmatrix} i & j & k \\ 1 & -2 & 3 \\ 1 & 1 & 1 \end{vmatrix} = i(-2-3) + \hat{j}(3-1) + \hat{k}(1+2)$$

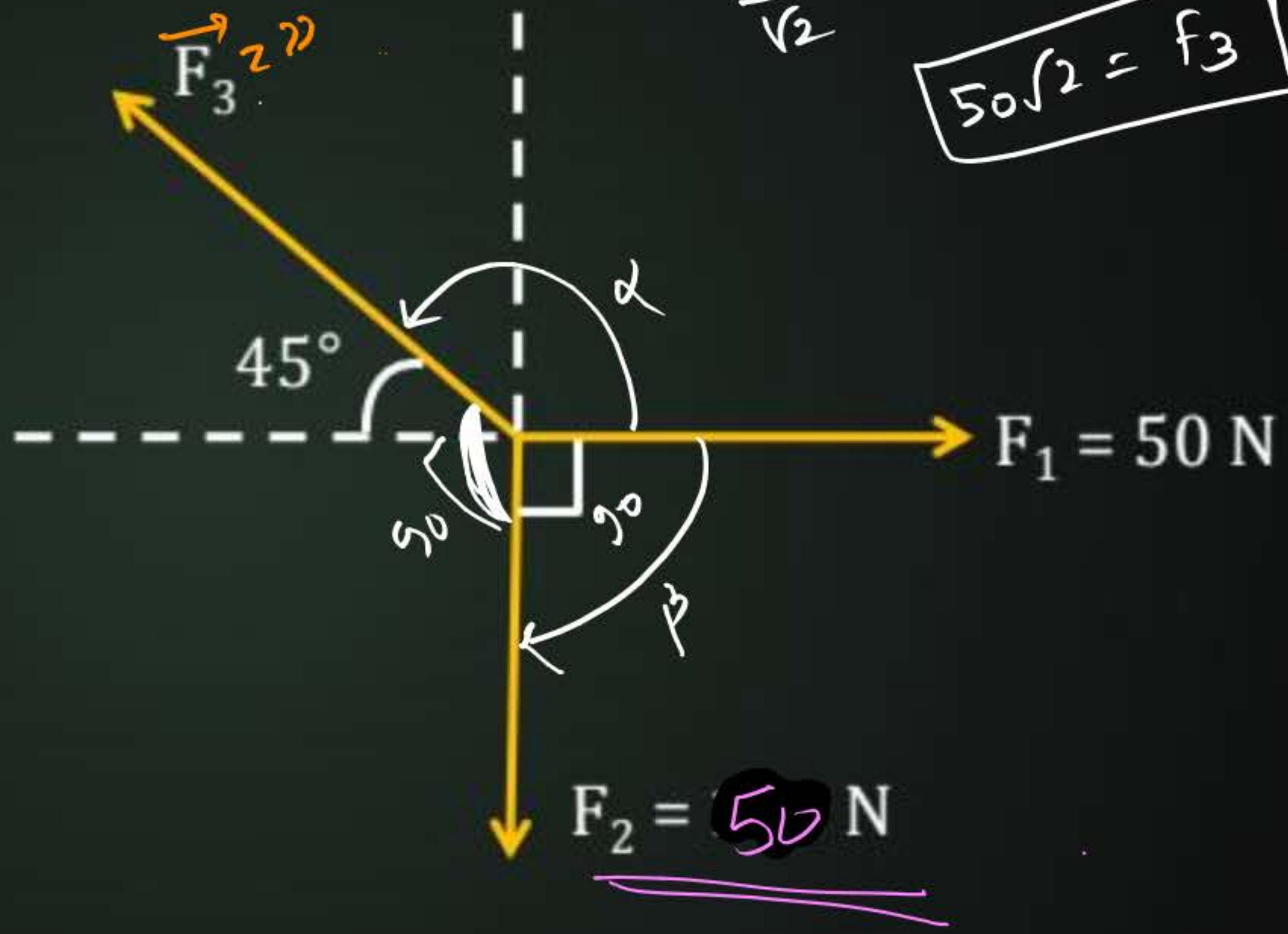
$$= (-5i + 2\hat{j} + 3\hat{k})$$

Ans M.R. wahha

QUESTION

(If $\vec{F_1} + \vec{F_2} + \vec{F_3} = 0$)

Find value of F_3 ?



→ Lami's thm

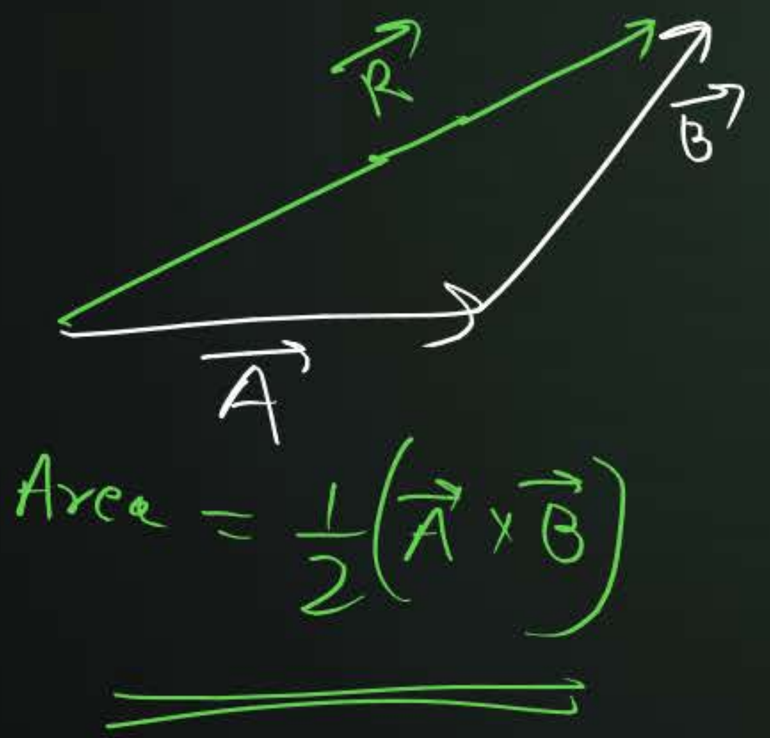
$$\frac{F_1}{\sin 135^\circ} = \frac{F_3}{\sin 90^\circ}$$

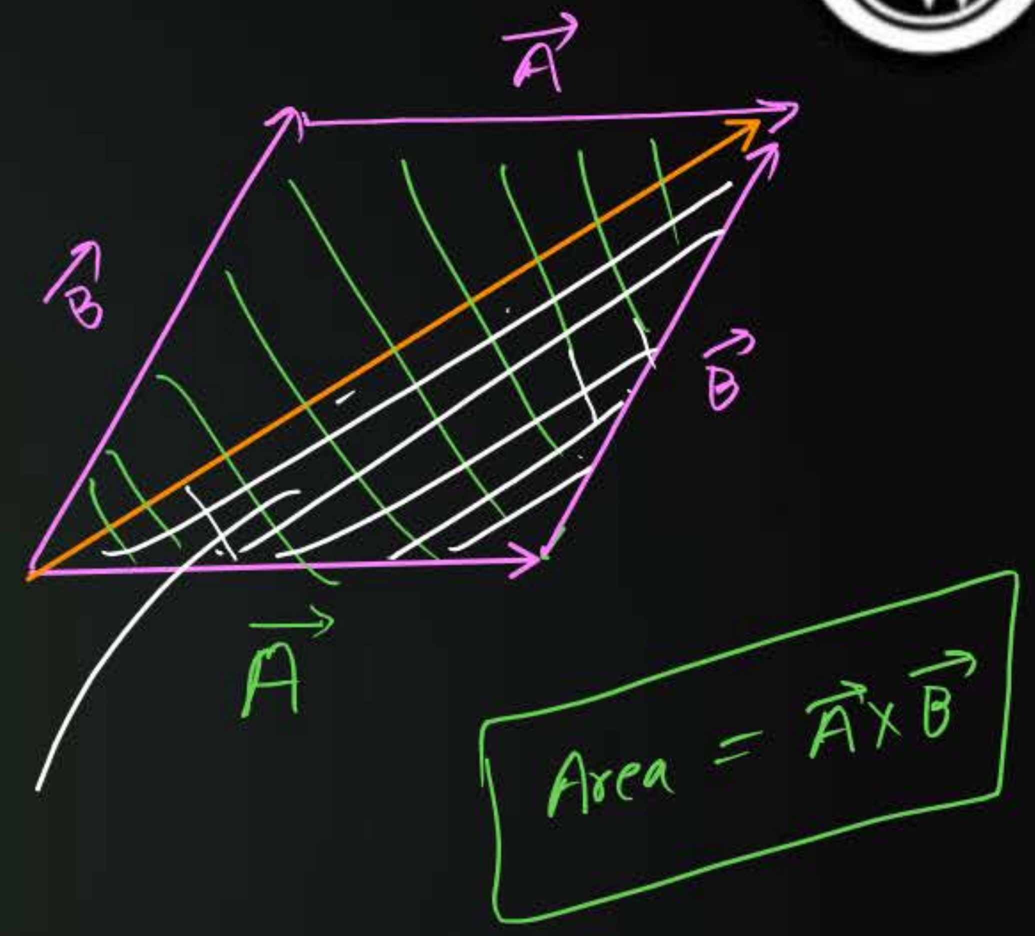
$$\frac{50}{\frac{1}{\sqrt{2}}} = \frac{F_3}{1}$$

$$\boxed{50\sqrt{2} = F_3}$$

- Area of parallelogram = $\vec{A} \times \vec{B}$
- Area of triangle determine by the two vectors :-

$$\text{Area} = \frac{1}{2}(\vec{A} \times \vec{B})$$





Unit and Measurement

Non - Physical quantity

Love, hate, handsome

Light, (Inertia)

↑ (does not have unit)



gussa (Nafrat)

→ You can compair it

but can't measure.

Love → can't measure

Physical quantity

→ quantity which can measure.

→ Height

→ Intensity of Light

→ mass

→ (moment of Inertia)

→ (Area)


Girls
Without Makeup
With Makeup
fundament P.Q
total = 7 P.Q
Derived P.Q.

Area = L^2 = m^2

PHYSICAL QUANTITY → quantity that can be measure.

Fundamental
physical quantity

Group of physical quantity independent upon each other.

- # Mass
- # length
- # Time
- # electric current
- # Amount of substance
- # Luminal Intensity
- # Temprature

Derived
physical quantity

Physical quantity which can be express in terms of base or fundamental quantity

Ex → energy, power, force, accⁿ, momentum

Supplementary
P.Q.

Angle and solid angle

Angle → unit radian

solid angle → unit → st·rad

→ have unit but does not have dimenson.

Unit dimn.

$$\text{Velocity} = \frac{\text{disp}^{\text{m}}}{\text{time}} = \left(\text{m/s}\right) = \left(\frac{L}{T}\right)$$

$$\Rightarrow m s^{-1} \Rightarrow L T^{-1}$$

PHYSICAL QUANTITY

Practical unit → a unit use for a personal comfort → Ex – 1hr, minute, shake (unit of time)

Practical unit of distan. → 1A°, Parsec, 1AU, light years

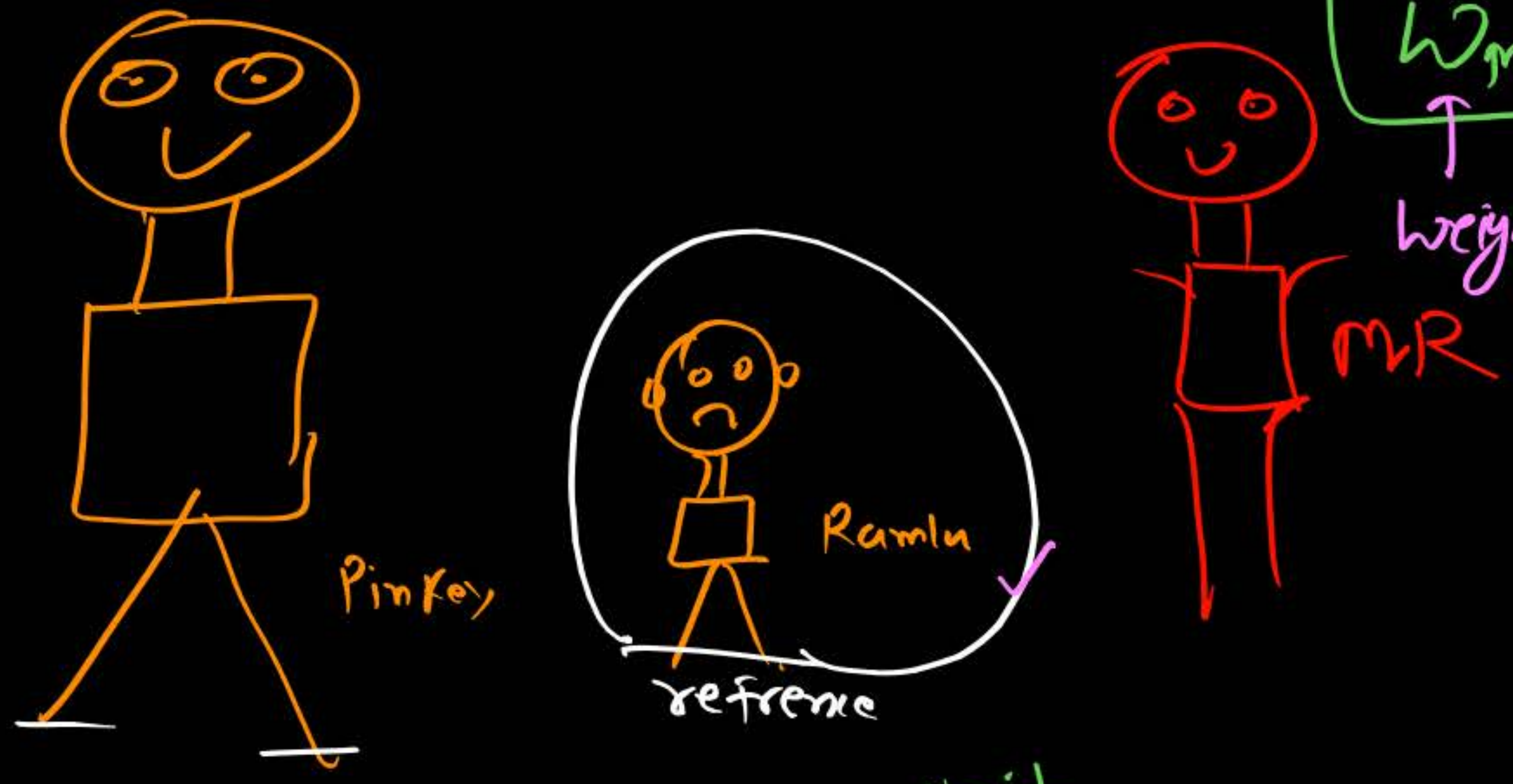
	Physical quantity	Unit, SI	C.G.S.	F.P.S	Dimension
1.	Mass	Kg	grm	(Pound)	M^1
2.	Length	Meter	cm	foot	L^1
3.	Time	Sec	sec	Sec	T^1
4	Temperature	Kelvin	Kelvin		θ^1 (K^1)
5.	Current	Ampere	Biot		A^1
6.	Amount of substance	Mole	mole		$(Mol)^1$
7.	Luminous Intensity	Candela	candela		Cd^1

Dimension ⇒ Power of fundamental P.Q in the formula of any P.Q.

QUESTION

Unit of distance is :

1. Fermimetre
2. Angstrom
3. Parsec
4. Light year (1 AU)
5. All of these



$W_{MR} = 10\ W_R$

weight of MR.

Unit

$W_p = 20\ W_R = 2 \times 10 W_R$

$W_p = 2\ W_{M.R}$



$W_e = 100\ W_R$

1 metre (SI unit of dist^n)

1 cm (C.G.S unit of Length)

100 cm = 1 m

$l = 1580\,cm$

$= 1580\,m$

$= 1580\,km$

$= 1580\,A^{\circ}$

$= 1580\,fm$

Wrong ✗

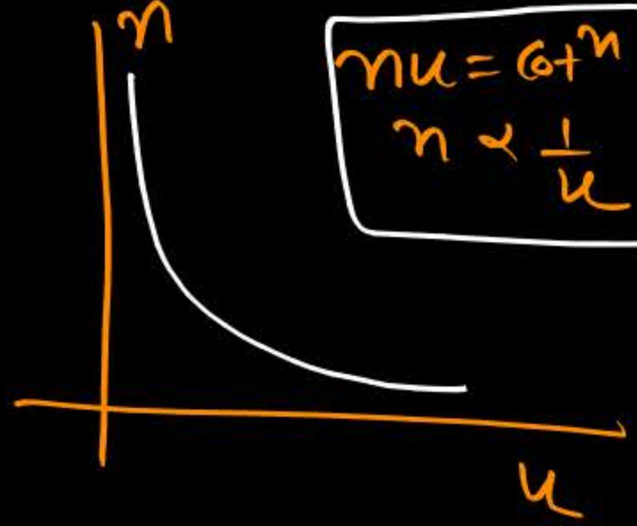
Measurement :-

$\Rightarrow nu = \text{const}^n$

$$n_1 u_1 = n_2 u_2$$

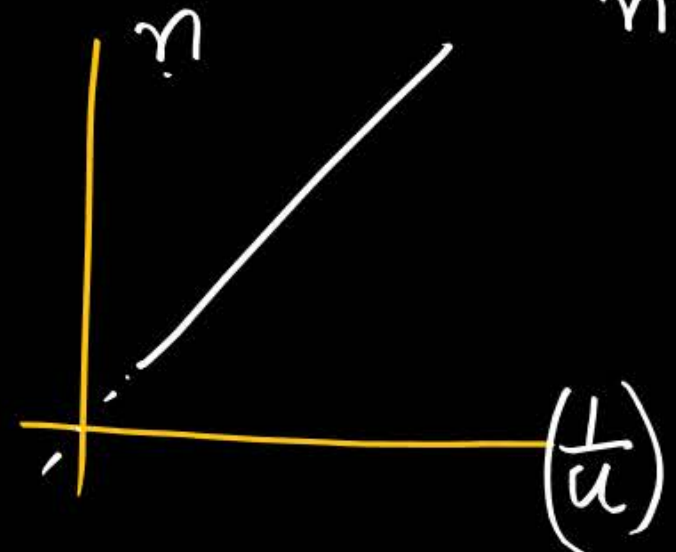
Measurement in 1st unit (for $n_1 u_1$)

Measurement in 2nd unit (for $n_2 u_2$)



$nu = \text{const}^n$

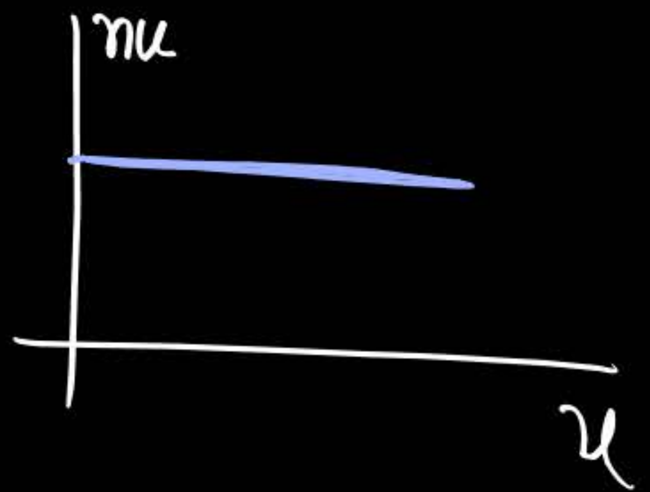
$n \propto \frac{1}{u}$



$nu = \text{const}^n$

$n = \frac{\text{const}}{u}$

$n^1 = \left(\frac{1}{u}\right)^1 \text{const}$





Measurement and Physical Quantity

$n_1 u_1 = n_2 u_2$

- n_1 ← Magnitude in 1^{st} unit
- u_1 ← 1^{st} Unit
- n_2 ← Magnitude in 2^{nd} Unit
- u_2 ← 2^{nd} unit

Q) If Area of object is $5\,m^2$ then find its value in C.G.S unit ??

Sol^n

$$n_1 u_1 = n_2 u_2 \quad \text{(for Area)}$$

$n_1 u_1$: S.I; $n_2 u_2$: C.G.S

$$5\,m^2 = 5\,(100\,cm)^2$$

$$= 5\,[10^4\,cm^2]$$

$$= 5 \times 10^4\,cm^2$$

$$5\,m^2 = n_2\,cm^2$$

$$5\,m^2 = n_2\,[10^{-2}\,m]^2$$

$$5\,m^2 = n_2\,10^{-4}\,m^2$$

$$n_2 = \frac{5}{10^{-4}} = 5 \times 10^4$$

Convert 25 m/sec in C.G.S unit ??

S.I me speed

Sol^n

$$n_1 u_1 = n_2 u_2$$

$$25\ m/s = n_2\ \frac{cm}{sec}$$

$$25 \times 100\ cm = n_2\ cm$$

$$n_2 = 2500$$

QUESTION

If unit of length becomes double then value of area $5m^2$ in new unit will be :-

$\underset{S.I}{\text{Area}} = 5m^2$

$\underset{\text{In new}}{\text{Area}} = n_2 u_2$

Value of Area In new syst.

$n_2 = \frac{5}{4}$

$n_1 u_1 = n_2 u_2$ (for area)

$5m^2 = n_2 (m'^2)$

$5m^2 = n_2 (2m)^2$

$5m^2 = n_2 4 m^2$

QUESTION

$1N = \frac{kg\,m}{s^2}$

Convert 1 Newton into Dyne.

1 Newton → S.I unit of force

Dyne → C.G.S unit of force.

$$1N = 10^5 \text{ Dyne}$$

$nu = \text{const}$

$$\underbrace{n_1 u_1}_{S.I} = \underbrace{n_2 u_2}_{C.G.S} \quad (\text{for force})$$

$$1 \frac{kg\,m}{s^2} = n_2 \frac{gm\,cm}{s^2}$$

$$10^3 gm \times 10^2 cm = n_2\, gm\, cm$$

$$10^5 = n_2$$

QUESTION

Convert values of 10 Joule in CGS unit?

S.I unit of energy

S.I / C.G.S

$n_1 u_1 = n_2 u_2$ (for energy)

$$10 \frac{kg \times m^2}{s^2} = n_2 \frac{grm\, cm^2}{s^2}$$

$10 \times 10^3 gm \times (100 cm)^2 = n_2\ gm\, cm^2$

$10 \times 10^3 \times 10^4 = n_2$

$10 \times 10^7 = n_2$

mass = kg
length = m
time → s

Velocity = m/s

acc^n = $\frac{v}{t} = \frac{m}{s \times s} = \frac{m}{s^2}$

force = ma = $\frac{kg\, m}{s^2}$

energy = F × dist^n = $\frac{kg\, m^2}{s^2}$

Power = $\frac{\text{energy}}{\text{time}} = \frac{kg\, m^2}{s^3}$



Kg
m
s

$u = m/s$

$a = \frac{m}{s^2}$

$F = kg\,\frac{m}{s^2}$

$E = \frac{kg\,m^2}{s^2}$

$P = \frac{kg\,m^2}{s^3}$

QUESTION

If unit of length 10m and unit of mass is 5 kg and unit of time is 2 sec then, find value of 10 Joule energy is new system of unit.

Sol^n

Energy = 10 Joule

$n_1 u_1 = n_2 u_2$

S.I Unit — New system

$10 \times \frac{kg\, m^2}{s^2} = n_2 \frac{kg'\, m'^2}{s'^2}$

$10 \frac{kg\, m^2}{s^2} = n_2 \frac{5kg\,(10m)^2}{(2s)^2}$

$10 = n_2 \frac{5 \times 100}{4}$

$n_2 = \frac{10}{125}$

$n_2 = \frac{2}{25}$

QUESTION

If unit of mass becomes double, unit of length becomes half and unit of time becomes $\frac{1}{4}$th then find value of 10 N force in new system of unit.

Sol^n

$$n_1 u_1 = n_2 u_2 \quad (\text{for force})$$

$$10\,\frac{kg\,m}{s^2} = \frac{n_2\,kg'\,m'}{s'^2}$$

$$10\,\frac{kg\,m}{s^2} = \frac{n_2\,2kg \times \frac{m}{2}}{\left(\frac{1s}{4}\right)^2}$$

$$10 = \frac{n_2}{\frac{1}{16}}$$

$$n_2 = \left(10 \times \frac{1}{16}\right) = \frac{5}{8}$$

QUESTION

अलग है।

If unit of length 10m and unit of mass is 5 kg and unit of time is 2 sec then, find unit of energy in new system.

Sol^n

$n u = c$ → No this is not applicable.

$n_1 u_1 = n_2 u_2$ ✗

$$\text{Unit of energy} = \frac{kg^1 m^2}{s^2} = \frac{5 kg (10 m)^2}{(2s)^2} = \frac{5 \times 100}{4} \frac{kg\, m^2}{s^2}$$

$$= 125 \frac{kg\, m^2}{s^2} \quad \text{Ans}$$

QUESTION

If unit of mass becomes double, unit of length becomes half and unit of time becomes $\frac{1}{4}$th then find unit of force.

$$n_1 u_1 = n_2 u_2$$

S.I.   New unit

Unit of force $= \frac{kg^1 m^1}{s^{12}}$

$$= \frac{2kg \; \frac{m}{2}}{\left(\frac{1}{4}s\right)^2} = 16\,\frac{kg\,m}{s^2}$$

QUESTION

(Q) If unit of length is x m in new system then find value of volume $y\ m^3$ in new system of unit

S-I

$\Longrightarrow nu = \text{const}^n$

$n_1 u_1 = n_2 u_2$ [for Volume]

$y\, m^3 = n_2\, m'^3$

$y\, m^3 = n_2 (x m)^3$

$y\, m^3 = n_2 x^3 m^3$

$n_2 = \frac{y}{x^3}$ Ans

(Q) If unit of length is x m in new system then find Unit of volume in new system.

Sol^n $nu = \text{const}^n$ ✗ Not applic.

Unit of volume $= m'^3 = (x m)^3 = x^3 m^3$

DIMENSIONAL FORMULA

Power of fundamental P.Q in the formula on any P.Q. is called dimension

Dimensional formula of a physical quantity(P) is

$$P = [M^x L^y T^z]$$

↑ any P.Q.

x, y & z are dimⁿ.

Velocity $= \frac{L}{T} = L^1 T^{-1}$

accⁿ $= \frac{v}{T} = \frac{L}{T \times T} = L^1 T^{-2}$

force $= m \times$ accⁿ $= M^1 L^1 T^{-2}$

Energy = force × distⁿ $= MLT^{-2} \times L = ML^2T^{-2}$ (work/energy)

Power $= \frac{E}{T} = \frac{ML^2T^{-2}}{T} = ML^2T^{-3}$

DIMENSION LESS PHYSICAL QUANTITY

- Angle/ Solid angle/ Strain

  Poisson's ratio, refractive index

  Trigonometry formula/ exponential functions, relative permittivity, efficiency, ratio, pure no. specific gravity

QUESTION

Which does not have same unit as other :-

1. watt - sec
2. kilowatt – hour
3. eV
4. Joule - sec

Ex. *Determine the dimension of temperature gradient*

Step-1

$$\text{temp. gradient} = \frac{\text{Temperature}}{\text{distance}}$$

temp. gradient =




THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 02 | Physics

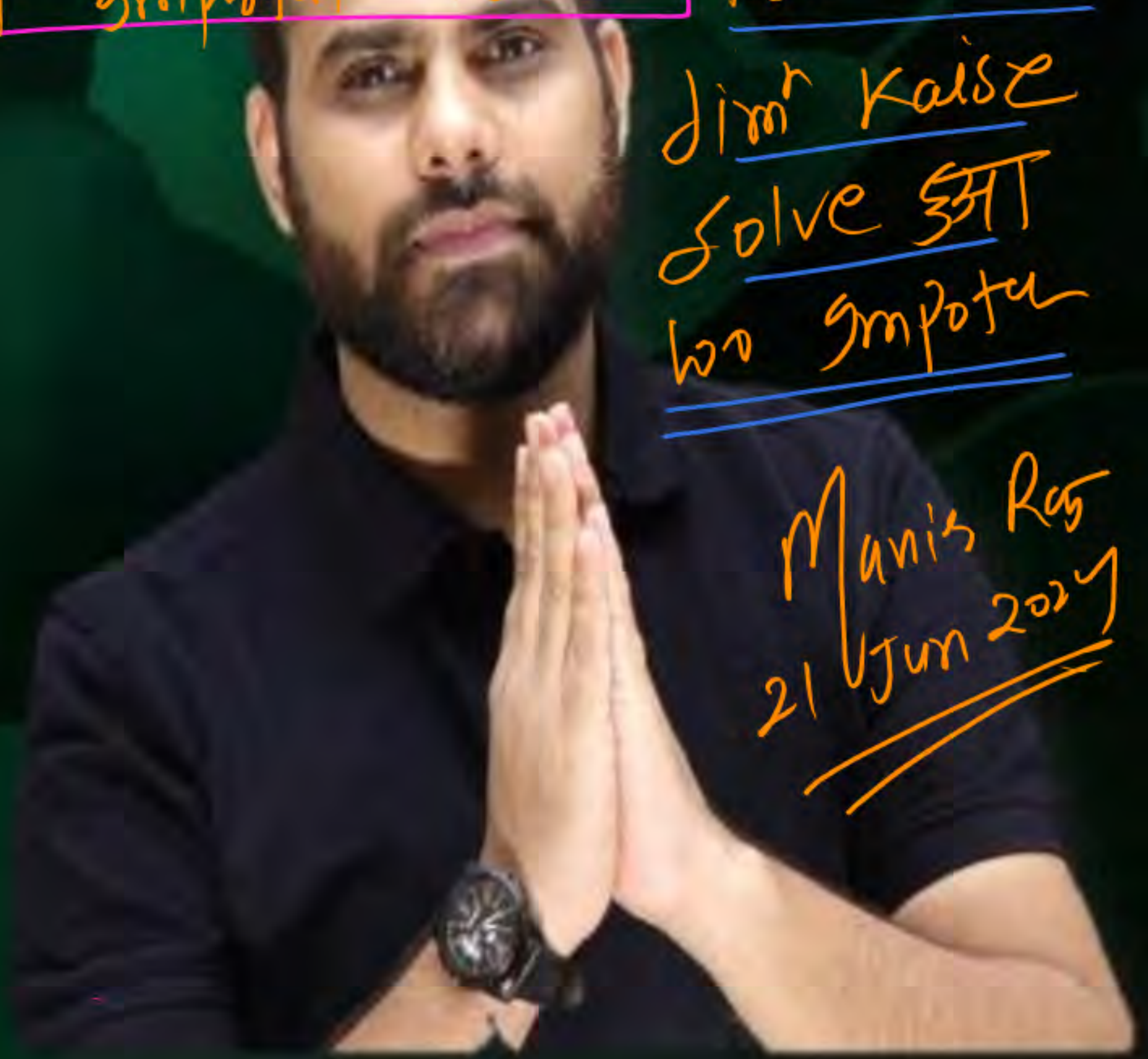
Units and Measurements

By- Dr. Manish Raj (MR SIR)

diffⁿ chapter के formula use होगा, but formula yad होना important नहीं है

formula में dimⁿ kaise solve हुआ wo important

Manish Raj
21 Jun 2024



Topics to be covered

1 #

Dim^{n} of all pysical quantity

2 #

Dimension of Different PQ

3 #

4 #



QUESTION

1. Which of the following group of physical quantity can be considered as a group of fundamental physical quantity.??

1. [Force, mass, time] 8%

2. Mass, force, acceleration

$F = m \times a$

3. Velocity, momentum, mass

$P = vm$

4. Velocity, time, displacement

$v = \frac{dis}{t}$

5. None of the above (82%)

(Wrong)

Fundament P.Q.

→ Group of P.Q. which are independent upon each other, They can't derive with the help of each other.

Ex, mass, length, time, Temp.

QUESTION

Which of the following is a characteristic of unit?

(Property)

1. The unit must be universally accepted
2. It must be invariable and well defined (Fixed)
3. It must be of suitable size and easily available
4. All the above

Dimension

\# length, displacement, distance, Radius, Position, focal length, (wavelength) (amplitude) $= L^1$
light year, parsec, 1 AU, → unit of distance

\# Velocity, speed, orbital velocity, critical velocity, Escape velocity $= LT^{-1}$
Terminal velocity
v
but angular velocity $(\omega) = T^{-1}$

\# acceleration, accⁿ due to gravity, centripetal accⁿ $= LT^{-2}$
Angular accⁿ $= T^{-2}$

\# Force, Tension, (weight = mg), frictional force, Normal rexⁿ $= MLT^{-2}$

\# (electro Motive force) = Potential diffⁿ $= \frac{W}{q} = \left[\frac{ML^2T^{-2}}{AT}\right]$
$= ML^2T^{-3}A^{-1}$

$W = qV = ML^2T^{-2}$

$I = \frac{q}{t}$

- **Area** $= b \times a = l^2 = L^2 M^0 T^0$
- **Volume** $= A \times l = L^3$
- **Velocity** $= LT^{-1}$
- **Acceleration** $= LT^{-2}$
- **Force** $= MLT^{-2}$
- **Energy** $= ML^2 T^{-2}$
- **Power** $= ML^2 T^{-3} = \frac{E}{T}$
- **Momentum** $p = mv = MLT^{-1}$
- **Impulse** $I = \Delta P = P_f - P_i = MLT^{-1}$

$5kg - 3kg = 2kg$ (mass)

Angular dispm $= \theta = M^0 L^0 T^0$

Angular velocity $= \omega = \frac{\theta}{T} = M^0 L^0 T^{-1}$

Same as frequency $f = \frac{1}{T} = T^{-1}$

Angular accn $= \alpha = \frac{\omega}{T} = T^{-2}$

Torque $= r \times F = L[MLT^{-2}] = ML^2 T^{-2}$

→ same as work and energy

Moment of Inertia $I = Mr^2 = ML^2$

Angular momentum $L = I\omega = ML^2 T^{-1}$

Angular Impulse $= ML^2 T^{-1}$

linear mass density $\Rightarrow \lambda = \frac{m}{L} = ML^{-1}$

Areal mass density $= \sigma = \frac{m}{\text{Area}} = \frac{m}{L^2} = ML^{-2}$

Volume mass density $=$ density $\rho = \frac{m}{\text{Volume}} = ML^{-3}$

linear charge density $= \frac{Q}{L} = \frac{AT}{L} = ATL^{-1}$

Areal charge density $= \frac{Q}{\text{Area}} = ATL^{-2}$

Volume charge density $= \frac{Q}{V} = ATL^{-3}$

Charge $= It$
$= A^1T^1$

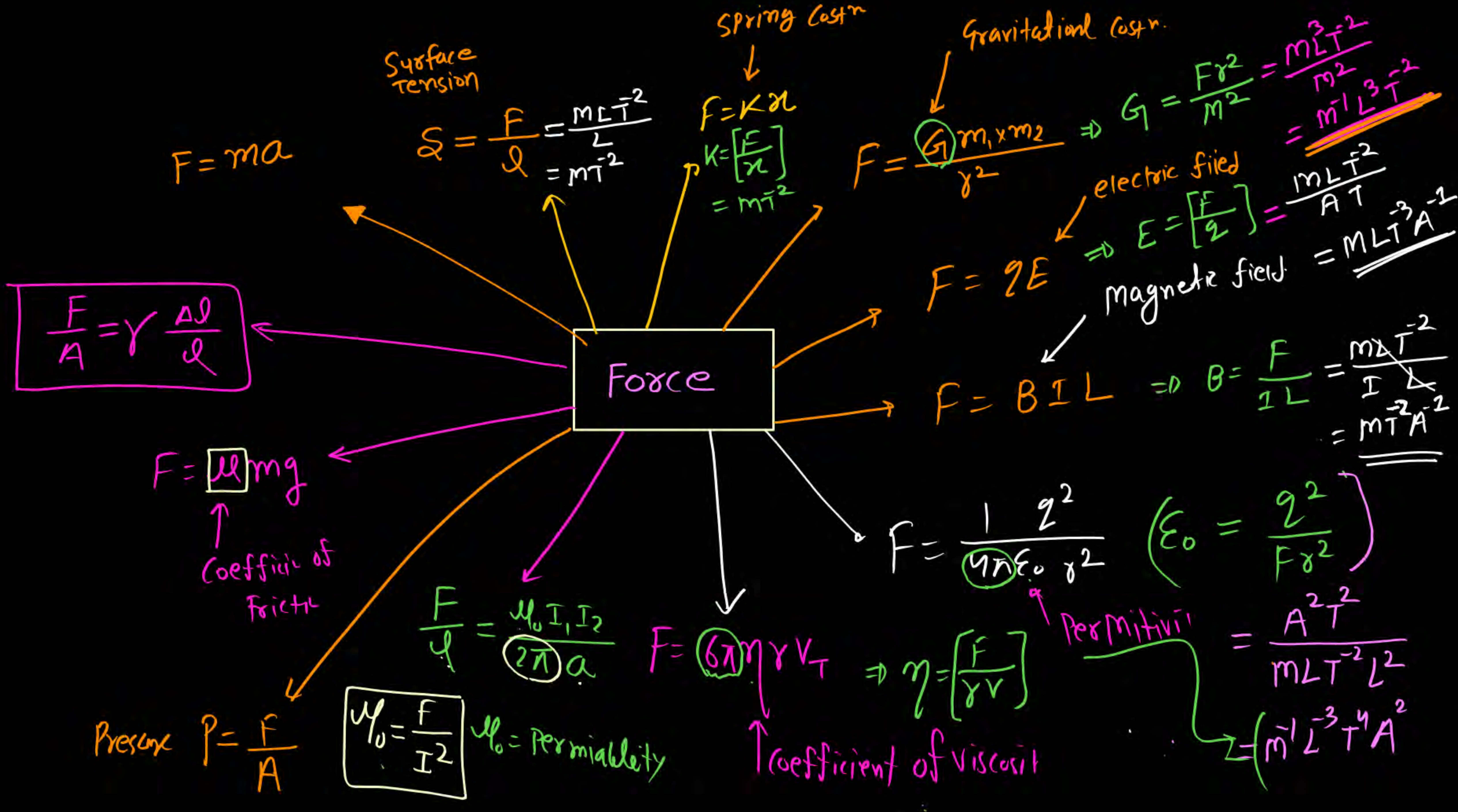
- **Gradient** → Change per unit length

- **Velocity gradient** $= \frac{\Delta V}{L} = \frac{LT^{-1}}{L} = T^{-1}$

- **Temperature gradient** $= \frac{\Delta \text{Temp}}{L} = \frac{K}{L} = K^{1}L^{-1}$

Length gradient $= \frac{\Delta L}{L} = \frac{L}{L} = M^0L^0T^0 = 1$

Time gradient $= \frac{\Delta \text{Time}}{L} = \frac{T}{L} = TL^{-1}$


Force
F = ma
Surface Tension
S = F/l = MLT^-2 / L = MT^-2
Spring Cost^n
F = Kx
K = [F/x] = MT^-2
Gravitational cost^n.
F = G m1 x m2 / r^2 => G = Fr^2 / M^2 = ML^3T^-2 / M^2 = M^-1 L^3 T^-2
electric filed
F = qE => E = [F/q] = MLT^-2 / AT = MLT^-3 A^-1
magnetic field
F = BIL => B = F/IL = MLT^-2 / IL = MT^-2 A^-2
F = 1/(4πε0) q^2/r^2 (ε0 = q^2 / Fr^2)
Permitivity
= A^2T^2 / MLT^-2 L^2
= M^-1 L^-3 T^4 A^2
F/A = Y Δl/l
F = μmg
Coefficient of Friction
F/l = μ0 I1 I2 / 2πa
μ0 = F/I^2
μ0 = Permiability
F = 6πηrvT => η = [F/rv]
Coefficient of viscosity
Pressure P = F/A

Energy (ML^2T^{-2})

Boltzman Constⁿ

$E = \frac{3}{2} K_B T$

$K_B = \frac{E}{T} = ML^2T^{-2}K^{-1}$

R (gas const)

$PV = nRT$

$R = \frac{(PV)}{nT} = \frac{\text{energy}}{nT}$

Planks Const

$E = hf$

$h = \frac{E}{f} = \frac{ML^2T^{-2}}{T^{-1}} = ML^2T^{-1}$

$\Rightarrow Q = mL$

L (latent Heat) $= \frac{Q}{m} = L^2T^{-2}$

$Q = ms\Delta T$

Specific heat $= \frac{Q}{m\Delta T} = \frac{ML^2T^{-2}}{M\,K} = L^2T^{-2}K^{-1}$

H/W: $\frac{dQ}{dt} = \frac{KAT}{L}$

thermal Conductivity

$K = \frac{Q}{t\,K\,\text{Length}} = \frac{ML^2T^{-2}}{TLK} = MLT^{-3}K^{-1}$

emf (V) $= \frac{U}{q}$

$V = \frac{U}{m} = \frac{ML^2T^{-2}}{M}$

$V = L^2T^{-2}$

↳ gravitational potential

Capacitance

$E = \frac{Q^2}{2C} \Rightarrow C = \frac{Q^2}{E} = \frac{A^2T^2}{ML^2T^{-2}} = M^{-1}L^{-2}T^4A^2$

Resistance

$H = I^2Rt \Rightarrow R = \frac{H}{I^2t} = \frac{ML^2T^{-2}}{A^2T} = ML^2T^{-3}A^{-2}$

$E = \frac{1}{2}LI^2 \Rightarrow L = \frac{E}{I^2} = ML^2T^{-2}A^{-2}$

(Self-Inductance, Mutual Inductance)

CHARGE

- **Electric Potential →**

$$V = \frac{U}{q} = \frac{ML^2T^{-2}}{AT}$$

- **Gravitational Potential →**

$$V = \frac{U}{m}$$

FORCE

# $F = G\frac{m_1 m_2}{r^2}$	$F = kx$	$F = qE$
$G = \frac{Fr^2}{m^2} = \frac{MLT^{-2} \times L^2}{m^2}$ $= M^{-1}L^3T^{-2}$	↑ Force constant or spring const. $K = \frac{F}{x}$ $= \frac{MLT^{-2}}{L}$ $= MT^{-2}$	$E = \frac{F}{q}$ $= \frac{MLT^{-2}}{AT}$

$F = qvB$	$F = 6\pi\eta rv$	$F = sl$
# $F = BIL$ $B = \frac{F}{IL}$ $= \frac{MLT^{-2}}{AL}$ $= MT^{-2}A^{-1}$	Ceffici to viscosil. $\eta = \frac{F}{rv}$ $= \frac{MLT^{-2}}{L \times LT^{-1}}$ $= ML^{-1}T^{-1}$ Ans	Surfa Tens $S = \frac{F}{l}$

$$F = \frac{q_1 q_2}{4\pi\varepsilon_0 r^2}$$

$$\varepsilon_0 = \frac{q^2}{F r^2}$$

$$= \frac{(AT)^2}{MLT^{-2} L^2}$$

$$\varepsilon_0 = M^{-1} L^{-3} T^4 A^2$$

$$P = \frac{F}{\text{Area}} = \frac{MLT^{-2}}{L^2} = ML^{-1}T^{-2}$$

$$\text{Stress} = \left(\frac{F}{A}\right) = ML^{-1}T^{-2}$$

$$F = \frac{\mu_0 I_1 I_2 d}{4\pi r}$$

$$\mu_0 = \frac{F}{I^2} = \frac{MLT^{-2}}{A^2}$$

$$= MLT^{-2}A^{-2}$$

ENERGY

$E = hf$

$h = \frac{E}{f} = \frac{ML^2T^{-2}}{T^{-1}}$

$h = ML^2T^{-1}$

Angular momentum

$L = I\omega$

$= ML^2T^{-1}$

$E = \frac{3}{2}K_BT$

$K_B = \frac{E}{\text{Temp}}$

$E = \frac{1}{2}\frac{Q^2}{C}$

$C = \frac{Q^2}{E}$

$$H = E = I^2Rt$$

$$PV = \eta RT$$

$$\frac{H}{t} = \frac{KA\Delta T}{\ell}$$

$E = \frac{1}{2} L I^2$

$U = \frac{1}{2}$ stress × strain

Stress = Y × strain

Hint

$F = BIL$

- **Magnetic Flux :**

$\phi = B \cdot A$

$= \frac{F}{IL} \times Area$

$= \frac{MLT^{-2}}{A\,L} \times L^2$

$= ML^2T^{-2}A^{-2}$

- **Electric Flux :**

$\phi = E\,Area$

Hooks law

$Stress = Y \cdot strain$

↑ Young modulus

Y (dim = stress) $= ML^{-1}T^{-2}$

Young modulus, Bulk modulus, Modulus of Rigidity, Pressure, stress, energy density

$\frac{energy}{Volume} = \frac{ML^2T^{-2}}{L^3} = (ML^{-1}T^{-2})$

$\frac{1}{2}\varepsilon_0 E^2$, $\frac{B^2}{2\mu_0}$, $U = \frac{1}{2}$ stress × Strain

✓ # $Strain = \frac{\Delta L}{L} = \frac{L^1}{L^1} = M^0L^0T^0$

μ_0 → have dim^n
ε_0 →

ε_r (Relative permitivity) $= \frac{\varepsilon_m}{\varepsilon_0} = M^0L^0T^0$

✓ # μ_r (Relative permiability) $= \frac{\mu_m}{\mu_0} = M^0L^0T^0$

✓ # Ratio of same P.Q is dimension less

✓ # Retive density $= \frac{\rho_m}{\rho_w} = M^0L^0T^0$

✓ # $F_r = \mu N$

$\Rightarrow \mu = \frac{F}{N} = M^0L^0T^0$, Poision ratio = dim^n less

refractive Index $= \mu = \frac{c}{v}$ = dim^n less

- Angular momentum and Plank's constant have same dimensional formula $[ML^2L^{-1}]$
- Electric field and potential gradient have same dimensional formula $[MLT^{-3}A^{-1}]$

  $E = -\frac{dv}{dr}$
- Surface tension, [redacted] * force gradient and spring constant have same dimensional formula $[ML^0T^{-2}]$
- Acceleration and gravitational field intensity have same dimensional formula $[M^0LT^{-2}]$

  $I = \frac{F}{m}$ = acc^n

- Pressure/ Energy density/ Bulk modulus/ Shear modulus/ Stress dimensions all have same

MR*

$$\text{Resistance} = R = WL = \frac{1}{WC}$$

DIMENSION LESS PHYSICAL QUANTITY

- Angle/ Solid angle/ Strain

  Poisson's ratio, refractive index

  Trigonometry formula/ exponential functions, relative permittivity,

  efficiency, ratio, pure no. specific gravity

QUESTION

The dimension of mutual inductance is:

[JEE Main 2022]

1. $[ML^2 T^{-2} A^{-1}]$
2. $[ML^2 T^{-3} A^{-1}]$
3. $[ML^2 T^{-2} A^{-2}]$
4. $[ML^2 T^{-3} A^{-2}]$

$E = \frac{1}{2} L I^2$

$L = \frac{E}{I^2} = ML^2 T^{-2} A^{-2}$

QUESTION

The SI unit of a physical quantity is pascal-second. The dimensional formula of this quantity will be [JEE Main 2022]

1. $[ML^{-1}T^{-1}]$
2. $[ML^{-1}T^{-2}]$
3. $[ML^{2}T^{-1}]$
4. $[M^{-1}L^{3}T^{0}]$

Pressure × time

$= \frac{F}{A} \times time$

$= \frac{ML^{1}T^{-2}}{L^{2}} \times T$

$= ML^{-1}T^{-1}$

QUESTION

[JEE Main 2023]

Match List-I with List-II:

	List-I		List-II
A.	Planck's constant (h)	I.	$[M^1 L^2 T^{-2}]$
B.	Stopping potential (Vs)	II.	$[M^1 L^1 T^{-1}]$
C.	Work function (ϕ)	III.	$[M^1 L^2 T^{-1}]$
D.	Momentum (p)	IV.	$[M^1 L^2 T^{-3} A^{-1}]$

1. A-III, B-I, C-II, D-IV
2. A-III, B-IV, C-I, D-II
3. A-II, B-IV, C-III, D-I
4. A-I, B-III, C-IV, D-II

QUESTION

Match List-I with List-II:

Choose the correct answer from the options given below: **[JEE Main 2023]**

1. A-IV, B-III, C-II, D-I
2. A-IV, B-III, C-I, D-II
3. A-III, B-IV, C-I, D-II
4. A-II, B-I, C-III, D-IV

	List-I		List-II
A.	Surface tension	I.	Kg m^{-1} s^{-1}
B.	Pressure	II.	Kg m^{-1}
C.	Viscosity	III.	Kg m^{-1} s^{-2}
D.	Impulse	IV.	Kg s^{-2}

QUESTION

Match List-I with List-II:

Choose the correct answer from the options given below: [JEE Main 2023]

List-I		List-II	
A.	Young's Modulus (Y)	I.	$[M L^{-1} T^{-1}]$
B.	Co-efficient of Viscosity (η)	II.	$[M L^{2} T^{-1}]$
C.	Planck's Constant (h)	III.	$[M L^{-1} T^{-2}]$
D.	Work Function (ϕ)	IV.	$[M L^{2} T^{-2}]$

1. A-II, B-III, C-IV, D-I
2. A-III, B-I, C-II, D-IV
3. A-I, B-III, C-IV, D-II
4. A-I, B-II, C-III, D-IV

H/W

QUESTION

Match List-I with List-II:

Choose the correct answer from the options given below: [JEE Main 2023]

1. A-III, B-II, C-I, D-IV
2. A-II, B-III, C-IV, D-I
3. A-III, B-II, C-IV, D-I
4. A-II, B-III, C-I, D-IV

List-I (Quantity)		List-II (Dimensional Formula)	
A.	Pressure gradient	I.	$[M^0 L^2 T^{-1}]$
B.	Energy density	II.	$[M^{-1} L^{-1} T^{-2}]$
C.	Electric field	III.	$[M^1 L^{-2} T^{-2}]$
D.	Latent heat	IV.	$[M^1 L^1 T^{-3} A^{-1}]$

H/W

QUESTION

Match List-I with List-II:

Choose the correct answer from the options given below: [JEE Main 2023]

List-I		List-II	
A.	Torque	I.	$Kg\, m^{-1} s^{-2}$
B.	Energy density	II.	$Kg\, ms^{-1}$
C.	Pressure gradient	III.	$Kg\, m^{-2} s^{-2}$
D.	Impulse	IV.	$Kg\, m^{2} s^{-1}$

1. A-IV, B-III, C-I, D-II
2. A-I, B-IV, C-III, D-II
3. A-IV, B-I, C-II, D-III
4. A-IV, B-I, C-III, D-II

H/W

QUESTION

Match List-I with List-II:

Choose the correct answer from the options given below: [JEE Main 2023]

List-I		List-II	
A.	Angular momentum	I.	$[ML^2 T^{-2}]$
B.	Torque	II.	$[ML^{-2} T^{-2}]$
C.	Stress	III.	$[ML^2 T^{-1}]$
D.	Pressure gradient	IV.	$[ML^{-1} T^{-2}]$

1. A-I, B-IV, C-III, D-II
2. A-III, B-I, C-IV, D-II
3. A-II, B-III, C-IV, D-I
4. A-IV, B-II, C-I, D-III

H/W

QUESTION

Match List-I with List-II:

Choose the correct answer from the options given below: [JEE Main 2022]

List-I		List-II	
A.	Torque	I.	Nms^{-1}
B.	Stress	II.	$J\,kg^{-1}$
C.	Latent Heat	III.	Nm^{-1}
D.	Power	IV.	Nm^{-2}

1. A-III, B-II, C-I, D-IV
2. A-III, B-IV, C-II, D-I
3. A-IV, B-I, C-III, D-II
4. A-II, B-III, C-I, D-IV

H/W


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture-3 | Physics

Units and Measurements



By- Dr. Manish Raj (MR SIR)

Topics to be covered

Todays Goal

→ H/W

→ Principle of Homegenity



QUESTION

Match List-I with List-II:

Choose the correct answer from the options given below: **[JEE Main 2023]**

List-I		List-II	
A.	Young's Modulus (Y)	I.	$[M L^{-1} T^{-1}]$
B.	Co-efficient of Viscosity (η)	II.	$[M L^{2} T^{-1}]$
C.	Planck's Constant (h)	III.	$[M L^{-1} T^{-2}]$
D.	Work Function (ϕ)	IV.	$[M L^{2} T^{-2}]$

1. A-II, B-III, C-IV, D-I
2. A-III, B-I, C-II, D-IV
3. A-I, B-III, C-IV, D-II
4. A-I, B-II, C-III, D-IV

$Y = \text{Pressure} = \frac{F}{A} = \frac{MLT^{-2}}{L^2} = ML^{-1}T^{-2}$

$F = 6\pi \eta r v$

$\eta = \frac{F}{rv} = \frac{MLT^{-2}}{L\,LT^{-1}} = ML^{-1}T^{-1}$

$E = hf$

$h = \frac{E}{f} = \frac{ML^2T^{-2}}{T^{-1}} = ML^2T^{-1}$

Work Function $= ML^2T^{-2}$

QUESTION

Match List-I with List-II:

Choose the correct answer from the options given below: **[JEE Main 2023]**

1. A-III, B-II, C-I, D-IV
2. A-II, B-III, C-IV, D-I
3. A-III, B-II, C-IV, D-I
4. A-II, B-III, C-I, D-IV

	List-I (Quantity)		List-II (Dimensional Formula)
A.	Pressure gradient	I.	$[M^0 L^2 T^{-1}]$
B.	Energy density	II.	$[M\ L^{-1} T^{-2}]$
C.	Electric field	III.	$[M^1 L^{-2} T^{-2}]$
D.	Latent heat	IV.	$[M^1 L^1 T^{-3} A^{-1}]$

QUESTION

Match List-I with List-II:

Choose the correct answer from the options given below: [JEE Main 2023]

1. A-I, B-IV, C-III, D-II
2. A-III, B-I, C-IV, D-II
3. A-II, B-III, C-IV, D-I
4. A-IV, B-II, C-I, D-III

	List-I		List-II
A.	Angular momentum	I.	$[ML^2 T^{-2}]$
B.	Torque	II.	$[ML^{-2} T^{-2}]$
C.	Stress	III.	$[ML^2 T^{-1}]$
D.	Pressure gradient	IV.	$[ML^{-1} T^{-2}]$

QUESTION

Match List-I with List-II:

Choose the correct answer from the options given below: [JEE Main 2022]

List-I		List-II	
A.	Torque	I.	Nms^{-1}
B.	Stress	II.	$J\,kg^{-1}$
C.	Latent Heat	III.	Nm
D.	Power	IV.	Nm^{-2}

1. A-III, B-II, C-I, D-IV
2. A-III, B-IV, C-II, D-I
3. A-IV, B-I, C-III, D-II
4. A-II, B-III, C-I, D-IV

DIMENSION LESS PHYSICAL QUANTITY

- Angle/ Solid angle/ Strain

  Poisson's ratio, refractive index

  Trigonometry formula/ exponential functions, relative permittivity,

  efficiency, ratio, pure no, specific gravity

relative velocity $\Rightarrow$ $V_{AB} = V_A - V_B =$ velo—

$\rightarrow$ LT^{-1}

QUESTION

If L, C and R are the self inductance, capacitance and resistance respectively, which of the following does not have the dimension of time? [JEE Main 2022]

1. RC
2. L/R
3. $\sqrt{LC}$
4. L/C

4kg > 2m ✗

4kg > 2kg ✓

4kg − 3m = ?? Not Possible

4S − 4kg = ✗

$\alpha > \beta$

that means α & β same dim^n

2

Principle of Homogenity → Dimension of each term of a dimensional equation on both the side should be same.

→ we can add, sub., or compuir a P.Q. which have same dimⁿ

" $\alpha = \beta + \gamma - \delta$ "

MR*

$\alpha = \beta = \gamma = \delta$ ← dimⁿ sincelly

You can multiply or divim a P.Q which have same or diffⁿ dimⁿ

$F = ma$

$P = \frac{E}{t}$

$F = at + bt^2$ find dim^n of a and b

Sol^n

$F = at = bt^2$

$a = \frac{F}{t}$

$= \frac{MLT^{-2}}{T}$

$= MLT^{-3}$

$b = \frac{F}{t^2} = MLT^{-4}$

$V = A \sin(\beta t)$ find dimⁿ of A and β

Sol:

$V = A \times 1$

$A = V = LT^{-1}$

(Ans)

$M^0 L^0 T^0 = 1$

$\sin(\beta t)$

$\beta t = 1$

$\beta = \frac{1}{t} = T^{-1}$ (freqⁿ)

(energy) $E = Ax + \frac{Bt}{(C - t^2)}$

dim of A, B, & C

Soln

$E = Ax = \frac{Bt}{t^2}$

& $C = t^2 = M^0L^0T^2$

$E = Ax$

$A = \frac{ML^2T^{-2}}{L}$

$A = MLT^{-2}$

$E = \frac{Bt}{t^2}$

$B = E \times t$

$= ML^2T^{-2}\,T$

$= ML^2T^{-1}$

$$\left(P + \frac{a}{V^2}\right) \times \left(b - V^2\right) = \frac{nRT}{3}$$

find dim^n of b ??

$$b = V^2 = (\text{volume})^2$$

$$= (L^3)^2$$

$$= L^6$$

Dimension → गोरी x..	must be dimⁿ less (A-E)	may or may not be dimⁿ (AB)	A P.Q does not have dimⁿ ???	A P.Q have dimension ??
Unit → (फलां कि दुकान)	A P.Q does not have unit then its dimⁿ ??	A P.Q have unit then its dimⁿ ??	may have unit or unit less	must have dimⁿ

Strain = unit less = dimⁿ less

Angle → unit → Not dimⁿ



True/ false

(1) A unitless P.Q may have dimension → false

(2) A P.Q have unit must have dim^n → false

(3) A P.Q have Dim^n must have unit → True

(4) A P.Q is dim^n less may have unit → True

Physical correct eqn	must be physically wrong ↑↑ Ans	may or may not be physically correct	A P.Q is physically correct then dimn??	A P.Q is physically Incorrect then dimn ??
dimensionally फली कि दुक्का	A equatio is dimn wrong??	A eqn is dimn correct then ??	must be correct (Ans)	may be dimn correct

$$K.E = \frac{1}{2} m^2 v$$

ML^2T^{-2} | M^2LT^{-1}

$$K.E = \frac{3}{2} m v^2$$


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 4 | Physics

3rd → 35 mint

(a) Yes

(b) NO

Units and Measurements



By- Dr. Manish Raj (MR SIR)

Today's Goal

1. Dimensional analysis

Recap of previous lecture

1 # K.B.D .. (questions)

→ Sare question notes मे लिखना है।

2 #

Questions on Principle of Homogenity.

3 #

Application of dim^n analysis

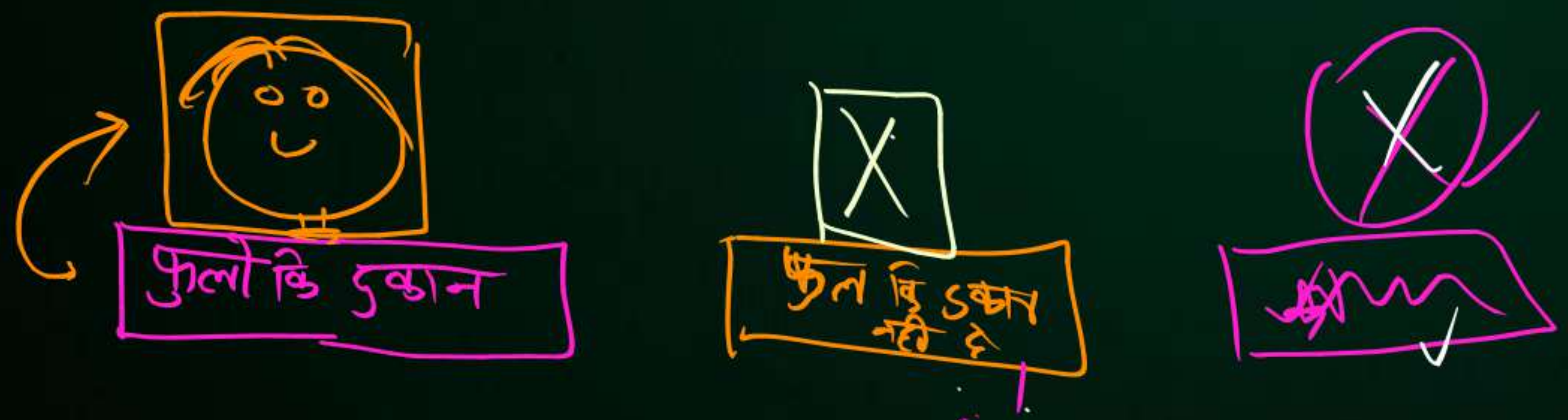
4 #

~~22%~~ → निकाला



PLANE AND SOLID ANGLE

Dimension	.... (may have dimn)	.... (must be dimn less)	A P. Q. does not have dimension ??	A. P Q. have dimension
Unit	A P.Q. have unit (then what about dimension??)	A P.Q. does not have unit	.... (May have unit??)	.... (must have unit)



QUESTION

True/ false

A unitless physical quantity may have dimension → false #

A dimensionless physical quantity may be unitless → True # Ex- Angle, Strain (Both are dim^n less)

A physical quantity have unit must have dimension → false #

A physical quantity have dimension may have unit → false #

A P.Q have dim^n then it must have unit → True ✓

K.B.D.

QUESTION

The pair of quantities having same dimensions is (Kar. NEET 2013)

1. Impulse and Surface Tension
2. Angular momentum and Work
3. Work and Torque
4. Young's modulus and Energy

2. Dimension of electric resistance (2007)

$E = H = I^2 R t$

$$R = \left[\frac{ML^2T^{-2}}{I^2 t}\right] = ML^2T^{-3}A^{-2}$$

$V = IR$

$$R = \left(\frac{V}{I}\right) = \frac{U}{qI} = \frac{U}{I^2 t}$$

3. Self-Induction (1989)

$$E = \frac{1}{2} L I^2$$

$$L = \frac{E}{I^2} = ML^2T^{-2}A^{-2}$$

4. Permeability (1991)

$$F = \frac{\mu_0}{4\pi} \frac{I_1 I_2 \ell}{d}$$

$$\mu_0 = \frac{F}{A^2} = MLT^{-2}A^{-2}$$

QUESTION

5. The density of a material in CGS system of units is $4\ g\ cm^{-3}$. In a system of units in which unit of length is 10 cm and unit of mass is 100 g, the value of density of material will be [Mains 2011]

1. 0.04
2. 0.4
3. 40
4. 400

$d = 4\ g/cm^3$

$l' = 10\ cm$

$m' = 100\ g$

$nu = \text{const}$

$n_1 u_1 = n_2 u_2$

$4 \frac{g}{cm^3} = n_2 \frac{g'}{(cm')^3}$

$\frac{4\ g}{cm^3} = n_2 \frac{100\ g}{(10)^3\ cm^3}$

$n_2 = 40$

DIMENSION OF STRESS??

[NEET-2020]

$$\text{Stress} = \frac{F}{\text{Area}} = \frac{MLT^{-2}}{L^2} = ML^{-1}T^{-2}$$

(7)
- **Magnetic field/Magnetic flux** (1999)

$\Rightarrow F = BIL$

$B = \frac{F}{IL}$ ✓

$\phi = B \cdot A$

(8)
- **Coefficient of viscosity**

$F = 6\pi\eta r v_T$

$\eta = \frac{F}{rv} = \frac{MLT^{-2}}{L\,LT^{-1}} = ML^{-1}T^{-1}$

QUESTION

If the dimensions of a physical quantity are given by $M^a L^b T^c$, then the physical quantity will be (2009)

1. velocity if $a = 1, b = 0, c = -1$
2. acceleration if $a = 1, b = 0, c = -2$
3. force if $a = 0, b = -1, c = -2$
4. pressure if $a = 1, b = -1, c = -2$

QUESTION

(20)

Which two of the following five physical parameters have the same dimensions ?

1. energy density

2. refractive index $(M^0L^0T^0)$

3. dielectric constant $(\varepsilon_r = k\ M^0L^0T^0)$

4. Youngs modulus

5. magnetic field

(2008)

1. 1 and 4

2. 1 and 5

3. 2 and 4

4. 3 and 5

(5) 2 and 3

QUESTION

Which pair do not have equal dimensions ? (2000)

1. Energy and torque
2. Force and impulse
3. Angular momentum and Planck's constant
4. Elastic modulus and pressure.

QUESTION

(12)

Electric field in a certain region is given by $\vec{E} = \left(\frac{A}{x^2}\hat{\imath} + \frac{B}{y^3}\hat{\jmath}\right)$. The SI unit of A and B are:

[JEE Main 2023]

1. $Nm^3\,C^{-1}$; $Nm^2\,C^{-1}$
2. $Nm^2\,C^{-1}$; $Nm^3\,C^{-1}$
3. $Nm^3\,C$; $Nm^2\,C$
4. $Nm^2\,C$; $Nm^3\,C$

$$\vec{E} = \frac{A}{x^2}\hat{i} + \frac{B}{y^3}\hat{j}$$

$$\frac{N}{C} = \frac{A}{x^2} = \frac{B}{y^3}$$

$$A = \frac{Nm^2}{C} \quad \Big| \quad B = \frac{Nm^3}{C}$$

hint $E = \frac{F}{q}$

$E \to N/C$

QUESTION

Assertion: Work = Torque is dimensionally correct but not physically.

Reason: Dimensional correctness of an equation ensures its physical correctness

1. If both Assertion & Reason are True & the Reason is a correct explanation of the Assertion.

2. If both Assertion & Reason are True but Reason is not a correct explanation of the Assertion.

3. If Assertion is True but the Reason is False.

4. If both Assertion & Reason are false.

QUESTION

The velocity v of a particle at time t is given by $v = at + \frac{b}{t + c}$, where a, b and c are constants. The dimensions of a, b and c are (2006)

1. $[L]$, $[LT]$ and $[LT^{-2}]$
2. $[LT^{-2}]$, $[L]$ and $[T]$
3. $[L^2]$, $[T]$ and $[LT^{-2}]$
4. $[LT^{-2}]$, $[LT]$ and $[L]$

QUESTION

An equation is given here $\left(P + \frac{a}{v^2}\right) = b\frac{\theta}{V}$ where P = Pressure, V = Volume and θ = Absolute temperature. If a and b are constants, the dimensions of a will be

(1996)

1. $[MT^{-5}\,T^{-1}]$
2. $[MT^{5}\,T^{1}]$
3. $[MT^{5}\,T^{-2}]$
4. $[M^{-1}\,L^{5}\,T^{2}]$

$\left(P + \frac{a}{V^2}\right) = \frac{b\theta}{V}$

MR*

$P = \frac{a}{V^2} = \frac{b\theta}{V}$

$a = PV^2$

$= ML^{-1}T^{-2} \times L^6$

$= ML^5T^{-2}$

QUESTION

(16) The time dependence of a physical quantity p is given by $p = p_0 \exp(-at^2)$, where a is a constant and t is the time. The constant a (1993)

1. is dimensionless
2. has dimensions $[T^{-2}]$
3. has dimensions $[T^2]$
4. has dimensions of p

$P = P_0 e^{-\alpha t^2}$

$-\alpha t^2 = M^0 L^0 T^0$

$\alpha t^2 = 1$

$\alpha = \frac{1}{t^2} = T^{-2}$

m

QUESTION

Assertion: The unit vectors $\hat{\imath}$, $\hat{\jmath}$ and $\widehat{k}$ have units of distance and dimensions $[M^0 L^1 T^0]$

Reason: The product of a scalar and a vector is a new scalar.

1. If both Assertion & Reason are True & the Reason is a correct explanation of the Assertion.
2. If both Assertion & Reason are True but Reason is not a correct explanation of the Assertion.
3. If Assertion is True but the Reason is False.
4. If both Assertion & Reason are false.

QUESTION

(18)

F + P

Assertion: Force is not added with pressure.

Reason: Quantities having different dimension are not added or subtracted.

1. If both Assertion & Reason are True & the Reason is a correct explanation of the Assertion.
2. If both Assertion & Reason are True but Reason is not a correct explanation of the Assertion.
3. If Assertion is True but the Reason is False.
4. If both Assertion & Reason are false.

QUESTION (19)

Assertion: Astronomical unit, light year and parsec measures distance.

Reason: Each has dimension of distance.

1. If both Assertion & Reason are True & the Reason is a correct explanation of the Assertion.
2. If both Assertion & Reason are True but Reason is not a correct explanation of the Assertion.
3. If Assertion is True but the Reason is False.
4. If both Assertion & Reason are false.

Resistance Ka unit (Ω)

Inductive Reaton $X_L = \omega L \ \Omega$

capacit Re - $X_C = \frac{1}{\omega C} \Omega$

dimensionally

inR*

$$R = \omega L = \frac{1}{\omega C}$$

19

2π $f = \omega = \frac{R}{L}$	$\omega = \frac{1}{RC}$	$\omega^2 = \frac{1}{LC}$
freque $= \frac{R}{L}$	$f = \frac{1}{RC}$	$\omega = \frac{1}{\sqrt{LC}}$
Time $= \frac{L}{R}$	$T = RC = CR$	freq $= \frac{1}{\sqrt{LC}}$
		Time $= \sqrt{LC}$

Principle of Homogeneity

A & B diff^r dim^n

$C - D = E$

✓ $5m - 2m = 3m$

✗ $4m - 4kg = 0$

Q) If A and B are physical quantity having different dimension then which of the following expression is correct??

(1) $A + B$ ✗

(2) $A - B$ ✗

(3) $A - B^2$

(4) $AB + B$

(5) $\frac{(A+B)}{B}$ ✗

(6) $A \cdot B$ corr

$AB + B$ ✓

$B(A+1)$

B (energy) (माना)

$A \rightarrow$ dimensionless

Ex: A = Area
B = length.

$A - B^2 \rightarrow$ may be correct ✓

Correct → 3, 4, 6

QUESTION

If L, C and R are the self inductance, capacitance and resistance respectively, which of the following does not have the dimension of time? [JEE Main 2022]

1. RC
2. L/R ✓
3. $\sqrt{LC}$
4. L/C ✗

Ans → 4

$R = \omega L = \frac{1}{\omega C}$

$\omega = \frac{R}{L}$

$\tau = \frac{L}{R}$

Dimension less function

(1) Trigonometric function

dimⁿless → $\sin(\theta)$ → dimⁿless

Ex-

$F = \sin(\alpha x)$

find dimⁿ of α.

Solⁿ $\alpha x = 1$

$\alpha = \frac{1}{x} = L^{-1}$

$F = A\sin(\theta)$ then find dimⁿ of A & B

Solⁿ $F = A = MLT^{-2}$

$B(\text{Ang}) = M^0L^0T^0$

Ex- $F = A\sin[Bt - Cx]$ find dimⁿ of $B/C = ??$

Solⁿ $Bt - Cx = 1 = \text{dim}^n\text{less}$

$Bt = Cx$

$\Rightarrow \left(\frac{B}{C}\right) = \frac{x}{t} = LT^{-1}$

$$y = A\sin(\omega t - kx + \phi)$$

find dim^n of A, ω, k and ϕ where y and x is Position.

Sol^n

$$y = A = L^1$$

$\omega t = kx = \phi = M^0L^0T^0 = 1$

- $\omega = \frac{1}{T} = T^{-1}$
- $k = \frac{1}{x} = L^{-1}$
- $\phi = M^0L^0T^0$

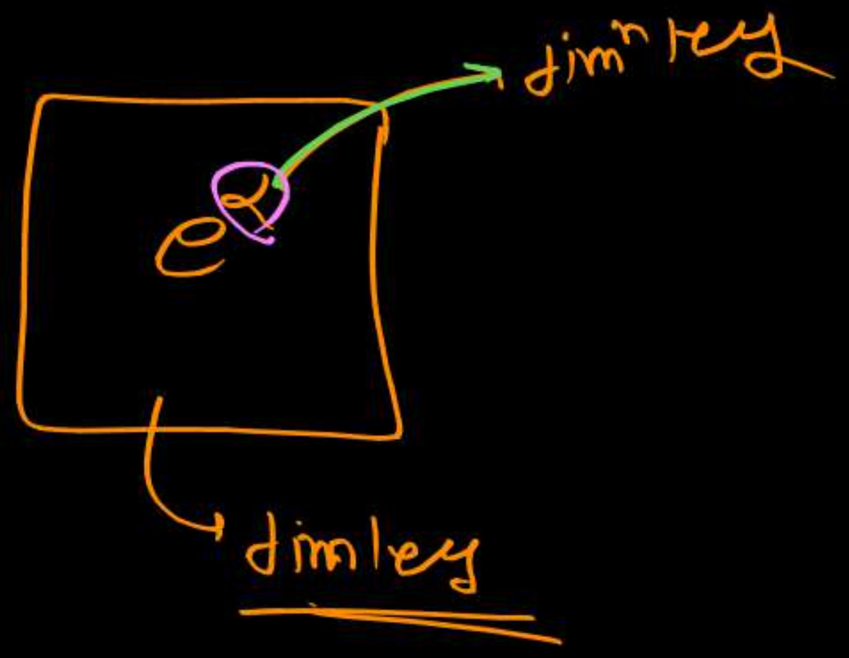
DIMENSIONLESS PHYSICAL QUANTITY

Angle, solid angle, coefficient of friction

Refractive index, Poisson ratio, strain, current gain, voltage gain, efficiency, relative permittivity, relative density

Any trigonometric ratio = $\sin\theta$, $\cos\theta$, $\tan\theta$

exponential function



Ex $V = \alpha e^{\beta t}$

find dimn of α & β ?

Soln $V = \alpha = LT^{-1}$ ✓

$\beta t = 1 \quad \beta = T^{-1}$ ✓

QUESTION

Velocity $V = \frac{\alpha}{\beta} e^{-\alpha t}$ then find dimension of α and β.

$$V = \frac{\alpha}{\beta} e^{-\alpha t}$$

$$V = \frac{\alpha}{\beta}$$

$$\alpha t = 1$$

$$\alpha = \frac{1}{t} = T^{-1}$$

$$\beta = \frac{\alpha}{V} = \frac{T^{-1}}{LT^{-1}}$$

$\beta = L^{-1}$ Ans

QUESTION

If velocity $v = \alpha t + \beta x - \gamma x t$, then find dimension of α, β and γ.

$$V = \alpha t = \beta x = \gamma x t$$

QUESTION

Different physical quantity can have same dimension?

(a) Yes [Work, Torque] [Angular momentum, plank const]

(b) NO

QUESTION

Two quantity have different dimension, can be same physical quantity.

→ NO

Ex

Length

(A) dimensional, varible → (velocity)

(B) dimension less, varible → relative density, strain, Angle

(C) dimensional, cost^n → Universal gravitation cost^n (G), Planck cost^n (h), Speed of light (c)

(D) dimensionless, const^n → $\pi = 3.14$, $e = 2.71$

PHYSICAL QUANTITY

1. Dimensionless; Constant

2. Dimensional; Constant

3. Dimensionless; Variable

4. Dimensional; Variable

QUESTION

Which of the following is a dimensional constant? (1995)

1. Relative density
2. Gravitational constant
3. Refractive index
4. Poisson's ratio.

QUESTION

On the basis of dimension, decide which of the following relation for displacement of a particle is not correct [NCERT]

1. $y = a \sin\left(\frac{2\pi t}{T}\right)$
2. $y = a \sin\left(\frac{vt}{\lambda}\right)$
3. $y = \sqrt{2}a \sin\left(\frac{2\pi t}{T}\right) \cos\left(\frac{2\pi x}{\lambda}\right)$
4. $y = \frac{x}{t} \sin(\lambda t)$

Ans (4)

QUESTION

Velocity $V = A\sin\left(x\sqrt{\alpha t}\right)$, find dimension of α.

$$x\sqrt{\alpha t} = 1$$

$$\sqrt{\alpha t} = \frac{1}{x}$$

$$\alpha t = \frac{1}{x^2}$$

$$\alpha = \frac{1}{x^2 T} = L^{-2}T^{-1}$$

QUESTION

Velocity $V = \frac{\alpha}{\beta + \sqrt{\text{density}}}$, find dimension of α and β.

$l_1 + l_2 = 1m$

density = $\frac{\text{mass}}{\text{volume}}$

$V = \frac{\alpha}{\beta + \sqrt{d}}$

$V = \frac{\alpha}{\beta = \sqrt{d}}$

MR*

$\beta = \sqrt{d}$

$\beta = \left(\frac{m}{L^3}\right)^{1/2} = m^{1/2} L^{-3/2}$.

$V = \frac{\alpha}{\sqrt{d}} = \frac{\alpha}{\beta}$

$\alpha = V\sqrt{d}$

$= LT^{-1} \times m^{1/2} L^{-3/2}$

$= m^{1/2} L^{-1/2} T^{-1}$

Dimension of differential term

dim^n $\Rightarrow$ $\dfrac{dy}{dx} = \dfrac{y}{x}$

$\Rightarrow \dfrac{d^2y}{dx^2} = \dfrac{y}{x^2}$

$\Rightarrow \dfrac{d^3y}{dx^3} = \dfrac{y}{x^3}$

Dimension of Integration

$\int y\,dx = y\,x$

dimensionally

QUESTION

If y = Force and x = velocity then find dimension of $\frac{dy}{dx}$. $= \frac{y}{x} = \frac{f}{v} = \frac{MLT^{-2}}{LT^{-1}}$

$= MT^{-1}$

QUESTION

$\int \frac{dx}{\sqrt{2ax-x^2}} = b$; find dimension of a and b of x are different

H/W

QUESTION

If maximum acceleration of oscillating particle is α and maximum velocity is β, then find time period [NEET 2013]

1. $2\pi\frac{\alpha}{\beta}$
2. $2\pi\alpha\beta$
3. $2\pi\frac{\beta}{\alpha}$
4. $\frac{2\pi\alpha^2}{\beta^2}$

11/w

QUESTION

Momentum of object is given as $P = \alpha t[1 - \beta^{\gamma x}]$ then, find dimension of α, β and γ. Where t is time x is position.

H/W

QUESTION

Assertion: If x and y are the distances along x and y axes respectively then the dimensions of $\frac{d^3y}{dx^3}$ is $M^0 L^{-2} T^0$.

Reason: Dimensions of $\int_a^b y\,dx$ is $M^0L^2T^0$.

1. If both Assertion & Reason are True & the Reason is a correct explanation of the Assertion.

2. If both Assertion & Reason are True but Reason is not a correct explanation of the Assertion.

3. If Assertion is True but the Reason is False.

4. If both Assertion & Reason are false.

M/W

QUESTION

Position of object Y is given $Y = A \sin(kx - \omega t)$ then, find dimension of k; ω and A.

H/W

QUESTION

If $Y = A \sin\left[\frac{2\pi}{\lambda}(ct - x)\right]$. Find dimension of c.

H/W


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 5 | Physics

Units and Measurements



By- Dr. Manish Raj (MR SIR)

Topics to be covered

1. # H|W ✓
2. # application of dim^n analysis ✓
   P.Y.Q ✓
3. # Application of dimension analysis
4. #



QUESTION

$\int \frac{dx}{\sqrt{2ax-x^2}} = b$; find dimension of a and b if x is distance

Sol^n.

$2ax = x^2$

$ax = x^2 - x$

$a = L^1$

$\int \frac{dx}{\sqrt{x^2}} = b$

$\frac{x}{x} = b$

$b = M^0 L^0 T^0$

$\frac{MR^\infty}{}$

$+, - \Rightarrow =$

H/W

QUESTION

If maximum acceleration of oscillating particle is α and maximum velocity is β, then find time period [NEET 2013]

1. $2\pi\frac{\alpha}{\beta}$
2. $2\pi\alpha\beta$
3. $2\pi\frac{\beta}{\alpha}$
4. $\frac{2\pi\alpha^2}{\beta^2}$

accⁿ

(S.H.M)

accⁿ = α

velocity = β

$a = \frac{v}{t}$

$= \frac{LT^{-1}}{LT^{-2}} = T^{-1}$

time $= \frac{v}{a} = \beta/\alpha$

H/W

QUESTION

Correction $P = \alpha t(1 - \beta e^{\gamma x})$

Momentum of object is given as $P = \alpha t[1 - \beta^{\gamma x}]$ then, find dimension of α, β and γ. Where t is time x is position.

Sol^n

$$P = \alpha t - \alpha t \beta e^{\gamma x}$$

MR* dim^n

$$P = \alpha t = \alpha t \beta \times 1$$

$$P = \alpha t$$

$$\alpha = \frac{P}{t} = \frac{MLT^{-1}}{T}$$

$$\alpha = MLT^{-2}$$

$$\alpha t = \alpha t \beta$$

$$1 = \beta$$

dim^{n}less

$$\gamma x = 1$$

$$\gamma = \frac{1}{x} = L^{-1}$$

H/W

QUESTION

Assertion: If x and y are the distances along x and y axes respectively then the dimensions of $\frac{d^3y}{dx^3}$ is $M^0 L^{-2} T^0$.

Reason: Dimensions of $\int_a^b y\,dx$ is $M^0L^2T^0$.

1. If both Assertion & Reason are True & the Reason is a correct explanation of the Assertion.
2. If both Assertion & Reason are True but Reason is not a correct explanation of the Assertion.
3. If Assertion is True but the Reason is False.
4. If both Assertion & Reason are false.

QUESTION

Position of object Y is given $Y = A \sin(kx - \omega t)$ then, find dimension of k; ω and A.

QUESTION

If $Y = A\sin\left[\frac{2\pi}{\lambda}(ct - x)\right]$. Find dimension of c.

$$Y = A\sin\left(\frac{2\pi}{\lambda}(ct - x)\right)$$

H/W

$$ct = x$$

$$c = \frac{x}{t} = LT^{-1}$$

Equation of force $F = \frac{a - x}{bt^2}$ then find dim^n of a & b.

Sol^n

$$a = x = L^1$$

$$F = \frac{x}{bt^2}$$

$$b = \frac{x}{Ft^2} = \frac{L}{MLT^{-2}T^2}$$

$$b = M^{-1}$$

Ans

force acting on object is Proportional to square of velocity then find dim^n of Proportional constant.

Soln

$$F \propto V^2$$

$$F = K V^2$$

$$K = \frac{F}{V^2} = \frac{MLT^{-2}}{L^2T^{-2}}$$

$$= ML^{-1}$$ Ans

$Y = \log_e^{\alpha t}$ then find dim^n of α ??

Sol^n

$\alpha t = M^0 L^0 T^0$

$\alpha = T^{-1}$

$\log_e x$ — dim^n less; x → dim^n less.

$Y = 2^{4m}$ ✗

$Y = (2^4)\, m$ ✓

Find dim^n of '2' & '6'

where F is force, v = velocity, t = time

$F = 2v - 6t$

(a) both are dim^n less (60%)

(b) MT^{-1}, MLT^{-3} (33%)

(c) $ML^{-1}T^{-2}$, MLT^{-3}

(d) MLT^{-3}, MT^{-1}

Sol^n

$F = 2v - 6t$

$F = 2v = 6t$

$2 = \frac{F}{v}$

$= \frac{MLT^{-2}}{LT^{-1}}$

$= MT^{-1}$

$6 = \frac{F}{t}$

$6 = \frac{MLT^{-2}}{T}$

$= MLT^{-3}$

$$s = ut + \frac{1}{2}at^2$$

$\frac{1}{2}$ → dim^n less

$$K.E = \frac{1}{2}mv^2$$

$\frac{1}{2}$ → dim^n less

Application of dim^n analysis

APPLICATION OF DIMENSIONAL ANALYSIS

1. If time period of simple pendulum depends on length of pendulum and acceleration due to gravity then derive formula of time in terms of l and g using dimensional analysis.
2. If length and acceleration taken as fundamental physical quantity then express dimension of time in terms of them.
3. In new system of unit of length is 2 m and unit of acceleration is 8 m/s^2 then find unit of time in new system.

Sol^n of all 3-question is same.

APPLICATION OF DIMENSIONAL ANALYSIS

1. **If time period of simple pendulum depends on length of pendulum and acceleration due to gravity then derive formula of time in terms of l and g using dimensional analysis.**

Soln

$T(l, g)$

$T \propto l$

$T \propto \frac{1}{l}$ ← Not given

$T \propto l^2$

$T \propto \sqrt{l}$

$T \propto l^x g^y$

dimensionally equal

$T = l^x g^y$

$M^0L^0T^1 = L^x (LT^{-2})^y$

$M^0L^0T^0 = L^x L^y T^{-2y}$

$M^0L^0T^1 = L^{x+y} T^{-2y}$

compair Power of time & length

$-2y = 1$

$y = -\frac{1}{2}$

$x + y = 0$

$x = -y$

$x = \frac{1}{2}$

Put value of x & y

$T = l^{1/2} g^{-1/2} = \frac{l^{1/2}}{g^{1/2}} = \sqrt{l/g}$

$$T = l^{x} a^{y}$$

same as 2nd ques → $T = l^{1/2} a^{-1/2}$

l a

2. If length and acceleration taken as fundamental physical quantity then express dimension of time in terms of them.

3. In new system of unit of length is 2 m and unit of acceleration is 8 m/s^2 then find unit of time in new system.

Soln: same as 1st question

$$T = l^{1/2} a^{-1/2} = \sqrt{\frac{l}{a}} = \sqrt{\frac{2\,m}{8\,m/s^2}} = \sqrt{\frac{s^2}{4}} = \frac{1}{2}\,sec$$

QUESTION

If force (F), acceleration (a) and time t is used as a fundamental P.Q. then find dimension of length in terms of them :-

1. $F^0 a^1 T^2$
2. $F a^2 T^2$
3. $F a^2 T^0$
4. $F^0 a T$

$l = F^x a^y T^c$ — Let (x, y & c) are power of F, a & T

$M^0 L^1 T^0 = (MLT^{-2})^x (LT^{-2})^y (T^c)$

$M^0 L^1 T^0 = M^x L^{x+y} T^{-2x-2y+c}$

$x = 0$ | $1 = x + y$, $y = 1$ | $-2x - 2y + c = 0$, $0 - 2 \times 1 + c = 0$, $c = 2$

$l = F^0 a^1 T^2$

Sol^n MR*: $M^0 T^0 L^1 = F^x a^y T^c$ (No mass)

$= F^0 a^1 (LT^{-2})^1 T^2$

$L = F^0 a^1 T^2$

$LT^{-2} \times T = LT^{-1}$

QUESTION

If force (F), acceleration (a) and time t is used as a fundamental P.Q. then find dimension of Area in terms of them :-

1. $F^0 a^1 T^2$
2. $F a^2 T^2$
3. $F a^2 T^0$
4. $F^0 a T$

$$\text{Area} = (A) = F^x a^y t^z$$

$$M^0 T^0 L^2 = F^0 a^2 (L^2 T^{-4}) T^4$$

$$L^2 = L^2 (F^0 a^2 T^4)$$

dimn of area

QUESTION

The frequency of vibrations f of a mass m suspended from a spring of spring constant K is given by a relation of type $f = cm^x K^y$, where c is a dimensionless constant. The values of x and y are:

1. $x = \frac{1}{2}, y = \frac{1}{2}$
2. $x = \frac{-1}{2}, y = \frac{-1}{2}$
3. $x = \frac{1}{2}, y = \frac{-1}{2}$
4. $x = \frac{-1}{2}, y = \frac{1}{2}$ ✓

$F = Kx$

$K = \frac{F}{x} = \frac{MLT^{-2}}{L} = (MT^{-2})$ ← spring constant

$f = m^x K^y = m^{-1/2} K^{1/2}$

$M^0 L^0 T^{-1} = M^x (MT^{-2})^y$

$M^0 T^{-1} = M^{x+y} T^{-2y}$

$x + y = 0$, $x = -\frac{1}{2}$ ✓

$+2y = +1$, $y = \frac{1}{2}$ ✓

QUESTION

If force, acceleration and time are basic fundamental P.Q. then find dimension of energy.

1. $F^2 A^{-1} T$
2. $F A T^2$
3. $F A T^{-2}$
4. $F A^{-1} T$

$E = F^x a^y T^z = F^1 a^1 T^2$

$ML^2T^{-2} = (MLT^{-2})^x (LT^{-2})^y T^z$

$M^1L^2T^{-2} = M^x L^{x+y} T^{-2x-2y+z}$

$x = 1$ | $2 = x + y$, $y = 1$ | $-2x - 2y + z = -2$, $-2 - 2 + z = -2$, $z = 2$

$E = F \times \text{dis}^n = F a t^2$

QUESTION

If energy E, velocity V and time T are taken as fundamental units, the dimensional formula for surface tension is

1. $[E V^{-2} T^{-2}]$
2. $[E^{-2} V T^{-2}]$
3. $[E^{-2} V T^{-2}]$
4. $[E^{-2} V^{-2} T^{2}]$

$E = \text{work}$

$$S = \frac{F \times l}{l \times l} = \frac{E}{l^2}$$

$S = v + l$

$l = v \times t$

$= L T^{-1} \times T$

$E\,(M L^2 T^{-2}) \quad v\,(L T^{-1}) \quad T\,(T)$

$M R^{a}$

$$S\,(M T^{-2}) = \frac{E^{a}\,(M L^2 T^{-2})}{V^2\,(L^2 T^{-2})\;T^2\,(T^2)}$$

$= E\,V^{-2}\,T^{2}$

QUESTION

If force F, area A and density D are taken as the fundamental units, the representation of Young's modulus 'Y' will be:

1. $[F^{-1} A^{-1} D^{-1}]$
2. $[F A^{-2} D^{2}]$
3. $[F A^{-1} D]$
4. $[F A^{-1} D^{0}]$

Plank's constant (h), speed of light in vacuum (c) and Newton's gravitational constant (G) are three fundamental constants. Which of the following combinations of these has the dimension of length? [NEET 2016]

1. $\dfrac{\sqrt{hG}}{c^{3/2}}$

2. $\dfrac{\sqrt{hG}}{c^{5/2}}$

3. $\sqrt{\dfrac{hc}{G}}$

4. $\dfrac{\sqrt{Gc}}{h^{3/2}}$

QUESTION

If dimensions of critical velocity v_c of a liquid flowing through a tube are expressed as $[\eta^x \rho^y r^z]$ where η, ρ, r are the coefficient of viscosity of liquid, density of liquid and radius of the tube respectively, then the values of x, y and z are given by

1. 1, 1, 1
2. 1, –1, –1
3. –1, –1, 1
4. –1, –1, –1

QUESTION

A physical quantity of the dimensions of length that can be formed out of c, G and $\frac{e^2}{4\pi\varepsilon_0}$ is [c is velocity of light, G is universal constant of gravitation and θ is charge]

1. $\frac{1}{c^2}\left[G\frac{e^2}{4\pi\varepsilon_0}\right]^{1/2}$
2. $c^2\left[G\frac{e^2}{4\pi\varepsilon_0}\right]^{1/2}$
3. $\frac{1}{c^2}\left[\frac{e^2}{G4\pi\varepsilon_0}\right]^{1/2}$
4. $\frac{1}{c}G\frac{e^2}{4\pi\varepsilon_0}$

QUESTION

The speed of light C, gravitational constant G and plant constant h are taken as fundamental P.Q then the dimension of time in the new system of unit

JEE

1. $G^{-1/2} h^{1/2} c^{-5/2}$
2. $G^{-1/2} h^{1/2} c^{-1/2}$
3. $G^{-1/2} h^{1/2} c^{-3/2}$
4. $G^{-1/2} h^{1/2} c^{1/2}$

QUESTION

In a new system of units energy (E), density (d) and power (P) are taken as fundamental units, then the dimensional formula of universal gravitational constant G will be

1. $[E^{-1} d^{-2} P^{2}]$
2. $[E^{-2} d^{-1} P^{2}]$
3. $[E^{2} d^{-1} P^{-1}]$
4. $[E^{1} d^{-2} P^{-2}]$

1. If force depends on normal reaction and strain then find rel^n b/w them using dim^n analysis.

2. If force depends on time, energy, velocity and acc^n then find rel^n b/w them.

3. If Torque, work and velocity taken as fundamental P.Q then find dim^n of length.

LIMITATION OF DIMENSIONAL ANALYSIS

(1) It is not use to derive dimensionless proportional constant.

(2) It can not derive dimensionless function, like $\sin\theta$, $\cos\theta$, $\tan\theta$ e^x etc.

(3) If physical quantity depends upon two P.Q. of same

(4) It can not derive formula which have '*t*' and '–' term

Ex : $S = ut + \frac{1}{2}at^2$

(5) We equate the power of M, L and T. So, it only work when quantity depends only on three physical quantity.

Ex : If force depends upon energy, velocity, time work.

QUESTION

Which of the following equation can be derived dimensionally

(1) $s = vt - \frac{1}{2}at^2$

(2) $v^2 = u^2 - 2as$

(3) $h = \frac{\omega^2 r^2}{2g}$

(4) $v = \frac{d}{t}$

QUESTION

Which of the following equation can not be derived dimensionally

1. $F = 6\pi r\eta$
2. $\theta = \omega t$
3. $\frac{d\theta}{dt} = \rho A v$
4. $P = \rho g h$

SIGNIFICANT FIGURES

Significant Figures (Meaningful Digits

- All non-zero digits are significant

  Ex – 44 m $\Rightarrow$ 2

- All zeros between non-zero digits are significant

  Ex – 405 m $\Rightarrow$ 3

- All zeros on left side are non-significant.
- Exact number have infinite significant figure
- Power form are not considered as significant figure.


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 6 | Physics

Units and Measurements

By- Dr. Manish Raj (MR SIR)



Topics to be covered

1. # H/W
2. # Signifint digit
3. # Accurcay & Pricision
4. # Basic of error





mass = 1 kg ✓

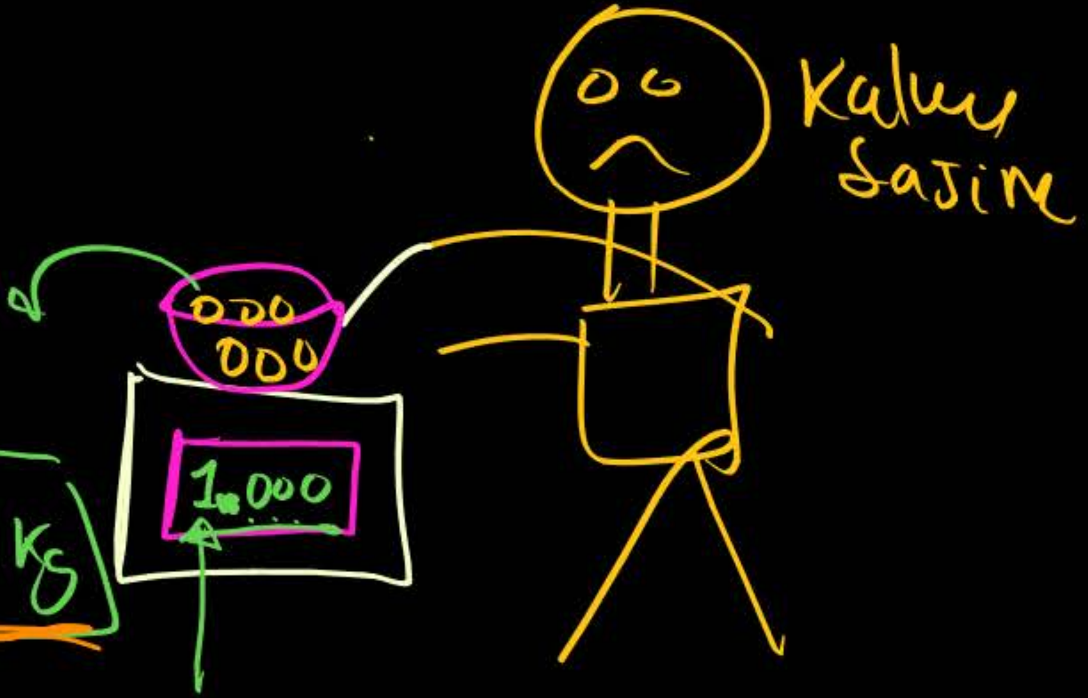
→ uncertain

M = 1.0 kg

= 1.00 kg

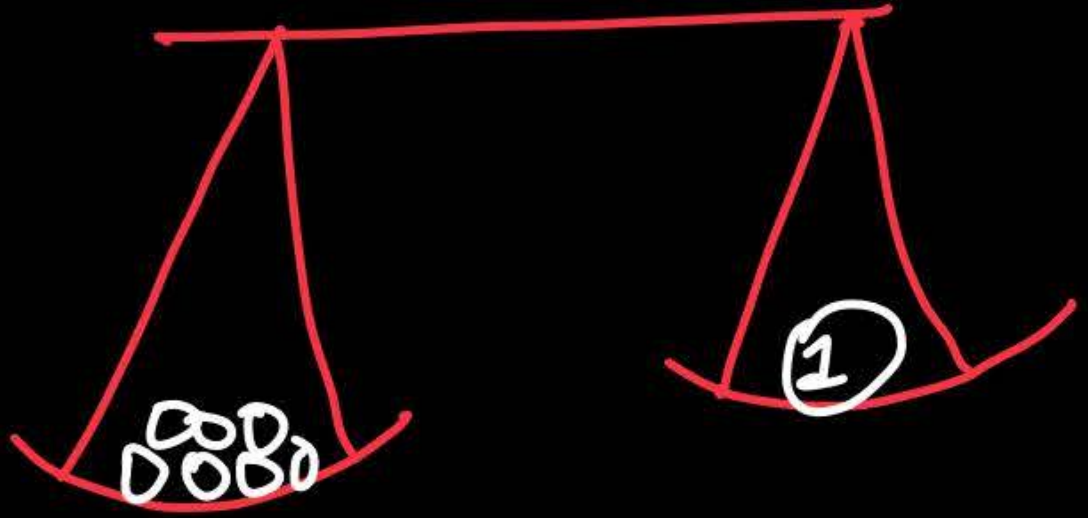
M = 1.000 kg

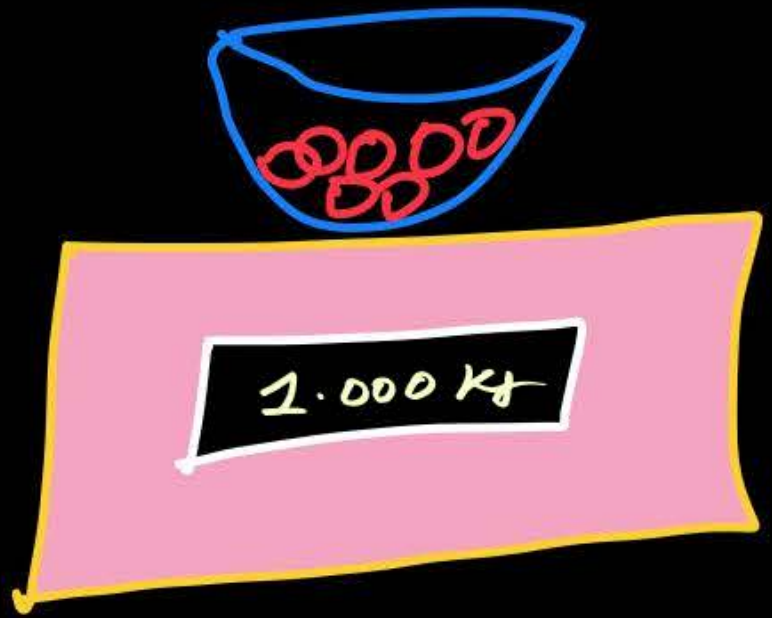
wrong representation



M = 1.000 kg

Correct.





Mass = 1 kg ✓

significant dig = 1

m = 1.000 kg ✓✓

Significant digit = 4

Significant figure (digit) = (All certain + one uncertain)

M = 256703 kg ⟹ 6 signif. = 5 certain + 1 uncertain

Significant digit Indicate Precision of Measurment

⟹ choice of change in different Unit does not affect the significant digit.

Rule of Counting of significant digit :-

1. all non-zero are significant
2. all zero b/w non zero are significant
3. Trailing zero without decimal point is not significant after decimal place all zero are significant
4. If number is less than one(1) all zero left of non zero are Not significant.
5. exact number have infinite significant no.
6. In Power form Power is not significant.

0.043m → 2

043m → 2

Ex 20 Pen
40 Ball
250 student

1 BMW ← Infy

$M = 1.02 \times 10^{14}$ kg → 3 → significant.

M = 10 kg → signfic = ①

M = 101 → 3 sig.

m = 1.0 g → 2 sig

Counting of Significant digit

1. 23.500 m	5
2. 402 cm	3
3. 5280 kg	3
4. 6.780	4
5. 0.034 grm	2
6. 3.070 grm	4
8. 1.608×10^{23}	4

QUESTION

Give the number of significant figures in each measurement.

1. 36.7 m → 3
2. 0.006606 s → 4
3. 2,002 kg → 4
4. 306,490,000 people → infinite

QUESTION

The number of significant figures in 3.04×10^{23} is :

1. 2
2. 3
3. 23
4. 25

QUESTION

The number of significant figures in 0.01020 is :

1. 1
2. 2
3. 3
4. 4

QUESTION

Given P = 0.0030 m, Q = 2.40 m and R = 3000 m, the number of significant figures in P, Q, R are respectively :

1. 1, 2, 1
2. 2, 3, 1
3. 4, 2, 1
4. 4, 2, 4

Rule of addition

$l_1 = 4.3$ m

$l_2 = 2.43$ m

uncertain

$l_1 + l_2 = ??$

$l_1 = 4.3$
$l_2 = 2.43$

$l_1 + l_2 = 6.73$ → wrong

$l_1 + l_2 = 6.7$ m

- **Addition or Subtraction**
  - Final result is written in minimum decimal places.

- **Multiplication or Division**
  - Final result written in minimum significant figure.

QUESTION

How many significant figures should the answer to this calculation contain?

$$\frac{(1.014 + 0.07)}{5.11}$$

1. 2
2. 3
3. 4
4. 1

QUESTION

Add these three length :-

$l_1 = 0.307$ m, 0.52 m and 0.4 m

1. 1.22 m
2. 1.2 m
3. 1.3 m
4. 1.7 m

0.307
0.52
0.4
―――――
1.227

1.23

1.2 Ans.

ROUNDING OFF

- If digit to be removed is less than 5 then there is no change in parimary number.
- If digit to be removed is greater than 5 then there previous number increases by 1.
- If digit is 5, then previous number remains same if even and increase by 1 then if odd.

Ex $4.32 = 4.3$

less than 5

Ex $4.69 = 4.7$

$4.35 \rightarrow 4.4$

$4.45 \rightarrow 4.4$

QUESTION

Calculate the correct number of significant figures for the final solution:

(i) Round 4.7475 to 4 significant figures → 4.748 → 4.75 ✓

(ii) Round 4.7465 to 4 significant figures → 4.746 → 4.75 ✓

QUESTION

[redacted]

(i) $76.4 \times 180.4 = ?$

(ii) $934.9 \div 0.00455 = ?$

$$\begin{array}{r} 76.4 \\ \times\ 180.4 \\ \hline 13782.56 \\ \hline \end{array}$$

$\Rightarrow 1378 = 13800$ ✓

$= 13700$ ✓

addition/sub → minimum decimal

Multi / div → significant

$\# \ 4 \times 3.2 = 12.8$

$= 13.0$

$= 10$

QUESTION

Number of significant digit in the result of $\frac{4.327}{2.515}$ m.

1. 2
2. 4
3. 3
4. 5

QUESTION

Taking into account of significant digit. What is the value of 9.99 m − 0.0099 m. = 9.9801 = 9.98 [NEET-2020]

1. 9.98 m
2. 9.890 m
3. 9.9 m
4. 9.9801 m

multiply this

$4 \times 3.2 = 12.8$ Ans

multiply this with significant

$4 \times 3.2 = 12.8$

$= 10$

Ans

QUESTION

The area of rectangle of length 55.3 m and breadth 25 m. [NEET-2022]

(1) 1382 ✗

(2) 1382.5 ✗

(3) 14×10^2 ✓

(4) 138×10^1 ✗

55.3
× 25

1382.5 = 1382.0 = 1380.0 = 1400.0

14×10^2 ✓ 1400 ✗

QUESTION

If A = 2.413 and B = 1.2 then find A + B.

2.413
1.2
3.613
= 3.6 Ans

QUESTION

If A = 25.5 and B = 5 then find $\frac{A}{B}$.

QUESTION

Express the final answer to the proper number of significant figures.

(i) 101.2 + 18.702 = ?

(ii) 202.88 – 1.013 = ?

$$\begin{array}{r} 18.702 \\ +\ 101.2 \\ \hline 119.902 \end{array}$$

$= \boxed{119.9}$ Ans

$$\begin{array}{r} 202.880 \\ -\ 1.013 \\ \hline 201.867 \end{array}$$

$= \boxed{201.87}$ Ans

QUESTION

$\frac{1.5}{1.5}$ is equal to

1. 1
2. 1.0
3. 1.00
4. 1.000

QUESTION

When 96.54 is divided by 2.40, the correct result is :

(1) 40.2250

(2) 40.225

(3) 40.23

(4) 40.2

QUESTION

Find round off value of $x = 16.351$ upto 3 digit.

$16.351 = 16.35 = 16.4$

1. 16
2. 16.33
3. 16.3
4. 16.4 ✓

QUESTION

Find round off value of $x = 3.250$ upto 2 digits.

$3.25(0) = 3.2(5) = 3.2$

1. 3.2 ✓
2. 3.25
3. 3.5
4. 3

Not in Syllabus

Accuracy → How close the measured value to the True value

→ accuracy of measure value.

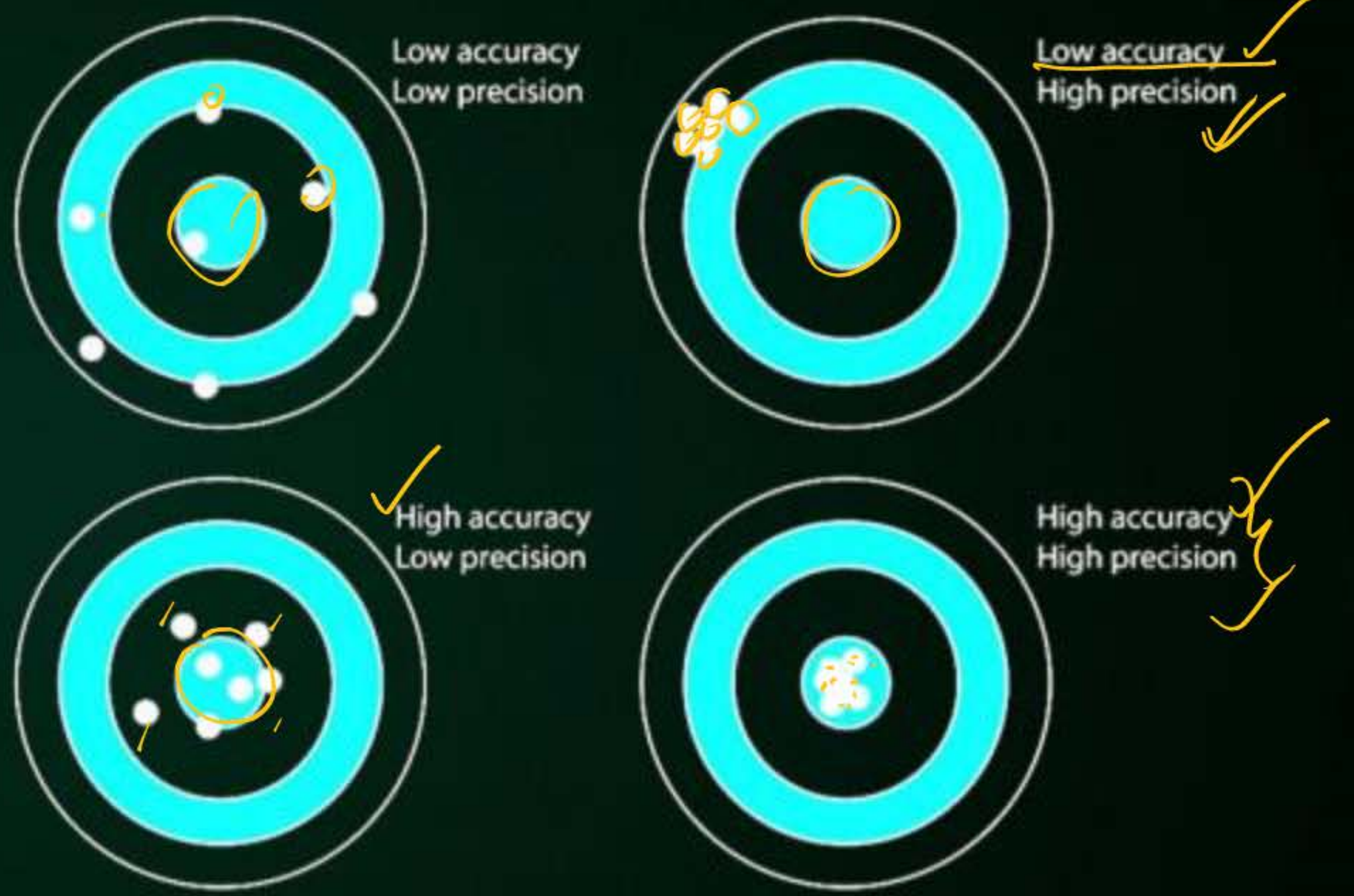
→ If True value is not given then most precise is most accurate.

Precision → How precise value is measure

→ High no of decimal place represent high Precision. ✓

Accuracy : It is the measure of how close the measured value is to the true value.

Precision : It tells us to what resolution or limit the quantity is measured.



QUESTION

If true value of length is 6.57 m then which of the following reading is most accurate [redacted]

1. 6.52 m
2. 6.61 m
3. 6.513 m
4. 6.68 m

Ans (2) most accurate

If most precise

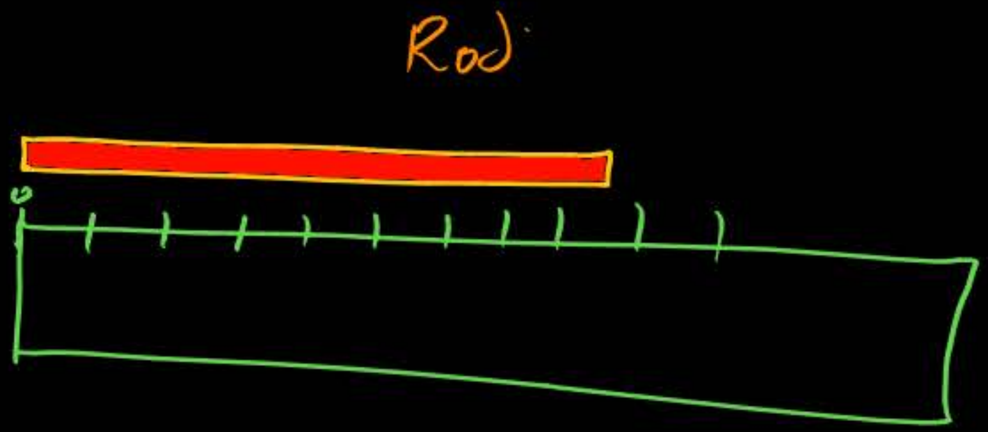
(3) 6.513 m

QUESTION

Which of the following reading is most accurate? [NEET 2024]

1. 2.4 m
2. 2.41 m
3. 2 m
4. 2.413 m

Ans (4)



40 → 1 s

$40 \times 3.2 = 130$ ✗

$= 100$ ✓

$\Rightarrow l_1 = 4.1 \text{ cm}$

$\Rightarrow l_2 = 4.3 \text{ cm}$

$l_3 = 3.8 \text{ cm}$

$l_4 = 3.9 \text{ cm}$

$$l_{Avg} = \left[\frac{4.1 + 4.3 + 3.8 + 3.9}{4}\right] = l_{True}$$

Absolute error → always +ve

$$\Delta l = |l_T - l_m| = |l_m - l_T|$$

$\Delta l_1 = |l_T - l_{m1}|$ absolute error in 1st reading

$\Delta l_2 = |l_T - l_{m2}|$ " in 2nd reading

$\Delta l_3 = |l_T - l_{m3}|$

$\Delta l_4 = |l_T - l_{m4}|$

$$(\Delta l)_{mean} = \frac{\Delta l_1 + \Delta l_2 + \Delta l_3 + \Delta l_4}{4}$$

(mean absolute error)

ABSOLUTE ERROR

- Different between measured value and true value. Ka mod.

$\Delta x = |x_T - x_m|$

- always +ve
- unit same as P.Q
- absolute error can't tell accuracy & precision

$\frac{(\Delta x)}{x_T}$ = Relative error

$\frac{\Delta x}{x_T} \times 100$ = % error

$(\Delta l_1)_{Ramlu} = 1\,cm$ → measure a length of 5cm Rod (5cm)

$(\Delta l_2)_{Kallu} = 1\,km$ → Measured dist^n b/w earth & sun (6400 km)

Kiska error bada hai

(a) Kallu 5%

(b) Ramlu 2%

(c) Can't say

QUESTION

If absolute error and actual value of a number are 5, 15 respectively then relative error is

1. 1/3
2. 3/2
3. 3
4. 100/3

QUESTION

In a series of successive measurements in an experiment, the readings of the period of oscillation of a simple pendulum were round to be 2.63s, 2.56s, 2.42s, 2.71s and 2.80s. Calculate

(i) The mean value of the period of oscillation

(ii) The absolute error in each measurement

(iii) The mean absolute error

(iv) The relative error

(v) The percentage error.

H/W

QUESTION

The refractive index (μ) of water is found to have the values 1.29, 1.33, 1.34, 1.35, 1.32, 1.36, 1.30 and 1.33. Calculate the mean value, absolute error, the relative error and the percentage error.

H/W

QUESTION

The speed of light C, gravitational constant G and plank constant h are taken as fundamental P.Q then the dimension of time in the new system of unit

1) $G^{+1/2} h^{1/2} c^{-5/2}$ ✓

2) $G^{-1/2} h^{1/2} c^{-1/2}$

3) $G^{+1/2} h^{1/2} c^{+3/2}$ ✗

4) $G^{-1/2} h^{1/2} c^{1/2}$ ✗

$$\text{time} = c^x G^y h^z = G^{1/2} h^{1/2} c^{-5/2} \quad \text{(JEE)}$$

$$M^0 L^0 T^1 = (LT^{-1})^x (M^{-1}L^3T^{-2})^y (ML^2T^{-1})^z$$

$$M^0 L^0 T^1 = M^{z-y} L^{x+3y+2z} T^{-x-2y-z}$$

$z-y=0$	$x+3y+2z=0$	$-x-2y-z=1$
$z=y$	$x+5y=0$	$5y-2y-y=1$
	$x=-5y$	$2y=1$
		$y=\frac{1}{2}$

QUESTION

In a new system of units energy (E), density (d) and power (P) are taken as fundamental units, then the dimensional formula of universal gravitational constant G will be

1. $[E^{-1} d^{-2} P^{2}]$
2. $[E^{-2} d^{-1} P^{2}]$
3. $[E^{2} d^{-1} P^{-1}]$
4. $[E^{1} d^{-2} P^{-2}]$

$F = N(\varepsilon\, \text{true})$

1. If force depends on normal reaction and strain then find rel^n b/w them using dim^n analysis.

Ex $T = (2\pi)\sqrt{\frac{l}{g}}$ ✓

→ Answer → Not Possible

$F = N^x [S]^y$

2. If force depends on time, energy, velocity and acc^n then find rel^n b/w them using dim^n analy

$F = T^x E^y V^z a^p = T^x (ML^2T^{-2})^y (LT^{-2})^p (LT^{-1})^z$ → (Not Possible to solve)

3. If Torque, work and velocity taken as fundamental P-Q then find dim^n of length

$l = \tau^x W^y V^z$ ← Not Possible

$= (ML^2T^{-2})^x (ML^2T^{-2})^y$

LIMITATION OF DIMENSIONAL ANALYSIS

$T = 2\pi\sqrt{\frac{L}{g}}$

$y = A\sin\theta$

(1) It is not use to derive dimensionless proportional constant.

(2) It can not derive dimensionless function, like $\sin\theta$, $\cos\theta$, $\tan\theta$ e^x etc.

(3) If physical quantity depends upon two P.Q. of same dimension

(4) It can not derive formula which have '+' and '–' term

Ex : $S = ut + \frac{1}{2}at^2$

(5) We equate the power of M, L and T. So, it only work when quantity depends only on three physical quantity.

Ex : If force depends upon energy, velocity, time work.

QUESTION

Which of the following equation can be derived dimensionally

(1) $s = vt - \frac{1}{2}at^2$

(2) $v^2 = u^2 - 2as$

(3) $h = \frac{\omega^2 r^2}{2g}$

(4) $v = \frac{d}{t}$

QUESTION

Which of the following equation can not be derived dimensionally

1. $F = 6\pi r\eta$ ✓

2. $\theta = \omega t$ ✗

3. $\frac{d\theta}{dt} = \rho A v$ ✗

4. $P = \rho g h$ ✗

Ans (1)


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture-7 | Physics

Units and Measurements

By- Dr. Manish Raj (MR SIR)



Topics to be covered

Absolute error
Relative
% error
question



Absolute Error

Absolute Error → Magnitude of difference of True value and measured value ✓

$$\Delta x = |x_T - x_m|$$

$$\Delta l = |l_T - l_m|$$

- ⇒ it can't tell about precision and accuracy of masurment
- ⇒ Unit of absolute error same as P.Q. whose error is calculated
- ⇒ Always positive
- ⇒ least count of instrument can be taken as absolute error.

Some Measured Value given :- (True value is not know)

$l_1 = 4.03$ cm → $l_1 = 4.0\boxed{2}$ $l_9 = 4.04$

$\boxed{\Delta l_1 = 0.01 cm}$ $\boxed{\Delta l = 0.01}$ ← Parability is high

$l_2 = 4.5$ cm $l_2 = 4.4 cm$ $l_2 = 4.6 cm$ → $\Delta l = 0.1 cm$

$\Delta l_2 = 0.1 cm$

$l_3 = 4.314$ cm → $\boxed{\Delta l = 0.001 cm}$

$\Delta l_3 = 0.001 cm$

$l_4 = 4$ cm → $\Delta l = 1 cm$

$\Delta l_4 = 1 cm$

question IIT-2006

measured mass of Object is 2·5 grm find absolute & % error in measurment of mass.

Soln

✓ True of mass is not given,

✓ one measure value is given, you can't find Avg.

$m_{True} = 2.5$ grm

$\Delta m = 0.1$ grm (absolute error)

$$\% \text{ error} = \frac{\Delta m}{m_T} \times 100$$

$$= \frac{0.1\,g}{2.5\,g} \times 100$$

$$= \frac{10}{2.5} = 4\%$$

Relative Error

↳ Tells us accuracy of measurement.

$$\left(\frac{\Delta x}{x_T}\right) = \frac{\text{Absolute error}}{\text{True Value}}$$

↳ unitless dimnless

$$\% \text{ error} = \frac{\Delta x}{x_T} \times 100$$

↳ unit less, dimn less

(Q) Ramlal measure a length of Rod is $l_m = 4.50$ cm where True length is 5cm.

Soln

$$\Delta l = |l_T - l_m| = |5\text{cm} - 4.50\text{cm}|$$

$$= 0.5 \text{ cm}$$

$$\frac{\Delta l}{l_T} = \frac{0.5}{5\text{cm}}$$

$$\% \text{ error} = \frac{0.5}{5} \times 100 = 10\%$$

(Q) Kallua measured mass of object as $m = 4.95$ kg. Where True mass is 5kg.

Soln

$$\text{Absolute error} = |m_T - m_m| = |5 - 4.95| \text{ kg}$$

$$= 0.05 \text{ kg}$$

$$\frac{\Delta m}{m_T} = \frac{0.05}{5} \quad 0.01$$

$$\% \text{ error} = \frac{0.05}{5} \times 100 = 1\%$$

measured a length of Rod $l_1 = 5.02$ cm $l_2 = 5.04$ cm & $l_3 = 4.97$ cm then find mean absolute and percentage error in measurment.

Sol

$$l_{True} = \frac{l_1 + l_2 + l_3}{3} = \frac{5.02 + 5.04 + 4.97}{3} = \frac{15.03}{3} = \boxed{5.01}$$

True length

$\Delta l_1 = |l_T - l_1| = |5.01 - 5.02| = 0.01$ cm

$\Delta l_2 = |5.01 - 5.04| = 0.03$ cm

$\Delta l_3 = |5.01 - 4.97| = 0.04$ cm

$$\Delta l_{ma} = \left[\frac{\Delta l_1 + \Delta l_2 + \Delta l_3}{3}\right]$$

$$\boxed{\Delta l = \frac{0.08}{3}}$$ ← mean absolute error

$$\% \text{ error} = \frac{|\Delta l|}{l_T} \times 100$$

$$= \frac{0.08}{3 \times 5.01} \times 100$$

$$= \frac{8}{3 \times 5.01} = \frac{8}{15.03} = 0.53\%$$

If absolute error and and actual value of P.Q are 5 and 15 then relative and % error.

$$\text{Relative error} = \frac{\Delta l}{l} = \frac{5}{15} = \frac{1}{3}$$

$$\%\ \text{error} = \frac{5}{15} \times 100 = 33.3\%$$

$$\frac{\Delta l}{l}$$

$$\Delta l = |l_T - l_m|$$

$$\frac{(\Delta l)}{(l_T)}$$

$$\# \quad \boxed{\frac{\Delta l}{l_T} \times 100}$$

$$y = m \cdot l$$

l_1 l_2

$$y = (l_1 + l_2)$$

Error Propagation in Mathematical formula :- Two P.Q having value A and B and their absolute error ΔA and ΔB then find error in Y as shown.

"$Y = A + B$"

"$\Delta Y = \Delta A + \Delta B$"

diff^n w.r.t 't'

$$\frac{dY}{dt} = \frac{dA}{dt} + \frac{dB}{dt}$$

$dY = dA + dB$

$\left(\frac{dY}{Y}\right) = \frac{(dA + dB)}{A + B}$

$Y = A - B$

$\{dY = dA + dB\}$

↳ Absolute error in Y

$$\frac{dY}{Y} = \frac{dA + dB}{A - B}$$

$$\frac{dY}{Y} \times 100 = \frac{dA + dB}{A - B} \times 100$$

$Y = (A \cdot B)$

(diff^n w.r.t. time)

$$\frac{dY}{dt} = \frac{dA}{dt} B + A\frac{dB}{dt}$$

$dY = B\,dA + A\,dB$

divide by Y both side

$$\frac{dY}{Y} = \frac{B\,dA + A\,dB}{Y}$$

$$\frac{dY}{Y} = \frac{B\,dA}{AB} + \frac{A\,dB}{AB}$$

$$\left(\frac{dY}{Y}\right) = \left(\frac{dA}{A}\right) + \left(\frac{dB}{B}\right)$$

↳ Relative error in Y

$$dY = Y\left(\frac{dA}{A} + \frac{dB}{B}\right)$$

↳ absolute error

MRX

$$y = A + B$$

$$\Delta y = \Delta A + \Delta B$$

$$\frac{\Delta y}{y} = \frac{\Delta A + \Delta B}{A + B}$$

$$y = A - B$$

$$\Delta y = \Delta A + \Delta B$$

$$\frac{\Delta y}{y} = \frac{\Delta A + \Delta B}{A - B}$$

$$y = (A \cdot B)$$

(relative errⁿ)

$$\frac{\Delta y}{y} = \frac{\Delta A}{A} + \frac{\Delta B}{B}$$

$$\Delta y = y\left(\frac{\Delta A}{A} + \frac{\Delta B}{B}\right)$$

$$y = \frac{A}{B}$$

$$\frac{dy}{y} = \frac{dA}{A} + \frac{dB}{B}$$

diffⁿ

$$\frac{dy}{dt} = \frac{B\frac{dA}{dt} + A\frac{dB}{dt}}{B^2}$$

$$dy = \frac{B\,dA + A\,dB}{B^2}$$

$$dy = \frac{dA}{B} + \frac{A\,dB}{B^2}$$

divide by (y)

$$\frac{dy}{y} = \frac{dA}{A} + \frac{A\,dB}{B^2 \cdot \frac{A}{B}}$$

$$\frac{dy}{y} = \frac{dA}{A} + \frac{dB}{B}$$

If some constant is multiplied with P.Q

$y = 4A$

(4 — ignored in relative error)

$$\frac{dy}{dt} = 4\frac{dA}{dt}$$

$$dy = 4\,dA$$

For relative error divide by y both side.

$$\Rightarrow \frac{dy}{y} = \frac{4\,dA}{4A} \qquad \frac{dy}{y} = \frac{dA}{A}$$

$y = 6A$

$$\frac{dy}{y} = \frac{dA}{A}$$

$y = 3AB$

$$\frac{dy}{y} = \left(\frac{dA}{A} + \frac{dB}{B}\right)$$

$y = A^n \leftarrow n = \text{some const}^n$

diffⁿ of y w.r.t 'A'

$$\frac{dy}{dA} = \frac{dA^n}{dA}$$

$$\frac{dy}{dA} = nA^{n-1}$$

$$dy = nA^{n-1}\,dA$$

(divide by y both side)

$$\frac{dy}{y} = \frac{nA^{n-1}\,dA}{A^n}$$

$$\frac{dy}{y} = \frac{n\,dA}{A^{n-n+1}}$$

$$\left(\frac{dy}{y}\right) = n\left(\frac{dA}{A}\right)$$

$$\frac{dx^n}{dx} = nx^{n-1}$$

$$Y = A^4$$

$$\frac{dY}{Y} = 4\frac{dA}{A}$$

$$Y = 3A^5 \leftarrow \text{Power}$$

↑ Coef^{n}

$$\frac{dY}{Y} = 5\frac{dA}{A}$$

$y = A + B$ or $y = A - B$

$\Delta y = \Delta A + \Delta B$; $\Delta y = \Delta A + \Delta B$ ✓

Subtraction / Addition → absolute

$\frac{\Delta y}{y} = \frac{\Delta A + \Delta B}{A + B}$

→ Add^n or sub^n
dir^n absolute

Product, Power, Division, Constant

→ dir^n relat

$y = A \cdot B$

$\frac{dy}{y} = \frac{dA}{A} + \frac{dB}{B}$

$y = \frac{A}{B}$

$\frac{dy}{y} = \frac{\Delta A}{A} + \frac{\Delta B}{B}$

$y = A^6$

$\frac{dy}{y} = 6\frac{dA}{A}$

→ $y = 3A^8$

$\frac{dy}{y} = 8\frac{\Delta A}{A}$

$$y = \frac{A^2\sqrt{B}}{C^3}$$

$$\frac{dy}{y} = 2\left(\frac{\Delta A}{A}\right) + \frac{1}{2}\left(\frac{\Delta B}{B}\right) + 3\left(\frac{\Delta C}{C}\right)$$

→ 5-6 time

PYQ

QUESTION

Percentage error in measuring the radius and mass of a solid sphere are 2% & 1% respectively. Then error in measurement of moment of inertia with respect to its diameter is :-

1. 3%
2. 6%
3. 5%
4. 4%

$I = \frac{2}{5} m R^2$ (given in question)

Ignore

$100 \times \frac{\Delta I}{I} = 100 \times \left(\frac{\Delta m}{M}\right) + 2\left[\frac{\Delta R}{R} \times 100\right]$

$= 1 + 2 \times 2$

$= 5\%$

Representation of P.Q with absolute error.

$\Rightarrow \quad l = [l_{value} \pm (\Delta l)]\ cm$

(l_{value}: final result; Δl: absolute)

$\Rightarrow \quad l = [l_{final\ res}\ cm \pm 2\%]$

QUESTION

A wire has a mass (0.3 ± 0.003) g, radius (0.5 ± 0.005) mm and length (6 ± 0.06) cm. The maximum percentage error in the measurement of its density is:

1. 1
2. 2
3. 3
4. 4

$M = 0.3\,g$, $\Delta m = 0.003\,g$

$R = 0.5\,mm$, $\Delta R = 0.005\,mm$

$l = 6\,cm$, $\Delta l = 0.06\,cm$



$$d = \frac{m}{\text{Volume}} = \frac{m}{\pi R^2 l}$$

$$100 \times \frac{\Delta d}{d} = \left[\frac{\Delta M}{M} + 2\frac{\Delta R}{R} + \frac{\Delta l}{l}\right] \times 100 = \frac{0.003}{0.3} \times 100 + \frac{2 \times 0.005}{0.5} \times 100 + \frac{0.06}{6} \times 100$$

$$= 1 + 2 + 1 = 4\%$$

*MR Problem

If $A = (6 \pm 1)$ and $B = (4 \pm 2)$ m then find $Z = 2A + B$ with absolute error.

$Z = 2A + B$

absolute error in (Z)

$\Delta Z = 2\Delta A + \Delta B$

$\Delta Z = 2 \times 1 + 2 = 4$

Vector → multiple revision is required

Why = ??

% error in Z $= \frac{\Delta Z}{Z} \times 100 = \frac{4}{16} \times 100 = 25\%$

$Z = 2A + B = 2 \times 6 + 4 = 16$

$Z_n = Z_{final} \pm \Delta Z = (16 \pm 4)$ an.

QUESTION

If mass of object is measured 5.4 grm then find % error in the measurement of mass. [IIT]

QUESTION

If percentage error in the measurement of momentum is 50% then percentage error in K.E.

QUESTION

If $l_1 = (10 \pm 2)$ cm and $l_2 = (20 \pm 1)$ cm. Find $l = l_1 + l_2$ with error.

QUESTION

Value of A = (10 ± 0.1) m and B = (20 ± 0.5) m then find: absolute error / relative error / % error

(i) $x = B + A$

(ii) $y = B - A$

(iii) $z = B . A$

(iv) $m = B/A$

Sol^n $x = B + A = 20 + 10 = 30$

$\Delta x = \Delta B + \Delta A$

$\Delta x = 0.5 + 0.1$

$\Delta x = 0.6$

$$\left[\frac{\Delta x}{x} = \frac{0.6}{30}\right]$$

(ii) $y = B - A = 20 - 10 = 10$

$\Delta y = \Delta B + \Delta A = 0.6$

$$\frac{\Delta y}{y} = \frac{0.6}{10}$$

(iii) $z = B \cdot A = 20 \times 10$

$$\left(\frac{\Delta z}{z}\right) = \frac{\Delta B}{B} + \frac{\Delta A}{A}$$

$$\left(\frac{\Delta z}{z}\right) = \left(\frac{0.5}{20} + \frac{0.1}{10}\right)$$

$$\Delta z = z\left(\frac{0.5}{20} + \frac{0.1}{10}\right)$$

$$= 200\left(\frac{0.5}{20} + \frac{0.1}{10}\right)$$

$$m = \frac{B}{A}$$

$$m = \frac{20}{10} = 2$$

$$\left(\frac{\Delta m}{m}\right) = \left(\frac{\Delta B}{B}\right) + \left(\frac{\Delta A}{A}\right)$$

QUESTION

A public park, in the form of a square, has an area of $(100 \pm 0.2)\ m^2$. The side of park is



1. (10 ± 0.01) m
2. (10 ± 0.1)m
3. (10 ± 0.02) m
4. (10 ± 0.2)m


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YAKEEN 2.0

FOR NEET 2025

Lecture-8 | Physics

Units and Measurements

By- Dr. Manish Raj (MR SIR)



Todays goal.

PhD on. Error

12th in Biology

PhD in physics

QUESTION

In a series of successive measurements in an experiment, the readings of the period of oscillation of a simple pendulum were round to be 2.63s, 2.56s, 2.42s, 2.71s and 2.80s. Calculate

(i) The mean value of the period of oscillation

(ii) The absolute error in each measurement

(iii) The mean absolute error

(iv) The relative error

(v) The percentage error.

$T_{mean} = T_{true} = \left[\frac{2.63+2.56+2.42+2.71+2.80}{5}\right]$ ← infinite s.f

$= \frac{13.12}{5} = 2.624$

$T_0 = 2.62s$

$\Delta T_1 = |T_0 - T_1|$

$= |2.62 - 2.63|$

$\Delta T_1 = 0.01$

$\Delta T_2 = |2.62 - 2.56| = 0.06$

$\Delta T_3 = 0.20$ $\quad \Delta T_5 = |2.62 - 2.80| = 0.18$

$\Delta T_4 = 0.09$

$\Delta T_{mean} = \frac{0.01 + 0.06 + 0.20 + 0.09 + 0.18}{5}$

mean absolute $\Rightarrow \frac{\Delta T_{mean}}{T_0} = \left[\frac{0.11}{2.62}\right] = \frac{0.54}{5} \approx 0.108 \approx 0.11$

$= \frac{\Delta T_{mean}}{T_0} \times 100$

QUESTION

Value of A = (10 ± 0.1) m and B = (20 ± 0.5) m then find:

(i) $x = B + A$ (ii) $y = B - A$

(iii) $z = B . A$ (iv) $m = B/A$

Soln $x = B + A = 20 + 10 = 30$

$\Delta x = \Delta B + \Delta A = 0.5 + 0.1 = 0.6$

Final value of $x = (30 \pm 0.6)\,m$

(iv) $m = \frac{B}{A} = \frac{20}{10} = 2$

$\frac{\Delta m}{m} = \frac{\Delta B}{B} + \frac{\Delta A}{A}$

$= \frac{0.5}{20} + \frac{0.1}{10} = \frac{5}{200} + \frac{1}{100}$

$= \frac{1}{40} + \frac{1}{100} = \frac{5+2}{200}$

$\frac{\Delta m}{m} = \left(\frac{7}{200}\right)$

$\Delta m = m\left(\frac{7}{200}\right)$

$= \frac{2 \times 7}{200}$

$= \left(\frac{7}{100}\right)$

(Q) If Temprature $T_1 = (340K \pm 5K)$ and $T_2 = (300K \pm 10K)$ find error in Temprature difference ??

(a) 50K ✗ (b) 40K (c) 15K ✓ (d) 5K ✓

Solⁿ Error in (Tempʳ difference ??)

$T' = T_1 - T_2$

$(\Delta T') = \Delta T_1 + \Delta T_2$ ✓

$= 5K + 10K = 15K$

Which Type error ??

- absolute error
- relative error
- % error

$$Z = A + B$$

find % error in Z ??

Soln → MR*

$$(\Delta Z = \Delta A + \Delta B)$$

% error in 'Z'

$$\Rightarrow \left(\frac{\Delta Z}{Z}\right) = \left(\frac{\Delta A + \Delta B}{A + B}\right)$$

$$\frac{\Delta Z}{Z} \times 100 = \left(\frac{\Delta A + \Delta B}{A + B} \times 100\right)$$

AR

$Z = \frac{A}{B}$ ✓

find absolute error in 'Z'

Soln. MR*

$$\left\{\frac{\Delta Z}{Z} = \frac{\Delta A}{A} + \frac{\Delta B}{B}\right\}$$

$$\Delta Z = Z\left(\frac{\Delta A}{A} + \frac{\Delta B}{B}\right)$$

$$(\Delta Z) = \frac{A}{B}\left(\frac{\Delta A}{A} + \frac{\Delta B}{B}\right)$$

absolute error in Z

QUESTION

A public park, in the form of a square, has an area of $(100 \pm 0.2)\ m^2$. The side of park is

1. (10 ± 0.01) m
2. (10 ± 0.1)m
3. (10 ± 0.02) m
4. (10 ± 0.2)m

$$l = 2\pi r^2$$

$$\frac{\Delta l}{l} = \frac{2\Delta r}{r}$$

$$A = l^2$$

$$\Delta A = (\Delta l)^2 \quad ✗$$

$$\Delta A = 2\Delta l \quad ✗$$

$$\frac{\Delta A}{A} = 2\frac{\Delta l}{l} \quad ✓$$

"$Z = \frac{4 A^{1/2}\sqrt{B}}{(C)^{1/3} D}$" "find % error in Z"

Sol^n

$$100 \times \frac{\Delta Z}{Z} = \left[\frac{1}{2}\frac{\Delta A}{A} + \frac{1}{2}\frac{\Delta B}{B} + \frac{1}{3}\frac{\Delta C}{C} + \frac{\Delta D}{D}\right] \times 100$$

QUESTION

In an experiment four quantities a, b, c and d are measured with percentage error 1%, 2%, 3% and 4% respectively. Quantity P is calculate as follows: $P = \frac{a^3 b^2}{cd}$, % error in P is

1. 10%
2. 7%
3. 4%
4. 14%

$$P = \frac{a^3 b^2}{cd} = a^3 b^2 c^{-1} d^{-1}$$

$$\frac{\Delta P}{P} = \left(3\frac{\Delta a}{a} + 2\frac{\Delta b}{b} + \frac{\Delta c}{c} + \frac{\Delta d}{d}\right) \times 100$$

$$= 3[1] + 2(2) + 3 + 4$$

$$= 3 + 4 + 7 = 14\%$$

QUESTION

A physical quantity is represented by $X = [M^a L^b T^{-c}]$. If percentage error in the measurement of M, L and T are $\alpha\%$, $\beta\%$ and $\gamma\%$ respectively, then maximum percentage error in measurement of X should be (Given that α, β and γ are very small)

1. $(\alpha a - \beta b + \gamma c)\%$
2. $(\alpha a + \beta b + \gamma c)\%$
3. $(\alpha a - \beta b - \gamma c)\%$
4. $(\alpha a + \beta b - \gamma c)\%$

QUESTION

The acceleration due to gravity is measured on the surface of earth by using a simple pendulum. If α and β are relative errors in the measurement of length and time period respectively, then percentage error in the measurement of acceleration due to gravity is

1. $\left(\alpha + \frac{1}{2}\beta\right)$ 15%
2. $(\alpha - 2\beta)$
3. $(2\alpha + \beta) \times 100$ (12%)
4. $(\alpha + 2\beta) \times 100$ ✓ 70%

$\frac{\Delta L}{L} = \alpha$

$\frac{\Delta T}{T} = \beta$

$\frac{\Delta g}{g} = ??$

$T = 2\pi\sqrt{\frac{l}{g}}$

$T^2 = \frac{l}{g}$

$g = \left(\frac{l}{T^2}\right)$

$\left[\frac{\Delta g}{g} = \left(\frac{\Delta l}{l}\right) + 2\frac{\Delta T}{T}\right]$

$100\left(\frac{\Delta g}{g}\right) = 100\left(\frac{\Delta l}{l} + 2\frac{\Delta T}{T}\right)$

$= 100(\alpha + 2\beta)$

The Temprature of two bodies measured are $\theta_1 = 10°C \pm 0.4°C$ and $\theta_2 = 40°C \pm 0.3°C$ find the sum and difference (change) in temprature with error limit.

$\theta_1 = 10°C$

$\Delta\theta_1 = 0.4°C$

$\theta_2 = 40°C$

$\Delta\theta_2 = 0.3°C$

(i) Sum of Temp $= \theta_1 + \theta_2$

$= 50°C$

absolute error $= \Delta\theta_1 + \Delta\theta_2$

$= 0.4 + 0.3$

$= 0.7°C$

Sum of Temp $= (50 \pm 0.7)°C$

(ii) θ' (diffn in Temp) (change in Temp) $= \theta_2 - \theta_1$

$= 40 - 10$

$= 30°C$

$\Delta\theta' = \Delta\theta_2 + \Delta\theta_1 = 0.7$

$= (30°C \pm 0.7°C)$

$= (30 \pm 0.7)°C$

The resistance of a Conductor $R = V/I$ where $V = (50 \pm 2)$ volt and $I = (9 \pm 0.3)$ Amp, find Percentage error in R. also find absolute error in R.

Soln

$$R = \frac{V}{I}$$

$$100 \times \frac{\Delta R}{R} = \left[\frac{\Delta V}{V} + \frac{\Delta I}{I}\right] \times 100$$

$$(\% \text{ error in } R) = \left(\frac{2}{50} + \frac{0.3}{9}\right) \times 100$$

$$= 4 + \frac{3}{90} \times 100 \quad (3.3)$$

$$= 7.3\%$$

Soln "$R = \frac{V}{I}$" $= \left(\frac{50}{9}\right)$

$$\frac{\Delta R}{R} = \frac{\Delta V}{V} + \frac{\Delta I}{I}$$

$$\Delta R = R\left(\frac{\Delta V}{V} + \frac{\Delta I}{I}\right)$$

$$\Delta R = \frac{50}{9}\left(\frac{2}{50} + \frac{0.3}{9}\right)$$

$$= \frac{50}{9}\left(\frac{1}{25} + \frac{1}{30}\right)$$

$$= \frac{50}{9}\left(\frac{6+5}{150}\right) = \frac{11}{27}$$

If Percentage error in speed and mass are 1% and 2% then find % error in K.E.

(speed) (mass)

Sol^n

$$K.E = \frac{1}{2} m v^2$$

(1/2: const^n)

$$100 \times \frac{\Delta K.E}{K.E} = \left[\left(\frac{\Delta m}{m}\right) + 2\left(\frac{\Delta v}{v}\right)\right] \times 100$$

$$= 2 + 2 \times 1$$

$$= 4\%$$

Find Percentage error in length of simple Pendulum if % error in in time is 4% and acceleration due to gravity is 2%.

Sol^n

$$T = 2\pi\sqrt{l/g}$$

$$T^2 = \frac{l}{g}$$

$$l = T^2 g$$

$$\left(100\,\frac{\Delta l}{l}\right) = \left(2\frac{\Delta T}{T} + \frac{\Delta g}{g}\right)100 = 10\%$$

QUESTION

The radius of a sphere is (5.3 ± 0.1) cm. The percentage error in its volume is

(1) $\frac{0.1}{5.3} \times 100$

(2) $3 \times \frac{0.1}{5.3} \times 100$

(3) $\frac{3}{2} \times \frac{0.1}{5.3} \times 100$

(4) $6 \times \frac{0.1}{0.3} \times 100$

$r = 5.3$ cm

$\Delta r = 0.1$ cm

$V = \frac{4}{3}\pi r^3$

$100 \times \frac{\Delta V}{V} = 3 \frac{\Delta r}{r} \times 100$

$= \left[3 \times \frac{0.1}{5.3} \times 100\right]$

QUESTION

If the error in the measurement of radius of a sphere is 2%, then the error in the determination of volume of the sphere will be:

1. 2%
2. 4%
3. 6%
4. 8%

$V = \frac{4}{3}\pi r^3$

$\frac{\Delta r}{r} \times 100 = 2\%$

$100 \times \frac{\Delta V}{V} = 3\left(\frac{\Delta r}{r} \times 100\right)$

$= 3 \times 2 = 6\%$

QUESTION

A force F is applied on a square area of side L. If the percentage error in the measurement of L is 2% and that in F is 4%, what is the maximum percentage error in pressure?

1. 2%
2. 4%
3. 6%
4. 8%

$$P = \frac{F}{L^2}$$

$$\frac{\Delta P}{P} = \left(\frac{\Delta F}{F} + 2\frac{\Delta L}{L}\right)100$$

$$= 4\% + 2 \times 2$$

QUESTION

The least count of a stop watch is 1/5 second. The time of 20 oscillations of a pendulum is measured to be 25 seconds. The maximum percentage error in the measurement of time will be

(1) 0.1%

(2) 0.8%

(3) 1.8%

(4) 8%

$\Delta T = \frac{1}{5}$ sec

$T = 25$ sec

$\frac{\Delta T}{T} \times 100 = \frac{1}{5 \times 25} \times 100 = \frac{4}{5} = 0.8$

IIT Adv-2016 → Time Period of Simple Pendulum $T = 2\pi\sqrt{l/g}$, l is about 100 cm and is known to have 1mm accuracy, Time period is 2s. The time of 100 oscillation measured by stop watch of L.C. 0.1 s. Percentage error in g.

Sol^n

$l = 100\,cm = 1\,m$

$\Delta l = 1\,mm = 10^{-3}\,m$

$T = 2\,sec$

$\Delta T = 0.1\,sec$

$T = 2\pi\sqrt{\frac{l}{g}}$

$T^2 = \frac{l}{g}$

$g = \frac{l}{T^2}$

$$\frac{\Delta g}{g} \times 100 = \frac{\Delta l}{l} \times 100 + 2\frac{\Delta T}{T} \times 100$$

$$= \frac{10^{-3}\,m \times 100}{1\,m} + 2\,\frac{0.1\,s}{2\,s} \times 100$$

$$= 0.1 + 10$$

$$= 10.1\,\%$$

QUESTION

If the percentage error in the measurement of momentum and mass of an object are 2% and 3% respectively, then maximum percentage error in the calculate value of its kinetic energy is

1. 2%
2. 1%
3. 5%
4. 7%

$$K.E = \frac{p^2}{2m}$$

$$\frac{\Delta K.E}{K.E} = 2\left(\frac{\Delta p}{p}\right) + \frac{\Delta m}{m}$$

$$= 2 \times 2 + 3$$

If error in Measurment of speed is 50% then find % error in kinetic energy.

Sol^n → we will not use conversional Method of error analysis

% error in speed = 50%

Let speed is v

$v_m = v + 50\% v = v + \frac{50}{100} v = \frac{3v}{2} = v_m$

measured speed

$\% \text{ error in } K.E = \frac{K.E_f - K.E_i}{K.E_i} \times 100$

- $K.E_i = \frac{1}{2} m v^2 \propto v^2$ (const)
- $K.E_i = Kv^2$
- $K.E_f = K v_f^2 = K\left(\frac{3v}{2}\right)^2 = \frac{9}{4} K v^2$

$= \left(\frac{\frac{9}{4}Kv^2 - Kv^2}{Kv^2}\right) 100$

$= \left(\frac{9}{4} - 1\right) \times 100$

$= \frac{5}{4} \times 100 = 125\%$

If % error in speed is 40% then find % error in K.E.

Soln {If speed of object is Increase by 40% then find percentage change in Kinetic enegy}

v (real speed) $= v$

v_m (measured speed) $= v + 40\% \, v$

$= v + \frac{40}{100} v$

$= v + \frac{2}{5} v = \frac{7v}{5}$

$K.E_i = \frac{1}{2} m v_i^2$

$K.E_f = \frac{1}{2} m \left(\frac{7v}{5}\right)^2 = \frac{1}{2} m \frac{49 v^2}{25}$

$\% \text{ error} = \frac{K.E_f - K.E_i}{K.E_i} \times 100$

$= \left[\frac{\frac{49}{25}K - K}{K}\right] \times 100$

$= \frac{49-25}{25} \times 100$

$= 24 \times 4$

$= 96\%$

QUESTION

A rectangular plate has length (2 + 0.02) cm and width (1 ± 0.01) cm. The maximum percentage error in the measurement of its area is

1. 1%
2. 2% ✓
3. 3%
4. 5%



$$A = l \times b$$

$$100 \times \frac{\Delta A}{A} = \left(\frac{\Delta l}{l} + \frac{\Delta b}{b}\right) \times 100$$

$$= \left(\frac{0.02}{2} + \frac{0.01}{1}\right) \times 100$$

QUESTION

If error in measuring diameter of a circle is 4%, the error in circumference of the circle would be:

1. 2%
2. 8%
3. 4%
4. 1%

$S = 2\pi R$

$S = \pi D$

QUESTION

$y = \sin\theta$ find percentage error in y if percentage error in θ is 2% at $\theta = \pi/6$ rad.

Sol^n

$y = \sin\theta$

(diff^n w.r.t 'θ')

$\frac{dy}{d\theta} = \frac{d\sin\theta}{d\theta} = \cos\theta$

$dy = \cos\theta\, d\theta$ — (1)

$\theta = \frac{\pi}{6}$ rad — 30°

$\frac{\Delta\theta}{\theta}\times 100 = 2\%$

$\frac{\Delta y}{y}\times 100 = ??$

% error in $y = \frac{dy}{y}\times 100 = \frac{\cos\theta}{\sin\theta}d\theta \times 100 = \cot\theta \frac{d\theta}{\theta}\times 100 \times \theta = 2\times\cot 30^\circ \times \frac{\pi}{6} = \frac{\pi}{3}\sqrt{3} = \frac{\pi}{\sqrt{3}}\%$

$y = \sin\theta \Rightarrow y = \sin 30^\circ \rightarrow y = \frac{1}{2} \rightarrow 0$

$$\left.\frac{dy}{d\theta}\right|_{\theta=30}$$

If $Y = m\tan\theta$, where m is constant then find Angle at which % error in 'Y' will be minimum.

Soln

$Y = m\tan\theta$ ✓

(diff w.r.t θ)

$$\frac{dY}{d\theta} = m\sec^2\theta \quad \text{--- (1)}$$

$$\frac{dY}{Y}\times 100 = \frac{m\sec^2\theta\, d\theta}{m\tan\theta}\times 100 = \frac{\frac{1}{\cos^2\theta}}{\frac{\sin\theta}{\cos\theta}}\, d\theta \times 100$$

Not for all

$$\frac{dY}{Y}100 = \frac{2\,d\theta\times 100}{2\sin\theta\cdot\cos\theta}$$

$$\underbrace{\frac{dY}{Y}\times 100}_{\text{min}} = \left[\frac{2\,d\theta\times 100}{\underbrace{\sin(2\theta)}_{\text{max}}}\right]_{\text{min}}$$

$2\theta = 90^\circ$

$\theta = 45^\circ$ Ans

Series combin

$$R = R_1 + R_2$$

$$\Delta R = \Delta R_1 + \Delta R_2$$

$$\frac{\Delta R}{R} = \frac{\Delta R_1 + \Delta R_2}{R_1 + R_2}$$

Parallel comb

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$-\frac{1}{R^2}\frac{dR}{dt} = -\frac{1}{R_1^2}\frac{dR_1}{dt} - \frac{1}{R_2^2}\frac{dR_2}{dt}$$

$$\boxed{\frac{dR}{R^2} = \frac{dR_1}{R_1^2} + \frac{dR_2}{R_2^2}}$$

$$\frac{d\left(\frac{1}{x}\right)}{dx} = -\frac{1}{x^2}$$

next class ?

We will discuss in next class

Two wire of Resistance $R_1 = (50 \pm 2)\,\Omega$ and $R_2 = (100 \pm 4)\,\Omega$ find equivalent capacitance in (a) Series (b) Parallel with absolute error.

H/W


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 8 (Part 02) Physics

Units and Measurements

By- Dr. Manish Raj (MR SIR)



Topics to be covered

1. PHD On Error Part-2
2. Questions on Error and Instrument
3.
4.



Q) $y = \frac{1}{x}$ find $\frac{dy}{dx}$ and $\frac{dy}{dt}$

$$\frac{dy}{dx} = \frac{d\left(\frac{1}{x}\right)}{dx} = \frac{dx^{-1}}{dx}$$

$$= -1\, x^{-1-1}$$

$$= -1\, x^{-2}$$

$$= -\frac{1}{x^2}$$

$$\frac{dy}{dt} = \frac{d\left(\frac{1}{x}\right)}{dt} \times \frac{dx}{dx} = \frac{d(1/x)}{dx} \times \frac{dx}{dt}$$

$$\frac{dy}{dt} = -\frac{1}{x^2}\frac{dx}{dt}$$

Series Resistance

$$R_{eq} = R_1 + R_2$$

$$\Delta R_{eq} = \Delta R_1 + \Delta R_2$$

$$\left(\frac{\Delta R_{eq}}{R_{eq}}\right) = \frac{\Delta R_1 + \Delta R_2}{R_1 + R_2}$$

$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} \rightarrow \text{Series}$$

$$\frac{1}{F} = \frac{1}{u} + \frac{1}{v}$$

Parallel Comb^n.

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$\frac{d\left(\frac{1}{x}\right)}{dt} =$$

differenation both side w.r.t 't'

$$-\frac{1}{R_{eq}^2}\frac{dR_{eq}}{dt} = -\frac{1}{R_1^2}\frac{dR_1}{dt} - \frac{1}{R_2^2}\frac{dR_2}{dt}$$

$$\frac{dR_{eq}}{R_{eq}^2} = \frac{(dR_1)}{R_1^2} + \frac{(dR_2)}{R_2^2}$$

\# $$(dR_{eq}) = R_{eq}^2\left(\frac{dR_1}{R_1^2} + \frac{dR_2}{R_2^2}\right)$$

$$100 \times \left(\frac{dR_{eq}}{R_{eq}}\right) = R_{eq}\left(\frac{dR_1}{R_1^2} + \frac{dR_2}{R_2^2}\right) \times 100$$

Two wire of Resistance $R_1 = (50 \pm 2)\,\Omega$ and $R_2 = (100 \pm 4)\,\Omega$ find equivalent Resistance ~~capacitance~~ in (a) Series (b) Parallel with absolute error.

Soln (i) Series

$R_{eq} = R_1 + R_2 = 100 + 50 = 150\,\Omega$

$\Delta R_{eq} = \Delta R_1 + \Delta R_2 = 6\,\Omega$

$(R_{eq})_{f} = (150 \pm 6)\,\Omega$

% err in $R_{eq} = \frac{\Delta R_{eq}}{R_{eq}} \times 100 = \frac{6}{150} \times 100 = 4\%$

(ii) Parallel

$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}$ ⇒

$\frac{1}{R_{eq}} = \frac{1}{100} + \frac{1}{50} = \frac{2+1}{100} = \frac{3}{100}$

$R_{eq} = \frac{100}{3}\,\Omega$

$\Delta R_{eq} = R_{eq}^2 \left(\frac{\Delta R_1}{R_1^2} + \frac{\Delta R_2}{R_2^2} \right)$

$(\Delta R_{eq}) = \frac{100 \times 100}{9} \left[\frac{2}{(50 \times 50)} + \frac{4}{(100 \times 100)} \right]$

$= \frac{100 \times 100 \times 2}{9 \times 50 \times 50} + \frac{4}{9}$

$= \frac{8}{9} + \frac{4}{9} = \frac{12}{9}\,\Omega$

% err

$\left[\frac{\Delta R_{eq}}{R_{eq}} \times 100 \right] = \frac{12}{9 \times \frac{100}{3}} \times 100 = 4\%$

Concept

R

ΔR

$\frac{\Delta R}{R}$

$\frac{\Delta R}{R} \times 100$

Series comb^n

$R_{eq} = R_1 + R_2$

$R_{eq} = \Delta R_1 + \Delta R_2$

$$\frac{\Delta R_{eq}}{R_{eq}} \times 100 = \frac{\Delta R_1 + \Delta R_2}{R_1 + R_2} \times 100$$

Parallel comb^n

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$-\frac{1}{R_{eq}^2}\frac{dR_{eq}}{dt} = -\frac{1}{R_1^2}\frac{dR_1}{dt} + \left(-\frac{1}{R_2^2}\frac{dR_2}{dt}\right)$$

$$\frac{dR_{eq}}{R_{eq}^2} = \frac{dR_1}{R_1^2} + \frac{dR_2}{R_2^2}$$

$$100 \times \left(\frac{\Delta R_{eq}}{R_{eq}}\right) = R_{eq}\left(\frac{dR_1}{R_1^2} + \frac{dR_2}{R_2^2}\right)$$

QUESTION

Two resistance $R_1 = (20\Omega + 2\Omega)$ and $R_2 = (5 \pm 1\Omega)$ are connected in parallel then find % and absolute error.

$$\frac{\Delta R_{eq}}{R_{eq}^2} = \frac{\Delta R_1}{R_1^2} + \frac{\Delta R_2}{R_2^2}$$

$$\Delta R_{eq} = R_{eq}^2\left(\frac{\Delta R_1}{R_1^2} + \frac{\Delta R_2}{R_2^2}\right)$$

Method → 2 (optional)

$$\Rightarrow \frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$\frac{1}{R_{eq}} = \frac{R_1 + R_2}{R_1 R_2}$$

$$R_{eq} = \frac{R_1 R_2}{(R_1 + R_2)}$$

→ Let ($Z = R_1 + R_2$) ✓

$$(\Delta Z) = \Delta R_1 + \Delta R_2$$

$$R_{eq} = \left(\frac{R_1 R_2}{Z}\right)$$

$$\frac{\Delta R_{eq}}{R_{eq}} = \frac{\Delta R_1}{R_1} + \frac{\Delta R_2}{R_2} + \frac{\Delta Z}{Z}$$

*MR Problem (MR Star ques)

If $Y = \frac{A}{A+B}$ then find % error in Y in A = (10 ± 2m) and B = (20 ± 2) m.

Sol^n $Y = \frac{A}{(A+B)}$

$Y = \frac{A}{Z}$

Let (माना)

$Z = A + B = 10 + 20 = 30$

$\Delta Z = \Delta A + \Delta B$

$\frac{\Delta Y}{Y} = \frac{\Delta A}{A} + \frac{\Delta Z}{Z}$

$100\frac{\Delta Y}{Y} = \frac{\Delta A}{A} \times 100 + \frac{\Delta Z}{Z} \times 100$

$= \frac{2}{10} \times 100 + \frac{4}{30} \times 100 = (20) + \left(\frac{40}{3}\right) = \frac{100}{3} = 33.3\%$

Instrument

Parally method

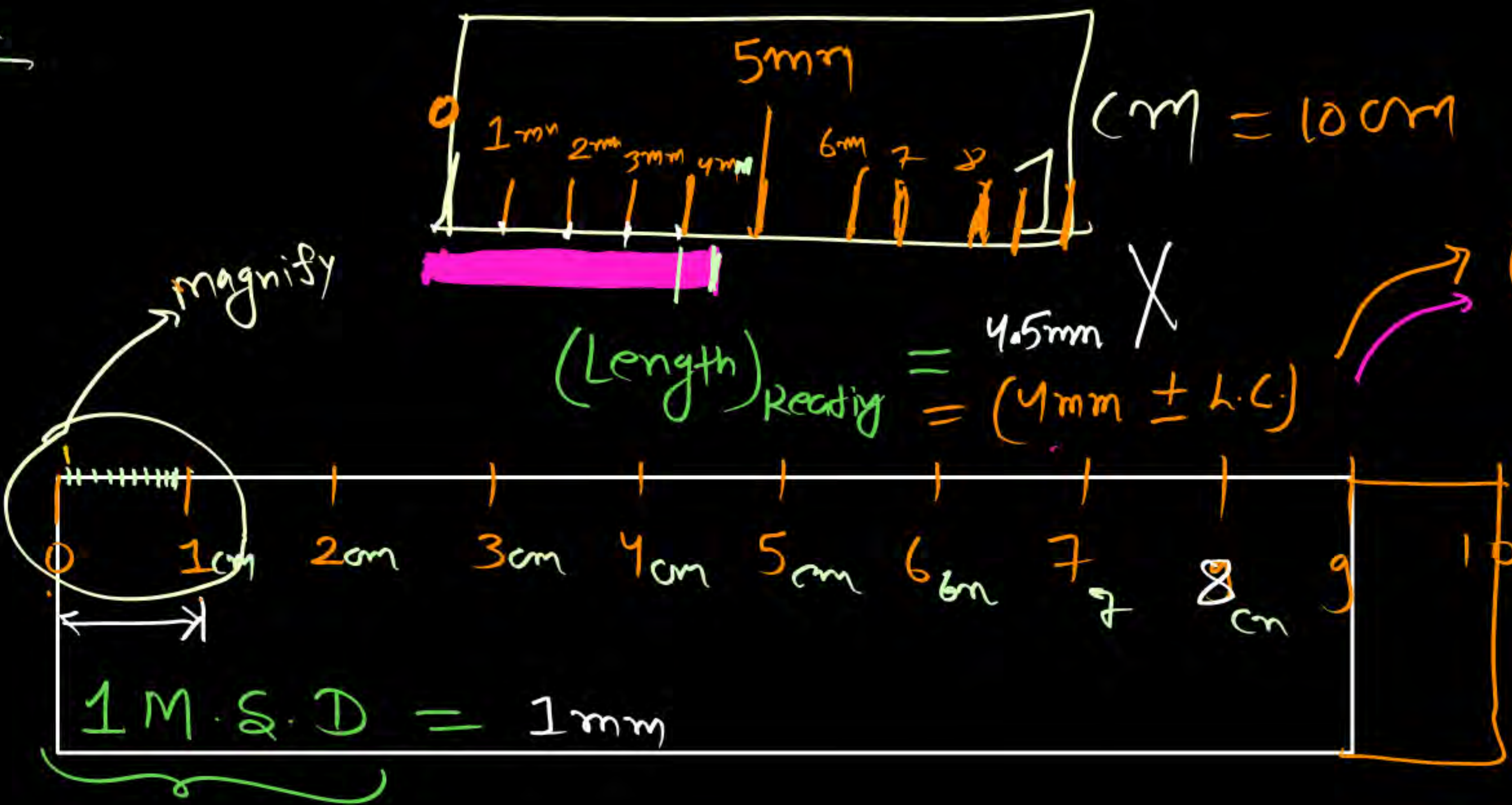
Measuring Instrument:-

1) metre scale

2) vernier Calliper

3) screw gauge

metre scale



cm = 10 cm

(Length)$_{Reading}$ = 4.5mm ✗

= (4mm ± L.C)

final reading

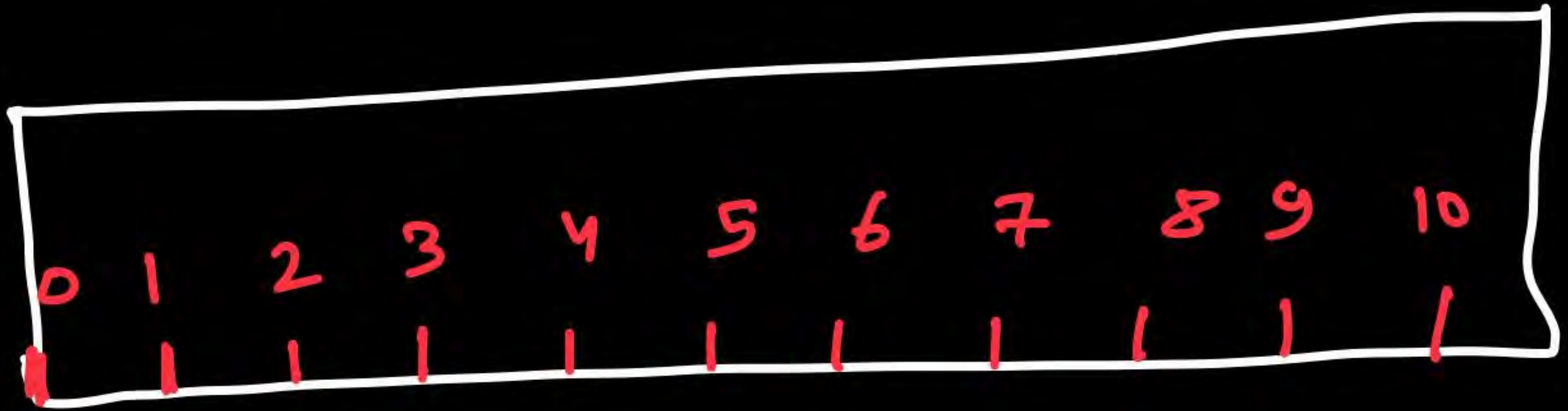
(4mm ± 1mm) Ans

1 Metre Scale division = 1mm

(Minimum reading that can be tanken from Instrument is = **1mm = L.C.** (Least-count)

or, (Max^m absolute error can be Performed by Instrument)

Least Count (Vernier Constant) = minimum Reading that can be taken by the instrument.



1) main scale division is 1 cm and 9 M.S.D coinside with 4 V.S.D then find L.C.

1) main scale division is 2 mm and 18 M.S.D coinside with 10 V.S.D then find L.C.


THANK YOU

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FOR NEET 2025

Lecture-9 | Physics

last lecture

You can start from here

Kinematics

80%

Zero

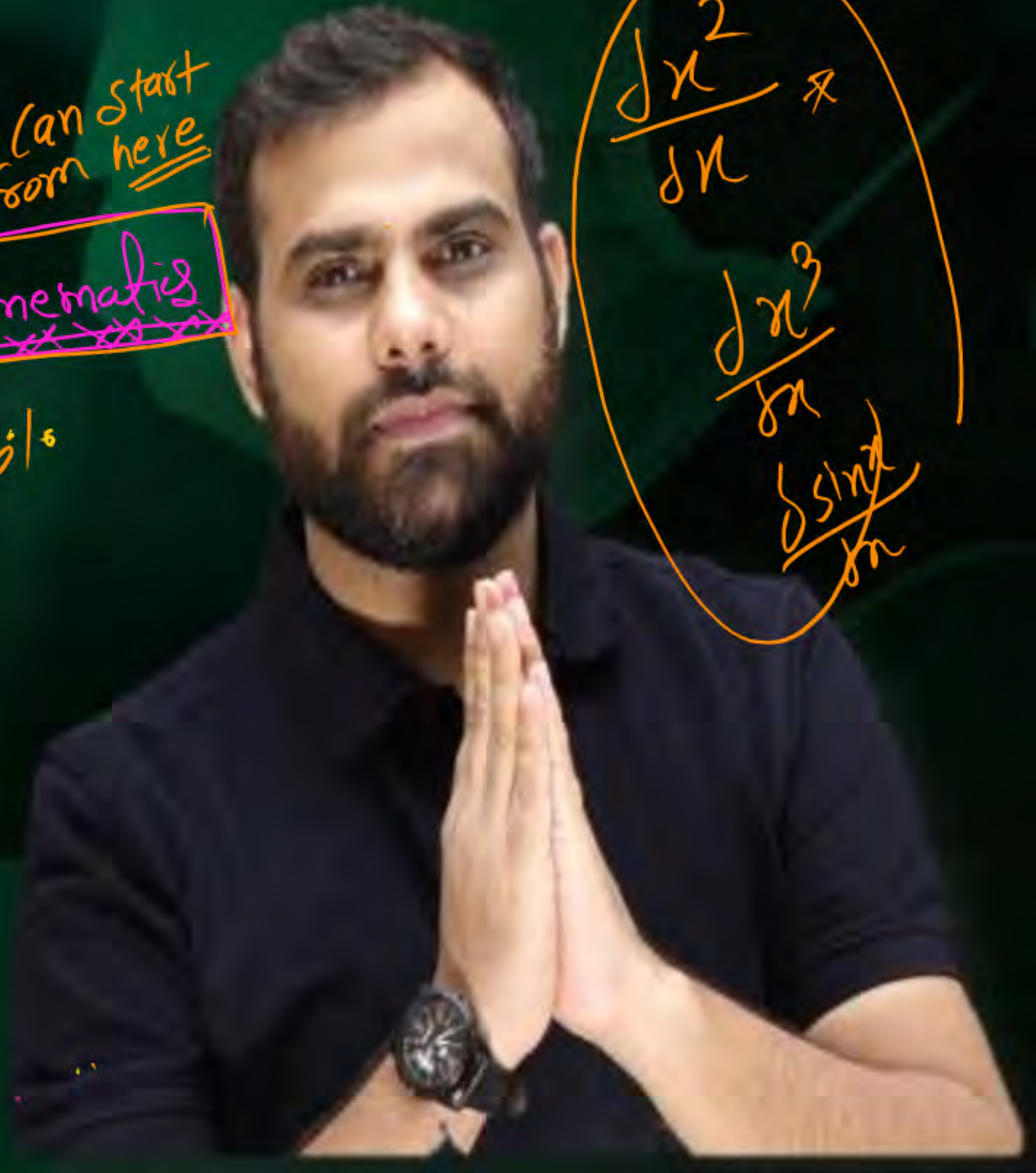
10-20% ekdum zero level

$\frac{dx^2}{dx}$

$\frac{dx^3}{dx}$

$\frac{d\sin x}{dx}$

Units and Measurements



By- Dr. Manish Raj (MR SIR)

Topics to be covered

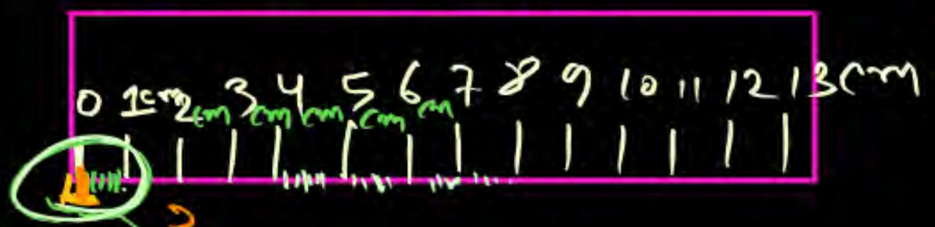
1. # Vernier Caliper
2. # Screw gauge
3. # systematic random error
4. #



metre scale

$1\,m = 100\,cm$
$1\,cm = 10\,mm$

\# metre scale



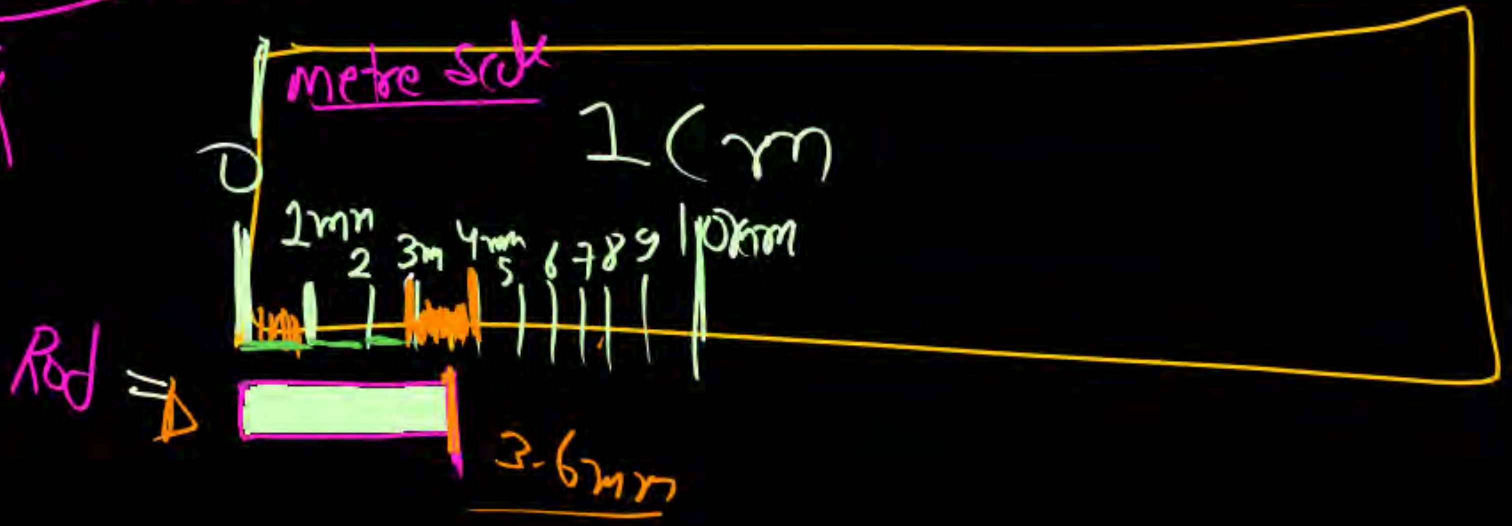
1mm
$1\,cm = 10\,mm$

L.C = minimum reading that can be taken by instrument is called L.C.

Magnifiy

\# $\frac{1\,mm}{10} = 0.1\,mm$

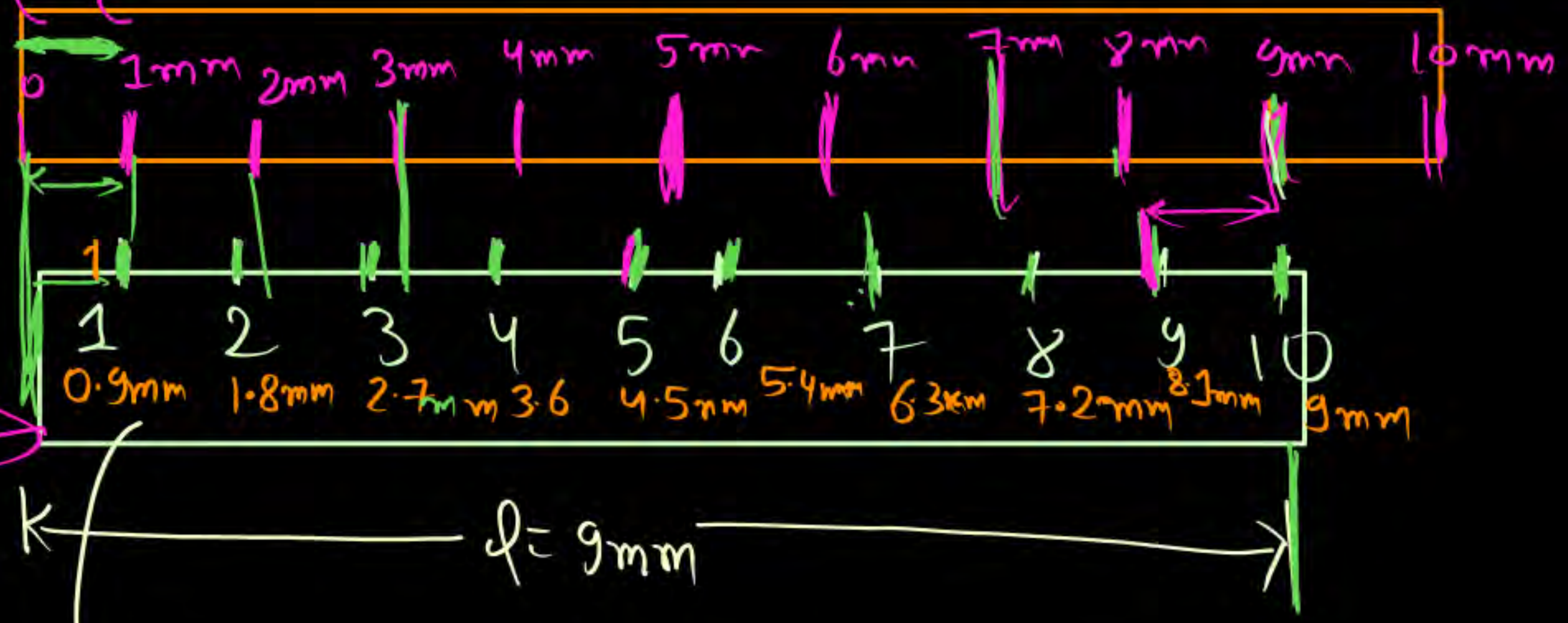
Reading = [$l_{measured\ valu}$ ± L.C]

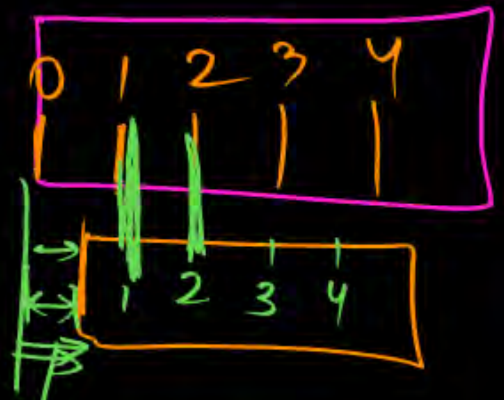


fixed

metre scale (main scale)

1 M.S.D (main scale division) = 1mm





Slide

0.1mm

vernier scale = 10 division = 9mm

$1\ V.S.D = \frac{9mm}{10} = 0.9mm$

$\therefore = 0.9mm$

$L.C = 1\ M.S.D - 1\ V.S.D$

smaller measurement

#

L.C of vernier scale = [1 M.S.D − 1 V.S.D]

L.C = 1mm metre scale ✓

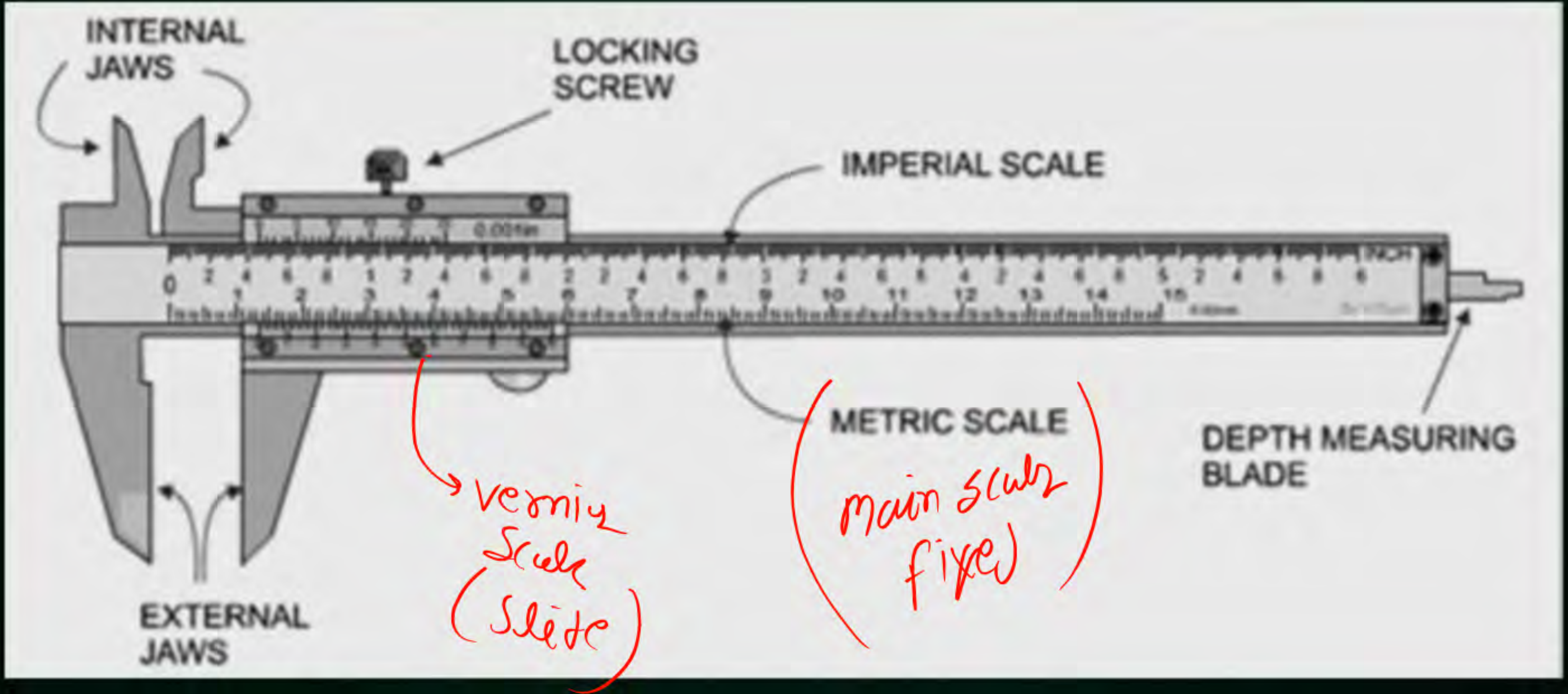
L.C = 0.1mm vernier caliper ✓

0.5mm ✓

0.05mm ✗

DIMENSIONAL FORMULA

Vernier Callipers



*MR Problem

In Vernier calipers 8 M.S.D. is coinside with 10 Vernier scale division then find least count.

$1\ M.S.D = 1\,mm$

$8\ M.S.D = 10\ V.S.D$

$L.C = 1\ M.S.D - 1\ V.S.D$

$= 1\ M.S.D - \left(\frac{8\ M.S.D}{10}\right)$

$= 1\ M.S.D\left[1 - \frac{8}{10}\right]$

$= 1\,mm\left[\frac{2}{10}\right] = 0.2\,mm$

$LC = .1\,mm$ This is better than

$L.C = 0.2\,mm$ (this)

1 M.S.D

or 1 V.S.D

x M.S.D = y V.S.D

given in question

$L.C = 1 M.S.D - 1 V.S.D$

Kite logo ko least count समझ आया??

Yes

NO

QUESTION

Least count of main scale of Vernier caliper is 1 cm and 4 main scale division coinside with 6 Vernier scale division then L.C. of Vernier scale.

* L.C of M.S.D = 1 cm

* 4 M.S.D = 6 V.S.D

$$L.C. = 1\ M.S.D - 1\ V.S.D$$

$$= 1\ M.S.D - \frac{4}{6}\ M.S.D$$

$$= M.S.D\left(1 - \frac{4}{6}\right) = \left(\frac{6-4}{6}\right) 1\,cm = \frac{2}{6}\,cm = \frac{1}{3}\,cm = 0.33\,cm$$

QUESTION

In certain vernier callipers, 25 divisions on the vernier scale have the same length as 24 divisions on the main scale. One division on the main scale is 1 mm long. The least count of the instrument is

1 M.S.D = 1 mm

(1) 0.04 mm

(2) 0.01 mm

(3) 0.02 mm

(4) 0.08 mm

25 V.S.D = 24 M.S.D

L.C = 1 M.S.D − 1 V.S.D

$= 1\text{ M.S.D} - \frac{24}{25}\text{ M.S.D}$

$= 1\text{ M.S.D}\left(\frac{25-24}{25}\right)$

$= 1\text{ mm}\left(\frac{1}{25}\right) = 0.04\text{ mm}$

QUESTION

In a Vernier calliper, one main scale division is x cm and n division of Vernier scale coincide with $(n - 1)$ division of the main scale. The least count of the Vernier caliper in cm is:

1. $\left(\frac{n-1}{n}\right)x$
2. $\frac{nx}{(n-1)}$
3. $\frac{x}{n}$ cm ✓
4. $\frac{x}{n-1}$

$1\ M.S.D = x\ cm$ ✓

$n\ V.S.D = n-1\ M.S.D$ ✓

$L.C = 1\ M.S.D - 1\ V.S.D$

$= 1\ M.S.D - \frac{n-1}{n}\ M.S.D$

$= 1\ M.S.D\left(1 - \frac{(n-1)}{n}\right) = x\ cm\left(\frac{n - n + 1}{n}\right) = \frac{x}{n}\ cm$

QUESTION

has n division per cm

The main scale of a Vernier callipers has n divisions/cm. n divisions of the Vernier scale coincide with $(n - 1)$ divisions of main scale. The least count of the Vernier callipers is

1. $\frac{1}{(n+1)(n-1)}$ cm
2. $\frac{1}{n}$ cm
3. $\frac{1}{n^2}$ cm ✓
4. $\frac{1}{n(n+1)}$ cm

$1\ cm = n$ division of main scale

$1\ M.S.D = \frac{1\ cm}{n}$

$n\ V.S.D = n-1\ M.S.D$

$L.C = 1\ M.S.D - 1\ V.S.D$

$= 1\ M.S.D - \frac{(n-1)}{n} M.S.D = \left[\frac{n - n + 1}{n}\right] \frac{1\ cm}{n} = \frac{1\ cm}{n^2}$

*MR Problem

One cm on the main scale of vernier callipers is divided into ten equal parts. If 20 divisions of vernier scale coincide with 8 small divisions of the main scale. What will be the least count of callipers ?

$1\,cm = 10\,M.S.D$

$1\,M.S.D = \frac{1\,cm}{10} = 0.1\,cm = 1\,mm$

$20\,V.S.D = 8\,M.V.D$

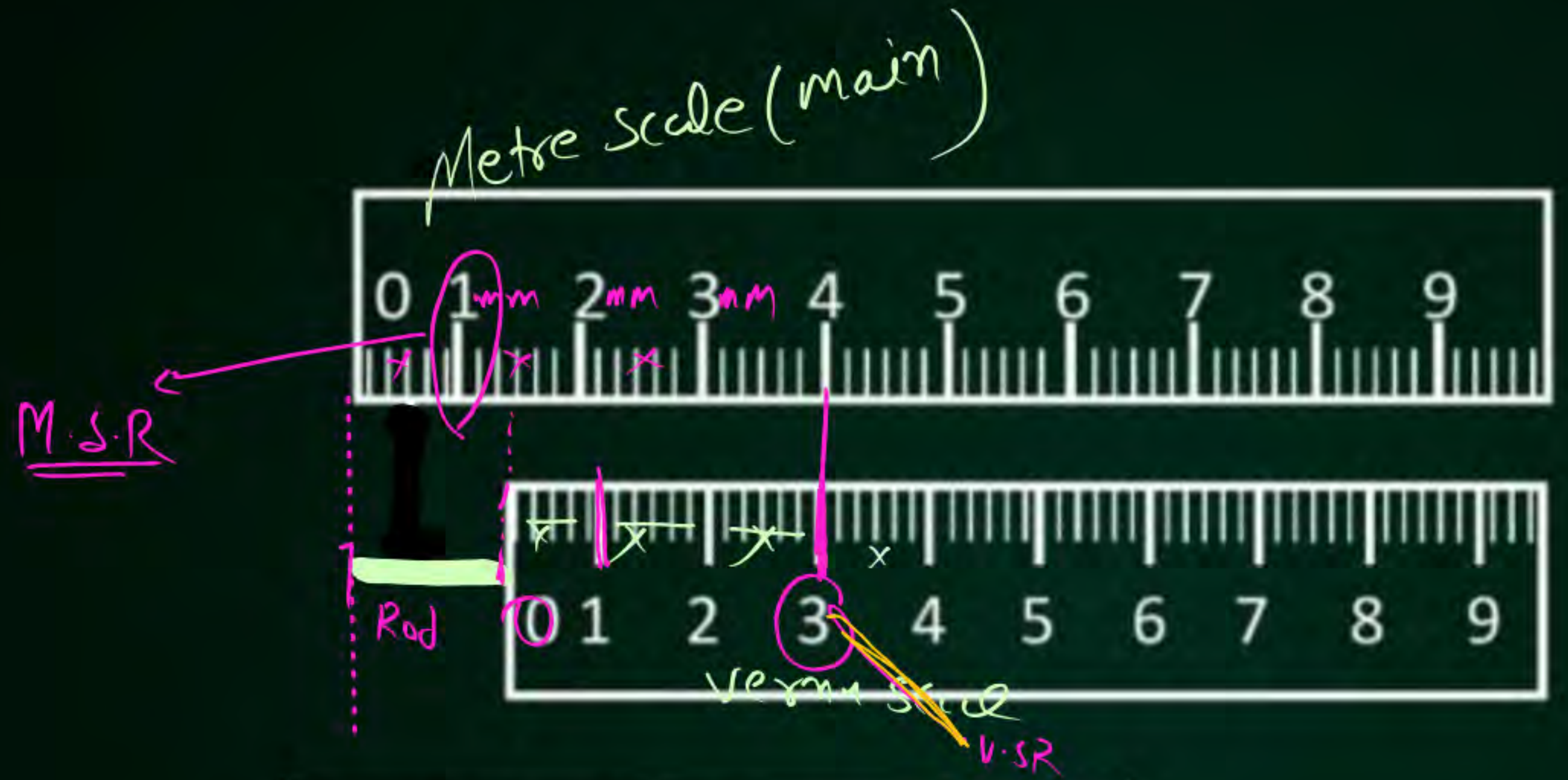
$L.C = 1\,M.S.D - 1\,V.S.D$

$= 1\,M.S.D - \frac{8}{20}\,M.S.D$

$= 1\,mm\left(\frac{20-8}{20}\right) = \frac{12}{20}\,mm$

Reading taken from Vernier callipers

$$\text{Reading} = [M.S.R + V.S.R(L.C)]$$



Length of Rod =

$= M.S.R + L.C\,(V.S.R)$

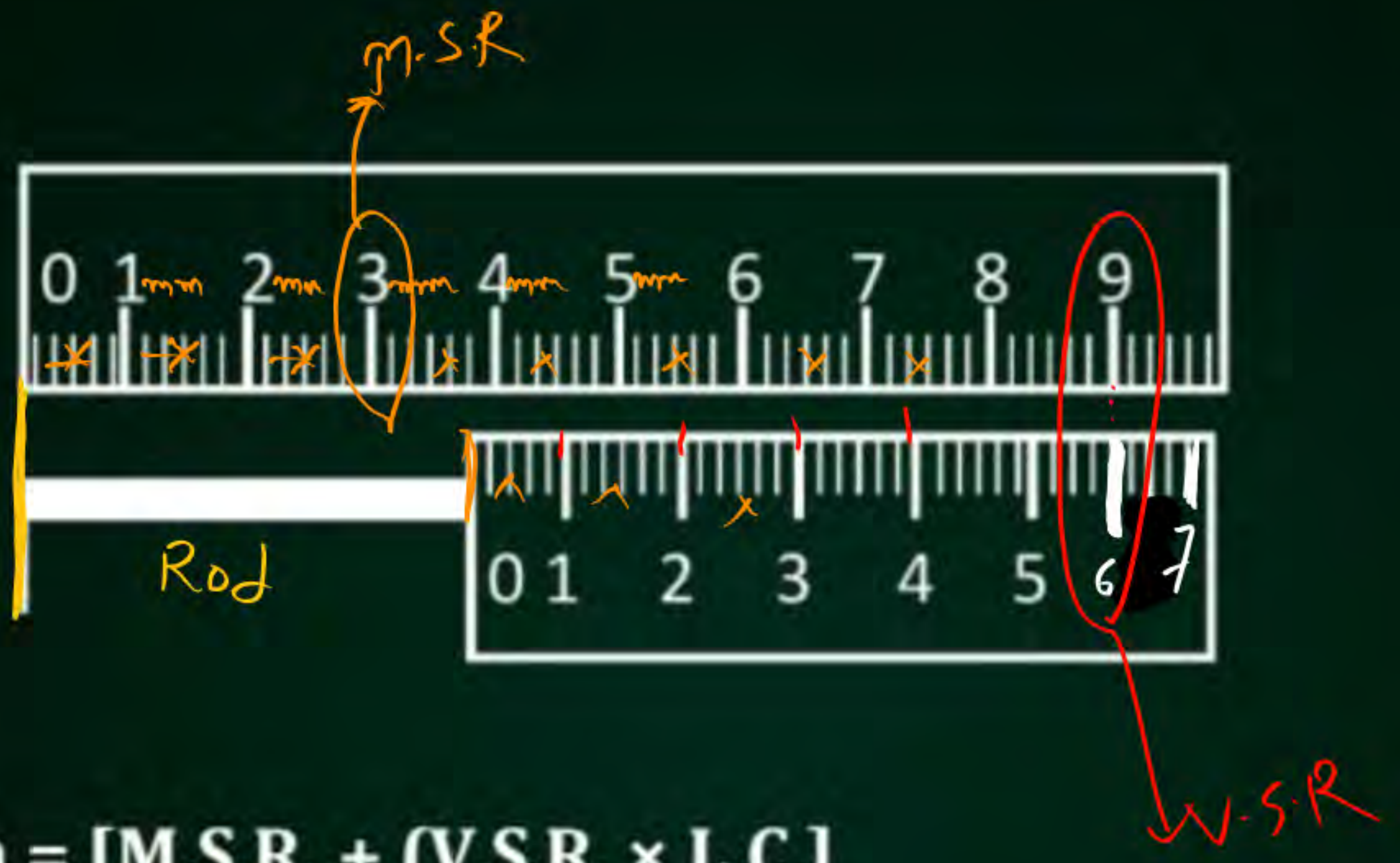
$= 1\,mm + 0.1 \times 3$

$= 1\,mm + 0.3\,mm = 1.3\,mm$

Final Answer

$= (1.3\,mm \pm 0.1\,mm)$

L.C



Length = [M.S.R. + (V.S.R. × L.C.]

Main scale Reading   Verier Scale Reading

$= 3\,mm + 6 \times 0.1\,mm$

$= 3\,mm + 0.6\,mm$

$= 3.6\,mm$

final Answer

length $= (3.6\,mm \pm 0.1\,mm)$

QUESTION

If measured length of Rod is 1.56 cm then instrument used is

(a) metre scale (L.C = 1 mm)

(b) Vernier calliper (L.C = 0.1 mm)

(c) screw gauge (L.C = 0.01 mm)

(चोर है)

$l = 1.56\,cm$

$= 1.56 \times 10\,mm$

$l = 15.6\,mm$

$10\,mm = 1\,cm$

$1\,mm = \frac{1}{10}\,cm = 0.1\,cm$

metre scale ✓

$L.C = 1\,mm = 0.1\,cm$

vernier callipers $L.C = 0.1\,mm = 0.01\,cm$

Screw gauge $L.C = 0.01\,mm$

QUESTION

Write down name of measuring instrument for given measurement :

(1) 87.3 mm ⇒ Vernier callipers

(2) 0.831 cm = 8.31 mm → screw gauge

(3) 6.7 cm = 67 mm → metre scale

(4) 6.7 mm = Vernier callipers

(5) 8.53 cm = 85.3 mm → Vernier callipers

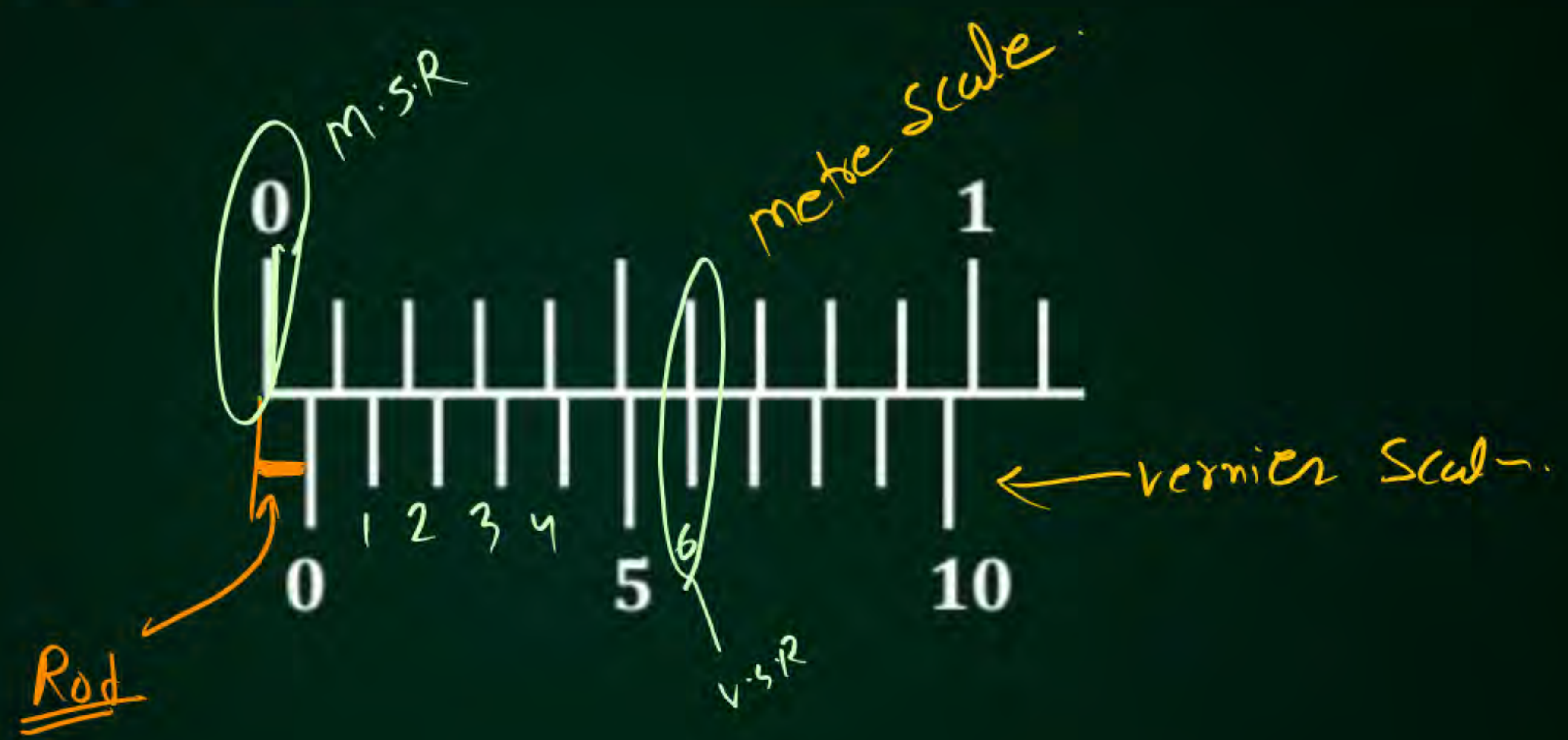
(6) 8.96 mm = screw gauge

(7) 9.812 cm ⇒ 98.12 mm → screw gauge

(8) 9.812 m = 9.812 (100 cm)

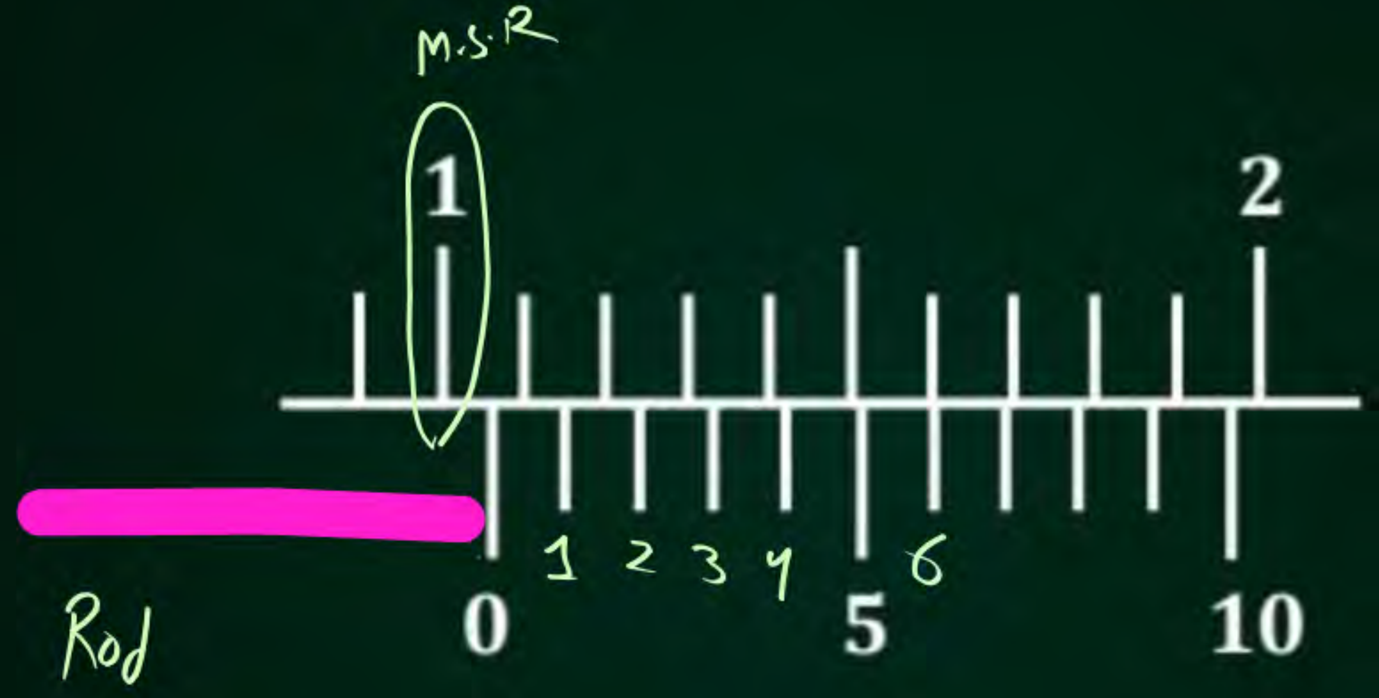
$= \frac{9812}{1000} \times 100\ cm = 9812\ mm$ → metre scale

Take Reading



Length of Rod = M.S.R + L.C (V.S.R)

= 0 + 6×0.1 = 0.6 mm.



length of Rod $= 1\,mm + 6 \times 0.1\,mm$

$= 1.6\,mm$ ✓



length = 7 mm + 5 × 0.1 mm

= 7.5 mm

final answer

= (7.5 mm ± 0.1 mm)

Ans

Zero error always subtracted with proper sign.



$M_{\text{True value of mass of fink}} = 70 - 20$

$= 50\,kg$ actual readiy

$M_{fink} = 70\,ky$

$M_{\text{ready}} = 20\,kg$ ✓
intal zero erros

Mass True rey $= 30kg - (-20kg)$

$= 50\,kg$

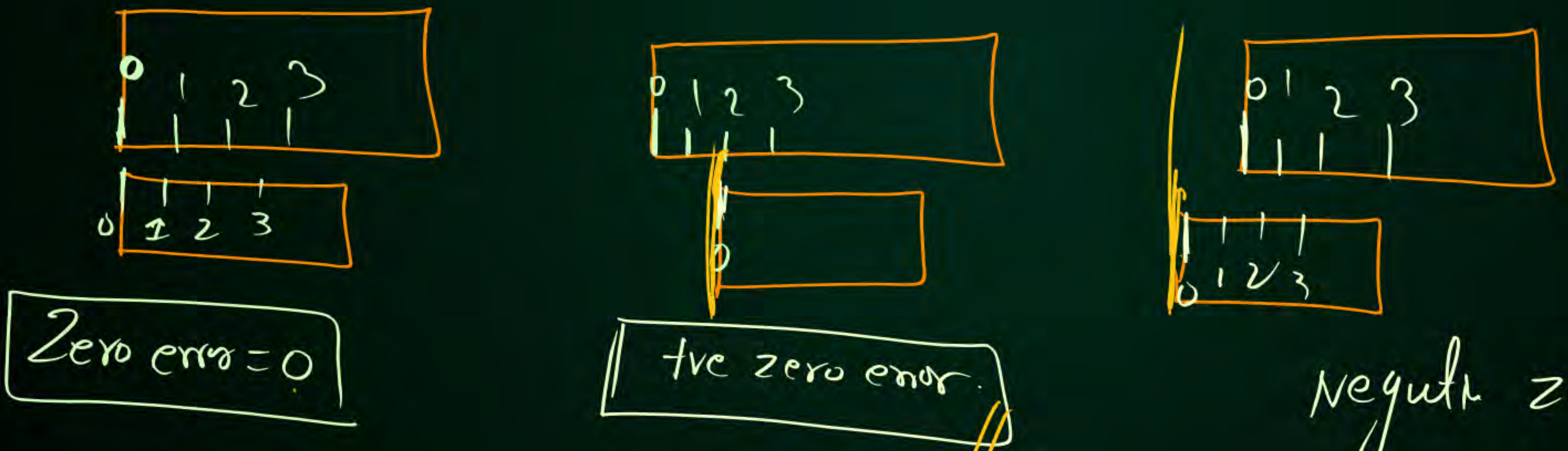


$M_{\text{intal}} = -20\,kg$
Zero erro

ZERO ERROR

zero error alway subtracted with proper sign

→ when zero of vernier not conside with zero of main scale is called zero error



Negative zero error.

QUESTION

Find the zero correction in the given figure.

1. 0.4 mm
2. 0.5 mm
3. -0.5 mm
4. -0.4 mm



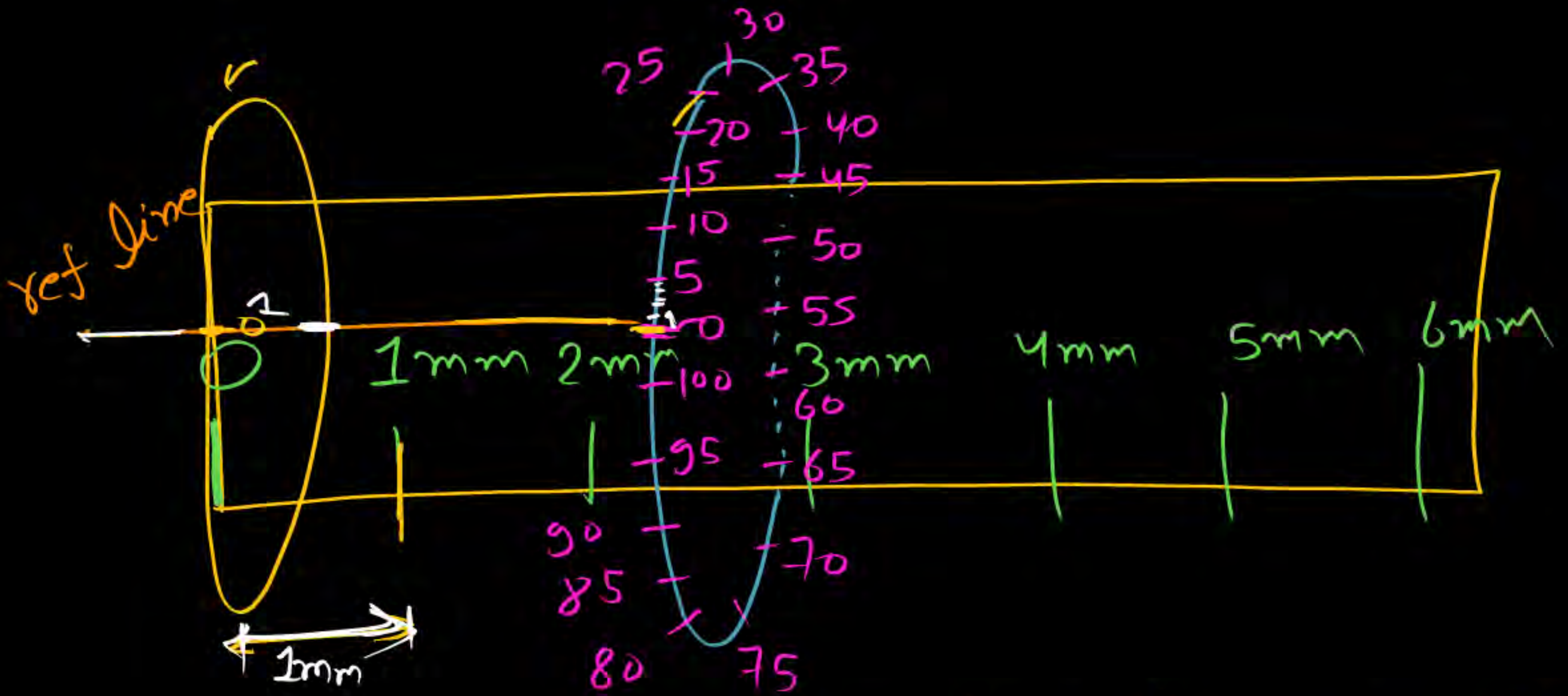
zero error = 5 × 0.1 = 0.5 mm

QUESTION

One centimeter on the main scale of Vernier calliper is divided into ten equal parts. If 10 divisions of Vernier scale coincide with 8 small divisions of the main scale, the least count of the callipers is:

1. 0.01 cm
2. 0.02 cm
3. 0.05 cm
4. 0.07 cm

Screw gauge



100 division cross किया तो 1mm

1 dision में dis^n = $\frac{1mm}{100}$

L.C = 0.01mm

L.C = $\frac{\text{Pitch (dis}^n\text{ travelled on main scale in one Rot}^n)}{\text{no of circul scale}}$

Distance travelled by circular scale, in one Rotation of circular scale = Pitch

= 1mm

SCREW GAUGE

travelled by circular scale

Distance on main scale in 1 Rotation :

$$= \text{Pitch} = 1\ \text{mm}$$

Minimum measurement that can be taken :

$$L.C = \frac{\text{Pitch}}{\text{No.of Circular division}}$$

$$L.C = \frac{1\ \text{M.S.D.}}{\text{No.of circular division}}$$

QUESTION

A screw gauge has least count of 0.01 mm and there arc 50 divisions in its circular scale. The pitch of the screw gauge is [NEET-2021]

(1) 0.01 mm

(2) 0.25 mm

(3) 0.5 mm ✓

(4) 1.0 mm

$$L.C = \frac{\text{Pitch}}{\text{no. of circular}}$$



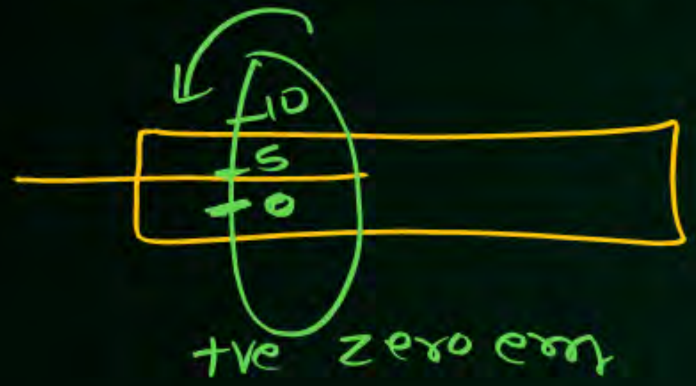
$$\text{Pitch} = L.C \times \text{no. of circular division}$$

$$= 0.01\,\text{mm} \times 50$$

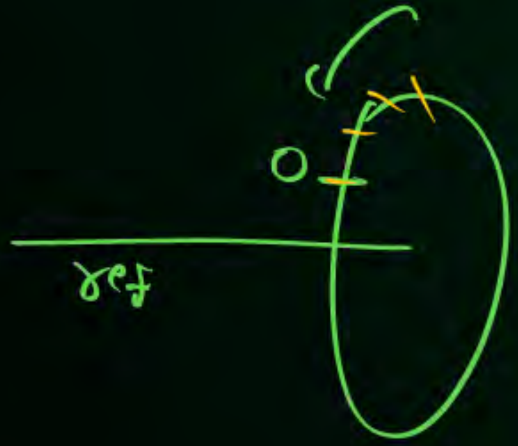
$$= .5\,\text{mm}$$

Zero error of screw gauge

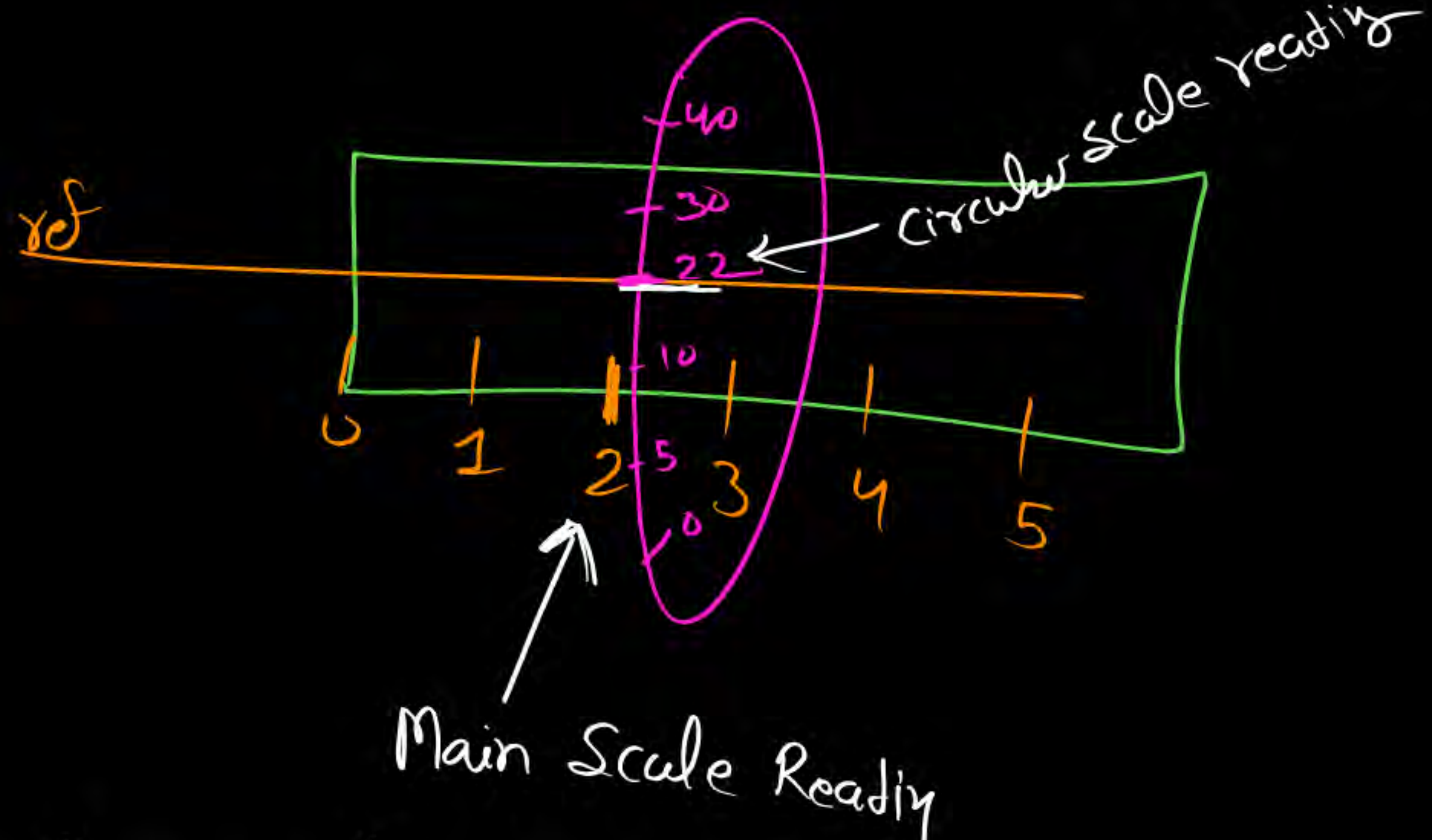
+ve zero → When zero of circular scale is below the reference level.



-ve zero → When zero of circular scale is above the reference level.



Reading = [(M.S.R + Circular Scale Reading (L.C))]



Reading = $(2\text{mm} + 0.01 \times 22)$

$= 2\text{mm} + 0.22\text{ mm}$

$(= 2.22\text{ mm})$

QUESTION

A student measured the diameter of a small steel ball using a screw gauge of least count 0.001 cm. The main scale reading is 5 mm and zero of circular scale division coincides with 25 divisions above the reference level. If screw gauge has a zero error of – 0.004 cm, the correct diameter of the ball is **[NEET-2021]**

1. 0.521 cm
2. 0.525 cm
3. 0.053 cm
4. 0.529 cm

L = 0.001 cm

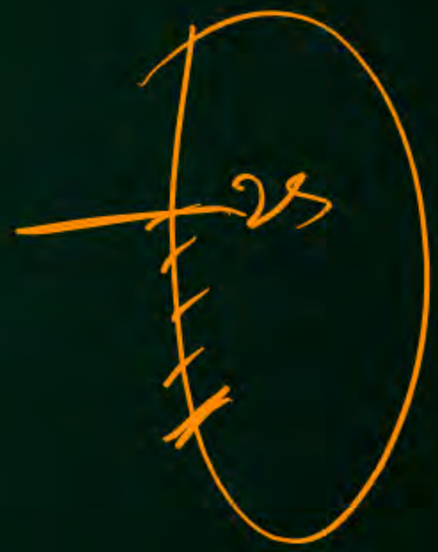
M.S.R = 5 mm

C.S.R = 25 div

Reading = 5 mm + 25 × 0.01 mm

= 5.25 mm ✓

= 5.25 mm − (−0.004 cm) = 0.525 cm + 0.004 cm = .529 cm



QUESTION

$L.C = \frac{(0.5\,mm)}{50} = 0.01\,mm$

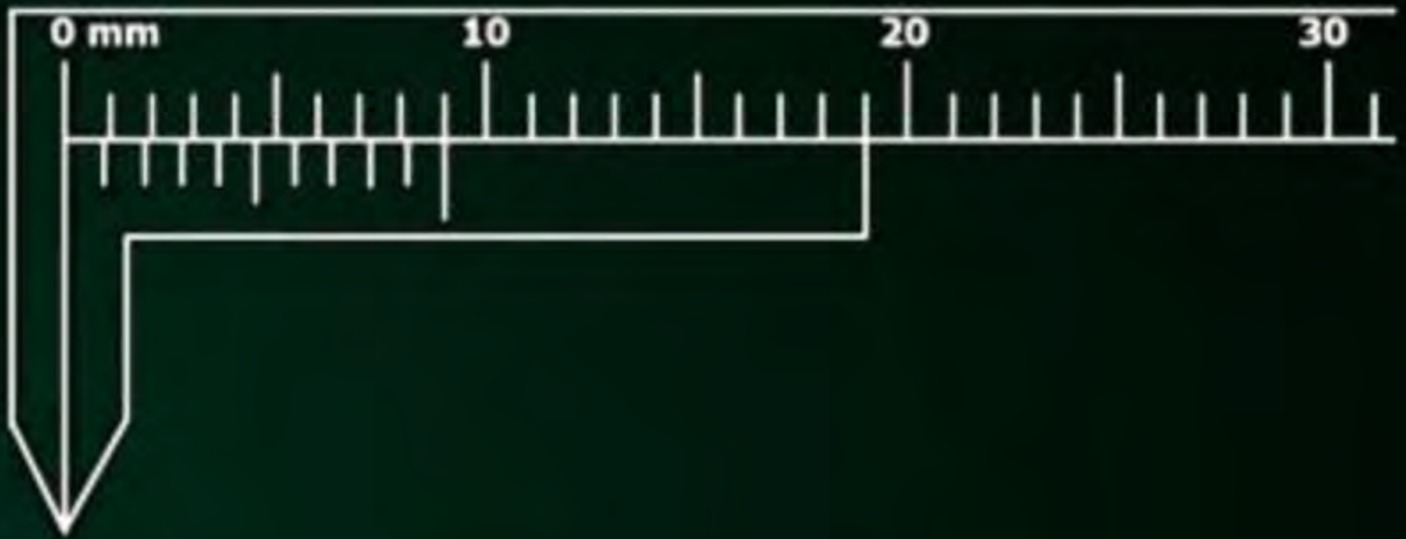
Two full turns (2 Rotn) of the circular scale of gauge cover a distance of 1 mm on scale. The total number of divisions on circular scale is 50. Further, it is found that screw gauge has a zero error of –0.03 mm. While measuring the diameter of a thin wire a student notes the main scale reading of 3 mm and the number of circular scale division in line, with the main scale as 35. The diameter of the wire is

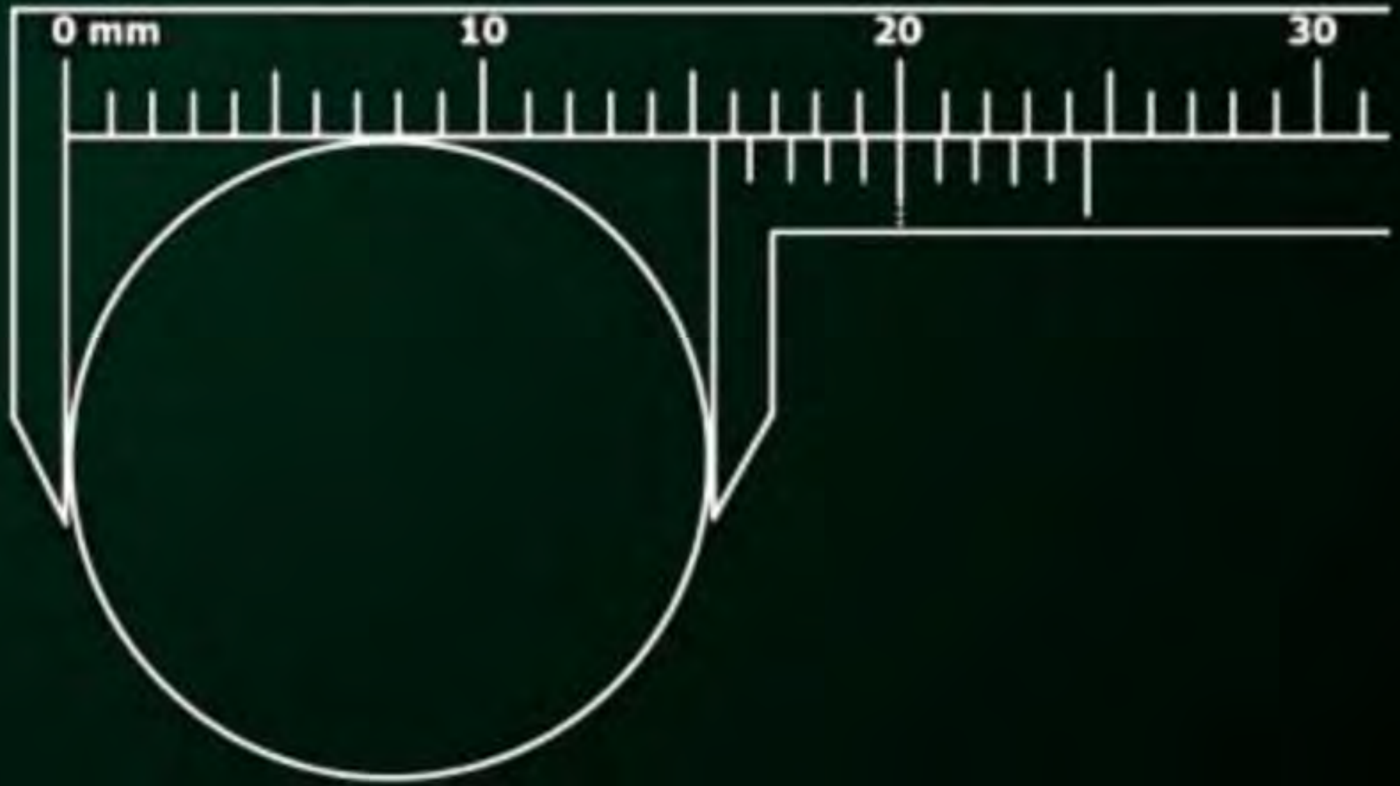
1. 3.32 mm
2. 3.73 mm
3. 3.67 mm
4. 3.38 mm ✓

$$\text{dia}^m = 3\,mm + (35 \times 0.01\,mm)$$
$$= 3\,mm + 0.35\,mm$$
$$= 3.35\,mm - (-0.03)$$
$$= 3.38\,mm$$

QUESTION

In the given Vernier scale, 10 divisions of the vernier scale is matching with 9 divisions of the main scale as shown in the first figure. Find the diameter of the object in the second figure. Assume the edge of the vernier as ‘0’ of the verrnier.





QUESTION

The pitch of a screw gauge is 1 mm and there are 100 division on its circular scale. When nothing is put in between its jaws, the zero of the circular scale lies 4 divisions below the reference line. When a steel wire is placed between the jaws, two main scale divisions are clearly visible and 67 divisions on the circular scale are observed. The diameter of the wire is

1. 2.71 mm
2. 2.67 mm
3. 2.63 mm
4. 2.65 mm

$L.C = \frac{1\,mm}{100}$

Zero = +ve 0.04 mm

M.S.R = 2 mm

C.S.R = 67 mm

Diameter = (2 mm + 0.67 mm)

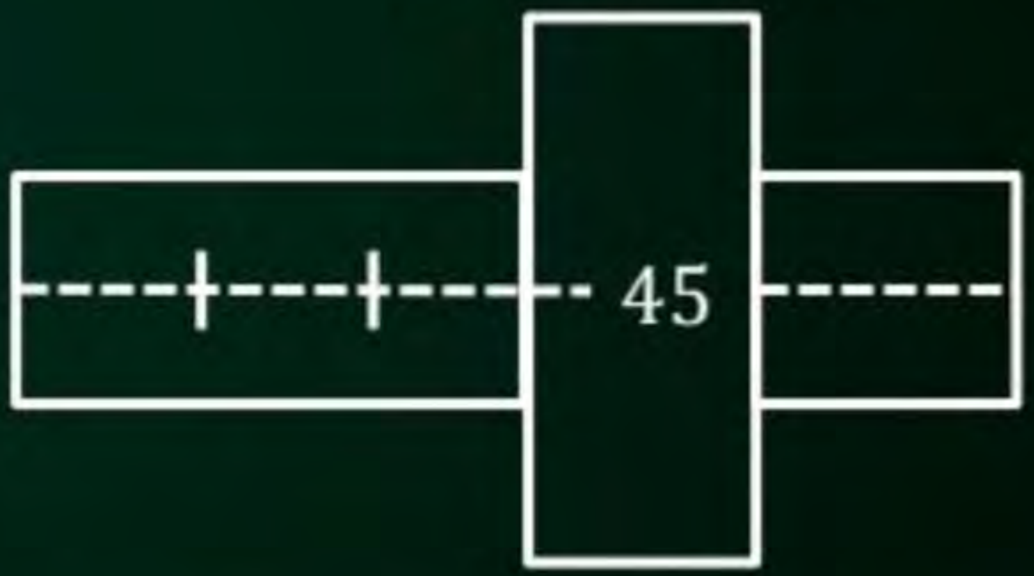
= 2.67 mm − 0.04 mm

= 2.63 mm

QUESTION

H/w

Consider a screw gauge without any zero error. What will be the final reading corresponding to the final state as shown? It is given that the circular head translates P MSD in N rotations. One MSD is equal to 1 mm.

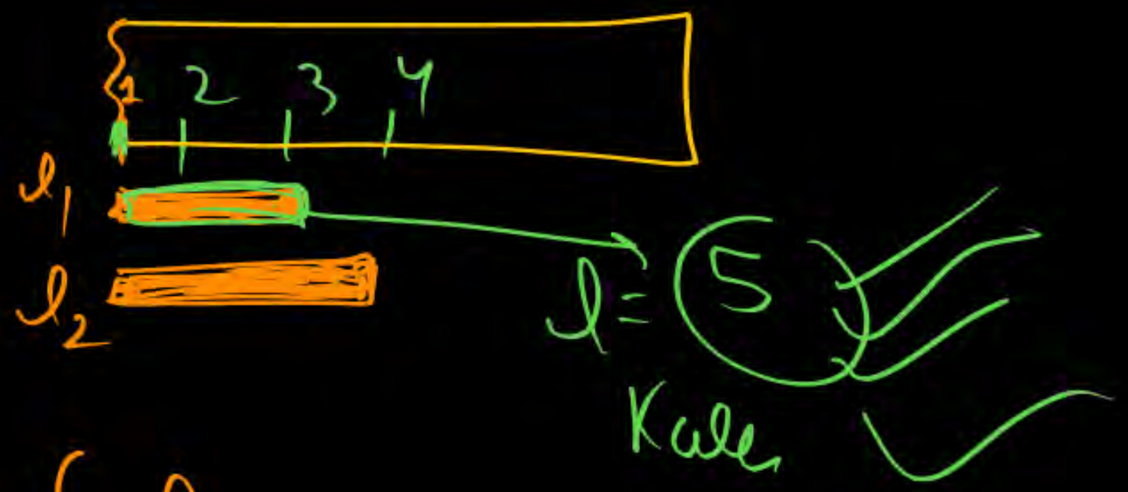


The circular scale has 100 divisions

1. $\left(\frac{P}{N}\right)\left(2+\frac{45}{100}\right)$ mm
2. $\left(\frac{N}{P}\right)\left(2+\frac{45}{N}\right)$ mm
3. $P\left(\frac{2}{N}+\frac{45}{100}\right)$ mm
4. $\left(2+\frac{45}{100}\times\frac{P}{N}\right)$ mm

Systematic error

- value of error is fixed
- Instrumental error
- Human / Personal error
- no of observation
  Can't decrease value of error

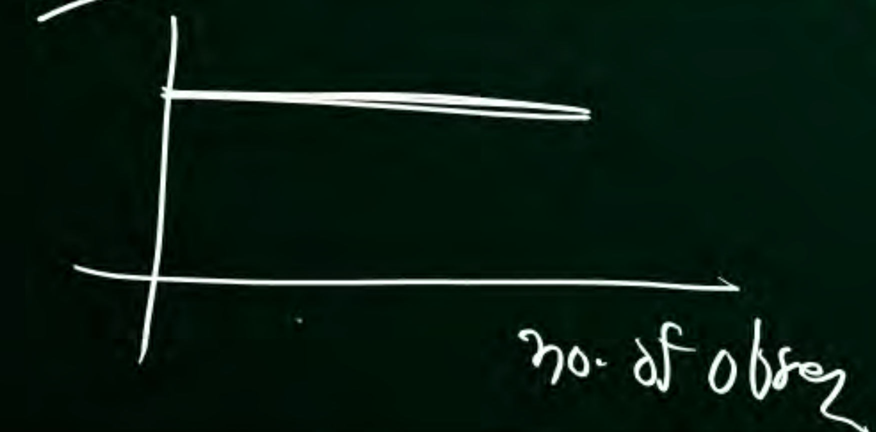


$$\left\{ \begin{aligned} l_1 &= 3mm \\ l_2 &= 4mm \end{aligned} \right\}$$

ERROR IN MEASUREMENT

Systematic Error

- Cause of error is known
- Fixed or constant error in magnitude
- Can't decrease by increasing no. of observation



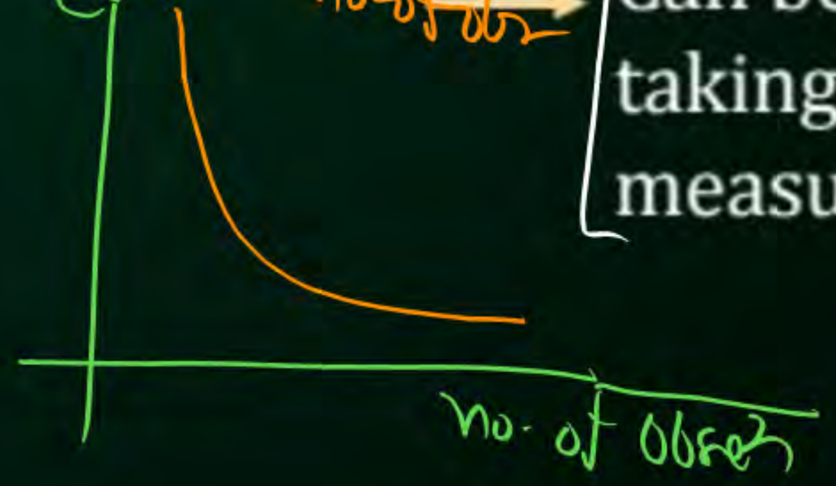
L.C. Error

Random Error

- Cause is not known
- due to random variation of temp, pressure
- Irregular or varies in magnitude
- Can be minimize by taking large no. of measurement

Random error $\rightarrow$ $n x = \text{const}$

$x \propto \frac{1}{n}$ (n = no. of obs)



Systematic Error

Type

- Instrumental error + zero error
- Wrong experimental technique
- Personal error

Random Error

Type

- Due to random change in pressure temperature

QUESTION

Zero error of an instrument introduces:

1. Systematic errors
2. Random errors
3. Both
4. None

QUESTION

In 5 no of observation systematic error is 12% then find error is 20 observation?

Fixed

Any

12%

QUESTION

In 5 no of observation random error is 12% then find error is 20 observation?

$n x = c + n$

$5 \times 12\% = 20 x$

$x = 3\%$


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 01 | **Physics**

- Motion In a Straight Line



By- Dr. Manish Raj (MR SIR)

Topics to be covered

1. # distance / displacement
2. #
3. #
4. #



Physics

11th Physics

40-45%
11th in NEET

- Kinematics (1-D, 2-D)
- Laws of Motion
- Work energy Power
- Rotation
- Gravitation, Solid
- Fluid
- Thermal, Thermo
- S.H.M / Wave

→ Physics for आधार
→ Concept
→ Raftar

12th Physics

60 to 55% 12th

- Electric charge field
- electric Pot^n, Capacit^n
- current electricity
- Magnetism, MEC
- Electromagnetic Indu^n
- A/C EMI
- Ray optics, wave optics
- Modern
- semiconductor

Distanc of Delhi Railway station ??

Ans wrong question - - - - - -

(Q) Distance of delhi Railway station from motihari (Bihar) ??

Ans 1050 km

from motihari (Bihar) → refrence is very important

"frame of refrence" — A Place from where we take obserbation,

"JGET is a frame of refrence





obserber → who take obserbation from frame of refrence,

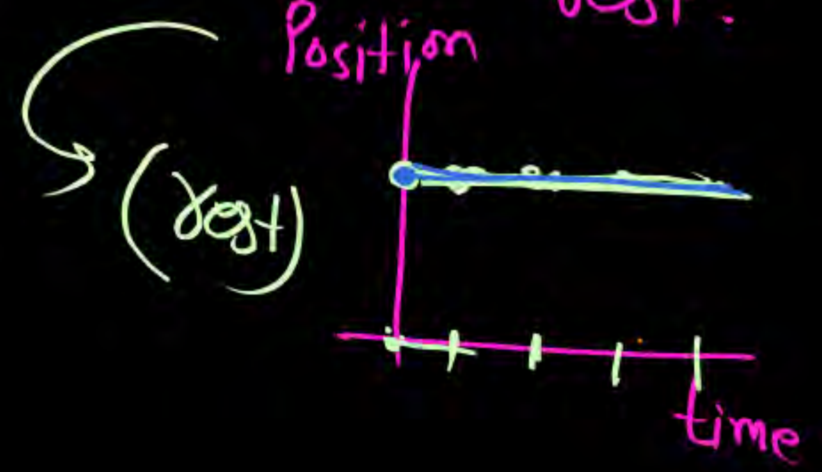
Frame of Reference

A placed from where we take observation. (Origin)

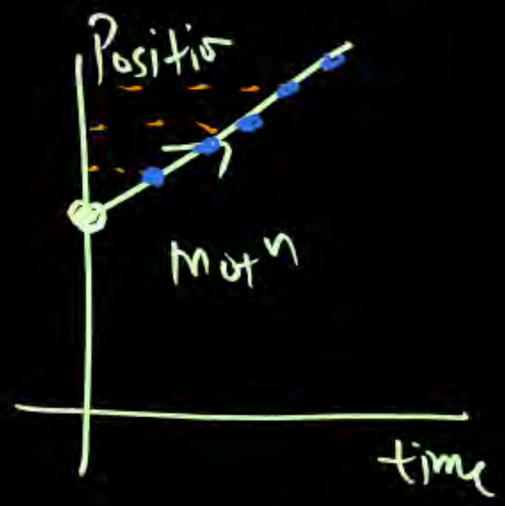
Observer:- A person who take observation is called observer.

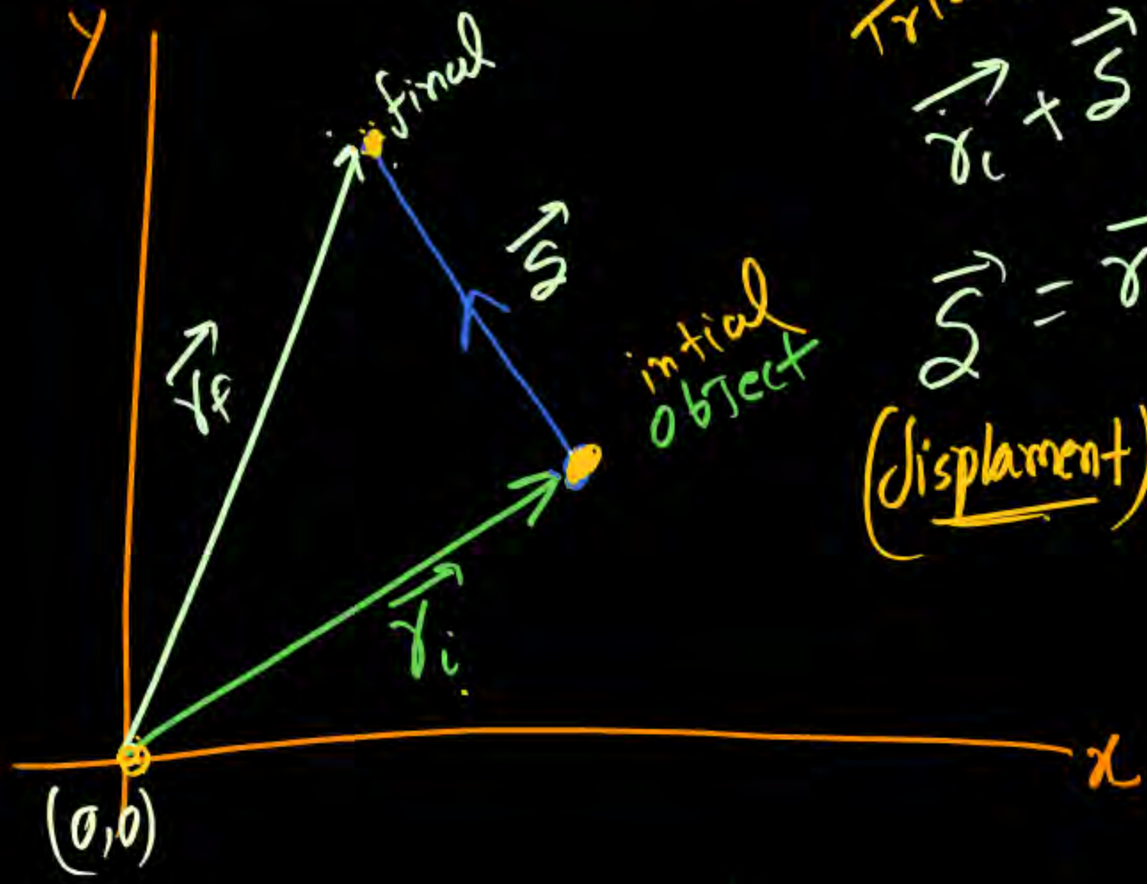
Position → Location of object w.r.t frame of refrence.

- Position is Not changing w.r.t. Time
  - → object is at rest.



- Position is changing w.r.t time → object is in motn





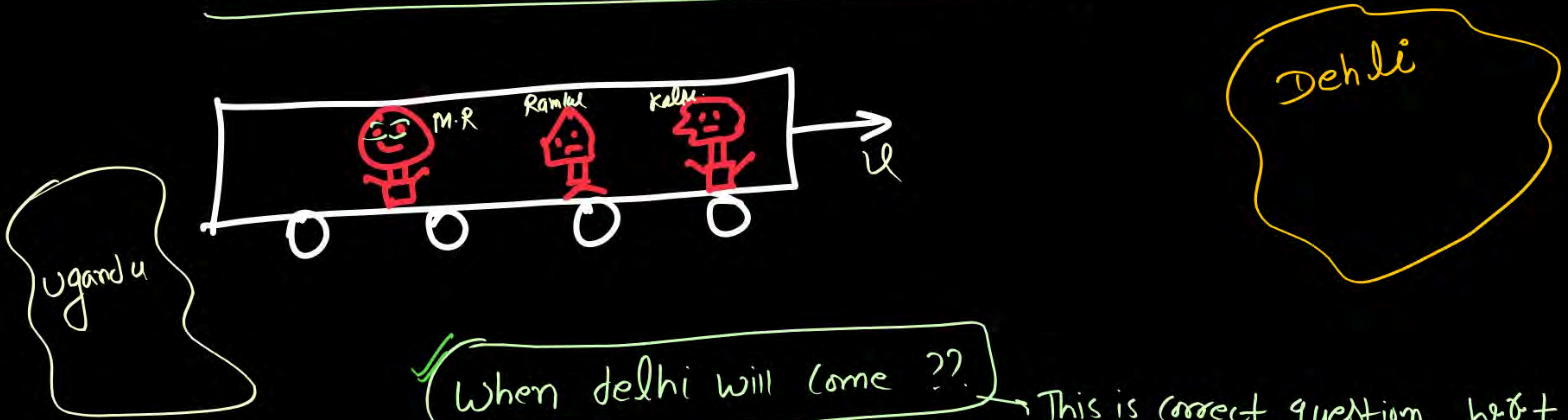
Triangle law of addition

$$\vec{r}_i + \vec{s} = \vec{r}_f$$

$$\vec{s} = \vec{r}_f - \vec{r}_i$$

(Displament) = Change in Position.

When delhi will come ??



When delhi will come ?? → This is correct question w.r.t M.R (Person sitting in train)

or, we are goining to delhi ?? → also correct w.r.t Person on ground.

frame of refrence
always (assume him) to be at rest.





Pinky is at rest w.r.t Kallua ✓

Pinky is in motion w.r.t. Ramlal ✓

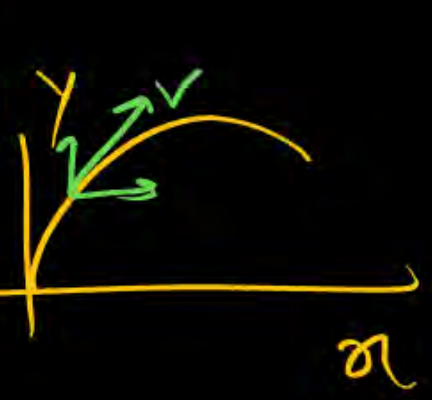
Rest and motion is a relative term, & relative to frame of refrence.

Nothing is at absolute rest or motion in this Universe.

1) One dimension Motion → motion in a straight line.
rectilinear motion (सिधा)

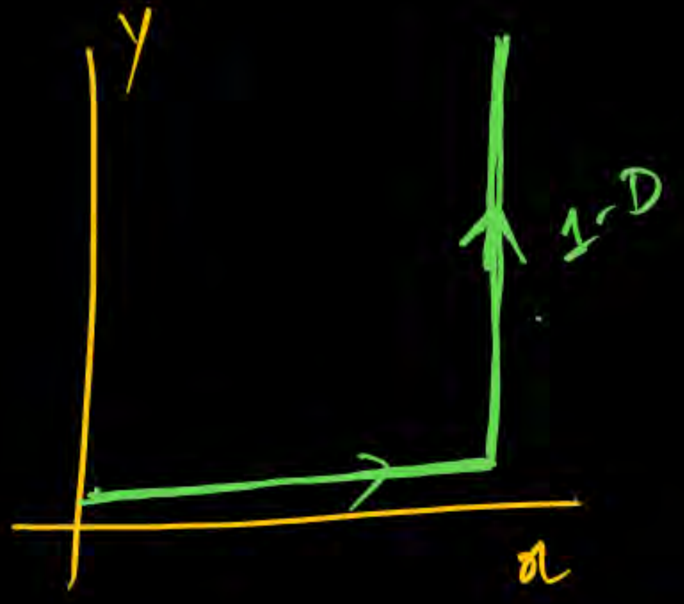
2) Motion in a plane (2-D)

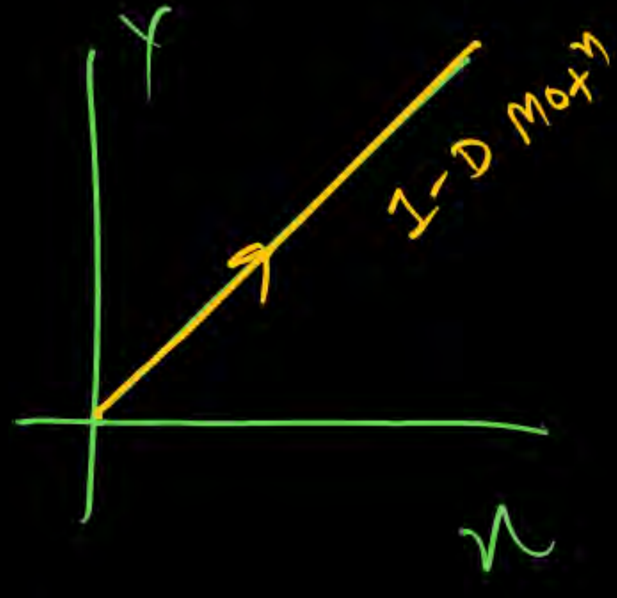
Ex – circular
→ Projectile



3) Theree dimensional Motion.

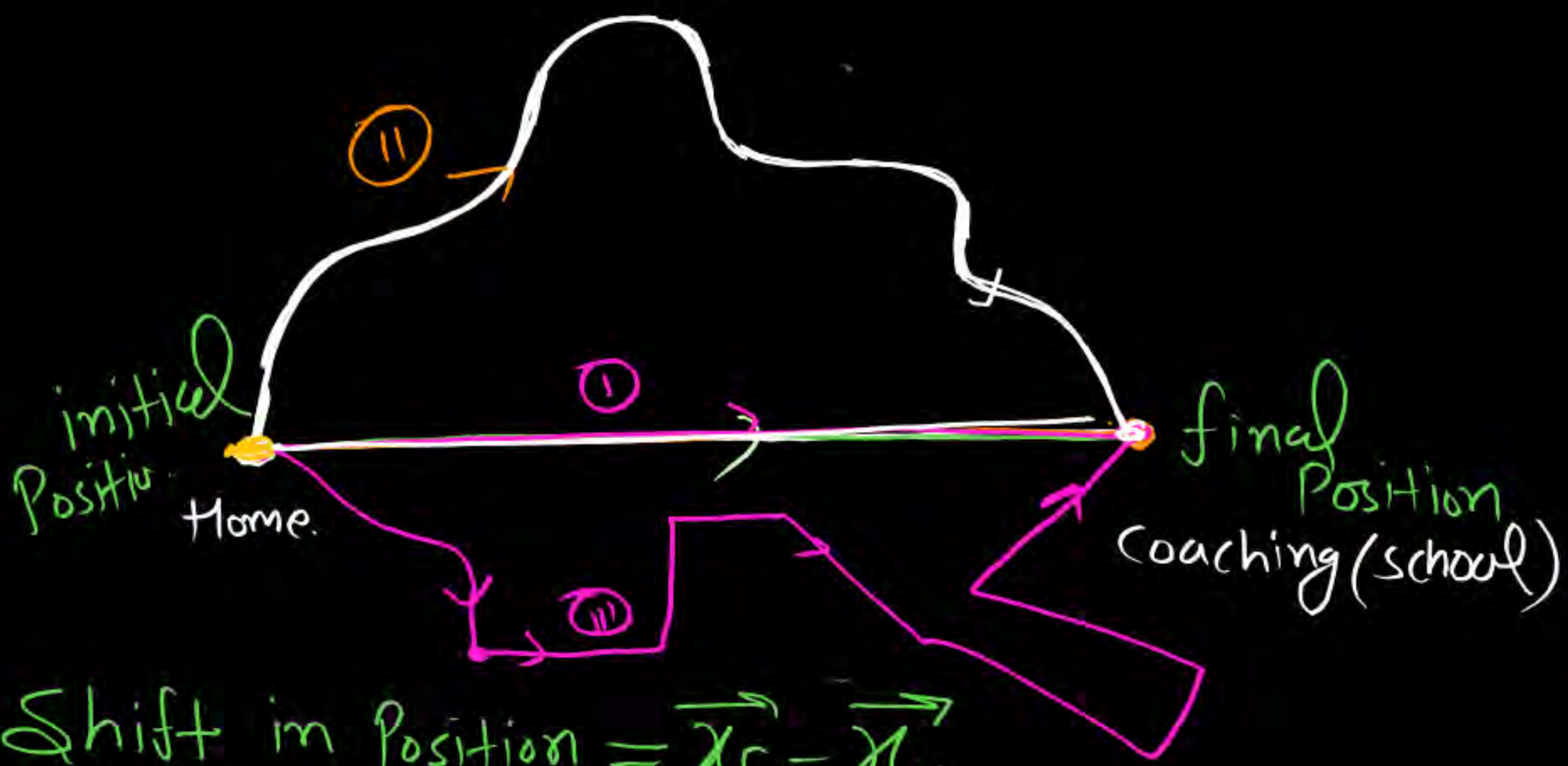
↳ Motn in space





Kinematics → Study of motn without knowing cause of motn.

↳ Ex – Speed, dispn, accn ⟶ force ✗



Shift in Position = $\vec{x_f} - \vec{x_i}$

\# displacement = straight line from intial & final Position

(always straight line)

(*) displacement same for all three Path

(*) does not depends on Path taken.

* distance = actual Path length.

= Total Path length.

= Scalar



Distance — How far actually object (moved)	Displacement → How far & where (Shif in Position is)
→ Actual Path length	→ How far / where
→ Total Path length	→ vector
→ depends on Path taken	→ magnitude & dirn.
→ Scalar (always additive)	→ does not depends on Path taken b/w Two Point.
→ Magnitude.	→ may be +ve, −ve, or zero for moving object (+ve, −ve represent dirn)
→ always +ve	→ It May decrease with time.
→ (It Can't decrease with time)	
→ unit (metre)	



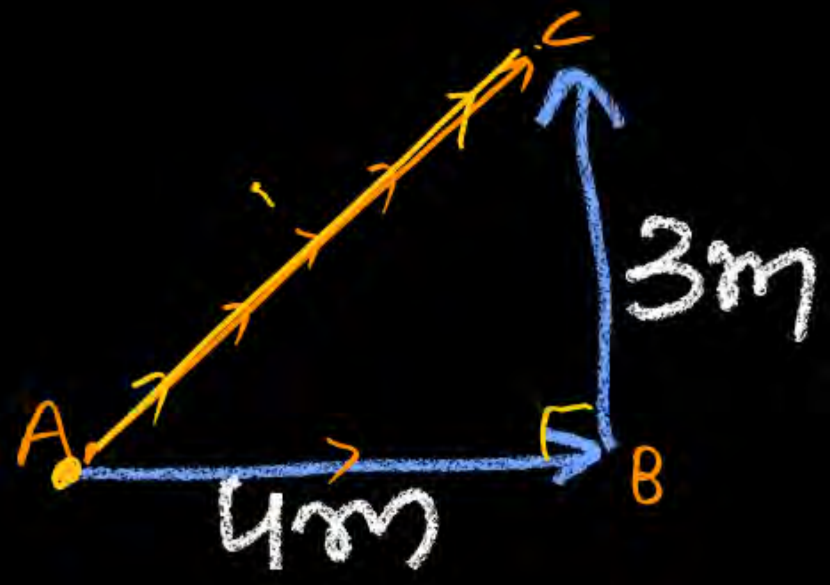
$distance_{A \to C} = 7m$

$|disp^m|_{A \to C} = 7m$



$disp^n = 4+3 = 7m$

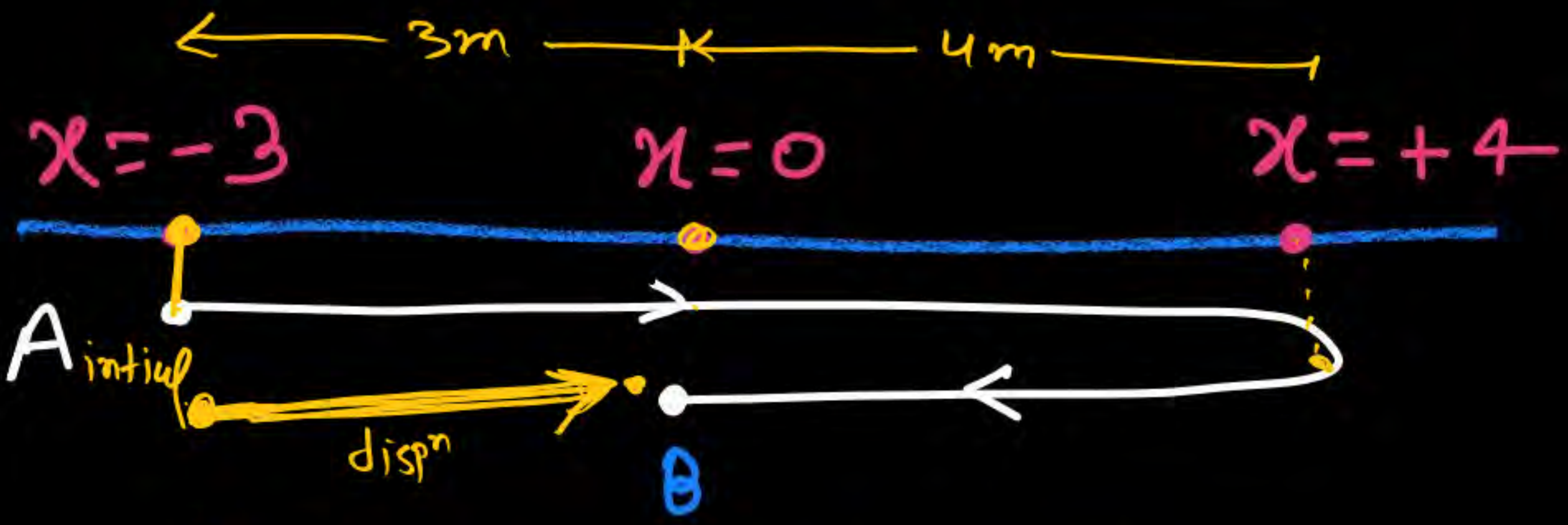
$|disp^m|_{A \to C} = 4-3 = 1m$



$distance = 7m$

$|disp^m| = 5m$

find displacement

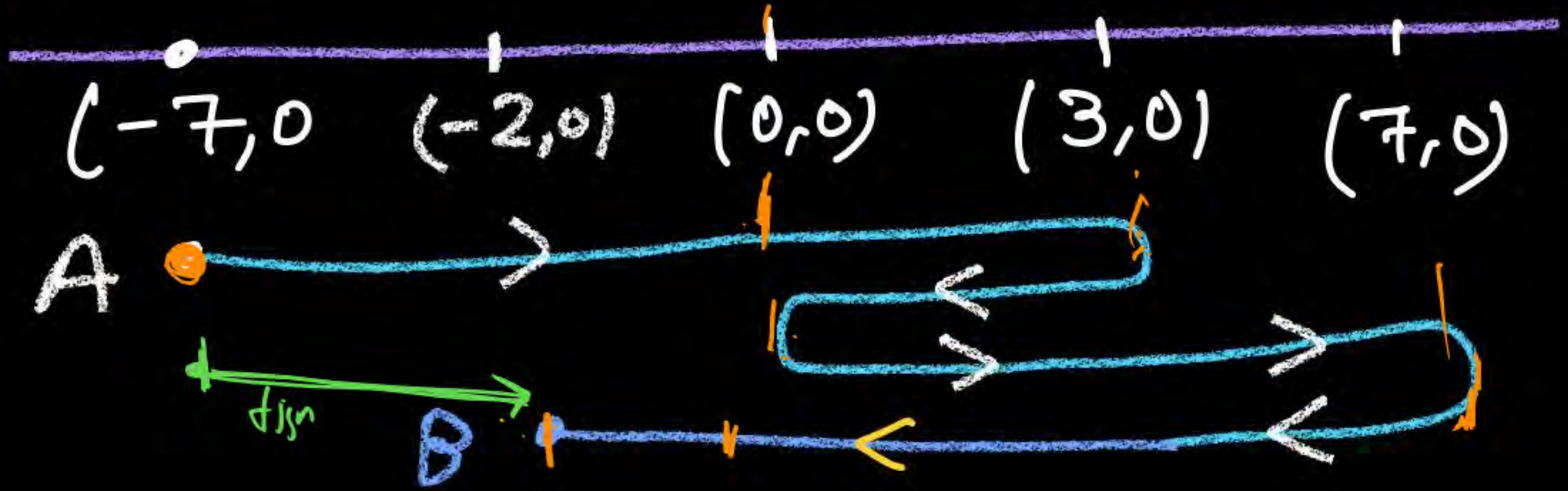


$|dist^n|_{A \to B} = 3 + 4 + 4 = 11m$

$|disp^n|_{A \to B} = +3m$

$= x_f - x_i = 0 - (-3) = +3m$

#



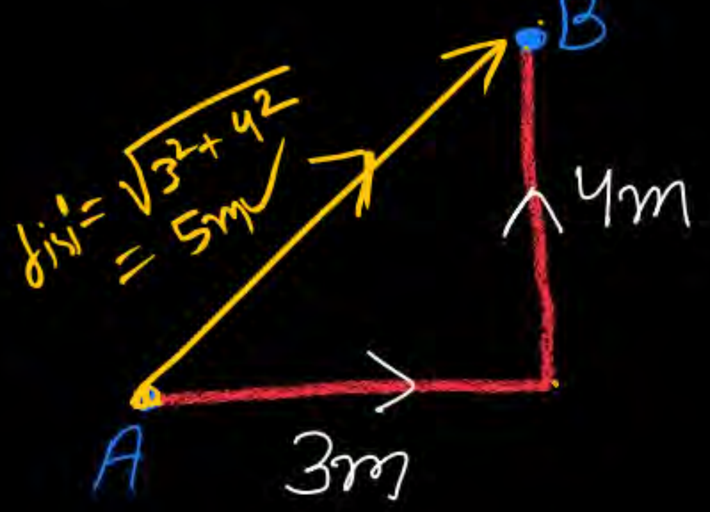
$|dist^n|_{A \to B} = 7m + 3m + 3m + 7m + 7 + 2m$

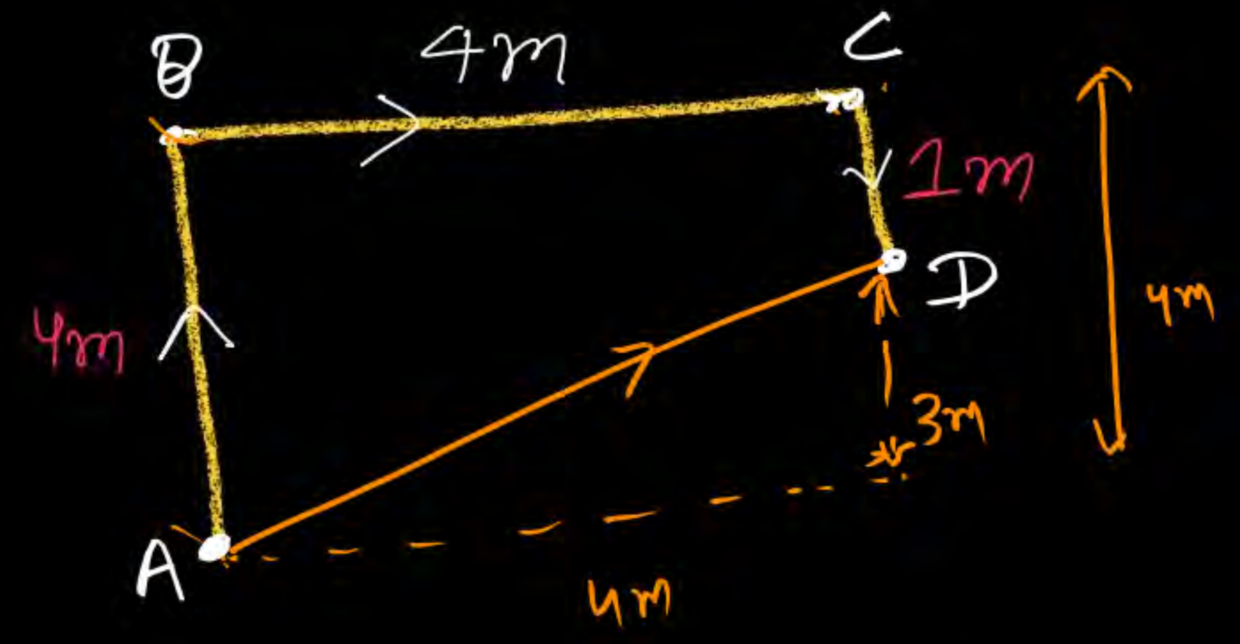
$= \underline{29m}$

$disp^n = x_f - x_i$

$= -2 - (-7) = 5m$

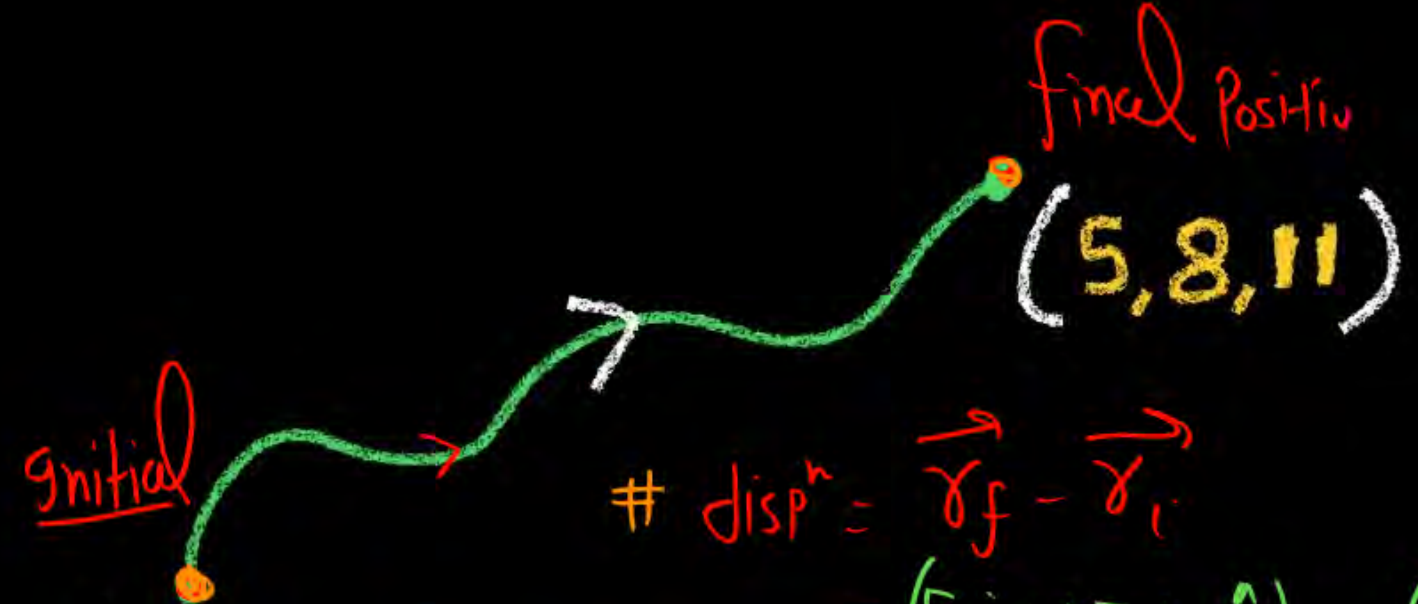
Find magnitude of displacement





$dis^n = (4+4+1)m = 9m$

$disp^n = \underline{5m}$



$disp^n = \vec{r}_f - \vec{r}_i$

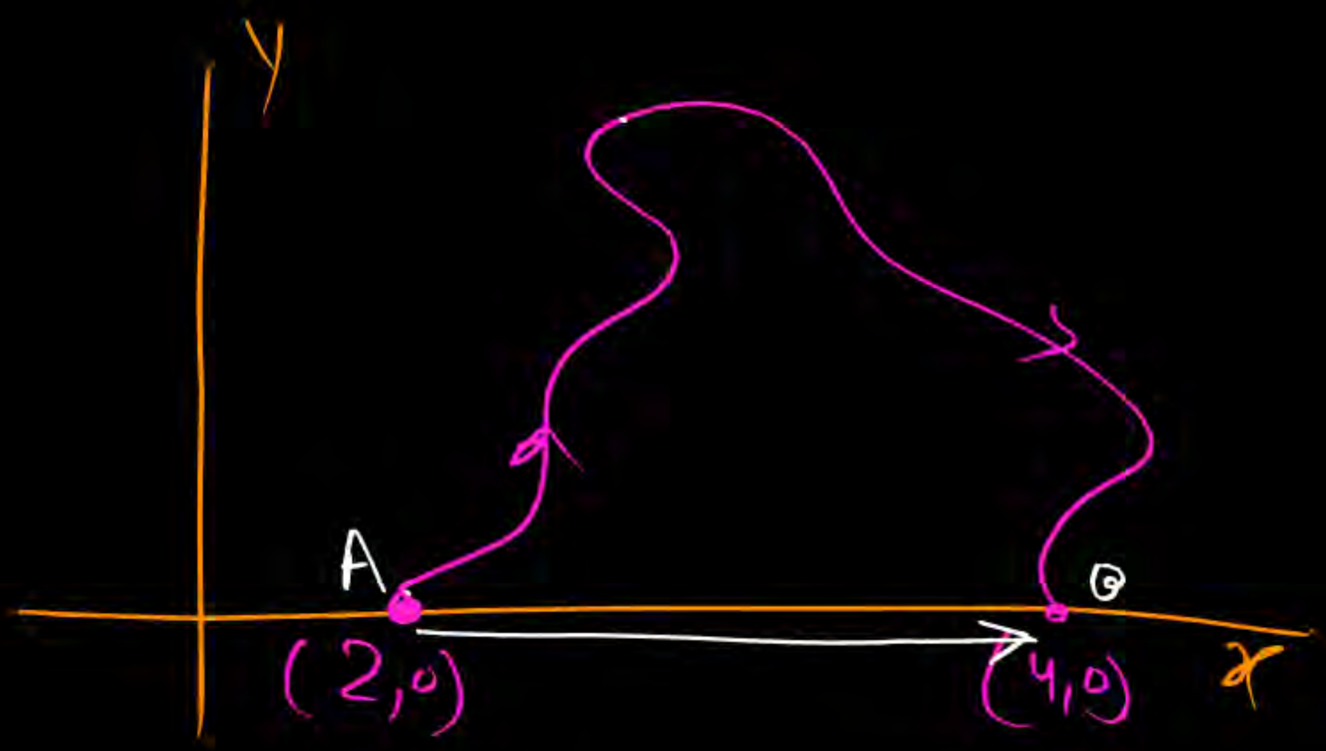
$= (5\hat{i}+8\hat{j}+11\hat{k}) - (2\hat{i}+4\hat{j}+6\hat{k}) = (3\hat{i}+4\hat{j}+5\hat{k})$

$|disp^n| = \sqrt{3^2+4^2+5^2}$

$= \sqrt{9+16+25} = \sqrt{50}$

$= \underline{5\sqrt{2}\ m}$

distance = Can't be calculate.

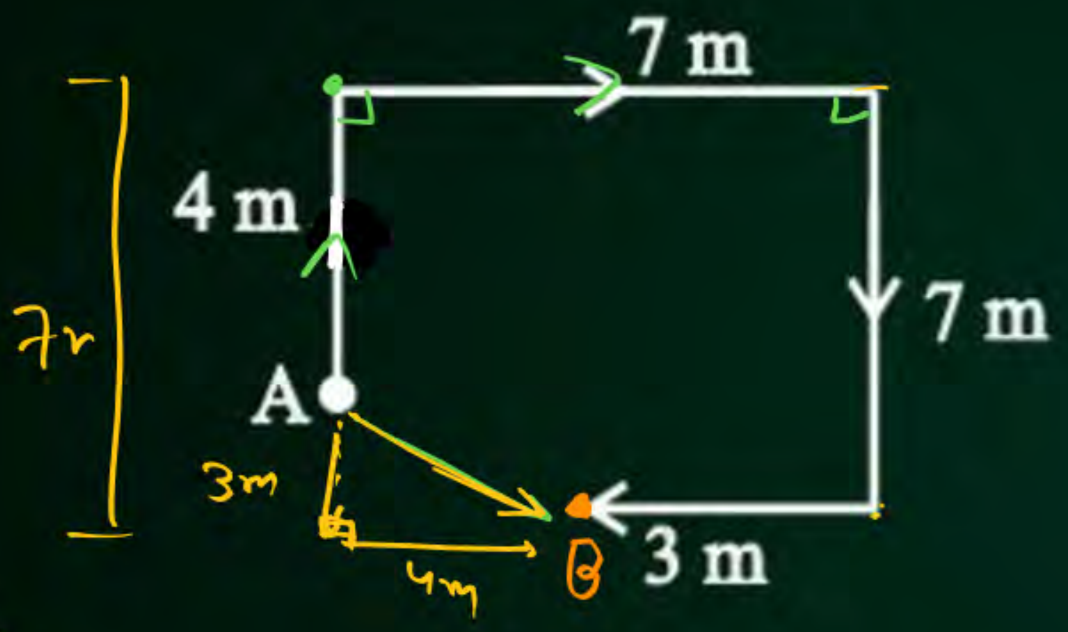


$disp^r = 4 - 2 = 2m\hat{i}$

$dist^n$ = can't be calculate

QUESTION

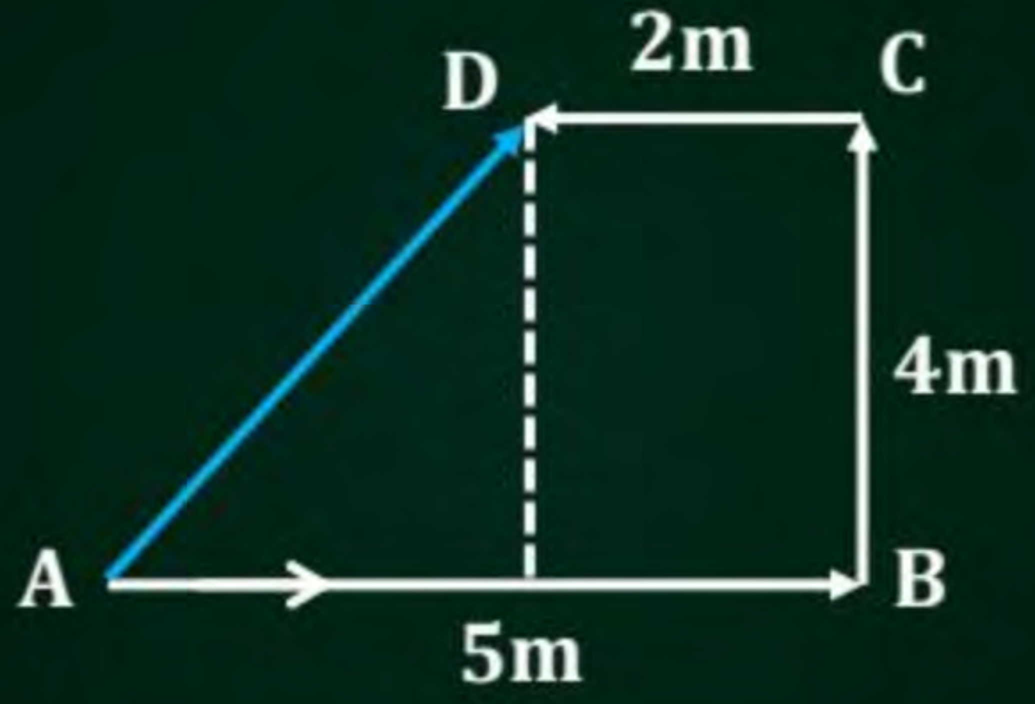
Find displacement between A & B



distn = 23m

|dism|$_{AB}$ → = 5m

$|Dispn|_{A \to D} =$

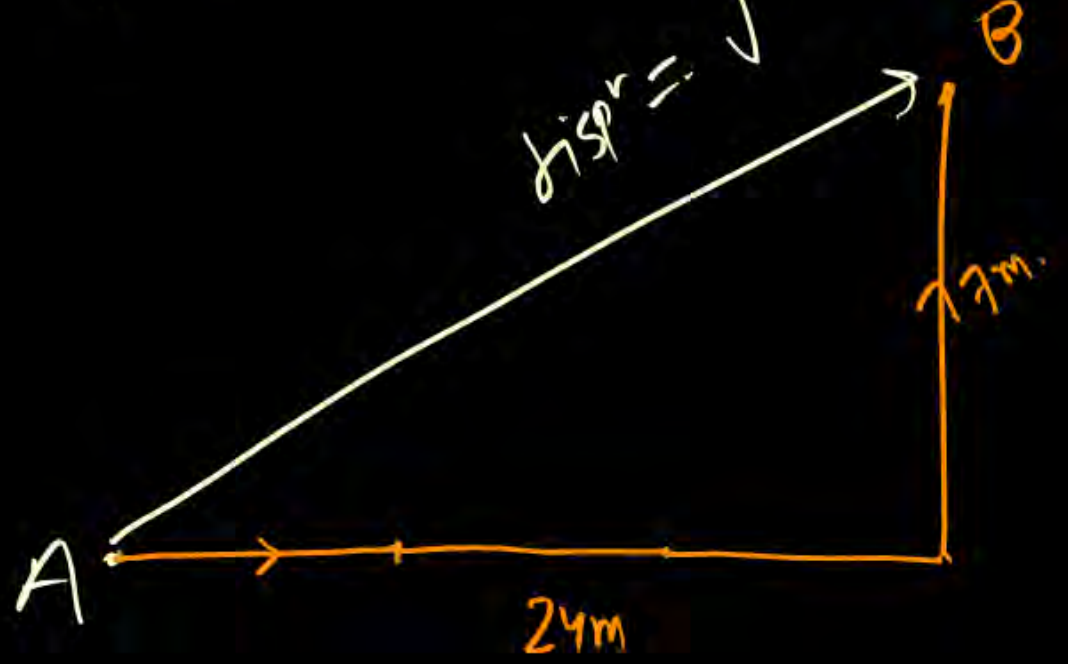


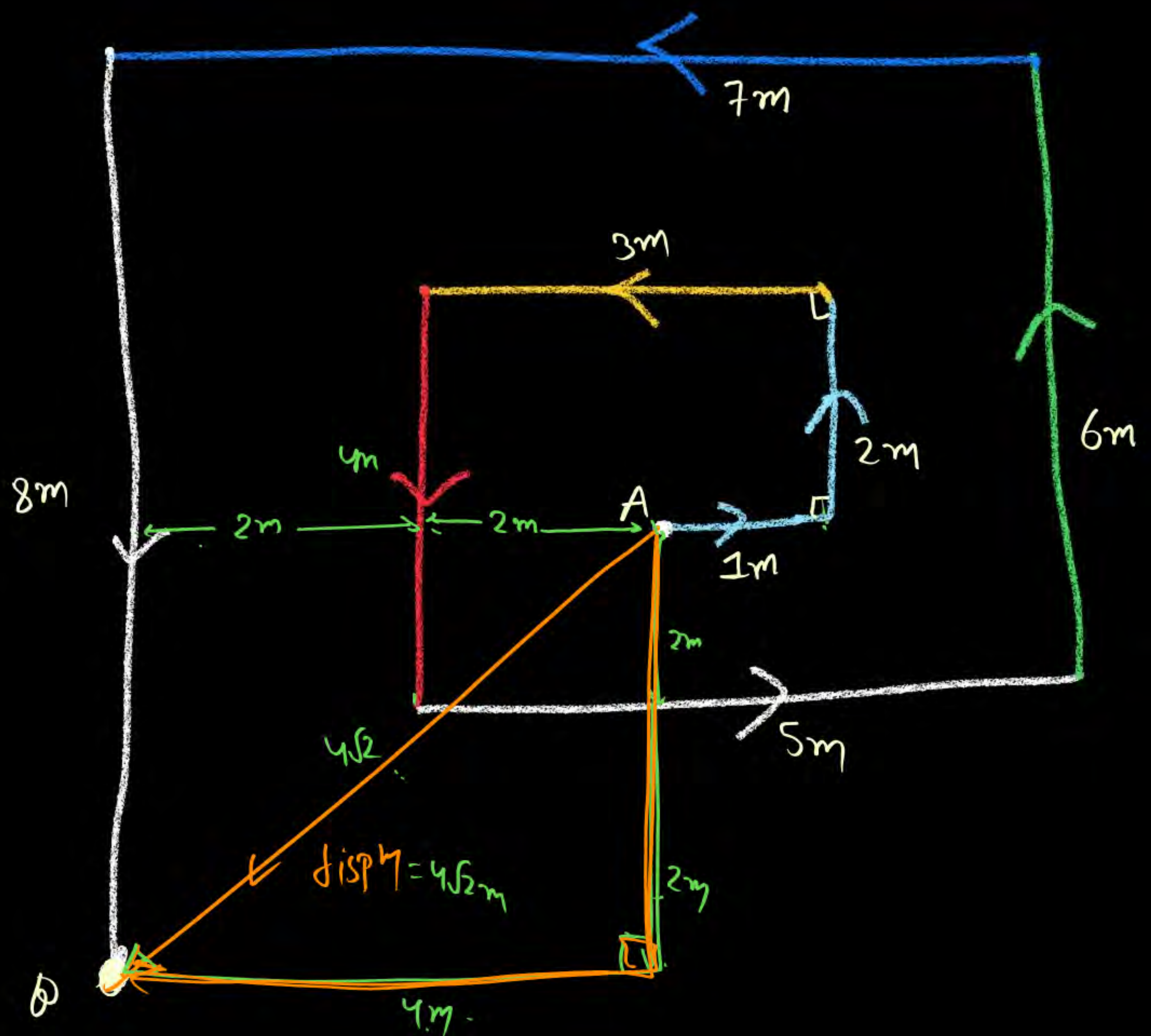


Sol n.

dispm.

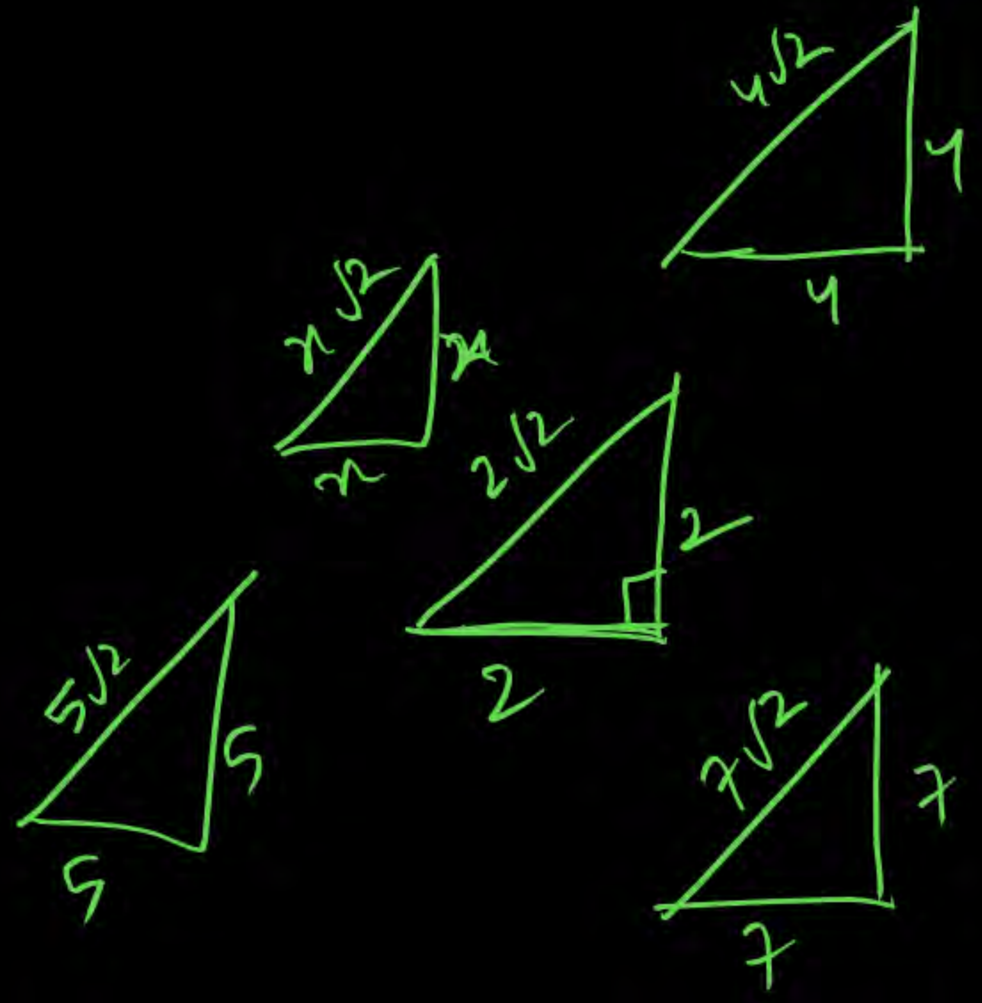
$$\text{disp}^r = \sqrt{24^2 + 7^2} = 25m.$$



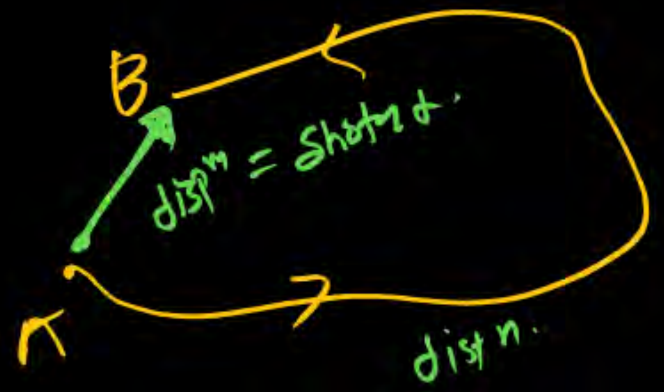


$$|\text{disp}^m|_{A\to B} = ?$$

$$= 4\sqrt{2}m$$



$$|disp^m| \le dist^n$$





$dist^n = |disp|$



$disp^m < dist^n$

QUESTION

Which of the following option is correct for motion in 1-D ??

1. distance = | disp^m | (34%) → This will be correct for motion in 1-D without change in dir^n.
2. distance > | disp^m | → object is moving in 1-D with change in dire^n.
3. distance ≥ | disp^m | (59.62)
4. distance < | disp^m | → This is never correct

QUESTION

Correct statement among the following is...

1. When displacement is zero, distance travelled is not zero. ✗
2. When displacement is zero, distance travelled is also zero. ✗
3. When distance is zero, displacement is not zero. ✗
4. Distance travelled and displacement are always equal. ✗

No one is correct

1. The displacement of a body is zero, then distance ??

Ans → distance may or may not be zero.

→ Two Possible case → (1) object चला ही नहीं। (2) चला फिर वहीं वापस आ गया।

2. The distance is not zero then displacement ??

↳ may be zero, or non-zero

(i) mot^n huaa → $(\vec{x}_f = \vec{x}_i)$

(ii) mot^n huaa → $\vec{x}_f \neq \vec{x}_i$

object हिला | चला ही नहीं

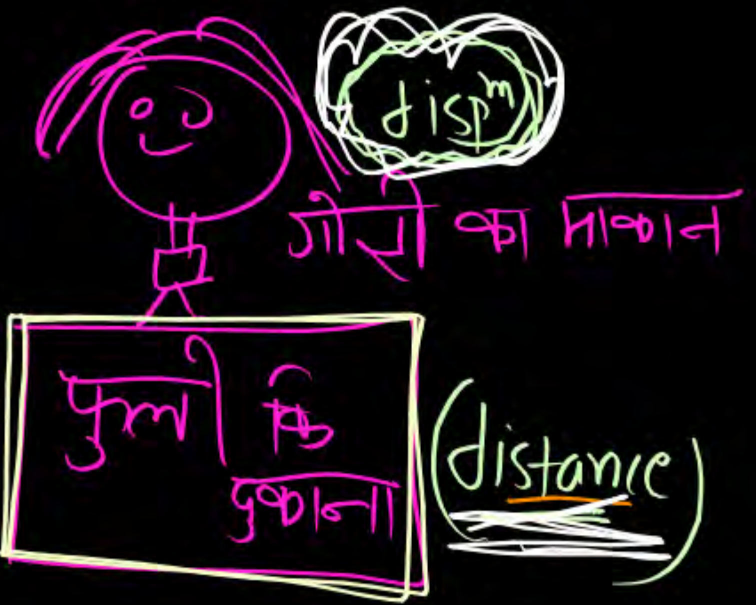
(Q) distance is zero then $disp^n$

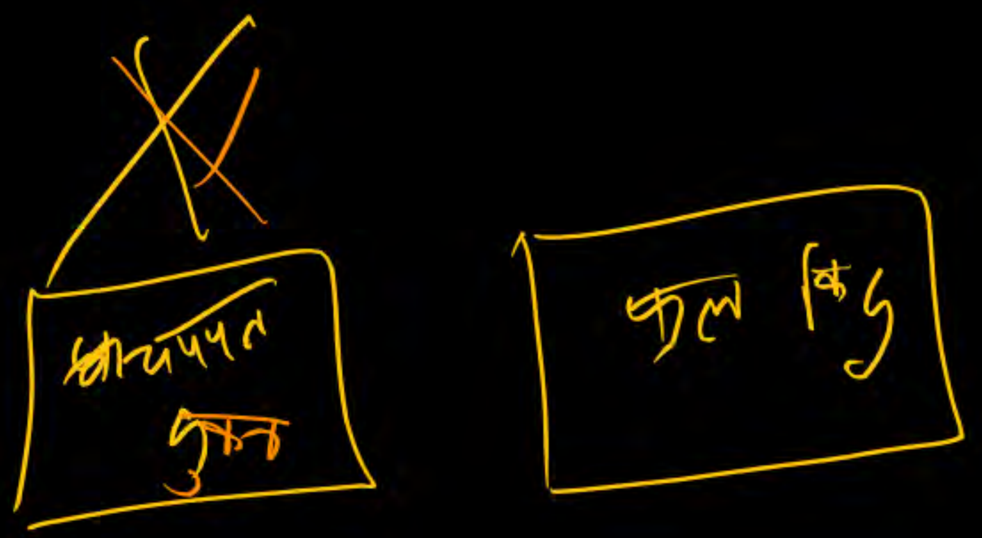
→ $disp^m$ must be zero.

Fill in the Blanks :-



Dispm	(A) Ans (Must be zero)	(B) may have dispm may not have, ...	If (dispm) is zero, then distance??	If dispm is not zero then distn??
(distance)	If distance is zero. then dispm ??	If distance is not zero then dispm??	(C) distn may or may not be zero	(D) must have distn





QUESTION

Which of the following option is correct for motion in 1-D, without change in direction.

1. distance = | disp^m |
2. distance > | disp^m |
3. distance ≥ | disp^m |
4. distance < | disp^m |

QUESTION

Which of the following option is correct for motion in 1-D, with change in direction.



1. $\text{distance} = |\text{disp}^{m}|$
2. $\text{distance} > |\text{disp}^{m}|$
3. $\text{distance} \geq |\text{disp}^{m}|$
4. $\text{distance} < |\text{disp}^{m}|$

QUESTION

Which of the following option is never correct for a moving object?

1. distance = | disp^{m} |
2. distance > | disp^{m} |
3. distance ≥ | disp^{m} |
4. distance < | disp^{m} |

QUESTION

The numerical ratio of displacement to distance is...

1. always less than 1
2. always greater than 1
3. always equal to 1
4. may be less than 1 or equal to 1

- **The magnitude of displacement may or may not be equal to the path length travelled by an object.**

- **The magnitude of the displacement for a complete motion may be zero but the corresponding path length is not zero.**

QUESTION

If initial position (x_1, y_1, z_1) & final finsitia (x_2, y_2, z_2) then find distance & displacement?

QUESTION

If initial position of object (2, 6, 9) and final position (8, -2, 19) then find displacement and distance

distance → Can't find

displacement → $\text{disp}^n = \vec{x}_f - \vec{x}_i$

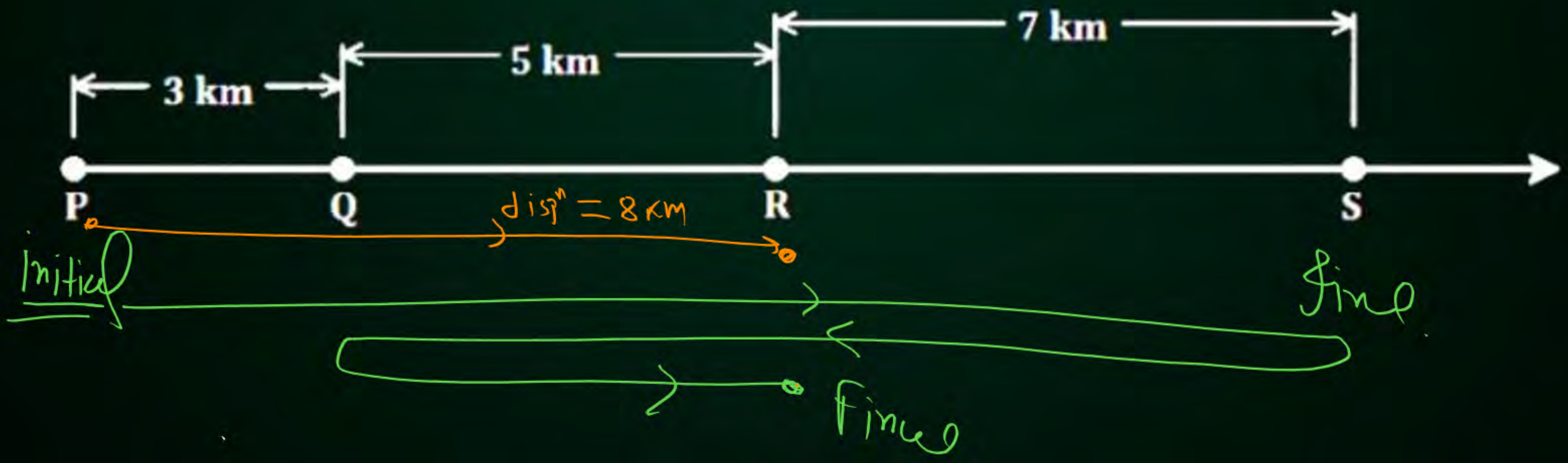
$= (8\hat{i} - 2\hat{j} + 19\hat{k}) - (2\hat{i} + 6\hat{j} + 9\hat{k})$

QUESTION

A car moving along in a straight highway from point P to point Q to point R and to point S, then back to point Q and finally to the point R as shown in the figure below.

(a) Find the distance travelled by car.

(b) Find the displacement of the car. 8km

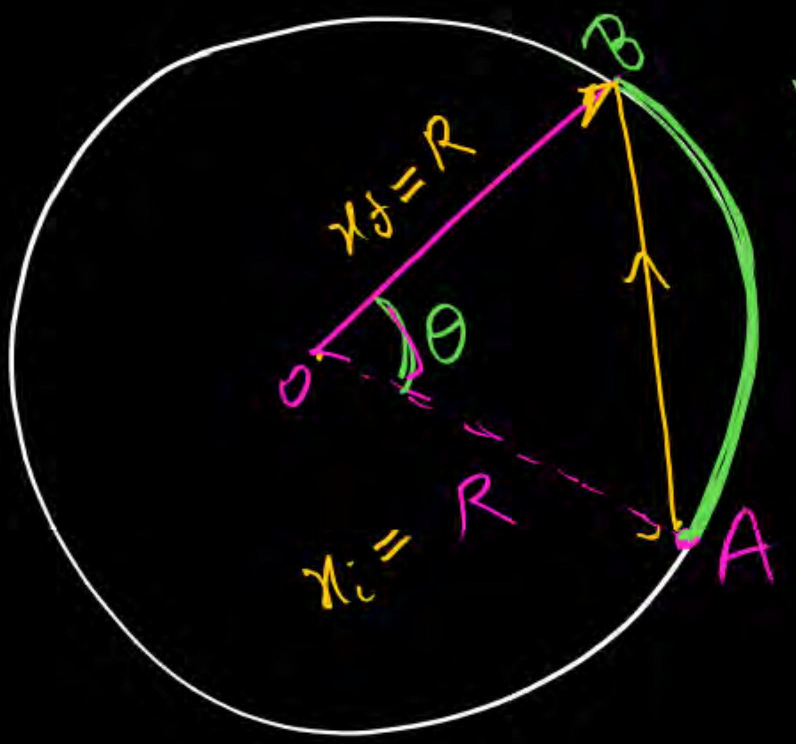


distance on circular Path = $R\theta$

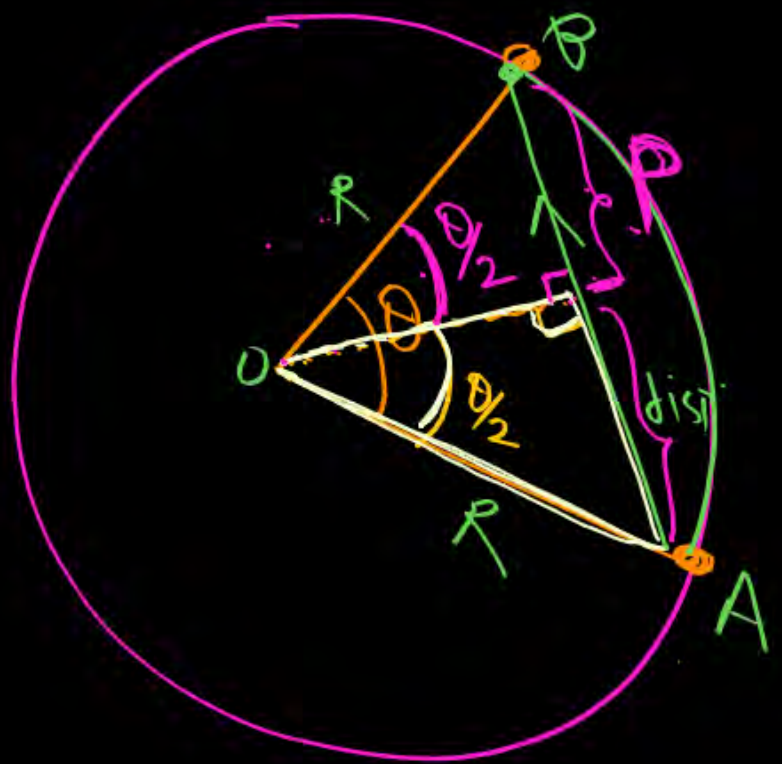
displacement on circular Path. ✓

$= \vec{x_f} - \vec{x_i}$

$= 2R\sin(\theta/2)$



method-2

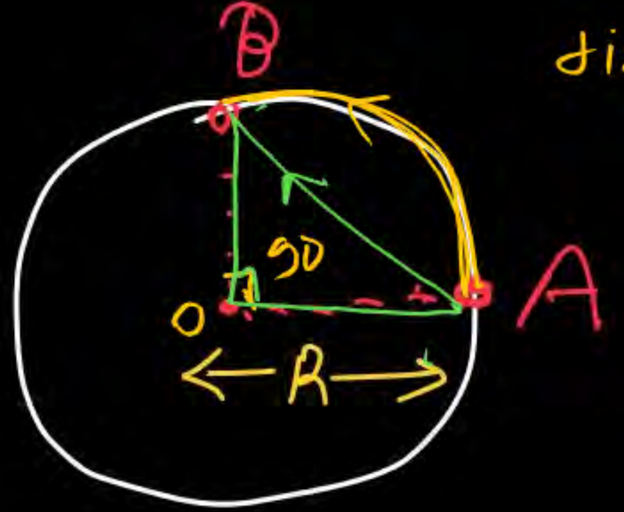


$\sin(\theta/2) = \frac{P}{R}$

$P = R\sin(\theta/2)$

$(\text{dist}^n)_{AB} = 2P = 2R\sin(\theta/2)$ → disp^m

Find Ratio of dispm to distance when body moves from A to B



$disp^m = 2R\sin(\theta/2)$

$= 2R\sin(90/2)$

$= 2R\sin(45)$

$= \frac{2R}{\sqrt{2}}$

$disp^m = \sqrt{2}R$

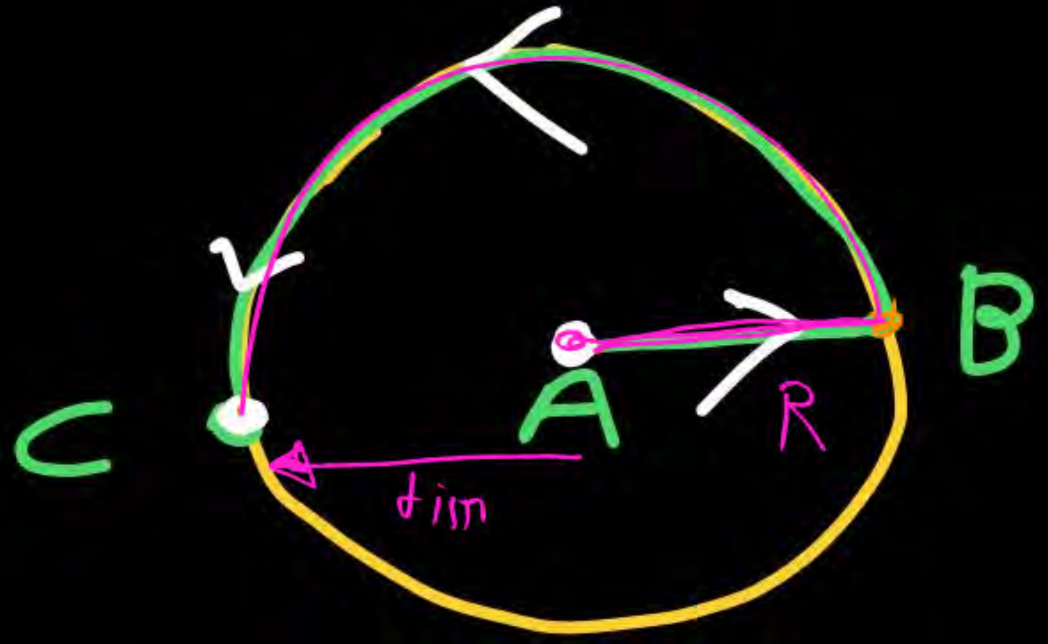
$dis^n = Arc$

$= R\frac{\pi}{2}$

Find ratio of $dist^n$ to $disp^m$ when object moves from A to C

$dist^n = (R + \pi R)m$

$|disp^m| = R$



Kallya complete one round of circular Path in 40 sec, what will be displacement in 3 mint 20 sec

$T = 200$ sec



$T = 40$ sec. (1 round)
$= 40$ sec
$= 40$ sec
$= 40$ sec
40 sec
200 sec → 5 round comp

$disp^m = 0$

$(dist^n)_{1\ Round} = 2\pi R$

$disp^n_{1\ round} = 0$

Position of object given as $x = (t^2 + 2t + 3)\,m$

find Position at $t = 2$ sec $\rightarrow$ $x_{(t=2)} = 2^2 + 2\times 2 + 3$

$= 4 + 4 + 3$

$= 11\,m$

find disp^n in $t = 2$ sec.

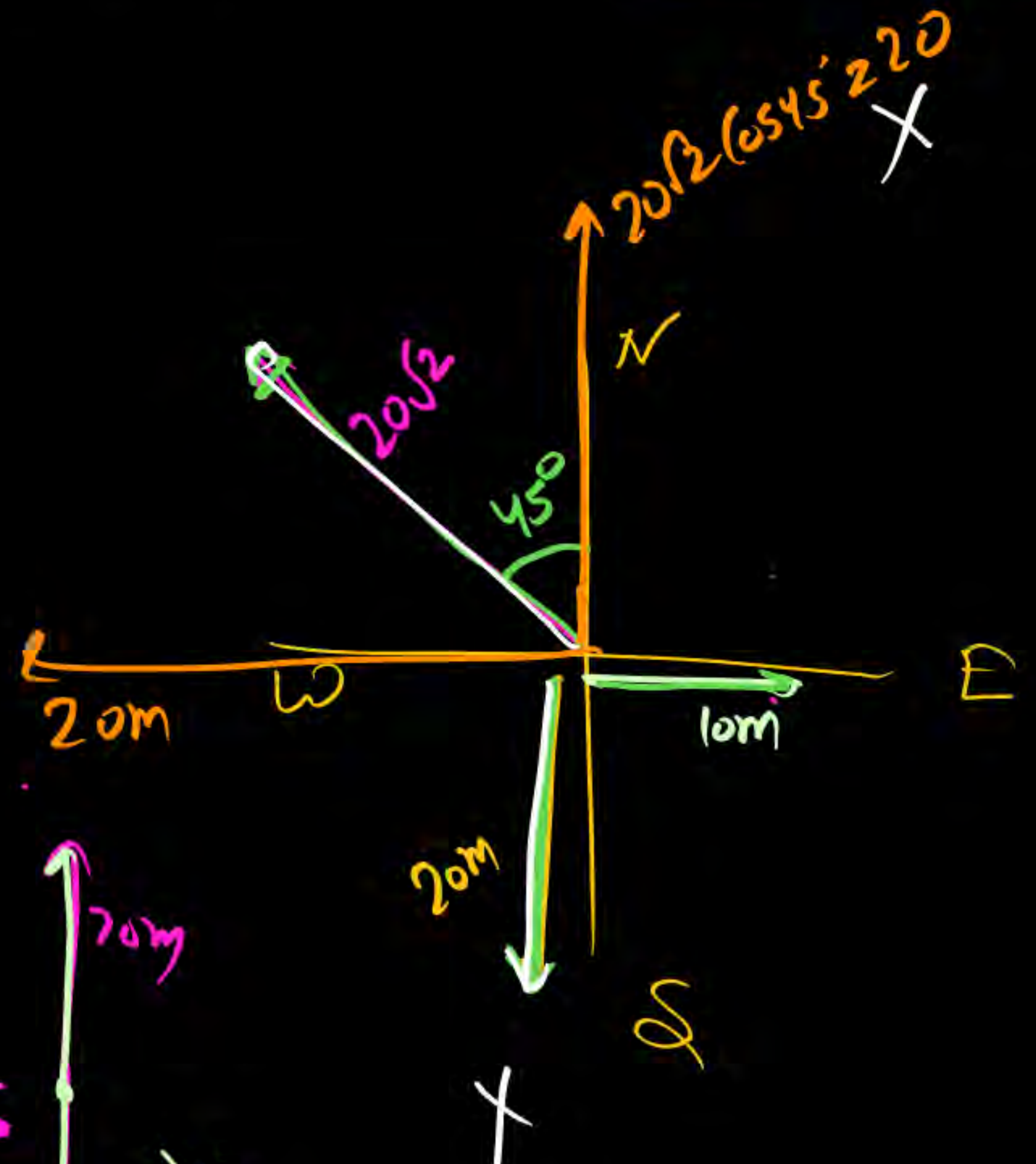
disp^m = change in Post^n $= (x_f)_{t=2} - (x_i)_{t=0}$

$= 11 - (3)$

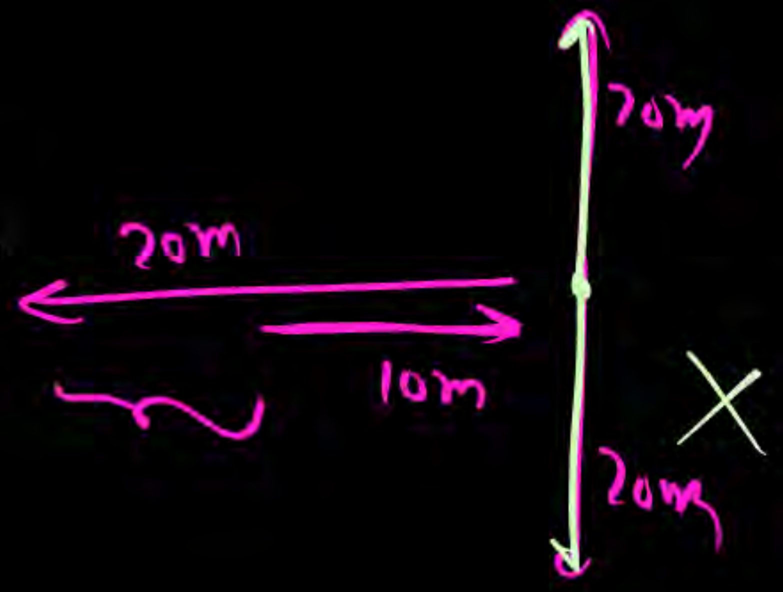
$= 8\,m$

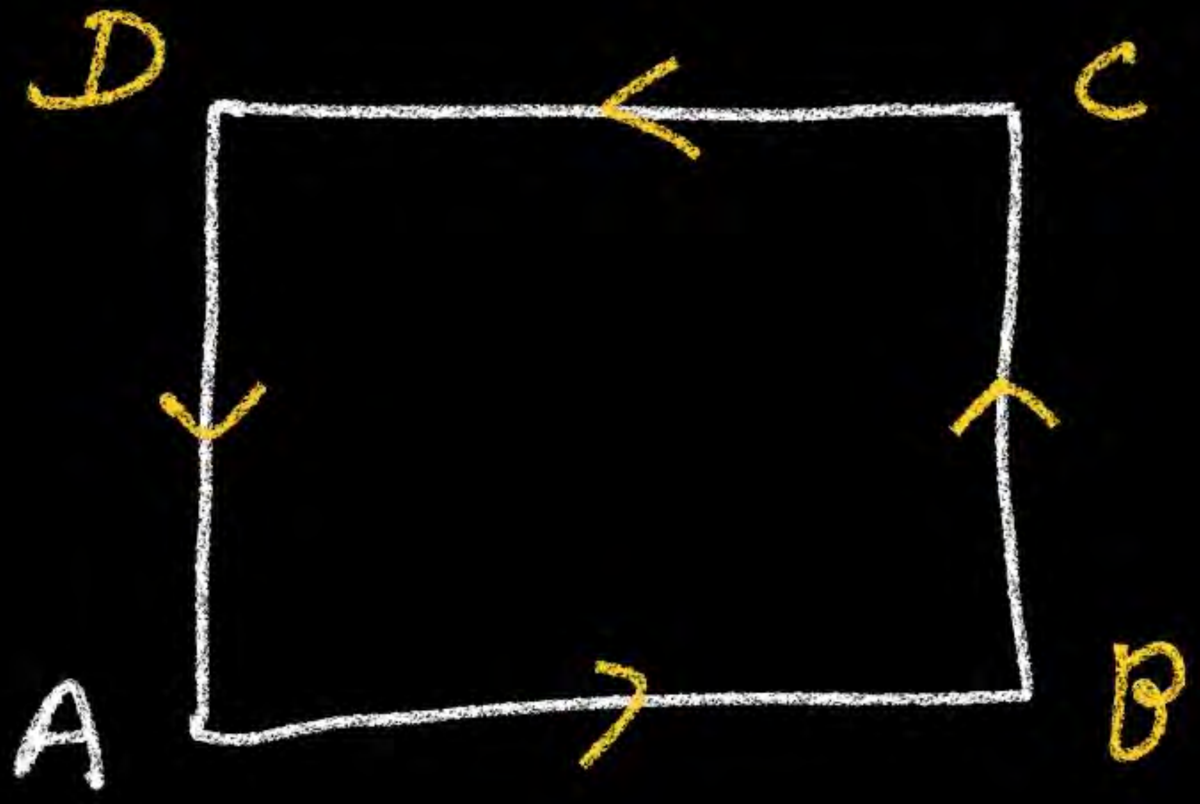
A students moves 10m towards east then 20m South and then $20\sqrt{2}$ North west then find displacement

(10m west) Ans.

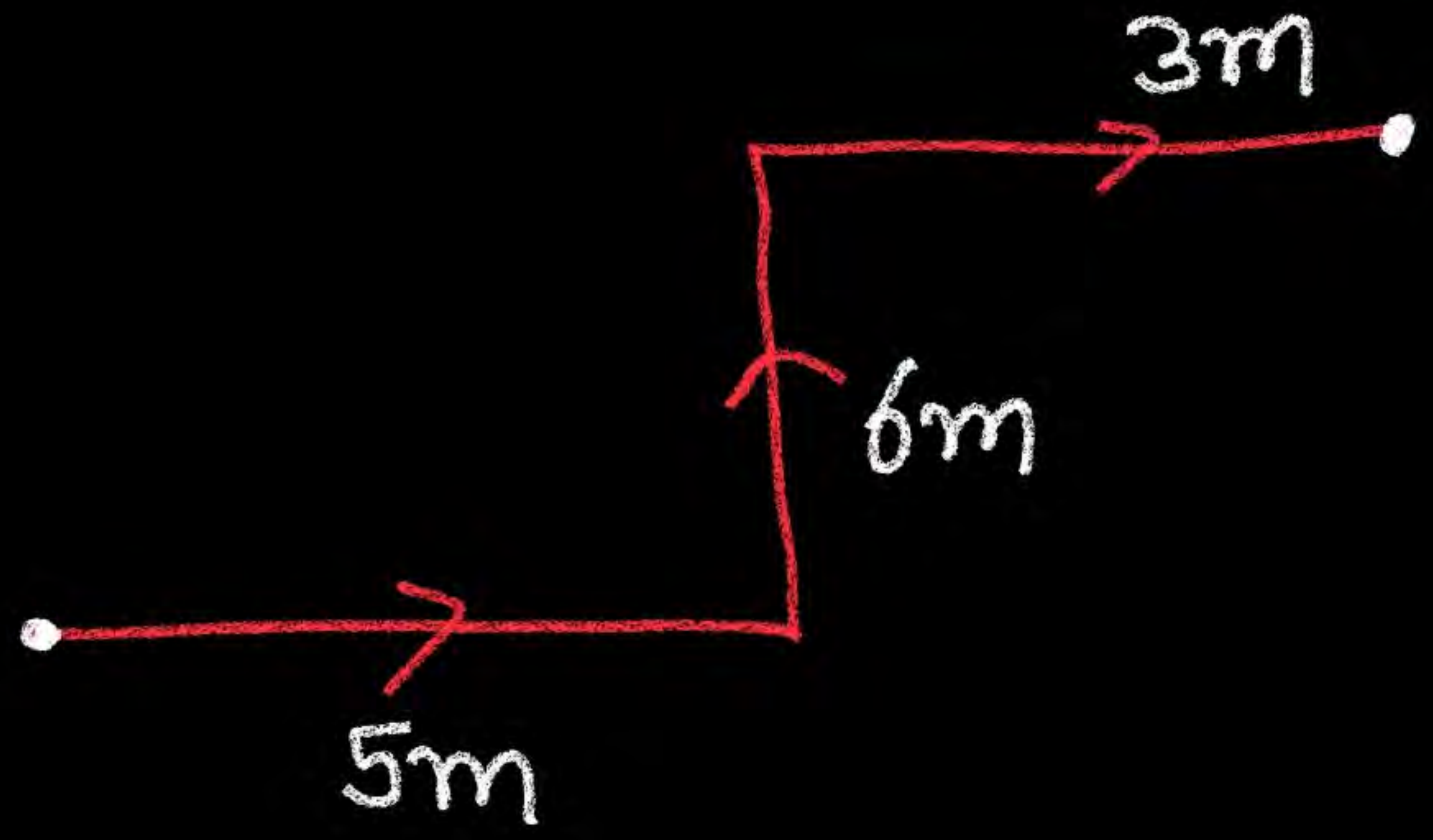


(Next Class में)





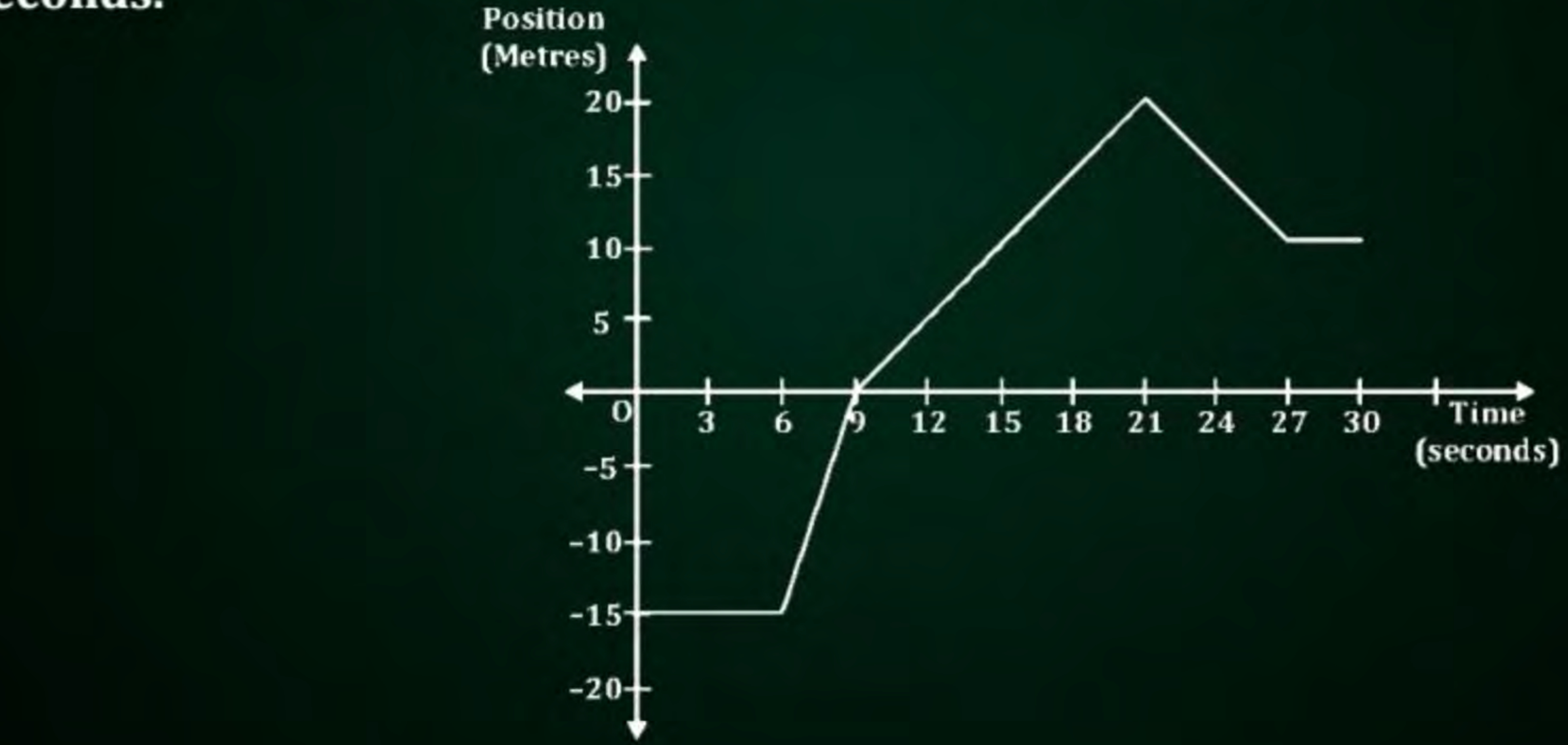
Path	distance	dispn
A→B		
A→C		
A→D		
A→A		



3m
6m
5m

QUESTION

The position-time graph for an elevator travels up and down is given below. Find the distance and displacement of the elevator between 6 seconds and 21 seconds.



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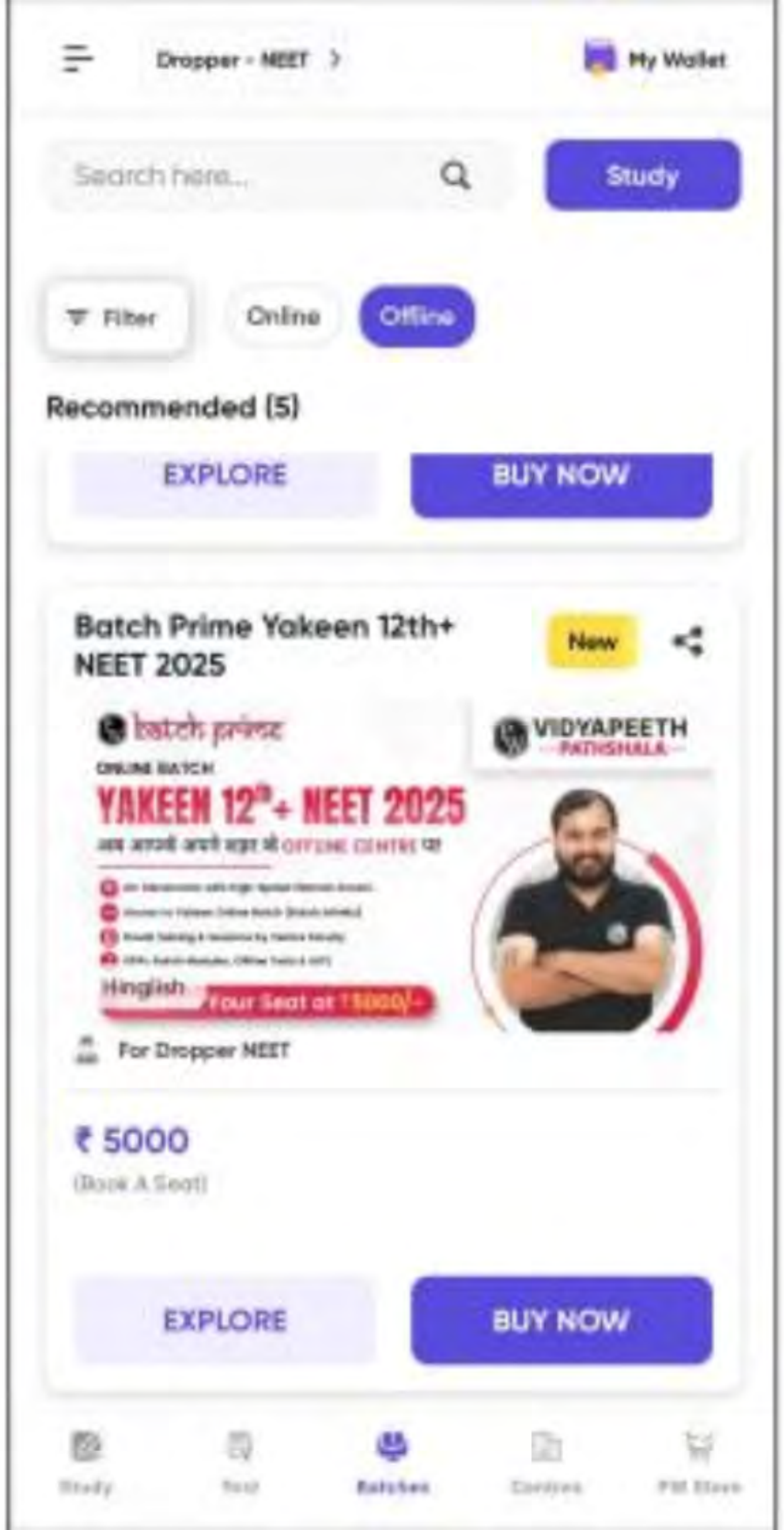
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THANK YOU

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FOR NEET 2025

Lecture-02 | Physics

Motion In a Straight Line

By- Dr. Manish Raj (MR SIR)



Topics to be covered [redacted]

3:15 subject graph
Technical
9:00

1 # H/W

2 # questions on distn / dispm

3 # Speed & velocity

4 # Question on displacement and speed / Velocity

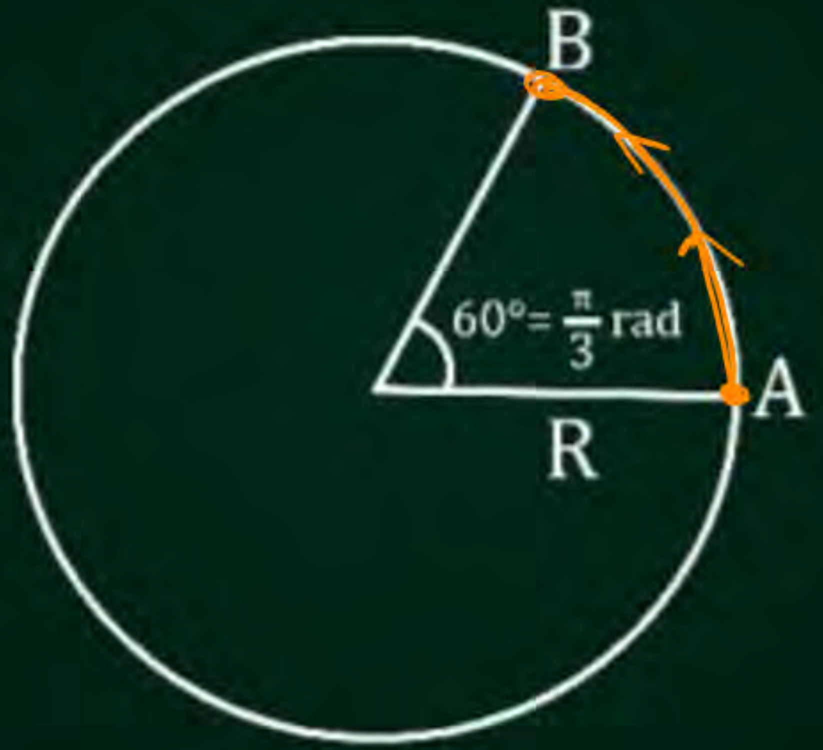


QUESTION

Gauss Law

$\phi = E \cdot A = \frac{N m^2}{C}$

1. **Object moves on a circular path by angle 60° then find ratio of distance to displacement.**



$\text{distance} = R\theta = \frac{R\pi}{3}$

$\text{disp}^m = 2R\sin(\theta/2)$

$= 2R\sin\left(\frac{60}{2}\right)$

$= 2R \times \frac{1}{2} = R$

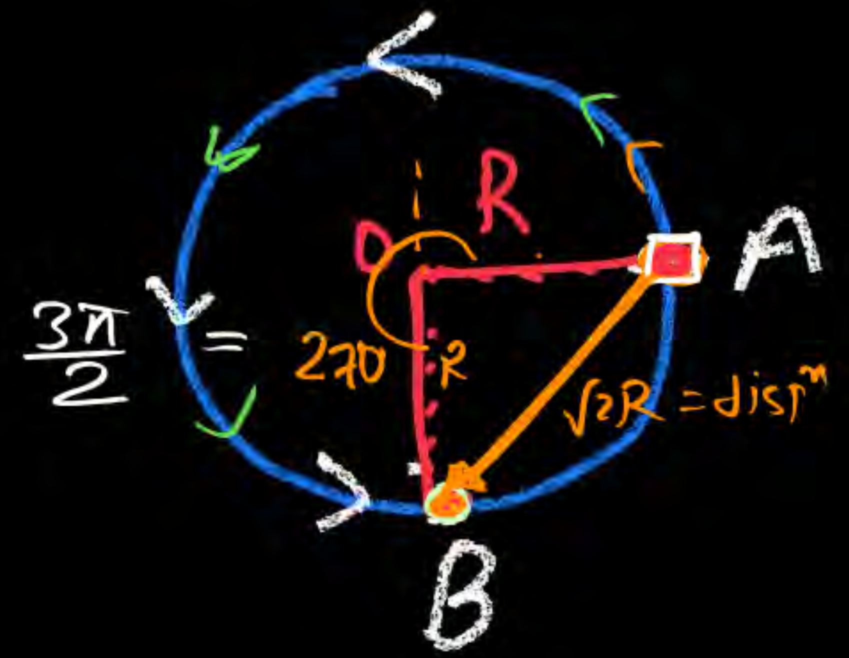
$\frac{\text{dist}^n}{\text{disp}^m} = \frac{\pi R}{3 \times R} = \left(\frac{\pi}{3}\right)$

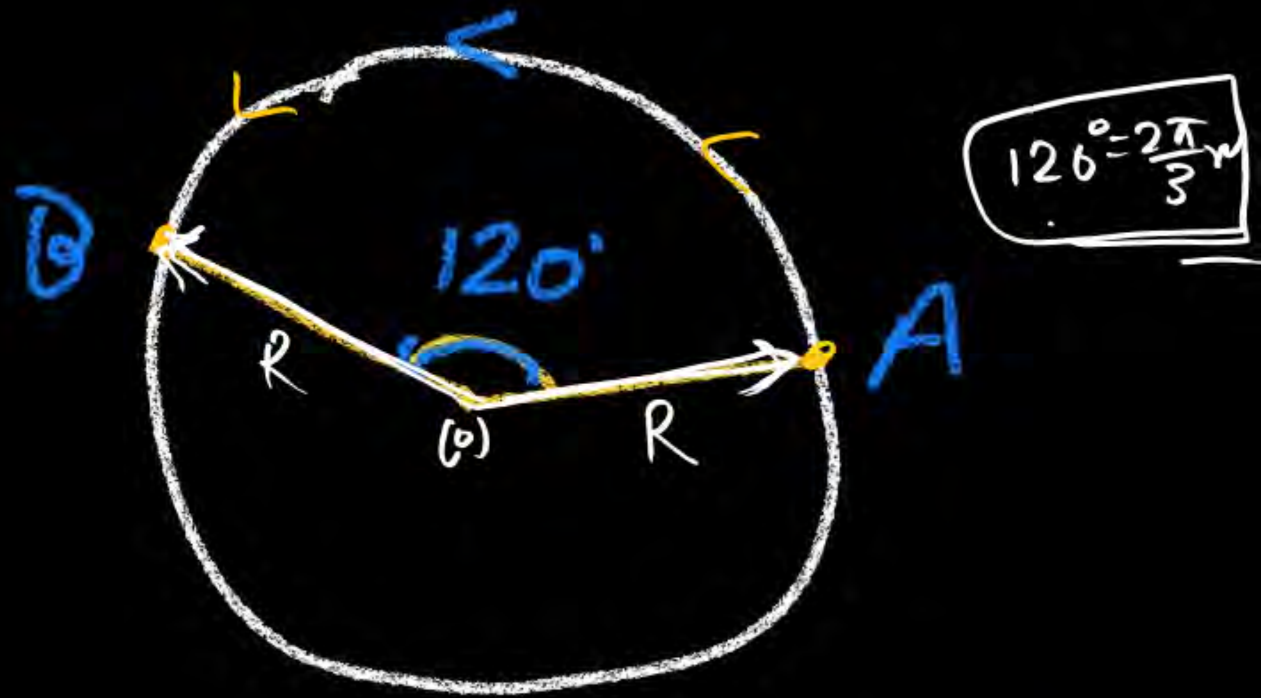
$d = \frac{m}{V} = \frac{m}{l^3}$

$d = \frac{m}{l^3}$

$\frac{\Delta d}{d} = \left(\frac{\Delta m}{m}\right) + 3\frac{\Delta l}{l}$

$100 \times \left(\frac{\Delta m}{m}\right) = \left(\frac{\Delta d}{d} + 3\frac{\Delta l}{l}\right) \times 100$





distⁿ = Arc length

$$\text{dis} = R\theta = \frac{R3\pi}{2} = \frac{3\pi R}{2}$$

$$\text{disp}^n = 2R\sin\theta/2$$

$$= 2R\sin\left(\frac{270}{2}\right)^{135}$$

$$= 2R\frac{1}{\sqrt{2}}$$

$$= \sqrt{2}R$$

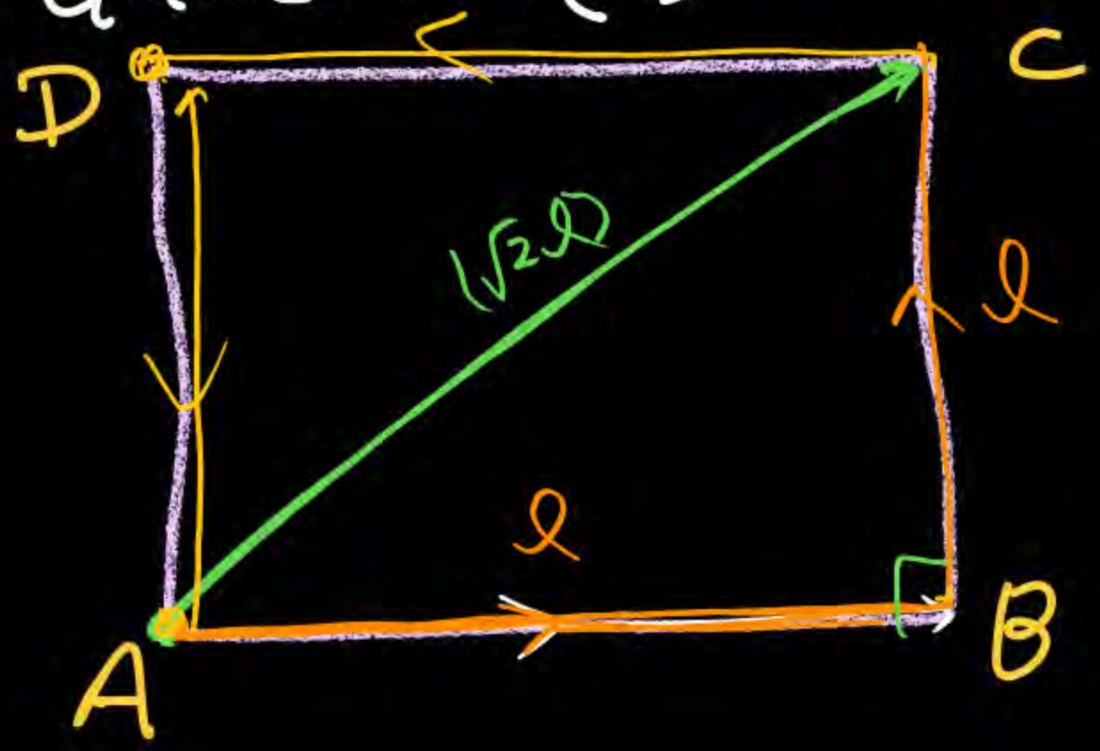
$$\text{dist}^n = R\theta = R\left(\frac{2\pi}{3}\right)$$

$$\text{disp}^n = 2R\sin\left(\frac{120}{2}\right)^{60}$$

$$= 2R\frac{\sqrt{3}}{2}$$

$$= \sqrt{3}R.$$

Question(2)



Motion	dispm	distn
$A \to B$	l	l
$A \xrightarrow{B} C$	$\sqrt{2}l$	$2l$
$A \xrightarrow{B \to C} D$	l	$3l$
$A \to A$	0	$4l$

"Object is moving on the side of square park of side length l.



QUESTION

Fill in the blanks : (may/must/must not/may not)

A. Distance travelled by object is zero the displacement must not be non-zero.

B. Distance travelled by object is not zero then displacement may be zero.

C. Displacement moved is zero then distance may or may not zero

D. If displacement is not equal to zero then distance (must not) equal to zero.

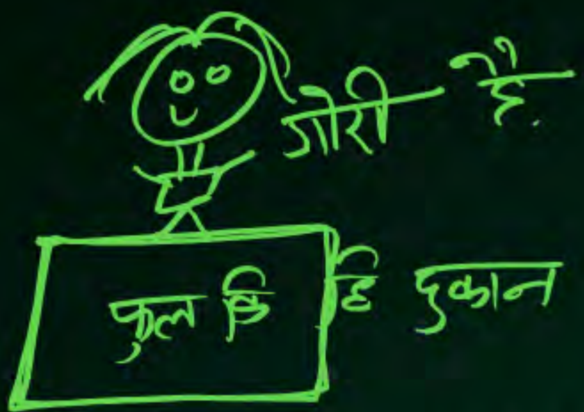
Case-1 (C)





Case-2

QUESTION



True / False :

A. Particle is moving on straight line, distance is equal to displacement (U-turn may be taken) — false

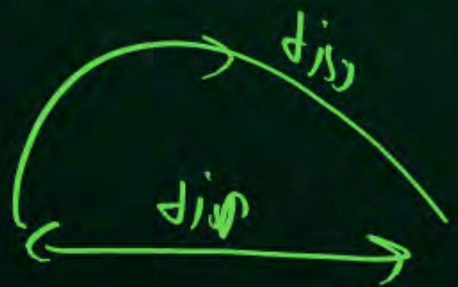
B. Displacement independ of choice of frame of reference — false

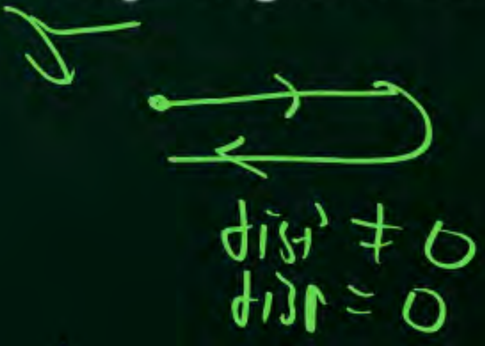
C. For a particle moving on parabolic path distance always grater than displacment — True

D. Displacement is not zero; then distance must not be zero — True

E. Distance is not equal to zero; then displacement may equal to zero. — True







QUESTION

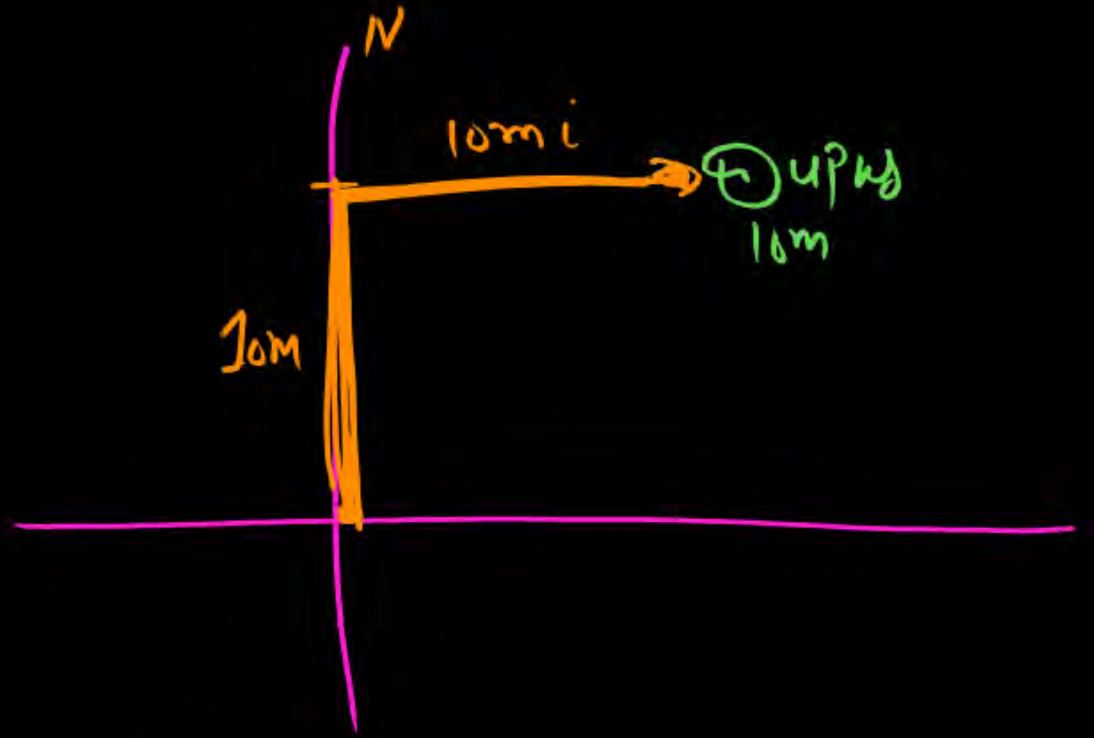
Statement-1: Distance and displacement is different physical quantity.

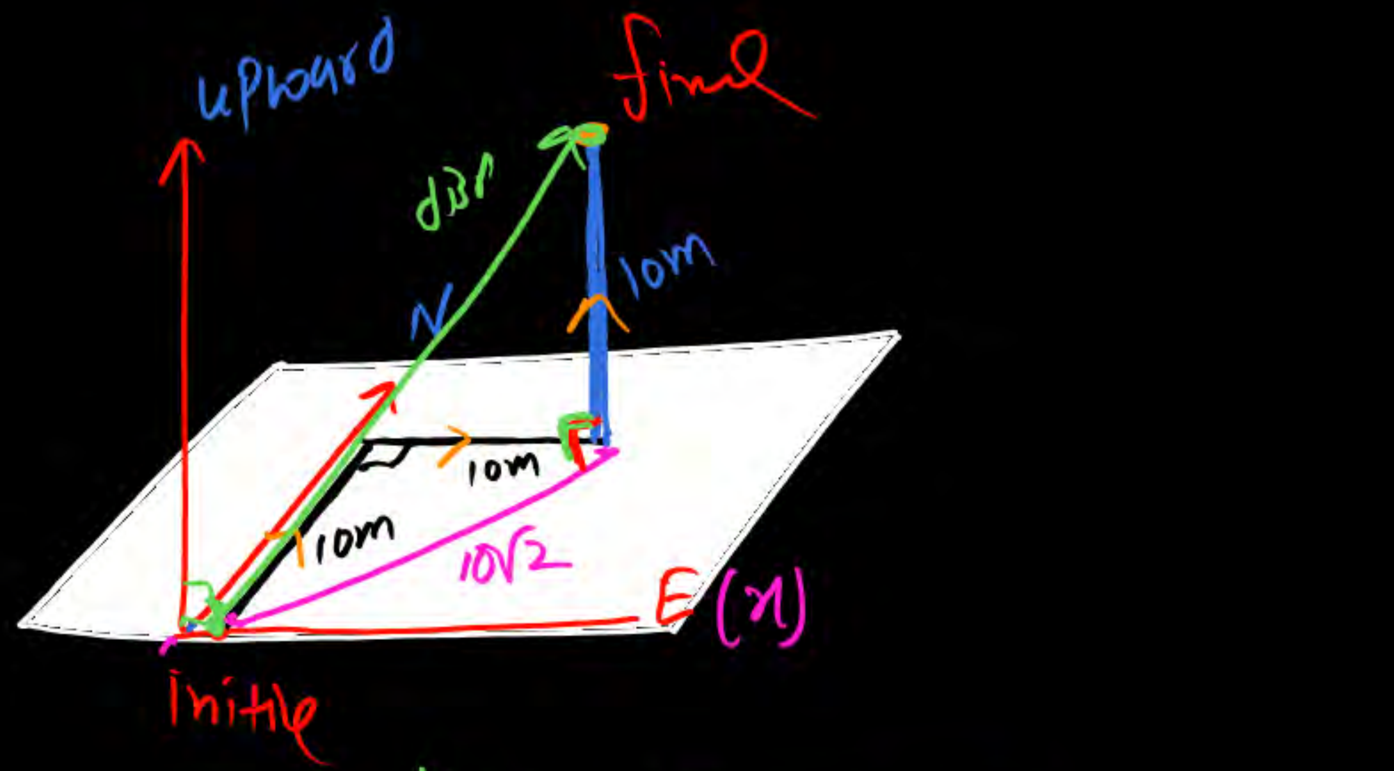
Statement-2: Distance and displacement have same unit and dimension.

1. Both are wrong
2. Both are correct
3. 1st wrong, 2nd correct
4. 1st correct, 2nd wrong

(question) 1

Ramlal moves 10m North then 10m east, then 10m climb upward then find displacement.





$\vec{S} = 10\hat{j} + 10\hat{i} + 10\hat{j}$

$|S| = \sqrt{10^2 + 10^2 + 10^2} = \sqrt{300} = 10\sqrt{3}\,m$

$dis = \sqrt{(10\sqrt{2})^2 + (10)^2}$

$= \sqrt{100 \times 2 + 100} = \sqrt{300} = 10\sqrt{3}$

QUESTION

Object moves from A(2, 3, –4) to B(3, 4, 1) to C(5, 7, 1). Find distance and displacement from A to C.

initial

final

dist^n → not able to find

$$disp^n = (\vec{r}_f)_C - (\vec{r}_i)_A$$

$$= 5\hat{i} + 7\hat{j} + 1\hat{k} - (2\hat{i} + 3\hat{j} - 4\hat{k})$$

$$disp^n = 3\hat{i} + 4\hat{j} + 5\hat{k}$$

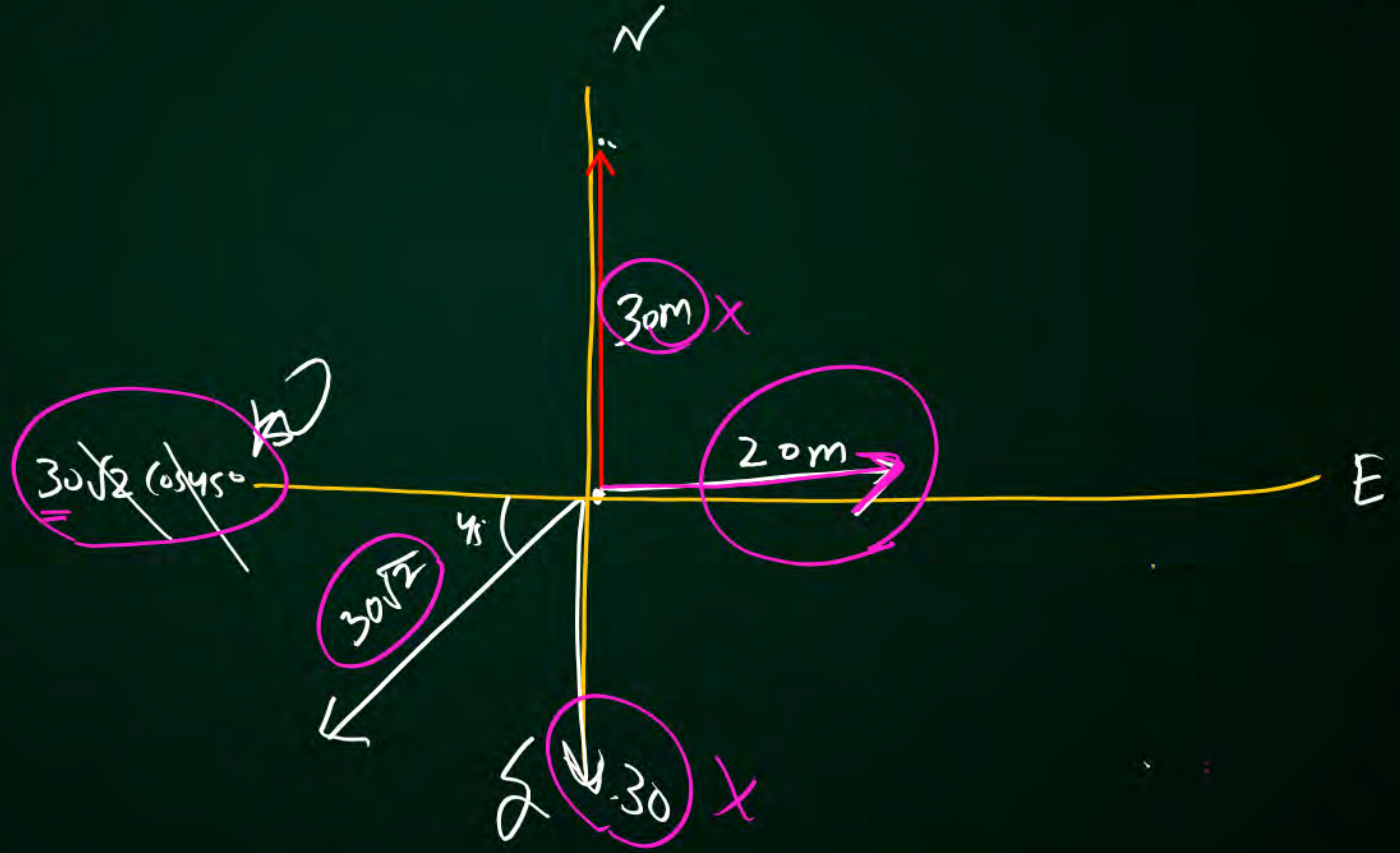
$$|disp| = \sqrt{9+16+25} = \sqrt{50} = 5\sqrt{2}$$



QUESTION

A person moves 30 m north and then 20 towards east and finally $30\sqrt{2}$m in south-west, then displacement. **(IIT-2012)**

1. 10 m North
2. 10 m South
3. 10 m West
4. Zero



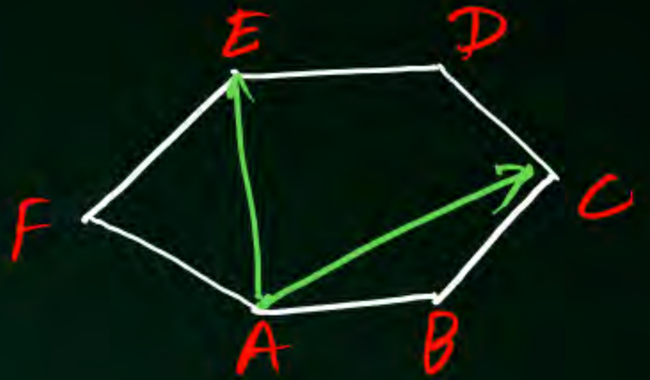
QUESTION

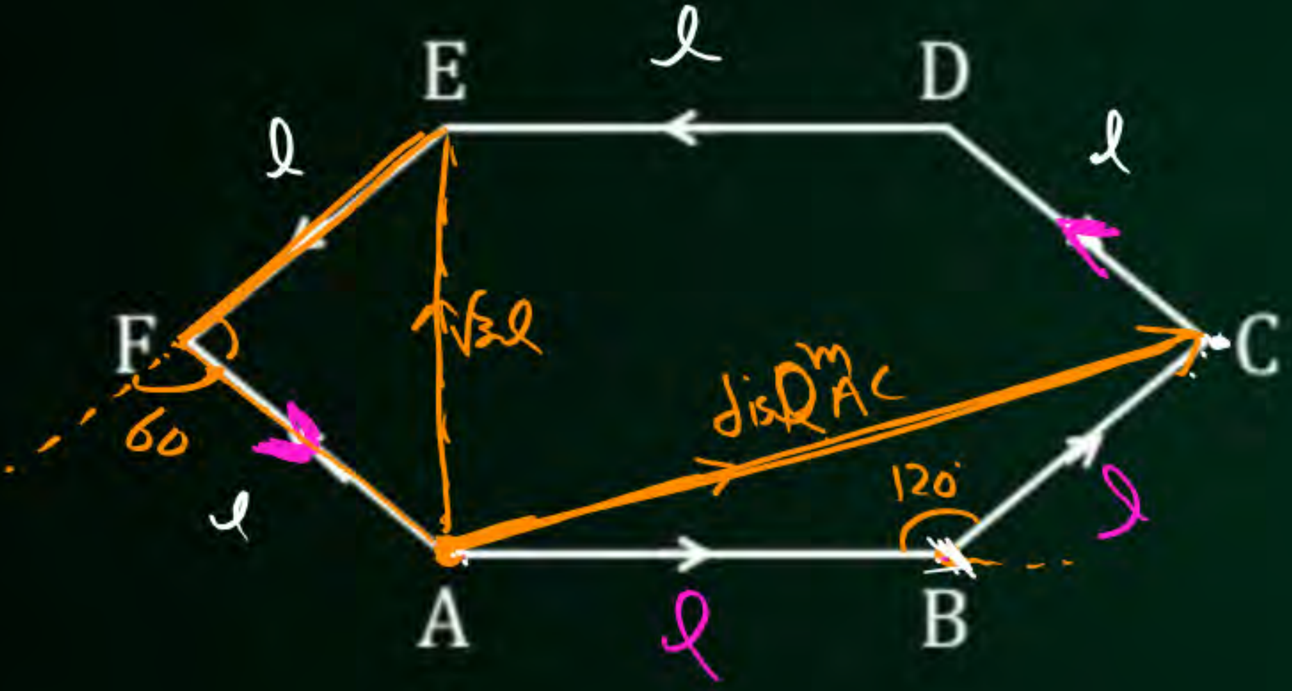
A person moves 20 m North then 30 m towards East and finally $40\sqrt{2}$ m South-West then his displacement.

1. $10\sqrt{2}\tan^{-1}(2)$ South of west
2. $10\sqrt{5}\tan^{-1}(2)$ South of west
3. $10\sqrt{5}\tan^{-1}(1/2)$ West of South
4. Both (2) and (3)

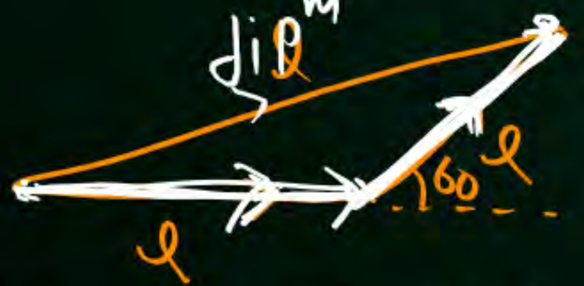
QUESTION

Object is moving on Hexagonal Path of side l.



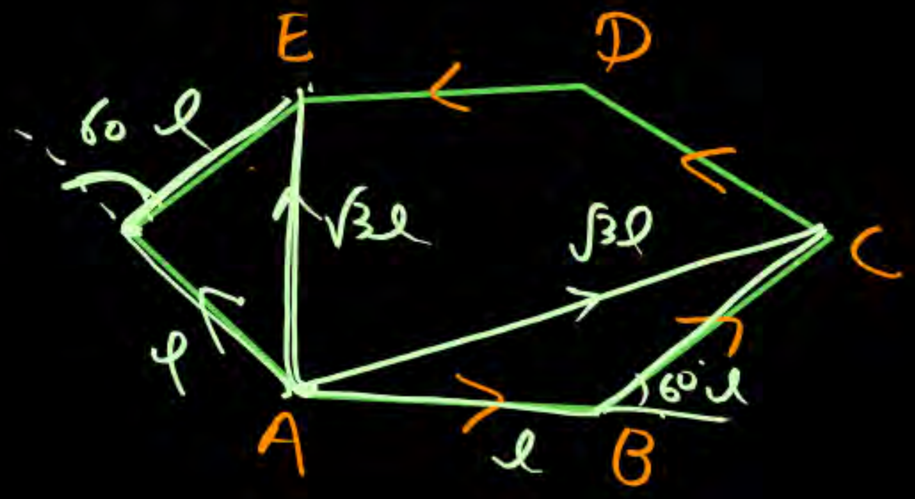


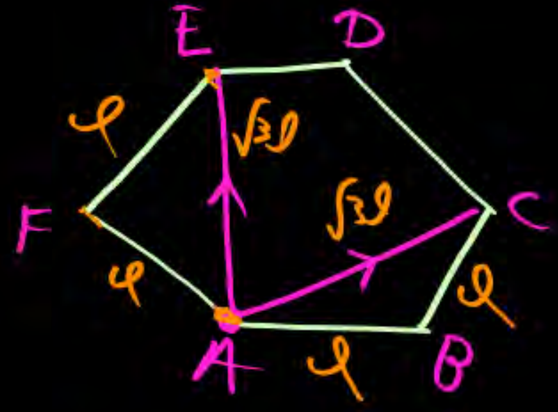
Motion	Distance	Displacement
$A \rightarrow B$	l	l
$A \rightarrow C$	$2l$	$\sqrt{3}l$
$A \rightarrow D$	$3l$	$2l$
$A \rightarrow E$	$4l$	$\sqrt{3}l$
$A \rightarrow F$	$5l$	l
$A \rightarrow A$	$6l$	0



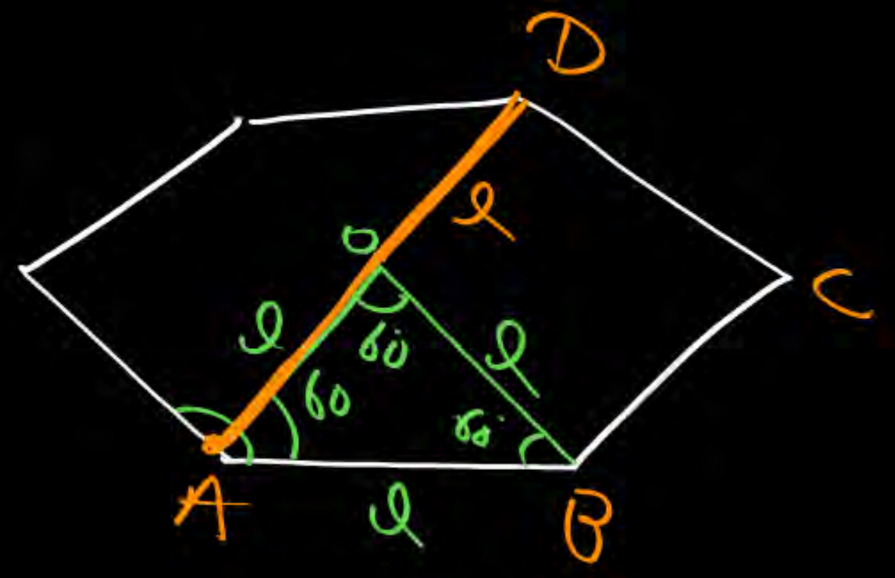
$$\text{dis}^{m} = \sqrt{l^2 + l^2 + 2ll\cos 60^\circ} = \sqrt{3}l$$







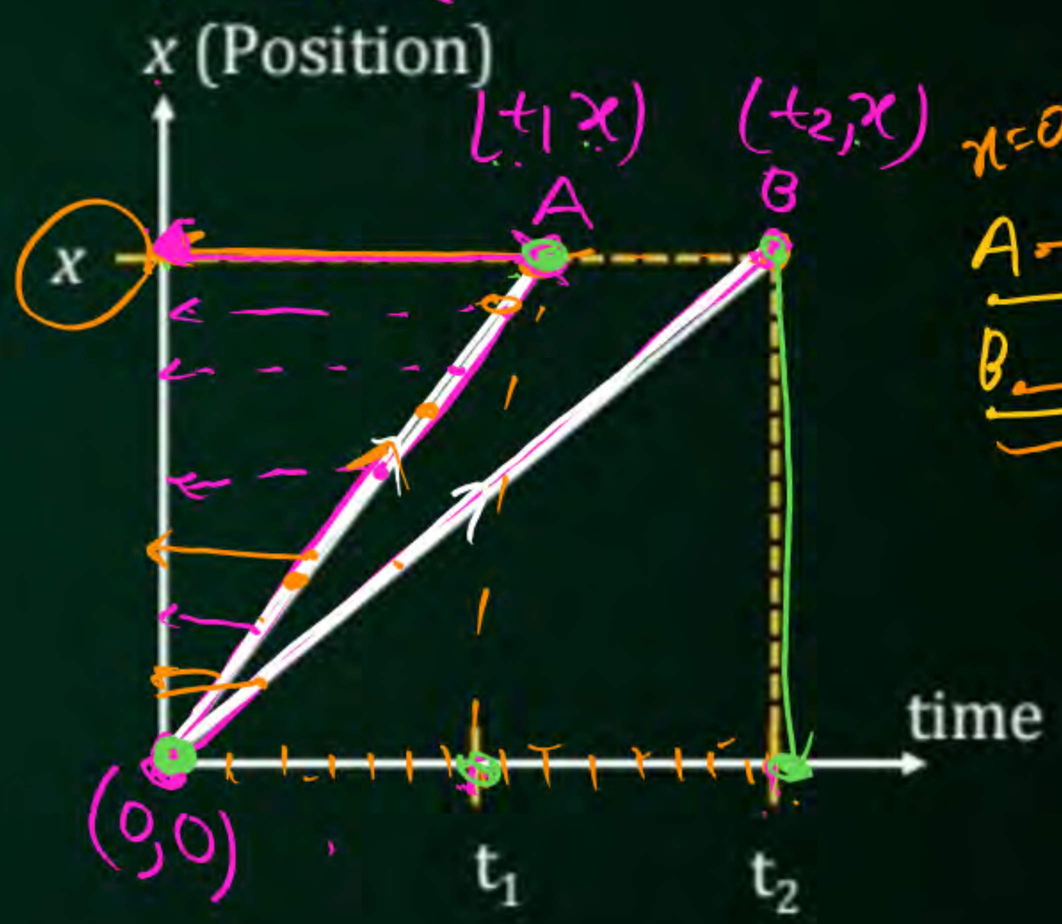
$\Rightarrow (AC = AE)$


D
C
A
B
O
60
60
60

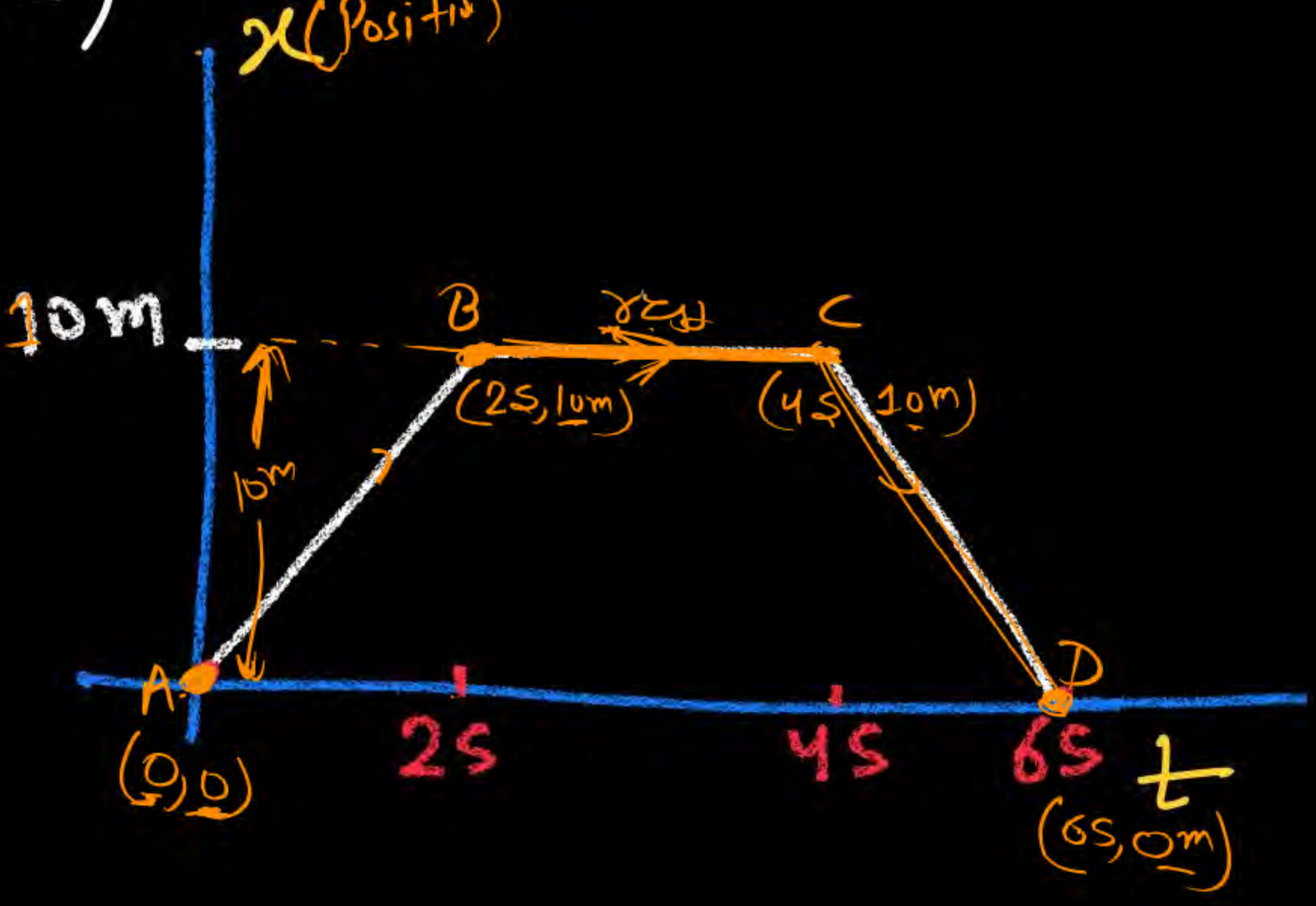
QUESTION

Position-time graph for two man are moving along x-axis as shown; then find correct relation between

1. displacmeent = displacement
2. displacmeent > displacement
3. displacmeent < displacement
4. None of these

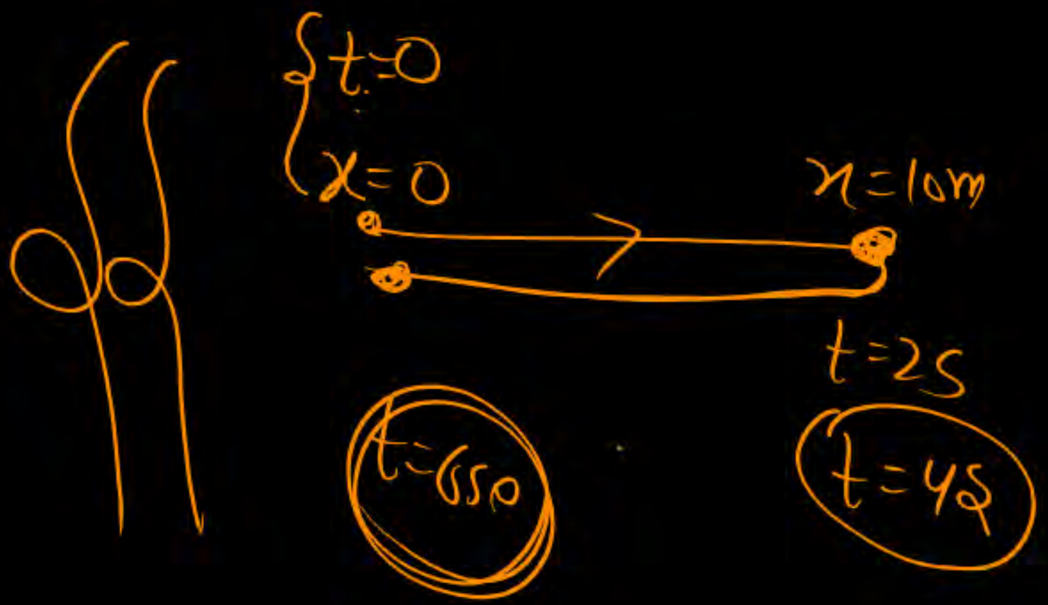


Q.2 (4)

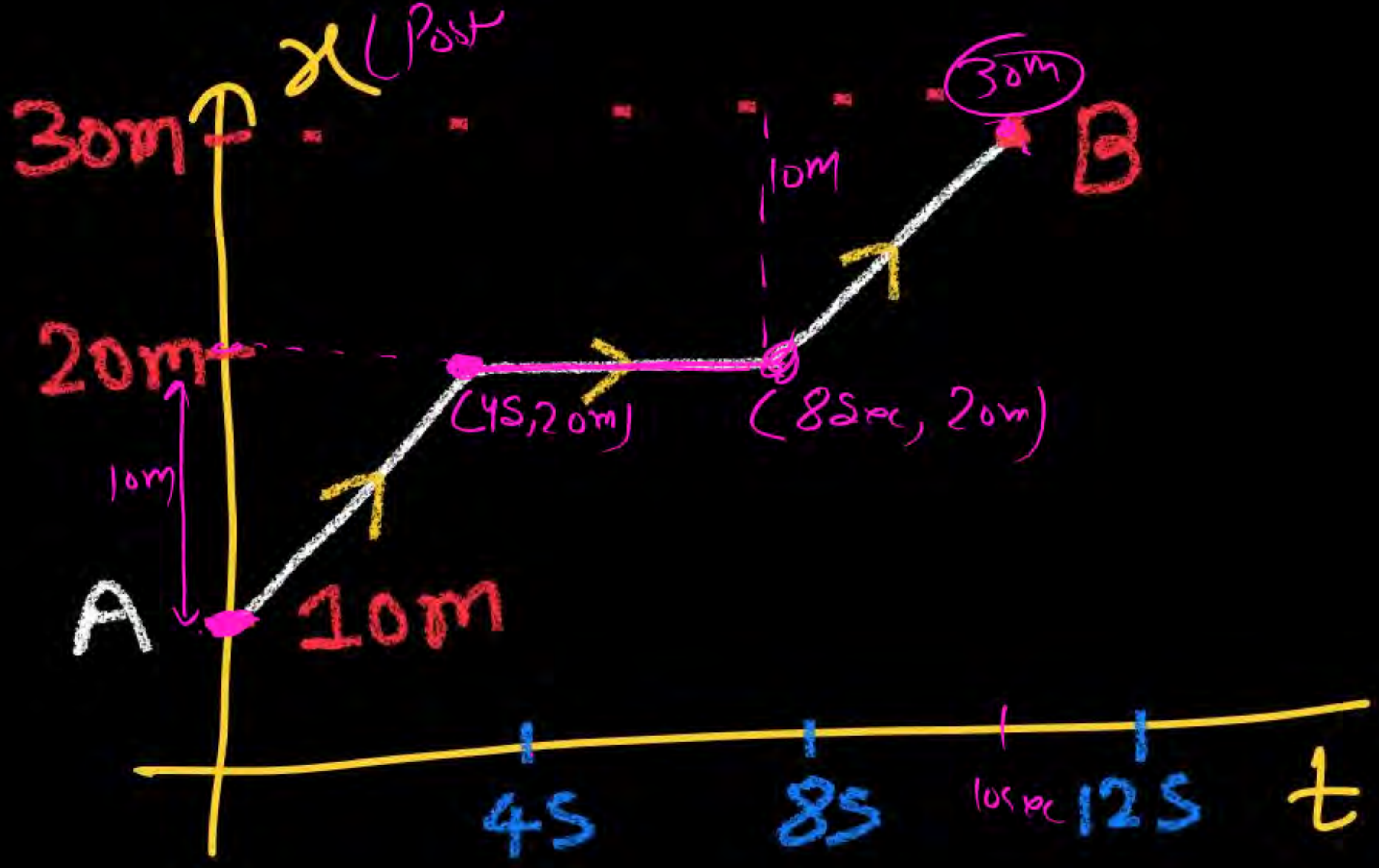


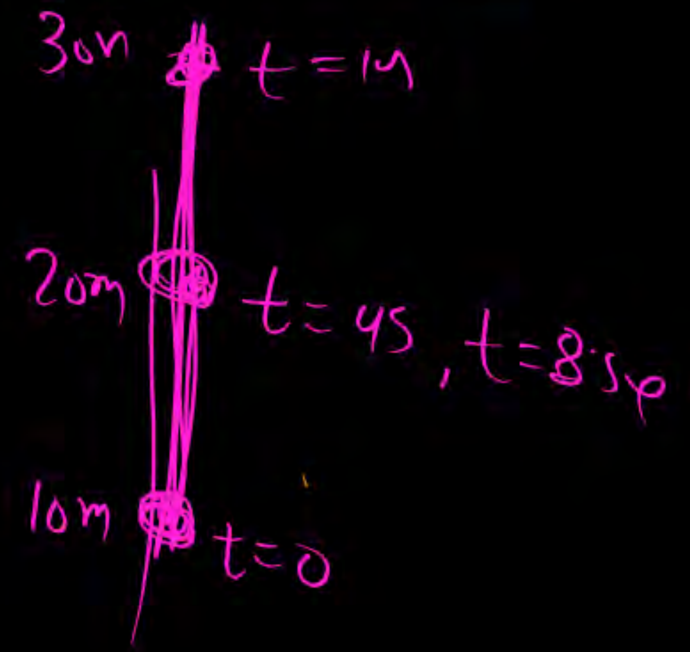
$$|distance|_{A \to D} = 20m$$

$$|disp^m|_{A \to D} = 0 - 0 = \underline{0m}$$



Question 3





$|distance|_{A \to B} = ??$

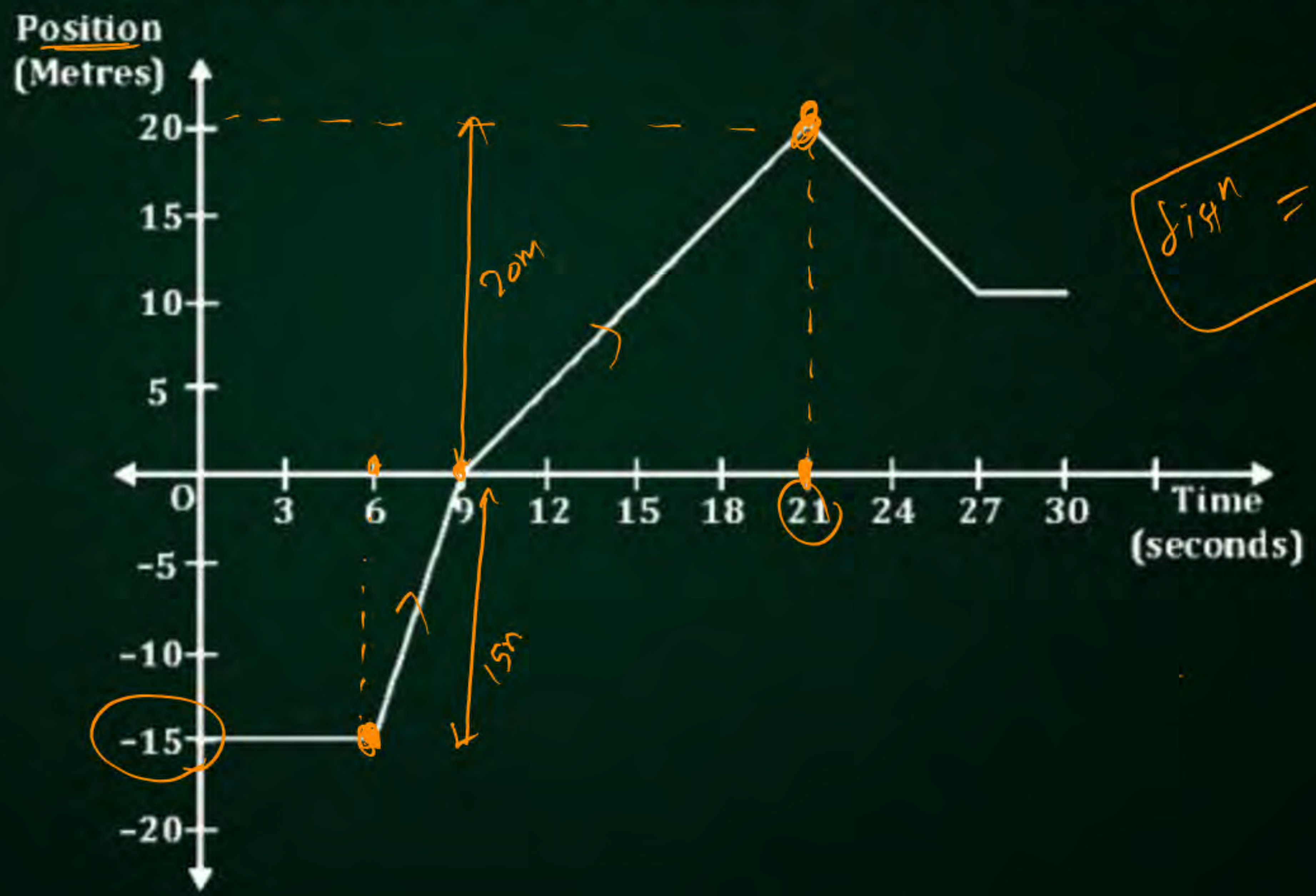
$= 20m$

$disp^n = 30 - 10$

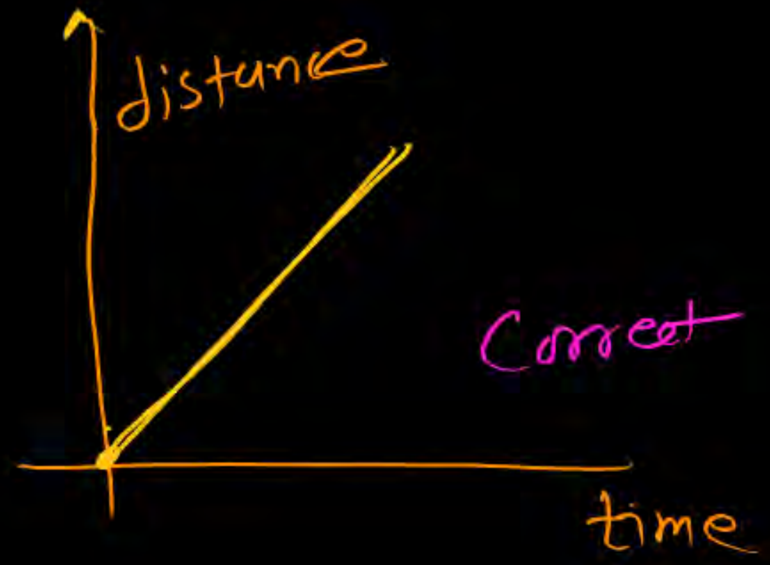
$= 20m$

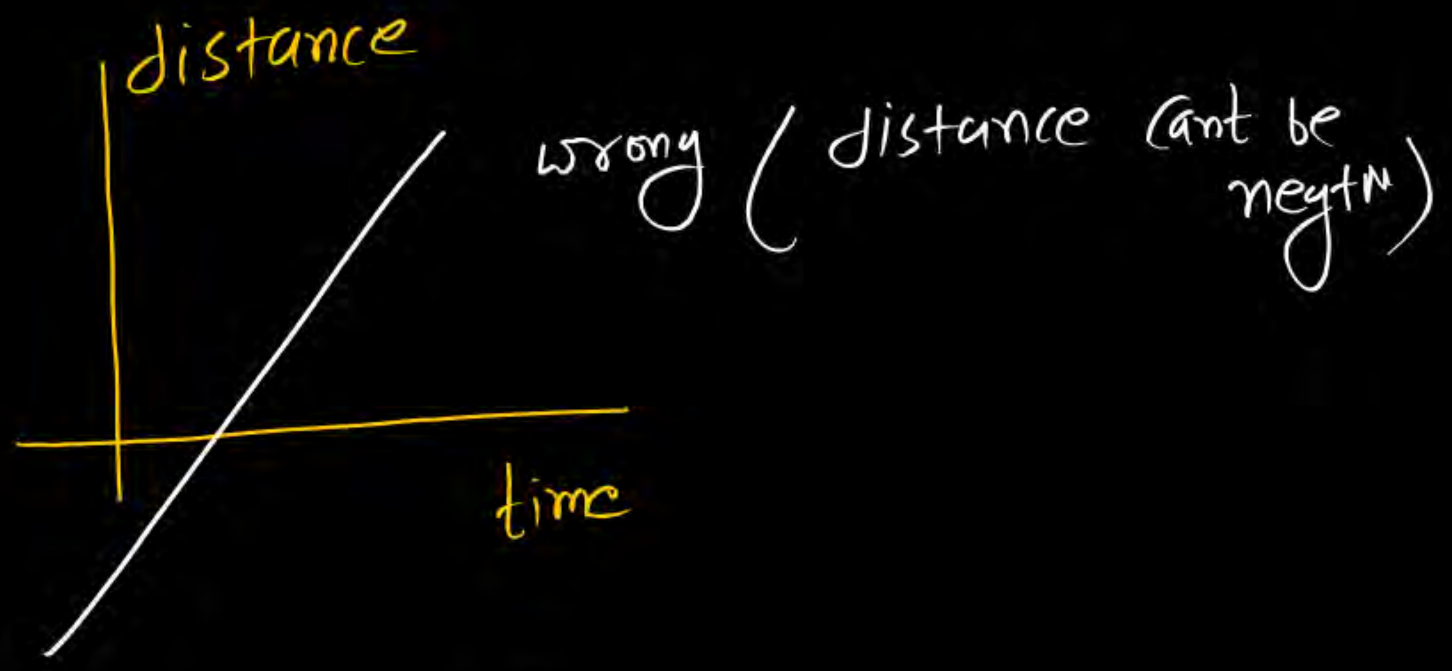
QUESTION

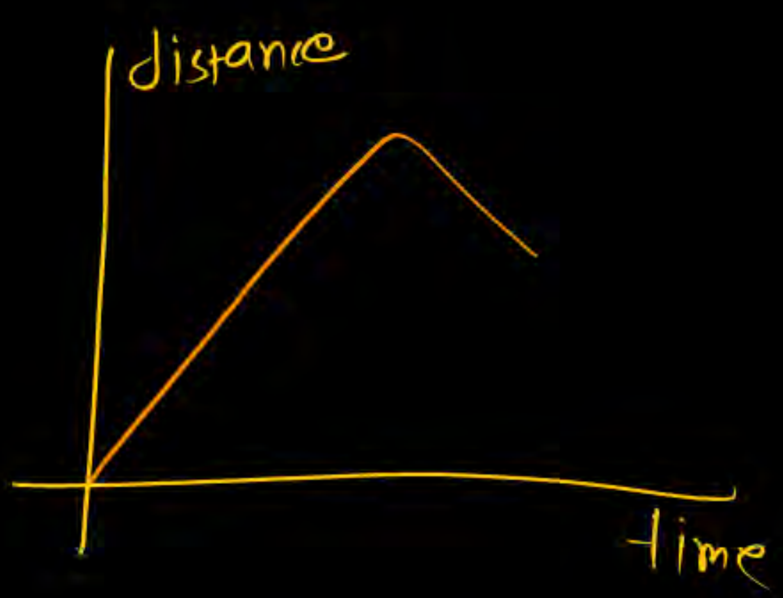
The position-time graph for an elevator travels up and down is given below. Find the distance and displacement of the elevator between 6 seconds and 21 seconds.

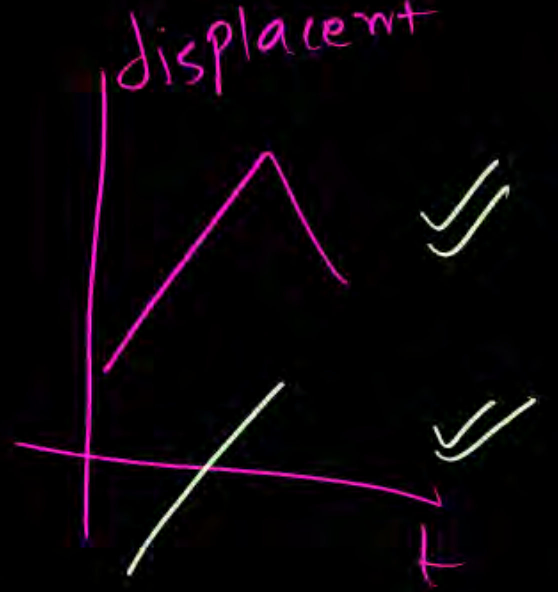


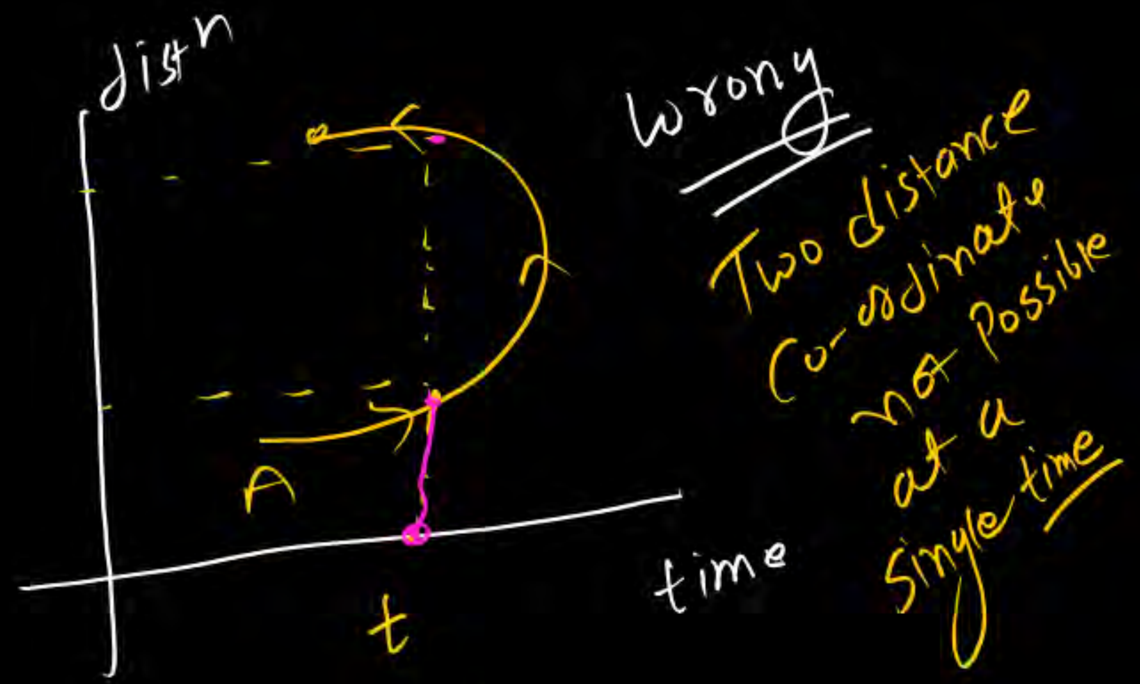
$$dis^n = 35m = disp^n$$







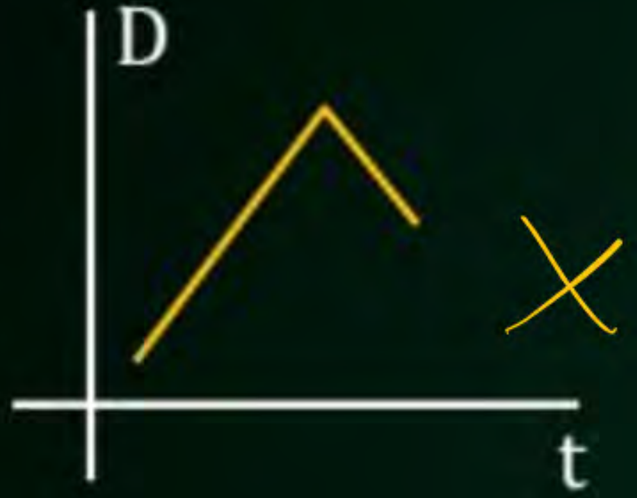


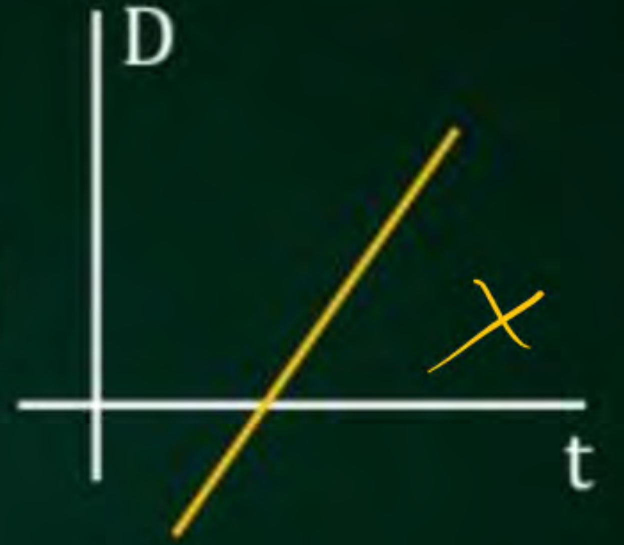


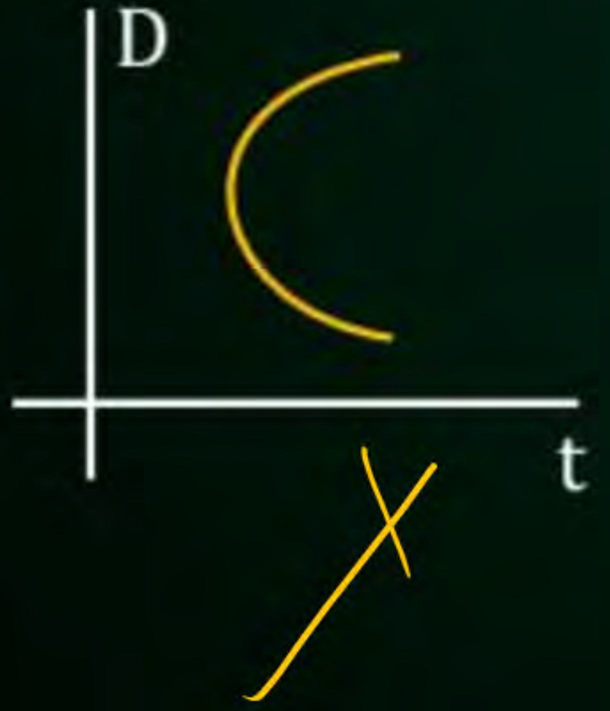
wrong graph
because dist^n can't decrease with time.

QUESTION

Which of the following graph is correct for distance-time.

1


2


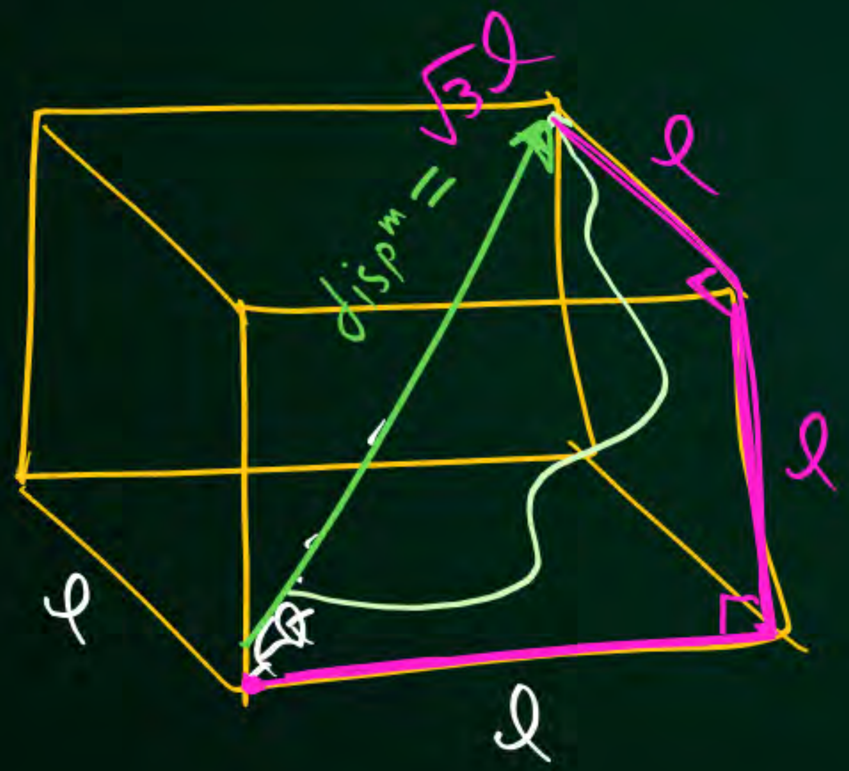
3


4


QUESTION

A butterfly start flying from a corner of the cubical room of side l and reaches to the opposite corner of the room. Find its displacement.

(Body diagonal)

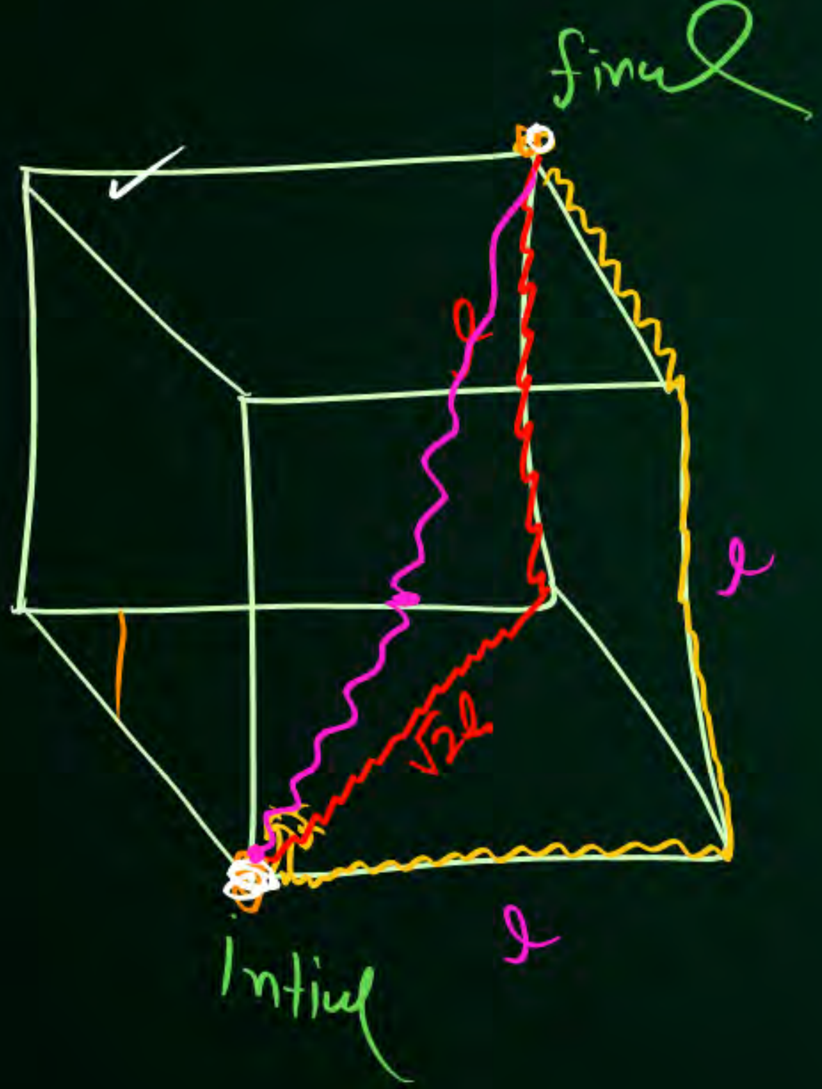


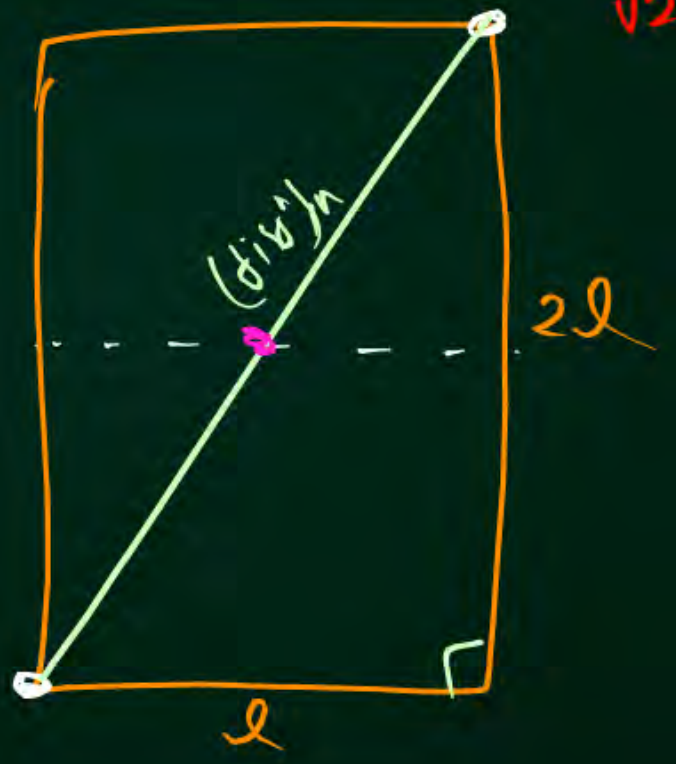
QUESTION

An ant start moving from a corner of the solid cubical room and want to reach opposite of body diagonal find minimum distance moved by ant.

→ $3l$

$\sqrt{2}l + l = 2.41\,l$





$$dis = \sqrt{l^2 + (2l)^2} = \sqrt{5l^2} = \sqrt{5}\,l$$

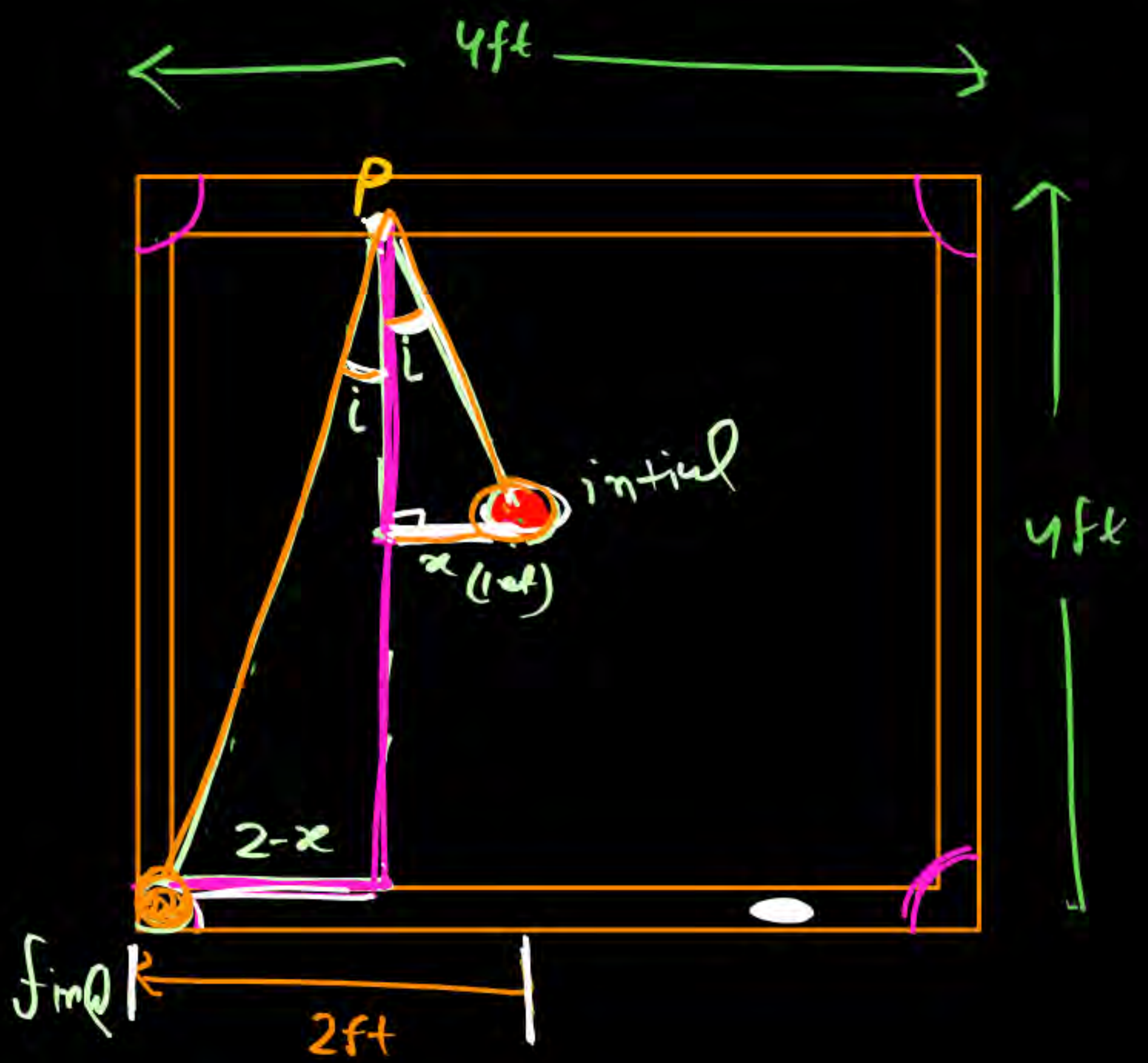
QUESTION

A carom board (4 ft × 4 ft square) has the queen at the centre. The queen, hit by the striker moves to the front edge, rebounds and goes in the hole behind the striking line. Find the magnitude of displacement of the queen

(i) from the centre to the front edge

(ii) from the front edge to the hole and

(iii) from the centre of the hole.



$$\left[\tan i = \frac{x}{2} = \frac{2-x}{4}\right]$$

$$2x = 2 - x$$

$$3x = 2$$

$$\boxed{x = \frac{2}{3}}$$

(i) (centre to front)



$$\text{dis} = \sqrt{4 + \frac{4}{9}} = \sqrt{\frac{40}{9}}$$

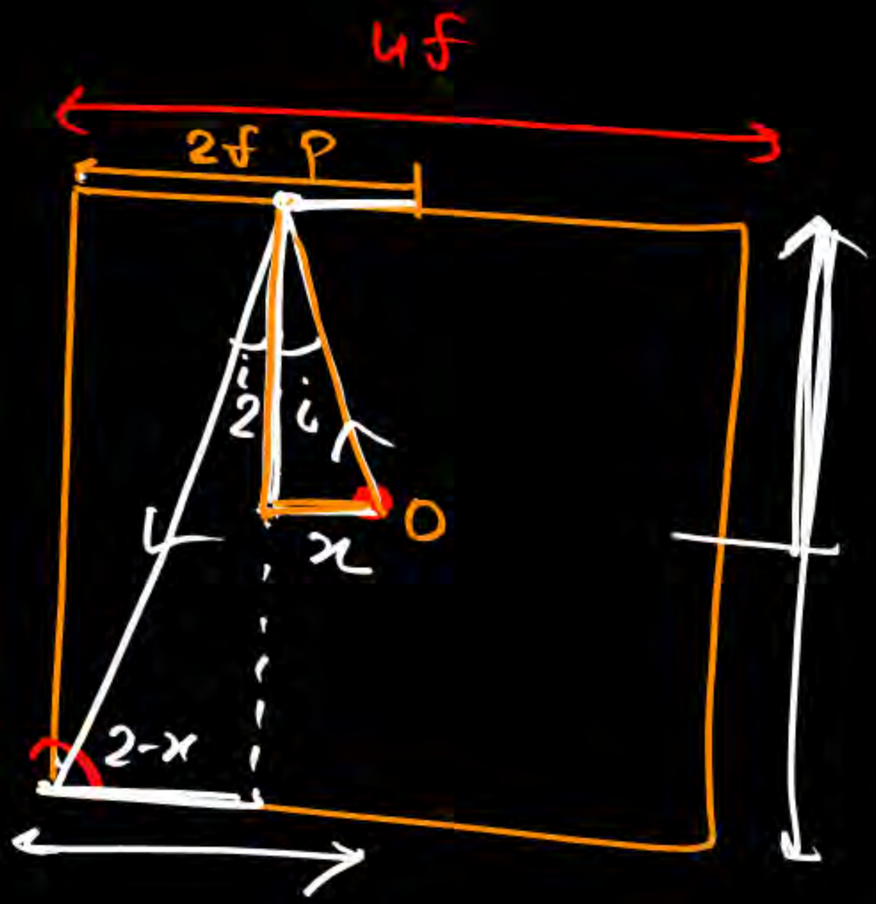
(ii) from front to hole.



$$\text{dis} = \sqrt{16 + \frac{16}{9}} = \sqrt{\frac{160}{9}} = 2 \times \sqrt{\frac{40}{9}} \text{ ft}$$

(iii) displacement centre to hole $= 2\sqrt{2}$ ft

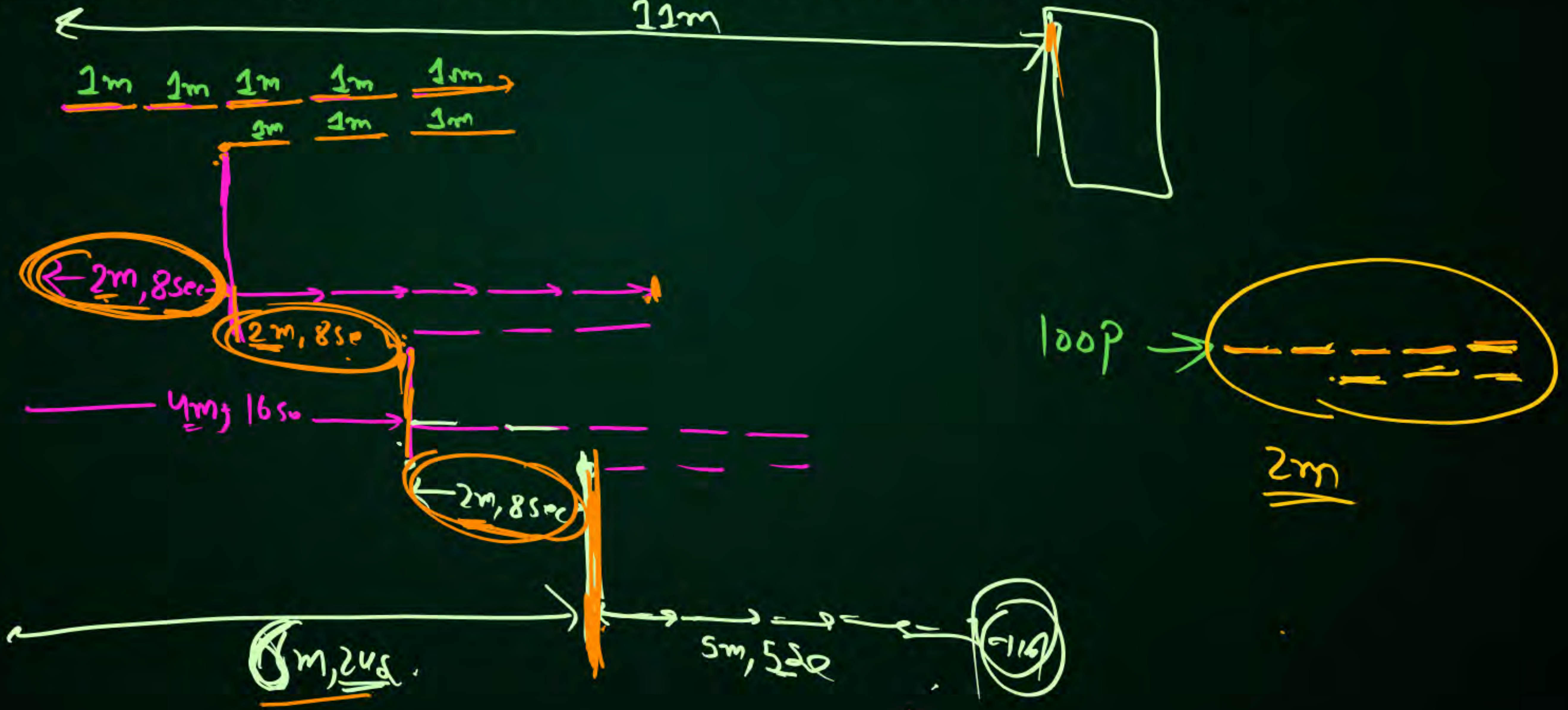




$$\tan i = \frac{x}{2} = \frac{2-x}{4}$$

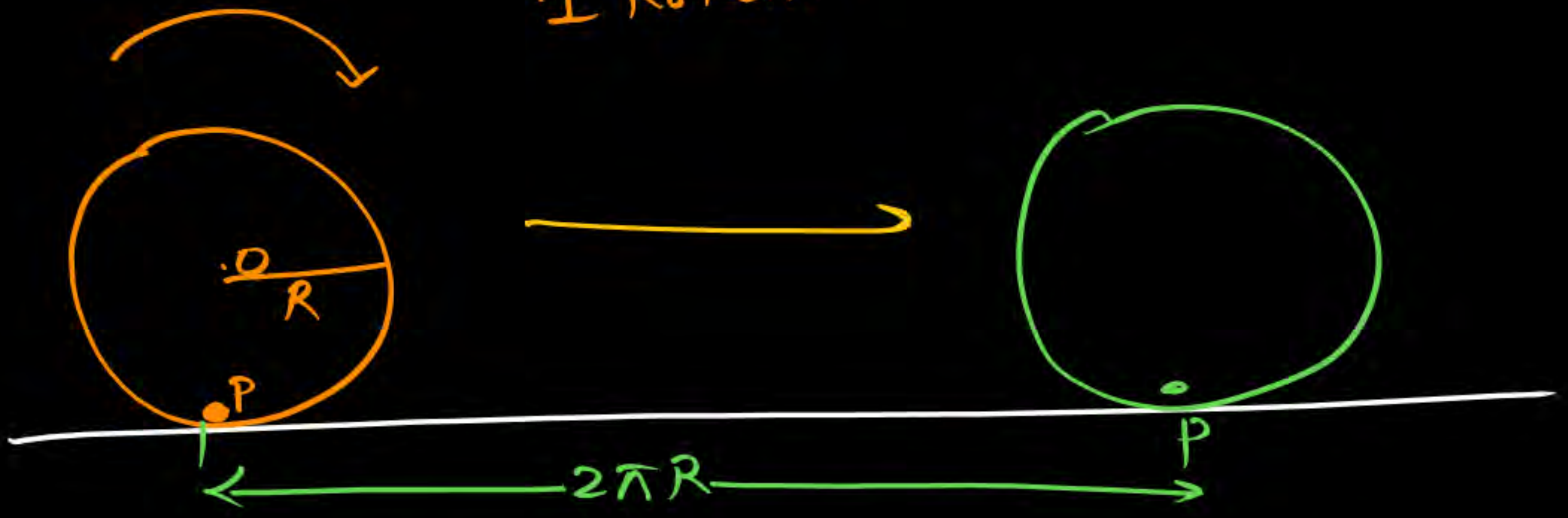
QUESTION

A drunkard is walking along a straight road. He takes 5 steps forward and 3 steps backward and so on. Each step is 1 m long and takes 1s. There is a pit on the road 11 m away from the starting point. The drunkard will fall into the pit after:



1. 21 s
2. 29 s
3. 31 s
4. 37 s

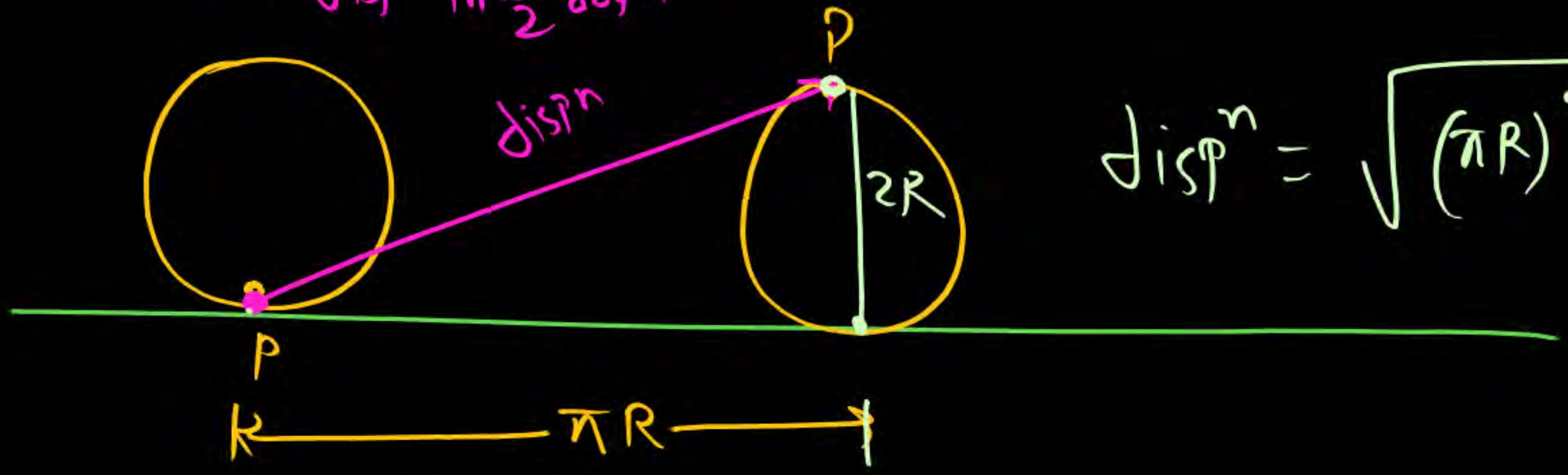
1 Rotation.



one leg stay for 5 s

disp^m of Point P in 1-Rot^n = $2\pi R$

disp^m in $\frac{1}{2}$ rot^n



$$\text{disp}^n = \sqrt{(\pi R)^2 + (2R)^2} = \sqrt{\pi^2 R^2 + 4R^2}$$

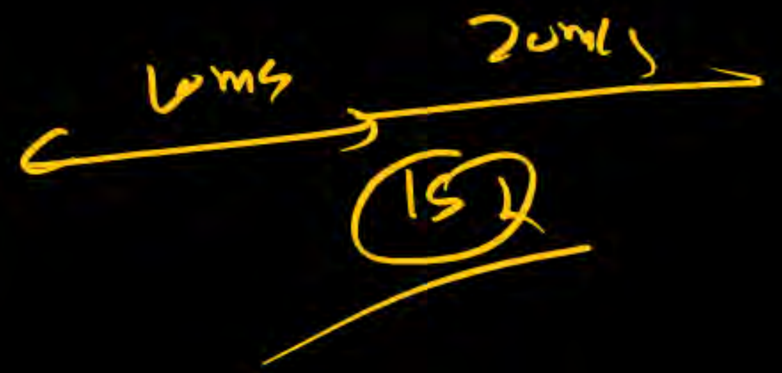
$$= R\sqrt{\pi^2 + 4}$$

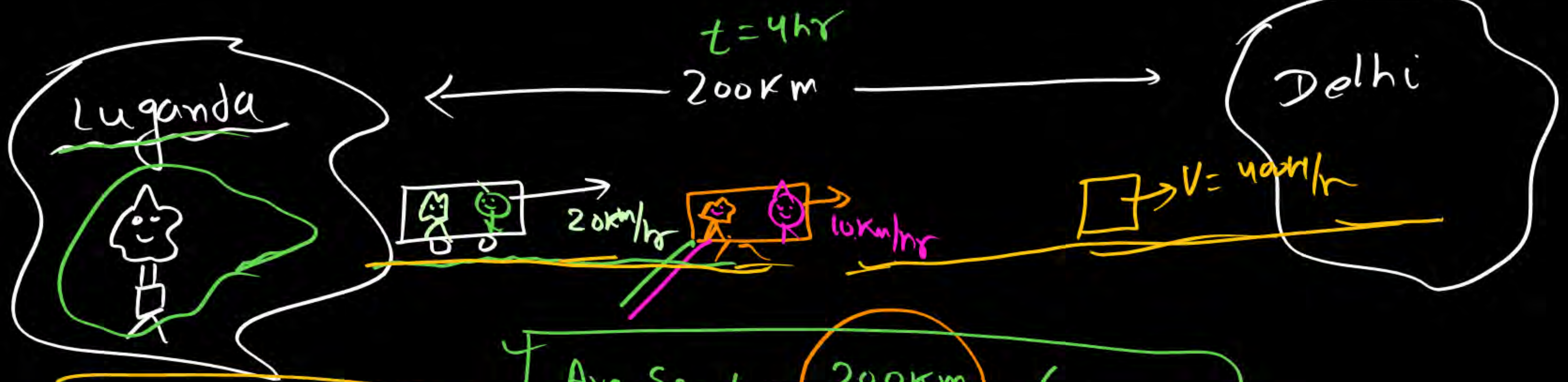
Over	Run
1	3
2	6
3	2
4	8
5	1

$$\text{Avg Run Rate} = \frac{3+6+2+8+1}{5} = \frac{20}{5}$$

Avg Run per over = 4 Run/over

Avg Run per over = 4 Run/over





$$\text{Avg. Speed} = \frac{200\,\text{Km}}{4\,\text{hr}} = 50\,\text{km/hr}$$

$$\text{Avg speed} = \frac{\text{total dist}^n}{\text{total time}}$$

(This is not a speed) → overall idea


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 03 | Physics

Motion In a Straight Line



By- Dr. Manish Raj (MR SIR)

Topics to be covered

1. # PhD on speed and velocity
2. Speed and Velocity
3. #
4. #



My **girlfriend** said she needs

* some **Time** and **Distance**

intraval



Is **she** Calculating Avg. speed

or Inst. ~~Instantaneous~~ **Velocity**??

In time 't'

Average speed = [Total distance] / [total time]

= overall Idea of Journey

= How fast in an intraval

= m/s

= scalar.

Avg velocity = (Total dispm) / total time taken.

$$|\text{Avg. velocity}| = \text{Avg speed}$$

$$\frac{\text{Total disp}^{m}}{\cancel{\Delta t}} = \frac{(\text{total dist}^{n})}{\cancel{\Delta t}}$$

If body is moving in 1-D without change in dir^n

$$\text{Avg. speed} \geq |\text{Avg. velocity}|$$



(in time)

Average velocity :

$$= \frac{\text{Total displacement}}{\text{Total time}}$$

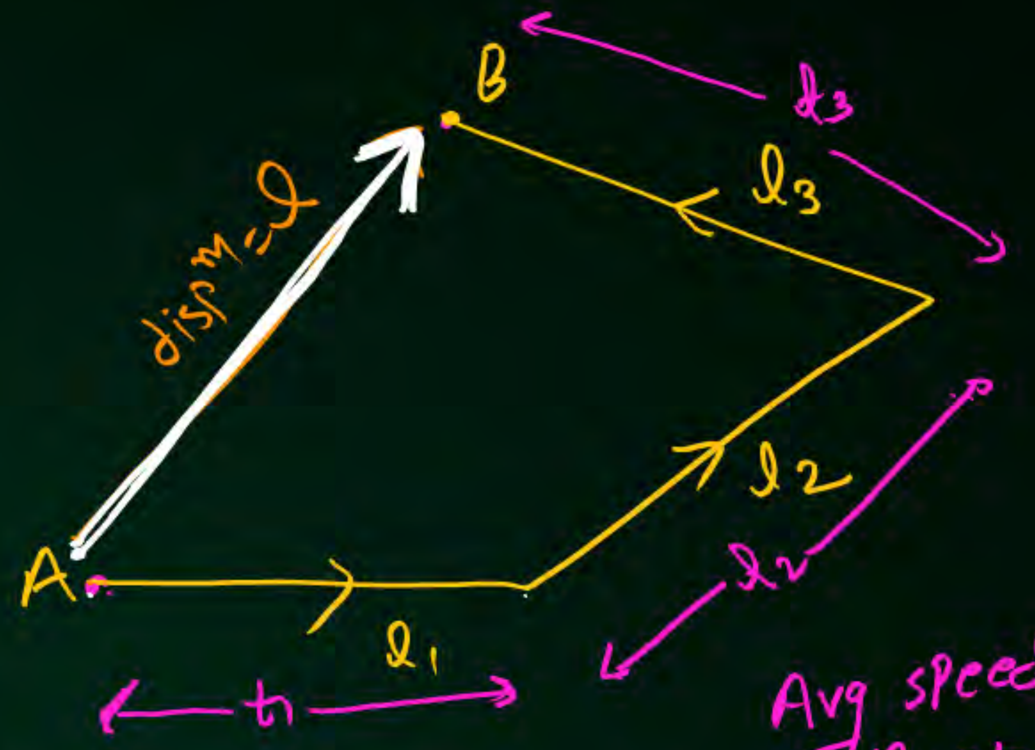
$$\vec{V}_{avg} = \frac{\int \vec{v}\, dt}{\int dt}$$

= (direction along displacement)

= m/s

$$S_{Avg.speed} = \frac{\int S_{inst}\, dt}{\int dt}$$

\# $$\vec{u}_{Avg} = \frac{\int \vec{V}_{inst}\, dt}{\int dt}$$



$$\text{Avg speed}_{A \to B} = \frac{l_1 + l_2 + l_3}{t_1 + t_2 + t_3}$$

$$\text{Avg. velocity} = \frac{l}{t_1 + t_2 + t_3}$$

along dispm ($\vec{l}$)

Avg. velocity	(A) - - - - - - - -	(B) - - - - - - - -	If Avg. velocity is zero then what about Avg. speed ??	If Avg. velocity is not equal to zero. then what about to velocity??
Avg. speed	If Avg speed is zero. then what about Avg. velocity	If Avg speed is not zero then what about Avg. velocity ??	(C) - - - - - - - -	(D) - - - - - - - -

(A) Ans

- Avg. speed = 0

चला / हिला हि नहीं

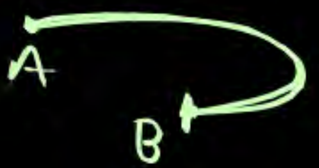
(A) Avg velocity must be zero

→ Avg. velocity must not be non-zero.

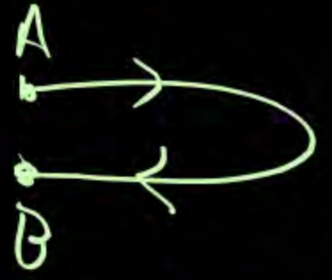


Avg speed ≠ 0

Case-1



Case-2



(B) May or may not be zero or non-zero

Avg velocity is zero

- Case-1

चला हि नहीं

Case-2



(C) Avg speed may be zero or non-zero

Avg velocity ≠ 0



(D)

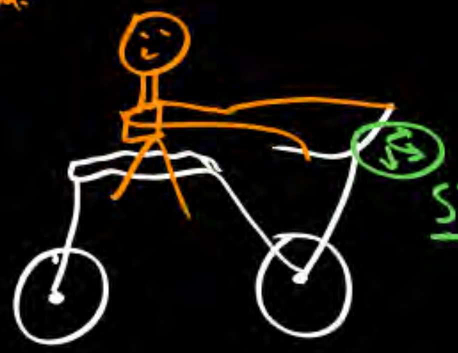
- Avg speed must be non-zero

(Instantaneous speed) = Rate of change in $dist^n$.
(at time 't')

$$s = \left(\frac{dx}{dt}\right) = \text{slope of distance-time.}$$

= (How fast)
= scalar
= magnitude
= m/s.

Ramlal



Speed is magnitude of velocity → always

Inst. velocity = How fast / where

Velocity = speed × dir^n

↳ The rate of change in $disp^n$

$$\vec{V} = \left(\frac{d\vec{x}}{dt}\right) = \text{slope of } disp^n\text{-time graph}$$

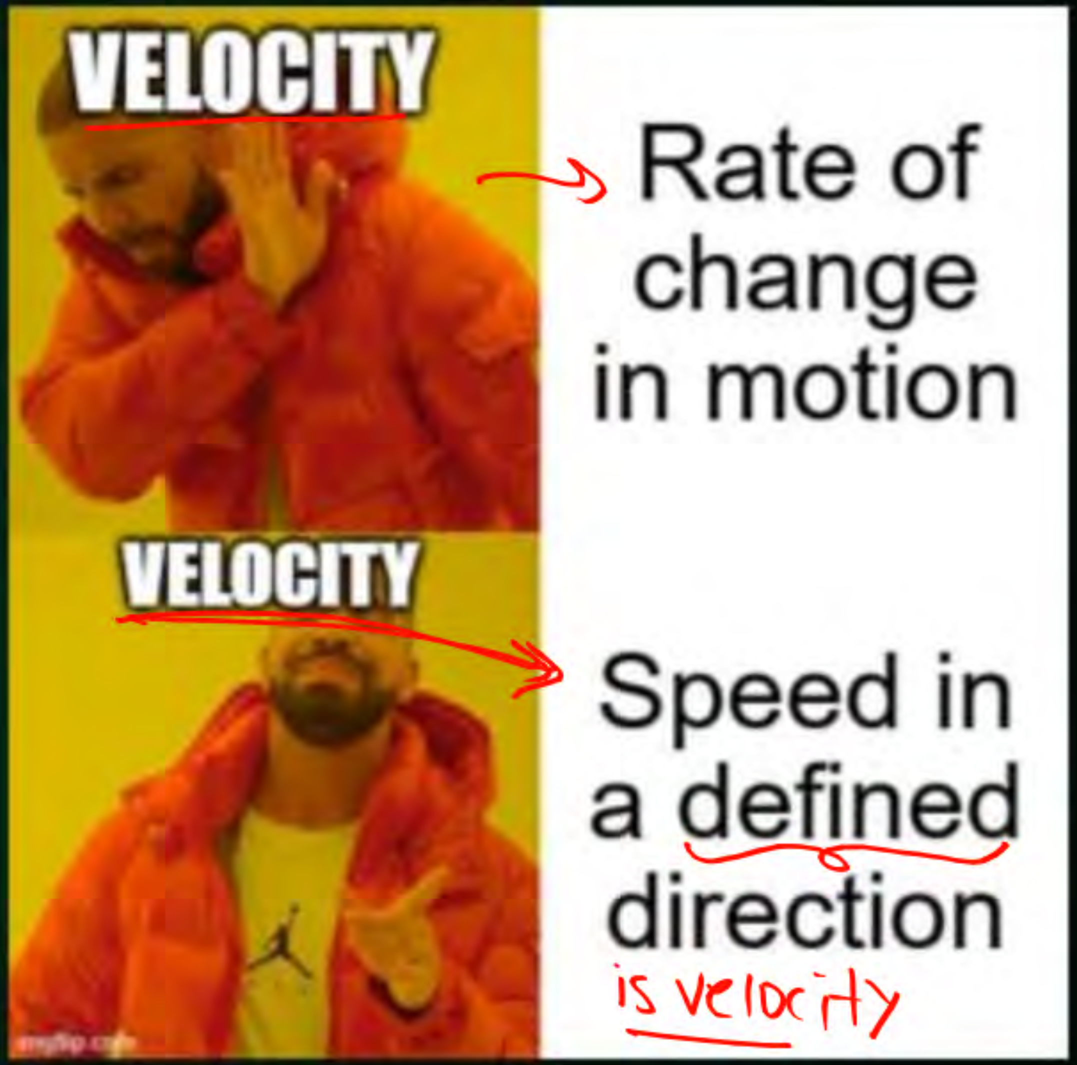
= vector
= dir^n → along motion



INSTANTANEOUS – (At time t)

Speed :

- ✓ How fast object is moving
- ✓ The rate of change in distance = $\frac{dx}{dt}$
- ✓ Slope of distance time graph
- ✓ Scalar
- ✓ Magnitude of velocity always
- ✓ Unit m/s



Instantaneous speed = How fast	Inst. velocity = How fast where
* scalar	vector
* Rate of change in direction	* Range of change in displacement
$S = \frac{dx}{dt}$	$\vec{v} = \frac{d\vec{x}}{dt}$
* slope of distance/time graph	* slope of dispm/time graph
* Magnitude of velocity	* diretion → along motn

Objet is moving in straight line without change in diretion, moves x_1 distance in time t_1 and then x_2 distance in time t_2 then fing Avg. speed and velocity.

Sol^n (1-D) → No U-turn



$$|\text{Avg velocity}| = \text{Avg speed} = \frac{\text{Total disp}^n}{\text{total time}} = \frac{x_1 + x_2}{t_1 + t_2} \checkmark\checkmark$$

object is at Position x_1 at time t_1 and at Position x_2 at time t_2 then find Avg speed & Avg velocity if it moving without change in dirn.

Soln



$$\text{Avg. velocity} = \frac{x_2 - x_1}{t_2 - t_1}$$

interval $= t_2 - t_1$

Speed = 100 m/s

speed = 0.01 m/s

Speed = 2 m/s

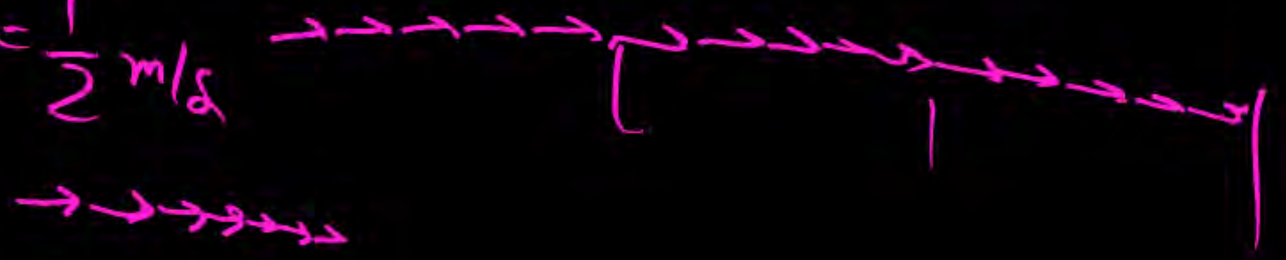
velocity = 100 m/s east

velocity = 2 m/s north



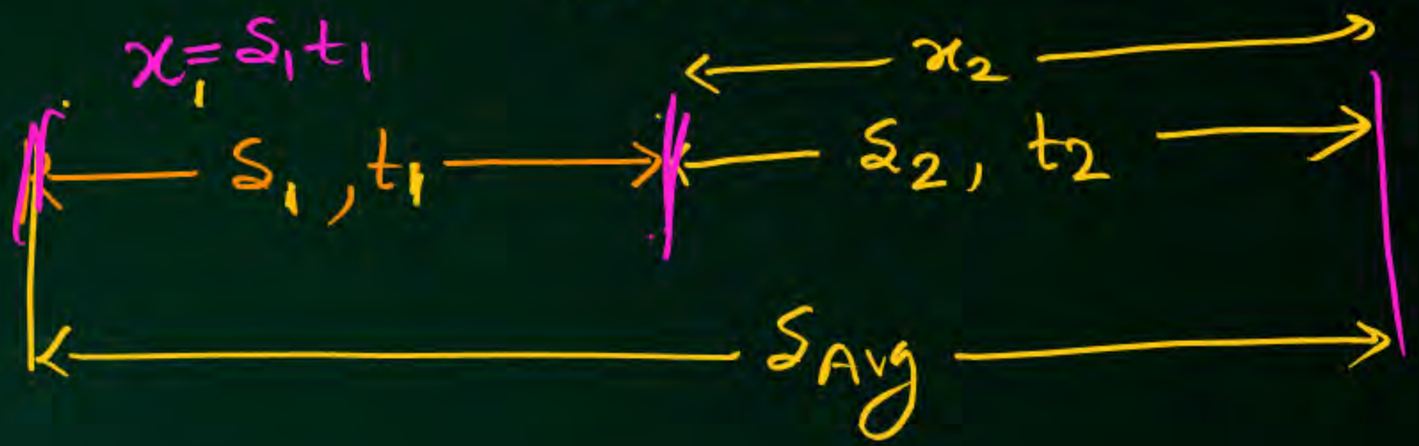
Speed = 5 m/sec

Speed = $\frac{1}{2}$ m/s



QUESTION

Object moves with speed S_1 for time t_1 and with speed S_2 for time t_2 then find Average Speed

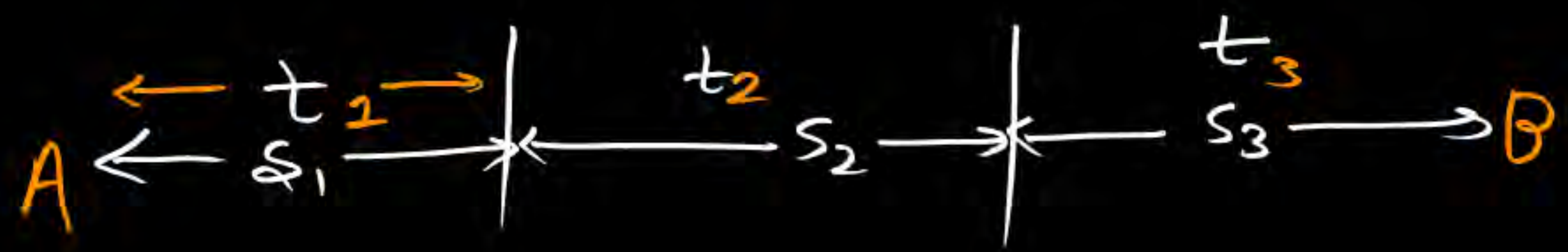


$$\text{Avg. Speed} = \frac{\text{Total dist}^n}{\text{total time}}$$

$$S_{Avg} = \frac{S_1t_1 + S_2t_2}{t_1 + t_2}$$

If time intraval is same $(t_1 = t_2 = t)$

$$S_{Avg} = \frac{t(S_1+S_2)}{2t} = \frac{S_1+S_2}{2}$$



$$\text{Avg speed} = \frac{\text{total dist}^n}{\text{total time}}$$

$$= \frac{s_1 t_1 + s_2 t_2 + s_3 t_3}{t_1 + t_2 + t_3}$$

Three equal time intervals $= t_1 = t_2 = t_3 = t$

$$S_{Avg} = \frac{t(s_1 + s_2 + s_3)}{3t} = \frac{s_1 + s_2 + s_3}{3}$$

$$S_{Avg} = \frac{s_1 + s_2 + s_3 + s_4}{4}$$

four equal time intervals

QUESTION

Object moves x_1 distance with speed S_1 and x_2 distance with speed S_2 then Average Speed of the total Journey.

dist^n = s × t

$t = \frac{\text{dist}}{\text{Speed}}$

|← s_1, x_1 ——→|← s_2, x_2 ——→|

$$\text{Avg. speed} = \frac{\text{total dist}^n}{\text{time}} = \left[\frac{x_1 + x_2}{\frac{x_1}{s_1} + \frac{x_2}{s_2}}\right]$$

If $x_1 = x_2 = x$ (Two equal dist^n interval)

$$\text{Avg speed} = \frac{2x}{x\left(\frac{1}{s_1} + \frac{1}{s_2}\right)} = \frac{2}{\frac{s_1+s_2}{s_1 s_2}} = \frac{2 s_1 s_2}{s_1 + s_2}$$

Two equal dist^n Interval

—— x_1, s_1 ⟶⟵ x_2, s_2 —— x_3, s_3 ⟶

$$\text{Avg speed} = \frac{x_1 + x_2 + x_3}{\frac{x_1}{s_1} + \frac{x_2}{s_2} + \frac{x_3}{s_3}} \qquad (x_1 = x_2 = x_3 = a)$$

Theree equal distn interval

$$\text{Avg speed} = \left(\frac{3}{\frac{1}{s_1} + \frac{1}{s_2} + \frac{1}{s_3}} \right)$$

A vehicle traval half the distance with V and remaing half with 2V, then Avg. speed.

NEET-2023

The MR*

$V < V_{Avg} < 2V$

$\frac{S/2}{V}$, $\frac{S/2}{2V}$

(a) $\frac{V}{3}$

(b) $\frac{2V}{3}$

19%

(c) $\frac{4V}{3}$

64%

(d) $\frac{3V}{4}$

$\frac{3}{4}V = 0.75V$

$$\text{Avg. speed} = \frac{2 \times V \times 2V}{V + 2V} = \frac{4V^2}{3V} = \frac{4V}{3}$$

A Train has speed 60 km/hr for one-hr and 40 km/hr for next half-hr, then Avg speed.

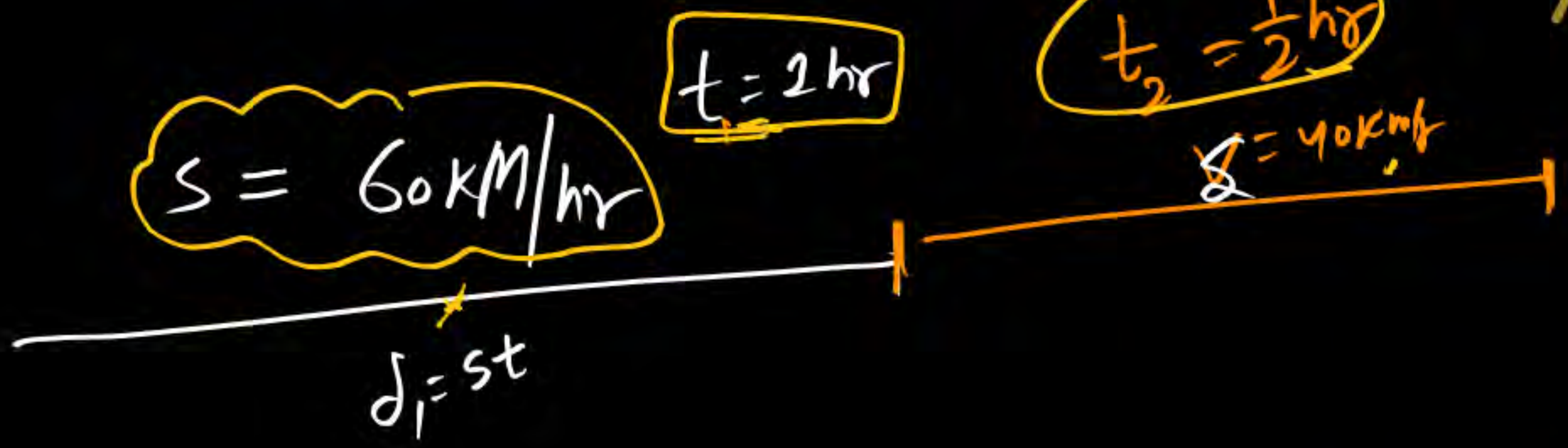
AIEEE/ JIPMER

(a) 50 ✗

(b) 53.33 ✓

(c) 48 ✗

(d) 70 ✗



The MR*

40 S_{Avg} 60

$$\text{Avg speed} = \frac{x_1 + x_2}{t_1 + t_2}$$

$$= \frac{60\,km + 20\,km}{\left(1 + \frac{1}{2}\right) hr}$$

$$= \frac{80\,km}{\frac{3}{2}\,hr} = \frac{160}{3} = 53.3$$

Object moves for 10s with speed 20m/s and then it moves with speed 30m/s for next 10sec. then find Avg. speed for complete Journy.

(Two equal time intraval)

Solⁿ

$$S_{Avg} = \frac{20+30}{2}$$

$$= 25 \text{ m/s}$$ ✓

Object moves 10m with speed 20m/s and then it moves with speed 30m/s for 10sec. then find Avg. speed for complete Journey.

|← 10m, 20m/s →|← 30m/s — 10sec →|

Solⁿ

Two equal time interval → $S_{Avg} = \frac{S_1 + S_2}{2}$ ✓

Two equal distance interval. $S_{Avg} = \frac{2 S_1 S_2}{S_1 + S_2}$ ✓

(#) $\text{Avg speed} = \left(\frac{\text{total dist}^n}{\text{total time}}\right) = \frac{d_1 + d_2}{t_1 + t_2}$

$$= \frac{d_1 + d_2}{t_1 + t_2} = \frac{10m + (30 \times 10)}{\left(\frac{10}{20}\right) + (10)} = \frac{310}{10.5}$$

$$= 29.52 \ m/s$$

$d = st$

$t = d/s$

Object moves 20m with speed 20m/s and then it moves with speed 30m/s for 20m then find Avg. speed for complete Journy.



$$S_{Avg} = \frac{2 \times 20 \times 30}{20+30} = \frac{40 \times 30}{50}$$

$$= \frac{120}{5} = 24\ m/s$$

QUESTION

If object moves $\frac{2}{5}$th distance of journey with speed 10 m/s and remaining with 30 m/s then average speed will be :

$\longleftarrow S \longrightarrow$

$\vdash \frac{2}{5}S \longrightarrow + \frac{3}{5}S \longrightarrow|$

$S_1 = 10\,m/s \qquad S_2 = 30\,m/s$

Sol^n

$$S_{Av} = \frac{S}{\frac{2S}{5\times 10} + \frac{3\times S}{5\times 30}} = \frac{1}{\frac{1}{25}+\frac{1}{50}} = \frac{1}{\frac{3}{50}} = \frac{50}{3}$$

16.6

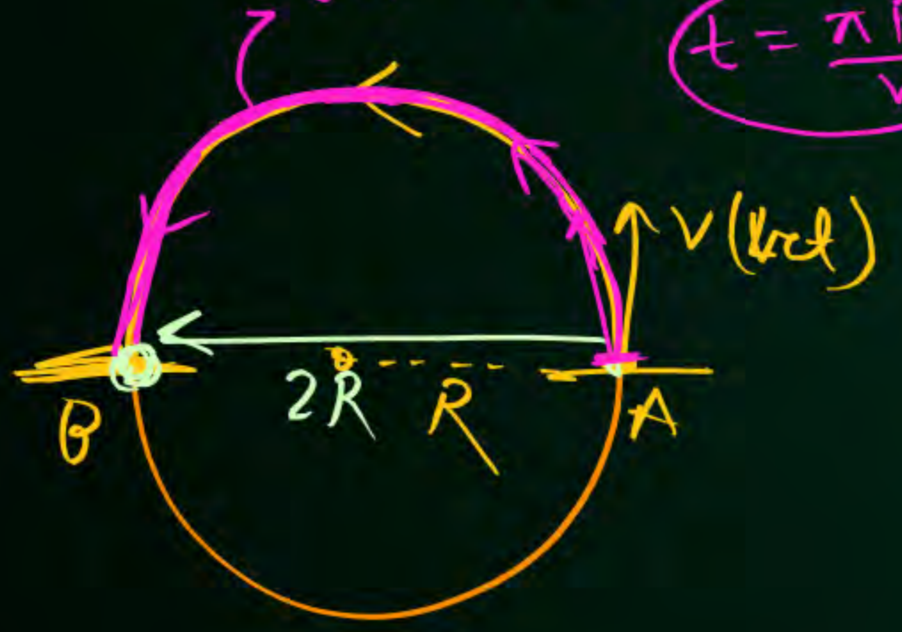
QUESTION

Object is moving on circular path with constant speed then find "Average Velocity" when it completed half revolution.

Speed = v

$dist^n = \pi R = vt$

$t = \frac{\pi R}{v}$



$\text{Avg velocity} = \frac{\text{Total disp}^n}{\text{total time}} = \frac{2R}{\frac{\pi R}{v}}$

$= \frac{2v}{\pi}$ m/s

QUESTION

A car travels from Kota to Jaipur with speed 30 km/h, and it returns along the same path with speed 60 km/h. Calculate average speed of the car. Avg. velocity ??

V_{Avg} speed $= \frac{2 s_1 s_2}{s_1 + s_2}$

$= \frac{30 \times 60 \times 2}{90}$

$= 40$

Two equal distn ind

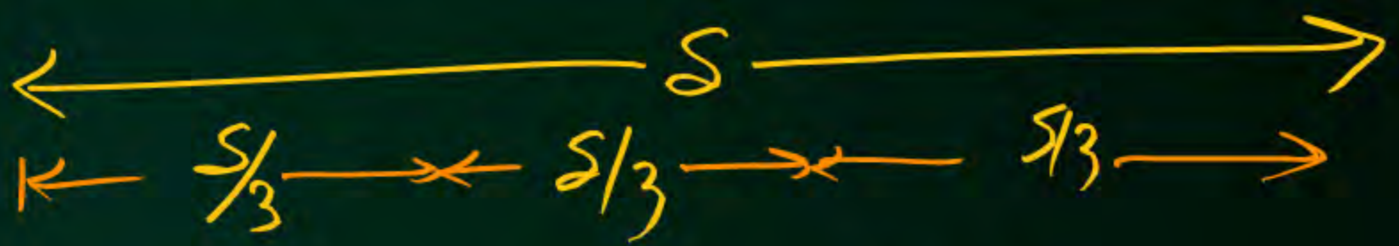


Avg velocity = 0

QUESTION

A body covers first one-third of the distance with velocity 10 ms^{-1} in same direction, the second one-third with a velocity 20 ms^{-1} and last one-third with a velocity of 30 ms^{-1}. The average velocity of body is

1. 17.8 ms^{-1}
2. 16.4 ms^{-1} ✓ 64%
3. 18.3 ms^{-1}
4. 20.2 ms^{-1} ✗



$S_1 = 10\,m/s \quad S_2 = 20 \quad S_3 = 30$

$$S_{Avg} = \frac{3}{\frac{1}{10}+\frac{1}{20}+\frac{1}{30}} = \frac{3}{\frac{6+3+2}{60}} \Rightarrow \frac{3\times 60}{11} = \frac{180}{11} = 16.3$$

Object Moves with speed V_1, V_2 and V_3 for 3- equal distance interval then find Avg. speed.

$$V_{Avg} = \frac{3}{\frac{1}{V_1} + \frac{1}{V_2} + \frac{1}{V_3}}$$

Object moves with v_1 for $t/3$ and with v_2 for $\frac{2t}{3}$ then find Avg. speed.

Sol^n

$$\text{Avg speed} = \frac{d_1 + d_2}{t_1 + t_2} = \frac{v_1\frac{t}{3} + v_2\frac{2t}{3}}{\frac{t}{3} + \frac{2t}{3}} = \frac{\frac{v_1 t + 2v_2 t}{3}}{t}$$

$$v_{Avg} = \frac{v_1 + 2v_2}{3}$$

QUESTION

A truck moves a distance of 50 km. It covers first half to the distance at speed of 200 m/s and second half at speed v. If average speed of truck is 100 m/s then value of *v* is



$$100 = \frac{2 \times 200 \times v}{v + 200}$$

$$v + 200 = 4v$$

$$3v = 200 \qquad v = \frac{200}{3}$$

QUESTION

A bus travels its half distance of journey with speed 5 m/s. It covers remaining distance in two equal time intervals with speed 15 m/s & 25 m/s. Calculate average speed of the bus for the whole journey.



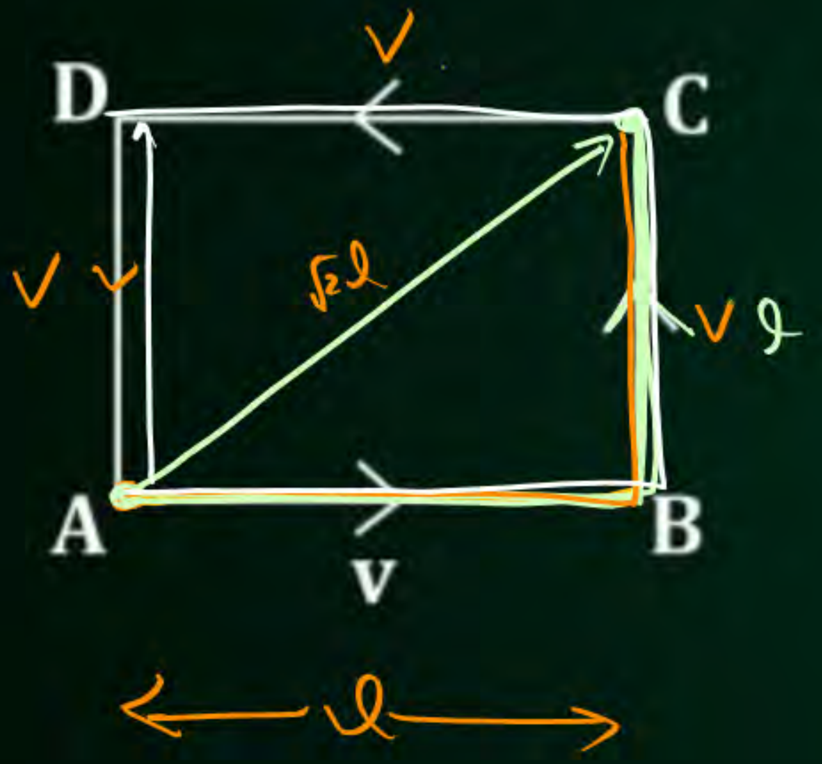
$$S_{Av} = \frac{2 \times 5 \times 20}{(20+5)} = \frac{2 \times 5 \times 20}{25}$$

$$S_{Av} = 8$$

$$V_{Av} = \frac{15+25}{2} = \frac{40}{2} = 20 \text{ m/s}$$

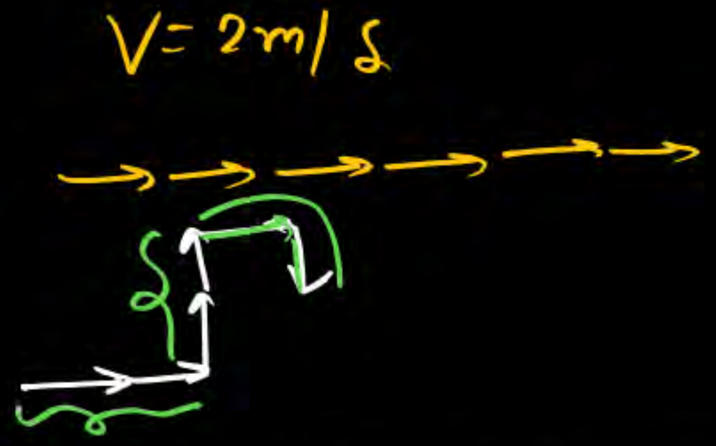
QUESTION

Object is moving with constant speed (v) on square track then find Average Velocity.



Motion	Avg. Speed	Avg. Velocity
A→B	v	v
A→C	v	$\frac{\sqrt{2}\,l}{2l/v} = \frac{v\sqrt{2}}{2} = \frac{v}{\sqrt{2}}$
A→D	v	$\frac{l}{3l/v} = v/3$
A→A	v	0

Constant speed (Uniform speed) ⇒ Travel (equal distance) in equal intraval of time.





(Uniform velocity) constant velocity ⇒ How fast / where

→ equal distance moved in (equal time intraval) in a fixed dirn.

If inst speed is constant, then what about Avg. speed ??

Sol^n Avg speed $= \frac{\int S_{inst}\, dt}{\int dt} = \frac{S_{inst} \int dt}{\int dt} = S_{inst}$

Q) If inst. velocity constant, then what about Avg. velocity.

Avg velocity $= v_{inst} =$ const^n.

Velocity	A ✓	B	If velocity is constant then what about speed.	If velocity is variable then what about speed
Speed	If speed is constant then what about velocity ??	If speed is variable then what about velocity	C	D ..... who change this velocity magnitude (speed) or direction ?? don't know ↳ speed may be variable or c(st)

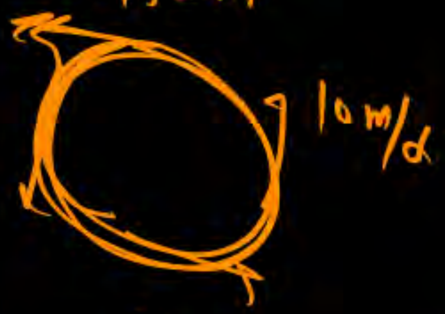
Speed = constⁿ
↳ we done know about dirⁿ.
↳ velocity may be variable or constⁿ

Velocity →

velocity = How fast / where.
How fast → varible
velocity must be variable

velocity const = How fast / where
Speed must be constⁿ

10m/s = const



→ → →
10m/s 10m/s 10m/s

5 10 m/s n
→ → → →

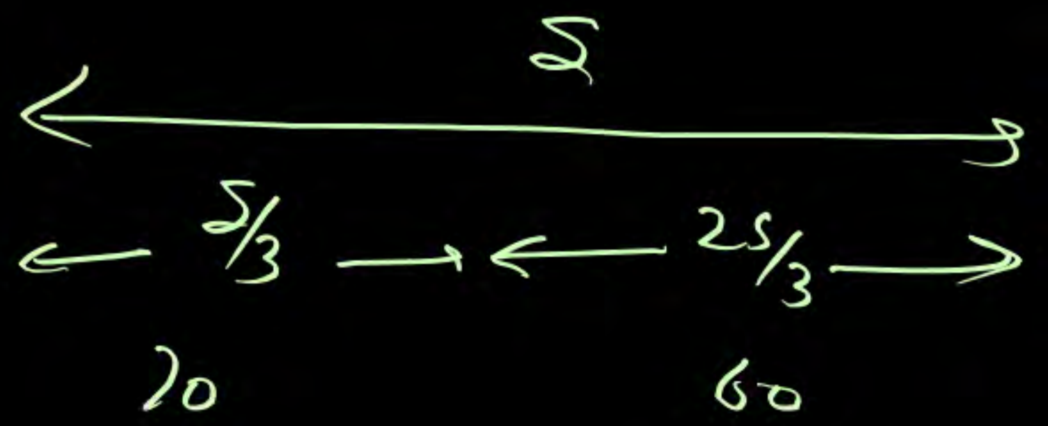
If speed is zero,

then what about Velocity

Must be zero ??

velocity = How fast / Where

CAR cover one third with speed 20 km/hr and rest with 60 km/hr.



Position $x = t^2 - 2t + 4$

then find velocity at $t = 2$ sec

Sol^n

$$\vec{v} = \frac{d\vec{x}}{dt} = 2t - 2 + 0$$

$$V = 2t - 2$$

$$(\vec{v})_{t=2} = 2 \times 2 - 2$$

$$= 4 - 2 = 2$$

$$\vec{x} = \alpha t^3 + \beta t^2 + \gamma t + \delta$$

find intial velocity.

Sol^n

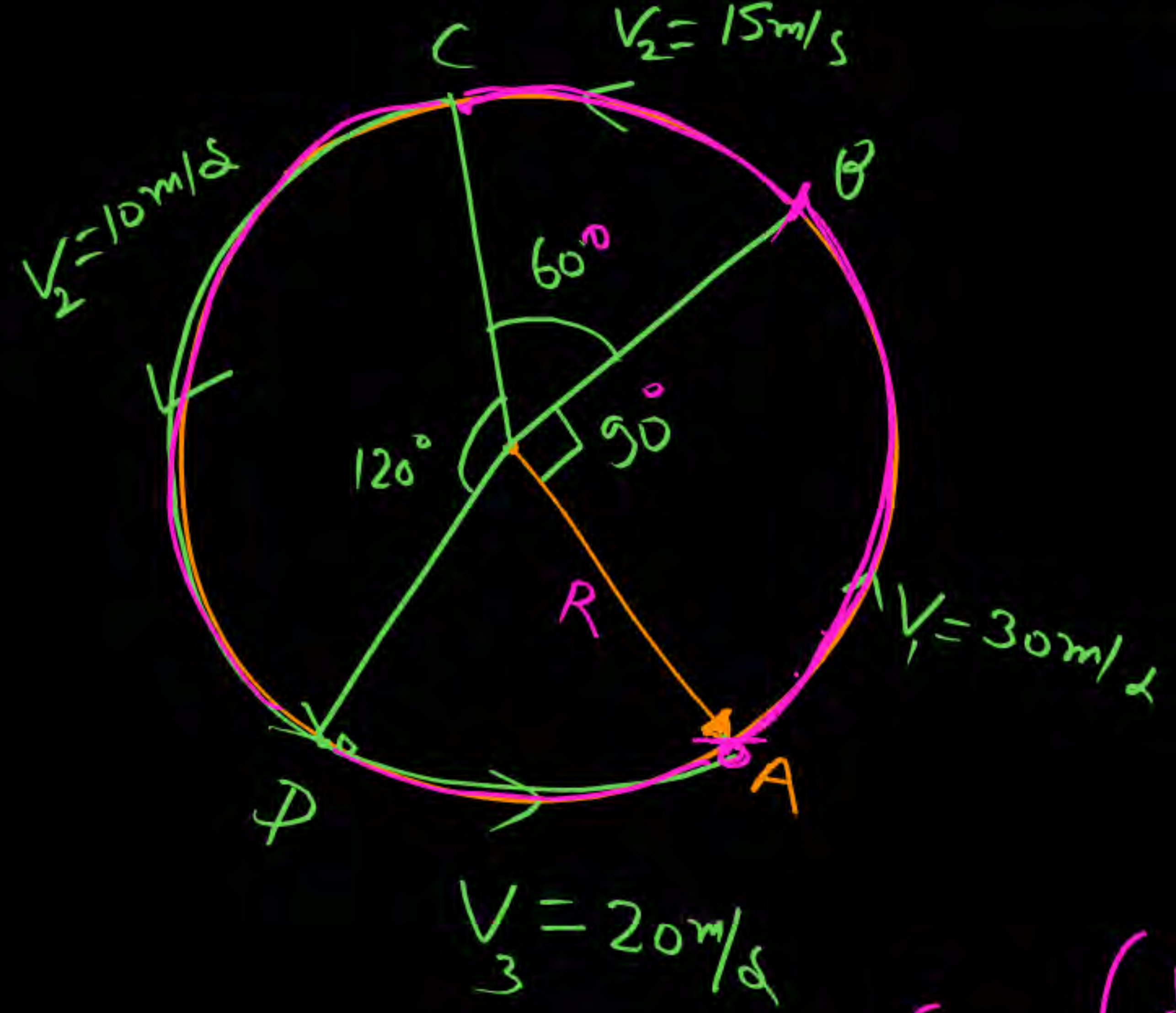
$$v = \frac{d\vec{x}}{dt} = \alpha(3t^2) + \beta(2t) + \gamma(1) + 0$$

$$V = 3\alpha t^2 + 2\beta t + \gamma$$

$$\vec{V}_{t=0} = \gamma \text{ m/s}$$

H/W

find Avg. speed in one Rotation??



$$S_{Avg} = \left(\frac{d_1 + d_2 + d_2 + d_3}{t_1 + t_2 + t_3 + t_4} \right)$$

4 mint

One leg stunt

Zero Type

Acceleration

→ How fast velocity is changing ✓

In time 't'

$$\vec{a}_{Avg} = \frac{\vec{V_f} - \vec{V_i}}{\Delta t}$$

$$\vec{a}_{Avg} = \frac{\int \vec{a}_{Inst}\, dt}{\int dt}$$

↳ (m/s^2), (vector)

at time 't'

$$\vec{a}_{Inst} = \left(\frac{d\vec{V}}{dt}\right) = \frac{d}{dt}\left(\frac{dx}{dt}\right) = \left(\frac{d^2(x)}{dt^2}\right)$$

= The Rate of change in velocity

= Slope of v-t graph.

= vector

→ dir^n along change in velocity.

unit → m/s^2

$$\vec{a} = \frac{dv}{dt} \times \frac{dx}{dx}$$

$$\vec{a} = \frac{dv}{dx} \times \frac{dx}{dt}$$

$$\boxed{\vec{a} = v\left(\frac{dv}{dx}\right)}$$ = velocity × (velocity gradient)

acceleration → velocity given to object per-sec ✓
↳ velocity taken out from object per sec ✓

$$\vec{a} = \frac{d\vec{v}}{dt} = \frac{\Delta (m/s)}{sec}$$

t=0
drop (v=0)

a = g = 10 m/s²

t = 1 sec
v = 10 m/s

t = 2 sec
v = 20 m/s

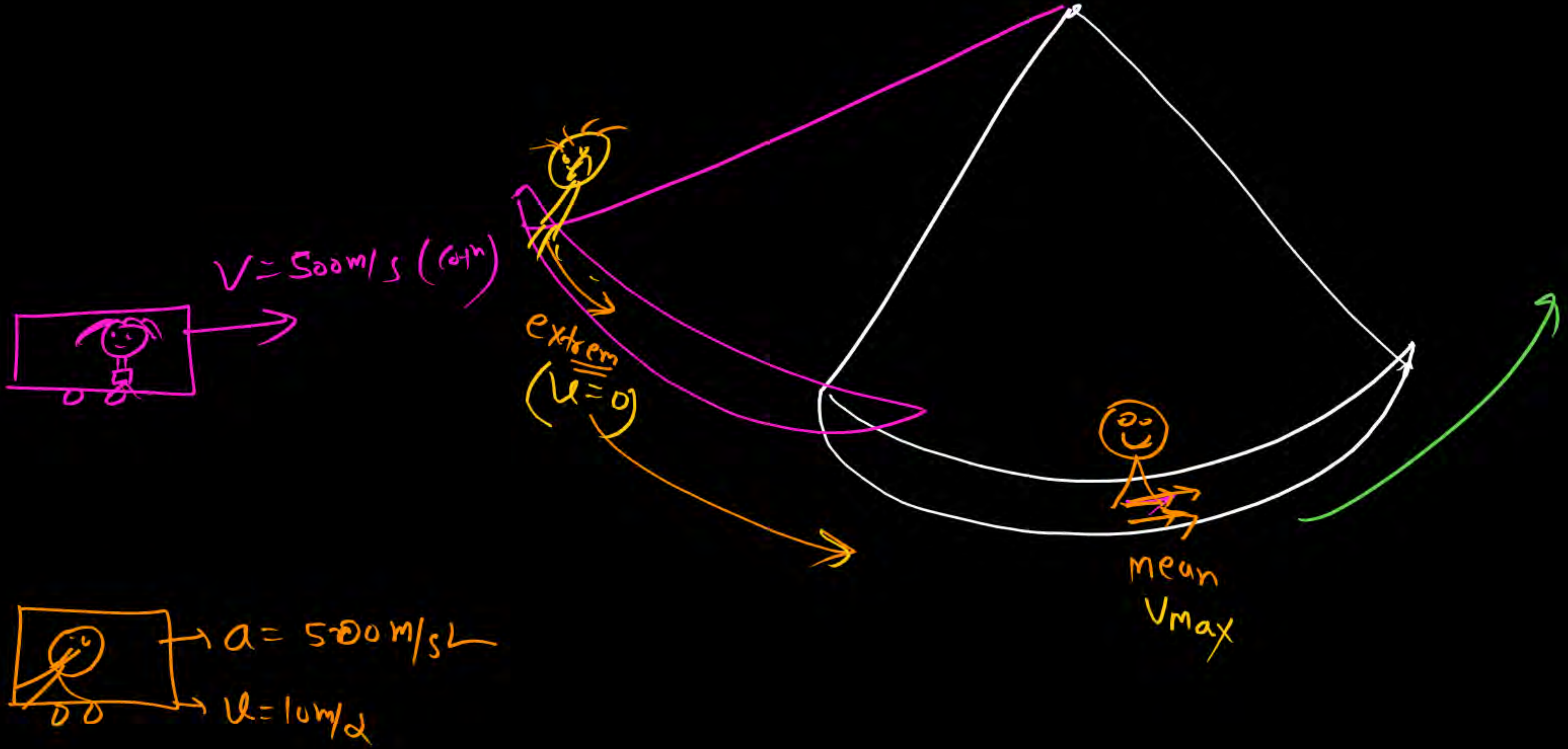
v = 30 m/s t = 3 sec

t=0
a = 5 m/s²
v = 10 m/s
fast

t = 1 sec
a = 5 m/s²
v = 15 m/s²
slow

a = 15 m/s² ← How fast velocity is change
v = 2 m/s
slow

t = 1 sec
a = 15 m/s²
v = 17 m/s
fast


V = 500m/s
extrem
(u=0)
mean
Vmax
a = 500 m/s²
u = 10m/s


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 04 | **Physics**

Motion In a Straight Line



By- Dr. Manish Raj (MR SIR)

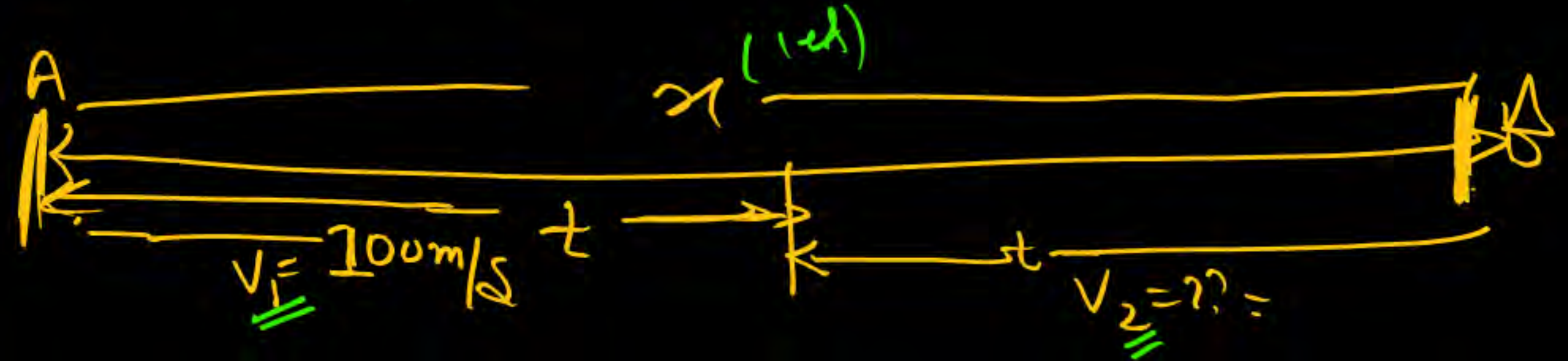
Topics to be covered

Kinematics – 4

1. # K.B.D → speed / velocity
2. # PhD. on acceleration
3. #
4. #



$(\text{Avg. speed})_{\text{B/w Two point}} = 200\ m/s$ ✓



$$\frac{V_1 + V_2}{2} = 200$$

$$100 + V_2 = 400$$

$$V_2 = 400 - 100$$

$$V_2 = 300\ m/s$$

equal time

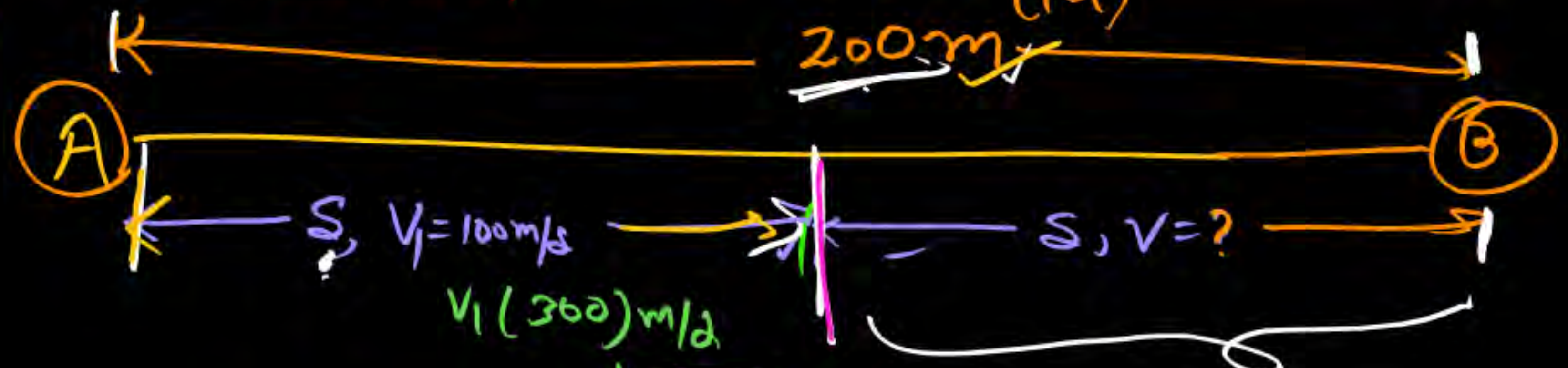
$$\frac{100 + (x - 100)}{2} = 200$$

$$100 + x - 100 = 400$$

$x = 400$ Ans.

(Avg speed) $= 200\,m/s$

Two Point



Avg speed $= \frac{200}{t} = 200$

$t = 1\,sec$

Half distⁿ of journy

$s = 100m$

time $= \frac{dist^n}{speed}$

$= \frac{100}{100} = 1\,sec$

$$\frac{2V_1V_2}{V_1+V_2} = 200$$

$$\frac{2 \times 100\,V_2}{100+V_2} = 200$$

$$V_2 = 100 + V_2$$

$$V_2 - V_2 = 100$$

$$0 = 100$$

If $V_1 = 300\,m/s$

$$\frac{2 \times 300\,V_2}{300+V_2} = 200$$

$$3V_2 = 300 + V_2$$

$$2V_2 = 300$$

$$V_2 = 150\,m/s$$

QUESTION

1. **Assertion :** The average and instantaneous velocities have same value in a uniform motion.

(velocity constn)

Reason : In uniform motion, the velocity of an object increases uniformly.

1. If both Assertion & Reason are True & the Reason is a correct explanation of the Assertion.
2. If both Assertion & Reason are True but Reason is not a correct explanation of the Assertion.
3. If Assertion is True but the Reason is False.
4. If both Assertion & Reason are false.

{motion, velocity} → same thing

{{पैसा, अमिर}} → (Same)

QUESTION

Average velocity in a time interval zero then in same time interval average speed is:

1. must be zero
2. may be zero
3. must be non-zero
4. may be –ve

QUESTION

AIPMT-2014

A particle is moving such that its position coordinates (x, y) are $(2\text{m}, 3\text{m})$ at time $t = 0$, $(6\text{m}, 7\text{m})$ at time $t = 2\text{s}$ and $(13\text{m}, 14\text{m})$ at time $t = 5$ s. The average velocity vector $\vec{v}_{avg}$ from $t = 0$ to $t = 5$ s is :

1. $\frac{1}{5}(13\hat{\imath} + 14\hat{\jmath})$
2. $\frac{7}{3}(\hat{\imath} + \hat{\jmath})$
3. $2(\hat{\imath} + \hat{\jmath})$
4. $\frac{11}{5}(\hat{\imath} + \hat{\jmath})$ ✓

$$\left(\vec{v}_{Avg}\right)_{t=0 \text{ to } t=5\text{sec}} = \frac{\vec{x}_f - \vec{x}_i}{\Delta t} = \frac{(13\hat{i} + 14\hat{j}) - (2\hat{i} + 3\hat{j})}{5}$$

$$= \left\{\frac{11\hat{i} + 11\hat{j}}{5}\right\}$$

QUESTION

A person travels along a straight road for the first $t/3$ time with a speed v_1 and for next $2t/3$ time with a speed v_2. Then the mean speed v is given by

Avg speed = $\frac{\text{Total dist}}{\text{total time}} = \frac{v_1\frac{t}{3} + v_2\frac{2t}{3}}{t}$

$= \frac{v_1}{3} + \frac{2v_2}{3} = \frac{v_1+2v_2}{3}$

1. $v = \frac{v_1+2v_1}{3}$ ✓

2. $\frac{1}{v} = \frac{1}{3v_1} + \frac{2}{3v_2}$

3. $v = \frac{1}{3}\sqrt{2v_1v_2}$

4. $v = \sqrt{\frac{3v_2}{2v_1}}$

Assertion : The average velocity of the object over an interval of time is either smaller than or equal to the average speed of the object over the same interval.

Reason : Velocity is a vector quantity and speed is a scalar quantity.

1. If both Assertion & Reason are True & the Reason is a correct explanation of the Assertion.
2. If both Assertion & Reason are True but Reason is not a correct explanation of the Assertion.
3. If Assertion is True but the Reason is False.
4. If both Assertion & Reason are false.

QUESTION

If speed = 0
velocity = 0

Object is moving with constant speed then velocity of object :

1. may be variable
2. must be constant
3. must be variable
4. may be zero

QUESTION

A particle is executing a circular motion of radius R with a uniform speed v. After completing half the circle, the change in velocity and in speed will be respectively

1. zero, zero
2. $2v$, zero
3. $2v$, $2v$
4. zero, $2v$

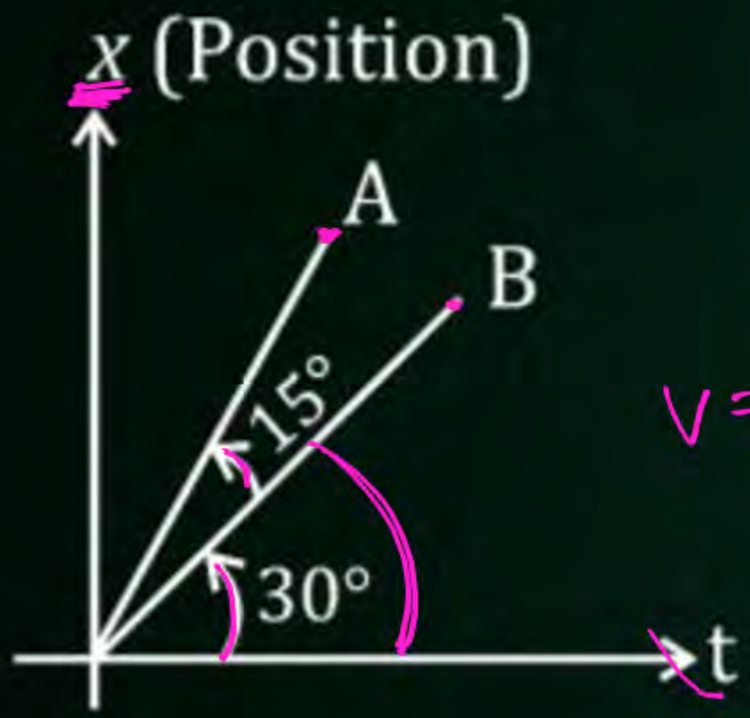


change in velo $= -v-(v)$

$= -2v$

QUESTION

Find ratio of velocity of A to B.



$v = \frac{d\vec{x}}{dt}$

$\frac{V_A}{V_B} = \frac{(\text{Slope})_A}{(\text{Slope})_B} = \frac{\tan 45°}{\tan 30} = \frac{1}{\frac{1}{\sqrt{3}}} = \frac{\sqrt{3}}{1}$

QUESTION

Position of object $x = 10t - 2t^2$. Find time when object comes to at rest.

↓ $v = 0$

Sol^n

$x = 10t - 2t^2$

$v = 10 - 2(2t)$

$v = 10 - 4t$

$0 = 10 - 4t$

$4t = 10$

$t = \frac{10}{4} = 2.5$ sec.

QUESTION

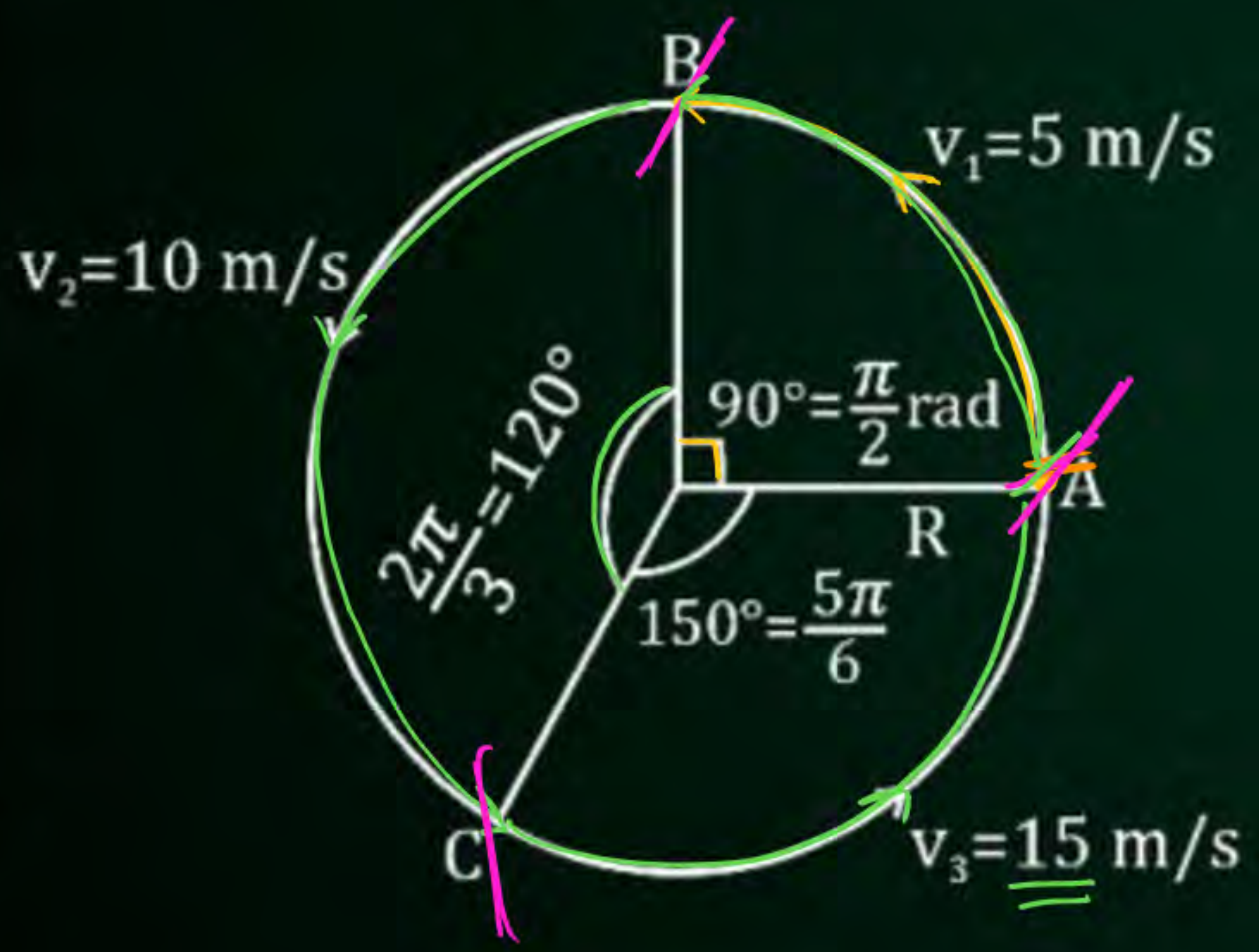
If position $x = t^2 + 4t + 6$. Find avg. speed and avg. velocity in 2-sec.

$$\text{Avg. speed} = (\text{Avg. velocity}) = \frac{\text{Total dispn}}{\Delta t} = \frac{(x_f)_{t=2} - (x_i)_{t=0}}{2-0} = \frac{18-6}{2} = \frac{12}{2} = 6\,m/s$$

diffⁿ से हमेशा instantaneous calculate होता है

QUESTION

A man is moving on circular path as shown then find avg. speed in one rotation.



$$\text{Avg speed} = \frac{2\pi R}{t_1 + t_2 + t_3}$$

$$= \frac{2\pi R}{\frac{R\pi}{2\times 5} + \frac{2R\pi}{3\times 5} + \frac{5\pi R}{6\times 15}}$$

$$= \frac{2}{\frac{1}{10} + \frac{1}{15} + \frac{1}{18}} = \frac{2}{\frac{18+12+10}{180}}$$

$$= \frac{2\times 180}{2\times 20} = 9 \text{ m/s}$$

QUESTION

Object is moving on circular path with speed v then find avg. velocity when it moves an angle θ.



$$(\text{Disp}^n)_{AB} = 2R\sin(\theta/2)$$

$$\text{Avg. velocity} = \frac{2R\sin(\theta/2)}{R\theta/v}$$

$$= \frac{2v\sin(\theta/2)}{\theta}$$

$\text{Avg. velocity} = v\left\{\frac{\sin(\theta/2)}{\theta/2}\right\}$

QUESTION

If object is moving with speed v = $3t^2$; then find avg. speed in 2-sec.

$$V_{inst.} = 3t^2$$

$$V_{Avg\ speed} = \frac{\int v\,dt}{\int dt} = \frac{\int_0^2 3t^2\,dt}{\int_0^2 dt} = \frac{3\left[\frac{t^3}{3}\right]_0^2}{(t)_0^2} = \frac{(2)^3 - (0)^3}{2-0} = \frac{8-0}{2}$$

$$= 4\ m/s$$

acceleration → Motion (slow/fast) का feel नहीं है।

- → How fast velocity is changing.
- → chang in velocity का feel है।
- → There is no relation b/w inst. velocity and inst. acc^n.

$a = v/t$ ← wrong

$$a_{Avg} = \frac{\Delta v}{\Delta t}$$

$$a_{inst} = \frac{d\vec{v}}{dt}$$

m → $\vec{u}$ ($a=0$), m → $\vec{u}$ ($a=0$), m → $\vec{u}$ ($a=0$)

($\vec{v}$ = Const velocity (Uniform mot^n) बड़ी उदास है जिंदगी)

$$a = \frac{d\vec{v}}{dt} = 0 \ (\vec{v} = const)$$

• $\vec{u}=0$ • $\vec{a}=0$ (Rest) → Rest मे रहेगा	$\vec{u}=0$ / $\vec{a}\neq 0$ (Rest) → motion मे आ जाएगा। At max^m height in motion under gravity
$\vec{u}\neq 0$ $\vec{a}=0$ uniform mot^n (उदास है।)	$\vec{u}\neq 0$ $\vec{a}\neq 0$ → Motion है → Motion मे change आएगा। accelerated mot^n.



$\rightarrow v = 20\,m/s$, $t = 0$

$\rightarrow u = 30\,m/s$, $t = 1\,sec$

$\rightarrow V = 38\,m/s$, $t = 2\,sec$

$\rightarrow u = 42\,m/s$, $t = 3\,sec$

$\rightarrow 44\,m/s$, $t = 4\,sec$

$a = \frac{30 - 20}{1} = 10\,m/s^2$ (Avg)

$a = \frac{38 - 30}{2 - 1} = 8\,m/s^2$

$a = \frac{42 - 38}{3 - 2} = 4\,m/s^2$

$a = \frac{44 - 42}{4 - 3}$

$a = 2\,m/s^2$

with time → $u \uparrow$ (velocity)

$a \downarrow$ (acc^n)

(No ret^n)

→ $u \uparrow$ $a \downarrow$

$\rightarrow u = 20\,m/s$, $t = 1\,s$

$\rightarrow u = 22\,m/s$, $t = 2\,se$

$\rightarrow V = 26\,m/s$, $t = 3\,s$

$\rightarrow u = 32\,m/s$, $t = 4\,s$

$\rightarrow 40\,m/s$, $t = 5\,sec$

$a = 2\,m/s^2$ | $a = 4\,m/s^2$ | $a = 6\,m/s^2$ | $a = 8\,m/s^2$

\# Velocity $\uparrow$
\# acc^n $\uparrow$

O ⟶ $30\ m/s^2$

$t = 0$

O ⟶ $v = 25\ m/s^2$

$t = 1\ sec$

O ⟶ $v = 15\ m/s^2$

$t = 2s$

O ⟶ $0\ m/s$

$t = 3s$

$a = -5\ m/s^2$

$a = \frac{15 - 25}{2 - 1}$

$= -10\ m/s^2$

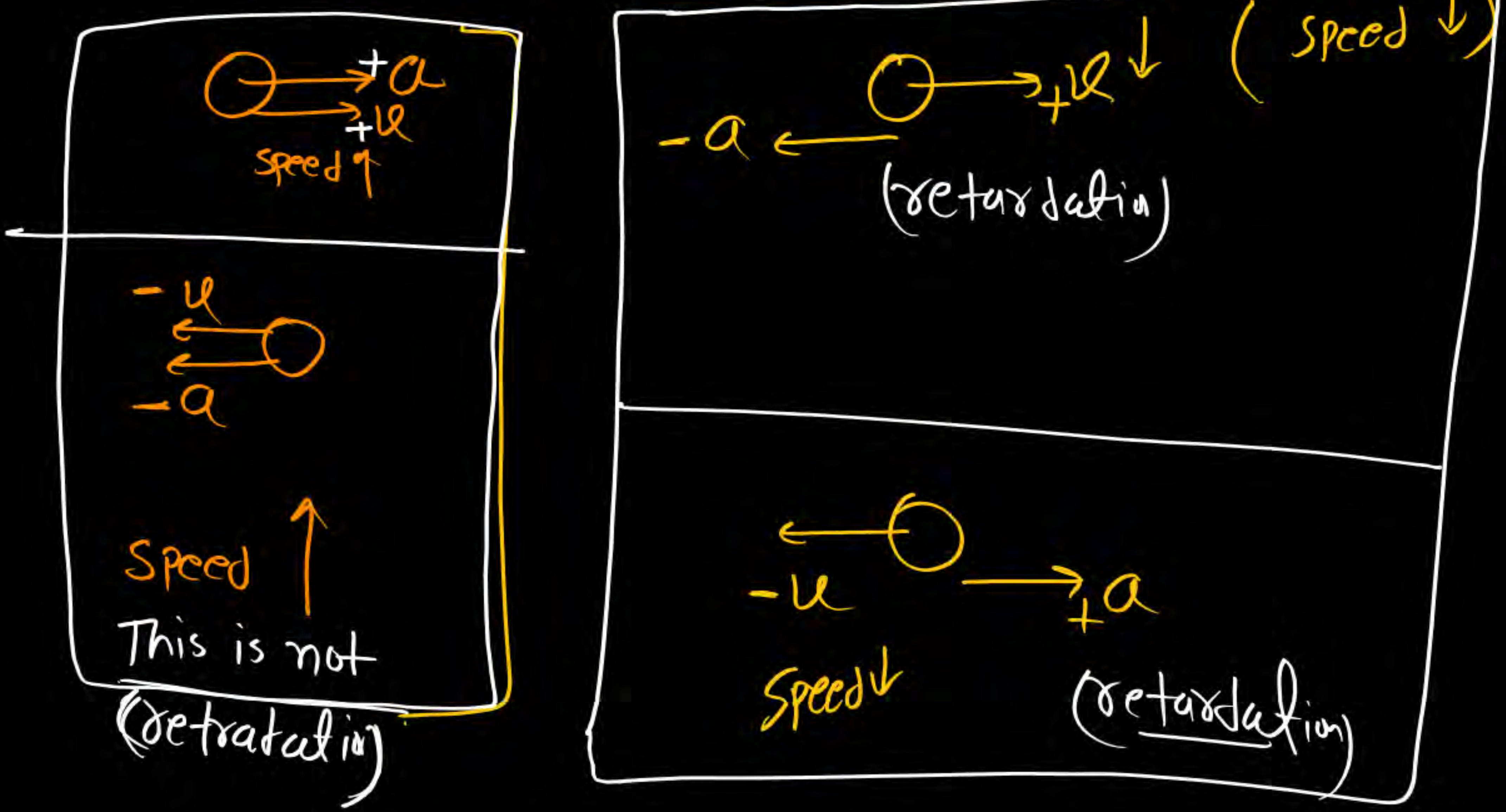
$a = \frac{0 - 15}{3 - 2}$

$a = -15\ m/s^2$

{ accⁿ ↑ , Velocit ↓ } → (retⁿ)

Retardation → धीरे होना → दुश्मन बन गया है, मेरा दोस्त जो पुराना

(Slow down) → acceleratin which is opposite to the velocity (speed ↓)



Retardation is -ve accⁿ ? ✓

(a) True

~~(b)~~ False

$\vec{F} = m\vec{a}$

m → gunⁿ

vector $\hat{n}$ +ve, −ve dir^n

(a) $u\uparrow$ $a\downarrow$ → Possible *

(b) $u\downarrow$ $a\uparrow$ → Possible (ret^n)

(c) $u\downarrow$ $a\downarrow$ → Possib (ret^n)

(d) $u\uparrow$ $a\uparrow$ → Possible

t = 0: $u \to 10\,m/s$; t = 1: $u \to 8\,m/s$; t = 2: $u \to 7\,m/s$

$a = \frac{8-10}{1} = -2\,m/s^2$

$a = -1\,m/s^2$

(e) $u = +ve$ $acc^n = -ve$

(f) $u_g = -ve$ $a = +ve$

(g) $u = +ve$ $a = +ve$

Possible

(h) $u = 0$ $a \neq 0$

(i) $u \neq 0$ $a = 0$

Possible

→ $\vec{u} = const^n$ $a \neq 0$ ✗ Not Possible

→ $\vec{u}\uparrow$, $\vec{a} = 0$ Not Possible

$\frac{d\vec{V}}{dt}$ = acc^n = The Rate of change in (velocity)

$\frac{d|\vec{V}|}{dt}$ = The Rate of change in (speed) = The rate of change in Magnitude of velocity

$\left|\frac{d\vec{V}}{dt}\right|$ = magnitude of (the rate of change in velociti)

= Magnitude of acc^n.



θ (Angle B/w $\vec{v}$ & $\vec{a}$) = 0°

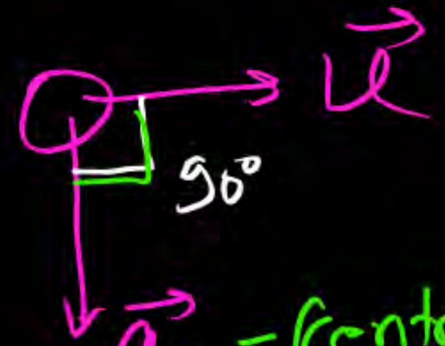
Speed ↑

(dir^n will no change)



* θ (B/w $\vec{v}$ & $\vec{a}$) = 180°
* Speed ↓ (Retardation)
* at this instant dir^n will not change after some-time it may take U-turn

at Point of U-turn
$v_{inst} = 0$

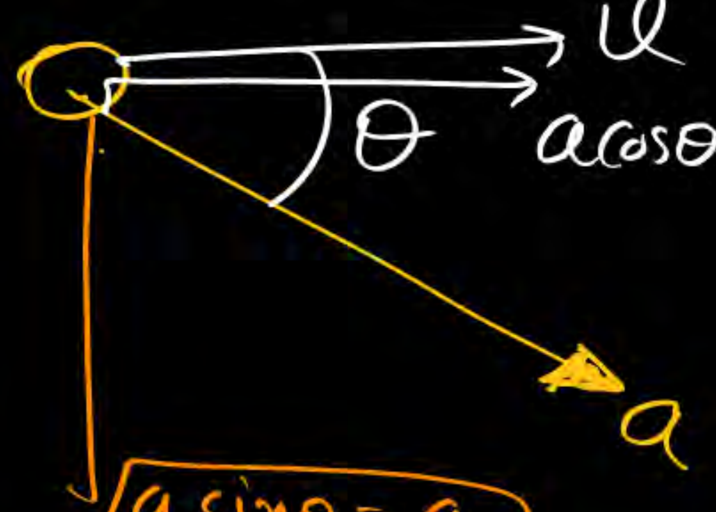


$\vec{a}_c$ = (centripetal acc^n)

at this instant speed will not change along x-axis.

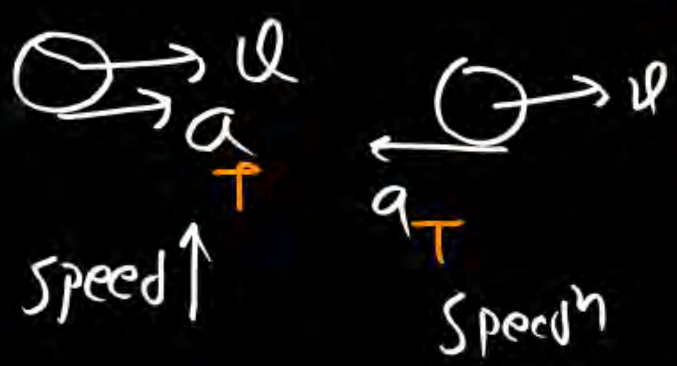
at this instant dir^n will change

✡ बिना रुके 1-D मे dir^n Change नही होता ||



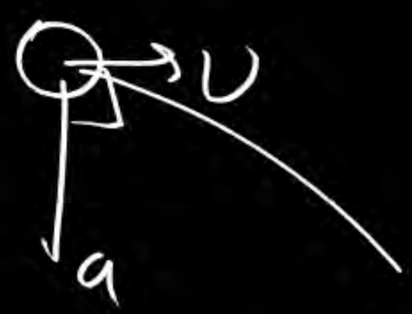
$a\cos\theta = a_T$ (tangential acc^n)
↳ speed change करेगा

$a\sin\theta = a_c$
↳ dir^n change



* Tangential



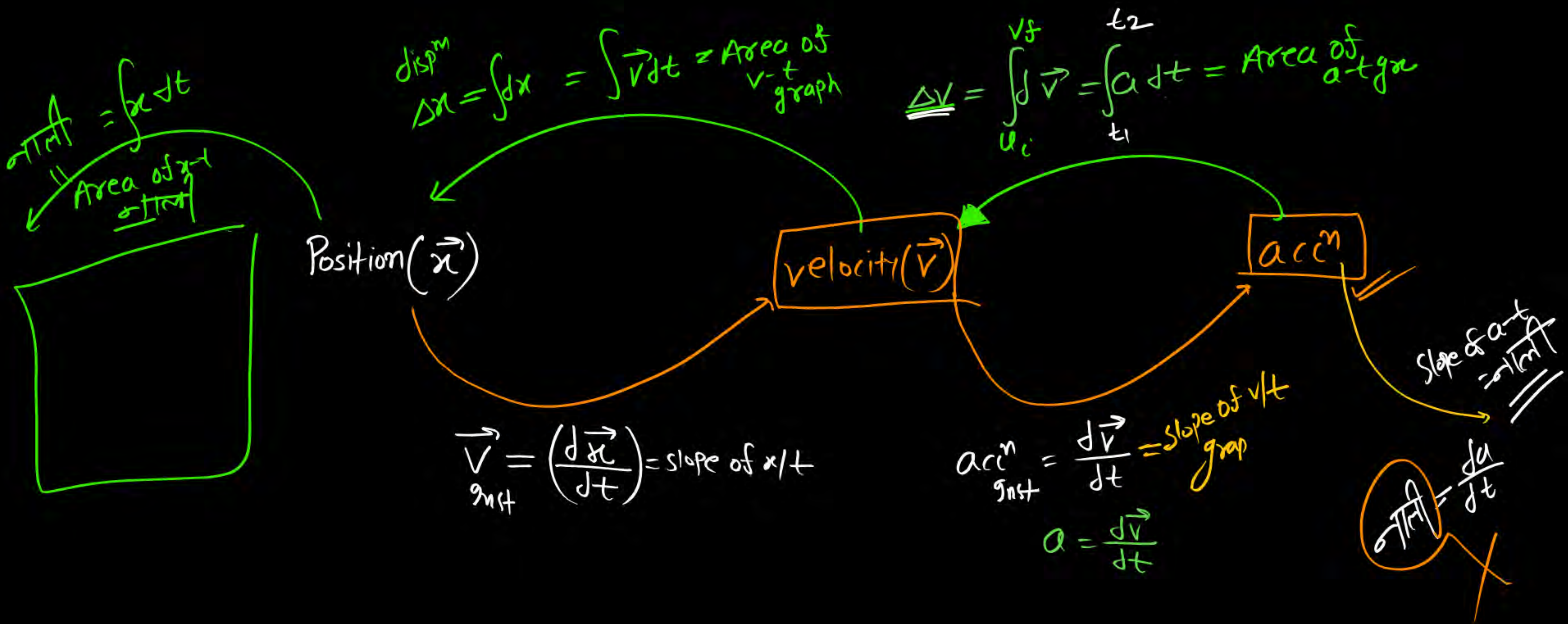


dir^n will change at this instant.

Who will decide future of mot^n ??

Sol^n. Path kya hoga
Speed kaisa hai
dir^n change होगा

Angle b/w $\vec{v}$ & $\vec{a}$



Position($\vec{x}$)
velocity($\vec{v}$)
acc^n
disp^m $\Delta x = \int dx = \int \vec{v}\,dt$ = Area of v-t graph
$\Delta v = \int_{u_i}^{v_f} d\vec{v} = \int_{t_1}^{t_2} a\,dt$ = Area of a-t gr
Area of x-t
$\vec{V}_{inst} = \left(\frac{d\vec{x}}{dt}\right)$ = slope of x/t
acc$^n_{inst}$ = $\frac{d\vec{v}}{dt}$ = slope of v/t grap
$a = \frac{d\vec{v}}{dt}$
slope of a-t
$\frac{da}{dt}$

MR* → step of sol^n → Nature of acc^n will decide

Ex

$a = 0$	$a = \text{const}^n$ ($a = 2\,m/s^2$)	a = variable
$\vec{u}$ = const^n Uniform motion $S = v \times t$ disp^m / dist^n	we will use eqn of mot^n. $\vec{v} = \vec{u} + \vec{a}t$ $s = ut + \frac{1}{2}at^2$ $v^2 - u^2 = 2as$	we will use (नानी concept) Integrat^n - diff^n with नानी का feel

QUESTION

Which of the following is possible :

(a) $\vec{V} = \cos t^n$ $\vec{a} = \cos t^n$

(b) $V\uparrow$ $a = \cos t^n$

(c) $V\uparrow$ $a = 0$

(d) $V\uparrow$ $a\downarrow$

(e) $V\downarrow$ $a\uparrow$

(f) $\mathrm{V} = \cos t^n$ $a\uparrow$

(g) $\mathrm{V} = \cos t^n$ $a = \cos t^n$

mR*

$a = 2\,m/s$

varib

$a = 2t$

$a = 2x$

$v = kt^1$

$v = 2t$

$x = t^2$

$v = \sqrt{x}$

→ accn = const

Think why ??

we will din in next ch

Thank you

YAKEEN 2.0

FOR NEET 2025

Lecture- 05 | Physics

Motion In a Straight Line

By- Dr. Manish Raj (MR SIR)



Topics to be covered

1. # Koin Banega Dr. . . . . (KBD)
2. # Ph.D on. Questions on Variable accn
3. #
4. #



QUESTION

Which of the following option is correct:

1. Velocity of object increasing and acceleration may decreasing.
2. Velocity of object decreasing and acceleration may increasing.
3. Acceleration may be non-zero when velocity of object is zero.
4. All of these.



Electrostatic force = long rang

$\downarrow\downarrow F \propto \frac{1}{r^2}$ ($r\uparrow$)

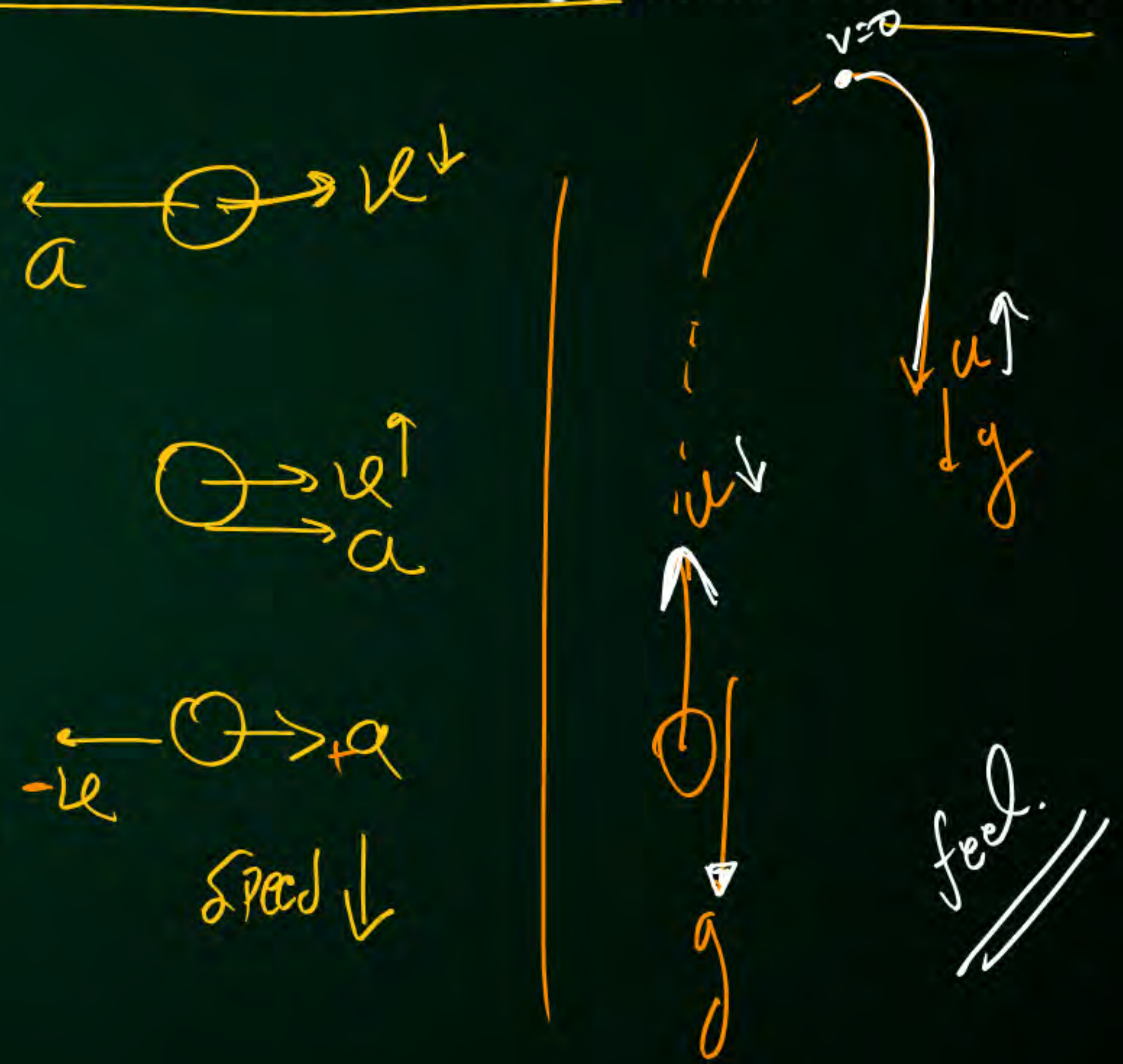
* always repulsive

air friction

QUESTION

Object is moving such that its velocity and acceleration is in opposite direction then

1. Speed may constant.
2. Speed may increasing.
3. Speed must be decreasing.
4. Speed may be increasing or decreasing.



QUESTION

An object is moving with constant velocity then which of the following option is correct

1. Acceleration may be increasing.
2. Acceleration is zero.
3. Acceleration is decreasing.
4. Acceleration is non-zero.

$\vec{v}$ = const
$a = 0$

QUESTION

Which of the following is wrong

1. Velocity increasing and acceleration decreasing.
2. $\vec{V}\downarrow$ and $\vec{a}\uparrow$
3. $\vec{V}\uparrow$ and $\vec{a} = 0$
4. None of these.

Ans → (3)

1. Object is moving with acceleration* $2\,m/s^2$ its velocity at $t=0$ is $10\,m/s$ then find its velocity at $t = 4$ sec.

Sol^n * $a = 2\,m/s^2$ $u_f = 18\,m/s$

$v = u + at$

$v = 10 + 2 \times 4 = 18\,m/s$

2. velocity at $t = 0$ sec is $10\,m/s$ its velocity becomes $40\,m/s$ after 6 sec then find acceleration.

$u = 10\,m/s$, $v = 40\,m/s$; $a = \frac{30}{6} = 5\,m/s^2$

$\vec{a} = \frac{\Delta v}{\Delta t} = \frac{v_f - v_i}{\Delta t}$

3. velocity at $t = 2$ sec is $20\,m/s$ at $t = 5$ sec it becomes $32\,m/s$ then velocity at 7 sec will be

Sol^n

$t = 2$ sec, $u = 20\,m/s$; $t = 5$ sec, $v = 32\,m/s$

$a = \frac{12}{3} = 4\,m/s^2$

$v = u + at$

$v = 32 + 4 \times 2 = 32 + 8 = 40\,m/s$

QUESTION

Vector कहाँ जाती बदली है

(*) very imp.

Ramlal is moving with velocity $3\hat{\imath} + 4\hat{\jmath}$ at $t = 0$ after 5 sec its velocity becomes $4\hat{\imath} + 3\hat{\jmath}$ then find average acceleration.

Sol^n

$\vec{u} = 3\hat{i} + 4\hat{j}$

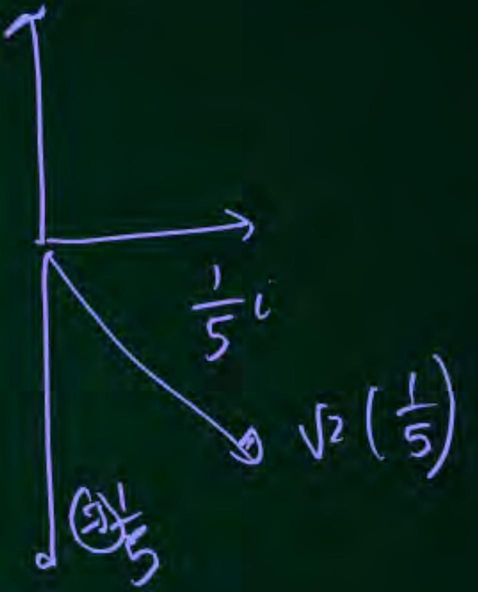
$\vec{V} = 4\hat{i} + 3\hat{j}$

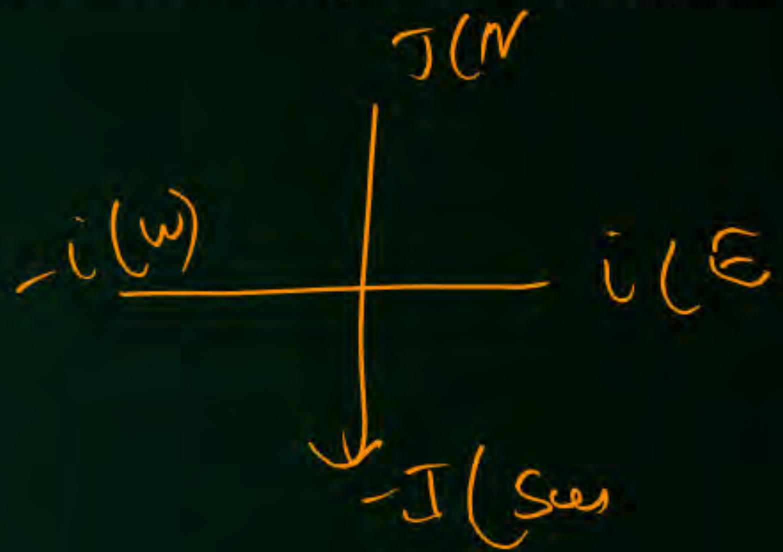
$$\vec{a}_{Avg} = \frac{\vec{v}_f - \vec{u}_i}{\Delta t}$$

$$= \frac{4\hat{i} + 3\hat{j} - 3\hat{i} - 4\hat{j}}{5}$$

$$\vec{a} = \frac{\hat{i} - \hat{j}}{5} = \frac{1}{5}\hat{i} - \frac{1}{5}\hat{j}$$

$a = \frac{\sqrt{2}}{5}$ m/s





$\vec{a} = \frac{\sqrt{2}}{5}$ m/s^2 (South-east)

QUESTION

Kallu is moving with speed 40 m/s in north after 10 sec he is moving with 40 m/s in east then find

(i) Magnitude of rate of change in velocity.

(ii) Rate of change in magnitude of velocity.

$\Rightarrow |\vec{V}_f| - |\vec{u}_i| = 0$

$\vec{u}_i = 40\hat{j}$ (North)

$t = 10 \text{ sec}$

$\vec{u}_f = 40 \text{ m/s east } \hat{i}$

$\vec{a} = \frac{40\hat{i} - 40\hat{j}}{10} = 4\hat{i} - 4\hat{j}$

$|\vec{a}| = 4\sqrt{2}$ (south east)

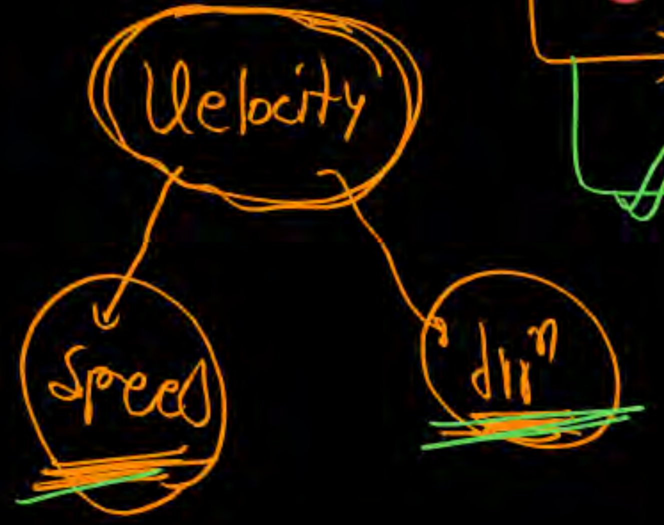


(*) Todays clues

- Object is moving with constant velocity then it is called uniform motion



- acceleration = 0 $\quad a = \frac{d\vec{v}}{dt} = 0$ ✓
- speed = $const^n$
- direction = fixed (No change in direction)
- Motion in straight line



- s ($disp^m$) = velocity × time

displacement = distance

- Avg. velocity = instantaneous velocity.

find acceleration in each term

$x = 4t^1 + 6$

diffⁿ w.r.t. time

$u = \frac{dx}{dt} = 4\frac{dt}{dt} + \frac{d6}{dt}$

$u = 4$

$a = \frac{dv}{dt} = 0$

$x = 3t^2 + 4t + 6$

diffⁿ w.r.t x

$u = \frac{dx}{dt} = 3\left(\frac{dt^2}{dt}\right) + 4\frac{dt}{dt} + 0$

$= 3 \times 2t + 4 \times 1$

$u = 6t + 4$

$a = \frac{dv}{dt} = 6\ m/s^2$

$x = 2t^3 + 5t$

$v = 2(3t^2) + 5 \times 1$

$v = 6t^2 + 5$

$a = \frac{dv}{dt} = 6(2t) + 0$

$a = 12t$

$x = t^4 + 4t$

$u = \frac{dx}{dt} = 4t^3 + 4$

$a = \frac{dv}{dt} = 4(3t^2)$

$a = 12t^2$

$v = 3t^2 + 4$

Solⁿ

$a = \frac{dv}{dt} = 3(2t)$

$a = 6t$

$v = 3t^1 + 4$

Solⁿ

$a = 3\frac{dt}{dt} + 0$

$a = 3$

$v = t^3 + 4$

Solⁿ

$a = \frac{dv}{dt}$

$a = 3t^2$

$v = 2x + 4$

$\frac{dv}{dx} = \frac{d(2x+4)}{dx} = 2\frac{dx}{dx} + 0$

$\frac{dv}{dx} = 2$

$a = v\frac{dv}{dx} = (2x+4) \times 2$

$= (4x+8)$

$x = \frac{4}{t^2}$

find acc^n

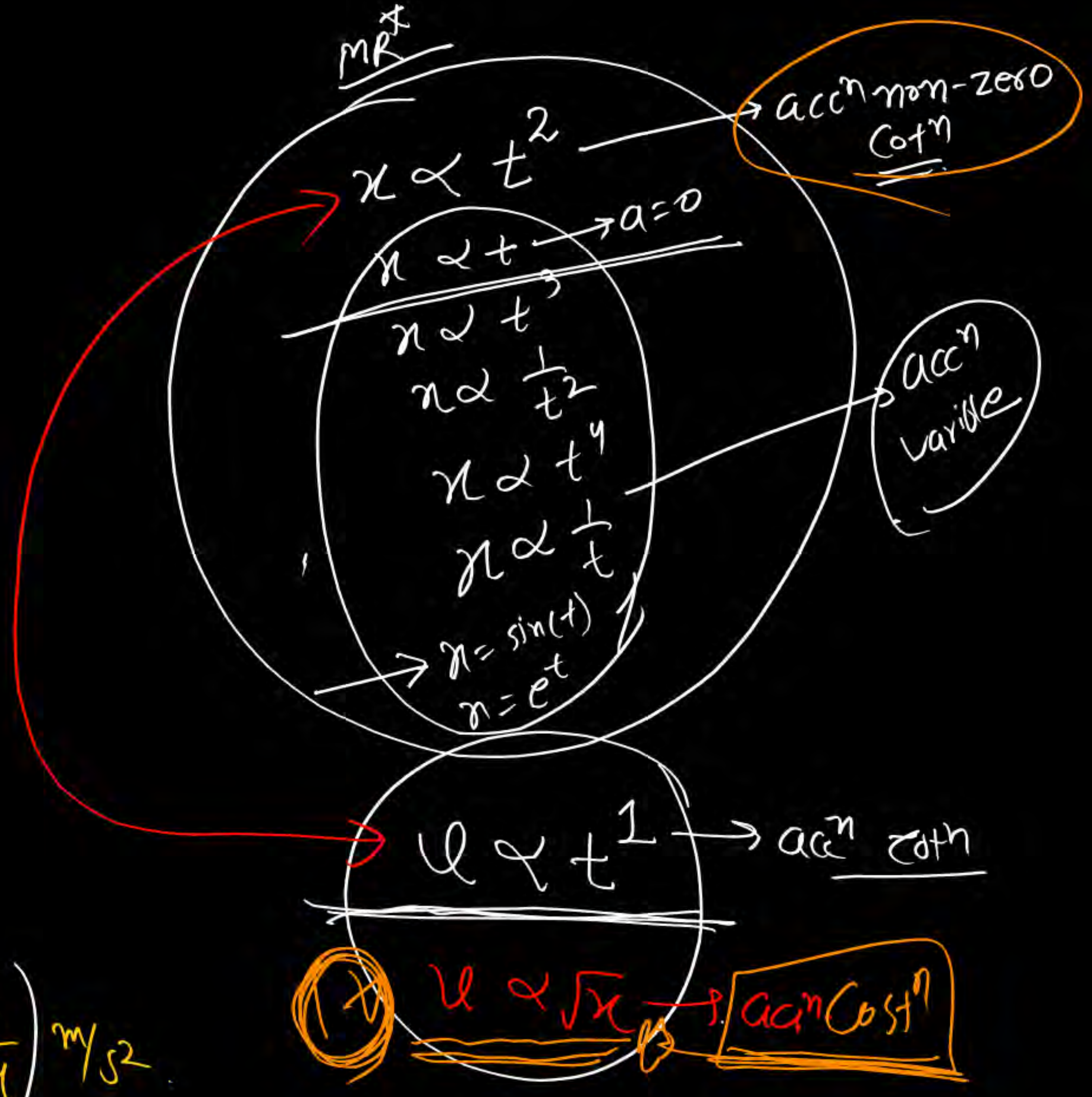
$$v = \frac{dx}{dt} = \frac{d(4t^{-2})}{dt}$$

$$= 4\left(\frac{dt^{-2}}{dt}\right)$$

$$= 4(-2) \times t^{-3}$$

$$v = -8t^{-3} = \frac{-8}{t^3}$$

$a = \frac{dv}{dt} = -8\frac{dt^{-3}}{dt} = 24t^{-4} = \left(\frac{24}{t^4}\right)$ m/s^2



QUESTION

In which case acceleration is constant.

1. $x = t^2 + 2t$ const

2. $x = 1/t^2$ Not const

3. $x = at$ e^t No const

4. $x = t^3$ Not const

5. $x = \sin(t)$ Not const

6. $xt^2 = \cos t^n$ → a = varible $x = \frac{1}{t^2}$

7. $x = \sqrt{3t + 5}$ → variu

8. $V = t^2$ → varib e

9. $V = kt$ → a = cst

10. $V = \sin(t)$ → varib acen

11. $V = kx^2$ varible acc

12. $V = k\sqrt{x}$ → a = cnt

13. $V = \frac{1}{x}$ → varibe ac.

- $x \propto t^2$
- $v \propto t$
- $v \propto \sqrt{x}$

accⁿ is non-zero cntⁿ

(12) $V = K\sqrt{x} = Kx^{1/2}$

$$\frac{dv}{dx} = K\frac{dx^{1/2}}{dx} = K\frac{1}{2}x^{\frac{1}{2}-1}$$

$$\frac{dv}{dx} = \frac{K}{2}x^{-\frac{1}{2}}$$

$$\frac{dv}{dx} = \frac{K}{2x^{1/2}}$$

$$a = v\frac{dv}{dx} = K\sqrt{x} \times \frac{K}{2x^{1/2}}$$

$$a = \left(\frac{K^2}{2}\right) = \text{cnt}$$

IIT - 2006

Q) Object is moving such that $V = K\sqrt{x}$ then find Position as function of time

$acc^n = const^n$

MP*

$x \propto t^2$

$v \propto t$

$v \propto \sqrt{x}$

(a) $x \propto t^2$

(b) $x \propto \sqrt{t}$ ✗

(b) $x \propto t^3$ ✗

(c) $x \propto t$ ✗

$x \propto t^2$

$u \propto t$

$u \propto \sqrt{x}$

In which case acceleration is uniform (constant)

(1) $x = \sqrt{t} + 4$ ✗ ($a \propto t^{-3/2}$)

(2) $\sqrt{x} = t - 3$ ✓
$x = (t-3)^2 = t^2 - 6t + 9$

(3) $x = t^{-2} + 4$ ✗

(4) $x = \frac{4}{t}$ ✗

(5) $x = t^3 + 4$ ✗

(6) $x = \frac{3}{t^2}$ ✗

(7) $x = 4t^2 + 6$ ✓

(8) $V = 3t^2 + 4$ ✗

(9) $V = 6t - 4$ ✓

(10) $V = \sqrt{x}$ ✓
one leg stand for next 5 min.

(11) $V = x^2 + 4$ ✗

(12) $V = 2x + 3$ ✗

(13) $a = 2t$ ✗

(14) $a = 3x$ ✗

(15) $a = 2t^2$ ✗

(16) $a = 5 m/s^2$ ✓

(17) $a = 3\sqrt{x}$ ✗

(18) $x = A\sin(\omega t)$ ✗

(19) $V = A\cos(\omega t)$ ✗
$a = -A\sin(\omega t)$

(20) $a = 2\sin(t)$ ✗

QUESTION

Object is moving such that its position given as a function of time $x = \alpha t^2 + \beta t + \gamma$ then find initial velocity, initial acceleration and initial position.

$x = \alpha t^2 + \beta t + \gamma$

diffⁿ w.r.t. time

$V = \frac{dx}{dt} = \alpha(2t) + \beta \times 1 + 0$

$V = 2\alpha t + \beta$

$a = \frac{dv}{dt} = 2\alpha \times 1 + 0 = 2\alpha$

acc^n initial $= 2\alpha$ m/s^2 (const^n)

$V = 2\alpha t + \beta$ → varible

$u_{t=0} = \beta$ m/s

$(x)_{t=0} = \gamma$ m

QUESTION

Object is moving with velocity $V = 4t^2 + 2t + 4$ then find velocity and acceleration at $t = 1$ sec.

$V = 4t^2 + 2t + 4$

$v_{t=1} = 4(1)^2 + 2\times 1 + 4 = 10\ m/s$

diff^n w.r.t time

$a = \frac{dv}{dt} = 4(2t) + 2\times 1 + 0$

$a = 8t + 2$ → varible acn

$a_{t=1} = 8\times 1 + 2 = 10\ m/s^2$

QUESTION

If V = kx the find acceleration at x = 2m.

Sol^n

$V = kx$

$\frac{dv}{dt}$ ✗

$\frac{dv}{dx} = k\frac{dx}{dx} = k$

$a = v\frac{dv}{dx}$

$$a = kx(k) = k^2x$$

$a = k^2x$

$$a = (2k^2)\ m/s^2$$

Ans



$V \propto x$

$a \propto x$

$v = x^2$

$\frac{dv}{dx} = 2x$

$a = v \frac{dv}{dx}$

$= x^2 (2x)$

$a = 2x^3$

QUESTION

Velocity of object $V = 3t^2$ then find acceleration in 2 sec and acceleration at 2 sec.

$$\vec{a}_{Avg\ (in\ 2\,sec)} = \frac{\vec{v}_f - \vec{v}_i}{\Delta t}$$

$$= \frac{(v)_{t=2} - v_{t=0}}{2-0}$$

$$= \frac{3(2)^2 - 0}{2-0}$$

$$a_{Avg} = \frac{12}{2} = 6\,m/s^2$$

$$\vec{a}_{inst} = \frac{dv}{dt}$$

$$= \frac{d\,3t^2}{dt}$$

$$= 3\frac{dt^2}{dt}$$

$$= 3(2t)$$

$$a = 6t$$

$$a_{(t=2)} = 6 \times 2 = 12\,m/s^2$$

Q $v = 3t$

$a = c\,or\,t^n$

$a_{inst} = a_{Avg}$

$$a_{inst} = 3\frac{dt}{dt} = 3\,m/s^2$$

$$a_{Avg} = 3\,m/s^2$$



QUESTION

If position $x = t^2 + 5t^3 + 6$ then find

(i) Initial acceleration. (t=0)

(ii) Initial velocity.

(iii) Acceleration at t = 2 sec.

u =

a

QUESTION

If position $x = at^2 - bt^3$ find time when the acceleration is zero.

$x = at^2 - bt^3$

$V = \frac{dx}{dt} = 2at - 3b(t^2)$

$a = \frac{dv}{dt} = 2a - 6bt$

$0 = 2a - 6bt$

$t = \frac{2a}{6b} = \frac{a}{3b}$

QUESTION

If velocity $V = k\sqrt{x}$ then find acceleration. [IIT-2006]

QUESTION

If position of object $x = t^2 - 4t + 5$ then find instant when velocity becomes zero and displacement when object comes to at rest.

Position at $t=2$: $x|_{t=2} = (2)^2 - 4\times 2 + 5 = 9 - 8 = 1\,m$

Sol^n

$x = t^2 - 4t + 5$ (Position)

$\frac{dx}{dt} = 2t - 4$

$V = 2t - 4 = 0$

$2t = 4$

$t = 2\,sec$

$disp^m = (x_f)_{t=2sec} - (x_i)_{t=0}$

$= ((2)^2 - 4\times 2 + 5) - (5)$

$= 4 - 8 + 5 - 5$

$= -4\,m$

Δx = $\int dx = \int_{t_1}^{t_2} v_{inst}\, dt$

displacement

area under graph = $\int x\, dt$

$\Delta v = \int dv = \int a_{ins}\, dt$ = change in velocity = Area of a-t graph = Δv

$\vec{x}$ → $\vec{V}$ → $\vec{a}$ → $\frac{da}{dt}$

diff^n of x w.r.t. 't'

$\vec{v}_{inst} = \frac{dx}{dt}$ (slope of x-t graph)

$\vec{a}_{inst} = \frac{dv}{dt}$

$\vec{a}_{inst} = v\frac{dv}{dx}$



- What is given
- What I have to find
- What is the nature of acc^n ??

$\vec{v}_{Avg} = \frac{\text{total disp}^n}{\text{total time}}$

$v_{Avg} = \left[\frac{\vec{x}_f - \vec{x}_i}{\Delta t}\right] = \frac{\int v\, dt}{\int dt}$

$\vec{a}_{Avg} = \frac{(\vec{v}_f - \vec{v}_i)}{\Delta t} = \frac{\int a\, dt}{\int dt}$

QUESTION

If velocity of object $V = 3t^2$ then find distance in 2 sec.

→ one-D mot^n without change in dir^n

→ $V = 3t^2$

$$\frac{dx}{dt} = 3t^2$$

$$\int dx = \int 3t^2\,dt$$

$$x = 3\int_0^2 t^2\,dt = 3\left[\frac{t^3}{3}\right]_0^2 = (2)^3 - 0^3 = 8\,m$$

QUESTION

Velocity of object $V = \beta x^{2n}$ then find acceleration. where β & n are const

Sol^n

$V = \beta x^{2n}$

~~$\frac{dv}{dt}$~~

diff^n w.r.t x

$\frac{dv}{dx} = \frac{d(\beta x^{2n})}{dx} = \beta \frac{dx^{2n}}{dx}$

$\frac{dv}{dx} = \beta\, 2n\, x^{2n-1}$

$a = v \frac{dv}{dx}$

$= \beta x^{2n} \times \beta 2n\, x^{2n-1}$

$a = 2n\beta^2 x^{4n-1}$

NEET-2015

QUESTION

The position of a particle moving along X-axis in given by $x = 10t - 2t^2$. Then the time (t) at which it will momently come to rest is

1. 0
2. 2.5 s
3. 55
4. 10 s

QUESTION

If the displacement of a particle varies with time as $\sqrt{x} = t + 7$, then

1. Velocity of the particle is inversely proportional t
2. Velocity of the particle is proportional to t^2
3. Velocity of the particle is proportional to $\sqrt{t}$
4. The particle moves with constant acceleration

QUESTION

The position x of particle moving along x-axis varies with time t as $x = A\sin(\omega t)$ where A and w are [illegible] positive constants. The acceleration a of particle varies with its position (x) as

1. $a = Ax$
2. $a = -\omega^2 x$
3. $a = A\omega x$
4. $a = \omega^2 x A$

$x = A\sin(\omega t)$

$v = A\cos(\omega t) \times \omega$

$v = A\omega\cos(\omega t)$

diffⁿ w.r.t. time $a = \frac{d(v)}{dt} = -A\omega\sin(\omega t) \times \omega$

$a = -A\omega^2\sin(\omega t)$

$a = -\omega^2 x$

QUESTION

The initial velocity of a particle is u (at $t = 0$) and the acceleration a is given by $\alpha t^{3/2}$. Which of the following relations is valid?

1. $v = u + \alpha t^{3/2}$
2. $v = u + \frac{3\alpha t^3}{2}$
3. $v = u + \frac{2}{5}\alpha t^{5/2}$
4. $v = u + \alpha t^{5/2}$

Ans

$a = \alpha t^{3/2}$

$\frac{dv}{dt} = \alpha t^{3/2}$

$\int_u^v dv = \int_{t=0}^{t} \alpha t^{3/2} dt$

$(v)_u^v = \alpha \left(\frac{t^{\frac{3}{2}+1}}{\frac{3}{2}+1}\right) = \alpha \frac{t^{5/2}}{5/2}$

$v = u + \frac{2\alpha}{5} t^{5/2}$

Eqn of motn Not valid for varible accn

$v = u + at$

$= u + \alpha t^{3/2}(t)$

$v = u + \alpha t^{5/2}$

QUESTION

A particle of unit mass undergoes one-dimensional motion such that its velocity varies according to $v(x) = bx^{-2n}$, where b and n are constants and x is the position of the particle. The acceleration of the particle as a function of x, is given by

[AIPMT-2015]

1. $-2n\beta^2 e^{-4n+1}$
2. $-2n\beta^2 x^{-2n-1}$
3. $-2n\beta^2 x^{-4n-1}$
4. $-2\beta^2 x^{-2n+1}$

$V = bx^{-2n}$

$\frac{dv}{dx}$ diffy

acc

already done

$a = v\frac{dv}{dx}$

QUESTION

A particle moves along a straight line such that its displacement at any time t is given by $s = (t^3 - 6t^2 - 3t + 4)$ meters. The velocity when the acceleration is zero is

1. 3 m/s
2. 42 m/s
3. - 9 m/s
4. - 15 m/s

$s = t^3 - 6t^2 - 3t + 4$

$\frac{ds}{dt} = v = 3t^2 - 6(2t) - 3$

$v = 3t^2 - 12t - 3$

$a = \frac{dv}{dt} = 3(2t) - 12$

जब $acc^n = 0$ है तभी velocity ??

$6t - 12 = 0$

$6t = 12$

$t = 2\,sec$

at t = 2 sec acc^n is zero

$v_{t=2} = 3(4) - 12(2) - 3$

$= 12 - 24 - 3$

$= -12 - 3$

$= -15$

(1) Position of object $x = t^3 - 6t^2 + 10$ find time when acceleration of object will be zero.

easy

$v = \frac{dx}{dt}$

$a = \frac{dv}{dt} = - - - = 0$

Position of object $x = 2t^3 - 4t^2 + 4$

then find, velocity, acceleration and Position at $t = 2$ Sec

easy

$x = 2t^3 - 4t^2 + 4$

$v = \frac{dx}{dt}$

$a = \frac{dv}{dt}$

Position $x = t^3 - 9t^2 + 4$. find velocity ?? when acceleration is zero.

Sol^n

$x = t^3 - 9t^2 + 4$

$v = 3t^2 - 18t$

$v = 3(3)^2 - 18 \times 3 = 27 - 54$

$= -27$ m/s

$a = 6t - 18$

$0 = 6t - 18$

$6t = 18$, $t = 3$

Position of object $x = 2t^3 - 24t + 4$ find acceleration when velocity of object is zero.

$$a = 12t$$

$$(a)_{t=2} = 12 \times 2 = 24\, m/s^2$$

$$x = 2t^3 - 24t + 4$$

$$v = 2(3t^2) - 24 \times 1 + 0$$

$$v = 6t^2 - 24 = 0$$

When $v = 0$

$$0 = 6t^2 - 24$$

$$6t^2 = 24$$

$$t^2 = 4$$

$$t = \sqrt{4} = 2\, sec$$

$$a = \frac{dv}{dt} = 6(2t) - 0 = 12t$$

QUESTION

A particle moving along x-axis has acceleration f, at time t, given $f = f_0\left(1 - \frac{t}{T}\right)$, Where f_0 and T are constants. The particle at $t = 0$ has zero velocity. At the instant $(t = T)$ the particle's velocity is

[AIPMT (Prelims)-2007]

1. $\frac{1}{2} f_0 T$ ✓
2. $f_0 T$
3. $\frac{1}{2} f_0 T^2$
4. $f_0 T^2$

$u = 0$, $t = 0$

$f = f_0\left(1 - \frac{t}{T}\right)$ (accn)

$\frac{dv}{dt} = f_0 - \frac{f_0 t}{T}$

$\int dv = \int f_0\, dt - \frac{f_0}{T}\int t\, dt$

$v = f_0 (t)_0^T - \frac{f_0}{T}\left(\frac{t^2}{2}\right)_0^T = f_0 T - \frac{f_0 T}{2} = \frac{f_0 T}{2}$ ✓


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 06 | **Physics**

Motion In a Straight Line



By- Dr. Manish Raj (MR SIR)

Topics to be covered

H/W (varible acc^n)

1. #
   - Motion with Constant acc^n
     - Equation of motion
     - NEET
2. #
3. #
4. #



QUESTION

A particle moving along x-axis has acceleration f, at time t, given $f = f_0\left(1 - \frac{t}{T}\right)$, Where f_0 and T are constants. The particle at $t = 0$ has zero velocity. At the instant when $f = 0$, the particle's velocity is

[AIPMT (Prelims)-2007]

1. $\frac{1}{2} f_0 T$
2. $f_0 T$
3. $\frac{1}{2} f_0 T^2$
4. $f_0 T^2$

$f = f_0\left(1 - \frac{t}{T}\right)$

acc^n varible → eq^n of mot^n not valid

$\frac{dv}{dt} = f_0 - \frac{f_0}{T} t$

$\int_{v=0}^{v} dv = f_0 \int_{t=0}^{T} dt - \frac{f_0}{T} \int_{0}^{T} t\, dt$

QUESTION

A body is moving with variable acceleration (a) along a straight line. The average acceleration of body in time interval t_1 to t_2 is

1. $\frac{a[t_2 + t_1]}{2}$
2. $\frac{a[t_2 - t_1]}{2}$
3. $\frac{\int_{t_1}^{t_2} a\,dt}{t_2 + t_1}$
4. $\frac{\int_{t_1}^{t_2} a\,dt}{t_2 - t_1}$

$$a_{Avg} = \frac{\int_{t_1}^{t_2} a\,dt}{\int_{t_1}^{t_2} dt} = \frac{\int_{t_1}^{t_2} a\,dt}{(t)_{t_1}^{t_2}} = \frac{\quad}{t_2 - t_1}$$

QUESTION

A particle moves in a straight line and its position x at time t is given by $x^2 = 2 + t$. Its acceleration is given by

1. $\dfrac{-2}{x^3}$
2. $-\dfrac{1}{4x^3}$
3. $-\dfrac{1}{4x^2}$
4. $\dfrac{1}{x^2}$

Integ $\leftarrow x \quad v \quad a$

$x^2 = 2 + t$

$x = \sqrt{t+2} = (t+2)^{1/2}$

diffⁿ with r.t. time

$\dfrac{dx}{dt} = \dfrac{d(t+2)^{1/2}}{dt} = \dfrac{1}{2}(t+2)^{\frac{1}{2}-1} \times (1+0)$

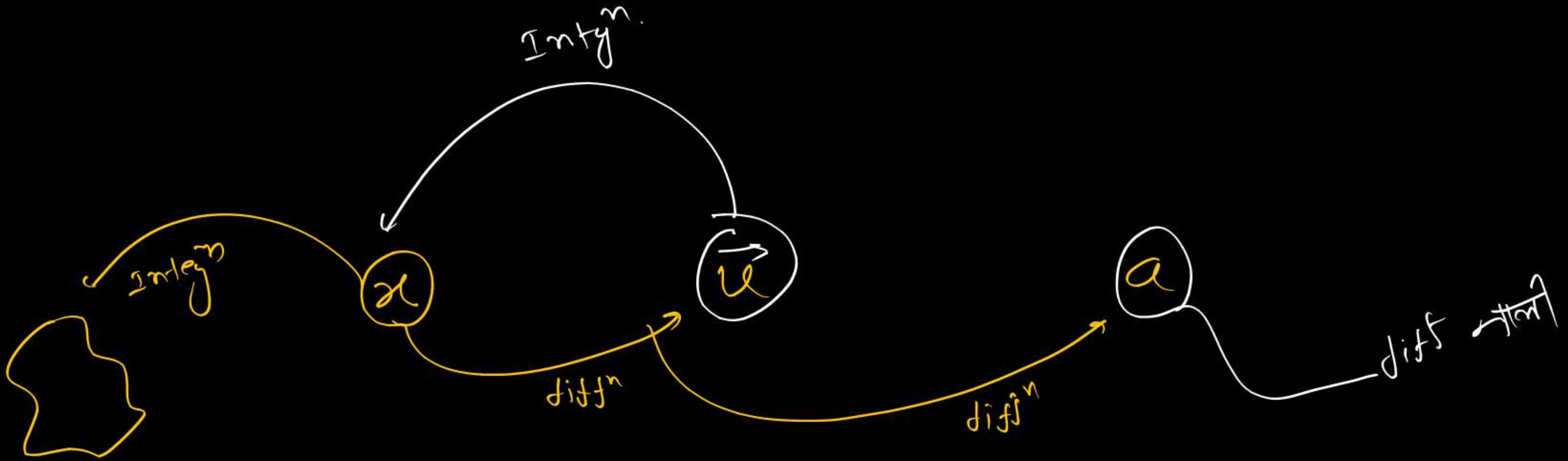
$v = \dfrac{1}{2}(t+2)^{-\frac{1}{2}}$

$\dfrac{dv}{dt} = \dfrac{1}{2}\left(-\dfrac{1}{2}\right)(t+2)^{-\frac{1}{2}-1}$

$a = -\dfrac{1}{4}(t+2)^{-\frac{3}{2}}$

$= -\dfrac{1}{4}\left((t+2)^{\frac{1}{2}}\right)^{(-3)}$ Think??

$= -\dfrac{1}{4}x^{-3} = \dfrac{-1}{4x^3}$



Intgn.
Integn
diffn
diffn
diff वाली

QUESTION

A particle moves a distance x in time t according to equation $x = (t + 5)^{-1}$. The acceleration of particle is proportional to [2010]

1. $(\text{velocity})^{3/2}$
2. $(\text{distance})^{2}$
3. $(\text{distance})^{-2}$
4. $(\text{velocity})^{2/3}$

$x = (t+5)^{-1}$

$\frac{dx}{dt} = -1(t+5)^{-2}$

$V = -1(t+5)^{-2}$

$a = \frac{dV}{dt} = -1(-2)[t+5]^{-3} = 2(t+5)^{-3}$

$= 2\left[(t+5)^{-1}\right]^{3} = 2x^{3}$

$a = 2\left((t+5)^{-2}\right)^{\frac{3}{2}}$

$a \propto V^{3/2}$

$$(t+5)^{-3} = (t+5)^{\frac{-2}{2}\times 3}$$

$$\Rightarrow (t+5)^{-1\times 3}$$

QUESTION

If acceleration of object $a = 2x^{3/2}$ then find velocity at x where initial velocity at $x = 0$ is 4 m/s

$$a = 2x^{3/2}$$

eqn of motn is not valid

$$v\frac{dv}{dx} = 2x^{3/2}$$

$$\int_4^v v\,dv = 2\int_{x=0}^{x} x^{3/2}\,dx$$

$$\left(\frac{v^2}{2}\right)_4^v = 2\left(\frac{x^{3/2+1}}{\frac{3}{2}+1}\right)_0^x$$

$$\frac{v^2-4^2}{2} = 2\frac{x^{5/2}}{5/2}$$

$$v^2-16 = \frac{8}{5}x^{5/2}$$

$$v = \sqrt{\frac{8}{5}x^{5/2}+16}$$

Ans

diffn

$\frac{dv}{dt}$

QUESTION

The displacement 'x' (in meter) of a particle of mass 'm' (in kg) moving in one dimension under the action of a force, is related to time 't' (in sec) by $t = \sqrt{x} + 3$. The displacement of the particle when its velocity is zero, will be

[NEET 2013]

1. 4 m
2. 0 m (zero)
3. 6 m
4. 2 m

$t = \sqrt{x} + 3$

$\sqrt{x} = t - 3$

$x = (t-3)^2$

disp^m $x = t^2 + 9 - 6t$

$\frac{dx}{dt} = V = 2t - 6 = 0$

$2t = 6$

$t = 3$ sec

disp^m $= x = t^2 + 9 - 6t$

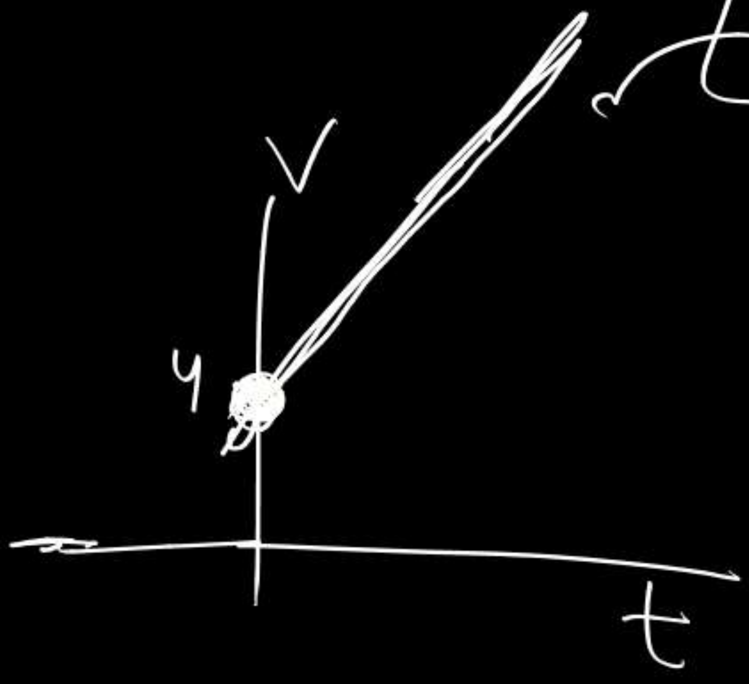
$(x)_{t=3} = 0$

(Q) $x = t^2 + 4t - 6$

find time when velocity will be zero ??

Sol^n

$v = \frac{dx}{dt} = 2t + 4 - 0$



$0 = 2t + 4$

$t = -2$ ✗ Not Possible

Velocity will be never zero

dist^n = |disp^n| always same in this question

1-D में U-turn tabhi hoga Jab velocity zero aayga. ⊛

$x = t^2 - 4t + 6$

$v = 2t - 4 + 0$

$v = 2t - 4$

$0 = 2t - 4$

$t = \frac{4}{2} = 2$ sec

rest में hoga at t = 2 sec

QUESTION

In which option object is moving in one-dimension without change in direction. ??

(1) $x = t^2 + 6t + 4$ ↑ No U-turn

$v = 2t + 6 = 0$

(2) $x = -t^2 - 4t + 4$ No U-turn

(3) $x = 4t - t^2 + 5$ → U-turn होगा

$V = 4 - 2t = 0$

$4 - 2t = 0$

$4 = 2t$

(4) Both 1 and 2.

63%

MR

× $x = t^2 + 4t + 4$

× $x = -4t - 8t^2 + 18$

u-turn नहीं होगा

✓ $x = +t^2 - 18t - 4$

✓ $x = -t^2 + 16t + 6$

u-turn होगा

QUESTION

Position $x = t^2 + 6t + 4$ then find distance and displacement in $t = 4$ sec.

$x_{t=0} = 4$

Sol^n

$x = t^2 + 6t + 4$

$\frac{dx}{dt} = V = 2t + 6$

No turn

$V = 2t + 6$

$0 = 2t + 6$

$2t = -6$

$t = -3$ ✗

dist^n = disp^m $= |x_f|_{t=4} - |x_i|_{t=0}$

$= (4)^2 + 6\times4 + 4 - 4$

$= 16 + 24 + 4 - 4$

$= 44 - 4 = 40m$

QUESTION

If position $x = t^2 - 6t + 2$ then find distance and displacement in 4 sec.

$v = \frac{dx}{dt} = 2t - 6$

$v = 2t - 6$

$v = 0 = 2t - 6$

$2t = 6$

$t = 3\text{ sec}$

Particle is at rest at $t = 3\text{ sec}$

$x_{t=0} = 2$

$x_{t=3} = -7$

$x_{t=4} = -6$

$\text{dist}^n \neq \text{disp}^m$

$t > 3\text{ sec}$

$\text{disp}^n = \vec{x}_f - \vec{x}_i$

$= (x)_{t=4} - x_{t=0}$

$= 16 - 24 + 2 - 2$

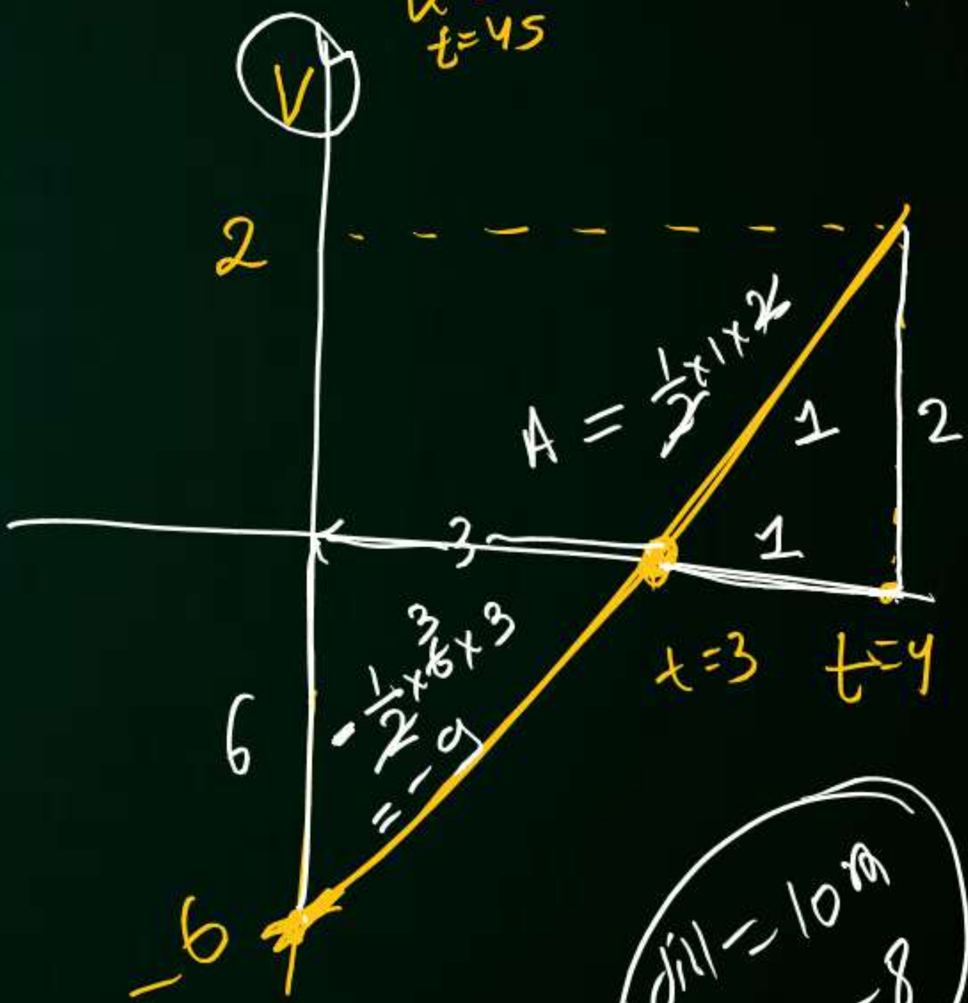
$= -8\text{ m}$ Ans

dist^n: $t = 3$s, $x = -7$; $t = 0$, $x = 2$; 1m, $x = -6$m, $t = 4$

$\text{dist}^n = 10\text{ m}$ Ans

MR*: $v = 2t - 6$

$v_{t=4s} = 2 \times 4 - 6 = 2$



$A = \frac{1}{2} \times 1 \times 2$

$= \frac{1}{2} \times 3 \times 6 = 9$

dist $= 10$ m

disp$^n = -8$

QUESTION

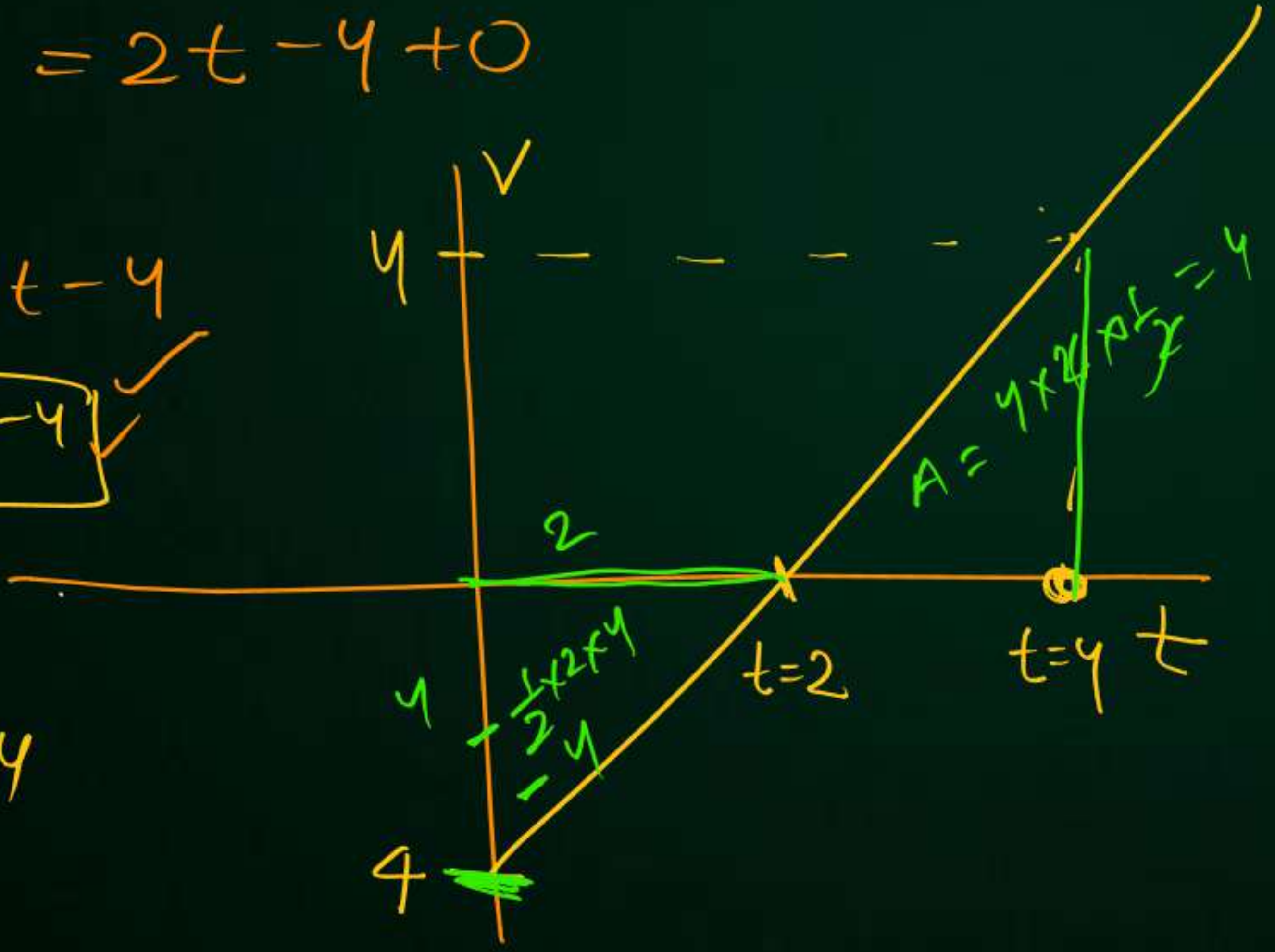
If position of object $x = t^2 - 4t + 3$ then find avg. speed (total distance) and avg. velocity (total displacement) in 4 sec.

$V = \frac{dx}{dt} = 2t - 4 + 0$

$V = 2t - 4$

$y = 2x - 4$

$V_{t=4} = 8 - 4 = 4$



$disp^m = 0$

$dist^n = 8m$

Avg speed = $\frac{\text{total dis}}{\text{tim}} = \frac{8}{4} = 2$

Avg velocity = 0

Motion with constant

Object starts his motⁿ from intial Position x_i at $t=0$ with velocity u and with constant acceleration 'a' then find its velocity after time 't'. also find dispᵐ in time 't'

Solⁿ

at $t = 0$ ✓

$u_i = u$ ✓

Initial Position $= x_i$ ✓

$a = \text{const}^n$ ✓

we know that

$$a = \frac{dv}{dt}$$

$$\int_u^v dv = \int_{t=0}^{t} a\,dt$$

$$\int_u^v dv = a\int_0^t dt$$

$$(v)_u^v = at$$

$$v - u = at$$

$\boxed{\vec{V} = \vec{u} + \vec{a}t}$

$\vec{V}$ = Final velocity

$\vec{u}$ = initial ve

(*) use with Proper sign.

(*) Put $\vec{v} = \frac{d\vec{x}}{dt}$

Eqⁿ of motⁿ free

$$\frac{d\vec{x}}{dt} = \vec{u} + \vec{a}t$$

$$\int_{x_i}^{x_f} d\vec{x} = \vec{u}\int_0^t dt + \vec{a}\int_0^t t\,dt$$

$$(x)_{x_i}^{x_f} = \vec{u}t + \frac{1}{2}\vec{a}t^2$$

$$\vec{x}_f - \vec{x}_i = \vec{u}t + \frac{1}{2}\vec{a}t^2$$

$$\boxed{\vec{s} = \vec{u}t + \frac{1}{2}\vec{a}t^2}$$

$$v^2 = u^2 + 2aS$$

$$v^2 - u^2 = 2aS \quad \text{--- (III)}$$

$$\vec{v} = \vec{u} + \vec{a}t \quad \text{--- (I)}$$

$$\vec{S} = \vec{u}t + \frac{1}{2}\vec{a}t^2 \quad \text{--- (II)}$$

time दिया है या पुछा है।

then use (I) & (II)

time नहीं दिया, या पुछा भी नहीं

then use (III)

object starts with initial velocity u and after some time its its velocity becomes v moving with const accn then find Avg. velocity.

let t = time of journey.

Soln

$$\text{Avg velocity} = \frac{\text{total disp}^n}{\text{total time}} = \frac{ut + \frac{1}{2}at^2}{t}$$

$$= u + \frac{1}{2}at$$

using eqn (I) $v - u = at$

$$\text{Avg velocity} = u + \frac{1}{2}(v-u)$$

$$= u + \frac{v}{2} - \frac{u}{2}$$

$$= \frac{u}{2} + \frac{v}{2} = \frac{\vec{u}+\vec{v}}{2}$$

$a = $ const → Projectile motion, Mot n under gravity

$$\vec{u}_{Avg.\ velocity} = \frac{\vec{u}_i + \vec{v}_f}{2}$$

$$\vec{v}_{av} = \frac{S}{t}$$

$$\vec{S} = v_{av}\, t$$

$$S = \left(\frac{\vec{u}+\vec{v}}{2}\right)t$$

4th eqn of

$a = \text{const}$

$\vec{v} = \vec{u} + \vec{a}t$

$\vec{s} = \vec{u}t + \frac{1}{2}\vec{a}t^2$

$v^2 - u^2 = 2as$

$u_{Avg} = \frac{\vec{u} + \vec{v}}{2}$ (avg

$s = \left(\frac{\vec{v}_i + \vec{v}_f}{2}\right)t$

QUESTION

Object starts his motion from x_i at $t = 0$ with initial velocity u and constant acceleration a then find its velocity and displacement after time 't'.

QUESTION

Object starts his motion with velocity u and constant acceleration a then find its avg. velocity in time 't'; if its velocity after time t is v.

QUESTION

If a car at rest accelerates uniformly to a speed of 144 km/h in 20 s, it covers a distance of [1997]

1. 1440 cm
2. 2980 cm
3. 20 m
4. 400 m

Motion with Constant Acceleration

$\vec{V} = \vec{u} + \overrightarrow{at}$

$V\ Arg = \frac{\vec{u}+\vec{v}}{2}$

$V^2 - u^2 = 2as$

$\vec{s} = \left(\frac{\vec{u}+\vec{v}}{2}\right)t$

$\vec{s} = \overrightarrow{ut} + \frac{1}{2}at^2$

QUESTION

The velocity of a body moving with a uniform acceleration of 2 m/sec^2 is 10 m/sec. Its velocity after an interval of 4 sec is:

1. 12 m/sec
2. 14 m/sec
3. 16 m/sec
4. 18 m/sec

$a = 2\,m/s^2$
$u = 10\,m/s$

QUESTION

A body of mass 10 kg is moving with a constant velocity of 10 m/s. When a constant force acts for 4 seconds on it, it moves with a velocity 2 m/sec in the opposite direction. The acceleration produced in it is:

1. $3\ m/sec^2$
2. $-3\ m/sec^2$
3. $0.3\ m/sec^2$
4. $-0.3\ m/sec^2$

$\vec{v} = \vec{u} + at$

$-2 = 10 + a \times 4$

$-2 - 10 = 4a$

$a = -\frac{12}{4} = -3$

QUESTION

Object starts his motion with velocity 10 m/sec after 8 sec its velocity becomes 24 m/sec then find total displacement in this interval.(a = constant)

$$S = \left(\frac{u+v}{2}\right)t$$

$$= \left(\frac{10+24}{2}\right) \times 8^{4}$$

$$= 34 \times 4 = 136\,m$$


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 07 | **Physics**

Motion In a Straight Line

By- Dr. Manish Raj (MR SIR)



Topics to be covered

1 # Questions on constant accⁿ

2 #

3 #

4 #



@mrsir_mrstar

The most disconsistent teacher

No dpp video solutions ❌❌

Lectures backlog ❌❌

Syllabus backlog (according to lecture planner) ❌❌

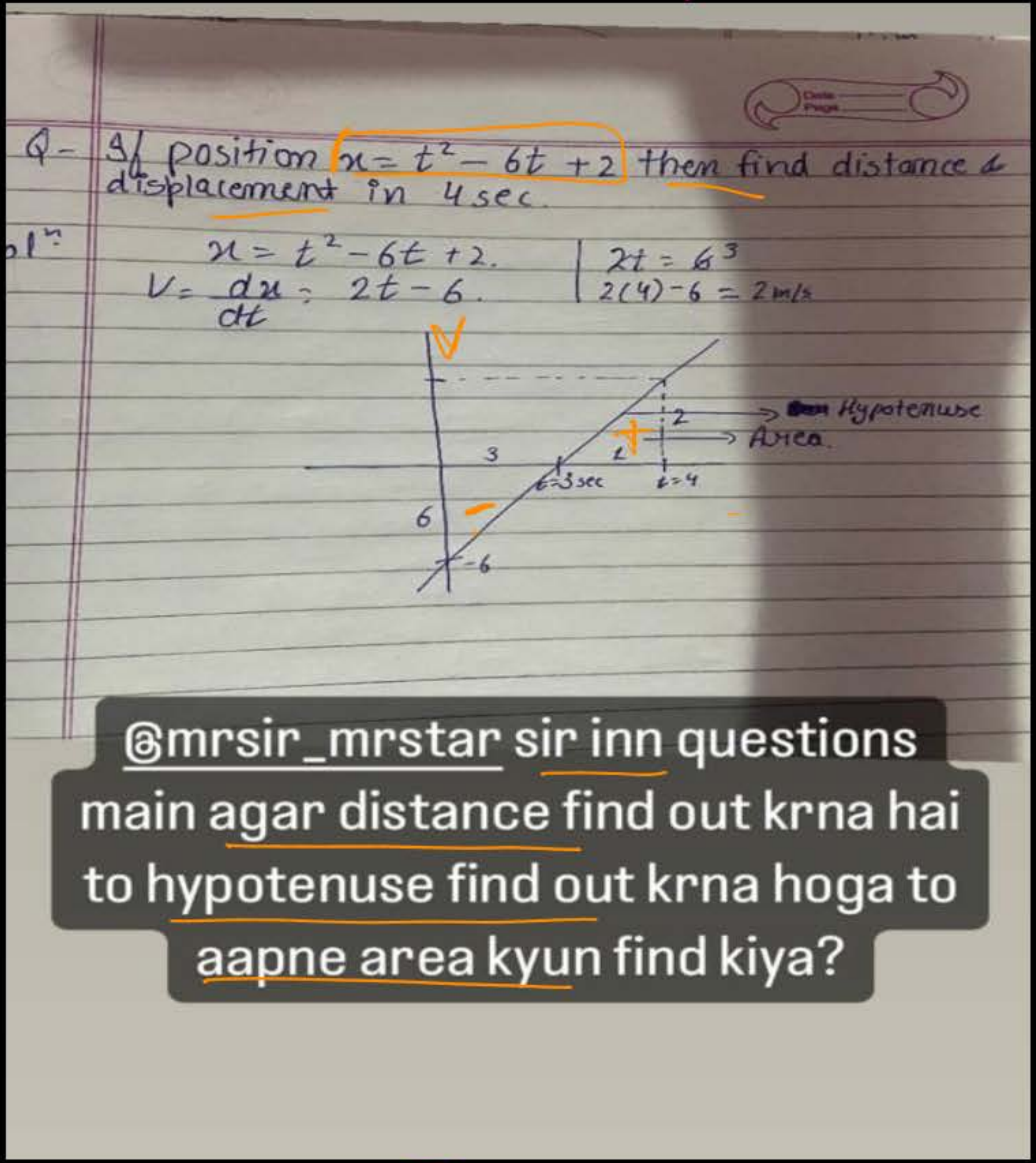
Not taking extra class to recover backlog

last week

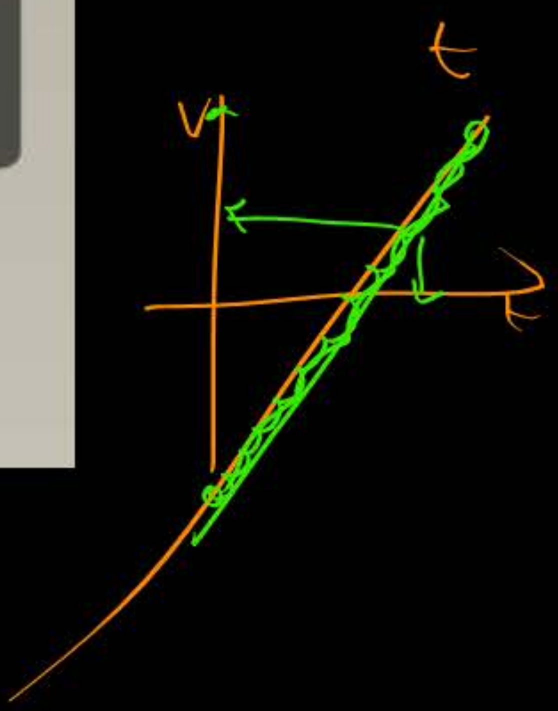
25-26 hr

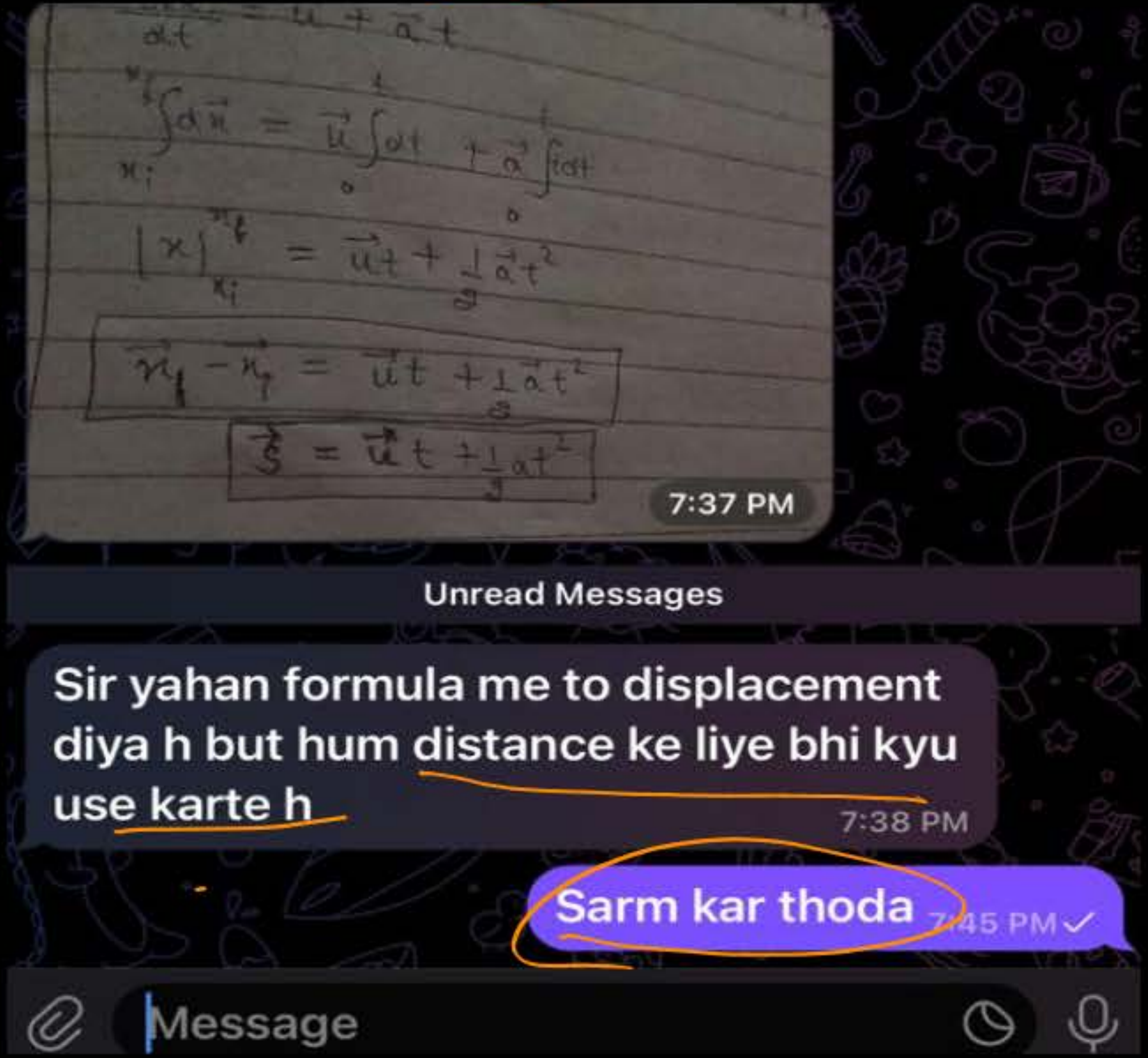
$\vec{s} = \vec{u}t + \frac{1}{2}\vec{a}t^2$

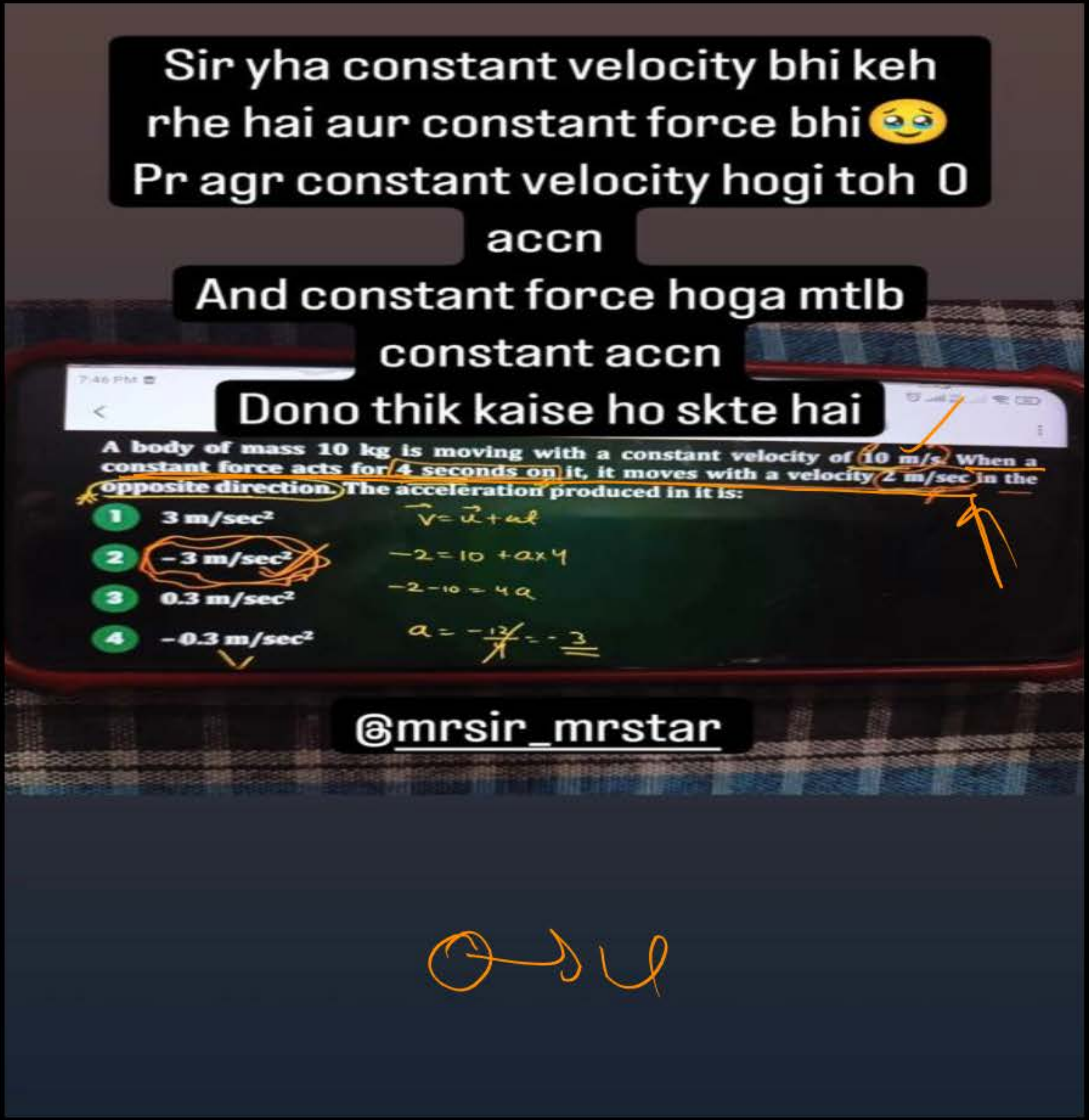
|disp^n| = |dist^n| with no change in dir^n

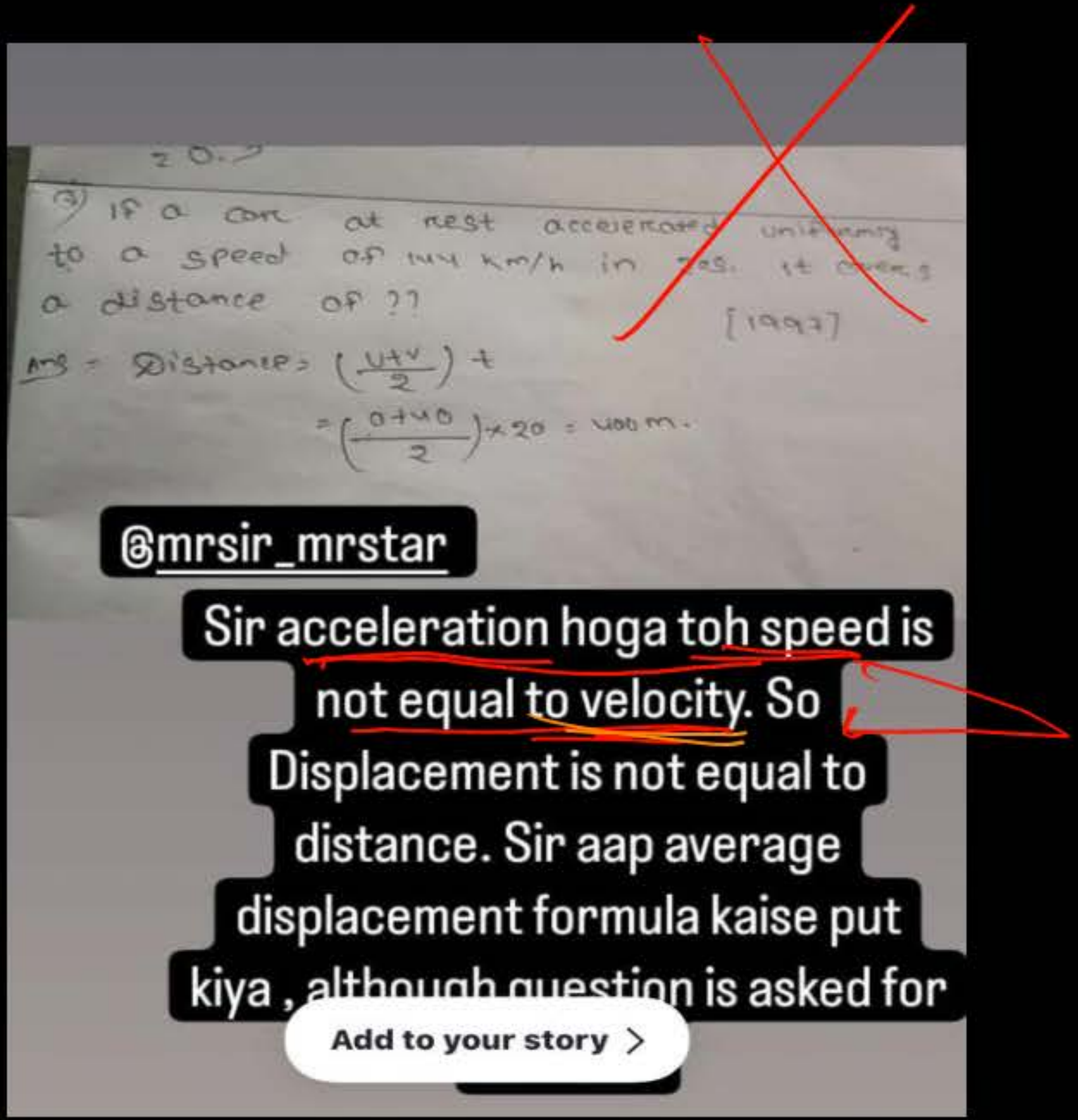









Sir yha constant velocity bhi keh rhe hai aur constant force bhi
Pr agr constant velocity hogi toh 0 accn
And constant force hoga mtlb constant accn
Dono thik kaise ho skte hai
A body of mass 10 kg is moving with a constant velocity of 10 m/s. When a constant force acts for 4 seconds on it, it moves with a velocity 2 m/sec in the opposite direction. The acceleration produced in it is:
1 3 m/sec²
2 -3 m/sec²
3 0.3 m/sec²
4 -0.3 m/sec²
−2 = 10 + a×4
−2 − 10 = 4a
@mrsir_mrstar


If a car at rest accelerated uniformly to a speed of 144 km/h in 20s. it covers a distance of ??
[1997]
Ans = Distance = (u+v / 2) t
= (0+40 / 2) × 20 = 400 m.
@mrsir_mrstar
Sir acceleration hoga toh speed is not equal to velocity. So Displacement is not equal to distance. Sir aap average displacement formula kaise put kiya , although question is asked for
Add to your story

39. $\int \frac{3}{(2-x)^2} dx$ is equal to :-

(1) $\frac{3}{(2-x)} + C$

(2) $\frac{5}{(2-x)} + C$

(3) $\frac{3}{2-x^2} + C$

(4) $\frac{-3}{(2-x)} + C$

$3\int (2-x)^{-2} dx$

$= \frac{3(2-x)^{-2+1}}{(-2+1)x-1}$

$= \frac{3(2-x)^{-1}}{1} = \frac{3}{(2-x)}$

Sir ye que bta dijiye bhut koshish ki nhi ho rha h

@mrsir_mrstar

Note में लिखना है

$\sqrt{2}$

19. In one dimensional motion, instantaneous speed v satisfies $0 \le v < v_0$.

velocity ka given नहीं

(a) The displacement in time T must always take non-negative values

(b) The displacement x in time T satisfies $-v_0 T < x < v_0 T$

(c) The acceleration is always a non-negative number

(d) The motion has no turning points

20. A vehicle travels half the distance with speed v_1 and the other half with speed v_2, then its average speed is:

19 th me V not kya hai??

@mrsir_mrstar

Uniform motion

↳ equal distⁿ in equal time in fixed direction

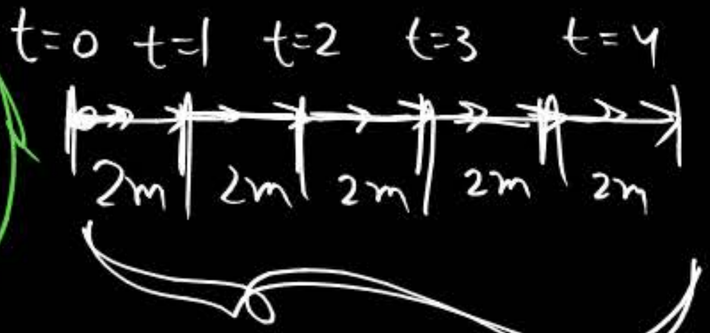
(a) costⁿ velocity ✓

(b) constⁿ speed ✗

$v = 2 m/s$ $(a = 0)$

↳ Costⁿ





$s = ut$

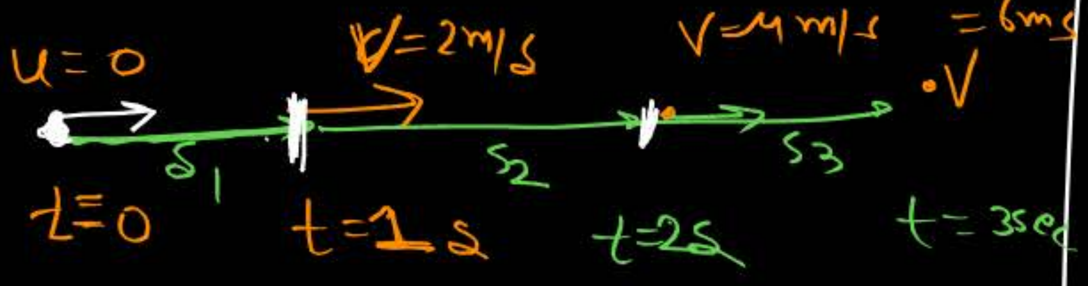
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* $a = \text{Costⁿ}$

v = change

= uniform rate से change

Ex* $a = 2 m/s^2$



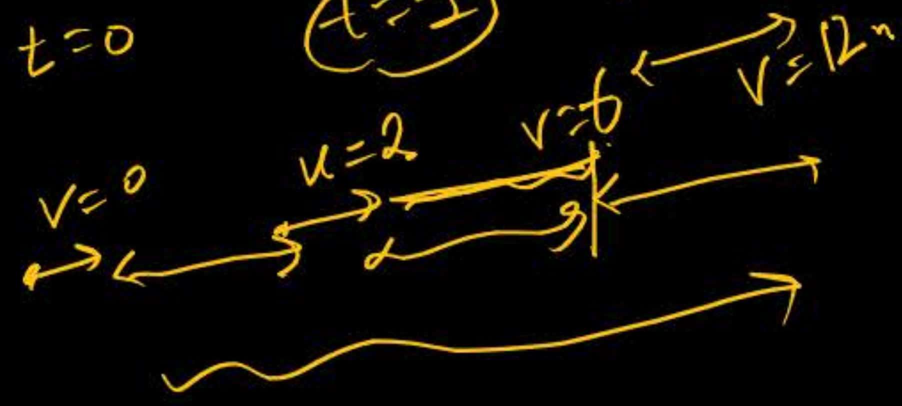
$s_1 < s_2 < s_3$ ✓

---

non-uniform acc

$a = 2t$

$a = 0$ $a = 2 m/s^2$ $a = 4$ $a = 6$



Eqn of motion constn accn

"$a = \frac{dv}{dt}$"

$\int dv = \int a\, dt$

$a = 2t$

$a = 3t^2$ } integrate होगा

$a = (ct)^n$ $a = 2\, m/s^2 = $ const

$$\int_u^v dv = a\int_{t=0}^{t} dt = a(t)$$

$(v-u) = at$

$\vec{v} = \vec{u} + \vec{a}t$ — (I)

(velocity)

$\vec{s} = \vec{u}t + \frac{1}{2}\vec{a}t^2$ — (II)

$v^2 - u^2 = 2as$

$\vec{u}_{Avg} = \frac{\vec{u}_i + \vec{v}_f}{2}$ — (III)

$s = \left(\frac{\vec{u} + \vec{v}_1}{2}\right)T$

IMP*

QUESTION

$disp^m = v_{Avg} \times Time$

$t = 0$ sec

Object starts his motion with velocity 10 m/sec after 8 sec its velocity becomes 24 m/sec then find total displacement in this interval.(a = constant)

$t = 0$
$u = 10$ m/s

$t = 8$ sec, $s = ??$
$V = 24$ m/s.

Method ⇒ 1

$V = u + at$

$24 = 10 + a \times 8$

$14 = 8a$

$a = \frac{14}{8}$

$s = ut + \frac{1}{2}at^2$

$= 10 \times 8 + \frac{1}{2} \times \frac{14}{8} (8)^2$

$= 80 + 56$

$= 136$ m

MR* (NEET)

$s = \left(\frac{u+v}{2}\right) T$

$= \left(\frac{10+24}{2}\right) \times 8$

$= 34 \times 4 = 136$ m

$$\text{disp}^m = v_{Avg} \times \text{Time}$$

(Q) This formula is valid for ??

15% (a) uniform motn

(b) Non-uniform motn.

63% (c) motn with constn accn

(d) motn with variable accn

(e) always (only 11%)

explanation

$$\text{disp}^m = \vec{v}_{Avg} \times \text{time}$$

$$\vec{v}_{\text{Avg veloc}} = \frac{\text{disp}^m}{\text{time}}$$

→ always valid

then why confusion

$$\vec{v}_{Avg} = \frac{\vec{u}_i + \vec{v}_f}{2}$$ → This is for const accn

Object starts his motion with velocity 10 m/s ($t=0$) and uniform acc^n {$2\ m\,s^{-2}$} then find velocity and displacement in 5 sec.

Sol^n

$u = 10\ m/s$ ($t=0$)

$a = 2\ m/s^2$

$T = 5\ sec$

$V = u + at$

$= 10 + 2 \times 5$

$V = 20\ m/s$

MR Rule

$S = ut + \frac{1}{2}at^2$

$= 10 \times 5 + \frac{1}{2} 2 (5)^2$

$= 50 + 25$

$= 75\ m$

Sol^n

$a = 2\ m/s^2$

$\frac{dv}{dt} = 2$

$\int_{u=10}^{v} dv = 2\int_{t=0}^{t} dt$

$[V]_{10}^{v} = 2(t)_0^t$

$V - 10 = 2t$

$'v' = 2t + 10$

$\frac{dx}{dt} = 2t + 10$

$\int_{x_i}^{x_f} dx = \int_0^5 2t\,dt + \int_0^5 10\,dt$

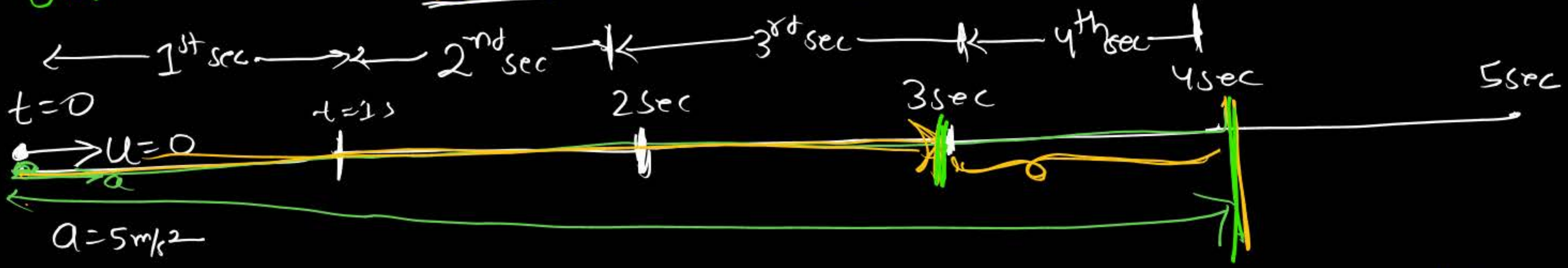
$\vec{S} = 2\left[\frac{t^2}{2}\right]_0^5 + 10(t)_0^5$

$= (5)^2 - (0)^2 + 10(5-0)$

$= 25 + 50$

$= 75\ m$

(1) Object starts his motⁿ from rest and accⁿ = 5 m/s². then find displacement in 4-sec and in 4th sec.



Solⁿ

$$\vec{S} = \vec{u}t + \frac{1}{2}\vec{a}t^2$$

$$= 0\times 5 + \frac{1}{2}5(4)^2$$

$$= \frac{5}{2}\times 16$$

$$S = 40m$$ dispᵐ in 4-sec

$$S_{in\,3sec} = ut + \frac{1}{2}at^2$$

$$= 0 + \frac{1}{2}\times 5\times(3)^2$$

$$= \frac{45}{2} = 22.5m$$

$$S_{in\,4^{th}\,sec} = 40 - 22.5$$

$$= 17.5m$$

7th



QUESTION

Object starts his motion with velocity u and acceleration "a" then find displacement in t^{th} sec.



$S_t = ut + \frac{1}{2}at^2$ — (1)

$S_{(t-1)} = u(t-1) + \frac{1}{2}a(t-1)^2$ — (2)

$S_{t^{th}} = S_t - S_{(t-1)}$

solve it by yours.

5th eqn of motion

$$S_{t^{th}} = u + \frac{a}{2}(2t-1)$$

→ dimensionally correct

apply it last quesn.

$S_{4^{th}} = 0 + \frac{5}{2}(2\times4-1)$

$= \frac{5}{2}[7]$

$= \frac{35}{2} = 17.5$

QUESTION

Object starts his motion from rest, constant '*a*' then find ratio of displacement in n^{th}-sec and n-sec. [IIT/NEET]

$u = 0$

$$S_{n\text{-sec}} = ut + \frac{1}{2}at^2$$

$$S_{n\text{-sec}} = \frac{1}{2}an^2$$

$$S_{n^{th}\,sec} = u + \frac{a}{2}(2n-1)$$

$$\frac{S_{n^{th}}}{S_n} = \frac{\frac{a}{2}(2n-1)}{\frac{1}{2}an^2}$$

$$= \left(\frac{2n-1}{n^2}\right) \text{Ans}$$

$$= \frac{2n}{n^2} - \frac{1}{n^2}$$

$$= \left(\frac{2}{n} - \frac{1}{n^2}\right)$$

QUESTION

(Q) **Object starts his motion from rest and constant acceleration then find ratio of displacement in 6th-sec and 6-sec.**

t = 5sec to t = 6sec

$$S_{nth} = 0 + \frac{a}{2}(2\times 6 - 1) = 11\left(\frac{a}{2}\right)$$

$$S_{n\text{-}sec} = ut + \frac{1}{2}a(6)^2 = \frac{a}{2}(36)$$

$$= 11 : 36$$

Object starts his motⁿ from rest and constⁿ accⁿ 'a'

then find dispᵐ in 1 sec, 2 sec, 3 sec, 4 sec, so on

Solⁿ

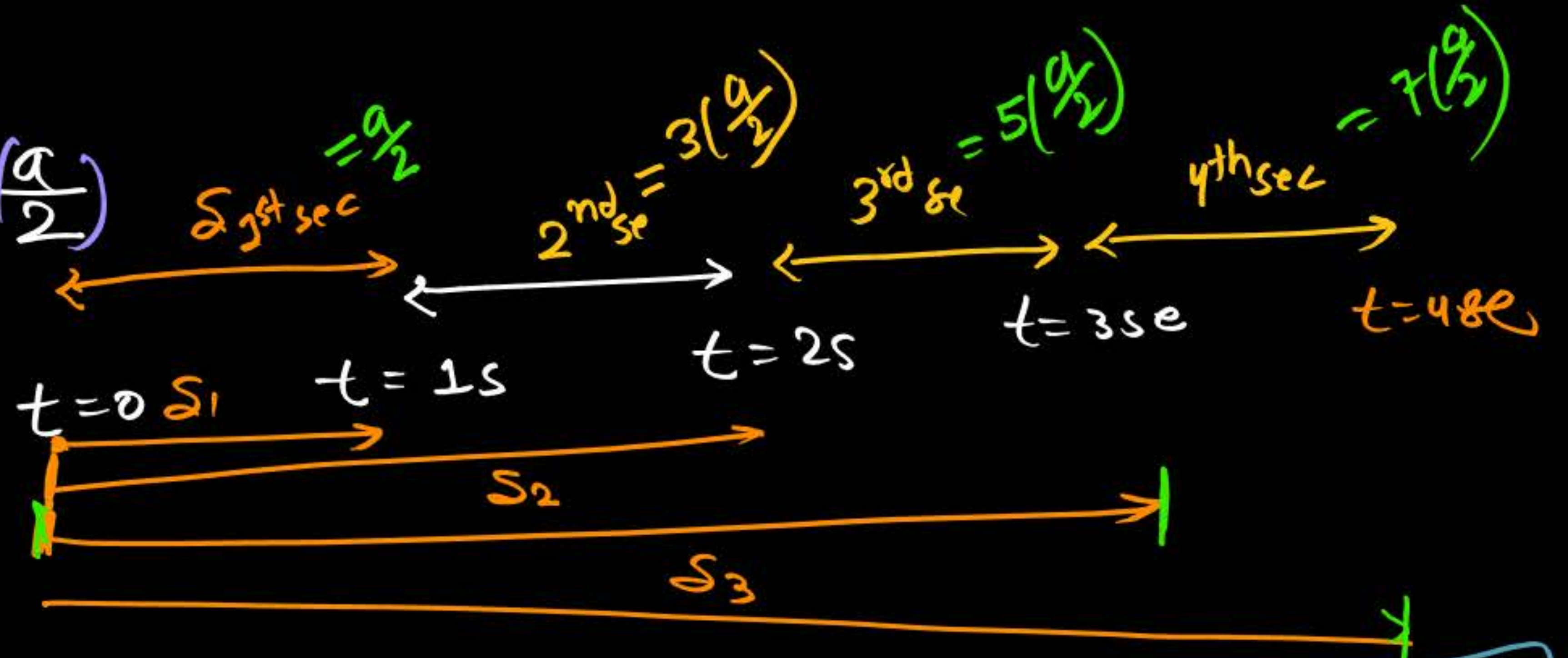
$$S_{1sec} = ut + \frac{1}{2}at^2 = \frac{a}{2}(1)^2 = \frac{a}{2}$$

$$S_{2sec} = \frac{1}{2}a(2)^2 = \frac{a}{2}(4)$$

$$S_{3sec} = \frac{1}{2}a(3)^2 = \frac{a}{2}(9)$$

$$S_{4sec} = \frac{1}{2}a(4)^2 = \frac{a}{2}(16)$$

in 4-sec



$$S_{1st} : S_{2nd} : S_{3rd\,se} : S_{4th} = x : 3x : 5x : 7x : 9x : 11x$$

$$S_{1sec} : S_{2sec} : S_{3sec} : S_{4sec} = \frac{a}{2} : 4\left(\frac{a}{2}\right) : 9\left(\frac{a}{2}\right) : 16\left(\frac{a}{2}\right) = 1 : 4 : 9 : 16 = x : 4x : 9x : 16x$$

Object starts his motion from rest and const^n acc^n 'a'

then find disp^m in 1st 2 sec (0 sec to 2 sec) and disp^m in t=2 sec to t=4 sec

Sol^n

$u = 0$

$a = const^n$

$$S = ut + \frac{1}{2}at^2 =$$

$$S_{(in\ sec\ 2\ sec)} = \frac{1}{2}a(2)^2 = 4\left(\frac{a}{2}\right)$$

$$S_{in\ 4\ sec} = \frac{1}{2}a(4)^2 = \left(\frac{a}{2}\right)16$$

total 4 sec ka

$$\frac{S_{(in\ 2\ sec)}}{S_{(in\ 4\ sec)}} = \frac{4(a/2)}{16(a/2)} = \frac{1}{4}$$

$$S_{\substack{in\ t=2\,sec \\ to\ t=4\,sec}} = S_{T=4\,sec} - S_{T=2}$$

$$= 16\left(\frac{a}{2}\right) - 4\left(\frac{a}{2}\right)$$

$$= 12\left(\frac{a}{2}\right)$$

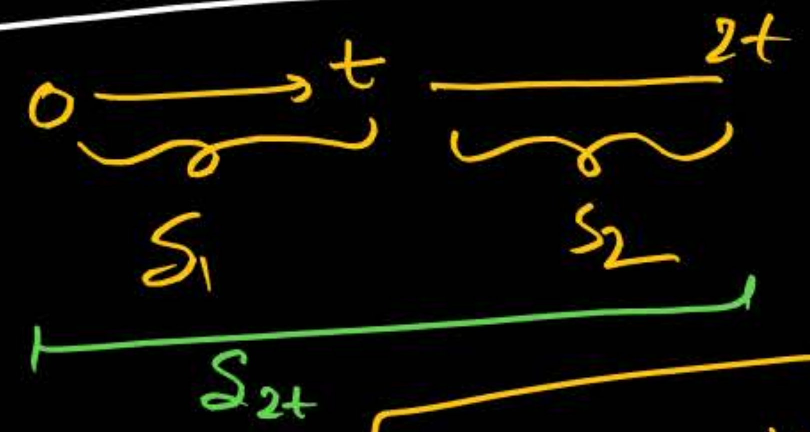
$$\frac{S_{disp^n\ in\ 2\text{-}sec}}{S_{disp\ in\ next\ 2\ sec}} = \frac{4(a/2)}{12(a/2)} = \frac{1}{3}$$

rest & con^n acc^n

$$\frac{S_{\text{in 0 to 5sec}}}{S_{\text{in 5sec to 1sec}}} = \frac{1}{3}$$

The imp*

from rest and con^n acc^n



$s_1 : s_2 = 1 : 3$

* $u = 0$ $a = \text{con}^n$

$$S_t = \frac{1}{2}at^2$$

$$S_{(2t)} = \frac{1}{2}a(2t)^2 = 4\left(\frac{1}{2}at^2\right)$$

$$\frac{S_{t\,sec}}{S_{in\,(2t)sec}} = \frac{1}{4} \quad \left[\frac{S_{t\text{-}sec}}{S_{next\,t\,sec}} = \frac{1}{3}\right]$$

If motⁿ starts from rest and constⁿ acc

It must be 1-D motⁿ without change in dirⁿ



QUESTION

If object starts his motion from rest and constant acceleration then its displacement and distance will be same?

QUESTION

Object starts his motion from rest and constant acceleration then find ratio of distance in 1-sec, in 2-sec and in 3-sec.

QUESTION

If $u = 0$ (initial velocity) and constant acceleration then find ratio of distance in 4-sec and 8-sec.

↳ total 8 sec (0 to 8 sec)

Sol^n $u = 0$

$a = a$

$$\frac{\vec{S}_{4sec} = \frac{1}{2}a(4)^2 = 16\left(\frac{a}{2}\right)}{S_{8\text{-}sec} = \frac{1}{2}a(8)^2 = 64\left(\frac{a}{2}\right)} = \frac{1}{4}$$

QUESTION

Object starts his motion from rest and constant acceleration then find displacement in in 5sec and in next 5sec.

0sec to 5sec

(5sec to 10sec)

$\Rightarrow 1 : 3$

a

QUESTION

Object starts from rest and constant acceleration it moves 80 m in 6-sec then find displacement in 12-sec.

Sol^n जानकारी

$u = 0$ ✓

$a = $ const.

$S = 80m$ in 6-sec.

$S = ut + \frac{1}{2}at^2$

$80 = 0 \times 6 + \frac{1}{2}a(6)^2$

$80 = \frac{1}{2} a\, 36$; $a = \frac{80}{18}$

M-2

$\frac{S_{6\text{-sec}}}{S_{12\text{-sec}}} = \frac{1}{4}$

$80 \times 4 = S_{12m}$

320 m

$S_{t=12sec} = ut + \frac{1}{2}at^2$

$= 0 + \frac{1}{2}\frac{80}{18}(12)^2$

$= \frac{40}{18} \times 12 \times 12$

$= 320m$

QUESTION

Object starts his motion from rest and constant acceleration then find ratio of displacement in 1^{st} s : 2^{nd} s : 3^{rd} s.

$$S_{1sec} : S_{in\,2sec} : S_{in\,3sec} = x : 4x : 9x$$

$$S_{1st} : S_{2nd\,sec} : S_{3rd\,s} = x : 3x : 5x$$

QUESTION

A particle experiences a constant acceleration for 20 sec after starting from rest. If it travels a distance S_1 in the first 10 sec and a distance S_2 in the next 10 sec, then:



1. $S_1 = S_2$
2. $S_1 = S_2/3$
3. $S_1 = S_2/2$
4. $S_1 = S_2/4$

$$\frac{S_1}{S_2} = \frac{1}{3}$$

$$S_1 = \frac{S_2}{3}$$

QUESTION

A body starts from rest. What is the ratio of the distance travelled by the body during the 4th and 3rd second.

⇒ 7 : 5

Ans

QUESTION

Object starts his motion from rest and constant acceleration and moves 100 m in 1st 5-sec then find displacement in next 5-sec.

300m

QUESTION

An object accelerates from rest to a velocity 27.5 m/s in 10 sec then find distance covered by object in next 10 sec.

1. 550 m
2. 137.5 m
3. 412.5 m
4. 275 m

0 — 10 sec ⟷ 20 sec, S = ??

$S_{\text{in 10 sec}} = \left(\frac{0+27.5}{2}\right) \times 10$

$S_{\text{in next 10 sec}} = 137.5$

QUESTION

Object starts his motion from u and constant acceleration then find velocity at mid point if velocity at end point is V.

$a = \text{const}^n$



$v = u + at$

$s = ut + \frac{1}{2}at^2$

$S_n = u + \frac{a}{2}(2n-1)$

$v^2 - u^2 = 2as$

3rd eqn of motion $(v^2 - u^2 = 2as)$ for compt Journey

$$v^2 - u^2 = 2as \quad \text{— (i)}$$

$$u_m^2 - u^2 = 2a\frac{s}{2} \quad \text{— (ii) for 1st half Journey}$$

$$\frac{v^2 - u^2}{v_m^2 - u^2} = 2$$

$$v^2 - u^2 = 2v_m^2 - 2u^2$$

$$v^2 - u^2 + 2u^2 = 2v_m^2$$

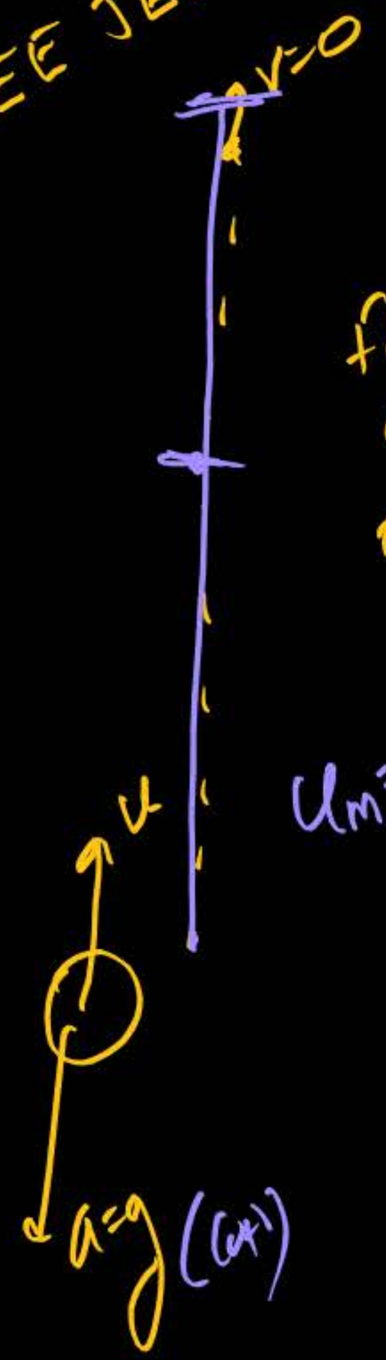
$$v^2 + u^2 = 2v_m^2$$

$$* \; v_m = \sqrt{\frac{v^2+u^2}{2}}$$

mR^*

$$u_{mid} = \sqrt{\frac{u^2+v^2}{2}}$$

AIEEE JEE main

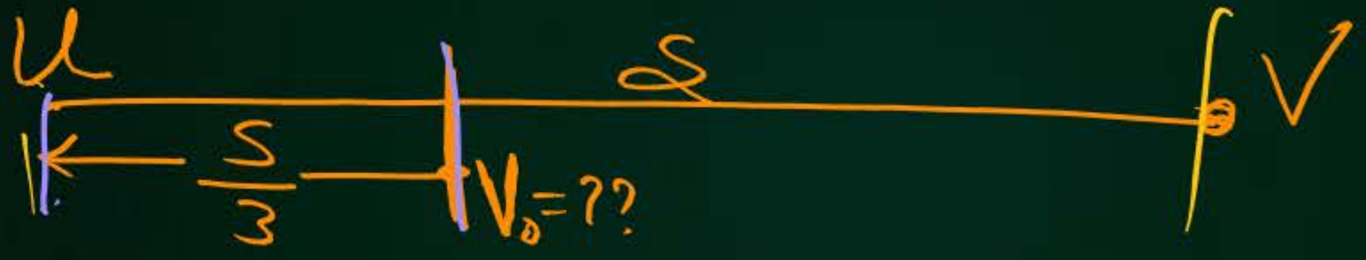


find velocity at mid point of max m ??

$$u_m = \sqrt{\frac{u^2+0}{2}} = \sqrt{\frac{u^2}{2}} = \frac{u}{\sqrt{2}}$$

QUESTION

Object starts his motion with u and constant acceleration a then find its velocity at one 3rd displacement of complete journey if final velocity is V.



Compt → $v^2 - u^2 = 2as$ — (1)

$V_0^2 - u^2 = \frac{2as}{3}$ — (11)

$v^2 - u^2 = 3V_0^2 - 3u^2$

$V_0 = \sqrt{\frac{v^2 + 2u^2}{3}}$

Ramlal MR

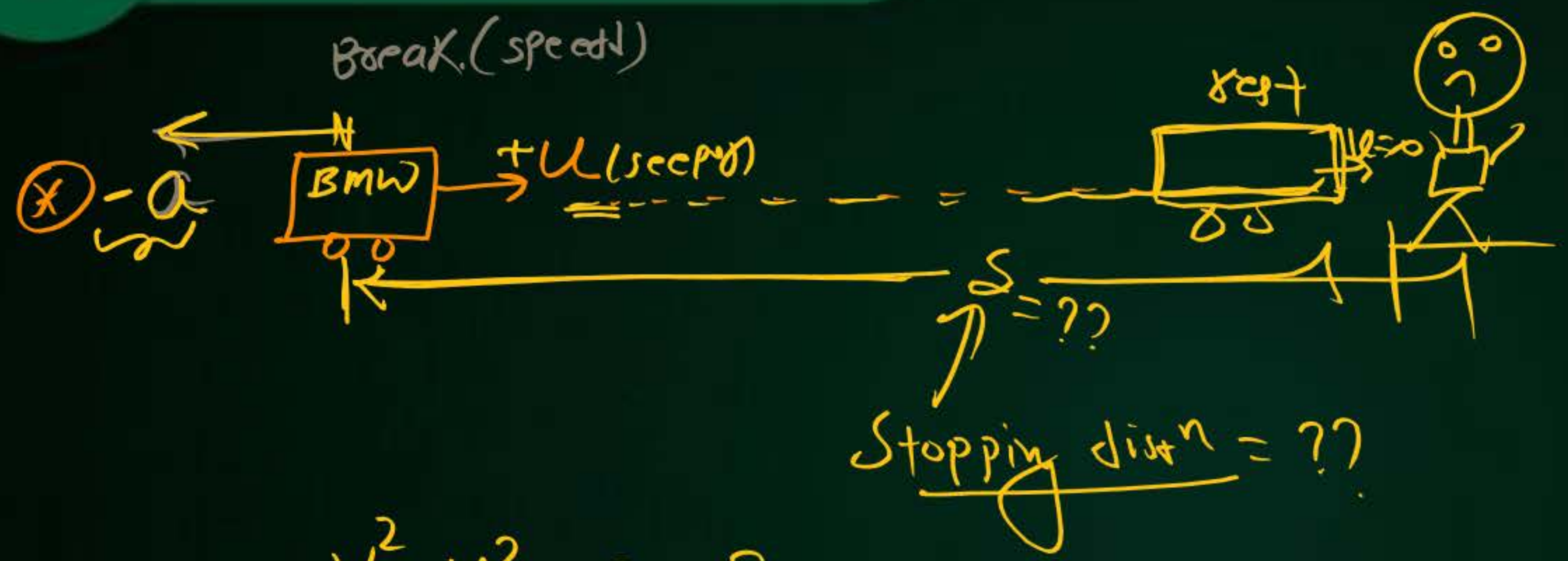
$\frac{S}{n}$ (v=??)

$V_0 = \sqrt{\frac{v^2 + (n-1)u^2}{n}}$

Ramu: u —S/4→ ... → v

$V_0 = \sqrt{\frac{v^2 + 3u^2}{4}}$

Stopping Distance



$$v^2 - u^2 = 2aS$$

$$0 - u^2 = -(2a)S$$

$$S = \frac{+u^2}{+2a}$$

$$\boxed{S = \frac{u^2}{2a}}$$

$$\boxed{S \propto u^2}$$

QUESTION

A motor car moving with a uniform speed of 20 m/sec comes to stop on the application of brakes after travelling a distance of 10 m. Its acceleration is:

1. $20\ m/sec^2$
2. $-20\ m/sec^2$
3. $-40\ m/sec^2$
4. $+2\ m/sec^2$

QUESTION

A car moving with a speed of 50 km/h can be stopped by applying brakes after atleast 6 m. If the same car is moving with a speed of 100 km/h, what is the minimum stopping distance?

1. 6 m
2. 12 m
3. 18 m
4. 24 m

QUESTION

A car moving with a speed of 40 km/h can be stopped by applying brakes after atleast 2 m. If the same car is moving with a speed of 20 km/h, what is the minimum stopping distance? [1998]

1. 4 m
2. 6 m
3. 8 m
4. 0.5 m

QUESTION

What will be the ratio of the distance moved by a freely falling body from rest in 4^{th} and 5^{th} seconds of journey ? [1989]

1. $4 : 5$
2. $7 : 9$
3. $16 : 25$
4. $1 : 1$

QUESTION

A car is moving along a straight road with a uniform acceleration. It passes through two points P and Q separated by a distance with velocity 30 km/h and 40 km/h respectively. The velocity of the car midway between P and Q is

[1988]

1. 33.3 km/h
2. $20\sqrt{2}$ km/h
3. $25\sqrt{2}$ km/h
4. 35 km/h.

QUESTION

A particle start moving from rest and constant acceleration. It travels a distance x in first $2s$ and y in $4s$ then correction relation is

1. $y = 3x$
2. $y = 4x$
3. $y = x$
4. $x = 4y$

QUESTION

A particle starts from rest and constant acceleration it moves 40 m in 3 sec then find distance in next 3 sec or 3 sec to 6 sec.

QUESTION

Object starts his velocity 10 m/s and acceleration 3 m/s^2 then find displacement between 4 sec to 8 sec.

QUESTION

A body starts from rest travelled a distance 120 m in the 8^{th} sec then acceleration is :

1. 10
2. 8
3. 16
4. 4

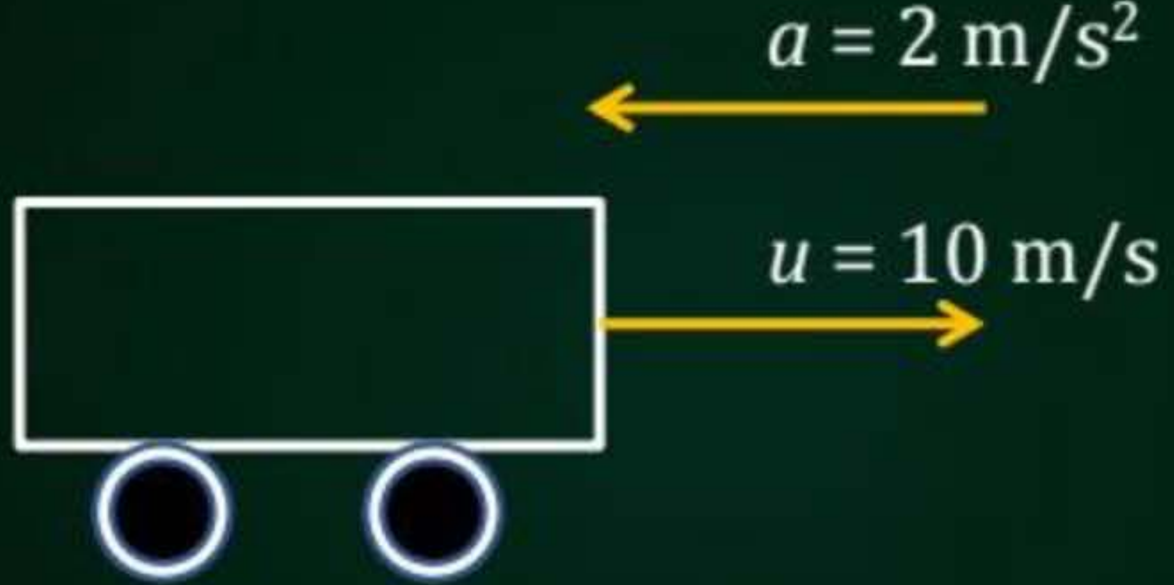
QUESTION

A body starts from rest with constant acceleration, it moves S_1, S_2 and S_3 distance in 1^{st}, 2^{nd} and 3^{rd} sec of its journey then correct relation is:

1. $S_1 = S_2 = S_3$
2. $5S_1 = 3S_2 = S_3$
3. $S_1 = \frac{1}{3}S_2 = \frac{1}{5}S_3$
4. $S_1 = \frac{1}{5}S_2 = \frac{1}{3}S_3$

QUESTION

Find distance travelled in 7 sec if its motion.



QUESTION

The initial velocity is 21 m/s and retardation 2 m/s^2 then distance and displacement in 11^{th} sec.

QUESTION

Object starts his motion from rest and constant acceleration α for some time t_1; it retards with β and comes to at rest in time t_2 then find total distance travelled and V_{max}.

[IMPORTANT]


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture - 08 | **Physics**

Motion In a Straight Line



By- Dr. Manish Raj (MR SIR)

Topics to be covered

सारे question notes में लिखने हैं

1 # • K.B.D.

with const^n acc^n

2 # questions on U-turn

• Rest to Rest (α, β) Prob^m

3 # Motion under gravity

4 #



QUESTION 1

A car is moving along a straight road with a uniform acceleration. It passes through two points P and Q separated by a distance with velocity 30 km/h and 40 km/h respectively. The velocity of the car midway between P and Q is

[1988]

(1) 33.3 km/h

(2) $20\sqrt{2}$ km/h

(3) $25\sqrt{2}$ km/h

(4) 35 km/h.

P — mid — Q

30 — 40

$v_{mid} = \sqrt{\frac{900+1600}{2}}$

$= \sqrt{\frac{2500}{2}}$

$= \frac{50}{\sqrt{2}} = 25\sqrt{2}$

$v_{Avg} = \frac{\vec{u}_i + \vec{v}_f}{2} = \frac{30+40}{2} = 70/2 = 35$

QUESTION 2

A car moving with a speed of 50 km/h can be stopped by applying brakes after atleast 6 m. If the same car is moving with a speed of 100 km/h, what is the minimum stopping distance?

1. 6 m
2. 12 m
3. 18 m
4. 24 m

QUESTION 3

A car moving with a speed of 40 km/h can be stopped by applying brakes after atleast 2 m. If the same car is moving with a speed of 20 km/h, what is the minimum stopping distance? [1998]

1. 4 m
2. 6 m
3. 8 m
4. 0.5 m

$s \propto u^2$

$s \propto \left(\frac{u}{2}\right)^2$

$\frac{2m}{4} = 0.5m$

QUESTION 4

$u=0$

A particle start moving from rest and constant acceleration. It travels a distance x in first 2s and y in 4s then correction relation is

1. $y = 3x$
2. $y = 4x$
3. $y = x$
4. $x = 4y$

$\frac{x}{y} = \frac{1}{4}$

$x = \frac{y}{4}$

Power of concept

last lecture

QUESTION 5

A particle starts from rest and constant acceleration it moves 40 m in 3 sec then find distance in next 3 sec or 3 sec to 6 sec.

$u = 0$

$a = \text{const}^n$

in $t = 3$ sec

$s = 40$ m

next sec

$s' = 3 \times 40$

$= 120$ m

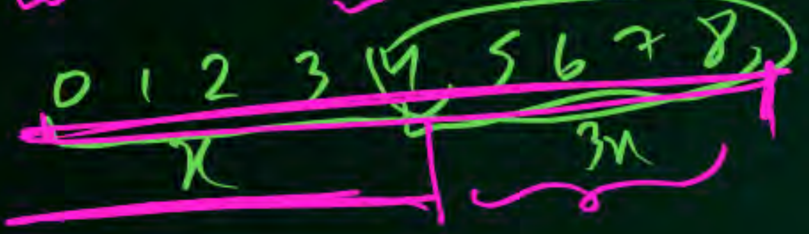
t=0 t=1 , 2 , 3 4 5 6 7 8

QUESTION 6

Object starts his velocity 10 m/s and acceleration 3 m/s^2 then find displacement between 4 sec to 8 sec.

$\{u = 10\ m/s\}$

$t_1 =$ 4, $t_2 =$ 8



Sol^n

$S_{t=0 \text{ to } 4sec} = ut + \frac{1}{2}at^2$

$= 10 \times 4 + \frac{1}{2} 3 (4)^2$

$= 40 + \frac{1}{8} 3 \times 16^8$

$= 40 + 24$

$\boxed{S = 64\ m}$

$\to 64 \times 3$

$= 192\ m$ (wrong) ✗

reason ??

$\boxed{S_{n^{th}} = u + \frac{a}{2}(2n-1)}$

→ Not application here

$S_{in\ t=8sec} = ut + \frac{1}{2}at^2$

$= 10 \times 8 + \frac{1}{2} 3\, 64^{32}$

$= 80 + 96 = 176\ m$

$S_{in\ 4sec} = 64$

$S_{in\ 4sec\ to\ 8s} = 176 - 64$

$= \boxed{112\ m}$

QUESTION 6

Object starts his velocity 10 m/s and acceleration 3 m/s² then find displacement between 4 sec to 8 sec.

$t = 0$, $u = 10\,m/s$

$u = 10\,m/s$ ($t = 0$) $\quad a = 3\,m/s^2$

$t_i = 4\,sec$ to $t_f = 8\,sec$

initial

$T = 4\,sec$

$v = u + at$

$= 10 + 3 \times 4$

$= 10 + 12$

$= 22\,m/s$

$u = 22\,m/s$ ($t = 4\,sec$)

$$s = ut + \frac{1}{2}at^2$$

$$= 22 \times 4 + \frac{1}{2}3(4)^2$$

$$= 88 + 24 = 112\,m$$

QUESTION 7

A body starts from rest travelled a distance 120 m in the 8th sec then acceleration is :

$S_{n^{th}} = u + \frac{a}{2}(2n-1)$

$120 = \frac{a}{2}(8 \times 2 - 1)$

$240 = a \times 15$

$16 = a$

1. 10
2. 8
3. 16 ✓
4. 4

⑧

body starts his motion with 4 m/s and const. accn it travel 20 m in 1st 2-sec then find distance in 4 sec.

Sol^n

$S = ut + \frac{1}{2}at^2$

$20 = 4 \times 2 + \frac{1}{2}a(2)^2$

$20 = 8 + 2a$

$12 = 2a$

$a = 6 \text{ m/s}^2$

* disp^m in 4-sec

$S' = 4 \times 4 + \frac{1}{2} \times 6(4)^2$

in 4 sec $= 16 + 48 = 64 \text{ m}$

Sol

$\frac{S_{in\ 2sec}}{S_{in\ 4sec}} = \frac{1}{4}$ ✗

$S_{in\ 4sec} = 80 \text{ m}$ ✗

महा पाप

wrong

QUESTION 8

A body starts from rest with constant acceleration, it moves S_1, S_2 and S_3 distance in 1^{st}, 2^{nd} and 3^{rd} sec of its journey then correct relation is:

1. $S_1 = S_2 = S_3$
2. $5S_1 = 3S_2 = S_3$
3. $S_1 = \frac{1}{3}S_2 = \frac{1}{5}S_3$
4. $S_1 = \frac{1}{5}S_2 = \frac{1}{3}S_3$

$S_1 : S_2 : S_3 = 1 : 4 : 9 : 16$

$S_1 : S_2 : S_3 = 1 : 3 : 5$

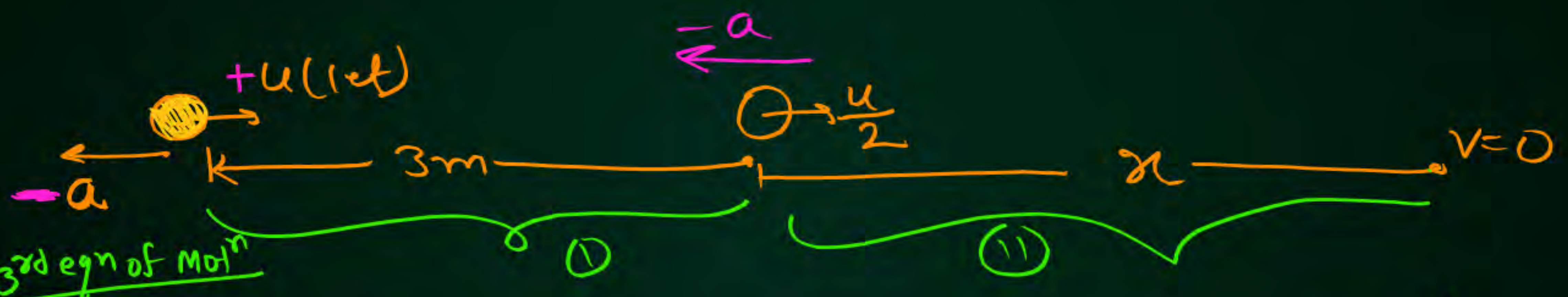
$\frac{S_1}{S_2} = \frac{1}{3}$

$S_1 = \frac{S_2}{3}$

QUESTION 9

Object loose (loss) its half velocity after travelling a distance 3 m with constance retardation, then find further distance after which it will stop.

1. 3 m
2. 1 m ✓
3. 2 m
4. 4 m



3rd eqn of Motn

$$\left(\frac{u}{2}\right)^2 - u^2 = -2a3 \quad -(1)$$

$$0 - \left(\frac{u}{2}\right)^2 = -2ax$$

$$\frac{\frac{u^2}{4} - u^2}{-\frac{u^2}{4}} = \frac{3}{x}$$

$$\frac{3}{x} = \frac{+\frac{3u^2}{4}}{+\frac{u^2}{4}}$$

$$\frac{3}{x} = 3$$

$$x = 1m \quad \text{Ans.}$$

QUESTION 10

No ratio applicable

A body is moving with uniform acceleration ~~describes~~ (moves) 40 m in the first 5 sec and 65 m in next 5 sec. Its initial velocity will be

(65+40=105 in total 10 sec)

1. 4 m/s
2. 2.5 m/s
3. 5.5 m/s ✓
4. 11 m/s

$a = $ const

$(t=0)$ $u = u_0$ (let)

$S = ut + \frac{1}{2}at^2$

total disp in 5 sec

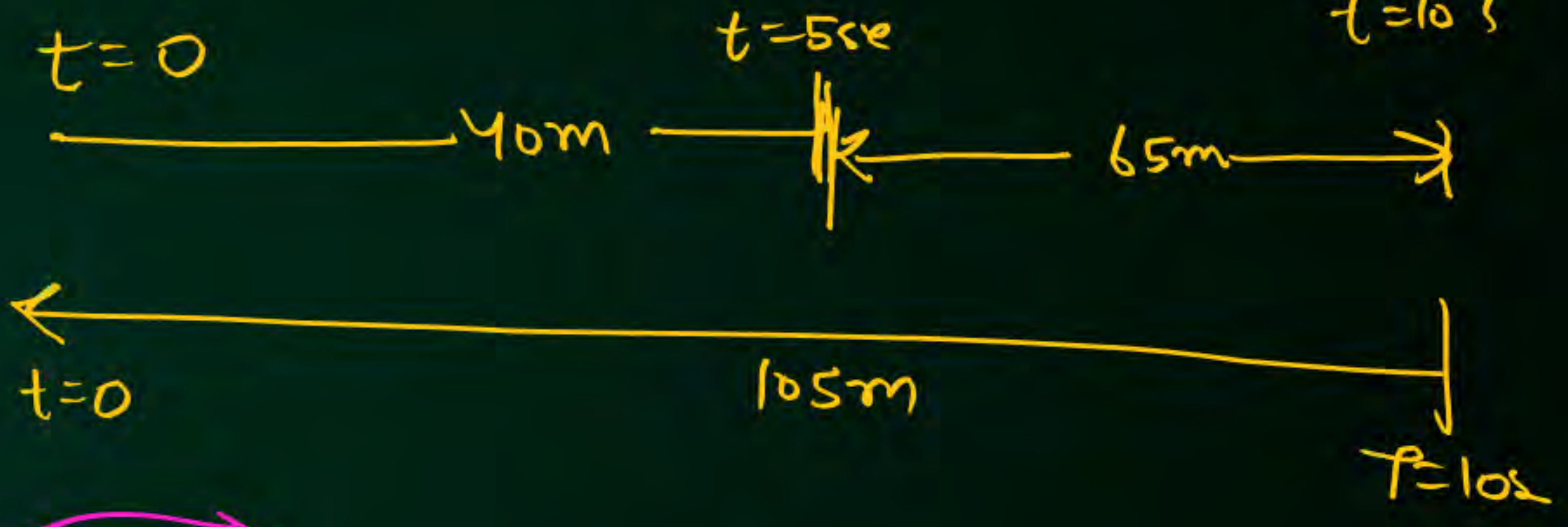
$40 = u_0 5 + \frac{1}{2}a(5)^2$

$40 = 5u_0 + \frac{25}{2}a$ — (i)

Total disp in 10 sec

$105 = 10u_0 + \frac{1}{2}a(10)^2$ — (ii)

Solve it by Yourself



$$\frac{40 - 5u_0 = \frac{25}{2}a}{105 - 10u_0 = \frac{50}{2}a}$$

$160 - 20u_0 = 105 - 10u_0$

$55 = 10u_0$

$u_0 = \frac{55}{10} = 5.5$ m/s

QUESTION

A particle moving with constant acceleration travels 24 m and 64 m in the first two consecutive interval of 4 sec its initial velocity is :

1st interval

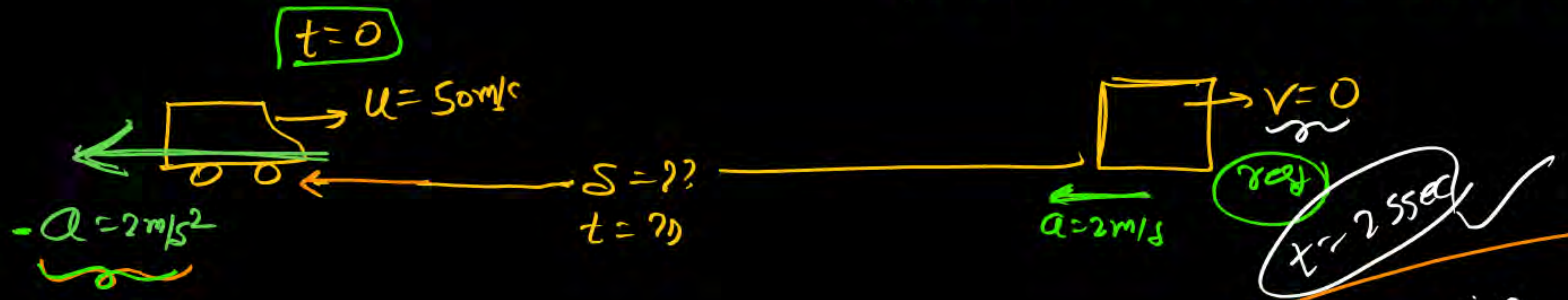
{ $t = 0$ to $t = 4\,sec$ } $S = 24\,m$

{ $t = 4\,sec$ to $t = 8\,sec$ } $S = 64\,m$

2nd interval

H/W

find time and distance after which it will stop ??



$v = u + at$

$0 = 50 - 2t$

$2t = 50$

$t = 25 \text{ sec}$

$s = \dfrac{u^2}{2a}$

$= \dfrac{(50)^2}{2 \times 2}$

$= \dfrac{2500}{4}$

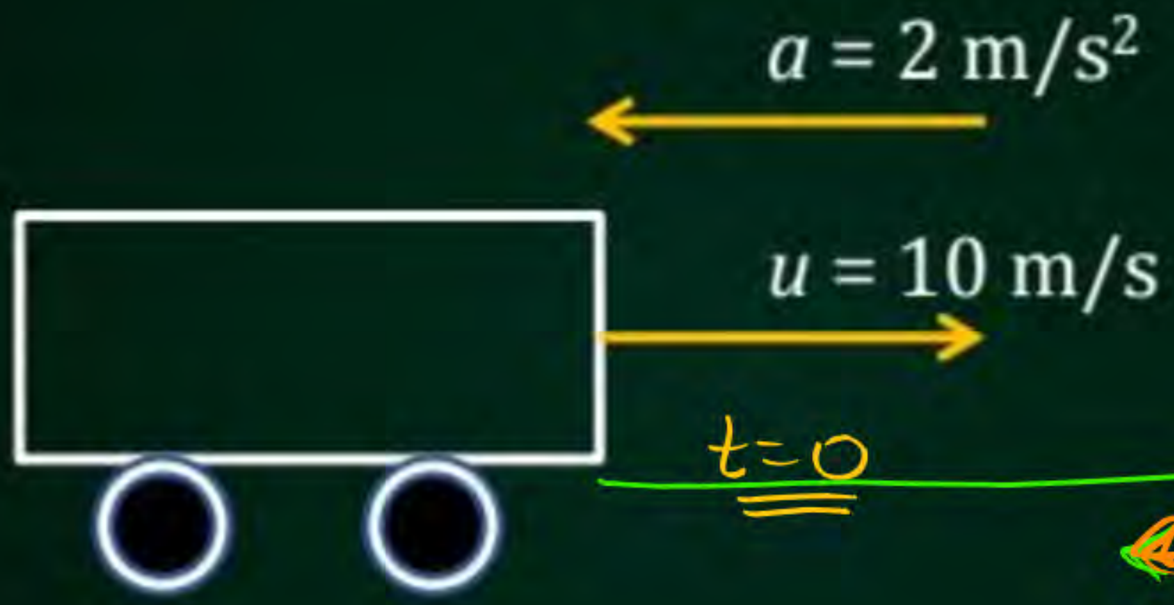
$= 625 \text{ m}$

In this question
distance = Disp^m in time (t=0 to 25 sec)

In this question
distance ≠ Disp^m in time (t > 25 se)

QUESTION

Find distance travelled in 7 sec if its motion. is given



Speed ↓

v = 0 (Rest) at t = 5 sec

t = 7 sec, t = 2 sec

$v = u + at$

$0 = 10 - 2t$

$t = 5$ sec

at 5 sec it will stop

$S_{(t=0 \text{ to } 5s)} = ut + \frac{1}{2}at^2$

$= 10 \times 5 - \frac{1}{2} \times 2 (5)^2$

$= 50 - 25$

$= 25$ m

$S_{(t=5s \text{ to } t=7s)} = \frac{1}{2}at^2$

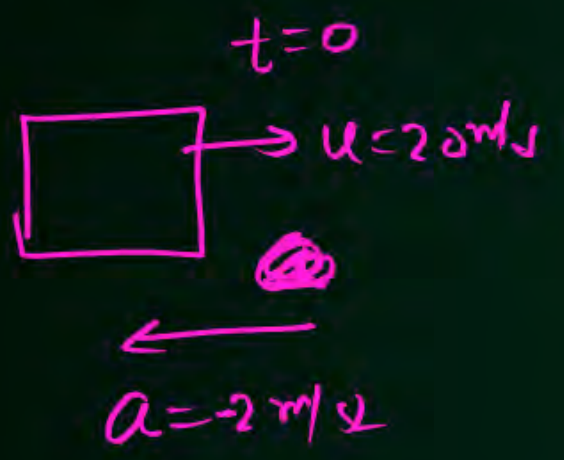
$= -\frac{1}{2} \times 2 (2)^2 = 4$ m

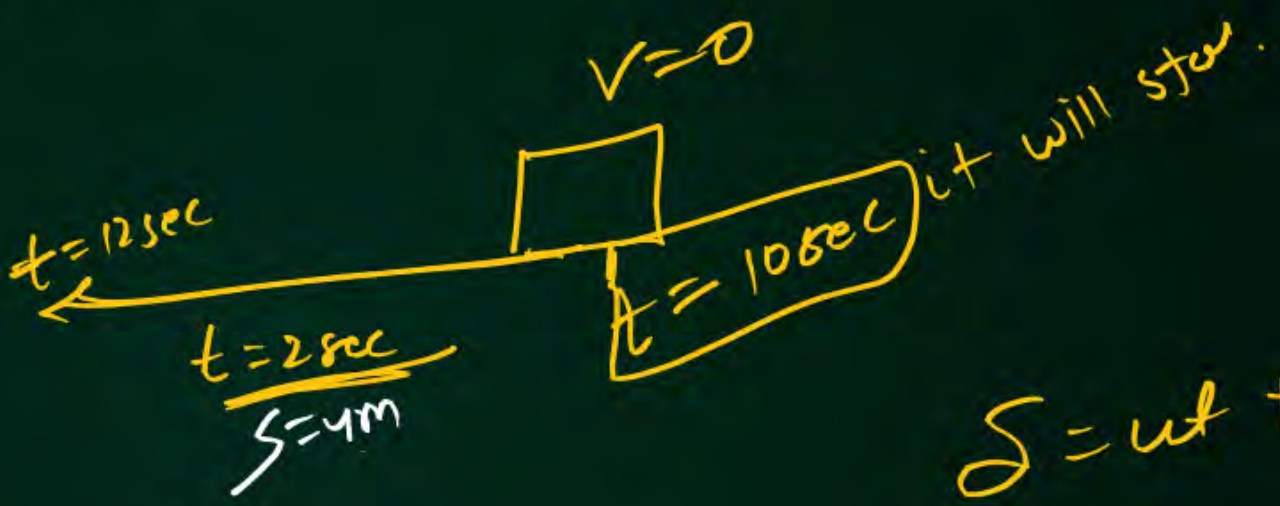
$S_{dist^n} = 29$ m

$S_{displacement} = 21$ m

QUESTION

The initial velocity of particle is 20 m/s and retardation 2 m/s^2 then find distance and displacement in 12 sec.





$S = ut + \frac{1}{2}at^2$

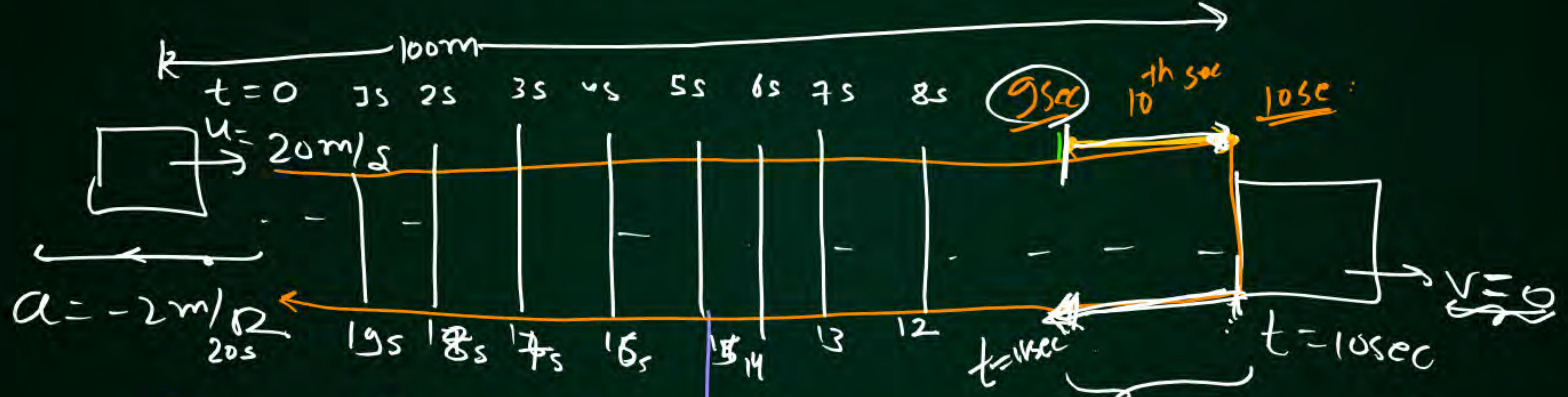
S = 104 distance

S = 96 dispm

QUESTION

The initial velocity of particle is 20 m/s and retardation 2 m/s² then find distance and displacement in 10th sec.

Sol^n



$$S_{n^{th}} = u + \frac{a}{2}(2n-1)$$

$$S_{10^{th}} = 20 - \frac{2}{2}(2\times10-1)$$

$$= 20 - 19$$

$$= 1m$$

Rest

$$S = ut + \frac{1}{2}at^2$$

$$= 0 + \frac{1}{2}2(1)^2$$

$$= 1m$$

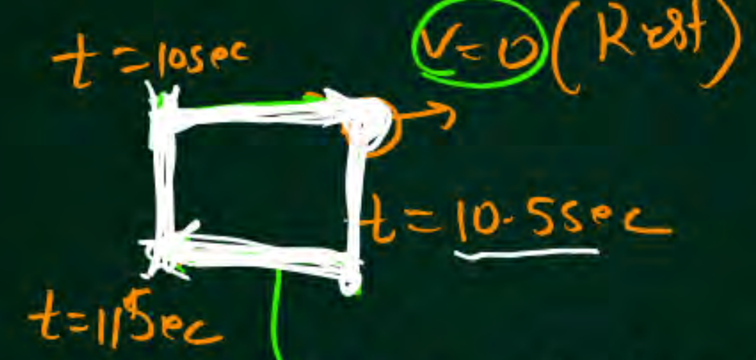
QUESTION

Level up
Never asked in NEET

The initial velocity is 21 m/s and retardation 2 m/s² then distance and displacement in 11th sec.

$t=0$

$u = 21$ m/s



$s = \frac{1}{2} \times 2 \left(\frac{1}{2}\right)^2 = \frac{1}{4} = 0.25$ m

$v = u + at$

$0 = 21 - 2t$

$t = \frac{21}{2} = 10.5$ sec.

at $t = 10.5$ sec object comes to at rest

50% ??

(a) 0, 0

25%

(b) 0.5 m, zero

(c) zero, 0.5 m

(d) 0.5 m 0.5 m

dispm

$S_{n^{th}} = u + \frac{a}{2}(2n-1)$

$= 21 - \frac{2}{2}(22-1)$

$= 21 - 21$

$= 0$

Reaction Time

think → Break लगा देते है

acctual me Break लगा



⊛ **Reaction time** → Time gap B/w desision and action is called reaction time.

$S = u t_0$

$t_0 = \frac{(S)}{u}$

Piyush Raj

QUESTION

Object starts his motion from rest and constant acceleration takes time T for s displacement then find time taken for 1st half and 2nd half displacement.

$u = 0$ (Rest)

acn = a

S, T ; t = T

$\frac{S}{2}$, t_1 (1st) ; $\frac{S}{2}$, t_2

(a) $t_1 = t_2$

(b) $t_1 > t_2$ ✓

(c) $t_1 < t_2$

Compt Journey

$S = \frac{1}{2} a T^2$ — (I)

$\frac{S}{2} = \frac{1}{2} a t_1^2$ — (II) (1st half)

(2nd half) $\frac{S}{2} = \frac{1}{2} a t_2^2$ ✗

(II)/(I)

$$\frac{S/2}{S} = \frac{\frac{1}{2} a t_1^2}{\frac{1}{2} a T^2}$$

$$\frac{1}{2} = \frac{t_1^2}{T^2}$$

$$t_1 = \sqrt{\frac{T^2}{2}} = \frac{T}{\sqrt{2}}$$



$$\frac{T}{2} < \frac{T}{\sqrt{2}}$$

$$t_1 + t_2 = T$$

$$t_2 = T - \frac{T}{\sqrt{2}}$$

$$= T\left(1 - \frac{1}{\sqrt{2}}\right) = T\frac{(\sqrt{2}-1)}{\sqrt{2}}$$

$$t_2 = \frac{T}{\sqrt{2}}(\sqrt{2}-1)$$

$$t_1 : t_2 = 1 : (\sqrt{2}-1)$$

$$\frac{t_1}{t_2} = \frac{\frac{T}{\sqrt{2}}}{\frac{T}{\sqrt{2}}(\sqrt{2}-1)} =$$

$$S_{1s} : S_{2s} : S_{3s} : S_{4s} = 1 : 4 : 9 : 16$$

distance travelled. $(u = 0, a = const)$

$$S_{1^{st}} : S_{2^{nd}} : S_{3^{rd}} : S_{4^{th}} = 1 : 3 : 5$$

Ratio of time in equal dist^n interval

$$t_{(\frac{s}{2})} : t_{next(\frac{s}{2})} = 1 : \sqrt{2} - 1$$

$u = 0$ $(a = const)$



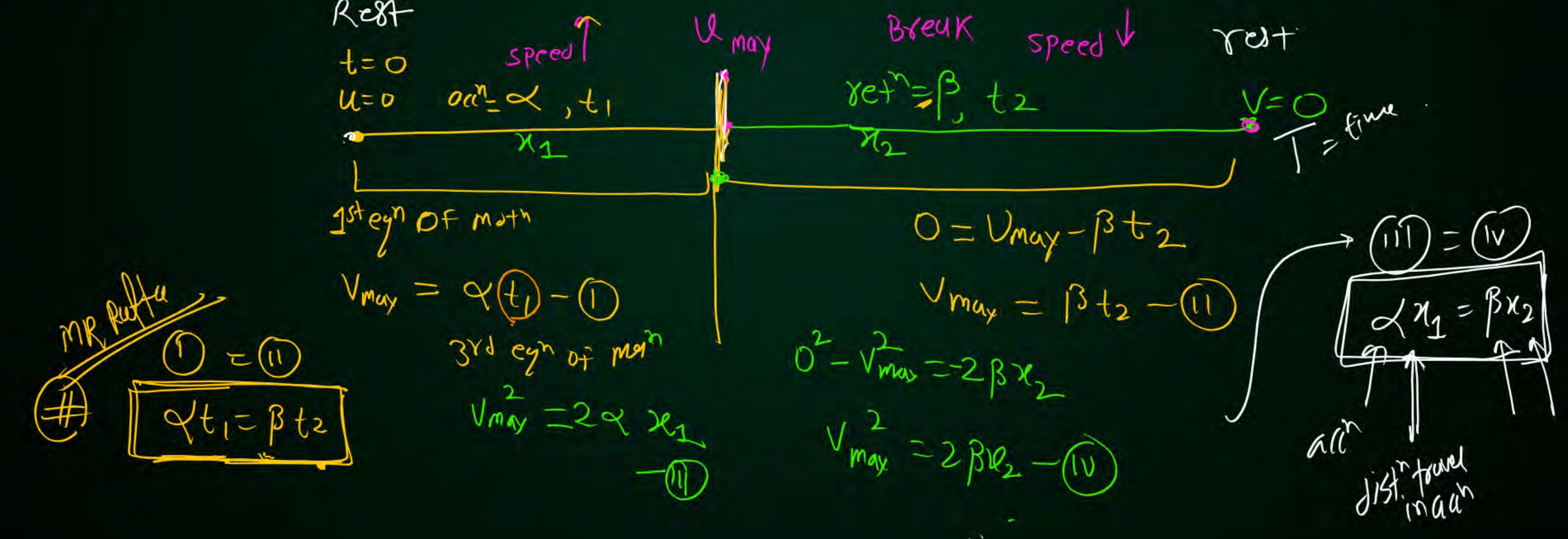
$$t_1 : t_2 : t_3 = 1 : \sqrt{2} - 1 : \sqrt{3} - \sqrt{2} : \sqrt{4} - \sqrt{3} : \sqrt{5} - \sqrt{4} : \sqrt{6} - \sqrt{5} : \sqrt{7} - \sqrt{6}$$

QUESTION

Rest to Rest motion

Object starts his motion from rest and constant acceleration α for some time t_1; then after retards with β and comes to at rest in time t_2 then find total distance travelled and V_{max}.

[IMPORTANT]



Total disp^n

$t_1 + t_2 = T$ (Total time of Journey)

Putting value of t_1 & t_2 from eq^n (I) & (II)

$\frac{V_{max}}{\alpha} + \frac{V_{max}}{\beta} = T$

$V_{max}\left(\frac{1}{\alpha} + \frac{1}{\beta}\right) = T$

(A)

$$V_{max} = \left(\frac{\alpha \cdot \beta}{\alpha + \beta}\right) T$$

$v = at$

$x_1 + x_2 = S$

By solving

$$S = \frac{1}{2}\left(\frac{\alpha \cdot \beta}{\alpha + \beta}\right) T^2$$

MR Ratta

$S = \frac{1}{2} a t^2$

QUESTION

A body starts from rest with acceleration 2 m/s^2 till it attains the maximum velocity then retards to rest with 3 m/s^2. If total time is 10 sec then maximum speed. (NEET)

$$V_{max} = \frac{\alpha \beta}{\alpha + \beta} T$$

$$= \frac{2 \times 3}{5} \times 10$$

$$= 12 \text{ m/s}$$

QUESTION

The engine of a motor cycle can produce maximum acceleration $5\ m/s^2$. It can produce maximum retardation $10\ m/s^2$ what is then minimum time in which he will cover a distance of 1.5 km.

1500m

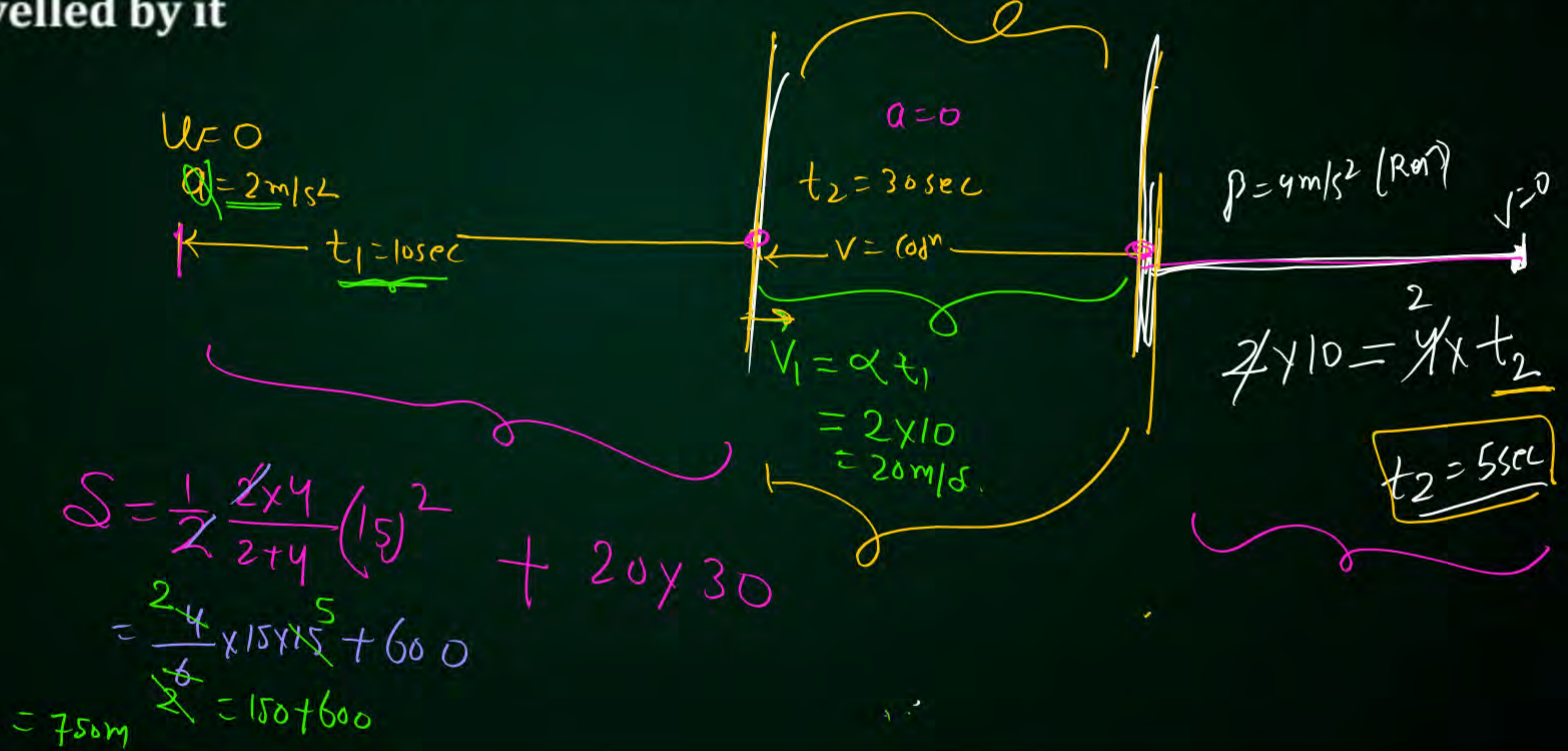
$$S = \frac{1}{2}\frac{\alpha\beta}{\alpha+\beta}T^2$$

1. 5 sec
2. 15 sec
3. 10 sec
4. 30 sec

QUESTION

A particle starts from rest, accelerates at 2 m/s^2 for 10s and then goes with constant speed for 30s and then decelerates at 4 m/s^2 till it stops. What is the distance travelled by it

1. 750 m
2. 800 m
3. 700 m
4. 850 m



Motion under gravity → completed

(a) Yes (63%)

(b) No, No Never (17%)

(c) don't know (17%)

Motion Under Gravity

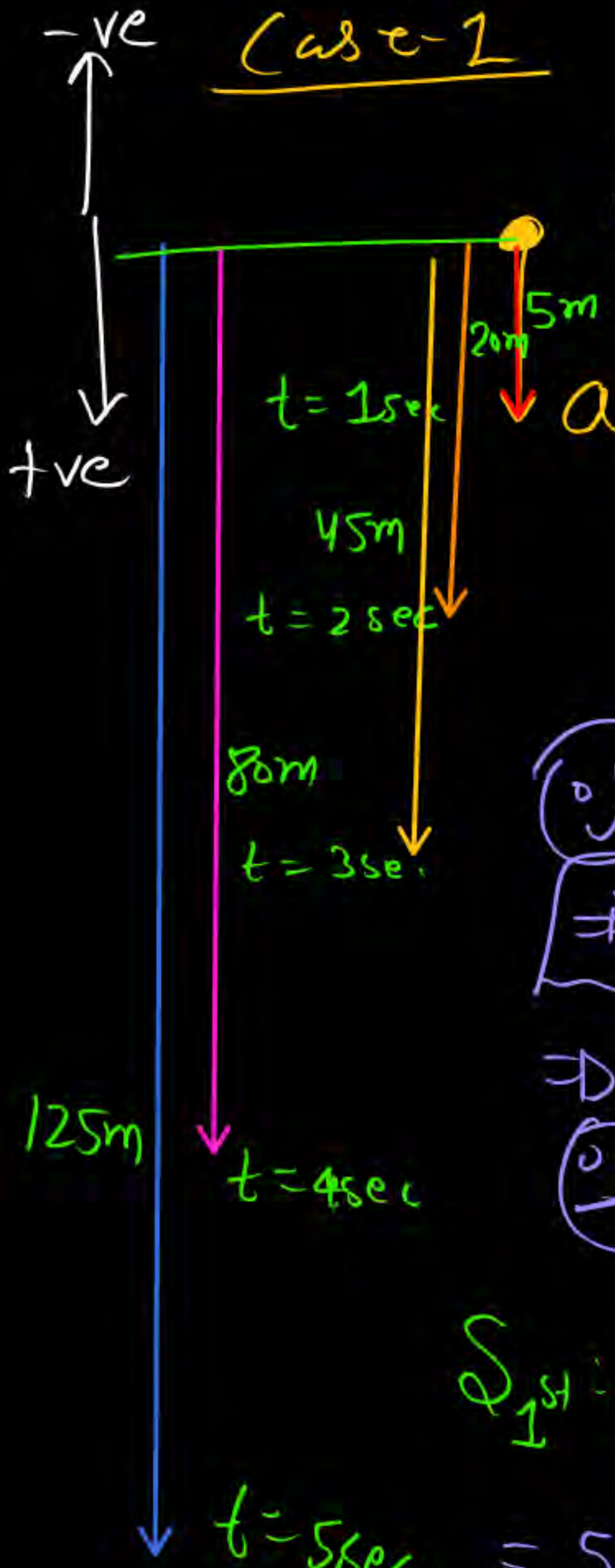
A non-uniform motion with constant acceleration :

- ✓ all equation of motion is valid
- ✓ it is just a good question of motion with constant acceleration
- ✓ $a = g = 9.8 = 10\ m/s^2$
- ✓ air resistance neglected

Case-1 Object is (drop, relesed)

rest
$u=0, t=0$

$a = +g = 10\,m/s^2$



⇒ 1 : 4 : 9 : 16 : 25

⇒ 1 : 3 : 5 : 7 : 9 : 11

$S_{1st} : S_{2nd} : S_{3rd} : S_{4th} =$

$= 5 : 15 : 25 : 35 : 45 : 55$

① dispⁿ in 1-sec $\quad S = ut + \frac{1}{2}at^2$

$S_1 = 0 + \frac{1}{2}10(1)^2 = 5m$

② dispⁿ in 2-sec $\quad S_2 = \frac{1}{2}10(2)^2 = 20m$

③ dispⁿ in 3sec $\quad S_3 = \frac{1}{2}10(3)^2 = 45m$

④ disp in 4-sec $\quad S_4 = \frac{1}{2}10(4)^2 = 80m$

⑤ 〃 〃 5sec $\quad S_5 = \frac{1}{2}10(5)^2 = 125m$

$S_{1sec} : S_{2sec} : S_{3sec} : S_{4sec} = 5 : 20 : 45 : 80 : 125$

$= 1 : 4 : 9 : 16 : 25$ ✓

Q Object is droped & moved 75m in last sec of it Journy then find total time of Journy

$T = 8\ sec$

205m → $T = 21\ sec$

145m → 15 sec

मजदूरी

$$S_{nt} = u + \frac{g}{2}(2n-1)$$

$$75 = 0 + \frac{10}{2}(2n-1)$$

$$15 = 2n-1$$

$$16 = 2n \quad n = \frac{16}{2} = 8$$


THANK YOU
835 m → in last 1 sec
T = 84 sec
835 = 5 (2n-1)

YAKEEN 2.0

FOR NEET 2025

Lecture- 09 | **Physics**

Motion In a Straight Line



By- Dr. Manish Raj (MR SIR)

Todays Goal

PhD on Motion under gravity

1. Object is droped and moves 135m in last 1 sec of its Journey then find time of Flight.

Sol^n

Ans $\boxed{T_f = 14 \text{ sec}}$

MR*

MR^h $n = \left[\dfrac{S_{n^{th}} + 5}{10}\right]$



MR* $S_{n^{th}} = u + \dfrac{g}{2}(2n-1)$

$S_{n^{th}} = \dfrac{g}{2} 2n - \dfrac{g}{2}$

$S_{n^{th}} = gn - \dfrac{g}{2}$ 5

$S_{n^{th}} + 5 = gn$

$n = \left(\dfrac{S_{n^{th}} + 5}{10}\right)$

1. Object is droped and moves 185m in last 1 sec of its Journey then find time of Flight & H from it is droped.

Soln

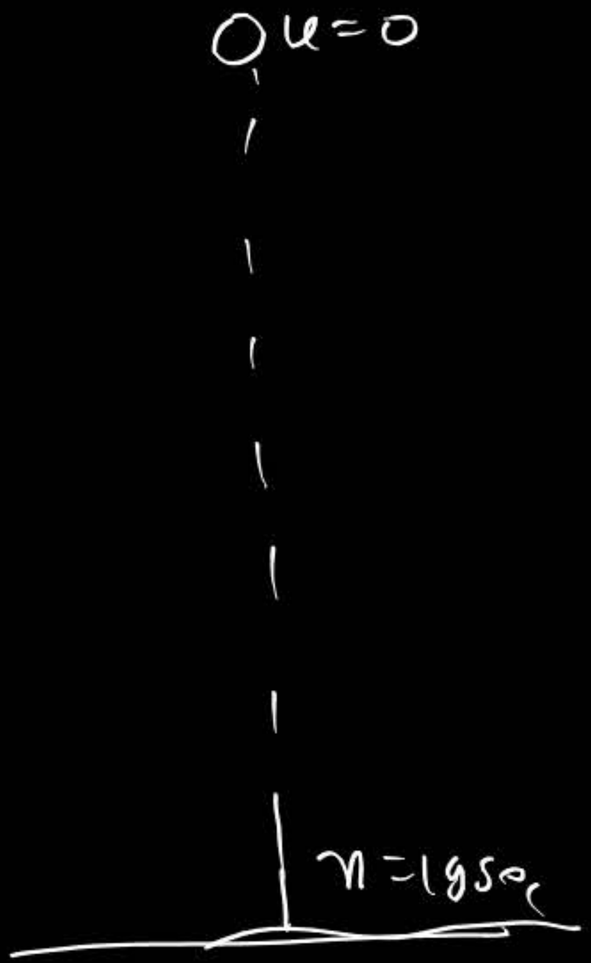
$n = \frac{185+5}{10}$

$\boxed{n = 19 \text{ sec}}$

$s = \cancel{ut}^{\,0} + \frac{1}{2}at^2$

$s = \frac{1}{2}g(19)^2$

$= 5(19)^2$



1. Object is droped and moves 55m in last 1 sec of its Journey then find time of Flight.
and H from it is droped

Sol

$$n = \frac{55+5}{10} = \frac{60}{10}$$

$n = 6$ sec.

$$H = \frac{1}{2} g t^2$$

$$= \frac{10}{2}(6)^2$$

$$= 5 \times 36 = 180\,m$$

QUESTION

Motion under gravity is an example of

(a) Non-uniform acceleration, uniform motion

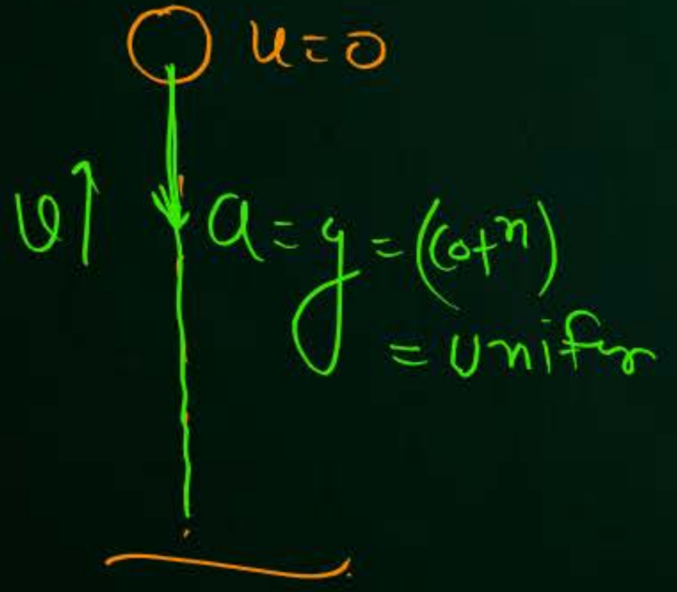
(b) Non-uniform motion, Non-uniform accelen

(c) Non-uniform motion, uniform acceleration

(d) Uniform motn, Uniform accn

$g = 10$

$g = 9.8$



Uniform Motion →

Uniform accn →

Object is droped from height 'H' from ground then find time taken to reach ground and velocity at ground.





$u = 0$ (droped

$a = g$ (downward)

$S = ut + \frac{1}{2}at^2$

$H = 0 + \frac{1}{2}gT^2$

$\frac{2H}{g} = T^2$

$$T = \sqrt{\frac{2H}{g}}$$

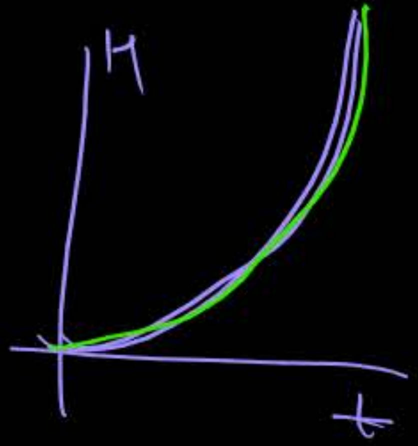
The MR*

$\uparrow T \propto \sqrt{H}\uparrow$

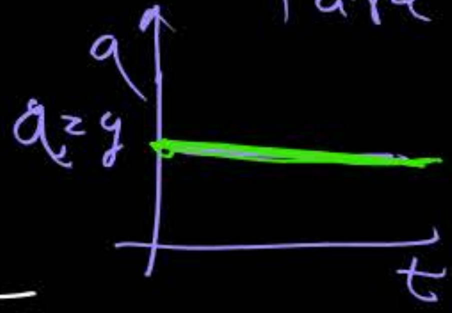
$\downarrow T \propto \frac{1}{\sqrt{g}}\uparrow$

dim^n check.

$\sqrt{\frac{L}{LT^{-2}}} = \sqrt{T^2} = \text{Time}$



UPword Para



from same Heigh
$T_{earth} < T_{moon}$

g = does not depends on mass.

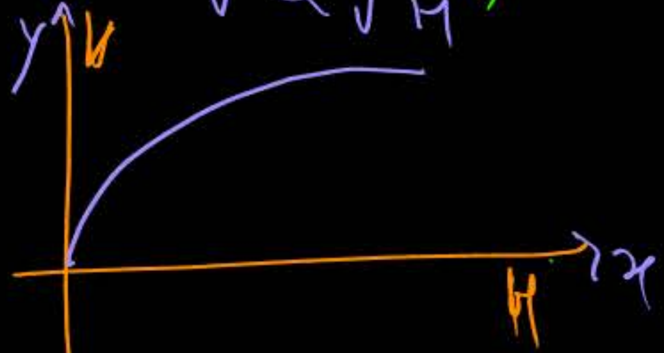
it's velocity at ground

3rd eq^n of Mot^n

$v^2 - u^2 = 2aS$ (with $u = 0$)

$$V = \sqrt{2gH}$$

$V \propto \sqrt{H}$

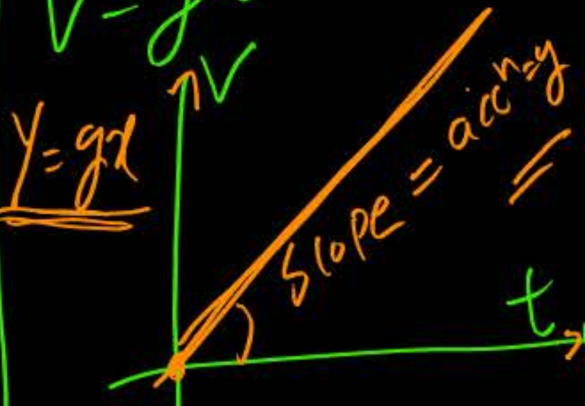


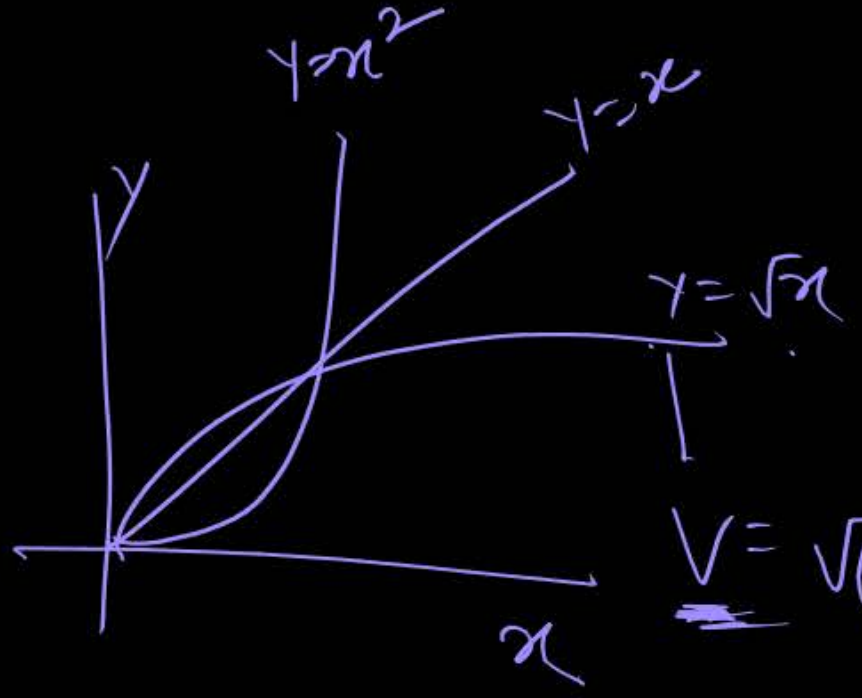
velocity after time 't'

$V = u + at$ (with $u = 0$)

$V = gt$

$y = gx$





$$V = \sqrt{2g\,H}$$

a

Ball is droped then find distance moved in each one sec. of time interval.

$S_{1st} = 5m$

$S_{2^{nd} sec} = 15m$

$S_{3^{rd}} = 25m$

$S_{4^{th}} = 35m$

$S_{1st} : S_{2nd} : S_{3rd} : S_{4} = 1 : 3 : 5 : 7 : 9 : 11 : 13$

$= 5 : 15 : 25 : 35 : 45 : 55 : 65$

Distance moved in 1s, 2s, 3s, 4s, 5sec ...

$S_{1sec} : S_{2-sec} : S_{3-se} : S_{4se} = 5 : 20 : 45 : 80 : 125 : 180 : 245 : 320 :$

$= 1 : 4 : 9 : 16 : 25 : 36 : 49 : 64$

Ball is drope and move 85m in n^{th} sec then find that time intraval.

Q) Ball is droped $(u=0)$ then find its dispm in 11^{th} sec of Journey

Soln

$$S_{n^{th}} = u + \frac{a}{2}(2n-1)$$

$$= \frac{10}{2}(2n-1)$$

$$S_{n} = 10n - 5 = 105\ m$$

Ans

$$S_{n^{th}} = u + \frac{a}{2}(2n-1)$$

$$85 = \frac{10}{2}(2n-1)$$

$$85 = 10n - 5$$

$$\frac{90}{10} = n$$

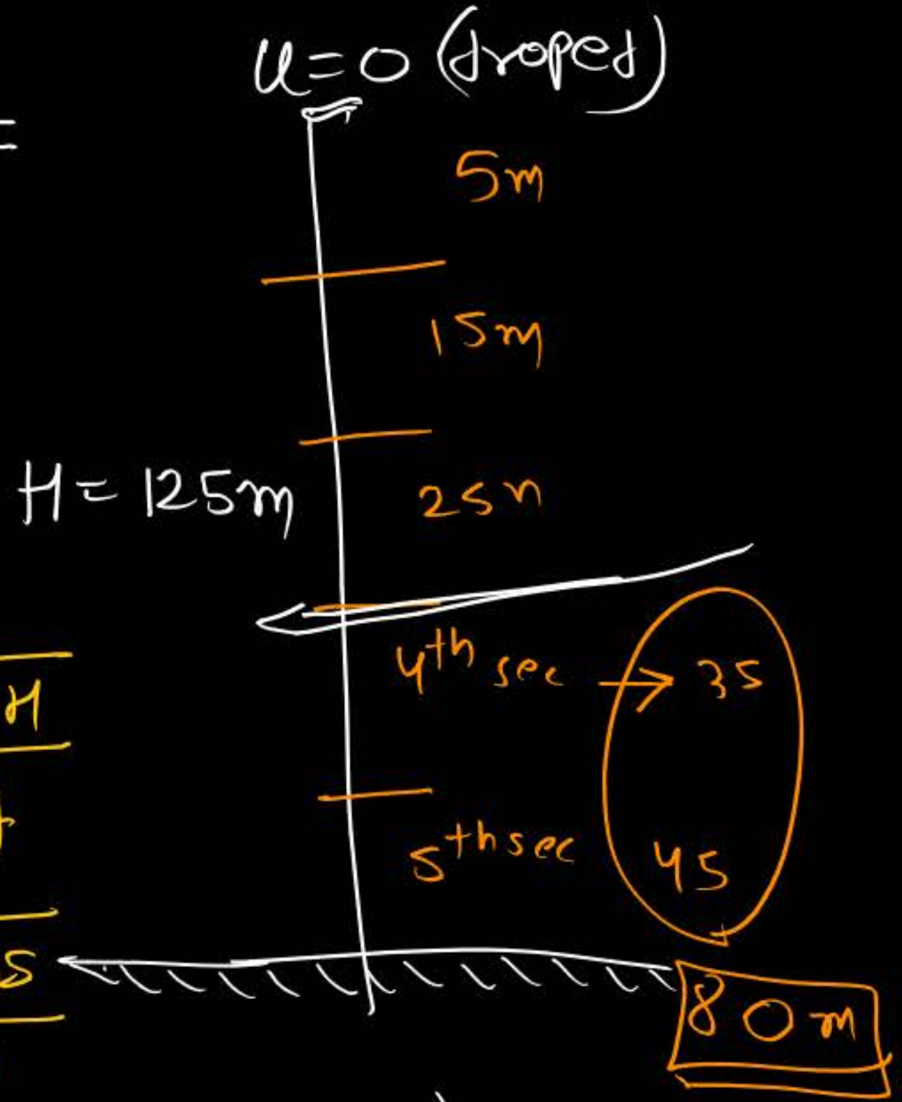
$$n = 9^{th}\ sec$$

Ball is droped from 125m then distance Moved in last 2 sec of Journey.

$$S_{\text{in }1^{st}\text{ }3\text{sec}} = \frac{1}{2}gt^2 = \frac{1}{2}\,10\,(3)^2 = 45\text{m}$$

$$S_{\text{last in }2\text{sec}} = 125 - 45 = 80\text{m}$$

Sol^n

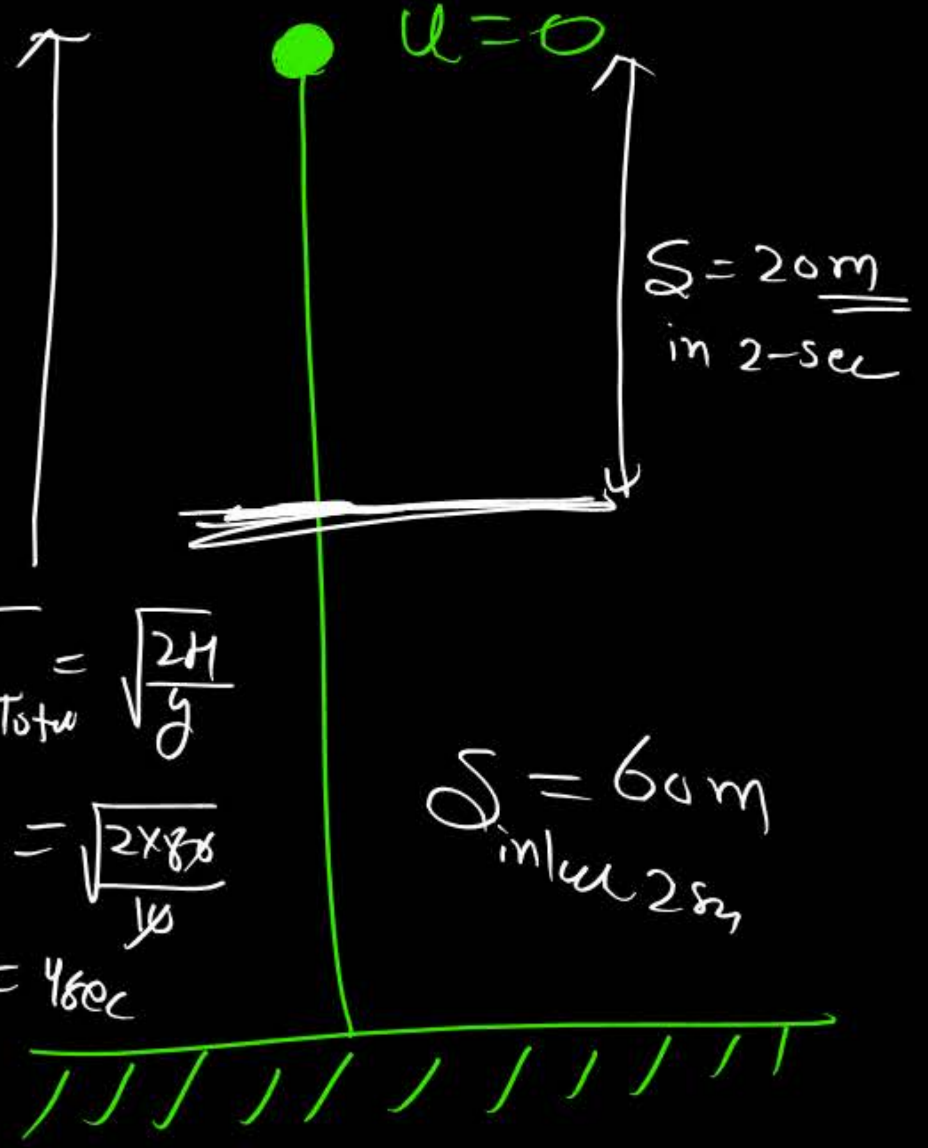


$$T = \sqrt{\frac{2H}{g}}$$

$$= \sqrt{\frac{2\times125}{10}}$$

$$= \sqrt{25} = 5\text{sec}$$ (Total)

Ball is droped from 80m then find ratio of distance moved in 1st 2sec and last 2-sec of Journey.



$T_{Total} = \sqrt{\frac{2H}{g}}$

$= \sqrt{\frac{2 \times 80}{10}}$

$= 4sec$

$$\frac{S_{in\ 1^{st}\ 2sec}}{S_{in\ last\ 2sec}} = \frac{20}{60} = \frac{1}{3}$$

A.

t = 0 drop

$u = 0$

$g = 10\,m/s^2$ ***

t = 1

$v = 10\,m/s$

t = 2

$v = 20\,m$

t = 3

$V = 30\,m$

t = 4

$V = 40\,m$

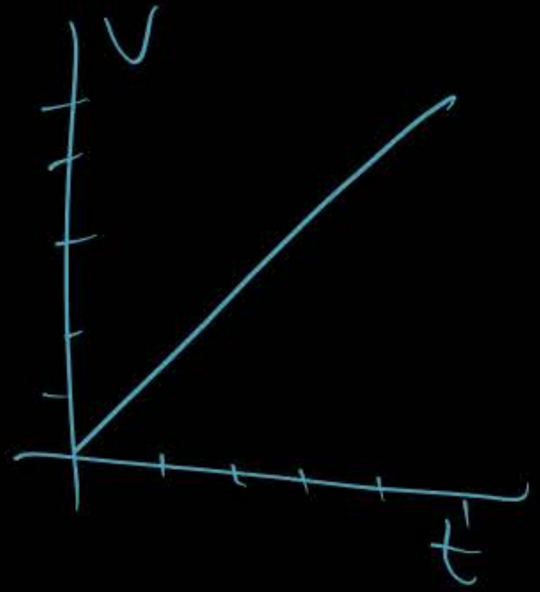
t = 5

$V = 50\,m/s$

$V = u + at$

$$V = gt$$

$V = 10 \times t$



Ball is droped then find ratio of distance in 3rd sec and 7th sec

Soln

$S = 1 : 3 : 5 : 7 : 9 : 11 : 13$

$5 : 15 : 25 : 35 : 45 : 55 : 65$

$S_{3rd} : S_{7th} = 5 : 13$

same

$= 25 : 65$

$= 15 : 39$ Ans

Ans

Object droped from Height 180m from ground find its velocity at ground. and total time of flight:-

$T = \sqrt{\frac{2H}{g}}$

$T = 6 sec$

$V = 60 m/s$

$V = \cancel{u}^{0} + at$

$= 10 \times 6$

$V = 60 m/s$

Ball is droped then find its velocity after each sec.

Ball is droped and touches the ground in 4-sec. then find height of tower from it droped, velocity at ground, and distance travelled in last-sec of its Journey.

Soln

$V_{(t=4)} = 40 m/s$

$S = 80m = H$

$S = \frac{1}{2} g t^2$

4 sec

$S_{in\ last\ 1\text{-}sec} = 35m$

S = 15n? 35

A ball is droped then find distance in 5th sec. of Journey

45m

A Ball is droped from a tower of Height 20m. then find velocity at ground.

$V = 20 m/s$

$H = 20m$

$T = 2 sec$

taken

$V = \sqrt{gH}$

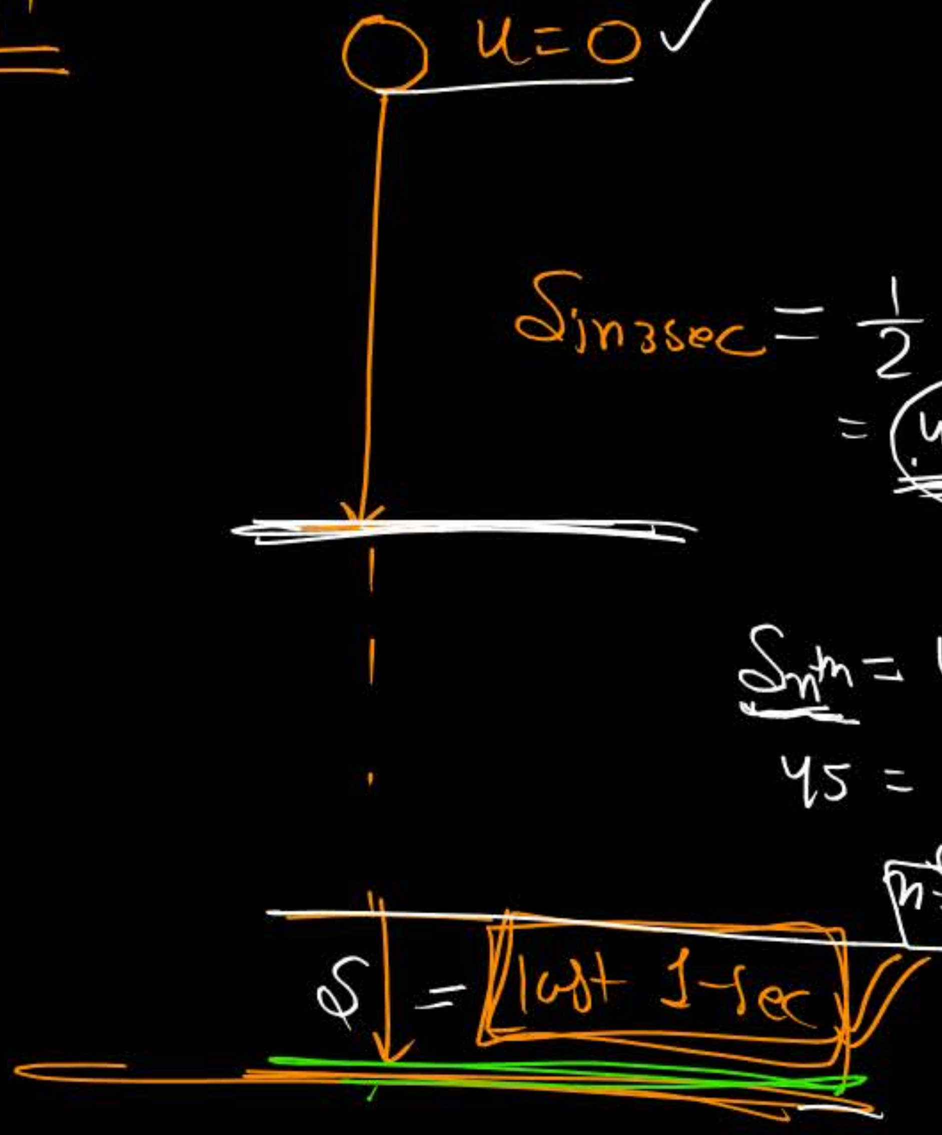
$= \sqrt{2 \times 10 \times 20}$

$= \sqrt{400}$

$= 20 m/s$

Object is droped and distance in last 1sec is equal to 1st 3sec then find height from ground from where ball is droped

Soln



$S_{in\,3sec} = \frac{1}{2} g (3)^2$

$= 45\,m$

$S_{n^{th}} = u + \frac{g}{2}(2n-1)$

$45 = \frac{10}{2}(2n-1)$

$n = 5$

$S_{n^{th}} = 5 : 15 : 25 : 35 : 45$

5^{th}

$T_f = 5\,sec$

$H = 125\,m$

$$\frac{gh}{25} \rightarrow \frac{9 \times 125}{25} = 45$$

$$\frac{9 \times 100}{25} = 36$$

$$H_{1sec} = 5m$$

$$H_{2se} = 20m$$

$$H_{3s} = 45m$$

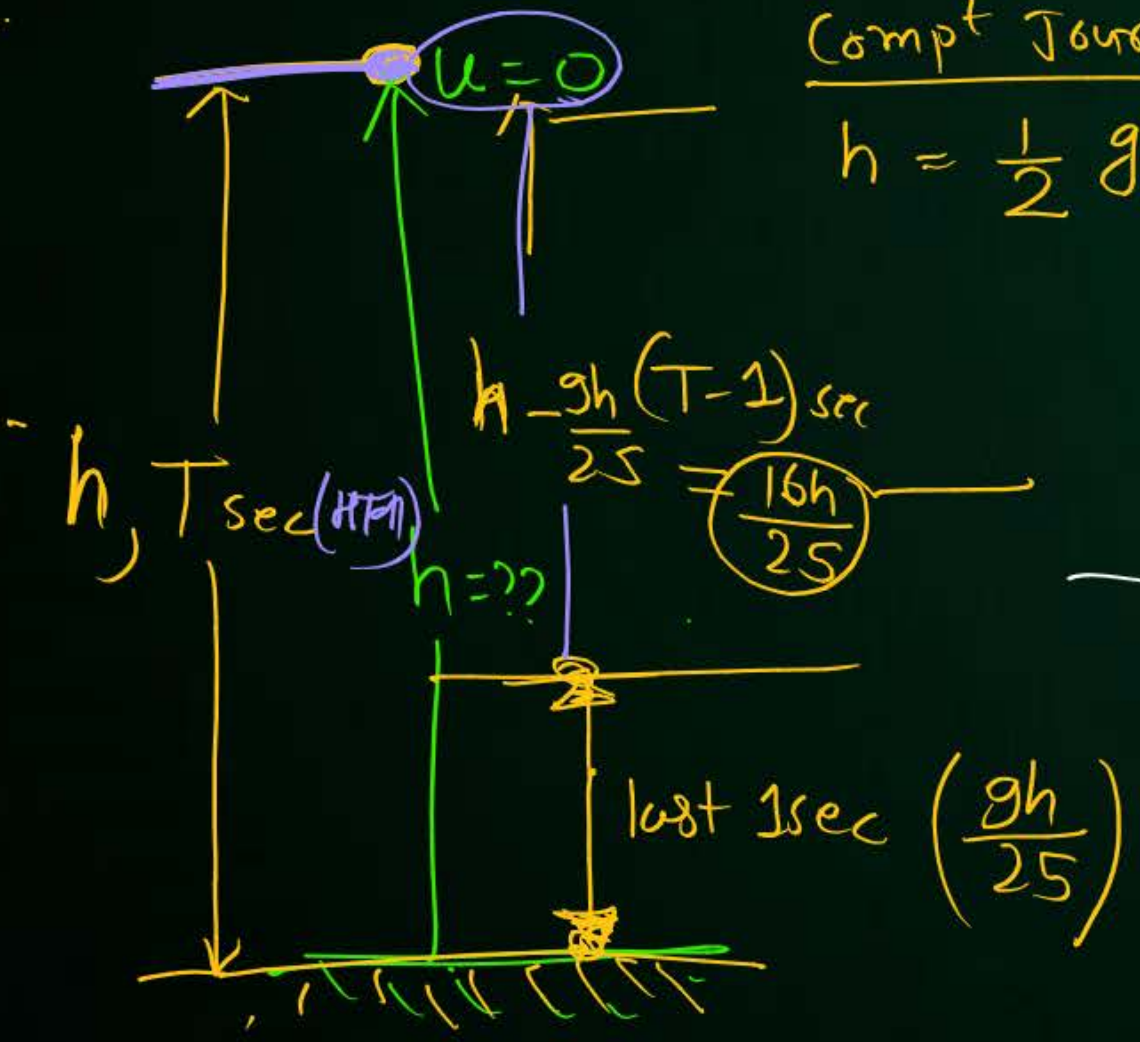
$$H_{4s} = 80m$$

$$h_{5} = 125$$

$$H_{6s} = 180$$

QUESTION

A particle is dropped under gravity from rest from a height h and it travels a distance $\frac{9h}{25}$ in the last second, the height h is :



Compt Journey

$h = \frac{1}{2} g t^2$ — (1)

$\frac{16h}{25} = \frac{1}{2} g (t-1)^2$ — (II)

$h = \frac{1}{2} g t^2$ — (1)

$\frac{16}{25} = \frac{(t-1)^2}{t^2}$

$\sqrt{\frac{16}{25}} = \frac{t-1}{t}$

$\frac{4}{5} = \frac{t-1}{t}$

$4t = 5t - 5$

$5 = 5t - 4t$

$t = 5\,sec$

125 m

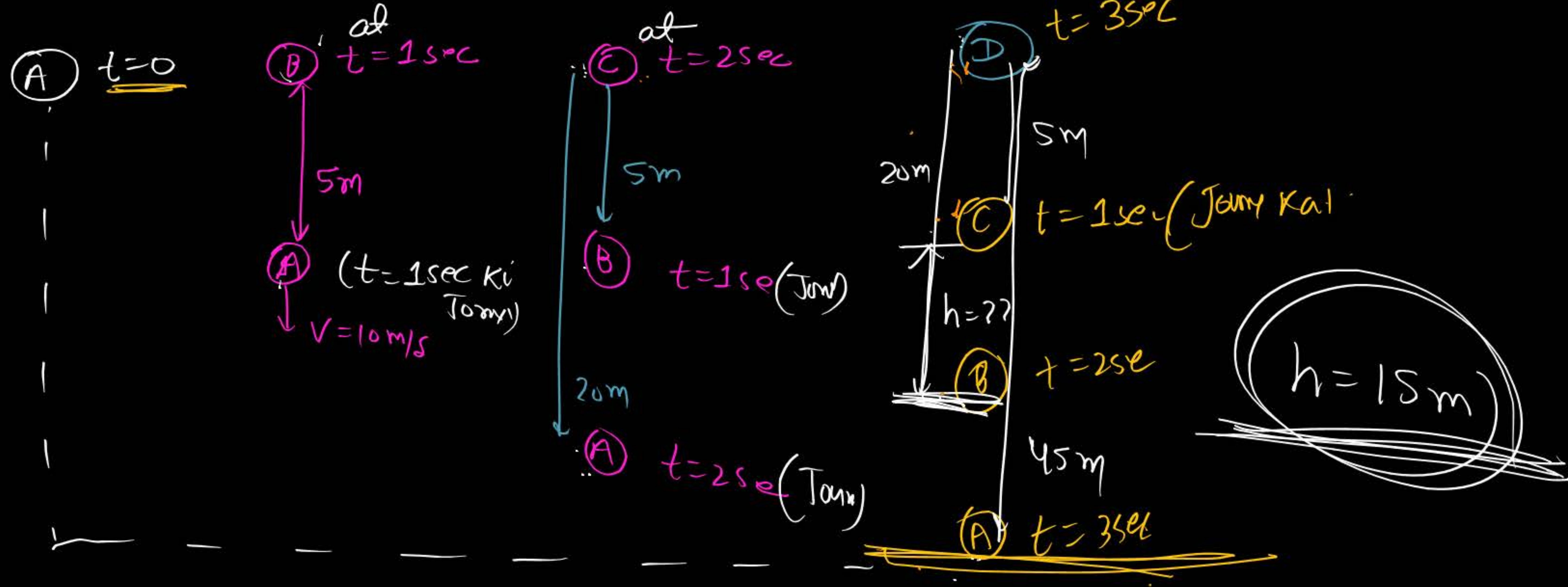
Ball is droped from Height H and it travell $\frac{7H}{16}$ in last sec of Journey then find 'H'

$\frac{7H}{16}$

H = 80m

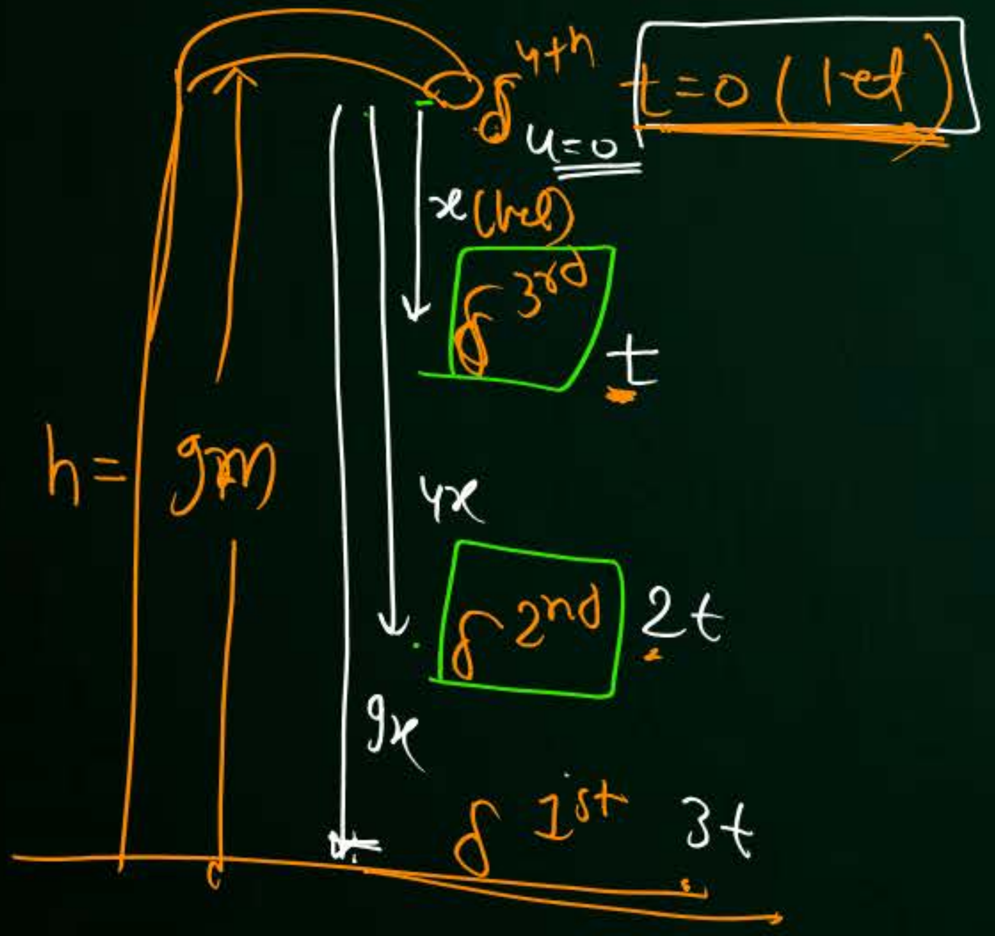
T_f = 4sec

A Ball is droped at t = 0 sec after 1 sec 2nd Ball is droped after 2 sec 3rd Ball is droped, after 3 sec 4th Ball is droped. then Find distance b/w 2nd and 3rd Ball when 4th Ball is about to fall.



QUESTION (NEET) (JEE)

Water drop is falling in a regular intervals when 1st drop is reaches to ground then 4th drop is about to release, then find distance between 2nd drop and 3rd drop. Height of water tap is 9m.



t = time interval

u = 0 a = ω

$S_t : S_{2t} : S_{3t} = x : 4x : 9x$

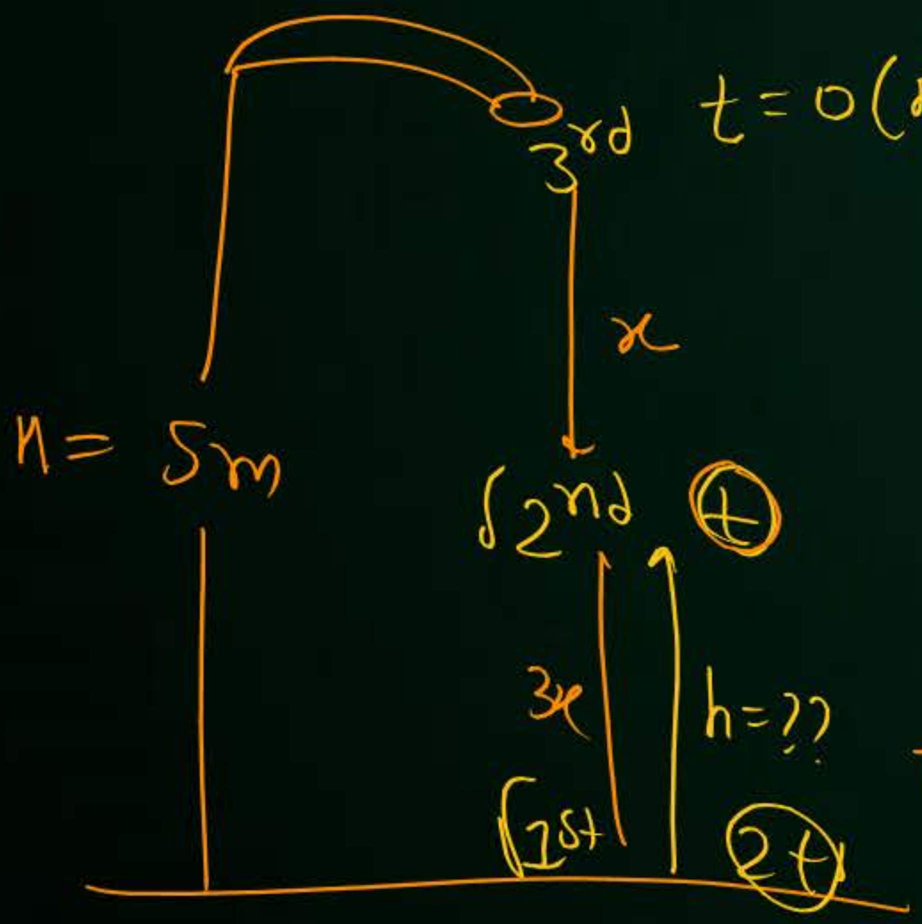
$9x = 9$

$x = 1\,m$

3m dist B/w 2nd & 3rd drop

QUESTION

Water drops falls at regular interval from a tap which is 5m above the ground. The 3rd leaving the tap at the instant the 1st drop touches the ground. How far above the ground is the second drop at that instant.



t = time interval (let)

$4x = H = 5$

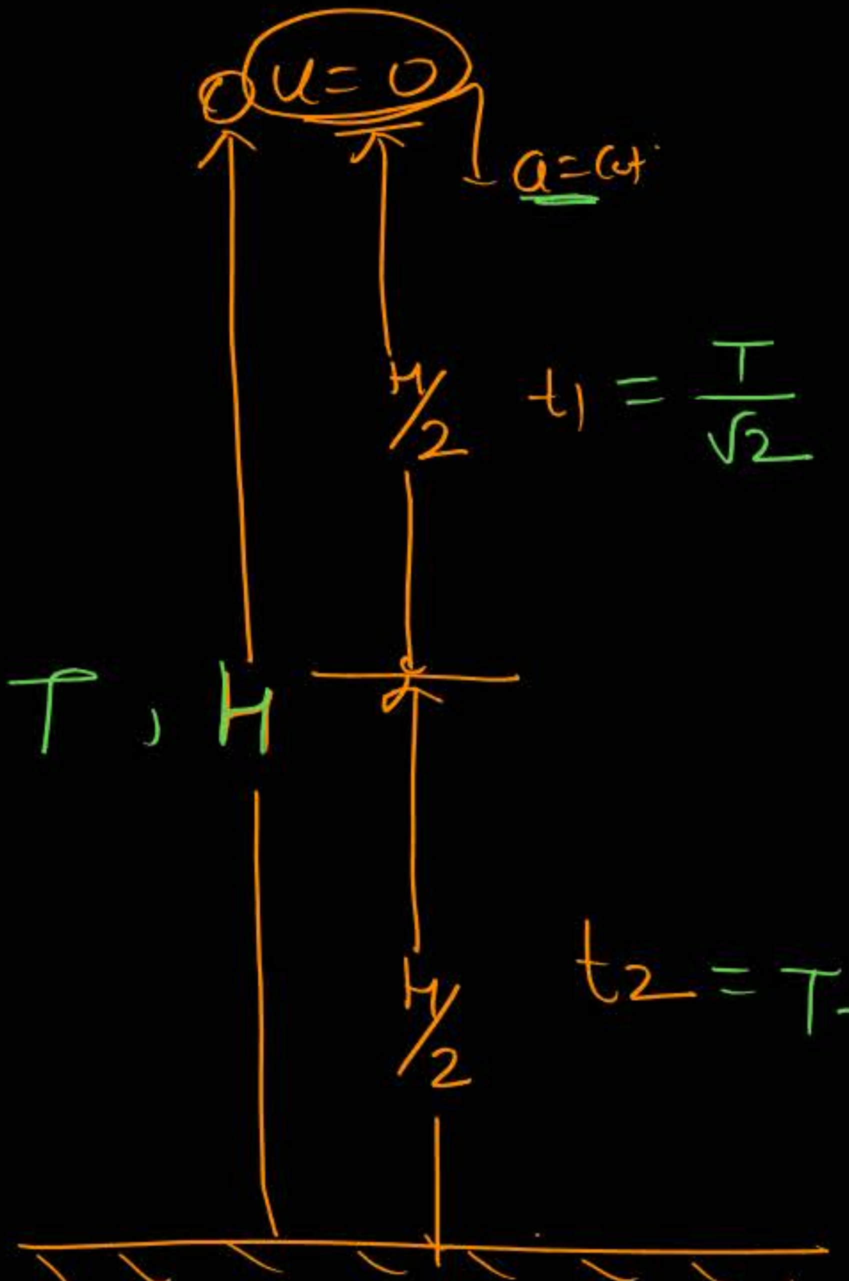
$x = \frac{5}{4}$

$h = 3x = 3\left(\frac{5}{4}\right) = 3.75\,m$

5 : 15 : 25 : 35

99%

Ball is droped from Height H then find ratio of time in 1st half and 2nd half distance.



$t_1 = \frac{T}{\sqrt{2}}$

$t_2 = T - \frac{T}{\sqrt{2}}$

$t_1 : t_2 = 1 : \sqrt{2}-1$

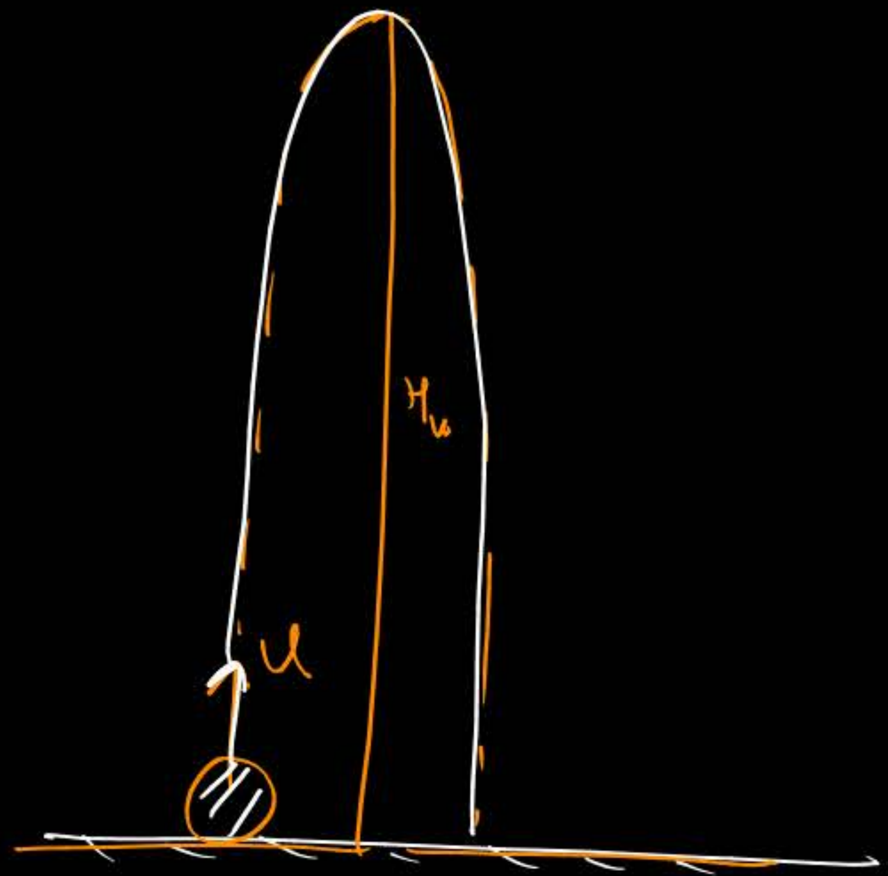
You need to watch Class

QUESTION

Object is dropped then it moves 2^{nd} half distance in last 1 sec of motion then find time of flight.

Motion under gravity

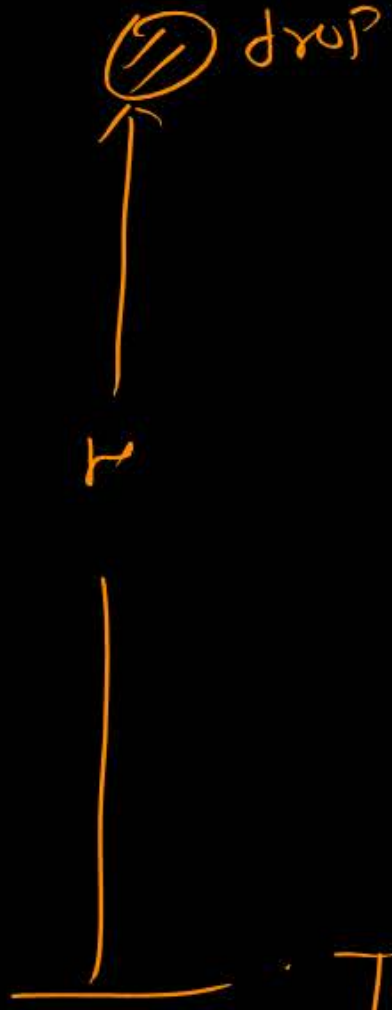
Type-1



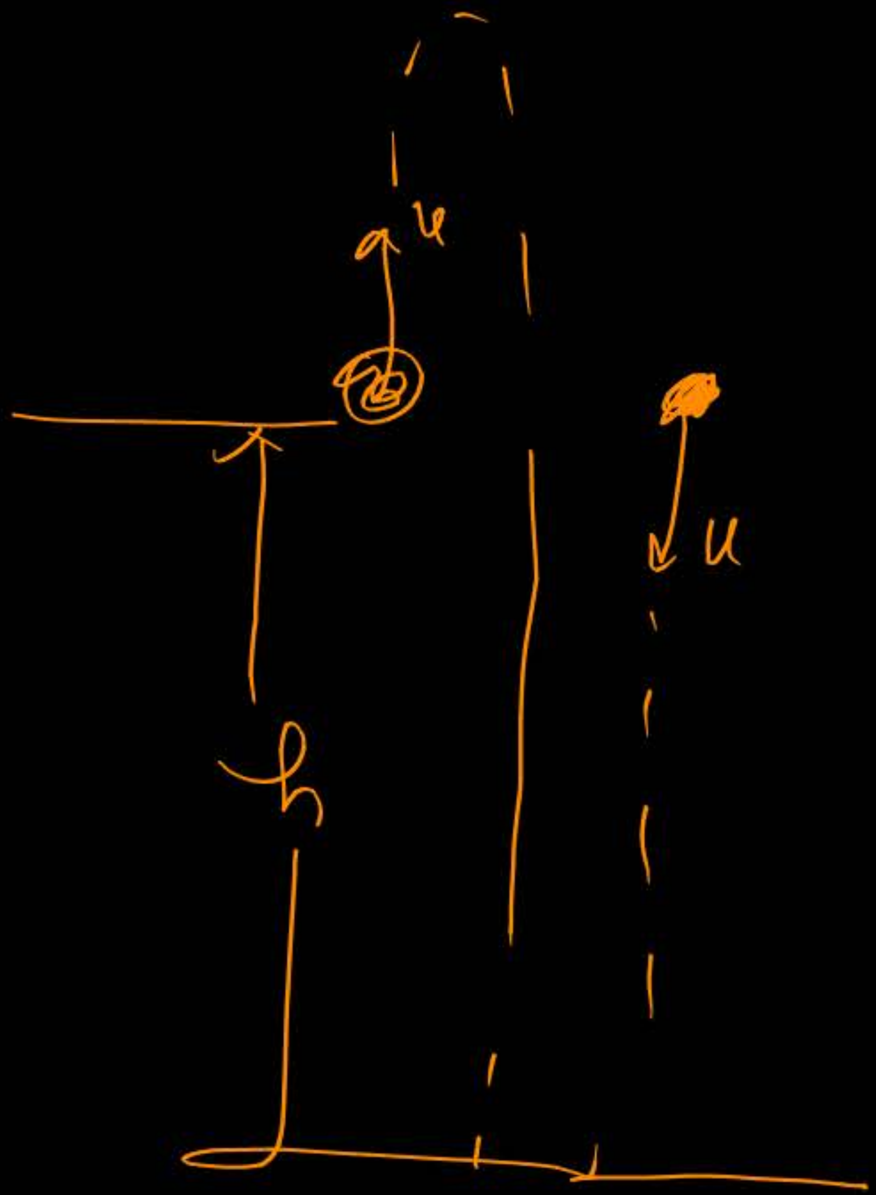
$T = \frac{2u}{g}$

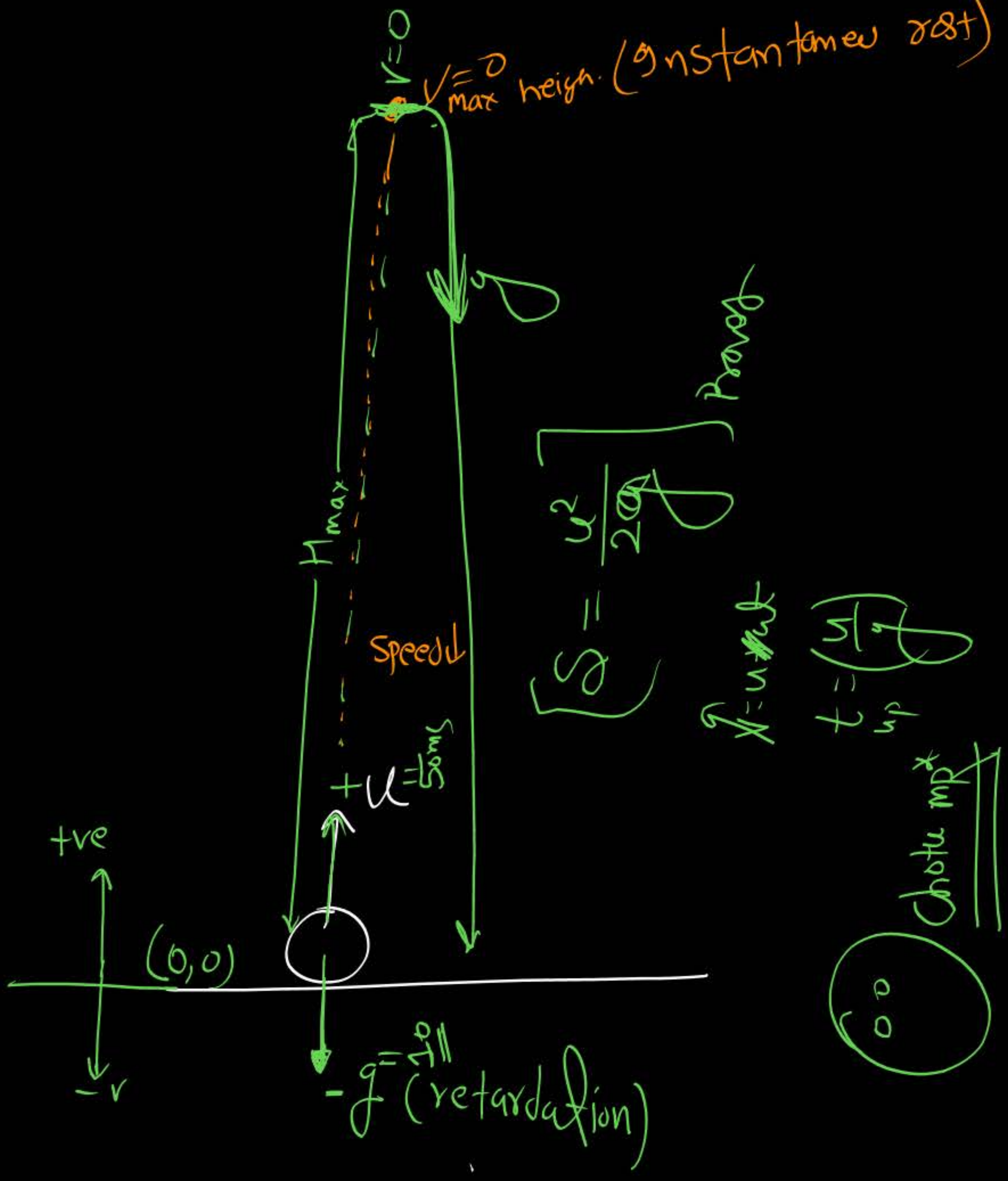
$H_h = u^2/2g$

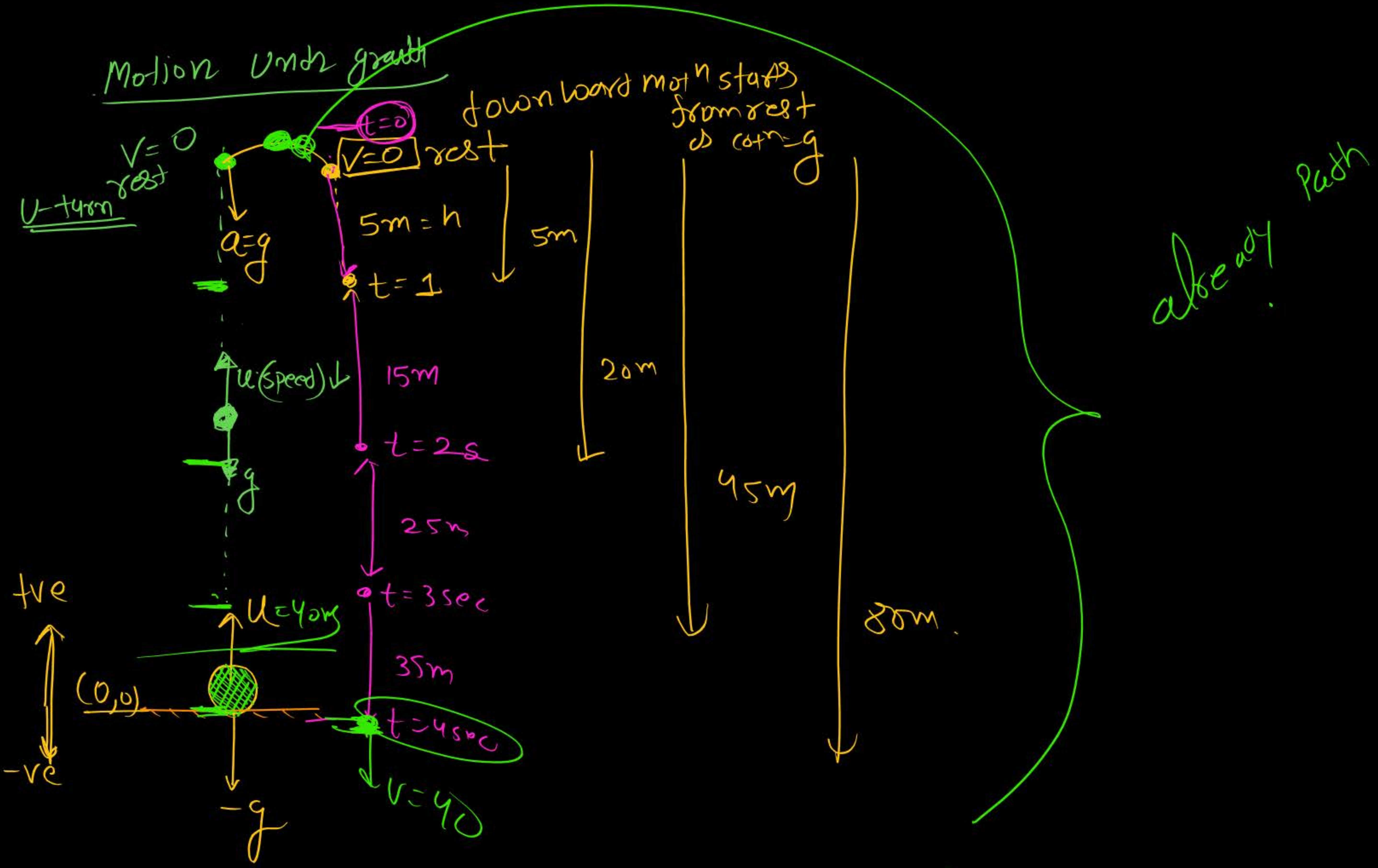
Type-2

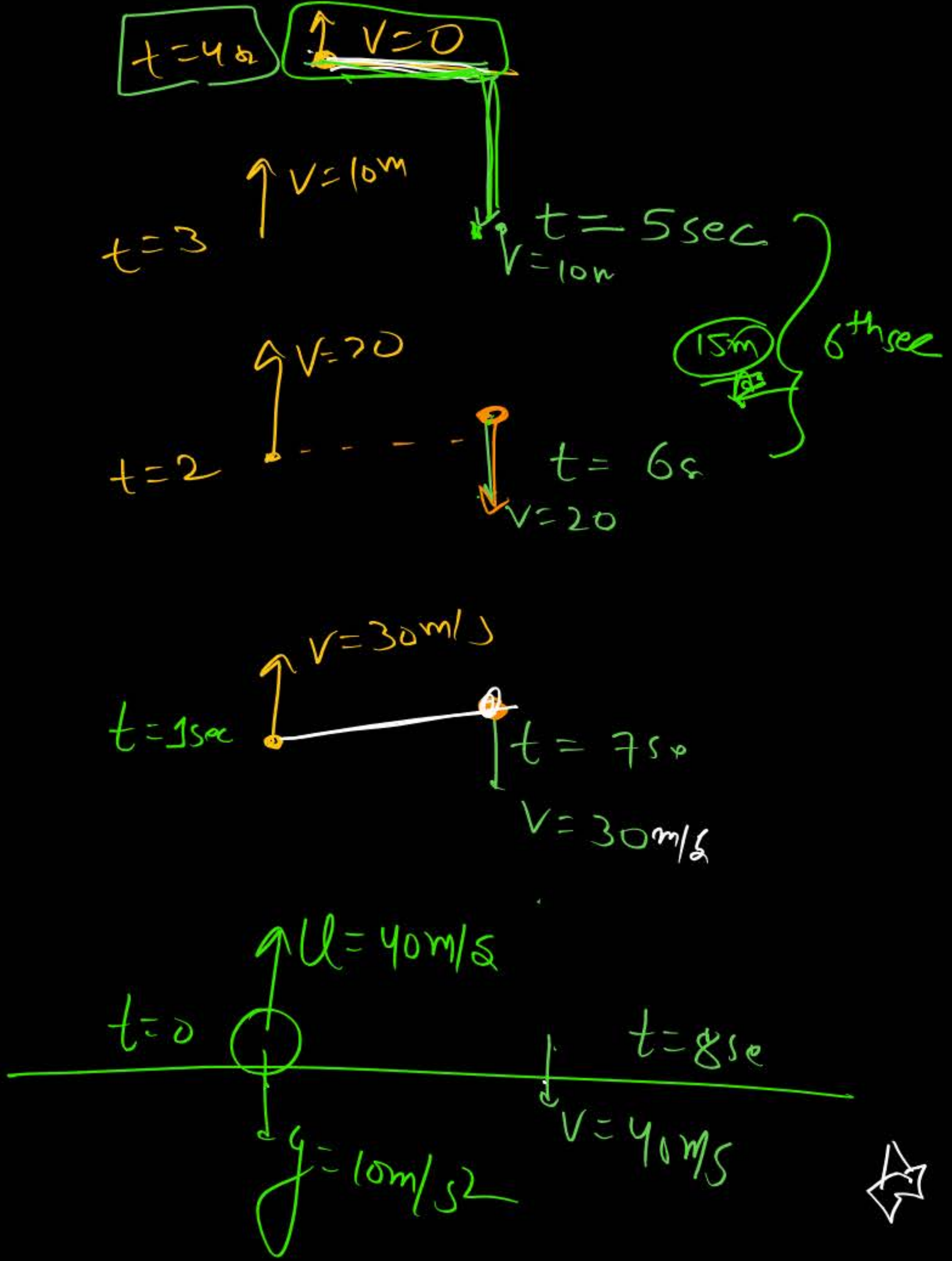


$T = \sqrt{\frac{2h}{g}}$




+ve
-ve
(0,0)
H_{max}
+u = 50 m/s
speed ↓
v = 0
V_{max} = 0
max heigh. (instantaneous rest)
g
-g = 10 (retardation)
$S = \frac{u^2}{2g}$
Proves
v = u - gt
$t_{up} = \left(\frac{u}{g}\right)$
Chotu mp*


Motion Under gravity
V = 0
rest
U-turn
a=g
u (speed)
g
+ve
-ve
U = 40 m/s
(0,0)
-g
t=0
V=0 rest
downward motion starts from rest
& acceleration = g
5m = h
5m
t = 1
15m
20m
t = 2s
25m
45m
t = 3sec
35m
80m
t = 4sec
V = 40
already Path



$$t = \frac{u}{g} = \frac{40}{10} = 4\,sec$$

$$v = u + at$$

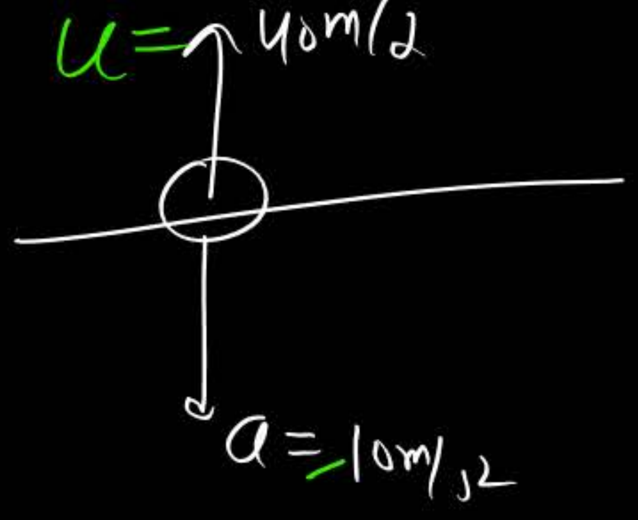
$$V_{t=7} = 40 - 10 \times 7 = 40 - 70 = -30\,m/s$$

$$T = \frac{2u}{g} = 2\left[\frac{40}{10}\right] = 8\,sec$$

$$H = 80m$$

$$H = \frac{u^2}{2g} = \frac{(40)^2}{2 \times 10} = \frac{1600}{20} = 80m$$

dispn in 6^{th} sec.

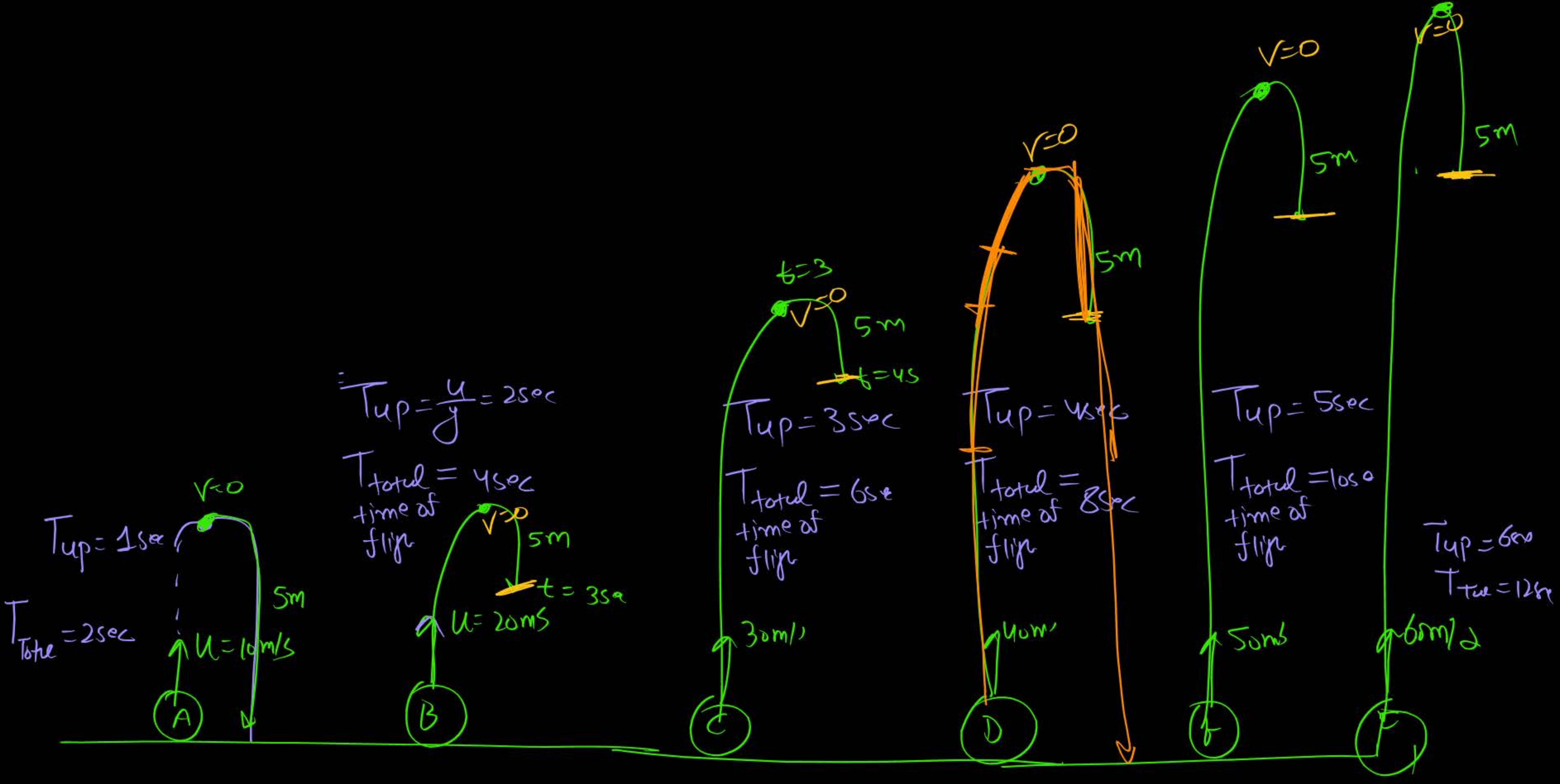


$$S_{6^{th}} = u + \frac{a}{2}(2n-1)$$

$$= 40 - \frac{10}{2}(2\times 6 - 1)$$

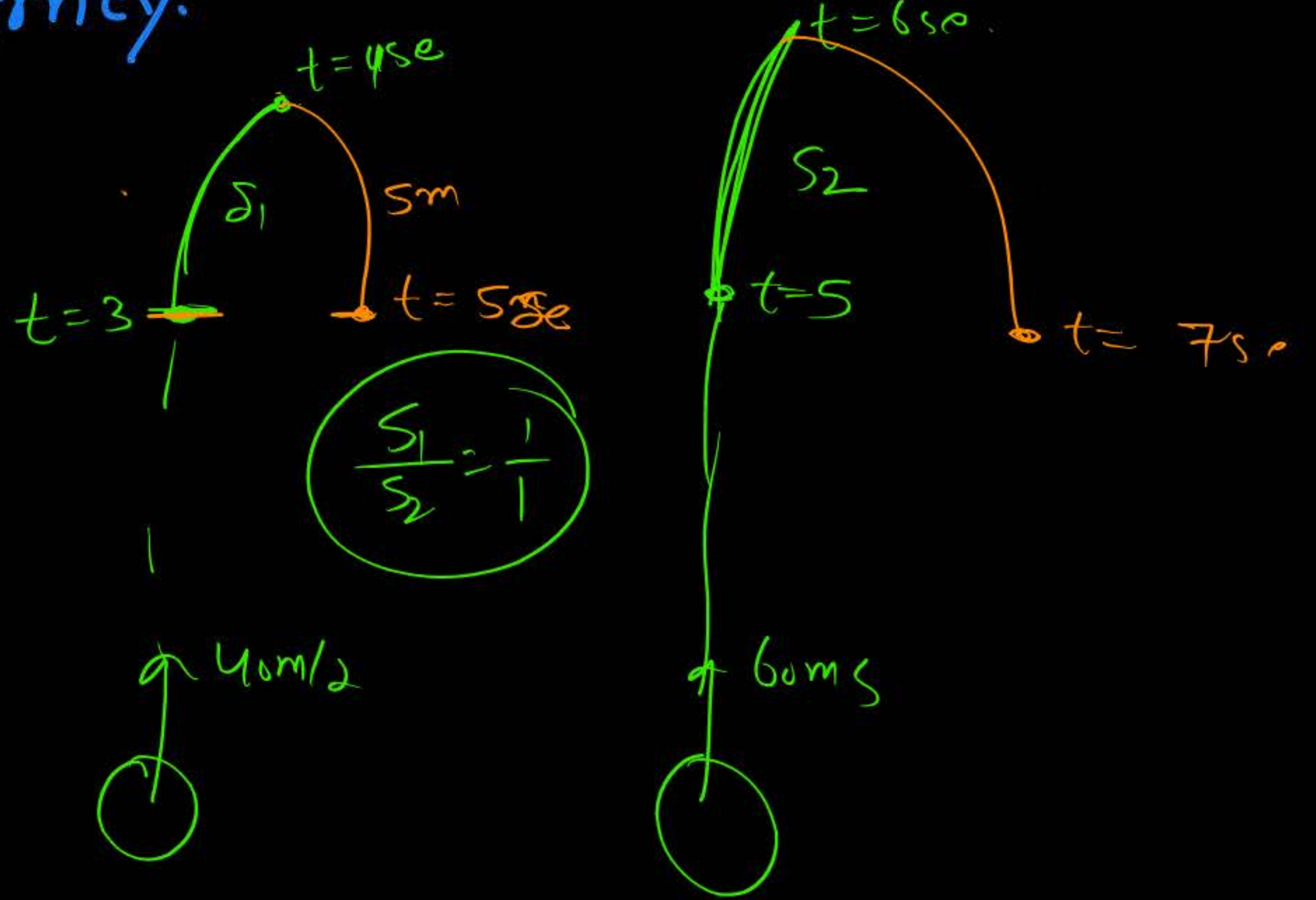
$$= 40 - 5(11)$$

$$= 40 - 55 = -15m$$



V=0
Tup = 1sec
5m
T Total = 2sec
U = 10m/s
A
Tup = u/g = 2sec
T total = 4sec
time of flight
V=0
5m
t = 3sec
U = 20mS
B
t=3
V=0
5m
t=4s
Tup = 3sec
T total = 6sec
time of flight
30m/s
C
V=0
5m
Tup = 4sec
T total = 8sec
time of flight
40m/s
D
V=0
5m
Tup = 5sec
T total = 10sec
time of flight
50m/s
V=0
5m
Tup = 6sec
60m/s

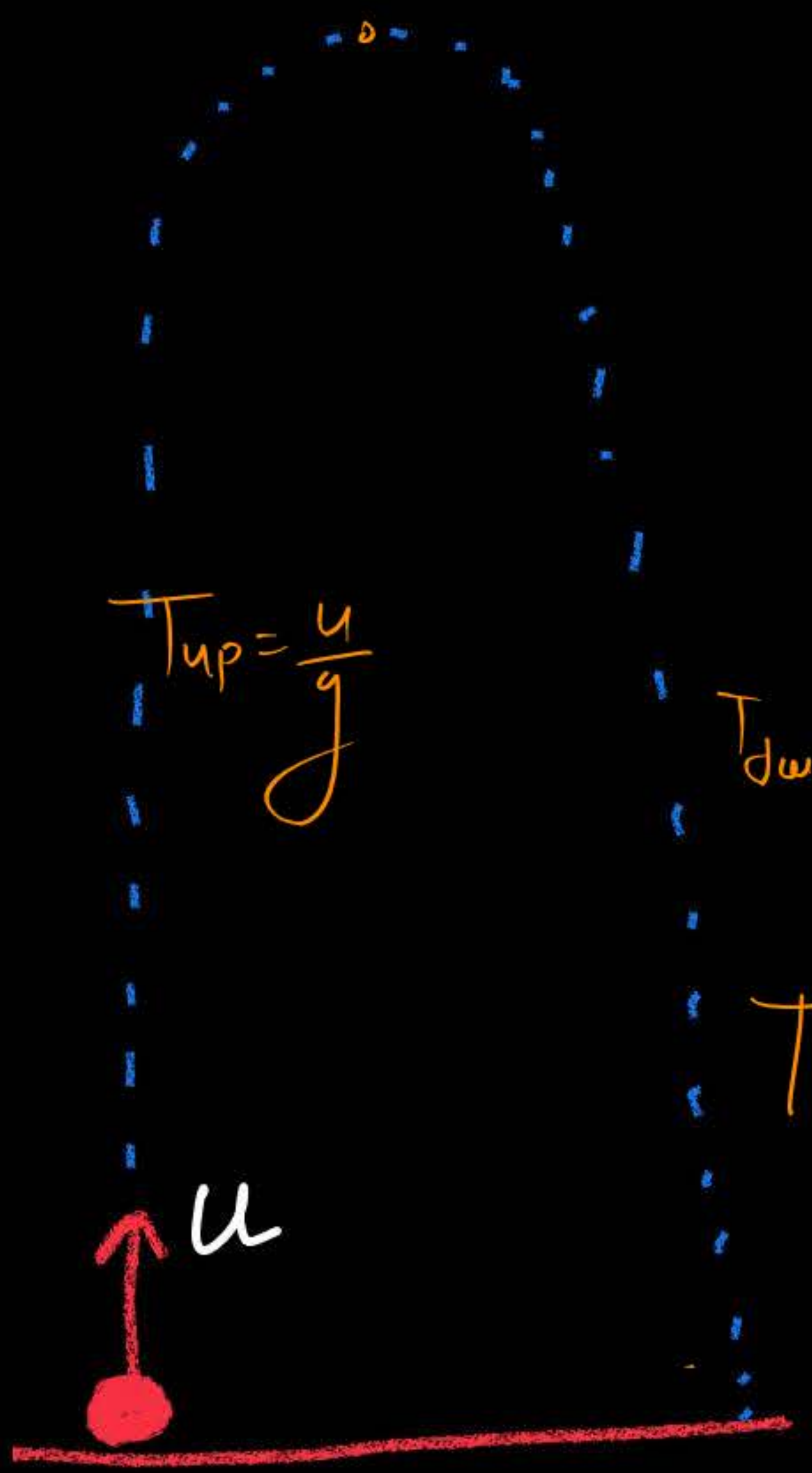
Object is Projected with 40m/s and 60m/s respectively then find ratio of distance in last-sec of upward Journey.



$\frac{S_1}{S_2} = \frac{1}{1}$

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Ground to Ground Motion under gravity



$T_{up} = \frac{u}{g}$

$T_{dw} = \frac{u}{g}$

$T_{t} = \frac{2u}{g}$

$H = \frac{u^2}{2g}$

Ball is droped from height 125m after 3sec it stoped and relesed at same instant Find Total time of flight.

H/W

Ball is Projected with speed 40 m/s then find

(i) H_{max} = 80m

(ii) T_f = 8sec

(iv) T_{upward} = 4sec

(v) speed after t = 5sec, 6sec (10m/s, 20m/s)

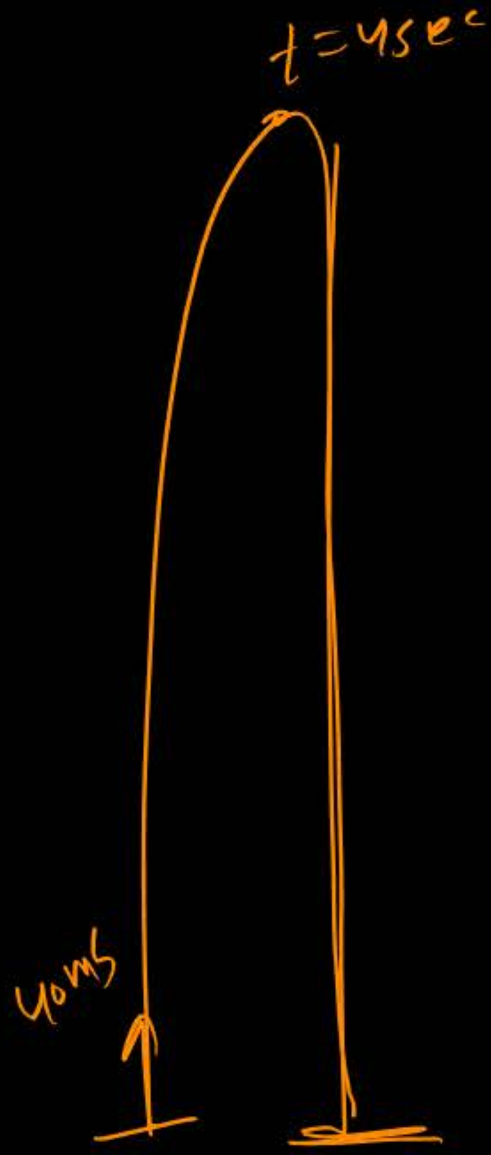
(vi) distance in 6 sec → 100m ✓

(vii) displacement in 6sec 60m

(viii) Avg speed in 7sec $\frac{125}{7}$

(ix) Avg velocity in 5sec → $\frac{75}{5}$

(x) distance moved in 8^{th} sec → 35m.



object is projected with 80m/s then find Avg. speed and velocity in 8-sec.

A Ball is droped and after 2sec other Ball is droped from same Point then Find distance b/w them after 4 sec from starting.

A Ball is thrown upward with speed 40 m/s then find Avg. velocity of upward Journey. and speed at half of the Maximum Height.

A Ball is thrown upward with u_0 if its velocity at half of Maximum Height is 20m/s then find it velocity u_0

A Body is droped and moved 80m in last 2-sec of Journey then find Height.

Ball is Projected up with 50 m/s then find distance moved in 8-sec

Ball is Projected up with 70m/s then find displacement in 10^{th} sec and 10 sec.

Ball is projected up its position at $t = 7s$ and $t = 11s$ is same then find velocity of projection and max^m Height.

object is Projected up with u its height at 3sec and 13 sec is same find u and that Height.

Ball is Projected up its distance travelled in 3^{rd} sec and 8^{th} sec is same then find max^m height

Ball is projected up with 55 m/s then find distance in 6^{th} sec.

If air resistance is not ignored *

QUESTION

A ball is dropped from a high rise platform at $t = 0$ starting from rest. After 6 seconds another ball is thrown downwards from the same platform with a speed v. The two balls meet at $t = 18$ s. What is the value of v ? (Take $g = 10\ m/s^2$)

[2010]

1. 75 m/s
2. 55 m/s
3. 40 m/s
4. 60 m/s

QUESTION

If a ball is thrown vertically upwards with speed u, the distance covered during the last t seconds of its ascent is [2003]

1. ut
2. $\frac{1}{2}gt^2$
3. $ut - \frac{1}{2}gt^2$
4. $(u + gt)t$


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 10 | **Physics**

Motion In a Straight Line



By- Dr. Manish Raj (MR SIR)

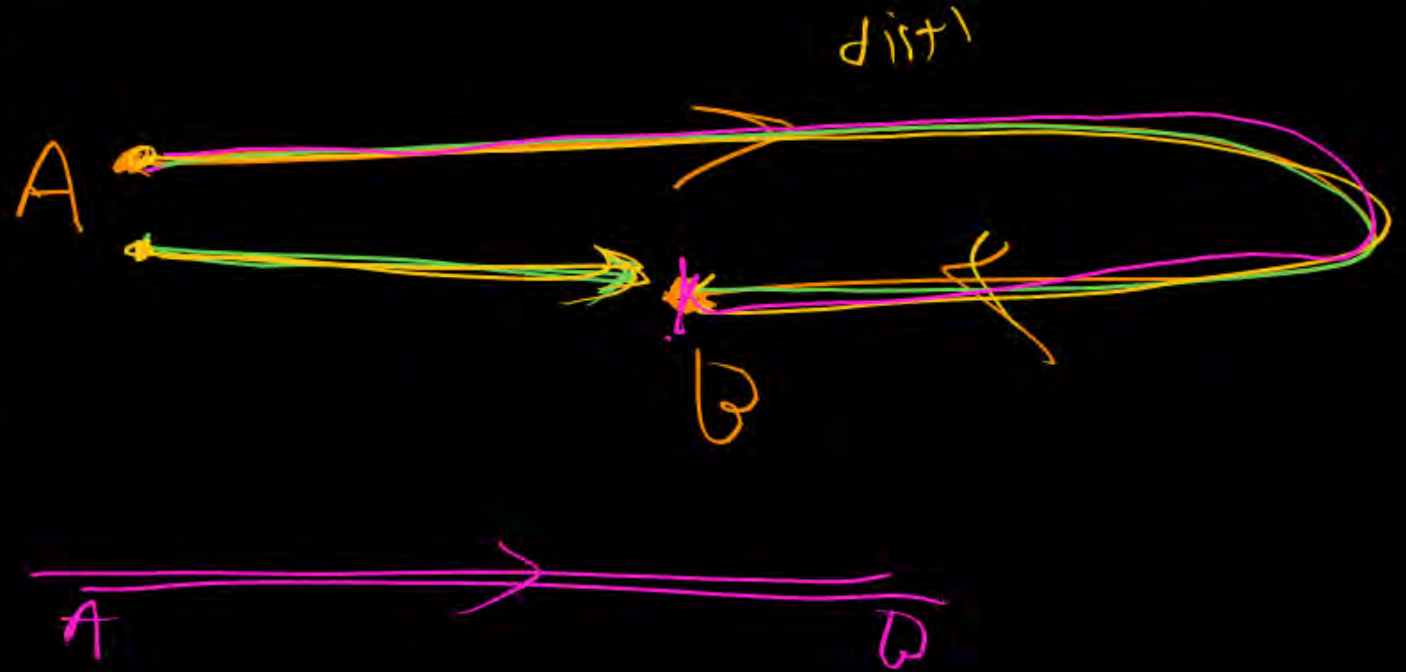
Todays Goal

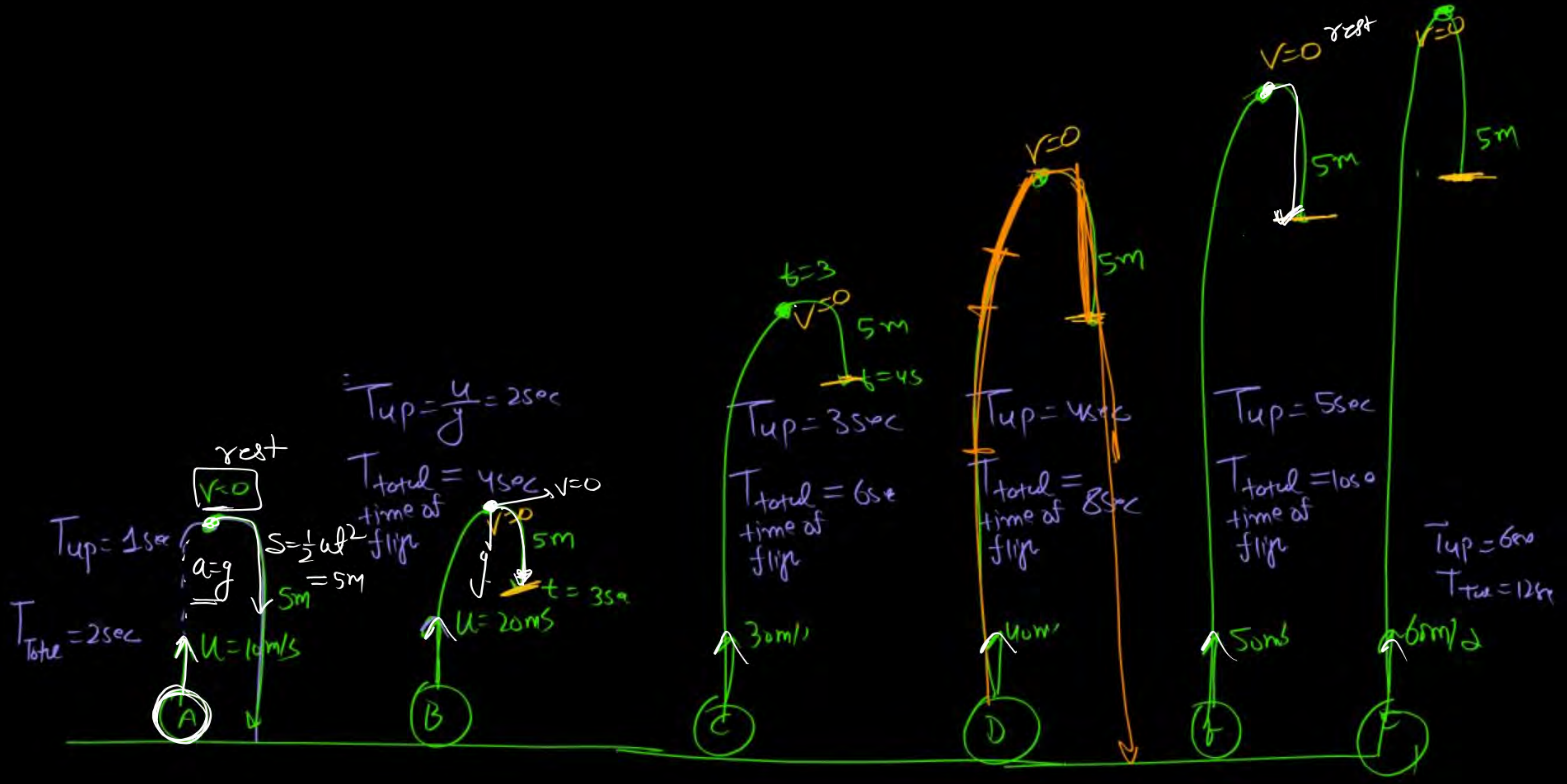
Post PhD on motion under gravity

distance x disp^{m}

shown

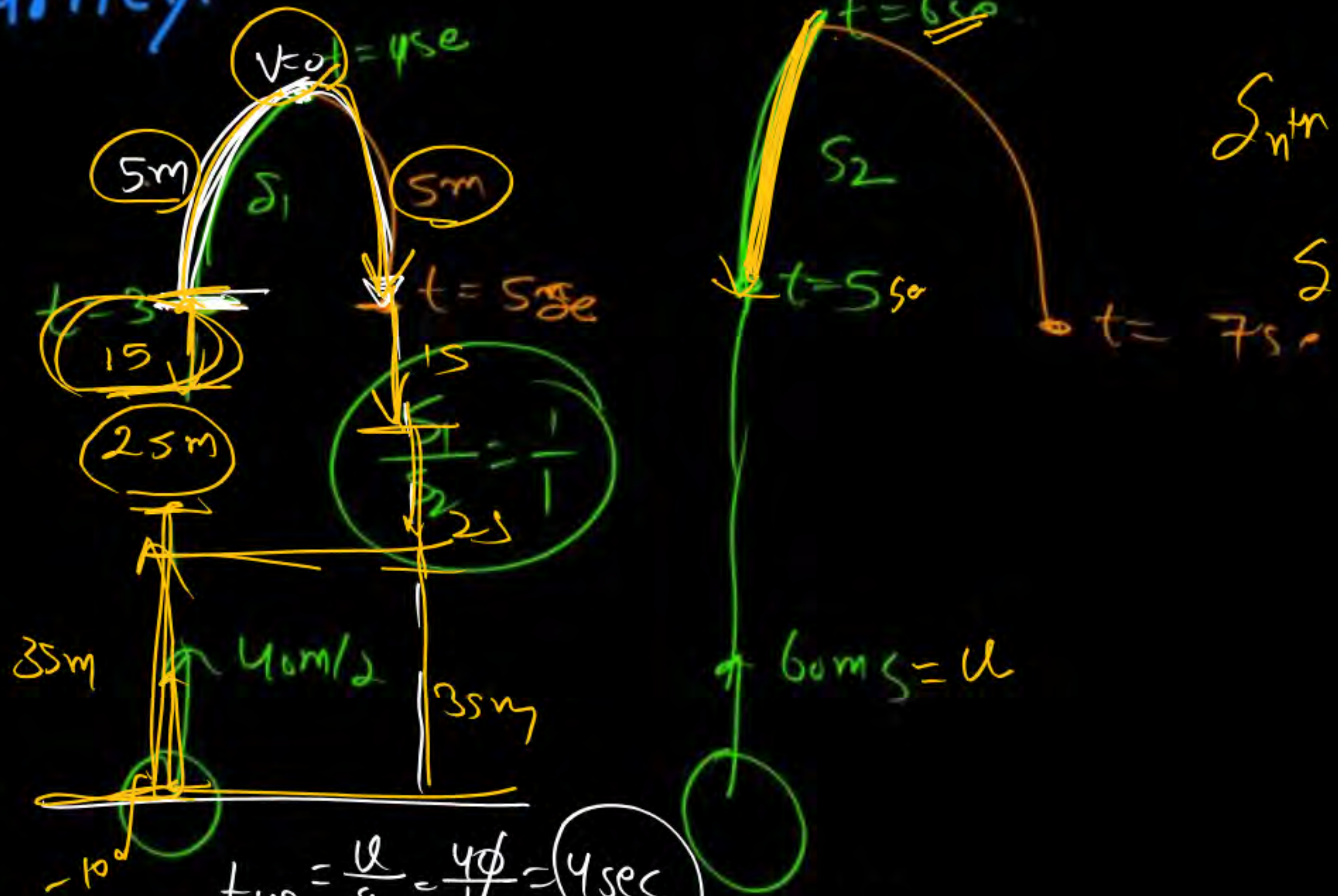






rest
V=0
Tup = 1sec
a=g
S=1/2 ut^2
=5m
5m
Ttotal =2sec
U=10m/s
A
Tup = u/g = 2sec
Ttotal = 4sec
time of flight
V=0
5m
t = 3sec
U=20m/s
B
t=3
V=0
5m
t=4s
Tup = 3sec
Ttotal = 6sec
time of flight
30m/s
C
V=0
5m
Tup = 4sec
Ttotal = 8sec
time of flight
40m/s
D
V=0
rest
5m
Tup = 5sec
Ttotal = 10sec
time of flight
50m/s
V=0
5m
Tup = 6sec
Ttotal = 12sec
60m/s

Object is projected with 40 m/s and 60 m/s respectively then find ratio of distance in last-sec of upward journey.



$S_{n^{th}} = u + \frac{a}{2}(2n-1)$

$S_{6^{th}} = 60 - 5(11)$

$= 60 - 55 = 5\,m$

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$t_{up} = \frac{u}{g} = \frac{40}{10} = 4\,sec$

3 to 4 sec

$S_{4^{th}} = u + \frac{a}{2}(2n-1) = 40 - 5(7) = 40 - 35 = 5\,m$

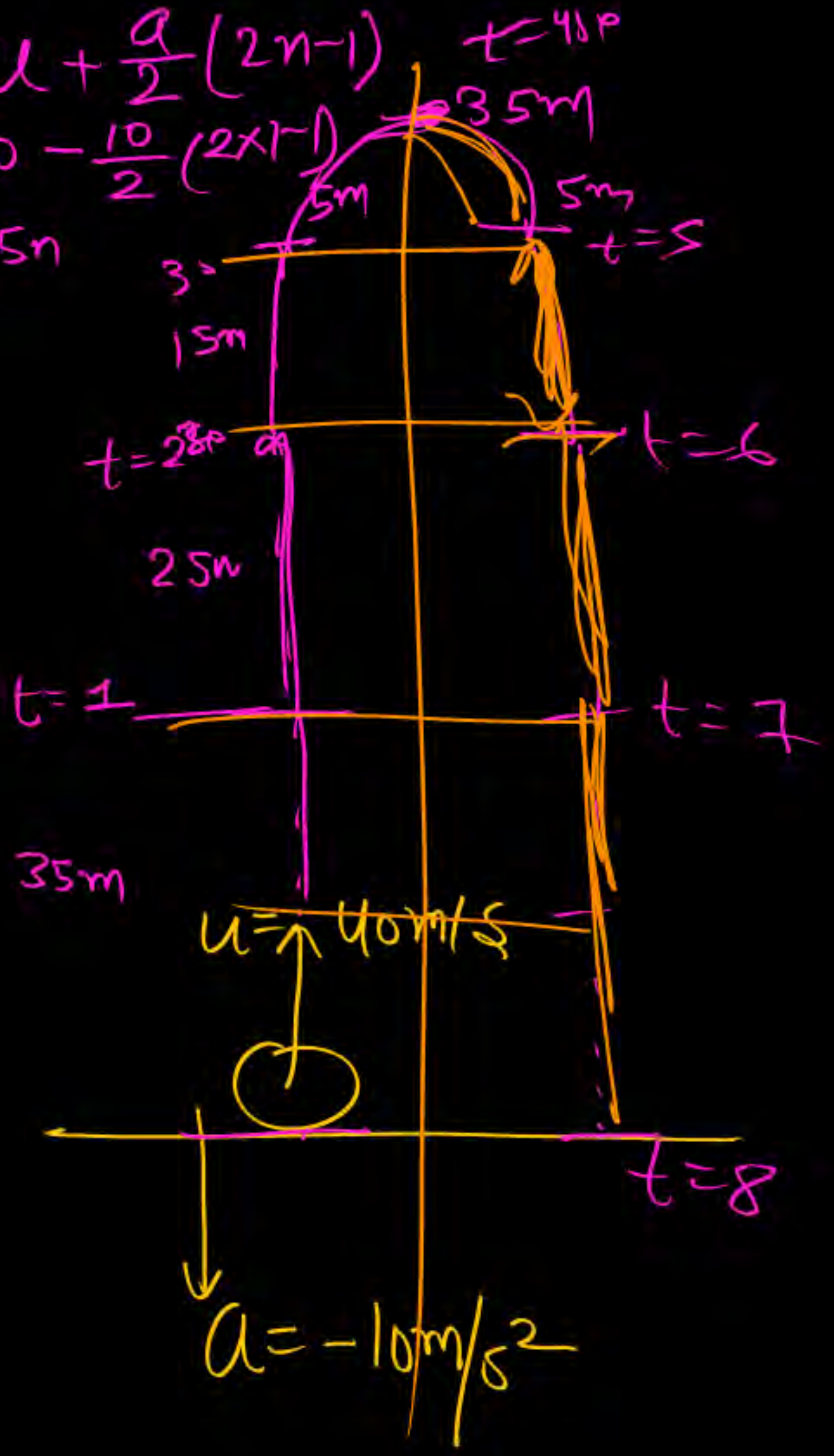
$S_{1st} = u + \frac{a}{2}(2n-1)$

$= 40 - \frac{10}{2}(2\times1-1)$

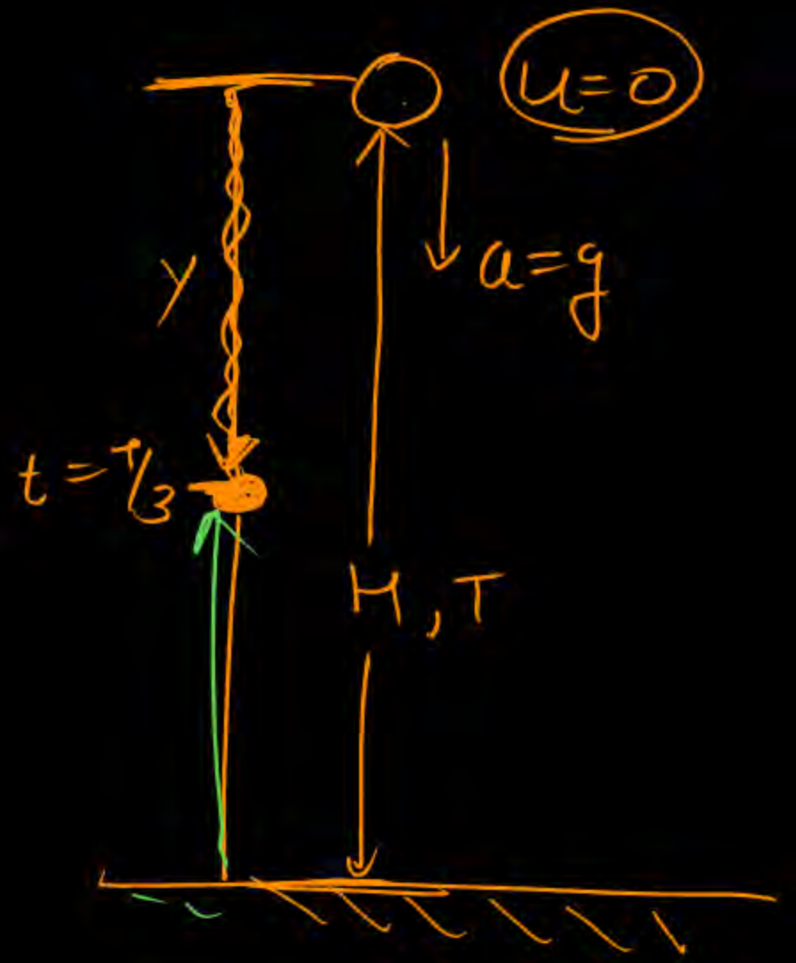
$S_{2nd} = 25m$

$S_{3rd} =$

$S_{4th} =$



Ball is dropped from height H and takes T time (to reach ground), find Position of ball from Ground after T/3 time.



$$s = ut + \frac{1}{2}at^2$$

$$H = \frac{1}{2}gT^2$$

$$T = \sqrt{\frac{2H}{g}}$$

$$y = \frac{1}{2}g\left(\frac{T}{3}\right)^2 = \frac{\frac{1}{2}gT^2}{9} = \frac{H}{9}$$

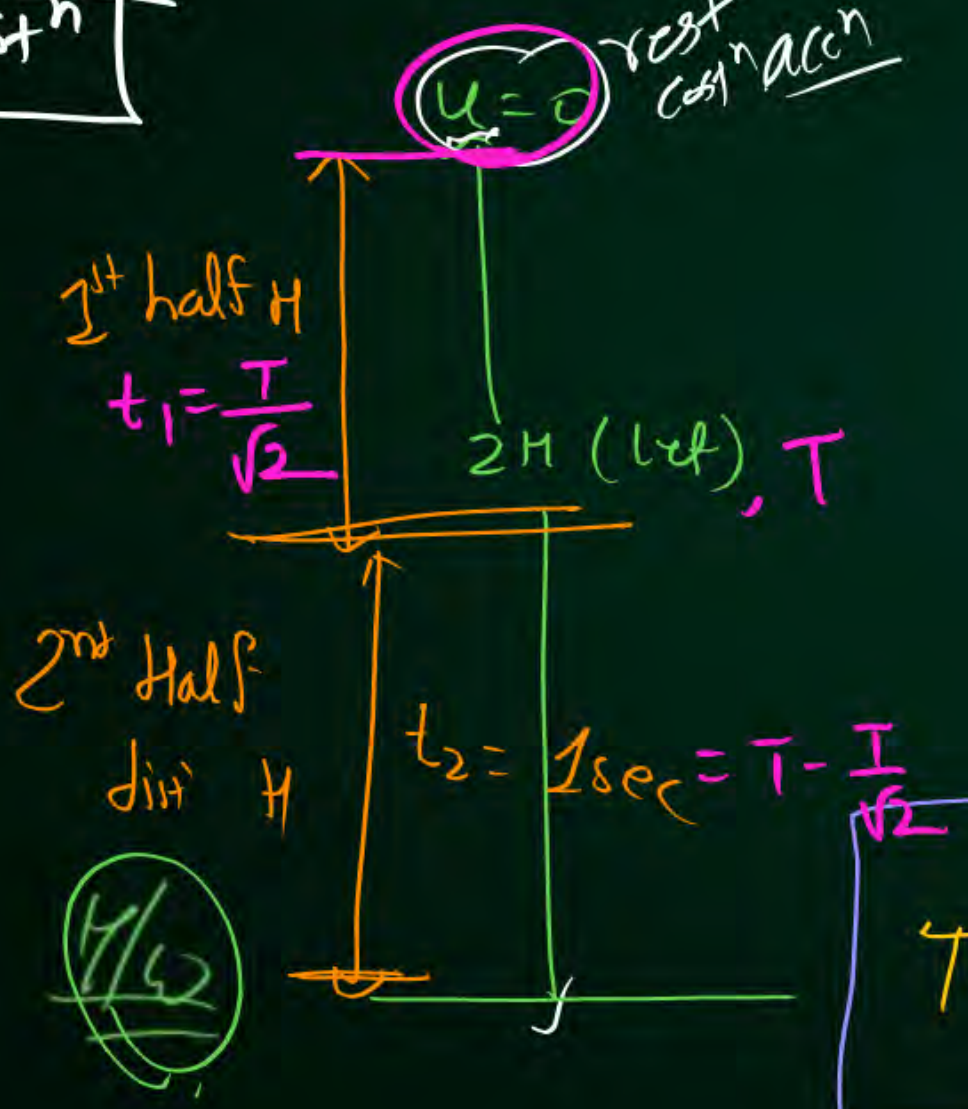
$$\text{Pos}^n \text{ from grnd} = H - \frac{H}{9} = \frac{8H}{9}\ m$$

QUESTION

IIT JEE 1-Page

Object is dropped then it moves 2^{nd} half distance in last 1 sec of motion then find time of flight.

rest & const^n acc^n → drop



$$T = \frac{\sqrt{2}}{\sqrt{2}-1} = (2+\sqrt{2})$$

Let T = Compt time of flight

The imp*

$$t_2 = T - \frac{T}{\sqrt{2}}$$

$$1 = T\left(1 - \frac{1}{\sqrt{2}}\right)$$

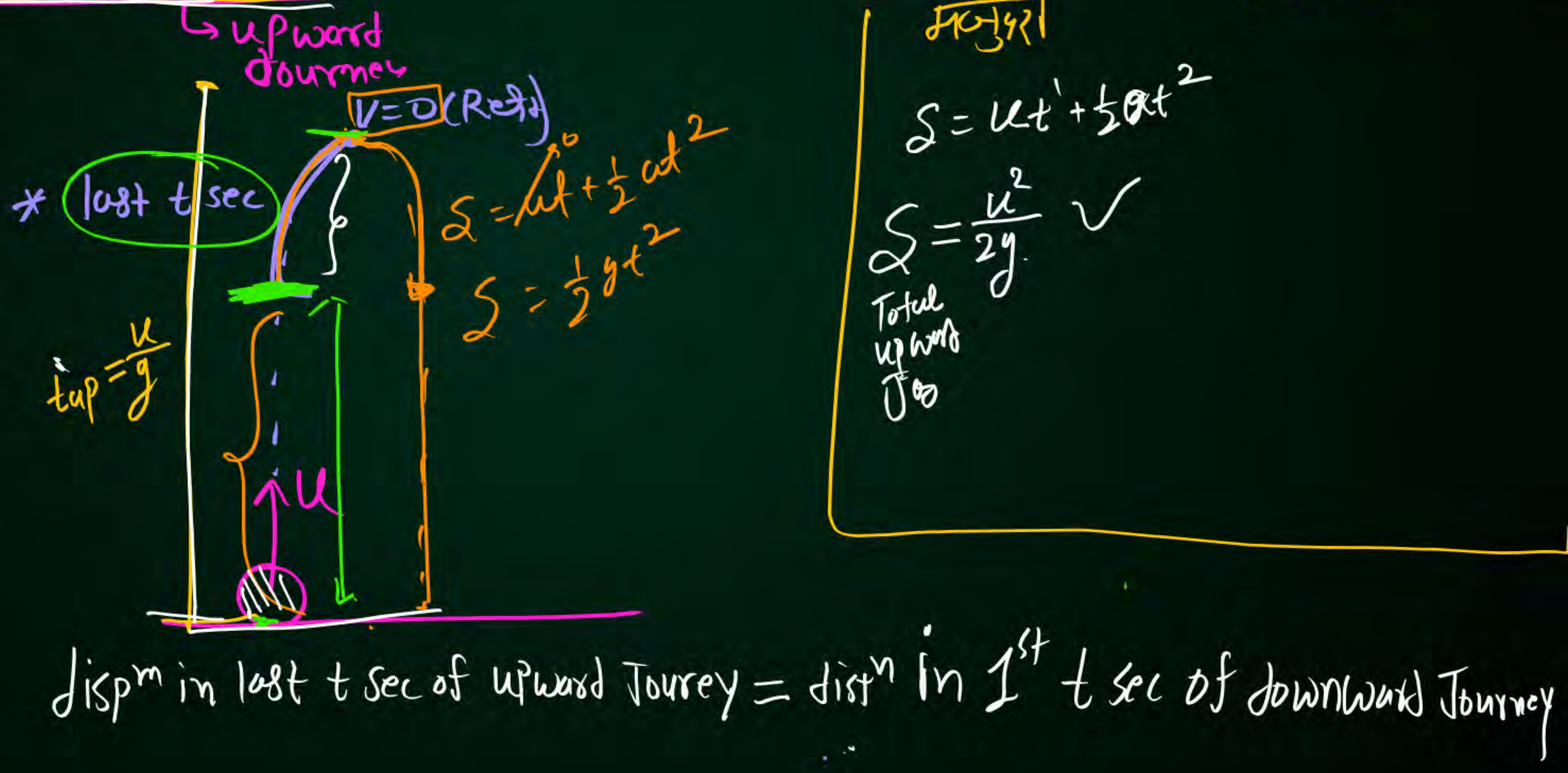
$$1 = T\left(\frac{\sqrt{2}-1}{\sqrt{2}}\right)$$

$$T = \frac{\sqrt{2}}{\sqrt{2}-1} \times \left(\frac{\sqrt{2}+1}{\sqrt{2}+1}\right) = \frac{2+\sqrt{2}}{1} = (2+\sqrt{2})$$

QUESTION

If a ball is thrown vertically upwards with speed u, the distance covered during the last t seconds of its ascent is [2003]

1. ut
2. $\frac{1}{2}gt^2$
3. $ut - \frac{1}{2}gt^2$
4. $(u + gt)t$



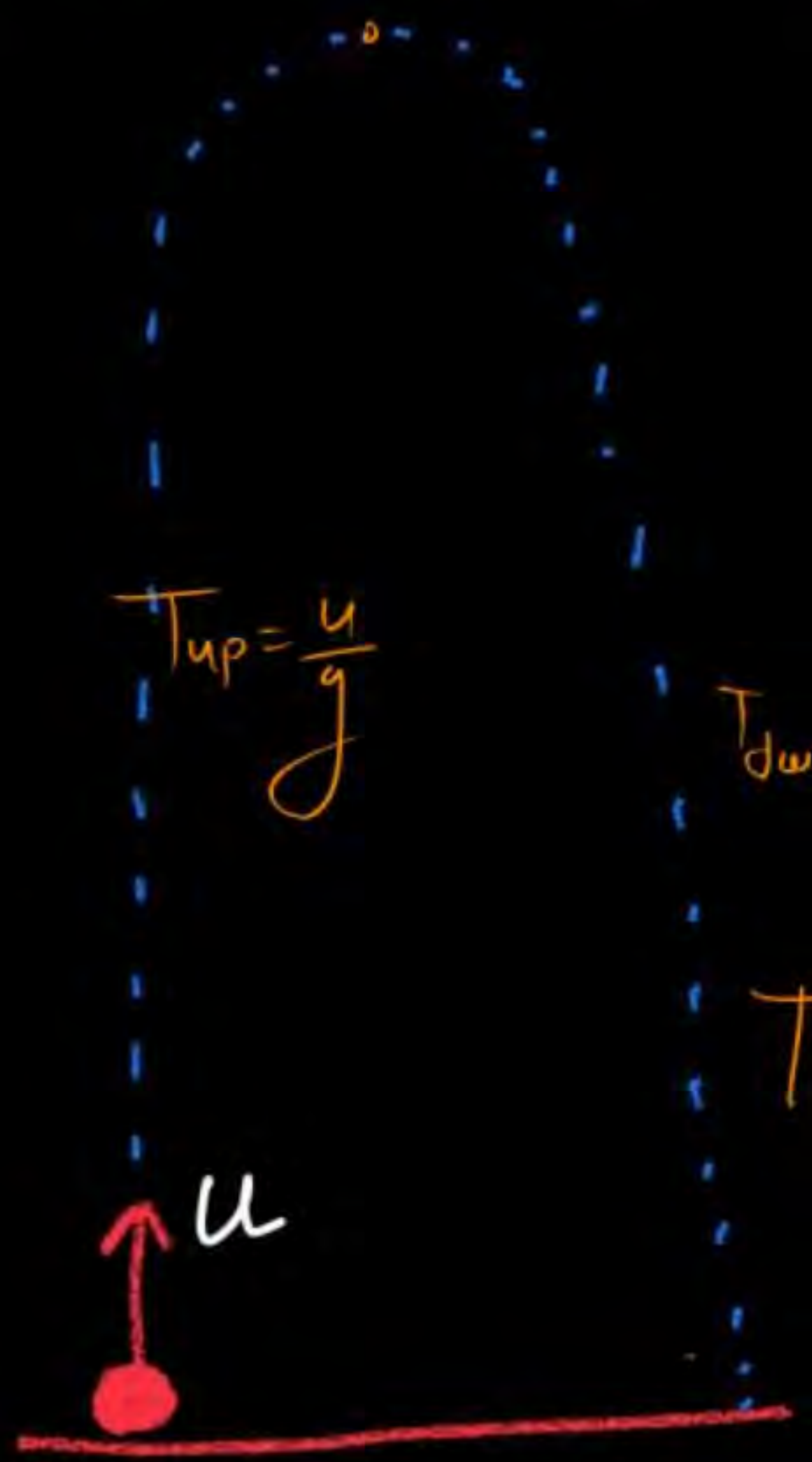
$$S = ut + \frac{1}{2}at^2$$

$$h = u\left(\frac{u}{g} - t\right) - \frac{g}{2}\left(\frac{u}{g} - t\right)^2 \checkmark$$

disp^m in time $t' = \left(\frac{u}{g} - t\right)$

disp^m in last t sec $= \frac{u^2}{2g} - h = \frac{1}{2}gt^2$

Ground to Ground Motion under gravity



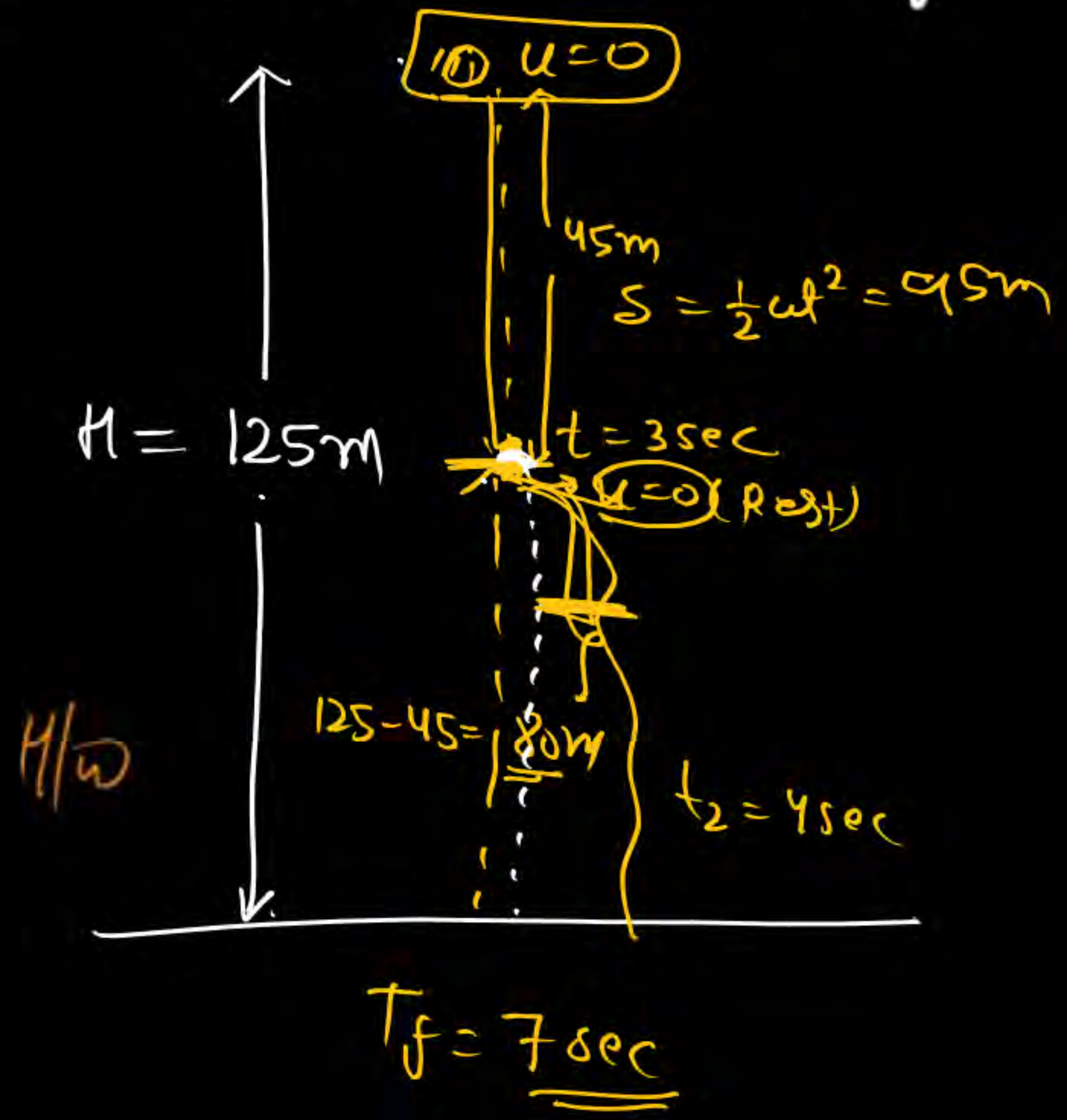
$T_{up} = \frac{u}{g}$

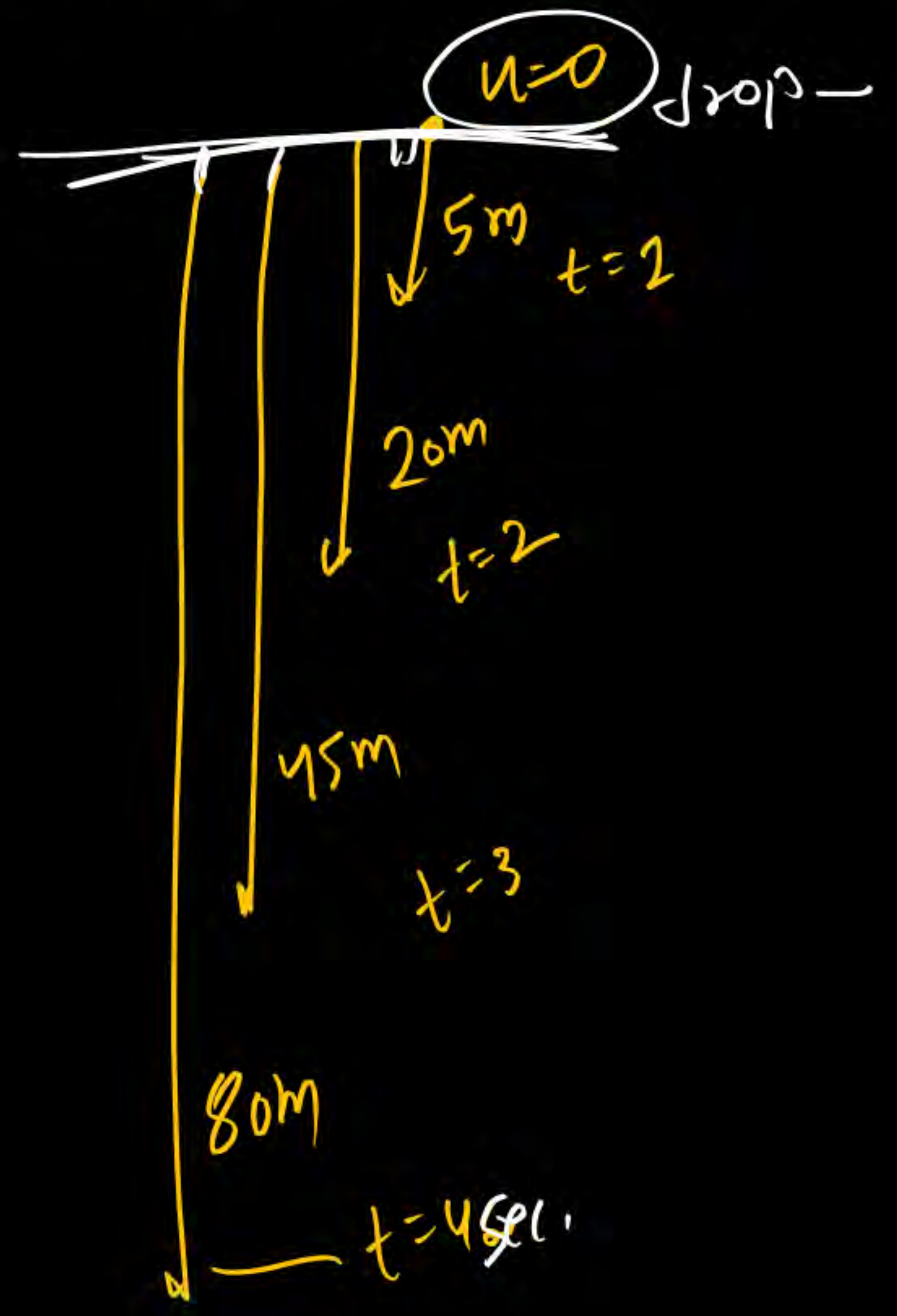
$T_{dw} = \frac{u}{g}$

$T_{tc} = \frac{2u}{g}$

$H_h = \frac{u^2}{2g}$

Ball is droped from height 125m after 3sec it stoped and relesed at same instant Find Total time of flight.





Ball is Projected up with 80 m/s then find distance travelled in last sec of Journey.

(a) 5m — 62% चोर हैं। गदहे हैं।

(b) 35 m

(c) 45 m

(d) 80 m.

(e) 75 m ✓

$t_{up} = \frac{u}{g} = \frac{80}{10} = 8\,sec$

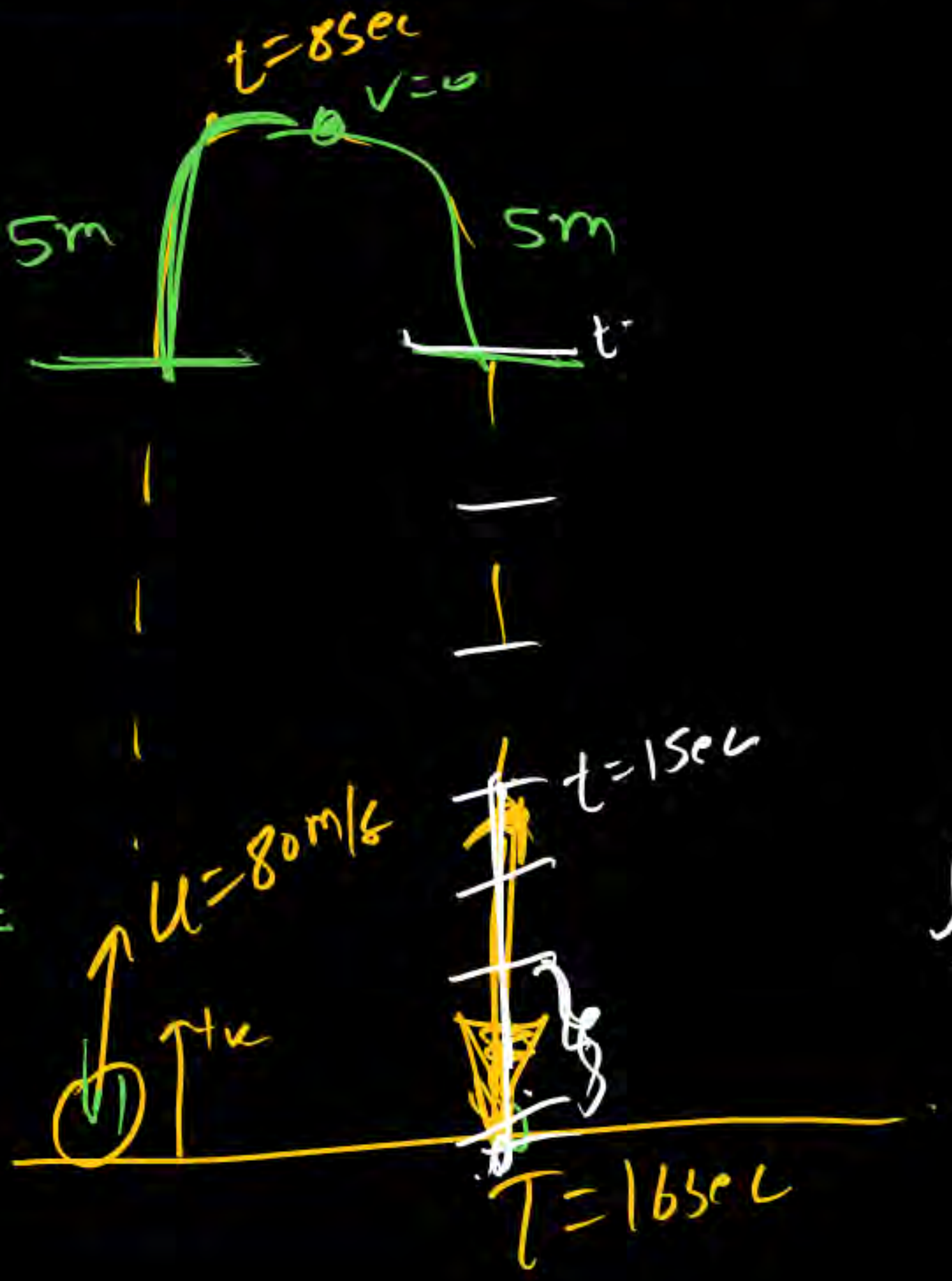
$n = 16$

$S_{n^{th}} = u + \frac{a}{2}(2n-1)$

$= 80 - \frac{10}{2}(31)$

$= 80 - 155$

$= -75\,m$



$T = \frac{2u}{g} = \frac{2 \times 80}{10}$

$= 16\,sec$

last sec 16th sec.

Ball is Projected with speed 40 m/s then find

(i) $H_{max} = 80m$ ✓

(ii) $T_f = 8 sec$ ✓ $\quad T_f = \frac{2u}{g} = \frac{2 \times 40}{10} = 8 sec$

(iv) $T_{upward} = 4 sec$ ✓

(v) speed after t = 5 sec, 6 sec (10 m/s, 20 m/s)

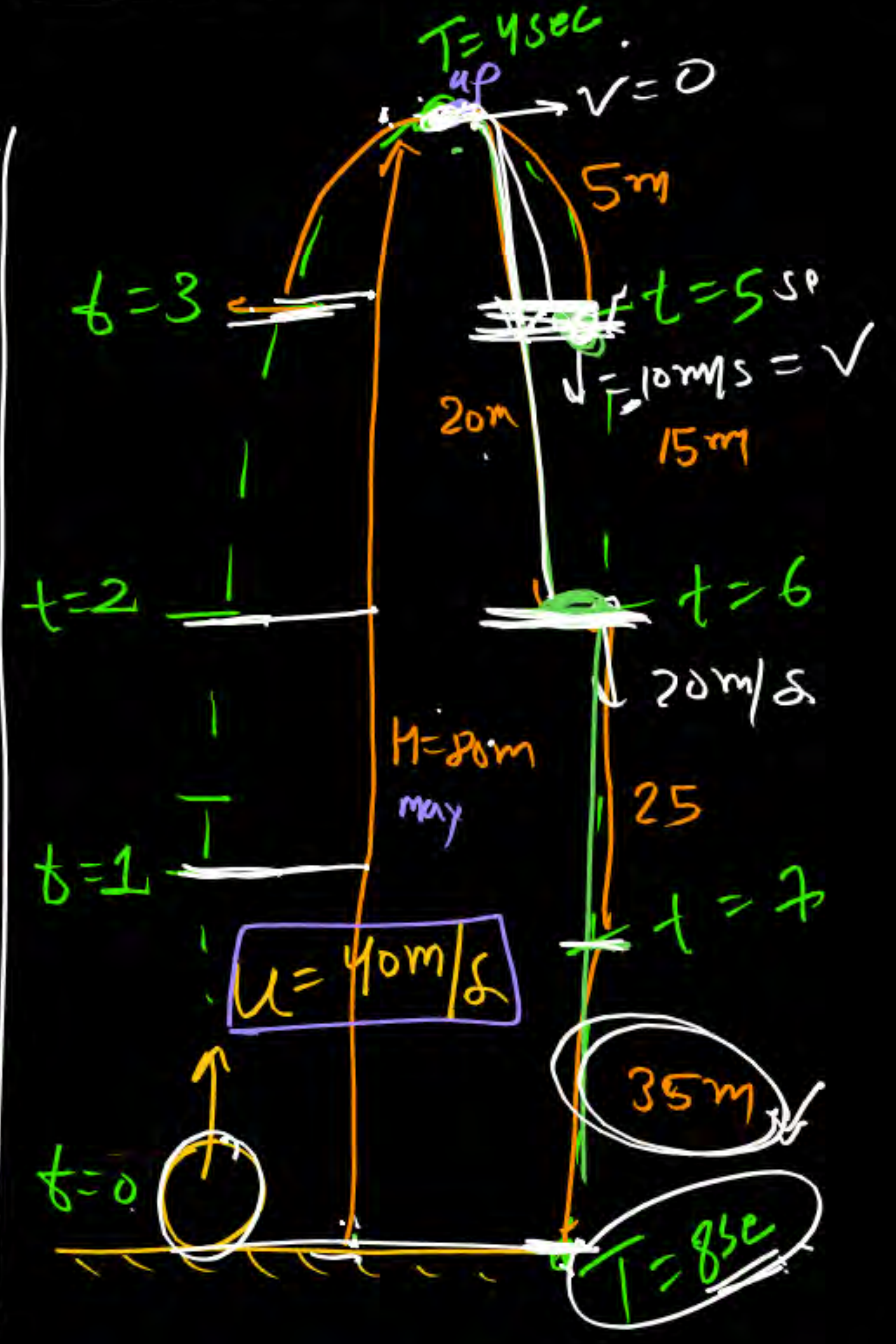
(vi) distance in 6 sec → 100 m ✓

(vii) displacement in 6 sec 60 m ✓

(viii) Avg speed in 7 sec = $\frac{125}{7}$ = $\frac{\text{total dis.}}{\text{time}}$

(ix) Avg velocity in 5 sec → $\frac{75}{5}$ = $\frac{\text{disp}}{\text{time}}$

(x) distance moved in 8^{th} sec. → 35 m



$$H_{max} = \frac{u^2}{2g} = \frac{40 \times 40}{2 \times 10} = 40 \times 2 = 80m$$

$$S_{n^{th}} = u + \frac{a}{2}(2n-1) = 40 - \frac{10}{2}(2 \times 8 - 1) = 40 - 75 = 35m$$

object is projected with 80m/s then find Avg. speed and velocity in 8-sec.



$t_{up} = 8 sec = \frac{u}{g} = \frac{80}{10} = 8 sec$

$$\text{Avg speed} = \text{Avg velocity} = \frac{\text{total disp}^n}{T} = \frac{\frac{u^2}{2g}}{2 \times \frac{u}{g}} = \frac{u}{2} = \frac{80}{2} = 40 m/s$$

$MP^{\times}$

$$\vec{v}_{Avg} = \frac{\vec{u}_i + \vec{v}_f}{2}$$

$a = g = const^n$

A Ball is thrown upward with speed 40m/s then find Avg. velocity of upward Journey. and speed at half of the Maximum Height.

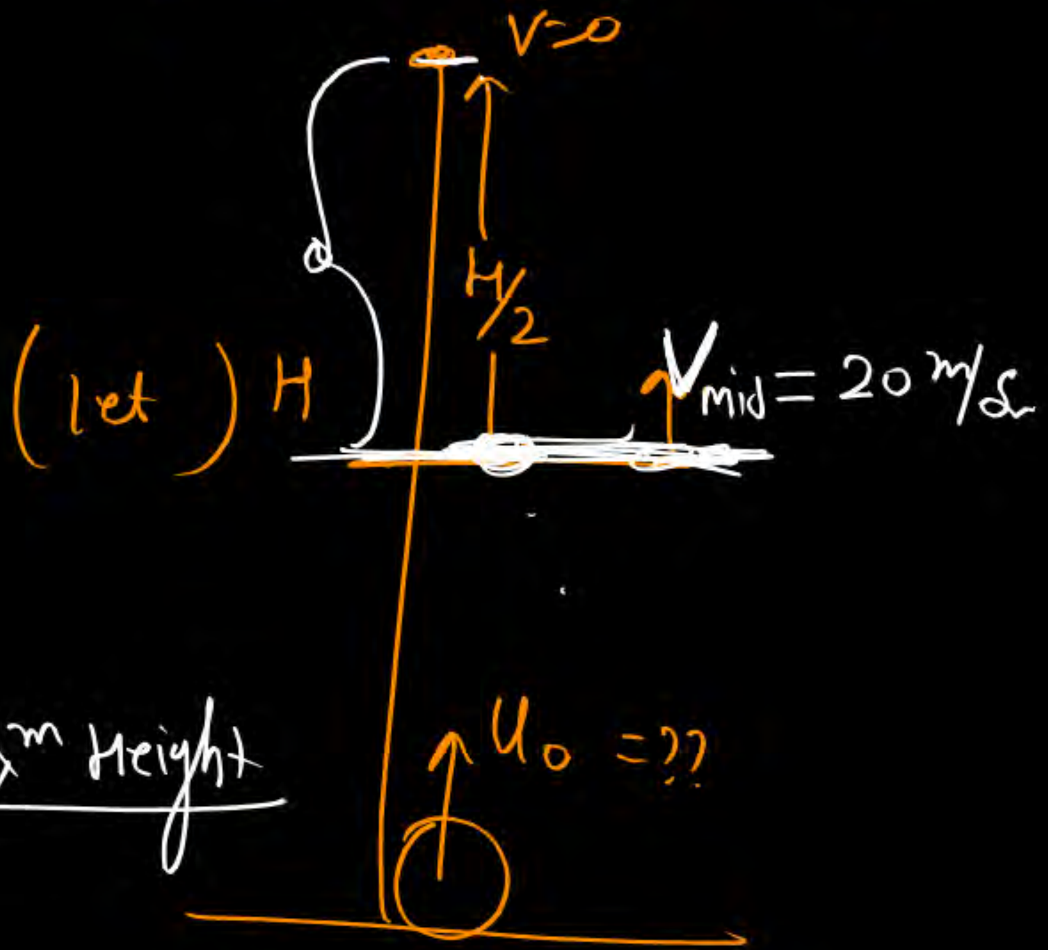
$$U_{mid} = \sqrt{\frac{u_i^2 + v_f^2}{2}} \quad *$$

$$[\text{Avg velocity}]_{\text{upward}} = \frac{40+0}{2} = 20\,m/s$$

$$U_{mid} = \sqrt{\frac{u^2 + v_f^2}{2}}$$

$$= \sqrt{\frac{(40)^2 + 0}{2}} = \frac{40}{\sqrt{2}} = 20\sqrt{2}$$

A Ball is thrown upward with u_0 if its velocity at half of Maximum Height is 20 m/s then find it velocity u_0



also

Find max^m Height

$$\frac{400}{10} = \frac{(20)^2}{2 \times g} = \frac{H}{2}$$

$$\boxed{H = 40\,m}$$

$$u_{mid} = \sqrt{\frac{u^2 + v^2}{2}}$$

$$20 = \sqrt{\frac{u_0^2 + 0}{2}}$$

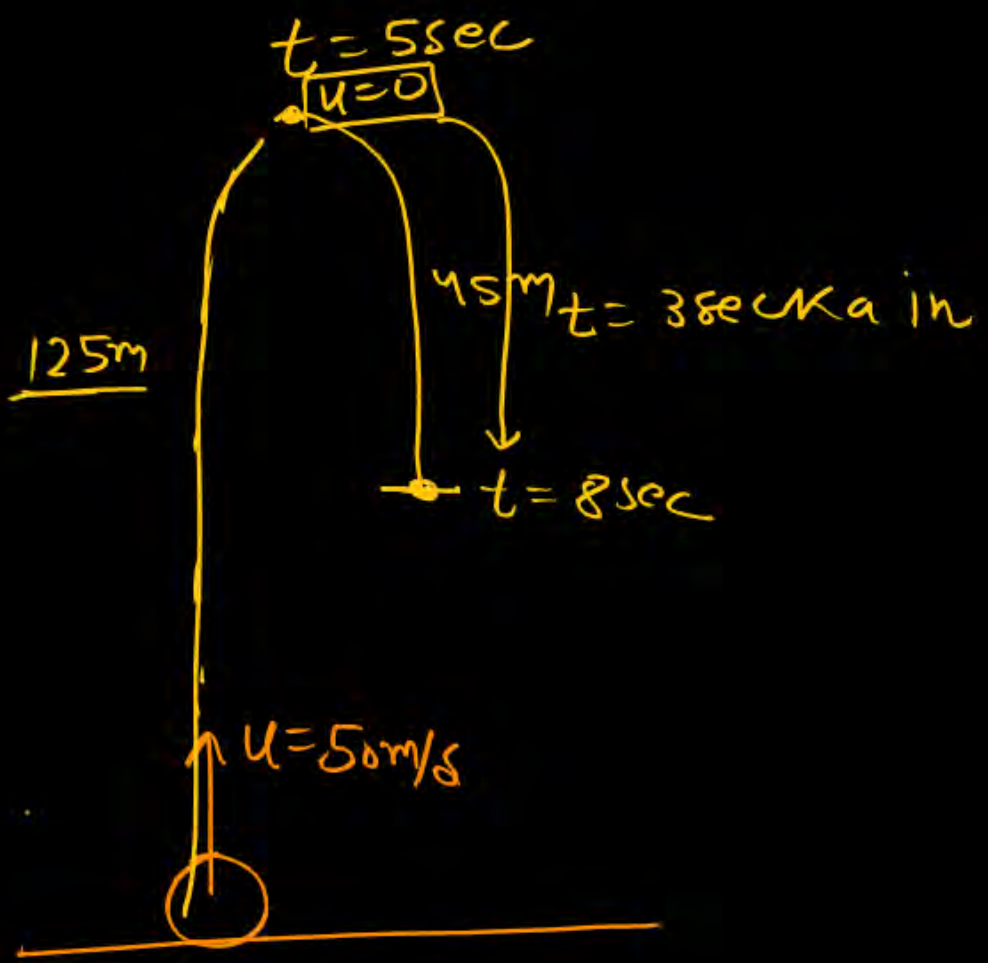
$$400 = \frac{u_0^2}{2}$$

$$\sqrt{800} = u_0$$

$$u_0 = 20\sqrt{2}$$

Ball is Projected up with 50m/s then find distance moved in 8-sec

Sol



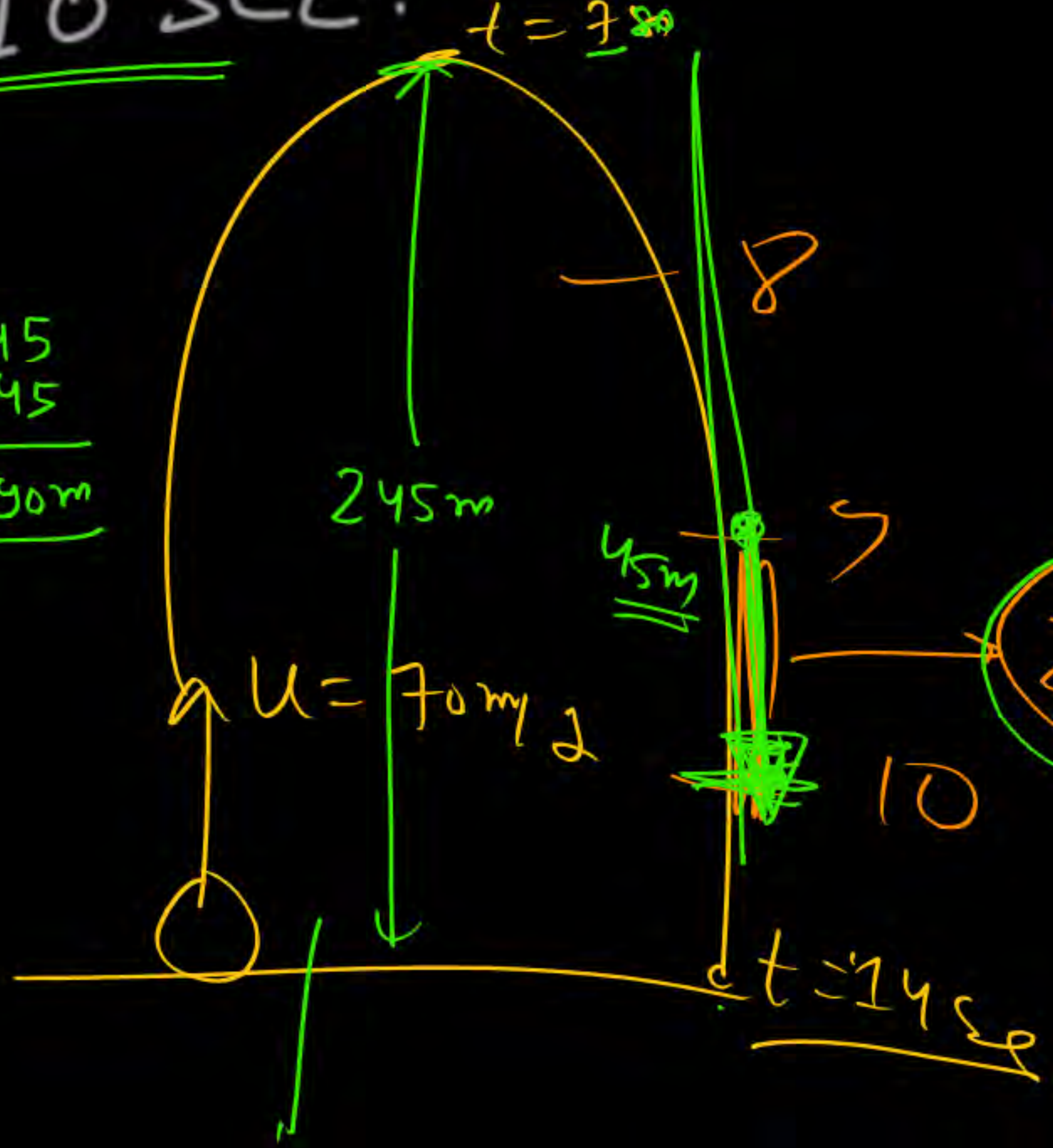
125
45

S = 170 m

Ball is Projected up with 70m/s then find displacement in 10th sec and 10 sec.

distⁿ in 10 sec = 245
45

dispⁿ = 290m



25m

Ans

$S = ut + \frac{1}{2}at^2$

dispⁿ $= 70 \times 10 - \frac{1}{2} \times 10 (10)^2$

$= 700 - 500$

$= 200m$

मजबूरी

$S_{n^{th}} = u + \frac{a}{2}(2n-1)$

$= 70 - \frac{10}{2}(2 \times 10 - 1)$

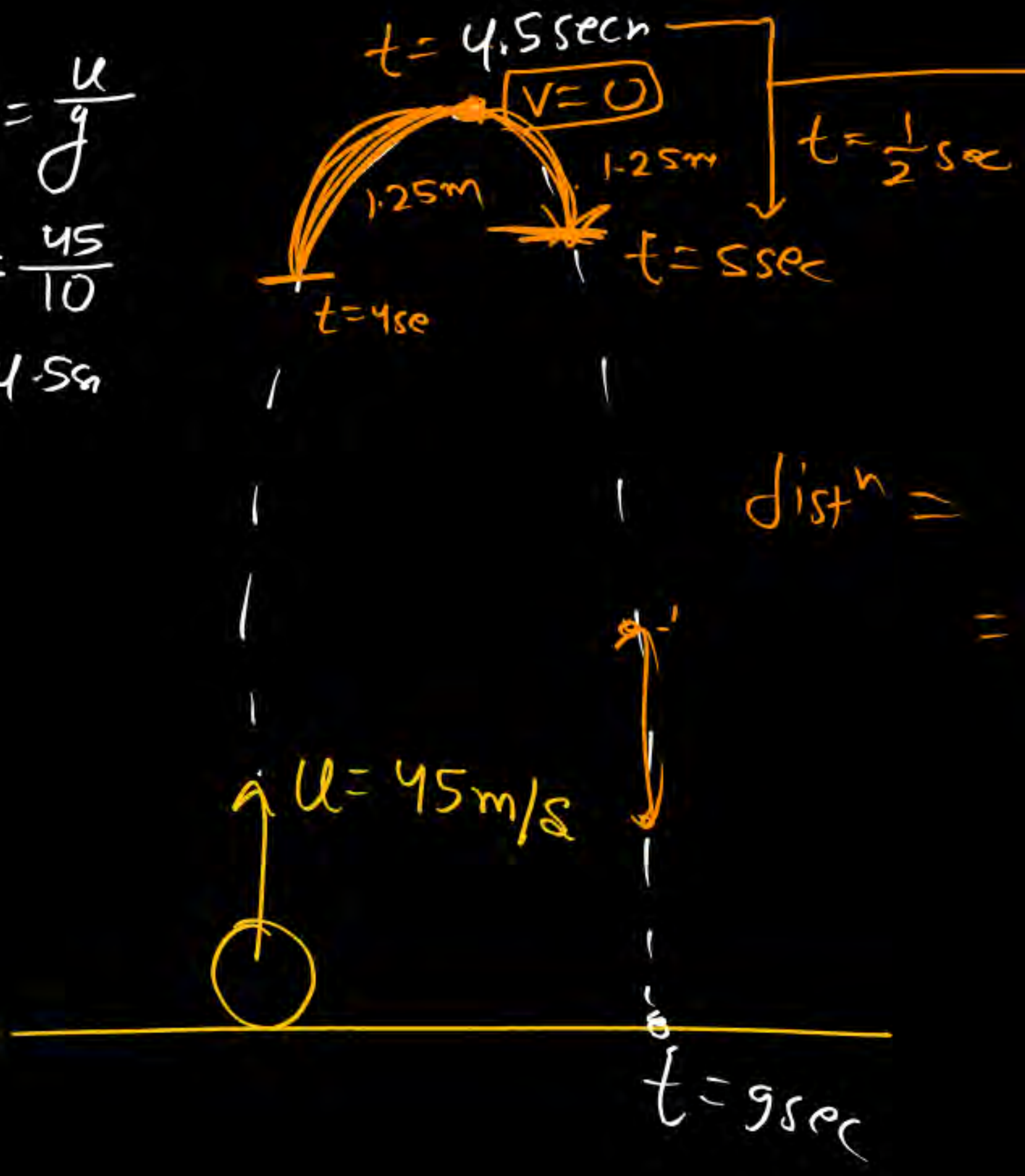
$= 70 - 5 \times (19)$

$= 70 - 95$

$= -25m$

Ball is Project up with 45 m/s then find dist^n moved in 5th sec.

$t_{up} = \frac{u}{g} = \frac{45}{10} = 4.5\,s$



$s = \frac{1}{2}at^2 + ut$ (with $ut = 0$)

$= \frac{1}{2}\,10\left(\frac{1}{2}\right)^2$

$= \frac{5}{4} = 1.25\,m$

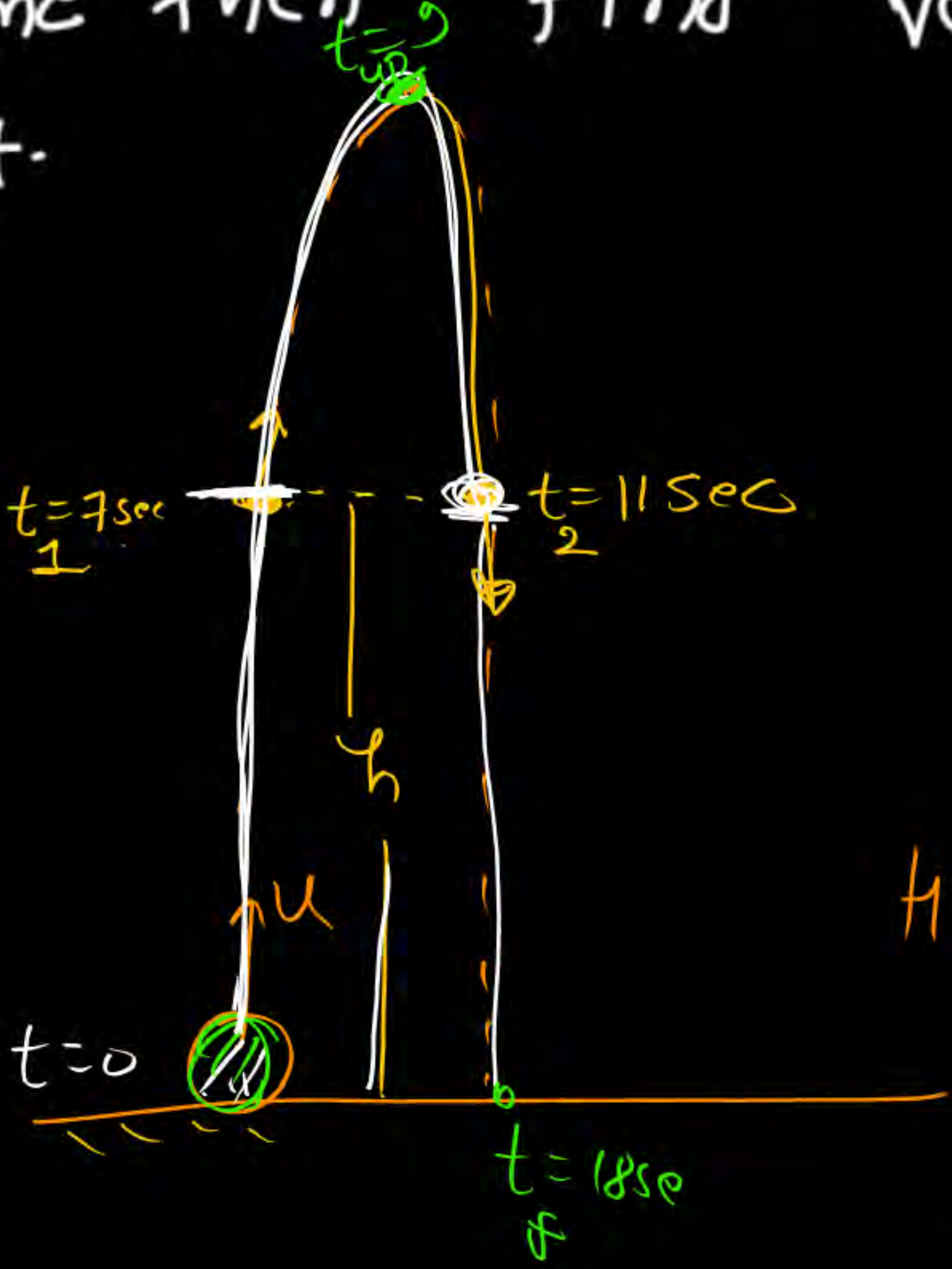
dist^n = 1.25 + 1.25

= **2.5 m**

disp^m in 5th sec = 0

5th sec is an interval of one sec from 4 sec to 5 sec

Ball is projected up its position at t = 7s and t = 11s is same then find velocity of projection and max^m Height.



$t_1 + t_2 = T_f$

$t_1 + t_2 = \frac{2u}{g}$

$18 = \frac{2u}{g}$

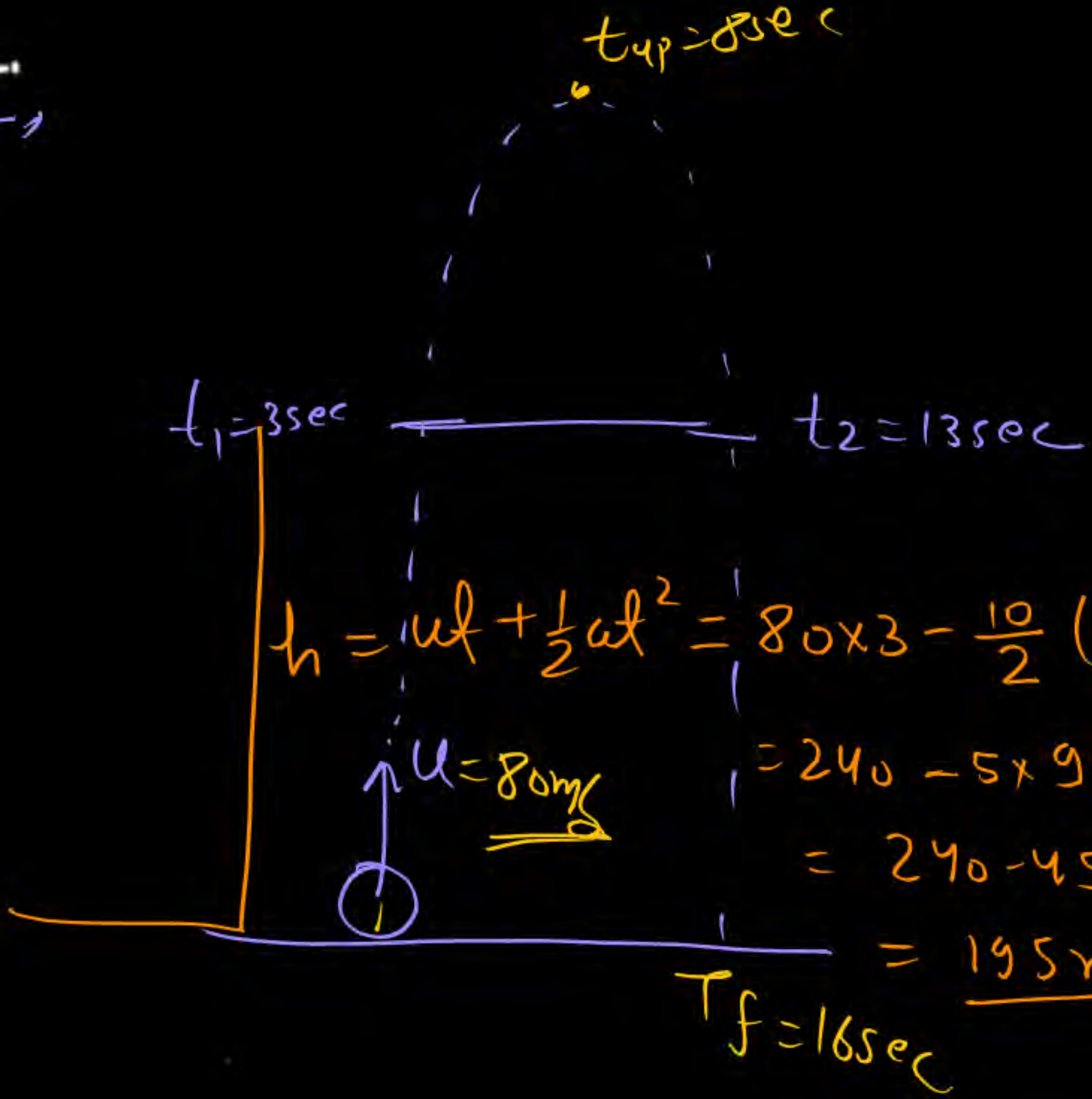
$u = 9 \times 10 = 90\,m/s$

$H = \frac{90 \times 90}{2 \times 10}$

$= 45 \times 9$

$= 405\,m$

Object is projected up with u, its height at 3 sec and 13 sec is same, then find u and that Height.



$$h = ut + \frac{1}{2}at^2 = 80 \times 3 - \frac{10}{2}(3)^2$$

$$= 240 - 5 \times 9$$

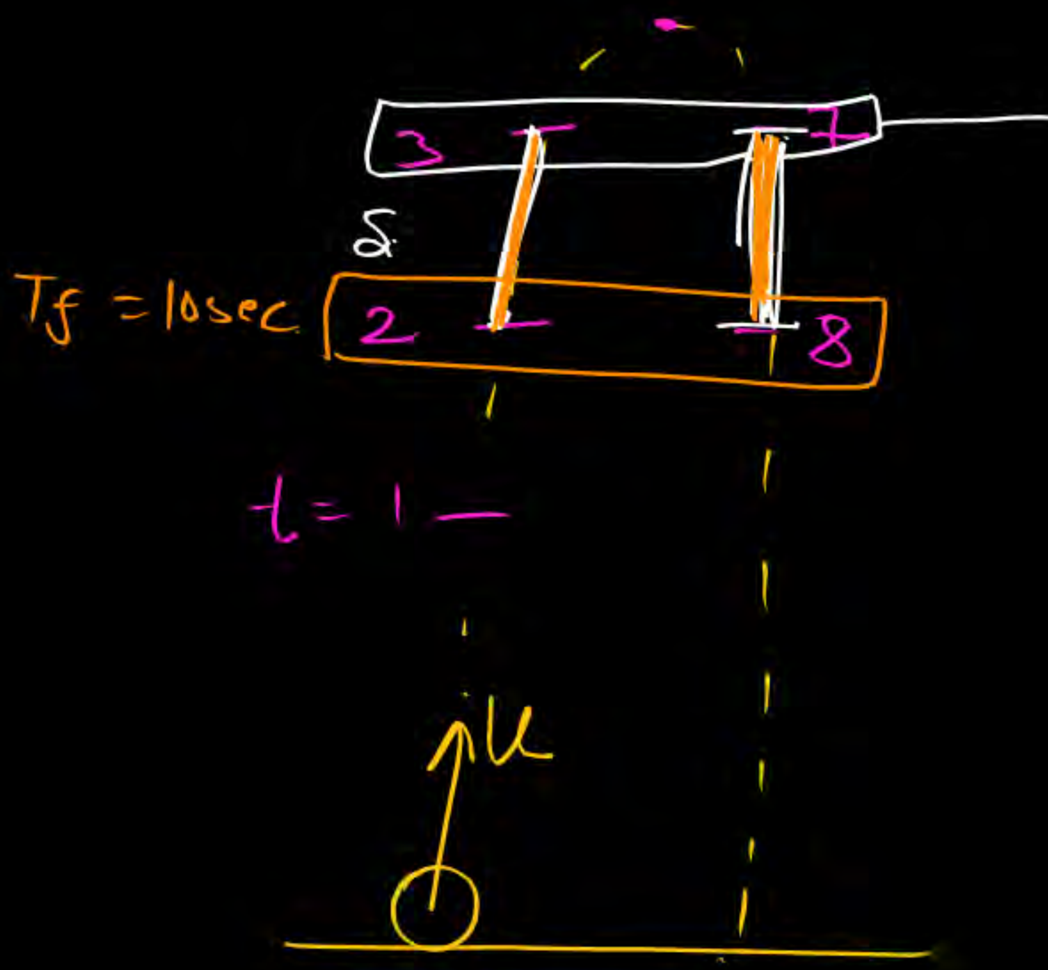
$$= 240 - 45$$

$$= 195\,m$$

Ball is Projected up its distance travelled in 3rd sec and in 8th sec is same then find max^m height

(2sec to 3sec) (7sec to 8sec)

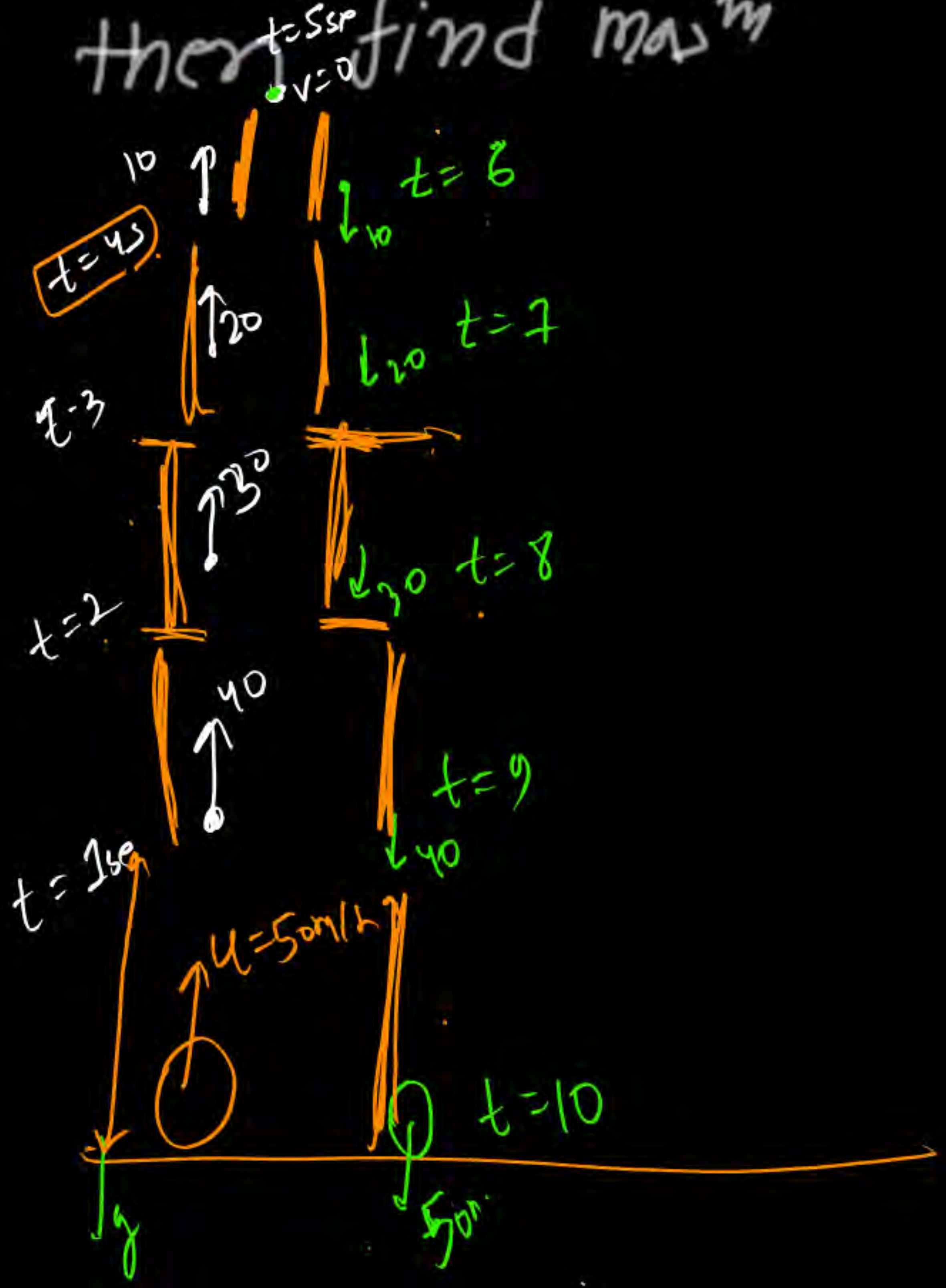
JEE



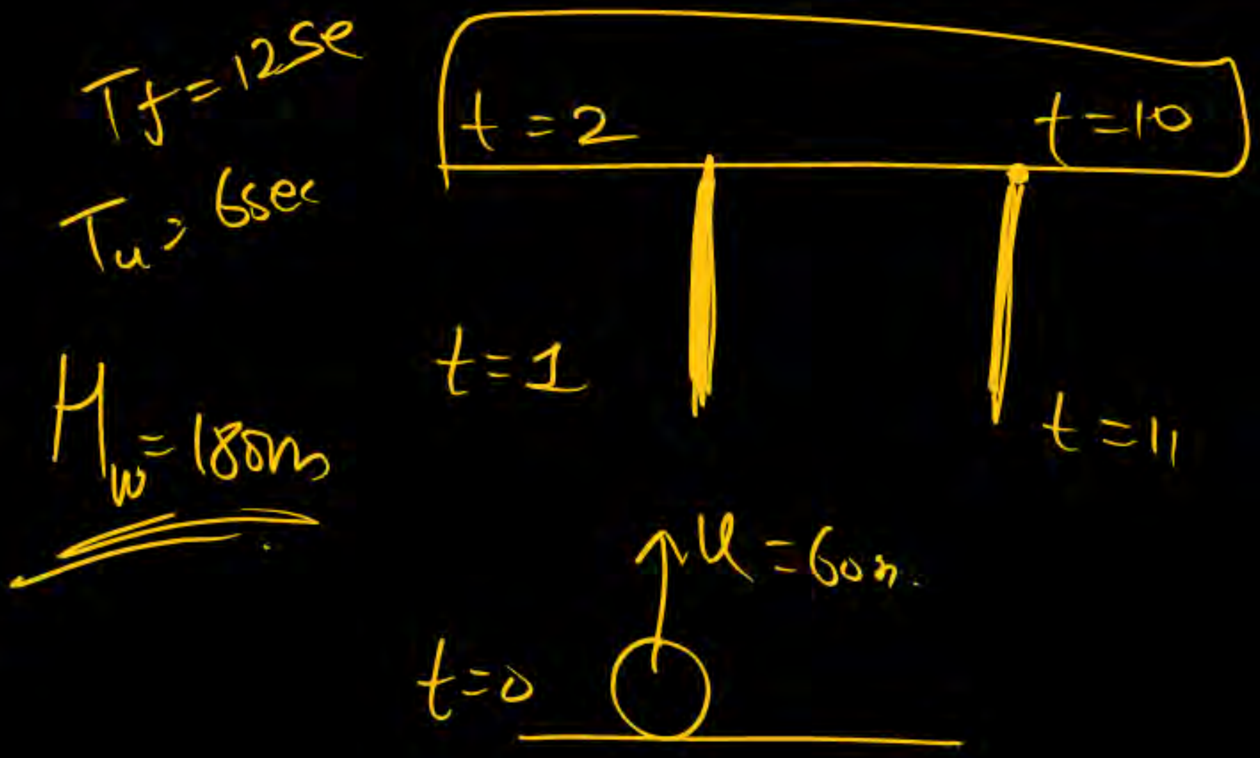
$T_f = 10sec$

$u = 50 m/s$

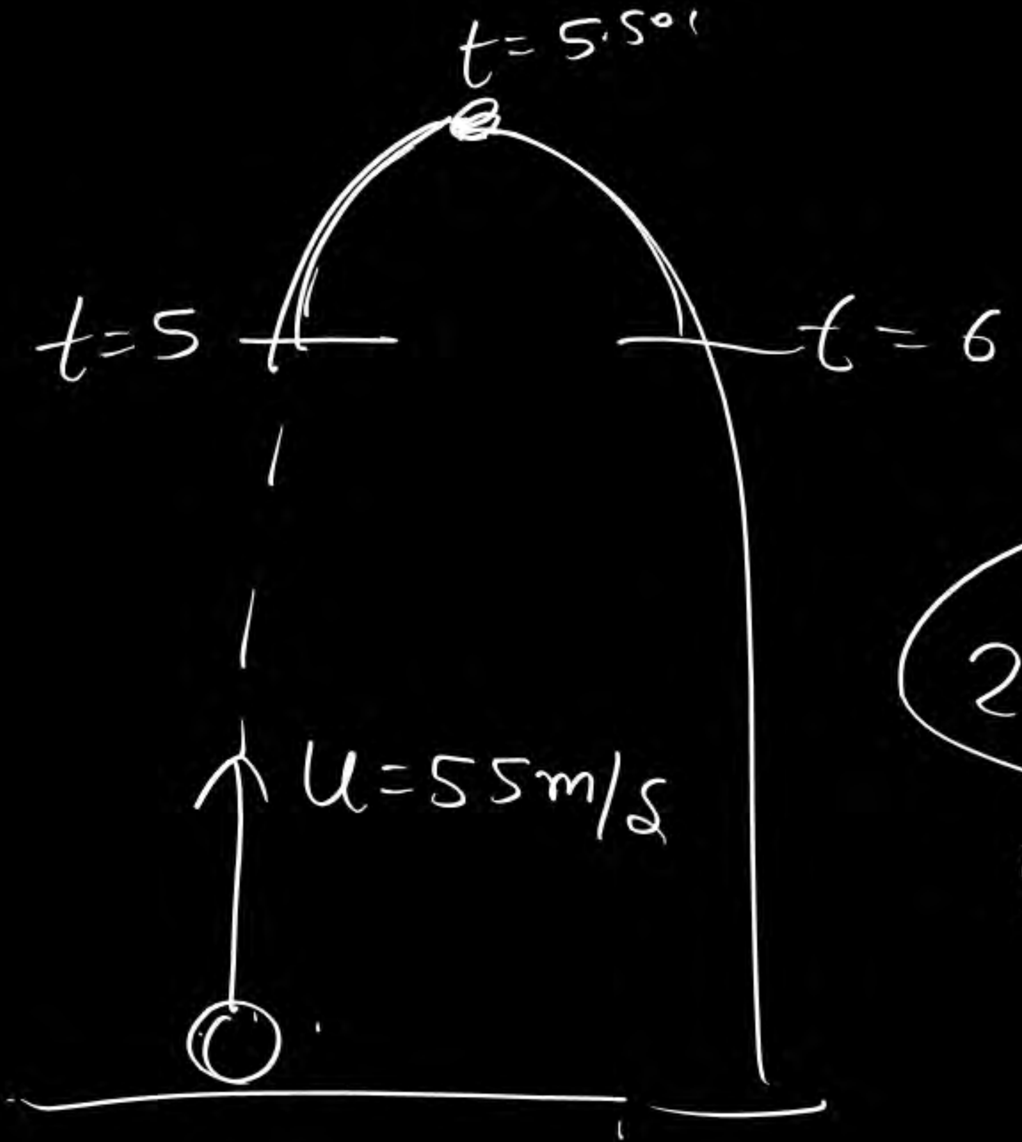
$H_m = 125 m.$



Ball Projected up & it move same dirⁿ in 2nd sec & 11th sec then find $T_f = ??$ H_{max}, $u = ??$



Ball is Projected up with 55 m/s then find distance in 6th sec.



2.5 m = dis

Ans

If air resistance is not ignored *

QUESTION

Object is projected with 40 m/s then find average speed and velocity in 6 sec.

$\frac{100}{6}$ m/s

Avg speed

$\frac{60}{6} = 10$ m/s

Avg velo

(a) Yes

(b) No

QUESTION

Ball is projected upward with velocity 50 m/s then find :

(i) Time of flight = 10 sec

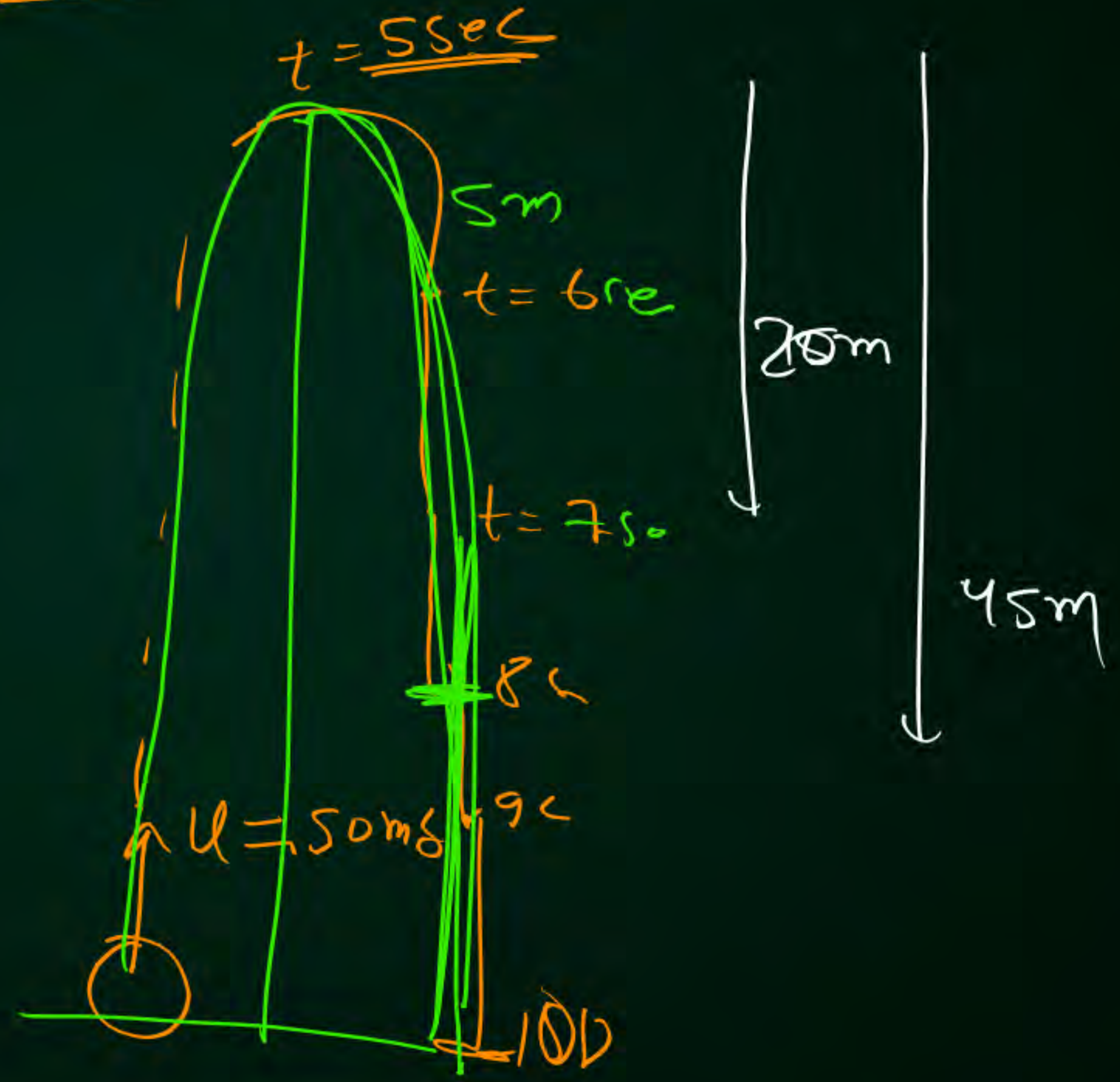
(ii) Maximum height = 125 m

(iii) displacement in 6 sec 120 m

(iv) Height at 7 sec = 105 m

(v) Average velocity in 8 sec = $\frac{80}{8}$

(vi) Average speed in 8 sec = $\frac{170}{8}$



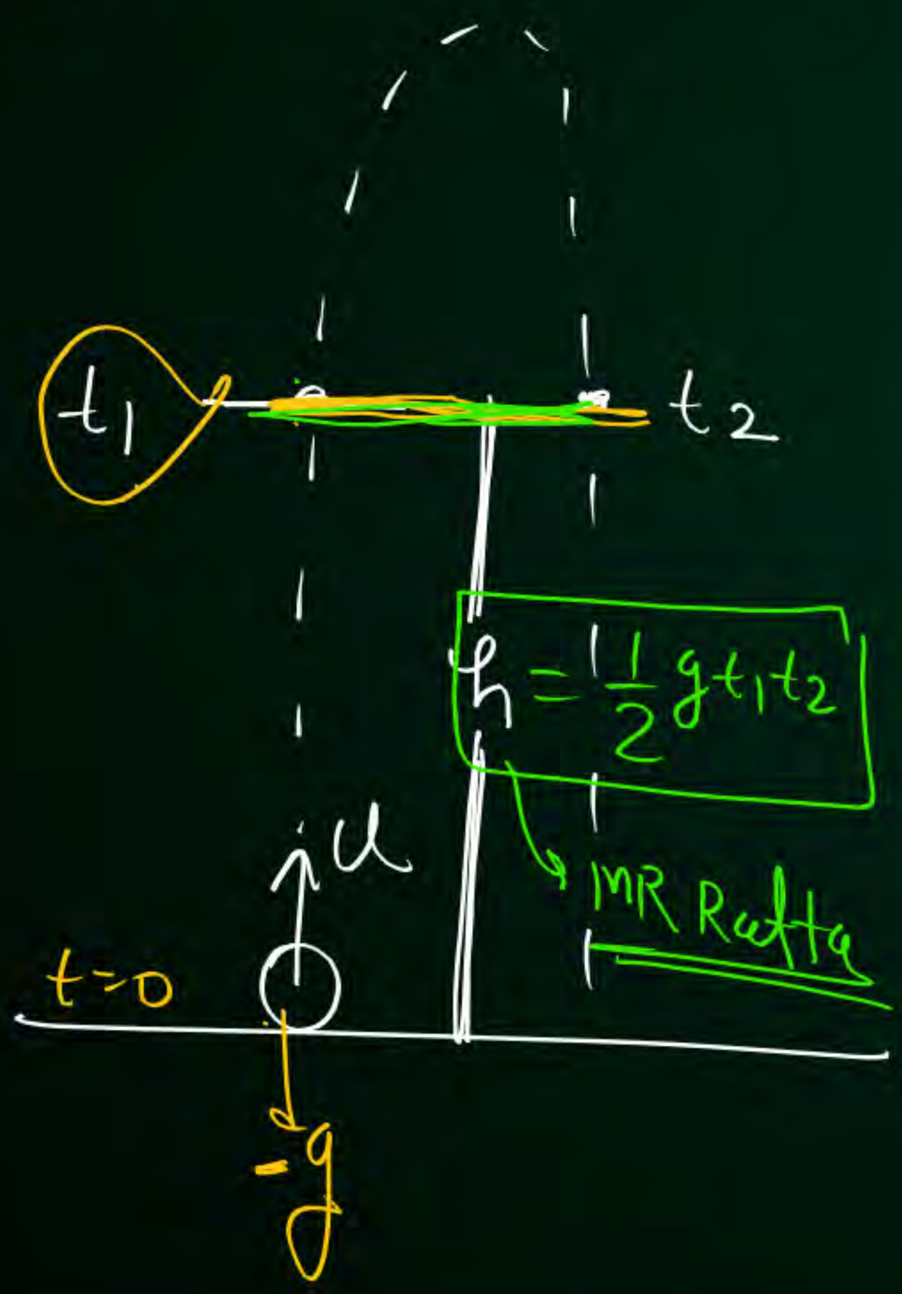
QUESTION

Object is projected in upward with velocity 75 m/s. Find distance in last 2 sec of upward journey.

20m

QUESTION

Ball is projected with speed u it crosses the height h in time t_1 and t_2 then find that height.



$$t_1 + t_2 = \frac{2u}{g} \quad (1)$$

$$u = \frac{(t_1+t_2)g}{2}$$

$$S = ut + \frac{1}{2}at^2$$

$$S = ut_1 - \frac{1}{2}gt_1^2$$

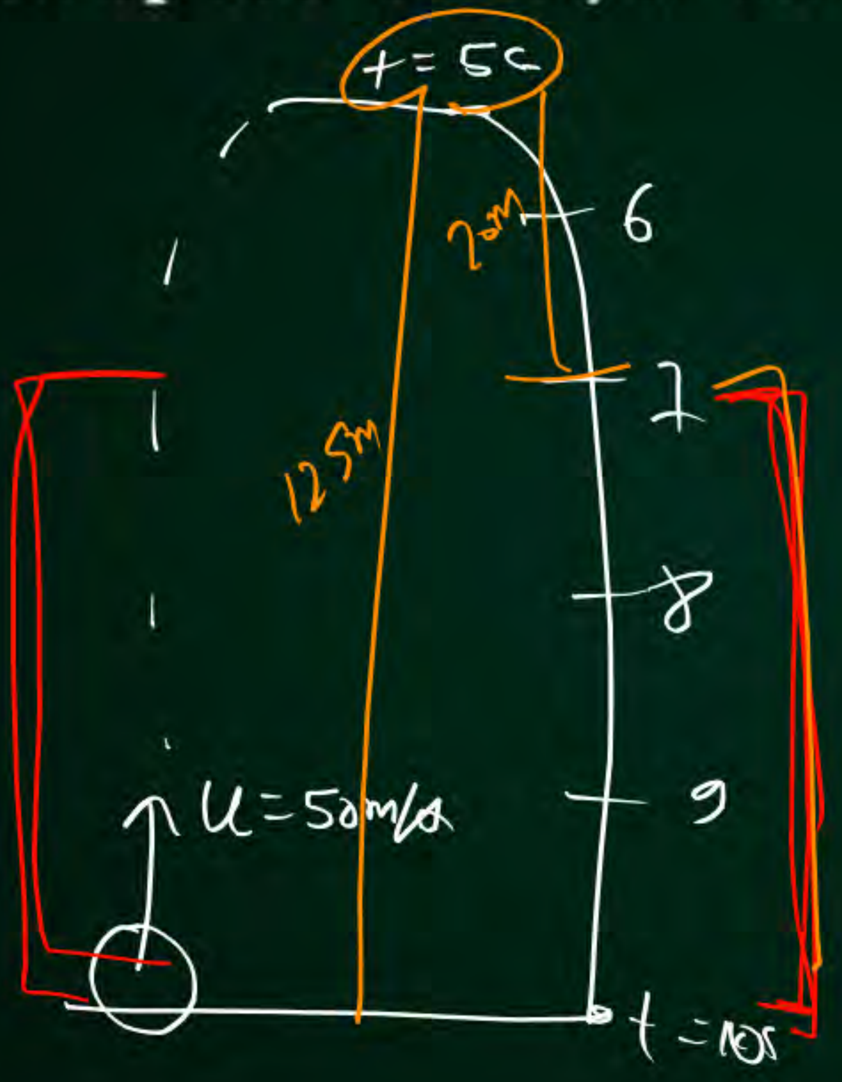
$$S = \frac{(t_1+t_2)}{2}g\,t_1 - \frac{1}{2}gt_1^2$$

$$= \frac{1}{2}gt_1^2 + \frac{1}{2}gt_1t_2 - \frac{1}{2}gt_1^2 = \frac{1}{2}gt_1t_2$$

QUESTION

Ball is projected with speed 50 m/s. Then, find displacement in last 3 sec of journey.

Sol^n



(a) 45m 28%

(b) 35m

(c) 105m (48%)

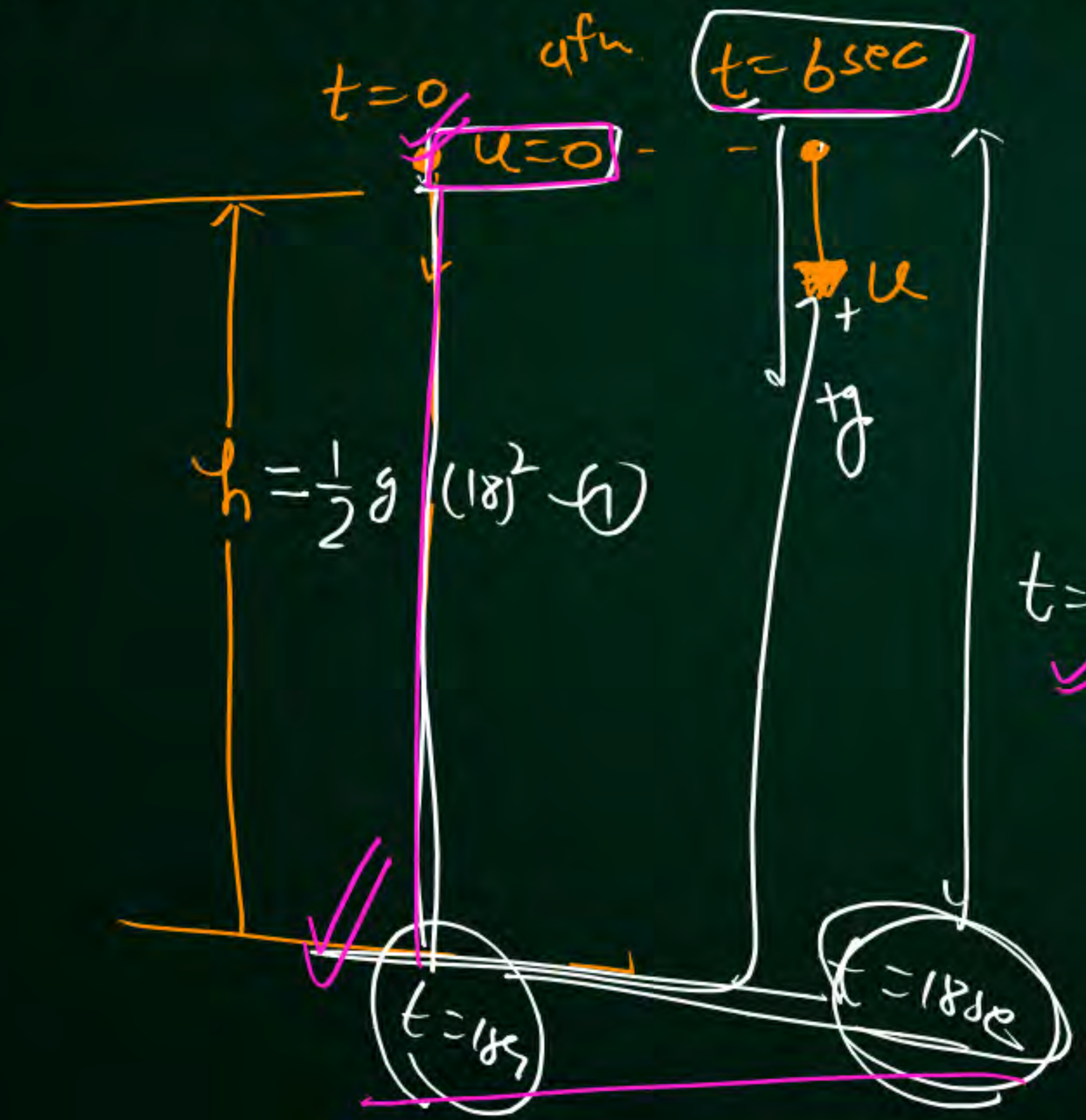
(d) 80m 12%

QUESTION

A ball is dropped from a high rise platform at $t = 0$ starting from rest. After 6 seconds another ball is thrown downwards from the same platform with a speed v. The two balls meet at $t = 18$ s. What is the value of v ? (Take $g = 10\ m/s^2$)

[2010]

1. 75 m/s
2. 55 m/s
3. 40 m/s
4. 60 m/s



$h = ut + \frac{1}{2}at^2$

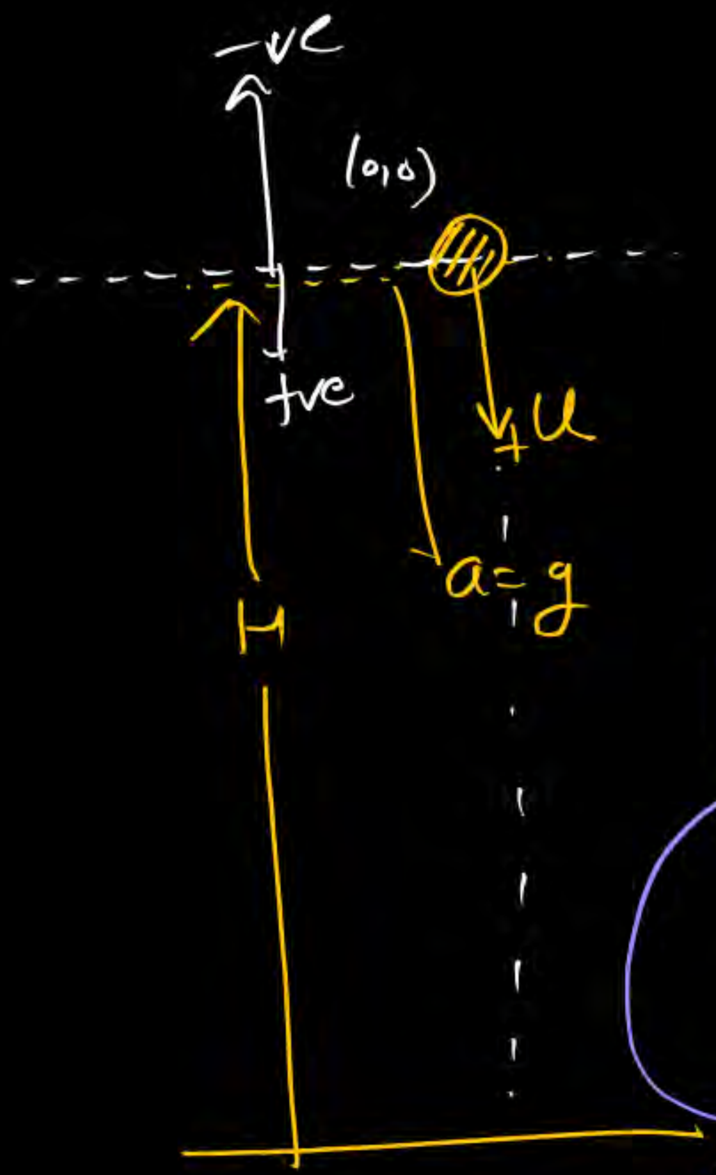
$h = v12 + \frac{1}{2}10(12)^2$ — (ii)

$\frac{1}{2}g(18)^2 = 12v + \frac{10}{2}(12)^2$

$5\left[(18)^2 - (12)^2\right] = 12v$

$12v = 5(324 - 144)$

$12v = 180 \times 5$



find dispm in t time, ball projected downwar

$$S = ut + \frac{1}{2}at^2$$

$$S = ut + \frac{1}{2}gt^2$$

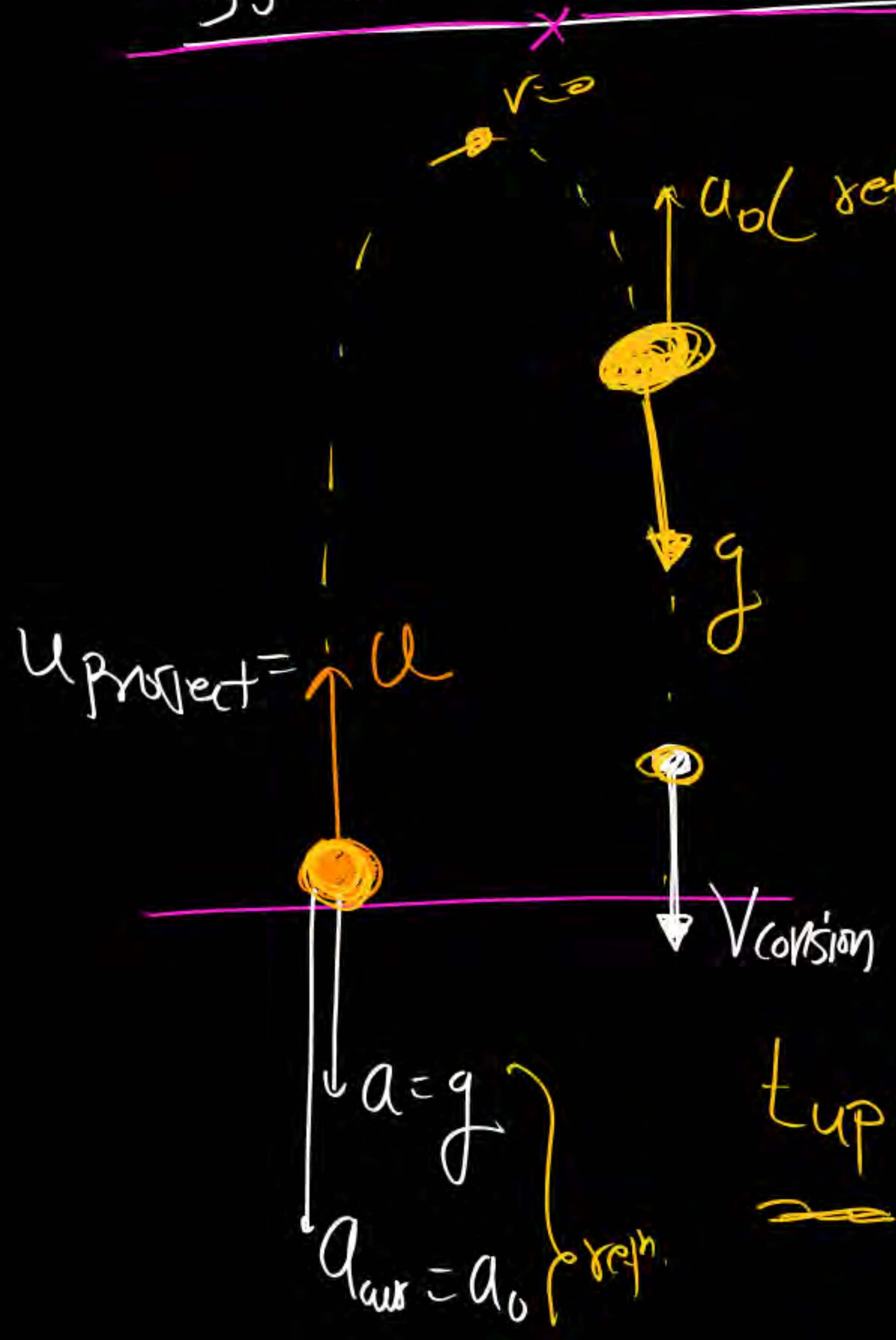
Velocity after 't' time

$$V = u + at$$

$$V = u + gt$$

If air resistance is considered → air resistance always acts opposite to the motⁿ

Let = a_0 is air resⁿ.



$t_{down} > \frac{u}{g}$ —(ii)

$t_{up} < \frac{u}{g}$ —(i)

$t_{up} < t_{down}$

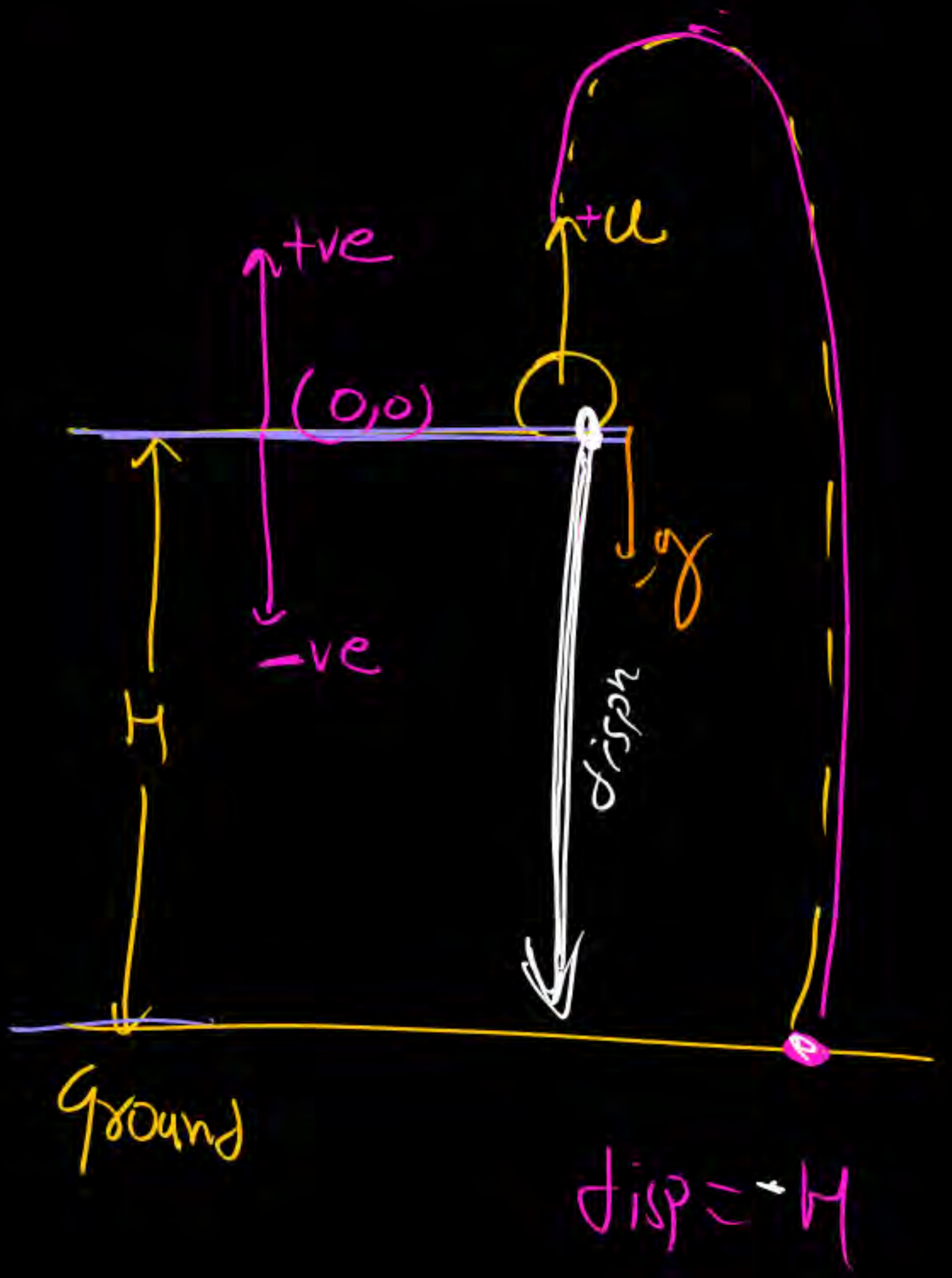
$u_{colsn} < u_{projn}$

QUESTION

Ball is projected with speed u_1 if air friction is not ignored then speed of collision u_2 and t_1 and t_2 are time of upward and downward time, then

1. $t_1 = t_2, u_1 > u_2$
2. $t_1 < t_2, u_1 > u_2$
3. $t_1 < t_2, u_1 < u_2$
4. $t_1 > t_2, u_1 > u_2$

Motion under gravity from some Height



$$S = ut + \frac{1}{2}at^2$$

$$-H = ut - \frac{1}{2}gt^2 \quad \text{--- (1)}$$

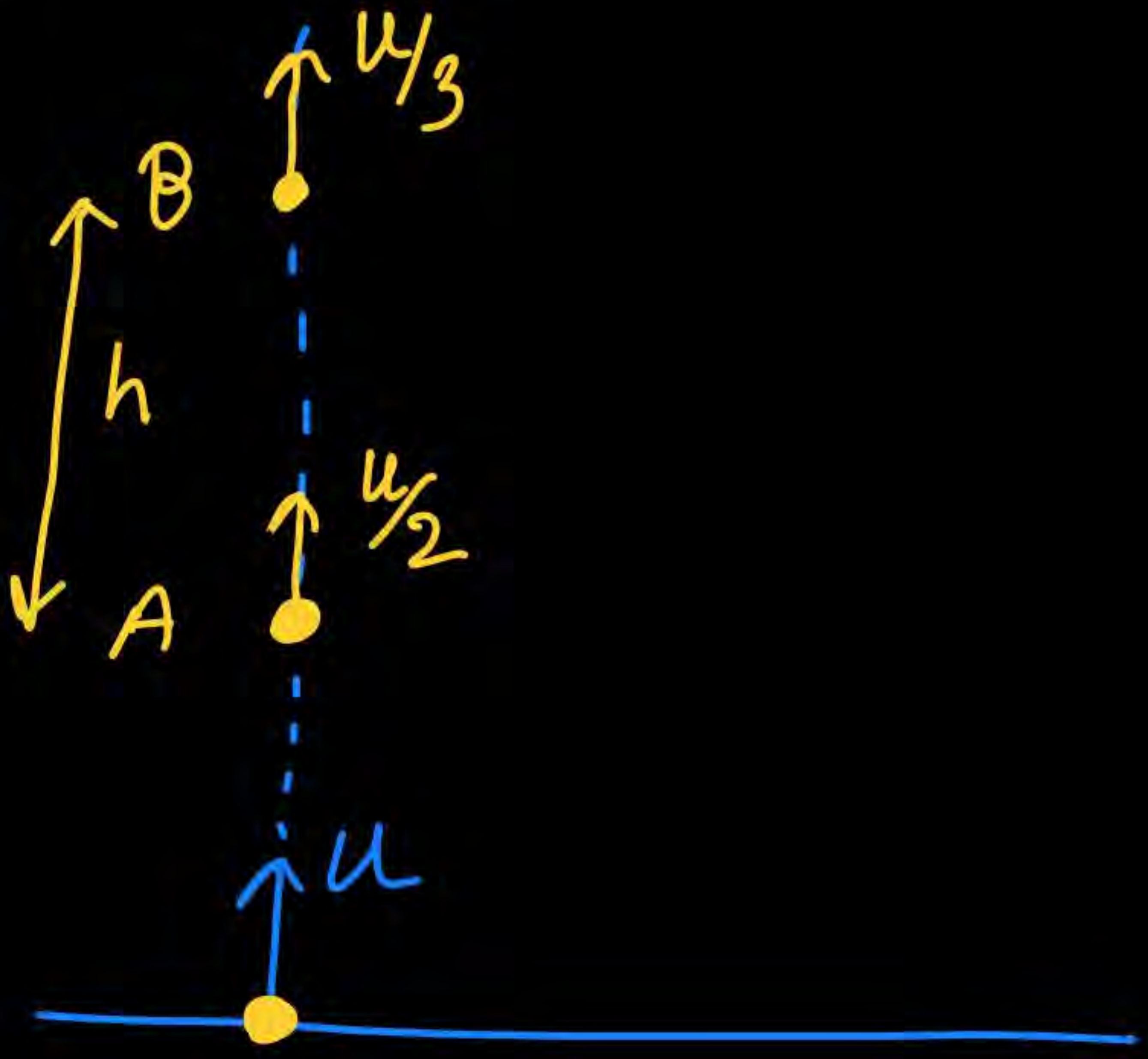
NEET

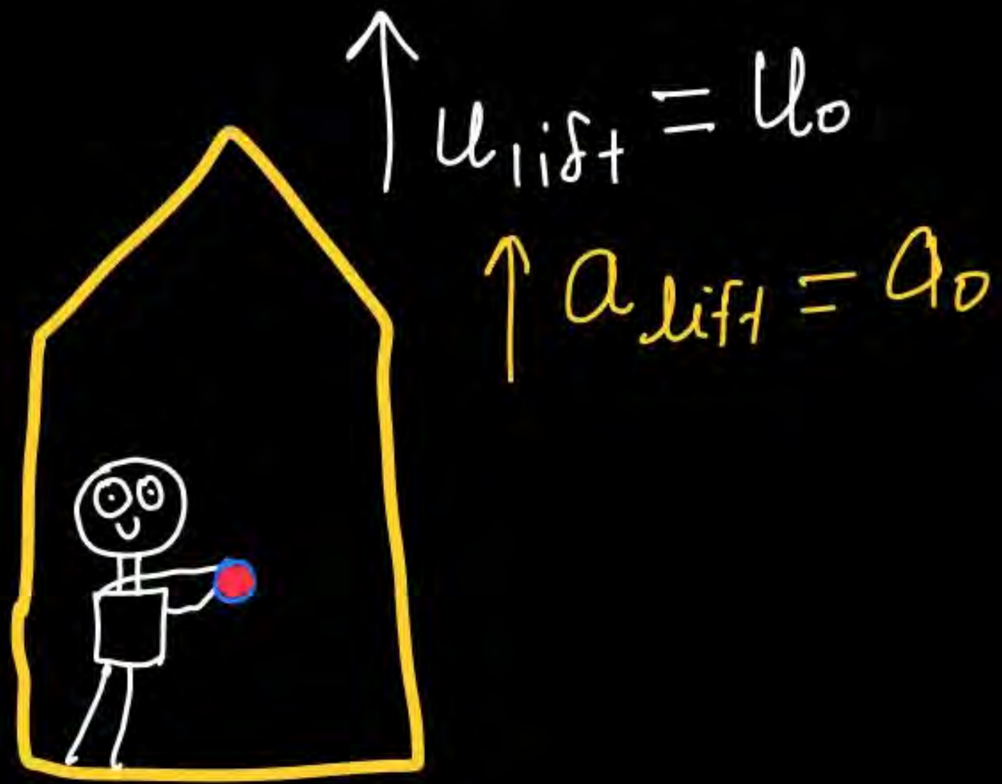
Ball is Projected with 50m/s then find displacement in 3-sec and 3^{rd} sec.

Ball is Projected with 50m/s then find displacement in 8-sec and 8th sec

If constant air friction is acting on object is a_0 then find time of flight of upward and downward Journey.

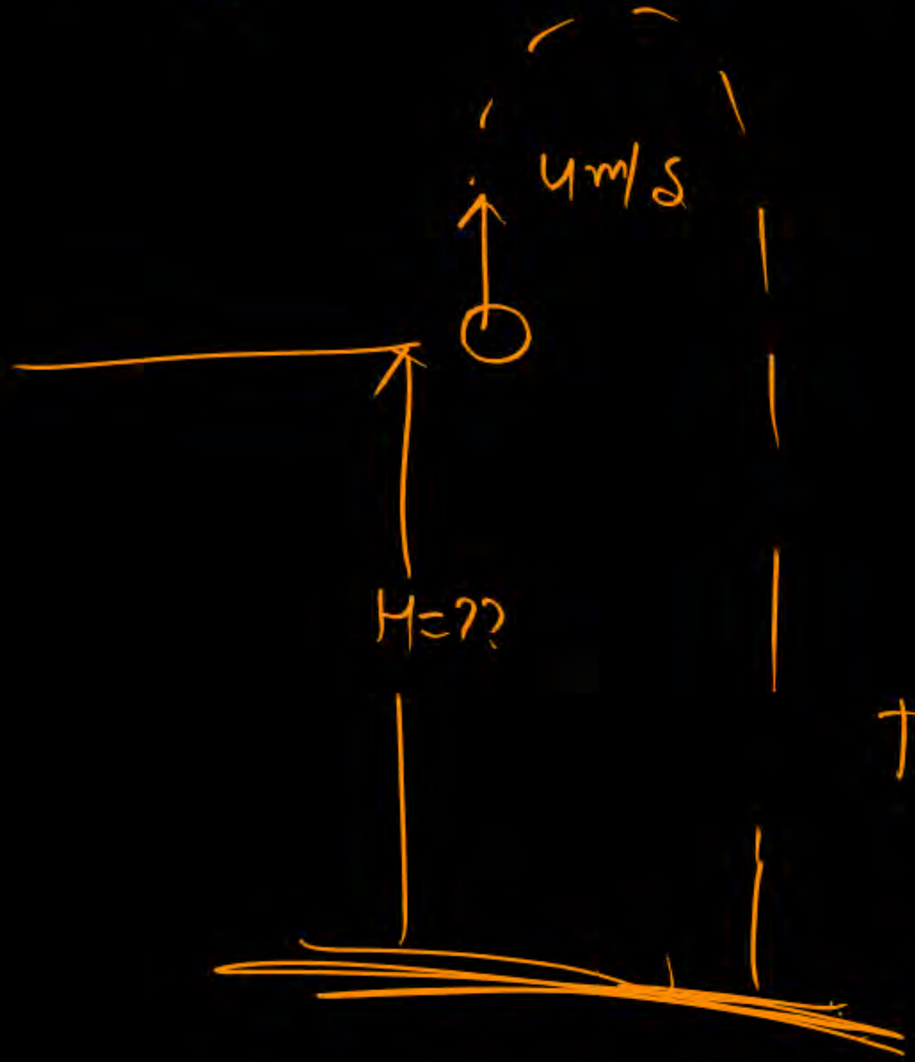
Ball is Projected with speed u as shown in Fig. then find distance B/w A & B





Ball is droped by Ramlal in moving lift then find, it's velocity and acceleration Just before released and Just after release.

Ball is Projected up with speed 4 m/s from a bridge. The Ball strikes the water surface after 4 sec. The Height of bridge above the water surface [NEET- 2023]



$$S = ut + \frac{1}{2}at^2$$

$$-H = 4 \times 4 - \frac{1}{2} 10 (4)^2$$

$$= 16 - 5(16)$$

$$= 16 - 80$$

$$-H = 64 \text{ m}$$

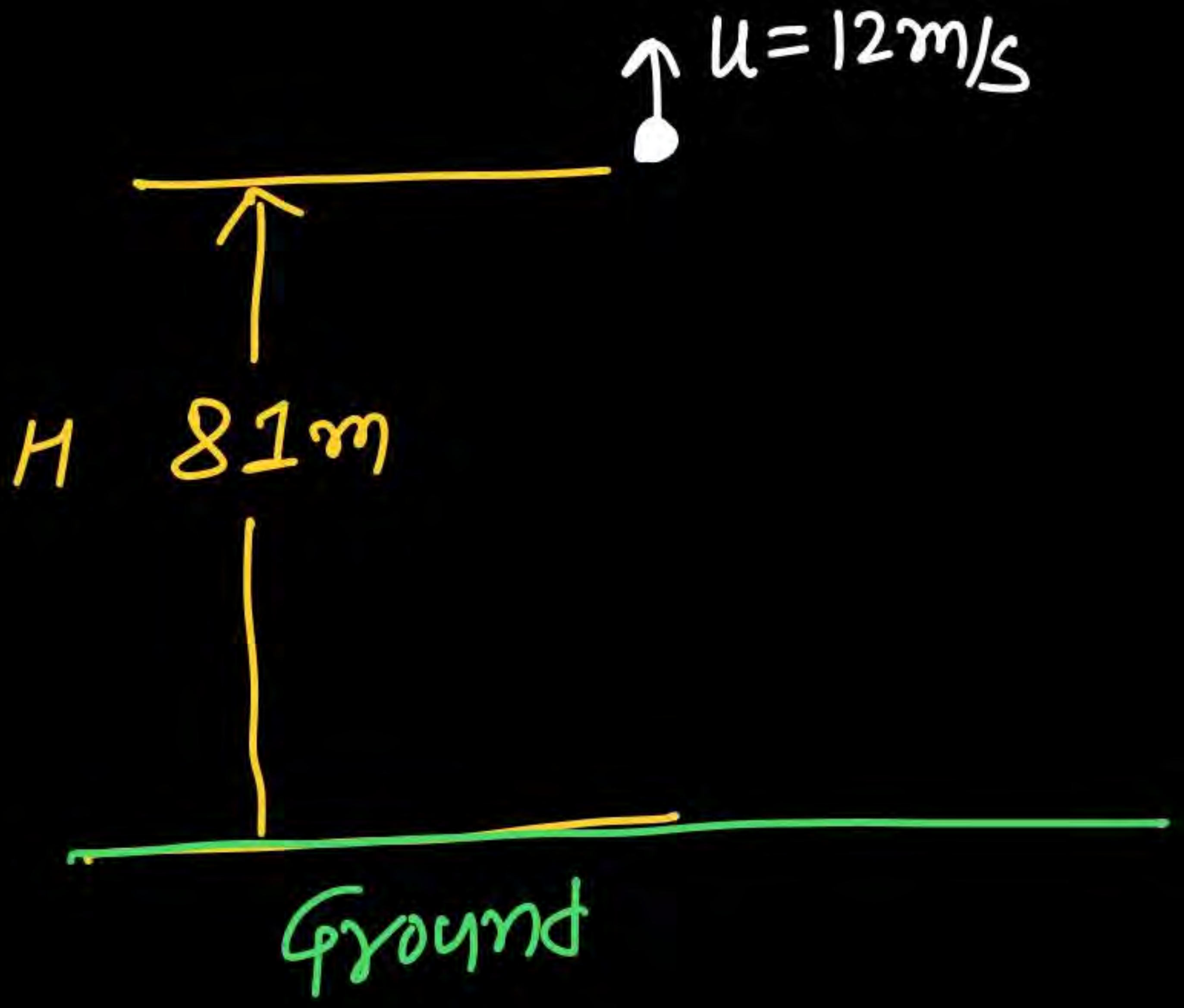
Find time of flight of ball

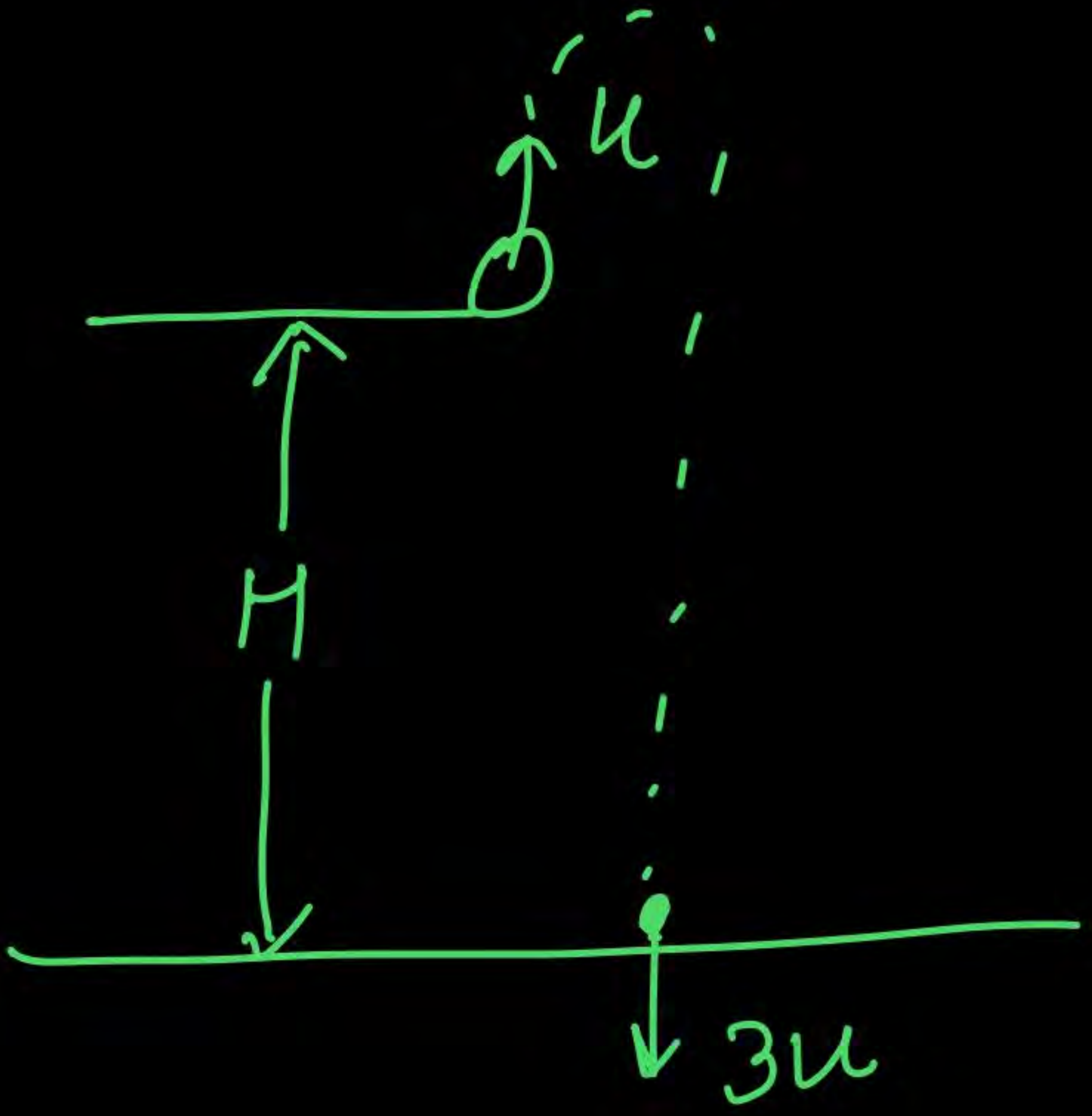
(a) 2.7 sec

(b) 5.4 sec

(c) 4.8 sec

(d) 6.9 sec





Find time of Flight and Maximum Height


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 11 | **Physics**

Motion In a Straight Line

By- Dr. Manish Raj (MR SIR)



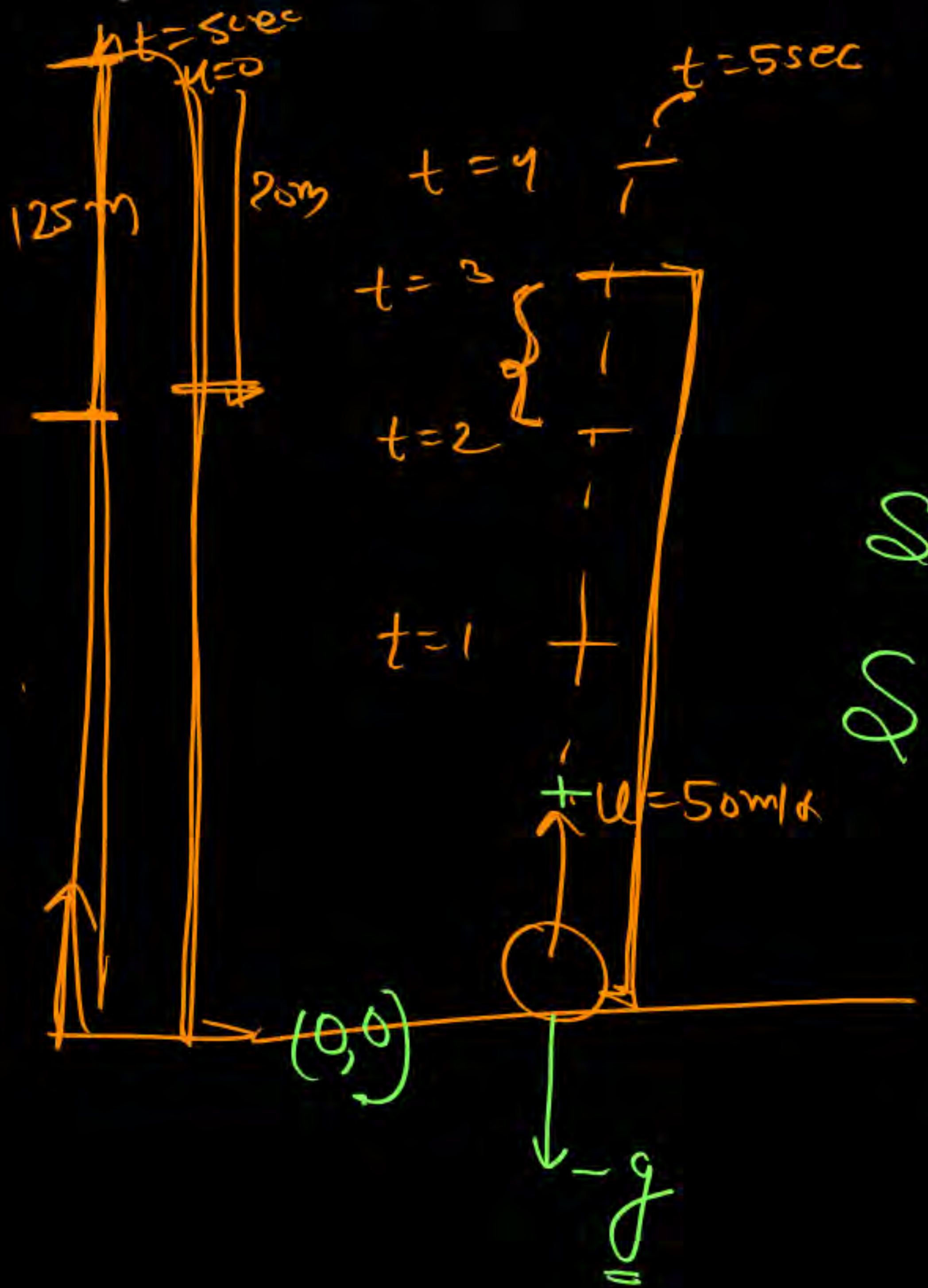
Todays Goal

- Motion Under gravity from Height
- Graph for 1-D motion

Ball is Projected with 50m/s then find displacement in 3-sec and 3rd sec.

total 3-sec

2sec to 3sec



$S = ut + \frac{1}{2}at^2$

$S = 50 \times 3 - \frac{1}{2} g (3)^2$

$= 150 - 5(9)$

$= 150 - 45$

$= 105\,m$

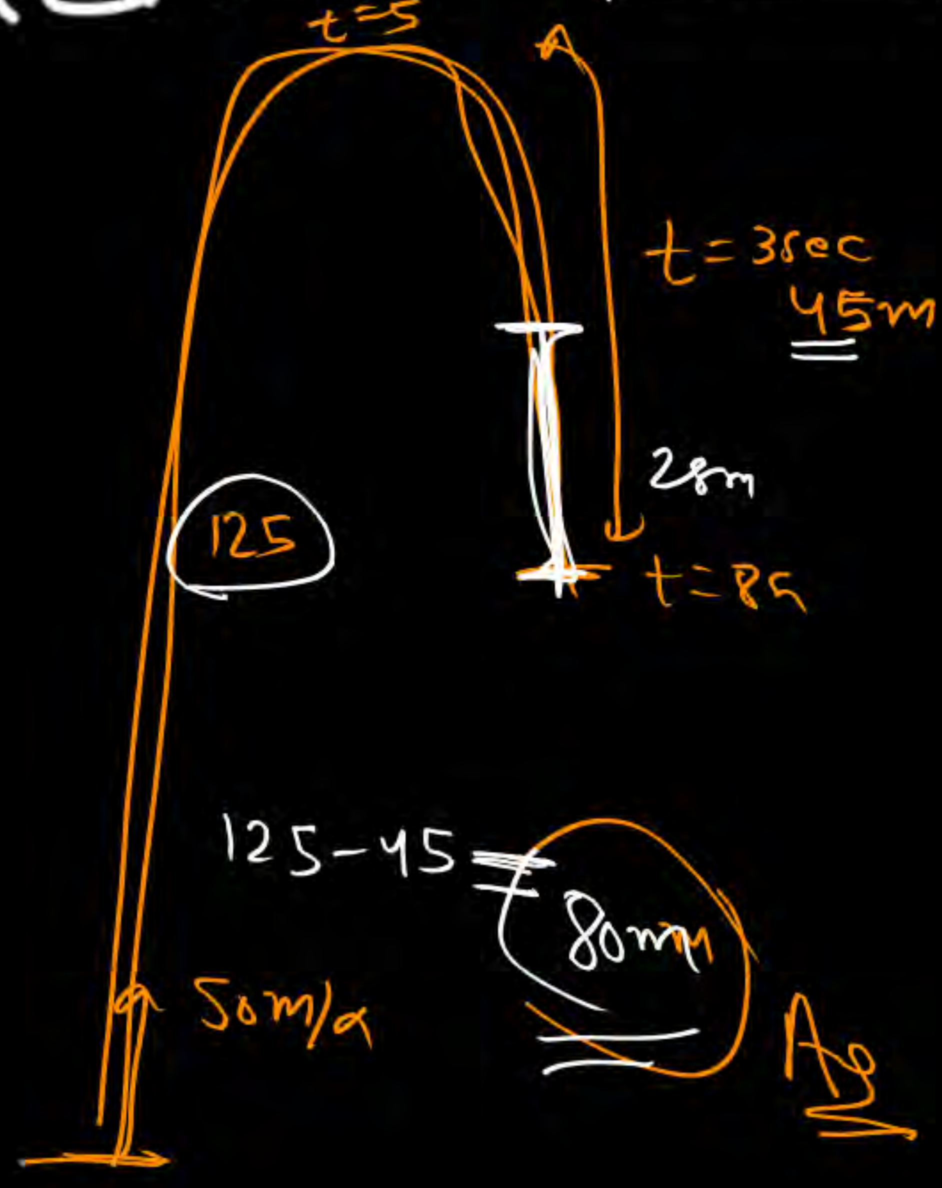
$S_{3rd} = u + \frac{a}{2}(2n-1)$

$= 50 - \frac{10}{2}[2 \times 3 - 1)$

$= 50 - 5(5)$

$= 25\,m$

Ball is Projected with 50m/s then find displacement in 8-sec and 8th sec



$$S = 50\times8 - \frac{1}{2}10(8)^2$$

$$= 400 - 64\times5$$

$$= 400 - 320$$

$$= 80m$$

Ball is Projected with speed u as shown in Fig. then find distance B/w A & B

IIT-2024



$$\left[v_f^2 - u_i^2 = 2as \right]$$

$$\left(\frac{u}{3}\right)^2 - \left(\frac{u}{2}\right)^2 = -2g\,h$$

$$\frac{u^2}{9} - \frac{u^2}{4} = -2g\,h$$

$$= \frac{-5u^2}{36} = -2g\,h$$

$$\boxed{\frac{5u^2}{72g} = h}$$

$$\left[\frac{u^2}{144}\right]$$

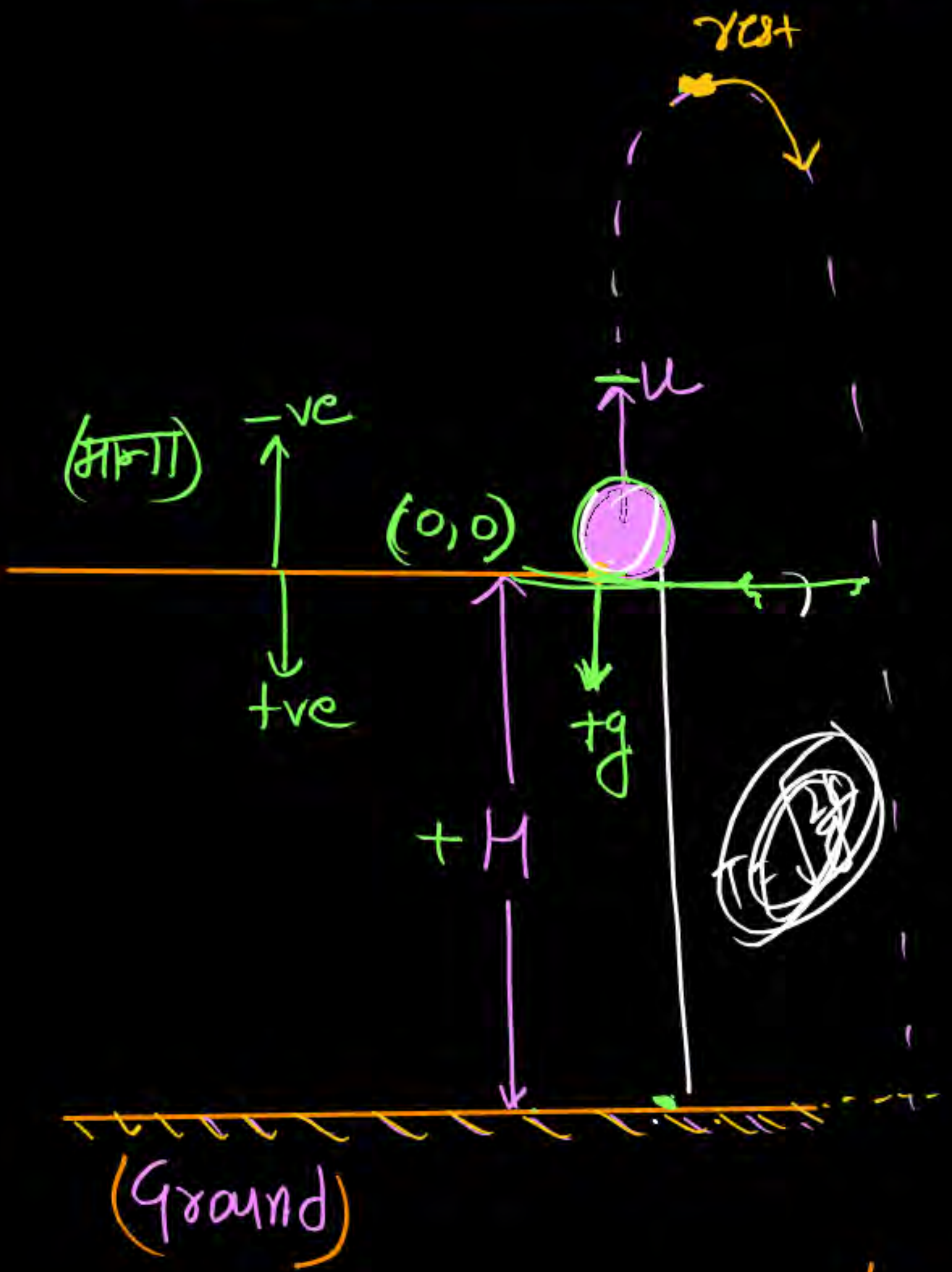
QUESTION

A stone is dropped from a building and 2 seconds later another stone is dropped. How far apart are these two stones by the time the first one has reaches at a speed of 30 m/s? (Take $g = 10\ \text{m/s}^2$)

1. 80 m
2. 100 m
3. 60 m
4. 40 m

motion under gravity
from some //

Motion under gravity from Height :- find time of flight



"$S = ut + \frac{1}{2}at^2$"

$H = -ut + \frac{1}{2}gt^2$

$$\frac{g}{2}t^2 - ut - H = 0$$

↳ quadratic eqⁿ of time.

multiply by $\left(\frac{2}{g}\right)$ bothside

$$t^2 - \frac{2u}{g}t - \frac{2H}{g} = 0$$

$a = 1$ $b = -\frac{2u}{g}$ $c = -\frac{2H}{g}$

$$t = \frac{\frac{2u}{g} \pm \sqrt{\left(\frac{2u}{g}\right)^2 + 4 \times 1\left(\frac{2H}{g}\right)}}{2a}$$

hint:- $ax^2 + bx + c = 0$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$t = \frac{\frac{2u}{g} \pm \sqrt{\left(\frac{4u^2}{g^2} + \frac{8H}{g}\right)}}{2}$$

$$t = \frac{\frac{2u}{g}}{2} + \frac{2\sqrt{\frac{u^2}{g^2} + \frac{2H}{g}}}{2}$$

NEETPhysics

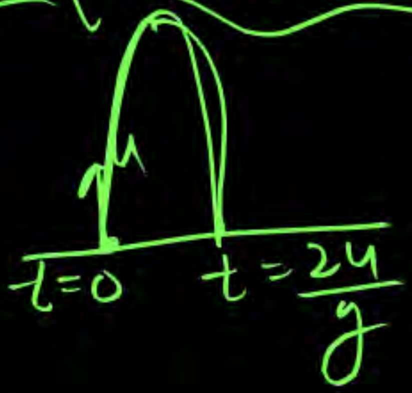
$$t = \frac{u}{g} + \sqrt{\frac{u^2}{g^2} + \frac{2H}{g}}$$

$$t = \frac{2u}{g}$$

MR* (dimⁿ)

The MR* of $u=0$: $T = \sqrt{\frac{2H}{g}}$ **

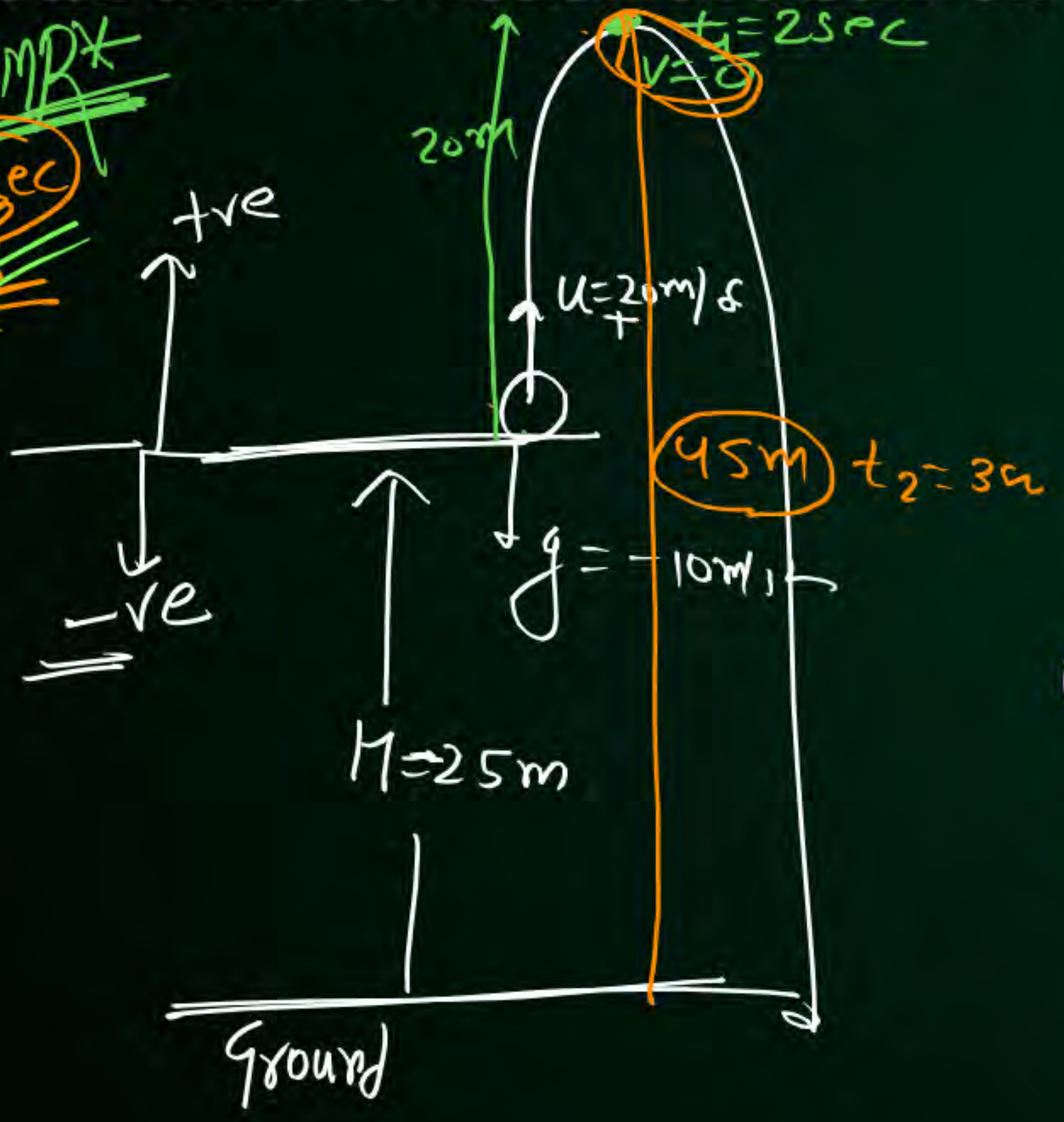
The MR* of $H=0$: $T = \frac{2u}{g}$



QUESTION

A ball is projected up with speed 20 m/s from a building height 25 m. Then, find total time to reach the ball on ground.

The MRX 5 sec



Method → 1 मजदूरी

$$s = ut + \frac{1}{2}at^2$$

$$-25 = 20t - \frac{1}{2} 10 t^2$$

$$0 = 20t - 5t^2 + 25$$

divided by 5 both side

$$-t^2 + 5 + 4t = 0$$

$$t^2 - 4t - 5 = 0$$

$$t^2 - 5t + t - 5 = 0$$

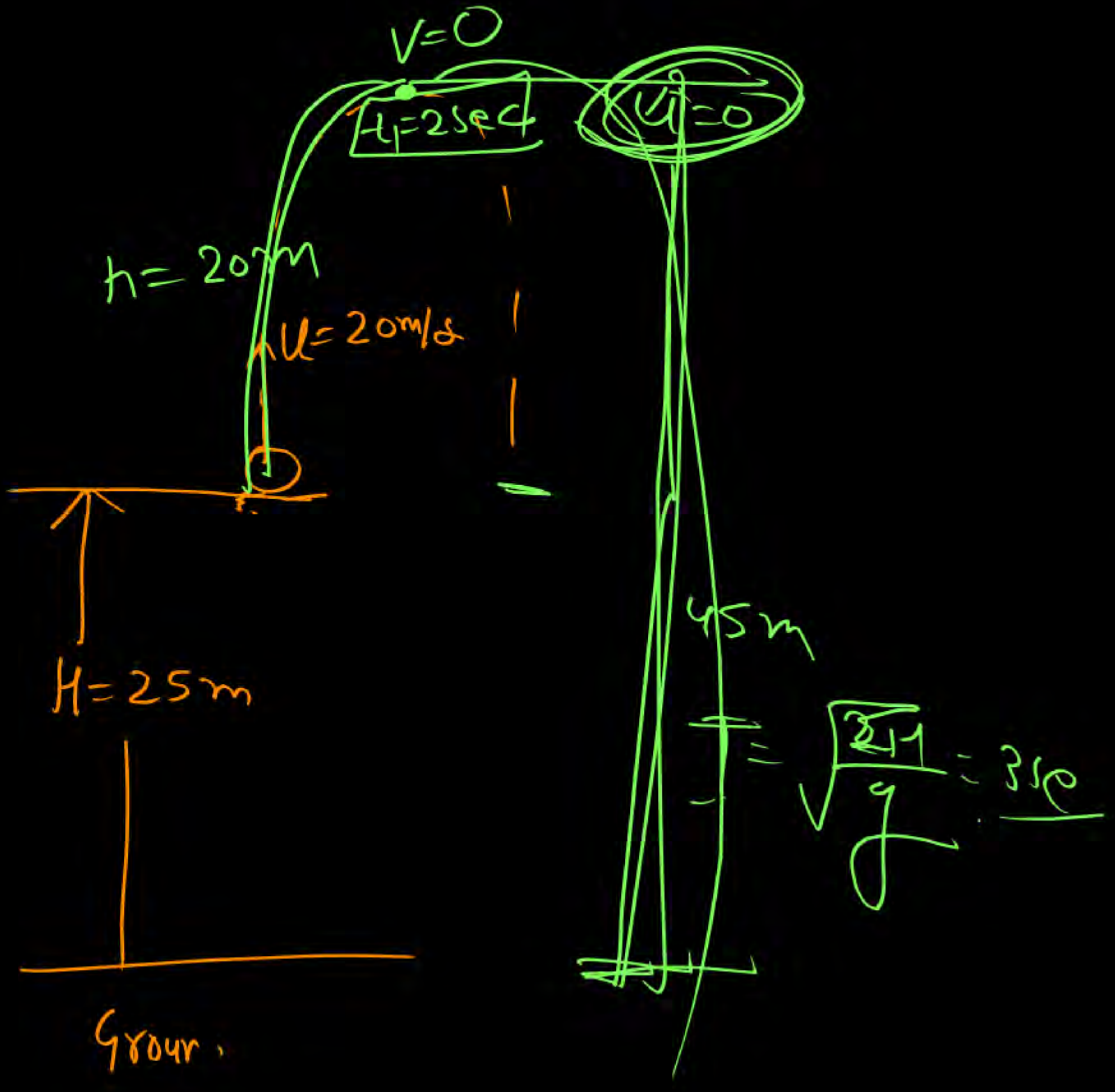
$$t(t-5) + 1(t-5) = 0$$

$$(t-5)(t+1) = 0$$

$(t-5) = 0$ | $(t+1) = 0$

$t = 5$ | $t = -1$ ✗

$$t = 5 \text{ sec}$$



$$T = \frac{u}{g} + \sqrt{\left(\frac{u}{g}\right)^2 + \frac{2H}{g}}$$

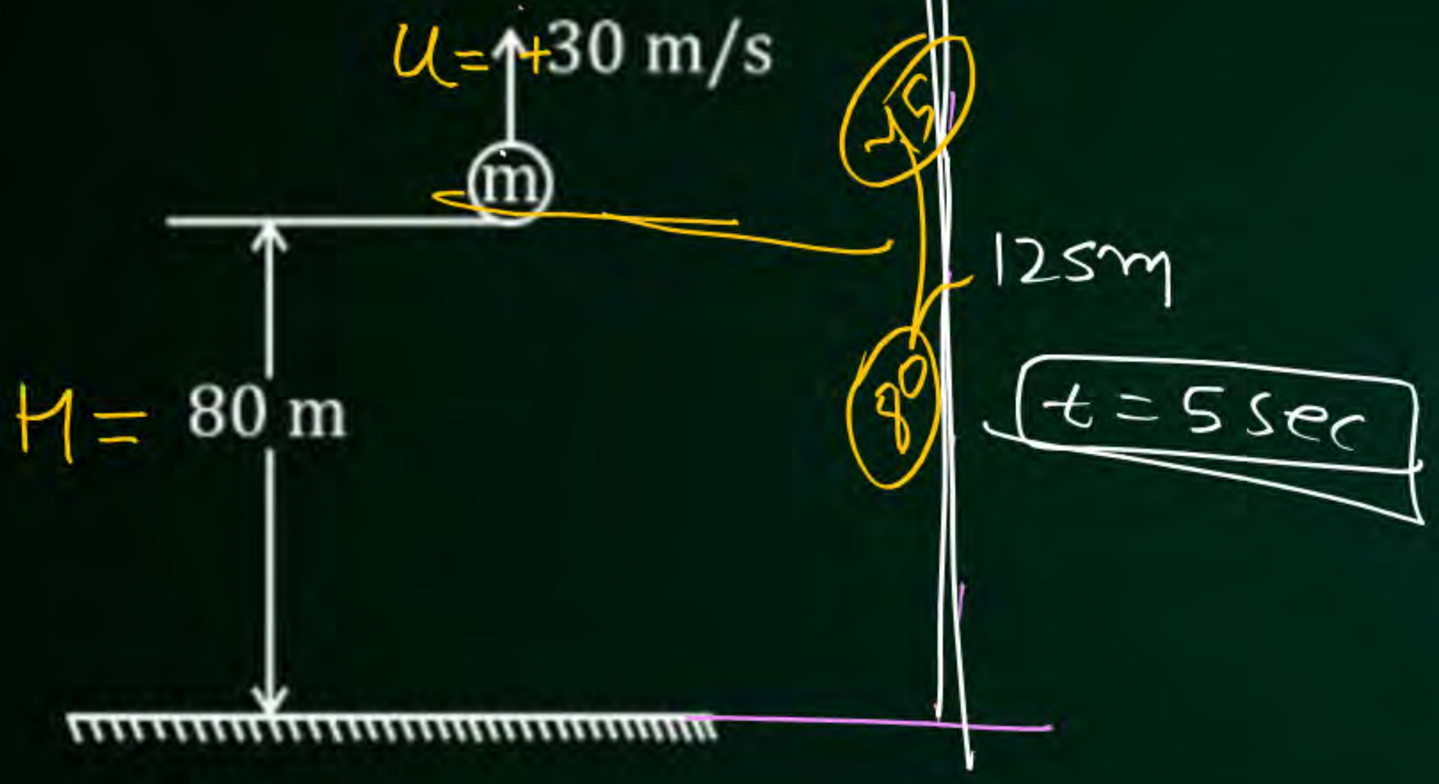
$$T = \frac{20}{10} + \sqrt{\left(\frac{20}{10}\right)^2 + \frac{2\times 25}{10}}$$

$$= 2 + \sqrt{4+5}$$

$$= 2+3 = 5\,s$$

QUESTION

Find time of flight.



t = 8 sec

AIIMS-17

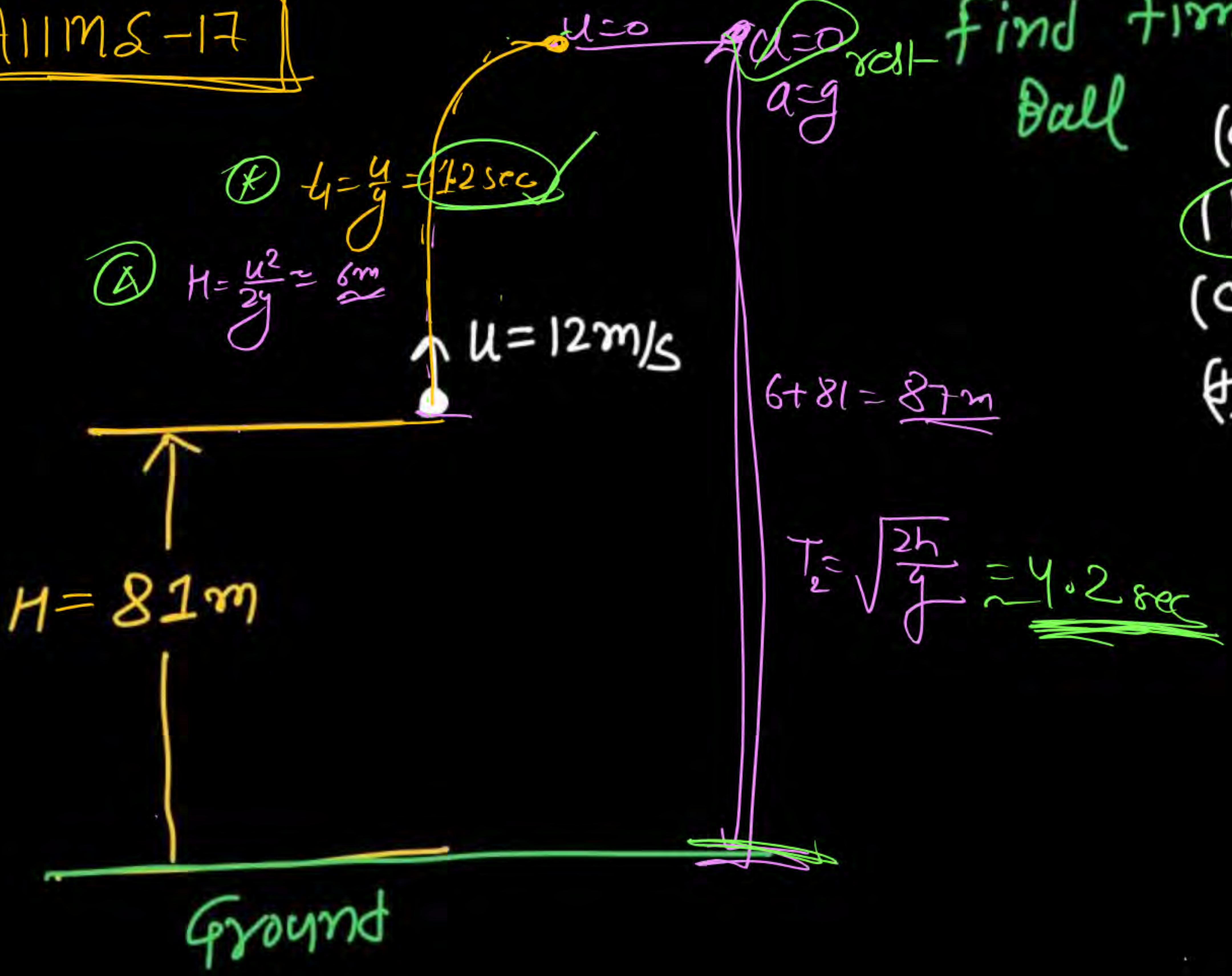
Find time of flight of Ball

(a) 2.7 sec ✗

(b) 5.4 sec ✓

(c) 4.8 sec ✗

(d) 6.9 sec ✗



QUESTION

Ball is projected from height of 75 m in upward direction with speed 10 m/s then find

(i) Total time of height. $t = 5\,sec$

(ii) Velocity at ground. ⇒ 40 m/s

(iii) Maximum height from ground. ↳ 80 m

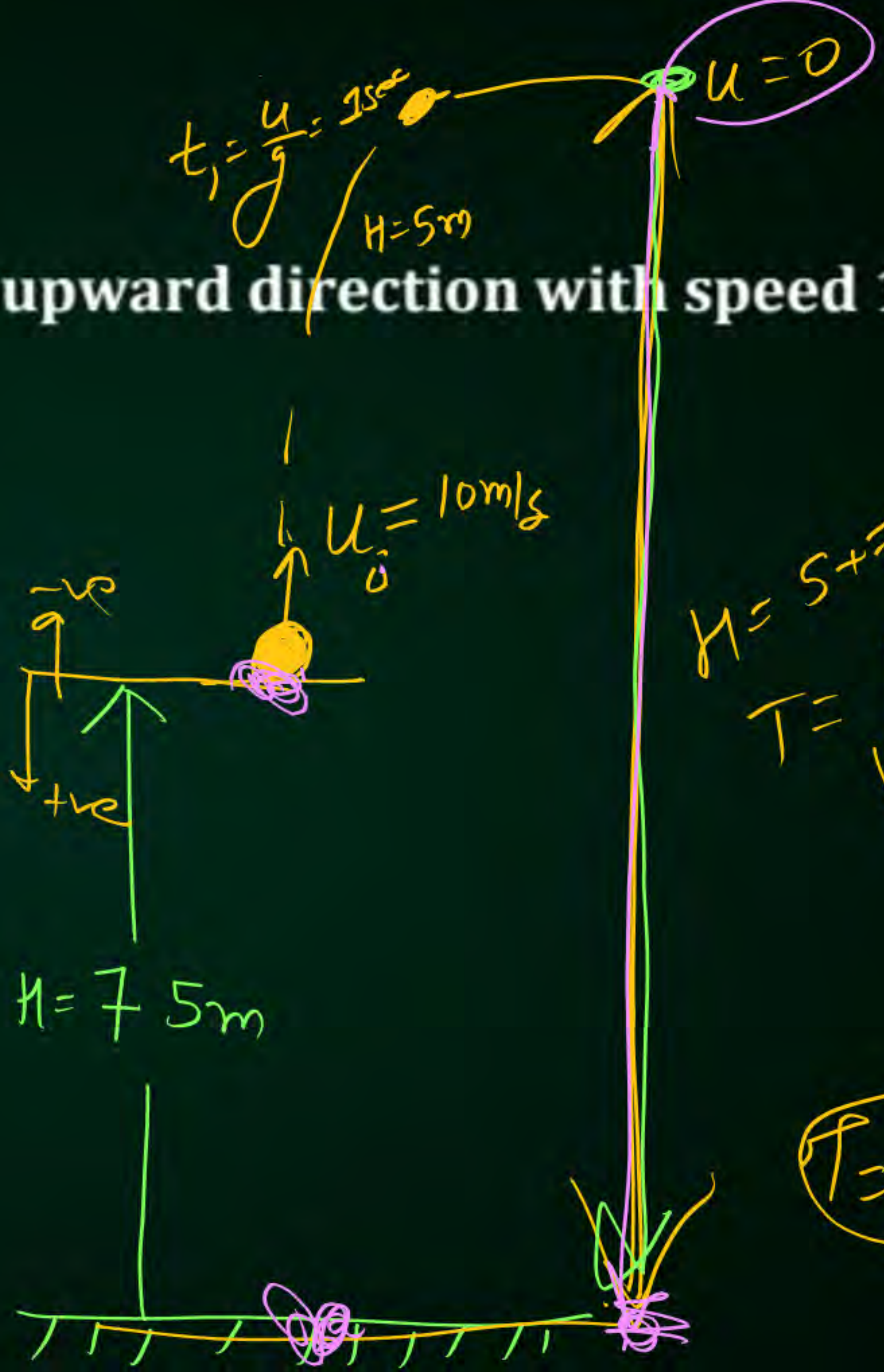
Sol^n "$v^2 - u^2 = 2as$" (disp^m)

$v^2 - (-10)^2 = 2 \times 10 \times 75$

$v^2 = 100 + 1500$

$v^2 = 1600$

$v = \sqrt{1600} = 40\,m/s$



$H = 5 + 75 = 80\,m$

$T = \sqrt{\frac{2H}{g}} = \sqrt{\frac{2 \times 80}{10}}$

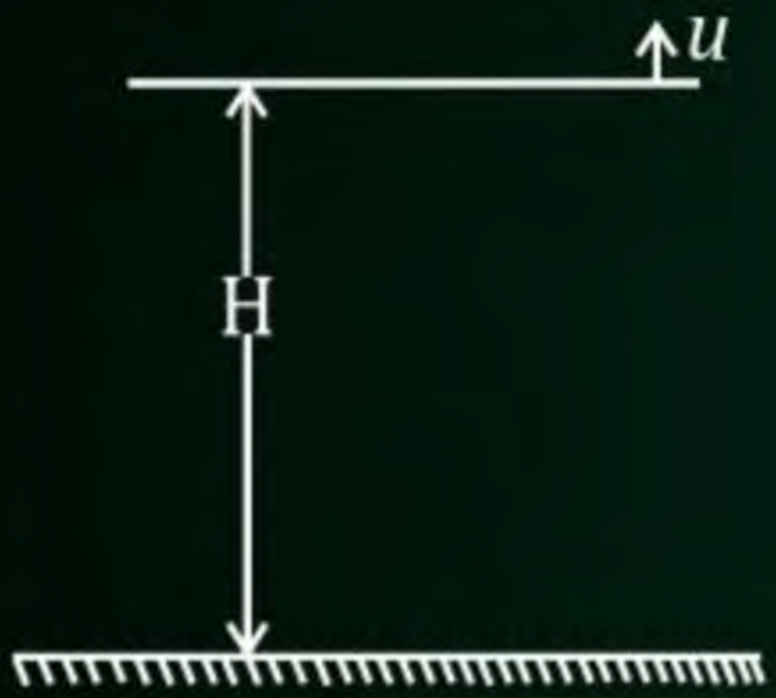
$= \sqrt{16}$

$= 4\,sec$

$T = 5\,sec$

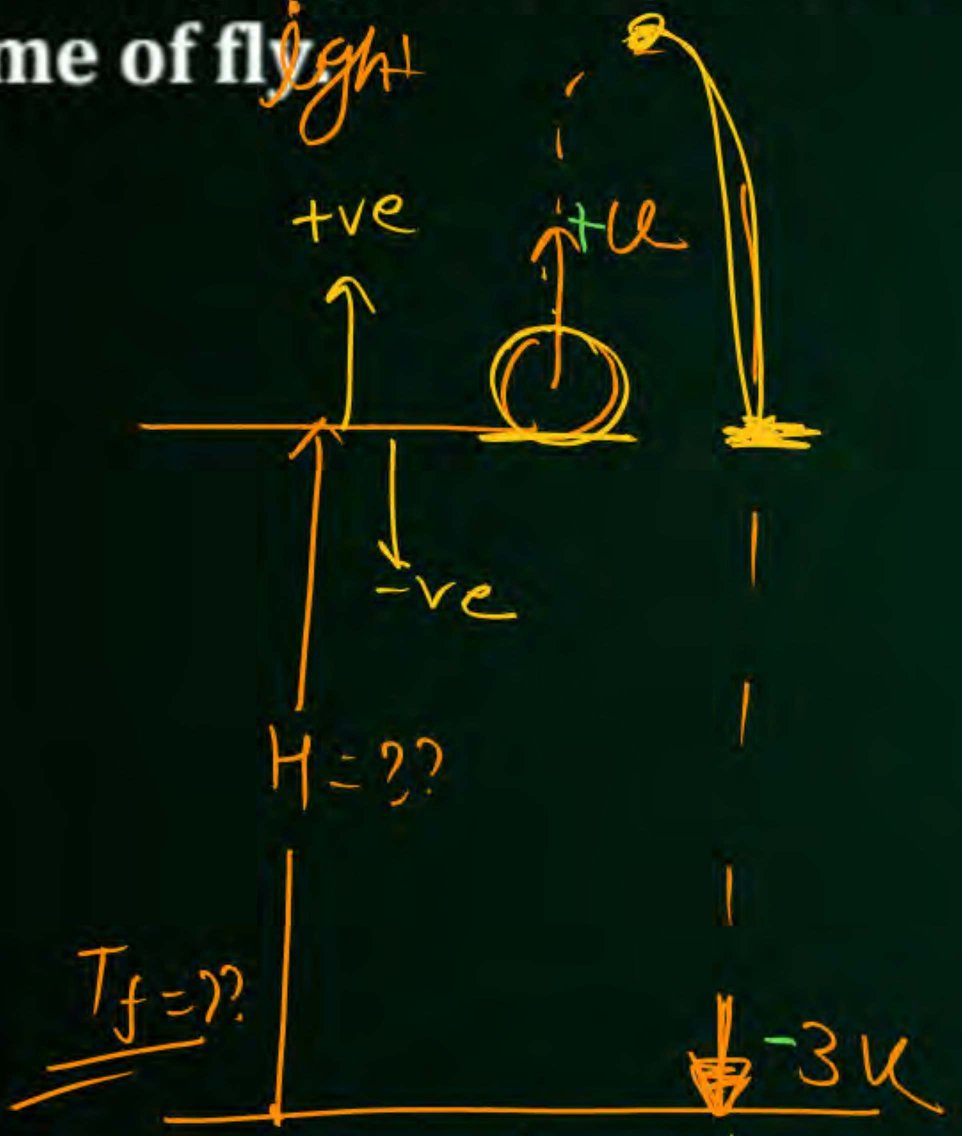
QUESTION

Motion under gravity from height to ground.



QUESTION

Ball is projected up with height H and collide with $3u$ at ground then find H and time of fly.



1st eqn of motn

$$v = u + at$$

$$3u = u - gt$$

~~$\frac{2u}{g} = t$~~

$$\vec{v} = \vec{u} + \vec{a}t$$

$$-3v = u - gt$$

$$gt = u + 3u$$

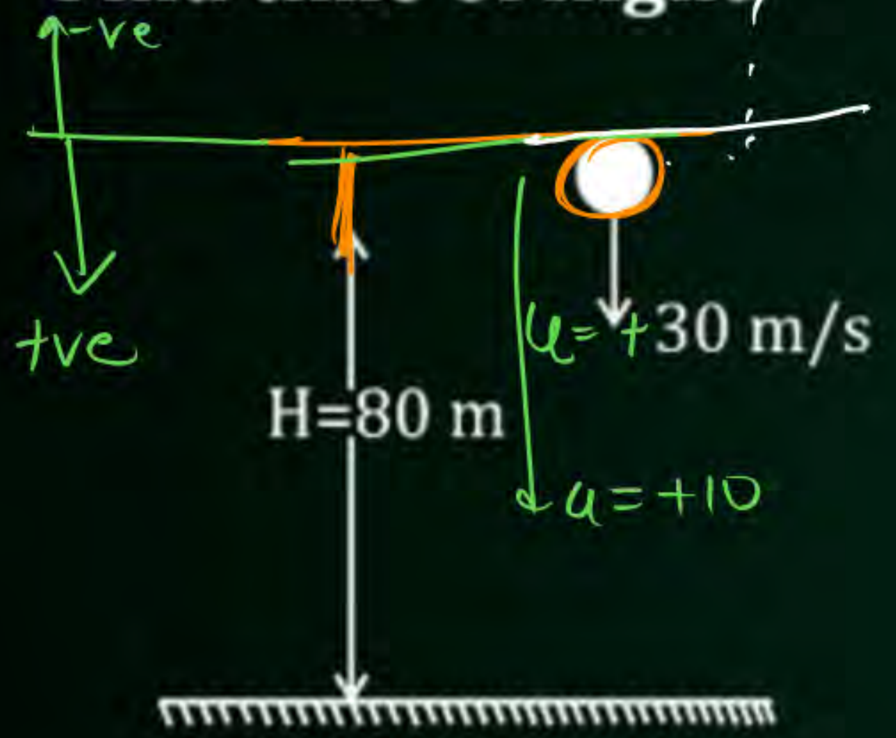
$$t = \frac{4u}{g}$$

$$(-3u)^2 - u^2 = 2(-g)H$$

$$\frac{8u^2}{2g} = H$$

QUESTION

Find time of flight



$$S = ut + \frac{1}{2}at^2$$

$$80 = 30t + \frac{10}{2}t^2$$

$$5t^2 + 30t - 80 = 0$$

$$t^2 + 6t - 16 = 0$$

$$t^2 + 8t - 2t - 16 = 0$$

$$t(t+8) - 2(t+8) = 0$$

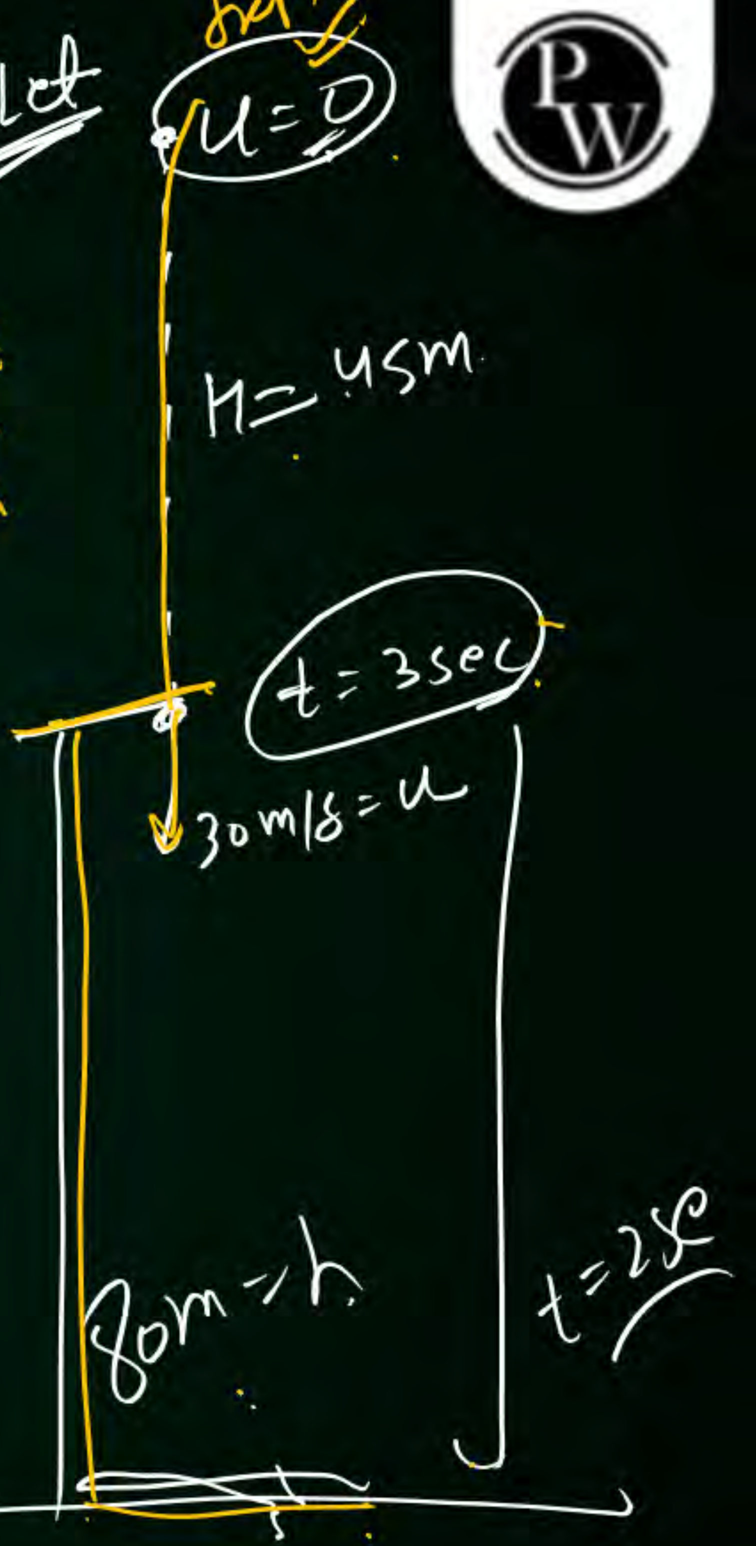
$$(t+8)(t-2) = 0$$

$t = -8$ ✗

$t = 2$ ✓

Let

MP*

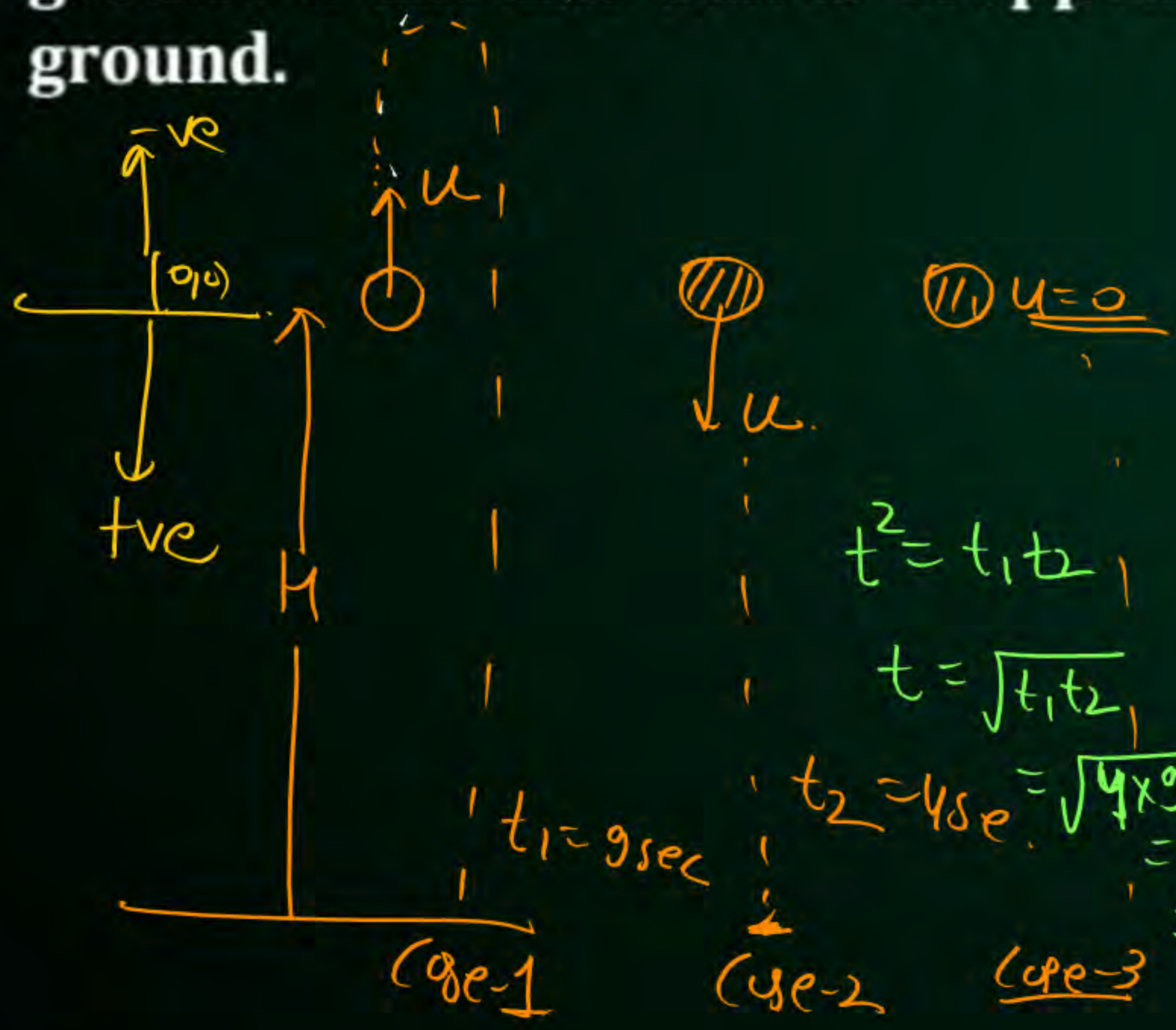


QUESTION NEET-2022

Repeat it by yourself

$H = \frac{1}{2} g t^2$ — (III)

A ball is projected up with speed u from height H and it takes 9s to reach ground another same ball projected downward with same speed it takes 4s to reach ground if another ball is dropped from same height. Then, it will take to reach ground.



$t^2 = t_1 t_2$

$t = \sqrt{t_1 t_2} = \sqrt{4 \times 9} = \sqrt{36} = 6$ sec

$H = -u t_1 + \frac{1}{2} g t_1^2$ — (I) $\times t_2$

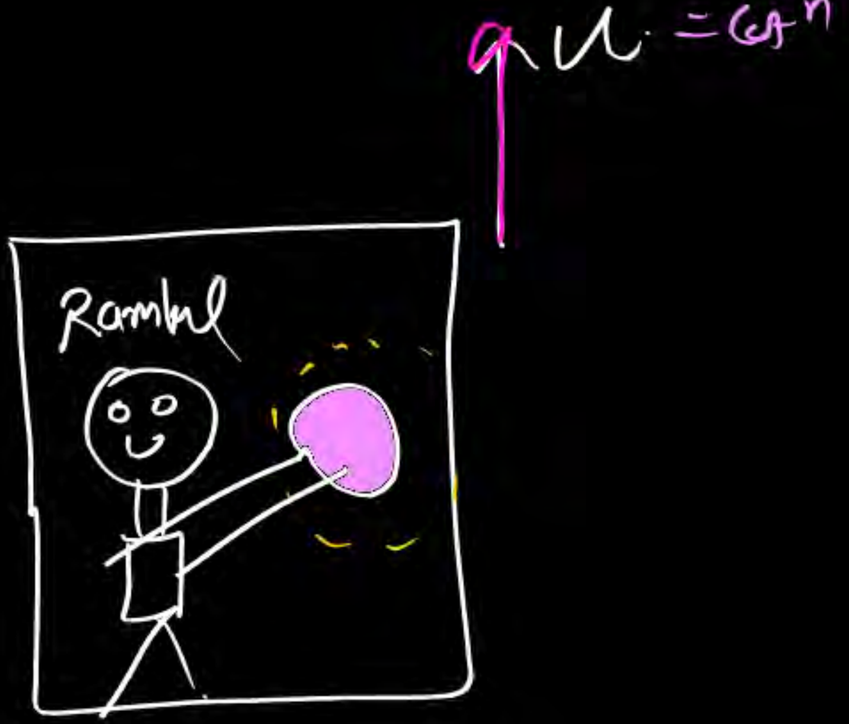
$H = u t_2 + \frac{1}{2} g t_2^2$ — (II) $\times t_1$

$H t_2 = -u t_1 t_2 + \frac{1}{2} g t_1^2 t_2$

$H t_1 = +u t_1 t_2 + \frac{1}{2} g t_2^2 t_1$

$H(t_1 + t_2) = \frac{1}{2} g (t_1^2 t_2 + t_1 t_2^2)$

$\frac{1}{2} g t^2 (t_1 + t_2) = \frac{1}{2} g t_1 t_2 (t_1 + t_2)$



Man relese (drop) a ball in lift. then find velocity of Ball Just after relese.

Before Relese

{ Ball was not Relesed. }

$V_{B(Ramlal)} = 0$

$u_{B(Kallu)} = u$ (Upward)

$a_{Ball} = 0$ (not)

Just after relese

$u_{Ball(Ramlal)} = 0$ ✓

$u_{Ball(Kallu)} = u$ (Upward)

$a_{Ball} = g$ (downward)



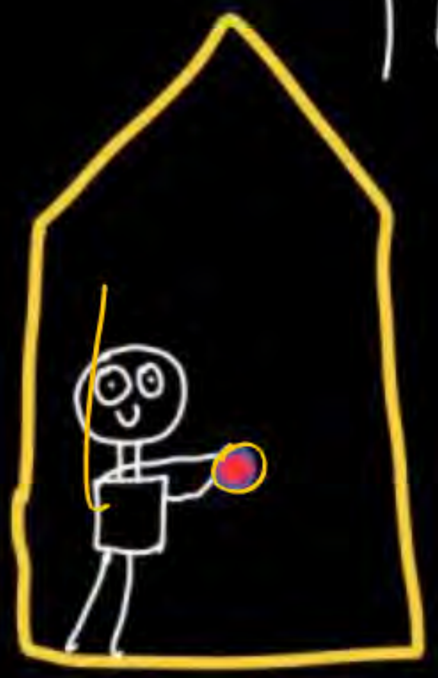
Ball is droped by Ramlal in moving lift then find, it's velocity and acceleration

Just after release.

w.r.t ground.

$\uparrow u_{lift} = u_0$

$\uparrow a_{lift} = a_0$

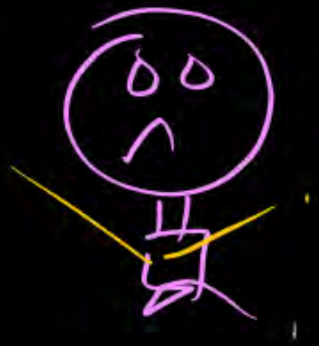


Just after released

$u_{Ball\,gro} = u_0$ (uPard)

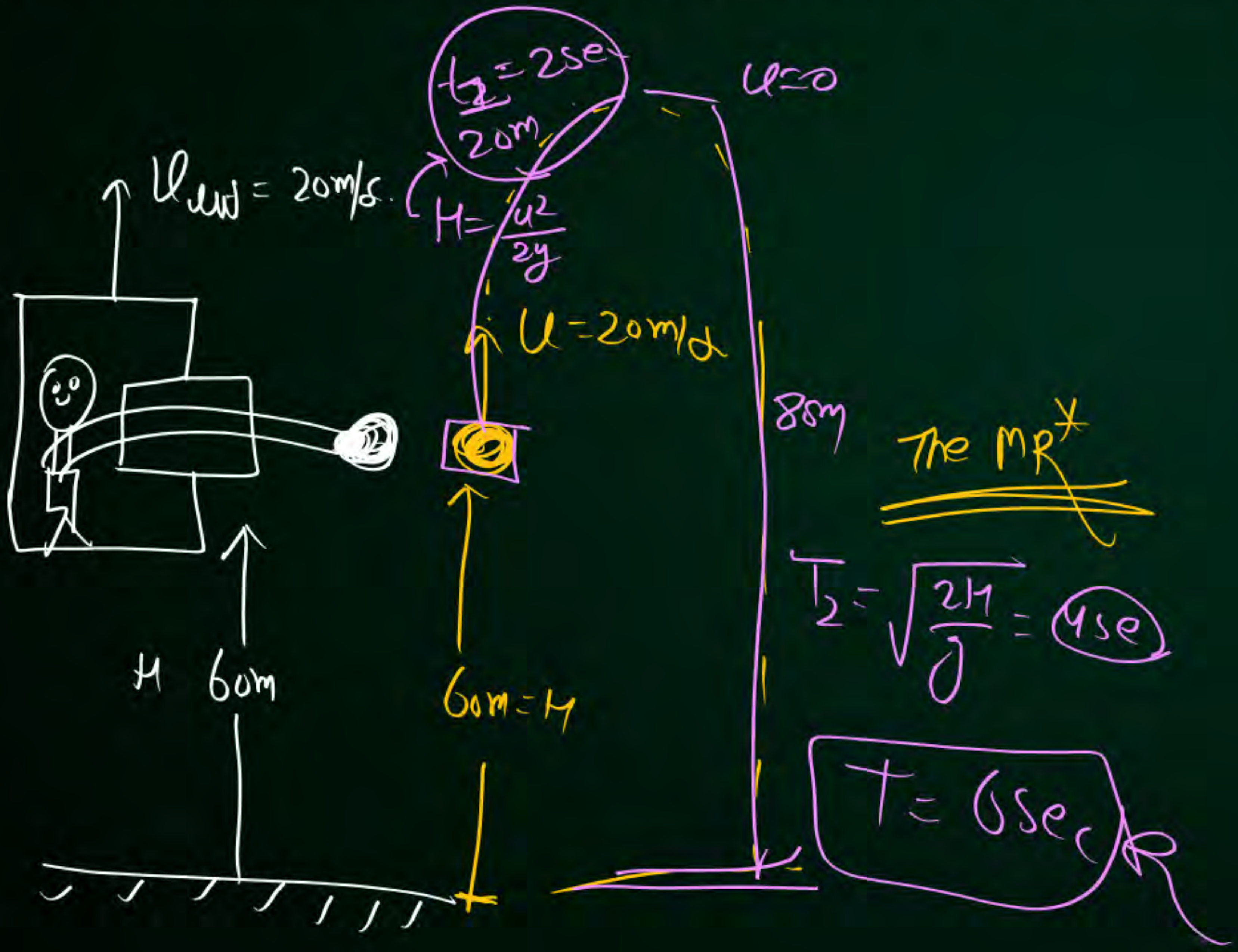
$a_{Ball\,grou} = g$ (down)

Ans

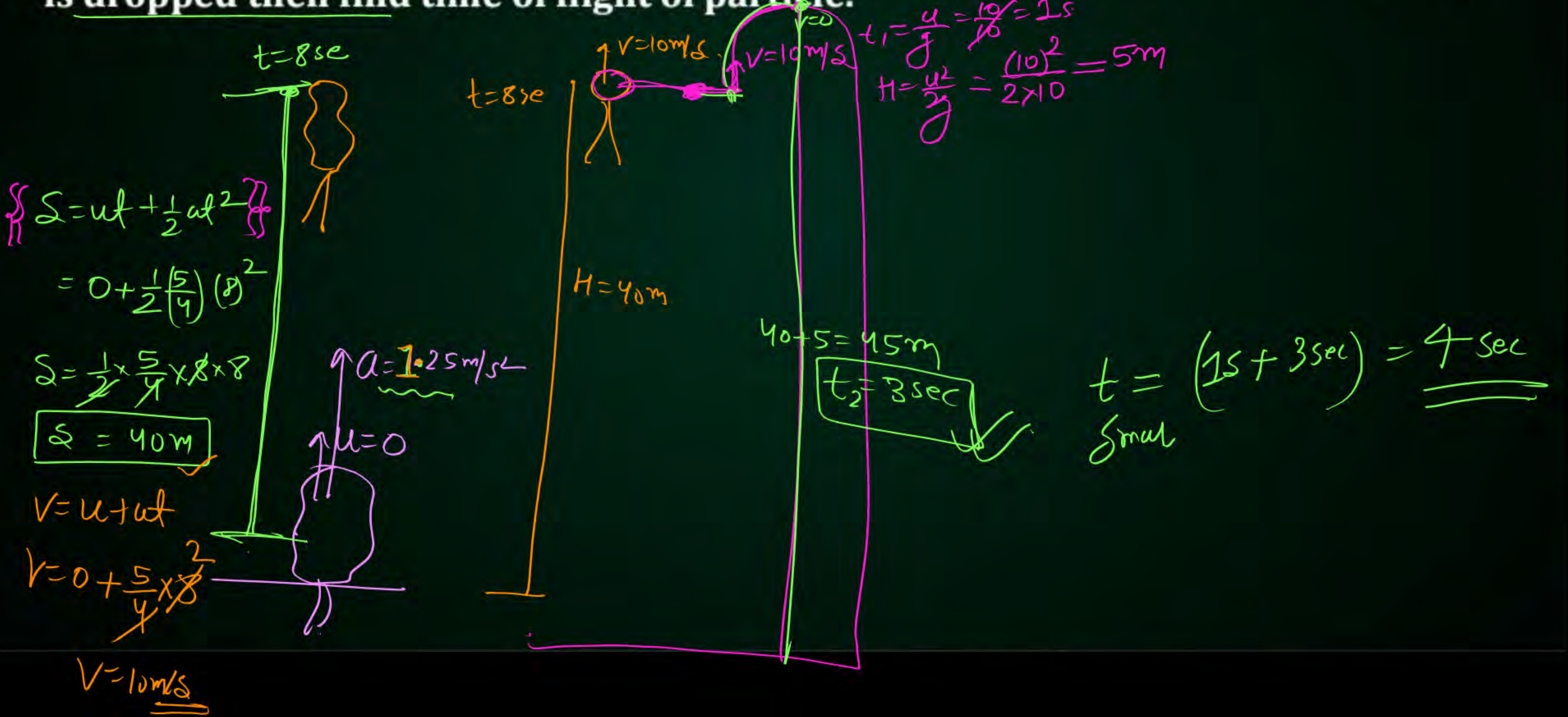


QUESTION

A lift is moving with uniform speed 20 m/s. Ball is released from lift when lift is at height 60 m from ground. Find total time of flight.



A balloon starts rainy up from ground with 1.25 m/s² after 8 sec a small particle is dropped then find time of flight of particle.



QUESTION

Rocket starts his motion in upward direction with acceleration 10 m/s² upward. After 5 sec engine off then find maximum height from ground.

$u = 0$

$v = u + at = 0 + 10 \times 5 = 50\ m/s$

$S = ut + \frac{1}{2}at^2 = 0 + \frac{1}{2} \times 10 (5)^2 = 5 \times 25 = 125\ m$

$a = 10\ m/s^2$

$H = 125\ m$

$v = 0$

$H = \frac{u^2}{2g} = \frac{(50)^2}{2 \times 10} = \frac{50 \times 50}{20} = 125\ m$

$u = 50\ m/s$

$a = g$

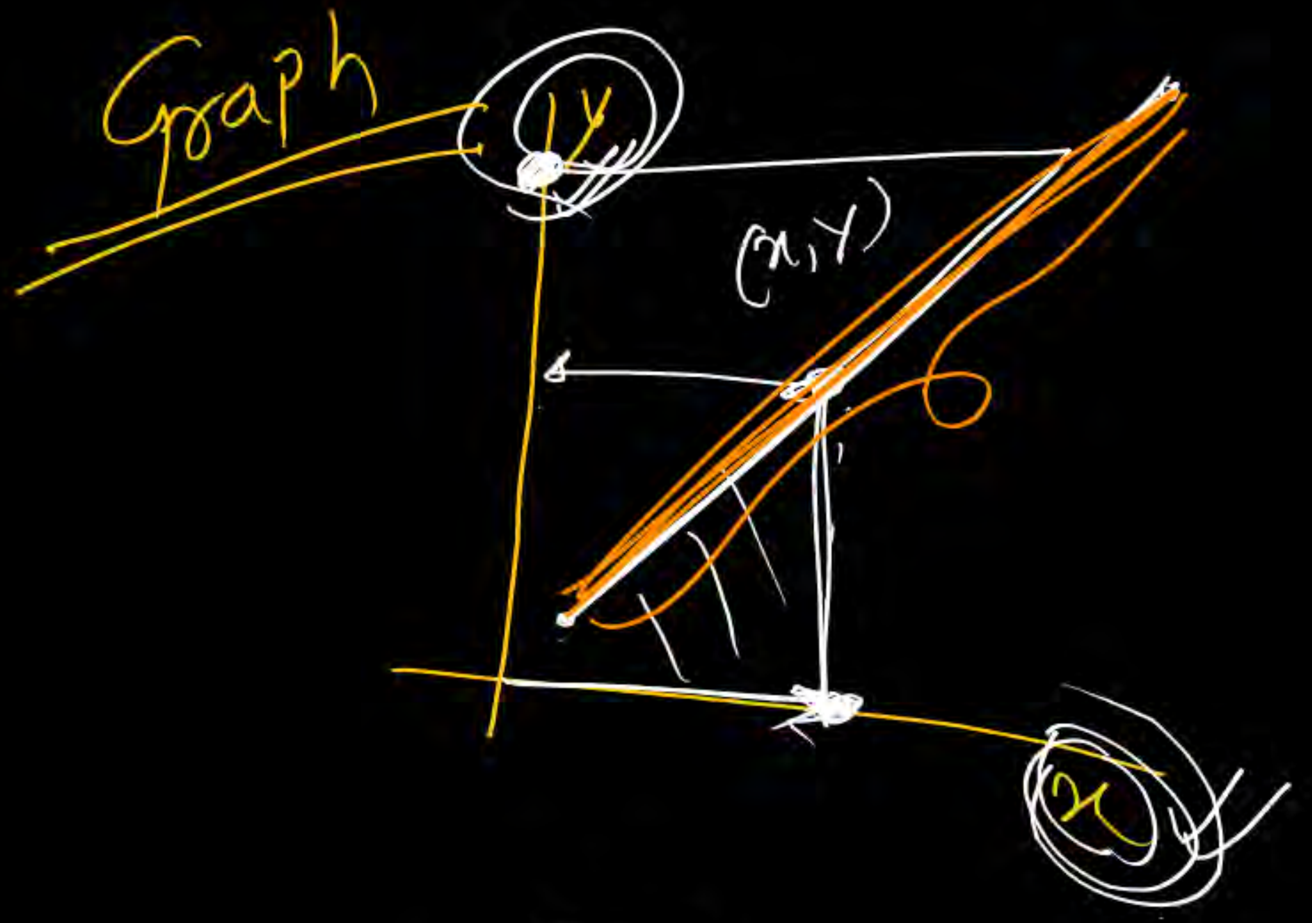
$H_{max\ from} = 125 + 125 = 250\ m$

Total time of flight from ground to ground $= 5\ sec + \frac{u}{g} + \sqrt{\frac{2H}{g}}$

$= 5\ sec + \frac{50}{10} + \sqrt{\frac{2 \times 250}{10}}$

$= 5 + 5 + \sqrt{50}$

$= 10 + 7.1 = 17.1$

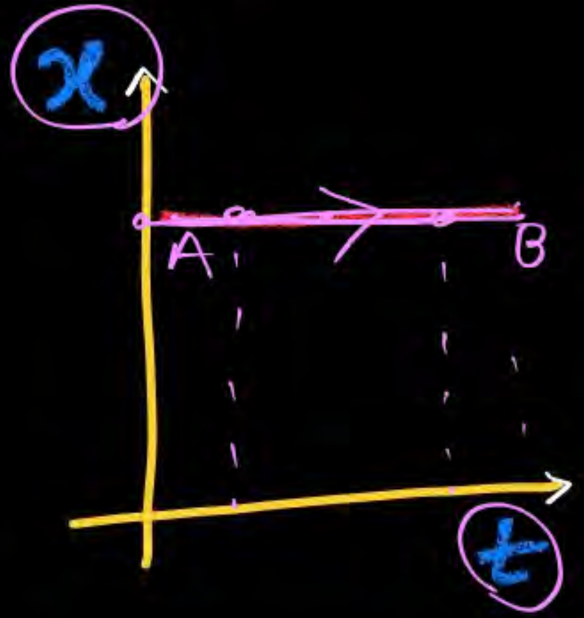


Slope $= \tan\theta = \frac{dy}{dx} = \frac{y}{x}$

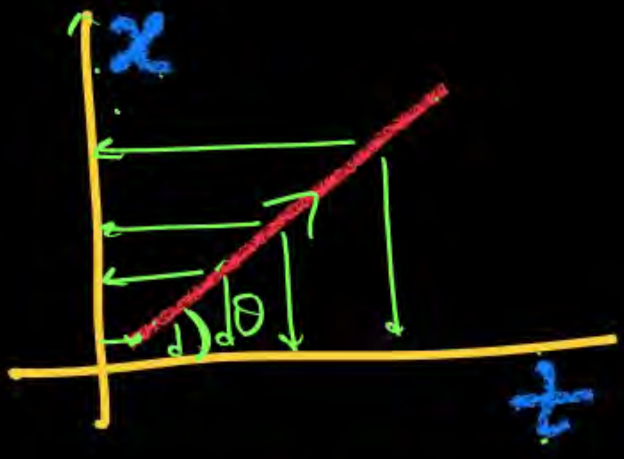
Area $= \int y\,dx =$

Graph for straight line :-

Position time graph



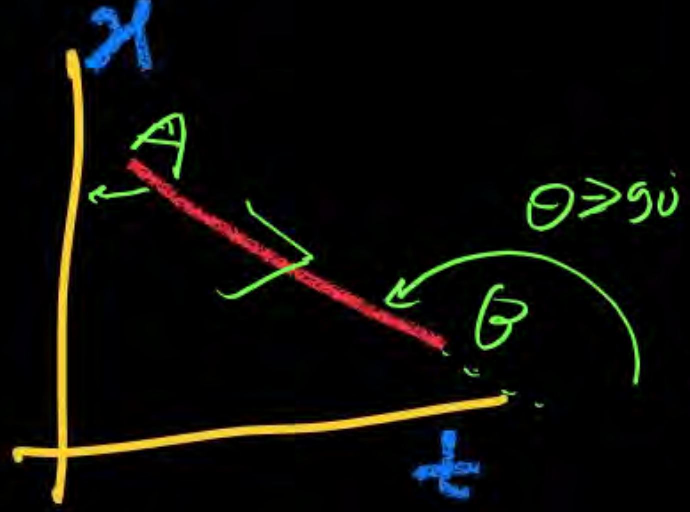
- Position = fixed
  cots
- time ↑
- Velocity = rest = 0
  1. Area X
  Slope = 0



- Positio ↑
- time ↑
- Slope = tanθ = +ve (cotⁿ)

Velocity = (+ve & cotn)

Uniform Motin



Positio ↓

time ↑

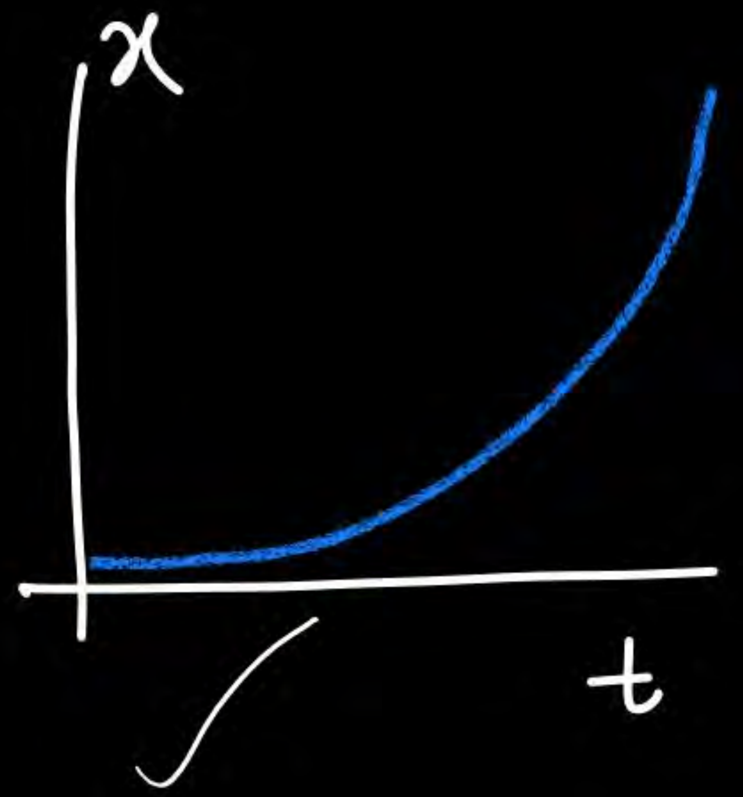
velociti = −ve & costⁿ (Slope)

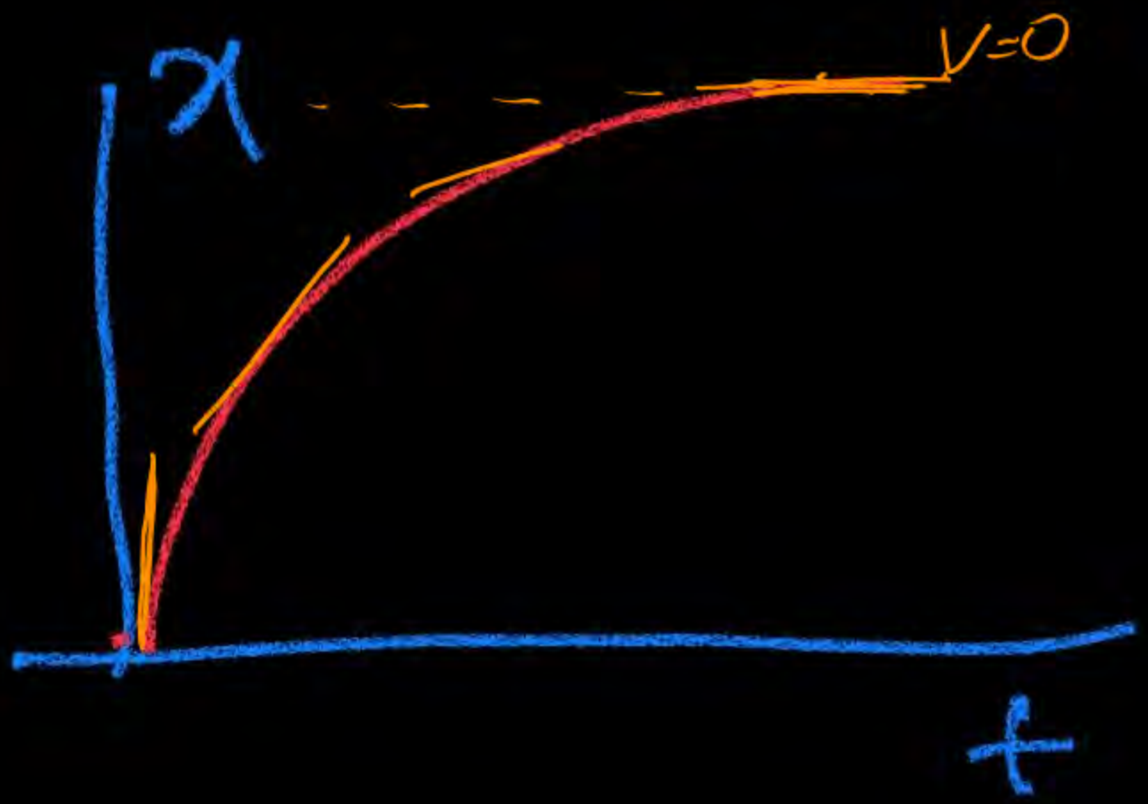


Position ↑ time ↑

velocity = (Slope) ↑

= +ve (Increasi)





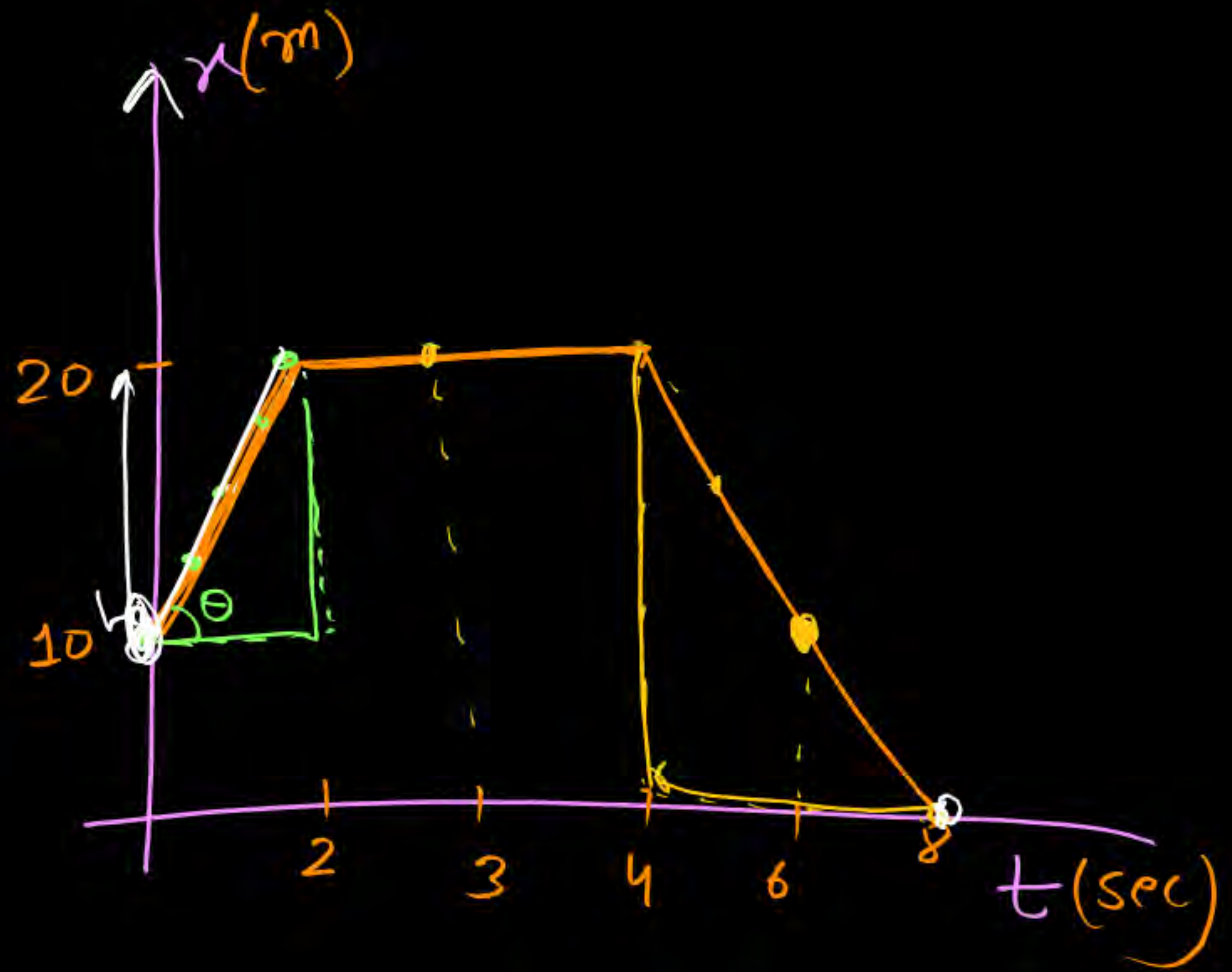
Velocity ⇒ +ve → decresing & finally Comes to at re



How many times object comes to a rest.

(Slope) = 2 time zero

velocity



find velocity at

$V_{t=0} = 5$ m/

$V_{t=1s} = 5$ 5m/s

$V_{t=3s} = 0$

$V_{t=6s} = -5$ m/s

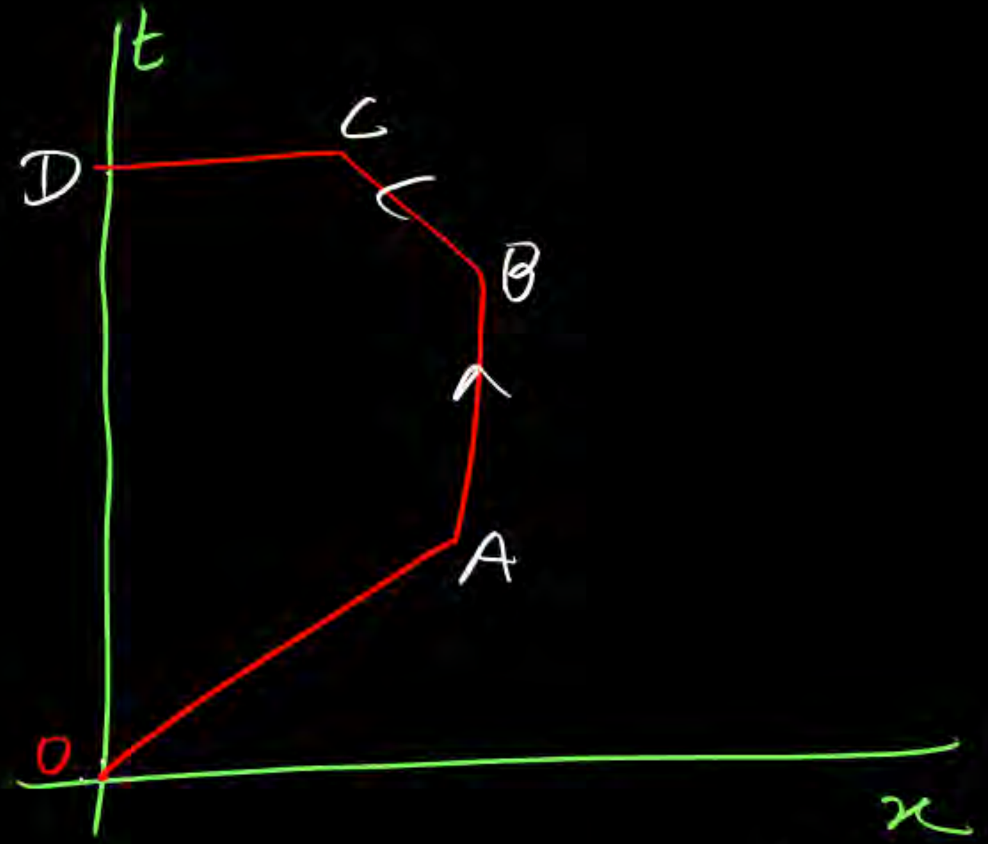
Slope of Position-time graph is velocity =

$\tan\theta = \frac{20/10}{2} = \frac{10}{2} = 5$

Instantaneous Velocity

Avg velocity in 8-sec = $\frac{\text{total disp}^n}{\Delta t} = \frac{0-10}{8} = -\frac{10}{8}$ m

Avg. speed in 8-sec = $\frac{30}{8}$



Find disp^m B/w 'O to D'

(a) dispⁿ = 0

(b) dispⁿ ≠ 0

Velocity - time graph

accⁿ - time graph.

Velocity Position graph


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture-12 | Physics

$x = t^2 + 2t$

Motion In a Straight Line



By- Dr. Manish Raj (MR SIR)

Topics to be covered

1. #

2. # Graph

3. #

4. #



Question

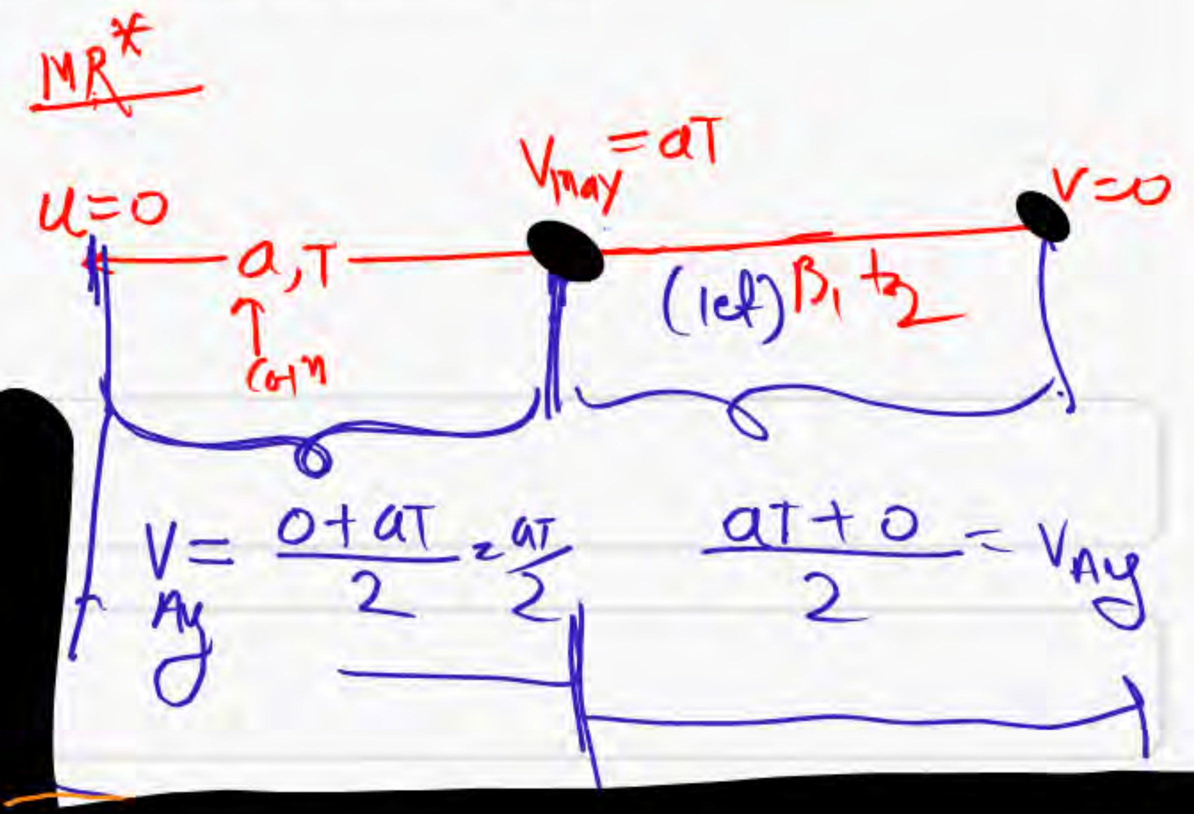
A car starts from rest and moves with uniform acceleration a on a straight road from time t = 0 to t = T. After that, a constant deceleration brings it to rest. In this process the average speed of the car is

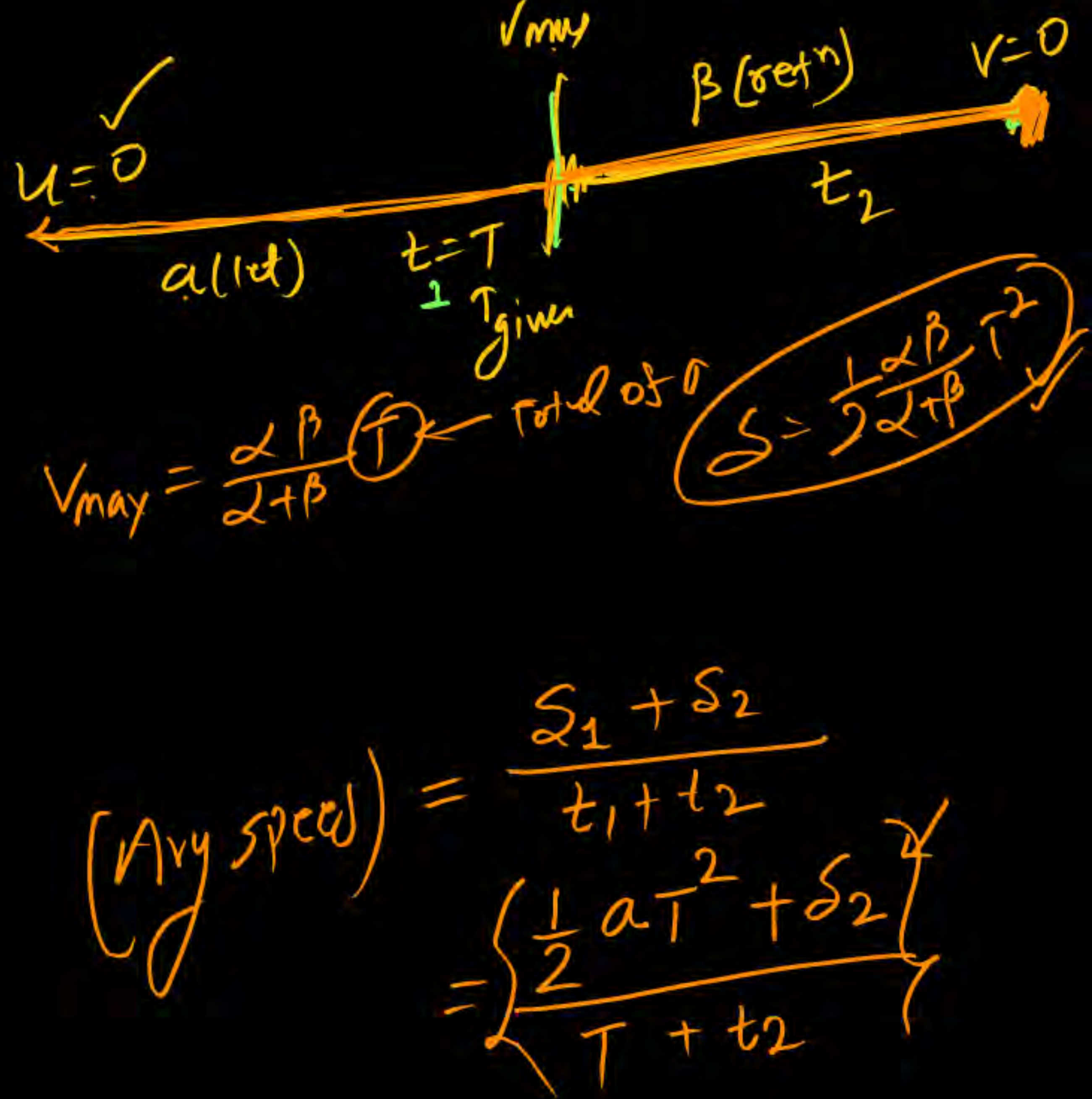
A. aT

B. $\frac{aT}{4}$

C. $\frac{3aT}{2}$

D. $\frac{aT}{2}$





Solution

The correct option is **C** $\frac{aT}{2}$

For First part,

$u = 0, t = T$ and acceleration $= a$

$\therefore\ v = 0 + aT$ and $S_1 = 0 + \frac{1}{2}aT^2 = \frac{1}{2}aT^2$

For second part,

$u = aT$, retardation $= a_1$, $v = 0$ and time taken $= T_1$(let)

$\therefore\ 0 = u - a_1T_1 \Rightarrow aT = a_1T_1$

and from $v^2 = u^2 - 2aS_2 \Rightarrow S_2 = \frac{u^2}{2a_1} = \frac{1}{2}\frac{a^2T^2}{a_1}$

$S_2 = \frac{1}{2}aT \times T_1$ (As $a_1 = \frac{aT}{T_1}$)

$\therefore V_{av} = \frac{S_1+S_2}{T+T_1} = \frac{\frac{1}{2}aT^2+\frac{1}{2}aT\times T_1}{T+T_1}$

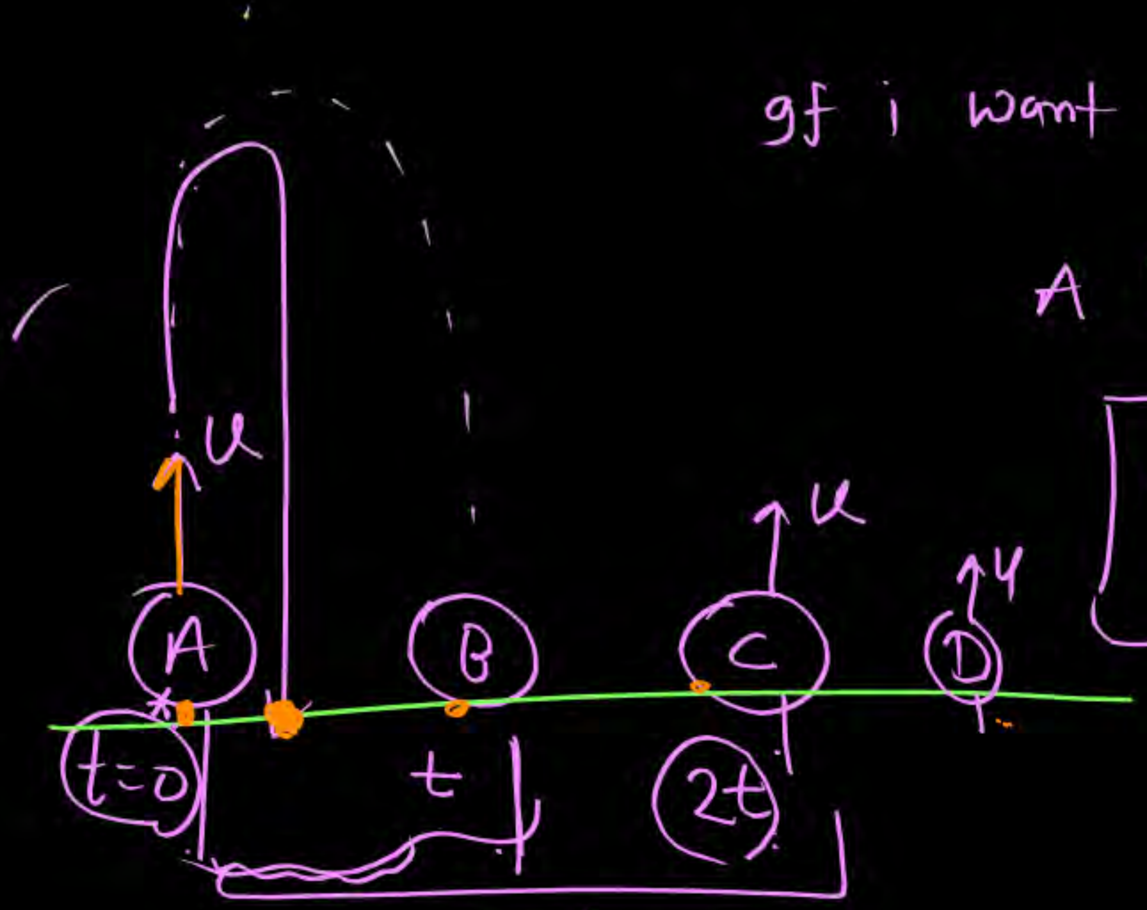
$= \frac{\frac{1}{2}aT(T+T_1)}{T+T_1} = \frac{1}{2}aT$

one and half page

A Jugglar wants to keep n Ball in air, if he is throwing Ball with Speed u then what shout be time intraval.

If i want to keep 2 – Ball in air

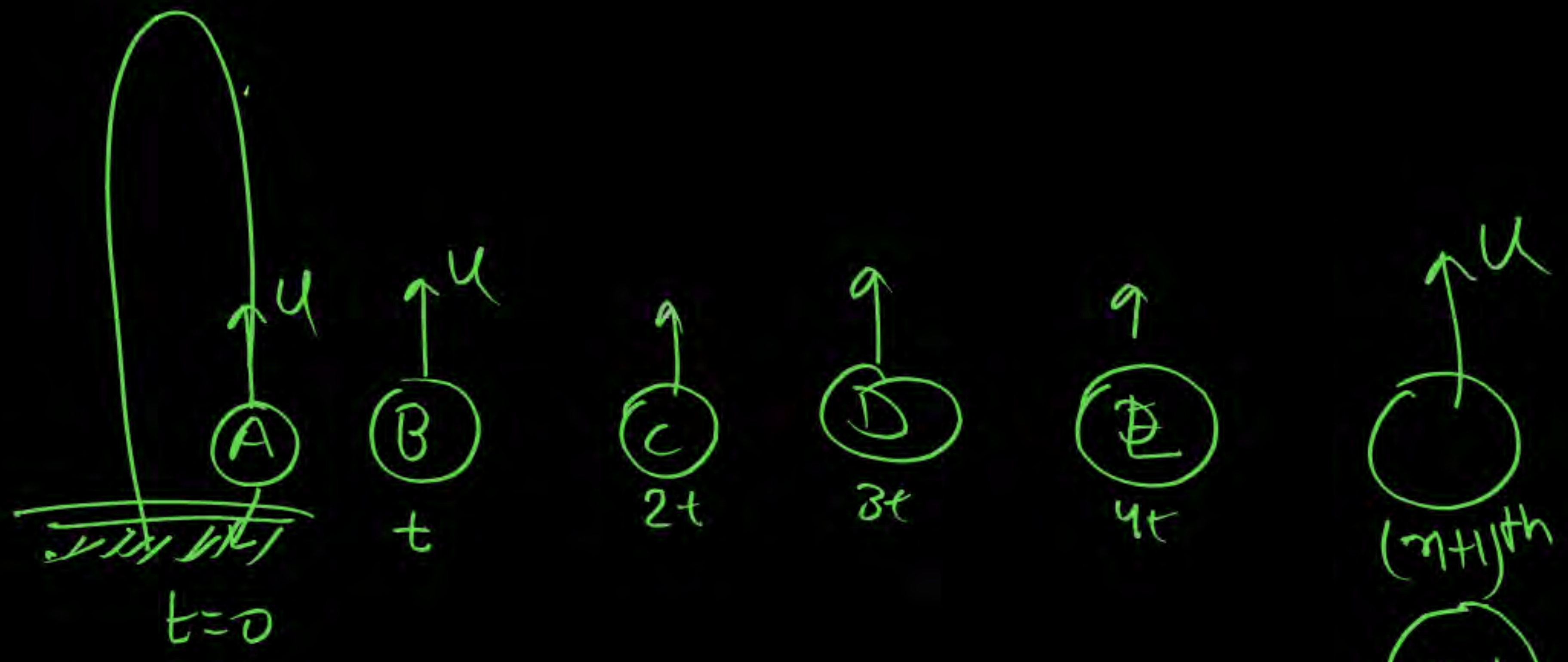
A Ball reach at a groul after time $= T_f = \frac{2u}{g}$



C Ball will be Projecte $= (2t) = \left(\frac{2u}{g}\right)$

time interval $= t$ (1cell)

A Jugglar wants to keep n Ball in air, if he is throwing Ball with Speed u then what shout be time intraval



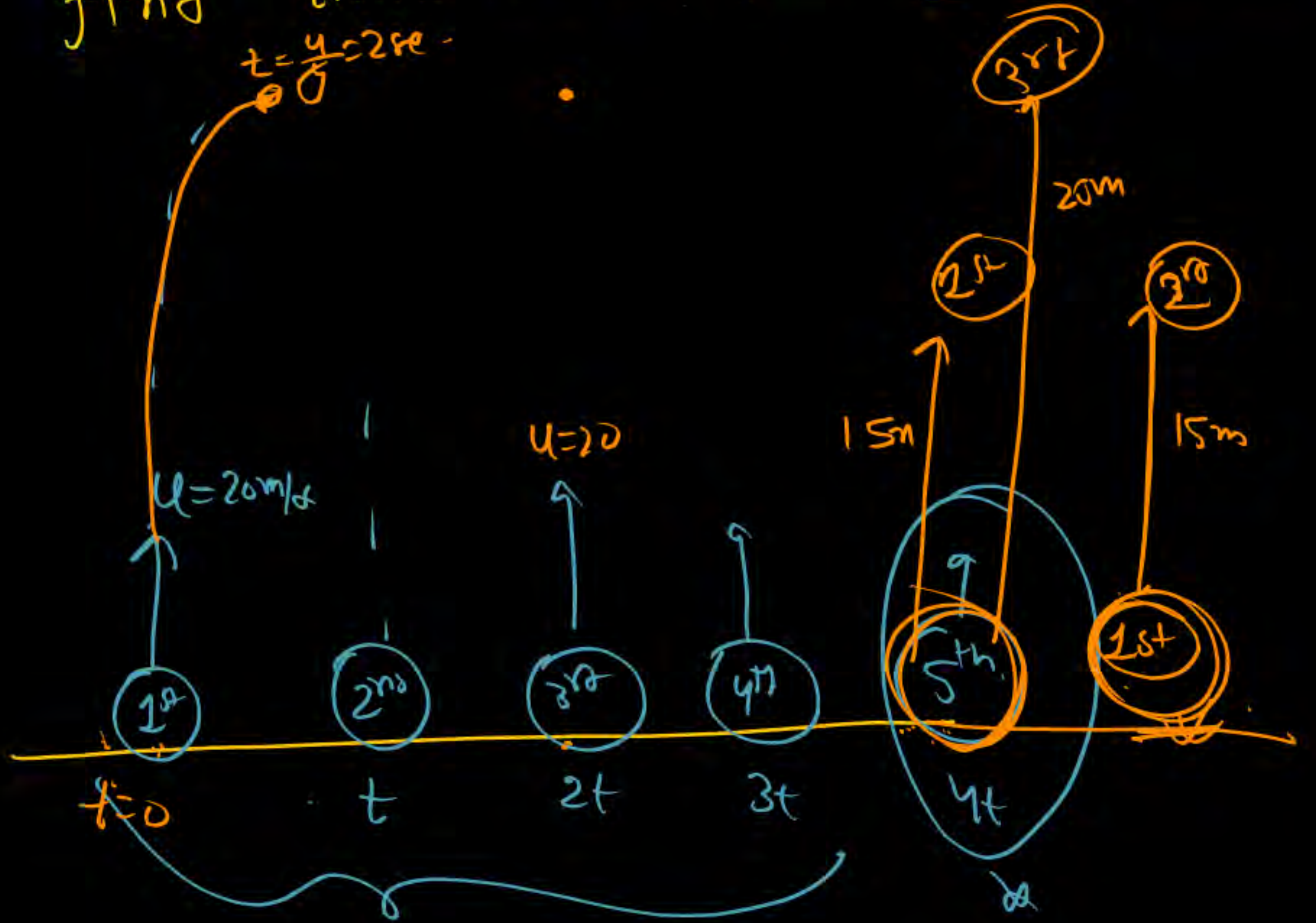
nt = Time of flight $= \frac{2u}{g}$

Ans

$$(nt) = \frac{2u}{g}$$

Jugglar Probm

A Jugglar maintain **4 Ball** in air with throwing speed 20m/s then find time intraval, and Position of Balls when one ball just about to Project.



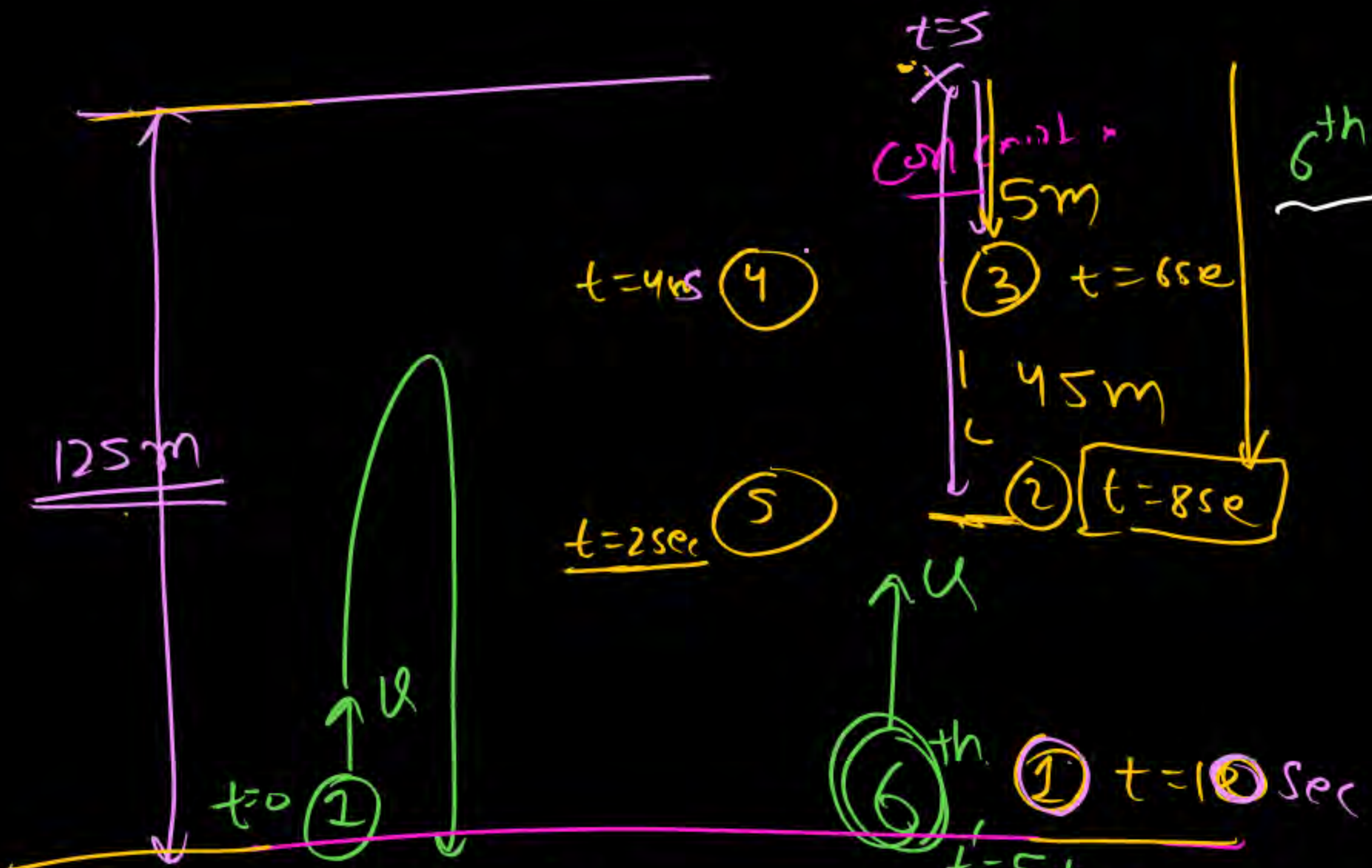
$$\frac{2u}{g}=4t$$

$$\frac{2\times 20}{10}=4t$$

$$4=4t$$

$$t=1\ sec$$

Juggler wants to keep 5 Ball in air he Project each Ball with a time intraval of 2 sec, then find velocity of Projection



6th ko tab Project Karenge Jab 1st ground pe return aayga.

$\frac{2u}{g} = 5t$

$\frac{2 \times u}{10} = 5 \times 2$

$u = 50 m/s$

0, 120m, 120m, 80m, 80m

Graph.

Step-1 : Note Book बंद कर दो

Step-2 : rough Book निकाल लो

Step-3 theory or questn जब M.R Teach करेगा तो सिर्फ focus से सुनना है

Step-4 जब question solve करना है (Pole) rough पे

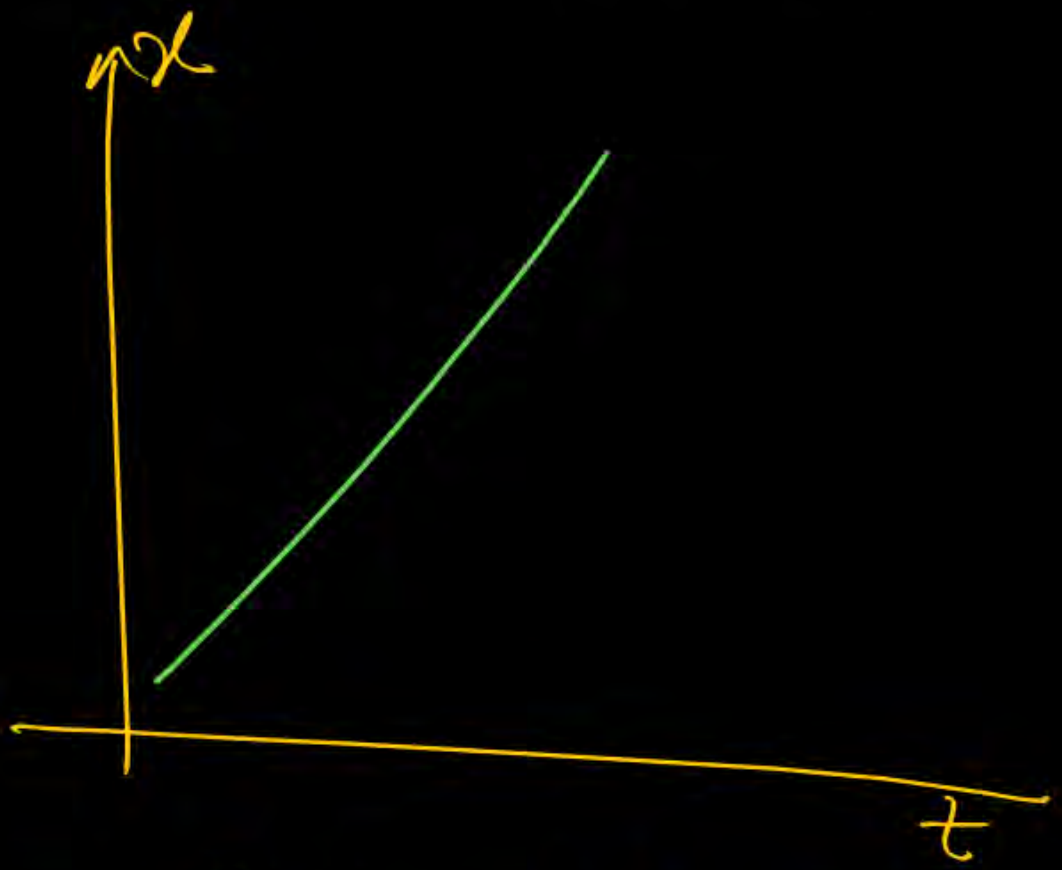
Step-5 → P.D.f से Notes बनाना है

→ ~~Cutss से [illegible] P.D.f~~

⟹ Notes बनाया है (मुझे sent)



Graph Position time



Y-axis → Position (x)

x-axis → time (t)

Slope = $\frac{dy}{dx} = \frac{dx}{dt}$ = velocity

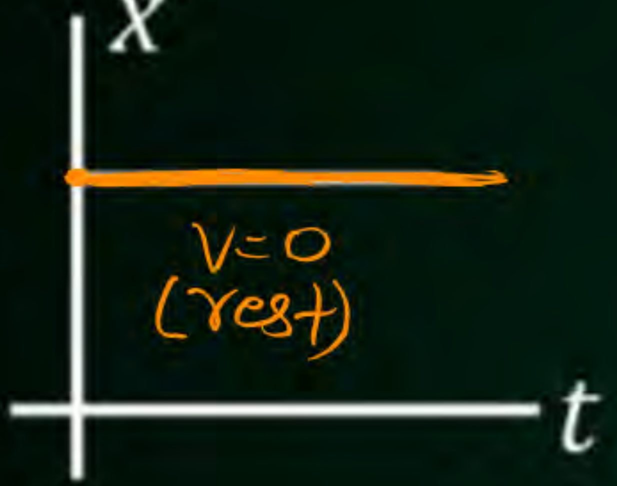
Area = $\int y\,dx$

= $\int$ position × time ✗

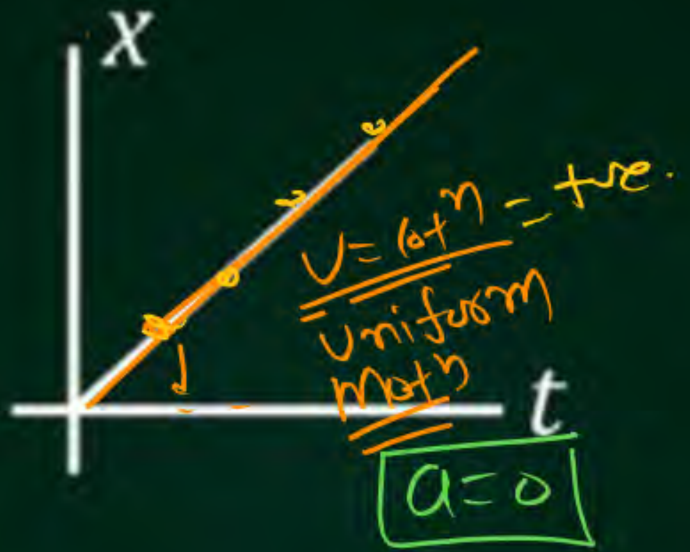
QUESTION 1

Comment nature of motion for given graph ?

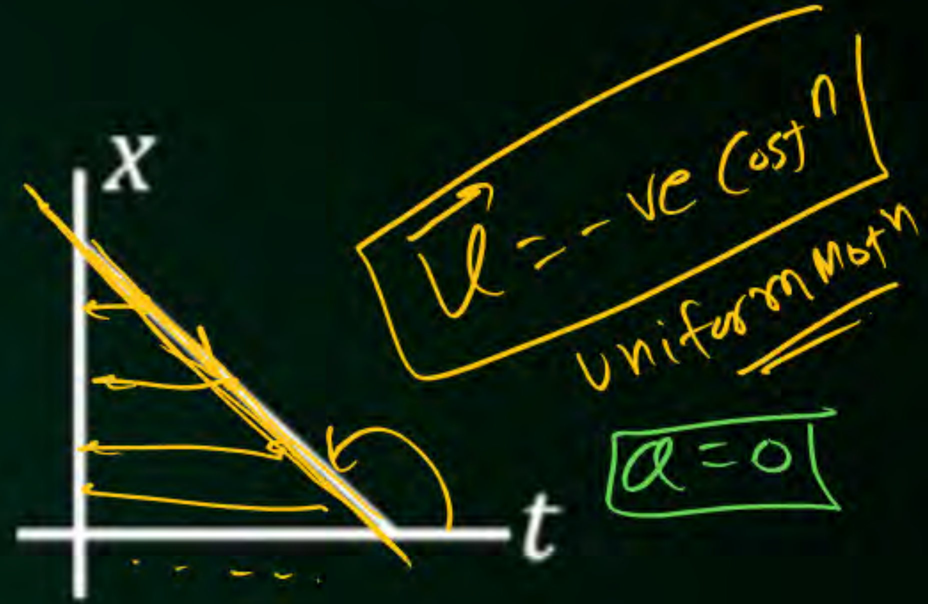
(i)



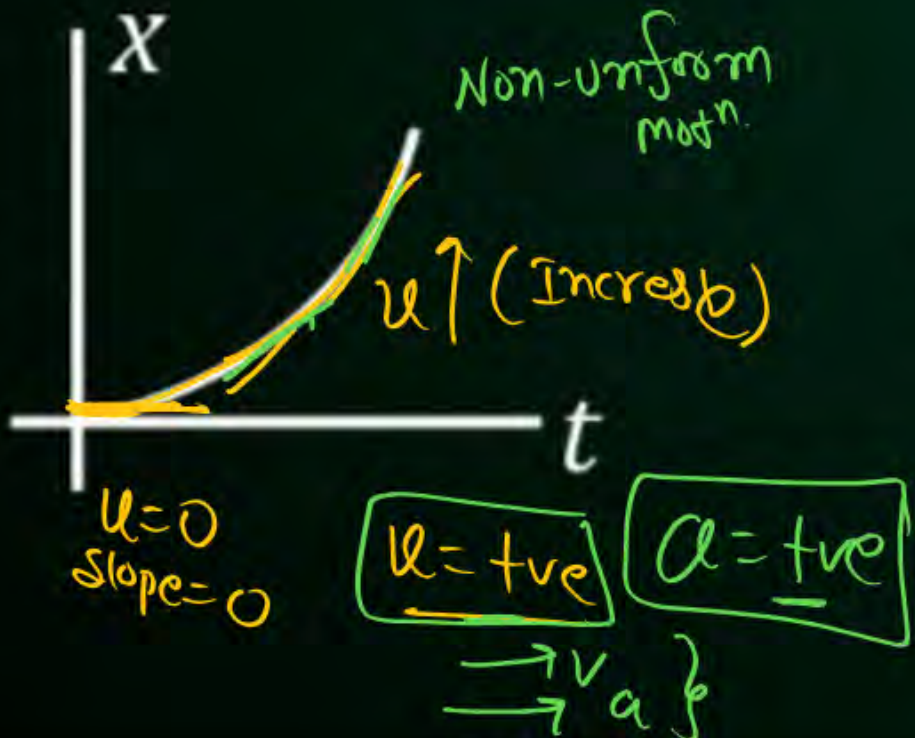
(ii)



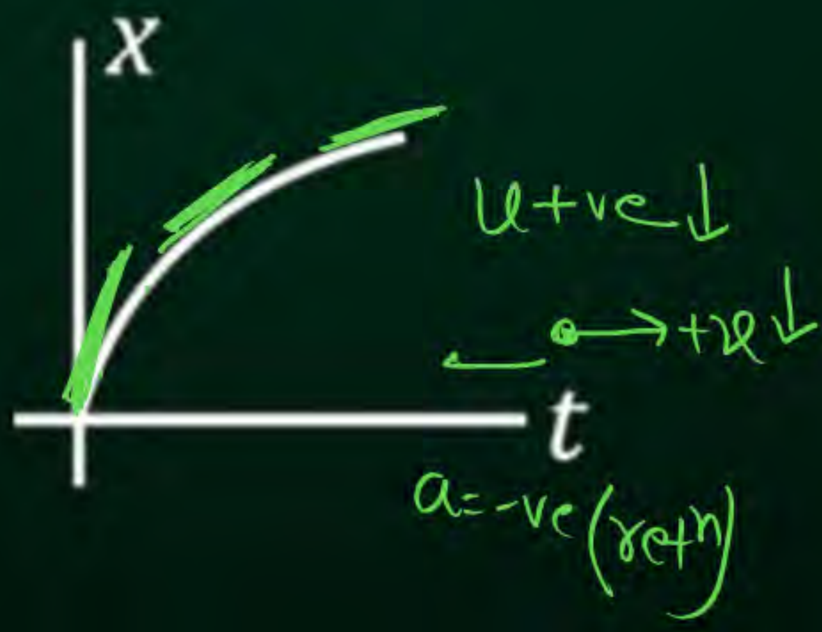
(iii)



(iv)



(v)



MP*

If x → is +ve & Incrg

v = +ve

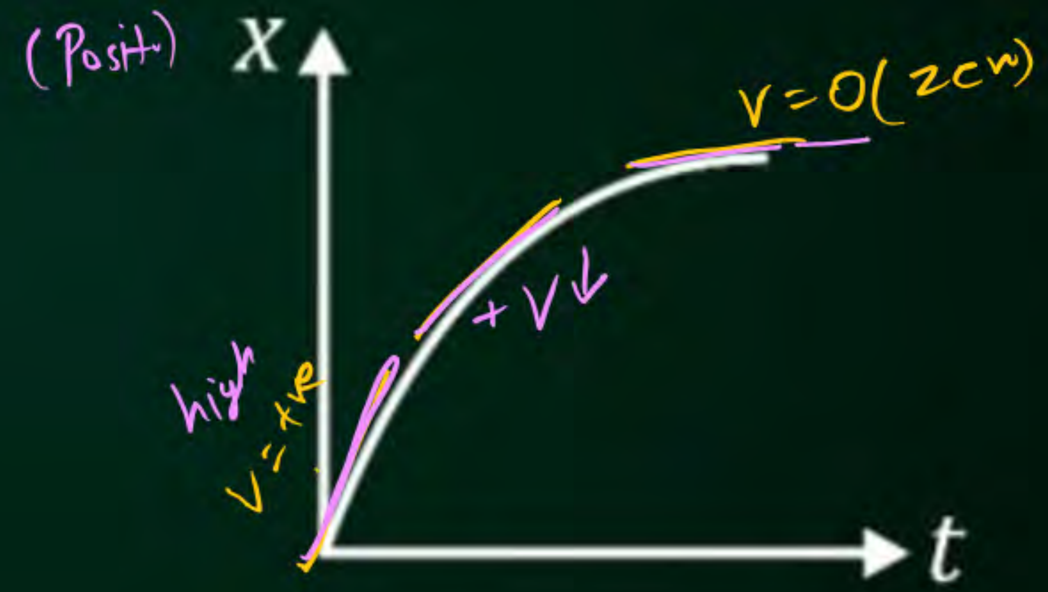
(x → is +ve & decrg

V = -ve)

QUESTION

Acceleration for given position-time graph is

1. –ve
2. +ve
3. zero
4. increasing



IIT-adv

In which time interval acc^n & velocity is Parallel (same-dir^n)

(a) t_1 to t_2

(b) t_1 to t_3

(c) t_2 to t_3

(d) None of the

[If acc^n & velocity is antiparallel speed ↓]

If acc^n & velocity is Parallel then (speed ↑)

t_1 to t_3 → acc^n is −ve

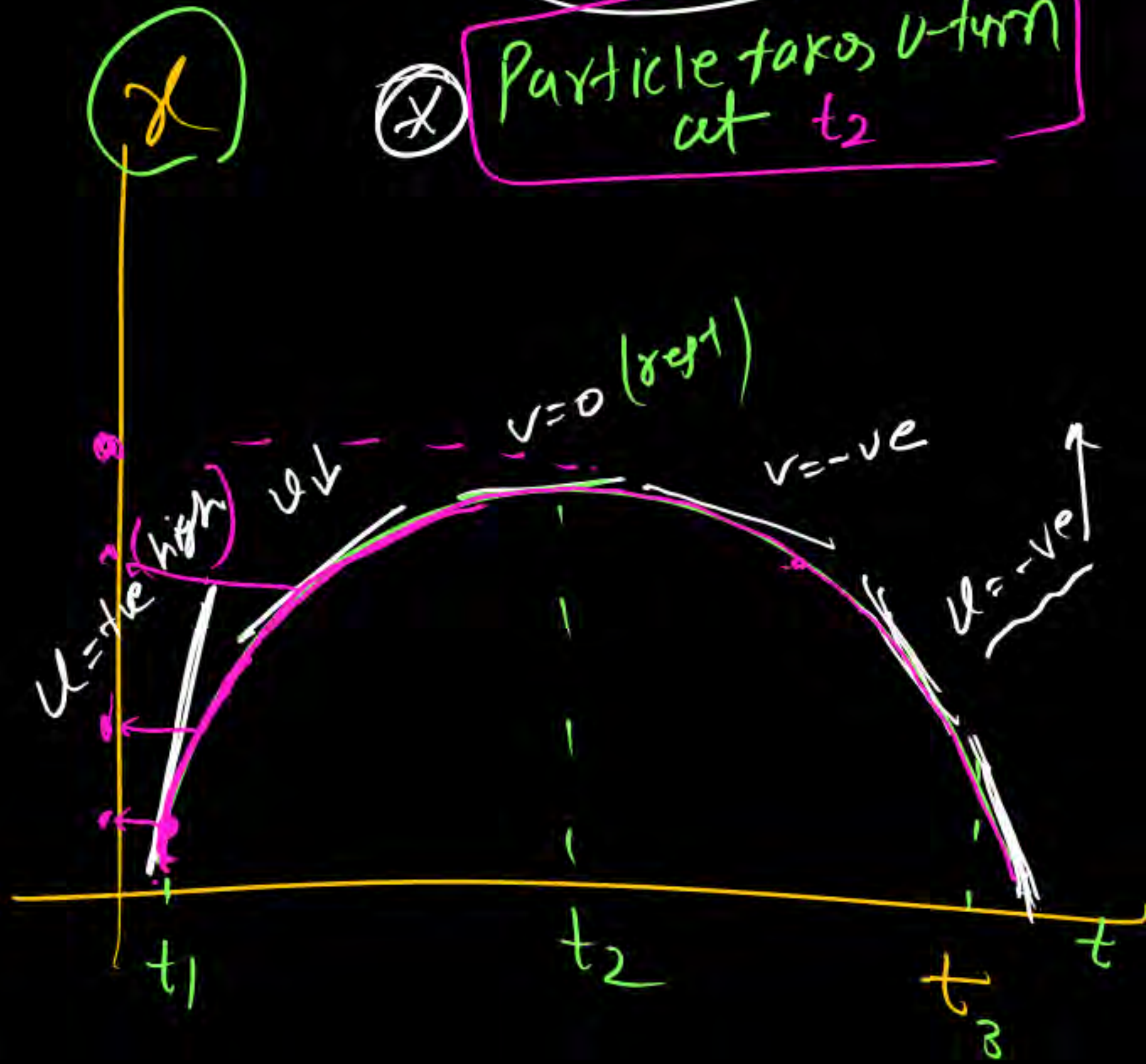
t_1 to t_2

$a = -ve$, v ↓

t_2 to t_3

$-v$, $-a$

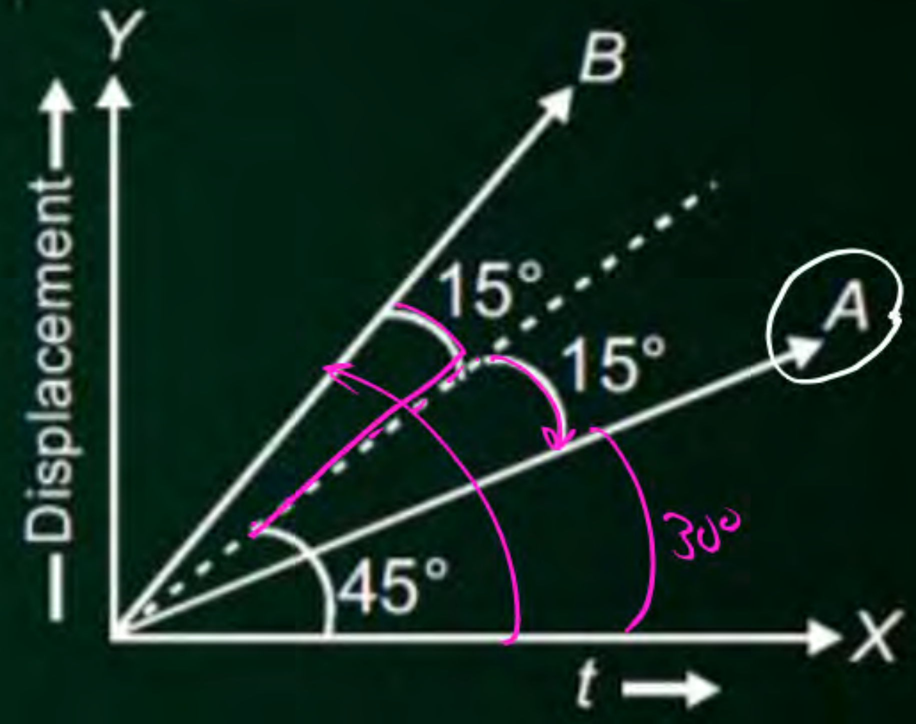
Particle takes U-turn at t_2

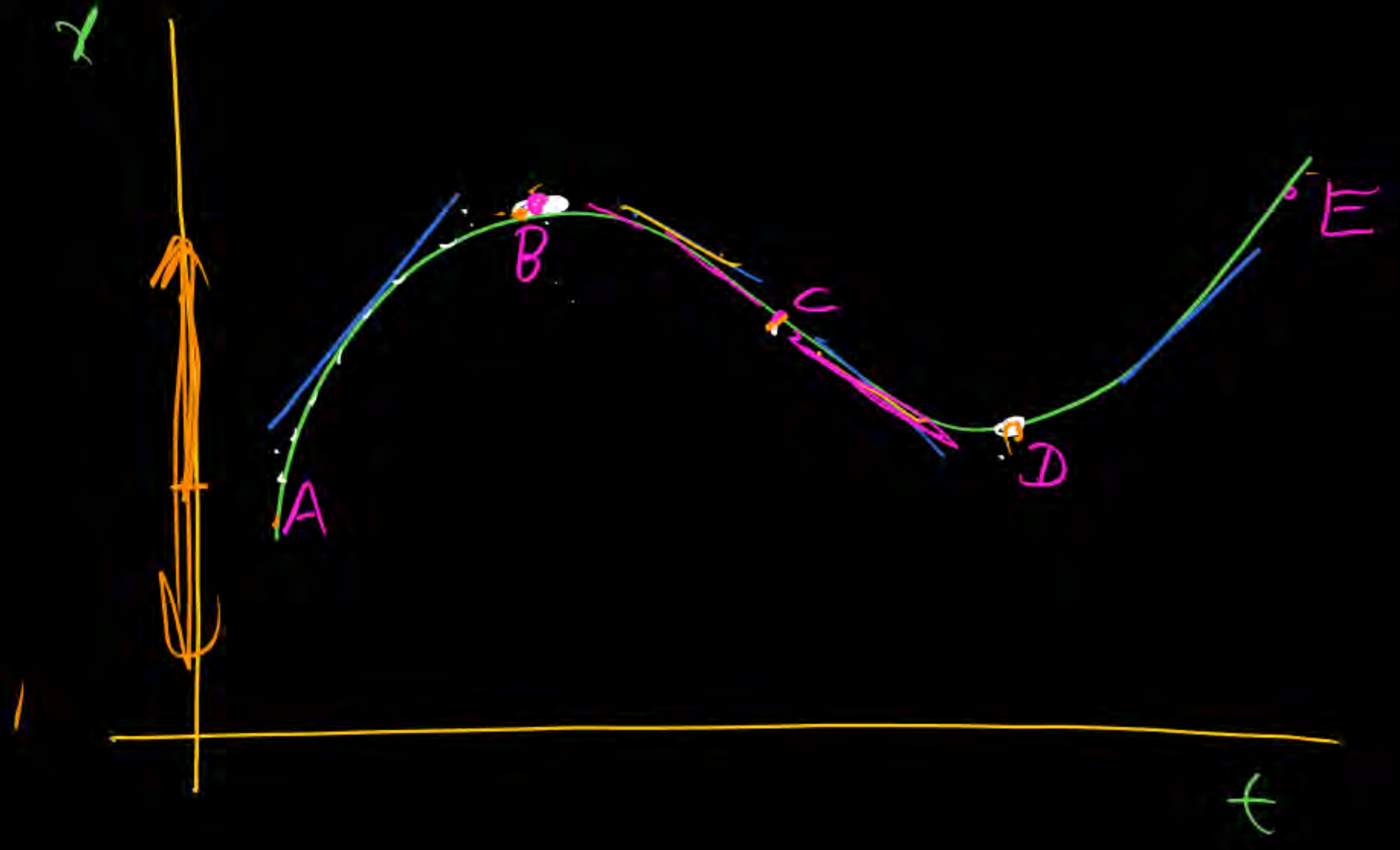


QUESTION

The displacement-time graph for two particles A and B is follows. The ratio v_A/v_B is

1. $1:2$
2. $1:\sqrt{3}$
3. $13:1$
4. $1:3$





One-leg stand for next 5 mint

at $V_B = V_D = 0$

$V_{AB} \rightarrow +ve$

$V_{BC} \rightarrow -ve$

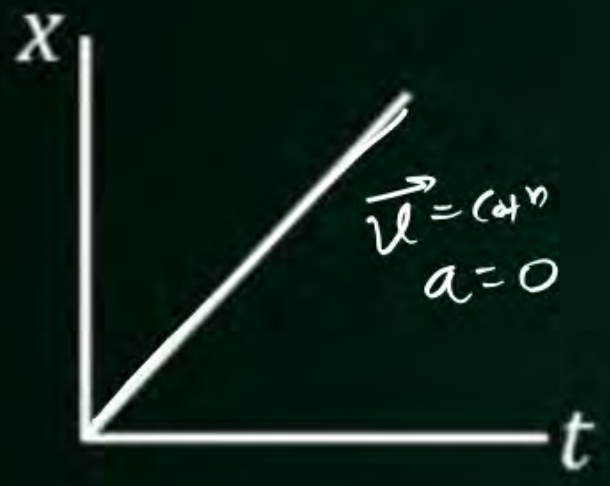
$V_{CD} \rightarrow -ve$

$V_{DE} \rightarrow +ve$

QUESTION

In which graph acceleration is non-zero constant ?

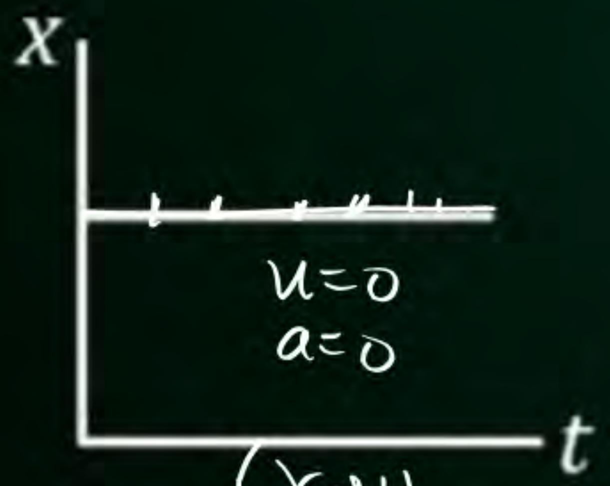
1.



2.



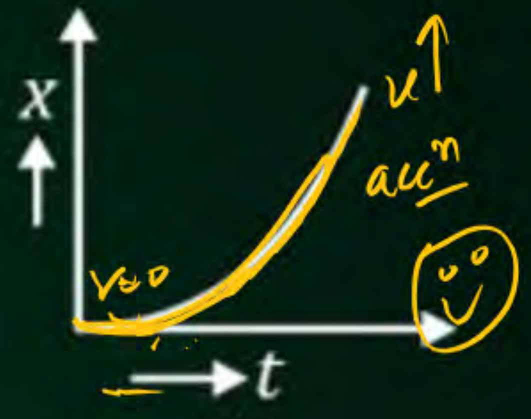
3.



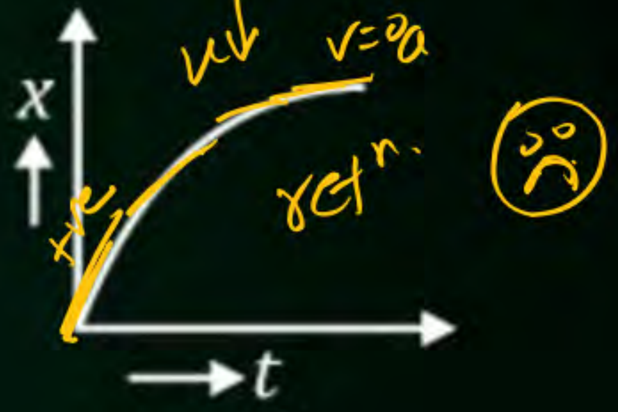
4. None of these

QUESTION

Figures (i) and (ii) below show the displacement-time graphs of two particles moving along the x-axis. We can say that



(i)



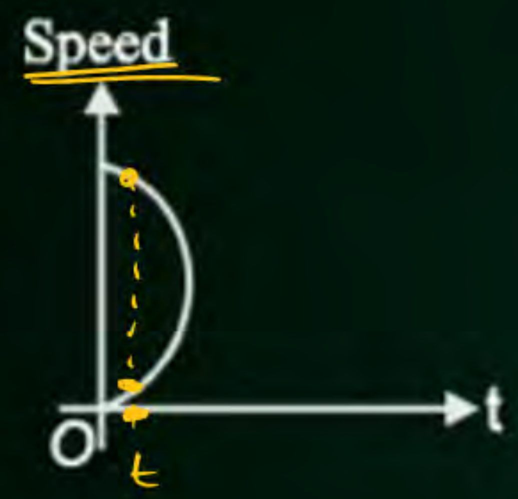
(ii)

1. Both the particles are having a uniformly accelerated motion
2. Both the particles are having a uniformly retarded motion
3. Particle (i) is having a uniformly accelerated motion while particle (ii) is having a uniformly retarded motion
4. Particle (i) is having a uniformly retarded motion while particle (ii) is having a uniformly accelerated motion

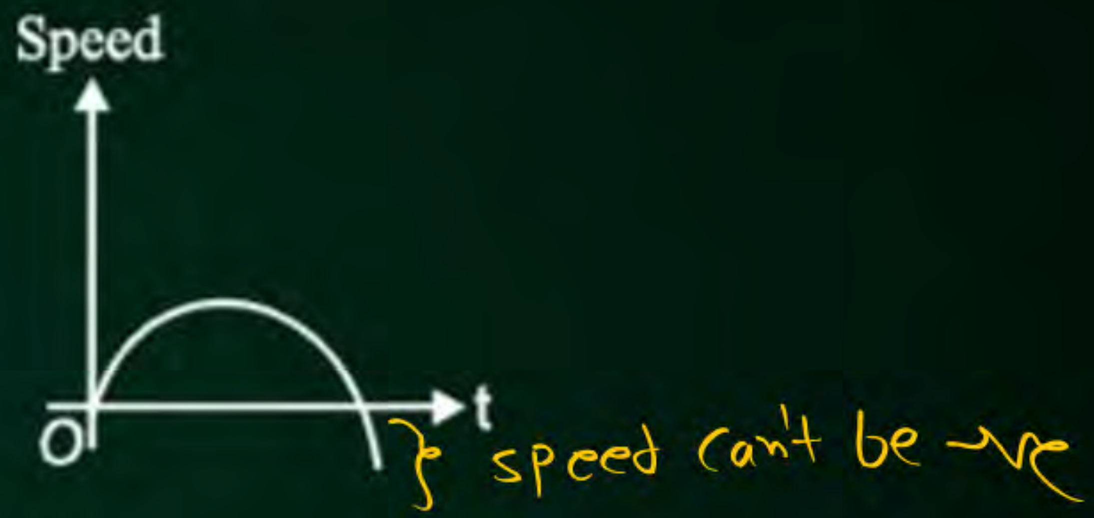
QUESTION

Which one of the following graph for a body moving along a straight line is possible?

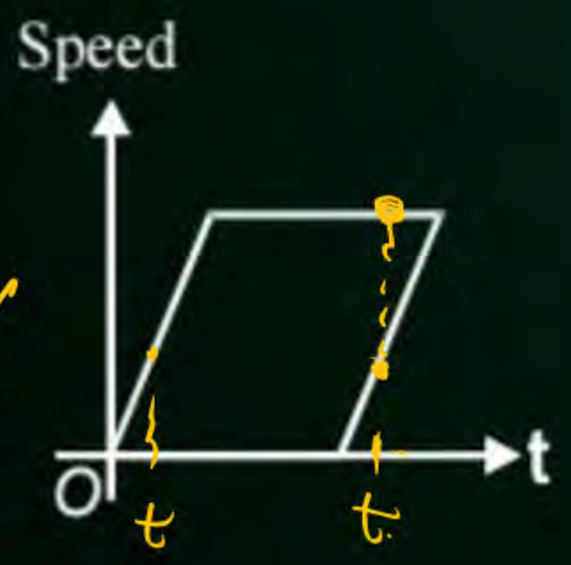
(1)



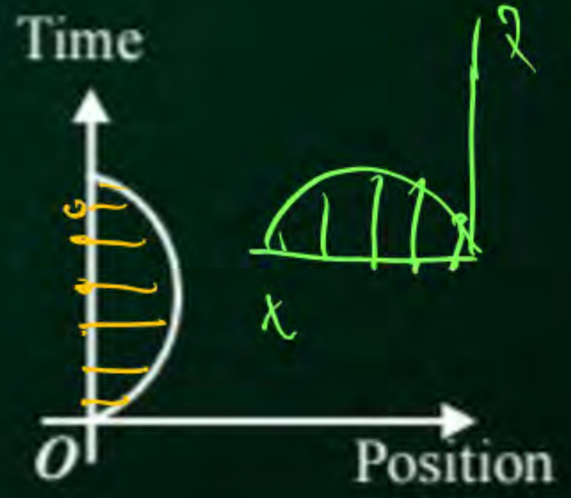
(2)



(3)



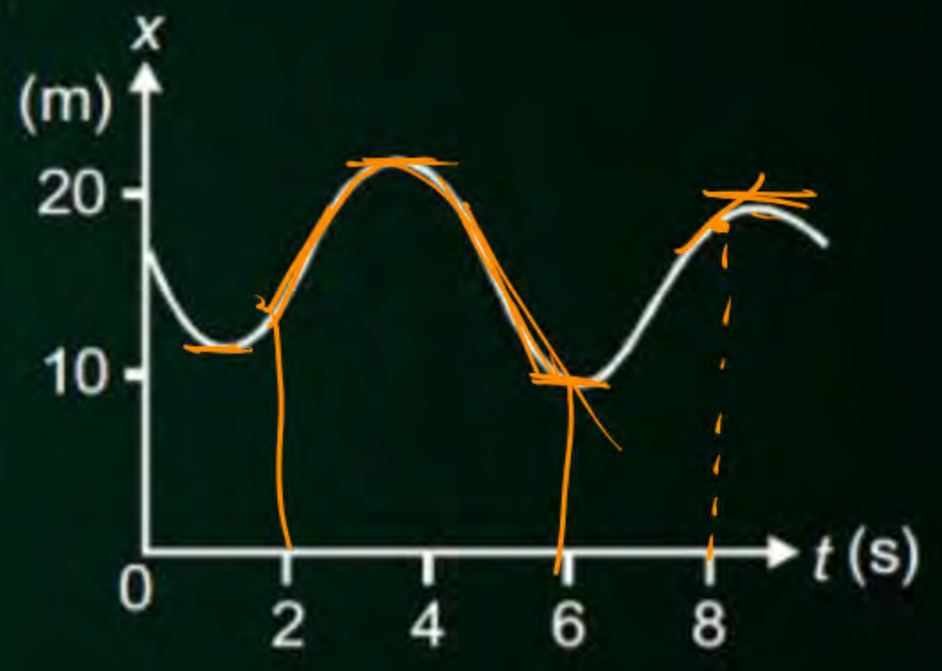
(4)



QUESTION

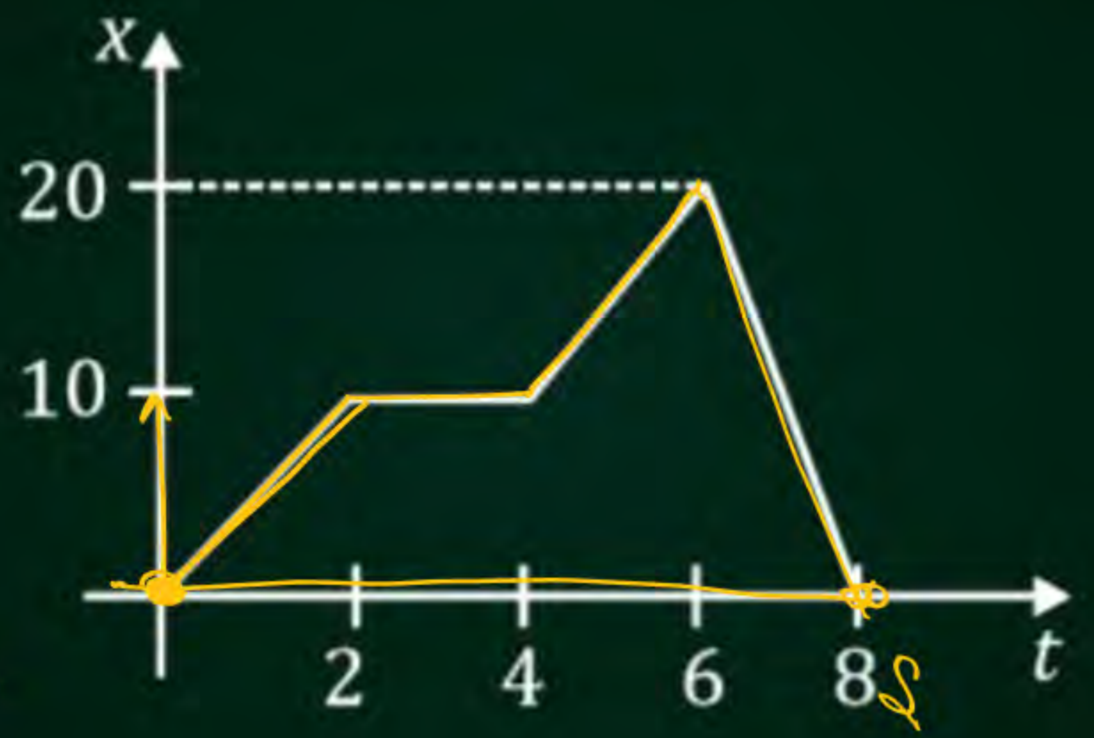
Figure shows the position of a particle moving on the x-axis as a function of time

1. The particle has come to rest 4 times
2. The velocity at t = 8 s is negative
3. The velocity remains positive for t = 2 s to t = 6 s
4. The particle moves with a constant velocity



QUESTION

Find avg speed and velocity in 8 sec.



Avg speed $= \frac{\text{total dist}}{\text{total time}}$

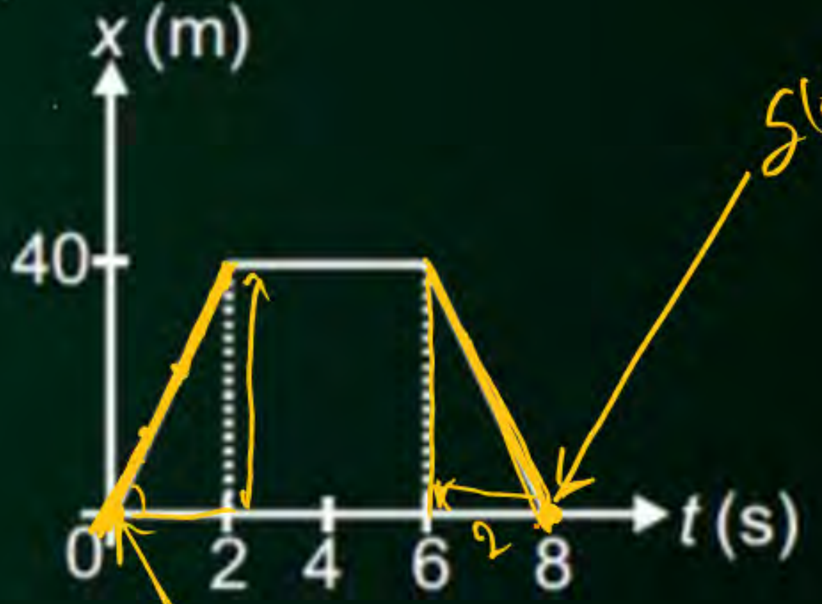
$= \frac{40}{8} = 5\,m/s$

Avg velocity $= \frac{0-0}{8}$

$= 0\,m/s$

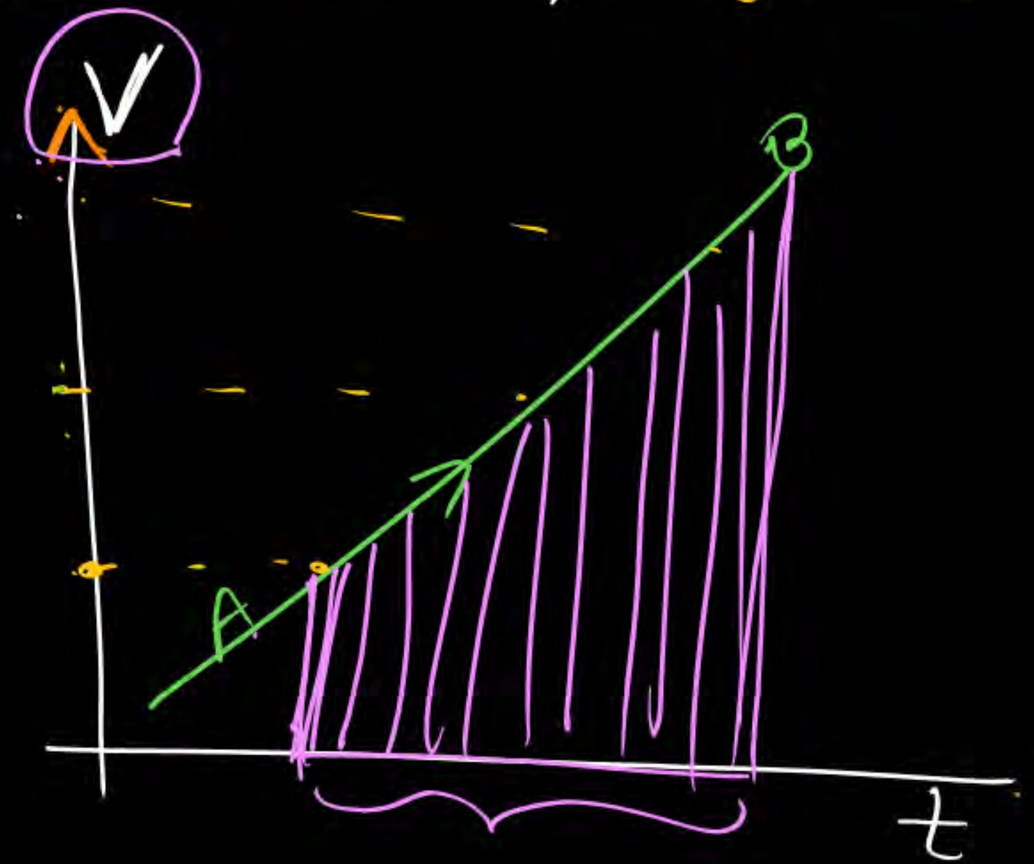
QUESTION

The position (x) of a particle moving along x-axis varies with time (t) as shown in figure. The average acceleration of particle in time interval $t = 0$ to $t = 8$ s is



1. $3\ m/s^2$
2. $-5\ m/s^2$
3. $-4\ m/s^2$
4. $2.5\ m/s^2$

Velocity - time graph



Velocity ⇒ y^{th} - co-ordinate

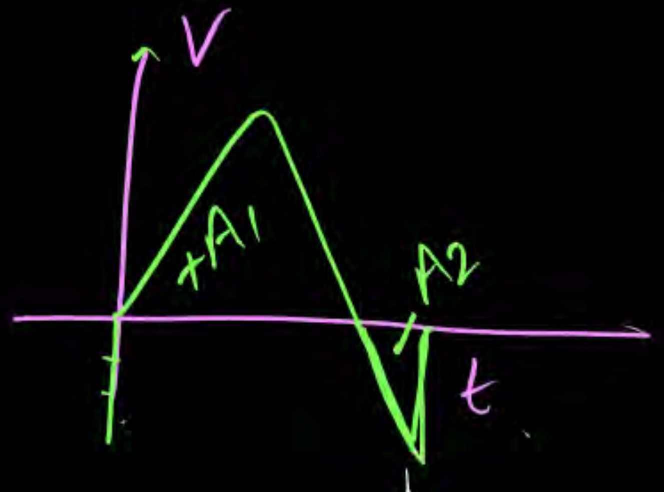
Velocit $A \to B \longrightarrow$ +ve 'V' ↑

time → x-coordinate

$$\text{Slope} = \left[\frac{dv}{dt}\right]$$

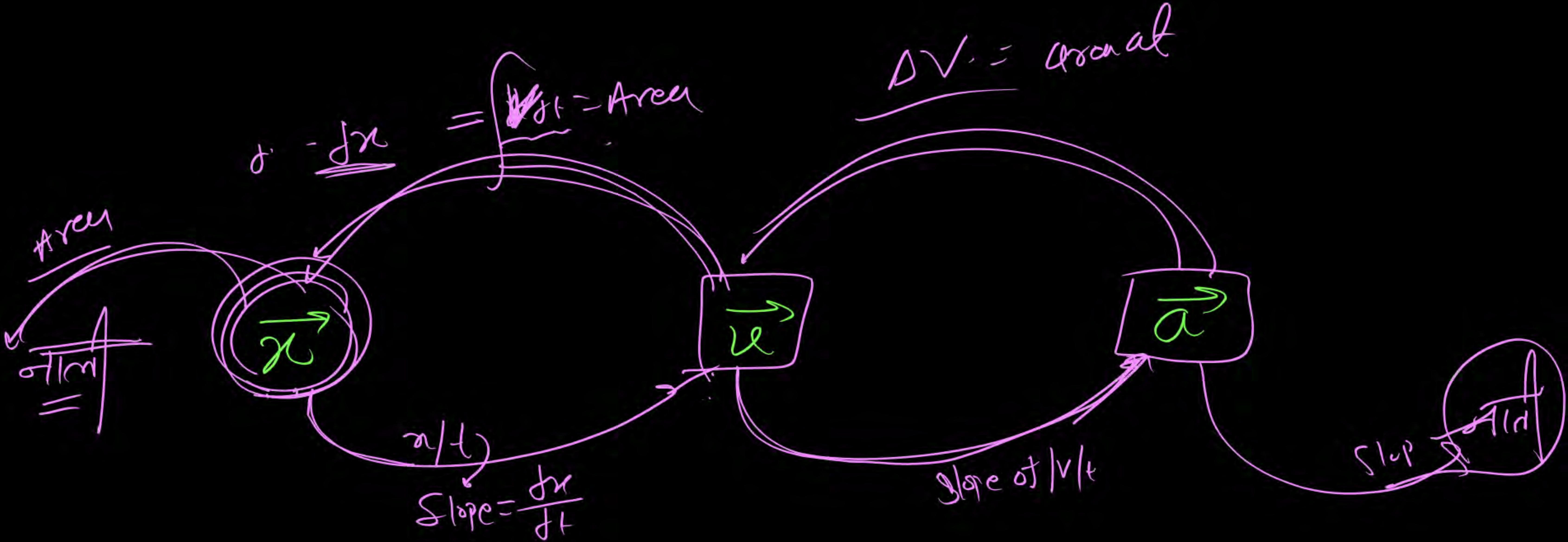
$$\text{Inst acc}^n = \text{Slope } \tan\theta$$

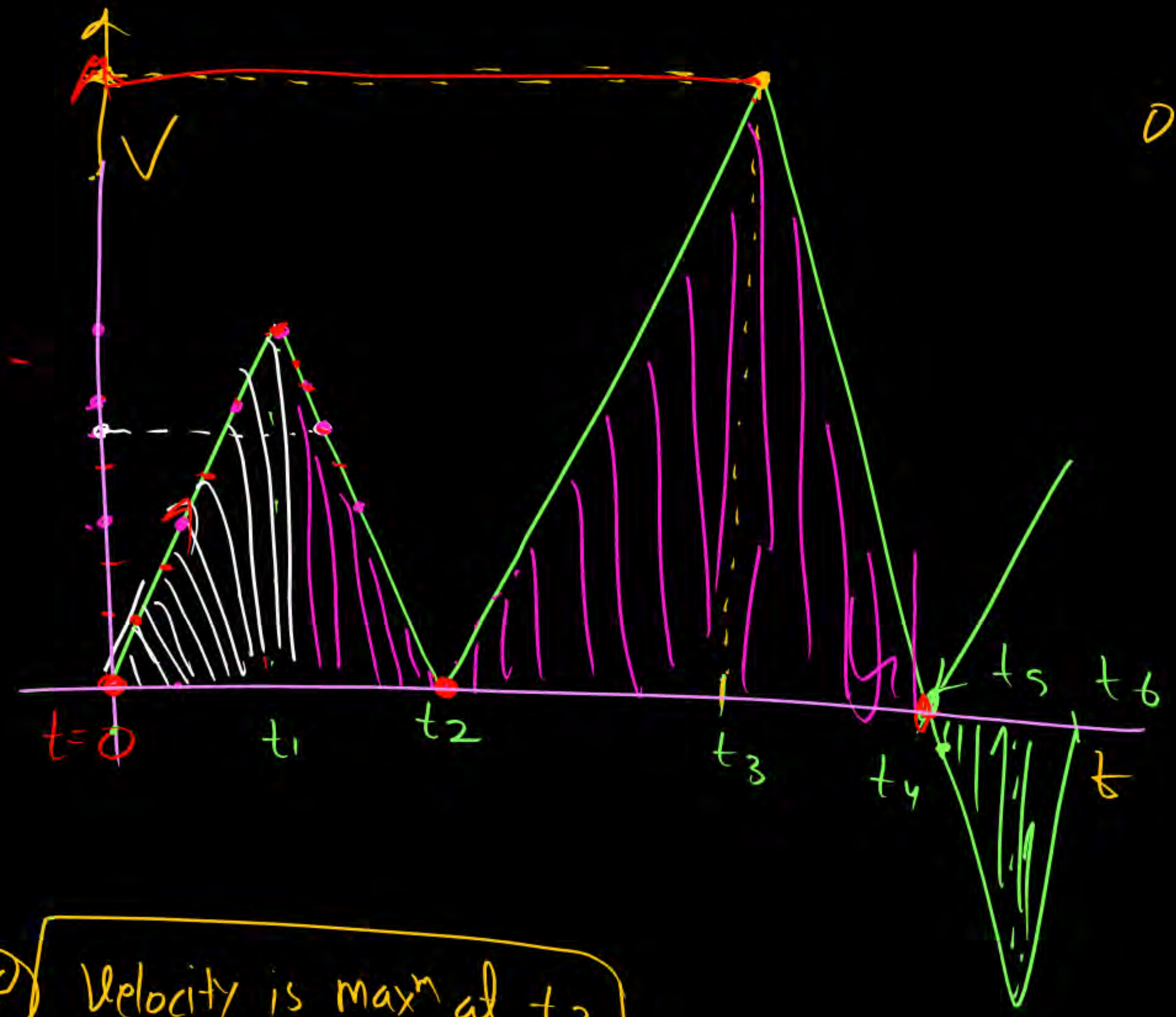
$$\text{Area under curve} = \int y\,dx = \int v\,dt = \Delta x = \text{disp}^m$$



$$\text{disp}^n = A_1 + A_2$$

$$\text{disp}^n = A_1 - A_2$$


Area
= Area
x
v
a
x/t
Slope = dx/dt
Slope of v/t
Slop



Object starts motn from origin (0,0) then its Position/dispm is maxm at.

(a) t_1

(b) t_3 ← 70%

(c) t_4 (17%) correct

(d) t_5

(e) t_6

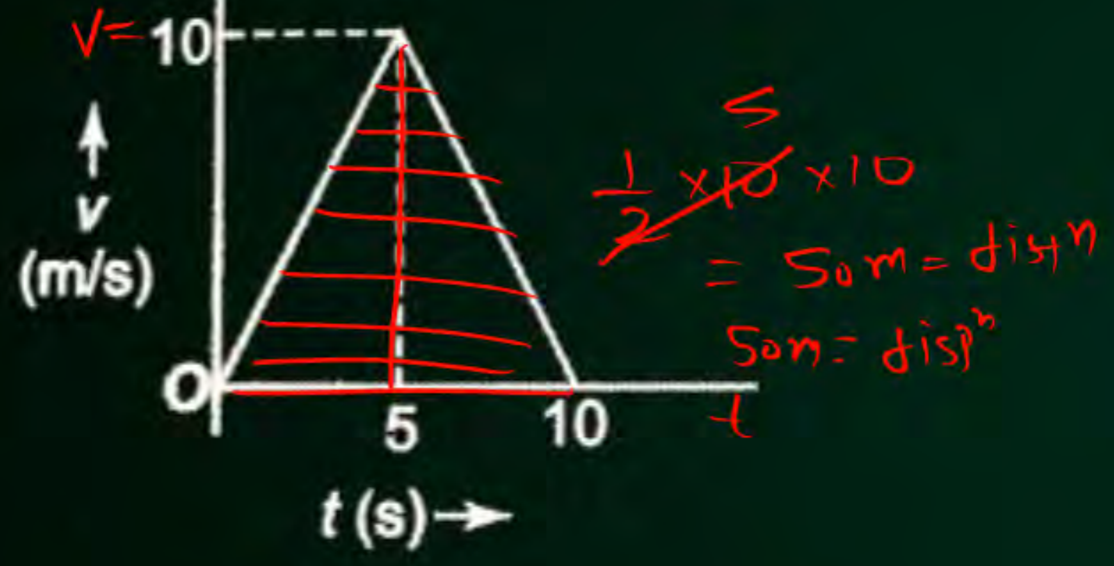
Velocity is maxm at t_3

One-D मे dirn change हेतु Velo V=0

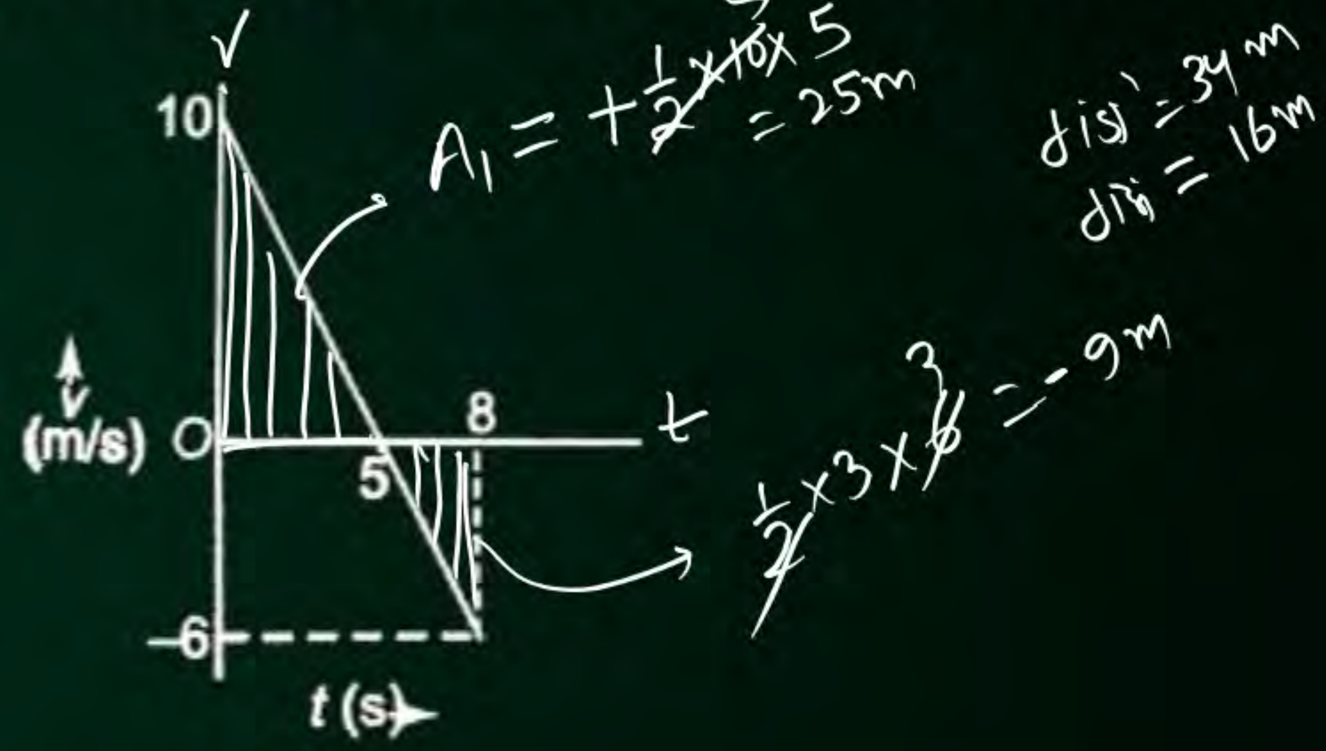
QUESTION

A particle is moving in a straight line. Its *v*-*t* graph in different cases are as shown below. Find the displacement and distance in time interval $t = 0$ to $t = 10$s for the following cases:

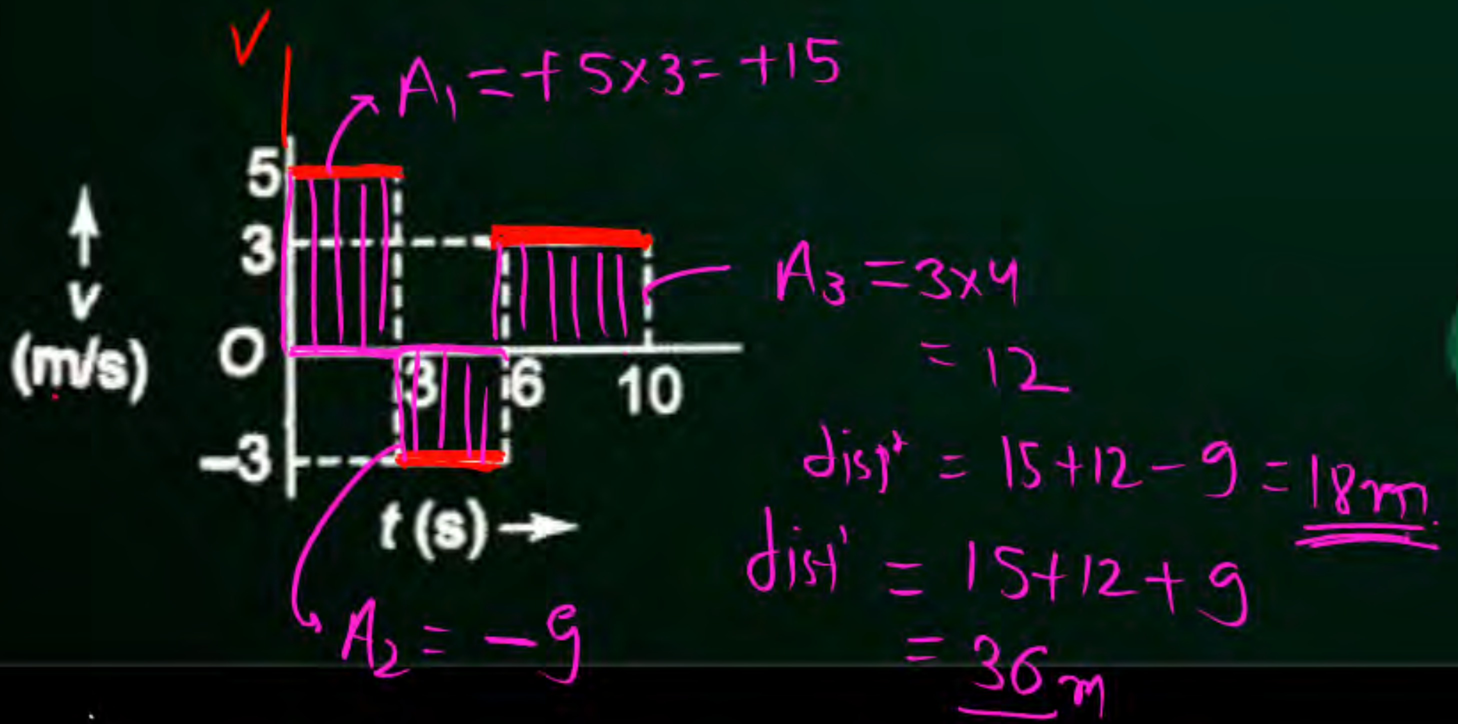
1



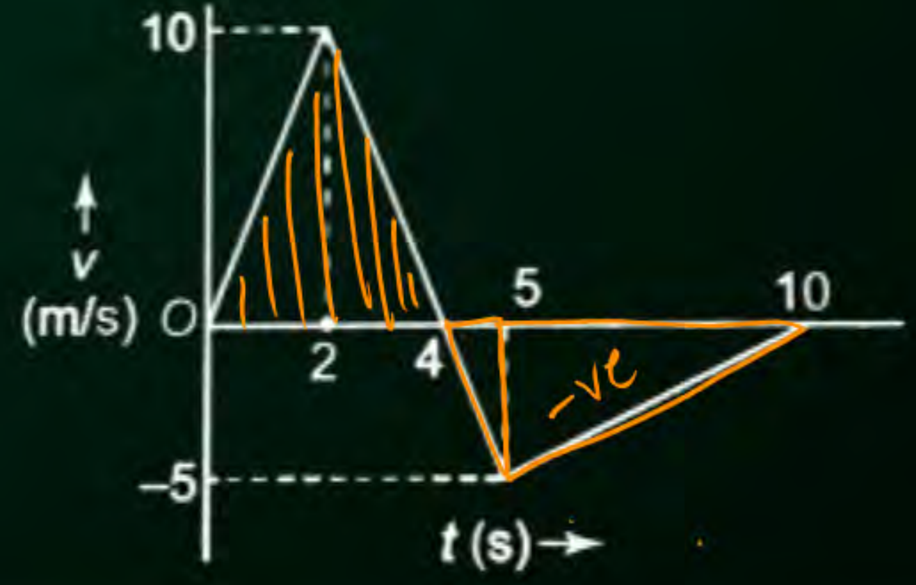
2

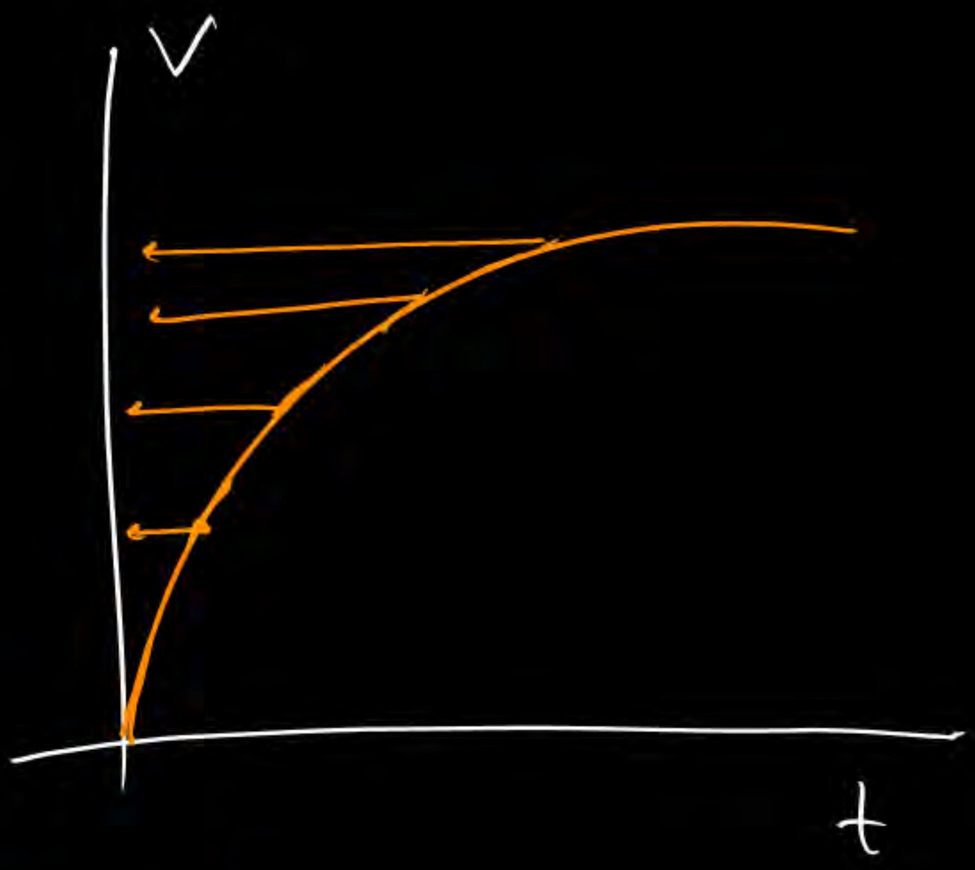


3



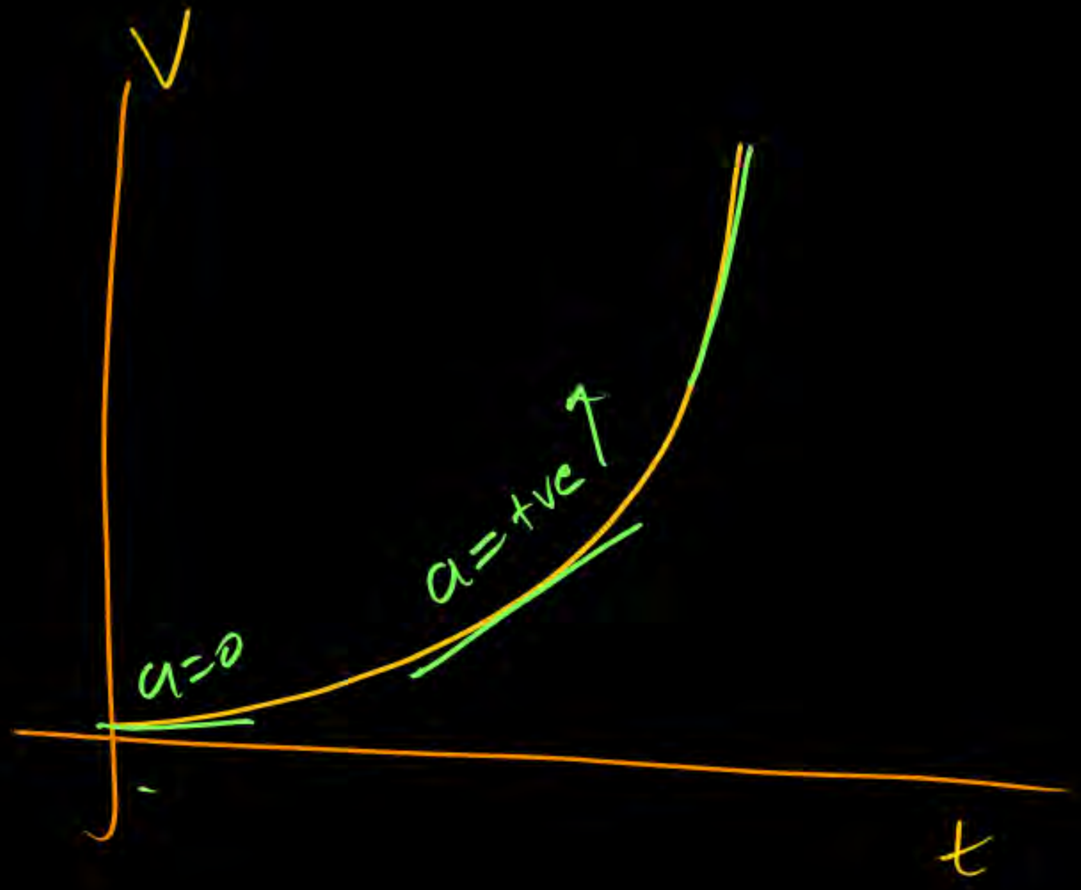
4





1^{st} $v\uparrow$ then $v = $ const

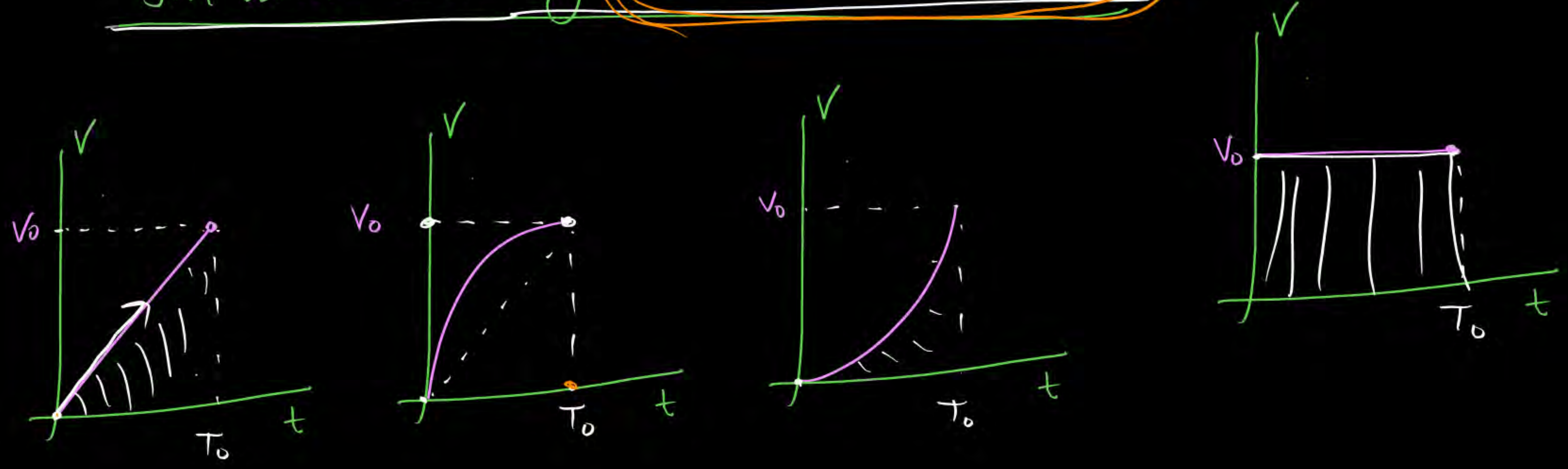
acc^n → decreasing & becomes zero



$v\uparrow$

acc^n → +ve ↑

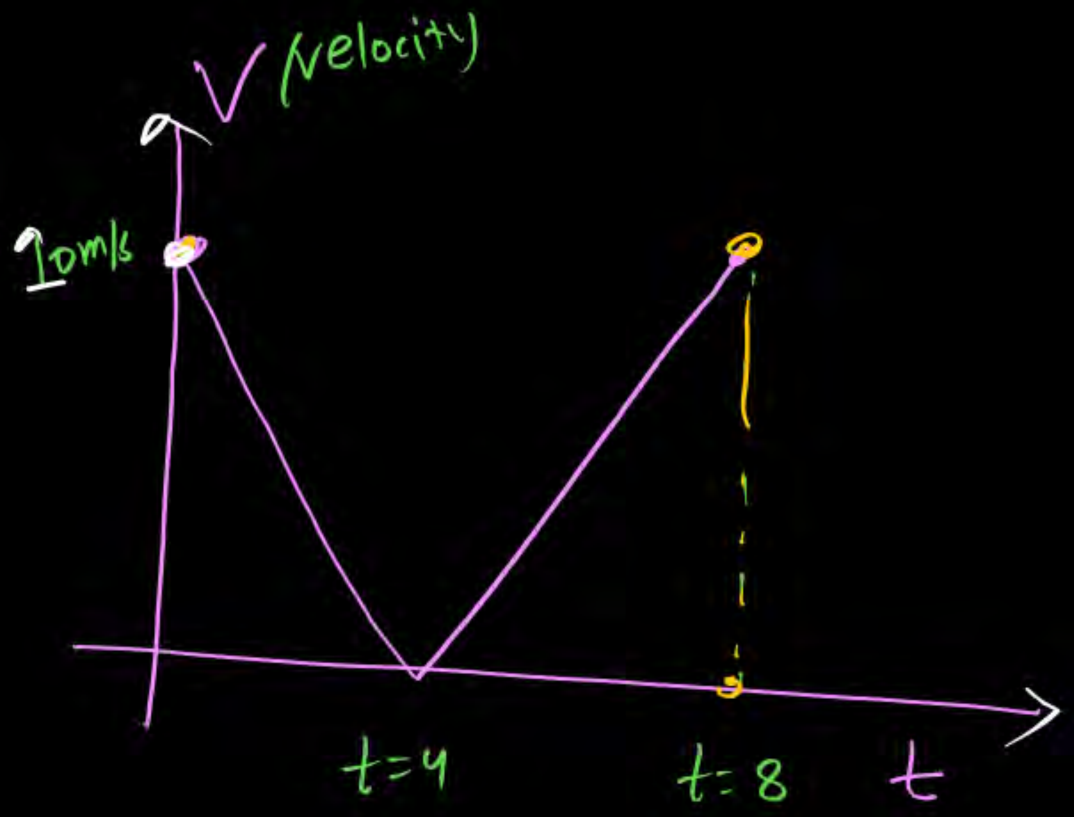
In which case Avg velocity is maximum ??



Avg velocity = $\frac{\text{(total disp}^n\text{)}}{\text{total time}} = \frac{\{\text{Area of } v/t\}}{T_0}$

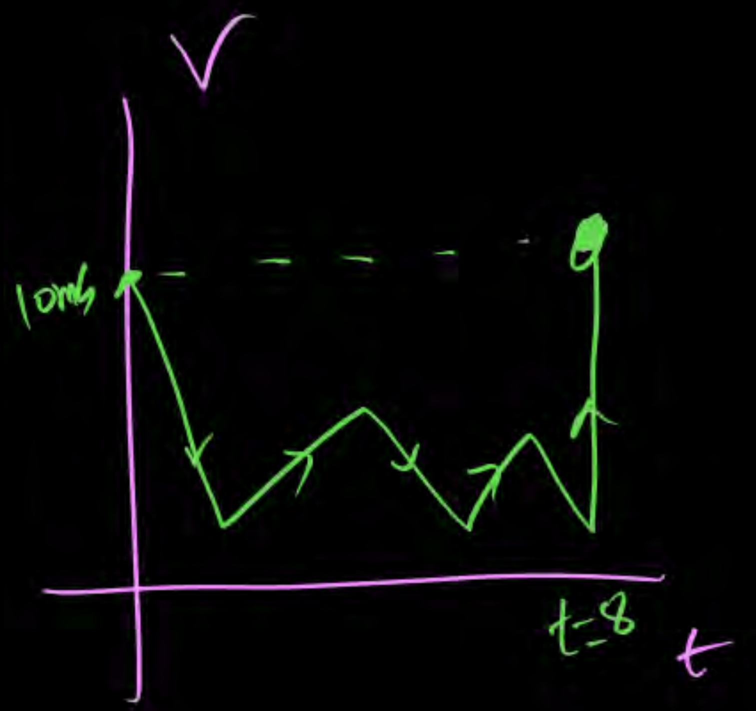
Ans (D)

Q



find Avg acc^n in 8-sec

Avg acc^n = $\frac{\vec{V}_f - V_i}{\Delta t} = \frac{10-10}{8} = 0$

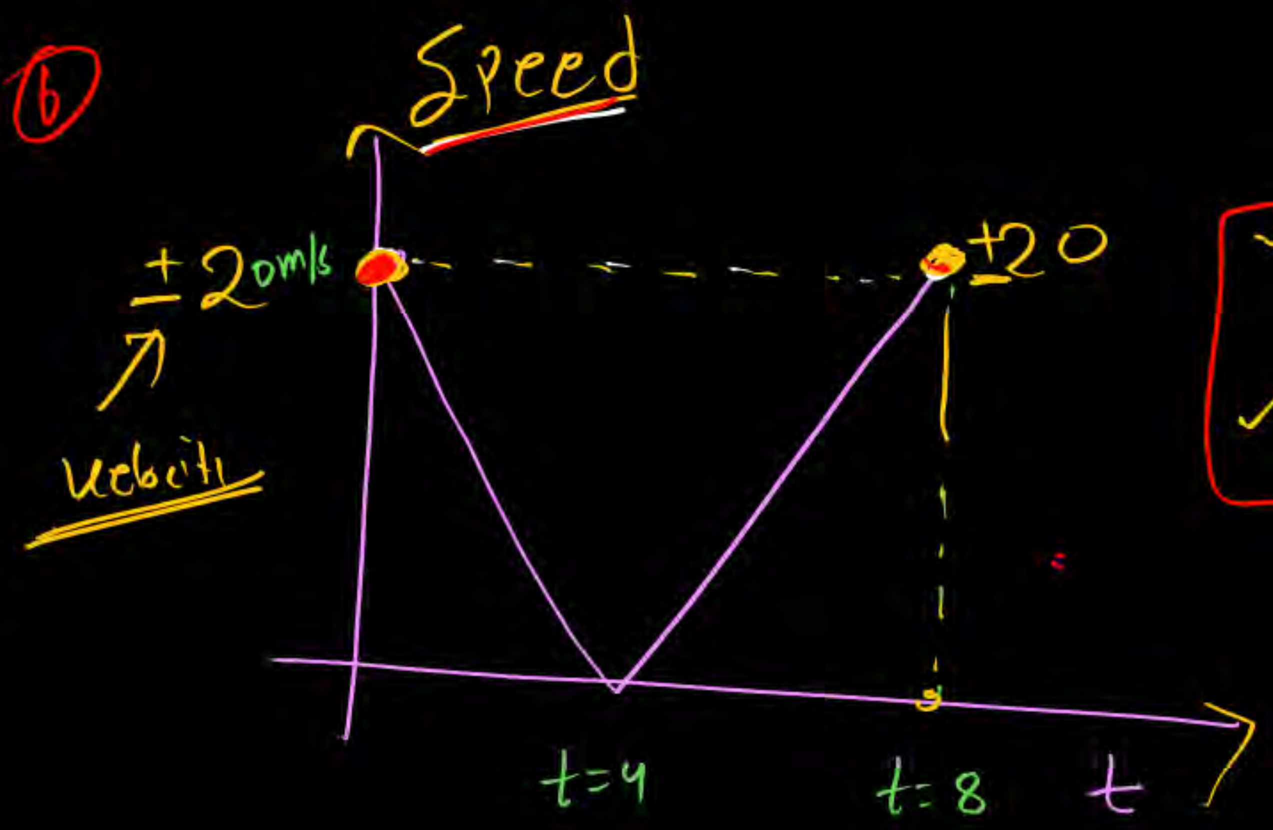


Avg acc^n = $\frac{\vec{V_f} - \vec{V_i}}{\Delta t}$

$= \frac{10-10}{8}$

$= 0$

(b)



$\vec{v}_f = +20$ ✓ $\vec{v}_i = +20$

$\vec{v}_f = -20$ ✓ $\vec{v}_i = -20$

↑ velocity

✓ (a) zero 36%

(b) $+5\,m/s^2$ 39%

(c) $-5\,m/s^2$ 10%

(d) all of them (13%)

find Avg acc^n in 8-sec

$\vec{a}_{Avg} = \dfrac{\vec{v}_f - \vec{v}_i}{\Delta t} = \dfrac{20-20}{8} = 0$

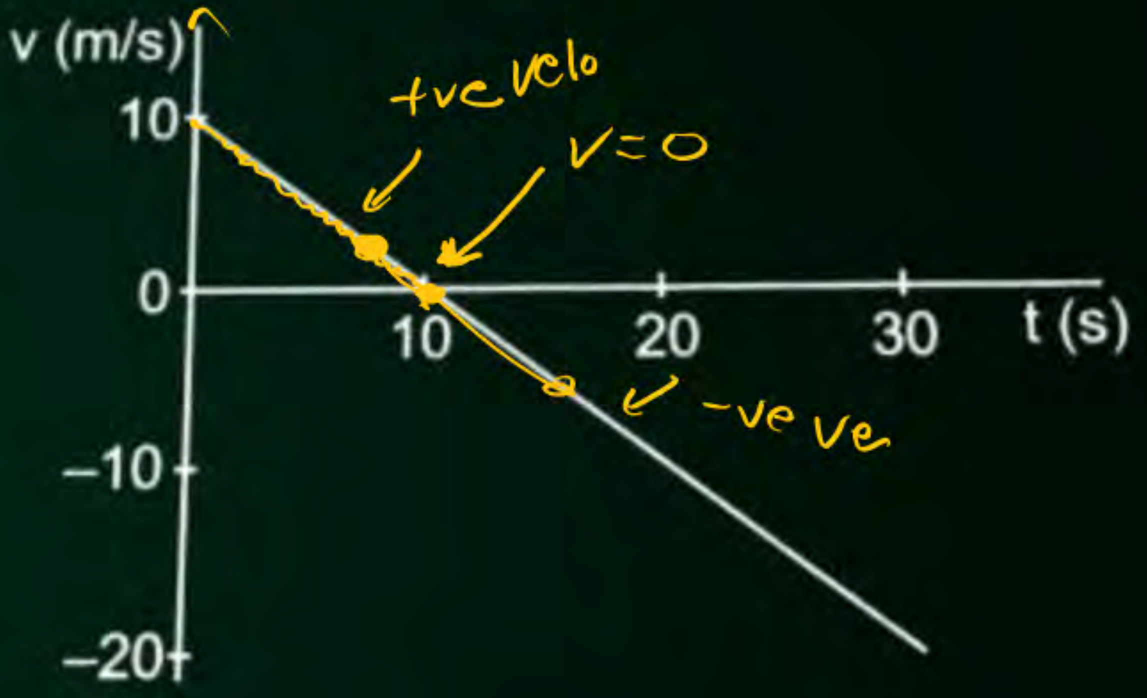
$= \dfrac{-20-(-20)}{8} = 0$

$a_{avg} = \dfrac{20-(-20)}{8} = \dfrac{40}{8} = +5$

$a_{avg} = \dfrac{-20-(20)}{8} = \dfrac{-40}{8} = -5$

QUESTION

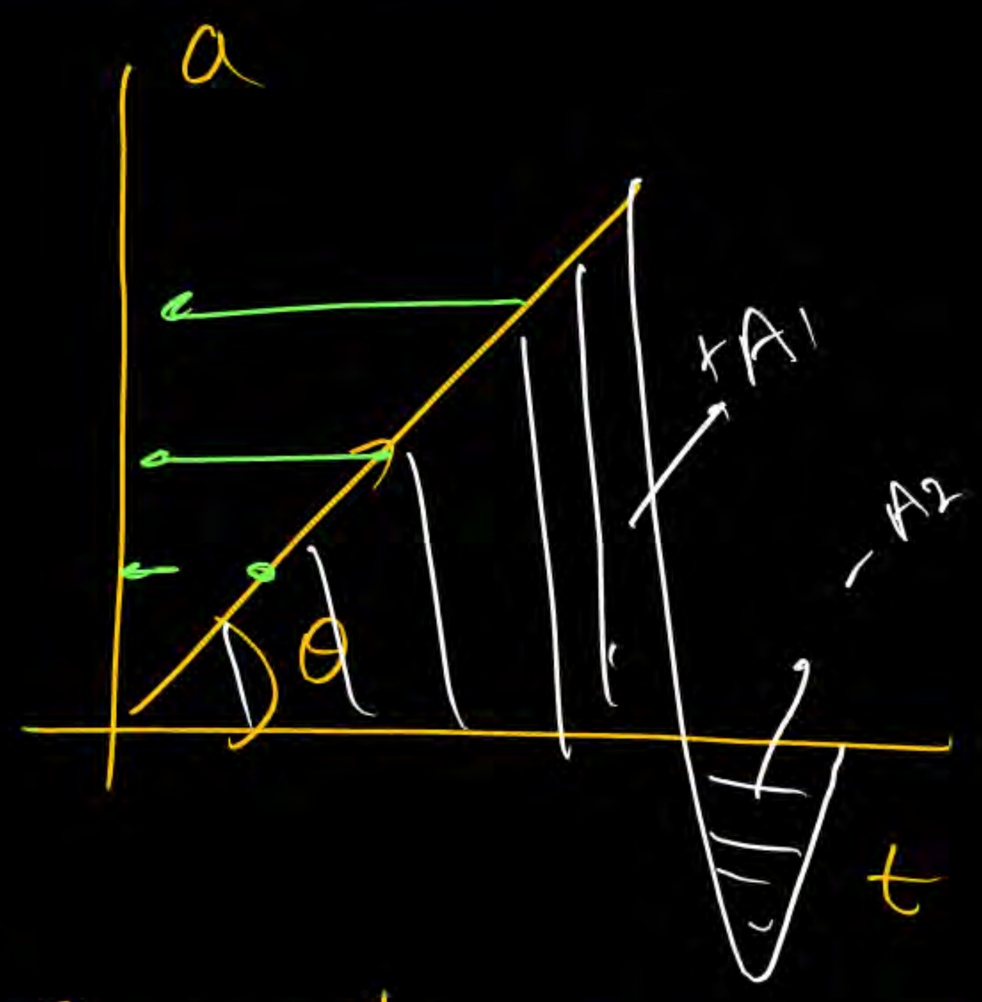
The velocity-time plot for a particle moving on a straight line shown in the figure



1. The particle has a constant acceleration
2. The particle has never turned around
3. The particle has a zero displacement
4. The average speed in the interval 0 to 10s is the same as the average speed in the interval 10s to 30s

U-turn 10sec पे हुआ

acceleration time graph



~~Slope = $\frac{da}{dt}$ = tanθ⟶ Jurk (गलत)~~

acc^n → y-th coordinate

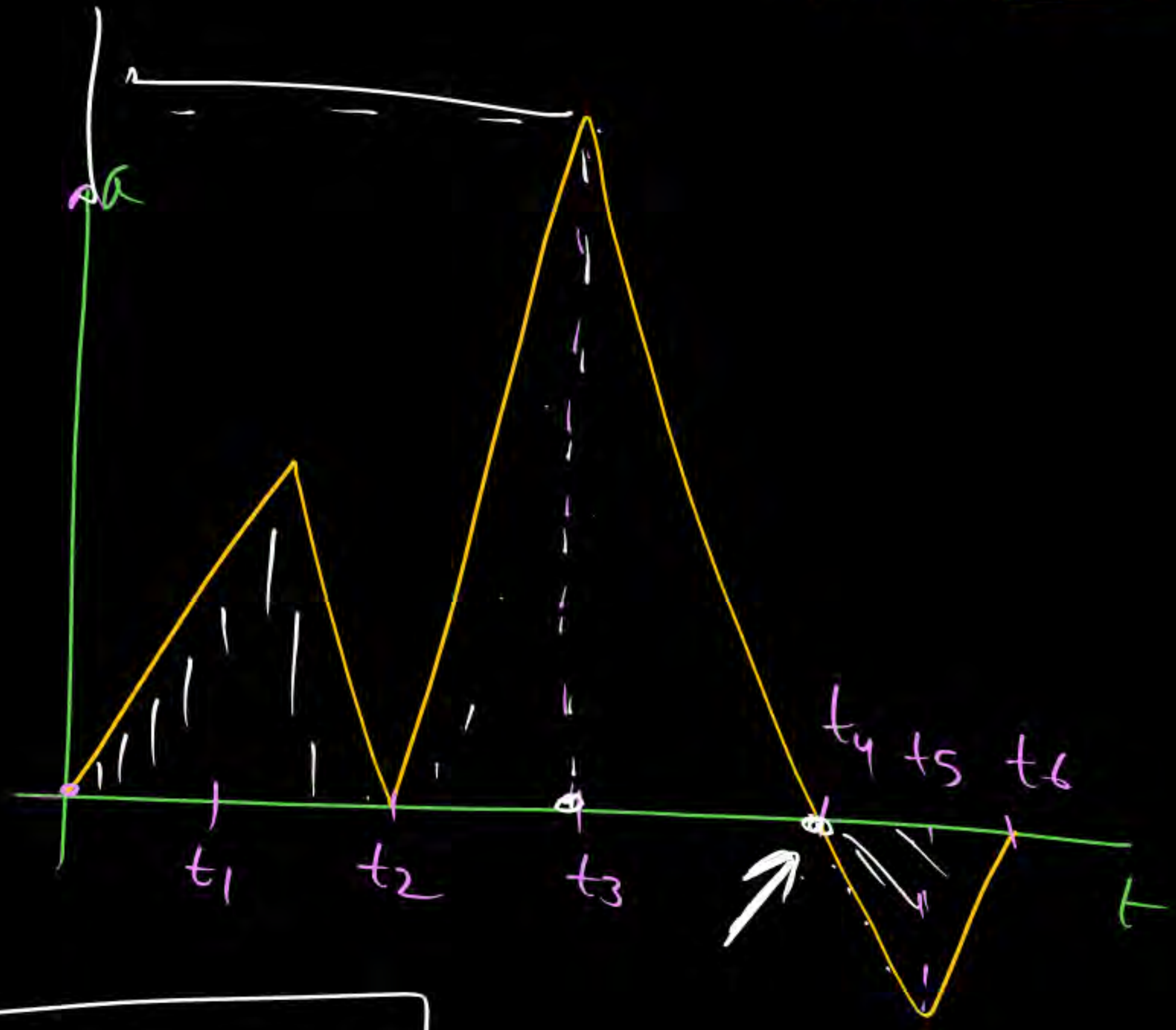
(+ve acc^n)↑

Area of a/t graph = $\int a\,dt = \Delta v$

$\Delta \vec{v} = A_1 - A_2$ ✗

area of a/t graph is velocity
↳ wrong

Find time when velocity is maximum if initial velocity is zero.



t = 0 to t = t4
acc^n +ve

Q acc^n is max^m at ??

(a) t_1

(b) t_3

(c) t_4

(d) t_5

(Q) Velocity is max^m at ??

(a) t_1

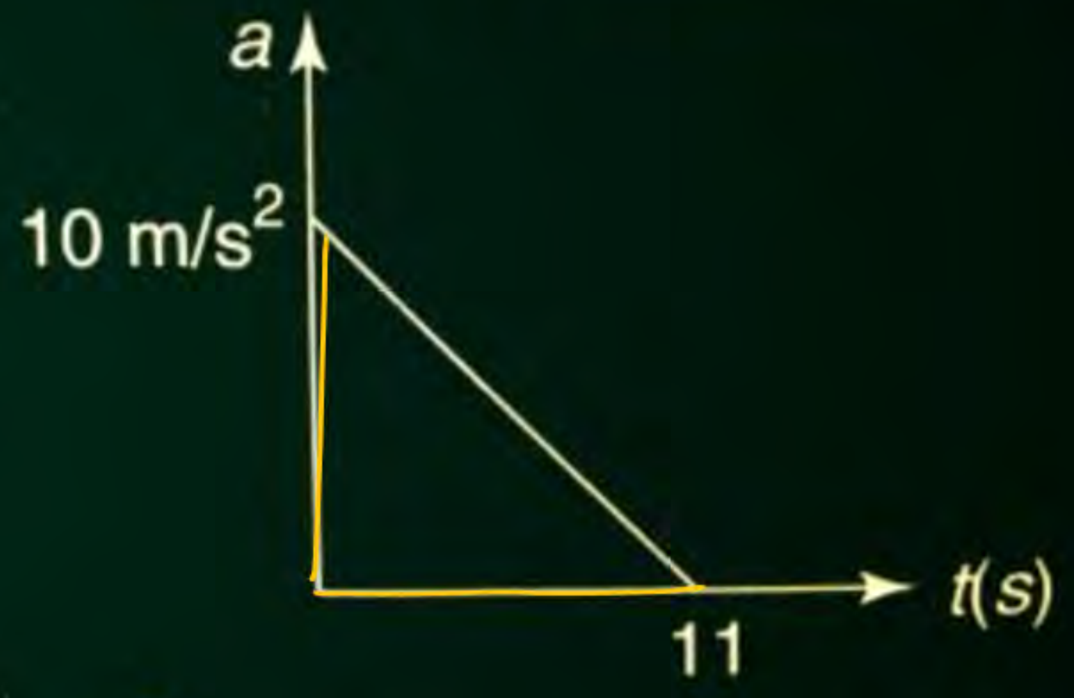
(b) t_2

(c) t_4 ✓

(d) t_5

QUESTION

A particle starts from rest. Its acceleration (a) versus time (t) is as shown in the figure. The maximum speed of the particle will be [IIT-JEE (Screening) 2004]



1. 110 m/s
2. 55 m/s
3. 550 m/s
4. 660 m/s

Velocity – Position



Velocity → y^{th} co-ordin

Positi → x - axis

$$\text{Slope} = \frac{dv}{dx}$$

$$\text{Slope} = \frac{dv}{dx} = \text{velocity gradinant}$$

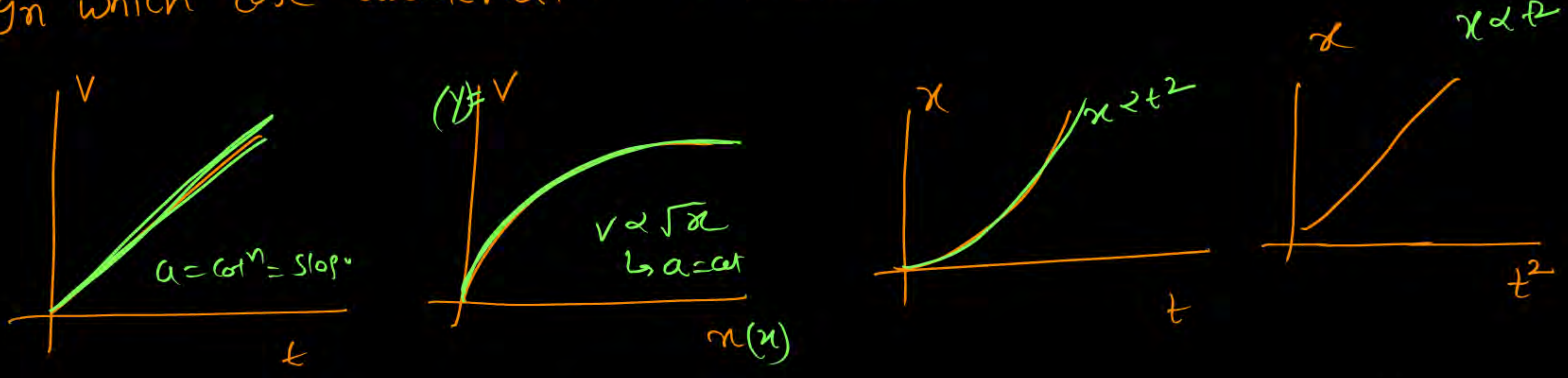
mutiply both side with v:

$$\text{Slope } v = v\frac{dv}{dx}$$

$$\text{Slope } v = a$$

$$\text{Slope} = \frac{a}{v}$$ ← Ratio of acc^n & veloch.

In which case acceleration is constant.



(a) (b) (c) (d)

(c) in all graph

QUESTION

A body is thrown vertically upwards. Which of the following graphs represents the velocity of the body against time correctly?

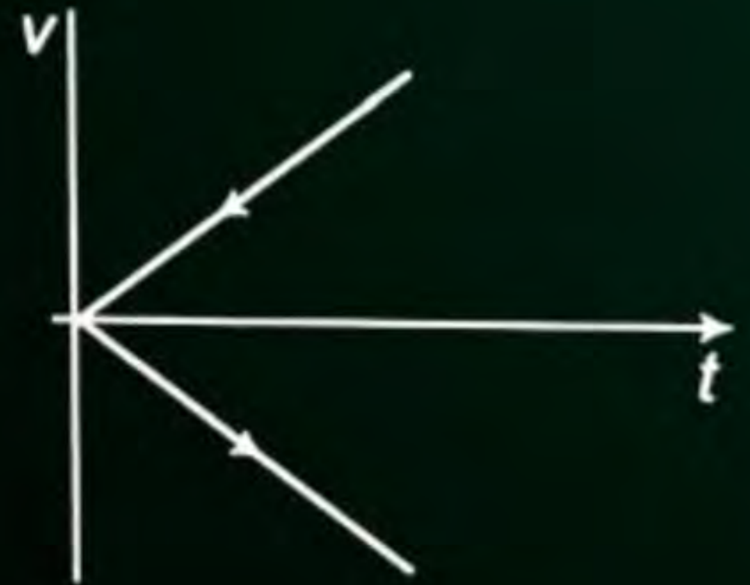
(1)



(2)



(3)



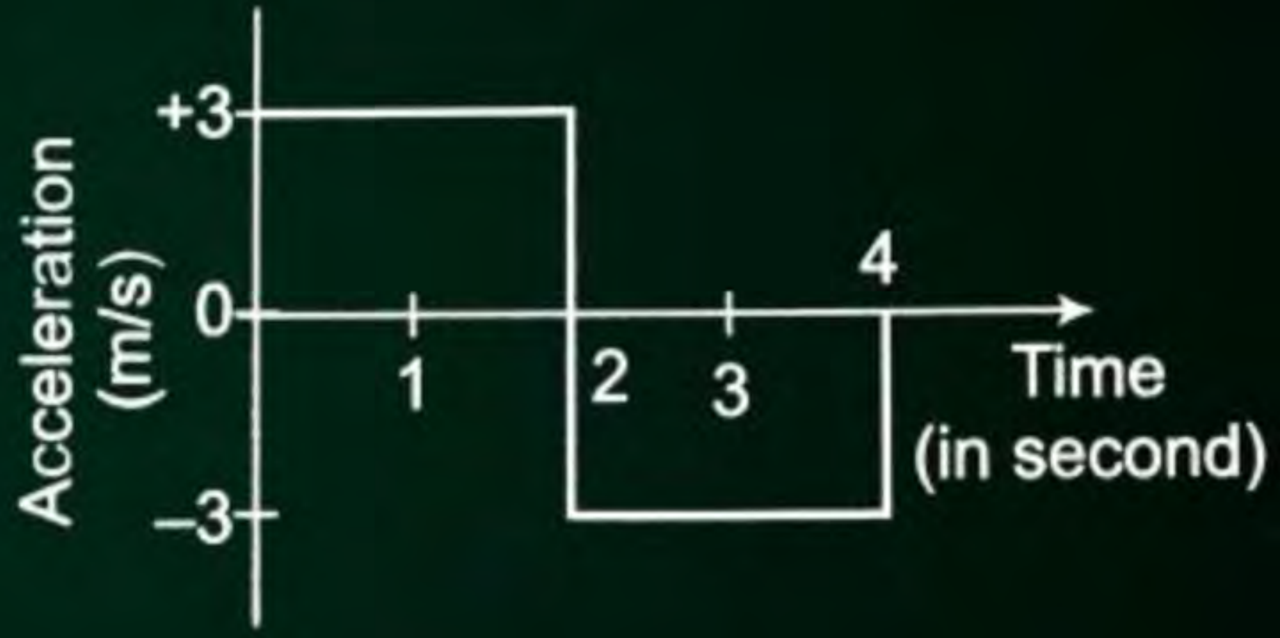
(4)



QUESTION

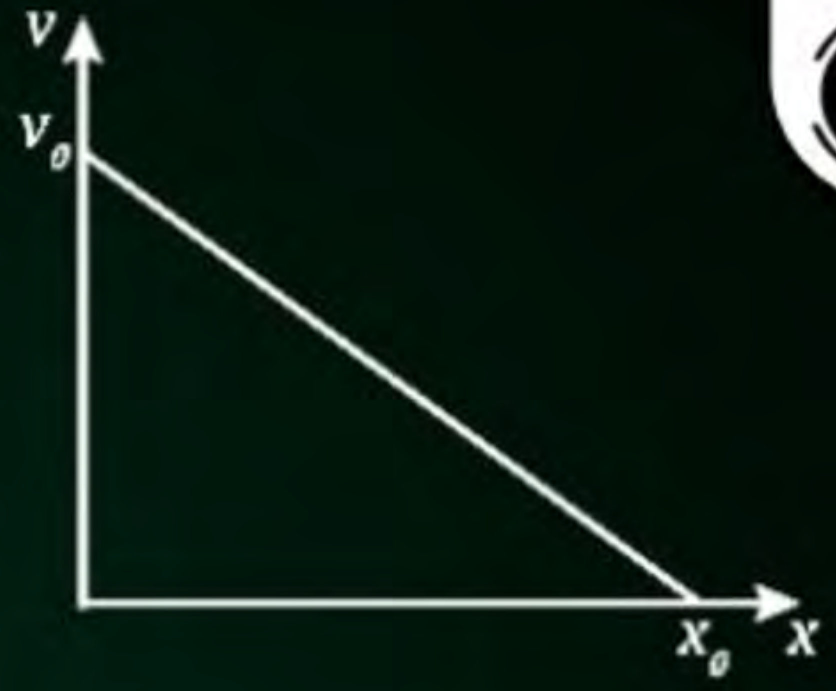
A particle starts from rest at $t = 0$ and moves in a straight line with an acceleration as shown below. The velocity of the particle at $t = 3s$ is

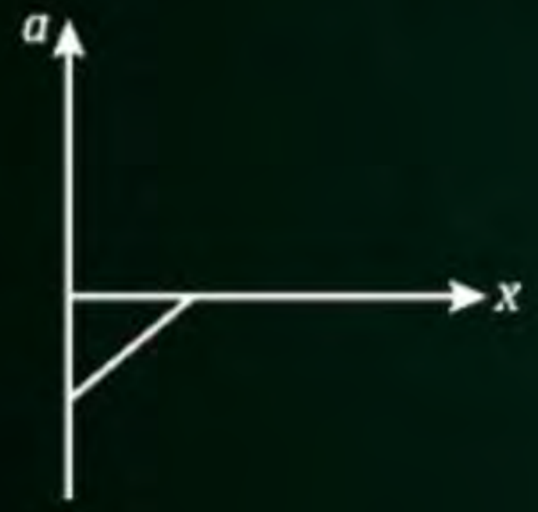
1. $2\ m/s$
2. $3\ m/s$
3. $4\ m/s$
4. $6\ m/s$

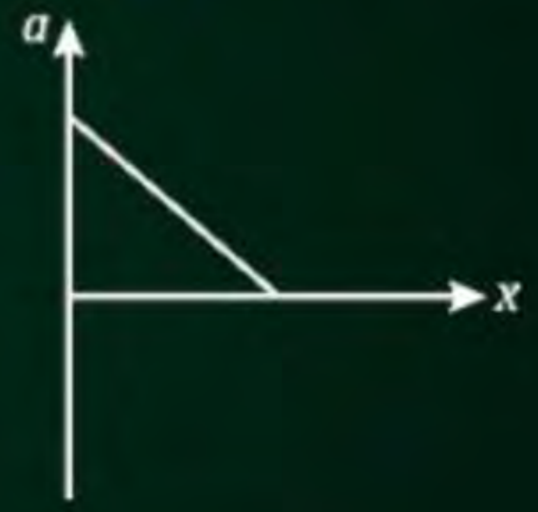


QUESTION

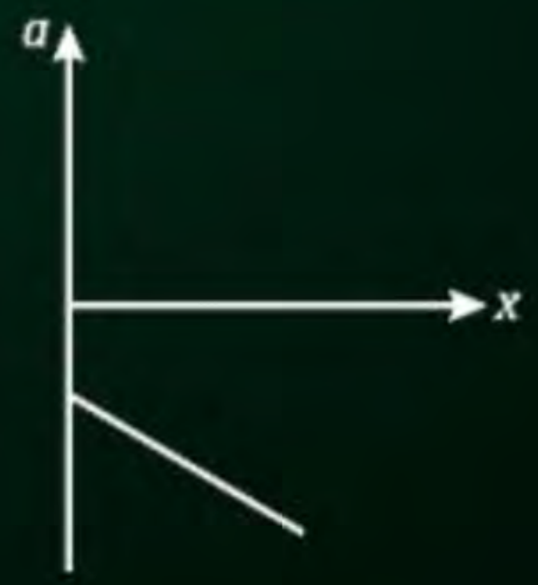
The given figure graph shows the variation of velocity with displacement. Which one of the graph given below correctly represents the variation of acceleration with displacement [IIT-JEE (Screening) 2005]



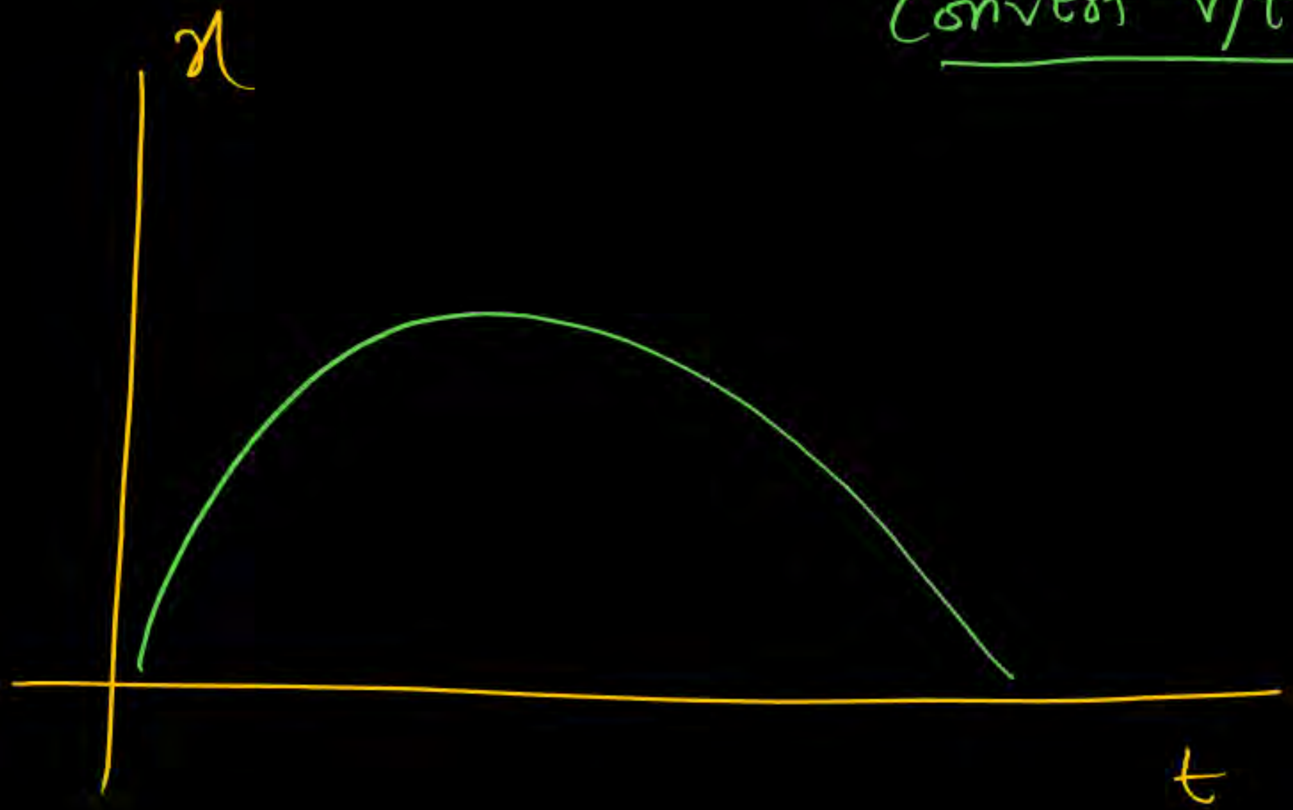
1. 

2. 

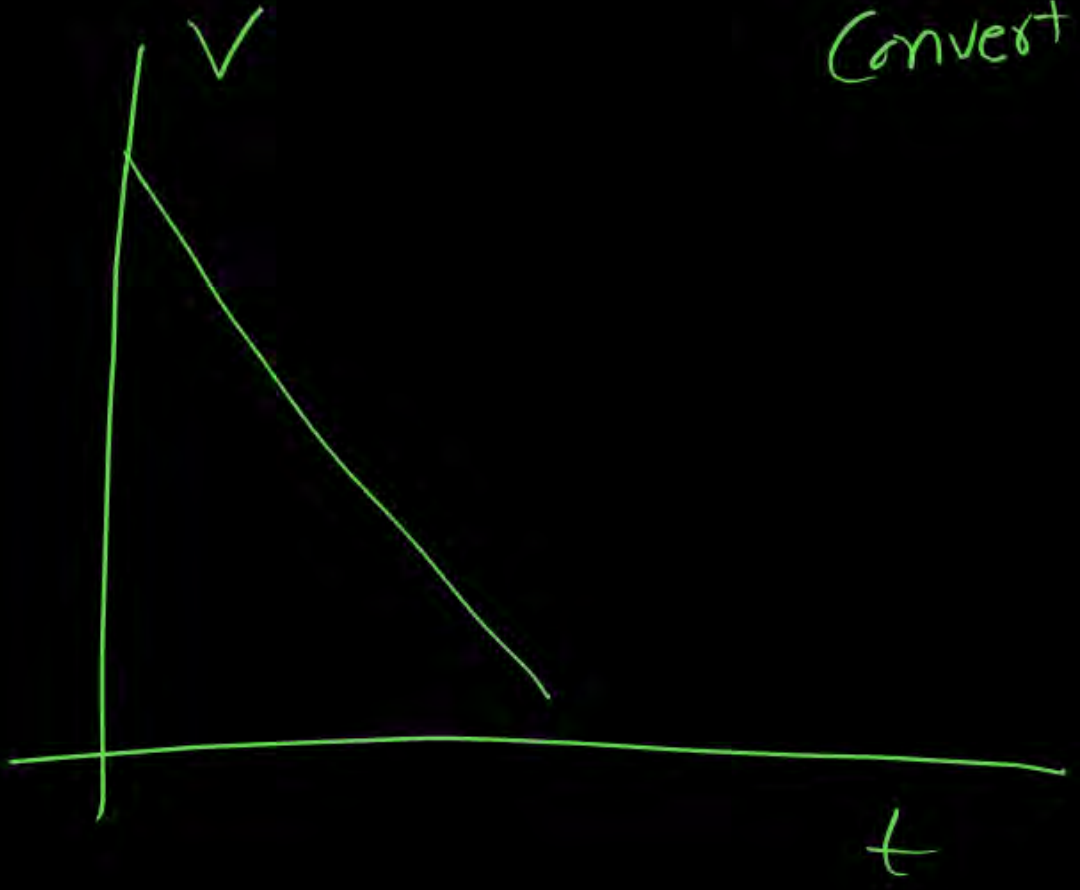
3. 

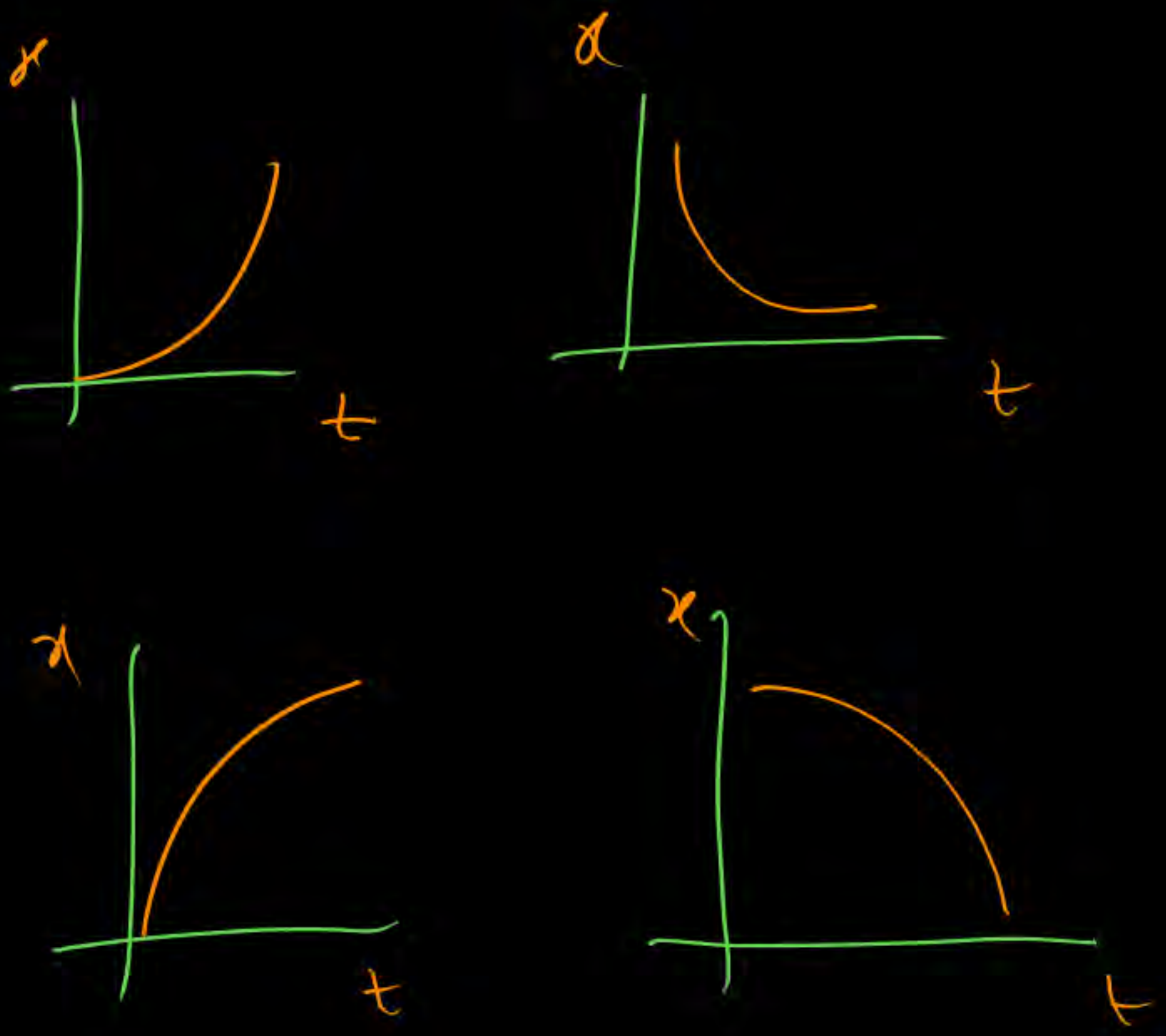
4. 

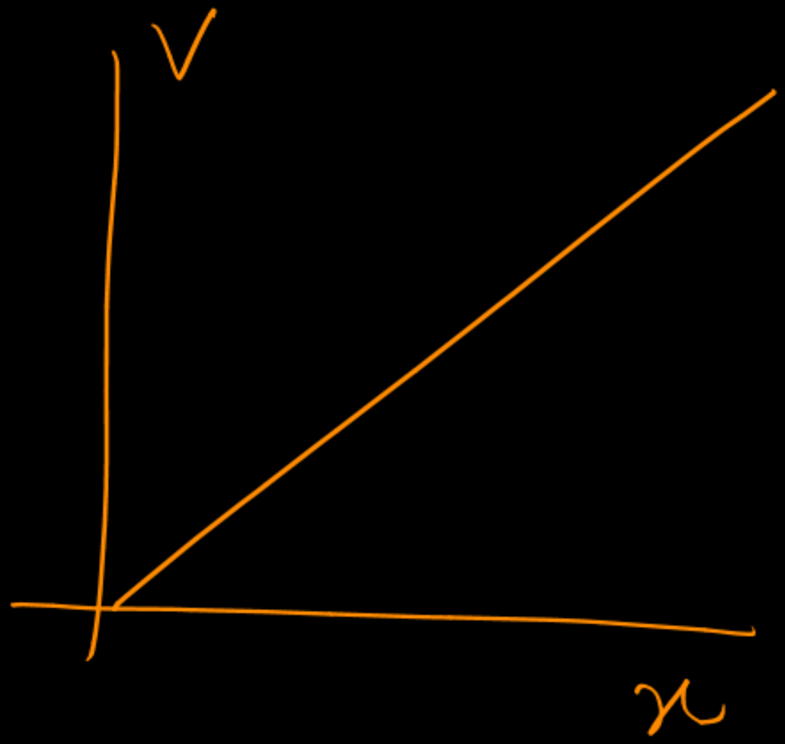
Convert v/t graph.



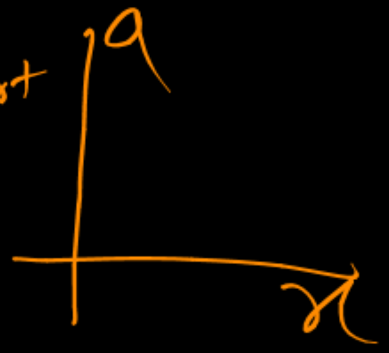
Convert v/t to x/t

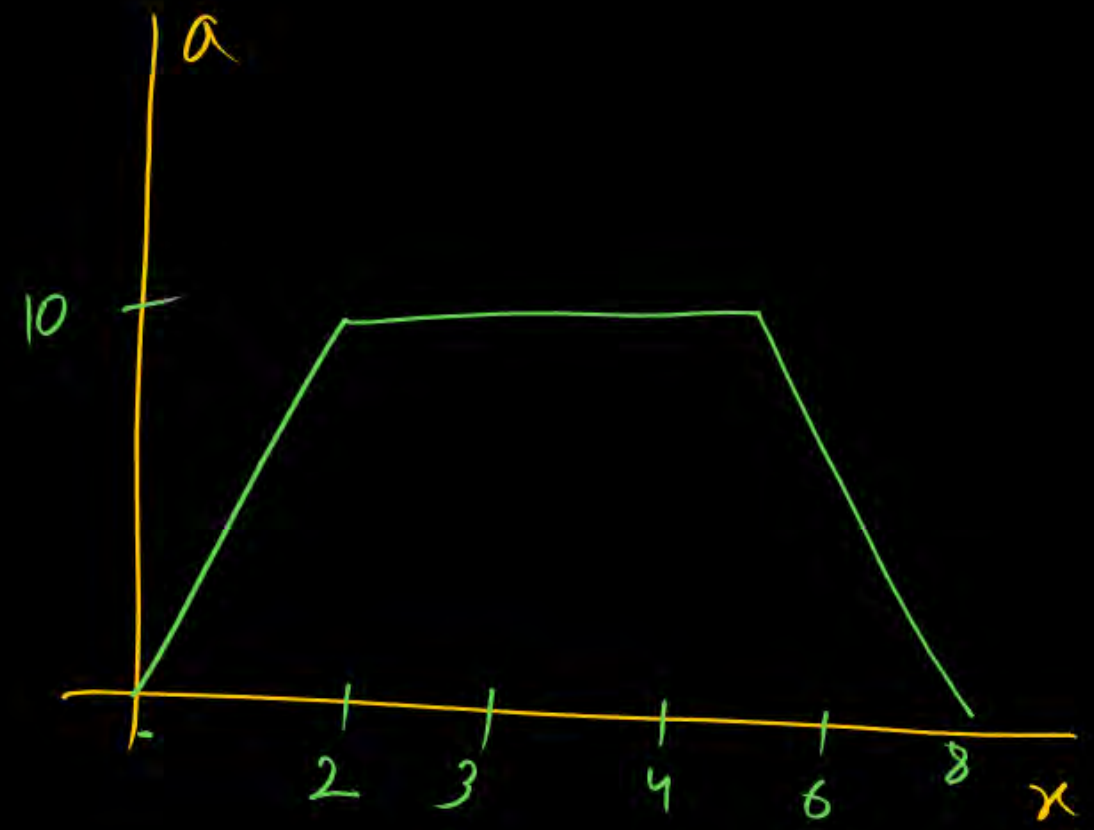






Convert

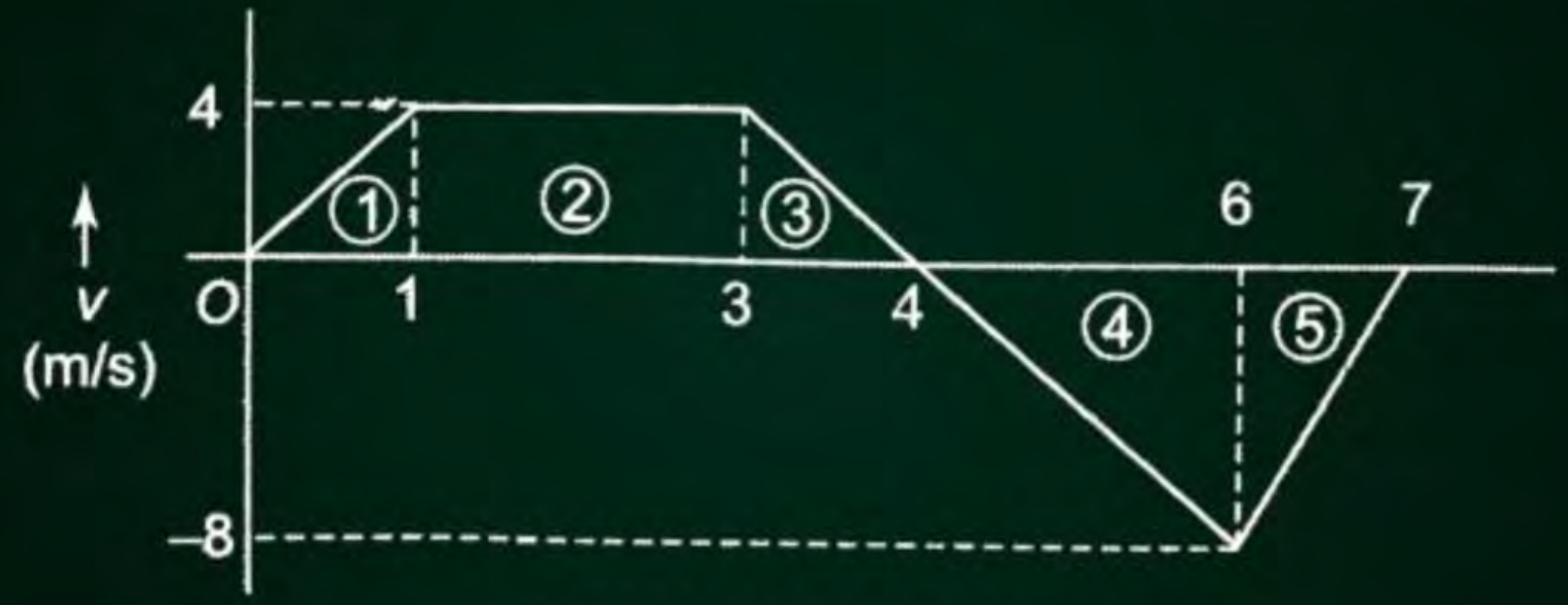




if initial velocity is 1 m/s then find velocity at $x = 8$ m.

QUESTION

A particle is moving in a straight line along the *x*-axis. Its velocity-time graph is as shown. Sketch the displacement-time and distance-time graphs.



THANK YOU



YAKEEN 2.0

FOR NEET 2025

Lecture-13 | Physics

Motion In a Straight Line

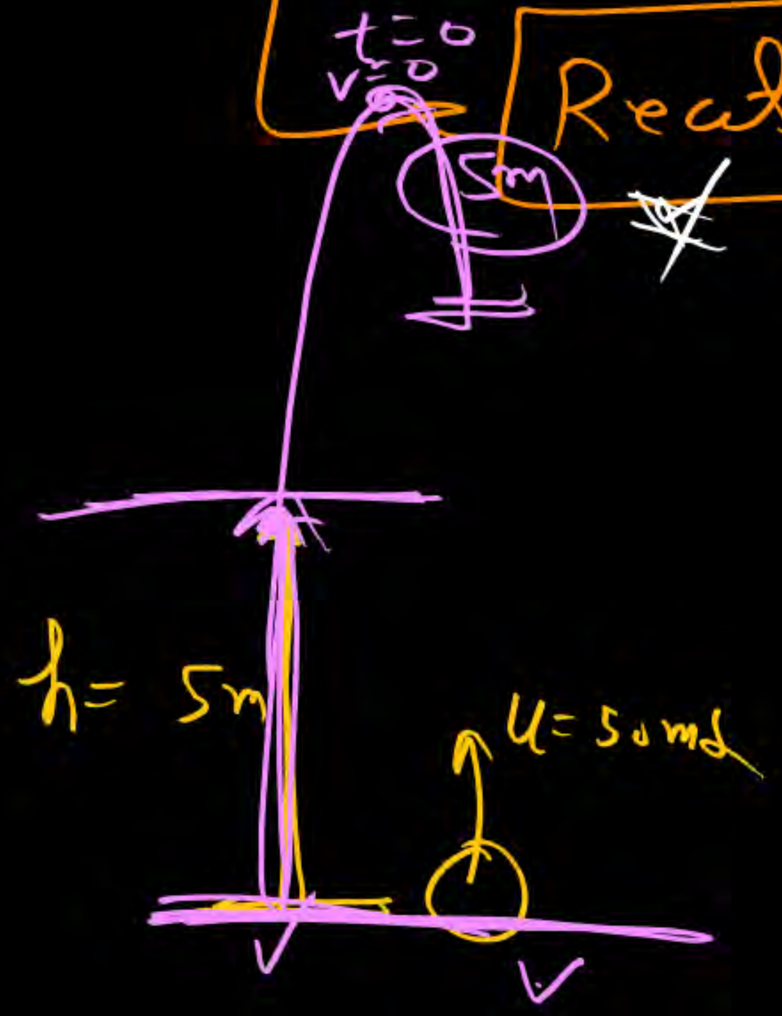
By- Dr. Manish Raj (MR SIR)



Todays Goal

question on Graph

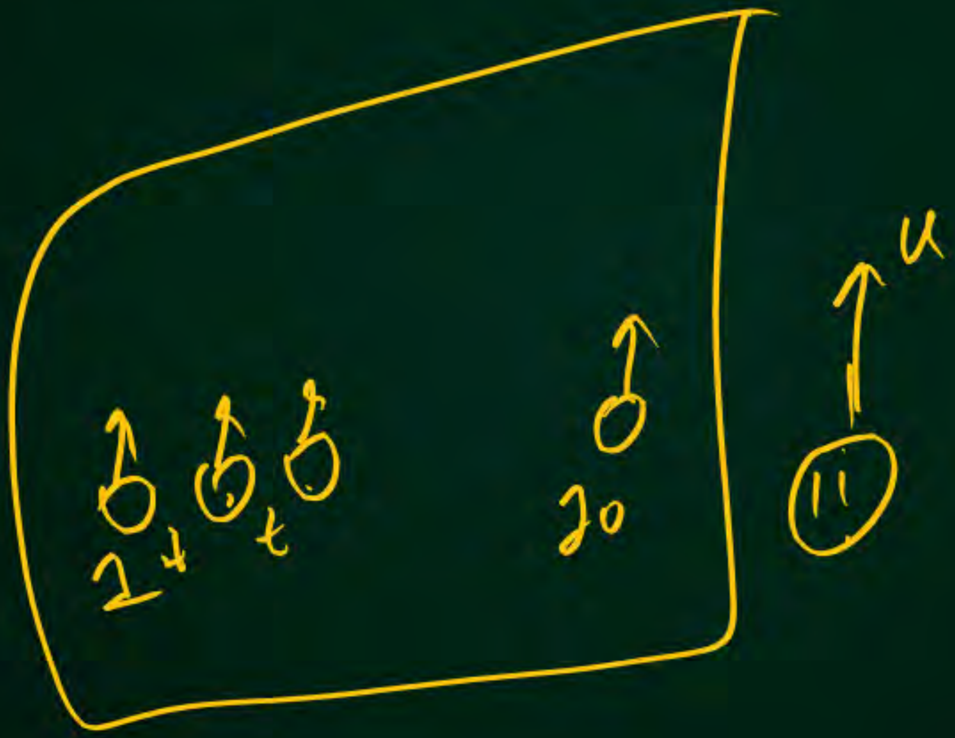
Relative motion in 1-D



QUESTION

A juggler maintains 10 balls in motion, making each of them rise at a height of 80 m from his hands. Find the time interval maintained by the juggler to keep the proper distance between them.

1. 0.6 s
2. 0.8 s
3. 1.0 s
4. 1.2 s



$H = \frac{u^2}{2g}$

$\frac{2u}{g} = 10t$ (time interval)

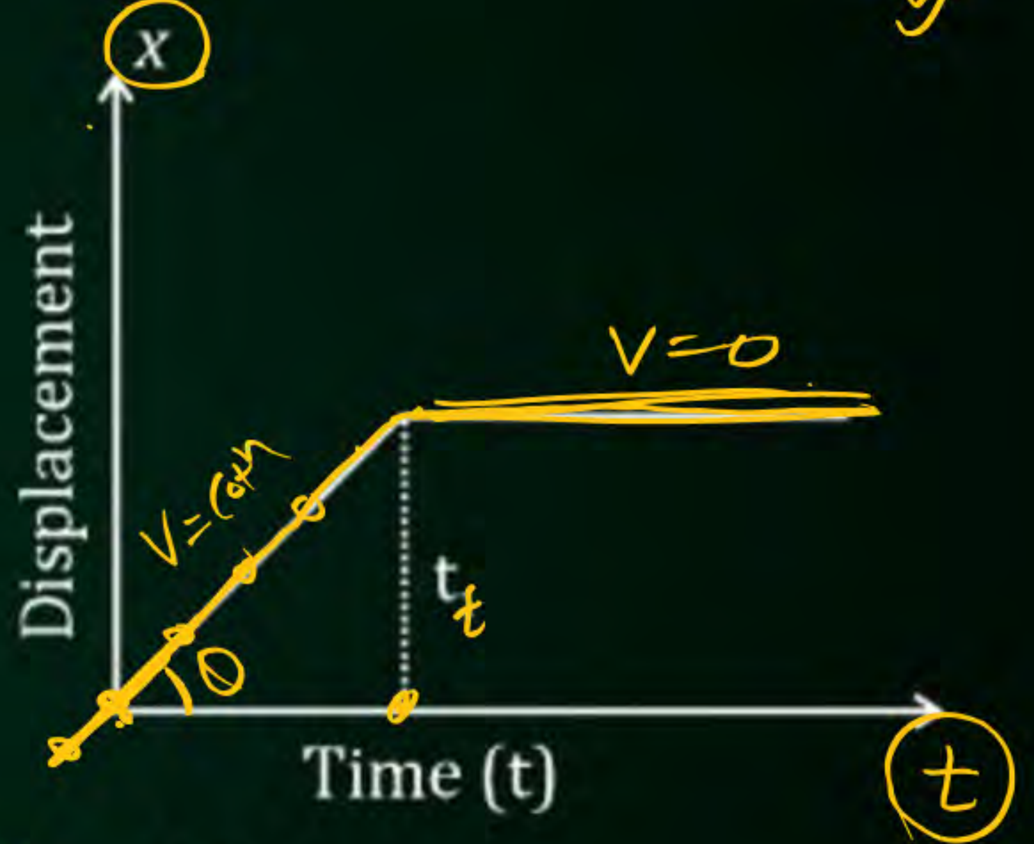
$\frac{2 \times 40}{10} = 10t$

$\frac{8}{10} = t$

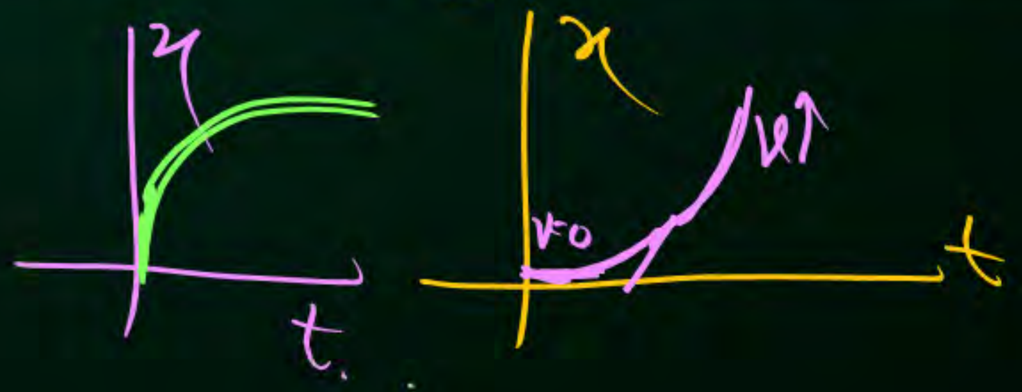
0.8 sec

QUESTION

The x-t graph shown in figure represents [CPMT1984]



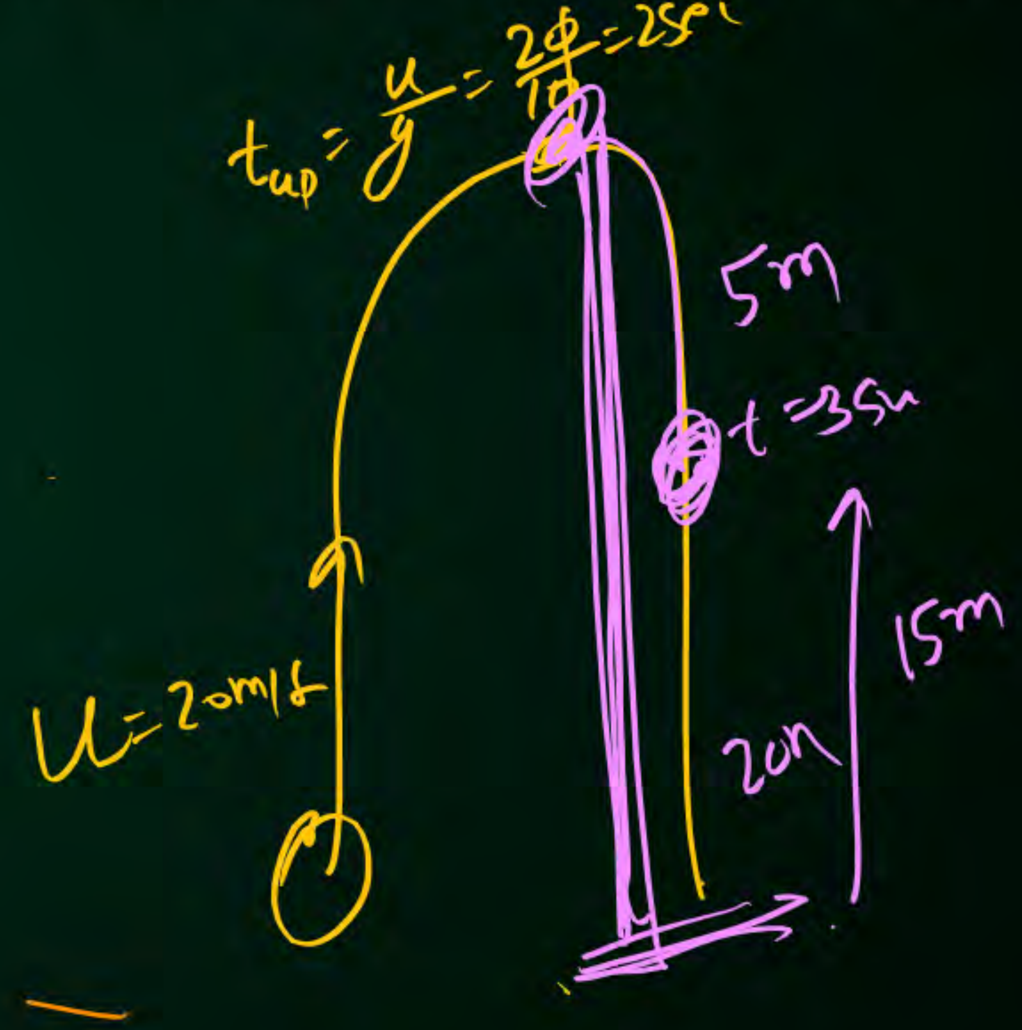
1. Constant velocity.
2. Velocity of the body is continuously changing.
3. Instantaneous velocity is zero at t = 0.
4. The body travels with constant speed upto time t_1 and then stops.



QUESTION

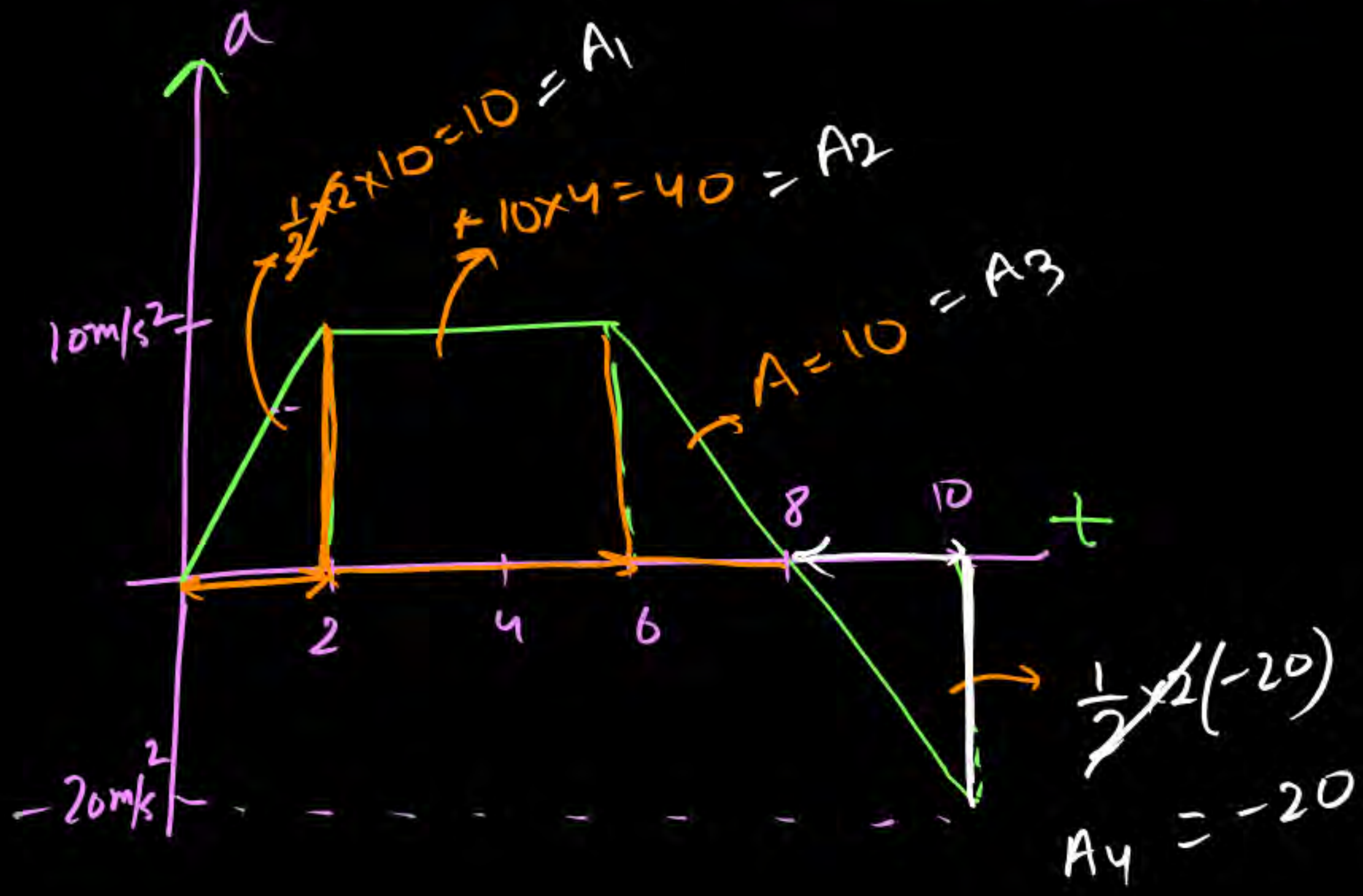
A juggler maintains four balls in the air with air with throwing speed 20 m/s upwards in regular time intervals. When one ball is about to leave his hand the height of balls in air from the ground will be:

1. 60 m, 80 m, 60 m, 0 m
2. 30 m, 40 m, 30 m, 0 m
3. 15 m, 20 m, 15 m, 0 m
4. 10 m, 20 m, 10 m, 0 m



(Q) If initial velocity is $-10\ m/s$ then find velocity at $t = 10\ sec$

Sol^n



area of a/t graph is change in velocity

$\Delta\vec{V} = \vec{V_f} - \vec{V_i} = 60 - 20$

$V_f = V_i + 40$

$= -10 + 40$

$V_f = 30\ m/s$

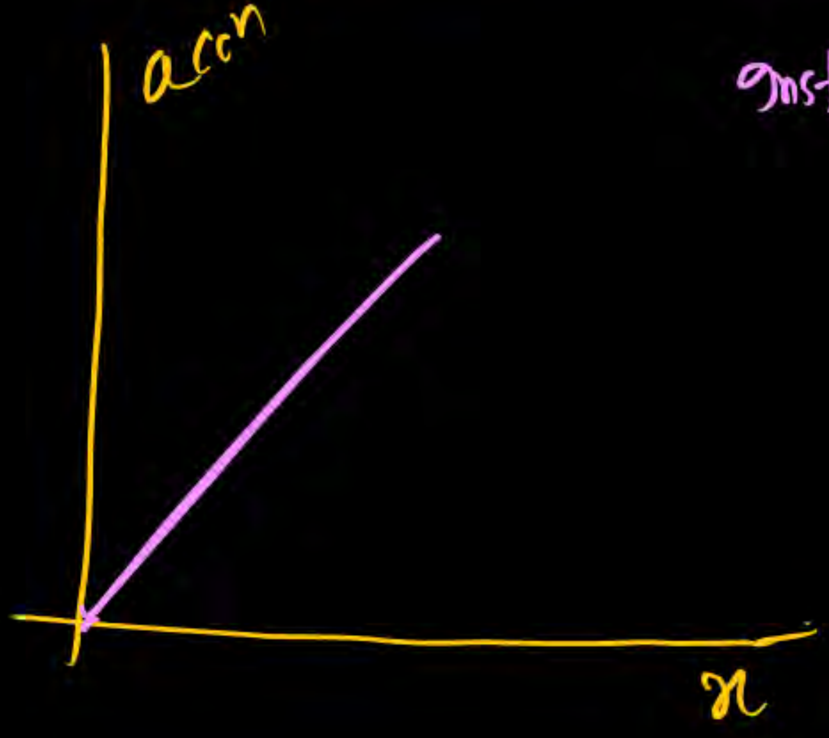
→ x/t graph

→ v/t → Area = Δx = disp
→ slope → a

→ a/t → slope ✗
→ Area = Δv ✓

v/x → slope = a/v
→ Area ✗

graph B/w accⁿ & Position



const. accⁿ → y^{th} co-ordinate
Position → x^{th} co-ordinate

slope = $\left(\frac{da}{dx}\right)$ (Not P.Q)

Area = $\int a\,dx$

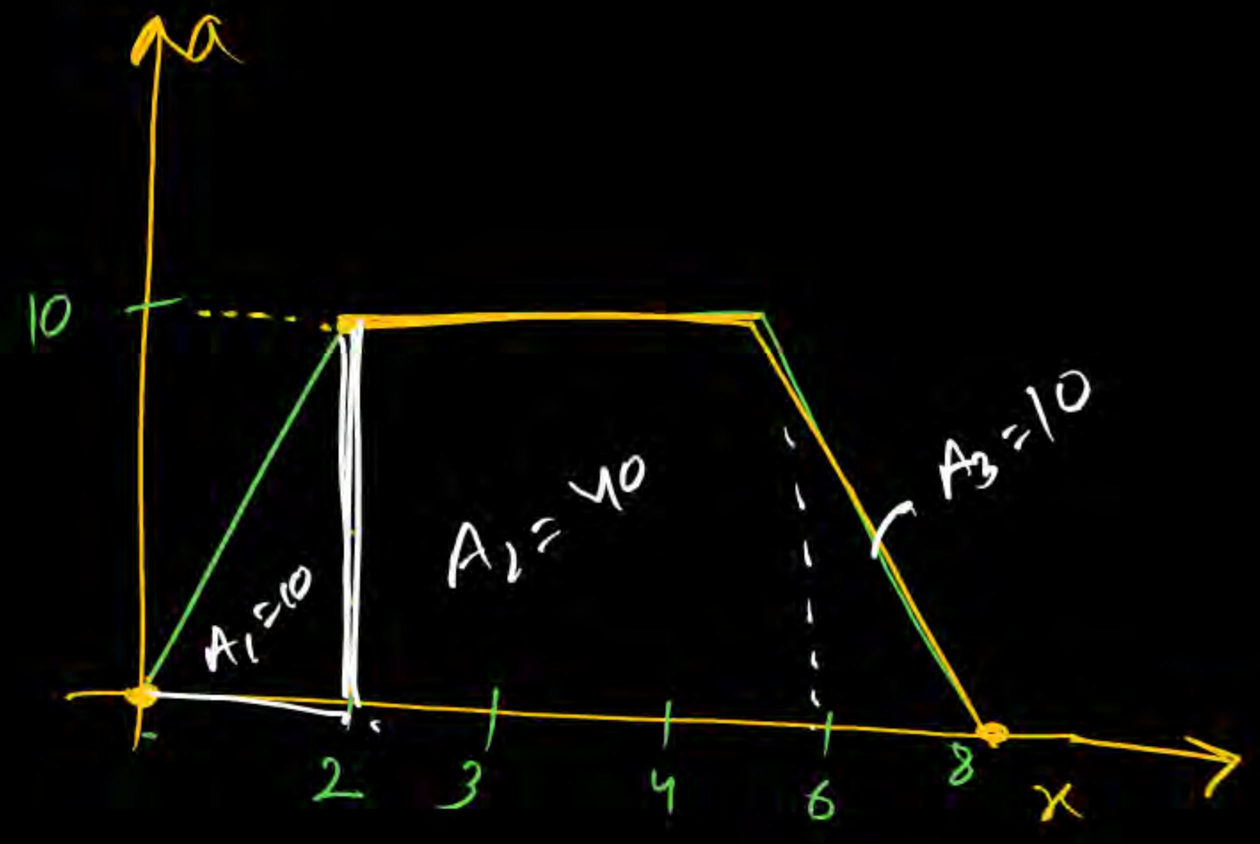
area = $\int v \frac{dv}{dx} dx$

area = $\int_u^v v\,dv$

* $a = \frac{dv}{dt} = v\frac{dv}{dx}$

* MR Ratte

Area = $\left[\frac{v^2}{2}\right]_u^v = \frac{v^2 - u^2}{2}$



* If initial velocity is 1 m/s then find velocity at x = 8 m.

Sol^n

$$\frac{v^2 - u^2}{2} = \text{Area of a-x graph}$$

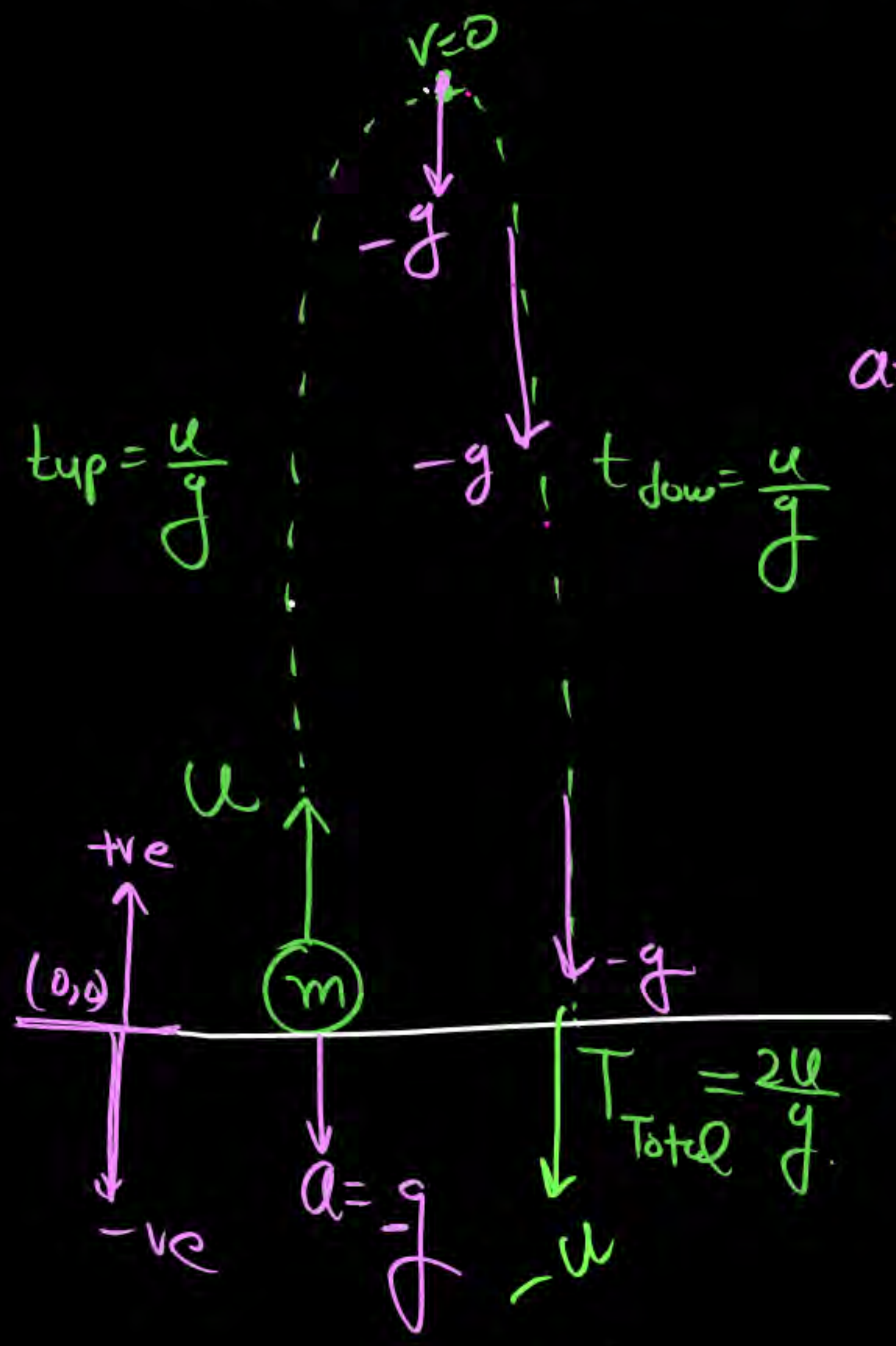
$$\frac{v^2 - u^2}{2} = 60$$

$$v^2 - (1)^2 = 120$$

$$v^2 = 121$$

$$v = \sqrt{121} = 11\ \text{m/s}$$

Ball is Projected upward then draw graph B/w a/t v/t x/t





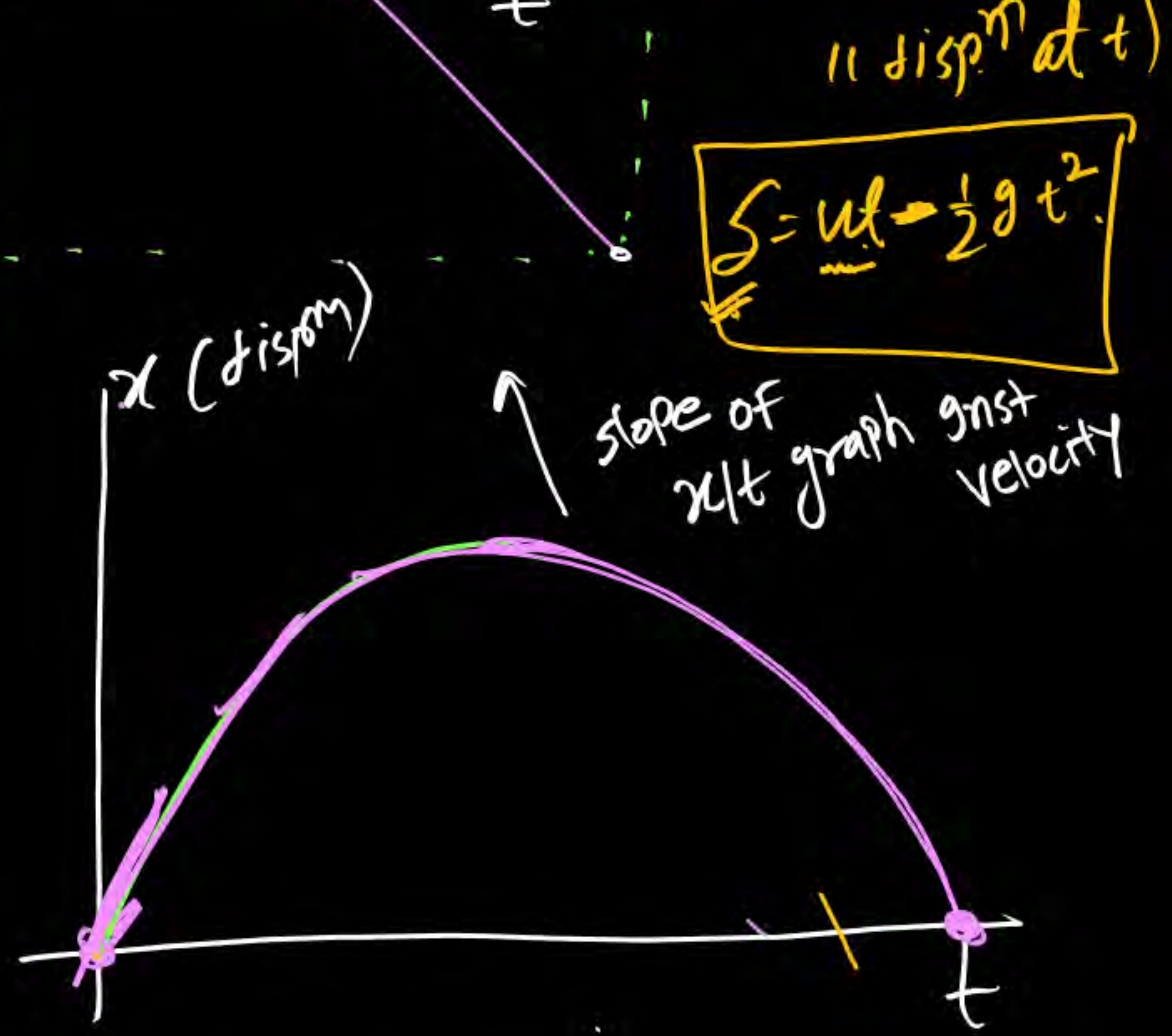


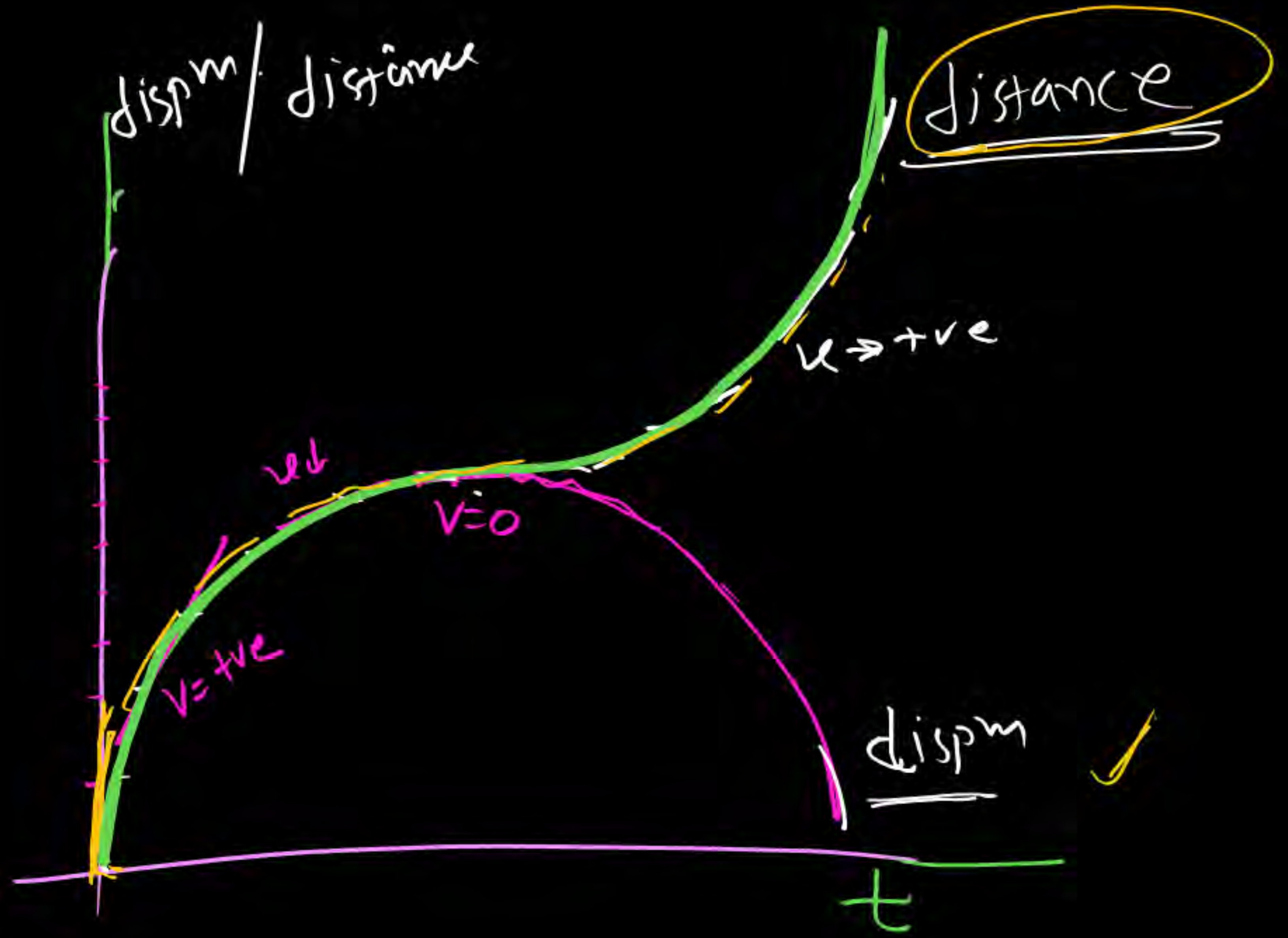
velocity of time 't'

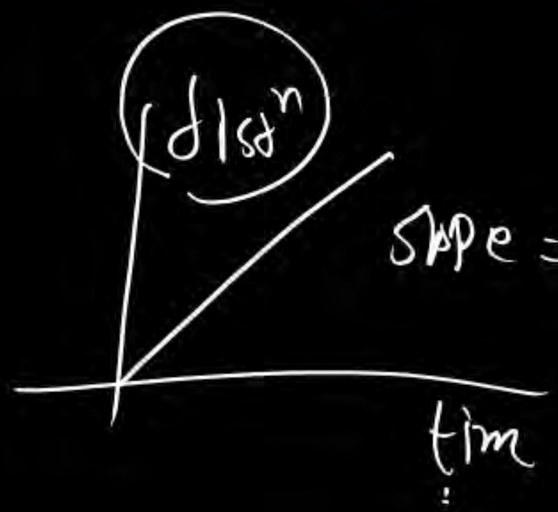
$$v = u + at$$

$$v = u - gt$$

$$y = mx + c$$

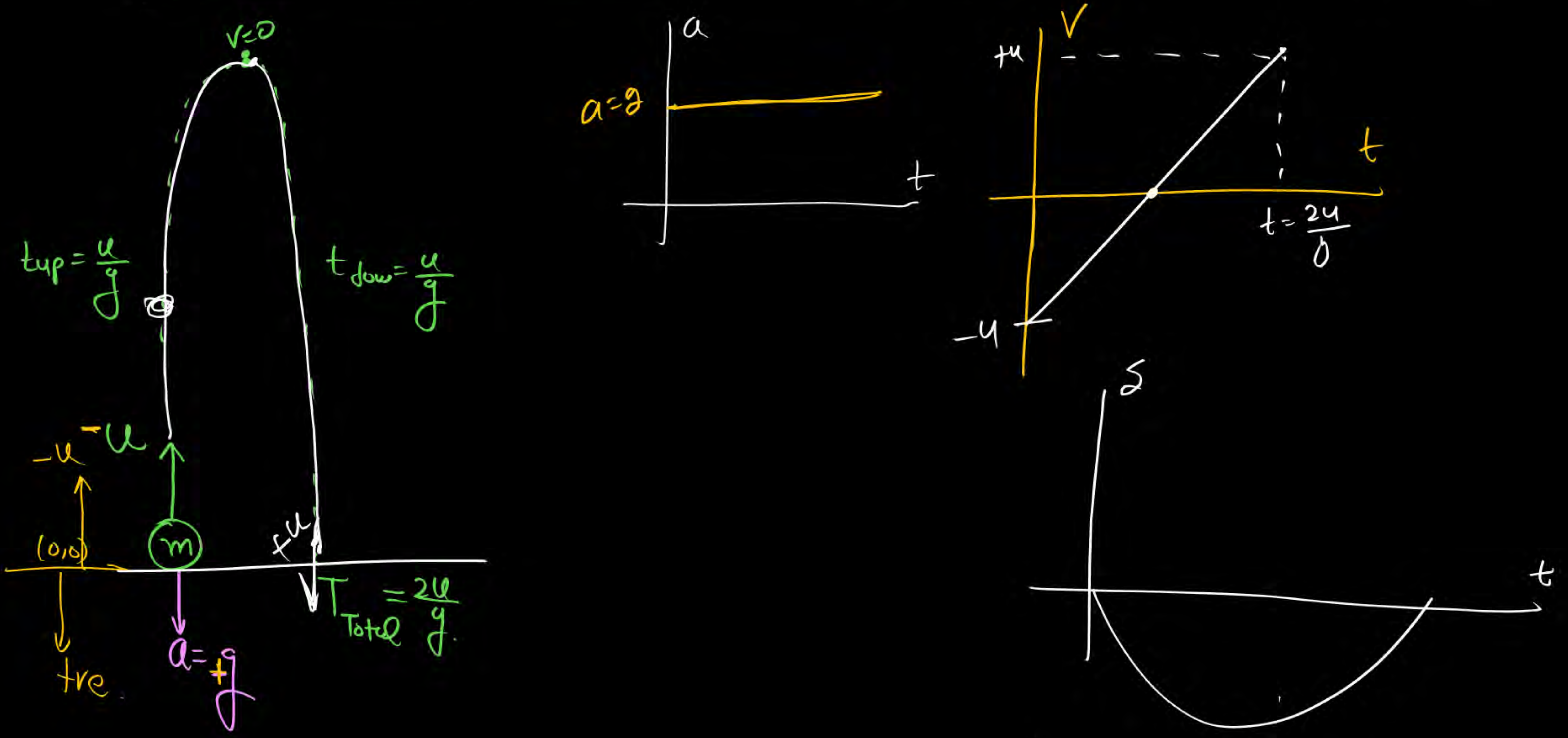






slope = inst Speed

Ball is Projected upward then draw graph B/w a/t v/t x/t

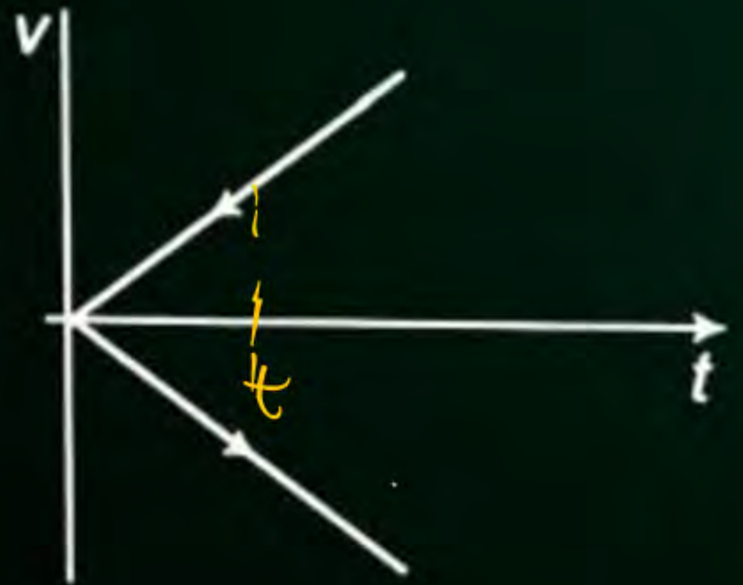


QUESTION

A body is thrown vertically upwards. Which of the following graphs represents the velocity of the body against time correctly?

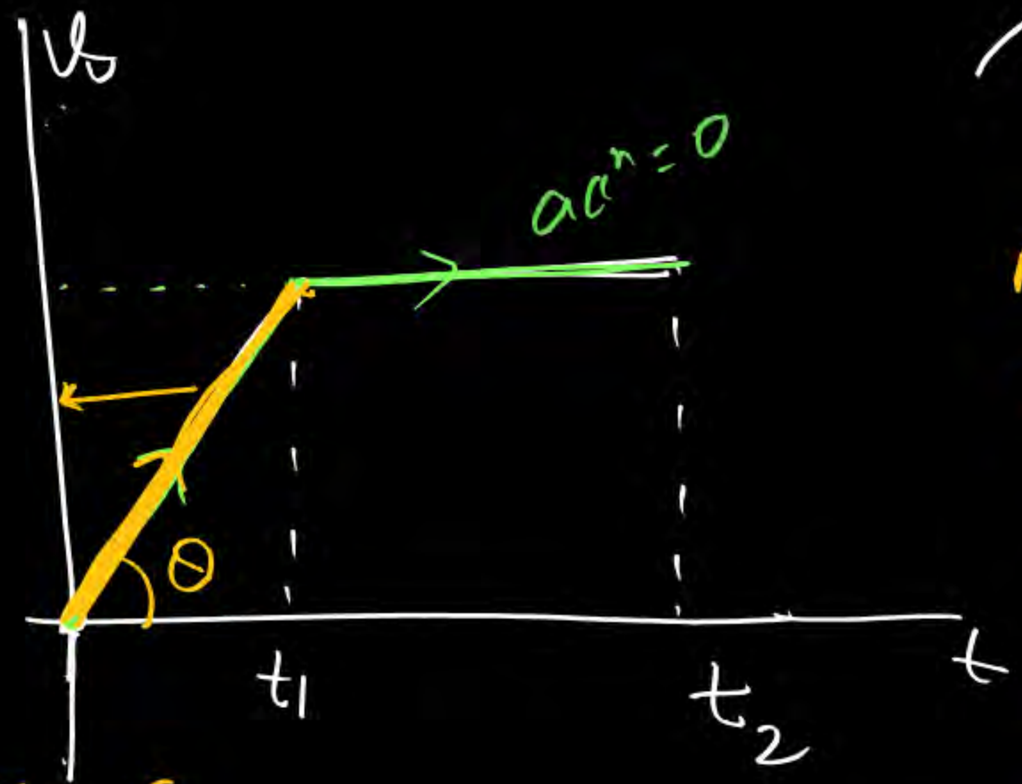
1 

2 

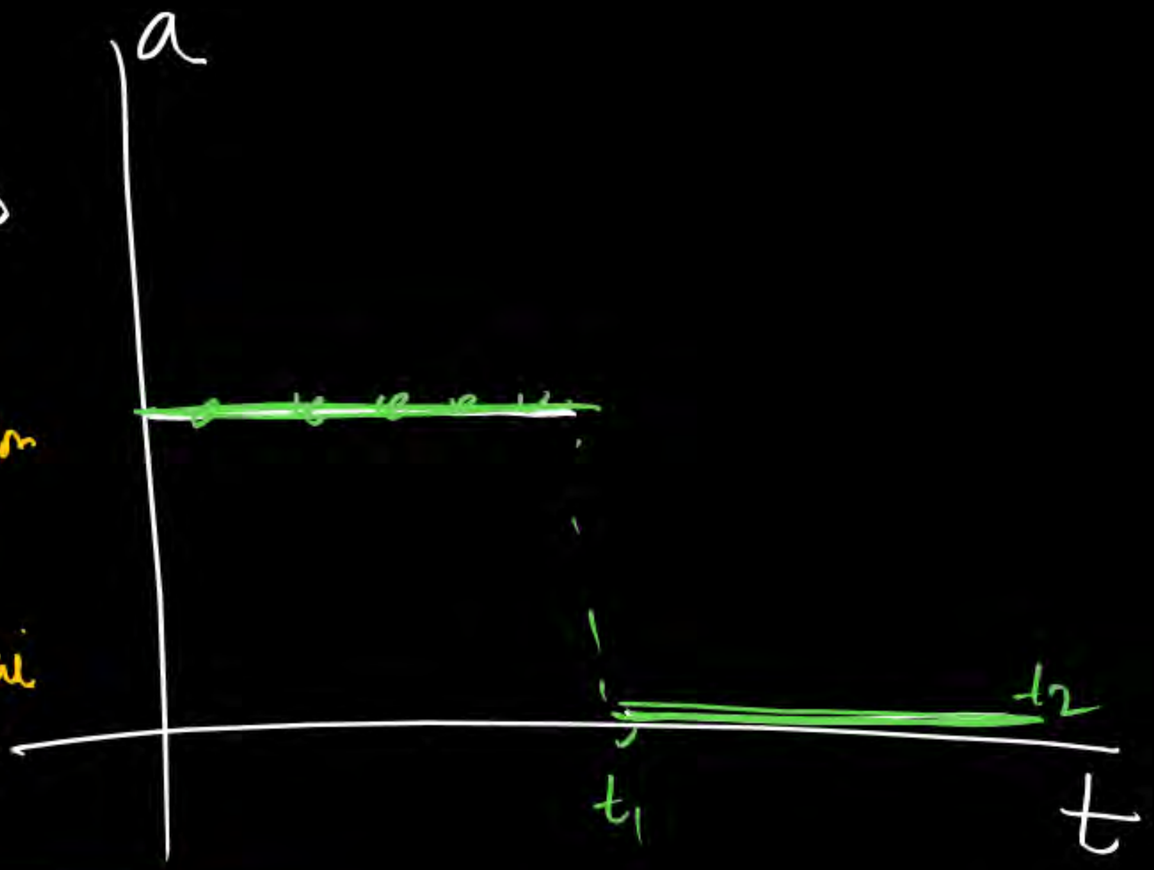
3 

4 

Graph conversion



Convert v/t graph into a/t

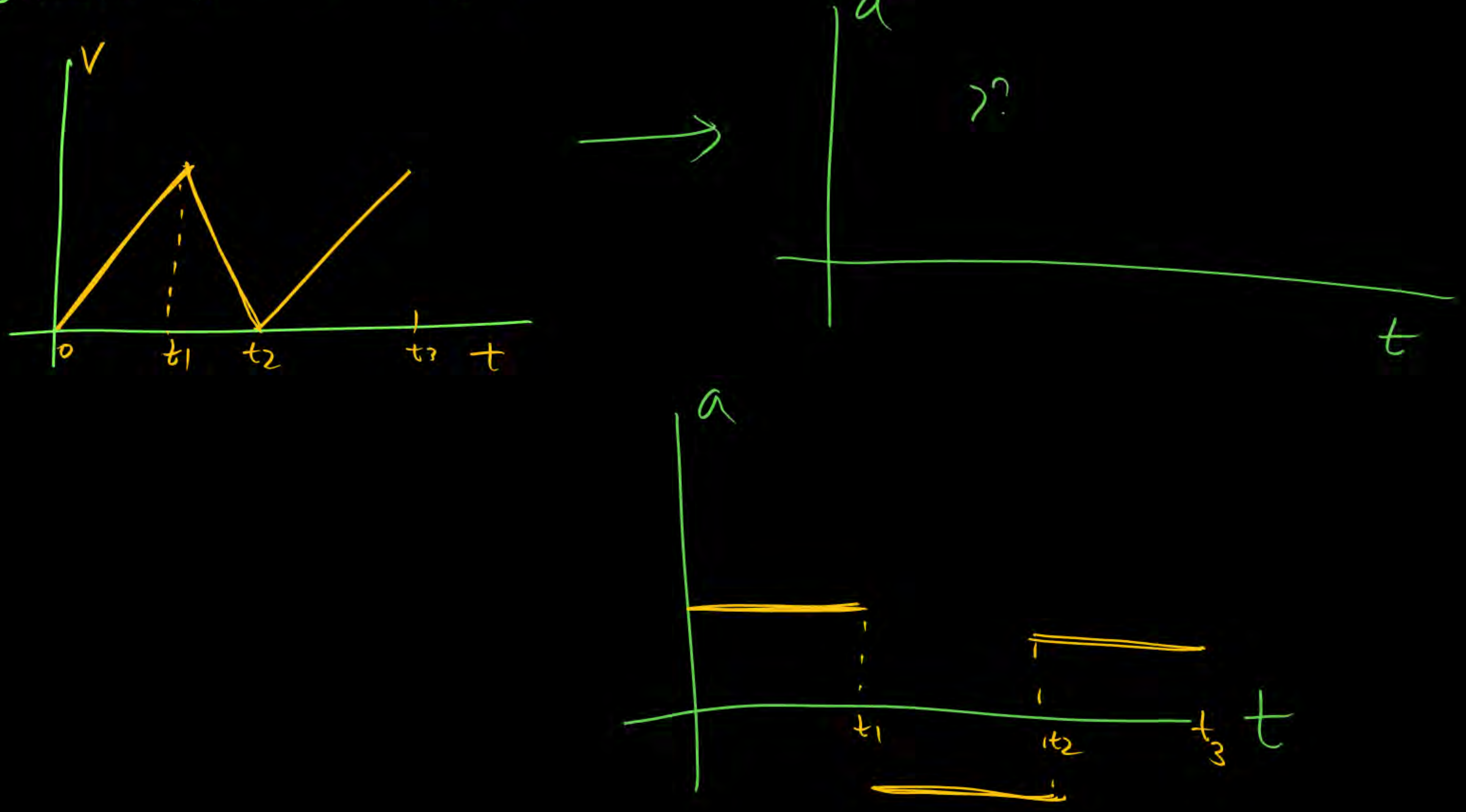


MR* graph conversion always slope ke concept se hota hai

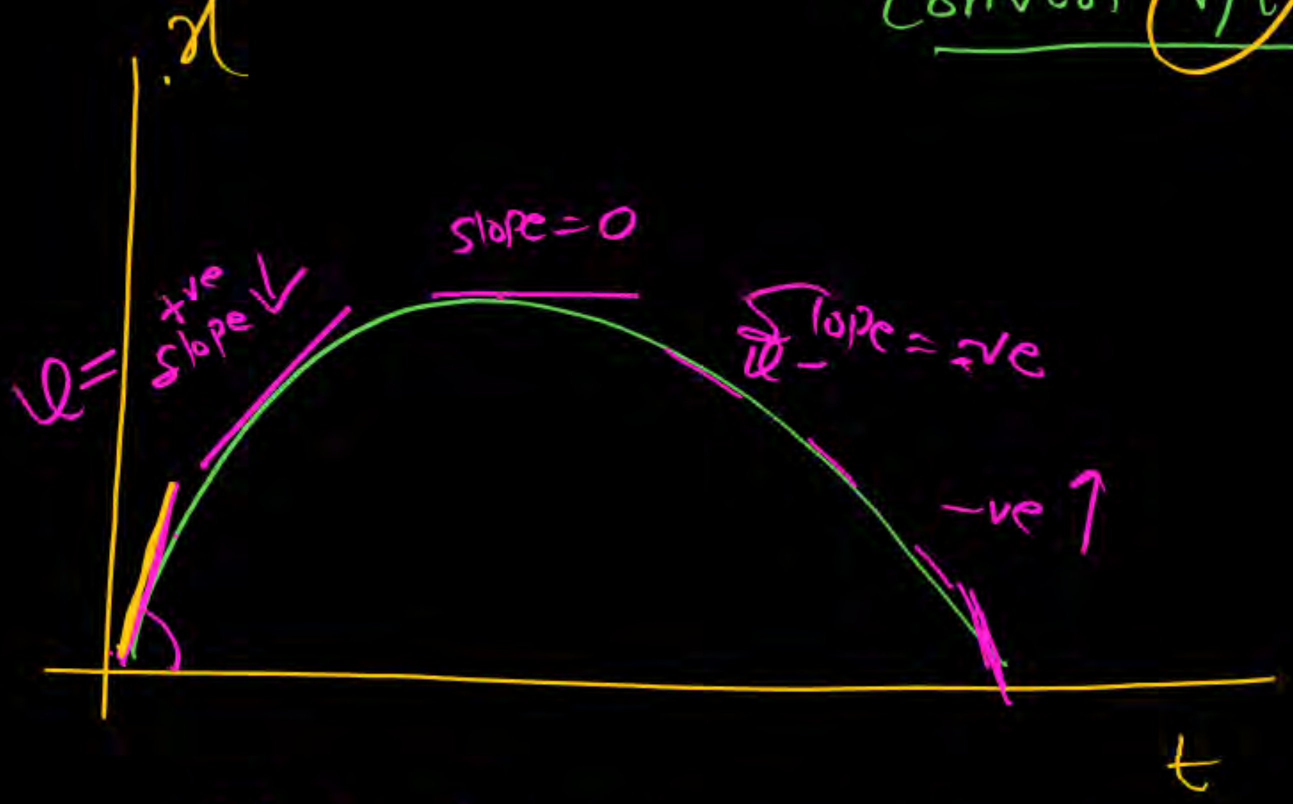
* acc^n ← $(\text{Slope})_{0 \text{ to } t_1} = +ve\,(\text{acc}^n)$
* acc^n ← Slope $(t_1 \text{ to } t_2) = 0$

MR* → option me wrong graph find karo

Convert v/t to a-t



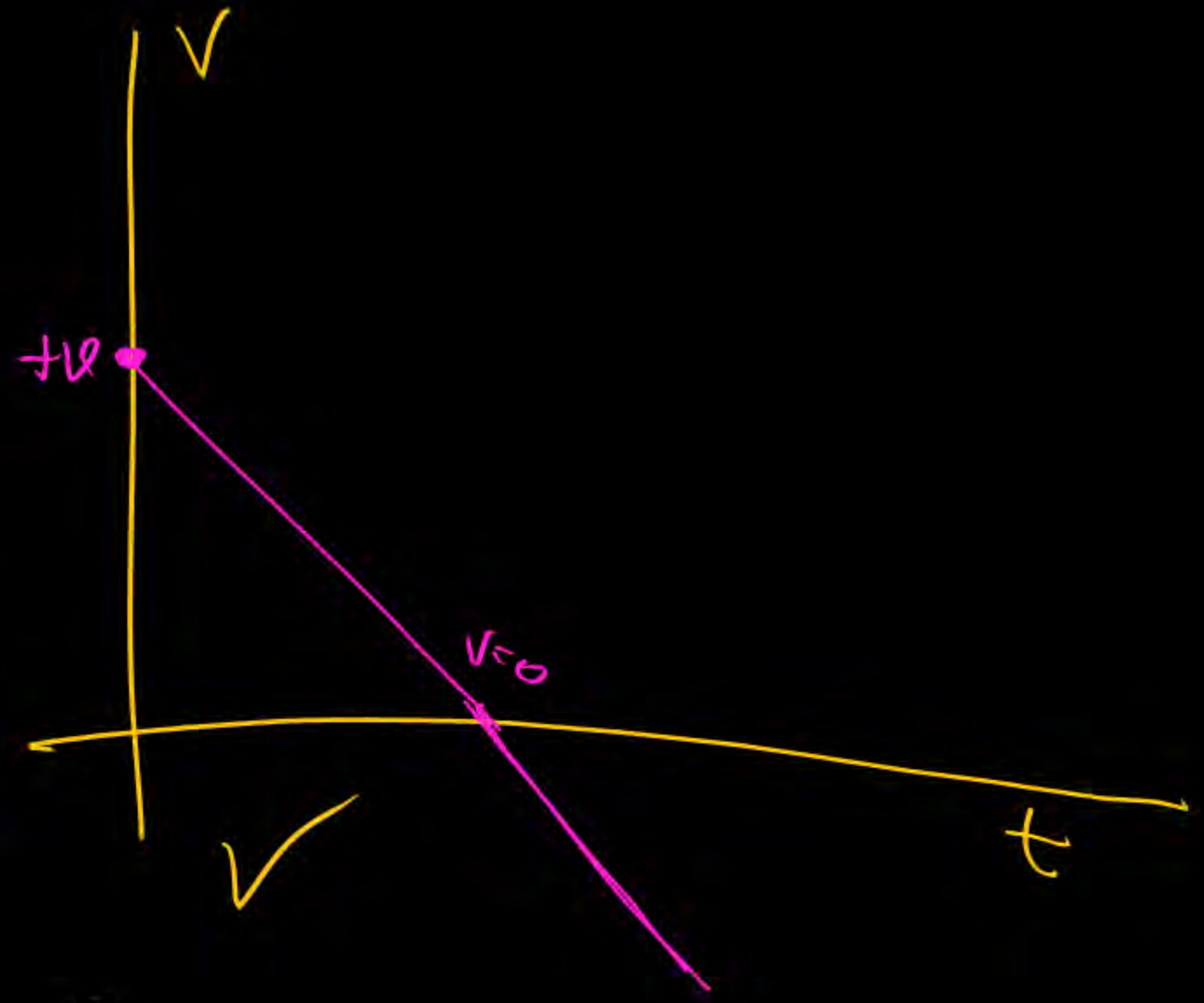
Convert v/t graph.



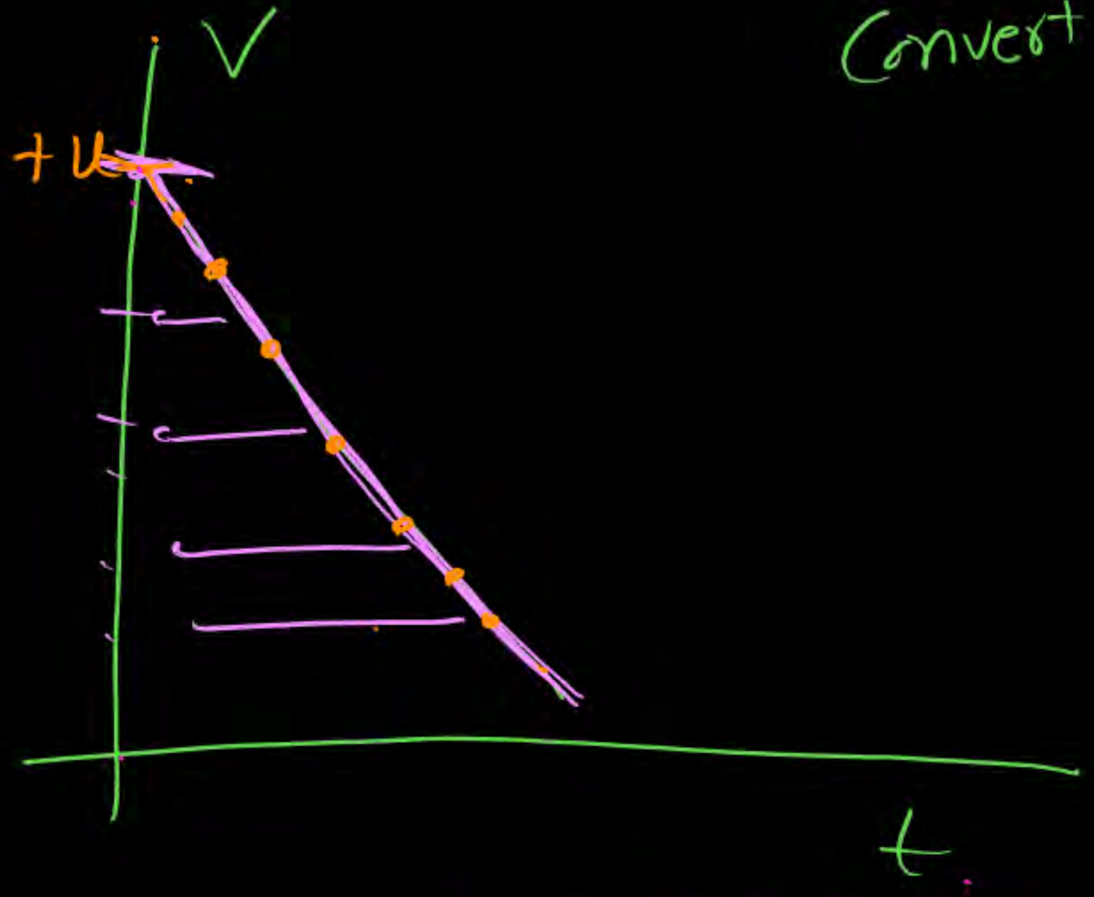


Slope of x/t → inst velocity



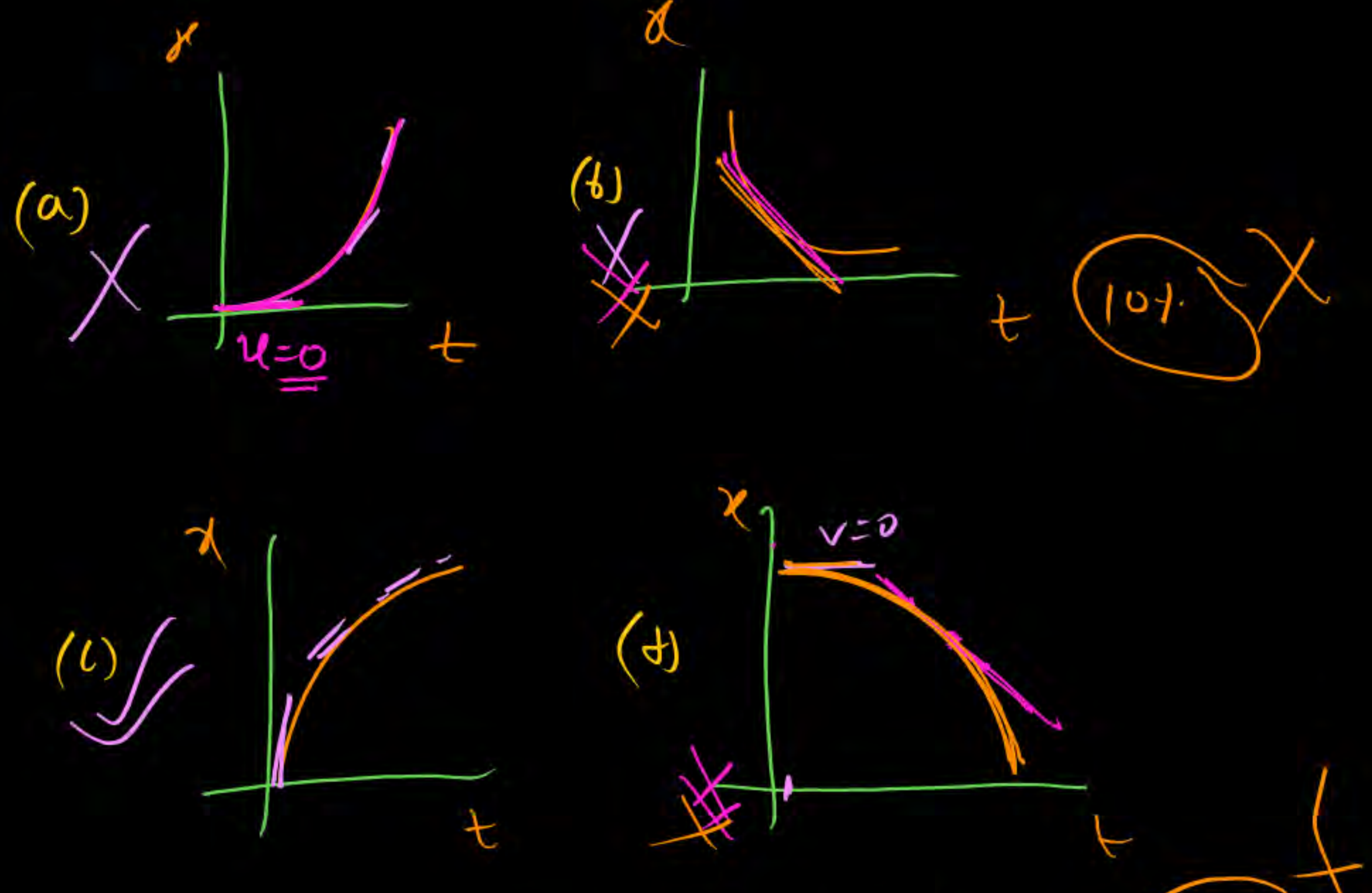


Convert v/t to x/t



Slope of v/t = accn

Slope of x-t velocity

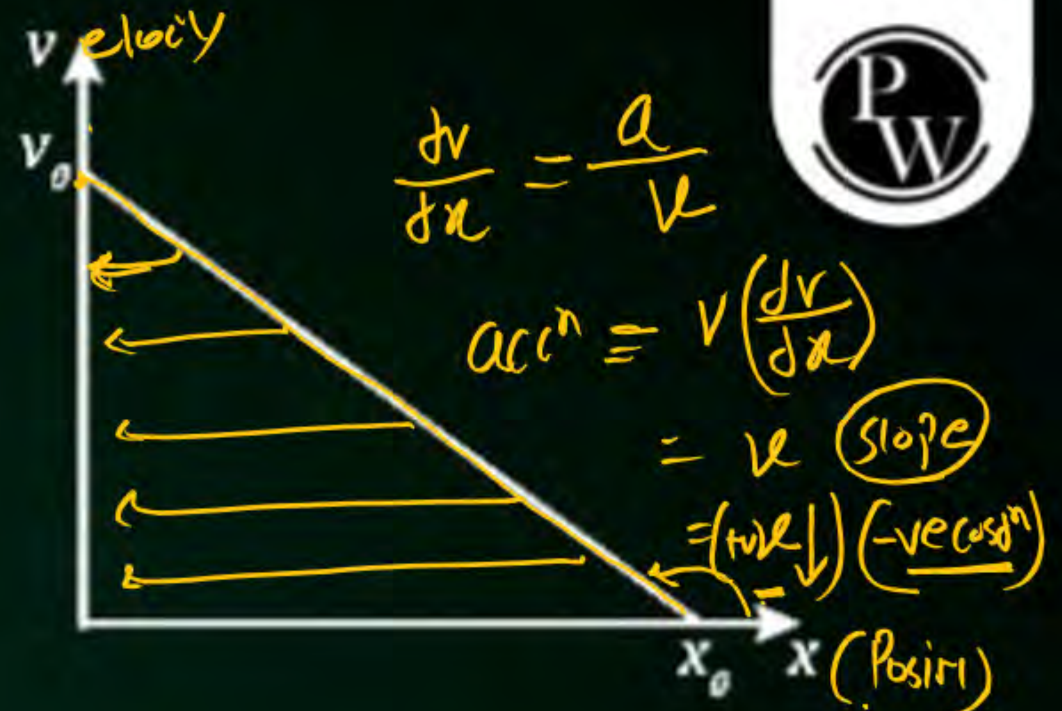


Slope x/t ⇒ Velo

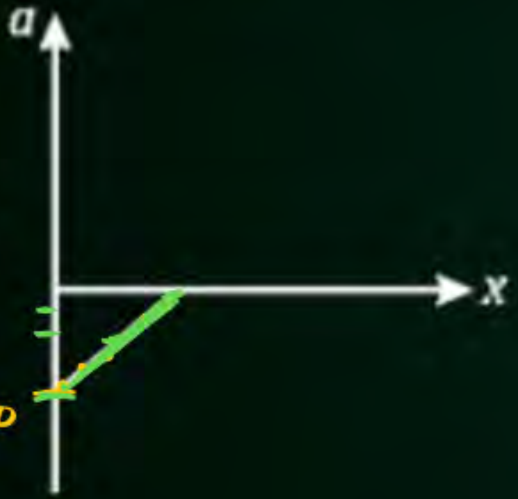
17%

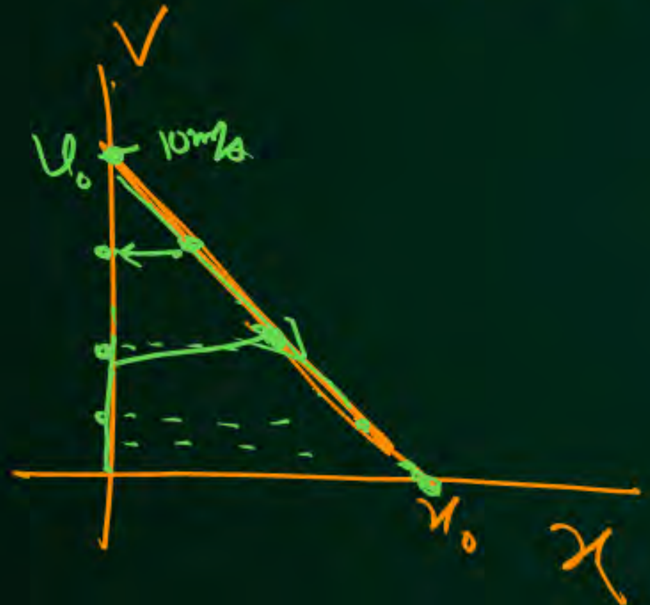
QUESTION

The given figure graph shows the variation of velocity with displacement. Which one of the graph given below correctly represents the variation of acceleration with displacement **[IIT-JEE (Screening) 2005]**

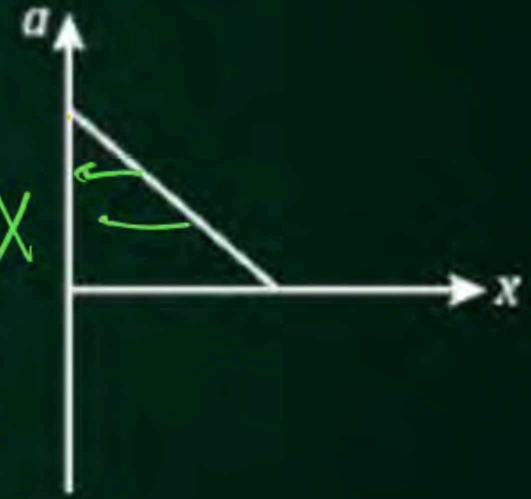


1





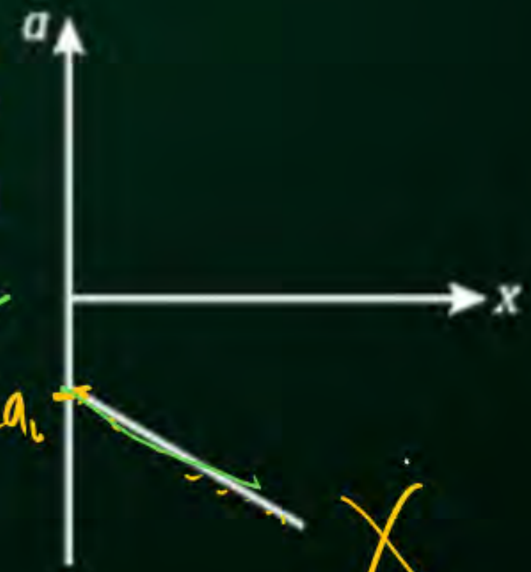
2



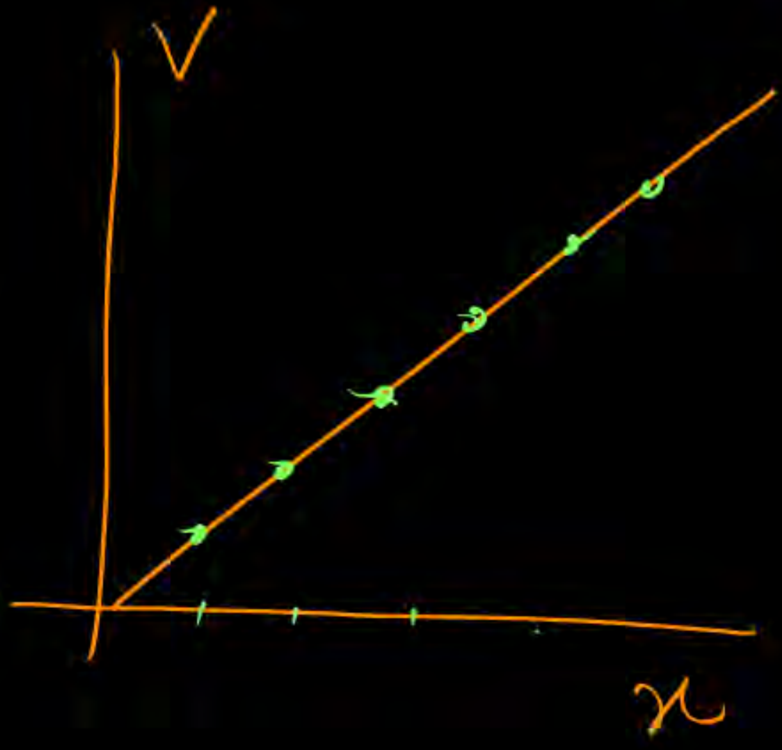
3

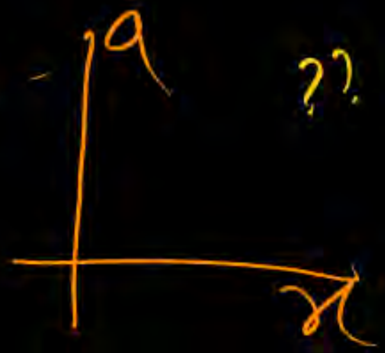


4



Convert v/x graph in a/x graph





$$a = v\left(\frac{dv}{dx}\right)$$

$$= v\,(\text{slope})$$

$$= v\uparrow\ (\text{+ve const})$$



eqⁿ according to graph

$$v \propto x \quad \text{— (1)}$$

$$v = kx$$

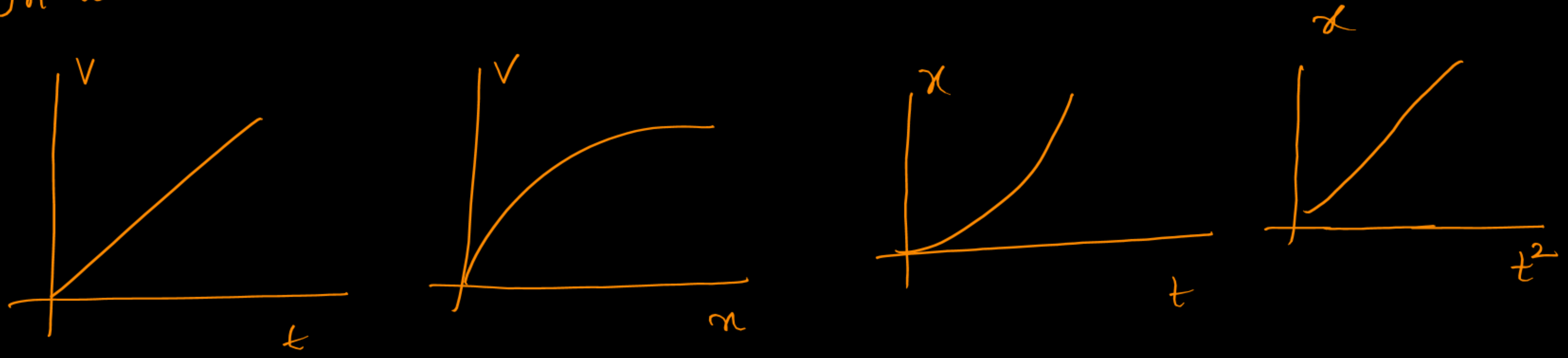
$$a = v\frac{dv}{dx}$$

$$\frac{dv}{dx} = k\frac{dx}{dx} = k$$

$$a = kx\,k$$

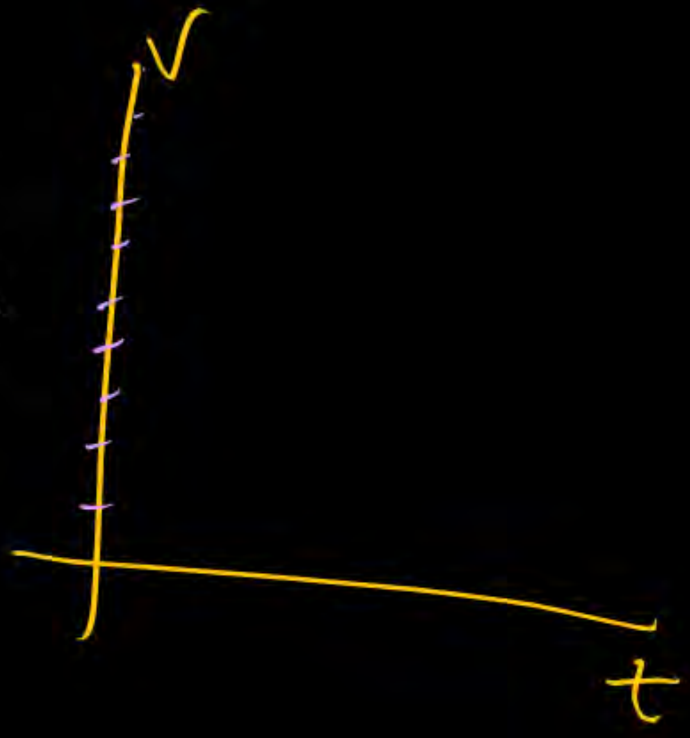
$$\boxed{a = k^2 x}$$

In which case acceleration is constant.

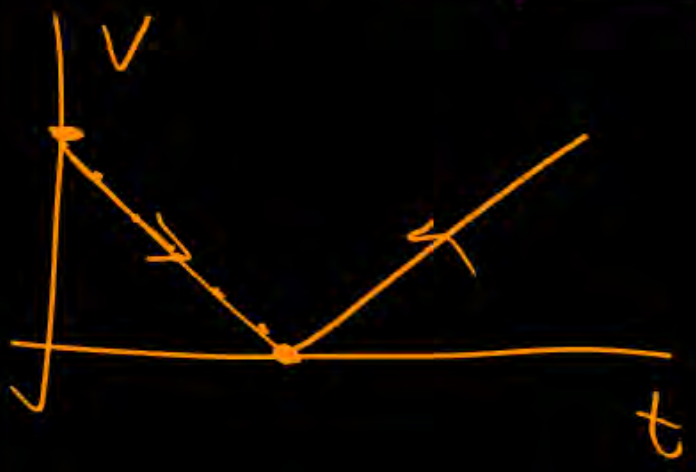




Convert it into v/t →



Slope of x/t graph → Velocity



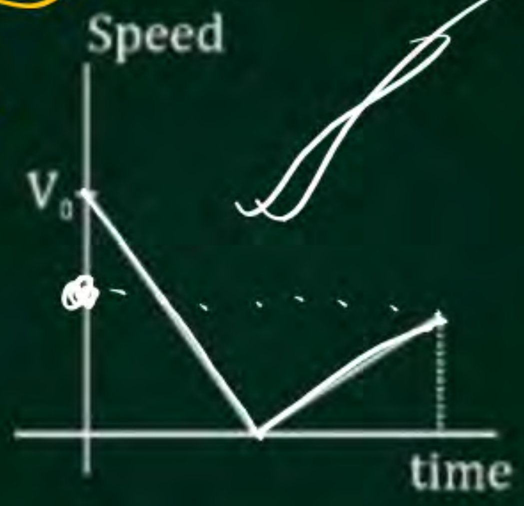
QUESTION

A ball is thrown vertically upwards. Which of the following plots represents the speed-time graph of the ball during its flight if the air resistance is not ignored? (acceleration due to air friction = a_0)

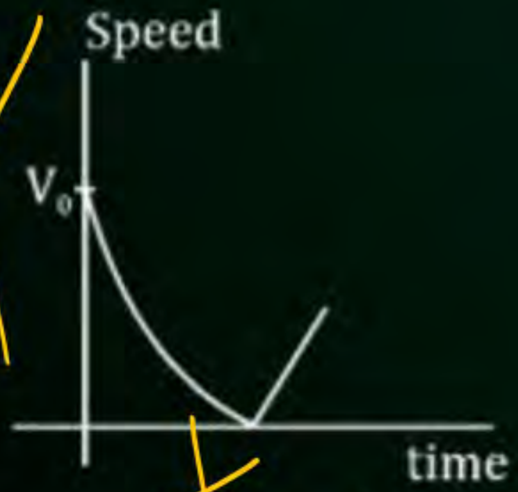
(1)



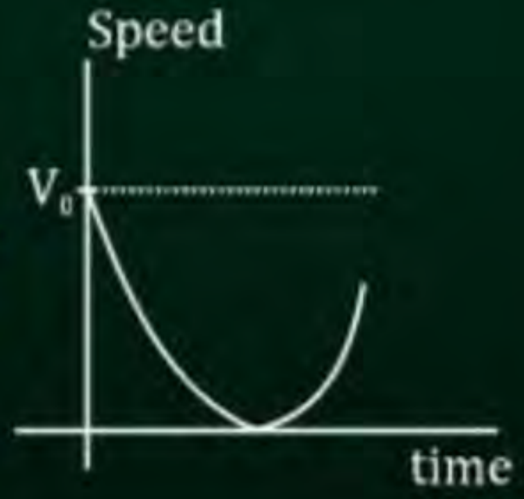
(2)

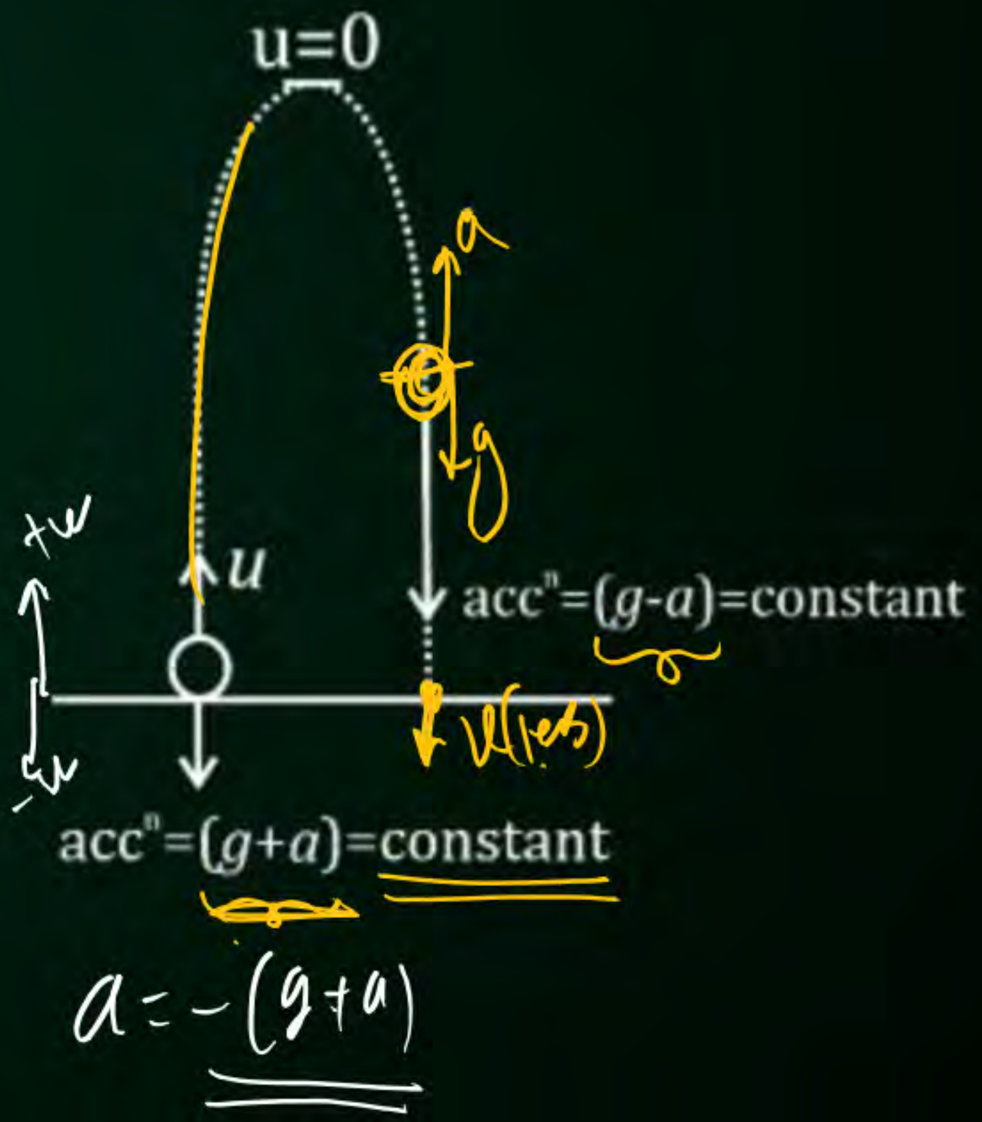


(3)

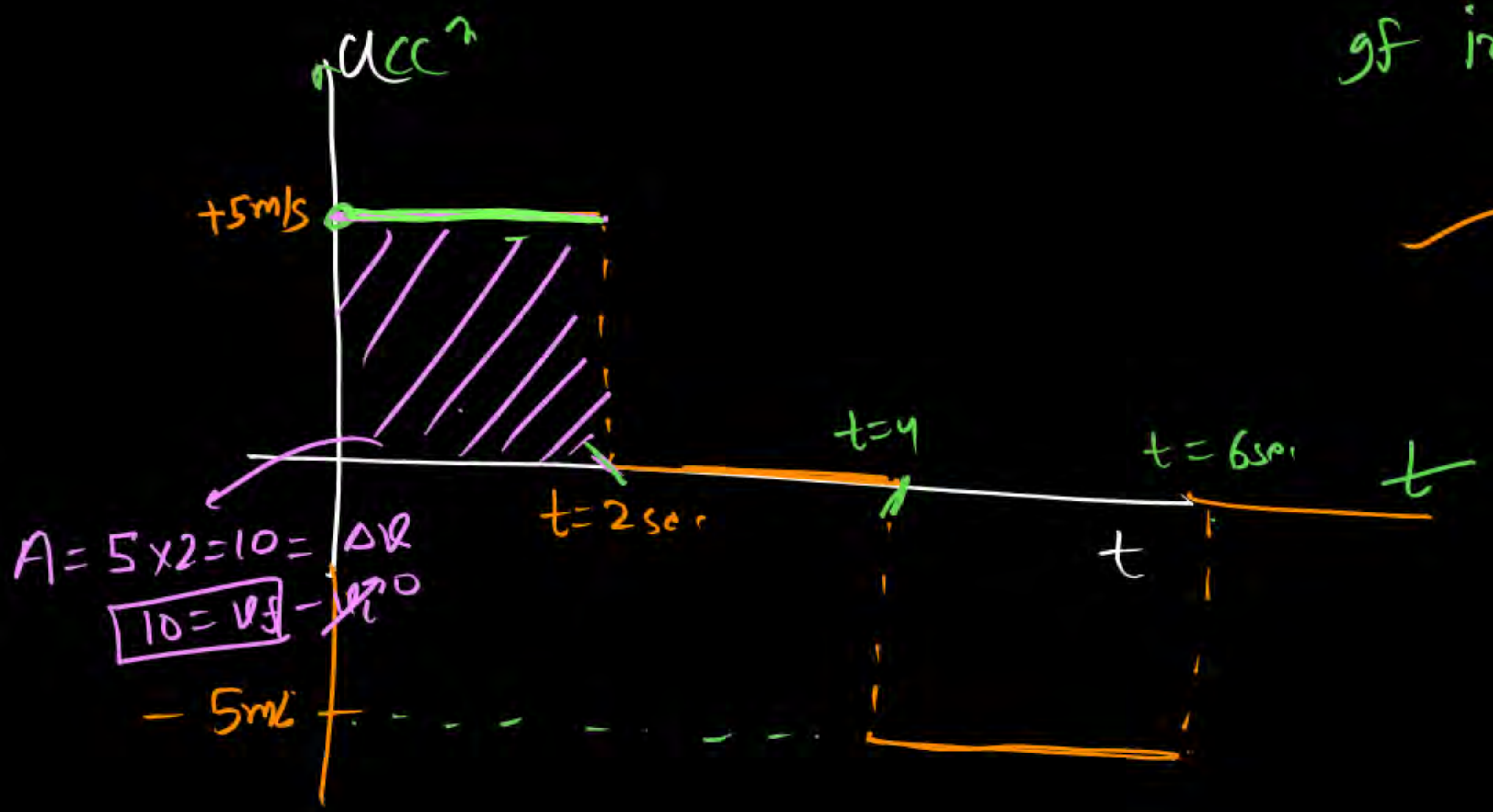


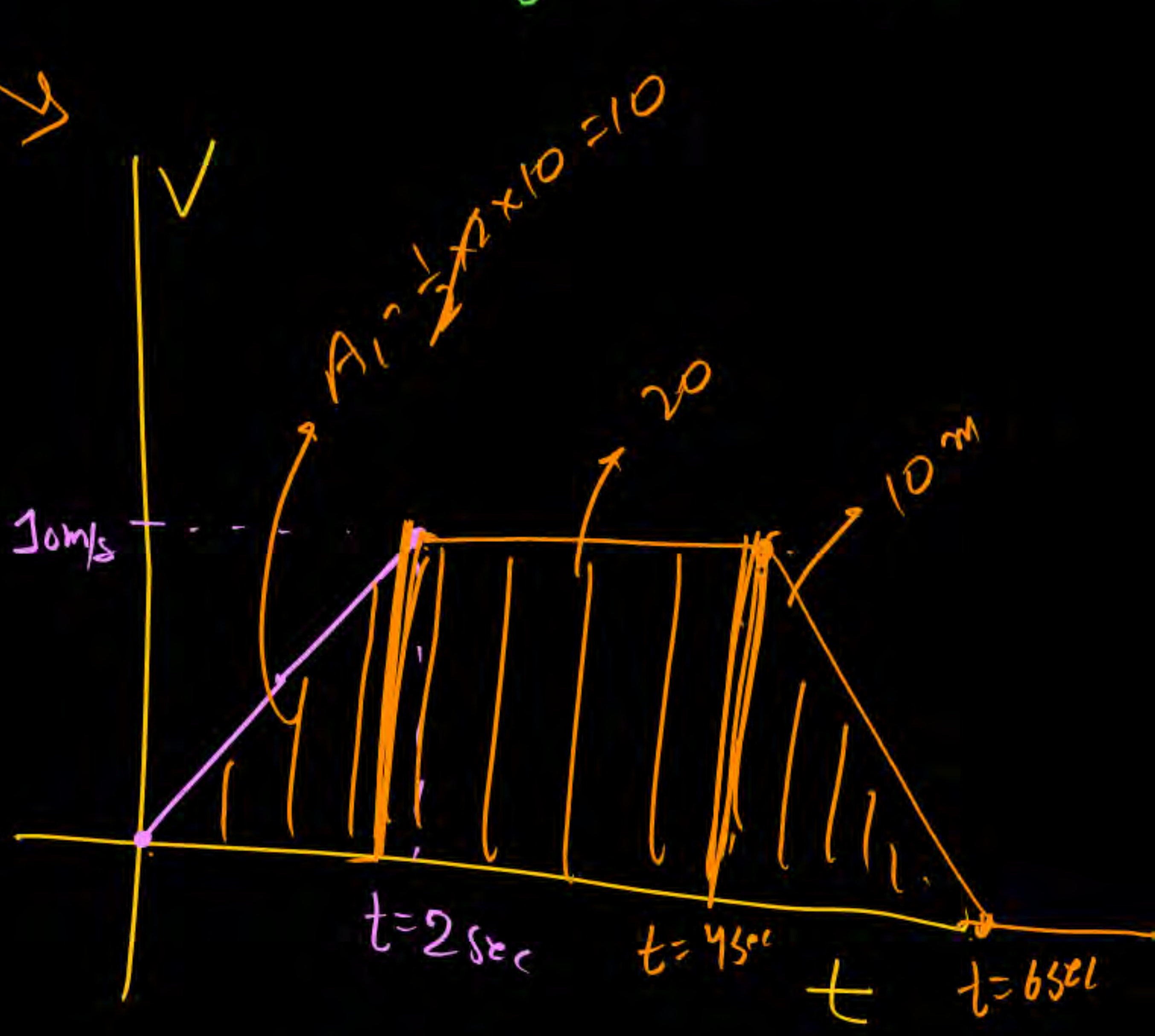
(4)





If initial velocity is zero then Draw graph b/w V/t



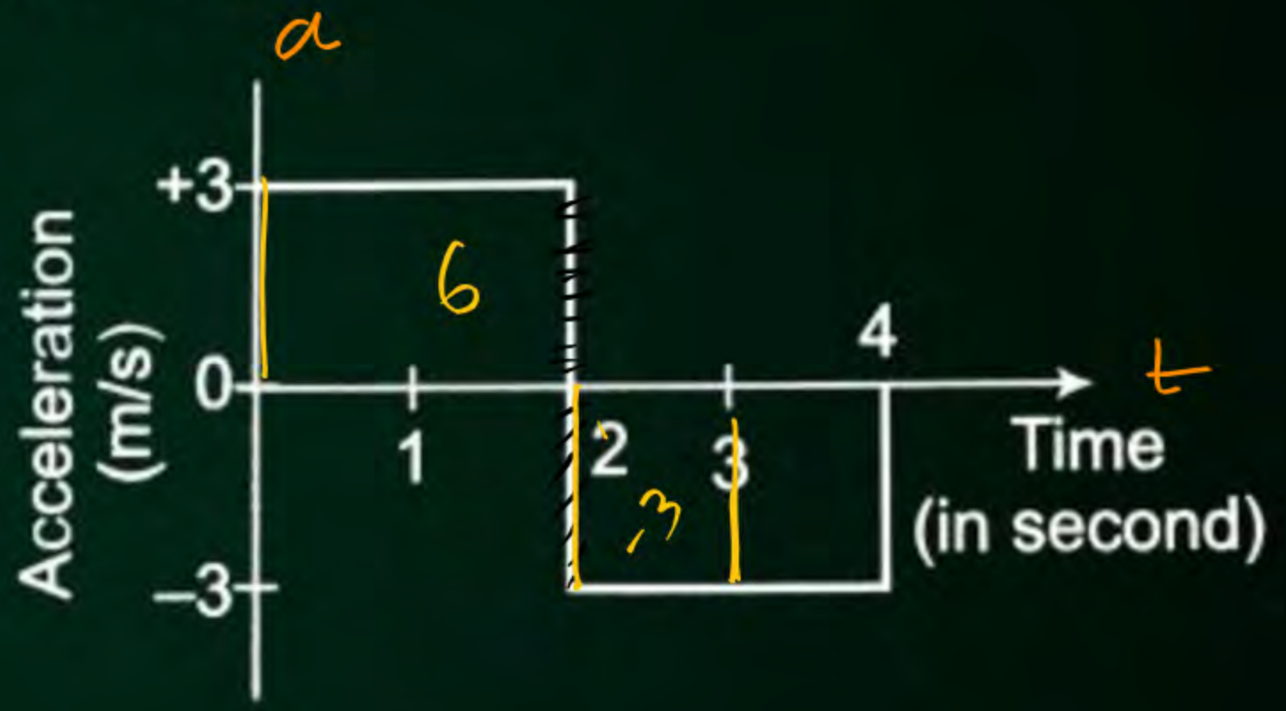


Slope of V/t → a_{inst}

40m = dispm

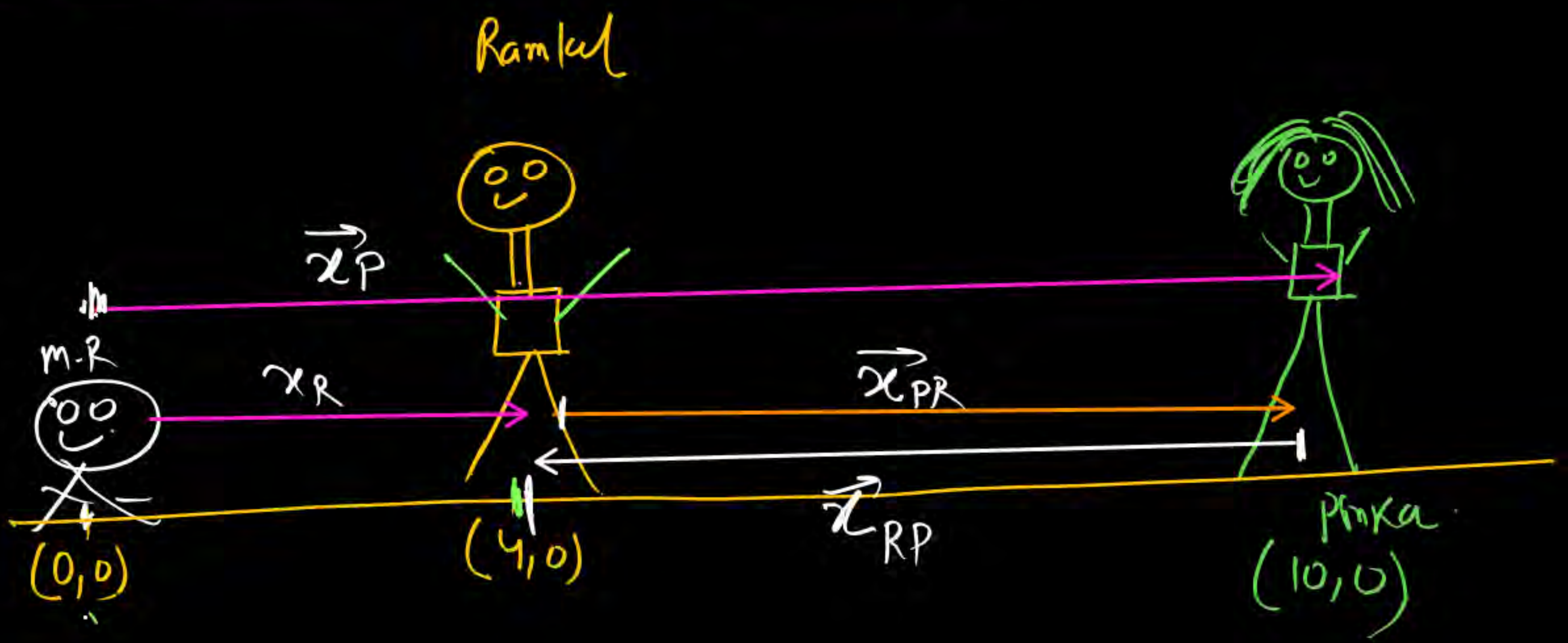
QUESTION

A particle starts from rest at $t = 0$ and moves in a straight line with an acceleration as shown below. The velocity of the particle at $t = 3s$ is



1. 2 m/s
2. 3 m/s
3. 4 m/s
4. 6 m/s

Relative velocity — in 1-D



x_R = Position of Ramlal from origin

x_p = Position of pinky from origin.

$$\vec{x}_{RP} = \vec{x}_R - \vec{x}_P$$

$$= 4m - 10m$$

$$\boxed{\vec{x}_{RP} = -6m}$$

obsevr dirn

"Position of Pinka w.r.t. Ramlal"

$$\vec{x}_{PR} = \vec{x}_P - \vec{x}_R = 10 - 4$$

$$= 6m$$

obsevr

$$\vec{x}_{RP} = -\vec{x}_{PR}$$

$$\vec{x}_{AB} = \vec{x}_A - \vec{x}_B$$

[Position of A w.r.t B]

diff^n w.r.t time

$$\frac{d\vec{x}_{AB}}{dt} = \frac{d\vec{x}_A}{dt} - \frac{d\vec{x}_B}{dt}$$

$$\vec{v}_{AB} = \vec{V}_A - \vec{V}_B$$

(Velocity of A w.r.t B) — obser.

$$\vec{v}_{BA} = \vec{v}_B - \vec{v}_A$$

(A ← obser.)

diff^n w.r.t tim.

$$\vec{a}_{BA} = \vec{a}_B - \vec{a}_A \quad *$$

Case-1

(A) → $\vec{v}_A = +5\hat{i}$ (B) → $\vec{v}_B = 10\hat{i}$

* $\vec{v}_{AB} = \vec{v}_A - \vec{v}_B = 5\hat{i} - 10\hat{i} = -5\hat{i}$ ← dirn

$\vec{v}_{BB} = v_B - v_B = 0$

$\vec{v}_{BA} = v_B - v_A = 10 - 5 = 5\hat{i}$

Case-3

(A) → $v_A = 10\,m/s$ (B) → $v_B = 10\,m/s$

$\vec{v}_{AB} = \vec{v}_A - \vec{v}_B = 10 - 10 = 0$

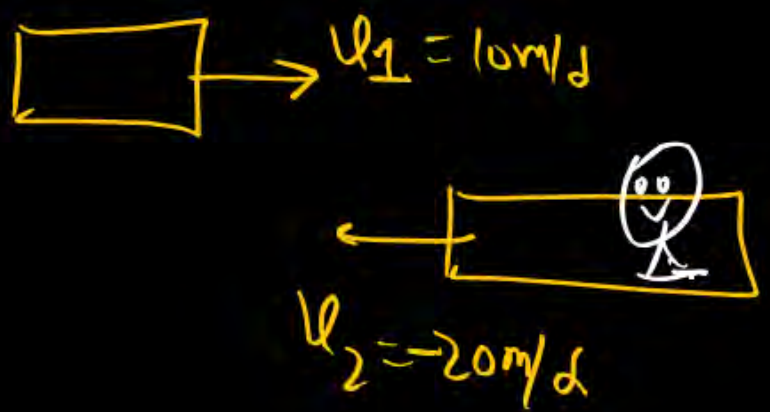
Case-2

(A) rest (B) → $v_B = 10\,m/s$

$\vec{v}_{AB} = v_A - v_B$

$= 0 - 10\,m/s = -10\,m/s\,\hat{i}$

Crossing



$\vec{v}_{12} = \vec{v}_1 - \vec{v}_2$

$= 10 - (-20)$

$= 30\,m/s\,\hat{i}$

QUESTION

Find

A → $V_A = 4\ m/s$ B → $10\ m/s$

$u_{AB} = $ ← 10 m/s, → 4 m/s, = ← 6 m/s

$\vec{u}_{BA} = 10 - 4$

$= 6\ m/s\ \hat{i}$

MR* $\vec{u}_{BA} = \vec{v}_B - \vec{v}_A$ → 10 m/s, ← −4, → 6 m/s

$\vec{u}_{BA} = \vec{v}_B - \vec{v}_A$

$= \vec{v}_B + (-\vec{v}_A)$

↑

A ki velocity उल्टा करो B में add कर दो

QUESTION

$x \text{ km/hr} \times \frac{5}{18} = y \text{ m/s}$

Find

A ⟶ $V_A = 15\text{ m/s}$

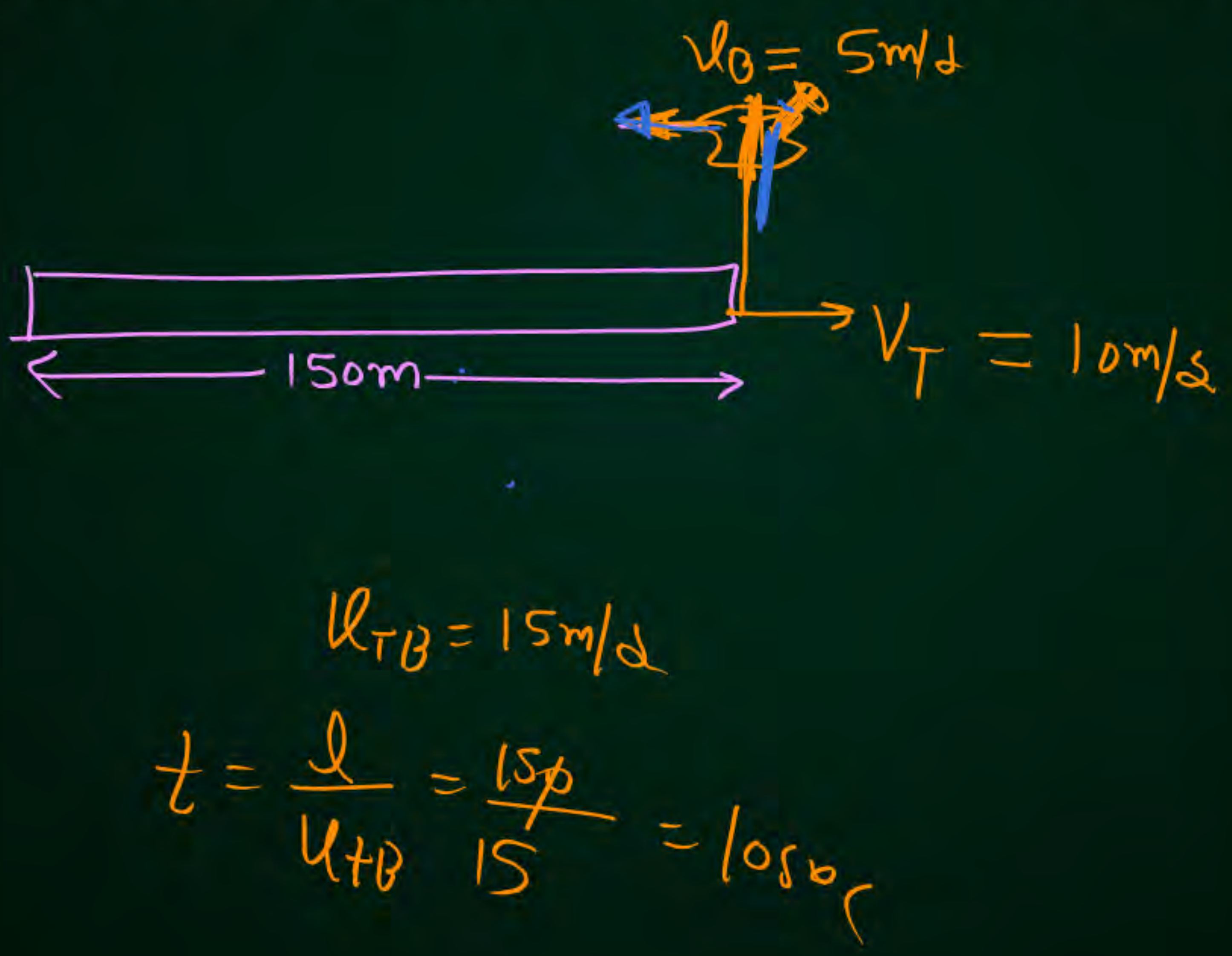
B ⟶ $\overset{3}{\cancel{54}}\text{ km/hr} \times \frac{5}{\cancel{18}} = 15\text{ m/s}$

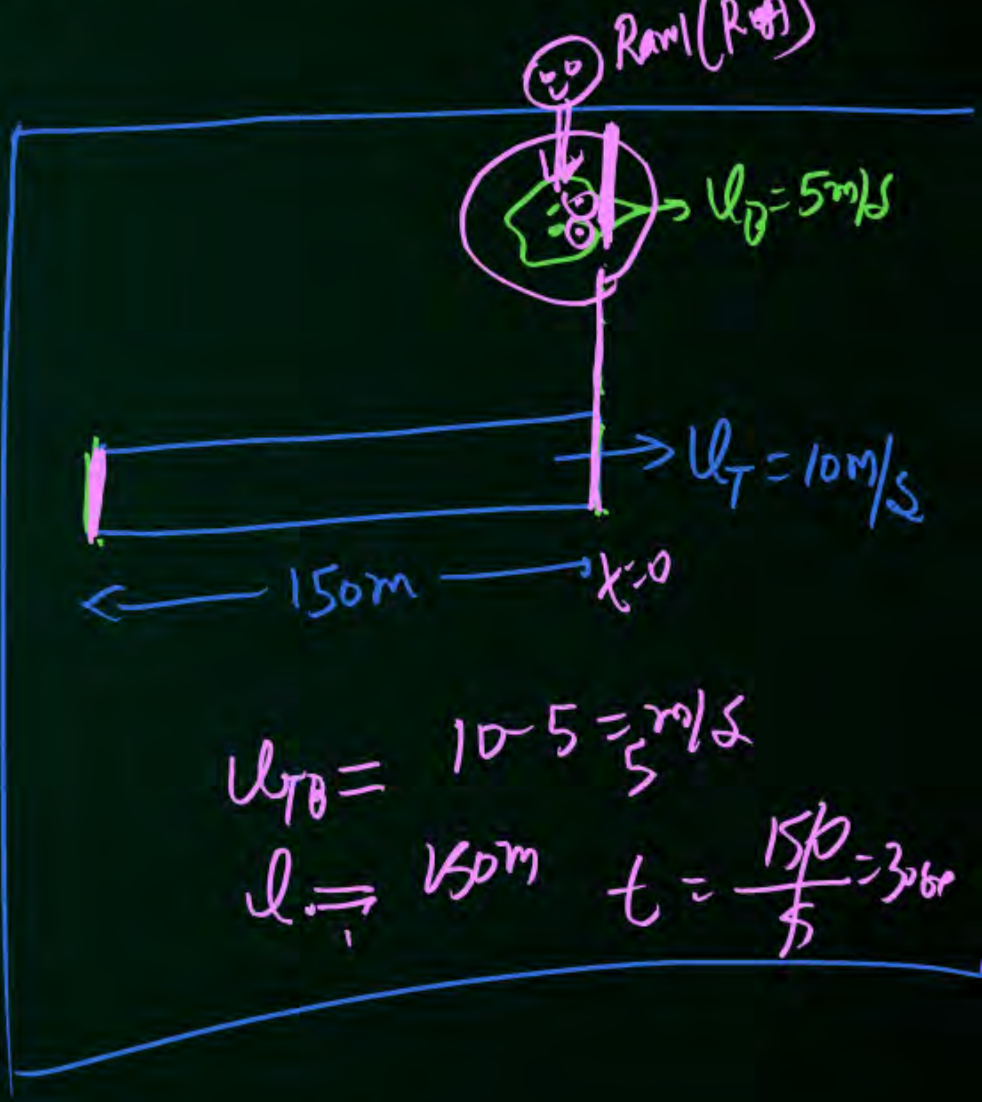
$u_{AB} = \overleftarrow{15} \; \overrightarrow{15} = 0$

QUESTION

A train of 150 m length is going towards a speed of 10 m/s. A bird is flying a to the track towards South. The time bird to cross the train is

1. 10 s
2. 15 s
3. 30 s
4. 12 s





QUESTION

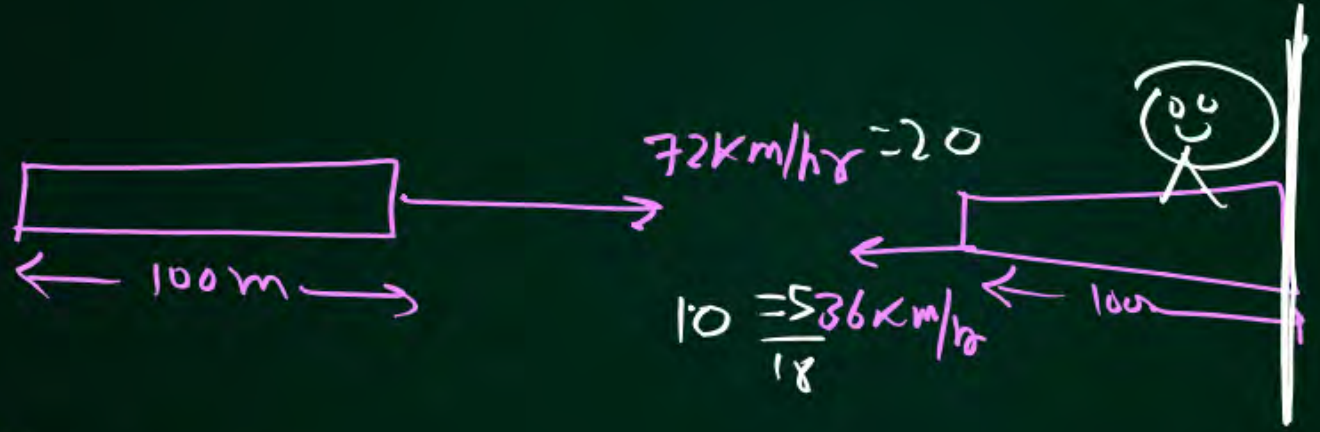
Two trains each of length 100 m moving parallel towards each other at speed 72 km/h and 36 km/h respectively. In how much time will they cross each other?

(1) 4.5 s

(2) 6.67 s ✓

(3) 3.5 s

(4) 7.25 s



$l = 200\,m$

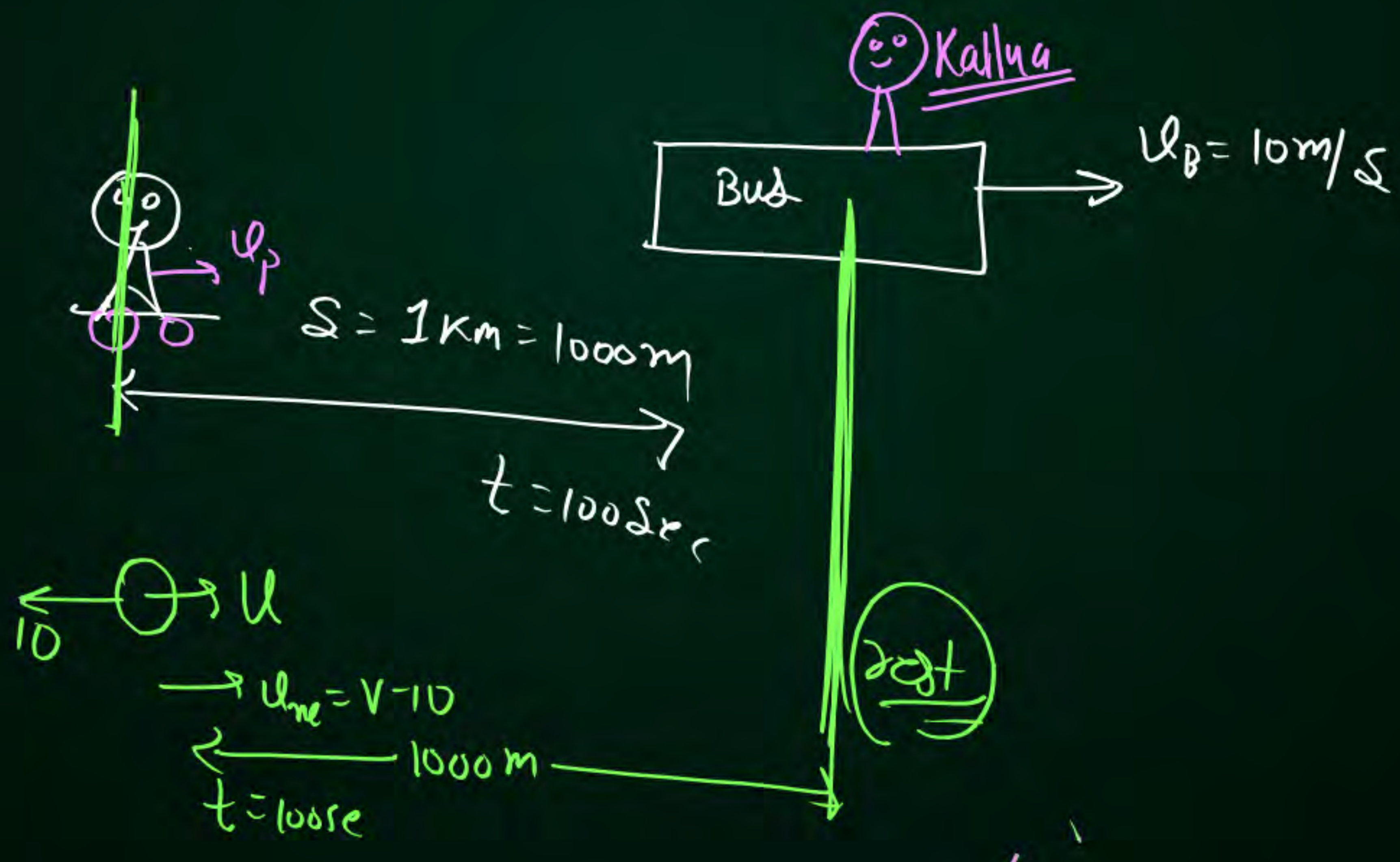
$v_{12} = 30$

$t = \frac{200}{30} = 6.67$

QUESTION

A bus is moving with a speed of 10 ms^{-1} on a straight road. A scooterist wishes to overtake the bus in 100 s. If the bus is at a distance of 1 km from the scooterist, with what speed should the scooterist chase the bus? [2009]

1. 40 ms^{-1}
2. 25 ms^{-1}
3. 10 ms^{-1}
4. 20 ms^{-1}



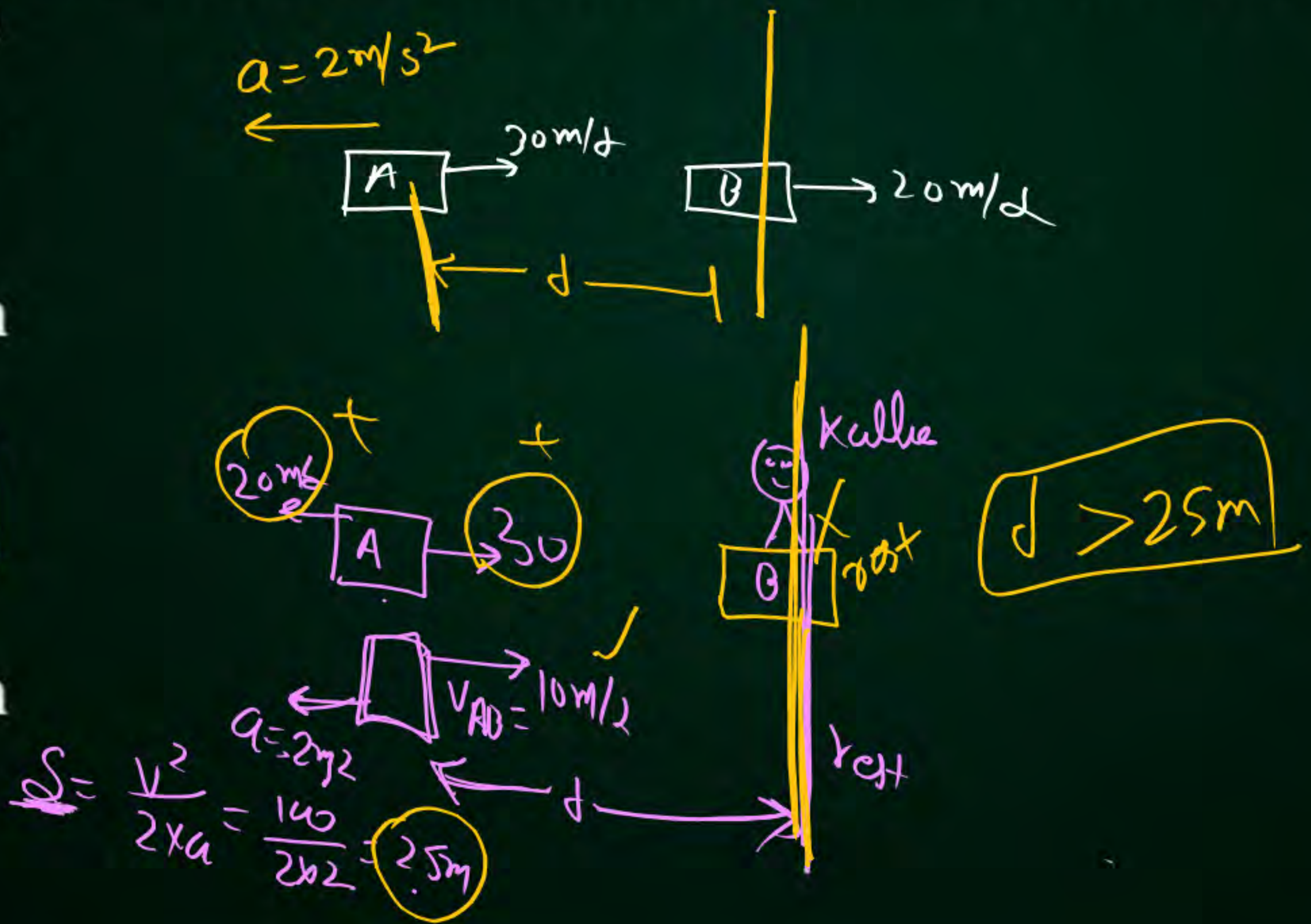
$u - 10 = \frac{1000}{100}$

$V = 20$ m/s

QUESTION

Two cars A and B are moving in same direction with velocities 30 m/s and 20 m/s. When car A is at a distance d behind the car B, the driver of the car A applies brakes producing uniform retardation of 2 m/s^2. There will be no collision when

1. $d < 2.5$ m
2. $d > 125$ m
3. $d > 25$ m
4. $d < 125$ m



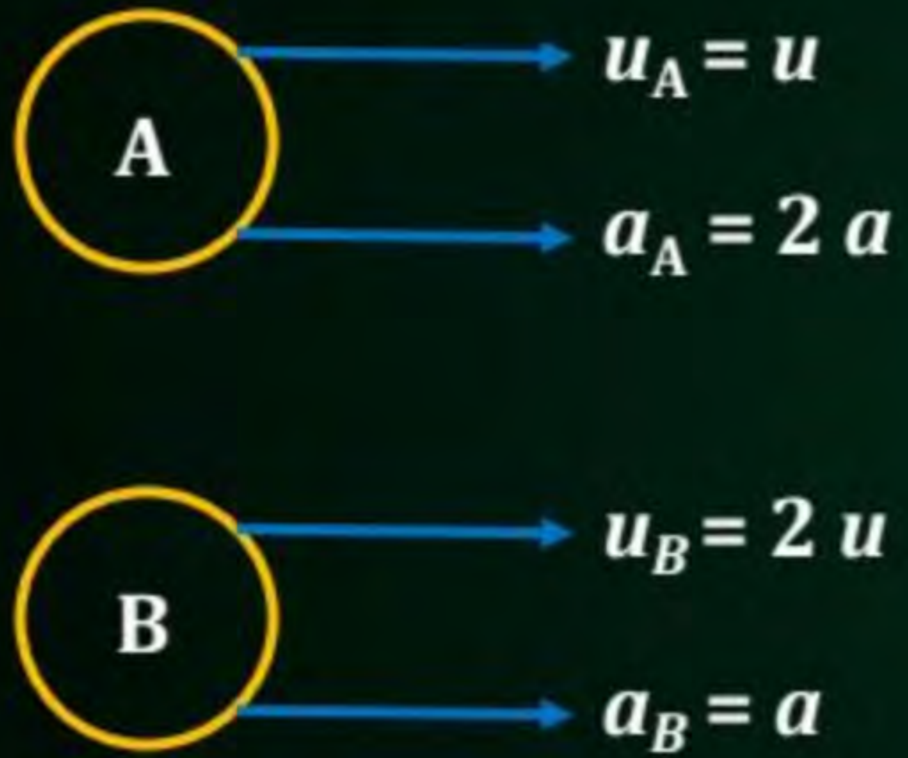
QUESTION

Two trains each of length 50 m are approaching each other on parallel rails. Their velocities are 10 m/sec and 15 m/sec. They will cross each other in-

1. 2 sec
2. 4 sec
3. 10 sec
4. 6 sec

QUESTION

Find time when they will meet again.



QUESTION

Preeti reached the metro station and found that the escalator was not working. She walked up the stationary escalator in time t_1. On other days, if she remains stationary on the moving escalator, then the escalator takes her up in time t_2. The time taken by her to walk up on the moving escalator will be [NEET -2017]

1. $\frac{t_1 + t_2}{2}$
2. $\frac{t_1 t_2}{t_2 - t_1}$
3. $\frac{t_1 t_2}{t_2 + t_1}$
4. $t_1 - t_2$

QUESTION

Two cars are moving in the same direction with a speed of 30 km/h. They are separated from each other by 5 km. Third car moving in the opposite direction meets the two cars after an interval of 4 minutes. The speed of the third car is

1. 30 km/h
2. 25 km/h
3. 40 km/h
4. 45 km/h


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 1 | Physics

Motion in a Plane



By- Dr. Manish Raj (MR SIR)

Todays Goal

- ✡ Questions on Relative motion in 1-D ✓
- ✡ General 2-D motion

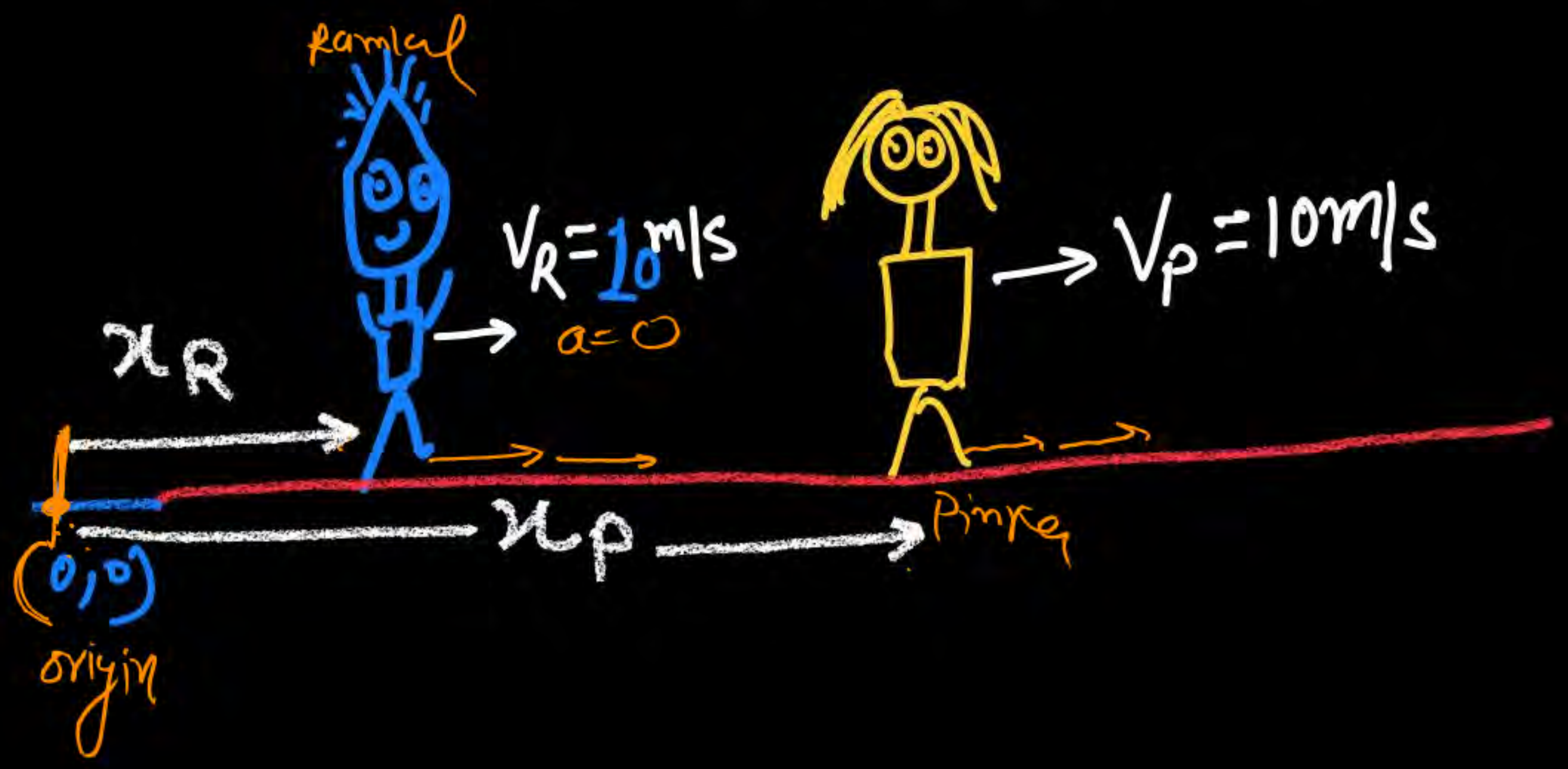
→ Step-1 Full Focus से Padho.

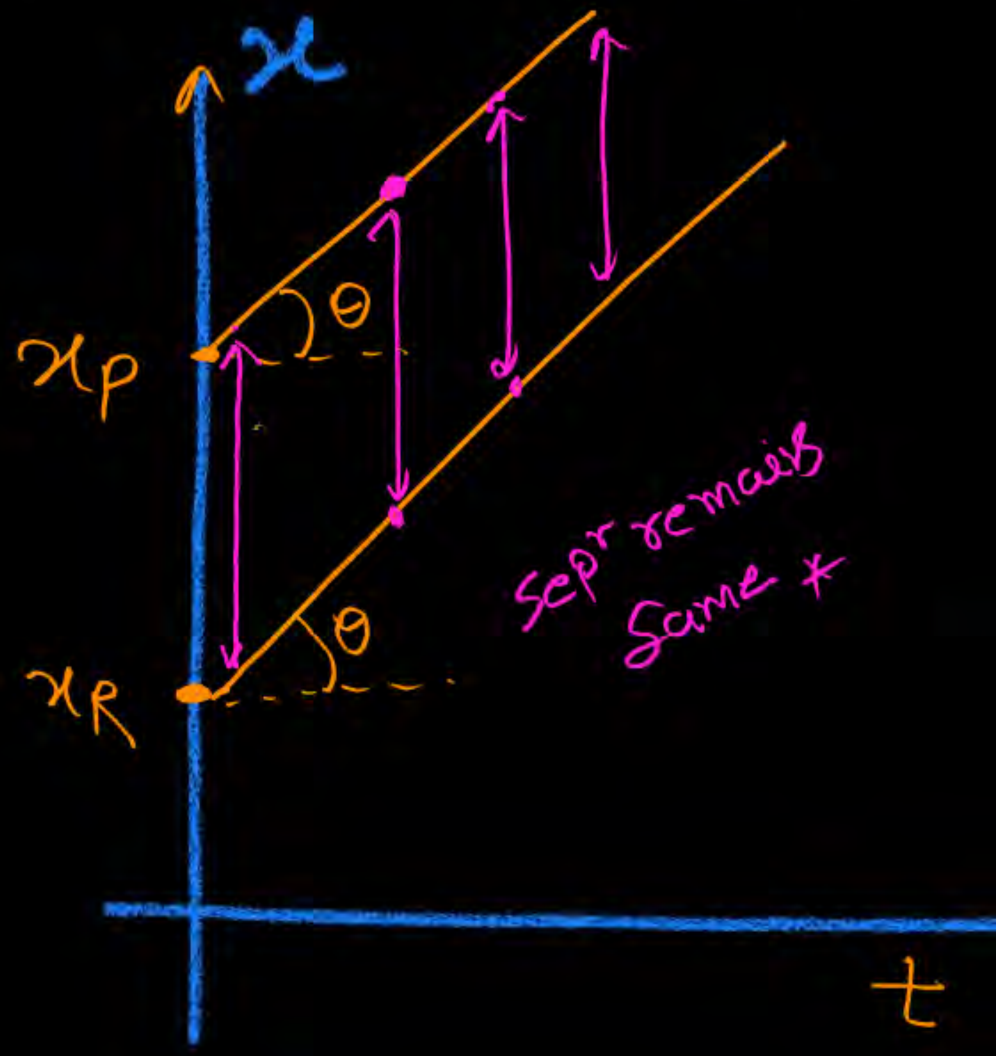
Step-2 → Pdf / Question rough में solve करो

Step-3 evening में Notes बनाओ P.df and rough Page की help से

Step-4 Video से देख लो जो Confusion होता

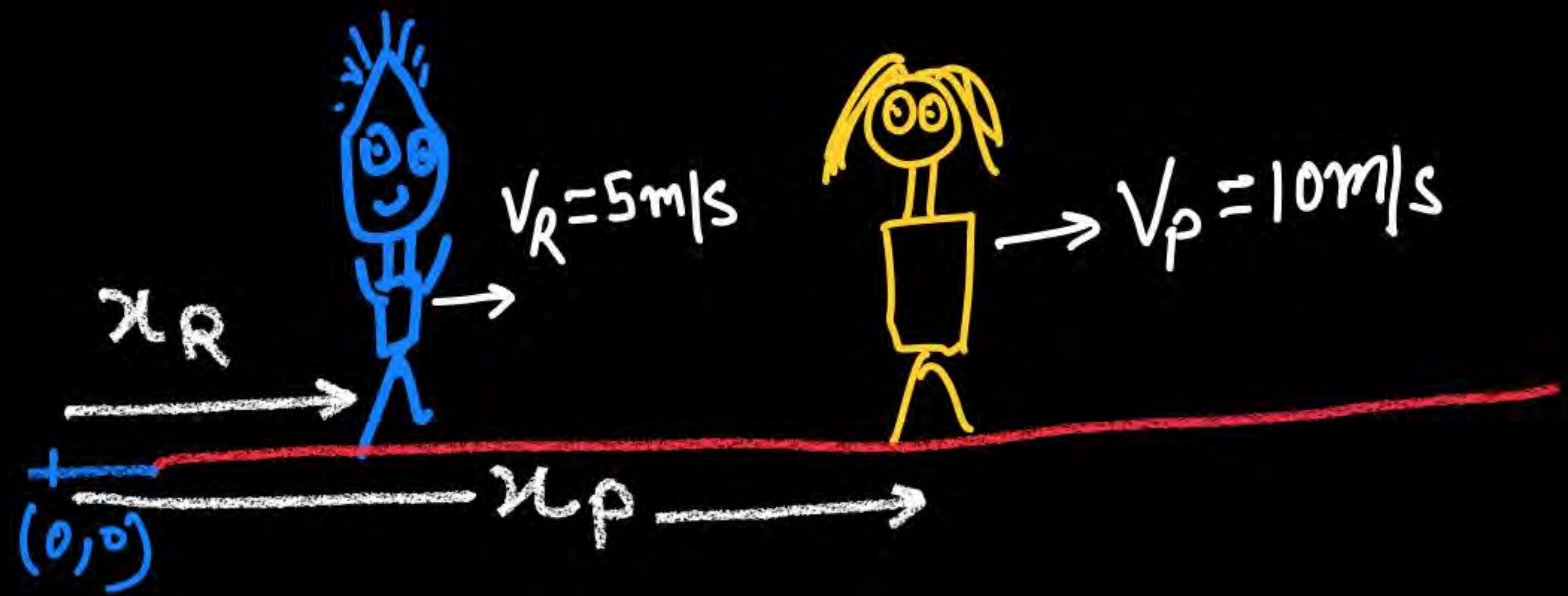
Q) Draw position time graph and comment on relative sepration





$v_{AB} = 0$

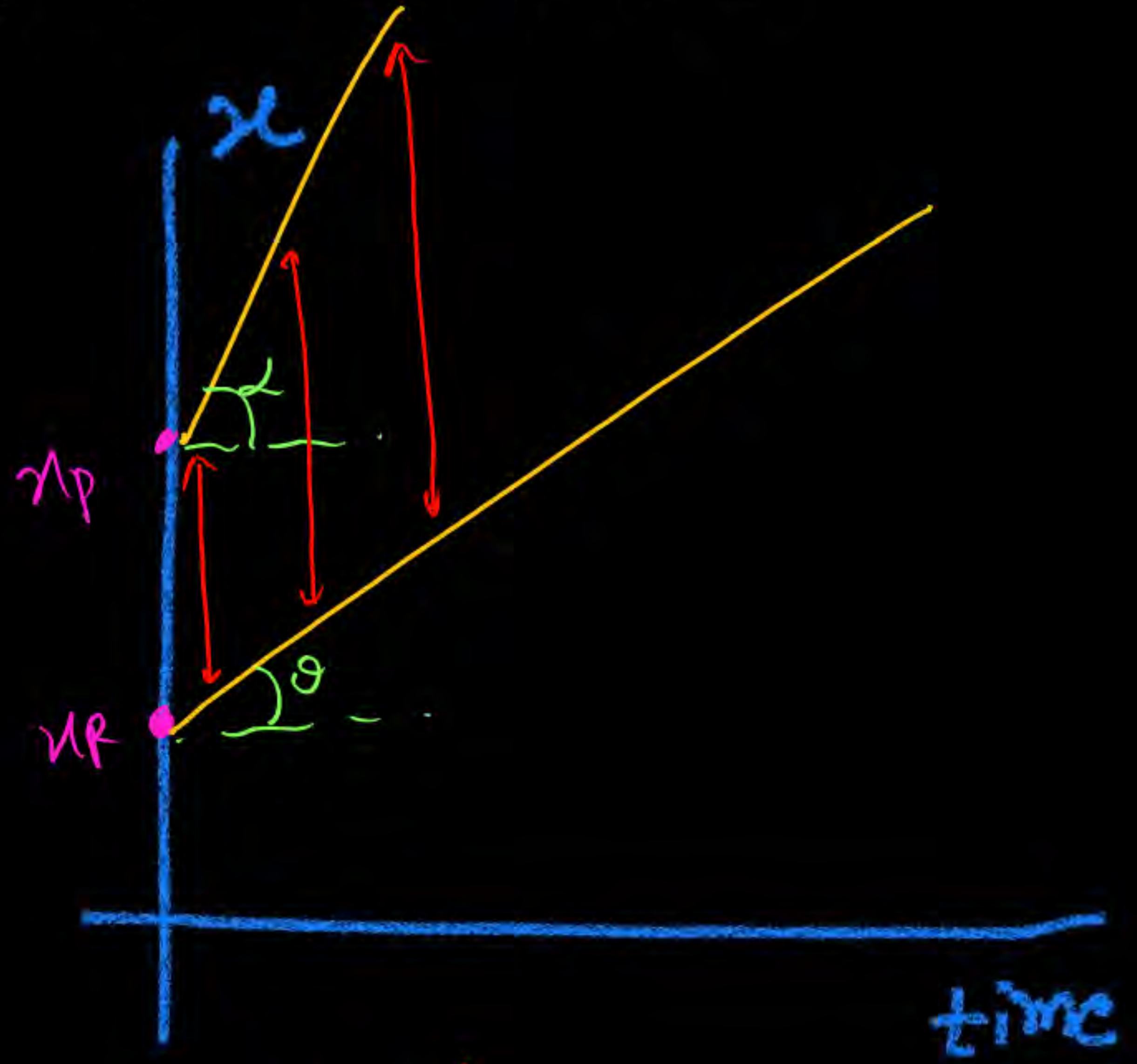
Draw position time graph and comment on relative sepration



$$\vec{V}_{PR} = V_P - V_R$$

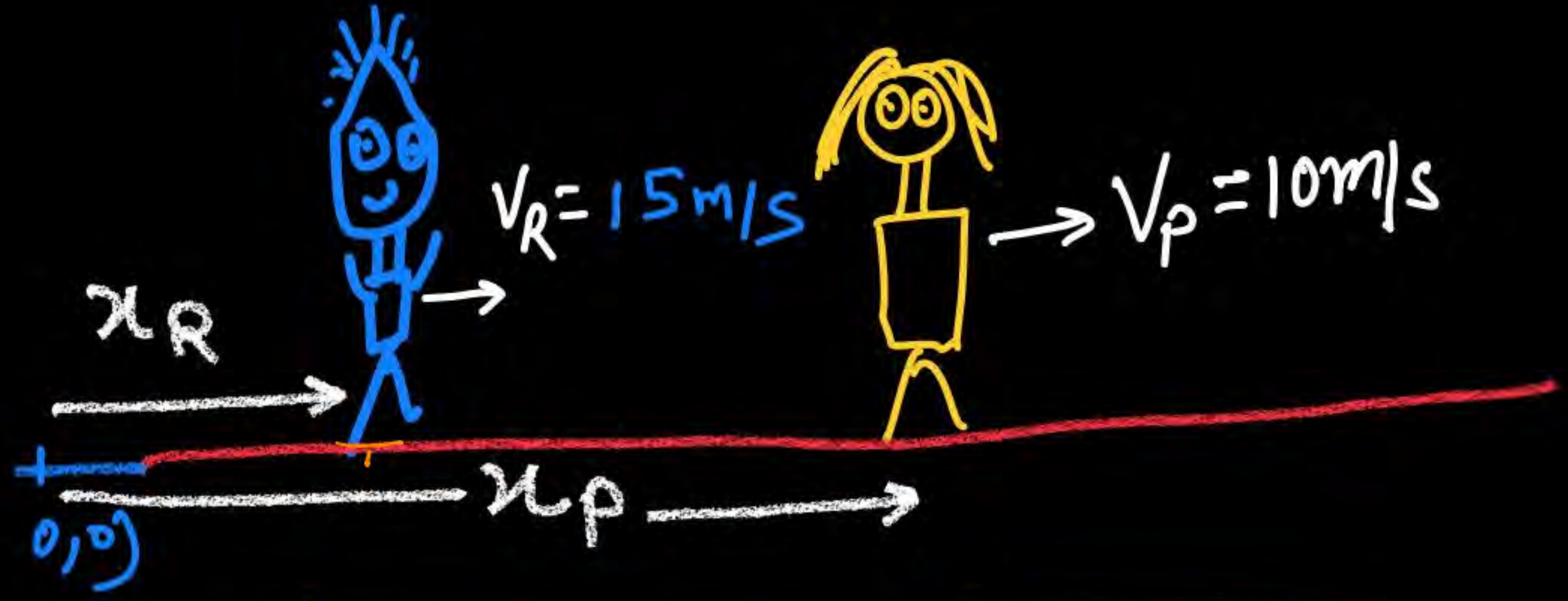
$$= 10 - 5$$

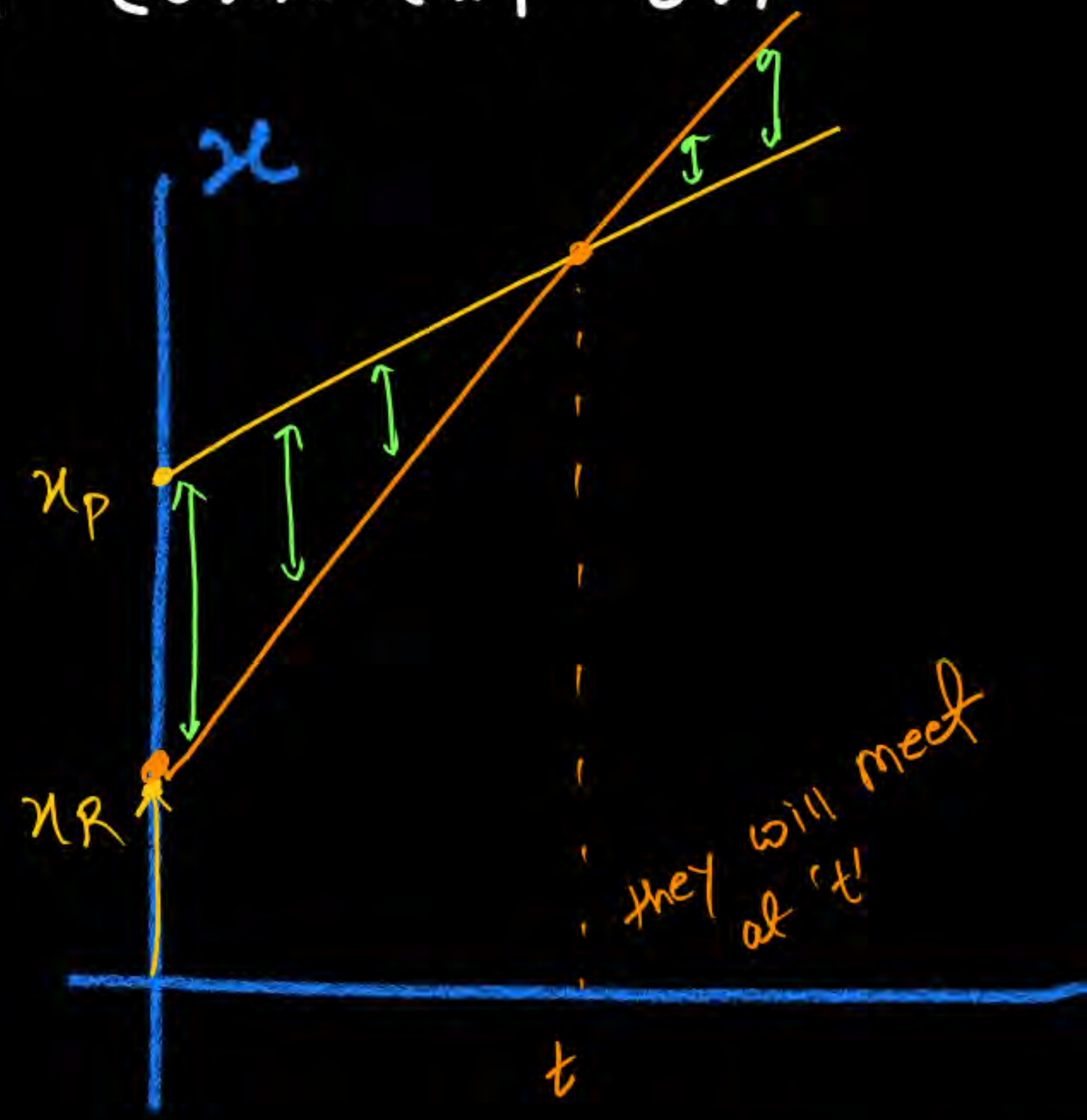
$$= 5\,m/s$$



Sepration b/w them Increasing

Draw position time graph and comment on relative sepration





$\vec{u}_{P(R)} = 10 - 15$

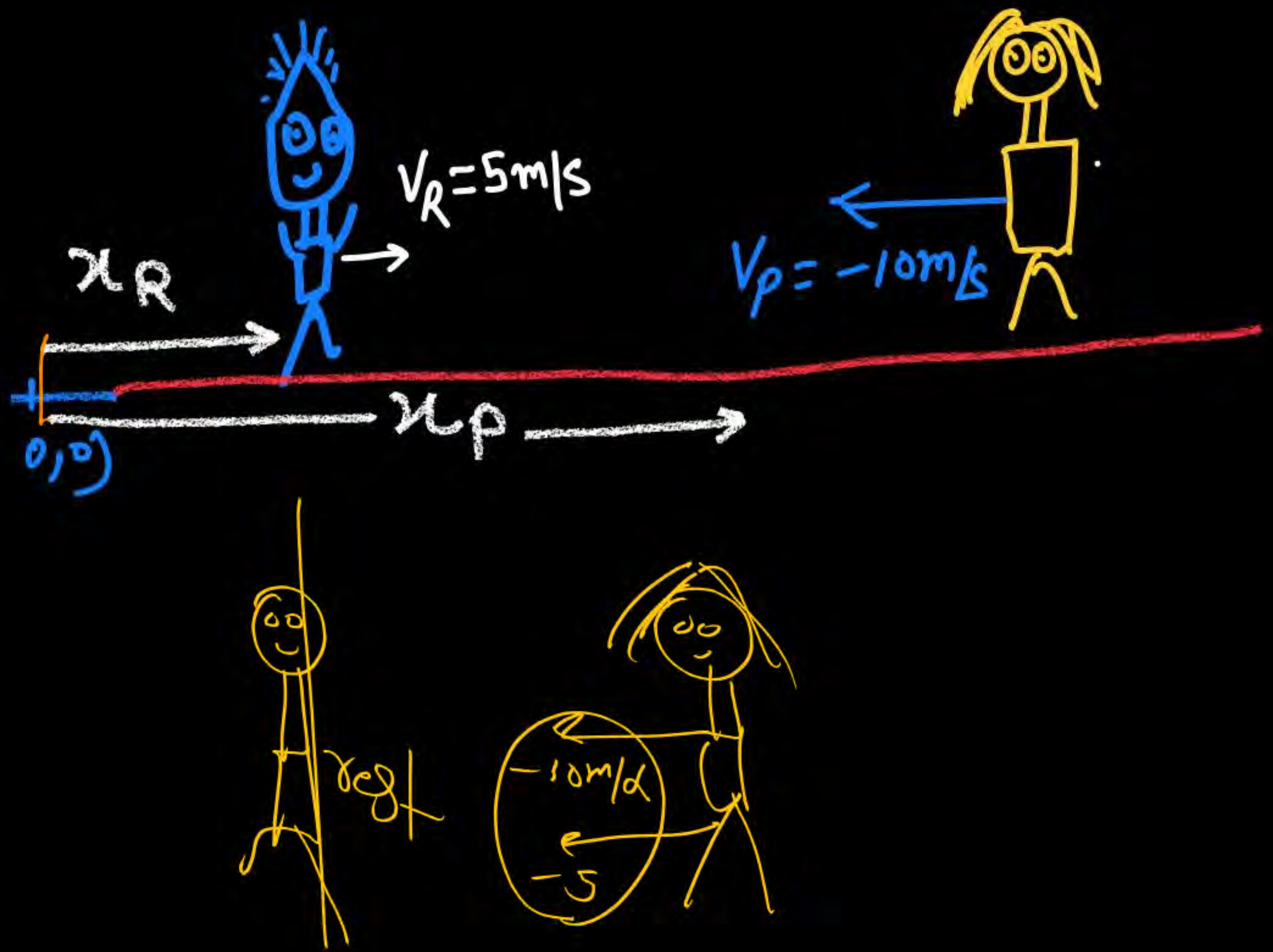
$= -5 m/s$

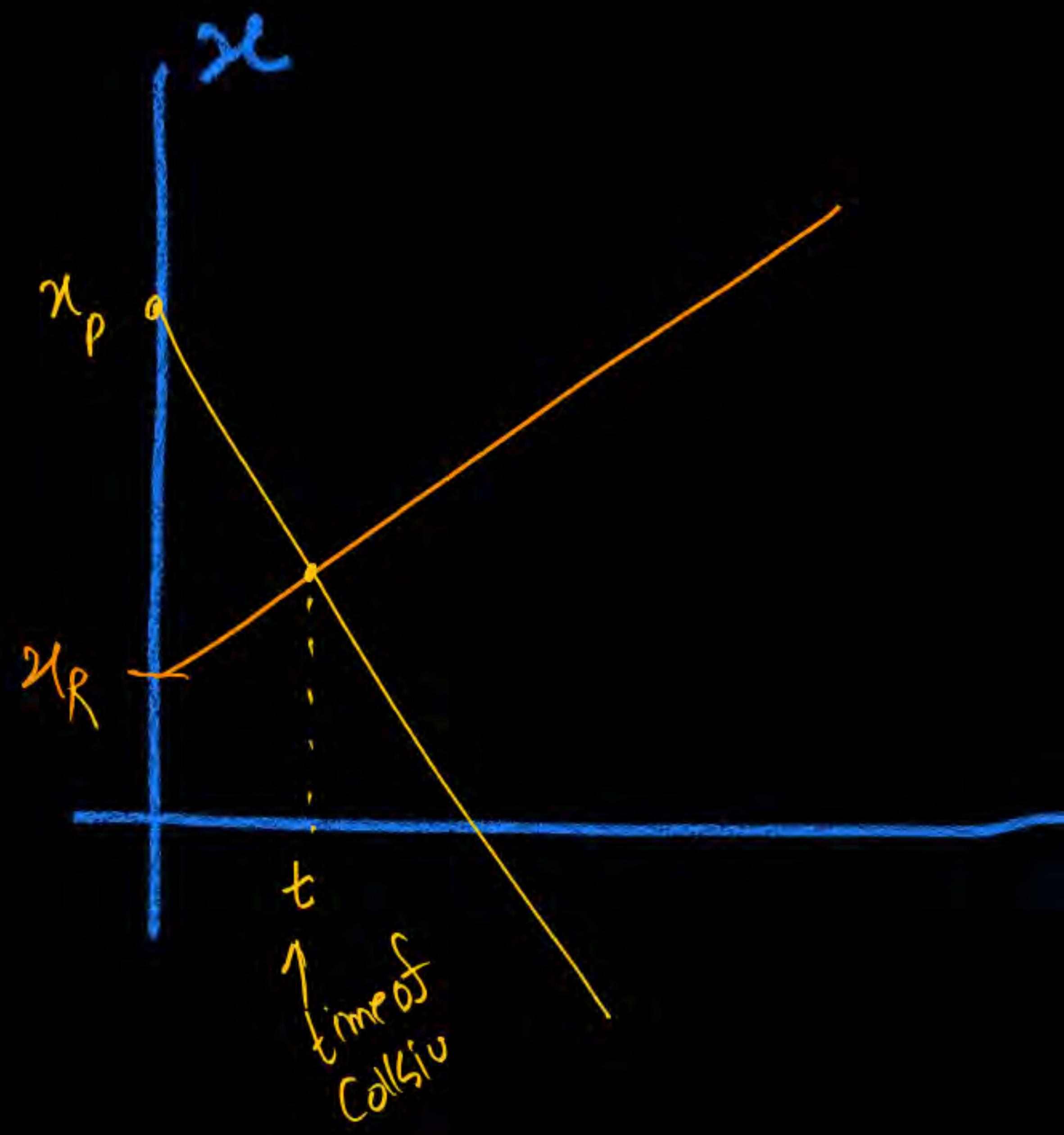
velocity of Pinky w.r.t Ramlal

$\vec{u}_{PG} = 10 m/s$

⊛ Jo observer Hota hai, wo khud ko rest me manta hai or uske pas to kuch usko ulta kar ke chipka deta hai jisko dekhta hai

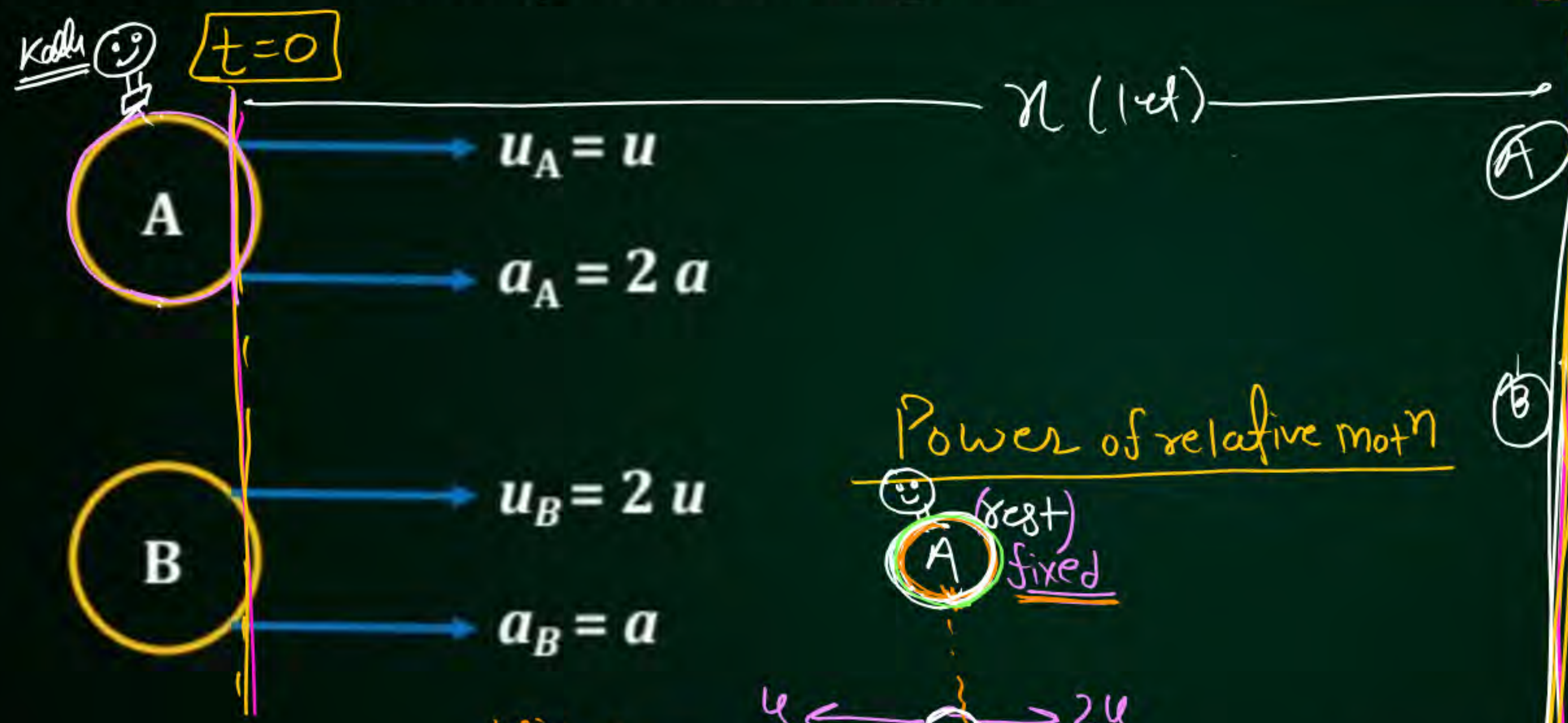
Draw position time graph and comment on relative sepration





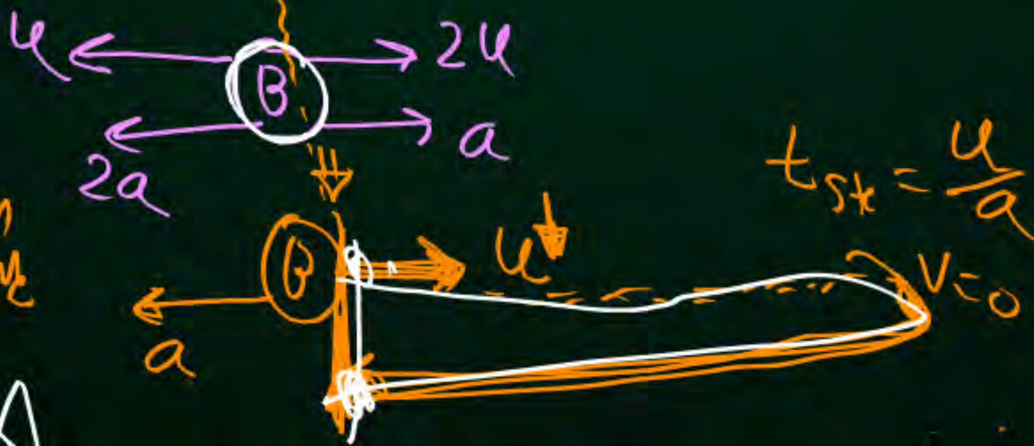
QUESTION

Find time when they will meet again.



Power of relative motⁿ

(rest) fixed



using concept of motion

$T_{tim} = \left(\frac{2u}{a}\right)$

Individual motion

at 't' for (a)

$x = ut + \frac{1}{2}(2a)t^2$ — (I)

for (b)

$x = 2ut + \frac{1}{2}at^2$ — (II)

(I) = (II)

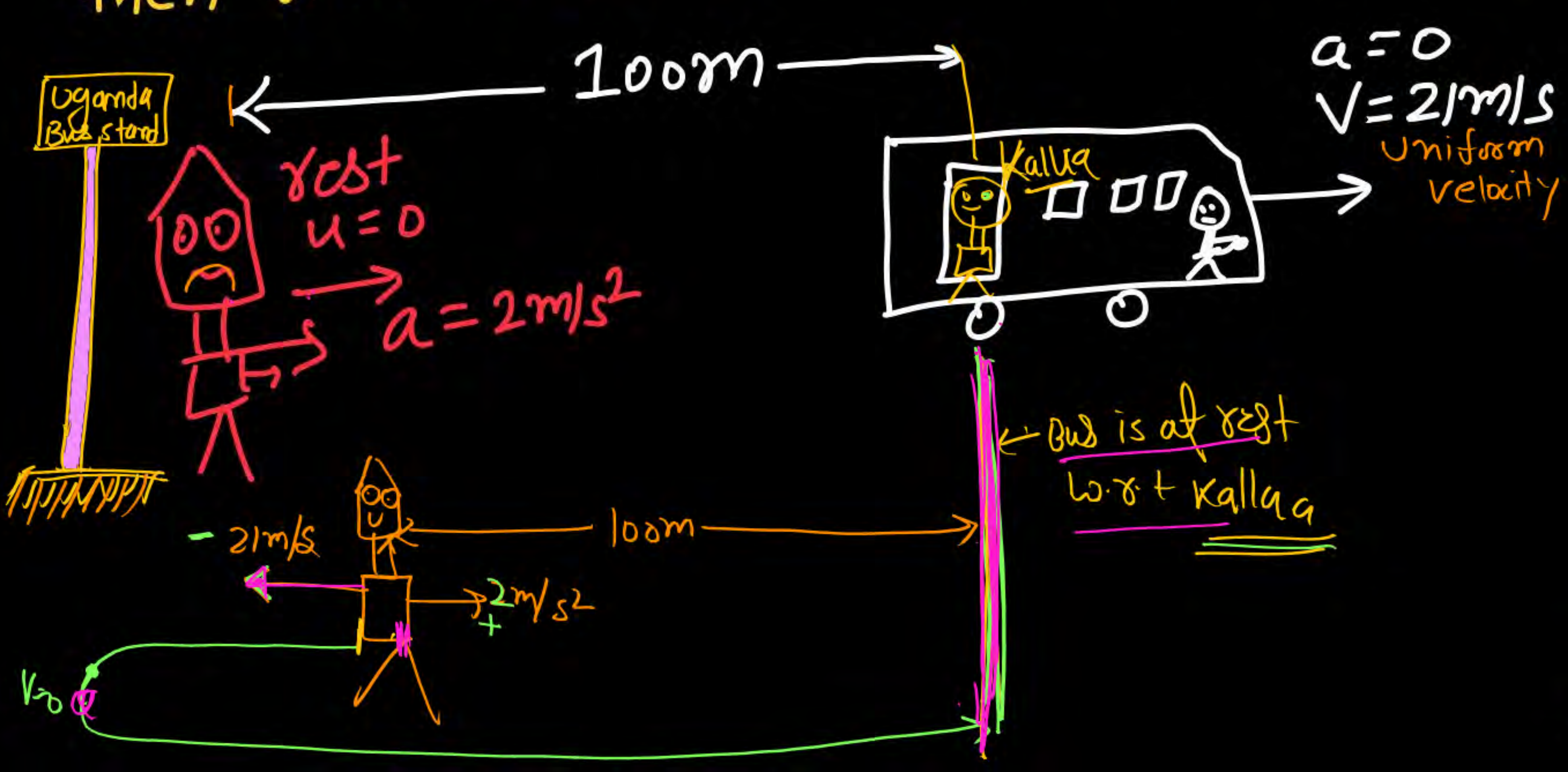
$ut + at^2 = 2ut + \frac{at^2}{2}$

$at^2 - \frac{at^2}{2} = 2ut - ut$

$\frac{at^2}{2} = ut$

$t = \left(\frac{2u}{a}\right)$ Ans

Q) Bus is moving with constant velocity 21 m/s and Ramlal starts his motion from rest and constant acceleration $2 \, m/s^2$. if intial distance is 100m then find time when Ramlal will catch the Bus.



Relative motion

dispm

$$s = ut + \frac{1}{2}at^2 \quad (RK)$$

$$100 = -21t + \frac{1}{2} \cdot 2\, t^2$$

$$t^2 - 21t - 100 = 0$$

$$t^2 - 25t + 4t - 100 = 0$$

$$t(t-25) + 4(t-25) = 0$$

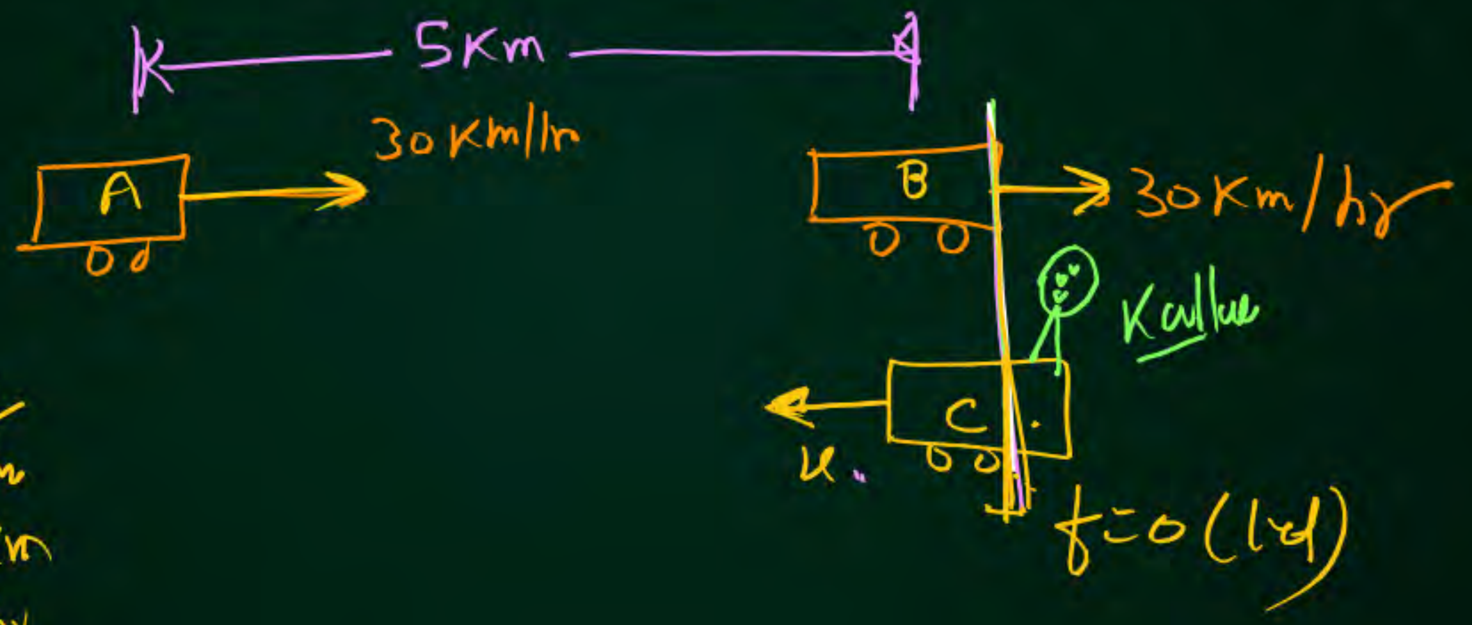
$$(t-25)(t+4) = 0$$

$t = 25$ sec

QUESTION

Two cars are moving in the same direction with a speed of 30 km/h. They are separated from each other by 5 km. Third car moving in the opposite direction meets the two cars after an interval of 4 minutes. The speed of the third car is

1. 30 km/h
2. 25 km/h
3. 40 km/h
4. 45 km/h



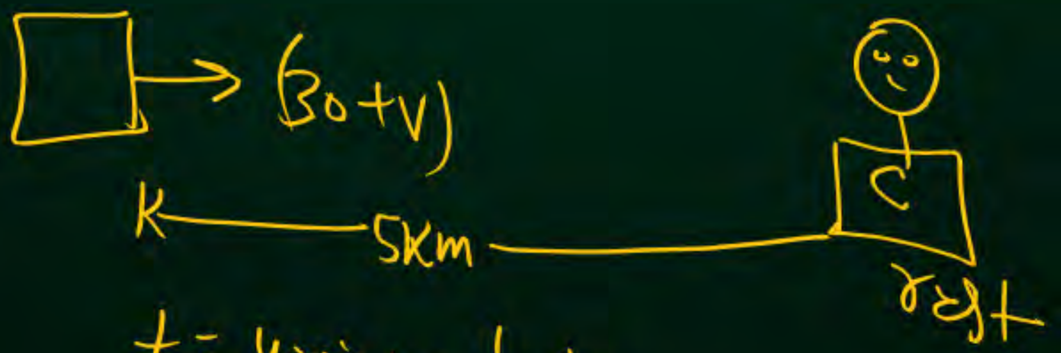
Speed = distn / time

$30+v = \frac{5\text{ km}}{\frac{1}{15}\text{ hr}}$

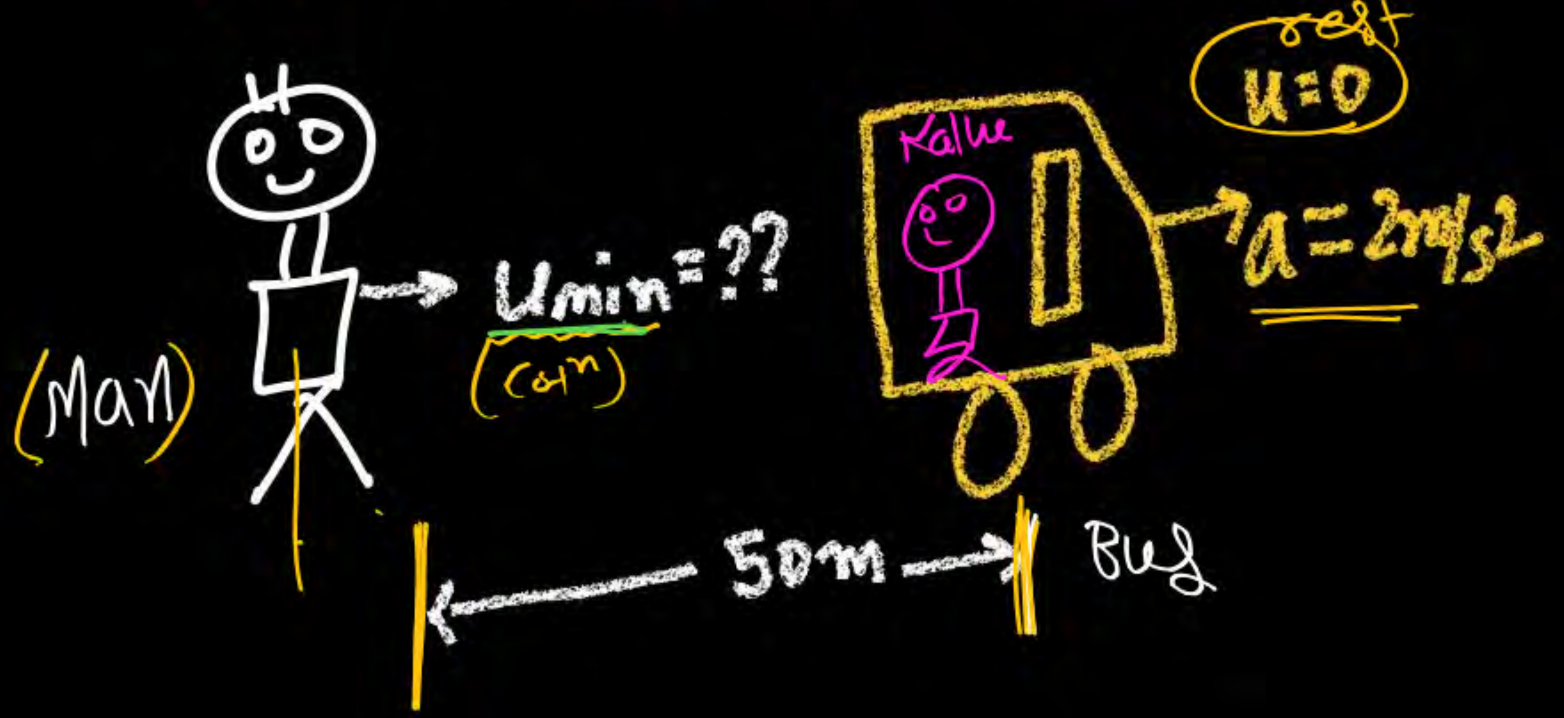
$30+v = 75$ km/hr

$v = 75-30$

$= 45$ km/hr



Find minimum velocity of Man so that he can catch the Bus who starts motion from rest and acceleration $2 m/s^2$

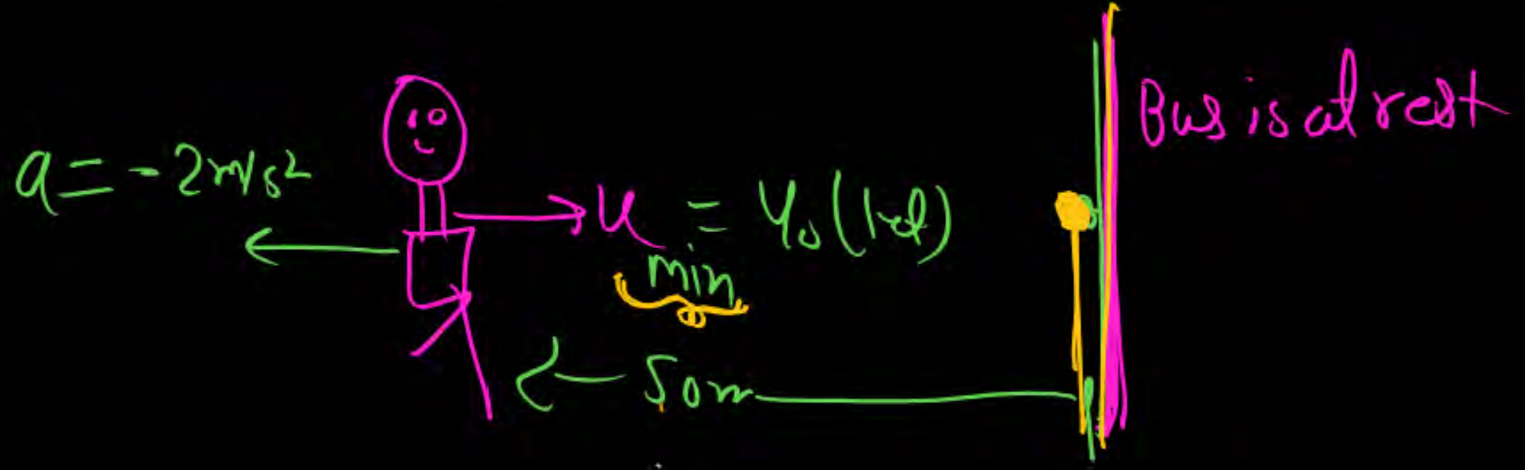


3rd eqn motn

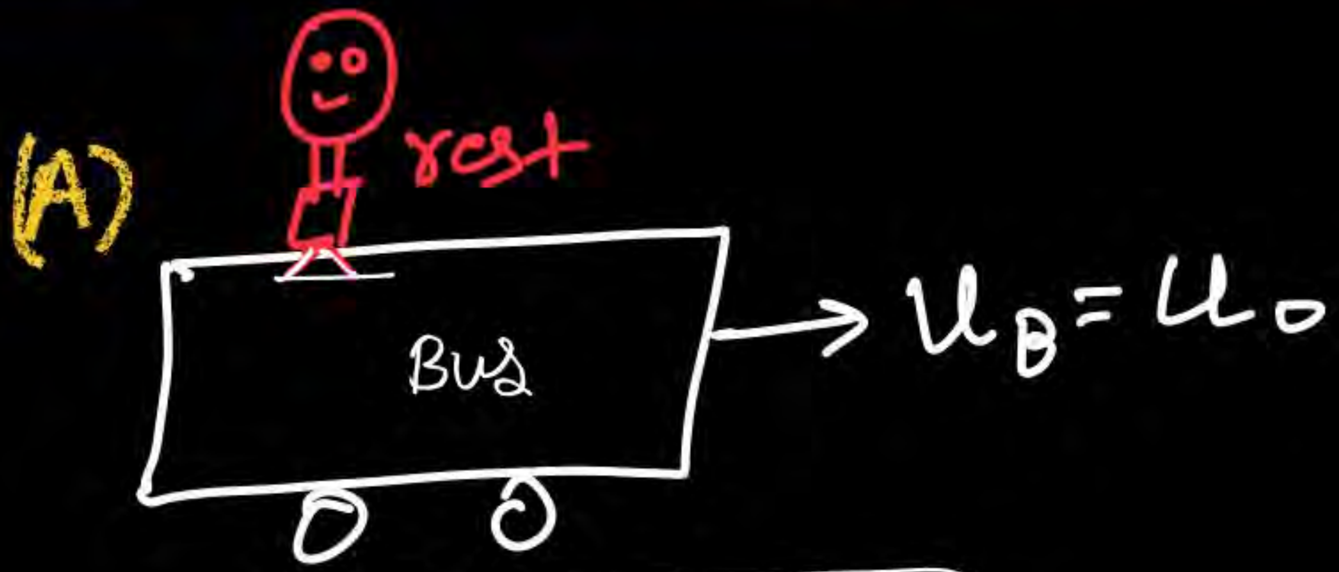
$$\cancel{v^2}^{0} - u^2 = 2as$$

$$+u_m^2 = +2 \times 2 \times 50$$

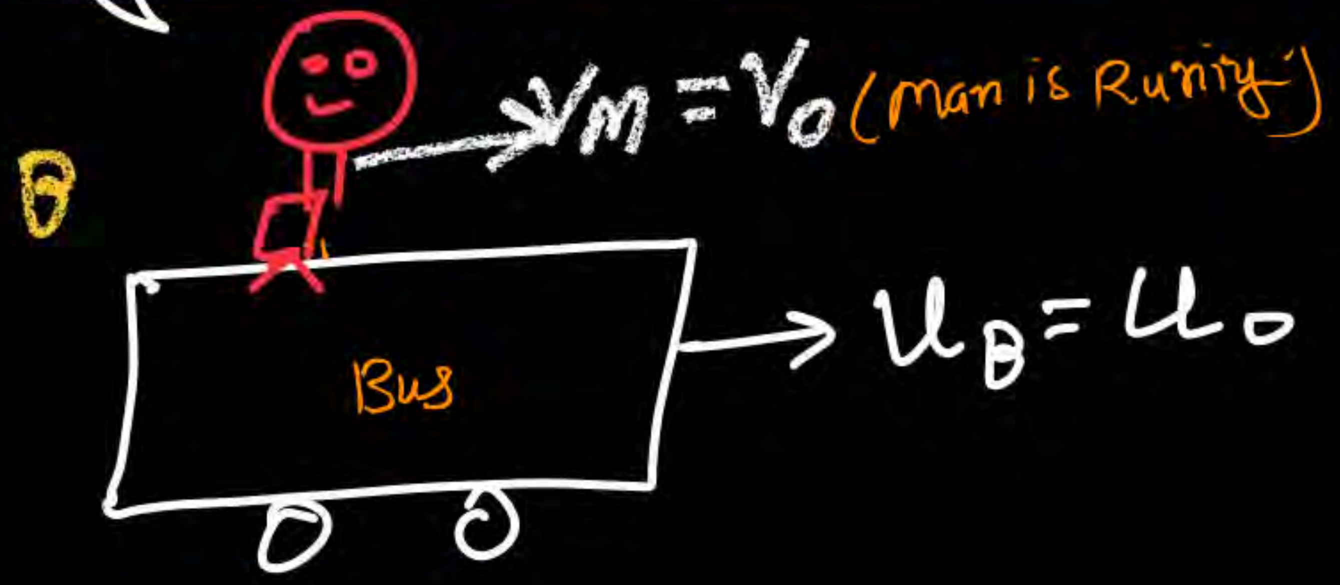
$$u_m = \sqrt{200} = \sqrt{100 \times 2} = 10\sqrt{2} \text{ m/s}$$



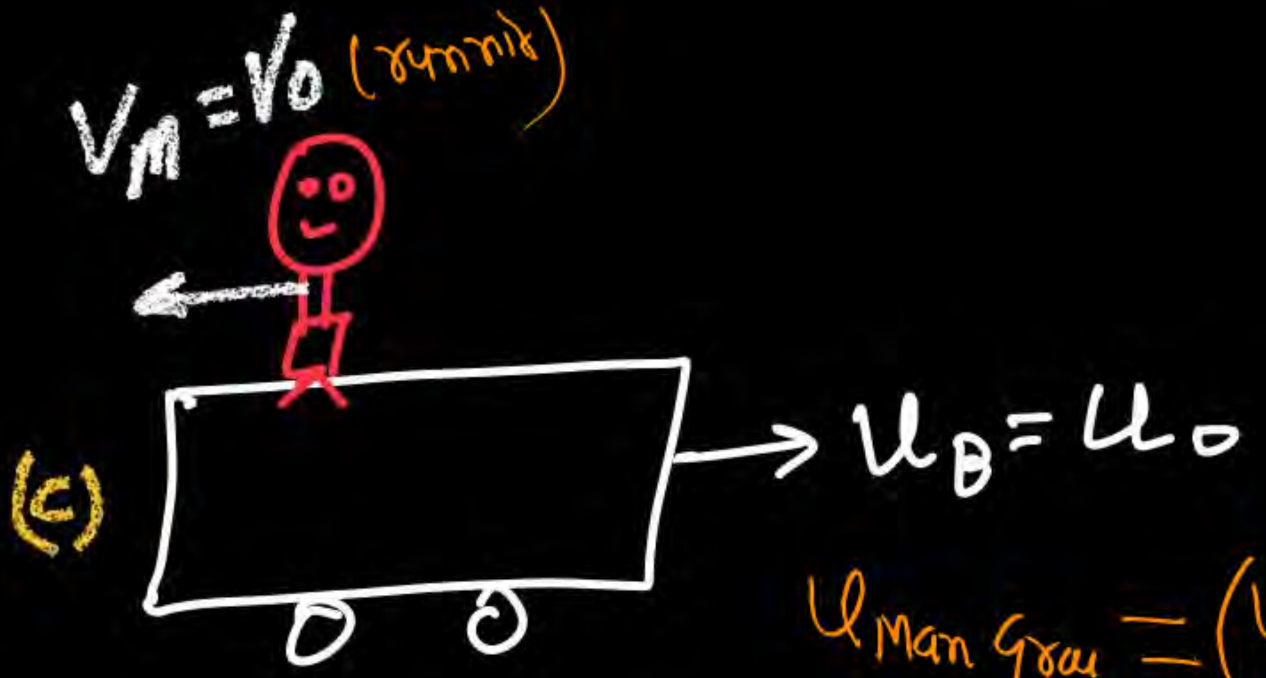
Relative Motion on Moving Frame



$$u_{m\,Ground} = u_0$$

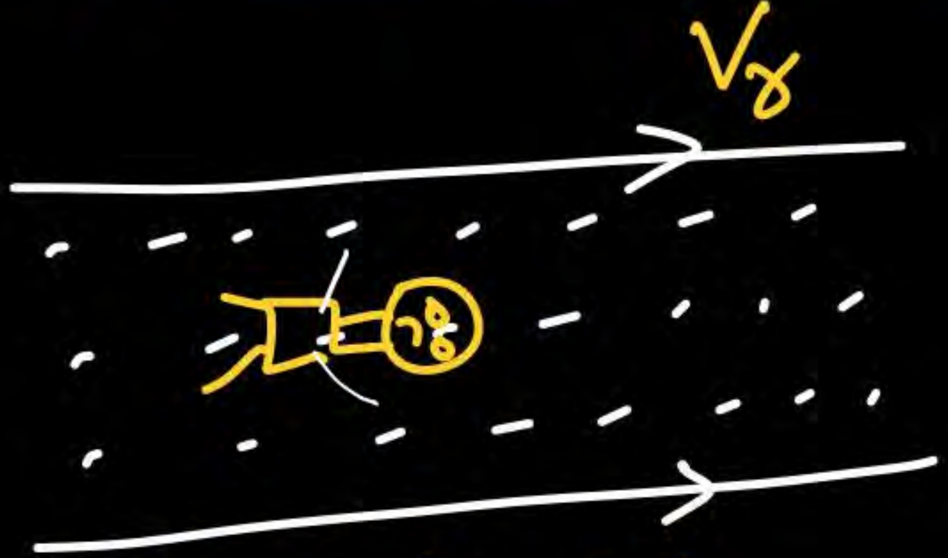


$$u_{m\,Groun} = u_0 + V_0$$



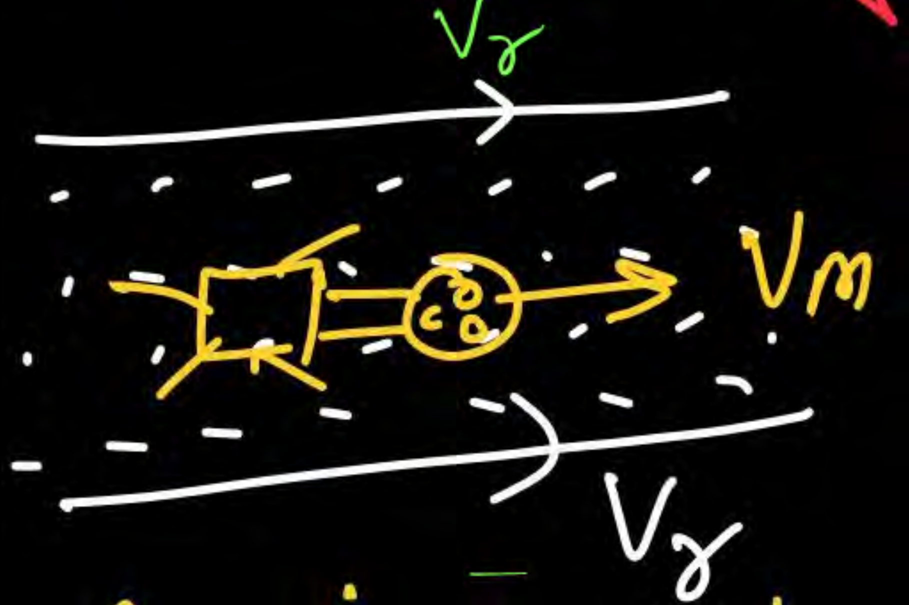
$$u_{Man\,Grou} = (u_0 - V_0)$$

Relative Motion in Moving River :-



* Man is not swiming

$$u_{m\,ground} = u_r$$



Man is swiming in (downstream)

dirn of Flow of river

$$u_{mg} = V_r + u_m$$



Man is swiming in (up-stream)

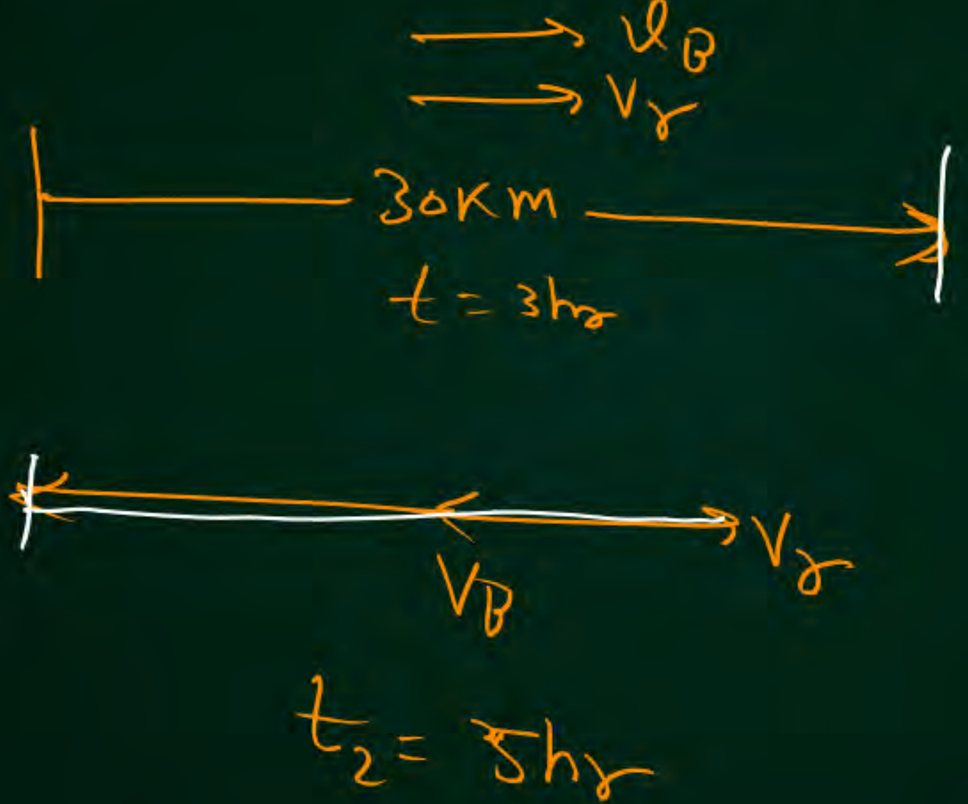
opposit to flow

$$u_{mg} = (V_r - V_m)$$

QUESTION

A boat travelled 30 km downstream in 3 hours and made the upstream trip in 5 hours. Find the speed of the boat in still water.

1. 8 km/hr
2. 12 km/hr
3. 6 km/hr
4. 10 km/hr



$$30\,km = (v_r + v_B) \times 3 \quad \text{— (I)}$$

$$30\,km = (v_B - v_r) \times 5 \quad \text{— (II)}$$

$$10 = v_r + v_B$$

$$6 = v_B - v_r$$

$$2v_B = 16$$

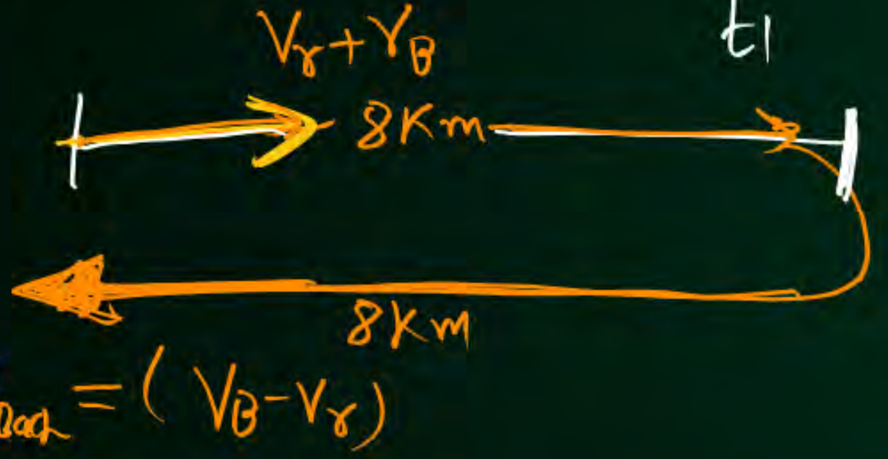
$$v_B = 8$$

QUESTION

A sailor can row a boat 8 km downstream and return back to the starting point in 1 hr.40 min. If the speed of the stream is 2 km/hr, find the speed of the boat in still water.

dir^n

$V_r = 2$ km/hr



$V_B + 2 = \frac{8}{t_1}$

$t_1 = \frac{8}{V_B + 2}$

$t_2 = \frac{8}{V_B - 2}$

$t_1 + t_2 = 1$ hr 40 mint

40 mint $= \frac{40}{60}$ hr $= \frac{2}{3}$ hr

$t_1 + t_2 = \left(1 \text{ hr} + \frac{2}{3} \text{ hr}\right) = \left(\frac{5}{3} \text{ hr}\right)$

$t_1 + t_2 = \frac{5}{3}$ hr

$\frac{8}{V_B + 2} + \frac{8}{V_B - 2} = \frac{5}{3}$

$\frac{8(V_B - 2 + V_B + 2)}{V_B^2 - 2^2} = \frac{5}{3}$

$\frac{8 \times 2 V_B}{V_B^2 - 4} = \frac{5}{3}$

$$48 v_B = 5v_B^2 - 20$$

$$5v_B^2 - 48 v_B - 20 = 0$$

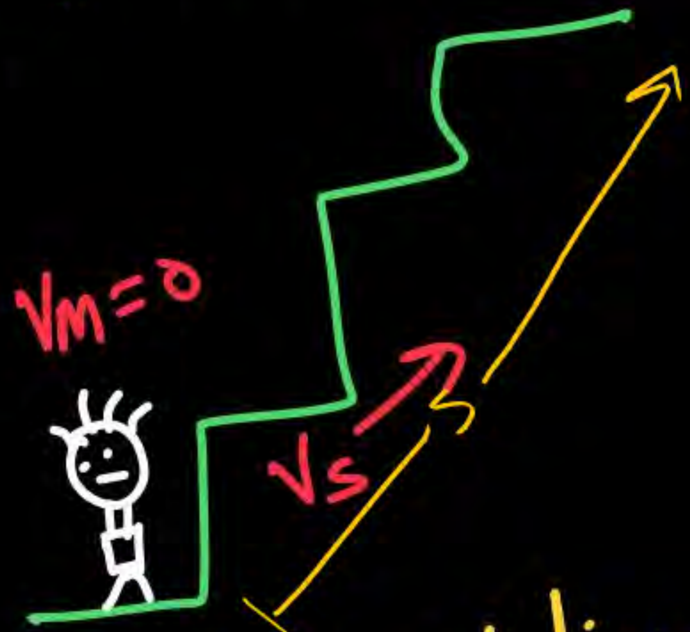
$$v_B = \frac{+48 \pm \sqrt{(48)^2 - 4 \times 5(-20)}}{2 \times 5}$$

Man is walking on escalator



Man is walking on stationary esc.

$$t = \frac{S}{u_m}$$



Man is stationary on moving escalator

$$t = \frac{S}{V_s}$$



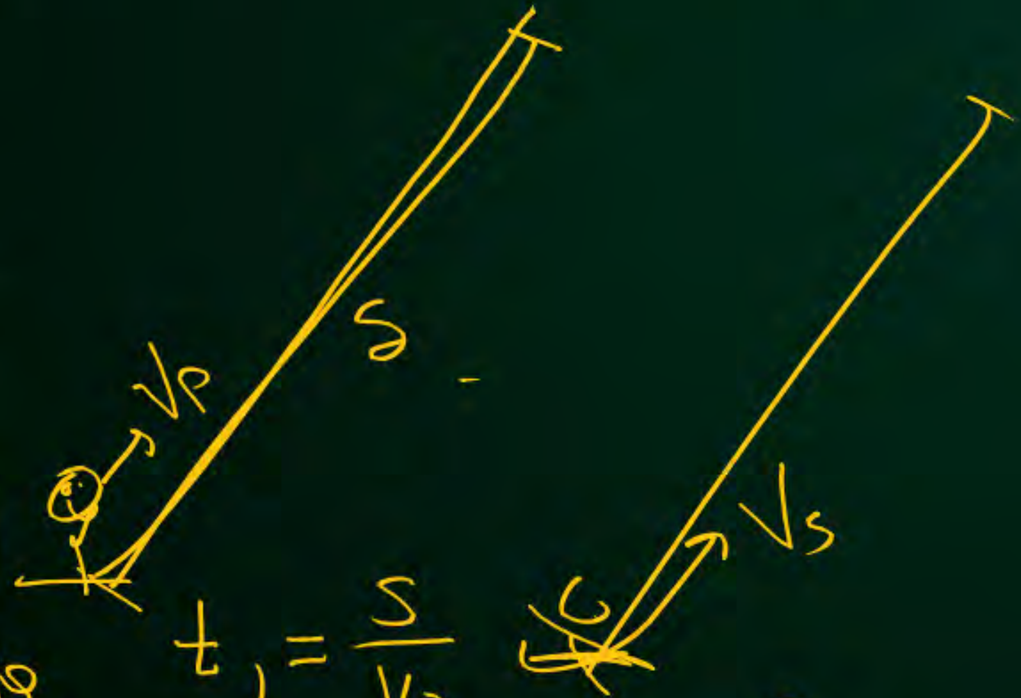
man is walking on moving escalator ✓

$$t = \left[\frac{S}{V_m + V_s}\right]$$

QUESTION

Preeti reached the metro station and found that the escalator was not working. She walked up the stationary escalator in time t_1. On other days, if she remains stationary on the moving escalator, then the escalator takes her up in time t_2. The time taken by her to walk up on the moving escalator will be **[NEET -2017]**

1. $\frac{t_1 + t_2}{2}$
2. $\frac{t_1 t_2}{t_2 - t_1}$
3. $\frac{t_1 t_2}{t_2 + t_1}$ Ans.
4. $t_1 - t_2$



$t_1 = \frac{S}{V_P}$

$t_2 = \frac{S}{V_S}$

$t = \frac{S}{V_P + V_S}$

$t = \frac{S}{\frac{S}{t_1} + \frac{S}{t_2}}$

$t = \frac{1}{\left(\frac{1}{t_1} + \frac{1}{t_2}\right)} = \frac{t_1 t_2}{t_1 + t_2}$

Relative motion in Motion Under gravity

at $t = 0$

(A) drop: $u_A = 0$, $a_A = g$

(B) $u_B = 20 m/s^2$, $a_B = g$

Find their relative velocity after 4 sec

	A	B
t = 1	$v = u + at = 10 m/s$	$v = 20 + 10 \times 1 = 30 m/s$
t = 2	20 m/s	v = 40 m/s
t = 3	30 m/s	50 m/s
t = 4	40 m/s	60 m/s

after 4-sec

$v_{BA} = v_B - v_A = 60 - 40 = 20 m/s$

Power of relative motn

A (rest), Kallu

B: $u = 20 m/s$, g, g

relative accn is zero, relative velocity constant ✓

$v_{BA} = 20 m/s$ ✓

$a_{BA} = 0$ ✓

Motion under gravity on one object w.r.t other object who is in free fall is uniform motⁿ with zero accⁿ.

Motⁿ under gravity is nonuniform $\vec{v}$ = Varible

$$\vec{a}_{BA} = a_B - a_A$$

$$= g - g = 0$$

$a_A = g$, u_1

$a_B = g$, u_2

$$\vec{u}_{BA} = u_B - u_A$$

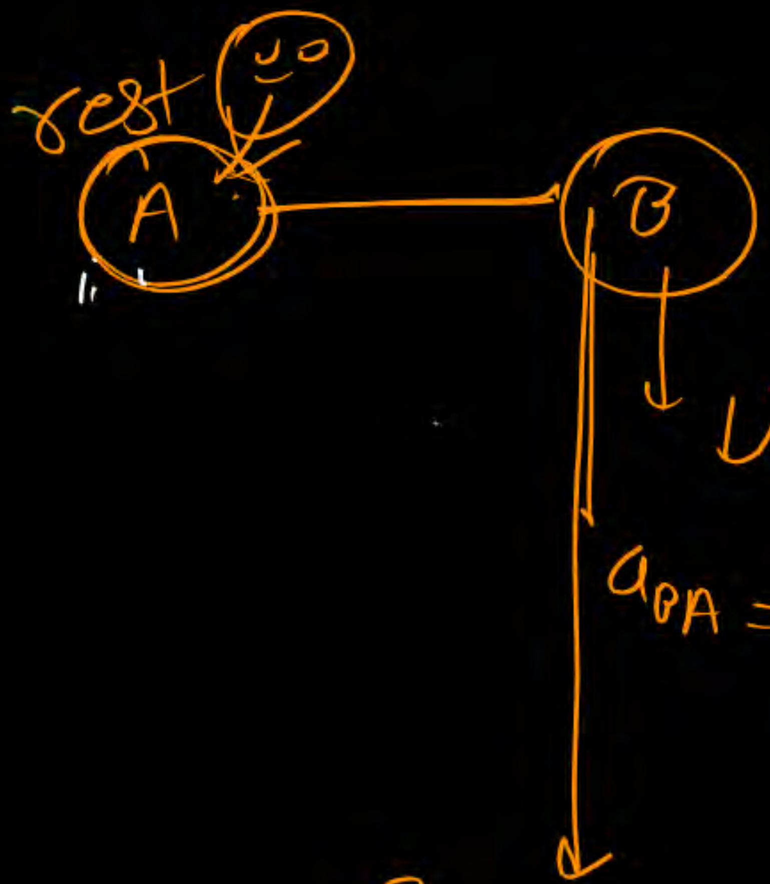
$$= u_1 - u_2 = \text{Cotn}$$

find distance between A and B after 3-sec



$\downarrow u_A = 0$ (drop)

$\downarrow u_B = 10\ m/s$



$v_{BA} = 10\ m/s$

$a_{BA} = 0$

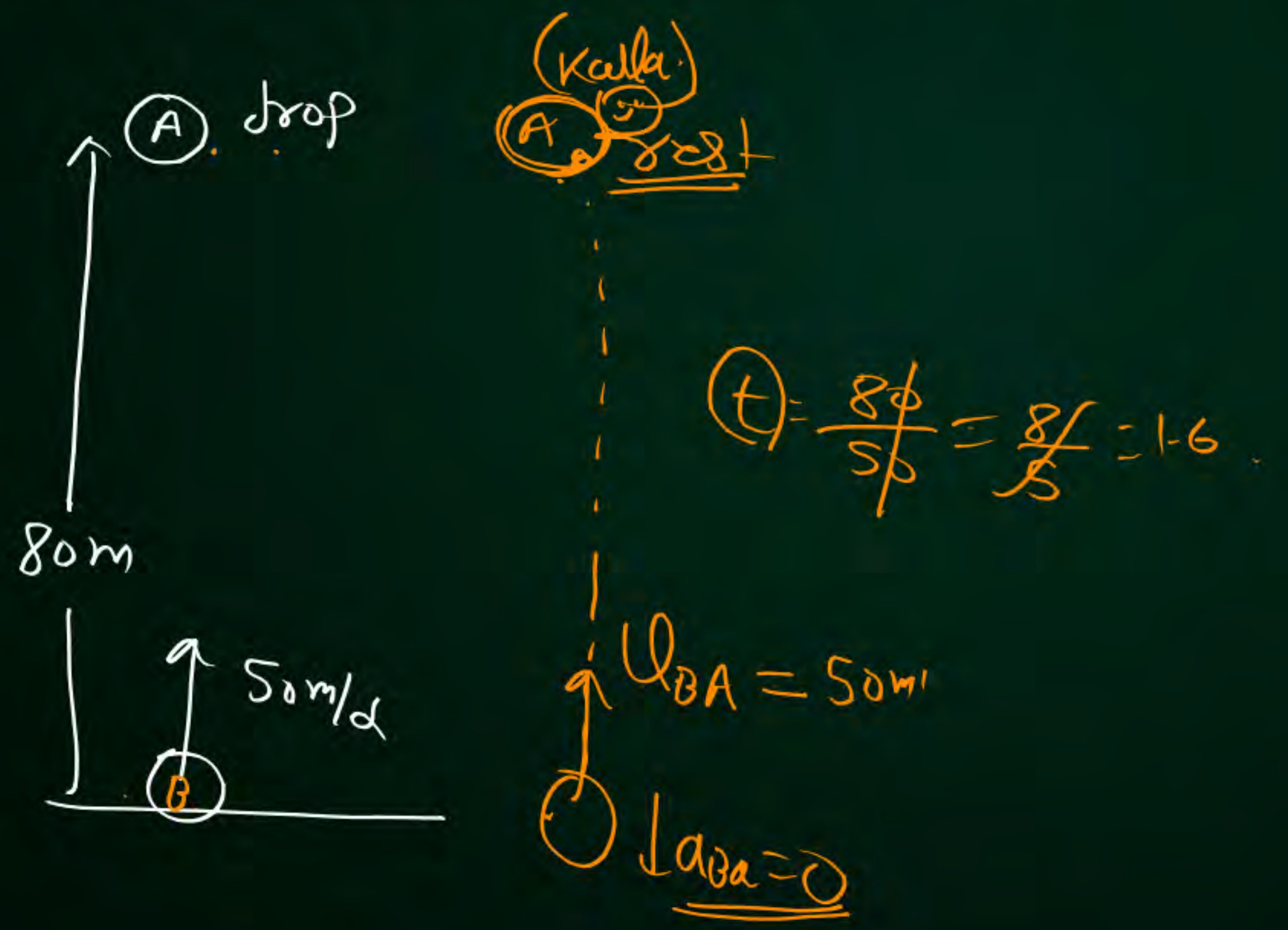
$S_{BA} = u_{BA} \times t$

$= 10 \times 3 = 30\ m$

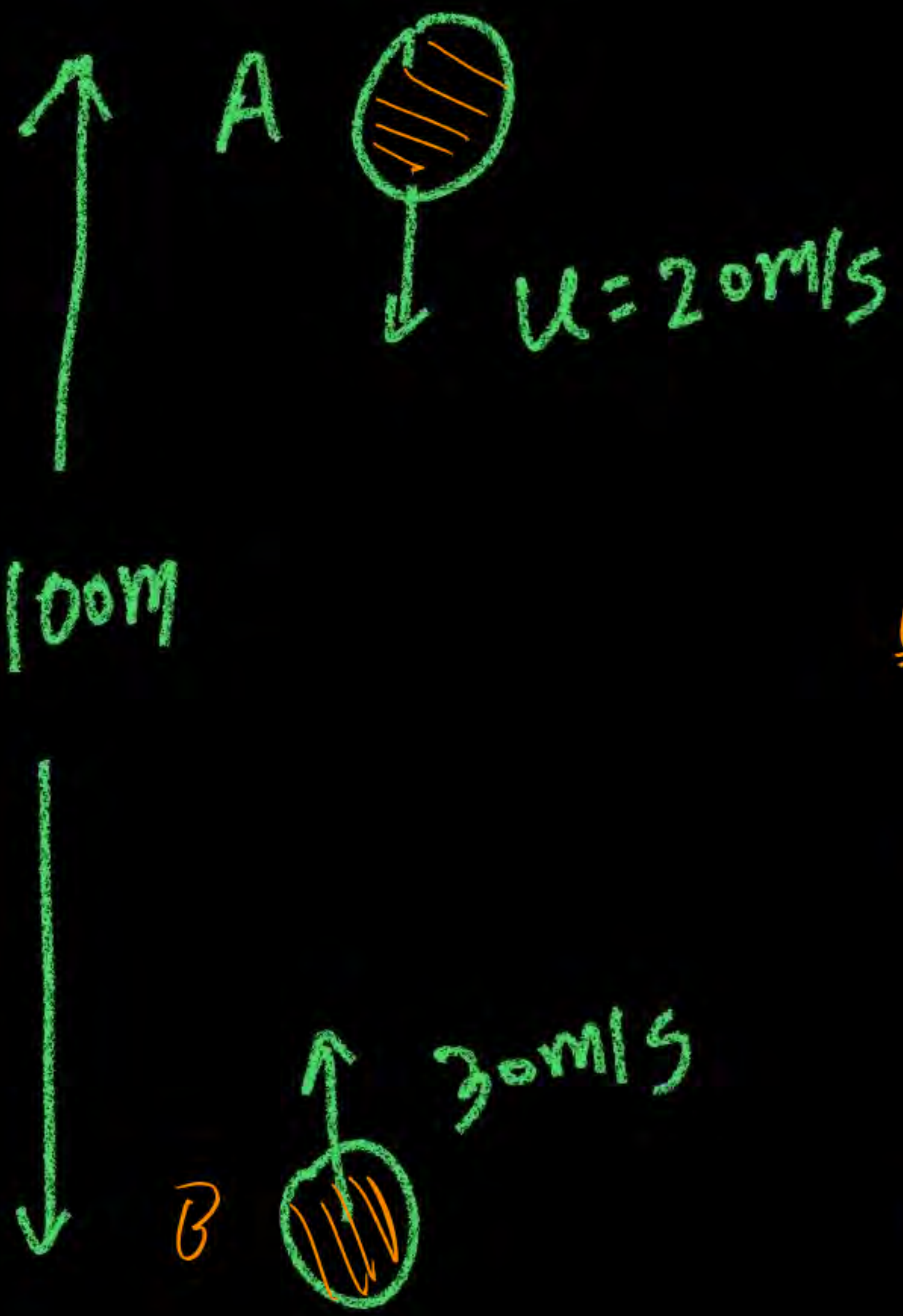
QUESTION

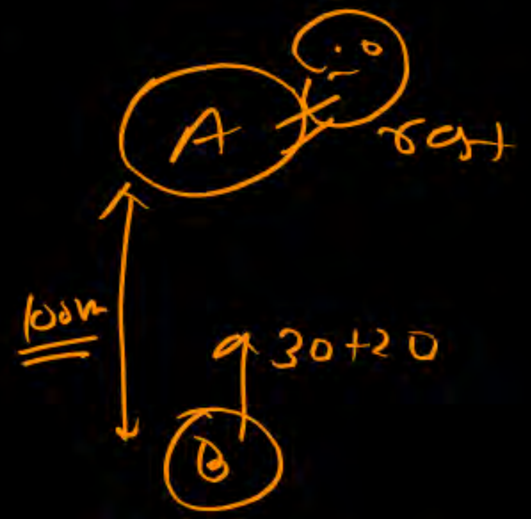
A ball is dropped from the top of a building of height 80 m. At same instant another ball is thrown upwards with speed 50 m/s from the bottom of the building. The time at which balls will meet is

1. 1.6 s
2. 5 s
3. 8 s
4. 10 s



find time of collision

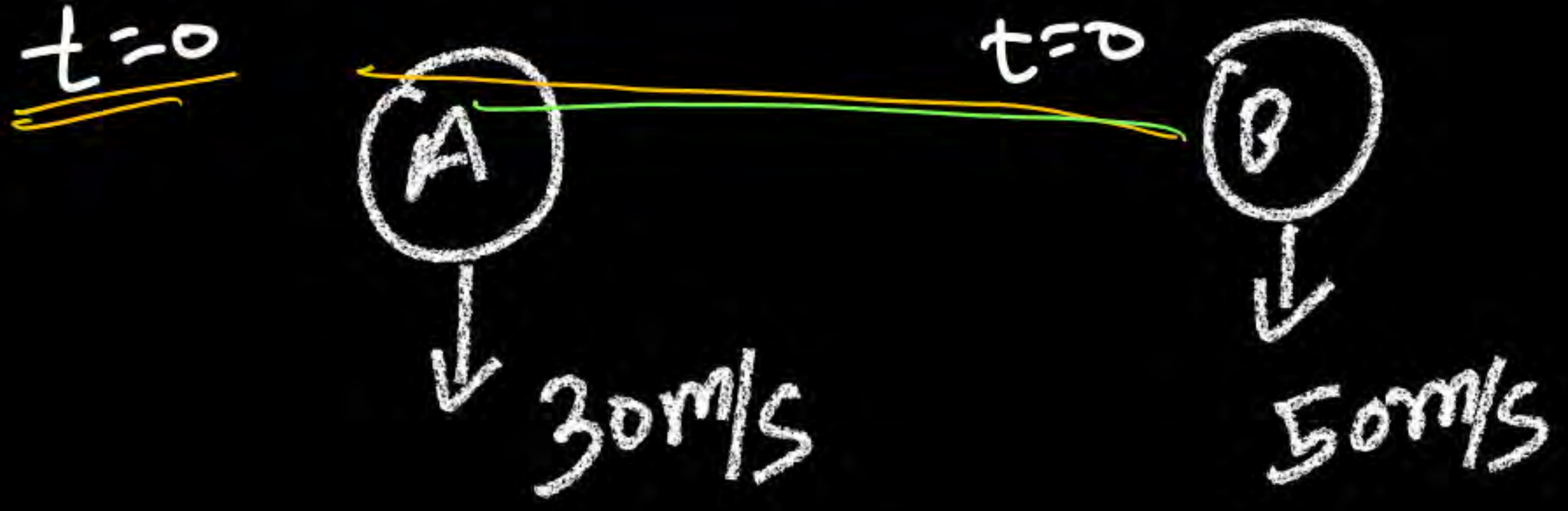




$a_{BA} = 0$

$u_{BA} = 50$

$t = \frac{100}{50} = 2\,sec$



find relative velocity of A w.r.t B after 4 sec and distance B/W them.

at $t = 0$

$$a_{BA} = 0$$

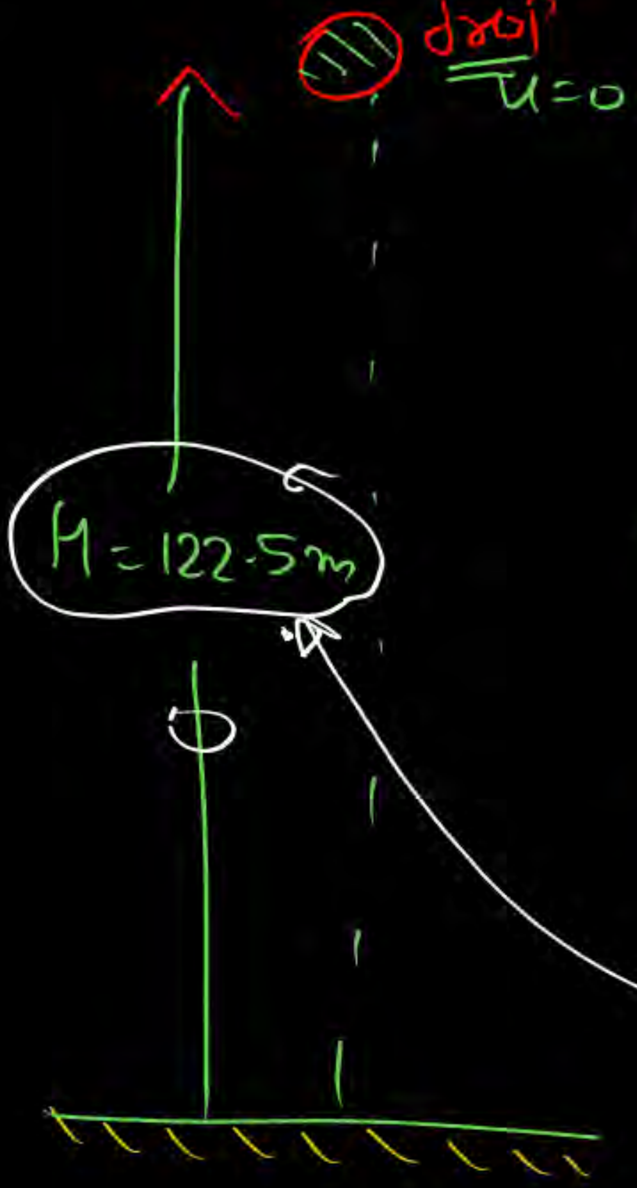
$$u_{BA} = 50 - 30 = 20 \text{ m/s}$$

at = 4 sec

* relative velocity will be same

$$S_{BA} = u_{BA} t = 20 \times 4 = 80 \text{m}$$

$\frac{792}{9.8} \Rightarrow 10$ 80 m



$$S = ut + \frac{1}{2}at^2$$

drop

$$T_f = \sqrt{\frac{2H}{g}}$$

$$T_f = \sqrt{\frac{2 \times 122.5}{9.8}}$$

$$T_f = \sqrt{\frac{125 \times 2}{10}}$$

$$= \sqrt{25}$$

$$= 5 \text{ sec}$$

A body is projected vertically up at t = 0 with a velocity of 98 m/s. Another body is projected from the same point with same velocity after 4 seconds. Both bodies will meet at t =

(1) 6 s (2) 8 s (3) 10 s (4) 12 s

$u = 100\ m/s$

98 m/s, a = 9.8

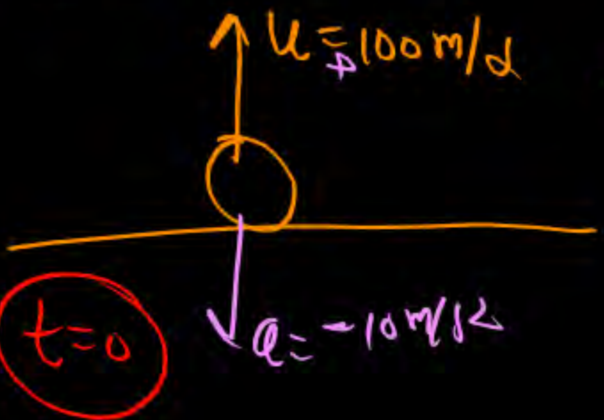
u = 100 m/s, a = 10 m/s

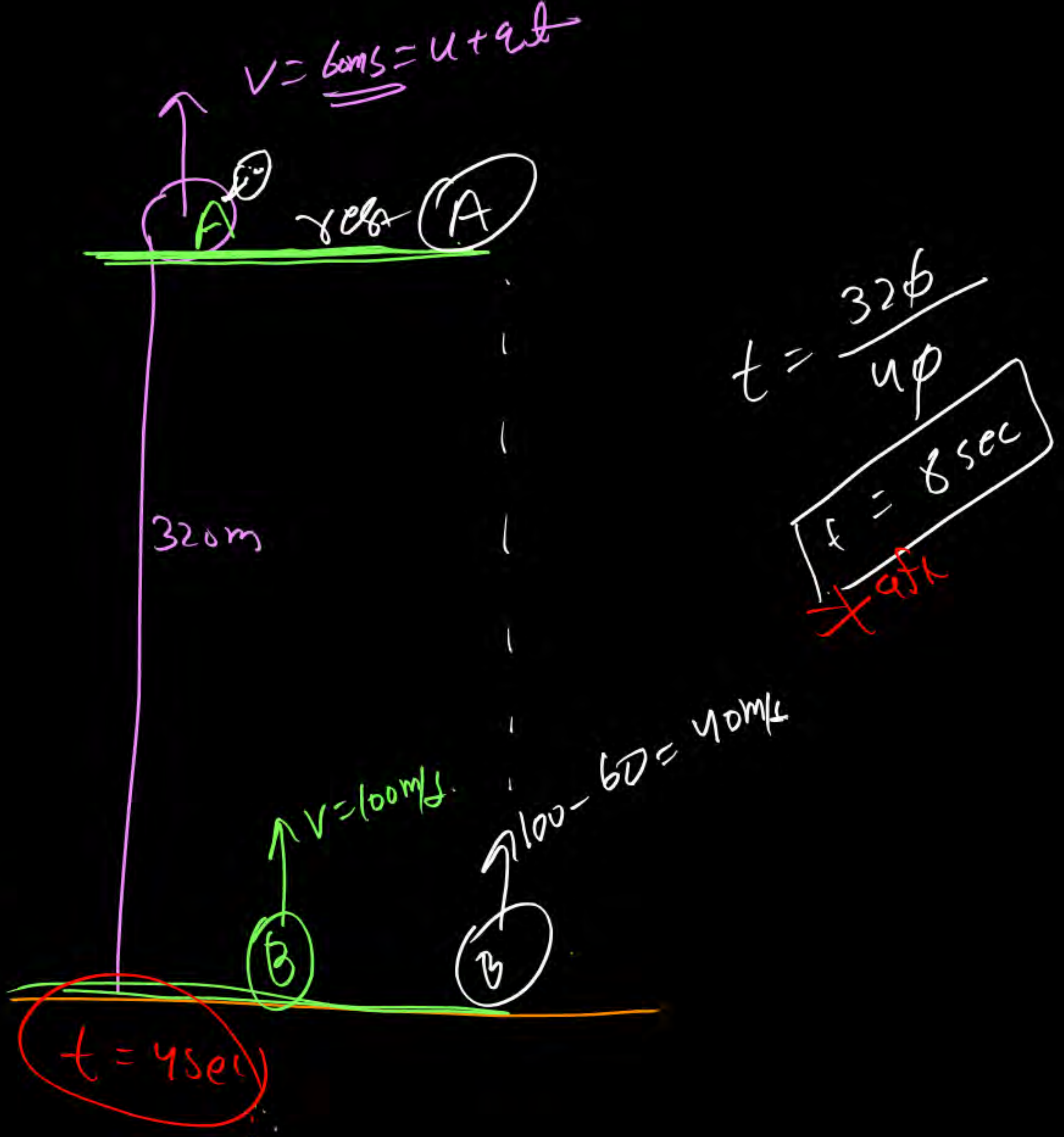
$S = ut + \frac{1}{2}at^2$

$= 100 \times 4 - \frac{1}{2} \times 10 (4)^2$

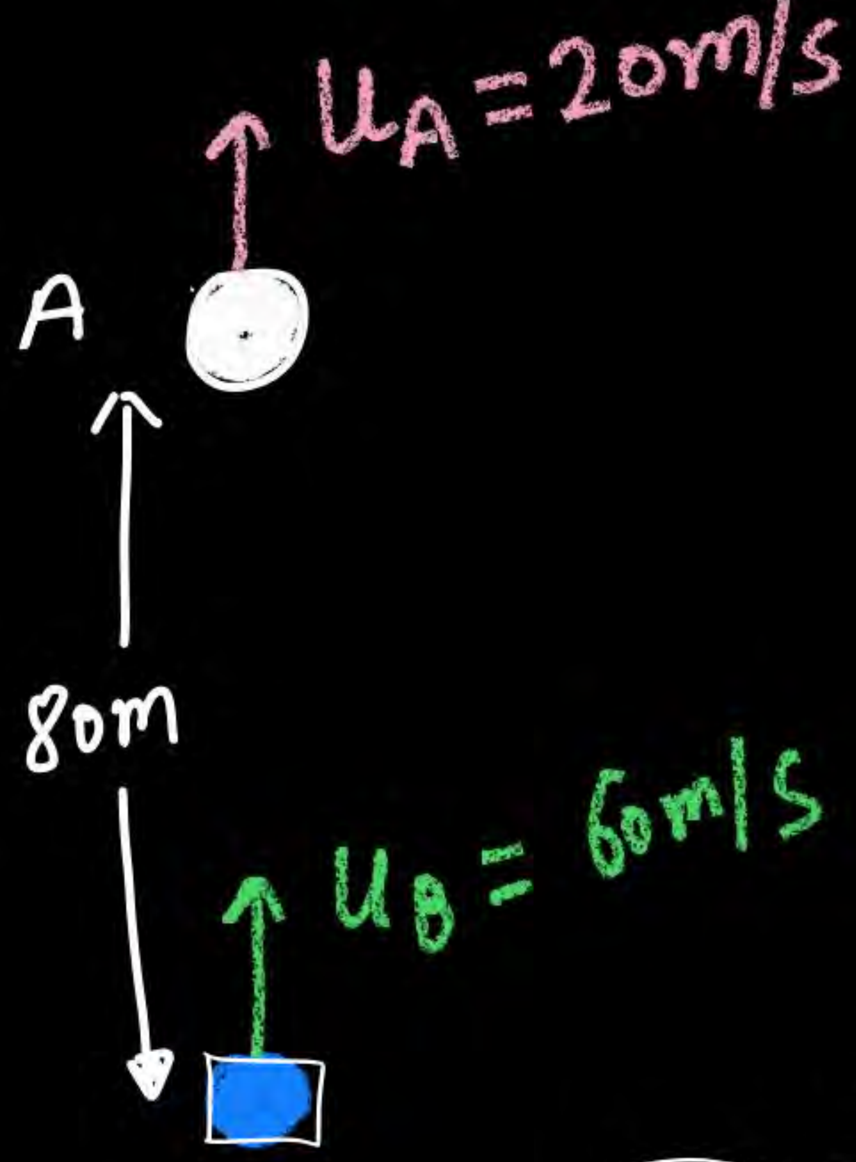
$= 400 - 5 \times 16$

$= 320 m$



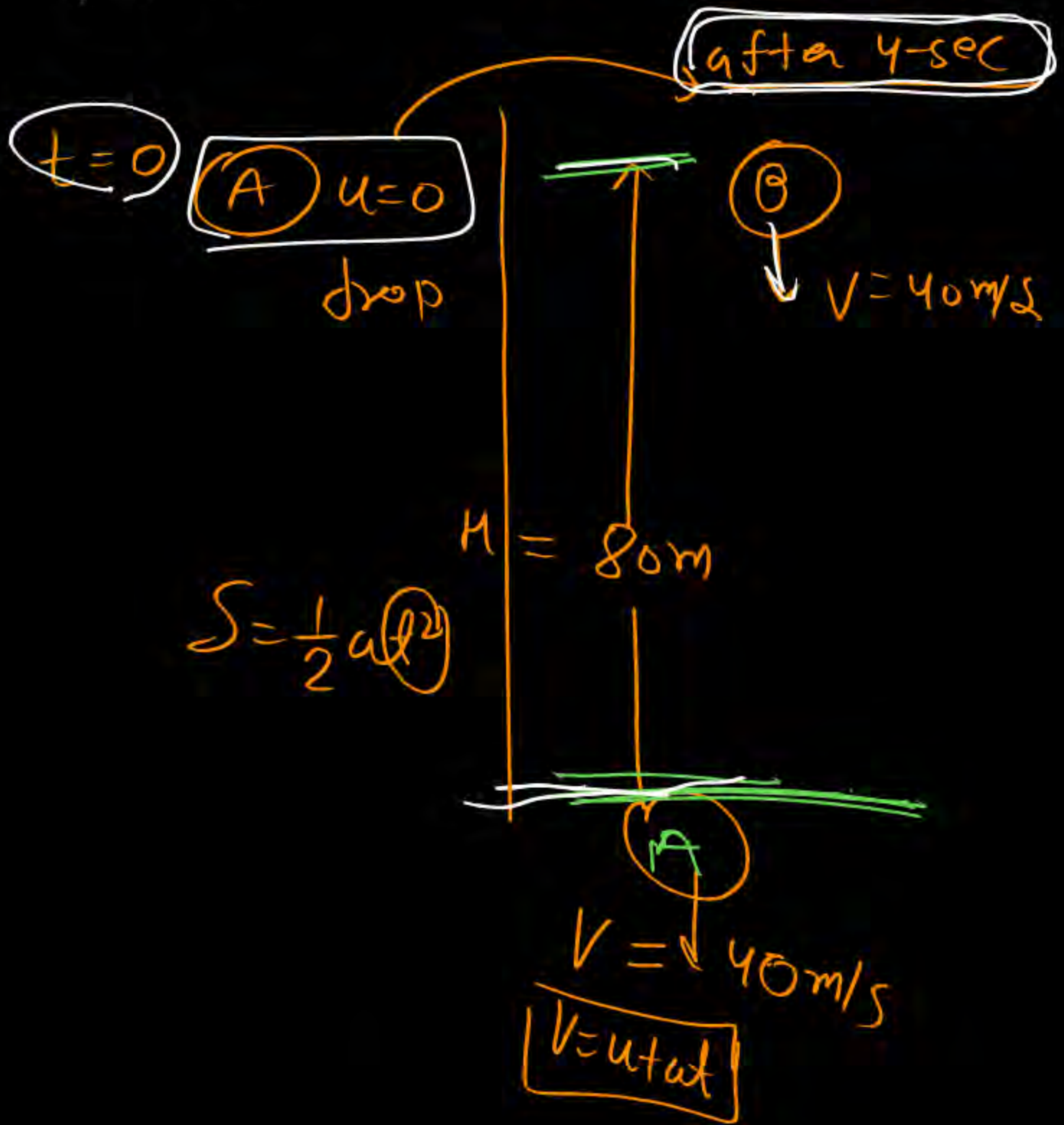


Find time of collision



$t = 2 sec$

Ball is drop and other Ball is Projected downward from Same point after 4 sec with 40 m/s then Find distance B/w them at 6 sec.



Ans 80m

$U_{t=6} = 0$

[1-D motion] + [1-D motion]

x-axis y-axis

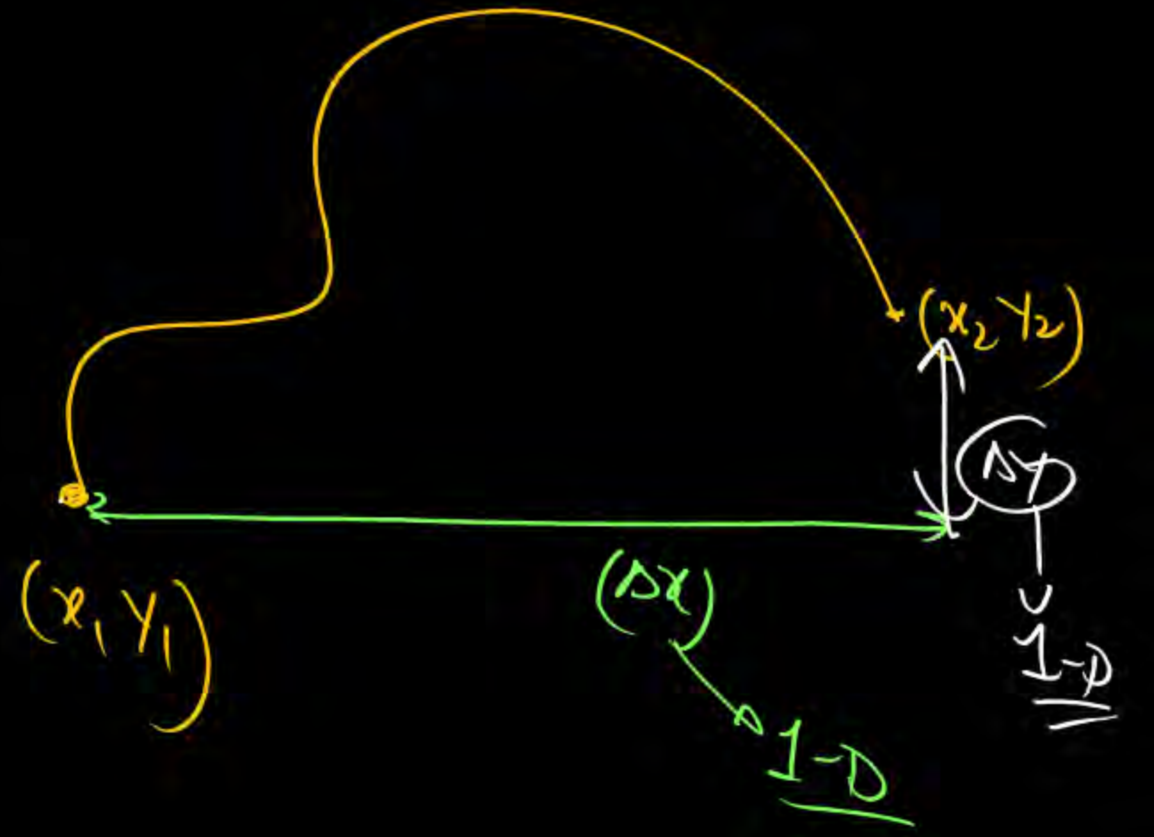
2-D motion

Motion in a plane

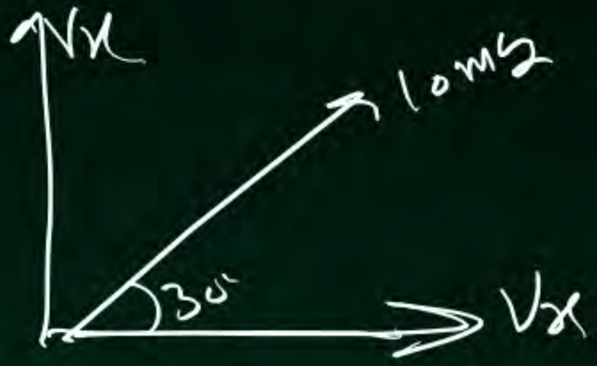
Projectile moti

Circular motion





2-D MOTION

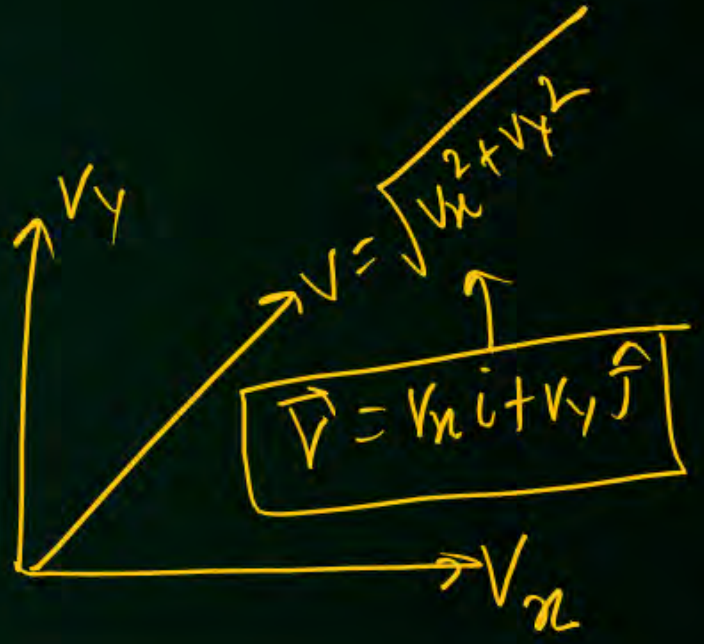


Vector ko तोड़ना (1-D) + (1-D)

VECTOR

- * Component of vector
- Magnitude of vector

Solve



2-D Motion = $[1\text{-D}]_{x\text{-axis}} + [1\text{-D}]_{y\text{-axis}}$

↓ Solve ↓ Solve

Magnitude

POSITION VECTOR IN PLANE

2-D

$\vec{r} = x\hat{i} + y\hat{j}$

$|\vec{r}| = \sqrt{x^2 + y^2}$

↳ magnitude of Positⁿ

$Disp^m = \vec{r_f} - \vec{r_i}$

$= (x_2\hat{i} + y_2\hat{j}) - (x_1\hat{i} + y_1\hat{j})$

$\vec{\Delta r} = \Delta x\hat{i} + \Delta y\hat{j}$

$\vec{r} = x\hat{i} + y\hat{j}$

diffⁿ w.r.t time

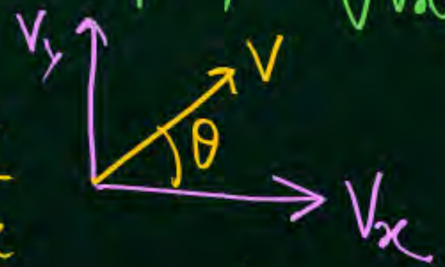
$\frac{d\vec{r}}{dt} = \left[\frac{dx}{dt}\right]\hat{i} + \frac{dy}{dt}\hat{j}$

$\vec{V} = V_x\hat{i} + V_y\hat{j}$

Speed $|\vec{V}| = \sqrt{V_x^2 + V_y^2}$

dirⁿ of motion

$\tan\theta = \frac{V_y}{V_x}$



diffⁿ w.r.t time

$\vec{a} = a_x\hat{i} + a_y\hat{j}$

$|a| = \sqrt{a_x^2 + a_y^2}$

$\frac{dv}{dt} = a_x\hat{i} + a_y\hat{j}$

$\int dv = \int a_x dt\,\hat{i} + \int a_y dt\,\hat{j}$

In a case of const^n acc^n → Eq^n of motion will be valid

1st eq^n of mot^n

$$\vec{V}_x = \vec{u}_x + \vec{a}_x t$$

$$\vec{V}_y = \vec{u}_y + \vec{a}_y t$$

3rd eq^n of mot^n

$$V_x^2 - u_x^2 = 2a_x x$$

$$V_y^2 - u_y^2 = 2a_y y$$

$$S = ut + \frac{1}{2}at^2$$

$$\Delta x = u_x t + \frac{1}{2}a_x t^2$$

$$\Delta y = u_y t + \frac{1}{2}a_y t^2$$

2-D motion 1-D से very-very easy, vector ka fluna के ज़ारी

QUESTION

If initial velocity of object $\vec{u} = 3\hat{i} + 4\hat{j}$ and after some time its velocity $v = 4\hat{i} + 3\hat{j}$ then find

(i) magnitude of change in velocity

(ii) change in magnitude of velocity.

$\vec{\Delta v} = \vec{V_f} - \vec{V_i}$

$= (4\hat{i}+3\hat{j}) - (3\hat{i}+4\hat{j})$

$\vec{\Delta v} = \hat{i} - \hat{j}$

$|\Delta v| = \sqrt{2}$

Change $= |V_f| - |V_i|$

$= 5 - 5 = 0$

QUESTION

Position of object $\vec{r} = 3t^2\,\hat{\imath} + (6t - t^2)\,\hat{\jmath}$, then find velocity and acceleration at $t = 1$ sec.

$\vec{r} = 3t^2\,\hat{i} + (6t - t^2)\,\hat{j}$

$\frac{d\vec{r}}{dt} = v = 3(2t)\,\hat{i} + (6 - 2t)\,\hat{j}$

$x = 3t^2$

$\frac{dx}{dt} = v_x = 6t$

$a_x = 6$

$y = 6t - t^2$

$\frac{dy}{dt} = v_y = 6 - 2t$

$a_y = 0 - 2$

$a_y = -2$

$\vec{v} = 6t\,\hat{i} + (6 - 2t)\,\hat{j}$

$v_{t=1} = 6i + 4\hat{j}$

$\vec{a} = 6i - 2\hat{j}$

QUESTION

x and y-coordinates of the particle at any time are $x = 5t - 2t^2$ and $y = 10t$, where x and y. Acceleration of the particle at $t = 2$s. **[NEET-2017]**

$x = 5t - 2t^2$

$v_x = 5 - 4t$

$\frac{dv_x}{dt} = a_x = 0 - 4$

$a_x = -4$

$y = 10t$

$\frac{dy}{dt} = v_y = 10$

$\frac{dv_y}{dt} = a_y = 0$

$\vec{a} = -4 \text{ m/s}^2$

QUESTION

A particle has initial velocity $2\hat{i} + 3\hat{j}$ and acceleration $(0.3\hat{i} + 0.2\hat{j})$. Magnitude of velocity after 10 sec. [NEET-2012]

$\vec{u} = \underbrace{2\hat{i}}_{u_x} + \underbrace{3\hat{j}}_{u_y}$

$\vec{a} = \underbrace{0.3\hat{i}}_{a_x} + 0.2\hat{j}$

$V_x = u_x + a_x t$

$V_x = 2 + 0.3 \times 10$

$= 2 + 3 = 5\hat{i}$

$V_y = 3 + 0.2 \times 10$

$= 3 + 2 = 5\hat{j}$

$5\sqrt{2}$

QUESTION

A position vector of a particle $r = 15t^2\,\hat{i} + (4 - 20t^2)\,\hat{j})$. Find acceleration at $t = 1$ sec

[JEE Main 2019]

1. 25
2. 40
3. 100
4. 50 ✓ Ans

$$\vec{r} = 15t^2\,\hat{i} + (4 - 20t^2)\,\hat{j}$$

$$\vec{V} = 30t\,\hat{i} + (0 - 40t)\,\hat{j}$$

$$\frac{d\vec{V}}{dt} = \vec{a} = 30\,\hat{i} - 40\,\hat{j}$$

QUESTION

A particle moving in plane such that $y = \frac{x^2}{4}$ and $x = \frac{t}{2}$ then find speed at t = 2 sec.

[JEE-2012]

QUESTION

A particle starting from origin moves in straight line and reach at a point $(\sqrt{3}, 3)$ then path makes an angle. [2007]

QUESTION

Object starts from the point $(2\hat{\imath}, 4\hat{\jmath})$ m at $t = 0$ with velocity $(5\hat{\imath} + 4\hat{\jmath})$ with constant acceleration $(4\hat{\imath} + 4\hat{\jmath})$ m/s^2. What is distance from particle from origin at t = 2 sec.

[JEE Main-2019]

$$\underset{x_f - x_i}{\Delta x} = ut + \frac{1}{2}at^2$$

$$x - 2 = 5\times 2 + \frac{1}{2}4(2)^2$$

$$y - 4 = 4\times 2 + \frac{1}{2}\times 4(2)^2$$

QUESTION

Potion of object $\vec{r} = (t^2 - 38t)\,\hat{i} + 2t^3\,\hat{j}$ find instant when velocity and acceleration are perpendicular. [JEE-2022]

QUESTION

A car starts from rest and acceleration $5\ m/s^2$ at $t = 4$ s. A ball is dropped out of a window by a person sitting in the car. What is the velocity and acceleration of the ball at $t = 6s$?

[NEET-2021]

1. $20\sqrt{2}\ m/s, 10\ m/s^2$
2. $20\ m/s, 5\ m/s^2$
3. $20\ m/s, 0$
4. $20\sqrt{2}\ m/s, 0$

QUESTION

A particle starts from origin with velocity $3\hat{j}$ m/s and acceleration $(6\hat{i} + 4\hat{j})$. Then find x-coordinates of particle when y-coordinates is 32. [IIT-2021]

H/w

QUESTION

Object is moving with velocity $V = 3 \sin(\omega t)\,\hat{i} + 3 \cos(\omega t)\,\hat{j}$ then find distance moved by object in 2 sec.

QUESTION

Object is moving in west with 5 m/s after 2 sec its velocity is 5 m/s in north then find acceleration.

QUESTION

Initial velocity of object is 5 m/s in east and acceleration of object is 2.5 m/s^2 north then find speed of object at $t = 2$ sec.

QUESTION

Acceleration of object $a = 2\,\hat{\imath} + 3\,t^2\,\hat{\jmath}$, then find velocity at $t = 1$ sec it initial velocity of object is zero.


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 02 | Physics

Motion in a Plane

By- Dr. Manish Raj (MR SIR)



Todays Goal

- * H/W (2-D revision)
- eq^n of Trajecotry
- feel of Projectile mot^n

1-D ✗ vector नहीं पढ़ा.

2-D mot^n ✗

$\vec{u} = 3\hat{i} + 4\hat{j}$

$|\vec{v}| = 5$ ✓

Questions on genral 2-D motion & equation of trajectory

$\vec{a} = \frac{d|\vec{v}|}{dt}$ ✗

$\vec{a} = \frac{d\vec{v}}{dt}$ ✓

2-D Motion ⟶ (1-D motion) + (with vector ka concept)

⟶ $[1\text{-}D]_{x\text{-ax.}} + [1\text{-}D]_{y\text{-axis}}$

$\left.\begin{array}{l}\vec{u}_x = 3t\,\hat{i} \\ \vec{v}_y = 4t\,\hat{j}\end{array}\right\}$ find acc^n

$\vec{v} = \vec{u}_x\hat{i} + u_y\hat{j}$

$\vec{v} = 3t\hat{i} + 4t\hat{j}$

$a_x\hat{i}$ $\quad a_y\hat{j}$

~~$|\vec{v}| = \sqrt{(3t)^2 + (4t^2)^2}$~~

~~$\frac{dv}{dt}$~~ ✗

POSITION VECTOR IN PLANE

2-D

$\vec{r} = x\hat{i} + y\hat{j}$ ✓

$|\vec{r}| = \sqrt{x^2+y^2}$ ✓

↳ magnitude of Positⁿ

$\text{Disp}^m = \vec{r}_f - \vec{r}_i$

$= (x_2\hat{i}+y_2\hat{j}) - (x_1\hat{i}+y_1\hat{j})$

$\vec{\Delta r} = \Delta x\hat{i} + \Delta y\hat{j}$

$\vec{r} = x\hat{i} + y\hat{j}$

diffⁿ w.r.t time

$\frac{d\vec{r}}{dt} = \left[\frac{dx}{dt}\right]\hat{i} + \frac{dy}{dt}\hat{j}$

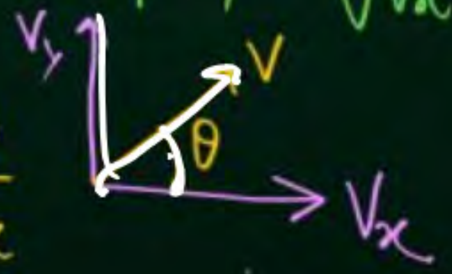
dirⁿ of vel

$\vec{V} = V_x\hat{i} + V_y\hat{j}$

dirⁿ of Motion

Speed $|\vec{V}| = \sqrt{V_x^2+V_y^2}$

$\tan\theta = \frac{V_y}{V_x}$



diffⁿ w.r.t time

$\vec{a} = a_x\hat{i} + a_y\hat{j}$

$|a| = \sqrt{a_x^2+a_y^2}$

$\frac{dv}{dt} = a_x\hat{i} + a_y\hat{j}$

$\int dv = \int a_x dt\,\hat{i} + \int a_y dt\,\hat{j}$

In a case of constⁿ accⁿ → Eqⁿ of motion will be valid

1st eqⁿ of motⁿ

$$\vec{V}_x = \vec{u}_x + \vec{a}_x t$$

$$\vec{V}_y = \vec{u}_y + \vec{a}_y t$$

3rd eqⁿ of motⁿ

* $V_x^2 - u_x^2 = 2a_x x$
* $V_y^2 - u_y^2 = 2a_y y$

$$S = ut + \frac{1}{2}at^2$$

$$\Delta x = u_x t + \frac{1}{2}a_x t^2$$

$$\Delta y = u_y t + \frac{1}{2}a_y t^2$$

2-D motion 1-D से very-very easy, vector ka flune का खेल

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If initial velocity of object $\vec{u} = 3\hat{i} + 4\hat{j}$ and after some time its velocity $v = 4\hat{i} + 3\hat{j}$ then find

(i) magnitude of change in velocity

(ii) change in magnitude of velocity.

$\vec{\Delta v} = \vec{V_f} - \vec{V_i}$

$= (4\hat{i} + 3\hat{j}) - (3\hat{i} + 4\hat{j})$

$\vec{\Delta v} = \hat{i} - \hat{j}$

$|\Delta v| = \sqrt{2} = \sqrt{1^2 + (-1)^2} = \sqrt{1+1} = \sqrt{2}$

Change $= |v_f| - |v_i|$

$= 5 - 5 = 0$

QUESTION

Position of object $\vec{r} = 3t^2\hat{i} + (6t - t^2)\hat{j}$, then find velocity and acceleration at $t = 1$ sec.

$$\vec{r} = 3t^2\,\hat{i} + (6t - t^2)\,\hat{j}$$

$$\frac{d\vec{r}}{dt} = v = 3(2t)\,\hat{i} + (6 - 2t)\,\hat{j}$$

$x = 3t^2$

$\frac{dx}{dt} = v_x = 6t$

$a_x = 6$

$y = 6t - t^2$

$\frac{dy}{dt} = v_y = 6 - 2t$

$a_y = 0 - 2$

$a_y = -2$

$\vec{v} = 6t\,\hat{i} + (6 - 2t)\,\hat{j}$

$v_{t=1} = 6i + 4\hat{j}$

$\vec{a} = 6i - 2\hat{j}$

QUESTION

x and y-coordinates of the particle at any time are $x = 5t - 2t^2$ and $y = 10t$, where x and y. Acceleration of the particle at $t = 2s$. **[NEET-2017]**

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$\frac{dv_y}{dt} = a_y = 0$

$\vec{a} = -4\ m/s^2$

QUESTION

A particle has initial velocity $2\hat{\imath} + 3\hat{\jmath}$ and acceleration $(0.3\hat{\imath} + 0.2\hat{\jmath})$. Magnitude of velocity after 10 sec. [NEET-2012]

$\vec{u} = \underbrace{2\hat{i}}_{u_x} + \underbrace{3\hat{j}}_{u_y}$

$\vec{a} = \underbrace{0.3\hat{i}}_{a_x} + 0.2\hat{j}$

$V_x = u_x + a_x t$

$\vec{V_x} = 2 + 0.3 \times 10$

$= 2 + 3 = 5\hat{i}$

$V_y = 3 + 0.2 \times 10$

$= 3 + 2 = 5\hat{j}$

$5\sqrt{2}$

QUESTION

A position vector of a particle $r = 15t^2\,\hat{i} + (4 - 20t^2)\,\hat{j})$. Find acceleration at $t = 1$ sec

[JEE Main 2019]

1. 25
2. 40
3. 100
4. 50

$\vec{r} = 15t^2\,\hat{i} + (4 - 20t^2)\,\hat{j}$

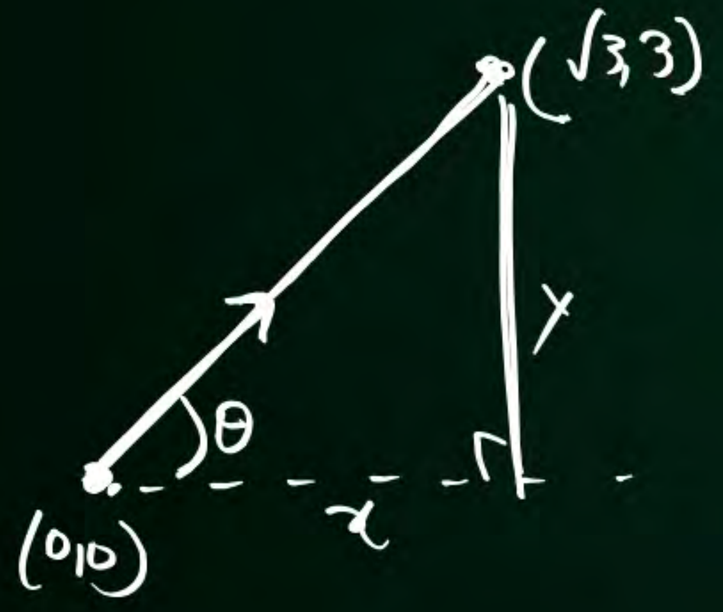
$\vec{v} = 30t\,\hat{i} + (0 - 40t)\,\hat{j}$

$\frac{d\vec{v}}{dt} = \vec{a} = 30\,\hat{i} - 40\,\hat{j}$

Ans

QUESTION

A particle starting from origin moves in straight line and reach at a point $(\sqrt{3}, 3)$ then path makes an angle. [2007]



$\tan\theta = \frac{3}{\sqrt{3}} = \sqrt{3}$

$\theta = 60^\circ$ a

QUESTION

A particle moving in plane such that $y = \frac{x^2}{4}$ and $x = \frac{t}{2}$ then find speed at t = 2 sec.

[JEE-2012]

$y = \frac{x^2}{4}$

$x = \frac{t}{2}$

$y = \frac{x^2}{4} = \frac{1}{4}\left(\frac{t}{2}\right)^2$

$y = \frac{t^2}{16}$

$\frac{dy}{dt} = V_y = \frac{2t}{16} = \frac{t}{8}\hat{j}$

$|V_y|_{t=2} = \frac{2}{8} = \frac{1}{4}\hat{j}$

$\frac{dx}{dt} = V_x = \frac{1}{2}\frac{dt}{dt} = \frac{1}{2}$ m/s $\hat{i}$

$V_x = \frac{1}{2}\hat{i}$

$\vec{V} = \vec{V}_x + \vec{V}_y$

$= \frac{1}{2} + \frac{1}{4} = \frac{2+1}{4} = \frac{3}{4}$ m/s

$\vec{V} = \frac{1}{2}\hat{i} + \frac{1}{4}\hat{j}$

speed $= |\vec{V}| = \sqrt{\left(\frac{1}{2}\right)^2 + \left(\frac{1}{4}\right)^2} = \sqrt{\frac{1}{4} + \frac{1}{16}} = \frac{\sqrt{5}}{4}$ m/s

QUESTION

Object starts from the point $(2\hat{\imath}, 4\hat{\jmath})$ m at $t = 0$ with velocity $(5\hat{\imath} + 4\hat{\jmath})$ with constant acceleration $(4\hat{\imath} + 4\hat{\jmath})$ m/s^2. What is distance from particle from origin at t = 2 sec.

[JEE Main-2019]

$\Delta x = ut + \frac{1}{2}at^2$ ($x_f - x_i$)

$x - 2 = 5 \times 2 + \frac{1}{2} 4 (2)^2$

$y - 4 = 4 \times 2 + \frac{1}{2} \times 4 (2)^2$

$t = 0$

$(x_i, y_i) = (2\hat{i}, 4\hat{j})$

$\vec{u} = (5\hat{i} + 4\hat{j})$ m/s

$\vec{a} = (4\hat{i} + 4\hat{j})$

$x_f - x_i = ut + \frac{1}{2}at^2$

$x_f - 2 = 5 \times 2 + \frac{1}{2} 4 (2)^2$

$x_f - 2 = 10 + 8 = 18$ $\quad x_f = 20$ m

$\Delta y =$

$y_f - y_i = u_y t + \frac{1}{2} a_y t^2$

$= 4 \times 2 + \frac{1}{2} 4 (2)^2$

$y_f - 4 = 8 + 8 = 16\hat{j}$

$y_f = 20\hat{j}$

$\vec{r}_f = 20\hat{i} + 20\hat{j}$

$|r_f| = 20\sqrt{2}$

QUESTION

Potion of object $\vec{r} = (t^2 - 38t)\,\hat{\imath} + 2t^3\,\hat{\jmath}$ find instant when velocity and acceleration are perpendicular.

[JEE-2022]

$\vec{A}$ & $\vec{B}$ will be perpendicular only when $\vec{A} \cdot \vec{B}$.

$\vec{r} = (t^2 - 38t)\,i + 2t^3\,\hat{j}$

$\frac{d\vec{r}}{dt} = \vec{v} = (2t-38)\hat{i} + 6t^2\hat{j}$

$\vec{a} = 2\hat{i} + 12t\,\hat{j}$

$\vec{a} \cdot \vec{v} = 0$

$\vec{a} \perp r\ \vec{v}$

$(2i + 12t\,\hat{j}) \cdot \left((2t-38)i + 6t^2\hat{j}\right) = 0$

$4t - 76 + 72t^3 = 0$

$72t^3 + 4t - 76 = 0$

$t = 1\,\text{sec}$ Ans

QUESTION

A car starts from rest and acceleration $5\ m/s^2$ at $t = 4$ s. A ball is dropped out of a window by a person sitting in the car. What is the velocity and acceleration of the ball at $t = 6s$?

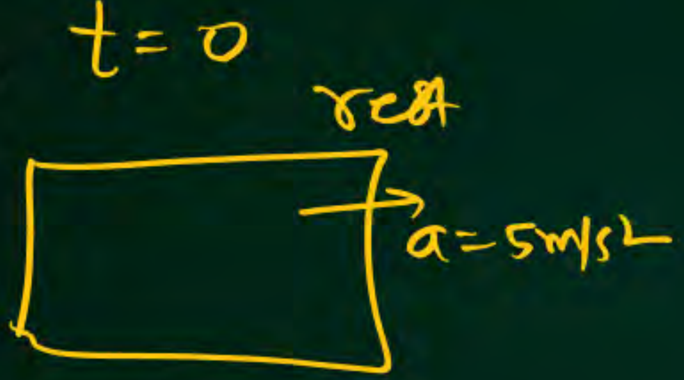
[NEET-2021]

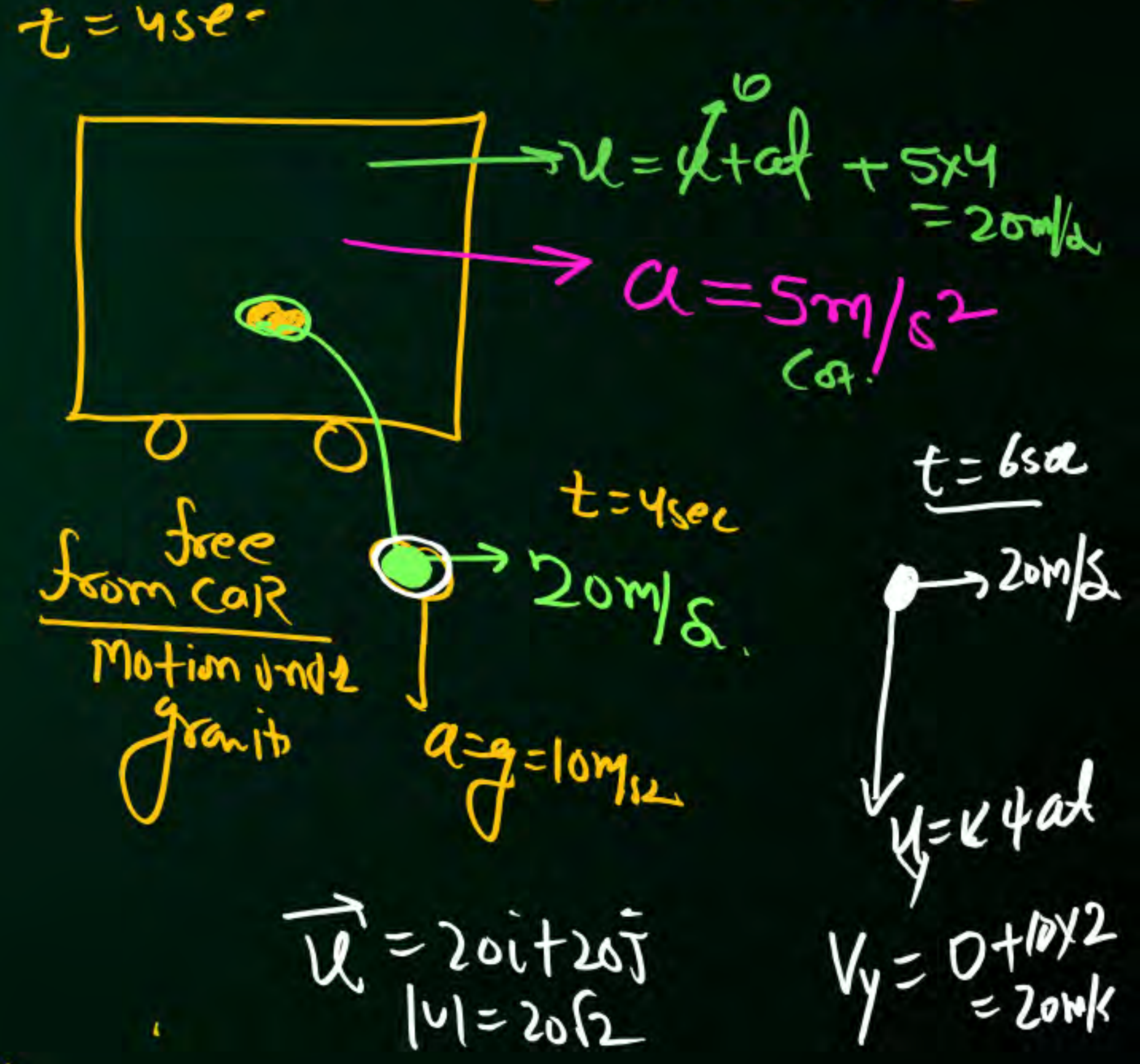
(1) $20\sqrt{2}$ m/s, $10\ m/s^2$

(2) 20 m/s, $5\ m/s^2$

(3) 20 m/s, 0

(4) $20\sqrt{2}$ m/s, 0





QUESTION

A particle starts from origin with velocity $3\hat{i}$ m/s and acceleration $(6\hat{i} + 4\hat{j})$. Then find x-coordinates of particle when y-coordinates is 32. [IIT-2021]

$(0,0)$

- $u = 3i + 0j$
- $a = 6i + 4\hat{j}$

$(x, 32)$

H/W

Initial velocity along x-axis $= 3$ m/s

$\Delta x = u_x t + \frac{1}{2} a_x t^2$

$= 3 \times 4 + \frac{1}{2} 6 (4)^2$

$= 12 + 3(16) = 60$ m

Motion along Y $(u_y = 0)$

$\Delta y = u_y t + \frac{1}{2} a_y t^2$

$32 = 0 + \frac{1}{2} 4 t^2$

$\frac{32}{2} = t^2$ $\quad t^2 = 16$

$t = \sqrt{16} = 4$ sec

QUESTION

Acceleration of object $a = 2\hat{i} + 3t^2\hat{j}$, then find velocity at $t = 1$ sec it initial velocity of object is zero.

$t = 0,\ u = 0\hat{i} + 0\hat{j}$

$a = 2\hat{i} + 3t^2\hat{j}$

$a_x = 2\hat{i}$

$\frac{d\vec{v}_x}{dt} = 2$

$\int dv_x = \int 2\, dt$

$v_x = 2t = 2\hat{i}$ m/s

$a_y = 3t^2$

$\frac{dv_y}{dt} = 3t^2$

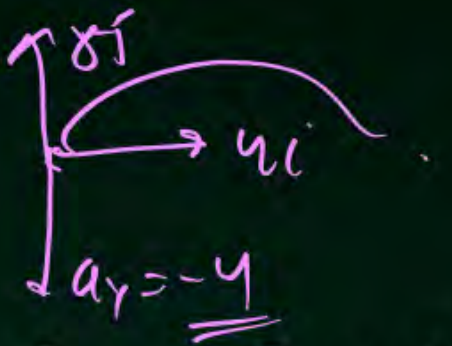
$\int dv_y = 3\int t^2\, dt$

$v_y = \frac{3t^3}{3} = 1\hat{j}$

$\vec{u} = 2i + 1\hat{j}$

$|\vec{u}| = \sqrt{(2)^2 + (1)^2} = \sqrt{5}$

QUESTION



Initial velocity of object $(4\hat{i} + 8\hat{j})$ m/s and acceleration $a = -4$ m/s^2 $\hat{j}$, then find velocity after t = 3 sec and displacement in 3 sec.

(t=0) $\vec{u}_i = (4\hat{i} + 8\hat{j})$ m/s

$\vec{a} = -4$ m/s^2 $\hat{j}$

$t = 3\,(v_f = ?)$

$\vec{V}_{fx} = u_x + a_x t$

$\vec{V}_{fx} = 4 + 0$

$\vec{V}_{fx} = 4\hat{i}$

$\vec{V}_{fy} = 8 - 4 \times 3$

$= 8 - 12$

$\vec{V}_{fy} = -4\hat{j}$

$\vec{V} = 4\hat{i} - 4\hat{j}$

$|V| = \sqrt{4^2 + (-4)^2}$

$= 4\sqrt{2}$

for dispm

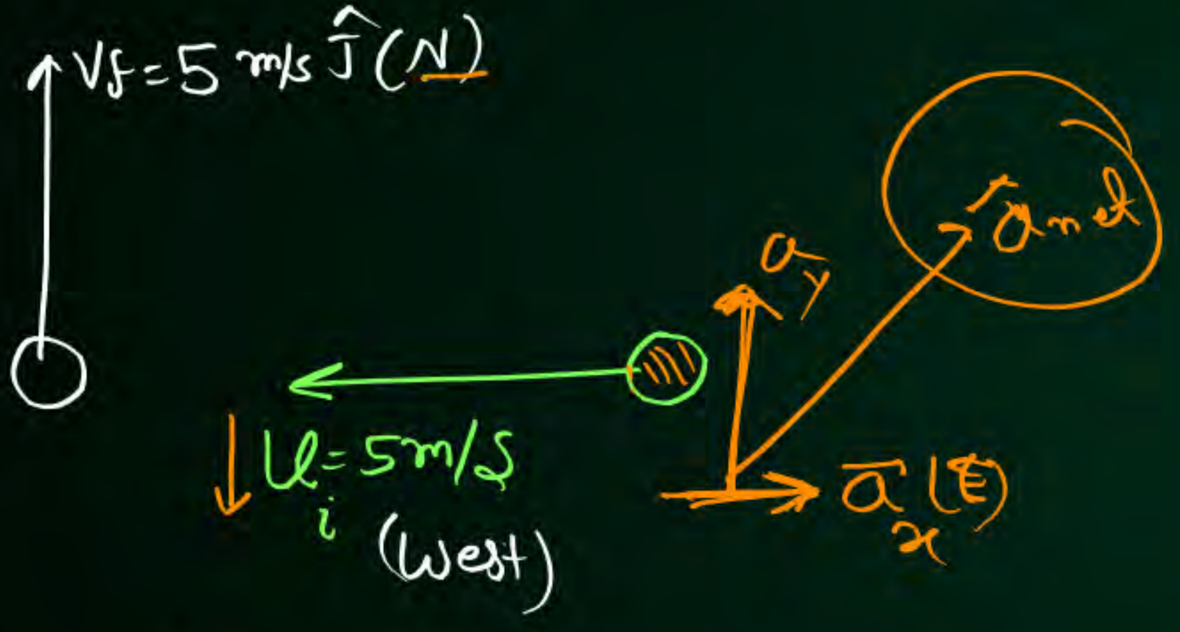
$x = u_x t + \frac{1}{2} a_x t^2 = 4 \times 3 = 12\hat{i}$

$\Delta y = 8 \times 3 - \frac{1}{2} \cdot 4 (3)^2 = 24 - 18 = 6\hat{j}$

$\vec{S} = 12\hat{i} + 6\hat{j}$

QUESTION

Object is moving in west with 5 m/s after 2 sec its velocity is 5 m/s in north then find acceleration.





$$\vec{a} = \frac{\vec{v}_f - \vec{u}_i}{t} = \frac{5\hat{j} - (-5\hat{i})}{2}$$

$$\vec{a} = \frac{5\hat{j} + 5\hat{i}}{2}$$

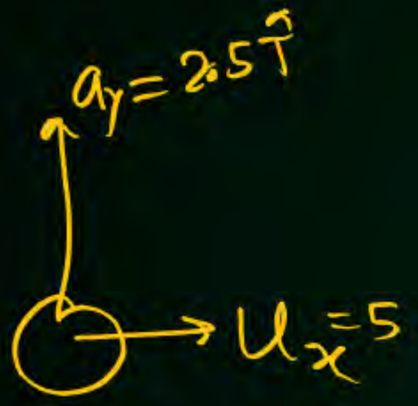
$$\vec{a} = \frac{5}{2}\hat{i} + \frac{5}{2}\hat{j}$$

$$|a| = \frac{5}{2}\sqrt{2} = \frac{5}{\sqrt{2}} \text{ m/s}^2$$

(North-east)

QUESTION

Initial velocity of object is 5 m/s in east and acceleration of object is 2.5 m/s^2 north then find speed of object at $t = 2$ sec.



$\vec{u}_i = 5\,m/s\,\hat{i}$ (east)

$\vec{a} = 2.5\,m/s^2\,\hat{j}$

$t = 2$ sec $\vec{v} = ??$

$\vec{v}_x = \vec{u}_x + a_x t$

$\vec{v}_x = 5\,m/s\,\hat{i}$

$\vec{v}_y = u_y + a_y t$

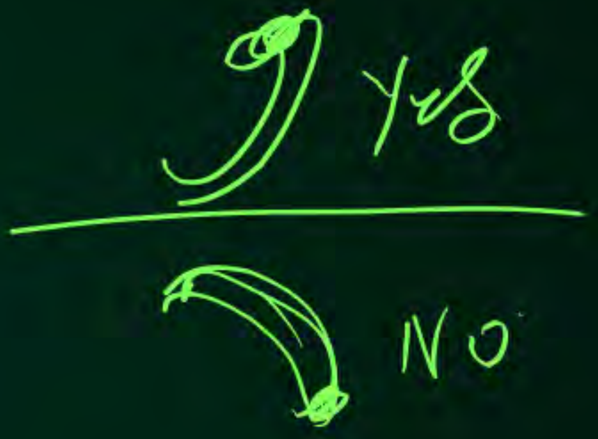
$= 0 + 2.5 \times 2$

$\vec{v}_y = 5\hat{j}$

$\vec{v} = 5\hat{i} + 5\hat{j}$

$|v| = 5\sqrt{2}$

50% Projectiles



QUESTION

Object starts from the point $(2\hat{i}, 4\hat{j})$ m at $t = 0$ with velocity $(5\hat{i} + 4\hat{j})$ with constant acceleration $(4\hat{i} + 4\hat{j})$ m/s^2. What is distance from particle from origin at t = 2 sec.

[JEE Main-2019]

$$x_f - x_i = u_x t + \frac{1}{2} a_x t^2$$

$$y_f - y_i = u_y t + \frac{1}{2} a_y t^2$$

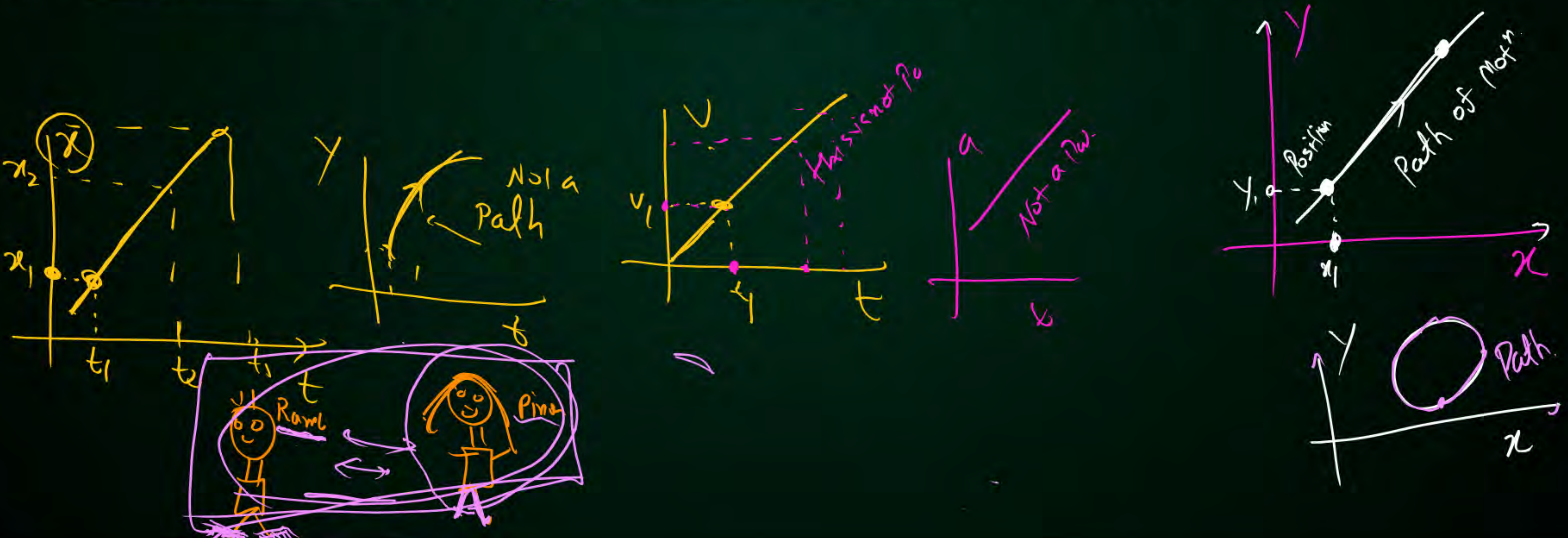
QUESTION

(H/W) * Level up

Object is moving with velocity $V = 3\sin(\omega t)\,\hat{i} + 3\cos(\omega t)\,\hat{j}$ then find distance moved by object in 2 sec.

EQUATION OF TRAJECTORY

- Path followed by object can be determine by relation between x and y.
- relation between 'x' and 'y' position represent path of object.



QUESTION

Position of object at time 't' $\vec{r} = 2t\,\hat{i} + 4t^2\,\hat{j}$, then find equation of trajectory.

$$\vec{r} = 2t\,\hat{i} + 4t^2\,\hat{j}$$

$x = 2t$

$y = 4t^2$ — (ii)

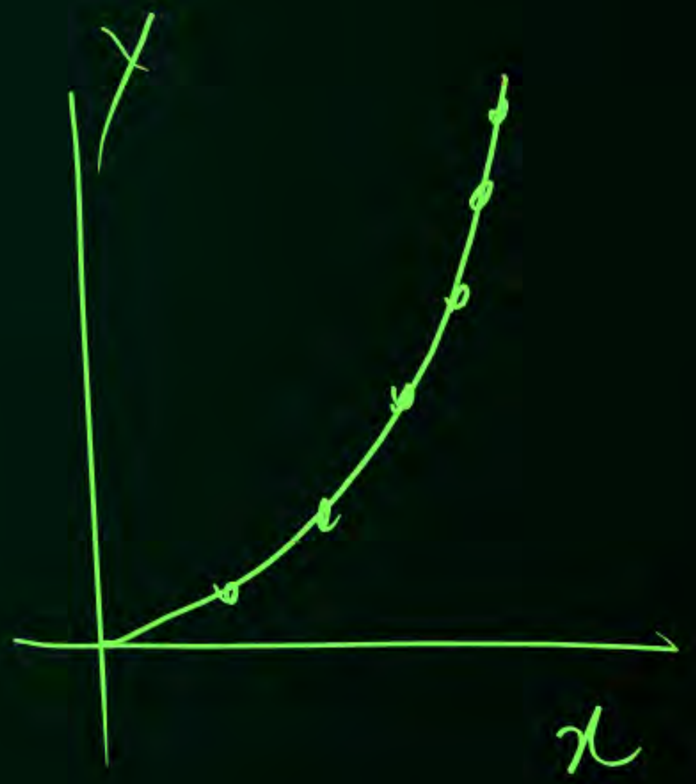
$t = \dfrac{x}{2}$

Putting value of time in eqn (ii)

$$y = 4\left(\frac{x}{2}\right)^2$$

$$y = 4\,\frac{x^2}{4}$$

$y = x^2$ → Parabola



QUESTION

If position of object $\vec{r} = 3\sin(\omega t)\,\hat{i} + 3\cos(\omega t)\,\hat{j}$, then object is moving on.

$\vec{r} = x\hat{i} + y\hat{j}$

square and add

Solve it

$x = 3\sin(\omega t)$ — (1)

$y = 3\cos(\omega t)$ — (11)

$\frac{x}{y} = \tan(\omega t)$

$(1)^2 + (11)^2$

$x^2 + y^2 = [3\sin(\omega t)]^2 + (3\cos(\omega t))^2$

$x^2 + y^2 = 9(\sin^2\omega t + \cos^2(\omega t))$

$x^2 + y^2 = 3^2$

eq^2 of circle

QUESTION

If position of object $\vec{r} = 4\sin(\omega t)\,\hat{i} + 3\cos(\omega t)\,\hat{j}$.

x y

#

$x^2 = [4\sin(\omega t)]^2$

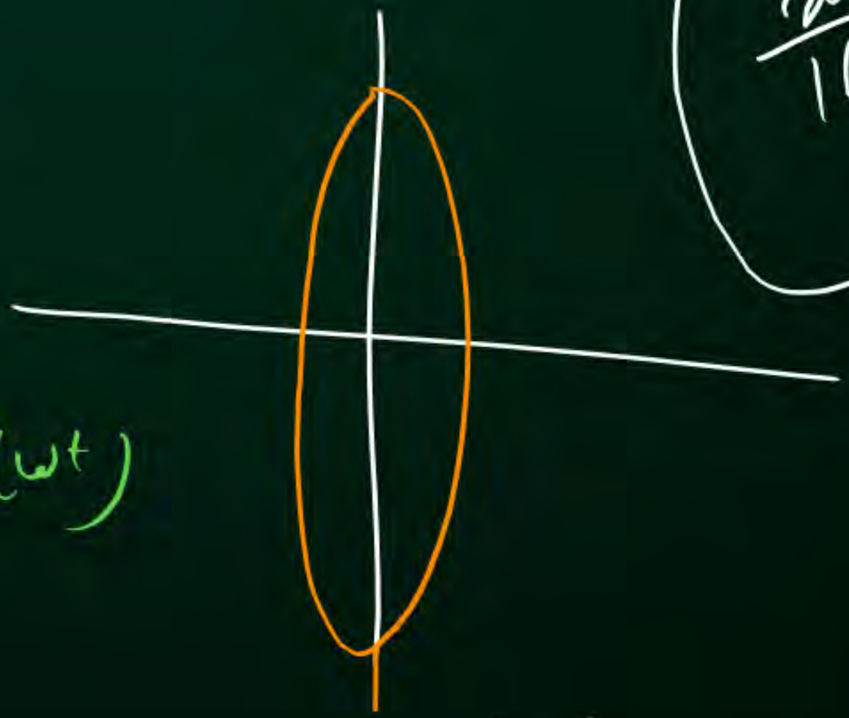
$y^2 = [3\cos(\omega t)]^2$

$x^2 + y^2 = 16\sin^2(\omega t) + 9\cos^2(\omega t)$

$\frac{x^2}{16} + \frac{y^2}{9} = \sin^2(\omega t) + \cos^2(\omega t) \rightarrow 1$

$\frac{x^2}{16} + \frac{y^2}{9} = 1$

eqn of ellips.



QUESTION

If position of object $\vec{r} = 4\sin(\omega t)\,\hat{i} + 3\sin(\omega t)\,\hat{j}$.

$x \qquad y$

$$\frac{x = 4\sin(\omega t)}{y = 3\sin(\omega t)}$$

42%

(a) ellipse

(b) circle

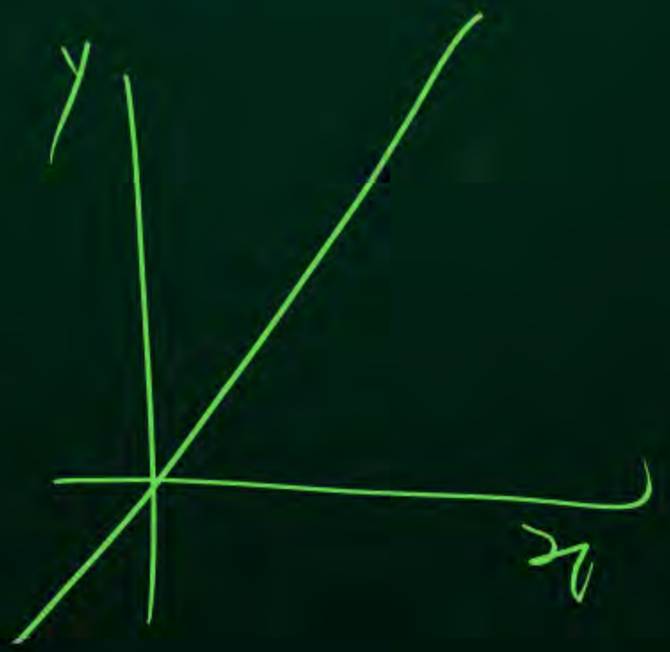
(c) Parallel

(d) straight line

38%

$$\frac{x}{y} = \frac{4}{3}$$

$$y = \frac{3}{4}x$$



QUESTION

IIT AIEEE

Velocity of object $\vec{V} = 2\hat{i} + x\hat{j}$ then equation of trajectory.

मजदूरी

$\vec{V} = 2\hat{i} + x\hat{j}$

$\vec{V} = v_x\hat{i} + v_y\hat{j}$

$V_x = 2$

$\frac{dx}{dt} = 2$ — (I)

$\int dx = 2\int dt$

$x = 2t$ — (I)

$V_y = x$

$V_y = x$

$\frac{dy}{dt} = x$

$dy = x\,dt$ — (II)

Putting value of (x)

$\int dy = \int 2t\,dt$

$y = 2\int t\,dt$

$y = 2\frac{t^2}{2}$

$y = t^2$

$y = \left(\frac{x}{2}\right)^2$

$y = \frac{x^2}{4}$ Para

MR

$v_x = 2$ $\quad$ $v_y = x$

$\frac{dx}{dt} = 2$

$\frac{dy}{dt} = x$

$\int x\,dx = \int 2\,dy$

$c + \frac{x^2}{2} = 2y$

$y = \frac{x^2}{4} + (c)$

QUESTION

A particle moving with velocity $V = y\,\hat{i} + x\,\hat{j}$ then find equation of trajectory.

[IIT-2020]

$\vec{V} = v_x\,\hat{i} + v_y\,\hat{j}$

$\vec{V} = y\hat{i} + x\,\hat{j}$ ← given

$V_x = y$ | $V_y = x$

$\frac{dx}{dt} = y$ | $\frac{dy}{dt} = x$

$\frac{dx/dt = y}{dy/dt = x}$ → $\int x\,dx = \int y\,dy$

$\frac{x^2}{2} = \frac{y^2}{2} + C$

$\frac{x^2}{2} - \frac{y^2}{2} = C$

$x^2 - y^2 = 2C$ → (const)

$x^2 - y^2 = K$

Not a straight line

$$y = \sqrt{x^2 + c}$$

$$= (x^2 + c)^{1/2}$$

$$y = x + c^{1/2}$$

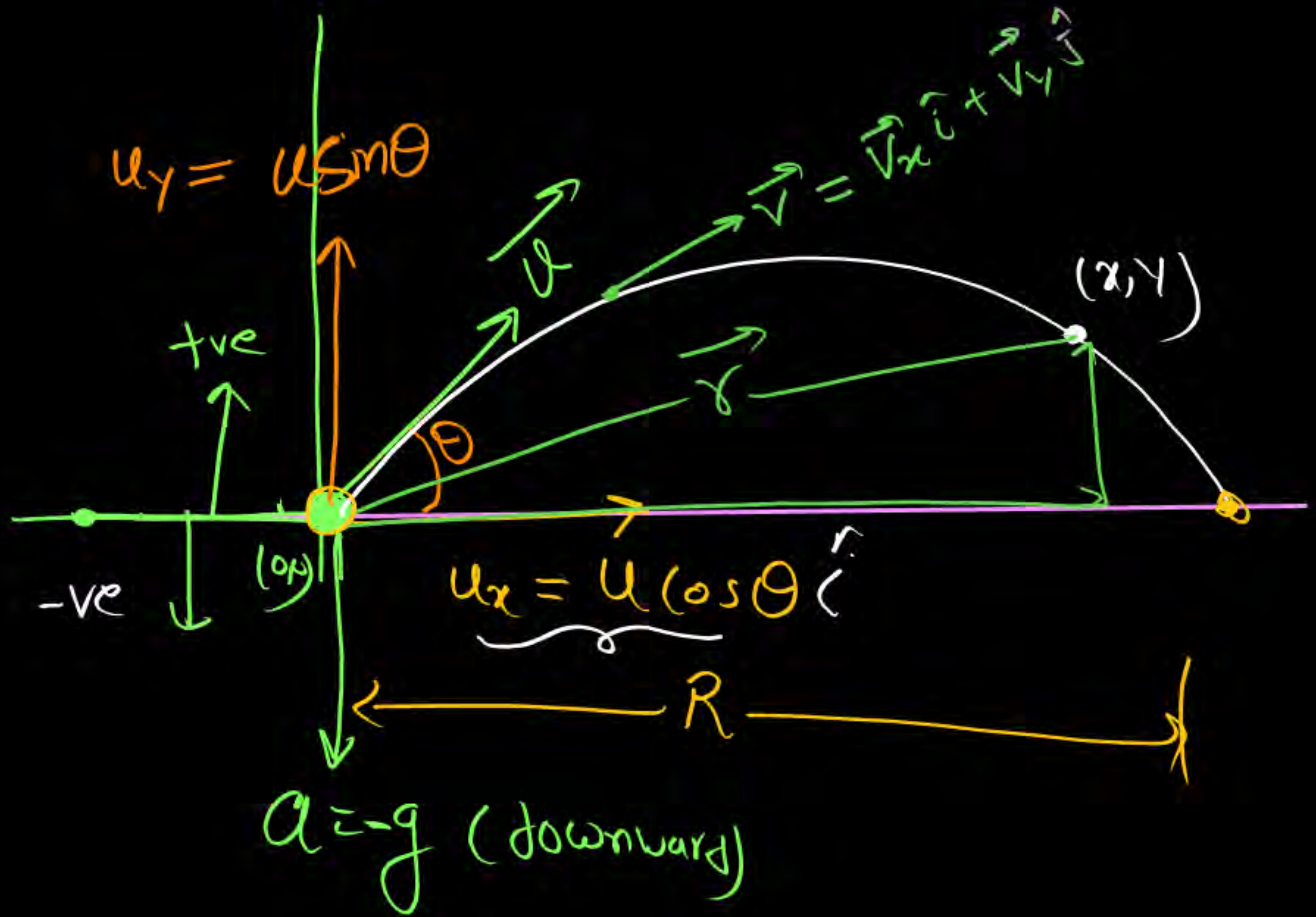
wrong

Projectile Motion

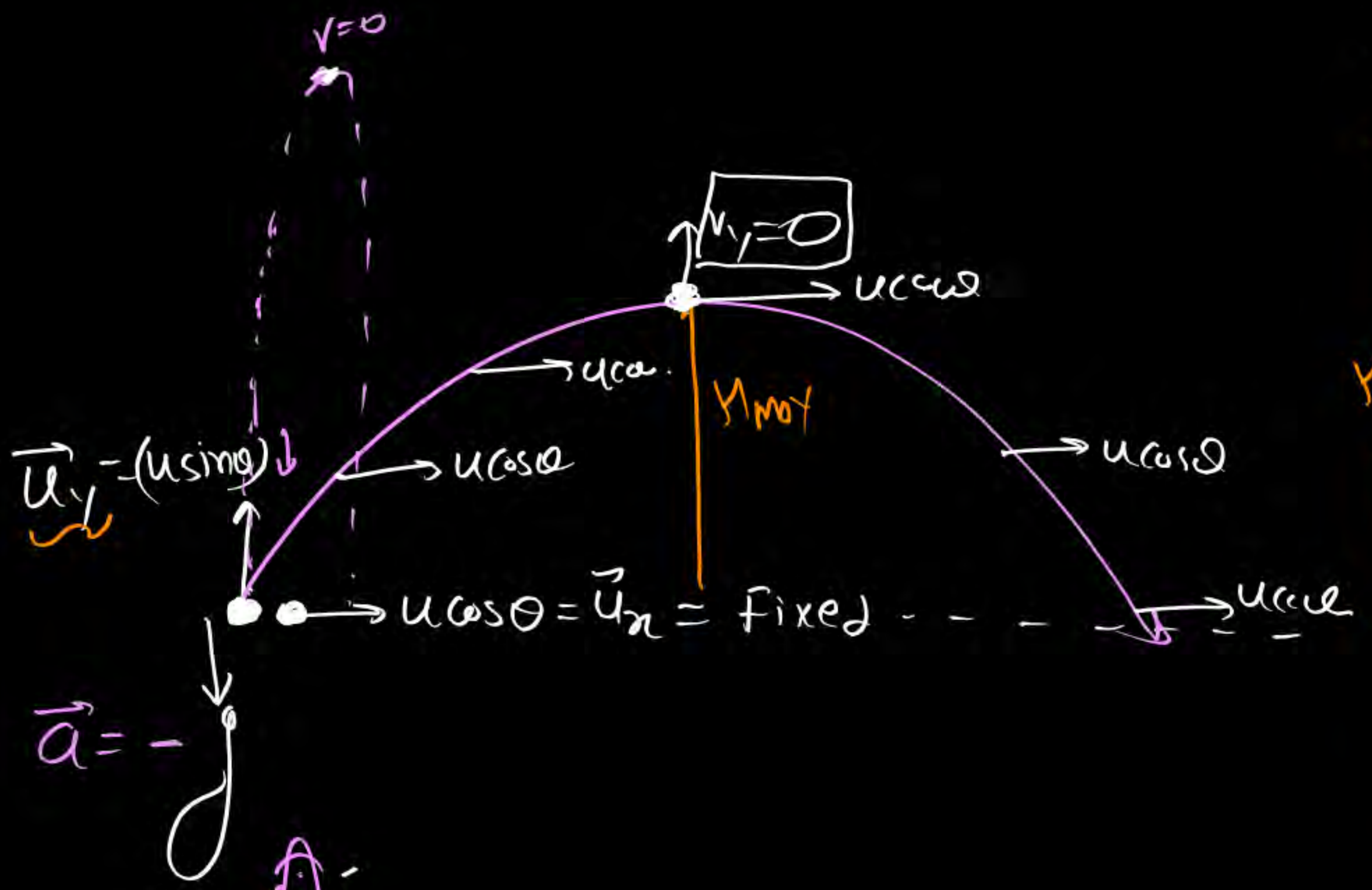
→ Example of 2-D **Non-uniform** with **uniform accn**

velocity variable

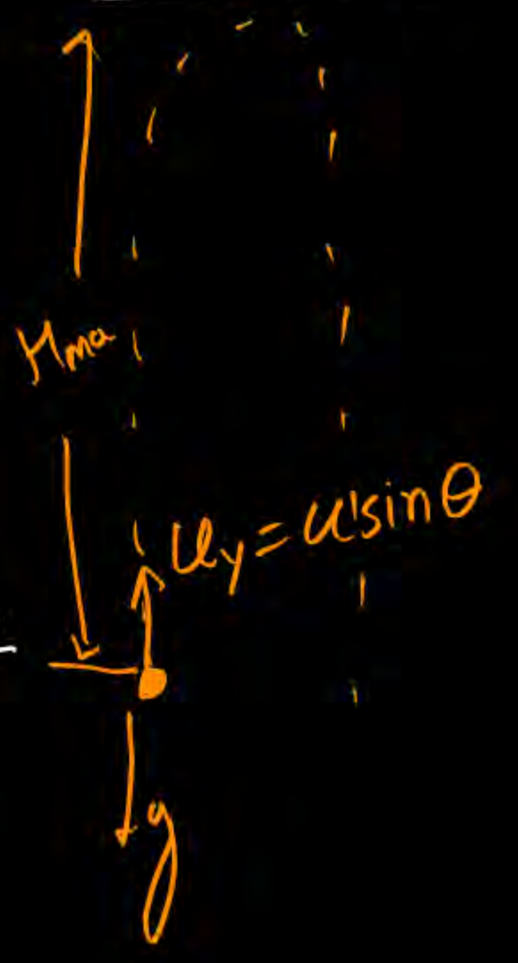
$\Downarrow$ $g = \text{const}$



x-axis	y-axis
$\vec{u}_x \,(t=0) = u\cos\theta\,\hat{i}$	$\vec{u}_y = u\sin\theta\,\hat{j}$
$\vec{a}_x = 0$, $\vec{v}_x = \text{const}^n$	$\vec{a}_y = -g\,\hat{j}$
Uniform motⁿ	(Non-uniform)
$\{\vec{v}_{x_t} = u\cos\theta\,\hat{i}\}$	$\vec{v}_{y_t} = (\vec{u}_y - gt)\hat{j}$
$x_t = u_x t = u\cos\theta \times t$	$\vec{v}_{y_t} = (u\sin\theta - gt)\hat{j}$
	$y = u_y t + \frac{1}{2}a_y t^2$
	$y = u\sin\theta\, t - \frac{1}{2}gt^2$



Motⁿ along y-axis is considered



$$T_f = \frac{2\vec{u}_y}{g} = \frac{2u\sin\theta}{g}$$ *

$$H_{max} = \frac{u_y^2}{2g} = \frac{u^2\sin^2\theta}{2g}$$ *

Rang

$$x = u_x T_f = u\cos\theta\left[\frac{2u\sin\theta}{g}\right]$$

$$R = \frac{2u^2\sin\theta\cdot\cos\theta}{g} = \frac{u^2\sin2\theta}{g}$$



PROJECTILE MOTION

- Projectile motion is 2-D non-uniform motion with uniform acceleration.

PROJECTILE MOTION

- **Motion under gravity in '*y*' + (1-D)$_x$ uniform motion**

QUESTION

A bullet is fired from a gun at the speed of 280 ms^{-1} in the direction 30° above the horizontal. The maximum height attained by the bullet is ________.

($g = 9.8\ ms^{-2}$, $\sin 30° = 0.5$) [NEET-2023]

1. 2000 m
2. 1000 m
3. 3000 m
4. 2800 m

QUESTION

A particle is thrown with the speed u at angle θ then find its speed when it is moving at an angle α from x-axis.

QUESTION

Velocity of projection $\vec{u} = 40\hat{\imath} + 30\hat{\jmath}$ then find H, T, R and angle of project.

RELATION BETWEEN HORIZONTAL RANGE AND MAXIMUM HEIGHT

QUESTION

The horizontal range and the maximum height of a projectile are equal. The angle of projection of the projectile is : [AIPMT Pre. 2012]

1. $\theta = \tan^{-1}$
2. $\theta = 45°$
3. $\theta = \tan^{-1}\left(\frac{1}{4}\right)$
4. $\theta = \tan^{-1}(4)$

QUESTION

The range of a projectile when fired at $75°$ with the horizontal is 0.5 km. what will be its range when fired at $45°$ with same speed :-

1. 0.5 km
2. 1.0 km
3. 1.5 km
4. 2.0 km

CONDITION OF MAXIMUM HORIZONTAL RNAGE

QUESTION

A missile is fired for maximum range with an initial velocity of 20 m/s. If $g = 10\ m/s^2$, the range of the missile is :- [AIPMT 2011]

1. 40 m
2. 50 m
3. 60 m
4. 20 m

QUESTION

Ball is projected with same speed at two different angle θ and $(90 - \theta)$ then prove that range will be same on these two different angle.

QUESTION

Two projectiles of same mass and with same velocity are thrown at an angle 60° & 30° with the horizontal, then which quantity will remain same:

[AIPMT 2000]

1. Time of flight
2. Horizontal range of projectile
3. Max height acquired
4. All of them

THANK YOU



YAKEEN 2.0

FOR NEET 2025

Lecture- 3 | Physics

Motion in a Plane

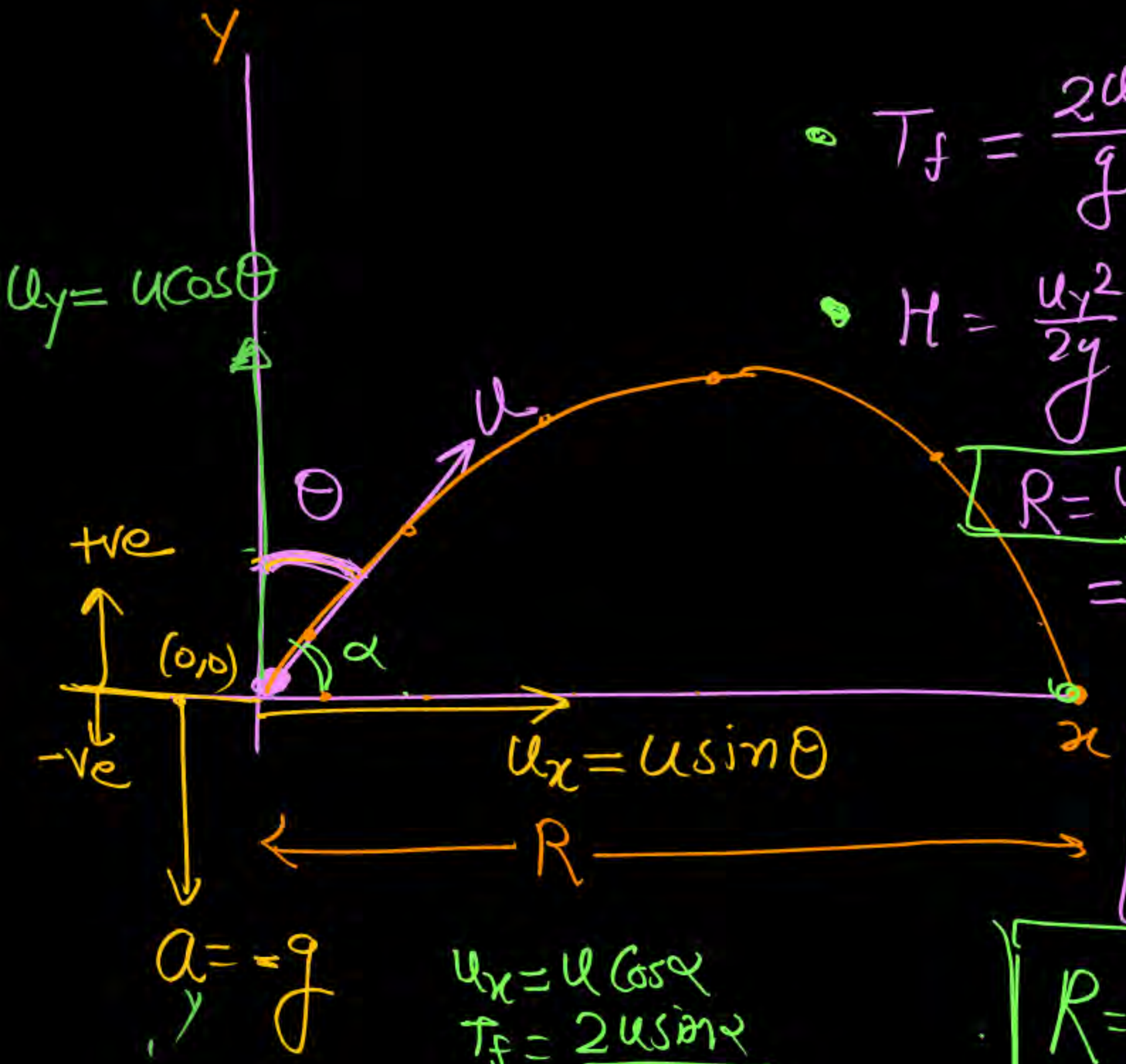


By- Dr. Manish Raj (MR SIR)

Todays goal
(#) Projectile में Ph.D

Projectile motion

Projectile motion - 2-D Non uniform (velocity varible) but uniform [constant acc^n]



- $T_f = \frac{2u_y}{g} = \frac{2u\cos\theta}{g}$
- $H = \frac{u_y^2}{2g} = \frac{u^2\cos^2\theta}{2g}$

$R = u_x T_f$

$= u_x \frac{2u_y}{g}$

$R = \frac{2u_x u_y}{g}$

$R = \frac{2u\cos\theta\,(u\sin\theta)}{g}$

$u_x = u\cos\alpha$

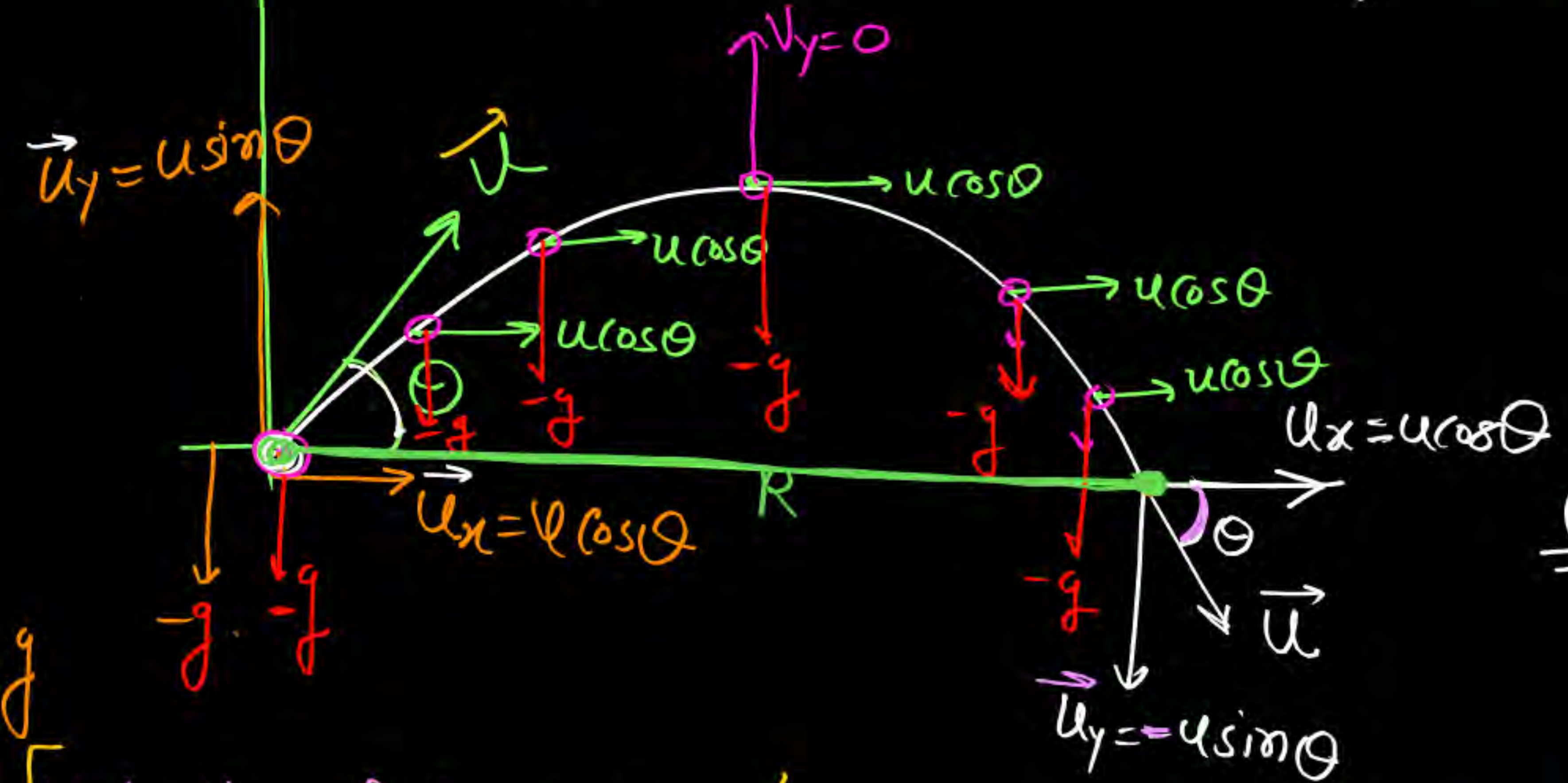
$T_f = \frac{2u\sin\alpha}{g}$

$R = u_x T_f = u\cos\alpha\left(\frac{2u\sin\alpha}{g}\right)$

(x-axis)	(y-axis)
$t=0$	$t=0$
$u_x = u\sin\theta$	$u_y = u\cos\theta$
$a_x = 0$	$\vec{a}_y = -g$
$\vec{V}_{x_t} = const^n = u\sin\theta$	$\vec{V}_{y_t} = (u_y - gt)\hat{j}$
$x = u_x t$	$y = \vec{u}_y t - \frac{1}{2} g t^2$
Range $= \vec{u}_x T_f$	disp^m in y - in time t

acc^n due to gravity at max^m Height $= -g$ (downwards)

Rate of change in velocity of projected particle at Half of max^m Height $= -g$



[Velocity of Projection ≠ velocity of collision at ground.
Speed of Projection = speed of collision same.]

(*) vertical Speed at max^m Height is zero → ✓

(*) Speed at max^m Height is minimum → ✓

velocity of Projection $\vec{u} = u_x\hat{i} + u_y\hat{j}$

" " collision $\vec{v}_f = u_x\hat{i} - u_y\hat{j}$

change in velocity $= \vec{v}_f - \vec{u}_i$

$= u_x\hat{i} - u_y\hat{j} - u_x\hat{i} - u_y\hat{j}$

$= -2u_y\hat{j} = -2u\sin\theta\,\hat{j}$

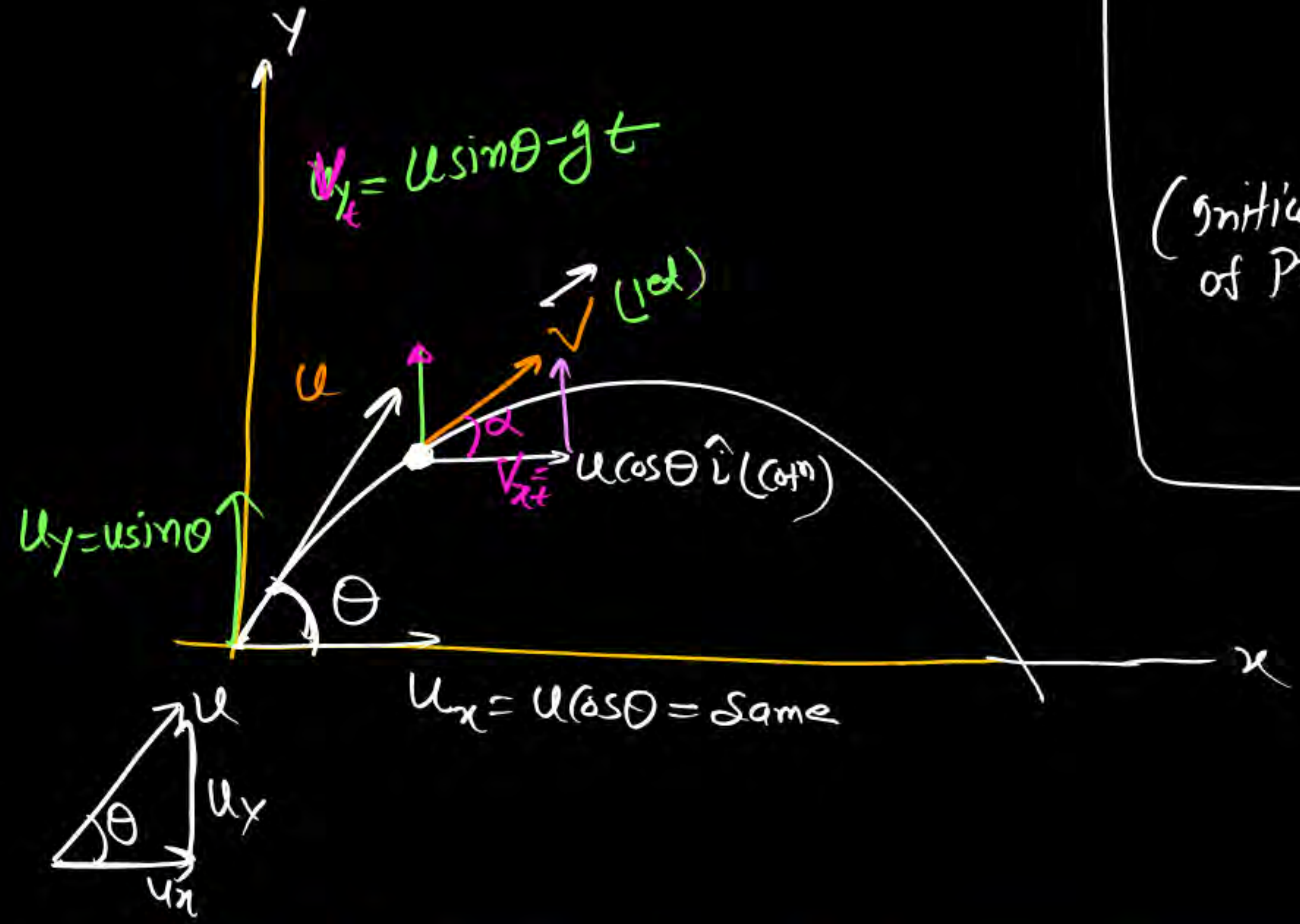
Avg velocity in compt $= \dfrac{\text{Total disp}^m}{\text{total time}} = \dfrac{R}{T_f}$

$= \dfrac{u_x T_f}{T_f} = u_x = u\cos\theta$

(*) Avg. velocity in compt max^n $= \dfrac{\vec{u}_i + \vec{v}_f}{2}$ [only valid in case of $const^n$ acc^n]

$= \dfrac{u_x\hat{i} + u_y\hat{j} + u_x\hat{i} - u_y\hat{j}}{2}$

$= \dfrac{2u_x\hat{i}}{2} = u_x\hat{i} = u\cos\theta$



Angle of Projection $= \tan\theta = \dfrac{u_y}{u_x}$ ✱

(Initial velocity of Projection) $\vec{u} = 30\hat{i} + 40\hat{j}$

$\tan\theta = \dfrac{u_y}{u_x} = \dfrac{40}{30}$ $\theta = 53°$

↑ Angle of Projection

dirⁿ of motion [dirⁿ of velocity at time 't']

$$\tan\alpha = \frac{V_{y_t}}{V_{x_t}} = \frac{u\sin\theta - gt}{u\cos\theta}$$

Speed of Projectile 1st ↓ then becomes minᵐ & Increase.

Velocity at time

$$\vec{V} = V_x\hat{i} + V_y\hat{j}$$

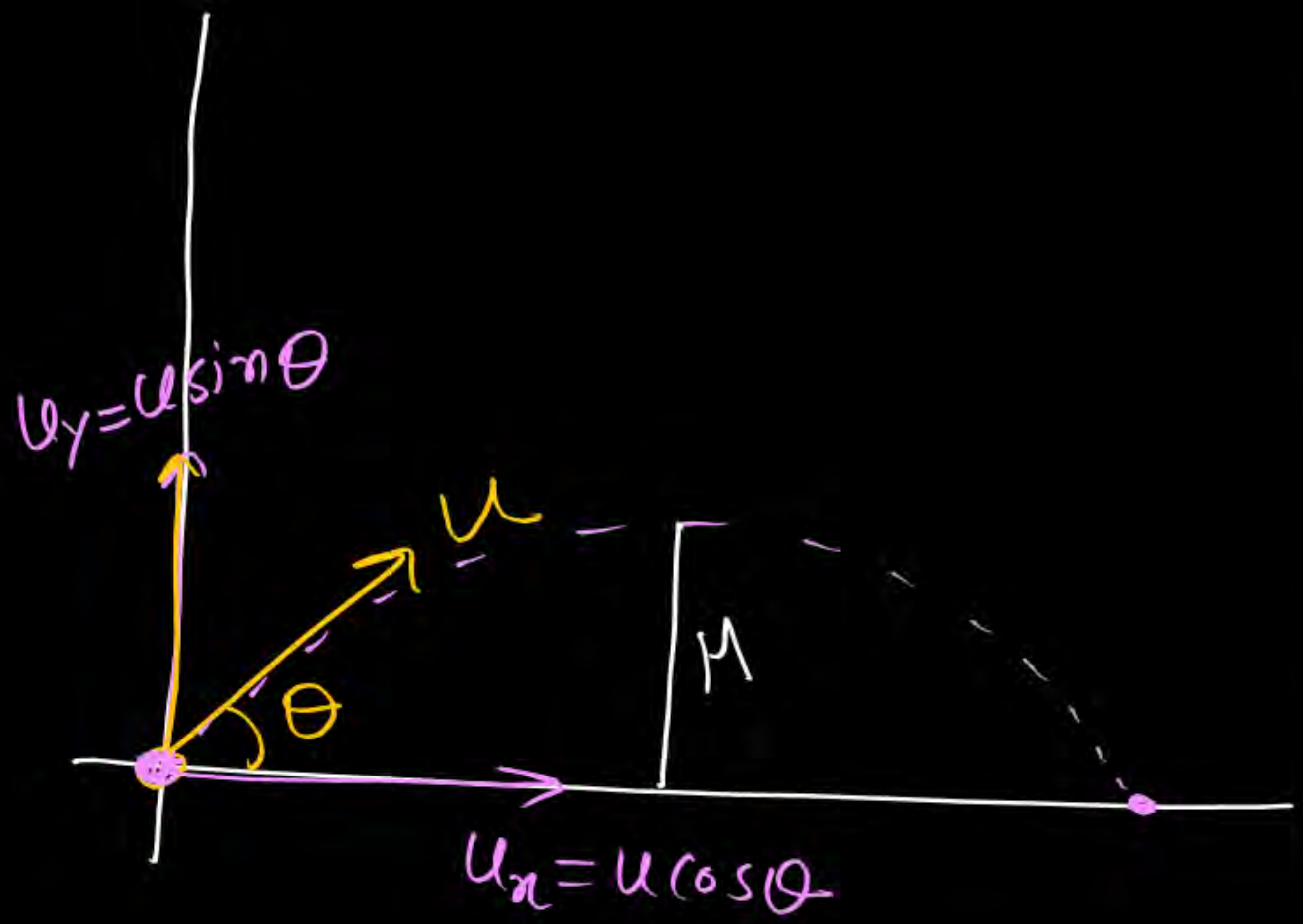
$$\vec{V} = u\cos\theta\,\hat{i} + (u\sin\theta - gt)\,\hat{j}$$

Speed → $|\vec{V}| = \sqrt{(u\cos\theta)^2 + (u\sin\theta - gt)^2}$

Velocity of Particle at time t is v & Moving at an angle α then find relⁿ b/w $\vec{V}$ & $\vec{u}$

✱ $V\cos\alpha = u\cos\theta$ ✱

$$V = \frac{u\cos\theta}{\cos\alpha} = u\cos\theta\sec\alpha$$



$T_f = \frac{2u_y}{g} = \frac{2u\sin\theta}{g}$

$$H_{max} = \frac{u_y^2}{2g} = \frac{u^2\sin^2\theta}{2g}$$

$$R = u_x T_f = \frac{2u_y u_x}{g} = \frac{u^2\sin 2\theta}{g}$$

Relⁿ B/w H & R

$$\frac{H}{R} = \frac{\dfrac{u_y^2}{2g}}{\dfrac{2u_y u_x}{g}}$$

$$\frac{H}{R} = \frac{u_y}{4u_x}$$

$$\frac{H}{R} = \frac{u\sin\theta}{4u\cos\theta}$$

$$\frac{H}{R} = \frac{\tan\theta}{4}$$

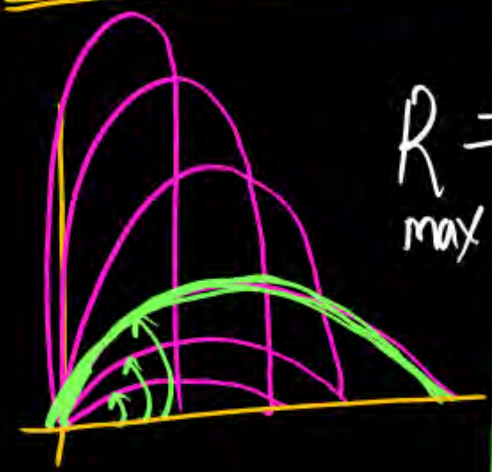
always valid (MR Ratta)

(*) $$H = \frac{R\tan\theta}{4}$$

Q If H & R is equal then angle of projection.

$\tan\theta = 4 \quad \theta = \tan^{-1}(4)$

Condition of Maximum Horizontal Range (u = same)



$$R_{max} = \frac{u^2[\sin 2\theta]_{max}}{g}$$

$\sin(2\theta)_{max} = 1$

at $2\theta = 90°$

$\theta = 45°$

at $\theta = 45°$ R will be maxᵐ

$$R_{max} = \frac{u^2}{g}$$ (*)

→ at Condⁿ of Maxᵐ Range Value of $(\text{Height})_{max} = \frac{R\tan 45°}{4}$

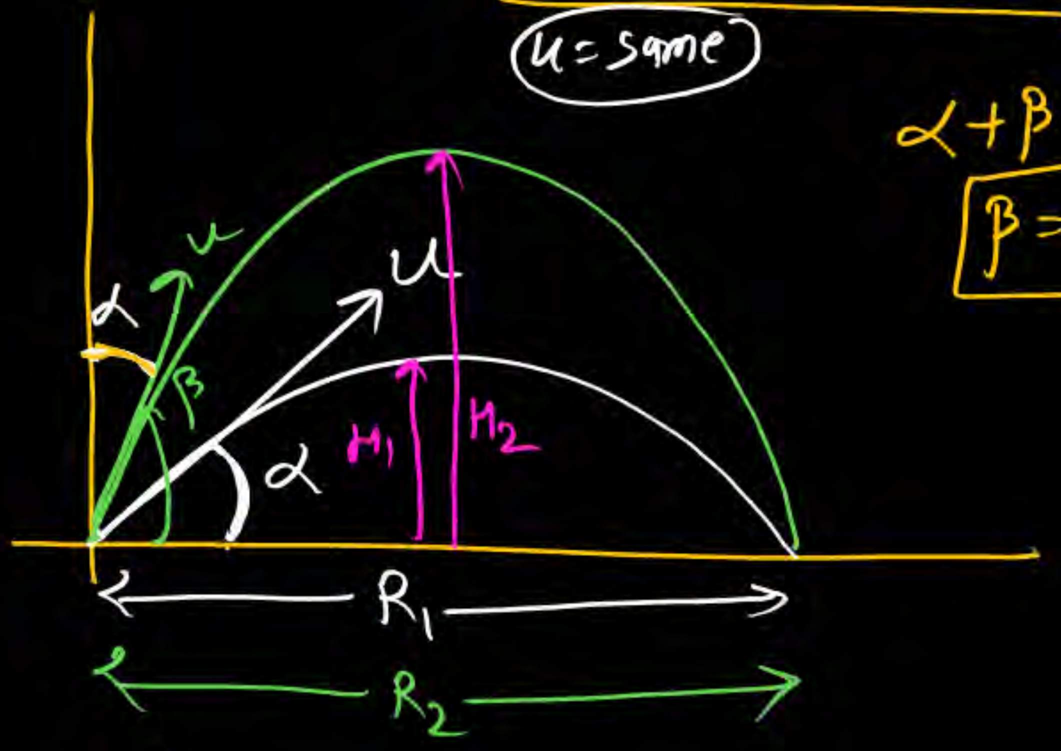
$$\left[H = \frac{R}{4}\right]$$

Complementry Angle

(u = same)

$\alpha + \beta = 90°$

$\beta = 90 - \alpha$



Proved

(*) $R_1 = \dfrac{u^2 \sin 2\alpha}{g}$ — (I)

(#) $R_2 = \dfrac{u^2 \sin 2\beta}{g}$ — (II)

$= \dfrac{u^2 \sin 2(90-\alpha)}{g} = \dfrac{u^2 \sin(180-2\alpha)}{g} = \dfrac{u^2 \sin 2\alpha}{g} = R_1$

θ_1 R_1	θ_2 R_2
30°	60°
50°	40°
37	53°
20	70°
42°	48
9°	81°
$\theta_1 = \frac{\pi}{4} - \alpha$	$\theta_2 = \frac{\pi}{4} + \alpha$

$R_1 = R_2$

$H_1 = \dfrac{u^2 \sin^2\alpha}{2g}$ — (I)

$H_2 = \dfrac{u^2 \sin^2\beta}{2g}$ — (II)

(I)/(II)

$\dfrac{H_1}{H_2} = \dfrac{\sin^2\alpha}{\sin^2\beta} = \dfrac{\sin^2\alpha}{\sin^2(90-\alpha)}$

$\dfrac{H_1}{H_2} = \dfrac{\sin^2\alpha}{\cos^2\alpha} = \tan^2\alpha$ *

$\dfrac{T_1}{T_2} = \dfrac{\frac{2u\sin\alpha}{g}}{\frac{2u\sin\beta}{g}} = \dfrac{\sin\alpha}{\sin(90-\alpha)}$

$\dfrac{T_1}{T_2} = \tan\alpha$ *

find Product of H_1 & H_2 in case of complementry Angle

$$\frac{H_1}{H_2} = \tan^2\alpha$$

$(R_1 = R_2)$

$$\frac{T_1}{T_2} = \tan\alpha$$

$$H_1 \cdot H_2 = \frac{u^2 \sin^2\alpha}{2g} \times \frac{u^2 \sin^2(90-\alpha)}{2g}$$

$$= \frac{u^4 \sin^2\alpha \cos^2\alpha}{4g^2} = \frac{4u^4 \sin^2\alpha \cos^2\alpha}{16 g^2}$$

$$H_1 H_2 = \frac{R^2}{16}$$

$$R^2 = \sqrt{16 H_1 H_2} = 4\sqrt{H_1 H_2}$$

$$H = \frac{R\tan\theta}{4}$$

$$H_1 \times H_2 = \frac{R\tan\alpha}{4} \times \frac{R\tan\beta}{4}$$

$$H_1 H_2 = \frac{R^2}{16} \tan\alpha \tan(90-\alpha)$$

$$H_1 H_2 = \frac{R^2}{16}$$

$$R = 4\sqrt{H_1 H_2}$$

A2

Equation of Trajectory → Rel^n B/w x^{th} & y^{th} co-ordinate

$x = u\cos\theta\, t$ — (I)

$y = u\sin\theta\, t - \frac{1}{2} g t^2$ — (II)

Putting value of t from eqn (I) to (II)

$$y = \frac{u\sin\theta\, x}{u\cos\theta} - \frac{1}{2} g \left(\frac{x}{u\cos\theta}\right)^2$$

$$y = x\tan\theta - \frac{1}{2}\frac{g x^2}{u^2\cos^2\theta}$$

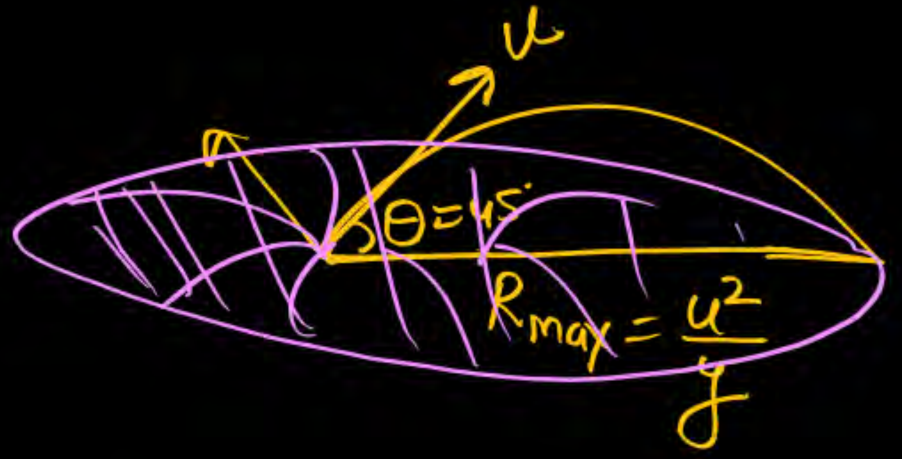
→ Parabola

$$y = x\tan\theta\left[1 - \frac{x g}{2u^2\cos^2\theta \times \tan\theta}\right]$$

$$y = x\tan\theta\left[1 - \frac{x g}{2u^2\cos^2\theta\,\frac{\sin\theta}{\cos\theta}}\right]$$

$$y = x\tan\theta\left[1 - \frac{x}{R}\right]$$

← mR Rutta



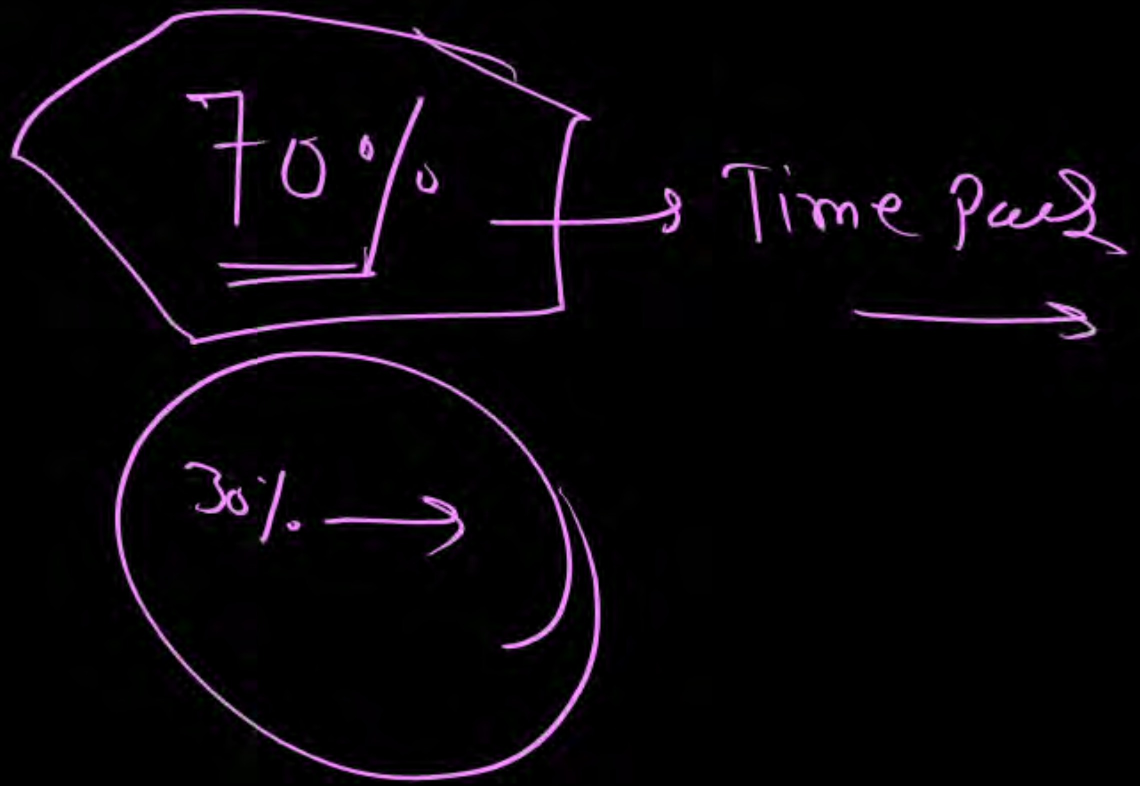
$$\text{Area} = \pi(\text{Radius}^2)$$

$$= \pi\left(\frac{u^2}{g}\right)^2$$

$$= \left(\frac{\pi u^4}{g^2}\right)$$

Ans.

Questions



QUESTION

A bullet is fired from a gun at the speed of 280 ms^{-1} in the direction 30° above the horizontal. The maximum height attained by the bullet is ________.

($g = 9.8\ ms^{-2}$, $\sin 30° = 0.5$) [NEET-2023]

1. 2000 m
2. 1000 m
3. 3000 m
4. 2800 m

$$H = \frac{u^2 \sin^2\theta}{2g}$$

$$= \frac{280 \times 280 \times \sin^2 30}{2 \times 10}$$

$$= 280 \times 14 \times \left(\frac{1}{2}\right)^2$$

$$= \frac{280 \times 14 \times 1}{2 \times 2}$$

$$= 980$$

QUESTION

Velocity of projection $\vec{u} = 40\hat{i} + 30\hat{j}$ then find H, T, R and angle of project.

$\vec{u} = u_x\hat{i} + u_y\hat{j}$

$R = \frac{2u_x u_y}{g} = \frac{2 \times 40 \times 30}{10} = 240\,m$

$T_f = \frac{2u_y}{g} = \frac{2 \times 30}{10} = 6\,sec$

$H = \frac{u_y^2}{2g} = \frac{(30)^2}{2 \times 10} = \frac{900}{2 \times 10} = 45\,m$

$\tan\theta = \frac{u_y}{u_x} = \frac{30}{40}$

$\theta = 37^\circ$

RELATION BETWEEN HORIZONTAL RANGE AND MAXIMUM HEIGHT

$$H = \frac{R\tan\theta}{4}$$

QUESTION

The horizontal range and the maximum height of a projectile are equal. The angle of projection of the projectile is : [AIPMT Pre. 2012]

1. $\theta = \tan^{-1}$
2. $\theta = 45°$
3. $\theta = \tan^{-1}\left(\frac{1}{4}\right)$
4. $\theta = \tan^{-1}(4)$

$H = \frac{R \tan\theta}{4}$

$\tan\theta = 4$

$\theta = \tan^{-1}(4)$

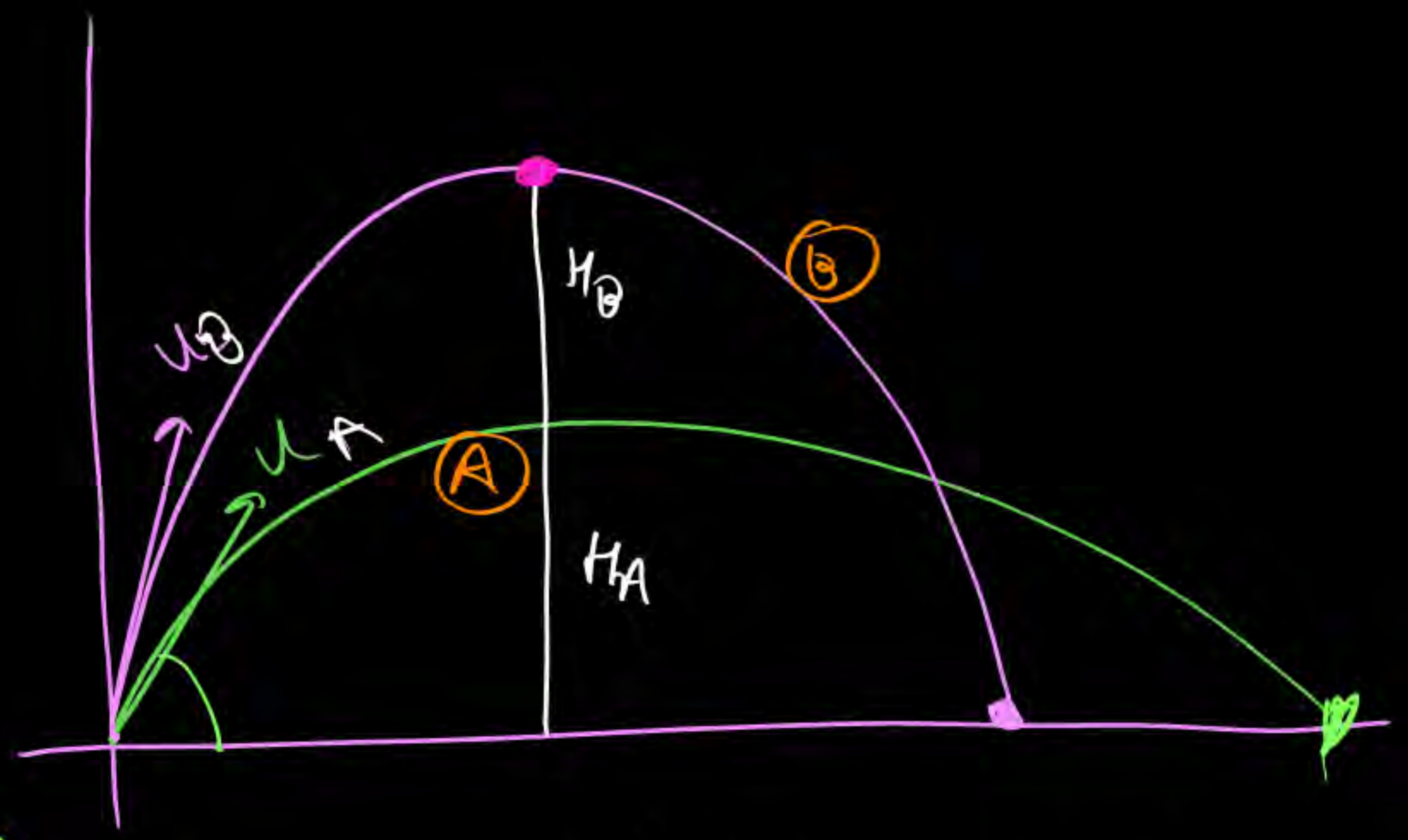
find reln b/w time of flight from a given path as shown in fig.

(a) $T_A = T_B$

(b) $T_A > T_B$

(c) $T_A < T_B$ (30%) ✓

(d) Can't say



Soln →

"$H_B > H_A$"

$$\frac{u_{yB}^2}{2g} > \frac{u_{yA}^2}{2g}$$

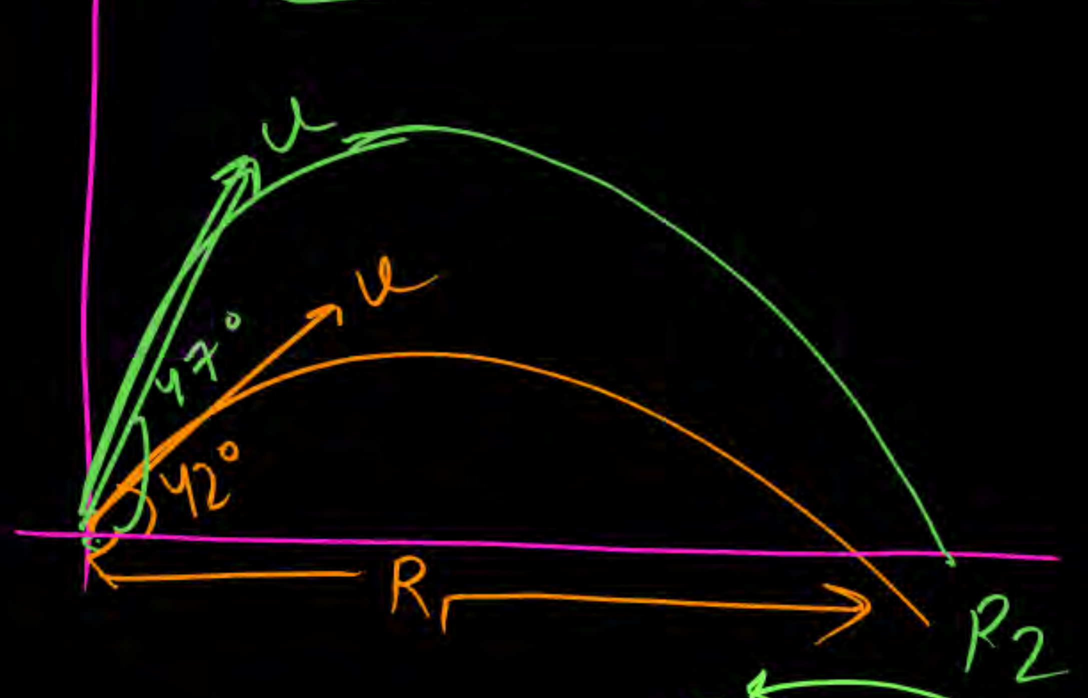
⊛ $u_{yB} > u_{yA}$

$$T_B = \frac{2u_{yB}}{g}$$

$$T_A = \frac{2u_{yA}}{g}$$

& 5 minit one leg stand who are @

u = same in Both case



Rel^n B/w R_1 & R_2

(a) $R_1 = R_2$ (48%)

(b) $R_1 > R_2$ (22%)

(c) $R_1 < R_2$ (27%)

(d) Can't say (2%)

42°	43°	44°	45°	46°	47°	48°
R_3	R_2	R_1	R_{max}	R_1	R_2	R_3

$$47 + 42 = 89°$$

(*) there are Not complementry angle

$$44 + 46 = 90$$

QUESTION

The range of a projectile when fired at 75° with the horizontal is 0.5 km. what will be its range when fired at 45° with same speed :-

1. 0.5 km
2. 1.0 km
3. 1.5 km
4. 2.0 km

$$\frac{R_1 = \frac{u^2 \sin 2\theta_1}{g}}{R_2 = \frac{u^2 \sin 2\theta_2}{g}}$$

$$\frac{0.5\,km}{R_2} = \frac{\sin(150°)}{\sin 90°} = \frac{\left(\frac{1}{2}\right)}{1}$$

$$\frac{0.5\,km}{R_2} = \frac{1}{2}$$

$$\boxed{R_2 = 1\,km}$$

QUESTION

An arrow is shot into the air. Its range is 200 metres and its time of flight is 5 s. If the value of g is assumed to be 10 ms^{-2} then the horizontal component of the velocity of arrow is :-

1. 25 m/s
2. 40 m/s
3. 31.25 m/s
4. 12.5 m/s

$R = 200\,m$

Consider motion along x-axis

$R = u_x T_f$

$200 = u_x \times 5$

$u_x = \frac{200}{5} = 40\,m/s$

QUESTION

Two projectiles of same mass and with same velocity are thrown at an angle 60° & 30° with the horizontal, then which quantity will remain same:

[AIPMT 2000]

1. Time of flight
2. Horizontal range of projectile
3. Max height acquired
4. All of them

QUESTION

For angles of projection of a projectile at angles (45° - θ) and (45° + θ), the horizontal ranges described by the projectile are in the ratio of :

[AIPMT 2006]

1. 1 : 1
2. 2 : 3
3. 1 : 2
4. 2 : 1

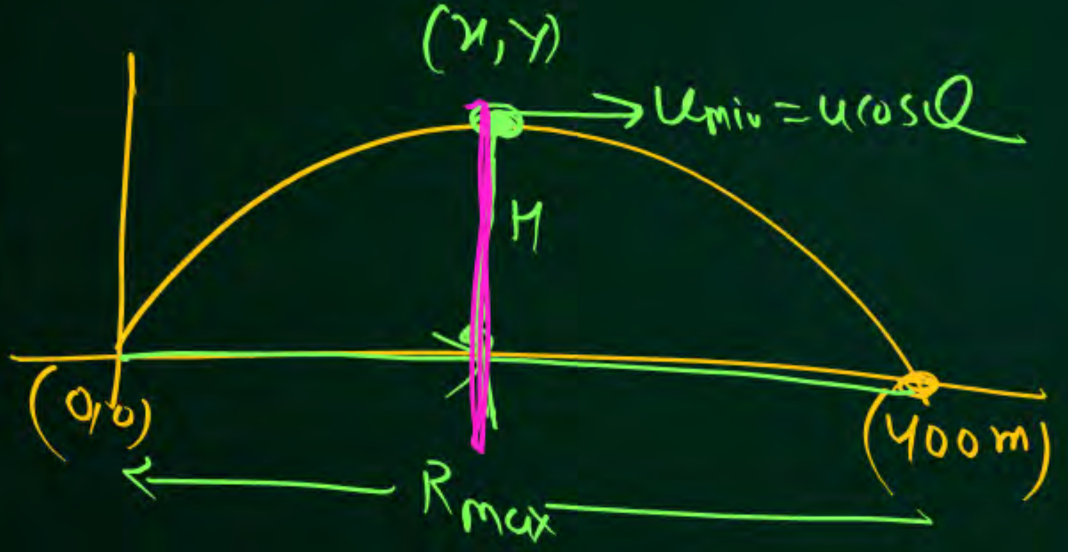
$\alpha + \beta = 45 - \theta + 45 + \theta$

$= 90°$

QUESTION

A projectile is thrown into space so as to have the maximum possible horizontal range equal to 400 m. Taking the point of projection as the origin, the coordinates of the point where the velocity of the projectile is minimum are :-

1. (400, 100)
2. (200, 100)
3. (400, 200)
4. (200, 200)



$$H = \frac{R\tan\theta}{4}$$

$$H = \frac{400}{4} = 100$$

QUESTION

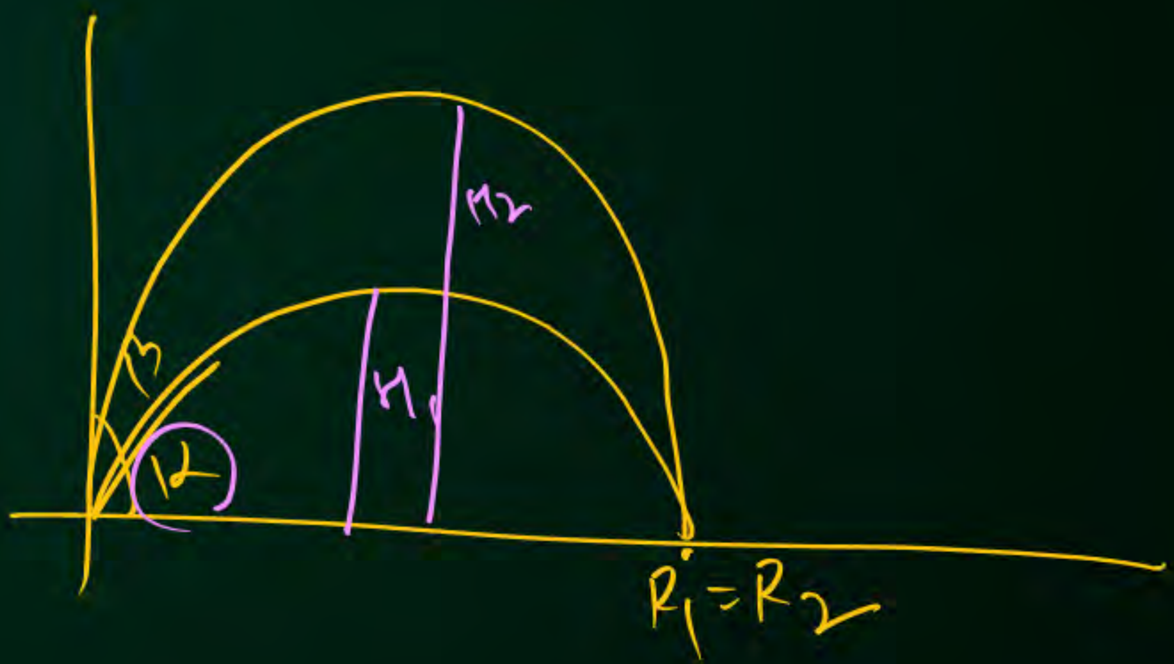
Two stones are projected with the same speed but making different angles with the horizontal. Their ranges are equal. If the angle of projection of one is $\pi/3$ and its maximum height is y_1 then the maximum height of the other will be :

1. $3y_1$
2. $2y_1$
3. $y_1/2$
4. $y_1/3$

$$\frac{H_1}{H_2} = \tan^2\alpha$$

$$\frac{y_1}{y_2} = (\tan^2 60)$$

$$\frac{y_1}{3} = y_2$$



QUESTION

A projectile has same range at two different angle if time of flight are t_1 and t_2 then range of the projectile will be? in terms of t_1 & t_2.

Let 1st angle of Projection is α (let)

2nd " " " " β

$$\alpha + \beta = 90^\circ$$

$$t_1 = \frac{2u\sin\alpha}{g}$$

$$t_2 = \frac{2u\sin\beta}{g} = \frac{2u\sin(90-\alpha)}{g} = \frac{2u\cos\alpha}{g}$$

$$t_1 t_2 = \frac{2u\sin\alpha}{g} \times \frac{2u\cos\alpha}{g}$$

$$t_1 t_2 = \frac{2 \times 2u^2\sin\alpha\cos\alpha}{g \times g}$$

$$t_1 t_2 = \frac{2R}{g}$$

(*) $$R = \frac{1}{2} g t_1 t_2$$

QUESTION

The horizontal range of a projectile is $4\sqrt{3}$ times its maximum height. Its angle of projectile will be:

1. $45°$
2. $60°$
3. $90°$
4. $30°$ ✓

$H = \frac{R\tan\theta}{4}$

$H = \frac{4\sqrt{3}H\tan\theta}{4}$

$\tan\theta = \frac{1}{\sqrt{3}}$

$\theta = 30°$

QUESTION

Two bodies are thrown up at angles of 45° and 60° respectively, with the horizontal. If both bodies attain same vertical height, then the ratio of velocities with which these are thrown is :

$\alpha =$ 45°, $\beta =$ 60°

(1) $\sqrt{\frac{2}{3}}$

(2) $\frac{2}{\sqrt{3}}$

(3) $\sqrt{\frac{3}{2}}$

(4) $\frac{\sqrt{3}}{2}$

$H_1 = H_2$

$\frac{u_1^2 \sin^2\theta_1}{2g} = \frac{u_2^2 \sin^2\theta_2}{2g}$

$\frac{u_1^2}{u_2^2} = \frac{\sin^2\theta_2}{\sin^2\theta_1}$

$\left\{\frac{u_1}{u_2}\right\} = \left(\frac{\sin\theta_2}{\sin\theta_1}\right)$

QUESTION

A projectile is fired from the surface of the earth with a velocity of 5 ms^{-1} and angle θ with the horizontal. Another projectile fired from another planet with a velocity of 3 ms^{-1} at the same angle follows a trajectory which is identical with the trajectory of the projectile fired from the earth. The value of the acceleration due to gravity on the planet is (in ms^{-2}) is: (given $g = 9.8\ m/s^2$) [AIPMT 2014]

1. 3.5
2. 5.9
3. 16.3
4. 110.8

$u_{ear} = 5\ m/s^2$

$u_p = 3\ m/s^2$

$H_1 = H_2$

$$\frac{u_1^2 \sin^2\theta}{2g_1} = \frac{u_2^2 \sin^2\theta}{2g_2}$$

$$\frac{25}{10} = \frac{9}{g_2}$$

$$g_2 = \frac{10 \times 9}{25} = 3.5$$

QUESTION

The equation of projectile is $y = \sqrt{3}x - \frac{gx^2}{2}$ the angle of projection is :

1. 30°
2. 60°
3. 45°
4. none

$y = \sqrt{3}x - \frac{gx^2}{2}$

$y = x\tan\theta\left(1 - \frac{x}{R}\right)$

$y = \sqrt{3}x\left(1 - \frac{gx}{2\sqrt{3}}\right)$

$R = \frac{2\sqrt{3}}{g}$

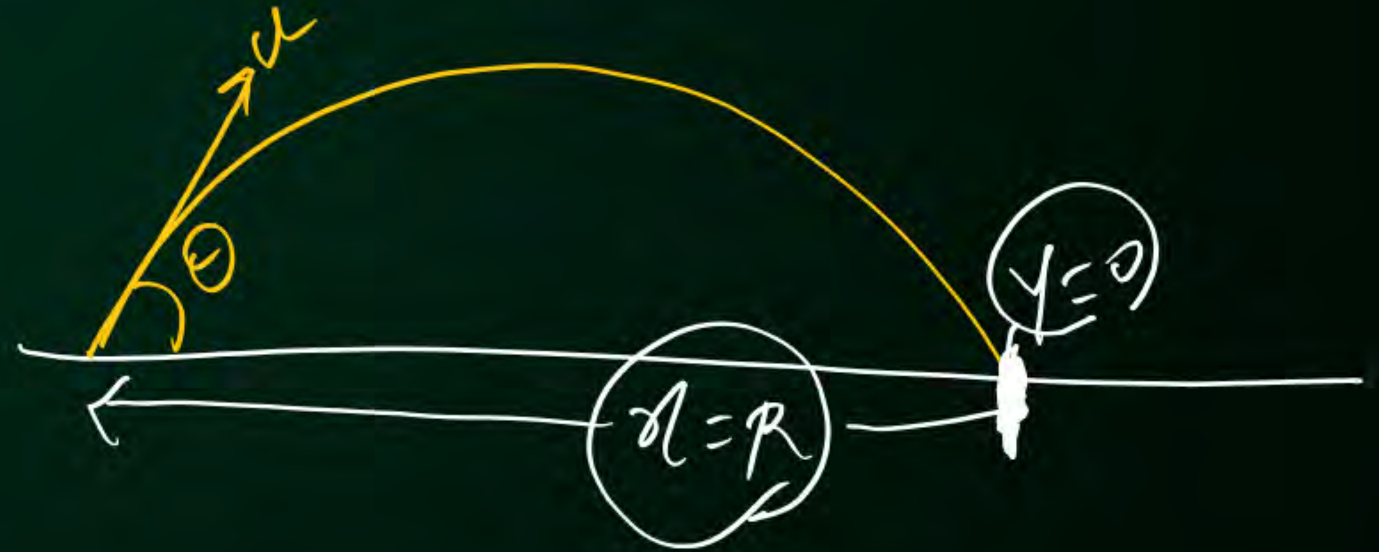
$\tan\theta = \sqrt{3}$

$\theta = 60°$

QUESTION

The equation of projectile is $y = 16x - \frac{x^2}{4}$ the horizontal range is :

1. 16 m
2. 8 m
3. 64 m
4. 12.8 m



QUESTION

The equation of trajectory of a projectile thrown from a level ground near the surface of earth is given by $y = ax - bx^2$, with y-axis in vertical direction and x-axis in horizontal direction, a and b are constants. Then,

(i) The range of the projectile is a/b.

(ii) At $x = a/2b$, the velocity of projectile becomes zero.

(iii) The maximum height attained by projectile is $a^2/4b$.

(iv) The angle of projectile is $\tan^{-1}(a)$.

1. (i) and (ii)
2. (ii) and (iii)
3. (i), (iii) and (iv)
4. All above


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 4 | **Physics**

Motion in a Plane



By- Dr. Manish Raj (MR SIR)

Topic To be Covered

1. # Questions on Projectile motn
2. # Horizontal Projection motn
3. # 

4. #



QUESTION

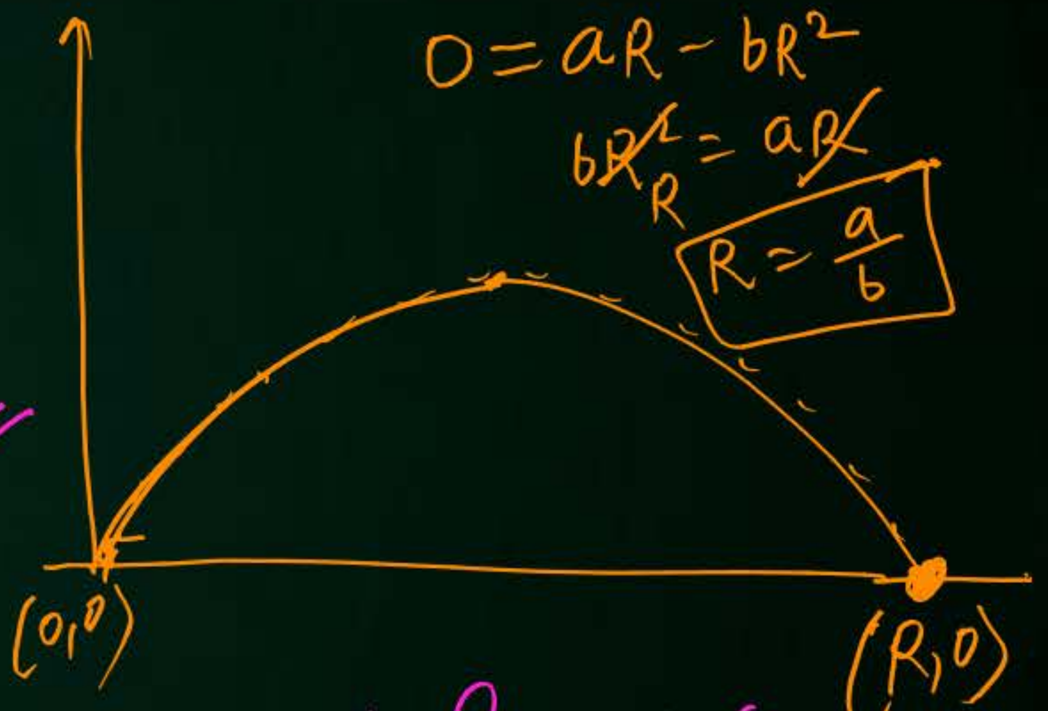
The equation of trajectory of a projectile thrown from a level ground near the surface of earth is given by $y = ax - bx^2$, with y-axis in vertical direction and x-axis in horizontal direction, a and b are constants. Then,

(i) The range of the projectile is a/b.

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(iii) The maximum height attained by projectile is $a^2/4b$.

(iv) The angle of projectile is $\tan^{-1}(a)$.



1. (i) and (ii)
2. (ii) and (iii)
3. (i), (iii) and (iv)
4. All above

Q Position of projected object at time t is $\vec{r} = 30t\,\hat{i} + (40t - 5t^2)\,\hat{j}$ then find (i) Angle of projection (ii) H_{max} (iii) R & T_f

Sol^n $\vec{r} = 30t\,\hat{i} + (40t - 5t^2)\,\hat{j}$

$$\frac{d\vec{r}}{dt} = 30\hat{i} + (40 - 10t)\,\hat{j}$$

$$\vec{V} = 30\hat{i} + (40 - 10t)\,\hat{j}$$

$t = 0$ $\vec{V} = 30\hat{i} + 40\hat{j}$

$$\tan\theta = \frac{u_y}{u_x} = \frac{40}{30}$$

$\theta = 53°$

$$T_f = \frac{2u_y}{g} = \frac{2 \times 40}{10} = 8$$

$$R = \frac{2u_x u_y}{g}$$

Particle is projected and its velocity at time 't' is $\vec{V_t} = \alpha\hat{i} + (\beta - \gamma t)\hat{j}$ then find H, R, T, Angle of projection.

Sol^n

$$\vec{V} = \alpha\hat{i} + (\beta - \gamma t)\hat{j}$$

$$\vec{u}_{t=0} = \alpha\hat{i} + \beta\hat{j}$$

Initial velocity

$\vec{u} = u_x\hat{i} + u_y\hat{j}$

$$\frac{d\vec{V}}{dt} = 0\hat{i} + 0 - \gamma\frac{dt}{dt}\hat{j}$$

$$\vec{a} = -\gamma\hat{j}$$

$$T_f = \frac{2\beta}{\gamma}$$

$$H = \frac{\beta^2}{2\gamma}$$

$$R = \frac{2\alpha\beta}{\gamma}$$

$$\theta = \tan^{-1}\left(\frac{\beta}{\alpha}\right)$$

2 mint leg stand



Particle is projected at other planet. & its position at time 't' is

$$\vec{r} = 3t\,\hat{i} + (4t - 2t^2)\,\hat{j}$$

find T_f, & Range.

Sol^n

$$\frac{d\vec{r}}{dt} = \vec{V} = 3\hat{i} + (4 - 4t)\hat{j}$$

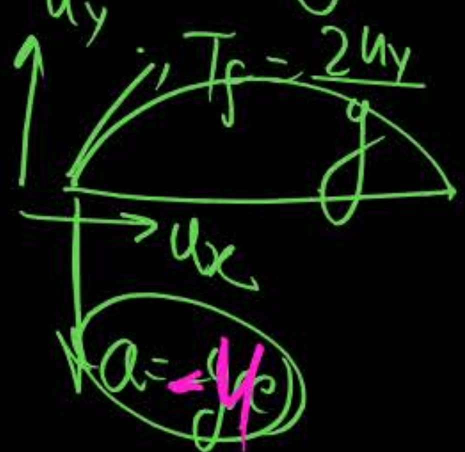
$$\frac{dv}{dt} = \vec{a} = 0\hat{i} + (0 - 4)\hat{j} = -4\hat{j}$$

$$V_{t=0} = 3\hat{i} + 4\hat{j}$$

initial velocity

$$\tan\theta = \frac{4}{3} \rightarrow \theta = 53^\circ$$

$$* \; H = \frac{u_y^2}{2g}$$

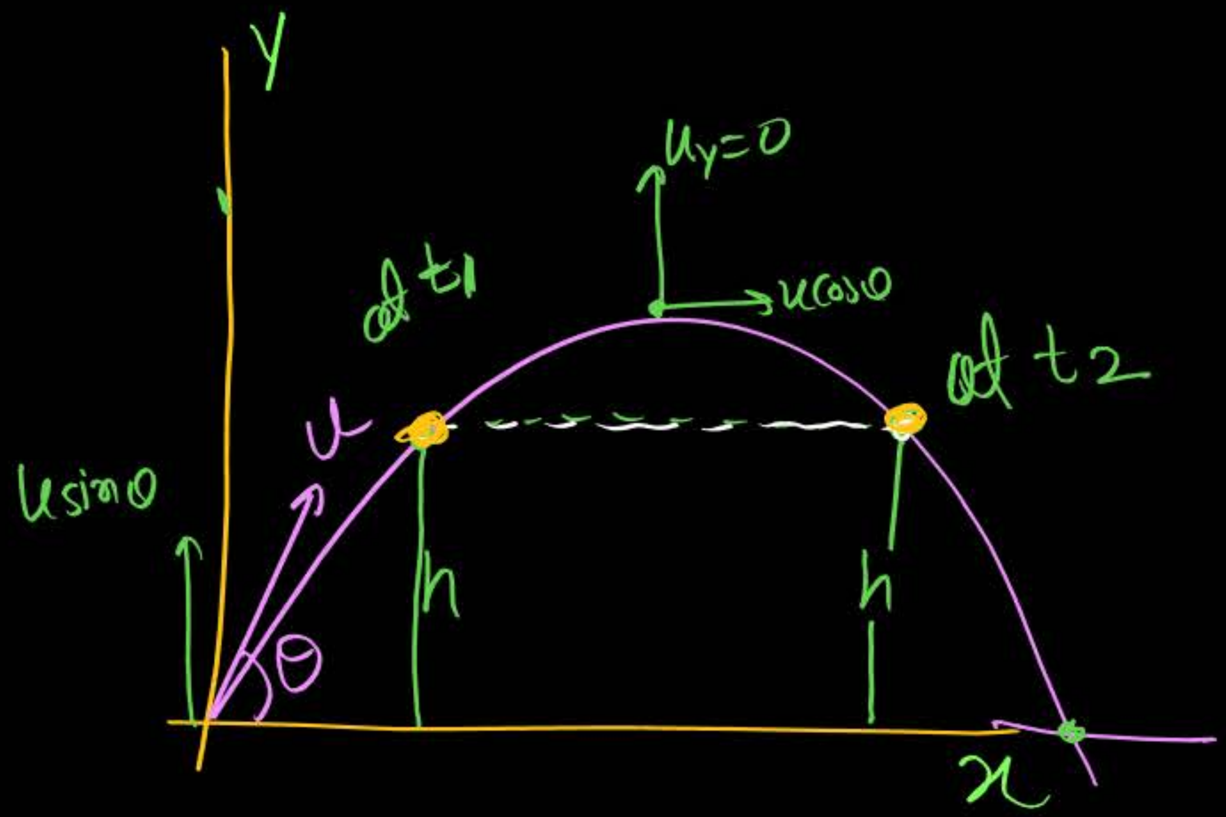


$$T_f = \frac{2u_y}{a_{gravity}} = \frac{2 \times 4}{4} = 2\,\text{sec}$$

$$H = \frac{u_y^2}{2a_g} = \frac{(4)^2}{2 \times 4} = 2\,m$$

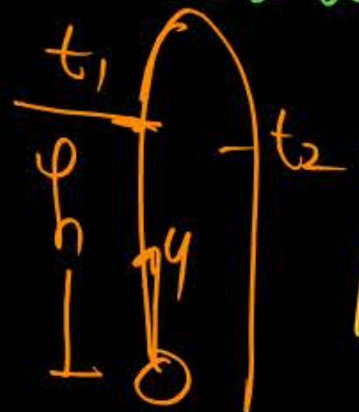
$$R = \frac{2u_x u_y}{a_g} = \frac{2 \times 4 \times 3}{4} = 6\,m$$

$$T_F = \frac{2u_y}{g}$$



$$h = \frac{1}{2} g t_1 t_2$$

using concept of motion under gravity.



$$h = \frac{1}{2} g t_1 t_2$$

QUESTION

Find relation between x_1, x_2 and h; if the ball is projected with speed u at angle θ.

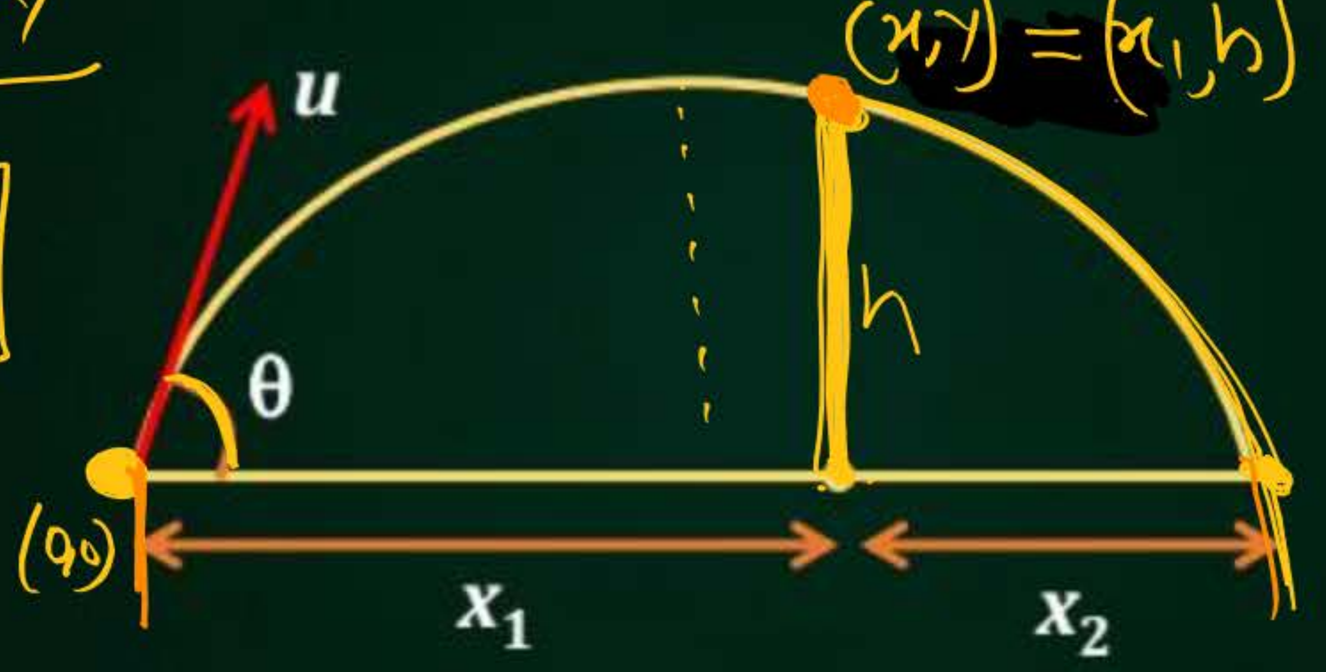
Eqⁿ of Trajectory

$$y = x\tan\theta\left[1 - \frac{x}{R}\right]$$

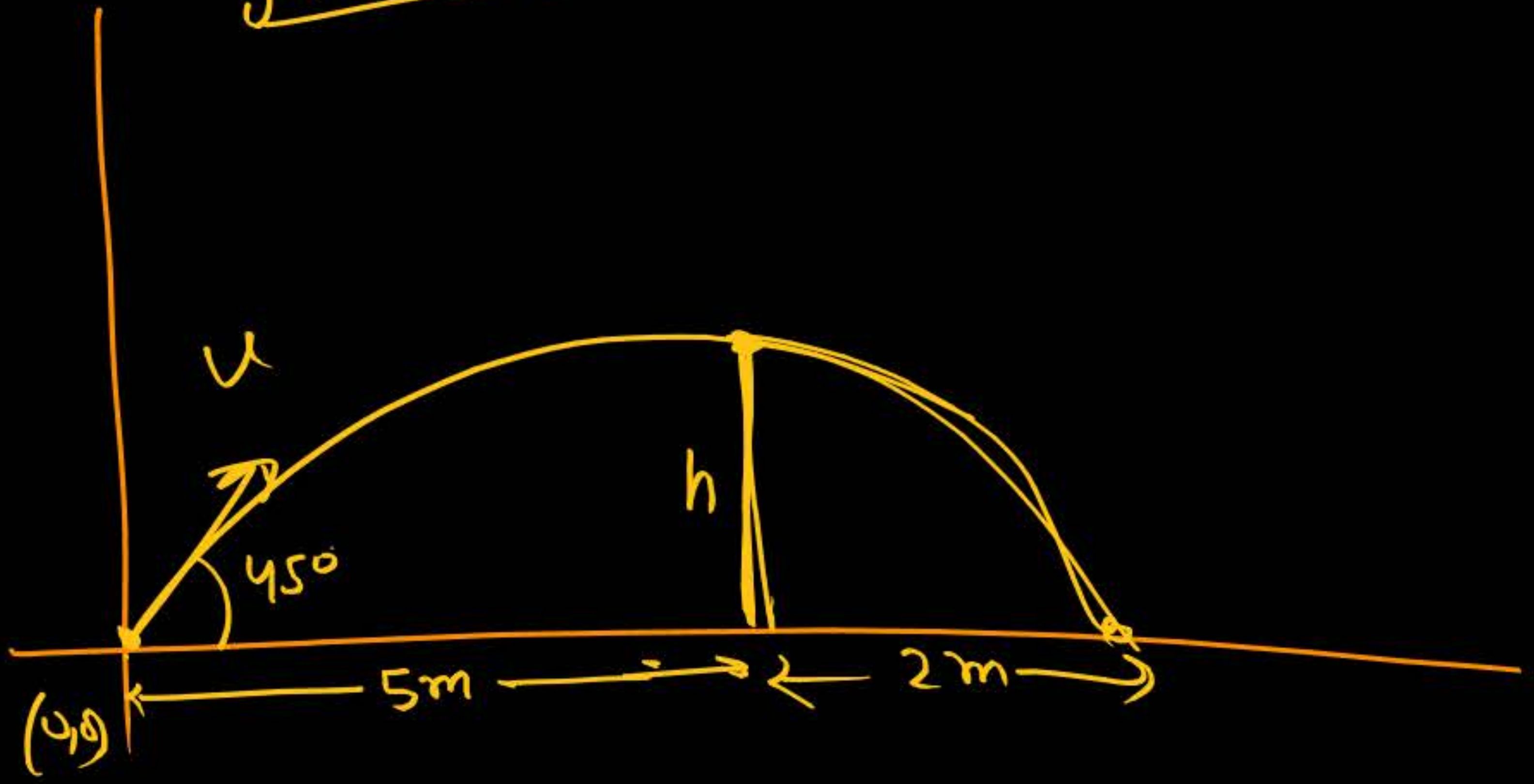
$$h = x_1\tan\theta\left[1 - \frac{x_1}{x_1+x_2}\right]$$

$$h = x_1\tan\theta\left[\frac{x_1+x_2-x_1}{x_1+x_2}\right]$$

$$\boxed{h = \frac{x_1 x_2 \tan\theta}{x_1+x_2}}$$



find = h = ??

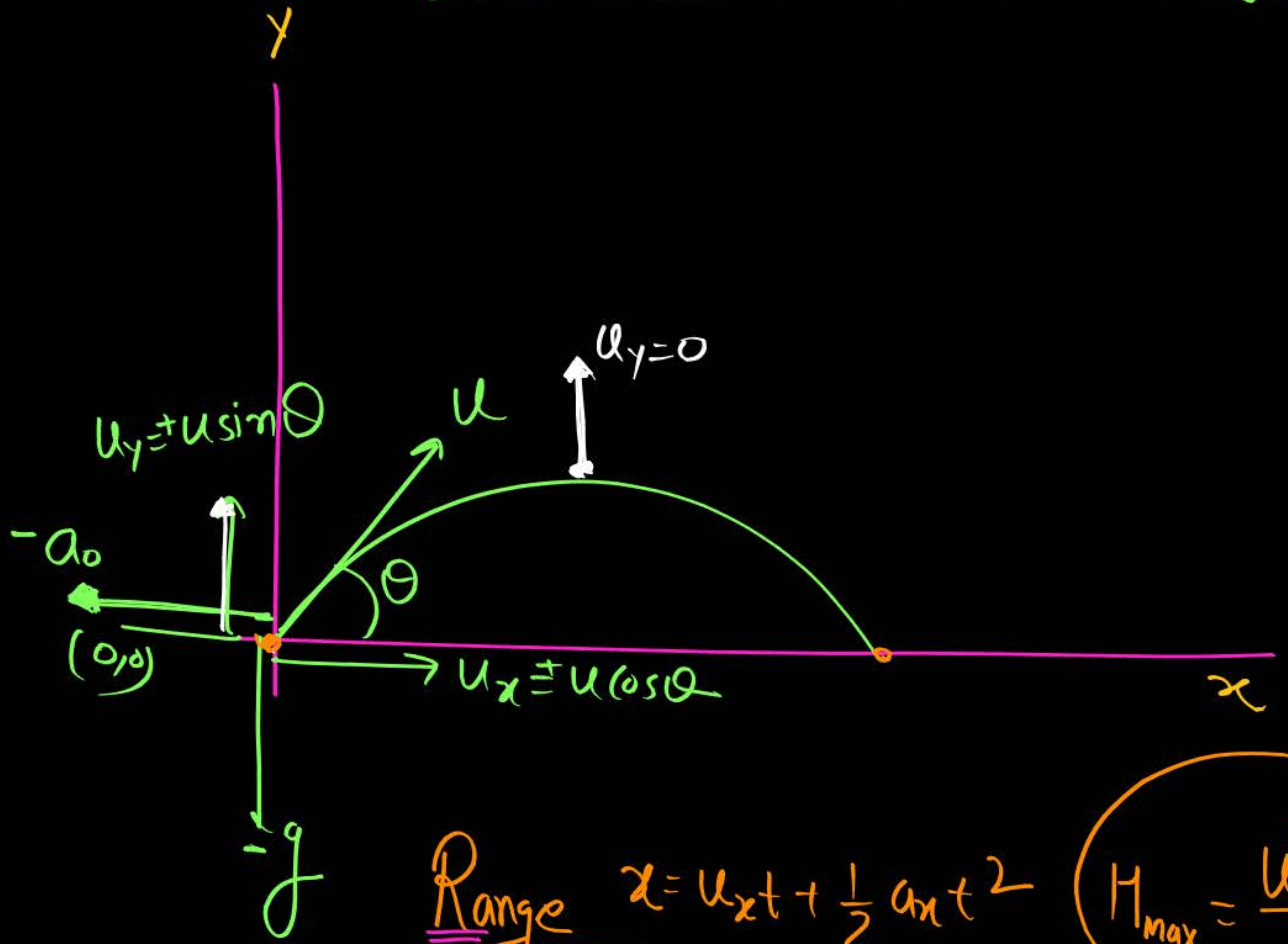


Sol^n $h = \dfrac{x_1 x_2 \tan\theta}{x_1 + x_2}$

$h = \dfrac{5 \times 2 \tan 45^\circ}{5+2} = \dfrac{10 \times 1}{7} = \dfrac{10}{7} m$ Ans

(level up) If air resistance a_0 is considered acting only along x-dir^n opposite to the motion then find H, T, R,

(level up)



Consider mo^n along y-axis from point of Projection to max^m Height

1st eq^n of motion

$$\vec{V_y} = u_y + a_y t$$

$$0 = u\sin\theta - gt$$

$$t = \frac{u\sin\theta}{g}$$

$$T_f = t_{up} + t_{don} = \frac{2u\sin\theta}{g}$$

No Change

Range $x = u_x t + \frac{1}{2} a_x t^2$

$$H_{max} = \frac{u^2\sin^2\theta}{2g}$$

No change

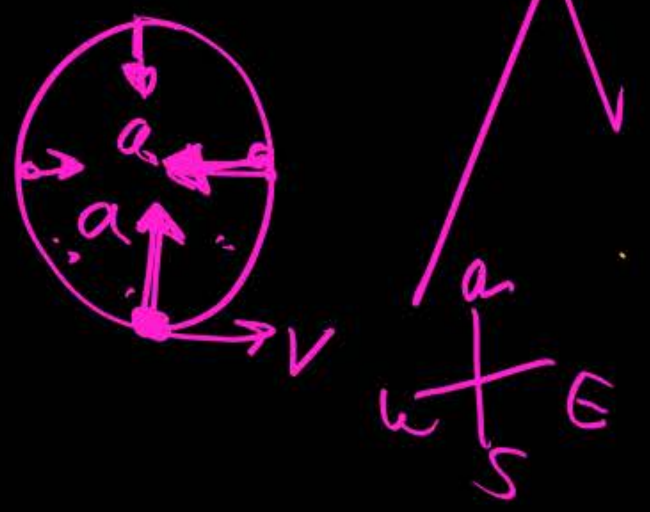
$$R = u\cos\theta\left[\frac{2u\sin\theta}{g}\right] - \frac{1}{2}a_0\left[\frac{2u\sin\theta}{g}\right]^2$$

Change

Object is moving such that its (Rate of change in velocity) is constant but (Rate of change in speed) is variable. Is this motion possible.

Rate of change in velocity → $acc^n = const^n$

→ circular ✗



→ This is possible in practice

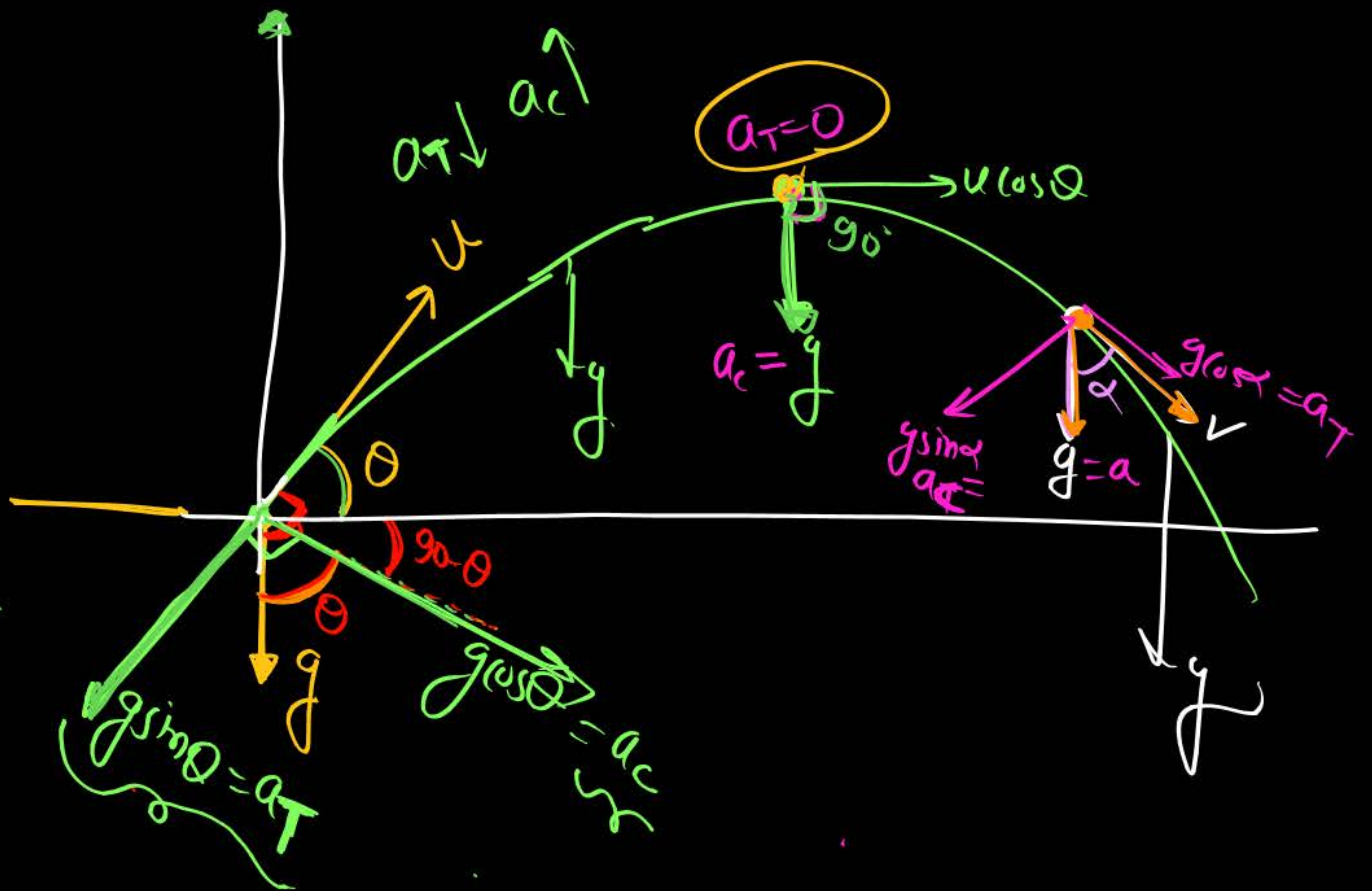
Rate of change in speed → $\frac{d|\vec{v}|}{dt} = a_T$

tangential acc^n in Projectile motion ??

Projectile = acc^n const^n

The rate of change in velocity = const^n

at max^m height centrepetal acc^n = g.

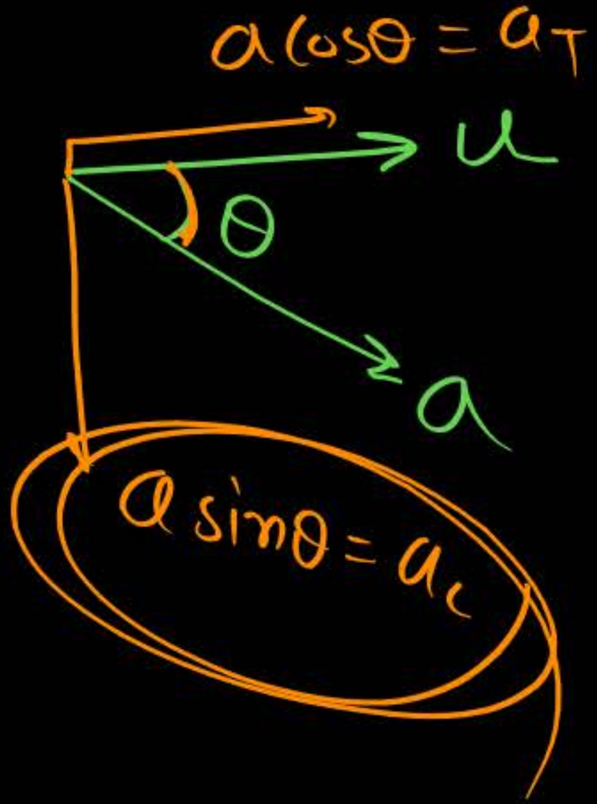


$$a_T = \frac{d|\vec{v}|}{dt}$$ = The rate of change in speed = variable

AIIMS - 2017

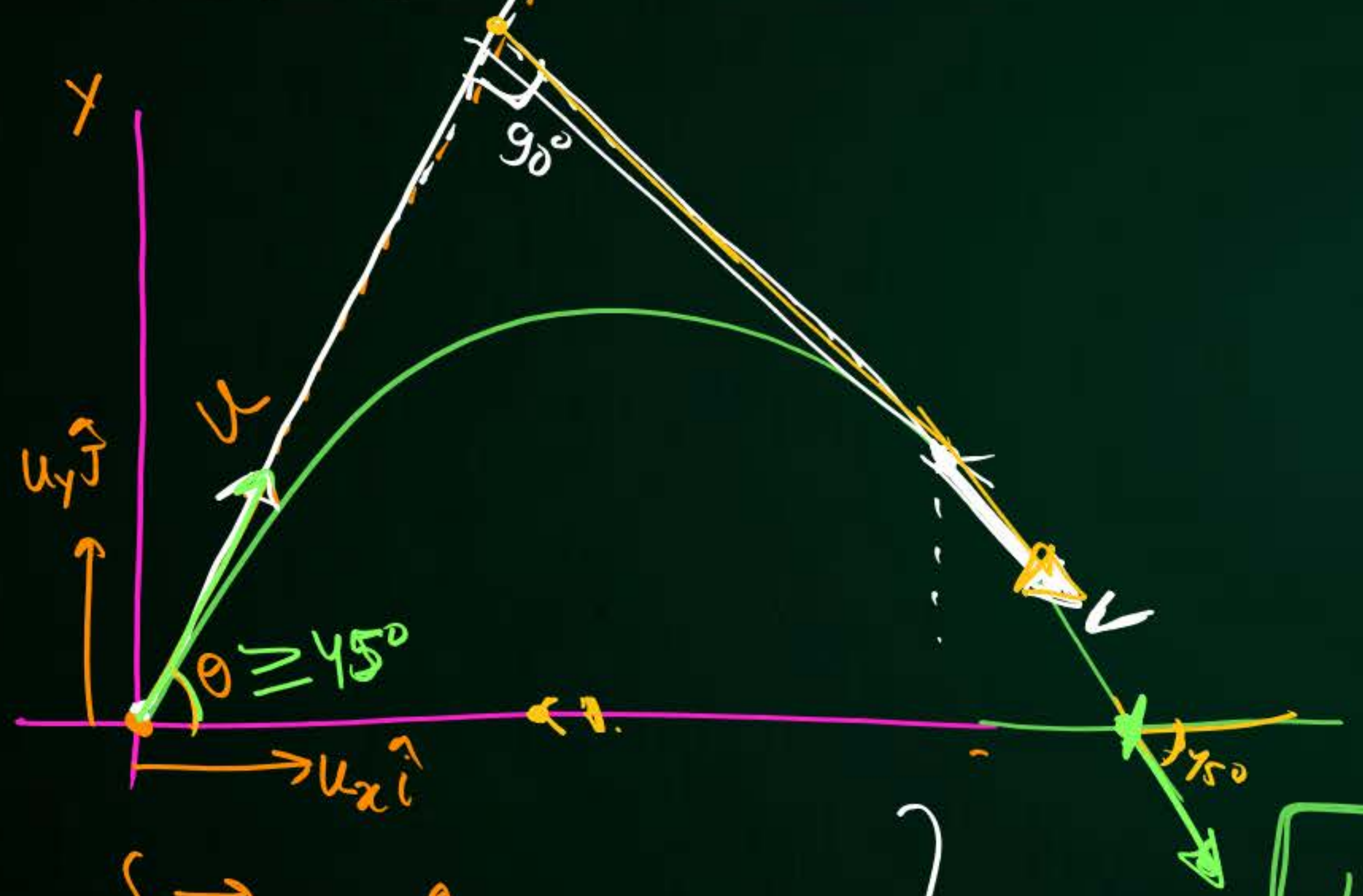
$\longrightarrow u\uparrow$, $\longrightarrow a = a_T$ } 1-D motⁿ, No dirⁿ change

$a = a_T \longleftarrow \quad \longrightarrow u\downarrow$] 1-D motⁿ, dirⁿ change



QUESTION

Ball is projected with speed u at angle θ then find time after which ball will be moving perpendicular to the initial direction of projection.



$$\vec{u_i} = u_x\hat{i} + u_y\hat{j}$$
$$\vec{V_t} = u_x\hat{i} + (u_y - gt)\hat{j}$$

$\vec{u_i} \perp r \ \vec{v_f} \quad (\vec{u_i}\cdot\vec{v_f} = 0)$

$$(u_x\hat{i} + u_y\hat{j})\cdot(u_x\hat{i} + (u_y - gt)\hat{j}) = 0$$

$$u_x^2 + u_y(u_y - gt) = 0$$

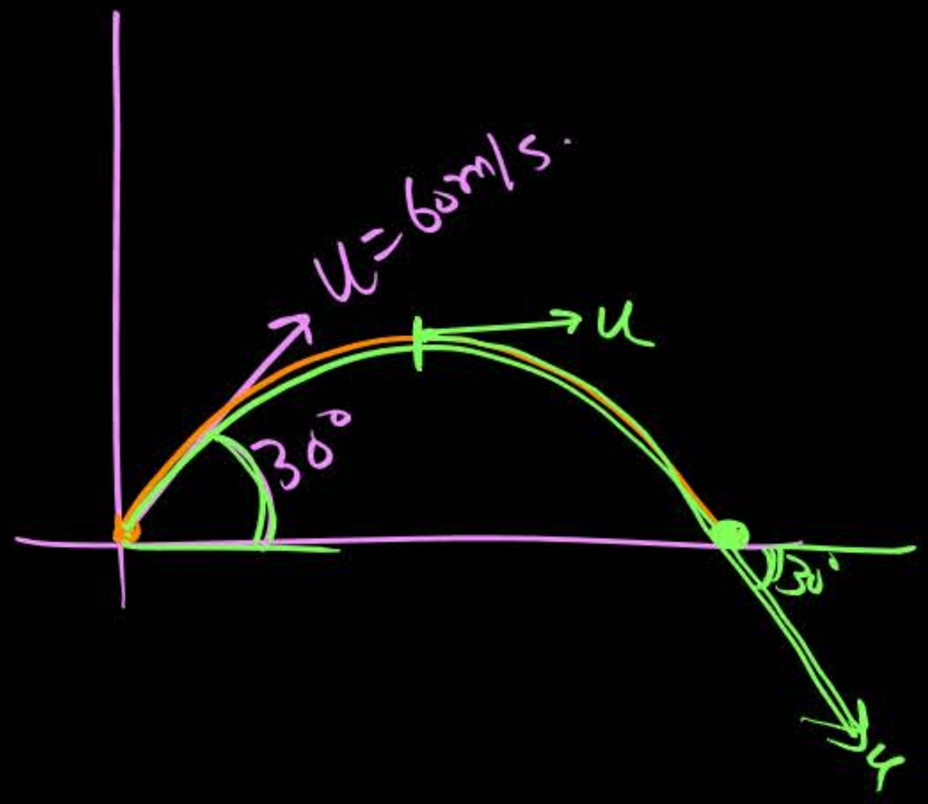
$$u_x^2 + u_y^2 - u_y gt = 0$$

$$u^2\cos^2\theta + u^2\sin^2\theta = u\sin\theta\, g t$$

$$u^2 = u\sin\theta\, g t$$

$$t = \frac{u}{g\sin\theta}$$

find time when object moving ⊥r to initial dirⁿ of Projection ??



$T_f = \frac{2u\sin\theta}{g} = \frac{2 \times 60 \times \sin 30^\circ}{10}$

$= 2 \times 6 \times \frac{1}{2} = 6\,sec$

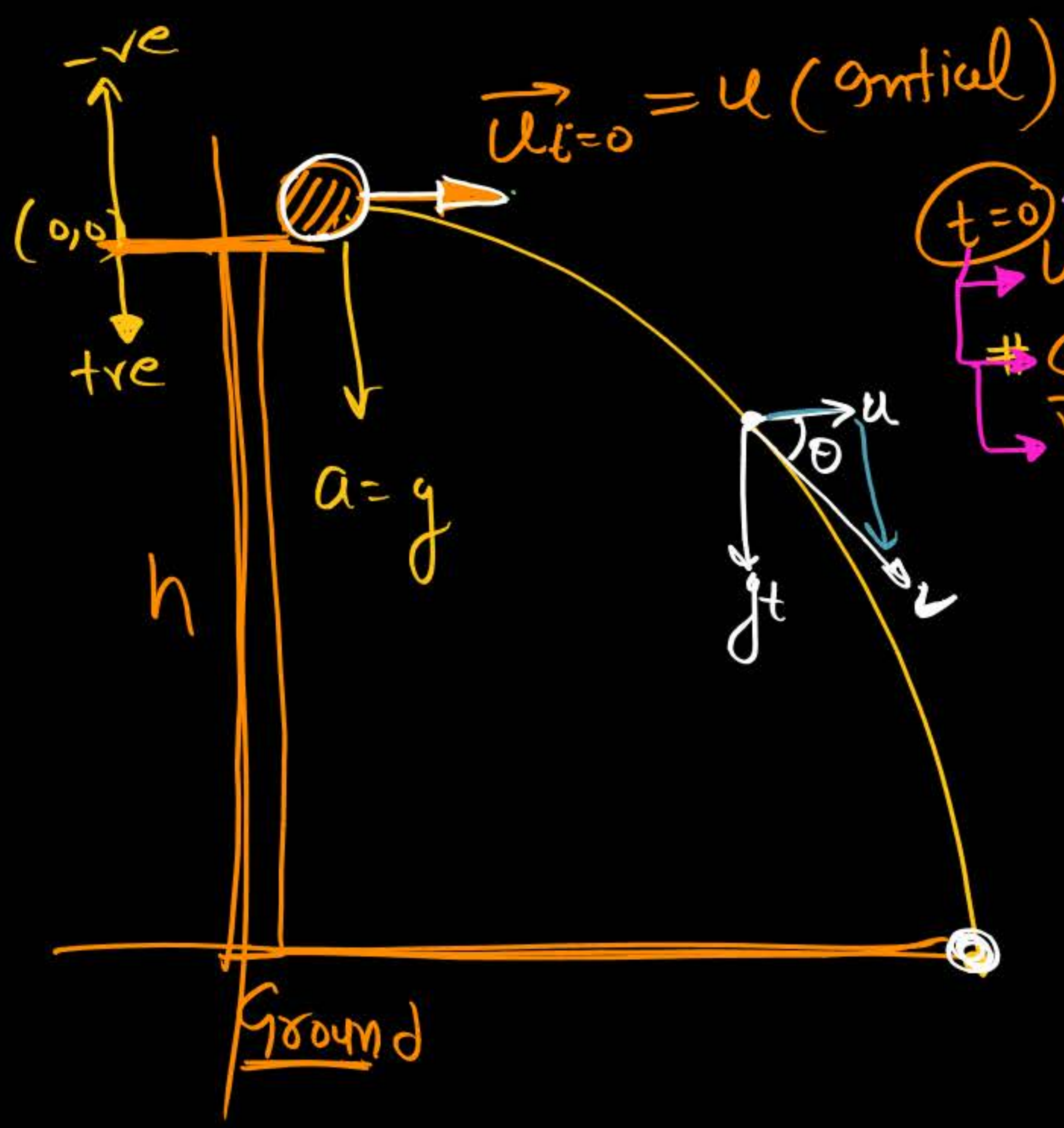
Solⁿ

$t = \frac{u}{g\sin\theta} = \frac{60}{10 \times \sin 30^\circ}$

$= \frac{6}{1/2} = 12\,sec$ ✗

Not Possible

Horizontal Projectile motion



$\vec{u}_{t=0} = u$ (initial)

x-axis	y-axis
$u_x = u$	$u_y = 0$
$a_x = 0$	$a_y = +g$ (down)
$\vec{V}_x = u$ (const^n) (Uniform Mot^n)	$\vec{V}_y = gt$
$x = u_x t$	$y = \frac{1}{2} g t^2$

(t = 0)

$$\vec{V}_t = u\hat{i} + gt\hat{j}$$

$$\tan\theta = \frac{gt}{u} \qquad |\vec{V}_t| = \sqrt{u^2 + (gt)^2}$$

dir^n of Mot^n from Horizontal at time 't' → $\theta = \tan^{-1}\left(\frac{gt}{u}\right)$

Eq^n of Trajectory

$$y = \frac{1}{2} g t^2$$

$$y = \frac{1}{2} g \left(\frac{x}{u}\right)^2 = \frac{1}{2} g \frac{x^2}{u^2}$$

→ Parabola

Consider mot^n along y-axis

$$S_y = u_y t + \frac{1}{2} a_y t^2$$

$$H = 0 + \frac{1}{2} g t^2$$

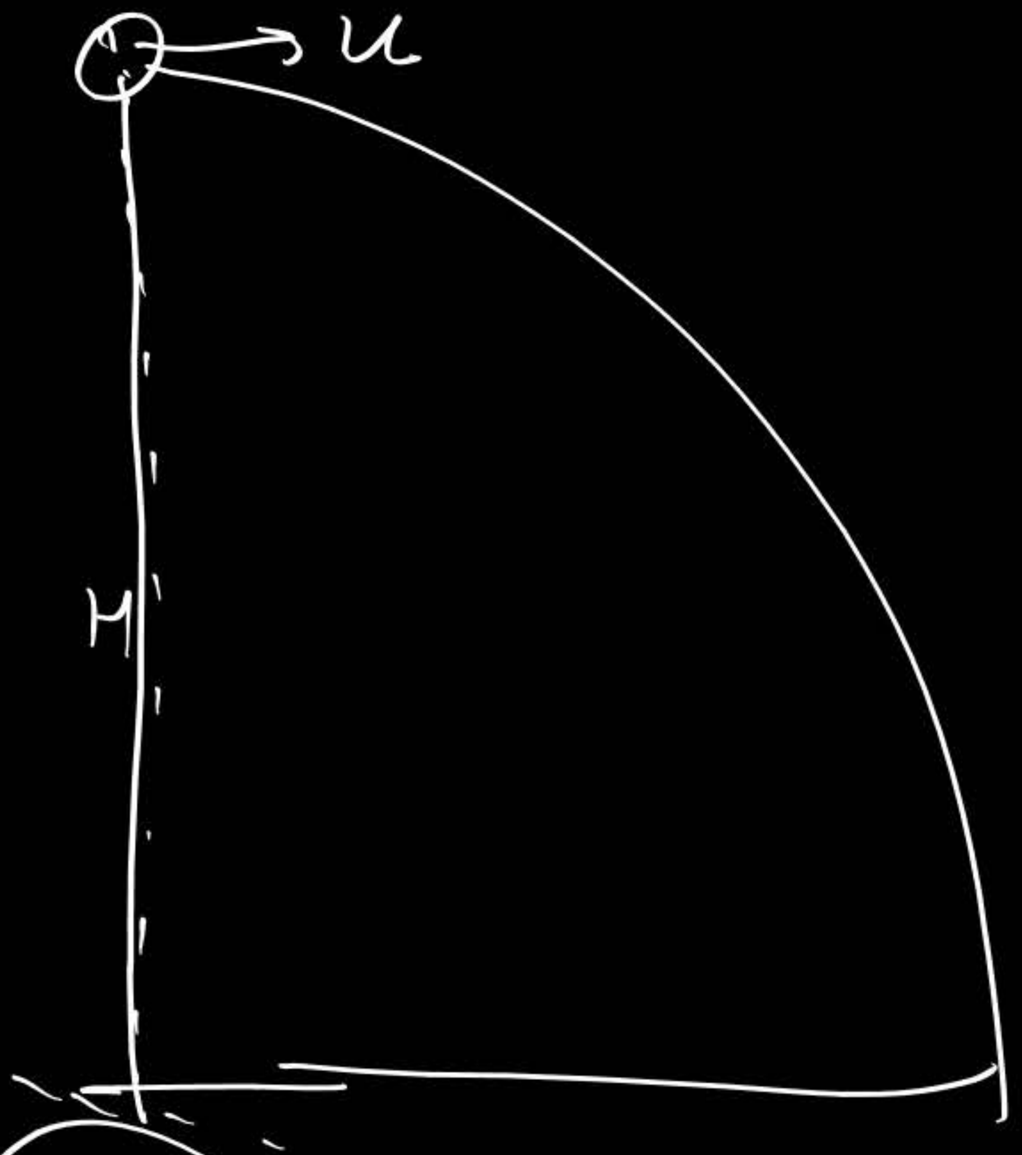
* $T = \sqrt{\frac{2H}{g}}$ time of flight

* Range $= u_x T_f$

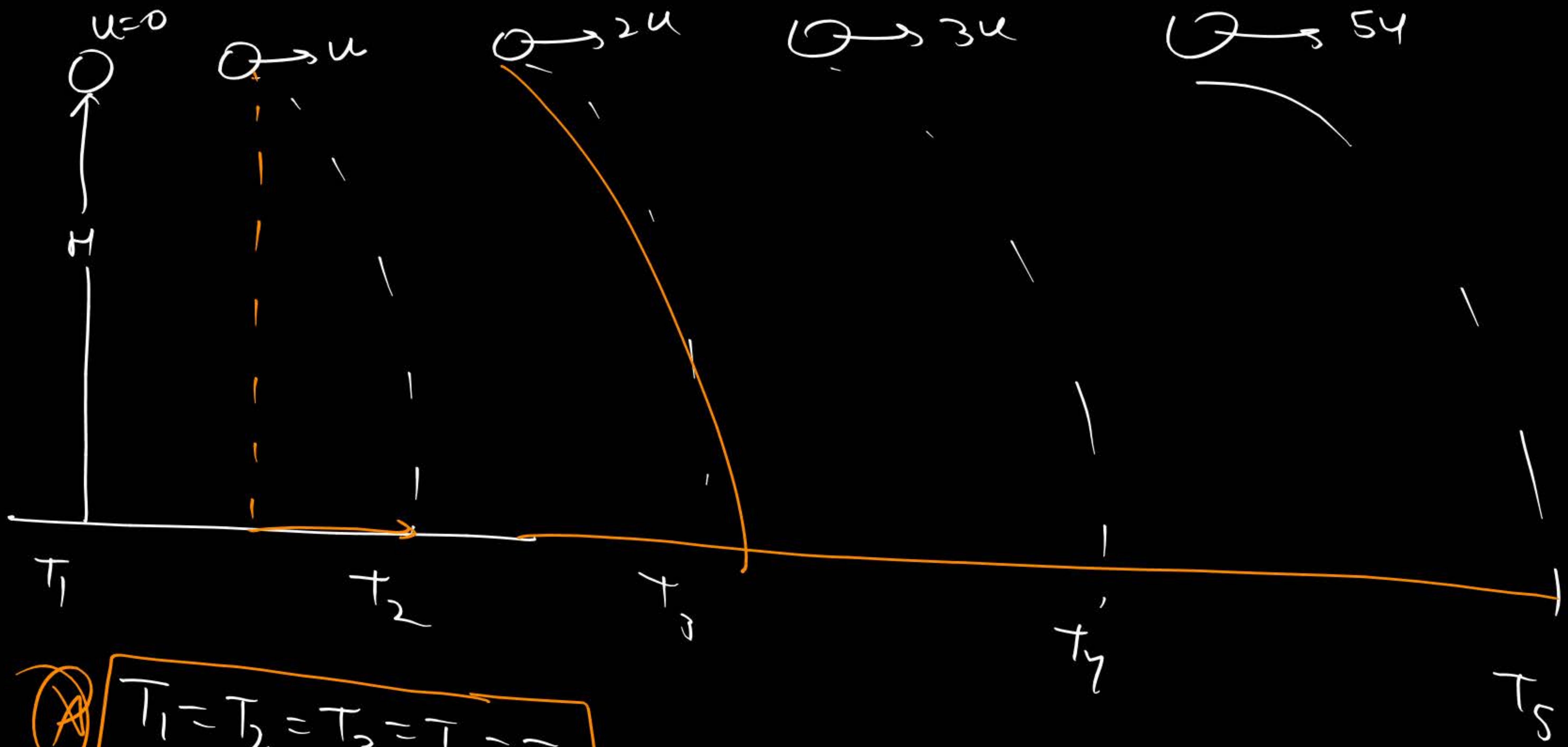
$$R = u\sqrt{\frac{2h}{g}}$$



$T = \sqrt{\frac{2H}{g}}$



$T = \sqrt{\frac{2h}{g}}$



$$T_1 = T_2 = T_3 = T_4 = T_5$$

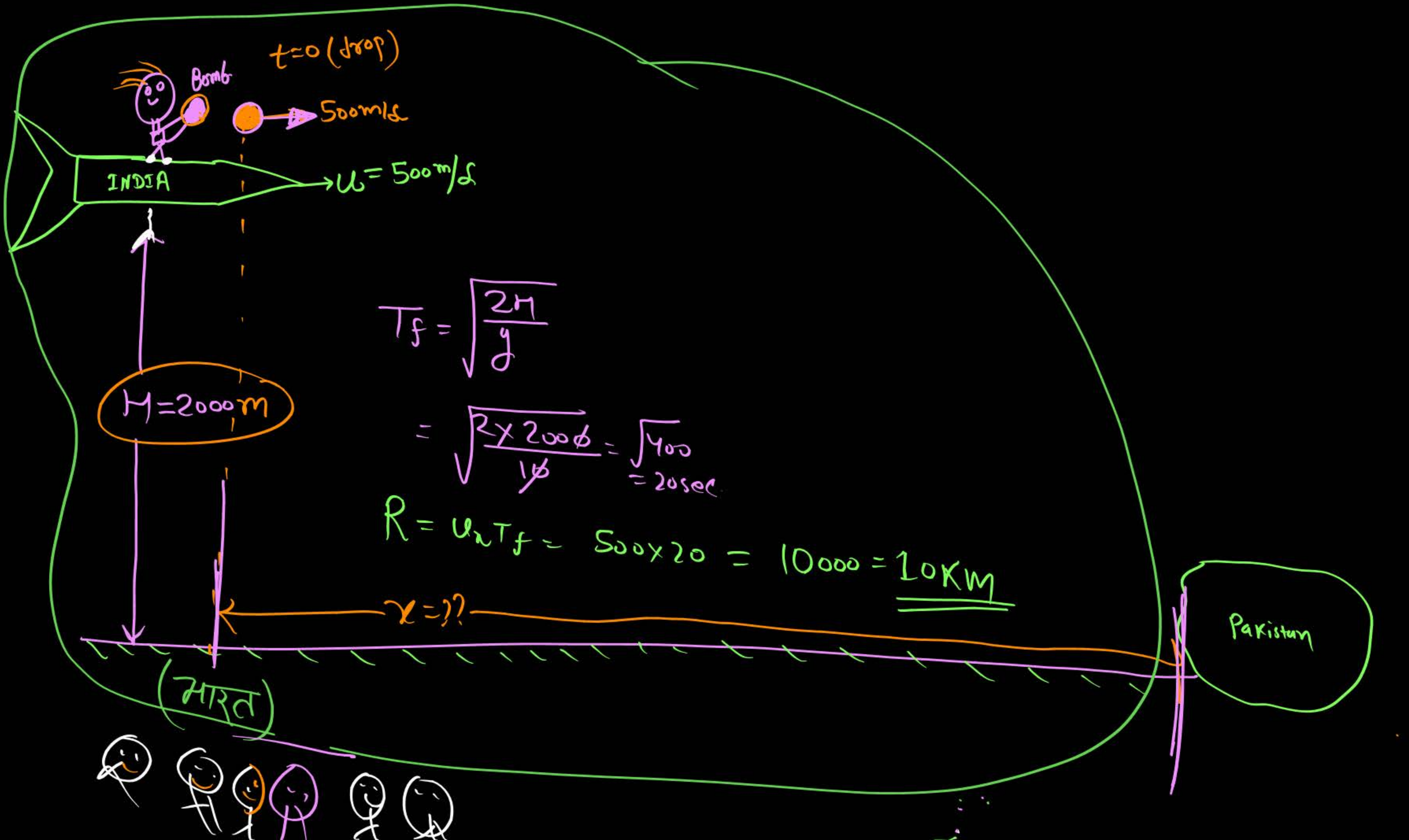
QUESTION

Ball is projected in horizontal direction with speed u from a tower of height 'H'.

QUESTION

When a particle is thrown horizontally, with initial velocity 'u' the resultant velocity of the projectile at any time t is given by:

1. gt
2. $\frac{1}{2}gt^2$
3. $\sqrt{u^2 + g^2t^2}$
4. $\sqrt{u^2 - g^2t^2}$



$$T_f = \sqrt{\frac{2H}{g}}$$

$$= \sqrt{\frac{2 \times 2000}{10}} = \sqrt{400} = 20\,\text{sec}$$

$$R = u_x T_f = 500 \times 20 = 10000 = \underline{\underline{10\,\text{KM}}}$$

QUESTION

80 m

A bomber is flying horizontally with a constant speed of 150 m/s at a height of 78.4 m. The pilot has to drop a bomb at the enemy target. At what horizontal distance from the target should he release the bomb:

1. Zero
2. 300 m
3. 600 m ✓
4. 750 m

$T = \sqrt{\frac{2 \times 80}{10}} = 4\,sec$

$R = u_x T_f$

$= 150 \times 4$

$= 600\,m$

QUESTION

A body is thrown horizontally from the top of a tower of height 5 m. It touches the ground at a distance of 10 m from the foot of the tower. The initial velocity of the body is (g = 10 ms)

1. 2.5 ms
2. 5 ms
3. 10 ms
4. 20 ms

$R = u_x T_f$

$10 = u_x \times 1$

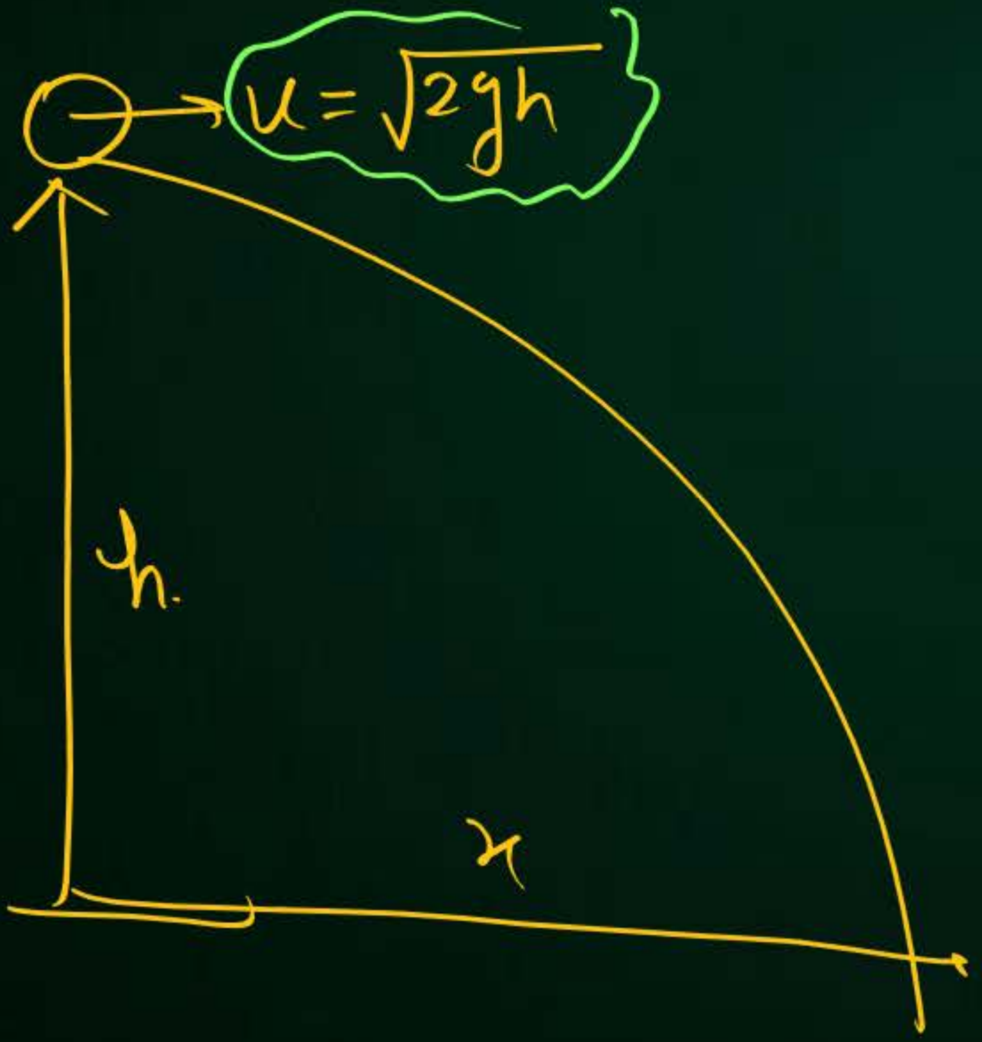
$u_x = 10\ m/s$

$t_f = \sqrt{\frac{2h}{g}} = 1\ sec$

QUESTION

A body is thrown horizontally with a velocity $\sqrt{2gh}$ from the top of a tower of height h. It strikes the level ground through the foot of the tower at a distance x from the tower. The value of x is:

1. h
2. $h/2$
3. $2h$
4. $2h/3$



$t_f = \sqrt{\frac{2h}{g}}$

Range $= u_x T_f$

$x = \sqrt{\frac{2h}{g}} \times \sqrt{2gh}$

$= 2h$

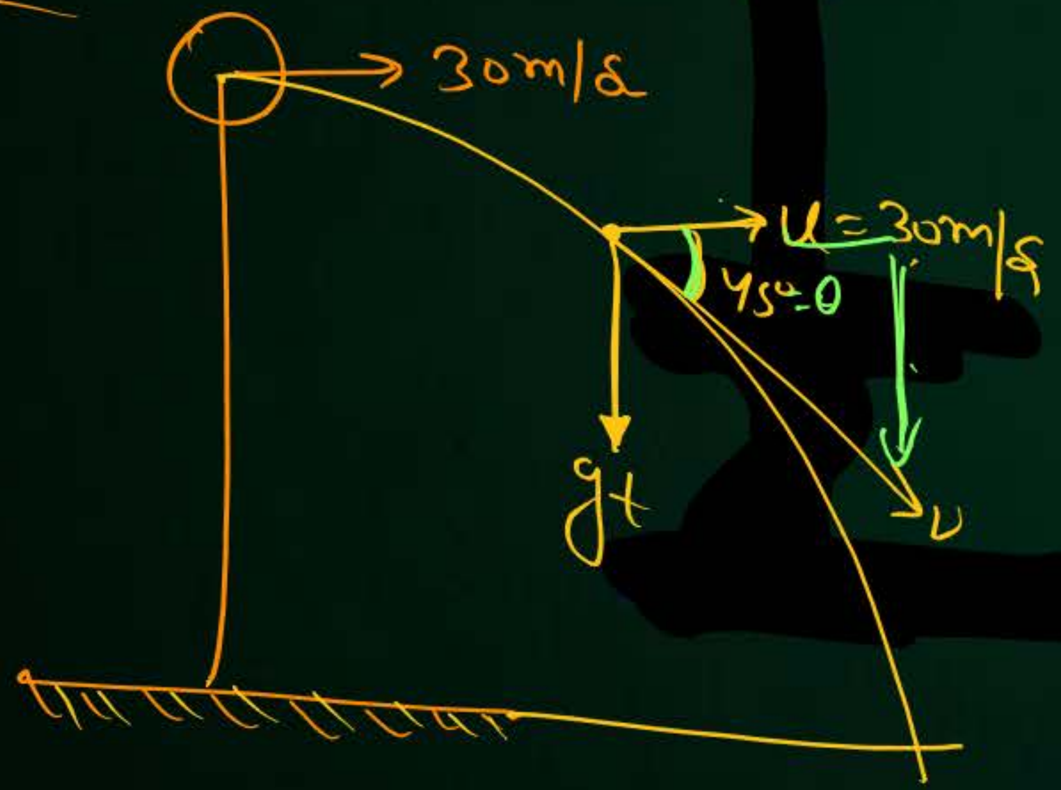
QUESTION

Ball is projected with 30 m/s in horizontal direction from some height. Find time when it is 45° from horizontal.

(Moving at)

[redacted]

Sol



$$\tan\theta = \frac{gt}{u}$$

$$\tan 45° = \frac{10 \times t}{30}$$

$$30 \times 1 = 10\,t$$

$$t = 3\,sec$$

QUESTION

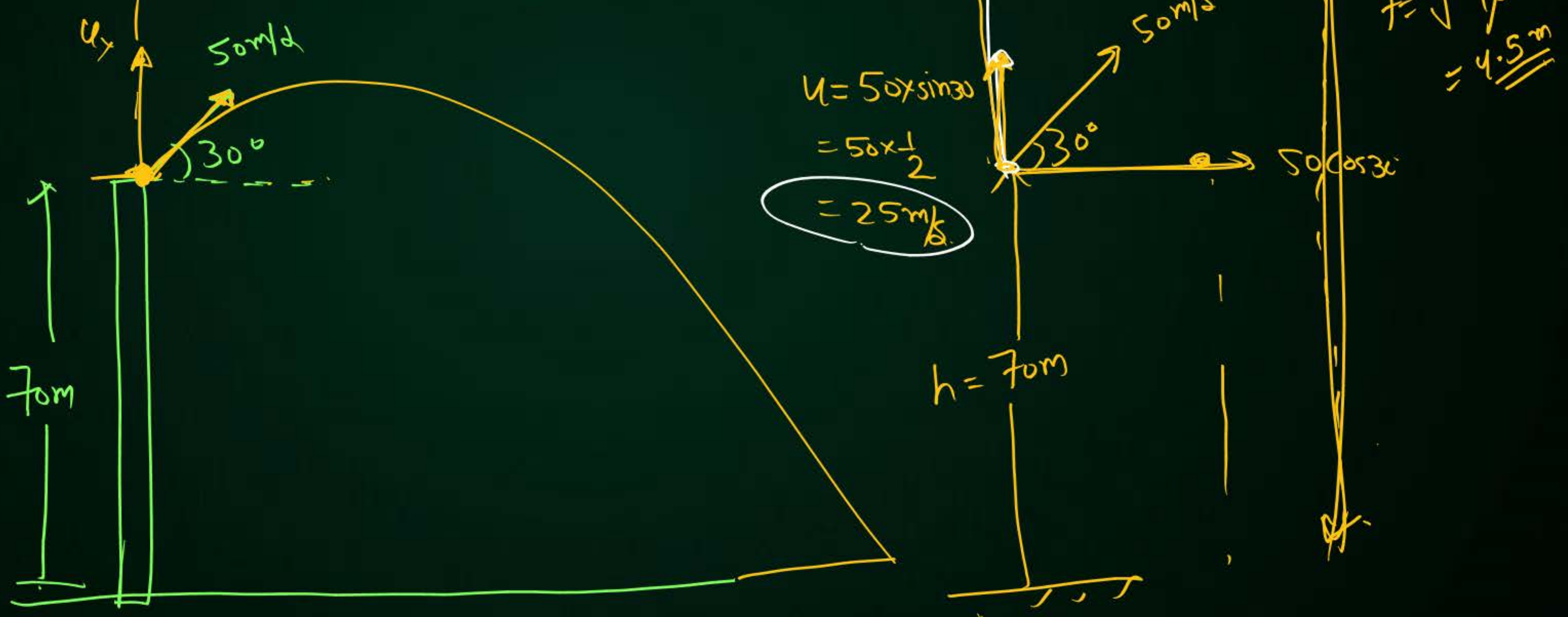
A bullet is fired in a horizontal direction from a tower while a stone is simultaneously dropped from the same point then:

1. The bullet and the stone will reach the ground simultaneously.
2. The stone will reach earlier.
3. The bullet will reach earlier.
4. Nothing can be predicted.

QUESTION

A ball is projected upwards from the top of the tower with a velocity $50 ms^{-1}$ making an angle $30°$ with the horizontal. The height of tower is 70 m. After how many seconds the ball will strike the ground?

1. 3 s
2. 5 s
3. 7 s
4. 9 s



QUESTION

True / False :

(i) A body x is dropped from the top of a tower. At the same time, another body y is thrown horizontally from the same position with a velocity U. Both bodies will reach the ground at same time.

True

QUESTION

(ii) A particle is projected from height h with horizontal velocity u, then range of particle is $u\sqrt{\frac{2H}{g}}$.

True

QUESTION

(iii) At the highest point of the path of projectile speed is zero.

fase

QUESTION

(iv) Horizontal velocity in projectile motion is zero at the highest point.

False

QUESTION

Assertion : Two bodies of different masses are projected horizontally with different speeds, they reach the ground simultaneously.

Reason : For both bodies, the vertical component of initial velocity is zero.

1. A
2. B
3. C
4. D

QUESTION

Assertion : Mass of the projectile does not affect the maximum height

Reason: Heavier the body, greater is the force required project it.

1. A
2. B
3. C
4. D

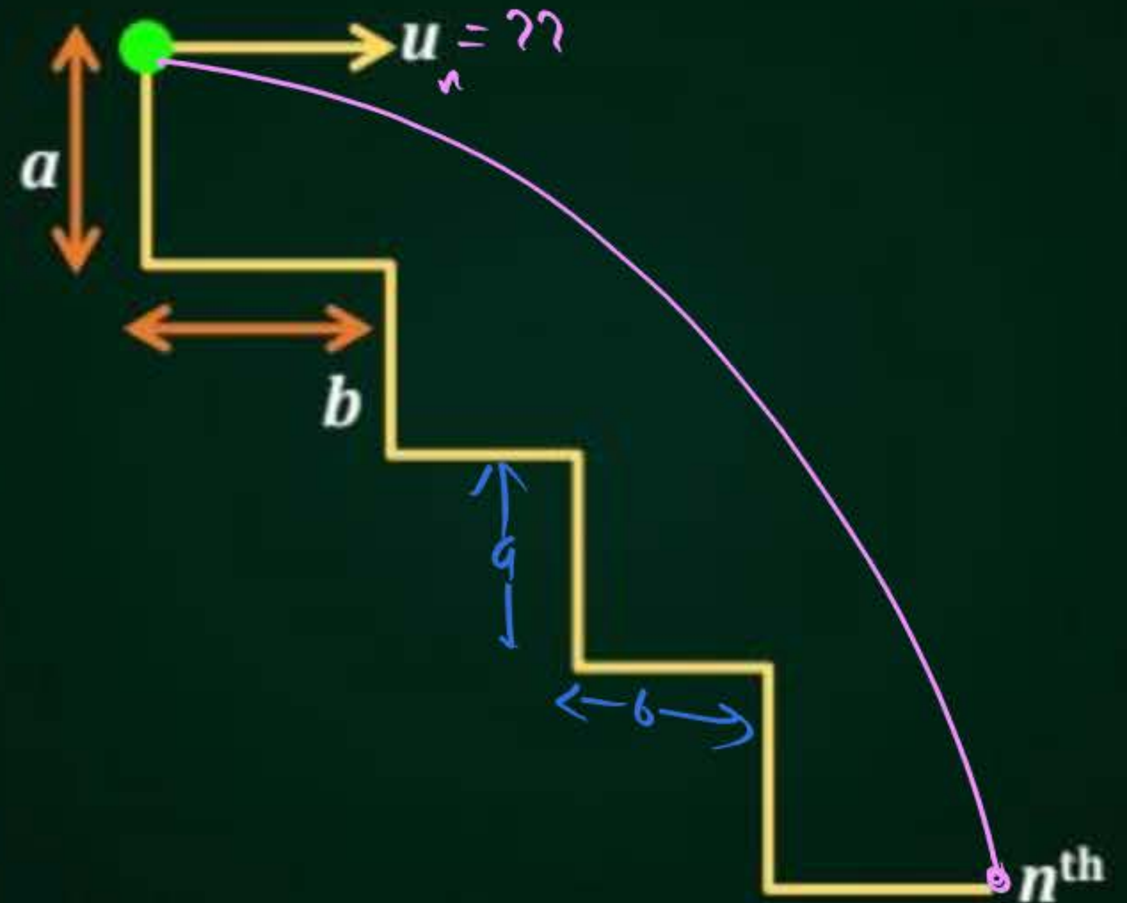
QUESTION

A bomber plane moves horizontally with a speed of 500 m/s and a bomb released from it, strikes the ground in 10 sec. Angle at which it strikes the ground will be ($g = 10\ \text{m/s}^2$) [MH CET 2003]

1. $\tan^{-1}\left(\frac{1}{5}\right)$
2. $\tan\left(\frac{1}{5}\right)$
3. $\tan^{-1}(1)$
4. $\tan^{-1}(5)$

QUESTION

Find velocity so that ball will fall on n^{th} step.



H/w

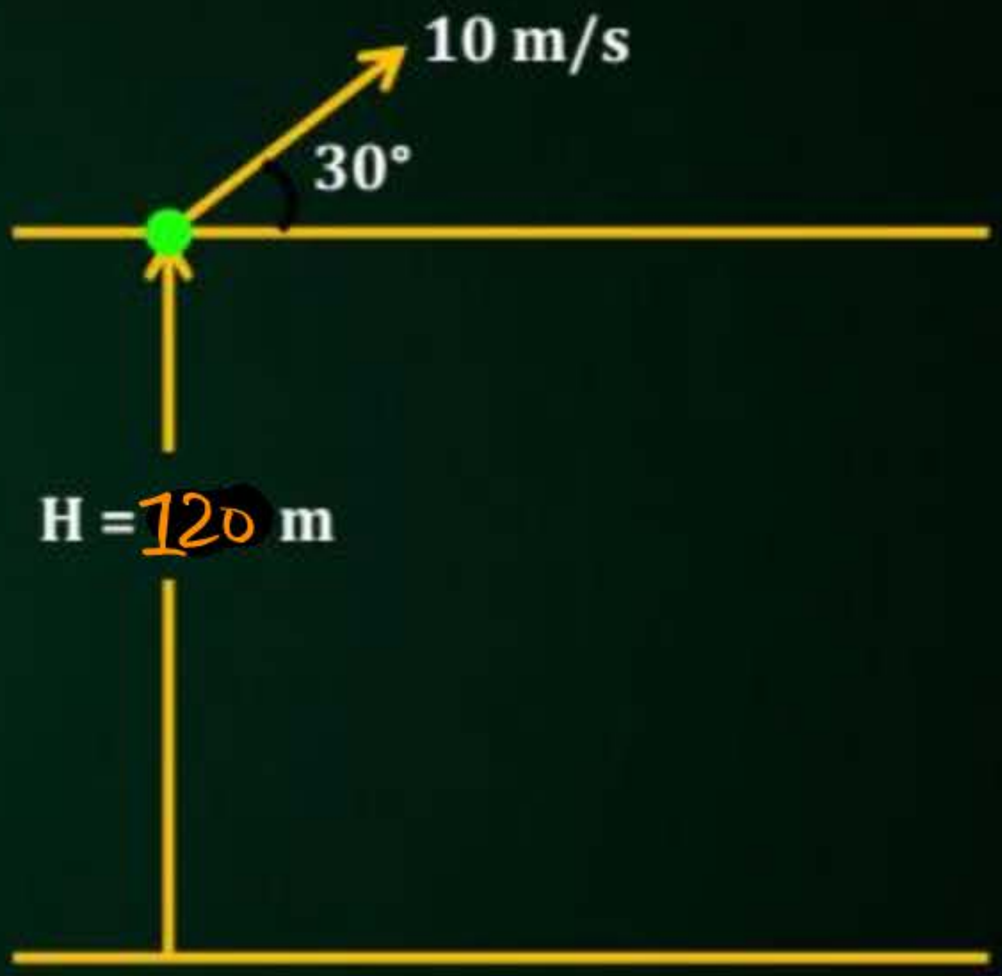
QUESTION

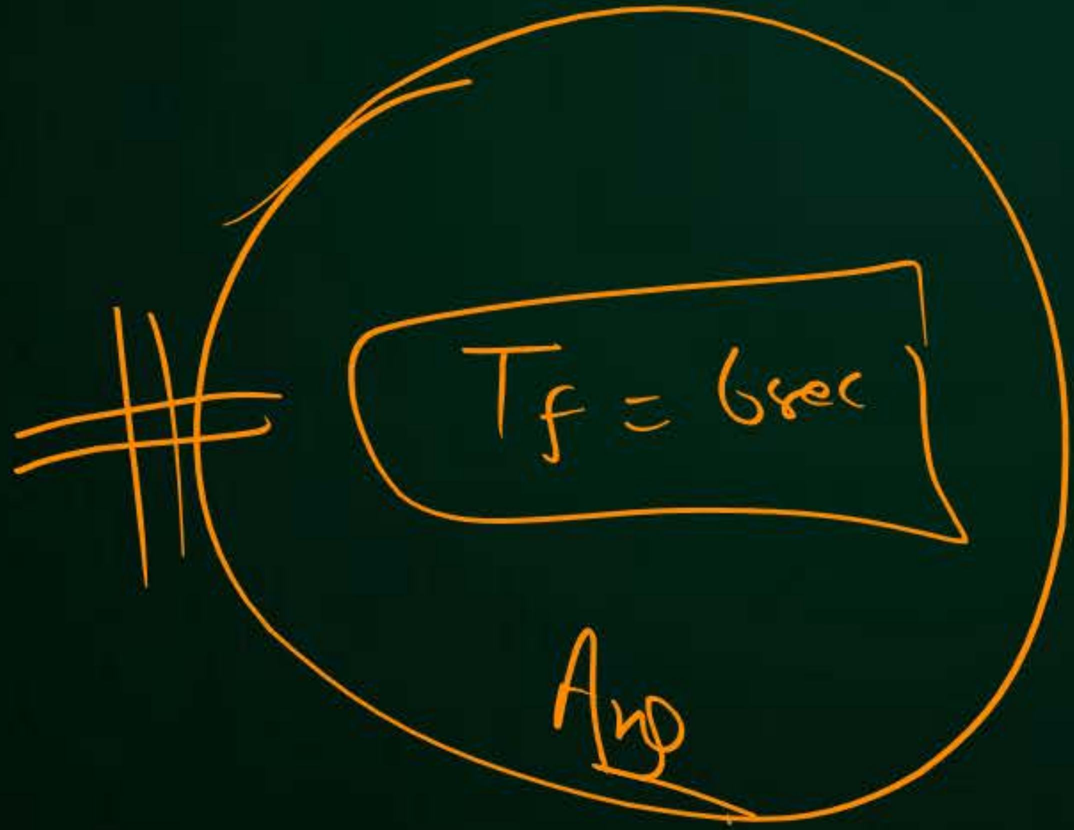
A ball is projected upwards from the top of the tower with a velocity 50 ms^{-1} making an angle $30°$ with the horizontal. The height of tower is 70 m. After how many seconds the ball will strike the ground ?

1. 3 s
2. 5 s
3. 7 s
4. 9 s

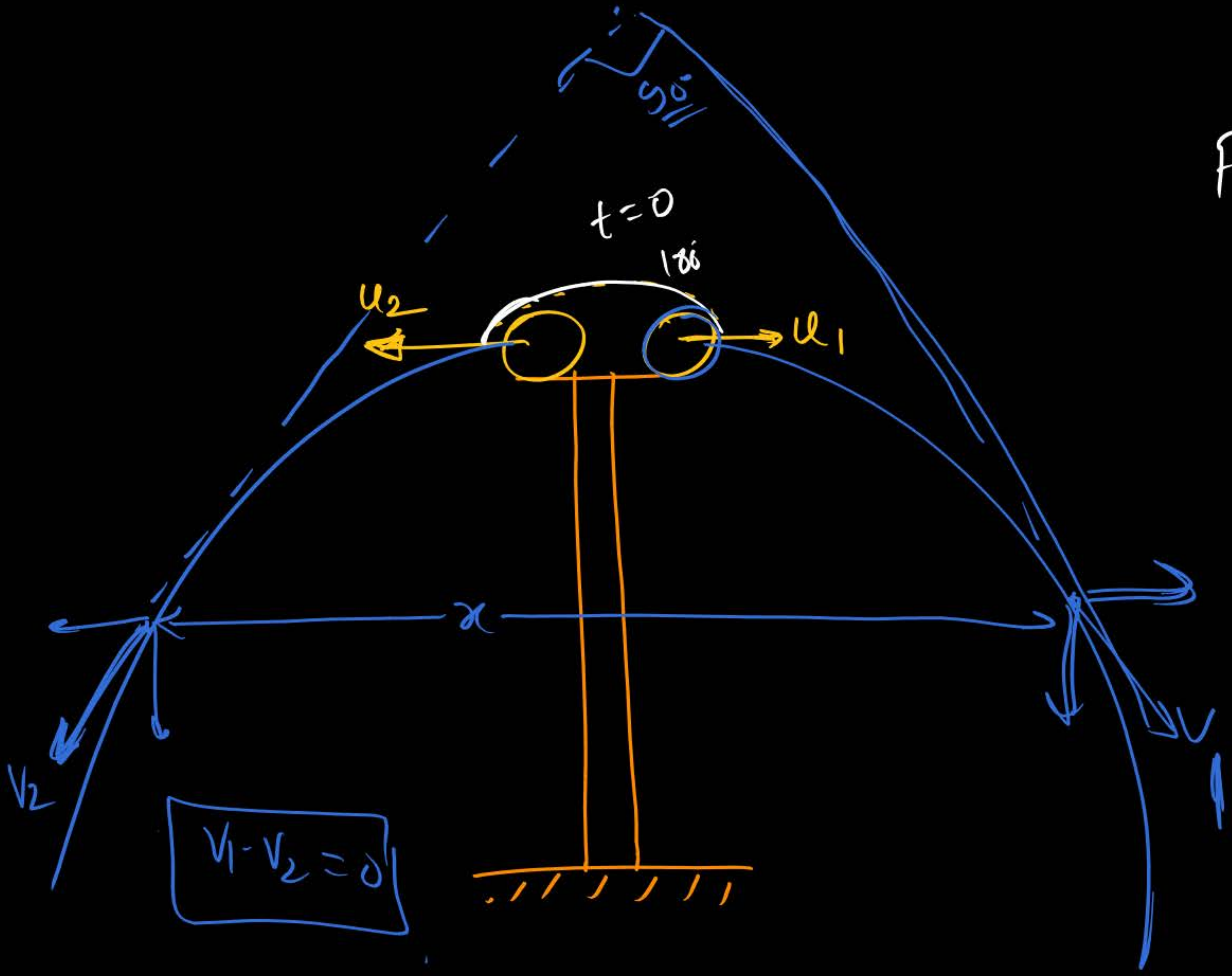
QUESTION

Find time of flight and range.





Find Time after which they are moving ⊥r to each other ??




THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 05 | Physics

8:15 to 8:45

Motion in a Plane

Physics के last Lecture ko revision

rough Page में लिखना है, last class के theory

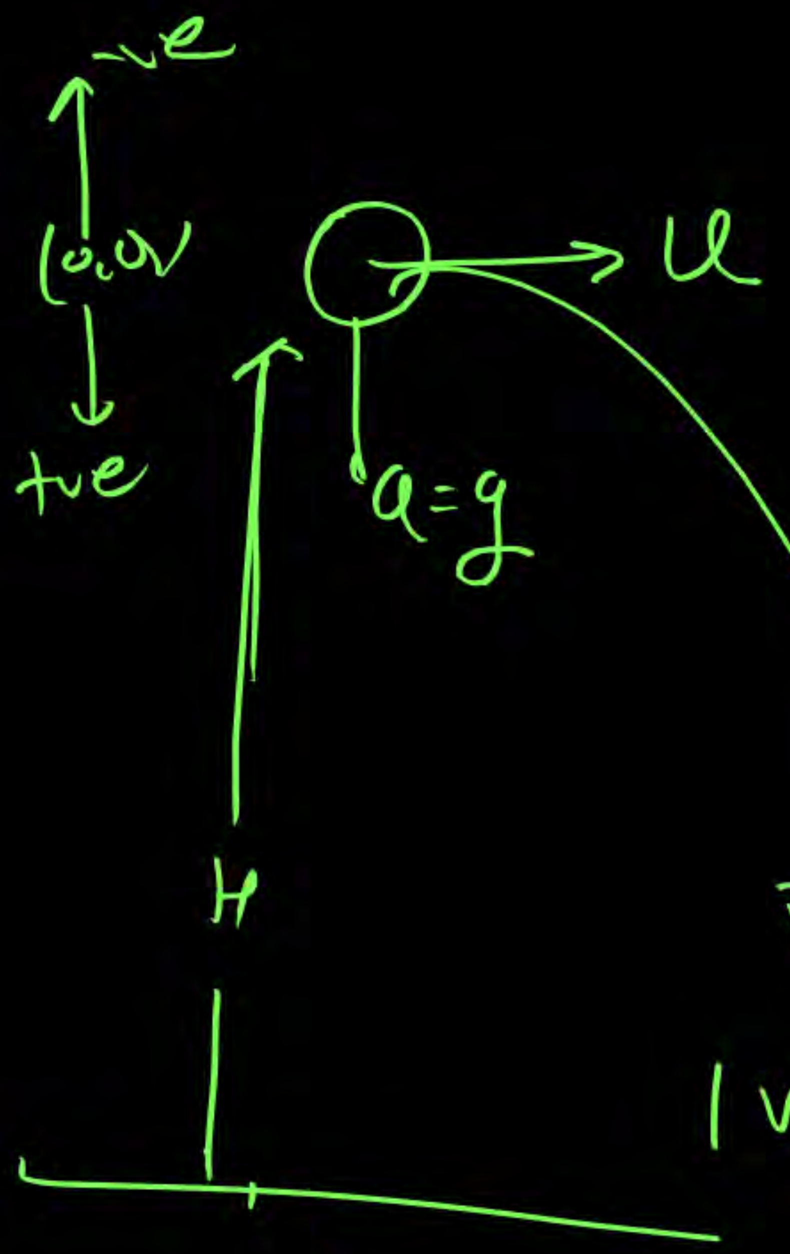


By- Dr. Manish Raj (MR SIR)

Topics to be covered

1. # Questions on Horizontal Projectile motn
2. # 2-D Relative motn
3. #
4. #





$u_x = u$

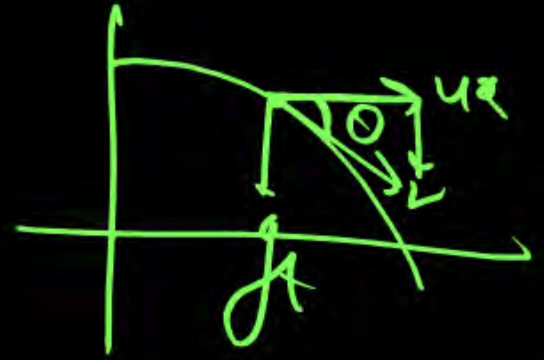
$a_x = 0$

$V_{tx} = u$ *

$x = ut$

$\vec{V} = u\hat{i} + gt\hat{j}$

$|V| = \sqrt{u^2 + (gt)^2}$



$\tan\theta = \frac{gt}{u}$

$u_y = 0$

$a_y = +g$

$V_{yt} = u_y + gt$

$V_{yt} = gt$

$y = \frac{1}{2} g t^2$

$y = \frac{1}{2} g \left(\frac{x}{u}\right)^2$

$y = \frac{1}{2} g \frac{x^2}{u^2}$

**

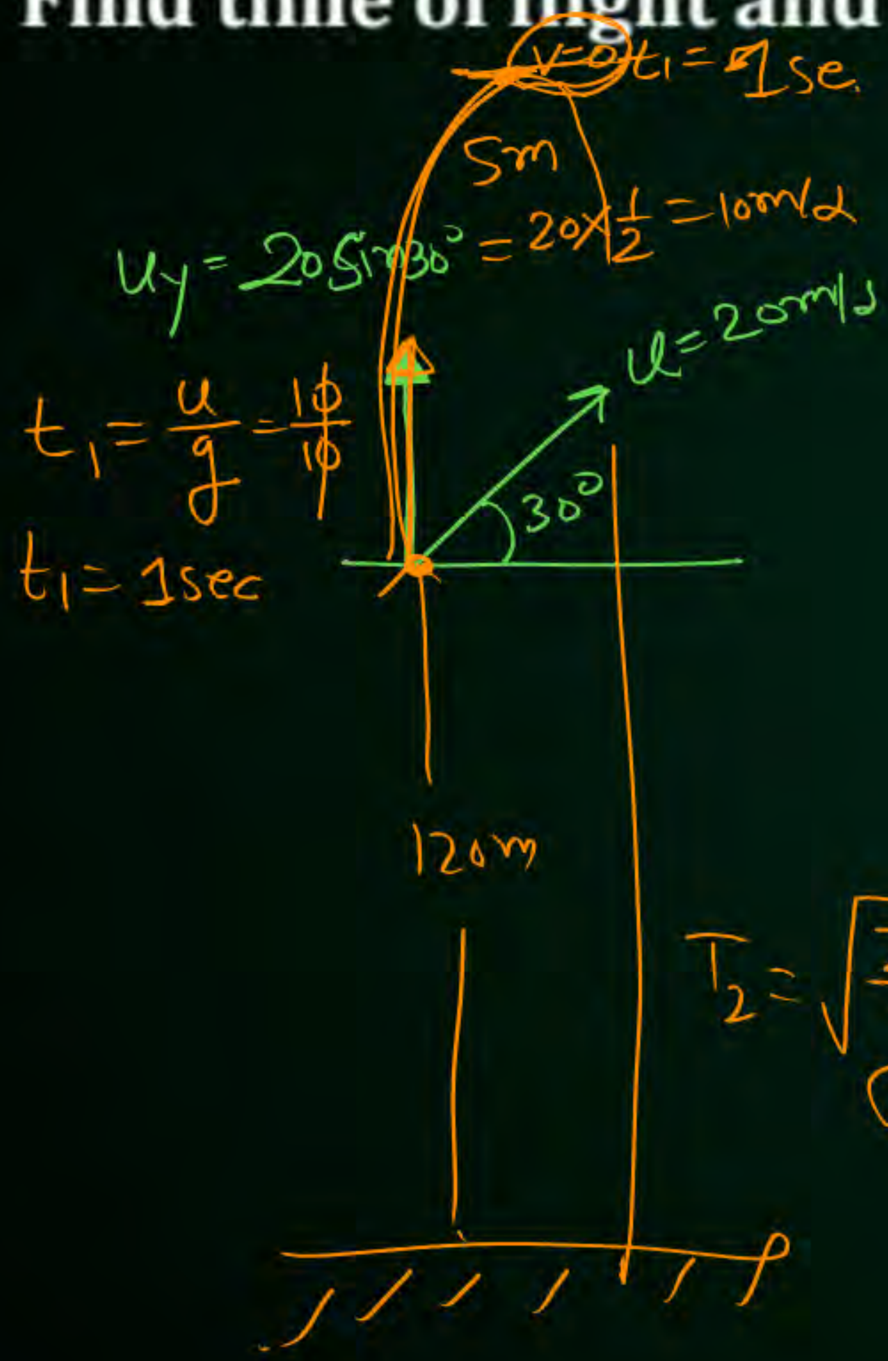
$T = \sqrt{\frac{2H}{g}}$

$R = u\sqrt{\frac{2H}{g}}$

8:30 to 8:45

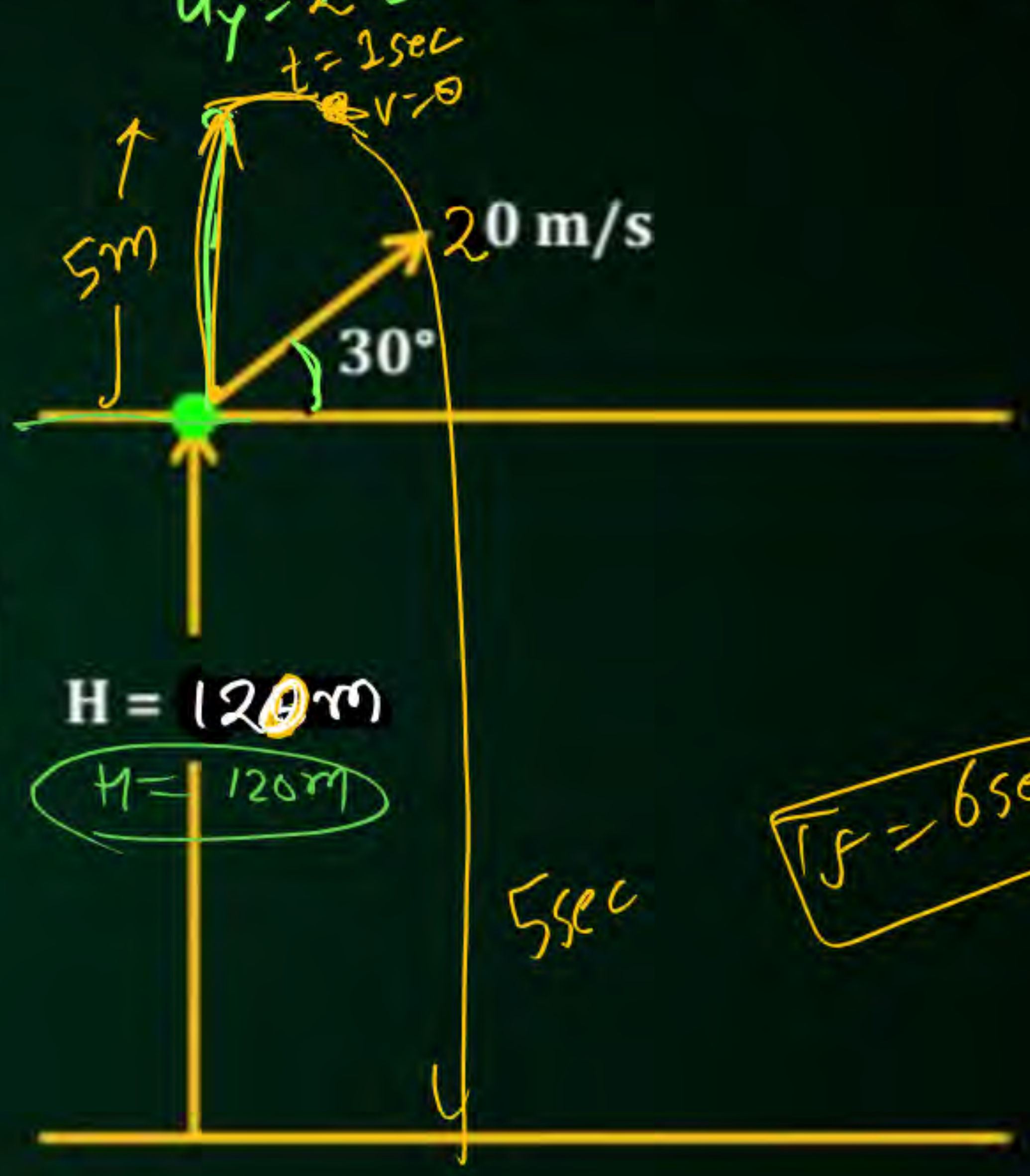
QUESTION

Find time of flight and range.



$$t = \frac{2u}{g} \qquad t = \sqrt{\frac{2H}{g}}$$

$$T_2 = \sqrt{\frac{2H}{g}} = \sqrt{\frac{2 \times 125}{10}} = \sqrt{25} = 5\text{ s}$$



$T_f = 6$ sec

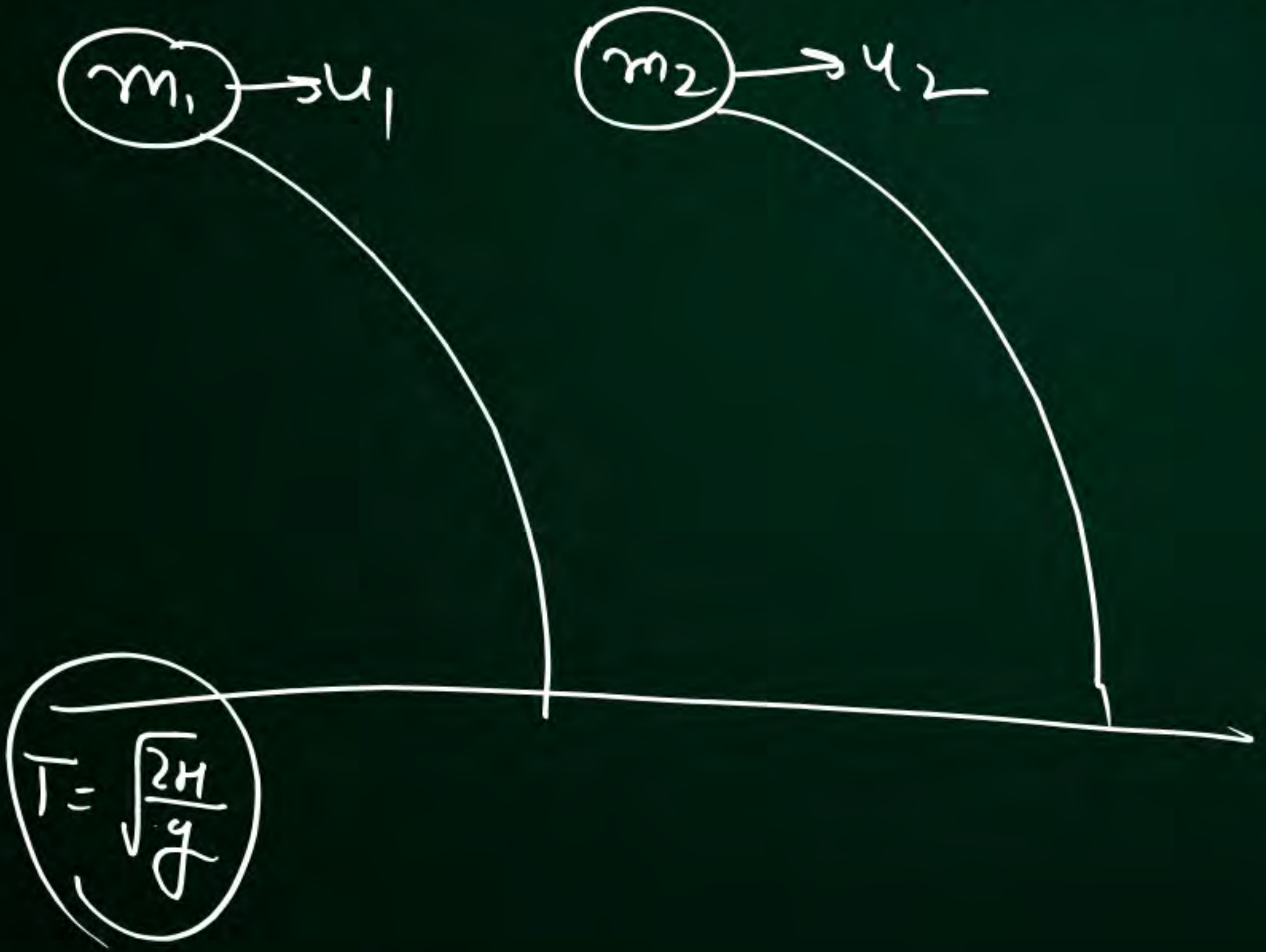
QUESTION

Assertion : Two bodies of different masses are projected horizontally with different speeds, they reach the ground simultaneously.

Reason : For both bodies, the vertical component of initial velocity is zero.

Both are correct & correct explanation.

1. A
2. B
3. C
4. D

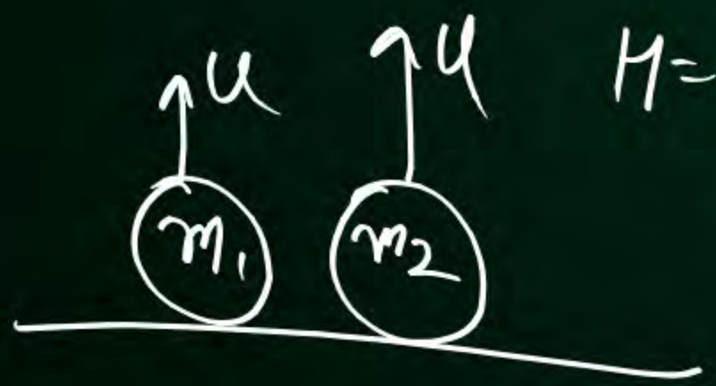


QUESTION

Assertion : Mass of the projectile does not affect the maximum height

Reason: Heavier the body, greater is the force required project it.

1. A
2. B (Both are correct)
3. C
4. D

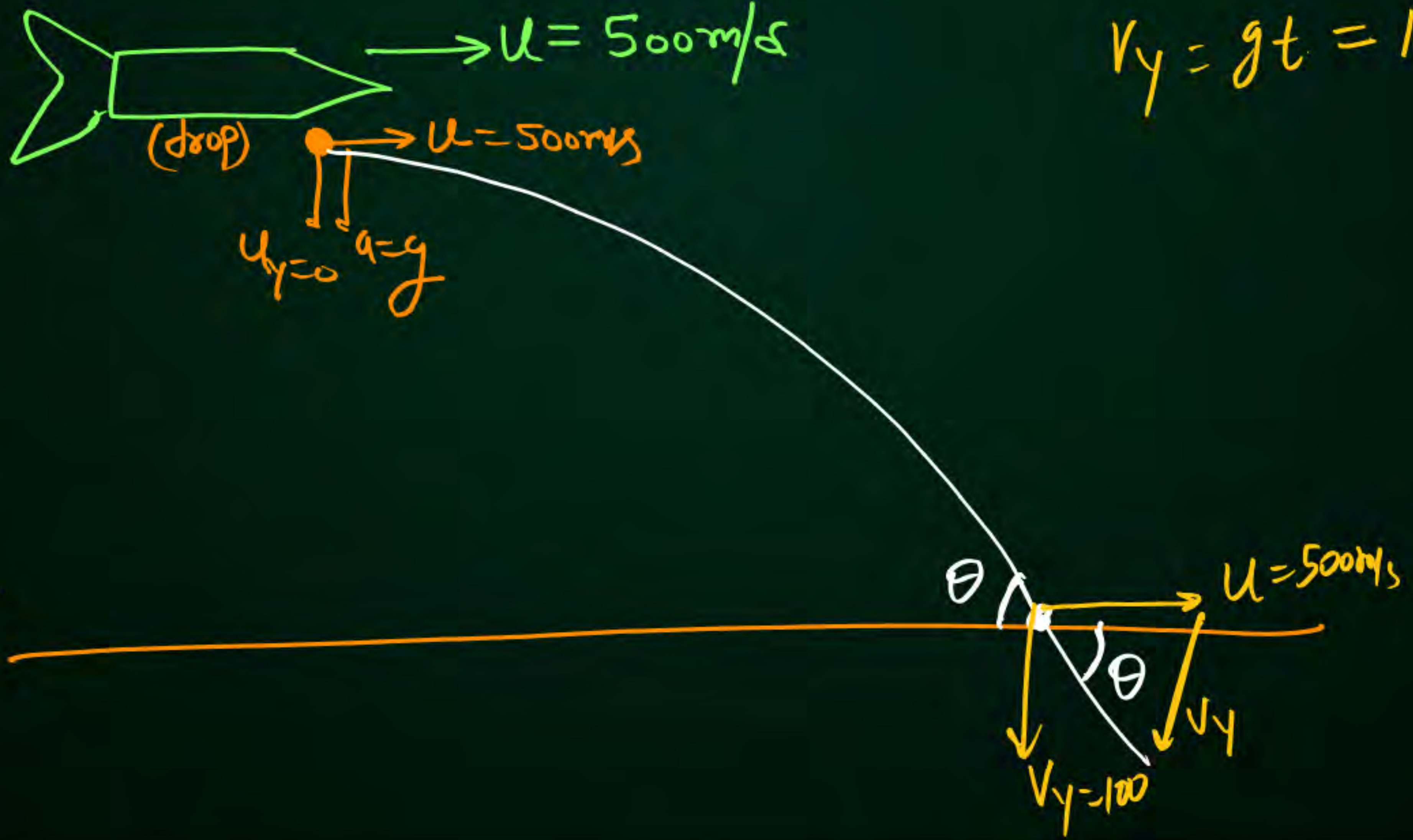


$H = \frac{u^2}{2g}$ $\quad H_{max} = \frac{u_y^2}{2g}$

QUESTION

A bomber plane moves horizontally with a speed of 500 m/s and a bomb released from it, strikes the ground in 10 sec. Angle at which it strikes the ground will be ($g = 10\ m/s^2$) **[MH CET 2003]**

1. $\tan^{-1}\left(\frac{1}{5}\right)$
2. $\tan\left(\frac{1}{5}\right)$
3. $\tan^{-1}(1)$
4. $\tan^{-1}(5)$



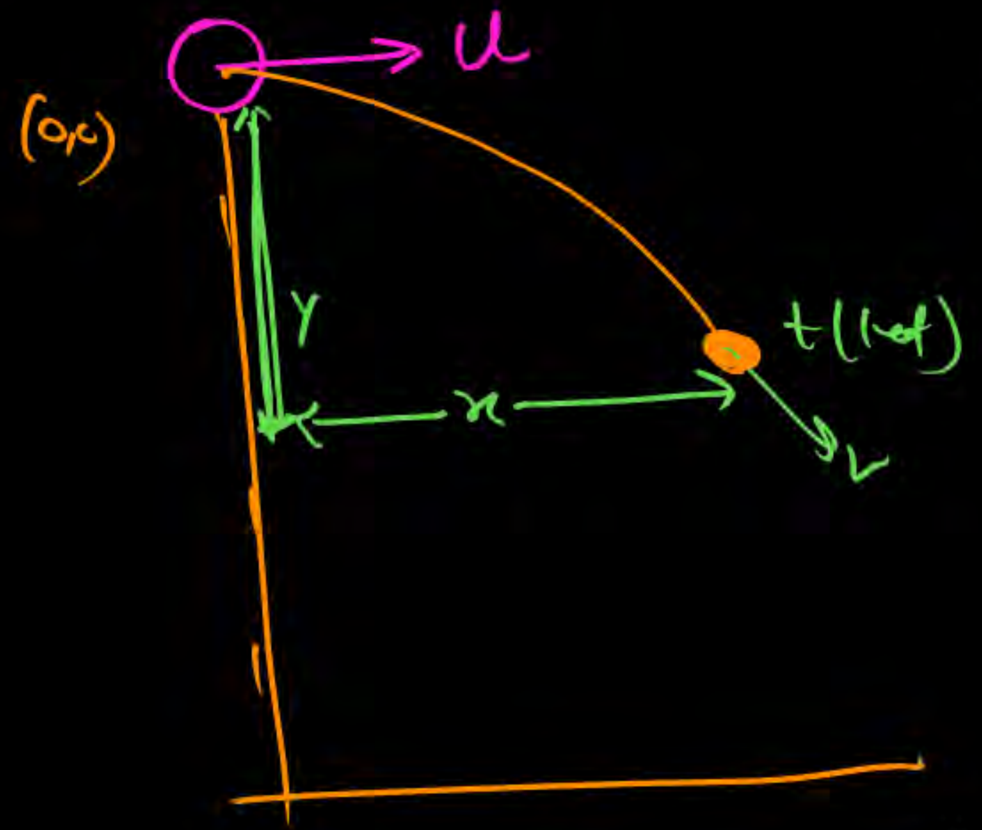
$v_y = gt = 10 \times 10 = 100$

$\tan\theta = \frac{u_y}{u_x} = \frac{100}{500}$

$\theta = \tan^{-1}\left(\frac{1}{5}\right)$

Q. Ball is Projected in Horizontal dirn with speed u then find its speed when it is at a Point where Horizontal and vertical dispm is Same.

Soln



$'y' = 'x'$

$\left\{\frac{1}{2} g t^2\right\} = \{u t\}$

$t = \frac{2u}{g}$ (*)

$\vec{u}_x = u\hat{i}$

$V_y = gt = g\frac{2u}{g} = 2u$ ✓

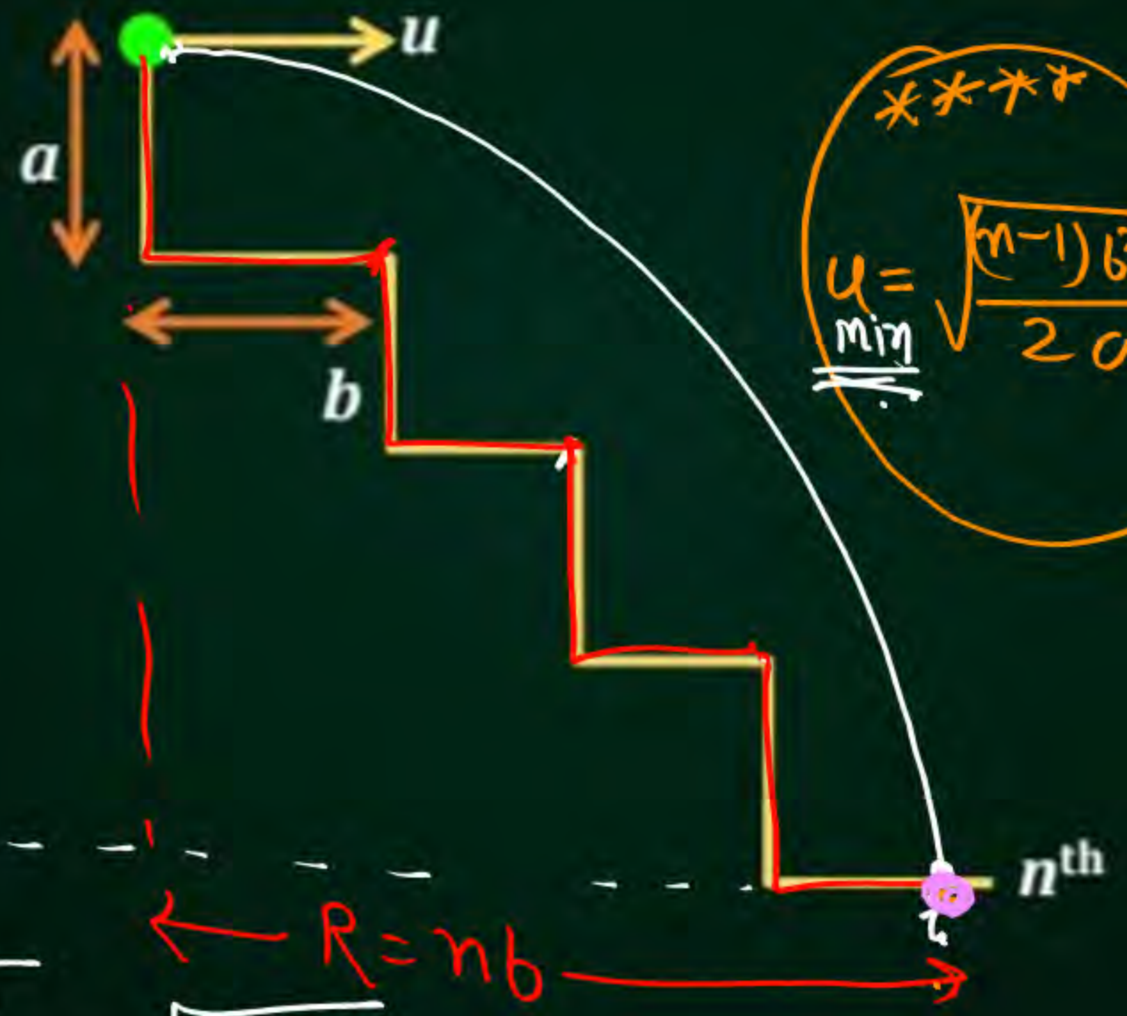
$\vec{V} = u\hat{i} + 2u\hat{j}$

$|V| = \sqrt{u^2 + 4u^2} = \sqrt{5u^2} = (\sqrt{5})u$ Ans

QUESTION

$y = \frac{1}{2} g \frac{x^2}{u^2}$

Find velocity so that ball will fall on n^{th} step.



Sol^n

$T_f = \sqrt{\frac{2H}{g}} = \sqrt{\frac{2na}{g}}$

$H = na$

$R = u_x T_f$ — (ii)

$nb = u\sqrt{\frac{2na}{g}}$

$u = nb\sqrt{\frac{g}{2na}} = \sqrt{\frac{n^2 b^2 g}{2na}} = \sqrt{\frac{nb^2 g}{2a}}$ Ans

****

$u_{min} = \sqrt{\frac{(n-1)b^2 g}{2a}}$

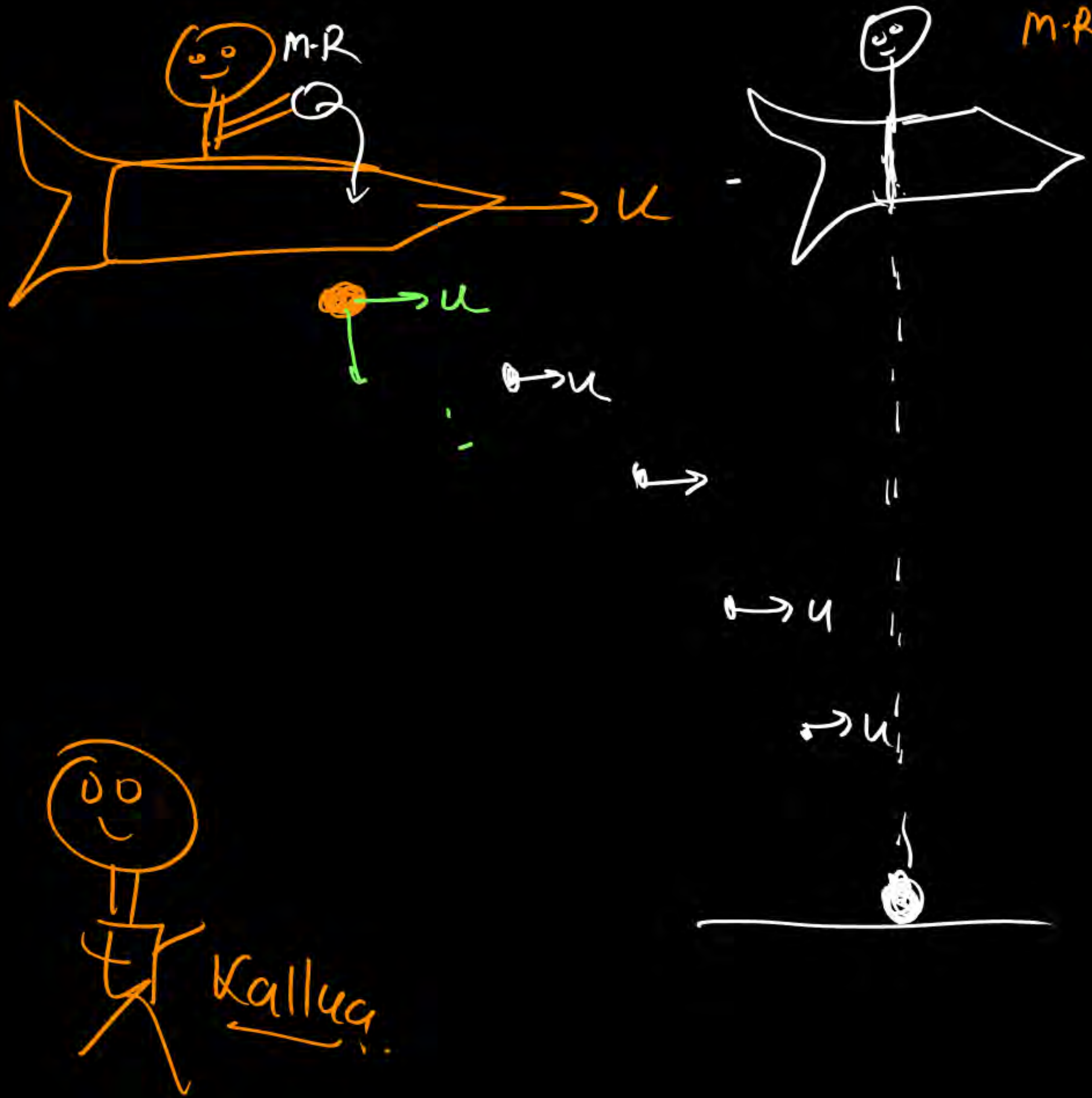
(b) $u = \sqrt{\frac{nbg}{2a}}$ ✗

(a) $u = \sqrt{\frac{nb^2 g}{2a}}$

dim^n: $\sqrt{\frac{L^2 \, LT^{-2}}{L}}$ → $\sqrt{L^2 T^{-2}}$ → LT^{-1}

(c) $u = \sqrt{\frac{nbg}{2a^2}}$ ✗

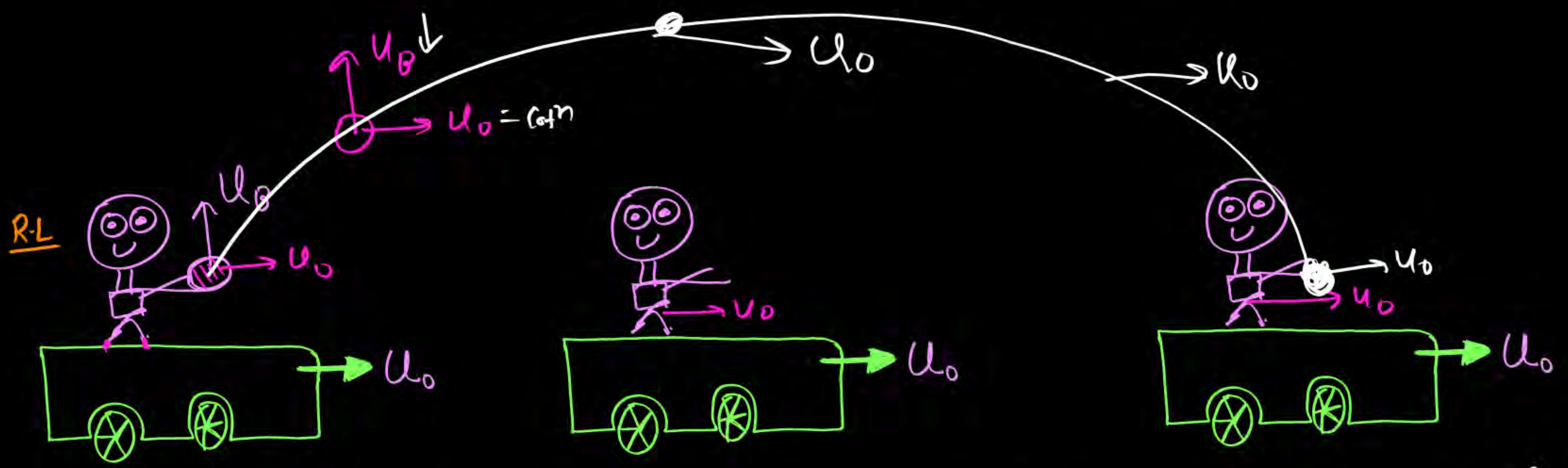
(d) $u = \sqrt{\frac{nabg}{2}}$ ✗



M.R. drops a ball from aroplane

Path of Ball w.r.t M.R = Straight line

Path of Ball w.r.t Kallua = Parabola



Ball is Projected up with speed u_B by Ramlal ??

$$H_{max} = \frac{u_B^2}{2g}$$

$$T_f = \frac{2u_B}{g}$$

$$R = \frac{2u_0 u_B}{g}$$

Kallu only

Path of Ball w.r.t Ramlal → straight line (y-axis)

Path of Ball w.r.t Kallu → Parabola



RELATIVE MOTION IN PLANE

→ vector subtraction

Relative velocity A w.r.t B → $\vec{V}_{AB} = \vec{V}_A - \vec{V}_B$ (B: observer)

$$\vec{V}_{BA} = \vec{V}_B - \vec{V}_A$$

$$\vec{V}_{AB} = -\vec{V}_{BA}$$

$$\vec{v}_{AB} = -\vec{v}_{BA}$$

$V_A = 10\,m/s\,\hat{i}$ $\quad$ $V_B = 20\,m/s\,\hat{i}$

$\vec{v}_{AB} = \vec{v}_A - \vec{v}_B$

$= 10 - 20$

$\vec{v}_{AB} = -10\,m/s$

$\vec{v}_{BA} = \vec{v}_B - \vec{v}_A$

$= 20 - 10$

$= 10\,m/s\,\hat{i}$

QUESTION

Velocity of Ramlal $\vec{V}_R = -3\hat{\imath} + 4\hat{\jmath}$ and velocity of Pinky $\vec{V}_P = 4\hat{\imath} + 3\hat{\jmath}$ then find velocity of Ramlal with respect to Pinky.

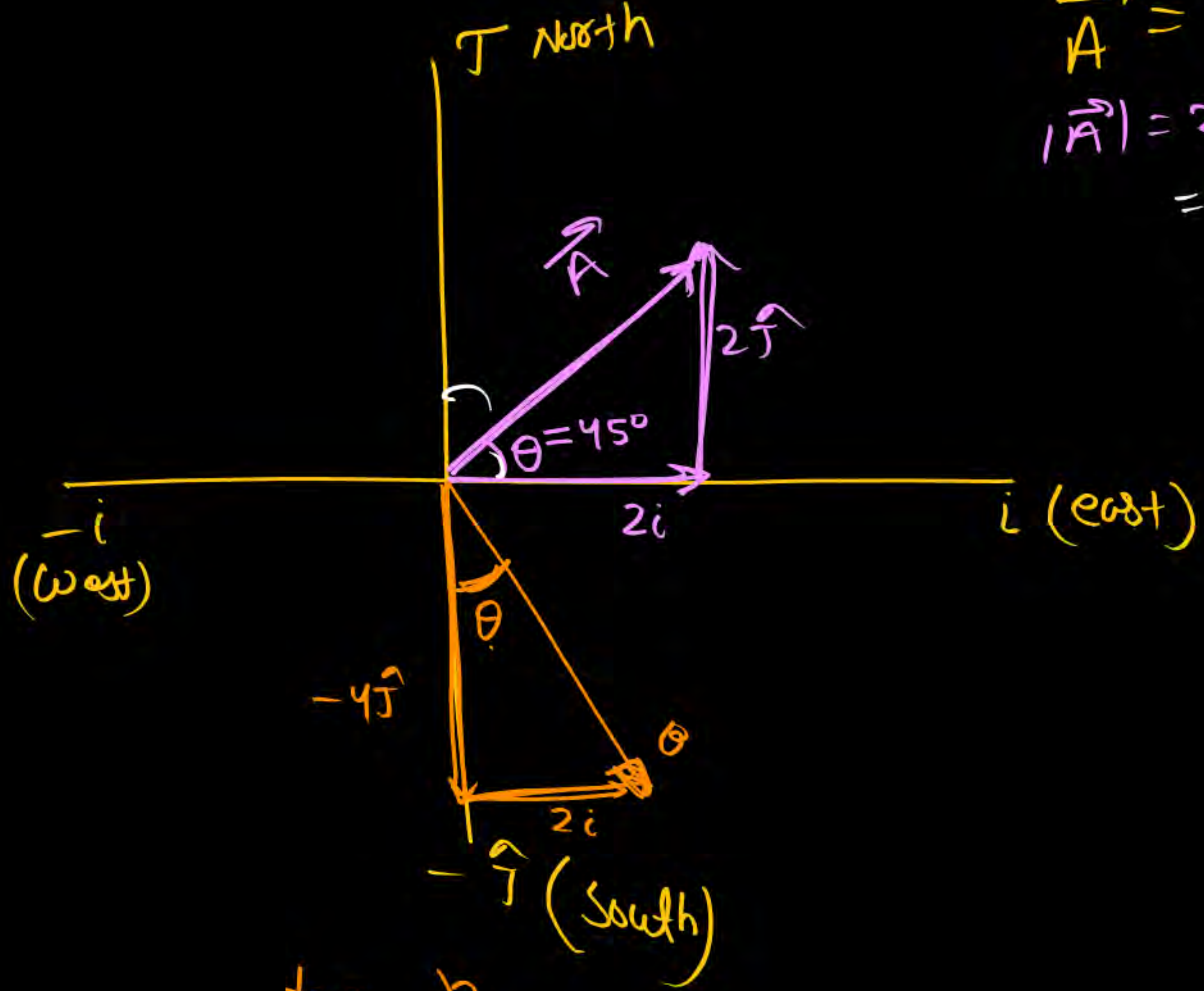
$$\vec{V}_R = -3\hat{i} + 4\hat{j}$$

$$\vec{V}_P = 4i + 3\hat{j}$$

$$\vec{v}_{RP} = \vec{v}_R - \vec{v}_P$$

$$= -3i + 4\hat{j} - 4i - 3\hat{j}$$

$$\vec{v}_{RP} = -7\hat{i} + \hat{j}$$



$\tan\theta = \frac{2}{4}$

$\tan\theta = \frac{1}{2}$

$\vec{A} = 2\hat{i} + 2\hat{j}$

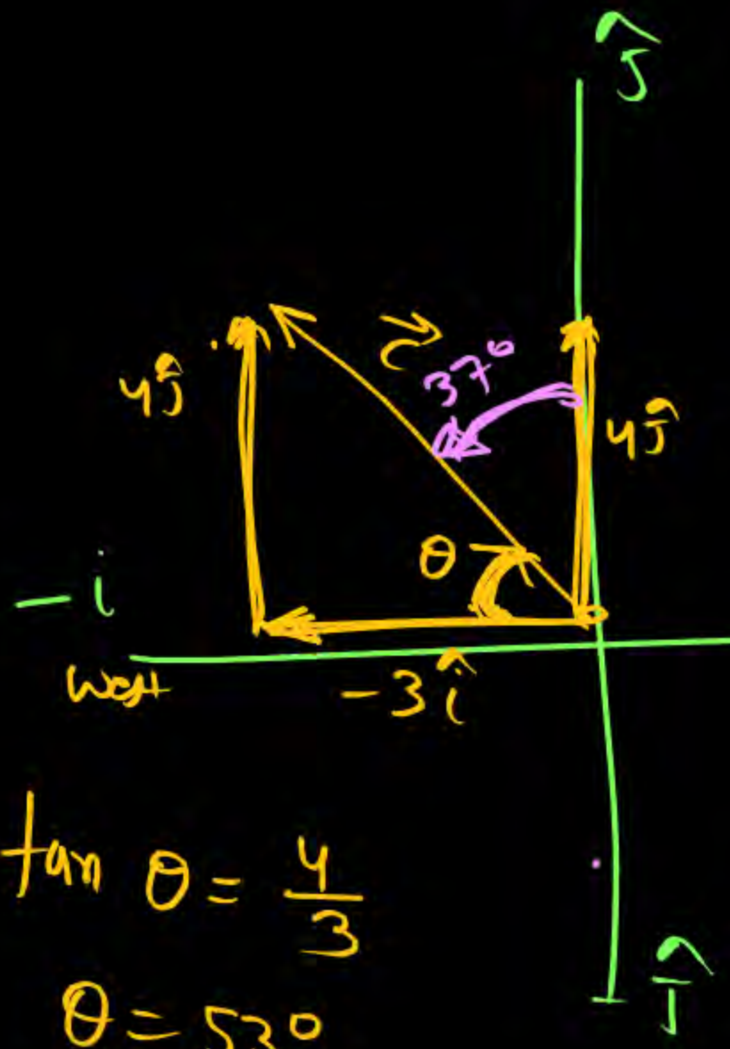
$|\vec{A}| = 2\sqrt{2}$ at $45°$ North of East

$= 2\sqrt{2}$ at $45°$ east of North

$= 2\sqrt{2}$ (North - east)

$\vec{B} = 2\hat{i} - 4\hat{j}$

$|B| = \sqrt{20}$ at $\theta = \tan^{-1}\left(\frac{1}{2}\right)$ east of South



$\tan\theta = \frac{4}{3}$

$\theta = 53°$

$\vec{C} = -3\hat{i} + 4\hat{j}$

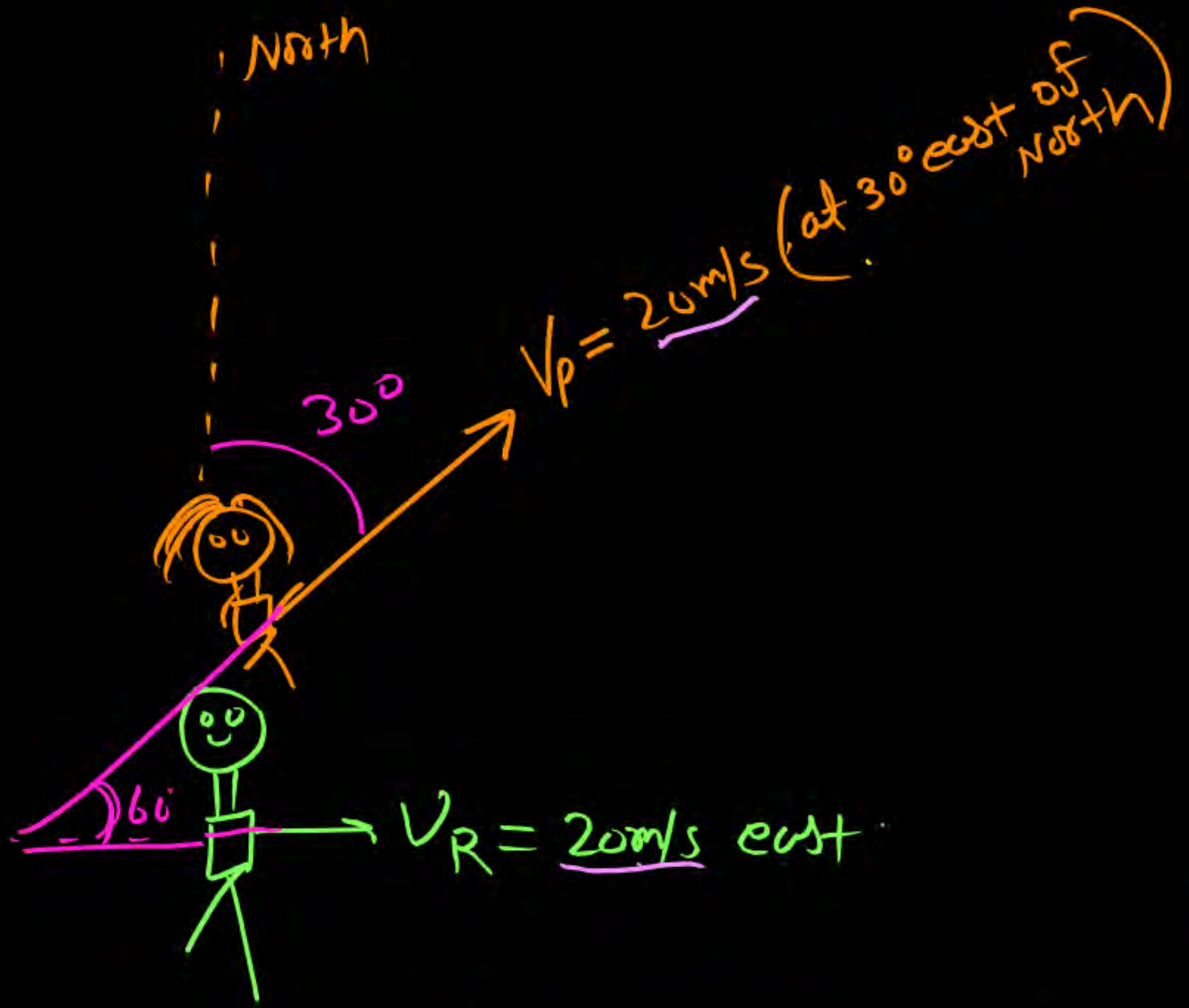
$|\vec{C}| = \sqrt{(-3)^2 + (4)^2}$

$= \sqrt{9+16} = \sqrt{25} = 5$

$|\vec{C}| = 5$ at $53°$ North of west

$= 5$ at $37°$ West of North

$$v_{PR} = ??$$



मजदूरी

$$20\cos 30^\circ = 20 \times \frac{\sqrt{3}}{2} = 10\sqrt{3}\,\hat{j}$$



$$20\sin 30^\circ = 20 \times \frac{1}{2} = 10\,\hat{i}$$

$$V_R = 20\,\hat{i}$$

$$v_{PR} = \vec{v}_P - \vec{V}_R$$

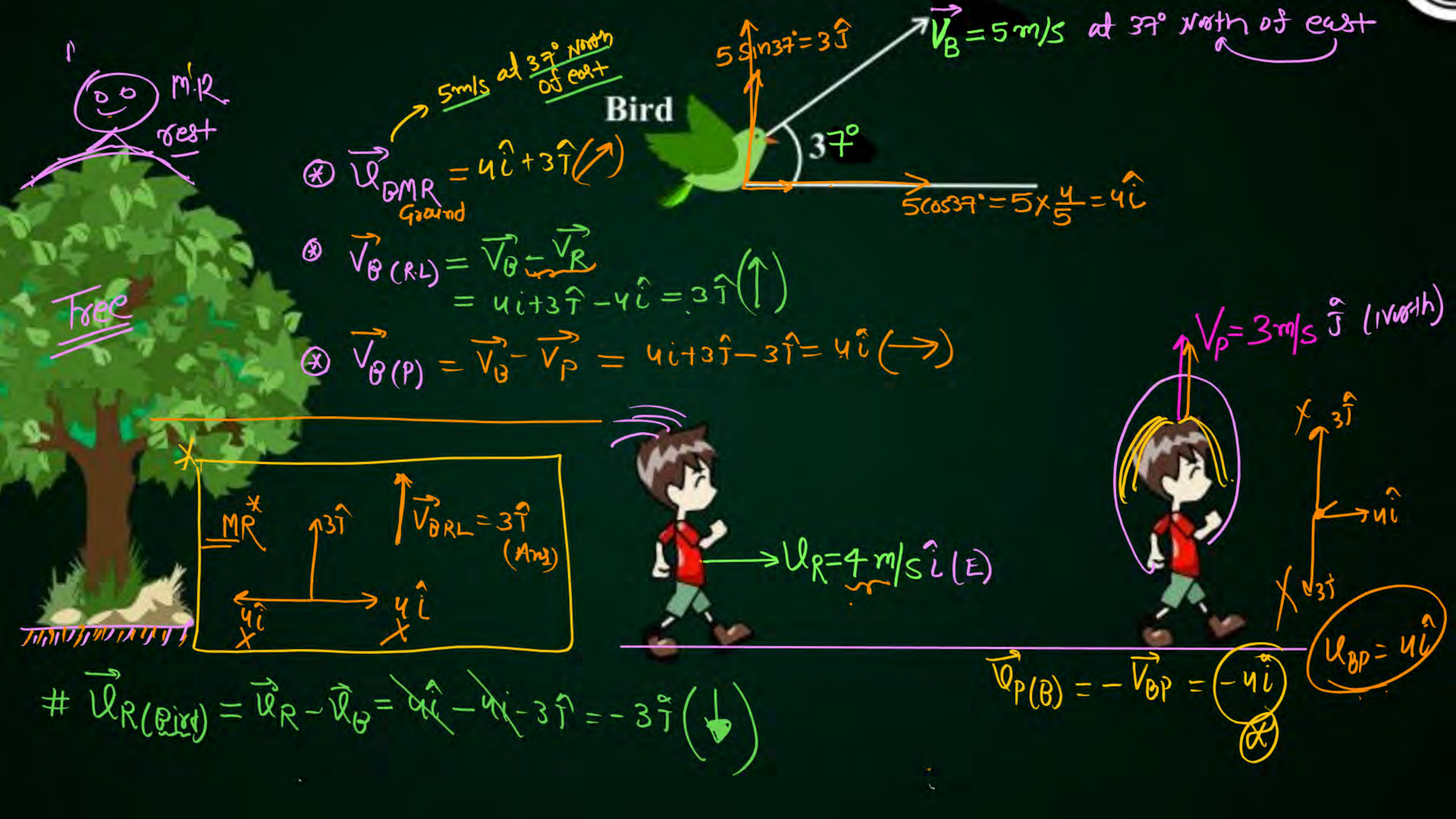
$$= 10\hat{i} + 10\sqrt{3}\,\hat{j} - 20\hat{i}$$

$$\vec{v}_{PR} = -10\hat{i} + 10\sqrt{3}\,\hat{j}$$

$$|V_{PR}| = \sqrt{(-10)^2 + (10\sqrt{3})^2} = \sqrt{100 + 300} = \sqrt{400} = 20\,m/s$$

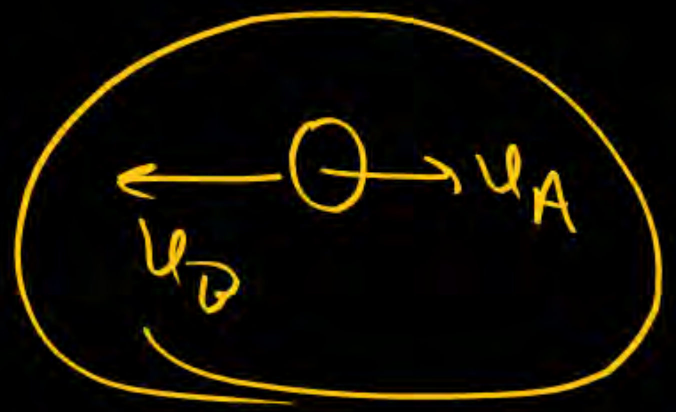
MR*

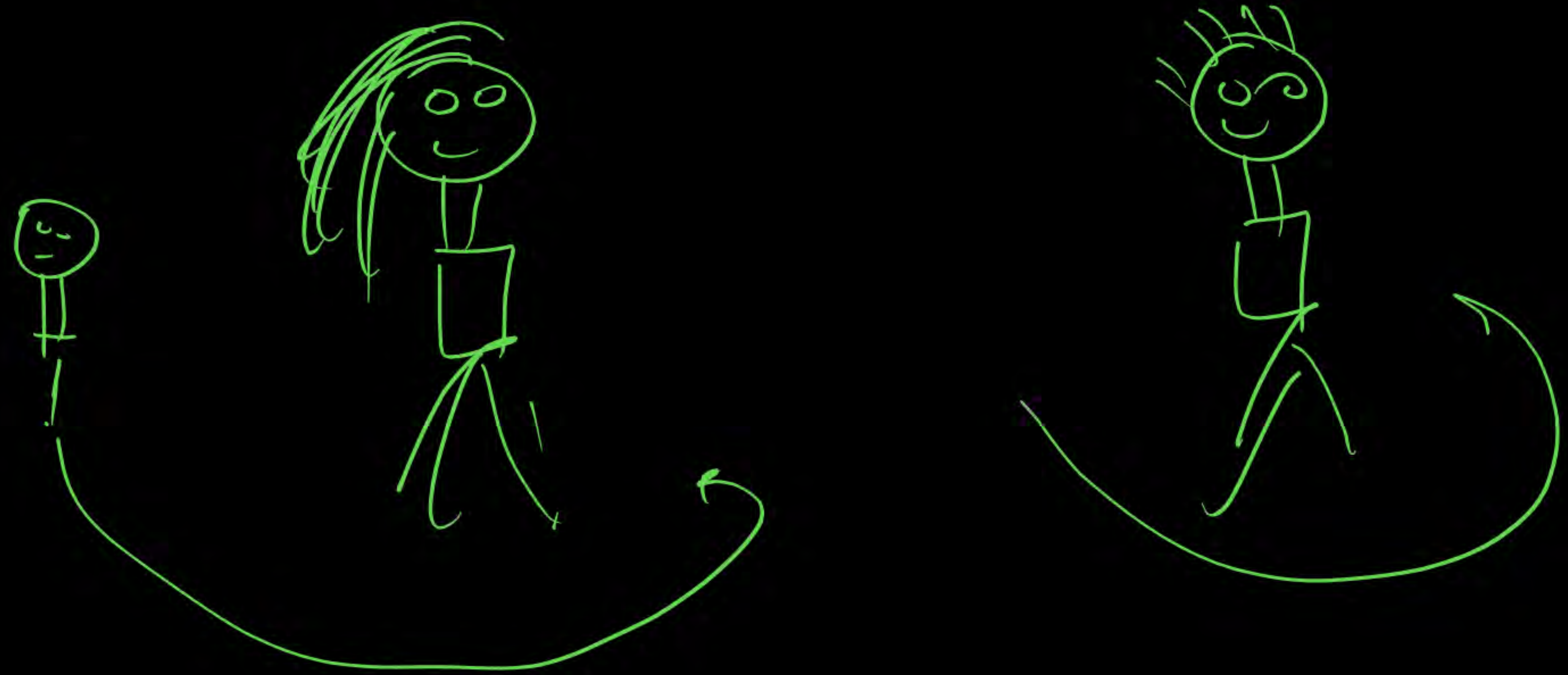
$$|\vec{v}_{PR}| = 20\,m/s$$



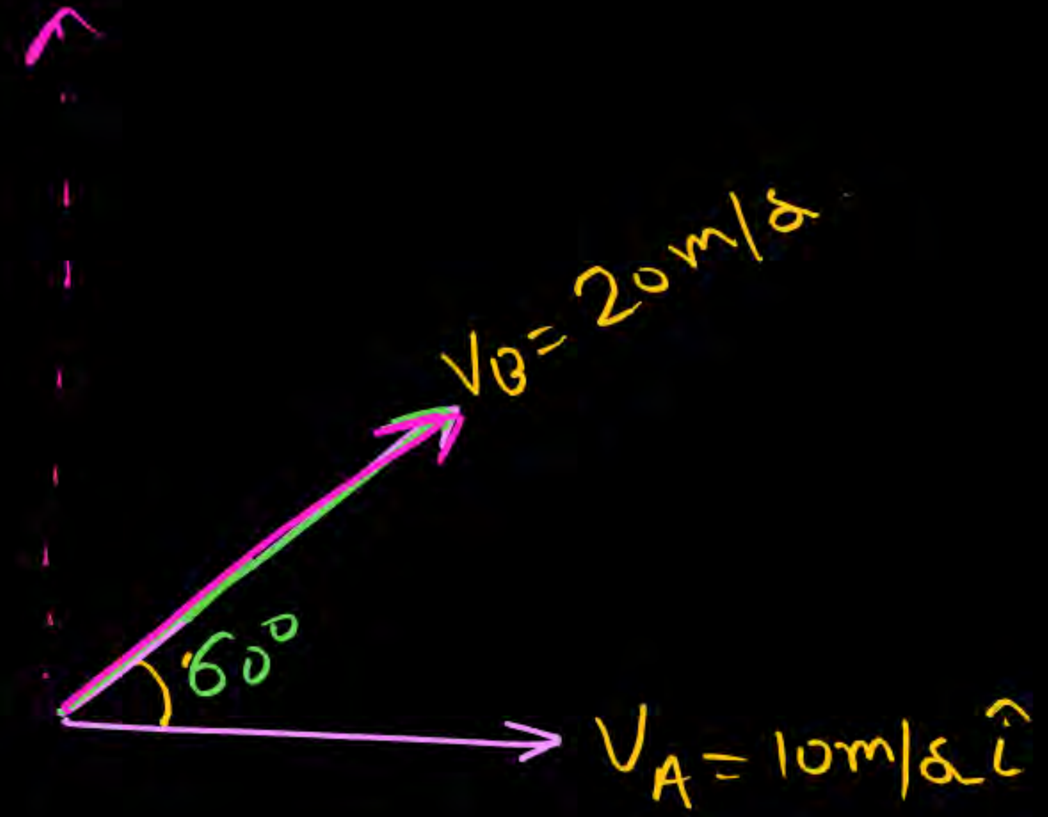
M.R
rest
Tree
5m/s at 37° North of east
* $\vec{u}_{BMR}$ (Ground) $= 4\hat{i} + 3\hat{j}$ (↗)
Bird
$5\sin 37° = 3\hat{j}$
$\vec{V}_B = 5$ m/s at 37° North of east
37°
$5\cos 37° = 5 \times \frac{4}{5} = 4\hat{i}$
* $\vec{V}_{B(R.L)} = \vec{V}_B - \vec{V}_R$
$= 4i + 3\hat{j} - 4\hat{i} = 3\hat{j}$ (↑)
* $\vec{V}_{B(P)} = \vec{V}_B - \vec{V}_P = 4i + 3\hat{j} - 3\hat{j} = 4\hat{i}$ (→)
$V_p = 3$ m/s $\hat{j}$ (North)
MR*
$3\hat{j}$
$\vec{V}_{BRL} = 3\hat{j}$ (Ans)
$4\hat{i}$
$4\hat{i}$
$u_R = 4$ m/s $\hat{i}$ (E)
$3\hat{j}$
$4\hat{i}$
$3\hat{j}$
$u_{BP} = 4\hat{i}$
$\vec{u}_{P(B)} = -\vec{V}_{BP} = -4\hat{i}$
$\vec{u}_{R(Bird)} = \vec{u}_R - \vec{u}_B = 4\hat{i} - 4\hat{i} - 3\hat{j} = -3\hat{j}$ (↓)

$$\vec{u}_{AB} = \vec{u}_A - \vec{u}_B \quad \text{(formula)}$$





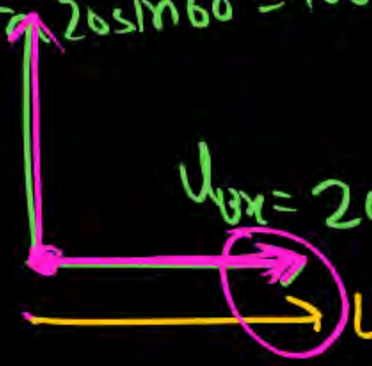
#



$\vec{u}_{BA} = ??$

Q. find velocity of B w.r.t. A ??

Soln



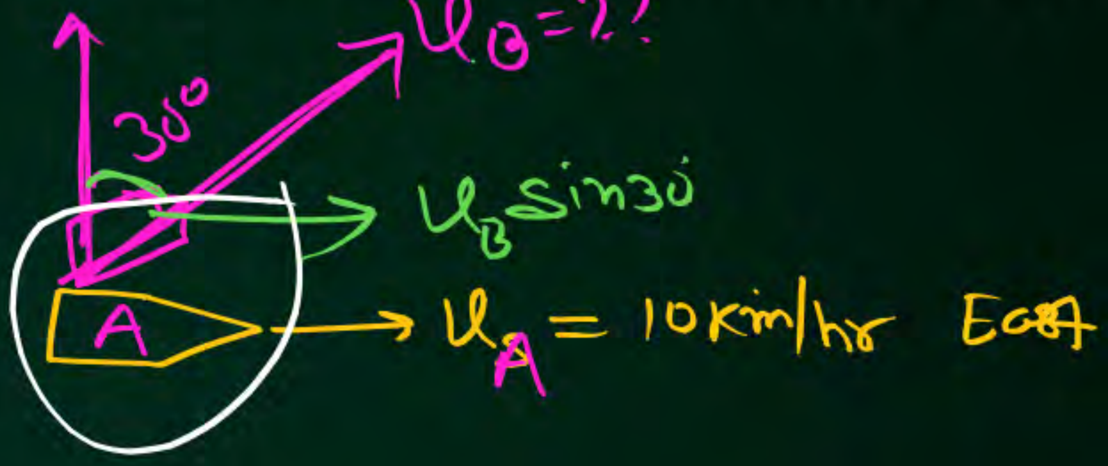
$\vec{V}_{BA} = \cancel{10\hat{i}} + 10\sqrt{3}\,\hat{j} - \cancel{10\hat{i}} = 10\sqrt{3}\,\hat{j}$ (↑)

$\vec{u}_{BA} = 10\sqrt{3}\,\hat{j}$

B appears to move in y w.r.t. A

QUESTION

A ship is travelling due east at 10 km/h. A ship heading 30° east of north is always due north from the first ship. The speed of the second ship in km/h is –



1. $20\sqrt{2}$
2. $20\sqrt{3/2}$
3. 20
4. $20/\sqrt{2}$

$v_B \sin 30° = v_A$

$v_B \frac{1}{2} = 10$

$v_B = 20$

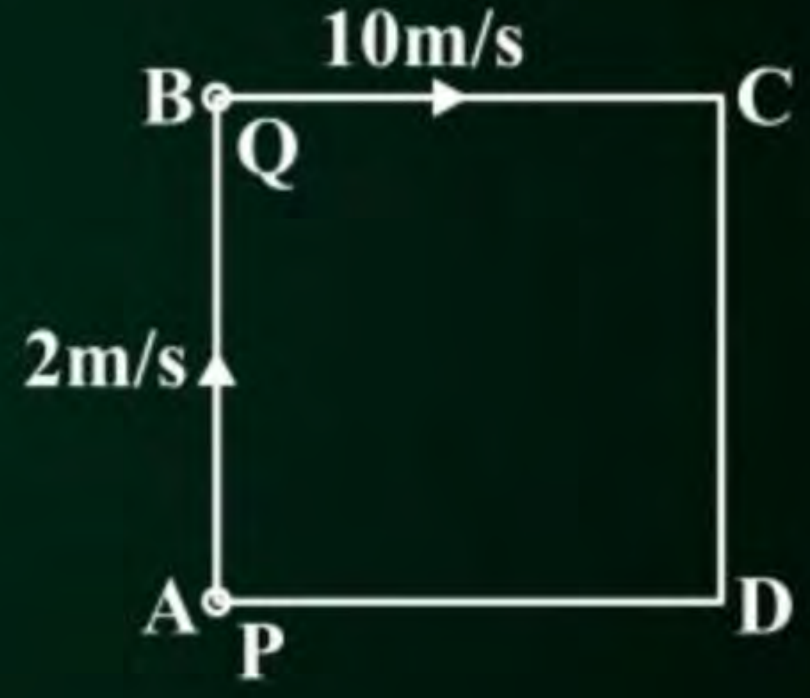
QUESTION

A bird is flying with a speed of 40 km/hr. in the north direction. A train is moving with a speed of 40 km/hr. in the west direction. A passenger sitting in the train will see the bird moving with velocity :-

1. 40 km/hr in NE direction
2. $40\sqrt{2}$ km/hr in NE direction
3. 40 km/hr in NW direction
4. $40\sqrt{2}$ km/hr in NW direction

QUESTION

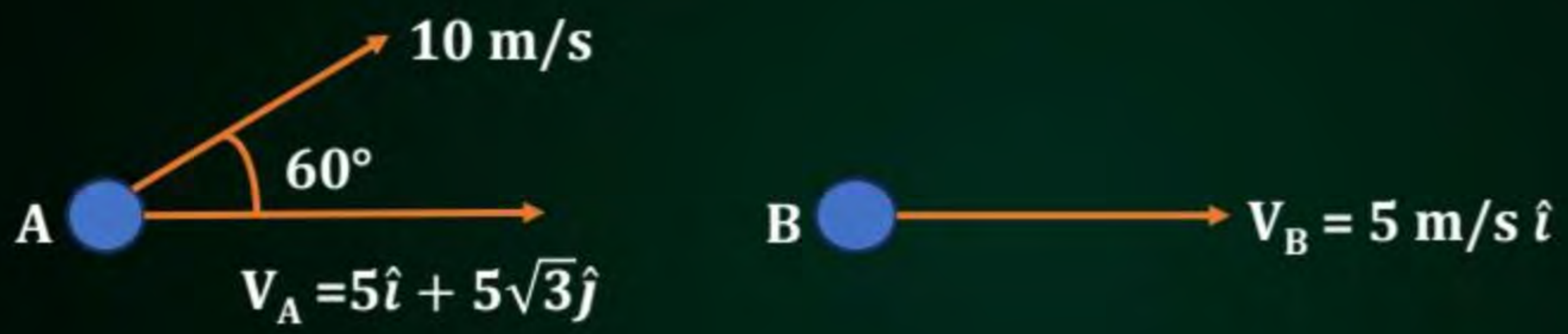
Two men P & Q are standing at corners A & B of square ABCD of side 8 m. They start moving along the track with constant speed 2 m/s and 10 m/s respectively. Find the time when they will meet for the first time.



1. 2 s
2. 3 s
3. 1 s
4. 6 s

QUESTION

Find velocity of A with respect to B.



QUESTION

A ship is travelling due east at 10 km/h. A ship heading 30° east of north is always due north from the first ship. The speed of the second ship in km/h is -

1. $20\sqrt{2}$
2. $20\sqrt{3/2}$
3. 20
4. $20/\sqrt{2}$

QUESTION

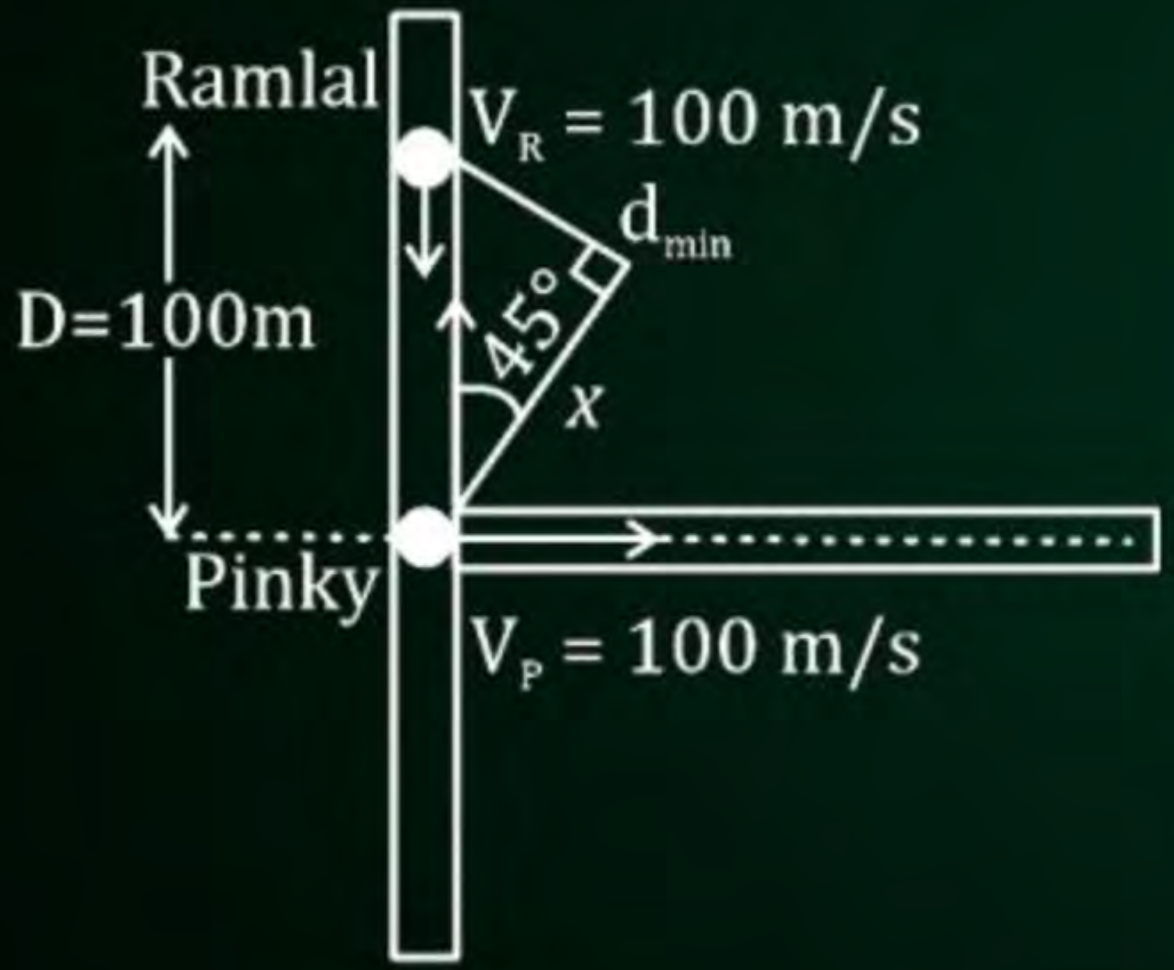
Car is moving with 30 m/s along east and truck is moving with speed 40 m/s at 30° N of E w.r.t. car then find velocity of truck.

QUESTION

A man 'A' moves in the north direction with a speed 10 m/s and another man B moves in E-30°-N with 10 m/s. Find the relative velocity of B w.r.t. A.

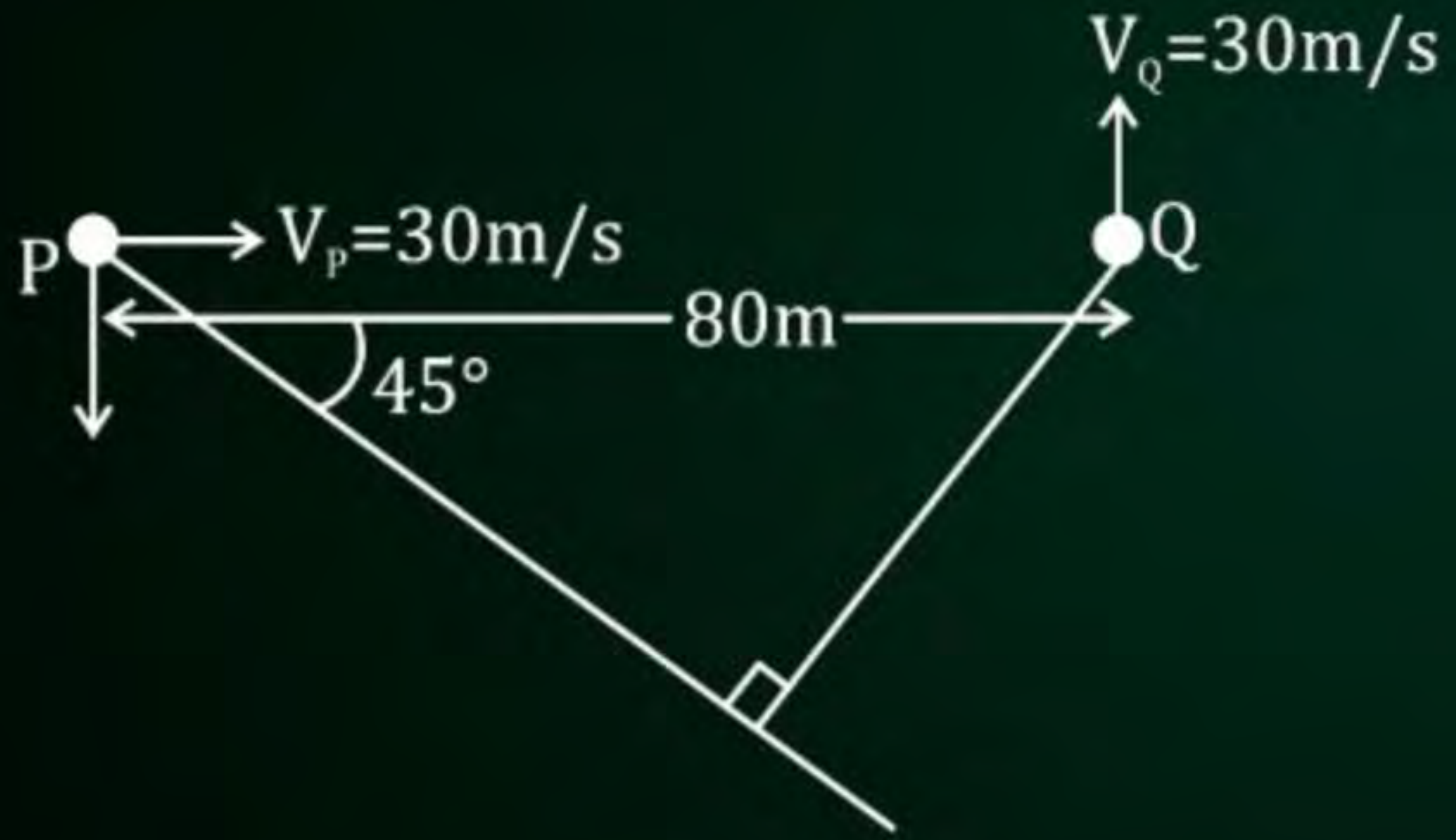
QUESTION

Find minimum separation between Ramlal and Pinky.



QUESTION

Find minimum separation between them.



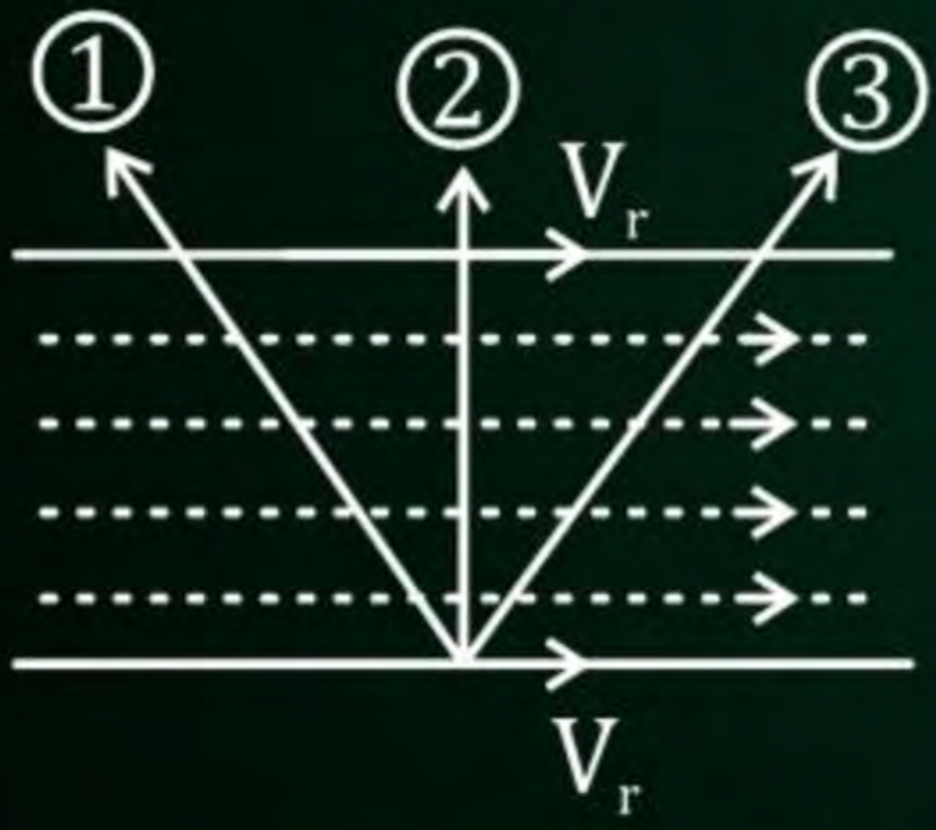
QUESTION

Find minimum separation between A and B.

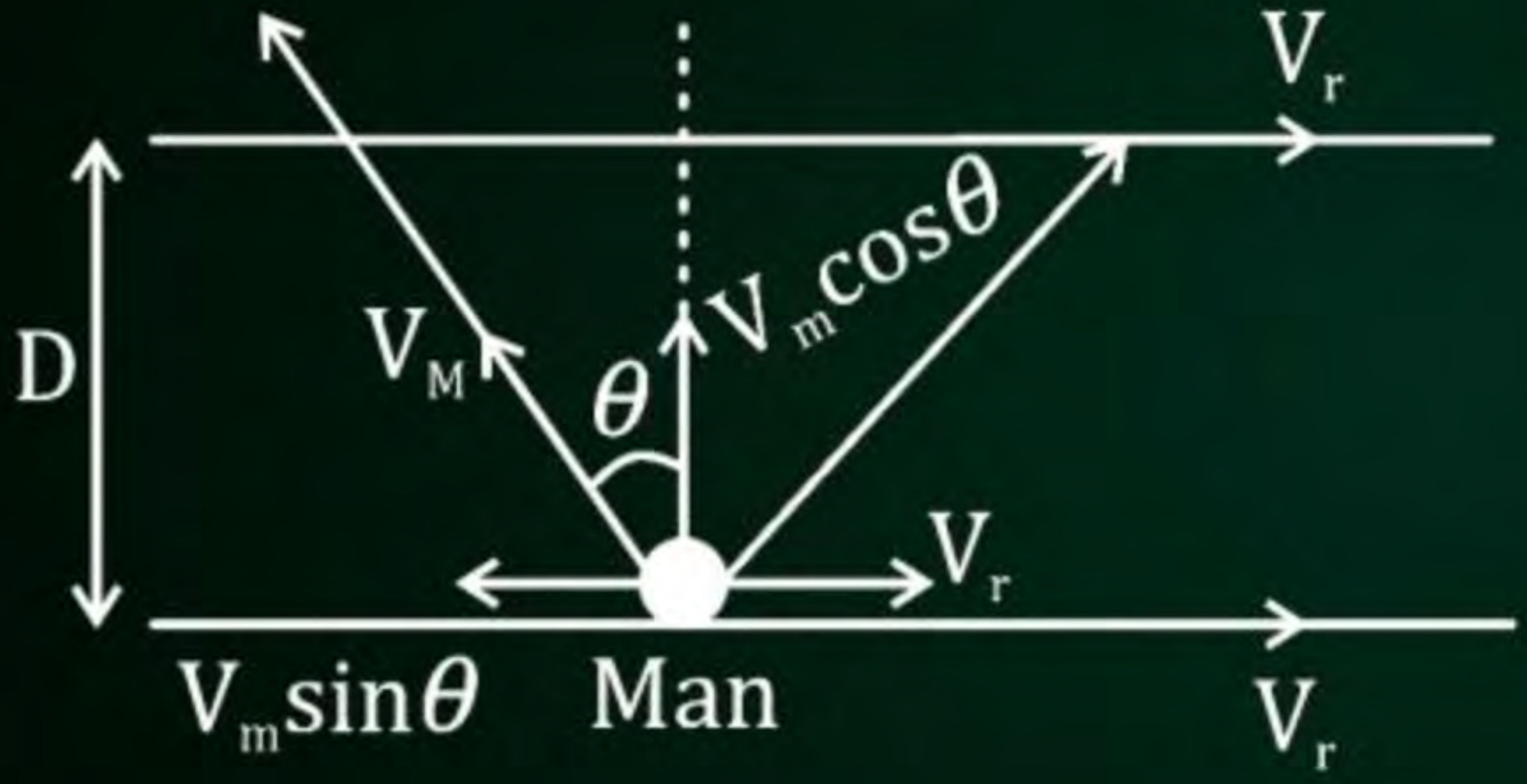


RIVER MAN PROBLEM

In which direction man will swim to cross the river in minimum time?



- **Crossing river in minimum time**



- Velocity of man with respect to river
- Velocity of man with respect to still water
- Velocity of man by which he can swim

All are same.

QUESTION

A river is flowing from east to west at a speed of 5m/min. A man on south bank of river, capable of swimming 10 m/min in still water, wants to swim across the river in shortest time; he should swim :-

1. due north
2. due north-east
3. Due north-east with double the speed of river
4. none of the above

QUESTION

A boat is sailing at a velocity $(3\hat{i} + 4\hat{j})$ with respect to ground and water in river is flowing with a velocity $(-3\hat{i} - 4\hat{j})$. Relative velocity of the boat with respect to water is :-

1. $8\hat{j}$

2. $5\sqrt{2}$

3. $6\hat{i} + 8\hat{j}$

4. $-6\hat{i} - 8\hat{j}$

QUESTION

A boat takes 2 hours to go 8 km and come back in still water lake. With water velocity of 4km/hr, the time taken for going upstream of 8 km and coming back is :-

1. 140 min
2. 150 min
3. 160 min
4. 170 min

QUESTION

A boat, which has a speed of 5 km/h in still water, crosses a river of width 1 km along the shortest possible path in 15 minutes. The velocity of the river water in km/h is -

1. 1
2. 3
3. 4
4. $\sqrt{41}$

QUESTION

A man wishes to swim across a river 0.5 km. wide. If he can swim at the rate of 2 km/h. in still water and the river flows at the rate of 1 km/h. The angle (w.r.t. the flow of the river) along which he should swim so as to reach a point exactly opposite his starting point, should be :-

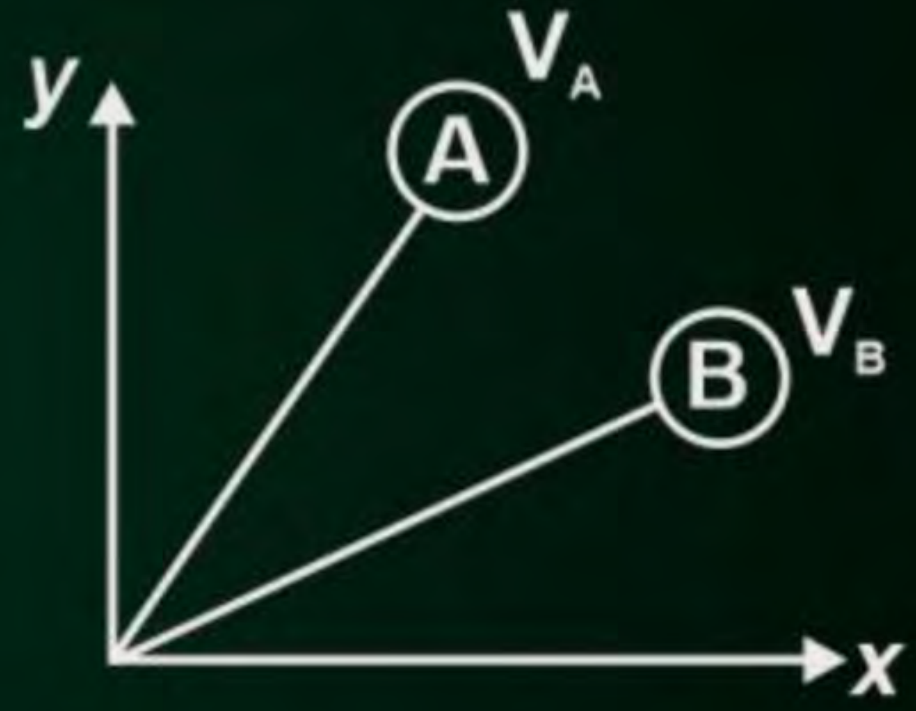
1. 60°
2. 120°
3. 145°
4. 90°

QUESTION

A boat moving towards east with velocity 4 m/s with respect to still water and river is flowing towards north with velocity 2 m/s and the wind is blowing towards north with velocity 6 m/s. The direction of the flag blown over by the wind hoisted on the boat is :-

1. North-west
2. South-east
3. $\tan^{-1}(1/2)$ with east
4. North

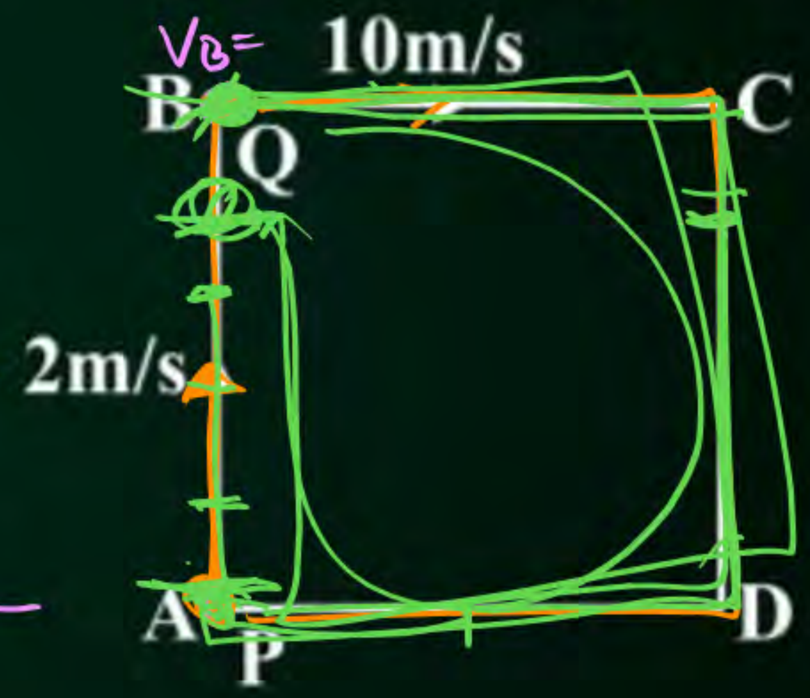
CONDITION OF COLLISION




THANK YOU

QUESTION

Two men P & Q are standing at corners A & B of square ABCD of side 8 m. They start moving along the track with constant speed 2 m/s and 10 m/s respectively. Find the time when they will meet for the first time.



1. 2 s
2. 3 s
3. 1 s
4. 6 s

QUESTION

Car is moving with 30 m/s along east and truck is moving with speed 40 m/s at 30° N of E w.r.t. car then find velocity of truck.



$\vec{v}_c = 30\,\text{m/s}\ \hat{i}$

$40\sin 30 = 20\hat{j}$



$40\cos 30° = 20\sqrt{3}\hat{i}$

$\vec{v}_{TC} = \vec{v}_T - \vec{v}_c$

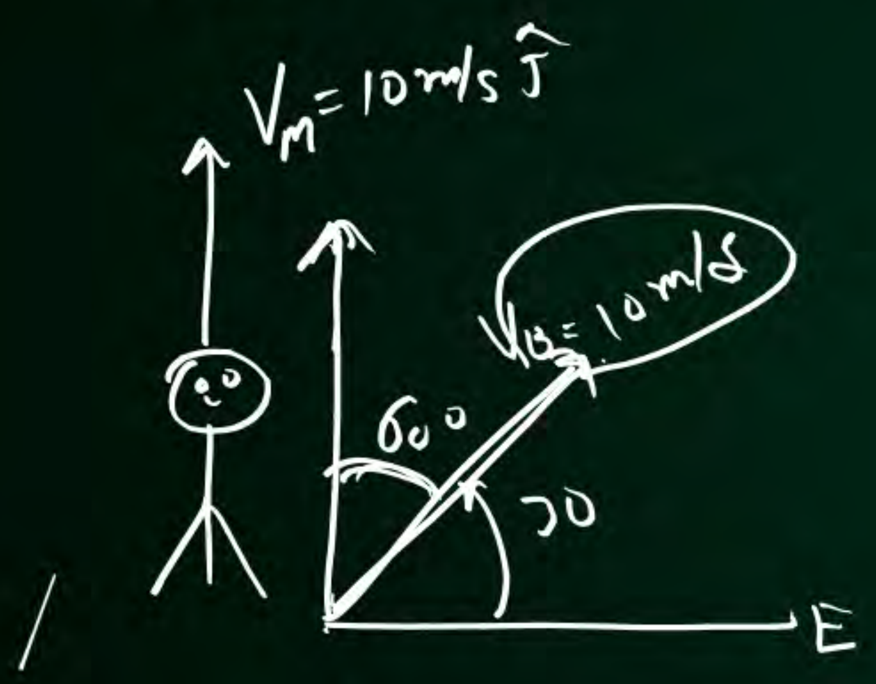
$20\sqrt{3}\hat{i} + 20\hat{j} = \vec{v}_T - 30\hat{i}$

$\vec{v}_T = 30\hat{i} + 20\sqrt{3}\hat{i} + 20\hat{j}$

$\vec{v}_T = (30 + 20\sqrt{3})\hat{i} + 20\hat{j}$

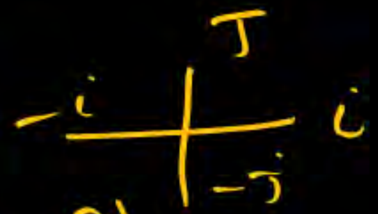
QUESTION

A man 'A' moves in the north direction with a speed 10 m/s and another man B moves in E-30°-N with 10 m/s. Find the relative velocity of B w.r.t. A.



$$\vec{v}_{BA} = \vec{v}_B - \vec{v}_A$$

min^m sep^n b/w Ramlal & Pinky



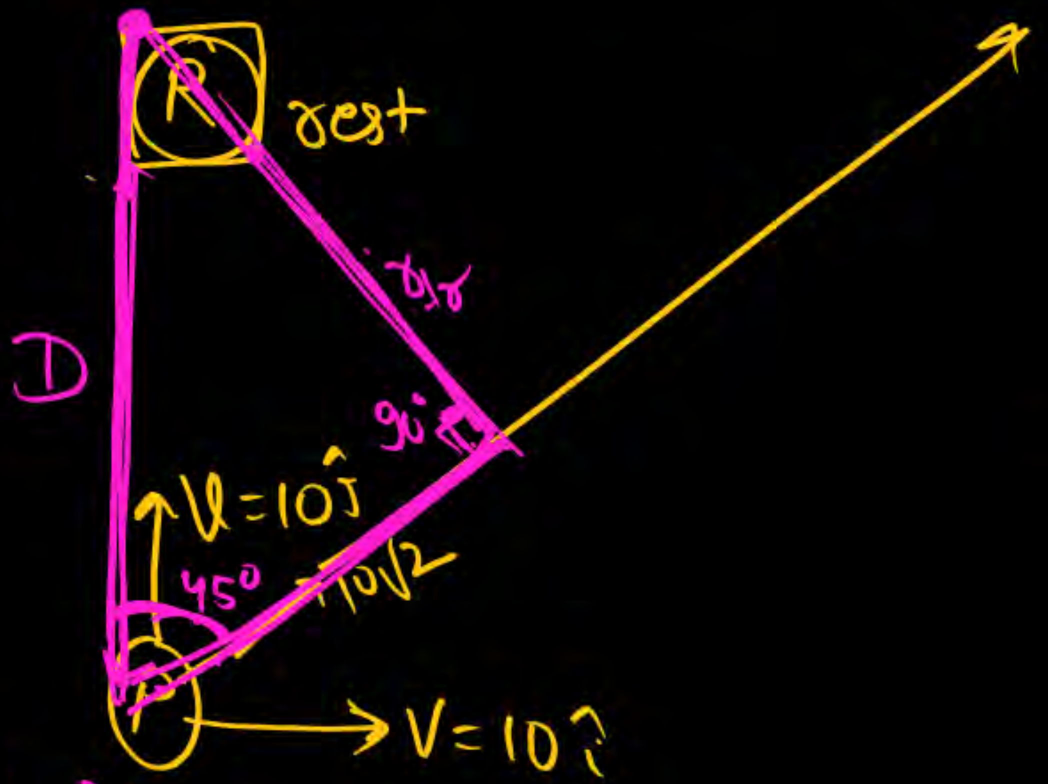
Sol^n

$\vec{u}_{RR} = 0$

$\vec{u}_{PR} = \vec{V}_P - \vec{V}_R = 10\hat{i} - (-10\hat{j})$

$= 10\hat{i} + 10\hat{j}$

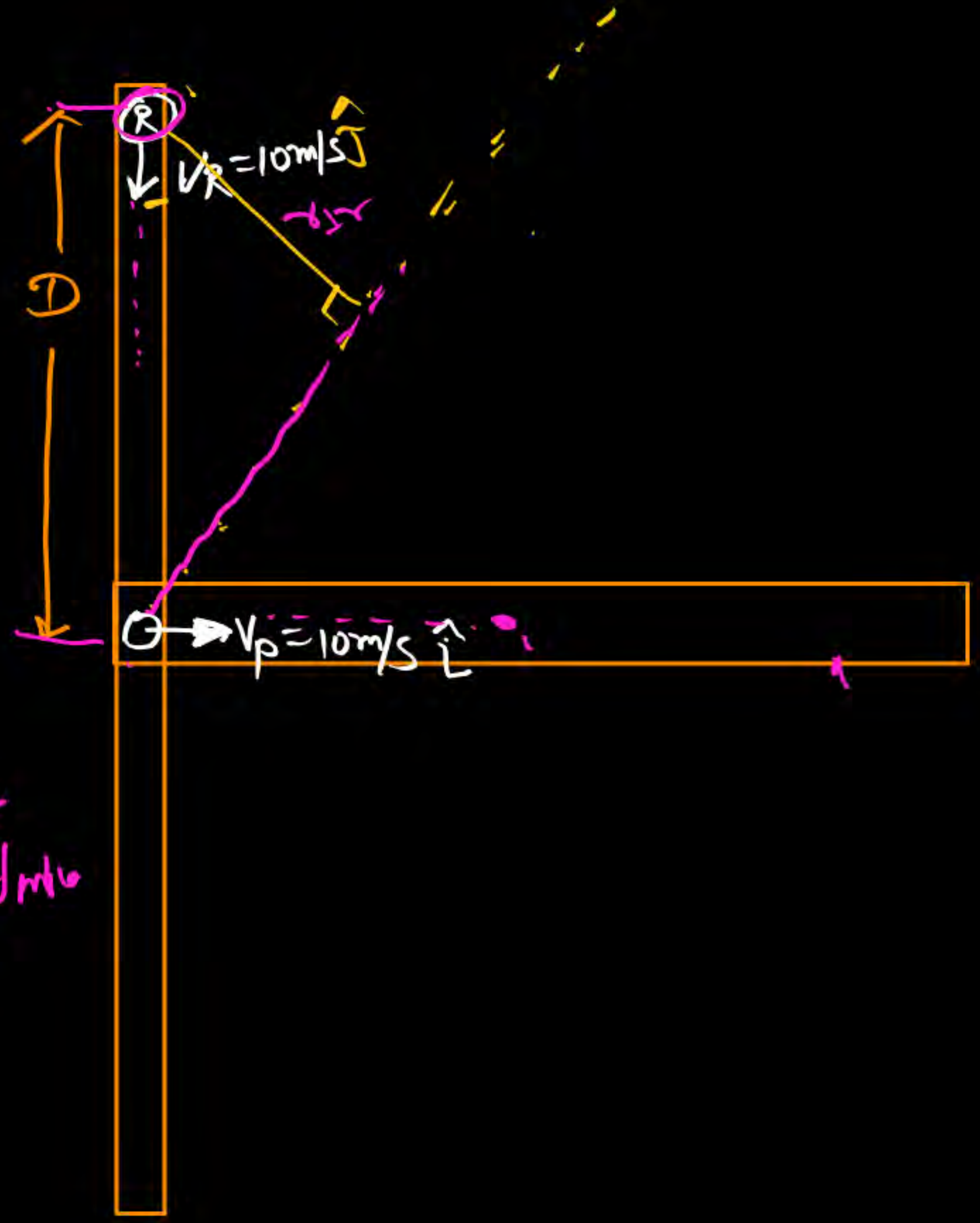
MR^*

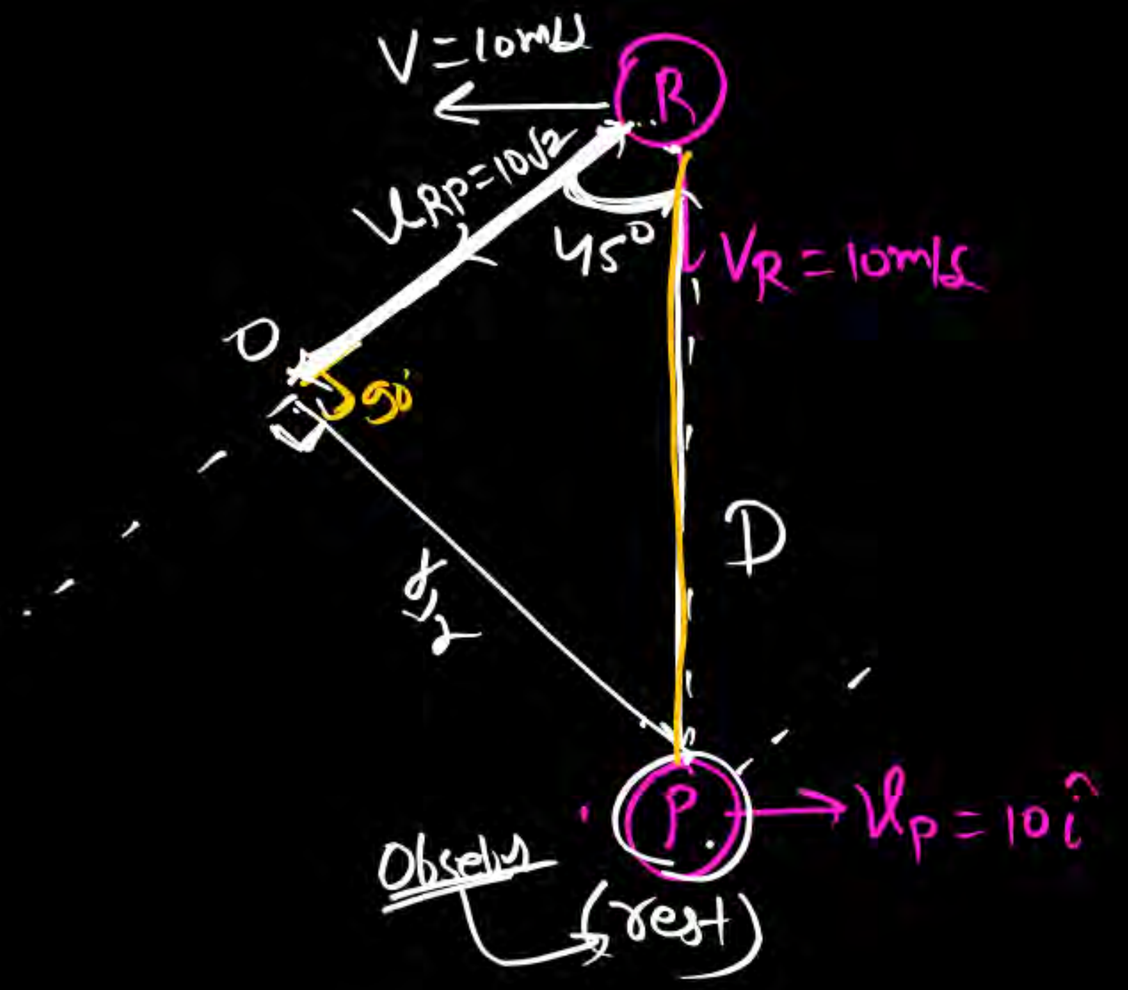


$\sin 45^\circ = \frac{r_{1r}}{D}$

$r_{1r} = D\frac{1}{\sqrt{2}} = \left(\frac{D}{\sqrt{2}}\right)$

$MR^* \Rightarrow \frac{D}{\sqrt{2}} = d_{min}$





find time when they are at min^m sep^n

$$\text{dist}_{RO} = \frac{d}{\sqrt{2}}$$

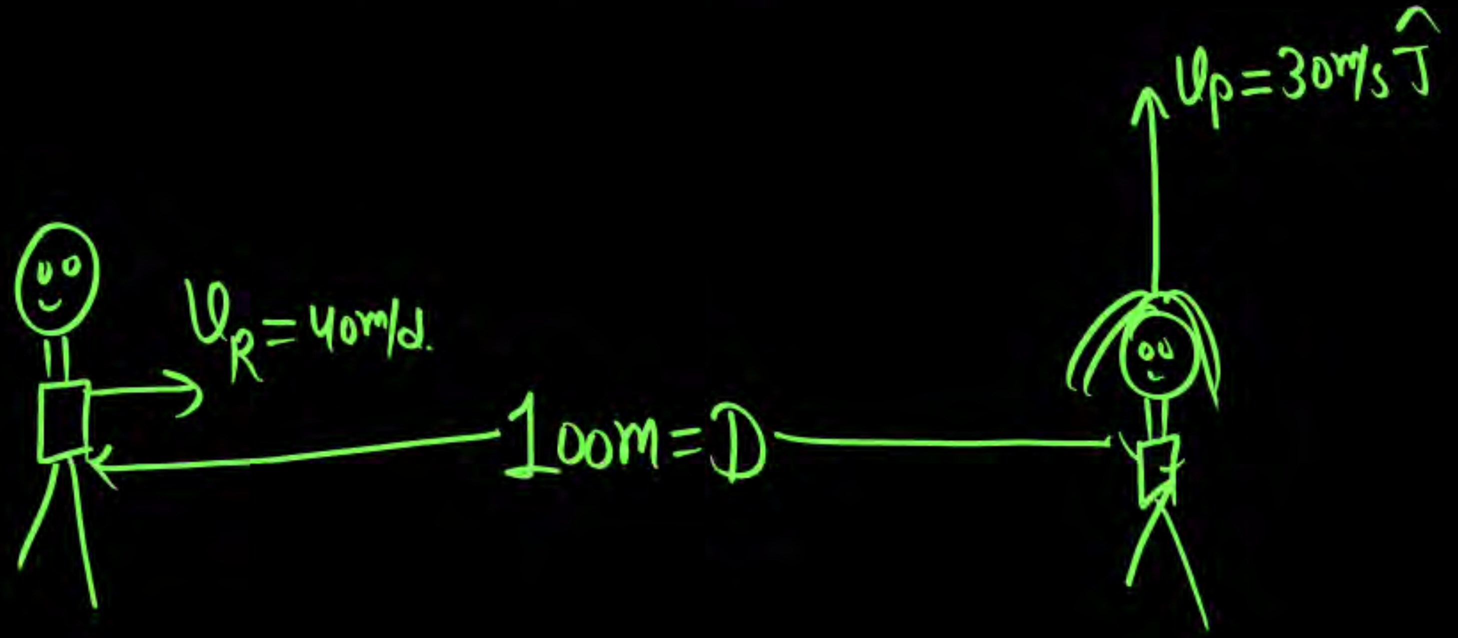
$$\text{time} = \frac{\text{dist}^n}{\text{speed}}$$

$$= \frac{d}{\sqrt{2}\cdot 10\sqrt{2}} = \frac{d}{10\times 2}$$ Ans

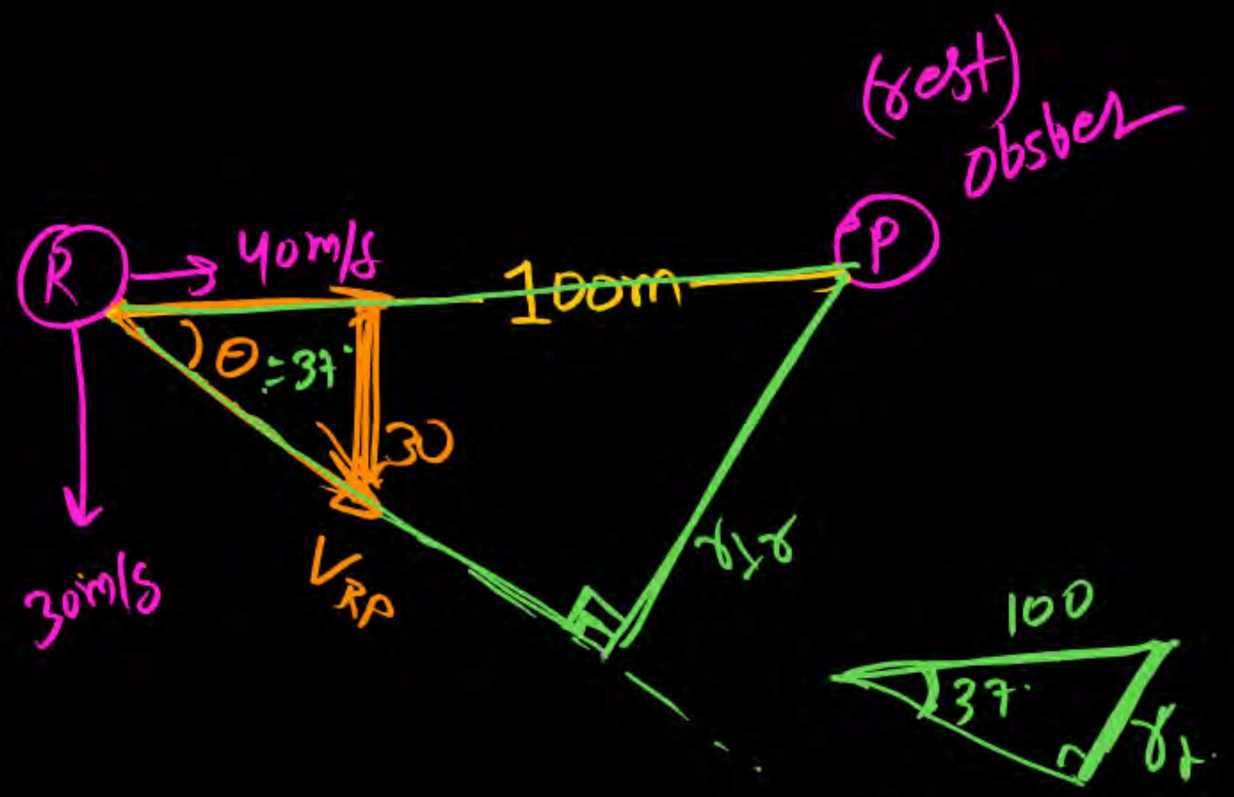
$$\sin 45^\circ = \frac{r_{\perp r}}{D}$$

$$r_{\perp r} = D \sin 45^\circ = \frac{D}{\sqrt{2}}$$ R

Find min^m sep^n B/w Ramlal & Pinky ??
as shown in fig.



Sol^n



$\tan\theta = \frac{30}{40}$

$\tan\theta = \frac{3}{4}$

$\theta = 37°$

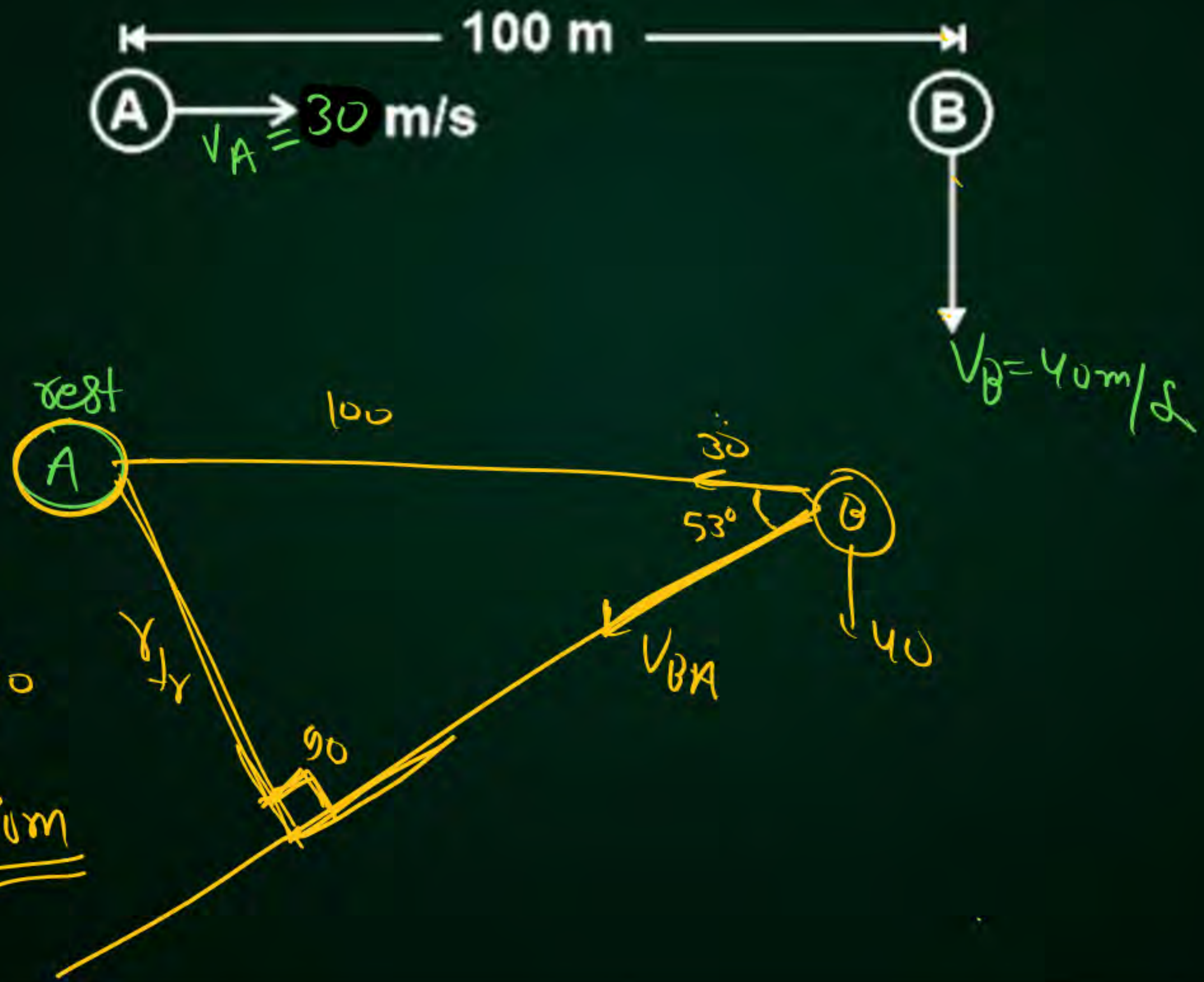
$\sin 37 = \frac{r_{\perp}}{100}$

$r_{\perp} = 100 \times \frac{3}{5}$

$r_{\perp} = 60m$

QUESTION

Find minimum separation between A and B.

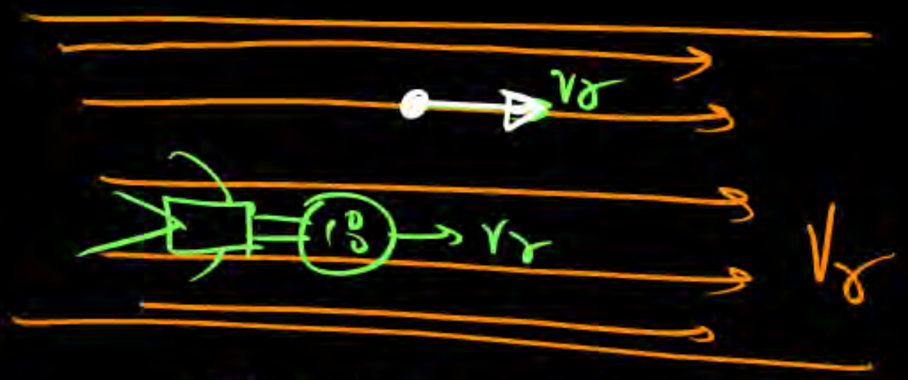


$\sin 53° = \frac{r_{\perp r}}{100}$

$r_{\perp r} = \frac{4}{5} \times 100$

$= 80\,m$

River Man Prob^m

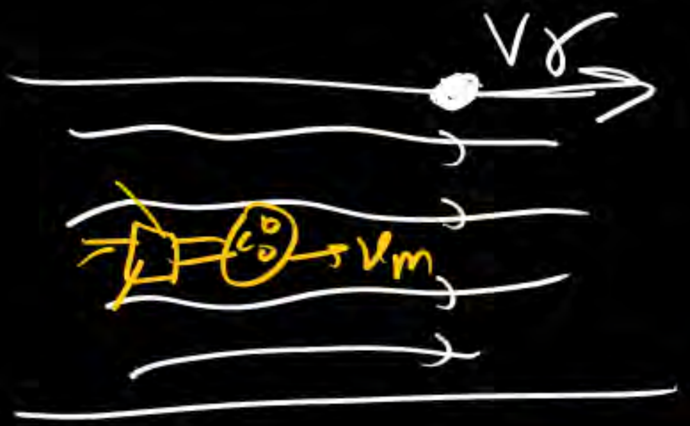


man is not swiming

$\vec{U}_{MG} = \vec{U}_r$

$\vec{U}_{M\,river} = 0$

Comment



man is swim $= U_m$

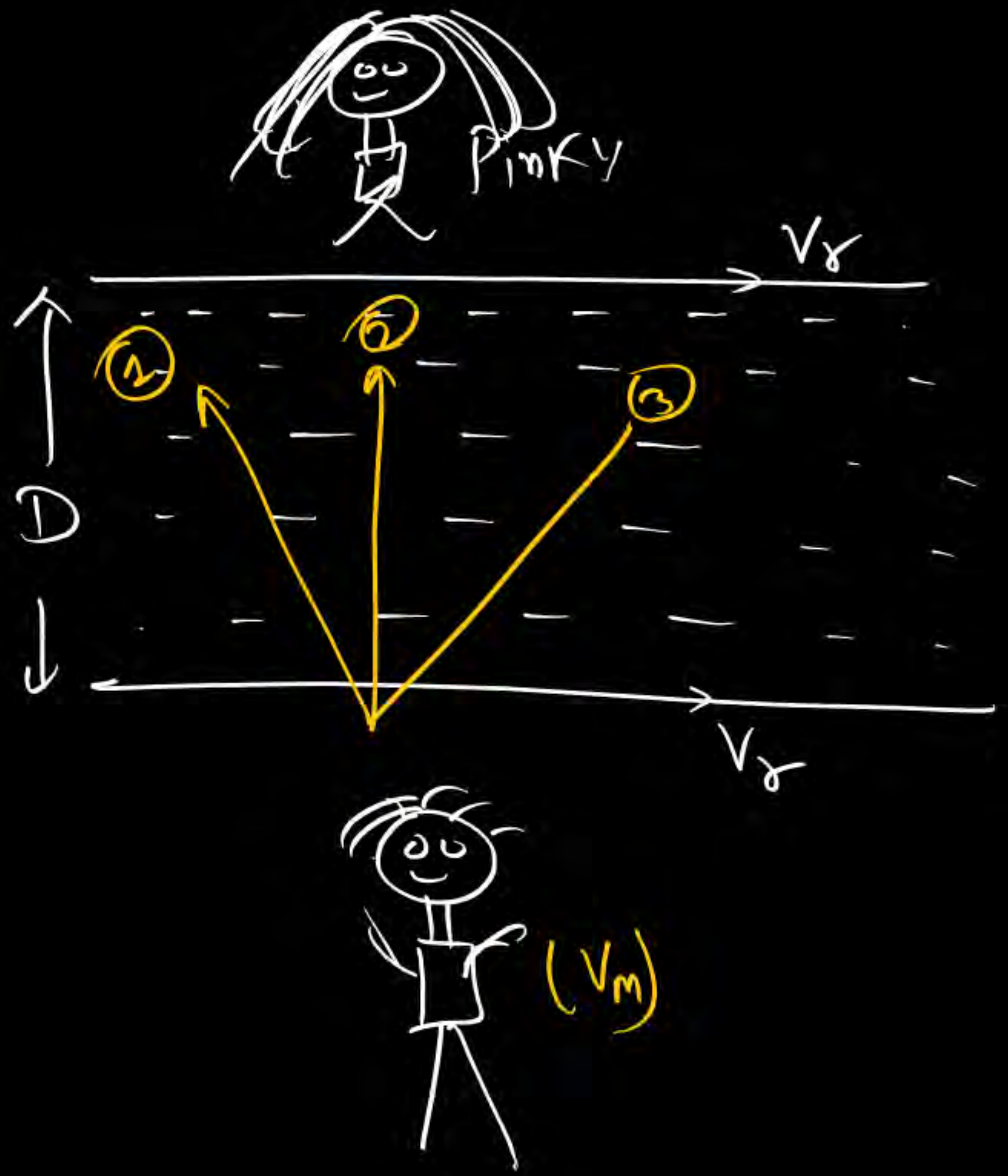
$\vec{U}_{mg} = \vec{U}_m + \vec{V}_r$

$\vec{U}_{m\,river} = (\vec{V}_m + \vec{V}_r) - V_r = \vec{U}_m$

V_m = velocity by which man can swim

U_{mR} = velocity of man w.r.t river

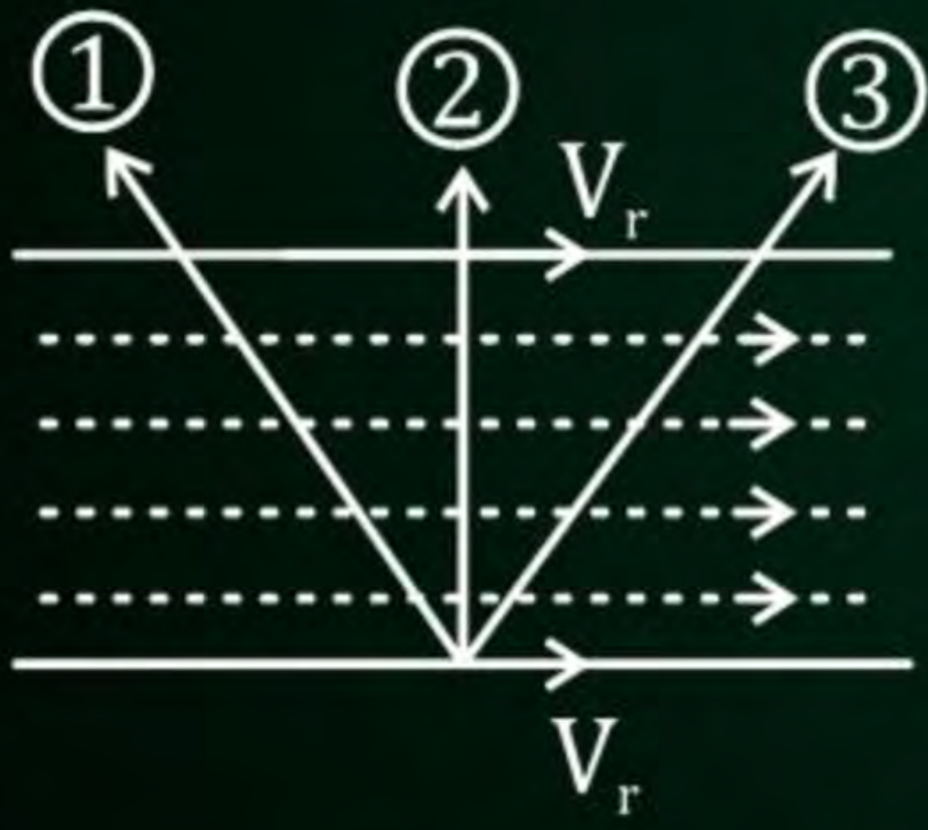
$U_{m\,still\,wr}$ = velocity of man in still water



In which dir^n Ramlal will swim to reach opposite corner of river in min^m time ?

RIVER MAN PROBLEM

In which direction man will swim to cross the river in minimum time?




THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 6 | Physics

Motion in a Plane



By- Dr. Manish Raj (MR SIR)

Topic to Be Covered

☆ River man problem

1. # Rain Man Problem

2. # Condition of collsion

3. # Relative motion in Projectile

4. #

~~1.25 min~~

~~30 min (Reco)~~



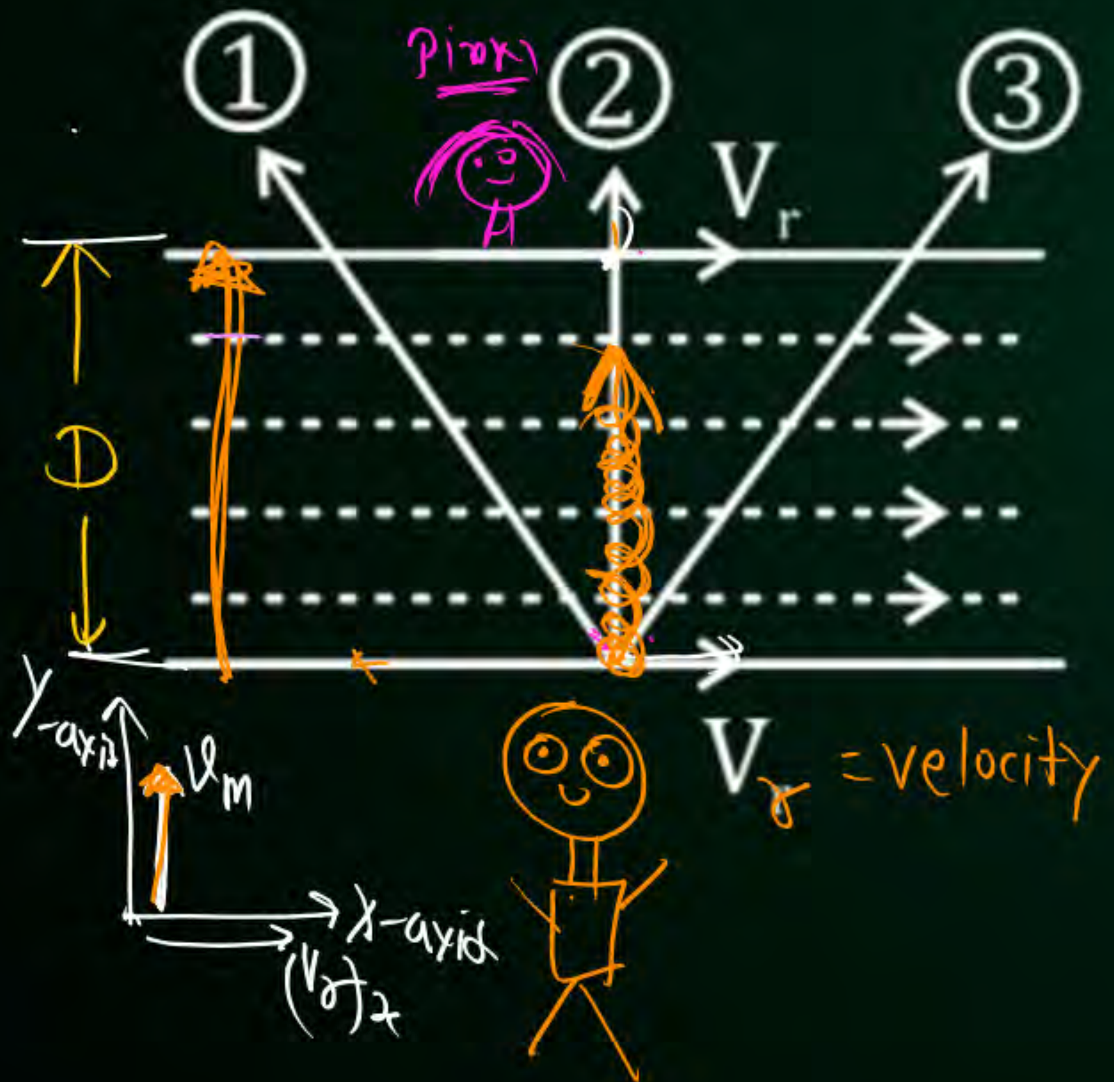
RIVER MAN PROBLEM

↳ 2-D Relative motion = [1-D] + [1-D]
x-axis ↑ y-axis

\# नदी (river) अपने दम पर पार किया जाता है। Ramlal अपनी पूरी जान आपने जान तक लगायेगा ॥

In which direction man will swim to cross the river in minimum time?

(a) 1 — 47%
(b) 2 — 22% ✓ Ans
(c) 3 — 28%
(d) None of these — 2%

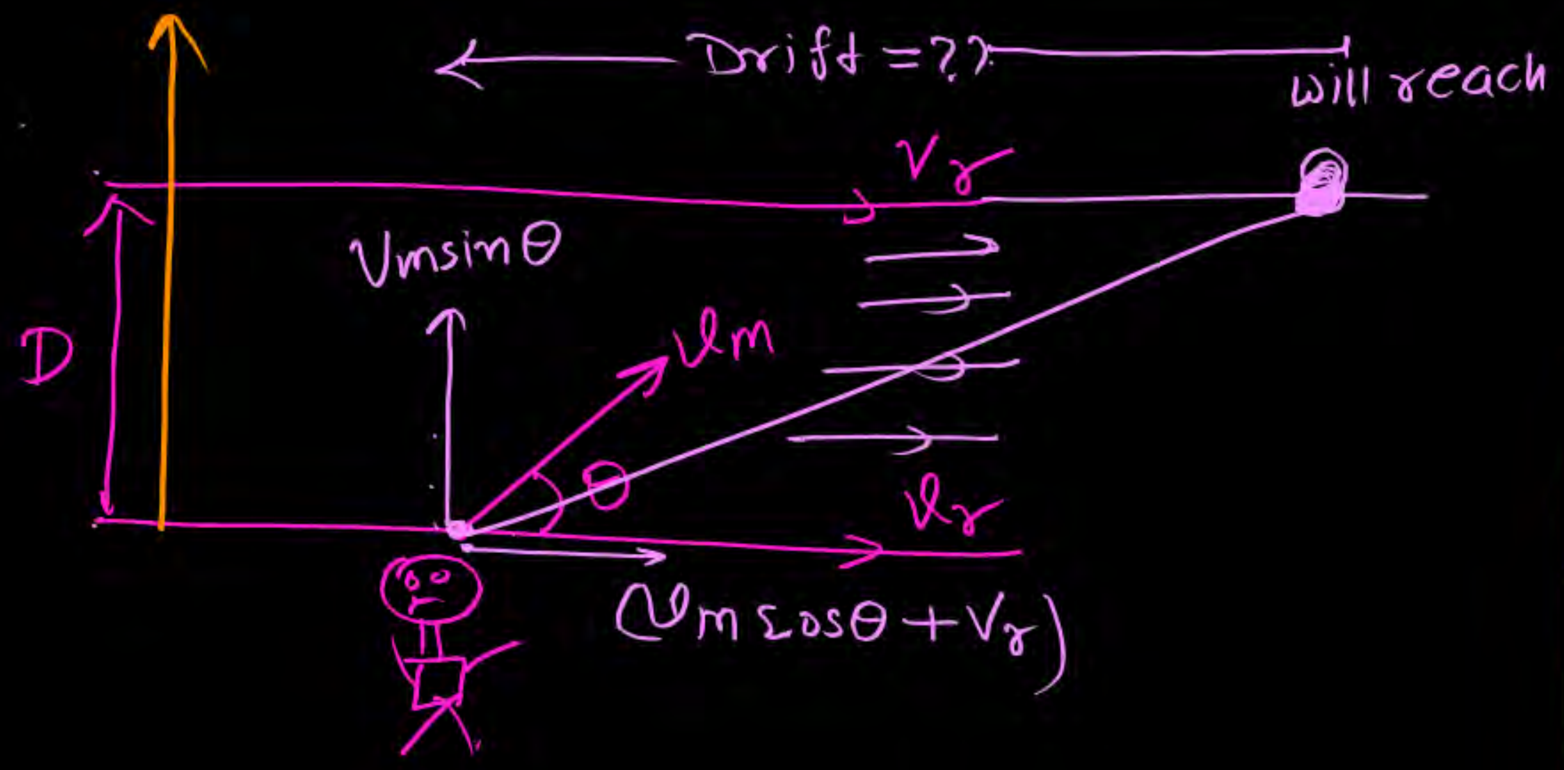


(Q) flow of river will support or oppose the man to cross the river??

~~(a) oppose (45%)~~

~~(b) support (26%)~~

✓ (c) No support or oppose 25%



t (time to cross river) $= \dfrac{D}{V_m \sin\theta}$

$$\text{Drift} = (V_m \cos\theta + V_r)\, t$$

for minimum time

$$(t)_{min} = \frac{D}{(V_m)(\sin\theta)_{max}}$$

(D) fixed

$$t_{min} = \left[\frac{D}{V_m}\right]$$

$|\sin\theta|_{max} = 1$

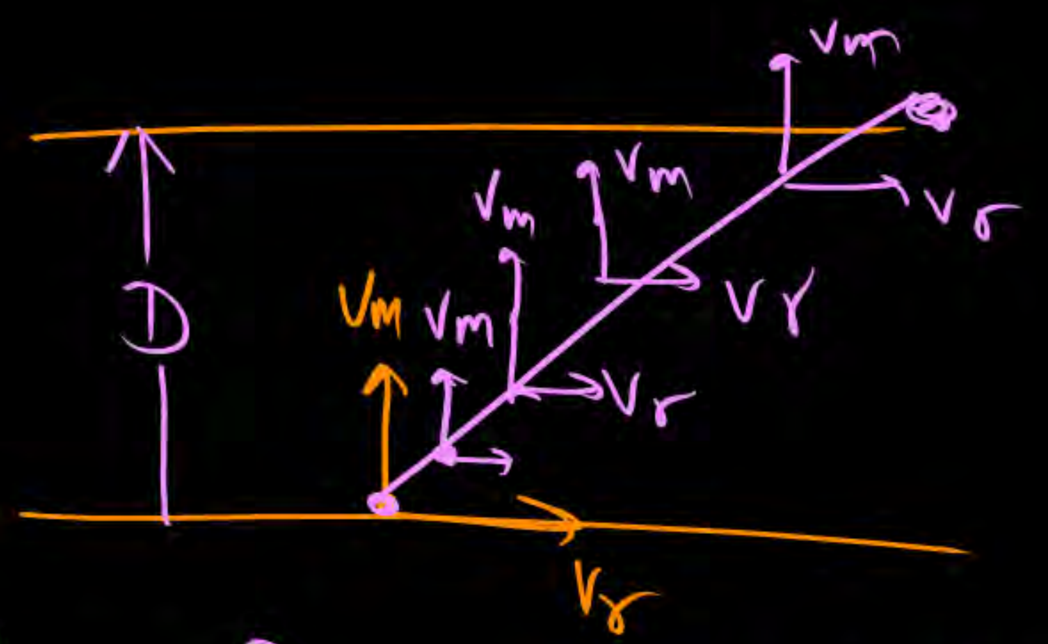
at $\theta = 90^\circ$

for minimum time

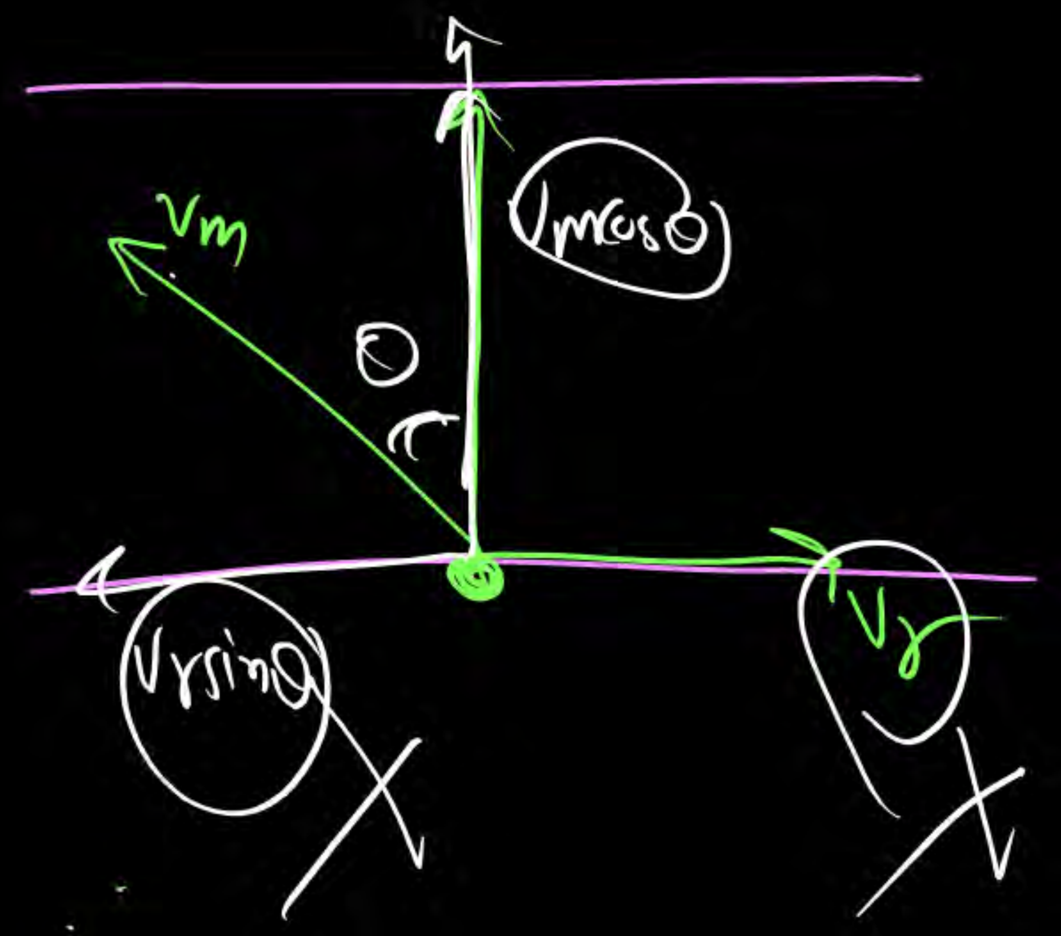


$$|\text{Drift}| = (V_m \cos 90 + V_r)\, t = V_r t_{min}$$

In case of minimum $= V_r \left(\dfrac{D}{V_m}\right)$



$$t_{min} = \frac{D}{V_m} \qquad Drift = V_r(t)$$



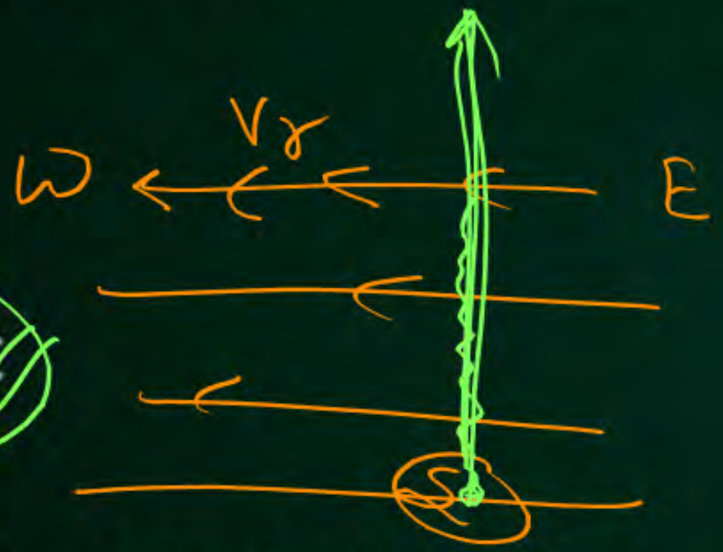
- Velocity of man with respect to river
- Velocity of man with respect to still water
- Velocity of man by which he can swim

All are same.

QUESTION

A river is flowing from east to west at a speed of 5m/min. A man on south bank of river, capable of swimming 10 m/min in still water, wants to swim across the river in shortest time; he should swim :-

1. due north
2. due north-east
3. Due north-east with double the speed of river
4. none of the above



QUESTION

A boat is sailing at a velocity $(3\hat{\imath} + 4\hat{\jmath})$ with respect to ground and water in river is flowing with a velocity $(-3\hat{\imath} - 4\hat{\jmath})$. Relative velocity of the boat with respect to water is :-

1. $8\hat{\jmath}$
2. $5\sqrt{2}$
3. $6\hat{\imath} + 8\hat{\jmath}$
4. $-6\hat{\imath} - 8\hat{\jmath}$

$\vec{v}_{Bg} = 3\hat{i} + 4\hat{j}$

$v_r = -3\hat{i} - 4\hat{j}$

$\vec{v}_{Br} = \vec{v}_B - \vec{v}_r$

$= 3\hat{i} + 4\hat{j} - (-3\hat{i} - 4\hat{j})$

$\vec{v}_{Br} = 6\hat{i} + 8\hat{j}$

QUESTION

A boat takes 2 hours to go 8 km and come back in still water lake. With water velocity of 4km/hr, the time taken for going upstream of 8 km and coming back is :-

opposite to flow

downstream = dir^n of flow

1. 140 min
2. 150 min
3. 160 min ✓
4. 170 min

V_B 8 Km

$V_r = 0$

$V_B = \frac{16 \text{ km}}{2 \text{ hr}} = 8 \text{ km/hr}$

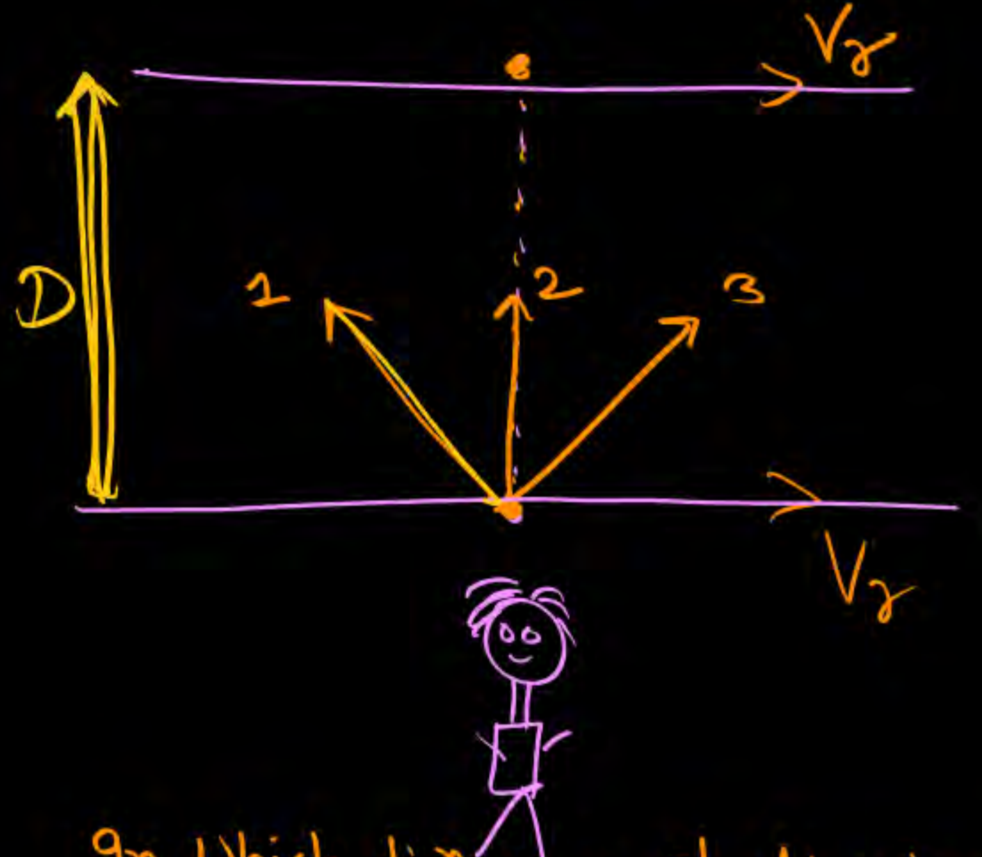
8 Km $t_1 = \frac{8}{12} \text{ hr} = \frac{2}{3} \text{ hr} = \frac{2}{3} \times 60 = 40 \text{ min}$

$V_r = 4$

$V_B = 8$ km/h

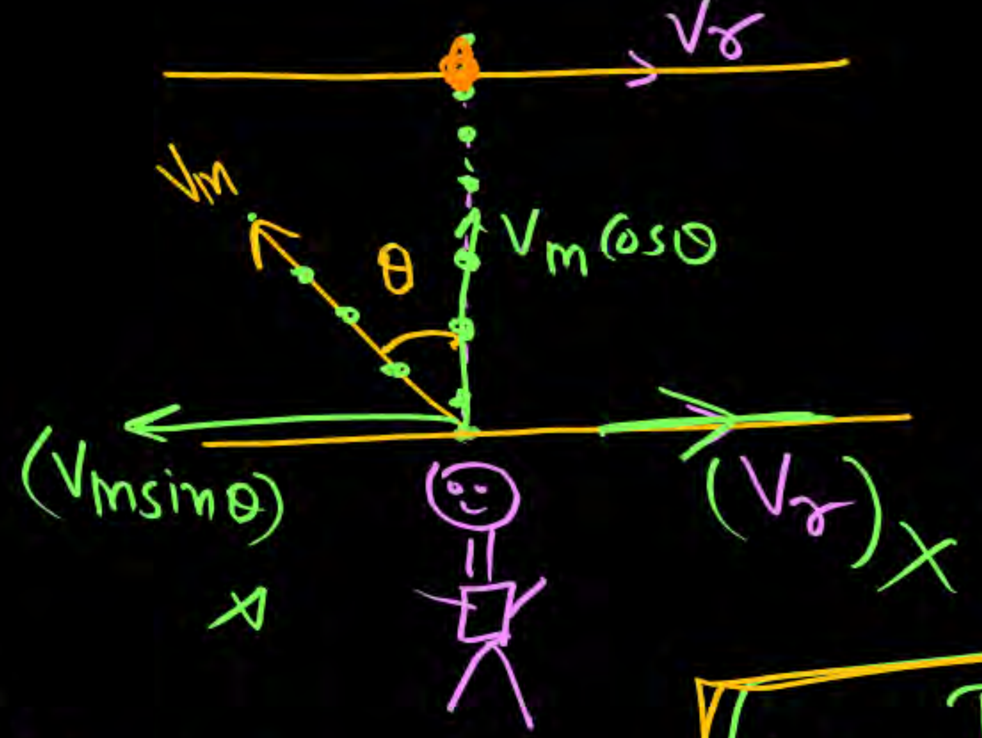
8 Km $t_2 = \frac{8}{4} = 2 \text{ hr}$

Swiming for zero Drift / swimining for minimum Path / Swiming so that man can reach exactly opposite point.



In which dir^n man should swim for minimium Path??

✓(a) 1 (b) 2 (c) 3



"$V_M \sin\theta = V_r$"

if $\sin\theta = \frac{V_r}{V_m}$

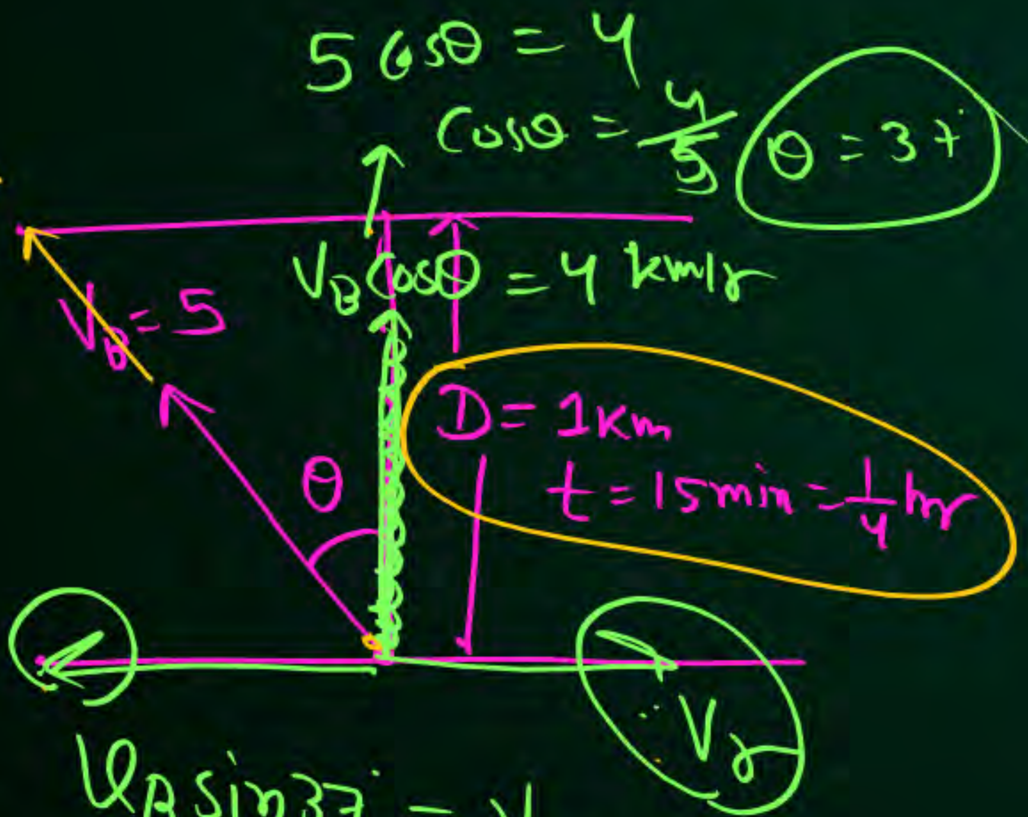
$$t = \frac{D}{V_m\cos\theta}$$

Drift = 0 #

QUESTION

A boat, which has a speed of 5 km/h in still water, crosses a river of width 1 km along the shortest possible path in 15 minutes. The velocity of the river water in km/h is -

1. 1
2. 3
3. 4
4. $\sqrt{41}$

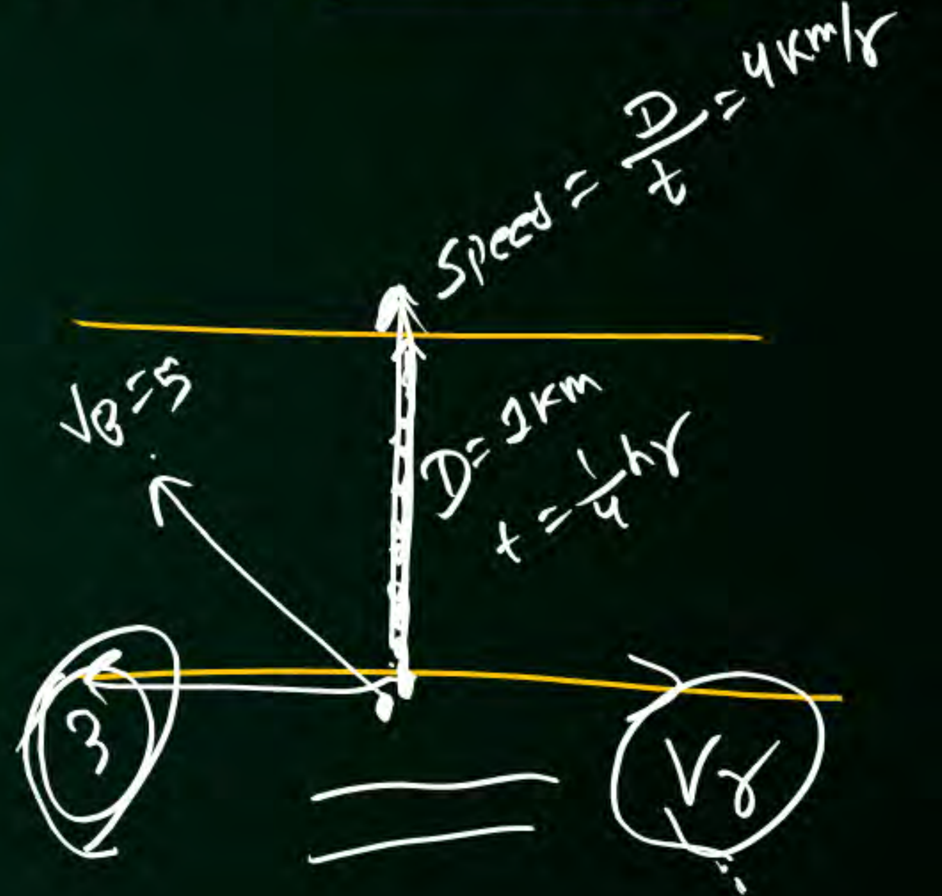


$v_B \sin 37° = V_r$

$5 \times \frac{3}{5} = V_r$

$V_r = 3$

Speed = dist / time = 1 Km / (1/4) = 4 Km/hr

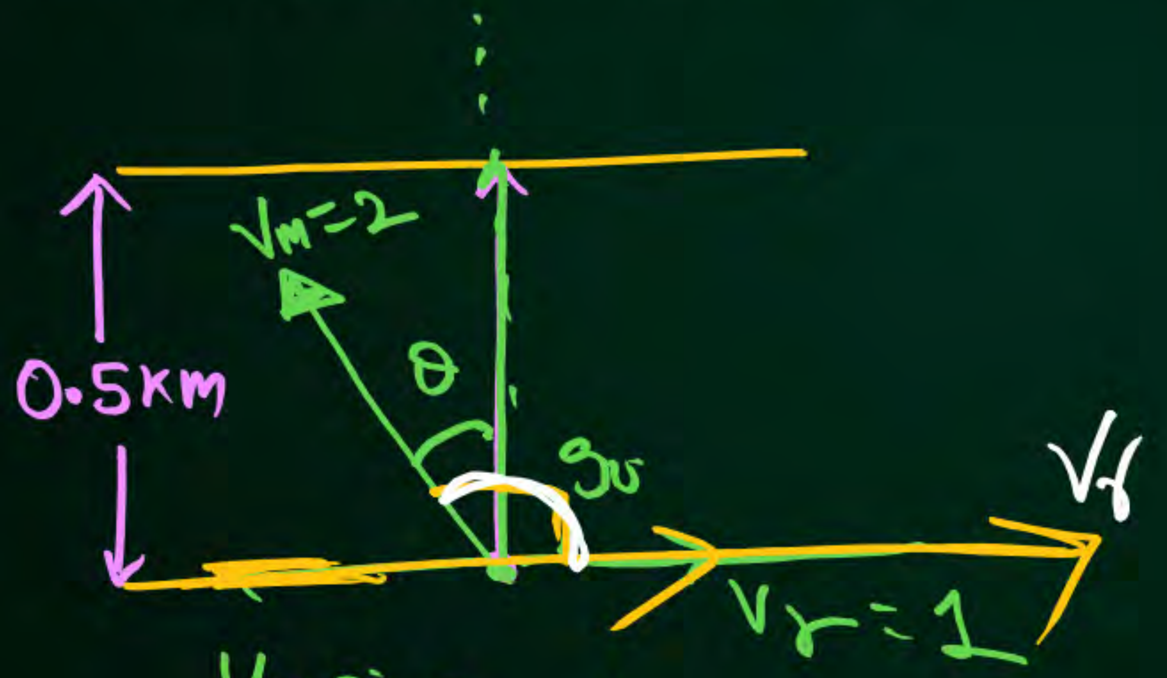


QUESTION

$v_M = 2\ km/hr$

A man wishes to swim across a river 0.5 km. wide. If he can swim at the rate of 2 km/h. in still water and the river flows at the rate of 1 km/h. The angle (w.r.t. the flow of the river) along which he should swim so as to reach a point exactly opposite his starting point, should be :-

1. 60°
2. 120°
3. 145°
4. 90°



$V_M \sin\theta = V_r$

$2 \sin\theta = 1$

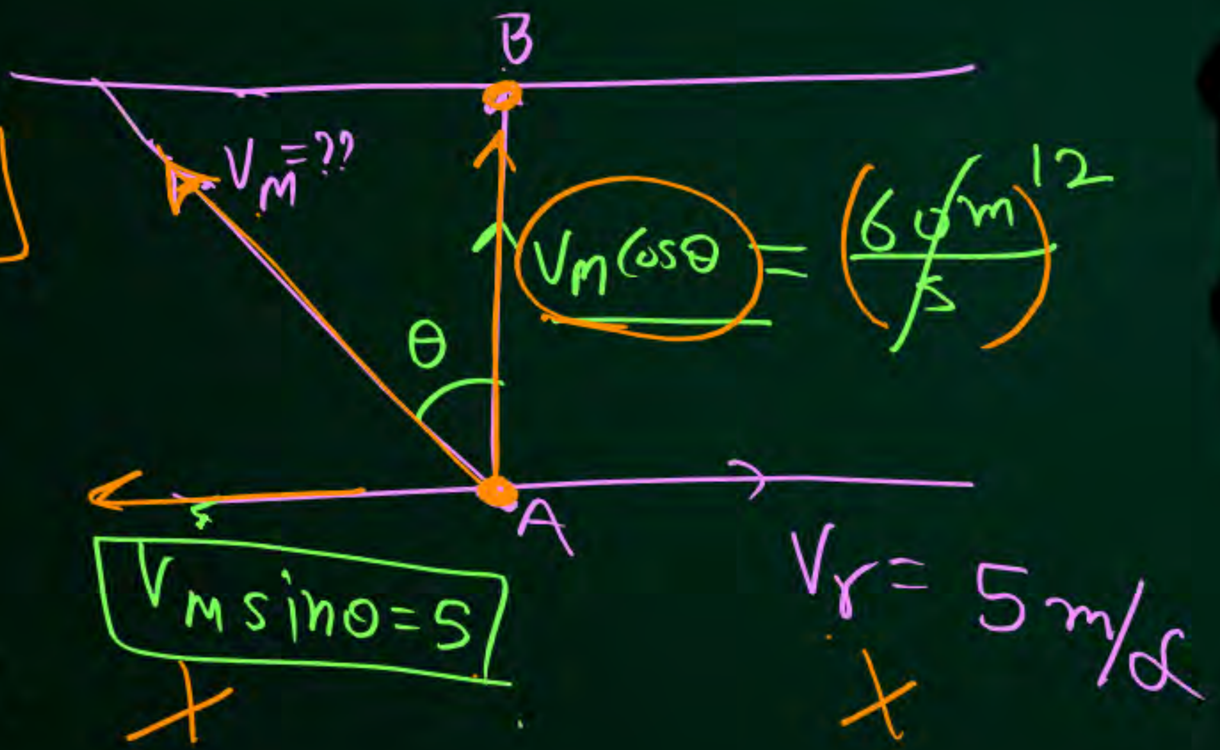
$\sin\theta = \frac{1}{2}$

$\theta = 30°$

QUESTION

A man is crossing a river flowing with velocity of 5 m/s. He reaches a point directly across at distance of 60 m in 5s. His velocity in still water should be:

1. 12 m/s
2. 13 m/s
3. 5 m/s
4. 10 m/s



$V_m^2 \cos^2\theta + V_m^2 \sin^2\theta = 12^2 + (5)^2$

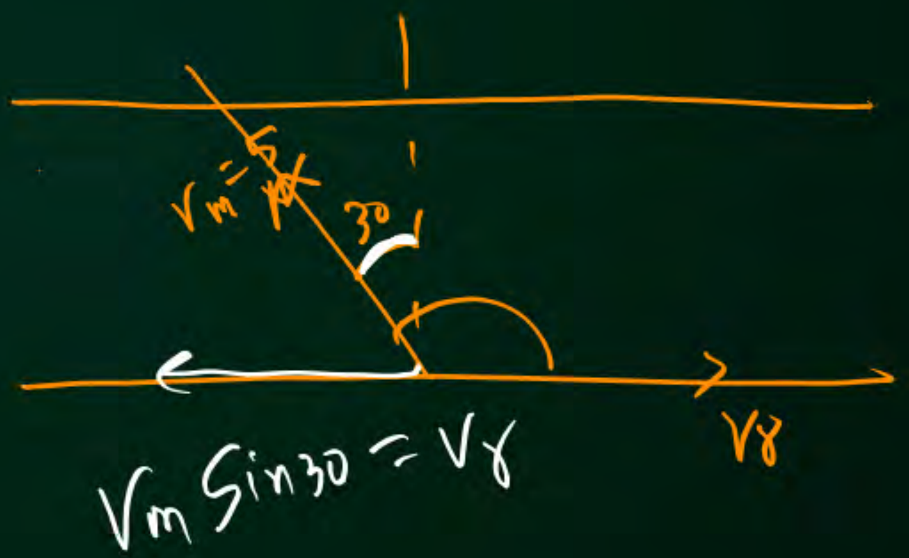
$V_m^2 (1) = 12^2 + 5^2$

$V_m = \sqrt{12^2 + 5^2}$

QUESTION

A person, reaches a point directly opposite on the other bank of a flowing river, while swimming at a speed of 5 m/s at an angle of 120° with the flow. The speed of the flow must be

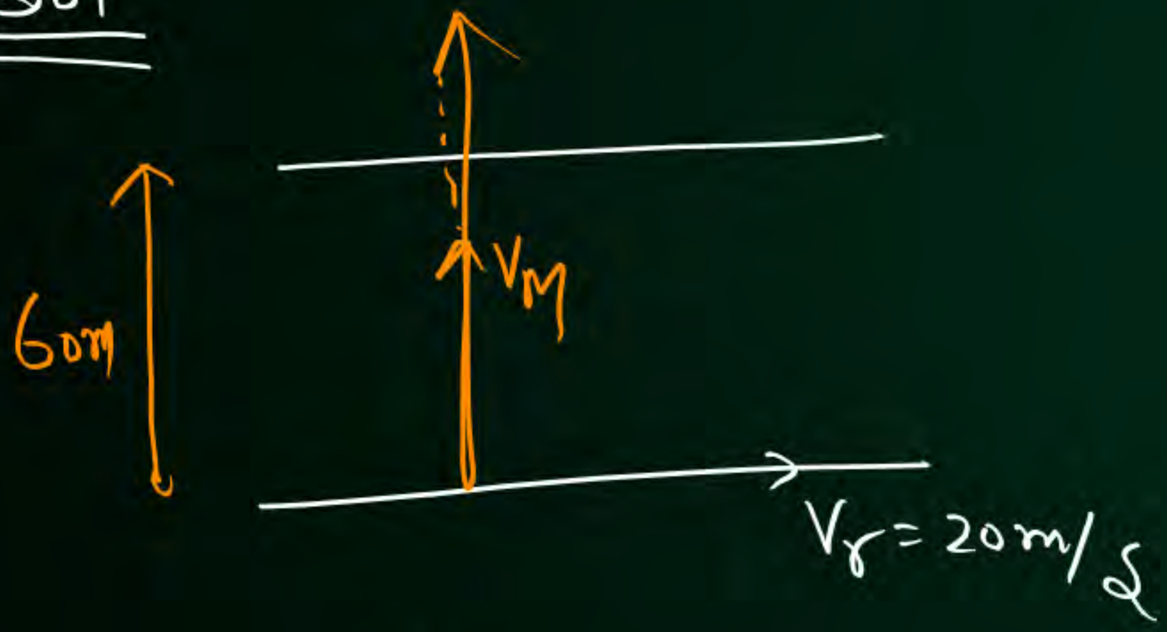
1. 2.5 m/s ✓
2. 3 m/s
3. 4 m/s
4. 1.5 m/s



QUESTION

River is flowing with speed 20 m/s a man can swim in flowing river with speed 10 m/s then find drift in a case of minimum time while the width of river is 60 m.

Sol^n



$V_M = 10 m/s$

$t_{min} = \frac{60}{10} = 6 sec$

[Drift = speed × time] along river

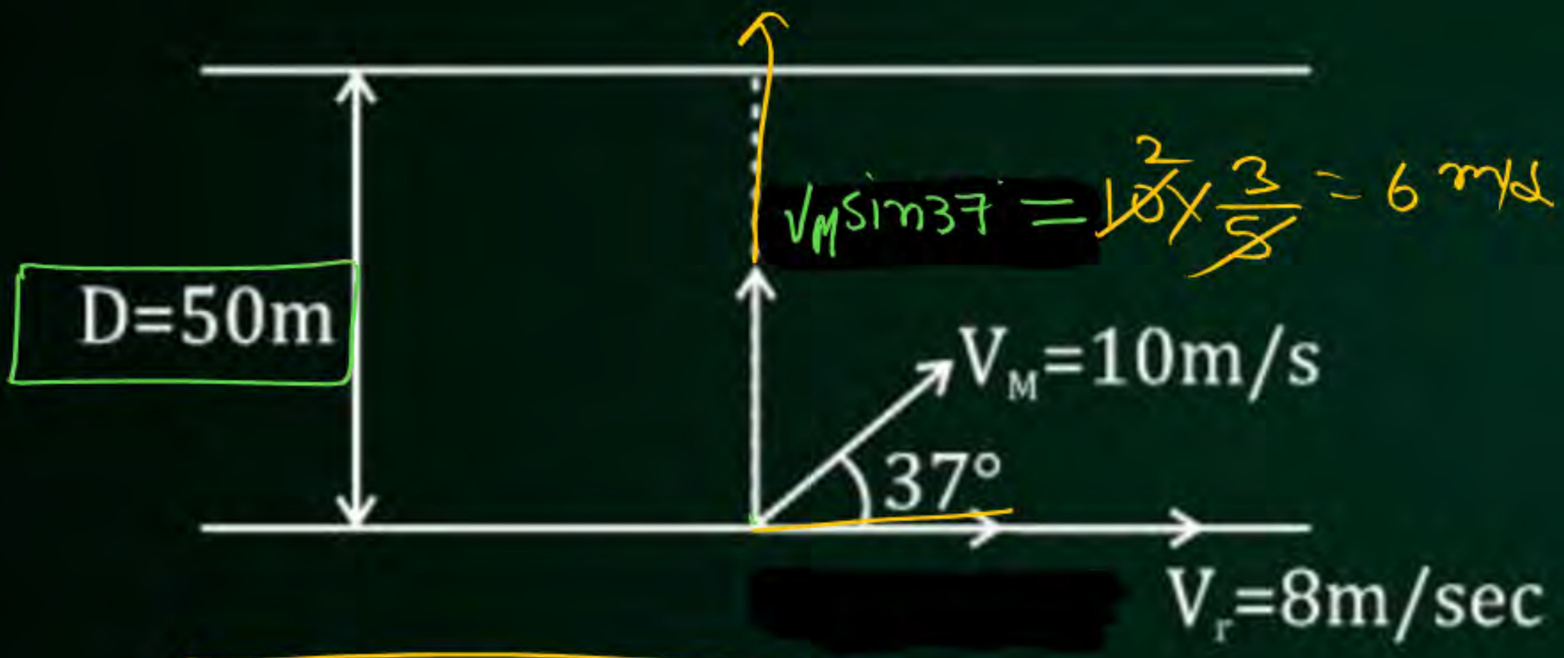
$= V_r \times t_{min}$

$= 20 \times 6$

$= 120 m$

QUESTION

Find drift and time taken to cross the river.



$$t = \frac{D}{6} = \frac{50}{6} \text{ sec}$$

$$= 8.33 \text{ sec}$$

$$\text{Drift} = (8 + V_m \cos 37^\circ)\ \text{time}$$

flow of river is 20m/s and man can swim in river with speed 10m/s then find angle at which man have to swim from flow. for zero Drift / to reach exactly opposite point, min^m path??

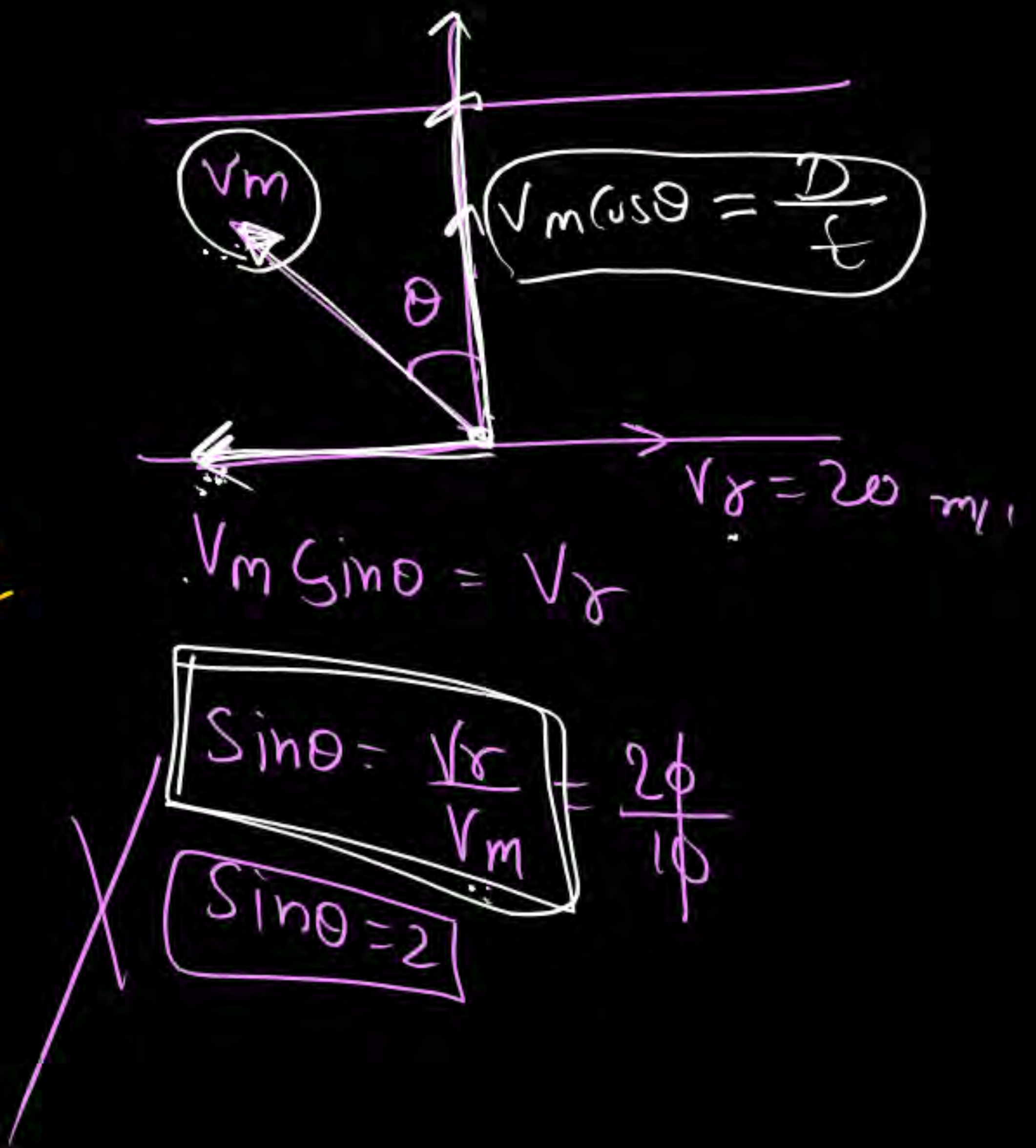
(a) 30° ✗

(b) 60

(c) 120 ✗

(d) none of these

67%



flow of river is 20m/s and man can swim in river with speed 10m/s then find angle at which man have to swim from flow. for zero Drift / to reach exactly opposite Point, min^m Path??

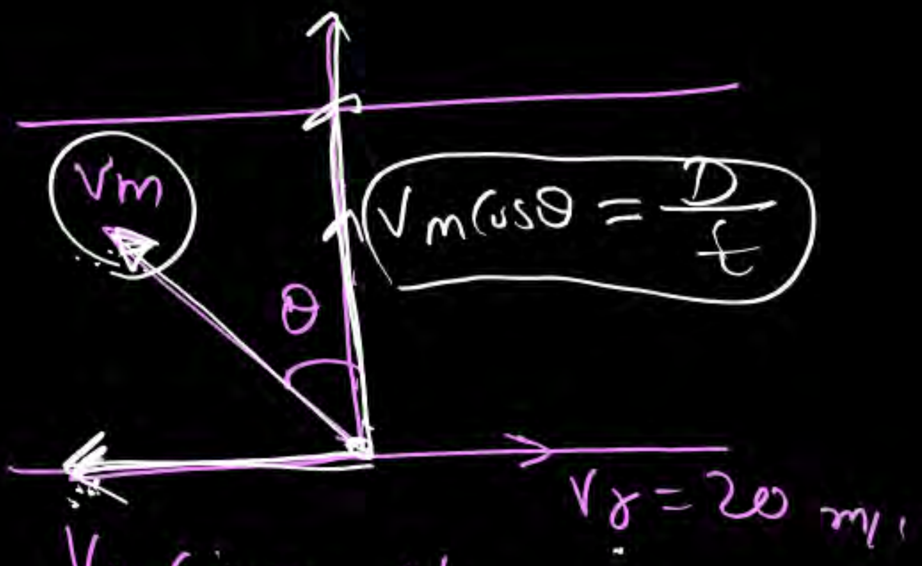
(a) 30° ✗

(b) 60°

(c) 120° ✗

(d) none of these

67%



$V_m \sin\theta = V_r$

$\sin\theta = \frac{V_r}{V_m} = \frac{20}{10}$

$\sin\theta = 2$

Flow of river is 200 m/s and man can swim in river with speed 10 m/s then find angle at which man have to swim for minimum time.

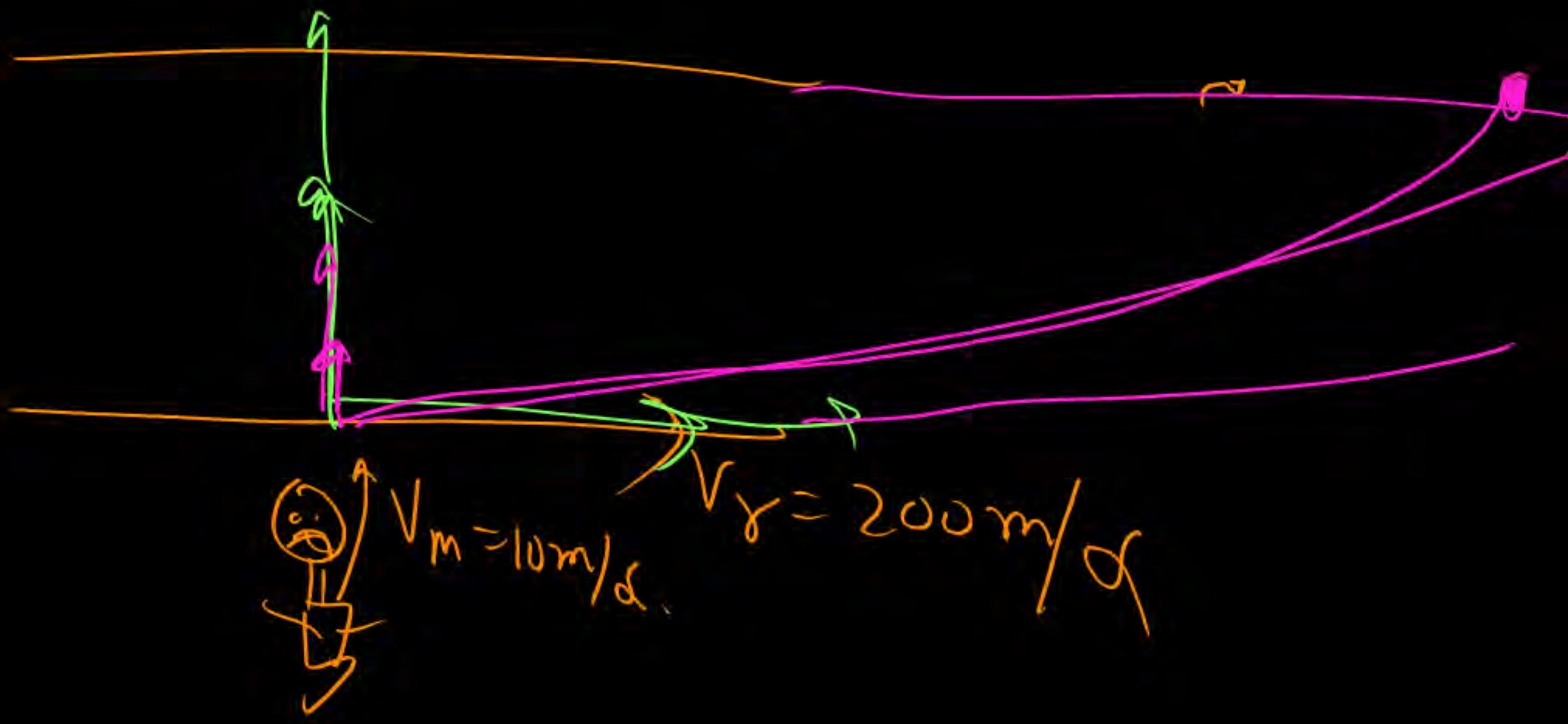
(a) 30°

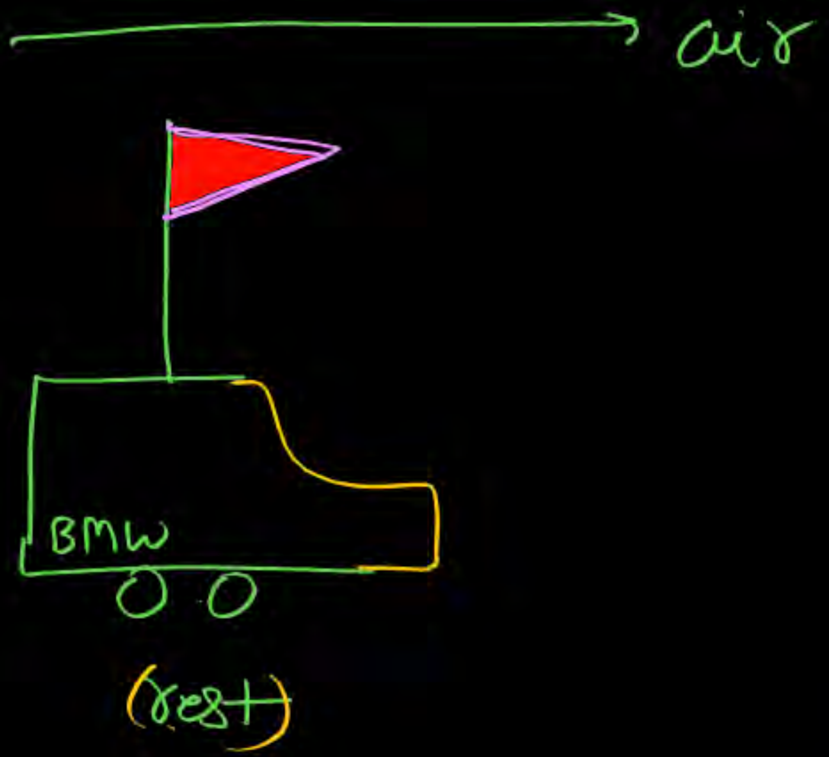
(b) 90°

(c) 120°

(d) none of these

20%

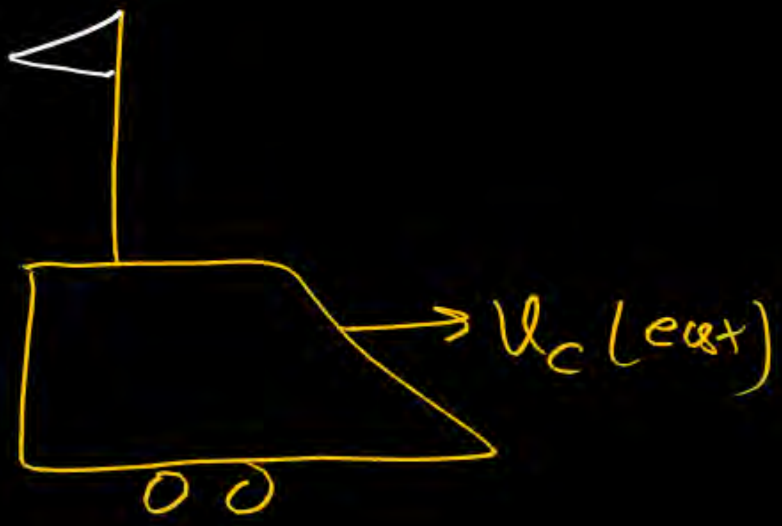




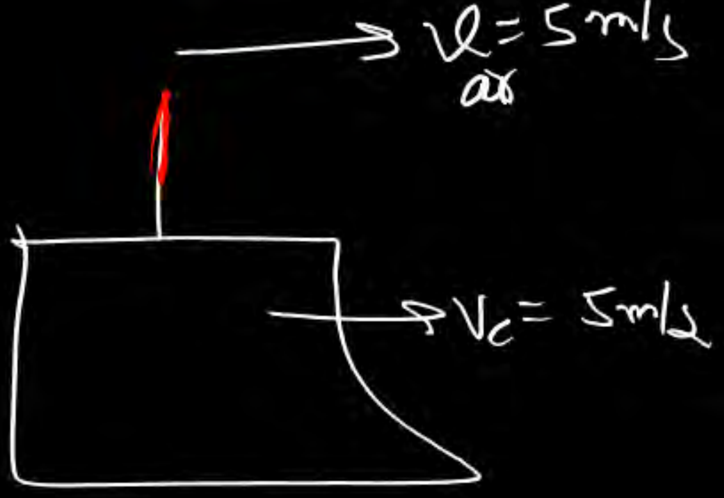
flag will blown in east



air is at rest



flag will blown in west

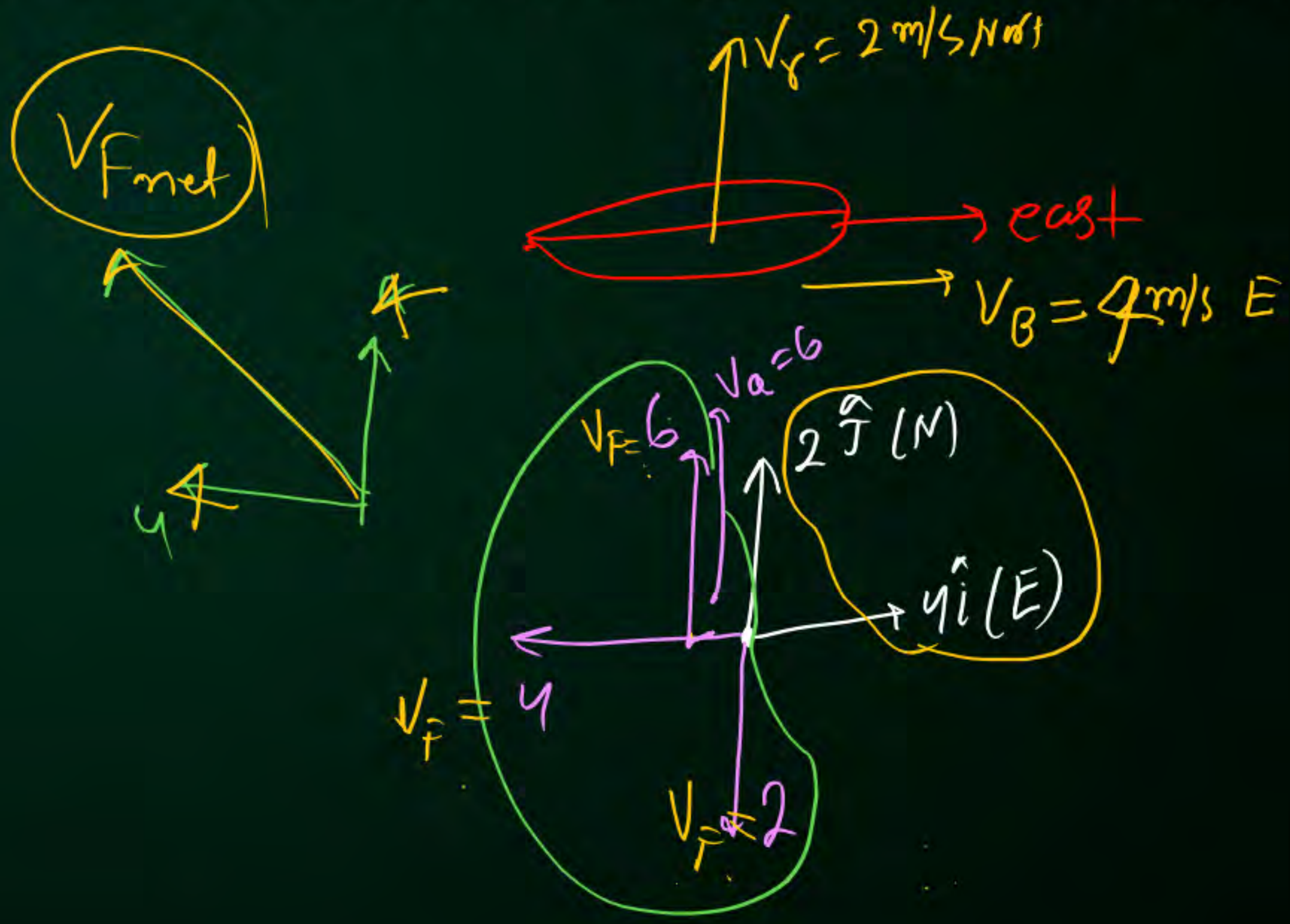


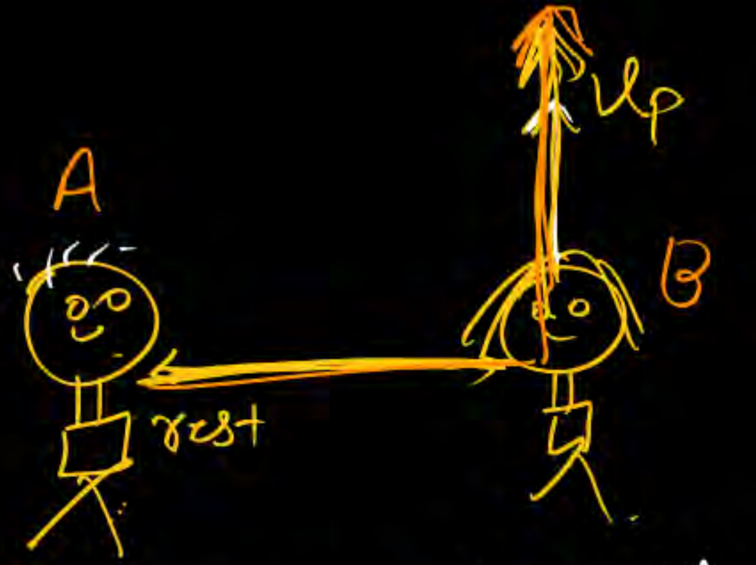
flag is at rest

QUESTION

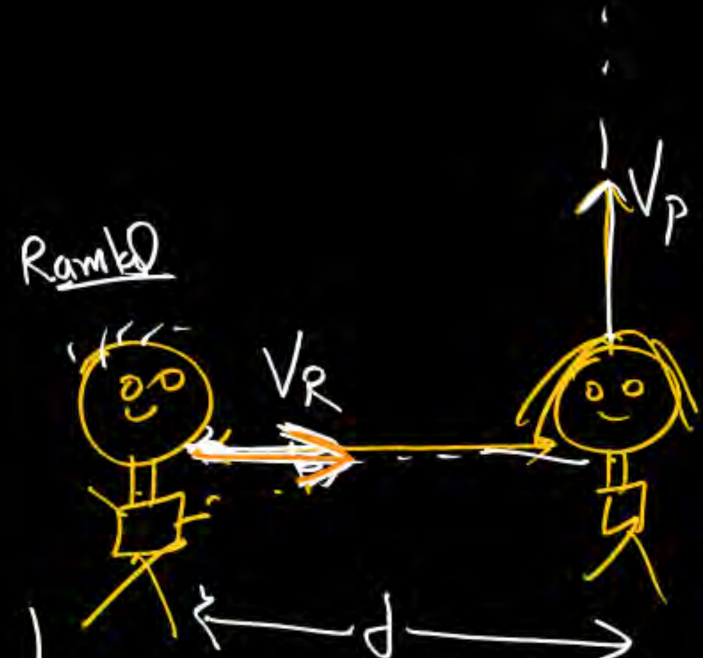
A boat moving towards east with velocity 4 m/s with respect to still water and river is flowing towards north with velocity 2 m/s and the wind is blowing towards north with velocity 6 m/s. The direction of the flag blown over by the wind hoisted on the boat is :-

1. North-west
2. South-east
3. $\tan^{-1}(1/2)$ with east
4. North



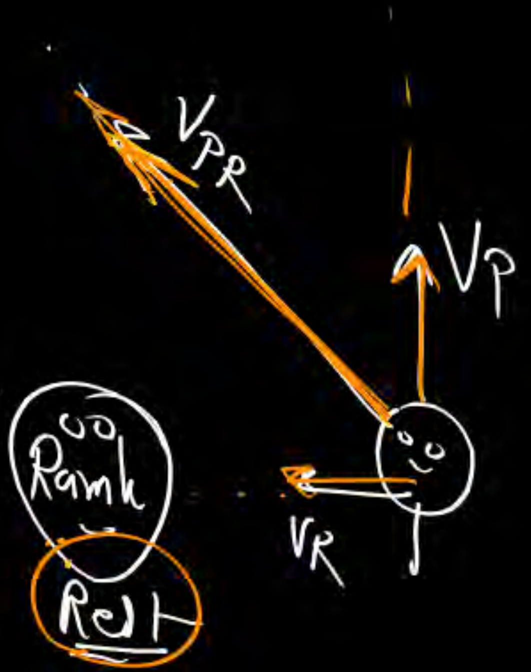


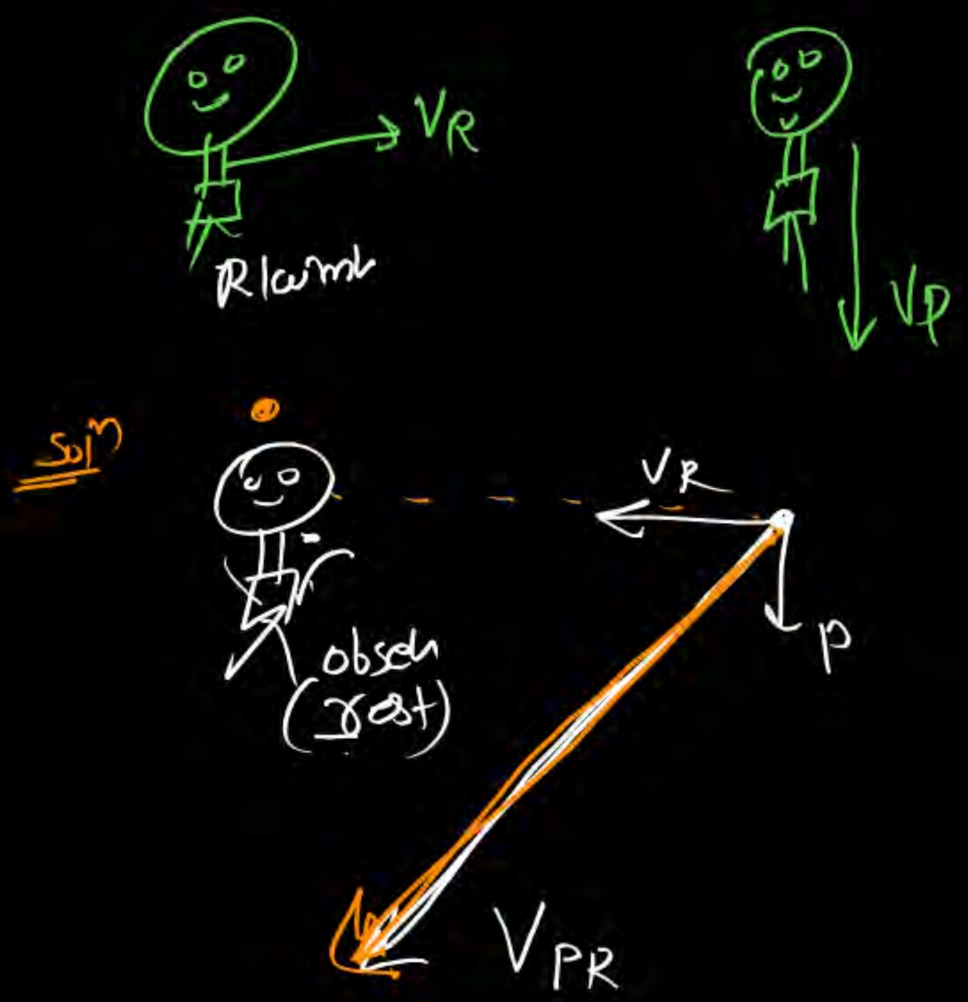
they will nevr meet



they will nevr meet

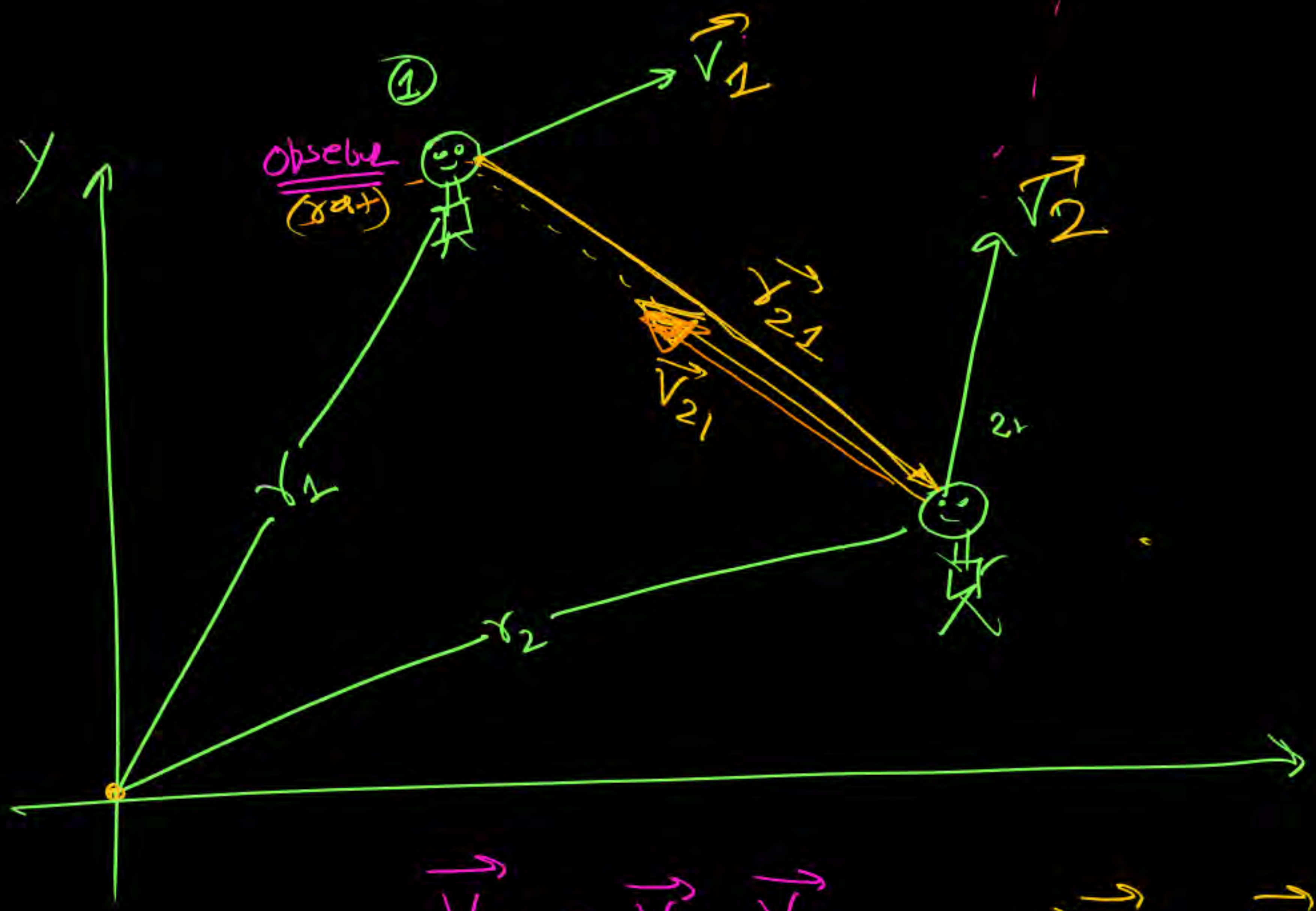
Ramlal (obsebr मानो)





(R) they will only meet when relative velocity 1st w.r.t other is towards their line of Joining.

Condition of collsion



$$\vec{V}_{21} = \vec{V}_2 - \vec{V}_1$$

$$\vec{r}_{21} = \vec{r}_2 - \vec{r}_1$$

dir^n of $\vec{V}_{21}$ $\longrightarrow$ $\hat{V}_{21} = \dfrac{\vec{V}_2 - \vec{V}_1}{|\vec{V}_2 - \vec{V}_1|}$

$$\hat{r}_{21} = \frac{\vec{r}_2 - \vec{r}_1}{|\vec{r}_2 - \vec{r}_1|}$$

Unit vector

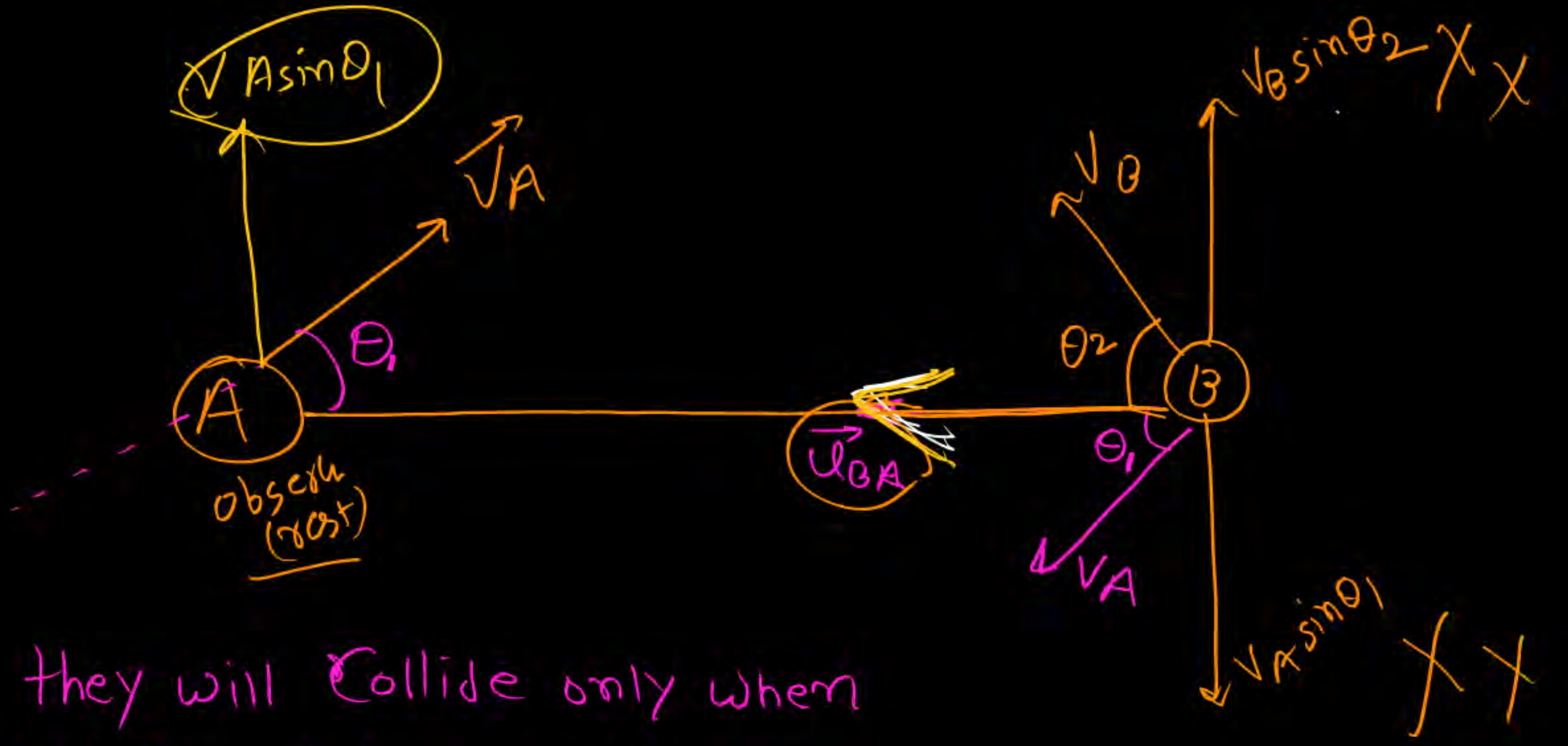
$$\hat{r} = \frac{\vec{r}}{|\vec{r}|}$$

Cond^n of collsion

$$\hat{V}_{21} = -\hat{r}_{21}$$

$$\frac{\vec{V}_2 - \vec{V}_1}{|\vec{V}_2 - \vec{V}_1|} = -\frac{\vec{r}_2 - \vec{r}_1}{|\vec{r}_2 - \vec{r}_1|}$$

NEET 2015

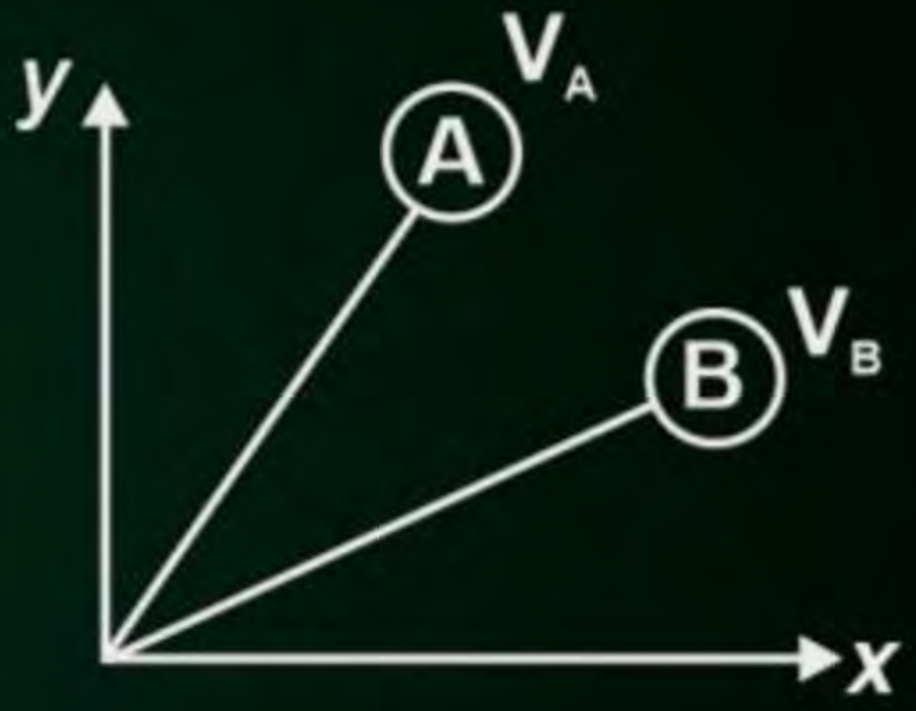


they will Collide only when relative Velocity along the line Joining

hence $\vec{v}_{BA}$ (relative velocity) ⊥r to line Joining will be zero.

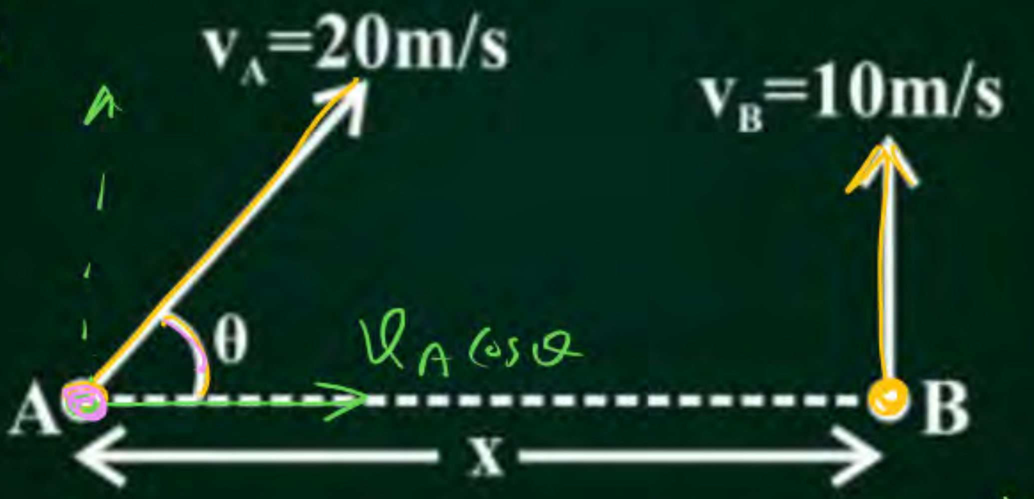
CONDITION OF COLLISION

- Direction of relative velocity must be in opposite to the direction of relative position.
- Component of their velocity must be same perpendicular to the line joining.
- $V_{BA} = 0$ perpendicular to line joining.



QUESTION

Two particles A and B are projected from the ground simultaneously in the directions shown in the figure with initial velocities $v_A = 20$ m/s and $v_B = 10$ m/s respectively. They collide after 0.5 s. Find out the angle θ and the distance x.

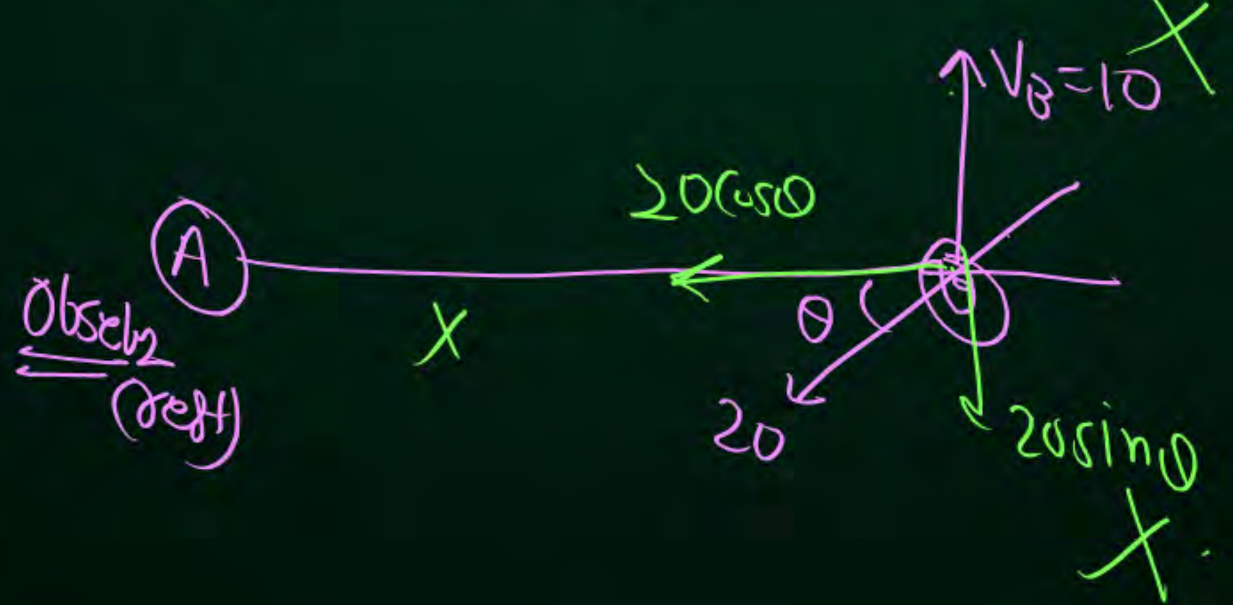


∴ Velocity same ⊥r to line joining

$[20 \sin\theta = 10]$

$\sin\theta = \frac{1}{2}$

$\theta = 30°$



$20 \sin\theta = 10$

$\sin\theta = \frac{1}{2}$

$\theta = 30$

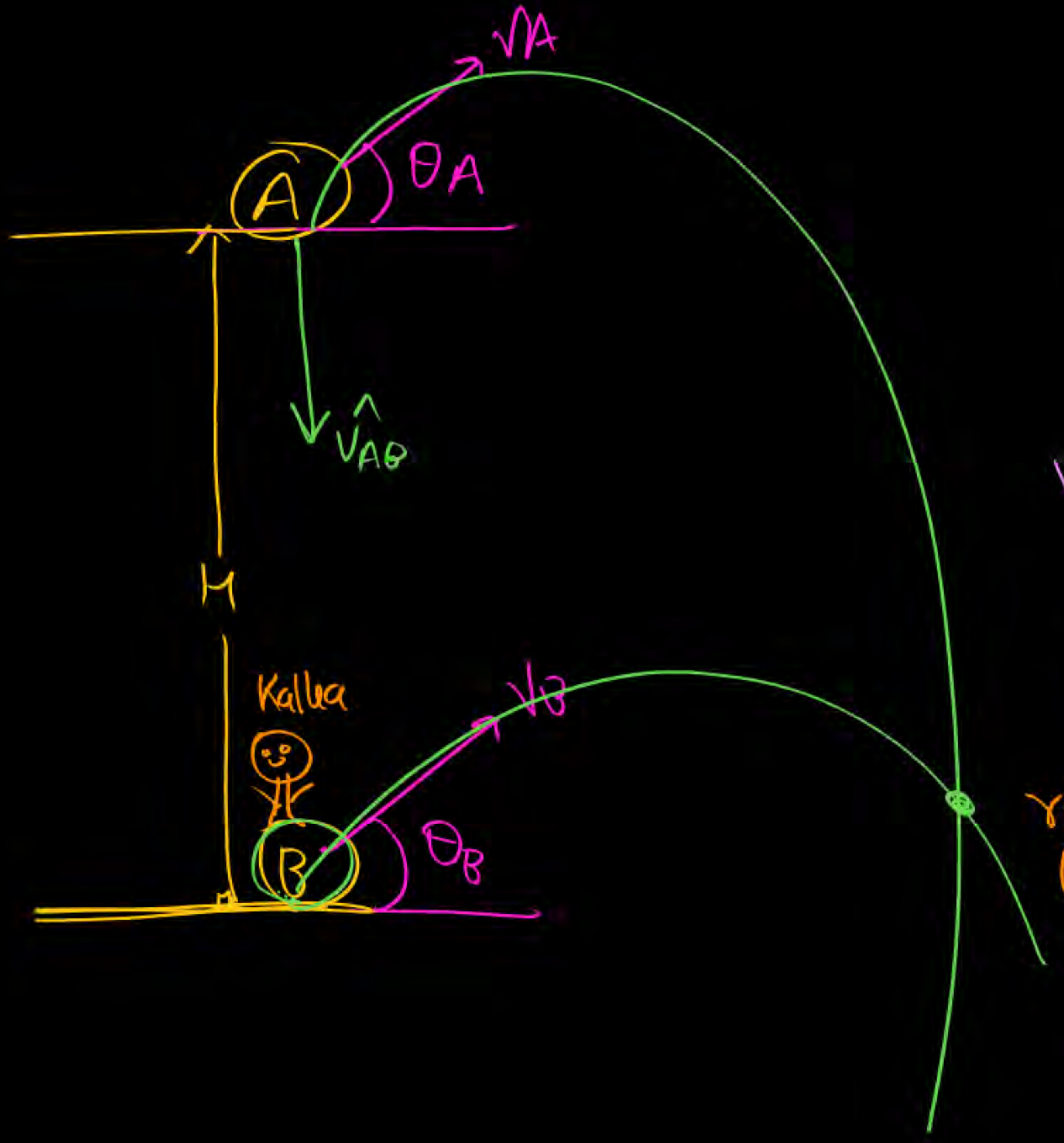
$x = 20 \cos 30 \times 0.5$

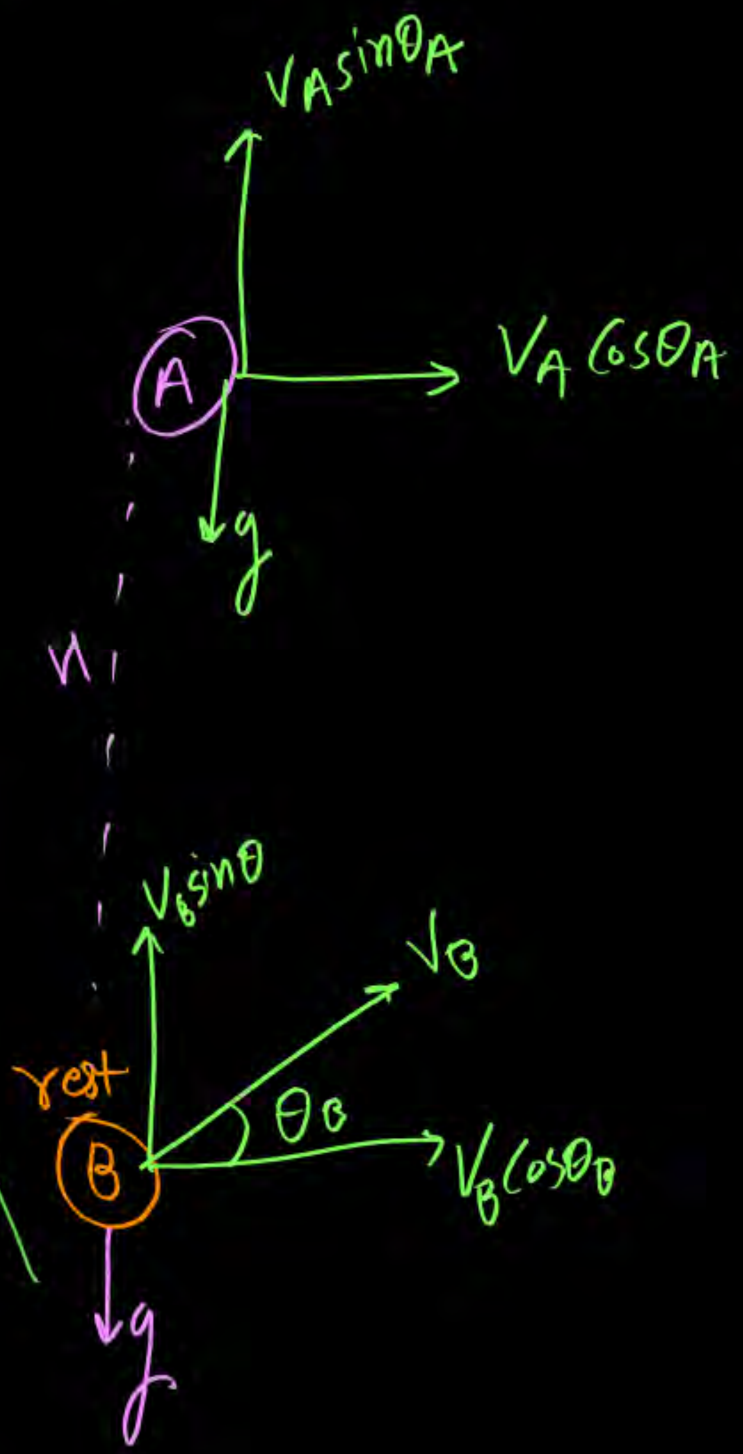
$= 10 \frac{\sqrt{3}}{2} = 5\sqrt{3}$

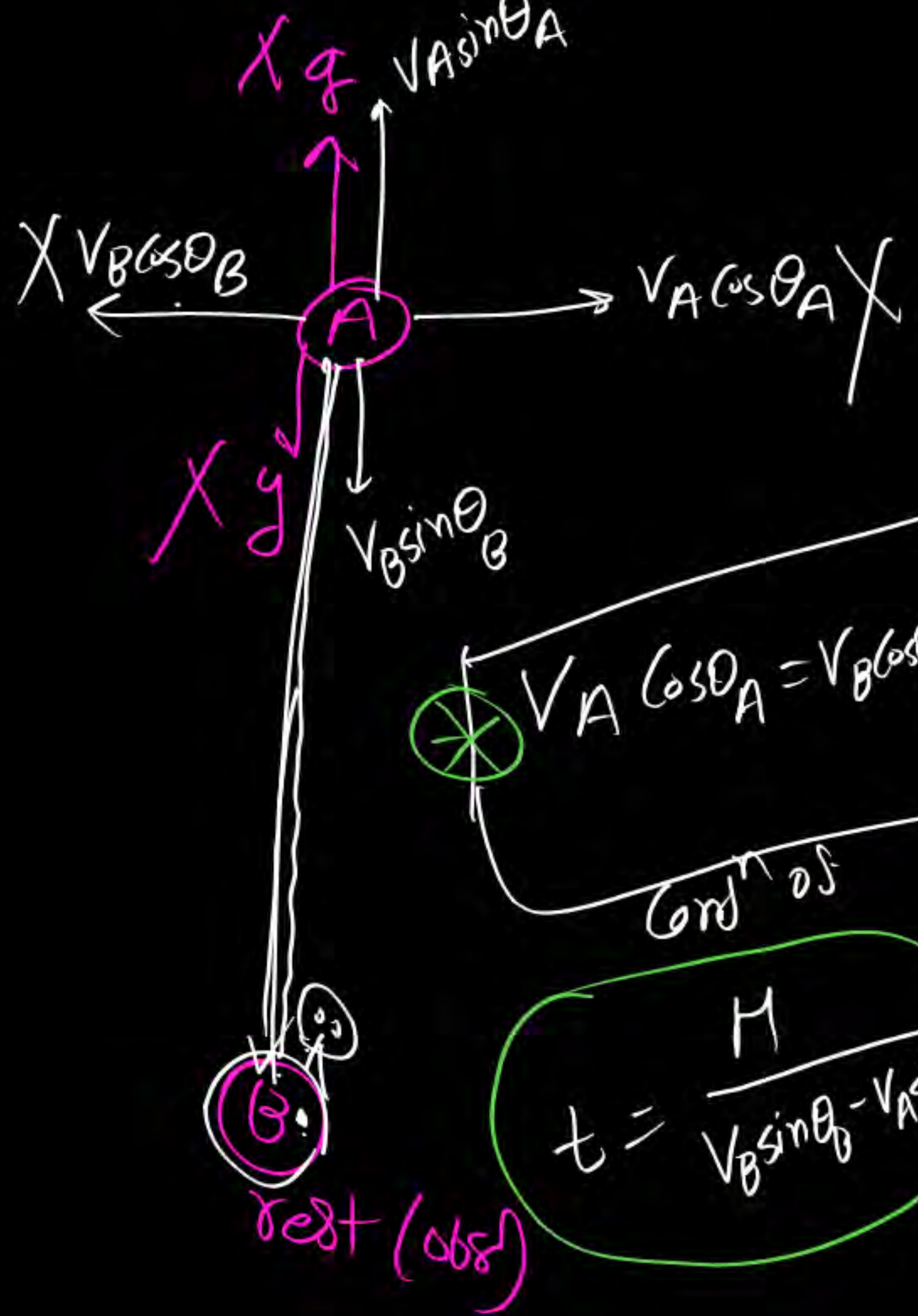
IIT-Adv 2015

Two Ball are Projected as shown in fig.

find time of collision and condition of collision ?!)







$$V_A\cos\theta_A = V_B\cos\theta_B$$

Cond^n of

$$t = \frac{H}{V_B\sin\theta_B - V_A\sin\theta_A}$$

Path Of Projectile → Parabola

Path of Projectile w.r.t another projectile is straight line.

$a_{AB} = 0$

relative acc^n = 0

relative velocity = Const

magnitude / dir^n = Const

Straight line

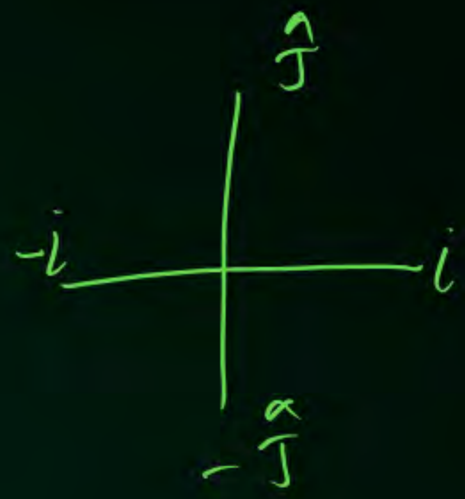




RAIN MAN PROBLEM

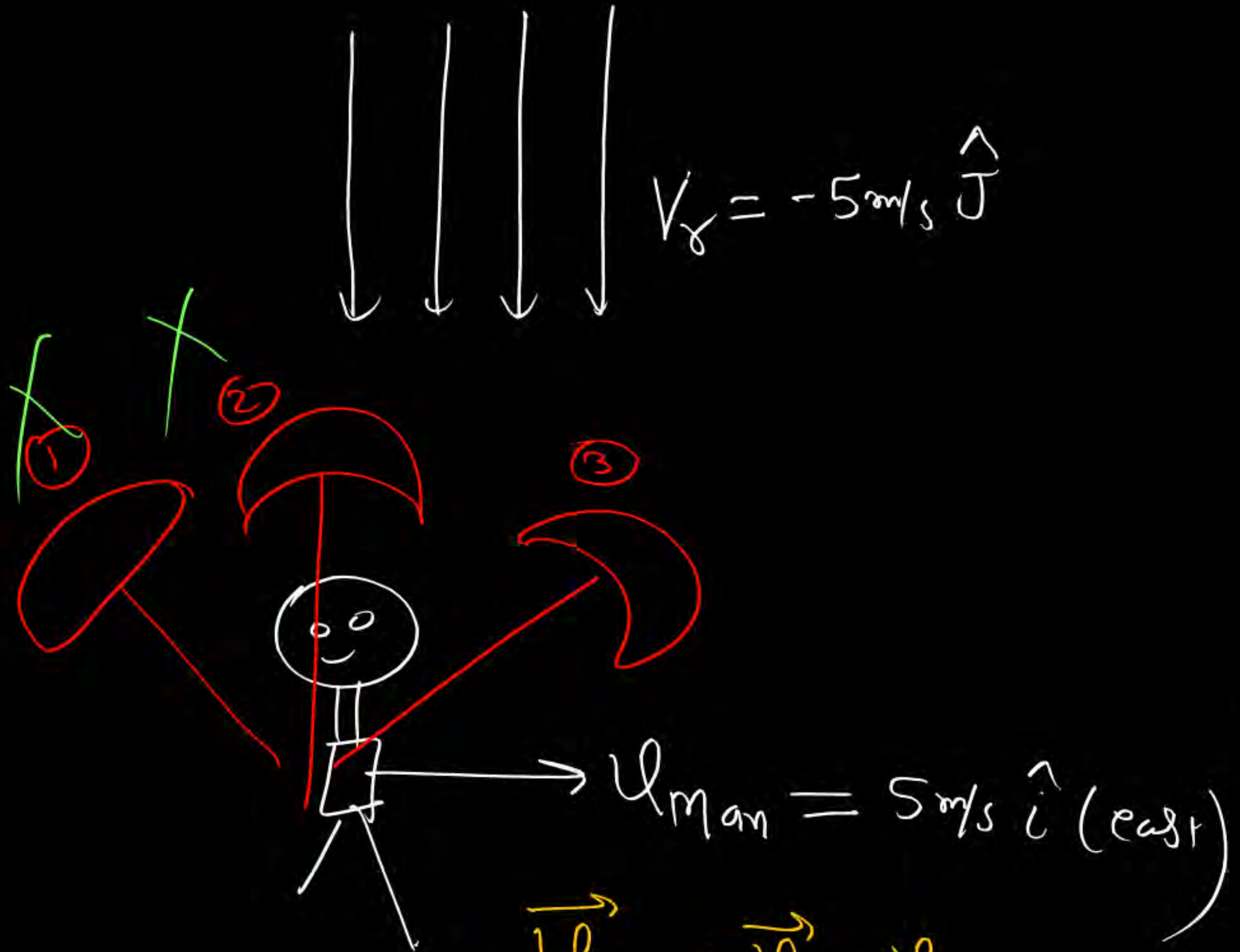


$v_r = -\hat{j}$



$$\left\{ \vec{u}_{RM} = \vec{V}_R - \vec{V}_M \right\}$$

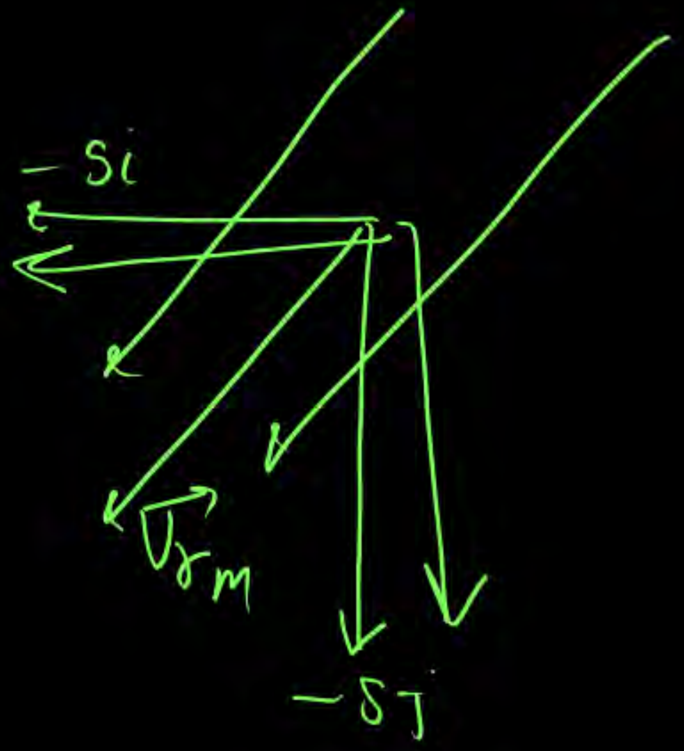
$\vec{u}_{RM}$ $\vec{u}_{mR}$ = छाता



$\vec{u}_{RM} = \vec{v}_R - u_M$

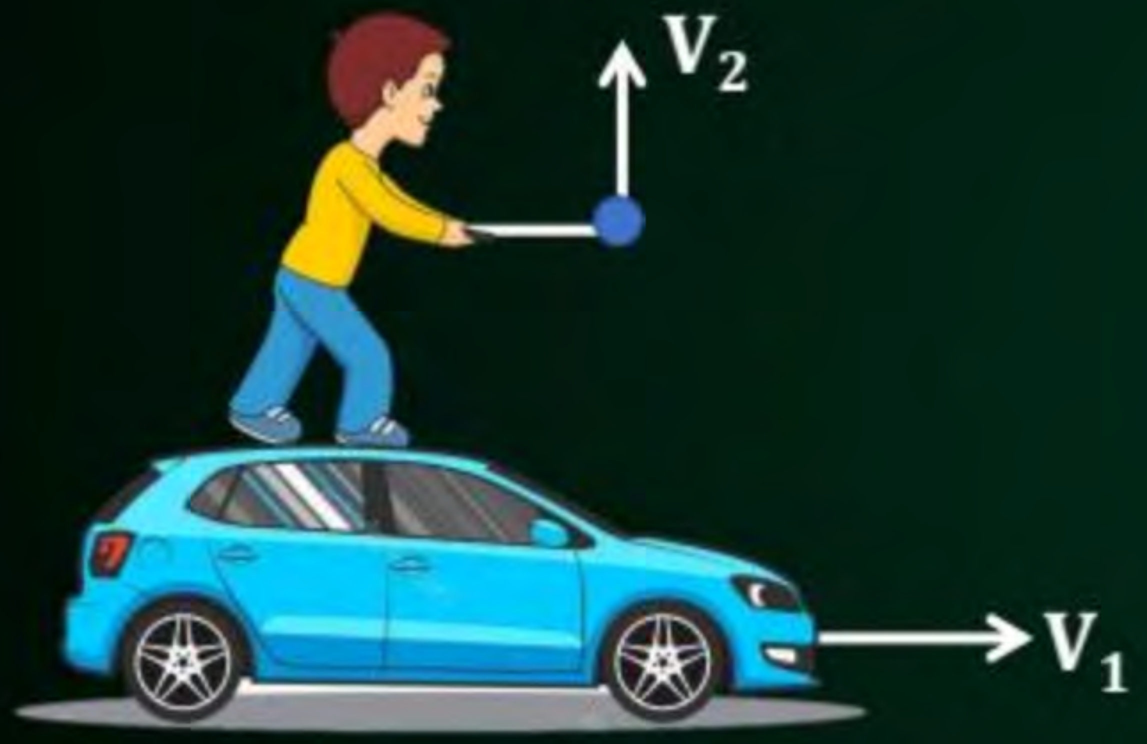
$= -5\hat{j} - 5\hat{i}$

relative velo of rain w.r.t m.



QUESTION

Find range and height of object.



QUESTION

A man standing on a road has to hold his umbrella at $30°$ with the vertical to keep the rain away. He throws the umbrella and starts running at 10 km/hr then he finds that rain drops are hitting his head vertically, then speed of rain drops with respect to moving man :-

1. 20 km/hr.
2. $10\sqrt{3}$ km/hr.
3. $10/\sqrt{3}$ km/hr.
4. 10 km/hr.

QUESTION

A man walks in rain with a velocity of 5 kmh^{-1}. The rain drops strike at him at an angle of 45° with the horizontal. Velocity of rain if it is falling vertically downward -

(1) 5 kmh^{-1}

(2) 4 kmh^{-1}

(3) 3 kmh^{-1}

(4) 1 kmh^{-1}

QUESTION

A car with vertical windshield moves in a rain storm at a speed of 40 km/hr. The rain drops fall vertically with constant speed of 20 m/s. The angle at which rain drops strike the windshield is

1. $\tan^{-1}\frac{5}{9}$
2. $\tan^{-1}\frac{9}{95}$
3. $\tan^{-1}\frac{3}{2}$
4. $\tan^{-1}\frac{2}{3}$

QUESTION

Four persons P, Q, R and S are initially at the tour corners of a square of side d. Each person now moves with a constant speed v in such a way that P always moves directly towards Q, Q towards R, R towards S, and S towards P. The four persons will meet after time

1. $\frac{d}{2v}$
2. $\frac{d}{v}$
3. $\frac{3d}{2v}$
4. They will never meet

QUESTION

Rain is falling vertically with a speed of 30 ms^{-1}. A woman rides a bicycle with a speed of 10 ms^{-1} in the north to south direction. What is the direction in which she should hold her umbrella ?

QUESTION

Man is at rest an find rain is falling with speed 50 m/s at angle 37° from vertical; now man starts moving with speed V_m, then find V_m so that rain appears to falling vertical downward with respect to moving man; also find V_{rm} / Vr

QUESTION

Four persons P, Q, R and S are initially at the tour corners of a square of side d. Each person now moves with a constant speed v in such a way that P always moves directly towards Q, Q towards R, R towards S, and S towards P. The four persons will meet after time

1. $\frac{d}{2v}$
2. $\frac{d}{v}$
3. $\frac{3d}{2v}$
4. The will never meet

QUESTION

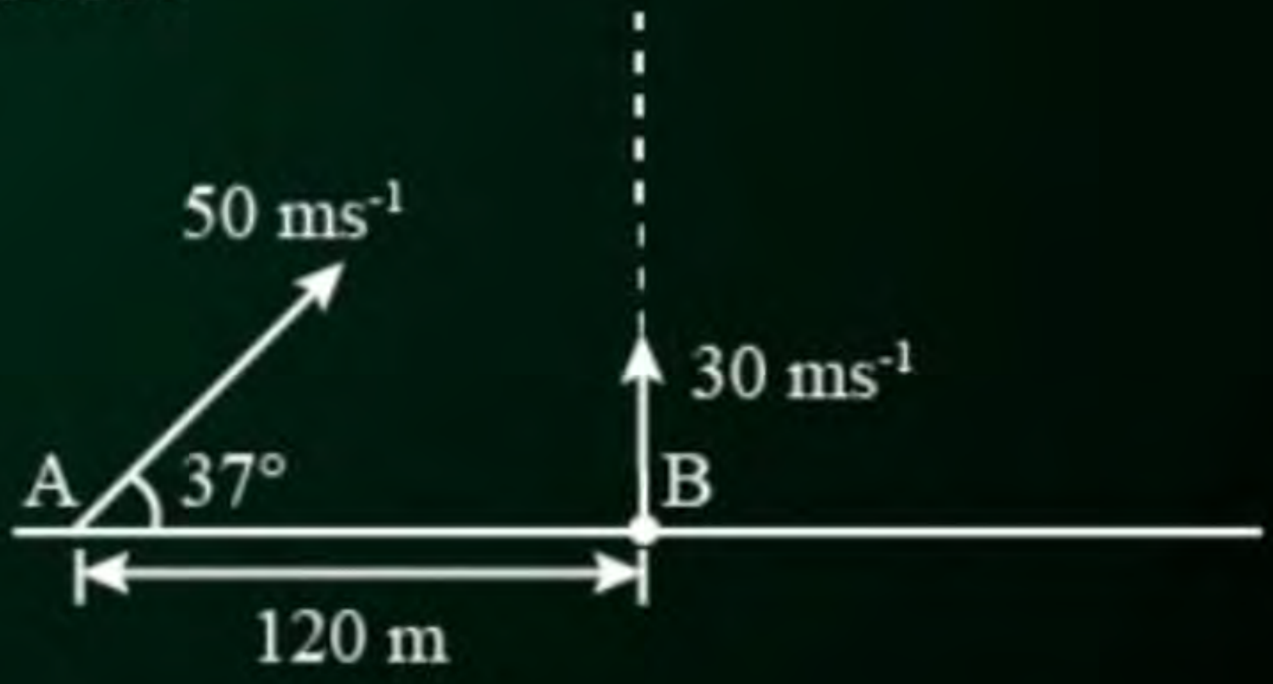
Balls A and B are thrown from two points lying on the same horizontal plane separated by a distance of 120 m. Which of the following statements is correct?

1. The balls can never meet.

2. The balls can meet if the ball B is thrown 1 s later.

3. The two balls meet at a height of 45 m.

4. None of the above



QUESTION

Two boys are standing at the ends A and B of a ground where AB = a. The boy at B starts running in a direction perpendicular to AB with velocity v_1. The boy at A starts running simultaneously with velocity v and catches the other boy in a time t, where t is -

1. $\frac{a}{\sqrt{v^2+v_1^2}}$

2. $\frac{a}{\sqrt{v^2-v_1^2}}$

3. $\frac{a}{(v-v_1)}$

4. $\frac{a}{(v+v_1)}$

QUESTION

A man sitting in a bus travelling in a direction from west to east with a speed of 40 km/h observes that the rain-drops are falling vertically downwards. To another man standing on ground the rain will appear.

1. To fall vertically downwards
2. To fall at an angle going from west to east
3. To fall at an angle going from east to west
4. The information given is insufficient to decide the direction of the rain

QUESTION

Two particles having position vectors $\vec{r}_1 = (3\hat{\imath} + 5\hat{\jmath})$ metres and $\vec{r}_2 = (-5\hat{\imath} - 3\hat{\jmath})$ meres are moving with velocities $\vec{v}_1 = (4\hat{\imath} + 3\hat{\jmath})$ m/s and $\vec{v}_2 = (\alpha\hat{\imath} + 7\hat{\jmath})$ m/s. If they collide after 2 seconds, the value of 'a' is :

1. 2
2. 4
3. 6
4. 8

QUESTION

A 2m wide truck is moving with a uniform speed $V_0 = 8\ ms^{-1}$ along a straight horizontal road. A pedestrian starts to cross the road with a uniform speed v, when the truck is 4 m away from him. The minimum value of v so that he can cross the road safely is

1. $2.62\ ms^{-1}$
2. $4.6\ ms^{-1}$
3. $3.57\ ms^{-1}$
4. $1.414\ ms^{-1}$

THANK YOU



YAKEEN 2.0

FOR NEET 2025

Lecture- 07 | Physics

Motion in a Plane

By- Dr. Manish Raj (MR SIR)



Topics to be covered

1. # Rain man Prob^m (Part-02)
2. # Kinematics of circular motion
3. #
4. #



(*) Circular motion

- (*) Kinematics of circular motn
  - (*) Motn in plane
  - * Uniform circular motn
  - Non-Uniform
  - This chapter.
- Dynamics of circular of motn
  - Banking of Road
  - motn of CAR
  - Laws of motion.
  - Death well
- Vertical circular motn
  - Work energy Power

QUESTION

$\vec{v}_{AB} = \vec{v}_{AG} - \vec{v}_{BG}$

A boat is moving with a velocity $3\hat{\imath} + 4\hat{\jmath}$ with respect to ground. The water in the river is moving with a velocity $-3\hat{\imath} - 4\hat{\jmath}$ with respect to ground. The relative velocity of the boat with respect to water is ??

(1) $8\hat{\jmath}$

(2) $-6\hat{\imath} - 8\hat{\jmath}$

(3) $6\hat{\imath} + 8\hat{\jmath}$

(4) $5\sqrt{2}$

$\vec{v}_{B\,River} = \vec{v}_{BG} - \vec{v}_{RG}$

QUESTION

- Two particles having position vectors $\vec{r}_1 = (3\hat{\imath} + 5\hat{\jmath})$ metres and $\vec{r}_2 = (-5\hat{\imath} - 3\hat{\jmath})$ meres are moving with velocities $\vec{v}_1 = (2\hat{\imath} + 3\hat{\jmath})$ m/s and $\vec{v}_2 = (\alpha\hat{\imath} + 7\hat{\jmath})$ m/s. If they collide after 2 seconds, the value of 'α' is :

(1) 2

(2) 4

(3) 6

(4) 8

$\vec{r}_1 = 3\hat{i} + 5\hat{j}$ | $\vec{v}_1 = 2\hat{i} + 3\hat{j}$

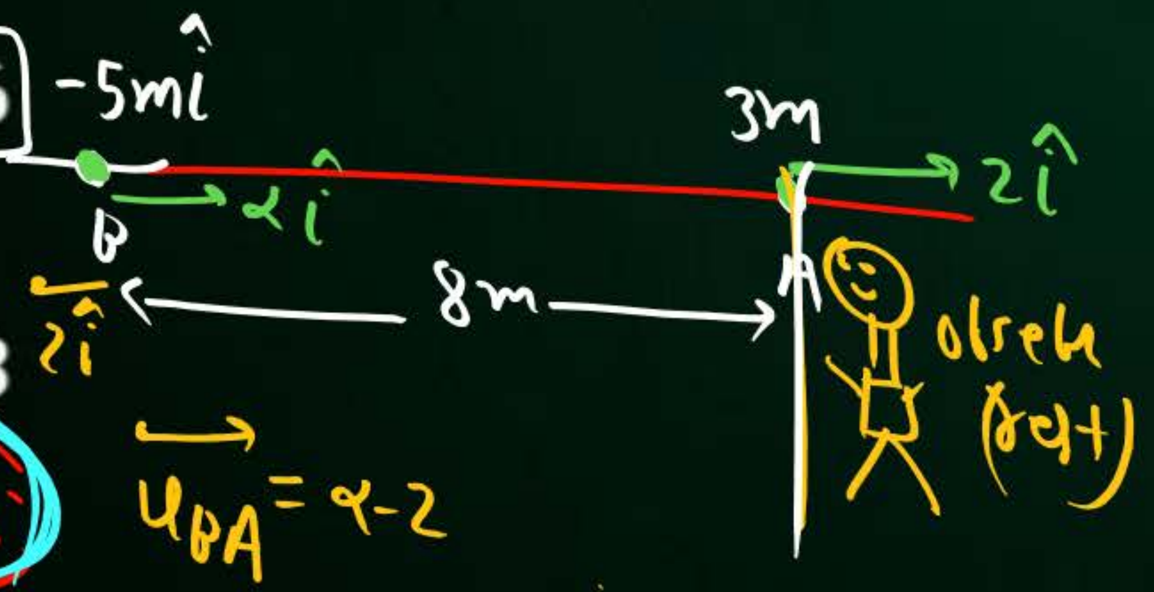
$r_2 = -5\hat{i} - 3\hat{j}$ | $v_2 = \alpha\hat{i} + 7\hat{j}$

only x-axis is considered

t = 2 sec

15%

56%



$\vec{u}_{BA} = \alpha - 2$

$S_{BA} = u_{BA} t$ — (1)

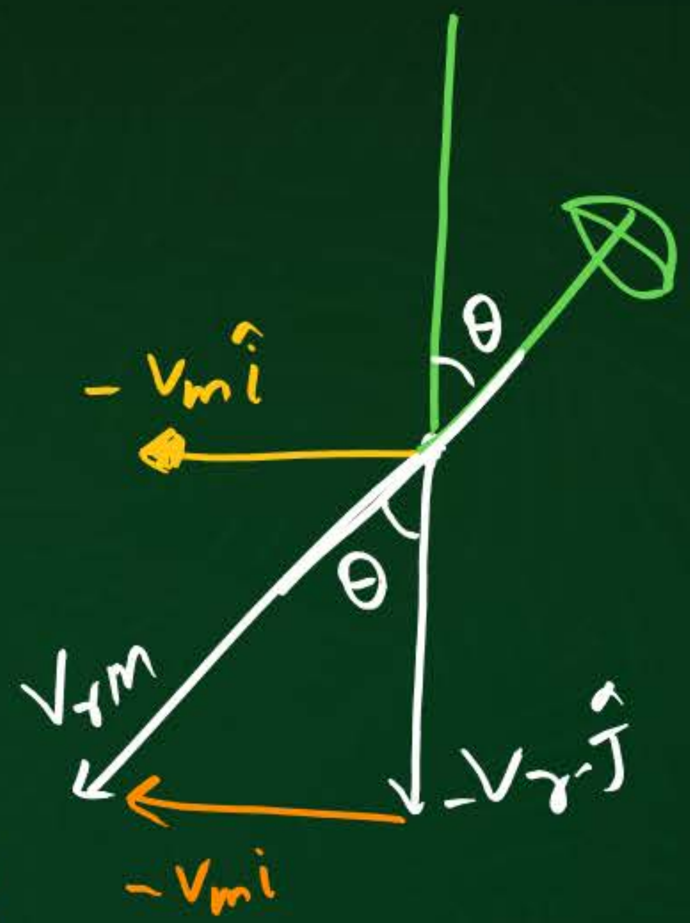
$4 \cdot 8 = (\alpha - 2) \cdot 2$

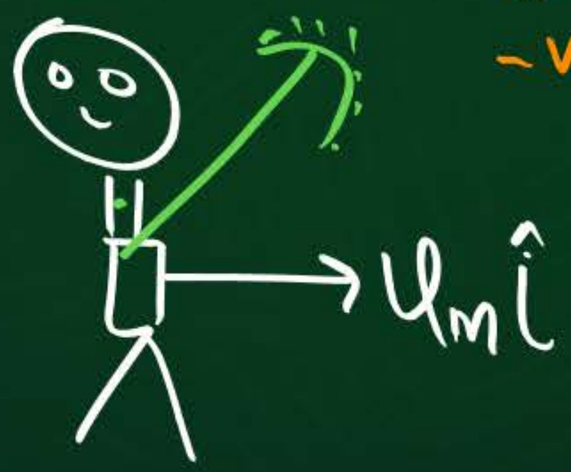
$4 = \alpha - 2$

$\alpha = 6$

Rain man - Problem







$$\vec{U}_{RM} = \vec{V}_R - \vec{V}_m$$

$$\tan\theta = \frac{V_m}{V_r}$$

$$\theta = \tan^{-1}\left(\frac{V_m}{V_r}\right)$$

↳ direction in which man have to hold his umbrella.

QUESTION

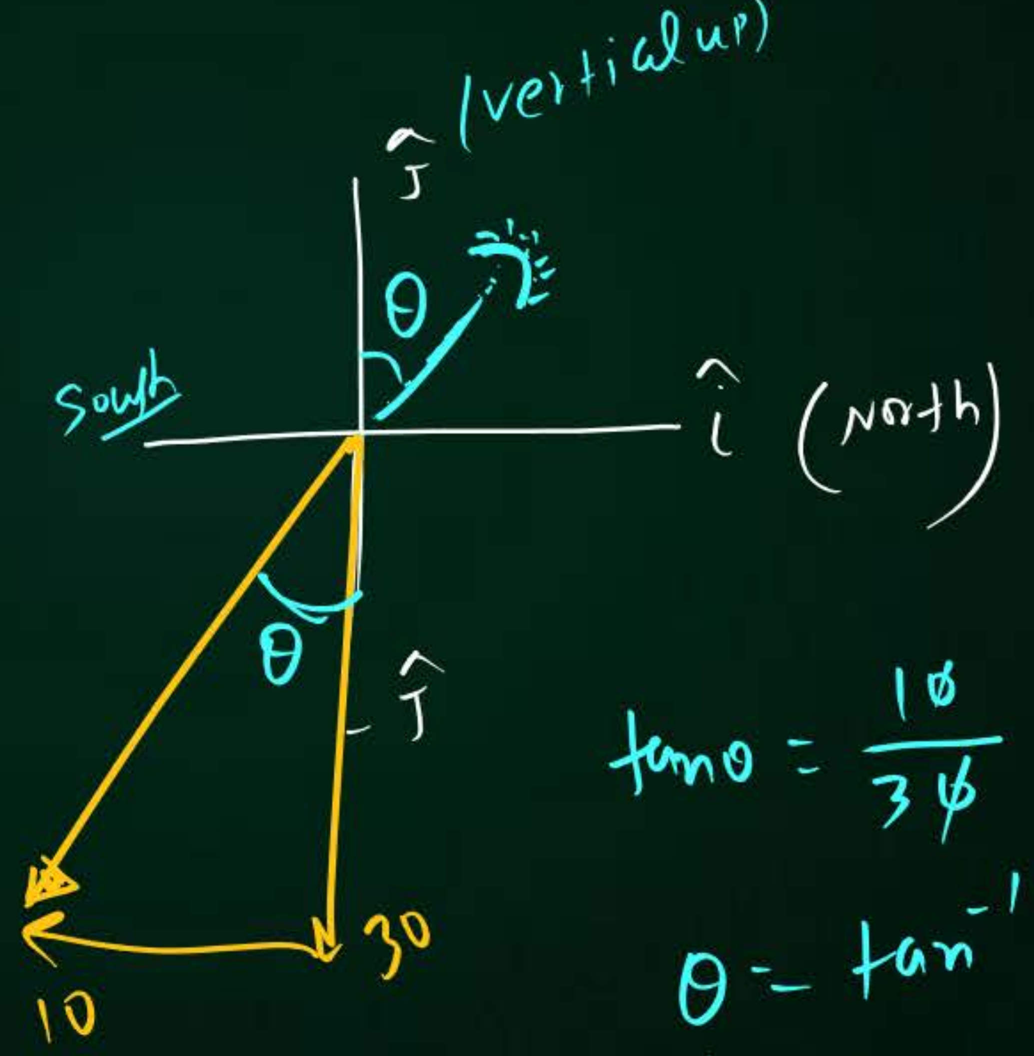
Rain is falling vertically with a speed of 30 ms^{-1}. A woman rides a bicycle with a speed of 10 ms^{-1} in the north [redacted] direction. What is the direction in which she should hold her umbrella ?

$v_r = -30\hat{j}$

$v_w = 10\hat{i}$

$v_{RW} = v_R - v_w$

$= -30\hat{j} - 10\hat{i}$



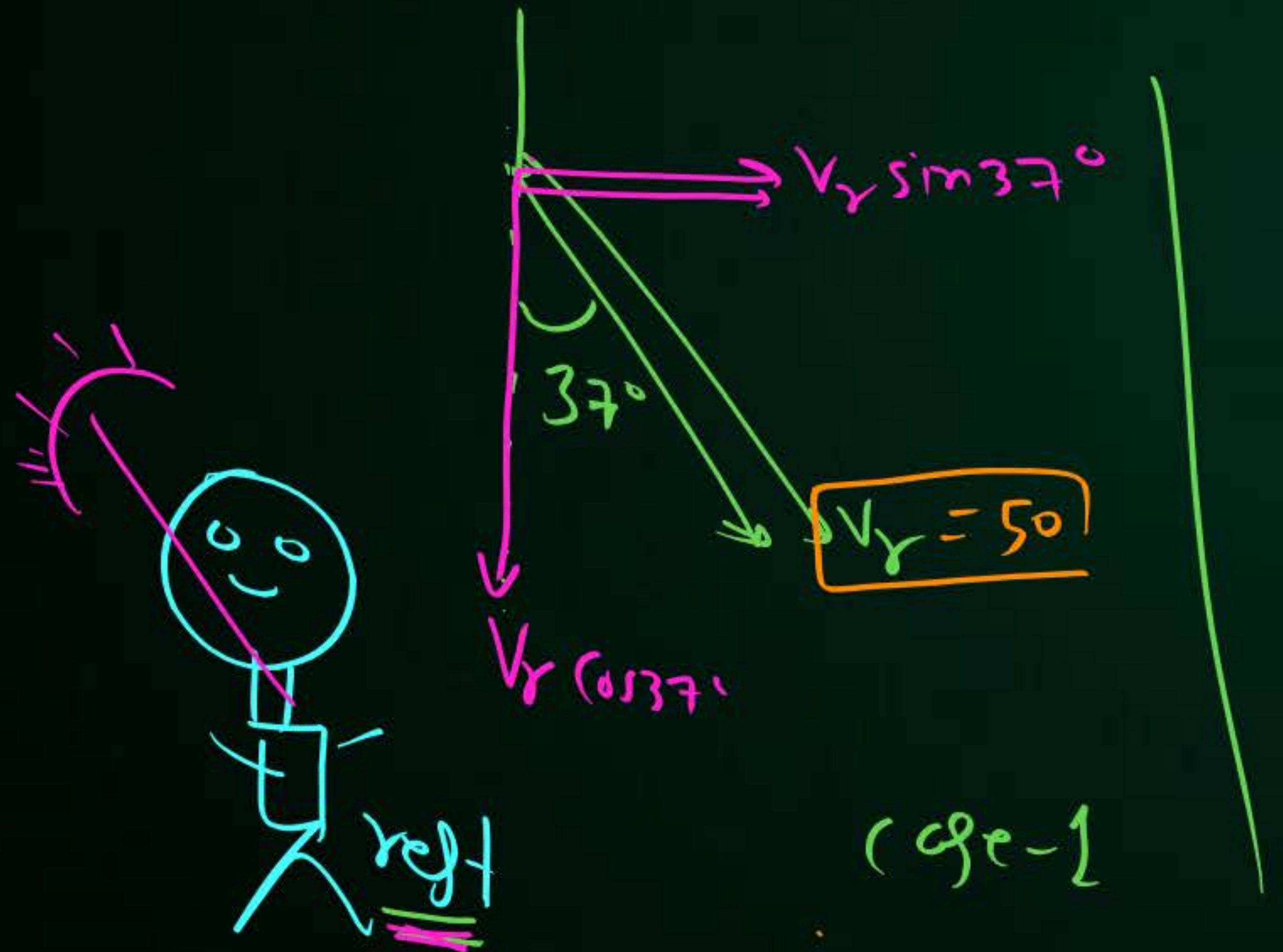
$\tan\theta = \frac{10}{30}$

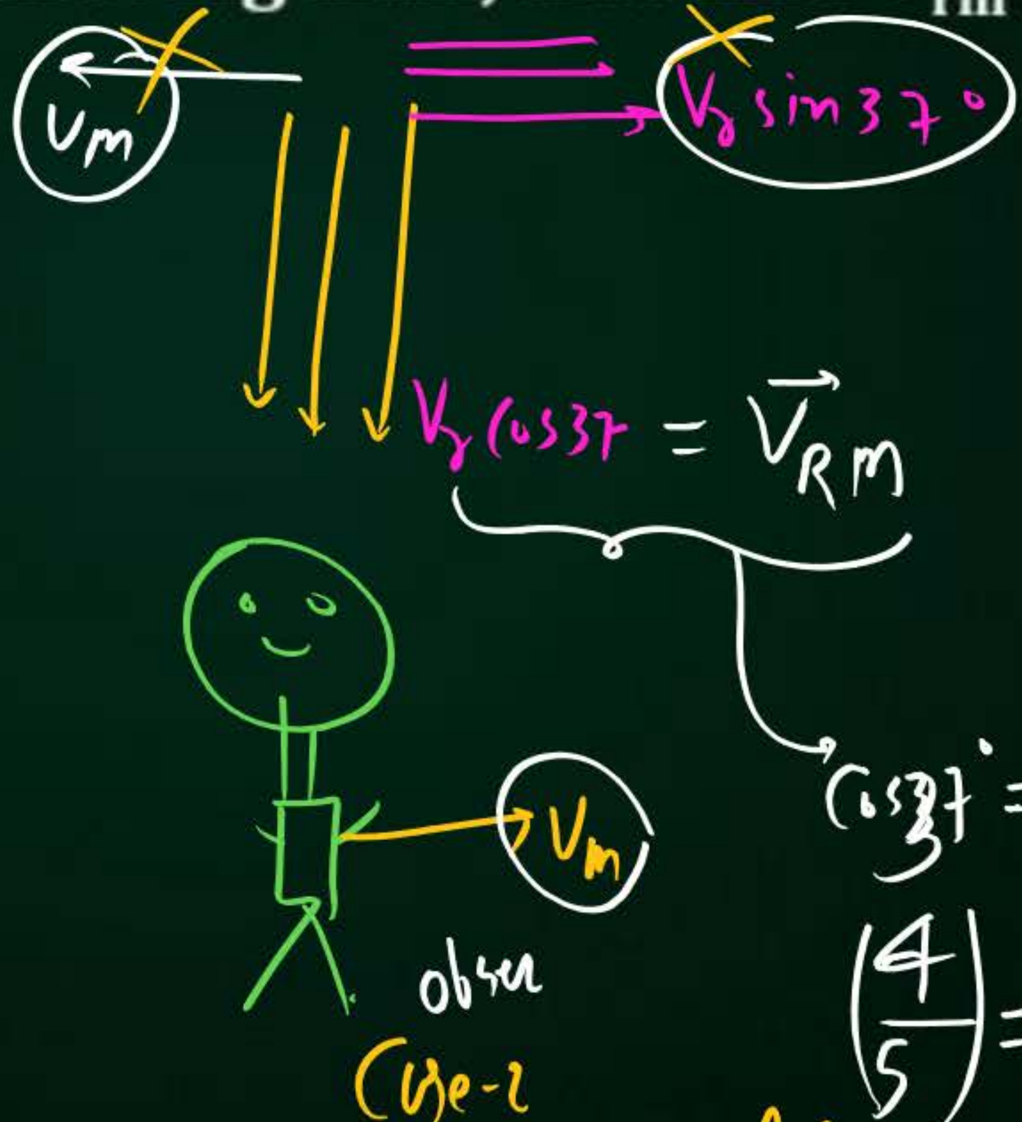
$\theta = \tan^{-1}\left(\frac{1}{3}\right)$

↳ from vertical

QUESTION

Man is at rest an find rain is falling with speed 50 m/s at angle 37° from vertical; now man starts moving with speed V_m, then find V_m so that rain appears to falling vertical downward with respect to moving man; also find V_{rm} / Vr





If $V_r \sin 37° = V_m$

then Rain appear to falling downward

$\cos 37° = \frac{V_{Rm}}{V_r}$

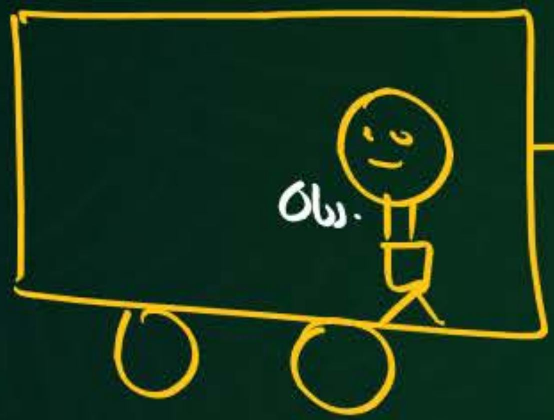
Ans $\left(\frac{4}{5}\right) = \left(\frac{V_{Rm}}{V_r}\right)$

$V_m = V_r \times \frac{3}{5}$

$= 50 \times \frac{3}{5} = 30$ m/s

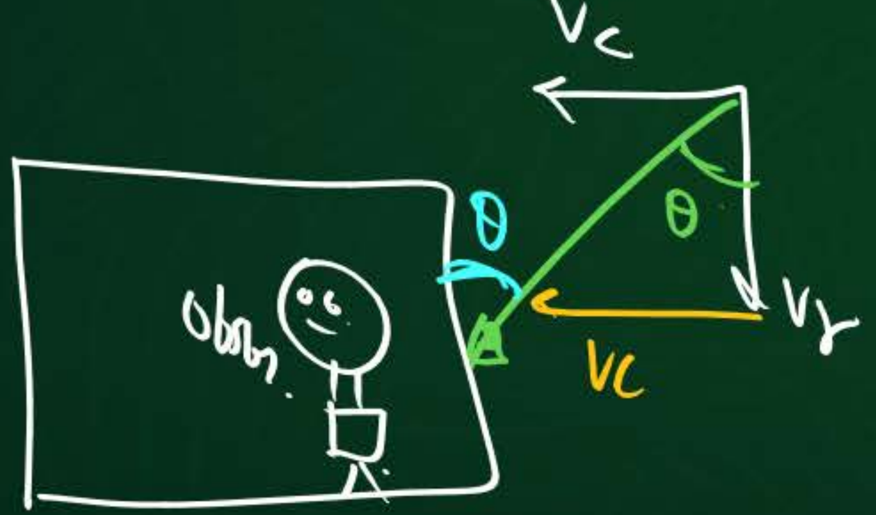


Find Angle at which rain is falling on car from vertical



$v_c = 18\,km/hr = 18 \times \frac{5}{18} = 5\,m/s$

Sol^n



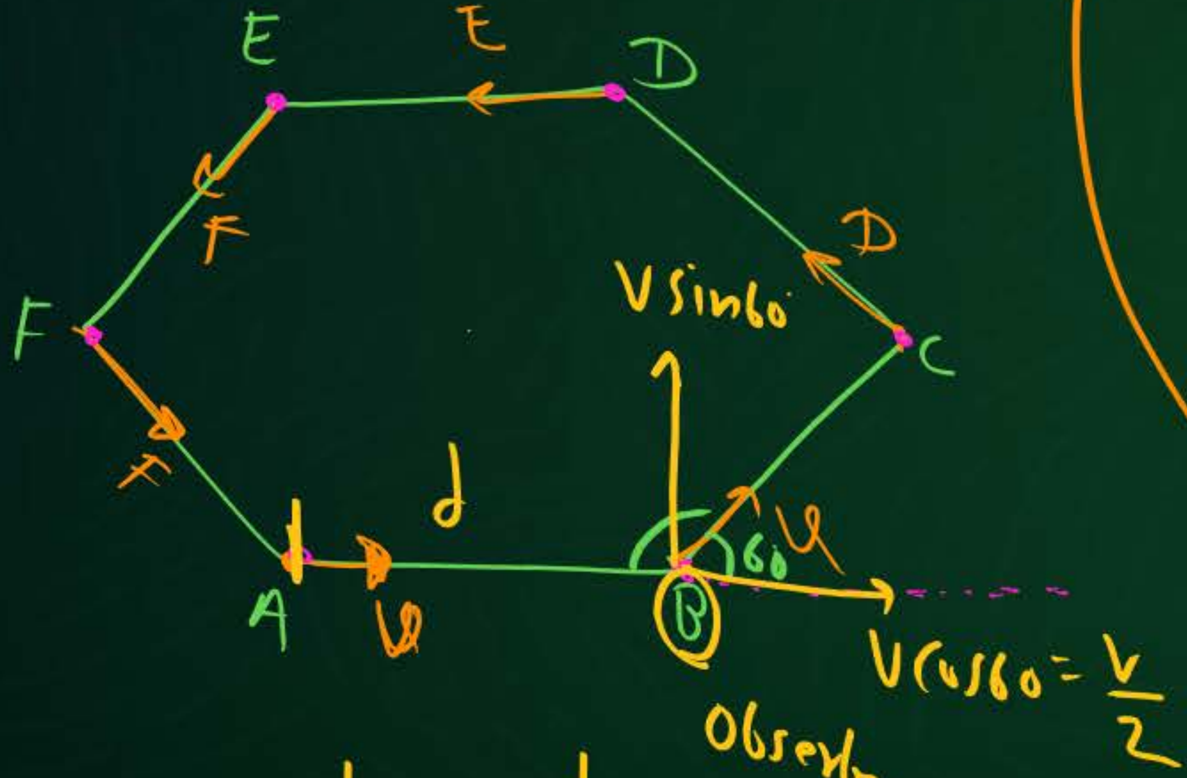
$\tan\theta = \frac{V_c}{V_r}$

~~$\tan\theta = \frac{18}{5}$~~ 2 ← onle leg stand for next 5 min

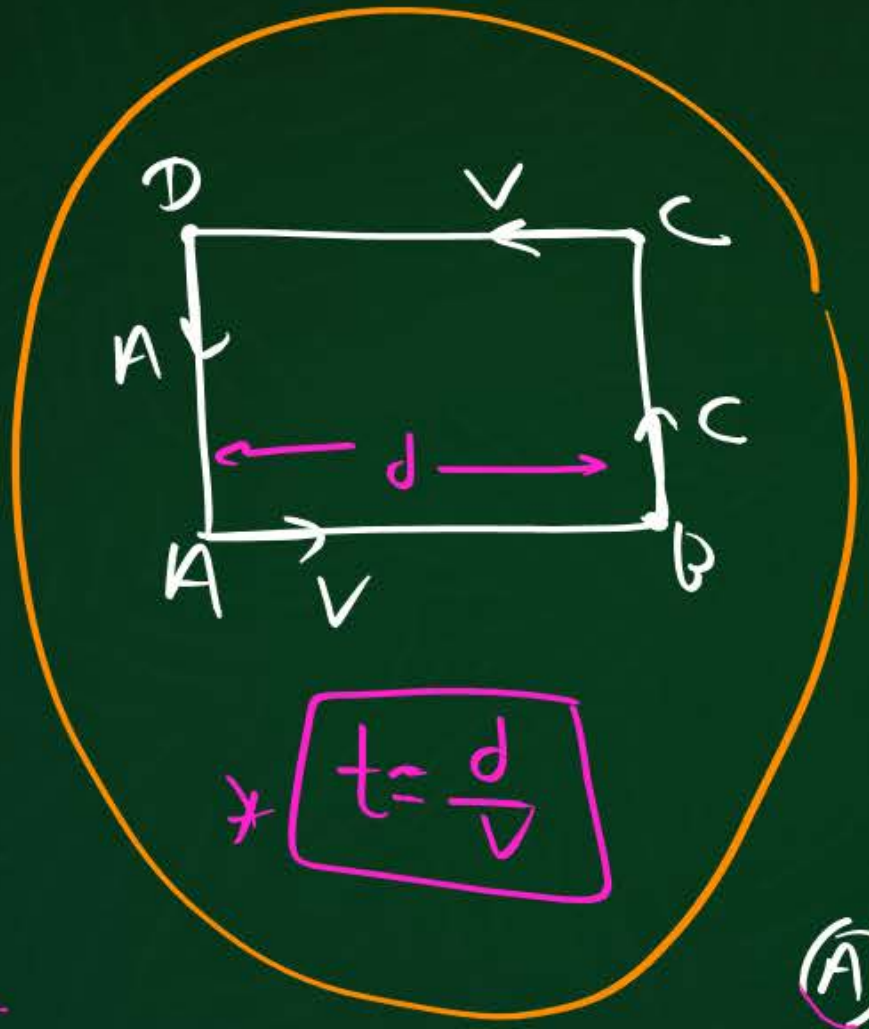
$\tan\theta = \frac{5}{9}$ $\boxed{\theta = \tan^{-1}\left(\frac{5}{9}\right)}$ ✓

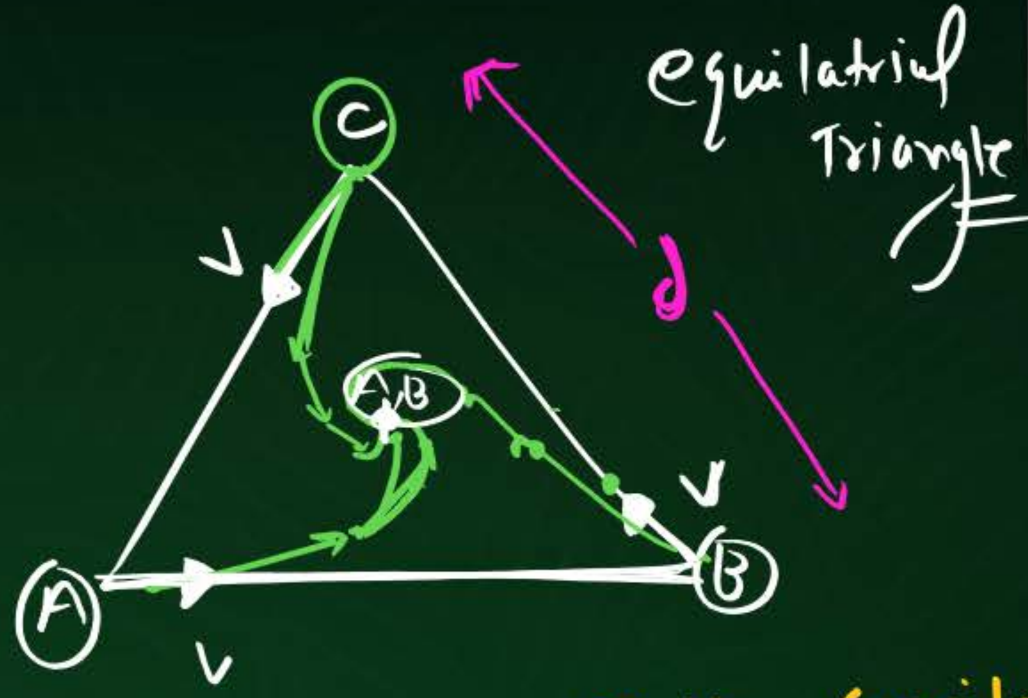


$$* \; t = \frac{d}{2v}$$

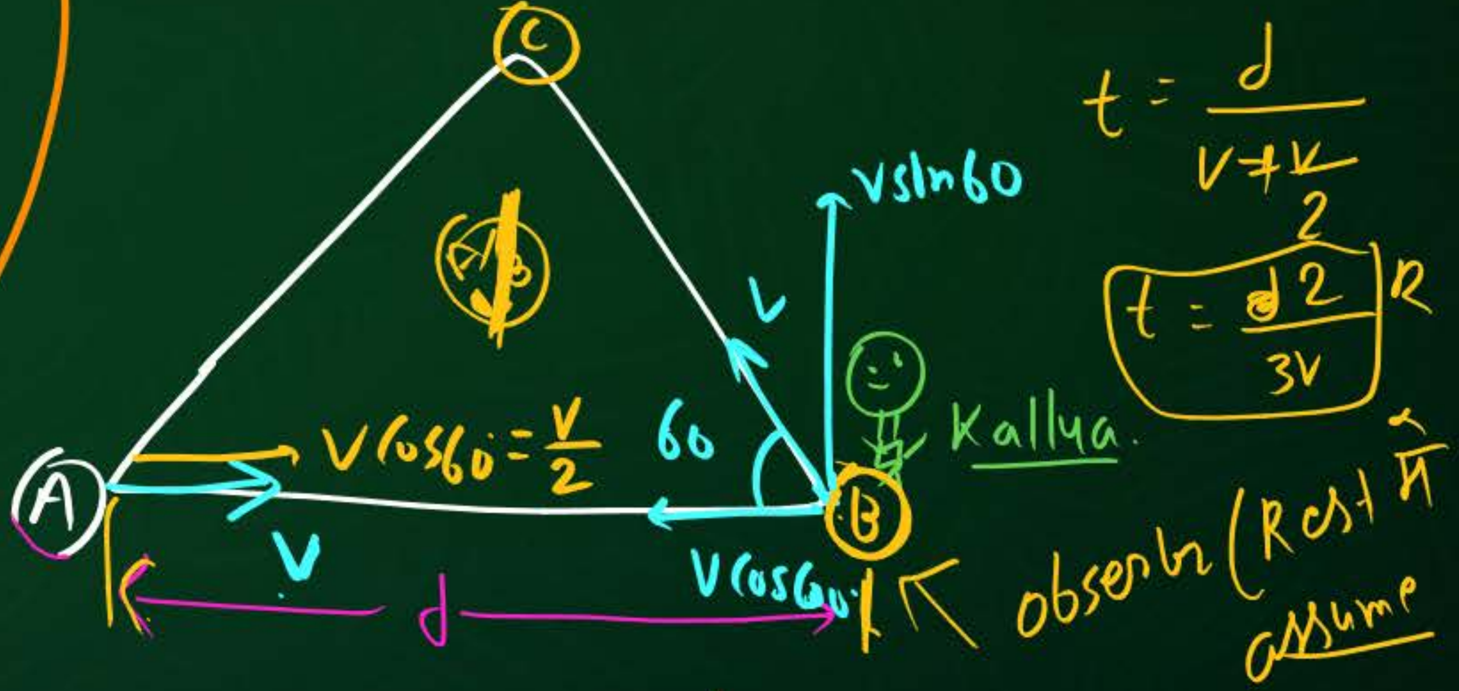


$$t = \frac{d}{v - \frac{v}{2}} = \frac{d}{\frac{v}{2}} = \left[\frac{2d}{v}\right]$$





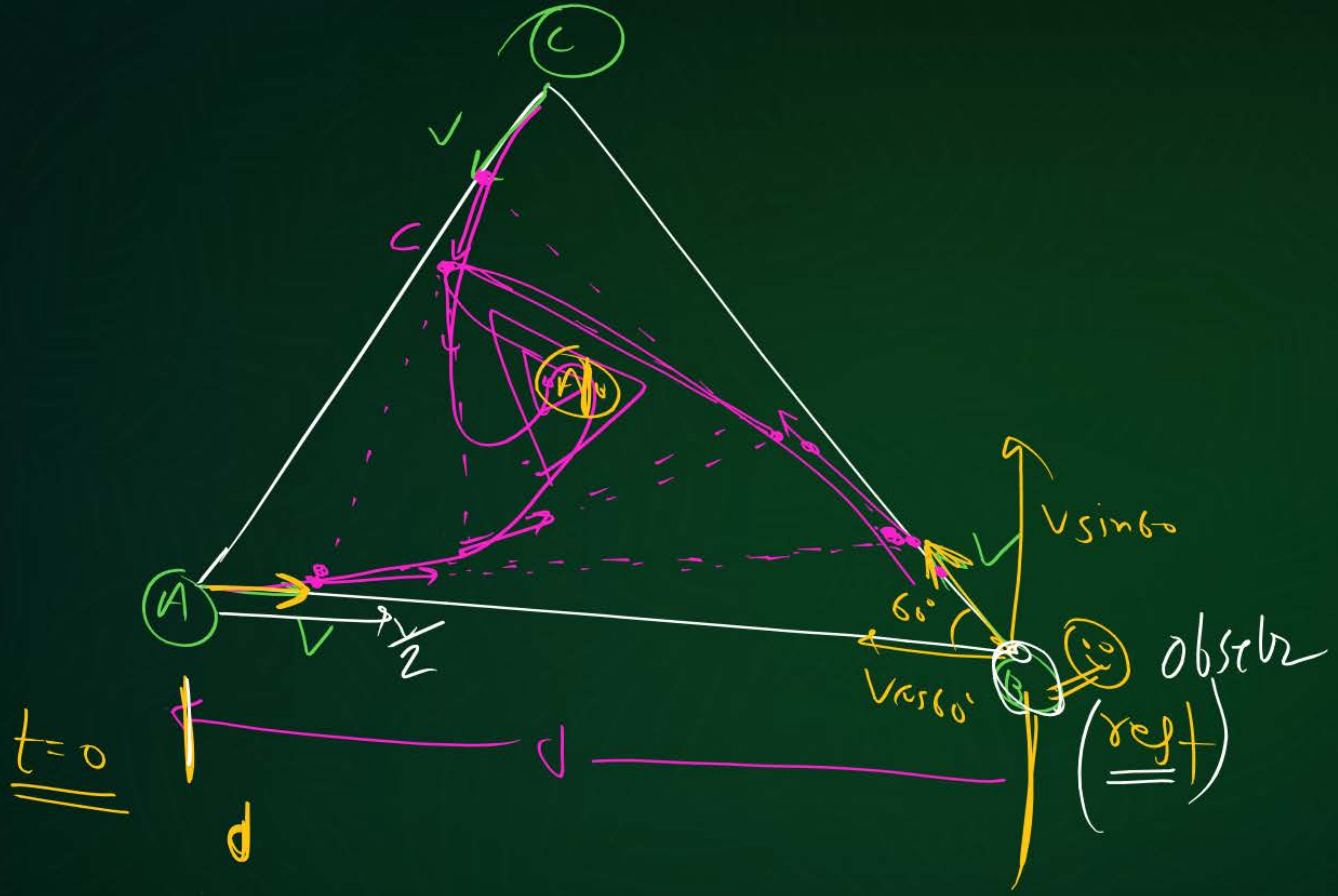
Motion considered only x-axis.



$$t = \frac{d}{v + \frac{v}{2}}$$

$$t = \frac{d\,2}{3v}$$

$t = 0$



A कितना चला B के respect में

$$t = \frac{d}{v + \frac{v}{2}}$$

$$t = \frac{d}{\frac{2v+v}{2}}$$

$$t = \frac{2d}{3v}$$

QUESTION

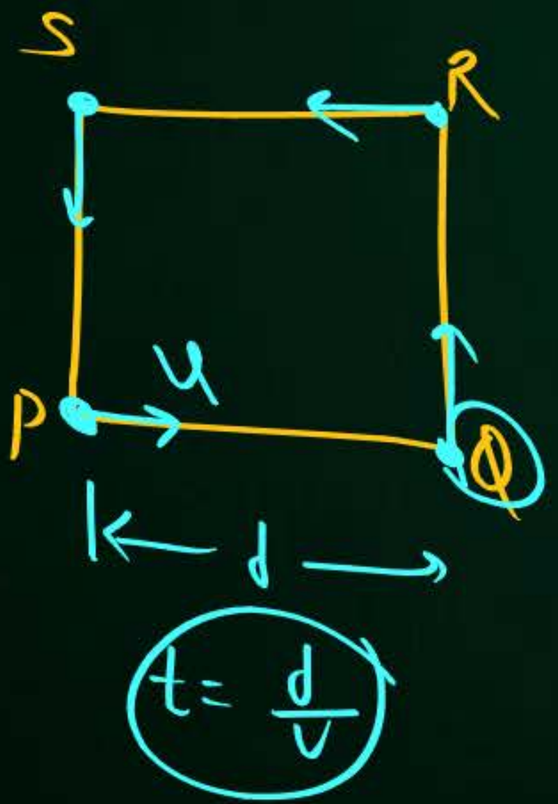
Four persons P, Q, R and S are initially at the four corners of a square of side d. Each person now moves with a constant speed v in such a way that P always moves directly towards Q, Q towards R, R towards S, and S towards P. The four persons will meet after time

(1) $\frac{d}{2v}$

(2) $\frac{d}{v}$

(3) $\frac{3d}{2v}$

(4) The will never meet



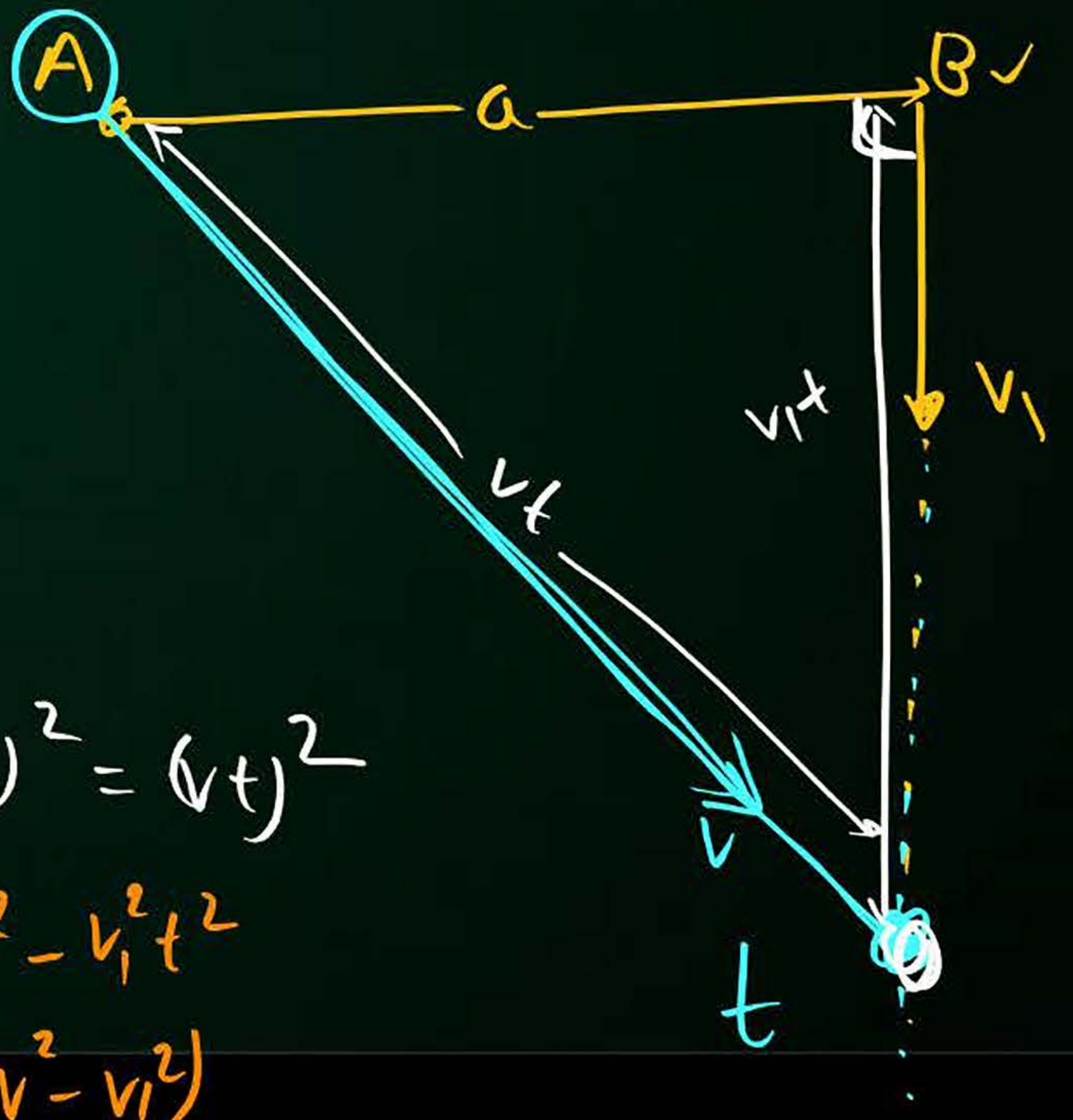
Two boys are standing at the ends A and B of a ground where AB = a. The boy at B starts running in a direction perpendicular to AB with velocity v_1. The boy at A starts running simultaneously with velocity v and catches the other boy in a time t, where t is -

(1) $\dfrac{a}{\sqrt{v^2 + v_1^2}}$

(2) $\dfrac{a}{\sqrt{v^2 - v_1^2}}$

(3) $\dfrac{a}{(v - v_1)}$

(4) $\dfrac{a}{(v + v_1)}$



$$a^2 + (v_1t)^2 = (vt)^2$$
$$a^2 = v^2t^2 - v_1^2t^2$$
$$a^2 = t^2(v^2 - v_1^2)$$

$$t^2 = \frac{a^2}{v^2 - v_1^2}$$

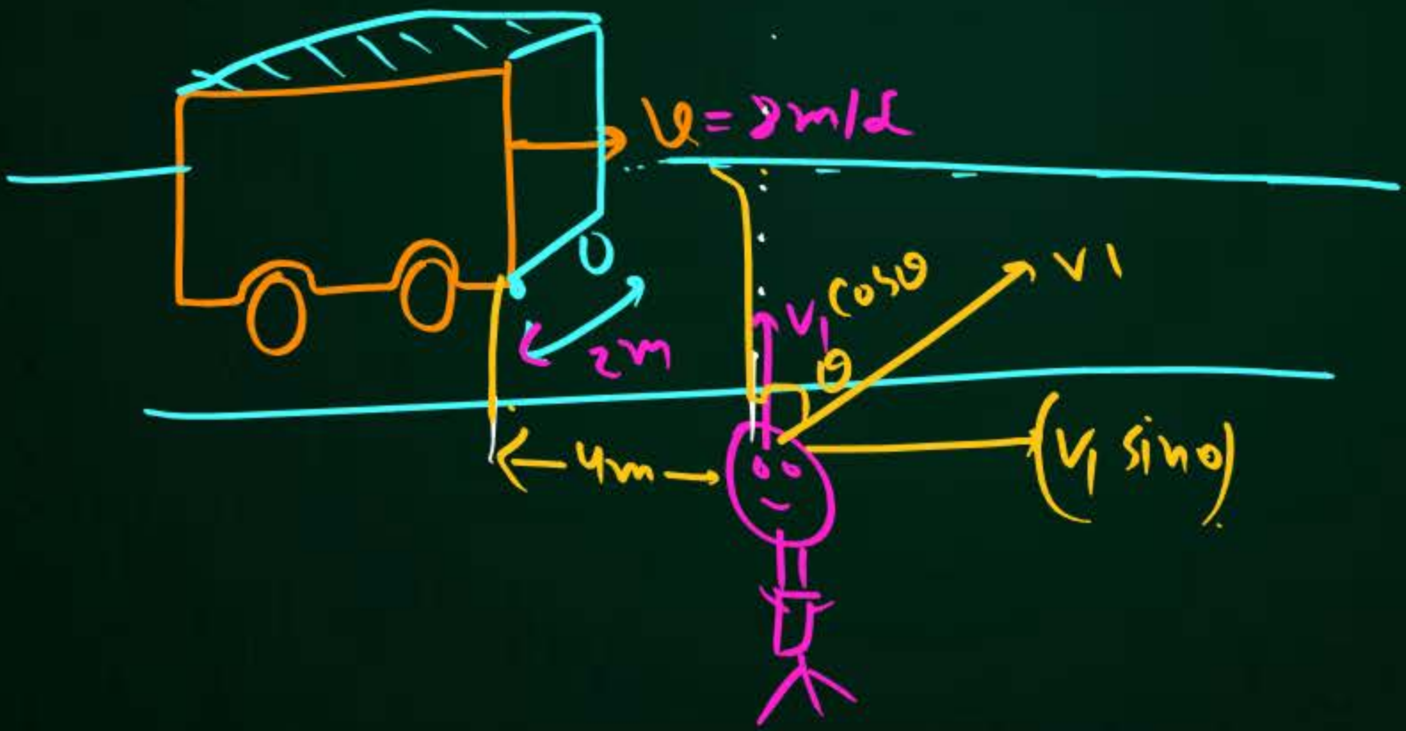
$$t = \sqrt{\frac{a^2}{v^2 - v_1^2}} = \frac{a}{\sqrt{v^2 - v_1^2}}$$

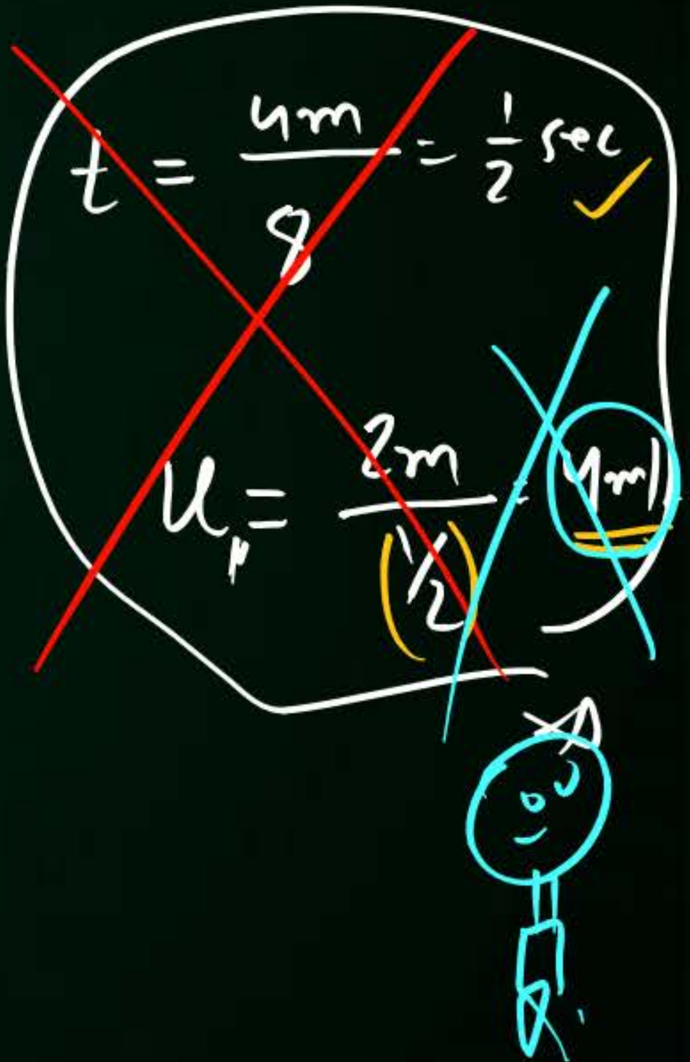
MR star question

QUESTION

A 2m wide truck is moving with a uniform speed $V_0 = 8\ ms^{-1}$ along a straight horizontal road. A pedestrian starts to cross the road with a uniform speed v, when the truck is 4 m away from him. The minimum value of v so that he can cross the road safely is

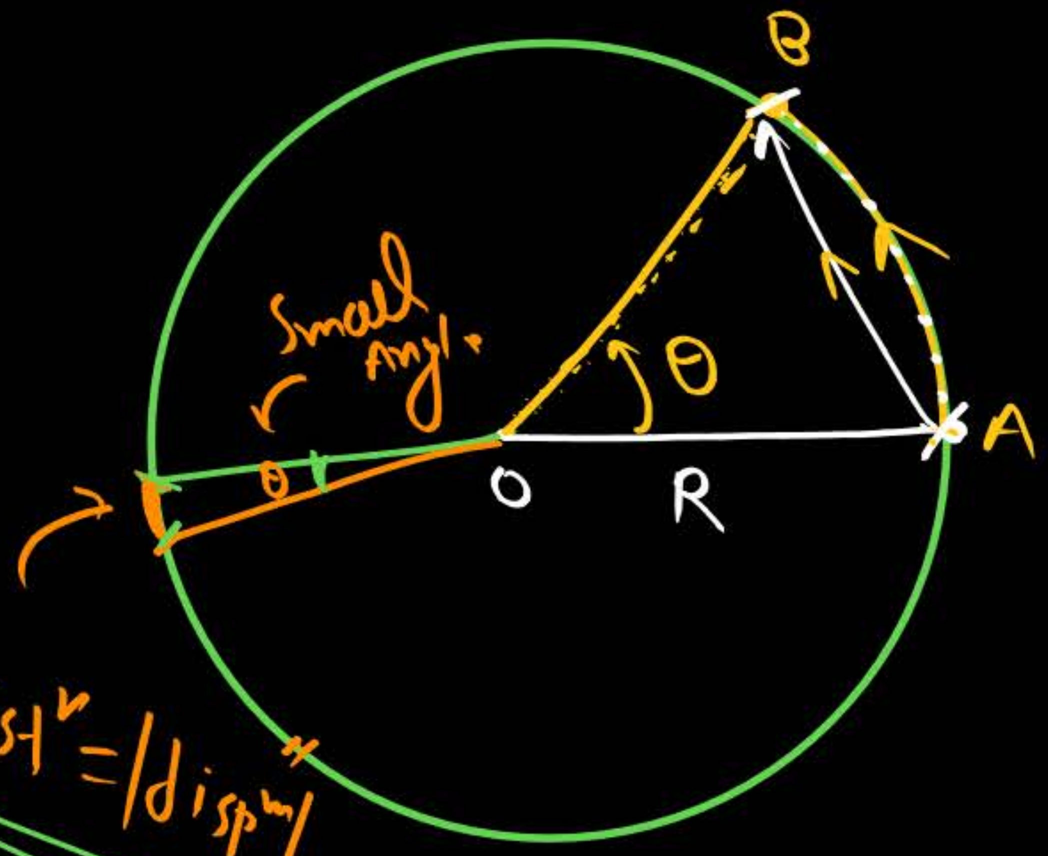
1. $2.62\ ms^{-1}$
2. $4.6\ ms^{-1}$
3. $3.57\ ms^{-1}$
4. $1.414\ ms^{-1}$





Kinematics of circular motion

→ Ex– Angular dispm, Angular velocity, angular accn



$\text{dist}^n = |\text{disp}^m|$ for small angle

(distance moved by object) = $R\theta$ = Arc

linear (displacement) = $2R\sin(\theta/2)$

⇒ change in Position

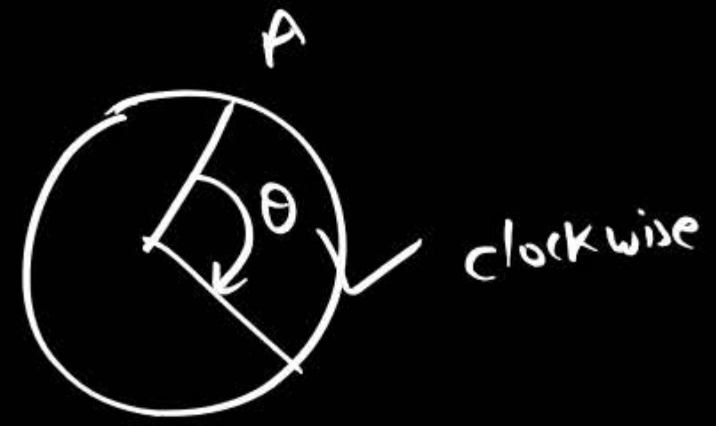
* If Angle is small

$\text{disp}^m = 2R\frac{\theta}{2} = R\theta$

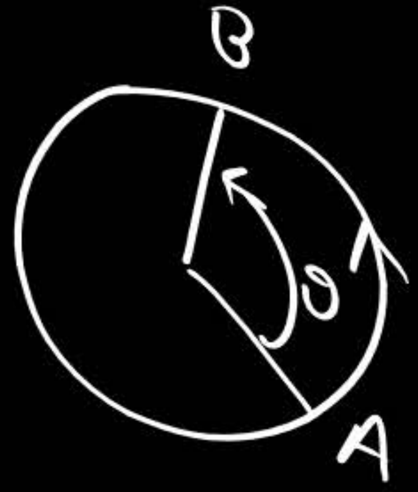
↑ distn

Angular displacement = θ

↳ vector [for Anti-clock ⊙ outward; for clock wise ⊗ downward]



θ $\otimes$ Inward



Anti-

θ $\odot$

(Angular dispn

1-D Motion (Rectilinar mo^n) → dir^n only charge at u-turn [at this point (v = 0)]

Circular Motion में {Circular Parametre} (θ, ω, α) → ka variation (feel)

one-D motion में {liner parametre} [v, S, a]

Jaisa hota hai Same Relate Karenge circular motion ka Angular Parametre, one-D ke liner Parameter se.

find Angular displacement in one compt Rotⁿ ??

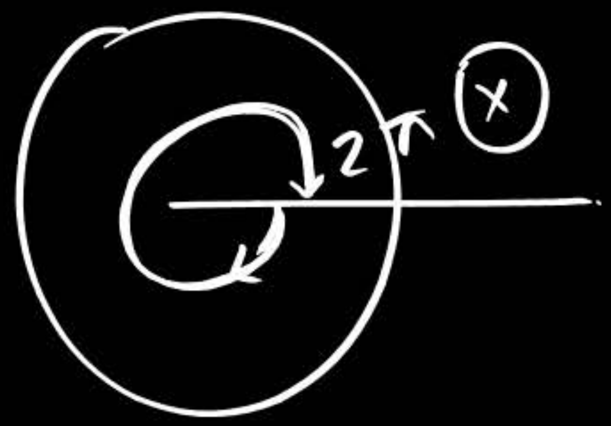
17%

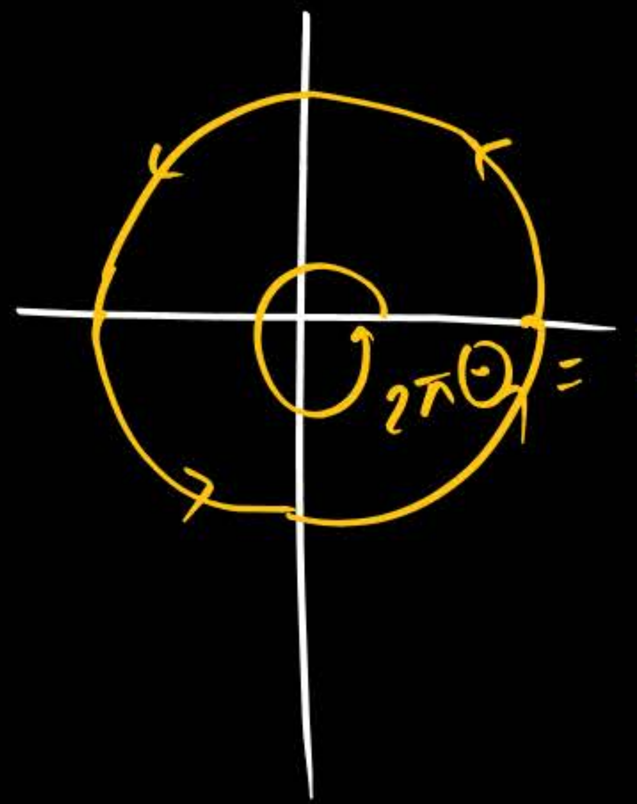
(a) 2π ✓

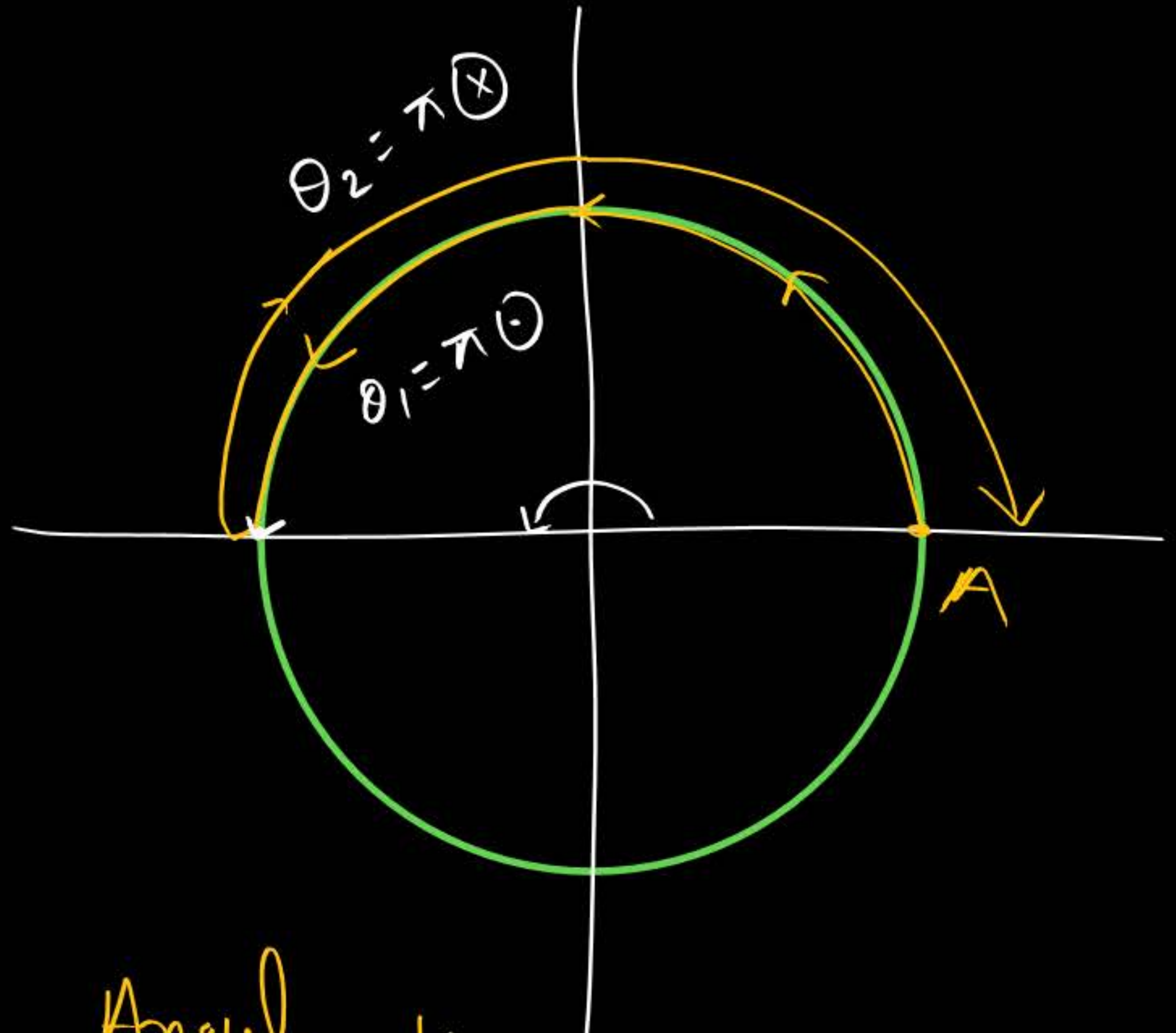
(b) Zero
70%

(c) π

(d) 2πR



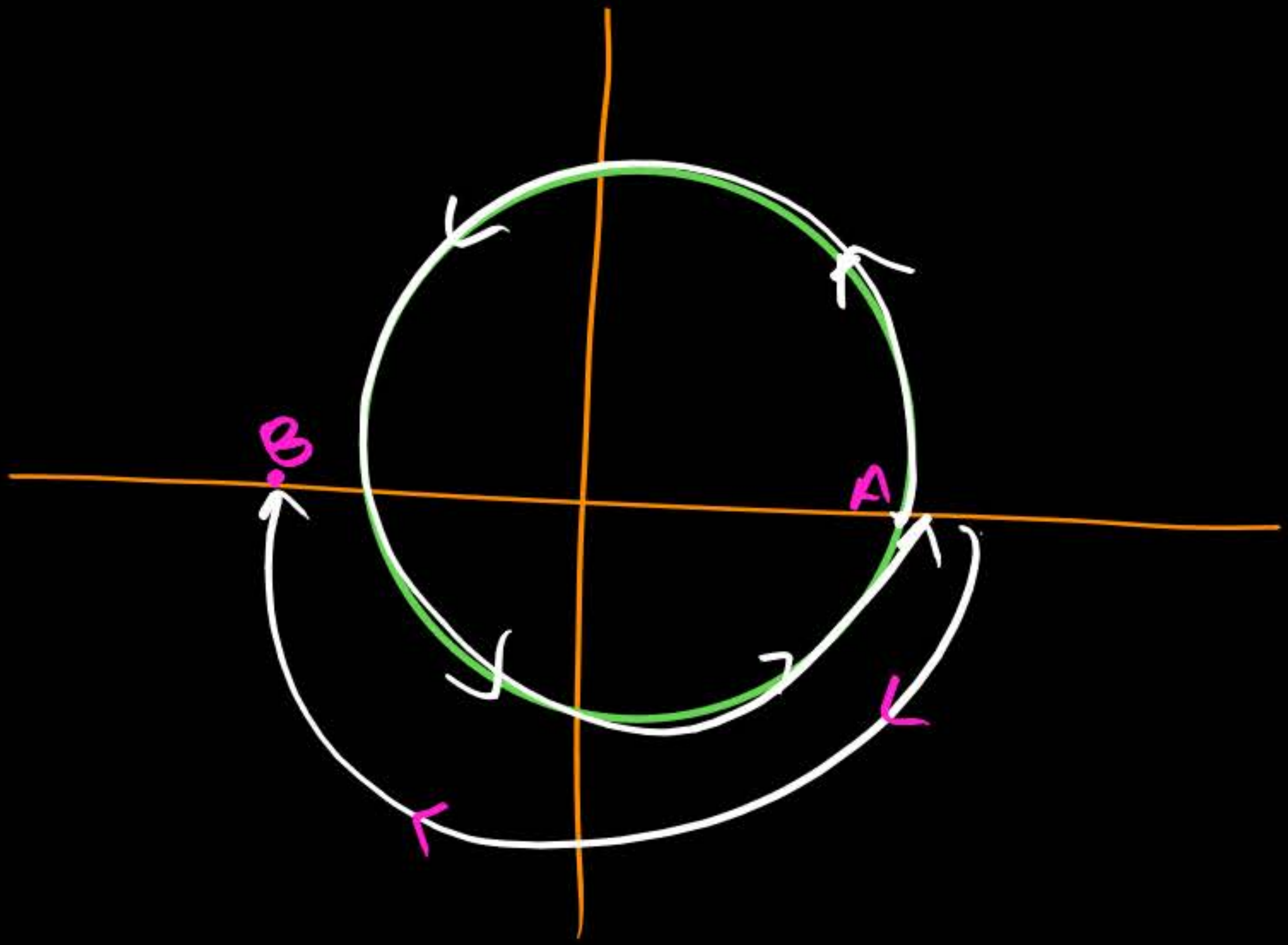




Angular dispⁿ = π⊙ − π⊗ = 0

Angular distance (total Angle move) = 2π

⇒ scalar

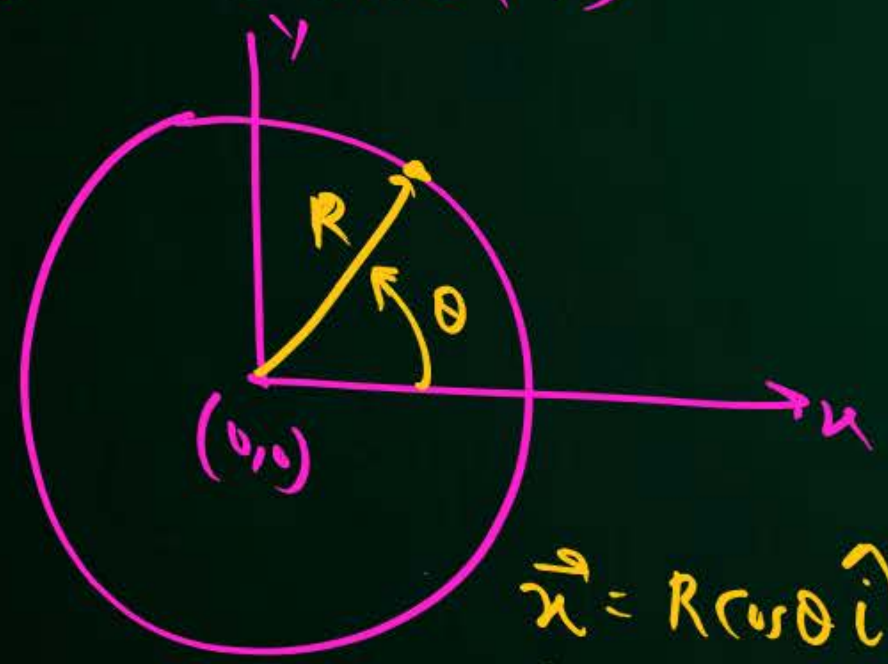


* Angular dispⁿ = π⊙
* Angular dispⁿ = 3π

CIRCULAR MOTION

- When object moves on the circumference of circle then motion is called circular motion.
- Position of object w.r.t. centre at any time 't' is $\vec{r} = R\sin\hat{j} + R\cos\theta\,\hat{i}$.

→ refⁿ = centre (0,0)



$\vec{x} = R\cos\theta\,\hat{i}$

$y = R\sin\theta\,\hat{j}$

$\vec{r} = x\hat{i} + y\hat{j}$

$\vec{r} = R\cos\theta\,\hat{i} + R\sin\theta\,\hat{j}$

linear Position

QUESTION

Find angular and linear displacement in one revolution.

QUESTION

Find angle rotated by angular displacement vector in one rotation.

QUESTION

Find angular displacement of hr. hand minute hand and sec. hand of clock in 12 hr.

ANGULAR Velocity

Angular velocity

In time 't' | at time 't'

$$\vec{\omega}_{Avg} = \frac{\vec{\theta}_f - \vec{\theta}_i}{\Delta t} = \frac{\vec{\Delta\theta}}{\Delta t}$$

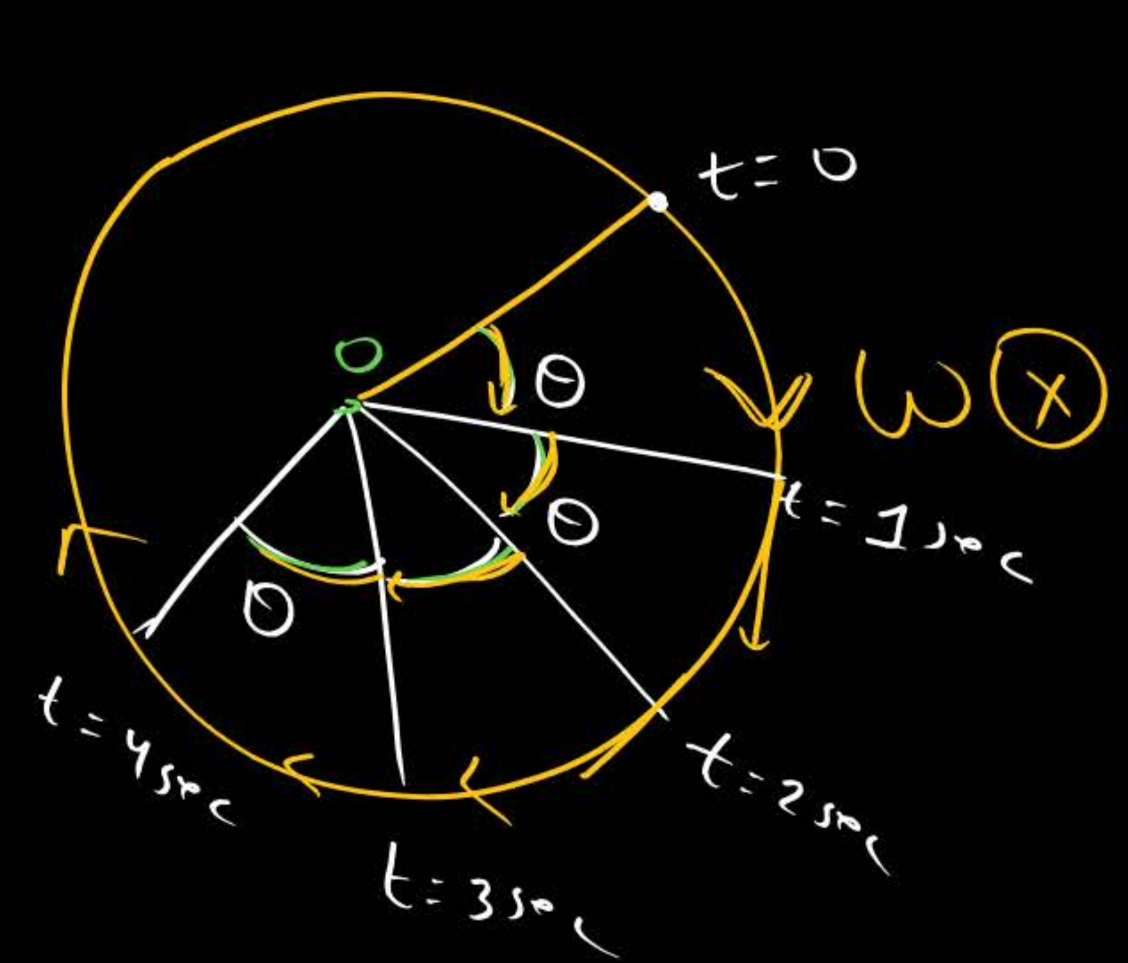
(*) $$\omega_{Avg} = \frac{\int \omega\, dt}{\int dt}$$

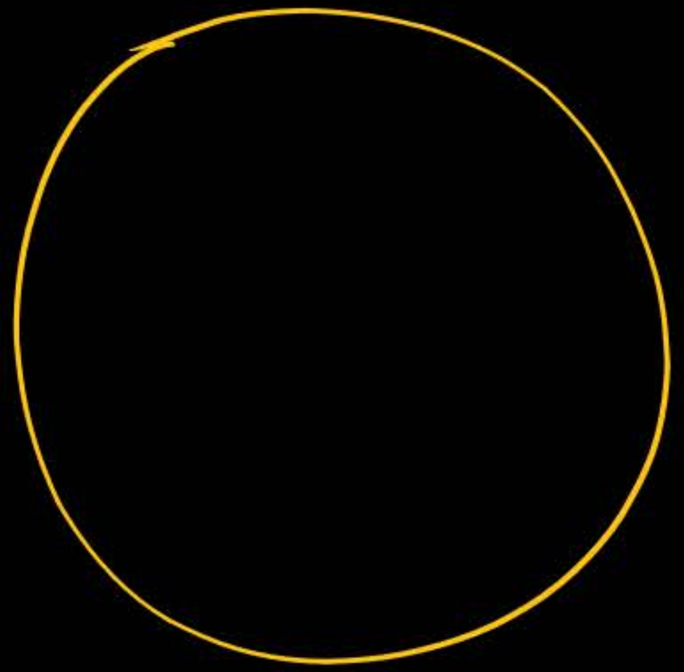
$$\vec{\omega}_{inst} = \frac{d\vec{\theta}}{dt}$$

- only two dir^n → Anticlock Mot^n (ω ⊙)
  → Clock wise Mot^n (ω ⊗)
- unit rad/sec
- (How fast Angle is changing) / where (dir^n)

(*) Angular speed $|\vec{\omega}|$ = How fast Angle is chaing.

Angular velocity = Angular speed / (dir^n)





$\vec{\omega}$ = const^n. [dir^n (X) fixed] = equal Angle in equal time intraval

[ω in fixed dir^n]

[Angula velocity is const^n]

Uniform (circula mot^n) ⟹ [Motion is Non-Uniform]

Velocity = variable / dir^n → change

QUESTION

Angular velocity of minute hand of a clock is:-

1. $\frac{2\pi}{1800}$ rad/s
2. 8π rad/s
3. $\frac{\pi}{1800}$ rad/s
4. $\frac{\pi}{30}$ rad/s

HOMEWORK FROM YAKEEN MODULE


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 08 | **Physics**

Motion in a Plane

By- Dr. Manish Raj (MR SIR)



Todays Goal

* Uniform circular motion
* Non-Uniform circul motn.

ANGULAR SPEED

→ The rate of change in Angular dist^n.

ω → {How fast Angle is changing}

→ Angular speed

→ Scalar

→ Unit rad/sec.

Angular velocity

In time 't'

$$\vec{\omega}_{Avg} = \frac{\Delta\vec{\theta}}{\Delta t}$$

at time 't'

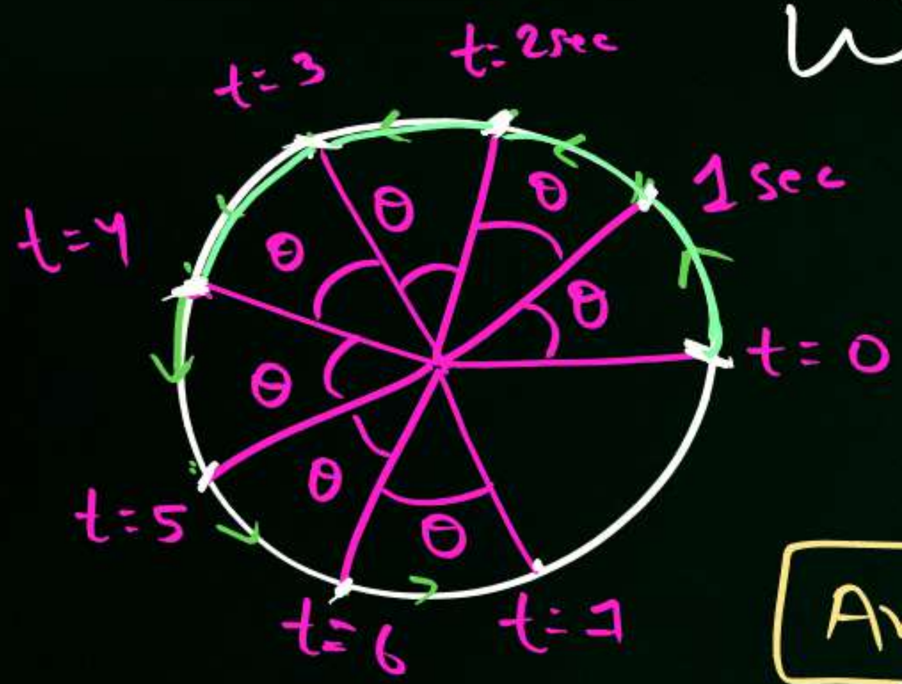
$$\vec{\omega}_{Inst} = \frac{d\vec{\theta}}{dt}$$ = The Rate of change in Angular Position.

→ How fast angle is changing / Where Anti-Clock ⊙ Clock ⊗

→ Vector

→ {magnitude of Angular velocity is speed}

→ rad/sec (T^{-1})



$\vec{\omega} = \text{Const}^n$

= {Uniform angular velocity}

= equal angle in equal time interval

Angular speed = Const^n

$\vec{\omega} = \frac{d\theta}{dt}$ ⊙ ✓fixed

Uniform circular mot^n

$\alpha = 0 = \frac{d\omega}{dt}$ (Const^n)

Speed = Const^n

$V = R\omega$

(Const^n) (Radius) (Const^n)

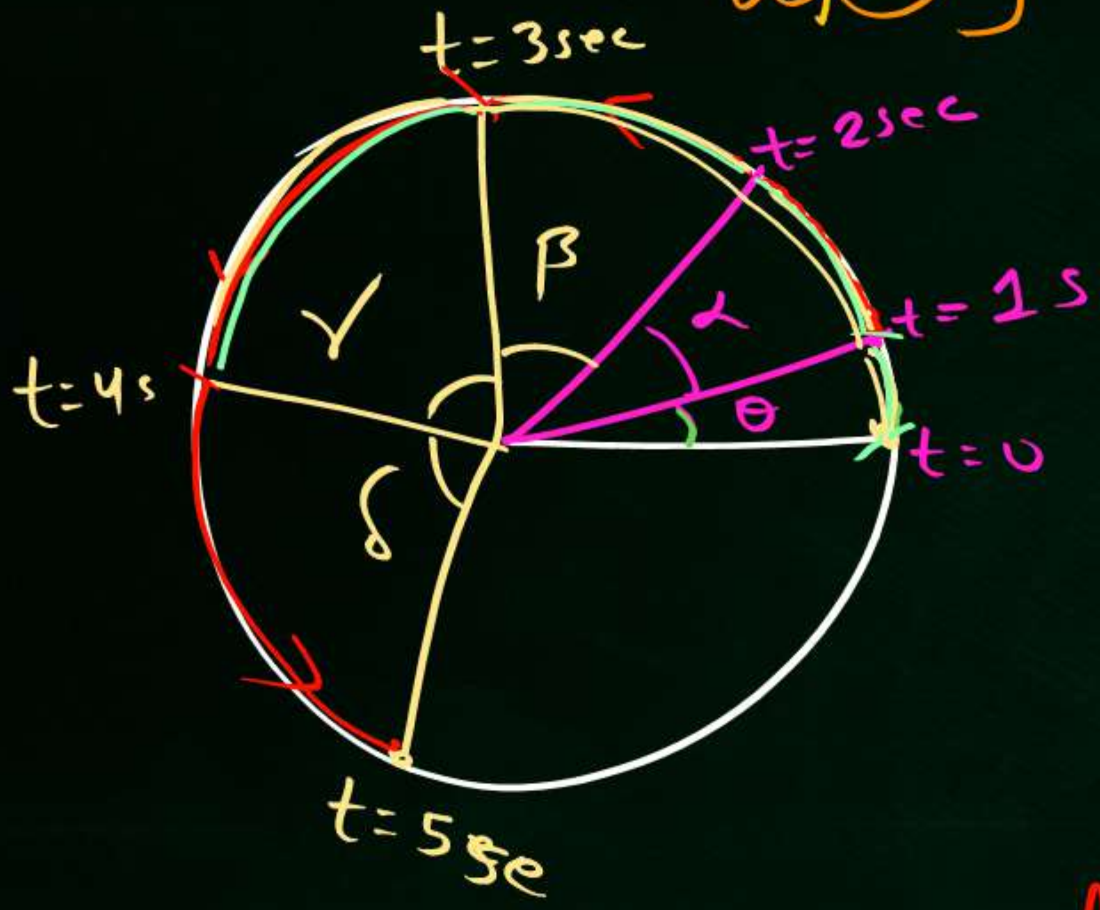
In circular motion Angular speed is constant then Angular velocity will be →

(35%)

(a) must be Const

(b) may be constant

62%



$\alpha \rightarrow \odot$
$\omega \uparrow \odot$

$\vec{\alpha}_{inst} = \frac{d\vec{\omega}}{dt} = \frac{d}{dt}\left(\frac{d\theta}{dt}\right)$

= The Rate of change in Angular velocity is called Angular acceleration

= slope of ω/t graph is Angular accⁿ

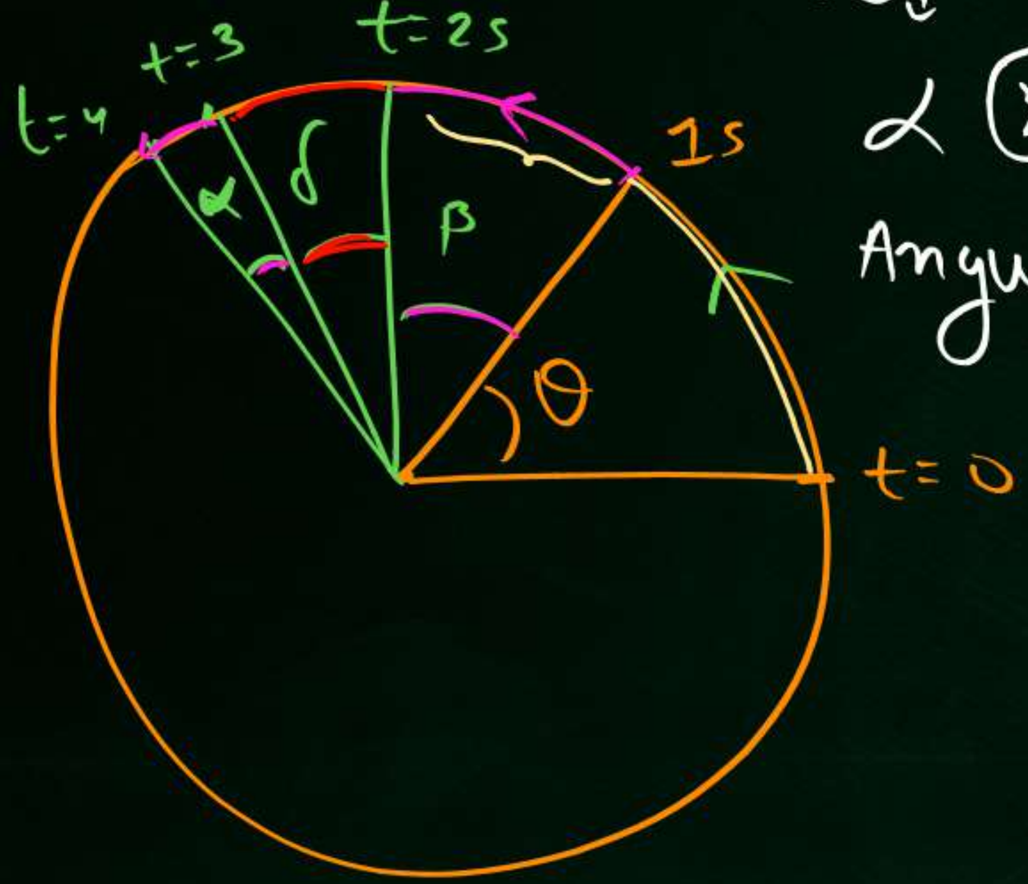
$\vec{\alpha}$ (Avg Angular acc) $= \frac{\vec{\omega}_f - \vec{\omega}_i}{\Delta t}$

ω (Angular speed) $\uparrow \odot$

Speed $\uparrow = R(\omega\uparrow)$

$$\vec{\alpha}_{inst} = \frac{d\vec{\omega}}{dt} = \frac{d^2\theta}{dt^2} = \omega\frac{d\omega}{d\theta}.$$

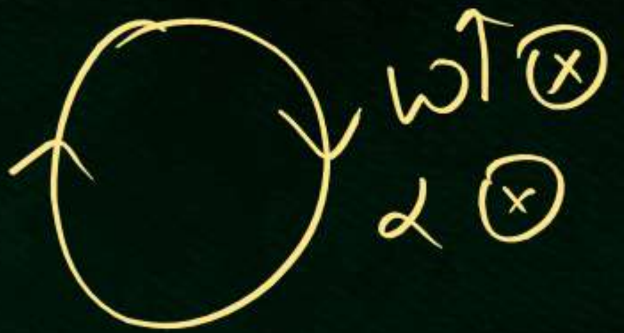
$$\vec{a}_{inst} = \frac{d\vec{v}}{dt} = \frac{d^2x}{dt^2} = \vec{v}\frac{d\vec{v}}{dx}.$$



$\omega \downarrow$ ⊙

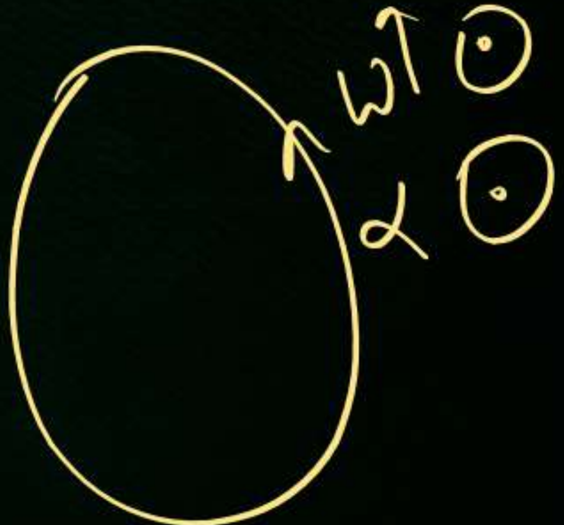
α ⊗

Angular retardation









$\vec{\alpha} = \dfrac{\vec{\omega}_f - \vec{\omega}_i}{\Delta t}$

$\theta > \beta > \delta > \alpha$

↳ dirⁿ along $\Delta\vec{\omega}$

Angular speed ↓

Speed ↓

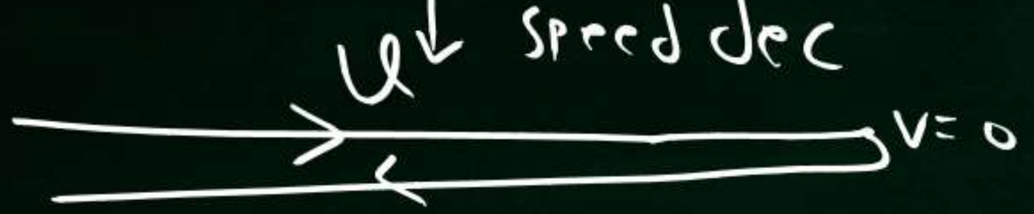
⊛ If $\omega \uparrow$ then $\vec{\alpha}$ ∥r to $\vec{\omega}$

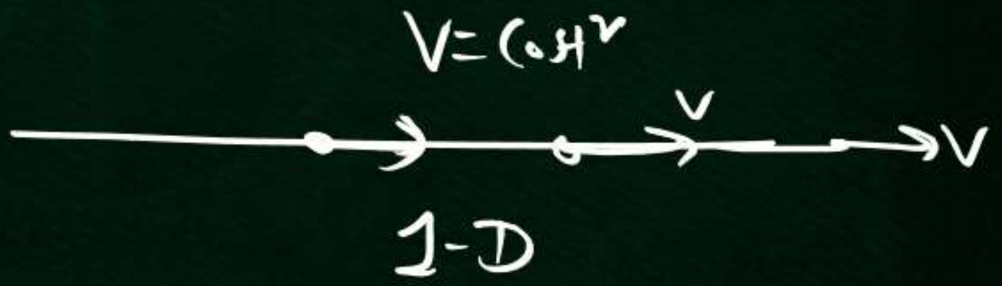
⊛ If $\omega \downarrow$ then $\vec{\alpha}$ Anti ∥r to $\vec{\omega}$

In 1-D motion speed is constⁿ then velocity will be

(a) uniform ✓ (53%)

(b) Non-uniform (44%) ✗





$$\int_{\omega_i}^{\omega_f} d\omega = \int_{t_1}^{t_2} \alpha\, dt$$

$$\int d\theta = \int \omega\, dt$$

नानी $= \int \theta\, dt$

दादी

$\vec{\theta}$ (Angular position)

$\Delta\theta$ (Angular dispⁿ) $= \int \omega\, dt =$ Area of $\omega - t$ graph

$\vec{\omega}$ (Angular velocity)

$\Delta\omega = \omega_f - \omega_i = \int \alpha\, dt =$ Area of α/t graph

$\vec{\alpha}$ (Angular acceleration)

"$\omega_{inst} = \dfrac{d\theta}{dt}$" = slope of θ/t graph

$$\vec{\omega}_{Avg} = \frac{\Delta\theta}{\Delta t} = \frac{\int \omega\, dt}{\int dt}$$

"$\alpha_{inst} = \dfrac{d\vec{\omega}}{dt} = \omega\dfrac{d\omega}{d\theta}$"

= slope of ω/t graph

$$\alpha_{Avg} = \frac{\omega_f - \omega_i}{\Delta t} = \frac{\int \alpha\, dt}{\int dt}$$

$\dfrac{d\alpha}{dt} =$ नाती

slope of α/t graph is नाती

Circular motⁿ

Angular dispᵐ → θ

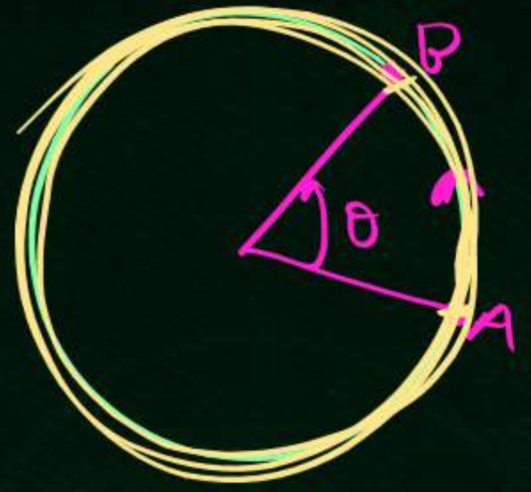
Angular velocity → $\vec{\omega}$

Angular accⁿ → α

$\alpha = \frac{d\omega}{dt}$ $\omega = \frac{d\theta}{dt}$

~~$a = R\alpha$~~

$a_T = R\alpha$ ✓



distⁿ ⇒ $s = R\theta$ diffⁿ

$\frac{ds}{dt} = R\frac{d\theta}{dt}$

(*) $V(\text{speed}) = R\omega$

diffⁿ w.r.t time.

$\frac{dv}{dt} = a_T = R\frac{d\omega}{dt}$

$a_t = R\alpha$

distance $= R\theta$

dispᵐ $= 2R\sin(\theta/2)$

velocity $= \vec{v} = \frac{d\vec{s}}{dt}$

accⁿ $= \vec{a} = \frac{dv}{dt}$

$$\vec{a} = \frac{d\vec{v}}{dt}$$

$$|\vec{a}| = \left|\frac{d\vec{v}}{dt}\right|$$

$$a_t = \frac{d|\vec{v}|}{dt}$$

⊛ **Angular accⁿ = 0** → $\omega = \text{const}$ Uniform circular motion

$\theta = \omega t$

Angular accⁿ = varible → Integration / diff

Angular accⁿ = const

$\vec{\omega}_f = \vec{\omega}_i + \vec{\alpha} t$

$\theta = \omega_i t + \frac{1}{2}\alpha t^2$

$\omega_f^2 - \omega_i^2 = 2\alpha\theta$

\# $\theta_{n^{th}} = \omega_i + \frac{\alpha}{2}(2n-1)$

$\theta = \left(\frac{\omega_i + \omega_f}{2}\right) T$

Level up.

$\theta_{stopping} = \frac{\omega_i^2}{2\alpha}$

$\theta = \frac{1}{2}\left(\frac{\alpha\beta}{\alpha+\beta}\right) T^2$

$a=0$	$a=$ const	$a:$ varib
$s=vt$	eqⁿ of motion	intⁿ & dif.

accⁿ = constⁿ.

$\vec{V} = \vec{u} + \vec{a}t$

$\vec{s} = \vec{u}t + \frac{1}{2}\vec{a}t^2$

$v^2 - u^2 = 2\vec{a}\cdot\vec{s}$

$v_{Avg} = \frac{\vec{u} + \vec{v}}{2}$

⊛ $\vec{s} = \left(\frac{u+v}{2}\right) T$

Stopping dis

$s = \frac{u^2}{2a}$

$s = \frac{1}{2}\frac{\alpha\beta}{\alpha+\beta} T^2$

⊛ $s_{n^{th}} = u + \frac{a}{2}(2n-1)$

Angle in one Rotⁿ = 2π

" " n - Rotⁿ = $2n\pi$

(*) no. of Rotⁿ = $\frac{\theta_{Total\ Ang}}{2\pi}$

$\theta_{total} = n(2\pi)$

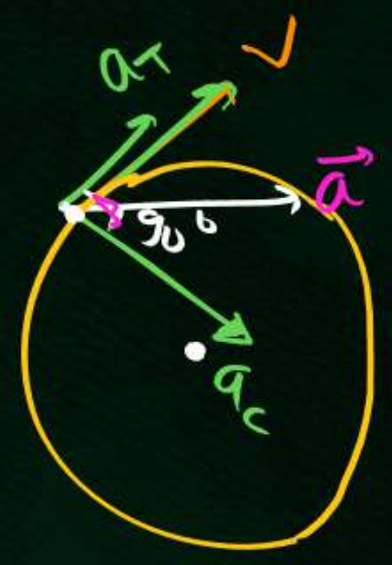
↑ (no. of Rotⁿ)

Angular acc	Tangential acc	centripetal	Acc^n
$\vec{\alpha} = \frac{d\omega}{dt}$	$\vec{a}_T$	$\vec{a}_c$	$\vec{a}$

$a_T = R\alpha$

$$a_c = \frac{v^2}{R}$$

→ We will study



$a_c \neq 0$

$a_T \neq 0$

$$\vec{a} = \vec{a}_T + \vec{a}_c$$

$$|\vec{a}| = \sqrt{a_T^2 + a_c^2}$$

magnitude of acc

1-D motion

$a_T \neq 0$

$a_c = 0$

2-D motion

Projectile



$a_T \neq 0$ ✓

$a_c \neq 0$ ✓

QUESTION

Angular displacement of object $\theta = t^2 + 2t + 5$ then, find angular speed at 2 sec and (in 2-sec)

Sol^n

$$\omega = \frac{d\theta}{dt}$$

$$\omega = 2t + 2$$

$$\omega_{t=2\,sec} = 2\times2+2$$

$$= 6\ rad/sec.$$

$$\vec{\omega}_{Avg} = \frac{\theta_f - \theta_i}{\Delta t}$$

$$= \frac{\{|\theta|_{t=2} - |\theta|_{t=0}\}}{2}$$

$$= \frac{13-5}{2} = \frac{8}{2} = 4\ rad/s$$

Angular velocity $\omega = 6t - t^2 + 6$ find time when Angular accn will be zero. ??

Soln

$$\alpha = \frac{d\omega}{dt} = 6 - 2t = 0$$

$$6 - 2t = 0$$

$$2t = 6$$

$$t = 3 \text{ sec}$$

Ans

QUESTION

Object completes 7 rotation in 22 sec on circular path of radius 1 m then find angular speed.??

(a) ω = varible

(b) ω = const^n

$$\omega = \frac{d\theta}{dt}$$

$$\omega_{Avg} = \frac{\theta_{total}}{t_{total}}$$

always valid

$$\omega_{Av} = \frac{\theta}{t} = \frac{7(2\pi)}{22} = \frac{7 \times 2 \times 22}{7 \times 22} = 2\ \text{rad/sec}$$

QUESTION

A body performing uniform circular motion completed 140 revolution in a second. Its angular speed is

1. 88 rad/s
2. 440 rad/s
3. 220 rad/s
4. 240 rad/s

$\omega = 280 \times \pi$

no of rot^n = 140

Total Ang = $2\pi(n)$

$\omega = \frac{\theta}{t} = \frac{140 \times 2\pi}{1}$

$= 280\pi$ rad

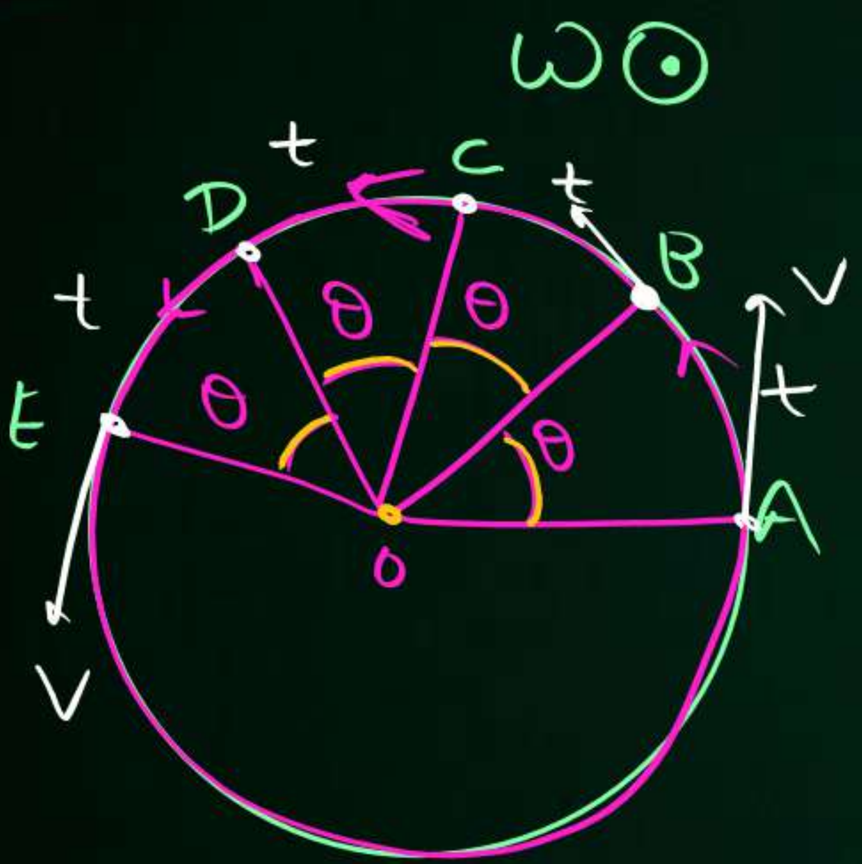
$= 280 \times \frac{22}{7}$

$= 880$

UNIFORM CIRCULAR MOTION

Uniform circular motion is → non-uniform motion with non uniform accⁿ.

$\vec{\omega}$ (Angular velocity) = Uniform ⟹ Angular accⁿ = 0 = α



Angular speed = Cotⁿ

Speed = Cotⁿ ⟹ $a_t = 0$ $a_T = R\alpha$

⊛ direction of motion = variable

Momentum (vector) = varible

⊛ Velocity = Variable

Kinetic energy (sclar) $= \frac{1}{2} m (\text{speed})^2$ = Cotⁿ

$\vec{a} \neq 0$

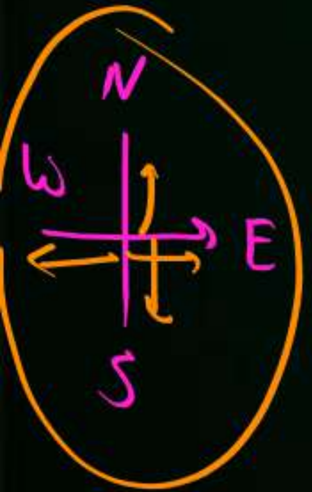
Work = ΔK.E = 0

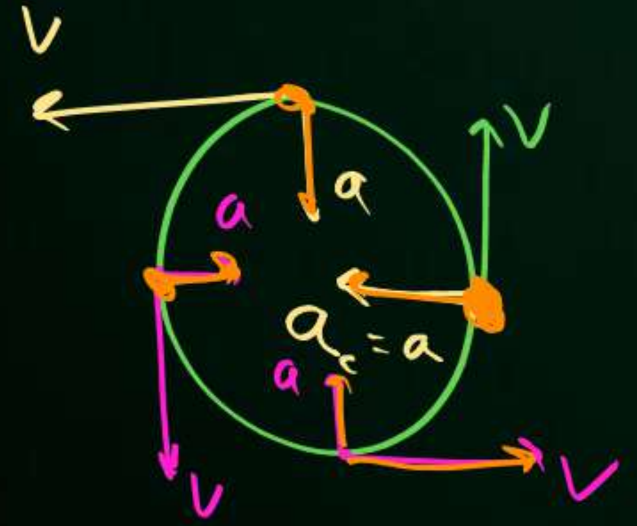
$\vec{a}_T = \vec{a}_c + \vec{a}_T$ (0) accⁿ ∝ a

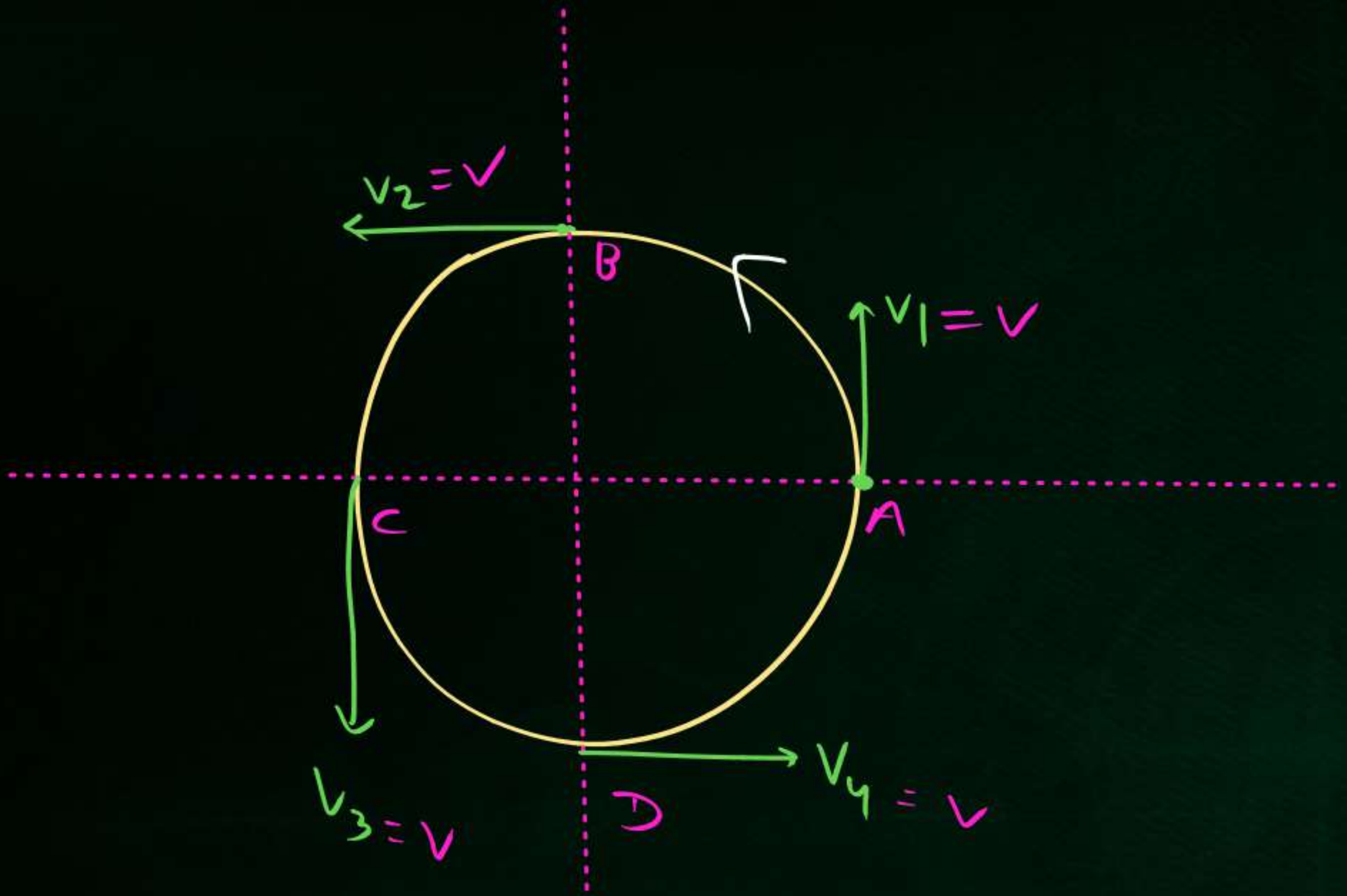
Power $= \frac{W}{t} = 0$

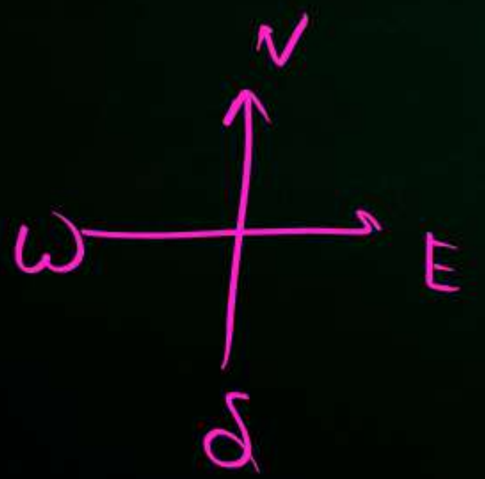
⊛ $a = \vec{a}_c$ = dirⁿ is changing (continuously)

Angular Momentum = Cotⁿ









Uniform circular motⁿ

Dirⁿ of change in velocity B/w AB

$$\Delta\vec{V} = \vec{V_B} - \vec{V_A}$$

$$= -\hat{i} - (\hat{j})$$

(South west)



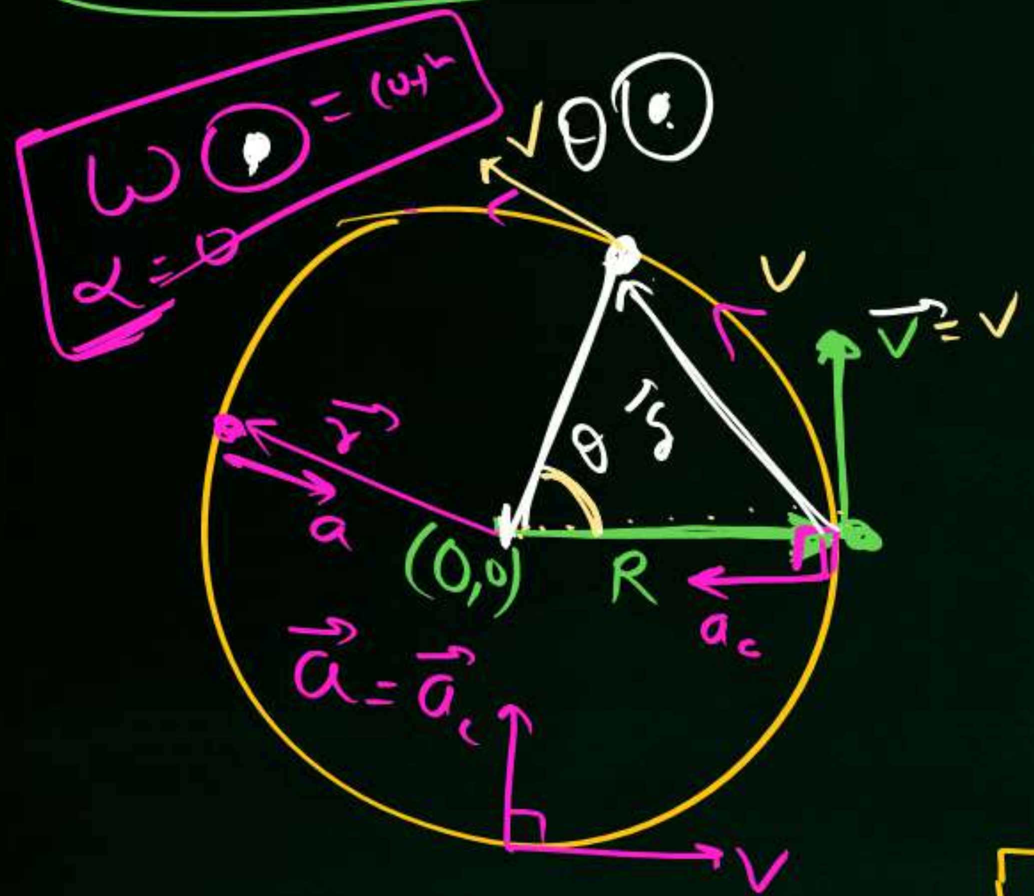
Dirⁿ of change in B/w BD

$$\Delta\vec{V} = \vec{V_D} - \vec{V_B} = v\hat{i} - (-v\hat{i})$$

$$= 2v(\hat{i}) \rightarrow (\text{east})$$

Acclelation in uniform circula motⁿ

Centre (origin) refⁿ



$\vec{\omega} \cdot \vec{v} = 0$

$\vec{a} \cdot \vec{v} = 0$ ✓

$\vec{a} \perp_r \vec{v}$

speed = constⁿ

$\vec{\gamma} \cdot \vec{v} = 0$

$\vec{\gamma} \perp_r \vec{v}$

↗ Position Vectr

$\vec{V} \perp_r \vec{a}_c$

$\vec{V} \perp_r \vec{\omega}$

$\vec{\theta} \perp_r \vec{\delta}$
↑ line

$\vec{\gamma}$ is anti Paral to $\vec{a}$

$a_T = 0$

$\vec{a} = \cancel{\vec{a}_T}^{\,0} + \vec{a}_c$

$\vec{a} = \vec{a}_c$ — only for UCM

change in velocity $= \vec{v}_f - \vec{v}_i$

$= 2v\sin(\theta/2)$

$$\overrightarrow{acc}_{Avg} = \frac{\Delta \vec{v}}{\Delta t} = \frac{2v\sin(\theta/2)}{\left(\frac{R\theta}{v}\right)}$$

$$= \frac{2v^2 \sin(\theta/2)}{R\theta}$$

$$\left(\vec{a}_{Avg}\right) = \frac{V^2}{R}\,\frac{\sin(\theta/2)}{(\theta/2)}$$

$$\lim_{\theta \to 0} \left|\vec{a}_{Avg}\right| = \vec{a}_{inst} = \frac{V^2}{R}\lim_{\theta\to 0}\frac{\sin(\theta/2)}{(\theta/2)}$$

$$\vec{a}_{int} = \vec{a}_{c_{inst}} = \frac{V^2}{R} = \omega^2 R$$

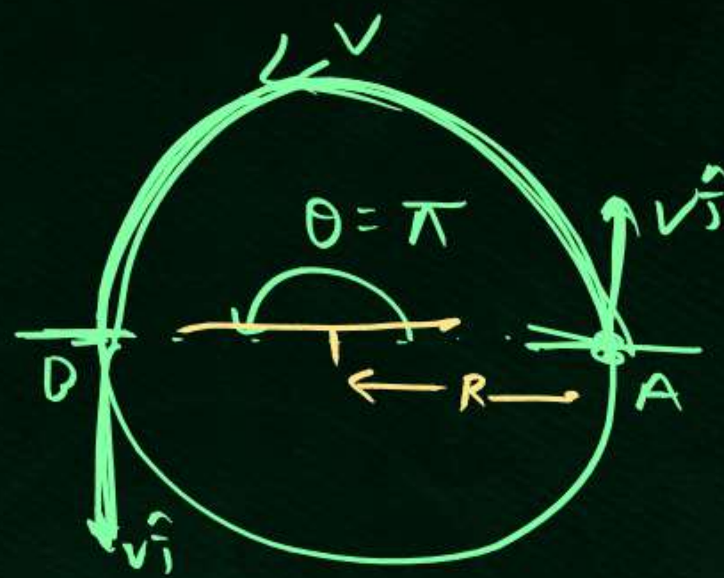
$$= 4\pi^2 f^2 R$$

U.C.M



$$\omega = \frac{2\pi}{T} = 2\pi f$$

$$\text{time} = \frac{\text{dist}^n}{\text{Speed}}$$

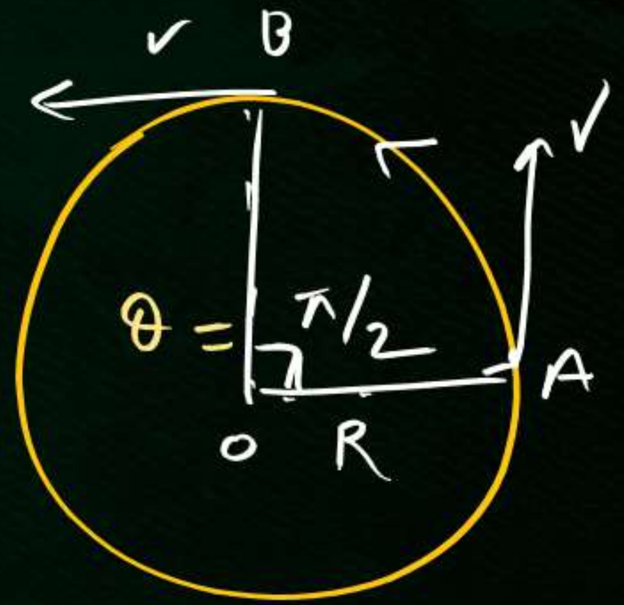


$$\text{Avg acc}^n = \frac{V^2}{R}\,\frac{\sin(\pi/2)}{(\pi/2)}$$

$$= \left(\frac{2V^2}{\pi R}\right)$$

IMP*

$$\vec{a}_{Avg} = \frac{|\Delta \vec{v}|}{\Delta t} = \frac{2v}{\frac{\pi R}{v}} = \frac{2v^2}{\pi R}$$



$$\vec{a}_{c_{Avg}} = \frac{V^2}{R}\,\frac{\sin\left(\frac{\pi}{2\times 2}\right)}{\frac{\pi}{2\times 2}} =$$

$$= \frac{V^2}{R}\,\frac{1}{\sqrt{2}\,\frac{\pi}{4}} = \frac{4v^2}{\sqrt{2}\pi R}$$

$$= \frac{2\sqrt{2}v^2}{\pi R}$$

$$\vec{a}_{Avg} = \frac{v^2}{R} \frac{\sin\theta/2}{\theta/2}$$

$$\lim_{\theta \to 0} \vec{a}_{Avg} = \frac{v^2}{R} \left(\frac{\sin\theta/2}{\theta/2} \right)$$

$$\vec{a}_{int} = \frac{v^2}{R} = \omega^2 R = 4\pi^2 f^2 R$$

$$\omega = 2\pi f$$

$$\lim_{\theta \to 0} \frac{\sin\theta}{\theta} = 1$$

$$\lim_{\theta \to 0} \frac{\sin\theta/2}{\theta/2} = 1$$

find acc^n ??

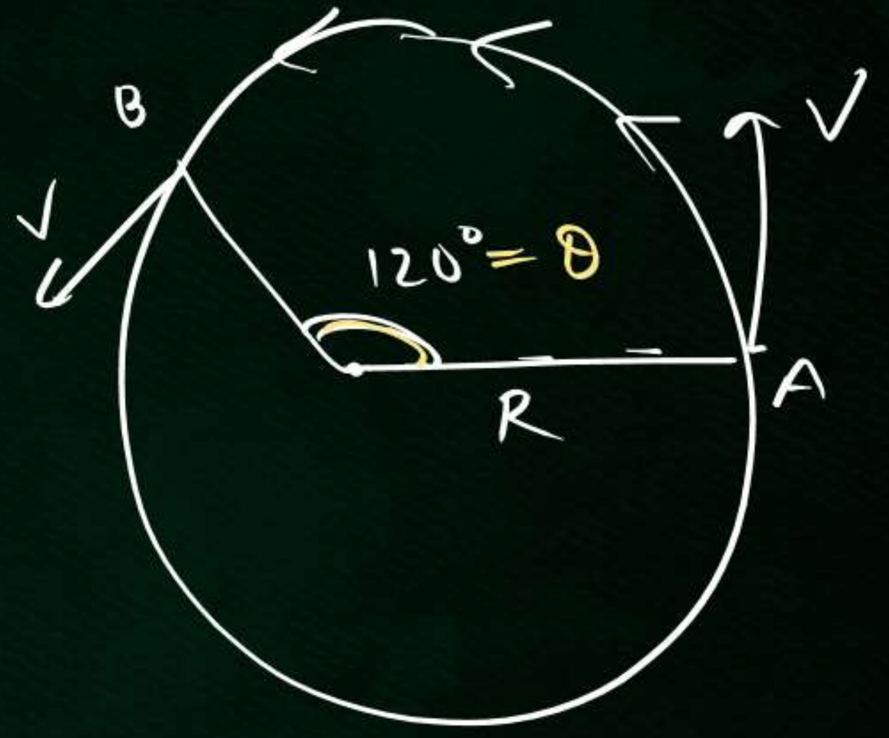
$a_t = 0$

$$\vec{a} = \vec{a}_c = \frac{v^2}{R}\frac{\sin(\theta/2)}{\theta/2}$$

$$= \frac{v^2}{R}\frac{\sin(60)}{\pi/3}$$

$$= \frac{3v^2}{R\pi}\frac{\sqrt{3}}{2}$$

$$a_{Avg} = \frac{3\sqrt{3}\,v^2}{2\pi R} = \vec{a}_c$$

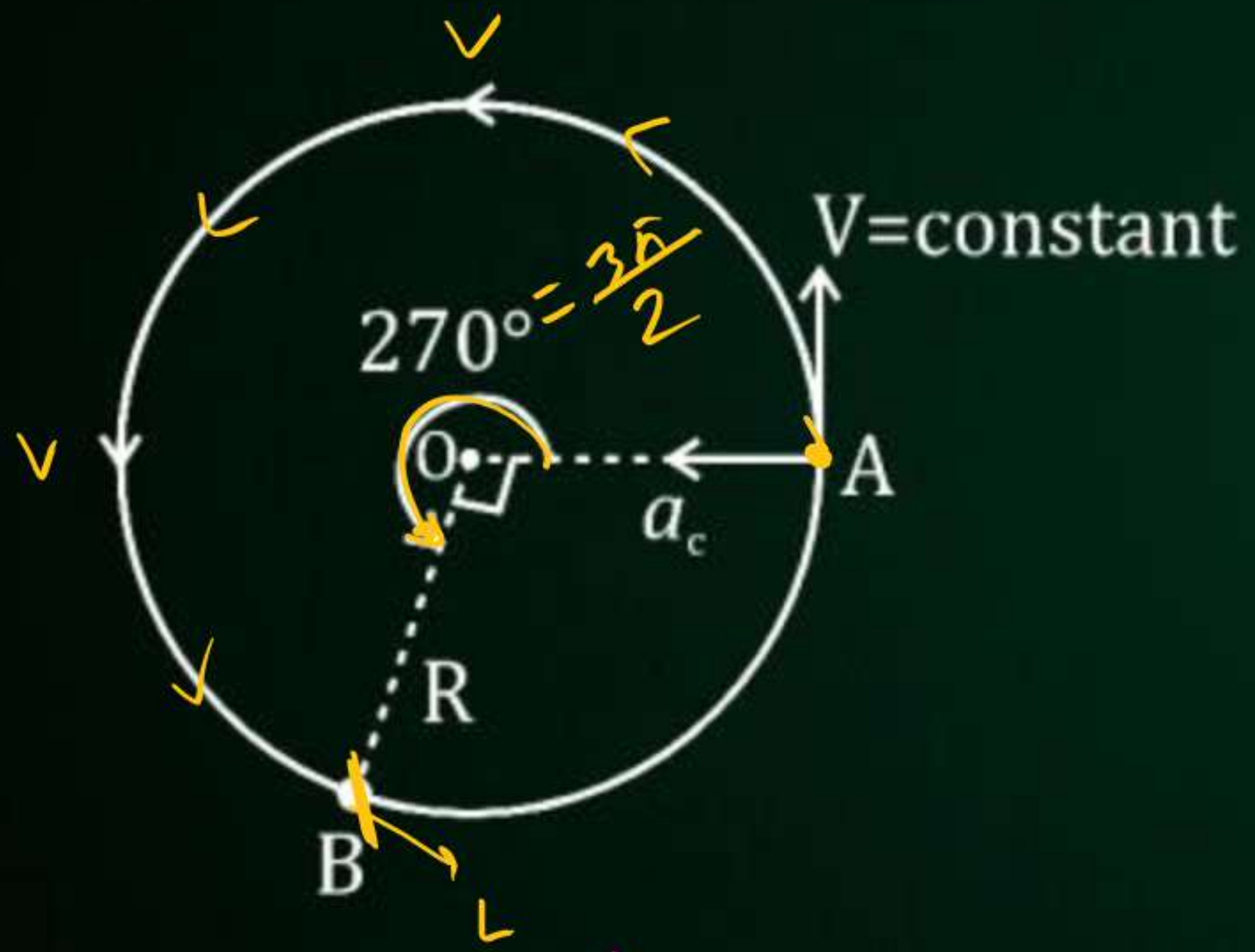


UCM ⇒ v = const.

- **Uniform circular motion is non-uniform motion with non-uniform accelerated motion.**

QUESTION

Find average acceleration between A and B. [AIPMT-2015]



$$\vec{a}_{Avg} = \frac{v^2}{R}\frac{\sin\left(\frac{270°}{2}\right)}{\frac{3\pi}{2\times 2}} = \frac{v^2}{R\sqrt{2}\,\frac{3\pi}{4}}$$

$$= \frac{4v^2}{3\sqrt{2}\pi R}$$

QUESTION

$$\frac{\omega_{\text{min hand}}}{\omega_{\text{sech hand}}} = \frac{1}{60}$$

Find angular speed of hr. hand.



$$\vec{\omega}_{hr} = \frac{2\pi}{12hr} = \frac{2\pi}{12 \times 60 \text{mint}} = \frac{2\pi}{12 \times 60 \times 60}\left(\frac{\text{rad}}{\text{sec}}\right)$$

$$\vec{\omega}_{\text{mint haw}} = \frac{2\pi}{60\text{min}} = \frac{2\pi}{60 \times 60} \text{rad/s}$$

$$\omega_{\text{second ha.}} = \frac{2\pi}{60\text{sec}} = \frac{2\pi}{60}\left(\frac{\text{rad}}{\text{sec}}\right)$$

QUESTION

Body moving in uniform circular motion rotated by 120° then find change in velocity.

$$\vec{\Delta v} = \vec{v_f} - \vec{v_i}$$

$$= 2v \sin(\theta/2)$$

QUESTION

In uniform circular motion acceleration is: ??

1. Constant (25%)
2. Variable (70%) ✓

Inst $\vec{a} = \vec{a_c} = \frac{v^2}{R} = \text{fixed}$

Magnitude

Cst^n

QUESTION

Angular speed of a uniformly circulating body with time period T is

1. $2\pi T$
2. $\frac{2\pi}{T}$ ✓
3. πT
4. $\frac{\pi}{T}$

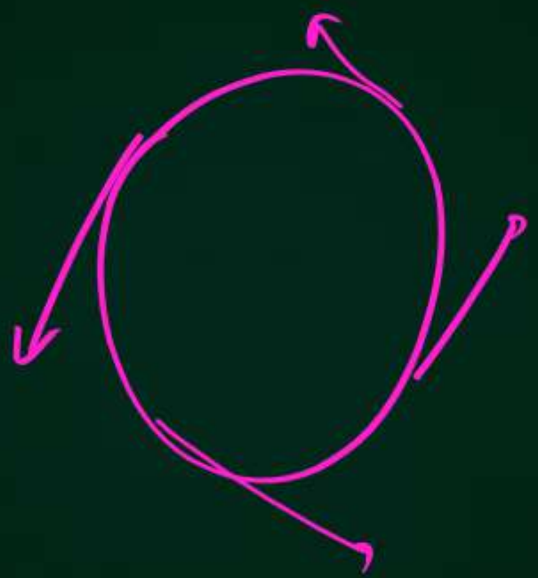
$\omega = \frac{\theta}{T} = \frac{2\pi}{T}$

QUESTION

An object moving in a circular path at constant speed has constant

1. Energy (K.E)
2. Velocity
3. Acceleration
4. Displacement

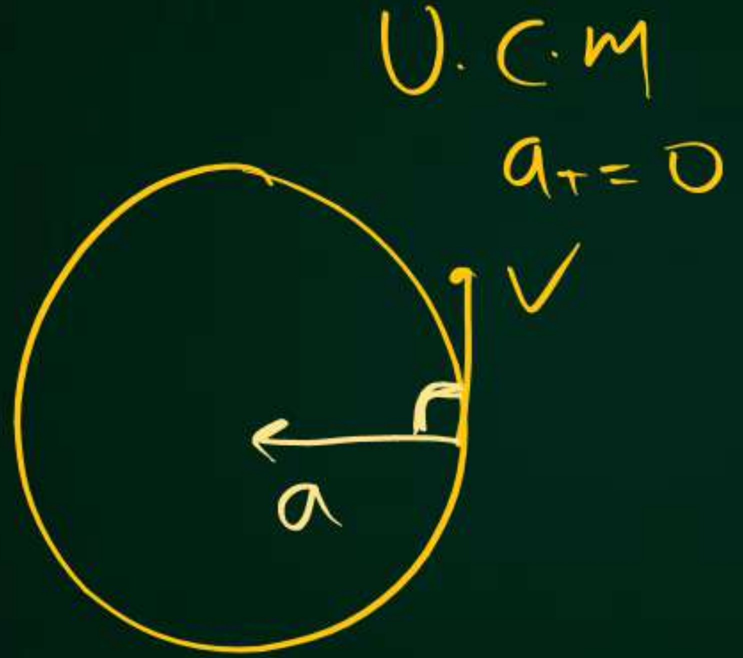




QUESTION

The angle between velocity vector and acceleration vector in uniform circular motion is

1. 0°
2. 180°
3. 90° ✓
4. 45°



QUESTION

Two cyclists cycle along circular tracks of radii R_1 and R_2 at uniform rates. If both of them take same time to complete one revolution, then their angular speeds are in the ratio



1. $R_1 : R_2$
2. $R_2 : R$
3. $1 : 1$
4. $R_1 R_2 : 1$

QUESTION

Speed of an object moving in circular path of radius 10 m with angular speed 2 rad/s is

1. 10 m/s
2. 5 m/s
3. 20 m/s
4. 30 m/s

$v = r\omega$
$= 10 \times 2$
$= 20$ m/s

Ans (3)

QUESTION

Centripetal acceleration of a cyclist completing acceleration of a cyclist completing 7 rounds in a minute along a circular track of radius 5 m with a constant speed, is

1. $2.7\ m/s^2$
2. $4\ m/s^2$
3. $3.78\ m/s^2$
4. $6\ m/s^2$

UCM

$t = 60\,sec$

$\omega = \frac{\theta_{total}}{t} = \frac{7(2\pi)}{60} = \frac{7\pi}{30}$

$\vec{a}_c = \omega^2 R$

$= \left(\frac{7\pi}{30}\right)^2 \times 5$

$= \left(\frac{7 \times 22}{7 \times 30}\right)^2 \times 5$

Put the value of $\pi = \frac{22}{7}$

QUESTION

If the frequency of an object in uniform circular motion is doubled, its acceleration becomes

1. Two times
2. Four times
3. Half
4. One fourth

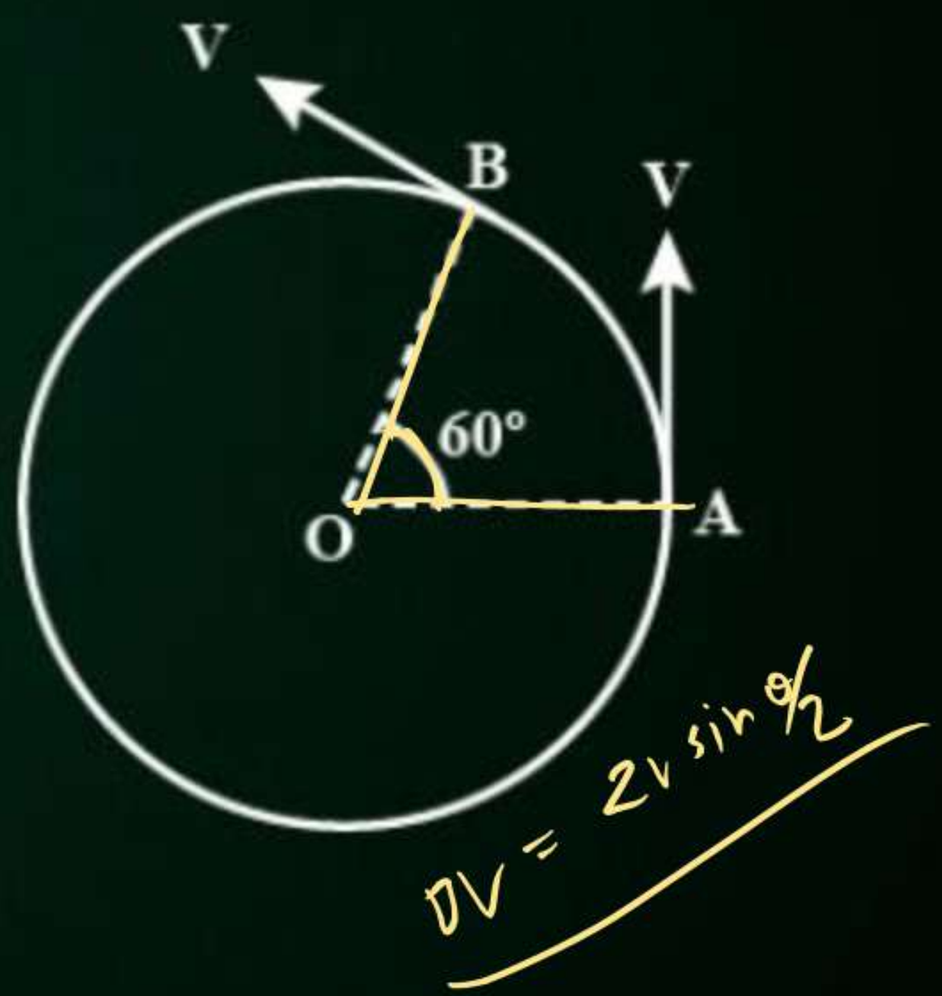
$\vec{a} = 4\pi f^2 R$

$a \propto f^2$

QUESTION

A particles is moving in a circle of radius r having centre at O, with a constant speed v. The magnitude of change in velocity in moving from A to B is

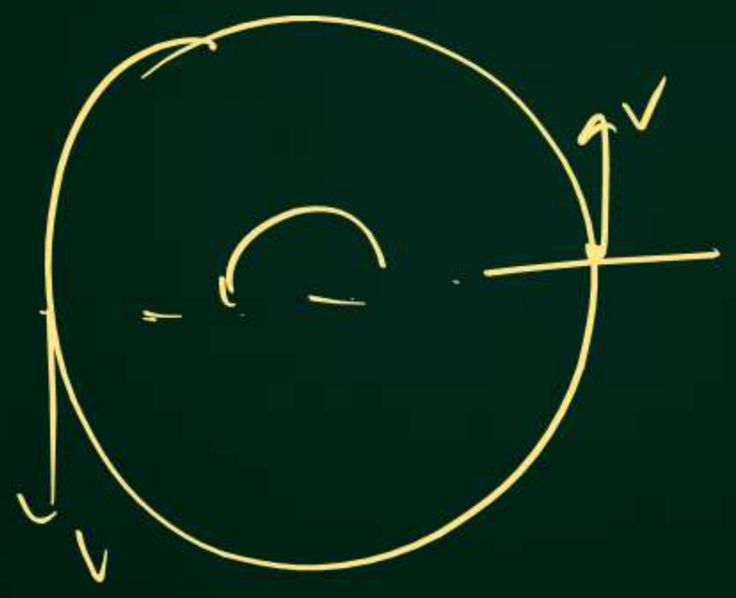
1. $2v$
2. 0
3. $\sqrt{3}\,v$
4. v



QUESTION

A body revolves with constant speed v in a circular path of radius r. The magnitude of its average acceleration during motion between two points in diametrically opposite direction is

1. Zero
2. $\frac{v^2}{r}$
3. $\frac{2v^2}{\pi r}$
4. $\frac{v^2}{2r}$



NON-UNIFORM CIRCULAR MOTION

Angula speed = variable ✓ ⟶ Angula $\alpha \neq 0$

$\alpha = \frac{d\omega}{dt}$

liner speed = varible ⟶ Tangential acc$^r \neq 0$

$a_T = \alpha R$

$V = R\omega$ (Speed)

direction = Variable ⟶ acc$^n \neq 0$

$\vec{a} = \vec{a}_T + \vec{a}_c$

$\vec{a}_T \perp_r \vec{\alpha}$

K.E = Varible

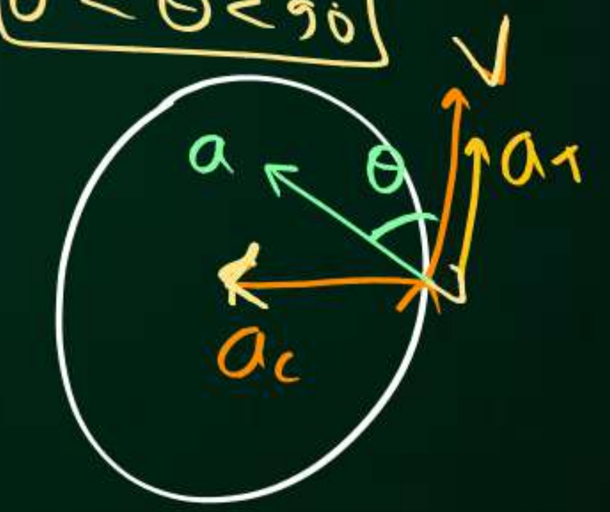
$\vec{P}$ (momen) = 11

Work ≠ 0

Powe ≠ 0

speed ↑

$0° < \theta < 90°$

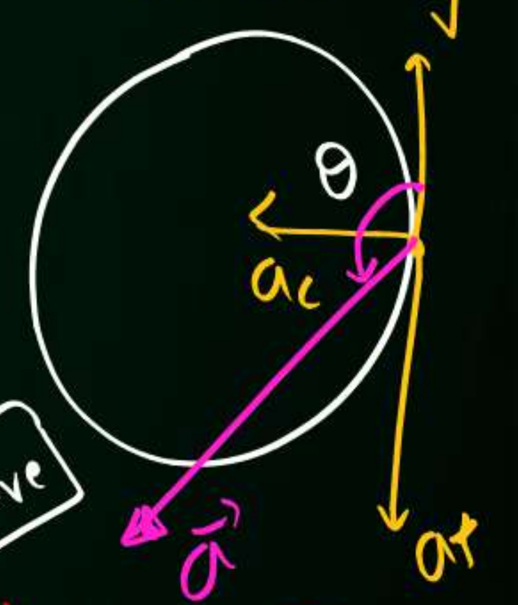


$\vec{u} \cdot \vec{a} = (av\cos\theta)$

= +ve.

speed ↑

Speed ↓



$\vec{a} \cdot \vec{u} = -ve$

speed ↓

$90° < \theta < 180°$

Angle b/w $\vec{a}$ & $\vec{V}$

$\vec{v} \cdot \vec{a} = 0$ (speed = const^n) ⟶ U.C.M.

$\vec{v} \cdot \vec{a} = +ve$ N.U.C.M ⟶ speed ↑

$\vec{v} \cdot \vec{a} = -ve$ N.U.C.M ⟶ speed ↓

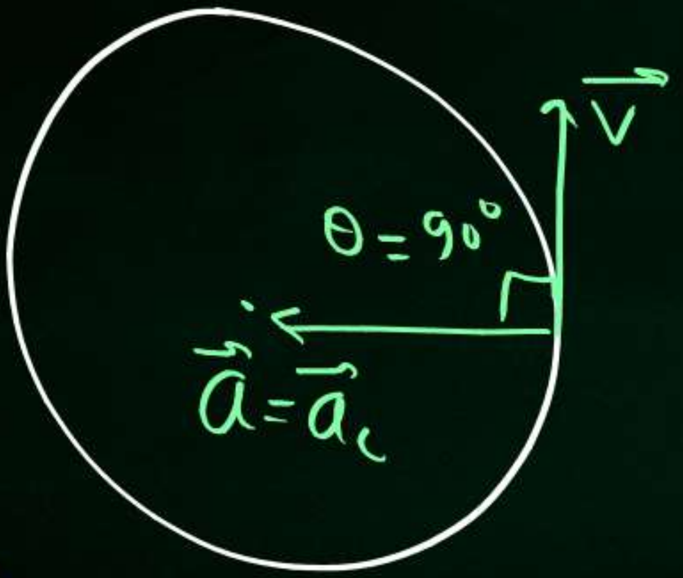
$\tan\theta = \frac{a_c}{a_T}$

$\theta = \tan^{-1}\left(\frac{a_c}{a_T}\right)$

Angle b/w $\vec{a}$ & $\vec{v}$

U.C.M

#



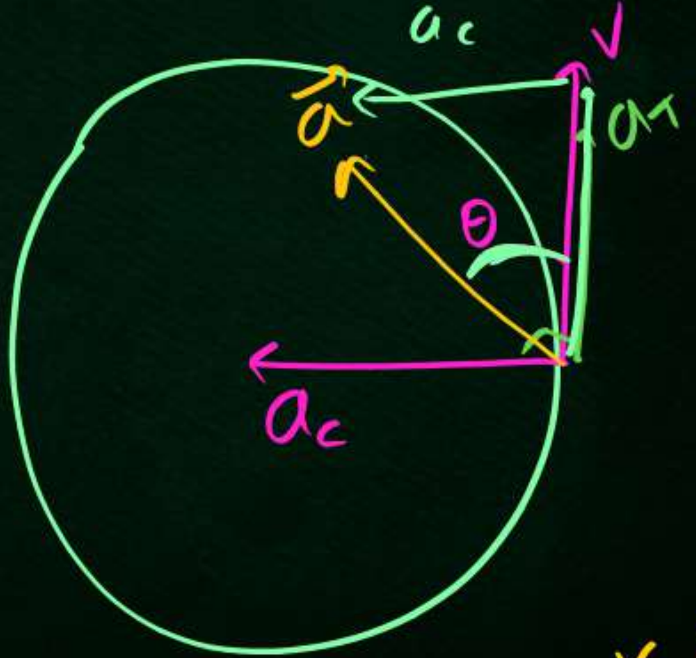
$a_T = \alpha = 0$

$a_T = 0$

(*) $\vec{a} = a_c = \frac{v^2}{R} = \omega^2 R$

N.U.Cm

speed ↑



$\vec{a} = \vec{a}_T + \vec{a}_c$

$|a| = \sqrt{a_T^2 + a_c^2}$

* $a_T = \frac{d|\vec{v}|}{dt}$ = Rate of change in speed

* $g_{nst}(a_c) = v^2/R$

MR *

→ circular motⁿ ke Question मे

decide kro UCM ki N.U.C.M

UCM:

$\vec{a} = \vec{a}_c = v^2/R$

Speed = const.

N.U.C.M:

$a_T = \frac{d|\vec{v}|}{dt}$

$a_c = v^2/R$

$|\vec{a}| = \sqrt{a_T^2 + a_c^2}$ ✓

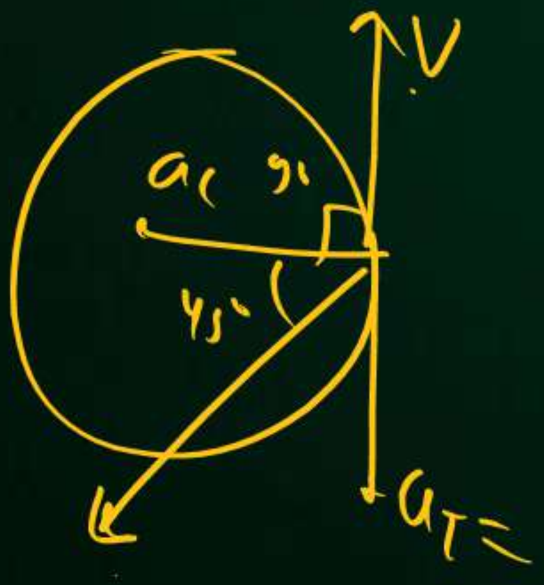
QUESTION

A body is moving on a circle of radius 80 m with a speed 20 m/s which is decreasing at the rate 5 m/s^2 at an instant. The angle made by its acceleration with its velocity is

1. 45°
2. 90°
3. 135°
4. 0°

$a_c = \frac{v^2}{R} = \frac{(20)^2}{80} = \frac{400}{80} = 5 m/s^2$

$a_T = 5 m/s^2$

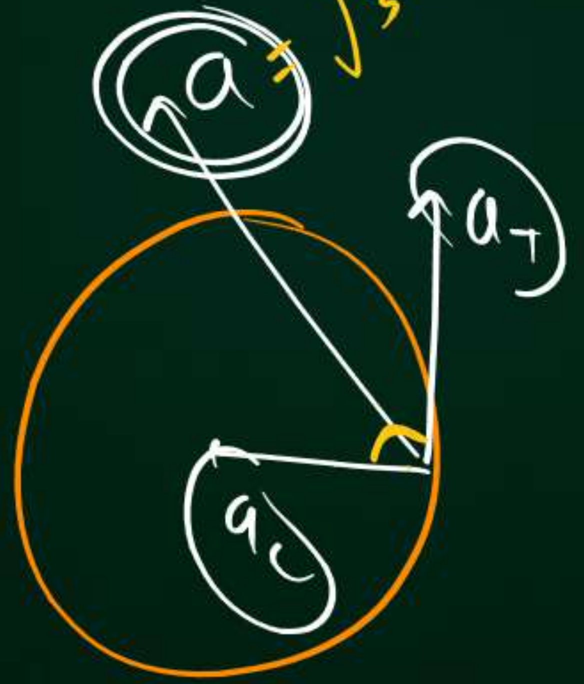


MR
Speed ↓
$\theta > 90°$

QUESTION

A car is moving at a speed of 40 m/s on a circular track of radius 400 m. This speed is increasing at the rate of 3 m/s^2. The acceleration of car is

1. 4 m/s^2
2. 7 m/s^2
3. 5 m/s^2
4. 3 m/s^2



QUESTION

A car travelling with linear velocity v on circular path of radius r its speed increasing at rate α, then find acceleration.

$$a_c = \frac{v^2}{R}$$

$$a_t = \alpha$$

$$a = \sqrt{\left(\frac{v^2}{R}\right)^2 + \alpha^2}$$

QUESTION

The distance of a particle moving on a circle of radius 12 m measured from a fixed point on the circle and measured along the circle is given by $s = 2t^3$ (in meters). The ratio of its tangential to centripetal acceleration at t = 1 sec.

1. 4 : 1
2. 1 : 2
3. 2 : 1
4. 3 : 1

QUESTION

A car is going round a circle of radius R_1 with constant speed. Another car is going round a circle of radius R_2 with constant speed. If both of them take same time to complete the circles, the ratio of their angular speeds and linear speeds will be

1. $\sqrt{\frac{R_1}{R_2}}, \frac{R_1}{R_2}$
2. $1, 1$
3. $1, \frac{R_1}{R_2}$
4. $\frac{R_1}{R_2}$

QUESTION

If θ is angle between the velocity and acceleration of a particle moving on a circular path with decreasing speed, then

N.U.C.M

(1) $\theta = 90^\circ$

(2) $0^\circ < \theta < 90^\circ$

(3) $90^\circ < \theta < 180^\circ$

(4) $0^\circ \le \theta \le 180^\circ$

QUESTION

If speed of an object revolving in a circular path is doubled angular speed is reduced to half of original value, then centripetal acceleration will become/remain

1. Same
2. Double
3. Half
4. Quadruple

$$a_1 = \frac{v^2}{R} = \omega^2 R = \omega v$$

$$V = R\omega$$

$$R = \frac{v}{\omega}$$

QUESTION

$a_c = v^2/R$.

A motor car is travelling at 30 m/sec on a circular road of radius 500 m. It is increasing its speed at the rate of 2.0 ms^{-2}. The total acceleration is:

a_t

1. 1.8 ms^{-2}
2. 2 ms^{-2}
3. 3.8 ms^{-2}
4. 2.7 ms^{-2}

QUESTION

Angular velocity of minute hand of a clock is:- M/W

(1) $\frac{2\pi}{1800}$ rad/s

(2) 8π rad/s

(3) $\frac{\pi}{1800}$ rad/s

(4) $\frac{\pi}{30}$ rad/s

QUESTION

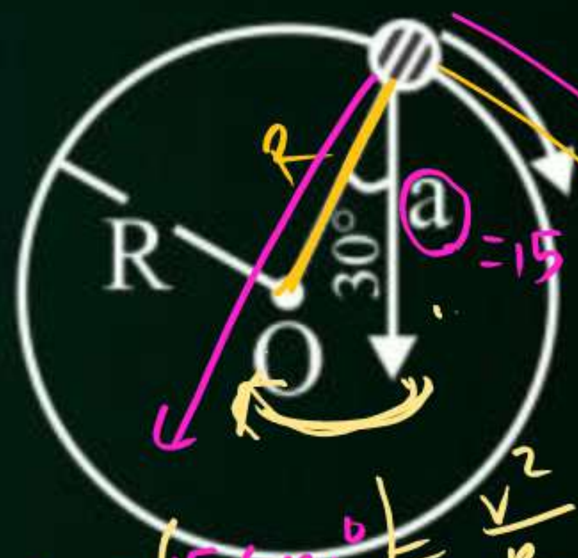
a_c

a_r and a_t represent radial and tangential acceleration. The motion of a particle will be uniform circular motion if :-

1. $a_r = 0$ and $a_t = 0$
2. $a_r = 0$ but $a_t \neq 0$
3. ✓ $a_r \neq 0$ but $a_t = 0$
4. $a_r \neq 0$ and $a_t \neq 0$

QUESTION

In the given figure, $a = 15\ \text{m}\ s^{-2}$ represents the total acceleration of a particle moving in the clockwise direction in a circle of radius R = 2.5 m at a given instant of time. The speed of the particle is



1. $4.5\ \text{m s}^{-1}$
2. $5.0\ \text{m s}^{-1}$
3. $5.7\ \text{m s}^{-1}$
4. $6.2\ \text{m s}^{-1}$

QUESTION

A car moves on a circular path such that its speed is given by $v = Kt$, where K = constant and t is time. Also given: radius of the circular path is r. The net acceleration of the car at time twill be

1. $\sqrt{K^2 + \left(\frac{K^2t^2}{r}\right)^2}$ ✓
2. $2K$
3. K
4. $\sqrt{K^2 + K^2t^2}$

speed

$v = Kt$

Rate of change in spee $a_t = K\frac{dt}{dt}$

$a_t = K.$

$a_c = \frac{v^2}{R} = \frac{K^2t^2}{R}$

$$\vec{r} = R\cos\theta\,\hat{i} + R\sin(\theta)\,\hat{j}$$

If Motion is Uniform

$$\omega = \frac{\theta}{t}$$

$$\theta = \omega t \quad \text{--- (1)}$$

$$\vec{r} = R\cos(\omega t)\,\hat{i} + R\sin(\omega t)\,\hat{j}$$

$$\vec{v} = \frac{d\vec{r}}{dt} = -\omega R\sin(\omega t)\,\hat{i} + \omega R\cos(\omega t)\,\hat{j}$$

$$\vec{a} = \frac{d\vec{v}}{dt} = -\omega^2 R\cos(\omega t)\,\hat{i} - \omega^2 R\sin(\omega t)\,\hat{j}$$



$$\vec{a} = -\omega^2\left(R\cos\omega t\,\hat{i} + R\sin(\omega t)\,\hat{j}\right)$$

$$\vec{a} = -\omega^2\,\vec{r}$$

dir.

QUESTION

H.W

The position vector of a particle $\vec{R}$ as a function of time is given by $\vec{R} = 4\sin(2\pi t)\hat{\imath} + 4\cos(2\pi t)\hat{\jmath}$, where R is in meters, t is in seconds and $\hat{\imath}$ and $\hat{\jmath}$ denote unit vectors along x-and y-directions, respectively. Which one of the following statements is wrong for the motion of particle?

1. Path of the particle is a circle of radius 4 m
2. Acceleration vector of along $-\vec{R}$
3. Magnitude of acceleration vector is v^2/R, where v is the velocity of particle
4. Magnitude of the velocity of particle is 8 meter/second

QUESTION

A particle moves so that its position vector is given by $\vec{r} = \cos \omega t \, \hat{x} + \sin \omega t \, \hat{y}$, where ω is a constant. Which of the following is true?

1. Velocity is perpendicular to $\vec{r}$ and acceleration is directed away from the origin.
2. Velocity and acceleration both the perpendicular to $\vec{r}$.
3. Velocity and acceleration both are parallel to $\vec{r}$.
4. Velocity is perpendicular to $\vec{r}$ and acceleration is directed towards the origin.

QUESTION

A particle is acted upon by a force of constant magnitude which is always perpendicular to the velocity of the particle, the motion of the particle takes place in a plane. It follows that:

1. Its velocity is constant
2. Its acceleration is constant
3. Its kinetic energy is constant
4. It moves in a straight line

QUESTION

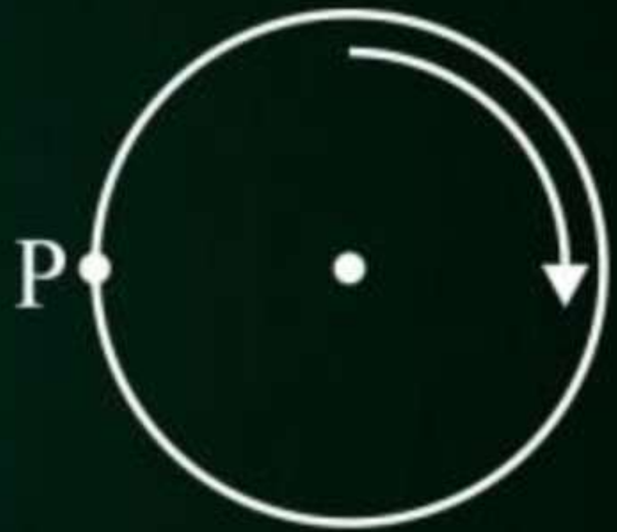
A music CD of 'Bajirao Mastani' is rotating clockwise (as shown). After turing it off, the CD slows down. Assuming it has not come to a stop yet, the direction of acceleration at point P is:

(1) 

(2) 

(3) 

(4) 



QUESTION

If the equation for the displacement of a particle moving on a circular path is given by $(\theta) = 2t^3 + 0.5$, where θ is in radians and t in seconds, then the angular velocity of the particle after 2s from its start is:-

1. 8 rad/s
2. 12 rad/s
3. 24 rad/s
4. 36 rad/s

QUESTION

A particle of mass 'm' describes a circle of radius (r). The centripetal acceleration of the particle is $4/r^2$. The momentum of the particle:-

1. $\frac{2m}{r}$
2. $\frac{2m}{\sqrt{r}}$
3. $\frac{4m}{r}$
4. $\frac{4m}{\sqrt{r}}$

QUESTION

A particle is moving around a circular path with uniform angular speed (ω). The radius of the circular path is r. The acceleration of the particle is:-

1. $\frac{\omega^2}{r}$
2. $\frac{\omega}{r}$
3. $v\omega$
4. vr

QUESTION

Two particles A and B are moving in uniform circular motion in concentric circles of radii r_A and r_B with speed v_A and v_B respectively. Their time period of rotation is the same. The ratio of angular speed of A to that of B will be

1. $1:1$
2. $r_A : r_B$
3. $v_A : v_B$
4. $r_B : r_A$

QUESTION

A particle starting from rest, moves in a circle of radius 'r'. It attains a velocity of V_0 m/s in the n^{th} round. Its angular acceleration will be

1. $\frac{V_0}{n}$ rad/s2

2. $\frac{V_0}{2\pi n r^2}$ rad/s2

3. $\frac{{V_0}^2}{4\pi n r^2}$ rad/s2

4. $\frac{{V_0}^2}{4\pi n r}$ rad/s2

QUESTION

A particle moves in a circle of radius 5 cm with constant speed and time period 0.2π s. The acceleration of the particle is

1. $15\ m/s^2$
2. $25\ m/s^2$
3. $36\ m/s^2$
4. $5\ m/s^2$

QUESTION

A stone tied to the end of a string of 1 m long is whirled in a horizontal circle with a constant speed. If the stone makes 22 revolutions in 44 seconds, what is the magnitude and direction of acceleration of the stone?

1. π^2 m s^{-2} and direction along the radius towards the centre

2. π^2 m s^{-2} and direction along the radius away from the centre

3. π^2 m s^{-2} and direction along the tangent to the circle

4. $\pi^2/4$ m s^{-2} and direction along the radius towards the centre.

QUESTION

A particle moves along a circle of radius $(20/\pi)$ m with constant tangential acceleration. If the velocity of the particle is 80 m/s at the end of the second revolution after motion has begun, the tangential acceleration is

1. $40\ m/s^2$
2. $640\pi\ m/s^2$
3. $160\pi\ m/s^2$
4. $40\pi\ m/s^2$

QUESTION

A body is whirled in a horizontal circle of radius 20 cm. It has an angular velocity of 10 rad/s. What is its linear velocity at any point on circular path?

(1) $20 \mathrm{~m/s}$

(2) $\sqrt{2} \mathrm{~m/s}$

(3) $10 \mathrm{~m/s}$

(4) $2 \mathrm{~m/s}$

QUESTION

The angular speed of a flywheel making 120 revolutions/minute is

1. 4π rad/s
2. $4\pi^2$ rad/s
3. π rad/s
4. 2π rad/s

QUESTION

A particle of mass 10g moves along a circle of radius 6.4 cm with a constant tangential acceleration. What is the magnitude of this acceleration, if the kinetic energy of the particle becomes equal to 8×10^{-4} J by the end of the second revolution after the beginning of the motion?

1. $0.15\ m/s^2$
2. $0.18\ m/s^2$
3. $0.2\ m/s^2$
4. $0.1\ m/s^2$

QUESTION

The radius vector of a particle moving on a circle is given by $\vec{r} = A\cos Bt\,\hat{\imath} + A\sin Bt\,\hat{\jmath}$ (A and B are constants). The radius of the circle and speed of the particle, respectively, are

1. A, AB
2. A, A^2/B
3. B, AB
4. B, A^2/B

QUESTION

A particle starts moving on a circular path from rest, such that its tangential acceleration varies with time as $a_t = kt$. Distance traveled by particle on the circular path in time t is

1. $\frac{kt^3}{3}$
2. $\frac{kt^2}{6}$
3. $\frac{kt^3}{6}$
4. $\frac{kt^2}{2}$


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture → 9 | Physics

Motion in a Plane



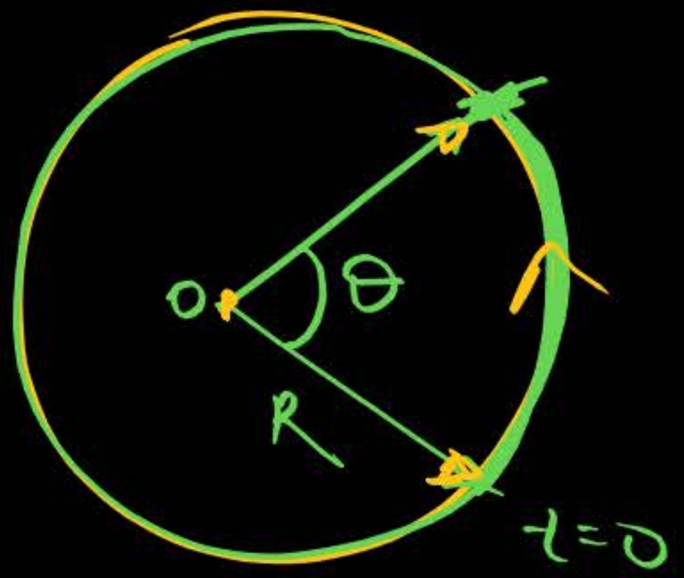
By- Dr. Manish Raj (MR SIR)

Topic To be Covered

✓ Revision of circular motion

✓ → H/W

Circular motn



* distance = Path length = $R\theta$
* dispm = $2R\sin\theta/2$
* Angular dispm = θ ⊙
  - Axial vector → Anti-clock ⊙ outwn
  - unit (rad) → Clock ⊗
  - dimnless

Angular velocity $\omega_{inst} = \frac{d\theta}{dt}$ $\omega_{Avg} = \frac{\Delta\theta}{\Delta t}$

- unit rad/sec
- dimn T^{-1}
- vector ω ⊙ Anti-clock ω ⊗ clockwise motn

$\vec{\omega}$ = const





Angular accn $\alpha = \frac{d\omega}{dt}$

- unit rad/s²
- dim → T^{-2}
- Axial vector
- dirn (change in ω ke along)





$\text{dist}^n = R\theta$

$\text{speed} = R\omega$

$v\,(\text{speed}) = R\omega$

$v = 2\pi f R$

diff^n w.r.t time

$\frac{dv}{dt} = a_t = R\alpha$ (v ← speed) *

$\omega = \frac{2\pi}{T} = 2\pi f$

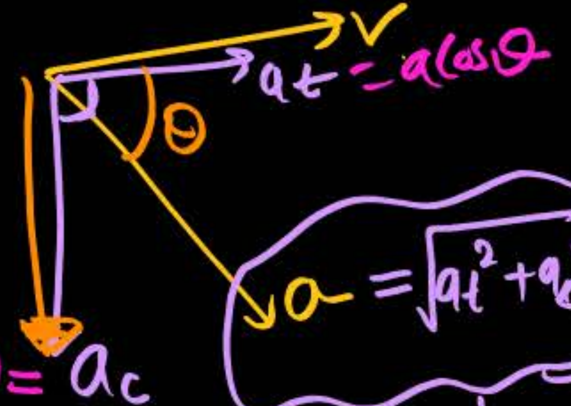
$\vec{\alpha}$	$\vec{a}_t$	$\vec{a}_c$	$\vec{a}$

$a_t = R\alpha$

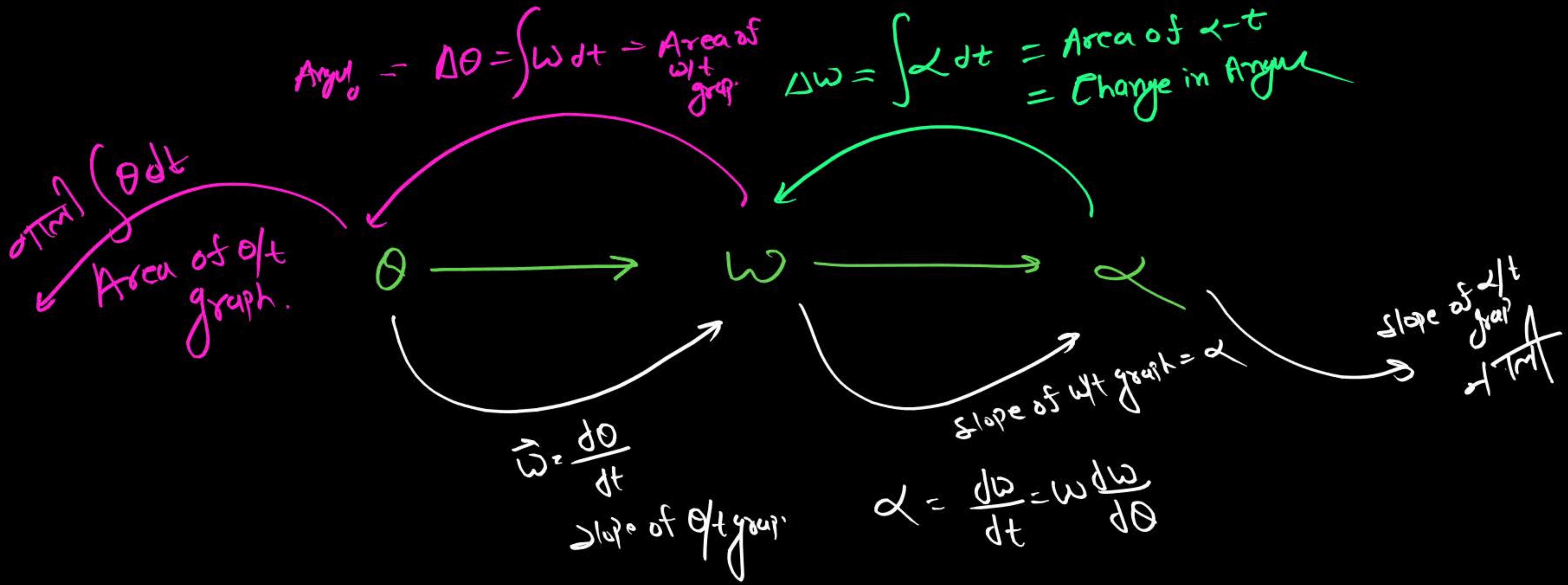
$|\vec{a}_c|_{inst} = v^2/R = \omega^2 R$

$(a_c)_{Avg} = \frac{v^2}{R}\,\frac{\sin\theta/2}{\theta/2}$

$\vec{a} = \vec{a}_t + \vec{a}_c$



$a = \sqrt{a_t^2 + a_c^2}$ *


Angle = ΔΘ = ∫ω dt = Area of ω/t graph
Δω = ∫α dt = Area of α-t = Change in Angular
∫θ dt
Area of θ/t graph.
θ
ω
α
ω = dθ/dt
slope of θ/t graph
α = dω/dt = ω dω/dθ
slope of ω/t graph = α
slope of α/t graph

$\alpha = 0$	$\alpha = const^n$	α – var
Uniform circular motn. $\theta = \omega t$	eqn of motion $\omega_f = \omega_0 + \alpha t$ $\theta = \omega_i t + \frac{1}{2}\alpha t^2$ $\omega_f^2 - \omega_i^2 = 2\alpha\theta$	Integrn – diffn

Angle dispn

$\omega_{Avg} = \frac{\omega_i + \omega_f}{2}$

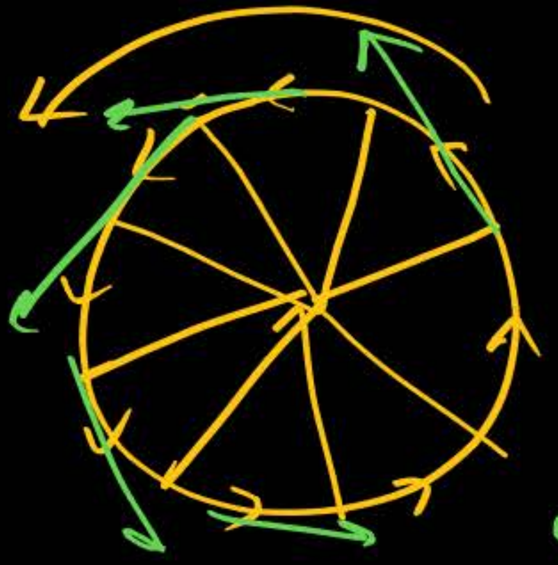
$\theta \propto t^2$

$\omega \propto t$

$\omega \propto \sqrt{\theta}$

$\alpha = const^n$

Uniform circular motⁿ → Non-uniform motion with Non-uniform acceleration.



$\vec{\omega} = \text{const}^n$

Angular speed = const^n → $\alpha = 0$

Speed = const^n → $a_t = 0$

dirⁿ of motⁿ → varible

Velocity → varible

acc$^n \neq 0$

$\vec{a} = \vec{a_t} + a_c$ (a_t → 0)

$\vec{a} = \vec{a_c}$

$\alpha = 0$, $a_t = 0$

K.E = const^n

work = 0

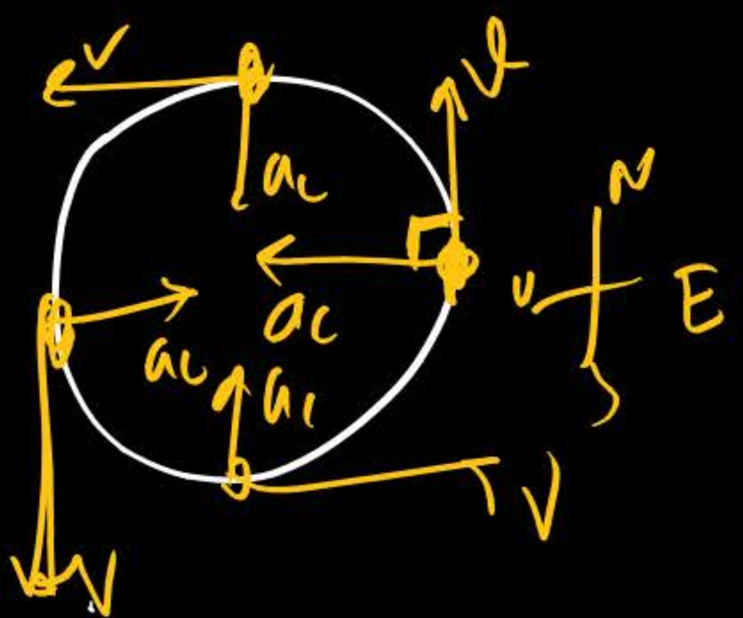
Power = 0

moment = varible

$$\vec{a_c} = \vec{a} = \frac{v^2}{R} = \omega^2 R = 4\pi^2 f^2 R$$

gn in U.C.M

$$(a_c)_{AB} = \frac{v^2}{R} \frac{\sin\theta/2}{\theta/2}$$ ✓



NUCM → non uniform circular motion



$\vec{\omega}$ = varible → $\alpha \neq 0$

speed = " → $a_t \neq 0$

$a_t = \frac{dv}{dt}$ = Rate of change in speed

$\alpha = \frac{d\omega}{dt}$

$$a_t = R\alpha$$

dirn → varble

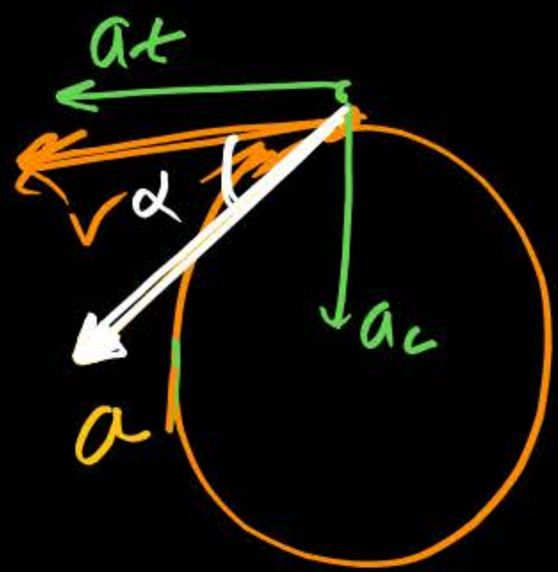
speed → var

K.E → "

work ≠ 0

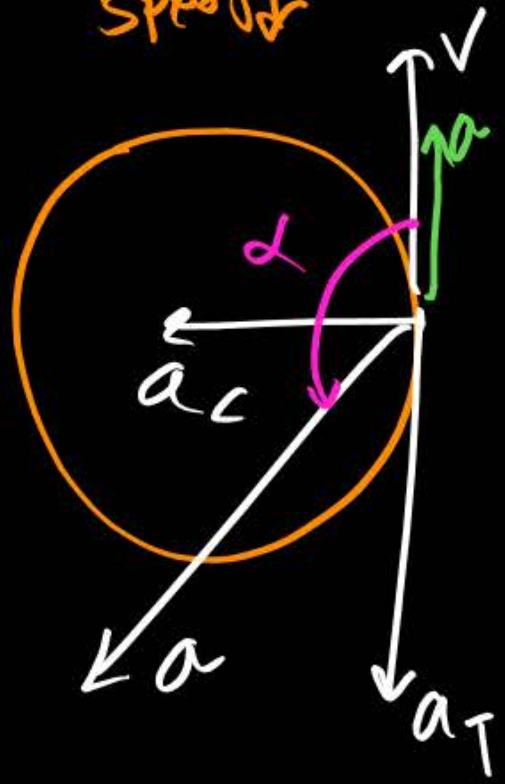
Powr ≠ 0

Speed ↑



$\alpha < 90^\circ$

speed ↓



$\alpha > 90^\circ$

Angle b/w $\vec{v}$ & $\vec{a}$ can't be 0° or 180°

QUESTION

A car is going round a circle of radius R_1 with constant speed. Another car is going round a circle of radius R_2 with constant speed. If both of them take same time to complete the circles, the ratio of their angular speeds and linear speeds will be

1. $\sqrt{\frac{R_1}{R_2}}, \frac{R_1}{R_2}$
2. $1, 1$
3. $1, \frac{R_1}{R_2}$
4. $\frac{R_1}{R_2}$

QUESTION

Centripetal acceleration of a cyclist completing [redacted] 7 rounds in a minute along a circular track of radius 5 m with a constant speed, is

1. $2.7\ \text{m/s}^2$
2. $4\ \text{m/s}^2$
3. $3.78\ \text{m/s}^2$
4. $6\ \text{m/s}^2$

$\omega = \frac{\theta_{total}}{t}$

$= \frac{2\pi \times 7}{60}$

$\omega = \frac{2 \times 7 \times 22}{7 \times 60} = \frac{11}{15}$

$a_c = \omega^2 R$

$= \frac{11 \times 11}{15 \times 15} \times 5 = \frac{121}{45} = 2.8$

QUESTION

A car is moving at a speed of 40 m/s on a circular track of radius 400 m. This speed is increasing at the rate of 3 m/s². The acceleration of car is

1. $4\ m/s^2$
2. $7\ m/s^2$
3. $5\ m/s^2$
4. $3\ m/s^2$

$a_t = 3\ m/s^2$

$V = 40\ m/s$

$a = \vec{a}_t + \vec{a}_c$ $\quad a_c = \frac{v^2}{R} = \frac{(40)^2}{400} = \frac{40 \times 40}{400} = 4$

$|a| = \sqrt{a_t^2 + a_c^2}$

$= \sqrt{(3)^2 + (4)^2}$

$= \sqrt{25}$

$= 5$

QUESTION

A car travelling with linear velocity v on circular path of radius r its speed increasing at rate α, then find acceleration.

$$a_c = v^2/R$$

$$a_t = \alpha$$

$$a = \sqrt{\left(\frac{v^2}{R}\right)^2 + \alpha^2}$$

QUESTION

The distance of a particle moving on a circle of radius 12 m measured from a fixed point on the circle and measured along the circle is given by $s = 2t^3$ (in meters). The ratio of its tangential to centripetal acceleration at $t = 2\,\text{sec}$

(1) 4 : 1

(2) 1 : 2 ✓

(3) 2 : 1

(4) 3 : 1

$R = 12\,m$

$s = 2t^3$



$\frac{d\,\text{dist}^n}{dt} = \frac{d\,2t^3}{dt}$

$v = 2(3t^2)$

$V = 6t^2$

$a_t = \frac{dv}{dt} = 12t$

$a_c = \frac{v^2}{R} = \frac{(6t^2)^2}{12} = \frac{36t^4}{12}$

$a_c = 3t^4$

$\frac{a_t}{a_c} = \frac{12t}{3t^4} = \frac{4}{t^3}$

$= \frac{4}{(2)^3} = \frac{4}{8} = \frac{1}{2}$

QUESTION

If θ is angle between the velocity and acceleration of a particle moving on a circular path with decreasing speed, then

1. $\theta = 90°$
2. $0° < \theta < 90°$
3. $90° < \theta < 180°$
4. $0° \leq \theta \leq 180°$



QUESTION

If speed of an object revolving in a circular path is doubled, angular speed is reduced to half of original value, then centripetal acceleration will become/remain

1. Same
2. Double
3. Half
4. Quadruple

$a_c = \frac{v^2}{R} = \frac{v^2}{v/\omega} = \frac{v^2\omega}{v}$

$a_c = v\omega$

$v = R\omega$

$R = \frac{v}{\omega}$

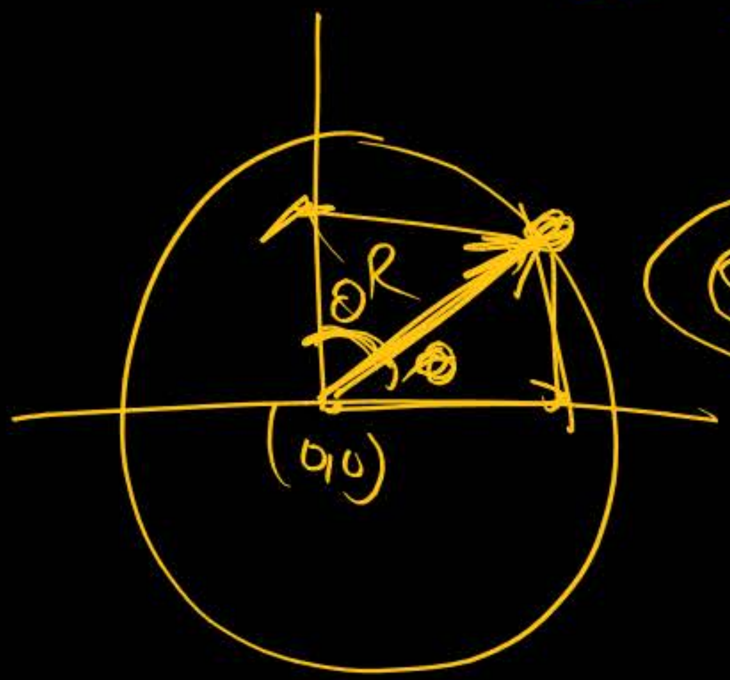
QUESTION

The position vector of a particle $\vec{R}$ as a function of time is given by $\vec{R} = 4\sin(2\pi t)\hat{\imath} + 4\cos(2\pi t)\hat{\jmath}$, where R is in meters, t is in seconds and $\hat{\imath}$ and $\hat{\jmath}$ denote unit vectors along x-and y-directions, respectively. Which one of the following statements is wrong for the motion of particle?

1. Path of the particle is a circle of radius 4 m
2. Acceleration vector of along $-\vec{R}$
3. Magnitude of acceleration vector is v^2/R, where v is the velocity of particle
4. Magnitude of the velocity of particle is 8 meter/second

Ans (4)

$$\vec{r} = R\sin(\theta)\,\hat{i} + R\cos(\theta)\,\hat{j}$$



$$\theta = \omega t$$

QUESTION

A particle moves so that its position vector is given by $\vec{r} = \cos \omega t\, \hat{x} + \sin \omega t\, \hat{y}$, where ω is a constant. Which of the following is true?

1. Velocity is perpendicular to $\vec{r}$ and acceleration is directed away from the origin.

2. Velocity and acceleration both the perpendicular to $\vec{r}$.

3. Velocity and acceleration both are parallel to $\vec{r}$.

4. Velocity is perpendicular to $\vec{r}$ and acceleration is directed towards the origin.



QUESTION

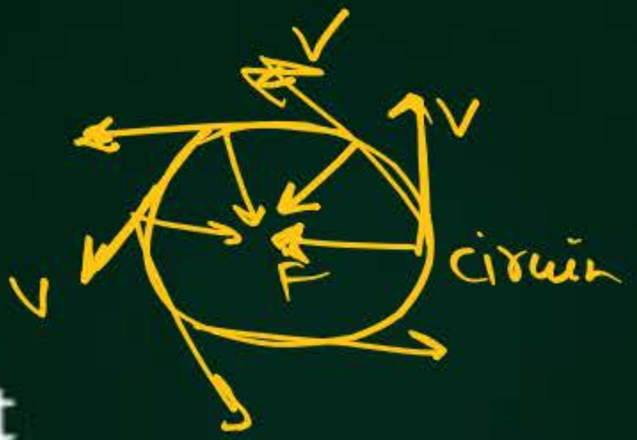
A motor car is travelling at 30 m/sec on a circular road of radius 500 m. It is increasing its speed at the rate of 2.0 ms^{-2}. The total acceleration is:

1. 1.8 ms^{-2}
2. 2 ms^{-2}
3. 3.8 ms^{-2}
4. 2.7 ms^{-2}

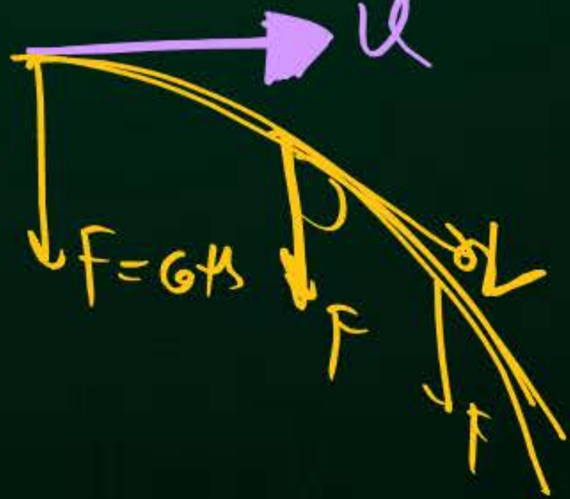
QUESTION

A particle is acted upon by a force of constant magnitude which is always perpendicular to the velocity of the particle, the motion of the particle takes place in a plane. It follows that:

1. Its velocity is constant
2. Its acceleration is constant
3. Its kinetic energy is constant
4. It moves in a straight line







Motion of charge in magnetic field

QUESTION

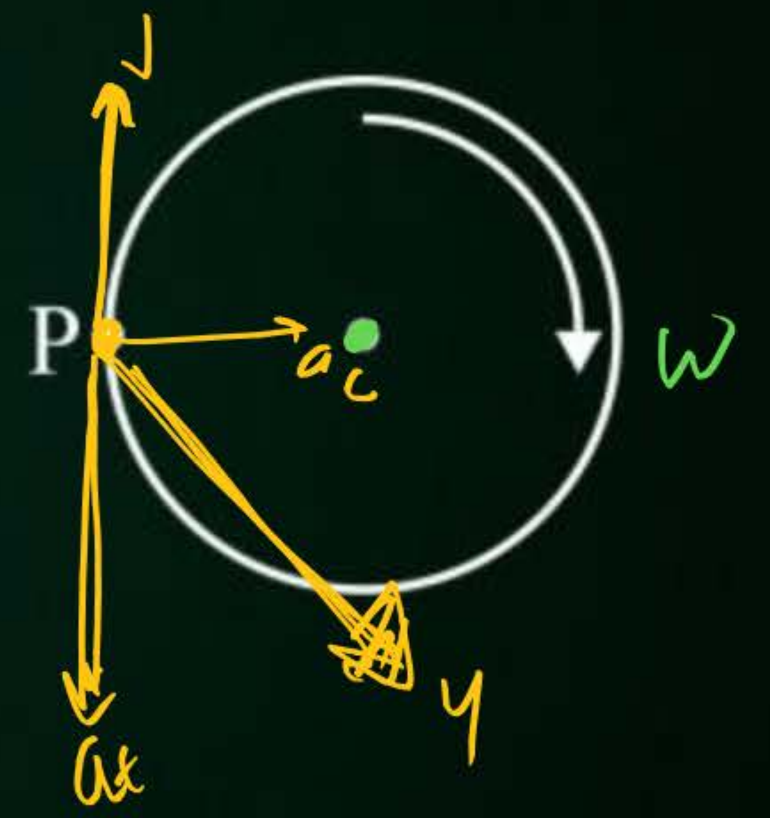
A music CD of 'Bajirao Mastani' is rotating clockwise (as shown). After turing it off, the CD slows down. Assuming it has not come to a stop yet, the direction of acceleration at point P is:

(1) ↑

(2) →

(3) ↗

(4) ↘



QUESTION

a_r and a_t represent radial and tangential acceleration. The motion of a particle will be uniform circular motion if :-

1. $a_r = 0$ and $a_t = 0$
2. $a_r = 0$ but $a_t \neq 0$
3. $a_r \neq 0$ but $a_t = 0$
4. $a_r \neq 0$ and $a_t \neq 0$

QUESTION

Angular velocity of minute hand of a clock is:-

1. $\frac{2\pi}{1800}$ rad/s
2. 8π rad/s
3. $\frac{\pi}{1800}$ rad/s
4. $\frac{\pi}{30}$ rad/s

$\omega = \frac{\theta}{t} = \frac{2\pi}{60 \times 60}$

QUESTION

If the equation for the displacement of a particle moving on a circular path is given by $(\theta) = 2t^3 + 0.5$, where θ is in radians and t in seconds, then the angular velocity of the particle after 2s from its start is:-

1. 8 rad/s
2. 12 rad/s
3. 24 rad/s ✓
4. 36 rad/s

$\omega = \frac{d\theta}{dt} = 2(3t^2)$

QUESTION

A particle of mass 'm' describes a circle of radius (r). The centripetal acceleration of the particle is $4/r^2$. The momentum of the particle:-

(1) $\frac{2m}{r}$

(2) $\frac{2m}{\sqrt{r}}$ ✓

(3) $\frac{4m}{r}$

(4) $\frac{4m}{\sqrt{r}}$

$a_c = \frac{4}{r^2} = \frac{v^2}{r}$

$v^2 = \frac{4r}{r^2}$

$v = \sqrt{\frac{4}{r}} = \frac{2}{\sqrt{r}}$

$p = mv = \frac{m2}{\sqrt{r}}$

QUESTION

A particle is moving around a circular path with uniform angular speed (ω). The radius of the circular path is r. The acceleration of the particle is:-

1. $\frac{\omega^2}{r}$
2. $\frac{\omega}{r}$
3. $v\omega$
4. vr

QUESTION

Two particles A and B are moving in uniform circular motion in concentric circles of radii r_A and r_B with speed v_A and v_B respectively. Their time period of rotation is the same. The ratio of angular speed of A to that of B will be

1. $1:1$
2. $r_A : r_B$
3. $v_A : v_B$
4. $r_B : r_A$

QUESTION

$v = r\omega$

A particle starting from rest, moves in a circle of radius 'r'. It attains a velocity of V_0 m/s in the n^{th} round. Its angular acceleration will be

$\alpha = ??$

1. $\frac{V_0}{n}$ rad/s2
2. $\frac{V_0}{2\pi n r^2}$ rad/s2
3. $\frac{V_0^2}{4\pi n r^2}$ rad/s2 ✓
4. $\frac{V_0^2}{4\pi n r}$ rad/s2

$V_i = 0$, $\omega_i = 0$, $t = 0$ → (n-rot^n, $\theta_{tot} = 2\pi n$) → $V_f = V_0$, $\omega_f = V_0 / R$

$\omega_f^2 - \omega_i^2 = 2\alpha\theta$

$\omega_f^2 - \omega_i^2 = 2\alpha \, 2\pi n$

$\left(\frac{V_0}{R}\right)^2 - 0 = 2\alpha \, 2\pi n$

$\alpha = \frac{V_0^2}{4\pi n R^2}$

QUESTION

A particle moves in a circle of radius 5 cm with constant speed and time period 0.2π s. The acceleration of the particle is

1. 15 m/s^2
2. 25 m/s^2
3. 36 m/s^2
4. 5 m/s^2

$T = 0.2\pi\ s$

U.C.M

$a = a_c = \omega^2 R$

$= \left(\frac{2\pi}{T}\right)^2 R$

$= \frac{4\pi^2}{(0.2\pi)^2} R$

$= \frac{4}{\frac{4}{100}} R$

$= 100 \times 5 \times \dots$

QUESTION

A stone tied to the end of a string of 1 m long is whirled in a horizontal circle with a constant speed. If the stone makes 22 revolutions in 44 seconds, what is the magnitude and direction of acceleration of the stone?

1. π^2 m s^{-2} and direction along the radius towards the centre
2. π^2 m s^{-2} and direction along the radius away from the centre
3. π^2 m s^{-2} and direction along the tangent to the circle
4. $\pi^2/4$ m s^{-2} and direction along the radius towards the centre.

1 rev ka time $T = \frac{44}{22} = 2$

$a_c = \left(\frac{2\pi}{T}\right)^2 R$

$= \left(\frac{2\pi}{2}\right)^2 R$

$= \pi^2 R$

QUESTION

A particle moves along a circle of radius $(20/\pi)$ m with constant tangential acceleration. If the velocity of the particle is 80 m/s at the end of the second revolution after motion has begun, the tangential acceleration is

(1) 40 m/s^2 ✓

(2) $640\pi \text{ m/s}^2$

(3) $160\pi \text{ m/s}^2$

(4) $40\pi \text{ m/s}^2$

$R = \frac{20}{\pi}$ m ✓

$v = 0$, $\omega = 0$ → $\theta = 4\pi$, dist^n $= 4\pi R$ → $v = 80$ m/s, $\omega = \frac{v}{R} = \frac{80}{R}$

$\omega_f^2 - \omega_i^2 = 2\alpha\theta$

$\left(\frac{80}{R}\right)^2 = 2\alpha(4\pi)$

$a_t = R\alpha$

$v = u + a_t t$ ✗

$v^2 - u^2 = 2 a_t s$

$v^2 = 2 a_t \, 4\pi \, \frac{20}{\pi}$

$(80)^2 = 2 a_t \ldots$

$80 \times 80 = 8 \times 20 \, a_t$

$a_t = 40$

QUESTION

A body is whirled in a horizontal circle of radius 20 cm. It has an angular velocity of 10 rad/s. What is its linear velocity at any point on circular path?

1. 20 m/s
2. $\sqrt{2}$ m/s
3. 10 m/s
4. 2 m/s

$v = R\omega$

QUESTION

The angular speed of a flywheel making 120 revolutions/minute is

1. 4π rad/s
2. $4\pi^2$ rad/s
3. π rad/s
4. 2π rad/s

$\frac{120 \text{ rev}}{60 \text{ sec}}$

$f = 2 Hz$

$\omega = 2\pi f$

$= 4\pi$

QUESTION

A particle of mass 10g moves along a circle of radius 6.4 cm with a constant tangential acceleration. What is the magnitude of this acceleration, if the kinetic energy of the particle becomes equal to 8×10^{-4} J by the end of the second revolution after the beginning of the motion?

1. 0.15 m/s^2
2. 0.18 m/s^2
3. 0.2 m/s^2
4. 0.1 m/s^2

QUESTION

A car moves on a circular path such that its speed is given by $v = Kt$, where K = constant and t is time. Also given: radius of the circular path is r. The net acceleration of the car at time twill be

1. $\sqrt{K^2 + \left(\frac{K^2t^2}{r}\right)^2}$
2. $2K$
3. K
4. $\sqrt{K^2 + K^2t^2}$

QUESTION

The radius vector of a particle moving on a circle is given by $\vec{r} = A\cos Bt\,\hat{i} + A\sin Bt\,\hat{j}$ (A and B are constants). The radius of the circle and speed of the particle, respectively, are

1. A, AB
2. A, A^2/B
3. B, AB
4. B, A^2/B

$v = R\omega$

$v = AB$

$\theta = \omega t$

$Bt = \omega t$

QUESTION

A particle starts moving on a circular path from rest, such that its tangential acceleration varies with time as $a_t = kt$. Distance traveled by particle on the circular path in time t is

1. $\frac{kt^3}{3}$
2. $\frac{kt^2}{6}$
3. $\frac{kt^3}{6}$
4. $\frac{kt^2}{2}$

$a_t = kt$

$\frac{dv}{dt} = kt$

$\int dv = \int kt\,dt$

$v = \frac{kt^2}{2}$

$\int ds = \int \frac{k}{2} t^2\,dt$

$s = \frac{k t^3}{2 \times 3} = \frac{kt^3}{6}$




THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 01 | **Physics**

Laws of Motion



By- Dr. Manish Raj (MR SIR)

Motion in plane → detailed Recorded lecture

☆ Circular motion → H/W → Recorded
(last lecture)

Todays Goal

→ Inertia
Type of force
Newton's 1st law

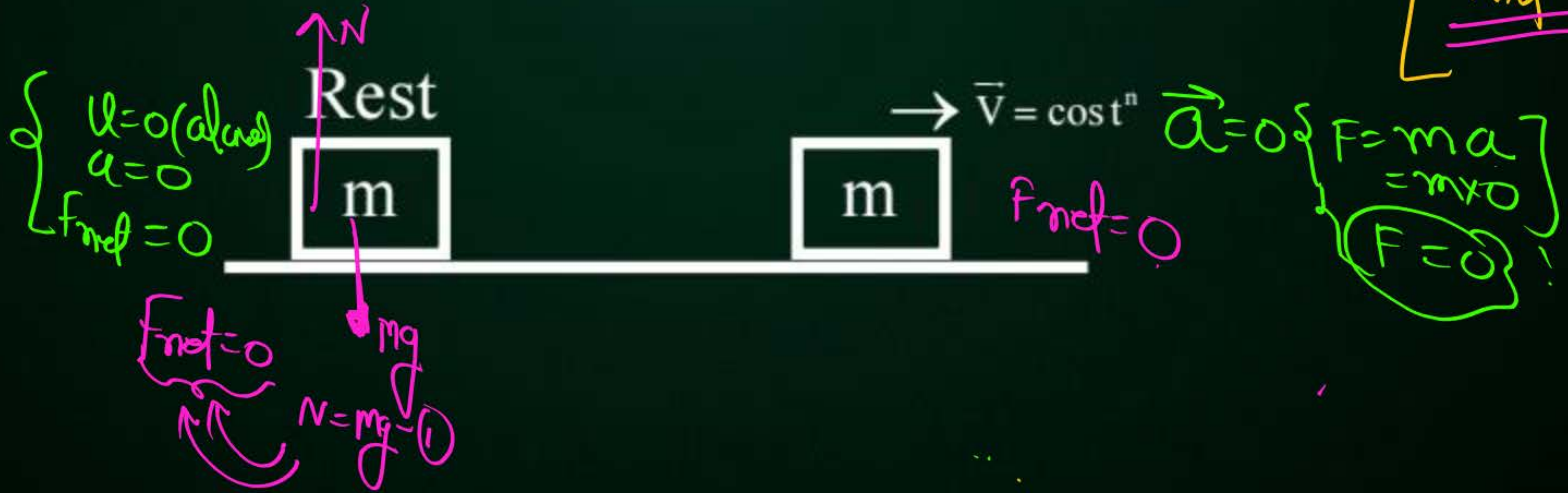
LAWS OF MOTION

Physical state of a body define with the help of velocity.

(1) State of Rest

(2) State of uniform motion ($\vec{V} = \text{cost}^n$)

Force is required to keep the object in a same state.



Change in State

Rest $\xrightarrow{to}$ State of Motion

State of Motion ($\vec{u}$ = const^n) → Rest / Speed ↑ / Speed ↓ / dir^n change

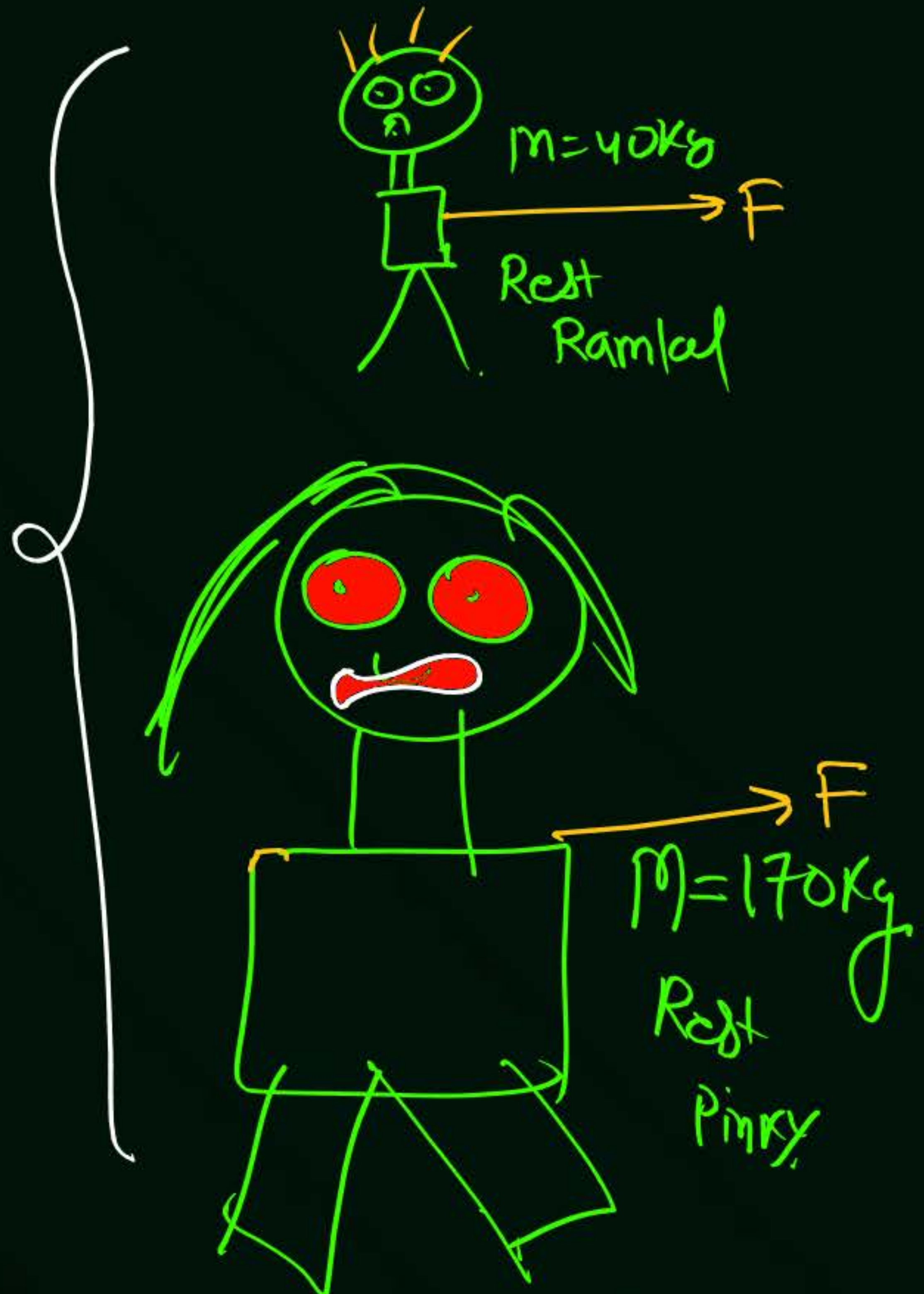
Force → Cause of change in a state of a body is called Force

→ {Pull or Push}



Inertia → Not a physical quantity

→ It is a property of object by virtue of which it oppose cause of change in state (force).



* Inertia $\propto$ Mass

↳ unit of Inertia

✗ (a) Kg

✓ (b) unit less.

Inertia of Pinky > Inertia of Ramlal

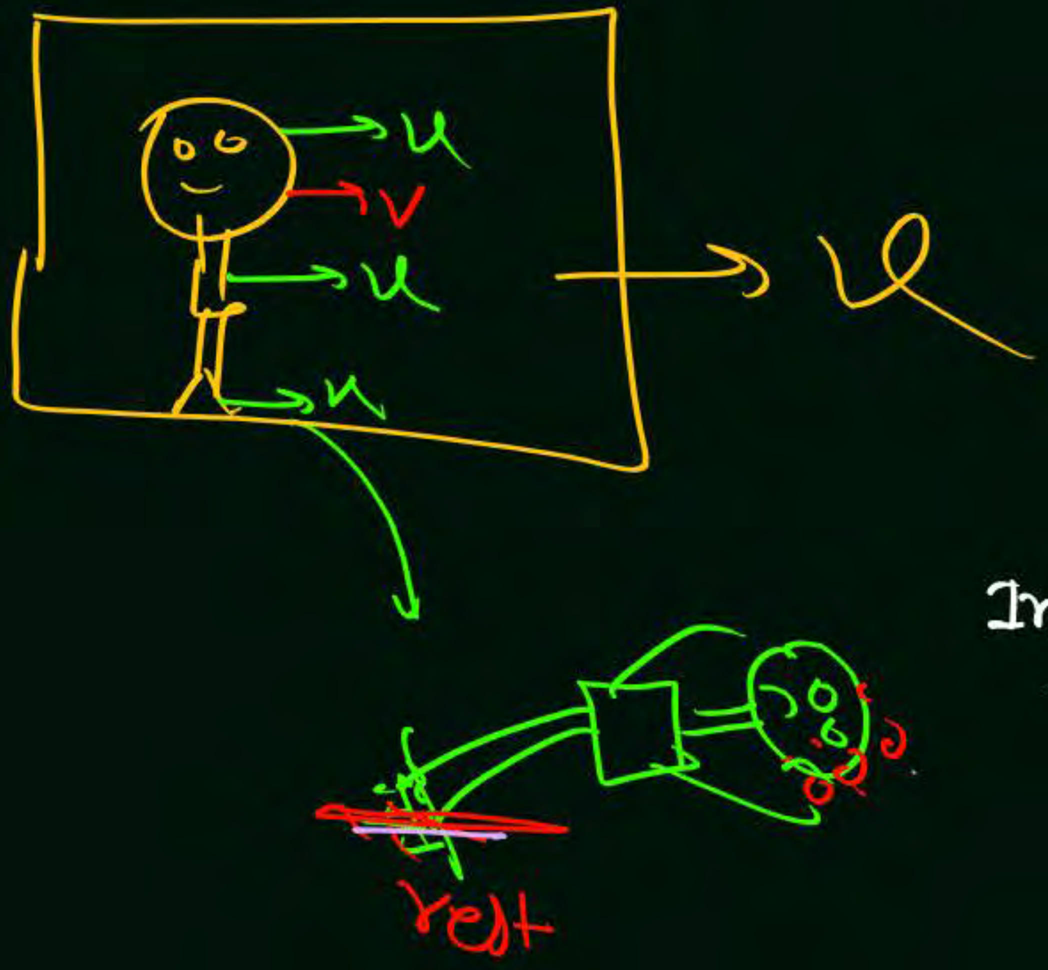
TYPE OF INERTIA

(i) Inertia of rest :

(ii) Inertia of Uniform Motion

- Speed Ki Inetia
- Direction Ki Inertia



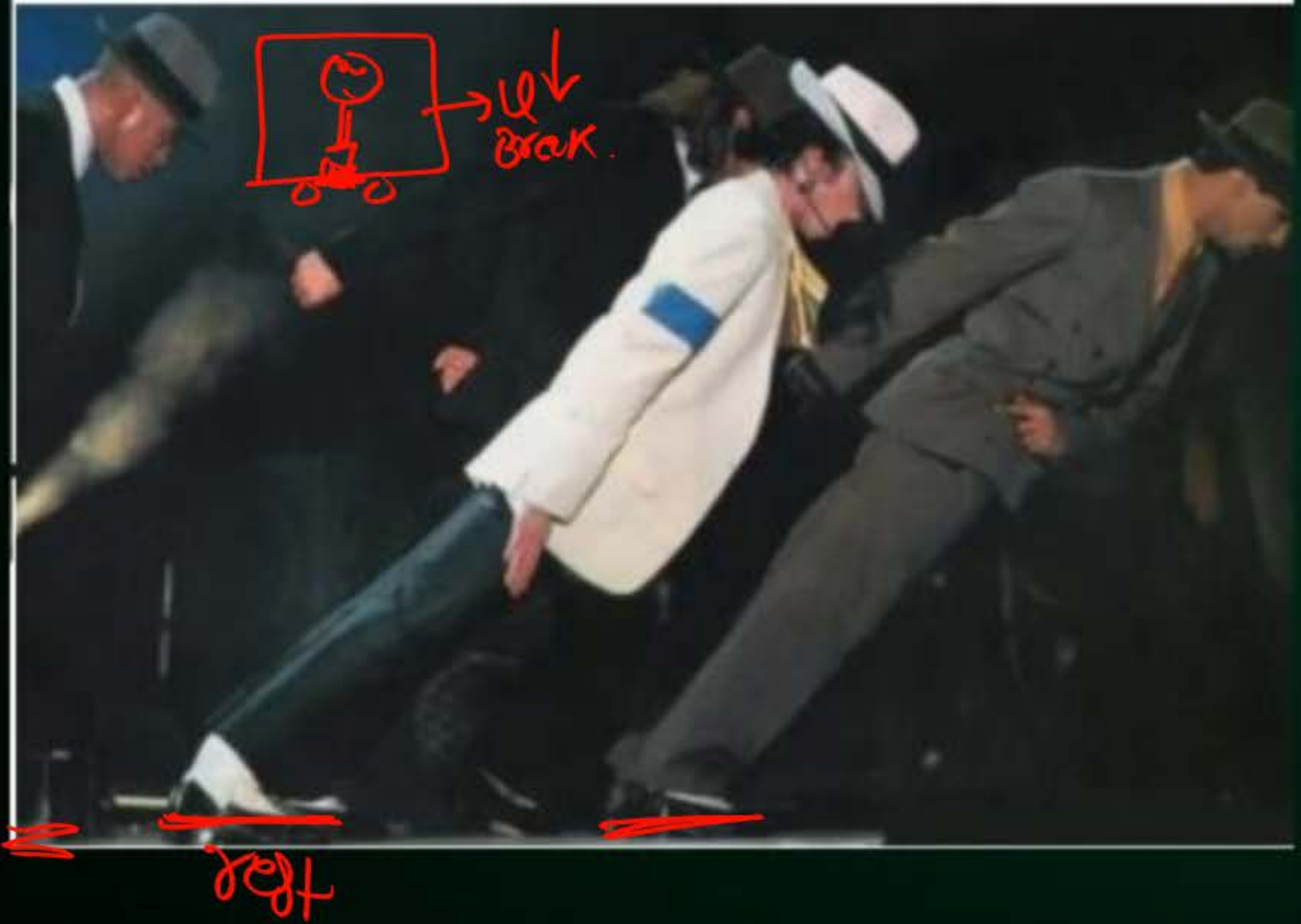


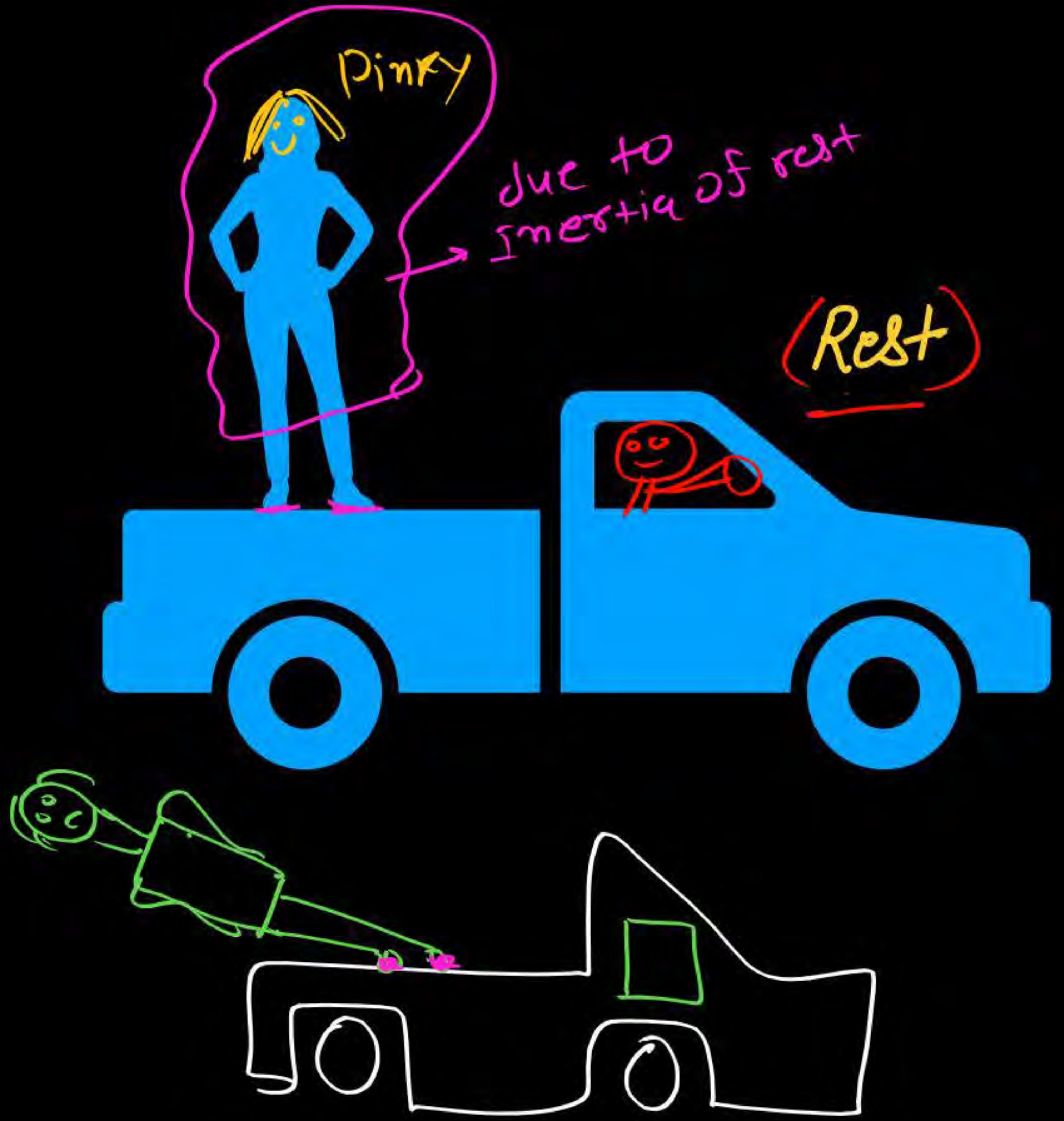
Inertia of Motion

Kids in the school bus when the driver randomly hits break

→ due to Inertia of uniform motion

speed ki Inertia



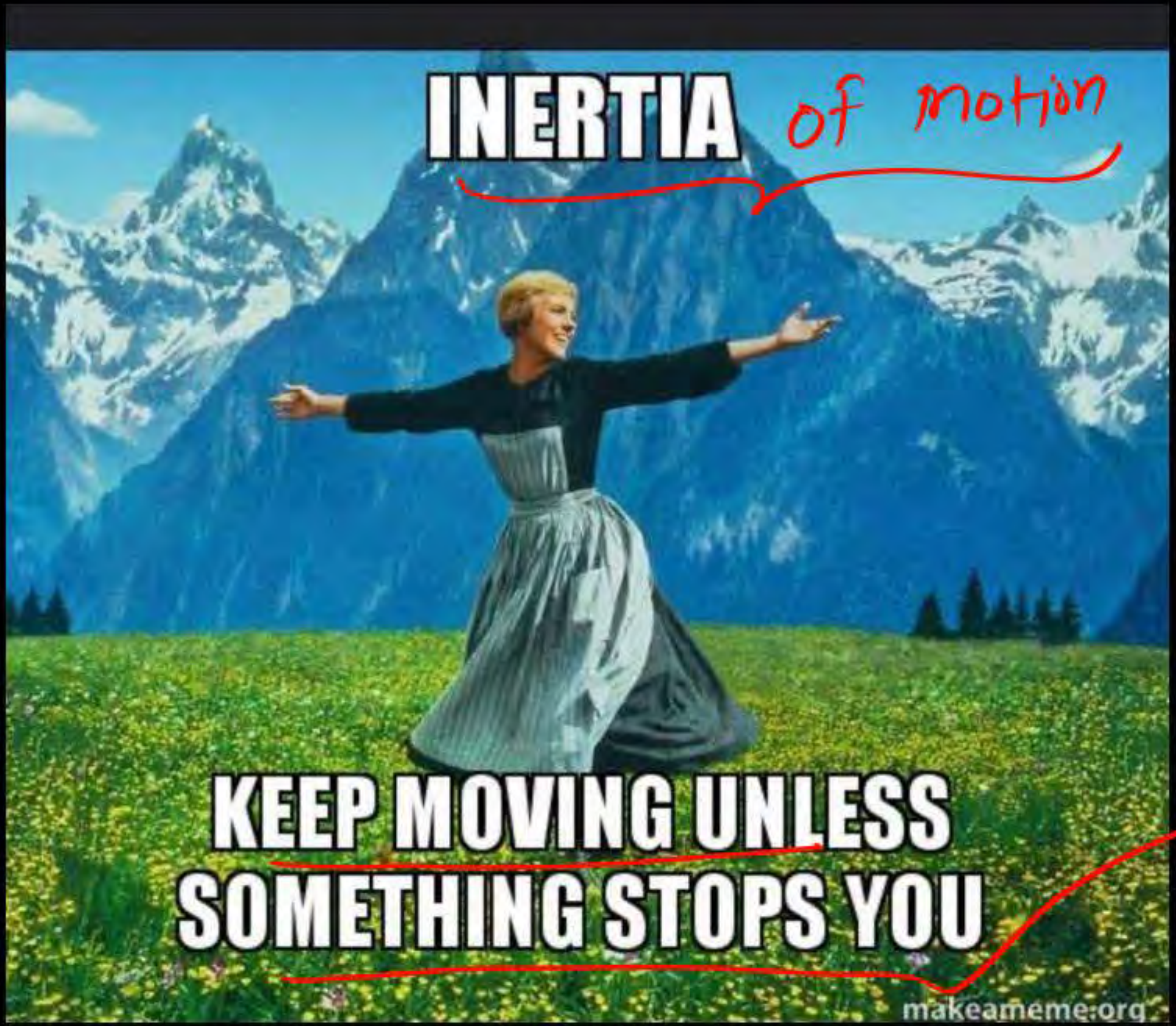


Suddenly car starts to move then Pinky will fall

(a) forward

(b) Backward

(c) Remain same.


INERTIA
of motion
KEEP MOVING UNLESS
SOMETHING STOPS YOU
makeameme.org

Newtons 1st Law ⇄ Law of Inertia.







$\vec{F}_{net} = 0$ then Body $\vec{a}_{nu} = 0$

Body will continue his state.

only state of a body will change when we apply external force

QUESTION

When an object is in equilibrium state, then

1. It must be at rest
2. No force is acting on it
3. Its net acceleration must be zero
4. All of these

QUESTION

When an object is at rest

1. Force is required to keep it in rest state
2. No force is acting on it
3. A large number of forces may be acting on it which balance each other
4. It is in vacuum

QUESTION

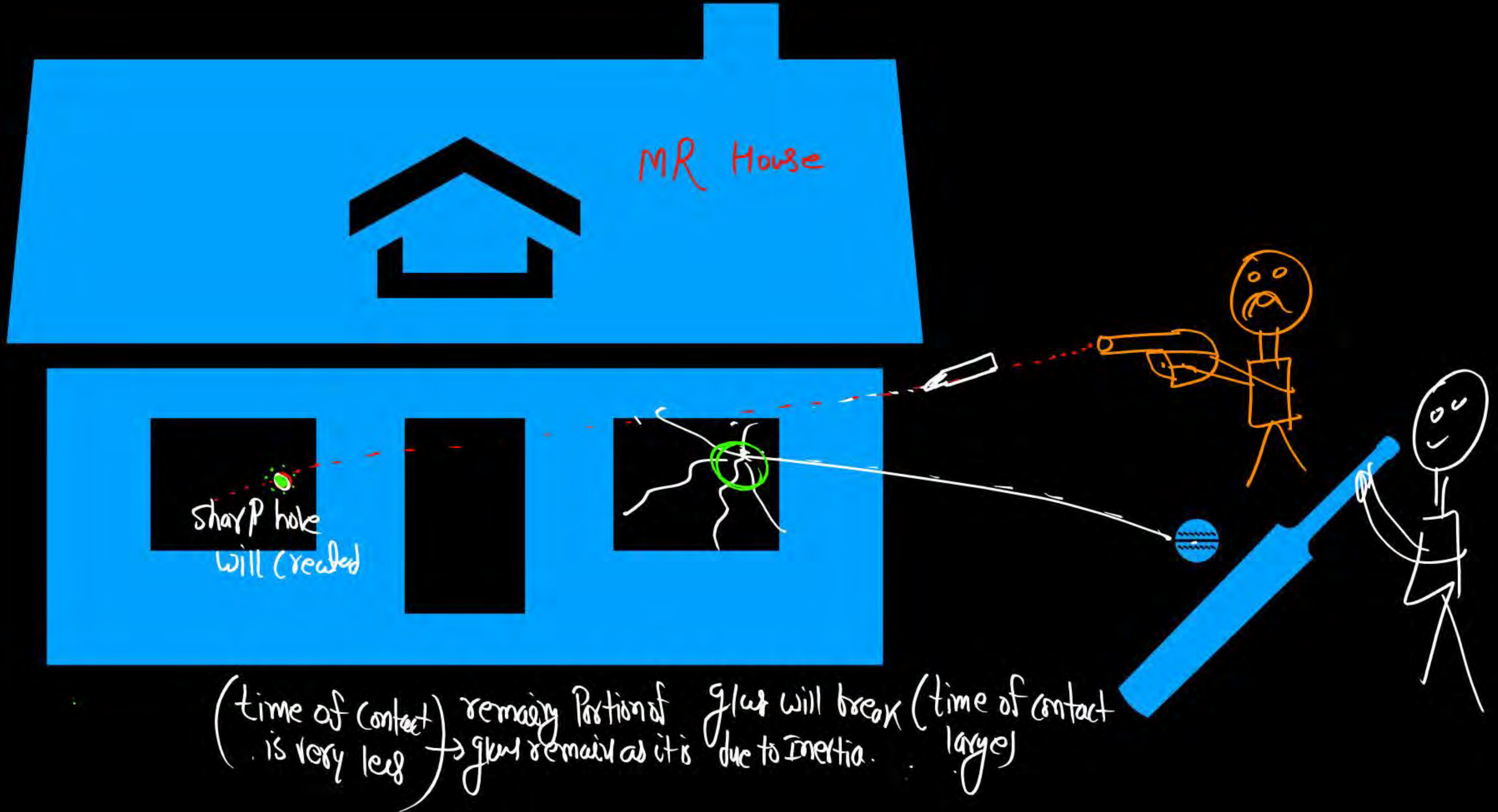
An athlete does not come to rest immediately after crossing the winning line due to the ??

1. Inertia of rest
2. Inertia of motion
3. Inertia of direction
4. None of these



suddenly pull → coin will fall in glass

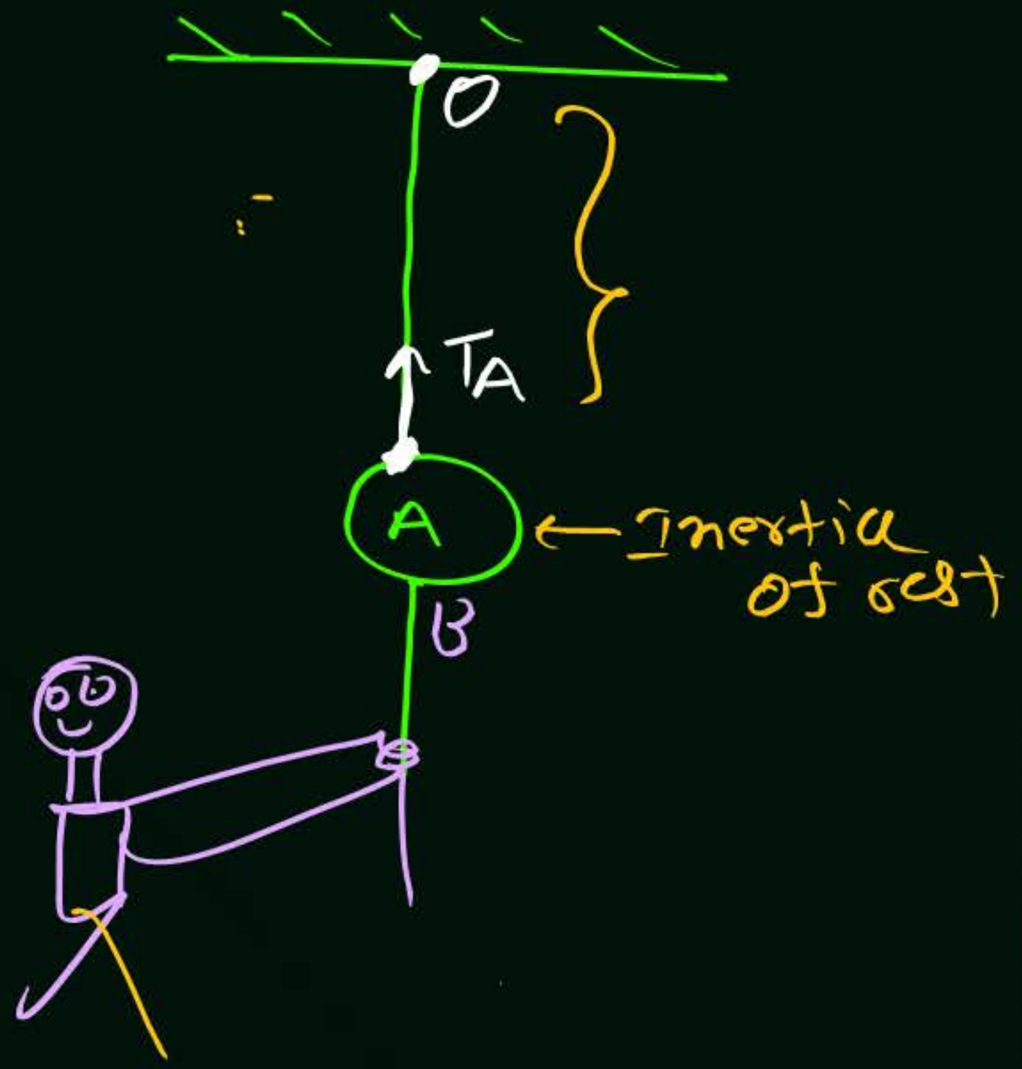
slowly pull → coin will no fall in glass


MR House
sharP hole will Created
(time of contect is very less) → remaing Portion of glass remain as it is
glass will break due to Inertia.
(time of contact large)

QUESTION

Why does the horse rider falls forward when a horse at full gallop stops suddenly?

due to Inertia of ini

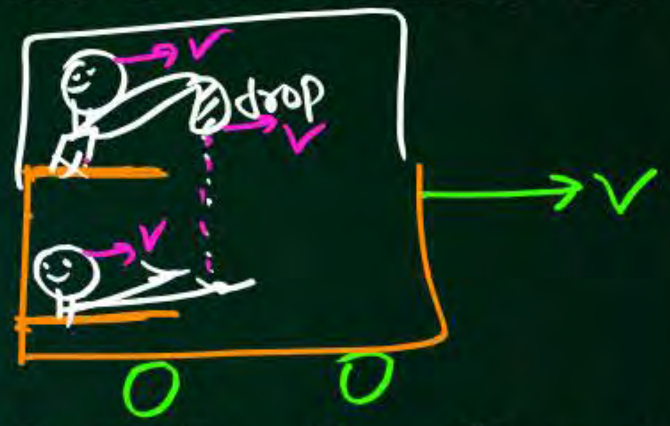


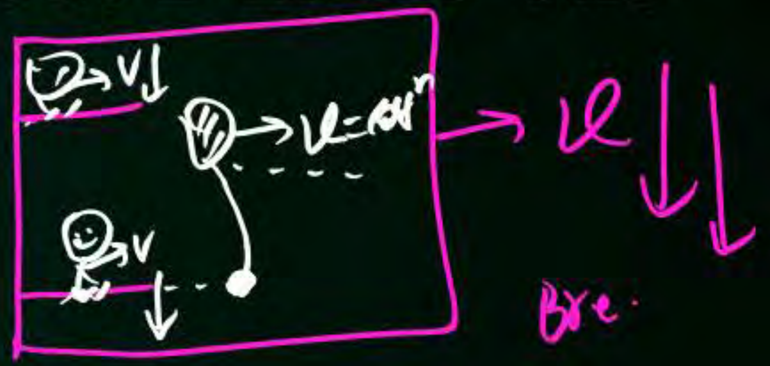
String will Break from

* [Suddenly Pull ⟶ Break from (B)
Slowly Pull ⟶ from 'OA'

QUESTION

A boy sitting on the topmost berth in the compartment of a train which is just point to stop on a railway station, drops an apple aiming at the open hand of his brother sitting vertically below his hands at a distance of about 2 meter The apple will fall :



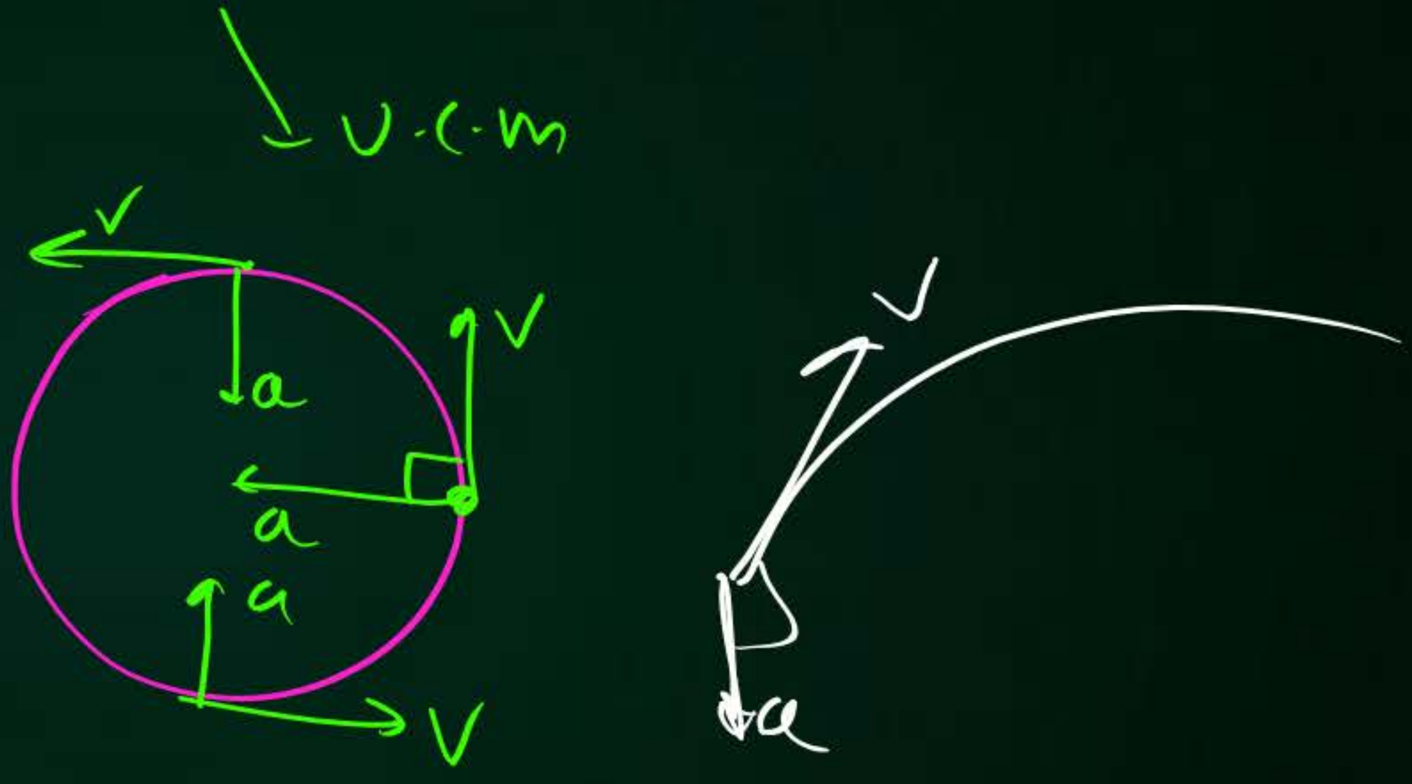


1. Precisely on the hand of his brother.
2. Slightly away from the hand of his brother in the direction of motion of the train.
3. Slightly away from the hand of his brother in the direction opposite to the direction of motion of the train.
4. None of the above

QUESTION

If a force of constant magnitude acts in direction perpendicular to the motion of a particle, then its

1. Speed is uniform
2. Momentum is uniform
3. Velocity is uniform
4. All of these



Force (fundamental)

1. gravitational force
2. Electromagnetic force
3. Strong Nuclear force
4. Weak Nuclear force

Derived force

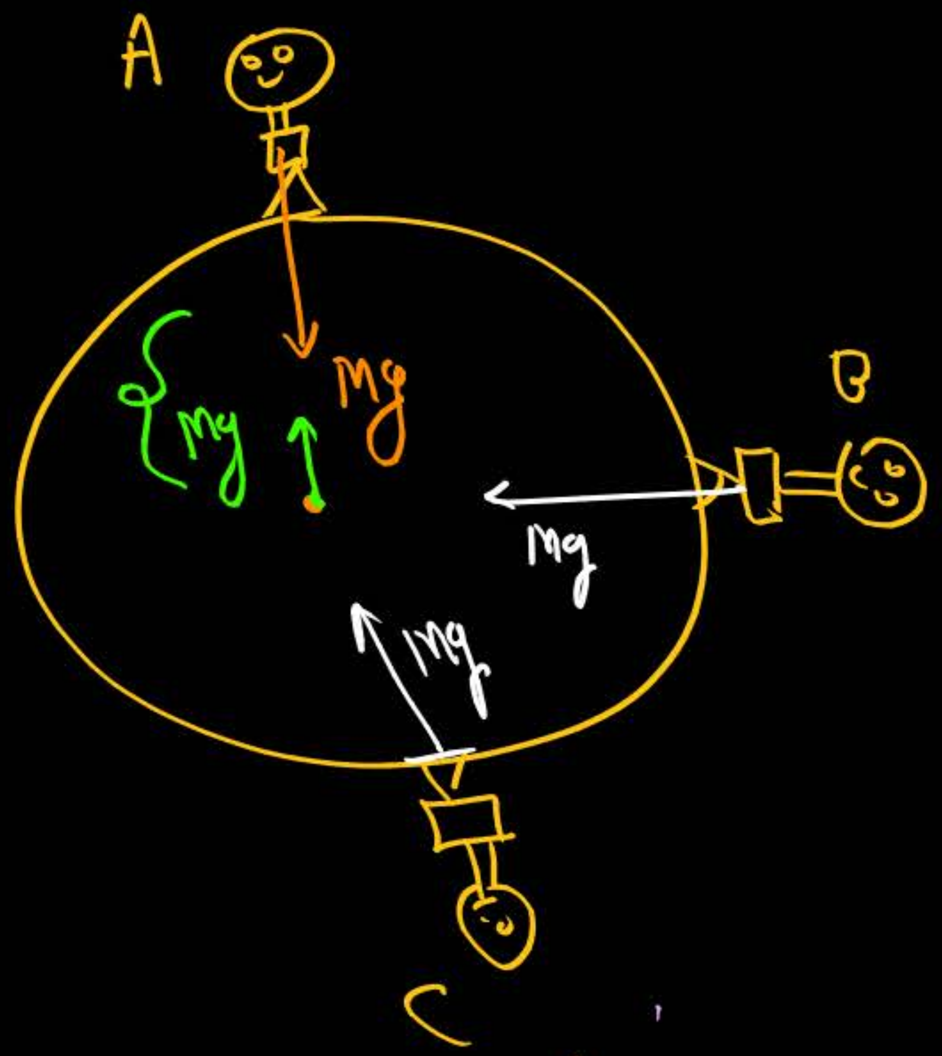
weight = mg (gravitational force)

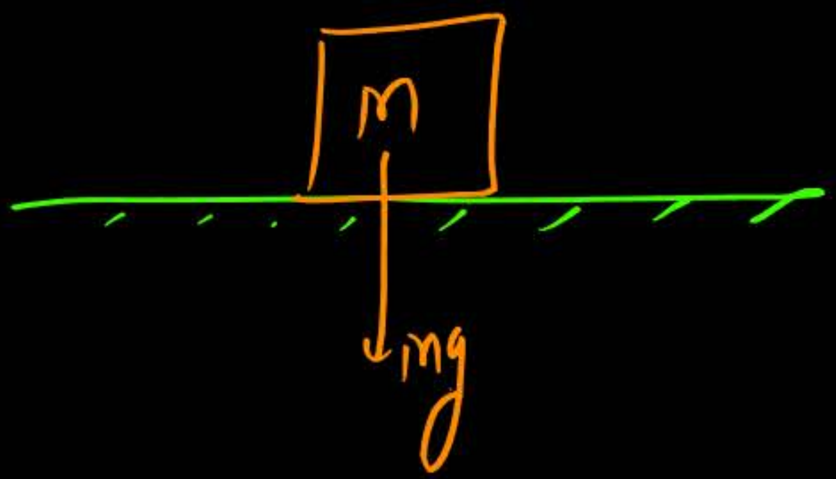
- Normal rexn.
- spring force
- Tension
- friction
- Buyant force
- viscous force

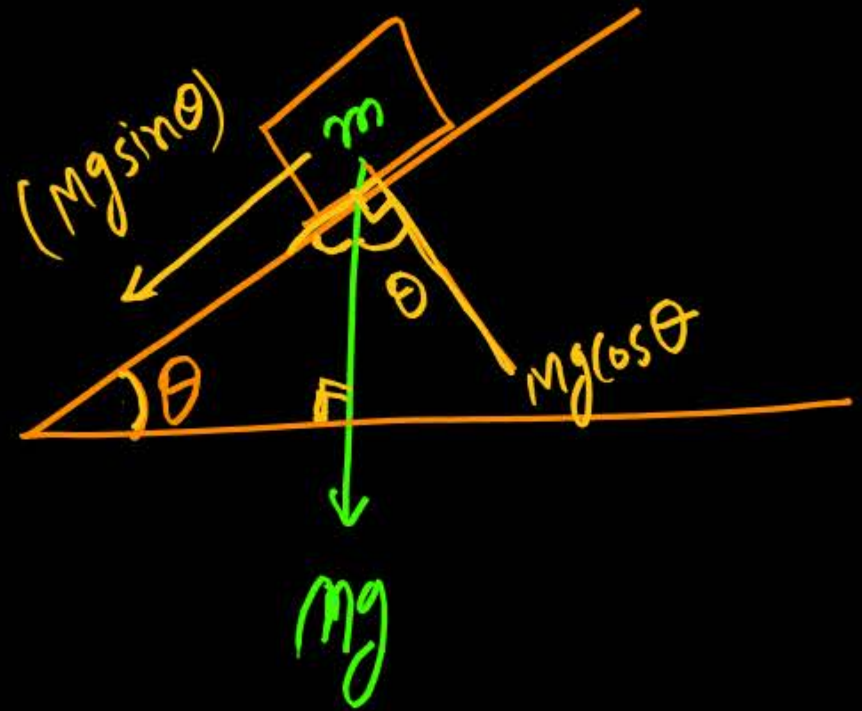
all are derived from Electro-magnetic force.

सबका एक ही बाप electromagnetic

Weight → This is gravitational force
→ unit (N)
→ $W = mg$ (dir^n towards centre of earth)



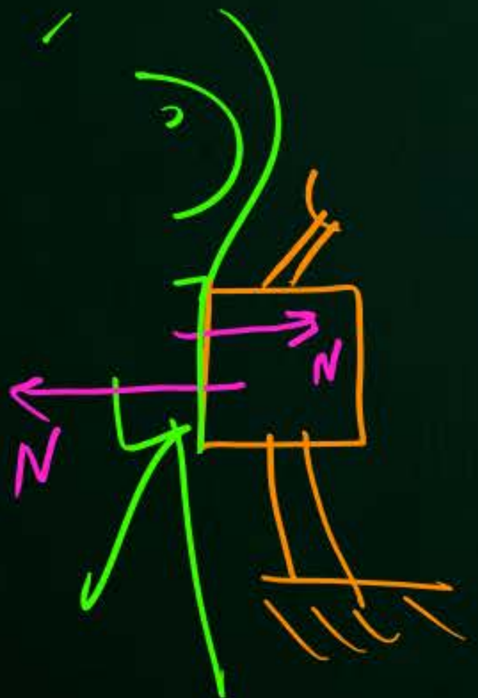




NORMAL REACTION

→ चिपकू force

- Contact force
- Always in pair
- Perpendicular to contact surface




THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 02 | **Physics**

Laws of Motion



By- Dr. Manish Raj (MR SIR)

Topics to be covered

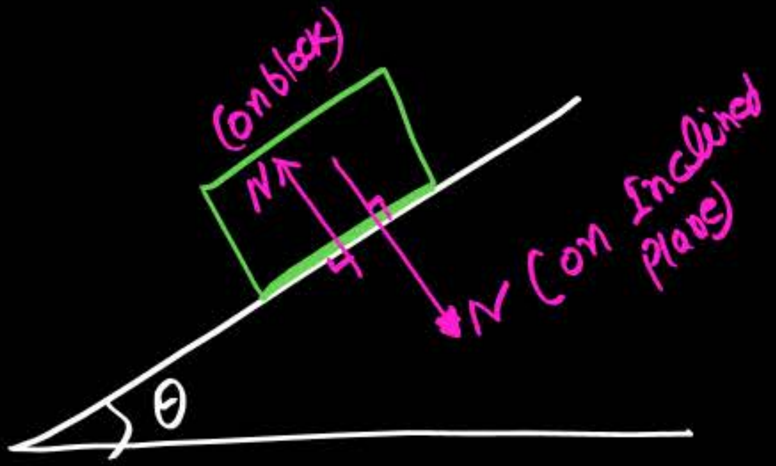
1. # Normal reaction, Tension, spring force
2. # Questions on (newtons 1st Law) (equilibrium)
   - $\vec{v} = 0$
   - $\vec{u} = \text{const}^n$
3. #
4. #

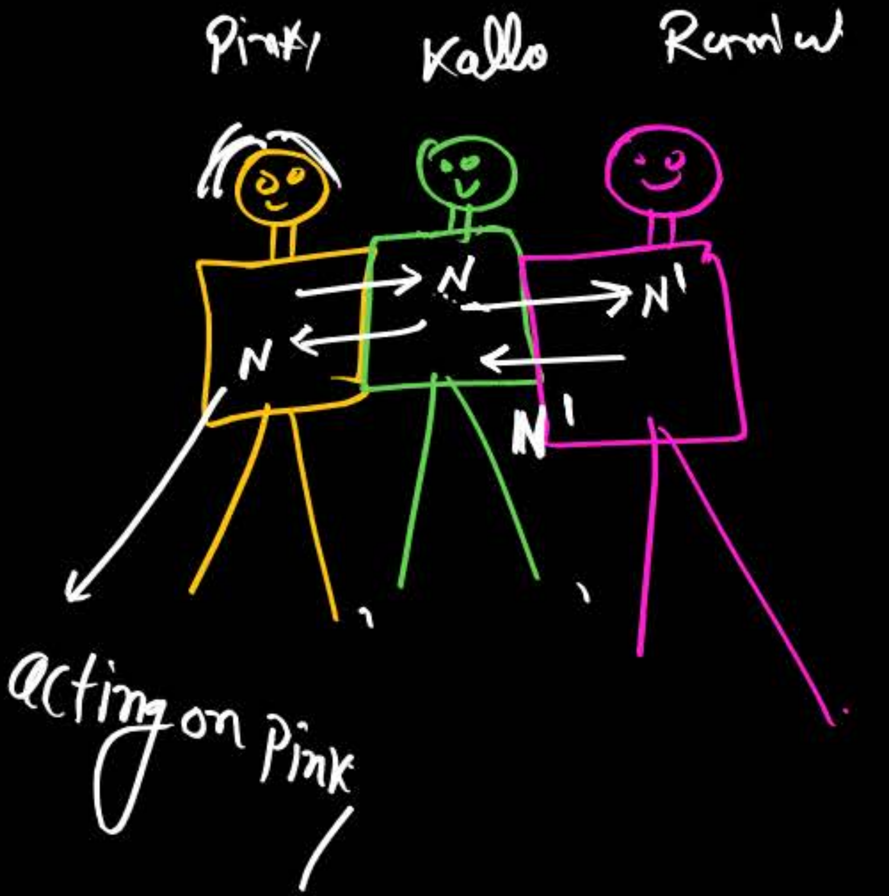


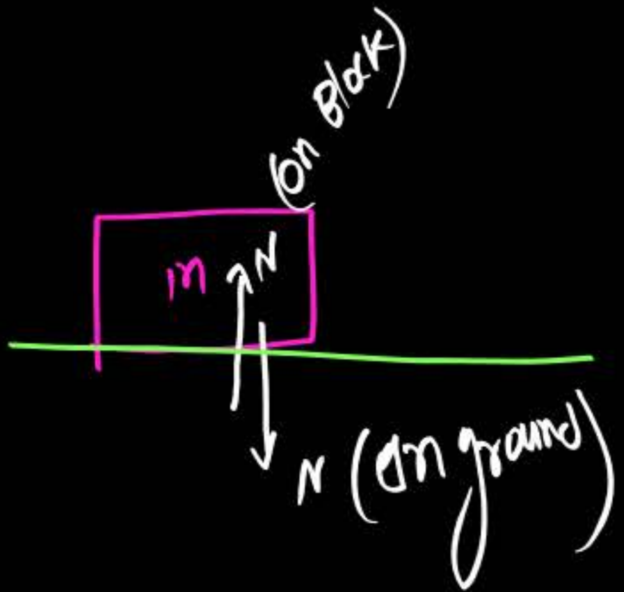
Normal rex^n → Contact force

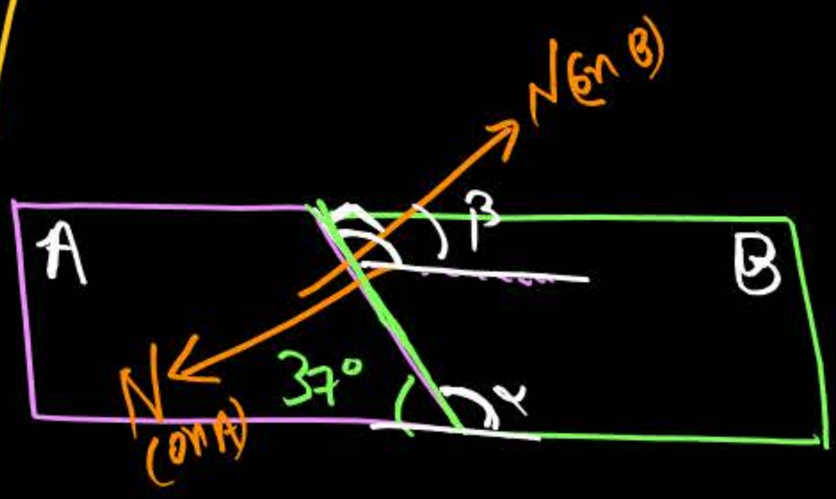
→ Normal rex^n always in Pair

→ acts ⊥r to contact surface







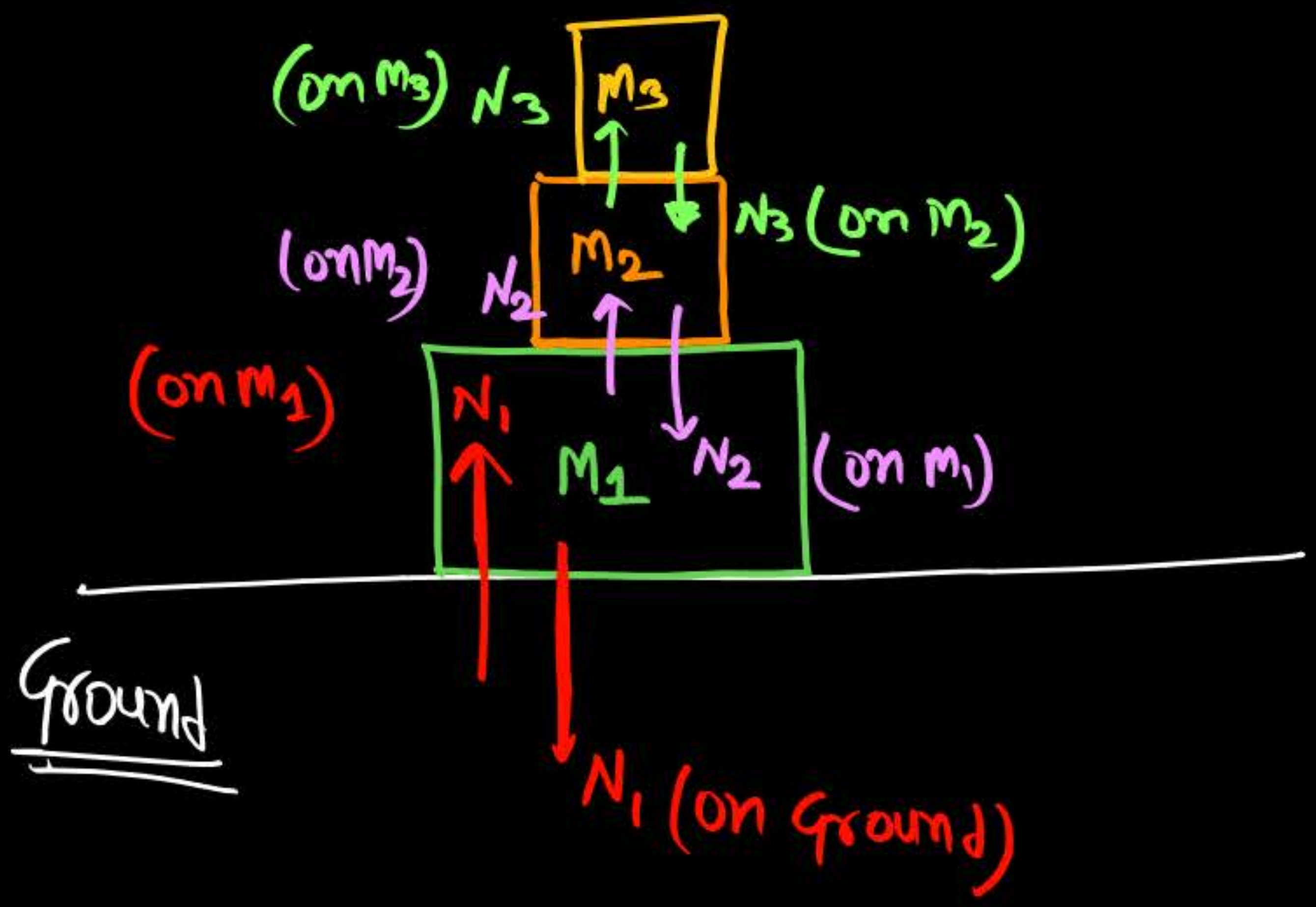


(Q)

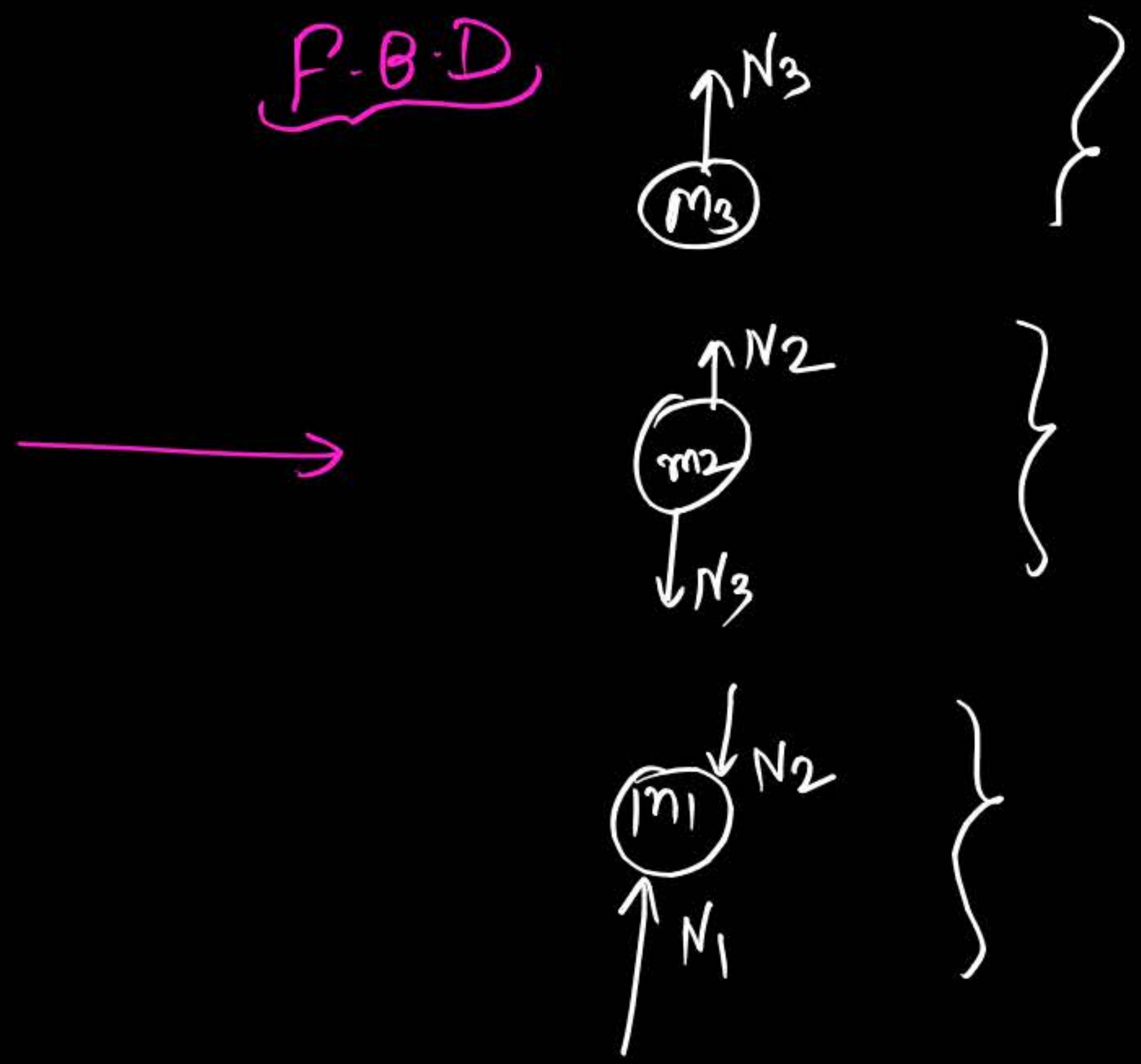
~~(a)~~ N on B makes 37° with $Horiz^n$

~~(b)~~ N on B makes 53° with $Horiz^n$

$\alpha = 143°$ $\beta = 143 - 90 = 53°$



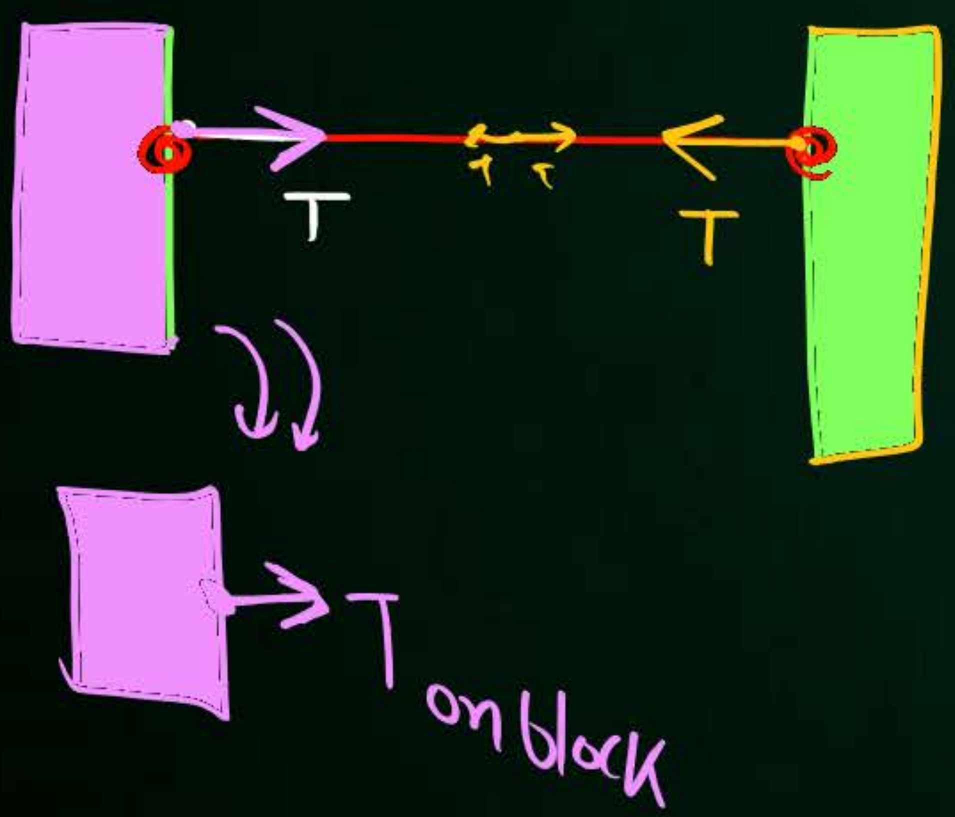
(on m3) N3
m3
N3 (on m2)
(on m2) N2
m2
(on m1) N1
M1
N2 (on m1)
Ground
N1 (on Ground)

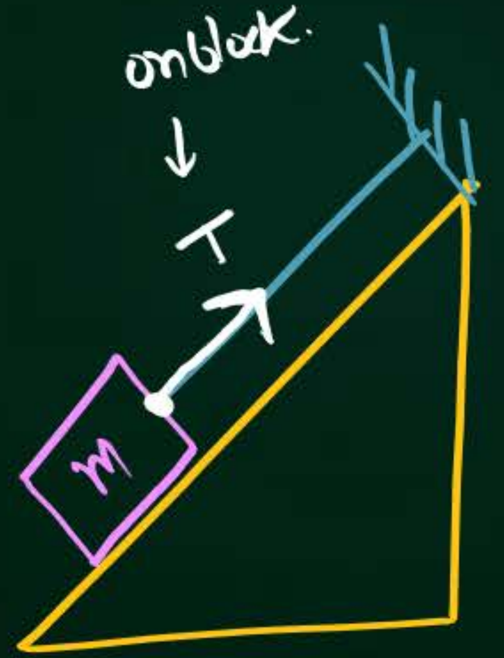


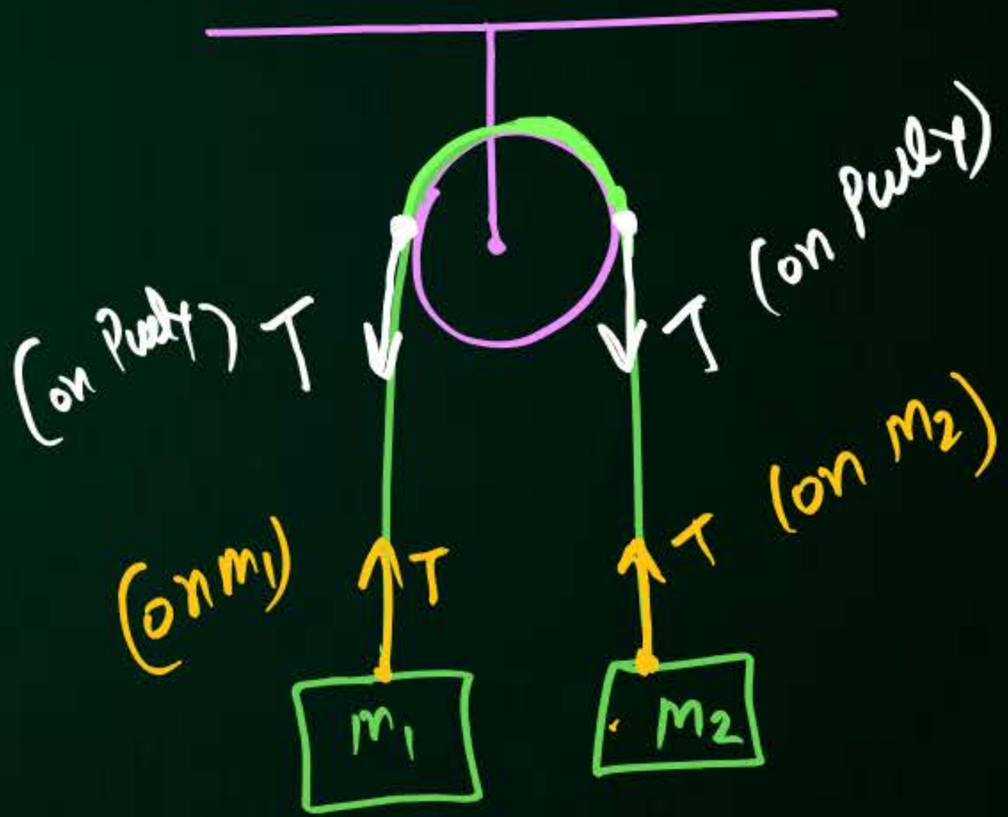
F.B.D
N3
m3
N2
m2
N3
N2
m1
N1

TENSION FORCE

- It away from contact point along the length of string
- In idea string (mass less) same at all point

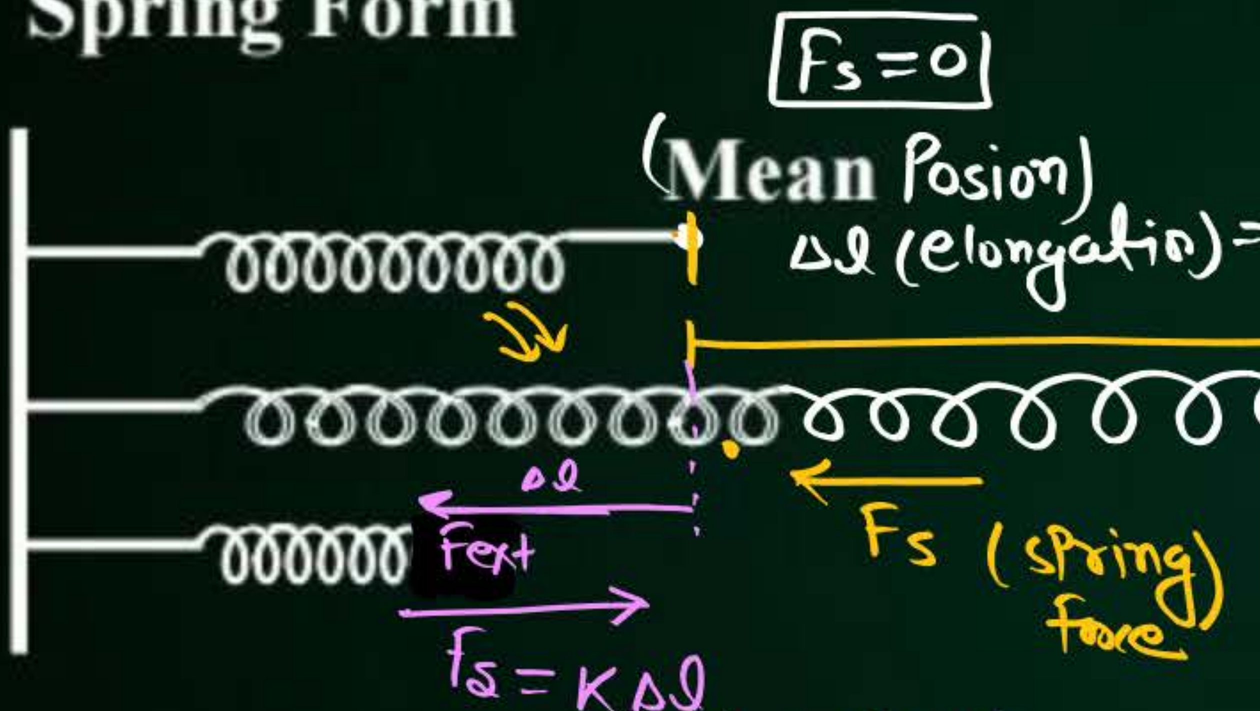






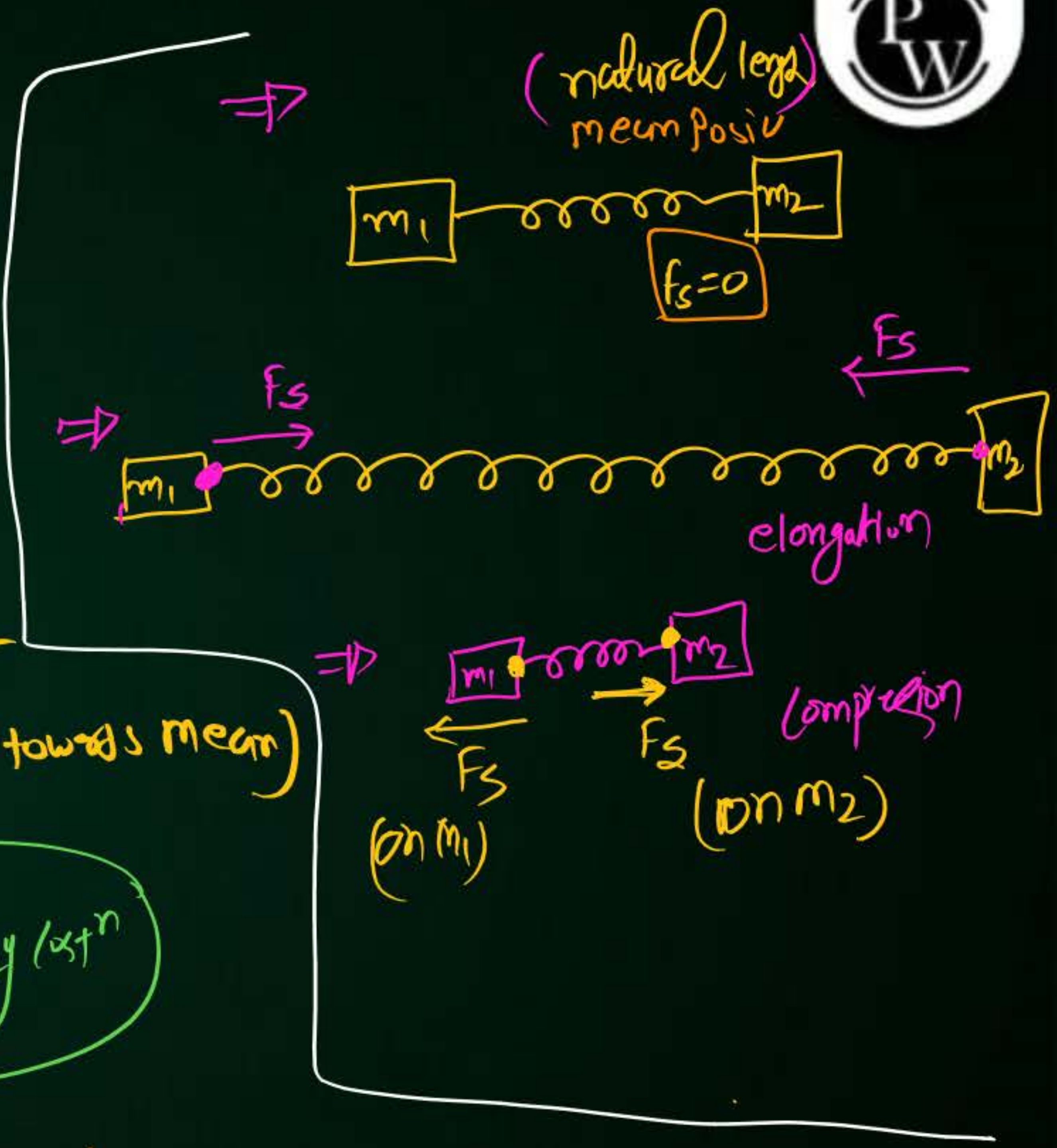
SPRING

Spring Form

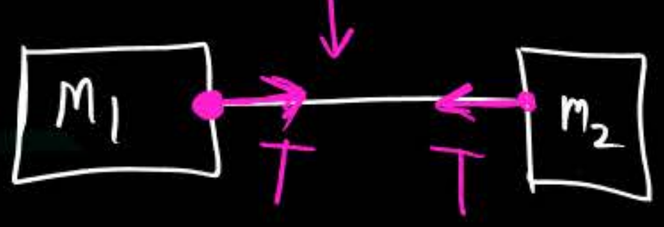


$F_s = K\Delta l$ (always towards mean)

K = Spring const^n



⊛ If string is cut, then Tension will becomes zero instantaneally





⇒ If spring is cut spring force not becomes zero instantaneously.

NEWTON'S 1ST LAW OF MOTION

❖ Law of Inertia/Law of equilibrium = Law of Inertial

$u = 0$	$u = const^n$
$a = 0$	$a = 0$
$F_{net} = 0$	$F_{net} = 0$

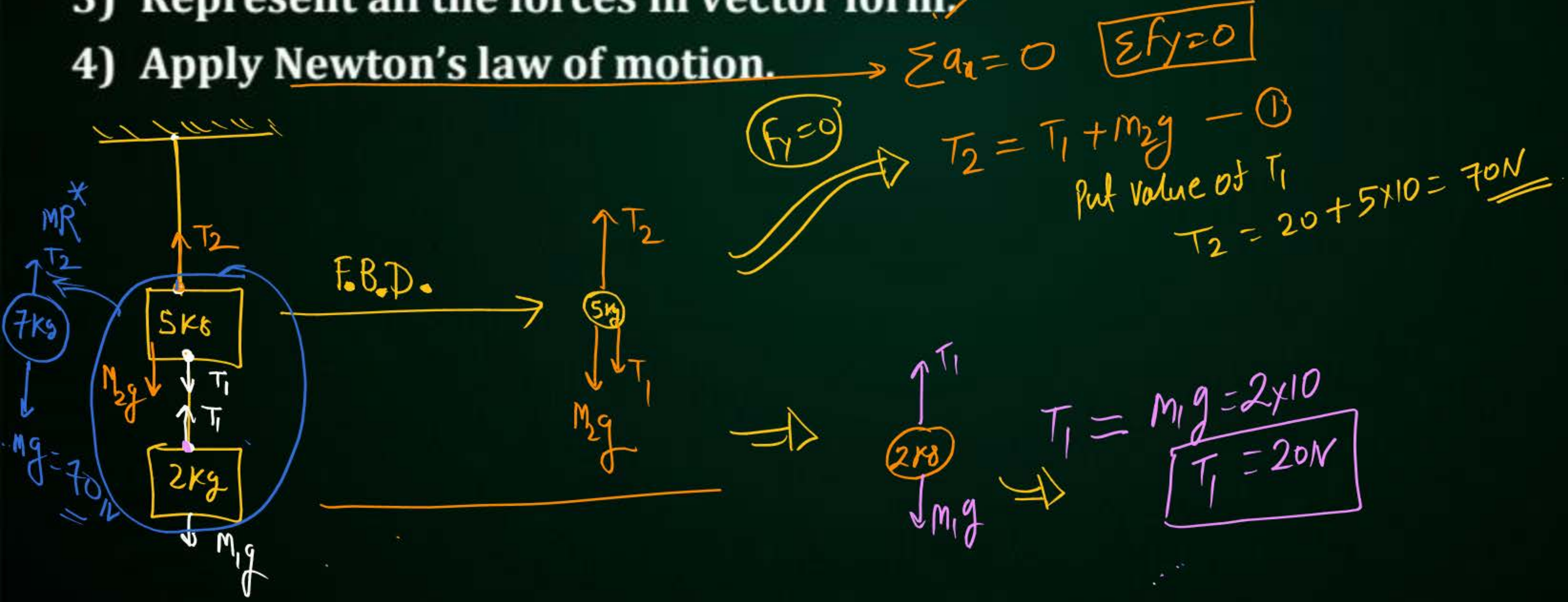
❖ Qualitative definition of Motion

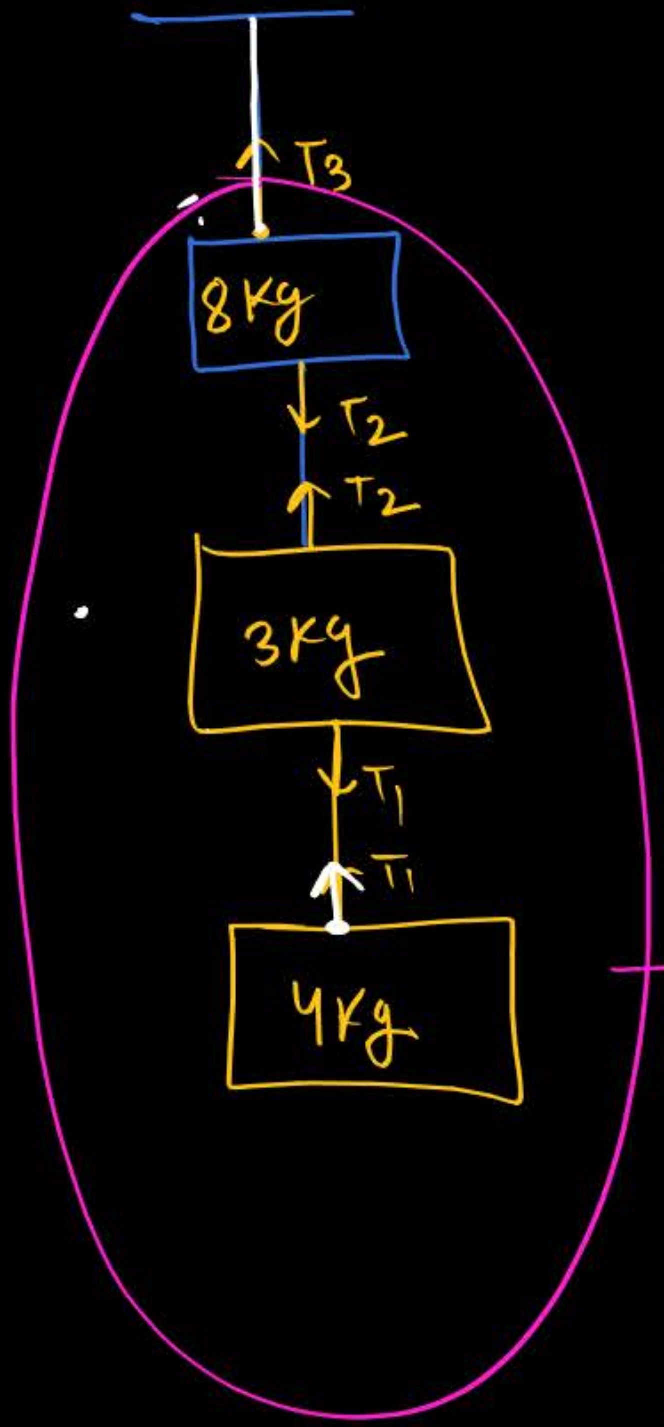
If $\sum F_{net} = 0$ (on body) then $\sum a_{sys} = 0$ → $\vec{u} = const^n$; $\vec{u} = 0$ rest

* "If net force acting on body is zero then it will continuous its state"

F.B.D. (FREE BODY DIAGRAM)

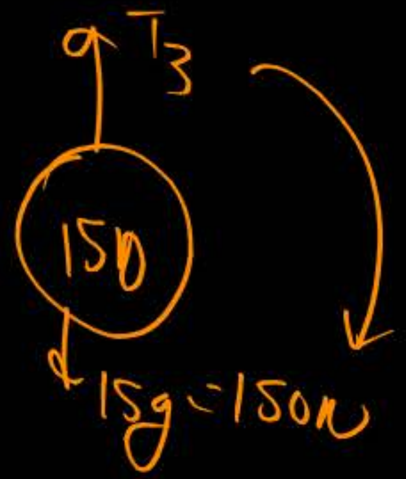
1) Take that body separate from the system; represent it by point.
2) Identify all the forces acting on that body.
3) Represent all the forces in vector form.
4) Apply Newton's law of motion.





$T_2 = 70N$ ✓

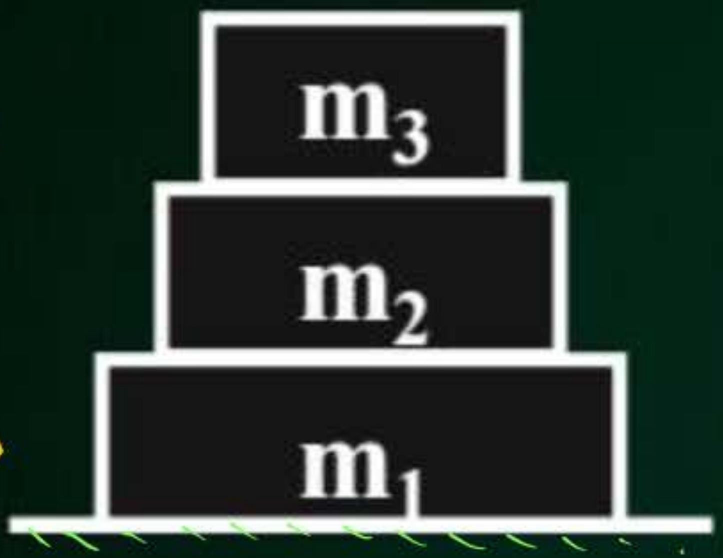
$T_1 = 40N$ ✓

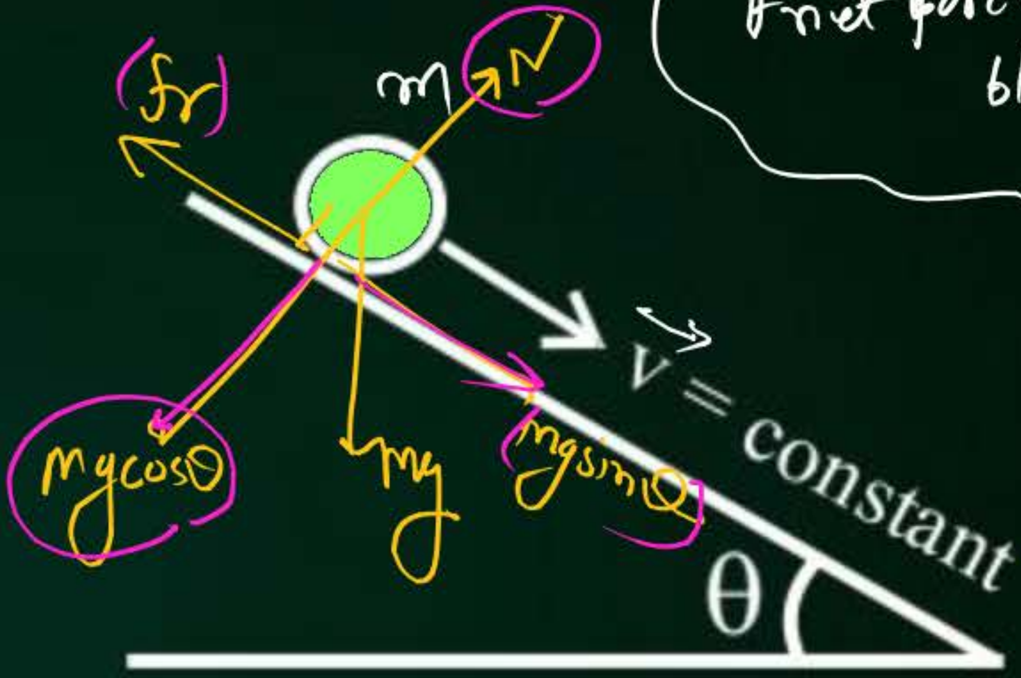


m_1, m_2 & m_3 are at rest
then find Net force on m_2 = ??

m_2 : $F_{net} = 0$

according to newtons 1st law





→ $a = 0$, $F_{net} = 0$

Fnet force on the block = 0 Ans

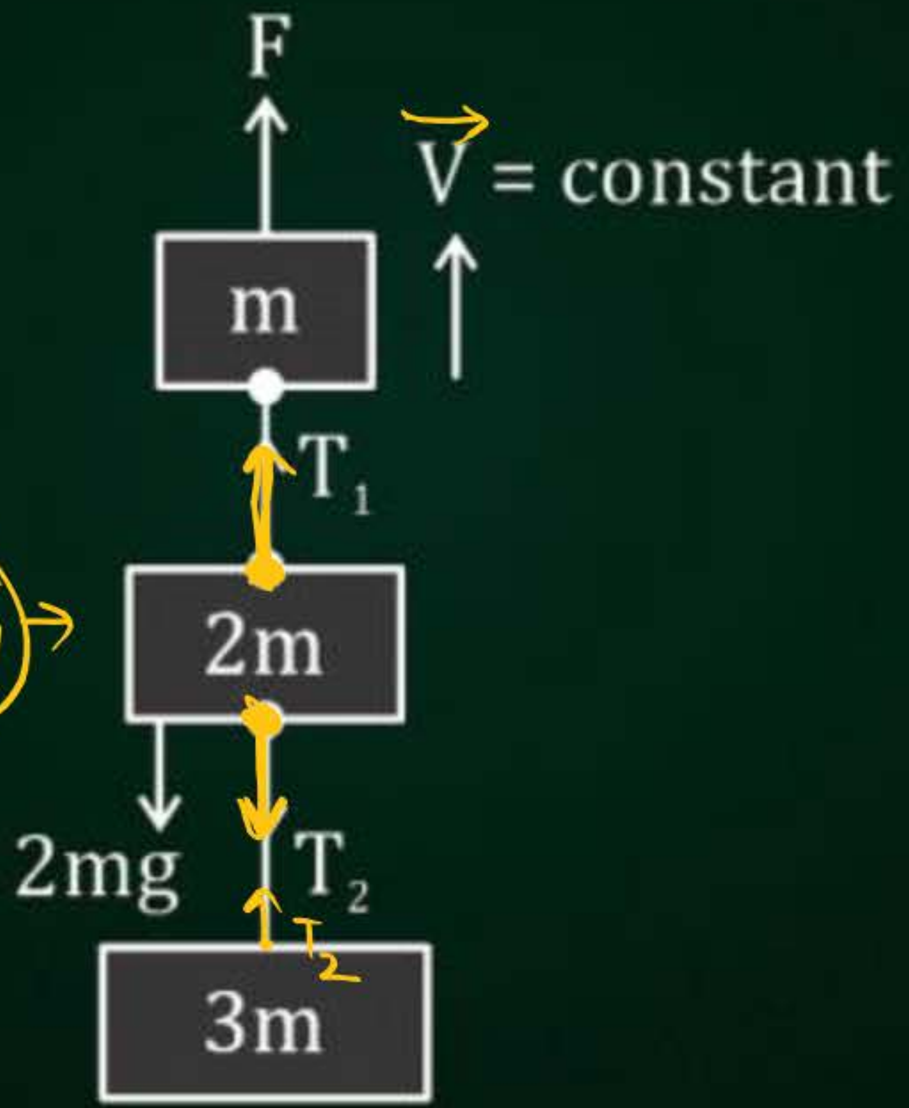
QUESTION

Find net force on 2m. ?? [NEET-2013]

Ans: F_{net} on $m_2 = 0$ Ans

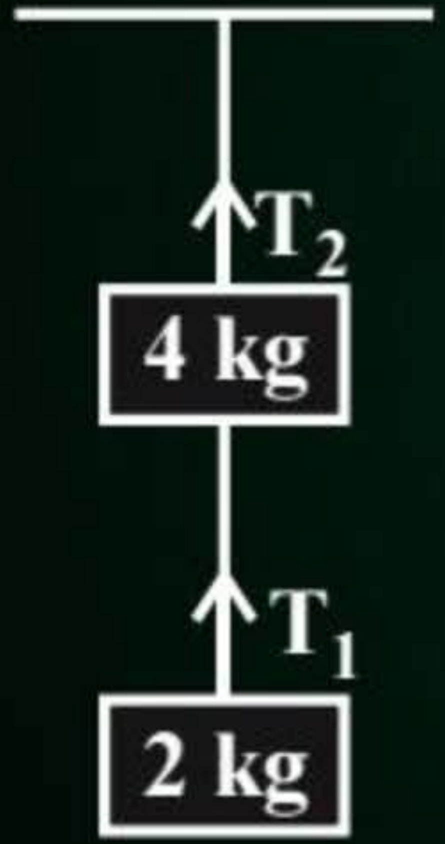
$T_1 = T_2 + 2mg$

Const^n velocity → $a = 0$, $F_y = 0$



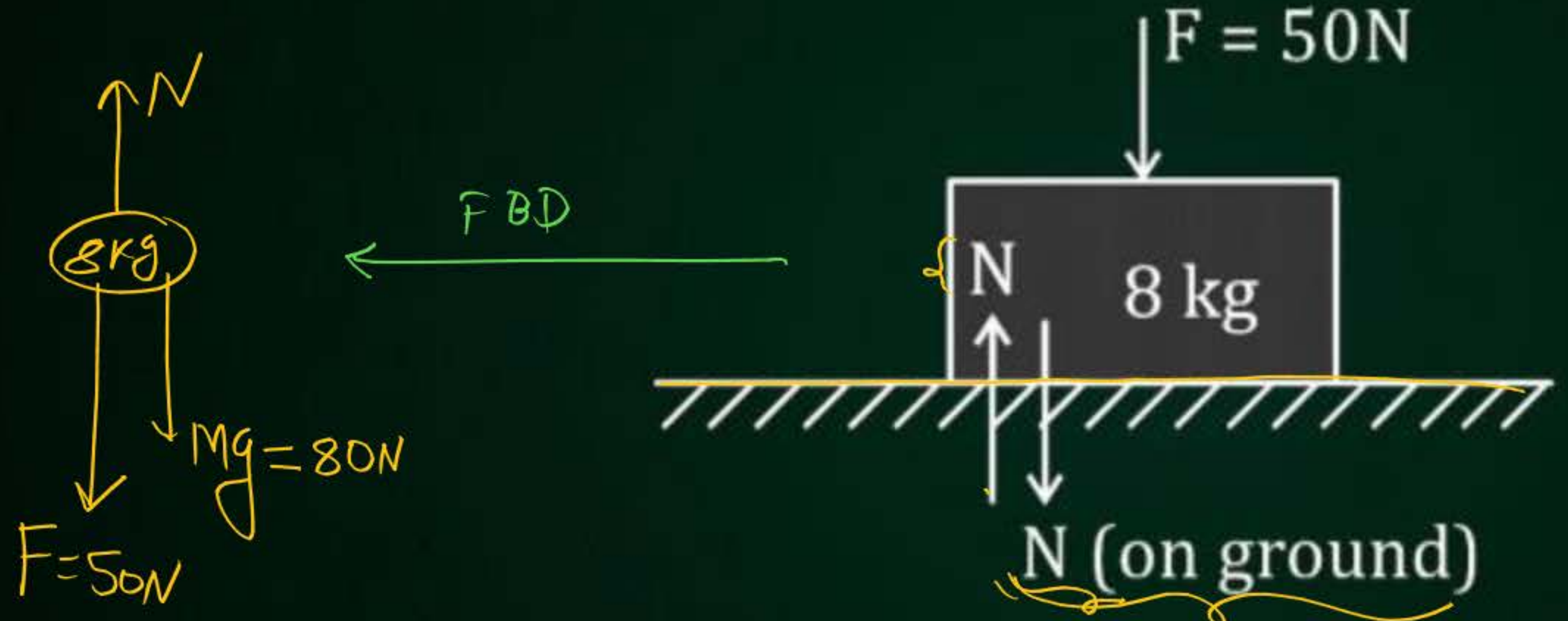
FORCE (F.B.D.)

Find T_1 and T_2.



QUESTION

Find contact force (normal) between 8 kg block and ground.

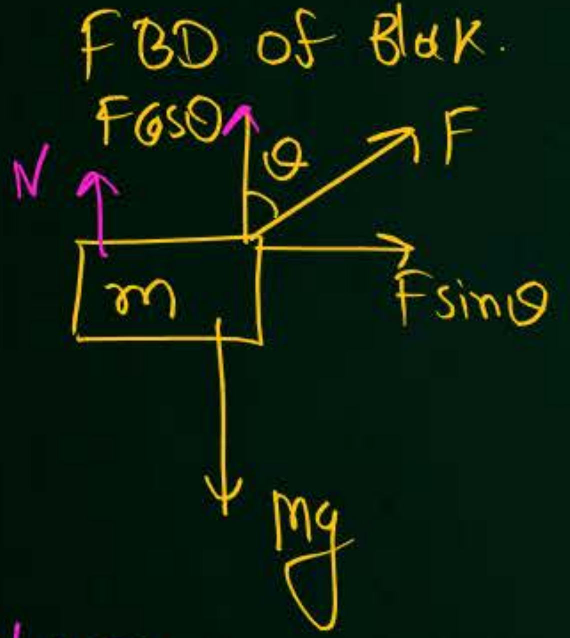


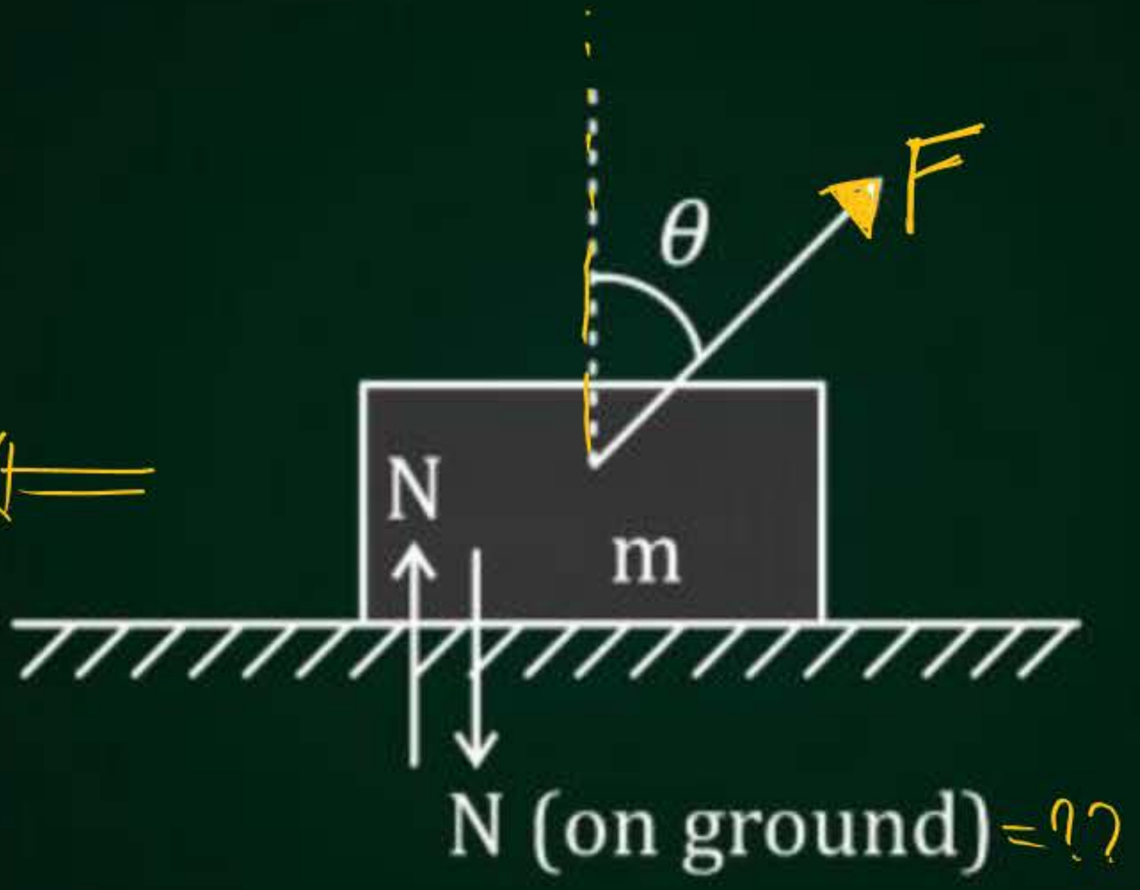
$N = F + mg$

$= 50 + 80 = 130N$

QUESTION

Find contact force on ground by block.





$\boxed{F_y = 0} \Rightarrow N + F\cos\theta = mg$

$N = (mg - F\cos\theta)$

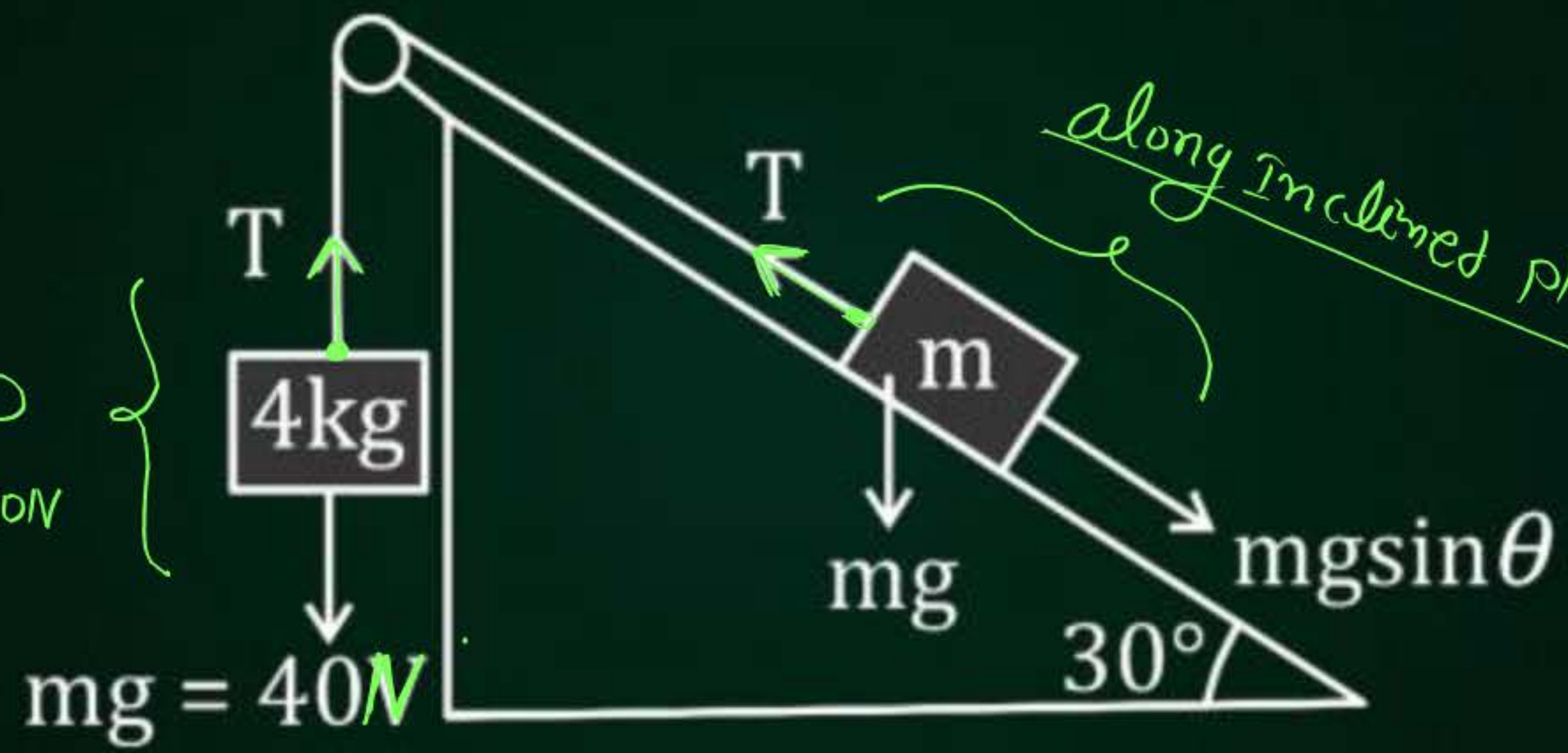
{Value of Normal rexn is same on ground & Block}

QUESTION

If system is in equilibrium then find value of m.

$F_y = 0$

$T = Mg = 40N$



along inclined plane $F_{net} = 0$

$T = mg\sin\theta$

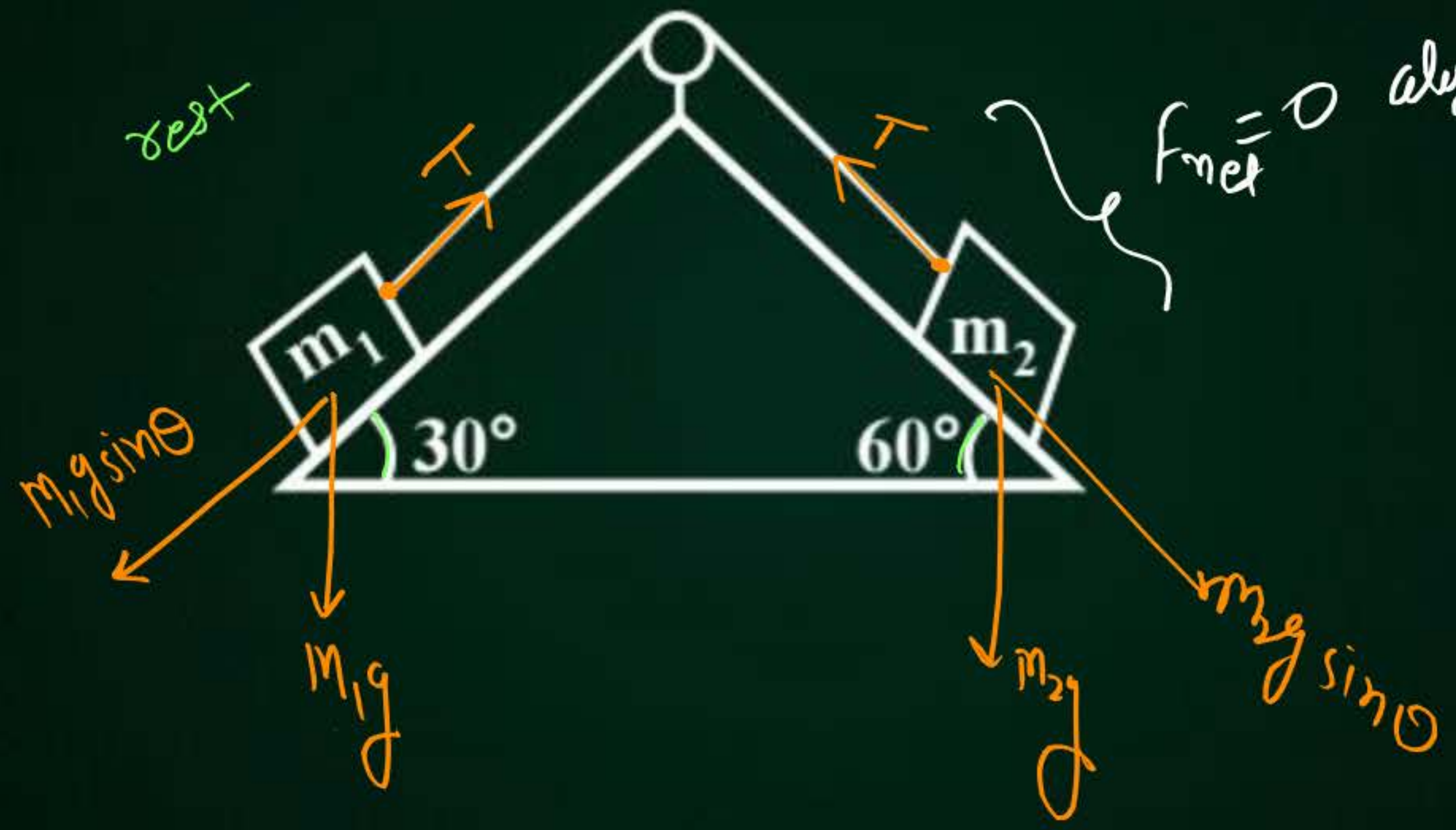
$40 = m \times 10 \sin 30^\circ$

$4 = \frac{m}{2}$

$m = 8\,kg$

QUESTION

Find relation between m_1 and m_2 so that system is in equilibrium.



$F_{net} = 0$ along incline

$T = m_2 g \sin 60° = m_1 g \sin 30°$

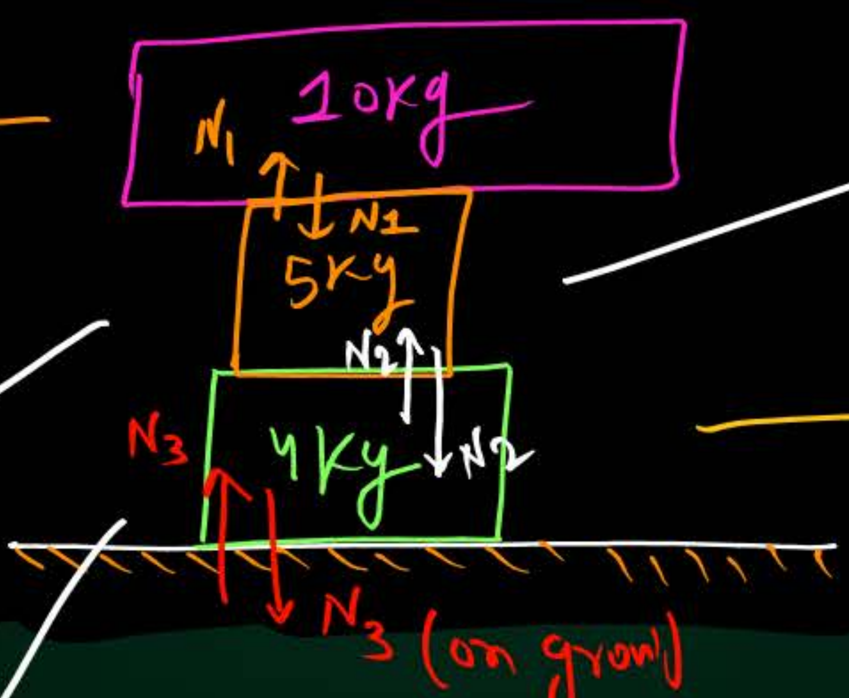
$m_2 \frac{\sqrt{3}}{2} = m_1 \frac{1}{2}$

$\frac{m_1}{m_2} = \frac{\sqrt{3}}{1}$

Ans.

QUESTION

Find force applied by 5kg on 10kg



F.B.D (10kg): $N_1 = 100N$, $mg = 100N$

(5kg + 10kg) together — MR*: 15kg, N_2, $mg = 150N$ Ans

MR*: 19kg, N_3, $mg = 190N$

Find force on 4kg due to 5kg

FBD of 5kg: N_2, $mg = 50N$, $N_1 = 100N$ ⇒ $N_2 = 150N$ Ans

FBD of 4kg: N_3, N_2, $mg = 40N$ → "$N_3 = N_2 + 40N$" —(ii)

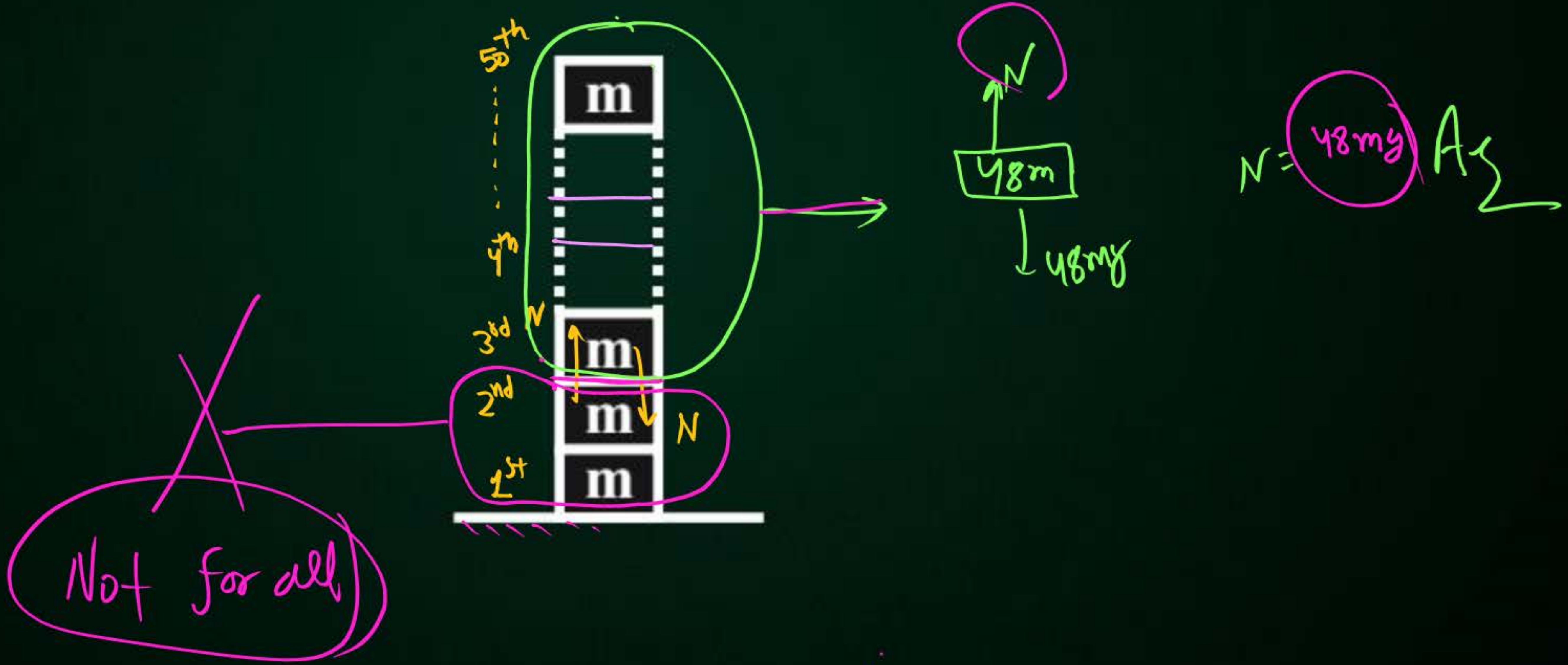
put N_2: $N_3 = 150 + 40$, $N_3 = 190N$

on ground by 4kg

(on 4kg due to ground)

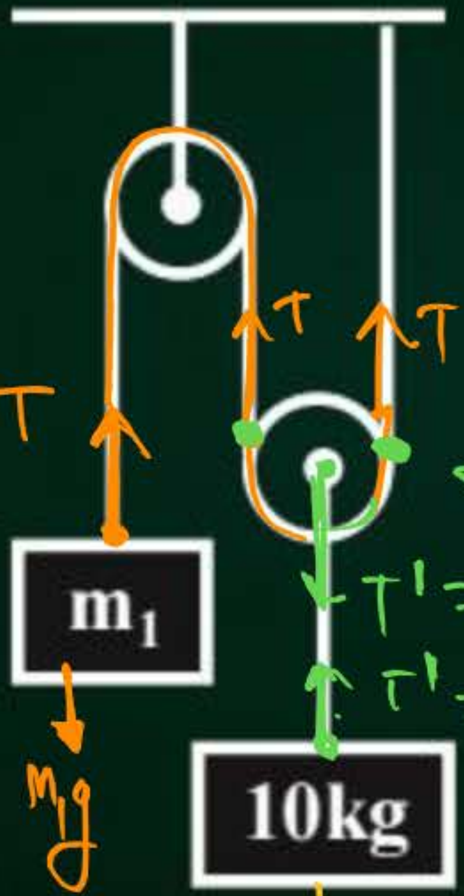
QUESTION

There are 50-identical block placed on over other shown in figure. Find contact force between 2^{nd} and 3^{rd} block.



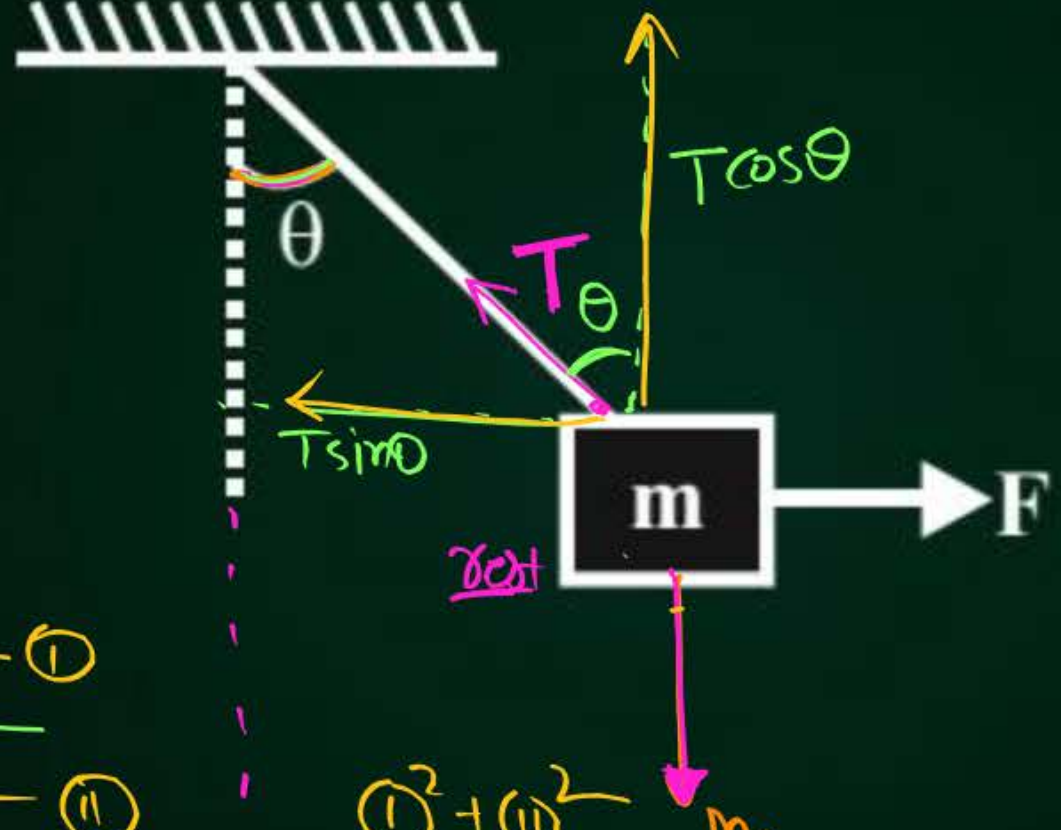
QUESTION

Find m_1 so that system is in equilibrium.



QUESTION

Find 'θ' angle made by string from vertical; find tension T in string



$\Sigma F_x = 0$ (rest)

$F = T\sin\theta$ — (i)

$mg = T\cos\theta$ — (ii)

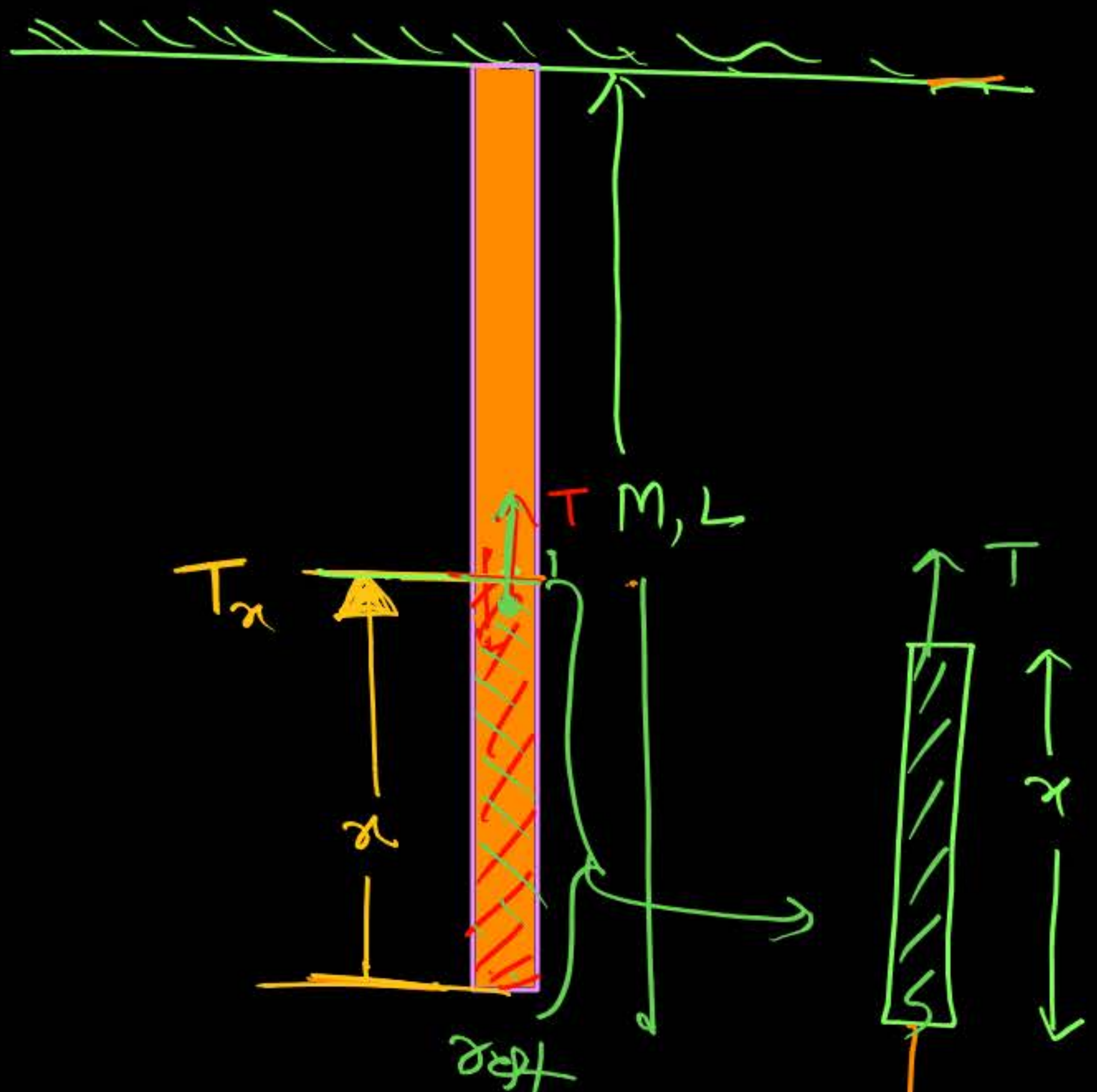
$\tan\theta = \frac{F}{mg}$ — (1)

$\theta = \tan^{-1}\left(\frac{F}{mg}\right)$

(i)^2 + (ii)^2

$T^2(\sin^2\theta + \cos^2\theta) = (mg)^2 + F^2$

$T = \sqrt{(mg)^2 + F^2}$ Ans.



$m'g = \frac{Mx}{L} g$

mass L length is M

" of unit length $= \frac{M}{L}$

" " x leng $= \frac{M}{L} x$

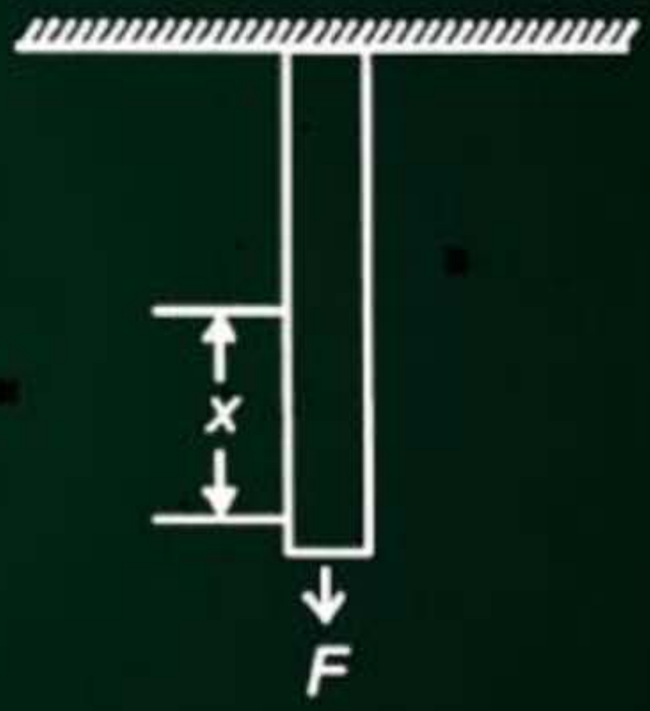
$$T = \frac{Mxg}{L}$$

Ans

imp*

QUESTION

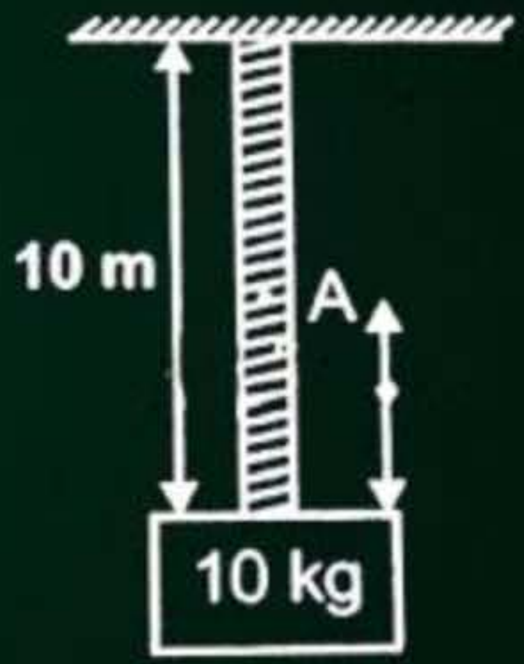
A vertical force F is applied at one end of a uniform rope of mass M and length L. Find out tension in the rope as a function of x.



1. $F + Mg$
2. $F + \frac{MgL}{x}$
3. $\frac{FL + Mgx}{L}$
4. $\frac{Fx + MgL}{L}$

QUESTION

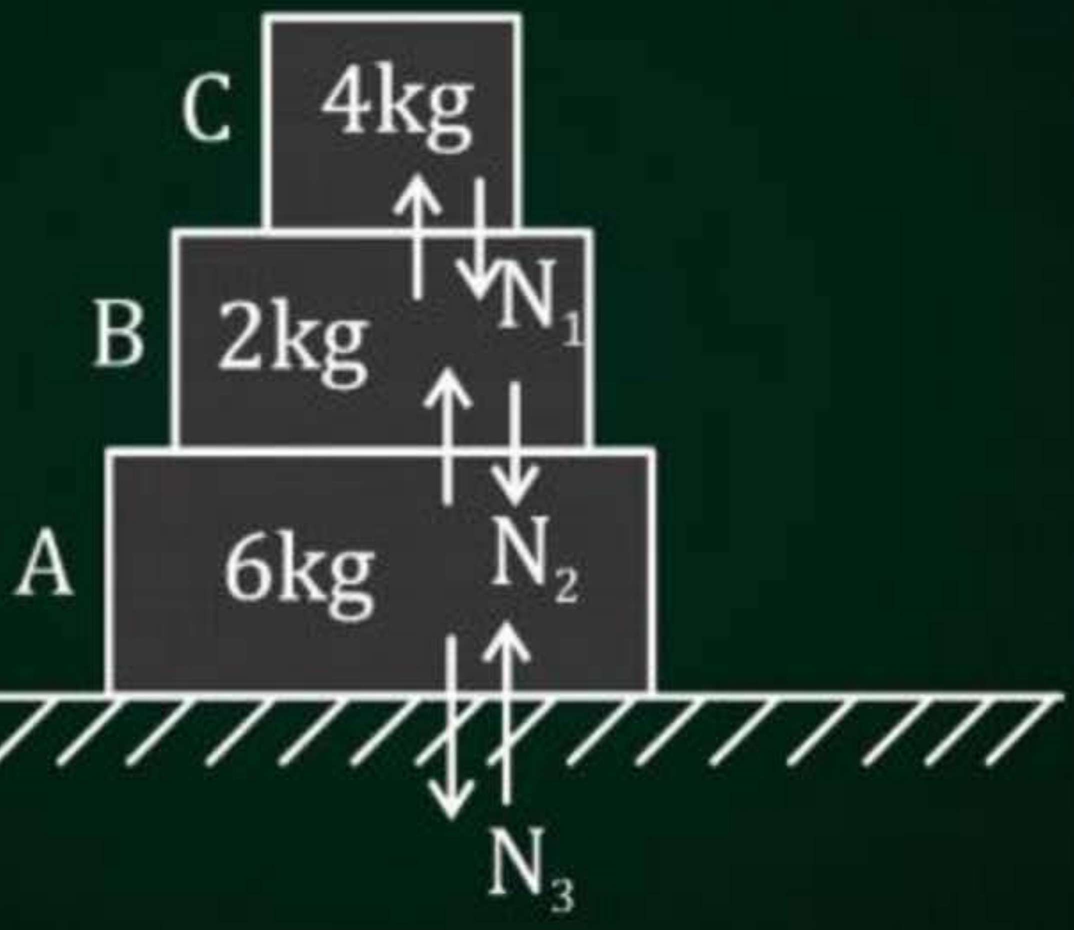
The adjoining figure shows a block of mass 10 kg connected to free end of a rope of mass 10 kg and length 10 m. The tension of the rope at point A is ($g = 10\ m/s^2$)



1. 170 N
2. 30 N
3. 130 N
4. 70 N

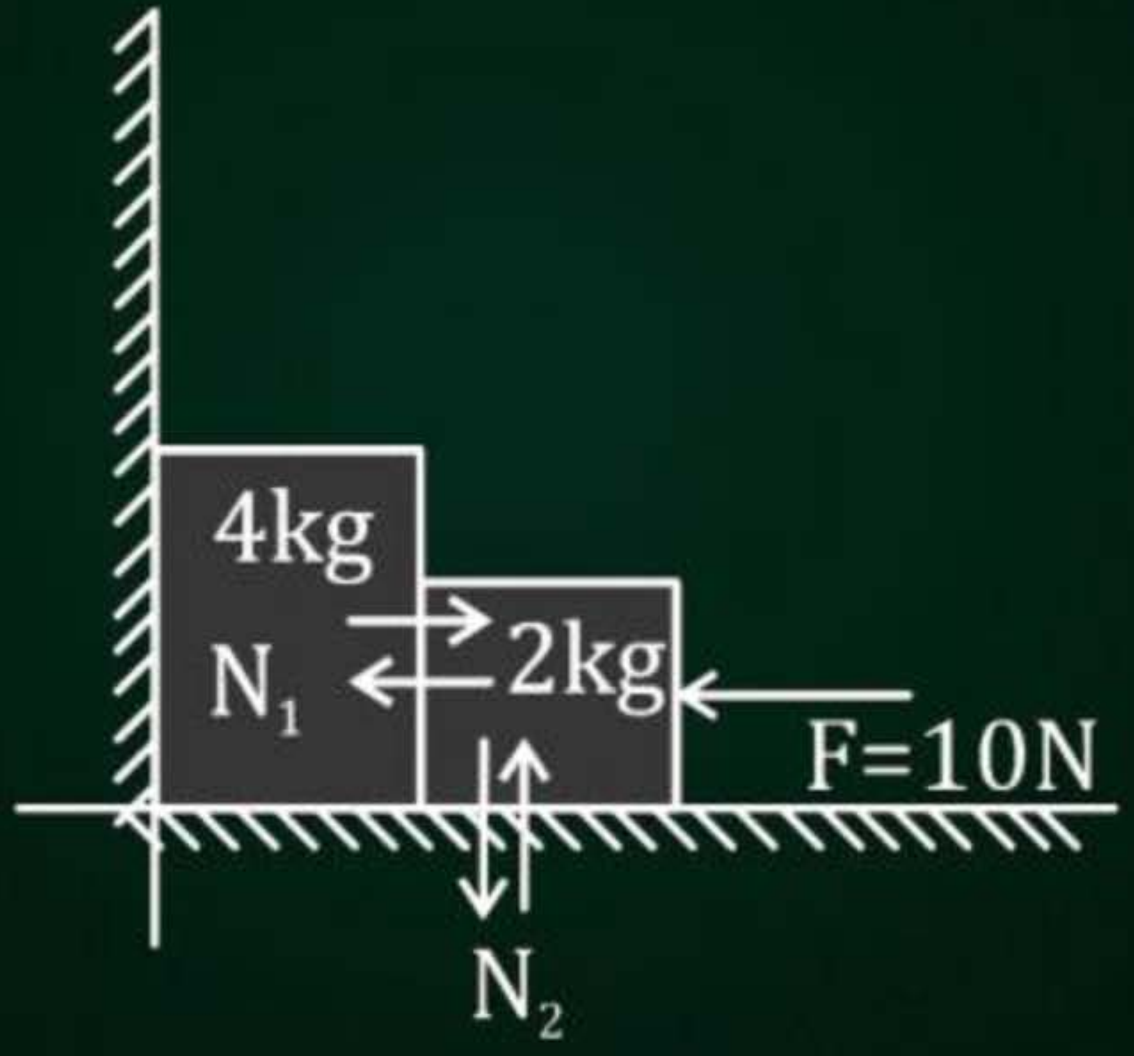
QUESTION

Find normal reaction (contact force) between A and B.



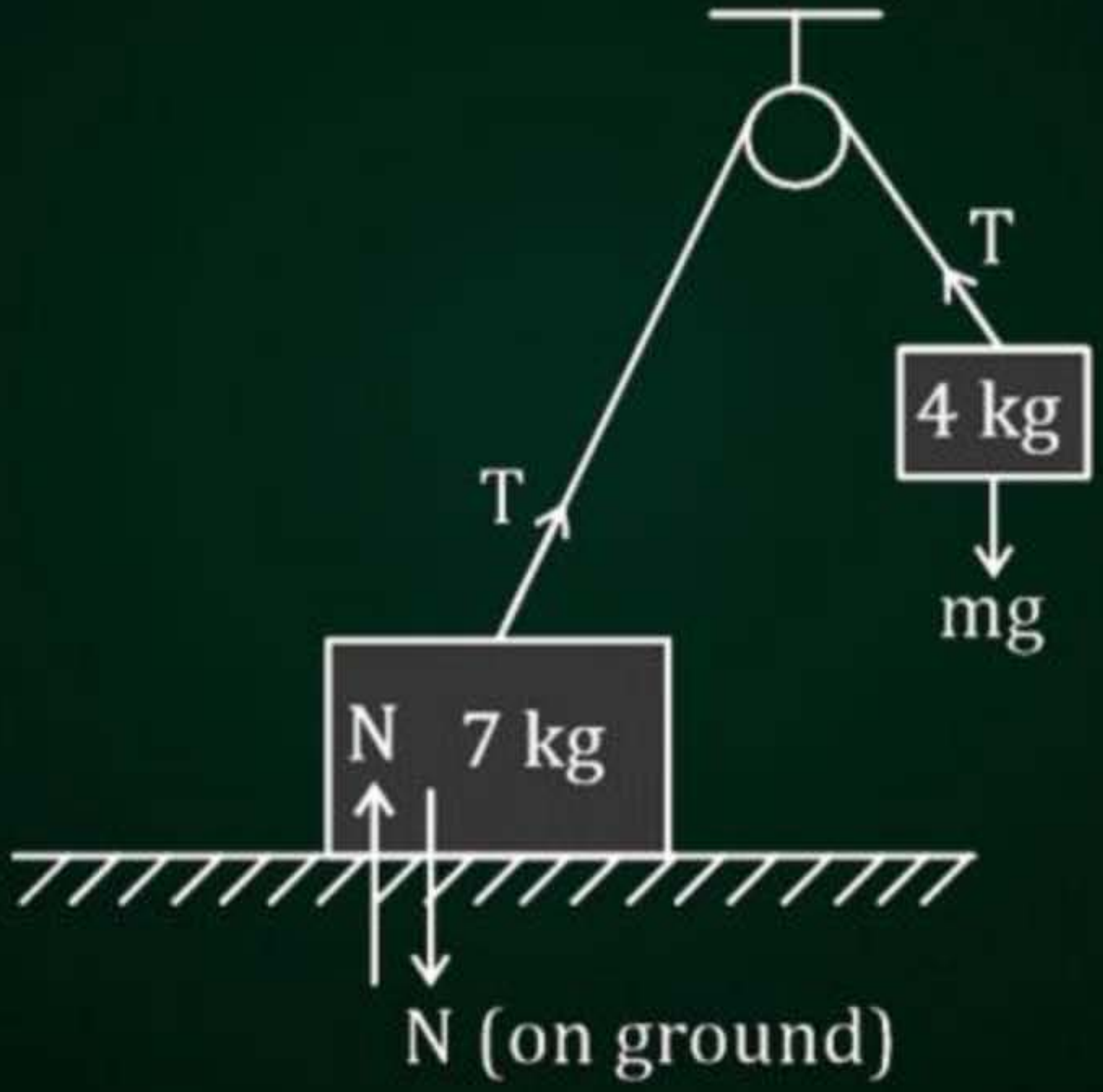
QUESTION

Find contact force between 4 kg block and 2 kg block.



QUESTION

Find contact force between ground and 7 kg block.



QUESTION

A mass of 10 kg is suspended vertically by a rope from the roof. When a horizontal force is applied on the mass, the rope deviated at an angle of 45° at the roof point. If the suspended mass is at equilibrium, the magnitude of the force applied is (Take, $g = 10\ ms^{-2}$) (2019 Main, 9 Jan II)

1. 70 N
2. 200 N
3. 100 N
4. 140 N

QUESTION

A uniform rope of mass M and length L is fixed at its upper end vertically from a rigid support. Then the tension in the rope at the distance l from the rigid support is

(1) $Mg\frac{L}{L+l}$

(2) $\frac{Mg}{L}(L-l)$

(3) Mg

(4) $\frac{L}{L}Mg$

QUESTION

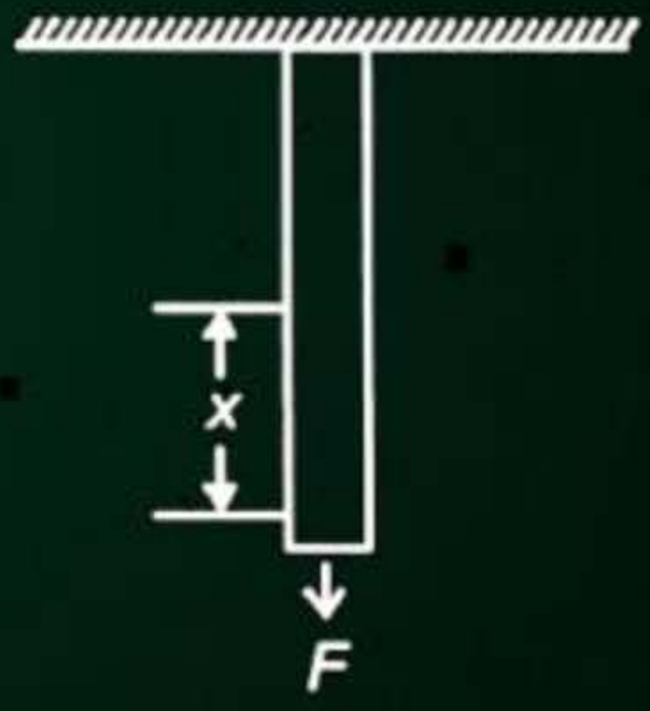
A vertical force F is applied at one end of a uniform rope of mass M and length L. Find out tension in the rope as a function of x.

1. $F + Mg$

2. $F + \frac{MgL}{x}$

3. $\frac{FL + Mgx}{L}$

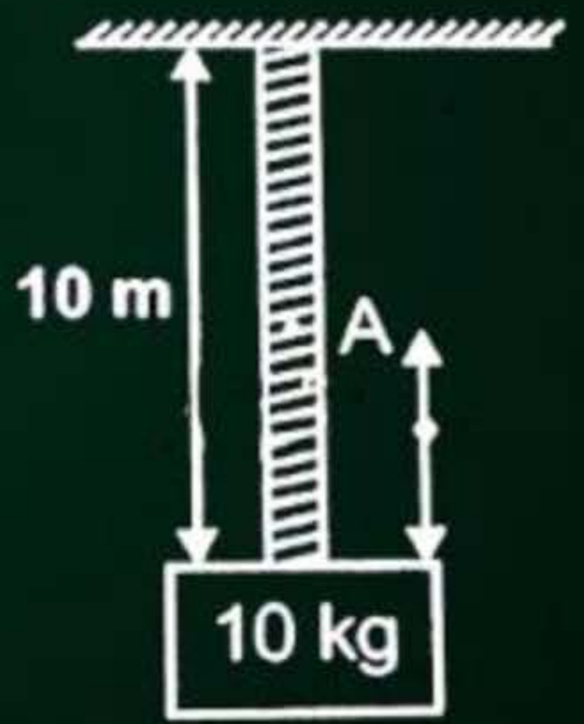
4. $\frac{Fx + MgL}{L}$



QUESTION

The adjoining figure shows a block of mass 10 kg connected to free end of a rope of mass 10 kg and length 10 m. The tension of the rope at point A is $(g = 10\ \mathrm{m/s^2})$

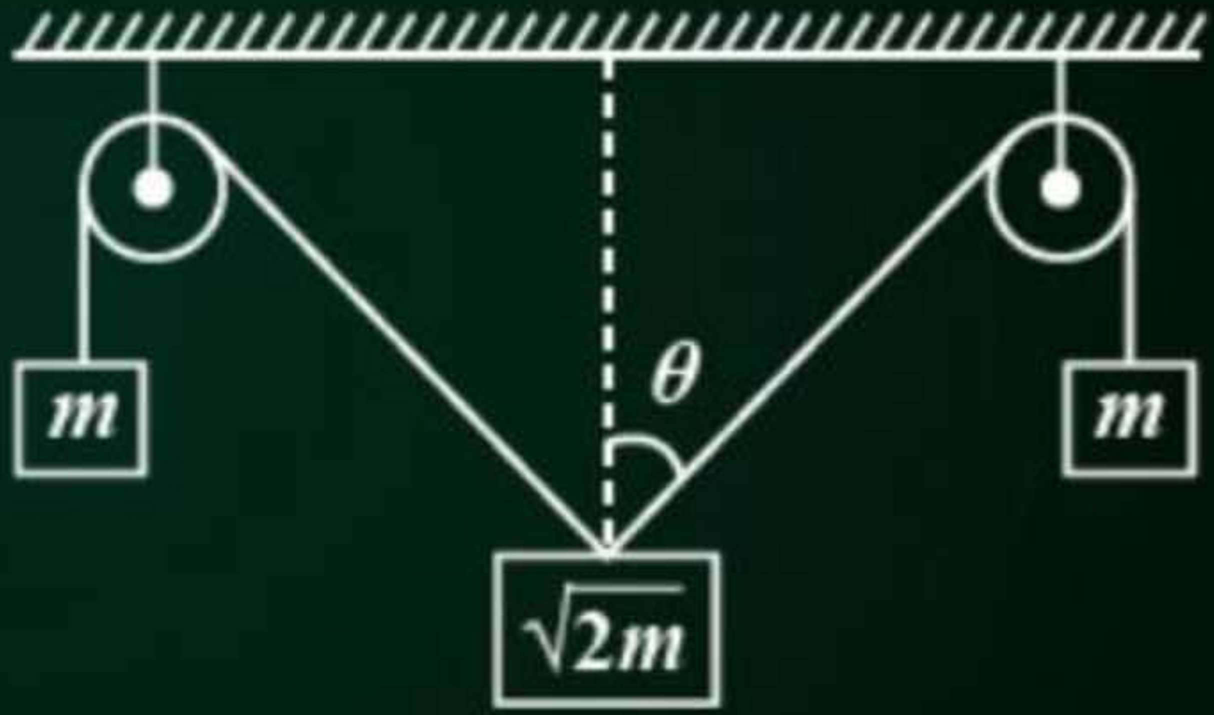
1. 170 N
2. 30 N
3. 130 N
4. 70 N



QUESTION

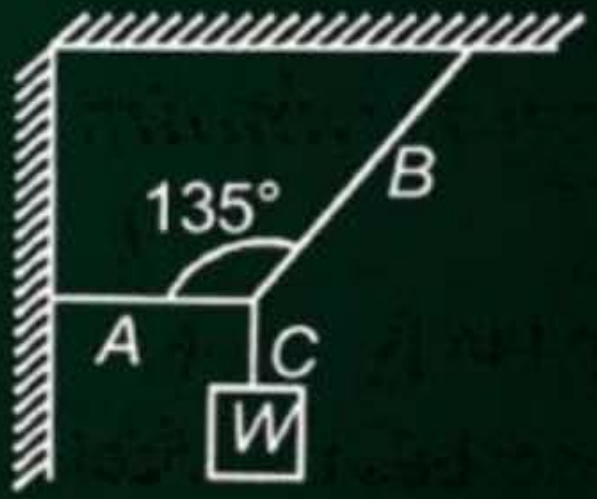
The pulleys and strings shown in the figure are smooth and of negligible mass. For the system to remain in equilibrium, the angle θ should be (2001, 2M)

1. 0°
2. 30°
3. 45°
4. 60°



QUESTION

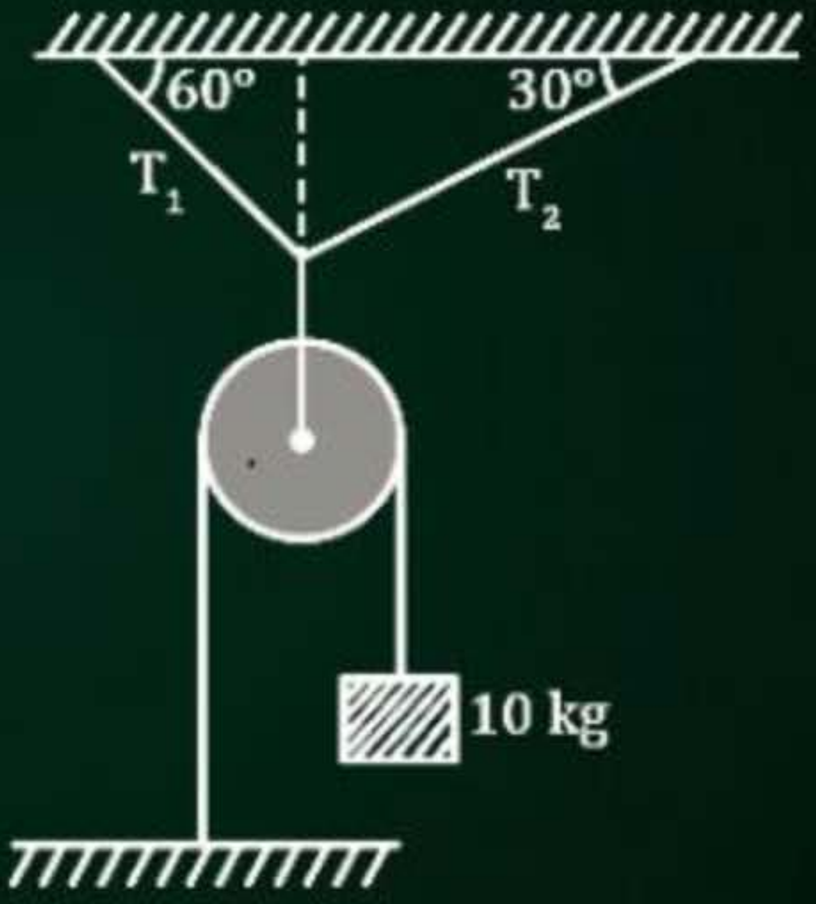
A block of weight W is supported by three strings as shown in figure. Which of the following relations is true for tension in the strings? (Here T_1, T_2 and T_3 are the tension in the strings A, B and C respectively)



1. $T_1 = T_2$
2. $T_1 = T_3$
3. $T_2 = T_3$
4. $T_1 = T_2 = T_3$

QUESTION

In the arrangement as shown, tension T_2 is ($g = 10\ \text{m/s}^2$)



1. 50 N
2. 100 N
3. $50\sqrt{3}$ N
4. $100\sqrt{3}$ N

QUESTION

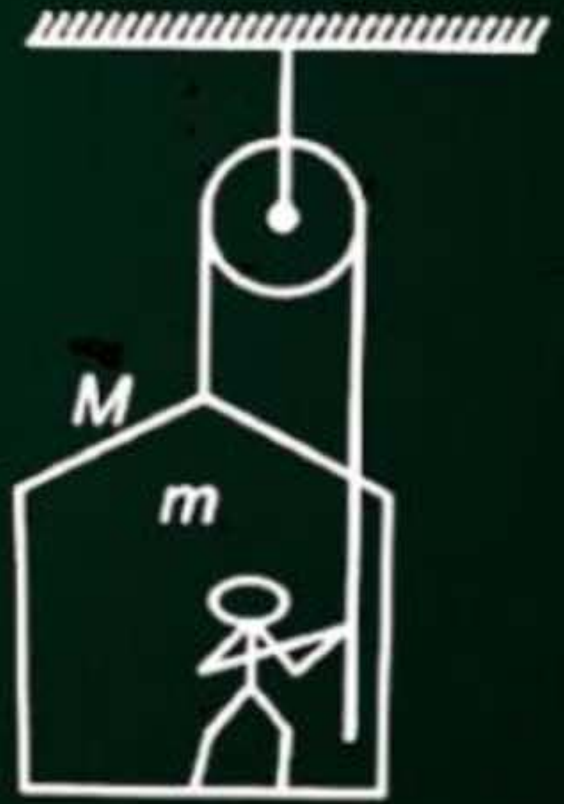
A man of mass m stands on a frame of mass M. He pulls a light rope, which passes over a pulley. The other end of the rope is attached to the frame. For the system to be in uniform motion, what force must the man exert on the rope ?

1. $\frac{(M+m)g}{2}$

2. $(M + m)g$

3. $(M - m)g$

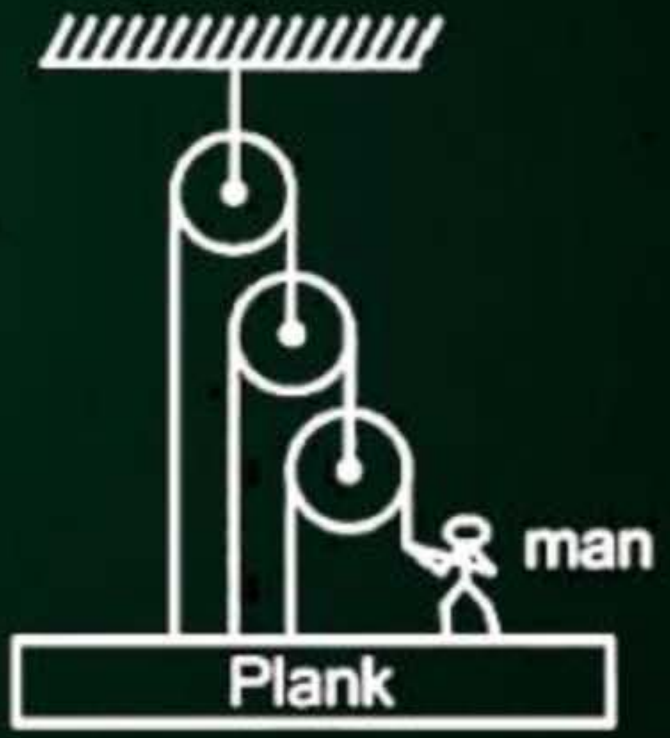
4. $(M + 2m)g$



QUESTION

A man (mass m) hold himself and plank (mass M) in equilibrium with the help of 3 pulley + string system. The force exerted by man upon rope is

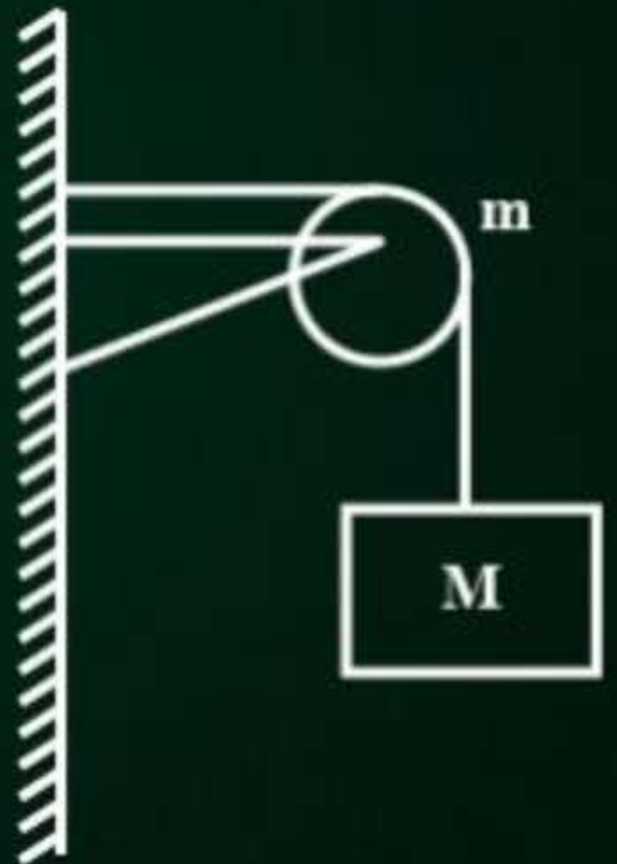
1. $\frac{(M+m)g}{7}$
2. $\frac{(M+m)g}{8}$
3. $\frac{(M+m)g}{6}$
4. $\frac{(M+m)g}{5}$



QUESTION

A string of negligible mass going over a clamped pulley of mass m supports a block of mass M as shown in the figure. The force on the pulley by the clamp is given by (2001, 2M)

1. $\sqrt{2}\,Mg$
2. $\sqrt{2}\,mg$
3. $g\sqrt{(M+m)^2+m^2}$
4. $g\sqrt{(M+m)^2+M^2}$



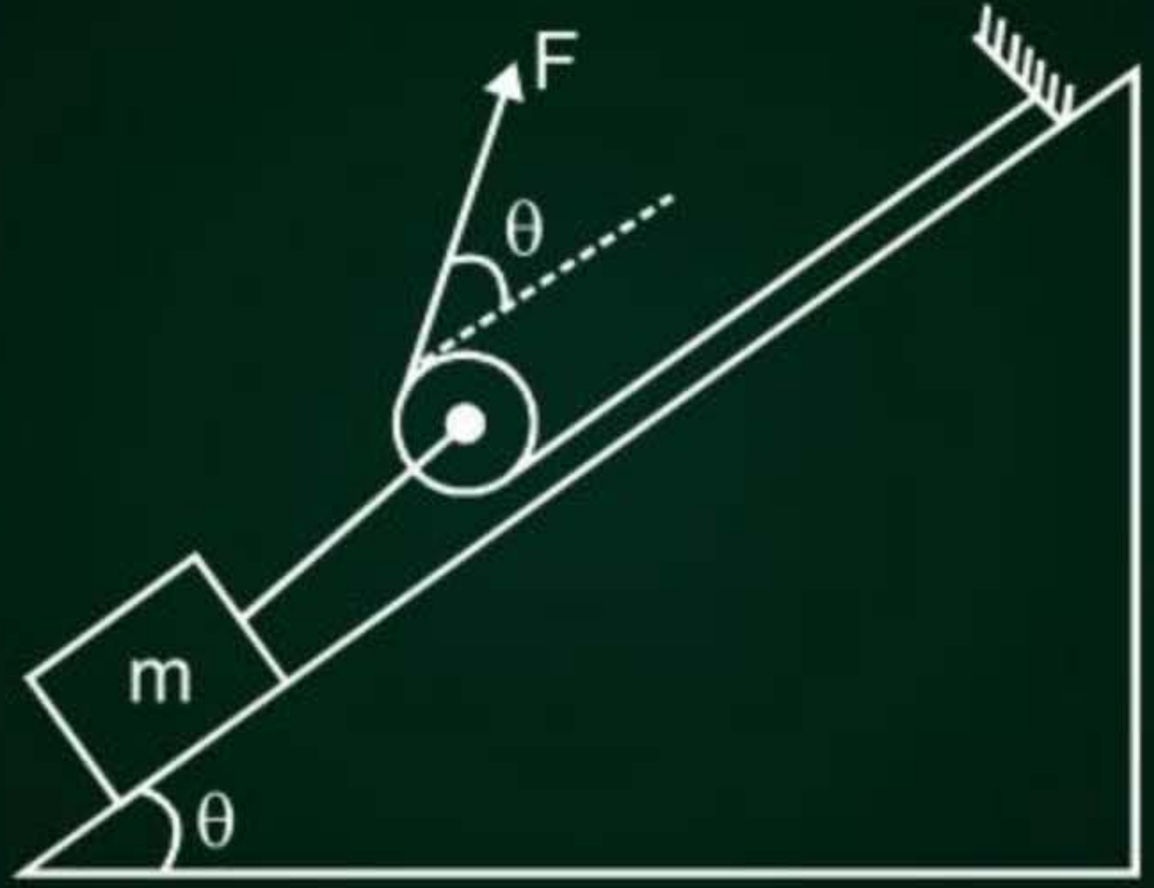
QUESTION

Find contact force between them.



QUESTION

Find F so that object of mass m will be at rest.



QUESTION

Figure shows two cases. In first case a spring (spring constant K) is pulled by two equal and opposite force F at both ends and in second case is pulled by a force F at one end. Extensions (x) in the spring will be

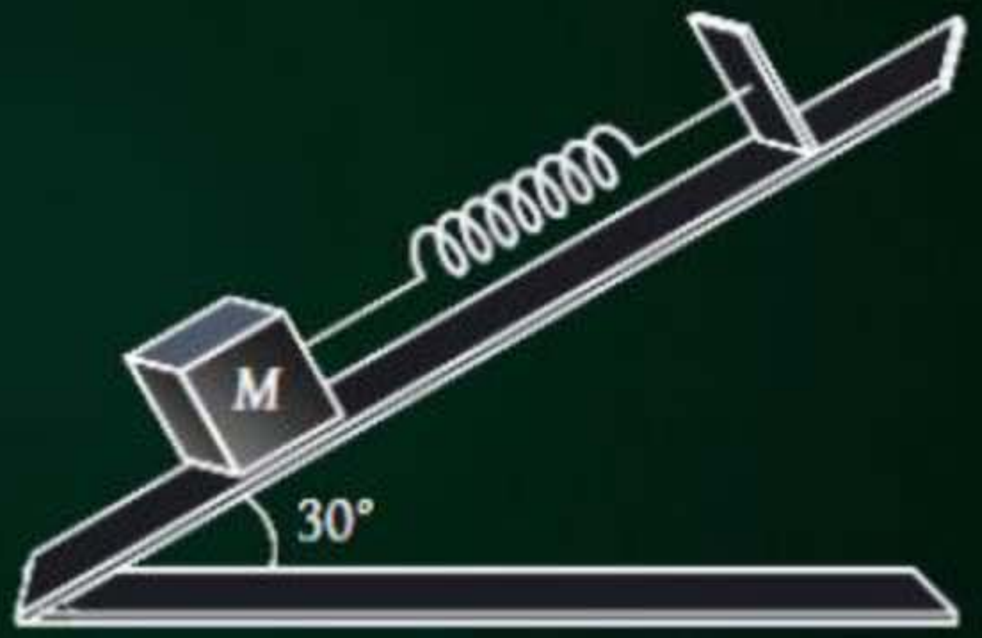


1. In both cases $x = \frac{2F}{K}$
2. In both cases $x = \frac{F}{K}$
3. In first case $x = \frac{2F}{K}$, in second case $x = \frac{F}{K}$
4. In first case $x = \frac{F}{K}$, in second case $x = \frac{2F}{K}$

QUESTION

A body of mass 5 kg is suspended by a spring balance on an inclined plane as shown in figure. The spring balance measure :

1. 50 N
2. 25 N
3. 500 N
4. 10 N



QUESTION

A block of mass 4 kg is suspended through two light spring balances A and B. Then A and B will read respectively :

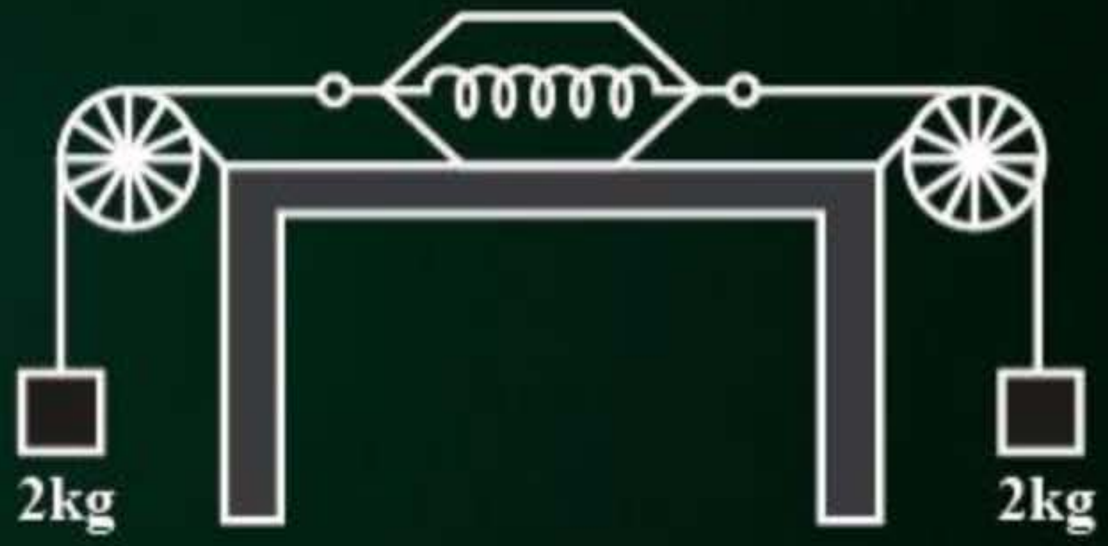
1. 4 kg and zero kg
2. zero kg and 4 kg
3. 4 kg and 4 kg
4. 2 kg and 2 kg



QUESTION

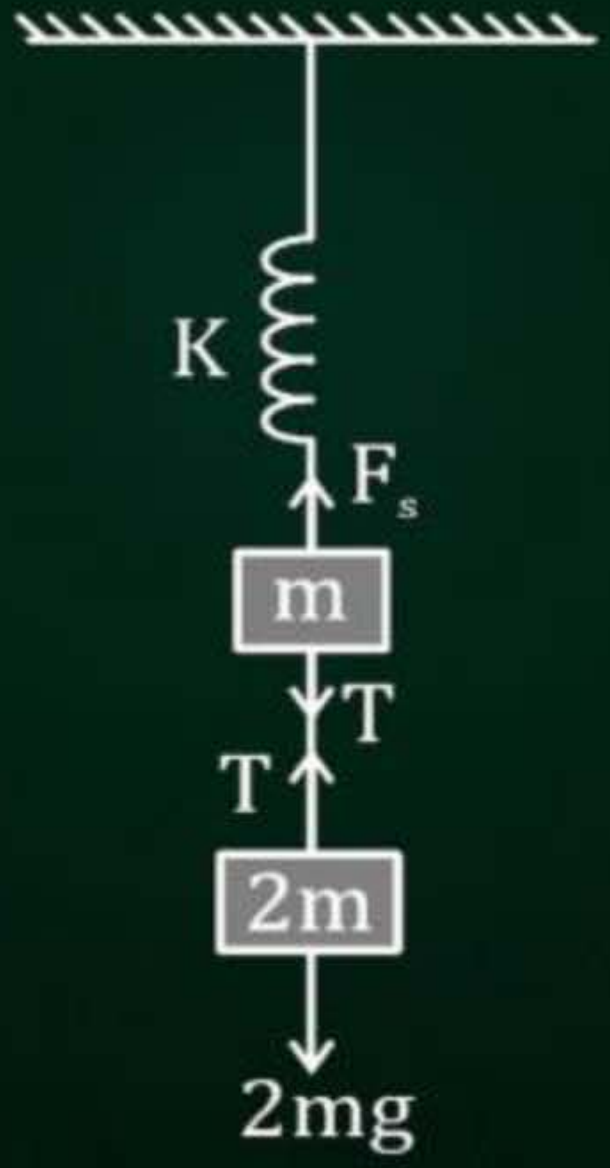
As shown in figure, two equal masses each of 2 kg are suspended from a spring balance. The reading of the spring balance will be:

1. Zero
2. 2 kg
3. 4 kg
4. Between zero and 2 kg



QUESTION

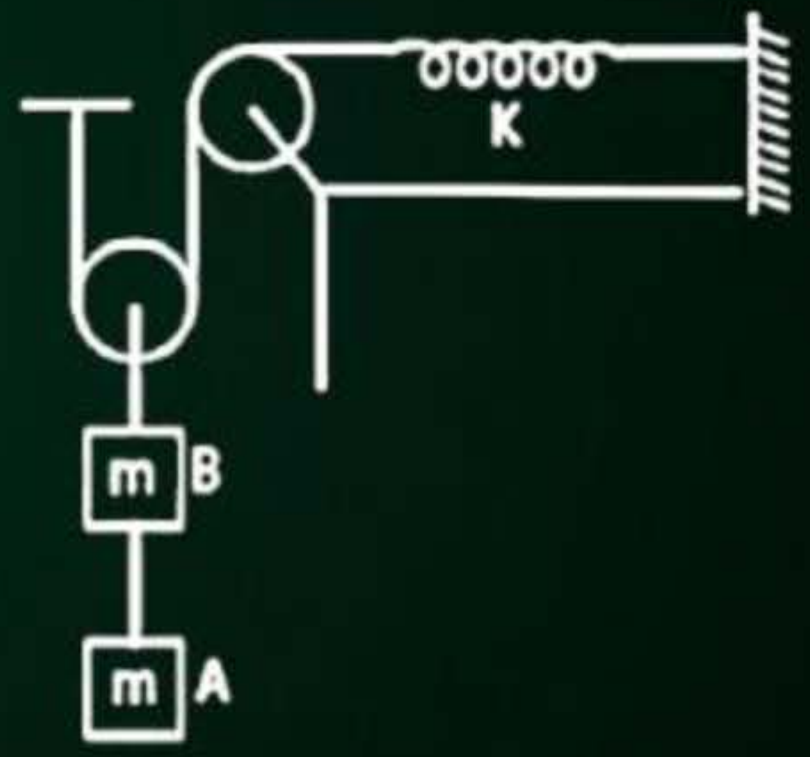
System as shown in figure is in equilibrium. If string is cut then find acceleration of A and B.



QUESTION

Initially both blocks A and B stay at equilibrium. If string between A and B is cut, then acceleration of block A and B just after cut will be :

1. g downward, g upward
2. $g/2$ downward, zero
3. g downward, g downward
4. $g/2$ downward, g upward



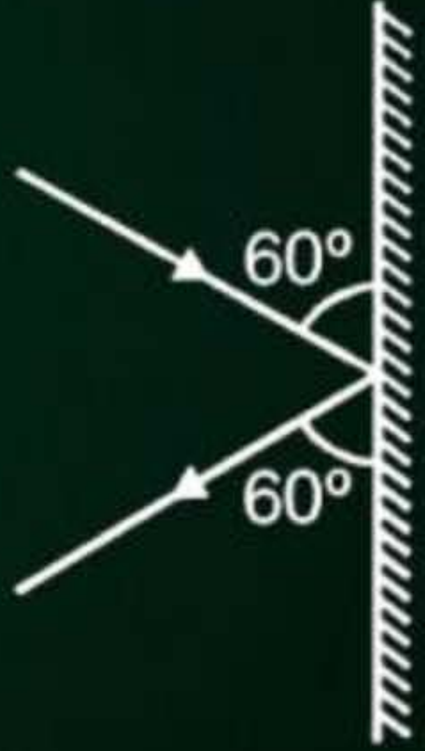
MOMENTUM

$$\vec{P} = m\vec{v}$$

QUESTION

A body of mass 3 kg moving with velocity 10 m/s hits a wall at an angle of $60°$ and returns at the same angle. The impact time was 0.2 s. Calculate the force exerted on the wall.

1. $150\sqrt{3}$ N
2. $50\sqrt{3}$ N
3. 100 N
4. 75 N



QUESTION

A 0.5 kg ball moving with a speed of 12 m/s strikes a hard wall at an angle of 30° with the wall. It is reflected with the same speed and at the same angle. If the ball is in contact with the wall for 0.25 s, the average force acting on the wall is:

[AIPMT (Prelims)-2006]

1. 48 N
2. 24 N
3. 12 N
4. 96 N



QUESTION

A cricketer catches a ball of mass 150 g in 0.1 s moving with speed 20 m/s, then the experiences force of

1. 300 N
2. 30 N
3. 3 N
4. 0.3 N

QUESTION

A ball of mass 50 g is dropped from a height of 20 m. A boy on the ground hits the ball vertically upwards with a bat with an average force of 200 N, so that it attains a vertical height of 45 m. The time for which the ball remains in contact with the bat is [Take $g = 10\ m/s^2$]

1. $1/20^{th}$ of a second
2. $1/40^{th}$ of a second
3. $1/80^{th}$ of a second
4. $1/120^{th}$ of a second

QUESTION

A force of 6 N acts on a body at rest and of mass 1 kg. During this time, the body attains a velocity of 30 m/s. The time for which the force acts on the body is

1. 7 second
2. 5 second
3. 10 second
4. 8 second

QUESTION

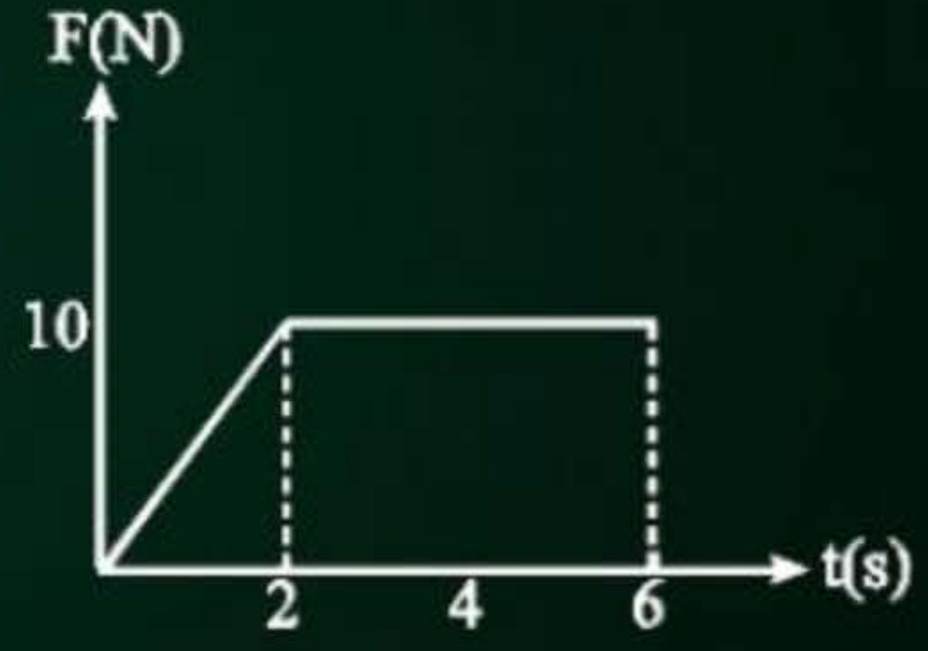
A weight Mg is suspended from the middle of a rope whose ends are at the same level. The rope is no longer horizontal. The minimum tension required to completely straighten the rope is

1. $Mg/2$
2. $Mg \cos 8$
3. $2\,Mg \cos 8$
4. Infinitely large

QUESTION

A body of mass 3 kg is acted on by a force which varies as shown in the graph below. The momentum acquired is given by :

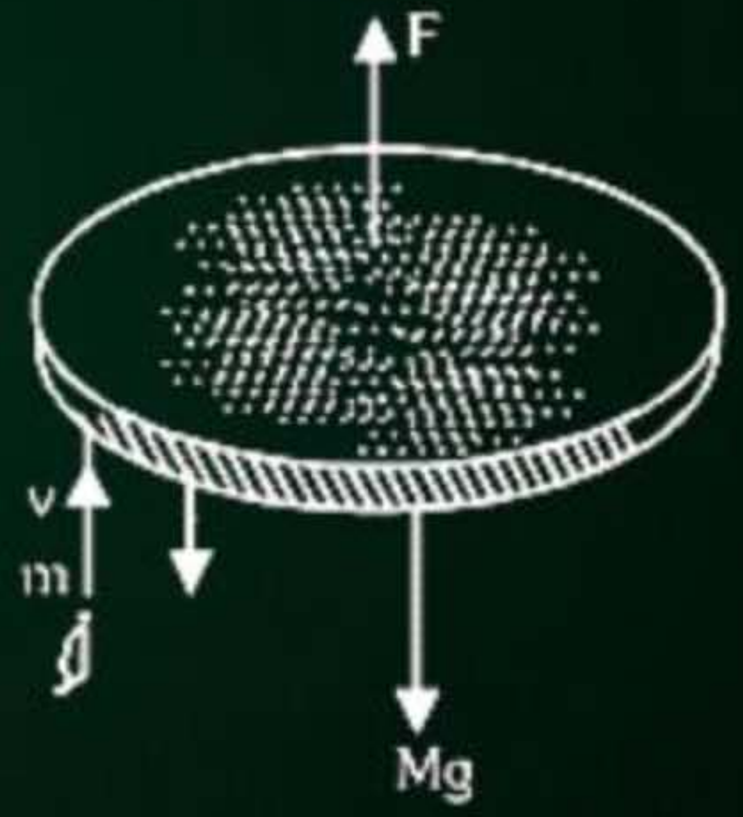
1. Zero
2. 5 N-S
3. 30 N-S
4. 50 N-S



QUESTION

A disc of mass 1.0 kg kept floating horizontally in air by firing bullets of mass 0.05 kg each vertically at it, at the rate of 10 per second. If the bullets rebound with the same speed, the speed with which these are fired will be-

1. 0.098 m/s
2. 0.98 m/s
3. 9.8 m/s
4. 98.0 m/s




THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 03 | **Physics**

Laws of Motion

By- Dr. Manish Raj (MR SIR)



Topics to be covered

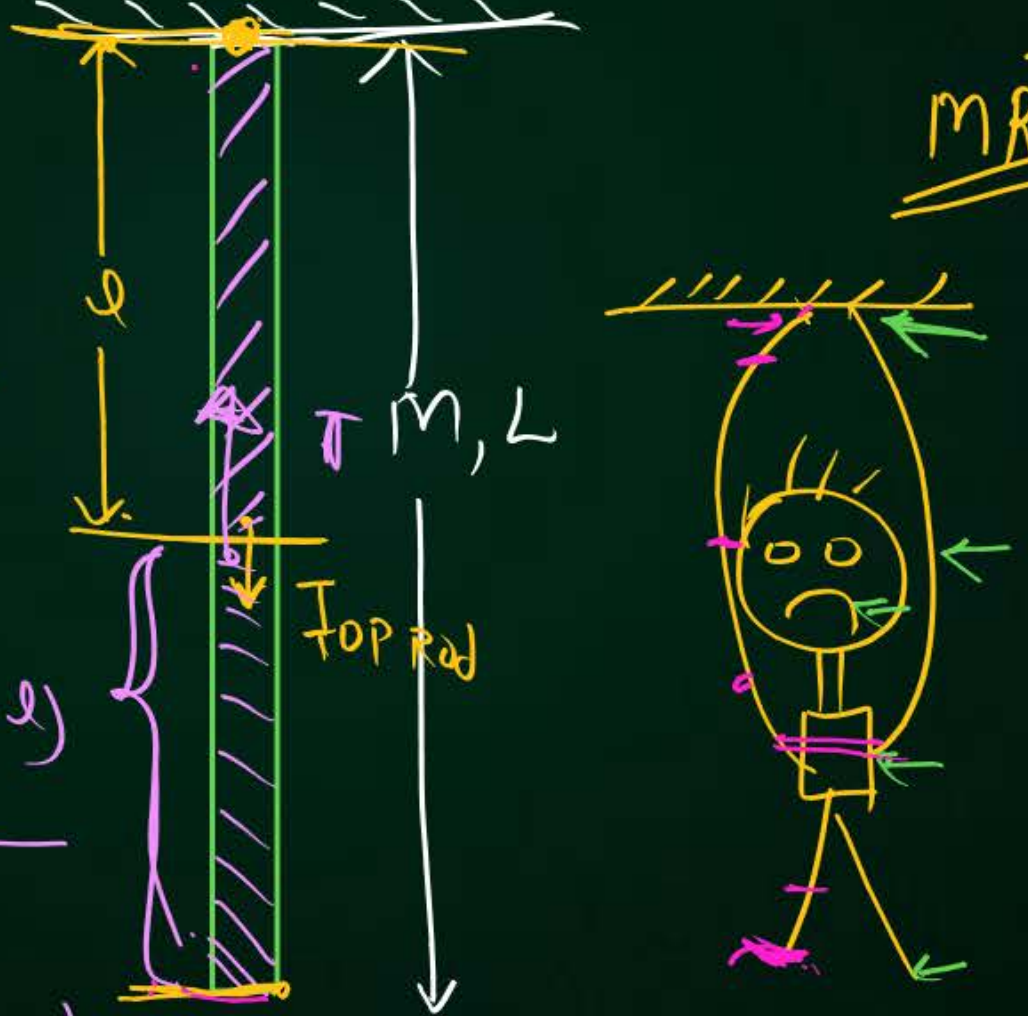
1. # questions on equilibrium
2. #
3. #
4. #



QUESTION

A uniform rope of mass M and length L is fixed at its upper end vertically from a rigid support. Then the tension in the rope at the distance I from the rigid support is

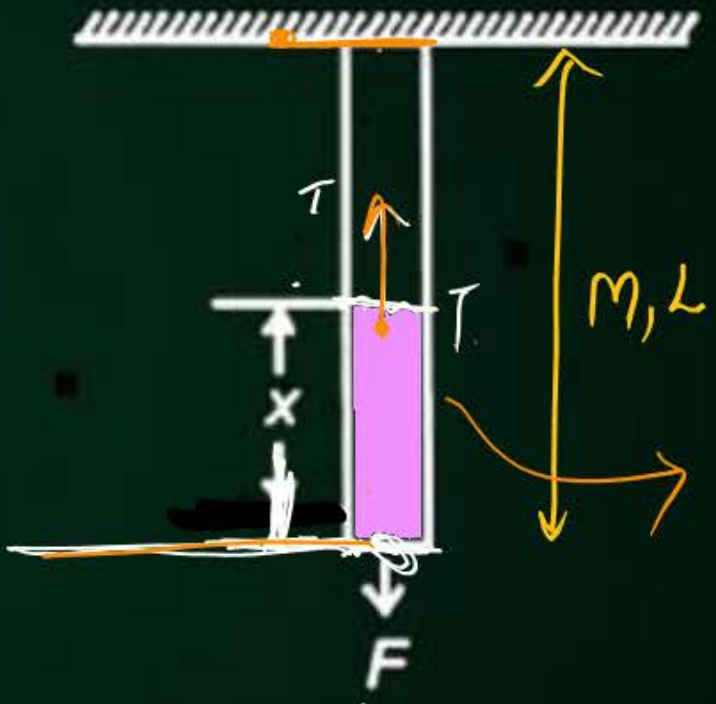
1. $Mg\frac{L}{L+I}$
2. $\frac{Mg}{L}(L-I)$
3. Mg
4. $\frac{I}{L}Mg$



QUESTION

A vertical force F is applied at one end of a uniform rope of mass M and length L. Find out tension in the rope as a function of x.

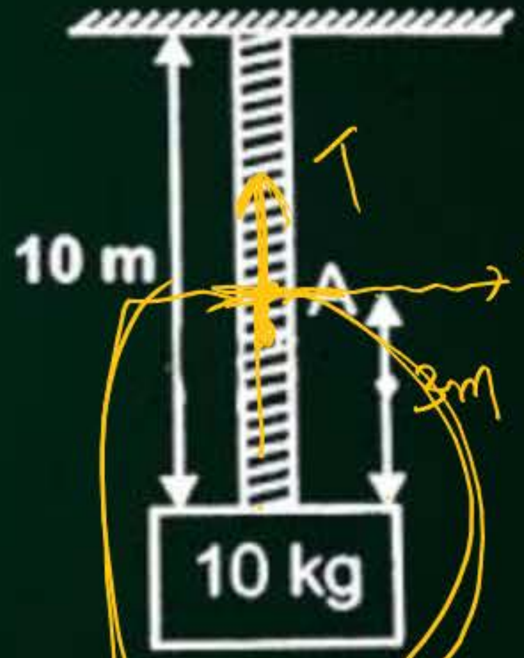
1. $F + Mg$
2. $F + \frac{MgL}{x}$
3. $\frac{FL + Mgx}{L}$
4. $\frac{Fx + MgL}{L}$



QUESTION

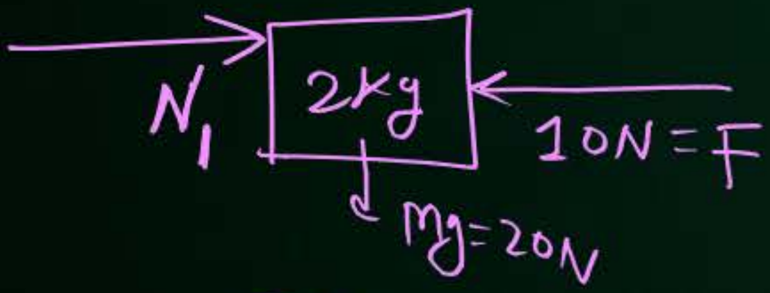
The adjoining figure shows a block of mass 10 kg connected to free end of a rope of mass 10 kg and length 10 m. The tension of the rope at point A is ($g = 10\ m/s^2$)

1. 170 N
2. 30 N
3. 130 N
4. 70 N



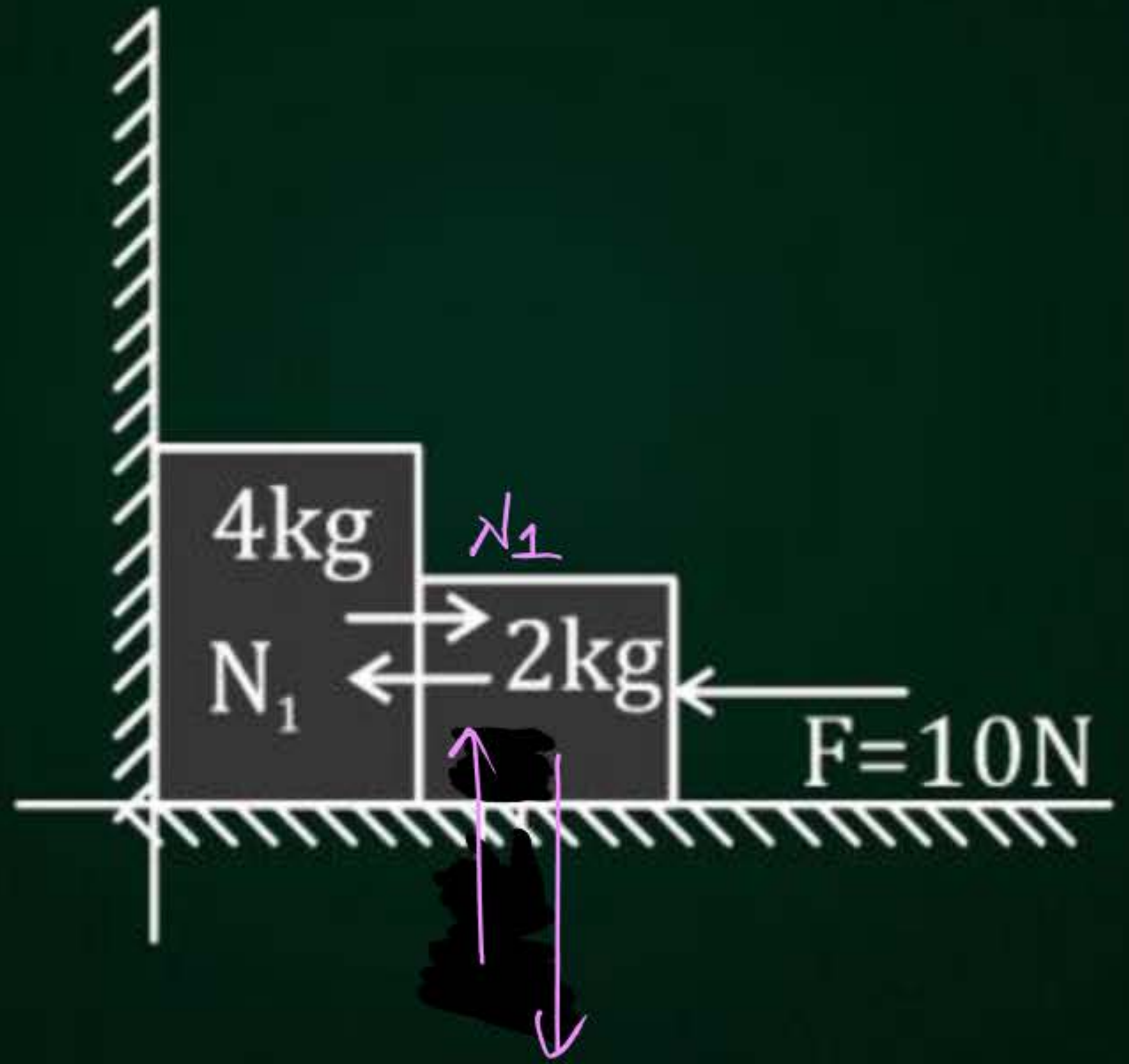
QUESTION

Find contact force between 4 kg block and 2 kg block.

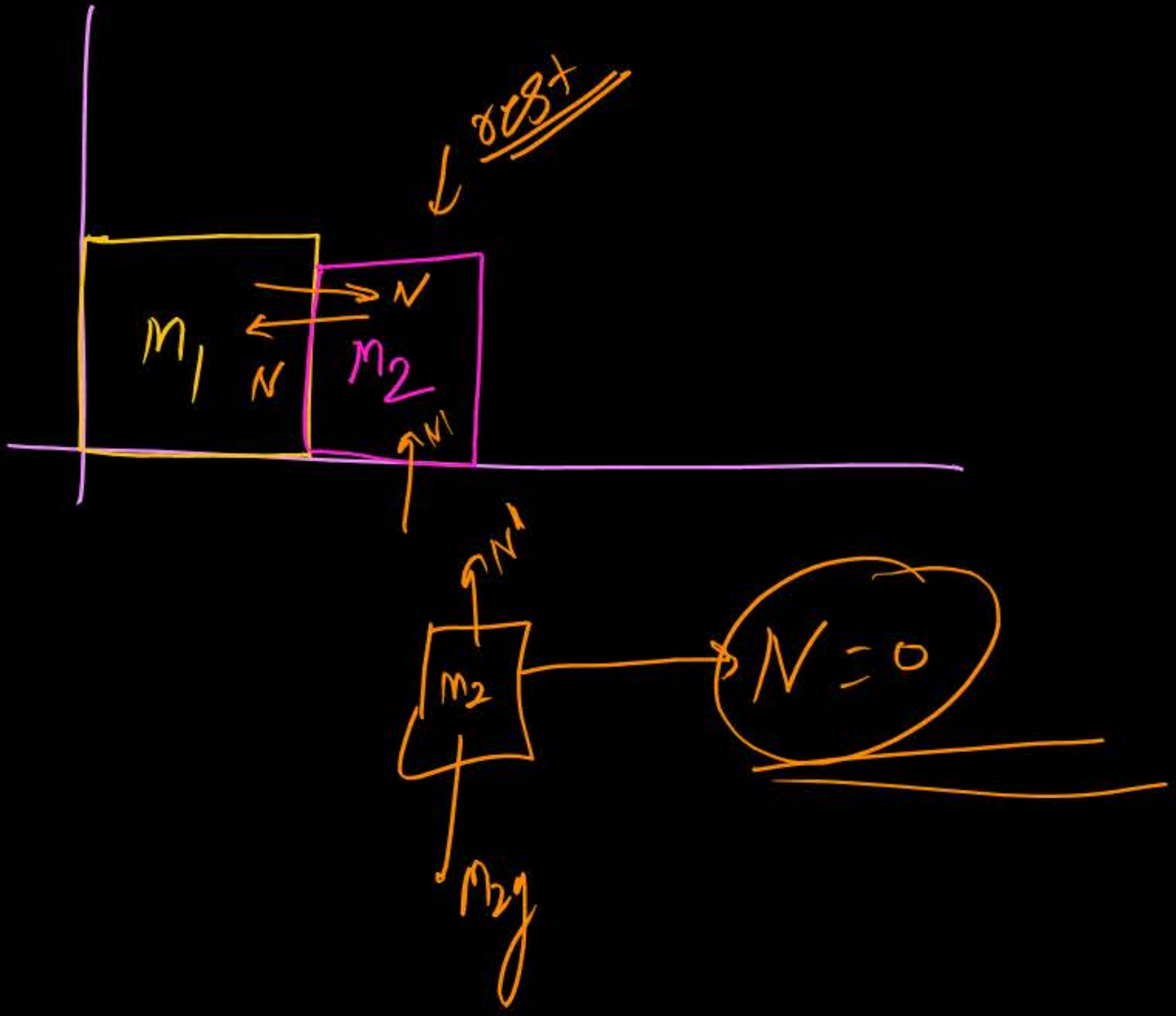


$\Sigma F_x = 0$

$N_1 = 10N$



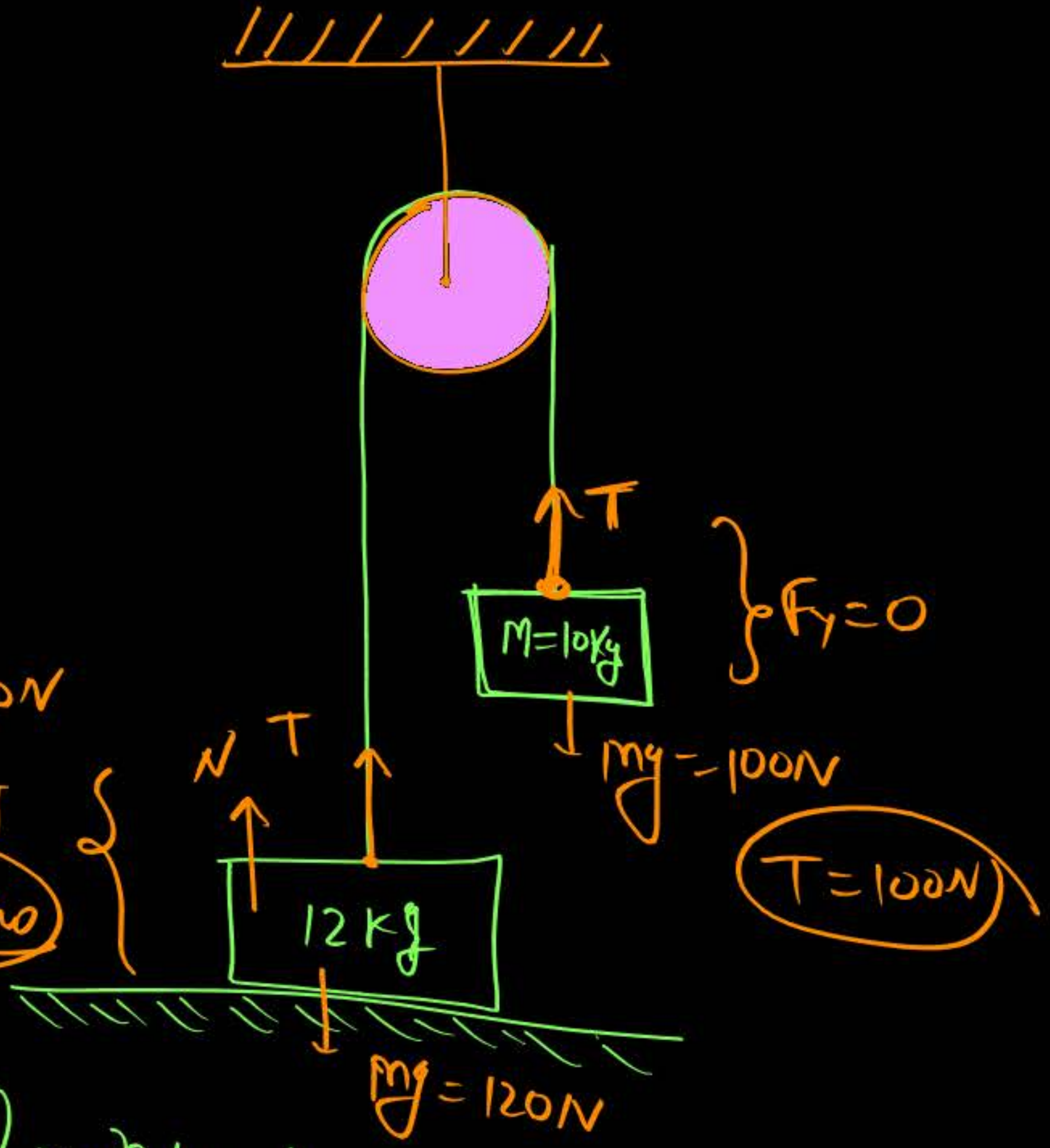
contant force b/w m_1 & m_2



$N + T = 120N$

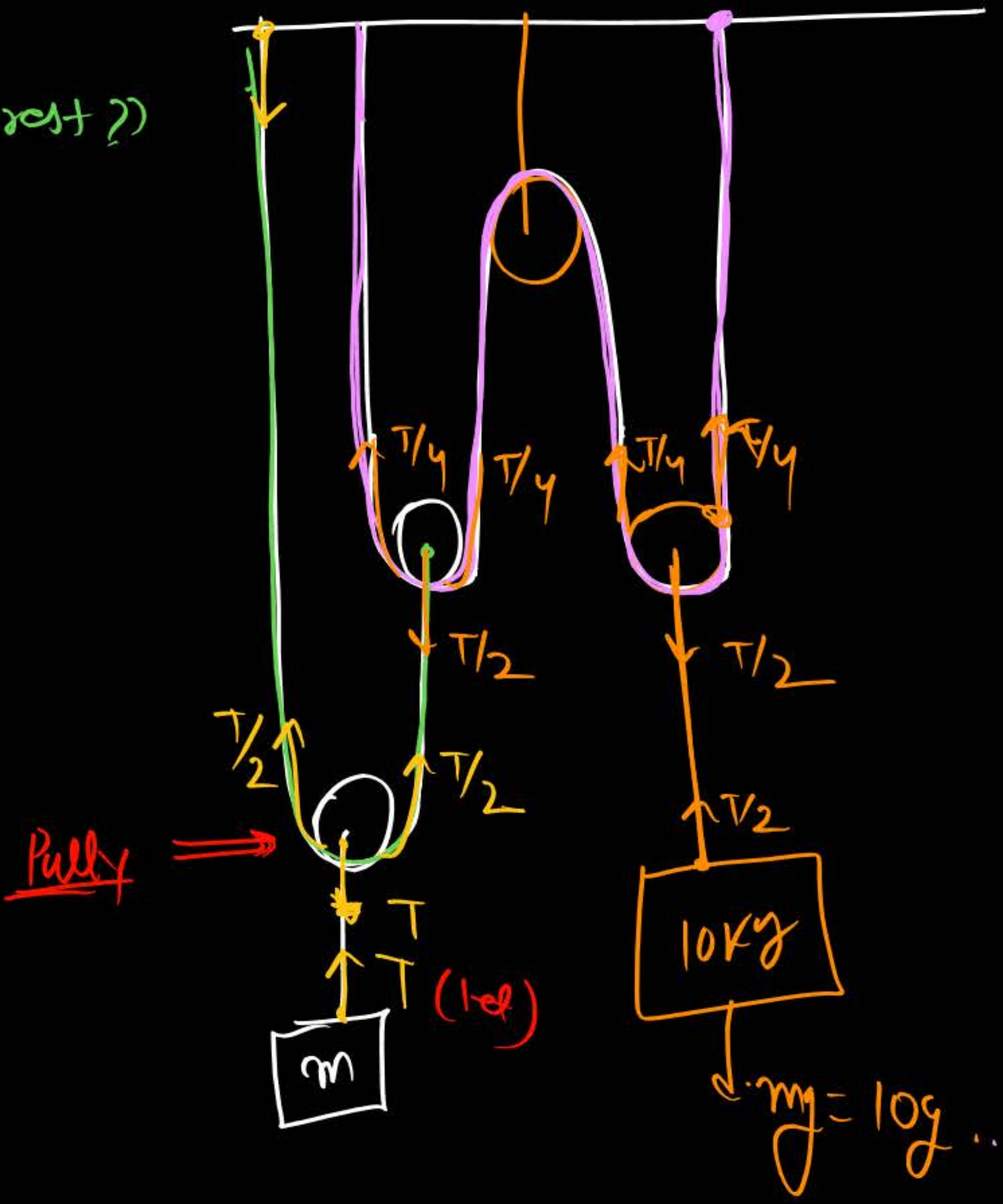
$N = 120 - T$

$N = 20\text{ Newton}$



Q) Normal rexn (contact force) on 12kg due to ground, if system is in eqm.

find $m = ??$ if system is at rest ??

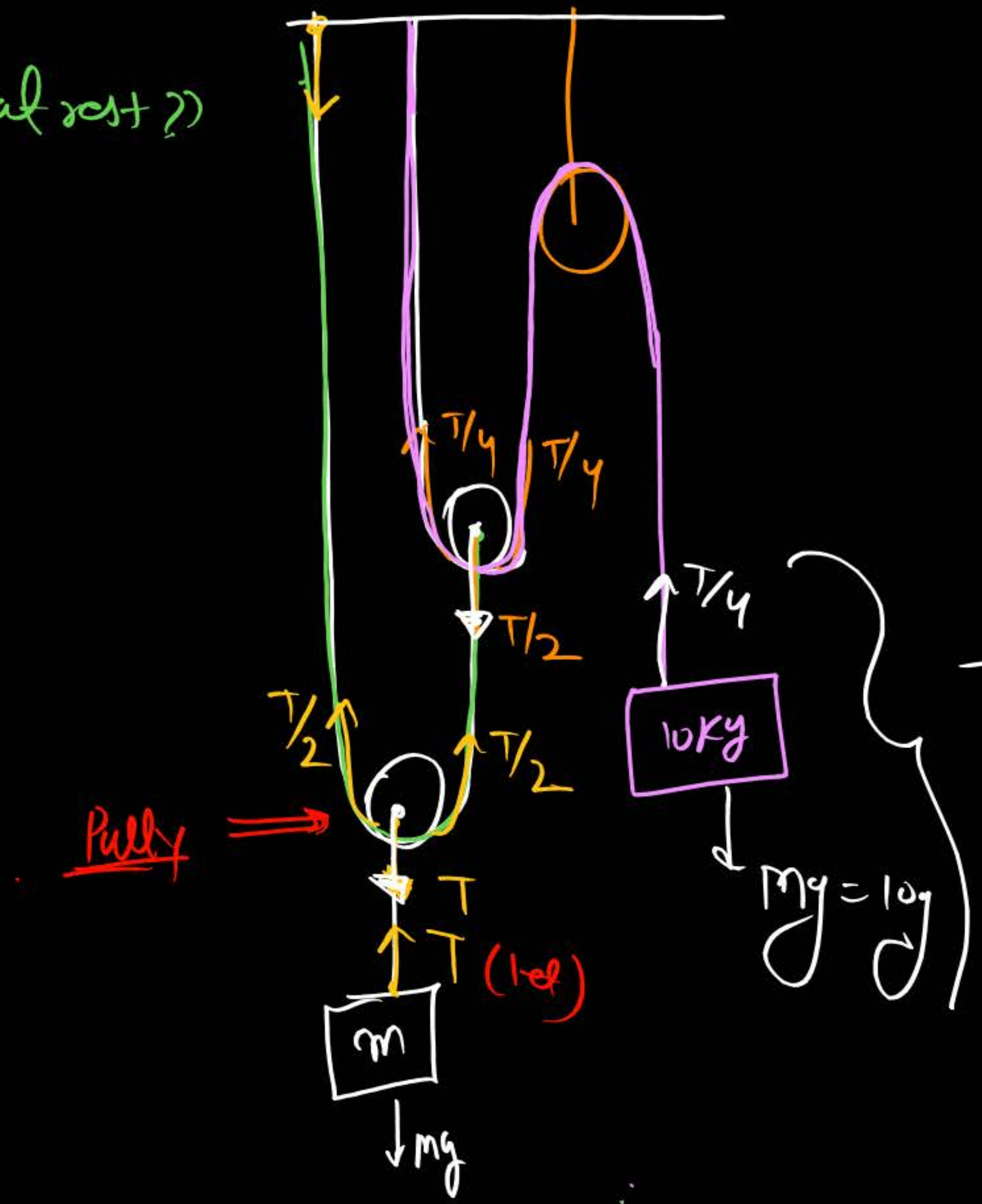


$$\frac{T}{2} = 10g \quad -(1)$$

$$\frac{mg}{2} = 10g$$

$$\boxed{m = 20\,kg}$$

find $m = ??$ if system is at rest ??



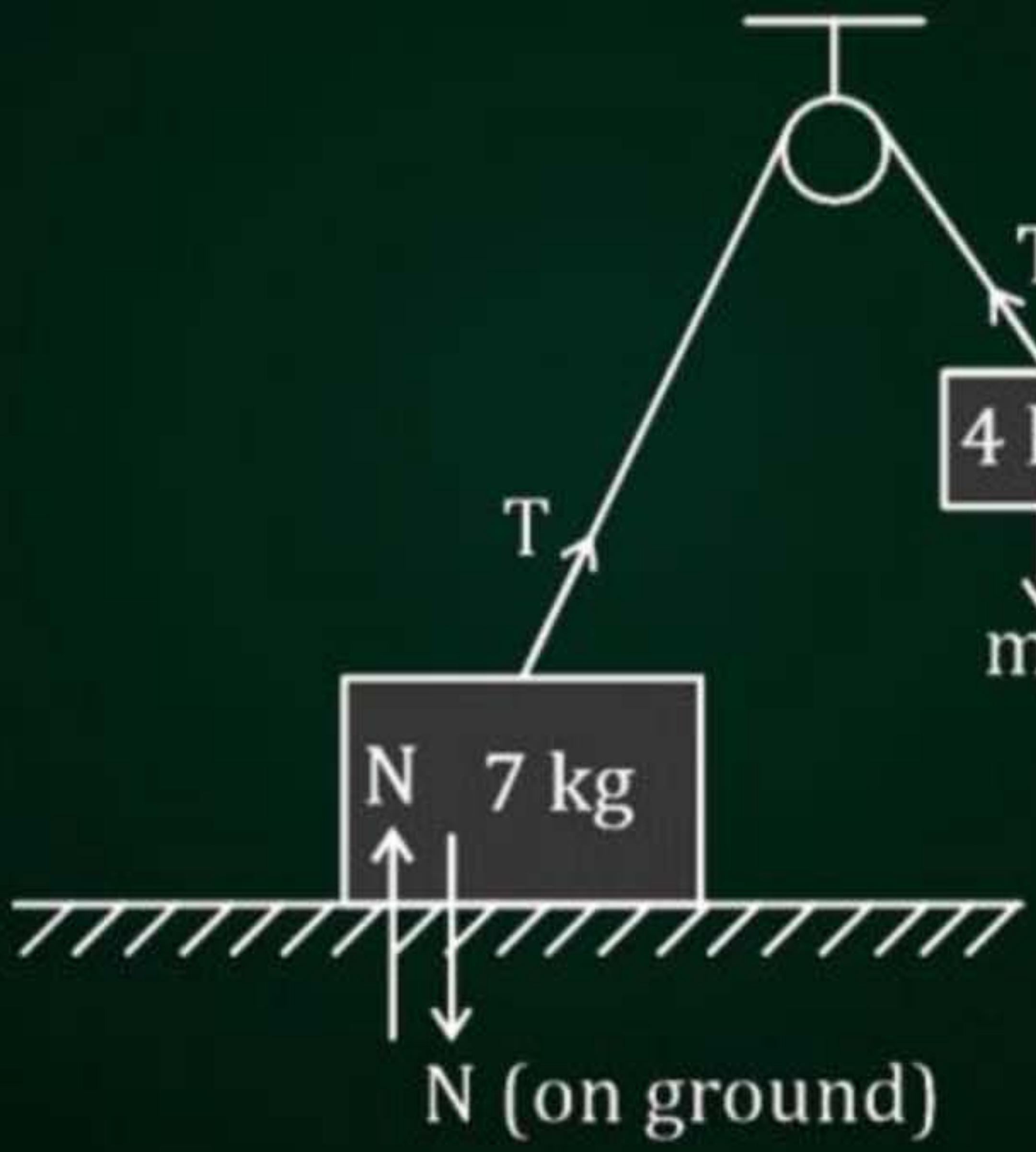
$$\frac{T}{4} = 10g$$

$$\frac{mg}{4} = 10g$$

$$m = 40\,kg$$

QUESTION

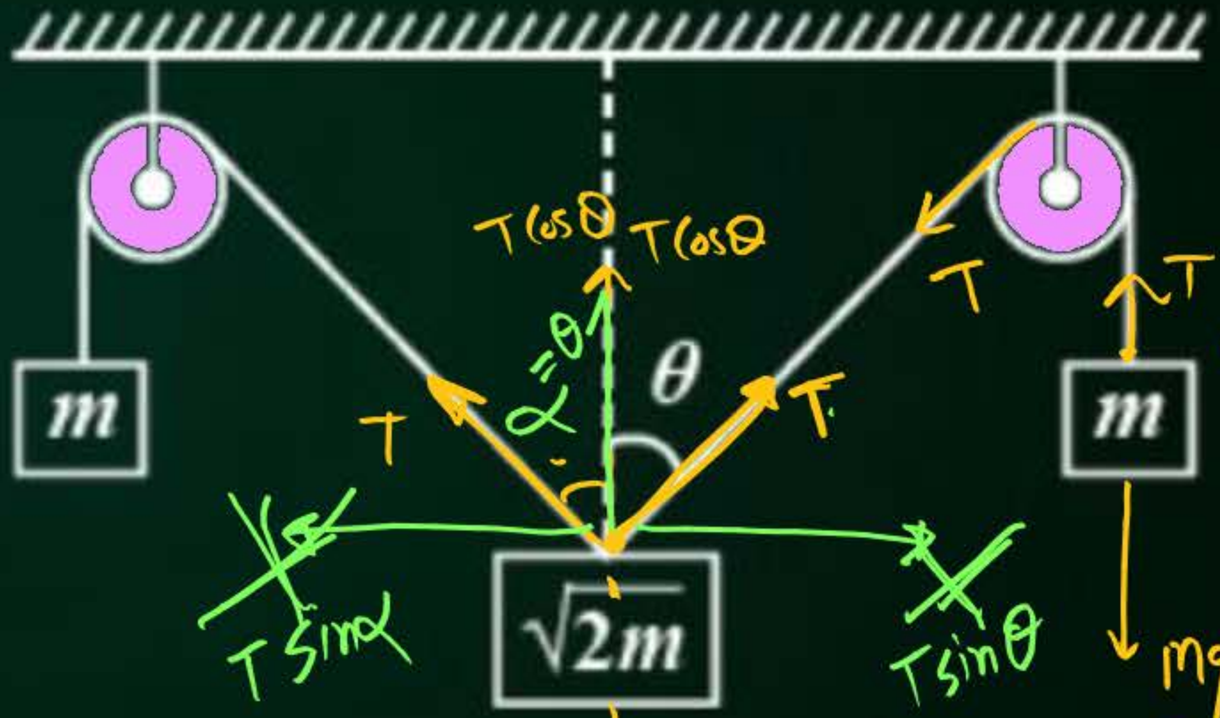
Find contact force between ground and 7 kg block.



QUESTION

The pulleys and strings shown in the figure are smooth and of negligible mass. For the system to remain in equilibrium, the angle θ should be (2001, 2M)

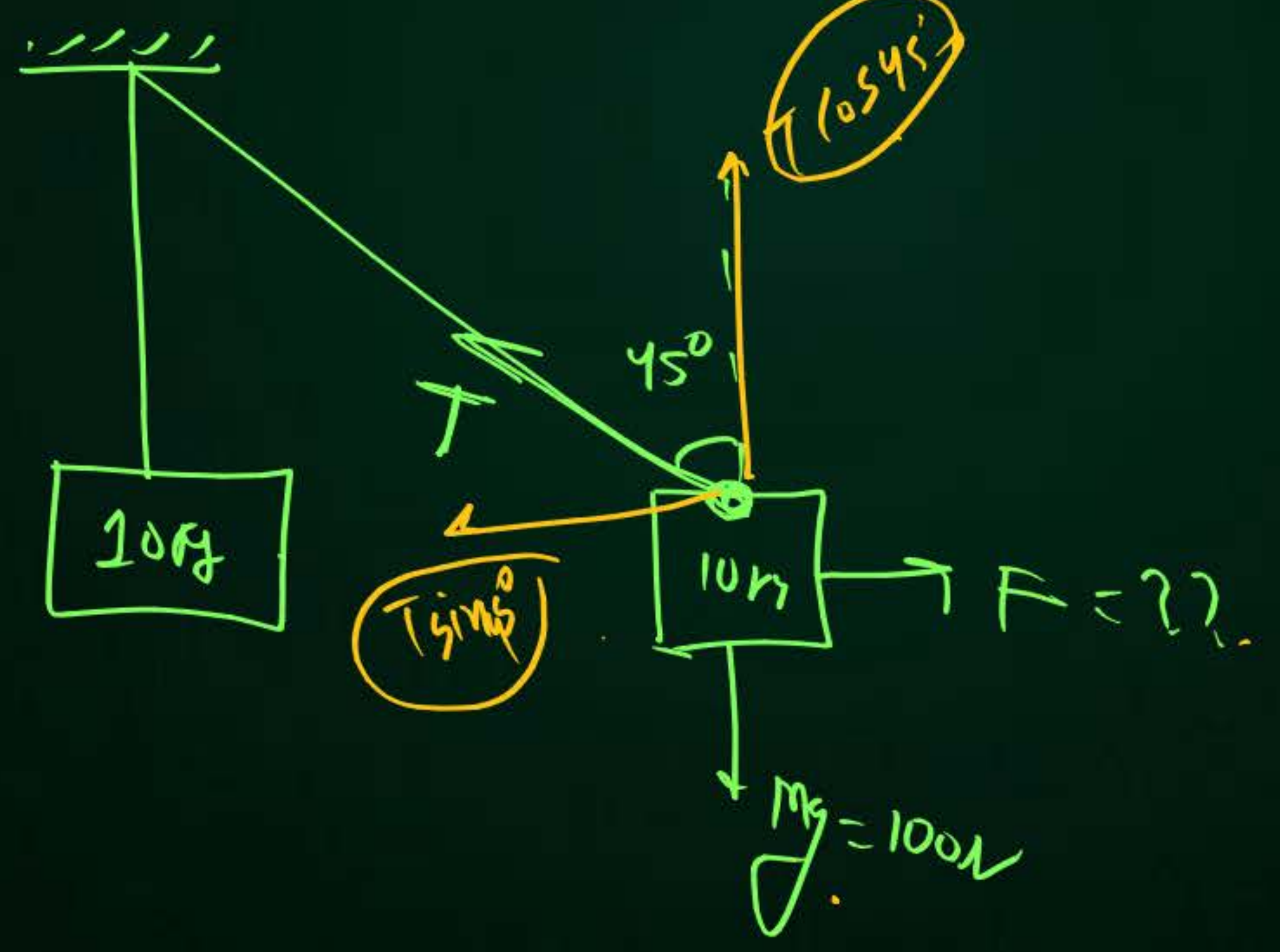
1. 0°
2. 30°
3. 45°
4. 60°



QUESTION

A mass of 10 kg is suspended vertically by a rope from the roof. When a horizontal force is applied on the mass, the rope deviated at an angle of 45° at the roof point. If the suspended mass is at equilibrium, the magnitude of the force applied is (Take, $g = 10\ \mathrm{ms^{-2}}$) **(2019 Main, 9 Jan II)**

1. 70 N
2. 200 N
3. 100 N Ans
4. 140 N



$T\cos 45° = mg = 100\,N$ — (1)

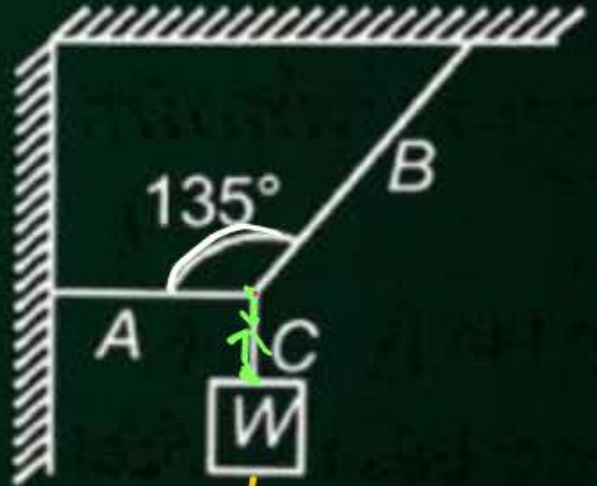
$T\sin 45° = F$ — (2)

(1) = (2)

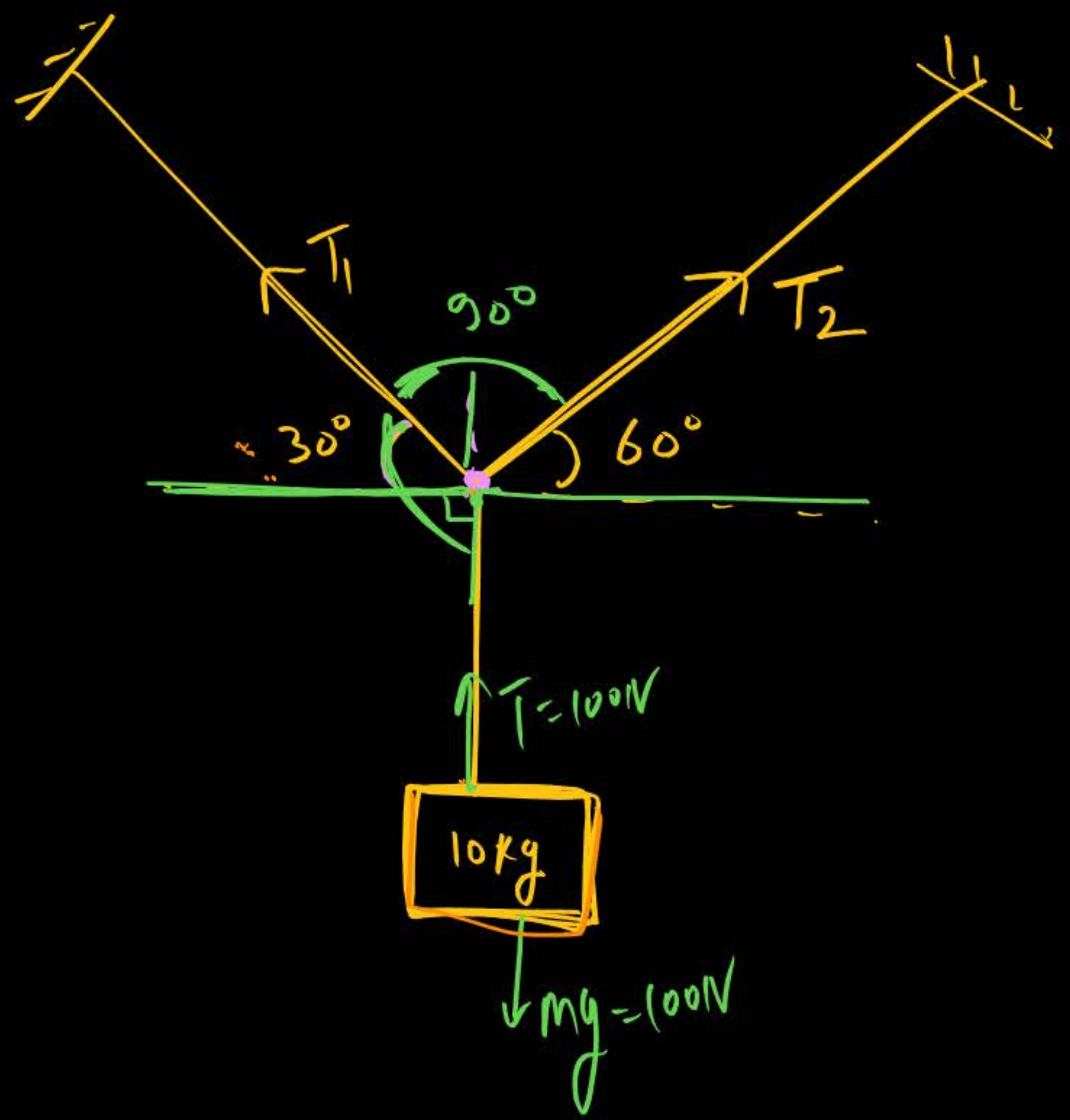
$F = 100\,N$

QUESTION

A block of weight W is supported by three strings as shown in figure. Which of the following relations is true for tension in the strings? (Here T_1, T_2 and T_3 are the tension in the strings A, B and C respectively)



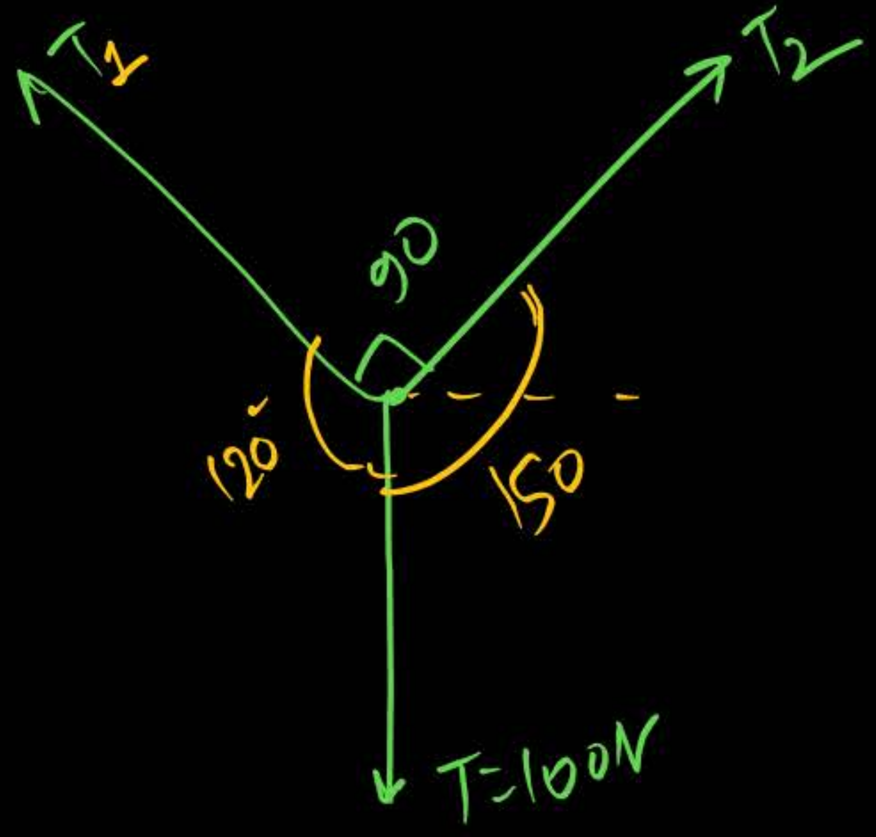
1. $T_1 = T_2$
2. $T_1 = T_3$
3. $T_2 = T_3$
4. $T_1 = T_2 = T_3$



$$\frac{T_1}{\sin 150} = \frac{T_2}{\sin 120} = \frac{100}{\sin 90}$$

$T_1 = 100 \times \frac{1}{2} = 50N$

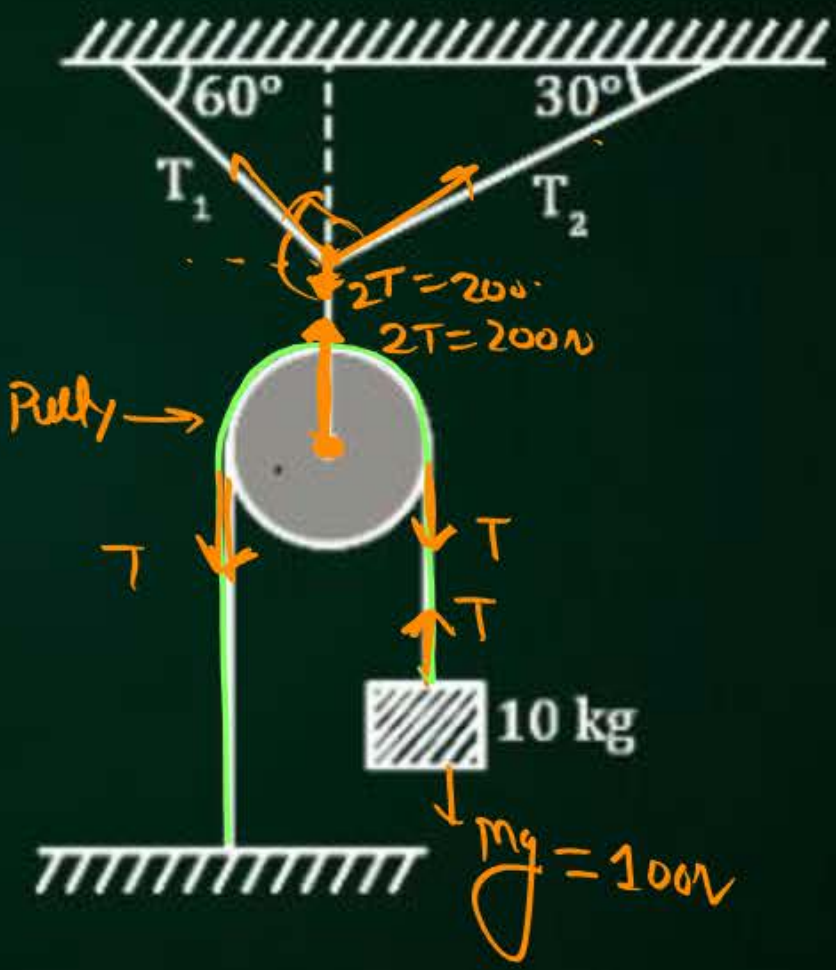
$T_2 = 100 \times \frac{\sqrt{3}}{2} = 50\sqrt{3}$



QUESTION

In the arrangement as shown, tension T_2 is $(g = 10\ \text{m/s}^2)$

1. 50 N (7%)
2. 100 N (28%)
3. $50\sqrt{3}$ N (42%)
4. $100\sqrt{3}$ N (22%)



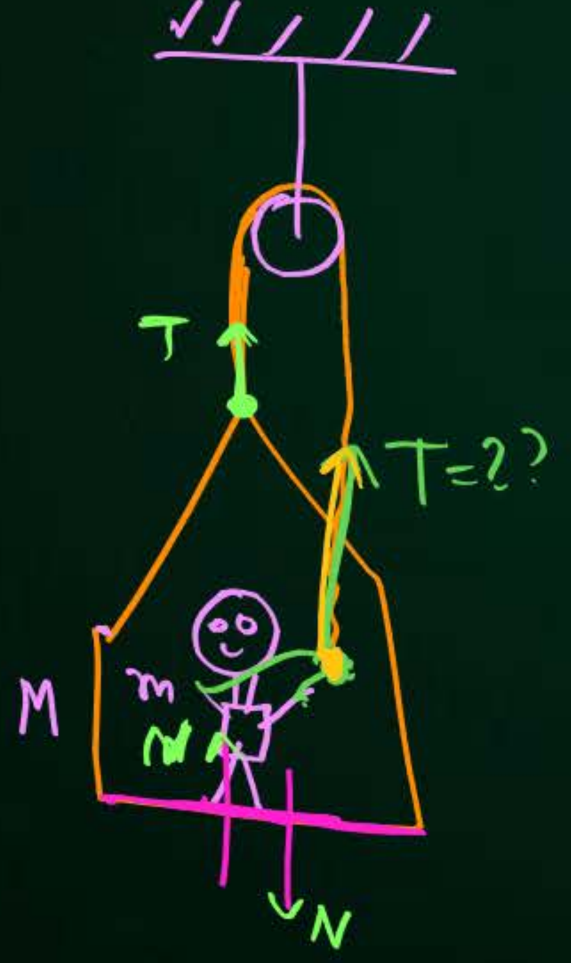
$$\frac{T_2}{\sin 150^\circ} = \frac{200}{\sin 90^\circ}$$

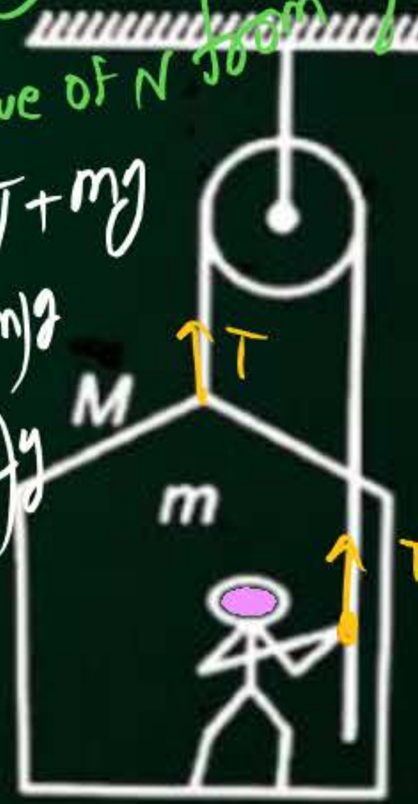
$$T_2 = 100\ \text{N}$$

QUESTION

A man of mass m stands on a frame of mass M. He pulls a light rope, which passes over a pulley. The other end of the rope is attached to the frame. For the system to be in uniform motion, what force must the man exert on the rope ?

1. $\frac{(M+m)g}{2}$
2. $(M + m)\,g$
3. $(M - m)\,g$
4. $(M + 2m)\,g$





QUESTION

A man (mass m) hold himself and plank (mass M) in equilibrium with the help of 3 pulley + string system. The force exerted by man upon rope is

(1) $\dfrac{(M+m)g}{7}$

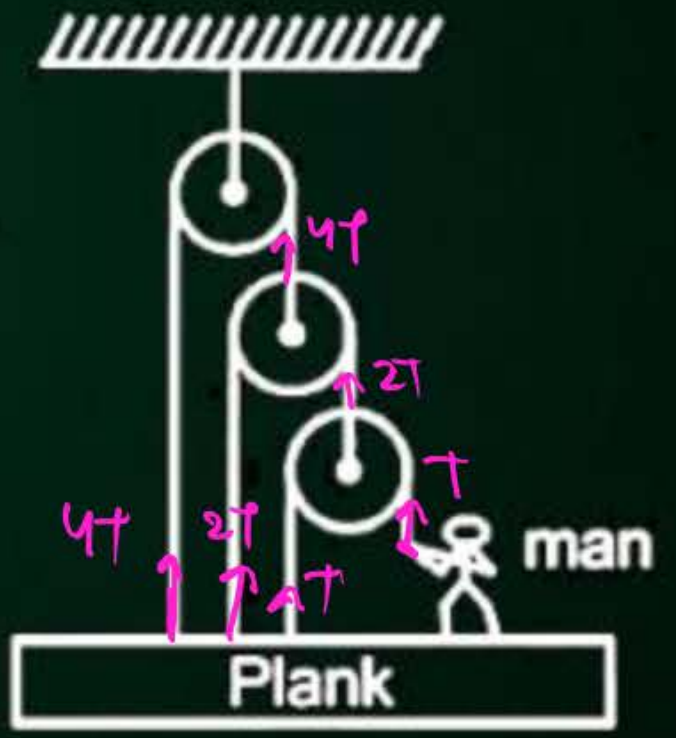
(2) $\dfrac{(M+m)g}{8}$

(3) $\dfrac{(M+m)g}{6}$

(4) $\dfrac{(M+m)g}{5}$



$T = \dfrac{(M+m)g}{8}$

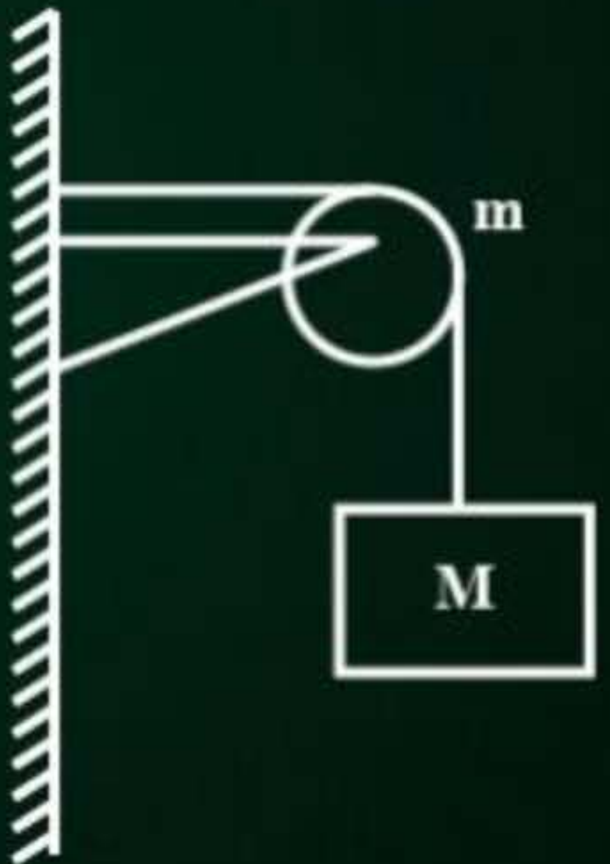


QUESTION

H|42

A string of negligible mass going over a clamped pulley of mass m supports a block of mass M as shown in the figure. The force on the pulley by the clamp is given by (2001, 2M)

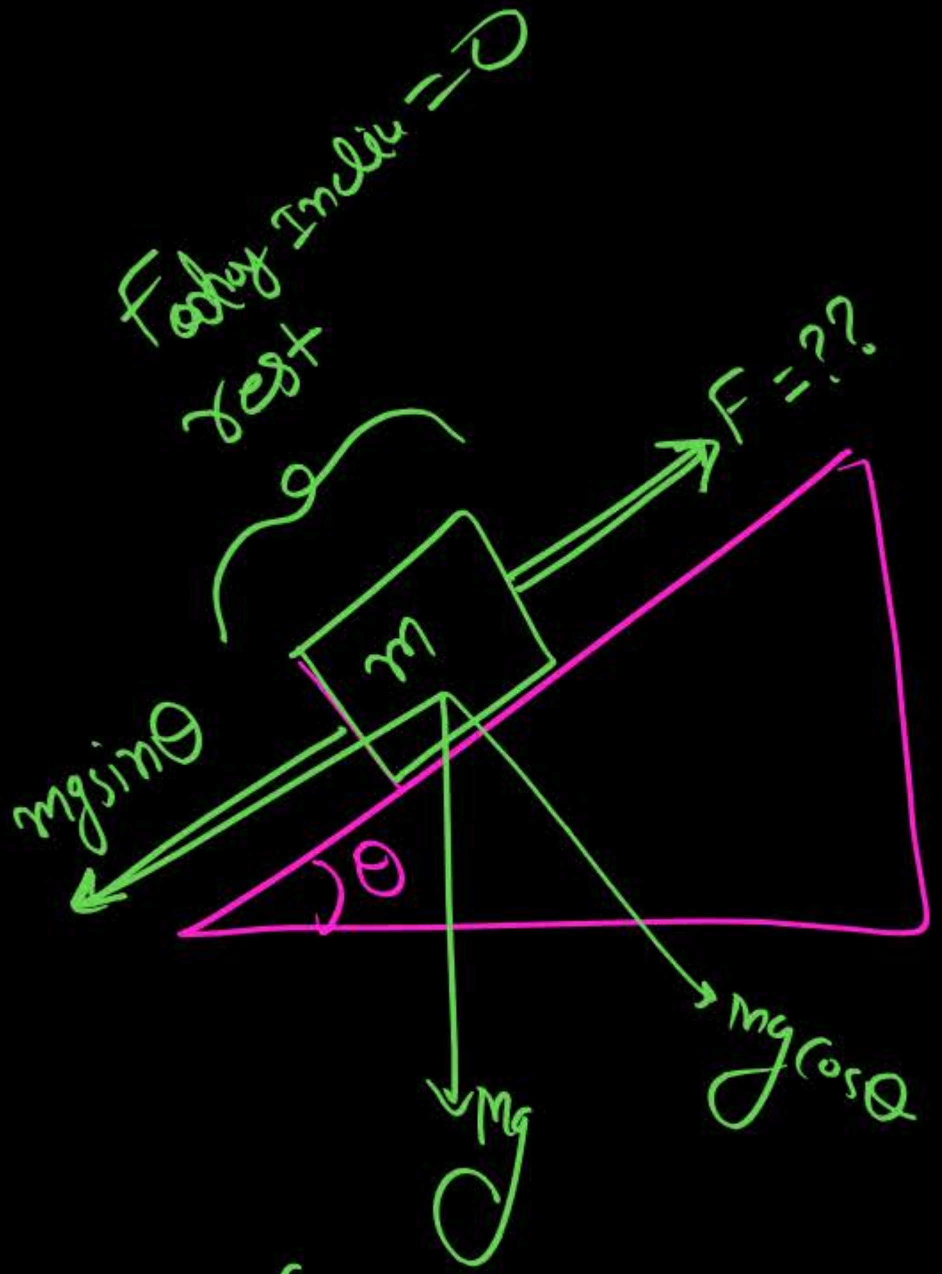
1. $\sqrt{2}\,Mg$
2. $\sqrt{2}\,mg$
3. $g\sqrt{(M+m)^2+m^2}$
4. $g\sqrt{(M+m)^2+M^2}$



QUESTION

Find contact force between them.

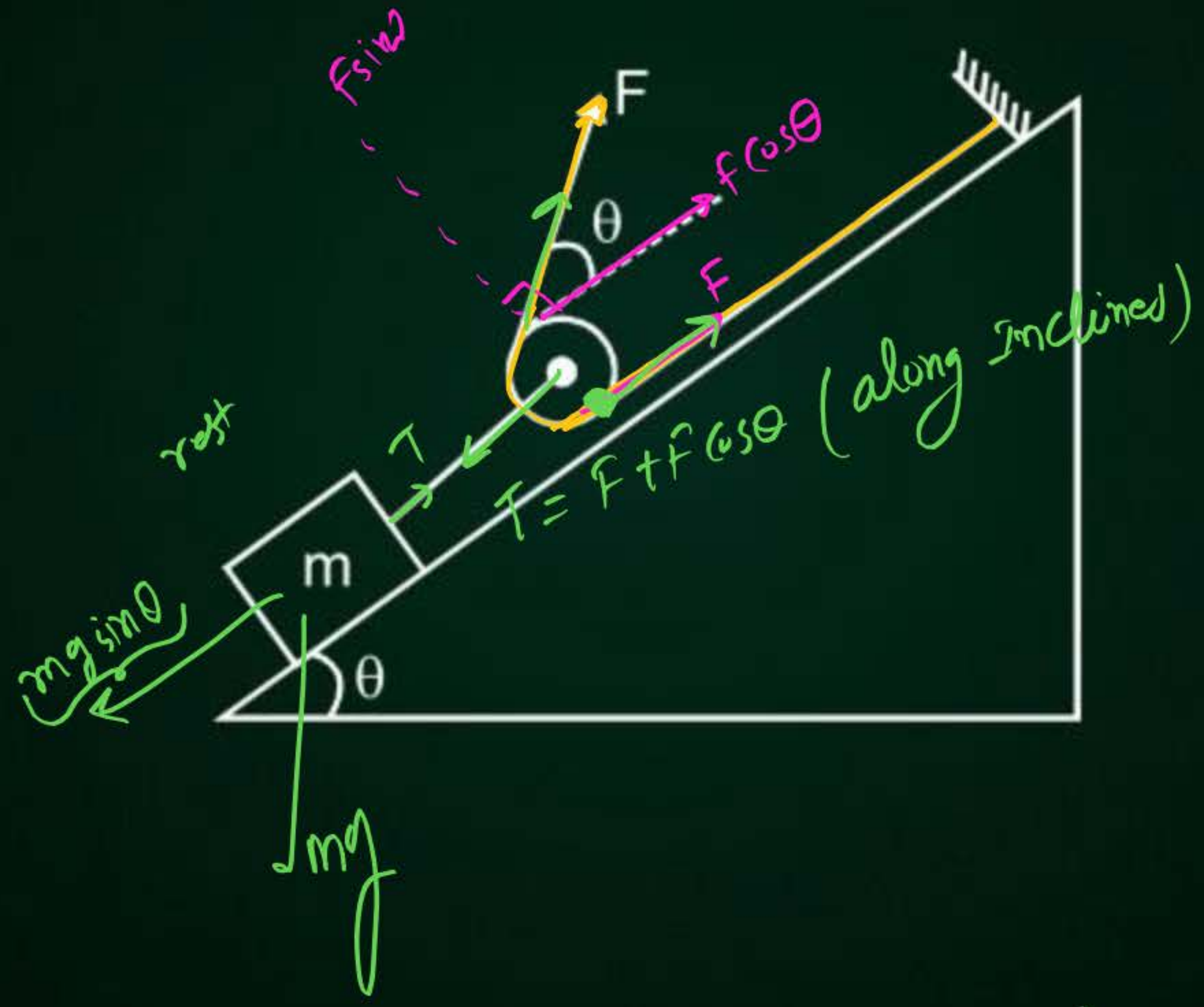




$$F = mg\sin\theta$$

QUESTION

Find F so that object of mass m will be at rest.



$$F + F\cos\theta = mg\sin\theta$$

$$F = \frac{mg\sin\theta}{(1+\cos\theta)}$$

Ans

find reading of spring or spring force

↓

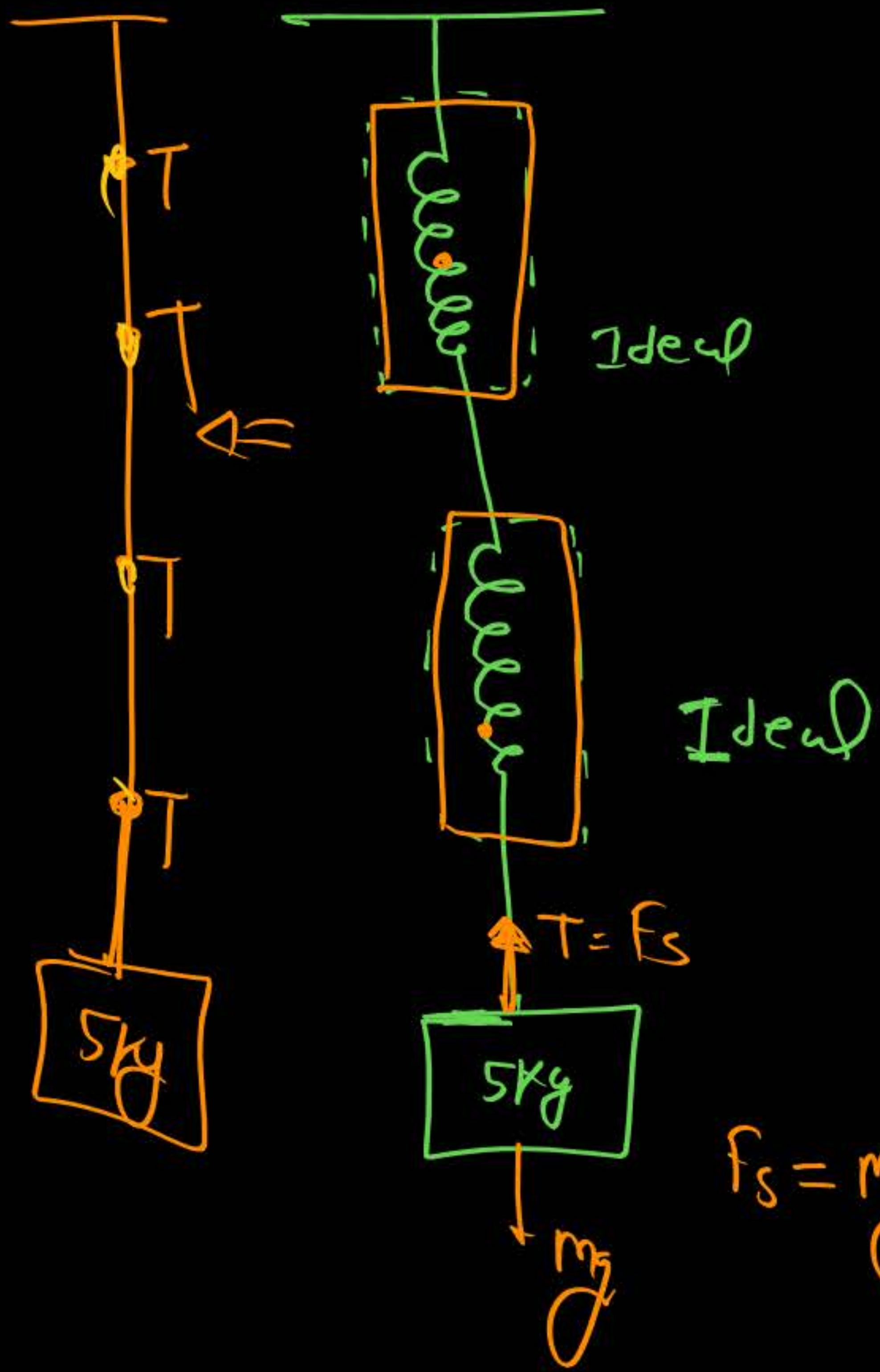
assume string there

↓

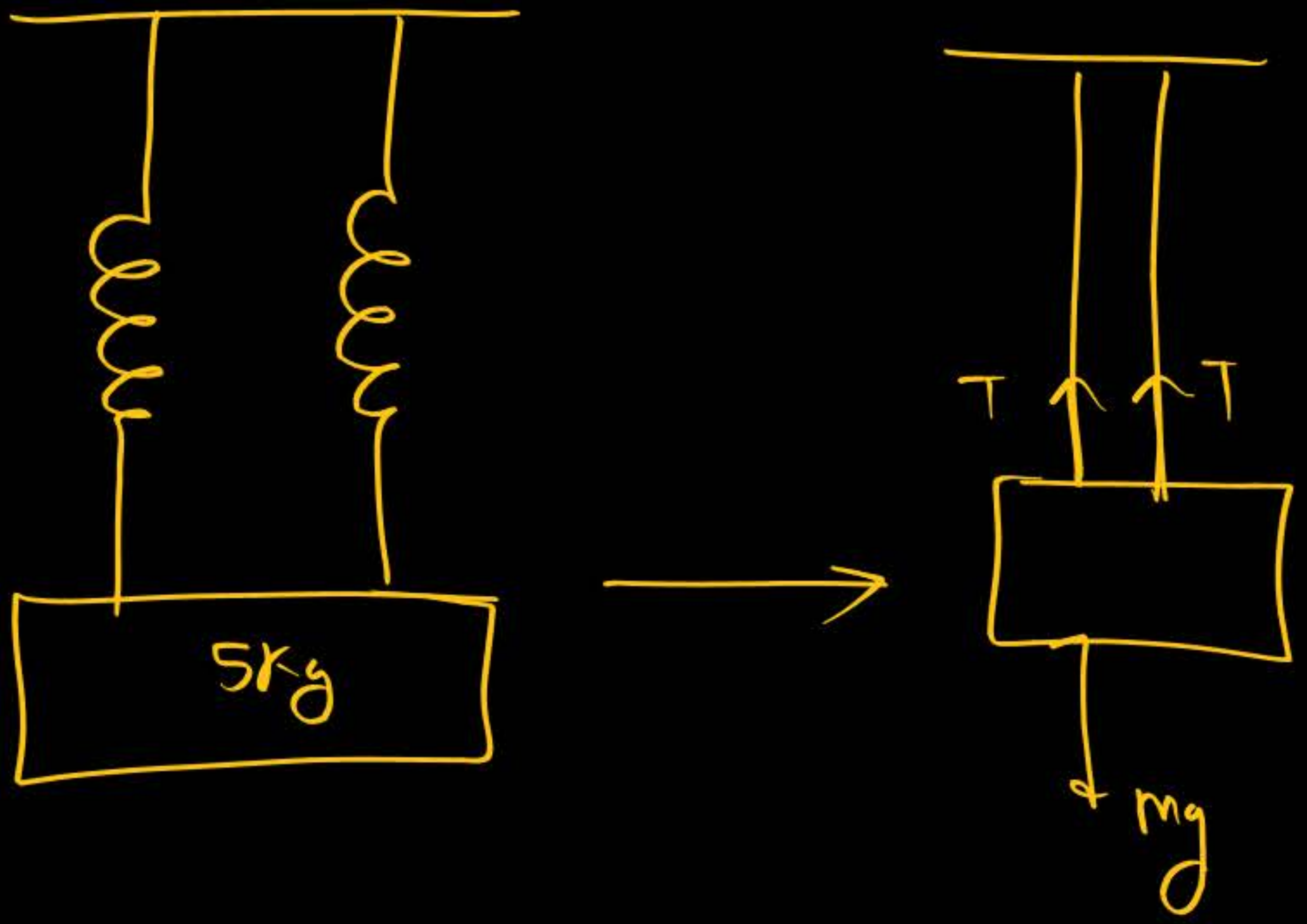
find Tension

↓

Spring force



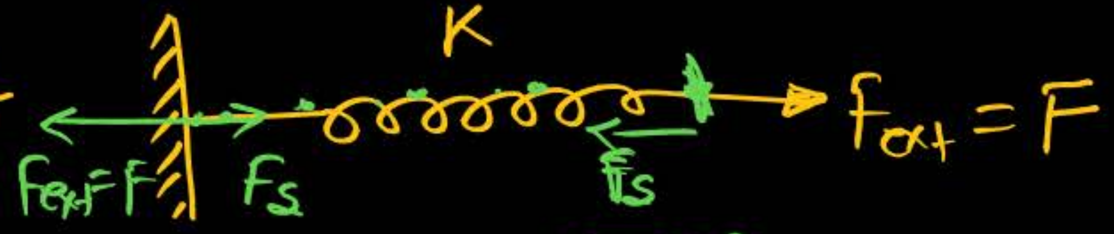
$f_s = mg = 50N$



$$2T = mg$$

$$F_s = T = \frac{50}{2} = 25N$$

Case-1



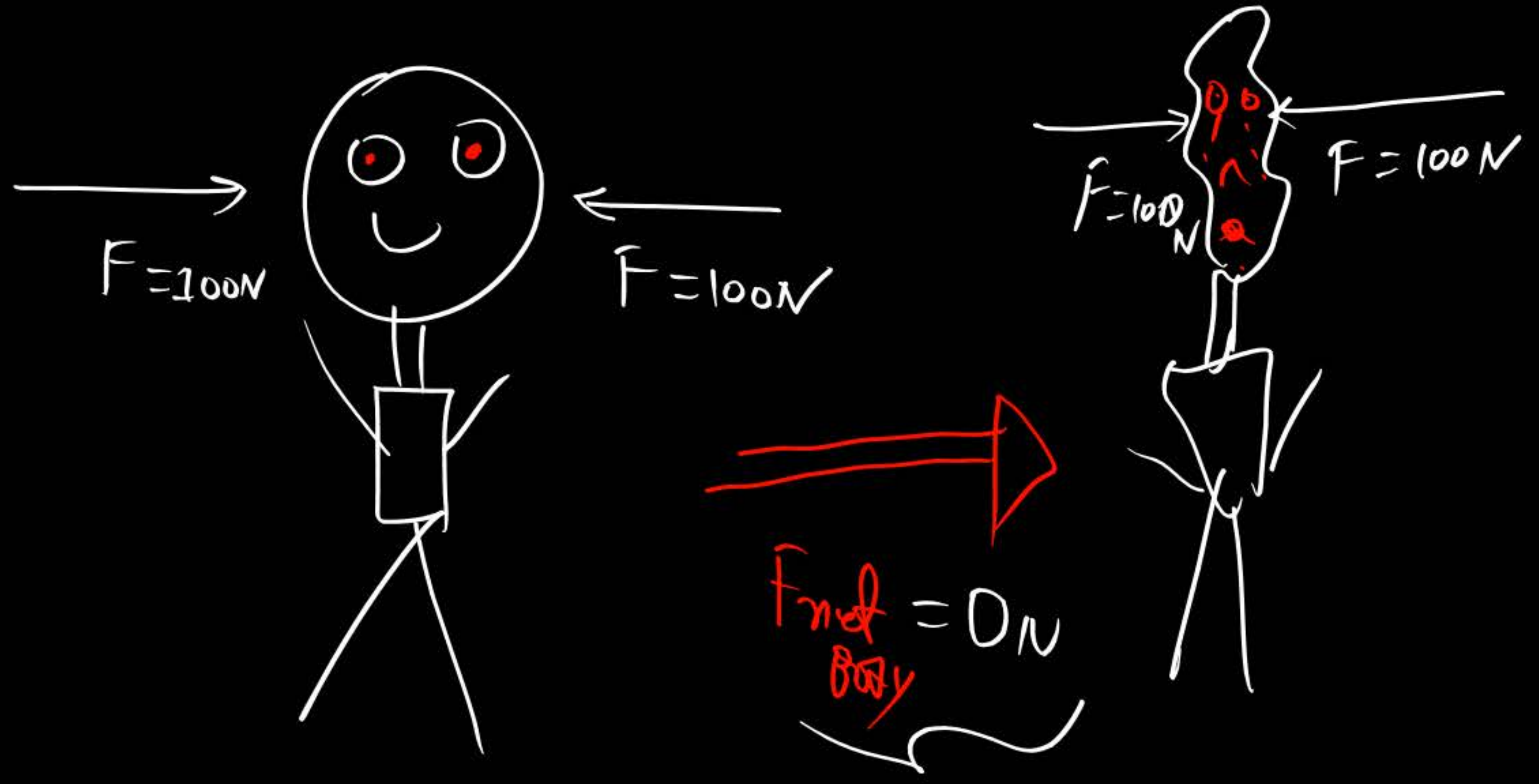
$$x = F/K$$

Case-2



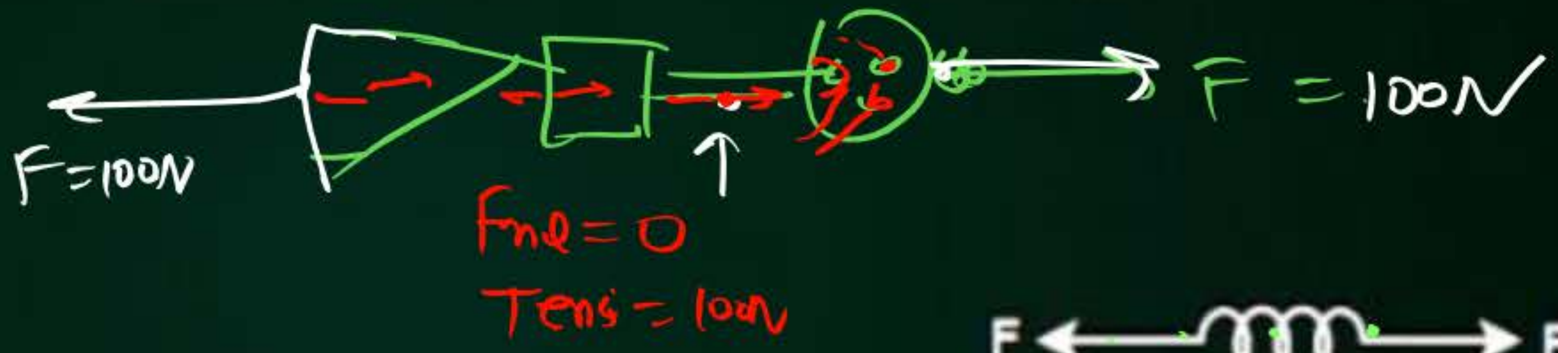
$$x = \frac{F}{K}$$

Balance force



QUESTION

Figure shows two cases. In first case a spring (spring constant K) is pulled by two equal and opposite force F at both ends and in second case is pulled by a force F at one end. Extensions (x) in the spring will be



1. In both cases $x = \frac{2F}{K}$

2. In both cases $x = \frac{F}{K}$



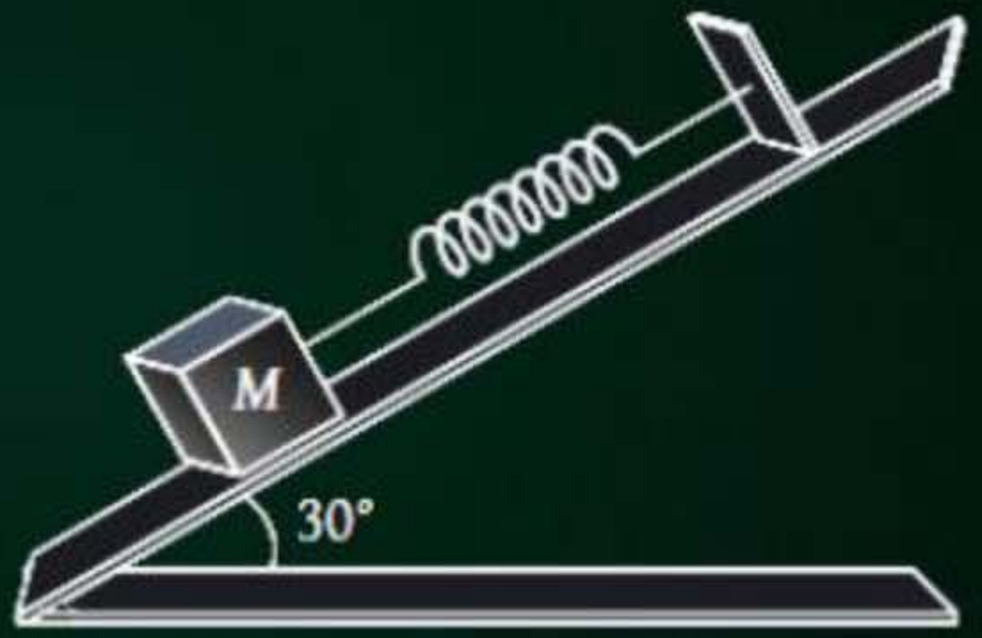
3. In first case $x = \frac{2F}{K}$, in second case $x = \frac{F}{K}$

4. In first case $x = \frac{F}{K}$, in second case $x = \frac{2F}{K}$

QUESTION

A body of mass 5 kg is suspended by a spring balance on an inclined plane as shown in figure. The spring balance measure :

1. 50 N
2. 25 N
3. 500 N
4. 10 N



QUESTION

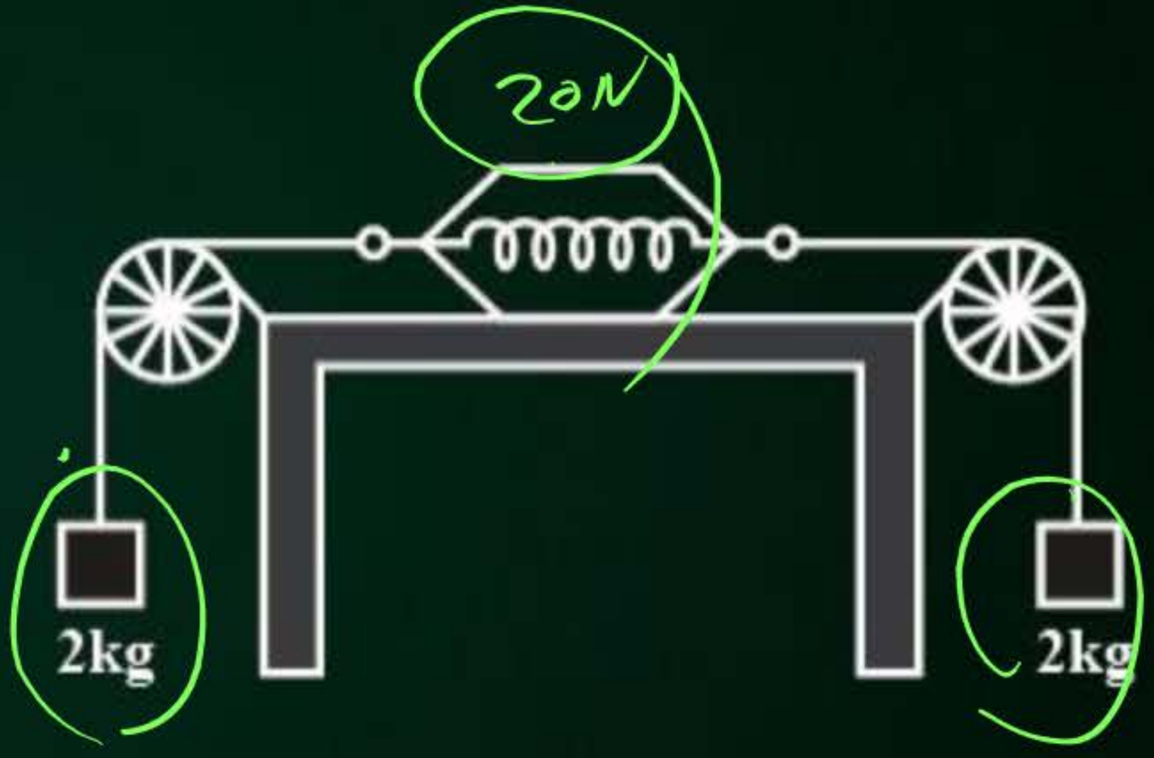
A block of mass 4 kg is suspended through two light spring balances A and B. Then A and B will read respectively :

1. 4 kg and zero kg
2. zero kg and 4 kg
3. 4 kg and 4 kg
4. 2 kg and 2 kg



QUESTION

As shown in figure, two equal masses each of 2 kg are suspended from a spring balance. The reading of the spring balance will be:



1. Zero
2. 2 kg
3. 4 kg
4. Between zero and 2 kg


THANK YOU

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FOR NEET 2025

Lecture- 04 | Physics

Laws of Motion



By- Dr. Manish Raj (MR SIR)

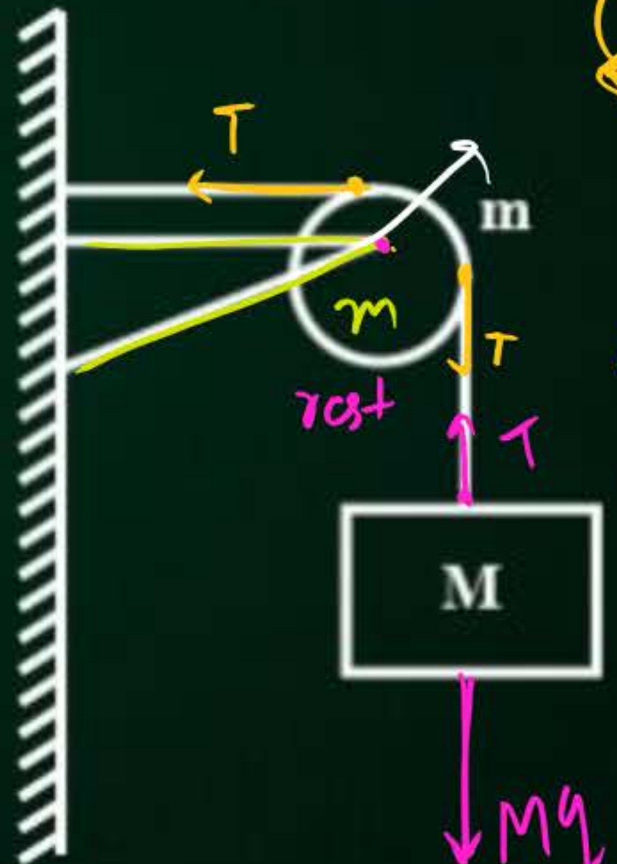
Topic To be Covered

- → H/W
- → Momentum
- → Conservation of Momentum
- → Newton's 2nd law → Force

QUESTION

A string of negligible mass going over a clamped pulley of mass m supports a block of mass M as shown in the figure. The force on the pulley by the clamp is given by (2001, 2M)

1. $\sqrt{2}\,Mg$
2. $\sqrt{2}\,mg$
3. $g\sqrt{(M+m)^2+m^2}$
4. $g\sqrt{(M+m)^2+M^2}$



Motion in a straight line ⟹

(Motion in a plane) ⟹

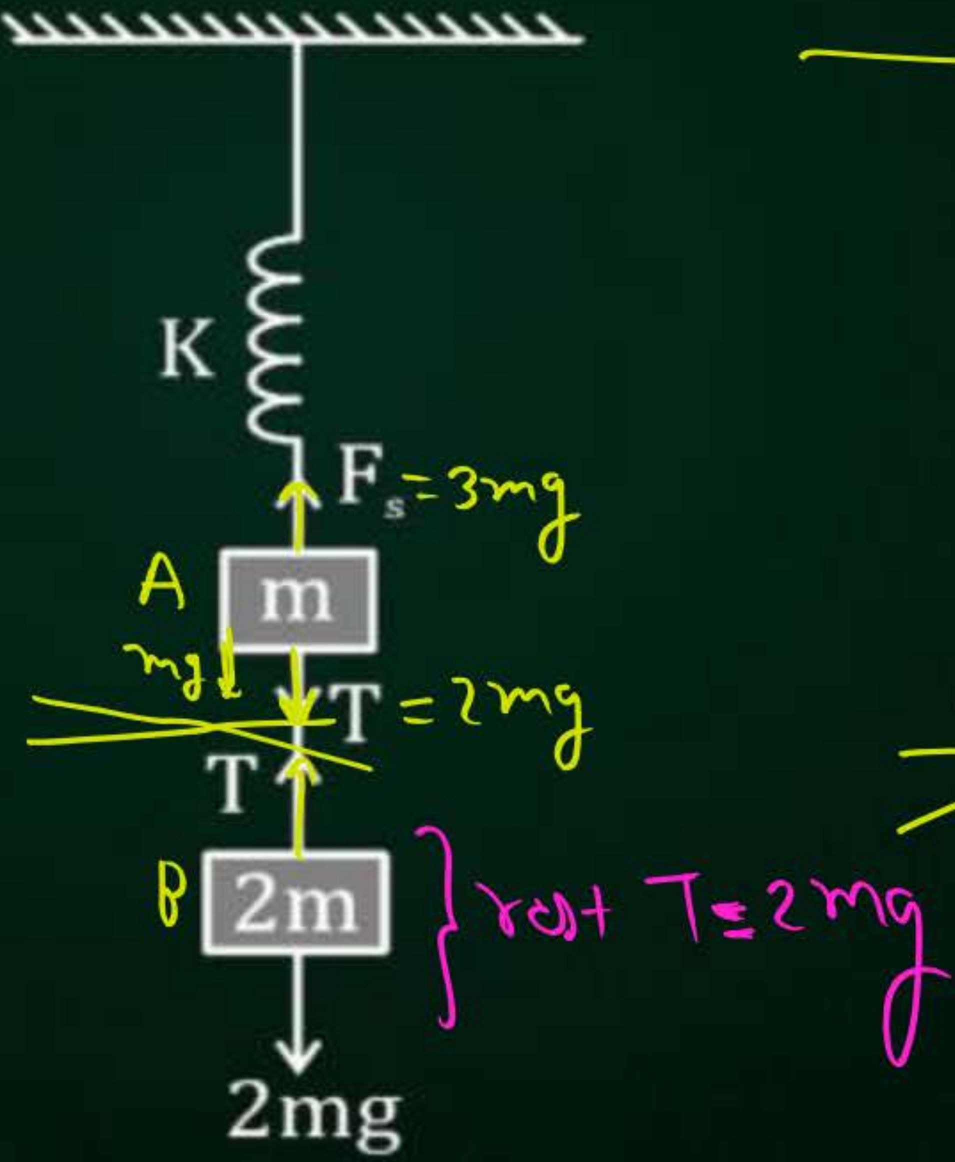
Total 9-lecture

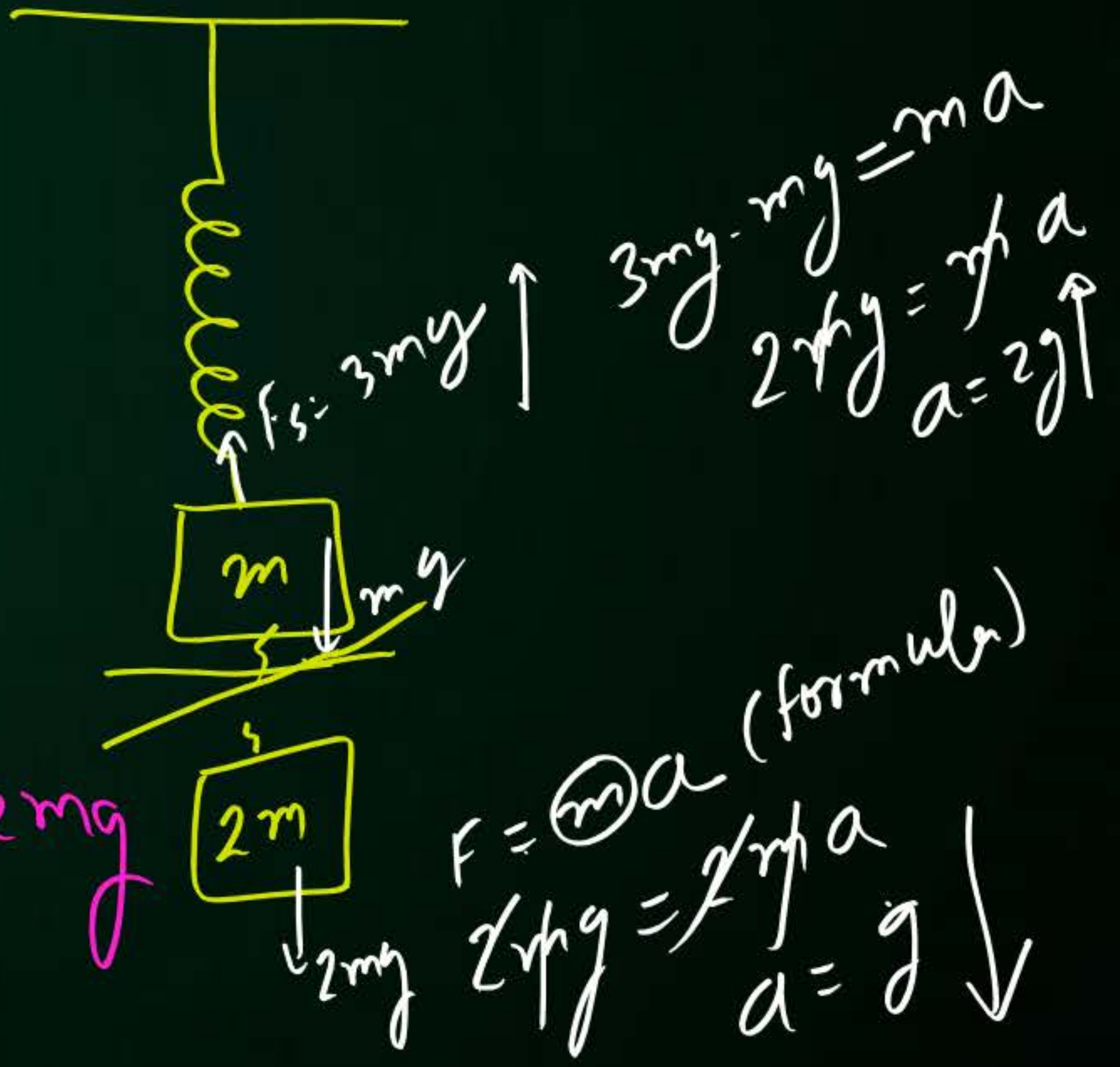
QUESTION

System as shown in figure is in equilibrium. If string is cut then find acceleration just after cutting the string of A and B.

$a_A = 2g \uparrow$

$a_B = g \downarrow$

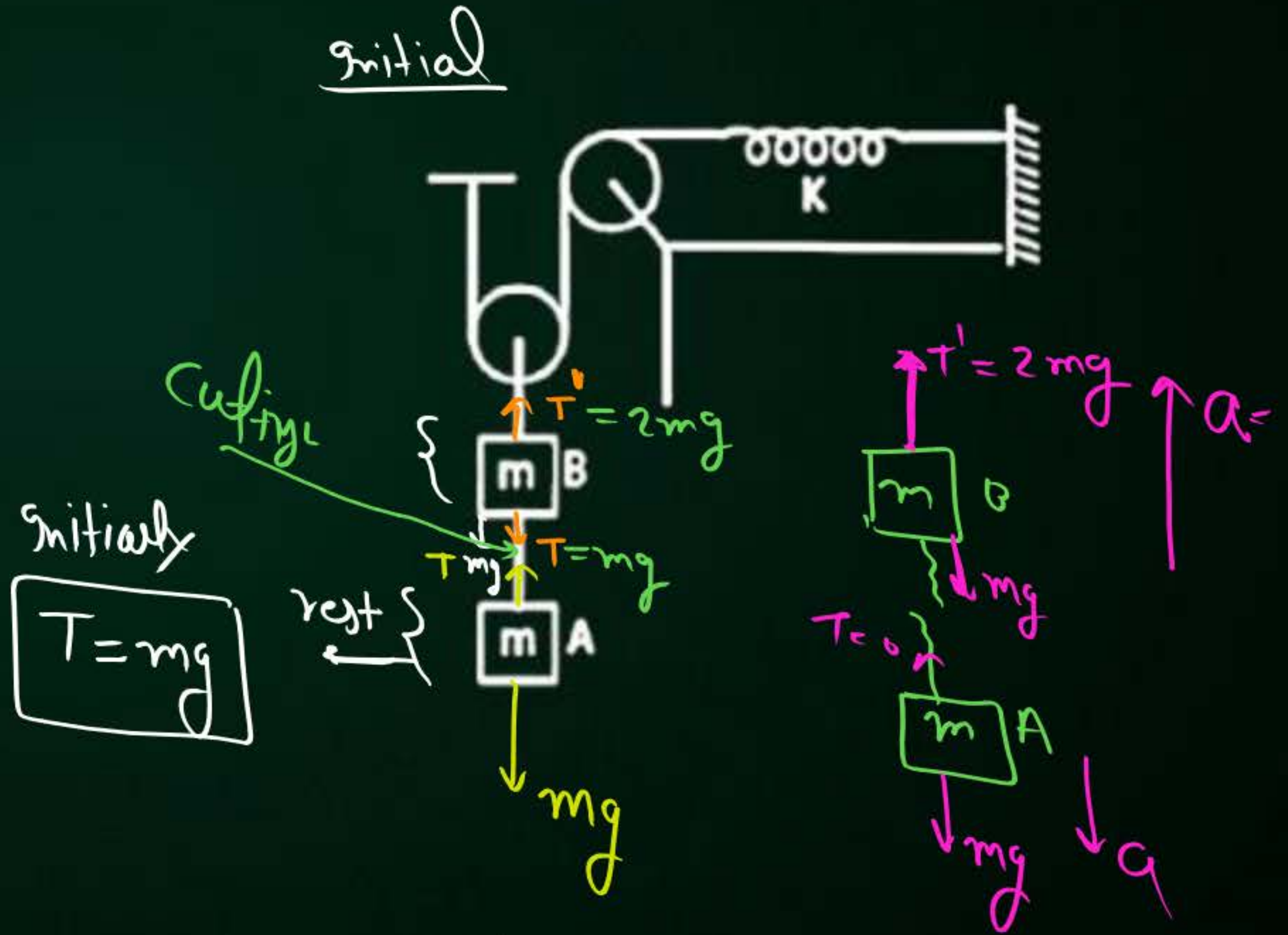


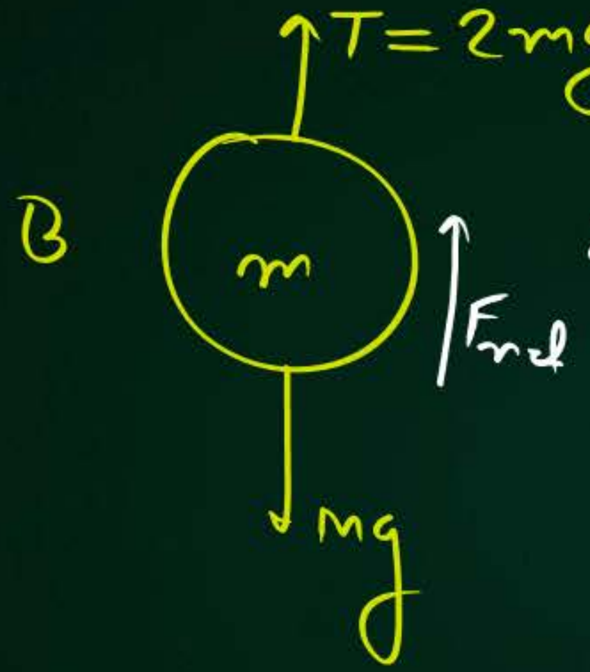


QUESTION

Initially both blocks A and B stay at equilibrium. If string between A and B is cut, then acceleration of block A and B just after cut will be :

1. g downward, g upward
2. $g/2$ downward, zero
3. g downward, g downward
4. $g/2$ downward, g upward





$$2mg - mg = ma$$

$$\cancel{m}g = \cancel{m}a$$

$$a = g \uparrow$$

A Train → u = 1 m/s

B M = 1 grm → V = 500 m/s

Kisko rokna easy hai

(a) A

(b) B

(c) dont know

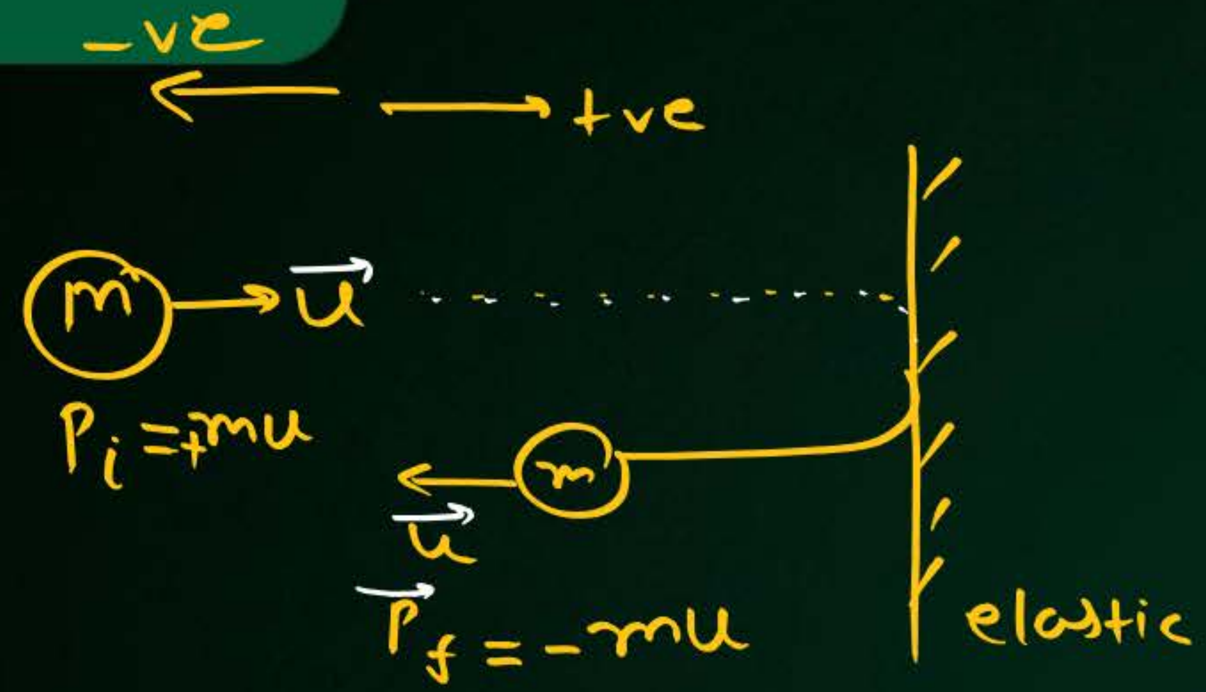
Momentum → Motion contained in a body is called momentum

1 kg → $\vec{v} = 10$ m/s, p ↑

1 grm → $\vec{v} = 10$ m/s, p ↓

$\vec{p} = m\vec{v}$

- → vector
- → dirn along velocity (motion)
- → unit → kg m/s
- → Can be −ve & +ve



Change in Momentum

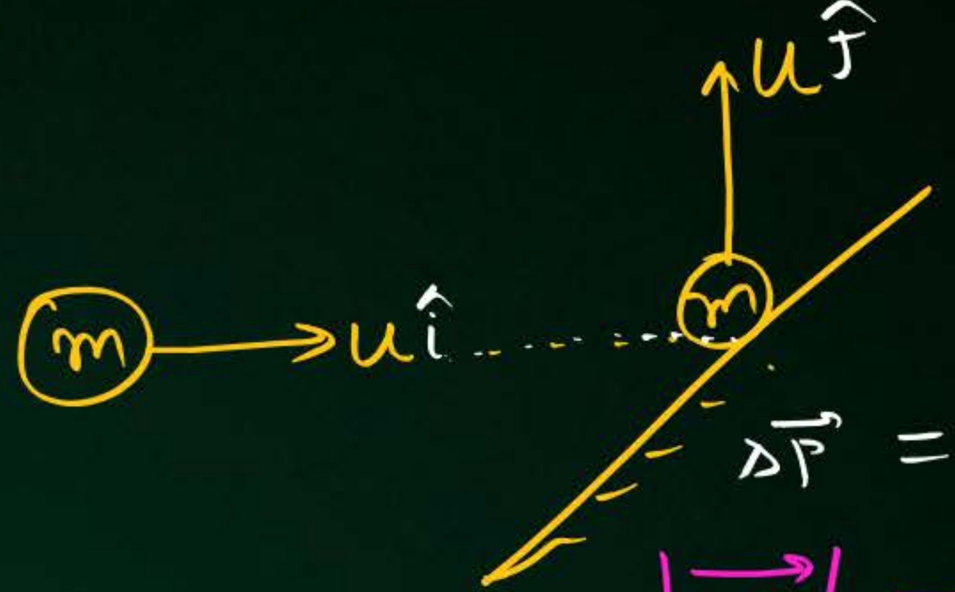
$$\vec{\Delta P} = \vec{P}_f - \vec{P}_i$$

$$= -m\vec{u} - m\vec{u}$$

$$\vec{\Delta P} = -2m\vec{u}$$

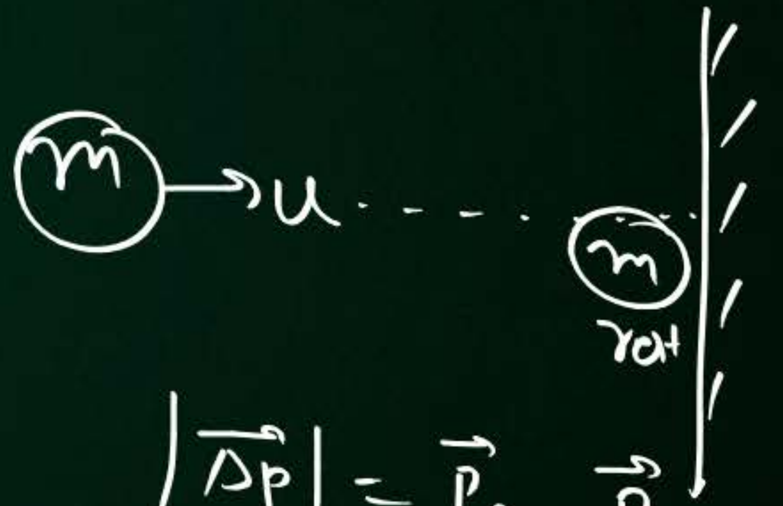
Magnitue of (change in Momentum) = 2mu ✓

Change in Magnitude of Momentum = 0 = $|\vec{P}_f| - |\vec{P}_i|$



$$\vec{\Delta P} = mu\hat{j} - mu\hat{i}$$

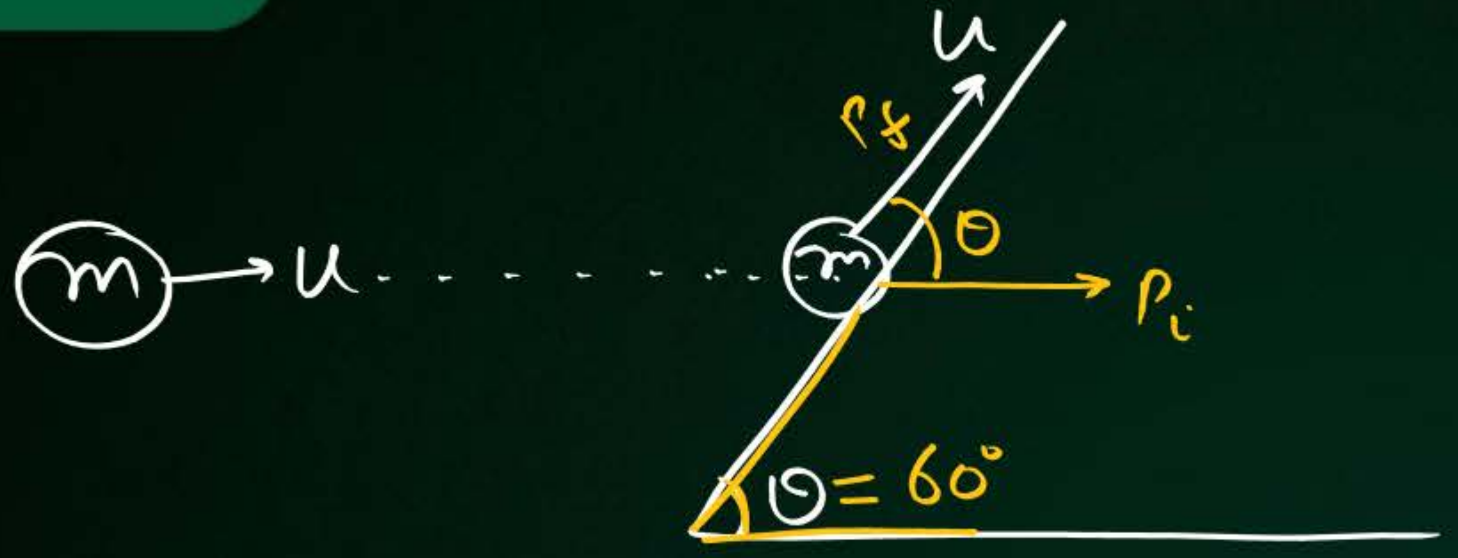
$$|\vec{\Delta P}| = \sqrt{2}\, mu$$



$$|\vec{\Delta p}| = \vec{P}_f - \vec{P}_i$$

$$= 0 - mu$$

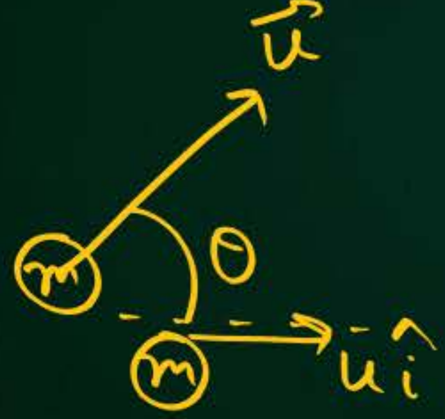
$$= mu \text{ (magnitude)}$$





$\Delta p = 0$

$\vec{\Delta p} = \vec{P_f} - \vec{P_i}$



(a) 2mu $\{= 2mu\sin(\theta/2)\}$

(b) zero $= 2mu\sin\left(\frac{60}{2}\right)$ (30°)

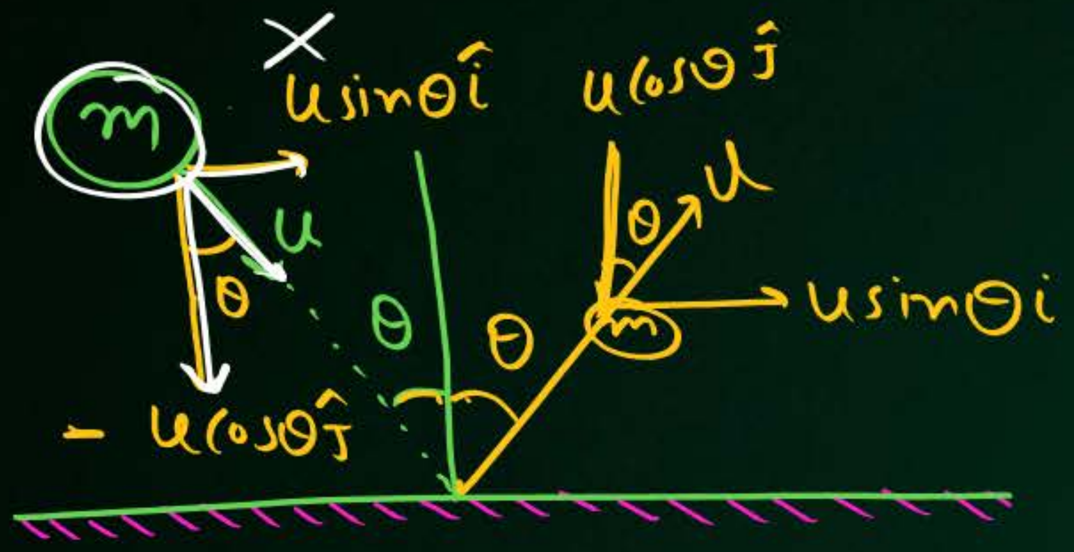
(c) mu $= 2mu \times \frac{1}{2}$

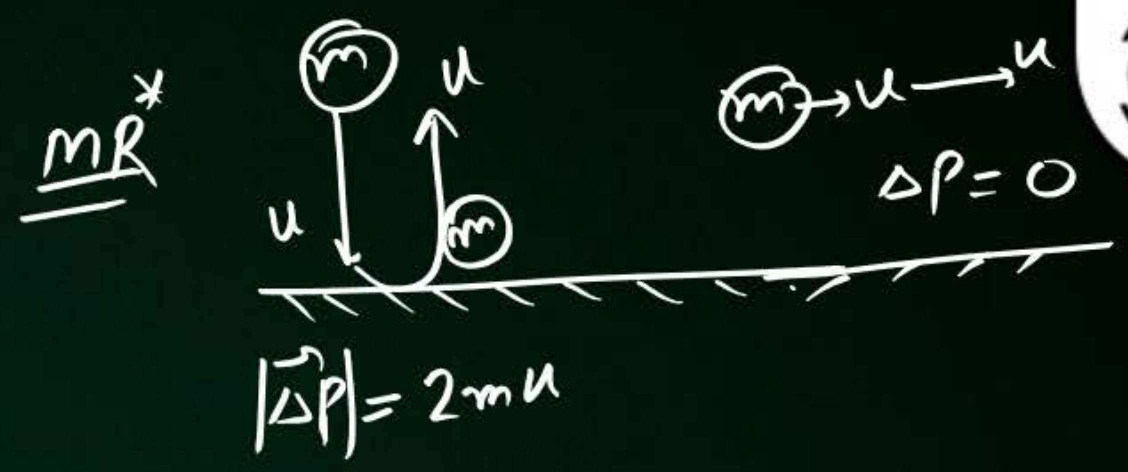
(d) $\sqrt{2}$ mu $= mu$

$P_i = mu\hat{i}$

$P_f = mu$ at θ

#

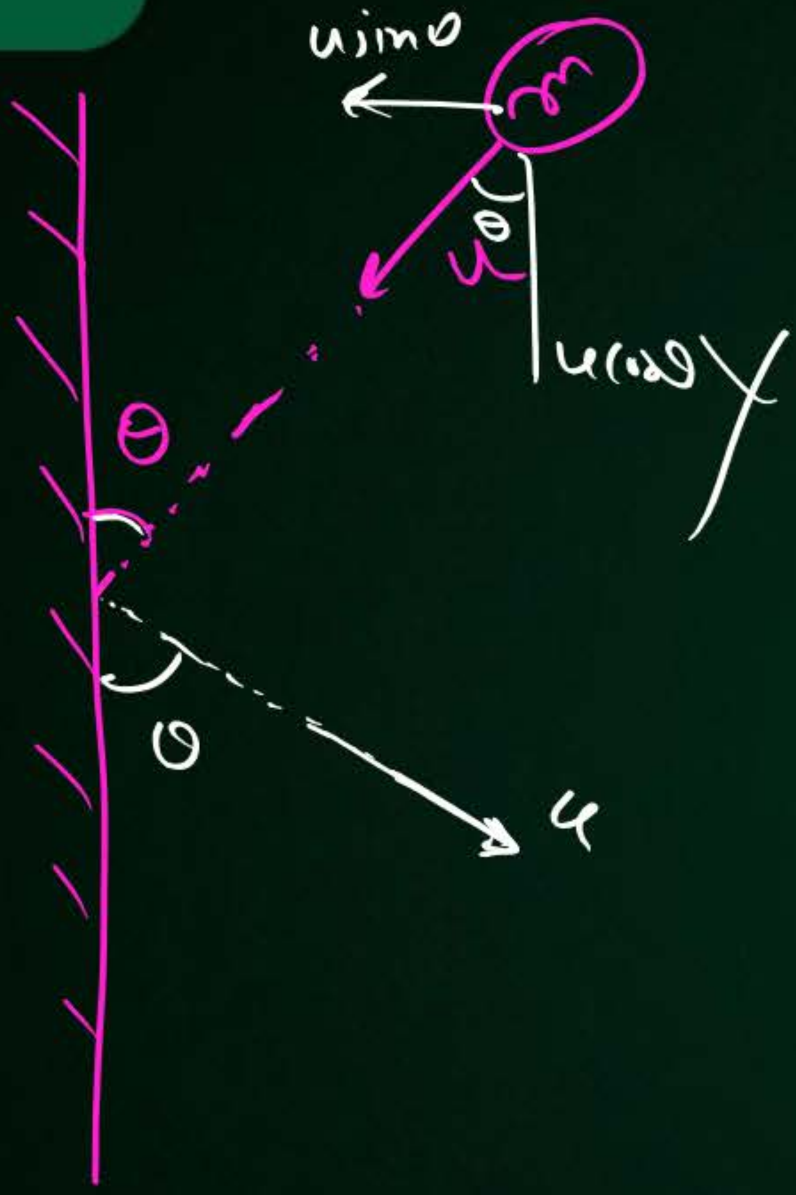




$$\vec{P_i} = mu\sin\theta\,\hat{i} - mu\cos\theta\,\hat{j}$$

$$\vec{P_f} = mu\sin\theta\,\hat{i} + mu\cos\theta\,\hat{j}$$

$$\vec{\Delta p} = \vec{P_f} - \vec{P_i} = (mu\sin\theta\,\hat{i} + mu\cos\theta\,\hat{j}) - (mu\sin\theta\,\hat{i} - mu\cos\theta\,\hat{j}) = 2mu\cos\theta\,\hat{j} = \vec{\Delta p}$$



$$|\overrightarrow{\Delta p}| = 2mu\sin\theta$$ ✓

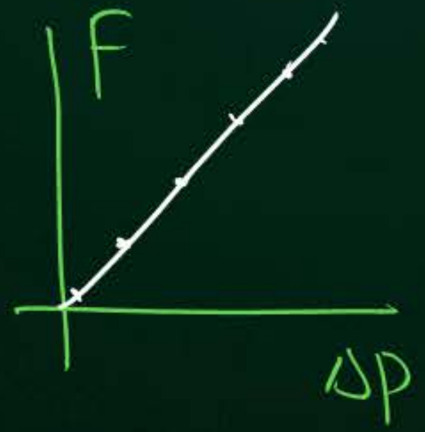
Newtons 2nd Law:

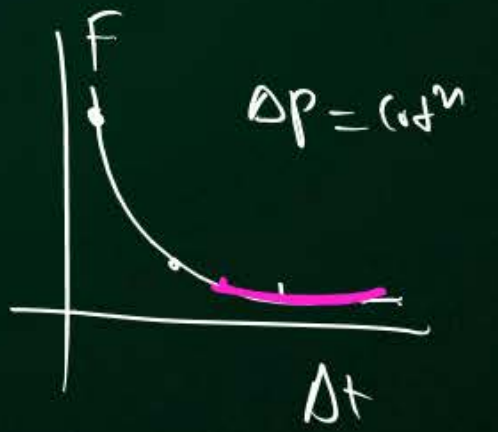
$$\vec{F} \propto \Delta\vec{P}$$

$$F \propto \frac{1}{\Delta t}$$

$$\vec{F}_{Avg} = \frac{\Delta\vec{P}}{\Delta t} = \frac{\vec{P}_f - \vec{P}_i}{\Delta t}$$







at time 't'

$$\vec{F}_{inst} = \frac{d\vec{P}}{dt}$$

- The rate of change in momentum is called force.
- Slope of P/t graph is force
- vector
- dir^n along change in momentum.

Impulse = Change in momentum $= \int dp = \int F\,dt$ = Area of F-t graph

P ⟷ $\vec{F}$

नाली $= \int p\,dt$ = Area of p-t graph

$\vec{F} = \dfrac{dp}{dt}$

F = slope of p/t graph

$\dfrac{dF}{dt} =$ नाली

slope F/t = नाली

MOMENTUM

$$\vec{P} = m\vec{v}$$

QUESTION

NEET-2014

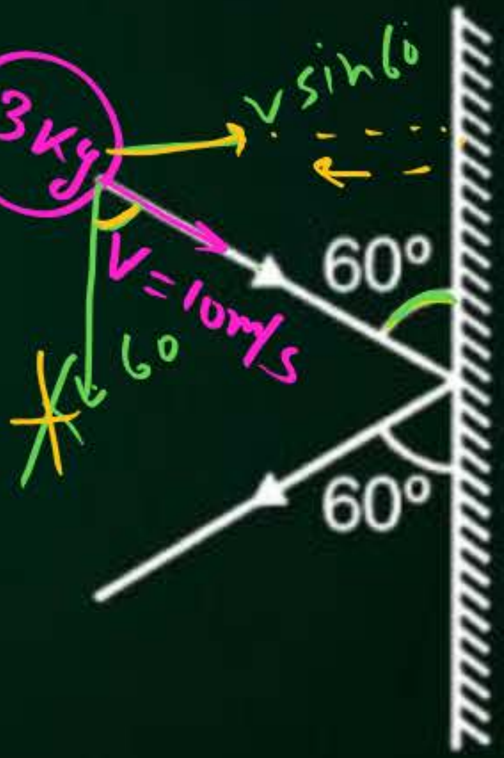
A body of mass 3 kg moving with velocity 10 m/s hits a wall at an angle of 60° and returns at the same angle. The impact time was 0.2 s. Calculate the force exerted on the wall.

(1) $150\sqrt{3}$ N Ans

(2) $50\sqrt{3}$ N

(3) 100 N

(4) 75 N



$$F_{Avg} = \frac{\Delta P}{\Delta t} = \frac{2mv\sin\theta}{\Delta t}$$

$$= \frac{2 \times 3 \times 10 \times \sqrt{3}}{2 \times \frac{2}{10}}$$

$$= 150\sqrt{3}$$

QUESTION

A 0.5 kg ball moving with a speed of 12 m/s strikes a hard wall at an angle of 30° with the wall. It is reflected with the same speed and at the same angle. If the ball is in contact with the wall for 0.25 s, the average force acting on the wall is:

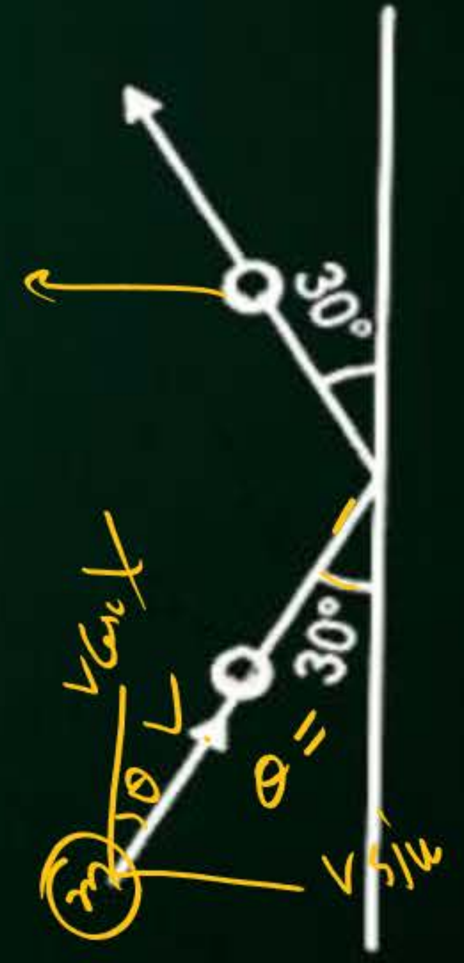
[AIPMT (Prelims)-2006]

1. 48 N
2. 24 N
3. 12 N
4. 96 N

$$= \frac{2mv\sin\theta}{\Delta t}$$

$$= \frac{2 \times \frac{1}{2} \times 12 \times \sin 30}{0.25}$$

$$= \frac{12 \times \frac{1}{2}}{\frac{1}{4}} = \frac{48}{2} = 24$$



QUESTION

A cricketer catches a ball of mass 150 g in 0.1 s moving with speed 20 m/s, then the experiences force of

1. 300 N
2. 30 N
3. 3 N
4. 0.3 N

$u_f = 0 \quad u_i = 20\,m/s$

$|\Delta \vec{v}| = 0 - 20 = -20$

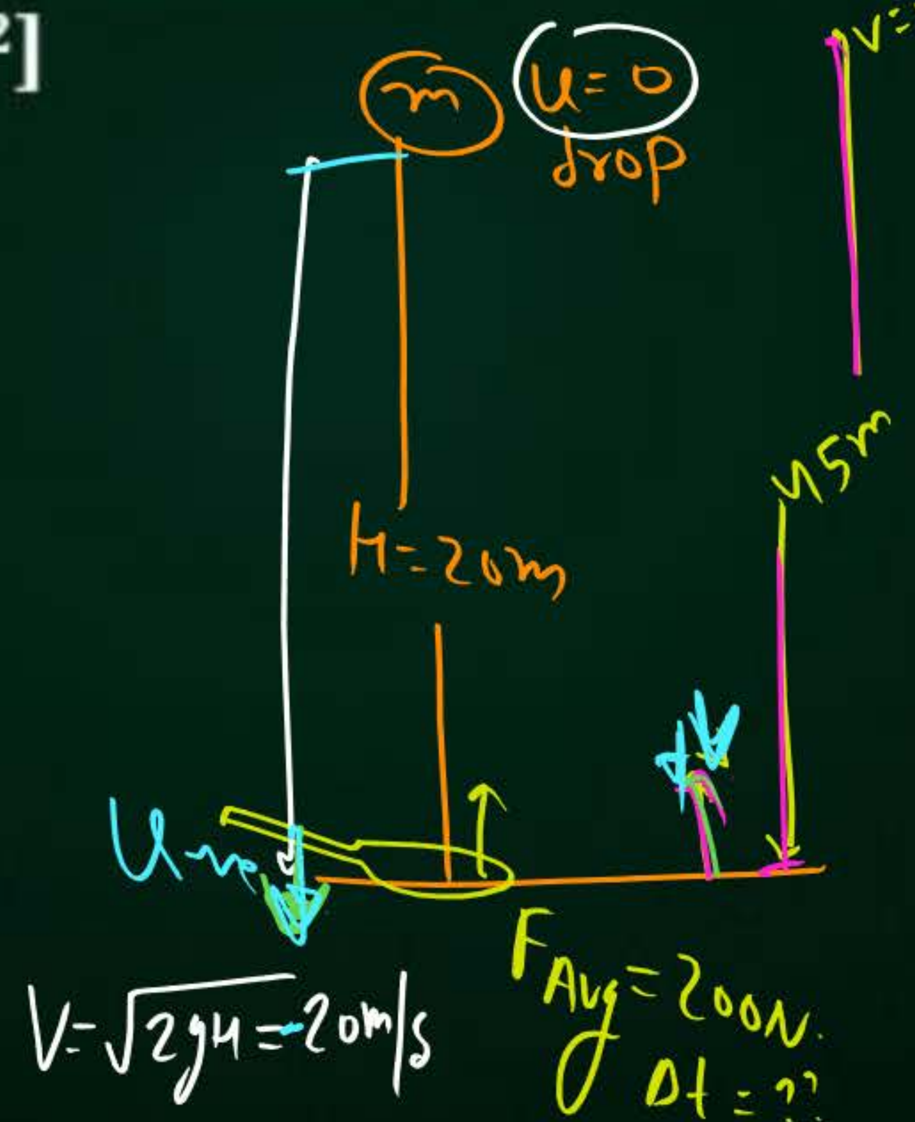
$F = 0 - \frac{150}{1000} \times \frac{20}{0.1}$

$- \frac{30}{1000} = 30\,N$

QUESTION

A ball of mass 50 g is dropped from a height of 20 m. A boy on the ground hits the ball vertically upwards with a bat with an average force of 200 N, so that it attains a vertical height of 45 m. The time for which the ball remains in contact with the bat is [Take $g = 10\ \text{m/s}^2$]

1. $1/20^{\text{th}}$ of a second
2. $1/40^{\text{th}}$ of a second
3. $1/80^{\text{th}}$ of a second
4. $1/120^{\text{th}}$ of a second



QUESTION

A force of 6 N acts on a body at rest and of mass 1 kg. During this time, the body attains a velocity of 30 m/s. The time for which the force acts on the body is

1. 7 second
2. 5 second
3. 10 second
4. 8 second

$u = 0$

$$F = \frac{\Delta \vec{p}}{\Delta t}$$

$$\vec{F} = \frac{\vec{p}_f - \vec{p}_i}{\Delta t} = \frac{m\vec{u}_f - m\vec{u}_i}{\Delta t}$$

$$F = \frac{m(\vec{v}_f - \vec{u}_i)}{\Delta t}$$

$$\Delta t = \frac{m(\vec{v}_f - \vec{u}_i)}{F} = \frac{1(30-0)}{6} = \frac{30}{6} = 5\ \text{sec}$$

newtons 2^{nd} law → definatation of Force

↳ The rate of change in momentum is c/d force

Force

- at time → $\vec{F} = \frac{d\vec{p}}{dt}$
- $\vec{F}_{Avg} = \frac{\overrightarrow{\Delta p}}{\Delta t}$

$$\vec{F} = \frac{d\vec{p}}{dt}$$

$$\vec{F} = \frac{d(mv)}{dt}$$

$$\vec{F} = v\frac{dm}{dt} + m\frac{dv}{dt}$$

$$\vec{F} = \vec{v}\frac{dm}{dt} + m\frac{d\vec{v}}{dt}$$

$m = \text{const}^n$

$$\vec{F} = m\frac{d\vec{v}}{dt}$$

$$\vec{F} = m\vec{a}$$

↳ This is not a 2^{nd} law
this is only a special case

$\vec{u} = \text{con}^n$

$$\vec{F} = \vec{v}\frac{dm}{dt}$$

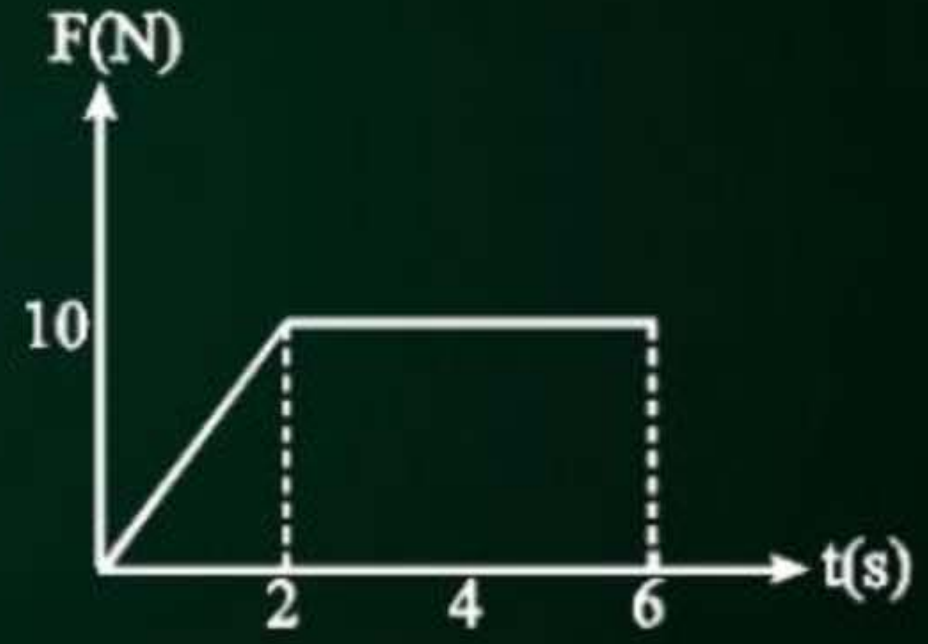
↳ Variable Mass System

If object is moving with constant velocity then force on it must be zero → False

QUESTION

A body of mass 3 kg is acted on by a force which varies as shown in the graph below. The momentum acquired is given by :

1. Zero
2. 5 N-S
3. 30 N-S
4. 50 N-S



Area of graph

QUESTION

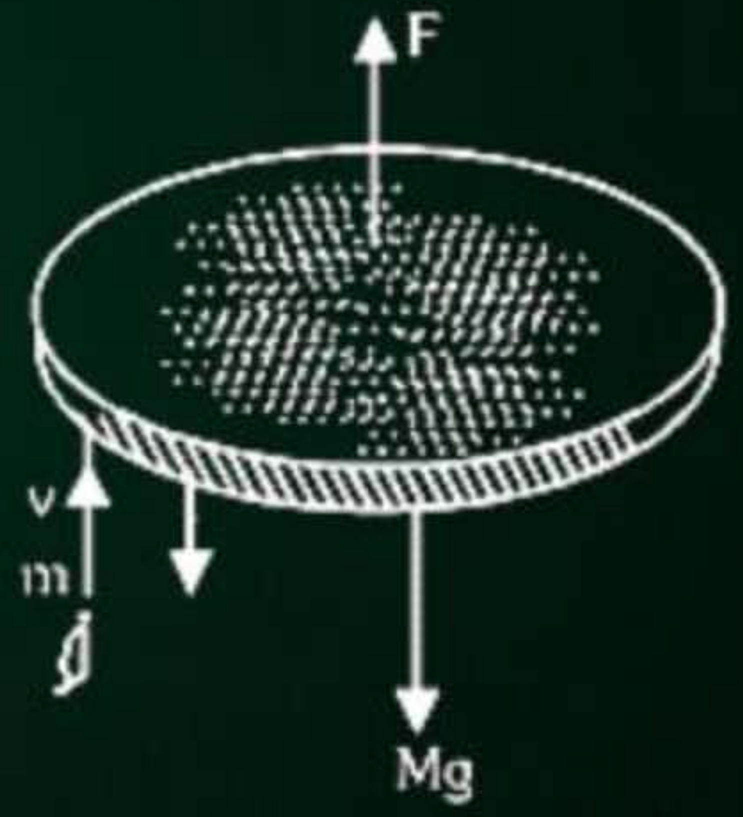
level up

A weight Mg is suspended from the middle of a rope whose ends are at the same level. The rope is no longer horizontal. The minimum tension required to completely straighten the rope is

1. $Mg/2$
2. $Mg \cos 8$
3. $2\,Mg \cos 8$
4. Infinitely large

QUESTION

A disc of mass 1.0 kg kept floating horizontally in air by firing bullets of mass 0.05 kg each vertically at it, at the rate of 10 per second. If the bullets rebound with the same speed, the speed with which these are fired will be-



1. 0.098 m/s
2. 0.98 m/s
3. H/W 9.8 m/s
4. 98.0 m/s

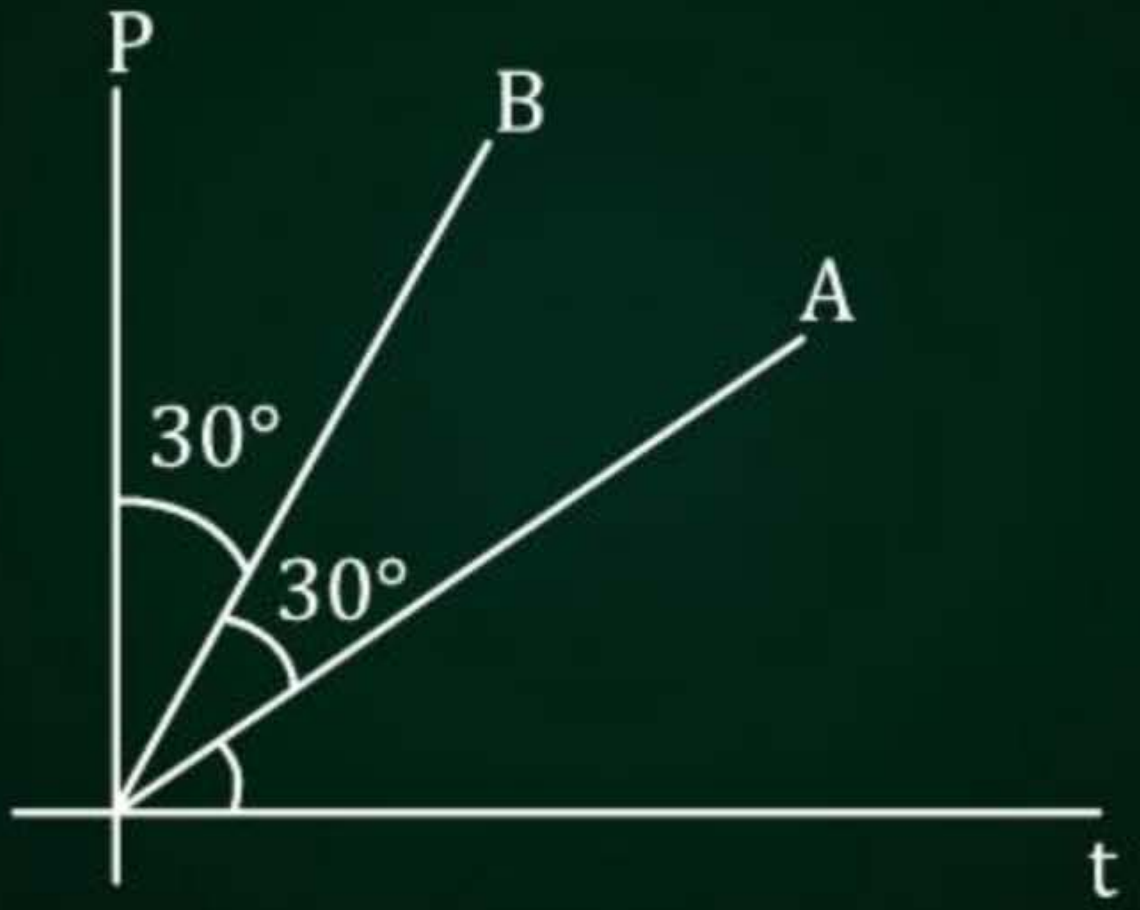
QUESTION

A stone of mass 1 kg is thrown with a velocity of 20 m/s across the frozen surface of a lake and it comes to rest after travelling a distance of 50 m. What is the magnitude of the force opposing the motion of the stone?

H/W

QUESTION

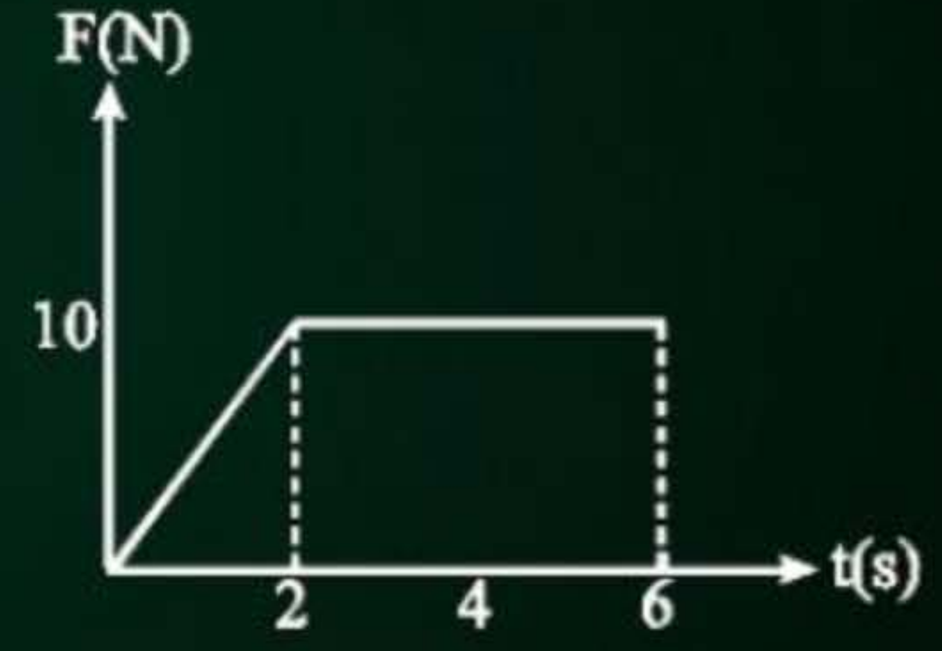
For two object P-t graph is given then find ratio of force acting on them.



QUESTION

A body of mass 3 kg is acted on by a force which varies as shown in the graph below. The momentum acquired is given by :

1. Zero
2. 5 N-S
3. 30 N-S
4. 50 N-S



QUESTION

The momentum p (in kg/m) of a particle is varying with time t (in s) as $p = 2 + 3t^2$. The force acting on the particle at $t = 3$ s will be

1. 18 N
2. 54 N
3. 9 N
4. 15 N

QUESTION

A force $\vec{F} = (2t\hat{\imath} + 3t^2\hat{\jmath})N$ acts on an object moving in xy plane. Find magnitude of change in momentum of the object in time interval $t = 0$ to $t = 2s$.

QUESTION

If the force on a rocket, that releases the exhaust gases with a velocity of 300 m/s is 210 N, then the rate of combustion of the fuel is :

1. 0.07 kg/s
2. 1.4 kg/s
3. 0.7 kg/s
4. 10.7 kg/s


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 5 | Physics

Laws of Motion



By- Dr. Manish Raj (MR SIR)

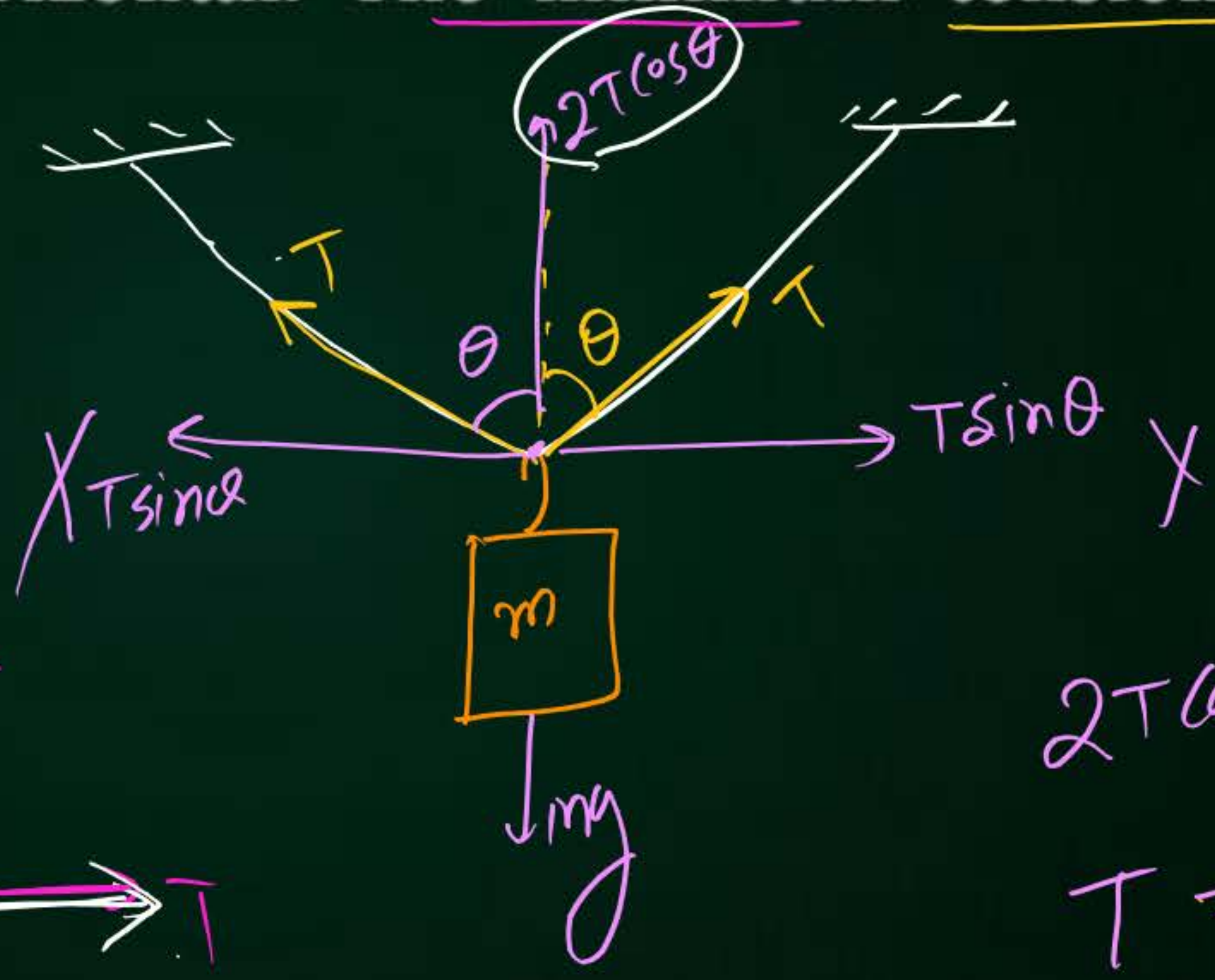
Topic to be Covered

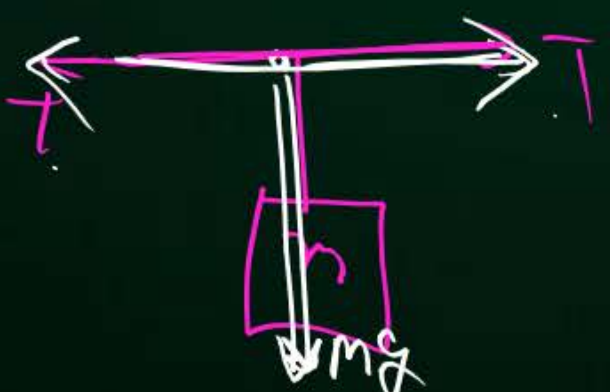
- H/W
- Variable mass system.
  - Ex- Ballon Prop^m
  - Rocket Prop^m
- Conservation of momentum
  - Gun Bullet system

QUESTION

A weight Mg is suspended from the middle of a rope whose ends are at the same level. The rope is no longer horizontal. The minimum tension required to completely straighten the rope is

1. $Mg/2$
2. $Mg \cos 8$
3. $2\ Mg \cos 8$
4. Infinitely large



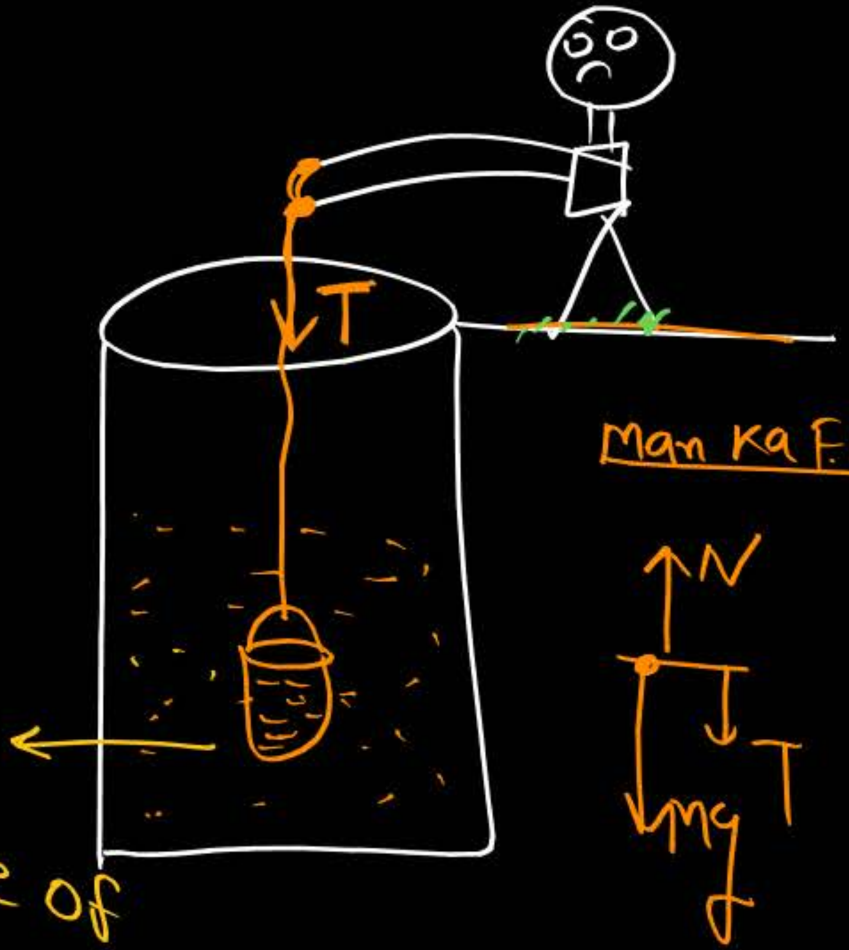


$2T\cos\theta = mg$

$T = \frac{mg}{2\cos\theta}$

for compt straight $\theta = 90°$

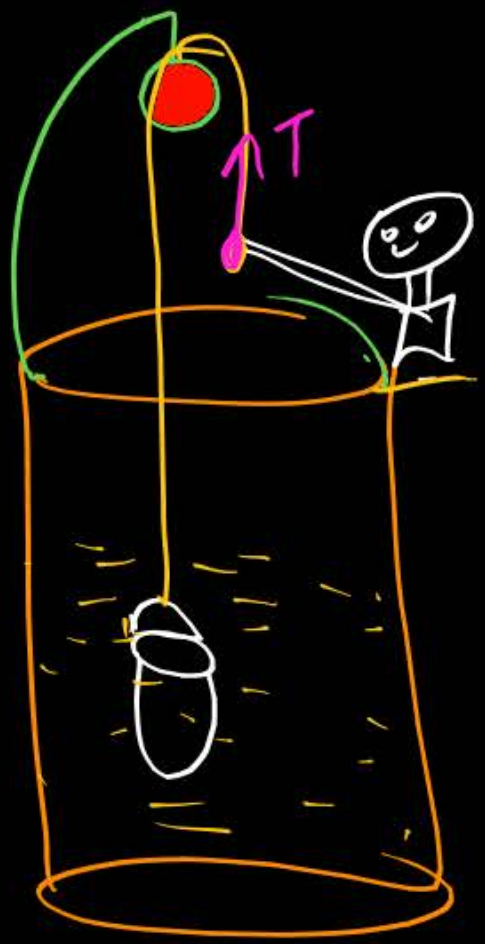
$T = \frac{mg}{2\cos 90} = \infty$



Size of bukket is same in both case

Man ka F.B.D

$N = T + mg$



F-BD of ma



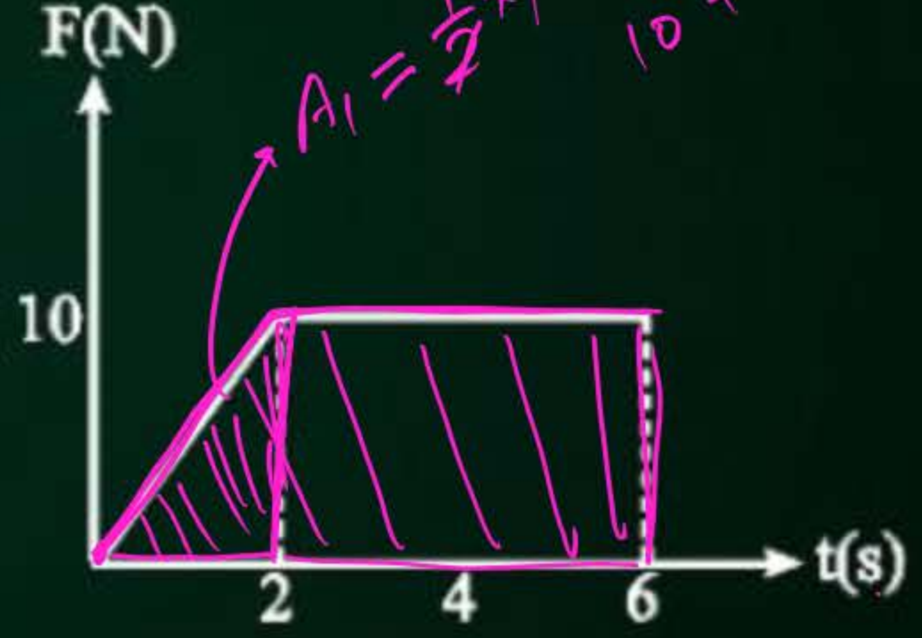
$N = mg - T$

QUESTION

A body of mass 3 kg is acted on by a force which varies as shown in the graph below. The momentum acquired is given by :

1. Zero
2. 5 N-S
3. 30 N-S
4. 50 N-S





QUESTION

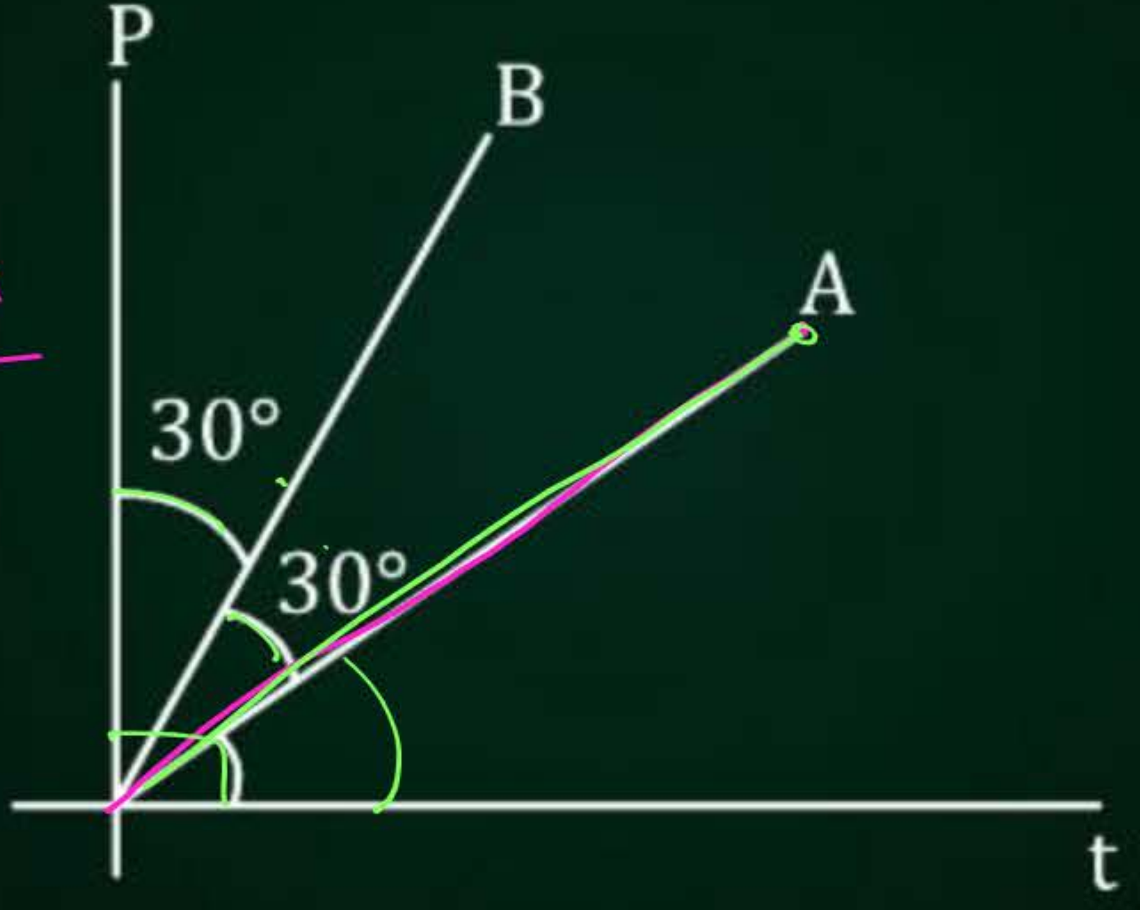
For two object P-t graph is given then find ratio of force acting on them.

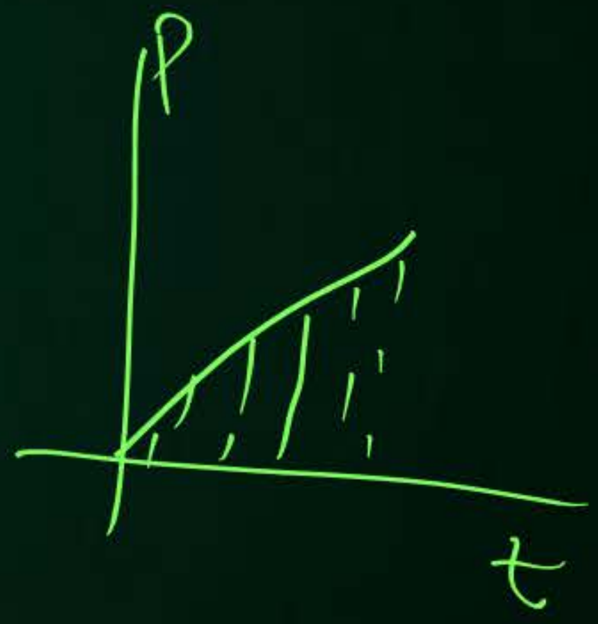
$\frac{F_A}{F_B} = ??$

$$\frac{F_A = \text{slope}_A = \tan\theta_A}{F_B = \text{slope}_B = \tan\theta_B}$$

$= \frac{\tan 30^\circ}{\tan 60^\circ}$

$$\frac{F_A}{F_B} = \frac{1}{3}$$





QUESTION

The momentum p (in kg/m) of a particle is varying with time t (in s) as $p = 2 + 3t^2$. The force acting on the particle at $t = 3$ s will be

1. 18 N
2. 54 N
3. 9 N
4. 15 N

$$P = 2 + 3t^2$$

$$F = \frac{dP}{dt} = 0 + 3(2t)$$

$$F = 6t$$

$$|F|_{t=3} = 6 \times 3 = 18\ N$$

$$\langle P \rangle_{Avg} = \frac{\int P\,dt}{\int dt}$$

QUESTION

A force $\vec{F} = (2t\hat{i} + 3t^2\hat{j})N$ acts on an object moving in xy plane. Find magnitude of change in momentum of the object in time interval $t = 0$ to $t = 2s$.

$F = 2t\hat{i} + 3t^2\hat{j}$

$\frac{dP}{dt} = 2t\hat{i} + 3t^2\hat{j}$

$\int_{P_i}^{P_f} dP = \int 2t\,dt\,\hat{i} + \int 3t^2\,dt\,\hat{j}$

$\Delta P = 2\left(\frac{t^2}{2}\right)_0^2 \hat{i} + 3\left(\frac{t^3}{3}\right)_0^2 \hat{j}$

~~$= 4 + 8 = 12$~~

$\vec{\Delta P} = 4\hat{i} + 8\hat{j}$

$|\vec{\Delta P}| = \sqrt{16+64}$

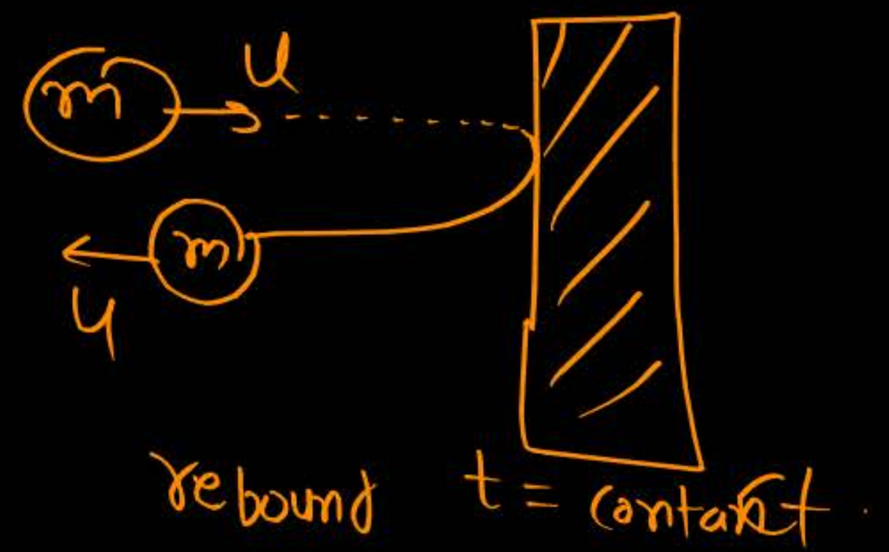
$= \sqrt{80}$

$= 4\sqrt{5}$ N-s

~~(a) 12.~~

~~(b) $\sqrt{80}$~~





Force applied by Ball on the wall = $(\hat{i})$

" " " Wall on the Ball = $\frac{|\Delta \vec{p}|}{t} = \frac{2mu}{t}$ * Force $(-\hat{i})$

QUESTION

A disc of mass 1.0 kg kept floating horizontally in air by firing bullets of mass 0.05 kg each vertically at it, at the rate of 10 per second. If the bullets rebound with the same speed, the speed with which these are fired will be-

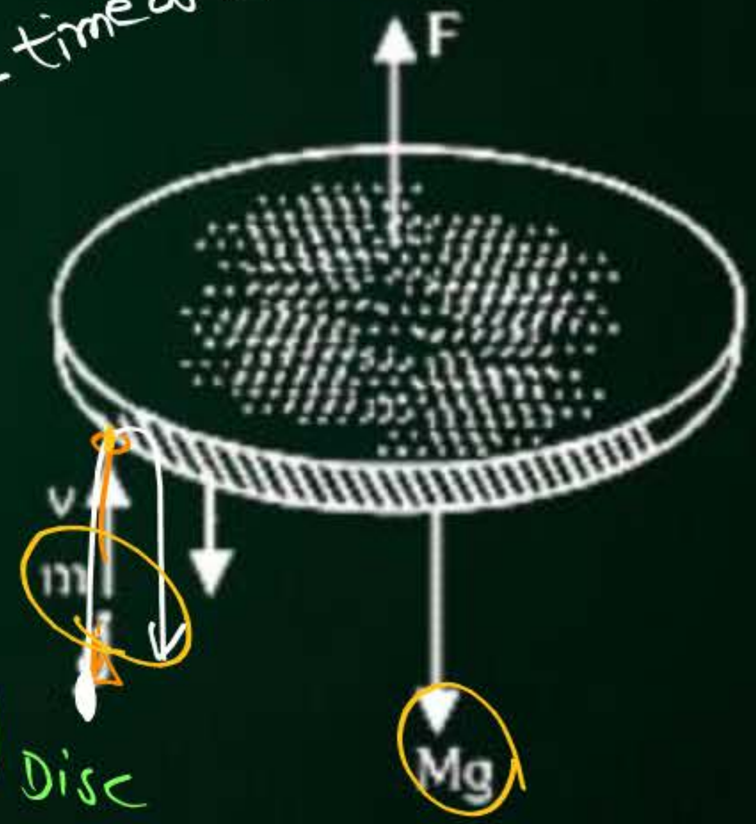
1. 0.098 m/s
2. 0.98 m/s
3. 9.8 m/s ✓
4. 98.0 m/s

Force on one bullet $= \frac{2mu}{t}$ ← time of collision

Force on N bullet $= N\left(\frac{2mu}{t}\right)$

Force on disc due to N bullet $= \text{"}N\text{"}\left(\frac{2mu}{t}\right)$ upward $= (Mg)_{Disc}$

$u = \frac{Mg}{2m} \times \frac{t}{N} = \frac{1 \times 9.8}{\left(\frac{2 \times 5}{100}\right) \times 10} = 9.8 \text{ m/s}$



NEWTON'S 3rd LAW OF MOTION

→ define Nature of force

→ There is always equal and opposite rex^n for every action force.

→ action & reaction acts on a diff^n Body at a same time.

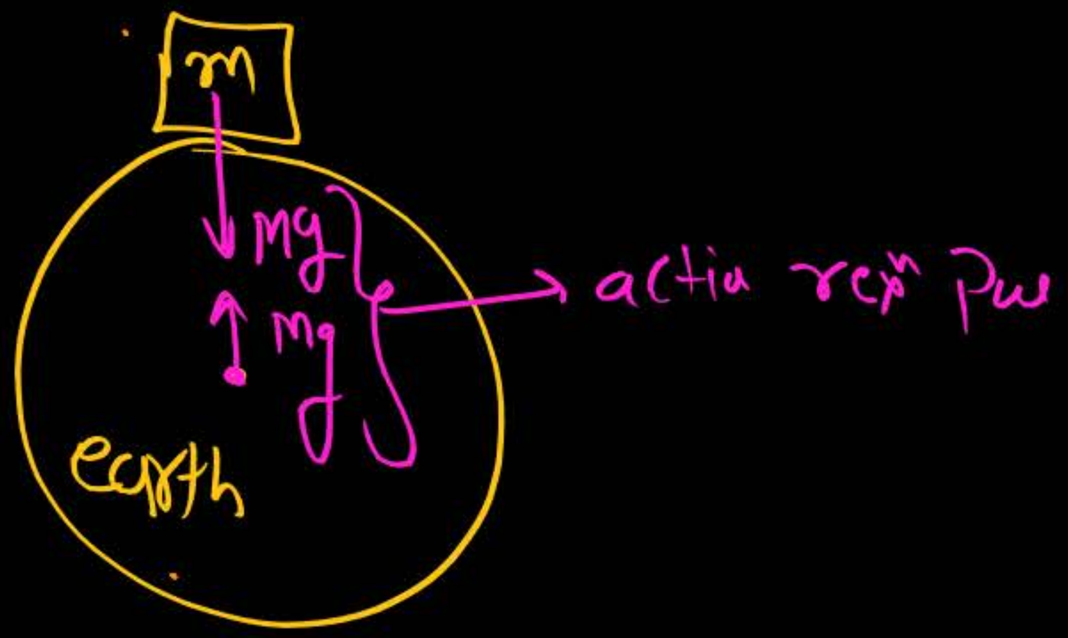
→ Action-rex^n force must be a same nature of force

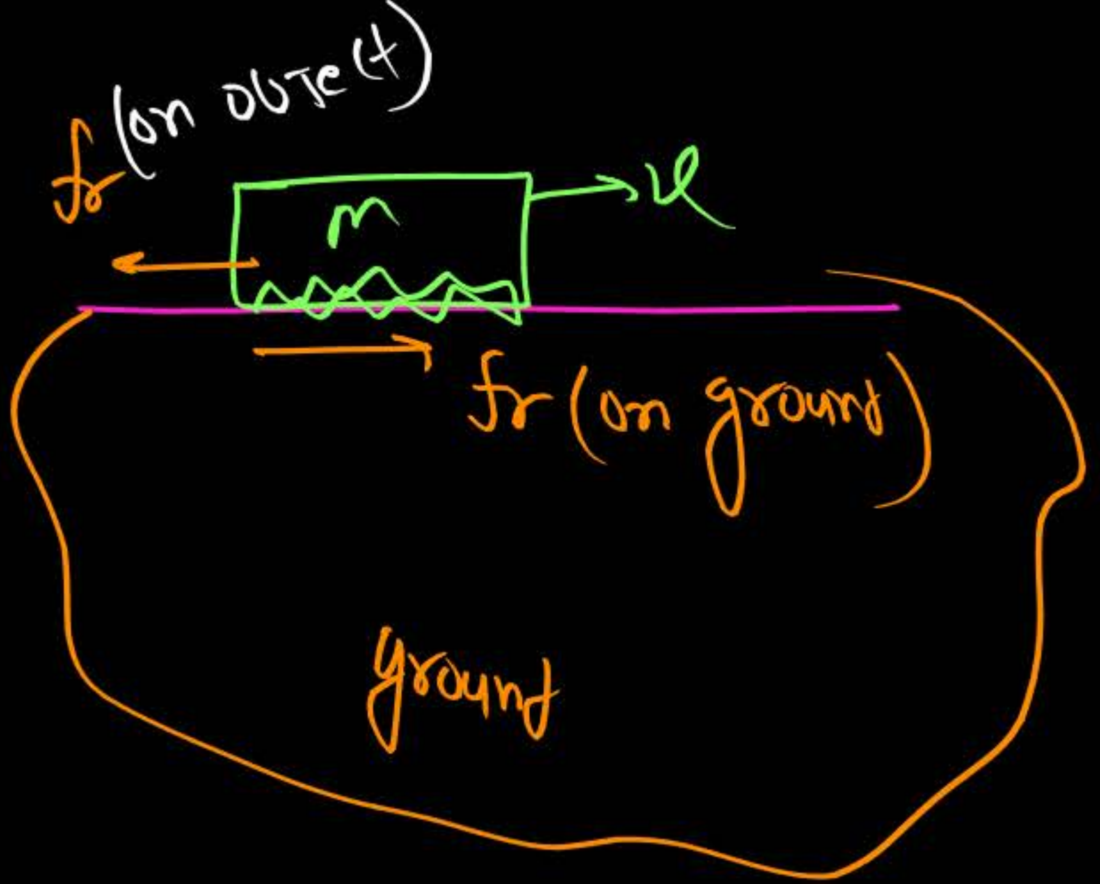
These two Normal are action rex^n Pair

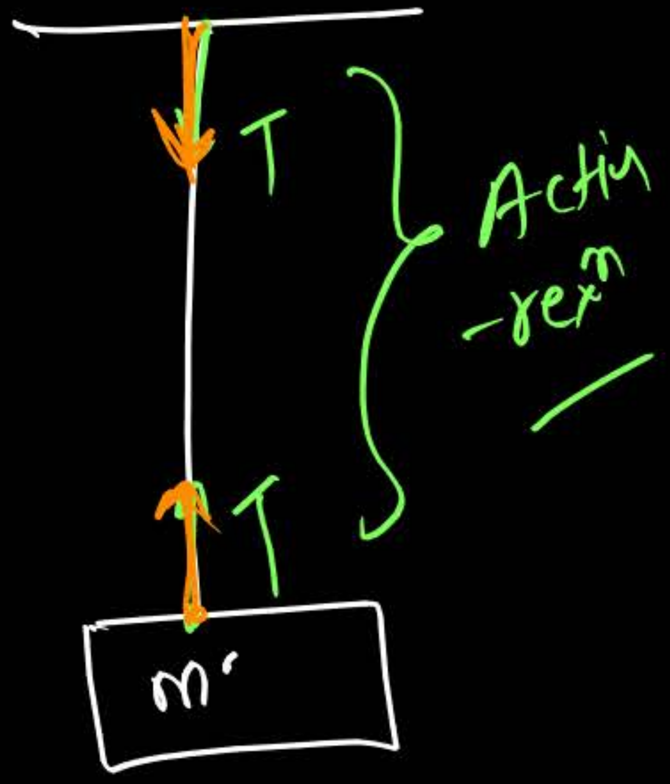
$N = mg$ ✗



Is Normal and mg are action reay^n pair
(a) yes (b) NO


m
mg
mg
earth
actia rexn pw


fr (on object)
m
v
fr (on ground)
ground


T
T
m'
Actin
-rexn

IMPULSE

- **Impulse** is defined as the change in momentum. It is measured as the product of the average force and time for which the force acts. It is a vector quantity directed along the direction of force.

$$I = \Delta \vec{P} = \vec{P_f} - \vec{P_i}$$

$$F = \frac{dp}{dt}$$

$$\int dp = \int F \cdot dt$$

$$\Delta p = I = \int F \cdot dt$$

QUESTION

If impulse varies with time t as $(kg\ ms^{-1}) = 20t^2 - 40t$. The change in momentum is minimum at

1. $t = 2s$
2. $t = 1s$ ✓
3. $t = 1/2\ s$
4. $t = 3/2\ s$

Impulse

$I = 20t^2 - 40t$

→ I will be maxⁿ or min $\frac{dI}{dt} = 0$

$\frac{dI}{dt} = 0 = 20\frac{dt^2}{dt} - 40\frac{dt}{dt}$

$0 = 20(2t) - 40 \times 1$

$0 = 40t - 40$

$40 = 40t$ $t = 1 sec$

QUESTION

do it

A balloon has 2 gm of air. A small hole is pierced into it. The air comes out with a velocity of 4 m/s. If the balloon shrinks completely in 2.5 s. The average force acting on the balloon is

1. 0.008 N
2. 0.0032 N
3. 8 N
4. 3.2 N



$$F = u\frac{dm}{dt}$$

$$= 4\,m/s\left[\frac{2\times10^{-3}}{5/2}\right] = \frac{16}{5}\times10^{-3}$$

$$= 3.2\times10^{-3}$$

$$= 0.0032\,N$$

Conservation of Momentum

$$\vec{F}_{system} = \frac{d\vec{p}}{dt} \quad \text{If } \vec{F}_{system} = 0 \text{ then } \frac{dp}{dt} = 0$$

$$\vec{p}_{system} = \text{const}^n$$

$F_{ext} = 0$

$p_i = 0$

rest



Ice berg, $T = -400°C$

$\vec{p}_i = \vec{p}_f$ Two Body

$$0 = m\vec{u} + M\vec{v}$$

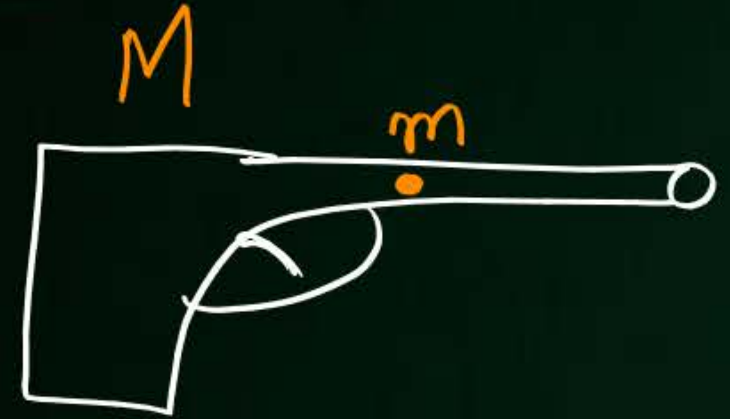
$$M\vec{v} = -m\vec{u}$$

$$\vec{v}_{man} = \frac{-m\vec{u}}{M}$$

CONSERVATION OF MOMENTUM

If net external force acting on the body/system is zero then momentum of body/system will be conserved.

GUN BULLET SYSTEM



(rest)

$F_{ext} = 0$

$P_i = 0$

Bullet fire



$\vec{P_f} = 0$

$m\vec{u} + M\vec{V_G} = 0$

$$\vec{V_G} = -\frac{m\vec{u}}{M}$$

$F_{ext} = 0$

$\vec{P_i} = \vec{P_f}$

$0 = \vec{P_B} + \vec{P_G}$

$\vec{P_G} = -\vec{P_B}$ *

equal & opposite momentum

$K.E = \frac{P^2}{2m}$ → same (P^2)

$\uparrow K.E \propto \frac{1}{m}\downarrow$

$K.E_{Bullet} > K.E_{Gun}$

Force on one bullet $= \frac{\Delta P}{t}$

$= \frac{mu - 0}{t}$

$= \frac{mu}{t}$

(*) t = time of firing.

If N bullet is fired in time 't'

$$F = \frac{Nmu}{t} = \left(\frac{N}{t}\right) mu = nmu$$

$n = \frac{N}{t}$ total no of bullet per sec

QUESTION

A bullet of mass 50 g is fired from a gun with initial velocity of 32 m/s. If mass of the gun is 4 kg, then calculate the recoil velocity of the gun.

$$u_G = \frac{mu}{M} = \frac{50 \times 10^{-3} \times 32}{4}$$

$$= 400 \times 10^{-3}$$

$$= .4 \text{ m/s}$$

QUESTION

A machine gun fires a bullet of mass 65 g with a velocity of 1300 m/s. The man holding it can exert a maximum force of 169 N on the gun. The number of bullets he can fire per second will be:

1. 1
2. 2
3. 3
4. 4

QUESTION

A bullet of mass 40 g is fired from a gun of mass 10 kg. If velocity of bullet is 400 m/s, the recoil velocity of the gun will be:

1. 1.6 m/s in the direction of bullet
2. 1.6 m/s opposite to the direction of bullet
3. 1.8 m/s in the direction of bullet
4. 1.8 m/s opposite to the direction of bullet

M/w.


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 06 | **Physics**

Laws of Motion

By- Dr. Manish Raj (MR SIR)



Topic To be Covered

1. # H/w (gun bullet
2. # ** Rocket
3. # *** Connected body dynamics
4. #



QUESTION

A bullet of mass 50 g is fired from a gun with initial velocity of 32 m/s. If mass of the gun is 4 kg, then calculate the recoil velocity of the gun.

Sol^n

$$u_G = \frac{m u_B}{M}$$

$$= \frac{50 \times 32}{1000 \times 4} = 0.4 \text{ m/s}$$

QUESTION

A machine gun fires a bullet of mass 65 g with a velocity of 1300 m/s. The man holding it can exert a maximum force of 169 N on the gun. The number of bullets he can fire per second will be:

1. 1
2. 2 ✓
3. 3
4. 4

$F = n m u$

$169 = n \frac{65}{1000} \times 1300$

$\frac{n}{2} = 1$

$n = 2$

QUESTION

A bullet of mass 40 g is fired from a gun of mass 10 kg. If velocity of bullet is 400 m/s, the recoil velocity of the gun will be:

1. 1.6 m/s in the direction of bullet
2. 1.6 m/s opposite to the direction of bullet
3. 1.8 m/s in the direction of bullet
4. 1.8 m/s opposite to the direction of bullet

$$u_g = \frac{m u_B}{M} = \frac{40 \times 10^{-3} \times 400}{10} = 16 \times 10^{-1} = 1.6 \text{ m/s}$$

ROCKET

→ variable mass-system.

→ Based on newtons 3rd Law or, conservation of momentum

($t=0$) M_0 = initial mass of Rocket.

$\left(\frac{dm}{dt}\right)$ = The Rate at which gas is burning = α



$F_{upthrust} = u\left(\frac{dm}{dt}\right)$

u = Velocity of gas ejecting w.r.t rocket.

{Mass of gas at time $t = M_0 - \frac{dm}{dt}t$}

FBD of Rocket ($t=0$)



{If $F_{net} = 0$

$u\frac{dm}{dt} = M_0 g$}

↳ about to launch

upthrust force just able to Balance gravitational force.

at $t=0$

F_{net} (upward) $= u\frac{dm}{dt} - M_0 g$

$M_0 a_0 = u\frac{dm}{dt} - M_0 g$

$$a_0 = \frac{\left(u\frac{dm}{dt}\right)}{M_0} - g$$

→ acc^n at time ($t=0$)

MR*

$$a_0 = \frac{u\frac{dm}{dt}}{M_0} - g$$

after time 't'

$$a_t = \frac{u\frac{dm}{dt}}{m_t} - g$$

$$a_t = \frac{\left\{u\frac{dm}{dt}\right\}}{\left(m_0 - \frac{dm}{dt}t\right)} - g$$

QUESTION

M_0

A 800 kg rocket is fired from earth so that exhaust speed is 1200 m/s. Then calculate mass of fuel burning per second, to provide initial thrust to overcome its weight. ($g = 10\ m/s^2$)

$$M_0 g = u \frac{dm}{dt}$$

$$\frac{dm}{dt} = 6.67$$

QUESTION

A cracker rocket is ejecting gases at a rate of 0.05 kg/s with a velocity 400 m/s. The accelerating force on the rocket is:

1. 20 dyns
2. 20 N ✓
3. 200 N
4. Zero

$\frac{dm}{dt} = 0.05\ kg/s$

$u = 400\ m/s$

$F_{thrust} = u\frac{dm}{dt}$

$= 400 \times \frac{5}{100}$

$= 20\ N$

QUESTION

A rocket of mass 5700 kg ejected mass at a constant rate of 15 kg/s with constant speed of 12 km/s. The acceleration of the rocket 1 minute after the blast is ($g = 10\ m/s^2$)

1. $34.9\ m/s^2$
2. $27.5\ m/s^2$
3. $3.50\ m/s^2$
4. $13.5\ m/s^2$

$$a_t = \frac{u\frac{dm}{dt}}{M_0 - \frac{dm}{dt}t} - g$$

QUESTION

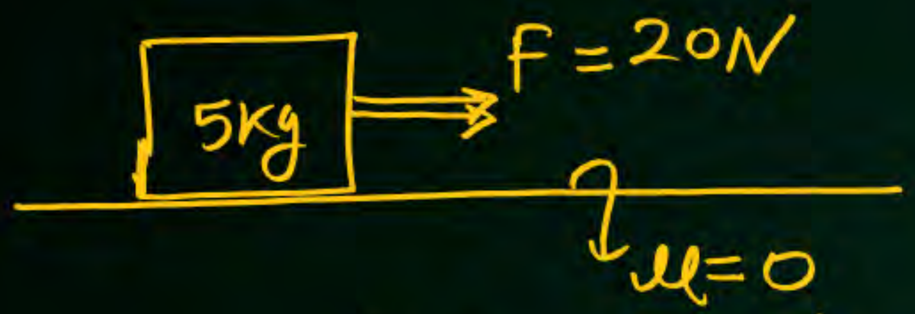
If the force on a rocket, that releases the exhaust gases with a velocity of 300 m/s is 210 N, then the rate of combustion of the fuel is :

1. 0.07 kg/s
2. 1.4 kg/s
3. 0.7 kg/s ✓
4. 10.7 kg/s

$210 = u \frac{dm}{dt}$

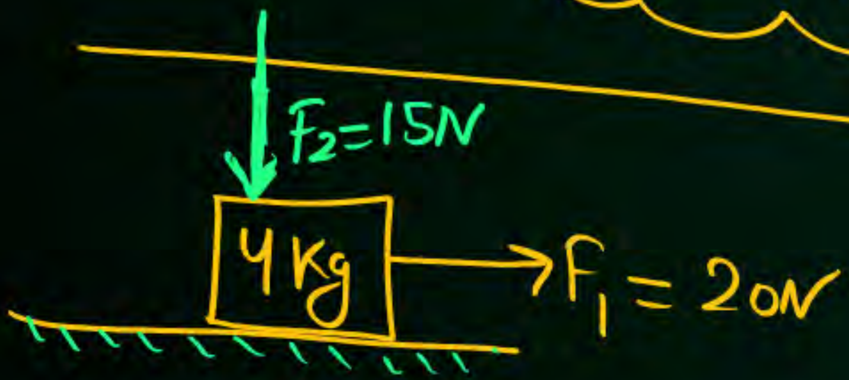
$\frac{210}{300} = \frac{dm}{dt}$

DYNAMICS OF A BODY

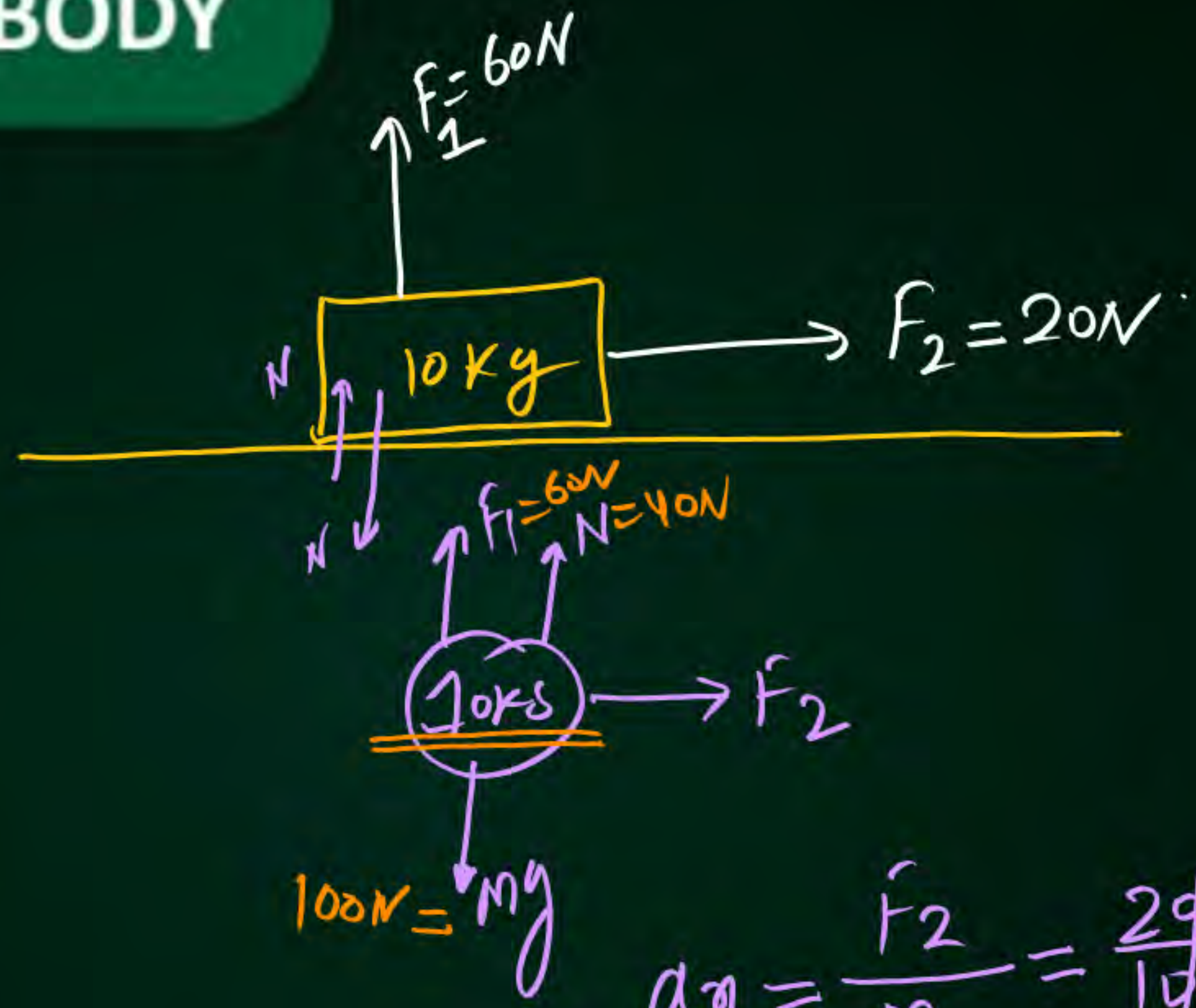


$$a = \frac{F_{net}}{m_{net}} = \frac{20}{5}$$

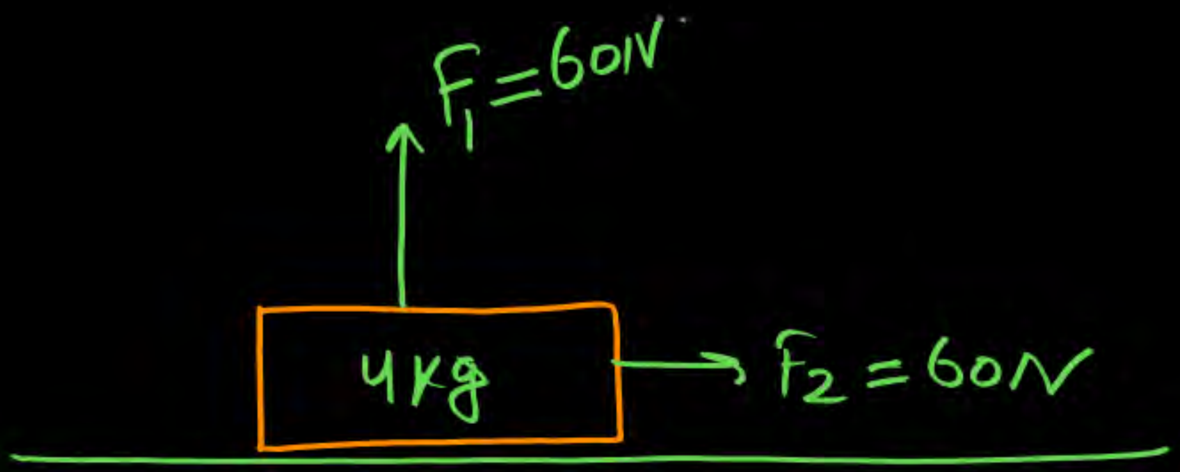
$$a = 4\ m/s^2$$



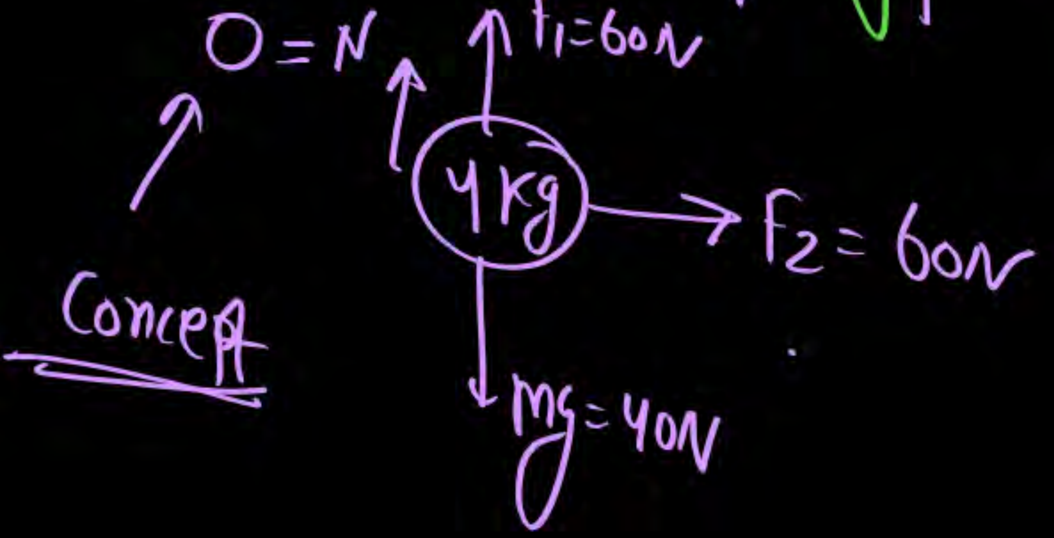
$$a_x = \frac{20}{4} = 5\ m/s^2\ \hat{i}$$



$$a_x = \frac{F_2}{m} = \frac{20}{10} = 2\ m/s^2$$

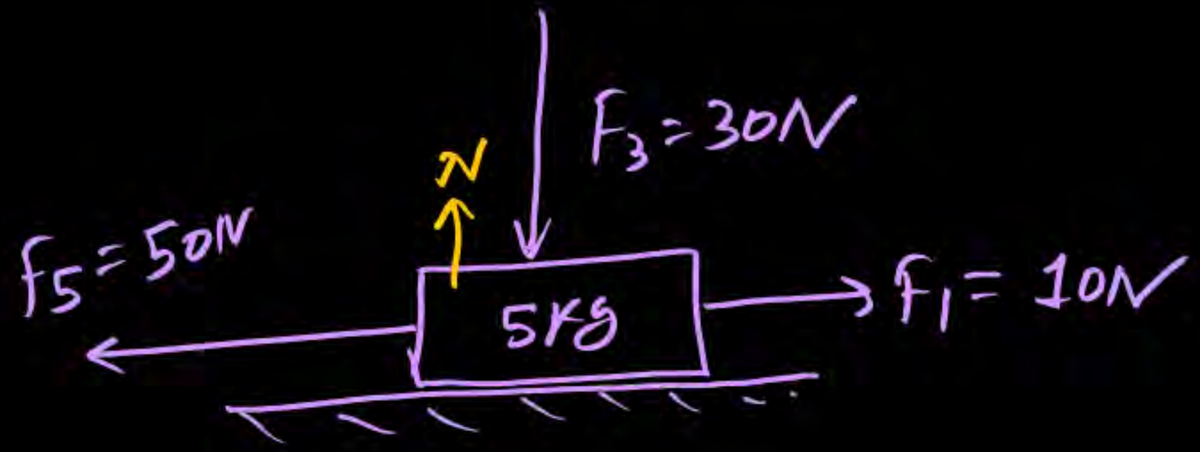


find acc^n of 4kg object.

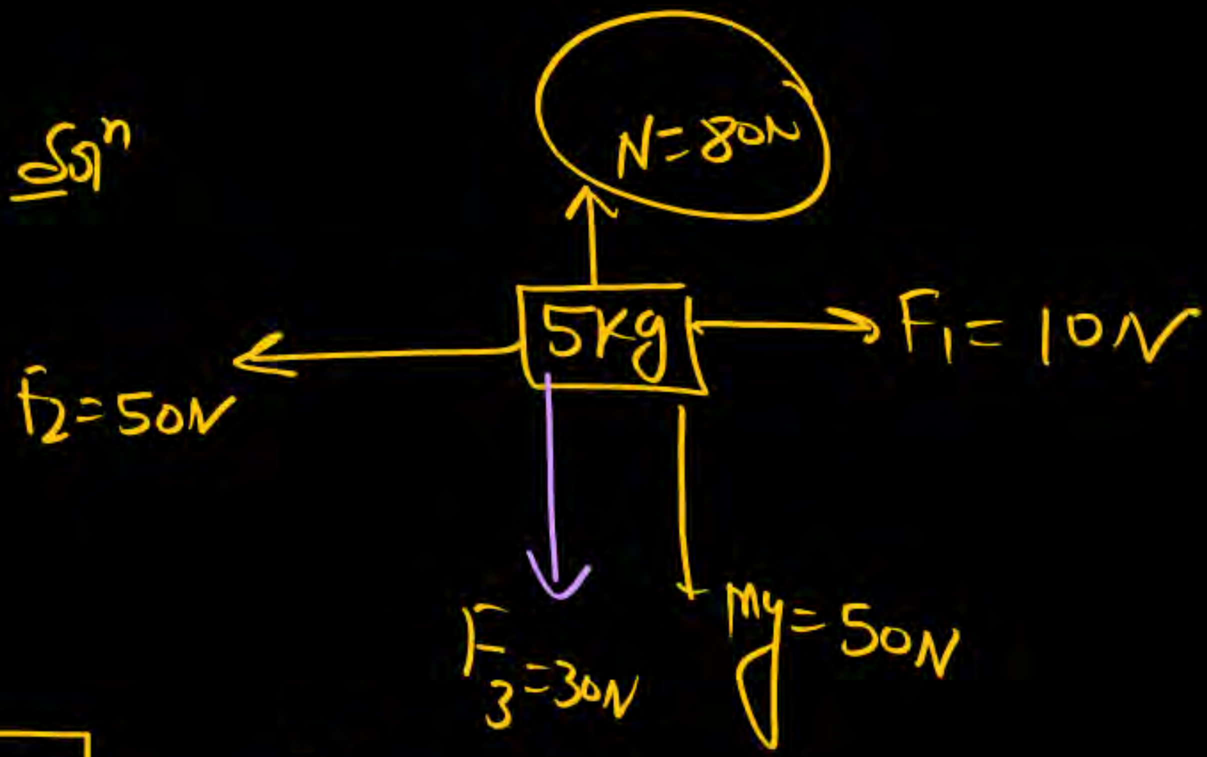


$$a_y = \frac{60-40}{4} = 5\hat{j}$$

$$a_x = \frac{60}{4} = 15\hat{i}$$



Sol^n



$$a_y = 0$$

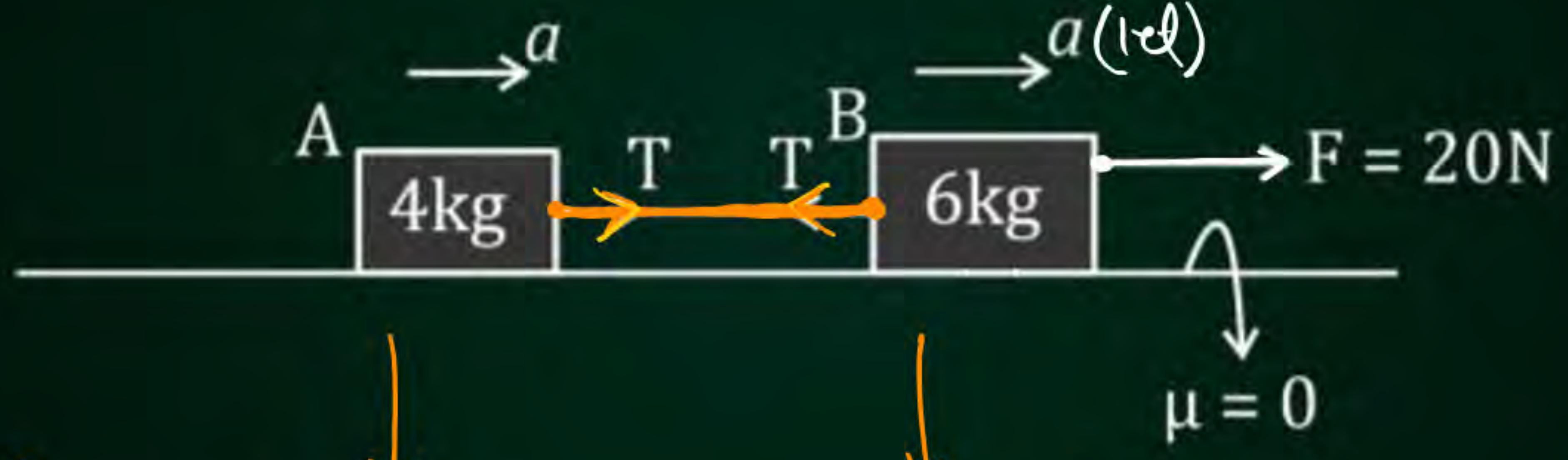
$$F = ma$$

$$(50-10) = 5 \cdot a$$

$$a = \frac{40}{5} = 8\, m/s^2 \left(-\hat{i}\right)$$

CONNECTED BODY MOTION

Find acceleration of A and B and Tension in string.



$20 - T = 6a$

$T = 4a$

$20 = 10a$

$a = \frac{20}{10} = 2\ m/s^2$

using eqn (ii) $T = m_2 a = 4 \times 2 = 8N$

F.B.D of 4kg

$T = m_2 a$ — (ii)

F.B.D of 6kg

T ← • → 20N

$20 - T = m_1 a$ — (i)

MR*

(4kg + 6kg) → 20N

$a = \frac{\text{Net force}}{\text{Net mass}}$

$= \frac{20}{10} = 2\ m/s^2$

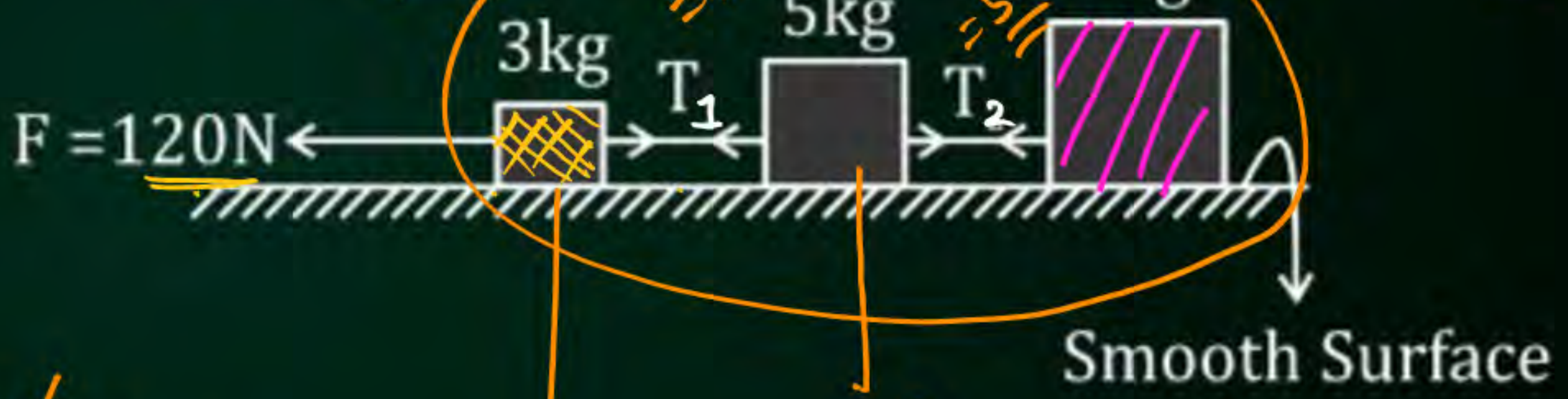
F = ma

force

QUESTION

Find T_1 and T_2 in the given figure are

1. 28 N, 48 N
2. 48 N, 28 N
3. 96 N, 56 N
4. 56 N, 96 N




THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 06 Part-2

Physics

Laws of Motion

By- Dr. Manish Raj (MR SIR)



Topic To be Covered

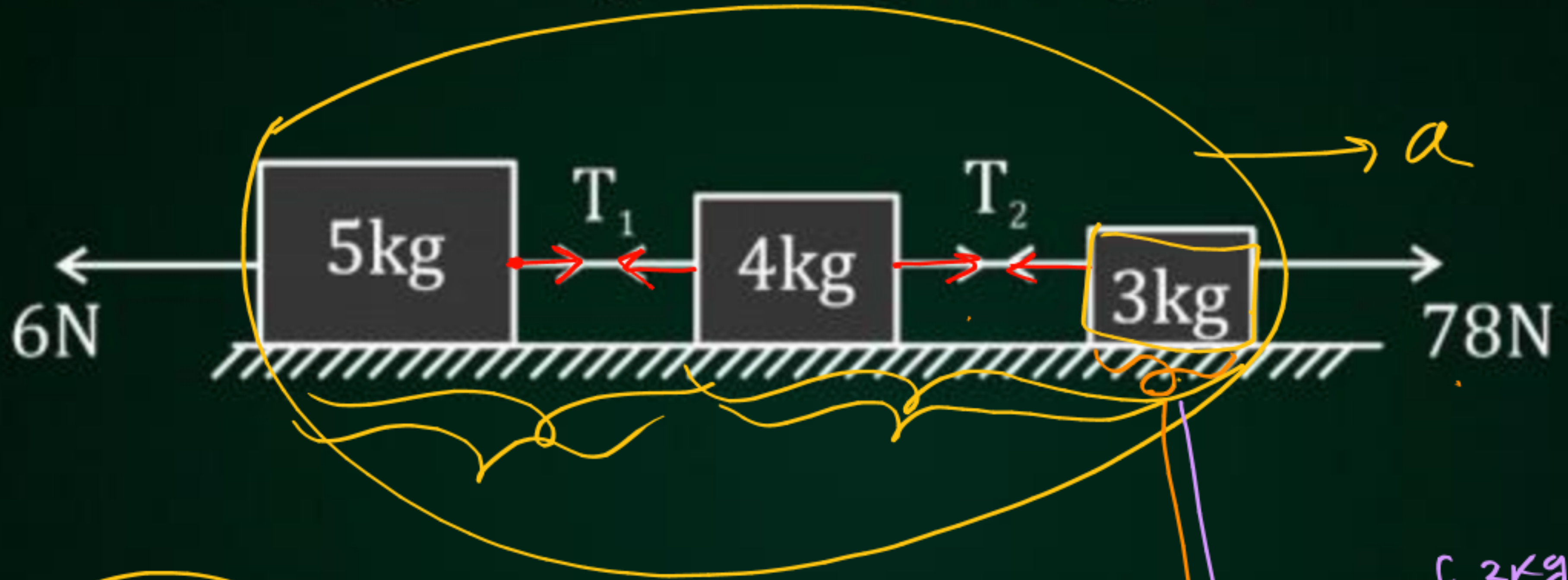
1. # H/w (gun bullet)
2. # ** Rocket
3. # *** Connected body dynamics
4. #

(Part-02)



QUESTION

What will be the tension T_1 and T_2 in the given figure?



$6N \leftarrow$ (5+4+3 = 12 kg) $\rightarrow 78N$, $\rightarrow a$

$a = \frac{(78-6)N}{12}$

$a = \frac{72}{12} = 6 \, m/s^2$

(5kg): $6N \leftarrow$ 5kg $\rightarrow T_1$, $\rightarrow a = 6 \, m/s^2$

$T_1 - 6 = ma$

$T_1 = 6 + 5 \times 6 = 36N$

F.B.D of 3kg

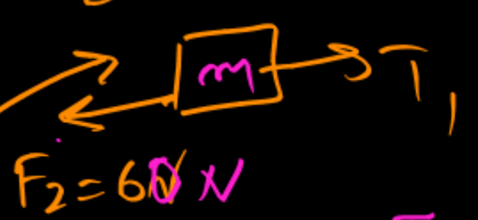
$T_2 \leftarrow$ 3kg $\rightarrow 78N$, $\rightarrow a$

$(78 - T_2) = 3 \times a$

$78 - 3 \times 6 = T_2$

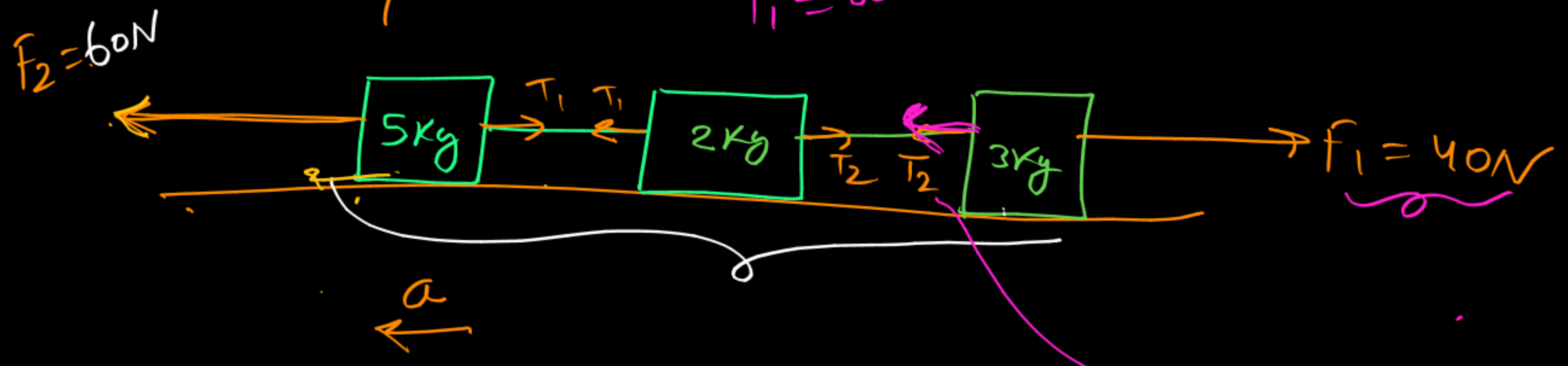
$78 - 18 = T_2$

$60 = T_2$



$60 - T_1 = ma$

$T_1 = 60 - ma = 60 - 5\times2 = 50N$



$T_2 = 46N$



$a = \frac{(60-40)}{10} = \frac{20}{10} = 2m/s^2$

MR* ⇒ $T_1 = 50N$

QUESTION

Three blocks A, B and C of masses 4 kg, 2 kg and 1 kg respectively, are in contact on a frictionless surface, as shown. If a force of 14 N is applied on the 4 kg block, then the contact force between A and B is [AIPMT-2015]

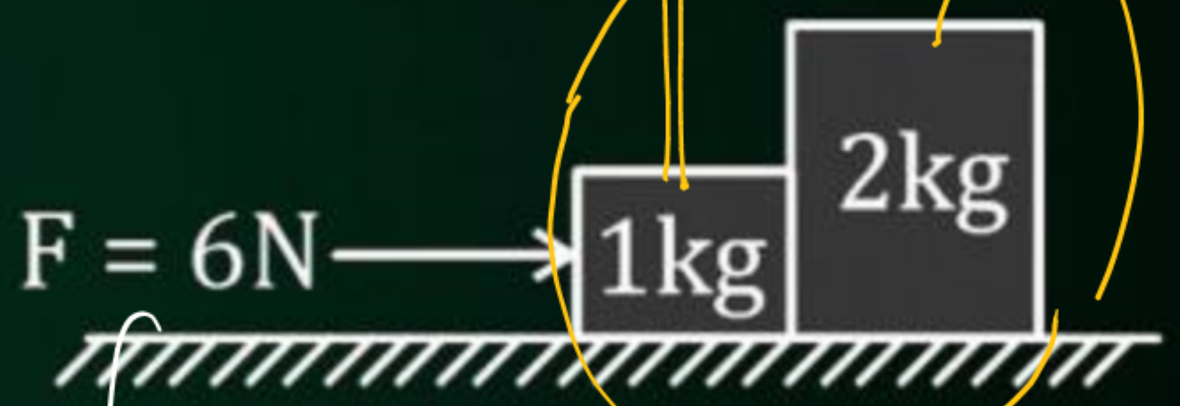


1. 18 N
2. 2 N
3. 6 N
4. 8 N

QUESTION

Arrangement of two block system is as shown. The net force acting on 1 kg and 2 kg blocks are (assuming the surface to the frictionless) respectively

1. 4 N, 8 N
2. 1 N, 2 N
3. 2 N, 4 N
4. 3 N, 6 N



QUESTION

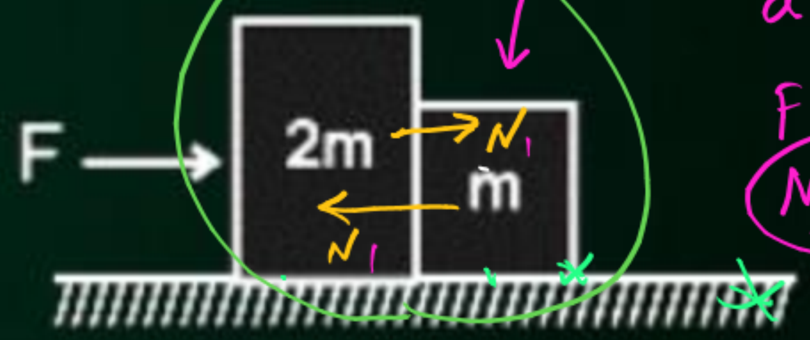
Two blocks are in contact on a frictionless table. One has mass *m* and the other 2m. A force F is applied on 2m as shown in the figure. Now the same force F is applied from the right on m. In the two cases respectively, the ratio of force of contact between the two blocks will be :

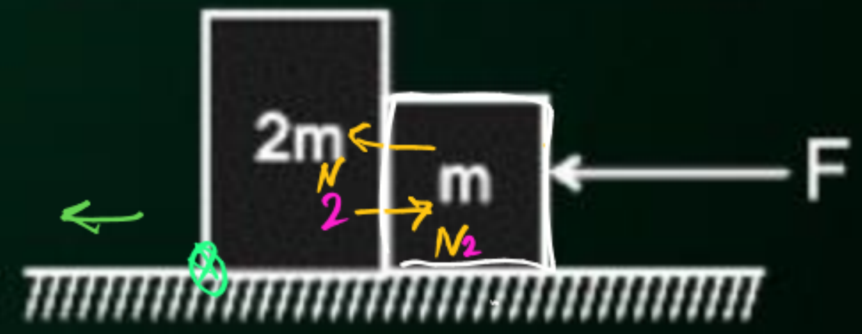
(1) Same

(2) 1 : 2

(3) 2 : 1

(4) 1 : 3





QUESTION

Figure shows a uniform rod of length 30 cm having a mass 3.0 kg. The rod is pulled by constant forces of 20 N and 32 N as shown. Find the force exerted by 20 cm part of the rod on the 10 cm part (all surfaces are smooth) is:



1. 36 N
2. 12 N
3. 64 N
4. 24 N

QUESTION

A massive string of length 8 m and mass 32 kg, then find tension of a point 3 m away from a end where force is applied.

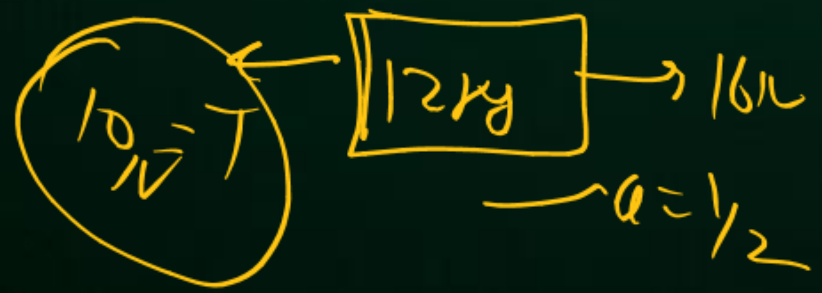
8m ⟶ 32 kg

1m ⟶ 4 kg/m = ρ

Mass for 3m leg = 4×3 = 12 kg



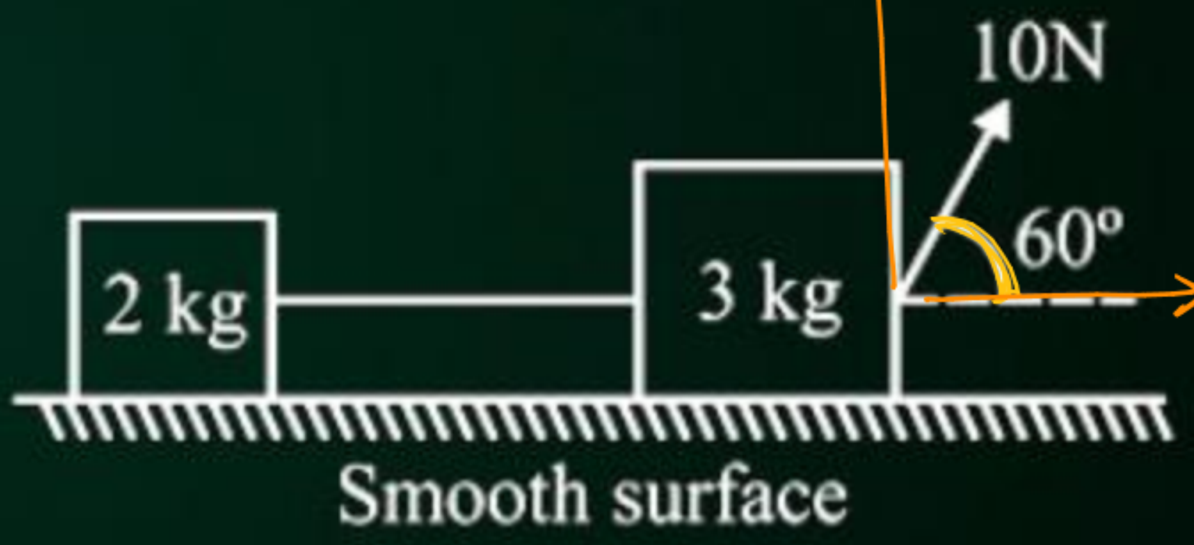
$a = \frac{16}{32} = \frac{1}{2}$ m/s



QUESTION

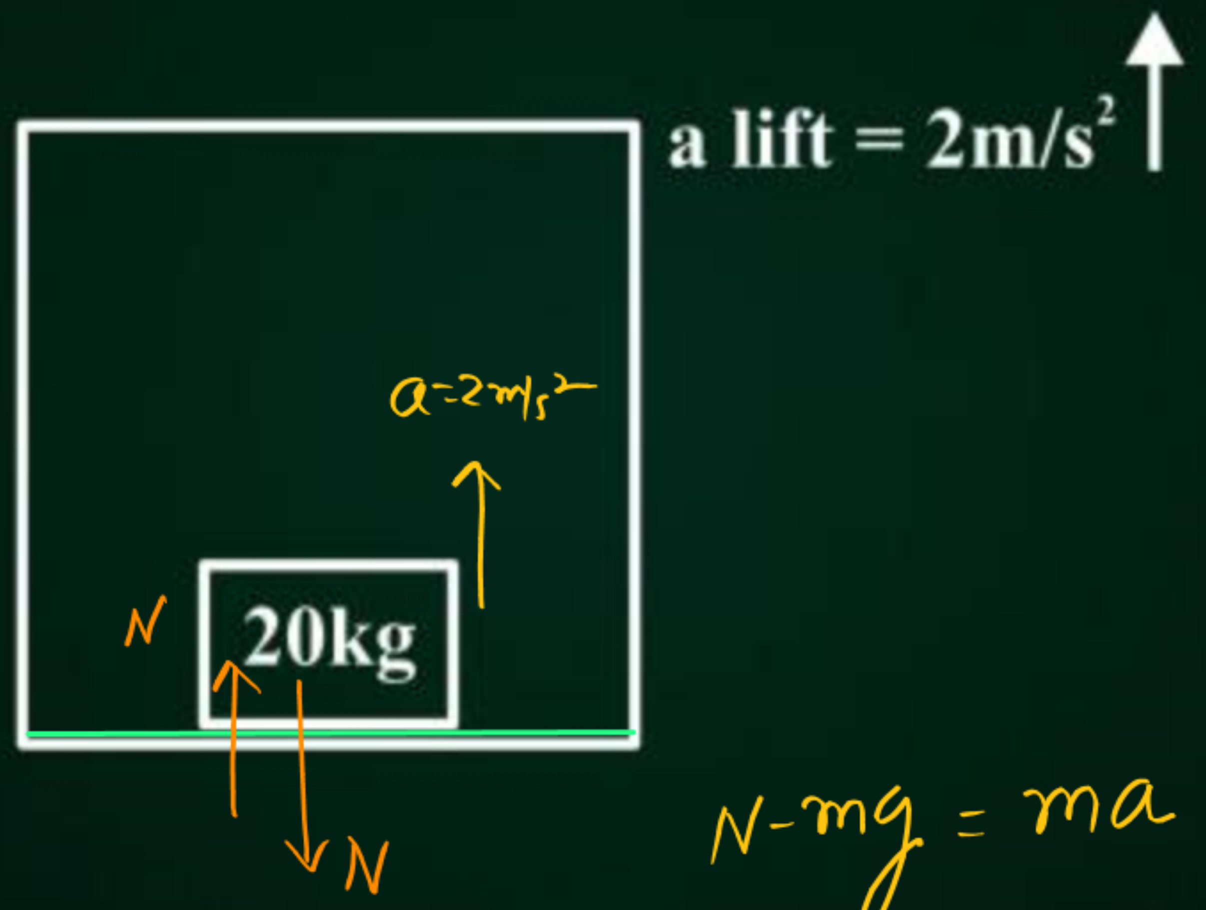
Figure shows two blocks connected by a light inextensible string as shown in figure. A force of 10 N is applied on the bigger block at 60° with horizontal, then the tension in the string connecting the two masses is

1. 5 N
2. 2 N
3. 1 N
4. 3 N



QUESTION

Find force applied on base of lift by 20 kg block.





$N - mg = ma$

$N = ma + mg$

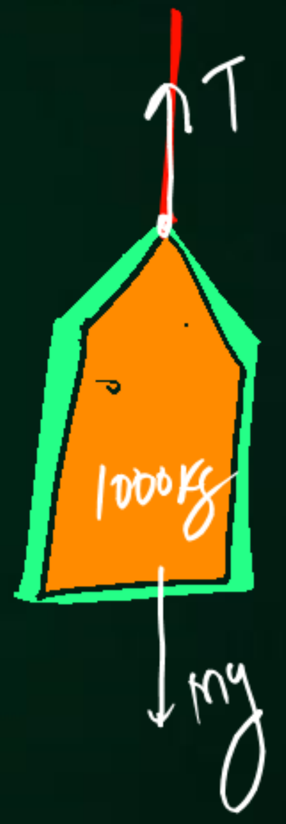
$= 20\times2 + 20\times10$

$= 240N$

QUESTION

A lift of mass 1000 kg is moving with acceleration of 1 m/s^2 in upward direction, then the tension developed in string which is connected to lift is

1. 9800 N
2. 10,800 N
3. 11,000 N
4. 10,000 N



$a = 1\ m/s^2$

$T - mg = ma$

$T - 1000 \times 10 = 1000 \times 1$

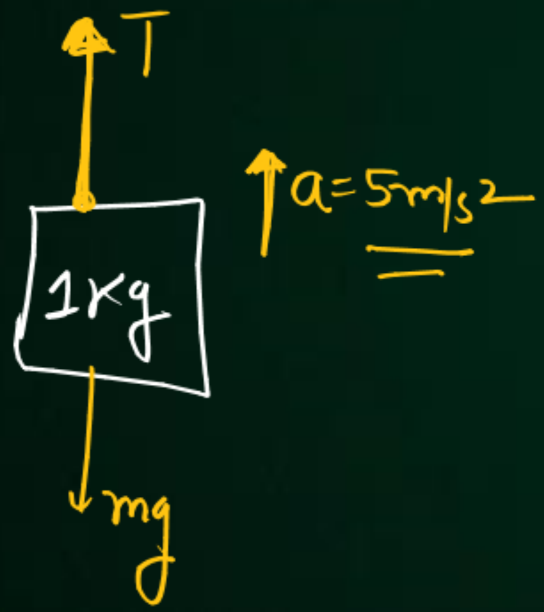
$T = 10000 + 1000$

$T = 11000\ N$

QUESTION

A mass of 1 kg is suspended by a thread. It is (i) lifted up with an acceleration 4.9 m/s^2, (ii) lowered with an acceleration 4.9 m/s^2. The ratio of the tensions is

1. 1 : 3
2. 1 : 2
3. 3 : 1
4. 2 : 1



$T - mg = ma$

$T = mg + ma$

$T_1 = 10N + 1\times5 = 15N$



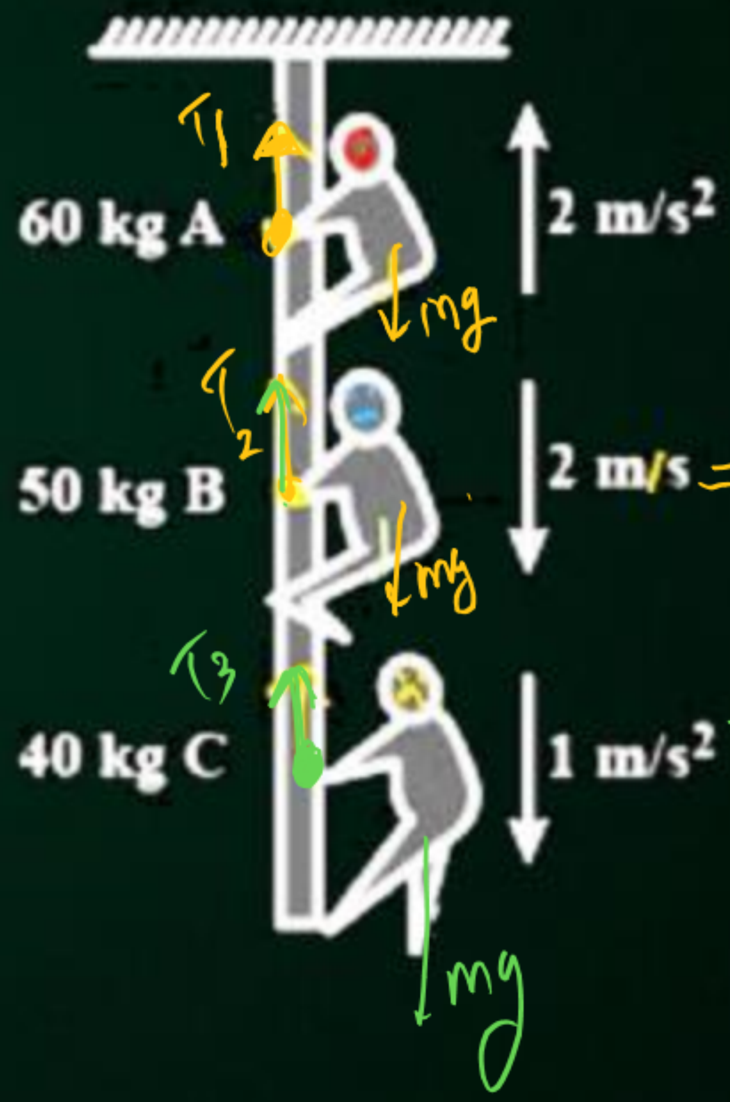
$mg - T = ma$

$T_2 = mg - ma = 1\times10 - 1\times5 = 5N$

QUESTION

Tension in the rope at the rigid support is ($g = 10\ m/s^2$)

1. 760 N
2. 1360 N
3. 1580 N
4. 1620 N



$T_1 - mg = ma$ —(1)

$T_1 = mg + ma$

$= 60\times10 + 60\times2$

$= 720N$

$2\ m/s = v$ (const^n)

$T_2 = mg$

$T_2 = 500N$

$1\ m/s^2 = a$

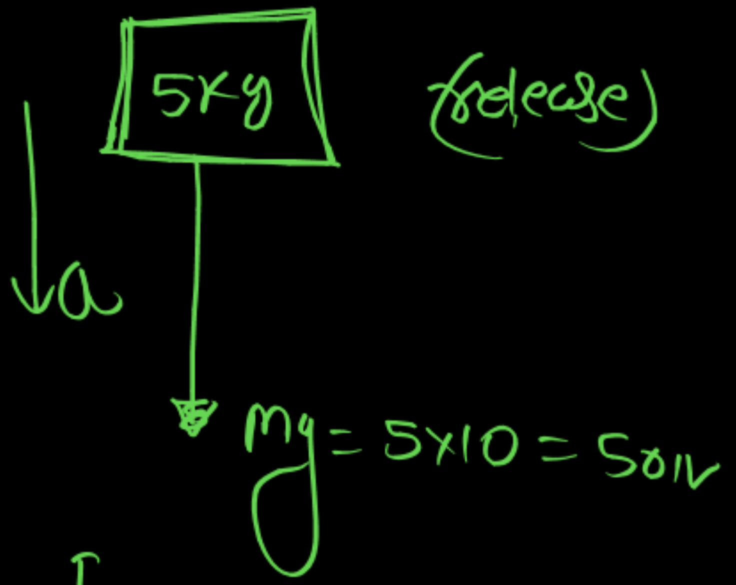
$mg - T_3 = ma$

$T_3 = mg - ma$

$= 400 - 40\times1$

$= 360N$

Case-1

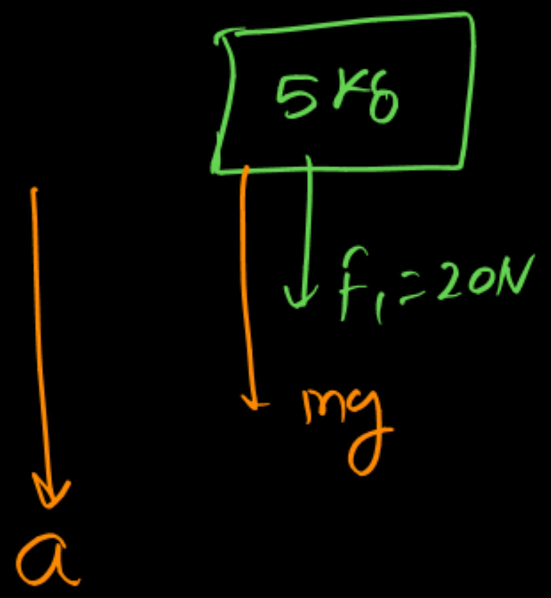


$F_{net} = ma$

$50 = 5 \times a$

$a = 10\, m/s^2$

Case-2



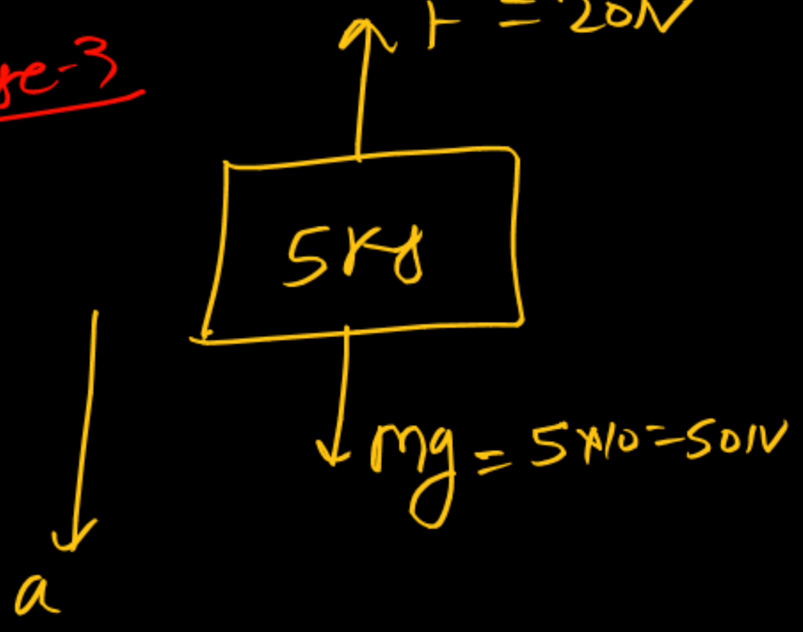
$mg + f_1 = ma$

$5 \times 10 + 20 = 5a$

$70 = 5a$

(A) $a = 14\, m/s^2$

Case-3

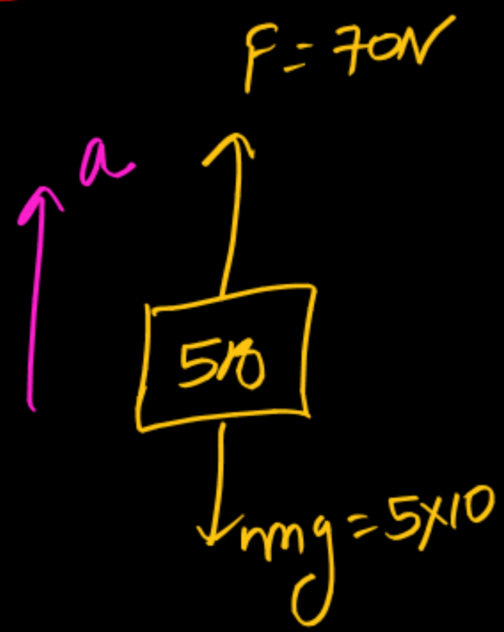


$50 - 20 = ma$

$30 = 5a$

$a = 6\, m/s^2$

Case-4



$(F_{net}) = ma$

$70 - 50 = 5 \times a$

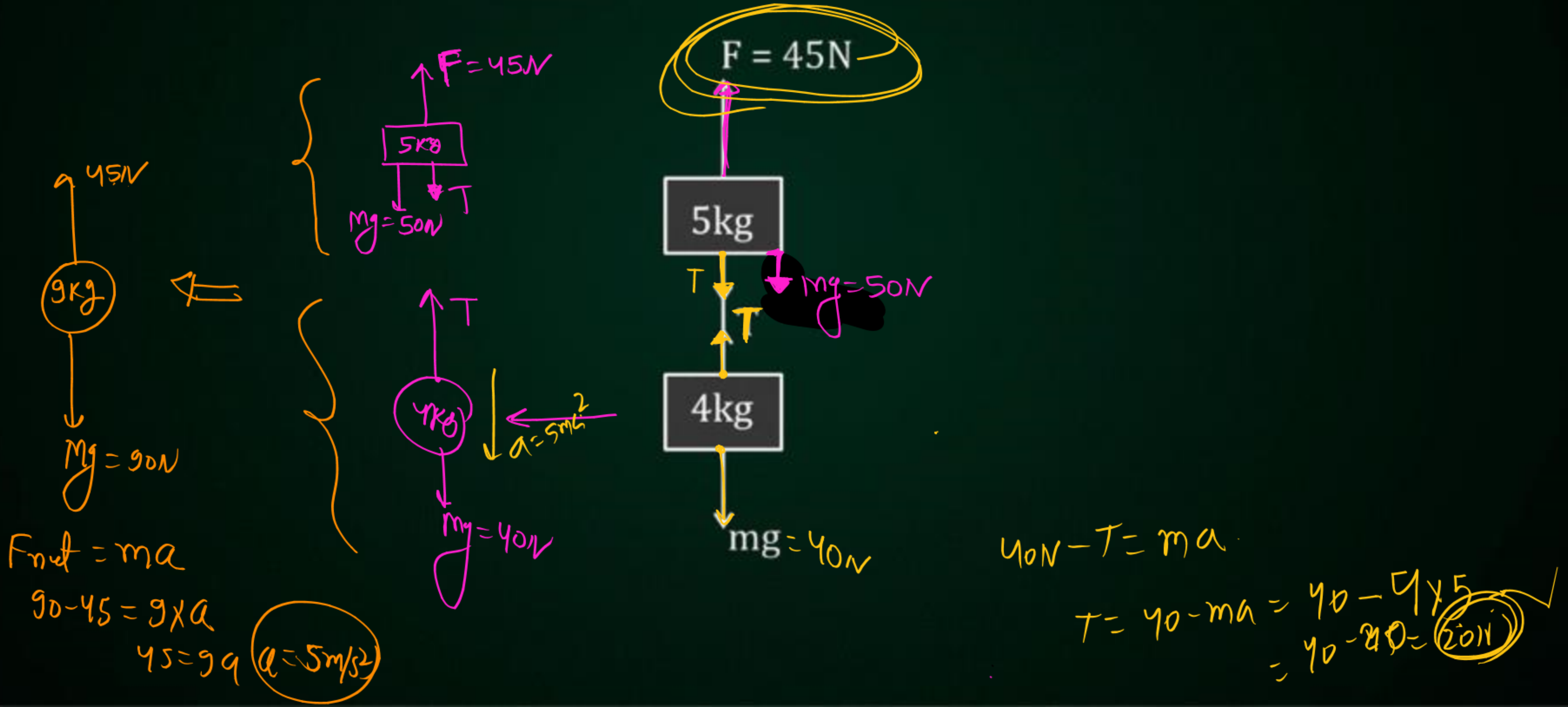
$20 = 5a$

$a = 4\, m/s^2$

upward

QUESTION

Find tension in string between 4 kg and 5 kg.

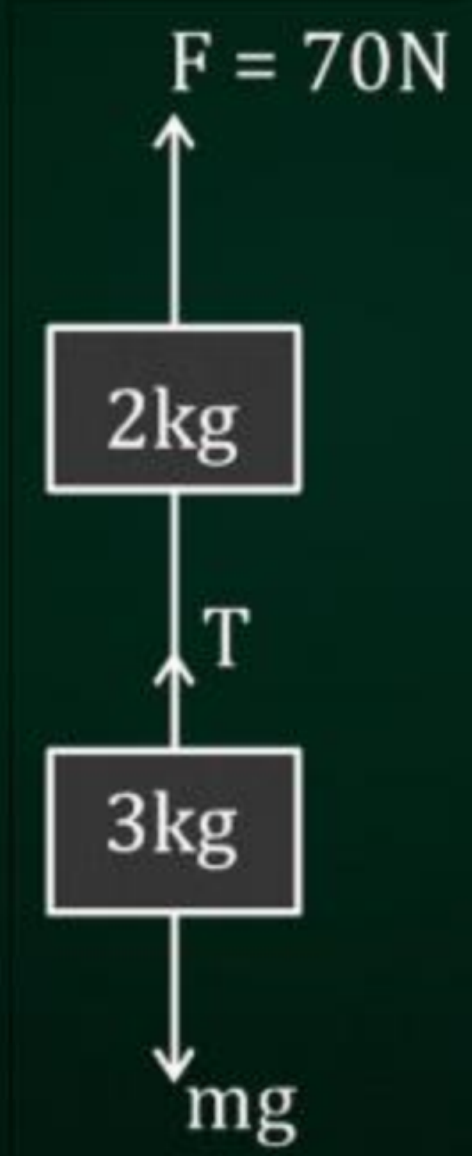


QUESTION

level up

accⁿ up

Find tension in string connected between 2 kg and 3 kg.




THANK YOU

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FOR NEET 2025

Lecture- 07 | Physics

Laws of Motion

By- Dr. Manish Raj (MR SIR)

50 mint lec-6 Part B

(a) NO
(b) yes



Topic to be Covered

1 # Pully Block system

2 #

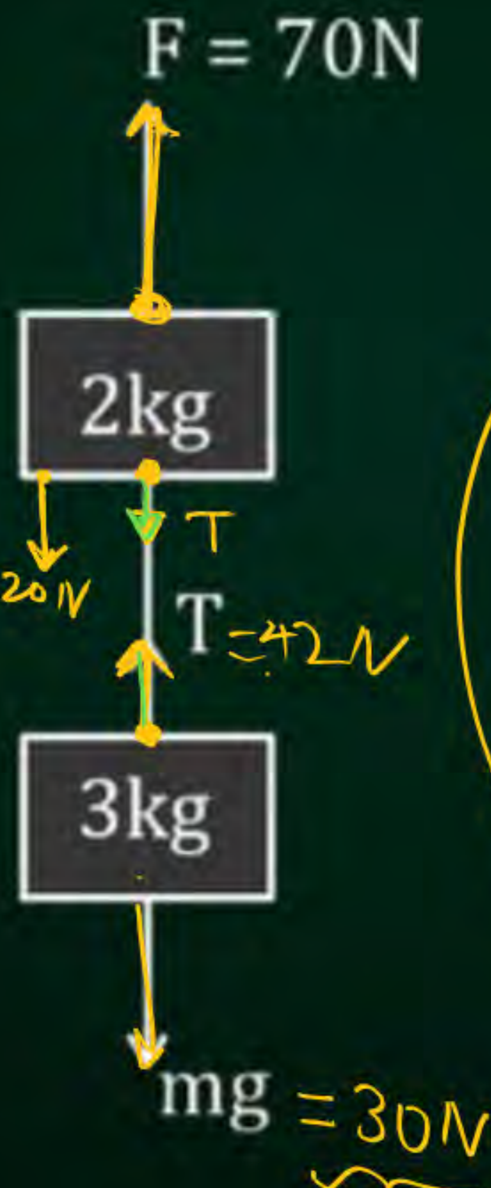
3 #

4 #



QUESTION (H/W)

Find tension in string connected between 2 kg and 3 kg.



(Let) a ↑

$70 - 20 - T = 2a$ — (i)

$T - 30 = 3a$ — (ii)

$70 - 20 - T = 2a$

$T - 30 = 3a$

$20 = 5a$

$a = 4\,m/s^2$

Putting value of a in eq (ii)

$T - 30 = 3 \times 4$

$T = 30 + 12 = 42N$

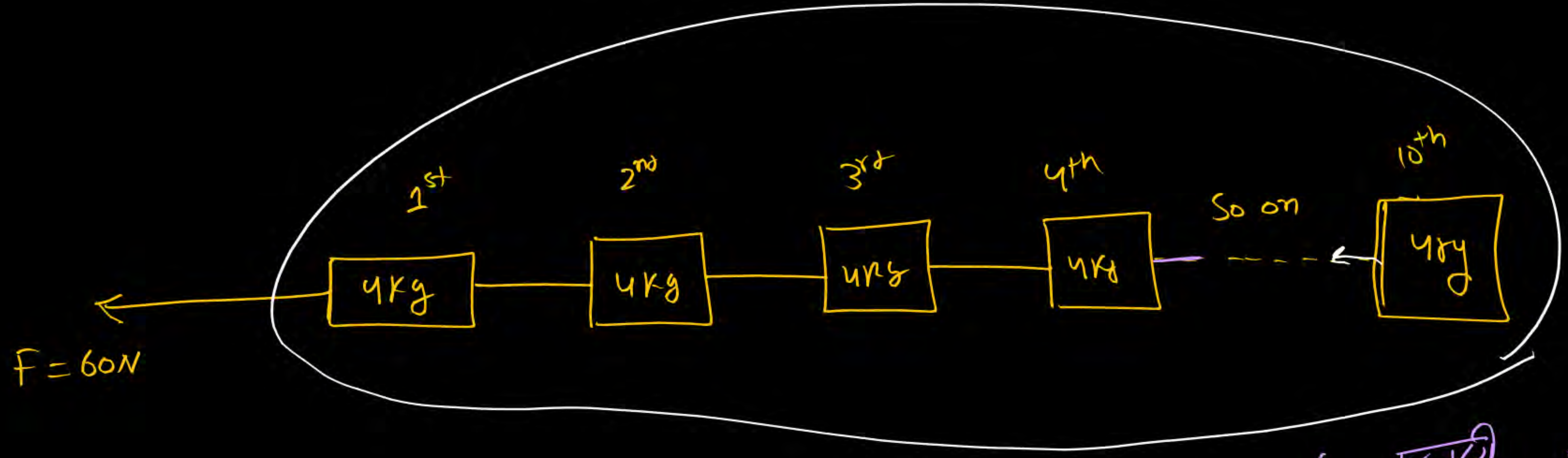
MR: 70N, 5kg, mg = 50N

$F_{net} = ma$

$20 = 5a$

$a = 4\,m/s^2$

3kg ko kitna khana hai — 12N



find Tension b/w 7th & 8th Block

$$a_{common} = \frac{60}{40} = \frac{3}{2}\ m/s^2$$

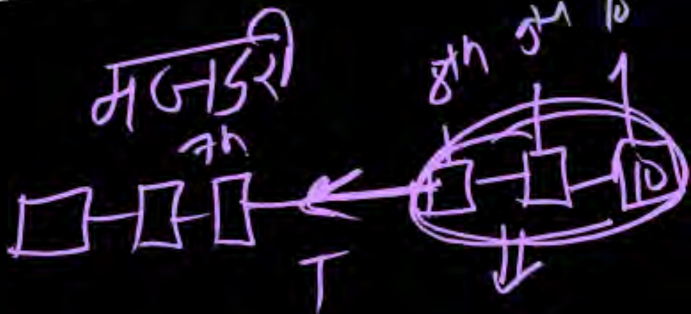
MR*

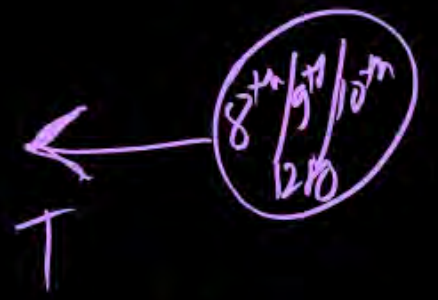
2 Block kitan force khayga = ma

$= 4 \times \frac{3}{2}$

$= 6N$

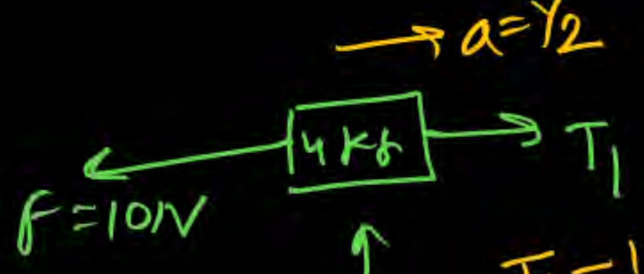
18N





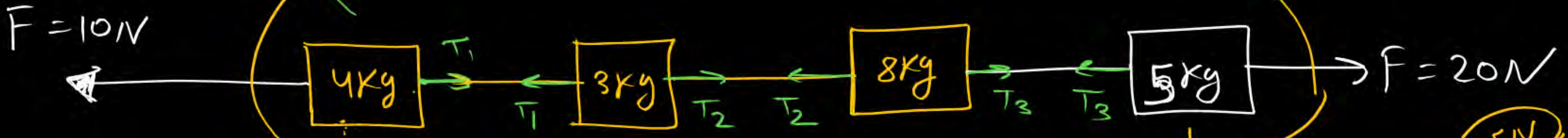
$T = ma$

$T = 6,12 \times \frac{3}{2} = 18N$



$T_1 - 10 = 4 \times \frac{1}{2}$

$T_1 = 2 + 10 = 12N$



$T_2 = 13.5N$

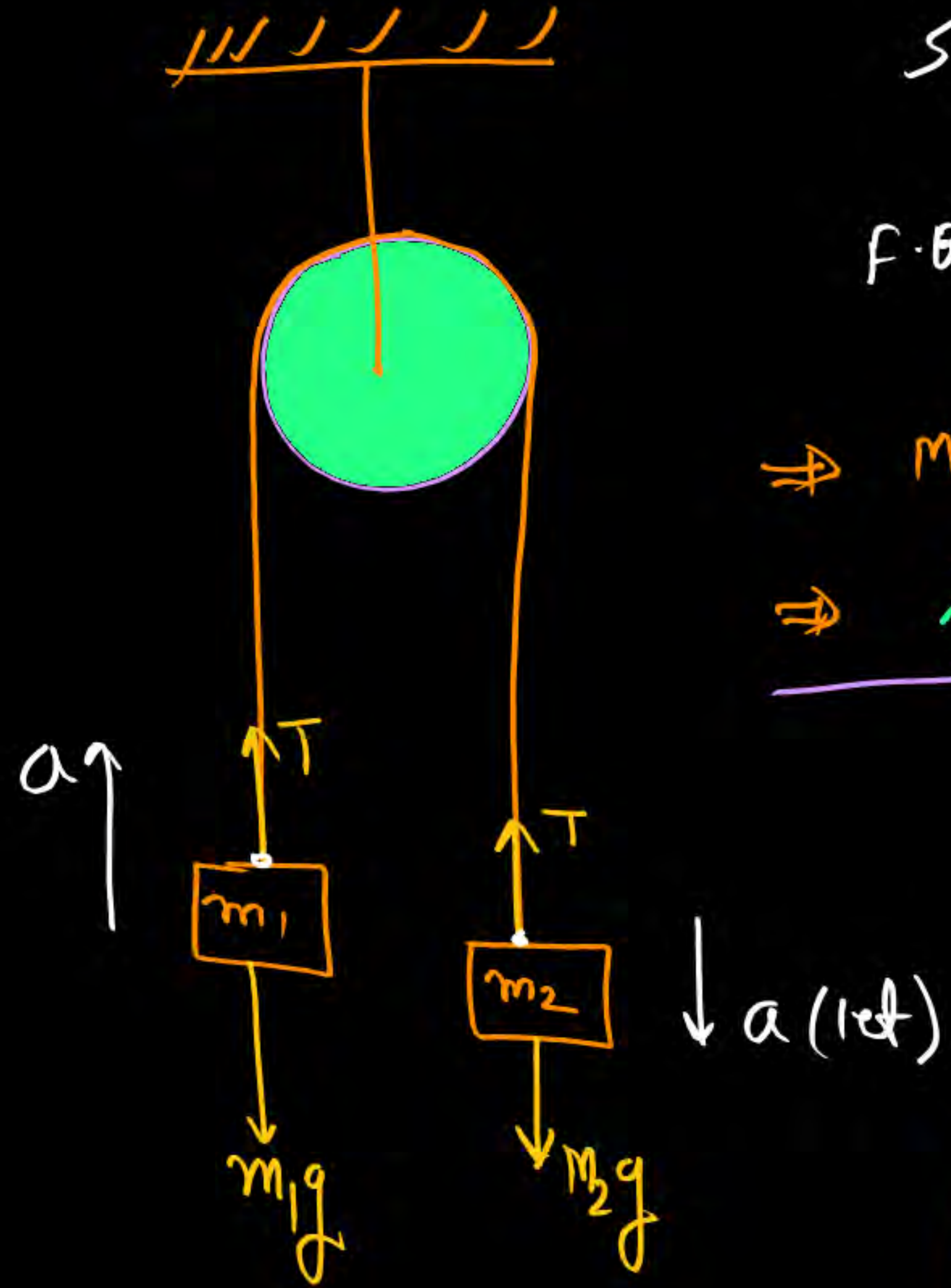
$T_3 = 20 - 5 \times \frac{1}{2} = 17.5N$

Soln



$a = \frac{F_{net}}{m} = \frac{20 - 10}{20}$

$a = \frac{1}{2} m/s^2$



string and Pully are Ideal

F.B.D of m_2

$F = ma$

$\Rightarrow m_2 g - T = m_2 a$ — (1)

$\Rightarrow T - m_1 g = m_1 a$ — (ii)

$m_2 g - m_1 g = (m_1 + m_2) a$

$$a = \frac{(m_2 - m_1) g}{m_1 + m_2}$$

NEET-2020

dim^n → $acc^n = acc^n$

$(m_2 > m_1)$

$$a = \left(\frac{m_1 + m_2}{m_2 - m_1}\right) g$$

The MR* If $m_1 = m_2$

$a = 0$

The MR* If $m_1 = 0$

$a = g$

$$a = \frac{2 m_1 m_2}{m_1 + m_2} g$$

force dim^n

Putting the value of ⓐ in eq ①

$$m_2 g - T = m_2 a$$

$$T = m_2 g - m_2 a$$

$$T = m_2 g - m_2 \left(\frac{m_2 - m_1}{m_2 + m_1}\right) g$$

$$= g\left[m_2 - \frac{m_2^2 + m_1 m_2}{m_2 + m_1}\right]$$

$$T = g\left(\frac{m_2^2 + m_1 m_2 - m_2^2 + m_1 m_2}{m_1 + m_2}\right)$$

$$T = \left(\frac{2 m_1 m_2}{m_1 + m_2}\right) g$$

Tension force

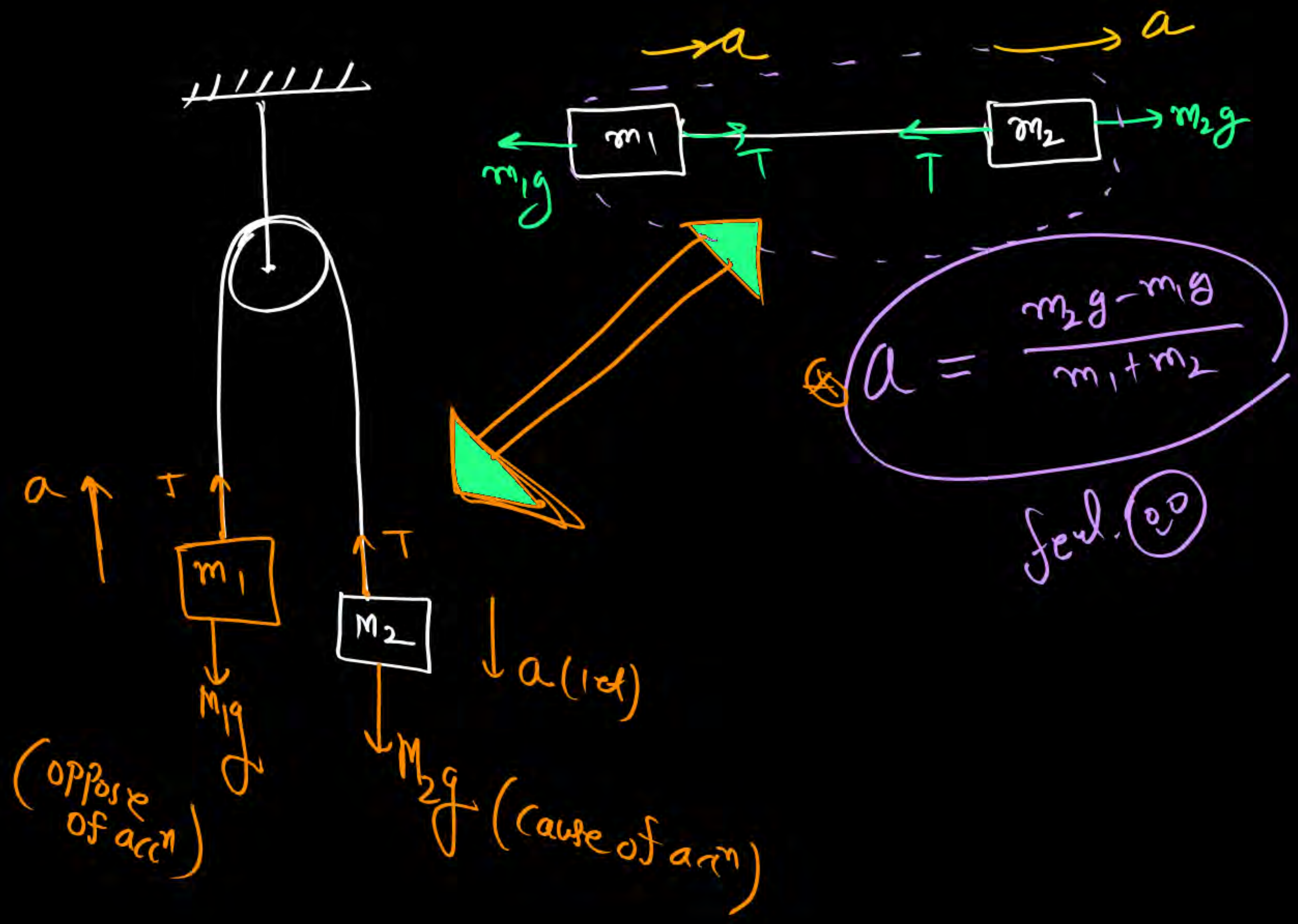
The mg

If $m_1 = 0$, $T = 0$

If $m_2 = 0$, $T = 0$



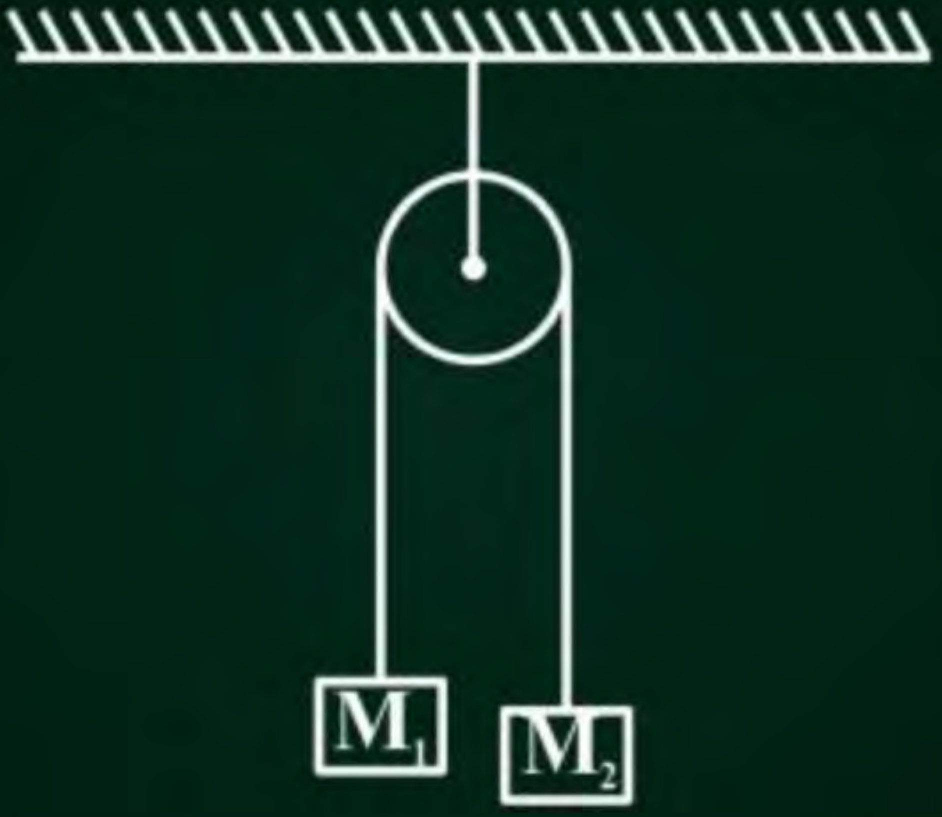
$\dim^n$



a
a
m_1
m_2
$m_1 g$
$m_2 g$
T
T
$a = \frac{m_2 g - m_1 g}{m_1 + m_2}$
feel.
a
T
T
m_1
M_2
a (1st)
$M_1 g$
(oppose of acc^n)
$M_2 g$
(cause of acc^n)

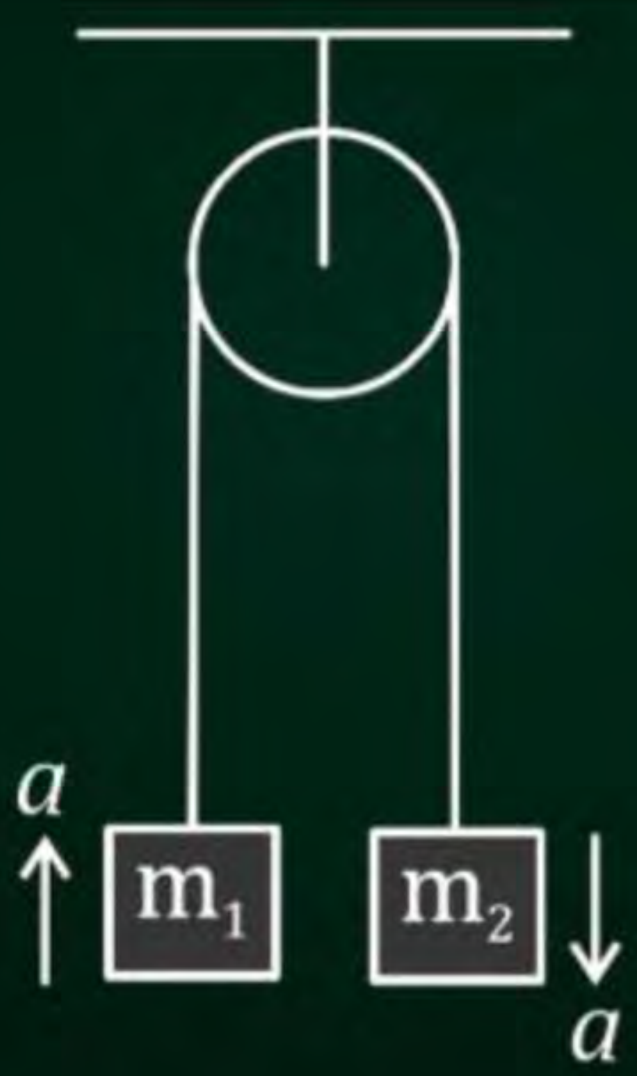
QUESTION

If ($M_2 > M_1$) then find acceleration of M_1 and M_2 and Tension in string.



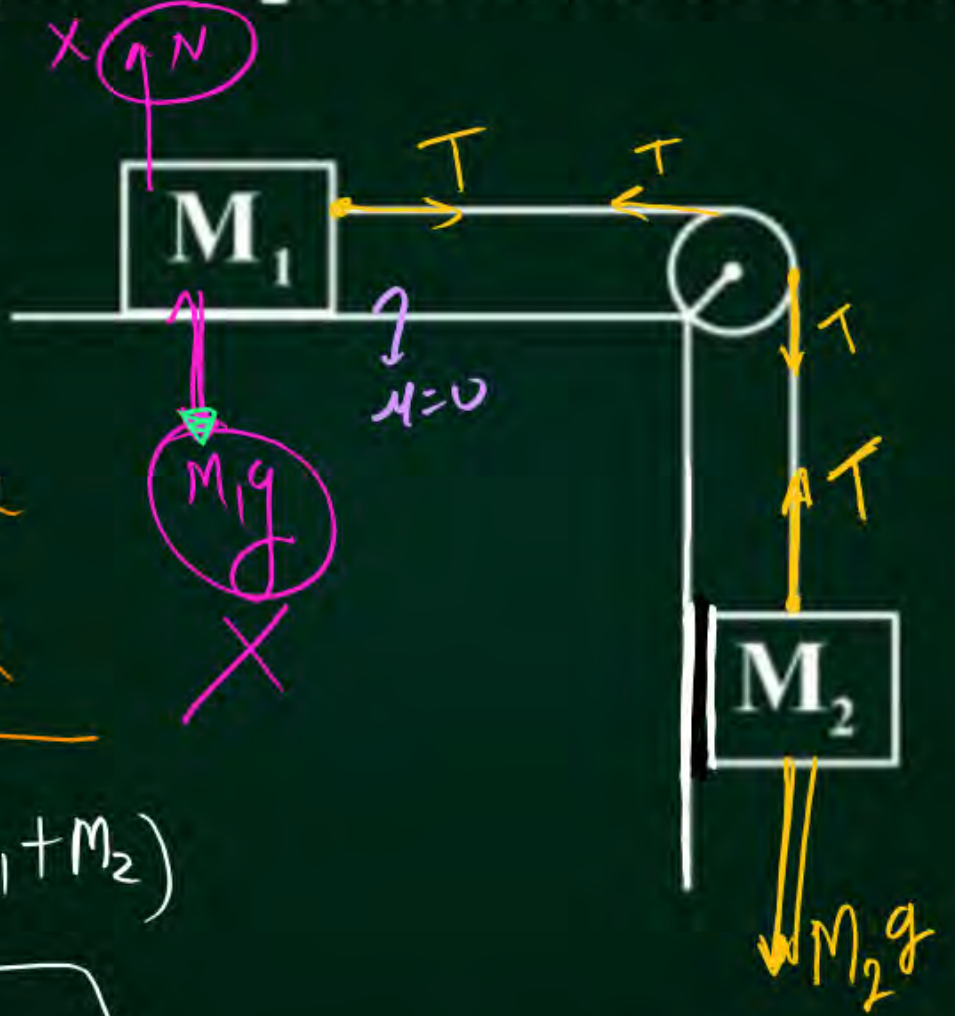
QUESTION

Find acceleration of m_1 and m_2. [NEET-2020]



QUESTION

Find acceleration of Block M_1 and M_2 and tension in string.



F.B.D of m_2

$$m_2 g - T = m_2 a$$

$$T = m_1 a$$

$$m_2 g = a(m_1 + m_2)$$

$a = \dfrac{m_2 g}{m_1 + m_2}$

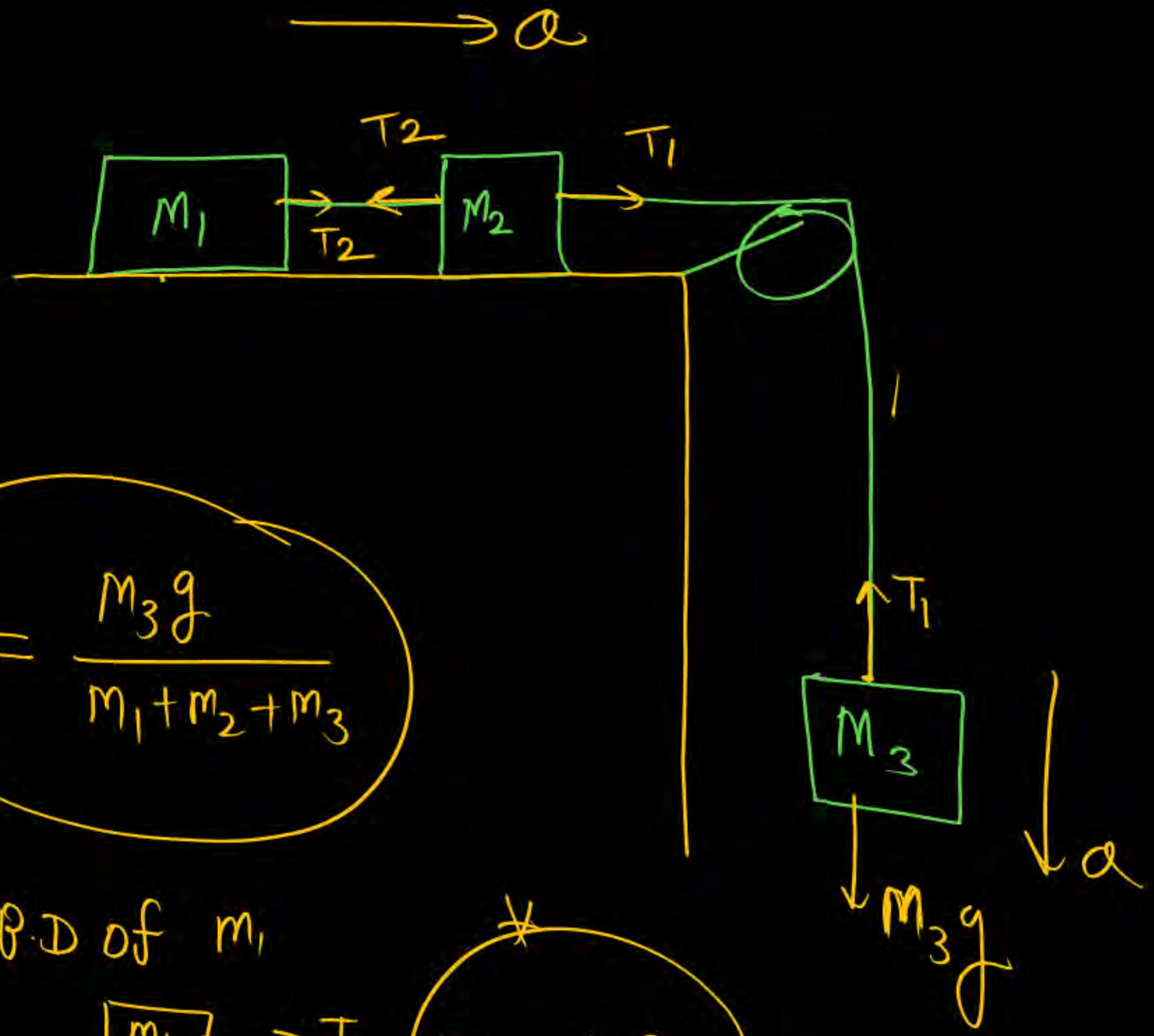
dim^n ✓

MR* if $m_2 = 0$, $a = 0$

MR* if $m_1 = 0$, $a = g$

$$a = \frac{m_2 g}{m_1 + m_2}$$

$$T = \frac{m_1 m_2 g}{m_1 + m_2}$$

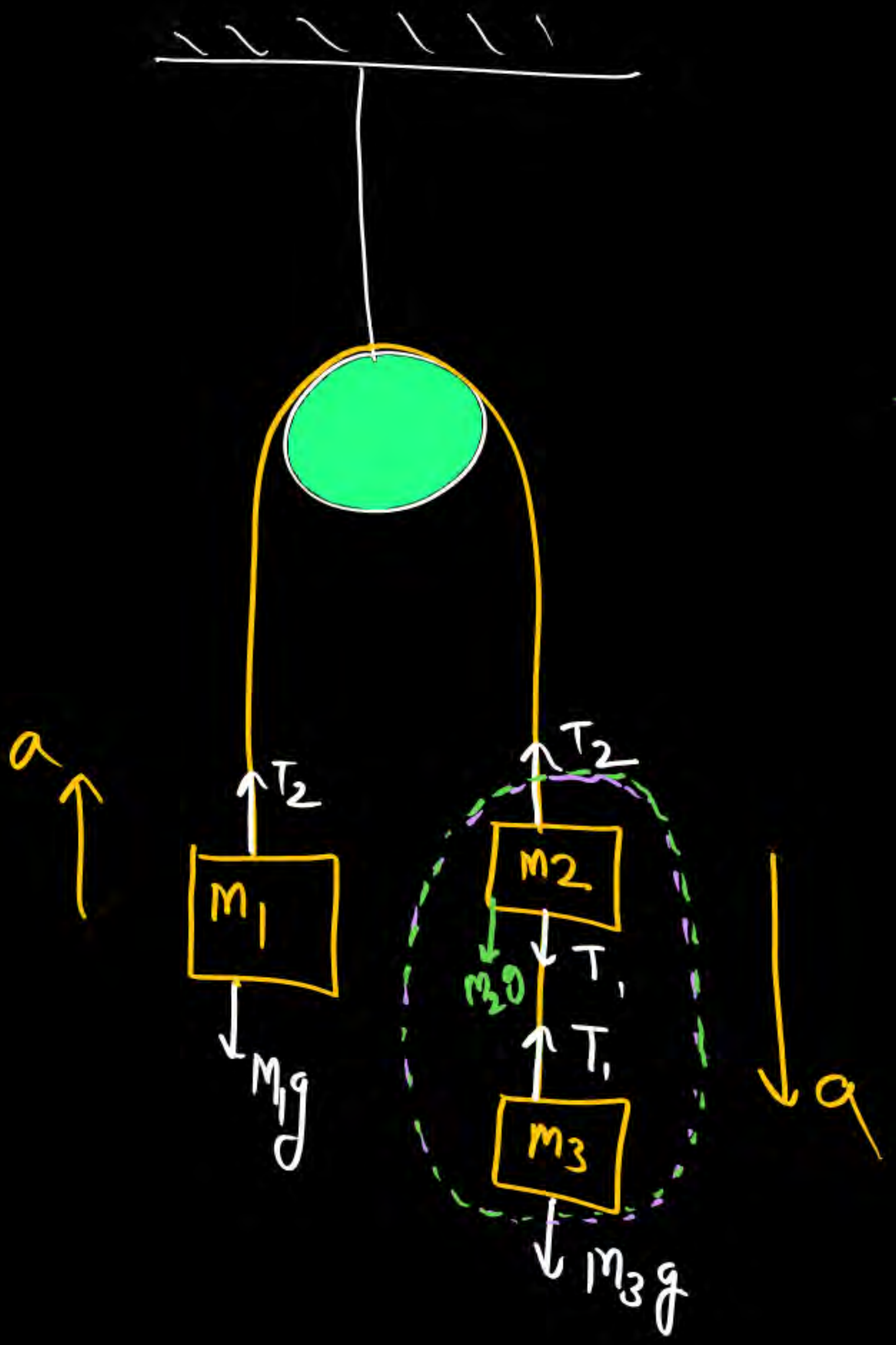


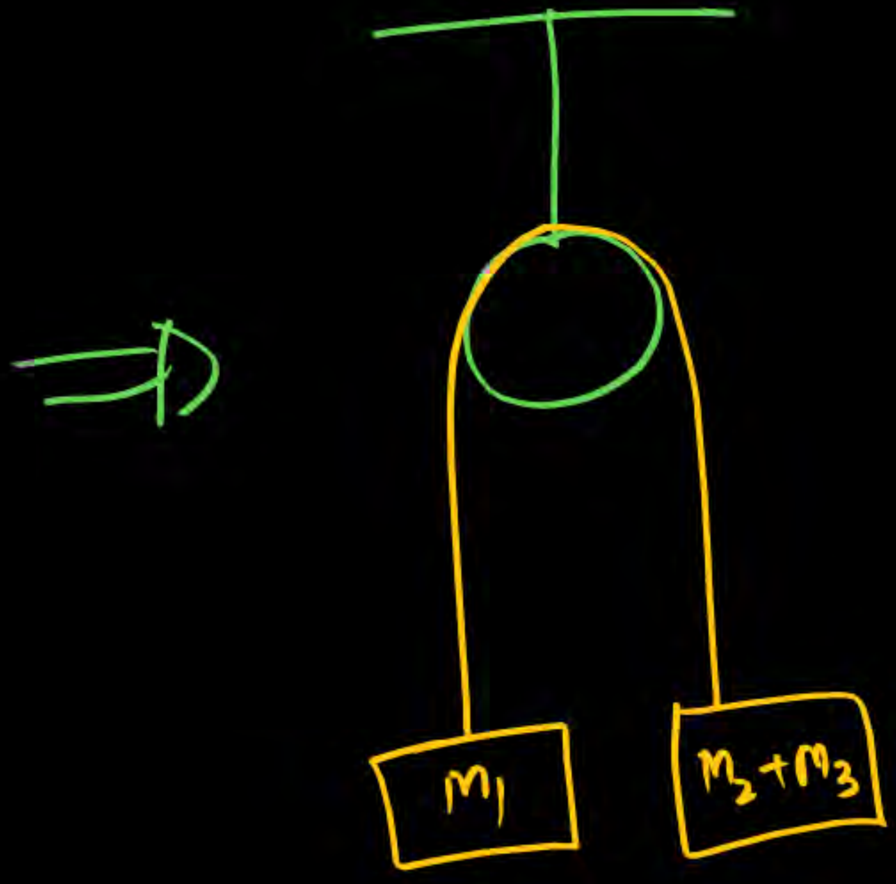
$$a = \frac{m_3 g}{m_1 + m_2 + m_3}$$

F.B.D of m_1



$$T_2 = m_1 a$$
$$= \frac{m_1 m_3 g}{m_1 + m_2 + m_3}$$





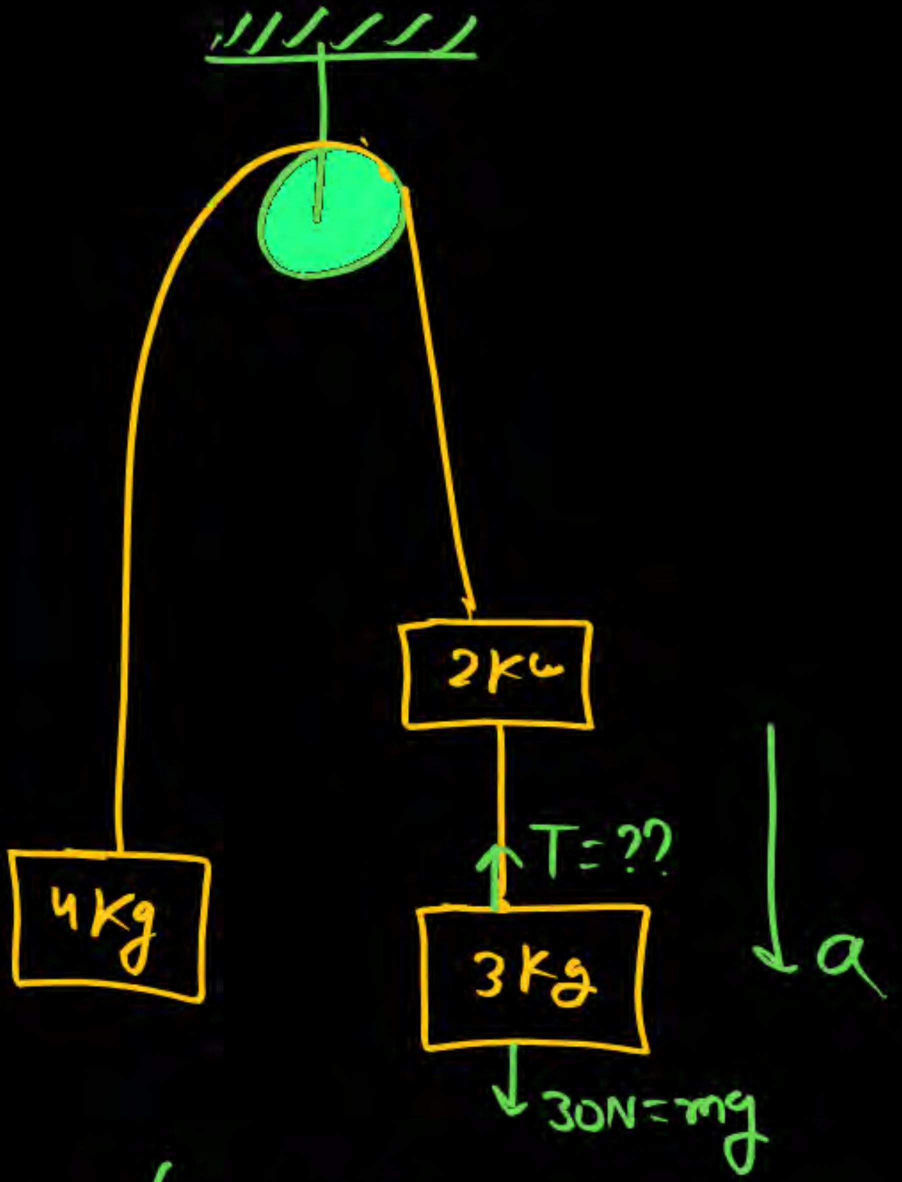
$$a = \frac{(m_2 + m_3 - m_1)g}{m_1 + m_2 + m_3}$$

To find T_1

F.B.D of m_3

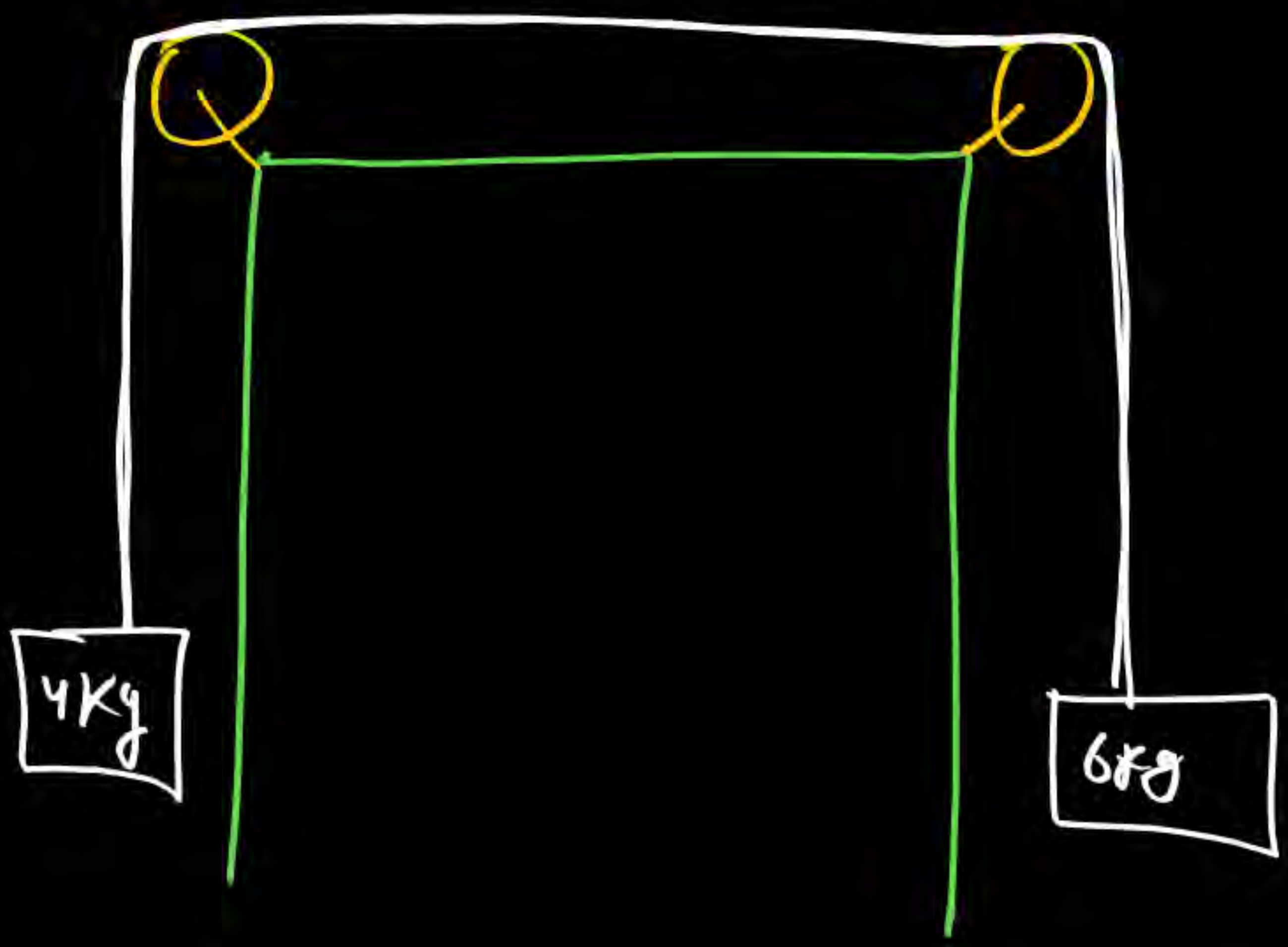
$F = ma$

$$m_3 g - T_1 = m_3 a$$



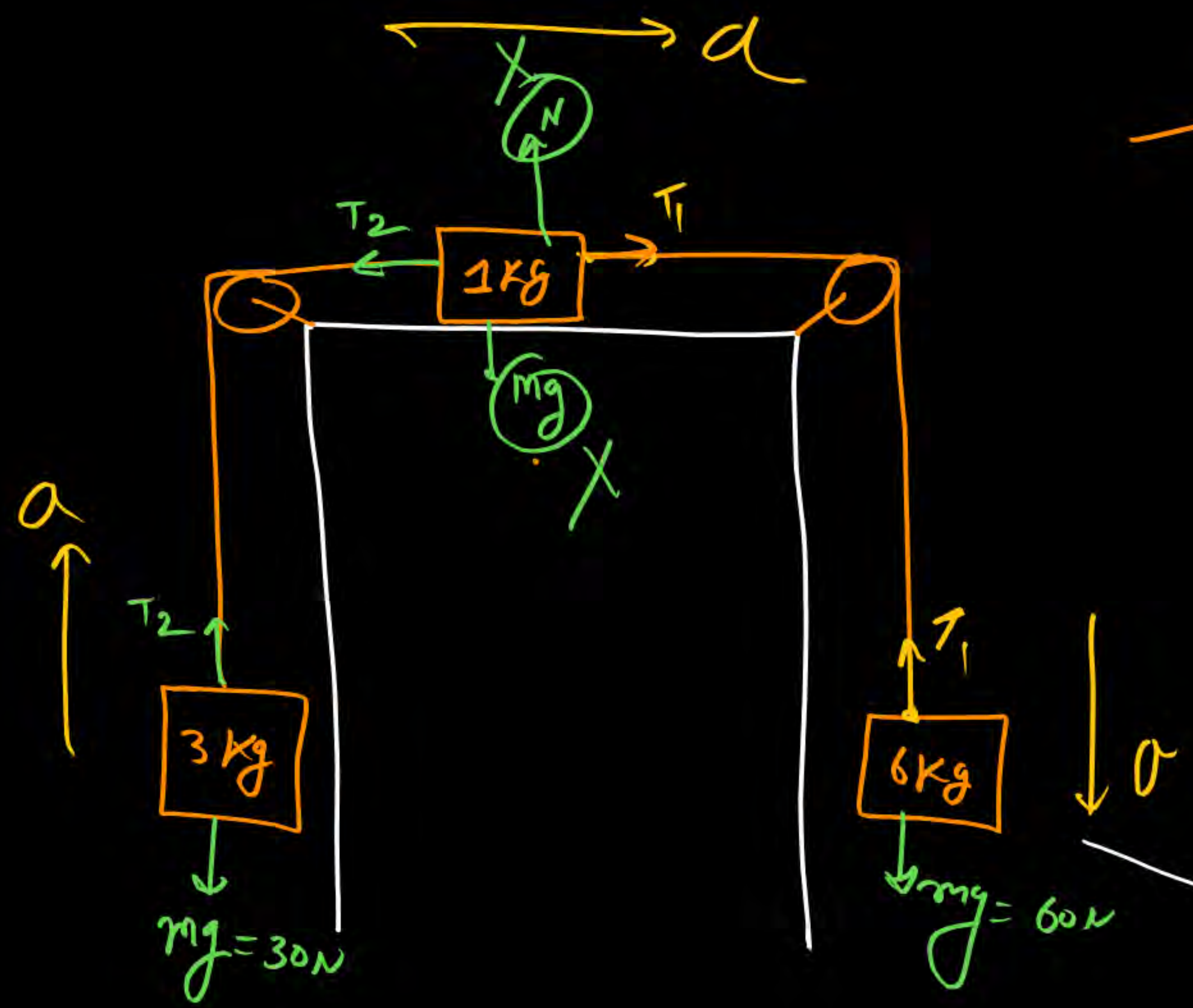
(*) $a = \frac{(3+2-4)g}{3+2+4} = \frac{g}{9} = \frac{10}{9}\ m/s^2$

$30 - T = 3 \times \frac{10}{9}$ $\quad T = 30 - \frac{10}{3} = \frac{80}{3} N$



$$a = \left(\frac{6-4}{6+4}\right) g = \frac{2g}{10} = 2\, m/s^2$$

$$T = \frac{2 \times 6 \times 4}{6+4} \times g = \underline{48\, N}$$

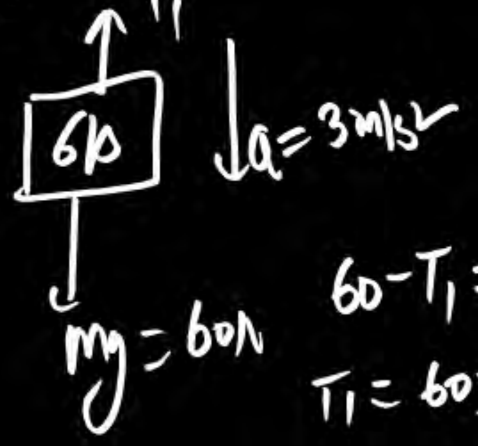


→ Tino ko chipka diya

$$a = \frac{60-30}{6+3+1} = \frac{30}{10} = 3 m/s^2$$

$$a = \left\{\frac{(6-3)g}{6+3+1}\right\} = 3 m/s^2$$

To find T_1

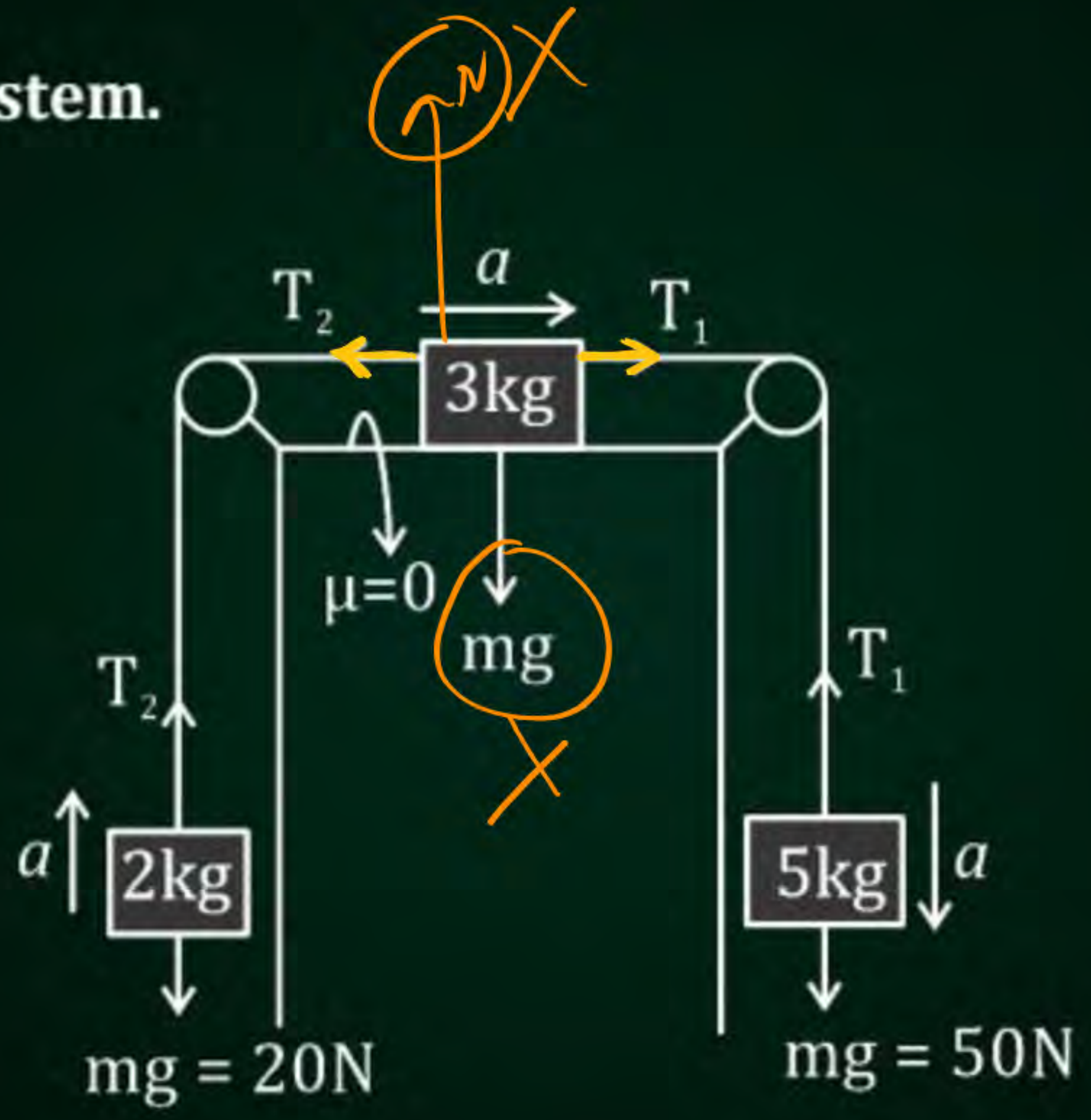


$60 - T_1 = 6 \times 3$

$T_1 = 60 - 18 = 42 N$

QUESTION

Find acceleration of system.

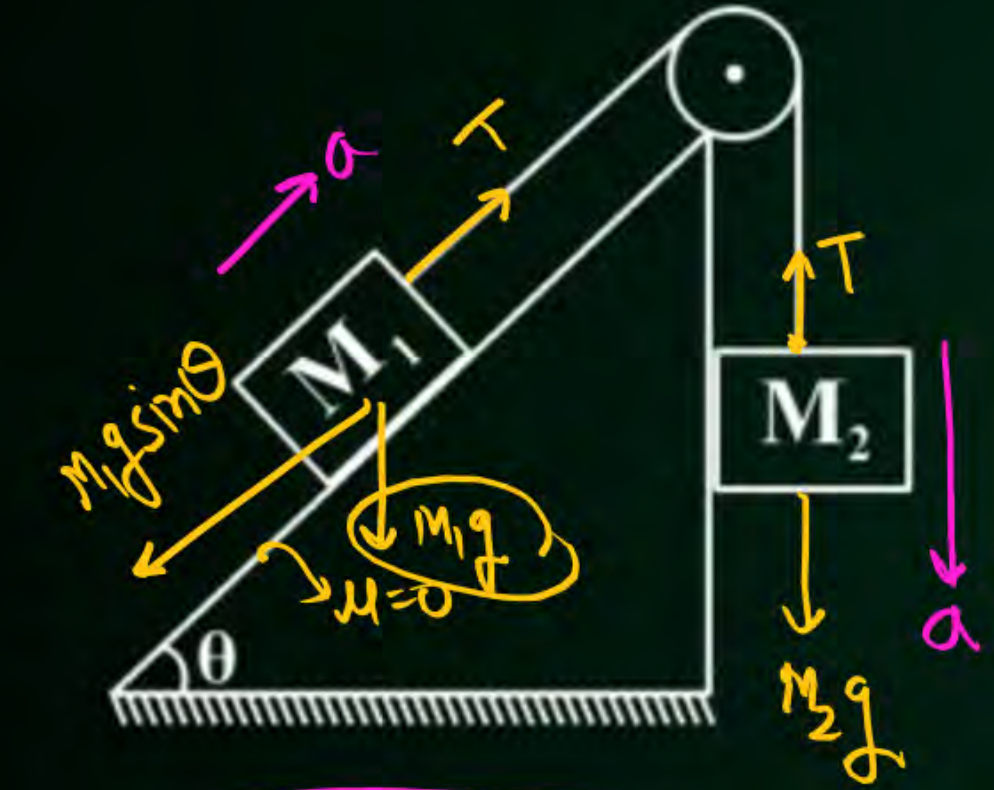


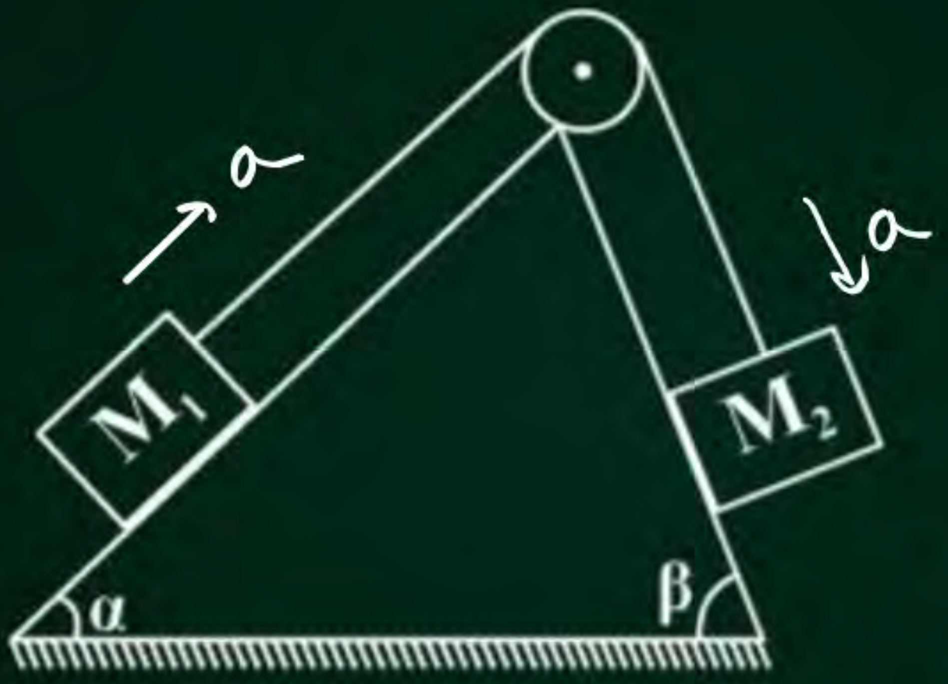
$a = \frac{50-20}{5+2+3}$

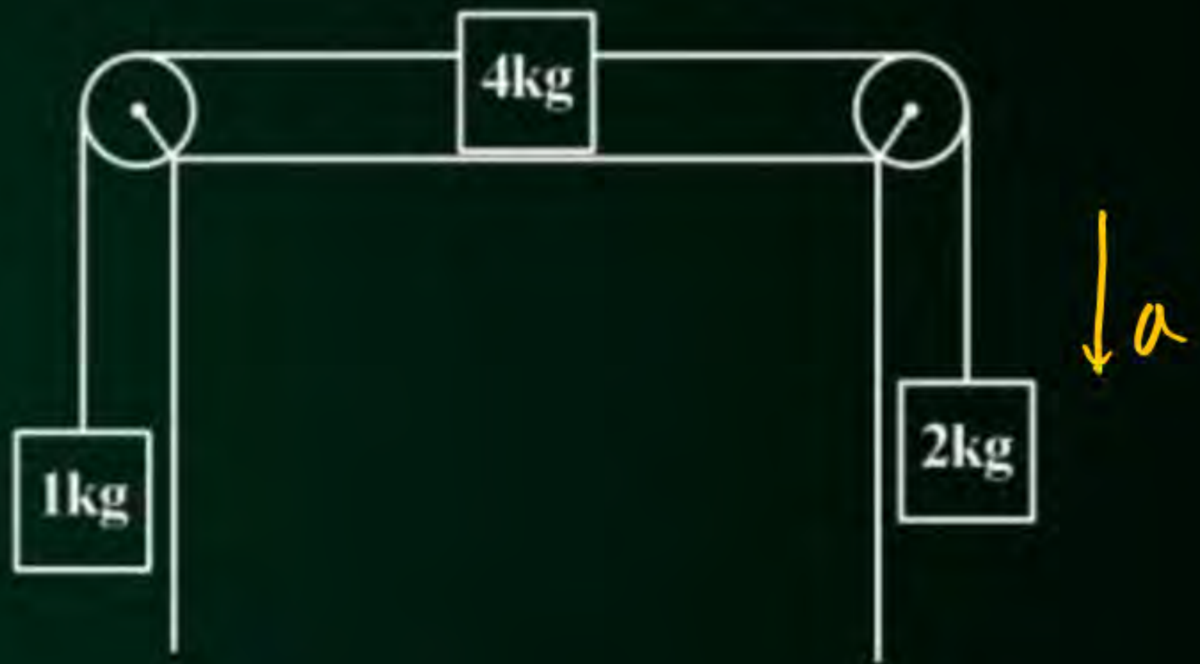
$a = \frac{30}{10} = 3\,m/s^2$

QUESTION

Find acceleration of M_1 and M_2.



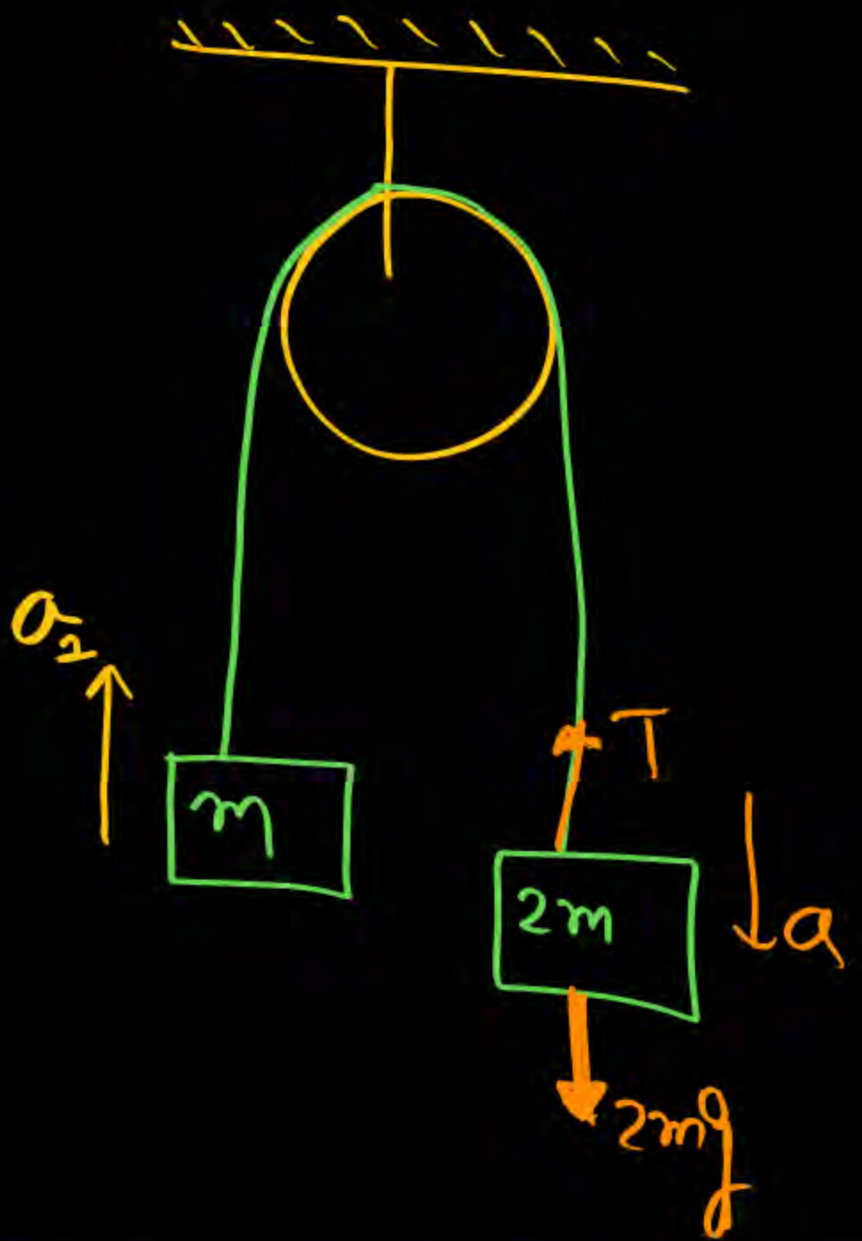




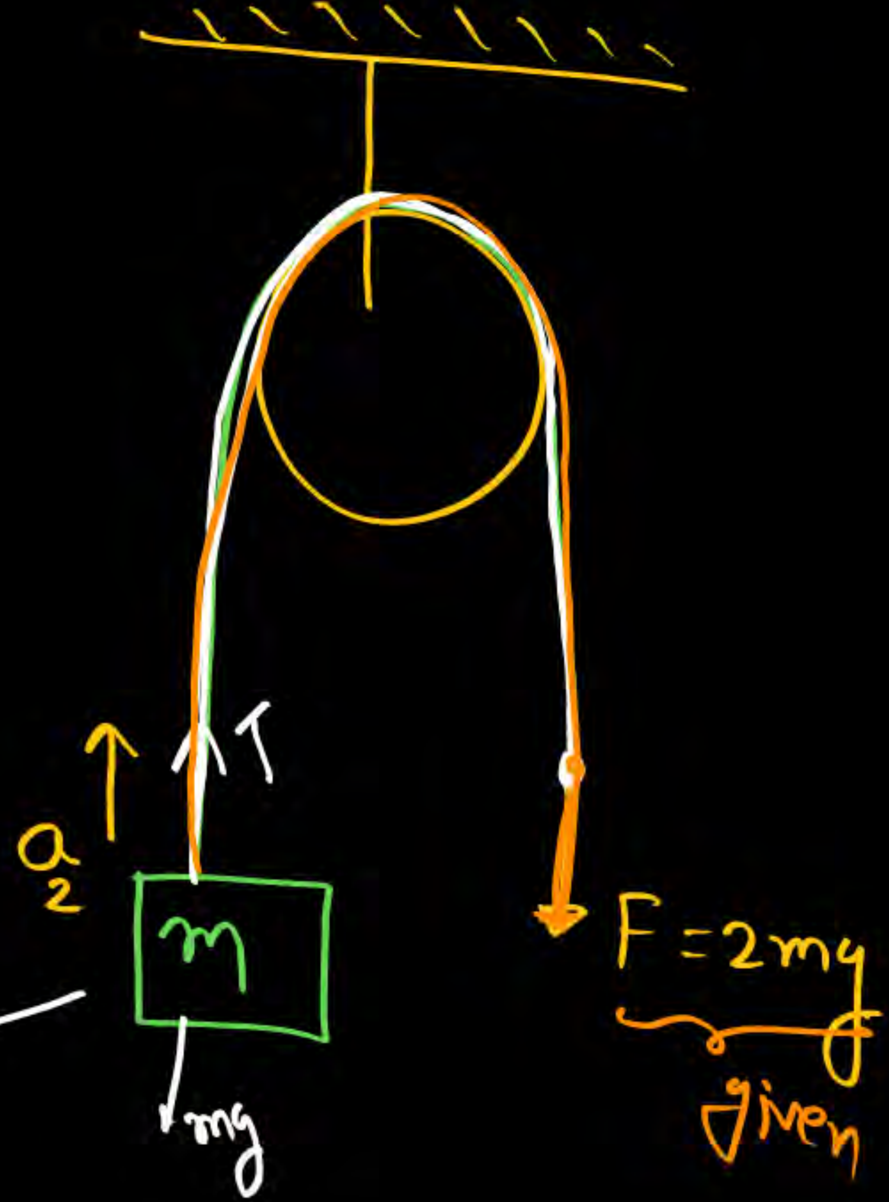
$$\# \quad a = \frac{[m_2 g - m_1 g \sin\theta]}{m_1 + m_2}$$

$$a = \frac{m_2 g \sin\beta - m_1 g \sin\alpha}{m_1 + m_2}$$

$$a = \frac{2g - 1g}{2+1+4} = \left(\frac{g}{7}\right) = \frac{10}{7}\ m/s^2$$



$$a_1 = \left(\frac{2m - m}{2m + m}\right) g = \frac{mg}{3m} = g/3$$



F.B.D



$$T - mg = m a_2$$

$$2mg - mg = m a_2$$

$$a_2 = \frac{mg}{m} = g$$

QUESTION

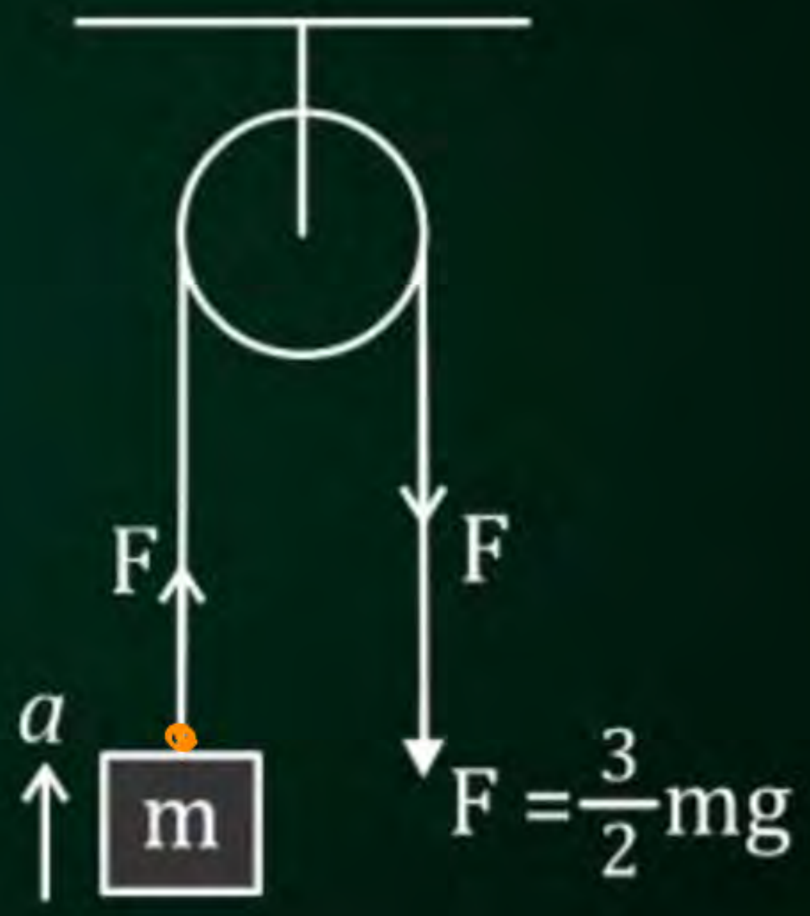
In the arrangement shown, the mass m will ascend with an acceleration (Pulley and rope are massless)

1. Zero
2. g/2
3. g
4. 2g

85.26

$a = \frac{\frac{3}{2}mg - mg}{m}$

$= g/2$



QUESTION

A system consists of three masses m_1, m_2 and m_3 connected by a string passing over a pulley P. The mass m_1 hangs freely and m_2 and m_3 are on a rough horizontal table (The coefficient of friction = μ). The pulley is frictionless and of negligible mass. The downward acceleration of mass m_1 is : (Assume $m_1 = m_2 = m_3 = m$)

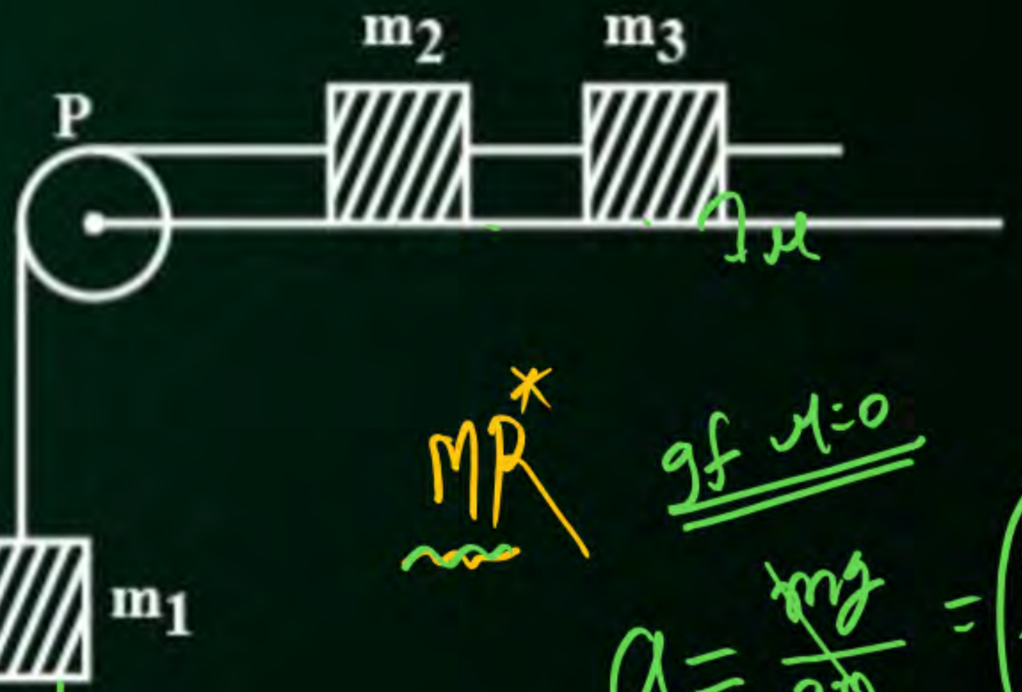
[AIPMT-2014]

(1) $\frac{g(1-g\mu)}{9}$

(2) $\frac{2g\mu}{3}$

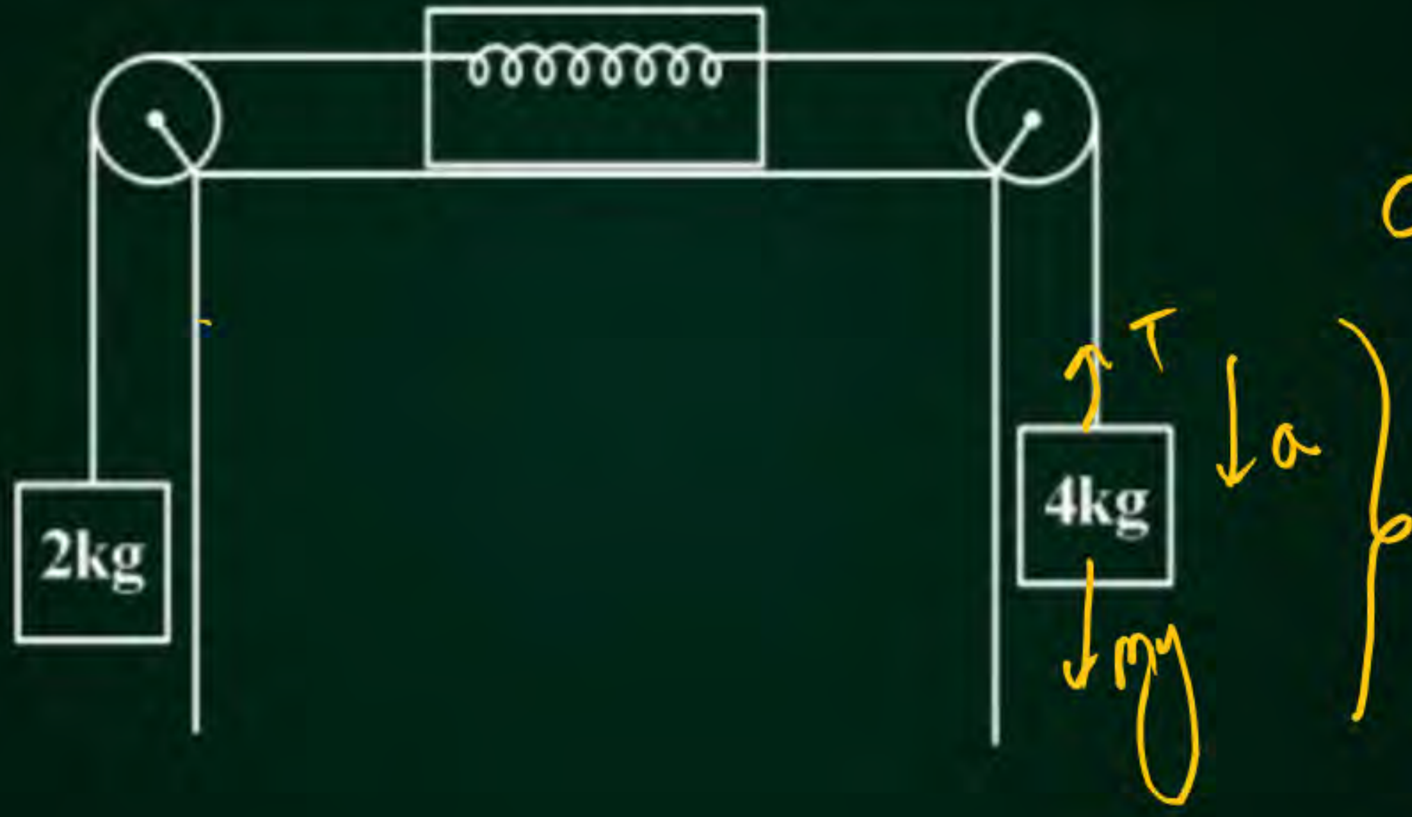
(3) $\frac{g(1-2\mu)}{3}$

(4) $\frac{g(1-2\mu)}{2}$



QUESTION

Reading of spring. ≃ Tension in a wire



$$a = \frac{(4-2)g}{4+2} = \frac{2g}{6}$$

$$a = g/3$$

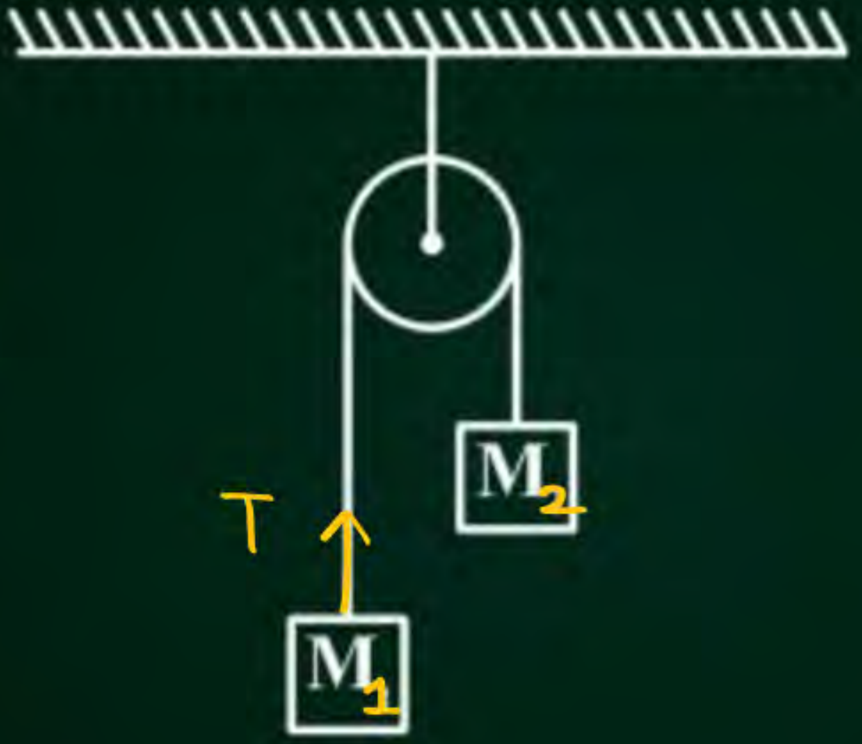
$$mg - T = ma$$

$$mg - T = \frac{mg}{3}$$

$$T = mg - \frac{mg}{3} = \frac{2mg}{3} = \frac{2 \times 4 \times 10}{3} = \frac{80}{3}\,N$$

QUESTION (IIT)

Find tension in string if ($M_1 >> M_2$)



as we know

$$T = \frac{2m_1m_2}{(m_1+m_2)}g$$

$$T = \frac{2m_1m_2g}{m_1+m_2}$$

$$T = \frac{2m_1m_2g}{m_1}$$

$$\boxed{T = 2m_2g}$$ Ans

- Tension force in string becomes zero exactly after cutting the string.
- Spring force in spring becomes zero slowly after cutting the spring.

Question)

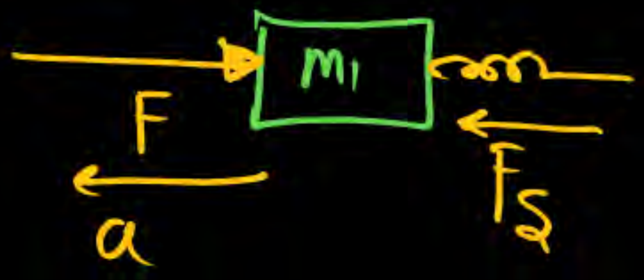


$$a' = \frac{F + m_1 a}{m_2}$$

as shown in fig. m_1 is moving with acc^n a in left then find acc^n of m_2.

Sol^n

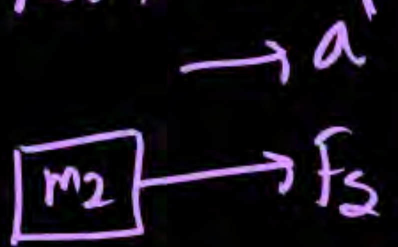
F.B.D of m_1



$F_s - F = m_1 a$ — (1)

$F_s = F + m_1 a$

m_2 ka F.B.D



$F_{net} = m_2 a'$

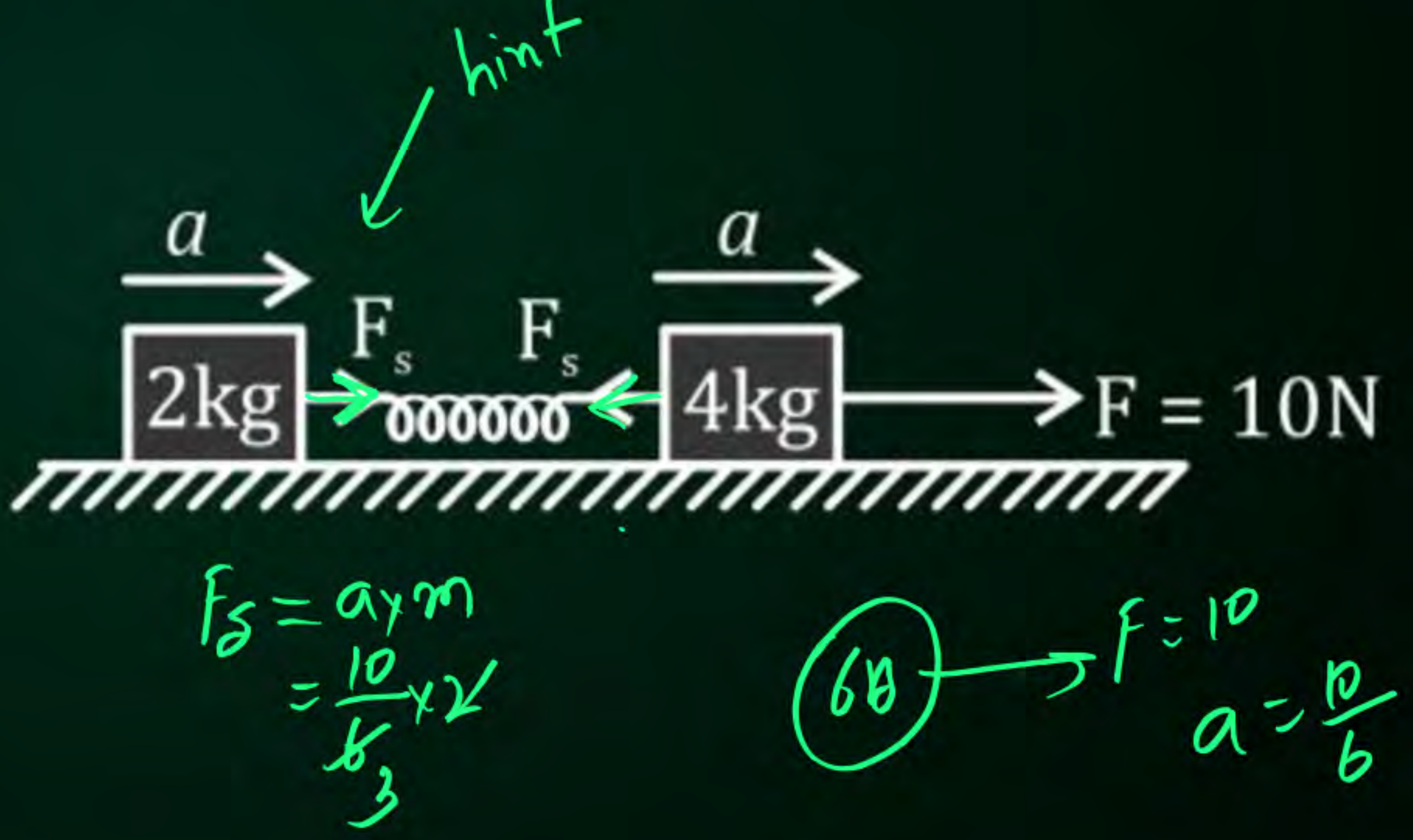
$F_s = m_2 a'$

$F + m_1 a = m_2 a'$

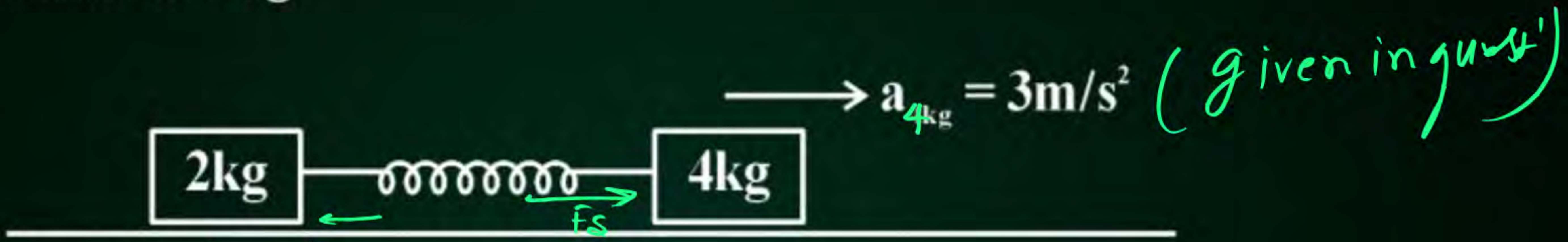
QUESTION

Two blocks of mass 2 kg and 4 kg are accelerated with same acceleration by a force 10 N as shown in figure on a smooth horizontal surface. Then the spring force between the two blocks will be (spring is massless)

1. 5 N
2. 10 N
3. $\frac{10}{3}$ N
4. $\frac{5}{3}$ N



Find acceleration of 2 kg.



$ma' = F_s$

$2a' = 12$

$a' = 6 m/s^2$

$F_s = 4 \times a$

$= 4 \times 3 = 12 N$

QUESTION

Two masses of 10 kg and 20 kg respectively are connected by a massless spring as shown in figure. A force of 200 N acts on the 20 kg mass. At the instant shown the 10 kg mass has acceleration $12\ m/s^2$ towards right. The acceleration of 20 kg mass at this instant is:



1. $12\ m/s^2$
2. $4\ m/s^2$
3. $10\ m/s^2$
4. zero

QUESTION

Find acceleration of B block if acceleration of A block is a_0 towards left.



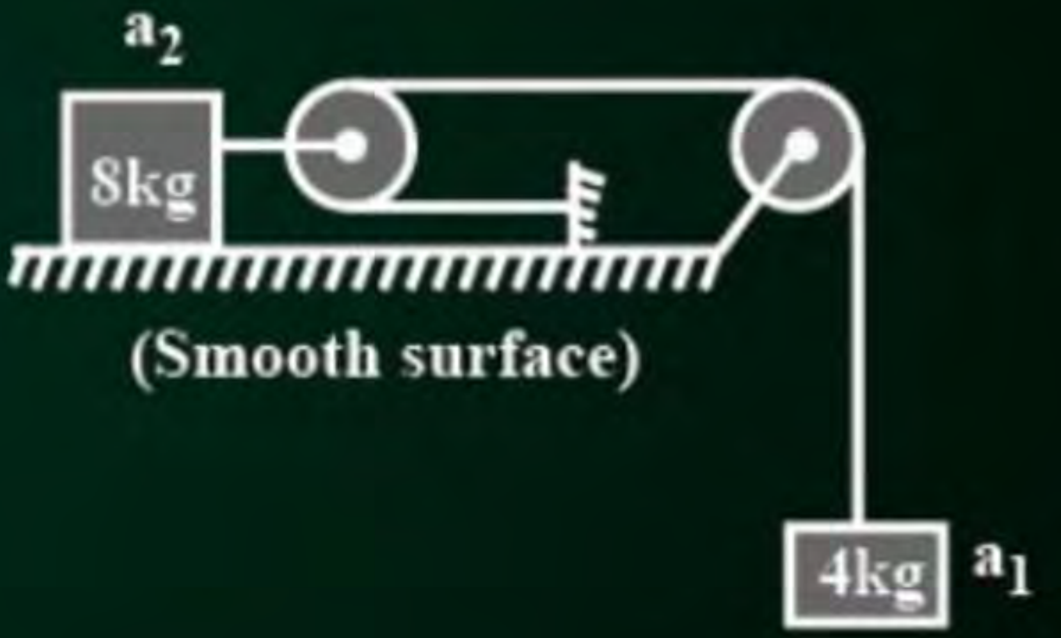
CONSTRAIN MOTION

- Total work done by internal force is zero.

QUESTION

If pulleys shown in the diagram are smooth and massless and a_1 and a_2 are acceleration of blocks of mass 4 kg and 8 kg respectively, then

1. $a_1 = a_2$
2. $a_1 = 2a_2$
3. $2a_1 = a_2$
4. $a_1 = 4a_2$

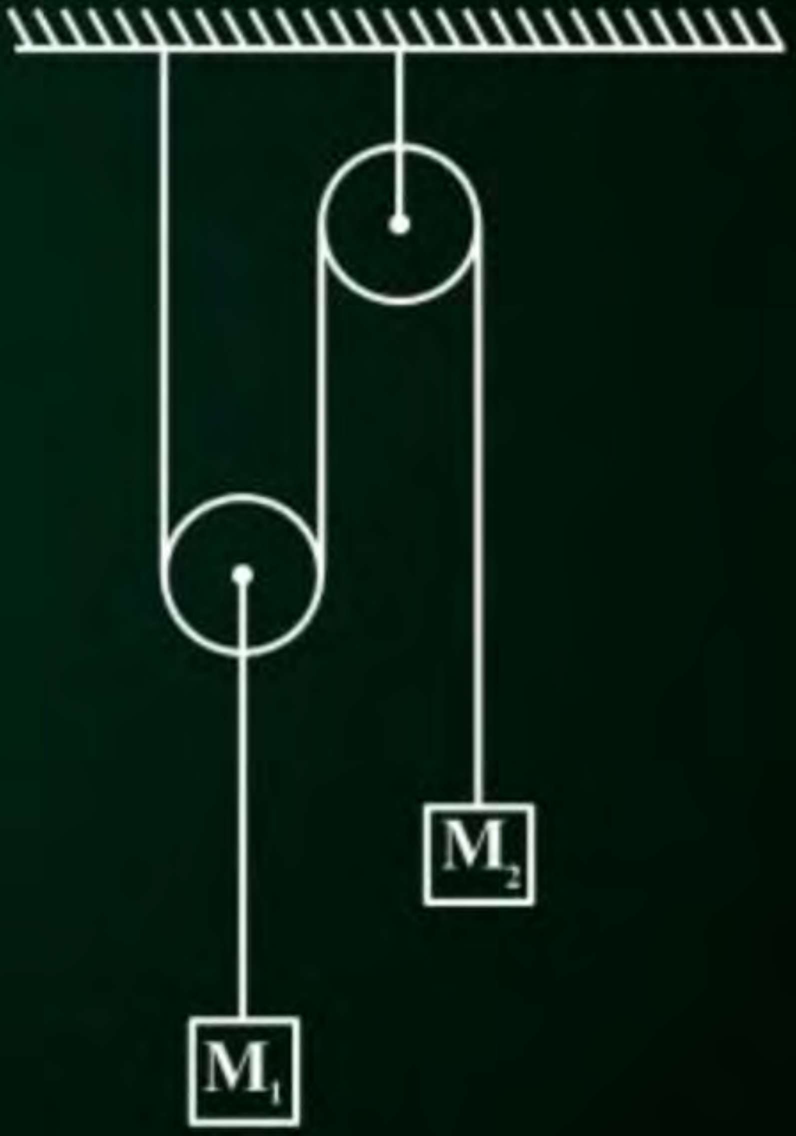


QUESTION

Constrain Motion :

Find relation between a_1 and a_2

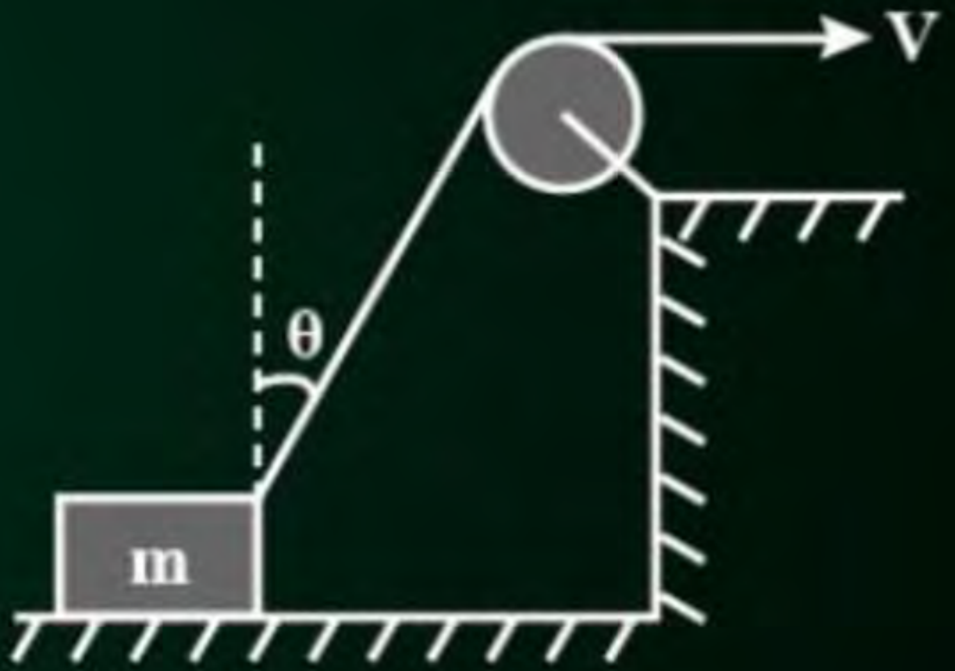




QUESTION

A block is dragged on smooth plane with the help of a rope which moves with velocity v. The horizontal velocity of the block is :

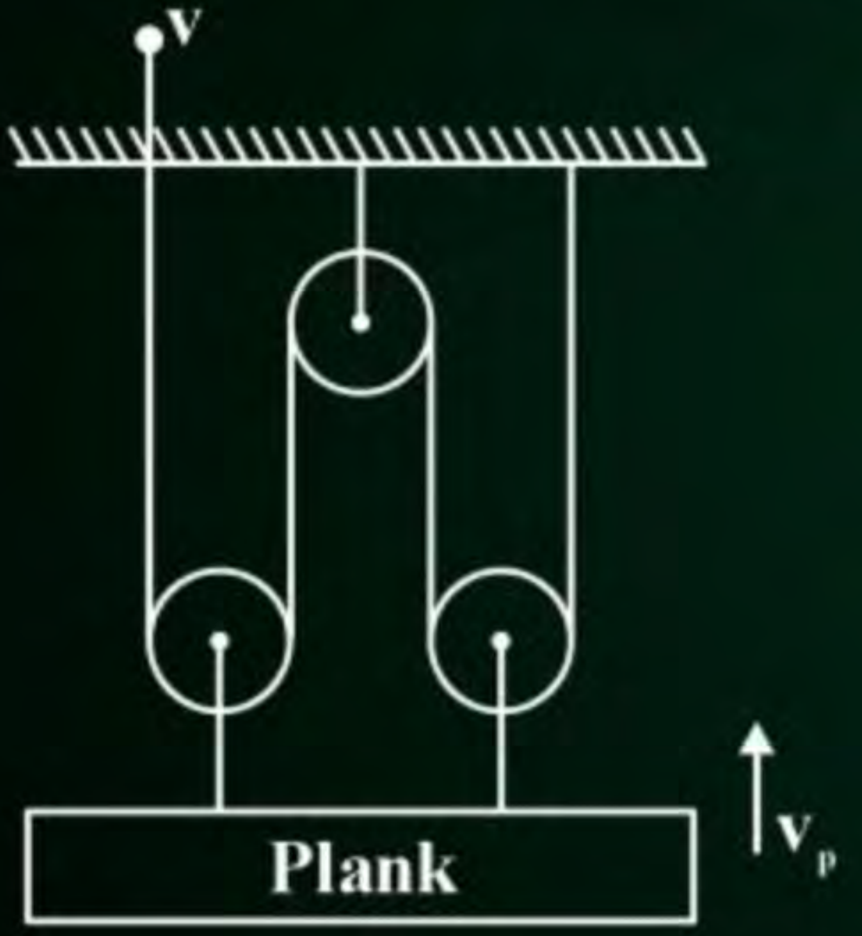
1. v
2. $\frac{v}{\sin\theta}$
3. $v\sin\theta$
4. $\frac{v}{\cos\theta}$

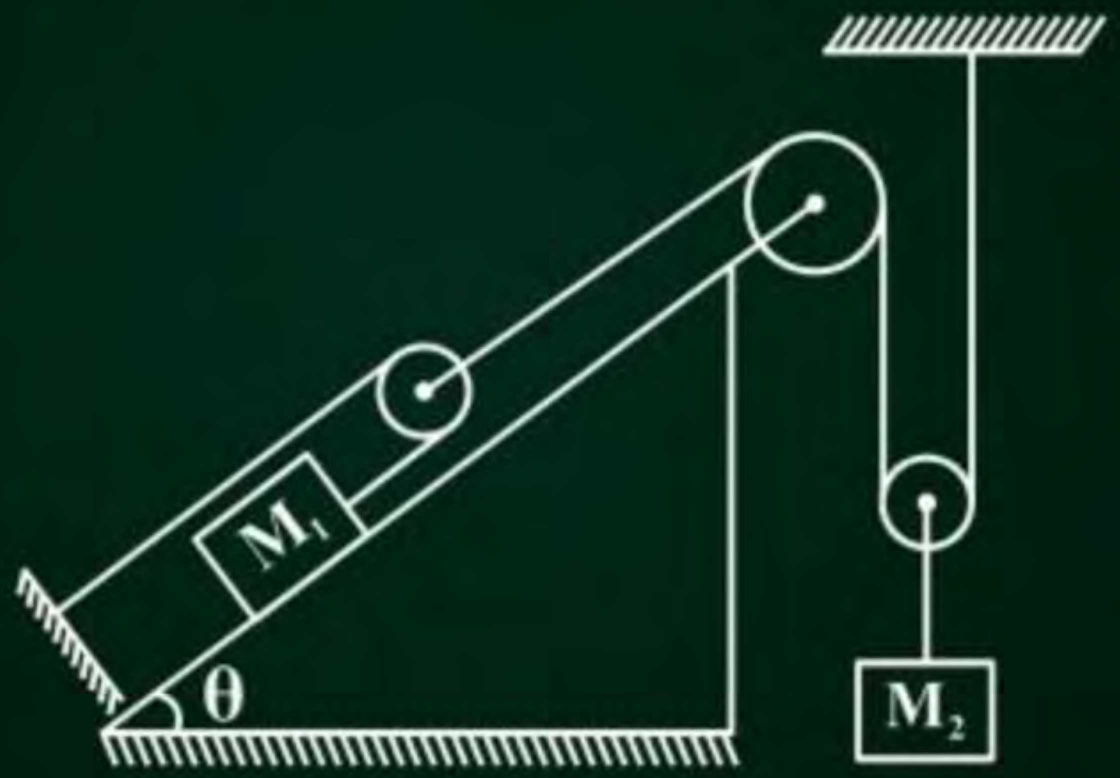


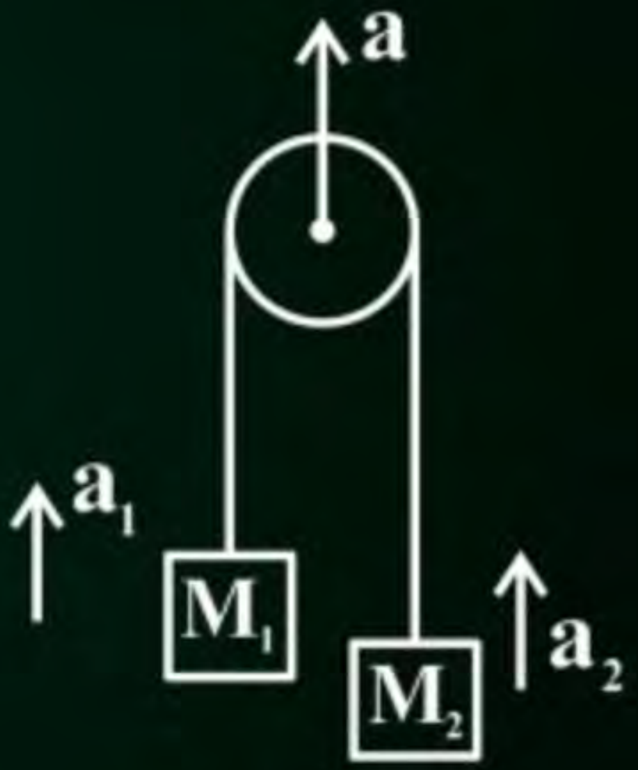
QUESTION

Constrain Motion :

Find relation between a_1 and a_2







QUESTION

In the figure shown, the pulley is moving with velocity u. The velocity of the block attached with string :

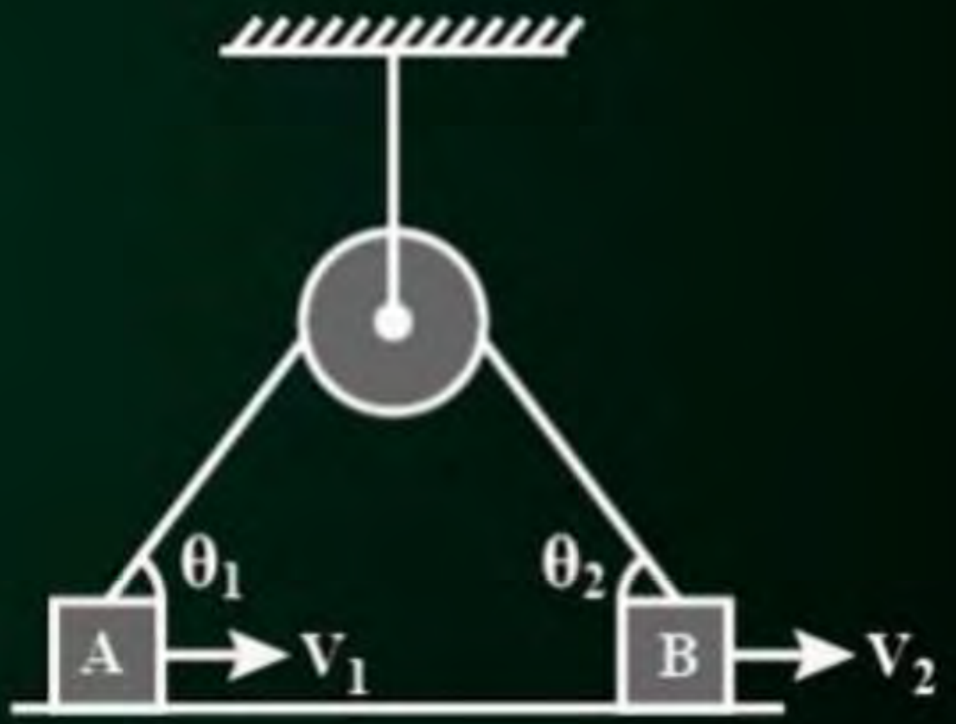


1. $4u$
2. $3u$
3. U
4. $2u$

QUESTION

In the figure shown, blocks A and B move with velocities v_1 and v_2 along horizontal direction. The ratio of $\frac{v_1}{v_2}$:

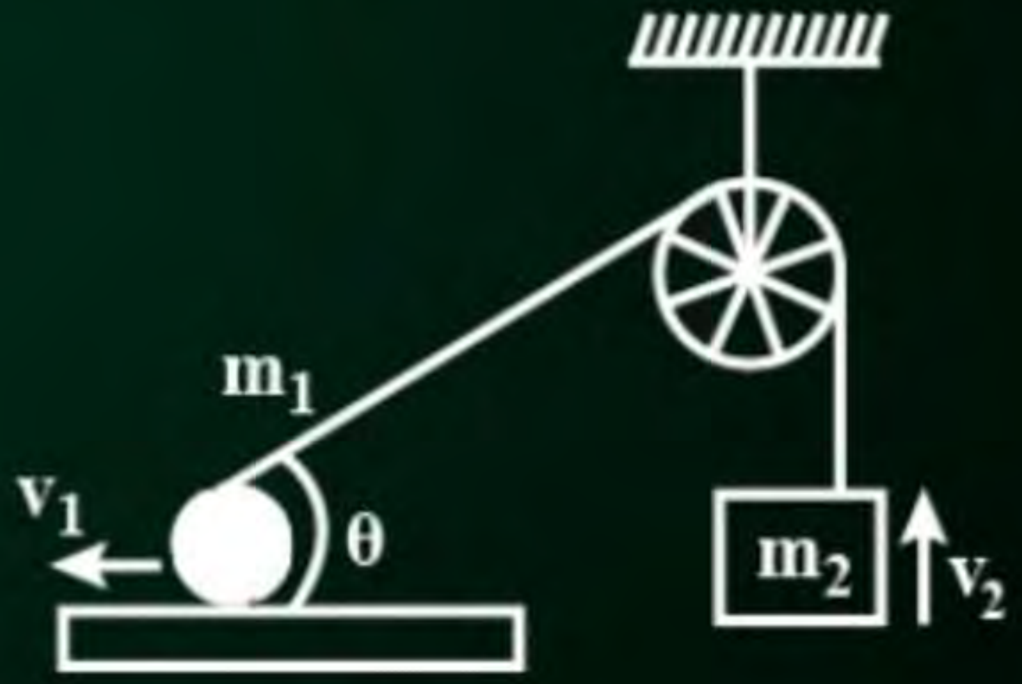
1. $\frac{\sin\theta_2}{\sin\theta_1}$
2. $\frac{\sin\theta_1}{\sin\theta_2}$
3. $\frac{\cos\theta_2}{\cos\theta_1}$
4. $\frac{\cos\theta_1}{\cos\theta_2}$



QUESTION

In figure, a ball of mass m_1 and a block of mass m_2 are joined together with an inextensible string. The ball can slide on a smooth horizontal surface. If v_1 and v_2 are the respective speeds of the ball and the block, Find $\frac{v_1}{v_2}$.

1. $\cos\theta$
2. $\sec\theta$
3. $\tan\theta$
4. $\sin\theta$



THANK YOU



YAKEEN 2.0

FOR NEET 2025

Lecture- 08 | Physics

Laws of Motion

By- Dr. Manish Raj (MR SIR)

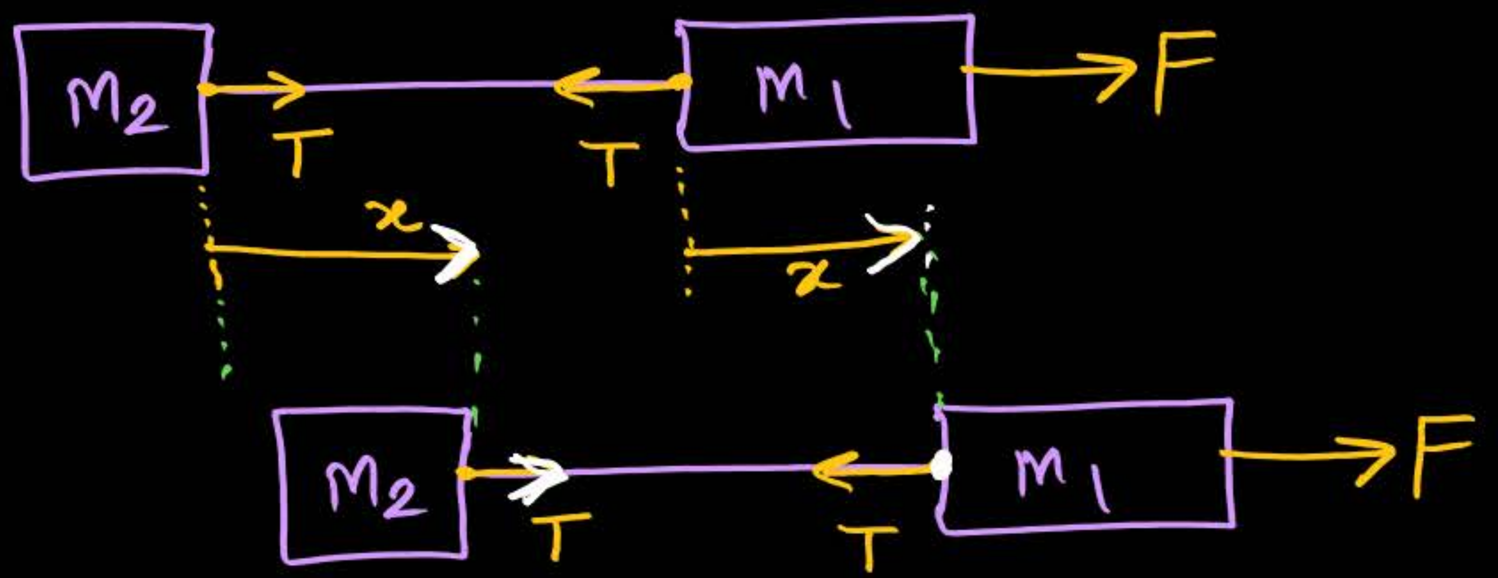


Topics to be covered

1. # Constrain motion
2. # Pseudo force
3. #
4. #



Initial Position



final Position

$$\overbrace{T_1 \cdot x_1}^{+ve} = \overbrace{T_2 \cdot x_2}^{-ve}$$

$\Rightarrow$ diff^n both side w.r.t time

$$T_1 \cdot \frac{dx_1}{dt} = T_2 \cdot \frac{dx_2}{dt}$$

$$\Rightarrow T_1 \cdot V_1 = T_2 \cdot V_2$$

diff^n w.r.t. time

$$\Rightarrow \vec{T_1} \cdot \vec{a_1} = \vec{T_2} \cdot \vec{a_2}$$

Work done by Tension on m_1 $= Tx \cos 180^\circ = -Tx$

" " " " " $m_2 = Tx$

$$W_1 + W_2 = W_{\text{Total work done by Tension on system}} = Tx - Tx = 0$$

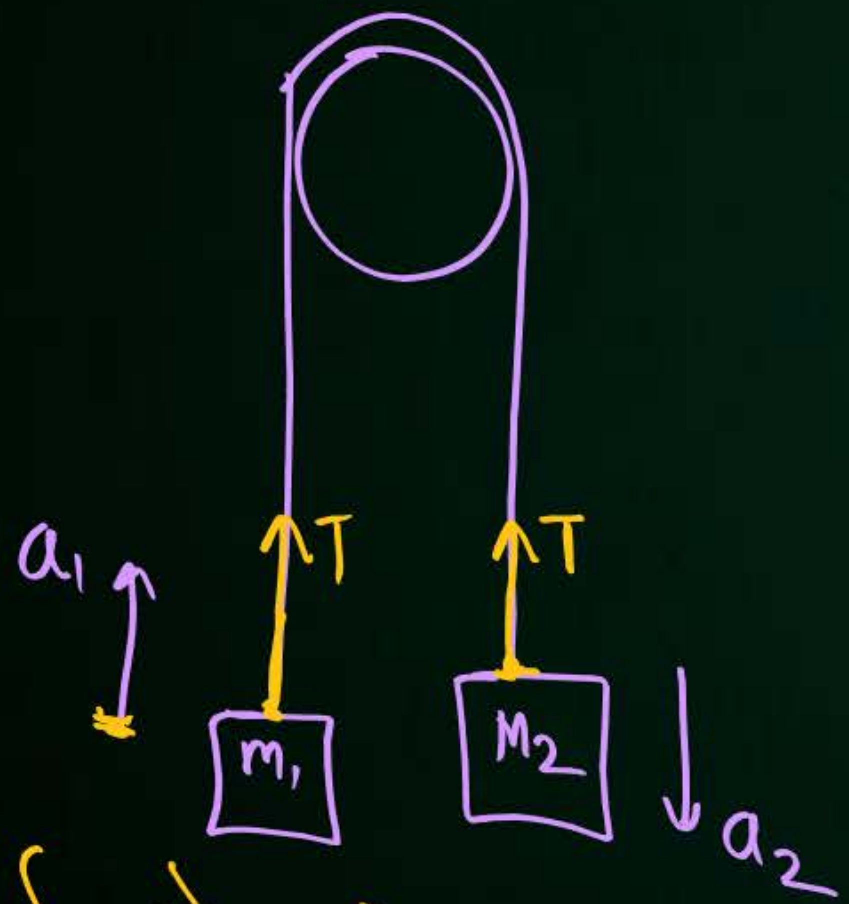
$W_1 = -W_2$

ignore

CONSTRAIN MOTION

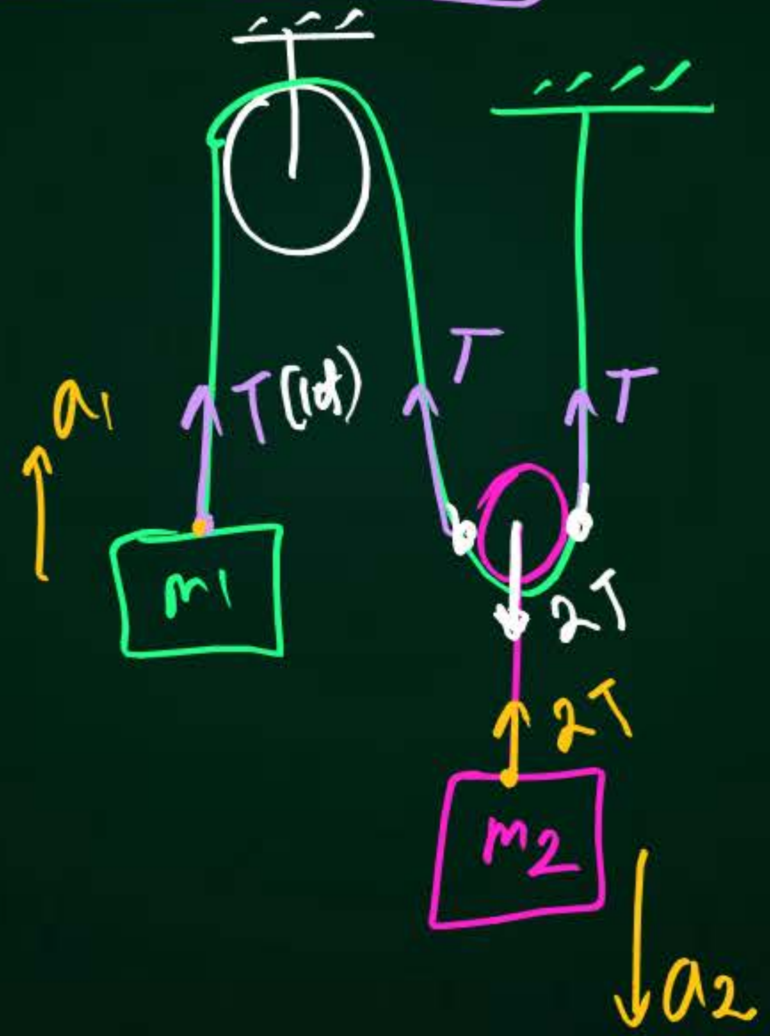
$F = m a = 0 \times a = 0$ for Pully

- **Total work done by internal force is zero.**



for { $a_1 T = T a_2$

$a_1 = a_2$



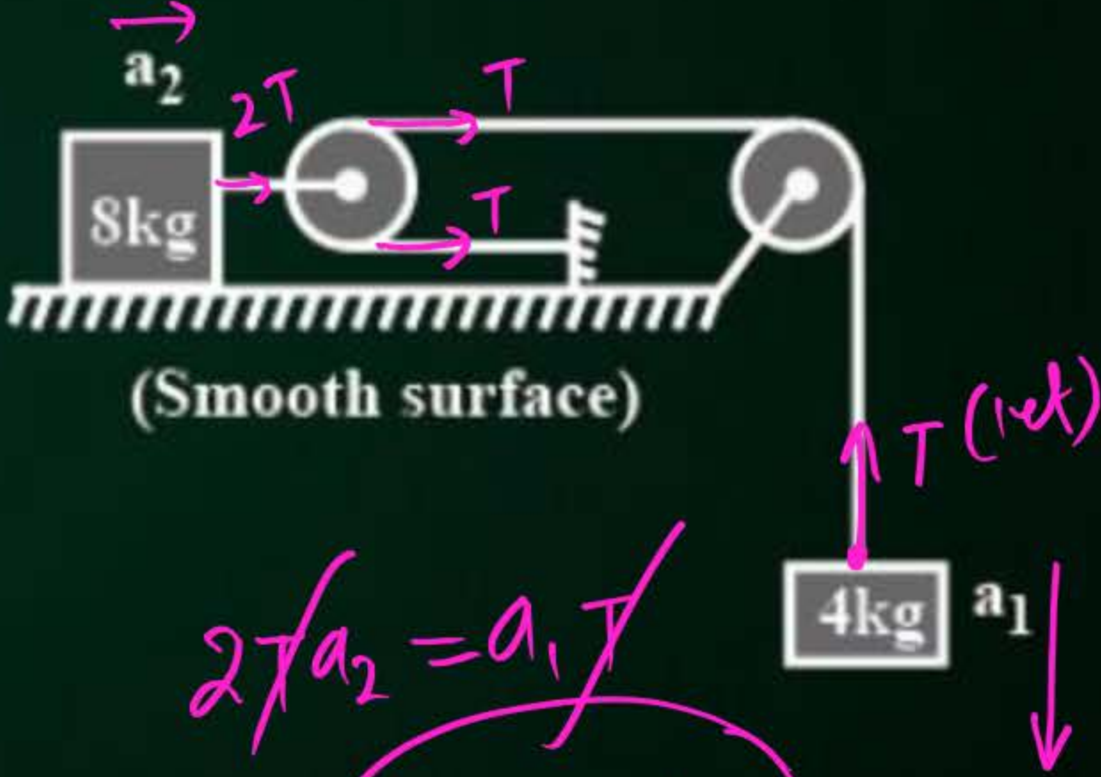
$T a_1 = 2T a_2$

$a_1 = 2a_2$

QUESTION

If pulleys shown in the diagram are smooth and massless and a_1 and a_2 are acceleration of blocks of mass 4 kg and 8 kg respectively, then

1. $a_1 = a_2$
2. $a_1 = 2a_2$
3. $2a_1 = a_2$
4. $a_1 = 4a_2$



QUESTION

Constrain Motion : $T a_1 = \frac{3T}{2} a_2$

Find relation between a_1 and a_2

$2a_1 = 3a_2$



38%

(a) $a_1 = a_2$

(b) $a_1 = 3a_2$

(c) $a_1 = 2a_2$

(d) $2a_1 = 3a_2$ (50%)

$2T a_1 = 3T a_2$

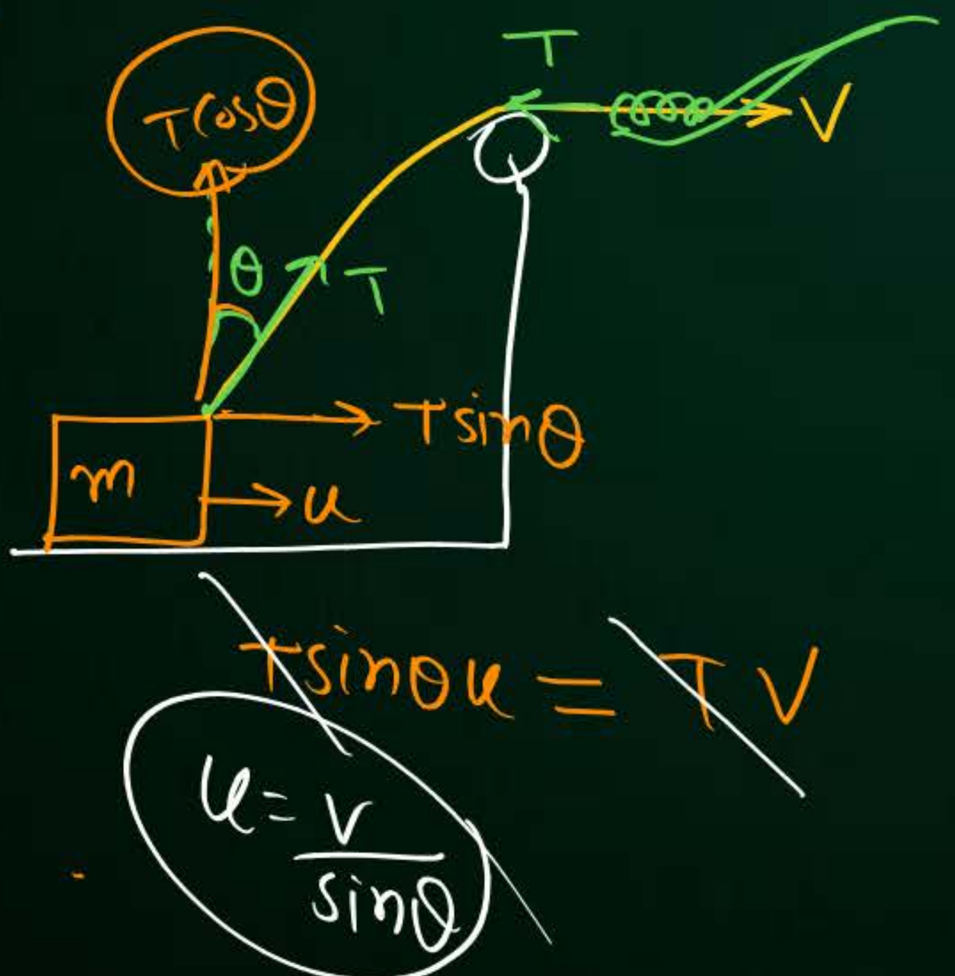
$2a_1 = 3a_2$

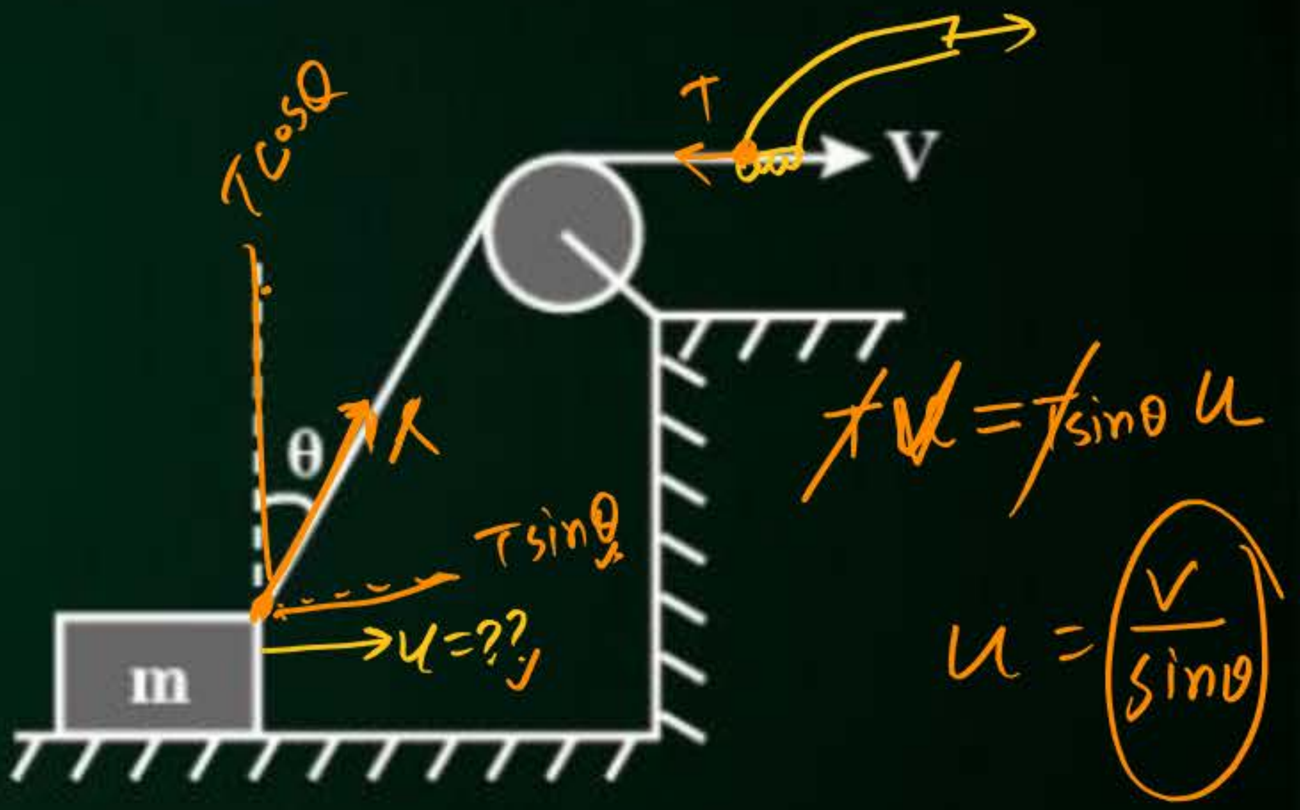
10 Bar

QUESTION

A block is dragged on smooth plane with the help of a rope which moves with velocity v. The horizontal velocity of the block is :

1. v
2. $\frac{v}{\sin\theta}$
3. $v \sin\theta$
4. $\frac{v}{\cos\theta}$

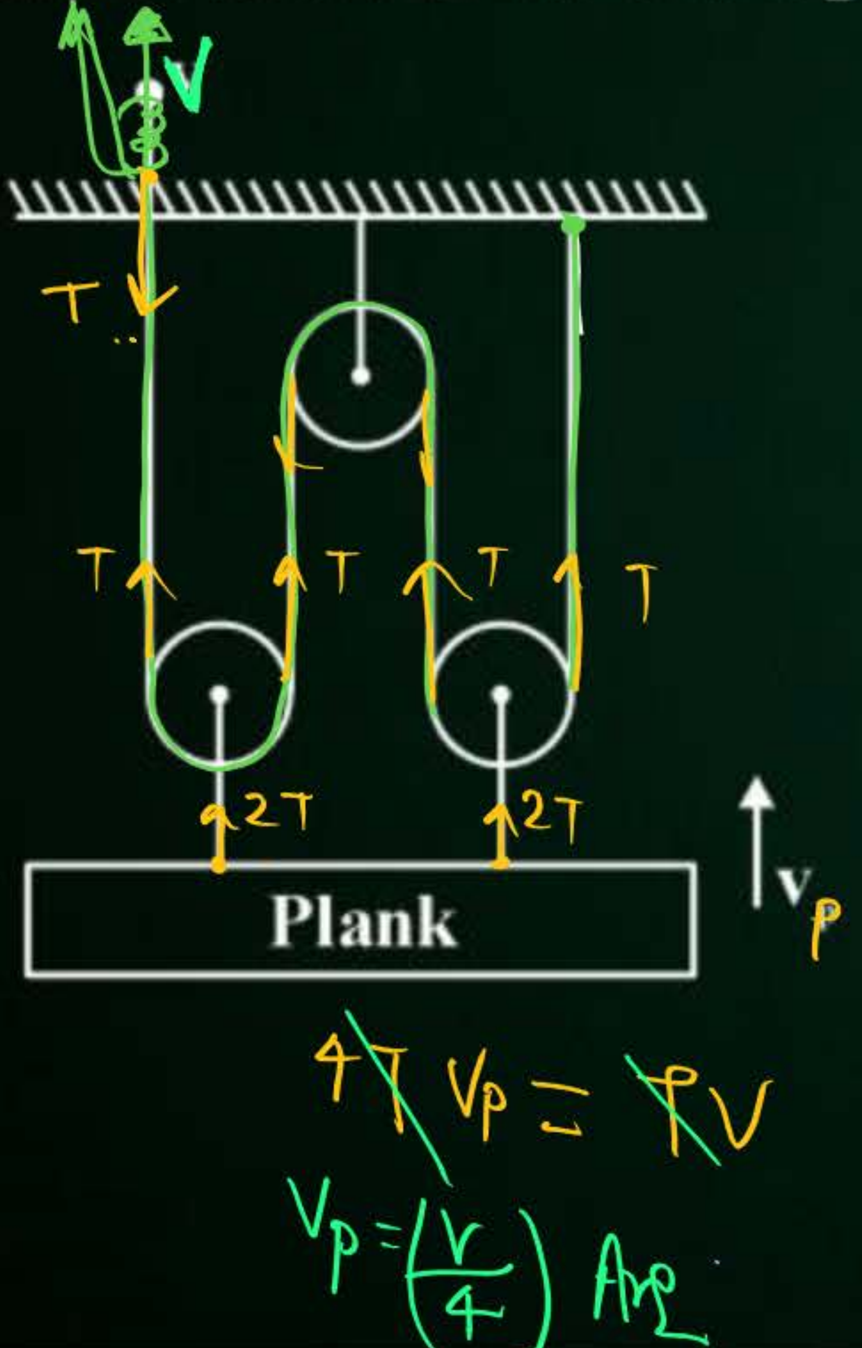


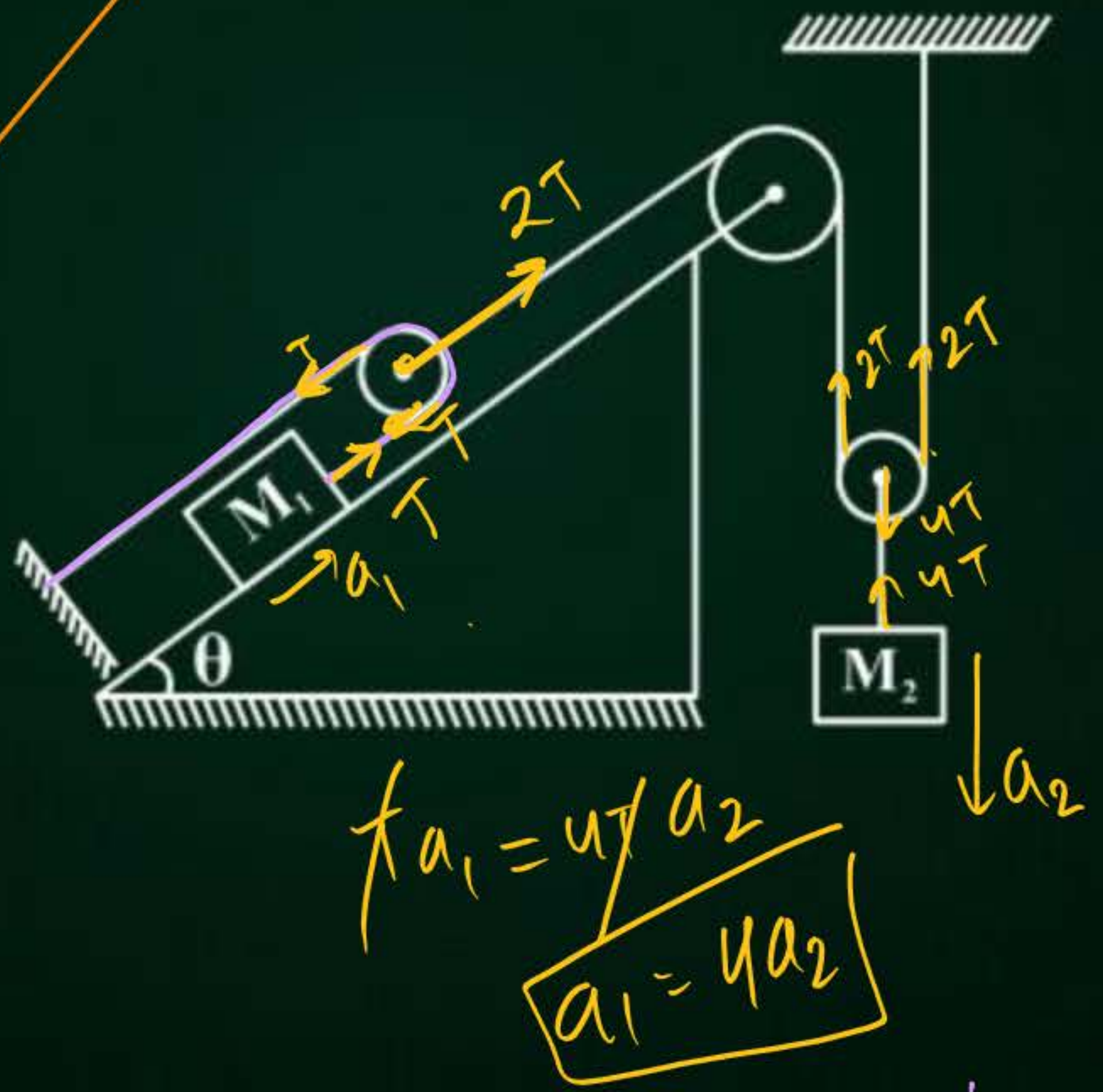


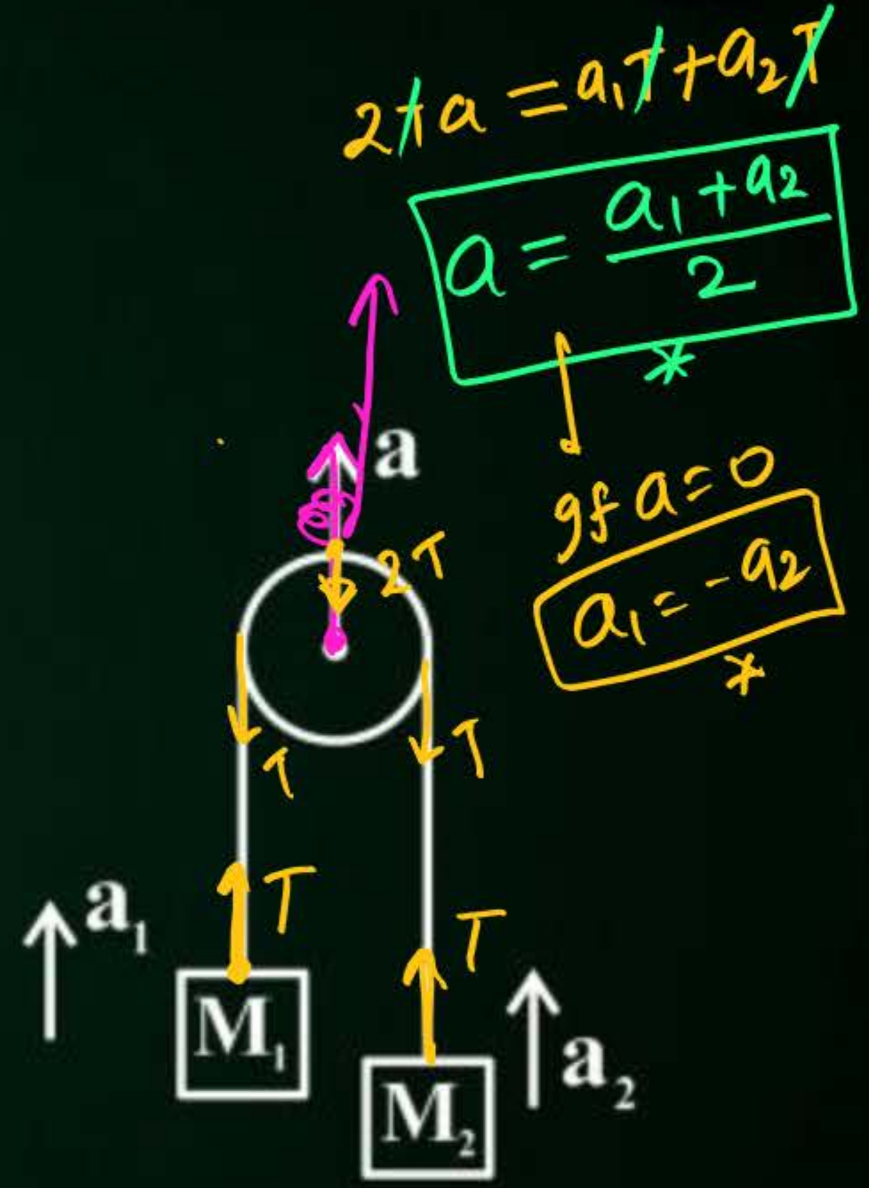
QUESTION

Constrain Motion :

Find relation between a_1 and a_2

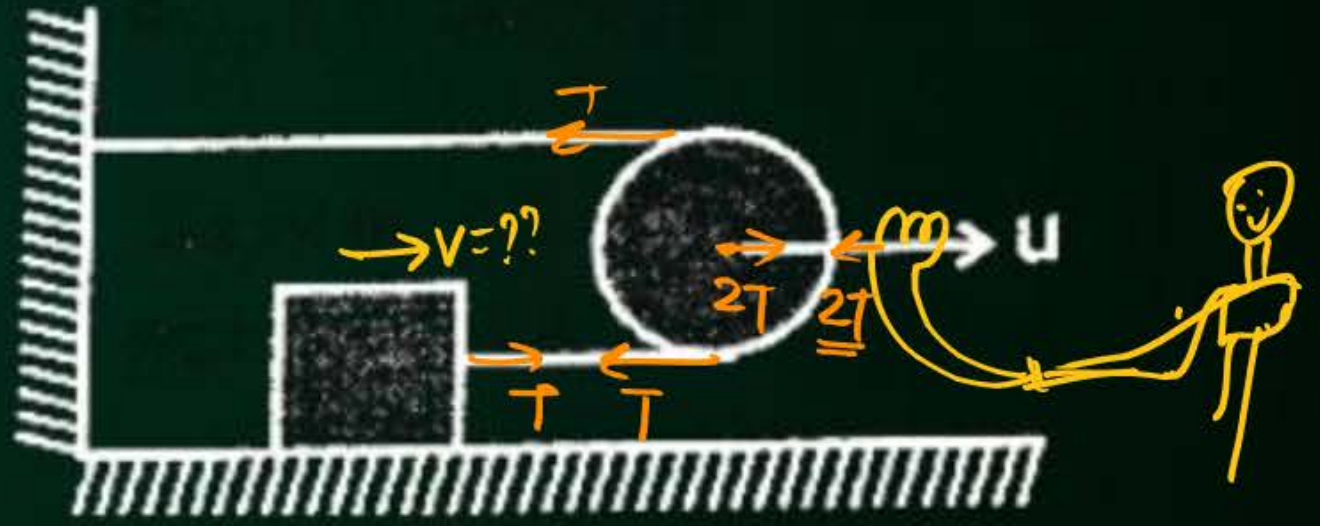






QUESTION

In the figure shown, the pulley is moving with velocity u. The velocity of the block attached with string :

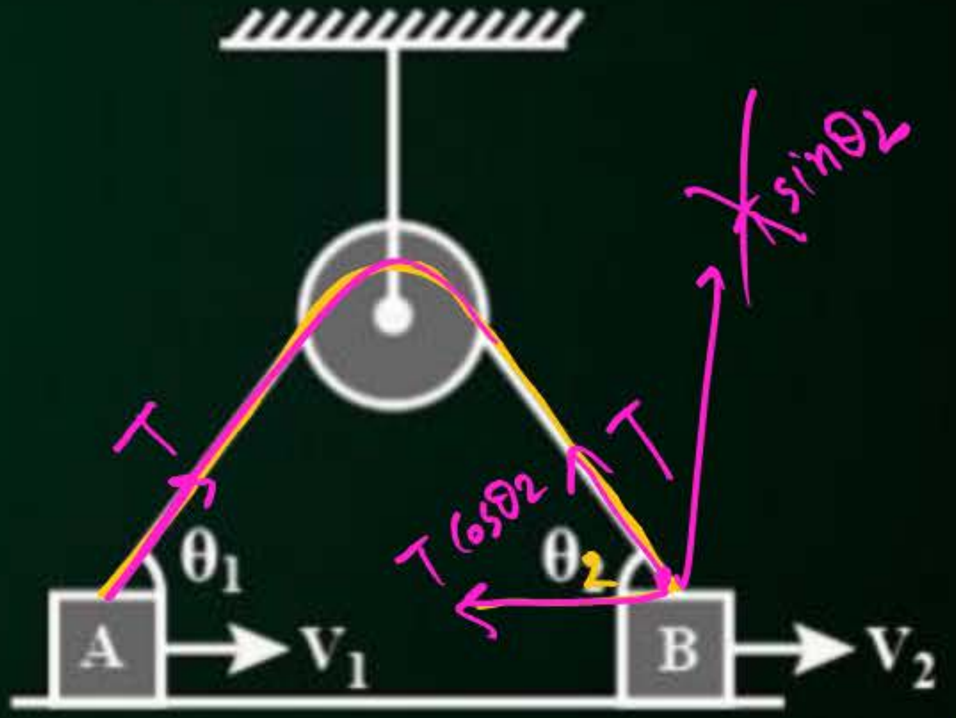


1. $4u$
2. $3u$
3. U
4. $2u$

QUESTION

In the figure shown, blocks A and B move with velocities v_1 and v_2 along horizontal direction. The ratio of $\frac{v_1}{v_2}$: ??

1. $\frac{\sin\theta_2}{\sin\theta_1}$
2. $\frac{\sin\theta_1}{\sin\theta_2}$
3. $\frac{\cos\theta_2}{\cos\theta_1}$
4. $\frac{\cos\theta_1}{\cos\theta_2}$



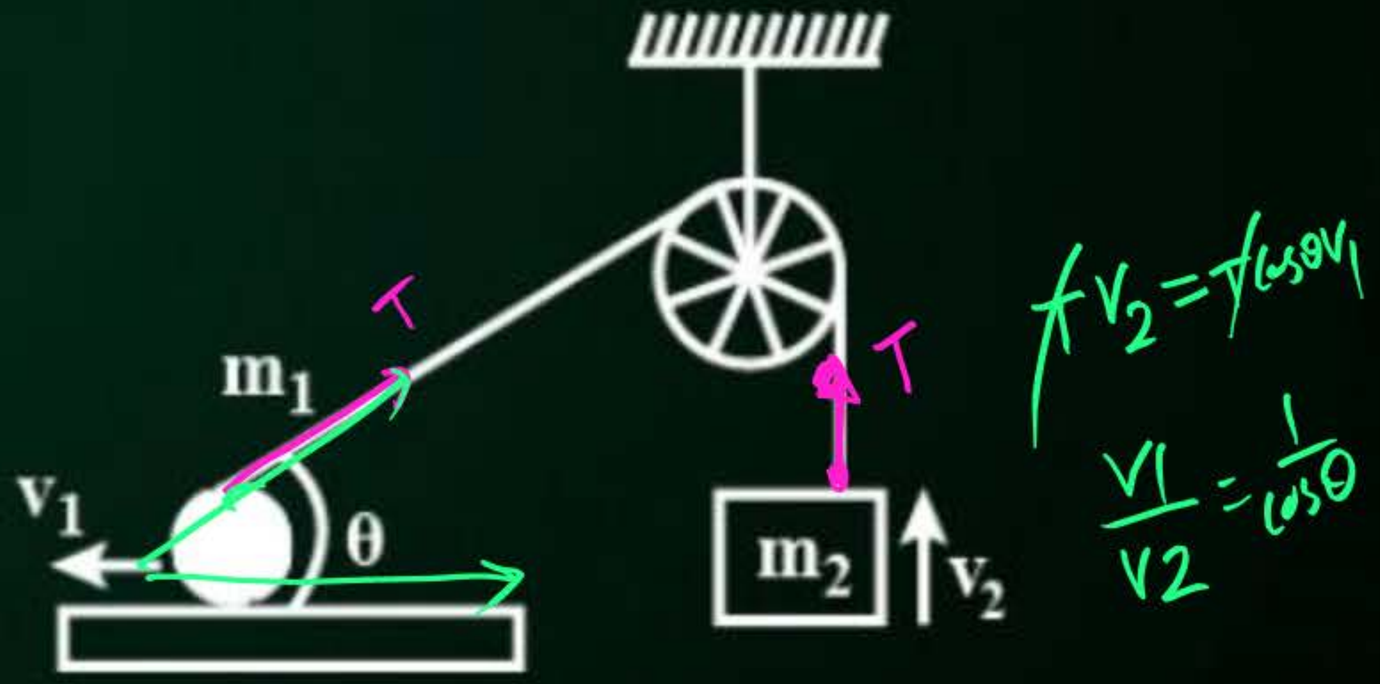
$V_2 T\cos\theta_2 = T\cos\theta_1 V_1$

$\frac{V_1}{V_2} = \frac{\cos\theta_2}{\cos\theta_1}$

QUESTION

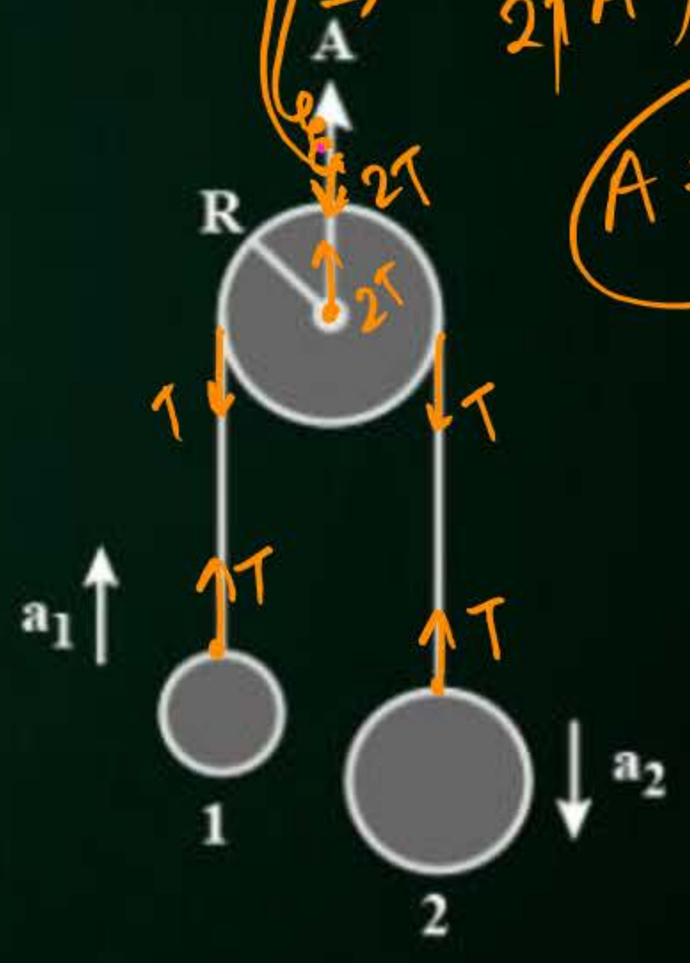
In figure, a ball of mass m_1 and a block of mass m_2 are joined together with an inextensible string. The ball can slide on a smooth horizontal surface. If v_1 and v_2 are the respective speeds of the ball and the block, Find $\frac{v_1}{v_2}$.

1. $\cos\theta$
2. $\sec\theta$
3. $\tan\theta$
4. $\sin\theta$



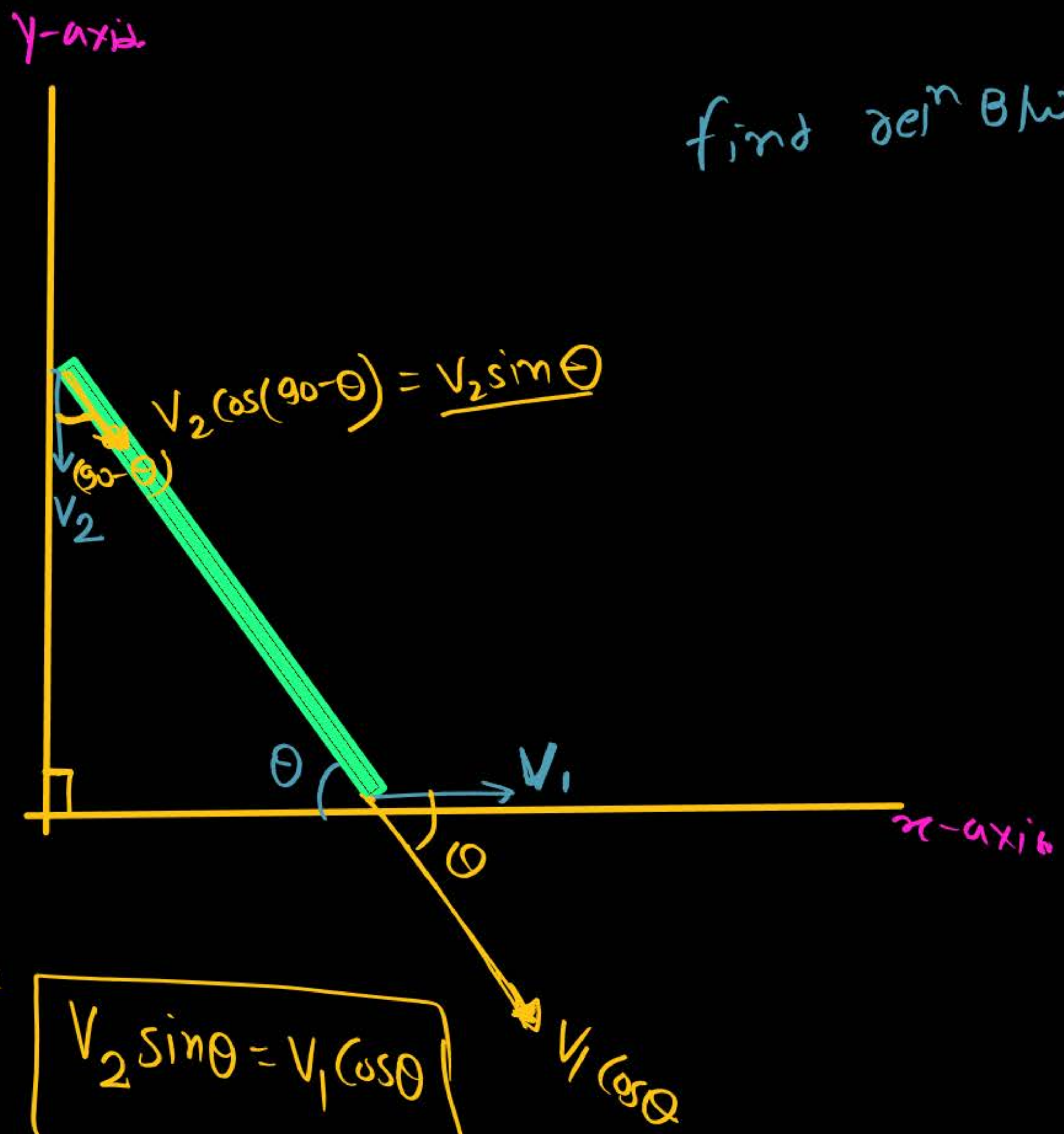
QUESTION

Two masses are connected by a string which passes over a pulley accelerating upward at a rate A as shown. If a_1 and a_2 be the acceleration of bodies 1 and 2 respectively then :



1. $A = a_1 - a_2$
2. $A = a_1 + a_2$
3. $A = \dfrac{a_1 - a_2}{2}$
4. $A = \dfrac{a_1 + a_2}{2}$

find relⁿ B/w V_1 & V_2.

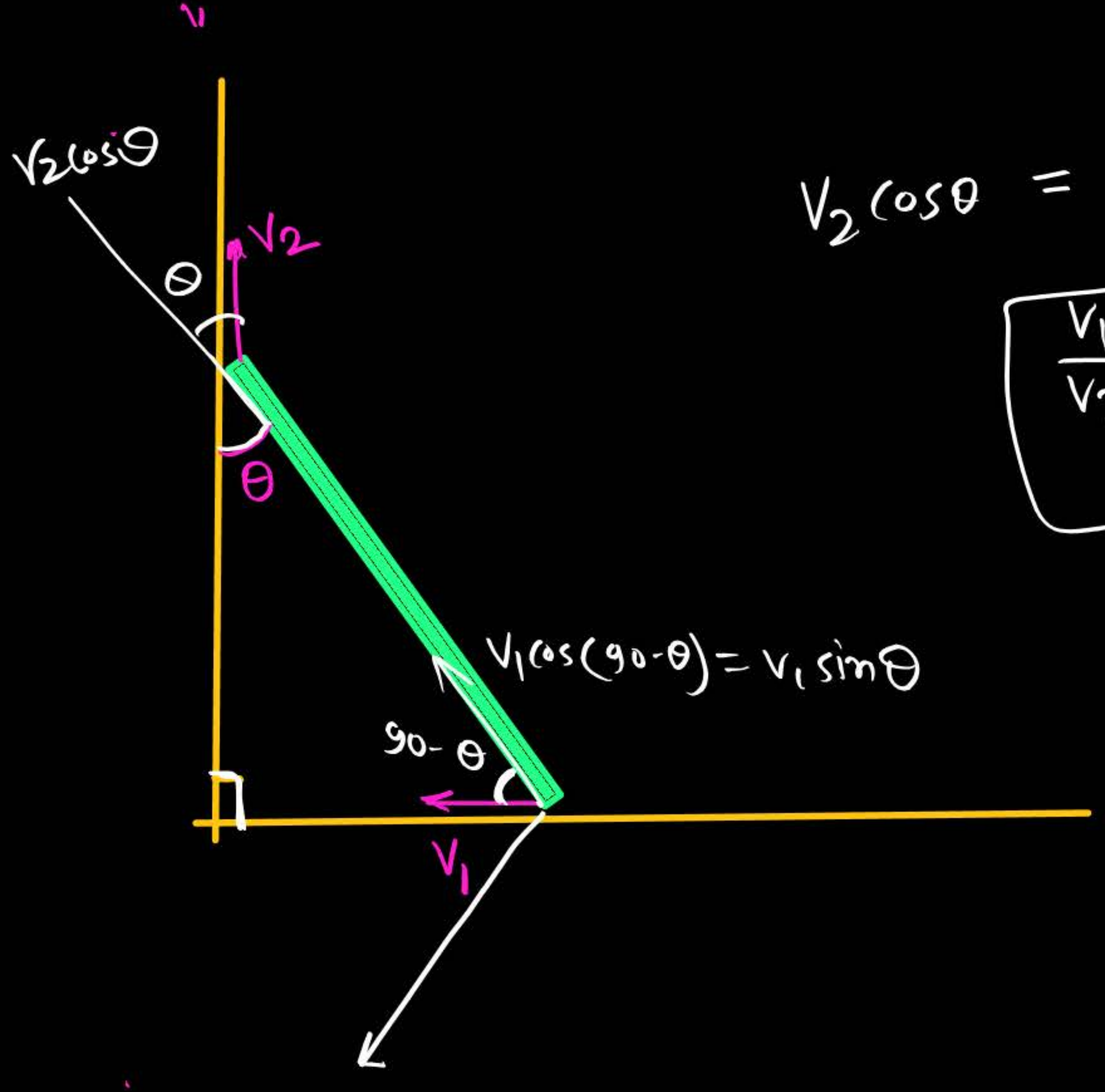


$$V_2\sin\theta = V_1\cos\theta$$

$$\frac{V_1}{V_2} = \tan\theta$$

Concept:-

Component of velocity along the length of Rod will be same for both the end.



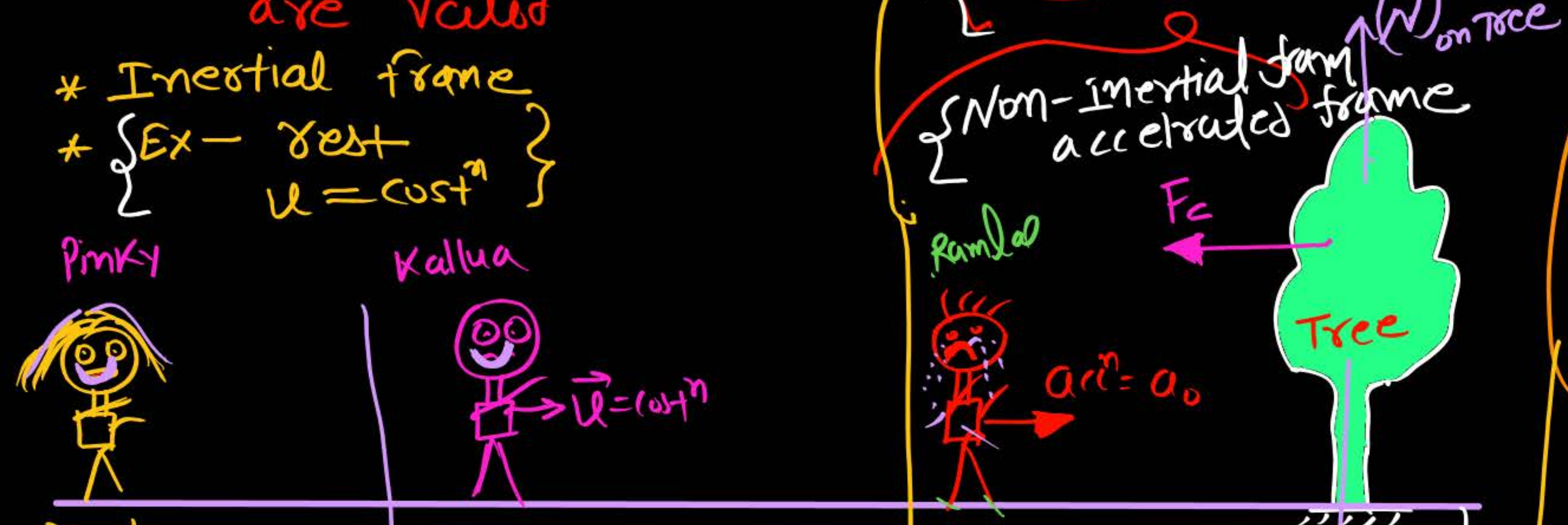
$$V_2 \cos\theta = v_1 \sin\theta$$

$$\frac{V_1}{V_2} = \frac{\cos\theta}{\sin\theta} = \cot\theta$$

* Newtons Laws of Motion are Valid

* Inertial frame

* { Ex - rest
  $u = \text{const}^n$ }



$\vec{F_x} = 0$; $a_x = 0$

$F_y = 0$ [N = mg]

$a_y = 0$

(10/10)

$\vec{F_x} = 0$, $\vec{V}_{Tree} = -\vec{u}$ (const^n)

$a_x = 0$

$F_y = 0$ (N = mg)

$a_y = 0$

(10/10)

{ Newton Law Invalid }

{ Non-inertial frame
accelrated frame }

$\vec{F_x} = 0$, $\vec{a}_{Tree} = -\vec{a_0}$

$\vec{F_y} = 0$ (N = mg)

$a_y = 0$

(0/10)

Pseudo force

$$\vec{F_c} = -m_{object}\,\vec{a_0}$$

→ can be applied from accelerate frame

→ Pseudo force is a non-real force, it is technique to validate laws of motion in non-Iertial frame

PSEUDO FORCE

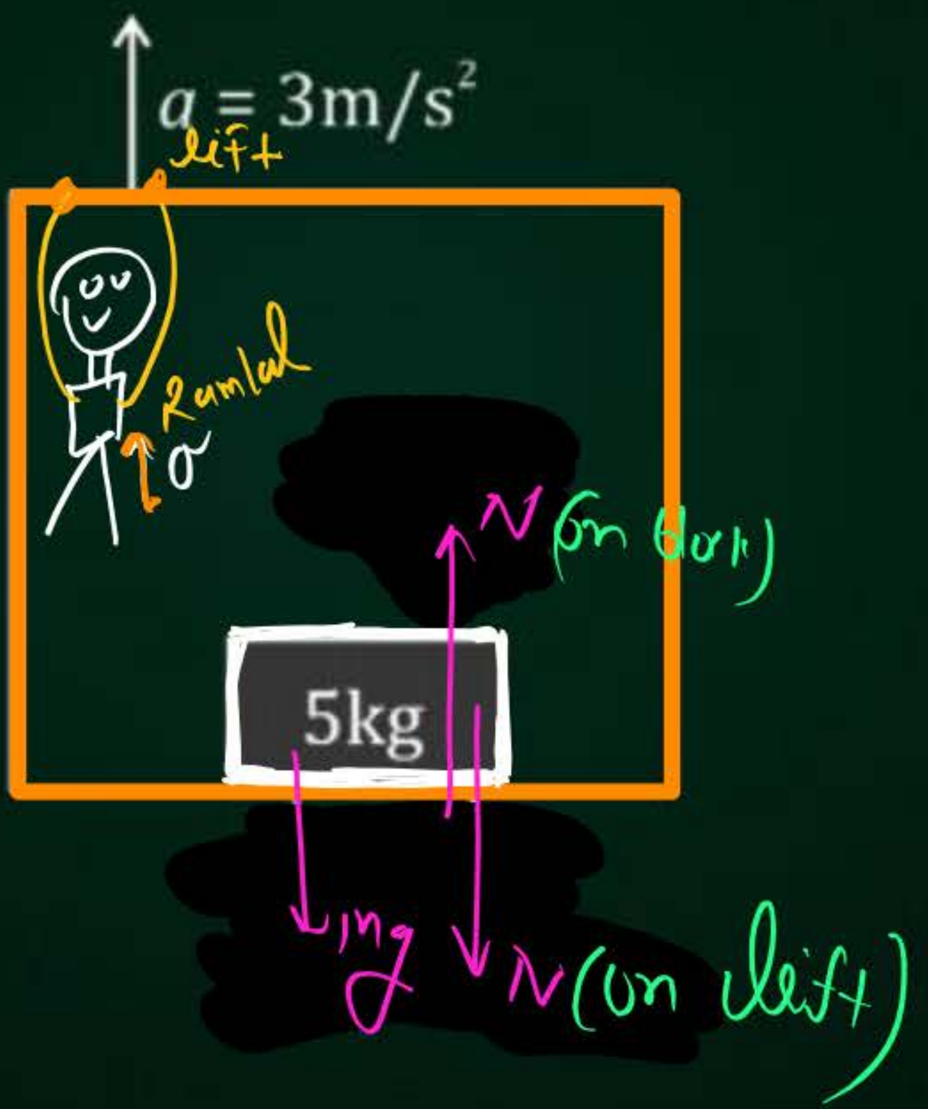
- A non real force having real effect.
- Technique to validate laws of motion in non-inertial form of reference.

PSEUDO FORCE

- A non real force having real effect.
- Technique to validate laws of motion in non-inertial form of reference.

QUESTION

Find contact force between block and surface of lift.



FBD of Block w.r.t Pinky

N, $a = 3 m/s^2$

5kg

mg

$F_{net} = ma$

$N - mg = ma$

$N = mg + ma$

$= m(g+a)$

$= 5(10+3)$

$N = 65N$

Pinky

Ground

Q Normal on block with respect to Pinky & Ramlal will be

(a) same 21%

(b) different (68%)

(c) dont know 9%

F.B.D of Block w.r.t Ramlal

N

5

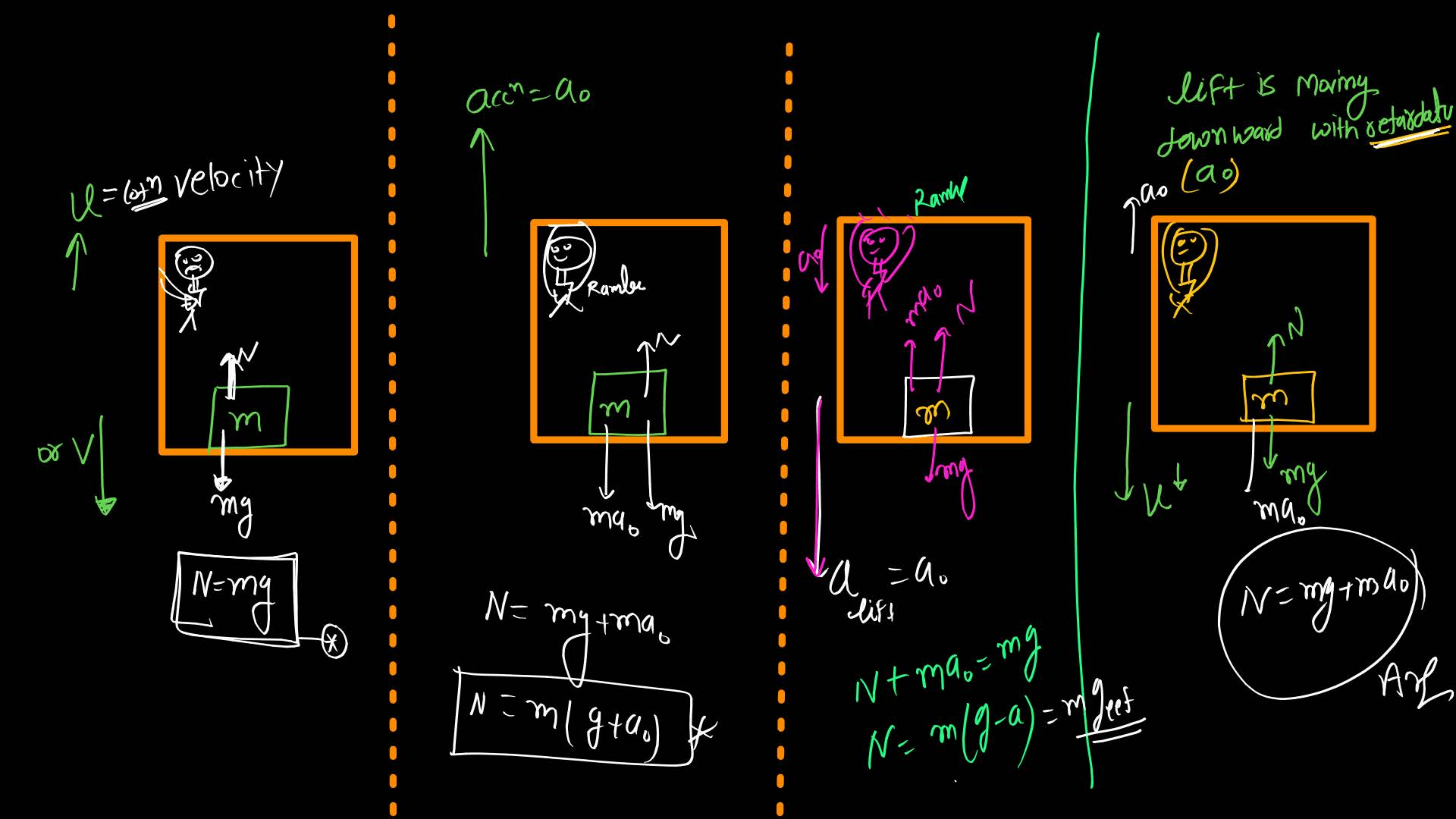
rest ($F_{net} = 0$)

mg

$F_C = ma$

$N = mg + ma$

$N = 65N$



u = const velocity
or v
N
m
mg
N = mg
acc^n = a_0
Ramlal
N
m
ma_0
mg
N = mg + ma_0
N = m(g + a_0)
Ramlal
a_0
ma_0
N
m
mg
a_lift = a_0
N + ma_0 = mg
N = m(g - a) = m g_eff
lift is Moving downward with retardation (a_0)
a_0
N
m
u
mg
ma_0
N = mg + ma_0

QUESTION

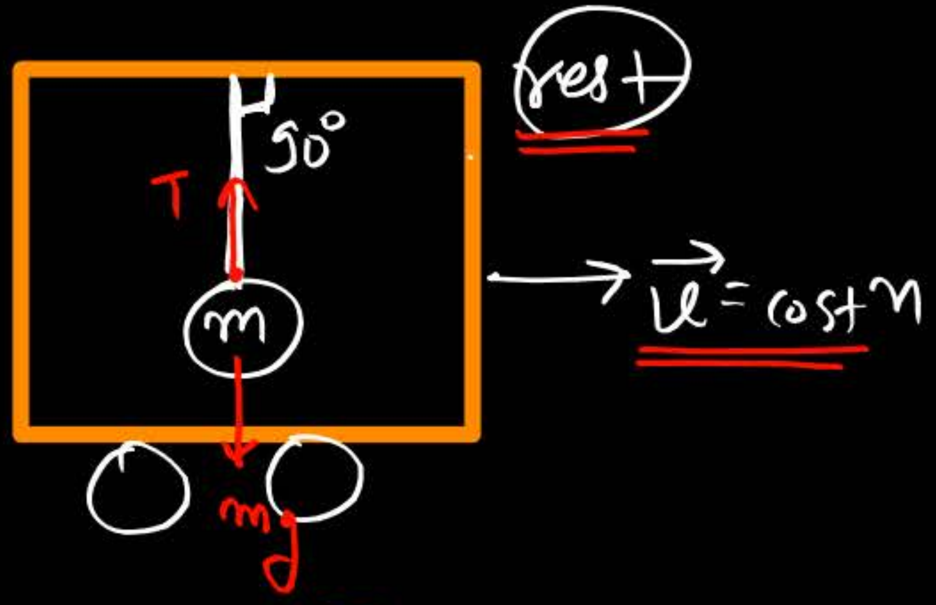
A man weighs 80 kg. He stands on a weighing scale in a lift which is moving upwards with a uniform acceleration of 5 m/s^2. What would be the reading on the scale ? ($g = 10\ m/s^2$)

1. Zero
2. 400 N
3. 800 N
4. 1200 N ✓

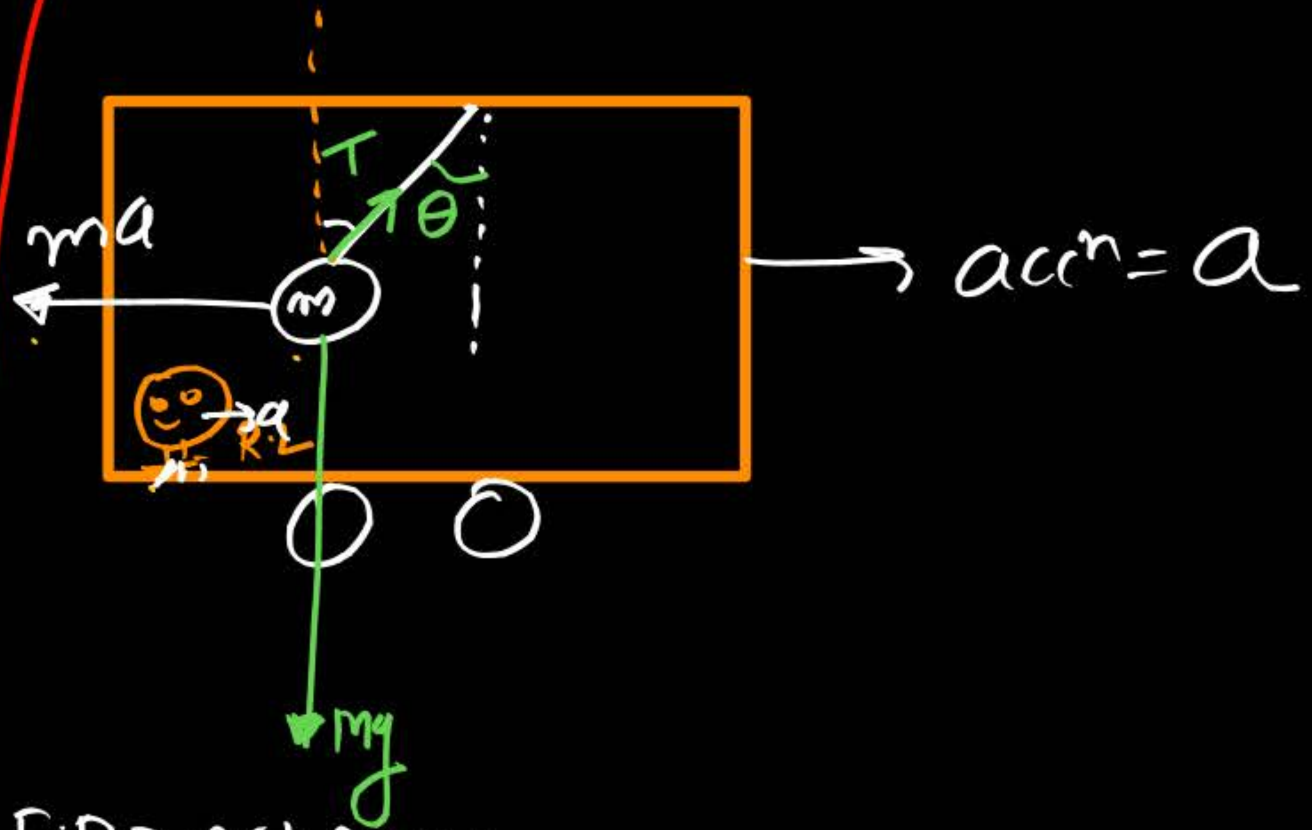
$N = m(g+a)$

$= 80(10+5)$

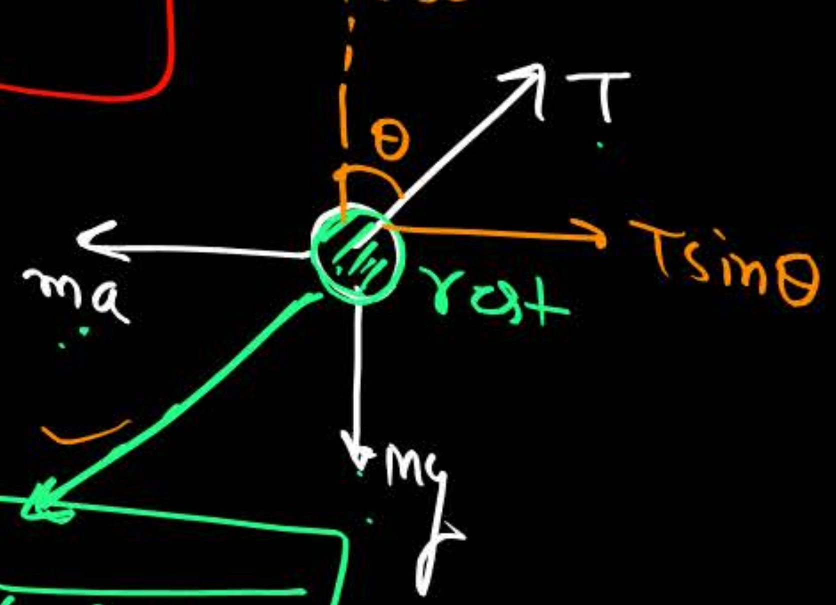
$= 1200 N$



$T = mg$



F.B.D w.r.t Ramu



$$T = \sqrt{(mg)^2 + (ma)^2}$$

$$\frac{T\sin\theta}{T\cos\theta} = \frac{ma}{mg}$$

$$\tan\theta = \frac{a}{g}$$

$$\theta = \tan^{-1}\left(\frac{a}{g}\right)$$

F.B.D w.r.t ground

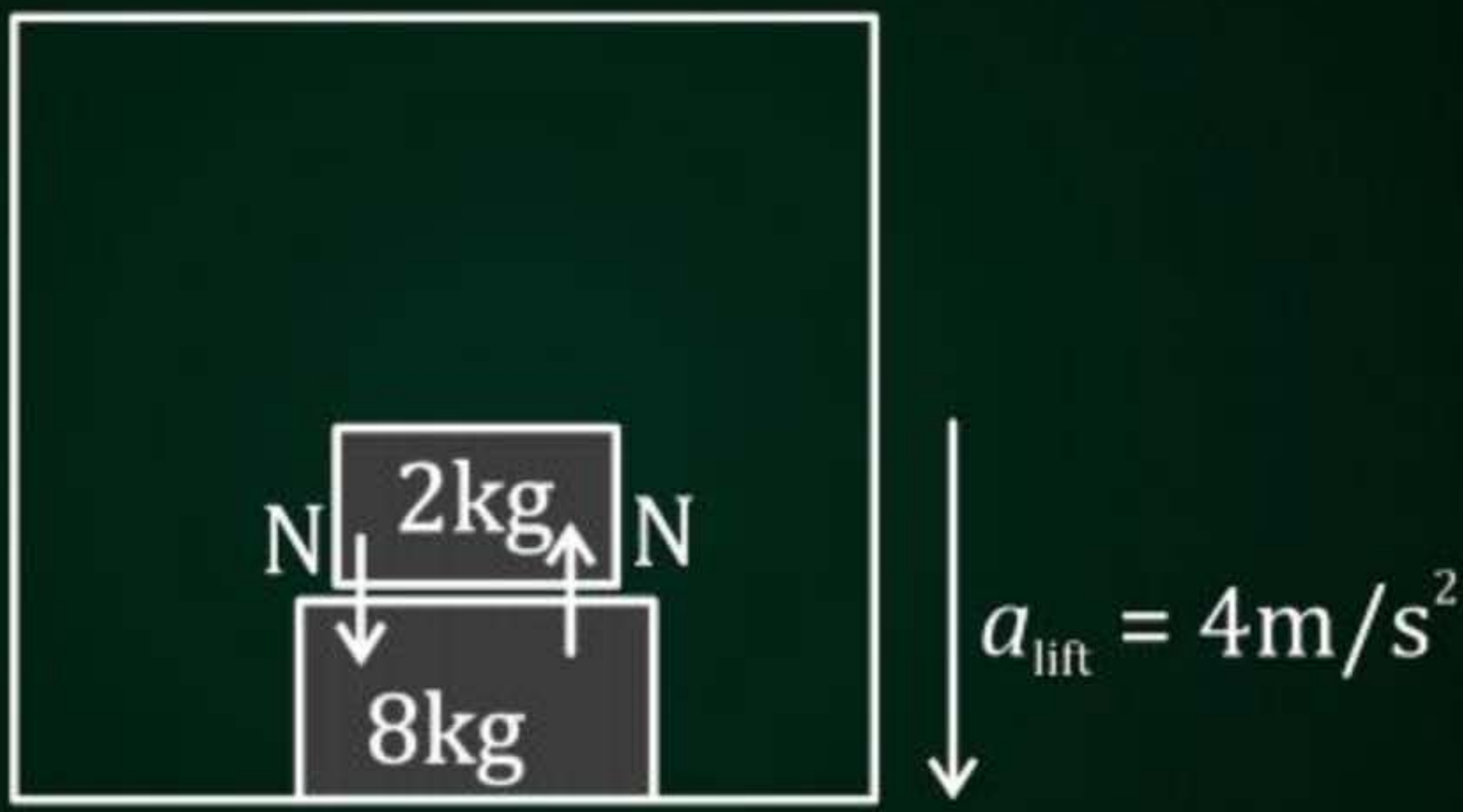


$F_{net} = ma$

$$\frac{T\sin\theta = ma}{T\cos\theta = mg}$$

QUESTION

Find contact force between 2 kg and 8 kg.



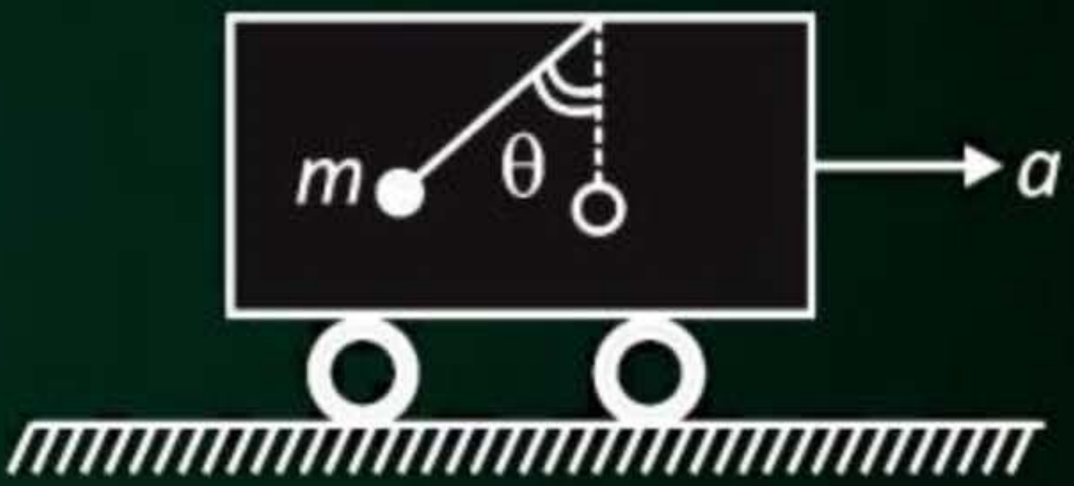
QUESTION

A small metallic sphere of mass m is suspended from the ceiling of a car accelerating on a horizontal road with constant acceleration a. The tension in the string attached with metallic sphere is

1. Mg
2. $m(g + a)$
3. $m(g - a)$
4. $m\sqrt{g^2 + a^2}$

QUESTION

If trolley accelerates horizontally with acceleration a then bob is displaced backward from its initial vertical position. The angular deflection of the bob in equilibrium is



1. $\theta = \cos^{-1}\left(\frac{a}{g}\right)$
2. $\theta = \sin^{-1}\left(\frac{a}{g}\right)$
3. $\theta = \cot^{-1}\left(\frac{a}{g}\right)$
4. $\theta = \tan^{-1}\left(\frac{a}{g}\right)$

QUESTION

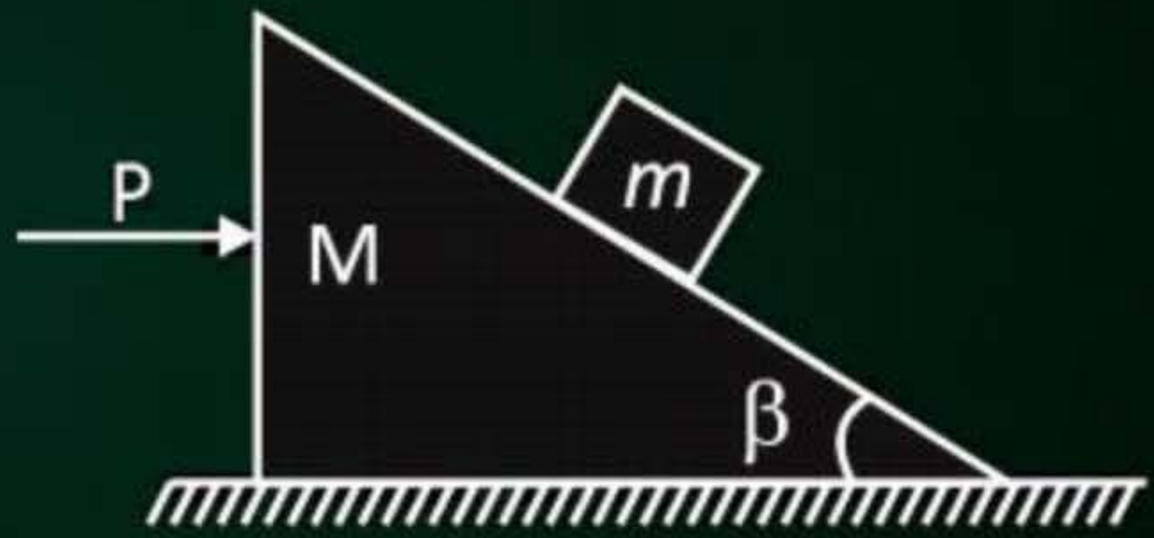
A block of mass m kg is kept on a weighing machine in an elevator. If the elevator is retarding upward by a ms^{-2}, the reading of weighing machine is (in kg)

1. mg
2. $m(g - a)$
3. $m\left(1 - \frac{a}{g}\right)$
4. $m(g + a)$

QUESTION

A block of mass m, is kept on a wedge of mass M, as shown in figure such that mass m remains stationary w.r.t. wedge. The magnitude of force P is

1. $g \tan \beta$
2. $mg \tan \beta$
3. $(m + M)g \tan \beta$
4. $mg \cot \beta$



QUESTION

A block of mass m is placed on a smooth wedge of inclination θ. The whole system is accelerated horizontally so that the block does not slip on the wedge. The force exerted by the wedge on the block (g is acceleration due to gravity) will be

1. $mg \cos \theta$

2. $mg \sin \theta$

3. mg

4. $mg/\cos \theta$

QUESTION

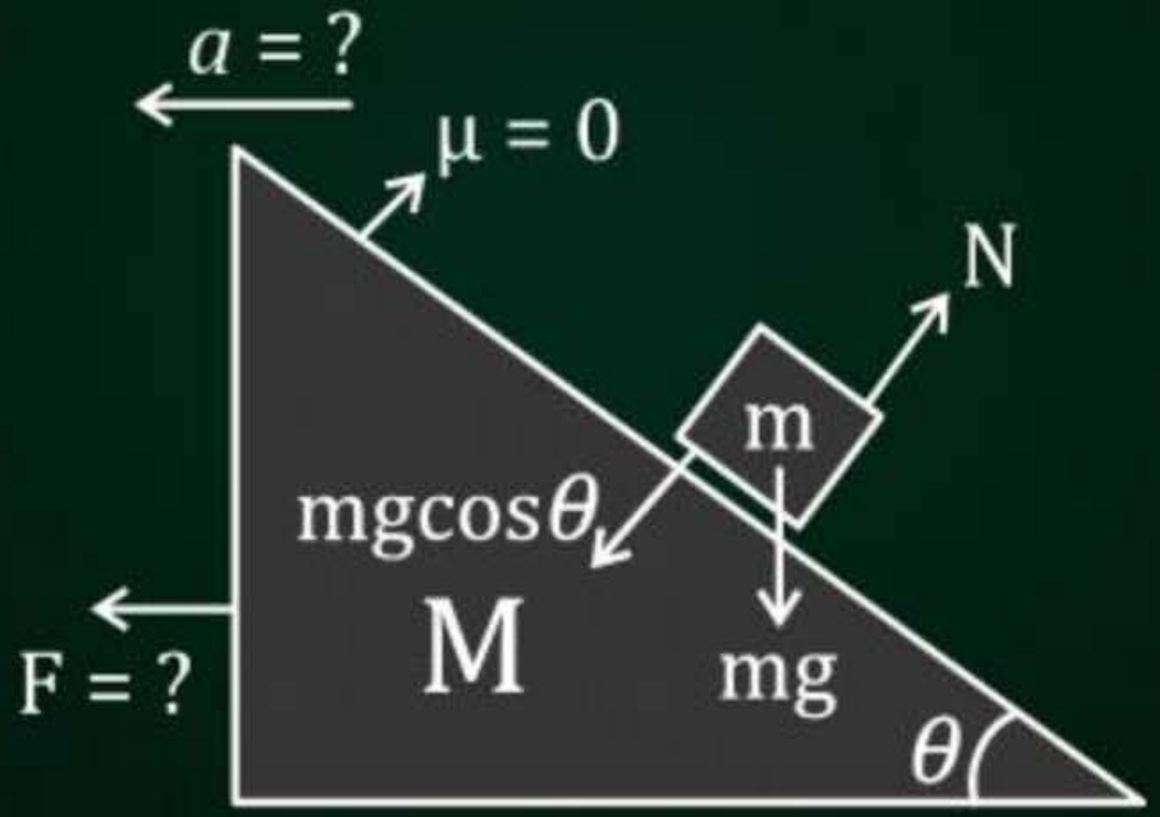
Select the correct statement regarding pseudo force

1. It is electromagnetic in origin
2. Newton's 3^{rd} law is applicable for it
3. It is a fundamental force
4. It is used to make Newton's law applicable in non-inertial frame

QUESTION

Find acceleration of inclined plane so that block will free fall.

For free fall N = 0.



QUESTION

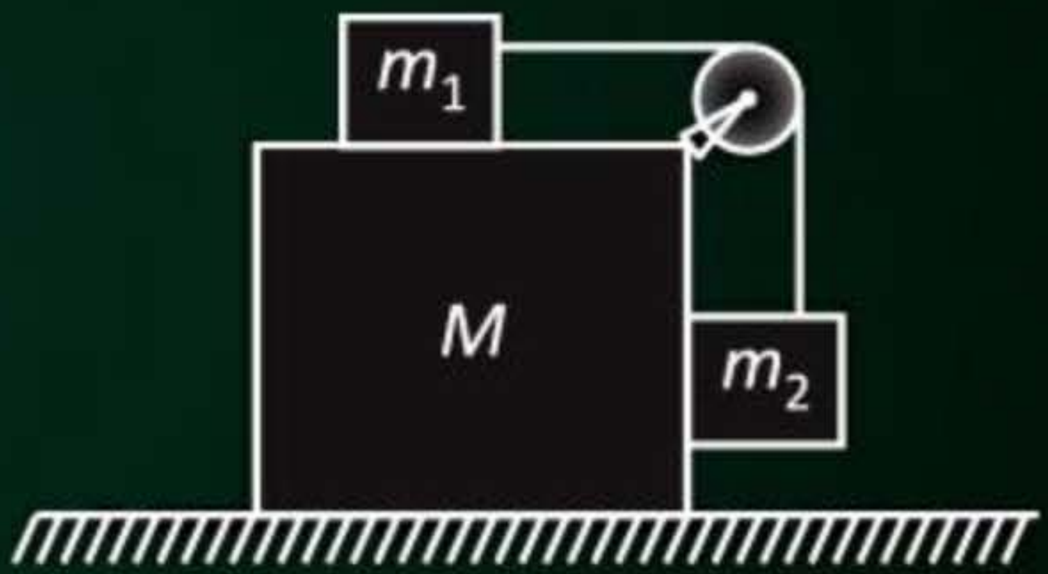
In the given arrangement all surfaces are smooth. What acceleration should be given to the system, for which the block m_2 doesn't slide down ?

1. $\frac{m_2 g}{m_1}$

2. $\frac{m_1 g}{m_2}$

3. g

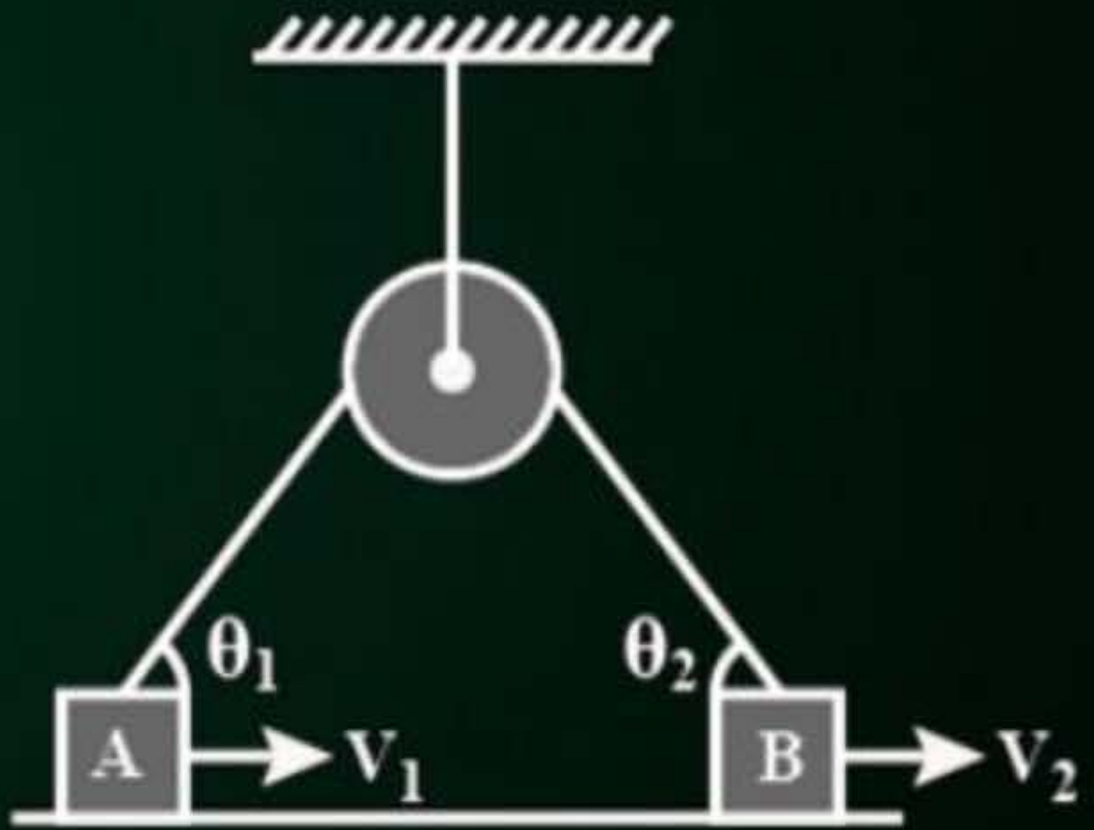
4. $\frac{m_2 g}{m_1 + m_2}$



QUESTION

In the figure shown, blocks A and B move with velocities v_1 and v_2 along horizontal direction. The ratio of $\frac{v_1}{v_2}$:

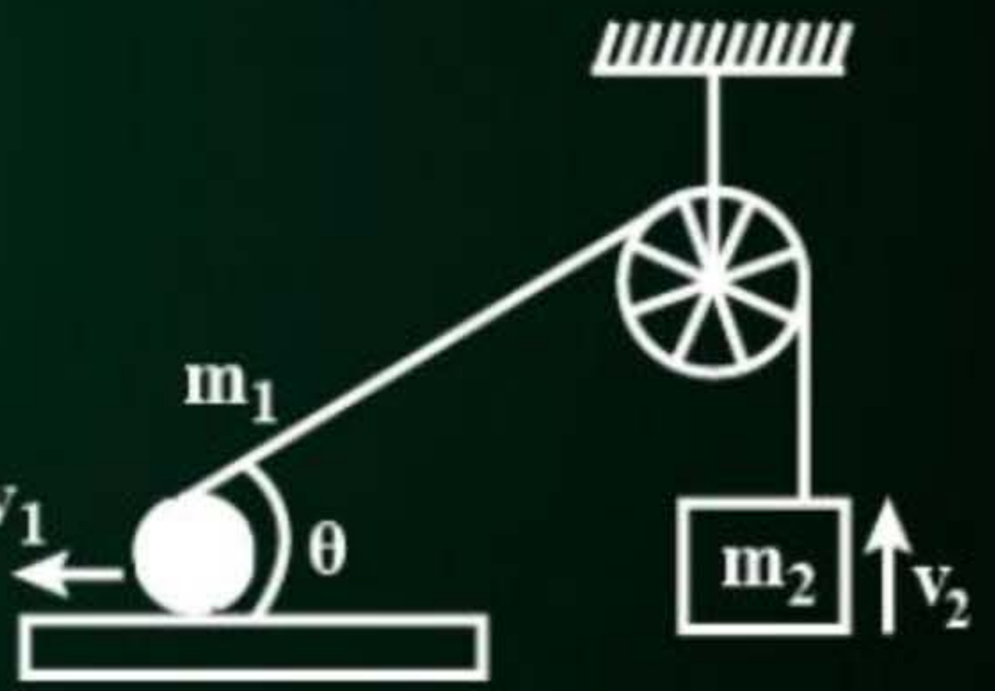
1. $\frac{\sin\theta_2}{\sin\theta_1}$
2. $\frac{\sin\theta_1}{\sin\theta_2}$
3. $\frac{\cos\theta_2}{\cos\theta_1}$
4. $\frac{\cos\theta_1}{\cos\theta_2}$



QUESTION

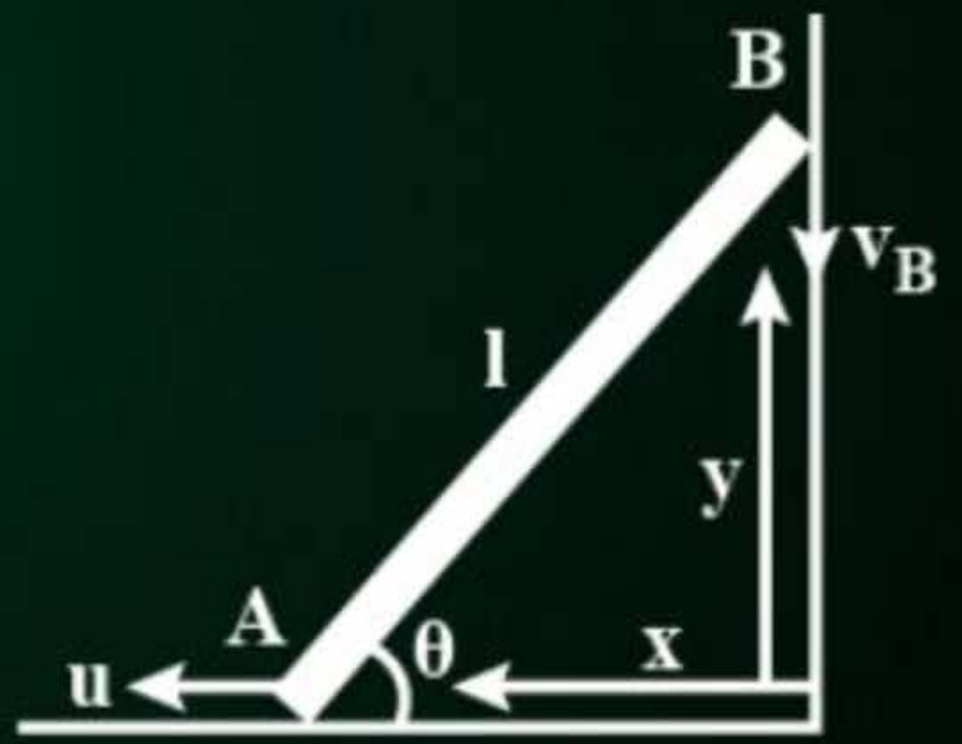
In figure, a ball of mass m_1 and a block of mass m_2 are joined together with an inextensible string. The ball can slide on a smooth horizontal surface. If v_1 and v_2 are the respective speeds of the ball and the block, Find $\frac{v_1}{v_2}$.

1. $\cos\theta$
2. $\sec\theta$
3. $\tan\theta$
4. $\sin\theta$



QUESTION

Figure shows a rod of length l resting on a wall and the floor. Its lower end A is pulled towards left with a constant velocity u. As a result of this, end B starts moving down along the wall. Find the velocity of the other end B downward when rod makes an angle θ with the horizontal.



1. $2u\sin\theta$
2. $u\sin\theta$
3. $u\cos\theta$
4. $2u\cos\theta$

QUESTION

A monkey of mass 20 kg is holding a vertical rope. The rope will not break when a mass of 25 kg is suspended from it but will break if the mass exceeds 25 kg. What is the maximum acceleration with which the monkey can climb up along the rope ? ($g = 10\ m/s^2$)

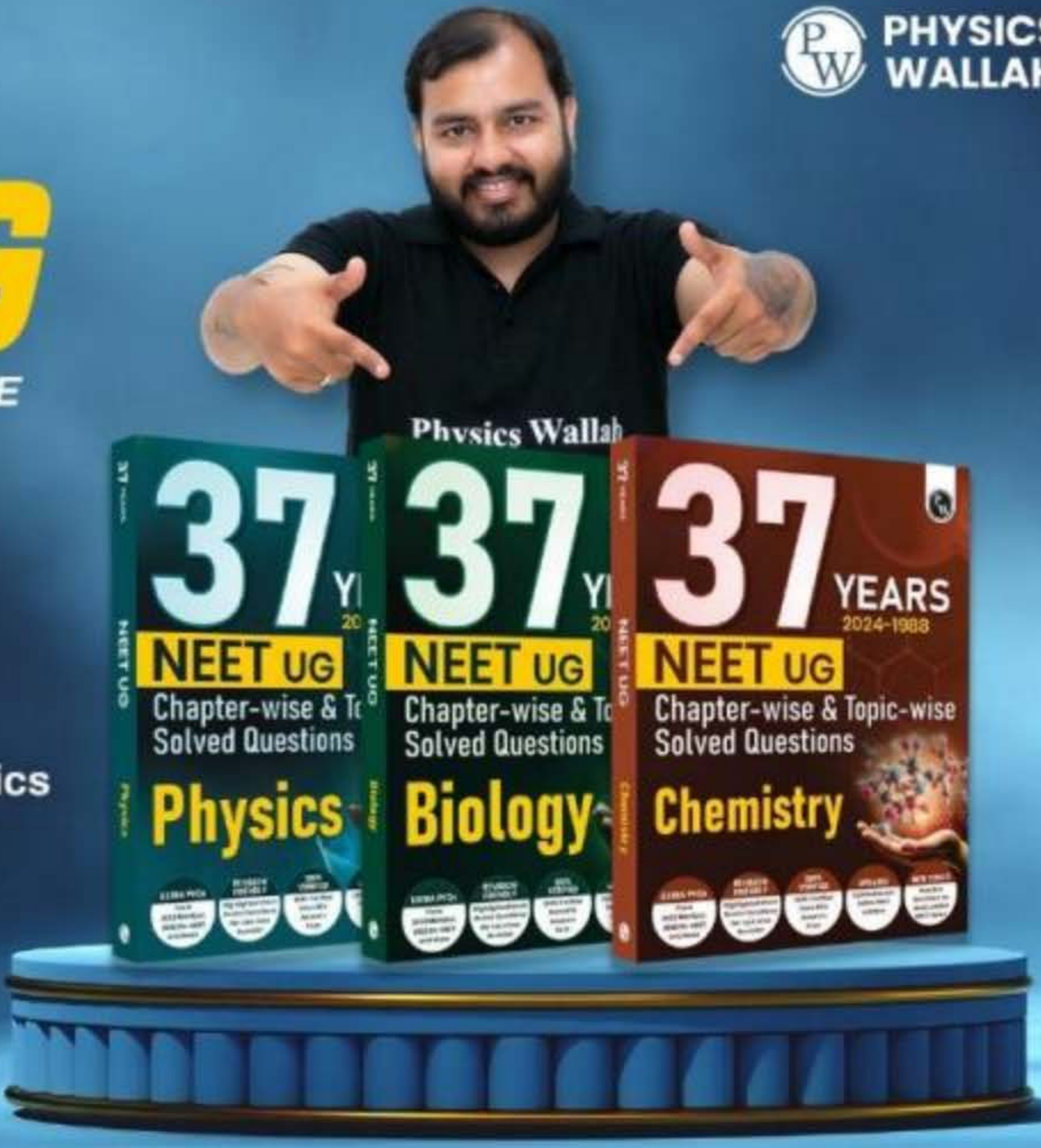
1. $5\ m/s^2$
2. $10\ m/s^2$
3. $25\ m/s^2$
4. $2.5\ m/s^2$

FRICTION

Let 100 N force is required to move this block.



Friction	Applied



Physics Wallah
37 YEARS 2024-1988
NEET UG
Chapter-wise & Topic-wise Solved Questions
Physics
Biology
Chemistry

HOMEWORK FROM YAKEEN MODULE


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 09 | Physics

Laws of Motion

By- Dr. Manish Raj (MR SIR)



Topics to be covered

1. # Questions on Pseudo Force
2. # Basic of Friction
3. #
4. #



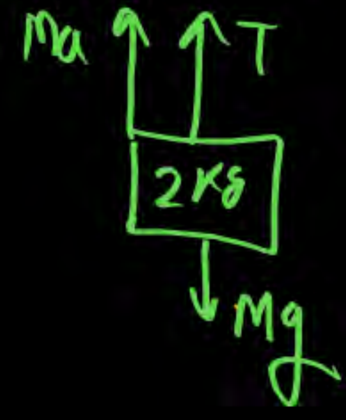
Pseudo force only applicable from acc^n (Non-Inertial frame.

↑ u(↓) moving upward with retardation = $4\,m/s^2$

Tension in wire ??



FBD w.r.t. Lift



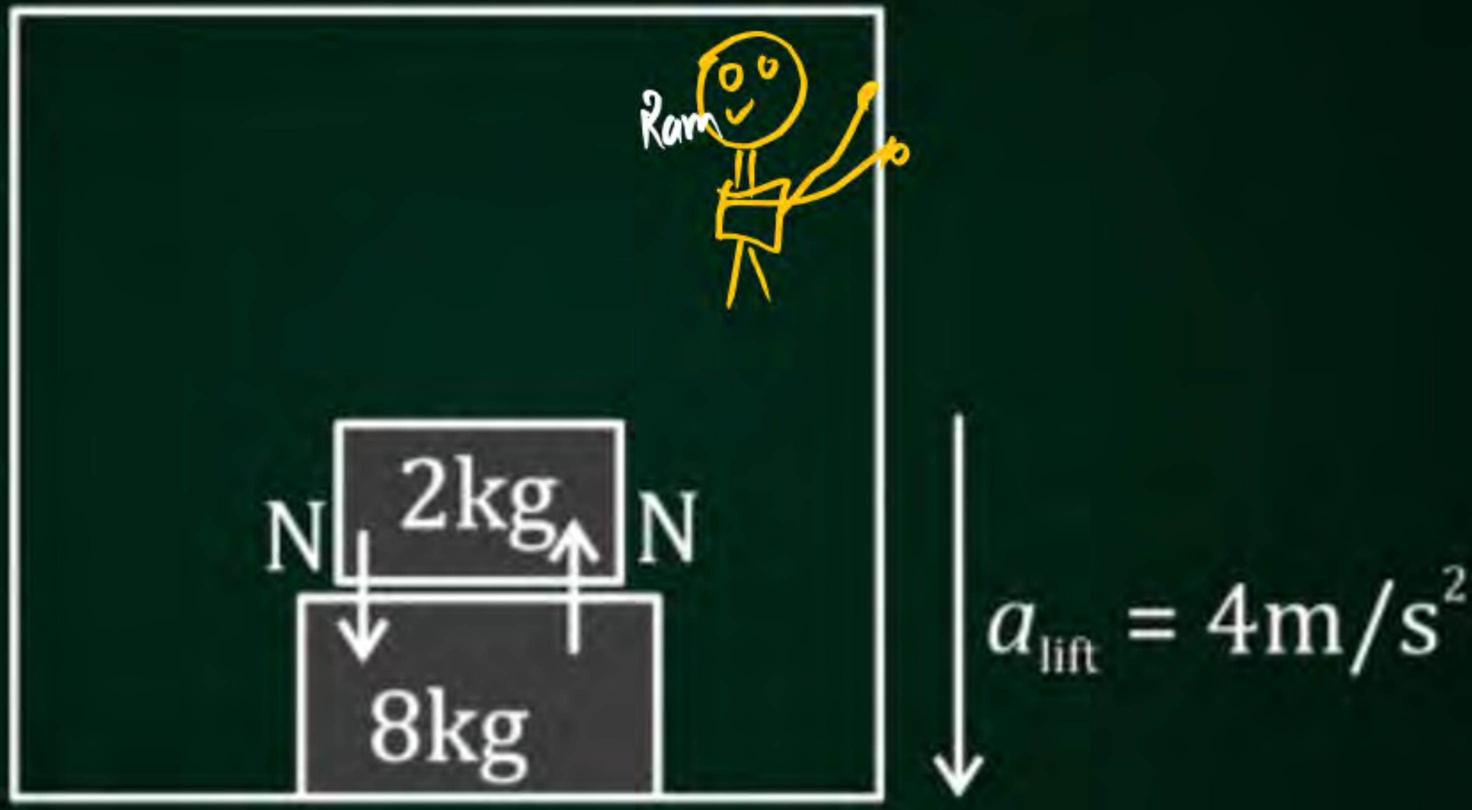
$T = mg - ma$

$= m(g-a)$

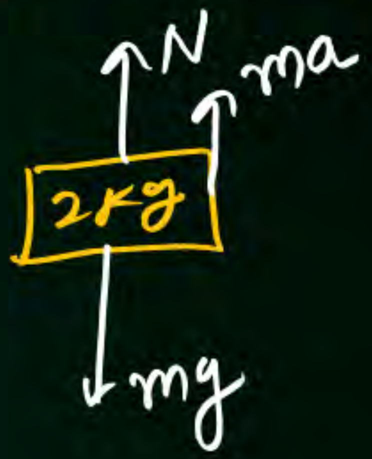
$= 2(10-4) = 12N$ (Ans)

QUESTION

Find contact force between 2 kg and 8 kg.



F.B.D of (2kg) w.r.t. Ram



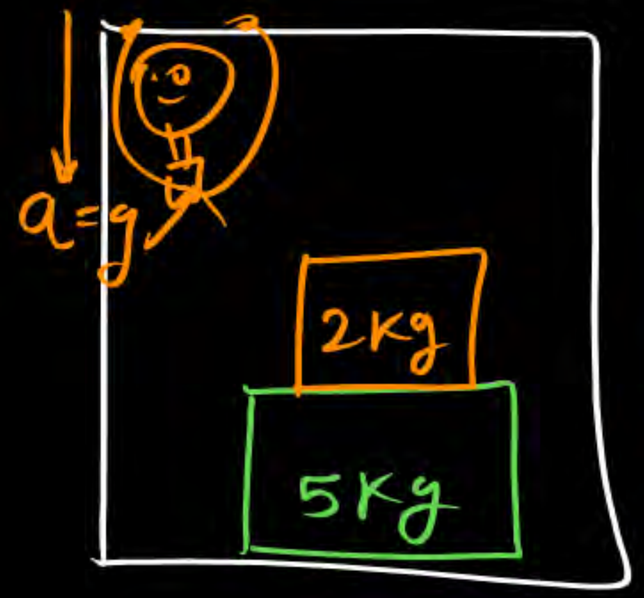
$N + ma = mg$

$N = mg - ma$

$= m(g-a)$

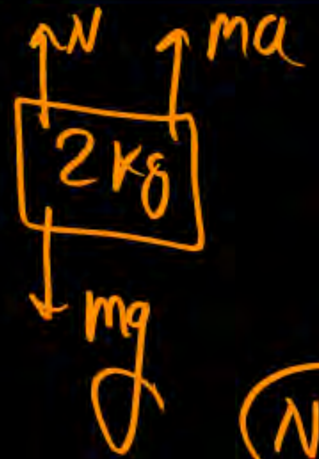
$= 2(10-4)$

$= 12N$



$\downarrow a = g$ (free fall)

find Normal rex^n b/w 2kg & 5kg



$N + ma = mg$

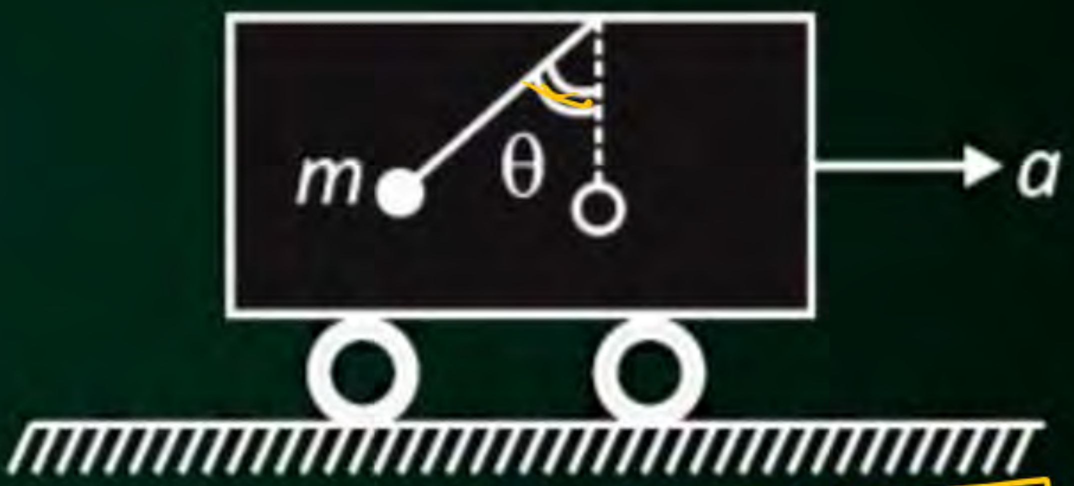
$N + \cancel{mg} = \cancel{mg}$

$\boxed{N = 0}$ Ans

QUESTION

If trolley accelerates horizontally with acceleration a then bob is displaced backward from its initial vertical position. The angular deflection of the bob in equilibrium is

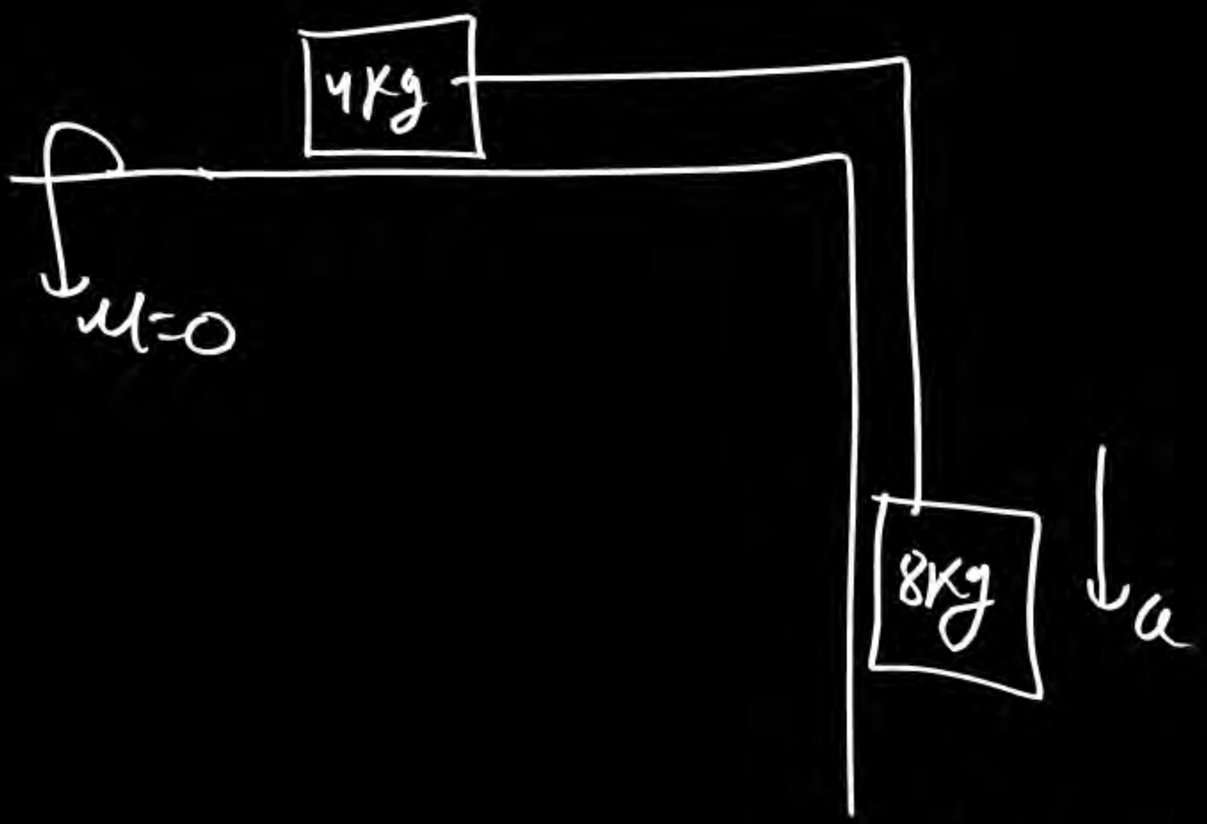
1. $\theta = \cos^{-1}\left(\frac{a}{g}\right)$
2. $\theta = \sin^{-1}\left(\frac{a}{g}\right)$
3. $\theta = \cot^{-1}\left(\frac{a}{g}\right)$
4. $\theta = \tan^{-1}\left(\frac{a}{g}\right)$



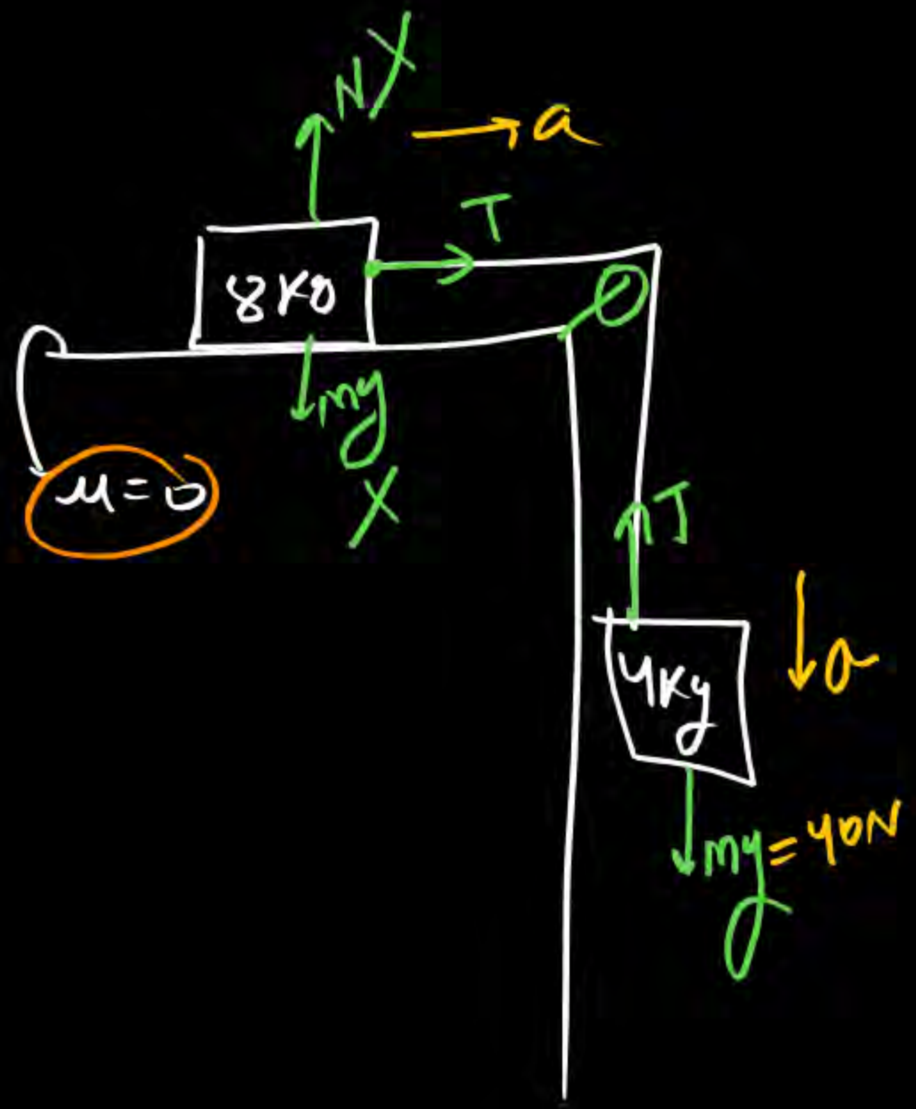
$\tan\theta = \frac{a}{g} = \frac{P}{B}$

$\sin\theta = \frac{P}{H} = \frac{a}{\sqrt{a^2+g^2}}$

$H = \sqrt{P^2+B^2} = \sqrt{a^2+g^2}$



$a =$



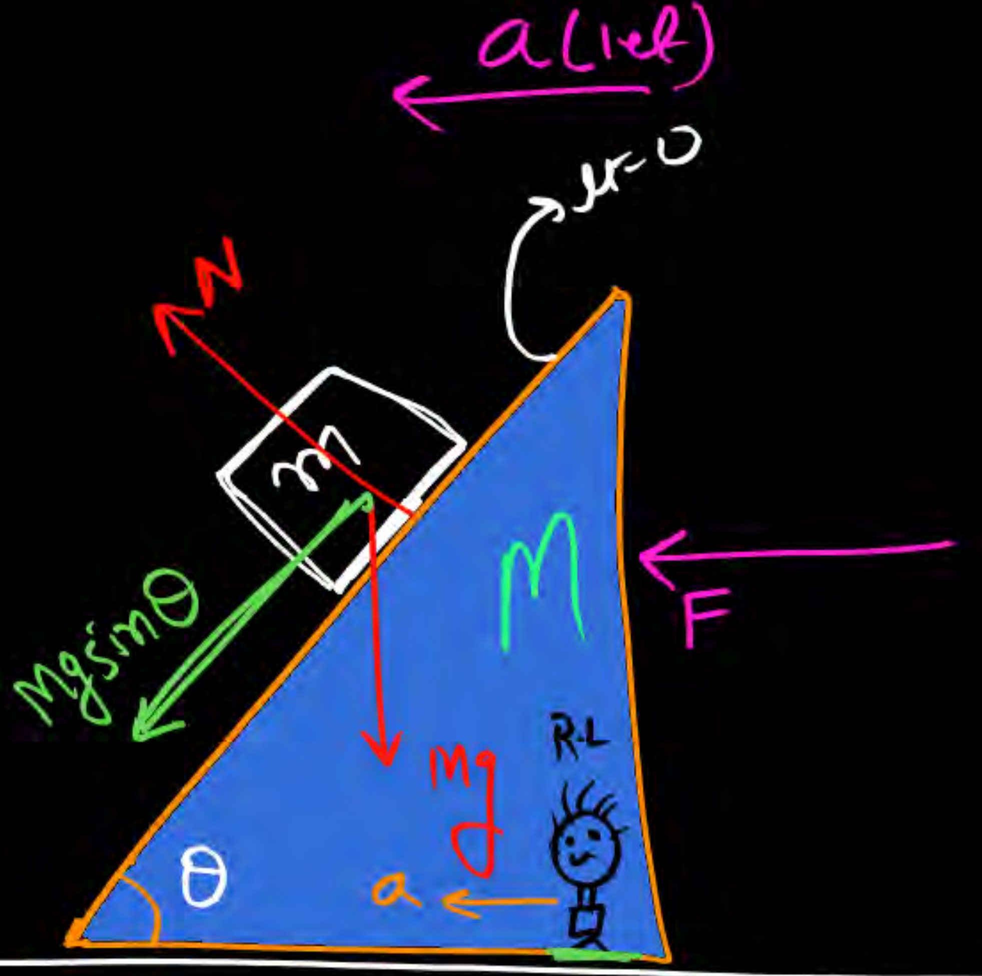
$40 - \cancel{T} = 4a$

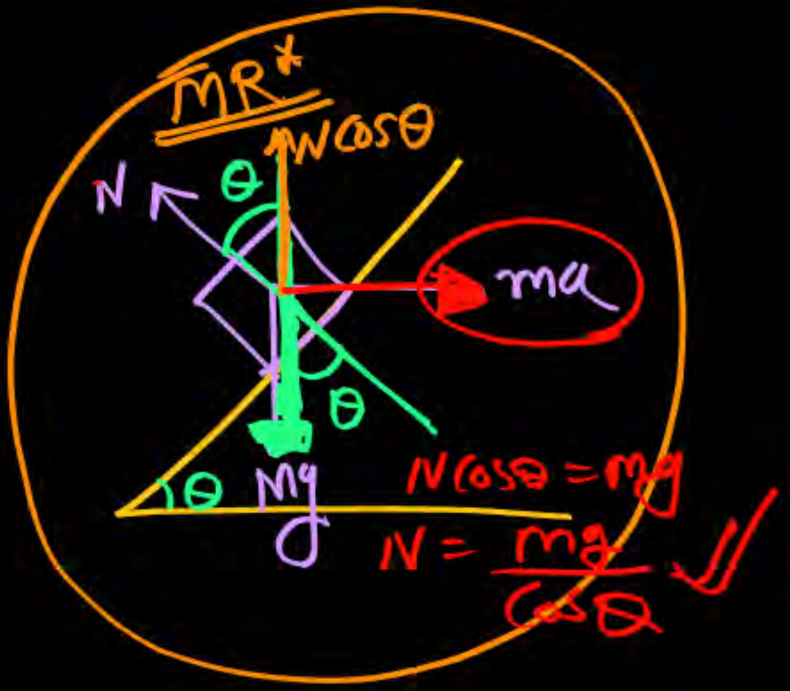
$\cancel{T} = 8a$

$40 = 12a$

$a = \frac{40}{12}\ m/s^2$

find acc^n of Inclined Plane so that Block will not slide w.r.t Inclined Plane.





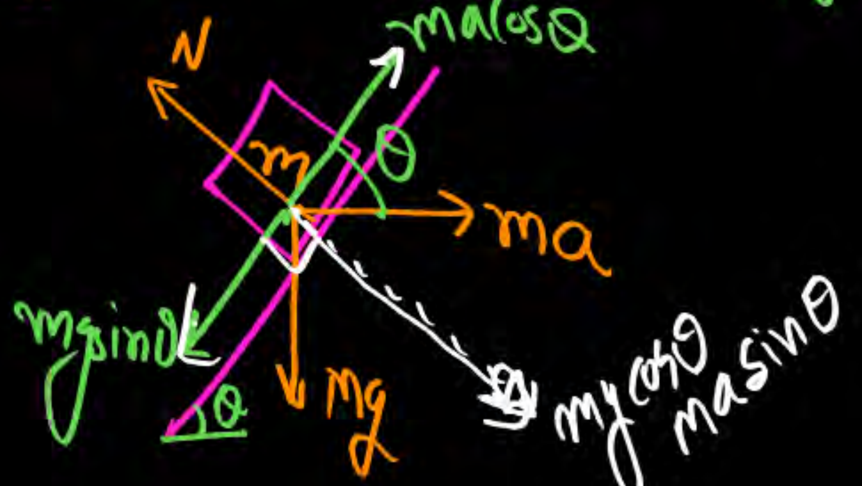
If $a < g\tan\theta$ slid downward

If $a = g\tan\theta$ [rest w.r.t Inclined]

If $a > g\tan\theta$ slid upward *

$F_{applied} = (M+m)\, g\tan\theta$

F.B.D w.r.t Ramlal



If $mg\sin\theta = ma\cos\theta$

$a = g\dfrac{\sin\theta}{\cos\theta}$

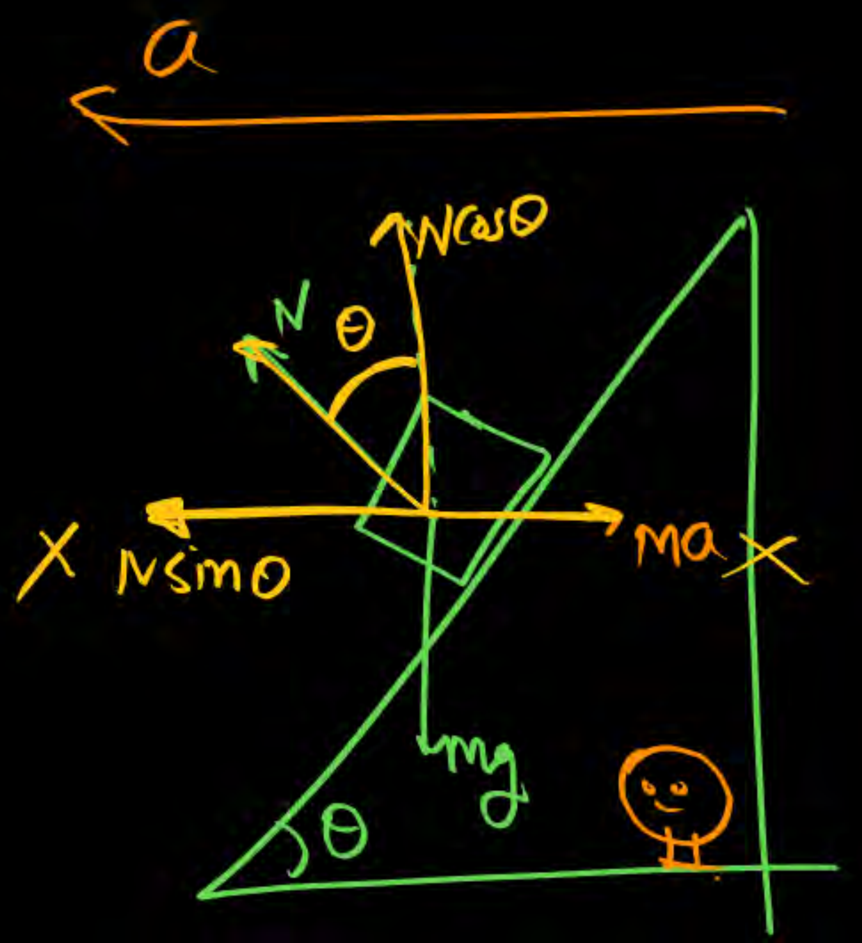
* $a = g\tan\theta$ ✓

find Normal rey^n

$N = mg\cos\theta$ ✗

$N = mg\cos\theta + ma\sin\theta$ ✓

$N = \dfrac{mg}{\cos\theta}$



$N\sin\theta = ma \quad (F_{net} = 0)$

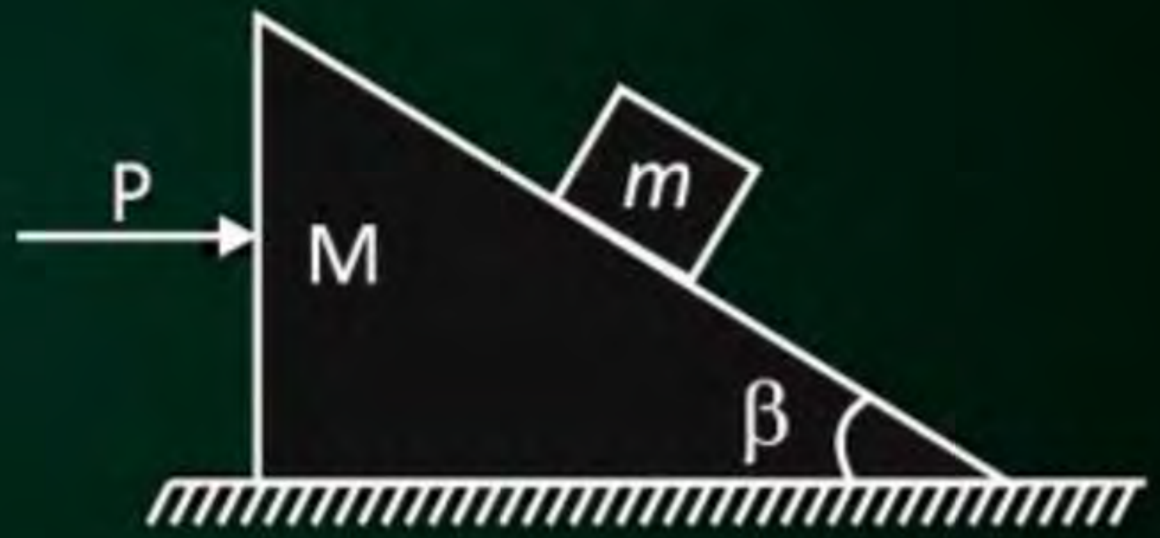
$N\sin\theta = mg\frac{\sin\theta}{\cos\theta}$

$N = \frac{mg}{\cos\theta}$

QUESTION

A block of mass m, is kept on a wedge of mass M, as shown in figure such that mass m remains stationary w.r.t. wedge. The magnitude of force P is

1. $g \tan \beta$
2. $mg \tan \beta$
3. $(m + M)g \tan \beta$
4. $mg \cot \beta$



QUESTION

A block of mass m is placed on a smooth wedge of inclination θ. The whole system is accelerated horizontally so that the block does not slip on the wedge. The force exerted by the wedge on the block (g is acceleration due to gravity) will be

1. $mg \cos \theta$
2. $mg \sin \theta$
3. mg
4. $mg/\cos \theta$

QUESTION

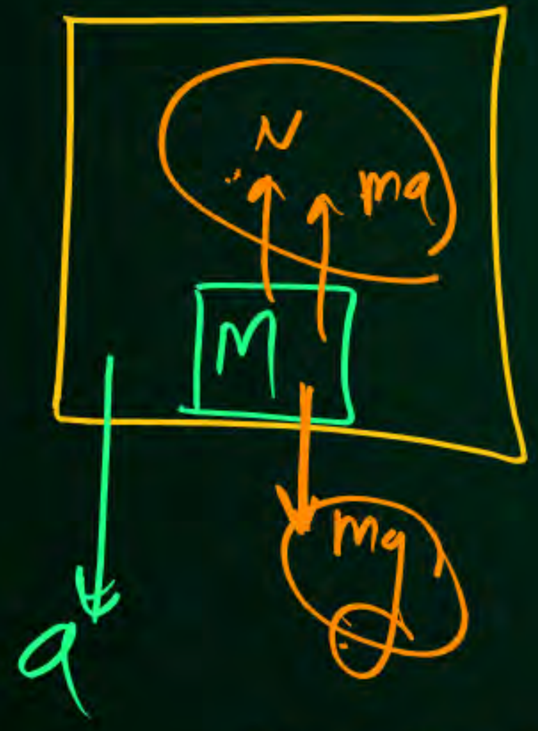
Select the correct statement regarding pseudo force

1. It is electromagnetic in origin
2. Newton's 3^{rd} law is applicable for it
3. It is a fundamental force
4. It is used to make Newton's law applicable in non-inertial frame

QUESTION

A man of mass m is standing in an elevator moving downward with an acceleration $\frac{g}{4}$. The force exerted by the bottom surface of the elevator on the man will be

1. $\frac{3mg}{4}$
2. $\frac{mg}{4}$
3. $\frac{5mg}{4}$
4. $\frac{7mg}{4}$



$N = mg - mg/4$

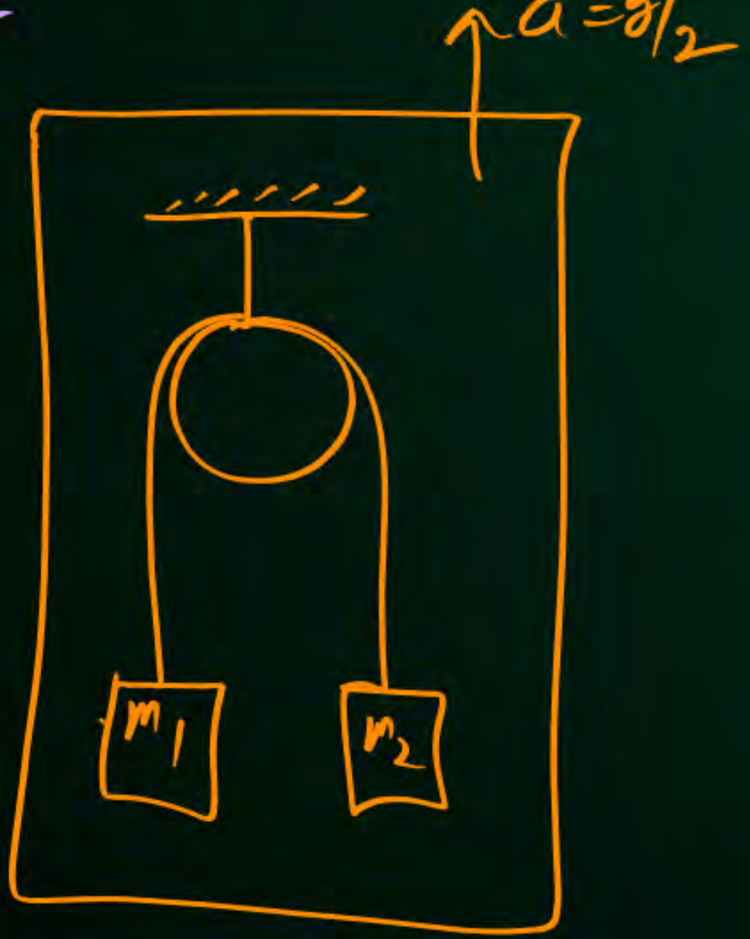
$= \frac{3mg}{4}$

QUESTION

H/w

Two blocks of masses 2 kg and 4 kg are hanging with the help of massless string passing over an ideal pulley inside an elevator. The elevator is moving upward with an acceleration $\frac{g}{2}$. The tension in the string connected between the blocks will be (Take $g = 10\ m/s^2$).

1. 40 N ✓
2. 60 N
3. 80 N
4. 20 N

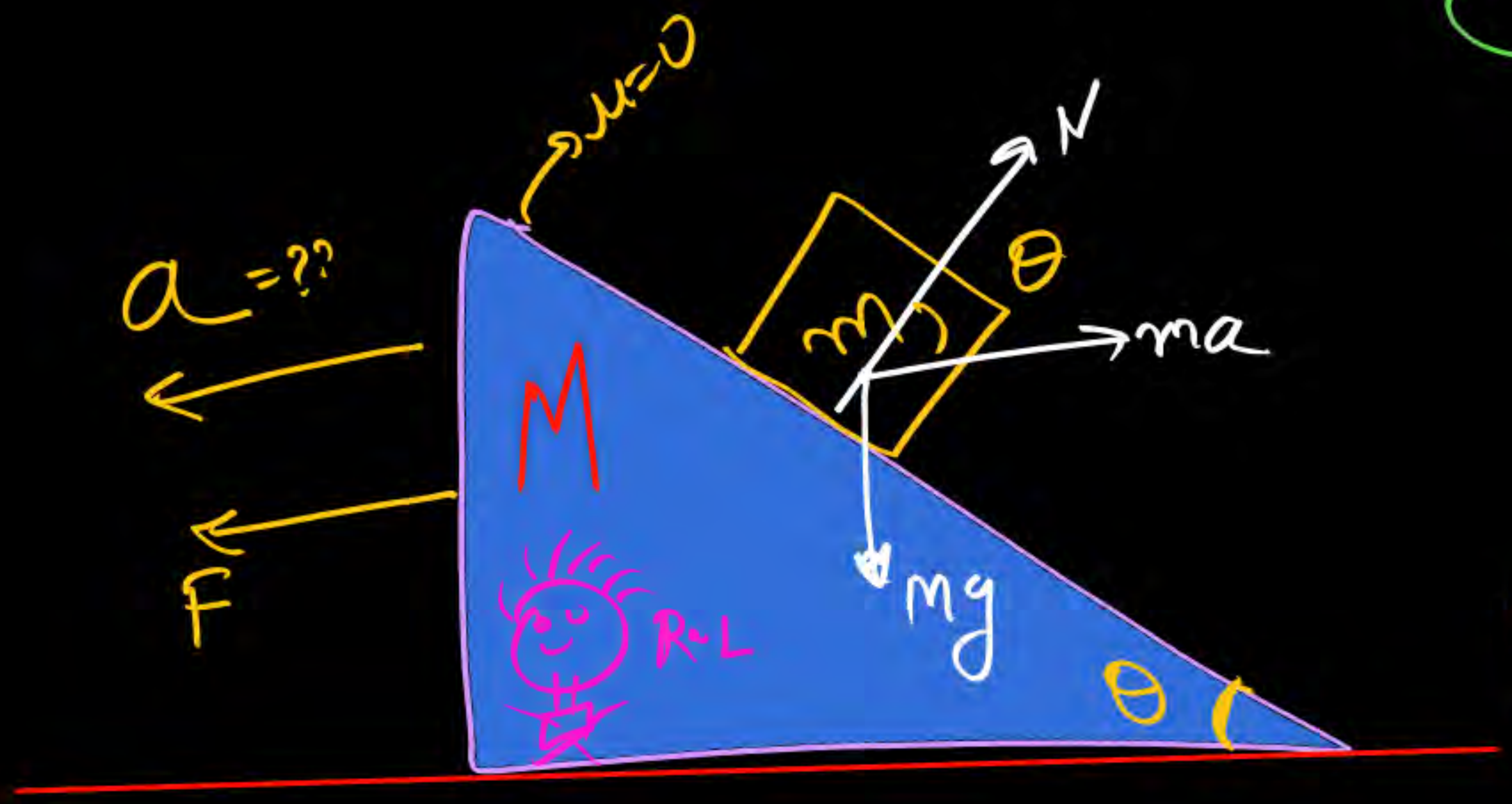


$$T = \frac{2 m_1 m_2}{m_1 + m_2}(g + a)$$

$$T = \frac{2 \times 2 \times 4}{2 + 4}(10 + 5)$$

$$= \frac{16}{6}(15) = 40\ N$$

Find acc^n of Inclined Plane so that Block will free fall.

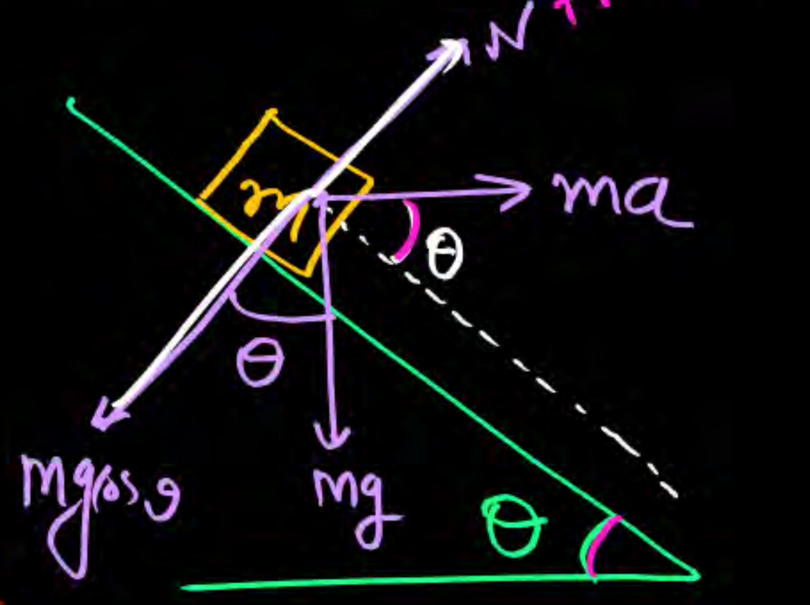


F.B.D w.r.t Reml

$\circledast$ $F = M_{net}\, a$

$= M g \cot\theta$

F.B.D. w.r.t Remlae

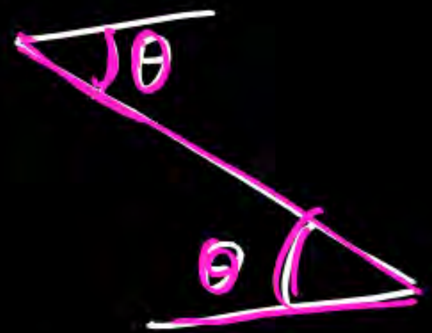


⊥r to Incline Plane

$N + ma\sin\theta = mg\cos\theta$, $N = 0$

for free fall $\Rightarrow N = 0$

$ma\sin\theta = mg\cos\theta$



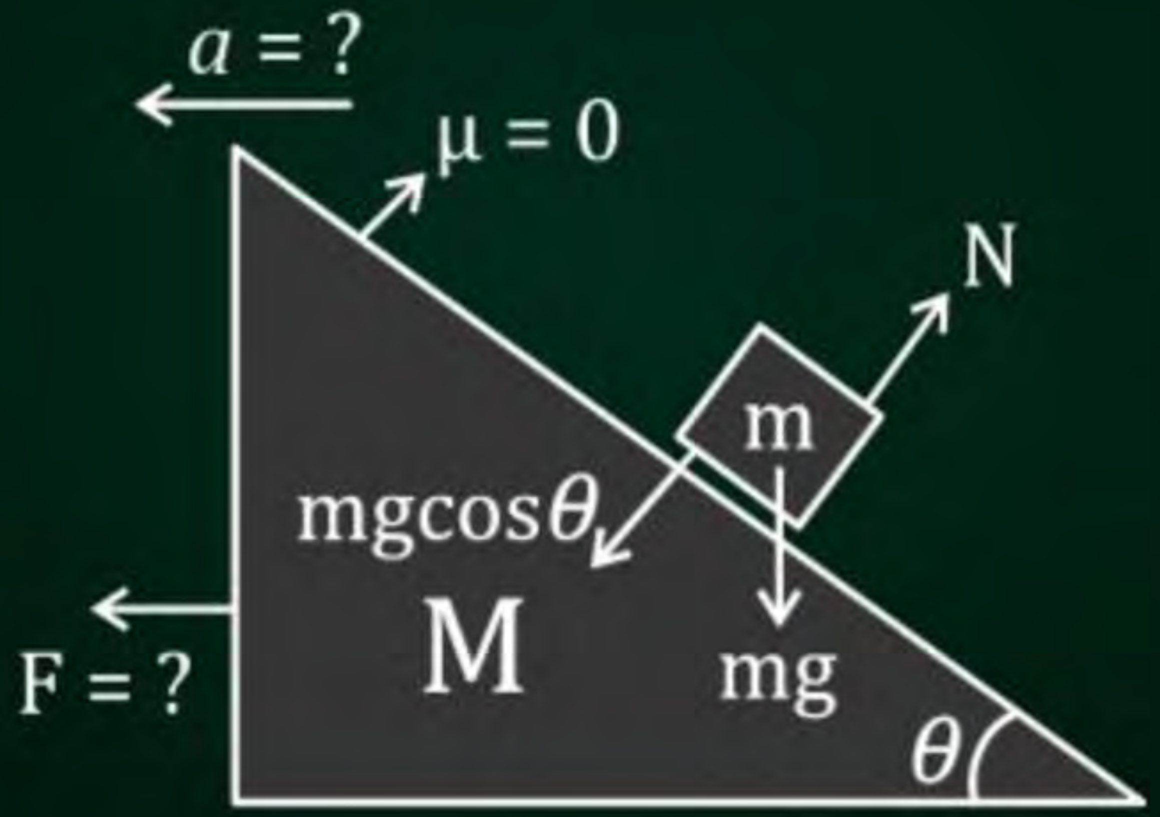
$a = g\dfrac{\cos\theta}{\sin\theta}$

$$a = g\cot\theta$$

QUESTION

Find acceleration of inclined plane so that block will free fall.

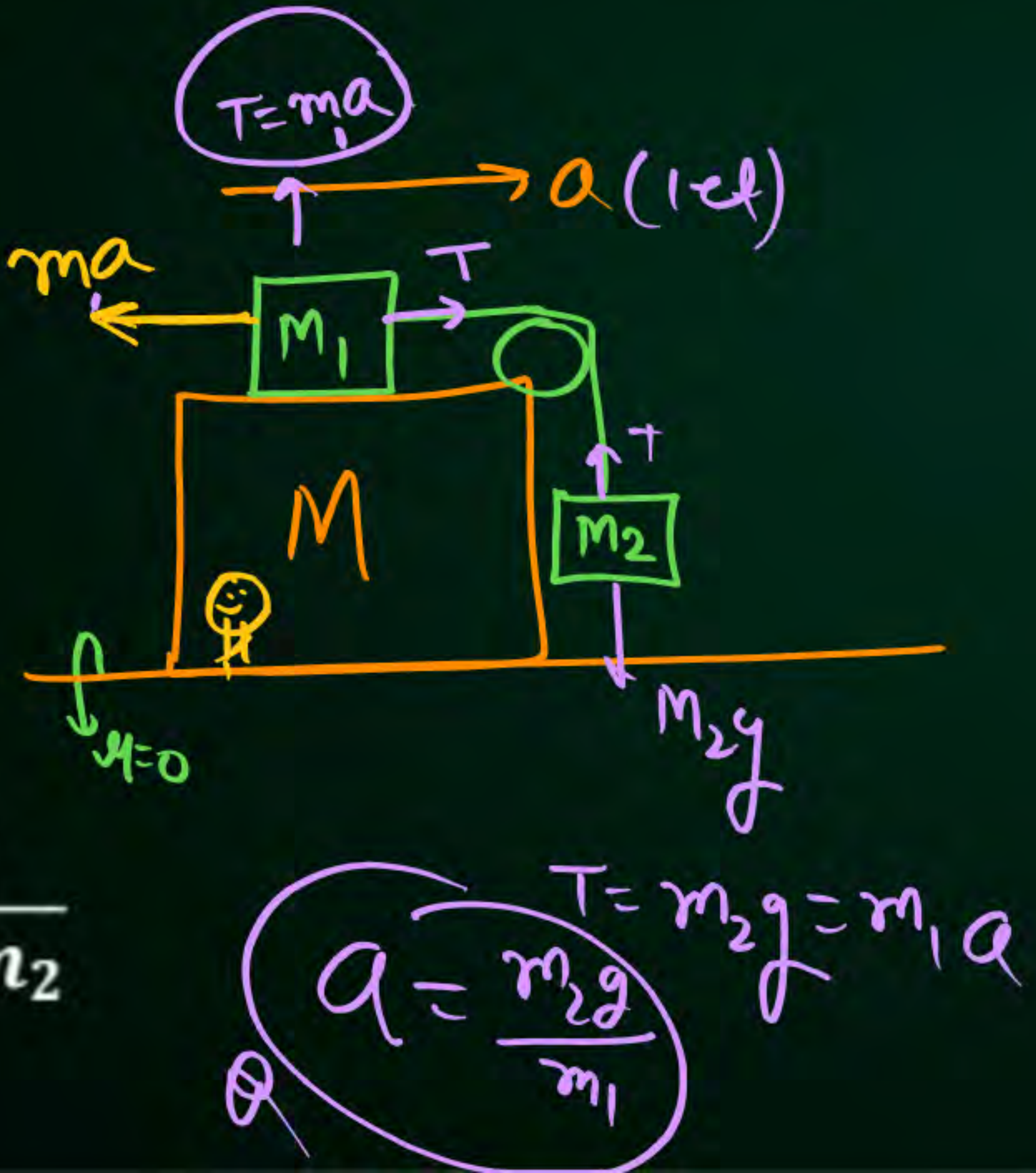
For free fall N = 0.

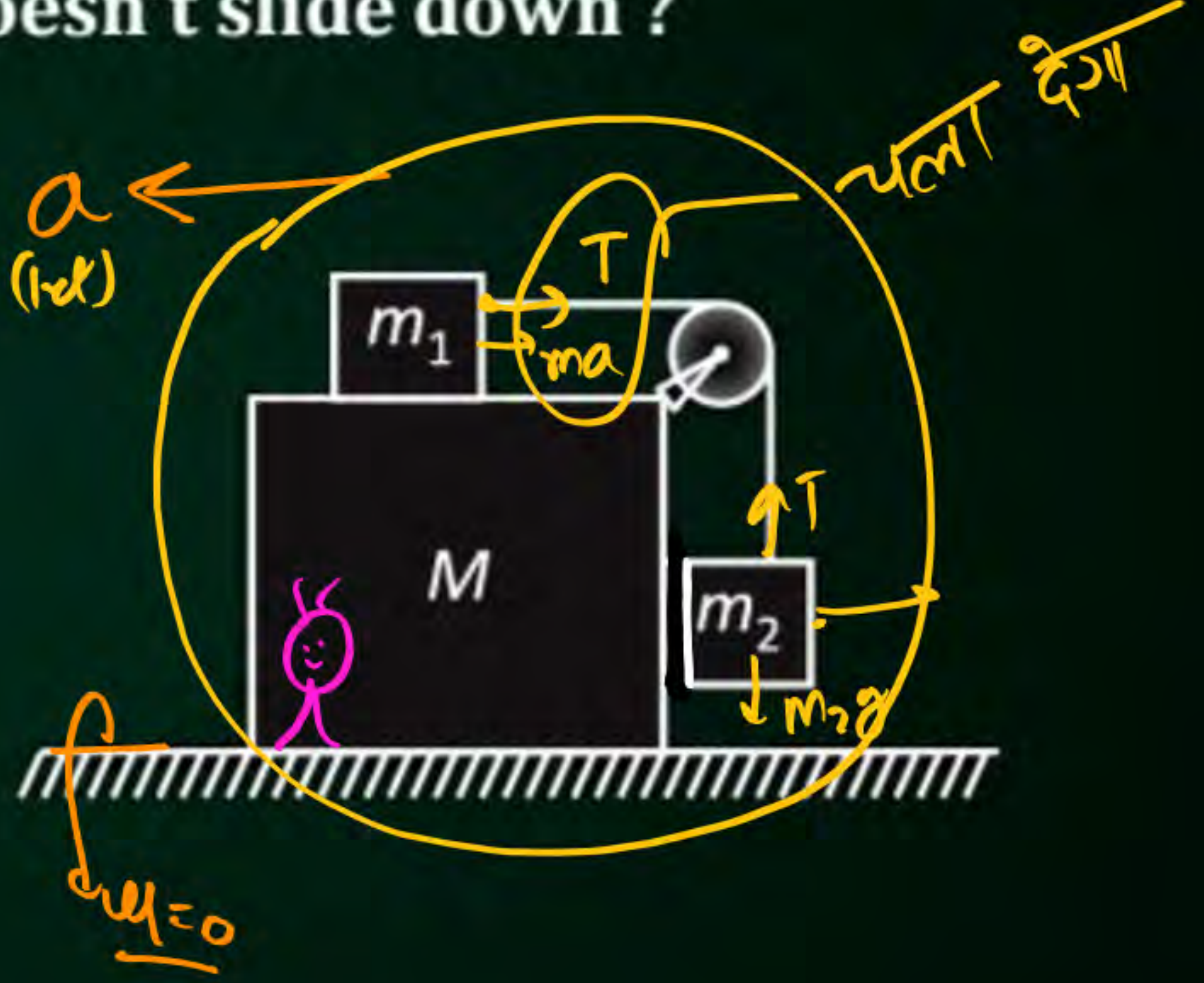


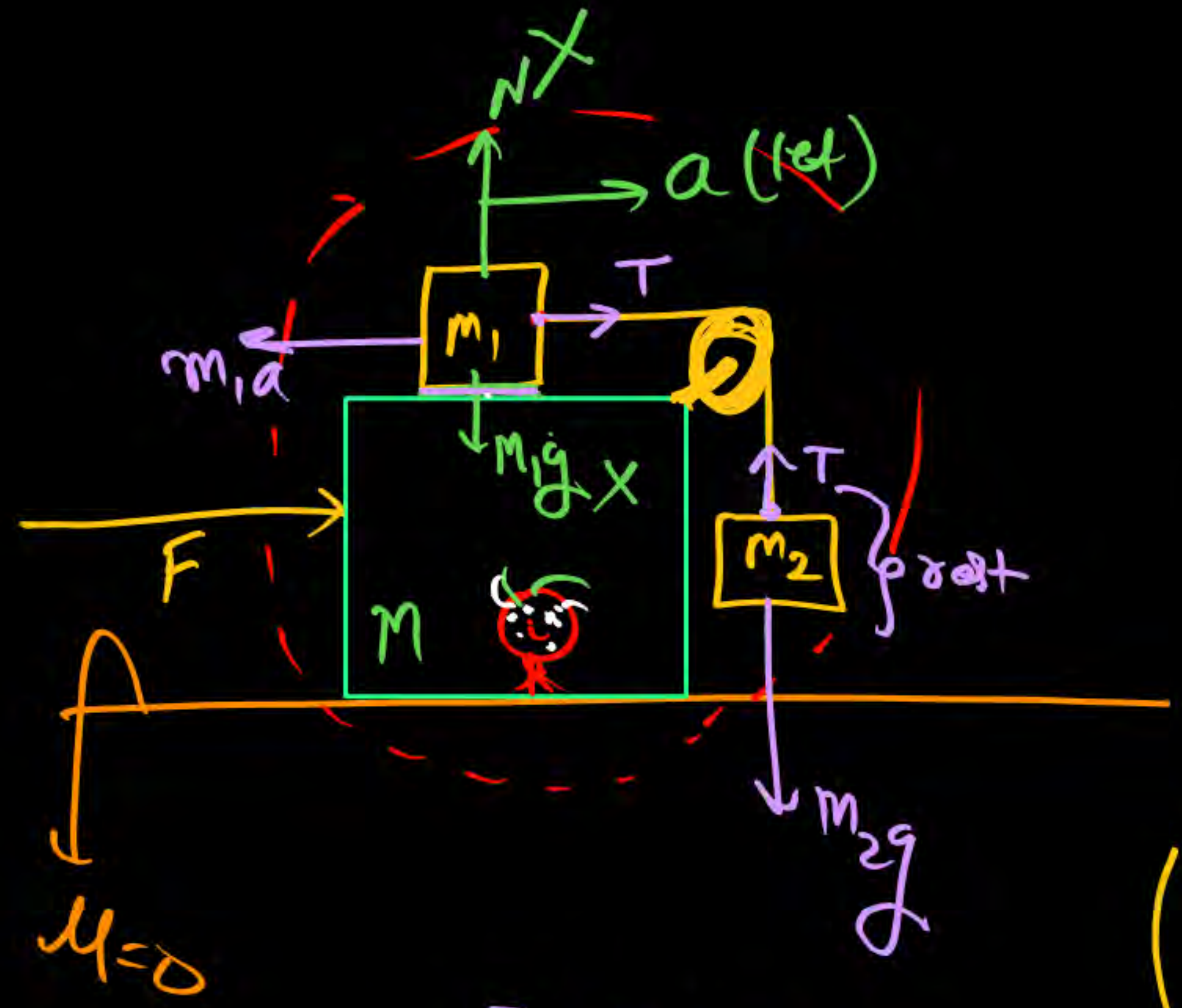
QUESTION

In the given arrangement all surfaces are smooth. What acceleration should be given to the system, for which the block m_2 doesn't slide down ?

1. $\frac{m_2 g}{m_1}$
2. $\frac{m_1 g}{m_2}$
3. g
4. $\frac{m_2 g}{m_1 + m_2}$







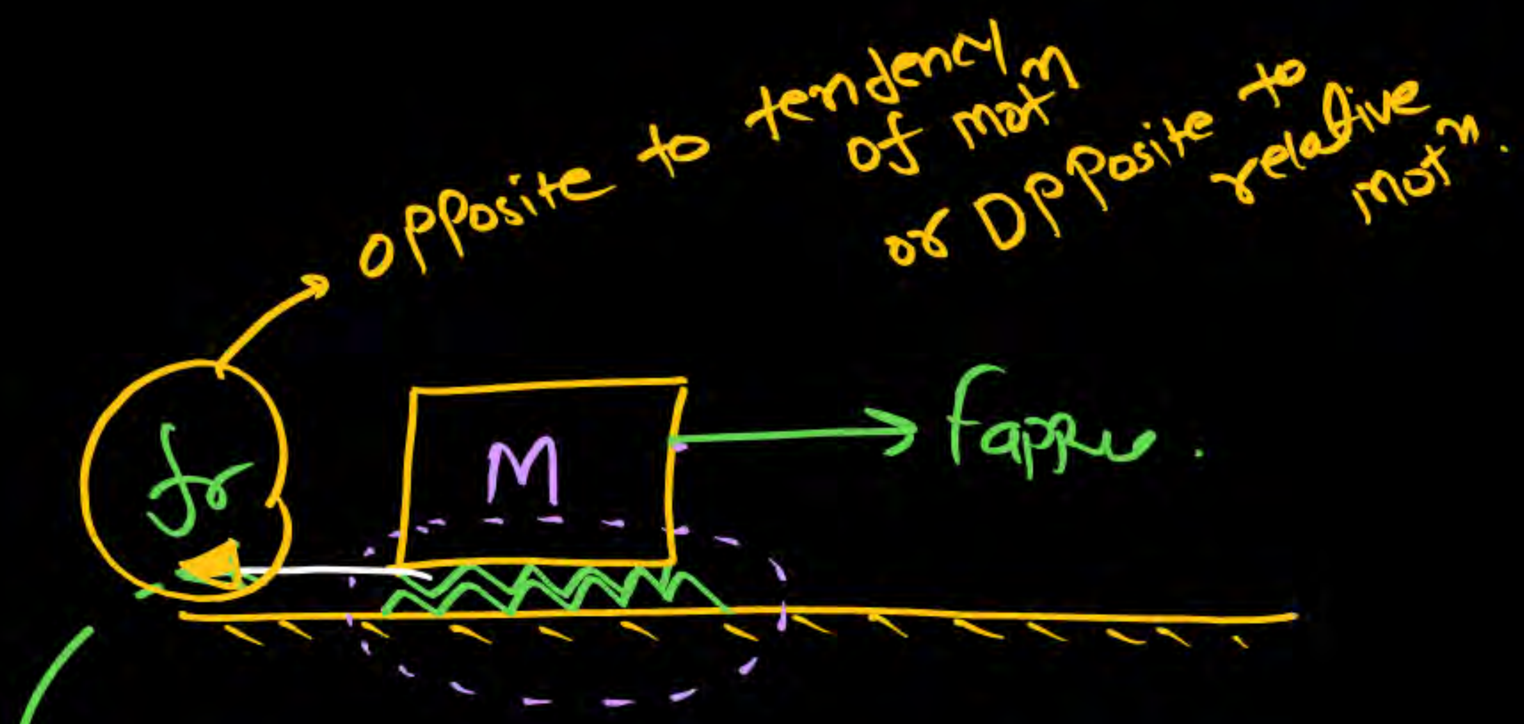
$$T = m_2 g = m_1 a$$

$$\# \quad a = \frac{m_2 g}{m_1}$$

force require for this acc^n

$$F = M_{net}\, a$$

$$= (M + m_1 + m_2)\frac{m_2 g}{m_1}$$



Interlocking {friction}

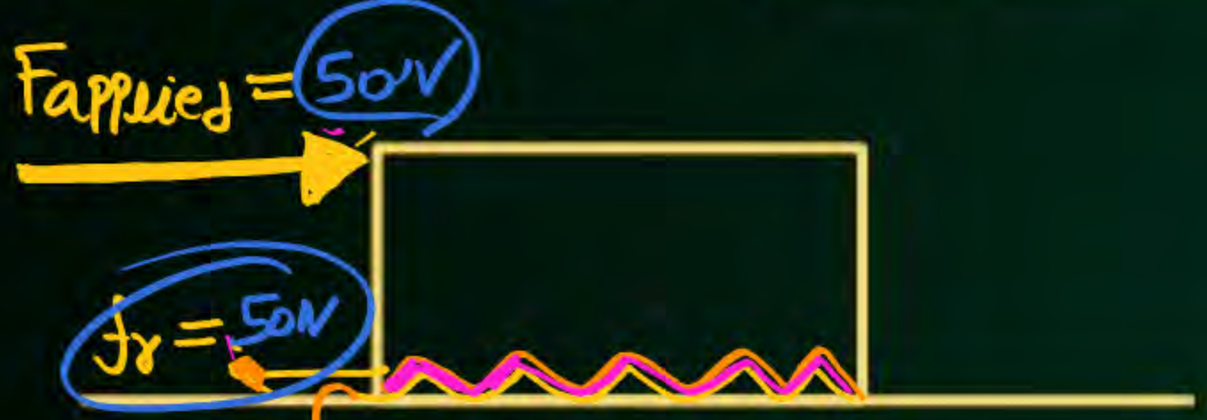
If we want to move this object we have to Break Interlocking

$F_{required}$ to Break Interlocking = $F_{limiting}$ friction force (अधिकतम)

friction force → contact force ✓
→ acts ‖r to contact surface ✓

→ Try to oppose relative motion or tendency of relative mot^n.

* Let 100 N force is required to move this block.



* $f_{static} = F_{applied}$ → rest, No sliding
$f_{limiting} = \mu_s N$ ← about to move
$f_{kinetic} = \mu_K N$

* Body is about to move → $F_{static\ friction}$ maximum $= F_{limiting\ friction}$

$(f_r)_{static}$ rest { static } $= F_{applied}$ — static friction

Friction	Applied
fr = 30N	Fapp = 30N
fr = 80N	Fapp = 80N
fr = 95N	Fapp = 95N
fr = 5N	Fapp = 5N
fr = 97N	Fapp = 97N
fr = 98N	Fapp = 98N
fr = 99N	Fapp = 99N
fr < 100N	Fapp = 100N
fr = 97N	Fapp = 120N
fr = 97N	Fapp = 150N
fr = 97N	

→ Object is in motion, f_K = Kinetic friction

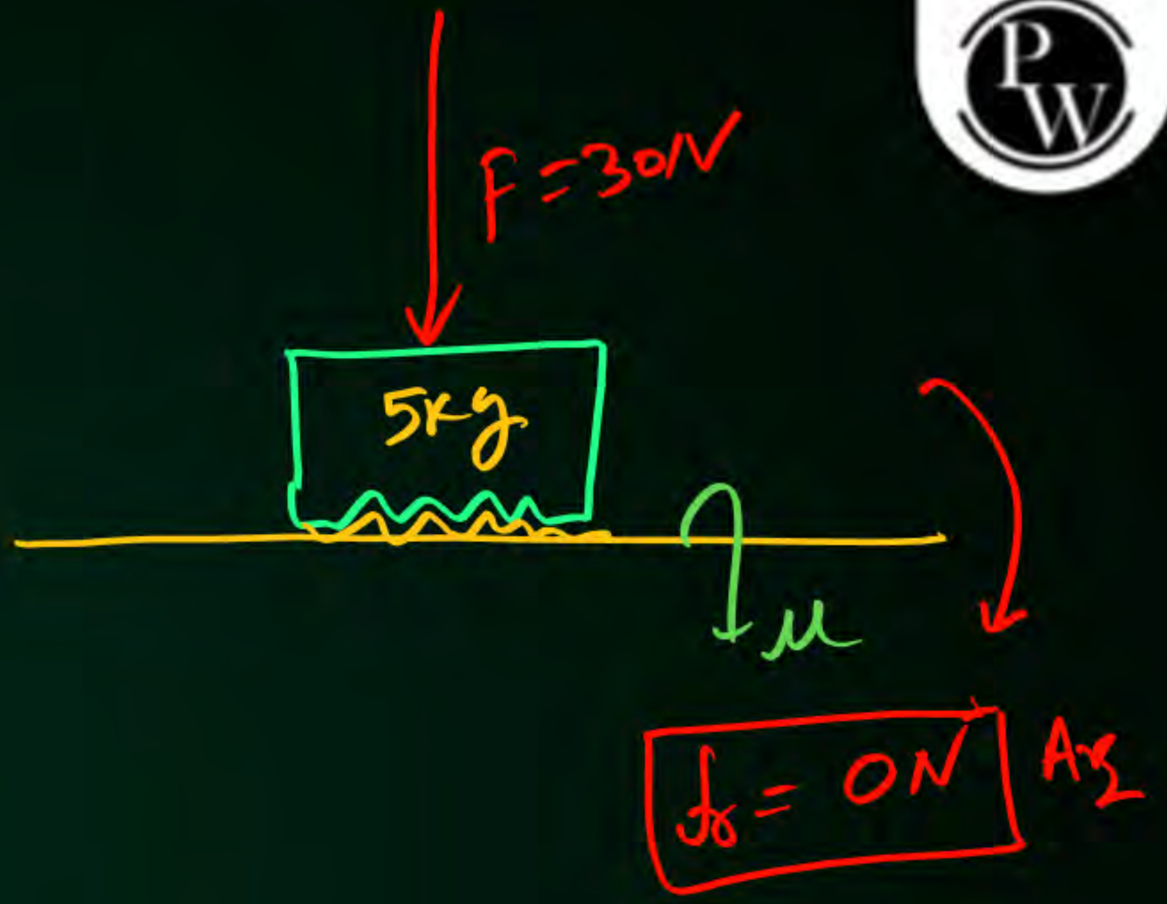
Example of Kinetic friction

* $\mu_s > \mu_K$ (μ_s / μ_l)

* sirf μ diya hai matlb $\mu_K = \mu_s$

Static friction force :

- Self adjustable force
- always equal to applied force
- only when tendency of motion
- object is at rest

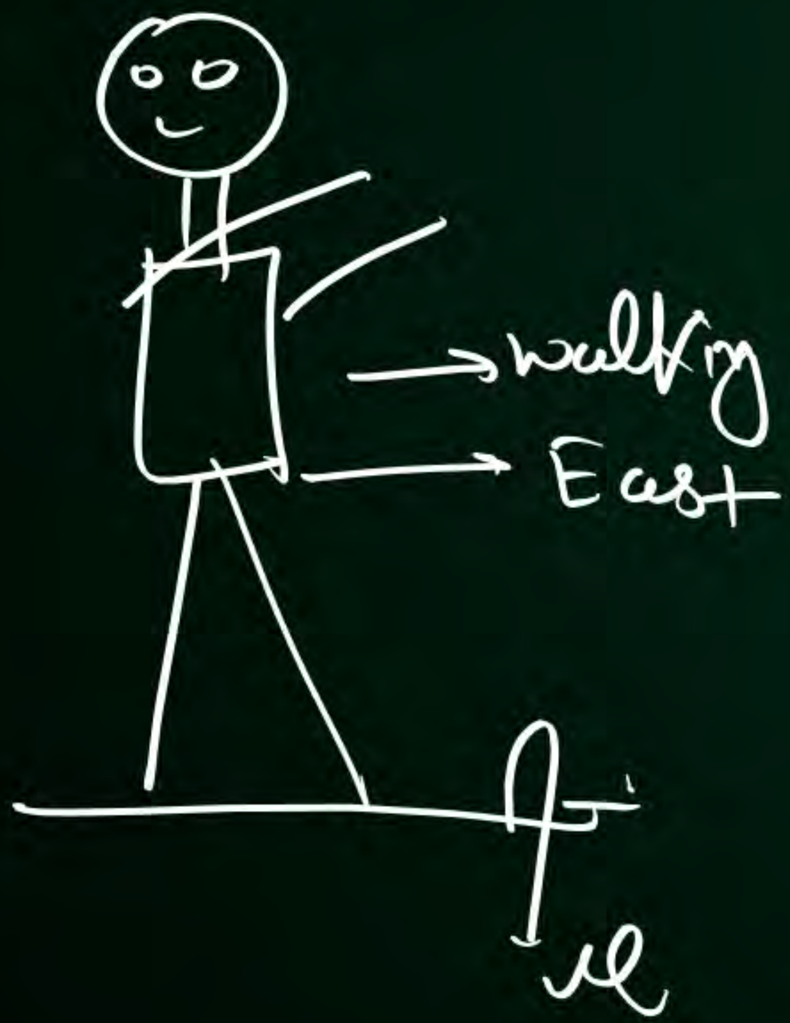


Limiting friction force :

- Maximum static friction
- When object about to move

✓ Kinetic friction (Sliding friction) :

- When object is in motion w.r.t. contact surface.



with const velocity

15% (a) east kinetic ✗

67% (b) west kinetic ✗

✓ (c) east static → only 7%

10% (d) west static ✗

✓ If N = 0 then friction must be zero : → True

✓ If F_r = 0 then normal must be zero : → false

Smooth surface

FRICTION

Friction force is also a contact force which acts parallel to contact surface. Which oppose relative motion or tendency of relative motion w.r.t. contact surface, in tangential direction.

Necessary condition to act friction :

1. Contact
2. Interlocking
3. Tendency or relative motion w.r.t. contact surface parallel to contact force. friction force oppose motion.



✓ **Friction is a Necessity :**

Without friction

- We cannot walk.
- A bicycle, a vehicle, a train etc. cannot be started or stopped.
- It would be impossible to climb a tree or pole, to fix a nail, to write with a pen, etc.

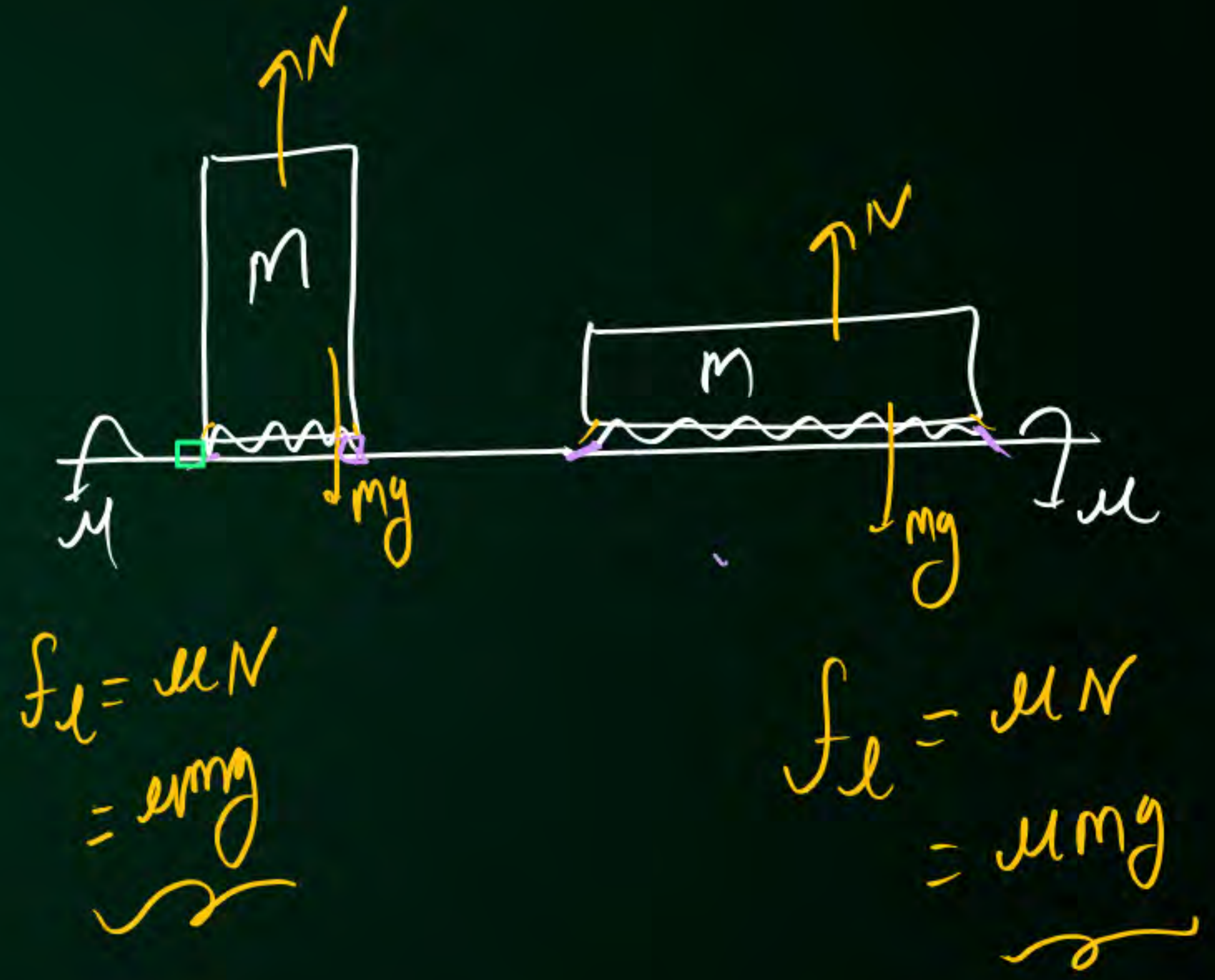
✓ **Friction is an Evil :**

- Wear and tear of tyres on the road is due to friction.
- Wear and tear of the machinery parts is due to friction.
- Heat produced by friction causes damage to the machines.
- Extra power is needed to overcome friction.

QUESTION

The limiting friction between two bodies in contact is independent of

1. Nature of the surface in contact
2. The area of surfaces in contact
3. Normal reaction between the surfaces
4. The materials of the bodies



QUESTION

Which of the following is self-adjusting force?

1. Static friction
2. Limiting friction
3. Kinetic friction
4. Rolling friction

QUESTION

Maximum force of friction is called

1. Limiting friction
2. Static friction
3. Sliding friction
4. Rolling friction

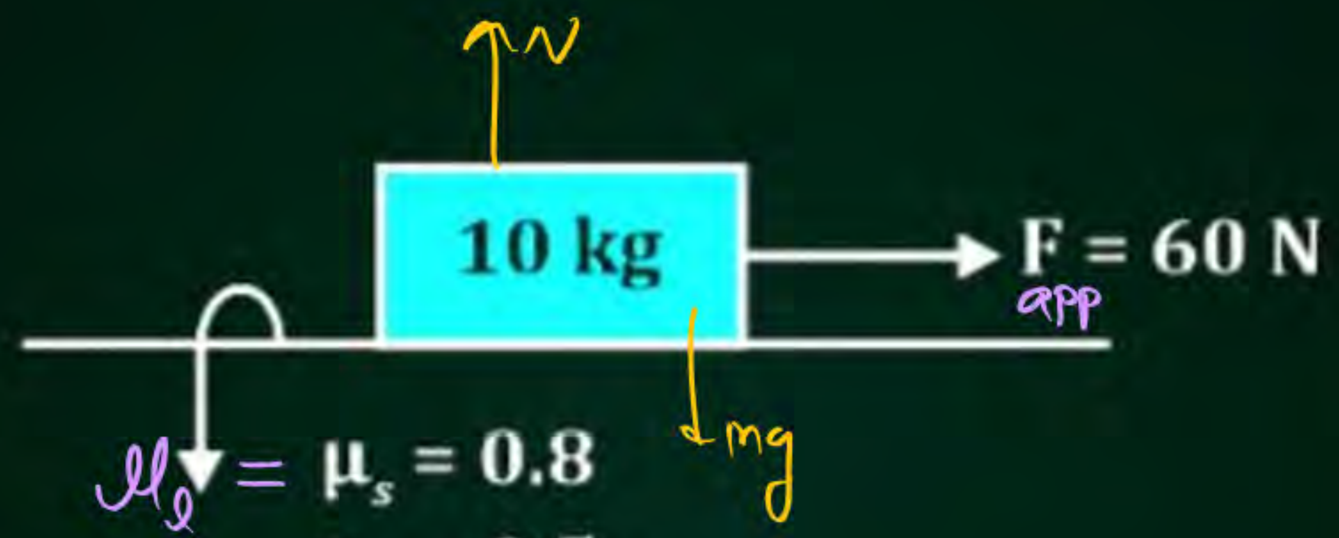
QUESTION

Which is a suitable method to decrease friction?

1. Polishing
2. Lubrication
3. Ball bearing
4. All of these

QUESTION

Find acceleration and friction between block and ground.



$\mu_l = \mu_s = 0.8$

$\mu_k = 0.5$

Step-1

find friction ki aukad.

$f_{limiting} = \mu_l N$

$= \frac{8}{10}(mg)$

$= \frac{8}{10} 10 \times 10$

$f_{limit} = 80N$

औकात

step-2

$\Rightarrow f_{applied} < f_{lim}$

$60N < 80N$

$a = 0$ (rest)

$f_{static} = 60N$ ✓ $F_{applied}$

QUESTION

Find acceleration and friction acting on object.



$\mu_s = 0.6$

$\mu_k = 0.4$

Step-1

$f_{s\,max} = \mu_s N$

$= \frac{6}{10}(mg)$

$= \frac{6}{10} \times 10 \times 10$

$= 60N$

Step-2

$f_{applied} > f_{lim}$

move करेगा



$f_{kine} = \mu_k N$

$= 0.4(mg)$

$= \frac{4}{10} \times 10 \times 10$

$= 40N$

$F_{net} = ma$

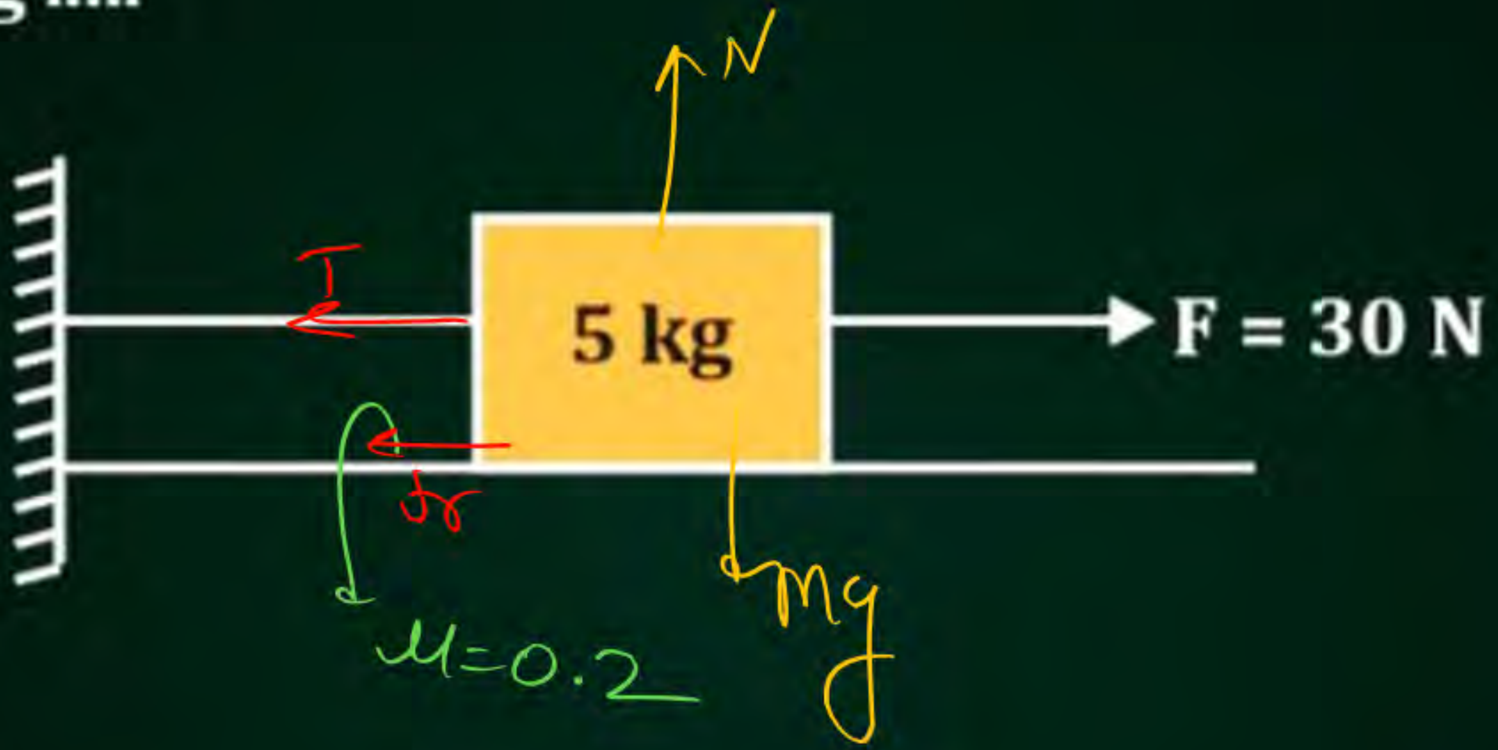
$80 - 40 = 10a$

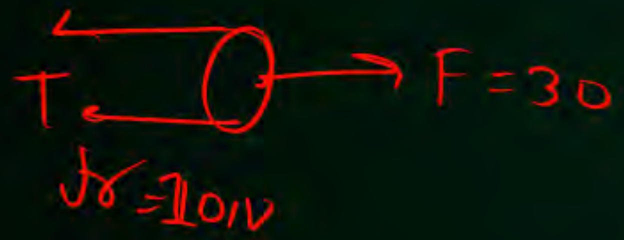
$40 = 10a$

$a = 4 m/s^2$

QUESTION

Find Tension in string .....





$T = 30 - 10$

$= 20N$

$f_{limit} = \mu N$

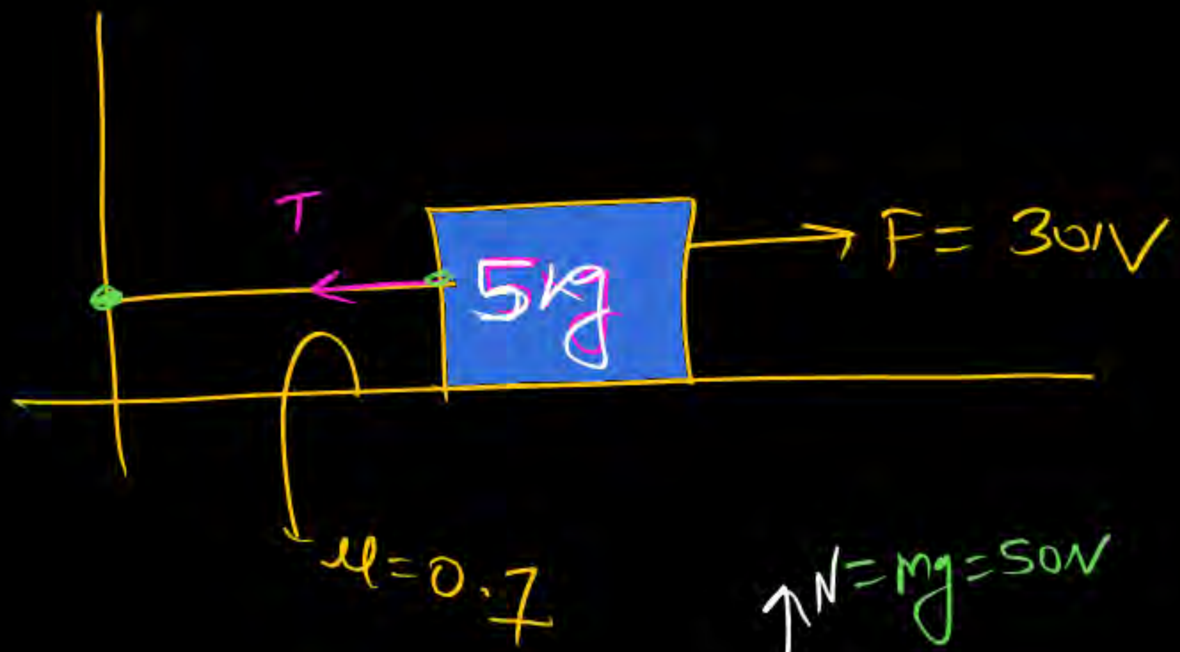
$= \frac{2}{10} \times 50$

$= 10N$

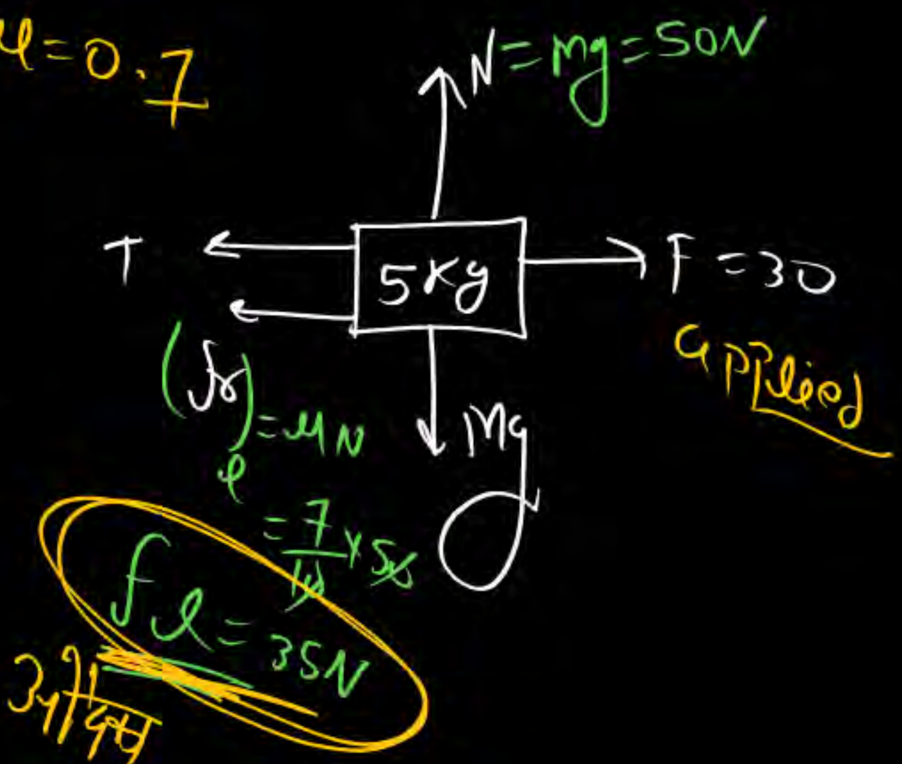
$N = mg$

$= 5 \times 10$

$N = 50N.$



find Tension & friction??

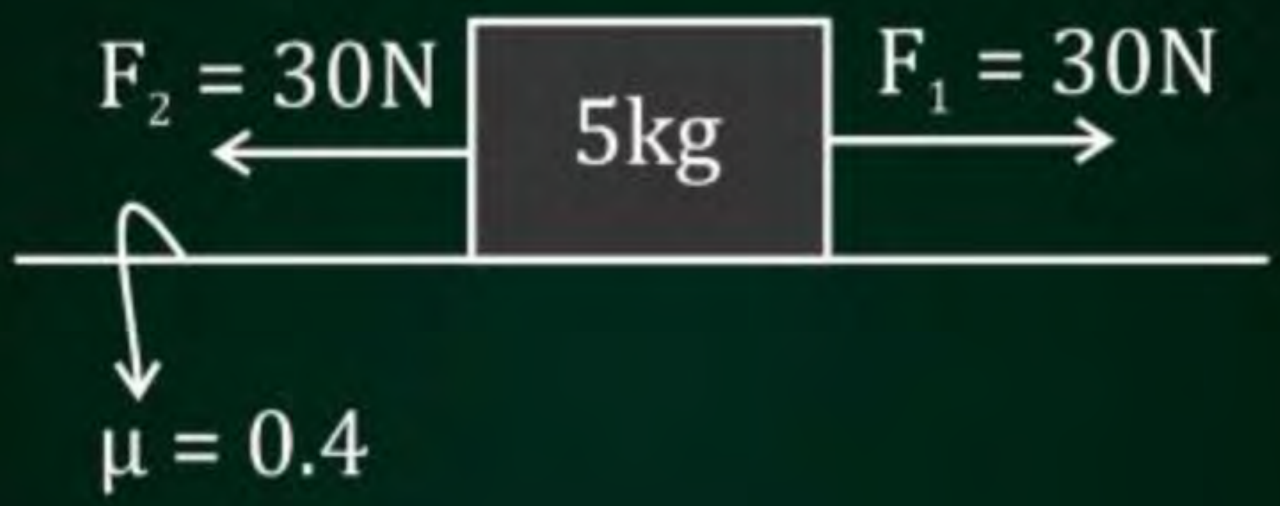


$f_{static} = 30N$

$T = 0$

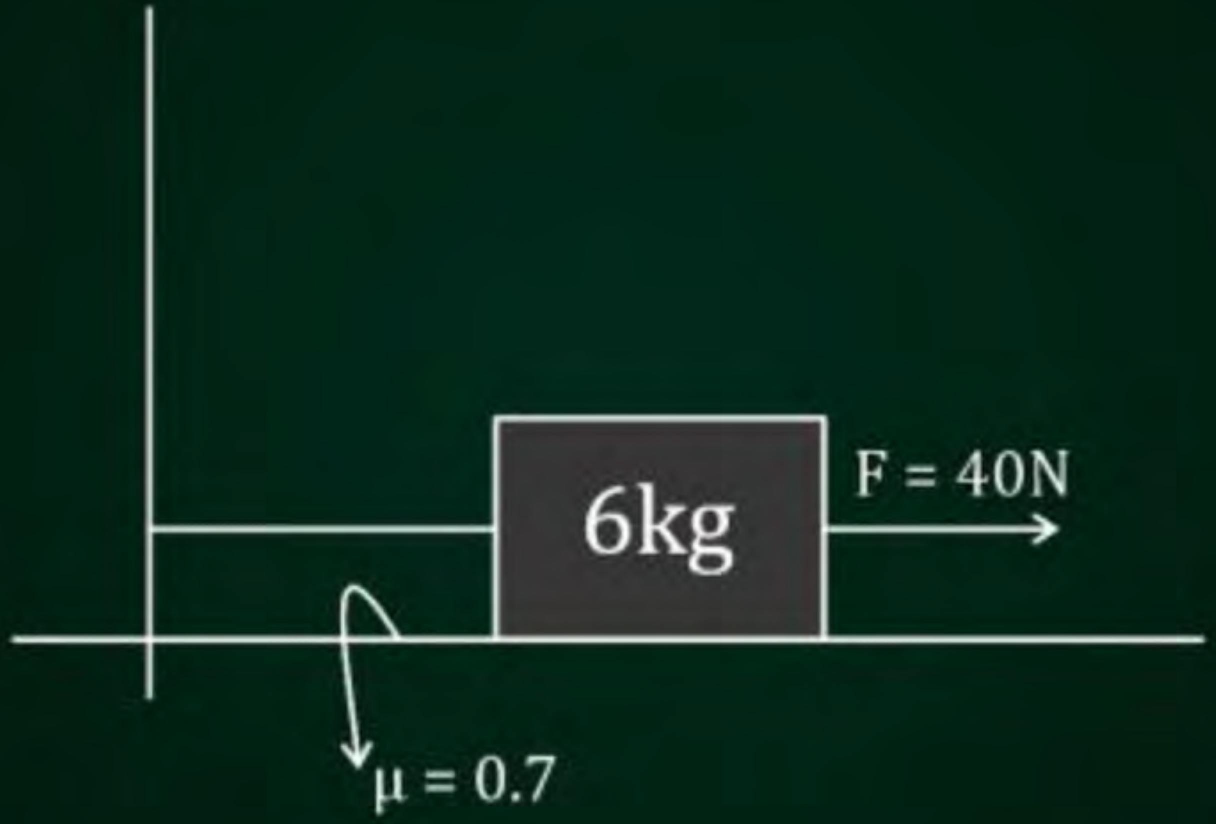
QUESTION

Find acceleration and friction.



QUESTION

Find Tension in string .....



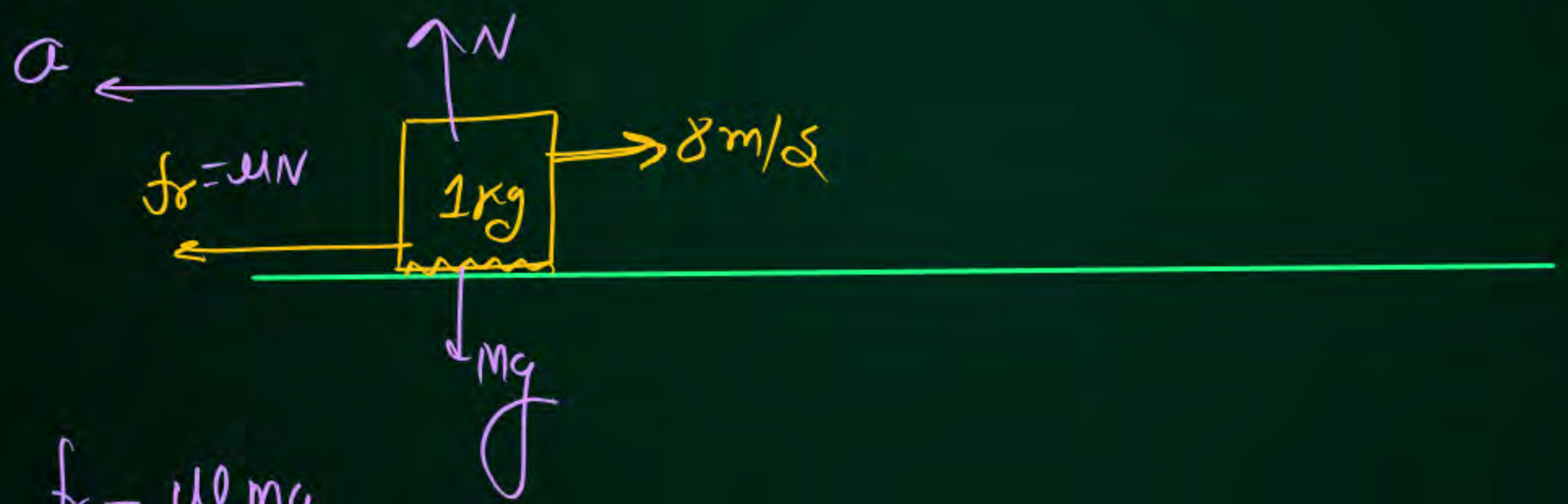
QUESTION

Object is thrown with velocity V_0 on rough surface of coefficient of friction μ, then stopping distance and time.

QUESTION

An object of mass 1 kg moving on a horizontal surface with initial velocity 8 m/s comes to rest after 10 s. If one wants to keep the object moving on the same surface with velocity 8 m/s the force required is

1. 0.4 N
2. 0.8 N
3. 1.2 N
4. Zero



$f_r = \mu mg$

$ma = \mu mg$

$a = \mu g$ retardation

$v = u + at$

$0 = 8 - \mu g \times t$

$8 = \mu g t$

$8 = \mu \times 10 \times 10$

$\mu = \frac{8}{100}$

$f_{applied} = f_{friction} = \mu mg$

$= \frac{8}{100} \times 1 \times 10 = 0.8\,N$

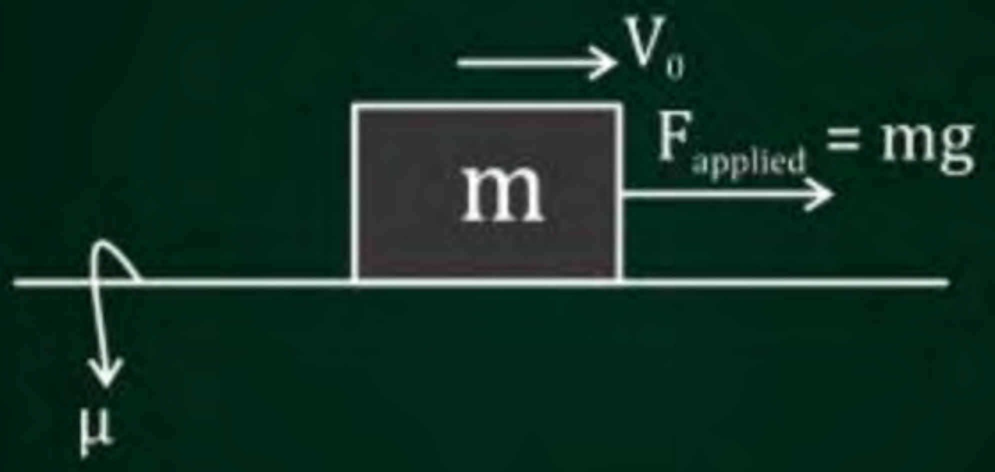
QUESTION

A heavy box is slid across a rough floor with an initial speed of 4 m/s. It stoops moving after 8 seconds. If the average resisting force of friction is 10 N, the mass of the box (in kg) is:

1. 40
2. 20
3. 5
4. 2.5

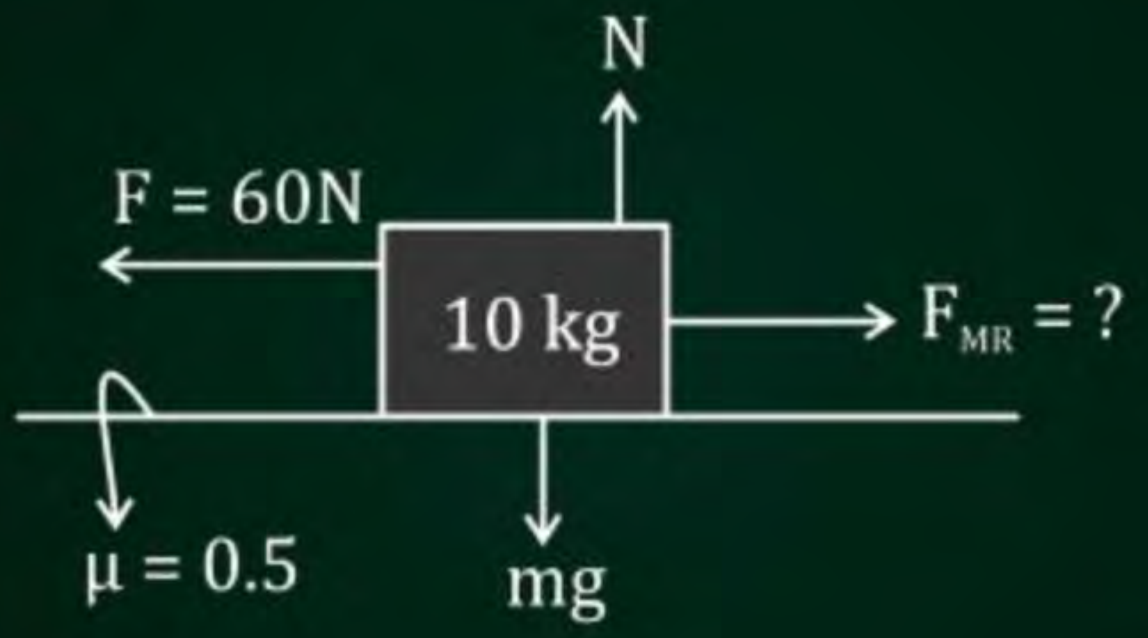
QUESTION

Object is moving with constant velocity under the applied force mg as shown in figure, then find constant force.



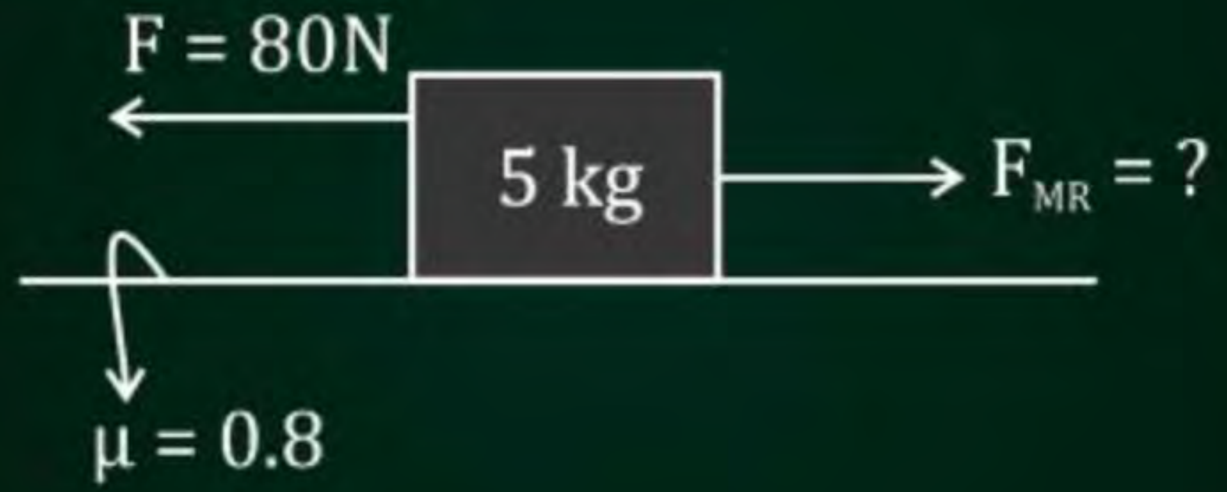
QUESTION

Find the applied force F_{MR} to keep the object at rest.



QUESTION

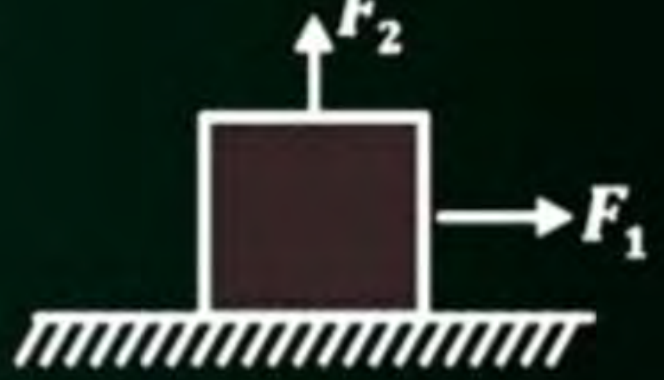
Find value of F_{MR} to keep the object at rest.



QUESTION

In the figure shown, horizontal force F1 is applied on a block but the block does not slide. Then as the magnitude of vertical force F2 is increased from zero the block begins to slide; the correct statement is

1. The magnitude of normal reaction on block increases
2. Static frictional force acting on the block increases
3. Maximum value of static frictional force decreases
4. All of these



QUESTION

A child weighing 25 kg slides down a rope hanging from a branch of a tall tree. If the force of friction acting against him is 200 N, the acceleration of child is ($g = 10\ m/s^2$)

1. $22.5\ m/s^2$
2. $8\ m/s^2$
3. $5\ m/s^2$
4. $2\ m/s^2$

THANK YOU



YAKEEN 2.0

FOR NEET 2025

Lecture- 10 | Physics

Laws of Motion

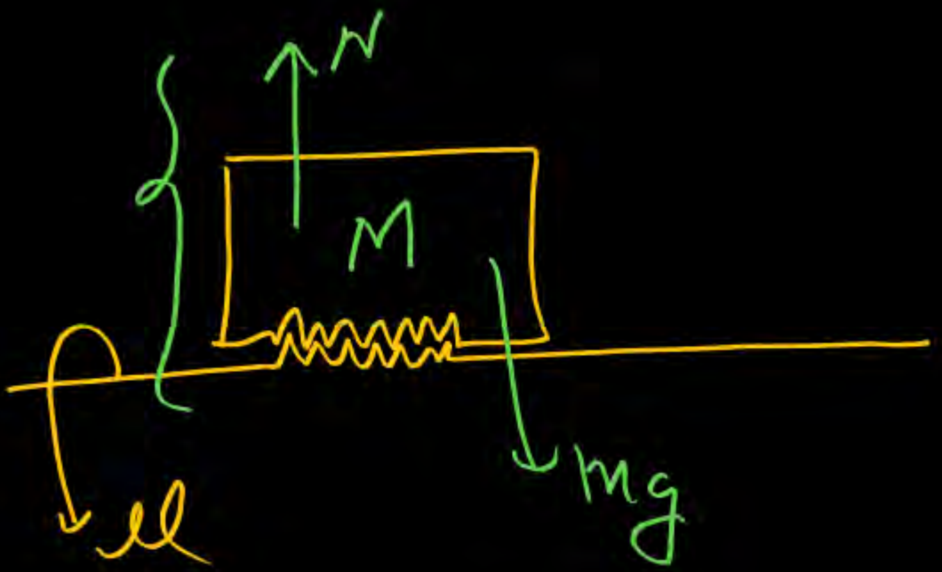
By- Dr. Manish Raj (MR SIR)



Topic To Be Covered-

1. # friction on Horizontal & vertical surface
2. #
3. #
4. #





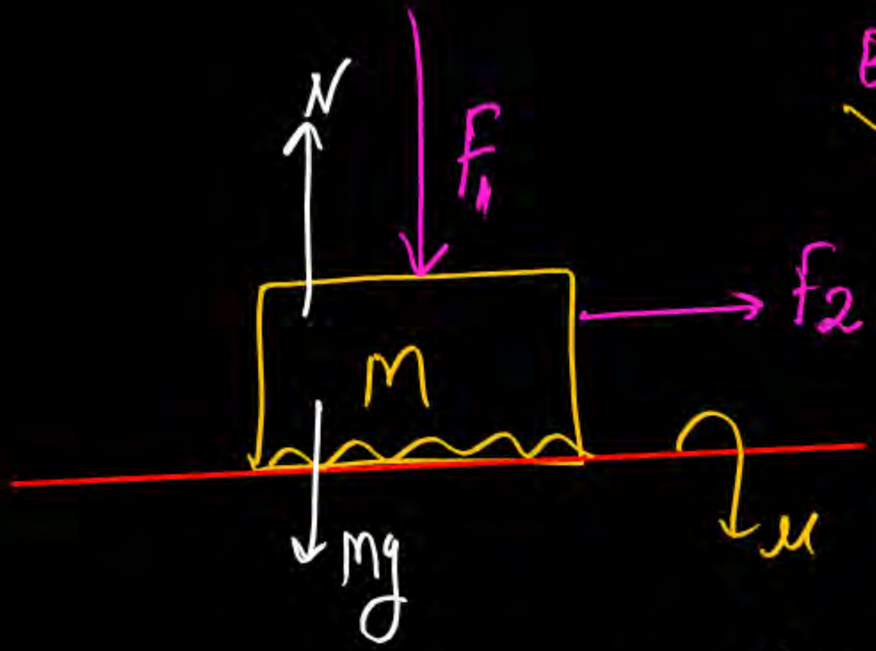
$N = mg$

$f_{limiting} = \mu N$

$f_{limiting} = \mu mg$

(*) $f_{kinetic} = \mu mg$

$f_{static} = F_{applied}$ } rest / Tendency of motion

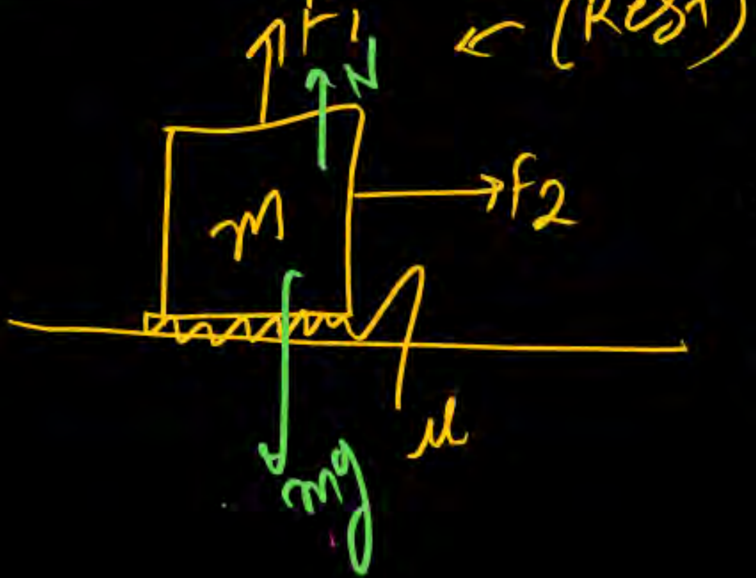


Body rest में है।

$f_{static} = F_2$

$N = mg + F_1$ — (1)

$f_{limiting} = \mu N = \mu(mg + F_1)$



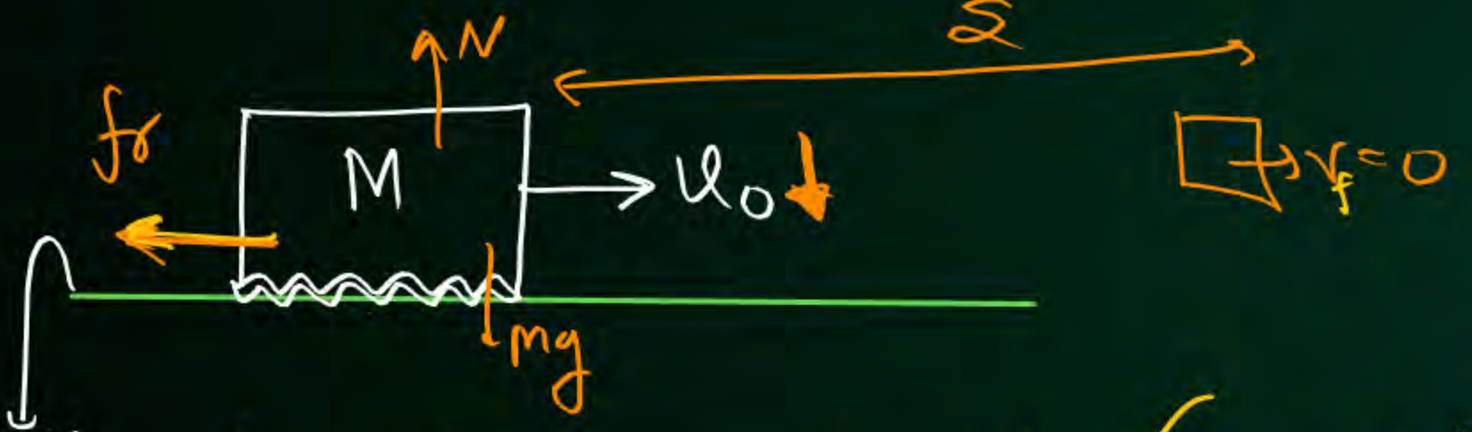
$N = mg - F_1$

$f_{limiting} = \mu(mg - F_1)$ ← Motion में होगी

$f_{static} = F_2$ (rest में given)

QUESTION

Object is thrown with velocity V_0 on rough surface of coefficient of friction μ, then stopping distance and time.



$f_r = \mu N$

$f_r = \mu mg$

$ma = \mu mg$

$a = \mu g$ (retⁿ)

$S = \frac{V_0^2}{2(a)}$ (stopping distⁿ)

$$S = \frac{V_0^2}{2\mu g}$$

$V_f = 0 \quad u_i = v_0$

$v = u + at$

$0 = u - \mu g t$

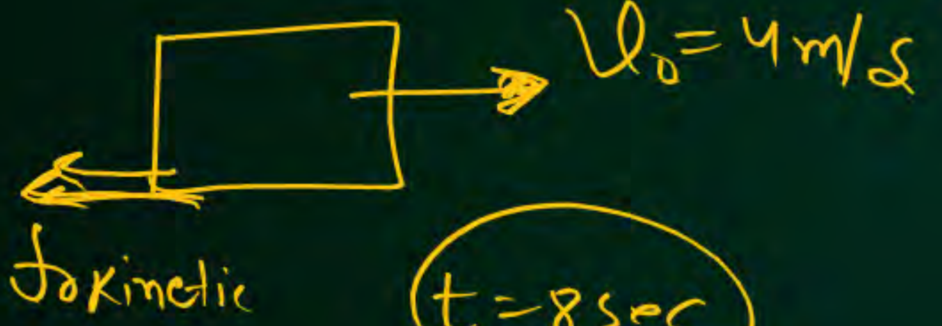
$$t = \frac{u}{\mu g}$$

(NEET)

QUESTION

A heavy box is slid across a rough floor with an initial speed of 4 m/s. It stoops moving after 8 seconds. If the average resisting force of friction is 10 N, the mass of the box (in kg) is:

1. 40
2. 20
3. 5
4. 2.5



$t = 8$ sec

$f_{Avg} = 10N = m\frac{4}{8}$

$v = u + at$

$0 = 4 + a \times 8$

$8a = -4$

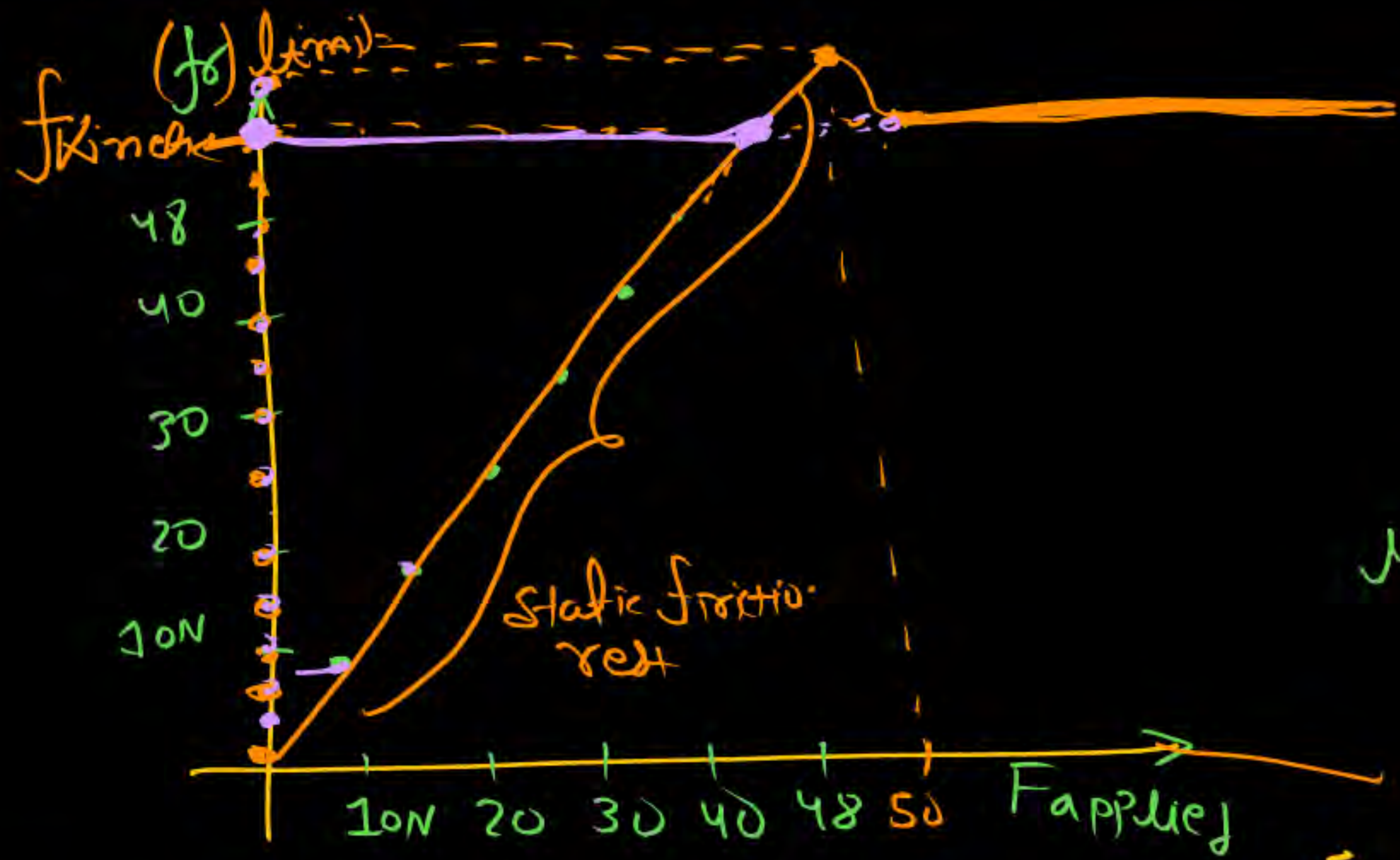
$a = -\frac{4}{8}$

$m = \frac{80}{4} = 20$

graph B/w friction and applied force.

f_{static} / $f_{kinetic}$

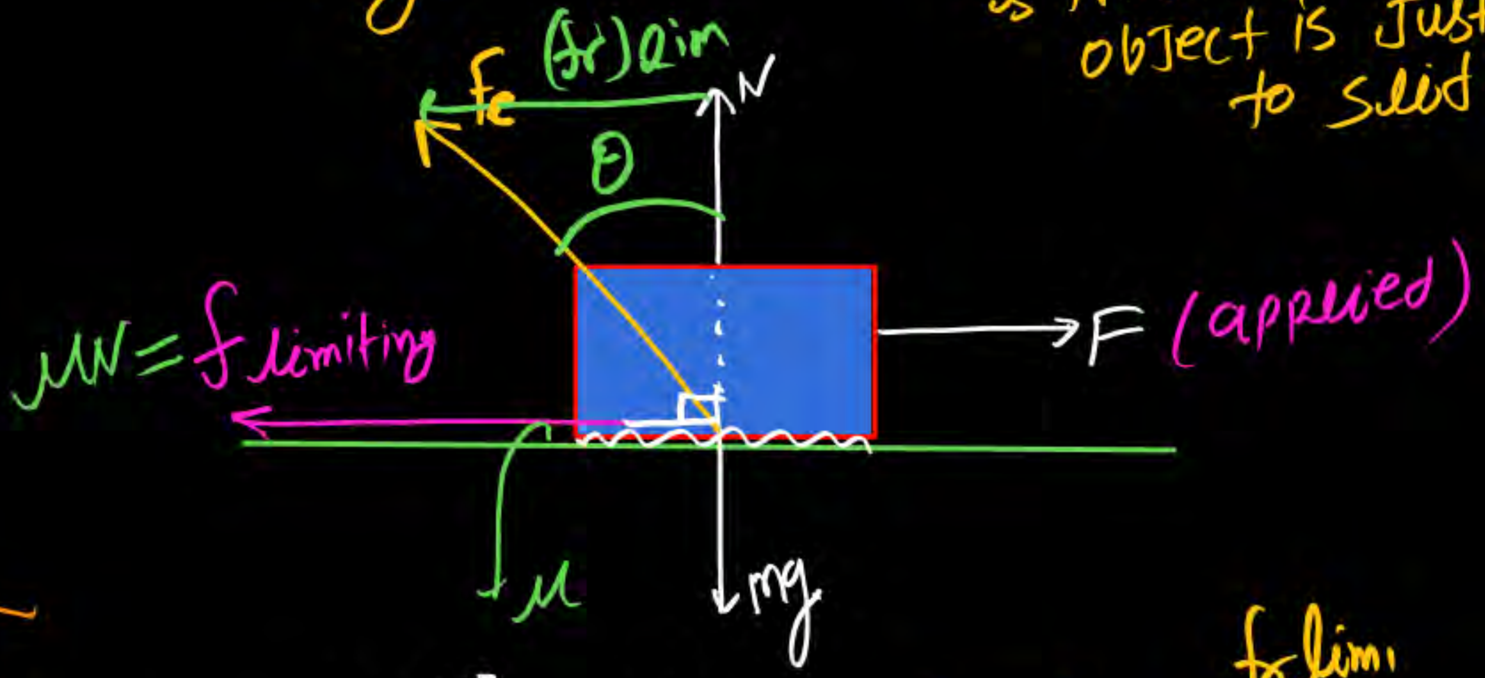
can't be compair.



$f_{static} \leq f_{limiting}$ ✓

$f_{kinetic} < f_{limiting}$

Angle of friction → Angle B/w contact force & Normal rexn when object is just about to slid.



$\vec{F_c} = \vec{N} + \vec{f_r}$

($\vec{N}$ and $\vec{f_r}$: perpendicular)

$|F_c| = \sqrt{N^2 + f_r^2}$

$\tan\theta = \frac{f_{r\,lim}}{N}$

$\tan\theta = \frac{\mu N}{N}$

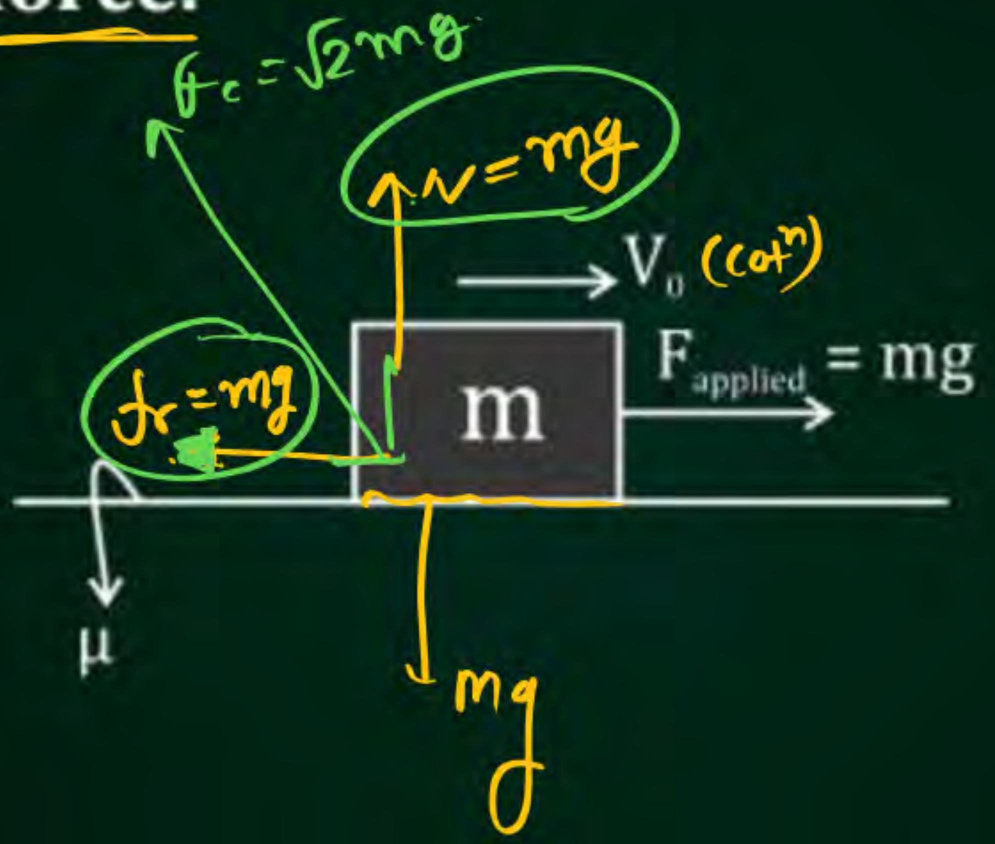
$\theta = \tan^{-1}(\mu)$

↳ Angle of friction

QUESTION

Object is moving with constant velocity under the applied force mg as shown in figure, then find constant force.

Contact



(a) mg

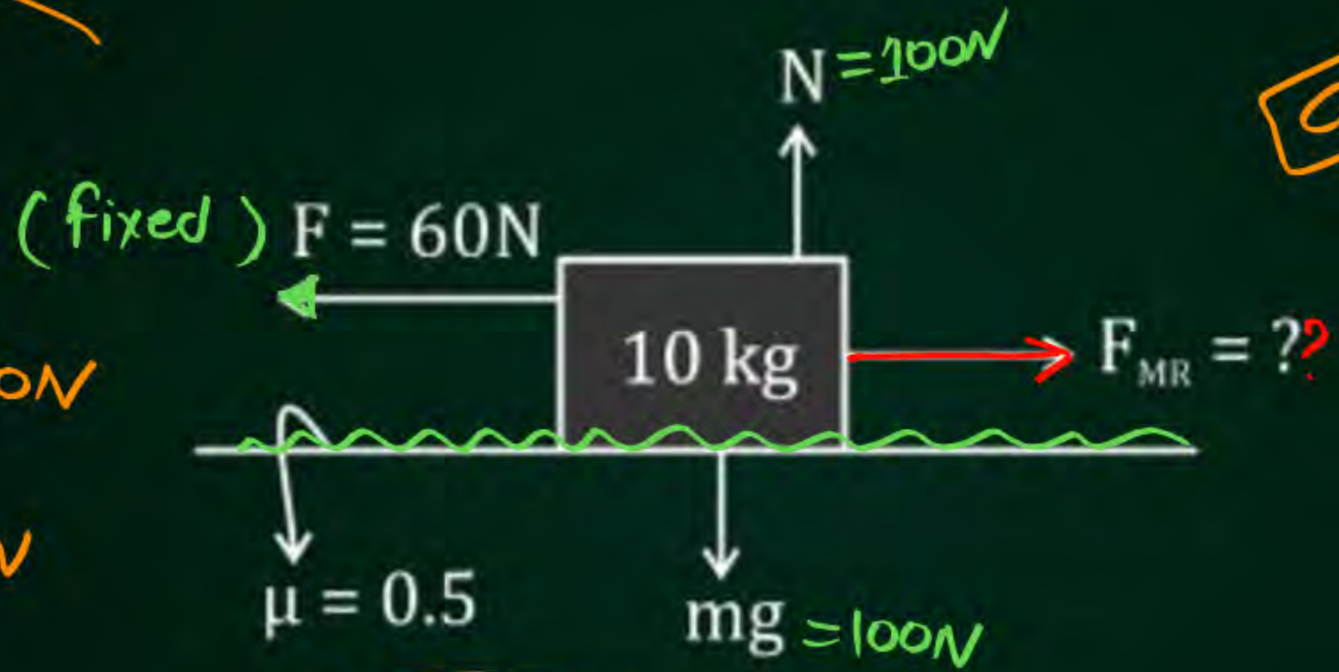
(b) $2mg$

(c) μmg

(d) $\sqrt{2}\, mg$

QUESTION

Find the applied force F_{MR} to keep the object at rest.



$20N \le F_{MR} \le 110N$

$(F - f_{r_{lt}}) \le F_{MR} \le (F + f_r)$

Case-1

F = 60N, $F_{MR} = 10N$, $(f_r) = 50N$

$(F_{MR})_{minimum} = 10N$

$(F_{MR}) = 20N$ ($f_r = 40N$ static)

$F_{MR} = 40N$ ($f_r = 20N$)

* $F_{MR} = 60N$ ($f_r = 0$)

$f_{r\,limiting} = \mu N$

$= \frac{5}{10} \times 100$

$= 50N$

Case-2

F = 60N, $F_{MR} = 70N$

$(f_r) = 10N$ (static)

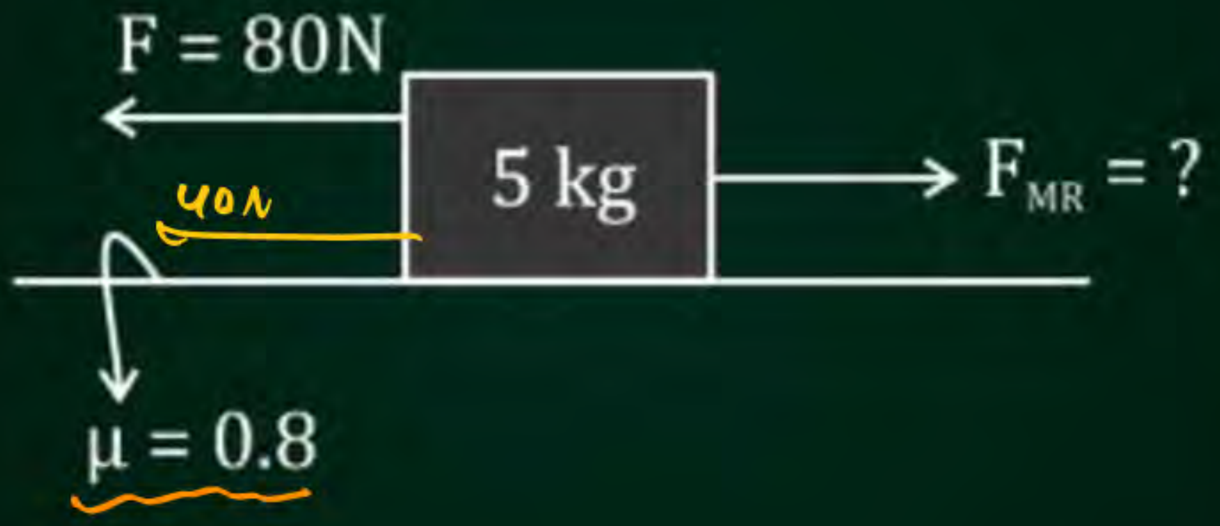
$F_{MR} = 100N$

$F_{MR\,maximum} = 110N \rightarrow (f_r) = 50N$

$F_{MR} = 111N$ (object will move)

QUESTION

Find value of F_{MR} to keep the object at rest.



$(F_{MR})_{min} = 40\,(N)$

$F_{max} = 120\,N$

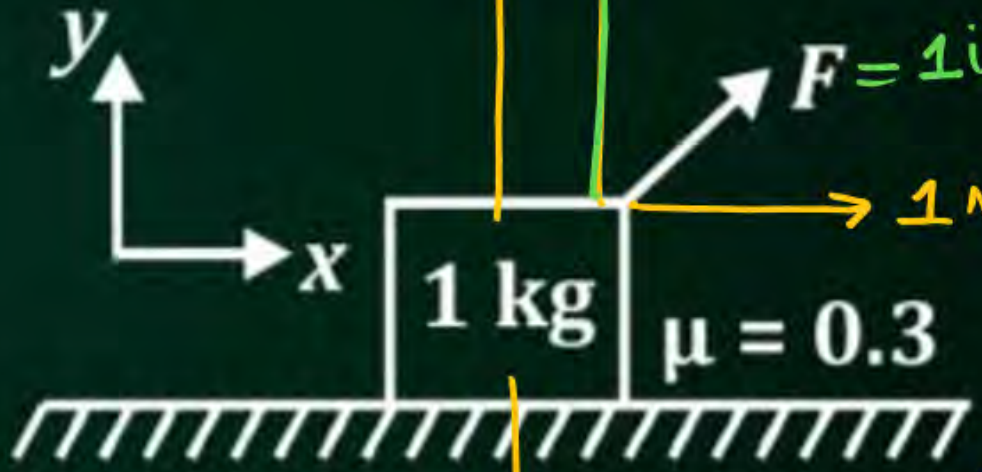
$f_{limit} = \mu N$

$= \frac{8}{10} \times 5 \times 10$

$= 40\,N$

QUESTION

A force $\vec{F} = \hat{i} + 4\hat{j}$ acts on the block shown. The force of friction acting on the block is



1. $-\hat{i}$
2. $-18\hat{i}$
3. $-2.4\hat{i}$
4. $-3\hat{i}$

ANGLE OF FRICTION

Angle between normal reaction and contact force when object is just about to move on horizontal surface.

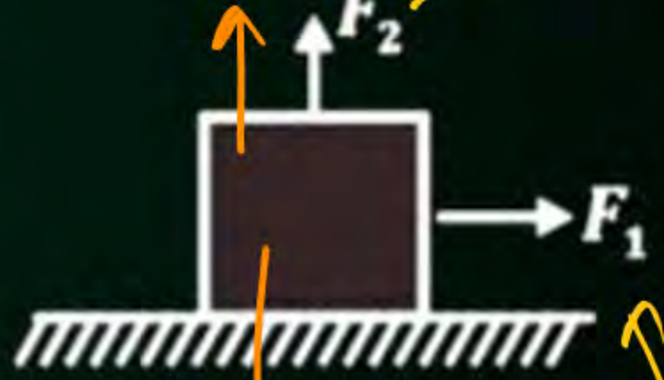
$\tan\theta = \mu$

$\theta = \tan^{-1}(\mu)$

QUESTION

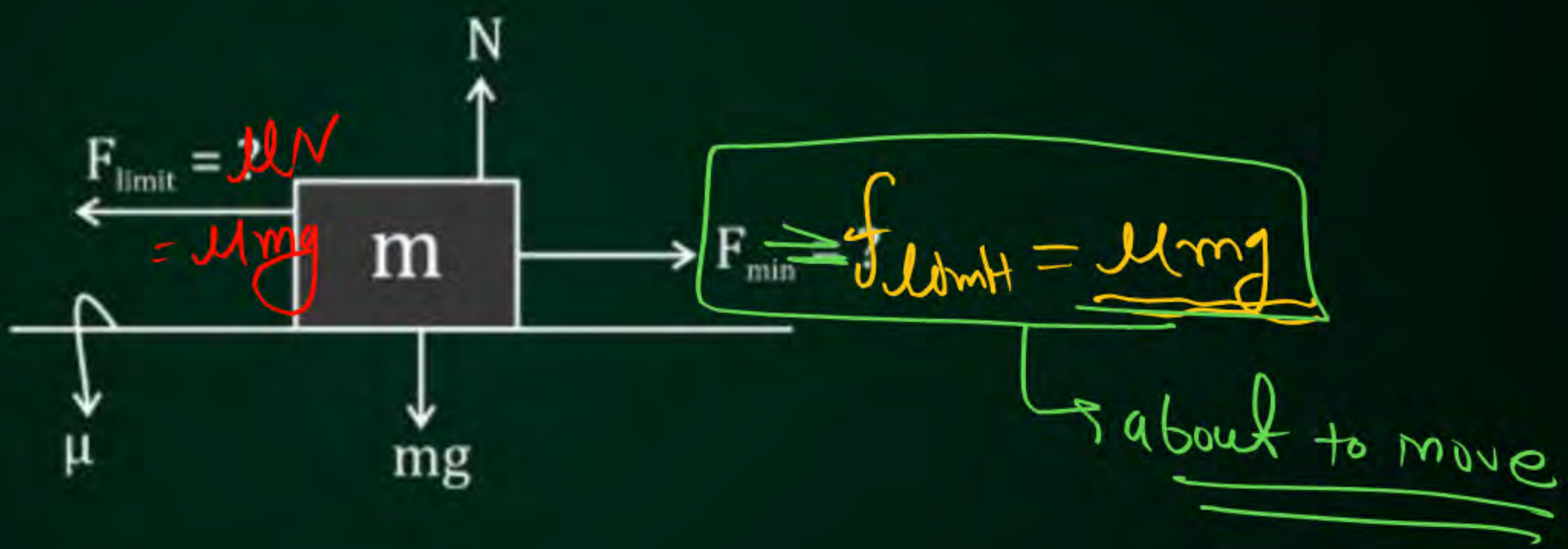
In the figure shown, horizontal force F1 is applied on a block but the block does not slide. Then as the magnitude of vertical force F2 is increased from zero the block begins to slide; the correct statement is

1. The magnitude of normal reaction on block increases
2. Static frictional force acting on the block increases
3. Maximum value of static frictional force decreases
4. All of these

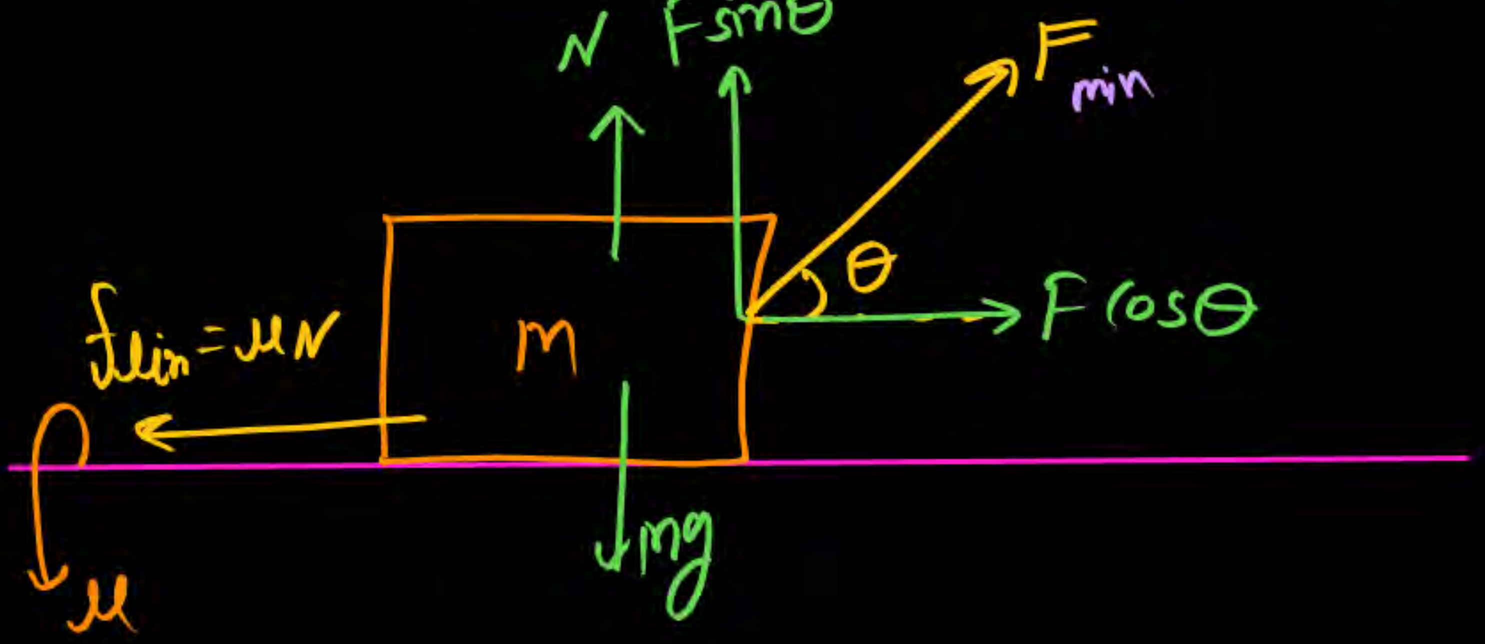


QUESTION

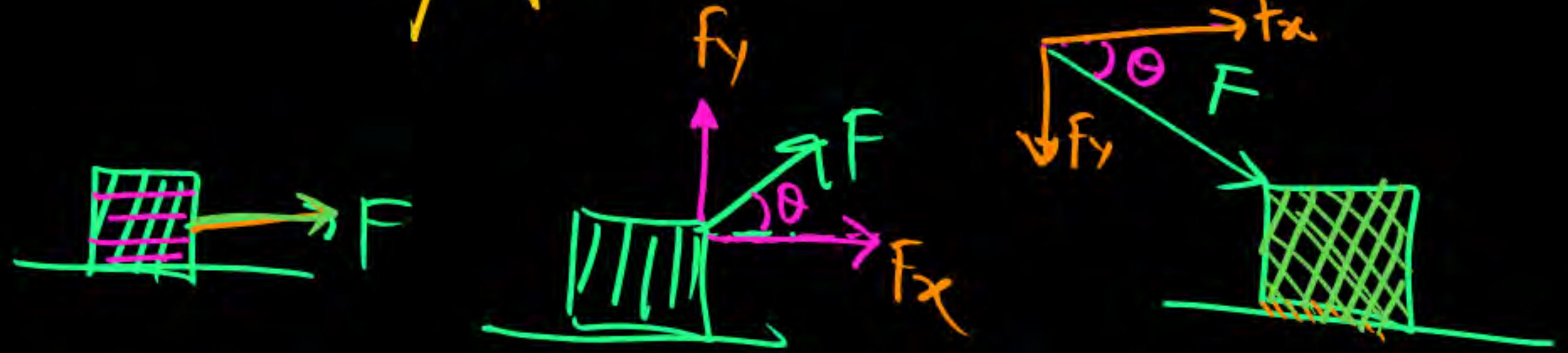
Find minimum force required to move this object on rough surface.



Minimum force requiries to move the object on rough Horizontal surface.



$F_{min} = \mu mg$ (crossed out)



$\Sigma F_y = 0$

$N + F\sin\theta = mg$

$$N = mg - F\sin\theta \quad (1)$$

$\Sigma F_x = 0$ (about to move)

$f_{lo} = \mu N = F\cos\theta$

$\mu(mg - F\sin\theta) = F\cos\theta$

$\mu mg - \mu F\sin\theta = F\cos\theta$

$\mu F\sin\theta + F\cos\theta = \mu mg$

$$F_{min} = \frac{\mu mg}{[\mu\sin\theta + \cos\theta]_{max}}$$ — $y(\mu)$

$y = \mu\sin\theta + \cos\theta$

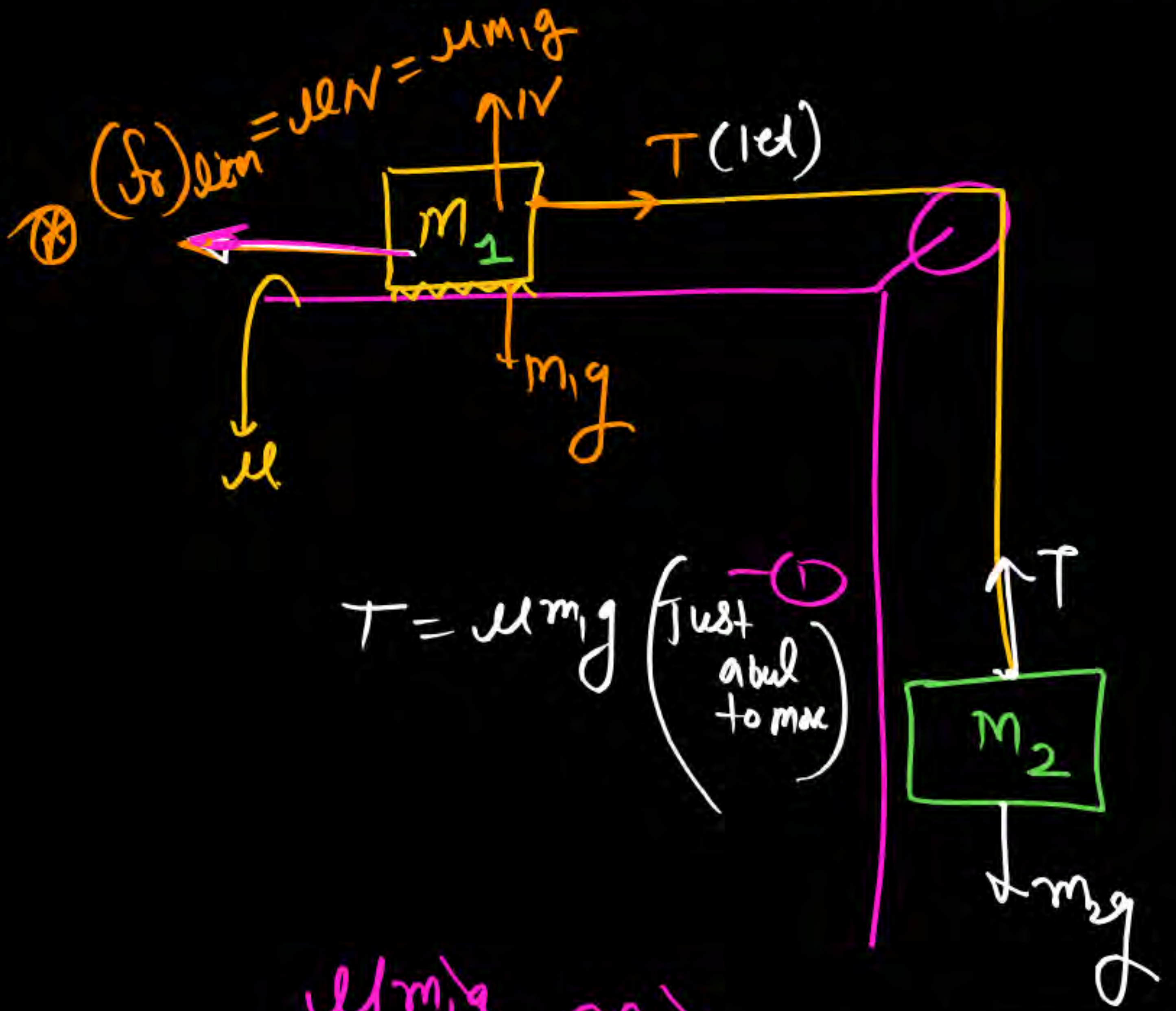
$y_{max} = \sqrt{\mu^2 + 1^2}$

$y_{max} = \sqrt{\mu^2 + 1}$

$$F_{min} = \frac{\mu mg}{\sqrt{\mu^2 + 1}}$$

↓ MR Ratte

Rel^n b/w m_1 & m_2 so that they will move ??



Just about to move

$T = \mu m_1 g$ (Just about to move) —(I)

$T = m_2 g$ (II)

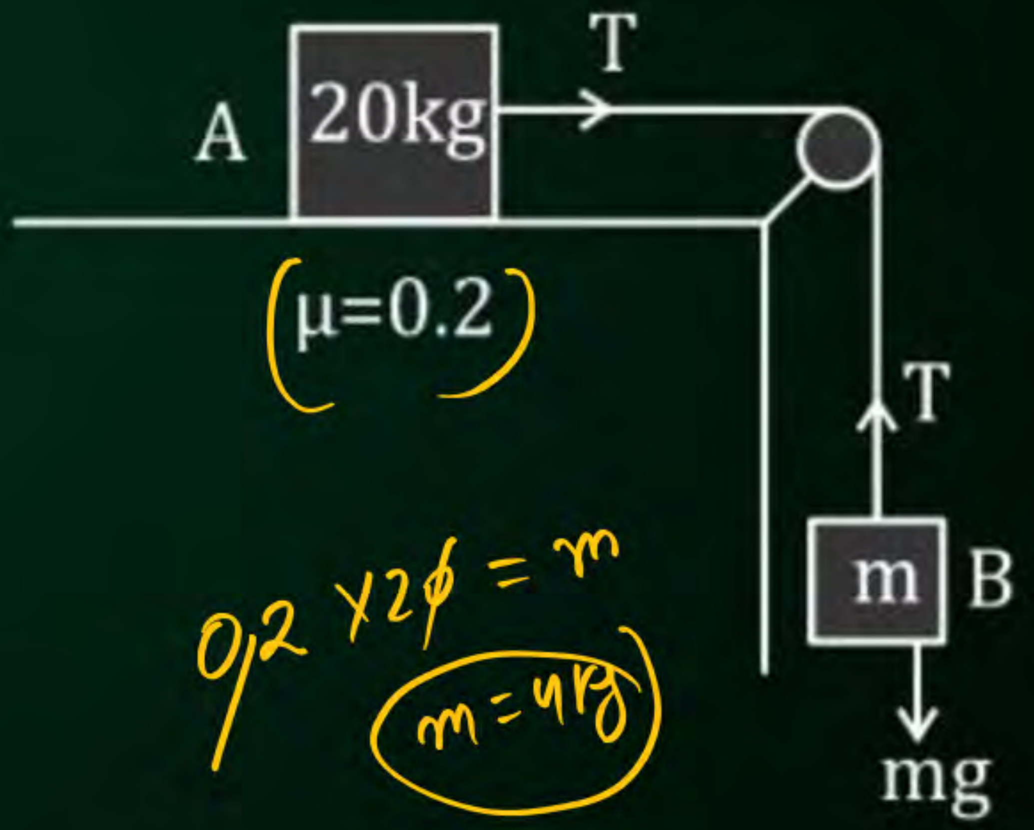
$\mu m_1 g = m_2 g$

μ (table ka mass) = लटका हुआ mass ✓

QUESTION

In the figure shown, the coefficient of static friction between the block A of mass 20 kg and horizontal table is 0.2. What should be the minimum mass of hanging block just beyond which blocks start moving?

1. 2 kg
2. 3 kg
3. 4 kg
4. 5 kg

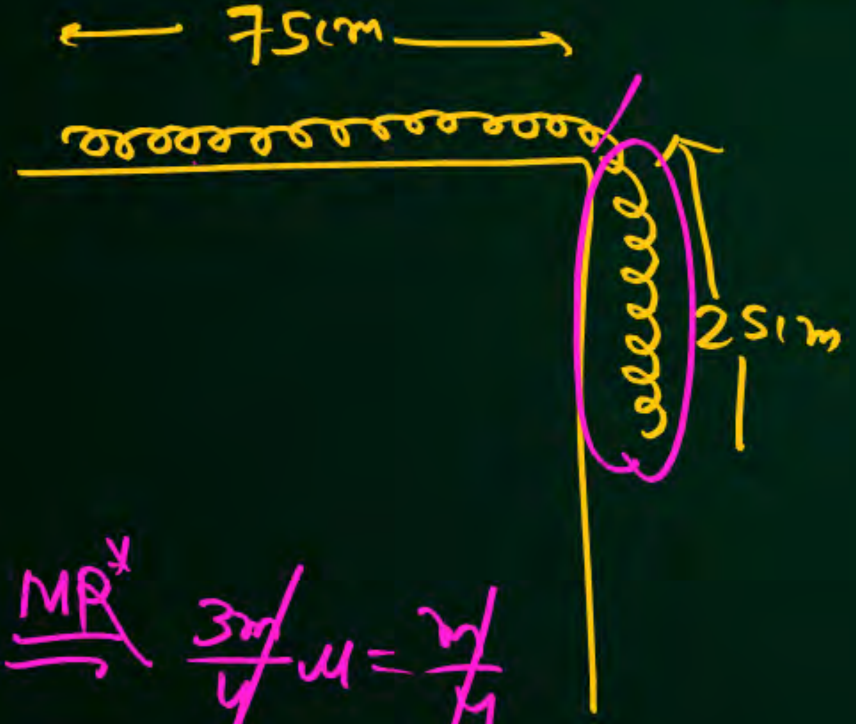


QUESTION

A metallic chain 1 long lies on a horizontal surface of a table. The chain starts sliding on the table if 25 cm (or more of it) hangs over the edge of a table. The correct value of the coefficient of friction between the table and the chain is

1m length ka mass m kg (let)

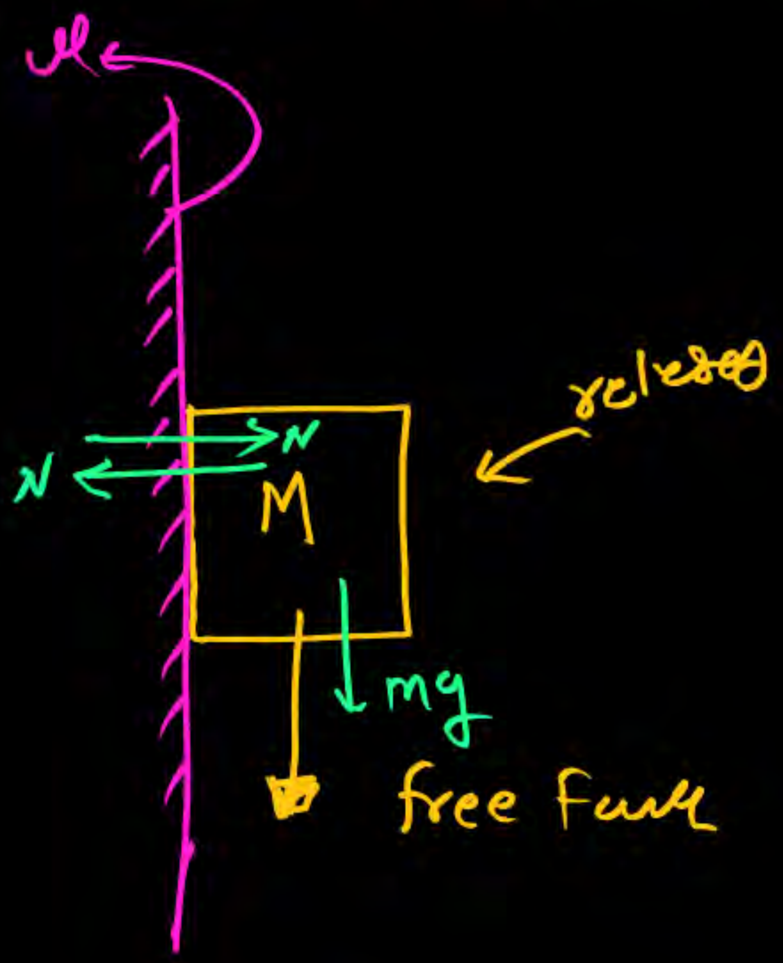
1. $\frac{1}{3}$
2. $\frac{2}{3}$
3. $\frac{1}{4}$
4. $\frac{1}{5}$



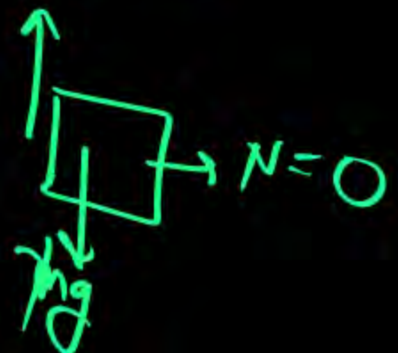
MR: $\frac{3m}{4}\mu = \frac{m}{4}$

$\mu = \frac{1}{3}$

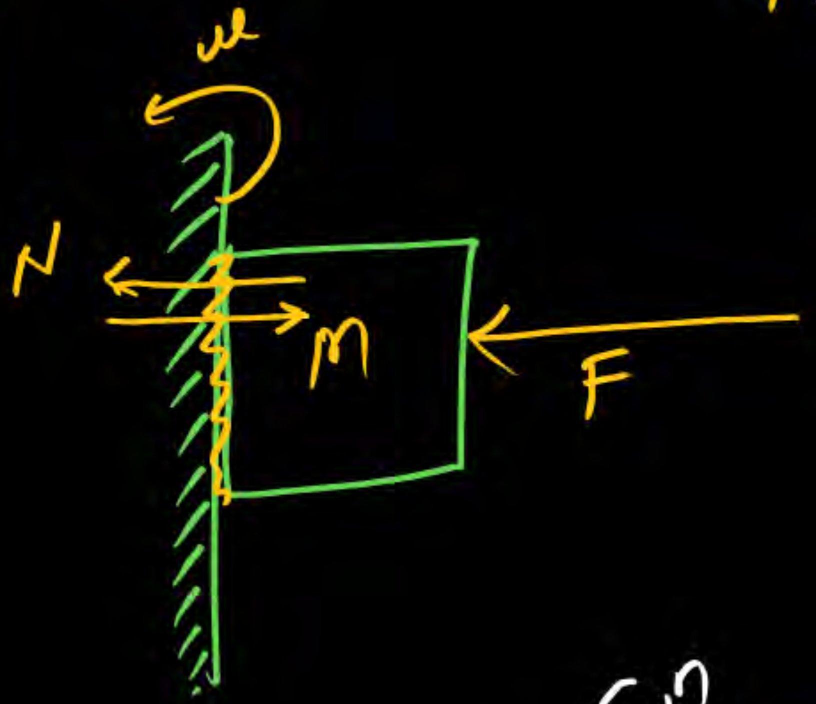
friction on vertical surface



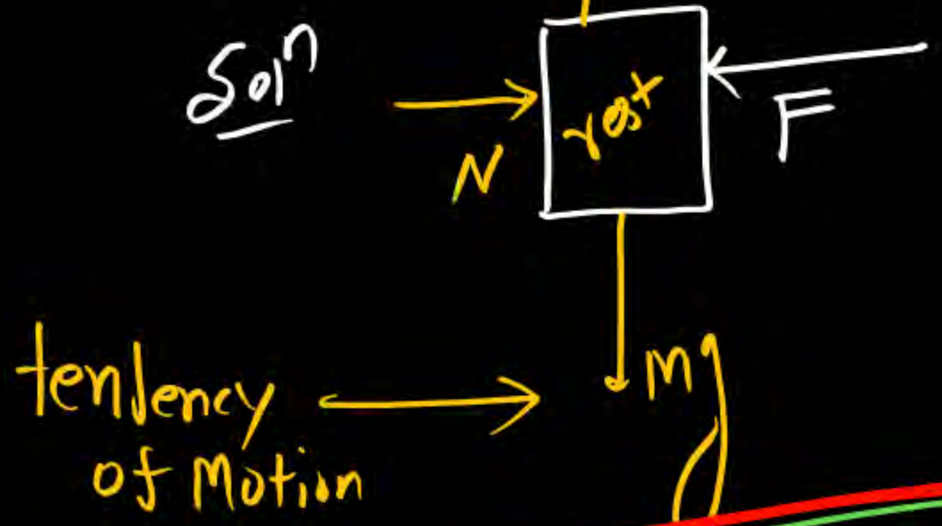
find friction acting on object. $f_r = \mu N = 0$



$\boxed{a = g}$ $\quad ma = mg$



find friction force acting on object. If object is at rest



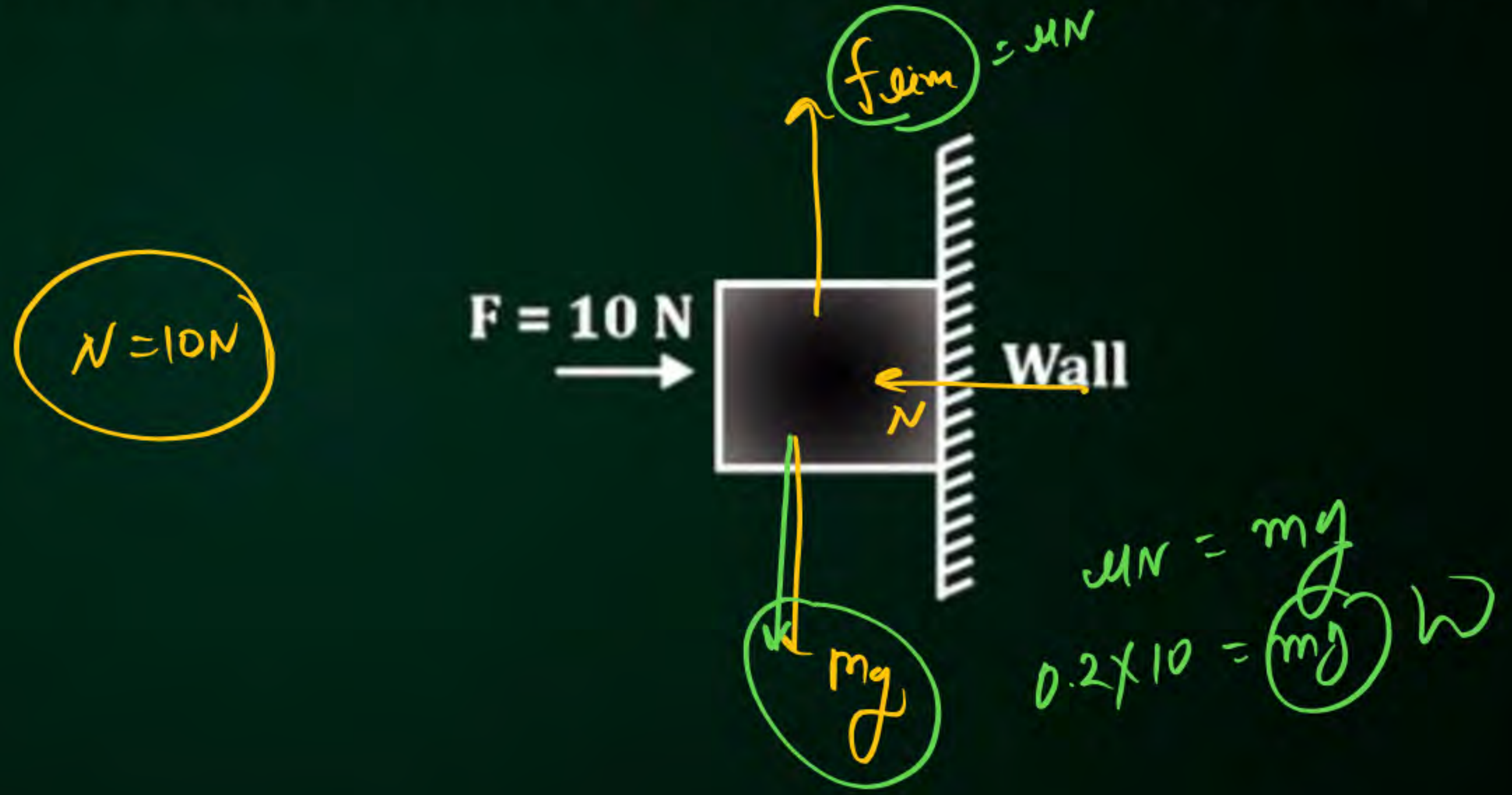
$(f_r)_{static} = mg$ Ans

$$f_{limit} = \mu N$$
$$\text{friction} = \mu F$$

QUESTION

A horizontal force 10 N is necessary to just hold a block stationary against a wall. The coefficient of friction between the block and the wall is 0.2, the weight of the block is

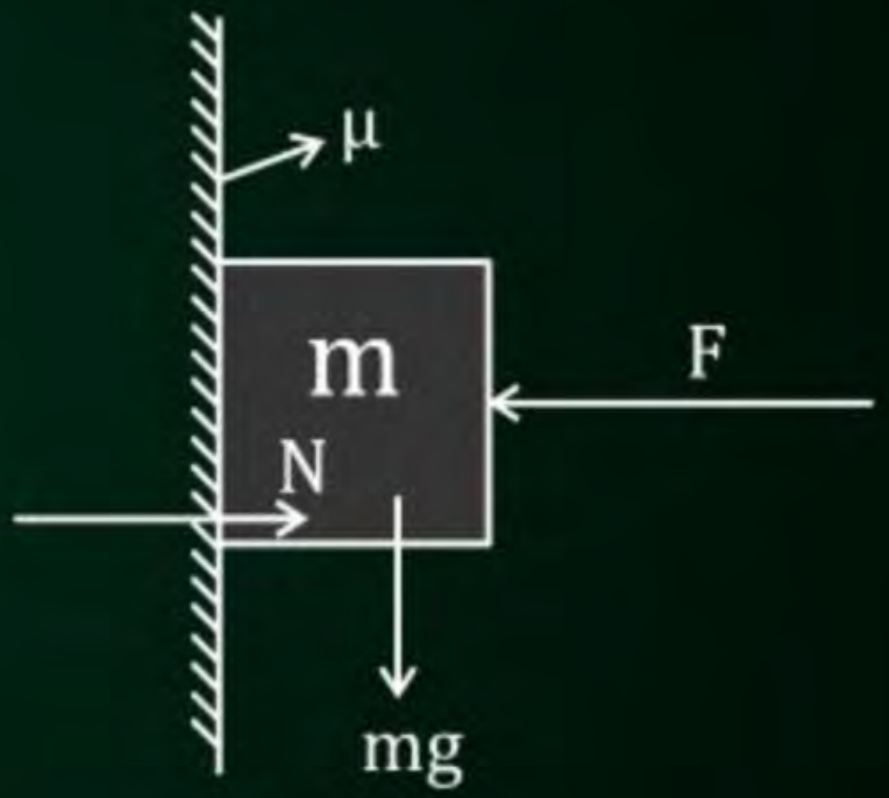
1. 20 N
2. 50 N
3. 100 N
4. 2 N



QUESTION

If object is at rest then find friction force acting on object.

1. μmg
2. μF
3. mg
4. Can't say



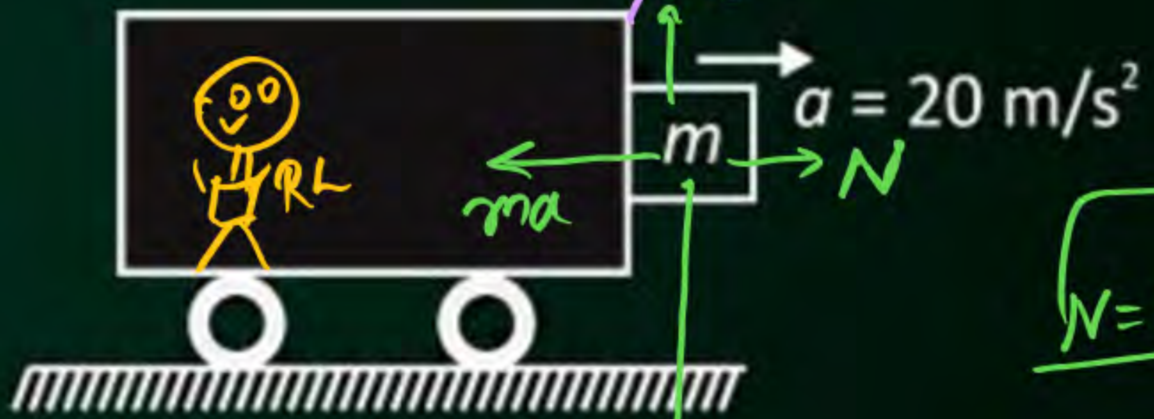
QUESTION

A child weighing 25 kg slides down a rope hanging from a branch of a tall tree. If the force of friction acting against him is 200 N, the acceleration of child is ($g = 10\ m/s^2$)

1. $22.5\ m/s^2$
2. $8\ m/s^2$
3. $5\ m/s^2$
4. $2\ m/s^2$

QUESTION

A vehicle is moving on a road with an acceleration $a = 20\ \text{m/s}^2$ as shown in figure. The frictional coefficient between the block of mass (m) and the vehicle so that block is does not fall downwards is $(g = 10\ \text{m/s}^2)$

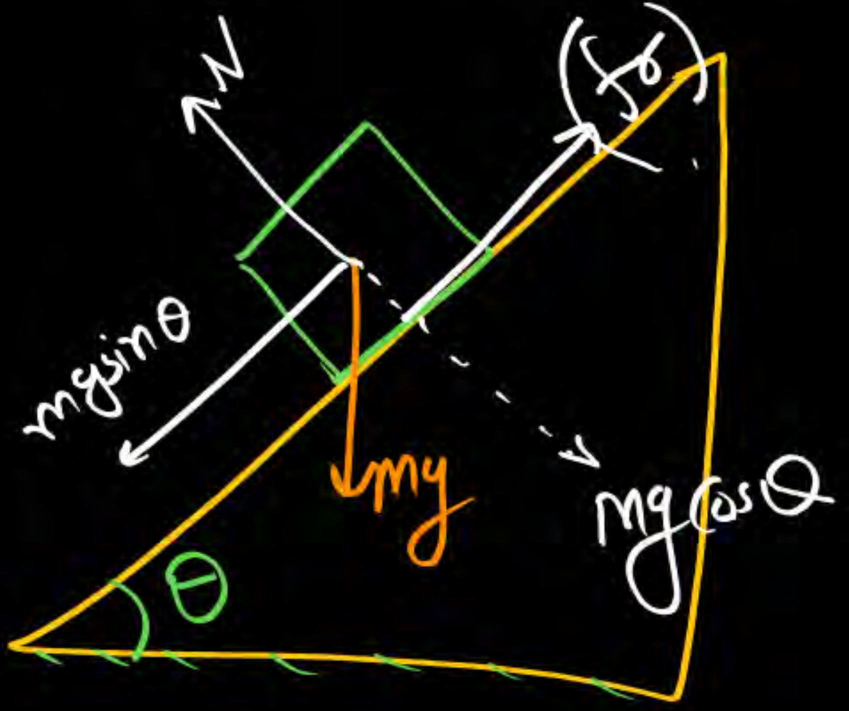


1. 0.5
2. 0.4
3. 2
4. 0.7

Friction on Inclined Plane

If $\theta \uparrow$ then

tendency of motion $= (mg\sin\theta)\uparrow$



$N = mg\cos\theta$

If $\theta\uparrow$ then $(\cos\theta)\downarrow$ hence Normal will decrease

$\downarrow \left(f_{limiting}\ \text{अधिकतम}\right) = \mu N = \mu mg\cos\theta$

Just about to slide

$mg\sin\theta = f_{lim}$

$mg\sin\theta = \mu mg\cos\theta$

$\sin\theta = \mu\cos\theta$

$\tan\theta = \mu$

Angle of repose

Angle at which object is just about to slide.

If $mg\sin\theta < f_{lim}$

object will not move

$\tan\theta < \mu$

छोटा बड़ा

$(f)_{static} = F_{applied} = mg\sin\theta$

If $\tan\theta > \mu$

move


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 11 | Physics

Newton's Law of Motion



By- Dr. Manish Raj (MR SIR)

Todays Goal

- Question on friction
- friction on Inclined Plane



Comments

Top Newest

@Rumaisa-wb3vi • 5 hr ago

Meine pehle hostel mein thi Delhi mein bache literally aise padhte h ki aap usse zyada padh hi nai sakte matla 101% utilisation of time no phone no family

7

1 reply

@UtkarshSharma-je7yq • 8 hr ago

Mai Jo Allen me hu phir bhi MR sir se padhta hu .
It's 100000% true ....bache bhut bhut bhut jyada mehnat karte h . 😢

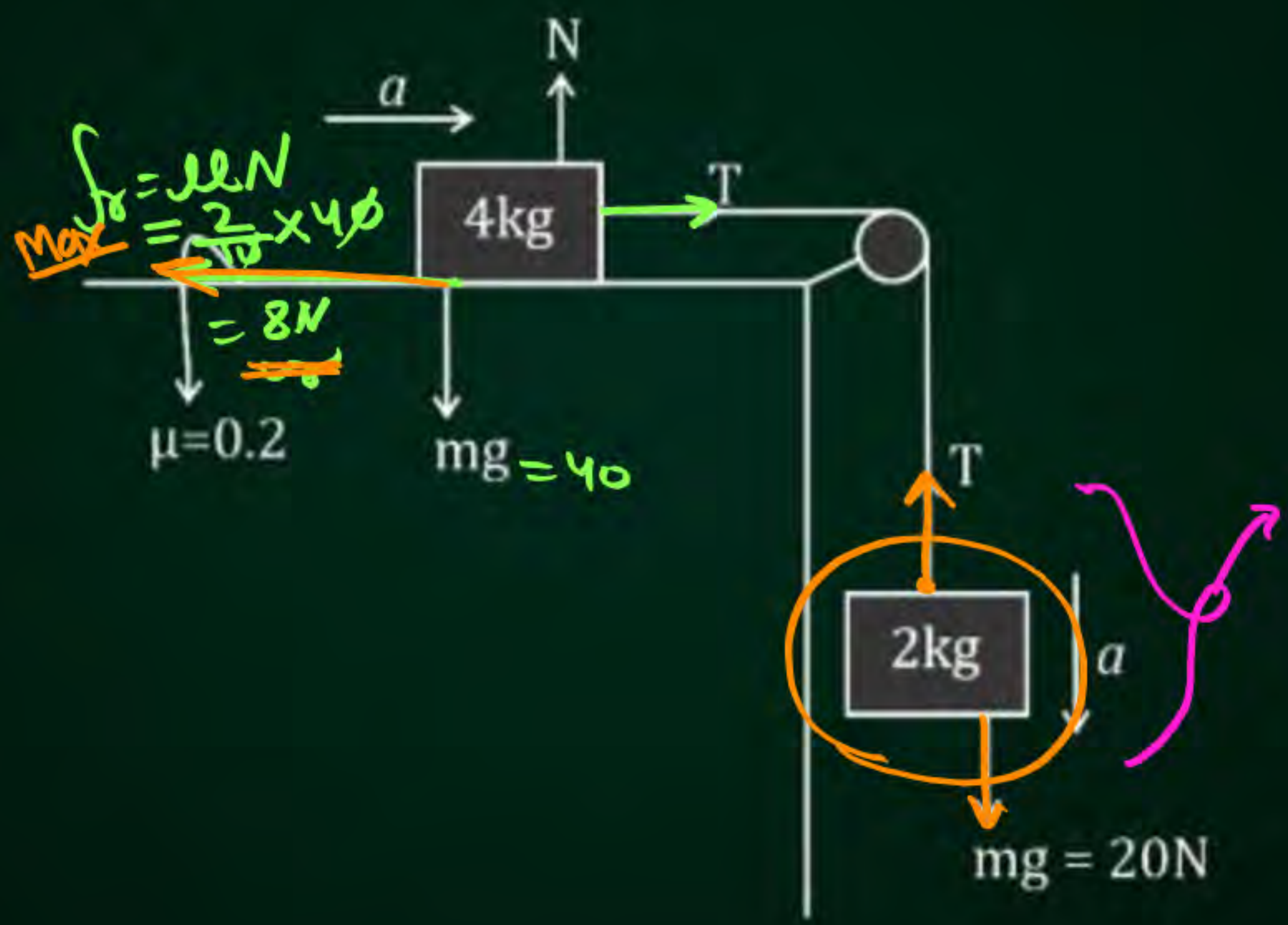
15

@SamriddhiDutta-oc7wi • 9 hr ago

QUESTION

Find friction, tension and acceleration of system

8N 16N $2 m/s^2$



$20 - T = 2a$ — (i)

$T - 8 = 4a$ — (ii)

$12 = 6a$

$a = 2 m/s^2$

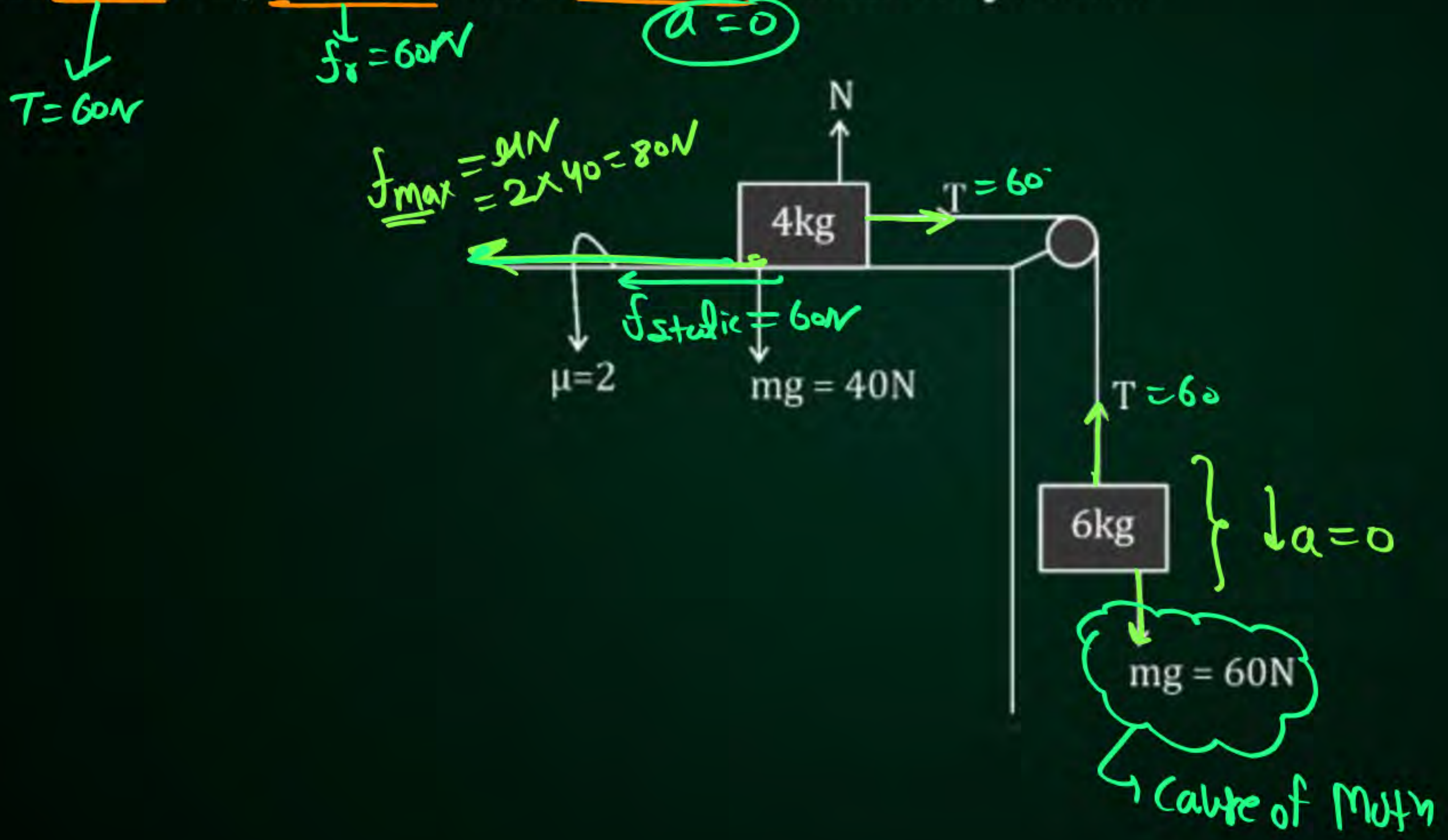
Put the value of 'a' in eq (i)

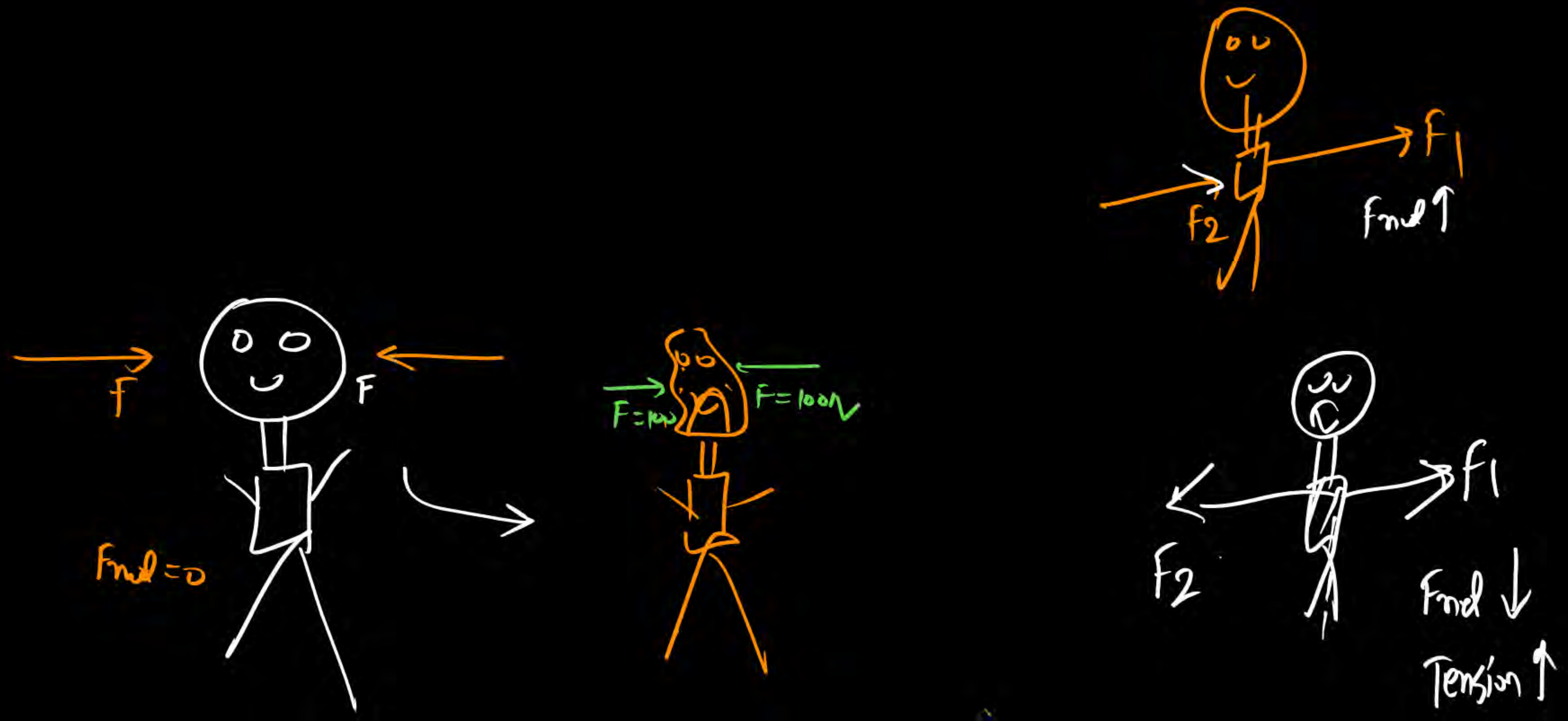
$20 - T = 2 \times 2$

$T = 20 - 4 = 16N$

QUESTION

Find tension, friction and acceleration of system.

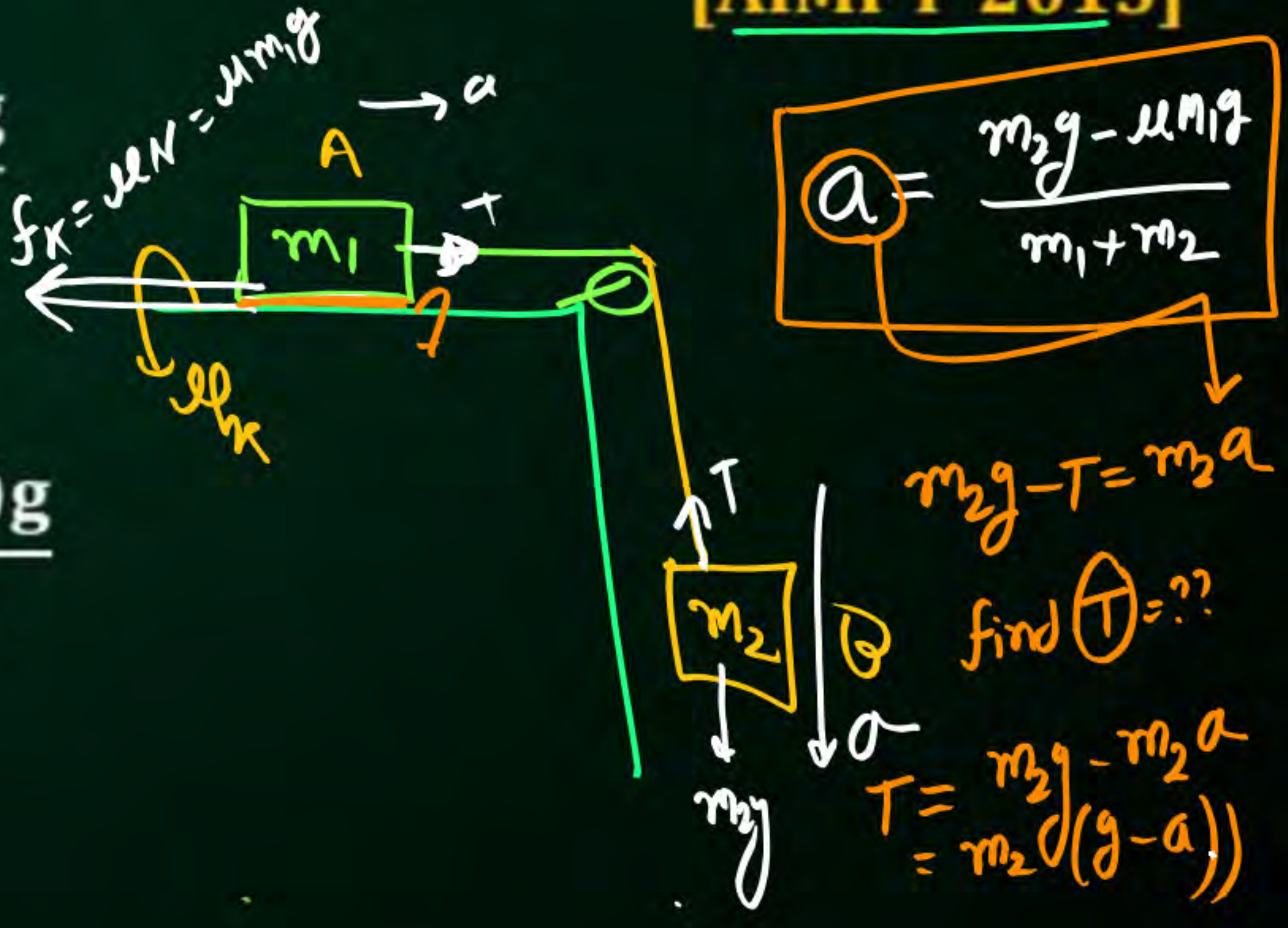



F
F
Fnet = 0
F=100N
F=100N
F1
F2
Fnet ↑
F1
F2
Fnet ↓
Tension ↑

QUESTION

A block A of mass m_1 rests on a horizontal table. A light string connected to it passes over a frictionless pulley at the edge of table and from its other end another block B of mass m_2 is suspended. The coefficient of kinetic friction between the block and the table is μ_k. When the block A is sliding on the table, the tension in the string is **[AIMPT-2015]**

1. $\dfrac{(m_2 + \mu_k m_1)g}{(m1 + m2)}$
2. $\dfrac{(m_2 - \mu_k m_1)g}{(m1 + m2)}$
3. $\dfrac{m_1 m_2 (1 + \mu_k)g}{(m1 + m2)}$
4. $\dfrac{m_1 m_2 (1 - \mu_k)g}{(m1 + m2)}$



QUESTION

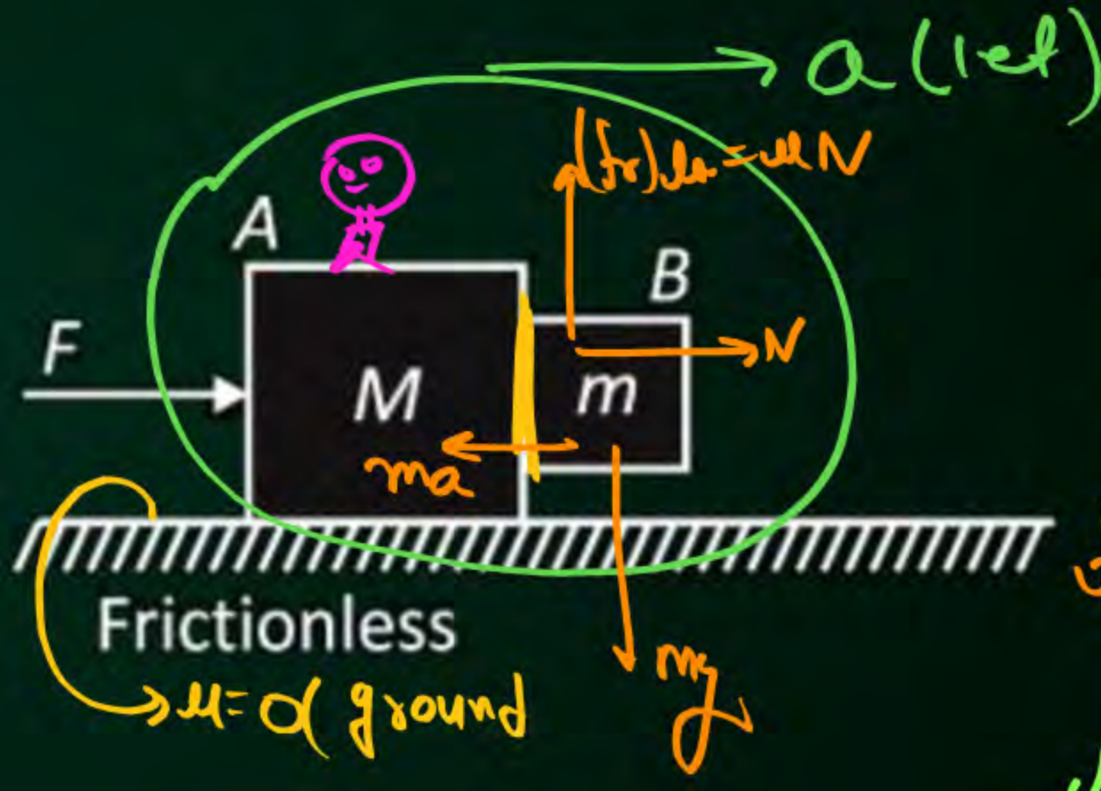
Coefficient of friction between A and B is μ. The minimum force F with which A will be pushed such that B will not slip down is

(1) $\dfrac{Mg}{\mu}$

(2) $\dfrac{mg}{\mu}$

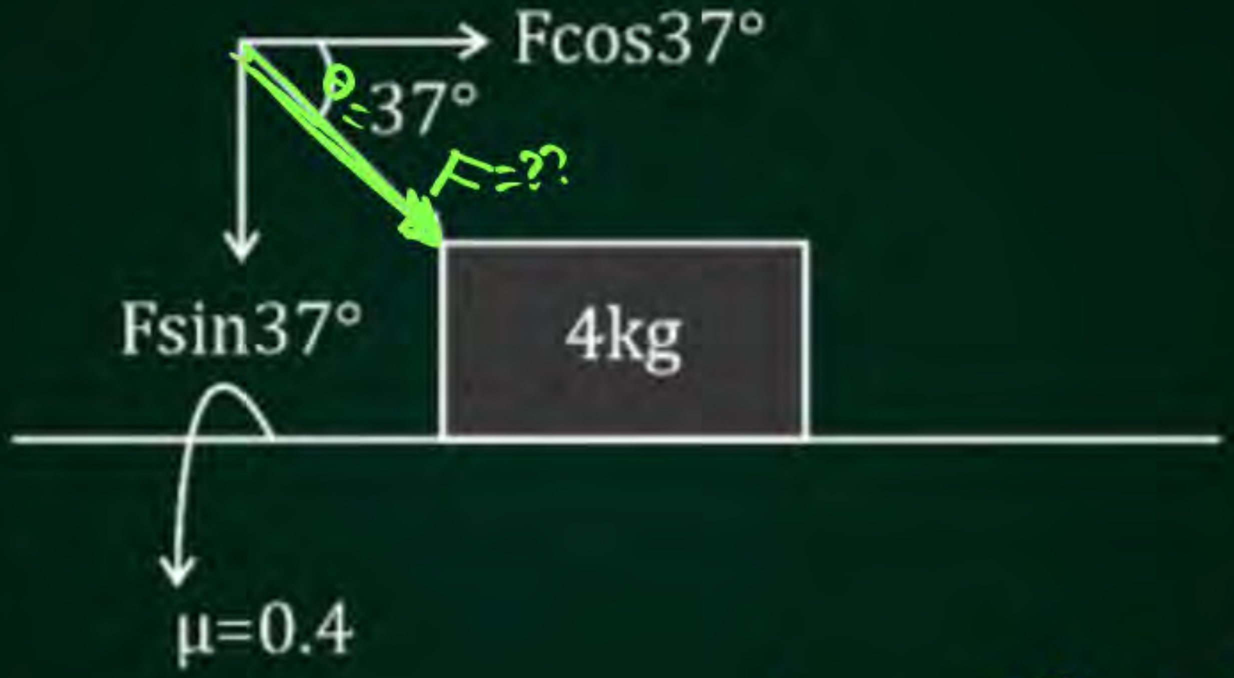
(3) $\dfrac{(M+m)g}{\mu}$

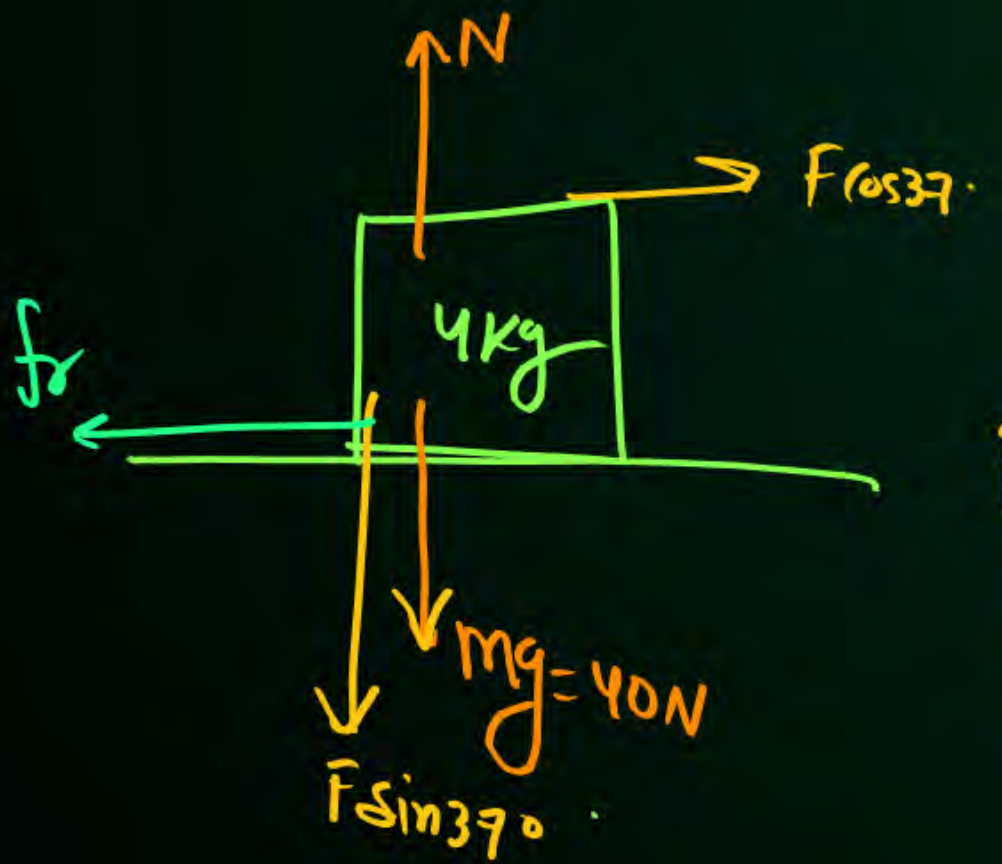
(4) $\dfrac{(M-m)g}{\mu}$



QUESTION

Find value of F so that object can move.





$F_y = 0$

$N = mg + F\sin 37^\circ$

$N = 40 + F \times \frac{3}{5}$ — (1)

$\Sigma F_x = 0$ (Just about to move)

$\rightarrow F\cos 37^\circ = f_{lim} = \mu N$

$F\frac{4}{5} = 0.4\left[40 + \frac{3F}{5}\right]$

$\frac{4F}{5} = 16 + \frac{12F}{50}$

$\frac{4F}{5} - \frac{12F}{50} = 16$

$\frac{40F - 12F}{50} = 16$

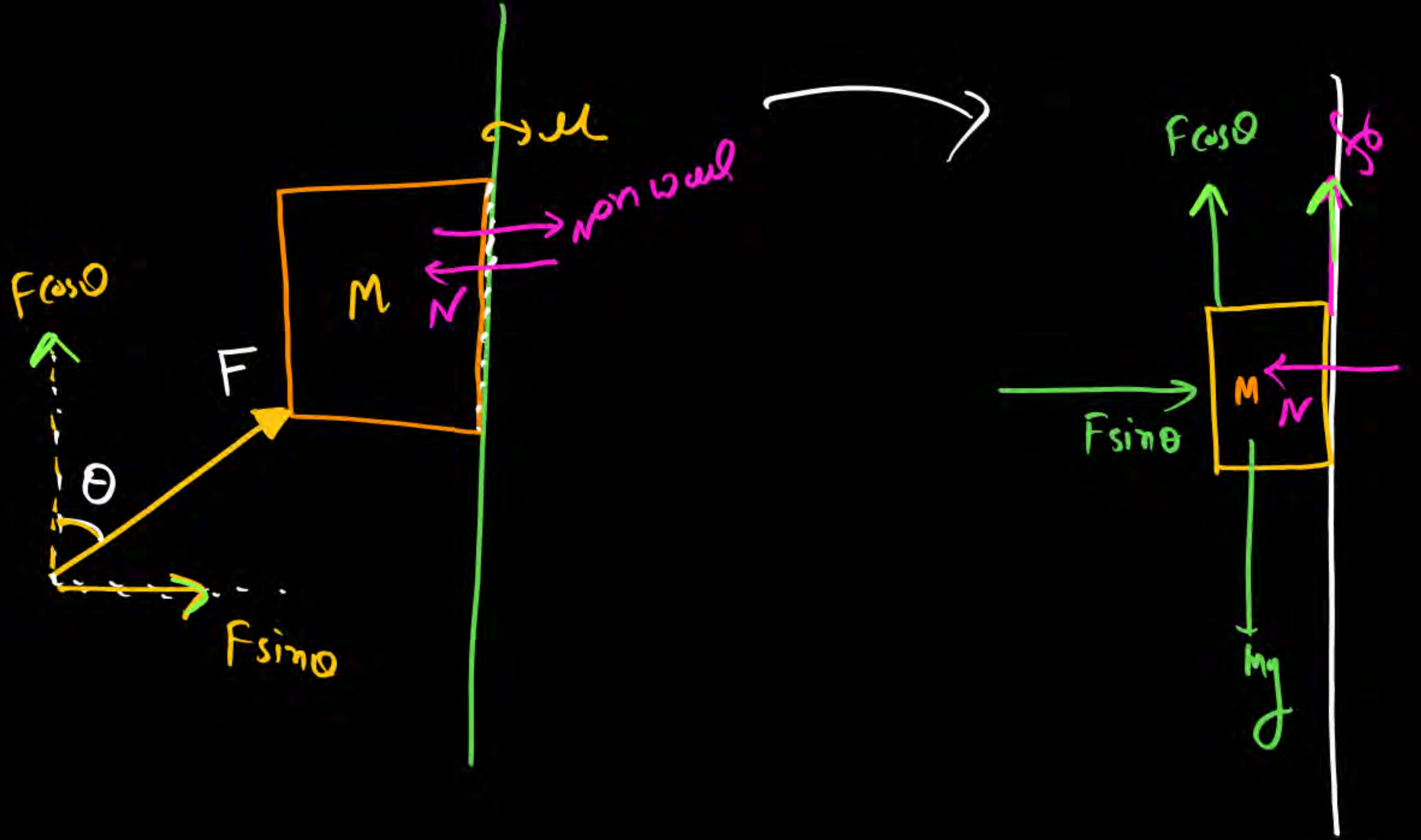
$28F = 16 \times 5$

$F =$

$$F = \frac{\overset{4}{\cancel{16}} \times 50}{\underset{7}{\cancel{28}}}$$

$$F = \frac{200}{7}$$

Find minimum value of F to keep the object at rest.



$\Sigma F_x = 0$

$N = F\sin\theta \quad \text{— (i)}$

$F_y = 0$

$mg = F\cos\theta + (f_s)_{lim}$

$mg = F\cos\theta + \mu N$

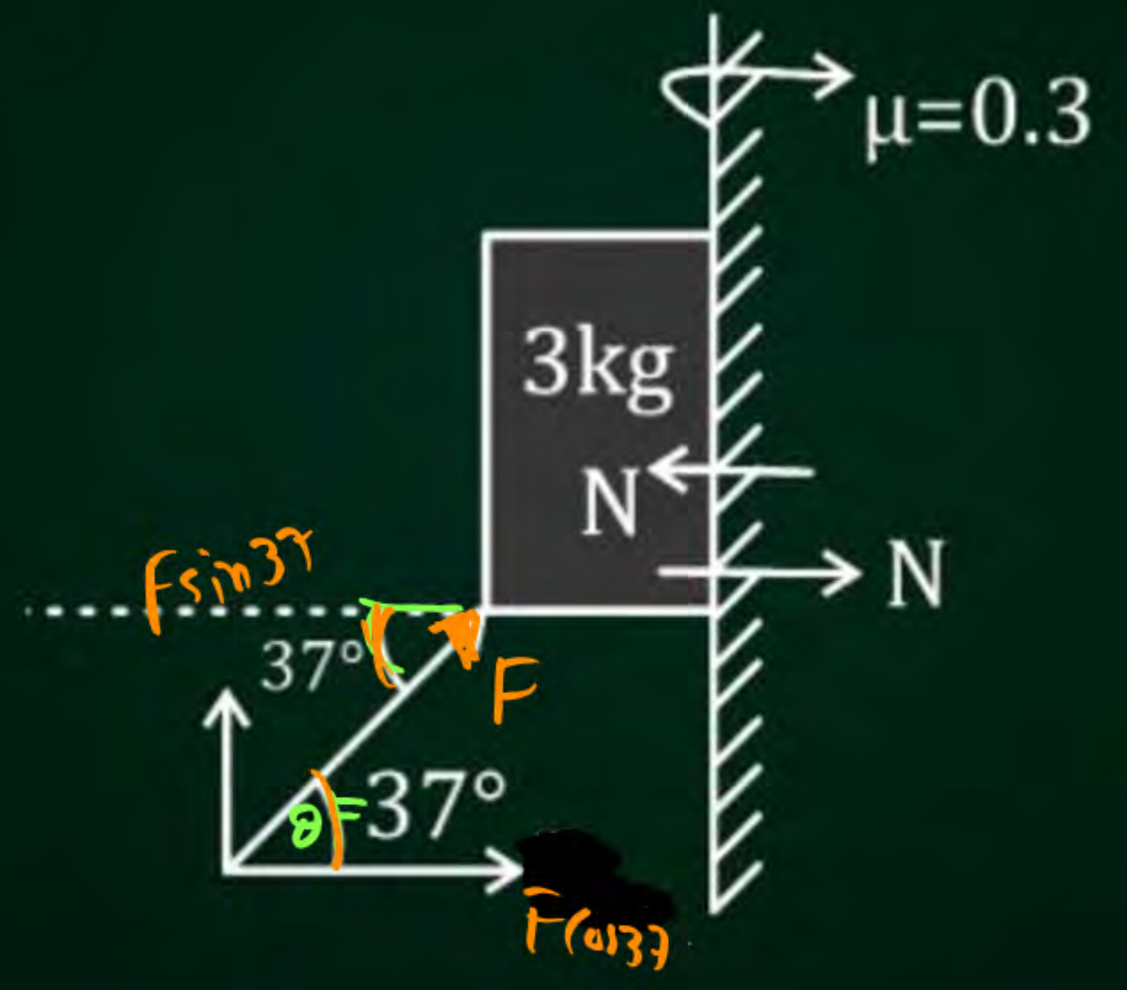
$mg = F\cos\theta + \mu F\sin\theta$

$F(\cos\theta + \mu\sin\theta) = mg$

$$F = \frac{mg}{\cos\theta + \mu\sin\theta}$$

QUESTION

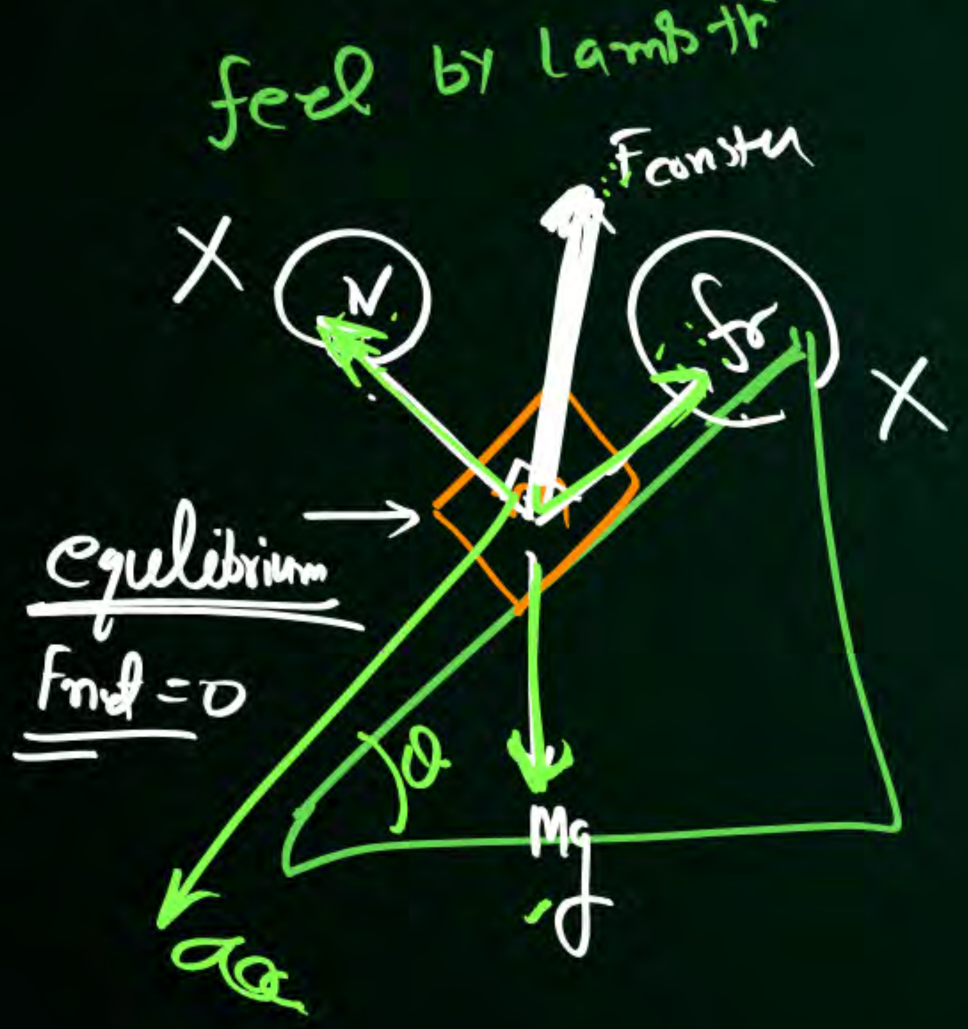
Find F_{min} so that object will at rest.



FRICTION ON INCLINED PLANE

FRICTION FORCE ON INCLINED PLANE

Angle of repose (α) : It is the maximum angle of inclination (α) of a rough inclined plane with horizontal such that the block kept on it remains at rest.



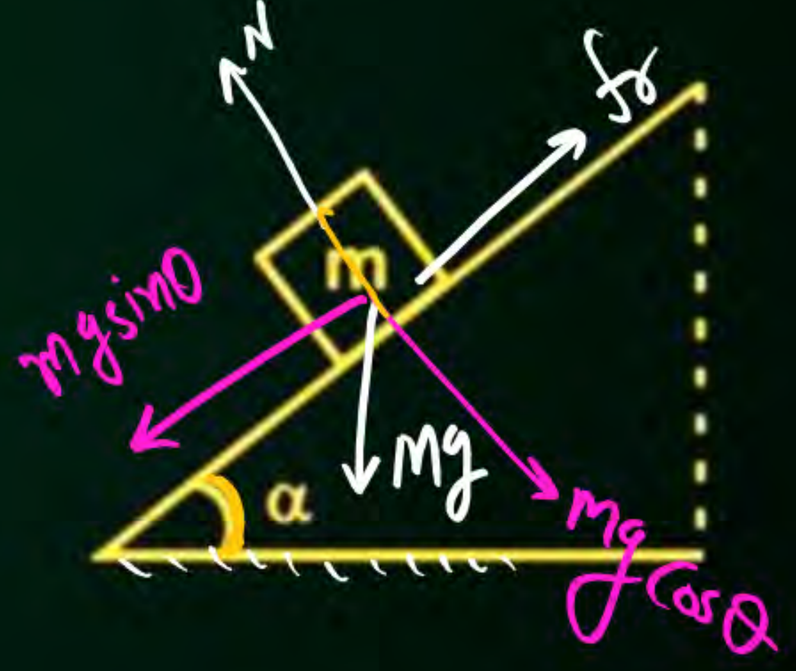
Just about to move

$$mg\sin\theta = (f_r)_{limit}$$

$$mg\sin\theta = \mu N$$

$$mg\sin\theta = \mu\, mg\cos\theta$$

$$\tan\theta = \mu$$



⊥r to Inclined Plane

$$N = mg\cos\theta \quad \text{—(1)}$$

If $\mu = \tan\theta$

→ Just about to move ($a=0$)

* $f_{friction\ limit} = mg\sin\theta = \mu mg\cos\theta$

$N = mg\cos\theta$

$\vec{F_c} = \vec{N} + \vec{fr}$

$\vec{F_c} = \sqrt{(mg\cos\theta)^2 + (mg\sin\theta)^2}$

$= mg\sqrt{\cos^2\theta + \sin^2\theta}$

$\Rightarrow F_c = mg$ ✓

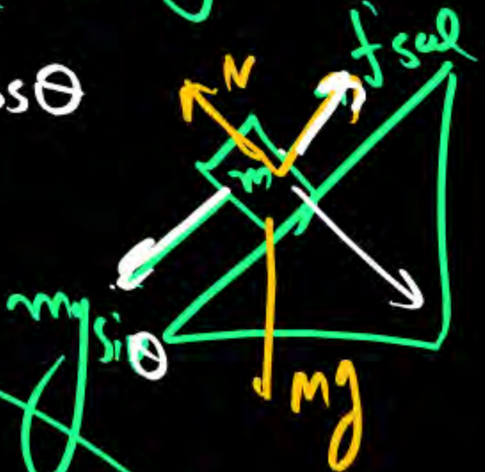
If $\mu > \tan\theta$

$f_{limit} > f_{applied}$ which is creating tendency of motion ($mg\sin\theta$)

→ Object is at rest

→ $f_{static} = mg\sin\theta$

→ $N = mg\cos\theta$

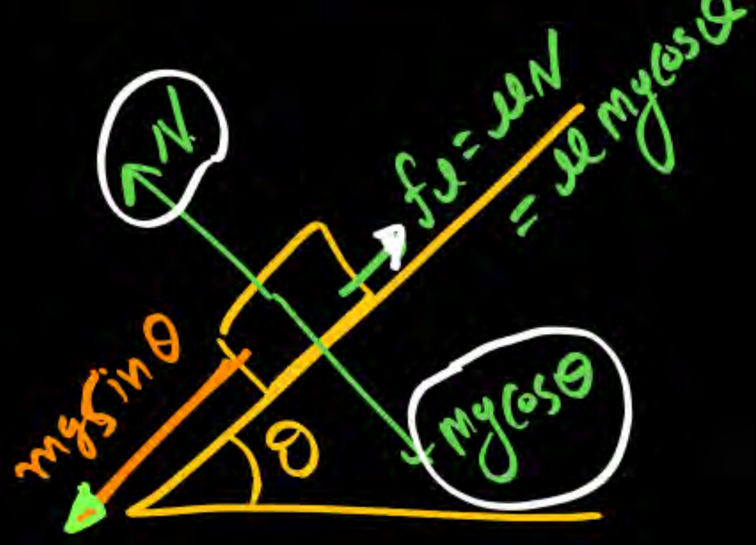


$F_{contact} = mg$ ✓

contact force

If $\mu < \tan\theta$

→ Object will move



$(F_{net})_{along\ incline} = ma$

$mg\sin\theta - \mu mg\cos\theta = ma$

$a = g\sin\theta - \mu g\cos\theta$

$|\vec{F_c}| = \sqrt{(mg\cos\theta)^2 + (\mu mg\cos\theta)^2}$

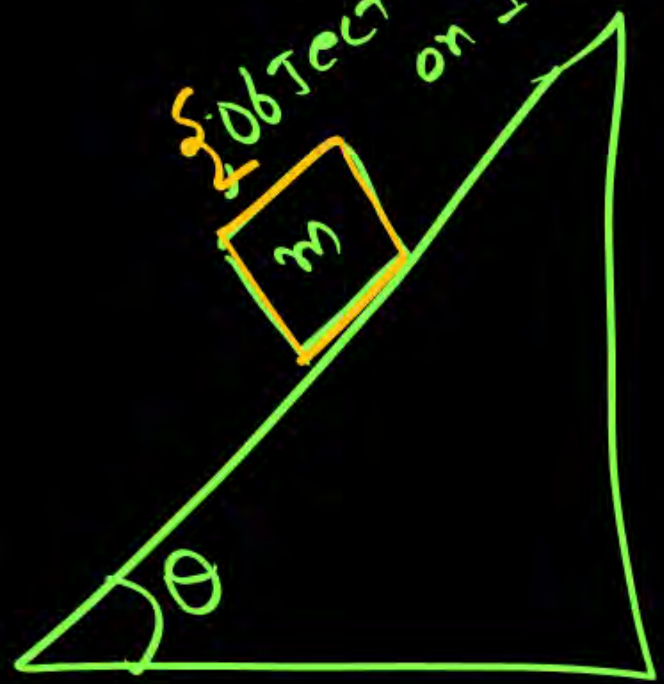
(Q) Object is placed on rough Incline Plane and angle is Increasing continously from 0° to 90° then Contact Force B/w object & Inclined Plane will be . (JEE adv)

Ans → Initially contact force will be remain consta mg

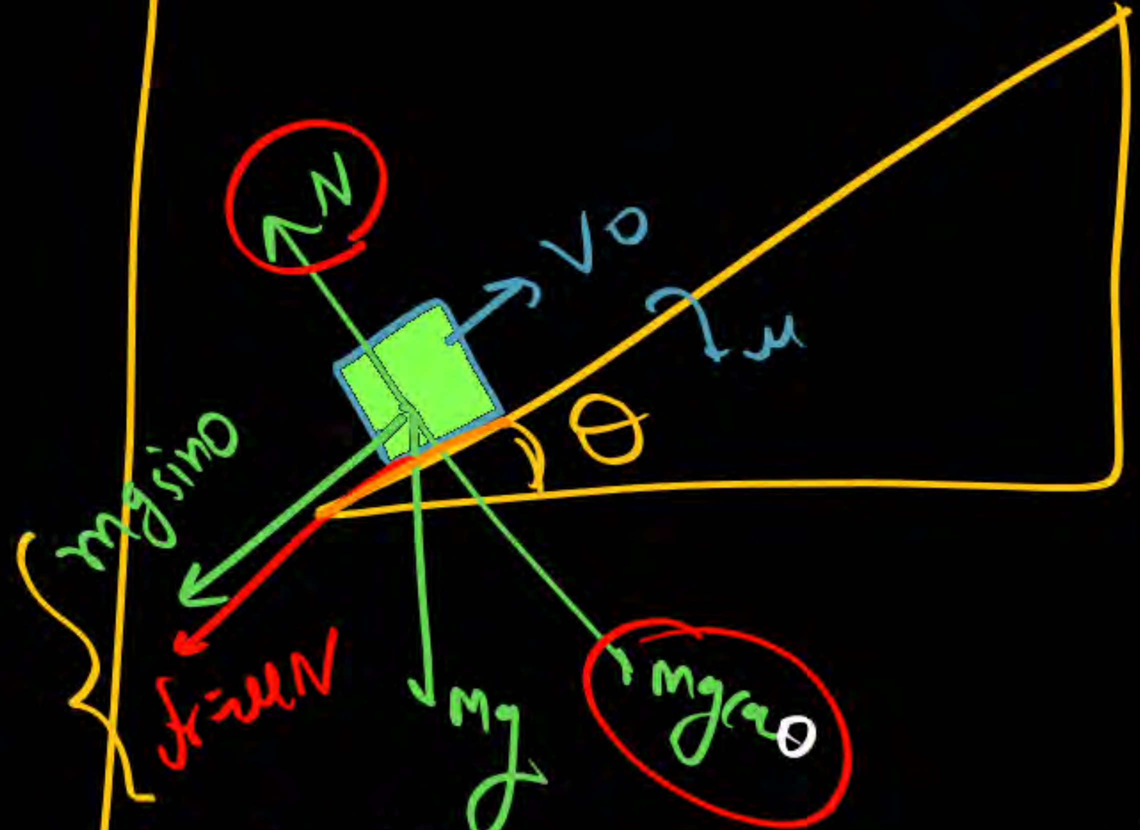
after angle of repose it will decrease ↓

$$F_C = mg\cos\theta\sqrt{1+\mu^2}$$

{Object is placed on inclined plane}



Object is thrown upward with velocity V_0 as shown

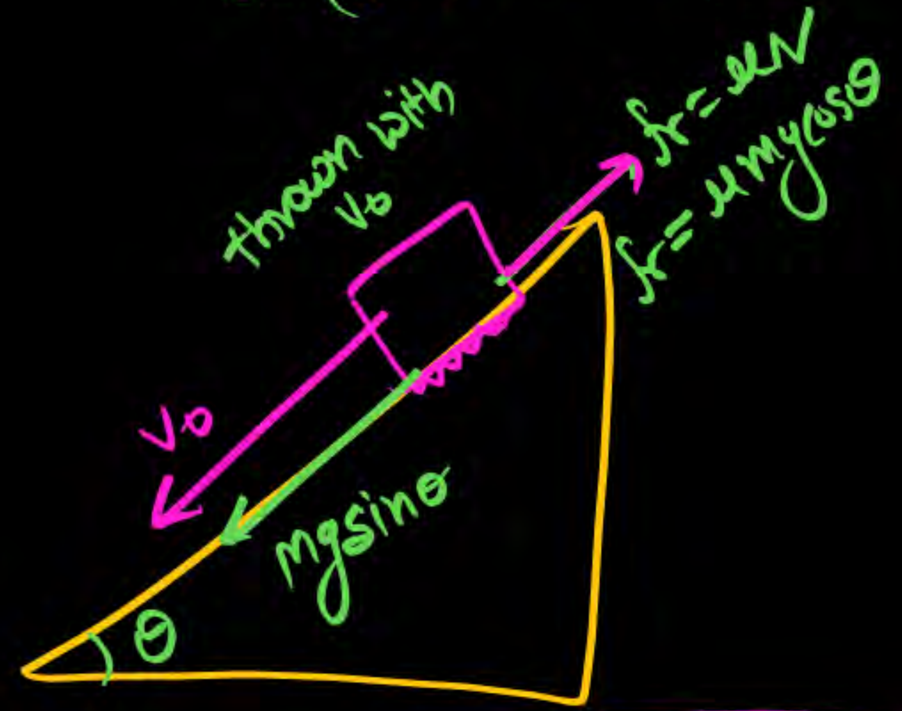


$f_r = \mu mg\cos\theta$

F_{net} along incline $= mg\sin\theta + \mu mg\cos\theta$

$a = g\sin\theta + \mu g\cos\theta$

If $(\mu > \tan\theta)$



$F_{net} = mg\sin\theta - \mu mg\cos\theta$

$ma = mg\sin\theta - \mu mg\cos\theta$

$a = g\sin\theta - \mu g\cos\theta$

QUESTION

A block of mass 1 kg is projected from the lowest point up along the inclined plane. If g = 10 ms^{-2}, the retardation experienced by the block is

1. $\frac{15}{\sqrt{2}}$ ms^{-2}
2. $\frac{5}{\sqrt{2}}$ ms^{-2}
3. $\frac{10}{\sqrt{2}}$ ms^{-2}
4. Zero



QUESTION

If a block moving up an inclined plane at 30° with a velocity of $5\ \mathrm{m/s}$, stops after $0.5\ \mathrm{s}$, then coefficient of friction will be nearly

1. 0.5
2. 0.6
3. 0.9
4. 1.1

QUESTION

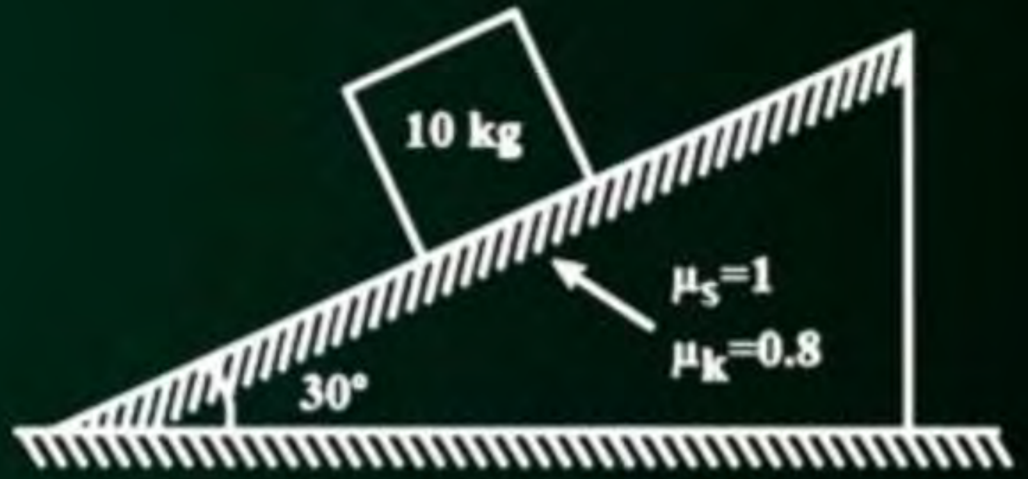
A block of mass m placed on an inclined plane of angle of inclination θ slides down the plane with constant speed. The coefficient of kinetic friction between block and inclined plane is

1. $\sin\theta$
2. $\cos\theta$
3. $\tan\theta$
4. $\tan^{-1}\theta$

QUESTION

A block of 10 kg mass is placed on a rough inclined surface as shown in figure. The acceleration of the block will be

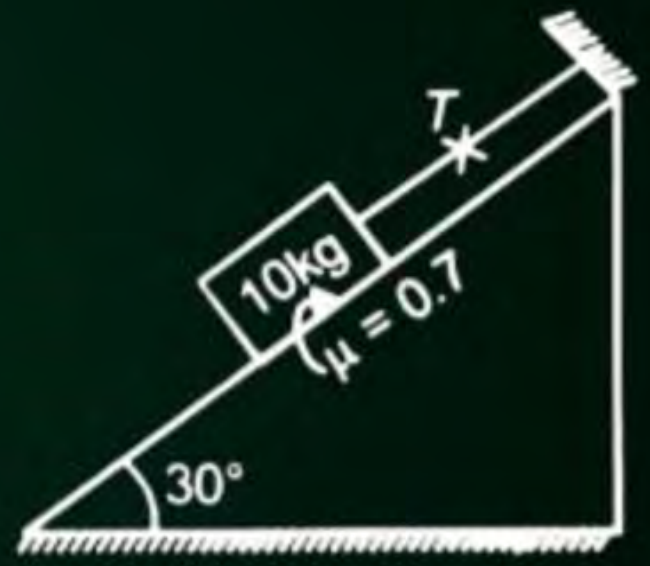
1. Zero
2. g
3. $\frac{g}{2}$
4. $\frac{\sqrt{3}g}{2}$



QUESTION

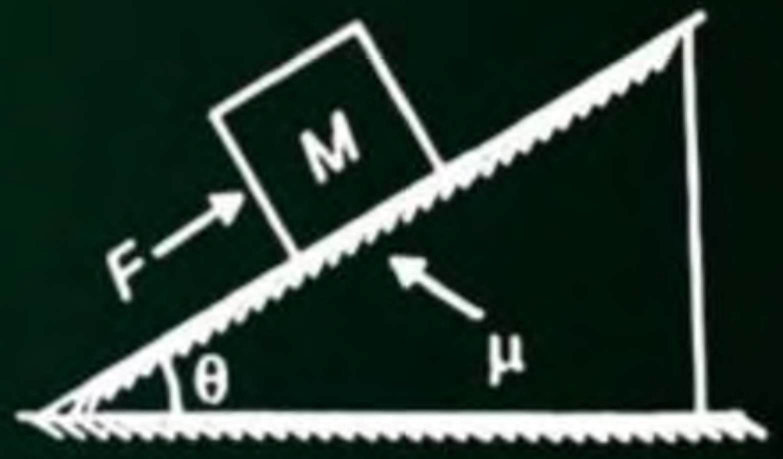
The tension T in the string shown in figure is

1. Zero
2. 50 N
3. 35V 3N
4. $(\sqrt{3}-1)50N$



QUESTION

A block (mass = M kg) is placed on a rough inclined plane. A force F is applied parallel to the inclined (as shown in figure) such that it just starts moving upward. The value of F is



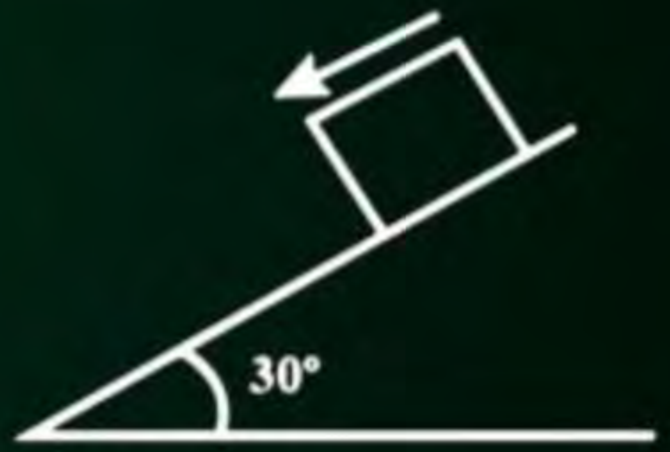
1. Mg sinθ – μ Mg cosμ
2. Mg sinθ + μMg cosθ
3. Mg sinθ
4. μ Mg cosθ

QUESTION

A block of mass 10 kg is released on rough incline plane. Block start descending with acceleration $2\ m/s^2$. Kinetic friction force acting on block is

(take $g = 10\ m/s^2$)

1. 10 N
2. 30 N
3. 50 N
4. $50\sqrt{3}$ N



QUESTION

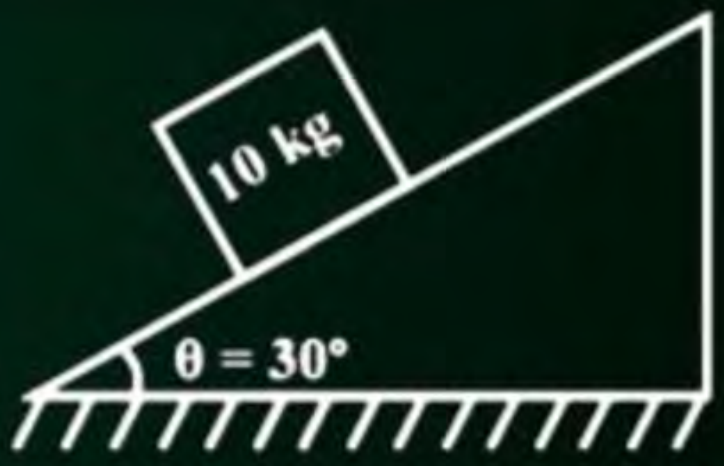
A block of mass 10 kg is kept on a fixed rough ($\mu = 0.8$) inclined plane of angle of indication 30°. The frictional force acting on the block is

(1) 50 N

(2) $50\sqrt{3}$N

(3) 52 N

(4) 54 N



QUESTION

Block of mass 10 kg is moving on inclined plane with constant velocity 10 m/s. The coefficient of kinetic friction between incline plane and block is

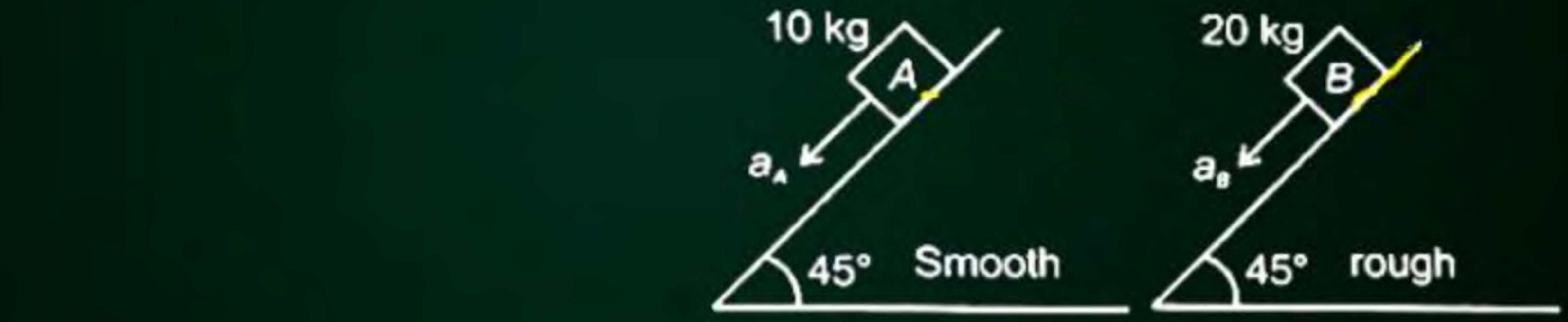
1. 0.57
2. 0.75
3. 0.5
4. None of these



QUESTION

The ratio of the acceleration of blocks A placed on smooth incline with block B placed on rough incline is 2 : 1. The coefficient of kinetic friction between block B and incline is

1. 0.5
2. 0.75
3. 0.57
4. None of these



QUESTION

The upper half of an inclined plane of inclination θ is perfectly smooth while lower half is rough. A block starting from rest at the top of the plane will again come to rest at the bottom, if the coefficient of friction between the block and lower half of the plane is given by

1. $\mu = \frac{2}{\tan\theta}$

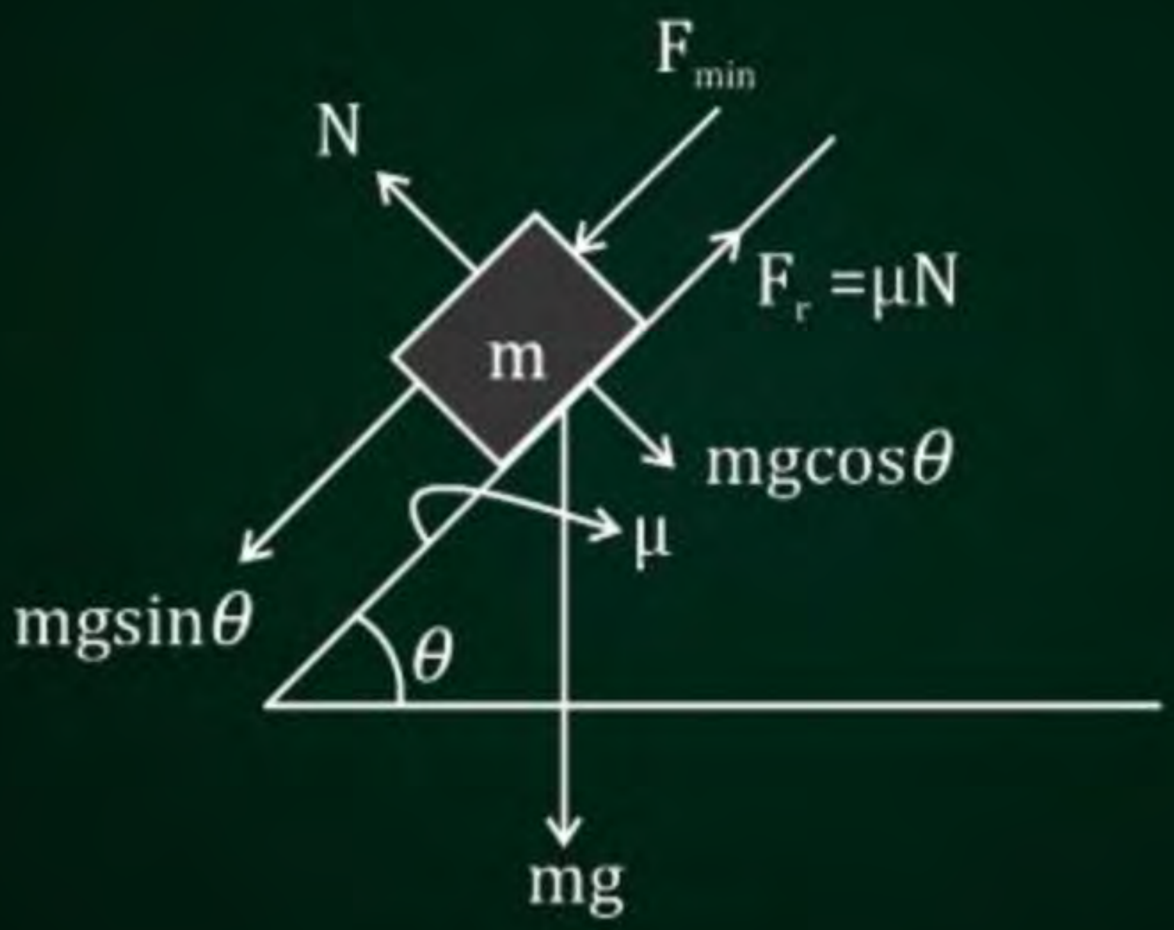
2. $\mu = 2\tan\theta$

3. $\mu = \tan\theta$

4. $\mu = \frac{1}{\tan\theta}$

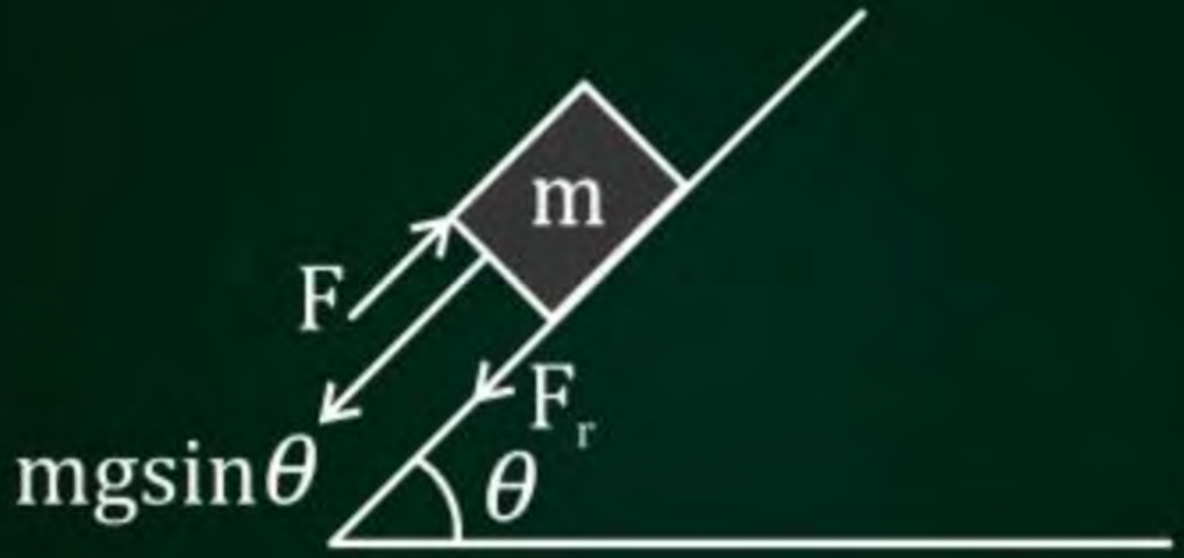
QUESTION

If $\mu > \tan\theta$, then find minimum force required to move this object.



QUESTION

If $\mu > \tan\theta$, then find minimum force required to move up to the inclined plane.




THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 12 | Physics

Laws of Motion

By- Dr. Manish Raj (MR SIR)

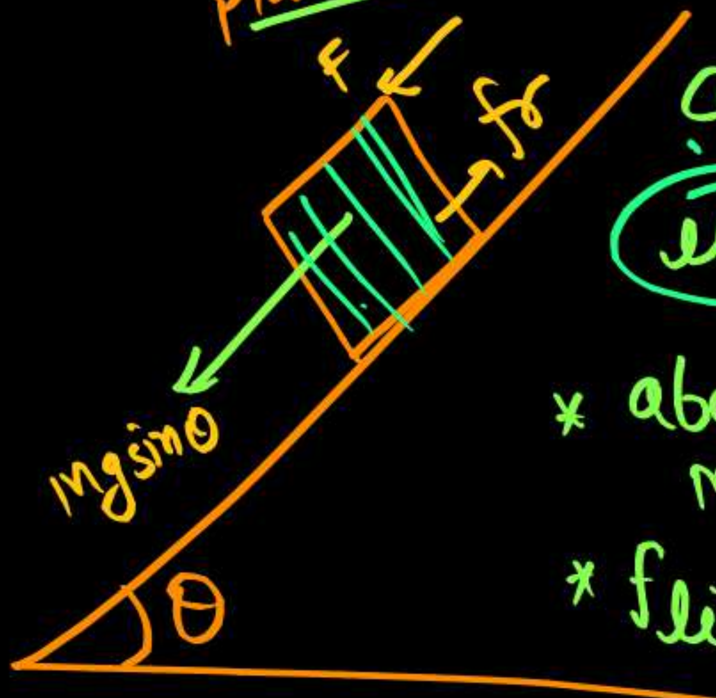


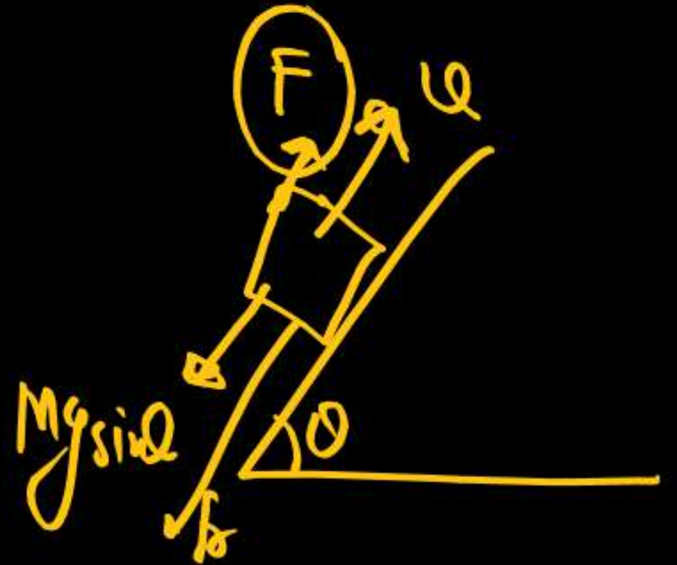
Todays Goal

PhD. on friction

Revision

placed on Inclined





case-1

$\mu = \tan\theta$

* about to move
* $f_{limiting} = \mu N$

= mgsinθ

case-2

* $\mu > \tan\theta$

rest

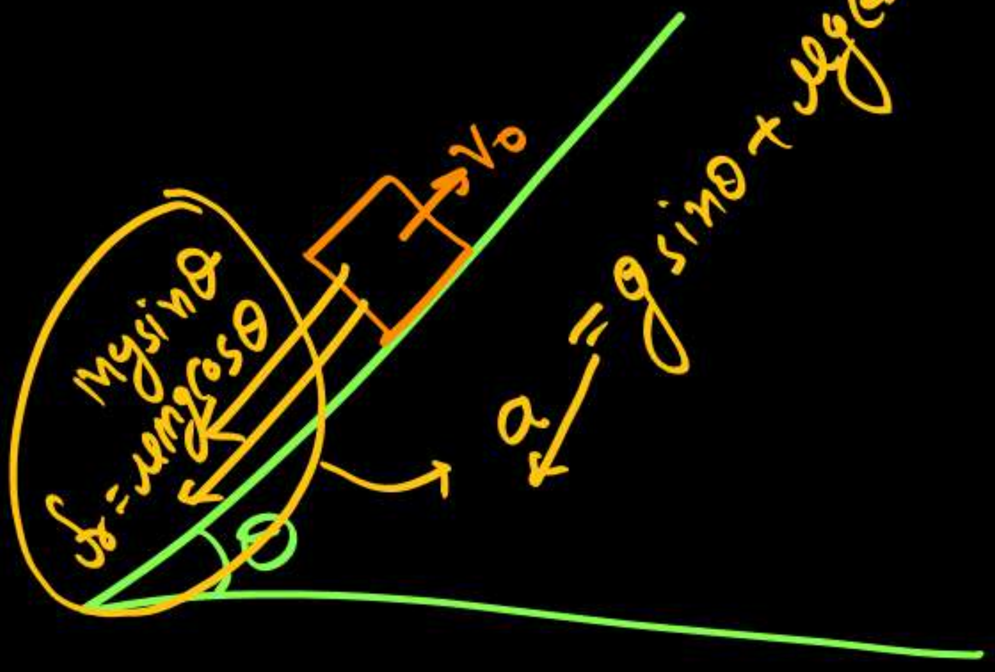
$(f_r)_{static} = mg\sin\theta$

Case-3

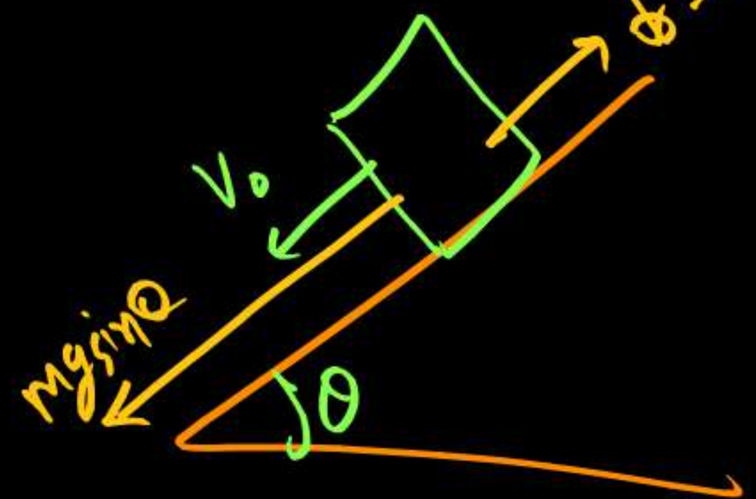
$\mu < \tan\theta$

$a = \frac{F_{net}}{M} = \frac{mg\sin\theta - \mu mg\cos\theta}{M}$

$a = g\sin\theta - \mu g\cos\theta$



$a = g\sin\theta + \mu g\cos\theta$



$f_r = \mu mg\cos\theta$

QUESTION

A cubical block rests on a plane of $\mu = \sqrt{3}$. The angle through which the plane be inclined to the horizontal so that the block just slides down will be

1. 30°
2. 45°
3. 60° (Ans)
4. 75°

$\mu = \tan\theta$

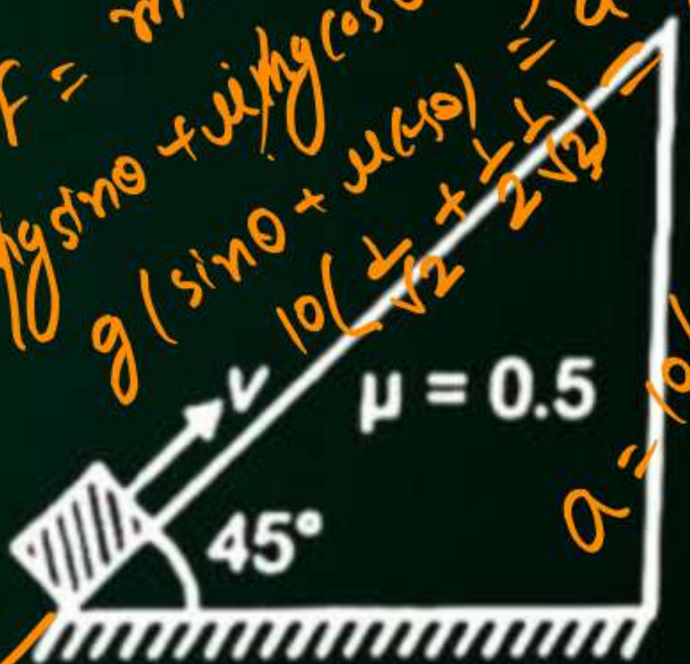
$\sqrt{3} = \tan\theta$

$\theta = 60^\circ$

QUESTION

A block of mass 1 kg is projected from the lowest point up along the inclined plane. If $g = 10\ ms^{-2}$, the retardation experienced by the block is

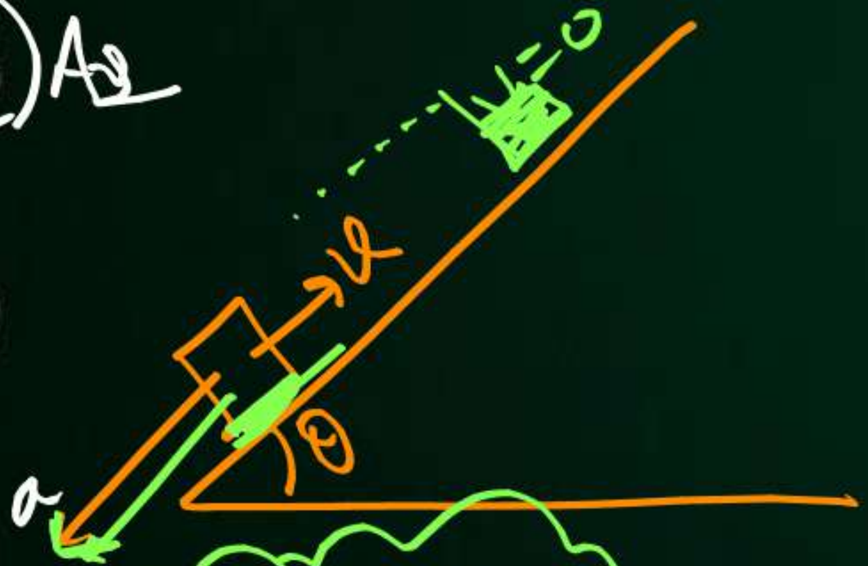
1. $\frac{15}{\sqrt{2}} ms^{-2}$
2. $\frac{5}{\sqrt{2}} ms^{-2}$
3. $\frac{10}{\sqrt{2}} ms^{-2}$
4. Zero



QUESTION

If a block moving up an inclined plane at 30° with a velocity of 5 m/s, stops after 0.5 s, then coefficient of friction will be nearly

1. 0.5
2. 0.6 Ans
3. 0.9
4. 1.1



$a = g\sin\theta + \mu g\cos\theta$

$a = 10 \times \frac{1}{2} + \mu \times 10\frac{\sqrt{3}}{2}$

$v = u + at$ — (1)

$0 = 5 - a \times \frac{1}{2}$

$a = 10$

$10\frac{1}{2} + \mu 10\frac{\sqrt{3}}{2} = 10$

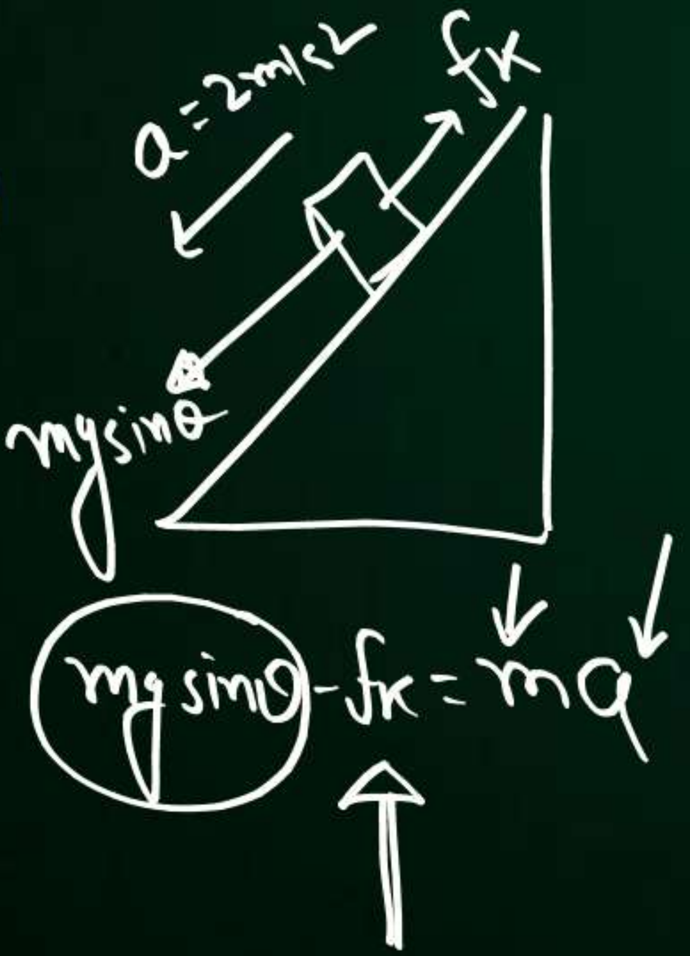
$\frac{\sqrt{3}\mu}{2} = 1 - \frac{1}{2} = \frac{1}{2}$

$\mu = \frac{1}{\sqrt{3}} = 0.58$

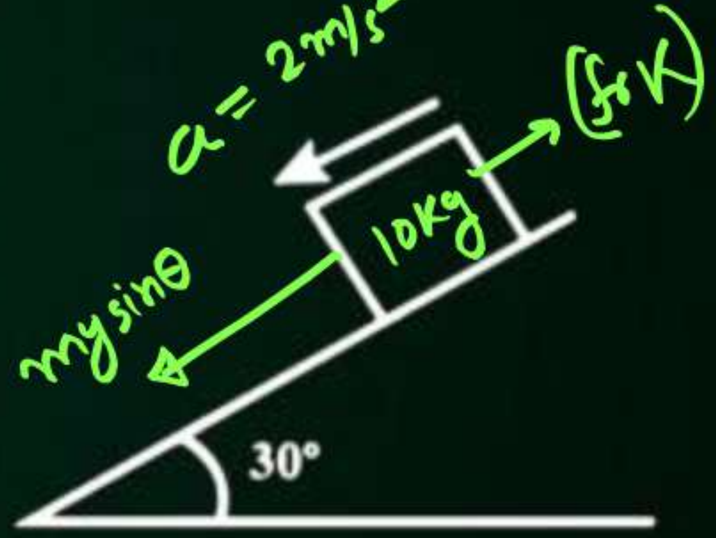
QUESTION

A block of mass 10 kg is released on rough incline plane. Block start descending with acceleration $2\ m/s^2$. Kinetic friction force acting on block is (take $g = 10\ m/s^2$)

1. 10 N
2. 30 N (Ans)
3. 50 N
4. $50\sqrt{3}$N



$mg\sin\theta - f_k = ma$



$mg\sin\theta - f_k = ma$ — (1)

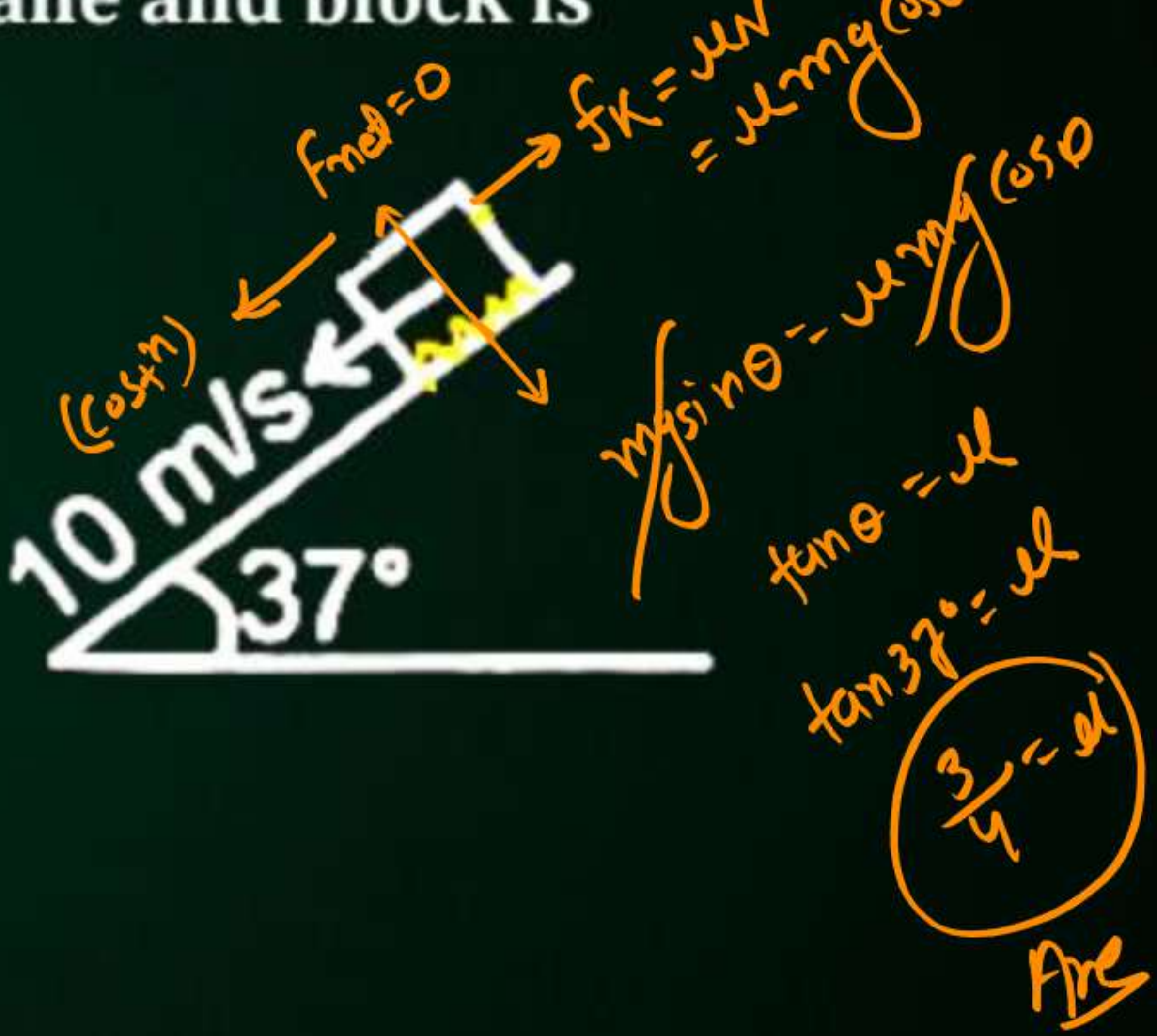
$10 \times 10 \times \frac{1}{2} - f_k = 10 \times 2$

$50 - 20 = f_k$

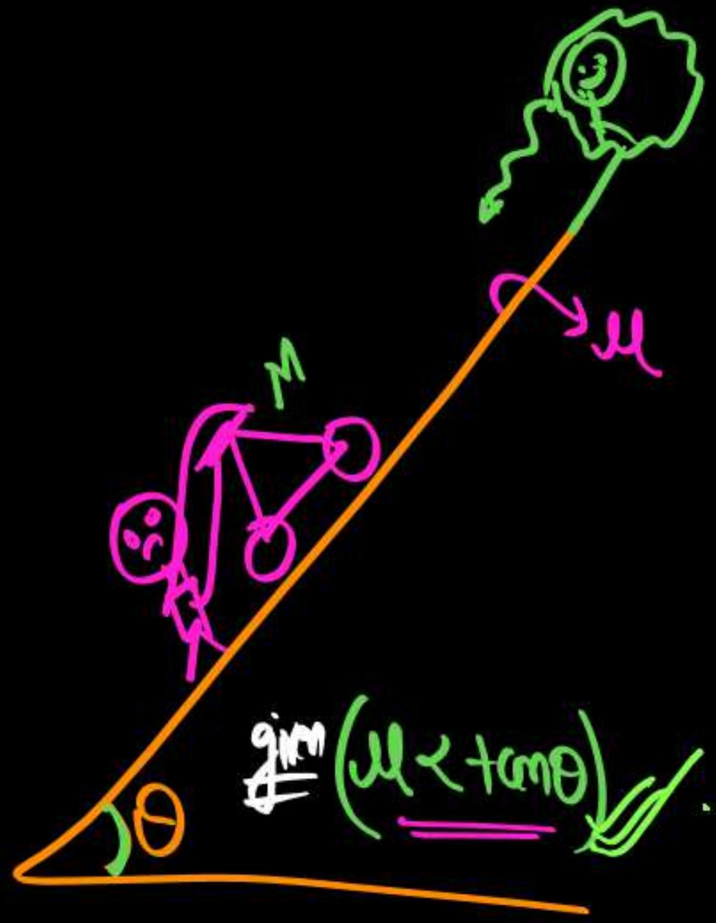
$f_k = 30\ N$

QUESTION

Block of mass 10 kg is moving on inclined plane with constant velocity 10 m/s. The coefficient of kinetic friction between incline plane and block is

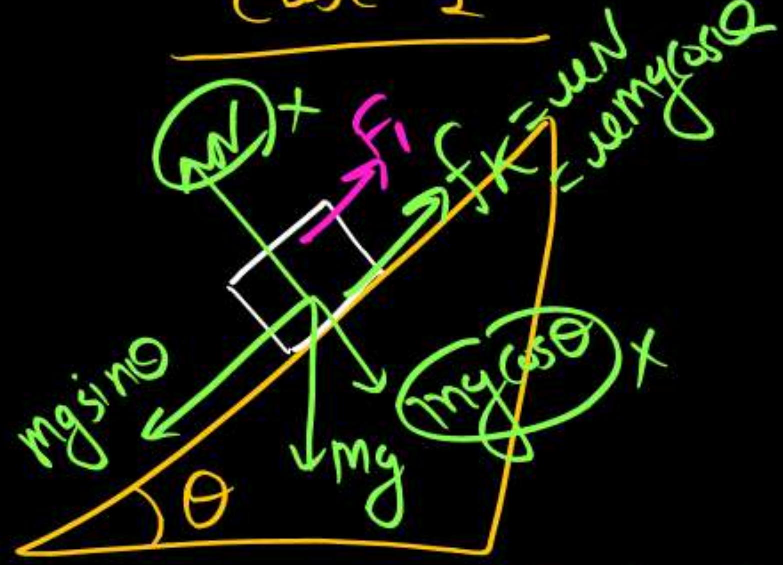


1. 0.57
2. 0.75
3. 0.5
4. None of these



given ($\mu < \tan\theta$)

Case-1



object Ko rest Me Rakhna hai

$\Sigma (F_{net})_{along} = 0$

$mg\sin\theta = F_1 + \mu mg\cos\theta$

$F_1 = mg\sin\theta - \mu mg\cos\theta$ Ans

(I) Minimum force required to keep the Bike at rest

(II) Minimum force required to Just move the object upward to Inclined



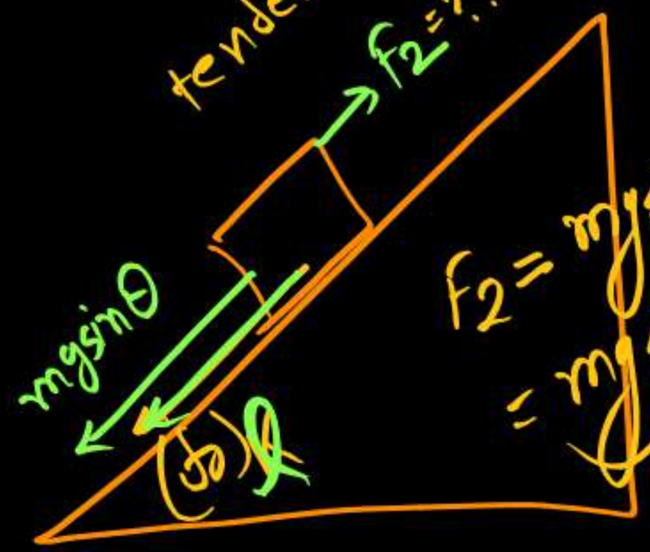
(a) same (50%)

(b) 1st easy 35%

(c) 2nd easy 14%

Case-2

tendency of motion upward



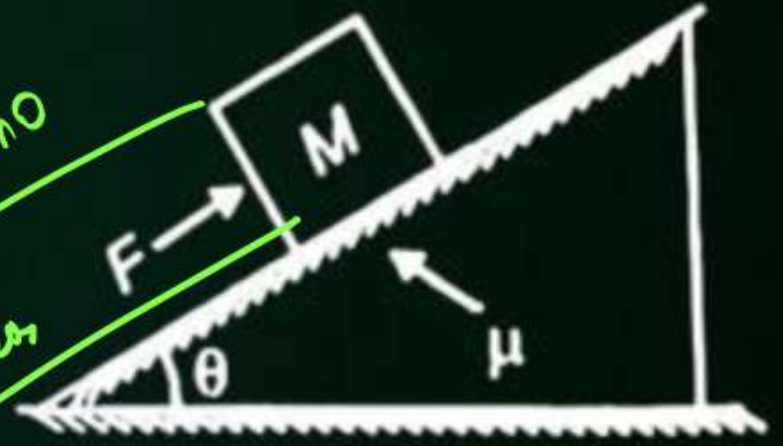
$F_2 = mg\sin\theta + f_{lim}$

$= mg\sin\theta + \mu mg\cos\theta$

QUESTION

A block (mass = M kg) is placed on a rough inclined plane. A force F is applied parallel to the inclined (as shown in figure) such that it just starts moving upward. The value of F is

1. $Mg \sin\theta - \mu Mg \cos\mu$
2. $Mg \sin\theta + \mu Mg \cos\theta$
3. $Mg \sin\theta$
4. $\mu Mg \cos\theta$

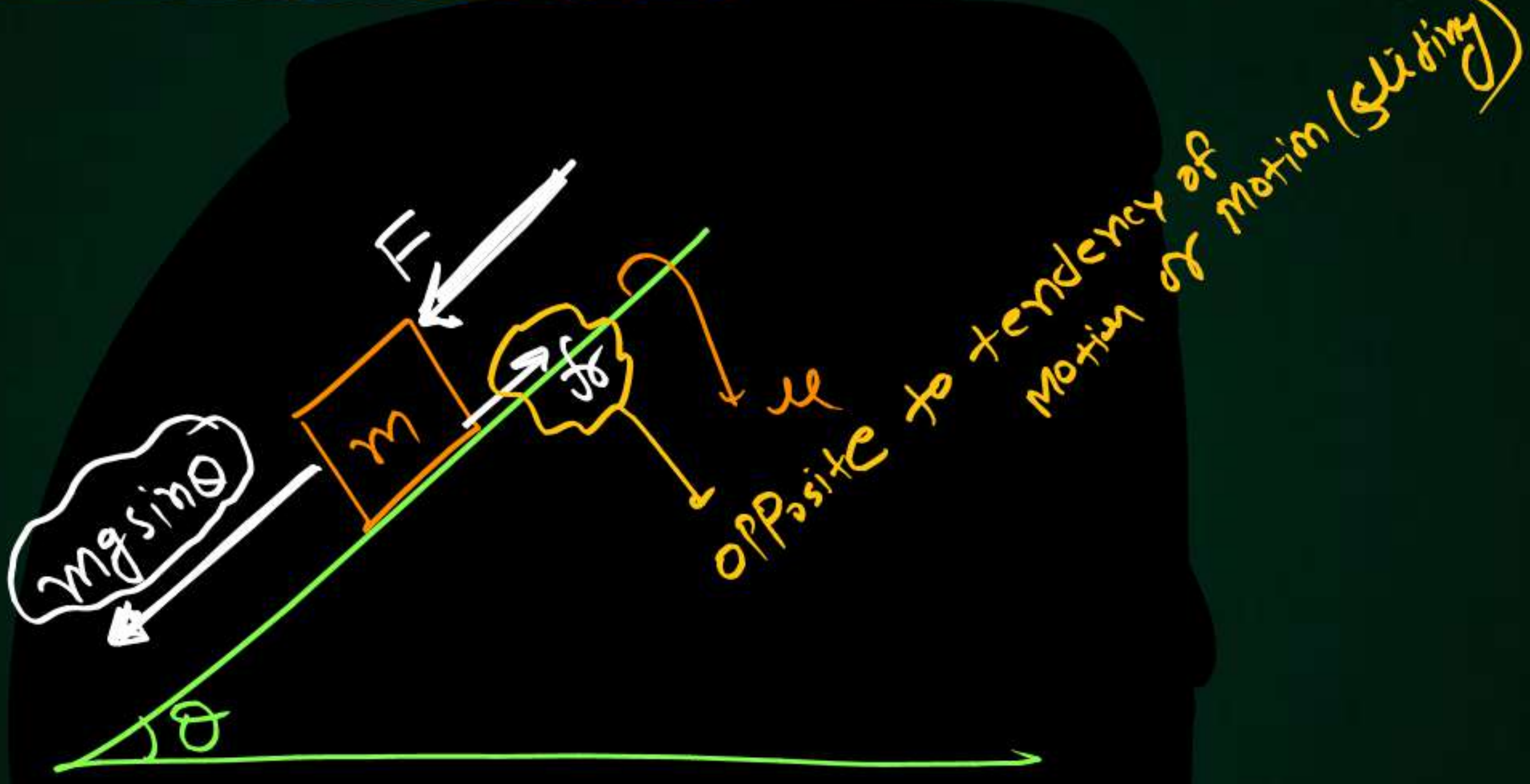


QUESTION

If $\mu > \tan\theta$, then find minimum force required to move this object.

→ object is at rest

F_{min} force to move this object.



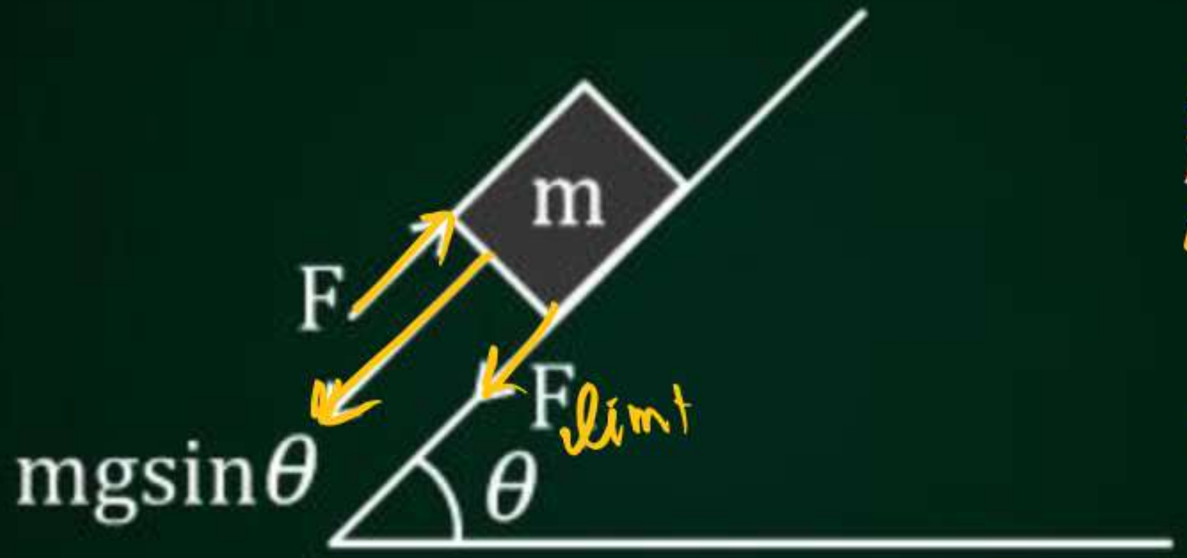
Just about to move on Inclined Plane

$mg\sin\theta + F = (f_r)_{limit}$

$F = \{\mu mg\cos\theta - mg\sin\theta\}$

QUESTION

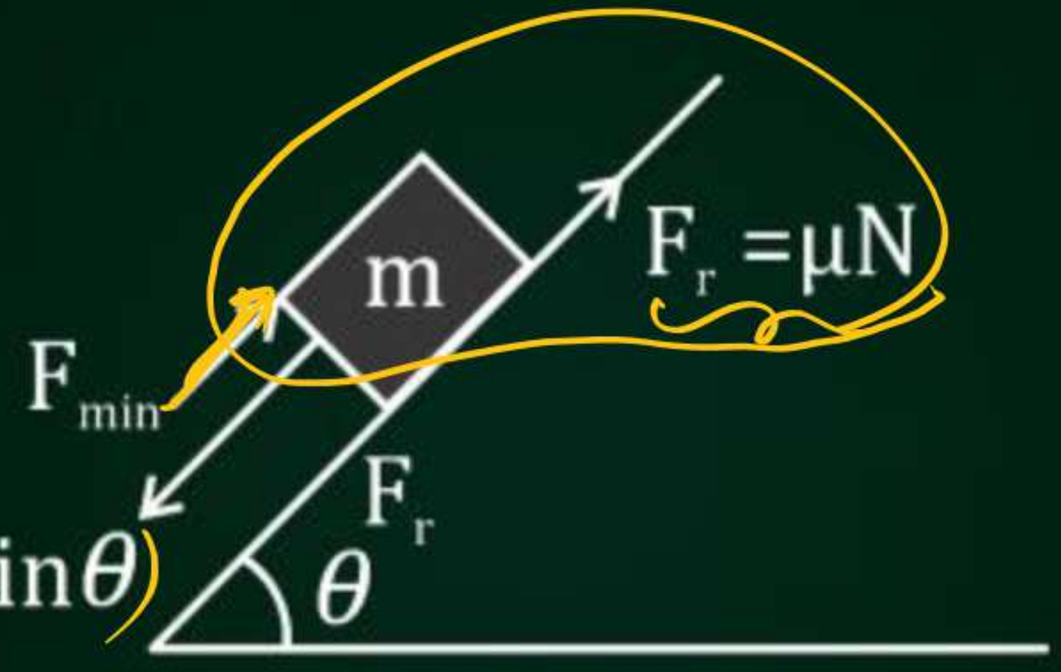
If μ > tanθ, then find minimum force required to move up to the inclined plane.



$F = mg\sin\theta + \mu mg\cos\theta$

QUESTION

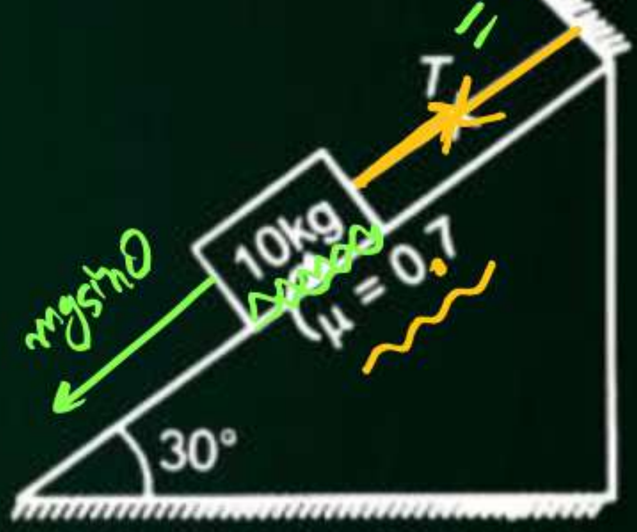
If $\mu < \tan\theta$, then find force required to keep the object at rest.



QUESTION

The tension T in the string shown in figure is

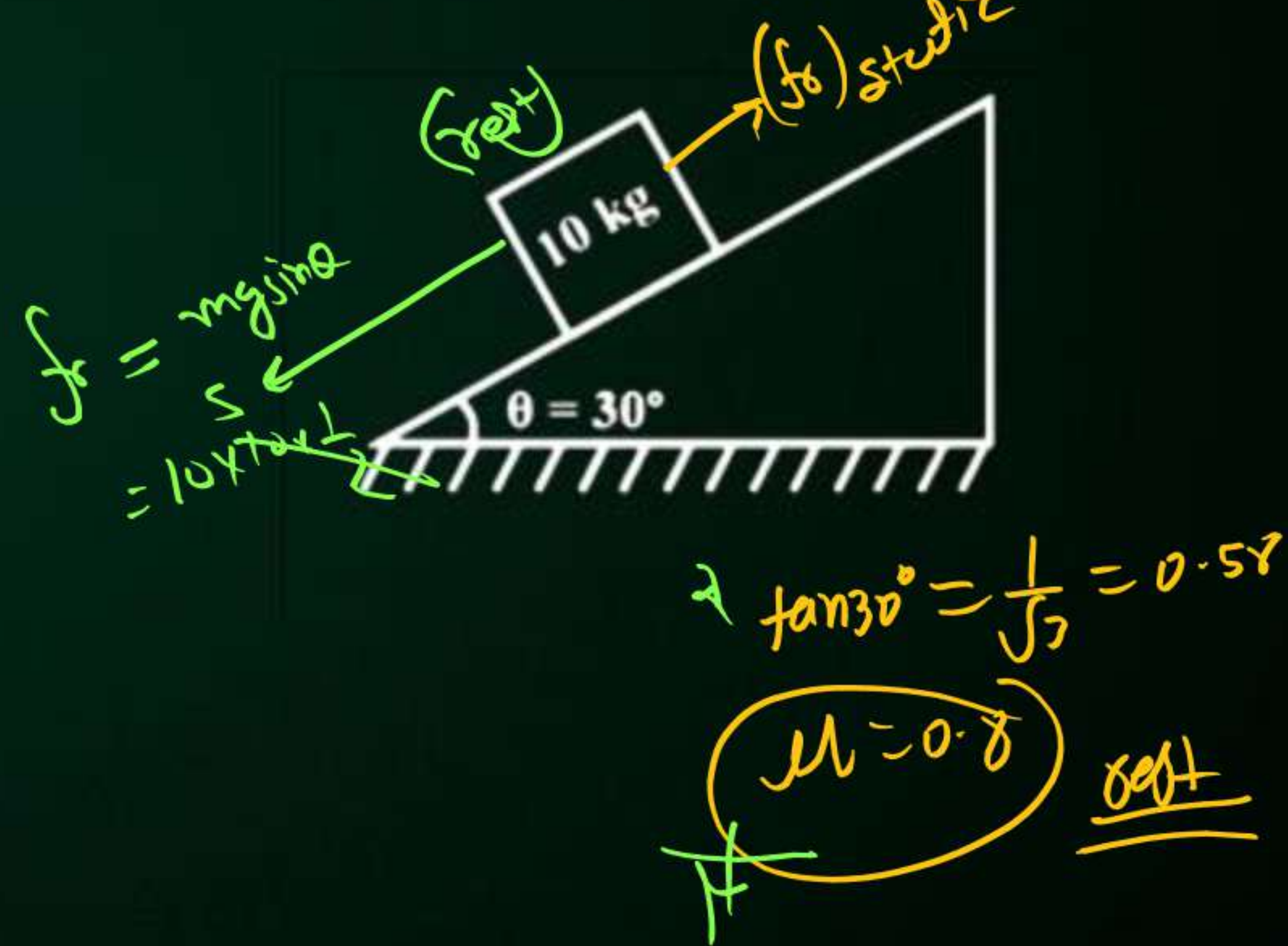
1. Zero
2. 50 N
3. 35V 3N
4. $(\sqrt{3}-1)50\text{N}$



QUESTION

A block of mass 10 kg is kept on a fixed rough ($\mu = 0.8$) inclined plane of angle of indication 30°. The frictional force acting on the block is

1. 50 N
2. $50\sqrt{3}$ N
3. 52 N
4. 54 N

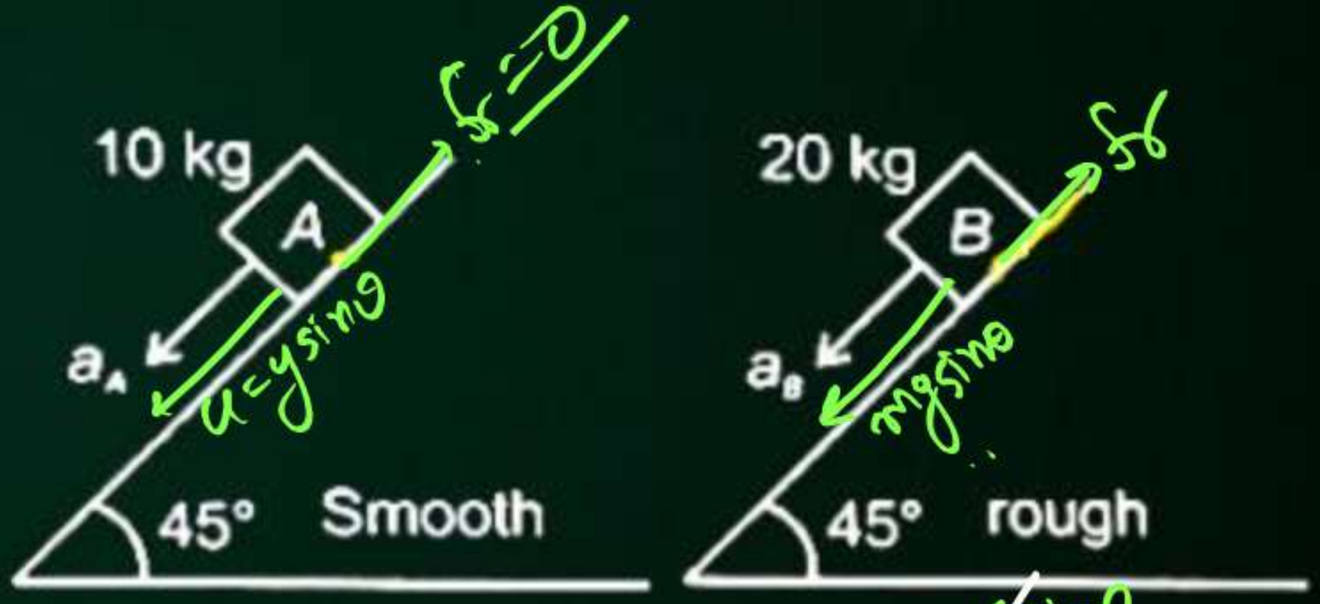


QUESTION

The ratio of the acceleration of blocks A placed on smooth incline with block B placed on rough incline is 2 : 1. The coefficient of kinetic friction between block B and incline is

1. 0.5 ✓
2. 0.75
3. 0.57
4. None of these

$$\frac{a_A}{a_B} = \frac{2}{1}$$



$$\frac{a_A = g\sin\theta}{a_B = g\sin\theta - \mu g\cos\theta}$$

$$\frac{2}{1} = \frac{\sin\theta}{\sin\theta - \mu\cos\theta} = \frac{1/\sqrt{2}}{\frac{1}{\sqrt{2}} - \mu\frac{1}{\sqrt{2}}}$$

$$\frac{2}{1} = \frac{1}{1-\mu}$$

$$1 - \mu = \frac{1}{2}$$

$$1 - \frac{1}{2} = \mu$$

$$\mu = \frac{1}{2}$$

IMR* (questions)

QUESTION

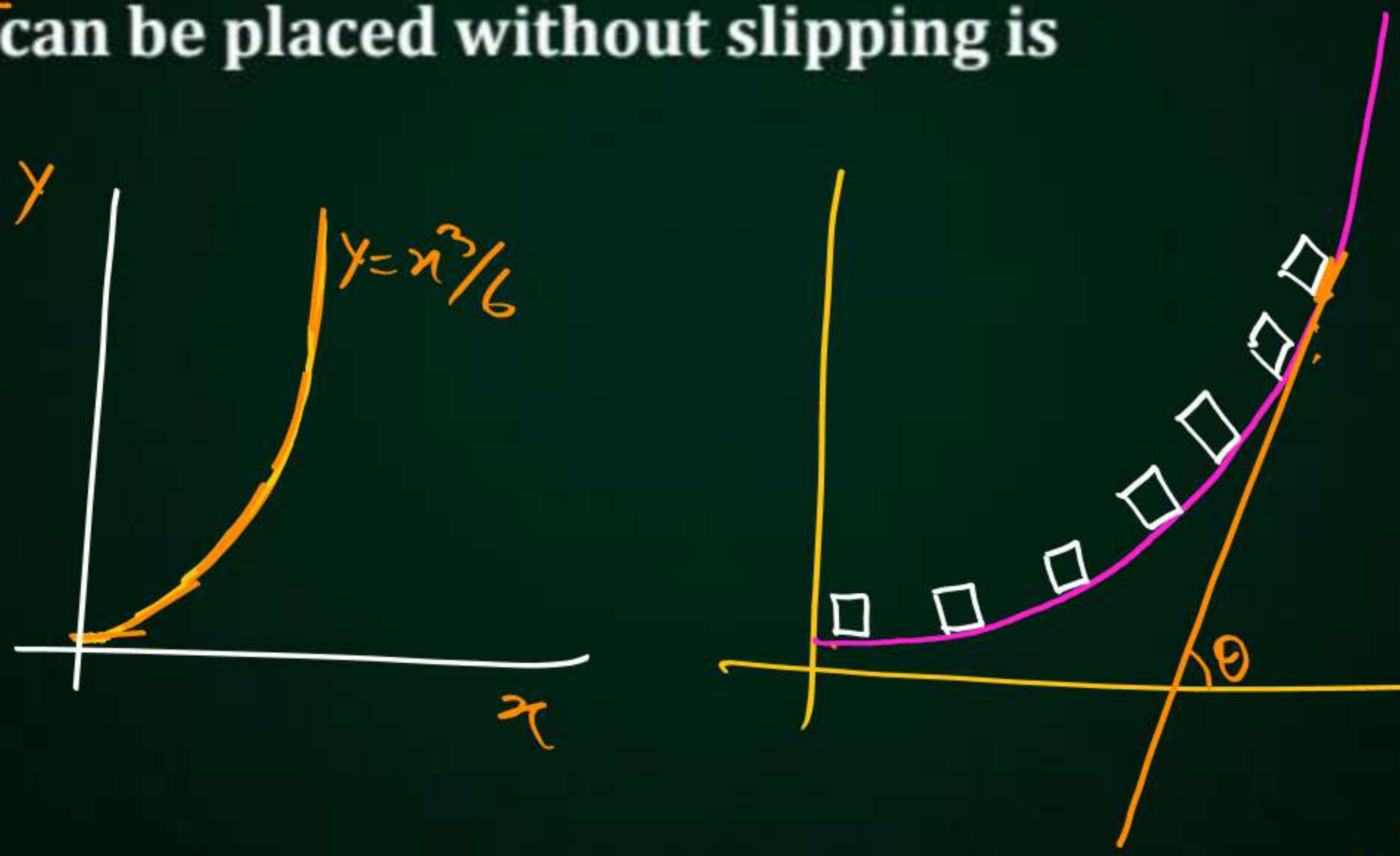
A block of mass m is placed on a surface with a vertical cross-section given by $y = \frac{x^3}{6}$. If the coefficient of friction is 0.5. The maximum height above the ground at which the block can be placed without slipping is

(1) $\frac{1}{6}$ m Ans

(2) $\frac{2}{3}$ m

(3) $\frac{1}{3}$ m

(4) $\frac{1}{2}$ m



Just about to move

$\mu = \tan\theta = \frac{dy}{dx}$

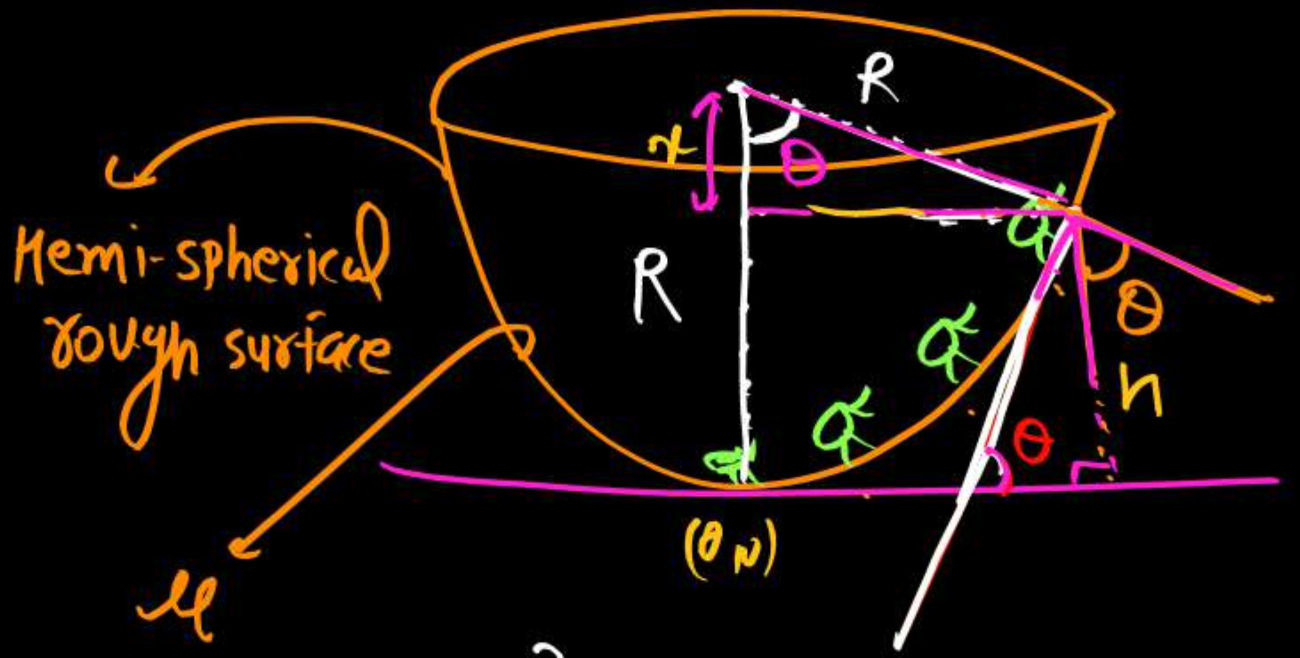
$\frac{1}{2} = \tan\theta = \frac{1}{6}\frac{dx^3}{dx}$

$\frac{1}{2} = \frac{1}{6} 3x^2$

$x = 1$

$y_{x=1} = \frac{(1)^3}{6} = \frac{1}{6}$

find Height from which chiti will lose contai & slip down.



$\frac{P}{B} = \tan\theta = \mu$ (Just abal to little)

$H = \sqrt{P^2+B^2} = \sqrt{1+\mu^2}$

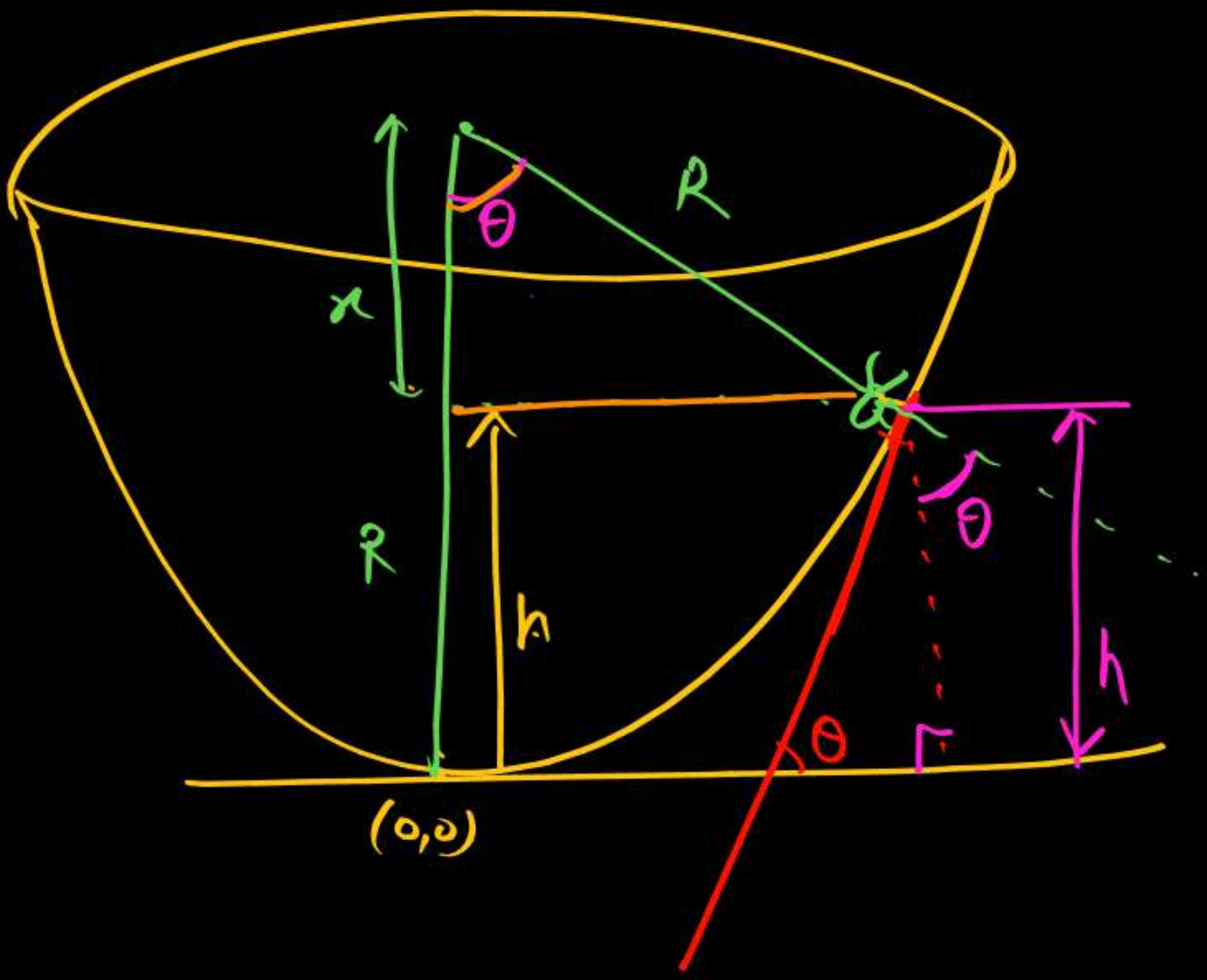
$\cos\theta = \frac{x}{R} = \frac{1}{\sqrt{1+\mu^2}}$

$x = \frac{R}{\sqrt{1+\mu^2}}$

Heigh from Base.

$h = R - x$

$= \left(R - \frac{R}{\sqrt{1+\mu^2}}\right)$



$$\frac{\mu}{1} = \tan\theta = \frac{P}{B} \quad \text{— (1)}$$

$$H = \sqrt{\mu^2+1}$$

$$\cos\theta = \frac{x}{R} = \frac{B}{H} = \frac{1}{\sqrt{\mu^2+1}}$$

$$x = \frac{R}{\sqrt{\mu^2+1}}$$

$$\text{hey } h = R - x$$

$$= \left(R - \frac{R}{\sqrt{\mu^2+1}}\right) \text{ Ans}$$

QUESTION

Gravel is dropped onto a conveyer belt at a rate of 0.5 kg/s. The extra force required in newton to keep the belt moving at 2 m/s is: (varible mass system)

1. 1 N
2. 2 N
3. 4 N
4. 0.5 N

0.5×2

$F = ma = m\frac{dv}{dt}$

$F = \frac{dm}{dt} v$

QUESTION

A block of 3 kg rests in limiting equilibrium on an inclined plane of inclination 30°. If the plane is raised to an inclination 60°, the force along the plane required to support it is at rest.

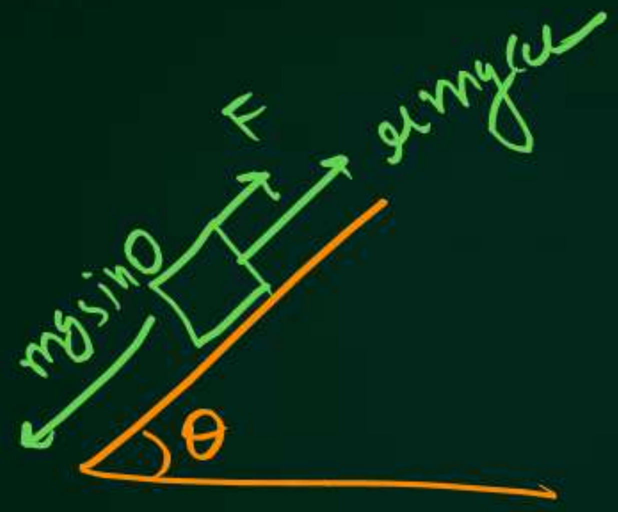
1. $\frac{10}{\sqrt{3}}$ N
2. $10\sqrt{3}$ N
3. 10 N
4. $\frac{10}{3}$ N

at rest

$\mu = \tan\theta$

$\mu = \tan 30^\circ$

$\mu = \frac{1}{\sqrt{3}}$



$F = mg\sin\theta - \mu mg\cos\theta$

$= 3\times10\times\frac{\sqrt{3}}{2} - \frac{1}{\sqrt{3}}\times3\times10\times\frac{1}{2}$

$= 30\left[\frac{\sqrt{3}}{2} - \frac{1}{2\sqrt{3}}\right] = 30\left(\frac{3-1}{2\sqrt{3}}\right) = \frac{30\times2}{2\sqrt{3}} = \frac{10\times3}{\sqrt{3}}$

QUESTION

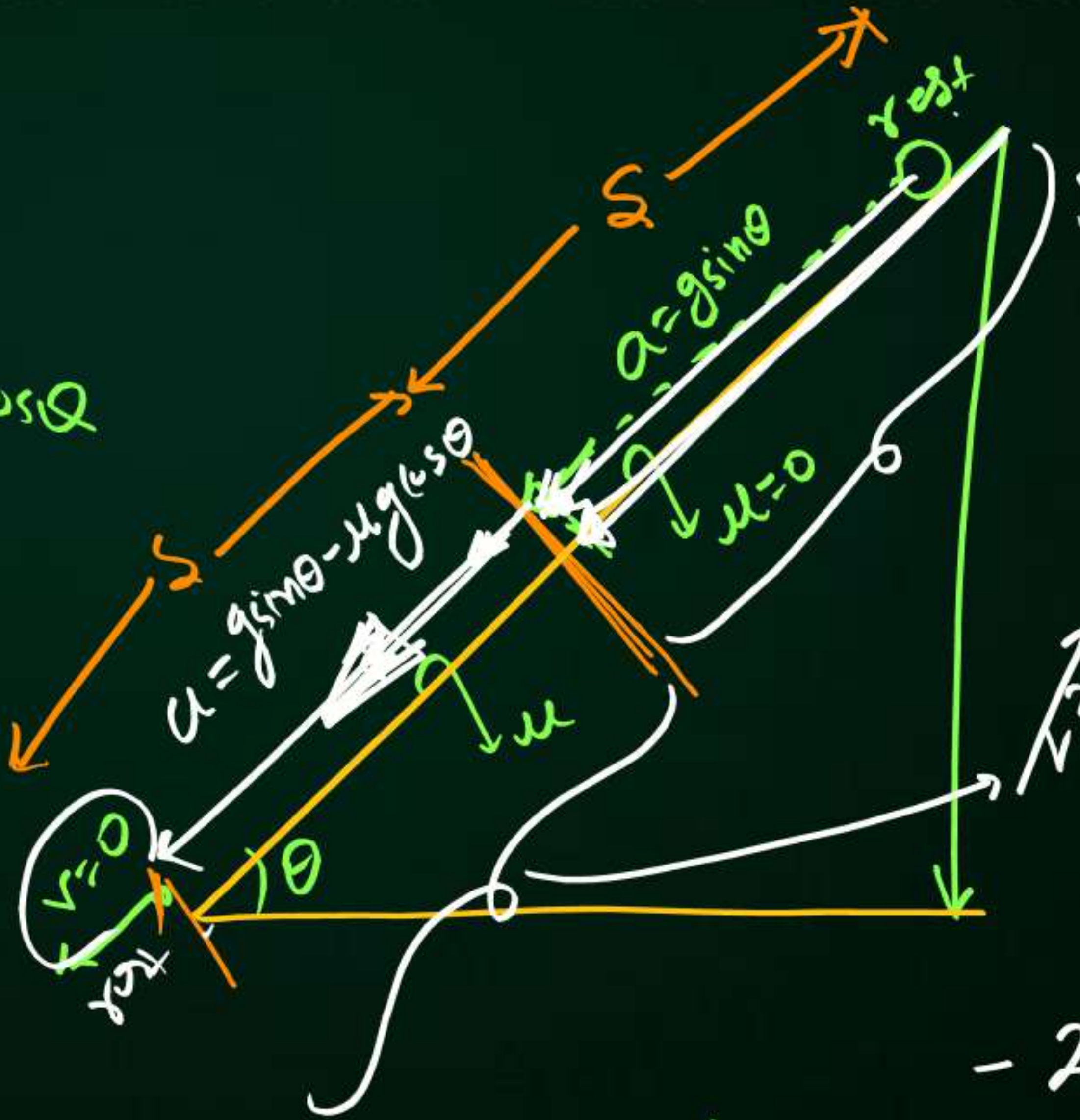
The upper half of an inclined plane of inclination θ is perfectly smooth while lower half is rough. A block starting from rest at the top of the plane will again come to rest at the bottom, if the coefficient of friction between the block and lower half of the plane is given by

1. $\mu = \frac{2}{\tan\theta}$
2. $\mu = 2\tan\theta$
3. $\mu = \tan\theta$
4. $\mu = \frac{1}{\tan\theta}$

$-2\sin\theta = 2\sin\theta - 2\mu\cos\theta$

$2\mu\cos\theta = 4\sin\theta$

$\mu = 2\tan\theta$



3rd eqn of motion

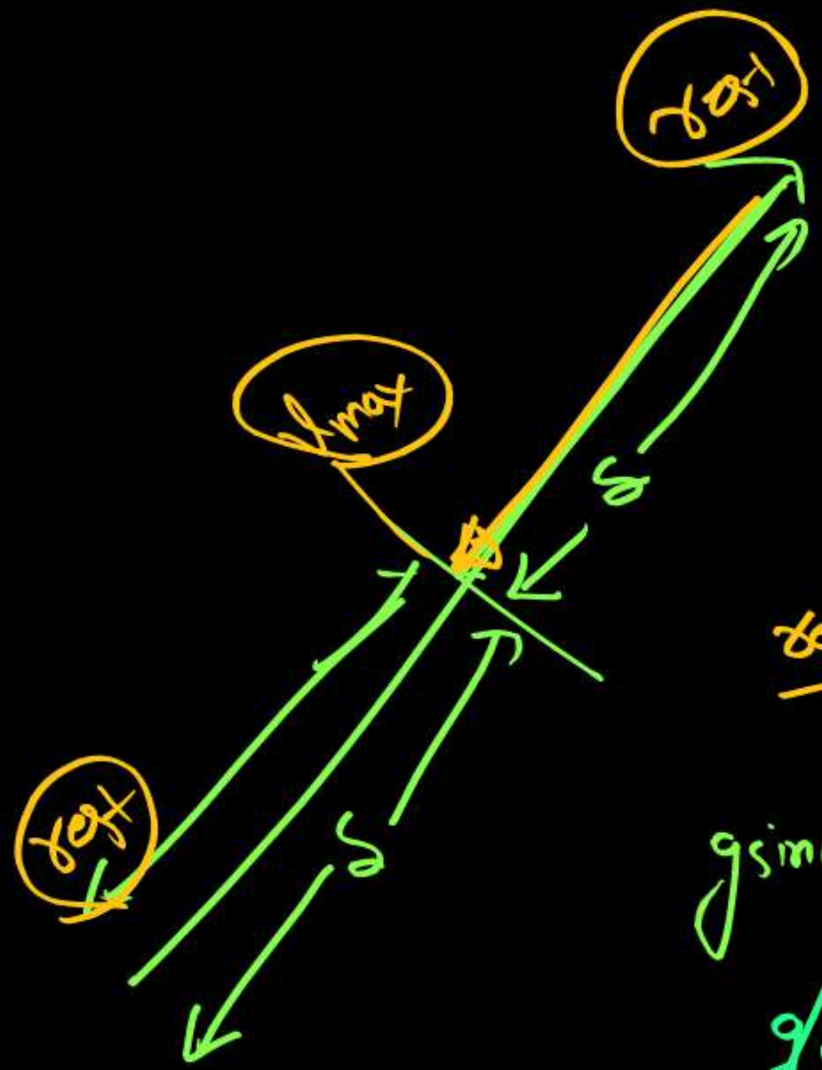
$v^2 - u^2 = 2as$

$v^2 = 2g\sin\theta\, s$ — (1)

$v^2 - u^2 = 2as$

$-v^2 = 2(g\sin\theta - \mu g\cos\theta)s$

$-2g\sin\theta\, s = (2g\sin\theta - 2\mu g\cos\theta)s$



rest to rest motion

$$g\sin\theta\, S = (\mu g\cos\theta - g\sin\theta)\, S$$

$$g\sin\theta = \mu g\cos\theta - g\sin\theta$$

$$2\sin\theta = \mu\cos\theta$$

$$\boxed{2\tan\theta = \mu}$$

QUESTION

A block rests on a rough inclined plane making an angle of 30° with the horizontal. The coefficient of static friction between the block and the plane is 0.8. If the frictional force the on the block is 10 N, the mass of the block (in kg) is (take $g = 10\ \text{m/s}^2$) [AIEEE 2004]

1. 2.0
2. 4.0
3. 1.6
4. 2.5

$\mu = 0.8$

$\tan 30° = \frac{1}{\sqrt{3}} = 0.58$

Rest

$f_{static} = mg\sin\theta$

$10 = m \times 10 \times \frac{1}{2}$

$m = 2\ \text{kg}$

QUESTION

The force required just to move a body up an inclined plane is double the force required just to prevent the body sliding down. If the coefficient of friction is 0.25, the angle of inclination of the plane is

1. $30°$
2. $45°$
3. $\tan^{-1}\left(\frac{1}{4}\right)$
4. $\tan^{-1}\left(\frac{3}{4}\right)$

QUESTION

A body of mass 10 kg is lying on a rough inclined plane of inclination 37° and $\mu = 1/2$, the minimum force required to pull the body up the plane is

1. 80 N
2. 100 N
3. 120 N
4. 60 N

$F = mg\sin\theta + \mu mg\cos\theta$

QUESTION

The upper half of an inclined plane of inclination $45°$ is perfectly smooth while the lower half is rough. A block starting from rest at the top comes back to rest at the bottom. The coefficient of friction for the lower half is

1. $\frac{1}{\sqrt{2}}$
2. 1
3. $\sqrt{2}$
4. 2

done

QUESTION

A body is sliding down an inclined plane $\left(\mu = \frac{1}{2}\right)$. If the normal reaction is twice that of the resultant downward force along the incline, the inclination of plane is

1. 15°
2. 30°
3. 45°
4. 60°

$N = mg\cos\theta$

$F_{net} = mg\sin\theta - \mu mg\cos\theta$

$mg\cos\theta = 2mg\sin\theta - 2\mu mg\cos\theta$

$\cos\theta = 2\sin\theta - 2\mu\cos\theta$

$\cos\theta = 2\sin\theta - \frac{1}{2}\cdot 2\cos\theta$

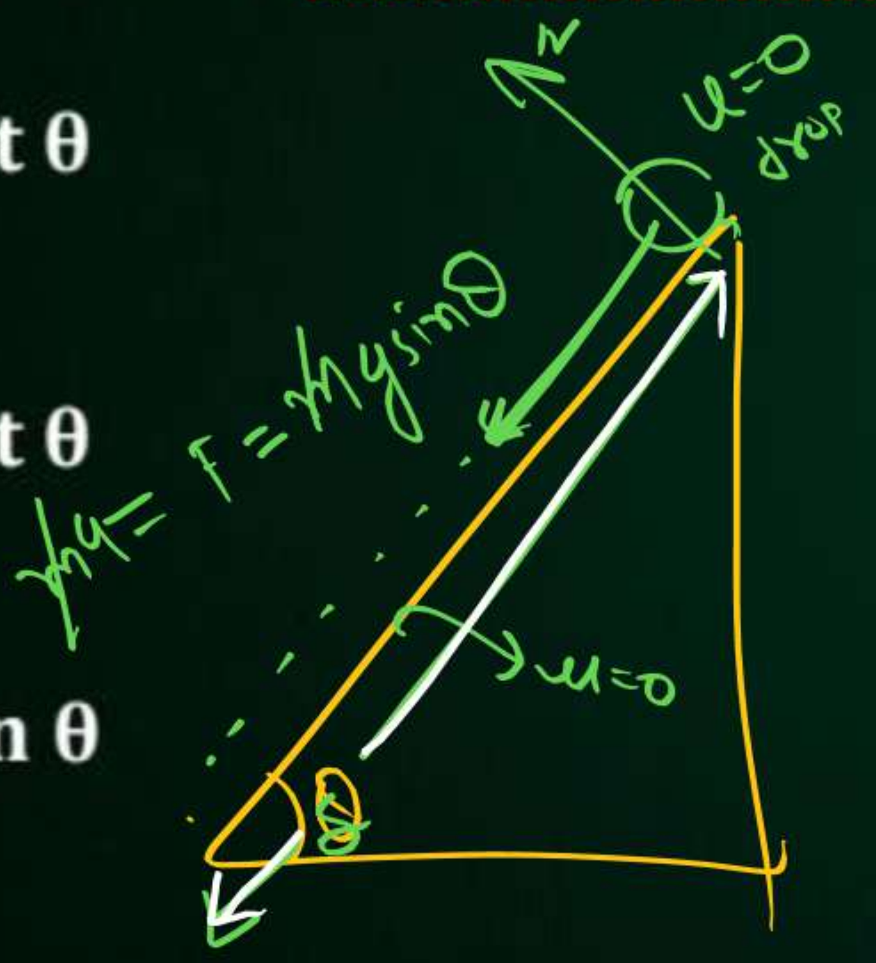
$2\cos\theta = 2\sin\theta$

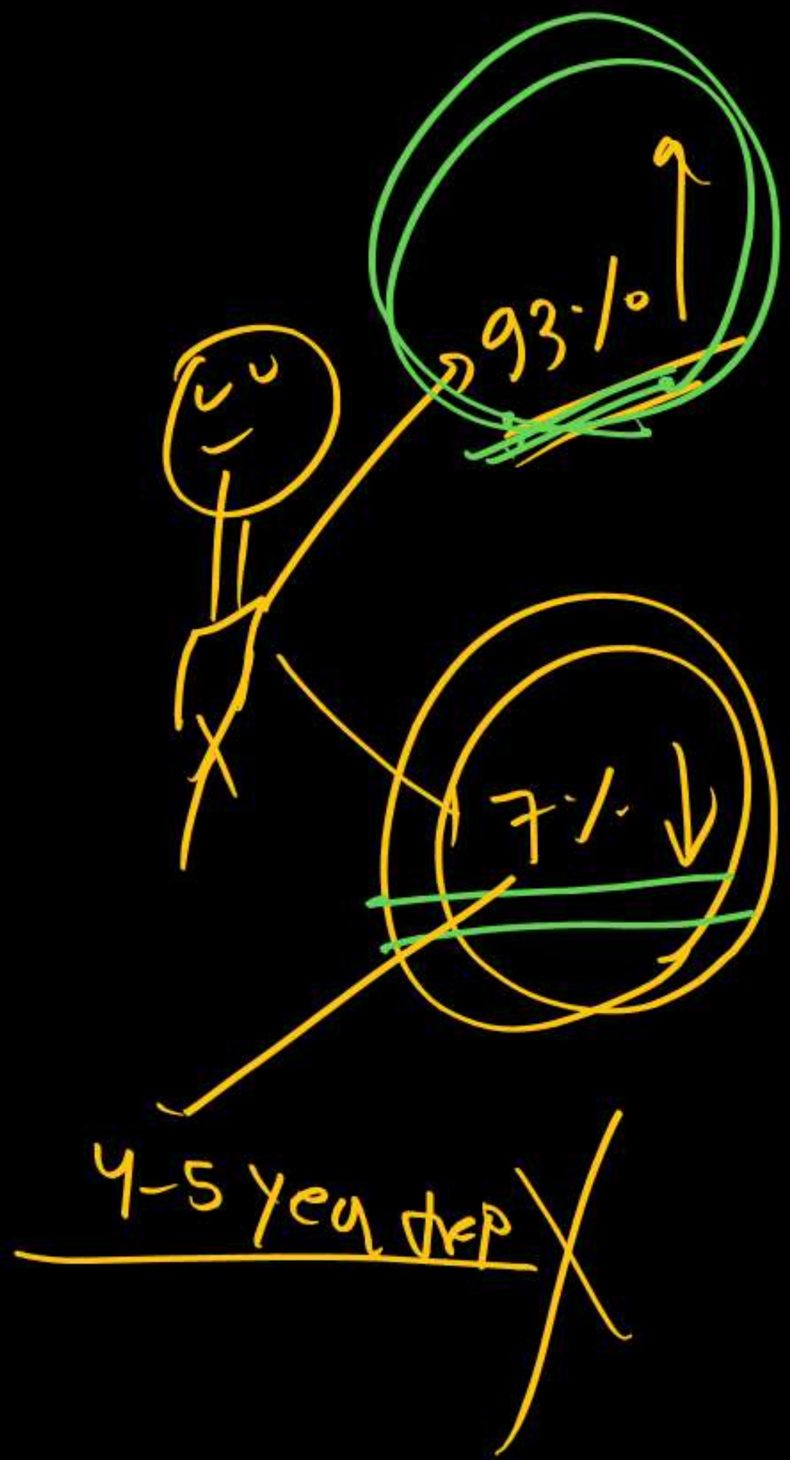
$\tan\theta = 2$

QUESTION

A block is released from the top of an inclined plane of inclination θ. Its velocity at the bottom of plane is v. If it slides down a rough inclined plane of the same inclination, its velocity at bottom is $v/2$. The coefficient of friction is

1. $\frac{3}{4}\cot\theta$
2. $\frac{1}{4}\cot\theta$
3. $\frac{1}{4}\tan\theta$
4. $\frac{3}{4}\tan\theta$




93%
7%
4-5 year step

QUESTION

A given object takes n times as much time to slide down a $45°$ rough incline as it takes down a perfectly smooth $45°$ incline. The coefficient of kinetic friction between the object and the incline is given by

1. $\left(1-\frac{1}{n^2}\right)$
2. $1-\frac{1}{n^2}$
3. $\sqrt{\left(1-\frac{1}{n^2}\right)}$
4. $\sqrt{1-\frac{1}{n^2}}$

H/W

QUESTION

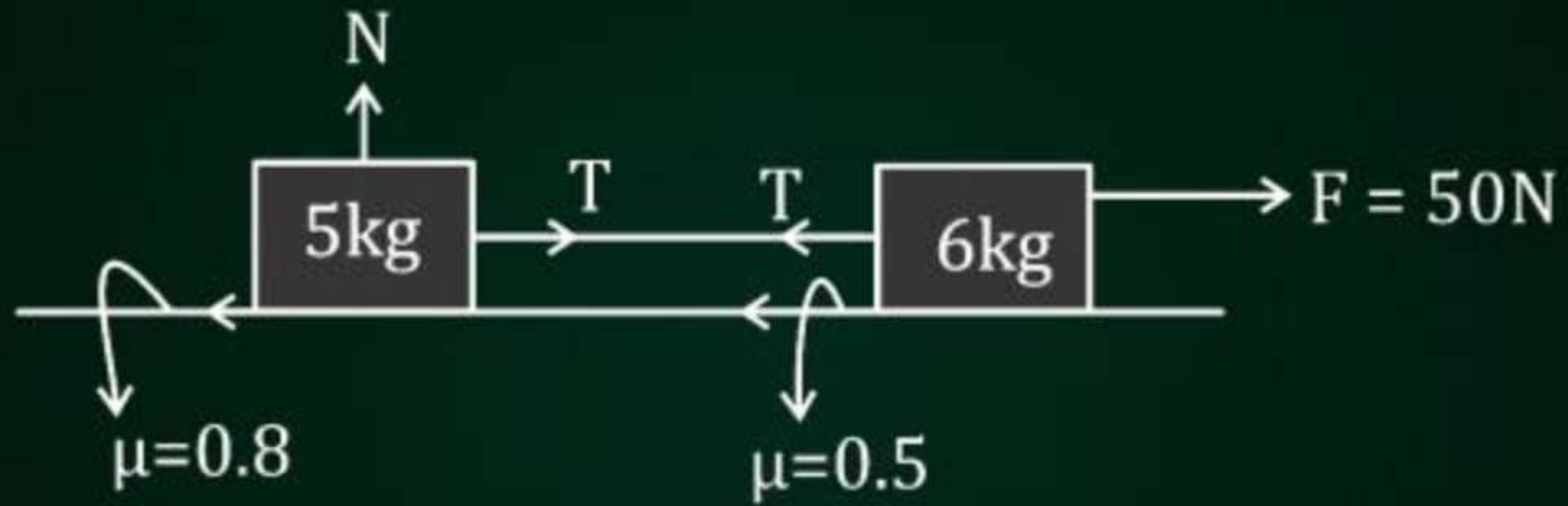
An ice cube is kept on an inclined plane of angle 30°. The coefficient of kinetic friction between the block and incline plane is the $1/\sqrt{3}$. What is the acceleration of the block? [BHU 2016]

1. Zero
2. $2\ m/s^2$
3. $1.5\ m/s^2$
4. $5\ m/s^2$

$\mu = \tan 30°$

QUESTION

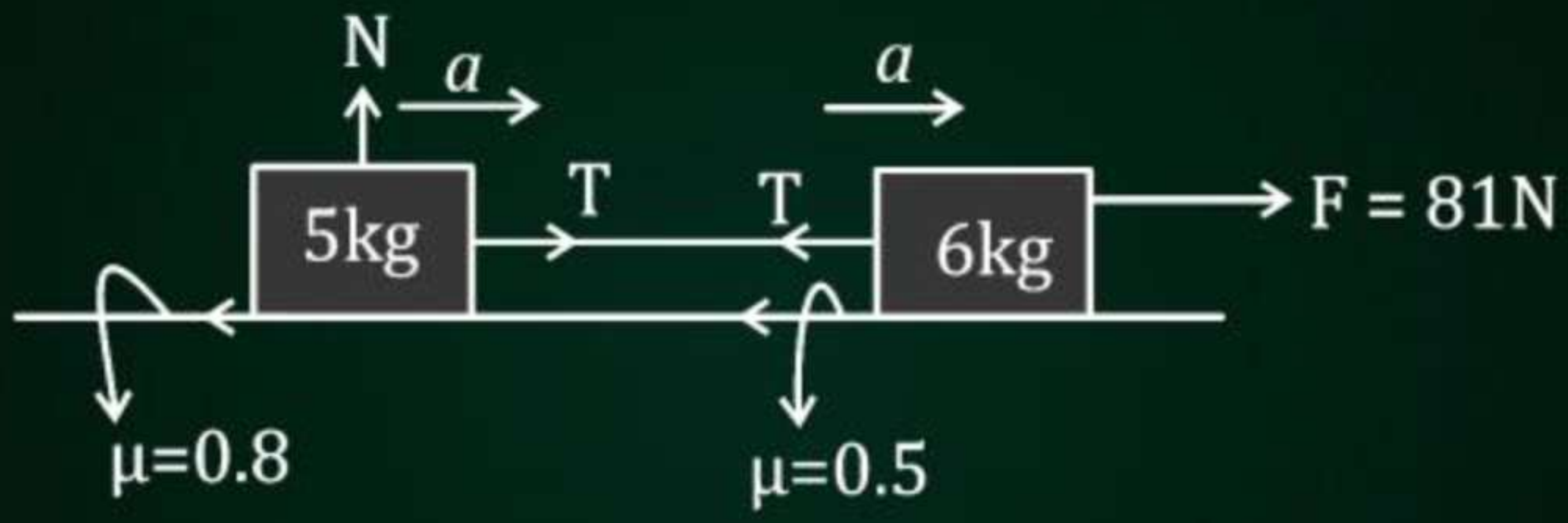
Find acceleration, tension and friction acting on objects.



H/W

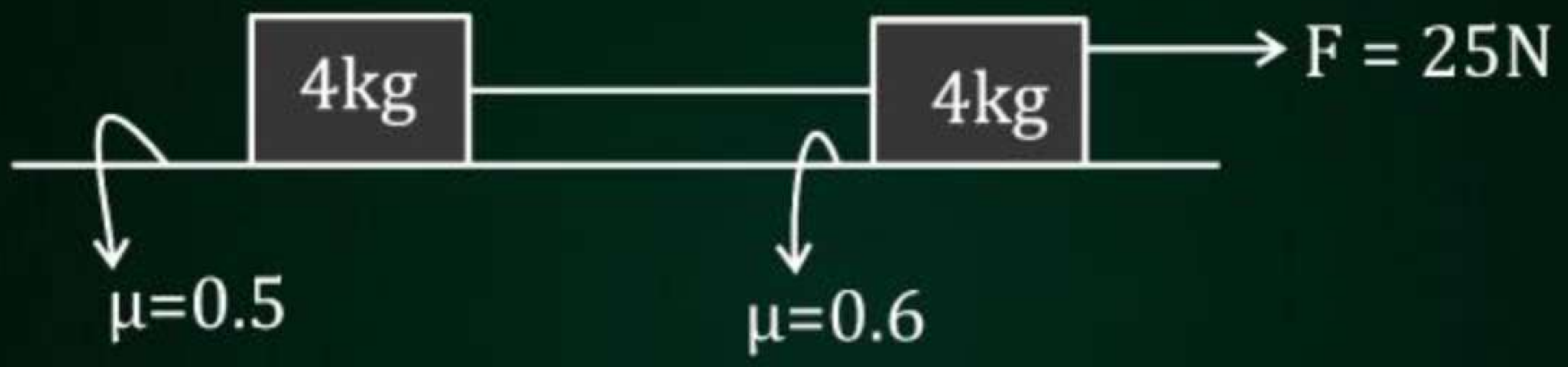
QUESTION

Find acceleration, tension and friction acting on objects.



QUESTION

Find tension, friction and acceleration.




THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture-12 | Physics

Laws of Motion

By- Dr. Manish Raj (MR SIR)



Topics to be covered

1. # Connected body friction

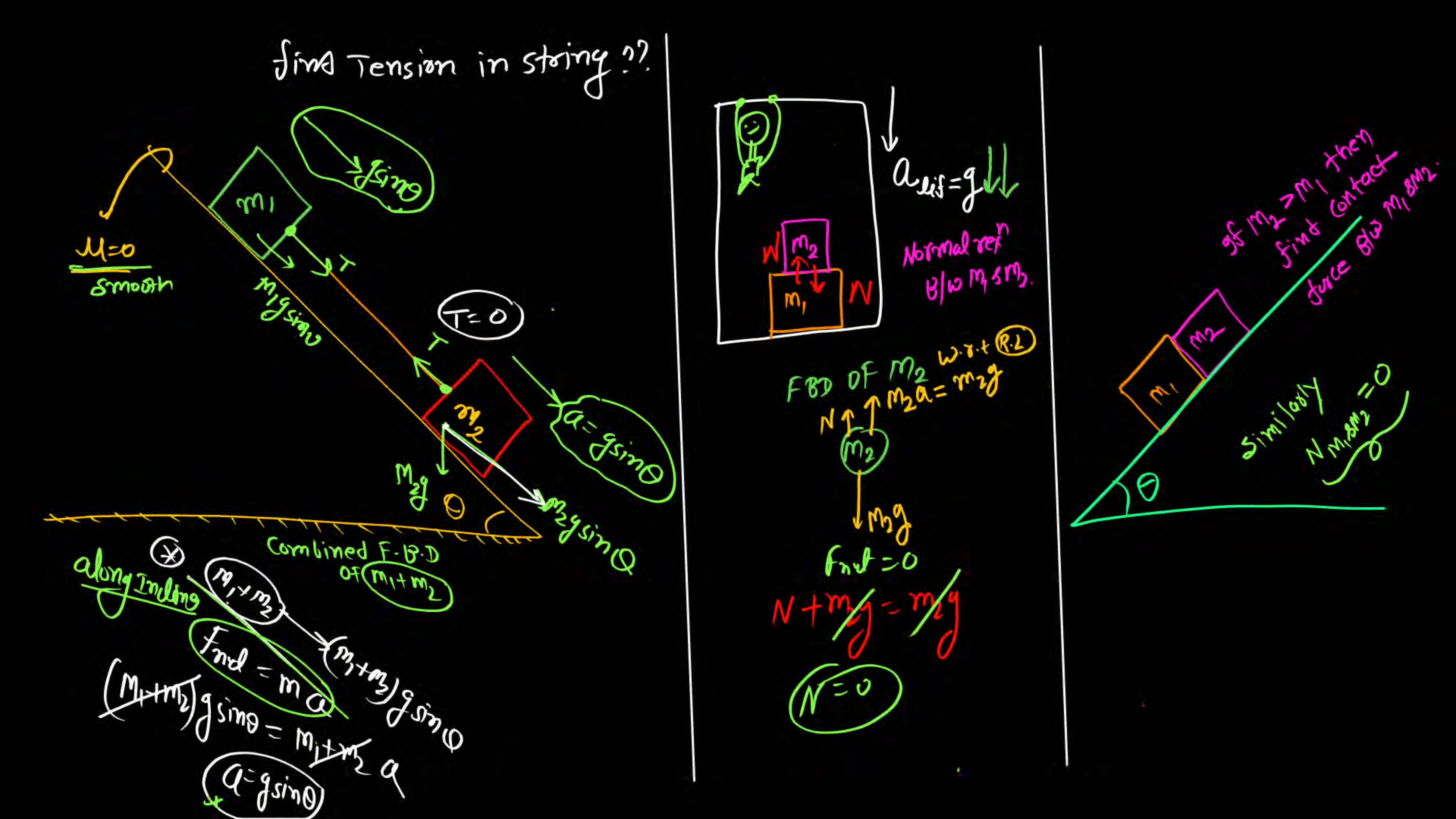
   friction in Block over Block

2. #

3. # Circular Dynamics

4. #

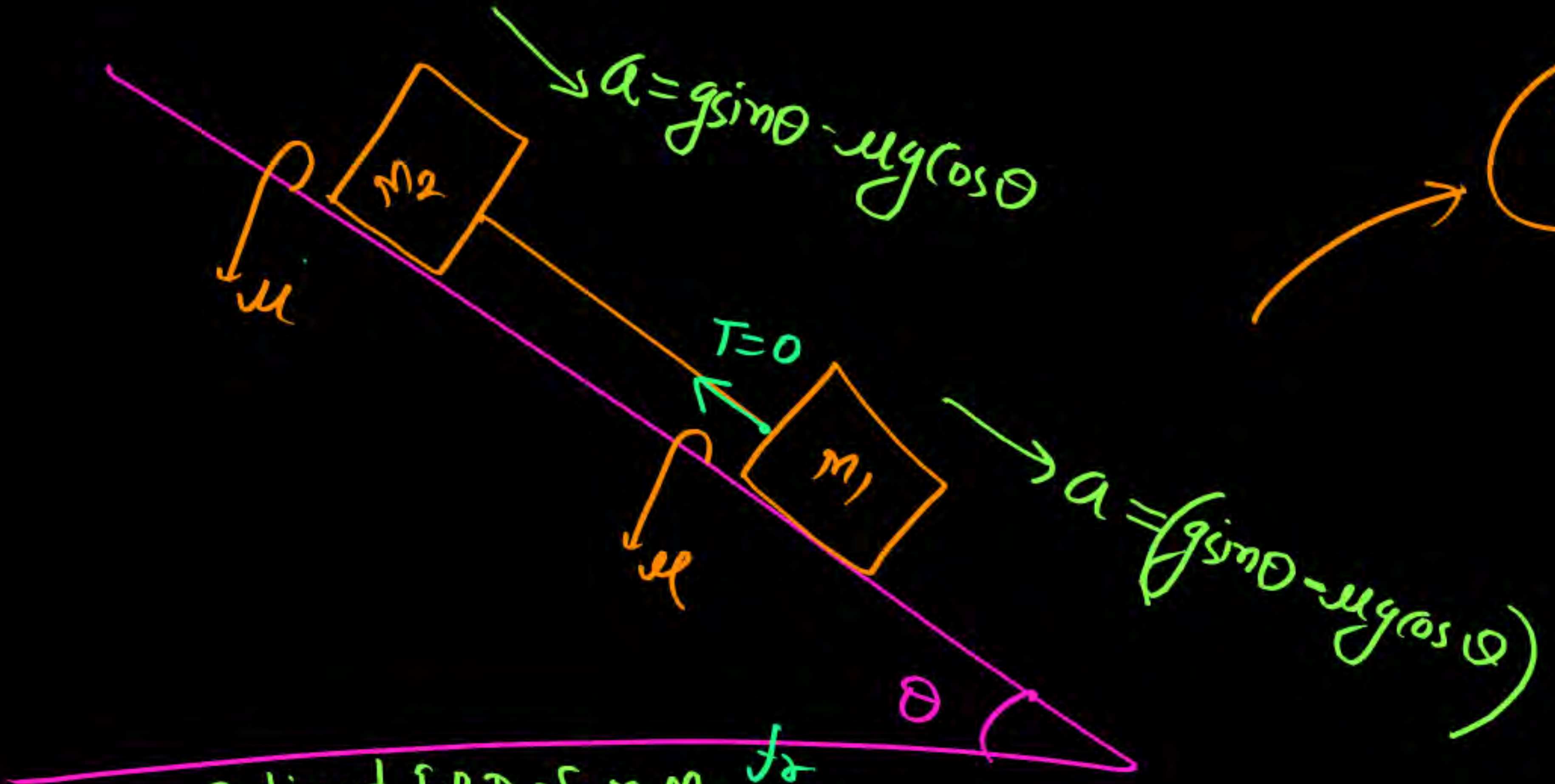




find Tension in string ??
μ=0
smooth
m1
g sinθ
T
m1g sinθ
T=0
T
m2
a = g sinθ
m2g
θ
m2g sinθ
Combined F.B.D of (m1+m2)
along Incline
(m1+m2)
(m1+m2) g sinθ
Fnet = ma
(m1+m2) g sinθ = m1+m2 a
a = g sinθ
a_lift = g
W
m2
m1
N
Normal rexn b/w m1 & m2.
FBD of m2 w.r.t (R.L)
N
m2a = m2g
m2g
Fnet = 0
N + m2g = m2g
N = 0
If m2 > m1 then find contact force b/w m1 & m2.
m2
m1
θ
Similarly
N m1 & m2 = 0

Find Tension in string:
if ($\tan\theta > \mu$)

$T = 0$





Combined f.B.D of $m_1 m_2$



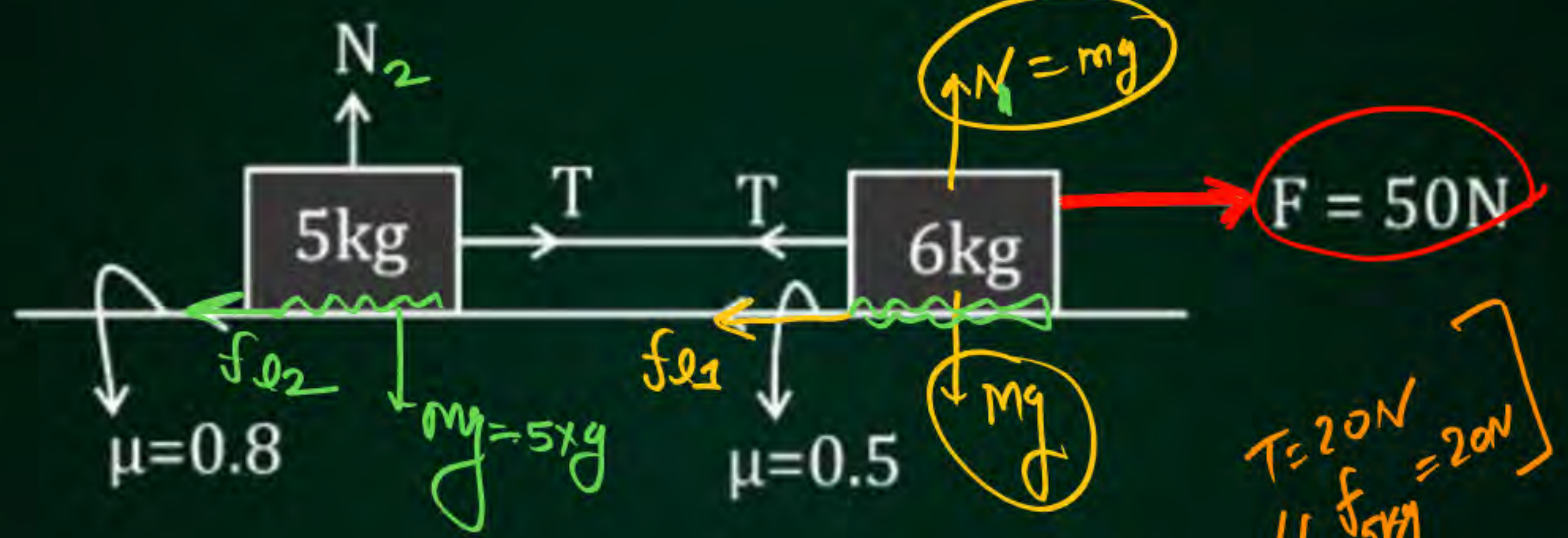
$$F_{net} = M_{net}\, a$$

$$(M_1+M_2)g\sin\theta - \mu(M_1+M_2)g\cos\theta = (M_1+M_2)a$$

$$\boxed{g\sin\theta - \mu g\cos\theta = a}$$

QUESTION

Find acceleration, tension and friction acting on objects.



Step-1

* $f_{limit_1} = \mu N_1 = \frac{5}{10} \times 6 \times g = 30N$

* $f_{lim_2} = \mu N_2 = \frac{8}{10} \times 5g = 40N$

Step-2

Compair Net f_{limit} friction with applied force

$(f_{l_1} + f_{l_2})_{max} = 70N$ ← (5+6) → $F_{ext} = 50N$

Step-3

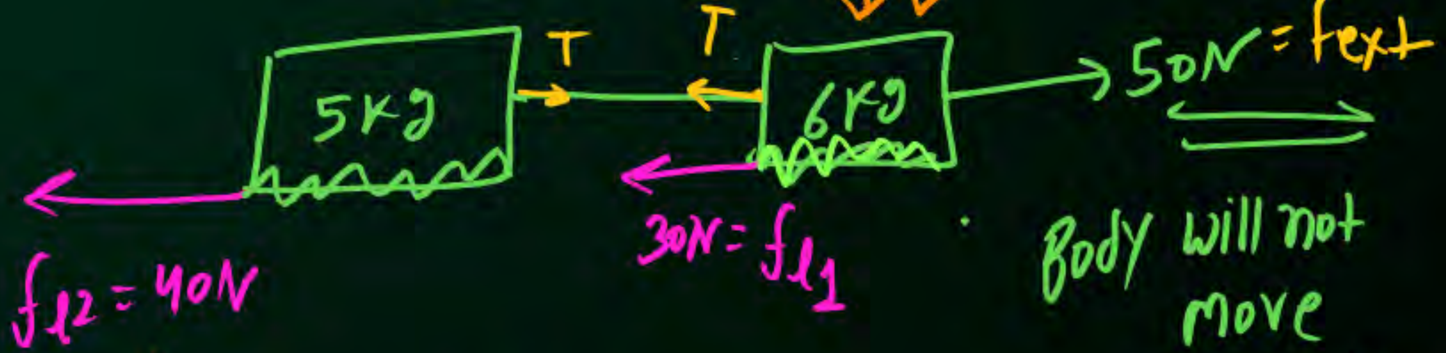
Make F.B.D of 1st object & Balance force on it.

$a = 0$ (find) $= 0$

$T = 20N$

$f_{6kg} = 30N$

$T = 20N$, $f_{5kg} = 20N$



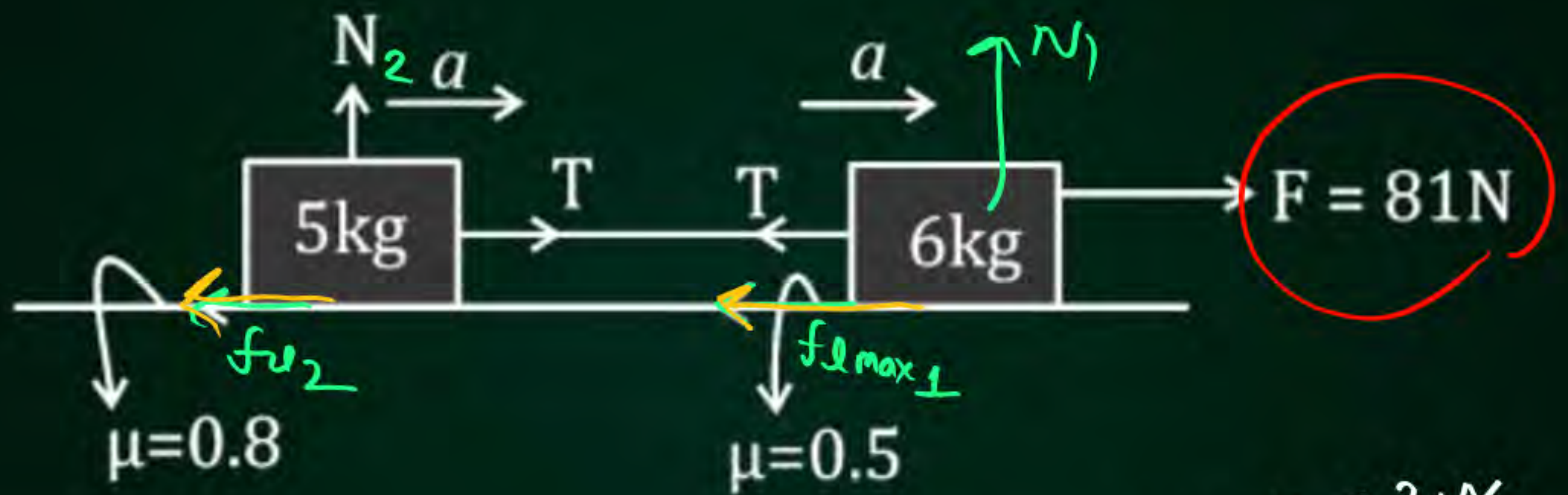
Body will not move

friction is self adjustable

$a_{system} = 0$ #

QUESTION

Find acceleration, tension and friction acting on objects.



Sol^n

$f_{l_1 max} = \mu N = \frac{5}{10} 6g = 30N$

$f_{l_2} = 40N$

$(f_1 + f_2)_{Max} = 70N$, $F = 81N$

$a = \frac{81-70}{11} = \frac{11}{11} = 1 m/s^2$

friction on 6kg is = 30N

$a = 1 m/s$, T, 81N, 30

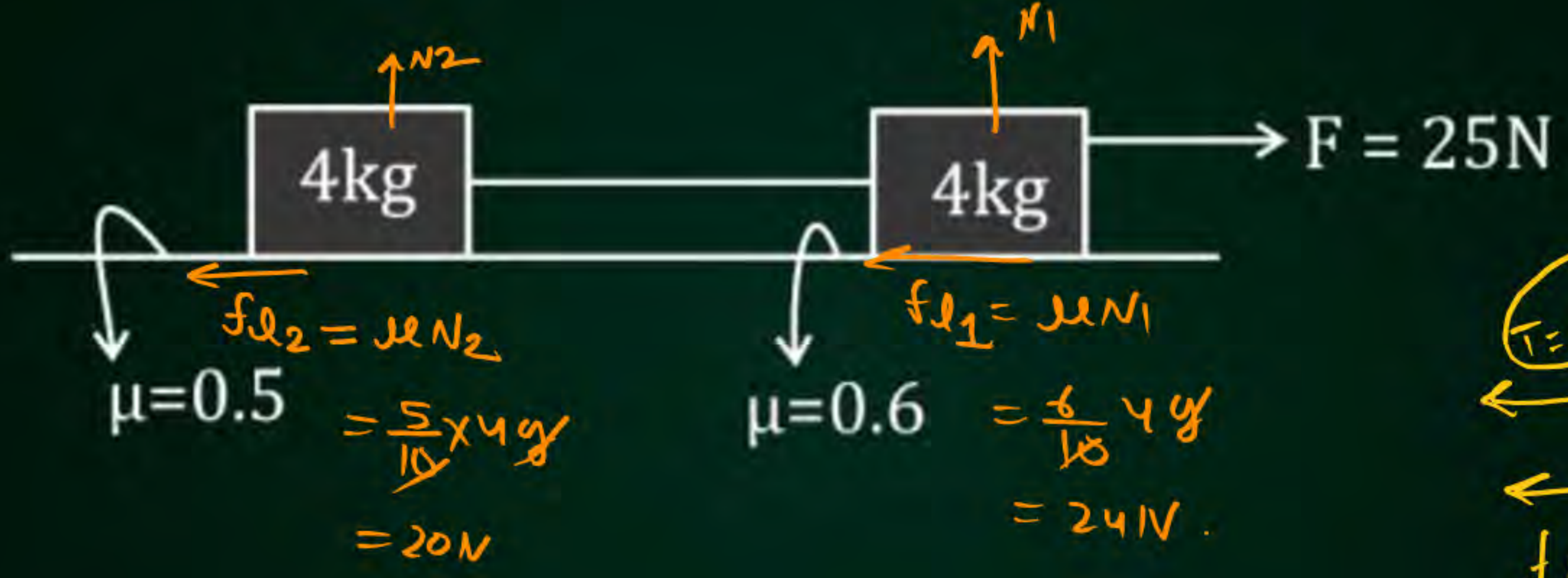
$81 - 30 - T = 6 \times 1$

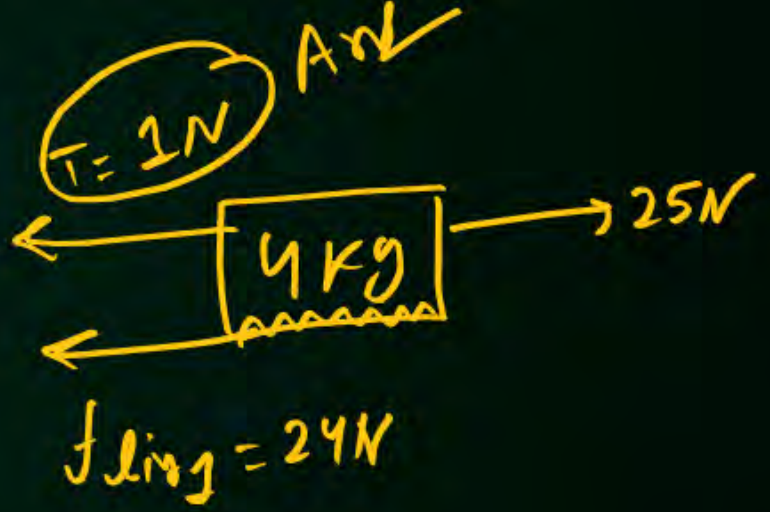
$51 - 6 = T$

$T = 45$ Newton Ans

QUESTION

Find tension, friction and acceleration.





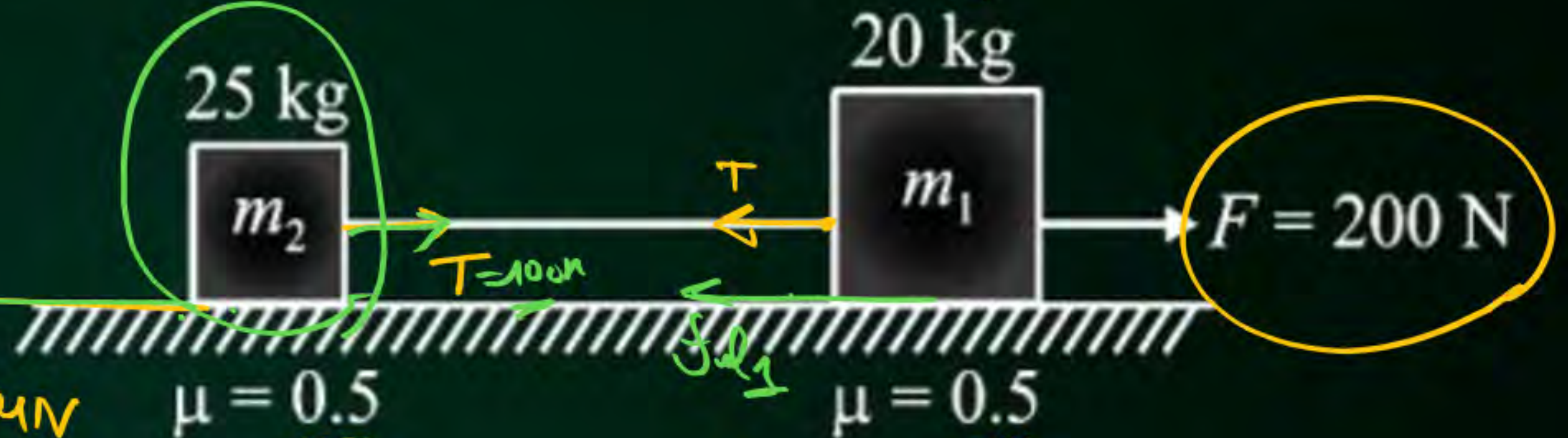
$f_{limit\ total} = 20 + 24$
$= 44N.$

$F_{applied} = 25N$

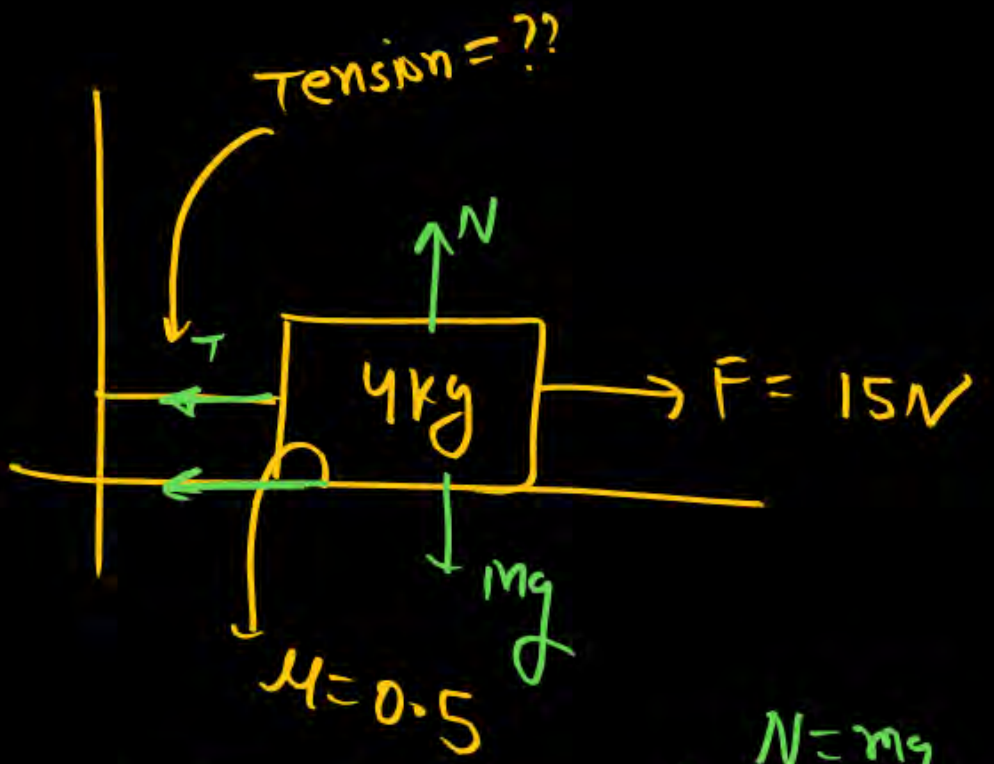
$a = 0$ (Bodies will be at rest)

QUESTION

In the given figure, $F = 200$ N, $m_1 = 20$ kg, $m_2 = 25$ kg, $g = 10\ \text{m/s}^2$. Find the friction acting on the block of mass m_2 [Take $g = 10\ \text{m/s}^2$]



1. 125 N
2. 120.5 N
3. 100 N
4. 123.2 N

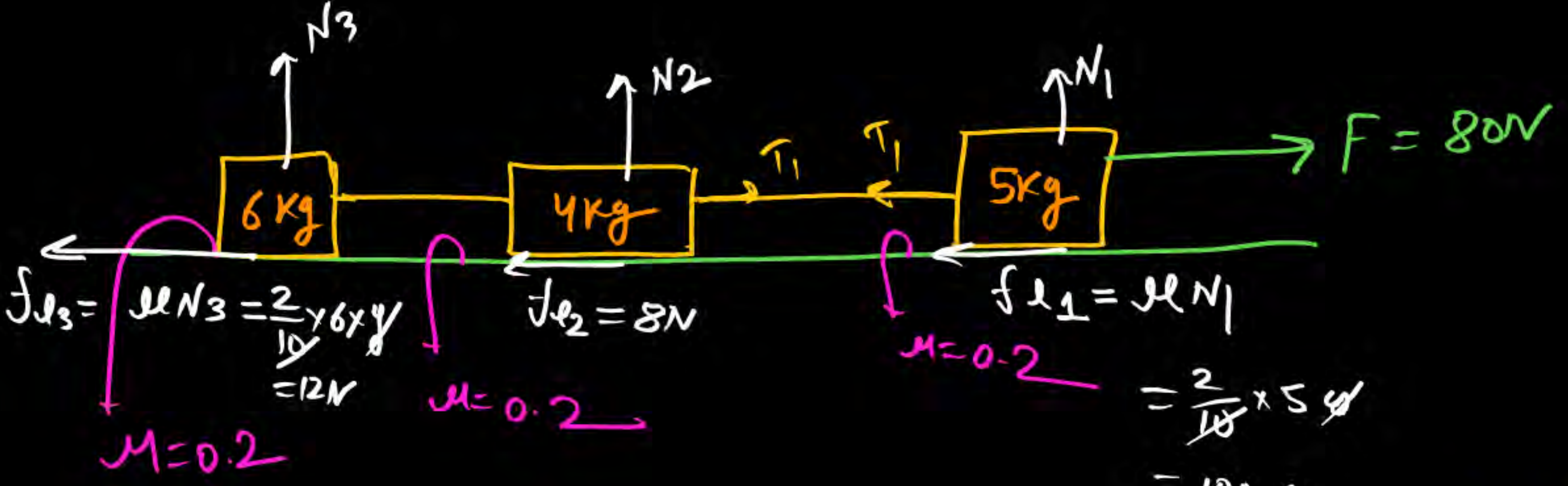


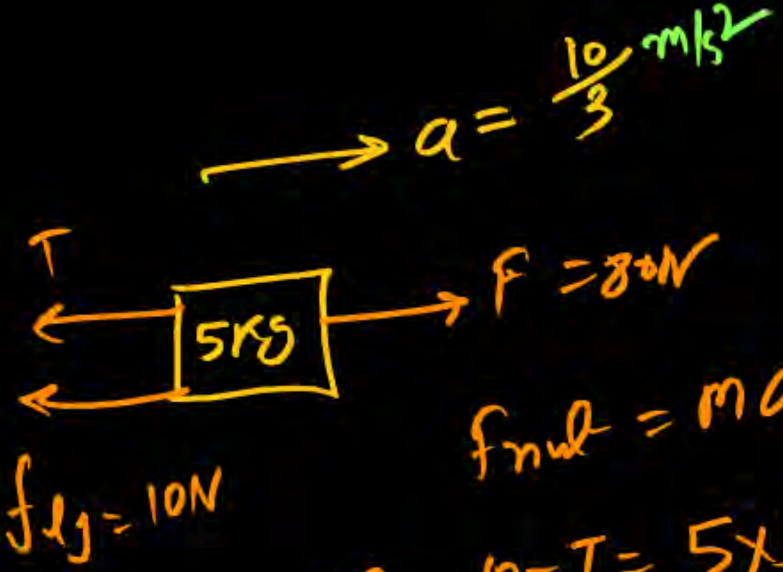
$N = mg$

$f_{l\,max} = \mu N = \frac{5}{10} \times 4 \times 10 = 20N$

Tension = 0

* Rest → $f_{net} = 0$
* $acc^n \rightarrow f = ma$





$f_{net} = ma$

$80 - 10 - T = 5 \times \frac{10}{3}$

$T = 70 - \frac{50}{3}$

$T = \frac{160}{3} N$ Ans

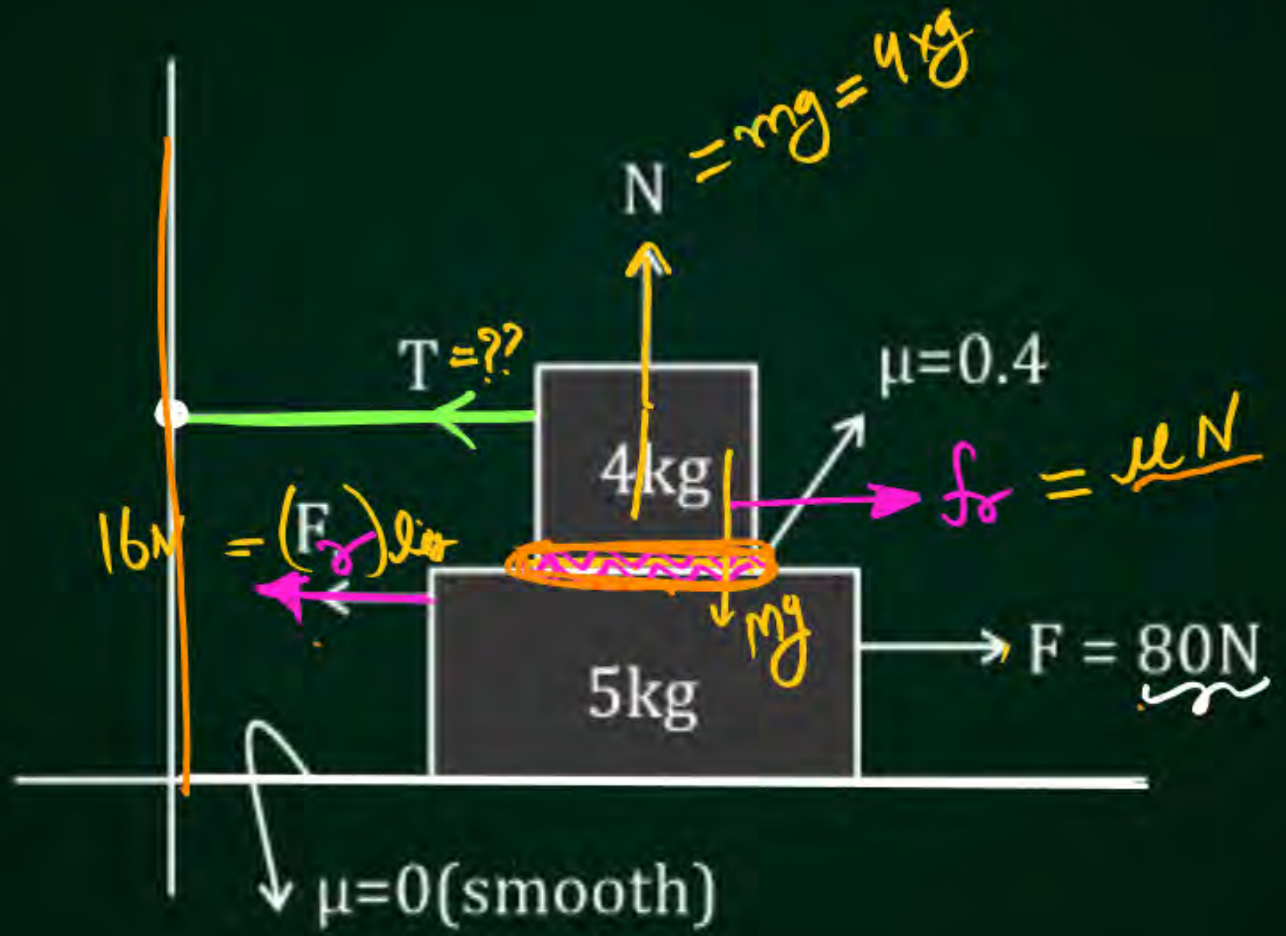
acc^n
Tension
friction

$f_{total\ lim} = 30N$

$F_{appl} = 80N$

$a = \frac{F_{net}}{M_{net}} = \frac{80 - 30}{15} = \frac{50}{15} = \frac{10}{3} m/s^2$

Find tension in string.



(a) T = 80N

(b) T = 16N

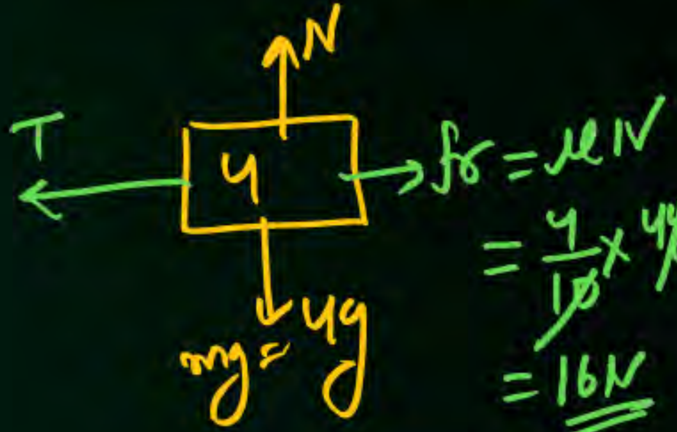
(c) T = 0

(d) T = 64 N



$a = \frac{80-16}{5} = m/s^2$

FBD of 4kg



$= \frac{4}{10} \times 4g$

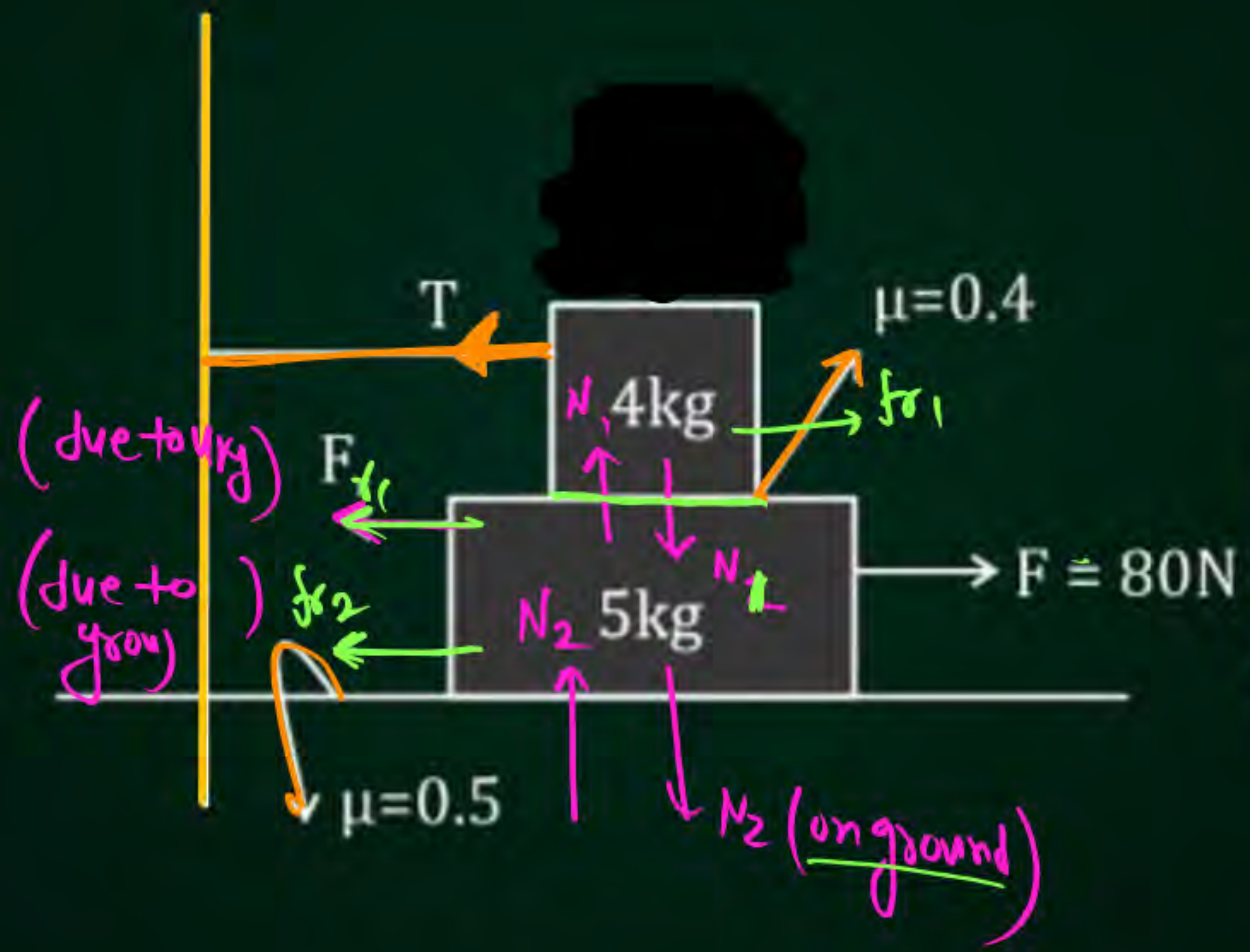
$= 16N$

$N = 4g$ — (1)

$T = (fr)_l = 16N$

QUESTION

Find tension in string.

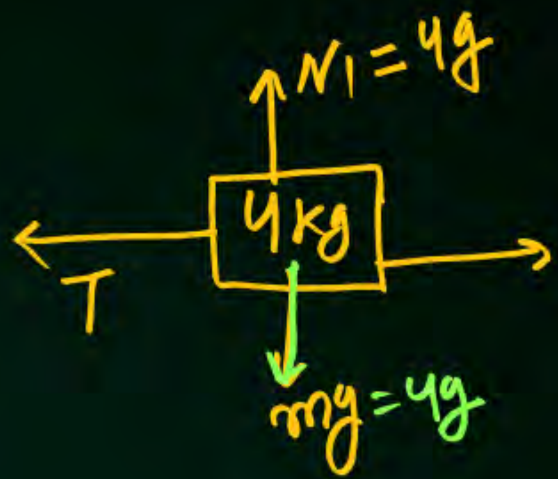


(a) 16N ✓

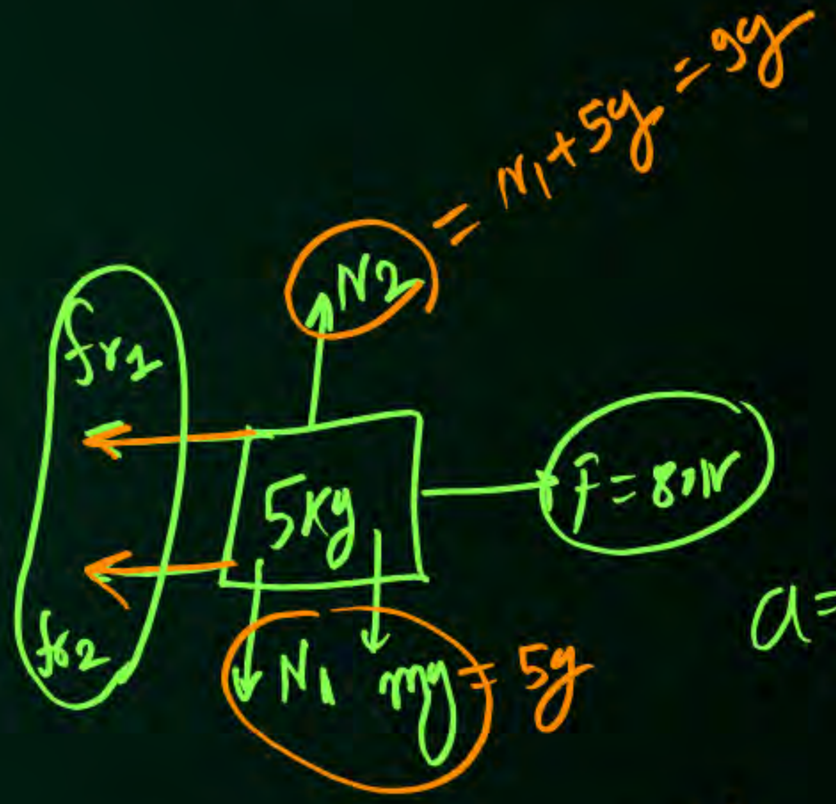
(b) 45N

(c) 55N

(d) 39N

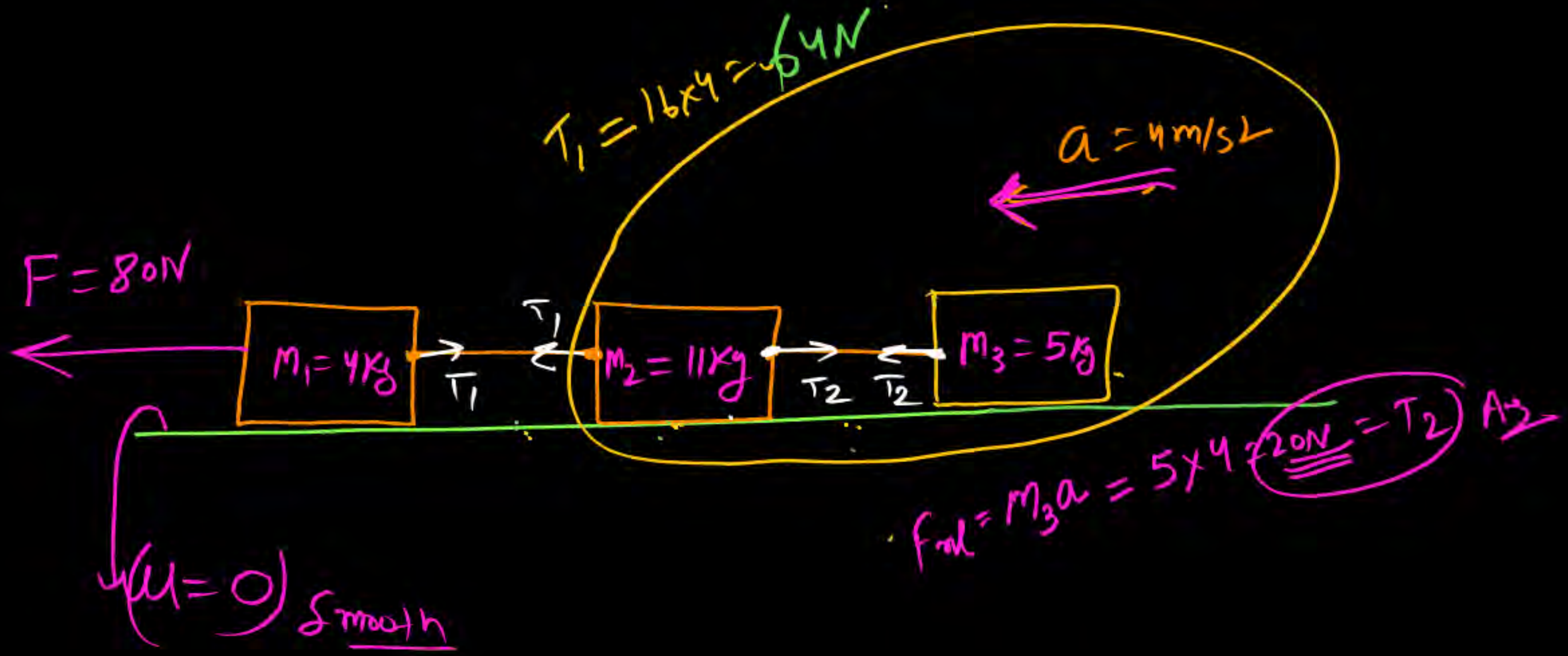


$(fr)_1 = \mu N_1 = \frac{4}{10} \times 40 = 16N$



$a = \frac{80-61}{5}$

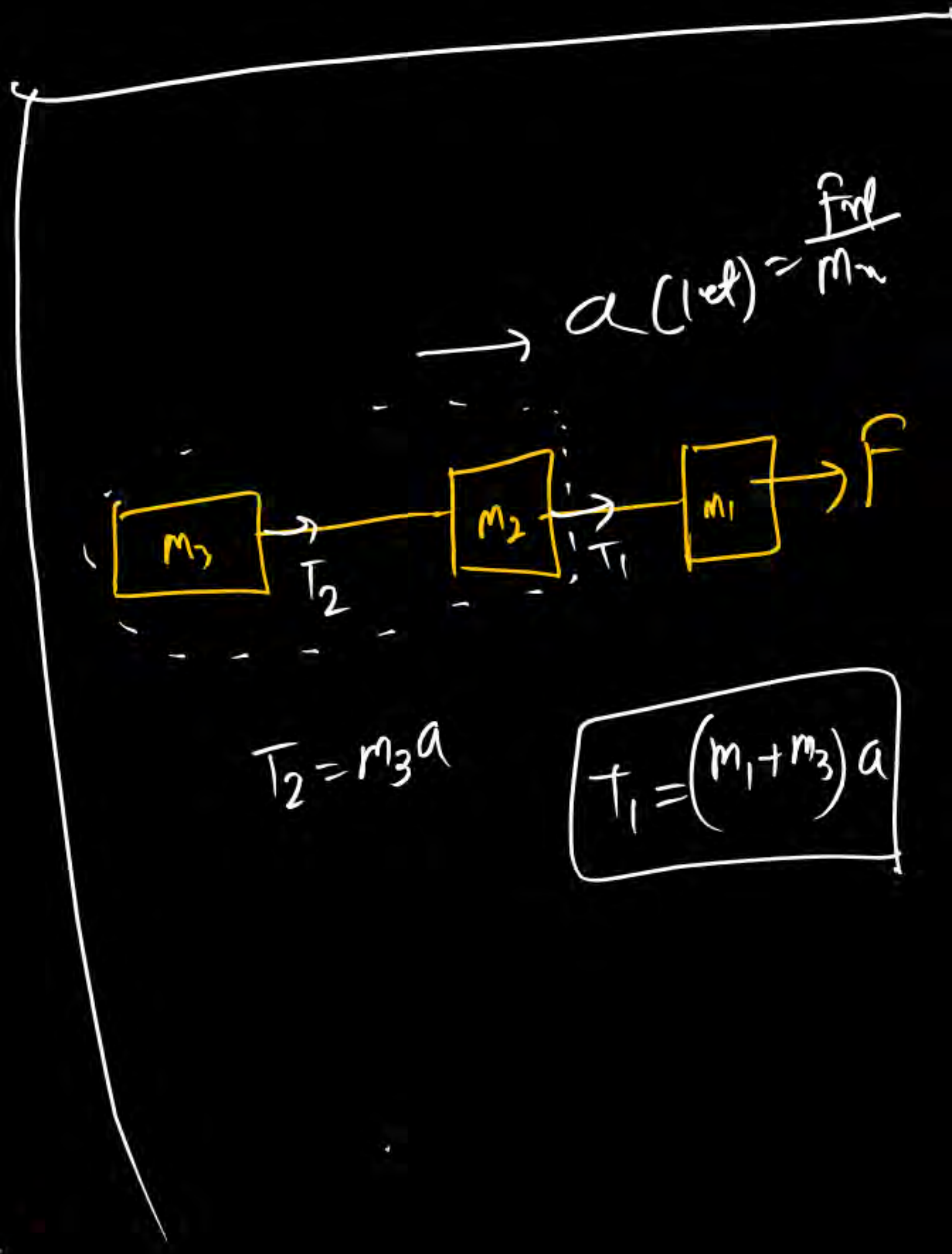
$fr_2 = \mu N_2 = .5 \times 9g = \frac{5}{10} \times 9 \times 10 = 45N$

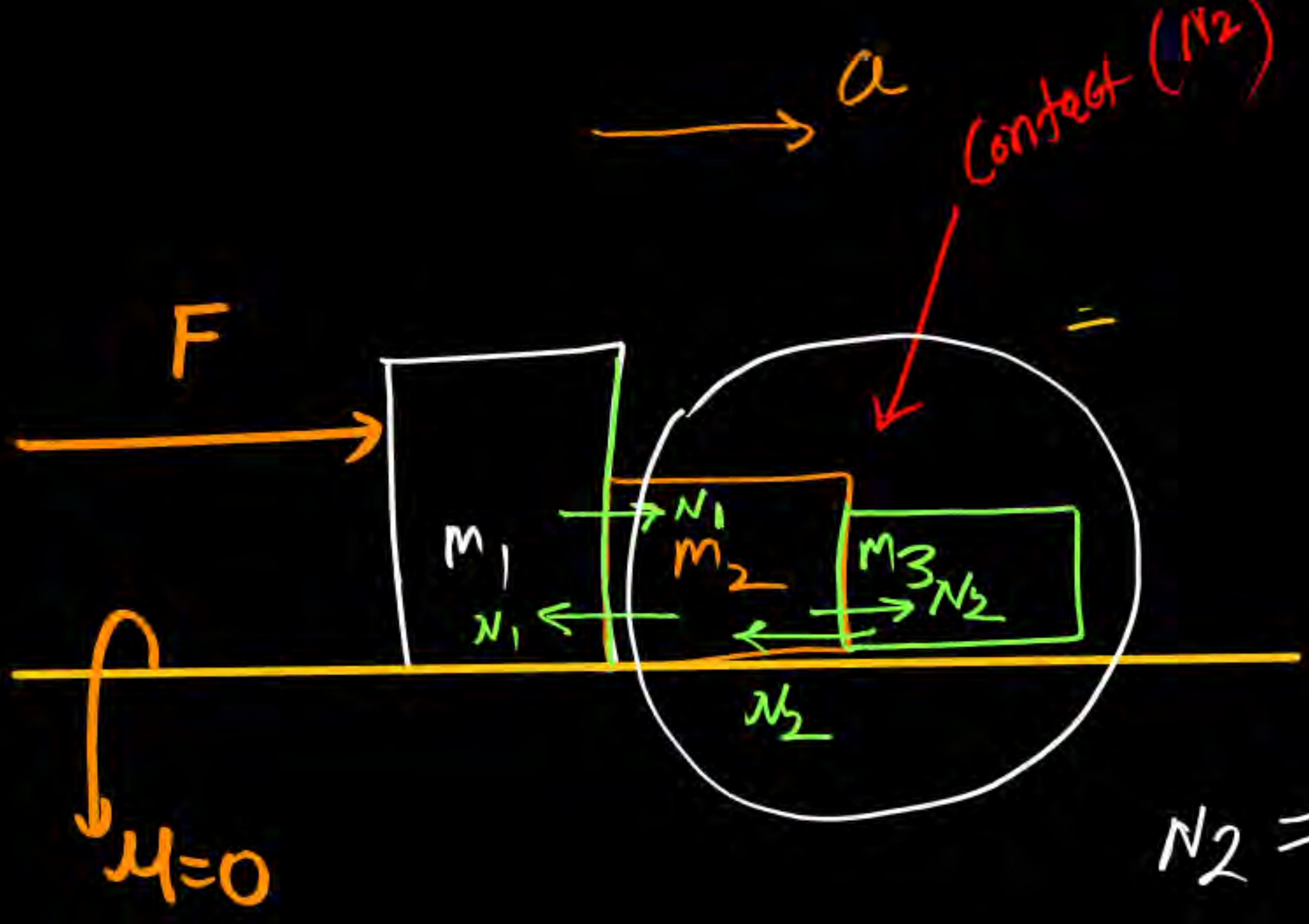


find Tension & accn of System ??



$a = \frac{F}{M} = \frac{80}{20} = 4 m/s^2$ (They are moving together)



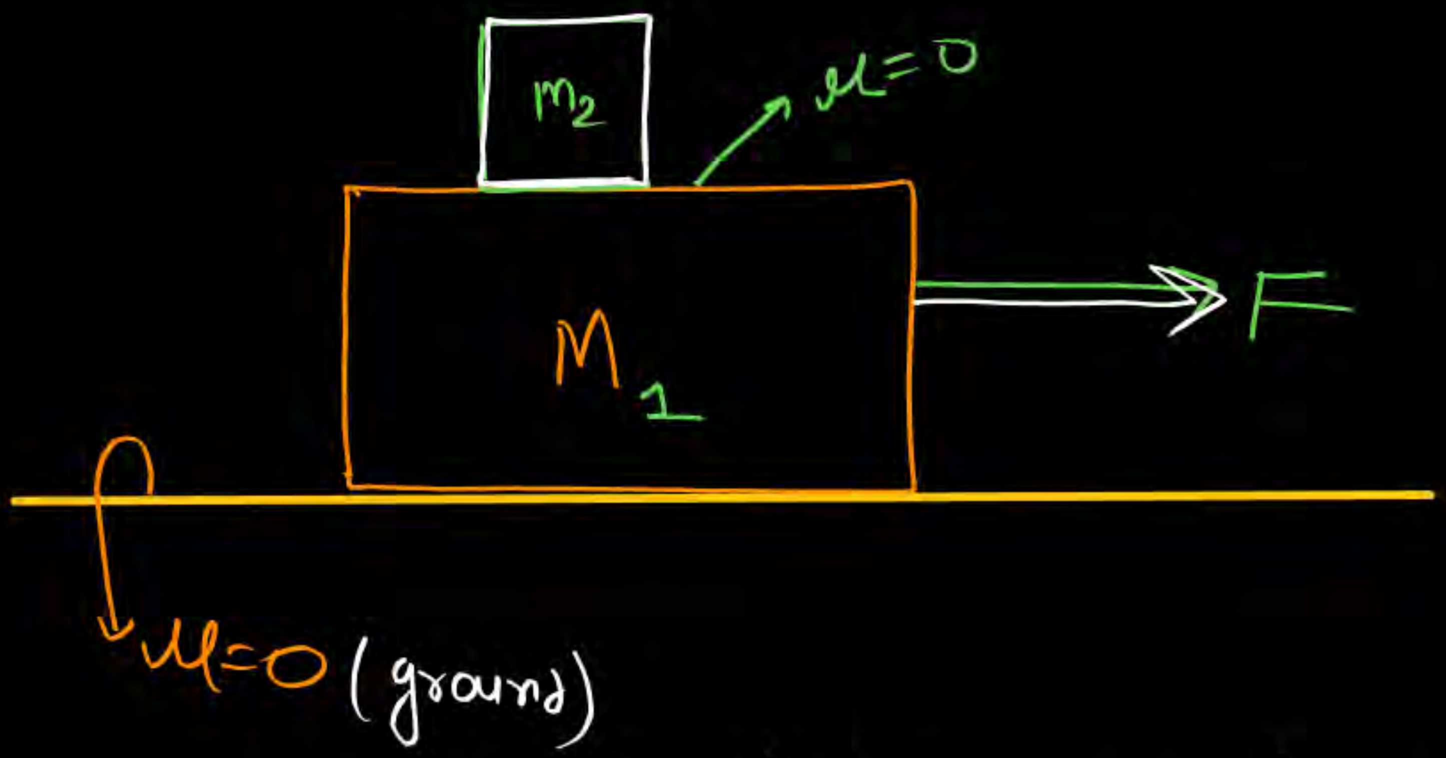


$$a = \frac{F}{m_1+m_2+m_3} \quad \text{(Move together)}$$

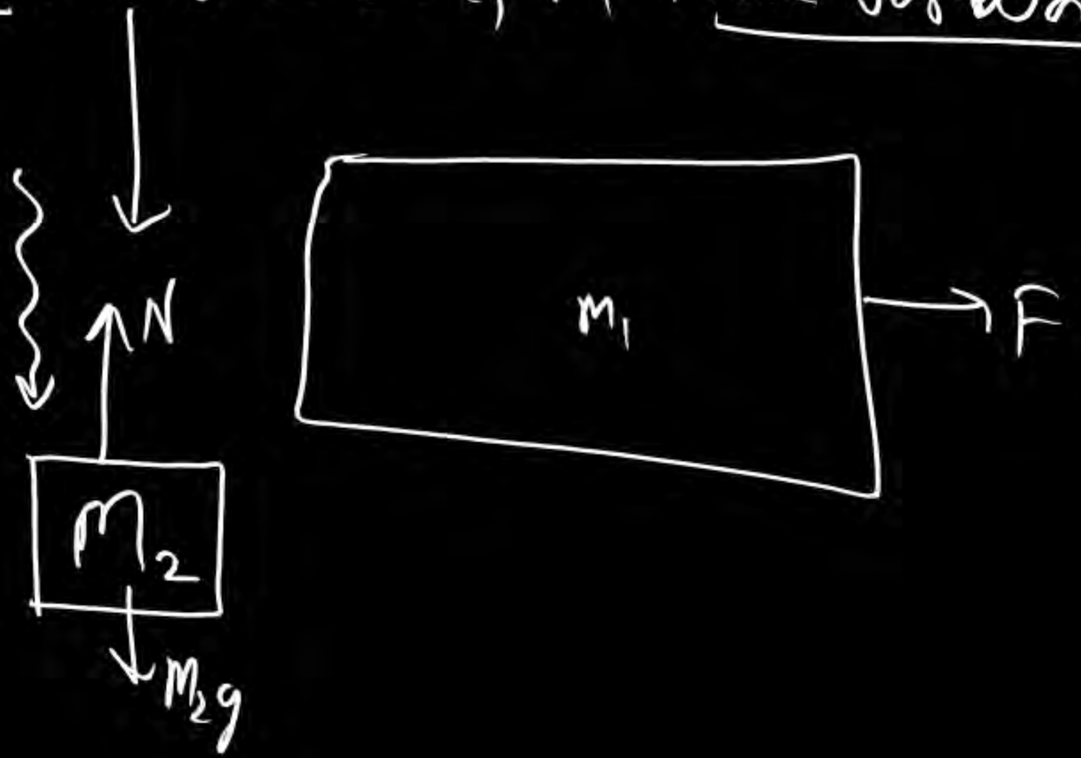
$$N_2 = a_{sys} \text{ (m front ka mass)}$$

$$N_2 = m_3 a = m_3\left(\frac{F}{m_1+m_2+m_3}\right)$$

$$N_1 = (m_2+m_3)\left(\frac{F}{m_1+m_2+m_3}\right)$$



m_2 will free fall, m_1 move forward





$$a_{sys} = \frac{F}{m_1 + m_2}$$

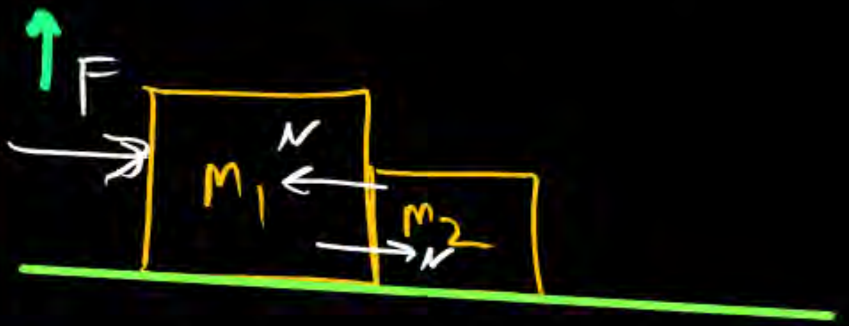
m_2 ka F.B.D



$$T = m_2 a \quad \text{— (1)}$$



$$F - T = m_1 a$$



$$a = \frac{F}{m_1 + m_2}$$

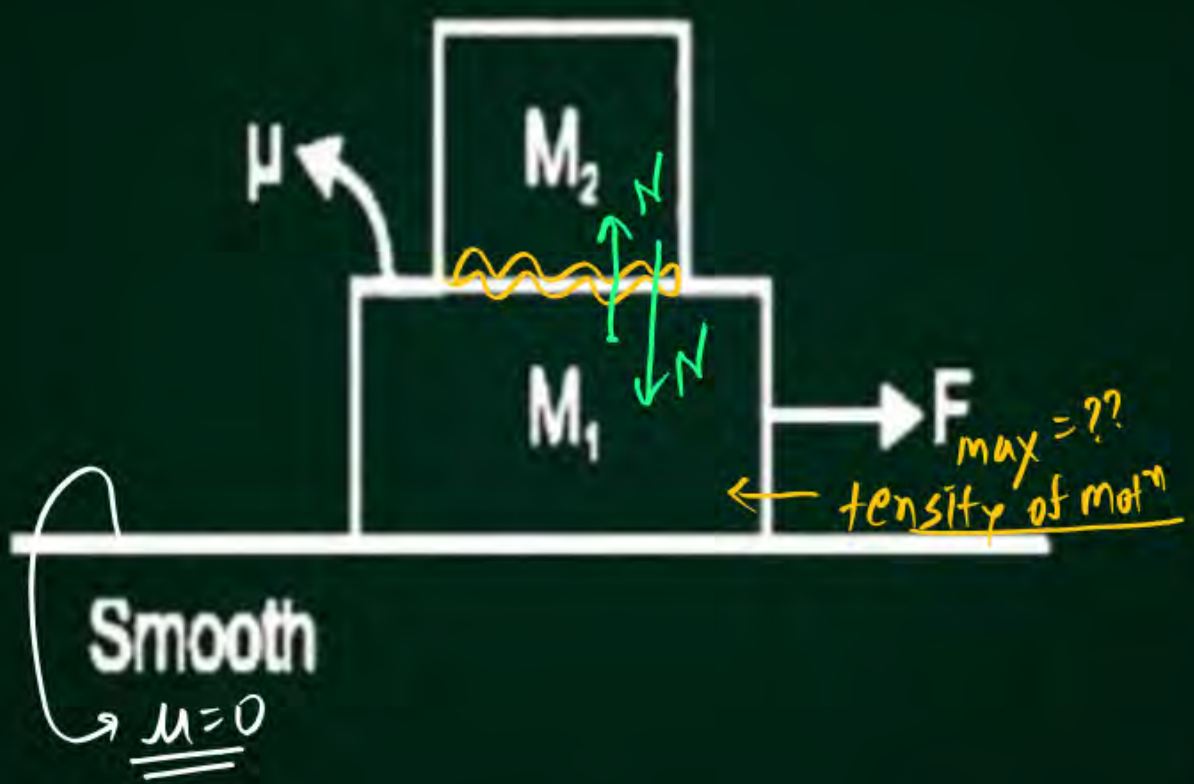
FBD of m_2

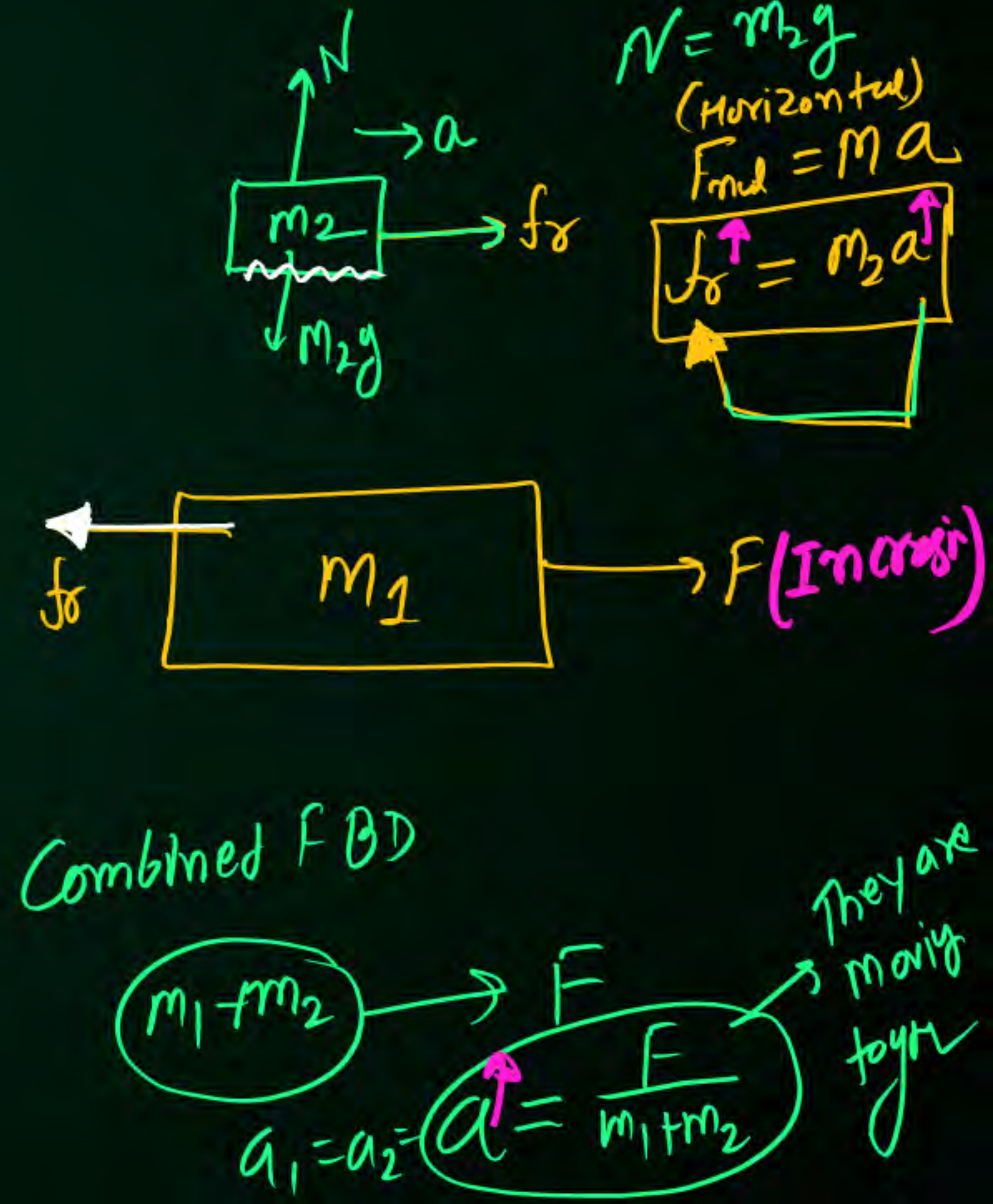


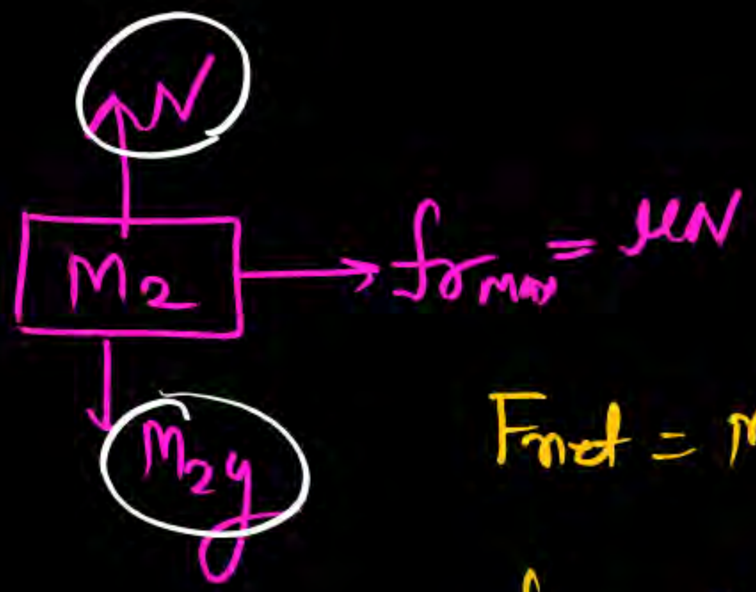
$$N = m_2 a$$

QUESTION

Two rough blocks system on smooth horizontal surface, find maximum force acting on lower block so that they will move together.







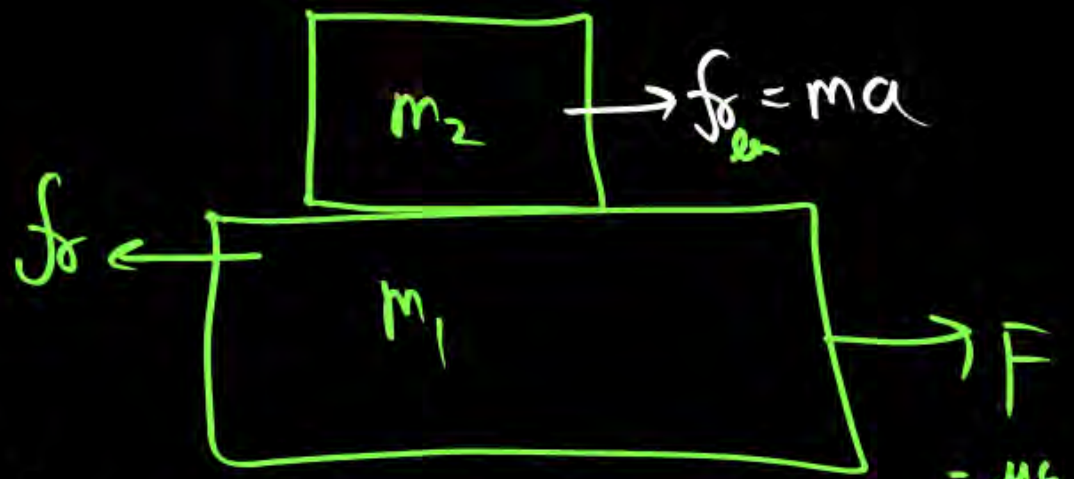
$F_{net} = ma$ (Horizontal

$f_{r\,max} = m_2 a_{max}$

$\mu N = m_2 a_m$

$\mu \cancel{m_2} g = \cancel{m_2} a_{max}$

$$a_{max} = \mu g$$



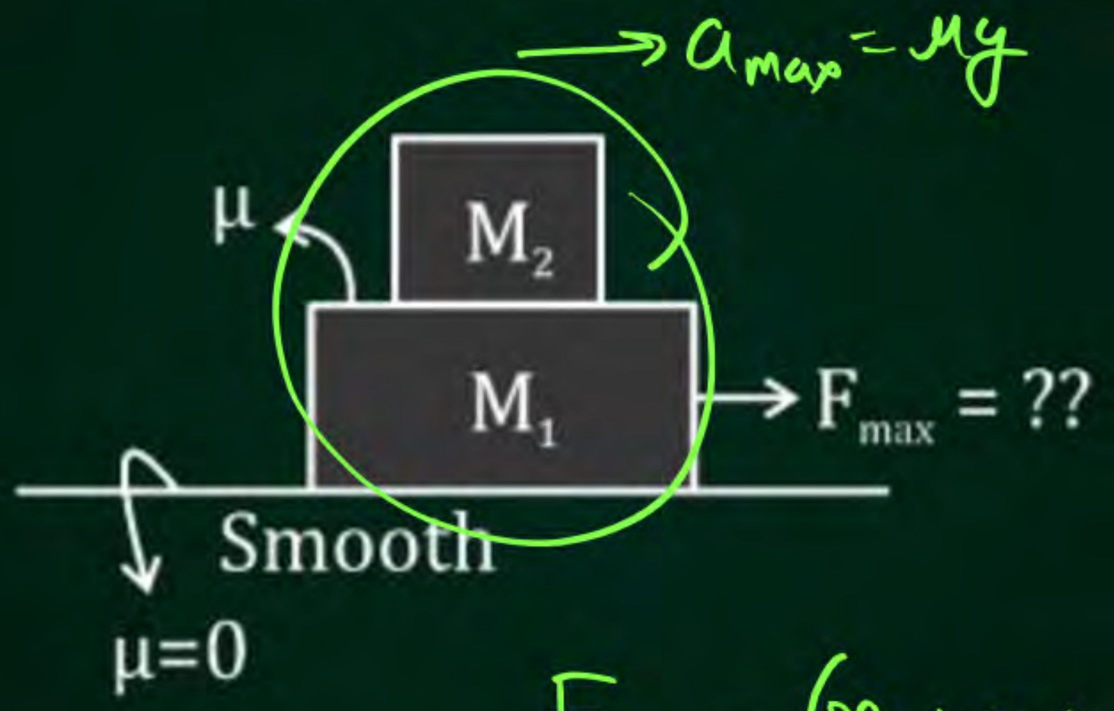
Case-1 $a < a_{max} (\mu g)$
they move together
f_{m_2} = static = $m_2 a$
Simple case

$a = a_{max}$ ($= \mu g$)
about to slide

$a > \mu g$ (a_{max})
they will not move together

QUESTION

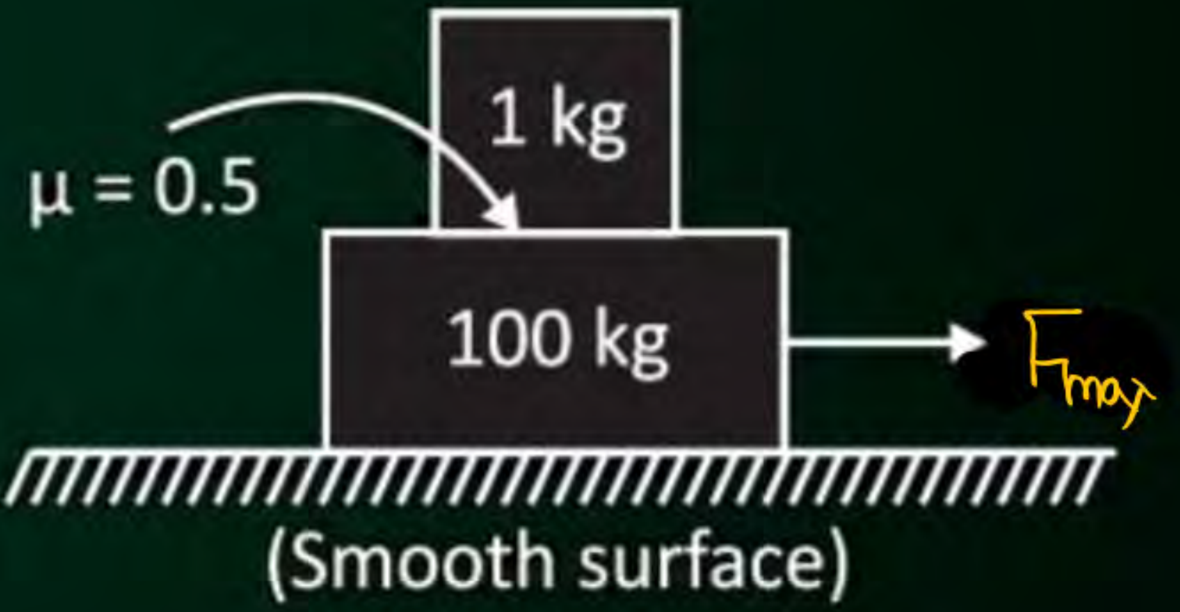
Two rough blocks system on smooth horizontal surface, find maximum force acting on lower block so that they will move together.



$$F_{max} = (m_1 + m_2) a_m$$
$$= (m_1 + m_2) \mu g$$

QUESTION

The maximum value of F which can be applied on the system shown in figure so that both blocks move together with same acceleration is



$a_{max} = \mu g = \frac{5}{10} \times 10 = 5\ m/s^2$

$F_{max} = (100+1)\mu g$

$= 101 \times 5$

$= 505\ N$

QUESTION

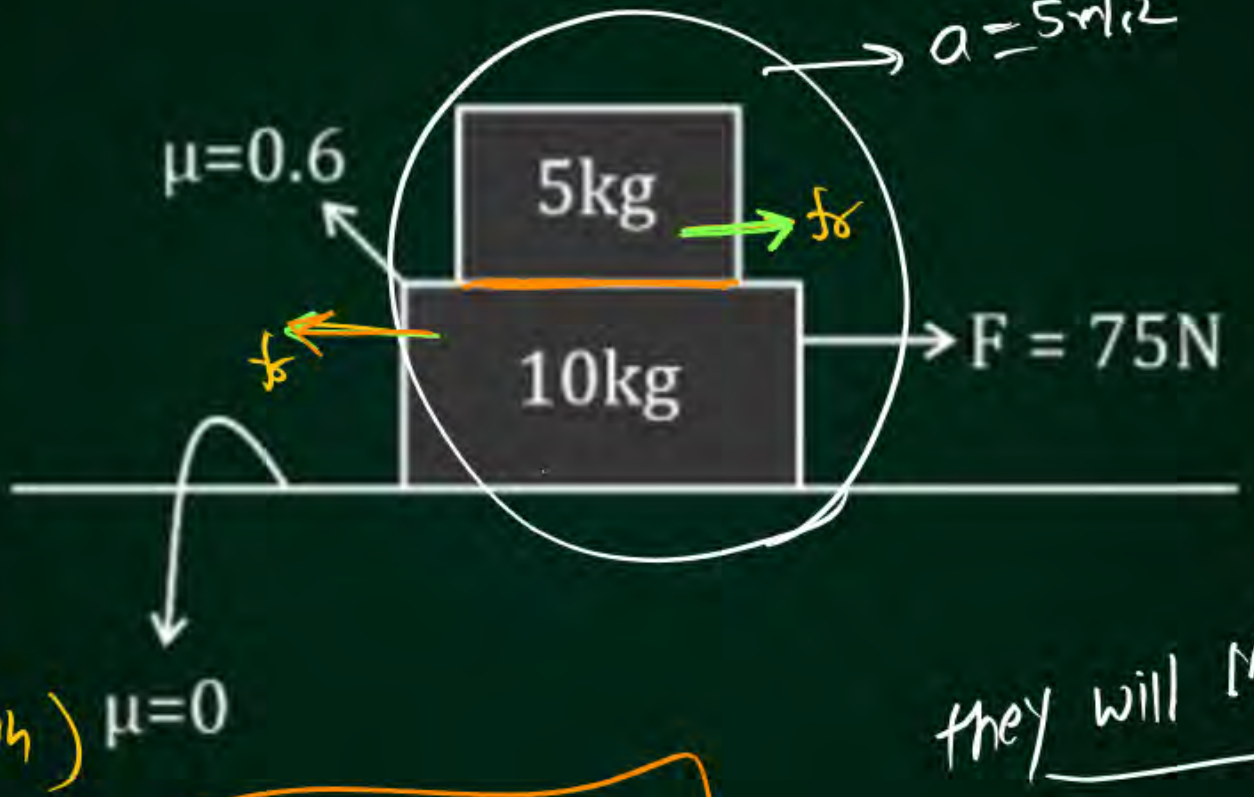
Find acceleration and friction acting on object.

Step-1

find $a_{max} = \mu g$

$a_{max} = 0.6 \times 10 = 6\ m/s^2$

for Compare



Step-2

assume they are Moving togethr

$(10+5) \rightarrow 75N$

$a = \frac{75}{15} = 5\ m/s^2$

step 3

$a_{togh} < a_{max}$

they will Move togethr with acn $5\ m/s^2$.

$5kg \rightarrow fr = ma$

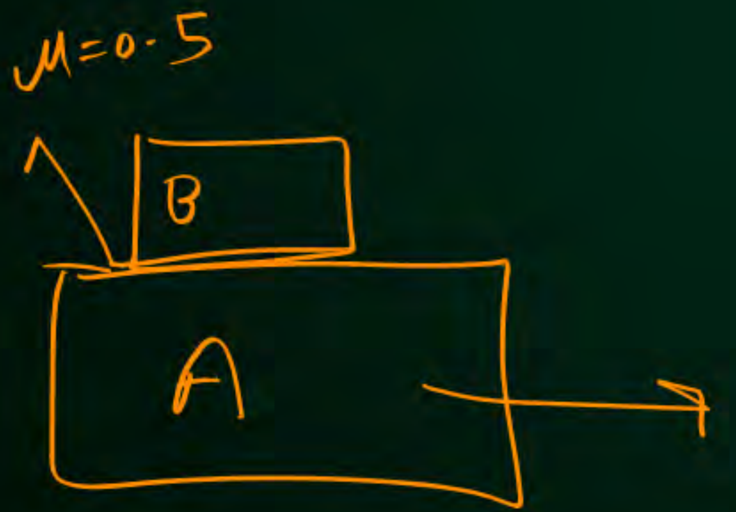
$fr = 5 \times 5$

$fr = 25N$ (static)

QUESTION

Two blocks A and B of masses 5 kg and 3 kg respectively rest on a smooth horizontal surface with B over A. The coefficient of friction between A and B is 0.5. The maximum horizontal force (in kg wt.) that can be applied to A, so that there will be motion of A and B without relative slipping, is:

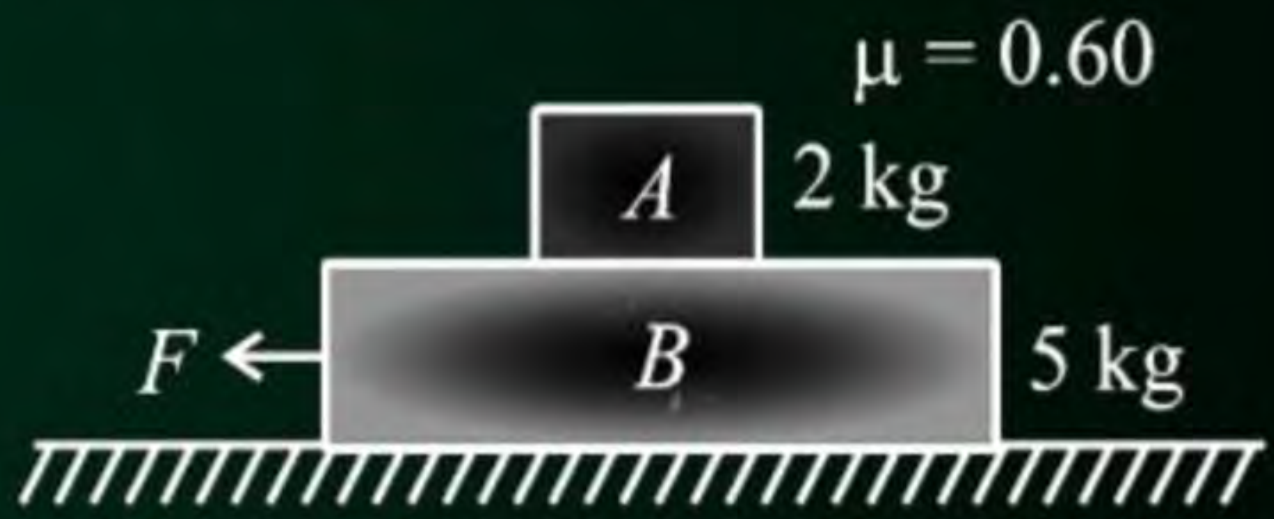
1. 1.5
2. 2.5
3. 4
4. 5



QUESTION

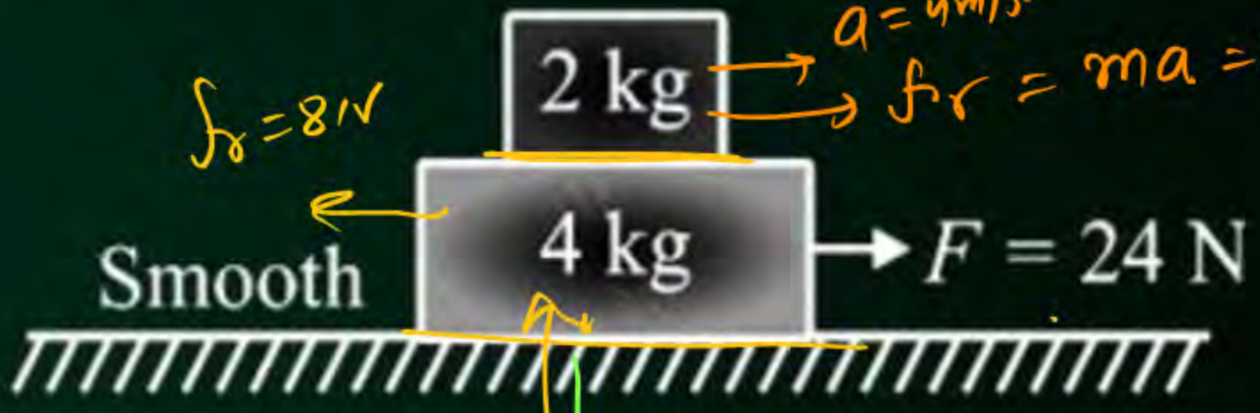
Two blocks (A) 2 kg and (B) 5 kg rest one over the other on a smooth horizontal plane. The coefficient of static and dynamic friction between (A) and (B) is the same and equal to 0.60. The maximum horizontal force F that can be applied to (B) in order that both (A) and (B) do not have any relative motion is :

1. 42 N
2. 42 kgf
3. 5.4 kgf
4. 1.2 N



QUESTION

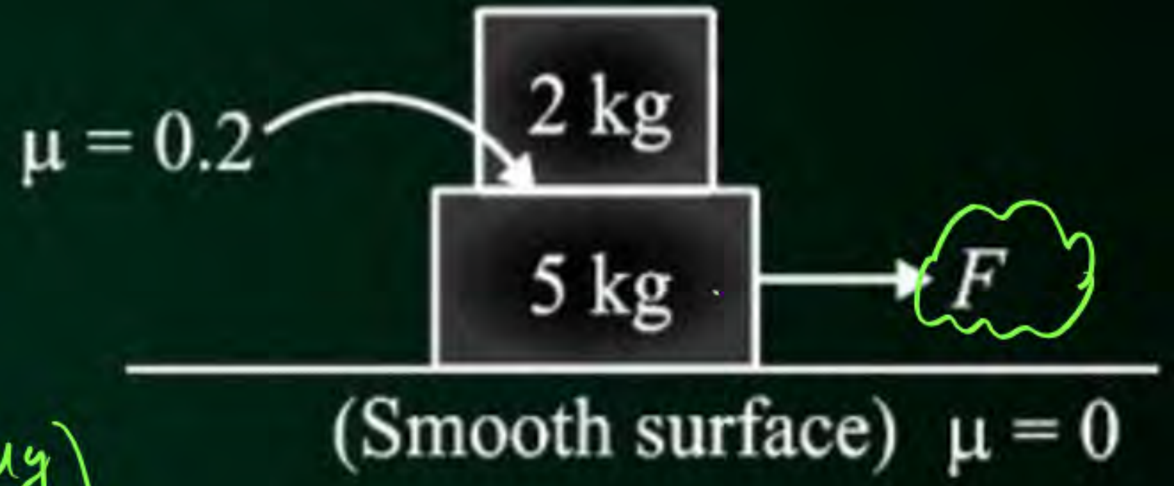
In the arrangement coefficient of friction between the two blocks is $\mu = \frac{1}{2}$. The force of friction acting between the two blocks is:



1. 8 N
2. 6 N
3. 10 N
4. 12 N

QUESTION

For what value of force F, the mass 2 kg starts its motion in left direction relative to 5 kg [Take $g = 10\ m/s^2$]



1. 4 N
2. 10 N
3. 14 N ✓
4. 7 N

limiting ($a_m = \mu g$)

$F_{max} = (5+2) \times 0.2 \times 10 = 14\ N$

$F_{applied} = 14\ N$ about to slipping

$F_{app} > 14\ N$ they will move separately

$F_{app} < 14\ N$ move together

QUESTION

Find acceleration and friction acting between them.

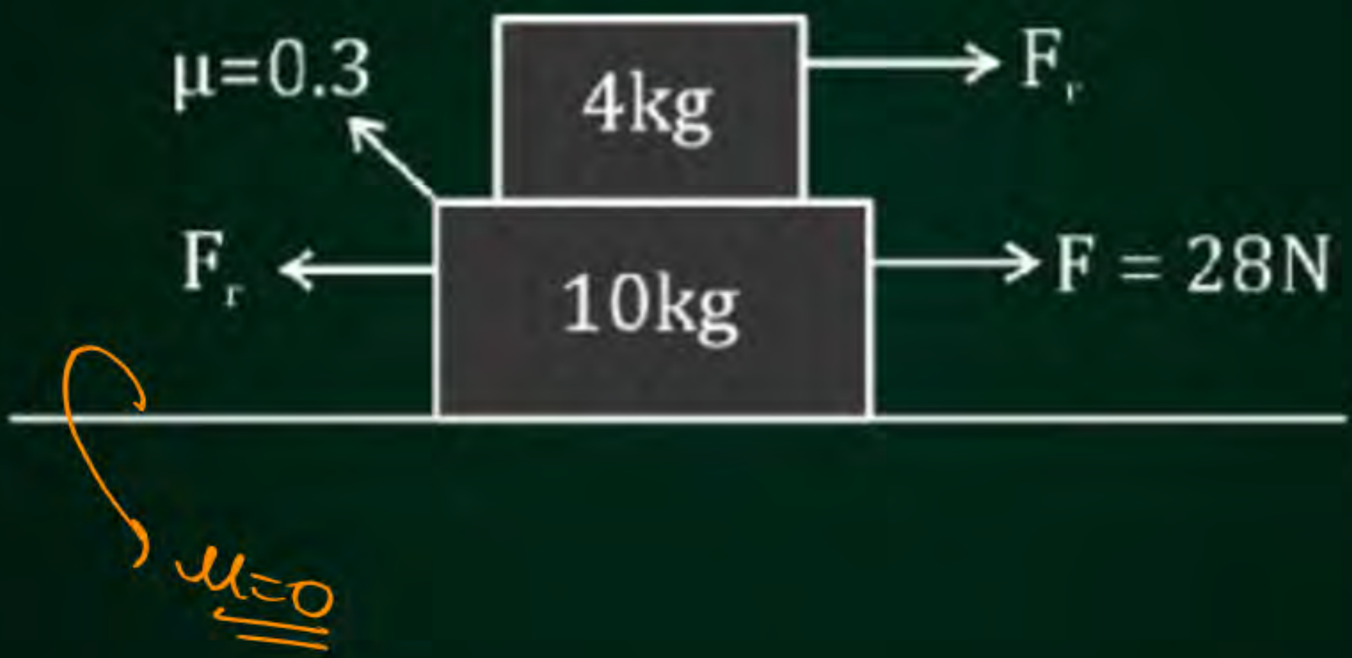
Step-1

$a_{max} = \mu g = 0.3 \times 10 = 3 m/s^2$

$a_{together} = \frac{28}{14} = 2 m/s^2$

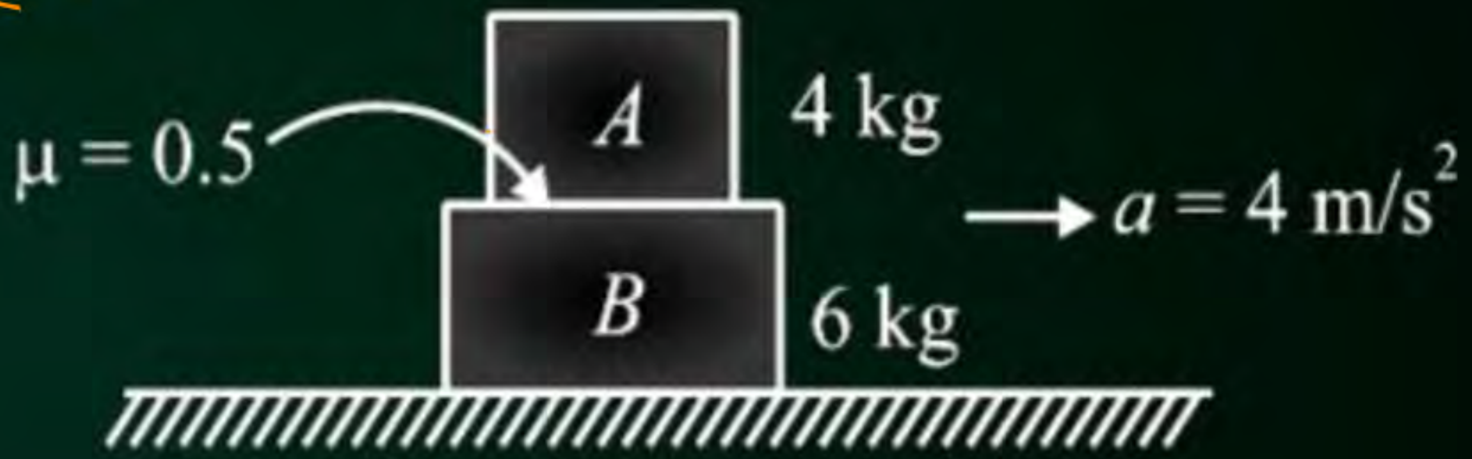
Move together

$f_r = 8N$



QUESTION

What is the friction force acting on the upper block when the system of two blocks moves with an acceleration of $4\ m/s^2$?

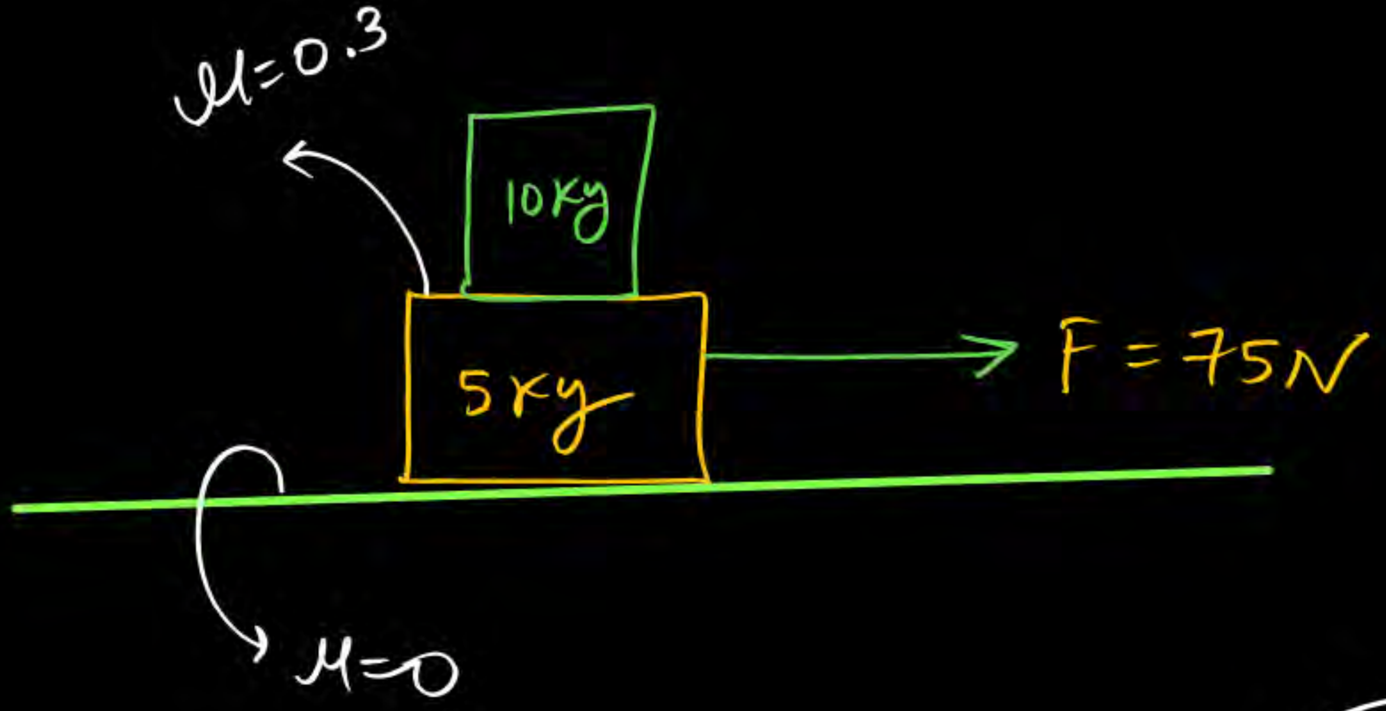


1. 20 N
2. 16 N
3. 12 N
4. Zero

find accⁿ of system & frictio B/w them

$\Rightarrow$ $$a_{max} = \mu g = \frac{3}{10} \times 10 = 3\,m/s^2$$

(upper block)



If they are moving togeth

$$a_{sys} = \frac{75}{15} = 5\,m/s^2$$

They will not moving togeth.

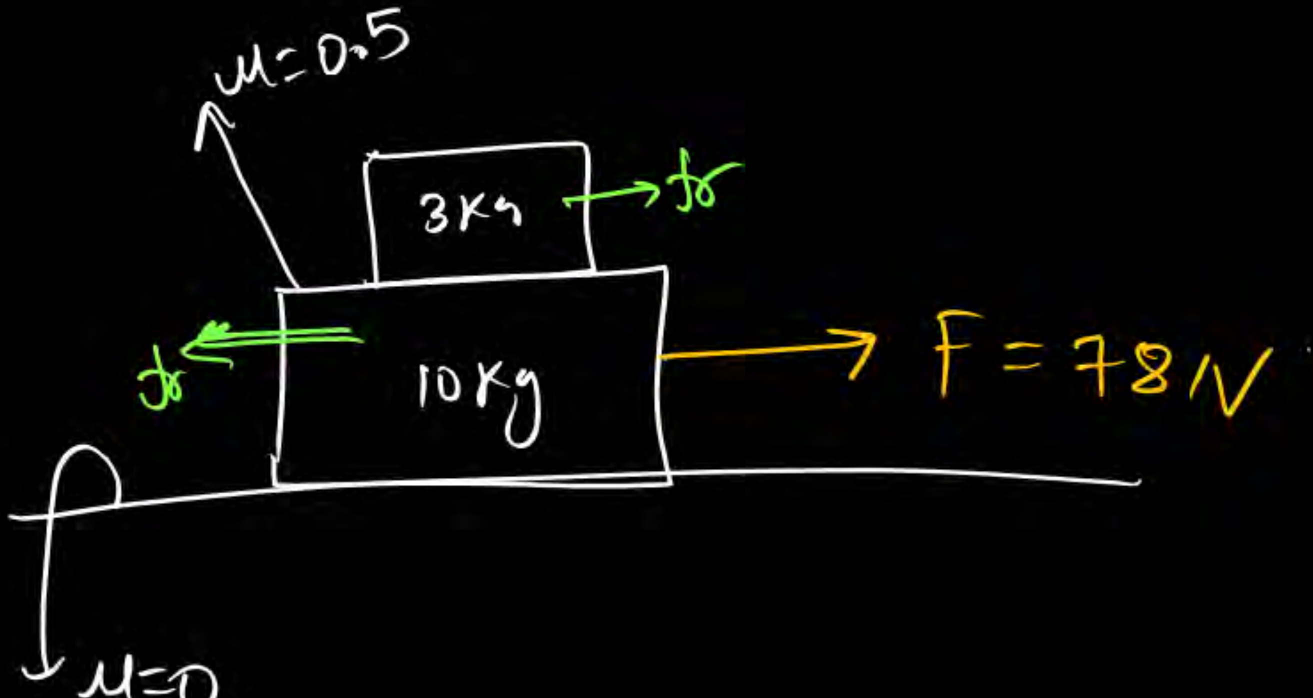
10kg $\rightarrow$ $f_{fr} = \mu N = \frac{3}{10} \times 10 \times 10 = m a_{max} = 3\,m/s^2$



$$a = \frac{75-30}{5} = \frac{45}{5} = 9\,m/s^2$$

IMP* If they are not moving $(a_{max})_{upr} = \mu g$

$a_{lowr} > a_{togeth}$ (blocks)



Find friction & accⁿ of both the block.

Solⁿ step-1 $(a_{max} = \mu g$

$= 5 \times 10 / 10$

$= 5 m/s^2$

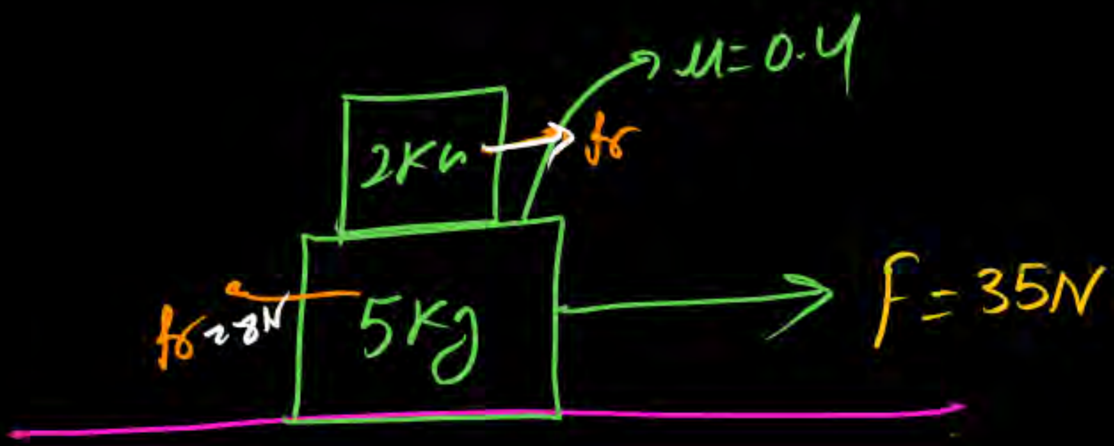
step-2

$a_{total} = \frac{78}{13} = 6 m/s^2$

$a_{3kg} = 5 m/s^2$

$f_r = 15N$

$a_{10} = \frac{78-15}{10} = \frac{63}{10} = 6.3 m/s^2$ Ans



Step-1

$a_{max} = \mu g$

$= 4$

$a_{total} = \frac{35}{7} = 5$

$a_{2kg} = 4 m/s^2$

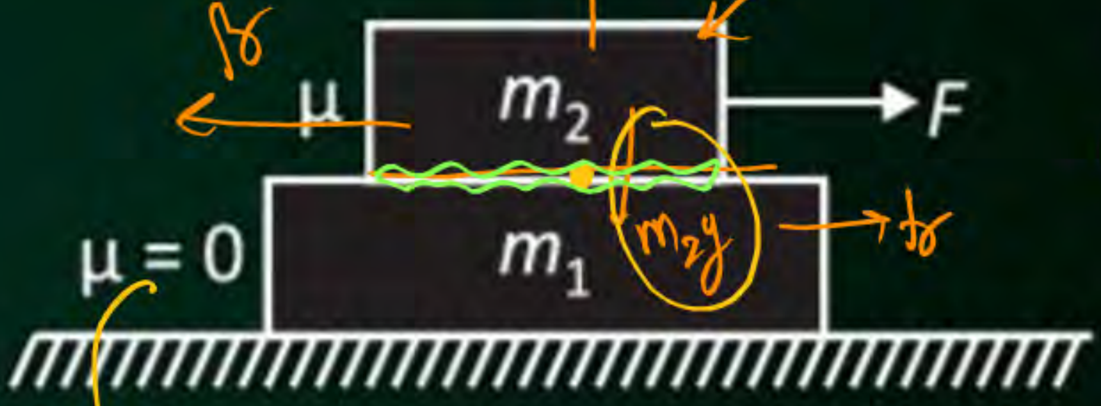
$f_r = 8N = m_2 a = 2 \times 4$

$a_{5kg} = \left(\frac{35-8}{5}\right)$

QUESTION

In the given arrangement the maximum value of F for which there is no relative motion between the blocks

1. [redacted]
2. [redacted]
3. [redacted]
4. [redacted]



$$F_{max} = (m_1 + m_2)\, a_m = (m_1 + m_2)\frac{\mu m_2 g}{m_1}$$

$$a_{max} = \frac{\mu m_2 g}{m_1}$$

$$a_{max} = \mu g\left(\frac{m_2}{m_1}\right)$$

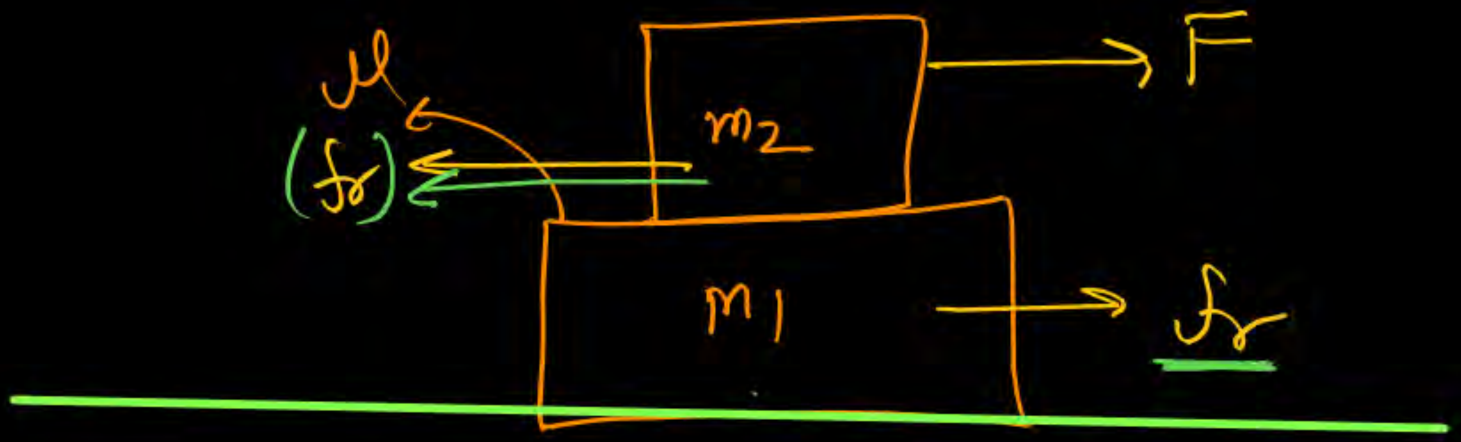
$f_r = m_1 a$

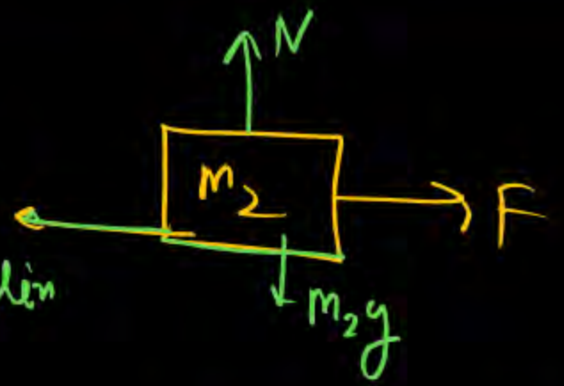
max^m acc^n so that move together

F.B.D of m_1

$$f_r^{max} = m_1 a_{max}$$

$$\mu m_2 g = m_1 a_m$$





$$\mu N = (f_r)_{lim}$$

$$\mu m_2 g = f_r$$



$$(f_r)_{max} = \mu m_2 g$$

$$F = ma$$

$$\mu m_2 g = m_1 a_{max}$$

$$a_{max} = \frac{\mu m_2 g}{m_1}$$


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture-14 | Physics

Laws of Motion

By- Dr. Manish Raj (MR SIR)



Topic To be Covered

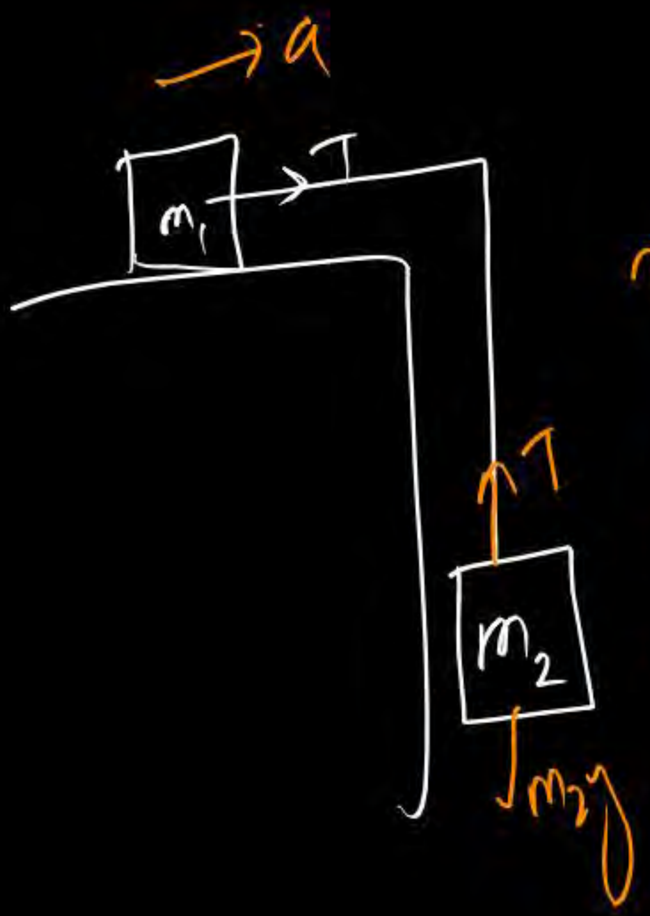
1 # Block over Block → Basic se MR tak.

2 # PhD. on circular Dynamics

3 #

4 #





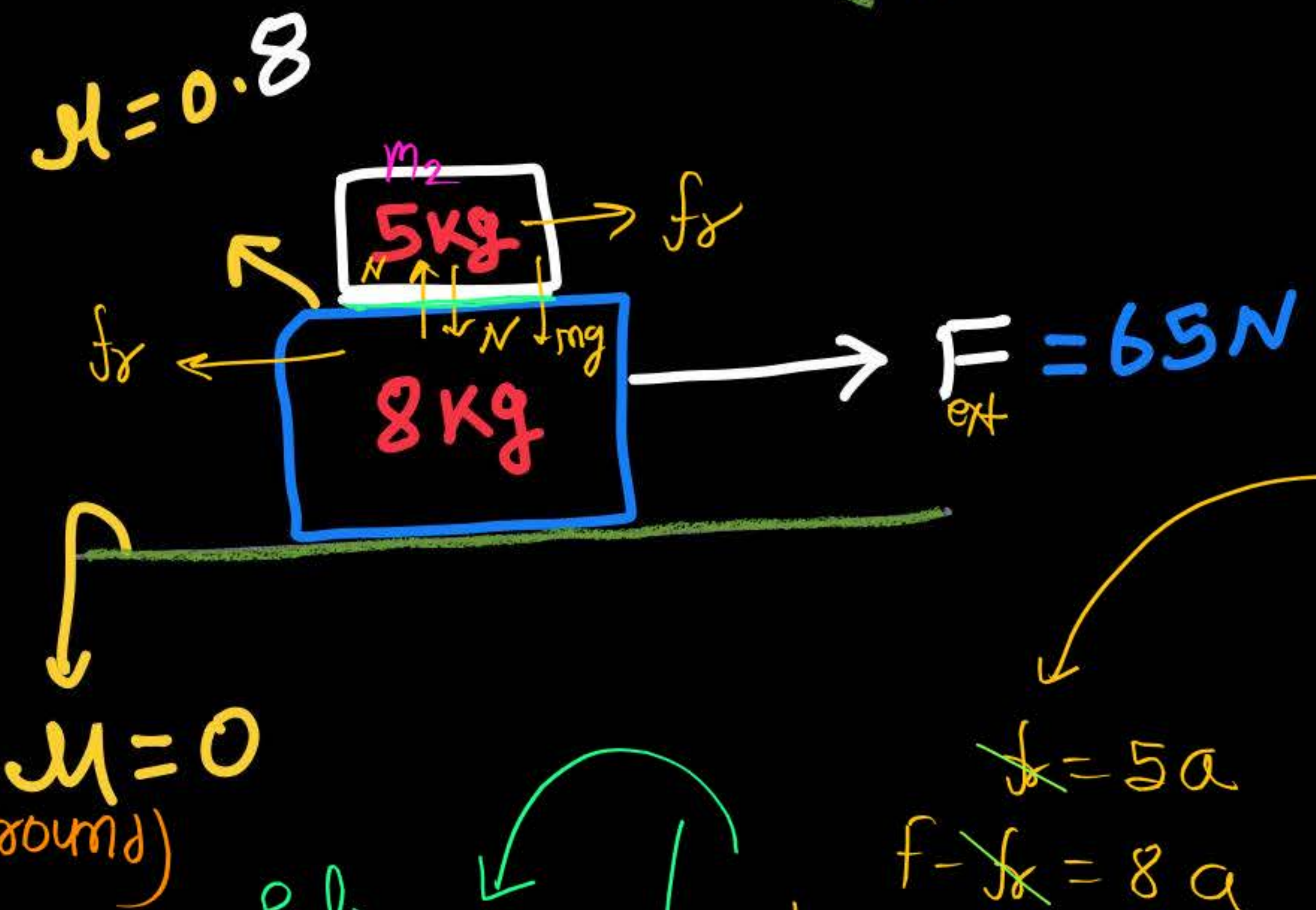
$$m_2 g - T = m_2 a$$

$$T = m_1 a$$

$$m_2 g = (m_1 + m_2) a$$



(Q). Find friction acting on Object & acc^n.



Sol^n

F.B.D of 5kg



$f_r = ma$ — (I) $\quad (F_x = ma_x)$

$mg = 50N$

$\Sigma F_y = 0$

$N = 50$ newton

F.B.D of 8kg



$\Sigma F_x = ma_x$

$F - f_r = ma$ — (II)

assumed they are moving together

$F - f_r = 8a$

$f_r = 5a$

$F - f_r = 8a$

$F = 13a$

$65 = 13a$

$a = \frac{65}{13} = 5 \, m/s^2$

Puting value of a in eq (1)

$f_r = ma$

$= 5 \times 5 = 25N$ → Ans of Fricti (required)

$a_1 = a_2 = 5 \, m/s^2$

check can friction apply 25N

$(f_r)_{lim} = \mu N$
$= 0.8 \times 50 = 40N$ (maximu)

IMP*

assume they are moving toggr

$$a = \frac{65}{8+5} = \frac{65}{13} = 5\,m/s^2$$

साथ-साथ

they are moving tog

$(f_s)_{ma} = \mu N = m_2 a_{ma}$

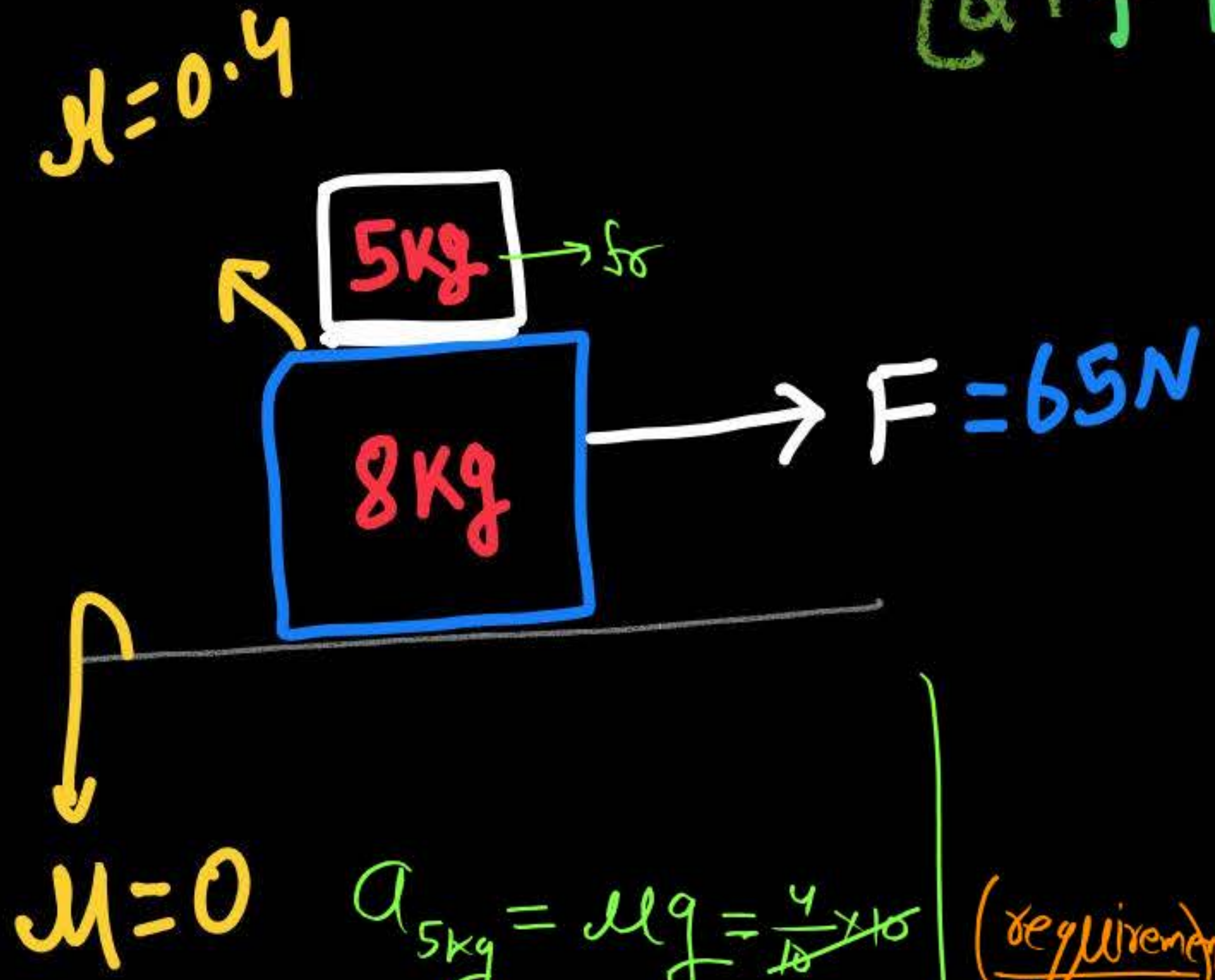
$\mu m_2 g = m_2 a_m$

$a_{max} = \mu g$

$a_m = \frac{8}{10} \times 10 = 8\,m/s^2$

chamka

(Q) Find friction acting on Object & accⁿ of object.



Solⁿ

F.B.D of 5kg

N, 5, fr = ma — (I), mg

$F_x = ma_x$

$f_r = 5a$ — (I)

fr ← [8kg] → F, → a

$F - f_r = 8a$ — (II)

assumed they are moving hence accⁿ are equ

$F - f_r = 8a$

$f_r = 5a$

$F = 13a$

$a = \frac{F}{13} = \frac{65}{13}$

$a = 5 m/s^2$

Puting value 'a' in eq (I)

(requirement) $f_r = 5a = 5 \times 5 = 25N$

$(f_r)_{limiting} = \mu N = \frac{4}{10} \times 50$

$= 20N$

they will not move together

$a_{5kg} = \mu g = \frac{4}{10} \times 10$

$= 4 m/s^2$

$f = ma = 5 \times 4$

$= 20N$

f = 20 ← [ ] → 65, → a

$a = \frac{65 - 20}{8} = \frac{45}{8} m/s^2$

MR*

$\{\{ a_{max} = \mu g \}\}$

$= 0.4 \times 10 = 4 m/s^2$

$a_{साथ-साथ} = \frac{65}{13} = 5 m/s^2$

they will not move toge

$a_{5kg} = 4 m/s^2$

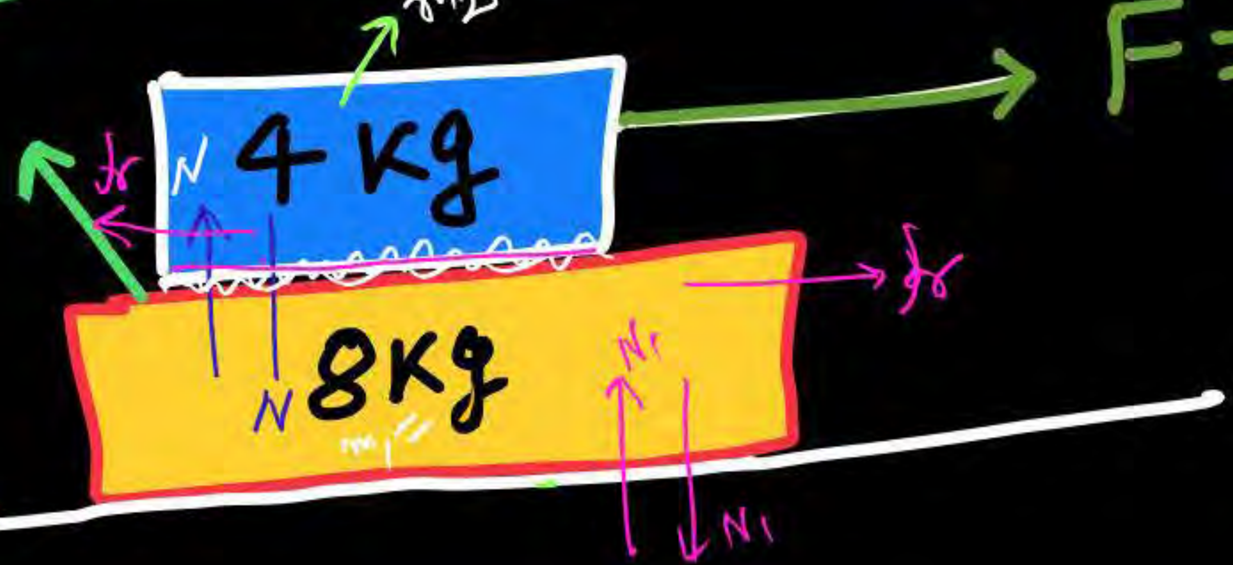
$fr = 5 \times 4 = 20N$



$a = \frac{65-20}{8}$

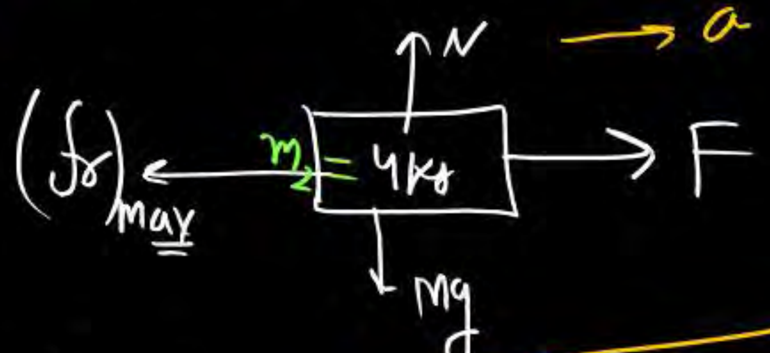
$\mu = 0.4$

F = find F_{max} so that they move togeth



$\mu = 0$
ground

F.B.D of 4 kg

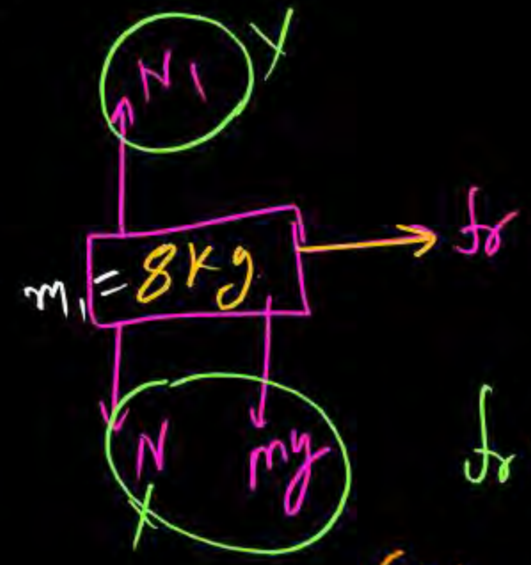


$\Sigma F_y = 0$

$N = mg$
$= 40$ Newt

$$F - fr = 4a \quad (1)$$

XX



$$fr = m_1 a \quad (11)$$

for maximum acceleration.

$$(fr)_{max} = m_1 a_{max}$$

$$\mu N = m_1 a$$

$$\mu m_2 g = m_1 a_{max}$$

$$a_{max} = \frac{\mu m_2 g}{m_1} = \mu g \left(\frac{\text{upper wala mass}}{\text{niche wala mass}}\right)$$

$$= \mu g \left(\frac{m_2}{m_1}\right)$$

$$a_{max} = \mu g \frac{m_2}{m_1} = \frac{4}{10} \times \frac{4}{8} \times 10$$

$$a_{max} = 2 \, m/s^2$$

Puttir vale of a eqn (11)

$$f_r = m_1 a$$
$$= 8 \times 2 = \underline{16N}$$

Putiy value of (f_r) & (a) in

$$F - f_r = m_2 a$$
$$F - 16 = 4 \times a$$
$$F = 16 + 4 \times 2 = 24\ \text{Newton}$$

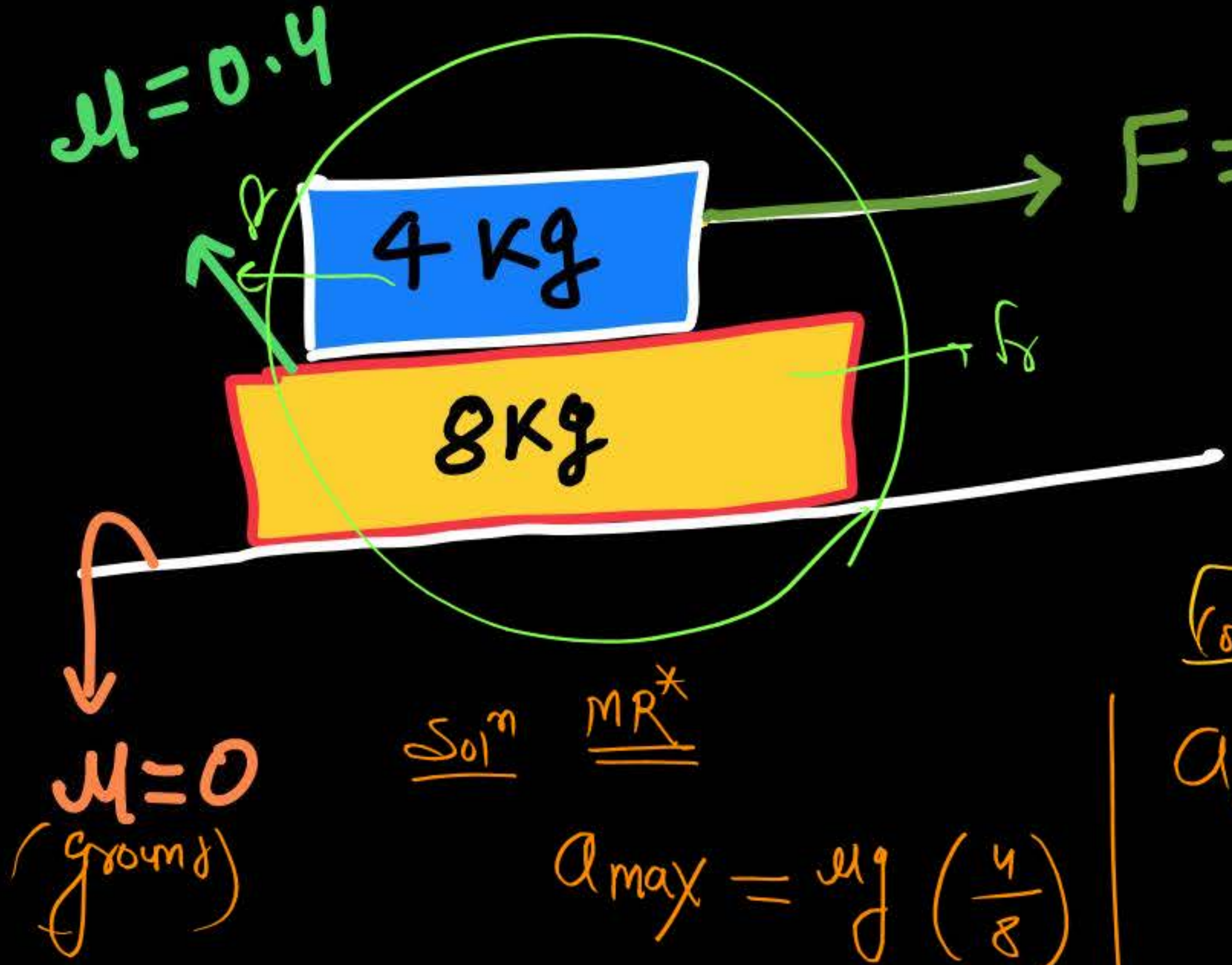
MR*

$$a_{max} = \mu g \left(\frac{m_{upar}}{m_{niche}}\right)$$
$$= \frac{4}{10} \times 10 \left[\frac{4}{8}\right] = 2\ m/s$$

$$a_{assum\ sath\text{-}sab,\ max} = \frac{F}{(8+4)}$$

$$F = a_{max}(12)$$
$$= 2 \times 12 = \underline{\underline{24N}}$$

find acc^n and friction on object



Sol^n MR*

$a_{max} = \mu g \left(\frac{4}{8}\right)$

$= \frac{4}{10} \times 10 \left(\frac{1}{2}\right)$

$= 2 \, m/s^2$

Combined F.B.D

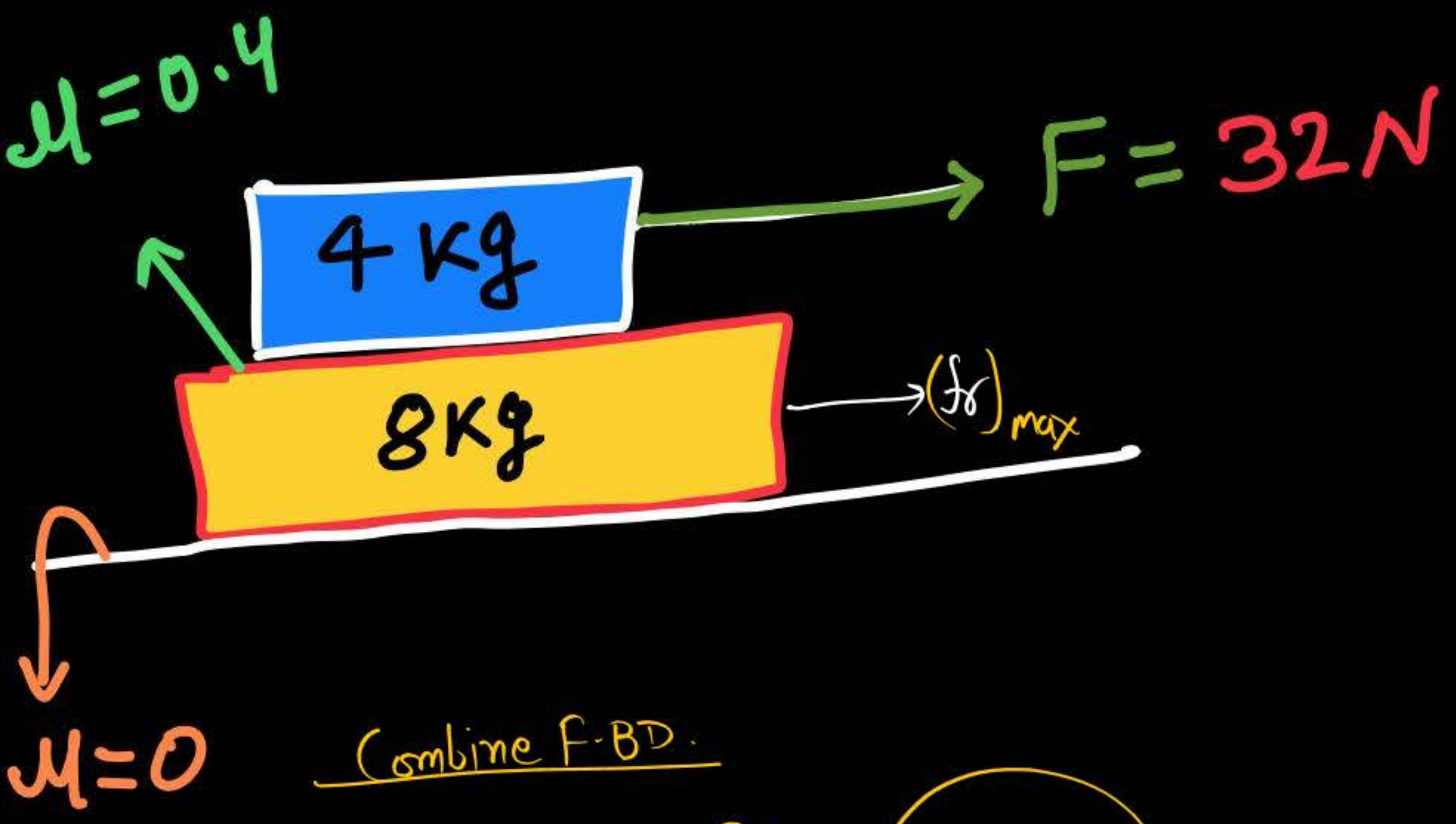
$a_{साथ-साथ} = \left(\frac{6}{12}\right) = \frac{1}{2} \, m/s^2$

they will move togeather with acc^n $= \frac{1}{2} \, m/s^2 = a_1 = a_2$

8 kg → $f = ma$

$= 8 \times \frac{1}{2} = 4N$

find arm and friction acting on Object.



Combine F.B.D.

$$a_{\text{साथ-साथ}} = \frac{32}{12} = 2.6 \, m/s^2$$

$$a_{max} = \mu g \left(\frac{4}{8}\right) = 2 \, m/s^2$$

Ans

they will not move togeth

F.B.D of 8kg

$$a_{8kg} = 2 \, m/s^2$$

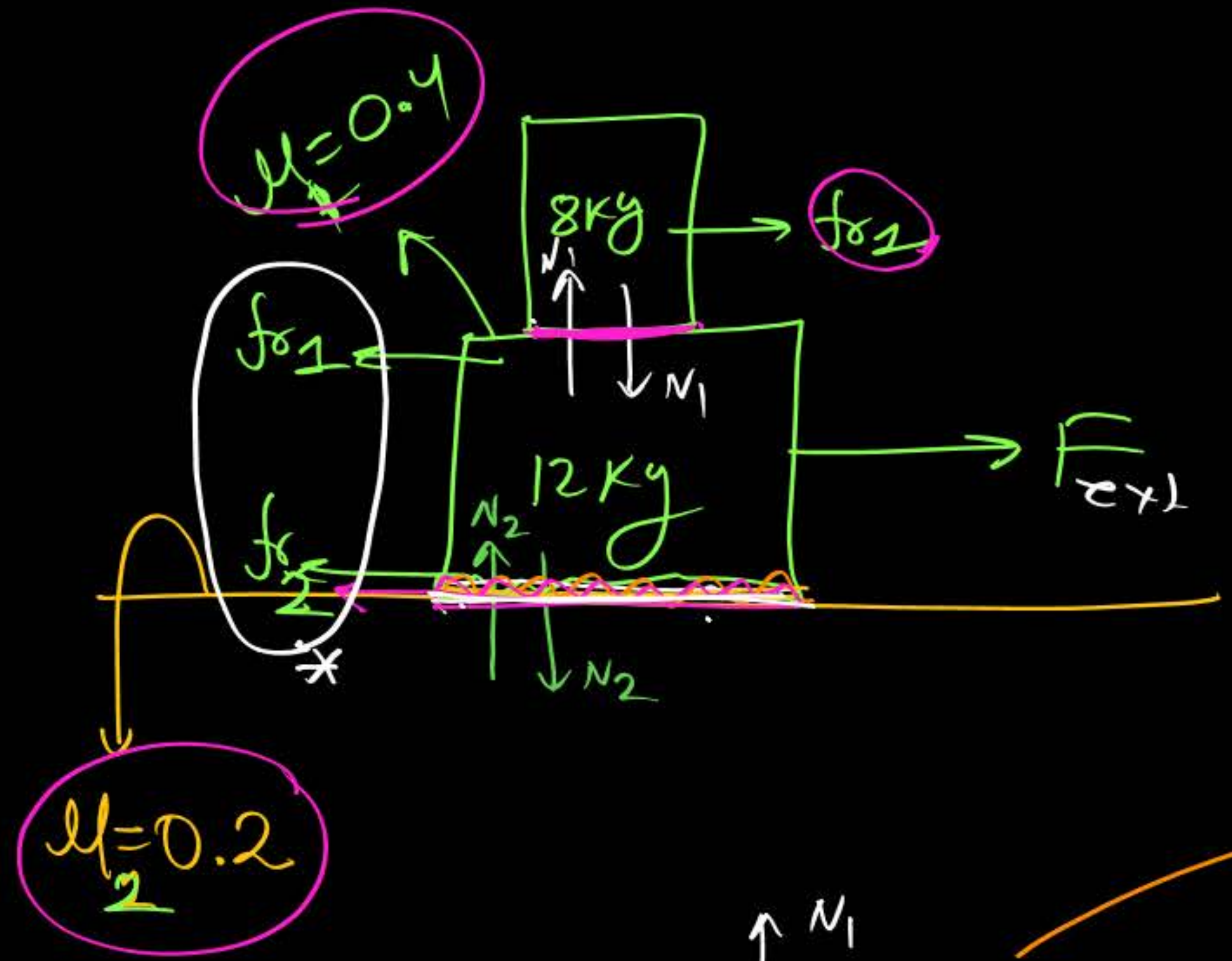
$$fr = ma = 8 \times 2 = 16N$$

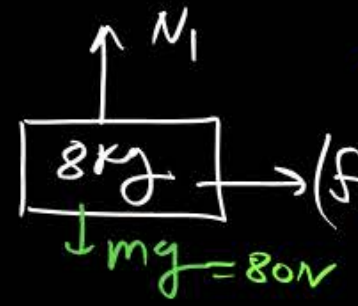


$$a = \frac{32-16}{4} = \frac{16}{4} = 4 \, m/s^2$$

Find F so that they will move together

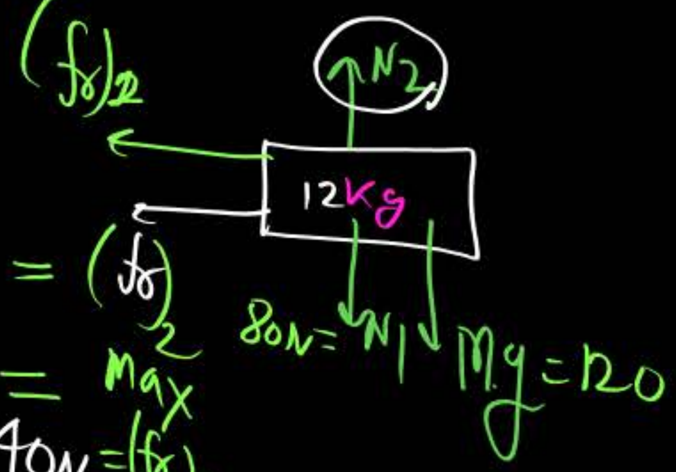
Not for NEET





$(f_{r_1})_{max} = \mu N_1 = \frac{4}{10} \times 8 \times 10 = 32\,N$ (max^m friction)

$a_{max} = \mu g = \frac{4}{10} \times 10 = 4\,m/s^2$



$N_2 = 200$ New

$\mu N_2 = (f_r)_{2\,max}$

$0.2 \times 200 =$

$40N = (f_r)_2$

Combined F.B.D



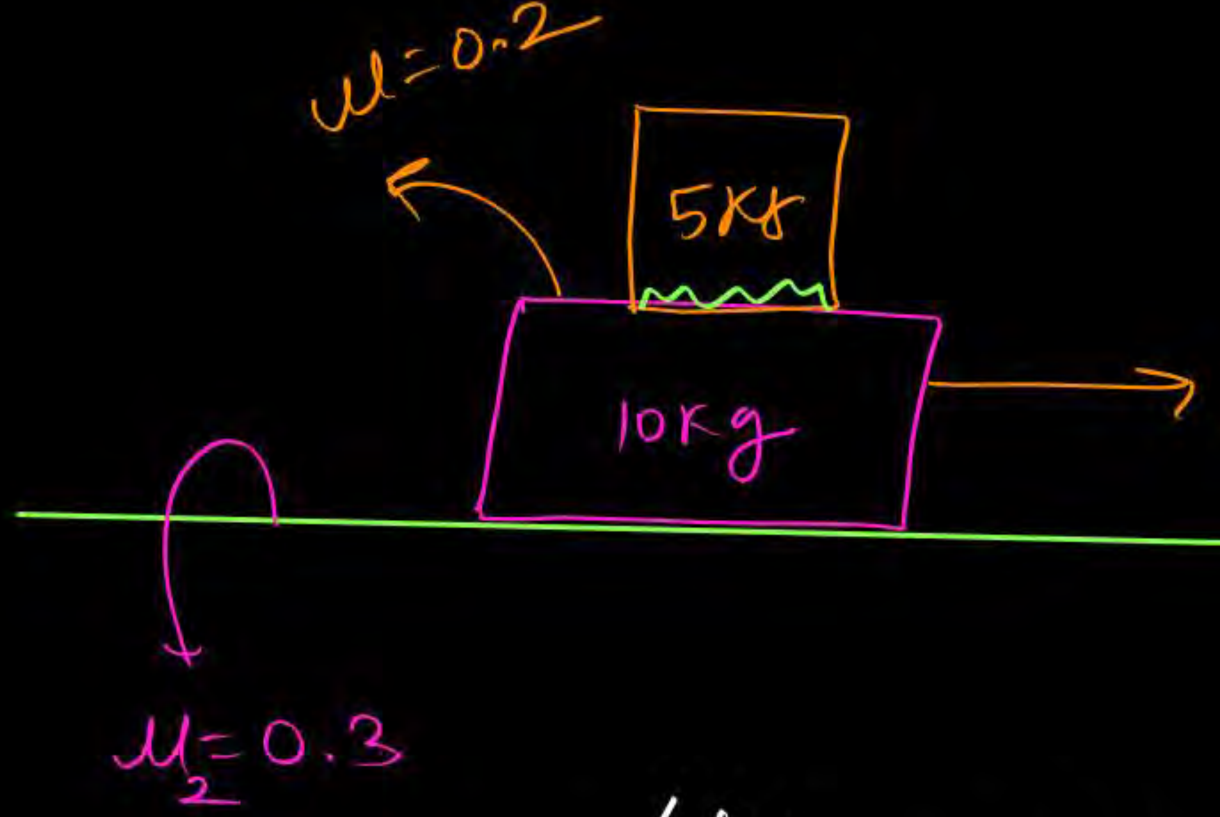
$(f_{r_2})_{max} = 40$ newton

$F_{max} - 40 = 20 \times a_{max}$

$F = 80 + 40 = 120N$

$40N \leq F \leq 120N$

Ground AB



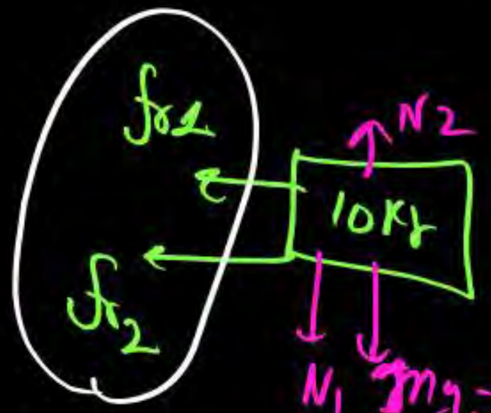
F = find F so that they move together

$45_N = F_{min}$ (so that they will start sliding)

$(f_{r1})_{max} = m a_m = 5 \times a_{ma} = 10$

$a_m = 2 m/s^2$

5kg → $f_{r1\,Max} = \mu N_1 = \frac{2}{10} \times 50 = 10N$

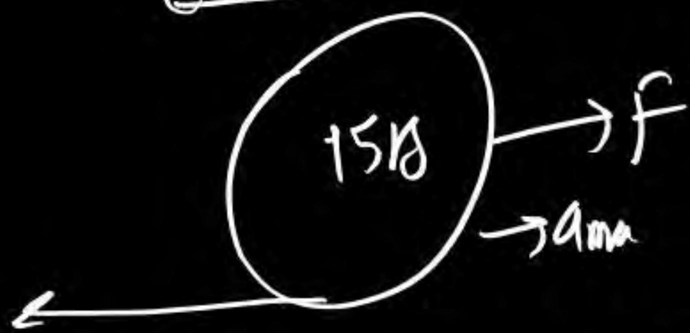


$mg = 100N$

$N_2 = 150$

$(f_r)_{max} = \mu N_2 = \frac{3}{10} \times 150 = 45N$

Combined FBD



$f_{r2} = 45N$

$F_{max} - 45 = 15 a_m$

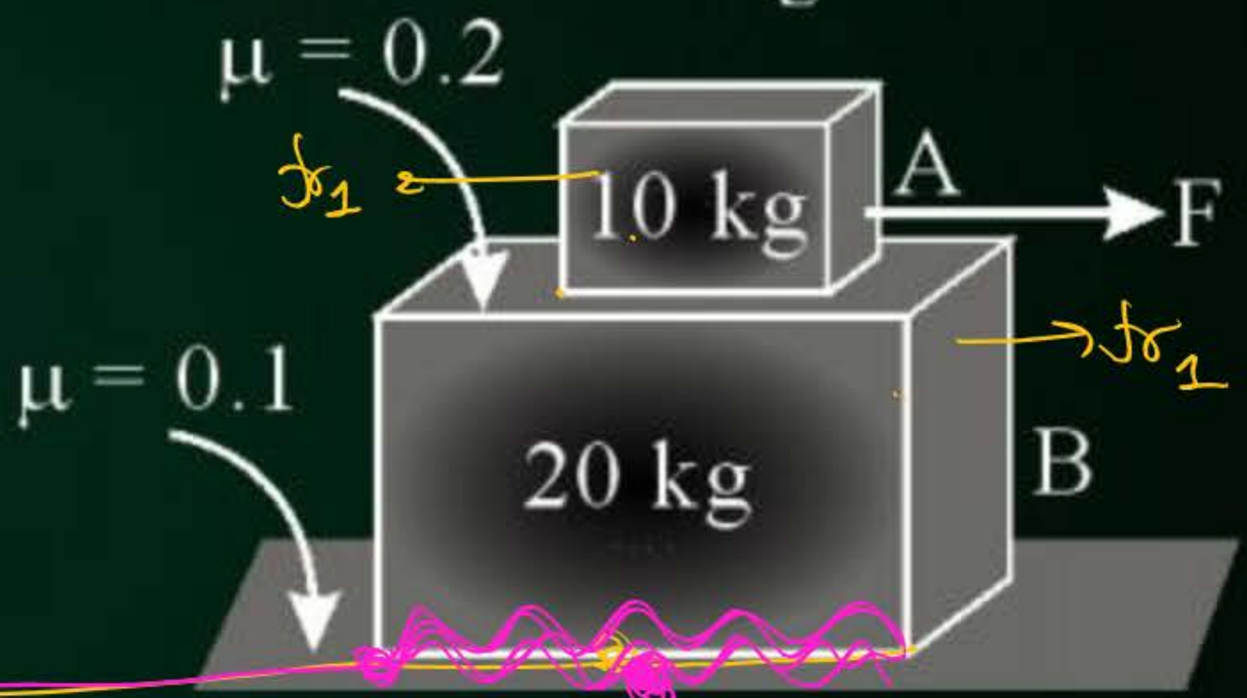
$F_{max} = 45 + 15 \times 2$

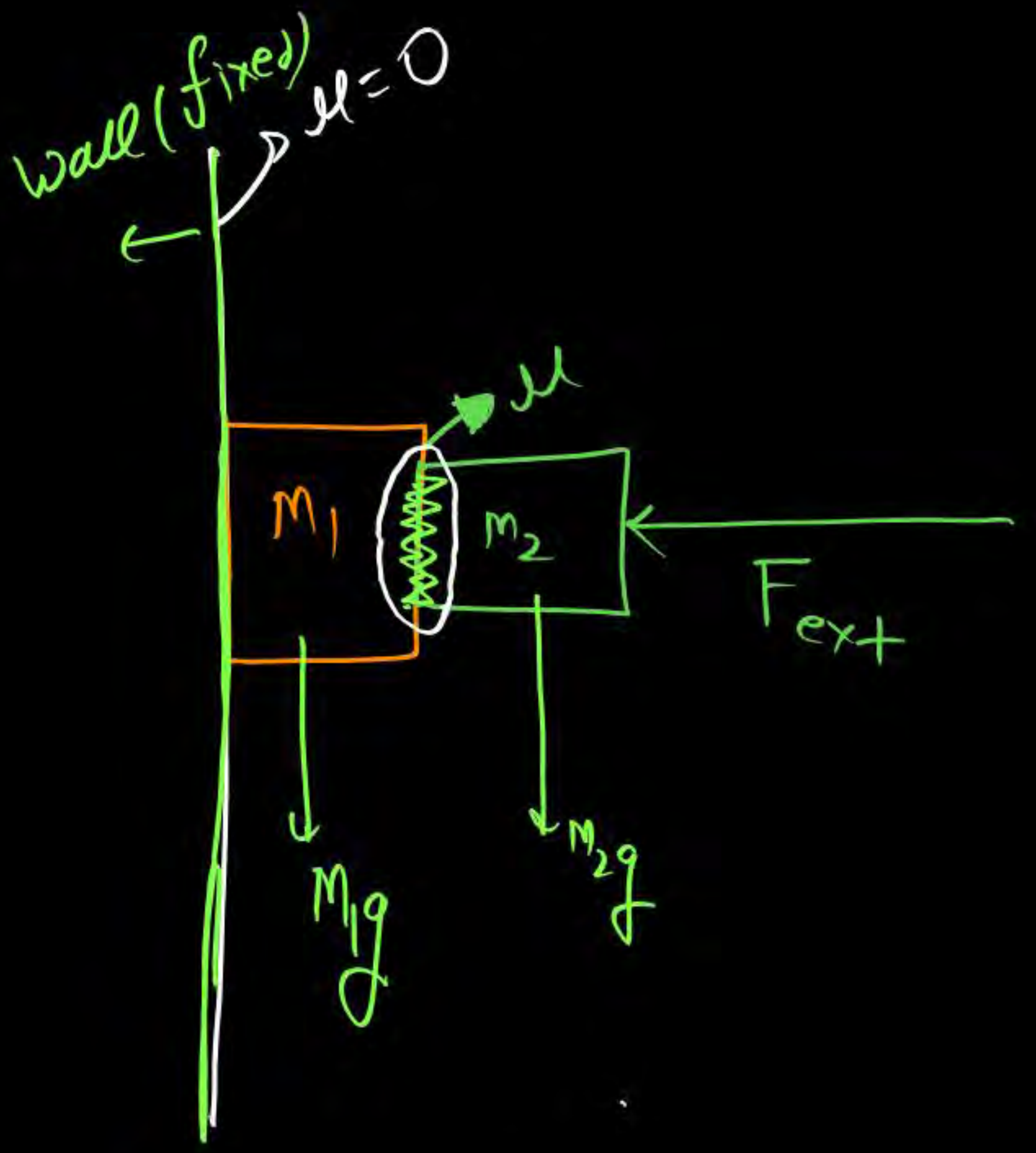
$= 75$ newton

QUESTION

In given diagram what is the minimum value of a horizontal external force F on Block 'A' so that block 'B' will slide on ground is:

1. 30 N
2. 20 N
3. 10 N
4. Not possible

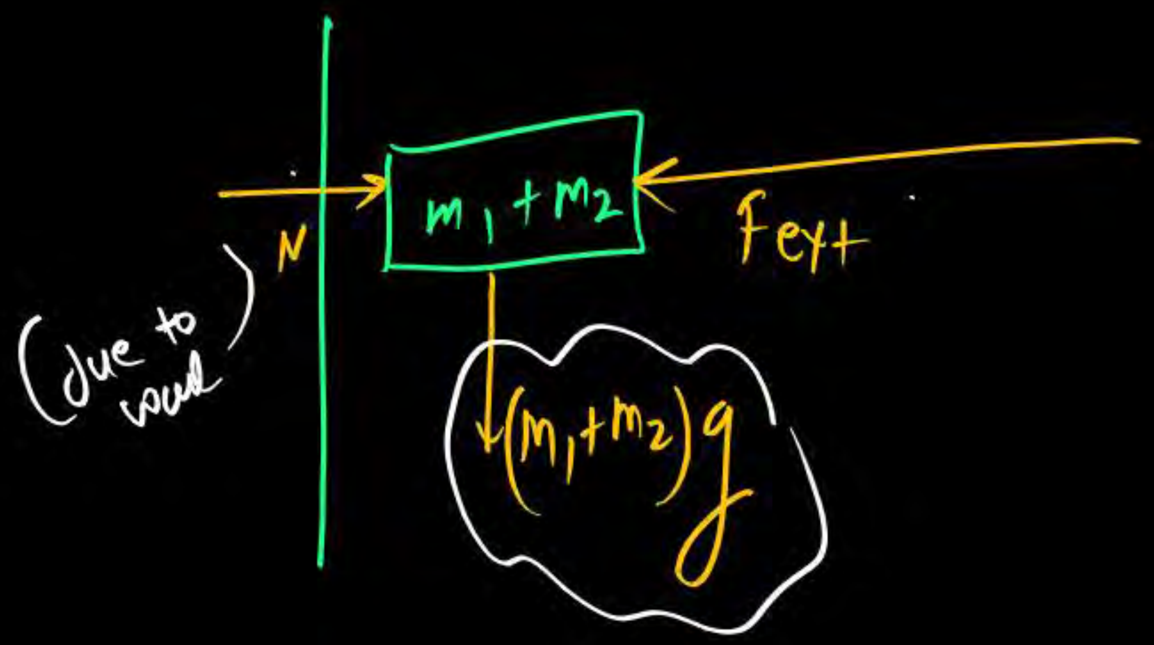




m_1 can't be in equilibrium

Ans

Combined F.B.D of m_1 & m_2



Circular Dynamics

Circular Dynamics

Q-1 Object (of mass "m") is moving on a straight line path with constant speed then force on that object must be zero → (a) True ✓ (b) False

$\vec{v}$ = const^n speed on straight line ⟶ $\vec{v}$ = const^n velocity = const^n ⟹ $a = 0$ ⟶ $F_{net} = ma = m \times 0 = 0$

Q-2 Object is moving on a circular path with constant speed then force on that object must be zero → (a) True (b) False ✓

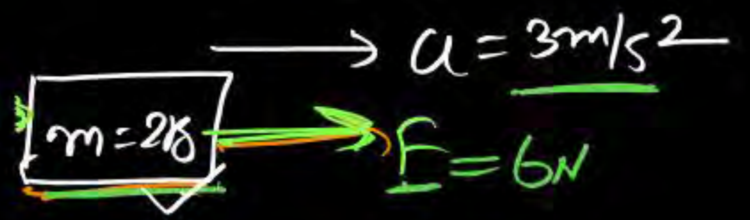


V = const^n speed

acc^n = $a_c = v^2/R$ ⟶ requirement of force

$a_T = 0$

$F_{net} = m a_c = \left(m v^2/R\right)$



$ma = 2 \times 3 = 6\ kg\,m/s^2$

Is this force??

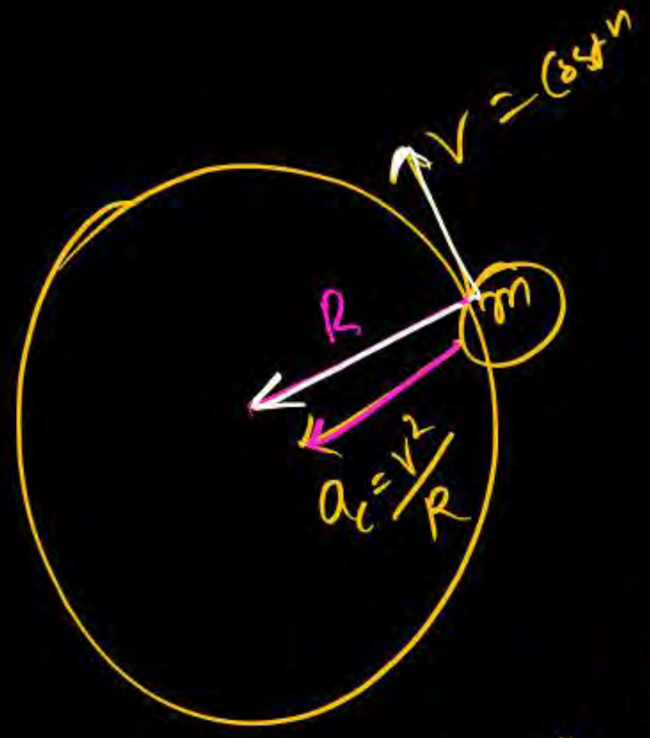
No this is not a force

this is requirement of force.

$F = ma$

$= 2 \times 3 = 6\ kg\,m/s^2$

$F = 6N$



V.C.M

$ma_c = \frac{mv^2}{R}$

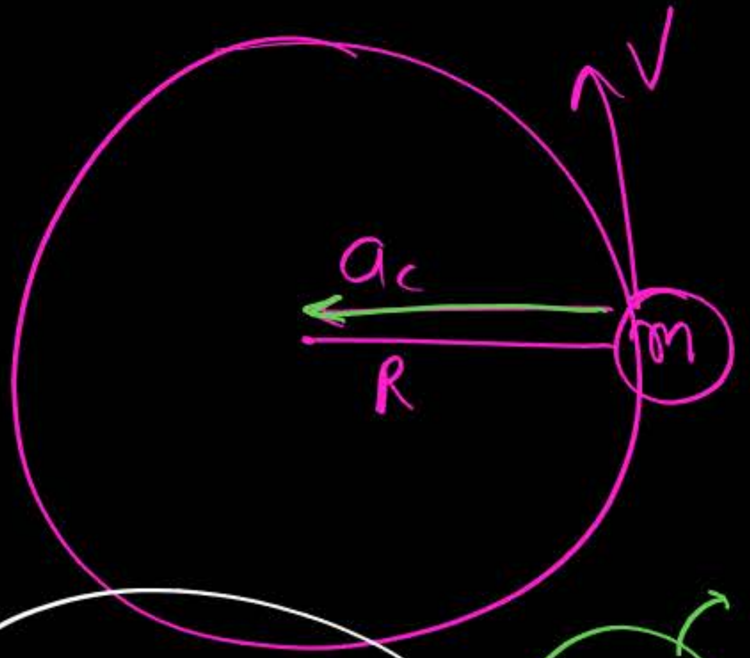
⇒ Is this force??

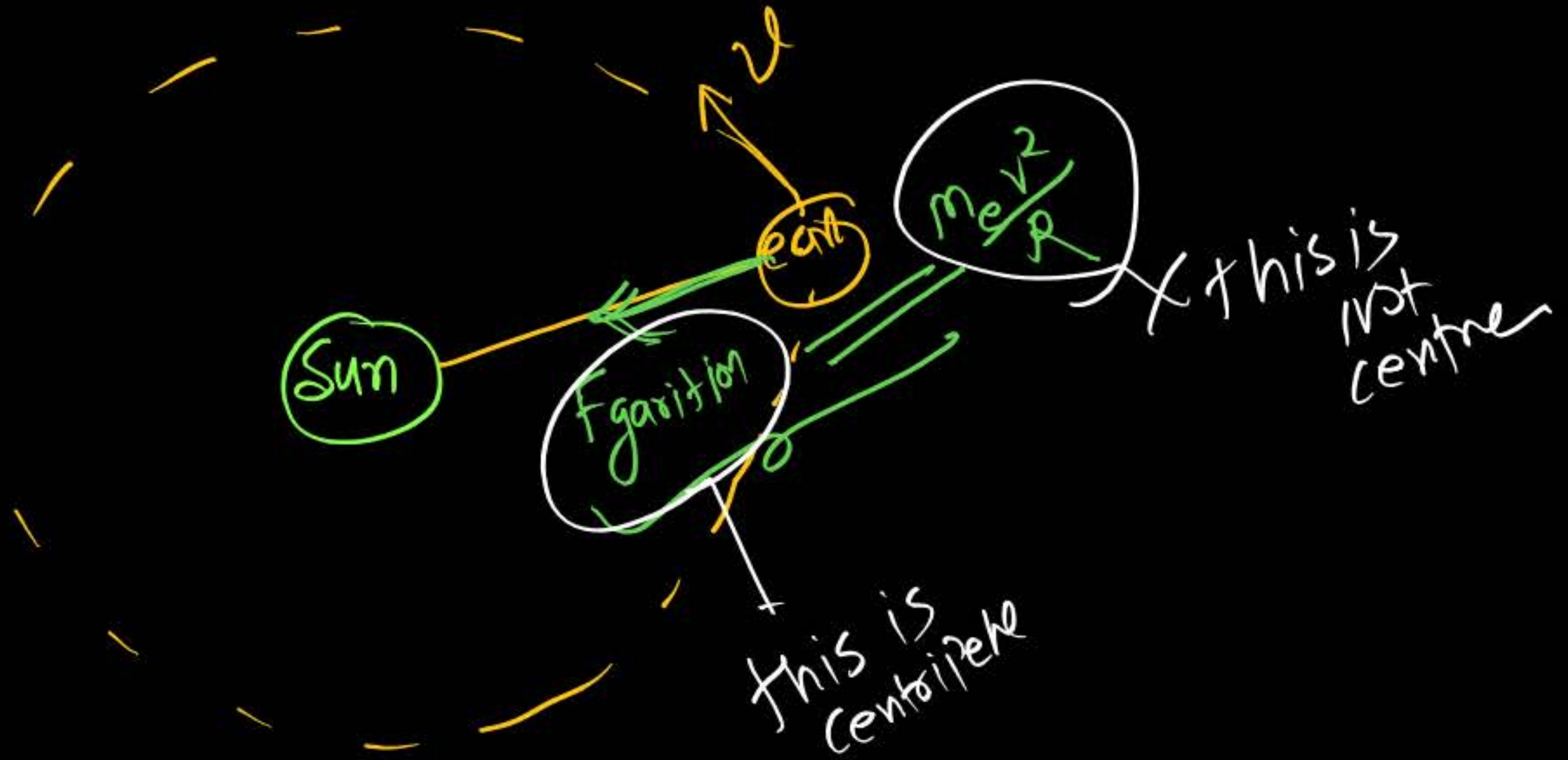
Sol^n No, this is not a force

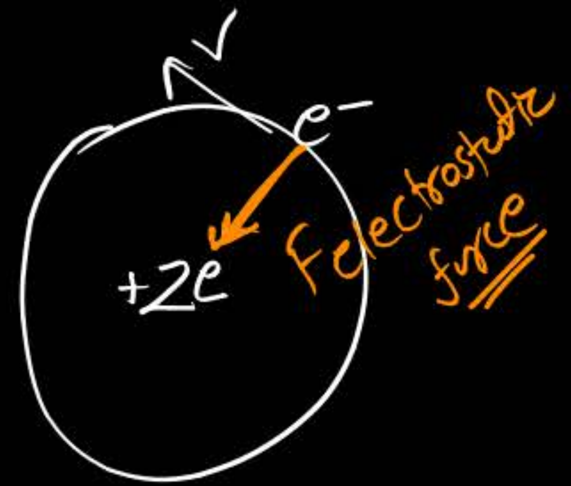
This is an requirement of force.

$F = \frac{mv^2}{R}$ → this is not a centripetal force

circula motion (U.C.M)



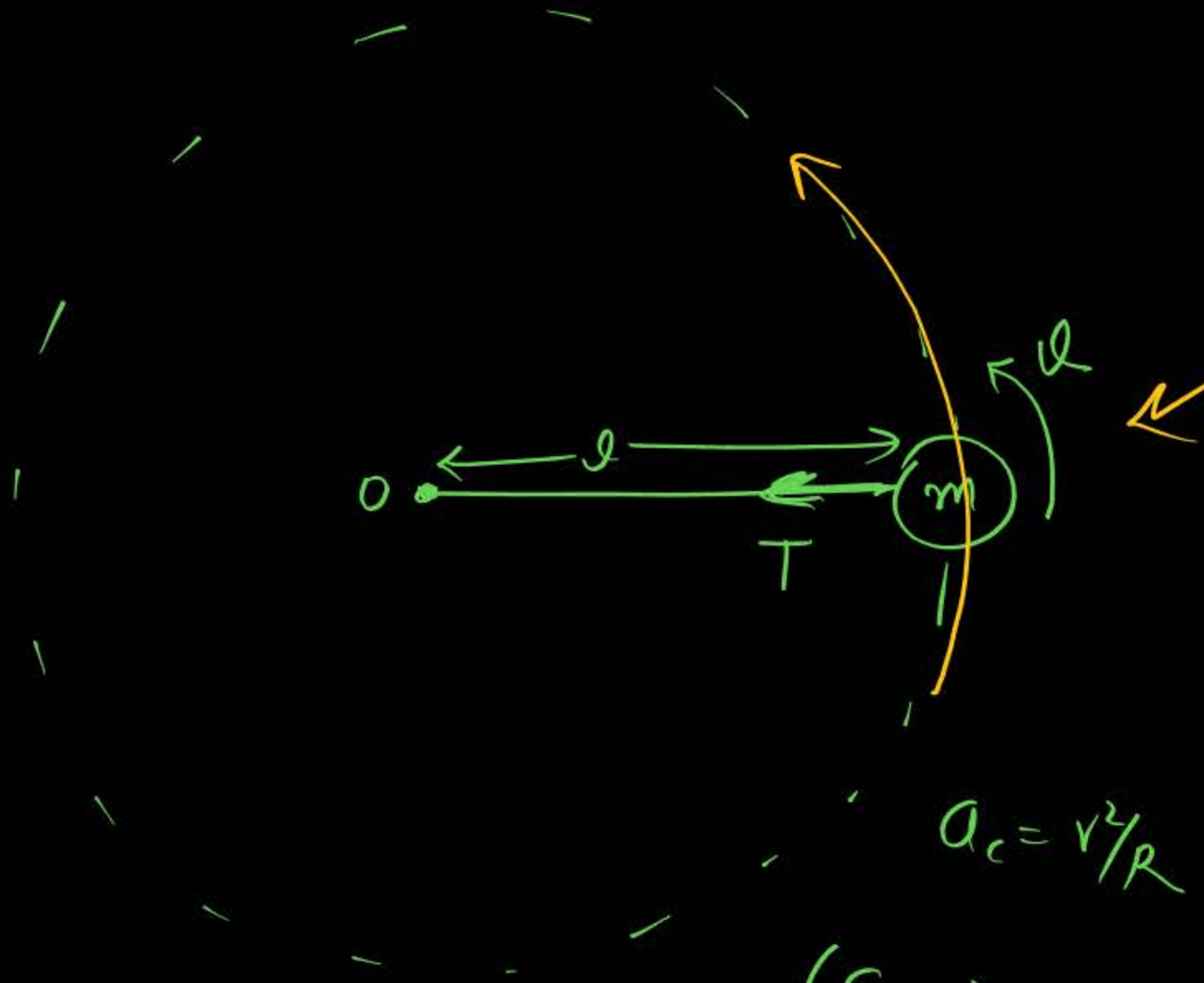




net force towards centre $= \frac{mv^2}{R}$ → this is requirment of force

towards centre

This requirment can be fullfilled by any real force like tension, spring, normal, gravitin, electros.



this object is accelerating with $a_c = v^2/R$ toward centre.

$a_c = v^2/R$

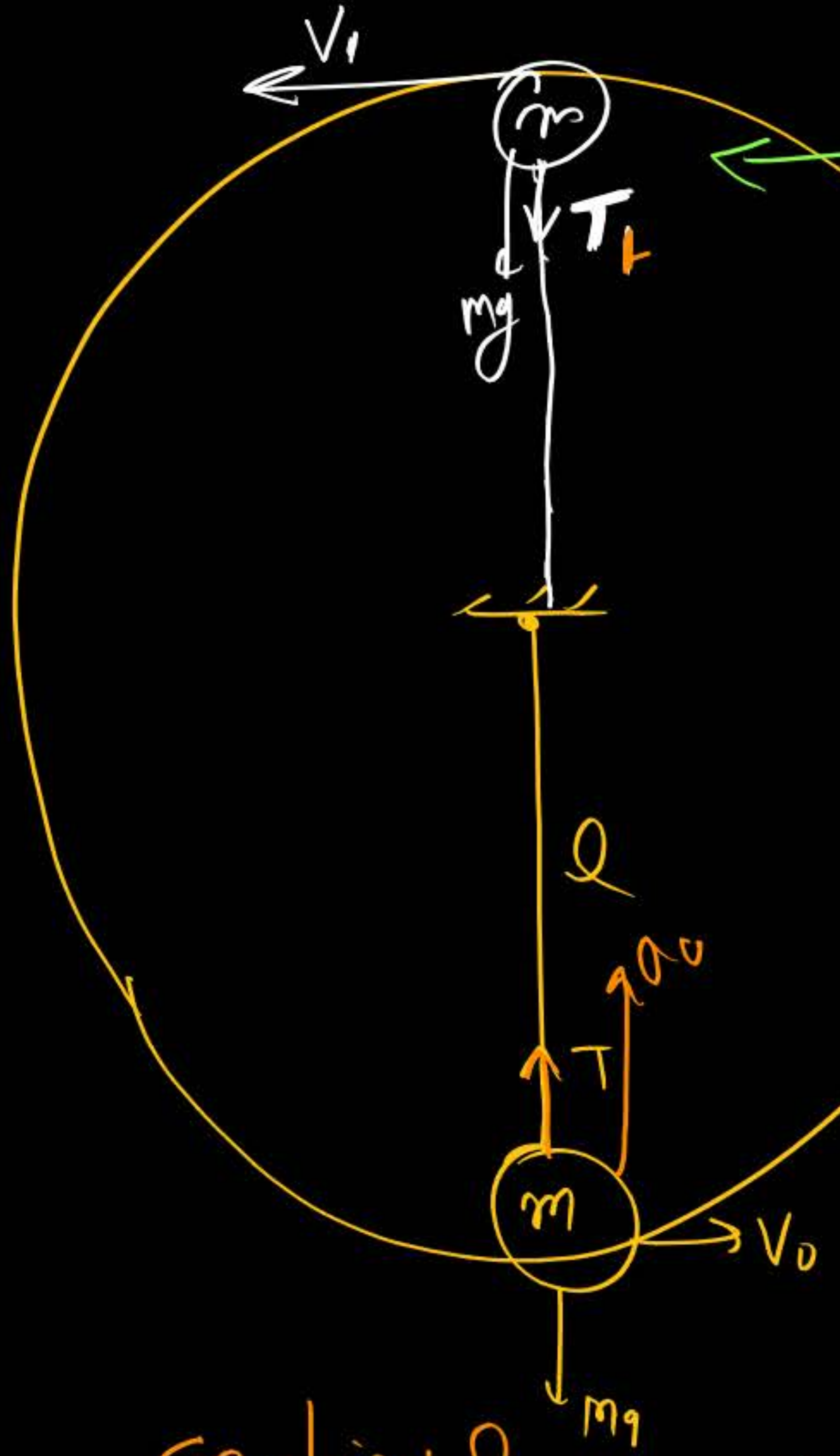
$$(\text{force})_{net} = ma = \left[m\frac{v^2}{R}\right]$$

net force toward cen

$$T = \left[\frac{mv^2}{R}\right]$$

net force toward centre = T

$F_{net} = ma$ (Newton 2nd law)



$T_1 + mg$ = Net centripetal force $= \frac{mv_1^2}{R}$

$F_{net} = m a_c$

$T - mg = \frac{mv^2}{R}$ — (1)

$ma_c = \frac{mv_0^2}{l}$

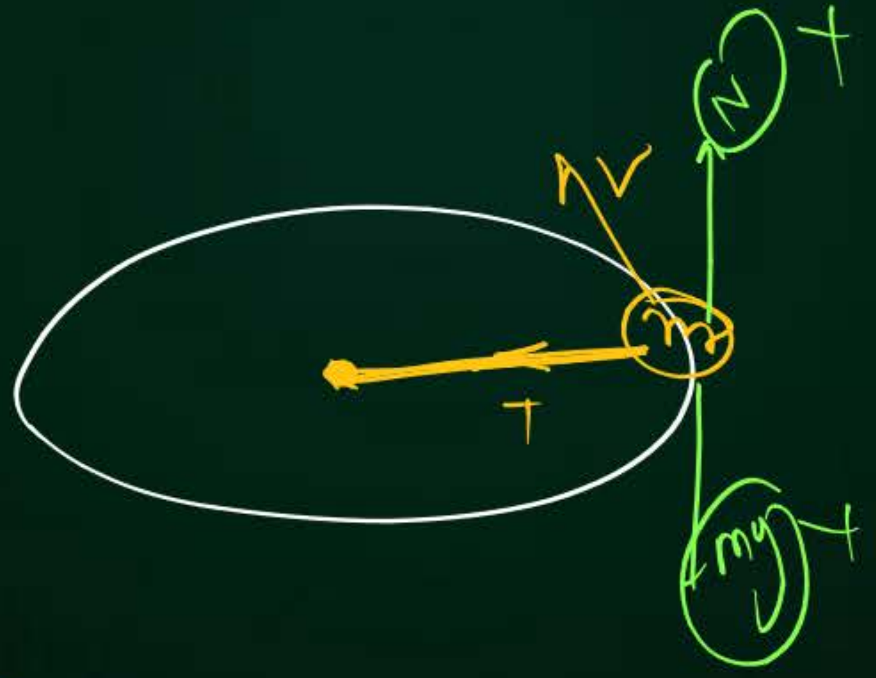
$T - mg$ = (centripetal force) net force towards centre

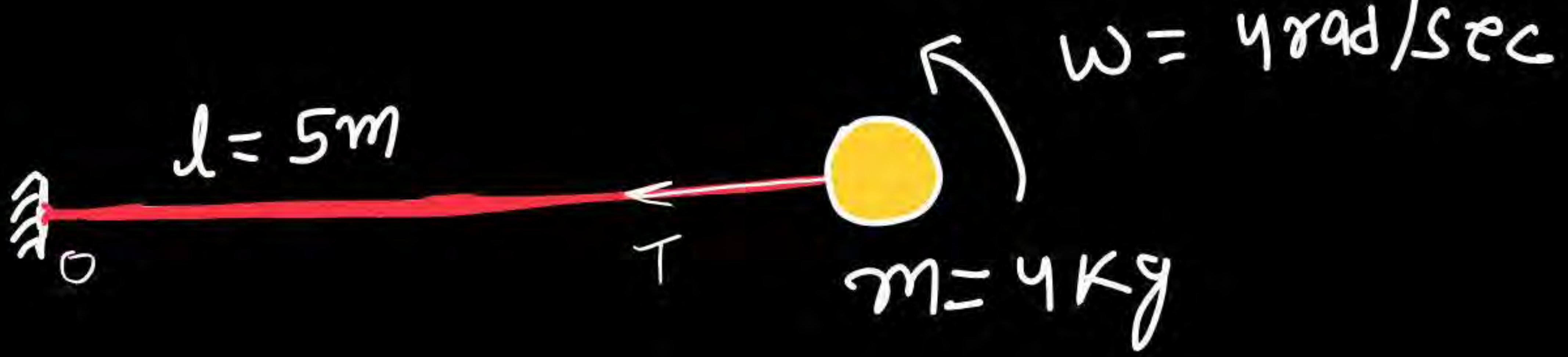
centripetal force ⟹ Net force acting towards the centre which fulfilled the requirement of mv^2/R.

QUESTION

One end of string of length l is connected to particle of mass m and the other end is connected to a small peg on a smooth horizontal table. If the particle moves in circle with speed v, the net force on the particle (directed towards center) will be (T represents the tension in the string) **[NEET-2017]**

1. Zero
2. T
3. $T + \frac{mv^2}{l}$
4. $T - \frac{mv^2}{l}$





Net force towards centre = centripetal force

$$T = \frac{mv^2}{R}$$

$$= 4 \times \frac{(R\omega)^2}{R}$$

$$= 4\left[\omega^2 R\right]$$

$$= 4\,(4)^2 \times 5$$

$$= 4 \times (16 \times 5)$$

$$= 320\,N$$



(*) Now object of mass m is at rest w.r.t. Ramlal. because Ramlal sitting on object

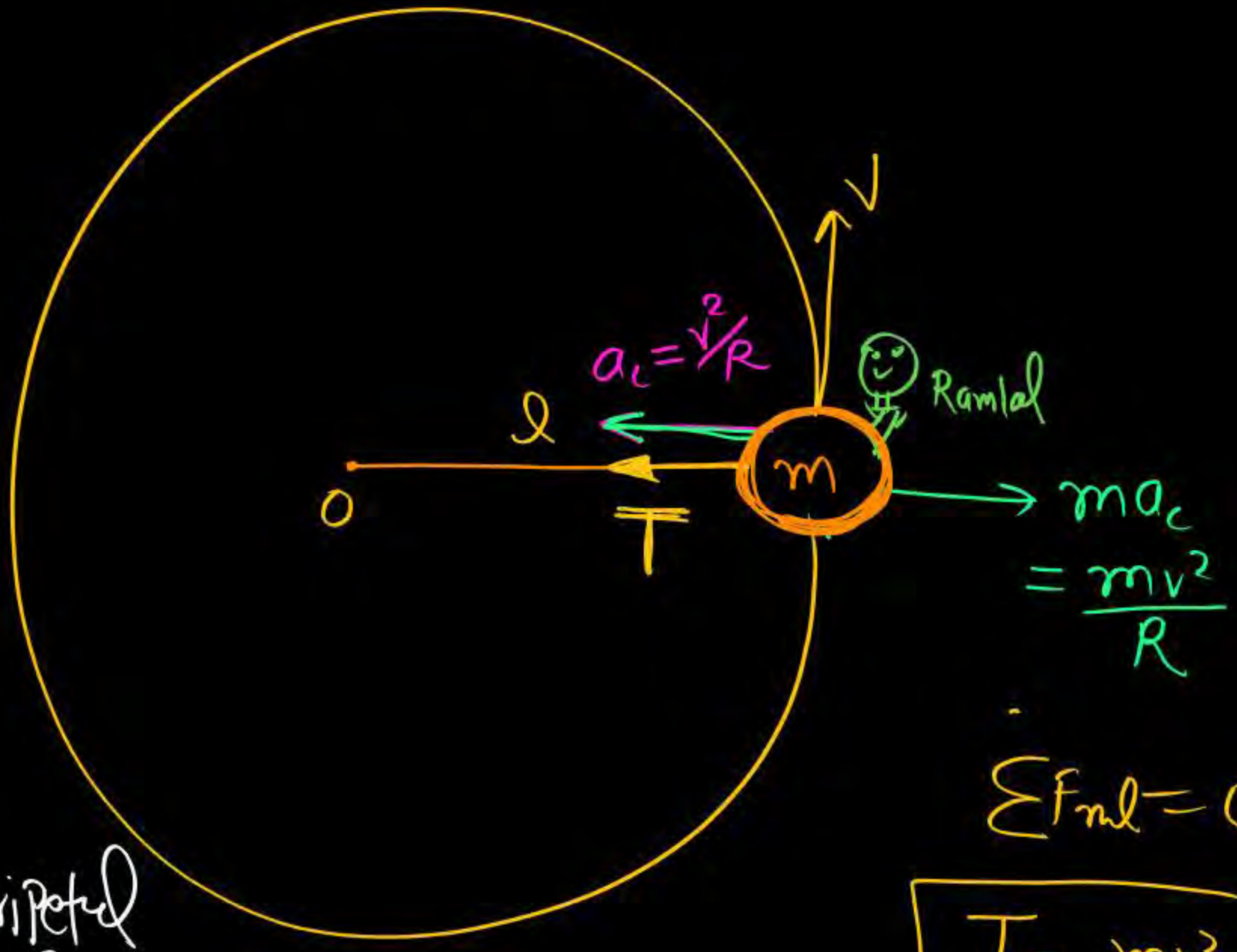
Ramlal is now Non-Inertial accelerated frame of refrence

↳ Ramlal now apply pseudo force

$$\vec{F}_{pseudo} = -m\vec{a}_c$$

$$= -m\frac{v^2}{R}$$

↑ dirn



$$\Sigma F_{net} = 0 \quad \left(\text{rest w.r.t Ramlal}\right)$$

$$T = \frac{mv^2}{R} \quad *$$

* $F_{pseudo\,force} = \frac{mv^2}{R}$ ↳ away from center

Centrifugal force

↳ Not a real force

Centripetal force



$F = ma$ (Newton's 2nd law)

$T = ma_c$

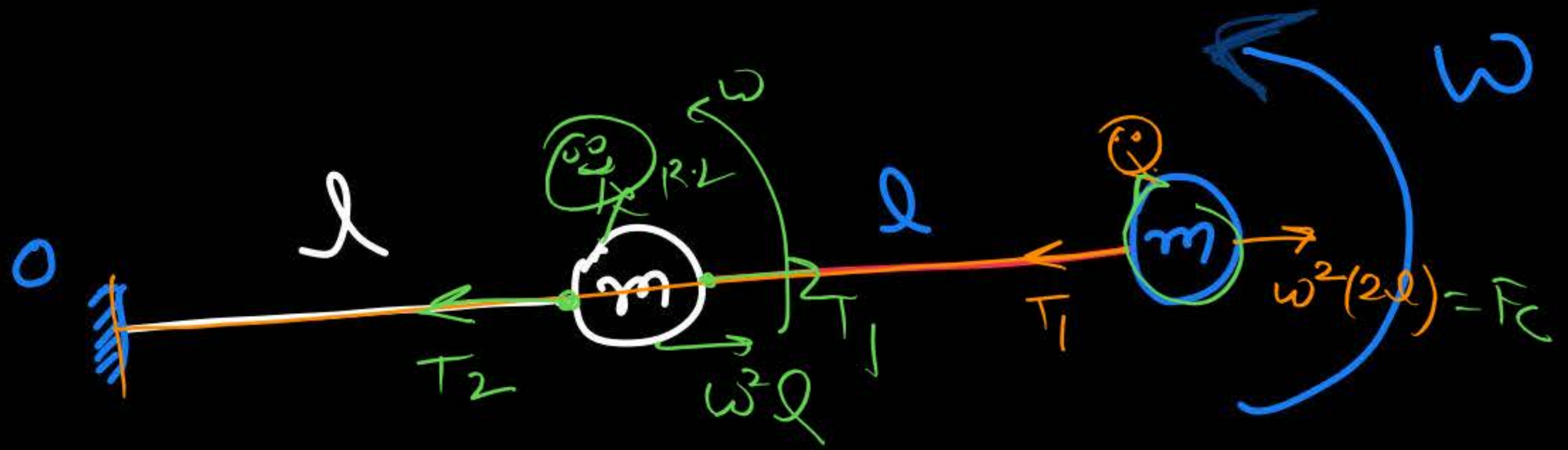
$T = \frac{mv^2}{R}$

Can centripetal and centrifugal act togather

(a) Yes

(b) NO (65%)

find Tension in both the string



$F_{net} = 0$

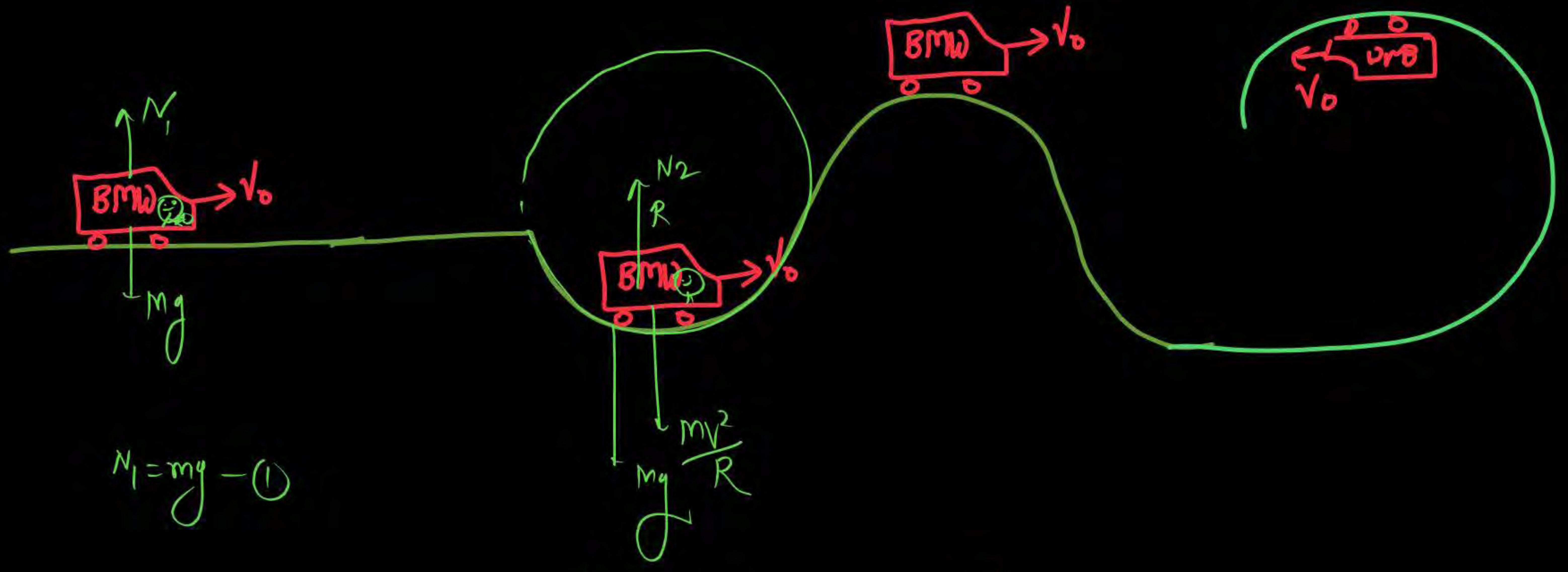
$T_1 = \omega^2 2l$ — (1)

$T_2 = T_1 + \omega^2 l$

$T_2 = \omega^2 2l + \omega^2 l$

$T_2 = 3\omega^2 l$

find Normal rexⁿ at each Point

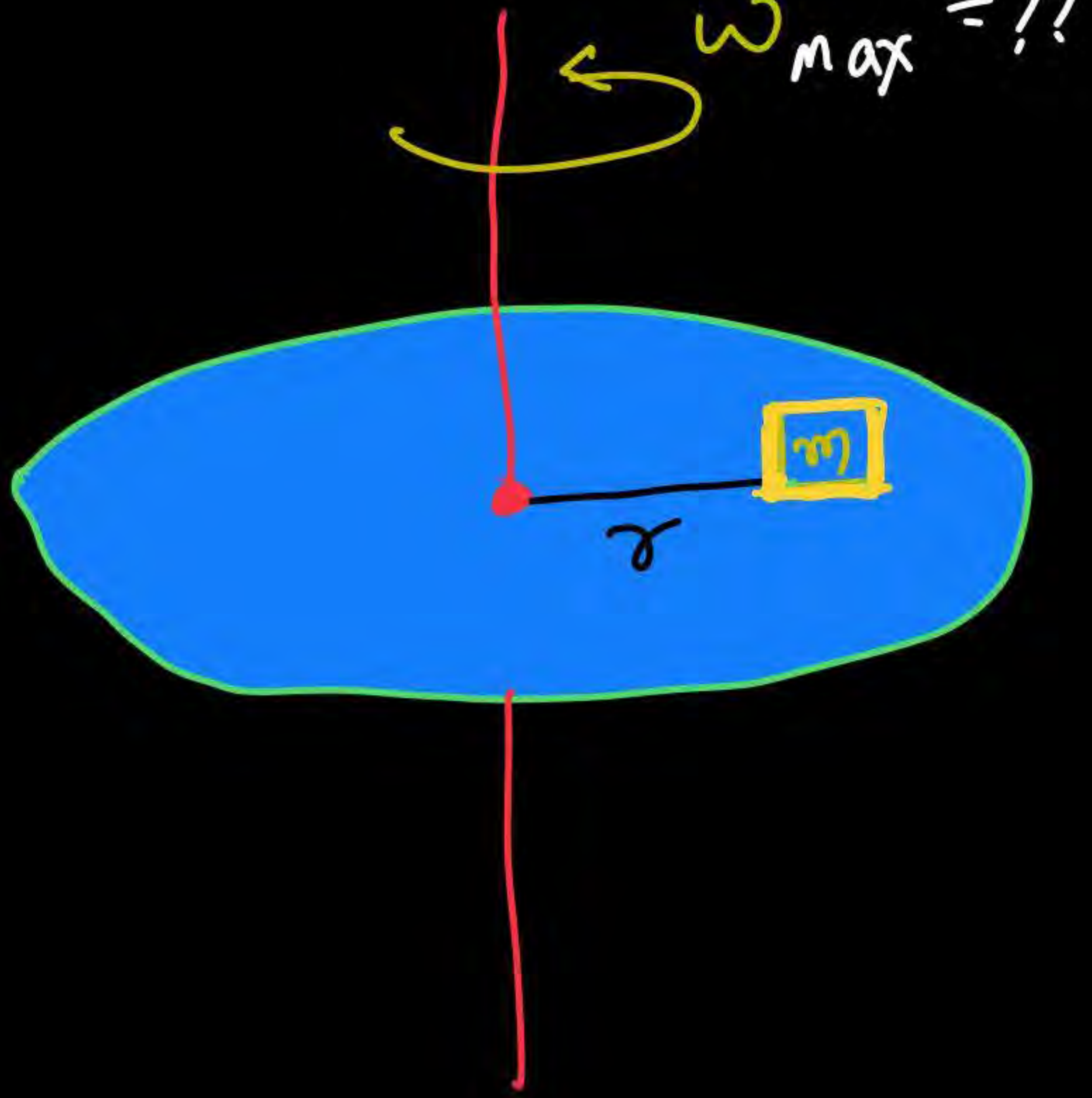


$N_1 = mg$ — (1)

$N_2 = \frac{mv^2}{R} + mg$



find ω_{min} so that Ramlal in Death well will not slip down



So that object keep at rest.

CIRCULAR DYNAMICS

- Study of cause of circular motion

CIRCULAR DYNAMICS

- Object is moving with constant speed in straight line without any external force.

  True.

- Object is moving with constant speed on circular path without any external force.

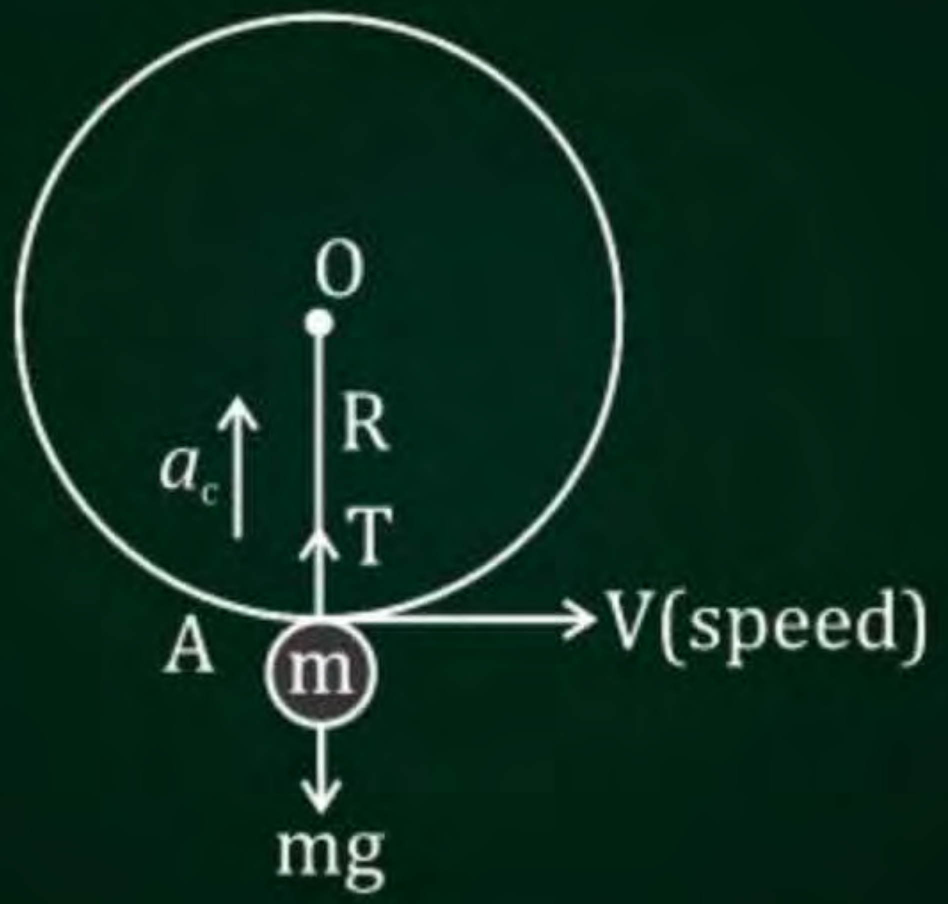
  False.

CENTRIPETAL FORCE

- It is not a force it is just a requirement to move the object on circular path.
- It is just name given to requirement of force that can be fulfilled by any real force.

QUESTION

Find centripetal force acting on object at point 'A'.



- **Can we apply centripetal force and centrifugal force simultaneously.**

  NO.

QUESTION

A cyclist riding the bicycle at a speed of $14\sqrt{3}$ m/s takes a turn around a circular road of radius $20\sqrt{3}$ m without skidding. What is his inclination to the vertical?

1. 30°
2. 45°
3. 60°
4. 75°

QUESTION

A bus turns a slippery road having coefficient of friction of 0.5 with a speed of 10 m/s. The minimum radius of the arc in which bus turns is (Take $g = 10\ m/s^2$)

1. 4 m
2. 10 m
3. 15 m
4. 20 m

QUESTION

A car is moving on a horizontal circular track of radius 0.2 km with a constant speed. If coefficient of friction between tyres of car and road is 0.45, then speed of car may be (Take $g = 10\ m/s^2$)

1. $15\ m/s$
2. $30\ m/s$
3. $20\ m/s$
4. $40\ m/s$

QUESTION

A boy is sitting on the horizontal platform of a joy wheel at a distance of 5 m from the center. The wheel begins to rotate and when the angular speed exceeds 1 rad/s, the boy just slips. The coefficient of friction between the boy and the wheel is ($g = 10\ m/s^2$)

1. 0.5
2. 0.32
3. 0.71
4. 0.2

QUESTION

A vehicle is moving on a track with constant speed as shown in figure. The apparent weight of the vehicle is

1. Maximum at A

2. Maximum at B

3. Maximum at C

4. Same at A, B and C



QUESTION

A car is moving on a horizontal circular road of radius 0.1 km with constant speed. If coefficient of friction between tyres of car and road is 0.4, then speed of car may be ($g = 10\ m/s^2$)

1. 5 m/s
2. 10 m/s
3. 20 m/s
4. All of these

QUESTION

A car of mass m is moving on a level circular track of radius R. If μ_s represents the static friction between the road and tyres of the car, the maximum speed of the car in circular motion is given by

1. $\sqrt{\mu_s m R g}$

2. $\sqrt{\frac{Rg}{\mu_s}}$

3. $\sqrt{\frac{mRg}{\mu_s}}$

4. $\sqrt{\mu_s R g}$

QUESTION

A gramophone record is revolving with an angular velocity ω. A coin is placed at a distance r from the centre of the record. The static coefficient of friction is μ. The coin will revolve with the record if

1. $r = \mu g \omega^2$
2. $r < \frac{\omega^2}{\mu g}$
3. $r < \frac{\mu g}{\omega^2}$
4. $r \geq \frac{\mu g}{\omega^2}$

QUESTION

A roller coaster is designed such that riders experience "weightlessness" as they go round the top of a hill whose radius of curvature is 20 m. The speed of the car at the top of the hill is between

1. 13 m/s and 14 m/s
2. 14 m/s and 15 m/s
3. 15 m/s and 16 m/s
4. 16 m/s and 17 m/s

QUESTION

A gramophone record is revolving with an angular velocity ω. A coin is placed at a distance r from the centre of the record. The static coefficient of friction is μ. The coin will revolve with the record if

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2. 0.32
3. 0.71
4. 0.2

QUESTION

A cyclist riding the bicycle at a speed of $14\sqrt{3}$ m/s takes a turn around a circular road of radius $20\sqrt{3}$ m without skidding. What is his inclination to the vertical?

1. $30°$
2. $45°$
3. $60°$
4. $75°$

QUESTION

A block of mass 10 kg is in contact against the inner wall of a hollow cylindrical drum of radius 1 m. The coefficient of friction between the block and the inner wall of the cylinder is 0.1. The minimum angular velocity needed for the cylinder to keep the block stationary when the cylinder is vertical about its axis, will be: $(g = 10\ m/s^2)$

1. $\sqrt{10}$ rad/s
2. $\frac{10}{2\pi}$ rad/s
3. 10 rad/s
4. 10π rad/s

MOTION OF CAR ON ROUGH HORIZONTAL SURFACE

QUESTION

A bus turns a slippery road having coefficient of friction of 0.5 with a speed of 10 m/s. The minimum radius of the arc in which bus turns is (Take $g = 10\ m/s^2$)

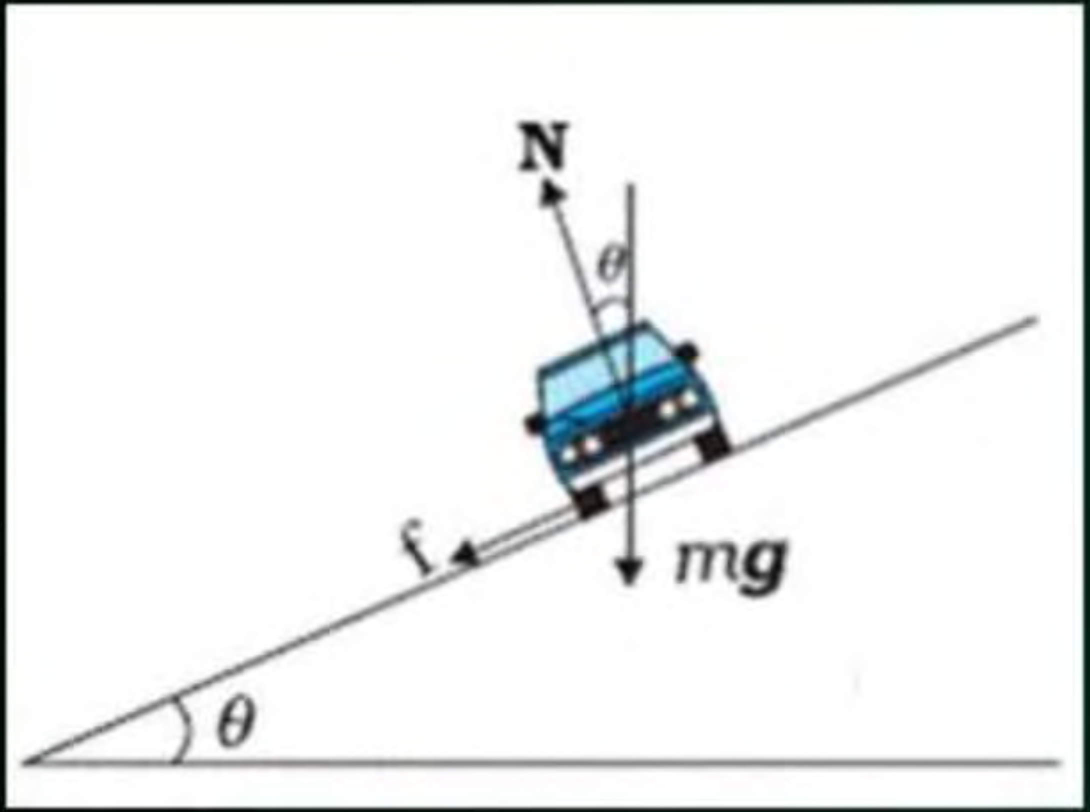
1. 4 m
2. 10 m
3. 15 m
4. 20 m

QUESTION

A car is moving on a horizontal circular track of radius 0.2 km with a constant speed. If coefficient of friction between tyres of car and road is 0.45, then speed of car may be (Take $g = 10\ m/s^2$)

1. $15\ m/s$
2. $30\ m/s$
3. $20\ m/s$
4. $40\ m/s$

MOTION OF CAR ON BANKED ROAD



QUESTION

A car is moving on a horizontal circular road of radius 0.1 km with constant speed. If coefficient of friction between tyres of car and road is 0.4, then speed of car may be ($g = 10\ m/s^2$)

1. 5 m/s
2. 10 m/s
3. 20 m/s
4. All of these

QUESTION

A car of mass m is moving on a level circular track of radius R. If μ_s represents the static friction between the road and tyres of the car, the maximum speed of the car in circular motion is given by

1. $\sqrt{\mu_s m R g}$
2. $\sqrt{\dfrac{Rg}{\mu_s}}$
3. $\sqrt{\dfrac{mRg}{\mu_s}}$
4. $\sqrt{\mu_s R g}$

MOTION OF CAR ON ROUGH BANKED ROAD

QUESTION

A car is negotiating a curved road of radius R. The road is banked at an angle θ, the coefficient of friction between the tyers of the car and the road is μs. The maximum safe velocity on this road is

(1) $\sqrt{gR^2 \frac{\mu_s + \tan\theta}{1 - \mu_s \tan\theta}}$

(2) $\sqrt{gR \frac{\mu_s + \tan\theta}{1 - \mu_s \tan\theta}}$

(3) $\sqrt{\frac{g}{R} \frac{\mu_s + \tan\theta}{1 - \mu_s \tan\theta}}$

(4) $\sqrt{\frac{g}{R^2} \frac{\mu_s + \tan\theta}{1 - \mu_s \tan\theta}}$

QUESTION

A roller coaster is designed such that riders experience "weightlessness" as they go round the top of a hill whose radius of curvature is 20 m. The speed of the car at the top of the hill is between

1. 13 m/s and 14 m/s
2. 14 m/s and 15 m/s
3. 15 m/s and 16 m/s
4. 16 m/s and 17 m/s

QUESTION

A tube of length L is filled completely with an incompressible liquid of mass M and closed at both end. The tube is then rotated in horizontal plane about one of its ends with a uniform angular velocity ω. The force exerted by the liquid at the other end is

1. $\frac{1}{2}M\omega^2L^2$
2. $M\omega^2L$
3. $\frac{1}{4}M\omega^2L$
4. $\frac{1}{2}M\omega^2L$


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 01 | **Physics**

Work, Energy and Power

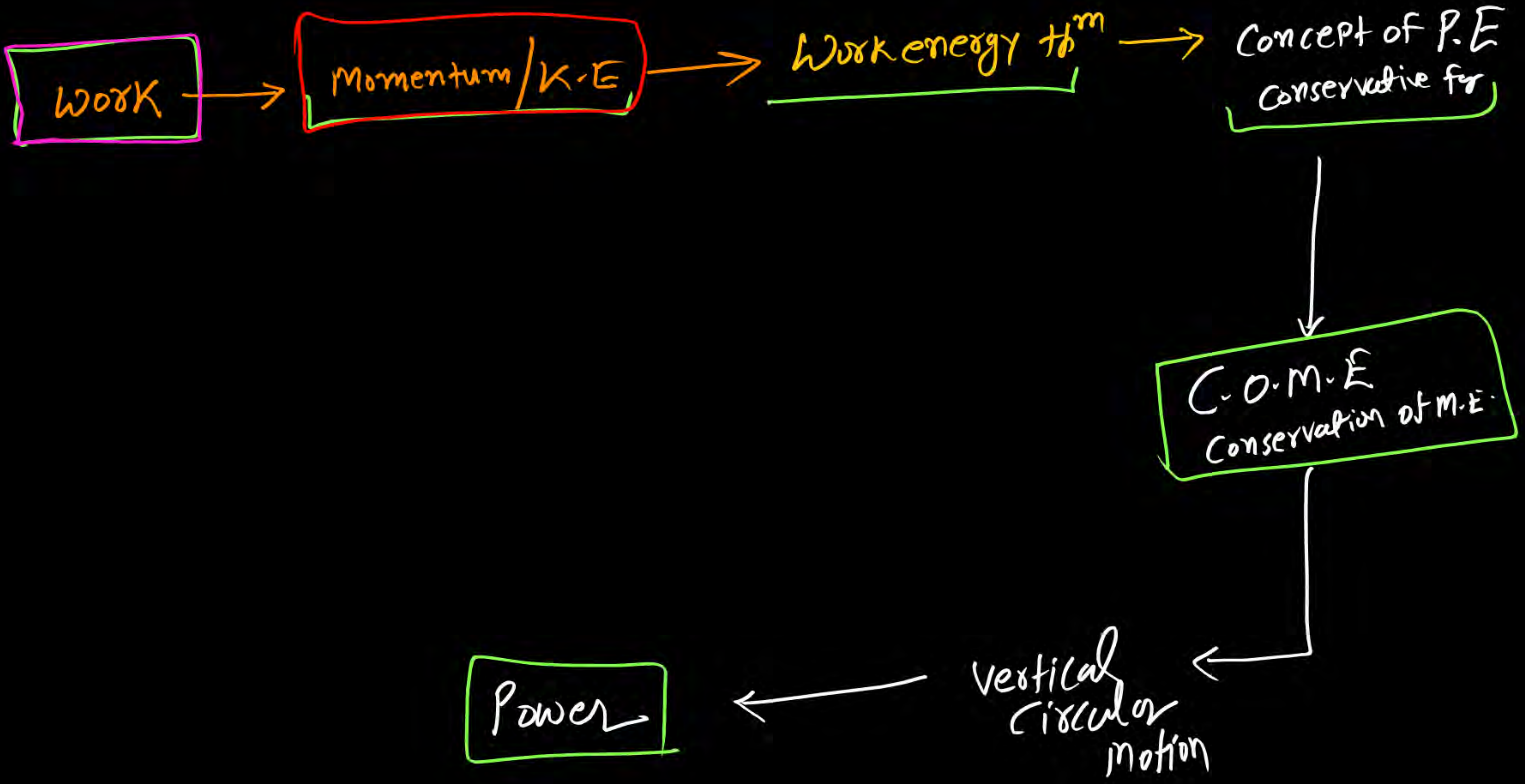
By- Dr. Manish Raj (MR SIR)



Topic To Be Covered

1. # feel of work.
2. #
3. #
4. #




Work
Momentum / K.E
Work energy thm
Concept of P.E
conservative for
C.O.M.E
Conservation of M.E.
vertical circular motion
Power

Anuksha Das · 6 hours ago Report

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Charlie paul · 23 hours ago Report

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Force (How much force)

$F = 100$ newton

How long (t)

$\{ F \times \Delta t = \Delta p \}$

(Scalar)

$F_{Avg} = \dfrac{\Delta p}{\Delta t}$

$F_{inst} = \dfrac{dp}{dt}$

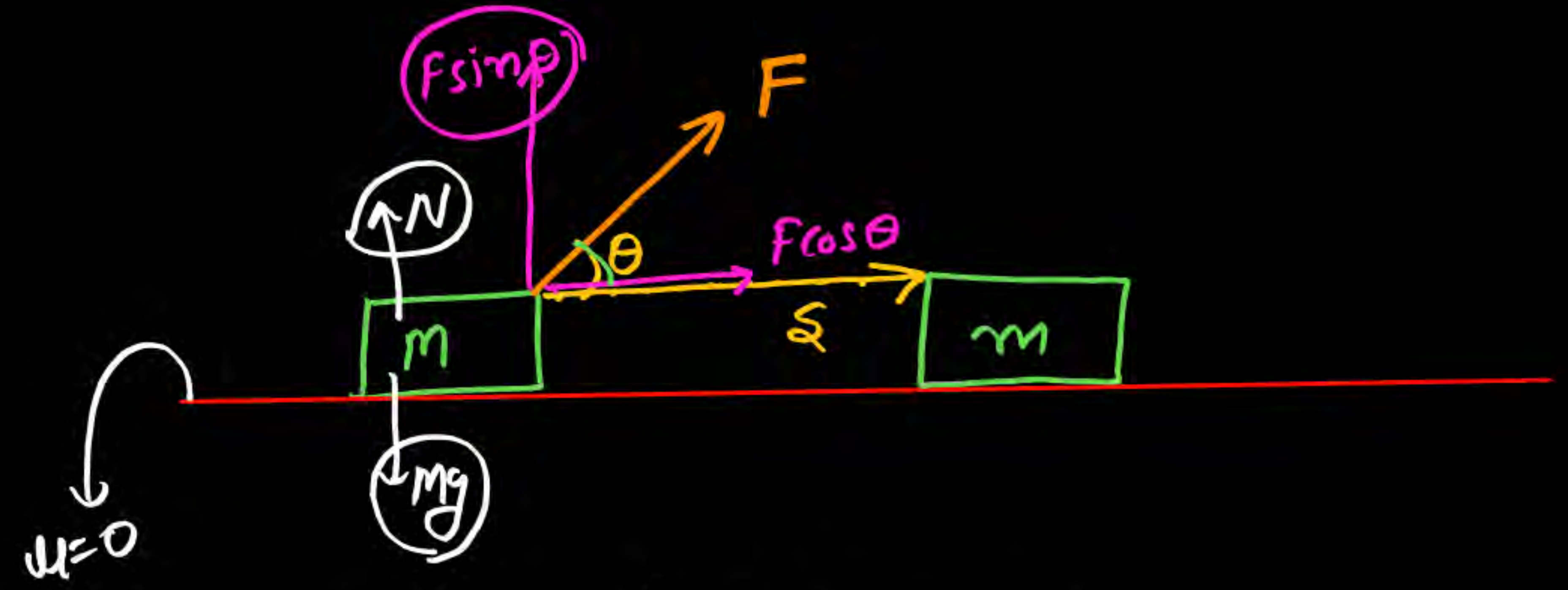
force & time is given, You have to calculate work

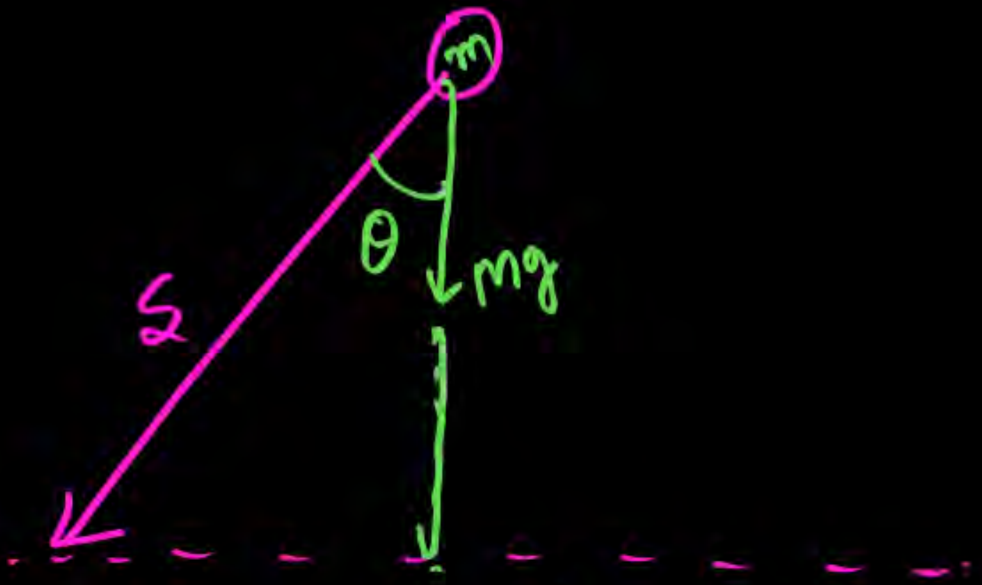
→ calculate Δp 1st then find K.E from Δp ($W = \Delta KE$)

How far (s)

$\{ \vec{F} \cdot \vec{s} = \text{Work} \}$

"In question if F & s is given & momentum is asked then You have to find work then use work = ΔK.E then find P from K.E





Work done by gravity on object $= (mg) S\cos\theta$

$\Sigma F_y = 0$

$S(\text{disp}^n) = 0$

$\Sigma F_{x\,net} = F\cos\alpha$

$S_x = \vec{S}$

Work $= F_x S_x$

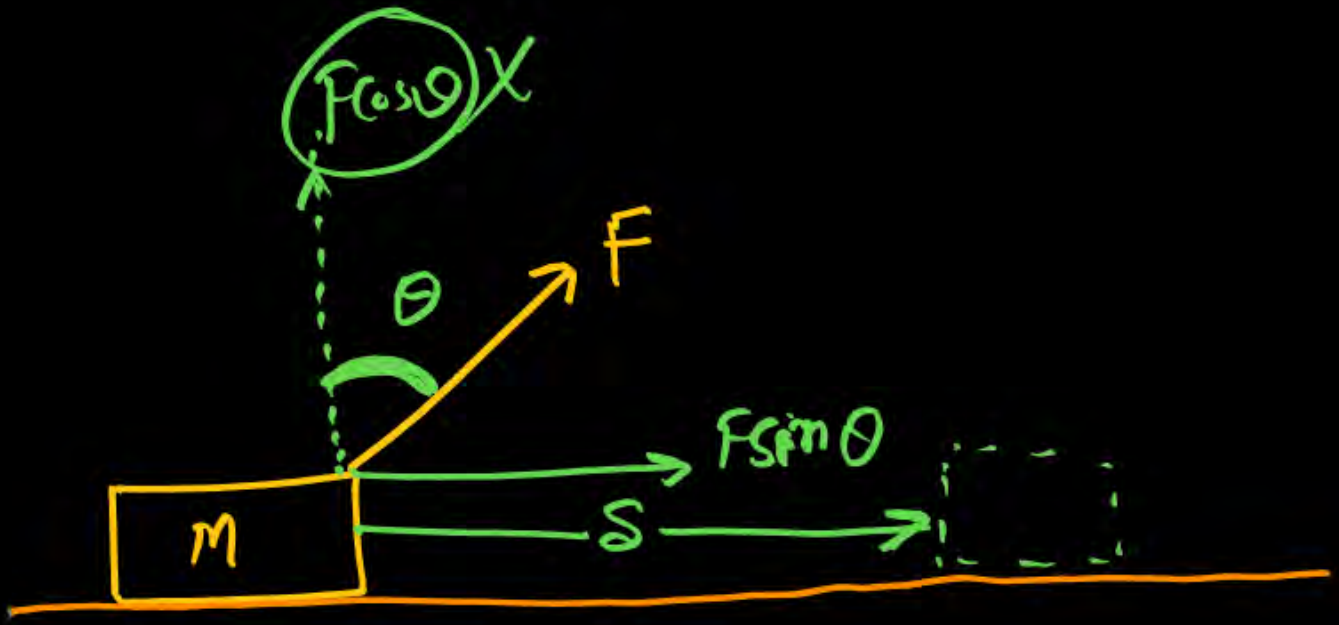
Work $= F\cos\theta\, S$

Work $=$ (comp^n of force along disp^m) S

Work $=$ (comp^n of disp^m along force) F

$W = \vec{F} \cdot \vec{S} = FS\cos\theta$ → Angle b/w force & disp^n

↳ Scalar (Nm = Joule)



Work = F S cosθ ✗

Work = Fsinθ · S ✓

$$w = (F_x\hat{i} + F_y\hat{j} + F_z\hat{k}) \cdot (x\hat{i} + y\hat{j} + z\hat{k})$$

$$= F_x x + F_y y + F_z z$$

work done by constant force

$\vec{F} = (m)\vec{a}$

* $W = FS\cos\theta$ → work may be +ve, −ve or zero
This will not represent dirⁿ

$W = \vec{F} \cdot \vec{S}$

- unit (Nm = 1 Joule)
- scalar
- depends on fram.
- always valid for all type of motion.
- $\vec{S}$ = dispⁿ of Point of application of force.
- work done by one force does not depends on Other force acting on that object
- ~~$W_{total} = F_{net} \cdot \vec{S}_{net}$~~ ✗

✓ $W_{total} = W_1 + W_2 + W_3 = F_1S_1 + F_2S_2 + F_3S_3$

work don by centripetal force is zero



W = +ve	W = 0	W = −ve
$0° \le \theta < 90$	$\theta = 90°$	$180 \ge \theta > 90°$
speed ↑	speed = constⁿ	speed ↓
K.E ↑	K.E = constⁿ	K.E ↓



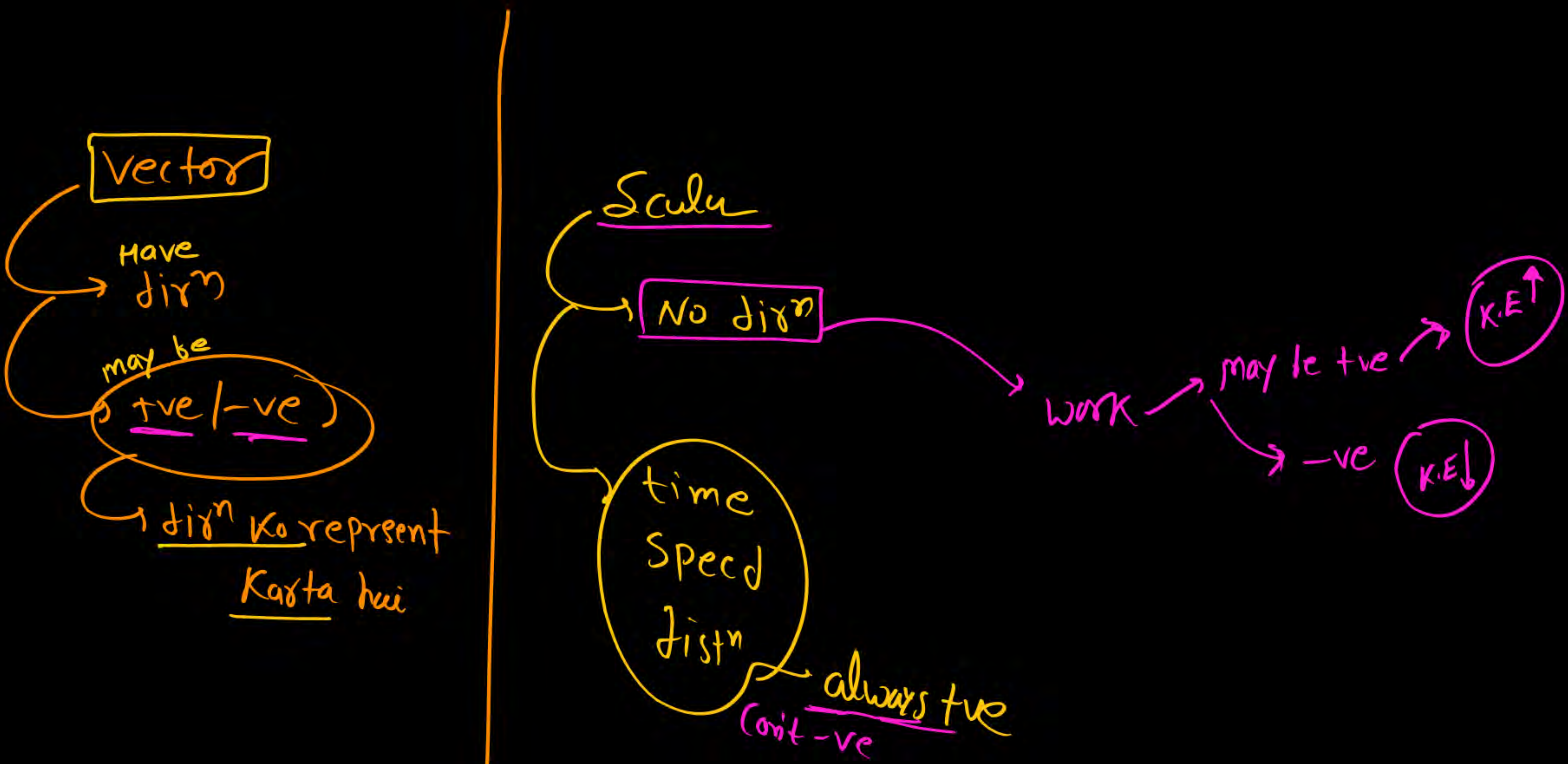
Work By Normal w.r.t Pinky =
Work By Normal w.r.t R.L ≠





$disp^m = 0$

work $= 0$
done


Vector
Have dirn
may be
+ve / -ve
dirn Ko represent Karta hai
Scalar
No dirn
work
may be +ve
K.E ↑
-ve
K.E ↓
time
Speed
distn
always +ve
Can't -ve

Force (F)

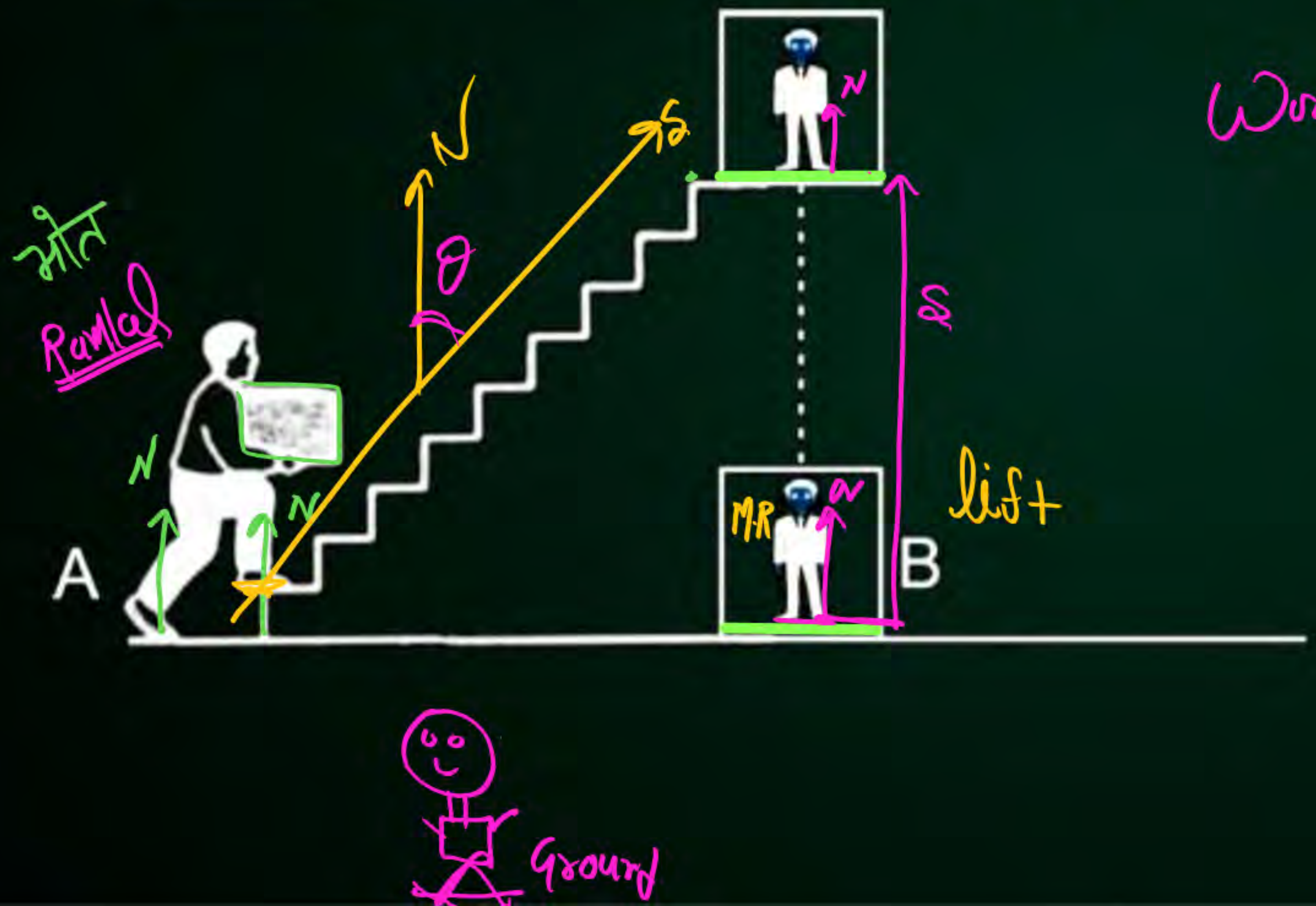
How far (s)

How long (t)

Work = Ve	Work = 0	Work = –Ve

WORK

Work by normal on Ramal $= 0$ (a) 56% ✓
$> NS$ (b) ✗
$< NS$ (c)



Work by Normal on M.R $\neq 0$
$= NS\cos 0^\circ$
$= NS$

QUESTION (NEET)

A force $\vec{F} = (2\hat{i} - \hat{j}\ 4 - \hat{k})\ N$ displaces a particle upto $\vec{d} = (3\hat{i} + 2\hat{j} - \hat{k})m$, Calculate work done.

1. Zero
2. 1 J ✓
3. 4 J
4. 12 J

$W = \vec{F} \cdot \vec{S}$

$= (2\hat{i} - 4\hat{j} - \hat{k}) \cdot (3\hat{i} + 2\hat{j} - \hat{k})$

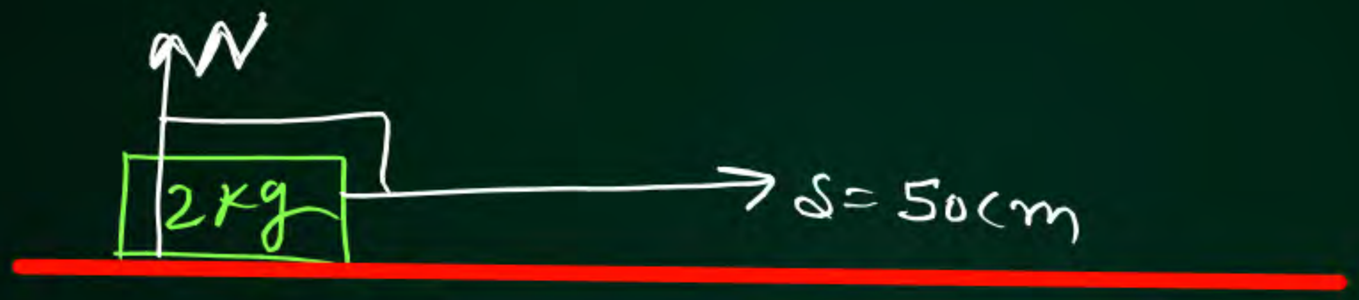
$= 6 - 8 + 1$ ~~$\sqrt{8^2 + 6^2 + (1)^2}$~~

$= -1$

QUESTION

A 2 kg mass lying on a table is displaced in the horizontal direction through 50 cm. The work done by the normal reaction will be:-

1. 0
2. 100 joule
3. 100 erg
4. 10 joule



QUESTION

A force of 10 N displaces an object by 10 m. If work done is 50 J then direction of force make an angle with direction of displacement:-

1. 120°
2. 90°
3. 60°
4. None of these

$W = F S \cos\theta$

$50 = 10 \times 10 \cos\theta$

$\cos\theta = \frac{1}{2}$

$\theta = 60°$

QUESTION

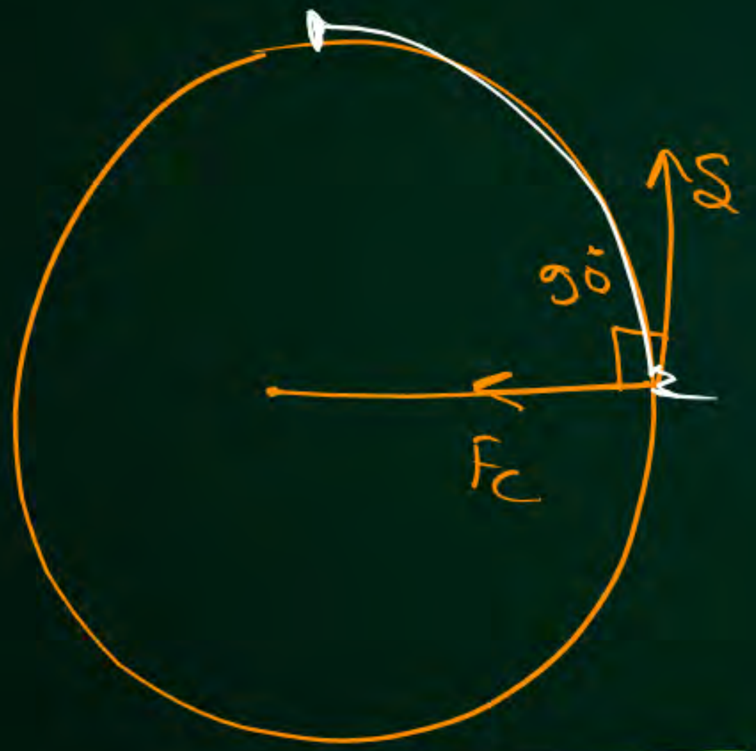
A stone of mass m is tied to a string of length ℓ at one end and by holding second end it is whirled into a horizontal circle, then work done will be:-

(1) 0

(2) $\left(\frac{mv^2}{\ell}\right)2\pi\ell$

(3) $(mg).2\pi\ell$

(4) $\left(\frac{mv^2}{\ell}\right)\ell$



Work = 0

U.C.M
speed = const^n
work = 0

QUESTION

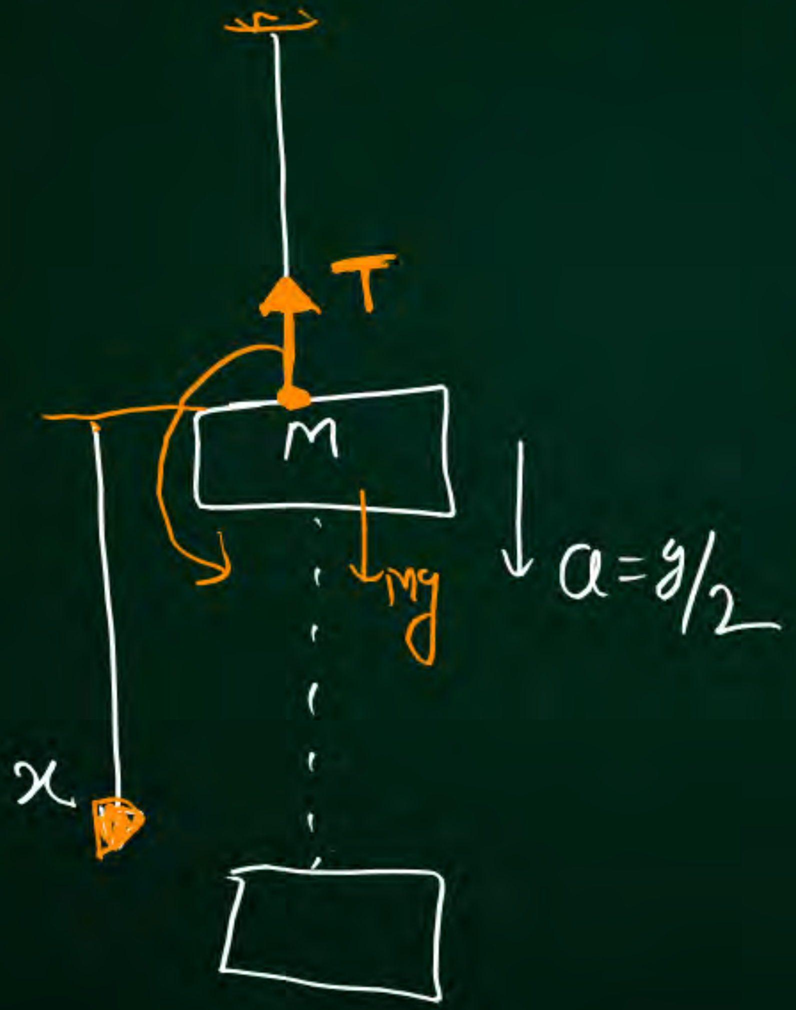
A rope is used to lower vertically a block of mass M by a distance x with a constant downward acceleration $g/2$. The work done by the rope on the block is:-

(1) Mgx

(2) $\frac{1}{2}Mgx^2$

(3) $-\frac{1}{2}Mgx$ Ans

(4) Mgx^2



$\Sigma F_y = ma_y$

$mg - T = ma$

$mg - T = \frac{mg}{2}$

$T = mg - \frac{mg}{2} = \frac{mg}{2}$

$W = \vec{T} \cdot \vec{x}$

$= \frac{mg}{2} x \cos 180^\circ = \frac{-mgx}{2}$

QUESTION

A particle moves from a point $(-2\hat{\imath} + 5\hat{\jmath})$ to $(4\hat{\imath} + 3\hat{\jmath})$ when a force of $(4\hat{\imath} + 3\hat{\jmath})$ N is applied. How much work has been done by the force? [NEET-II-2016]

1. 5 J
2. 2 J
3. 18 J
4. 11 J

$\vec{r}_i \rightarrow \vec{r}_f$, $\vec{F}$

$\vec{Force} = (4\hat{i}+3\hat{j}) \cdot [\vec{r}_f - \vec{r}_i]$

$= (4\hat{i}+3\hat{j}) \cdot [6\hat{i} - 2\hat{j}]$

$= 24 - 6 = 18\text{ J}$

QUESTION

A uniform force of $(3\hat{i} + \hat{j})$ newton acts on a particle of mass 2 kg. Hence the particle is displaced from position $(2\hat{i} + \hat{k})$ meter to position $(4\hat{i} + 3\hat{j} - \hat{k})$ meter. The work done by the force on the particle is: **[NEET (UG)-2013]**

1. 15 J
2. 9 J
3. 6 J
4. 13 J

QUESTION

$r_i = \hat{i} + 2\hat{j}$ $\quad$ $r_f = 2\hat{i} + \hat{j} + 4\hat{k}$

A particle moves from point P(1, 2) to Q(2, 1, 4) under the action of a constant force $\vec{F} = (2\hat{\imath} + \hat{\jmath} + \hat{k})N$. Work done by the force is

1. 2 J
2. 4 J
3. 16 J
4. 8 J

Work

F = constant (const^n)

$W = \vec{F} \cdot \vec{S}$

$W = FS\cos\theta$

F = variable

$$\int dW = \int_{S_i}^{S_f} F \cdot dS$$

Work = $\int F \cdot dS$ = Area of F-S graph

Integ^n → Area of W/S graph

$dW = \int \vec{F} \cdot \vec{dS}$ = Area of F/S graph

Force —Integ^n→ Work (S)

Work (S) —diff^n (w.r.t) S→ Force

Force —diff^n→

$F = \frac{dW}{dS}$ = slope of work/S graph

$\Delta P = \int F \cdot dt$

For —→ P

P —diff→ For

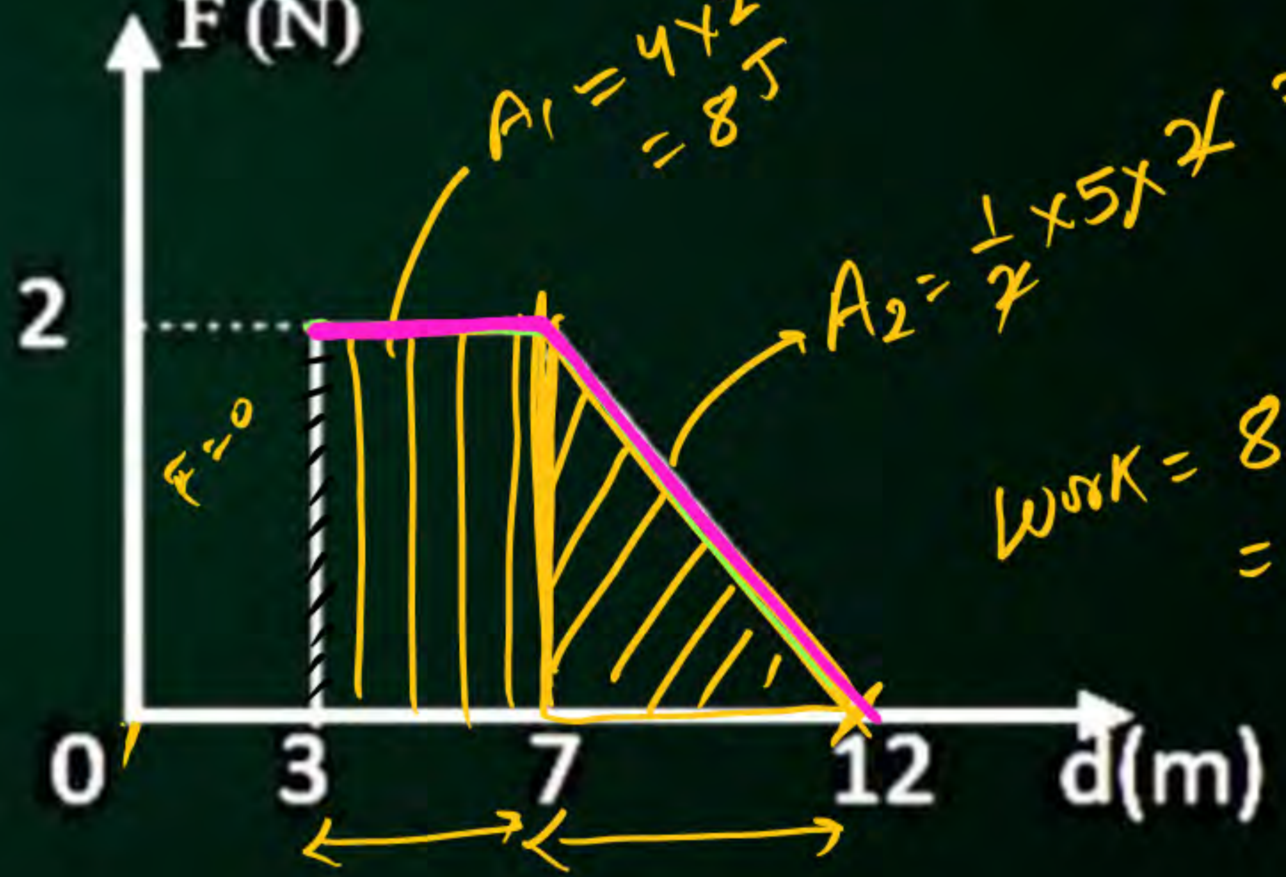
$F = \frac{dP}{dt}$

QUESTION

Force F on a particle moving in a straight line varies with distance d as shown in the figure. The work done on the particle during its displacement of 12 m is:

[AIPMT-2011]

1. 18 J
2. 21 J
3. 26 J
4. 13 J



QUESTION

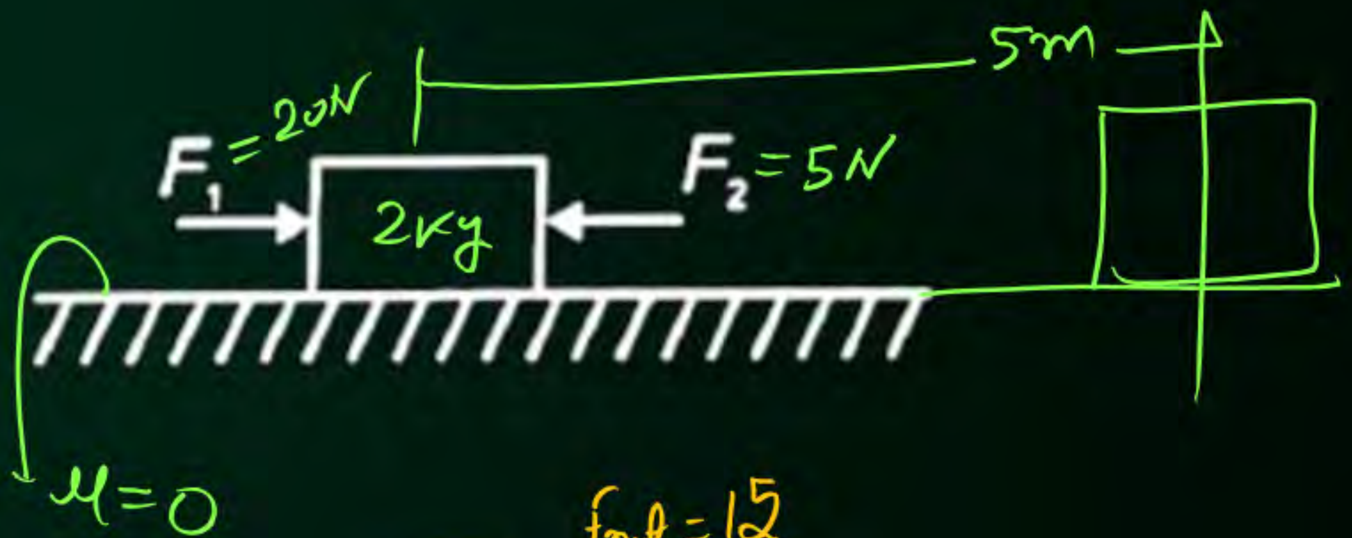
A block of mass 2 kg is placed on a smooth horizontal surface. Two forces $F_1 = 20$ N and $F_2 = 5$ N start acting on the block in opposite directions as shown. If block gets displaced by 5 m in the direction of net force then work done by F_2 is

(1) -75 J

(2) 75 J

(3) -25 J

(4) 25 J



Work = $F_2 S$

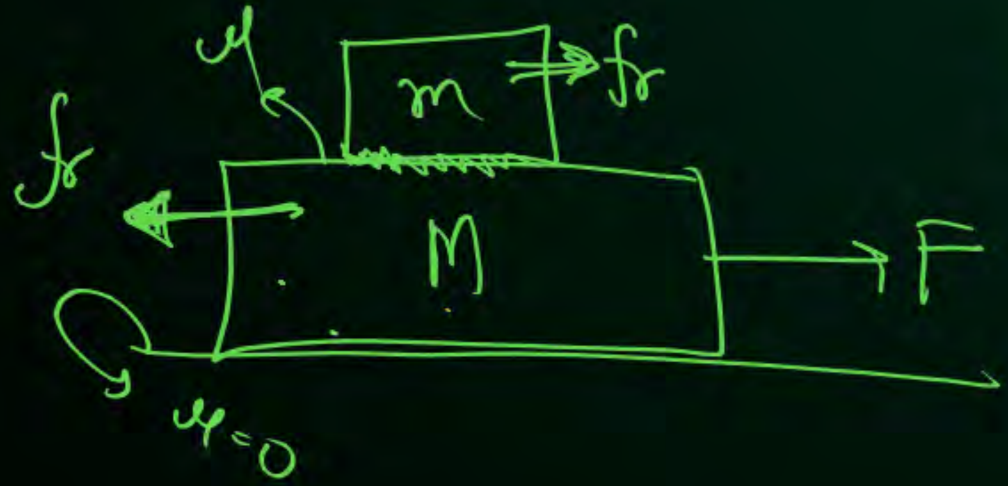
$= 5 \times 5 \cos 180°$

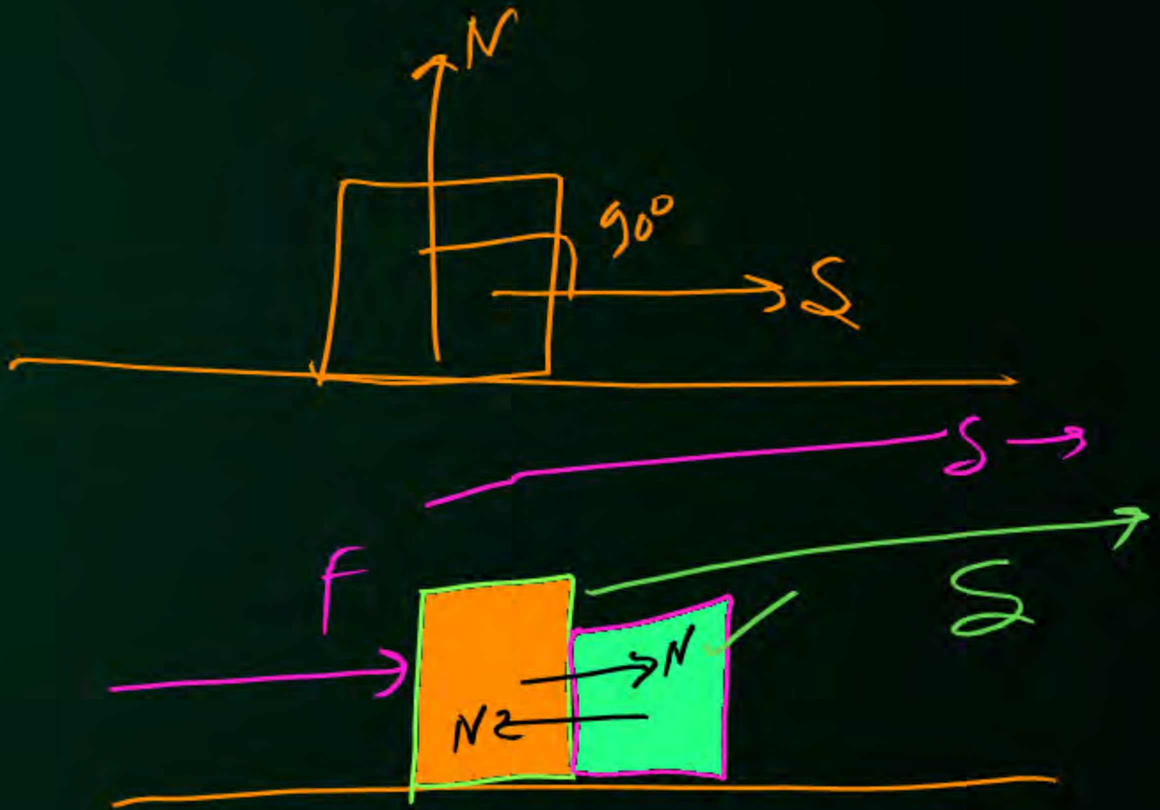
$= -25$ J

QUESTION

Work done by frictional force

1. Is always negative
2. Is always positive
3. Is zero
4. May be positive, negative or zero

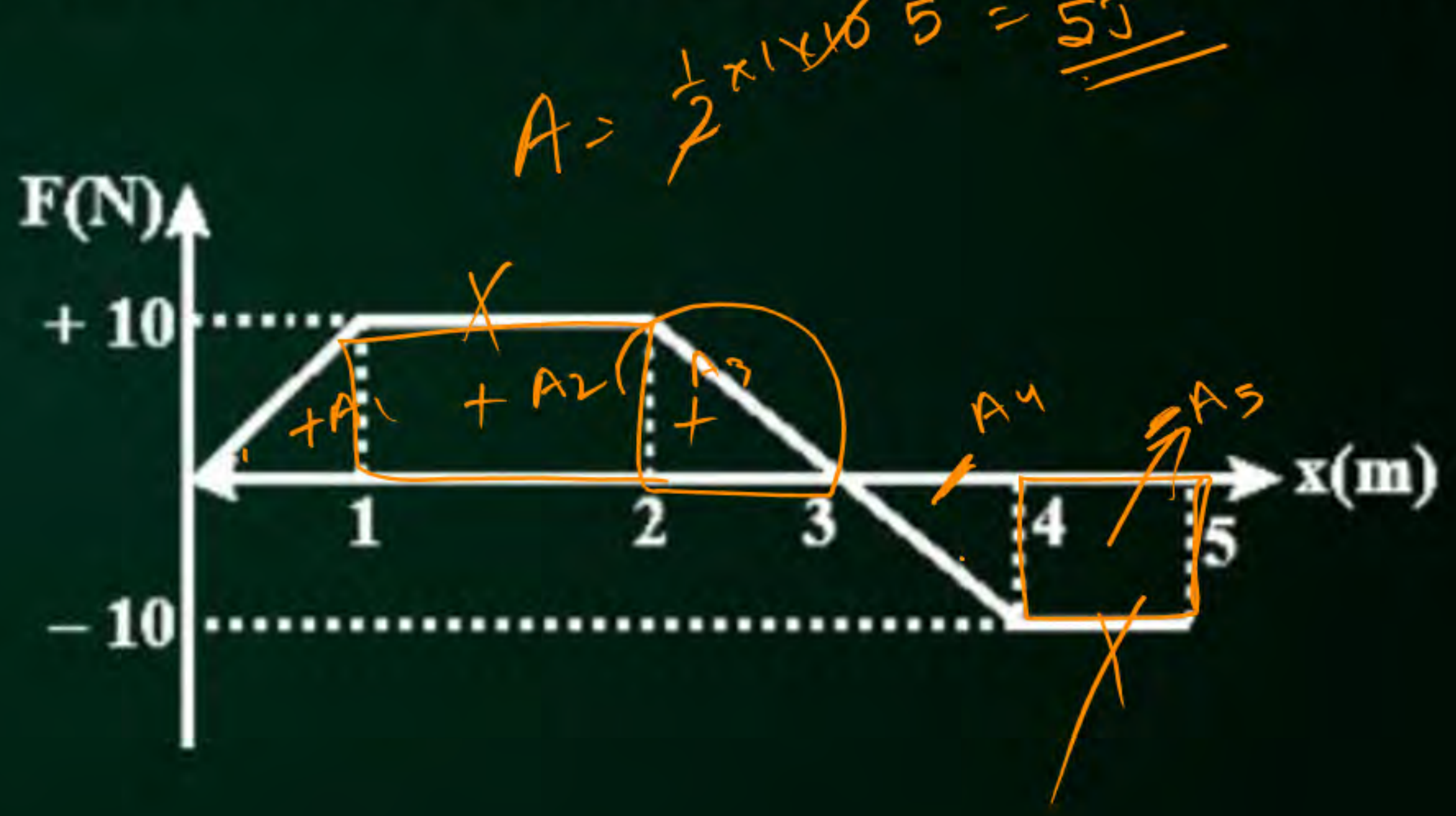




QUESTION

A position dependent force F acting on a particle and its force-position curve is shown in the figure. Work done on the particle, when its displacement 0 to 5 m is

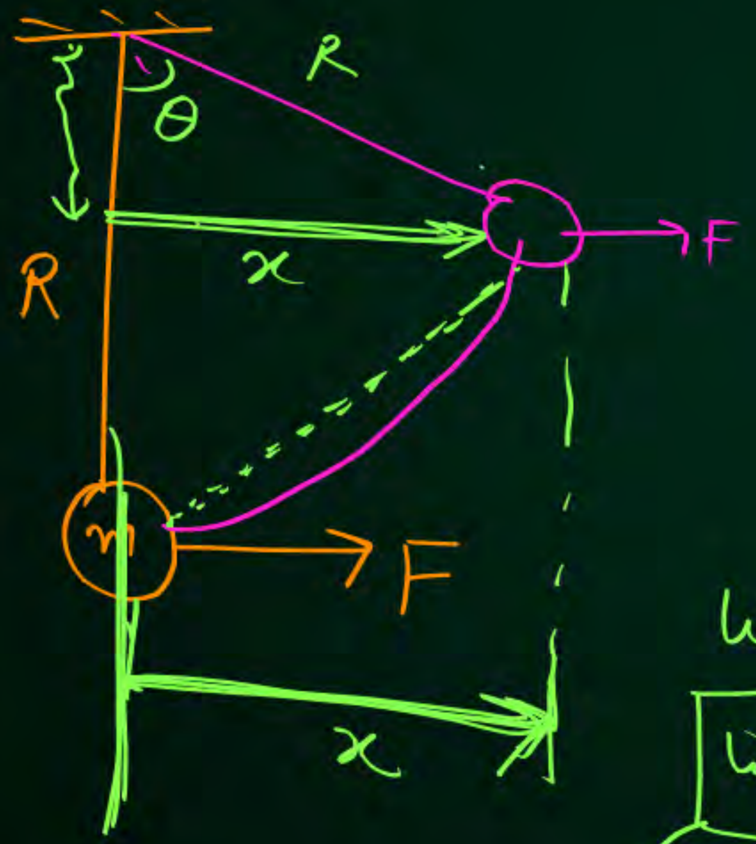
1. 35 J
2. 25 J
3. 15 J
4. 5 J

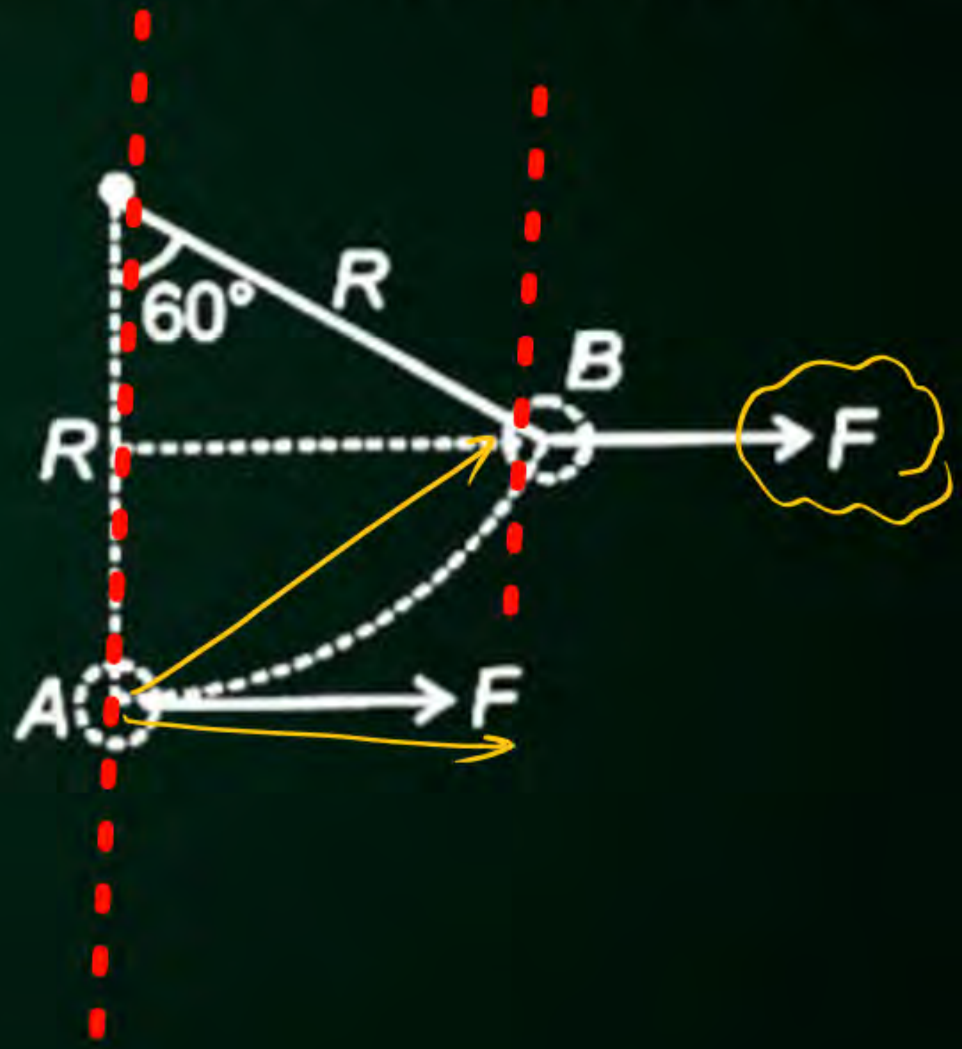


QUESTION

block of mass m is pulled along a circular arc by means of a constant horizontal force F as shown. Work done by this force in pulling the block from A to B is

1. $FR/2$
2. FR
3. $\frac{\sqrt{3}}{2}FR$ ✓
4. mgR





$W = F_x \times x$

$W = F R \sin\theta$

$= F R \sin 60° = \frac{FR\sqrt{3}}{2}$

$\sin\theta = \frac{x}{R}$

$x = R\sin\theta$

QUESTION

varible

A force $F = Kx^2$ acts on a particle at an angle of 60° with the x-axis. The work done in displacing the particle from x_1 to x_2 will be:

1. $\frac{kx^2}{2}$

2. $\frac{k}{2}(x_2^2 - x_1^2)$

3. $\frac{k}{6}(x_2^3 - x_1^3)$

4. $\frac{k}{3}(x_2^3 - x_1^3)$

$dW = \vec{F} \cdot d\vec{x}$

$\int dW = \int Kx^2 \, dx \cos 60^\circ$

$\text{Work} = \frac{K}{2} \int_{x_1}^{x_2} x^2 \, dx$

$= \frac{K}{2} \left[\frac{x^3}{3} \right]_{x_1}^{x_2} = \frac{K}{6} \left[x_2^3 - x_1^3 \right]$

QUESTION

A particle moves along X-axis from $x = 0$ to $x = 1$ m under the influence of a force given by $F = 3x^2 + 2x - 10$. Work done in the process is

1. +4 J
2. −4 J
3. +8 J
4. −8 J

$dW = F \cdot dx$

$= \int_0^1 3x^2 dx + \int_0^1 2x\,dx + \int_0^1 -10\,dx$

$dW = \int F_x dx + \int F_y dy + \int F_z dz$

QUESTION

A particle moves along x-axis from $x = 0$ to $x = 5$ metre under the influence of a force $F = 7 - 2x + 3x^2$. The work done in the process is

1. 70
2. 135
3. 270
4. 35

$F = 7 - 2x + 3x^2$

$dw = F\,dx$

$dw = (7 - 2x + 3x^2)\,dx$

$= \int 7\,dx - \int 2x\,dx + \int 3x^2\,dx$

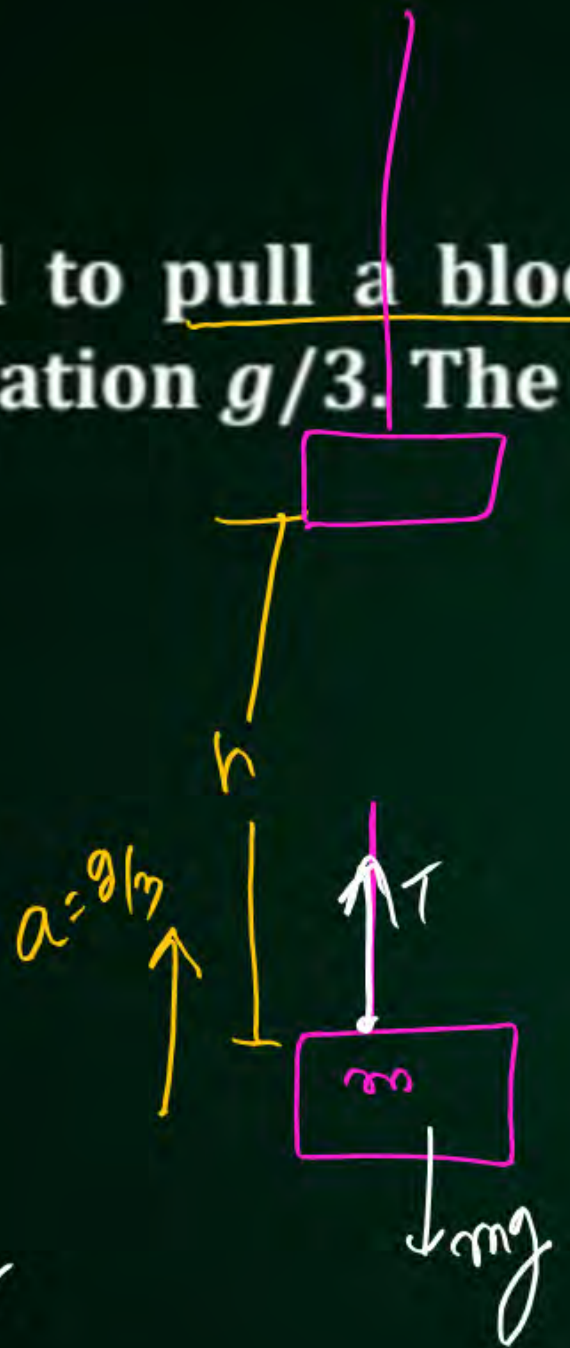
$= 7x - 2\left(\frac{x^2}{2}\right) + 3\left(\frac{x^3}{3}\right)$

$= \left(7x - x^2 + x^3\right)_0^5$

QUESTION

A string is used to pull a block of mass m vertically up by a distance h at a constant acceleration $g/3$. The work done by the tension in the string is

1. 2/3 mgh
2. $(-mgh)/3$
3. Mgh
4. 4/3 mgh ✓



$W = Th\cos 0^\circ$

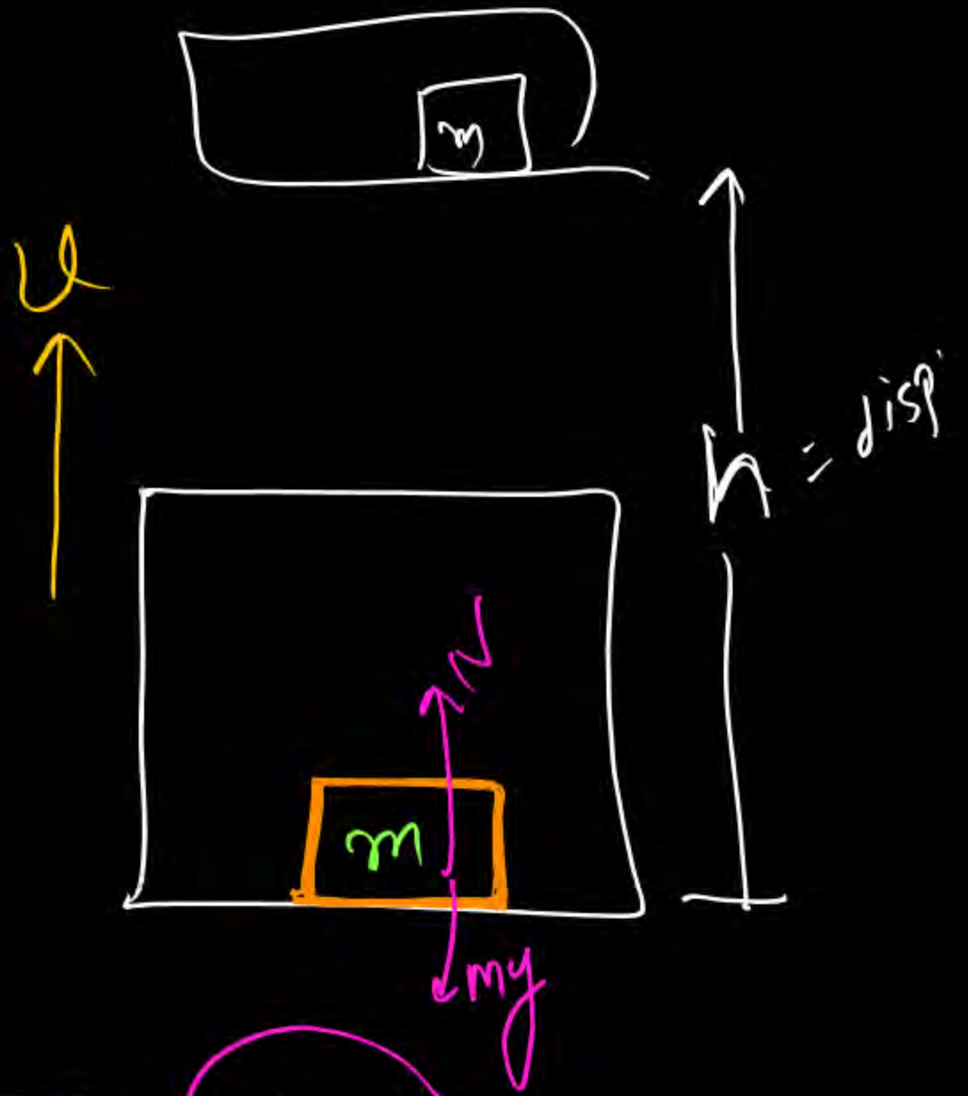
$= Th = \frac{4mgh}{3}$

$T - mg = ma$

$T = mg + ma$

$= mg + \frac{mg}{3} = \frac{4mg}{3}$

find work done by Normal in dispⁿ h ??



$F_y = 0$

$a = 0$

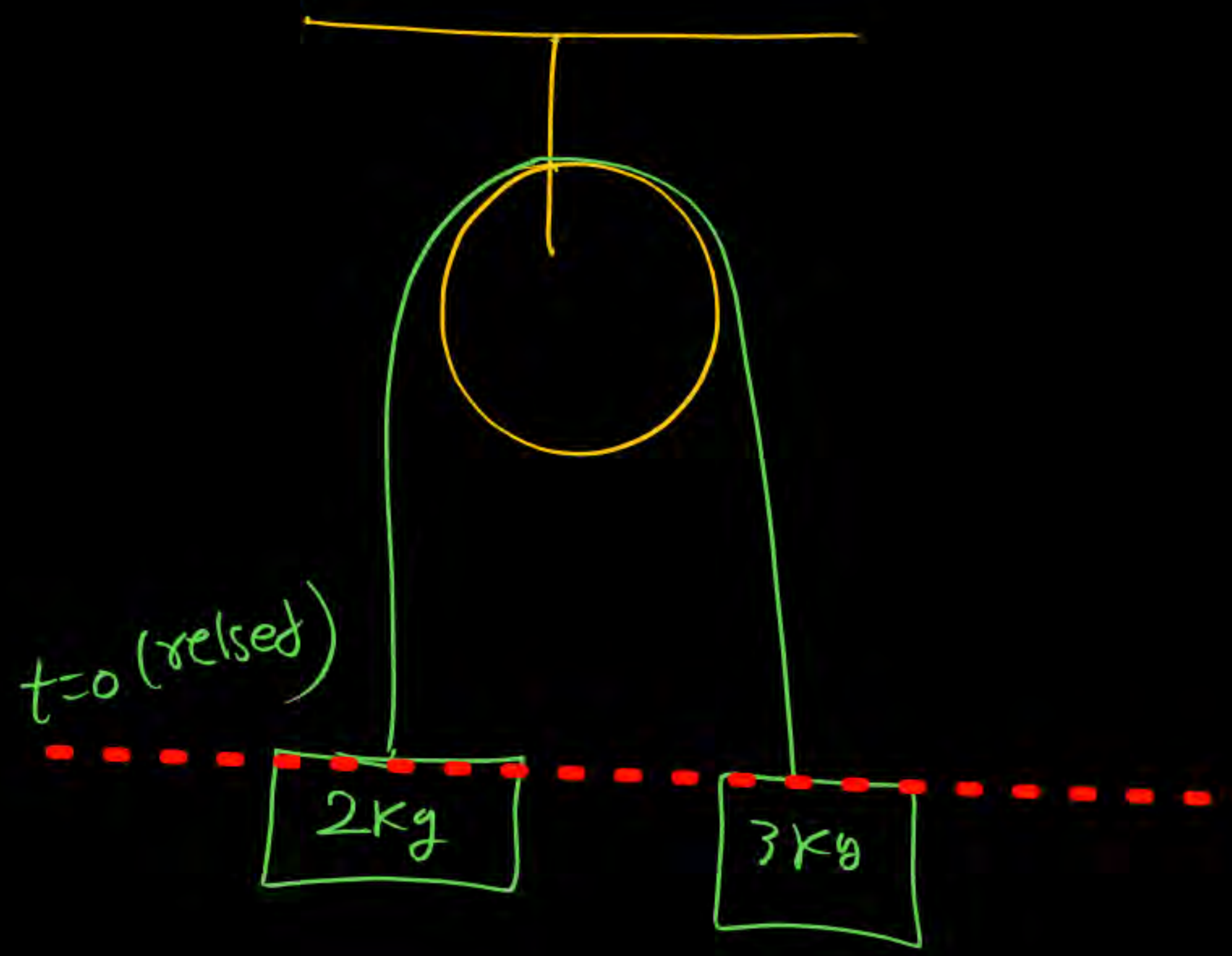
$N = mg$



(a) zero

(b) mgV

(c) mgh



find work done in 2 sec by
Tension on 3kg and 2kg

& By gravity on 3kg & 2kg

REVISION

HOMEWORK FROM YAKEEN MODULE

THANK YOU



YAKEEN 2.0

FOR NEET 2025

Lecture- 02 | Physics

Work, Energy and Power

By- Dr. Manish Raj (MR SIR)



Topics to be covered

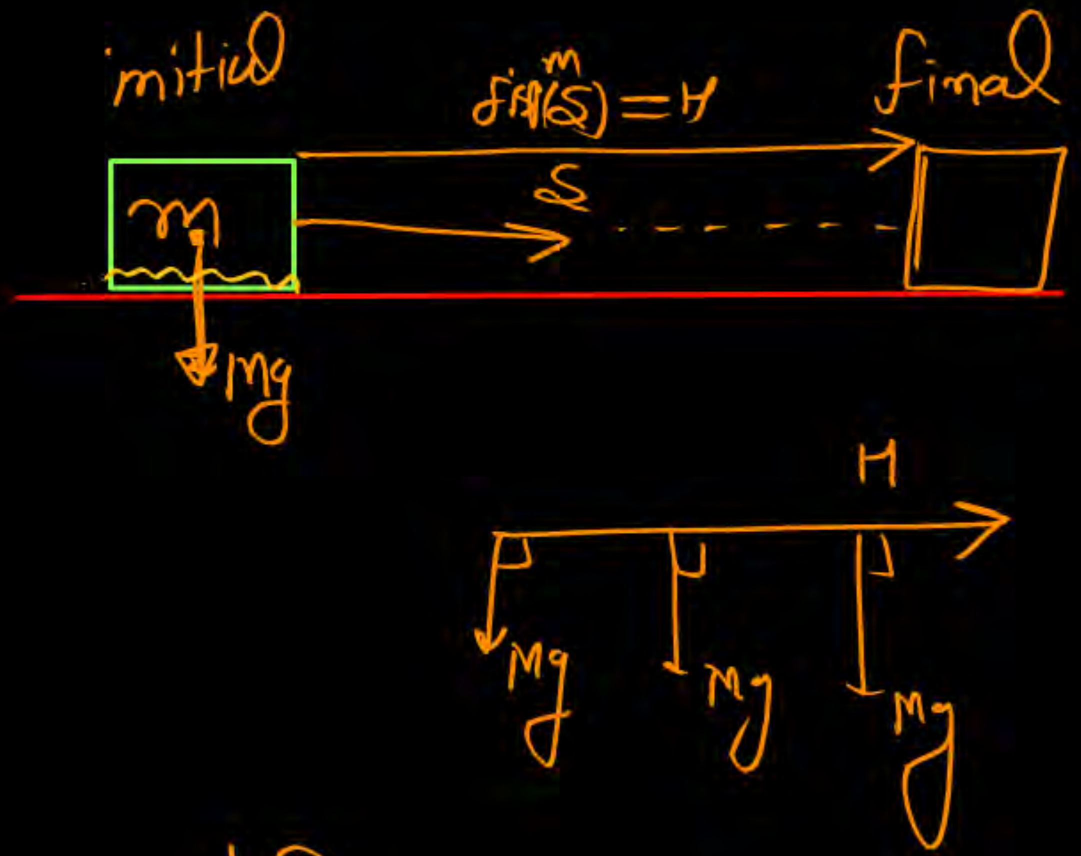
1. # Work done by gravity, friction, spring
2. # Rel^n B/w "K.E" & momentum
3. # Work energy theorem
4. #



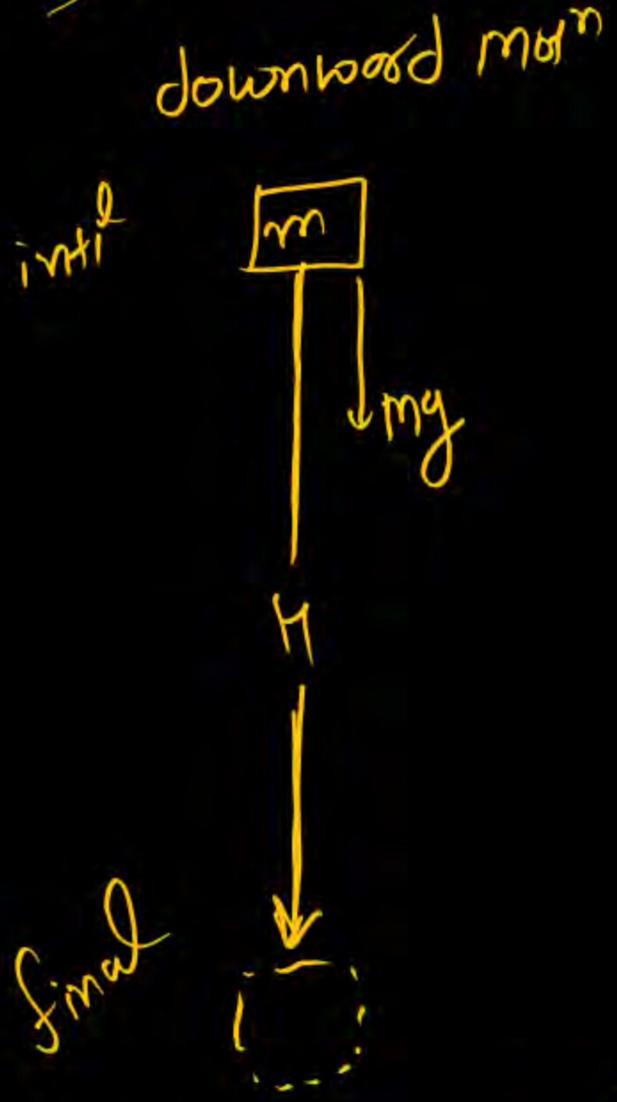
AAJ ka lecture full focus

Se Padhna hai

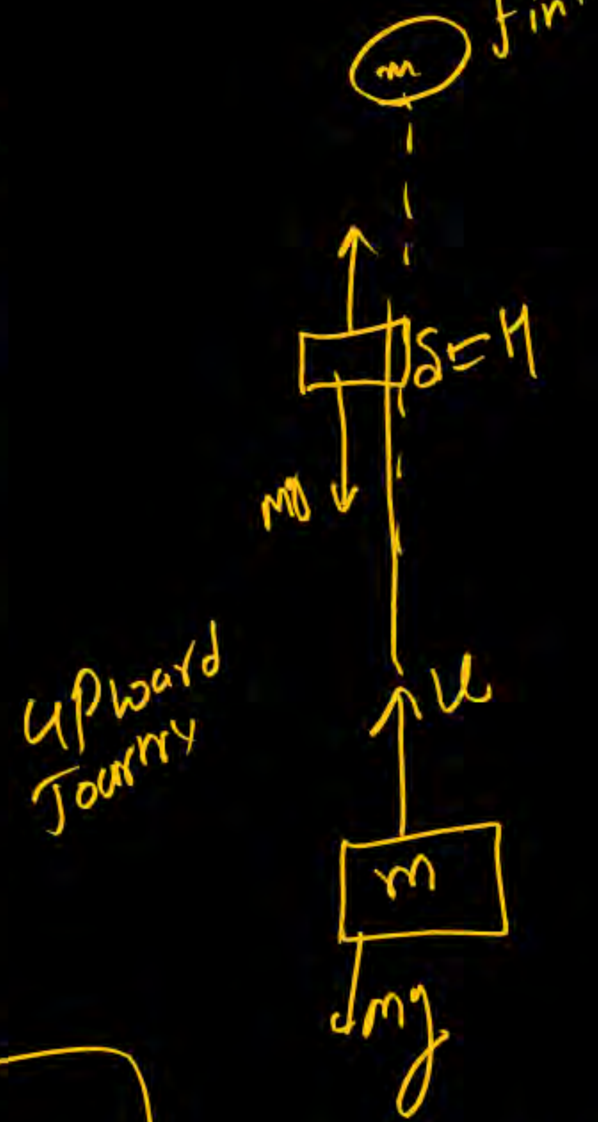
Work done by gravity $(F = mg)$



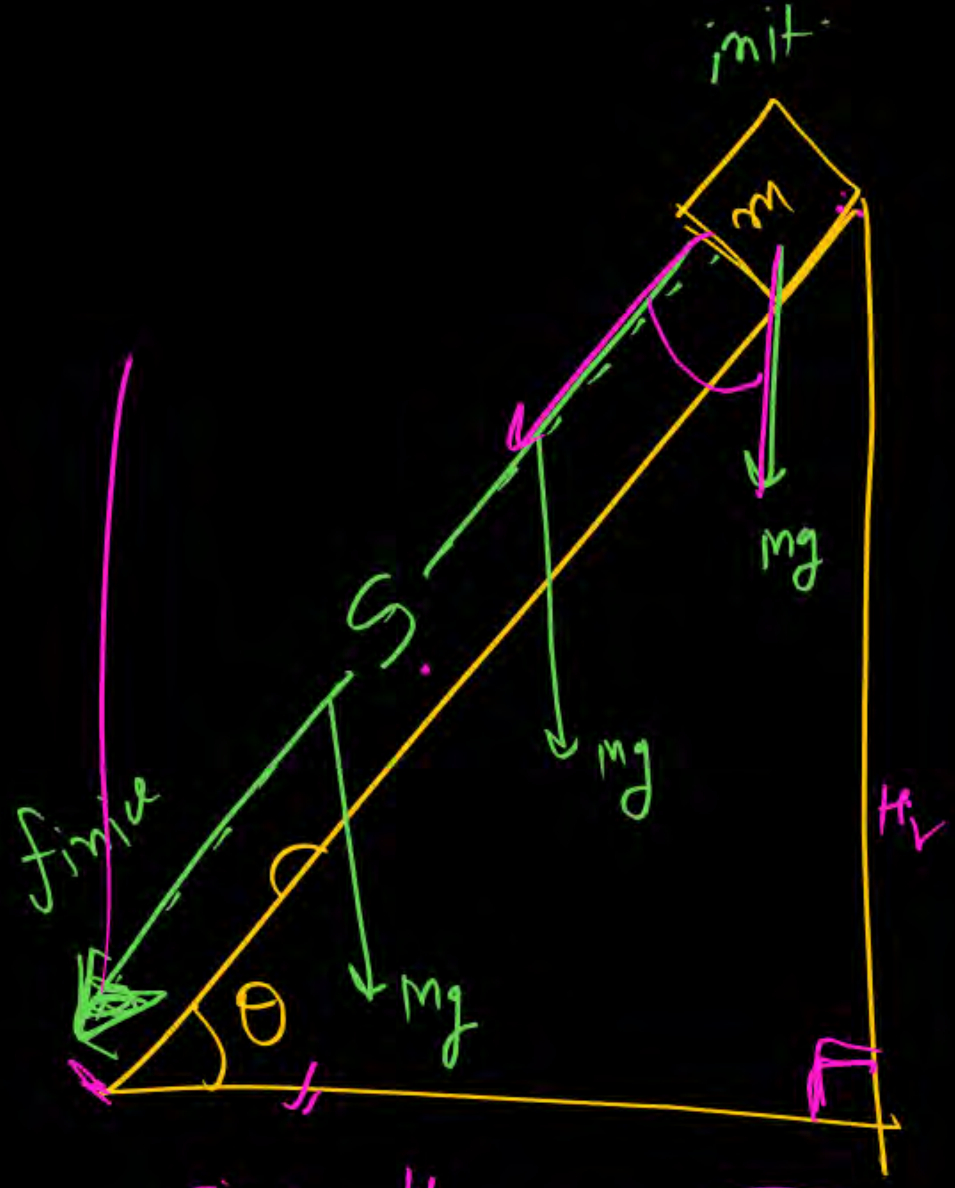
$$W_{gravity} = 0 = mgH\cos 90^\circ$$



$$W = mg(H)\cos 0^\circ$$
$$= mg(H)_{vertical\ disp}$$

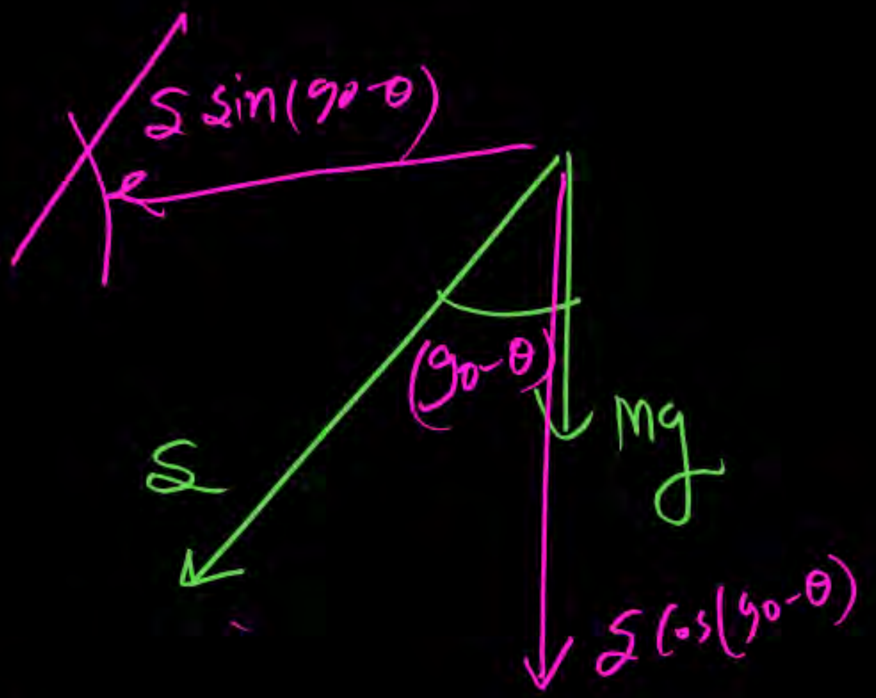


$$W = mgH\cos 180^\circ$$
$$W = -mgH$$



$\sin\theta = \frac{H_v}{S}$ $\quad H_v = S\sin\theta$

$W_{grav} = (mg) \times (\text{Vertical disp})$



$W = mgS\cos(90-\theta)$

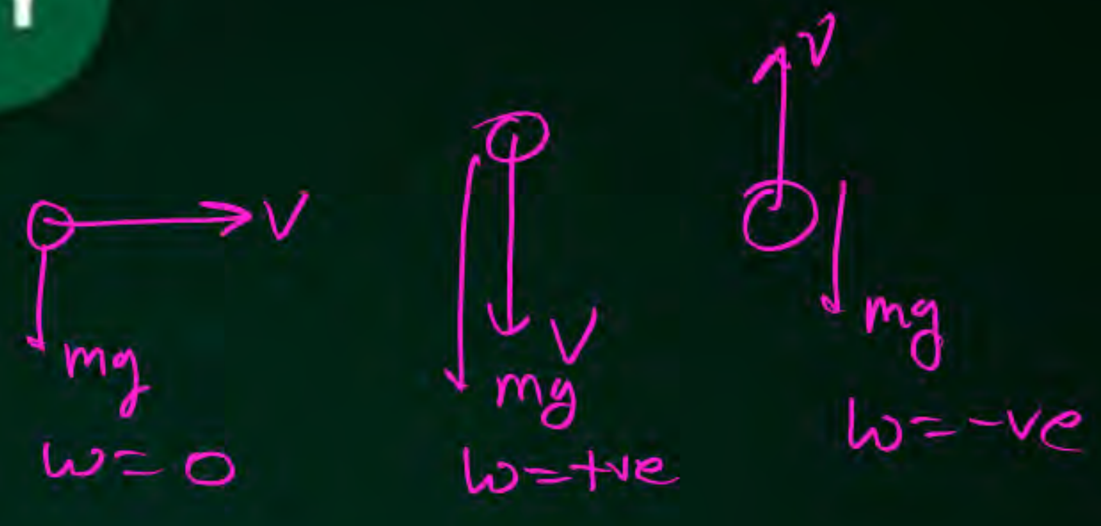
$W = mg(S\sin\theta)$



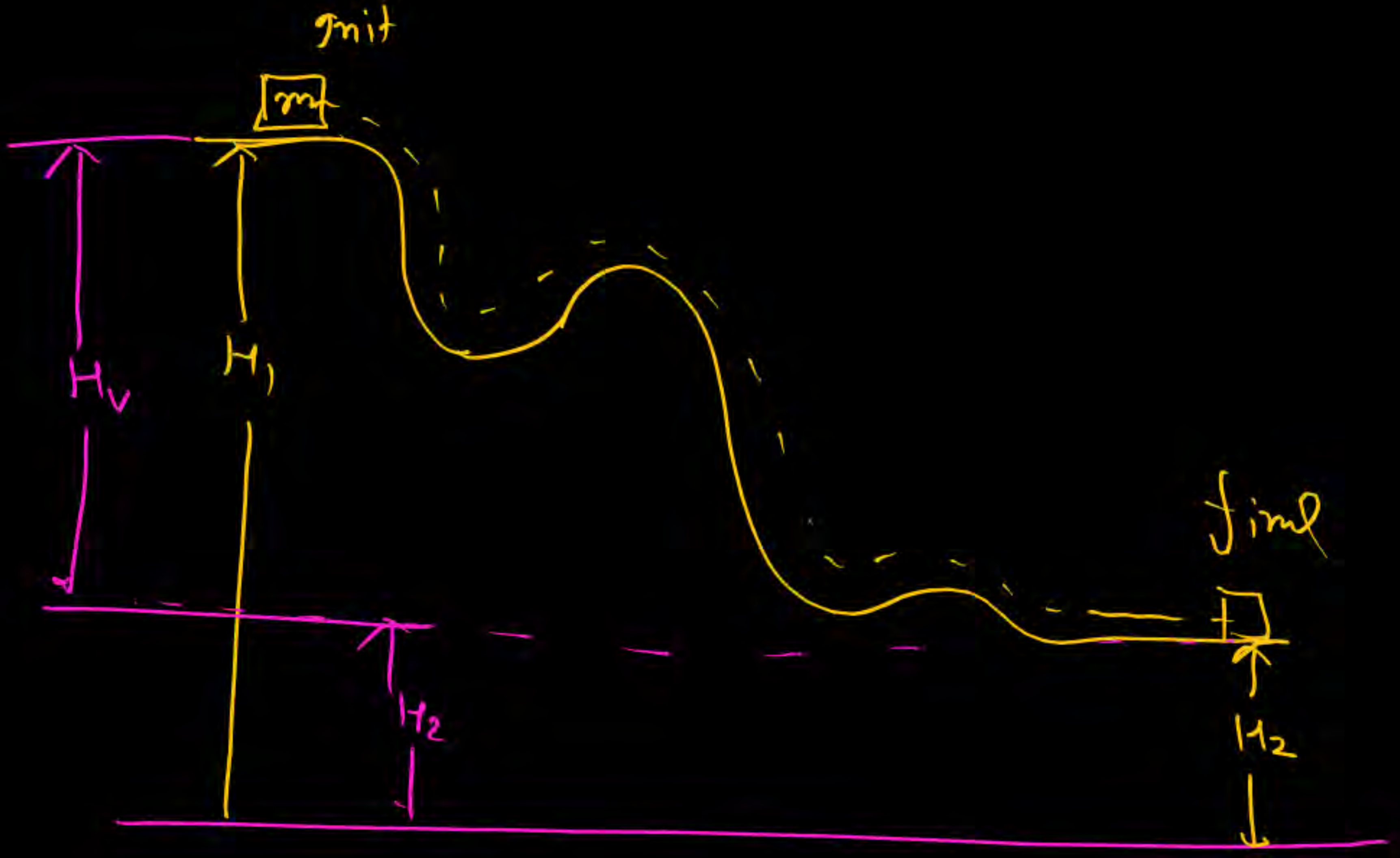
$W = mg\sin\theta\, S$

WORK DONE BY GRAVITY

- Does not depends on path.







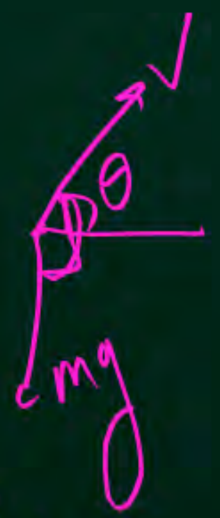
$$W = mg(H_1 - H_2)$$

Ans

QUESTION

A force of constant magnitude acts on a particle such that its always perpendicular to the velocity of particle moving in a plane then

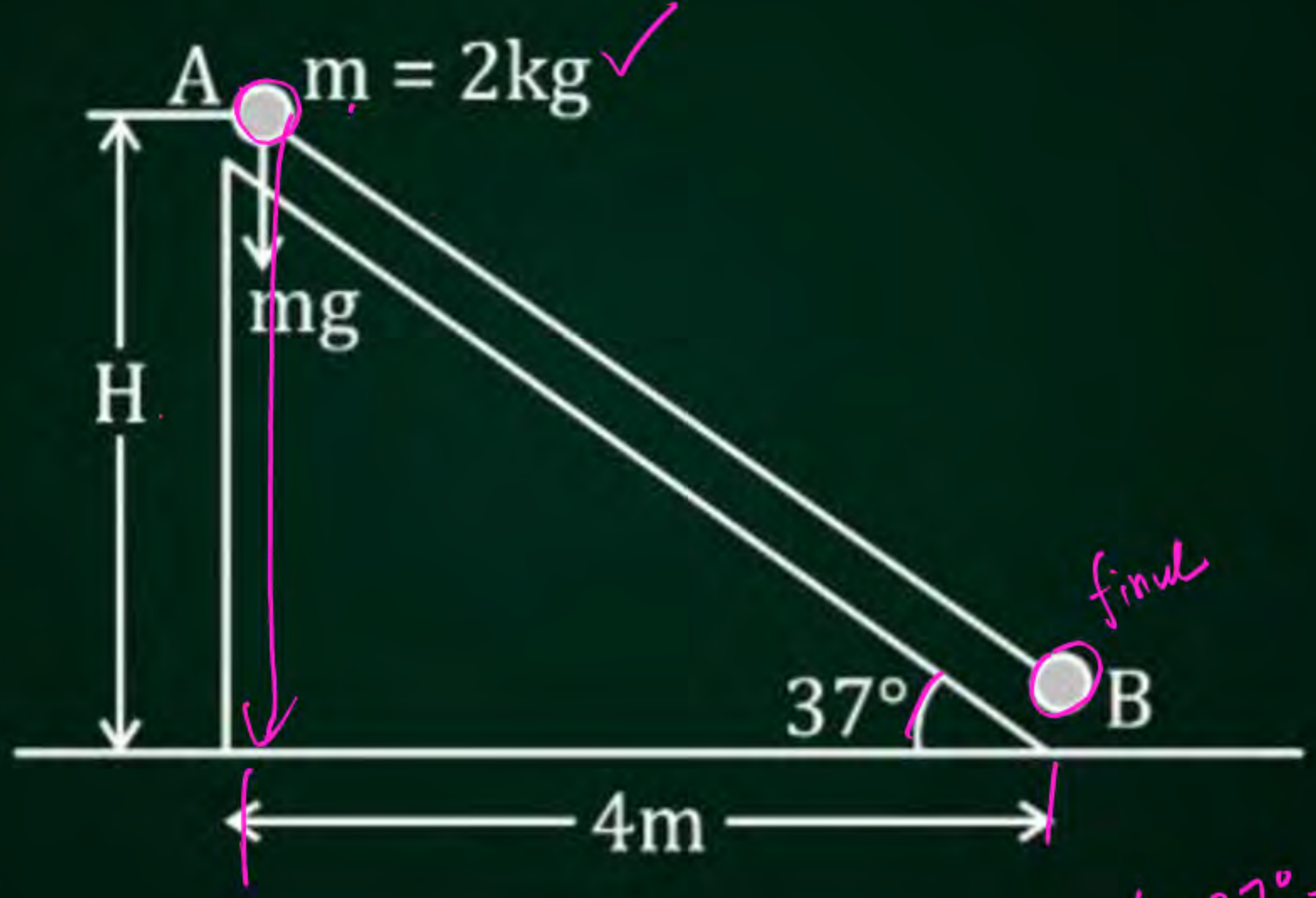
1. its velocity is constant.
2. its acceleration is constant.
3. Its kinetic energy is constant.
4. Its linear momentum is constant.





QUESTION

Find work done by gravity when object moves from A to B.



$W = mg\,H_v$

$= 2 \times 10 \times 3$

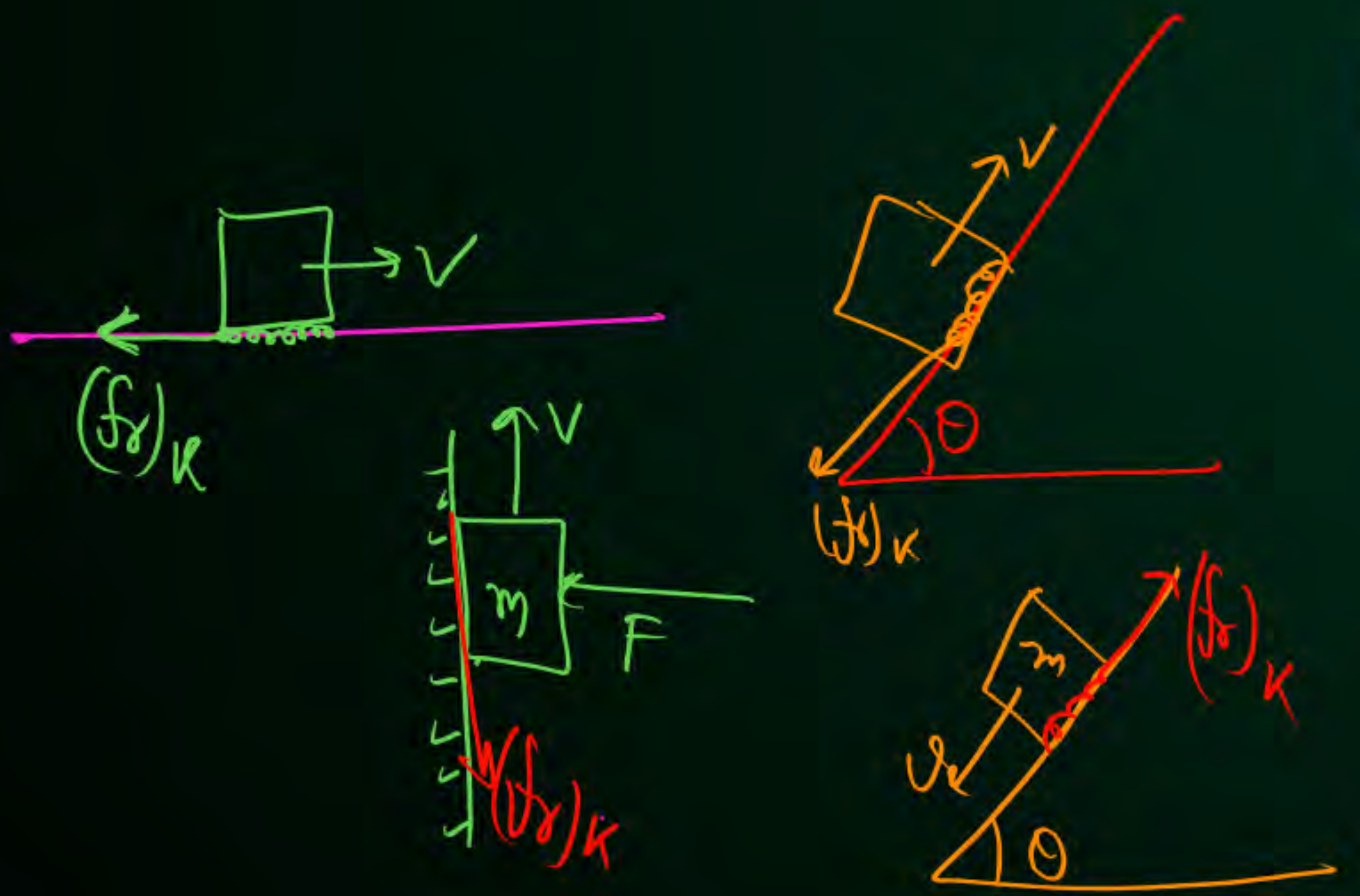
$= 60\text{ J}$

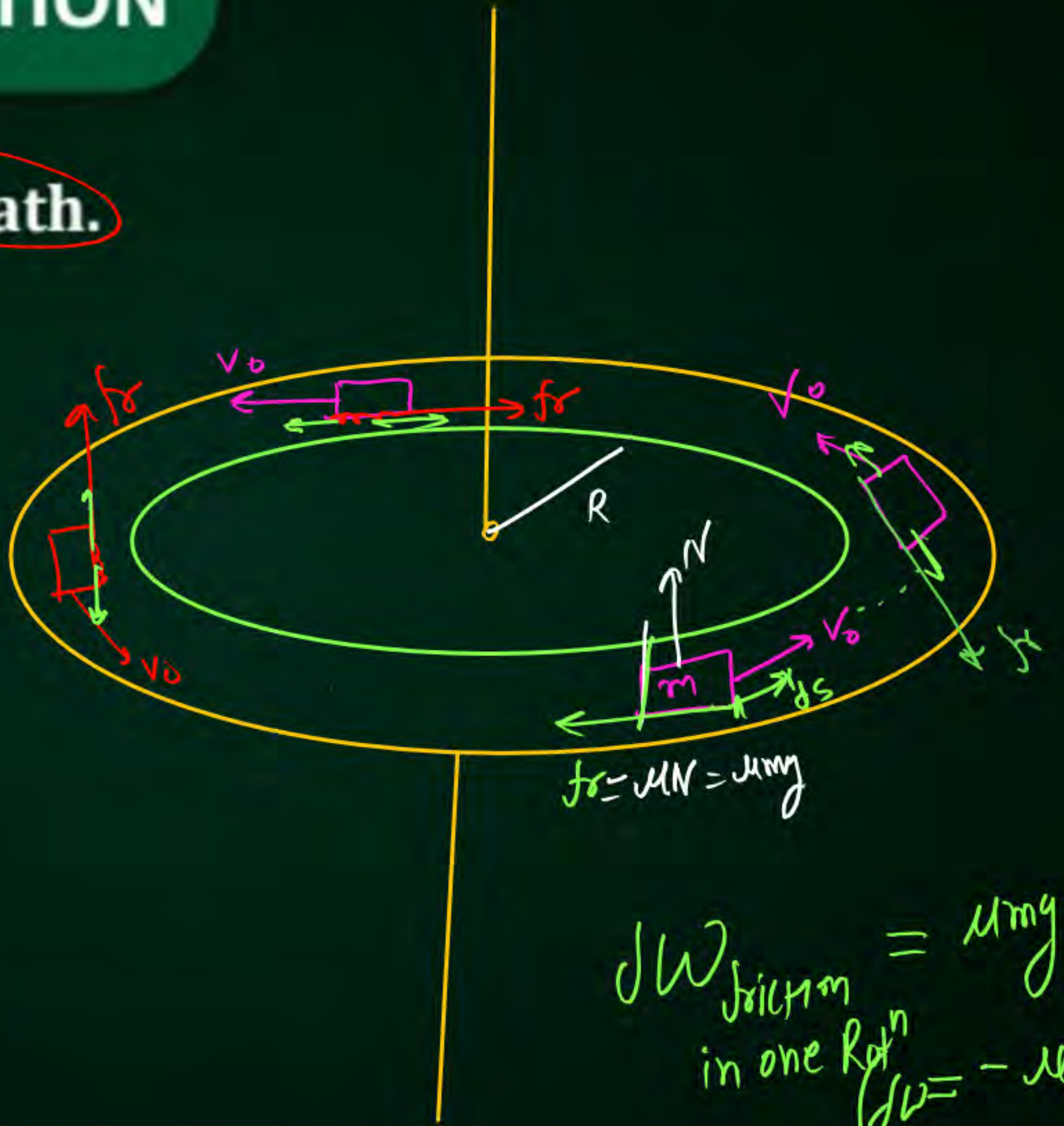
$\tan 37° = \frac{H}{4} = \frac{3}{4}$

$H = 3$

WORK DONE BY FRICTION

- Friction always acts along the path.
  (It depends on path.)





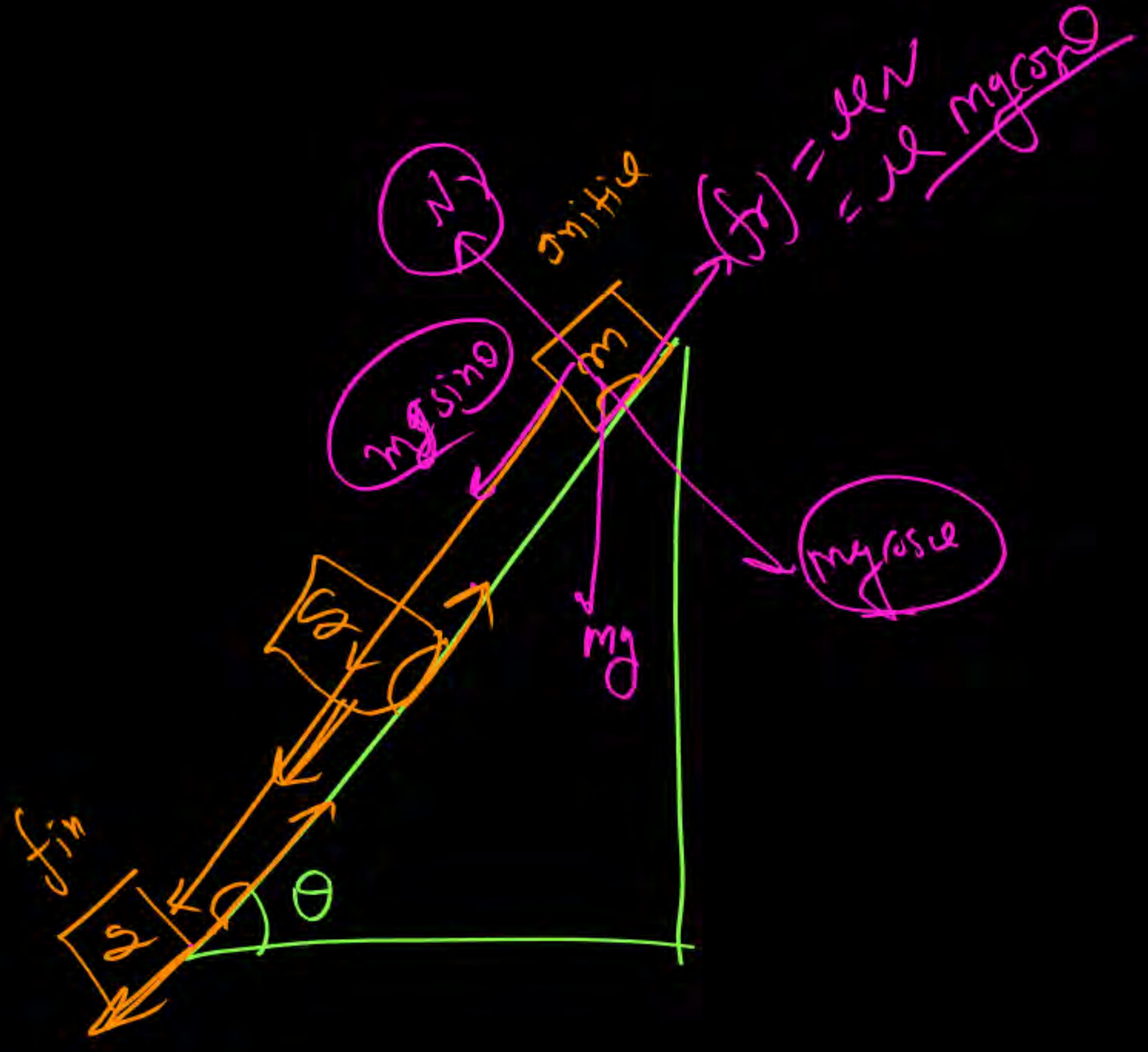
$$f_r = \mu N = \mu mg$$

$$dW_{friction} = \mu mg\, ds \cos 180^\circ$$

in one Rotⁿ

$$\int dW = -\mu mg \int ds$$

$$W = -\mu mg(2\pi R)$$

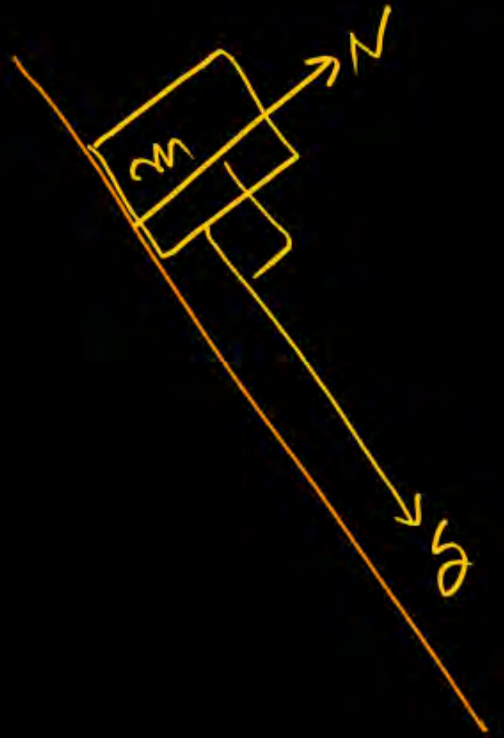


$$W_{fr} = -(mg\cos\theta\, s)$$

Work done by Normal



$$W = 0 = NS\cos 90° = 0$$

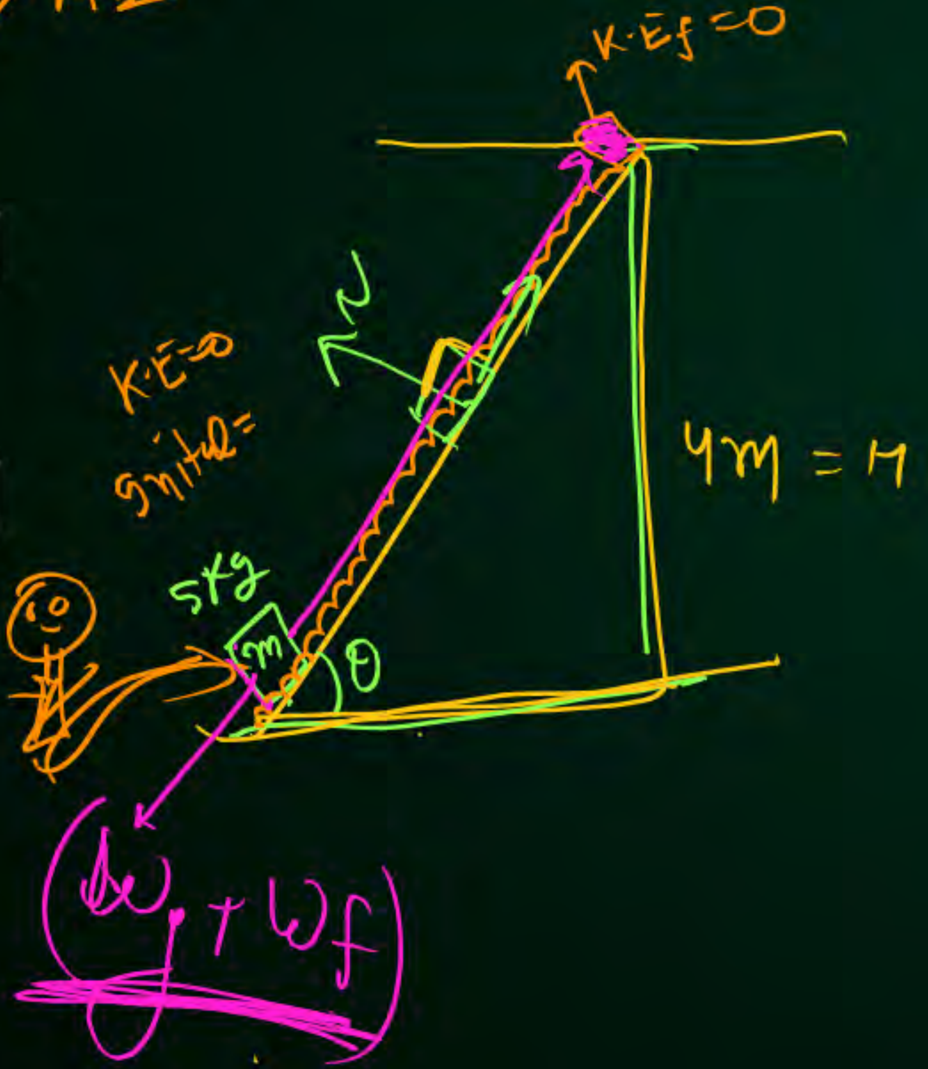


$$W_{Normal} = 0$$
on incline

QUESTION

If 250 J of work is done in sliding a 5 kg block slowly up an inclined plane of height 4 m. Work done against friction is: ($g = 10\ ms^{-2}$)

1. 50 J
2. 100 J
3. 200 J
4. zero



$\Delta K.E = 0$

$W_{tol} = \Delta K.E$

$W_{Man} + W_g + W_{fr} = \Delta K.E = 0$

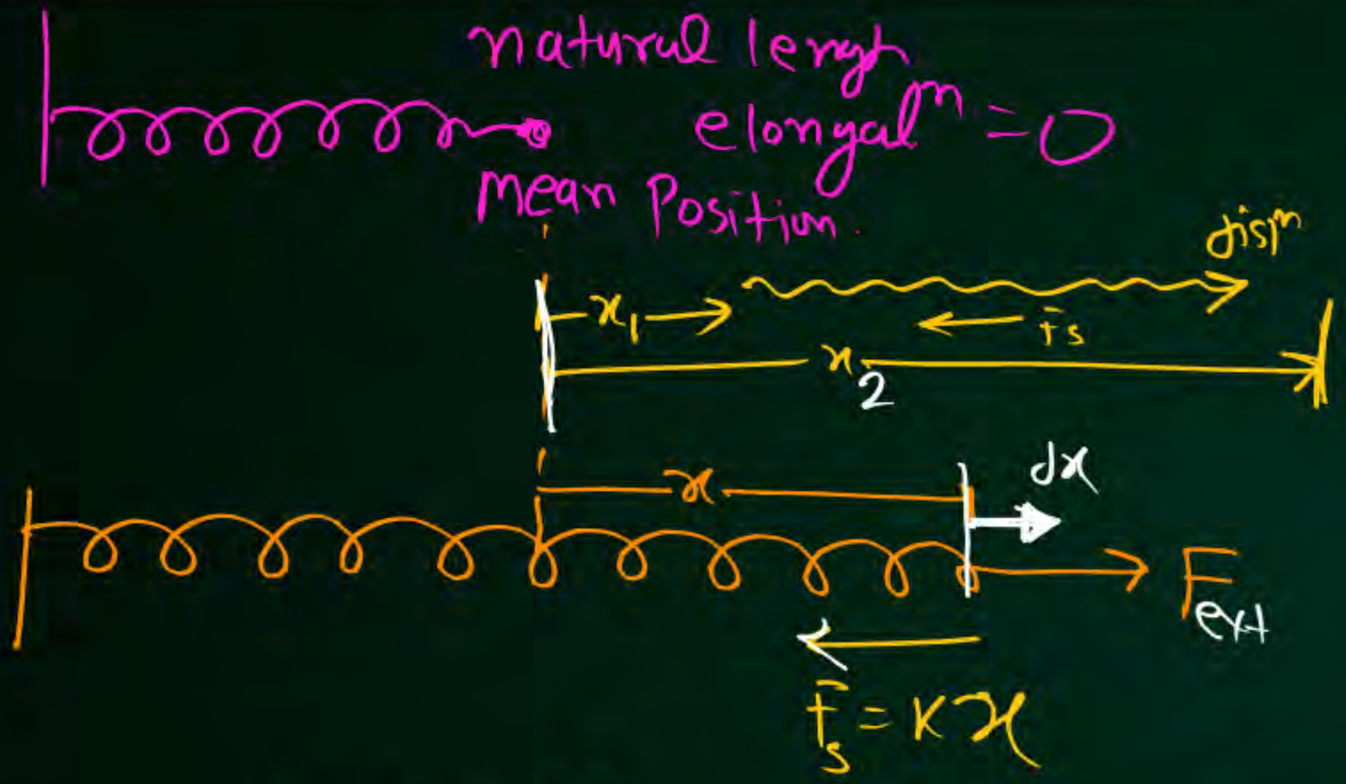
$250 - mg \times 4 + W_{fr} = 0$

$250 - 5 \times 10 \times 4 + W_f = 0$

$250 - 200 + W_{fr} = 0$

$W_{fr} = -50\ J$

WORK DONE BY SPRING



Work done by spring in disp^n dx

$$dW = -Kx\,dx$$

Work in elongation x_1 to x_2

$$\int dW = -\int Kx\,dx$$

$$W = -K\int_{x_1}^{x_2} x\,dx$$

$$W = -K\left[\frac{x^2}{2}\right]_{x_1}^{x_2}$$

$$W = -\frac{1}{2}K\left[x_2^2 - x_1^2\right]$$

(x_2: final, x_1: initial)

work done in Comp^n from x_1 to x_2 by spring force

$$W = -\frac{1}{2}K\left[x_2^2 - x_1^2\right]$$

AS

QUESTION

If work done by spring is ω in elongation 2 m then find work done in further elongation by 2 m.

1. ω
2. 3ω
3. 2ω
4. 4ω

$W_{0\to 2m} = -\frac{1}{2}K[2^2 - 0^2]$

$W = -\frac{K4}{2} = -2K$ — (1)

$W_{2m\to 4m} = -\frac{K}{2}[4^2 - 2^2]$

$= -\frac{K}{2} 12^{6} = -6K = -2K(3)$

$= 3W$

QUESTION

The force constant of a wire is k and that of another wire is $2k$. When both the wires are stretched through same distance, then the work done:

1. $W_2 = 2W_1^2$
2. $W_2 = 2W_1$
3. $W_2 = W_1$
4. $W_2 = 0.5W_1$

$W_1 = \frac{1}{2} k x^2$

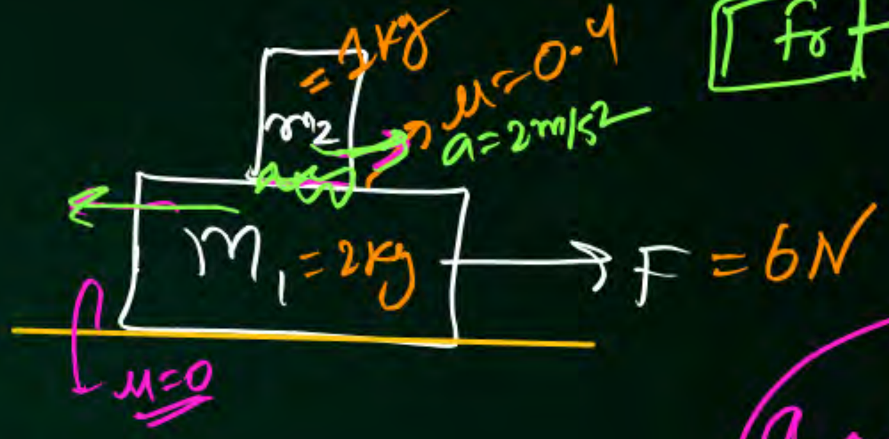
$W_2 = \frac{1}{2}(2k) x^2$

$\frac{W_1}{W_2} = \frac{1}{2}$

$2W_1 = W_2$

QUESTION

Which of the following statements is correct?



1. Work done by static friction is always zero
2. Work done by kinetic friction is always negative
3. The negative of the work done by the conservative internal force on a system equals the change in kinetic energy
4. The work done by all the forces acting on a system equals the change in kinetic energy

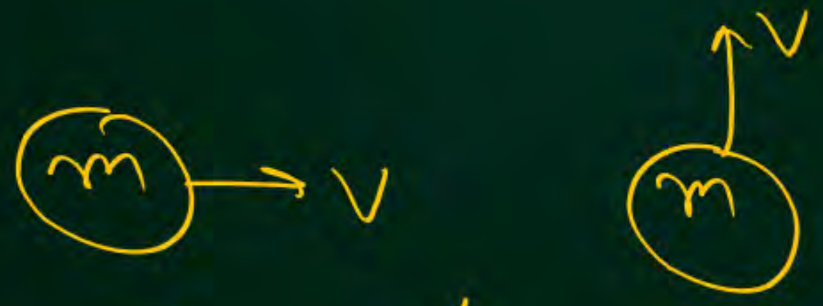
MOMENTUM

- Motion contained in a body.
- Vector (direction along velocity).

$\vec{p} = m\vec{v}$

↑ velocity

- → Vector
- → dir^n along velocity
- → Can be +ve, −ve



$\vec{p}_1 \neq \vec{p}_2$

KINETIC ENERGY = energy stroed in a body due to its more.

$$K.E = \frac{1}{2} m (\text{speed})^2$$

- → Scalar
- → No dir^n
- → K.E. Can't be -ve

$$K.E = \frac{1}{2} m v^2$$

$$K.E = \frac{1}{2} m v^2 \times \left(\frac{m}{m}\right)$$

$$K.E = \frac{1}{2} \frac{m^2 v^2}{m}$$

$$\vec{P} = m\vec{v}$$

$$P = mv$$

$$K.E = \frac{P^2}{2m}$$

This is the Rel^n B/w K.E & momentum → (wrong)

This is the Rel^n B/w K.E & Magnitude of momentum

$$2m K.E. = P^2$$

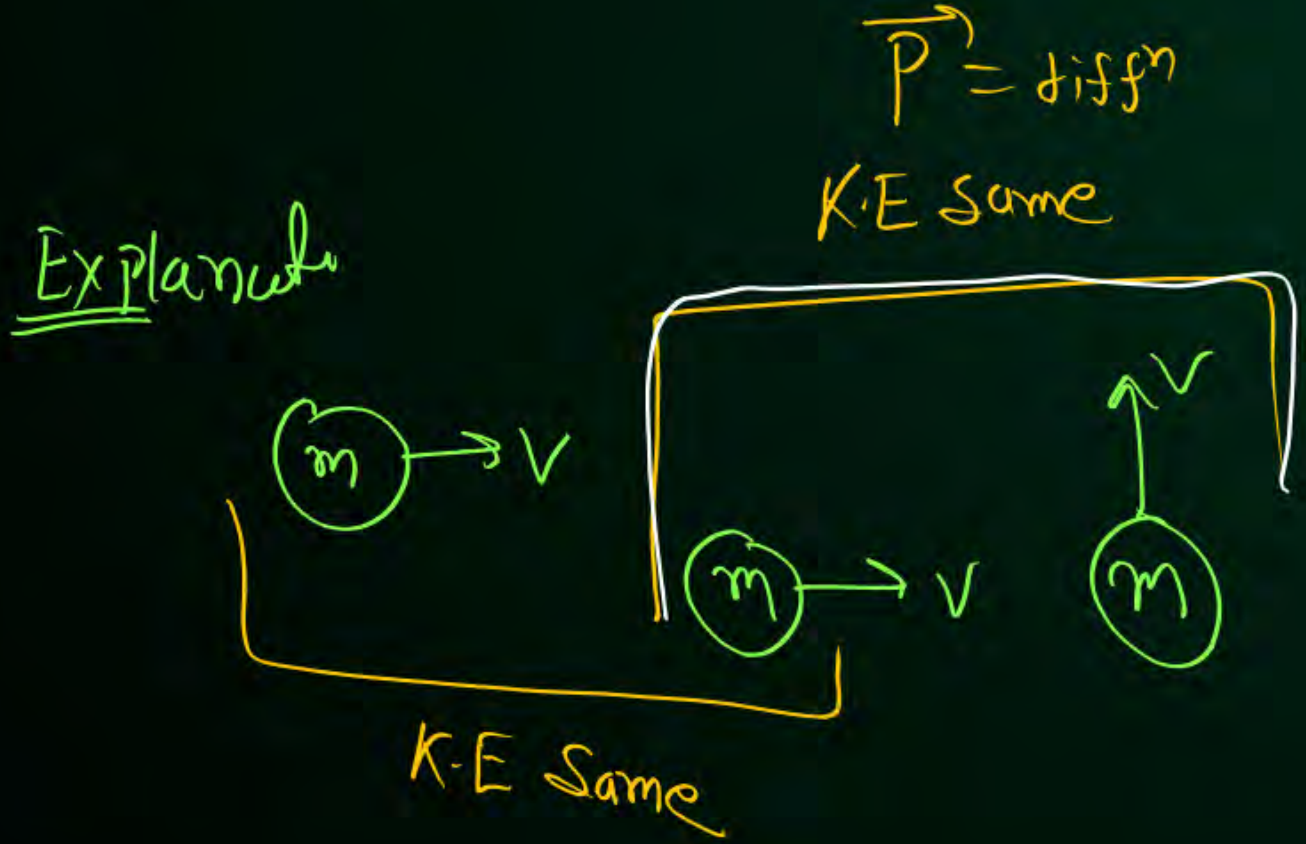
$$P = \sqrt{2m.K.E}$$

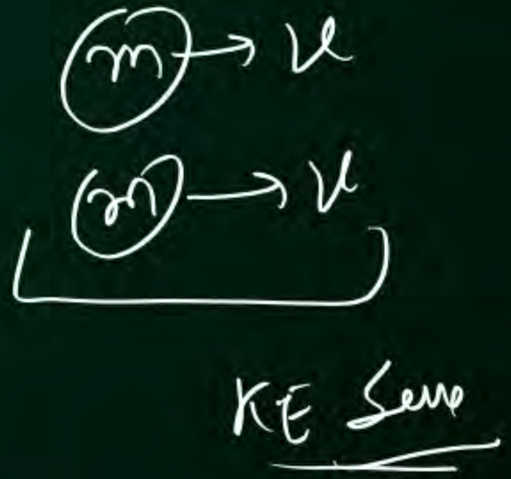
- Two identical particle having same kinetic energy must have same momentum.

[False]

- Two identical particle having same momentum must have same kinetic energy.

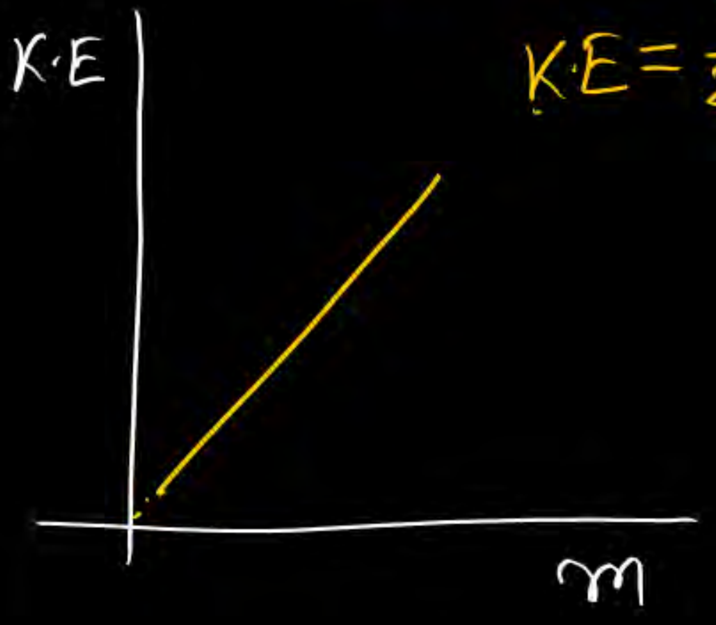
[True]





Graph

for Constn speed



$K \cdot E = \frac{1}{2} m v^2$ (v^2 → const^n)

$\vec{v}$ = const^n

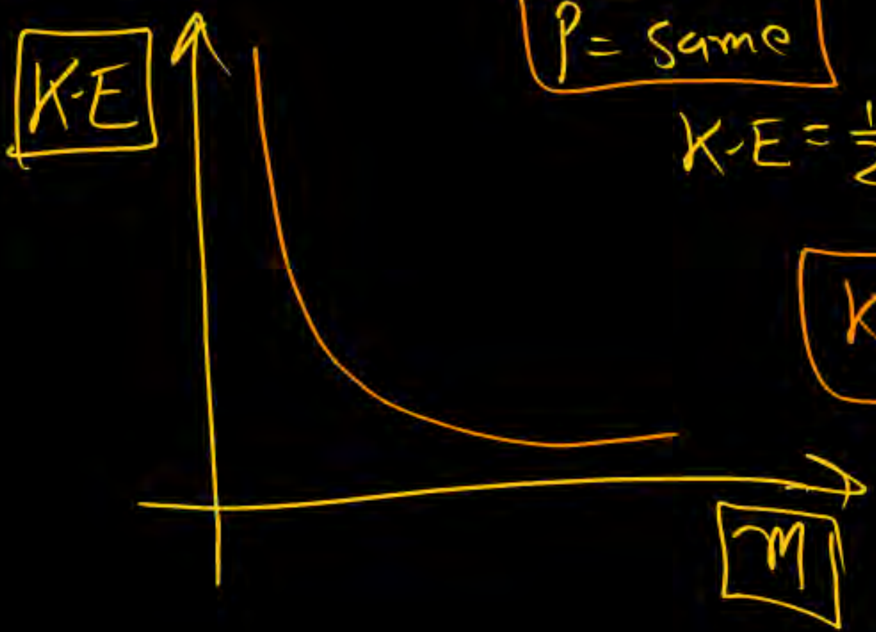
$\vec{p} = m \vec{v}$



P = same

$K \cdot E = \frac{1}{2} m v^2 = \frac{p^2}{2m}$ (p^2 → const^n)

$K \cdot E \propto \frac{1}{m}$



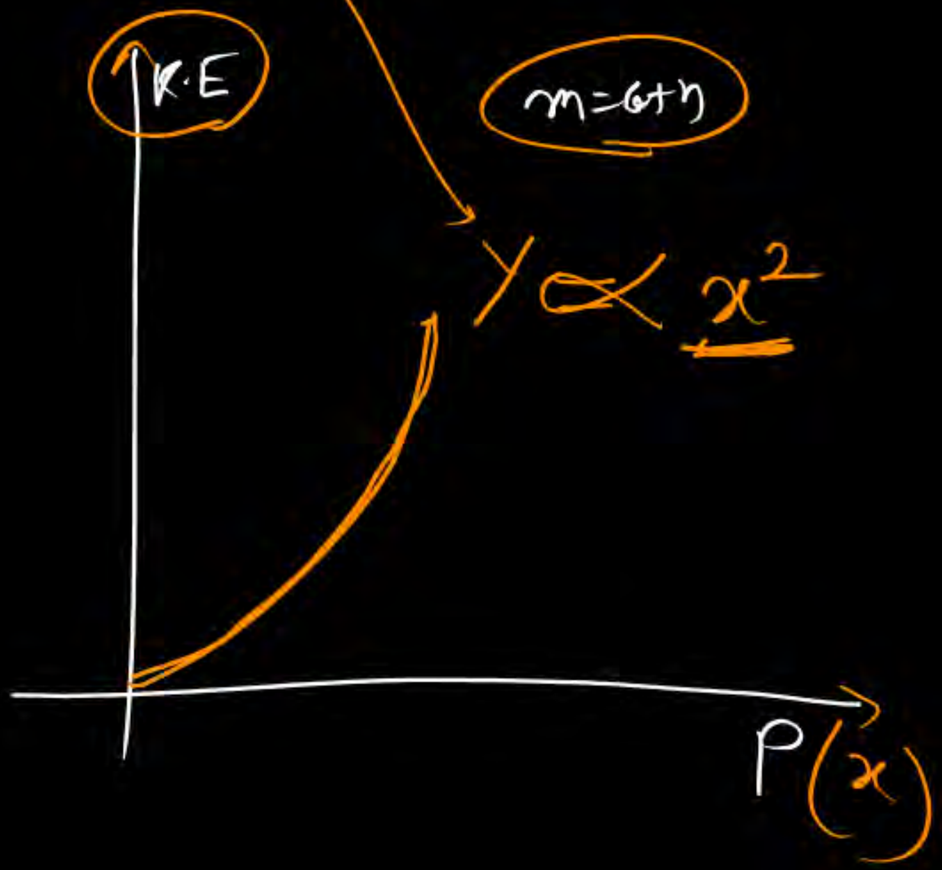
K.E = const^n

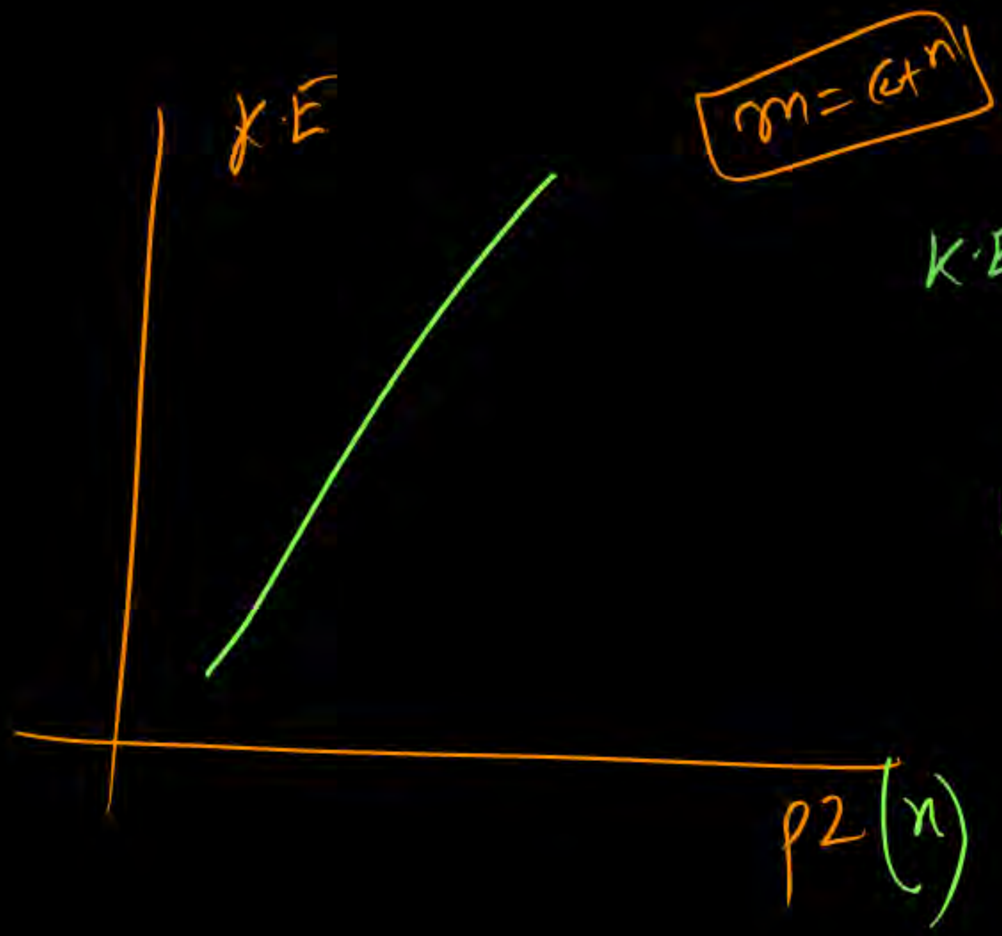
$p = \sqrt{2m(K \cdot E)}$ (K·E → const)

$p \propto \sqrt{m}$



$K.E = \frac{p^2}{2m}$





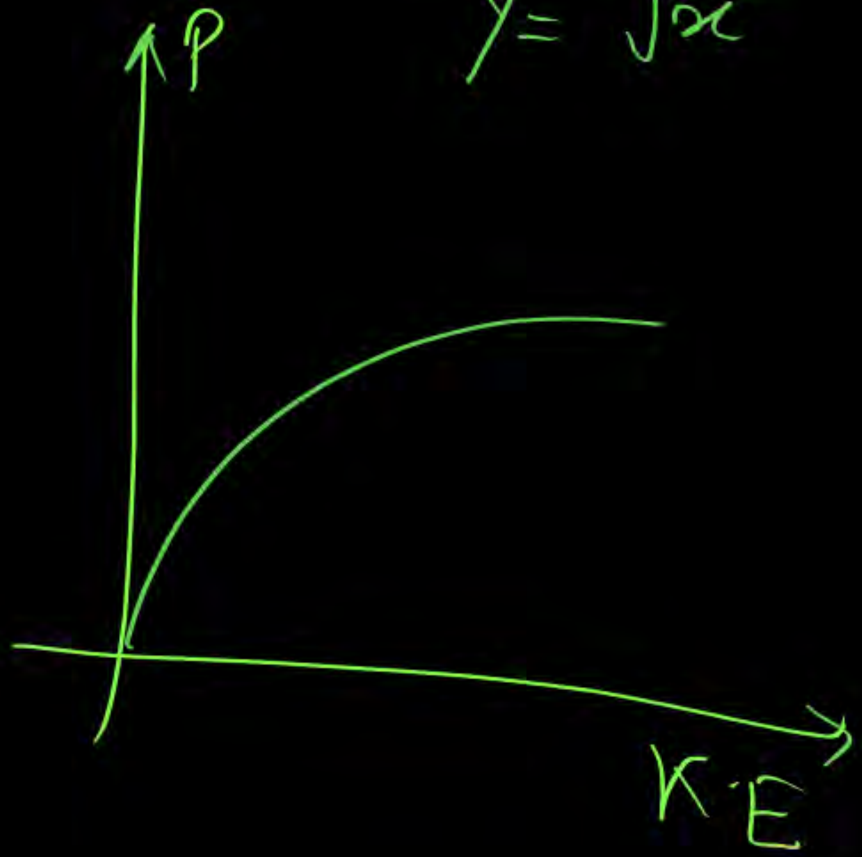
$K.E = \frac{p^2}{2m}$ — cut

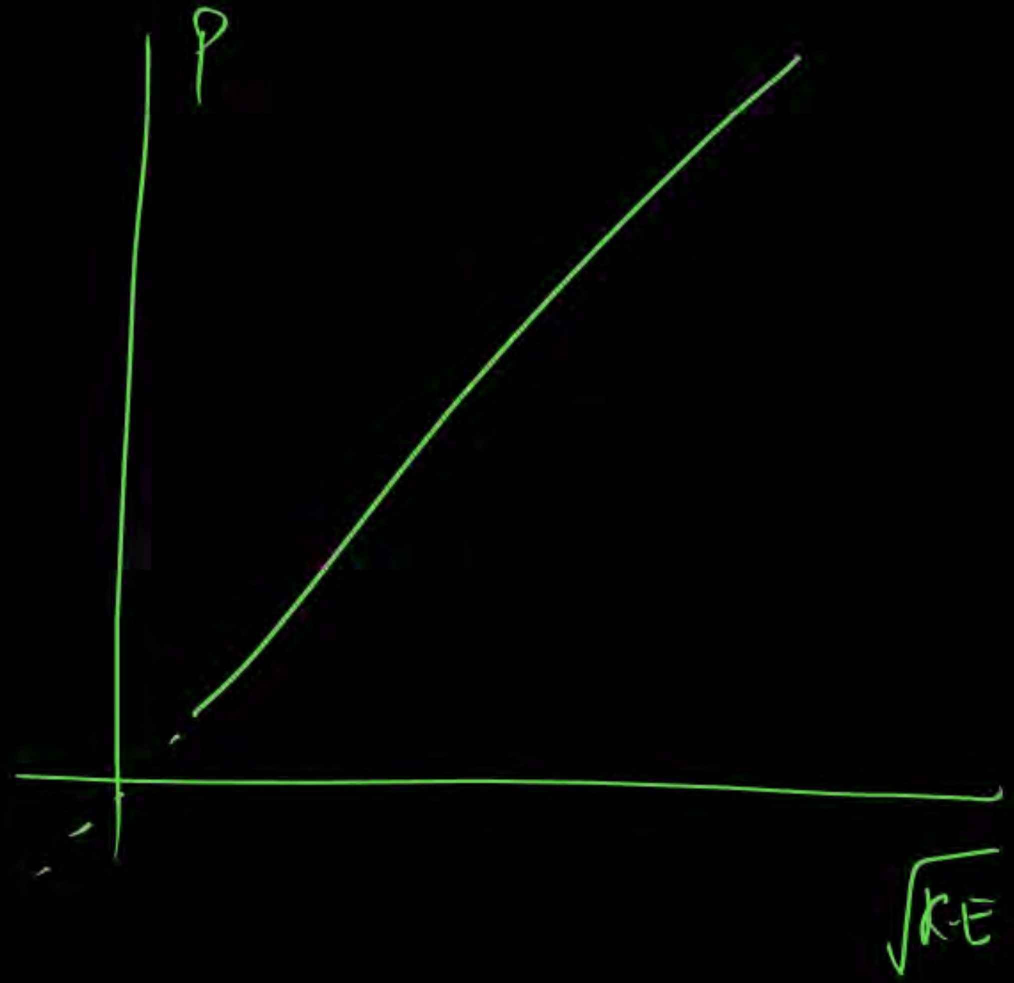
$K.E \propto p^2$

$y \propto x$

$$P = \sqrt{2m\,K.E}$$

$$y = \sqrt{x}$$





QUESTION

Two bodies of masses m_1 and m_2 have same momentum. The ratio of their KE is

1. $\sqrt{\dfrac{m_2}{m_1}}$
2. $\sqrt{\dfrac{m_1}{m_2}}$
3. $\dfrac{m_1}{m_2}$
4. $\dfrac{m_2}{m_1}$

$K.E = \frac{1}{2}mv^2$

$K.E = \frac{p^2}{2m}$ → const

$\frac{K.E_1}{K.E_2} = \frac{m_2}{m_1}$

QUESTION

Two bodies with kinetic energies in the ratio of 4 : 1 are moving with equal linear momentum. The ratio of their masses is

1. 4 : 1
2. 1 : 1
3. 1 : 2
4. 1 : 4 ✓

$K.E \propto \frac{p^2}{2m}$ → Same

$K.E \propto \frac{1}{m}$

$\frac{4}{1} = \frac{m_2}{m_1}$

Object of mass 4kg is moving with velocity $\vec{V} = \hat{i} + \hat{j}$ then find K.E

$|V| = \sqrt{1^2 + 1^2}$

$= \sqrt{2}$

$K.E = \frac{1}{2} m (\text{speed})^2$

$= \frac{1}{2} m (\text{magnitude of velocity})^2$

$= \frac{1}{2} \times 4 (\sqrt{2})^2$

$= 2 \times 2$

$= 4J$

Small % change

Change is less than 5%

→ we will use error analysis

% error

$$K.E = \frac{p^2}{2m}$$

$$100\left(\frac{\Delta K.E}{K.E}\right) = \left(2\frac{\Delta p}{p} + \frac{\Delta m}{m}\right)100$$

% Change

$$\Rightarrow 100\left(\frac{\Delta K.E}{K.E}\right) = \left(\frac{2\Delta P}{p} - \frac{\Delta m}{m}\right)100$$

large % change

change is $\geq 10\%$

$$\%\text{ change in } x = \frac{x_f - x_i}{x_i} \times 100$$

Q) If momentum is Incrsed by 3% then % change in K.E

$$K.E = \frac{p^2}{2m} \rightarrow \text{const}$$

$$100 \times \frac{\Delta K.E}{K.E} = 2\frac{\Delta p}{p} \times 100$$

$$\% \text{ change in KE} = 2\left(\frac{\Delta p}{p} \times 100\right)$$

$$= 2 \times 3$$

$$= 6\%$$

QUESTION

If the linear momentum is increased by 50%, the kinetic energy will increase by:

1. 50%
2. 100%
3. 125%
4. 25%

Let initial Momentum is P_0

$P_f = P_0 + P_0 50\%$

$P_f = P_0 + \frac{P_0 50}{100} = \frac{3P_0}{2}$

$K.E_i = \left(\frac{P_0^2}{2m}\right)$

$K.E_f = \frac{P_f^2}{2m} = \frac{\left(\frac{3P_0}{2}\right)^2}{2m}$

$\%$ change in $K.E = \frac{K.E_f - K.E_i}{K.E_i} \times 100 = \frac{\frac{9}{4}\left(\frac{P_0^2}{2m}\right) - \frac{P_0^2}{2m}}{\frac{P_0^2}{2m}} \times 100$

$= \frac{\frac{P_0^2}{2m}\left(\frac{9}{4} - 1\right)}{\frac{P_0^2}{2m}} \times 100$

$= \frac{5}{4} \times 100 = 125\%$

MR: $P_f = 150\% P_0 = \frac{150}{100} P_0 = \frac{3P_0}{2}$

$K.E_f = P_f^2 = \frac{9}{4} P_0^2 = 225 / 100 = 225\%$

Momentum is Incrsess to 300% $\Rightarrow P_f = 300\% \, P_i$

Momentum is Incrsess by 300% $\Rightarrow P_f = P_0 + 300\% \, P_0 = 400\% \, P_0$

QUESTION

Two bodies of masses m1 and m2 are moving with same kinetic energy. If P_1 and P_2 are their respective momentum, the ratio $\frac{P_1}{P_2}$ is equal to

1. $\frac{m_1}{m_2}$
2. $\sqrt{\frac{m_2}{m_1}}$
3. $\sqrt{\frac{m_1}{m_2}}$
4. $\frac{m_1^2}{m_2^2}$

H/w

$P = mv$ ✗

$P = \sqrt{2m\,K.E}$ ✓

QUESTION

KE of a body is increased by 44%. What is the percent increases in the momentum?

(1) 10%

(2) 20%

(3) 30%

(4) 44%

$K.E_f = 144\% \, K.E_i$

$K.E_f = \frac{144}{100} K.E_i$

$P_f = \sqrt{2m \, K.E_f} = \sqrt{\frac{144}{100} K.E_i}$

$P_f = \frac{12}{10} \sqrt{KE_i}$

$P_f = 1.2 P_i$

$= 120\%$

QUESTION

If kinetic energy of a body is increased by 300% then percentage change in momentum will be

1. 100%
2. 150%
3. 265%
4. 73.2%

$K.E_f = 400\% \; K.E_i$

$K.E_f = \frac{400}{100} K.E_i$

$P_i = \sqrt{K.E_i}$

$P_f = \sqrt{K.E_f} = \sqrt{4K.E_i}$

$P_f = 2\sqrt{K.E_i}$

$P_f = 2P_i$

QUESTION

When momentum of a body increases by 200%, its Ke increases by

1. 200%
2. 300%
3. 400%
4. 800%

H/W

QUESTION

When momentum of a body increases to 200%, its Ke increases by

1. 200%
2. 300%
3. 400%
4. 800%

H/W

Work - energy theorem

Work done by all the force is equal to change in 'K.E'

$$W_{ext^n F} + W_{int} + W_{pseu} + W_{GF} + W_{N.C.F} + W_{11} + W_f + W_{en} + W_{gr} = \Delta K.E$$

$W_{all\ for} = \Delta K.E$

→ allways valid

$\Delta K.E = \text{work} = \vec{F} \cdot \vec{S}$

object of mass 8 kg is moving such that disp $s = t^2$ then find work done in 2-sec on that object.

$\frac{ds}{dt} = v = 2t$

Sol^n

$W = \vec{F} \cdot \vec{S}$

$\frac{ds}{dt} = v$

$\frac{dv}{dt} = a$

$F = ma$

$K.E = \frac{1}{2} m v^2$

$K.E = \frac{1}{2} m (2t)^2$ ✗

$K.E_i = 0$ ✓

$K.E_f = \frac{1}{2} \times 8 (2 \times 2)^2$ ✓

$= 4 (4)^2$

$= 4 \times 16 = 64 J$

$W = K.E_f - K.E_i$

$W = K.E_f - K.E_i$

$= \frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2$

$W = \frac{1}{2} m \left[v_f^2 - v_i^2 \right]$

THANK YOU



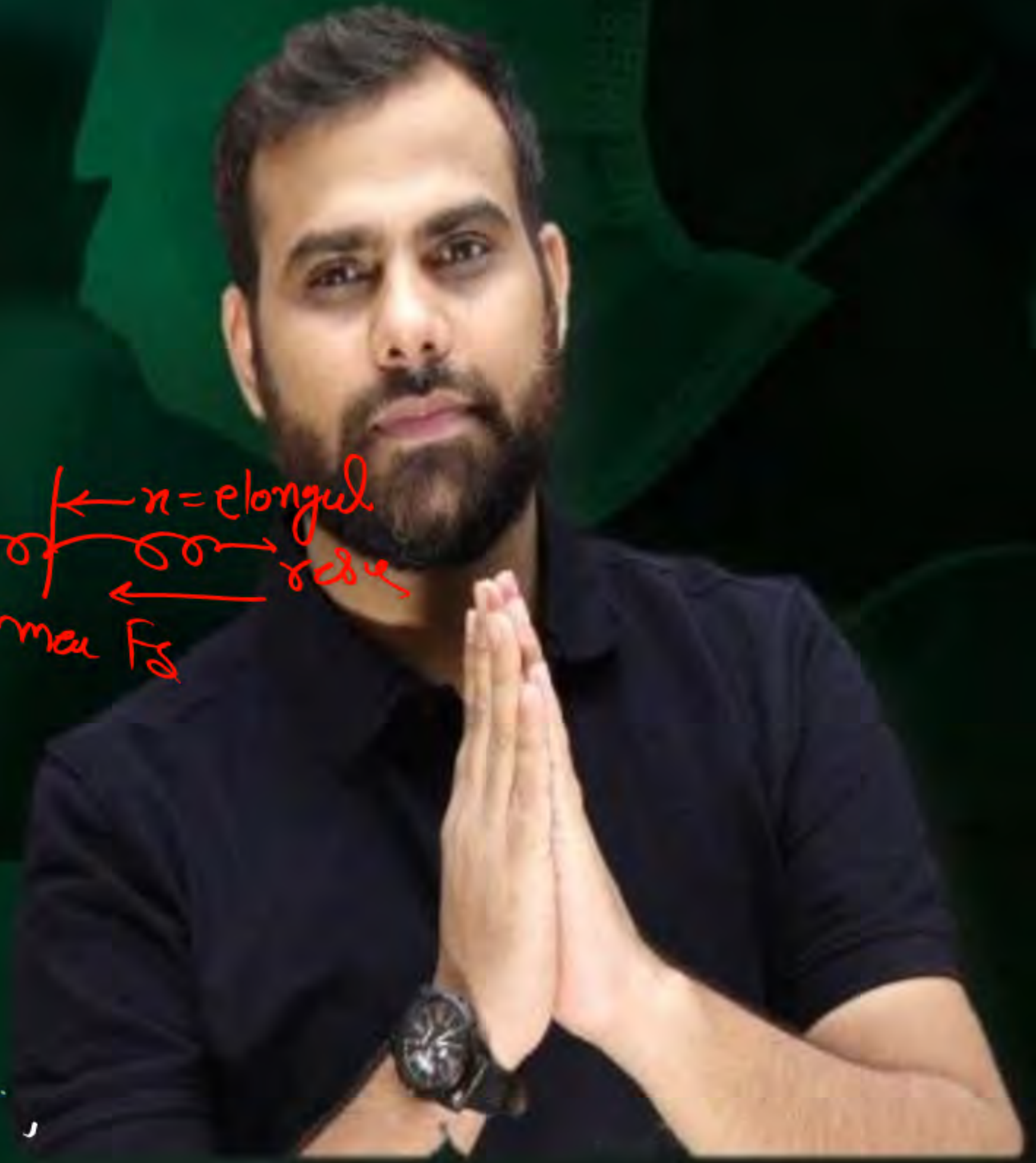
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FOR NEET 2025

Lecture- 03 | Physics

Work, Energy and Power

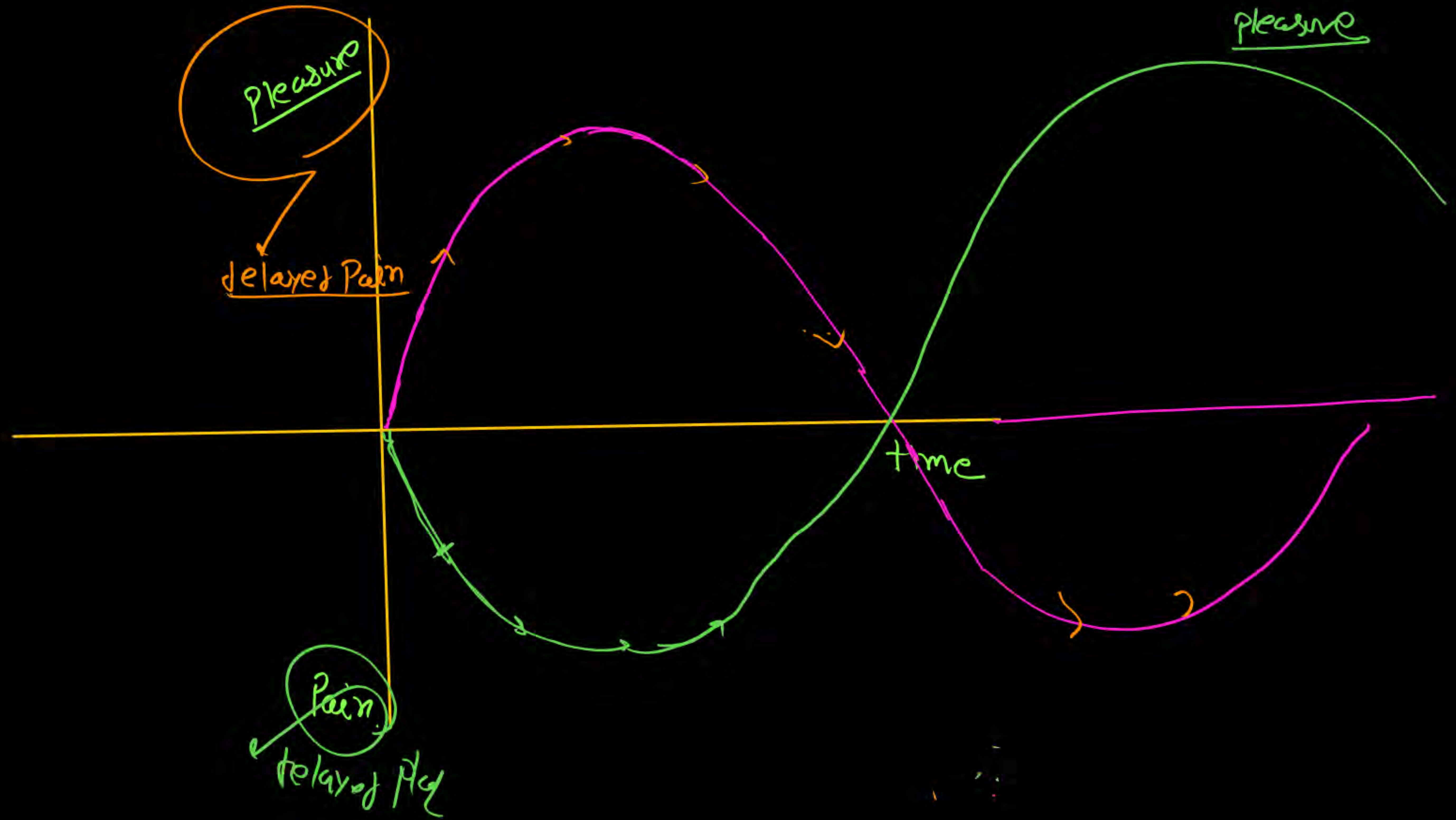
By- Dr. Manish Raj (MR SIR)



Topics to be covered

1. # Questions on % change
2. # "Work energy theorem"
3. #
4. #





Pleasure
delayed Pain
pleasure
time
Pain
delayed Pleas

⇒ 1 rupee → Incre by 100% → $1 + 1 \times 100\%$

$= 1 + 1 \times \frac{100}{100} = 2$ rup

100% → 200% 1 $= \frac{200}{100} \times 1 = 2$

- If KE increase by 44% then $KE_F = 144\%\ Ke_i$
- If KE decrease by 44% then $KE_F = 56\%\ Ke_i$
- If KE increase by 30% then $KE_F = 130\%\ Ke_i$
- If KE decrease by 17% then $KE_F = 83\%\ Ke_i$
- If KE is changed to 30% then $KE_F = 30\%\ Ke_i$

If momentum is Increased to 120% → $P_f = 120\%\ P_i$

QUESTION

If percentage change in KE is 3% then find percentage change in momentum.

$p = mv$

$$\frac{\Delta K.E}{K.E} \times 100\% = 3\%$$

$$P = \sqrt{2m\,K.E}$$

(2m → Constⁿ)

$$P = \sqrt{K.E} = (K.E)^{1/2}$$

$$100 \times \frac{\Delta p}{p} = \frac{1}{2}\left(\frac{\Delta K.E}{K.E} \times 100\right)$$

$$= \frac{3}{2}\%$$

(Q) If K.E is ↓ decⁿ by 2% then find % change in Momentum.

Solⁿ

$$P = \sqrt{2m \, K.E}$$

$$\frac{\Delta P}{P} \times 100 = \frac{1}{2}\left(\frac{\Delta K.E}{K}\right) \times 100$$

$$= -\frac{1}{2} \times 2 = -1\%$$

If momentum is ↑ by 3% then % change in K.E

Sol^n

$K.E = \frac{p^2}{2m}$ → C

$100 \times \frac{\Delta K.E}{K.E} = 2\left(\frac{\Delta p}{p} \times 100\right)$

$= 2 \times 3 = 6\%$

QUESTION

KE of a body is increased by 44%. What is the percent increases in the momentum?

1. 10%
2. 20%
3. 30%
4. 44%

$K.E_f = 144\% \, K.E_i$

$K.E_f = \frac{144}{100} K.E_i$

$P = \sqrt{2m \, K.E_i}$

$P_f = \sqrt{K.E_f} = \sqrt{\frac{144}{100} K.E_i}$

$= \frac{12}{10}\sqrt{K.E_i}$

$= \frac{12}{10} \times 100 = 120\% \, P_i$

QUESTION

If kinetic energy of a body is increased by 300% then percentage change in momentum will be

1. 100% Ans
2. 150%
3. 265%
4. 73.2%

$K.E_f = 400\% \, K.E_i$

$P_i = \sqrt{K.E_i}$

$P_f = \sqrt{K.E_f} = \sqrt{\frac{400}{100} KE_i}$

$P_f = \frac{20}{10} P_i$

$P_f = 2P_i$

$= 200\% \, P_i$

QUESTION

When momentum of a body increases by 200%, its Ke increases by

1. 200%
2. 300%
3. 400%
4. 800% ✓

$P_f = 300\% \cdot P_i$

$P_f = \frac{300}{100} P_i$

$K.E_i = P_i^2$

$K.E_f = P_f^2 = (3P_i)^2$

$= 9P_i^2$

$K.E_f = 900\%$

QUESTION

If KE decrease by 19% then percentage change in momentum?

$K.E_f = 81\% K.E_i$

$K.E_f = \frac{81}{100} K.E_i$

$P_f = \sqrt{K.E_f}$

$= \sqrt{\frac{81}{100} K.E_i}$

$= \frac{9}{10} P_i$

$= 90\%$

→ decrease by 10%

K.E is Incresed to 1600% of intial K.E → % change in momen

$K.E_f = 1600\% \, KE_i$

$= \frac{1600}{100} KE_i$

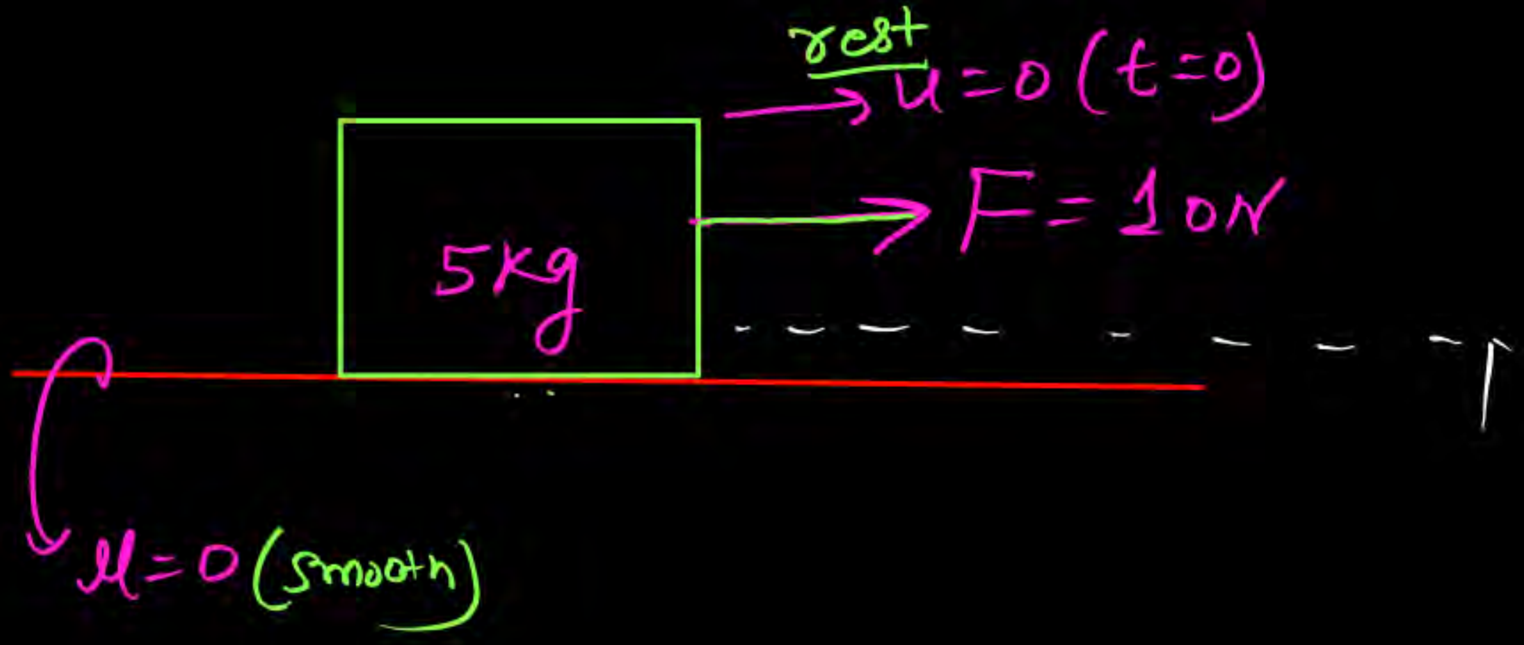
$P_f = \sqrt{K.E_f} = \sqrt{16\, K.E_i}$

$P_f = 4 P_i$

400%

300%

Ans



Q. find work done by F on object in 4-sec.

Sol^n

$$W = \vec{F} \cdot \vec{s}$$

$$a = \frac{F}{m} = \frac{10}{5} = 2\ m/s^2$$

$$s = ut + \frac{1}{2}at^2$$

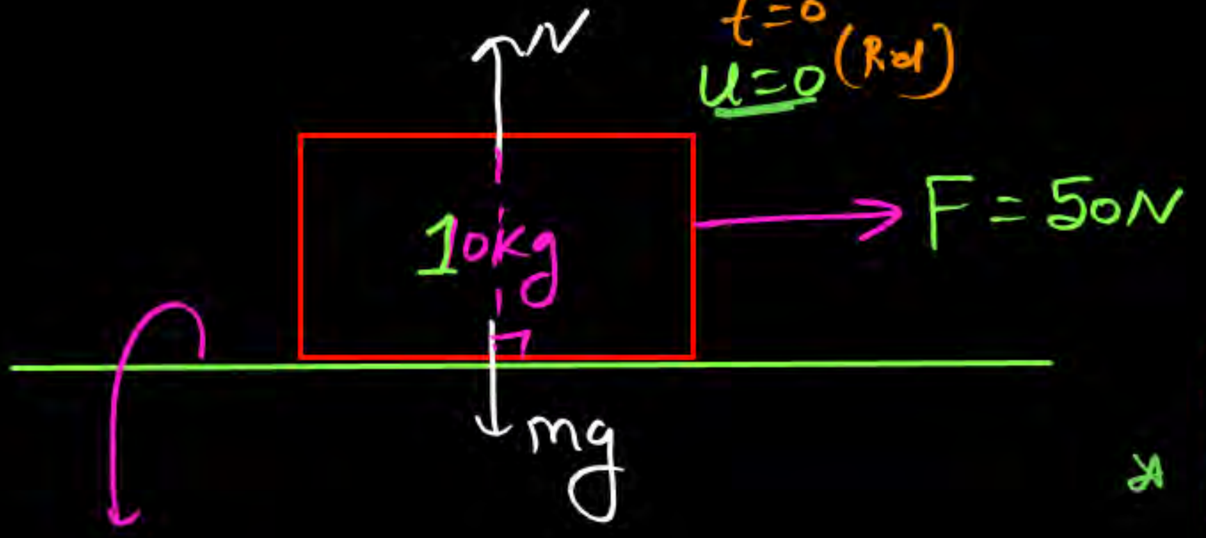
$$s = 0 + \frac{1}{2}\cdot 2\,(4)^2 = 16m$$

$$W = F \cdot s$$

$$= 10 \times 16$$

$$= 160J$$

find work done by friction force in 3-sec



$\mu = 0.2$

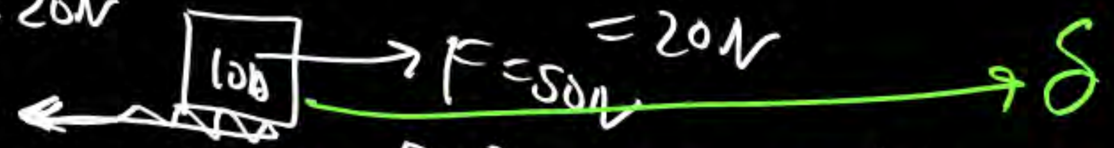
Sol^n

$f_{limit} = \mu N = \frac{2}{10}(mg)$

$= \frac{2}{10} \times 10 \times 10$

$= 20N$

$f_r = 20N$



$a = \frac{50-20}{10} = \frac{30}{10} = 3\,m/s^2$

$V = u + at$
$= 0 + 3 \times 3$
$V = 9\,m/s$

$K.E = \frac{1}{2}mv^2$
$= \frac{1}{2} \times 10 (9)^2$
$= 5 \times 81$
$= 405\,J$

$s = ut + \frac{1}{2}at^2$

$s = \frac{1}{2} \times 3 (3)^2 = \frac{27}{2}\,m$

$W = f_{fr} \cdot s$

$= 20 \times \frac{27}{2} \cos 180°$

$W_{friction} = -270\,J$

$W_F = 50 \times \frac{27}{2}$
$= 25 \times 27\,J$
$= 675\,J$

$W_{Total} = W_f + W_F$

$= -270 + 675$

$W = +405\,J$

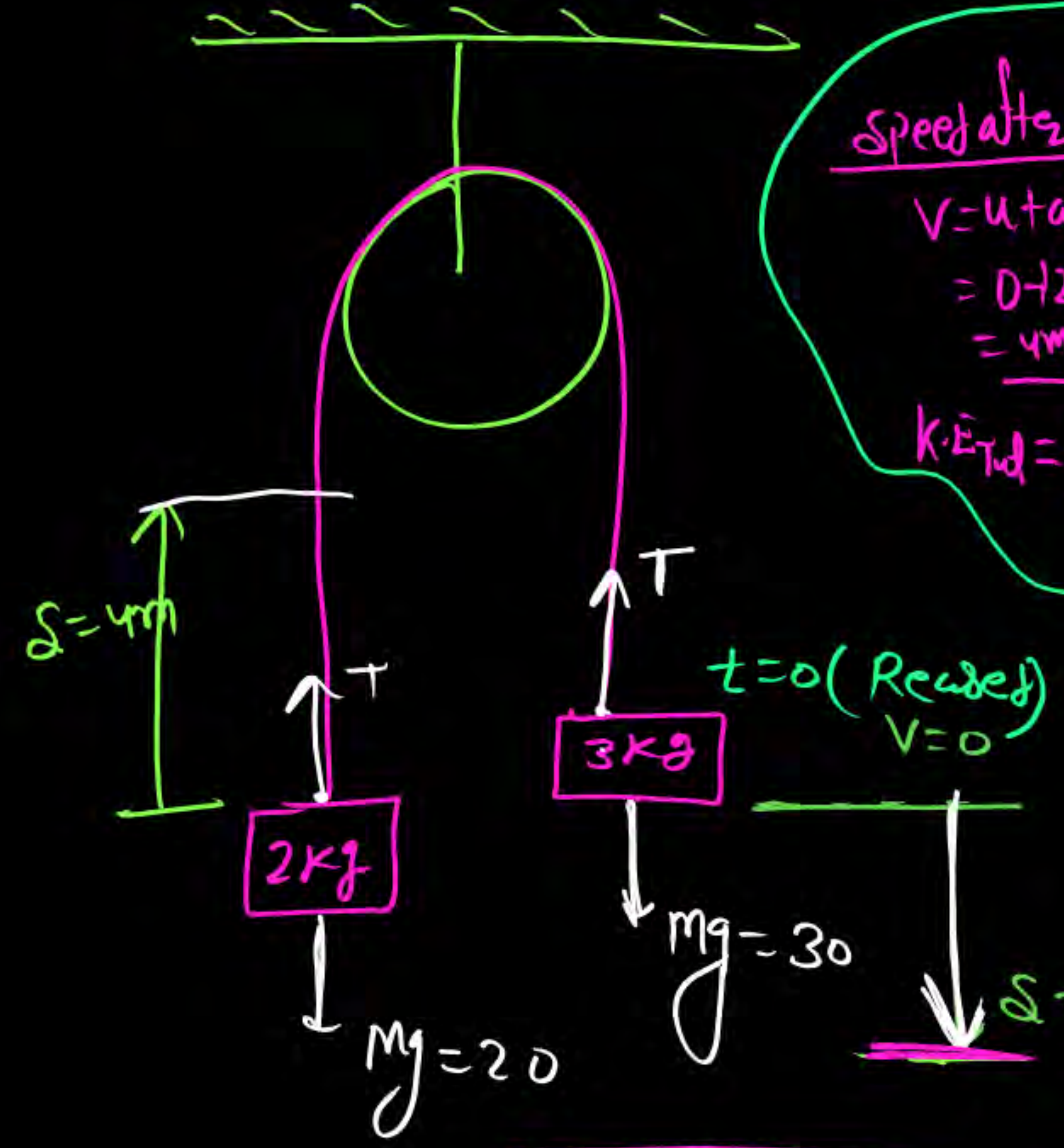
$\Delta KE = W_{Total}$

$K.E_f - K.E_i = 405$

$(K.E_f) = 405\,J$

t = 3 sec

find work done by Tension on (2kg) and on (3kg) and on the system in t = 2 sec.



$s = \frac{1}{2}at^2 = \frac{1}{2} 2 (2)^2 = 4m$

Speed after 2 sec

$v = u + at$

$= 0 + 2 \times 2$

$= 4 m/s$

$K.E_{Total} = \frac{1}{2}3(4)^2 + \frac{1}{2}2(4)^2$

$= \frac{1}{2}3 \times 16 + 16$

$= 24 + 16 = 40$

next page

$W_{on\ 3kg\ by\ T} = 24 \times 4m \cos 180^\circ = -96 J$

$W_{on\ 2kg\ by\ T} = +96 N = 24 \times 4 J$

$W_{on\ 3kg\ by\ gravity} = 30 \times 4 = 120 J$

$W_{on\ 2kg\ by\ gravity} = 20 \times 4 \cos 180^\circ = -80 J$

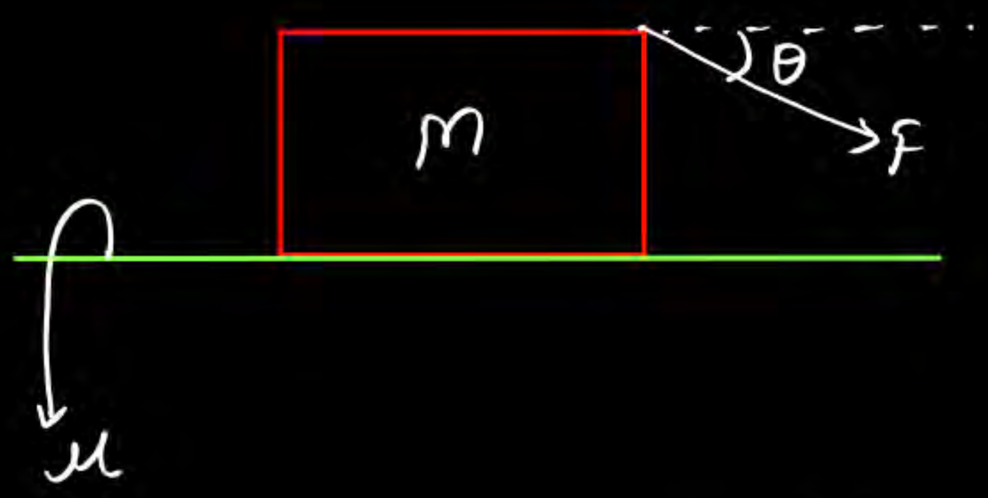
$W_{Total\ on\ system\ by\ Tension} = 0$

$W_{Total\ on\ system\ by\ gravity} = 120 - 80 = 40 J$

$W_{Total\ work\ system} = 40 J$

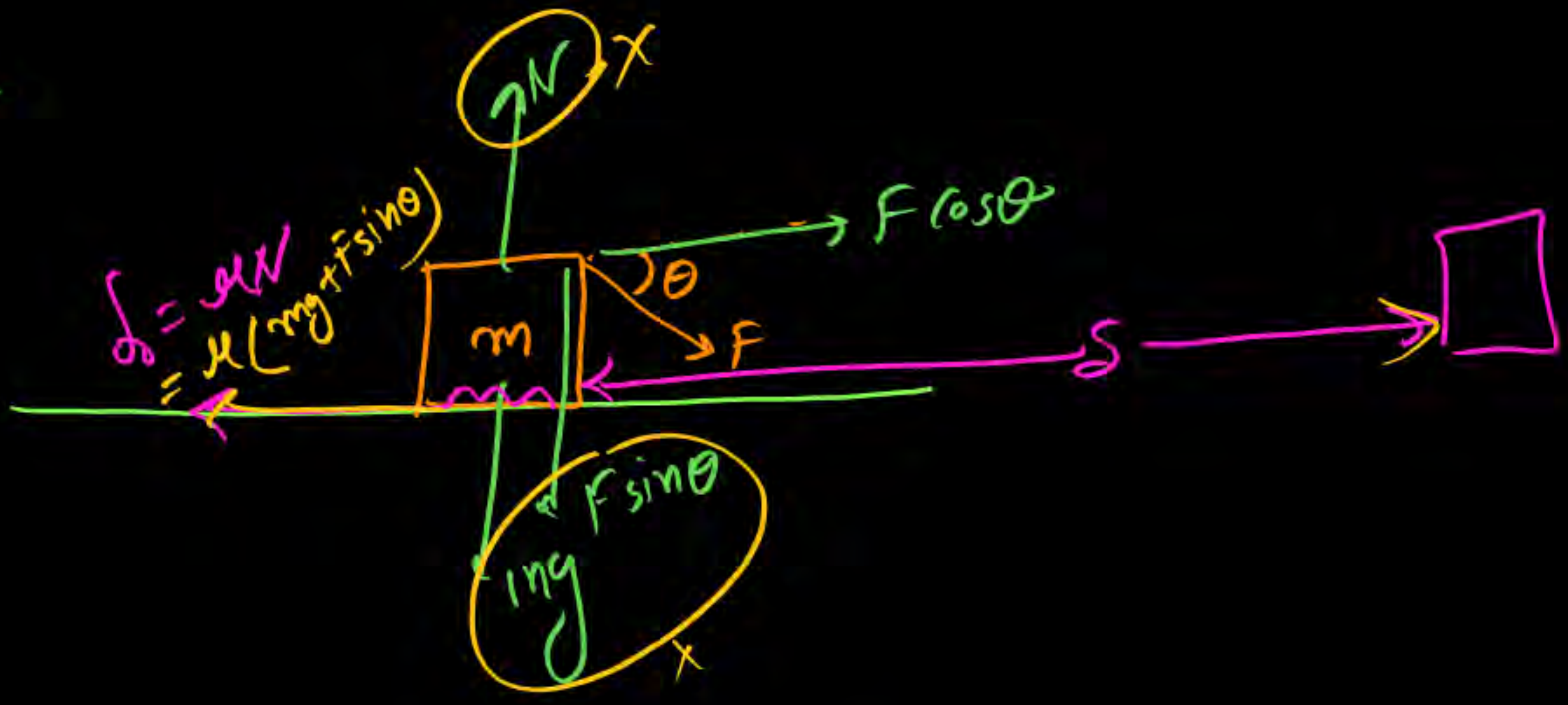
$a = \left(\frac{m_2 - m_1}{m_2 + m_1}\right) g = \left(\frac{3-2}{3+2}\right) 10 = 2 m/s^2$

$T = \frac{2 m_1 m_2}{m_1 + m_2} g = \frac{2 \times 3 \times 2}{5} \times 10 = 24 N$



find work done by friction on block when objec displace (S) in forword dir^n.

Soln



$N = mg + F\sin\theta$

$$W_f = -\mu(mg + F\sin\theta)S$$

Ap

Work energy – Theorem

- always valid for all fram
- Valid for all type motn
- valid all type of force
- Valid in all chain
- always valid

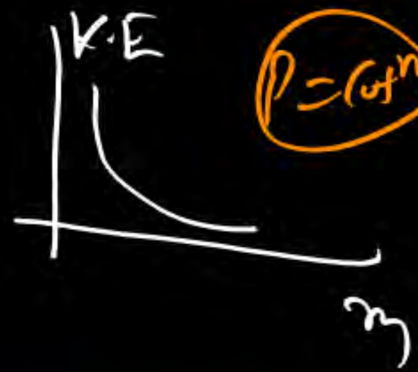
$W_{\text{all the force}} = \Delta K.E$ *

→ appy of all the laws

$$K.E = \frac{1}{2}mv^2$$

$$K.E = \frac{p^2}{2m}$$

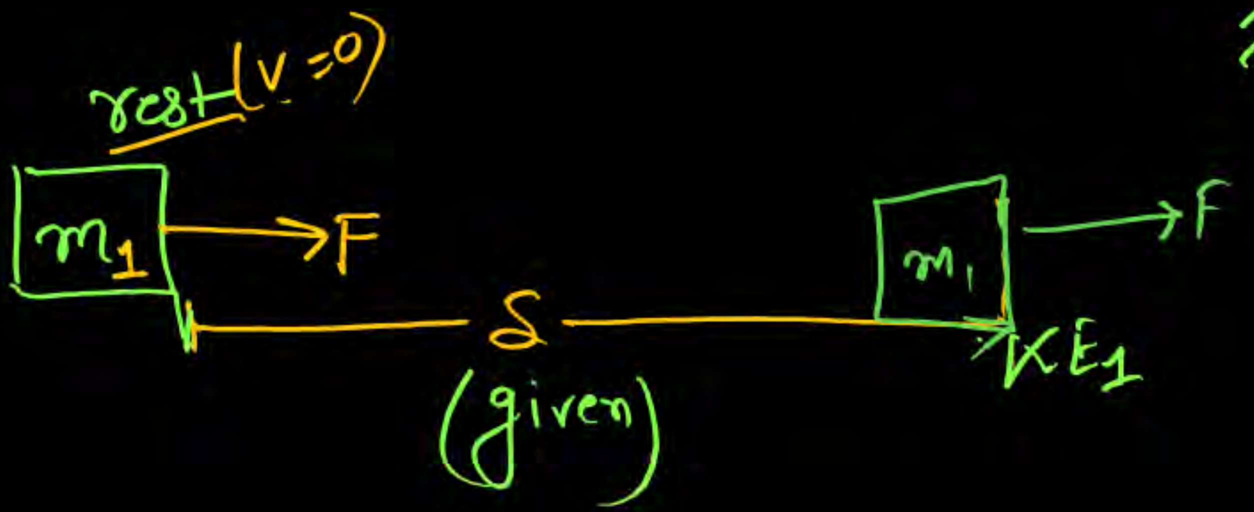




$*\Delta KE = W = F.S$

$K.E_f - K.E_i = F.S$ (K.E_i = 0; same)





Soln

$$(\text{Work})_{\text{by } F} = FS \quad \text{—} \; (1)$$

$$(\text{Work}) = \Delta K.E = K.E_f - K.E_i \quad (K.E_i \to 0)$$

$$= K.E_1 \quad \text{—} \; (1)$$

$$\boxed{K.E_1 = FS}$$



$$\text{Work} = FS \quad \text{—} \; (1)$$

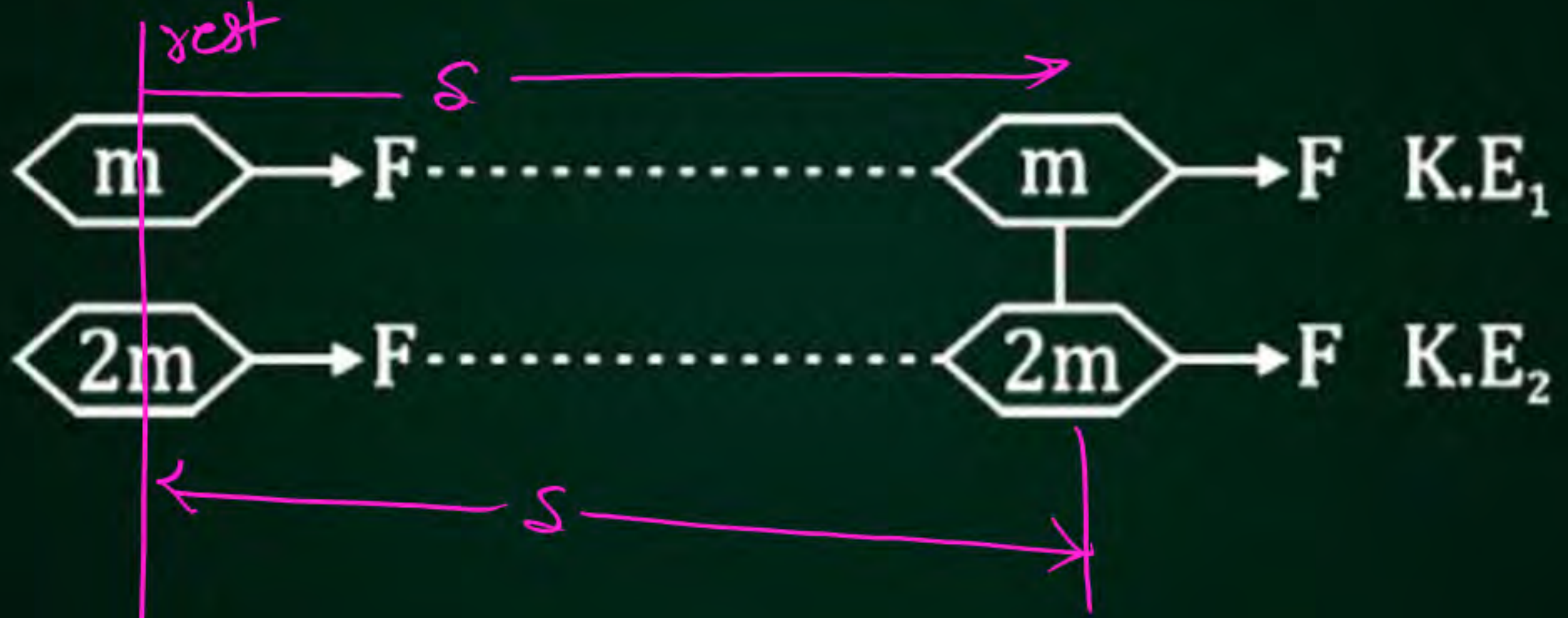
$$\text{Work} = K.E_2 - 0 \quad \text{—} \; (11)$$

$$\boxed{FS = K.E_2}$$

WORK-ENERGY THEOREM

IIT

Work done by all the force is equal to change in K.E.



$\frac{K.E_1}{K.E_2} = ??$

Sol^n $\frac{K.E_1}{K.E_2} = 1:1$ Ans

QUESTION

KE acquired by a mass m in travelling a certain distance d, starting from rest, under the action of a constant force F is

1. Directly proportional to $\sqrt{m}$ X
2. Directly proportional to m X
3. Directly proportional to $\frac{1}{m}$ X
4. None of these ✓

K.E = work = Fd

$W_{all\,F} = \Delta K.E$

$W_{all\,F} = K.E_f - K.E_i$

$W_{all\,F} = 0$

$K.E = const$

If $W_{all\,F} = +ve$

$\Delta K.E = +ve$

$K.E_f - K.E_i = +ve$

($K.E \uparrow$)

Speed $\uparrow$

If $W_{all\,F} = -ve$

$K.E_f - K.E_i = -ve$

$K.E \downarrow$

QUESTION

Under the action of a force, a 2 kg body moves such that its position x as a function of time t is given by $x = t^2/3$, where x is in metres and t in seconds. The work done by the force in first two seconds is

1. 1600 J
2. 160 J
3. 16 J
4. 16/9 J

$$x = \frac{t^3}{3}$$

$$v = \frac{dx}{dt} = \frac{1}{3}\frac{dt^2}{dt} = \frac{2t}{3}$$

$$v_{t=0} = 0$$

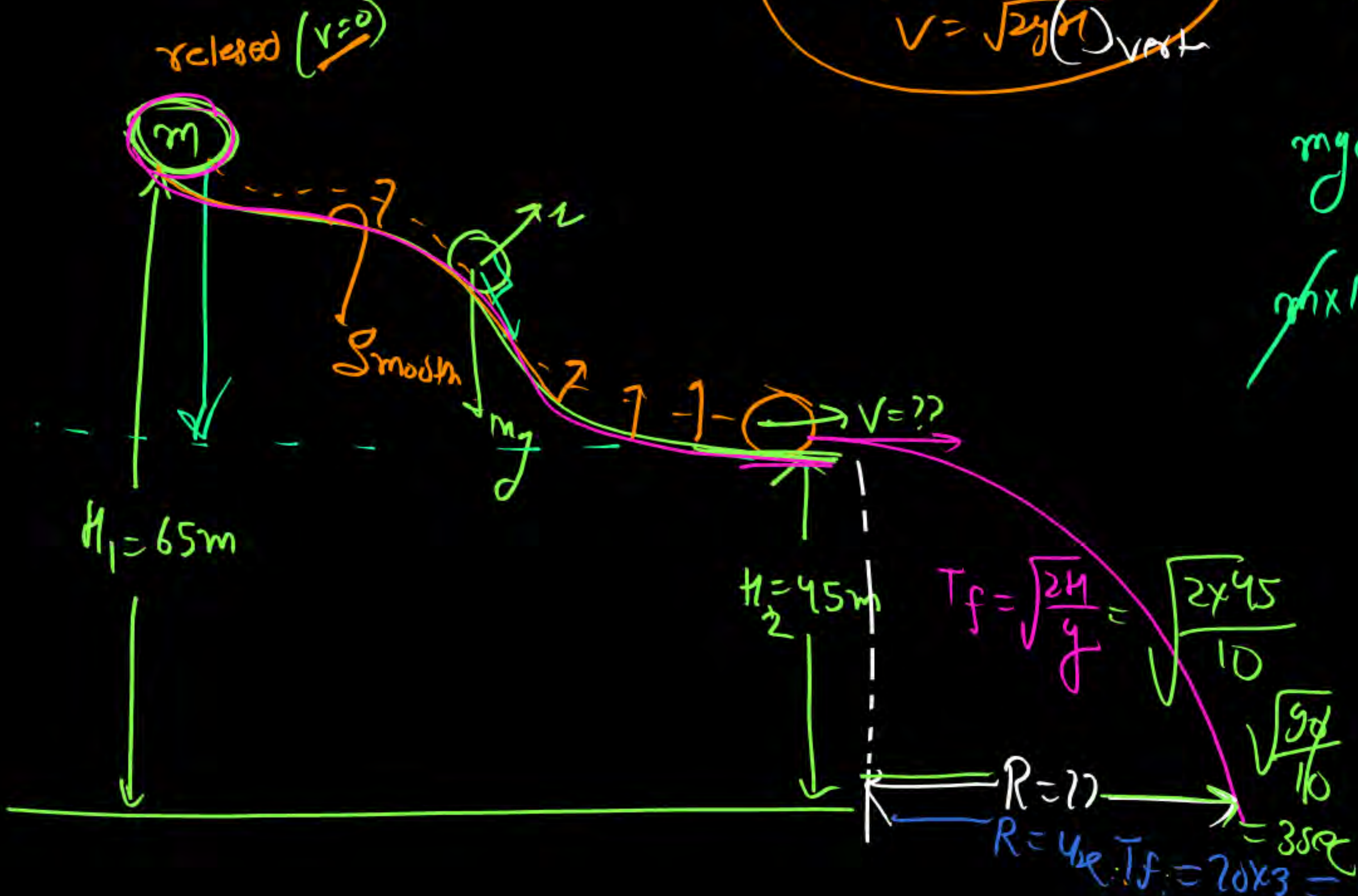
$$v_{t=2} = \frac{4}{3}$$

$$W = \frac{1}{2}m\left[v_f^2 - v_i^2\right]$$

$$= \frac{1}{2} \cdot 2\left[\left(\frac{4}{3}\right)^2 - 0\right]$$

$$= \frac{16}{9}\ J$$

AIIMS-2017



~~first gravity~~ $\propto mR$

$mgH = \frac{1}{2}mv^2$

$V = \sqrt{2g(H)_{vert}}$

Sol^n

Work energy th^m

$W_g + W_N = \Delta K.E$

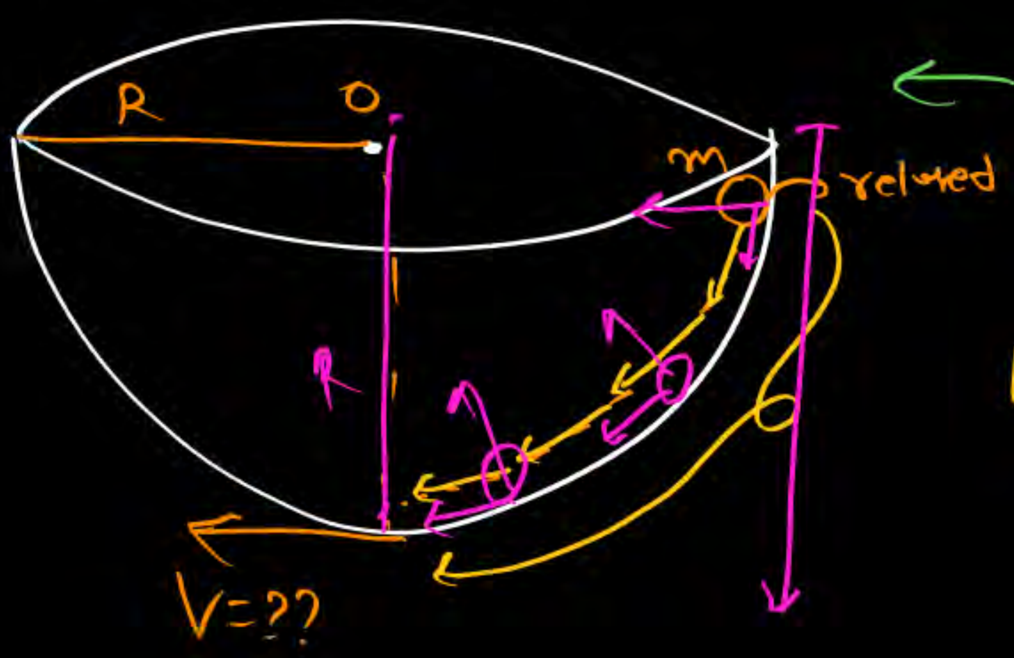
$mgH_r + 0 = \frac{1}{2}m\left[v_f^2 - v_i^2\right]$

$m \times 10 \times (65-45) = \frac{1}{2} m v_f^2$

$10 \times 20 = \frac{1}{2} v_f^2$

$400 = v_f^2$

$v_f = \sqrt{400} = 20\,m/s$



← Hemi-spherical (smooth)

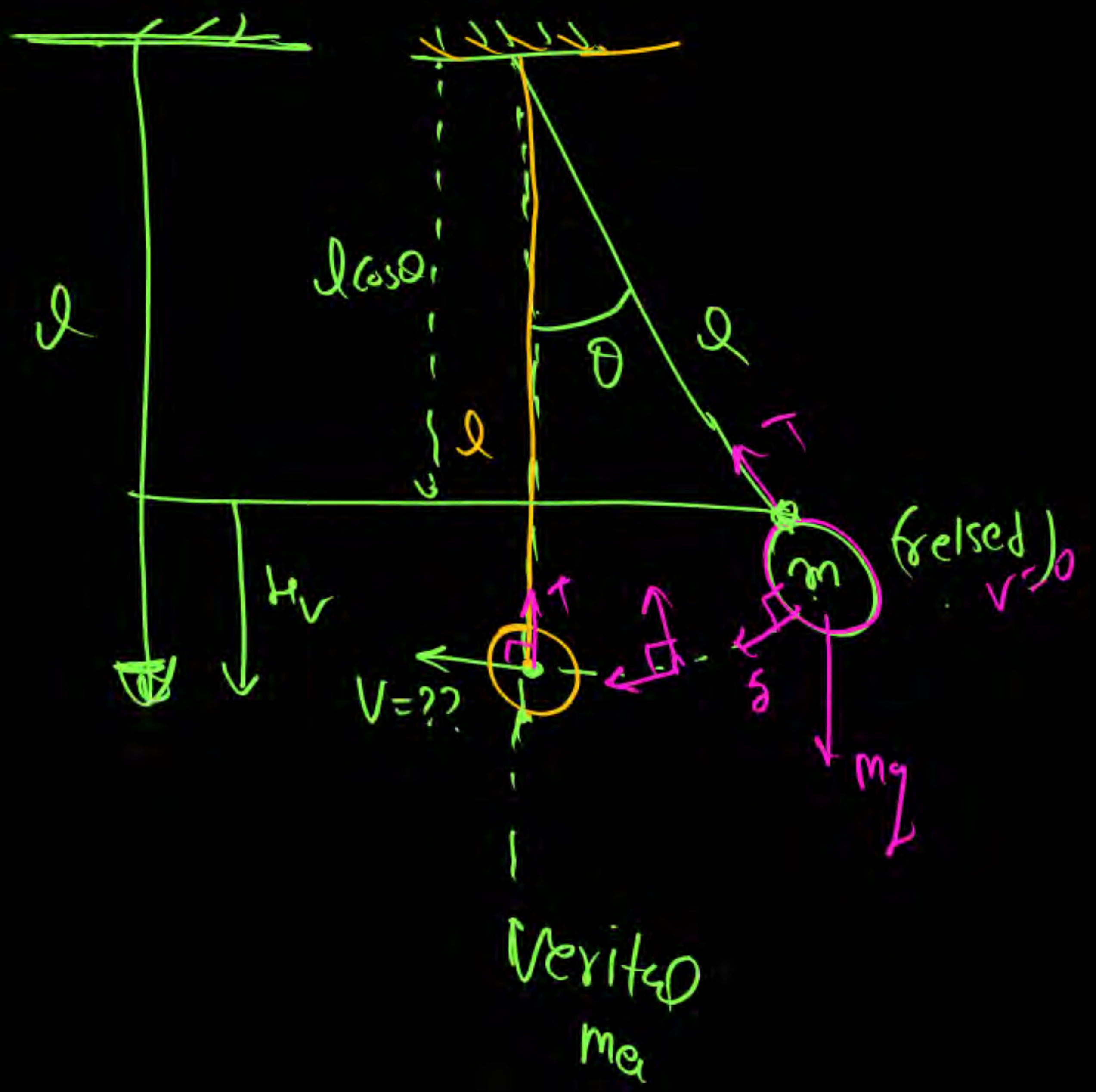
Work energy th^m

$W_g + \cancel{W_N}^{0} = \Delta K.E.$

$\cancel{m}gH = \frac{1}{2}\cancel{m}v_f^2 - \cancel{K.E._i}^{0}$

$v_f = \sqrt{2gH}$

$= \sqrt{gR}$



Work - energy thm

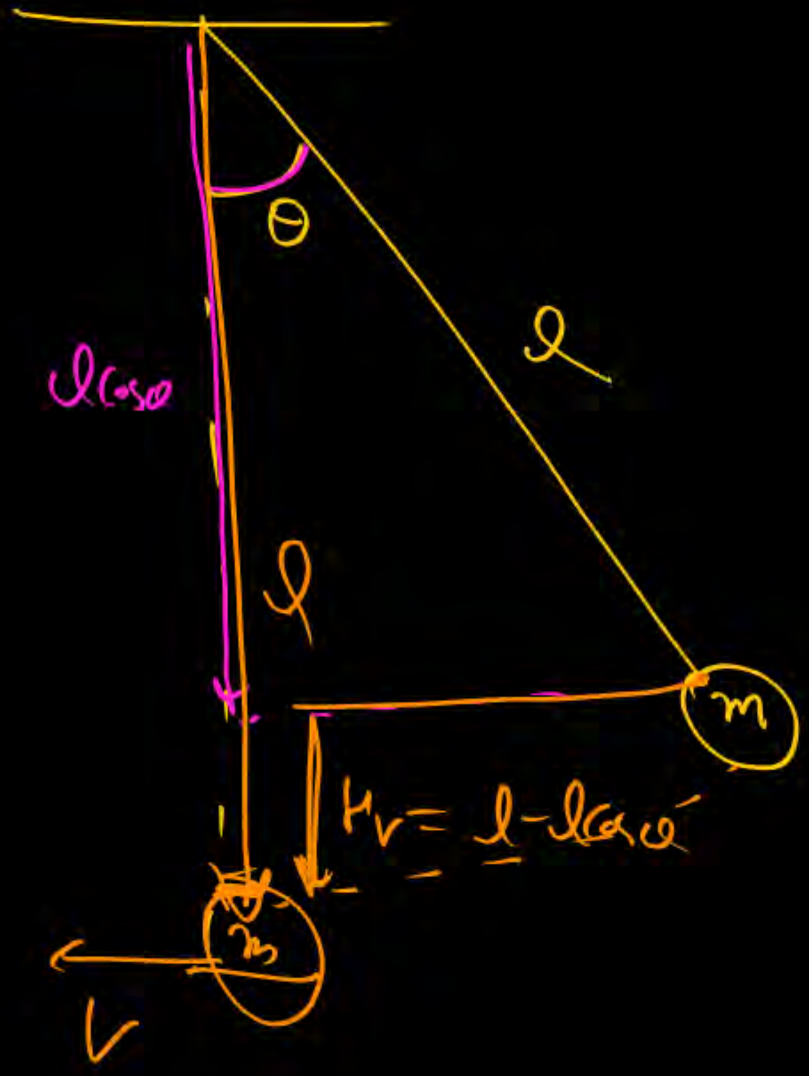
$$W_g + W_T^{\,0} = \Delta K.E$$

$$= K.E_f - K.E_i^{\,0}$$

$$mg(H_{ver}) =$$

$$mg(l - l\cos\theta) = \frac{1}{2} m v^2$$

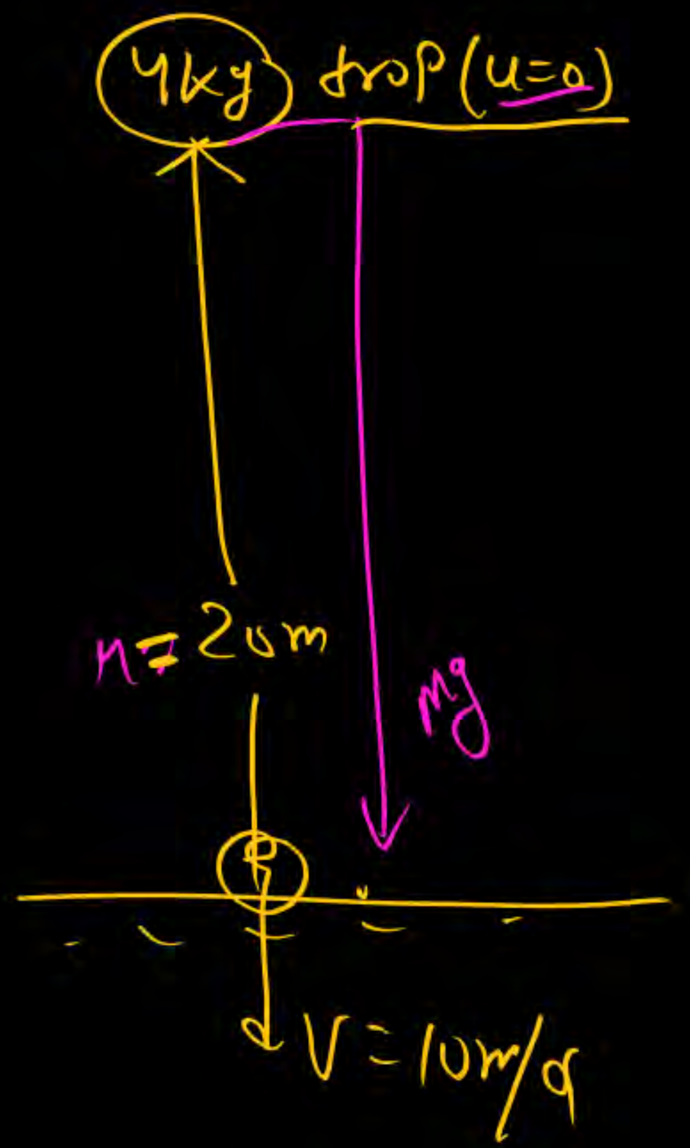
$$\sqrt{2gl(1-\cos\theta)} = V$$



vertical

$$W_g = mg\,(l - l\cos\theta) = mgl(1-\cos\theta)$$

Q) Object of mass 4 kg droped from Height 20m (from ground) then its speed at ground is 10 m/s then find work done by air friction



Soln

$W_{airf} = \Delta K.E$

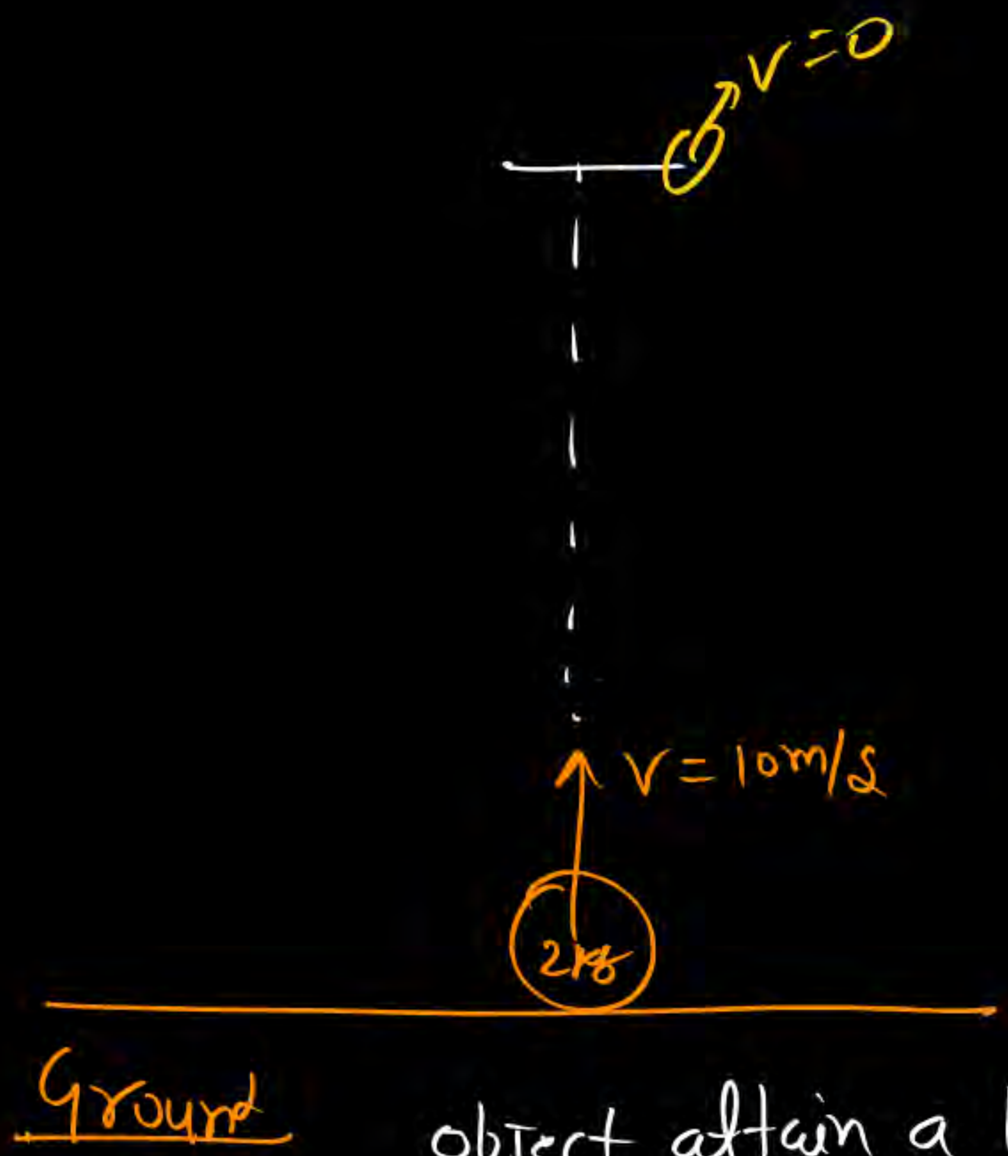
$W_g + W_{airf} = \Delta KE$

$mgh + W_{airf} = KE_f - \cancel{KE_i}$ (0)

$4 \times 10 \times 20 + W_{air} = \frac{1}{2} \cancel{4}^{2} (10)^2$

$800 + W_{airf} = 200$

$W_{airf} = 200 - 800 = -600J$

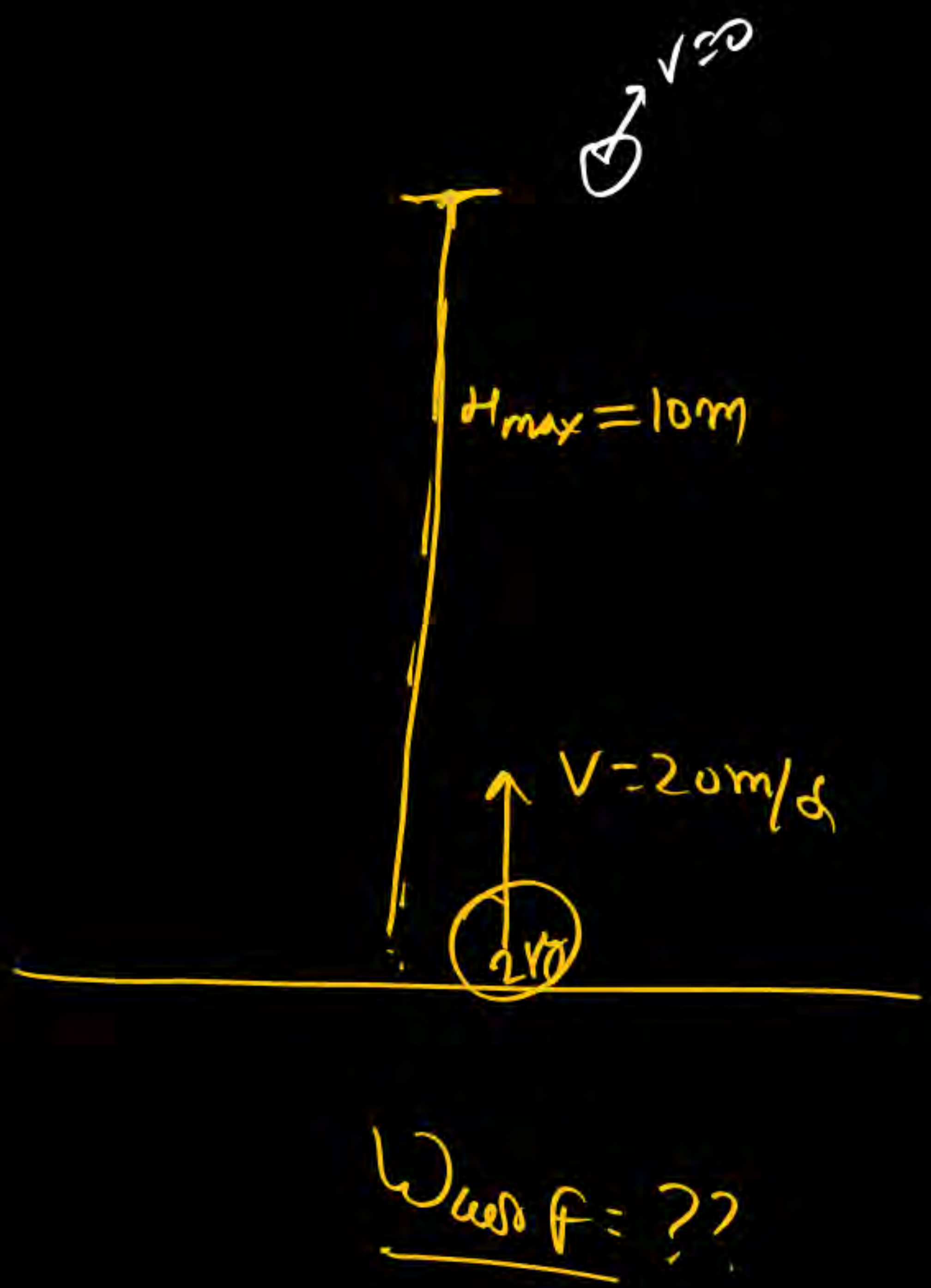


object attain a Maximum height of 5 m then find work done by friction.

$$W_{all\,f} = 0$$ Ans

$$W_{all\,F} = \Delta K.E$$

$$W_g + W_{air} = \Delta KE$$



$W_{ar} = \Delta K.E$

$-mgH + W_{airf} = K.E_f - K.E_i$ (with $K.E_f = 0$)

$-2 \times 10 \times 10 + W_{airf} = -\frac{1}{2} \times 2 \times (20)^2$

$-200 + W_{af} = -400$

$W_{airf} = -400 + 200$

$= -200J$

QUESTION

A particle of mass 3 kg is moving along x-axis and its position at time t is given by equation $x = (2t^2 + 5)$ m. Work done by all the forces acting on it in time interval t = 0 to t = 3 is

1. 144 J
2. 72 J
3. 108 J
4. 216 J

$x = 2t^2 + 5$

$v = 4t$

$v_{t=0} = 0$

$v_{t=3} = 12$

$W = \frac{1}{2} m (v_f^2 - v_i^2)$

$= \frac{1}{2} \times 3 [144 - 0]$

$= 72 \times 3$

$72 \times 13 = 216$

The MR* feel

QUESTION

A particle of mass 2 kg travels along a straight line with velocity $v = a\sqrt{x}$, where a is a constant. The work done by net force during the displacement of particle from $x = 0$ to $x = 4$ m is

1. a^2
2. $2a^2$
3. $4a^2$ Ans
4. $\sqrt{2}a^2$

$W = \frac{1}{2}m(v_f^2 - v_i^2)$

$v = a\sqrt{x}$

$v_i = a\sqrt{x_i} = 0$

$v_f = a\sqrt{4} = 2a$

$W = \frac{1}{2}m[v_f^2 - v_i^2]$

$= \frac{1}{2} \cdot 2[4a^2]$

QUESTION

A particle of mass m starts moving from origin along x-axis and its velocity varies with position (x) as $v = k\sqrt{x}$. The work done by force acting on it during first "t" seconds is

1. $\frac{mk^4t^2}{4}$
2. $\frac{mk^2t}{2}$
3. $\frac{mk^4t^2}{8}$
4. $\frac{mk^2t^2}{4}$

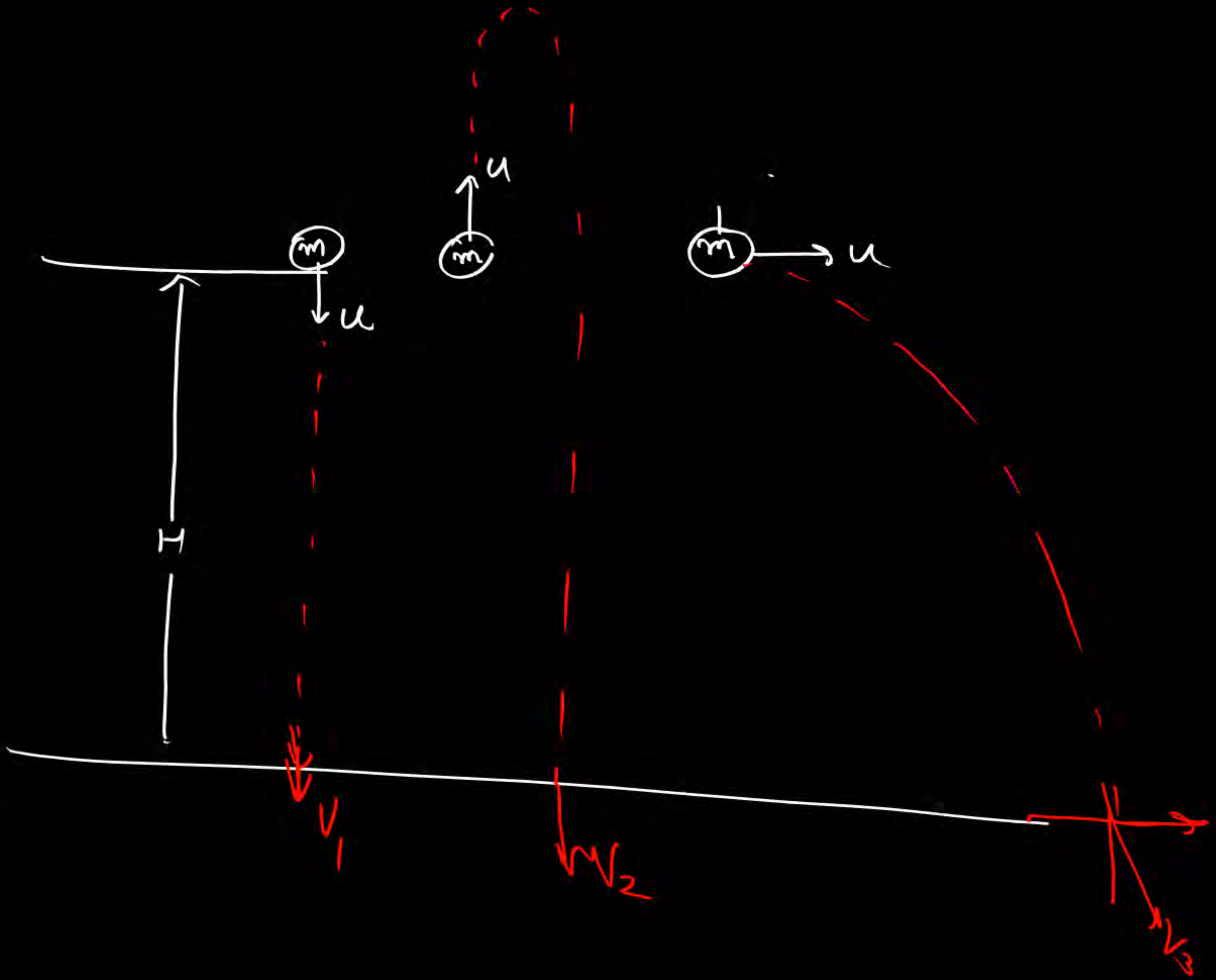
$v = k\sqrt{x}$

$\frac{dx}{dt} = k\sqrt{x}$

$\int \frac{dx}{\sqrt{x}} = \int k\,dt$

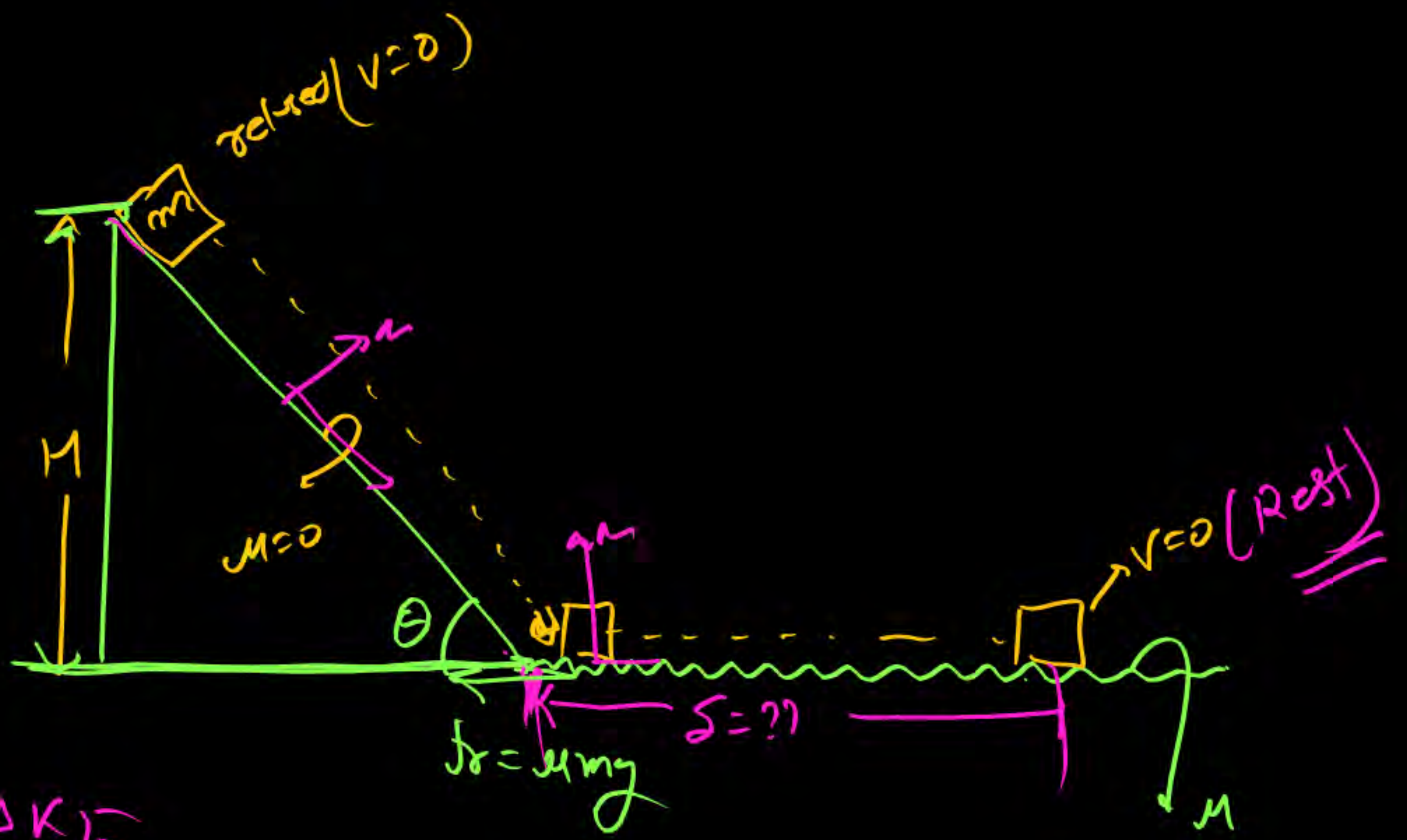
$v = \frac{dx}{dt}$

H/W



Compair V_1 & V_2 and V_3

Speed



Work-energy th^n

$$W_g + W_N + W_{fr} = \Delta KE$$

$$= KE_f - KE_i$$

$$mgH + 0 - \mu mgS = 0$$

$$mgH = \mu mgS$$

$$S = H/\mu \ (H/\omega)$$

Thank you

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FOR NEET 2025

Lecture- 04 | **Physics**

Work, Energy and Power



1 up
2 down

By- Dr. Manish Raj (MR SIR)

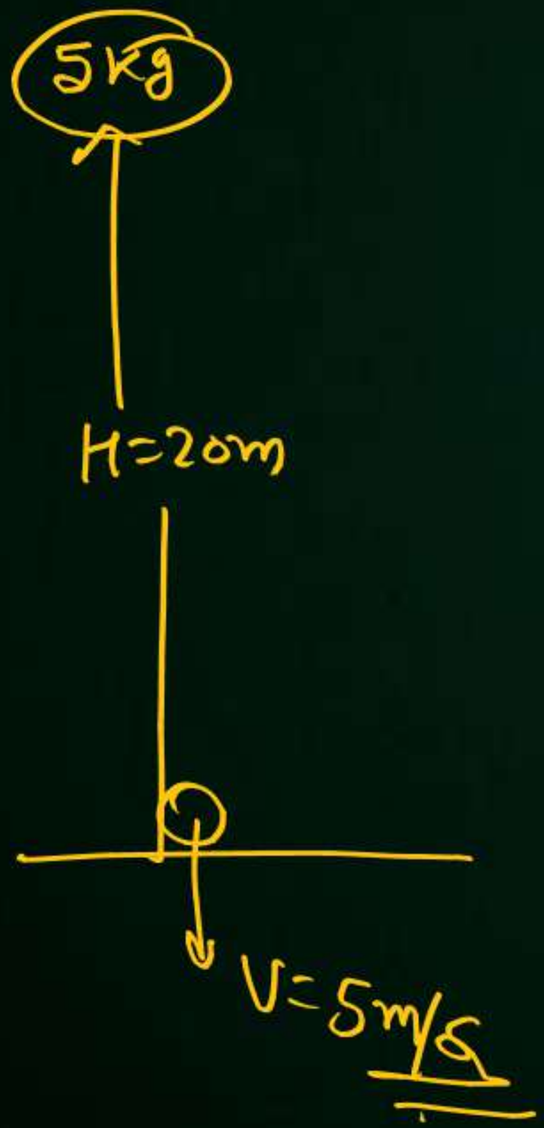
Topics to be covered

1. ## K.B.D........
2. ## H/W
3. # (x) Concept of Potential
   Conservative Non-conservative force.
4. #



QUESTION

(1) Object 5 kg dropped from a height 20 m then its velocity at ground is 5 m/s, then find work done by friction.



Sol^n Work energy th^n

$W_g + W_{airf} = \Delta K.E$

$mgH + W_{airf} = K.E_f - K.E_i$ ($K.E_i \to 0$)

$5\times10\times20 + W_{air} = \frac{1}{2}5(5)^2$

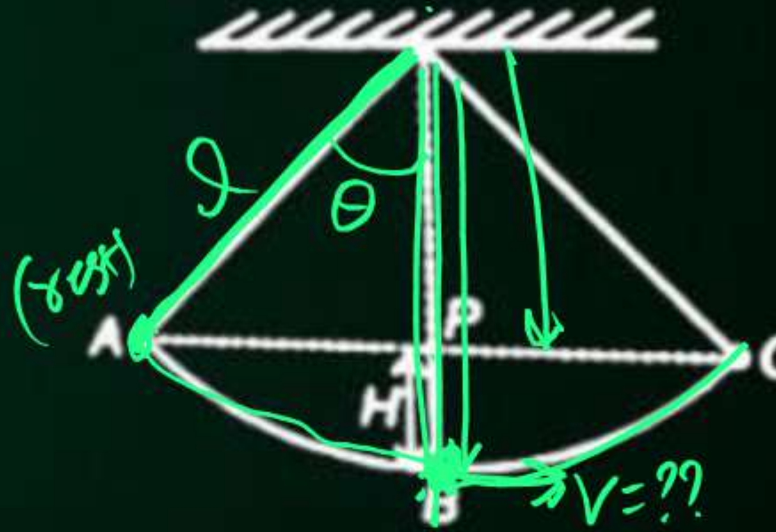
$W_{at} = 62.5 - 1000$

$= -937.5\ J$

QUESTION

A simple pendulum with a bob of mass m oscillates from A to C and back to A such that PB is H. If the acceleration due to gravity is g, then the velocity of the bob is passes through B is

1. $\sqrt{1\,mgH}$
2. $\sqrt{2\,gH}$
3. Zero
4. $\sqrt{1\,gH}$



$V = \sqrt{2gH}$

$V = \sqrt{2g\,l(1-\cos\theta)}$

QUESTION

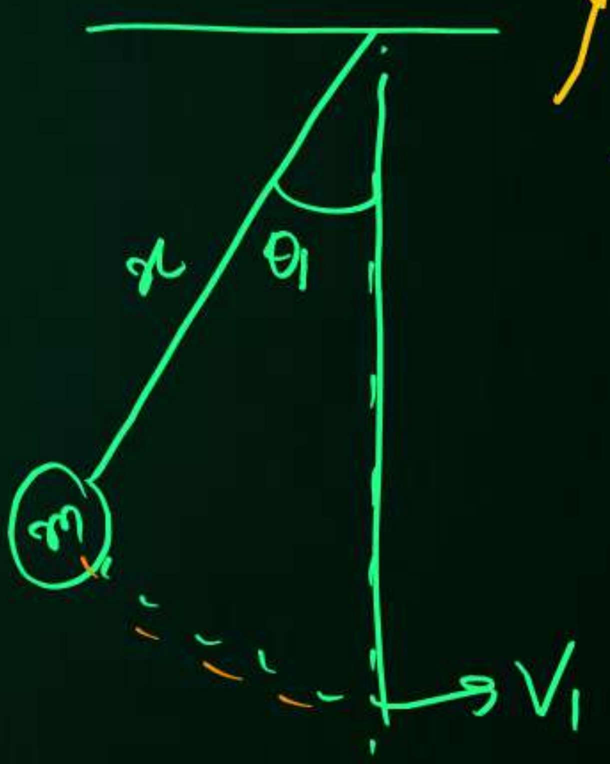
A simple pendulum with bob of mass m and length x is held in position at an angle θ_1 and then angle θ_2 with the vertical. When released from these positions, speeds with which it passes the lowest positions are v_1 and v_2 respectively. Then, v_1/v_2 is

(1) $\dfrac{1-\cos\theta_1}{1-\cos\theta_2}$

(2) $\sqrt{\dfrac{1-\cos\theta_1}{1-\cos\theta_2}}$

(3) $\sqrt{\dfrac{2gx(1-\cos\theta_1)}{1-\cos\theta_2}}$

(4) $\sqrt{\dfrac{1-\cos\theta_1}{2gx(1-\cos\theta_2)}}$



$$y = \frac{30}{20} = \frac{3}{2}$$

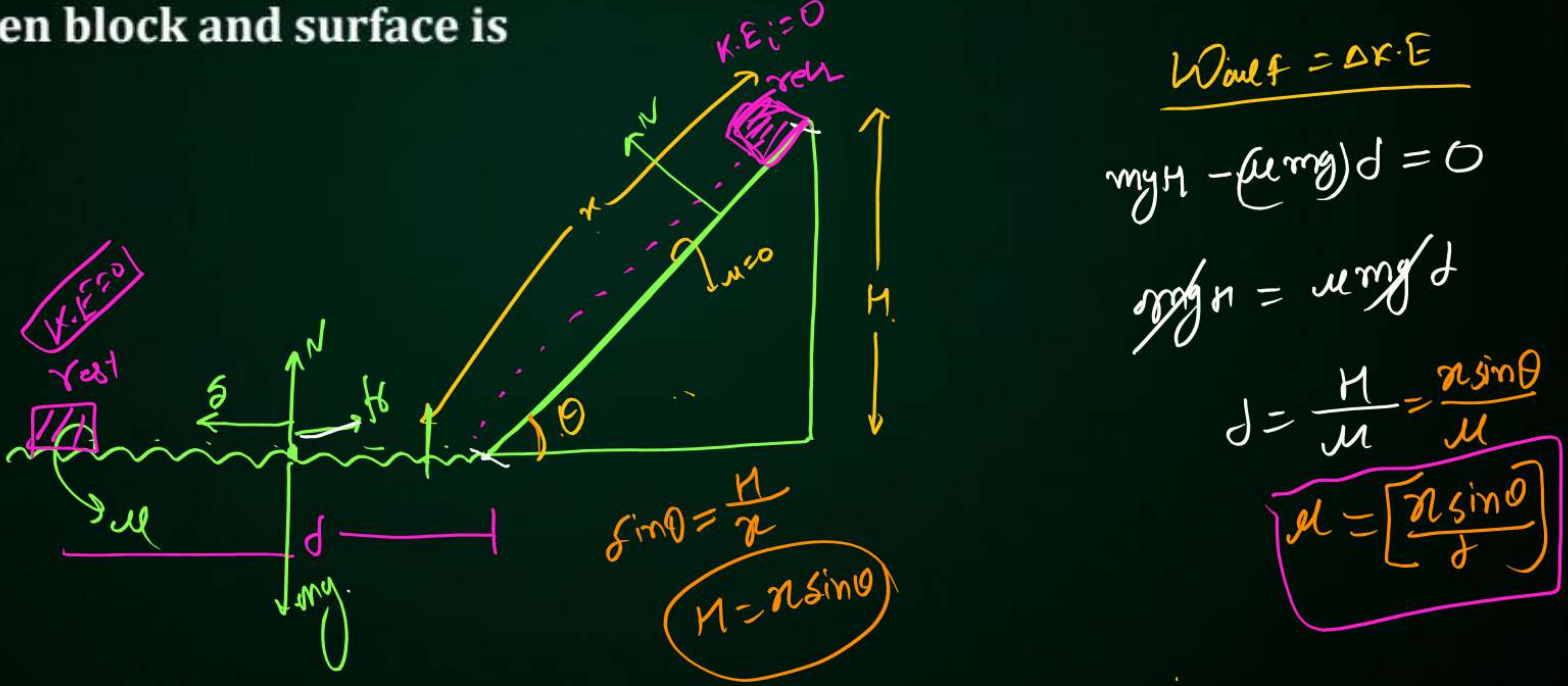
$$y = \frac{37}{27} = \frac{3}{2}$$

$$y = \frac{\sqrt{9}}{\sqrt{4}} = \frac{9}{4} \quad Q = 2.25$$

$$= \frac{5 \times 2}{(2 \times 1) \times 2}$$

$$y = \frac{\sqrt{9}}{\sqrt{4}} = \frac{3}{2} = 1.5$$

A block of mass m is released on the top of a smooth inclined plane of length x and inclination θ as shown in figure. Horizontal surface is rough. If block comes to rest after moving a distance d on the horizontal surface, then coefficient of friction between block and surface is



1. $\dfrac{x\sin\theta}{2d}$
2. $\dfrac{x\cos\theta}{2d}$
3. $\dfrac{x\sin\theta}{d}$
4. $\dfrac{x\cos\theta}{d}$

QUESTION

The position x of a particle moving along x-axis at time (t) is given by the equation $t = \sqrt{x} + 2$, where x is in meters and t in seconds. Find the work done by the force in first four seconds.

1. Zero
2. 2 J
3. 4 J
4. 8 J

$t = \sqrt{x} + 2$

$t_i = 0$

$t_f = 4\ sec$

$\sqrt{x} = t - 2$

$x = (t-2)^2$

$W = F \cdot (disp^n) = 0$

$x_i = 4m$

$x_f = (2)^2 = 4m$

$\Delta S = x_f - x_i = 0$

Method 2

$x = (t-2)^2$

$v = \frac{dx}{dt} = 2(t-2)^1 \times (1-0)$

$v = 2(t-2)$

$W = \frac{1}{2}m[16-16] = 0$

$V_{t=0} = -4 m/s$

$V_{t=4} = 2(4-2) = 4 m/s$

QUESTION

A stone with weight w is thrown vertically upward into the air from ground level with initial speed v_0. If a constant force f due to air drag acts on the stone throughout its flight. The maximum height attained by the stone is

1. $h = \dfrac{v_0^2}{2g\left(1 + \dfrac{f}{w}\right)}$

2. $h = \dfrac{v_0^2}{2g\left(1 - \dfrac{f}{w}\right)}$

3. $h = \dfrac{v_0^2}{2g\left(1 + \dfrac{w}{f}\right)}$

4. $h = \dfrac{v_0^2}{2g\left(1 - \dfrac{w}{f}\right)}$



MR* of air friction $f=0$

$$\left[H = \frac{v_0^2}{2g}\right]$$

MR* $f \neq 0$

$$H < \frac{v^2}{2g}$$

$\Rightarrow H$

QUESTION

Ball is projected with speed 10m/s at 30° from Horizontal.

Find speed at ground.

Beauty of work energy th^m

$W_{gr} = \Delta K.E$

$mgH = \frac{1}{2}m[v_f^2 - v_i^2]$

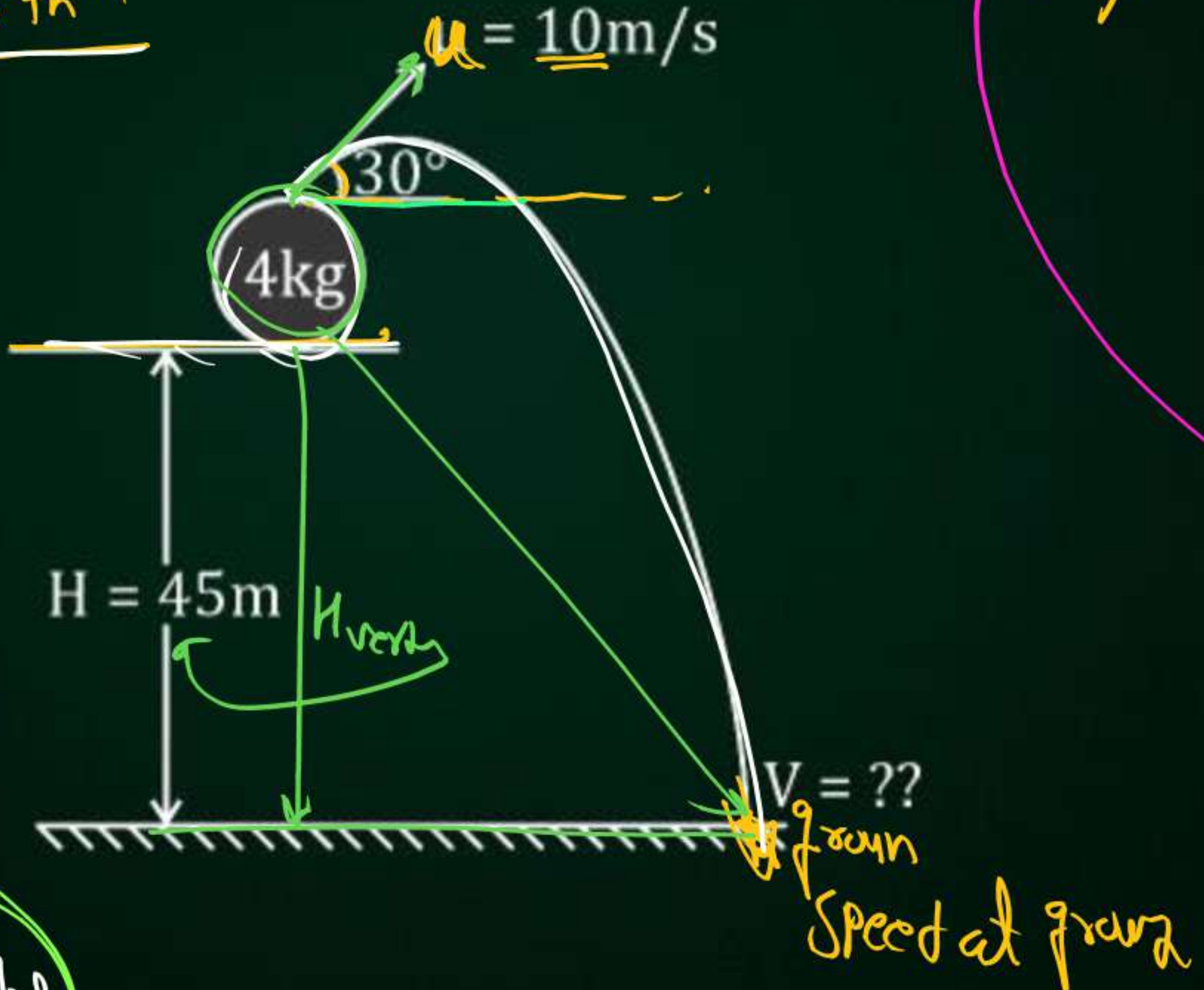
$4 \times 10 \times 45 = \frac{1}{2} 4 (v_f^2 - 10^2)$

$900 = v_f^2 - 100$

$1000 = v_f^2$

$v_f = \sqrt{1000} = 10\sqrt{10}$ Ans

Bhokwa Master



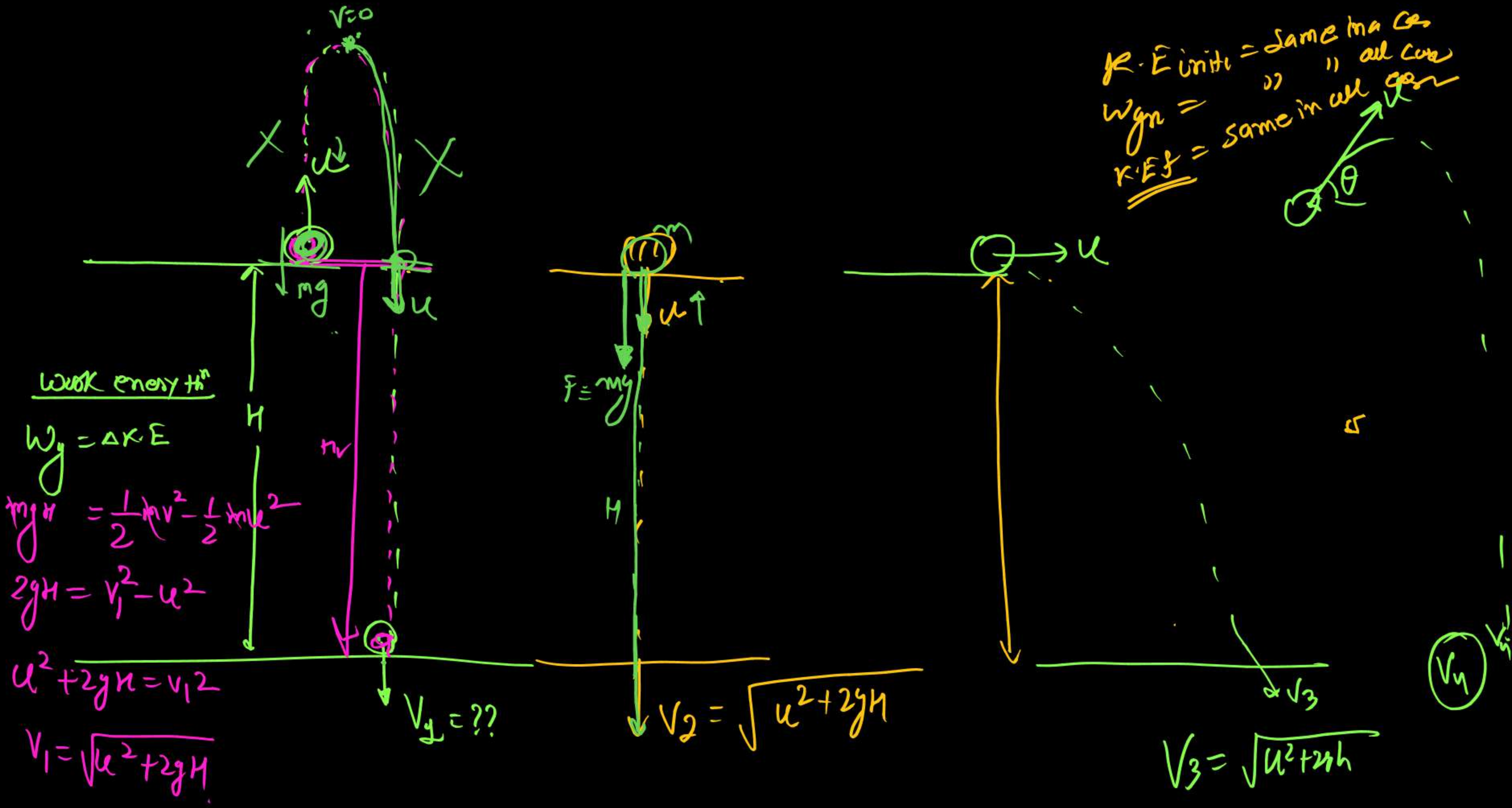
Why 30° is not used here??

→ because K.E is a scalar it have speed not direction

Who tew Bogue

M.R

the whe esy



V=0
u
mg
u
H
Work energy th^n
$W_g = \Delta K.E$
$mgH = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$
$2gH = v_1^2 - u^2$
$u^2 + 2gH = v_1^2$
$v_1 = \sqrt{u^2 + 2gH}$
$V_1 = ??$
m
F = mg
H
$V_2 = \sqrt{u^2 + 2gH}$
u
V_3
$V_3 = \sqrt{u^2 + 2gh}$
K.E initi = same in all cas
Wgr = " " all cas
K.E f = same in all case
u
θ
V_4

QUESTION

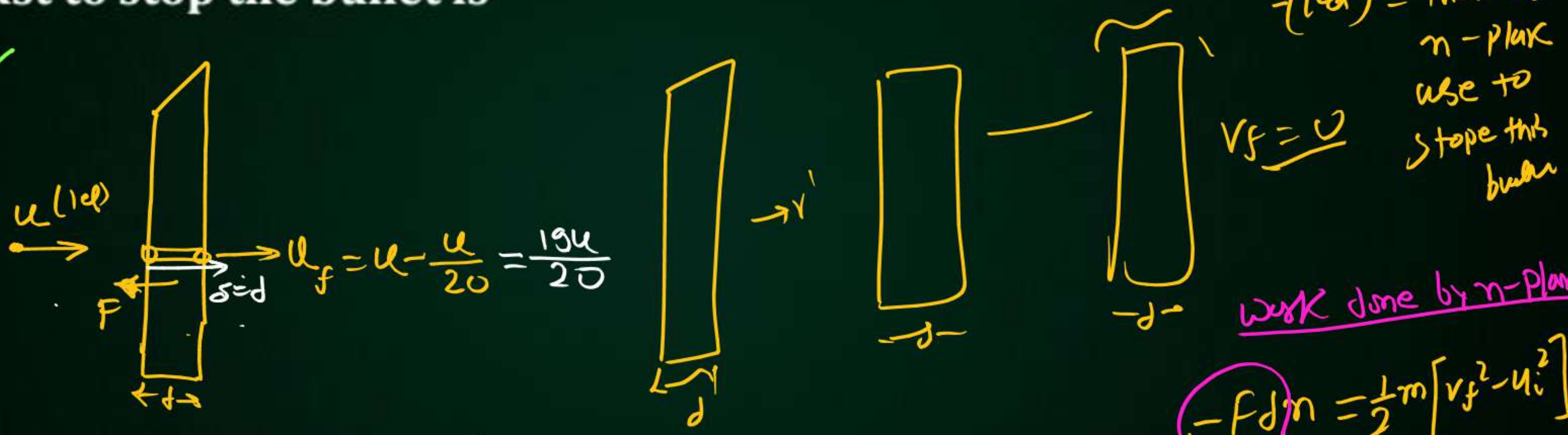
A rifle bullets loses (1/20)th of its velocity in passing through a plank. Assuming that the plank exerts a constant retarding force, the least number of such planks required just to stop the bullet is

(1) 11

(2) 20

(3) 21

(4) Infinite



$$u_f = u - \frac{u}{20} = \frac{19u}{20}$$

$$-F \cdot d = \frac{1}{2} m \left[v_f^2 - u_i^2 \right] \quad (1)$$

Work done by one plane

Work done by n-plank

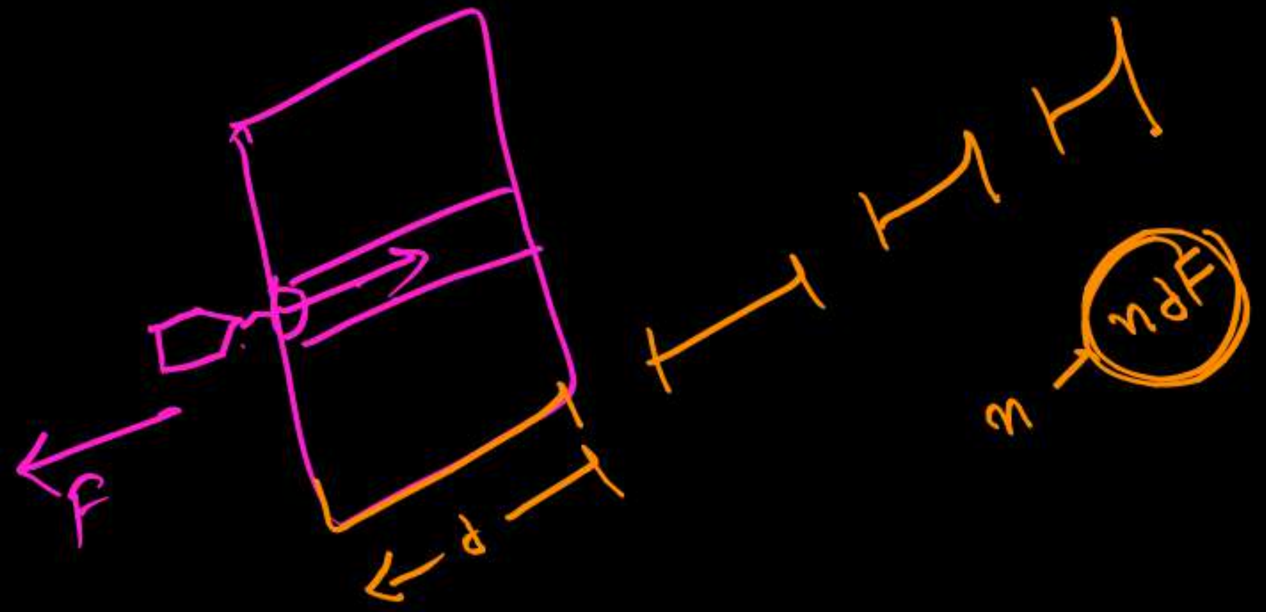
$$-Fd\,n = \frac{1}{2} m \left[v_f^2 - u_i^2 \right]$$

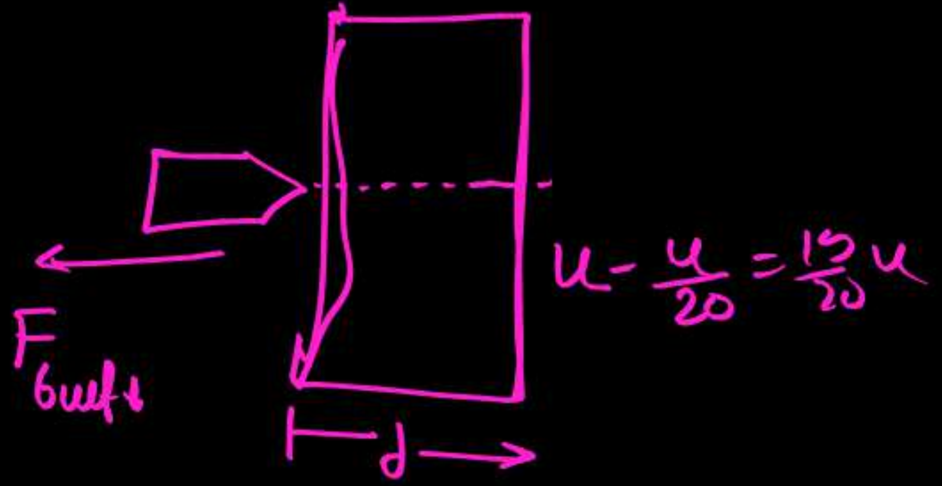
$$\frac{1}{2} m\, n \left[\left(\frac{19u}{20}\right)^2 - u^2 \right] = \frac{1}{2} m \left[0 - u^2 \right]$$

$$n \left(\frac{361}{400} - 1 \right) u^2 = -u^2$$

$$n\left(\frac{361-400}{400}\right) = -1$$

$$n = \frac{+400}{+39} = 10.5$$





$$-Fd = \frac{1}{2}m\left[\left(\frac{19u}{20}\right)^2 - u^2\right]$$

$$-Fdn = \frac{1}{2}m\left[0 - u^2\right]$$

$$\frac{1}{n} = \frac{\frac{361u^2}{400} - u^2}{-u^2} = \frac{u^2\left(\frac{361}{400} - 1\right)}{-u^2} = \frac{361-400}{400}$$

$$\frac{1}{n} = \frac{39}{400}$$

$$n = \frac{400}{39}$$

10

QUESTION

If position of object is proportional to time ($x \propto t$), then find work as a function of time.

95% समझ आजा

5%

If $x \propto t$

(work) = ??

$x \propto t$

$x = kt$

$v = \frac{dx}{dt} = k$

$a = \frac{dv}{dt} = 0$

$F = 0$

$W = 0$

100 5% मे हैं → ε

Notes → सारे बाते लिखती है

→ 50 Compt Note बनाते है

Notes → Basic theory

→ speci cases → textbook

Focus

→ Basic Qu the

→ 50 sum se Nahi hove

50% select

DPP → जरूरी

Test

Assig level-up

QUESTION

If acceleration of object is proportional to time (a = kt), then find KE as a function of time.

Sol^n

$a \propto t$

$\frac{dv}{dt} = kt$

$\int dv = \int kt\, dt$

$V = \frac{kt^2}{2}$

$K.E(t) = K.E = \frac{1}{2} m v^2$

$K.E = \frac{\frac{1}{2} m k^2 t^4}{4}$

$K.E \propto t^4$

Ans

QUESTION

H/W

A particle of mass m starts moving from origin along x-axis and its velocity varies with position (x) as $v = k\sqrt{x}$. The work done by force acting on it during first "t" seconds is

1. $\frac{mk^4t^2}{4}$
2. $\frac{mk^2t}{2}$
3. $\frac{mk^4t^2}{8}$ Ans
4. $\frac{mk^2t^2}{4}$

$V = K\sqrt{x}$

$\frac{dx}{dt} = K\sqrt{x}$

$\int \frac{dx}{\sqrt{x}} = \int K\,dt$

$\int \frac{dx}{x^{1/2}} = \int K\,dt = Kt$

$\frac{x^{-\frac{1}{2}+1}}{-\frac{1}{2}+1} = Kt$

$\frac{\sqrt{x}}{\frac{1}{2}} = Kt$

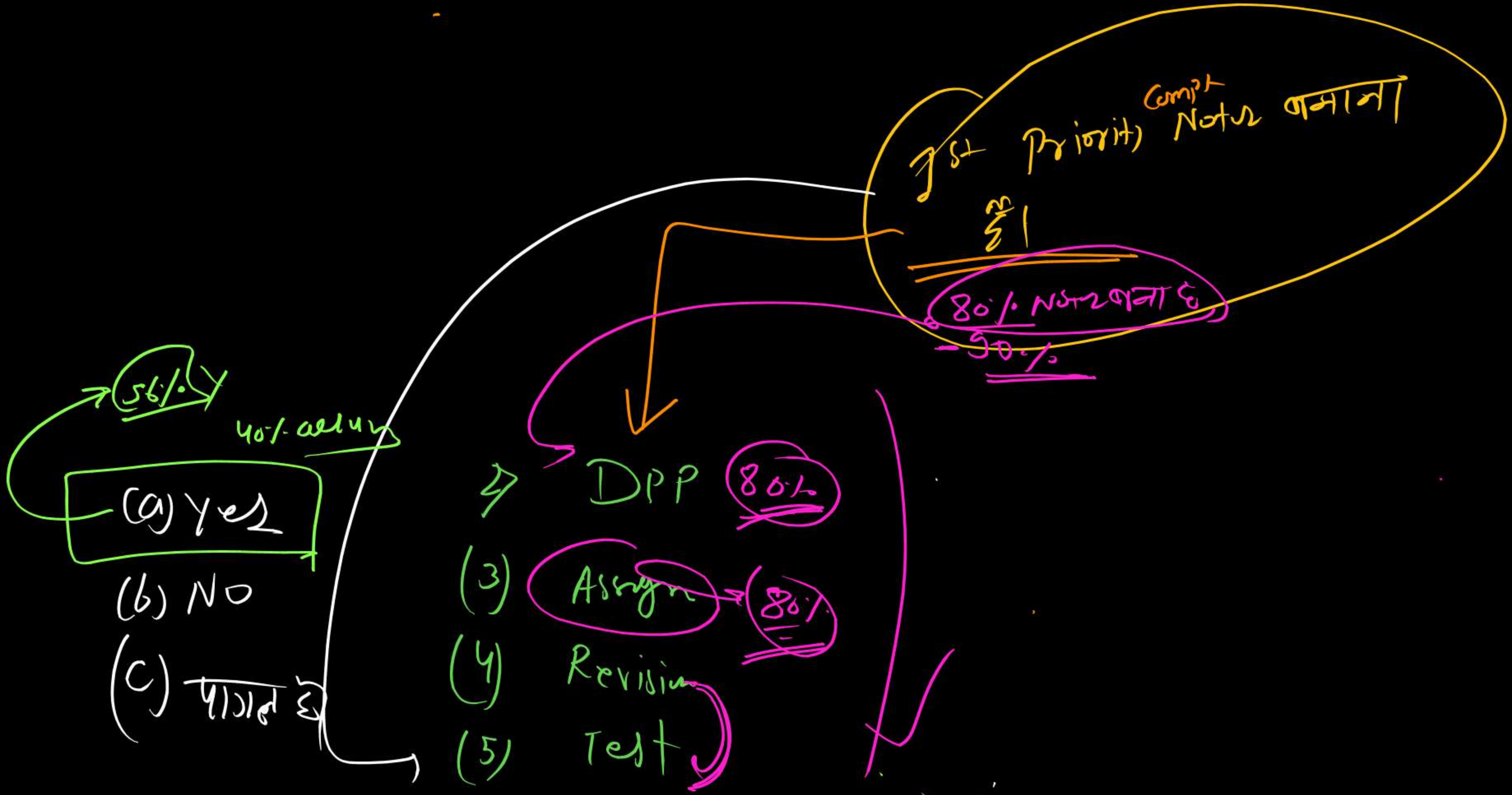
$\sqrt{x} = \frac{1}{2}Kt$

$x = \frac{K^2}{4}t^2$

$\frac{dx}{dt} = V = \frac{K^2}{4}2t = \frac{K^2t}{2}$

$W = \Delta K.E = \frac{1}{2}m\left[\frac{K^4t^2}{4}\right] - 0$

$= \frac{mK^4t^2}{8}$



1st Priority Compt Notes बनाना है।
80% Notes बनाते है
50%
56%
40% अधूरे
(a) Yes
(b) NO
(c) पागल है
2 DPP 80%
(3) Assign 80%
(4) Revision
(5) Test

QUESTION

If constant force acting on object then find KE as a function of time.

Sol^n

$F = \text{const}^n$

$a = \text{const}^n$

$F = ma$ (↑ fixed)

$a = \text{const}^n$

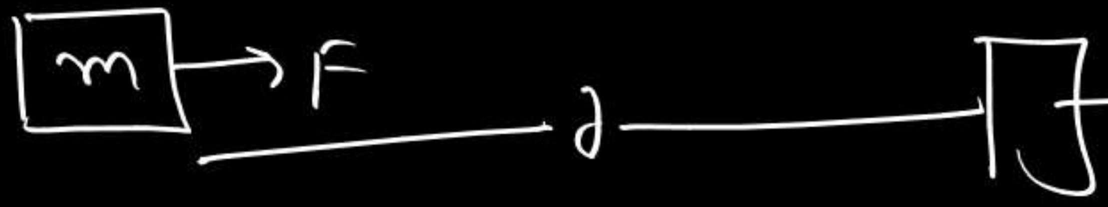
imp* $x \propto t^2 \; (v \propto t)$

[redacted]

$K.E = \frac{1}{2} m v^2 \propto t^2$ (const^n)

$K.E \propto t^2$

Ans



$\Delta K.E = \text{work}$

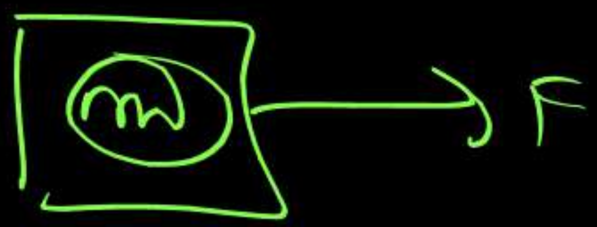
$\Delta K.E = F \cdot d$

$\Delta KE = ma \cdot d$

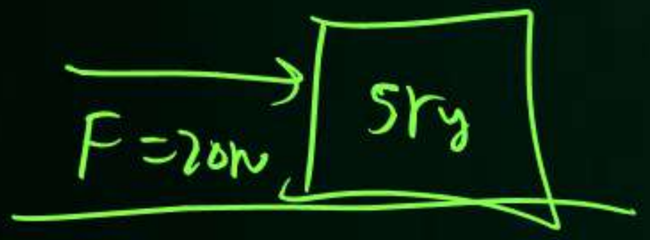


$F = ma$

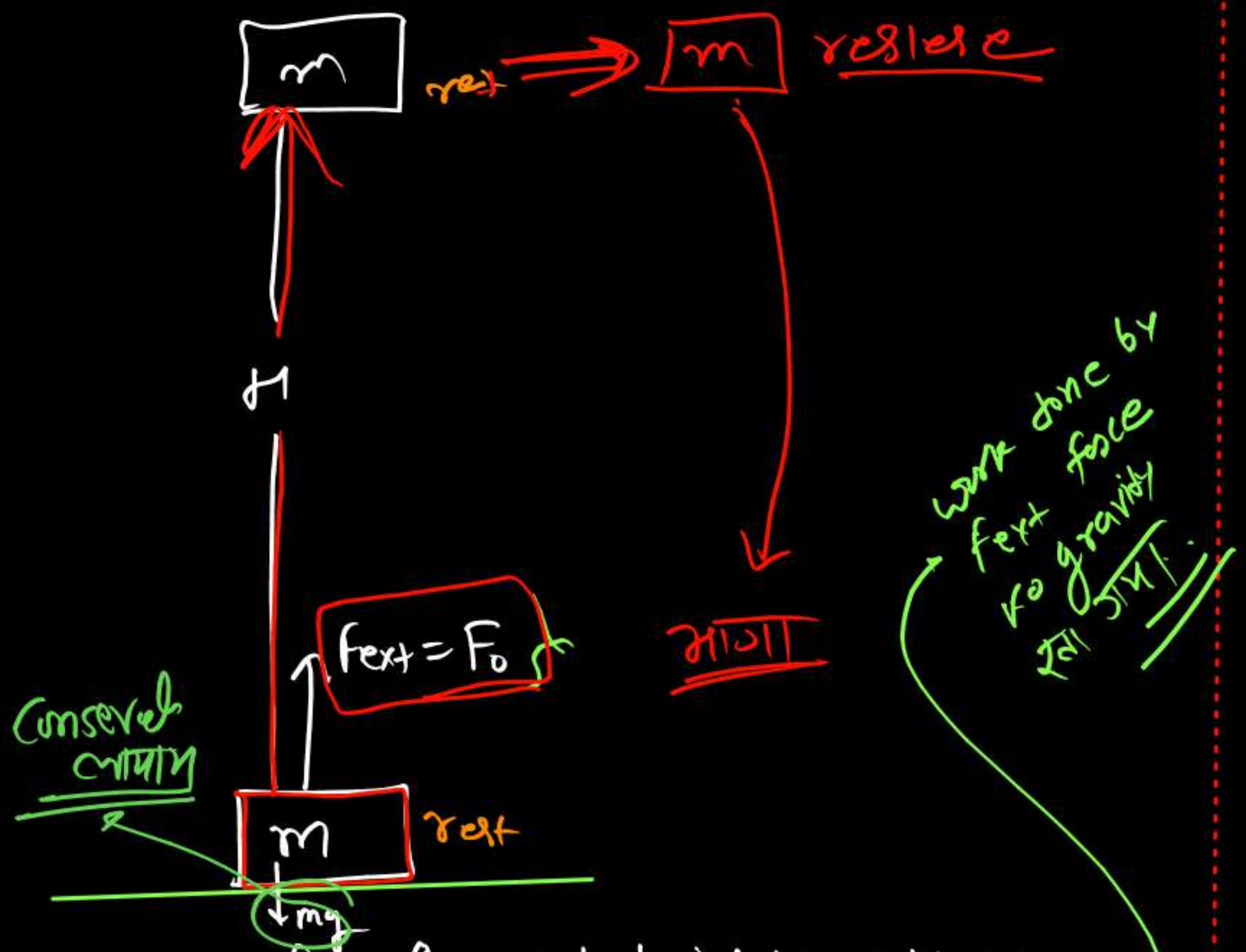
$a = \frac{F}{m}$


m
F

- Force can be stored in the body → No
- Work can be stored in the body → No
- Heat can be stored in the body → No
- KE can be stored in the body → Yes







Object moved from ground to height H slowly by Fext

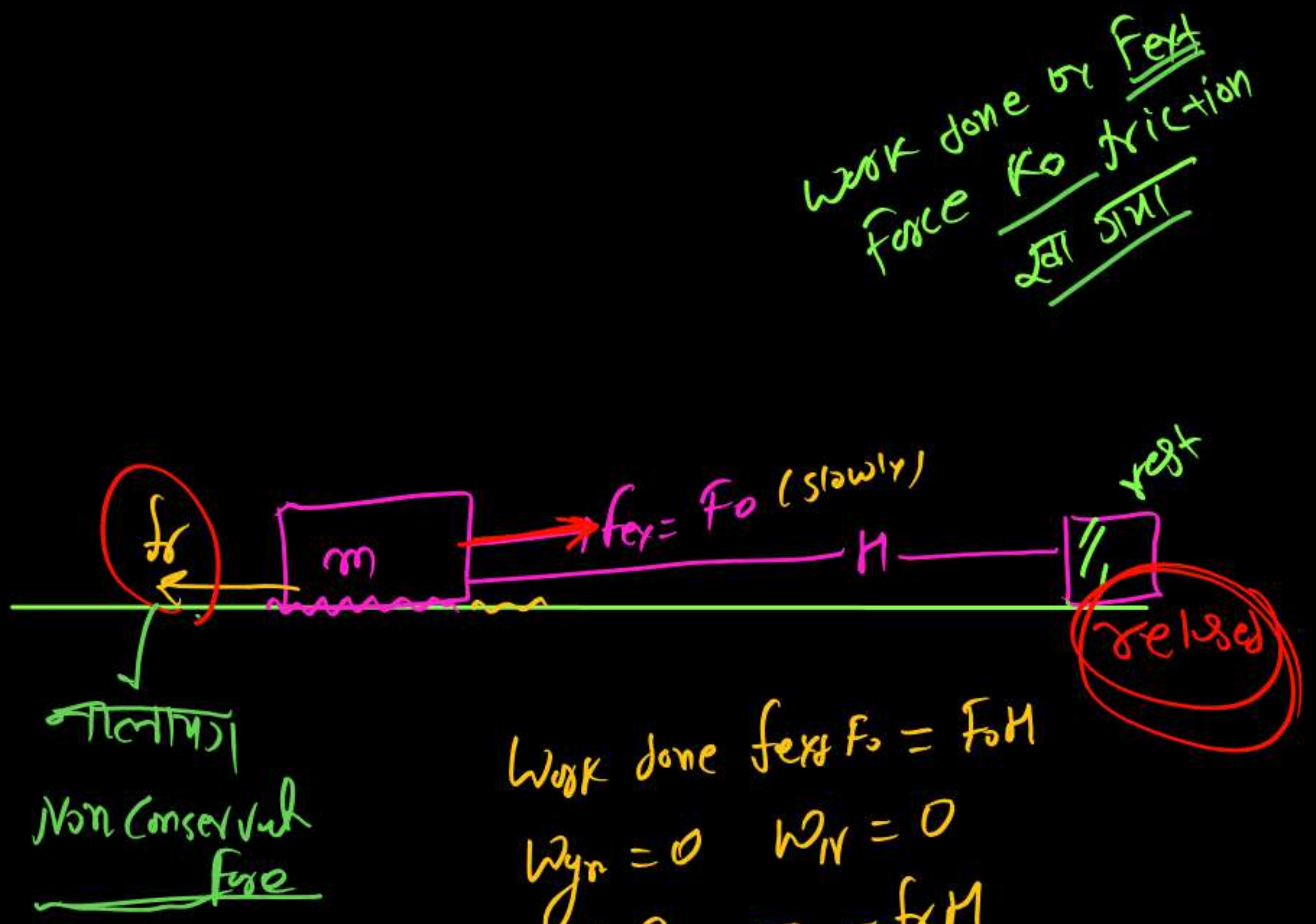
$W_{ext} = F_0 H$

$W_{grav} = -mgH$

$W_{Total} = \Delta K.E \to 0$

$W_{ext} + W_{gr} = 0$

$W_{ext_F} = -W_{gravit}$



Work done fext $F_0 = F_0 H$

$W_{gr} = 0 \quad W_N = 0$

$W_{fr} = -f_r H$

$W_{total} = \Delta KE$

$W_{ext} + W_{fric} = \Delta K.E$

$W_{extF} = -W_{friction}$

Conservation Force	Non Conservation Force
Work done does not depend on path. Ex.- Gravity, Electrostatic Force, Spring Force.	Work done depends on path taken. Ex.- Friction, Normal Force, Tension.
Potential Energy should due to negative work done by Conservation Force.	Potential Energy is not defined for Non- Conservation Force.
Work done by C.F. is reversible.	Work done by N.C.F. is non-reversible.
Work done in close loop is zero.	Work done in close loop may or may not be zero.


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 05 | **Physics**

Work, Energy and Power

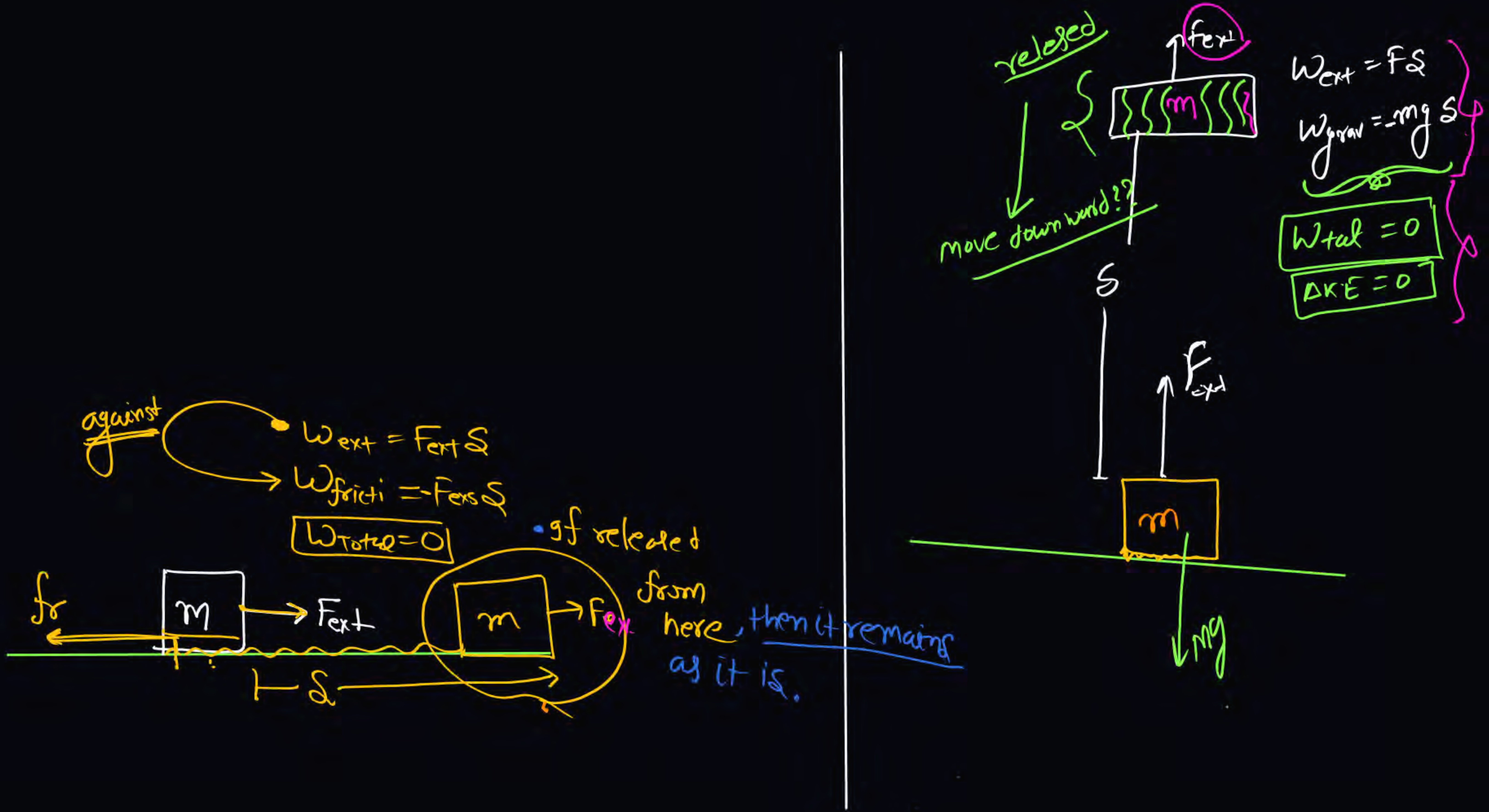


By- Dr. Manish Raj (MR SIR)

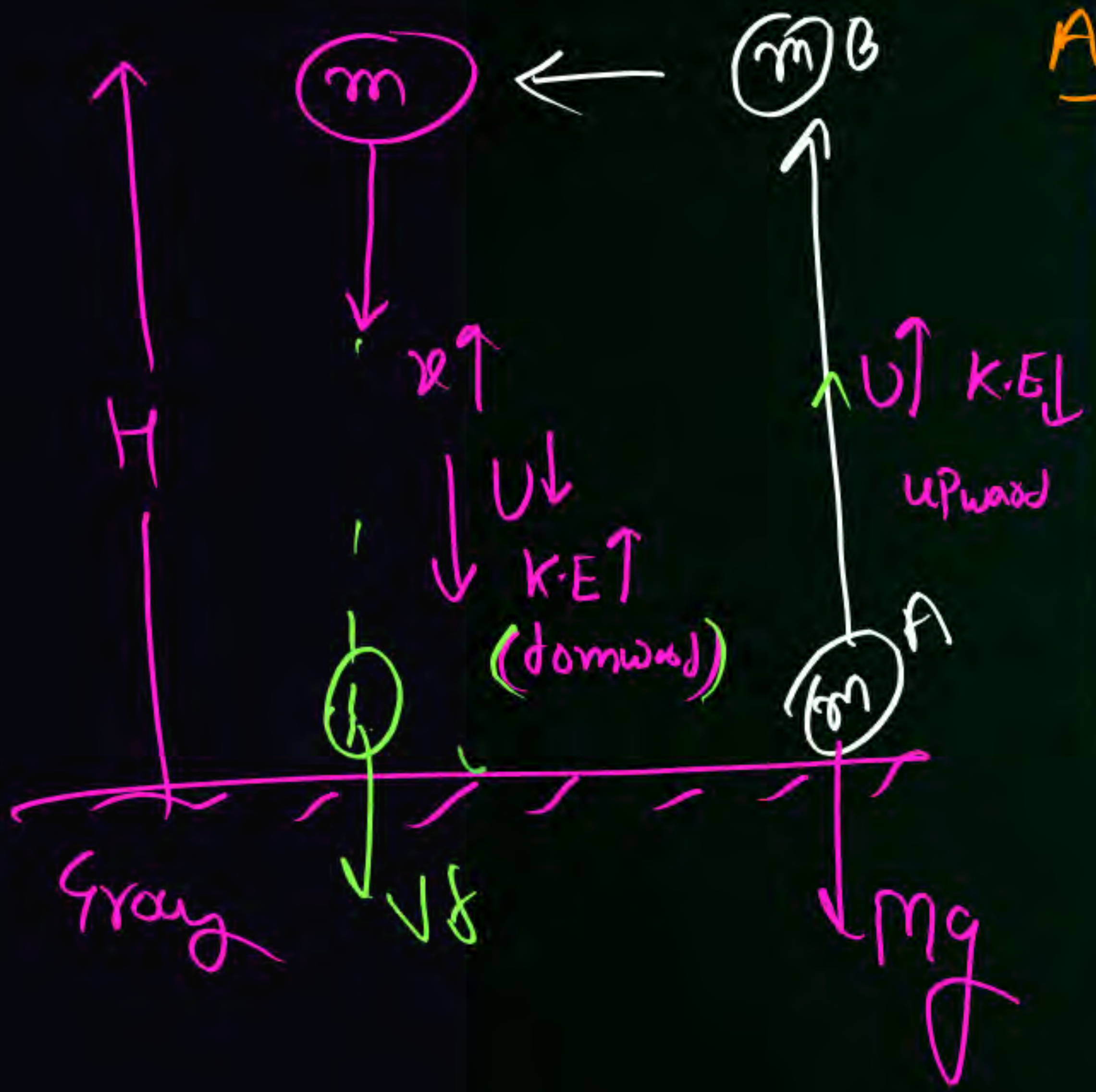
Topics to be covered

1. # Concept of Potential energy.
2. # Conservative & Non-conservative force
3. # Conservation of mechanical energy
4. #




against
W ext = Fext S
W fricti = -Fext S
W Total = 0
• gf released
from here, then it remains as it is.
fr
m
Fext
m
Fex
S
released
fext
m
move downward??
S
W ext = FS
W grav = -mg S
W total = 0
ΔK.E = 0
Fext
m
mg

one object of mass 'm' is released from Height 'H', then why it moves downwards with increasing speed ??



Ans →

Explanation - 1	Explanation - 2
Work done by gravity will increase its KE.	Potential energy is stored; when it move from A to B P.E.↑ and K.E.↓.
Wg = mgh = ΔK.E.	U(loss)→ K.E.(gain) (when moves downwards)

Based on work energy theorem ✓

gravitation

–ve work done by gravitational force stored as a energy in the object

→ Conservative force

$$\Delta U = -W_{\text{conservative force}}$$

ΔU — change in Potential energy



→ Not a new P.Q it is Just a name given to –ve work done by Conservative force

→ ✗ Potential energy is not a P.Q
it is not defined. always ΔU is a defined.

friction

→ decipative force

→ work done by friction can't stroed as a energy. Complity loss in form of heat.

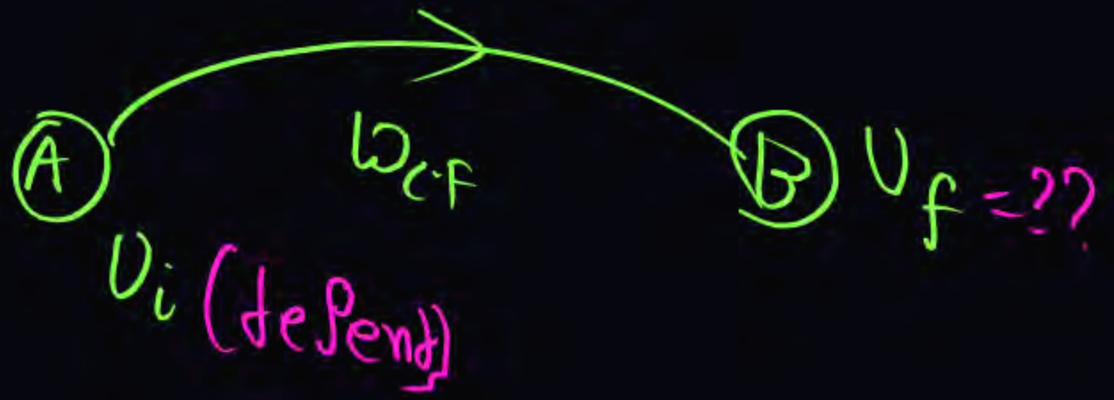
→ Non-Conservative force

Potential energy at a Point does not have unique value may be anything depends on refrence Point

$$\Delta U = -W_{CF}$$

$$U_f - U_i = -W_{C.F}$$

depends



- **Change in PE is just a name given to negative work done by CF.** → Yes

Concept

$$\Delta U = -W_{C.F}$$

- Potential energy is not a physical quantity, it is not defined at a point. Value of potential energy is not a unique value it may be anything depending on reference point.
- Change in Potential Energy is defined.
- Change in Potential Energy does not depends on reference. Point.

Potential energy depends on ref^n.

formula

$$\Delta U = -W_{C.F.}$$

change in P.E.

MR Ratta

$$U_f - U_i = -W_{C.F}$$

feel आया Potential ref^n पे depend kyu करता है।

$$U_f = -W_{C.F} + U_i$$

dep

(1) why always change in Potential energy it defined why not only Potential energy is define =??

(2) why Potential energy depends on refrence Point.





Conservation Force	Non Conservation Force
Work done does not depend on path. Ex.- Gravity, Electrostatic Force, Spring Force.	Work done depends on path taken. Ex.- Friction, Normal Force, Tension.
Potential Energy should due to negative work done by Conservation Force. $\Delta U = -W_{C.F}$	Potential Energy is not defined for Non- Conservation Force.
Work done by C.F. is reversible.	Work done by N.C.F. is non-reversible.
Work done in close loop is zero.	Work done in close loop may or may not be zero.

Concept of potential energy only introduce due to conservative force.

QUESTION

Potential energy is defined

1. Only in conservative fields
2. As the negative of work done by conservative forces
3. As the negative of work done by external forces when $\Delta K = 0$
4. All of these



$$\Delta U = -W_{C.F}$$

-ve work done by C.F equal change in Potential energy

POTENTIAL ENERGY

- It is a energy stored due to shape, size and position.
- It depends on a reference point.
- It may be positive, negative and zero.
- It is a scaler quantity. (does not have dirn)
- It always decreases in every natural phenomena.



$U_1 = +5J$ → unstable system

$U_2 = -5J$ → Stable System

here $U_1 > U_2$ → True (a) (25%) / False (b) (72%)

+5N, −5N → value equal, dirn opposite

+ve, −ve dirn

$+Q_1$ $-Q_2$

$V = -ve$ ✓✓

F attractive

$+Q_1 \longleftrightarrow +Q_2$

$V = +ve$
unstable

F → repulsive force

generally

In every natural Phenomena [स्वतः हो रहा है]

$W_{ext} = 0$

→ Potential energy (↓)

$u \leftarrow e^+ \quad e^+ \rightarrow u$

moving away

$\Rightarrow U \downarrow$

$v \leftarrow e^+ \quad e^- \rightarrow u$

moving away

$U \uparrow$

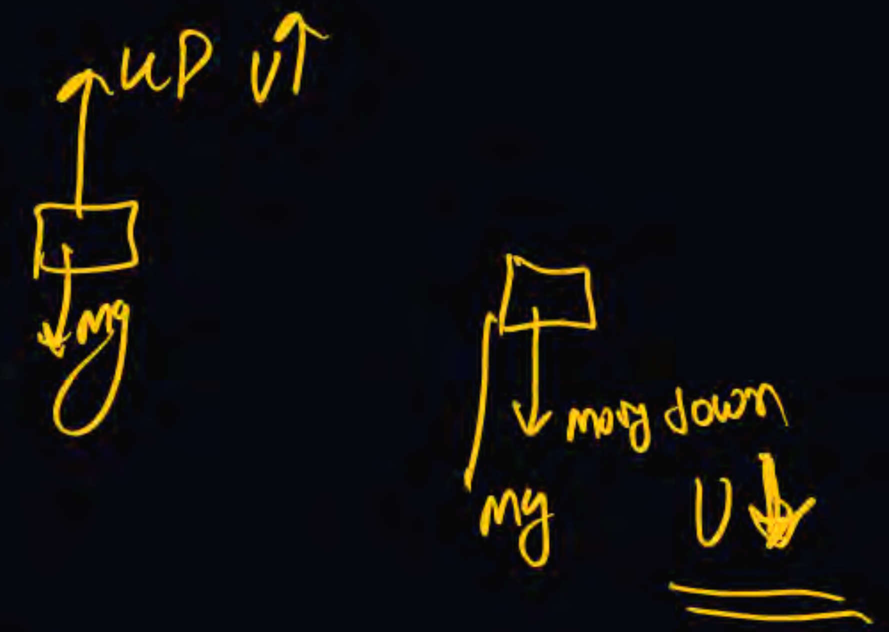
Wext form

$e^- \rightarrow u \quad u \leftarrow e^-$

moving towards each other

$(U \uparrow)$

$$\Delta U = -W_{c.f}$$



If $W_{c.f} = +ve$

$$U_f - U_i = -(W_{c.f})$$ (+ve)

$$U_f - U_i = -ve$$

$$U_f < U_i$$

$U\downarrow$ Potential energy ↓

If $W_{c.f} = -ve$

$$\Delta U = -W_{c.f}$$

$$U_f - U_i = -[-ve]$$

$$U_f - U_i = +ve$$

$$U_f > U_i$$

$U\uparrow$ increases

we know that

$\Rightarrow \Delta U = -W_{C.F}$

small chaye

$dU = -W_{C.F}$

$dU = -F_{C.F} \cdot dr$

$$\vec{F}_{C.F} = -\frac{dU}{dr}$$

→ Potential energy is Scalar



$\left(\frac{dU}{dr}\right)$ = Potential enery Veltor gradiant

$$\vec{F}_{C.F} = -\frac{dU}{dr}$$

$$\vec{F}_{gravi} = -\frac{dU}{dr}$$ ← gravitational potential energy

$$\vec{F}_{electrostatic} = -\frac{dU}{dr}$$ → electrostell potential energy

$$\vec{F}_{C.F} = -\frac{dU}{dr}\hat{r}$$

$$\vec{F}_{C.F} = -\left[\left(\frac{\partial U}{\partial x}\right)_{y,z} \hat{i} + \left(\frac{\partial U}{\partial y}\right)_{x,z} \hat{j} + \left(\frac{\partial U}{\partial z}\right)_{x,y} \hat{k}\right]$$

y, z Const^n

x, z = Const^n

x, y ⇒ Const^n

Partial diff^n

$$dU = -F \cdot dr$$

$$\int_{U_i}^{U_f} dU = -\int_{r_i}^{r_f} \vec{F}_{C.F} \cdot d\vec{r}$$

\# $$\boxed{\Delta U = -\int F_{C.F} \cdot dr}$$ *

Biyoyoyaya -

ek Bap tha har Law Ka

→ **Work energy theorem**

$W_{all\ force} = \Delta K.E$

→ Bap always valid. always applicable.

$W_{C.F} + W_{N.C.F} = \Delta K.E$

☆ If $W_{N.C.F} = 0$ (Work done by N.C.F is zero. N.C.F may be acting on the object or may not but $W_{N.C.F} = 0$ must)

$W_{C.F} + 0 = \Delta K.E$

$-\Delta U = \Delta K.E$

$\Delta U = -W_{C.F}$

$W_{C.F} = -\Delta U$

→ mother of laws

→ always valid.

$\Delta K.E + \Delta U = 0$

$\Delta (K.E + U) = 0$

$\Delta (M.E) = 0$

$M.E = C^{nt}$

$(K.E + U)_i = [K.E + U]_f$

→ Conservation of mechanical energy

(Beta) → only valid when $W_{N.C.F} = 0$

Bap of law

$$W_{all\ Force} = \Delta K.E$$

$$W_{C.F} = -\Delta U$$

mother is always

$$W_{C.F} + W_{N.C.F} = \Delta K.E$$

If $K.E = $ const^n, $\Delta K.E = 0$

Speed = const^n

$$W_{C.F} + W_{N.C.F} = 0$$

We put $W_{C.F} = -\Delta U$ (mother of law)

$$-\Delta U + W_{N.C.F} = 0$$

$$W_{N.C.F} = \Delta U$$

$$W_{N.C.F} = \Delta U$$

Beti of law

Not always valid

only valid when $K.E = $ const^n

N.C. force is against C.F

$W_m = \Delta U$

$W_{N.C.F} = \Delta U$

$W_{C.F} = -\Delta U$

$W_{ext F'}$ (Non-Conservtn) $= \Delta U = U_f - U_i$

K.E = Cont ✓

(1) Work done in bringing q charge Slowly from infinity to Point is Potential energy at that point ✓ ($V_{infinity} = 0$)

Both are correct

(2) -ve work done in bringing q charge from infinity to the point by electric field is called potential energy.

$-W_{C.F} = \Delta U$ ($V_{infinity} = 0$)

पहले

(a) Ratta tha

(b) Samjha tha

1. The potential energy U(x) of a particle moving long x-axis is given by $U(x) = ax - bx^2$. Find the equilibrium position of particle.

$F_{net} = 0$

$F = -\frac{dU}{dx}$

$F = -\left[\frac{d(ax - bx^2)}{dx}\right]$

$0 = a - b2x$

$a = 2bx$

$x = \left(\frac{a}{2b}\right)$

2. The potential energy of an object of mass m moving in xy-plane in a conservative field is given by $U = ax + by$, where x and y are position coordinates of the object. Find magnitude of its acceleration.

$a = F/m$

$|\vec{F}| = \frac{dU}{dx}\hat{i} + \frac{dU}{dy}\hat{j}$

$F_{\text{magnitude}} = \frac{d(ax+by)}{dx}\hat{i} + \frac{d(ax+by)}{dy}\hat{j}$

$F = (a+0)\hat{i} + (0+b)\hat{j}$

$F = a\hat{i} + b\hat{j}$

$|F| = \sqrt{a^2+b^2}$

$a = \frac{\sqrt{a^2+b^2}}{m}$ Ans

$|\vec{F}| = \left(\frac{dU}{dr}\right) = a+b$

$a = \left(\frac{a+b}{m}\right)$ Ans

(Wrong)

QUESTION

If potential energy $U = \left(\frac{a}{x^4} - \frac{b}{x^5}\right)$, then find x for which object will be in equilibrium.

$U = ax^{-4} - bx^{-5}$

$|F| = \frac{dU}{dx} = 0$

$|F| = \frac{d(ax^{-4} - bx^{-5})}{dx}$

$-4ax^{-5} + 5bx^{-6} = 0$

$5bx^{-6} = 4ax^{-5}$

$\frac{5b}{x \cdot x^5} = \frac{4a}{x^5}$

$x = \frac{5b}{4a}$

QUESTION

If potential energy $U = xy + yz + zx$, then find force at (1, 1, 1).

$$|F_x| = \left(\frac{dU}{dx}\right)_i = y + 0 + z = (y+z)\,\hat{i} = 2\hat{i}$$

$$F_y = \left(\frac{\partial U}{dy}\right)\hat{j} = (x+z)\,\hat{j} = 2\hat{j}$$

$$F_z = \left(\frac{dU}{dz}\right)\hat{k} = (y+x)\,\hat{k} = 2\hat{k}$$

$2\sqrt{3}$ Ans

QUESTION

If work done by C.F. to move the object from A to B is 50 J then find potential energy at A if $U_B = -20$ J.

1. 30 J
2. - 30 J
3. 70 J
4. - 70 J

QUESTION

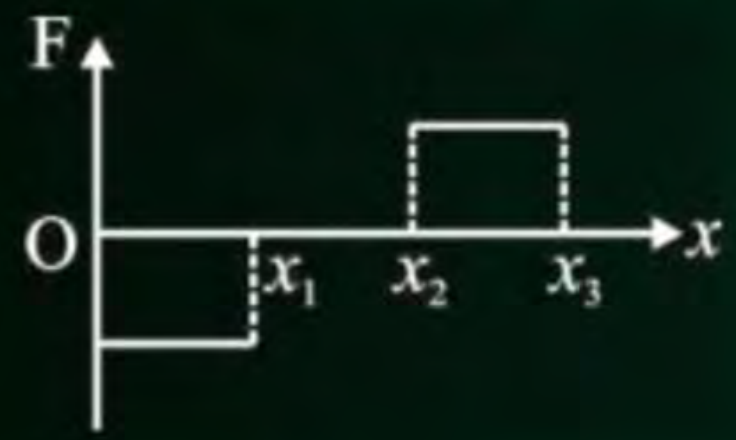
If work done by C.F. is –30 J in moving from A to B if potential energy at A is 30 J then find potential energy at B.

1. 60 J
2. -60J
3. 0
4. 30 J

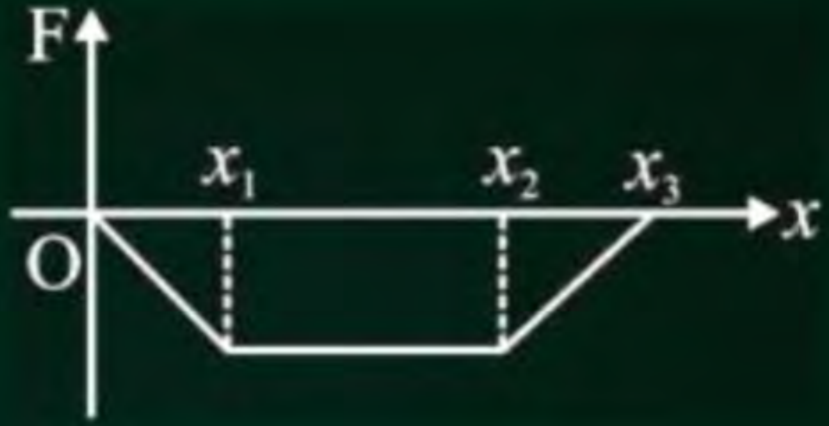
QUESTION

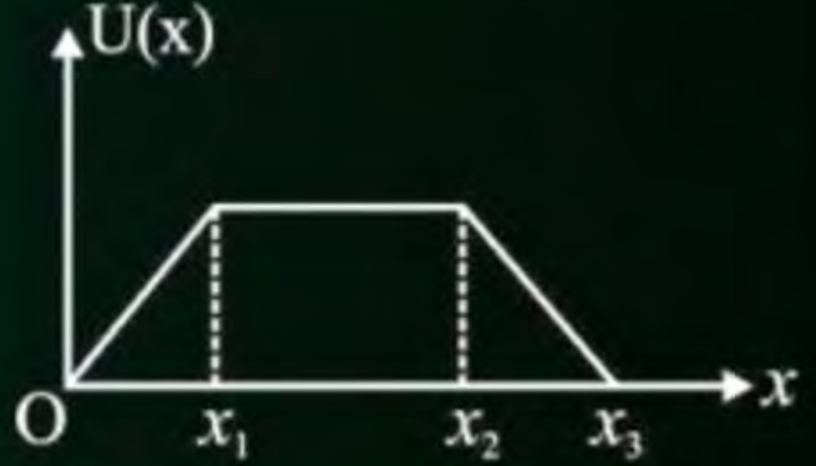
The variation of potential energy U of a system is show in figure. The force acting on the system is best represented by

(1)

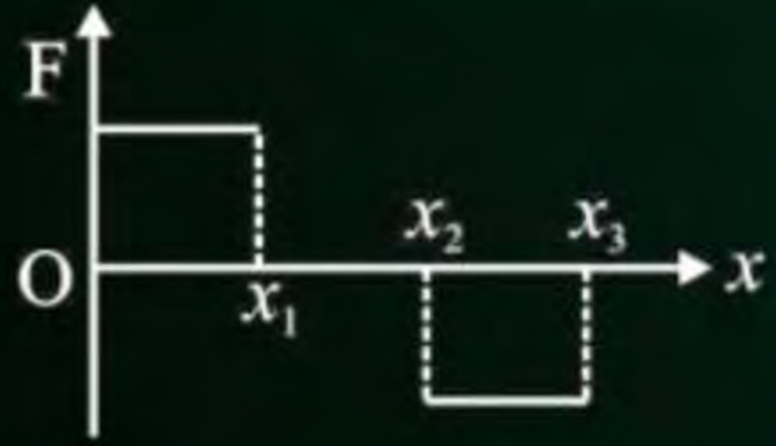


(2)

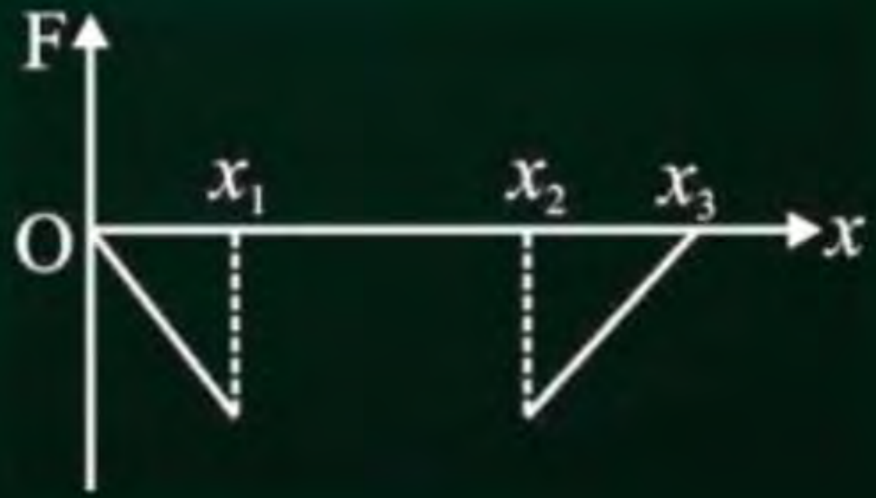




(3)



(4)



QUESTION

Work done in bringing object from A to B slowly is 40 J, then find potential energy at B if $V_A = -30$ J.

GRAVITATIONAL POTENTIAL ENERGY

WORK DONE BY GRAVITATION FIELD ONLY POTENTIAL



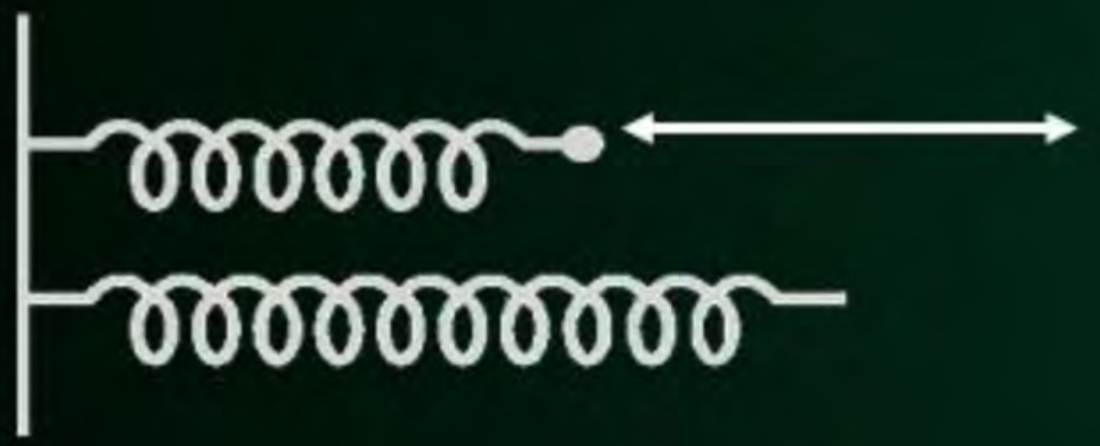
QUESTION

One third part of chain is hanging then find work to put back the hanging part (slowly).

QUESTION

A chain is on a frictionless table with one fifth of its length hanging over the edge. If the chain has length L and mass M, the work required to be done to pull the hanging part back onto the table is

WORK DONE BY SPRING FORCE AND POTENTIAL ENERGY



STORED POTENTIAL ENERGY AT ELONGATION / COMMPERSION

QUESTION

Force constants K_1 and K_2 of two springs are in the ratio 5 : 4. They are stretched by same length. If potential energy stored in one spring is 25 J then potential energy stored in second spring is

1. 25 J
2. 16 J
3. 100 J
4. 20 J

QUESTION

Two springs have their force constants in the ratio of 3 : 4. Both the springs are stretched by applying equal force F. If elongation in first spring is x then elongation in second spring is

1. $3x$
2. $4x$
3. $\frac{4}{3}x$
4. $\frac{3}{4}x$

QUESTION

A spring with spring constants k when compressed by 1 cm, the potential energy stored is U. If it is further compressed by 3 cm, then change in its potential energy is

1. 3 U
2. 9 U
3. 8 U
4. 15 U

QUESTION

Two similar springs P and Q have spring constants K_P and K_Q such that $K_P > K_Q$. They stretched first by the same amount (case a), then by the same force (case b). The work done by the springs W_P and W_Q are related as in case (a) and case (b), respectively

1. $W_P < W_Q$; $W_Q < W_P$

2. $W_P = W_Q$; $W_P = W_Q$

3. $W_P = W_Q$; $W_P > W_Q$

4. $W_P > W_Q$; $W_Q > W_P$

QUESTION

A block of mass m moving with velocity v_0 on a smooth horizontal surface hits the spring of constant k as shown. The maximum compression in spring is



QUESTION

A chain of mass M length L placed on table then find speed of chain when it becomes vertical.


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 06 | Physics

Work, Energy and Power

By- Dr. Manish Raj (MR SIR)



Todays Goal

Gravitational Potential energy → details Gravitational

Spring Potential energy

electrostatic Potential → only formul.

C.O.M.E ⇒ Conservation of mechanical energy

QUESTION

If work done by C.F. to move the object from A to B is 50 J then find potential energy at A if $U_B = -20$ J.

1. 30 J (Ans)
2. - 30 J
3. 70 J
4. - 70 J (Wrong)

$-W_{C.F} = \Delta U$

$W_{C.F.} = -\Delta U$

$-50J = U_B - U_A$

$-50 = -20 - U_A$

$U_A = 50 - 20$

$= 30J$

Ans



QUESTION

If work done by C.F. is –30 J in moving from A to B if potential energy at A is 30 J then find potential energy at B.

(1) 60 J ✓

(2) -60J

(3) 0 ✗

(4) 30 J

$W_{C.F} = -30J$

$A \longrightarrow B$

$U_A = 30J \qquad U_B = ??$

$-W_{C.F} = \Delta U$

$-(-30) = U_f - U_A$

$30 = U_B - 30J$

$U_B = 60J$

$W_{ext} = \Delta U$

$W_{C.F} = -\Delta U$

QUESTION

Work done in bringing object from A to B slowly is 40 J, then find potential energy at B if $U_A = -30$ J.

Sol^n A ⟶ B

$W_{ext} = \Delta U$

$40J = U_f - U_i$

$40J = U_B - (-30)$

$40 - 30 = U_B$

$U_B = 10J$ Ans

$W_{ext} = \Delta U$

$40 = U_B - U_A$

$U_B = 40 + U_A$

$= 40 - 30$

$= 10J$

(Q) work done in bring object from B to A is −30J if Potential at A is −20J ten find Potential at B.

(B: initial, A: final)

Sol^n

(a) 10J (54%) ✓

(b) 50J

(c) −50J (25%)

(d) −10J

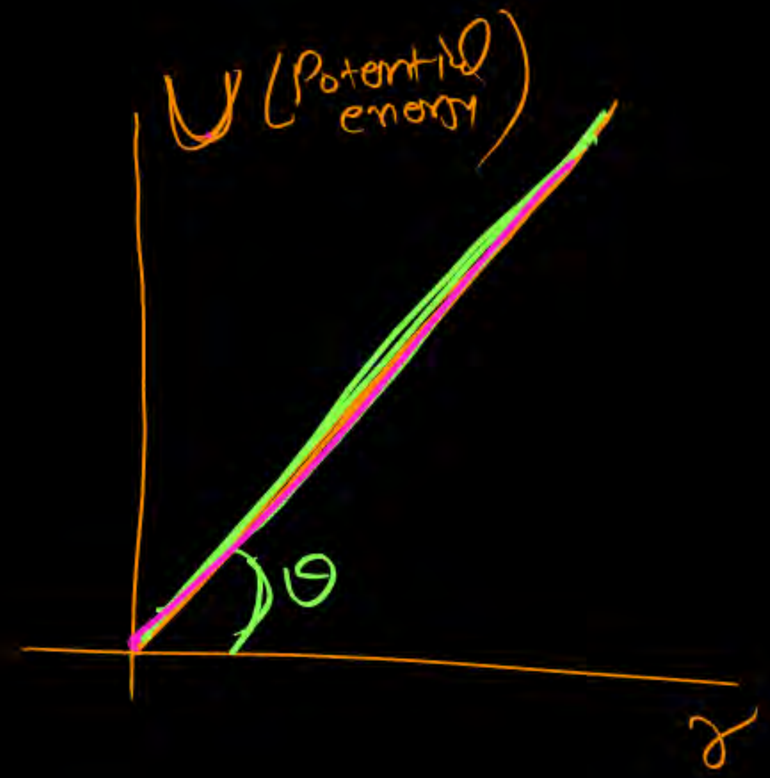
B ⟶ A (final)

$W_{ext F} = V_A - V_B$

$-30J = -20 - V_B$

$V_B = -20 + 30$

$= 10J$

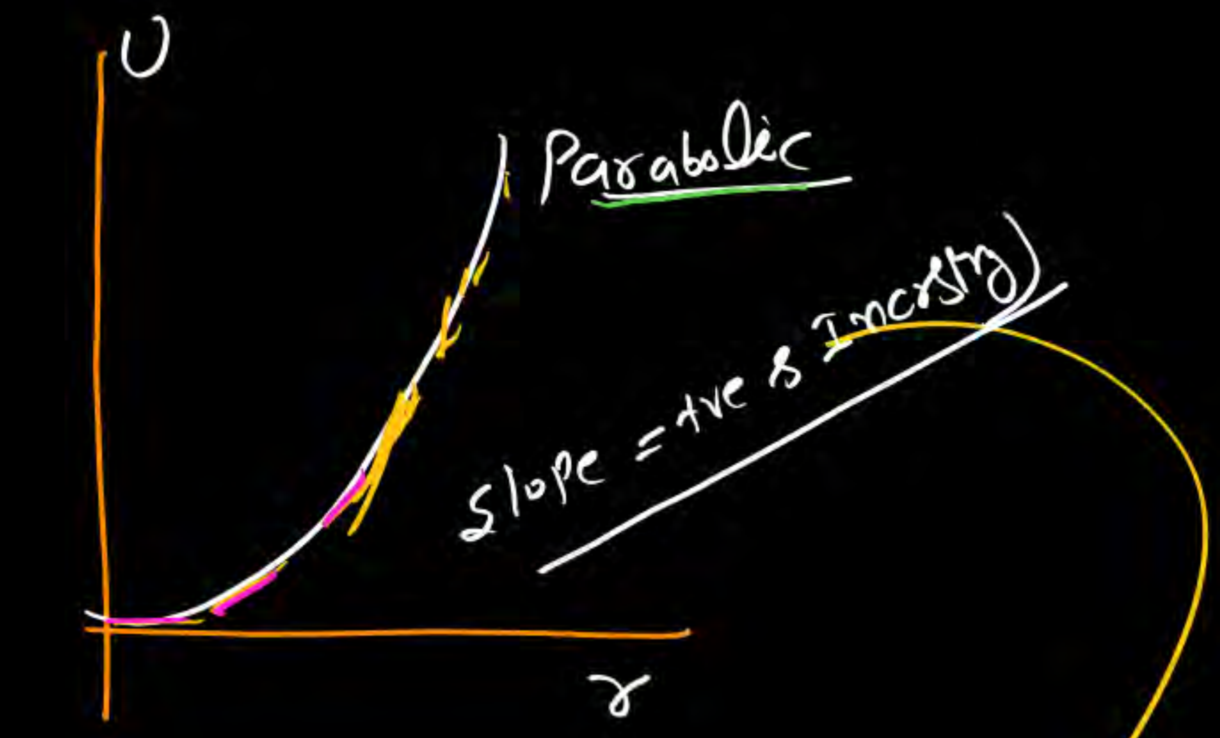


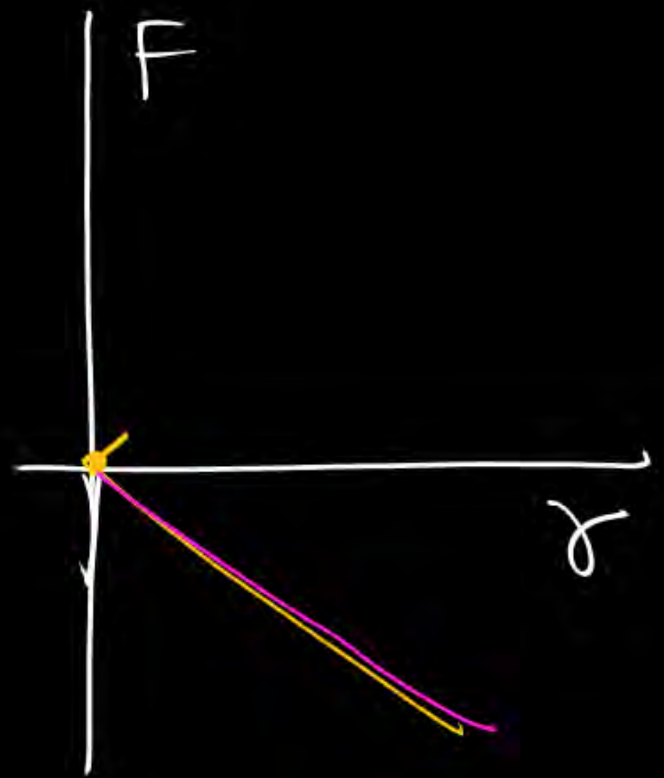


$$\vec{F} = -\frac{dU}{dr} = -\text{Slope of U/r graph}$$

$$\vec{F} = -(\text{+ve const})$$

$$0 \times 100\% = 0$$



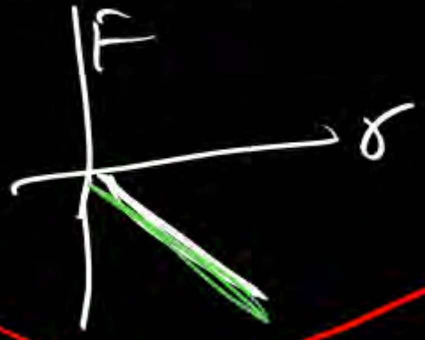


2nd metod

$U \propto r^2 \rightarrow F = -\frac{dU}{dr} = -\frac{dr^2}{dr}$

graph से परवलय

$\therefore \boxed{F = -2r}$



$\vec{F} = -\left[\frac{\partial U}{\partial r}\right]$ → slope of U/r grap

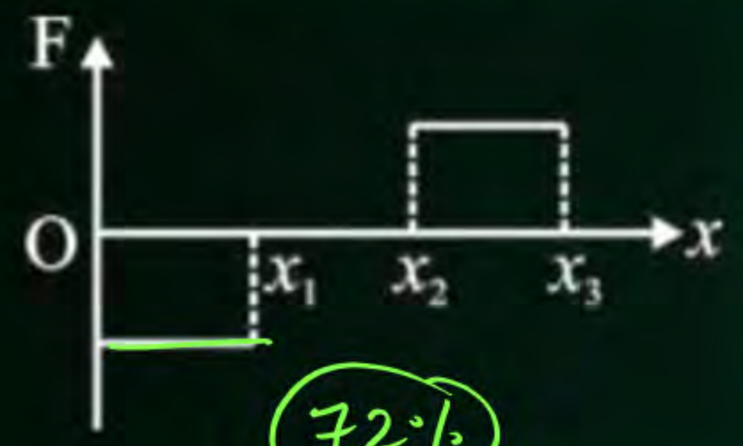
$\vec{F} = -ve$ [slope of U/r grap)

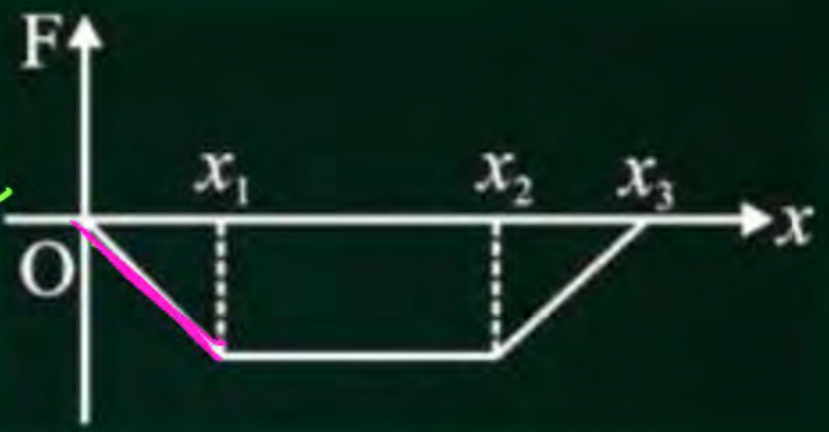
$= -$ [+ve & Incrsing)

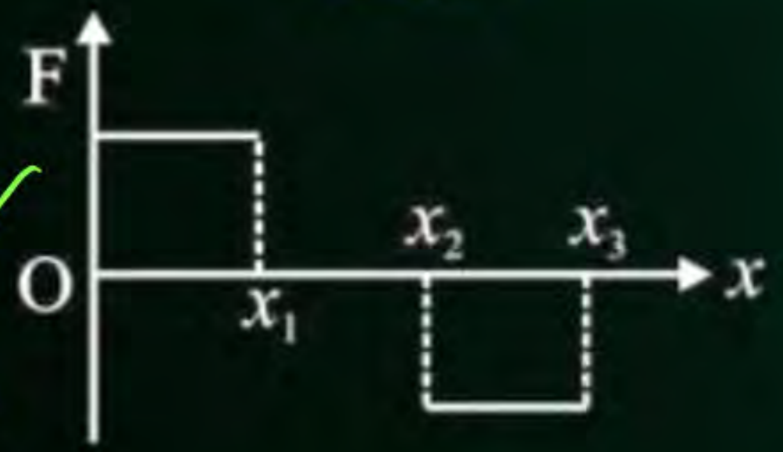
$\vec{F} = -ve$ Incrsiy

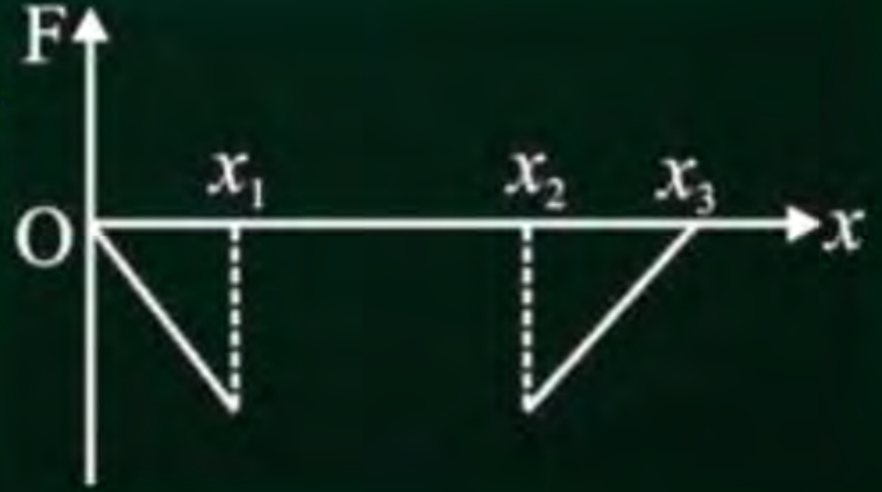
QUESTION

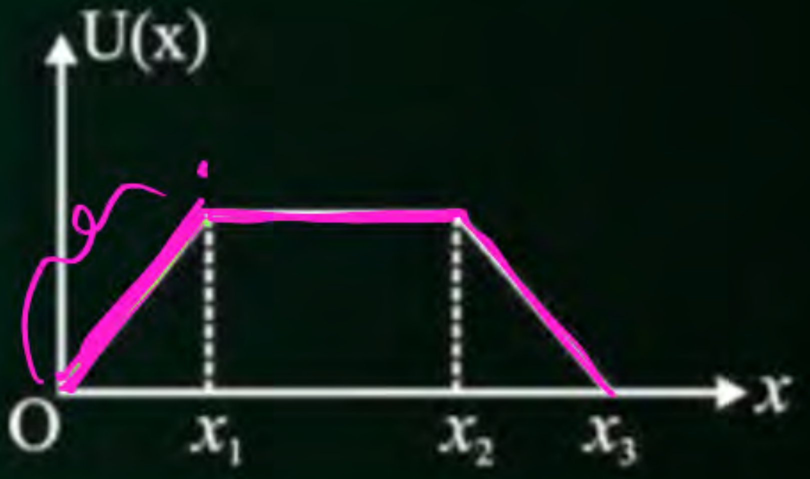
The variation of potential energy U of a system is show in figure. The force acting on the system is best represented by

1. 

2. 

3. 

4. 



Gravitational Potential energy

$-W_{c.f} = \Delta U$

$-W_{c.f} = U_f - U_i$



$-(-mgH) = U_B - U_A$

$mgH = (U_B - U_A)$

ref^n if ⇒ $U_A = 0$



$\Delta U = -W_{c.f}$

$U_A - U_B = -mgH$

$mgH = [U_B - U_A]$

#Change in (P.E) b/w A to B = mgH

$\Delta U = (U_B - U_A) = mgH$

If $U_A = 0$

$U_B = mgH$ ✗

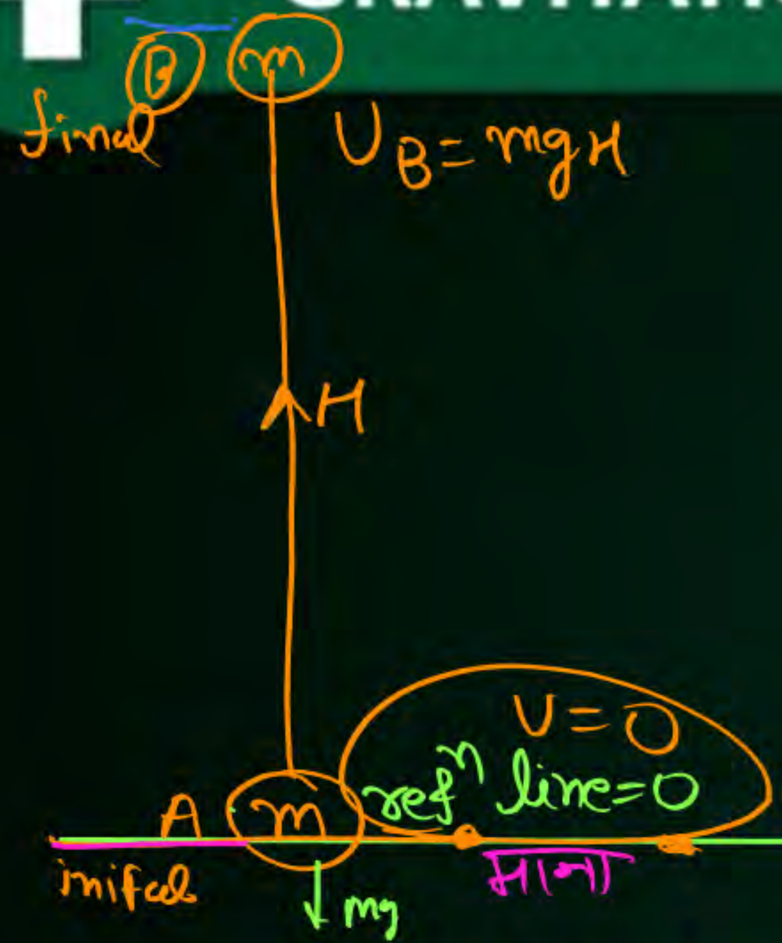
If $U_A = 10J$

$U_B - 10 = mgH$

$U_B = mgH + 10$

$\Delta U = U_B - U_A = mgH$

GRAVITATIONAL POTENTIAL ENERGY

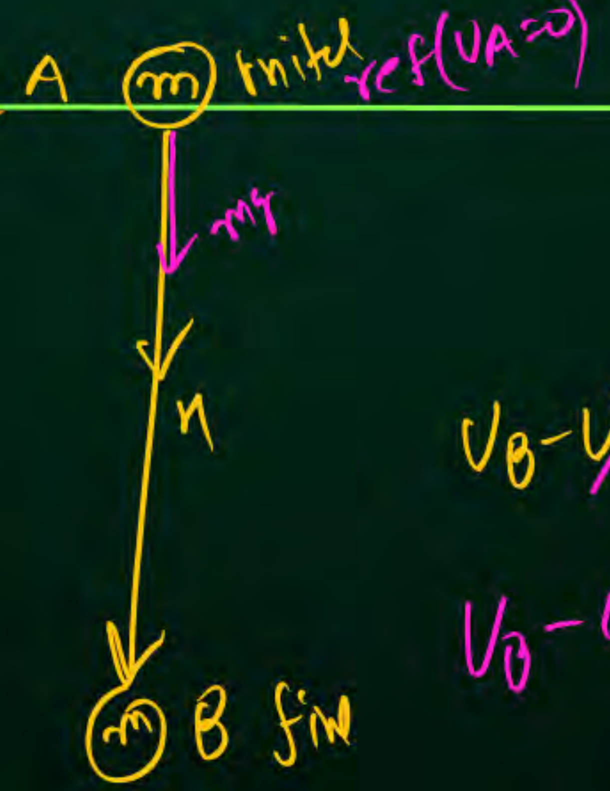


$-W_{C.F} = \Delta U$ (formula)

$-(-mgH) = U_B - U_A$

$+mgH = U_B - U_A$ ($U_A = 0$)

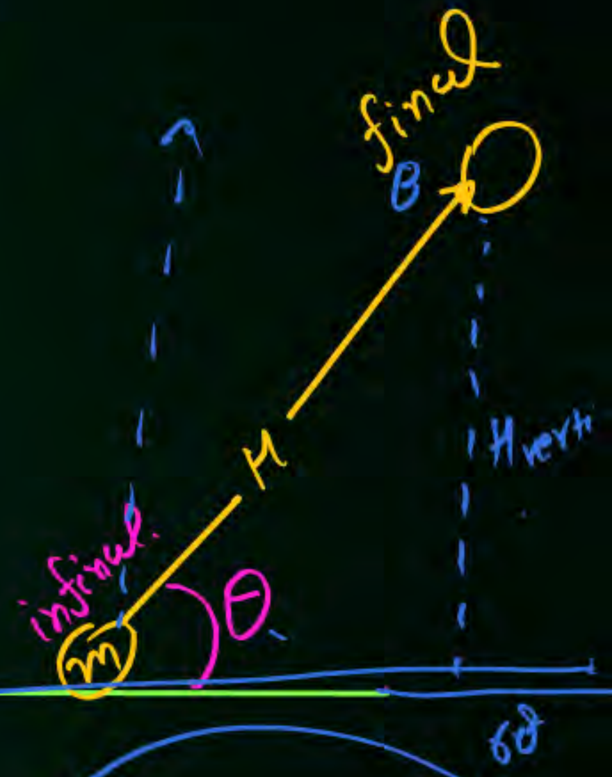
$U_B = mgH$



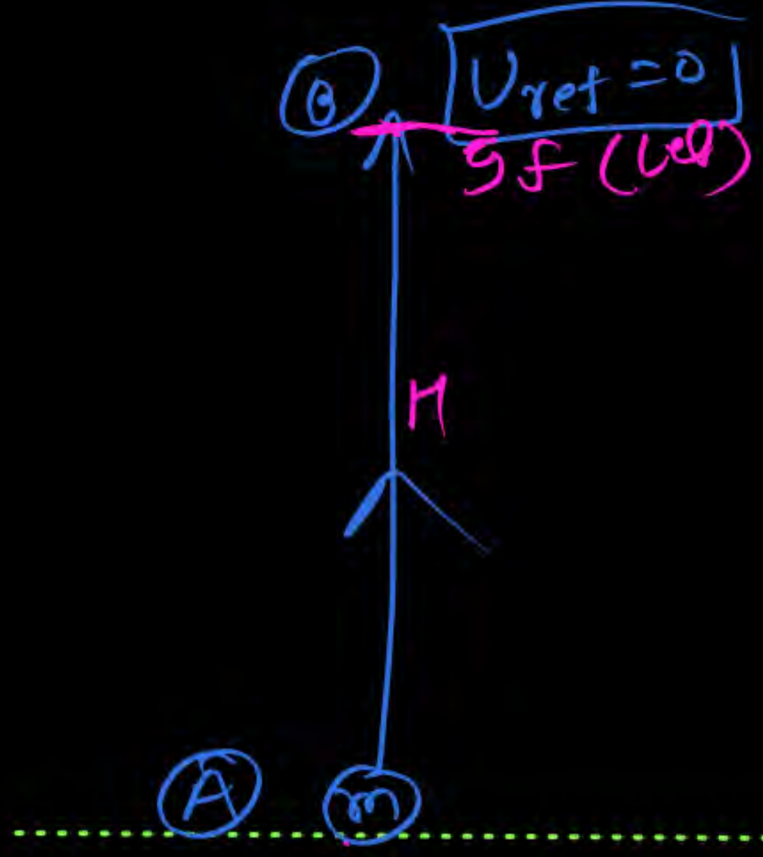
$U_B - U_A = -W_{C.F}$ (formula) ($U_A = 0$)

$U_B - 0 = -(mgH)$

$U_B = -mgH$



$U_B = mgH\sin\theta$



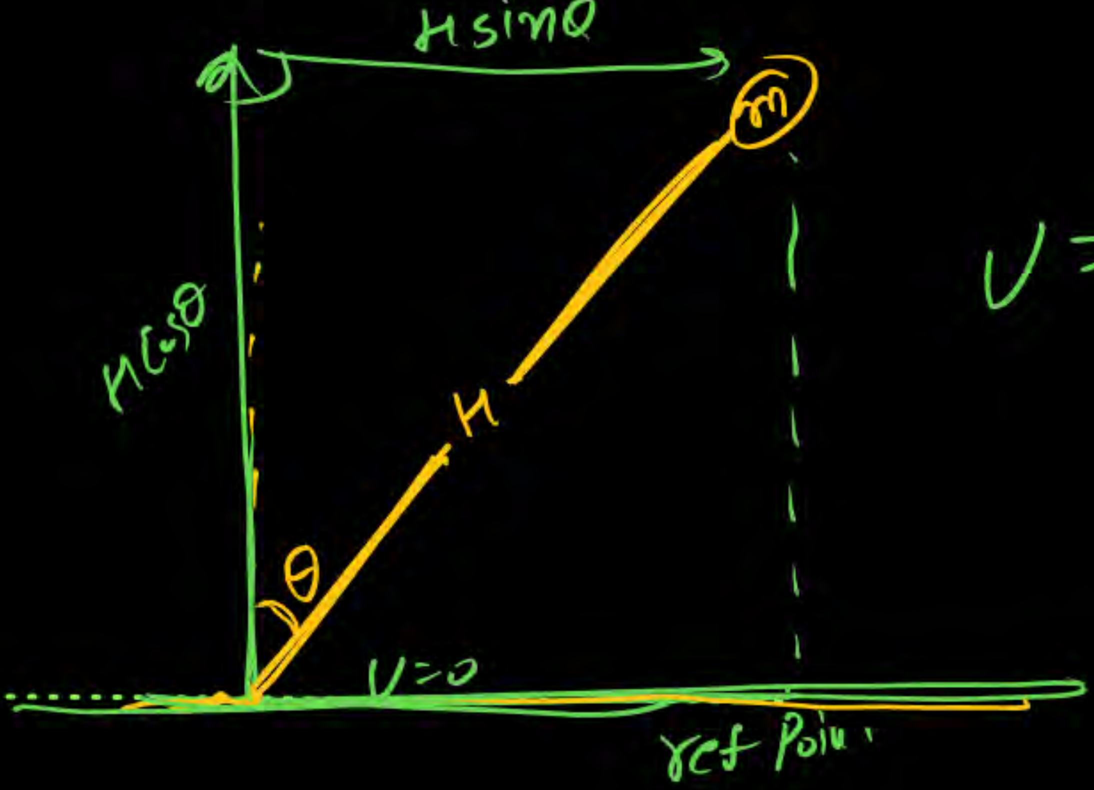
$U_A = ??$

$-W_{c.m} = \Delta U$ (formula)

$-[-mgH] = U_B - U_A$ (with $U_B = 0$)

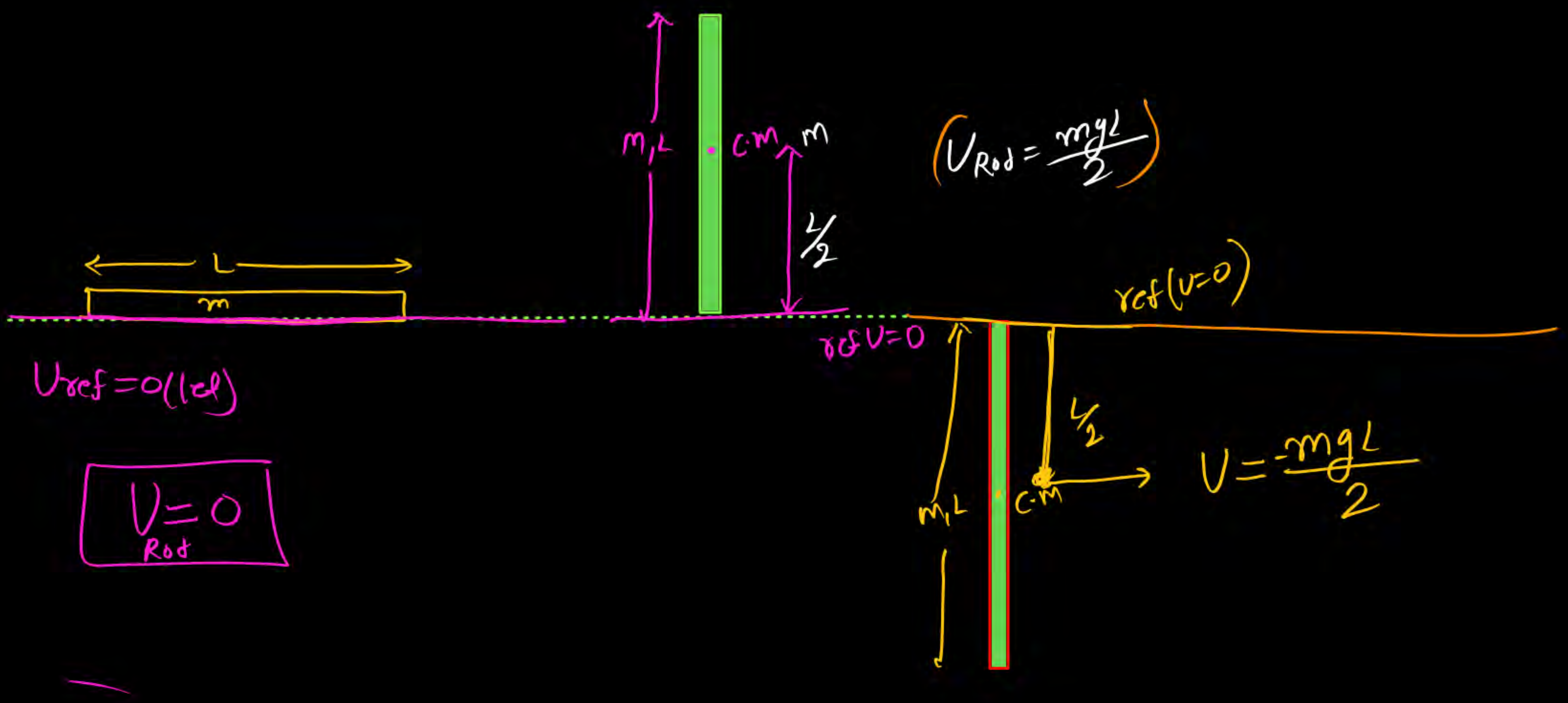
$mgH = -U_A$

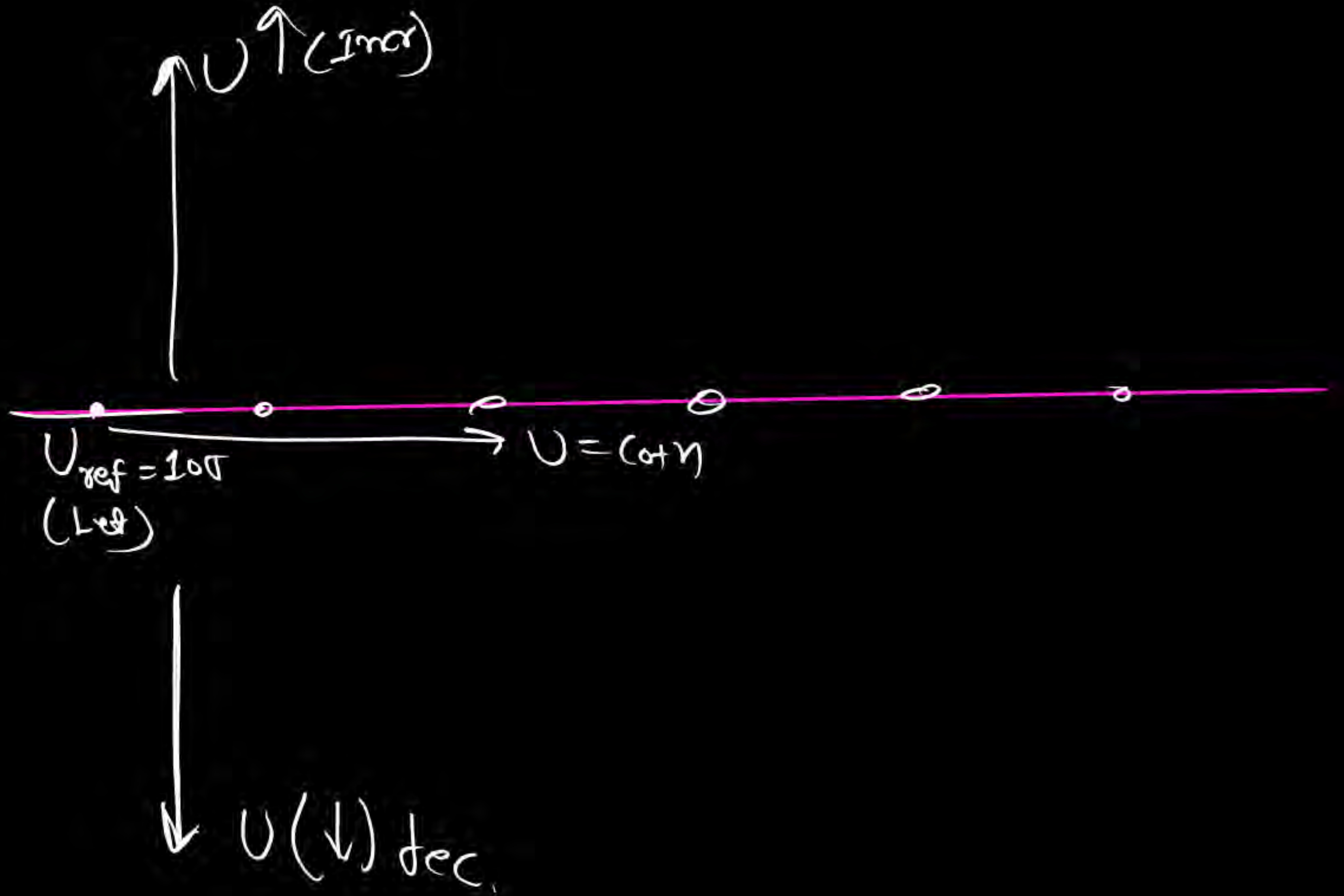
$U_A = -mgH$

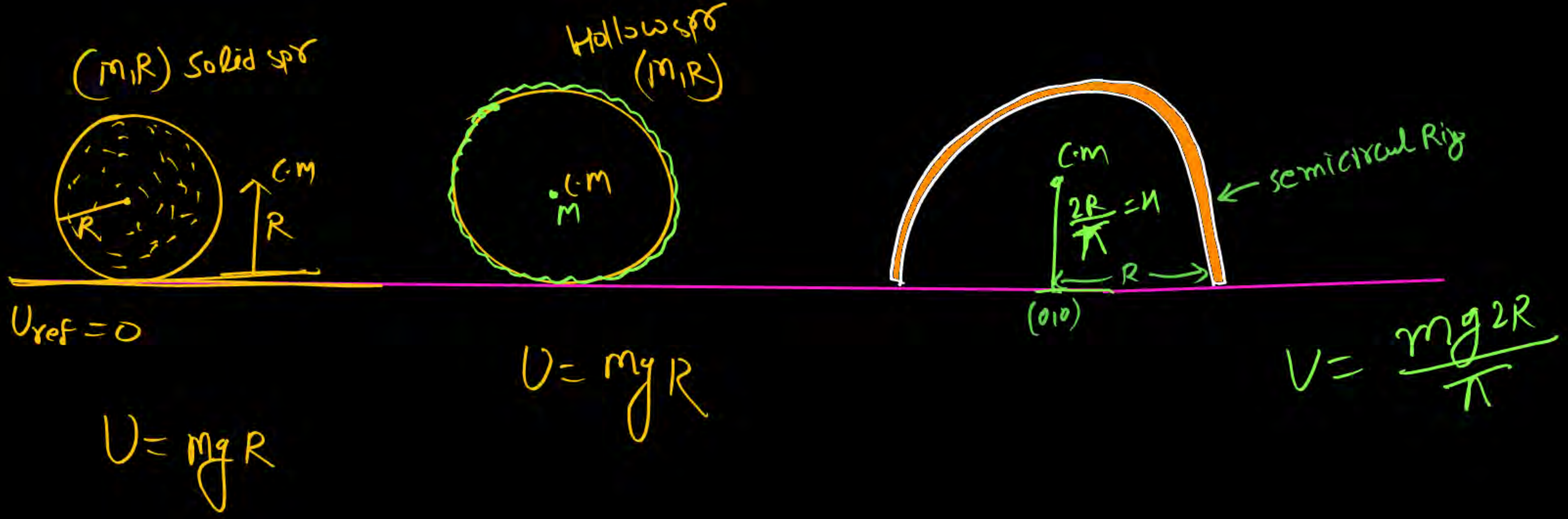


$U = mgH\cos\theta$ ✓

Potential energy of continous object.

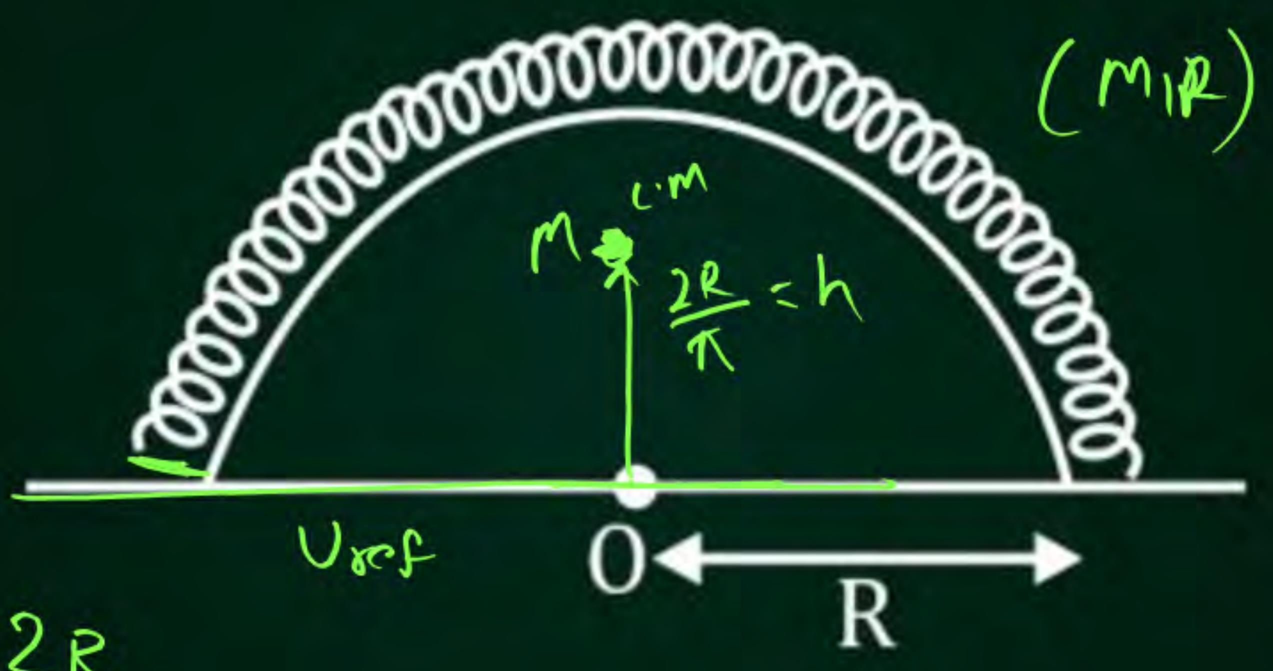



U ↑ (Incr)
U_ref = 10V
(Let)
U = Cont
U (↓) dec.

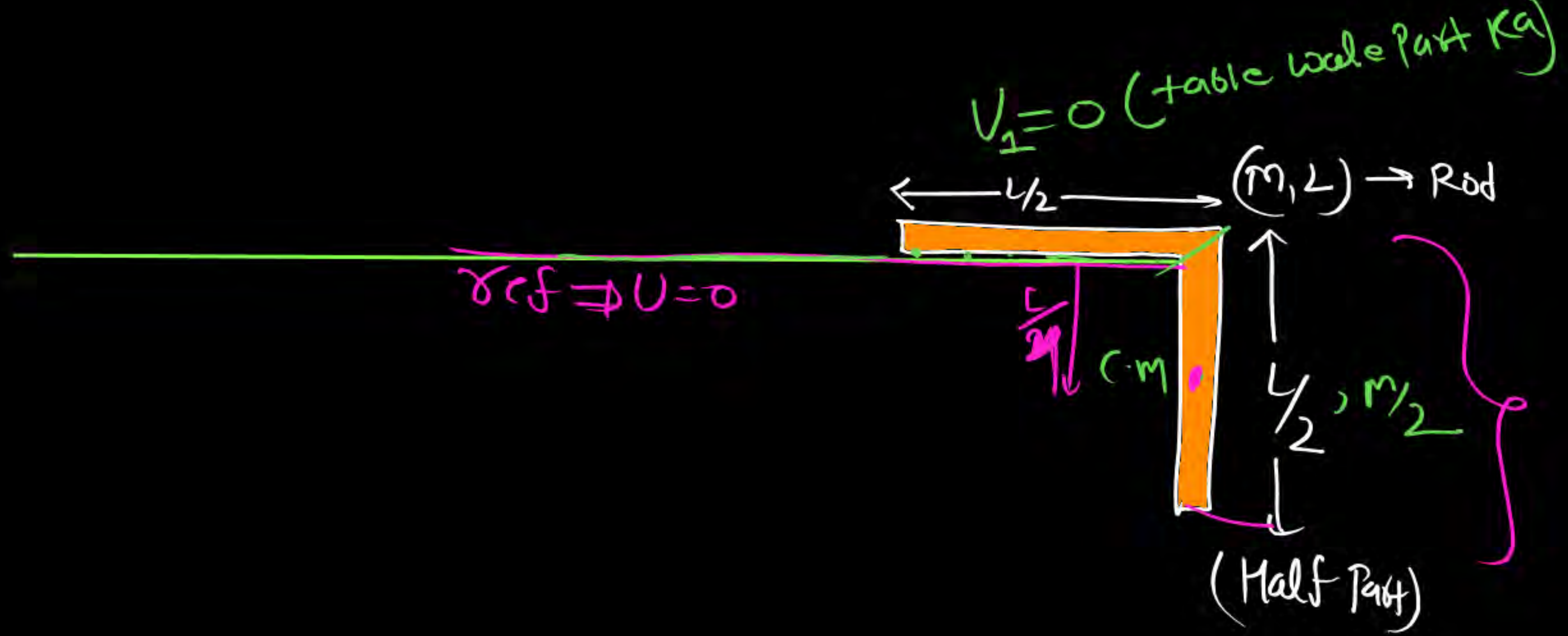

(M,R) Solid spr
C.M
R
R
U_ref = 0
U = mgR
Hollow spr
(M,R)
C.M
M
U = mgR
C.M
2R/π = h
R
(0,0)
semicircal Rig
V = mg2R/π

QUESTION

Find potential energy of chain of mass M placed on hemispherical surface.



$U = \frac{mg\,2R}{\pi}$

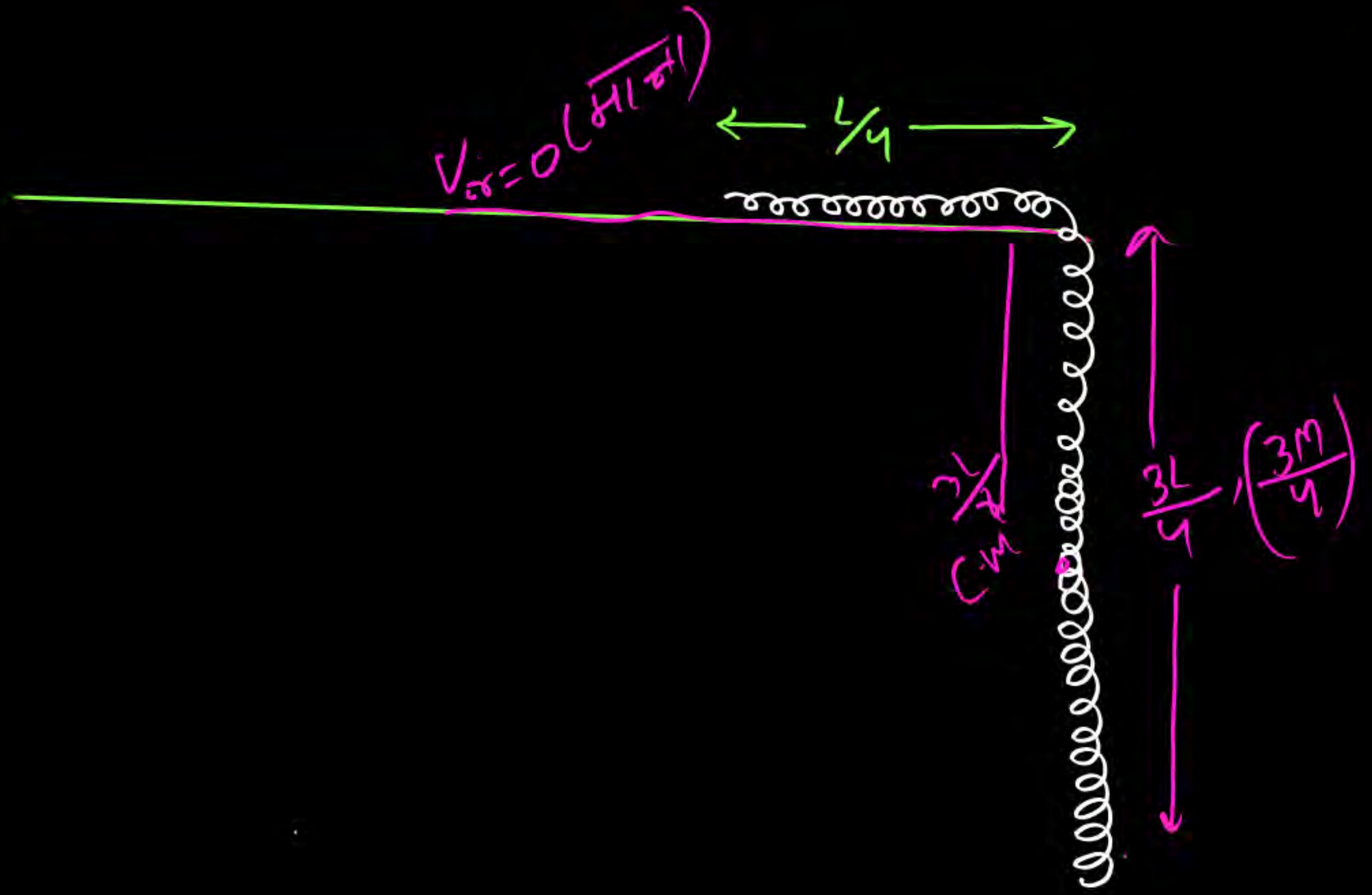


$$U = U_1 + U_2$$

$$= 0 - \frac{mgL}{2 \times 4}$$

$$= -\frac{mgL}{8}$$

Chain (M, L)



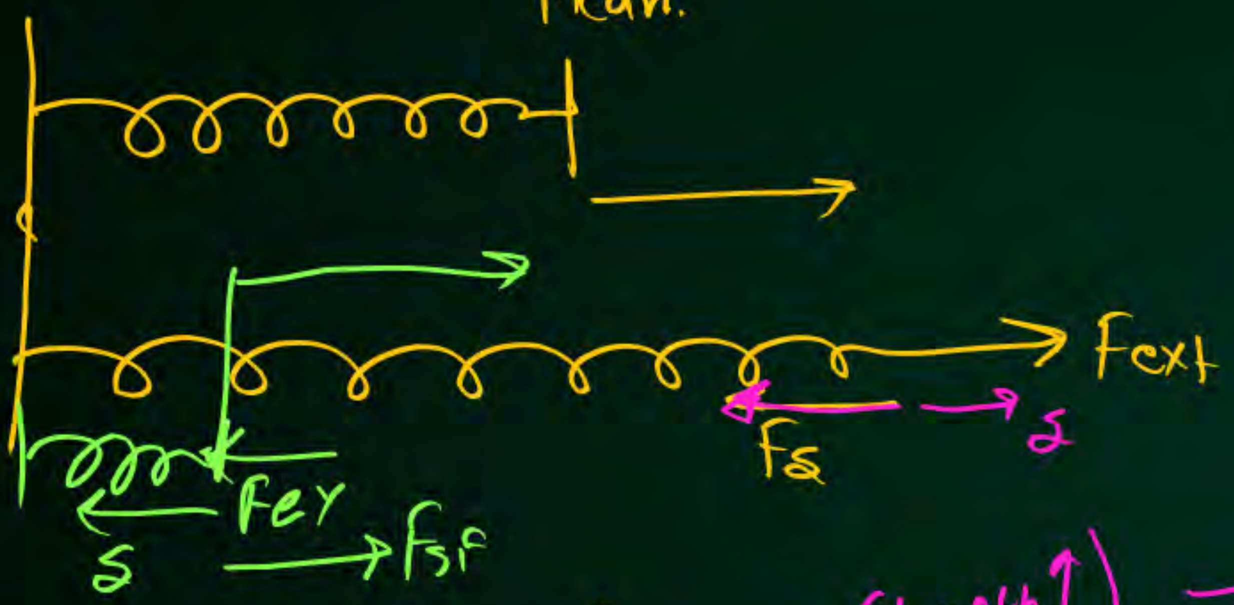
Sol^n

Jo table Hai

$$U = 0 - \frac{3Mg}{4}\left(\frac{3L}{8}\right)$$

$$\boxed{U = -\frac{9MgL}{32}}$$

STORED POTENTIAL ENERGY AT ELONGATION / COMMPERSION



Spring force always acts towards mean

$W_{s.f} = -\frac{1}{2}k[x_2^2 - x_1^2]$ ($x_1 \to x_2$)

$-W_{s.f} = \Delta U$

$+\left[+\frac{1}{2}k[x_2^2 - x_1^2]\right]_{x_1 \to x_2} = U_2 - U_1$

$\frac{1}{2}k[x_2^2 - x_1^2] = U_2 - U_1$ ($U_1 = 0$)

if $x_1 = 0$ (mean) $U_1 = 0$ (ref)

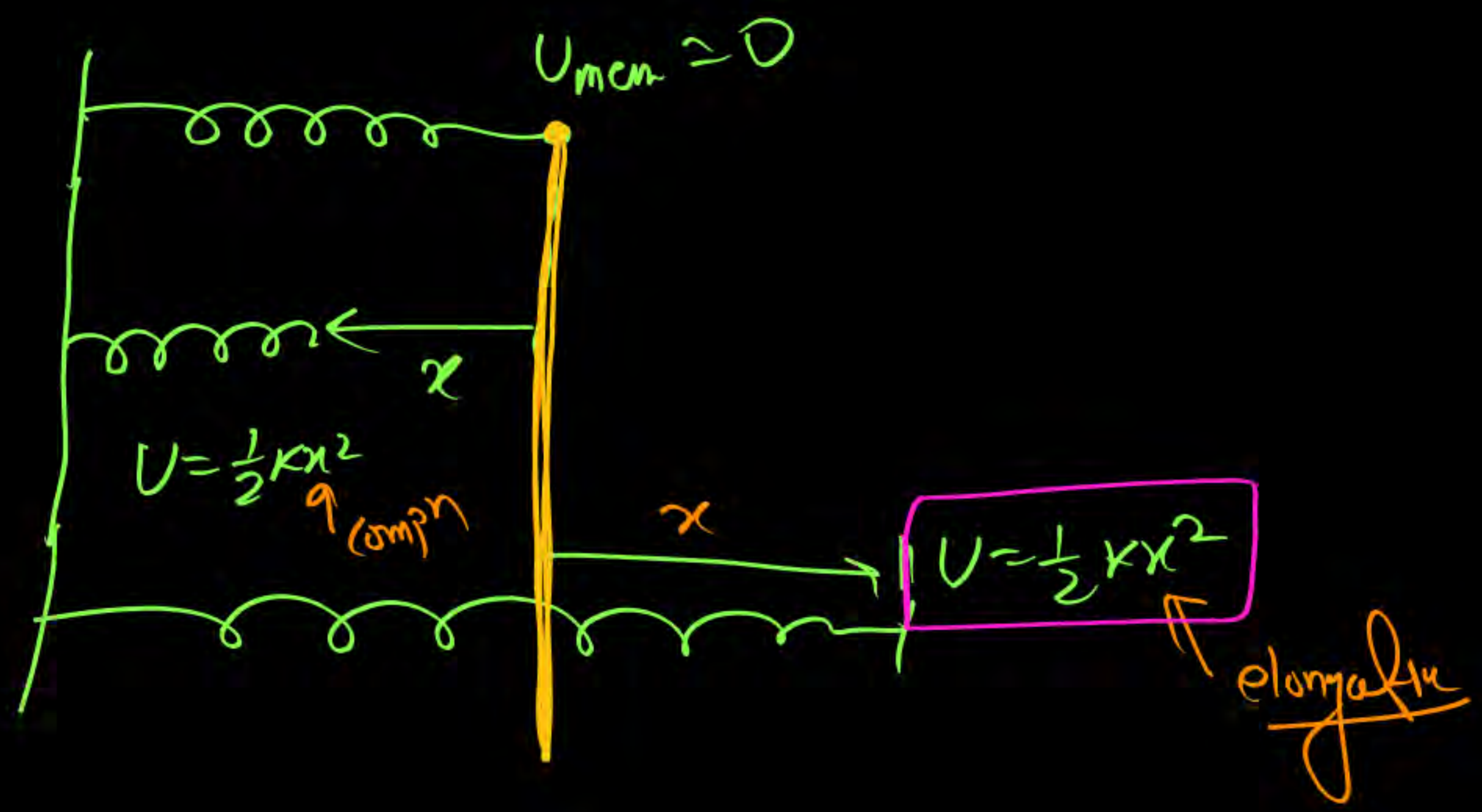
$U_x = \frac{1}{2}kx^2$

Work done by S.F in elongation → (length↑) −ve

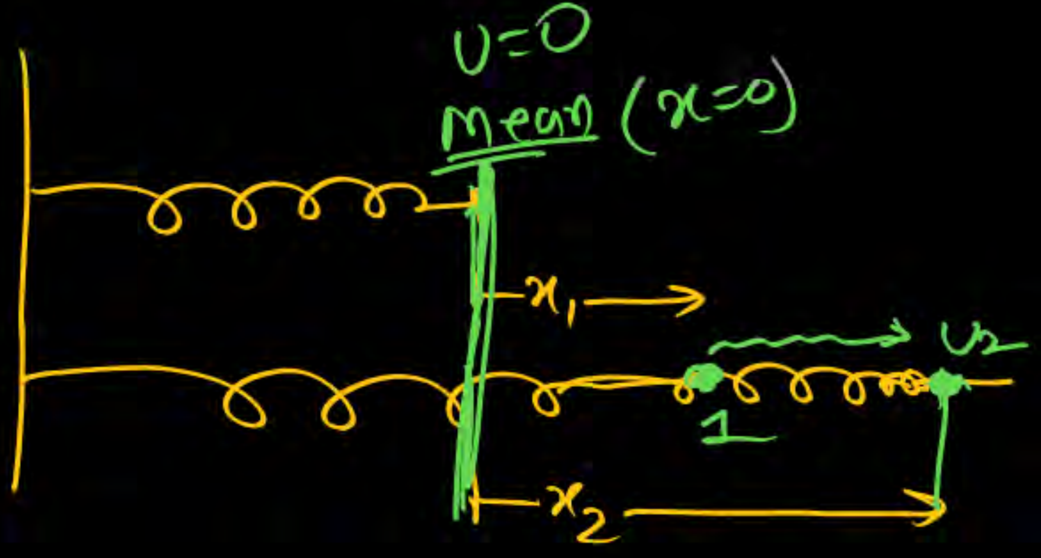
" " " " in compression from mean → −ve

" " " " in moving from elongation to mean → +ve

" " " " " " from compression to mean → +ve



$U_{mean} = 0$
x
$U = \frac{1}{2}kx^2$
compn
x
$U = \frac{1}{2}kx^2$
elongation



$$U_1 = \frac{1}{2} k x_1^2 \longrightarrow (1)$$

$$U_2 = \frac{1}{2} k x_2^2 \longrightarrow (11)$$

$$U_2 - U_1 = \frac{1}{2} k (x_2^2 - x_1^2)$$

$$U = \frac{1}{2} k x^2$$

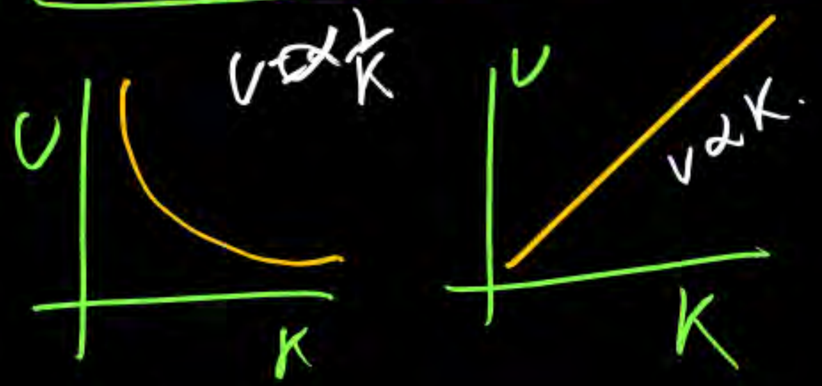


$$F = kx$$

$$U = \frac{1}{2} k x^2 = \frac{1}{2} K \left[\frac{F}{K}\right]^2$$

$$U = \frac{1}{2} \frac{F^2}{K}$$

$$U = \frac{1}{2} K x^2$$

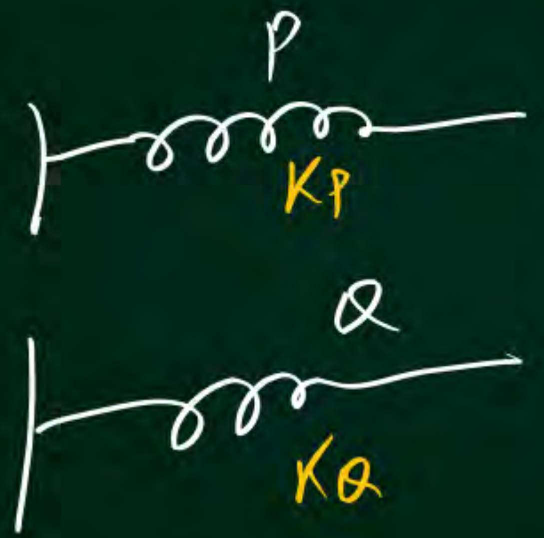


QUESTION

Two similar springs P and Q have spring constants K_P and K_Q such that $K_P > K_Q$. They stretched first by the same amount (case a), then by the same force (case b). The work done by the springs W_P and W_Q are related as in case (a) and case (b), respectively

(NEET-2015)

1. $W_P < W_Q$; $W_Q < W_P$
2. $W_P = W_Q$; $W_P = W_Q$
3. $W_P = W_Q$; $W_P > W_Q$
4. $W_P > W_Q$; $W_Q > W_P$



$K_P > K_Q$

x = same

$W = -\frac{1}{2}Kx^2$

$W(\text{magn}) = \frac{1}{2}Kx^2$

$W \propto K$ (x = same)

F = same, $Kx = F$

$W = \frac{1}{2}Kx^2$

$W = \frac{F^2}{2K}$

QUESTION

A spring with spring constants k when compressed by 1 cm, the potential energy stored is U. If it is further compressed by 3 cm, then change in its potential energy is

1. 3 U
2. 9 U
3. 8 U
4. 15 U

$x_i = 0$, $x_f = 1\,cm$] $U = \frac{1}{2}kx^2 = \frac{1}{2}k$

$x_i = 1\,cm$, $x_f = 4\,cm$] $\Delta U = ?? = \frac{1}{2}k(4^2 - 1^2)$

$= U[16-1) = 15U$

QUESTION

Force constants K_1 and K_2 of two springs are in the ratio 5 : 4. They are stretched by same length. If potential energy stored in one spring is 25 J then potential energy stored in second spring is

1. 25 J
2. 16 J
3. 100 J
4. 20 J

$\frac{K_1}{K_2} = \frac{5}{4}$

x = same

$U_1 = \frac{1}{2} K_1 x^2$

$U_2 = \frac{1}{2} K_2 x^2$

$\frac{25}{U_2} = \frac{5}{4}$

$U_2 = 20$ J

QUESTION

Two springs have their force constants in the ratio of 3 : 4. Both the springs are stretched by applying equal force F. If elongation in first spring is x then elongation in second spring is

1. $3x$
2. $4x$
3. $\frac{4}{3}x$
4. $\frac{3}{4}x$

$\frac{K_1}{K_2} = \frac{3}{4}$

$F = \text{same}$

$F = Kx = \text{same}$

$K_1 x_1 = K_2 x_2$

$x_2 = \frac{K_1}{K_2} x$

$= \frac{3}{4} x$

Work energy th^m ⟷ Conservation of mechanical energy theorem

(extⁿ / frictⁿ / normal / tension)

जहाँ Hum वहाँ C.O.M.E नहीं

जहाँ C.O.M.E वहाँ Hum नहीं ||

Step-1

- Identity all force acting on the object or system given question

Step-2

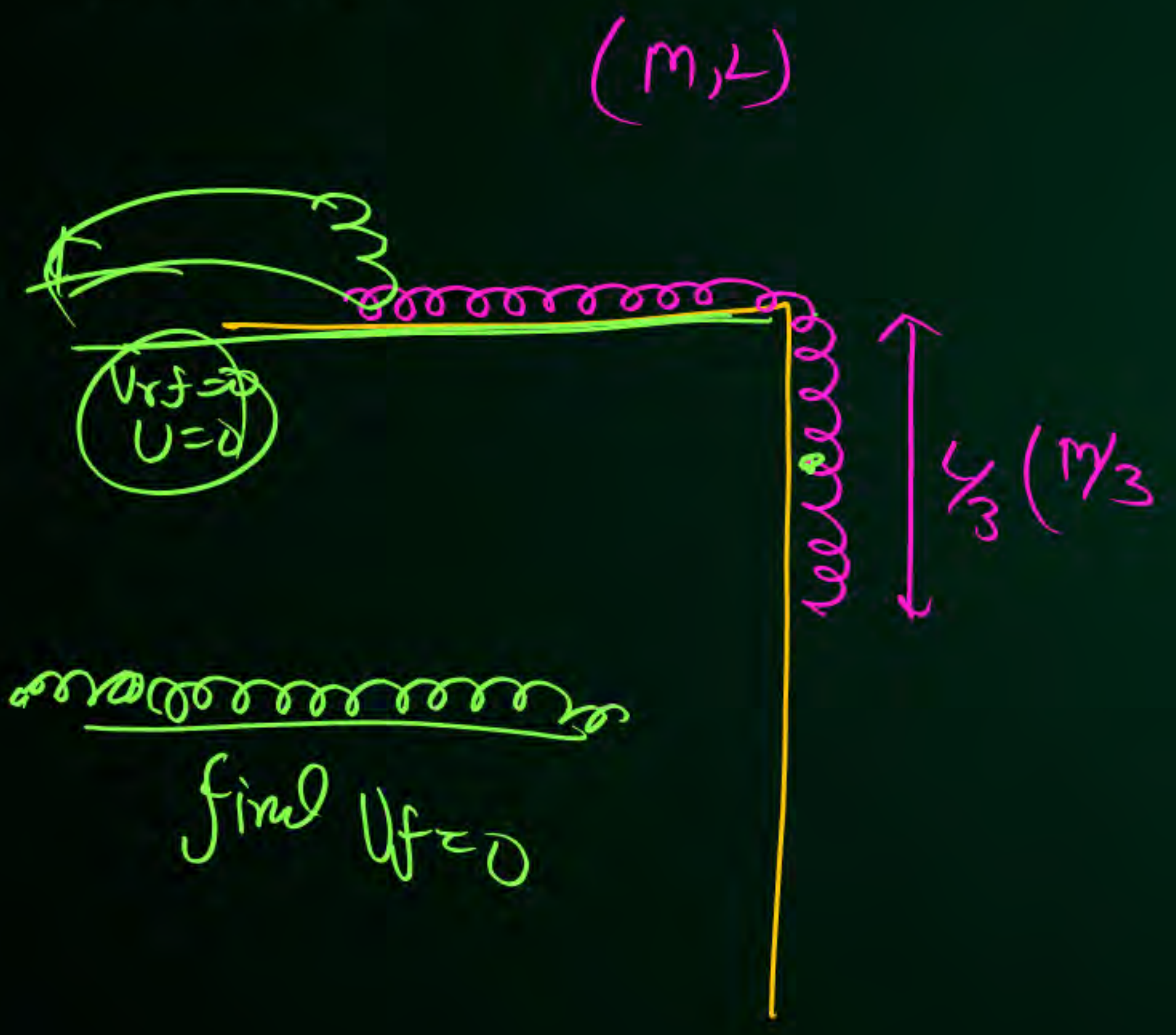
- find Nature of work due to all the indivisual force.

Step-3

If work done by N.C.F is
- zero → then apply C.O.M.E
- Not zero → Work energy theorem

QUESTION

One third part of chain is hanging (down from table) then find work to pull back the hanging part of chain on table (slowly).



Work energy th^m (C.O.M.E ✗)

$W_{C.F} + W_{N.C.F} = \Delta K.E = 0$ (slowly)

$W_{N.C.F} = -W_{C.F}$

$W_{N.C.F} = -[-\Delta U]$

$W_{N.C.E} = +\Delta U = U_f - U_i$

$W_{N.C.F}$ (Ext) $= U_f - U_i$ (with $U_f = 0$)

$= -\left[-\frac{m}{3} g \frac{L}{6}\right]$

$= \frac{mgL}{18}$

QUESTION

A chain is on a frictionless table with one fifth of its length hanging over the edge. If the chain has length L and mass M, the work required to be done to pull the hanging part back onto the table is



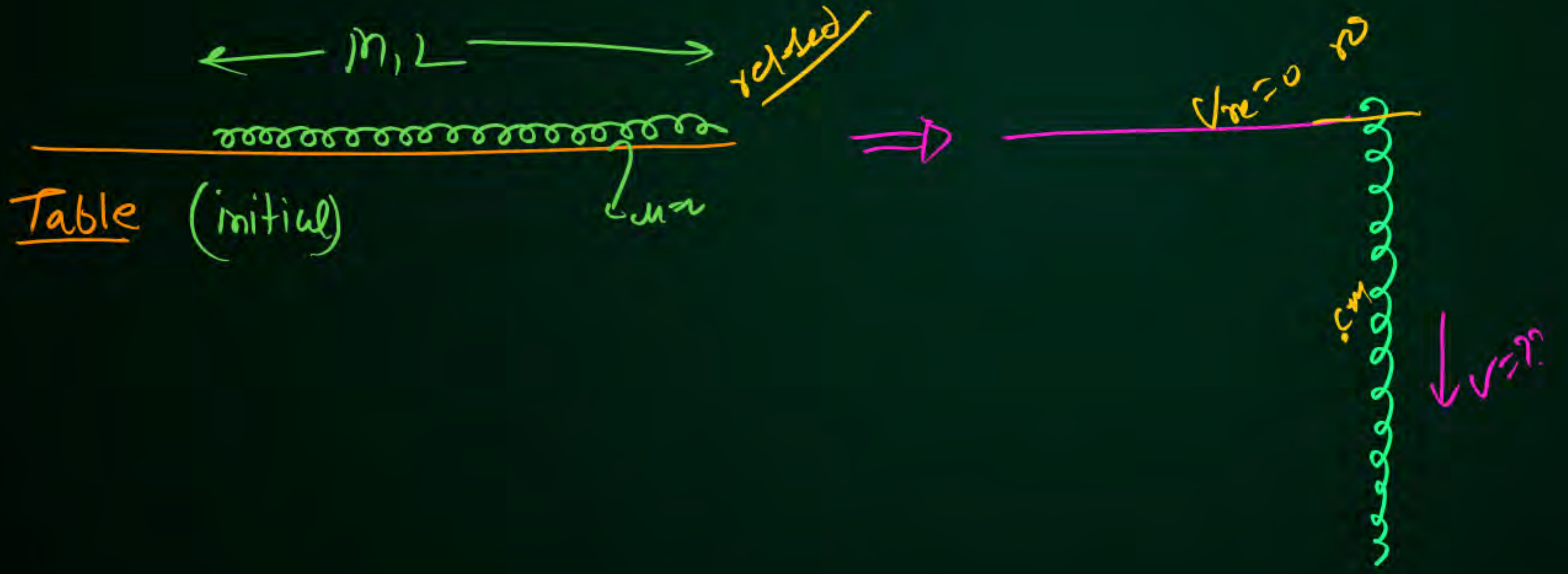
$$U_i = -\frac{m}{5} g \frac{L}{10}$$

$$W_{N.C.F} = \Delta U$$

$$= 0 - \left[-\frac{mgL}{50}\right] = \frac{mgL}{50} \text{ Ans}$$

QUESTION

A chain of mass M length L placed on table then find speed of chain when it becomes vertical. as shown in figure



1) Normal & gravity

$W_N = 0$ $W_g = +ve$

C.O.M.E

$(KE + U)_i = (K.E + U)_f$

$0 + 0 = \frac{1}{2}mv^2 - \frac{mgL}{2}$

$\frac{1}{2}mv^2 = \frac{mgL}{2}$

$v = \sqrt{gl}$ Ans

QUESTION

A uniform cable of mass M and length L is placed on a horizontal surface such that its $\frac{1}{n}$th part is hanging below the edge of the surface. To lift the hanging part of the cable up to the surface, the work done should be: [IIT-2022]

1. $\frac{MgL}{n^2}$
2. $\frac{MgL}{2n^2}$
3. $\frac{2MgL}{n^2}$
4. $nMgL$

QUESTION

A block of mass m moving with velocity v_0 on a smooth horizontal surface hits the spring of constant k as shown. The maximum compression in spring is



QUESTION

A uniform chain of length 3 m and mass 3 kg overhangs a smooth table with 2 m laying on the table. If k is the kinetic energy of the chain in joule as it completely slips off the table, then the value of k is ________.

Take $g = 10\ \text{m/s}^2$

[IIT-2021]

1. 40.0
2. 40.00
3. 40
4. None of these

QUESTION

A air bubble in water raising up then potential energy of water bubble will

QUESTION

Two proton moving towards each other the P.E. will increase or decrease?

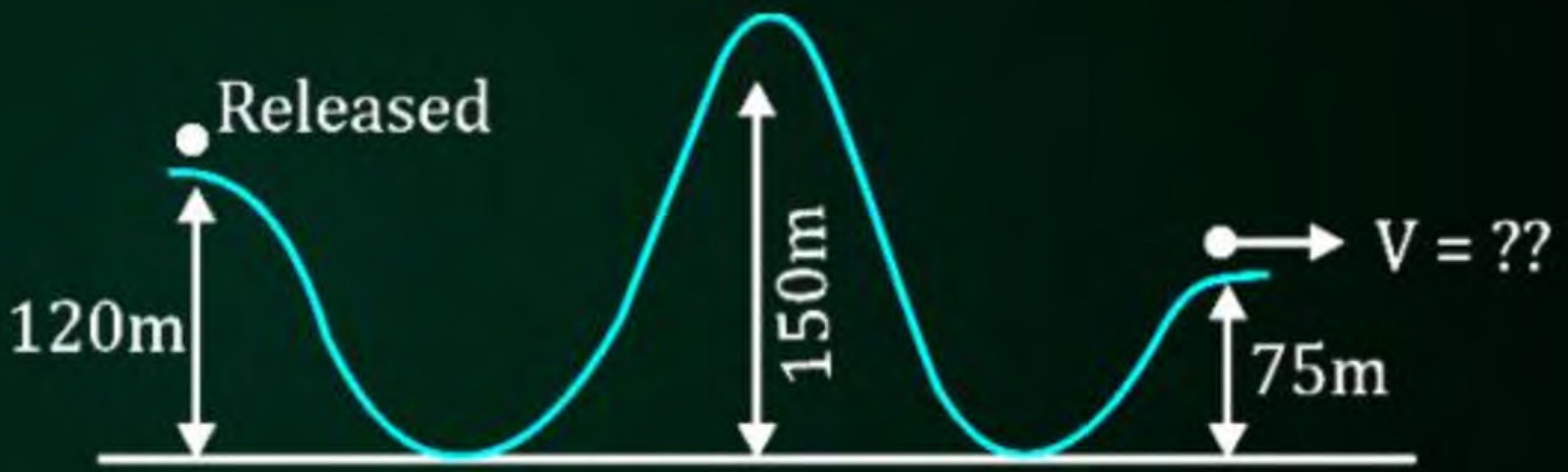
QUESTION

Electron and Proton moving towards each other then P.E. will increase or decrease?

QUESTION

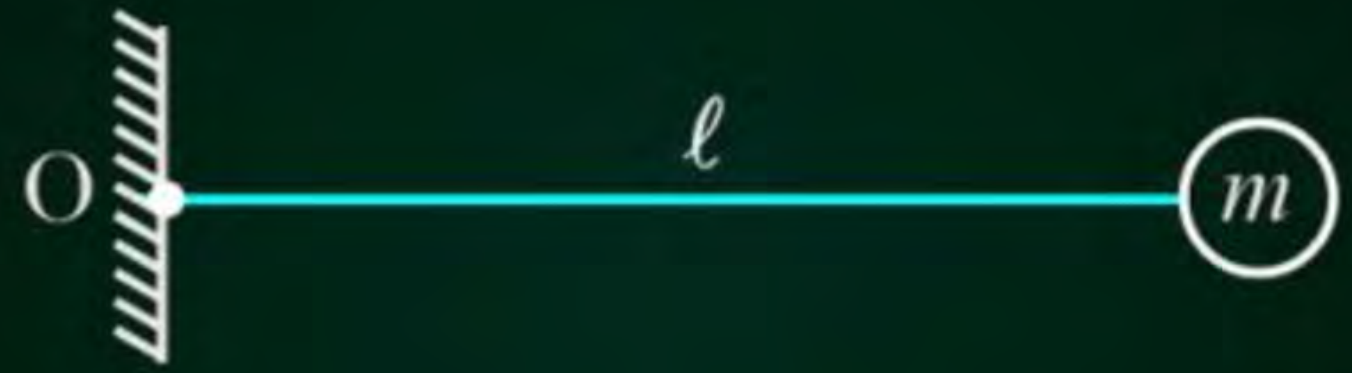
The value of V will be:

1. $V = 30\ m/s$
2. $V > 30\ m/s$
3. $V < 30\ m/s$
4. Not possible



QUESTION

Ball is released from horizontal position then find its speed when it rotated by 60°.



QUESTION

Calculate K.E. and potential energy when ball is projected up with speed 20 m/s after 1 sec.

QUESTION

Initially half length of chain hanged vertically from table and released from smooth table find, speed of chain when it becomes vertical.


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 07 | **Physics**

Work, Energy and Power

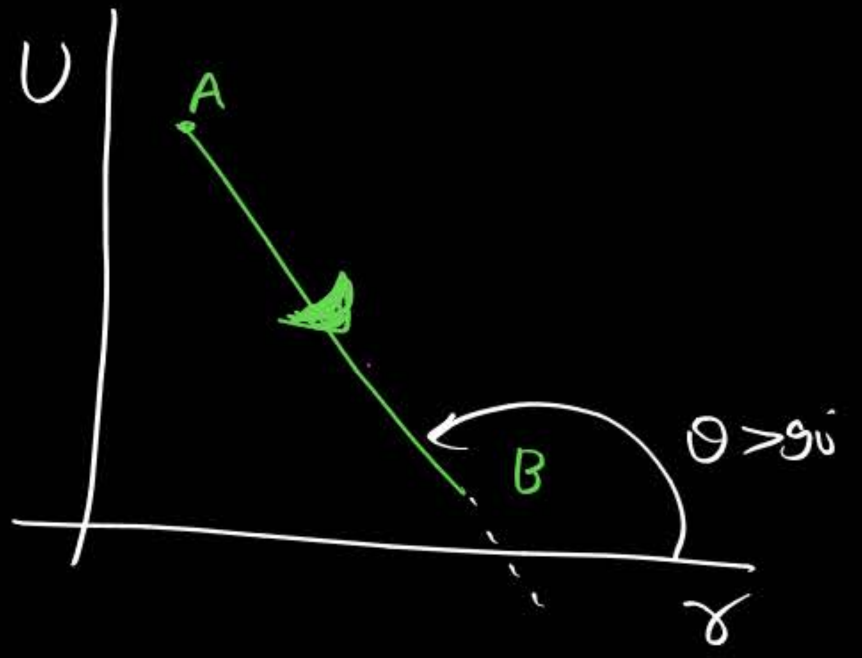


By- Dr. Manish Raj (MR SIR)

Topics to be covered

1. # Questions on conservation of mechanical energy
2. # PhD on C.O.M.E
3. # Yakeen+ → वही पढ़ेगे जो NEET मे नही आयेगा
4. #





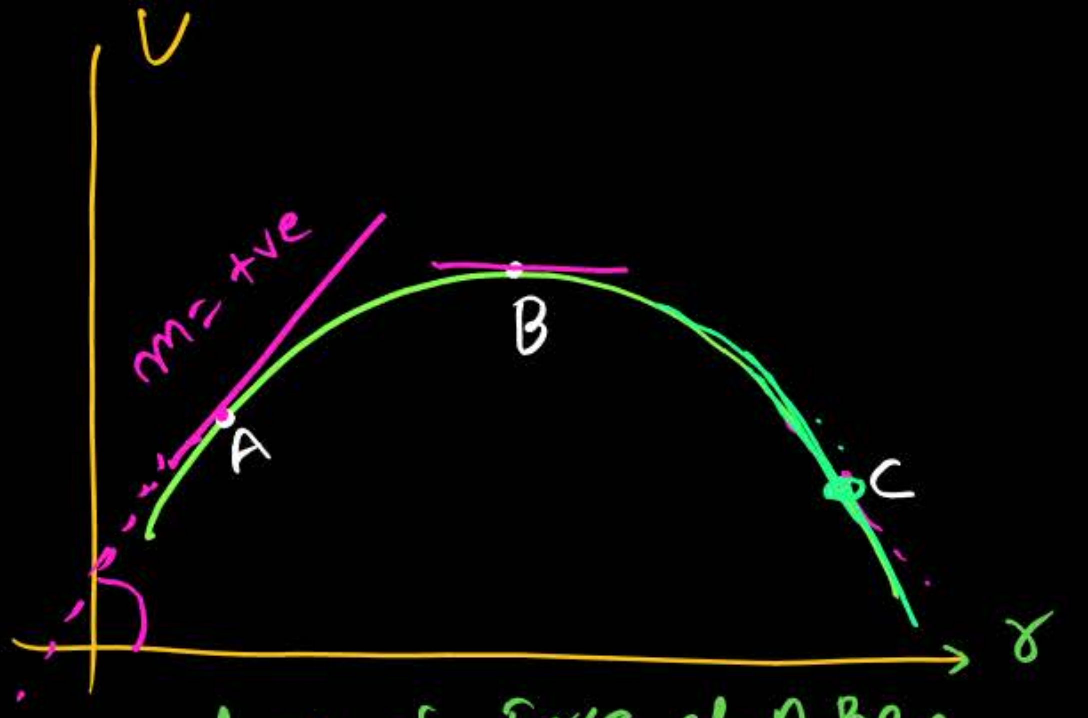
force acting on object according to this U/r graph.

Sol^n $\vec{F} = -\frac{dU}{dr} = -(\text{slope})$

$= -(-ve)$

$\vec{F} = +ve$ (dir^n)

↑ dir^n



nature of force at A, B & C

$\Rightarrow F_A$ (at) $\Rightarrow (-ve)$

$\Rightarrow F_B \Rightarrow$ zero $F = -\frac{dU}{dr} = \text{zero}$

$\Rightarrow F_C \Rightarrow (+ve)$

at A → F = −ve

at B → F = 0

at C → F = +ve

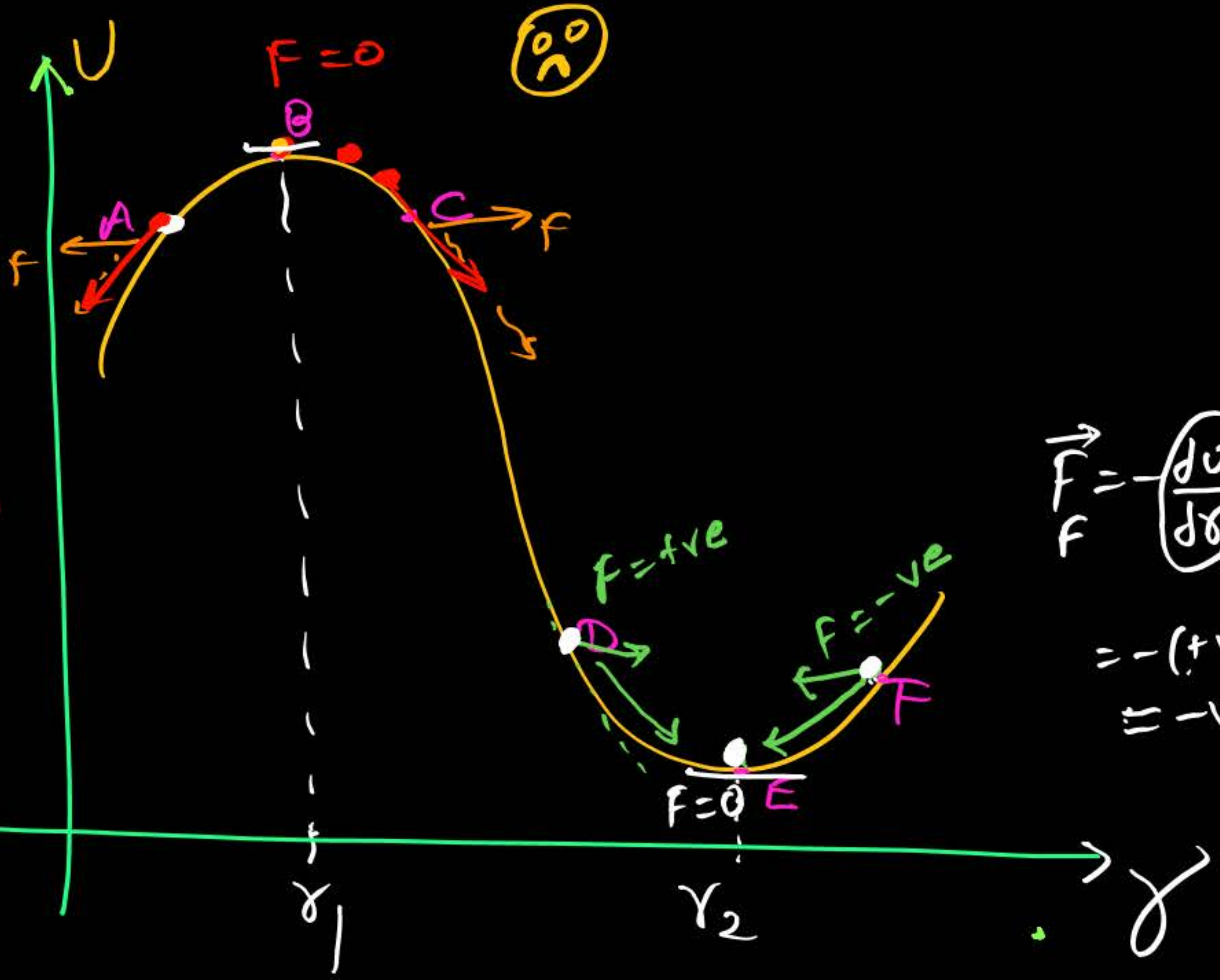
→ at B object is in equilibrium

but this is unstable equilibrium

at B $\left(\frac{dU}{dr}\right) = 0$

at B $\left(\frac{d^2U}{dr^2}\right) = -ve$ (maximum)





$\vec{F} = -\frac{dU}{dr}$

$= -(+ve)$

$= -ve$

" at E Stable equilibrium

$F_E = 0 = \left(\frac{dU}{dr}\right) = 0$

$\left[\left(\frac{d^2U}{dr^2}\right) = +ve\right]$ minimum



QUESTION

At which point particle is at equilibrium.

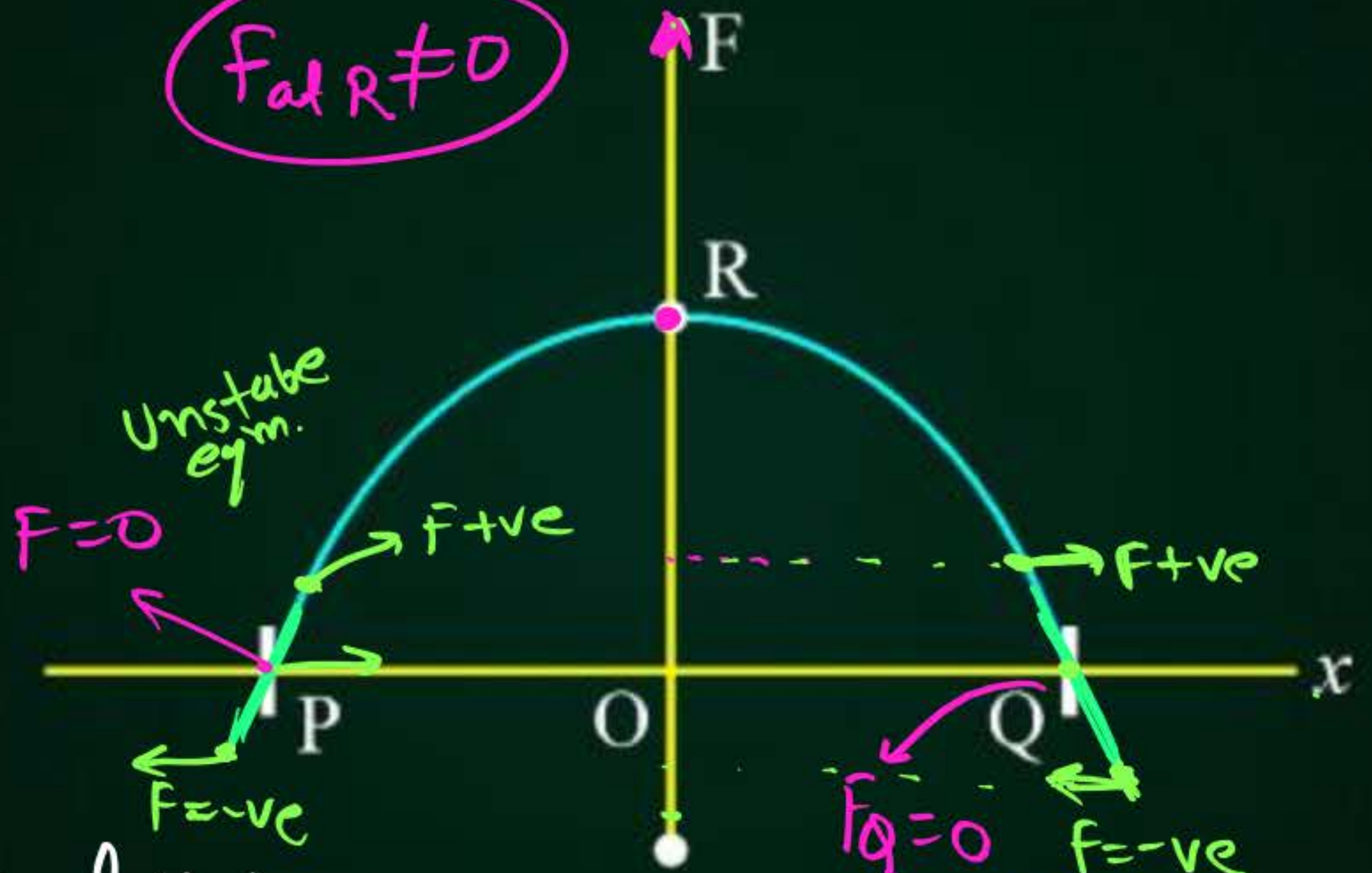
(a) At P ✓

(b) at R (68%) — wrong

(c) at Q ✓

(d) at P and Q (27%)

Ans – (d)



"at equilibrium force on object is zero" which is at 'P' and 'Q'

[at Q → stable equilibri.
at P → unstable equilibrium

Method-2

Stable equilibrium is at (Minima) $\frac{d^2U}{dr^2} = +ve$

we know

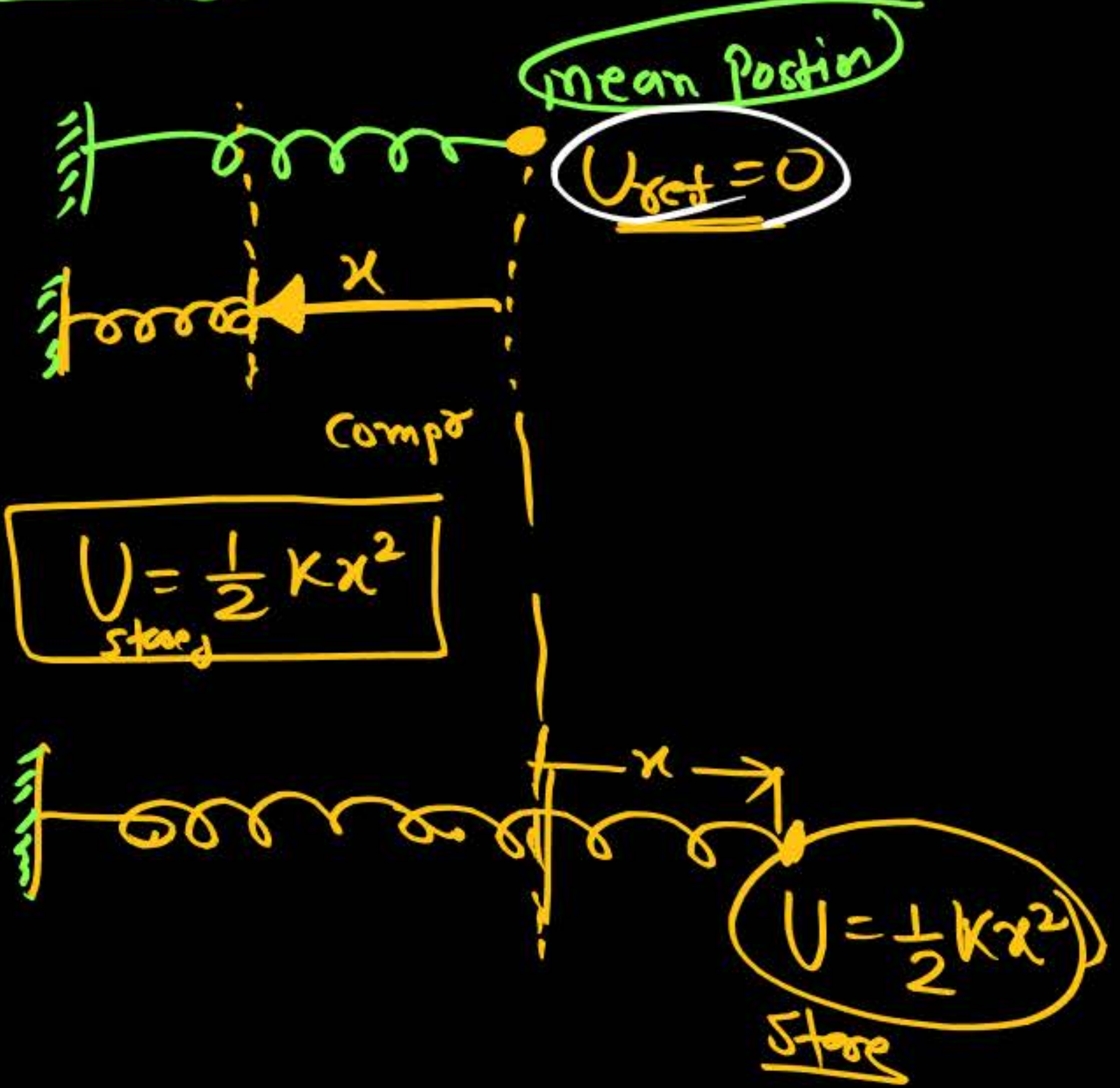
$F = -\frac{dU}{dr}$ (diff^n)

$\frac{dF}{dr} = -\frac{d^2U}{dr^2}$

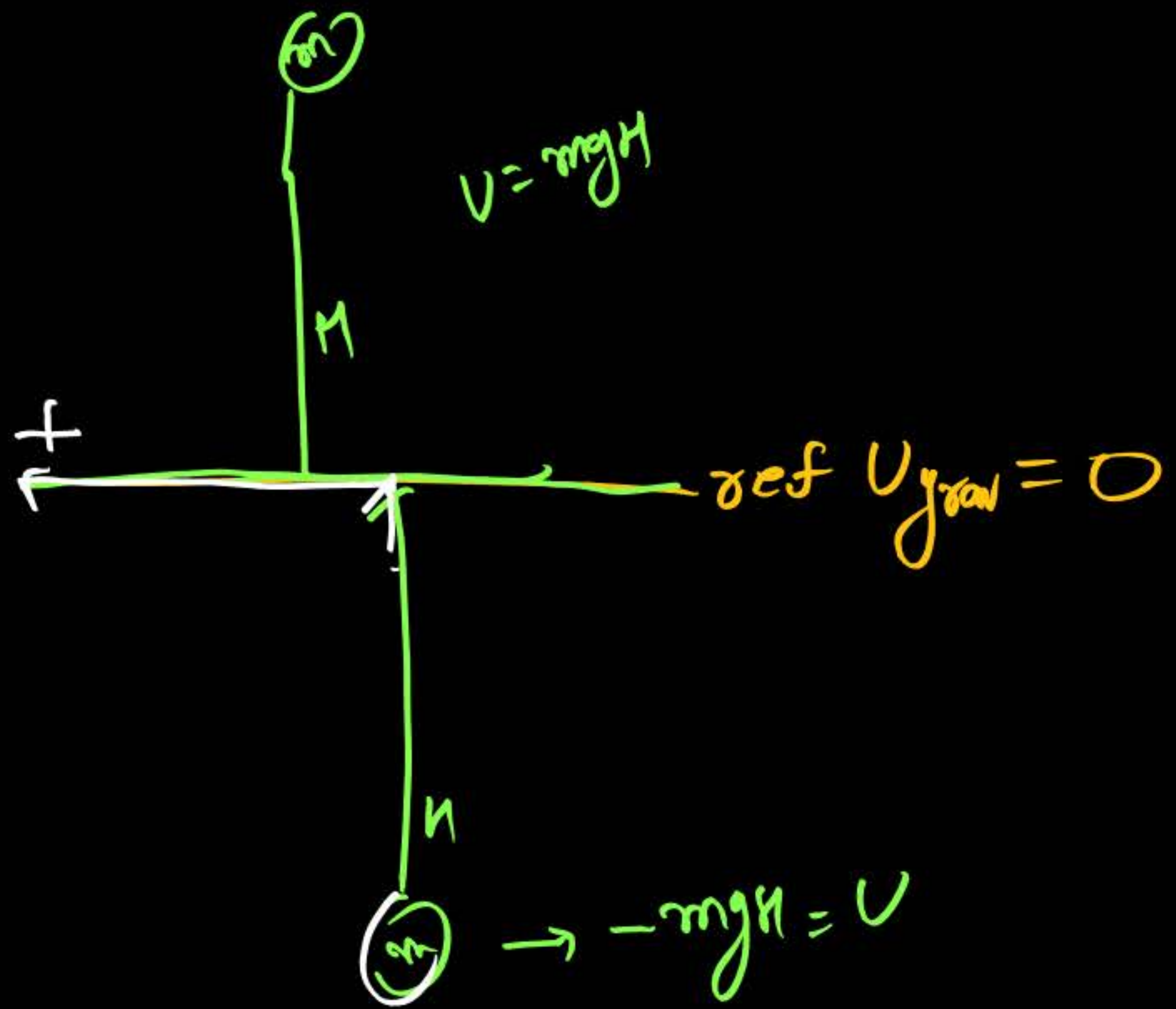
$\frac{dF}{dr} = -[+ve]$ stable eq^n

Slope of F/r $= \frac{dF}{dr} = -ve$ for stable eq^n

Spring Potential energy



$$U_{stored} = \frac{1}{2}kx^2$$



Step → 1

→ Identify all the force acting on object.

Step-2

then find Nature of work done by all the force.

Step-3

→ If $W_{N.C.F} = 0$ ✓ then C.O.M.E apply.

WET is also valid

If $W_{N.C.F} \neq 0$ ✓ → C.O.M.E Not Valid ✓

apply Work energy thm

Is Conservation of mechanical energy is derived from WET → yes

---

(Q) Is Work energy theorem can derived from mechanical energy theorem →

(a) yes — 30%

(b) NO — 66%

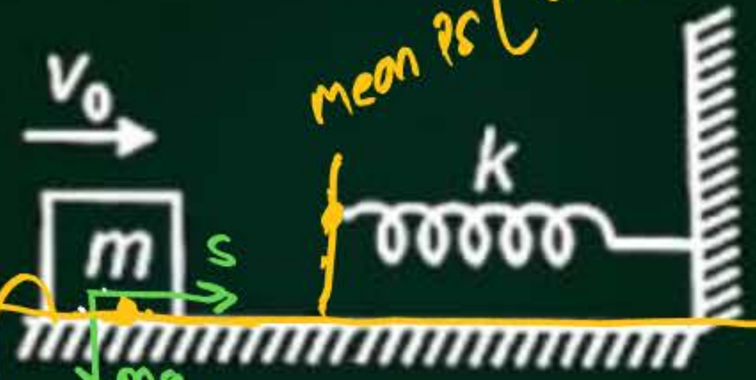


QUESTION

$-W_{C.F} = \Delta U$

(Q) A block of mass m moving with velocity v_0 on a smooth horizontal surface hits the spring of constant k as shown. The maximum compression in spring is

Step-1 → mg^0, N^0, spring → conservative force



mean position ($U=0$)

$\mu = 0$

Method-1

Work energy theorem

- $W_{all\ force} = \Delta K.E$

$W_N + W_g + W_{sf} = K.E_f - K.E_i$

$0 + 0 - \frac{1}{2}Kx_m^2 = 0 - \frac{1}{2}mv_0^2$

$-\frac{1}{2}Kx_m^2 = -\frac{1}{2}mv_0^2$

$x = \sqrt{\frac{mv_0^2}{K}}$ Ans

$v = 0$ (stop)

x_{max} find

Method-2

C.O.M.E

$K.E_i + U_i = K.E_f + U_f$

$\frac{1}{2}mv_0^2 + U_g^0 + U_{sp}^0 = 0 + \frac{1}{2}Kx^2$

$x^2 = \frac{mv_0^2}{K}$

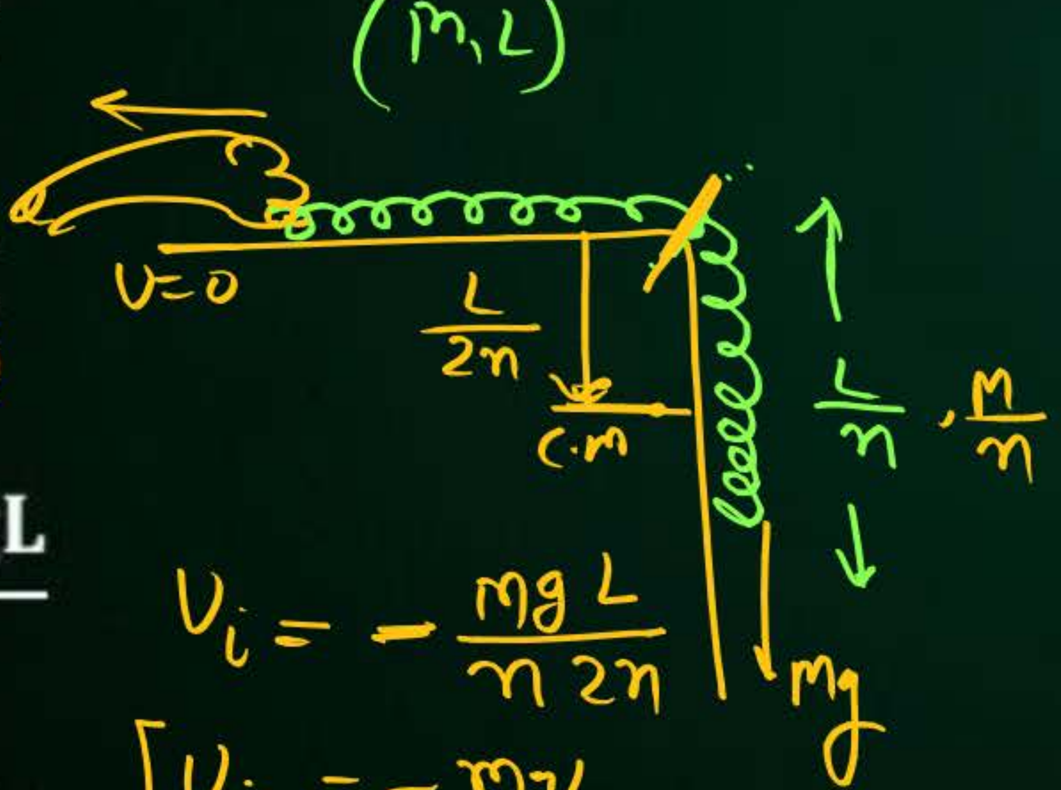
$x = \sqrt{\frac{mv_0^2}{K}}$ Ans

QUESTION

$W_{NCF} = W_{ext} = \Delta U$ — only valid when W_{NCF} is agst C.F.

A uniform cable of mass M and length L is placed on a horizontal surface such that its $\frac{1}{n}$th part is hanging below the edge of the surface. To lift the hanging part of the cable up to the surface, the work done should be: [IIT-2022]

1. $\frac{MgL}{n^2}$
2. $\frac{MgL}{2n^2}$
3. $\frac{2MgL}{n^2}$
4. $nMgL$

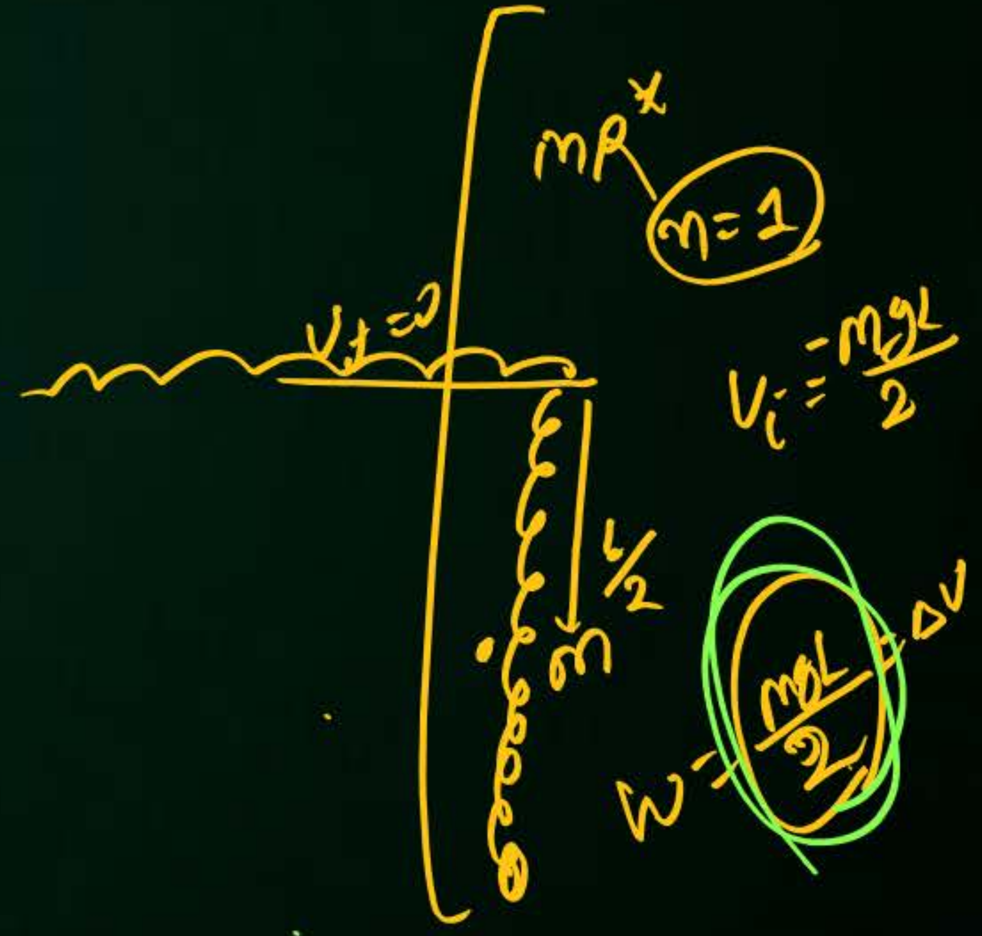


$U_i = -\frac{mgL}{n\,2n}$

$U_i = -\frac{mgL}{2n^2}$

$U_f = 0$

$W_{ext} = \Delta W$ (against C.F)



QUESTION

A uniform chain of length 3 m and mass 3 kg overhangs a smooth table with 2 m laying on the table. If k is the kinetic energy of the chain in joule as it completely slips off the table, then the value of k is ________.

Take $g = 10\ \mathrm{m/s^2}$

[IIT-2021]

1. 40.0
2. 40.00
3. 40
4. None of these



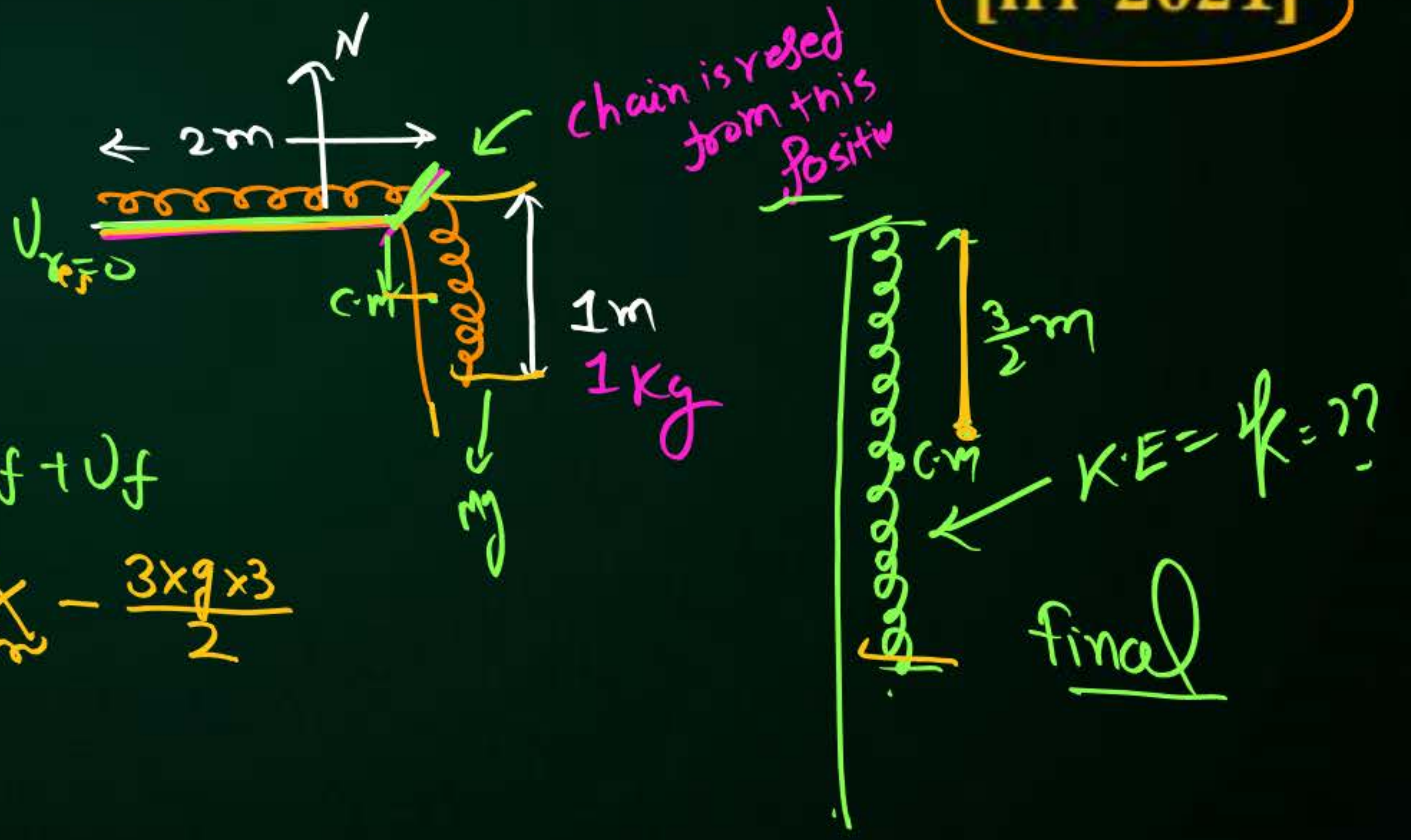
C.O.M.E

$K.E_i + U_i = K.E_f + U_f$

$0 - \frac{1 kg\, g \times 1}{2} = K - \frac{3 \times g \times 3}{2}$

$\frac{9g}{2} - \frac{g}{2} = K$

$\frac{8g}{2} = K$



QUESTION

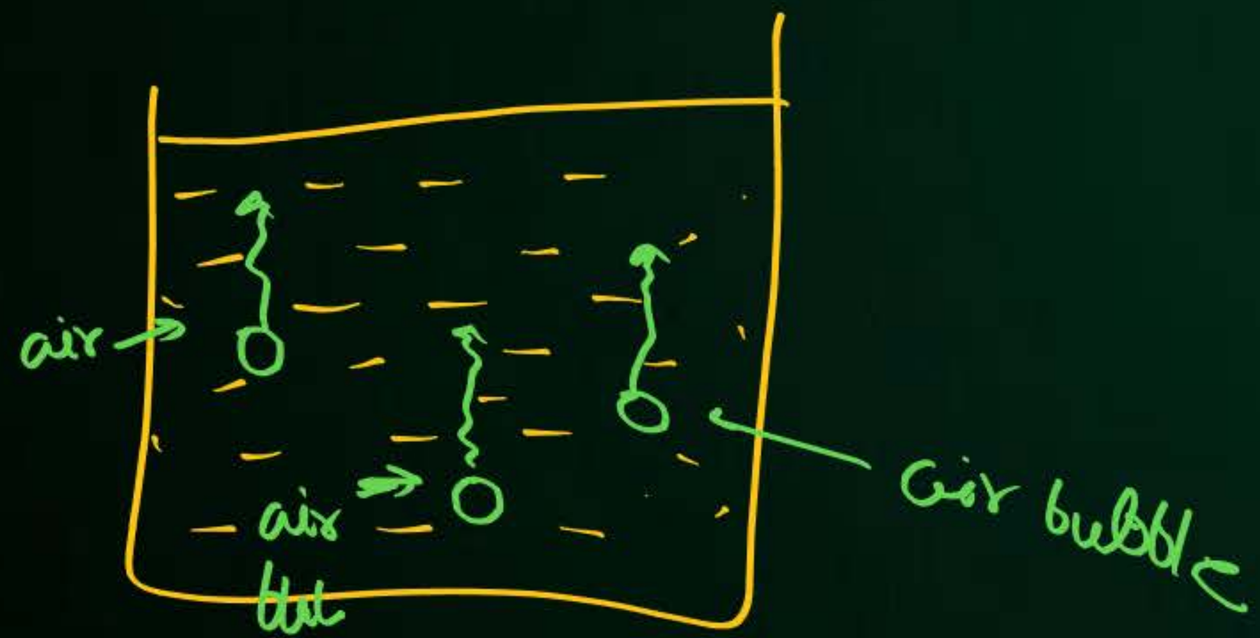
A air bubble in water raising up then potential energy of water bubble will

(a) Inc (30%)

(b) dec (53%)

(c) Const

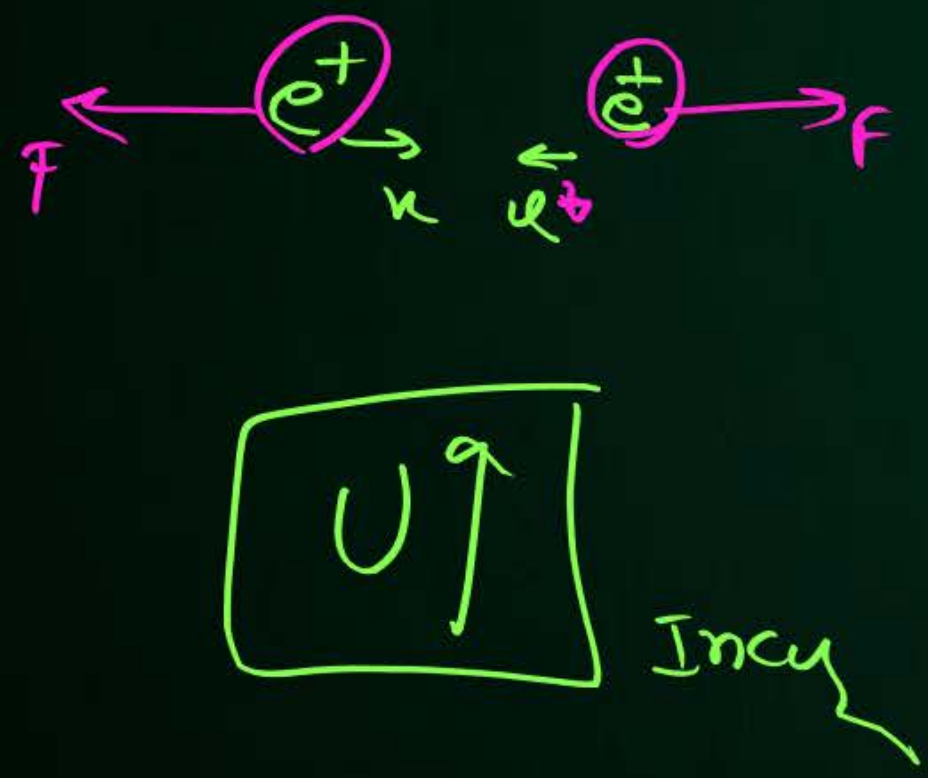
(d) Can't say



natural event

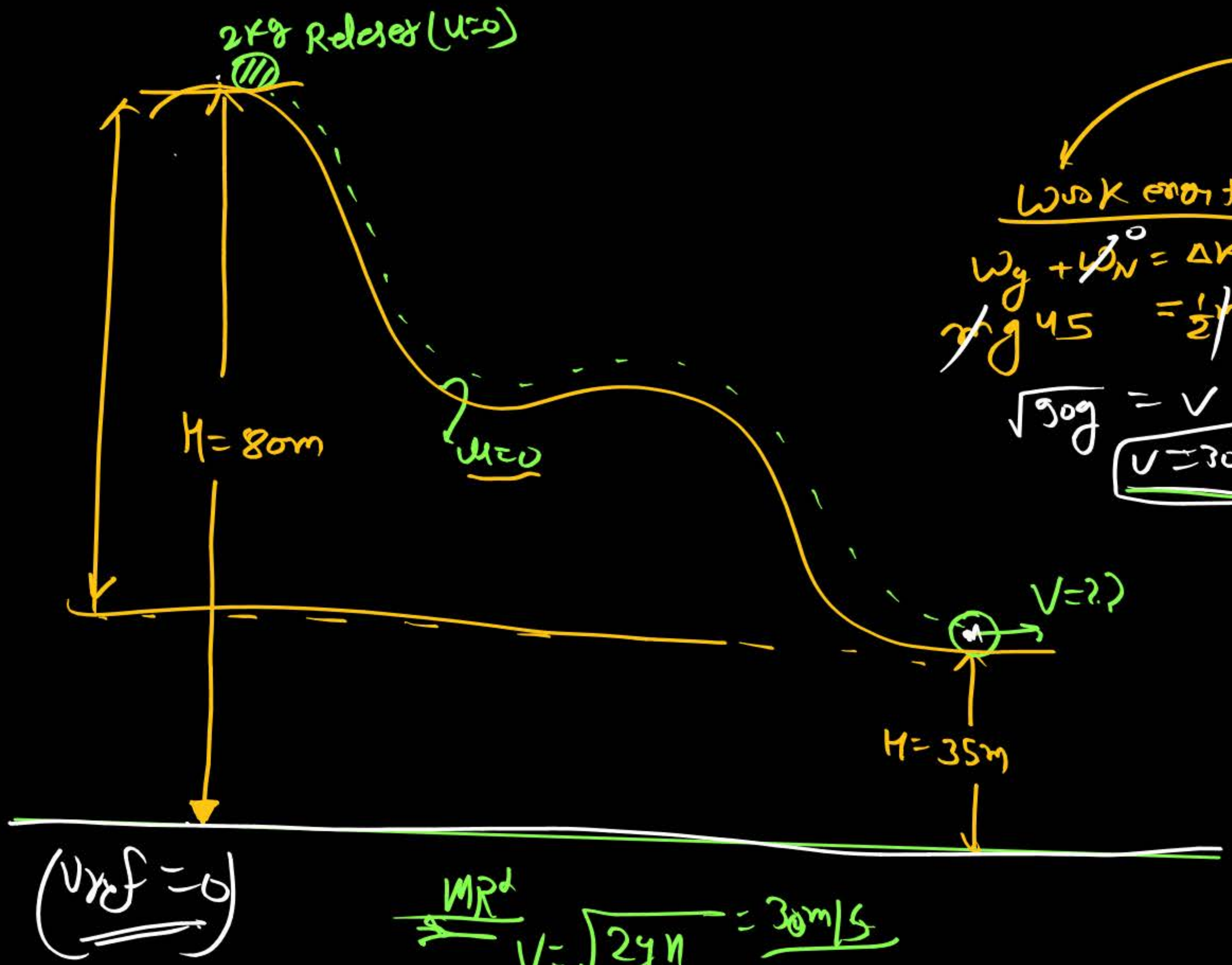
QUESTION

Two proton moving towards each other the P.E. will increase or decrease?



QUESTION

Electron and Proton moving towards each other then P.E. will increase or decrease?



MR^d

$V = \sqrt{2gh} = 30\,m/s$

Step → 1 Identify all force

$W_N = 0$ | $W_g \neq 0$

→ $W_{N.C.F} = 0$

C.O.M.E can apply

Work energy thm

$$W_g + W_N^{\,0} = \Delta K.E$$

$$mg\,45 = \frac{1}{2}mv^2 - 0$$

$$\sqrt{90g} = v$$

$$v = 30\,m/s$$

$$(K.E + U)_i = (K.E + U)_f$$

$$0 + mg80 = \frac{1}{2}mv^2 + mg35$$

$$80mg - 35mg = \frac{1}{2}mv^2$$

$$45mg = \frac{1}{2}mv^2$$

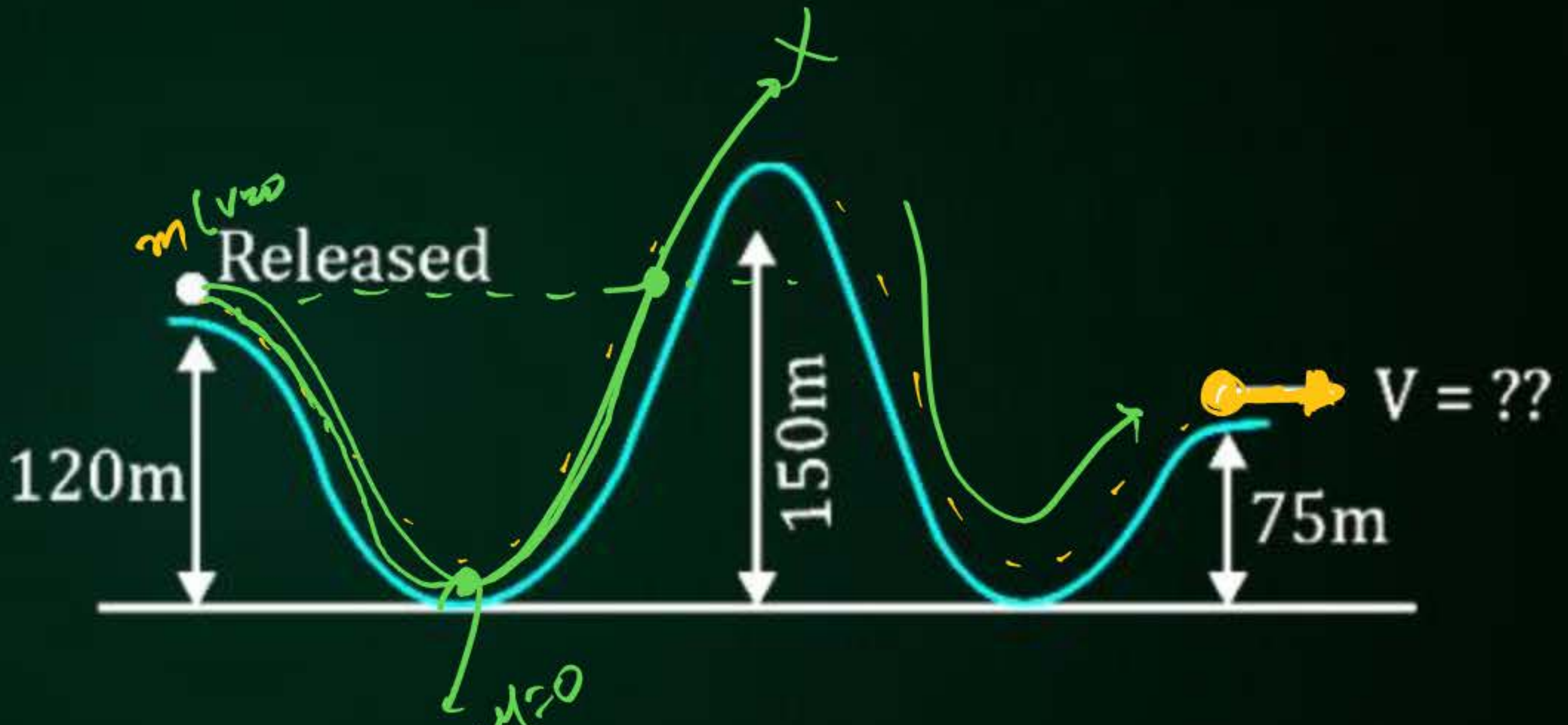
$$90g = v^2$$

$$v = \sqrt{900} = 30\,m/s$$

QUESTION

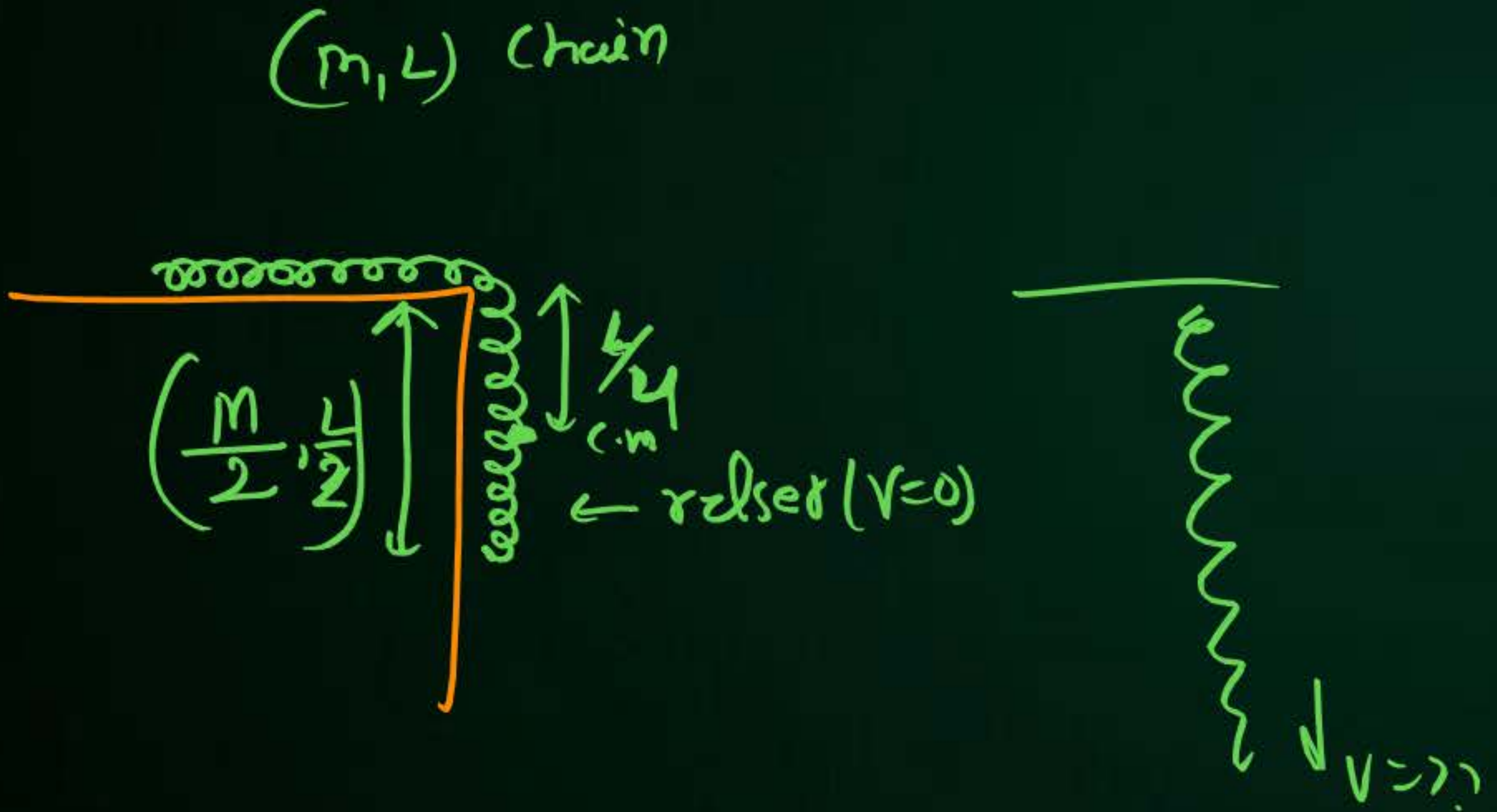
The value of V will be:

1. V = 30 m/s
2. V > 30 m/s
3. V < 30 m/s
4. Not possible



QUESTION

Initially half length of chain hanged vertically from table and released from smooth table find, speed of chain when it becomes vertical.



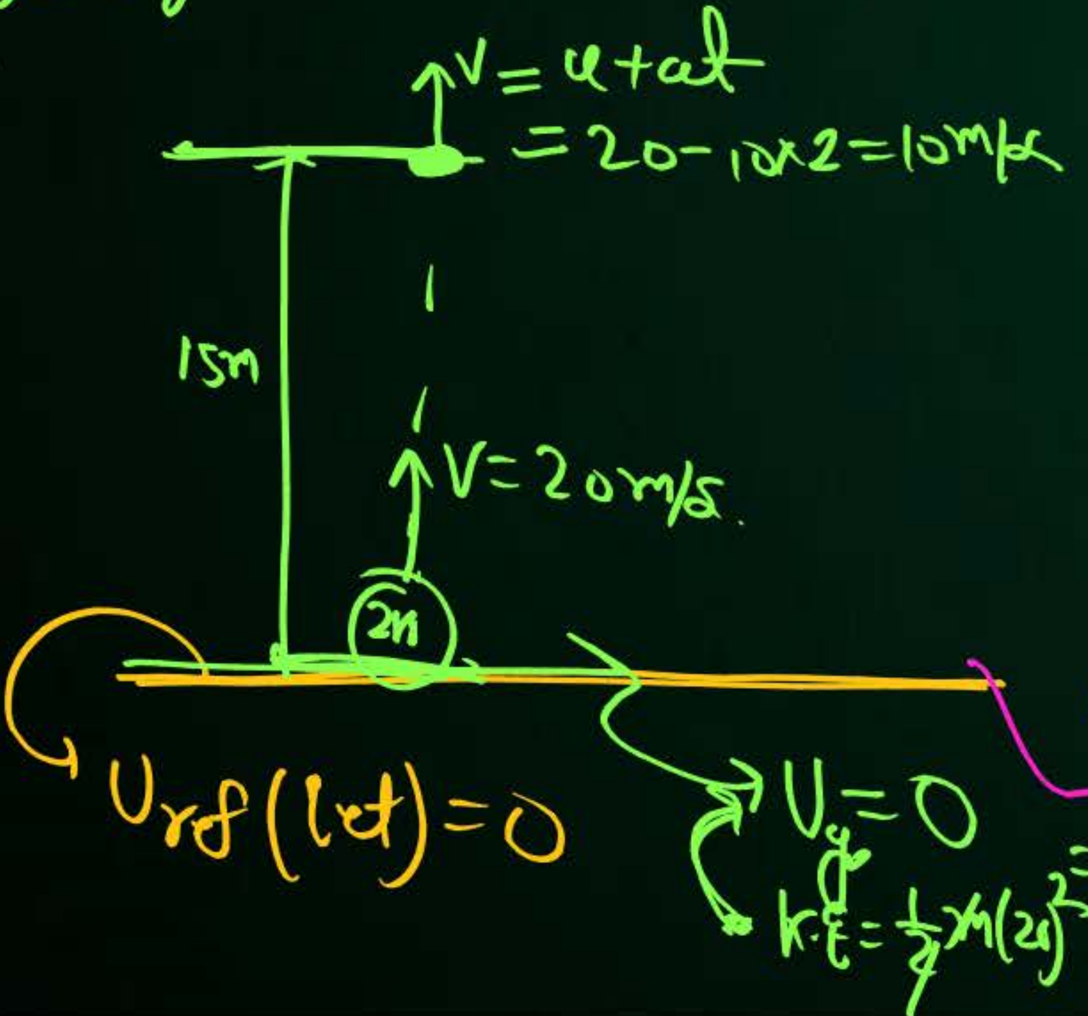
QUESTION

Calculate K.E. and potential energy when ball is projected up with speed 20 m/s after 1 sec. mass of object is 2 kg

at 1 sec

$K.E = \frac{1}{2}mv^2 = \frac{1}{2}m(10)^2 = 100J$

$U = mgH = 2 \times 10 \times 15 = 300J$



$S = ut + \frac{1}{2}at^2$

$S = 20 \times 1 - \frac{1}{2}g(1)^2$

$= 20 - 5 = 15m$

at $t = 2$ sec

$H = 20m$

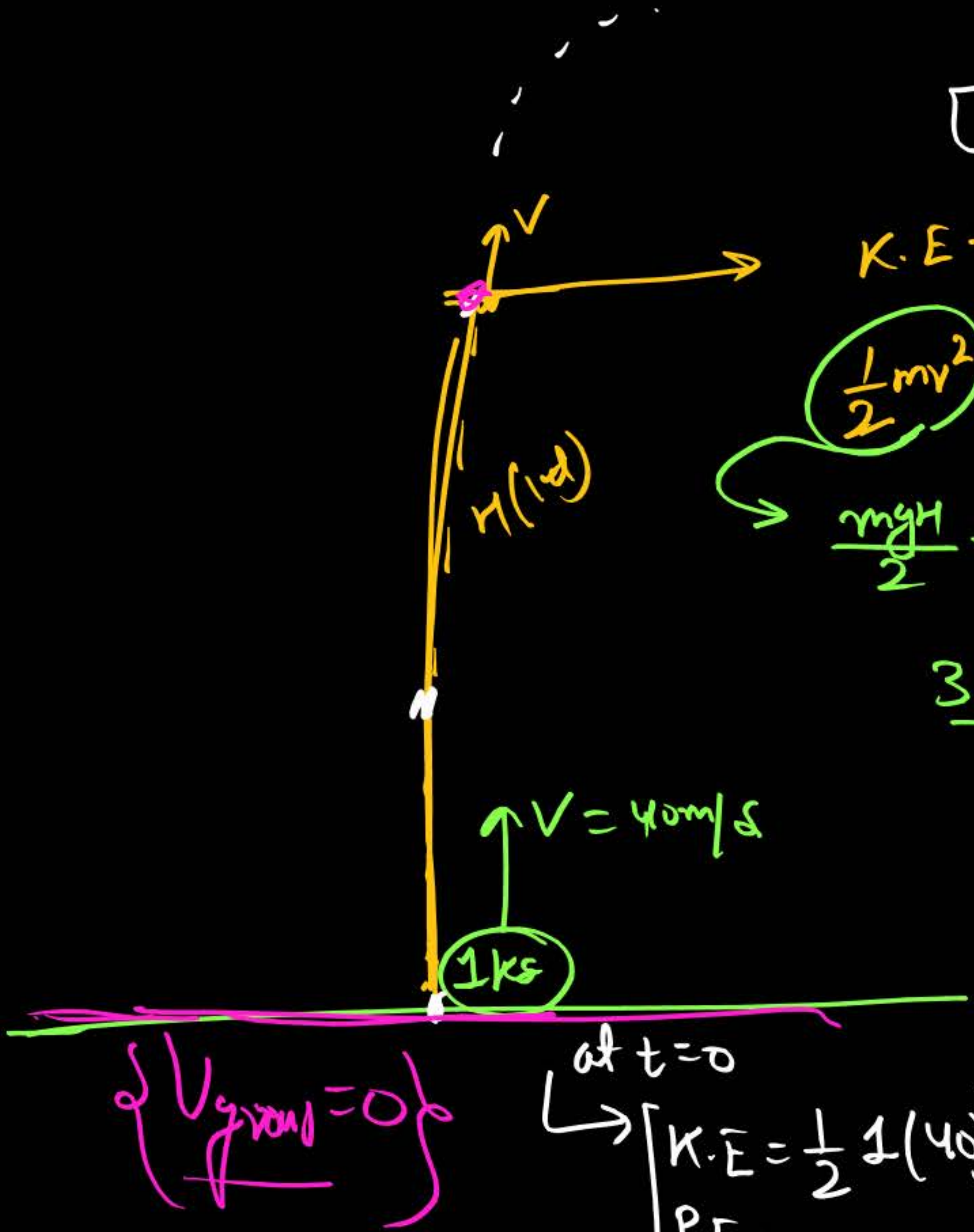
$U = mgH = 2 \times 10 \times 20$

$= 400J$

$(K.E)_{min} = 0J$

M.E = const

Find hight from ground when K.E of object is half of P.E.



$$M.E = \text{Cost}^n$$

$$K.E + U = \text{Cost}^n$$

$$\frac{1}{2}mv^2 + mgH = 800 \quad -(1)$$

$$\frac{mgH}{2} + mgH = 800 \quad (\text{due to ques})$$

$$\frac{3mgH}{2} = 800$$

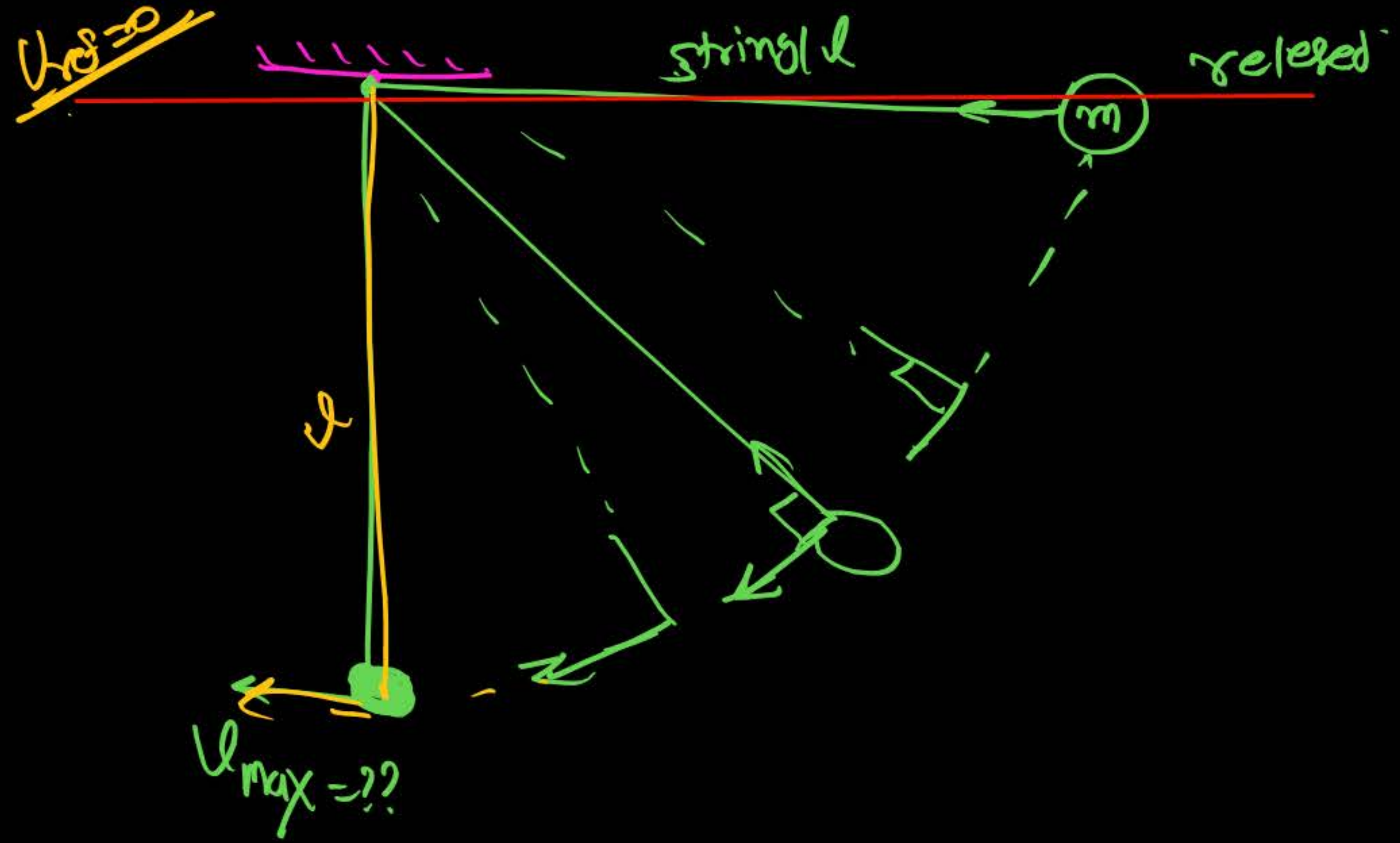
$$\frac{3 \times 1 \times 10H}{2} = 800$$

$$H = \frac{160}{3} = 53.3\,m$$

at $t = 0$

$$K.E = \frac{1}{2} 1 (40)^2 = \frac{1600}{2} = 800J$$

$$P.E = 0$$



step-I T / mg

WT = 0

C·O·M·E

$(K.E + U)_{itial} = (K.E + U)_{final}$

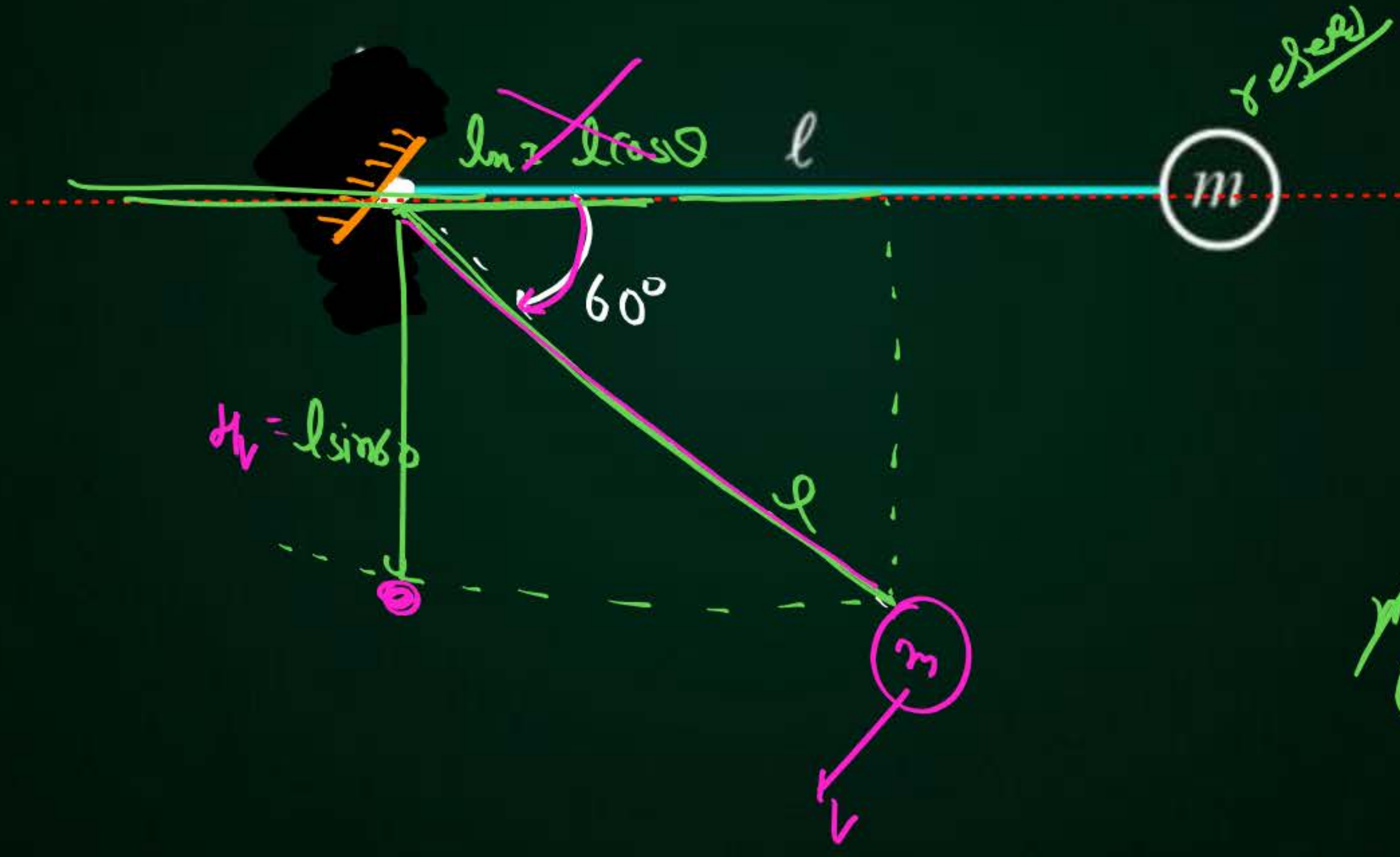
$0 + 0 = \frac{1}{2}mv^2 - mgl$

$mgl = \frac{1}{2}mv^2$

$v = \sqrt{2gl}$

QUESTION

Ball is released from horizontal position then find its speed when it rotated by 60°.



$V_{initial} = 0$

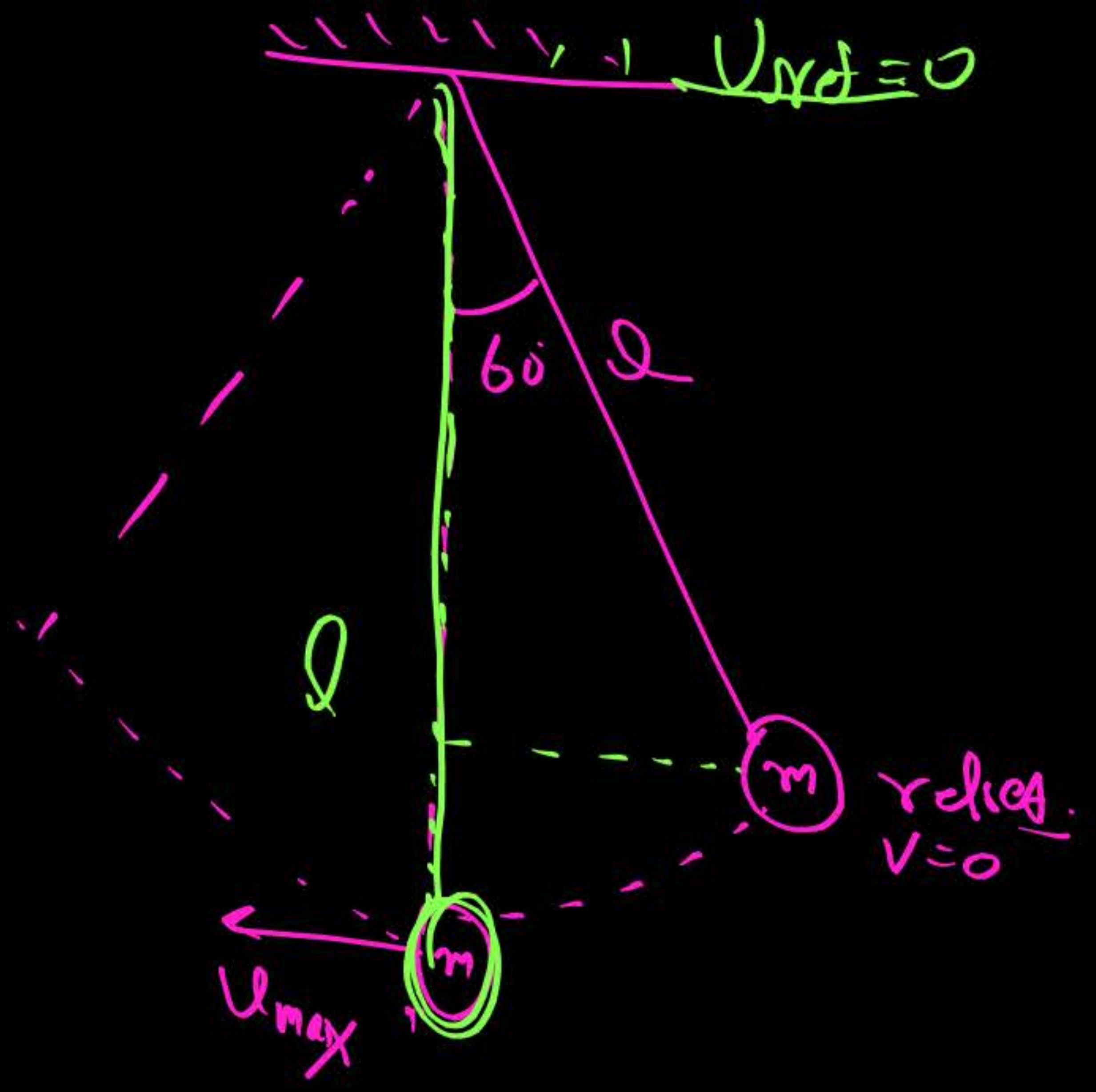
$(K.E + P.E)_i = (K.E + P.E)_f$

$0 + 0 = \frac{1}{2}mv^2 - mgl\sin 60$

$mgl\sin 60 = \frac{1}{2}mv^2$

$2gl \times \frac{\sqrt{3}}{2} = v^2$

$v = \sqrt{gl\sqrt{3}}$ Ans



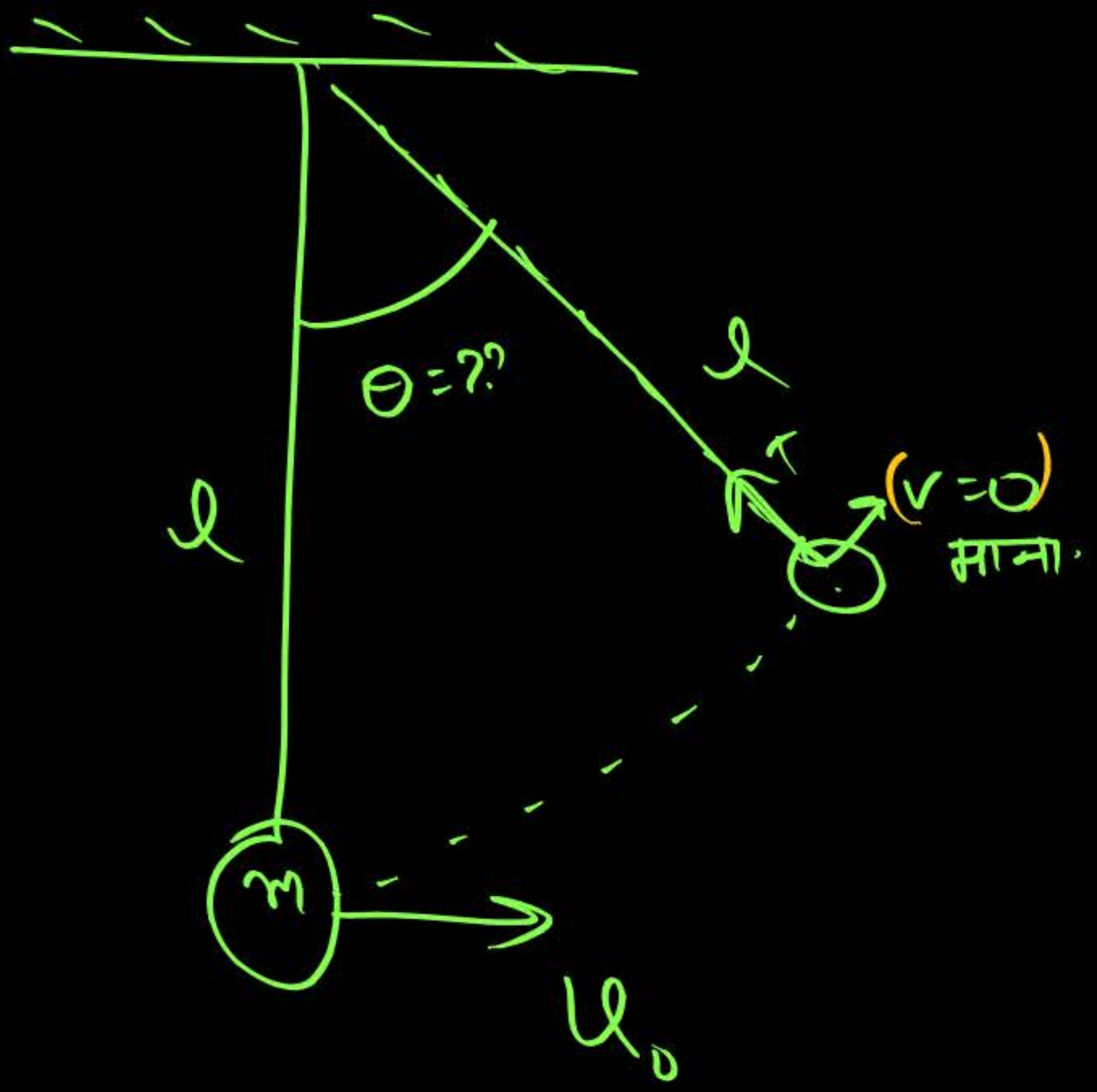
find speed of ball when string becomes vertical.

C.O.M.E

$$K.E_i + U_i = K.E_f + U_f$$

$$0 - mgl\cos\theta = \frac{1}{2}mv^2 - mgl$$

find θ = ??



C.O.M.E

$(K.E + U)_{mean\ ini} = (K.E + U)_{fi}$

here non conservative force is present but $W_{N.C.F} = 0$ ✗

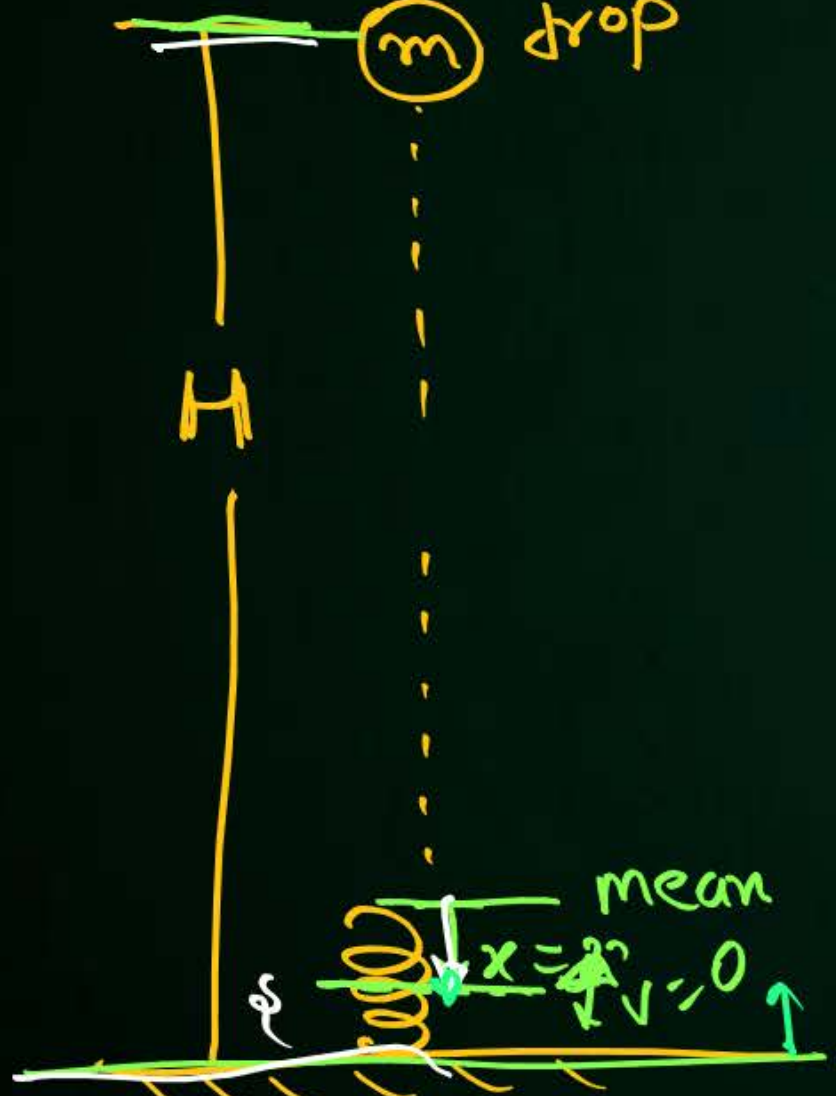
QUESTION

When a conservation force does positive work on a body

1. The potential energy increases
2. The potential energy decreases
3. Total energy increases
4. Total energy decreases

QUESTION

Ball is dropped from height H from ground then find maximum compression in spring, if length of spring is negligible in compare to H.



$$(K.E + U)_i = (K.E + U)_f$$

$$0 + mgH = 0 + \frac{1}{2}Kx^2$$

$$x = \sqrt{\frac{2mgH}{K}}$$

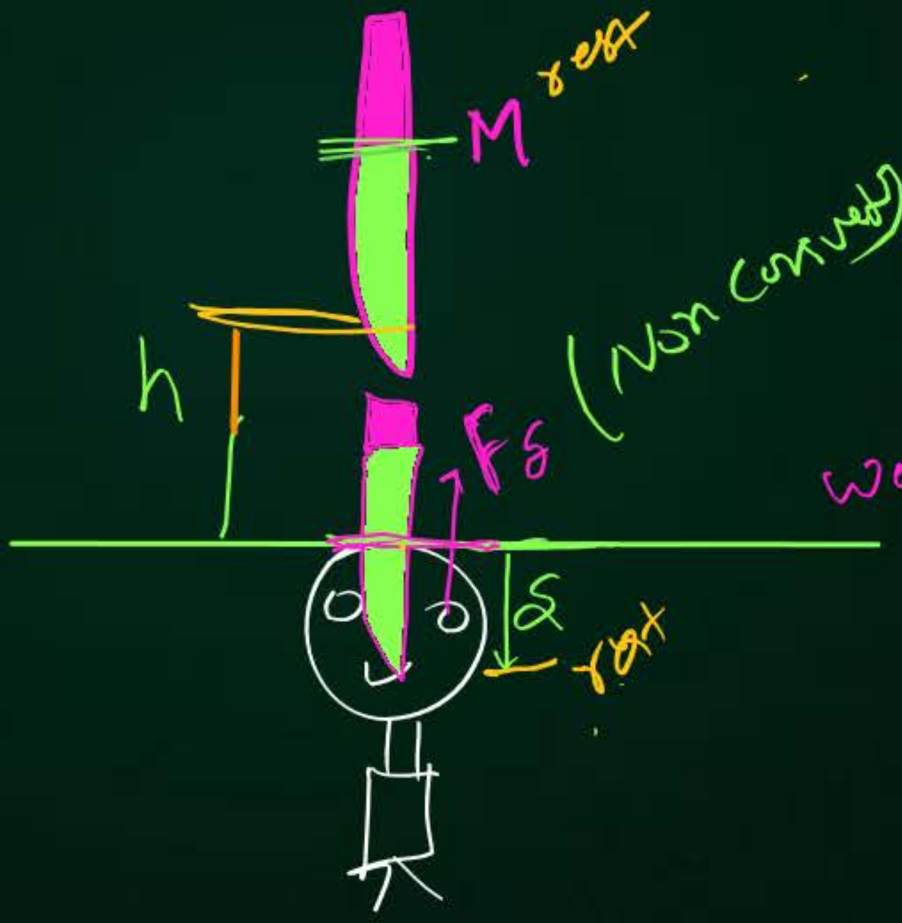
Ans

step-1
gravity | spring

step-2
Appl COM

QUESTION

An open knife edge of mass M is dropped from a height h on a wooden floor. If the blade penetrates distance into the wood, the average resistance offered by the wood to the blade is [AIMPT]



1. Mg

2. $Mg\left(1+\frac{h}{s}\right)$

3. $Mg\left(\frac{1-h}{s}\right)$

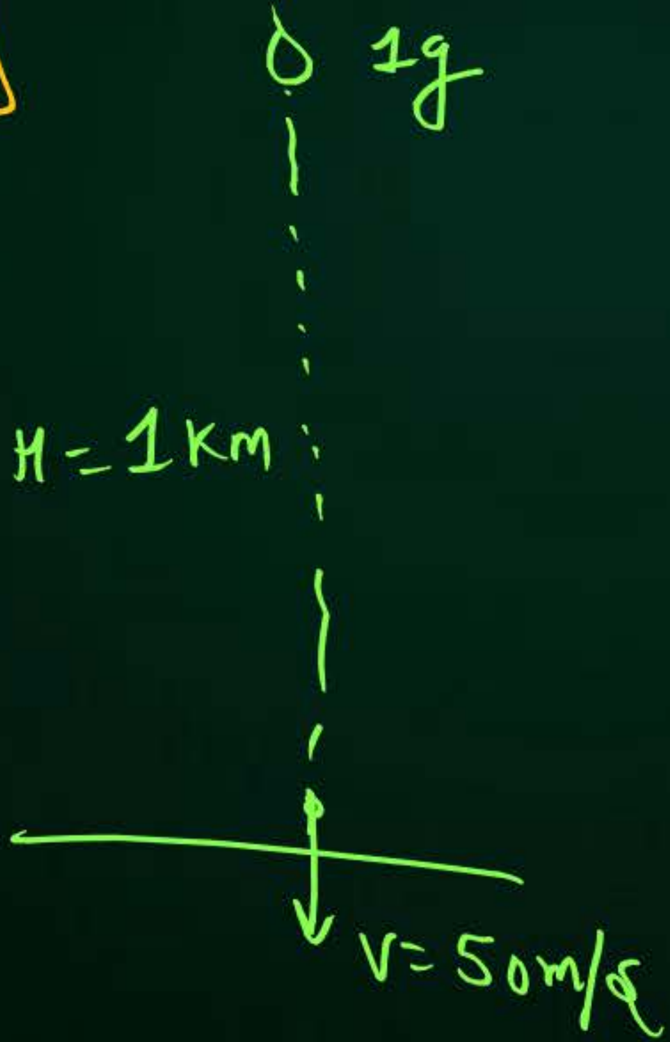
4. $Mg\left(\frac{1+h}{s}\right)^2$

QUESTION

ID: 37

Consider a drop of rain water having mass 1 g falling from a height of 1 km. It hits the ground with a speed of 50 m/s. Take 'g' constant with a value 10 m/s². The work done by the (i) gravitational force (ii) resistive force of airs is: [NEET-2017]

1. (i) 10 J (ii) –8.75 J
2. (i) 10 J (ii) 8.75 J
3. (i) 1.25 J (ii) –8.75 J
4. (i) 100 J (ii) –8.75 J



C.O.M.E is not applicable

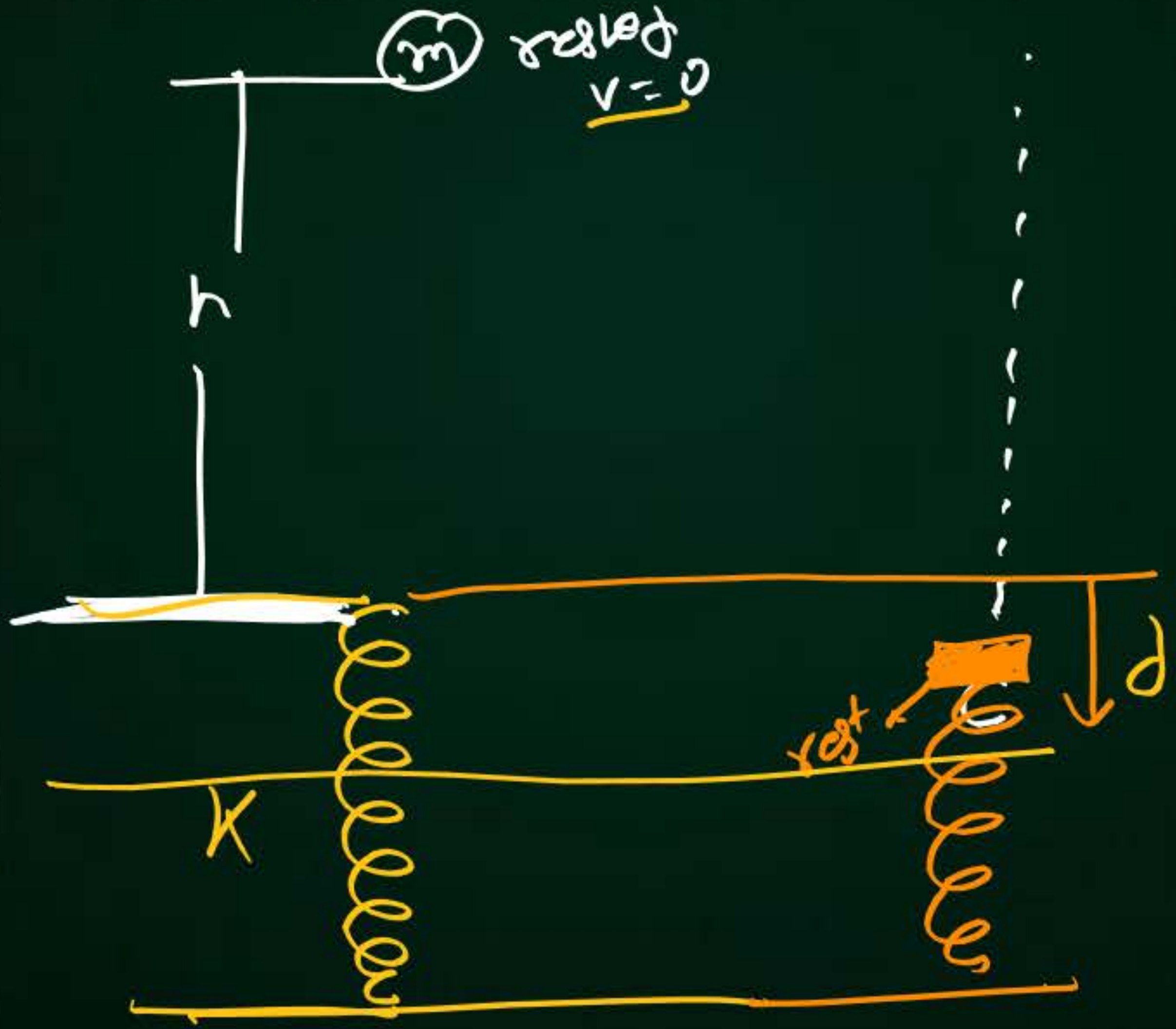
$W_g = mgH$

$= \frac{1}{1000} \times 10 \times 1000$

$= 10\,J$

A vertical spring with force constant k is fixed on a table. A ball of mass m at a height h above the free upper end of the spring falls vertically on the spring so that the spring is compressed by a distance d. The net work done in the process is

1. $mg(h + d) - \frac{1}{2}kd^2$
2. $mg(h - d) - \frac{1}{2}kd^2$
3. $mg(h - d) + \frac{1}{2}kd^2$
4. $mg(h + d) + \frac{1}{2}kd^2$



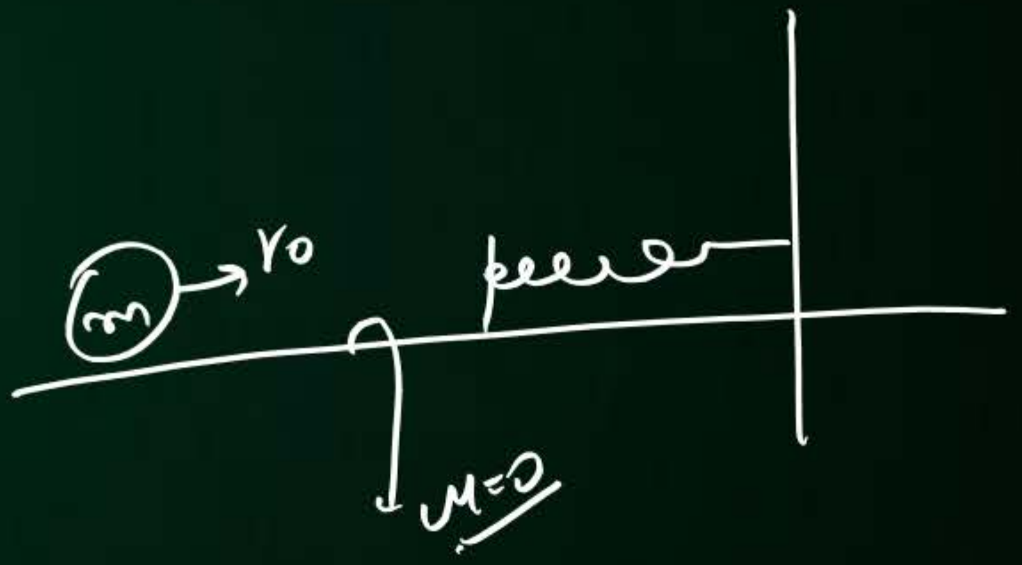
$W_{net} = W_g + W_{sf}$

$= mg(h+d) - \frac{1}{2}kd^2$

QUESTION

A mass of 0.5 kg moving with a speed of 1.5 m/s on a horizontal smooth surface, collides with a nearly weightless spring of force constant k = 50 N/m. The maximum compression of the spring would be

1. 0.15 m
2. 0.12 m
3. 0.5 m
4. 0.25 m

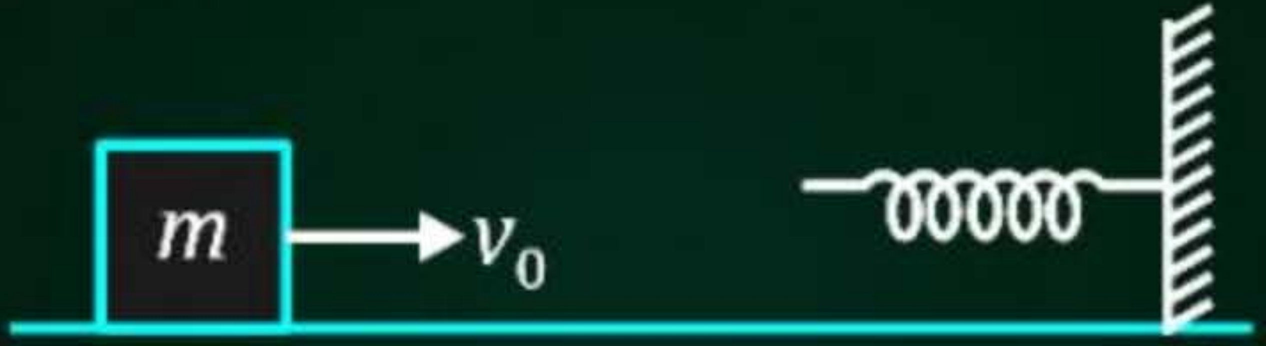


done

QUESTION

Level up

Find (maximum compression) and speed of block when spring is half compressed of maximum length.



Soln

(C.O.M.E) upto max^m comp^n

find (x_{max})

(COME) initial to half of comp^n

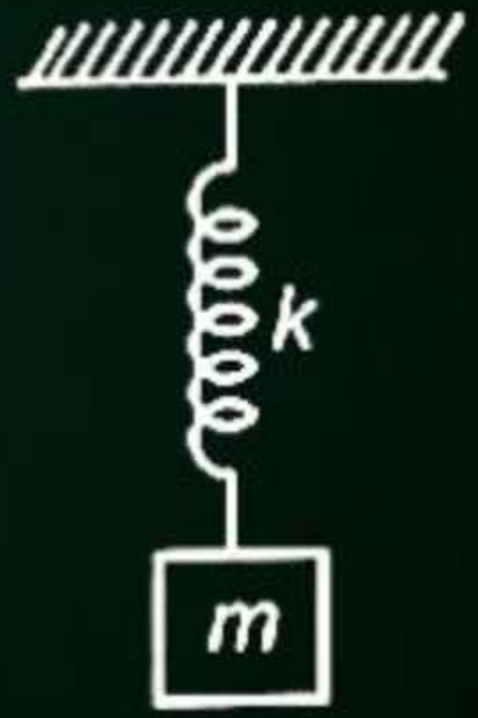
$$\frac{1}{2}mv_0^2 + 0 = \frac{1}{2}mv_1^2 + \frac{1}{2}k\left(\frac{x_m}{2}\right)^2$$

QUESTION

Initially mass m is held such that spring is in relaxed condition. If mass m is suddenly released, maximum elongation in spring will be

1. $\frac{m}{k}g$
2. $\frac{2mg}{k}$
3. $\frac{m}{2kg}$
4. $\frac{m}{4kg}$

H/W



QUESTION

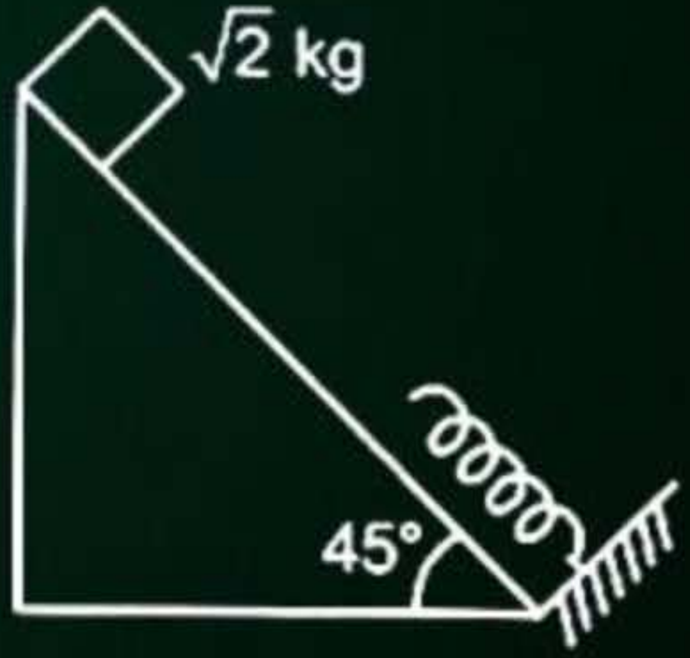
A particle of mass m is moving in horizontal circle of radius r under centripetal force equal to $-K/r^2$; where K is constant then find total mechanical energy.

H/W

QUESTION

A block of mass $\sqrt{2}$ kg is released from the top of an inclined smooth surface as shown in figure. If spring constant of spring is 100 N/m and block comes to rest after compressing the spring by 1 m, then the distance travelled by block before it comes to rest is

1. 1 m
2. 1.25 m
3. 2.5 m
4. 5 m



H/W

QUESTION

In the figure shown, a particle is released from the position Aon a smooth track. When the particle reaches at B, then normal reaction on it by the track is

1. mg
2. $2\ mg$
3. $2/3\ mg$
4. $m^2\ g$



H/W

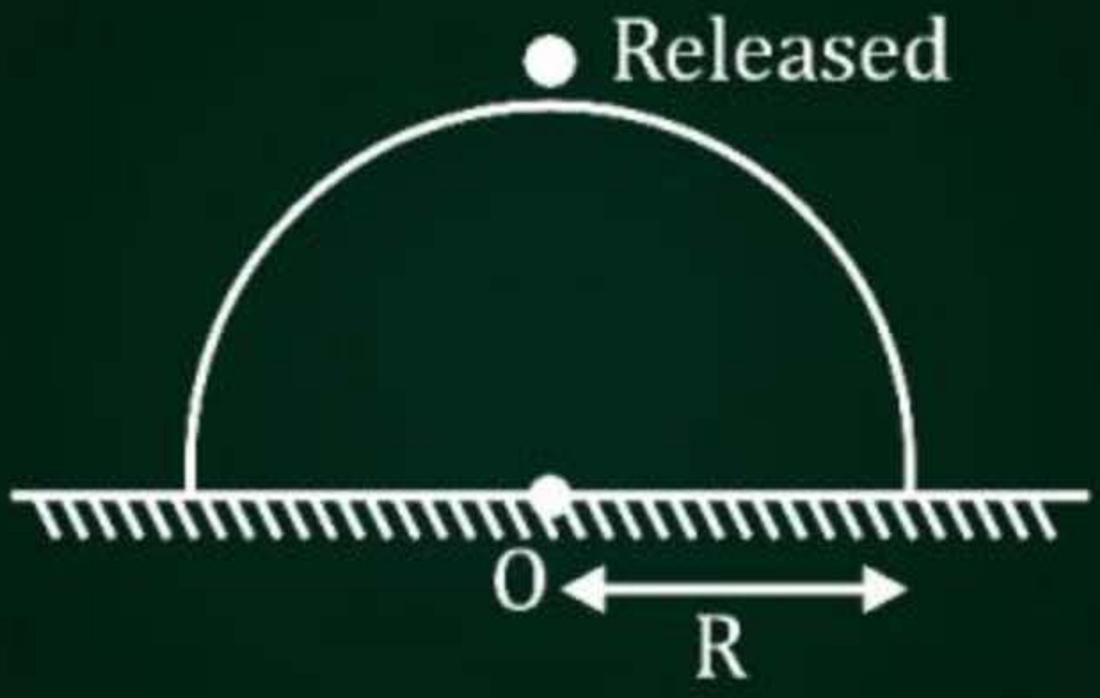
QUESTION

The PE of a 2 kg particle, free of move along x-axis is given by $V(x) = \left(\frac{x^3}{3} - \frac{x^2}{2}\right)$ J. The total mechanical energy of the particle is 4 Maximum speed (in ms^{-1}) is

1. $\frac{1}{\sqrt{2}}$
2. $\sqrt{2}$
3. $\frac{3}{\sqrt{2}}$
4. $\frac{5}{\sqrt{6}}$

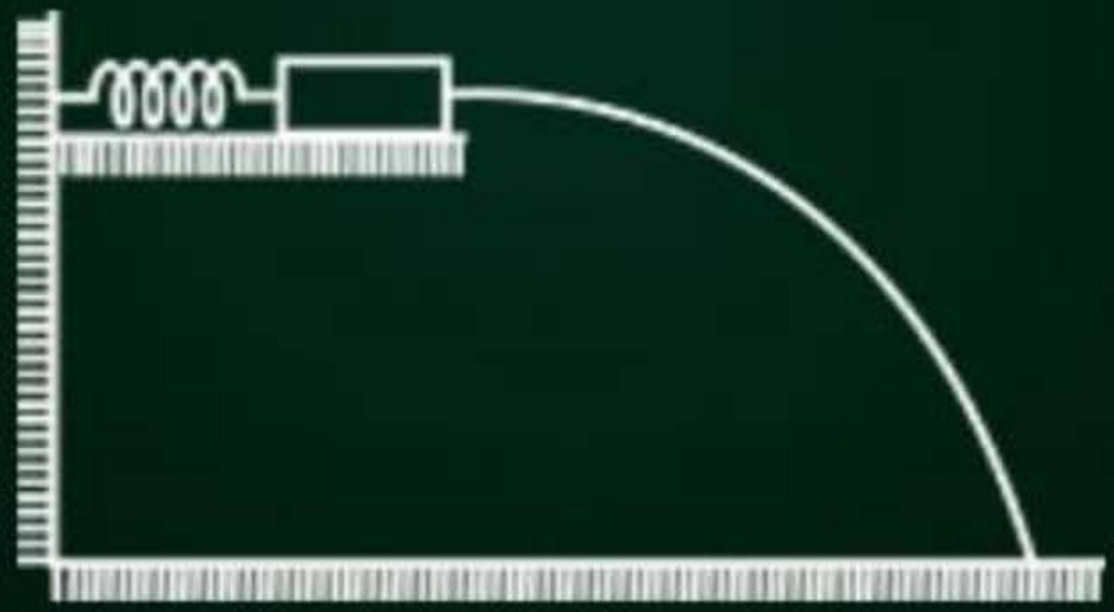
QUESTION

A ball of mass m released then find angle from vertical where, it will loose contact, hemispherical surface is smooth.



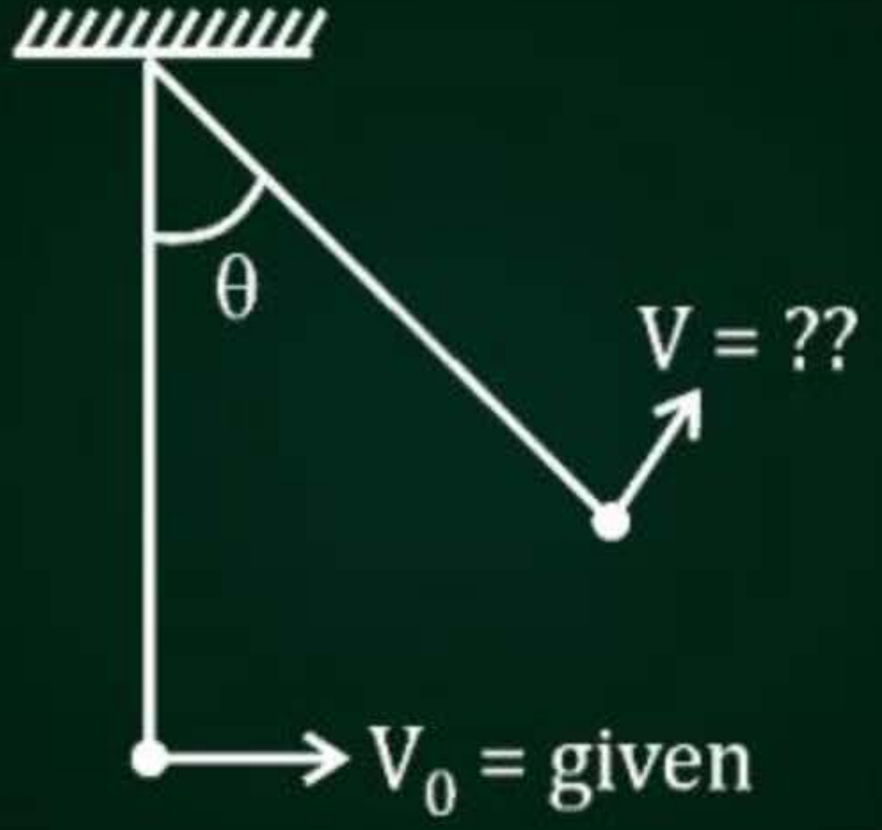
QUESTION

A shown in figure there is a spring block system. Block of mass 500 g is pressed against a horizontal spring fixed at one end to compress the spring through 5.0 cm. The spring constant is 500 N/m. When released, the block moves horizontally till it leaves the spring. Calculate the distance where it will hit the ground 4 m below the spring?



QUESTION

Find velocity of ball when string will make an angle θ from vertical.



THANK YOU



YAKEEN 2.0

FOR NEET 2025

Lecture- 08 | Physics

Work, Energy and Power

By- Dr. Manish Raj (MR SIR)



Todays Goal

⇒ Revision

⇒ H/W

- Questions on mechanical energy

Work energy theorem

$W_{(all\ forces)} = \Delta K.E$

→ असली Law

→ Always valid

Case-1 $\vec{F} \cdot d\vec{s} = \Delta K.E$

Case-2 $x(t)$, $v(t)$, $v(x)$

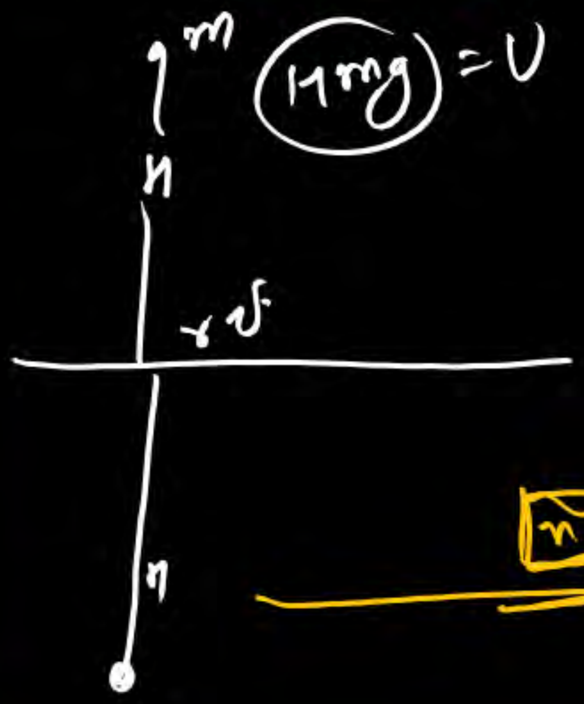
$Work = \Delta K.E = \frac{1}{2} m (v_f^2 - v_i^2)$

$W_{N.C.F} + W_{C.F} + W_{ifl} + W_{ext} + W_{p} = \Delta K.E$

$-W_{C.F} = \Delta U$ असली formula

$-W_{C.F} = U_f - U_i$ (with U_i crossed out and marked 0)







$K.E + U = K.E + U_f$

$\frac{1}{2} m v_i^2 + 0 + 0 = 0 + \frac{1}{2} k x^2$

Step-1 → Identify total no. of forces

Step-2 Nature of work done

$W_{N.C.F} = 0$ – COME

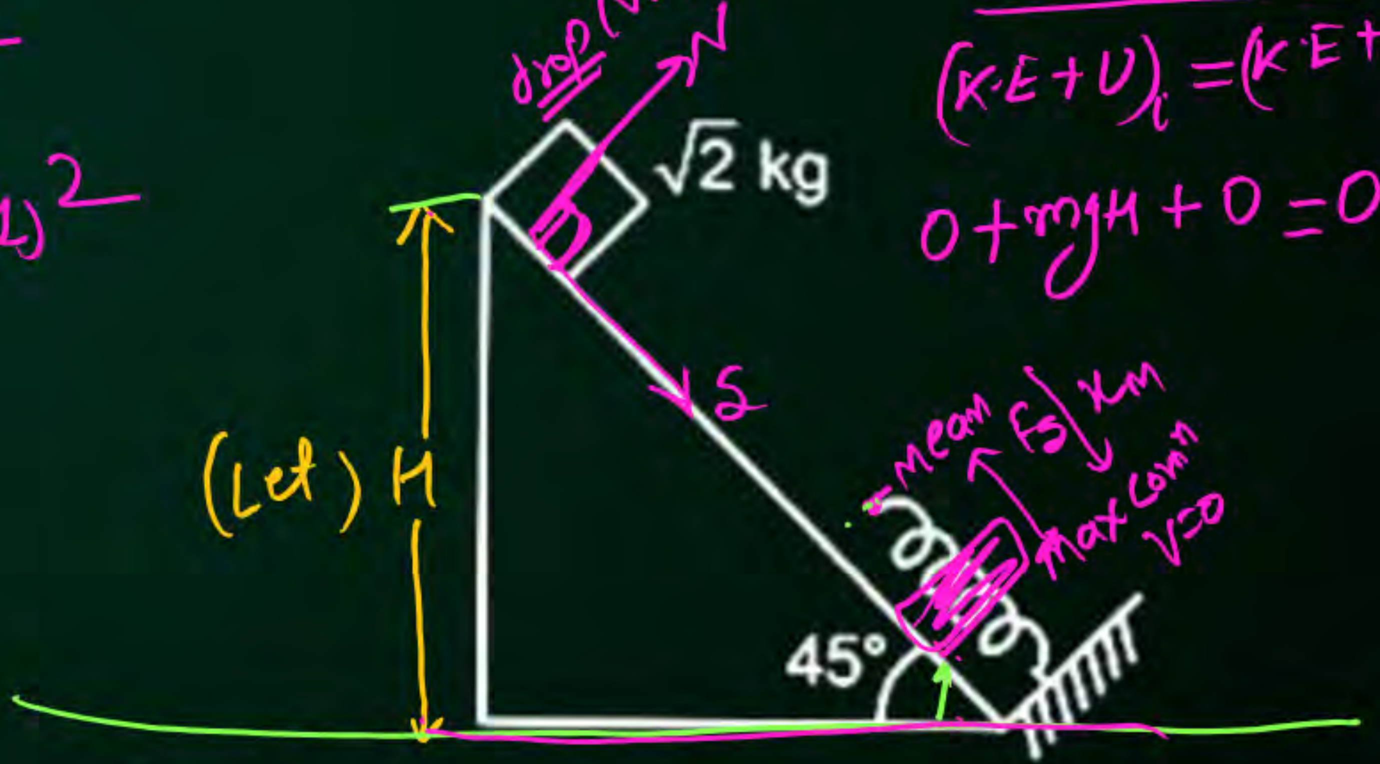
$W_{N.C.F} \neq 0$

WET[n]

$W = \Delta K.E$

QUESTION

A block of mass $\sqrt{2}$ kg is released from the top of an inclined smooth surface as shown in figure. If spring constant of spring is 100 N/m and block comes to rest after compressing the spring by 1 m, then the distance travelled by block before it comes to rest is



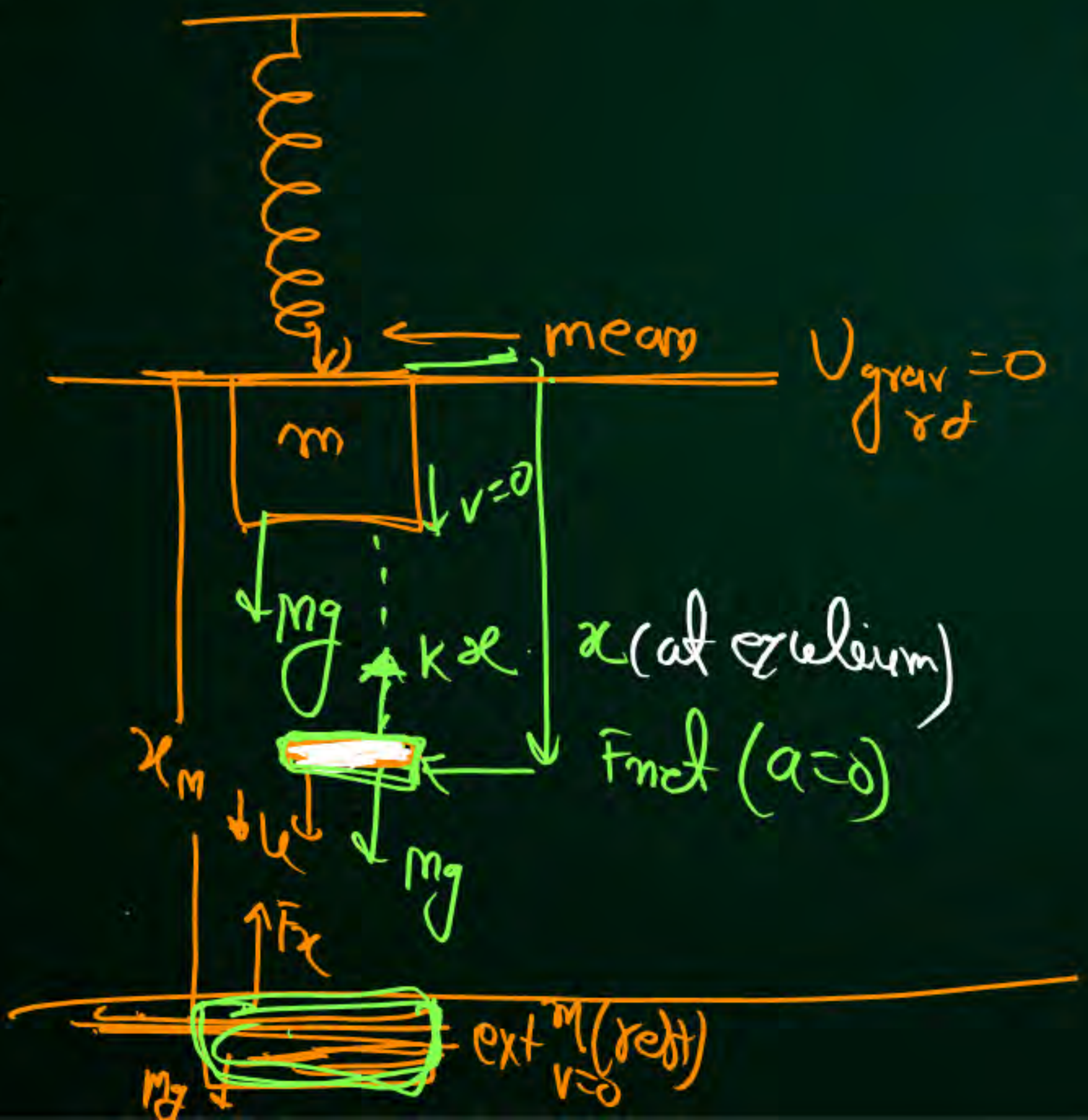
1. 1 m
2. 1.25 m
3. 2.5 m
4. 5 m

QUESTION

Initially mass m is held such that spring is in relaxed condition. If mass m is suddenly released, maximum elongation in spring will be

1. $\frac{m}{k}g$
2. $\frac{2mg}{k}$
3. $\frac{m}{2kg}$
4. $\frac{m}{4kg}$

C.O.M.E



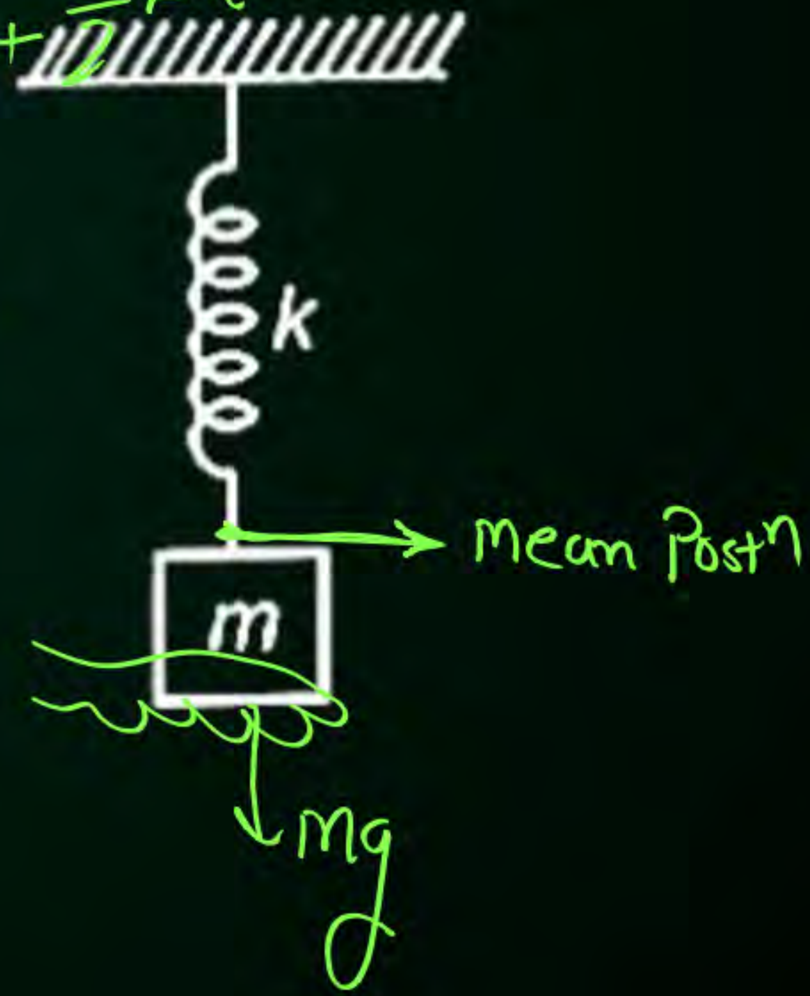
$(K.E+U)_i = (K.E+U)_f$

$0+0+0 = 0 - mgx_m + \frac{1}{2}kx^2$

$mgx_m = \frac{1}{2}kx_m x_m$

$x_m = \left[\frac{2mg}{K}\right]$

Ans 2



QUESTION

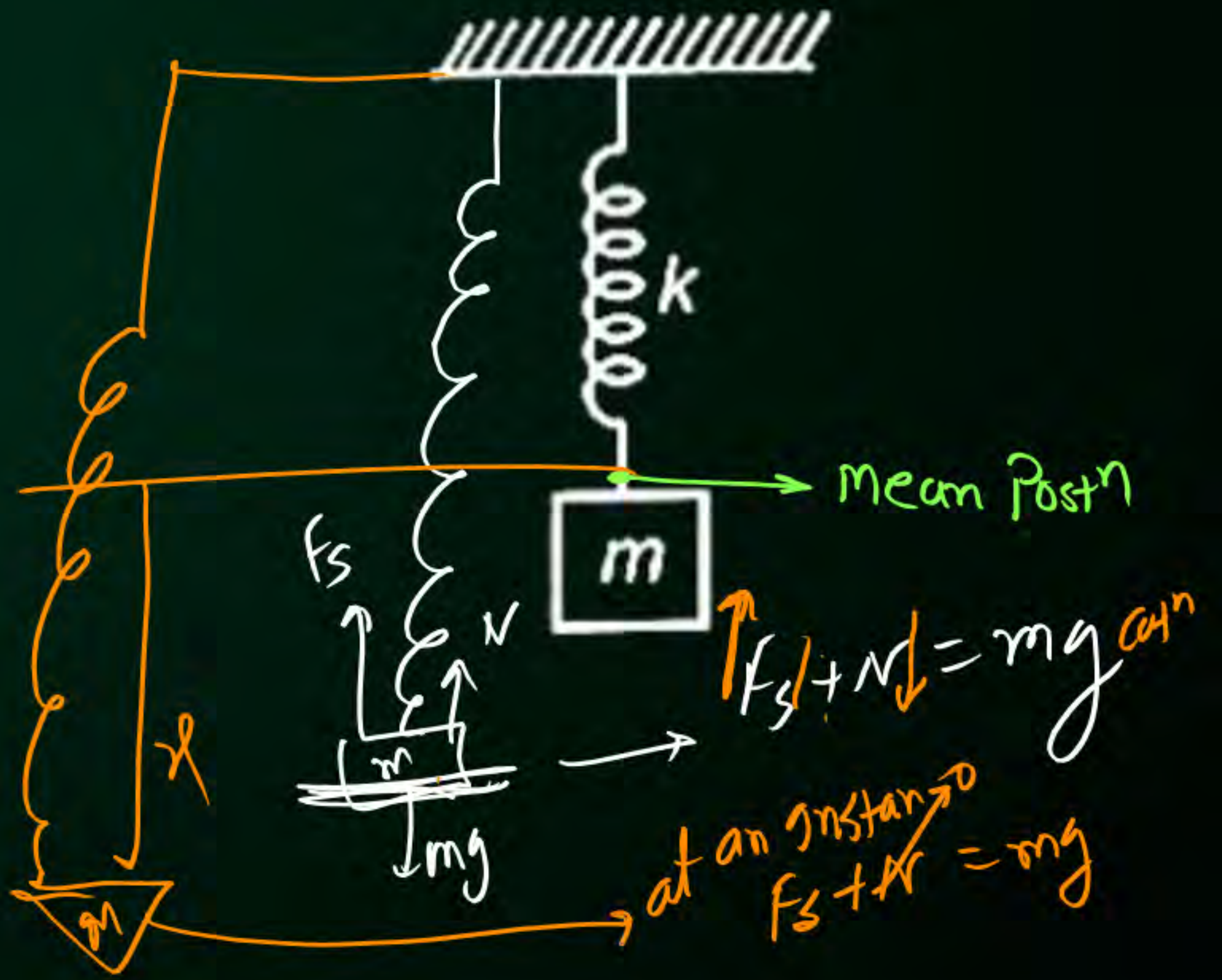
Initially mass m is held such that spring is in relaxed condition. If mass m is released, maximum elongation in spring will be

1. $\dfrac{m}{k}g$
2. $\dfrac{2mg}{k}$
3. $\dfrac{m}{2kg}$
4. $\dfrac{m}{4kg}$

C.O.M.E नहीं लगेगा

$kx = mg$

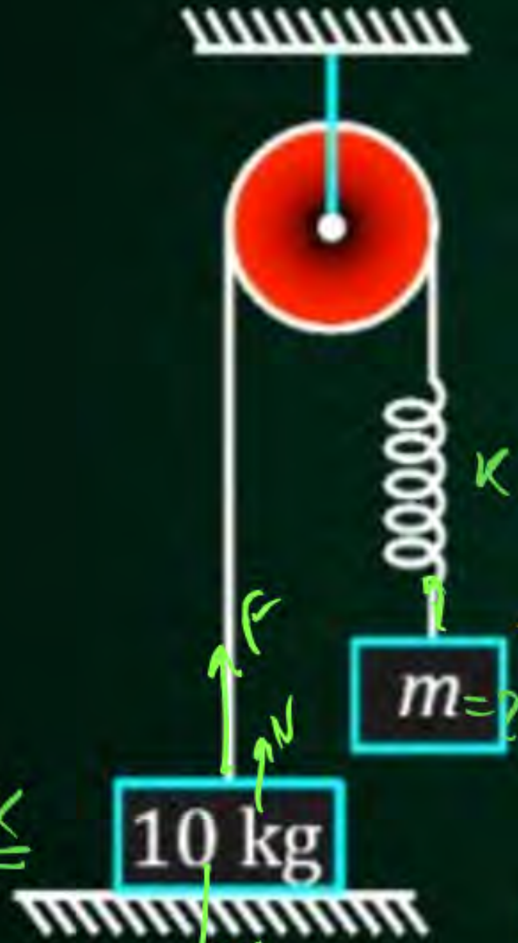
$x = \dfrac{mg}{k}$ Ans



QUESTION

Find minimum value of m so that block leave contact from ground.





released when spring is at natural length

QUESTION

A particle of mass m is moving in horizontal circle of radius r under centripetal force equal to $-K/r^2$; where K is constant then find total mechanical energy.

$F_c = -\frac{K}{r^2}$

dirⁿ



$F = \frac{K}{r^2} = \frac{mv^2}{r}$

$\frac{K}{r} = mv^2$ — (1)

Multiply by $\frac{1}{2}$ both side

$K.E = \frac{1}{2}mv^2 = \frac{K}{2r}$

$F = -\frac{dU}{dr}$

$dU = -F \cdot dr$

$\int dU = \int \frac{K}{r^2} dr$

$U = K\left[-\frac{1}{r}\right]$

$U = -\frac{K}{r}$

$K.E + P.E = M.E$

$\frac{K}{2r} - \frac{K}{r} = M.E$

$M.E = -\frac{K}{2r}$

gravitation

atom

QUESTION

The PE of a 2 kg particle, free of move along x-axis is given by $V(x) = \left(\frac{x^3}{3} - \frac{x^2}{2}\right)$ J. The total mechanical energy of the particle is 4 J. Maximum speed (in ms^{-1}) is

1. $\frac{1}{\sqrt{2}}$
2. $\sqrt{2}$
3. $\frac{3}{\sqrt{2}}$
4. $\frac{5}{\sqrt{6}}$

$U = \frac{x^3}{3} - \frac{x^2}{2}$

M.E = 4 J

Mass = 2 kg

C.O.M.E

K.E + U = Const

K.E + U = M.E

$(K.E)_{Max} + U_{min} = 4J$

$\frac{1}{2} m v_m^2 + U_{min} = 4J$

$v_m^2 - \frac{1}{6} = 4$

$v_m^2 = 4 + \frac{1}{6} = \frac{25}{6}$

$v_m = \sqrt{\frac{25}{6}}$ m/s

$U = \frac{x^3}{3} - \frac{x^2}{2}$

We have to find U_{min} ??

U will be max^m or min^m at

$\frac{dU}{dx} = 0 = \frac{3x^2}{3} - \frac{2x}{2}$

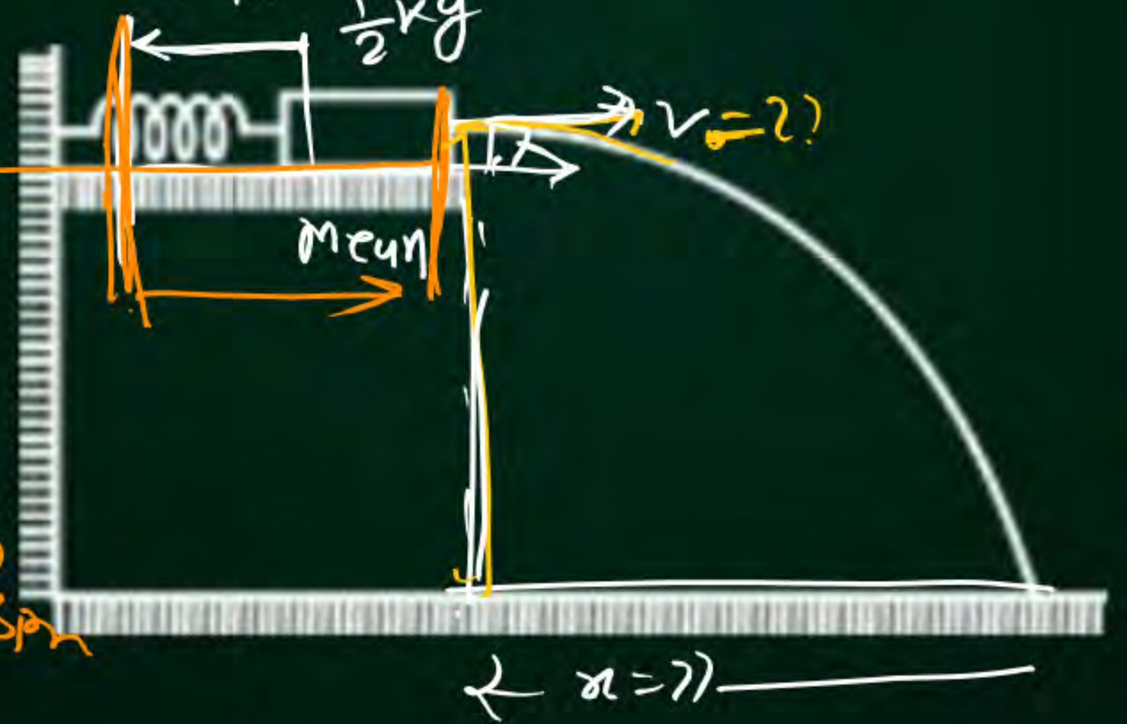
$x^2 - x = 0$

$x(x-1) = 0 \rightarrow x = 0, x = 1$

$U_{x=0} = 0$

$U_{x=1} = \frac{1}{3} - \frac{1}{2} = \frac{2-3}{6} = \frac{-1}{6}$

A shown in figure there is a spring block system. Block of mass 500 g is pressed against a horizontal spring fixed at one end to compress the spring through 5.0 cm. The spring constant is 500 N/m. When released, the block moves horizontally till it leaves the spring. Calculate the distance where it will hit the ground 4 m below the spring?



C.O.M.E

Compression to mean

$K.E + U = \text{Const}$

$0 + 0 + \frac{1}{2}kx^2 = \frac{1}{2}mv^2 + 0 + 0$

$\frac{1}{2} 500 \left(\frac{5}{100}\right)^2 = \frac{1}{2} \cdot \frac{1}{2} v^2$

$\frac{500 \times 25}{100 \times 100} = \frac{1}{2} v^2$

$\frac{250}{100} = v^2 \quad v = \sqrt{\frac{25}{10}}$

$T_f = \sqrt{\frac{2H}{g}} = \sqrt{\frac{2 \times 4}{10}} = \sqrt{\frac{8}{10}}$

$R = u_x T_f$

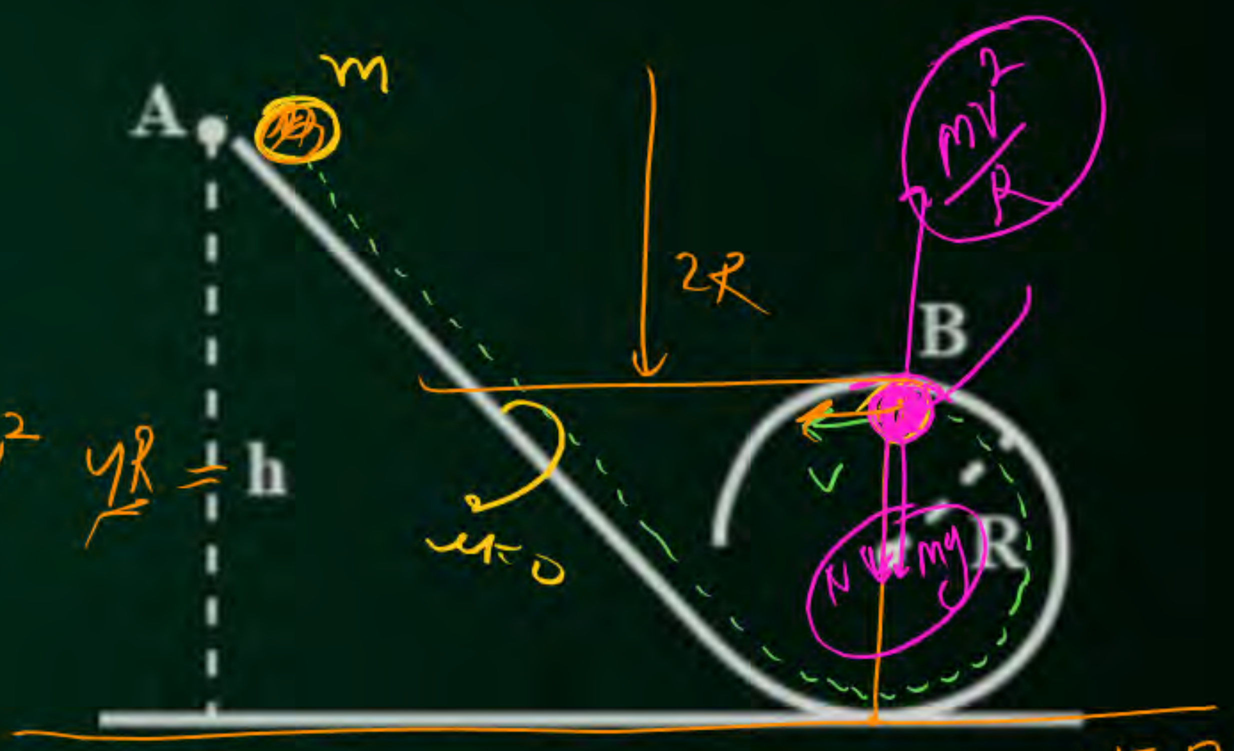
$= \sqrt{\frac{25}{10}} \times \sqrt{\frac{8}{10}}$

$= \sqrt{\frac{200}{100}} = \sqrt{2}\ m$

QUESTION

In the figure shown, a particle is released from the position A on a smooth track. When the particle reaches at B, then normal reaction on it by the track is

1. 3mg
2. 2 mg
3. 2/3 mg
4. $m^2 g$



(C.O.ME) B/w A & B

K.E + U =

$0 + mg4R = mg(2R) + \frac{1}{2}mv^2$ 4R = h

$4gR - 2gR = \frac{v^2}{2}$

$2gR = \frac{v^2}{2}$

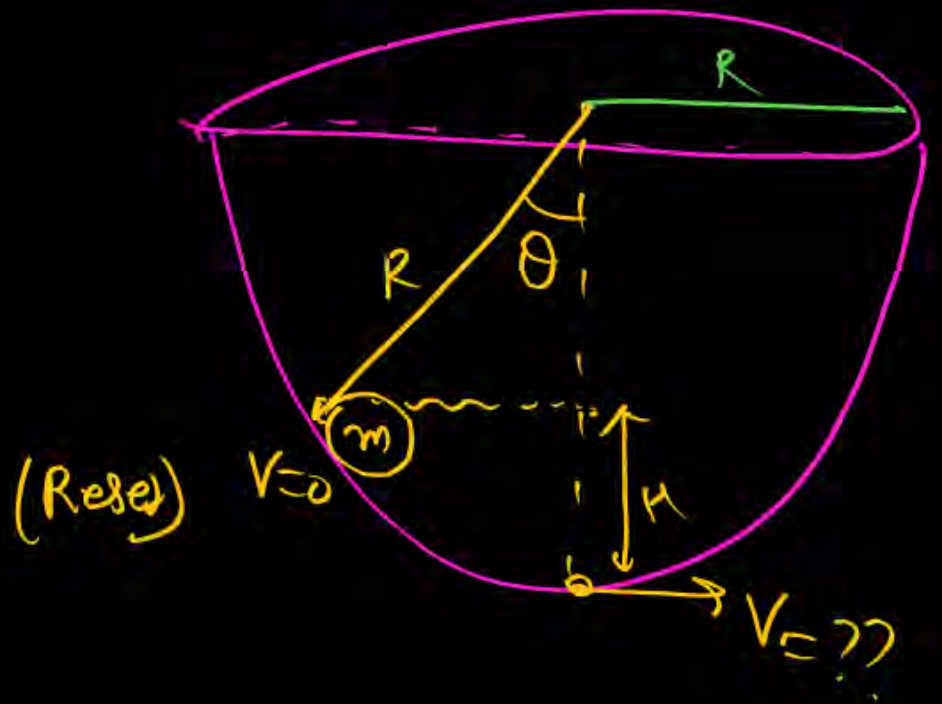
$v^2 = 4gR$

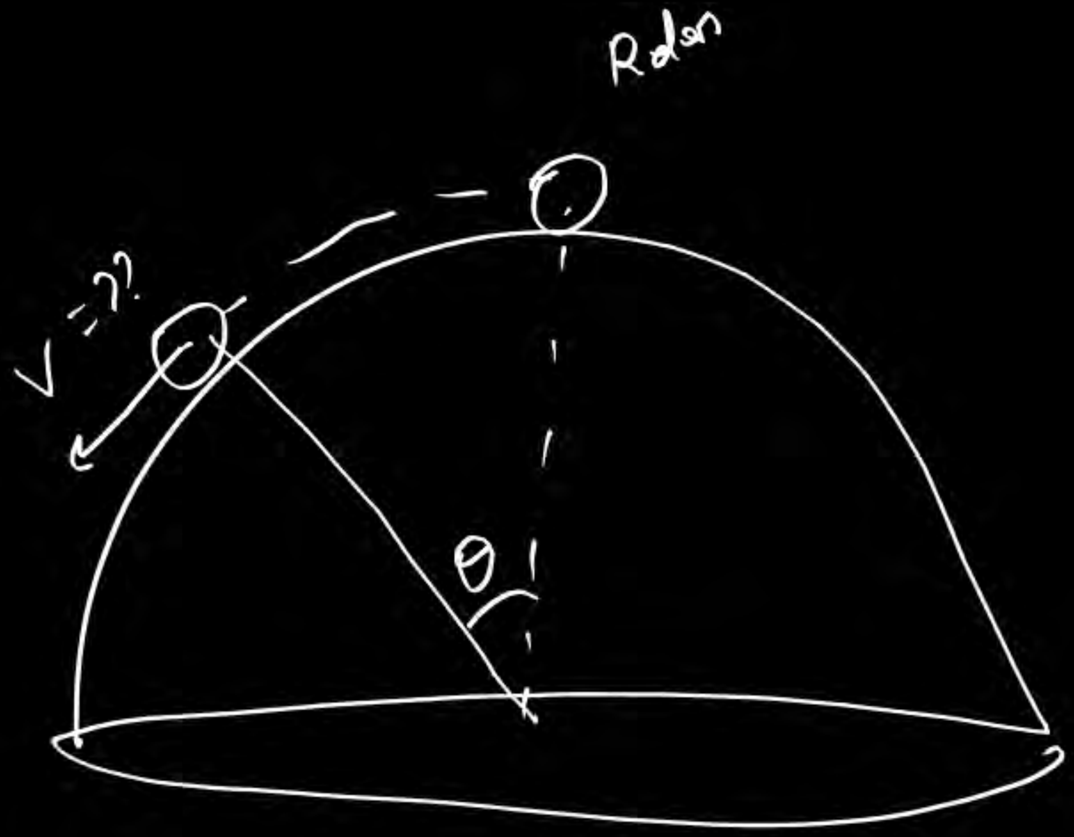
$V = \sqrt{2gH_w} = \sqrt{2g(2R)}$

$\frac{mv^2}{R} = N + mg$

$\frac{m\,4gR}{R} = N + mg$

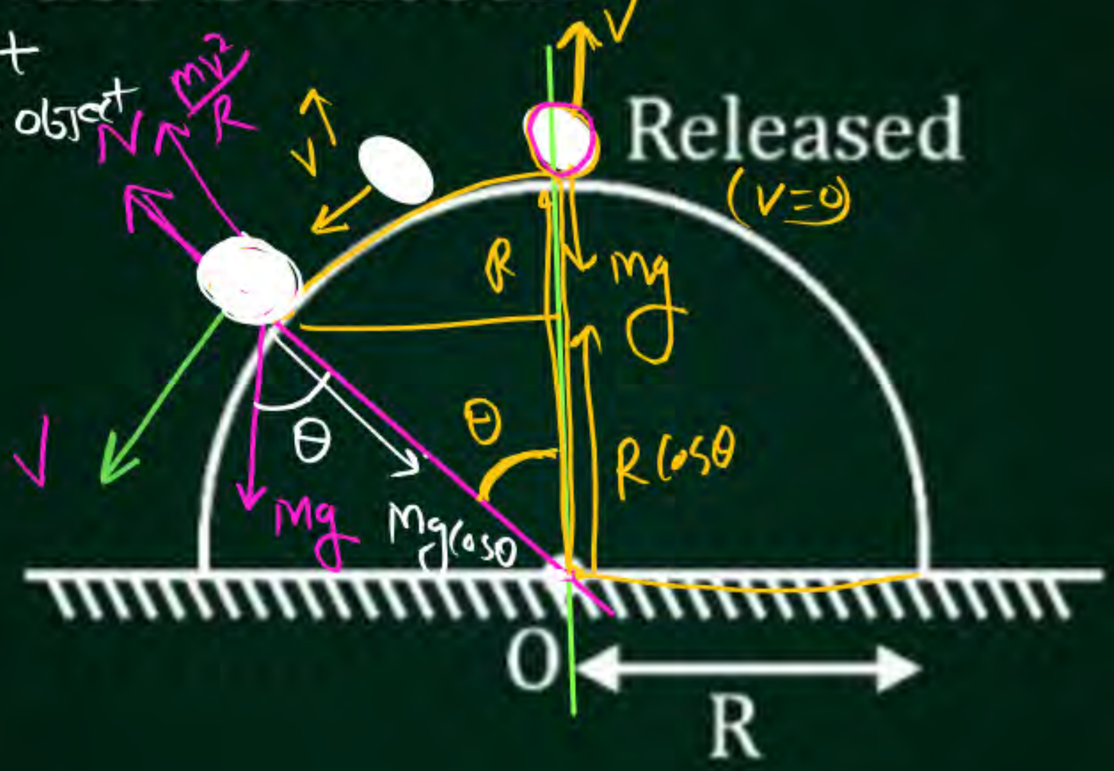
$N = 4mg - mg = 3mg$


R
R
θ
m
(Resel)
V=0
H
V=??


Rdon
V=??
θ

QUESTION

A ball of mass m released then find angle from vertical where, it will loose contact, hemispherical surface is smooth.



F.B.D of object w.r.t Ramlal sitting on object

$$mg\cos\theta = N + \frac{mv^2}{R}$$

If contact becomes zero ($N=0$)

$$mg\cos\theta = \frac{mv^2}{R}$$

Putting value of 'v'

$$mg\cos\theta = \frac{m}{R}\,2gR(1-\cos\theta)$$

$$\cos\theta = 2(1-\cos\theta)$$

$$3\cos\theta = 2$$

$$\cos\theta = \frac{2}{3}$$

$$\theta = \cos^{-1}(2/3)$$ Ans.

MB* $v = \sqrt{2g(H_{ver})_{dis}}$

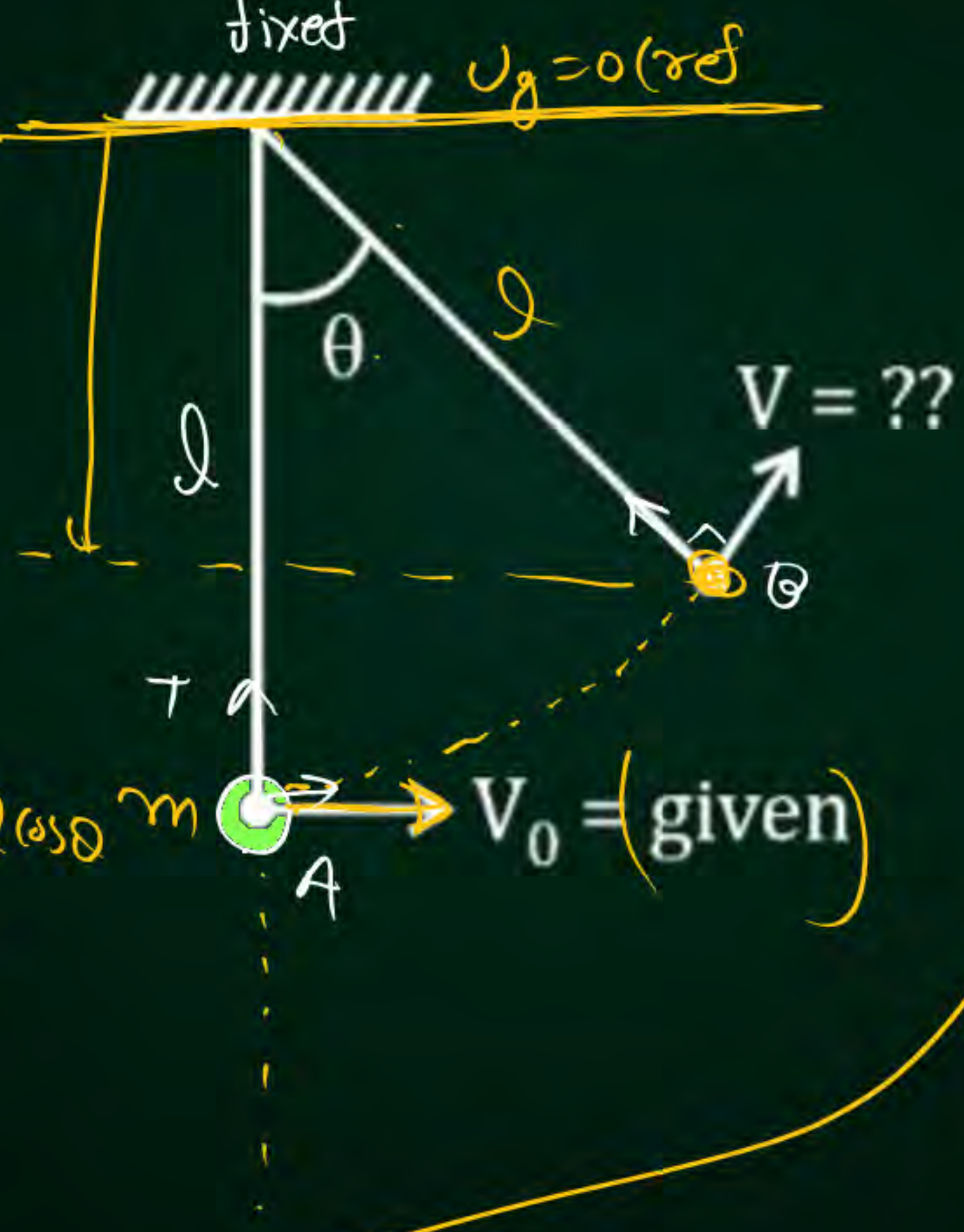
$$v = \sqrt{2g(R - R\cos\theta)}$$

$$v = \sqrt{2gR(1-\cos\theta)}$$

QUESTION

Find velocity of ball when string will make an angle θ from vertical.

$W_{Tension} = 0$



C.o.M.E. B/w A & B

$(K.E + U)_i = (K.E + U)_f$

$-mgl + \frac{1}{2}mv_0^2 = \frac{1}{2}mv^2 - mgl\cos\theta$

$gl\cos\theta - gl + \frac{v_0^2}{2} = \frac{v^2}{2}$

$gl(\cos\theta - 1) + \frac{v_0^2}{2} = \frac{v^2}{2}$

Both side multiplied by 2

$v^2 = v_0^2 + 2gl(\cos\theta - 1)$

$V = \sqrt{v_0^2 + 2gl(\cos\theta - 1)}$ (smaller than 1)

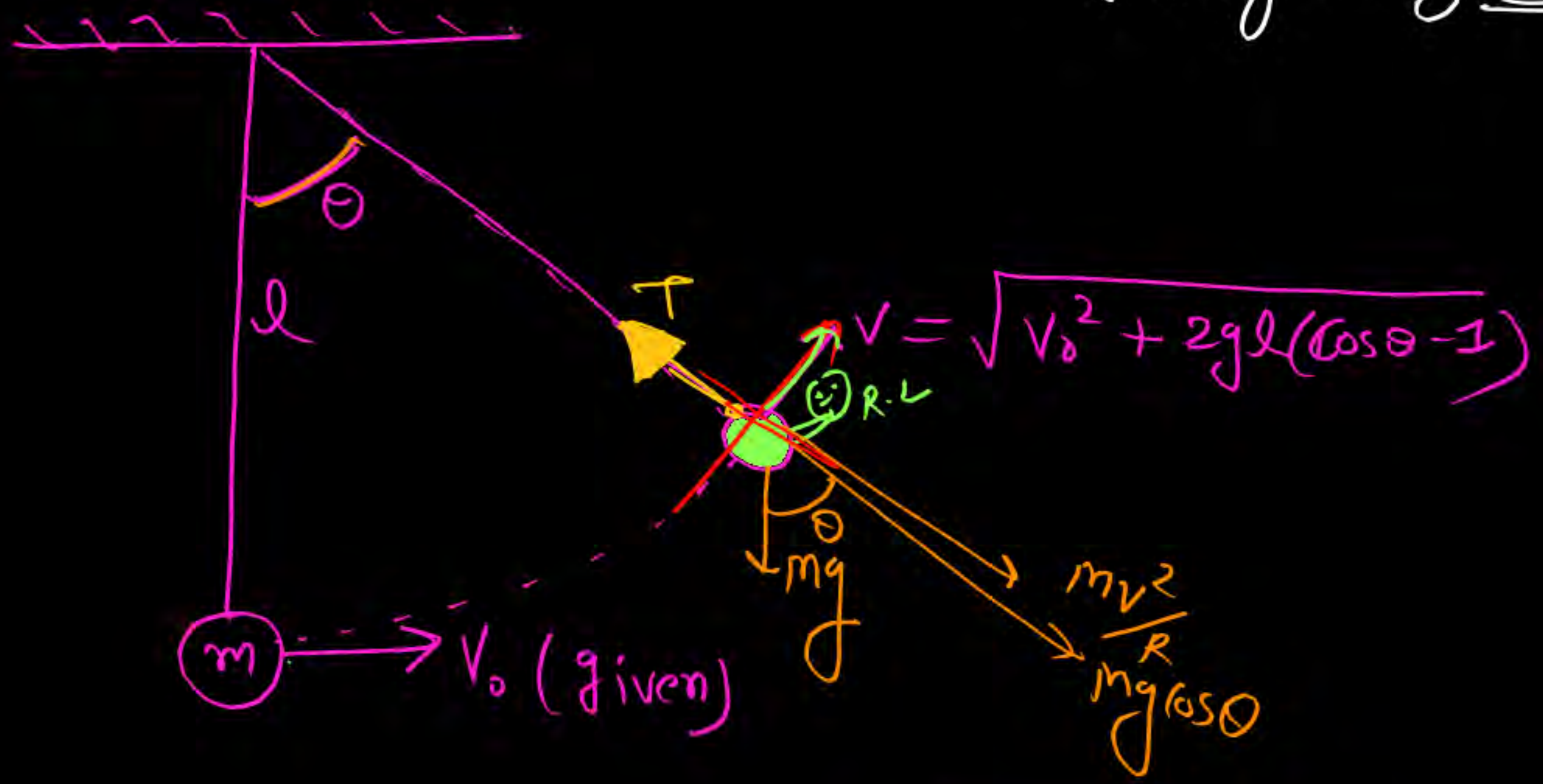
dim^n analysis

mR* gf $\theta = 0°$

$u = v_0$

$V < v_0$

find Tension when object is Rotated through angle 'θ'



F.B.D of object w.r.t Ramlal

$(F_{net})_{along\ radius} = 0$

$$T_{\theta} = \frac{mv^2}{l} + mg\cos\theta$$

→ Tension at angle T_θ

Putting value of V

$$T = \frac{m}{l}\left(V_0^2 + 2gl(\cos\theta - 1)\right) + mg\cos\theta$$

$$T = \frac{mV_0^2}{l} + \frac{2mgl(\cos\theta - 1)}{l} + mg\cos\theta$$

$$T = \frac{mV_0^2}{l} + 2mg\cos\theta - 2mg + mg\cos\theta$$

$$T = \frac{mV_0^2}{l} - 2mg + 3mg\cos\theta$$

MR. Rafte

$$T = \frac{mv_0^2}{l} - 2mg + 3mg\cos\theta$$

$$T_{(\theta=0)} = \frac{mv_0^2}{l} - 2mg + 3mg$$

$$T_{\theta=0^\circ} = \frac{mv_0^2}{l} + mg$$

$T_B =$ $T_D =$

$T_C =$

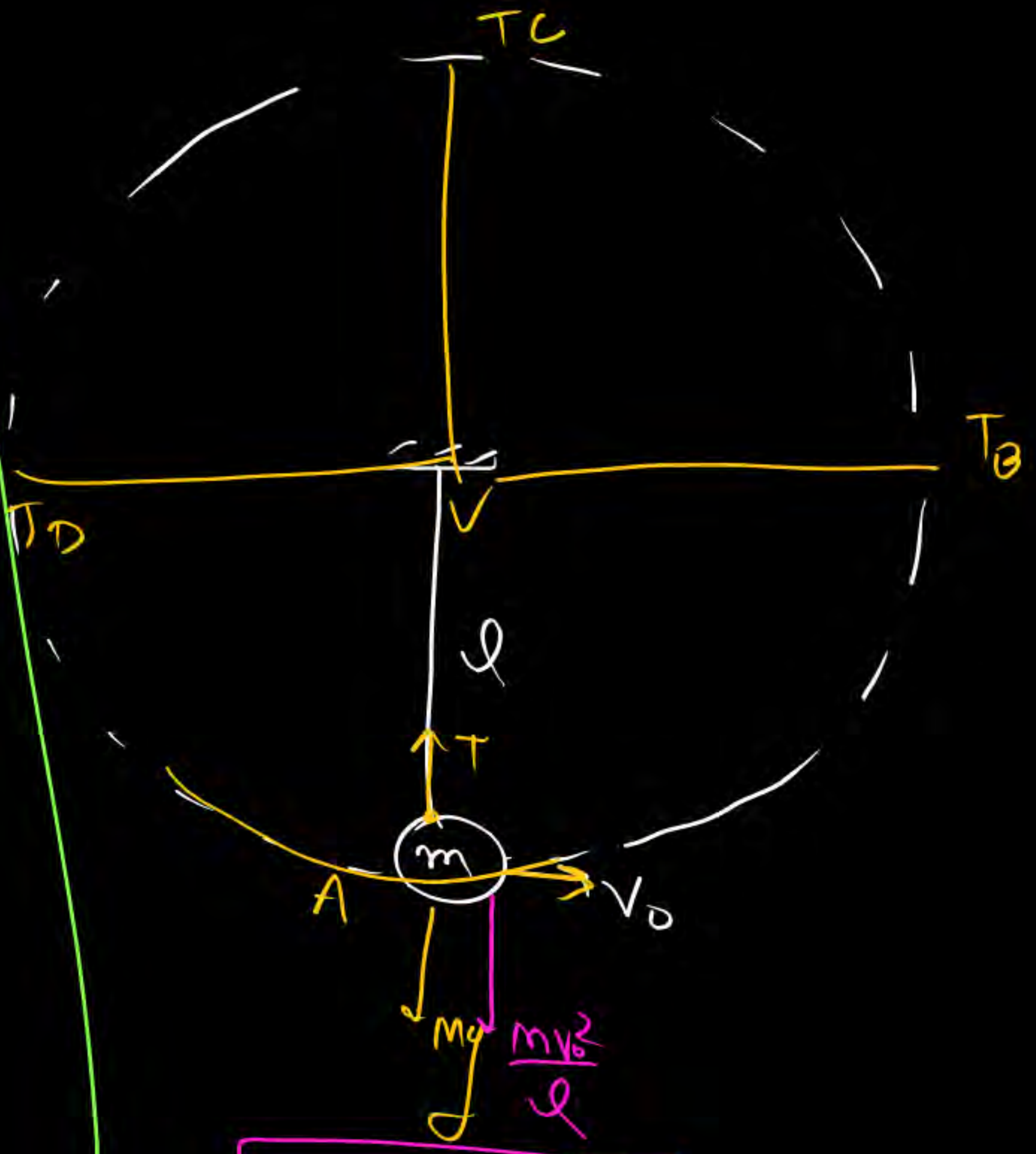
$T_A - T_B = ??$

$T_A - T_C =$

$T_A - T_D =$

$T_B - T_D = ??$

H/W



$$T_A = mg + \frac{mv_0^2}{l}$$


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 09 | **Physics**

Work, Energy and Power



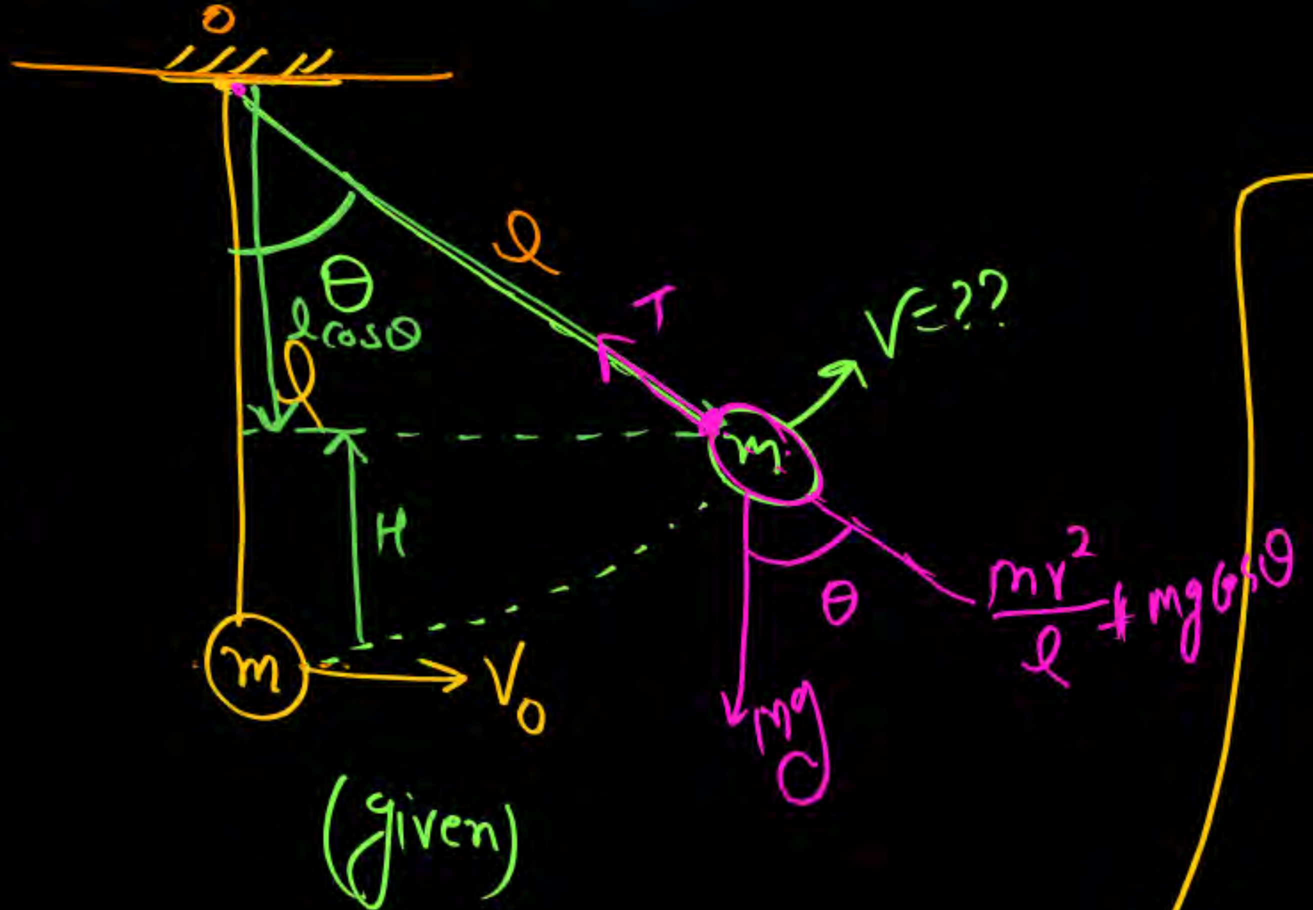
By- Dr. Manish Raj (MR SIR)

Vertical circular motion

→ This is an example of conservation mehanical enegy.

Vertical circular motion

If velocity at mean position is v_0 then find velocity after θ angular dispm??



Work energy thm

$W_g + W_T^{\,0} = \Delta K.E$

$-mgH = \frac{1}{2}m(v^2 - v_0^2)$

$-mg(l - l\cos\theta) = \frac{1}{2}m(v^2 - v_0^2)$

$-2gl(1-\cos\theta) = v^2 - v_0^2$

$v^2 = v_0^2 - 2gl(1-\cos\theta)$

$v = \sqrt{v_0^2 - 2gl(1-\cos\theta)}$

$V = \sqrt{V_0^2 + 2gl(\cos\theta - 1)}$

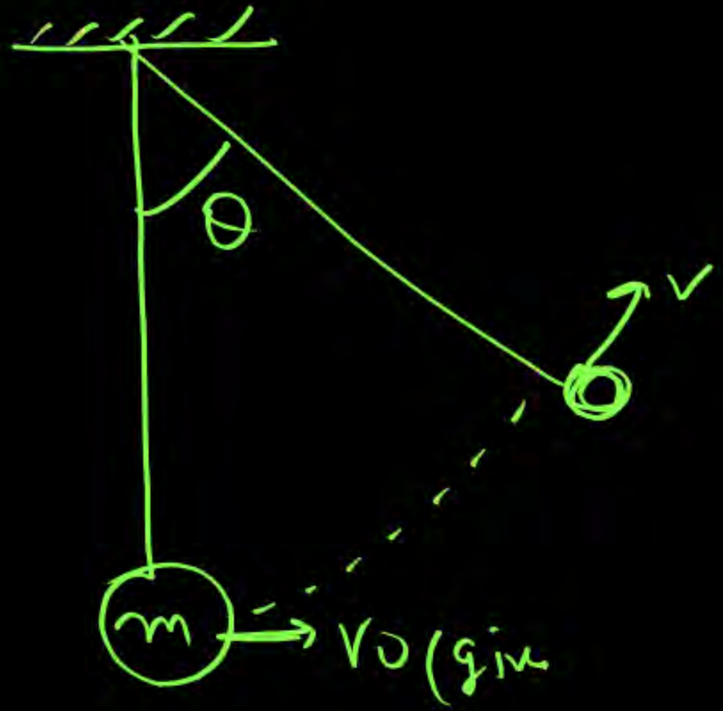
F.B.D w.r.t Ramlal sitting on object.

$F_{\text{along radius}} = 0$

$$T = \frac{mv^2}{l} + mg\cos\theta$$

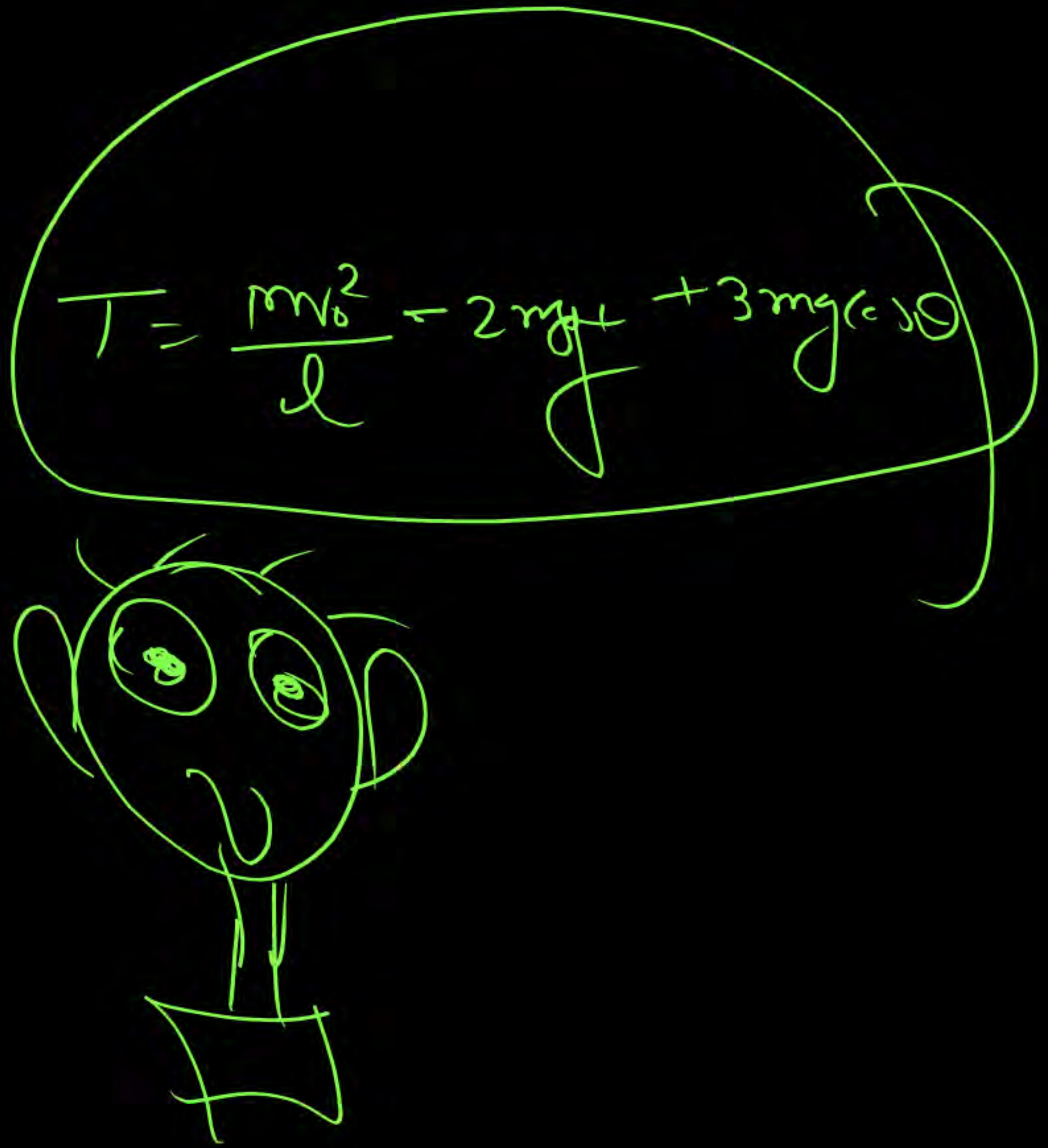
Put value v in terms v_0

$$T = \frac{mv_0^2}{l} - 2mg + 3mg\cos\theta$$



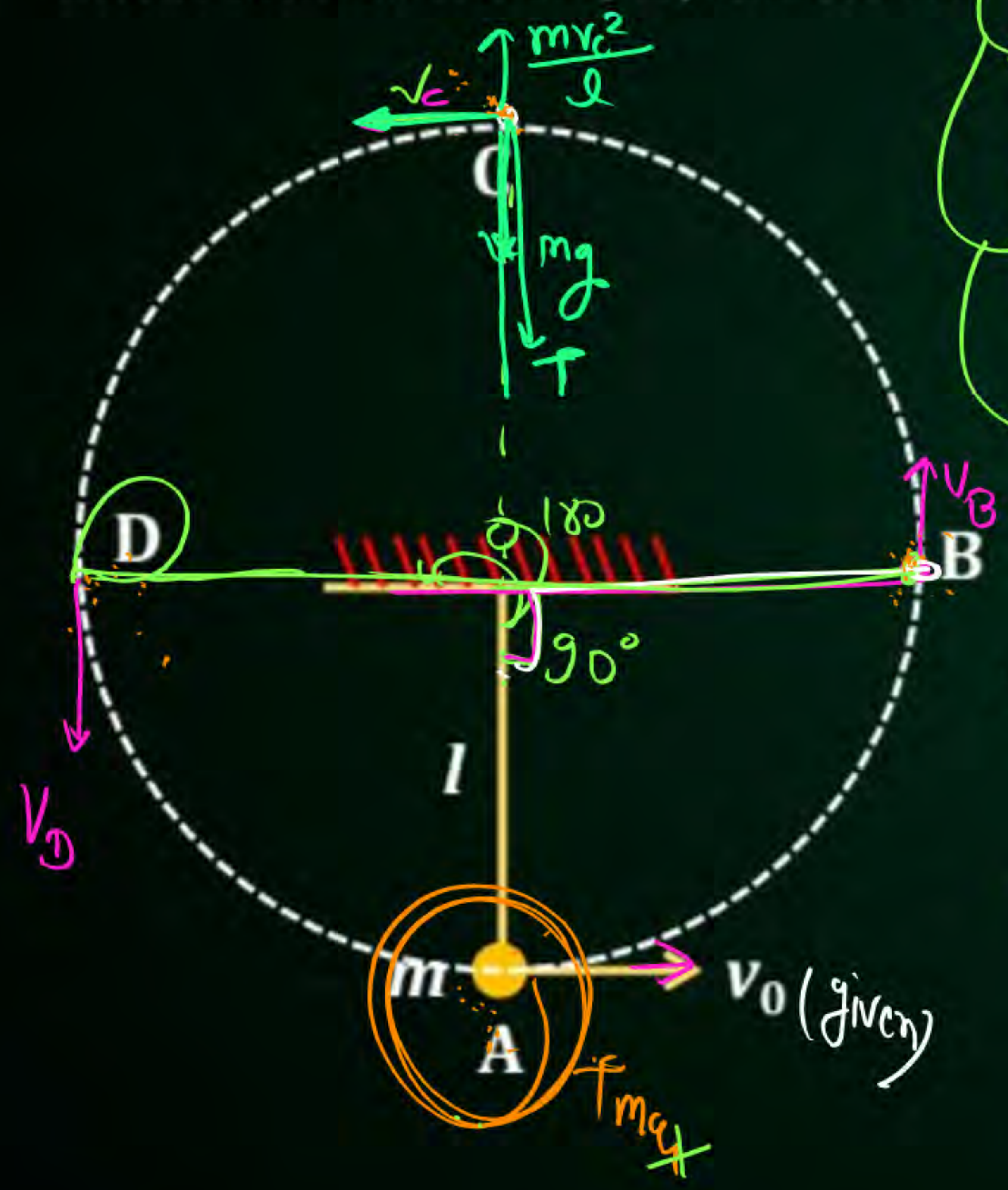
$V^2 = V_0^2 + 2gl(\cos\theta - 1)$ — (1)

$T = \dfrac{mV_0^2}{l} - 2mg + 3mg\cos\theta$ — (2)



QUESTION

Find tension at A, B, C and D.



$$\left\{ V_{\text{At } \theta}^2 = V_0^2 + 2gl(\cos\theta - 1) \right\}$$

$$V_B^2 = V_0^2 - 2gl \quad (\theta = 90°) \quad \text{—} (\text{i})$$

$$V_C^2 = V_0^2 - 4gl \quad (\theta = 180) \quad \text{—} (\text{ii})$$

$$V_D^2 = V_0^2 - 2gl \quad (\theta = 270°) \quad \text{—} (\text{iii})$$

$$V_{\theta=0} = V_0$$

$$T_{\text{at Angle } \theta} = \frac{mv_0^2}{l} - 2mg + 3mg\cos\theta$$

$$T_B = \frac{mv_0^2}{l} - 2mg \quad (\theta = 90°)$$

$$(T_C)_{\theta=180} = \frac{mv_0^2}{l} - 5mg \quad \text{minm.}$$

$$T_D = \frac{mv_0^2}{l} - 2mg \quad (\theta = 270)$$

Tension depends on given velocity v_0

$$\left(T_{\theta=0} \text{ at A}\right)_{\text{maximum}} = \frac{mv_0^2}{l} + mg$$

diffrence in tension at different Point does not depend on velocity.

$$\{T_B - T_D = 0\}$$

$$T_A - T_B = 3mg \qquad T_A - T_D = 3mg \qquad T_C - T_B = -3mg$$

$$T_A - T_C = 6mg \qquad T_B - T_C = 3mg \qquad T_D - T_C = 3mg$$

2

QUESTION

If $\frac{T_{max}}{T_{min}} = 3$, then find T_{max} = ______. If object of mass m.

$\frac{T_{max}}{T_{min}} = 3$

we know that

$\left\{ \cdot\ T_{max_A} - T_{min_C} = 6mg \right\}$

$T_{max} - \frac{T_{max}}{3} = 6mg$

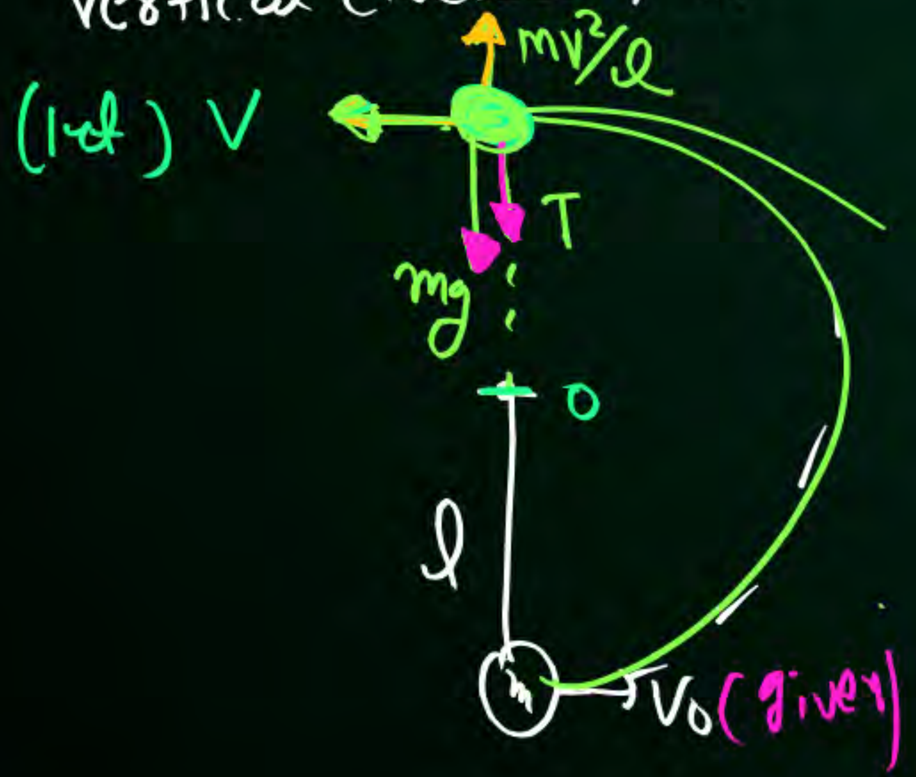
$\frac{3T_{max} - T_{max}}{3} = 6mg$

$2T_{max} = 18mg = 9mg$

QUESTION

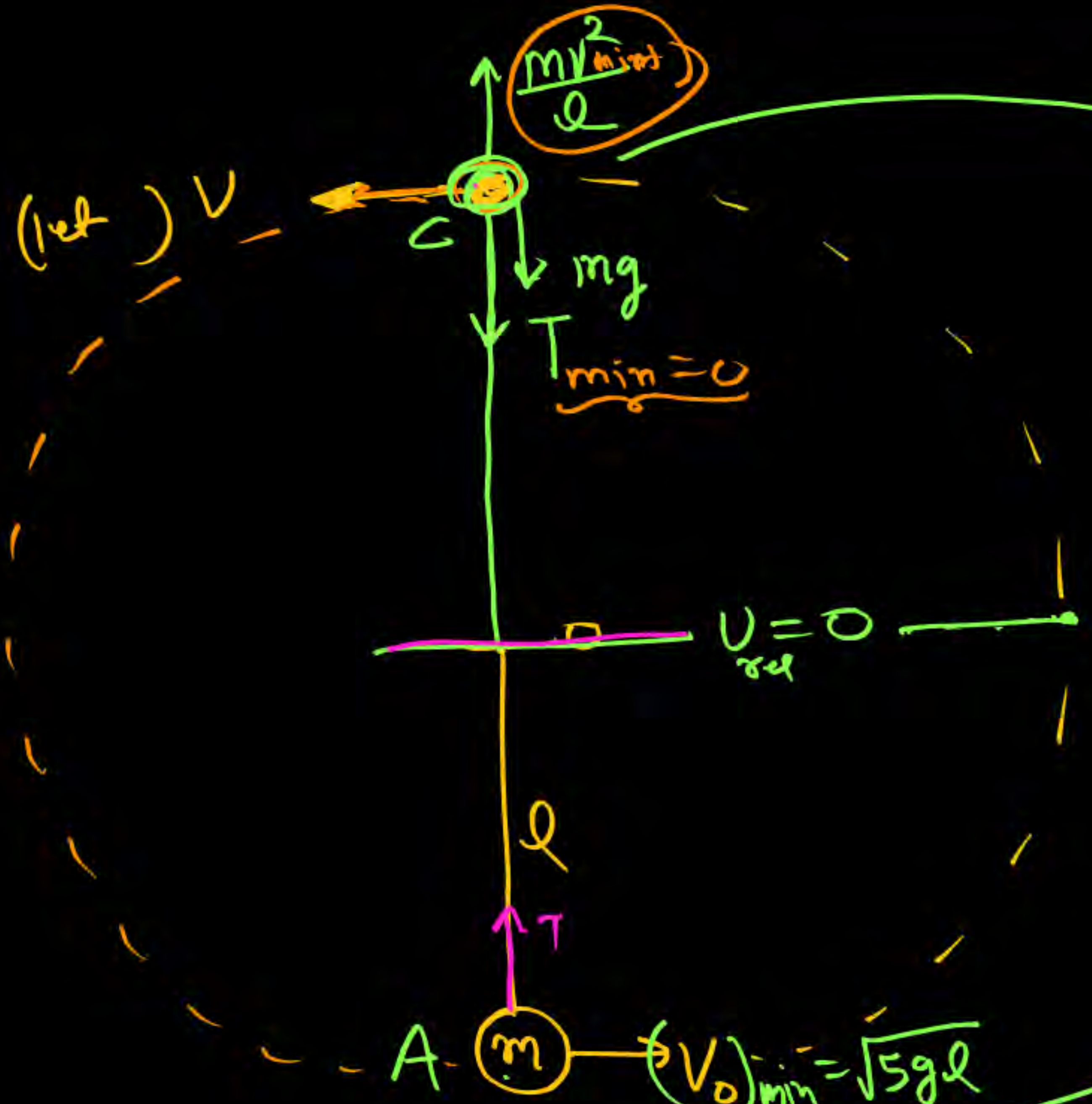
Find minimum given velocity at mean position so that it complete vertical circular motion.

find minimum possible velocity value of object at top point so that it can complet vertical circule motn.





$(v_0)_{min} = \sqrt{5gl}$



at Top Point

$$\downarrow T + mg = \left(\frac{mv^2}{l}\downarrow\right)$$

⇒ If g decrease speed ↓ then Then Tension will decrease.

$$\cancel{T_{min}}^{0} + \cancel{m}g = \frac{\cancel{m}v_{min}^2}{l}$$

$$V_{min} = \sqrt{gl}$$

↳ minimum velocity required at topmost point to complete vertical circular motion ✓

COME B/W A & C

$$(K.E + P.E)_A = (K.E + P.E)_C$$

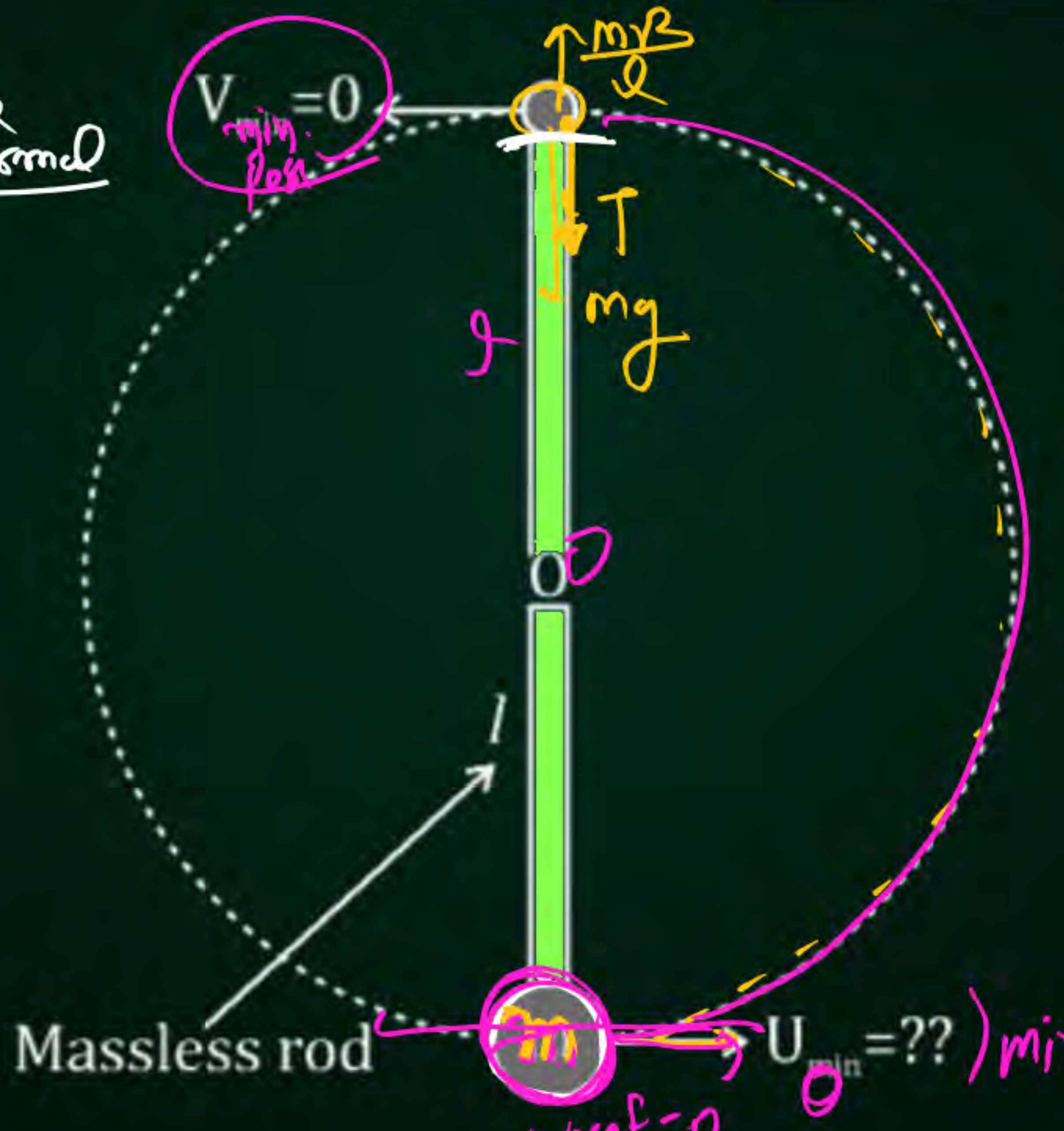
$$-\cancel{m}gl + \frac{1}{2}\cancel{m}(v_0^2)_{min} = \frac{1}{2}\cancel{m}(\sqrt{gl})^2 + \cancel{m}gl$$

$$\frac{v_0^2}{2} = \frac{5gl}{2} \qquad V_0 = \sqrt{5gl}$$

Bottom

QUESTION

Find minimum velocity so that it will complete vertical circular motion. if object connected with massless Rod.



$\frac{mv^2}{l} = T + mg$ at top point

$\frac{mv^2}{l} \to 0$, T become Normal

$V_{min} = 0$ min. pos.

$U_{min} = ??$) min^m given velocity

$U_{ref} = 0$

$(KE + U) = \text{const}^n$

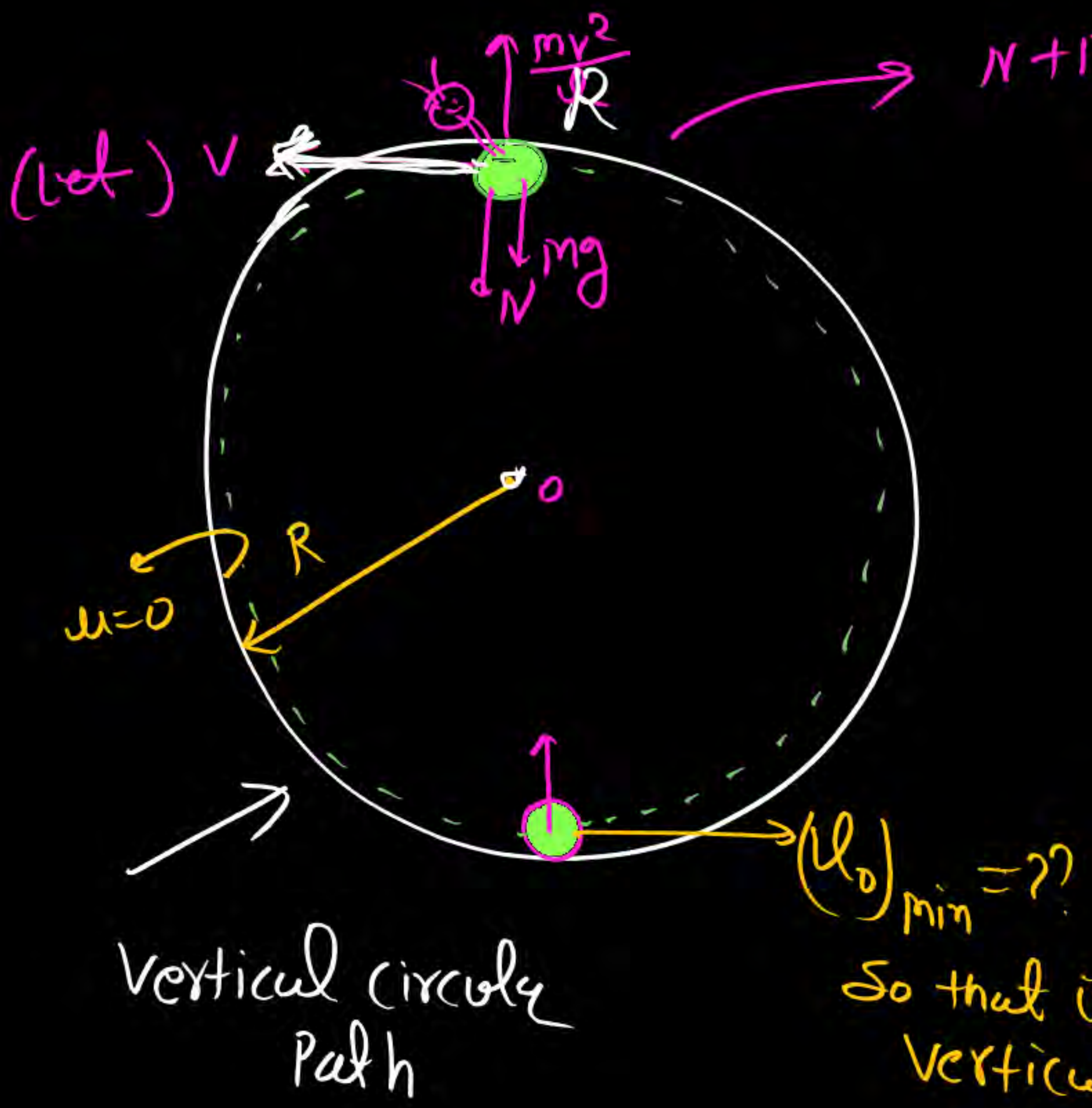
$0 + \frac{1}{2}mv_0^2 = 2mgl + \frac{1}{2}mv^2$

$v_0^2 = 4gl$

$v_0 = \sqrt{4gl}$

$v_0 = 2\sqrt{gl}$

min given velocity to complete circular motion



So that it compt vertical circular motn.

$N + mg = \frac{mv^2}{R}$

→ speed Increase $\left\{ \uparrow N + mg = \frac{mv^2}{R} \uparrow \right\}$

→ speed decrease $\left\{ \downarrow N + mg = \frac{mv^2}{R} \downarrow \right\}$

$N + mg = \frac{mv_{min}^2}{R}$ (N = 0)

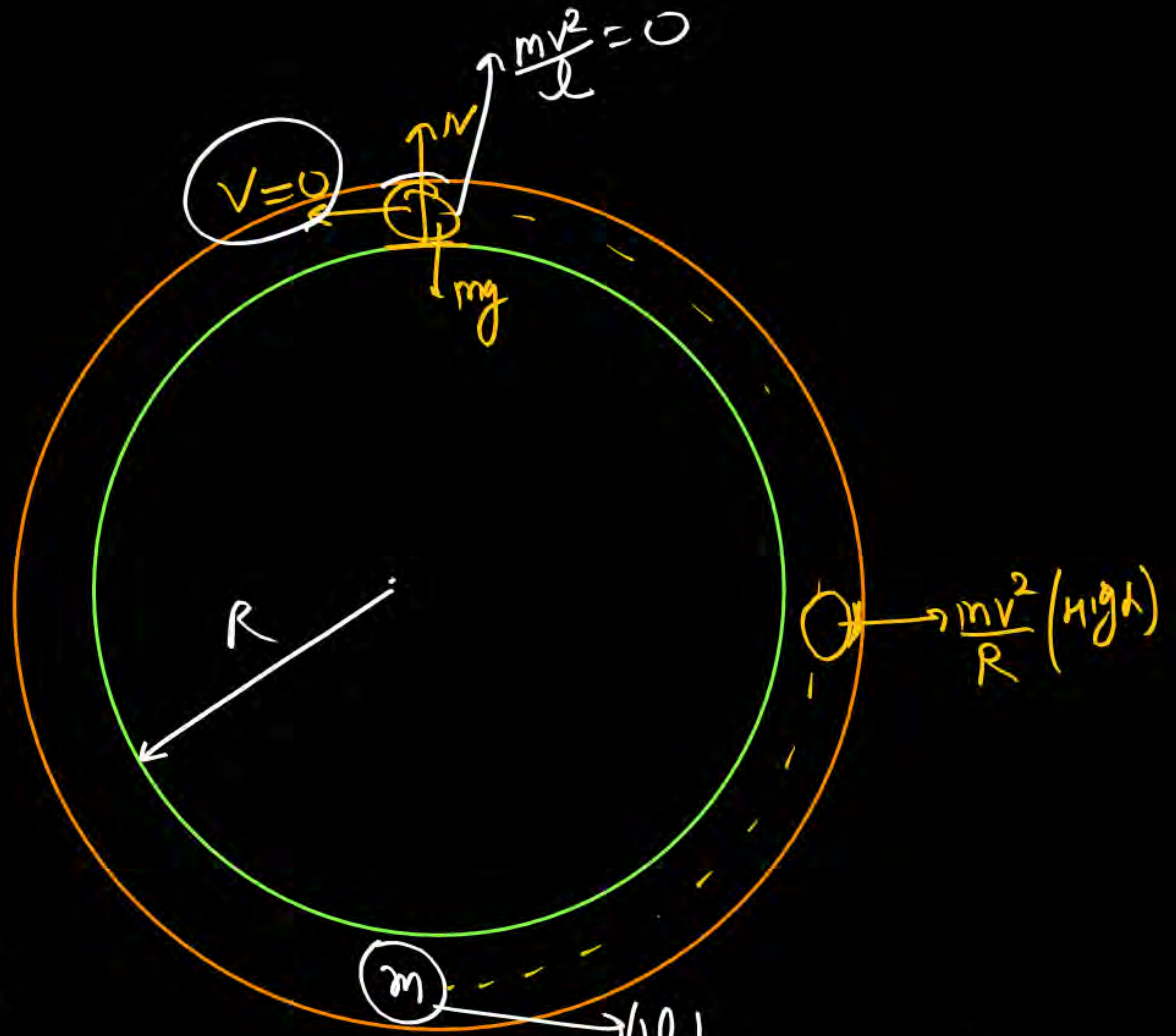
To just compt vertical circular motion.

$N = 0$

$mg = \frac{mv_{min}^2}{R}$

$u_{min} = \sqrt{gR}$ at top point

$(V_0)_{\substack{Bottom \\ min}} = \sqrt{5gR}$



Vertical circule path

(u_o) given minⁿ so that compt vertical circular path.

$= (u_{Bottom})_{min} = \sqrt{4gR}$ //

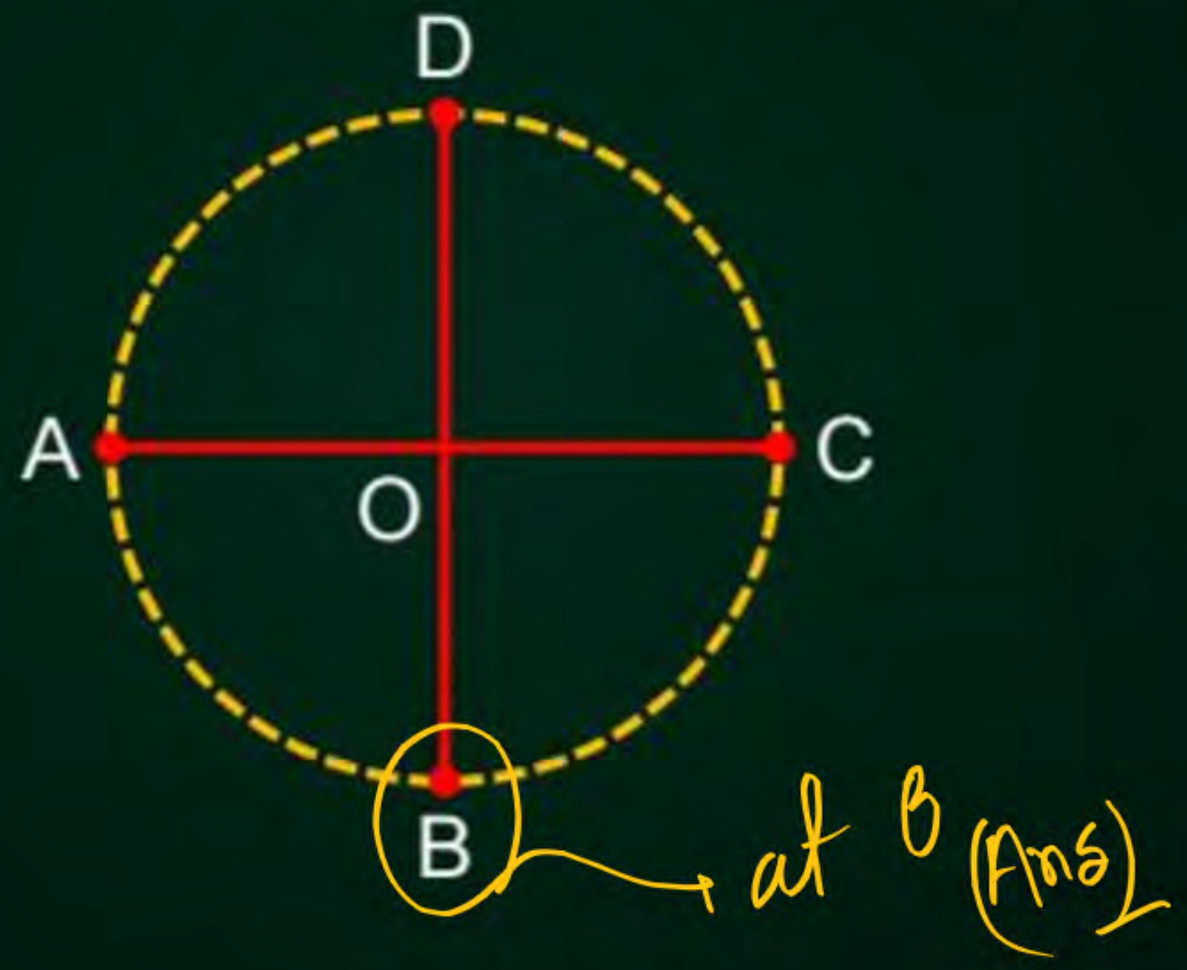
QUESTION

Find minimum given velocity at mean position so that it will complete vertical circular motion if it is connected will massless rod.

$u = \sqrt{4gl}$

QUESTION

As shown in figure, a particle of mass m a performing vertical circular motion. The velocity of the particle is increased, then at which point and the string break ?



QUESTION

A stone of mass 1 kg is tied with a string and it is whirled in a vertical circle of radius 1 m. If tension at the highest point is 14 N, then velocity at lowest point will be :

(1) 3 m/s

(2) 4 m/s

(3) 6 m/s

(4) 8 m/s   Ans



$T_{max} - T_{min} = 6mg$

$T_{max} - 14 = 6\times1\times10$

$T_{max} = 74\ N$

$T = \frac{mv^2}{l} + mg$ — (1)

$74 = \frac{1v^2}{1} + 1\times10$

$74 - 10 = v^2$

$v = \sqrt{64} = 8\ m/s$

Biyoya Power

$T = \frac{mV_0^2}{l} - 5mg$

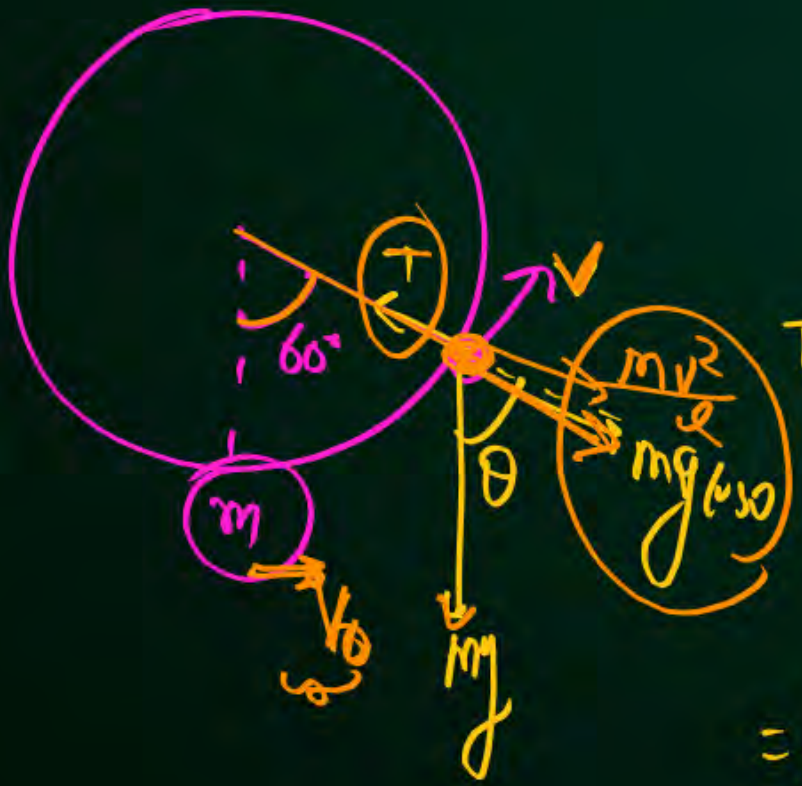
$14 + 5\times1\times10 = \frac{1v_0^2}{1}$

$V_0 = \sqrt{64} = 8\ m/s$

QUESTION

A particle of mass 200 g, is whirled into a vertical circle of radius 80 cm using a massless string. The speed of the particle when the string makes an angle of 60° with the vertical line is 1.5 ms^{-1}. The tension in the string at this position is:

1. 1 N
2. 1.56 N ✓
3. 2 N
4. 3 N



$T = \frac{mv^2}{l} + mg\cos\theta$

$= m\left[\frac{v^2}{l} + g\cos\theta\right]$

$= \frac{1}{5}\left[\frac{9}{4 \times \frac{8}{10}} + 10 \times \frac{1}{2}\right] = \frac{1}{5}\left[\frac{45}{16} + 5\right]$

$= \frac{9}{16} + 1 = \frac{25}{16}\, N = 1.56\, N$

Biyoya Power ✗

$T = \frac{mv_0^2}{l} - 2mg + 3mg\cos\theta$

$T = m\left[\frac{v_0^2}{l} - 2g + 3g\cos\theta\right]$ → wrong

QUESTION

Just compt vertical circular motion.

A particle of mass 200 g is moving in a circle of radius 2m. The particle is just "looping the loop". The speed of the particle and the tension in the string at highest point of the circular path are ($g = 10\ m/s^2$)

1. $4\ ms^{-1}$, 5 N
2. $4.47\ ms^{-1}$, 0 — Ans
3. $2.47\ ms^{-1}$, 0
4. $1\ ms^{-1}$, 0

$T_{top} = 0$

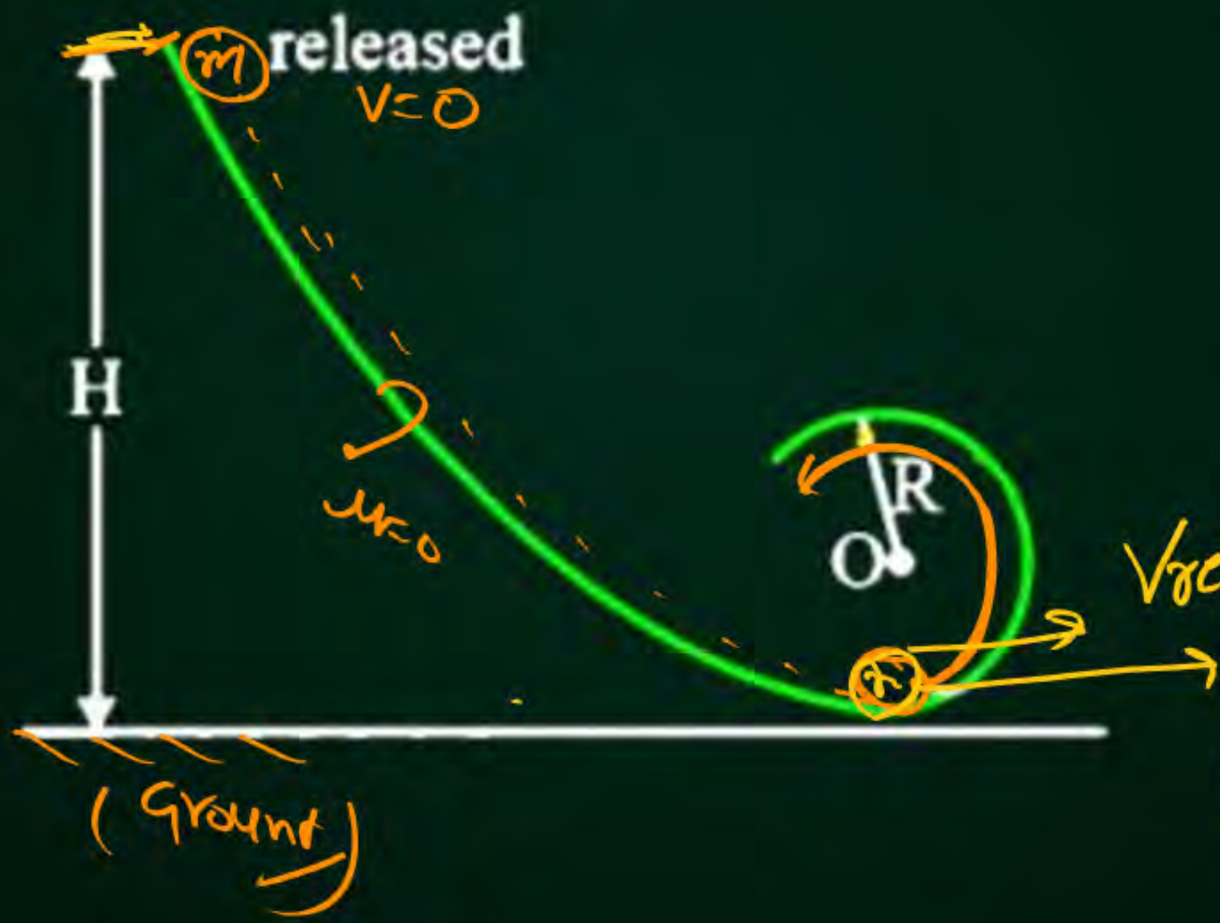
$v = \sqrt{gl} = \sqrt{10 \times 2} = \sqrt{20} = 4.47$

QUESTION

Find relation between "H" & "R" so that object will complete vertical circular motion.

Height   Radius





Ball will compt vertical circular mot.

$\{ V_{gain} \geq V_{required} \}$

$V_{required} = \sqrt{5gR}$

$V_{gain} = \sqrt{2gH}$

$\sqrt{2gH} \geq \sqrt{5gR}$

$2H \geq 5R$

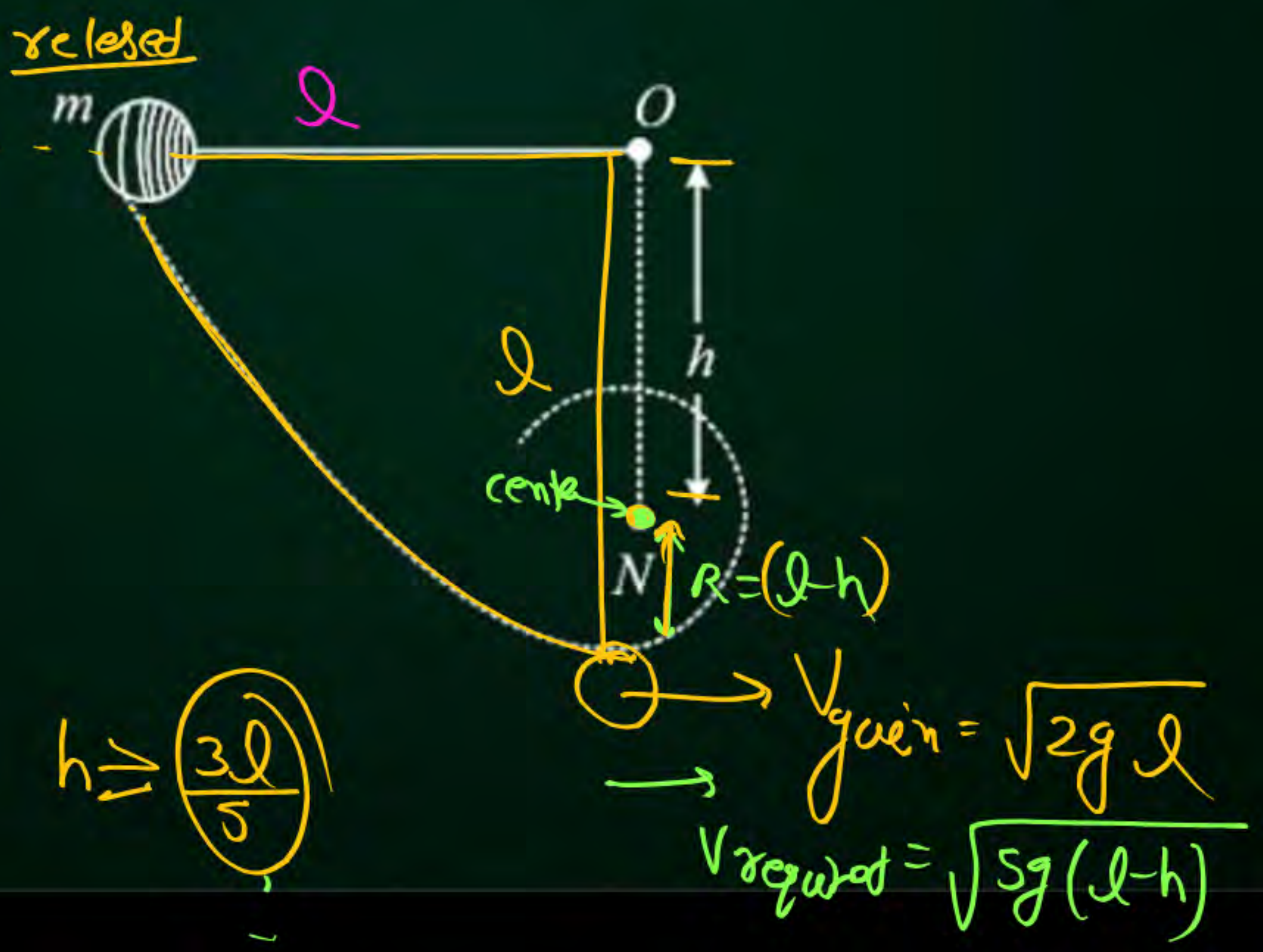
$\left[H \geq \frac{5R}{2} \right]$ A2

$\frac{2H}{5} \geq R$

QUESTION

A particle of mass m attached to the end of string of length l is released from the horizontal position. The particle rotates in a circle about O as shown. When it is vertically below O, the string makes contact with a nail N placed directly below O at a distance h and rotates around it. For he particle to swing completely around the nail in a circle.

find rⁿ B/w l & h



$V_{requir} \leq V_{gain}$

$\sqrt{5g(l-h)} \leq \sqrt{2gl}$

$5l - 5h \leq 2l$

$5l - 2l \leq 5h$

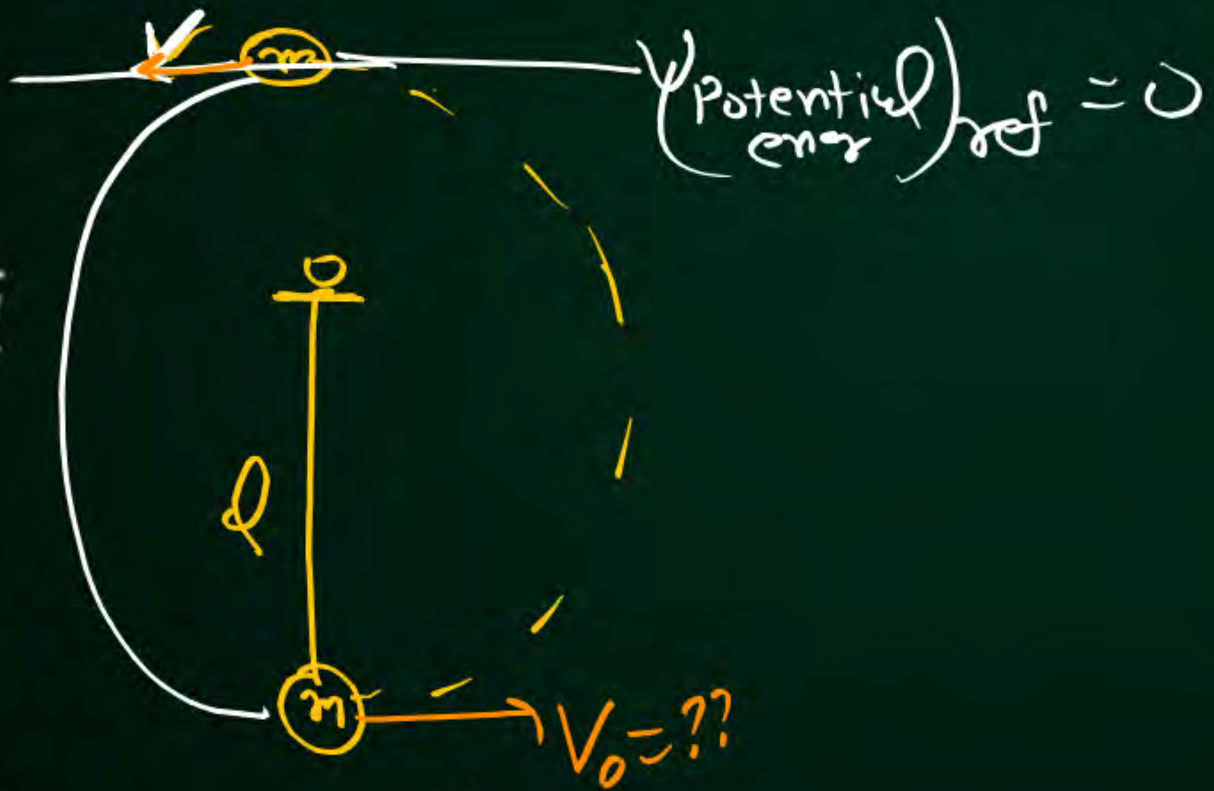
$3l \leq 5h$

$h \geq \frac{3l}{5}$

QUESTION

A stone is tied to one end of a light inextensible string of length l and made to rotate on a vertical circle keeping other end of the string at the centre. If speed of the highest point is v ($v > \sqrt{gl}$) then its speed at the lowest point is

1. $\sqrt{4gl}$
2. $\sqrt{v^2 + 2gl}$
3. $\sqrt{v^2 + gl}$
4. $\sqrt{v^2 + 4gl}$



COME

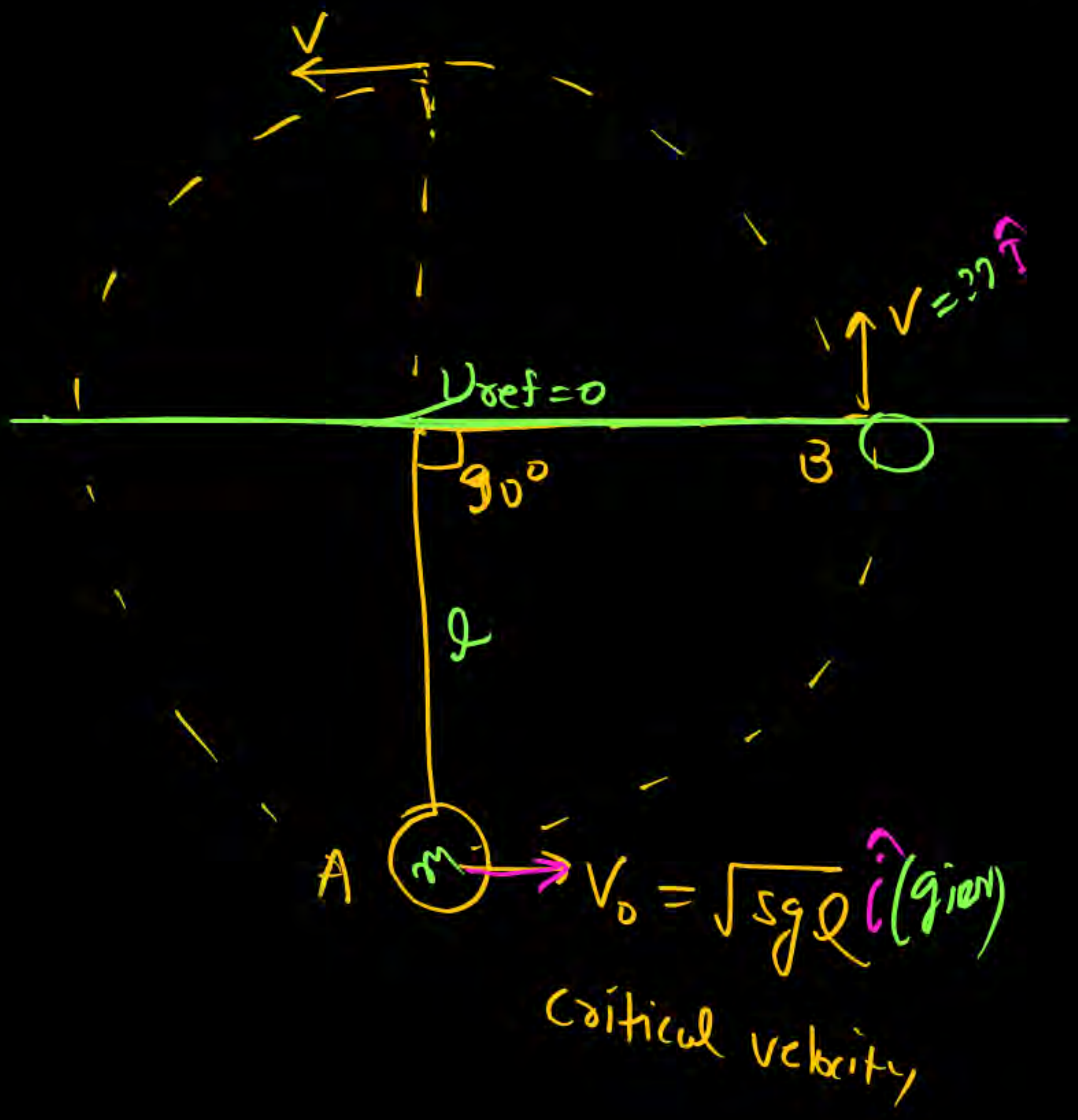
$(K.E + P.E)_{Top} = (K.E + P.E)_{Bot.}$

$\frac{1}{2} m v^2 + 0 = \frac{1}{2} m v_0^2 - 2mgl$

$\frac{v^2}{2} = \frac{v_0^2}{2} - 2gl \times 2$

$v_0 = \sqrt{v^2 + 4gl}$

find velocity at B and also find change in velocity b/w A & B.



C.O.M.E

$(K.E + U)_A = (K.E + U)_B$

$\frac{1}{2} m v_0^2 - mgl = \frac{1}{2} m v^2 + 0$

$\frac{5gl}{2} - gl = \frac{v^2}{2}$

$\frac{3gl}{2} = \frac{v^2}{2}$

$V = \sqrt{3gl}$

Change in velocity ⇒ $\vec{V_B} - \vec{V_A} = \sqrt{3gl}\,\hat{j} - \sqrt{5gl}\,\hat{i}$

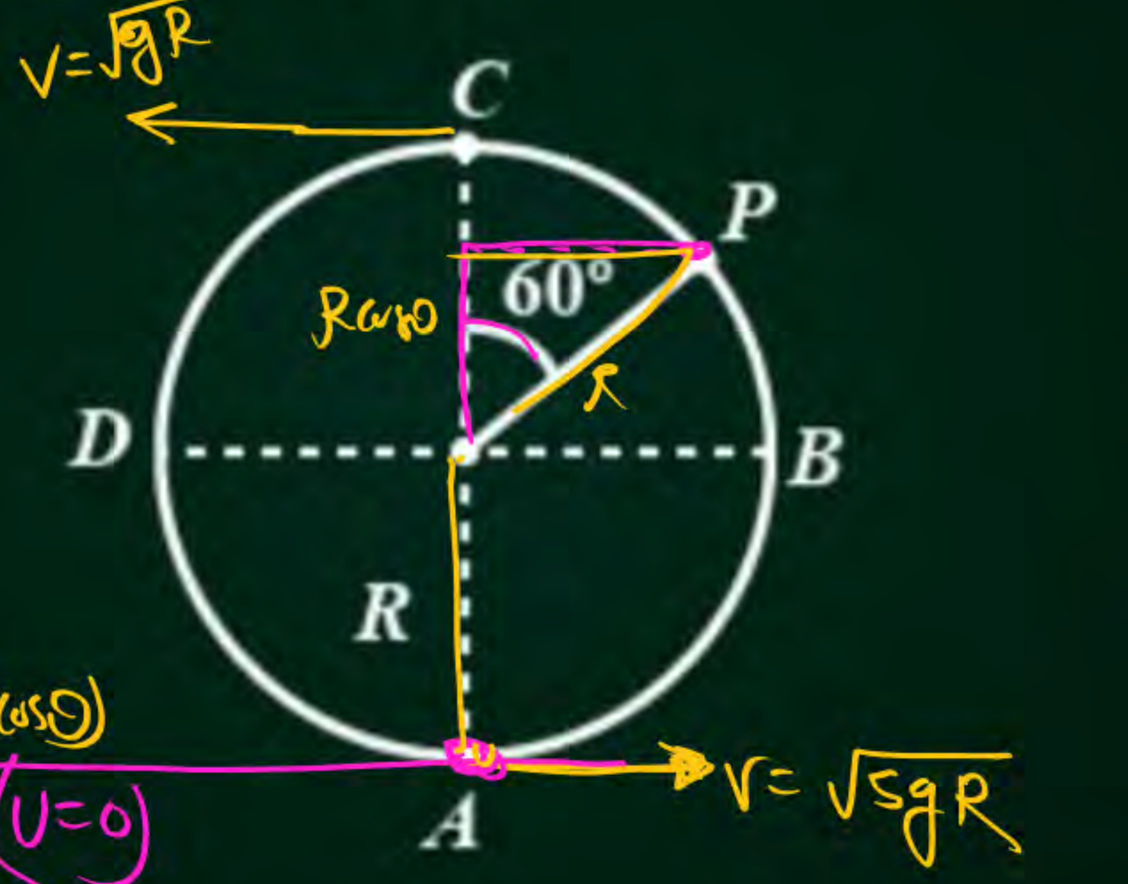
$|\vec{V_B} - \vec{V_A}| = \sqrt{3gl + 5gl}$

$= \sqrt{8gl}$ (Ans)

# Given velocity at bottom Point	will Compt. circular motion ??	Tension at top	V at to P
(1) $V > \sqrt{5gl}$	yes	$T_{top} > 0$	$V_{Top} > \sqrt{gl}$
(2) $V = \sqrt{5gl}$	✓ Just compt vertical circular mo.	$T_{top} = 0$	$V_{Top} = \sqrt{gl}$
(3) $\sqrt{2gl} < V < \sqrt{5gl}$ *	No	leave the circular Path where Tension becomes zero ($\theta > 90°$)	→ after that it will move on parabolic Path like Projectile
(4) $V < \sqrt{2gl}$	NO	leve the circular Path $\theta < 90°$, & at that Point velocity will be zero	→ & do oscillation.
(5) $V <<< \sqrt{2gl}$	NO	S.H.M	

QUESTION

A particle is moving along a vertical circle of radius R. The velocity of particle at P will be : (assume critical condition at C)



$(C.O.M.E)_{A \& P}$

$(K.E+U)_A = (K.E+U)_P$

$0+\frac{1}{2}m5gR = \frac{1}{2}mv^2 + mg(R+R\cos\theta)$

ref $(U=0)$

$\frac{5mgR}{2} = \frac{1}{2}mv^2 + mgR(1+\cos 60^\circ)$

$\frac{5gR}{2} - \frac{3gR}{2} = \frac{v^2}{2}$

$v = \sqrt{2gR}$

QUESTION

If velocity $V_0 = \sqrt{3gR}$ is given at the mean position then find angle where bob will leave circular path.

Sol^n

$\sqrt{2gR} < V$

$T_\theta = \frac{mV_0^2}{R} - 2mg + 3mg\cos\theta$

$0 = \frac{m\,3gR}{R} - 2mg + 3mg\cos\theta$

$2g = 3g + 3g\cos\theta$

$\frac{2g}{3g} = 1 + \cos\theta$

$\frac{2}{3} = 1 + \cos\theta$

$\cos\theta = \frac{2}{3} - 1$

$= \frac{2-3}{3}$

$\cos\theta = -\frac{1}{3}$

$\theta = \cos^{-1}\left(-\frac{1}{3}\right)$ Ans

QUESTION

If given velocity at mean is $V_0 = \sqrt{gR}$ then angle where it will leave circular path.

(*) method wrong

$T = \frac{mv^2}{l} - 2mg + 3mg\cos\theta$

$0 = \frac{mgR}{R} - 2mg + 3mg\cos\theta$

$0 = g - g + 3g\cos\theta$

$3\cos\theta = 0$

$\cos\theta = 0 \quad \theta = 90$ ✗

It will leave circular path & return back from a point where velocity becomes is zero.

$V_{at\,\theta}^2 = V_0^2 + 2gl(\cos\theta - 1)$

$0 = (\sqrt{gl})^2 + 2gl(\cos\theta - 1)$

$0 = gl + 2gl\cos\theta - 2gl$

$gl = 2gl\cos\theta$

$\frac{1}{2} = \cos\theta \quad \theta = 60°$

Power

Work energy th^m

We know that
$dW = F \cdot dS$

At time 't'

$P_{inst} = \frac{dW}{dt}$ = The rate of work done is called instantaneous power.

$P_{inst} = \frac{F \cdot dS}{dt}$

$P_{inst} = \vec{F} \cdot \vec{v}$ → Scalar

$P_{inst} = FV\cos\theta$ ← Angle b/w F & V

In time 't'

$P_{Avg} = \frac{\Delta W}{\Delta t} = \frac{(\Delta K.E)}{\Delta t}$

$P_{Avg} = \frac{\int P_{inst}\, dt}{\int dt}$

Total Work $= \int P\, dt$ = Area of P-t graph

Work → (diff) → P_{inst} → (diff)

Work ← (integration) ← P_{inst}

$P = \frac{dW}{dt}$ = slope of Work - time graph.

Area of F/S graph → work

Area of P/t graph → work

QUESTION

One coolie takes 1 minute to raise a suitcase through a height of 2 m but the second coolie takes 30 s to raise the same suitcase to the same height. The powers of two coolies are in the ratio

1. 1 : 2
2. 1 : 3
3. 2 : 1
4. 3 : 1

QUESTION

If a force of 9 N is acting on a body, then find instantaneous power supplied to the body when its velocity is 5 m/s in the direction of force

1. 195 watt
2. 45 watt
3. 75 watt
4. 100 watt

QUESTION

Ball is projected with u at angle θ then find power delivered by gravitational force at maximum height.

QUESTION

A body of mass m is projected from ground with speed u at an angle θ with horizontal. The power delivered by gravity to it at half of maximum height from ground is

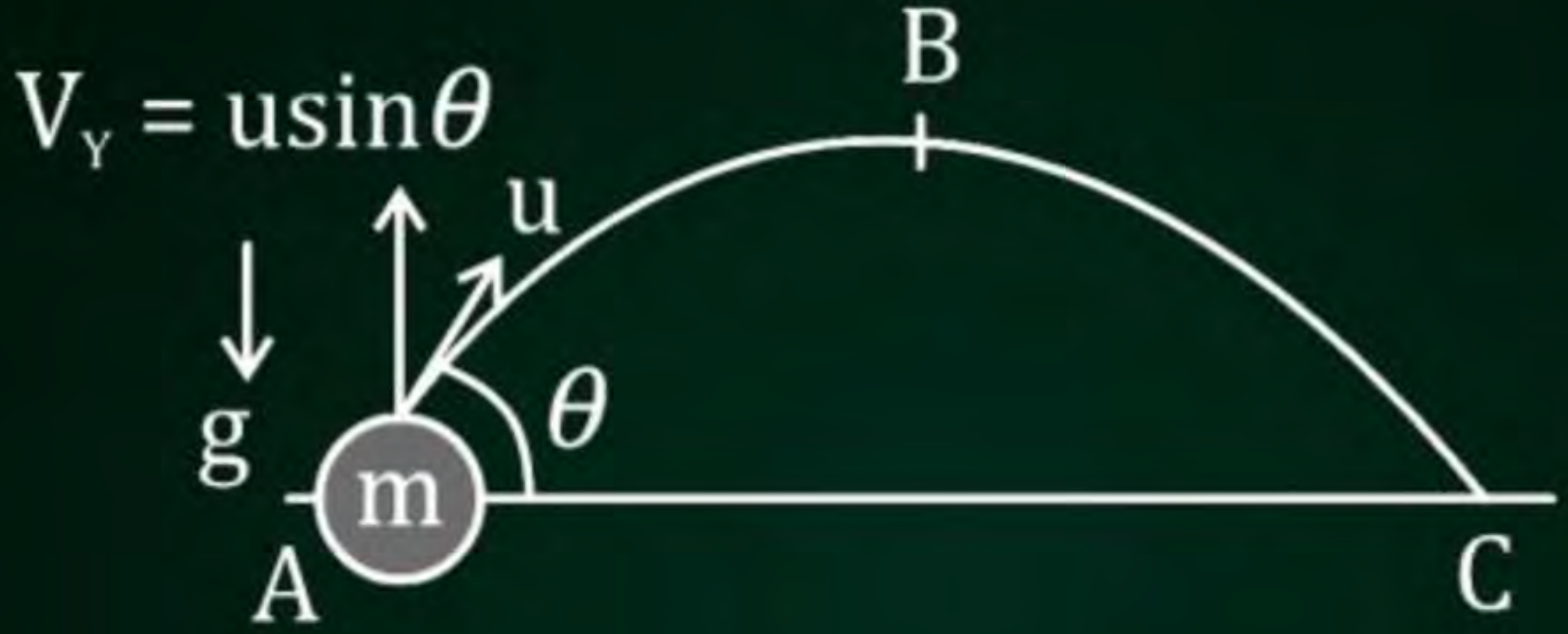
1. $\frac{mgu\cos\theta}{\sqrt{2}}$

2. $\frac{mgu\sin\theta}{\sqrt{2}}$

3. $\frac{mgu\cos(90+\theta)}{\sqrt{2}}$

4. Both (b) and (c)

H/W



- Power delivered by gravitational force from A to B is negative.
- Power delivered by gravitational force from B to C is positive.
- Magnitude of power is decrease as object move from A to B.

h/w

QUESTION

A body projected vertically form the earth reaches a height equal to earth's radius before returning to the earth. The power exerted by the gravitational force is greatest

[AIPMT (Prelims)-2011]

1. At the instant just after the body is projected
2. At the highest position of the body
3. At the instant just before the body hits the earth
4. it remains constant all through

H/W

QUESTION

A particle moves with the velocity $\vec{v} = (5\hat{i} + 2\hat{j} - \hat{k})\ ms^{-1}$ under the influence of a constant force, $\vec{F} = (2\hat{i} + 5\hat{j} - 10\hat{k})$ N. The instantaneous power applied is

1. 5 W
2. 10 W
3. 20 W
4. 30 W

H/w

QUESTION

The power of a pump, which can pump 500 kg of water to height 100 m in 10 s is

1. 75 kW
2. 25 kW
3. 50 kW
4. 500 kW

H/W


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 10 | Physics

Work, Energy and Power

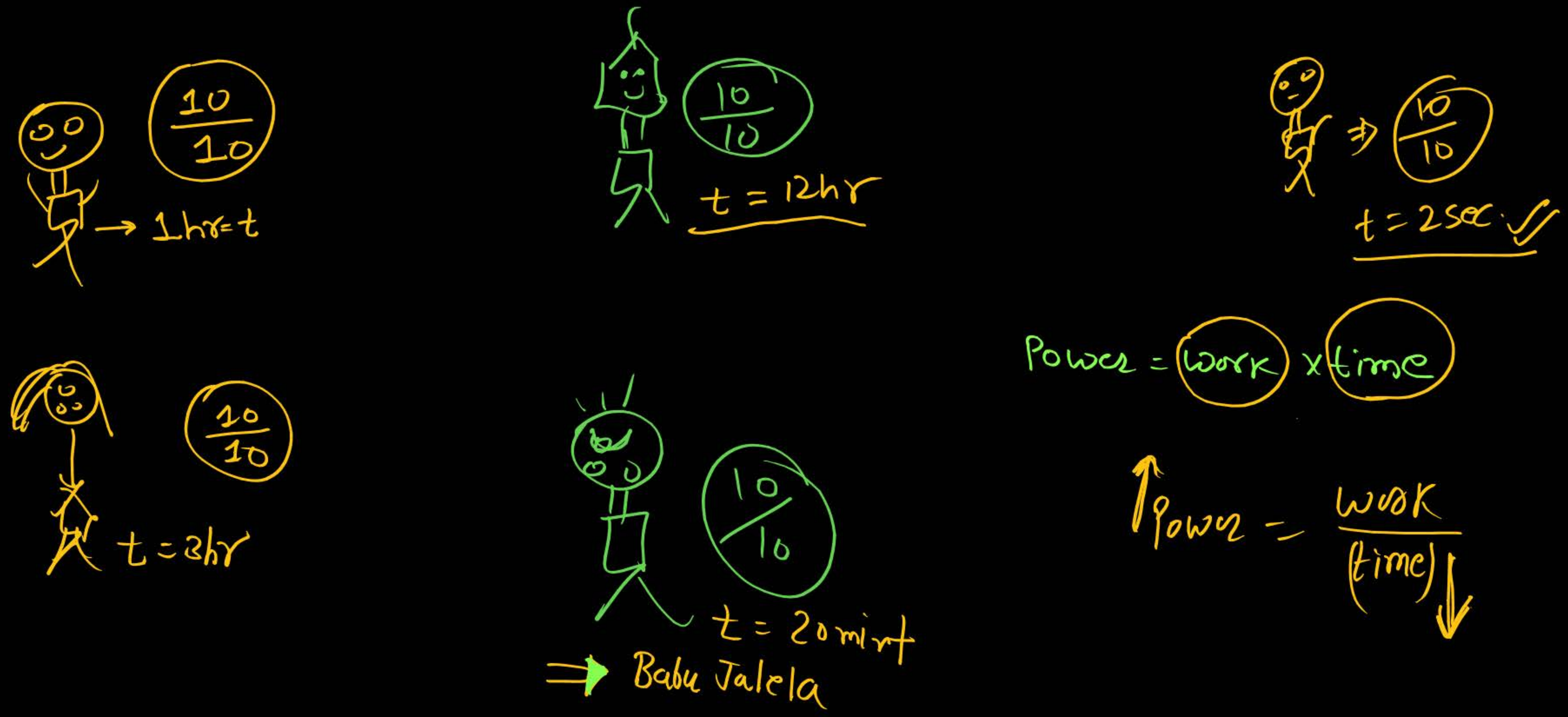
By- Dr. Manish Raj (MR SIR)



Topics to be covered

1. # PhD. on Power
2. #
3. #
4. #





10/10
1hr=t
10/10
t = 12hr
10/10
t = 2sec
10/10
t = 3hr
10/10
t = 20mint
⇒ Babu Jalela
Power = work x time
Power = work/(time)

Power

at time 't'

P_{inst} = Rate of work done. ✓

$$P_{inst} = \frac{dW}{dt} = \vec{F}\cdot\left(\frac{d\vec{s}}{dt}\right) = \vec{F}\cdot\vec{V}$$

- Unit J/sec = watt ✓
- slope of work-time graph ✓
- Scalar (does not have dirⁿ)
- May be +ve, −ve, zero.

$P = \vec{F}\cdot\vec{v}$

- $P = FV\cos\theta$ (Angle b/w $\vec{F}$ & $\vec{v}$)

$\theta = 0^\circ$	$\theta = 90^\circ$	$\theta = 180$
$P = F\cdot V$	$P = 0$	$P = -FV$
energy Injected into body		energy eJected from body

in time 't'

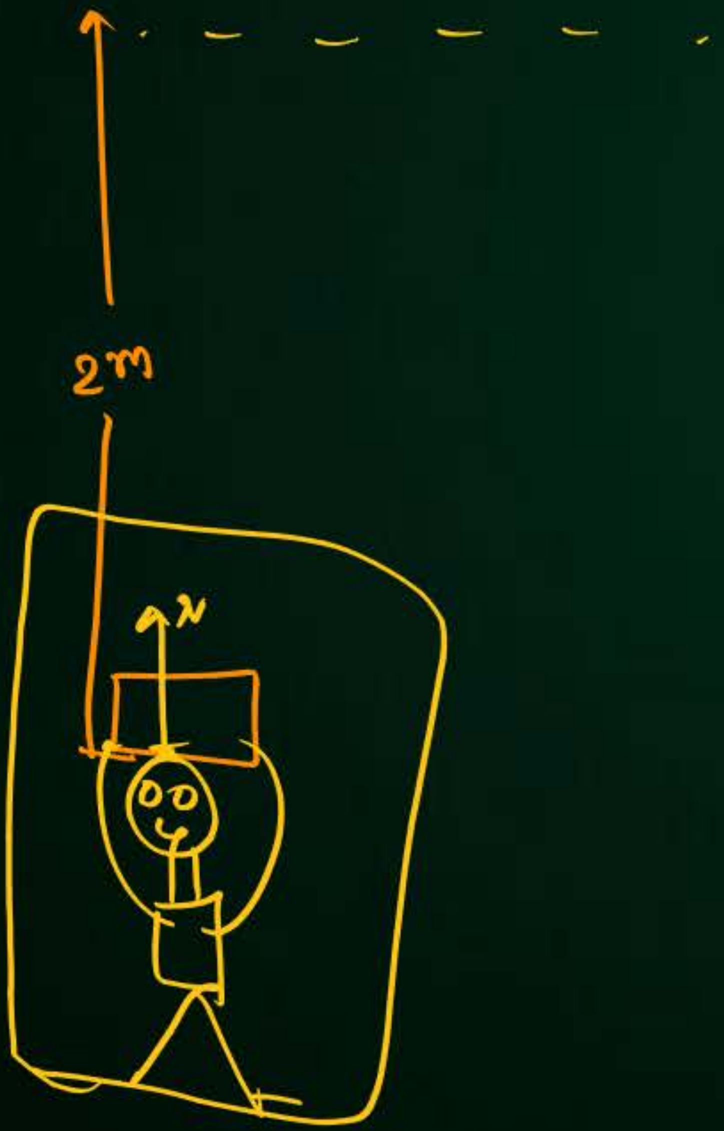
$$P_{Avg} = \frac{\Delta W}{\Delta T} = \frac{\Delta K.E}{\Delta T}$$

$$= \frac{\int P\,dt}{\int dt}$$

QUESTION

One coolie takes 1 minute to raise a suitcase through a height of 2 m but the second coolie takes 30 s to raise the same suitcase to the same height. The powers of two coolies are in the ratio

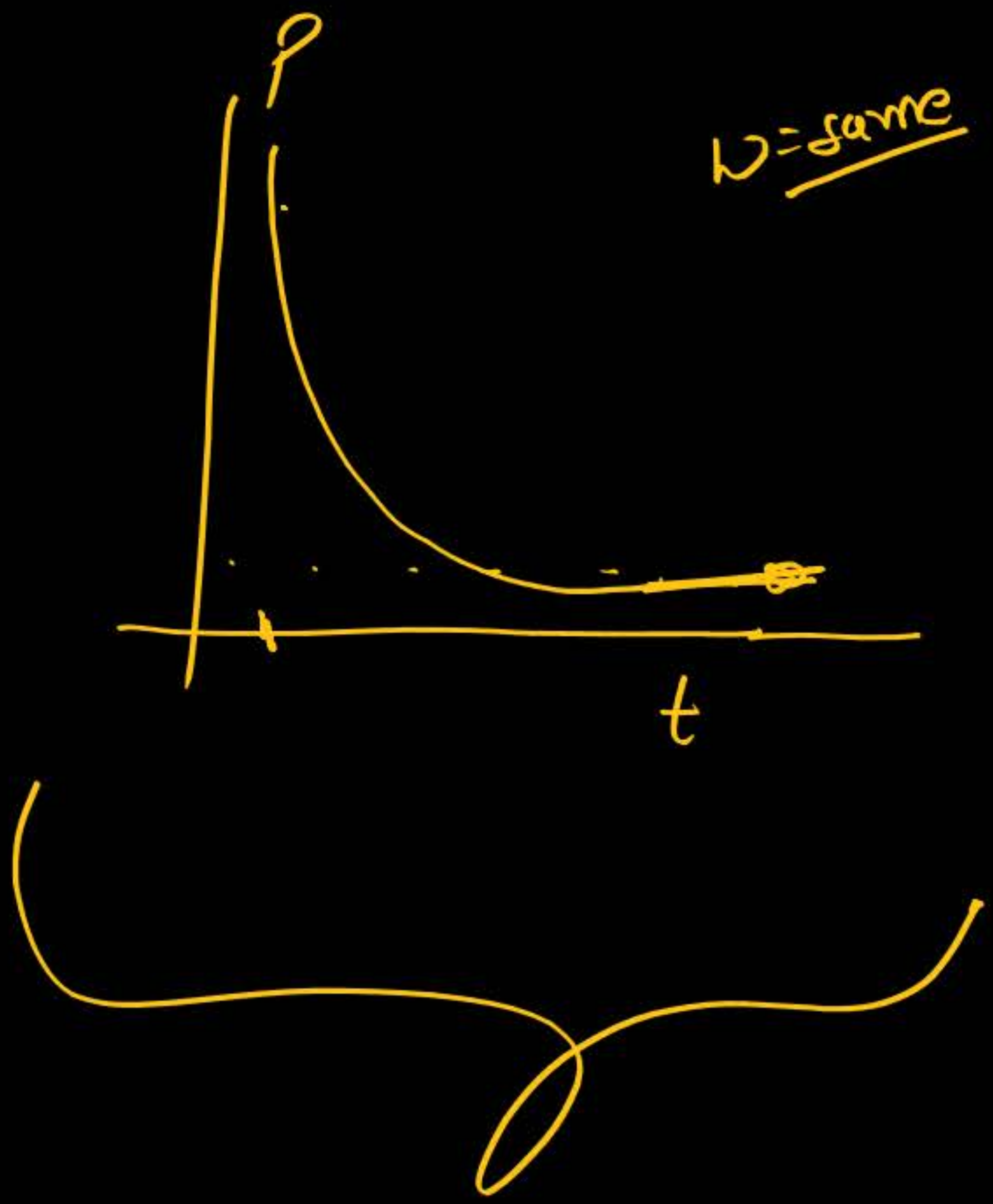
1. 1 : 2 ✓
2. 1 : 3
3. 2 : 1
4. 3 : 1



$$\frac{P_1 = \frac{W}{t_1}}{P_2 = \frac{W}{t_2}}$$

$$\frac{P_1}{P_2} = \frac{t_2}{t_1} = \frac{30\text{ sec}}{60\text{ sec}}$$

$$\frac{P_1}{P_2} = 1:2$$


ω=same
ρ
t

QUESTION

If a force of 9 N is acting on a body, then find instantaneous power supplied to the body when its velocity is 5 m/s in the direction of force

1. 195 watt
2. 45 watt
3. 75 watt
4. 100 watt

$F = 9N$

$v = 5 m/s$

$\longrightarrow F$

$\longrightarrow v$

$\theta = 0°$

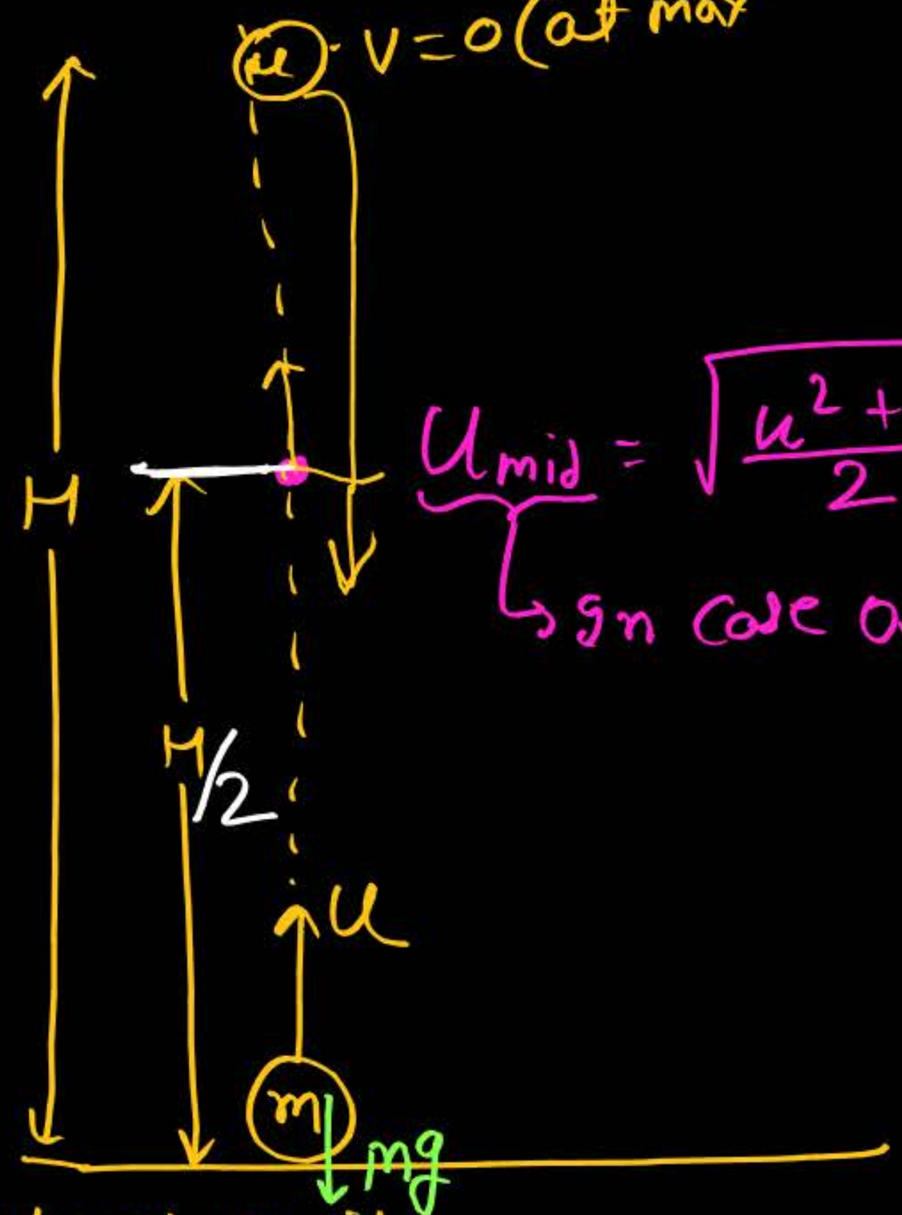
$P_{inst} = Fv\cos\theta$

$= 9 \times 5 \cos 0°$

$= 45 W$

1 HP = 746 watt

Q)



$u_{mid} = \sqrt{\frac{u^2 + 0^2}{2}} = \sqrt{\frac{u^2}{2}} = \frac{u}{\sqrt{2}}$

→ 9n case of constant accn.

• Projected with velocity u in upward direction.

⇒ $P_{in\ upward\ Journey} = -ve$

$P_{in\ downward\ Journey} = +ve$

Soln

Power delivered by gravitational force at point of Projection

$P = mgu \cos 180°$

$\boxed{P = -mgu}$

• Power delivered by gravitational force at Half of maxm Height

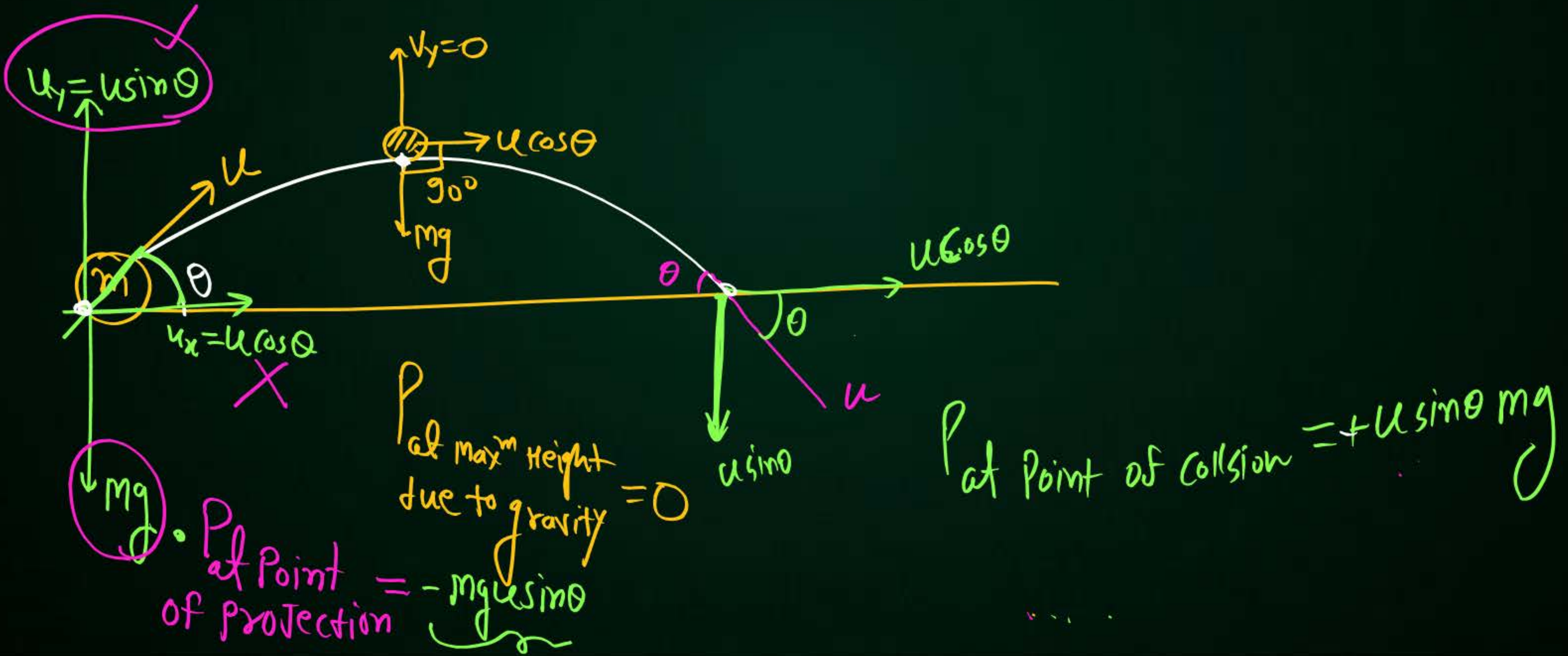
$P = mg \frac{u}{\sqrt{2}} \cos 180°$

$P = -\frac{mgu}{\sqrt{2}}$ or $\frac{mgu}{\sqrt{2}}$

• $\boxed{P_{at\ max^m\ Height} = 0}$

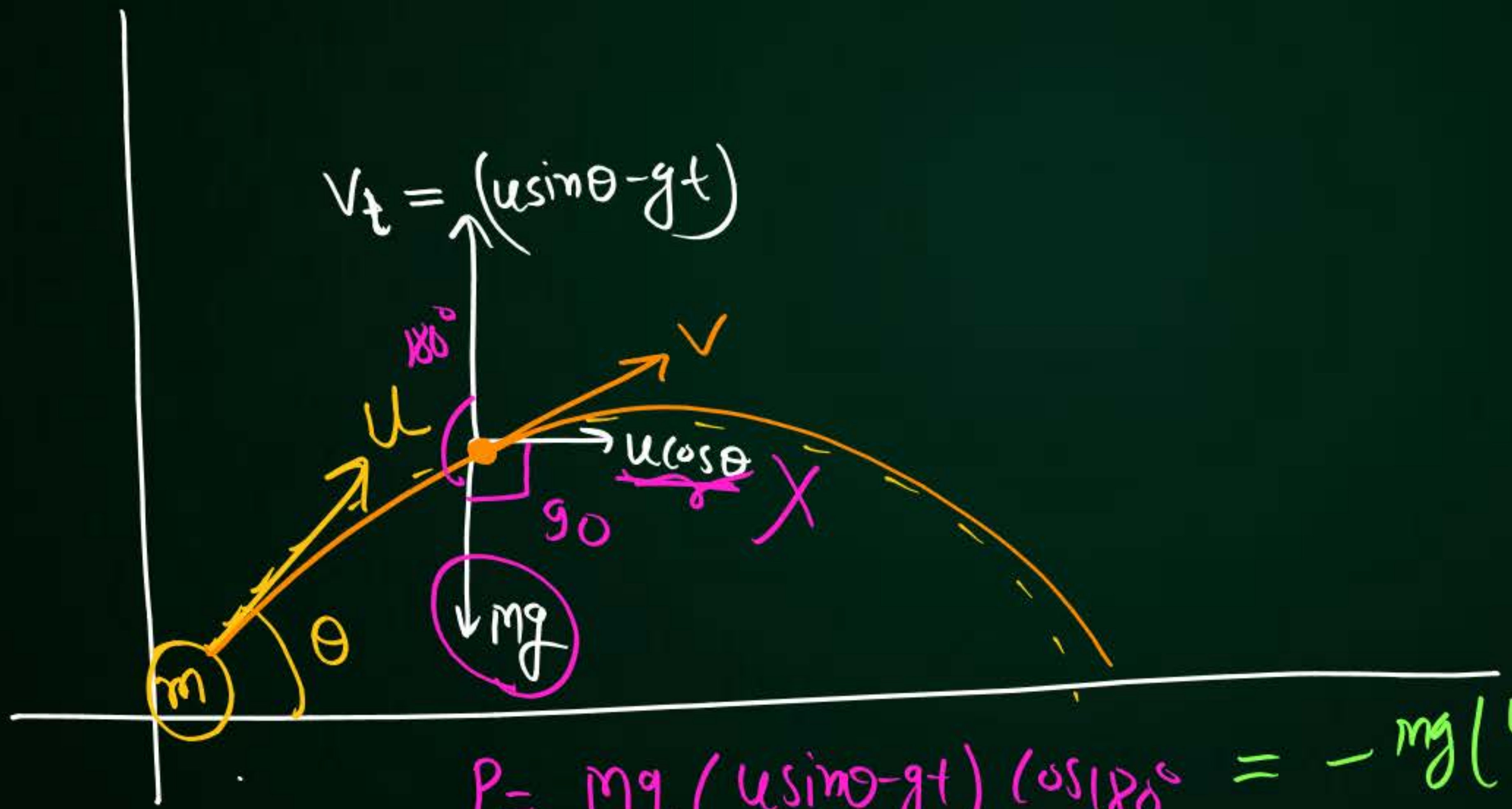
QUESTION

Ball is projected with u at angle θ then find power delivered by gravitational force at maximum height. ??

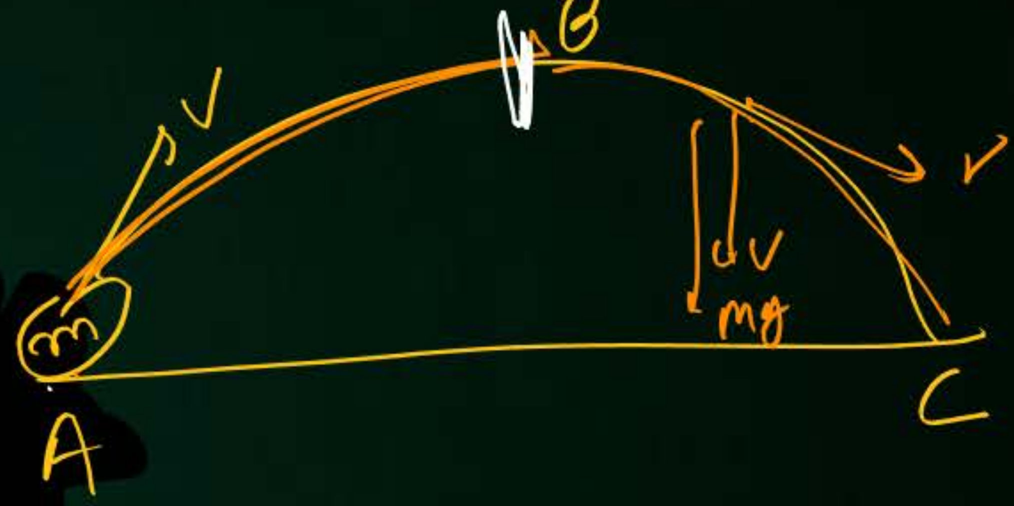


QUESTION

Ball is projected with u at angle θ then find power delivered by gravitational force at time ‘t’. ??



$P = mg(u\sin\theta - gt)\cos 180° = -mg(u\sin\theta - gt)$



- Power delivered by gravitational force from A to B is negative. ✓
- Power delivered by gravitational force from B to C is positive. ✓
- Magnitude of power is decrease as object move from A to B.

Reason → Magnitude of vertical velocity is decresing from A to B.

A → Point of Projection

B → At max^m Height

QUESTION

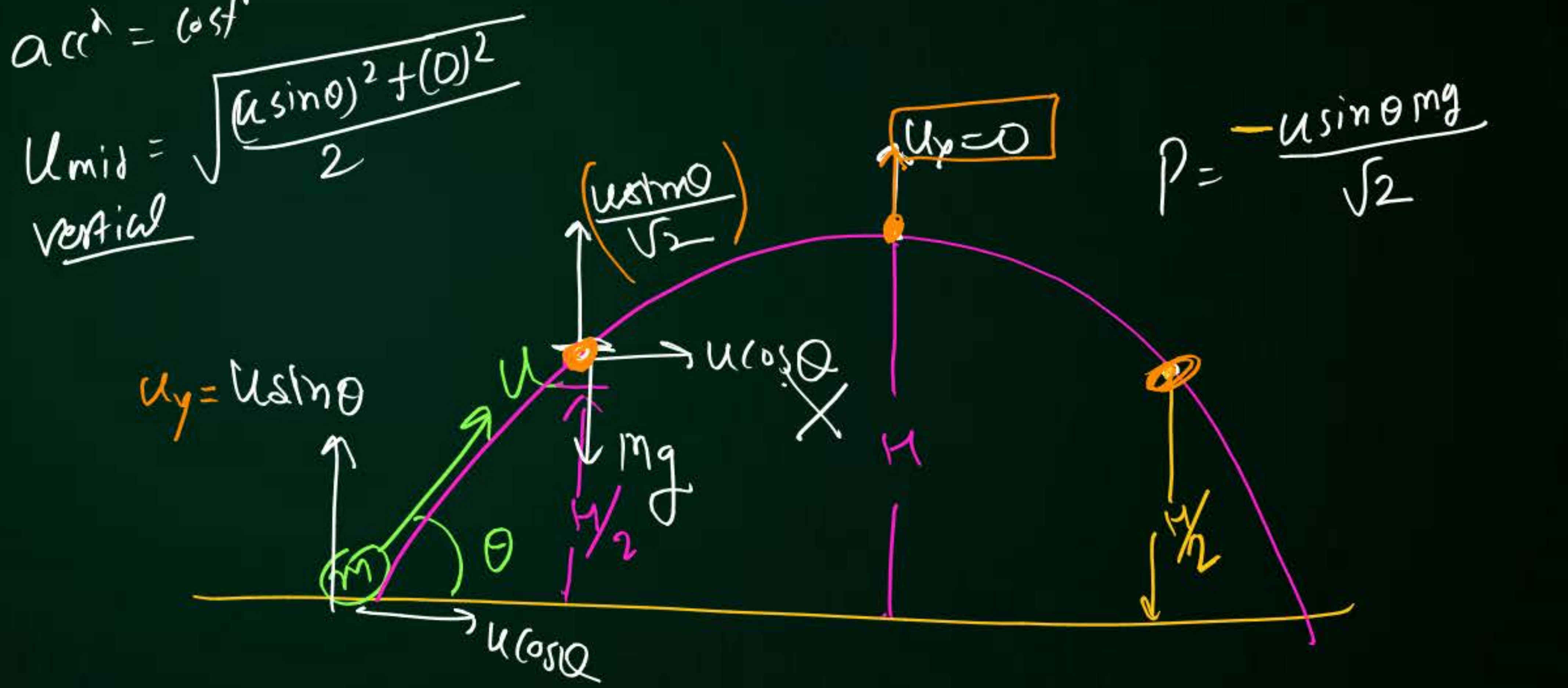
A body of mass m is projected from ground with speed u at an angle θ with horizontal. The power delivered by gravity to it at half of maximum height from ground is

(1) $\dfrac{mgu\cos\theta}{\sqrt{2}}$

(2) $\dfrac{mgu\sin\theta}{\sqrt{2}}$

(3) $\dfrac{mgu\cos(90+\theta)}{\sqrt{2}}$

(4) Both (b) and (c)



QUESTION

A body projected vertically form the earth reaches a height equal to earth's radius before returning to the earth. The power exerted by the gravitational force is greatest

[AIPMT (Prelims)-2011]

1. At the instant just after the body is projected (-ve)
2. At the highest position of the body
3. At the instant just before the body hits the earth (+ve)
4. it remains constant all through

Ans → (1) & (3)

QUESTION

MR* → eqn मे 3-varible नहीं आना चाहिए

A body is being moved from rest along a straight line by a machine delivering constant power. The distance covered by body in time *t* is proportional to

1. $\sqrt{t}$
2. $t^{3/2}$
3. $t^{3/4}$
4. t^2

u=0, P = const^n

S (dist^n) as a function of time(t) ??

S ← v ← a

$P_{const} = F \cdot V$

$P = maV = const^n$

$aV = K$ ($K = const^n$)

$\frac{dv}{dt} V = K$

$\int V dv = \int K dt$

$\frac{V^2}{2} = Kt$

$V^2 = 2Kt$

$V = \sqrt{2Kt}$ (constant ko ignore)

$\frac{dS}{dt} = \sqrt{t}$

$\int dS = \int \sqrt{t}\, dt$

$S = \frac{t^{\frac{1}{2}+1}}{\frac{1}{2}+1} = \frac{t^{3/2}}{\frac{3}{2}}$

QUESTION

If position of object $x \propto t$ then find power delivered as a function of time.

Sol^n →

$x \propto t^1$

diff^n w.r.t. time

$\frac{dx}{dt} = V = 1$ (const)

velocity = const

Speed = const

K.E. = const

W = 0

$a = \frac{dv}{dt} = 0$

F = 0

Instantaneous $P = F \cdot v$

$= 0 \times v = 0$

zero

QUESTION

$P = F \cdot v$

$P = mav$

The position (x) of a body moving along x-axis at time (t) is given by $x = 3t^2$, where x is in metre and t is in second. If mass of body is 2 kg, then find the instantaneous power delivered to body by force acting on it at $t = 4$ s.

$x = 3t^2$, $v \rightarrow F$ $(\theta = 0°)$

$x = 3t^2$ (Position)

diff^n w.r.t. time

$v = \frac{dx}{dt} = \frac{d3t^2}{dt}$

$v = 3\frac{dt^2}{dt}$

$v = 3(2t) = 6t$

$v = 6t$

diff^n w.r.t time.

$\frac{dv}{dt} = a = 6$

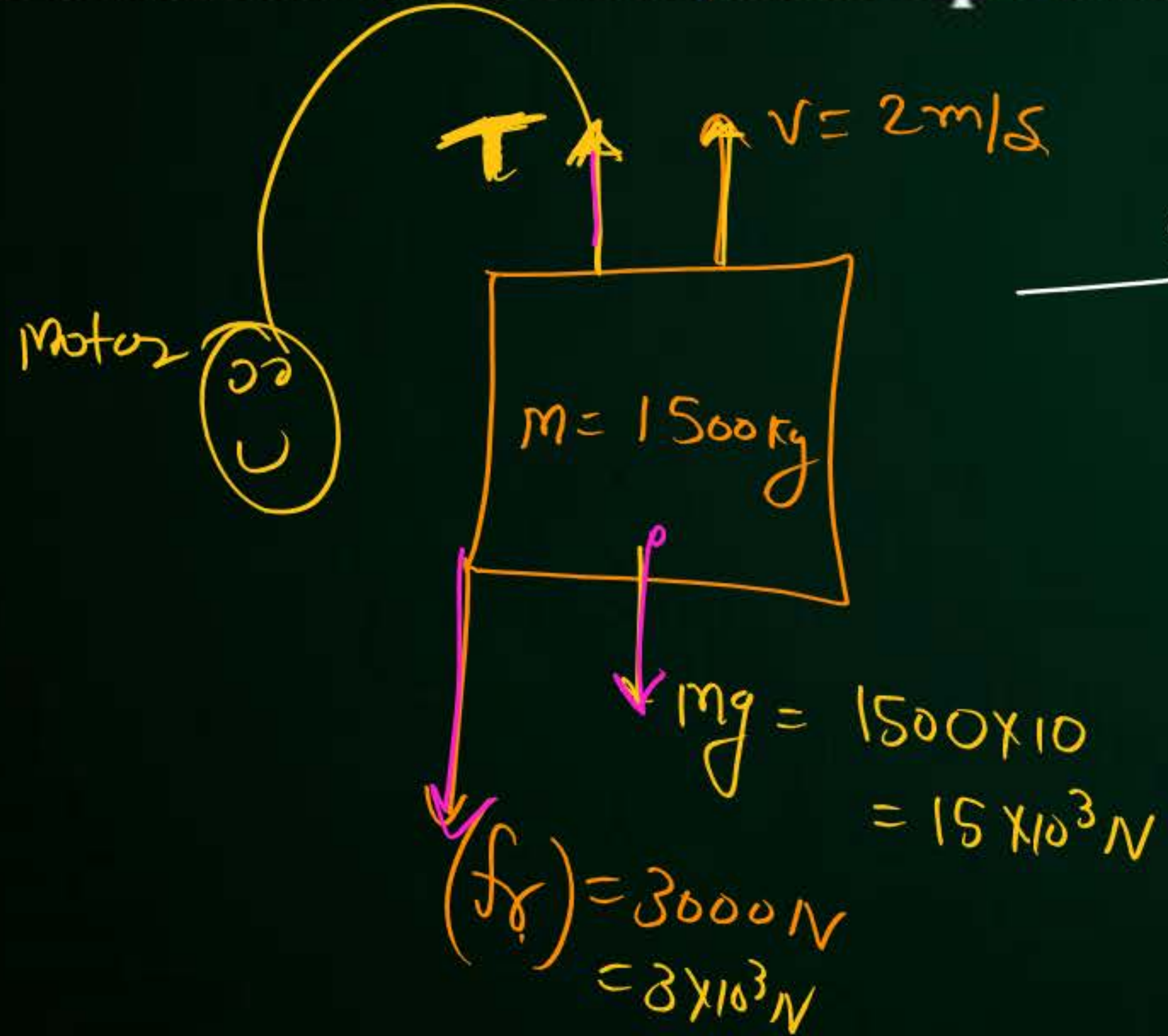
$F = ma = 2 \times 6 = 12N$

$P = F \cdot v = 12 \times 6t = 72t$

$P_{t=4s} = 72 \times 4 = 288 W$

QUESTION

An elevator that can carry a maximum load of 1500 kg (elevator + passengers) is moving up with a constant speed of 2 ms^{-1}. The frictional force opposing the motion is 3000 N. Find the minimum power delivered by the motor of the elevator in watts as well as in horse power ($g = 10\ ms^{-2}$)



$\{F_{net} = 0\} \rightarrow$

$T = mg + f_r$

$= 15000 + 3000$

$T = 18000\ N$

$P_{By\ Tensi} = T \times V$

$= 18000 \times 2$

$= 36 \times 000$

$= 36\ K\ Watt$

$P_{net} = 0$

Power deliv

1HP = 746 watt

QUESTION

A particle moves with the velocity $\vec{v} = (5\hat{i} + 2\hat{j} - \hat{k})\ ms^{-1}$ under the influence of a constant force, $\vec{F} = (2\hat{i} + 5\hat{j} - 10\hat{k})$ N. The instantaneous power applied is

1. 5 W
2. 10 W
3. 20 W
4. 30 W ✓

$v = 5\hat{i} + 2\hat{j} - \hat{k}$

$F = 2\hat{i} + 5\hat{j} - 10\hat{k}$

$P = \vec{F} \cdot \vec{v}$

$= (2\hat{i} + 5\hat{j} - 10\hat{k}) \cdot (5\hat{i} + 2\hat{j} - \hat{k})$

$= 10 + 10 + 10$

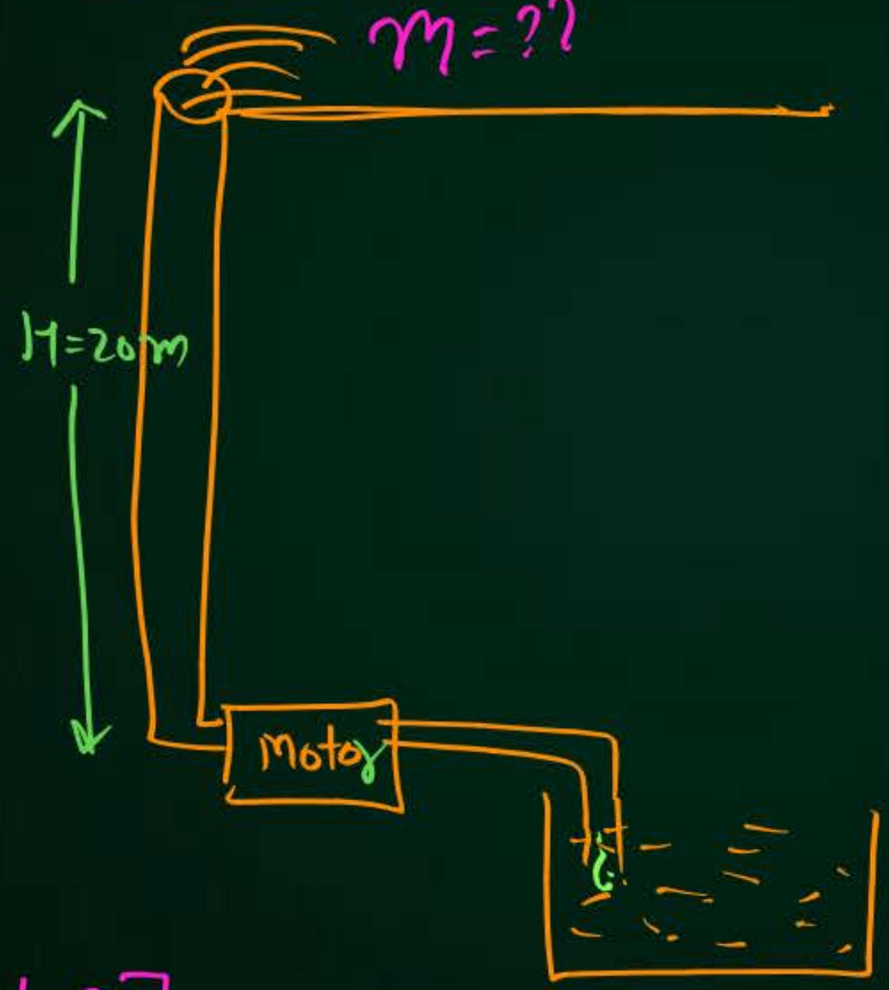
$= 30$ watt

QUESTION

density = $\frac{m}{Volume}$

volume = $\frac{mass}{density}$

The power of water pump is 4 kW. If $g = 10\ ms^{-2}$, the amount of water it can raise in 1 minute to a height of 20 m is



(1) 100 litre

(2) 1000 litre

(3) 1200 litre

(4) 2000 litre

- S.I unit $\rho = 10^3\ kg/m^3$
- C.G.S unit $\rho = 1\ gm/cm^3$

1 litre $= 10^{-3}\ m^3$

$1\ m^3 = 10^3$ litre

$P_{Avg} = \frac{W}{T} = \frac{mgh}{60}$

$4 \times 10^3 = \frac{m \times 10 \times 20}{60}$

mass: $m = 12 \times 10^2\ kg$

- Volume = $\frac{mass}{densi.}$

$= \frac{12 \times 10^2}{10^3}\ m^3$

$= 12 \times 10^2 \times 10^3 \times 10^{-3}$

QUESTION

The power of a pump, which can pump 500 kg of water to height 100 m in 10 s is

1. 75 kW
2. 25 kW
3. 50 kW ✓ (Ans)
4. 500 kW

$P_{Avg} = \frac{W}{time}$

$P_{Avg} = \frac{work}{time} = \frac{mgh}{time}$

$= \frac{500 \times 10 \times 100}{10}$

$= 500 \times 100$

$= 5 \times 10^4$

$= 50\ kW$

QUESTION

An engine pumps 800 kg of water through height of 10 m in 80 s. Find the power of the engine if its efficiency is 75%.

$\Rightarrow P_{pump\ actual} \times 75\% = \frac{mgh}{t}$

$\eta = \frac{P_{out}}{P_{in}}$

$\eta = \frac{mgh}{t\, P_{pump}}$

$75\%\, P_{pump} = \frac{mgh}{t}$

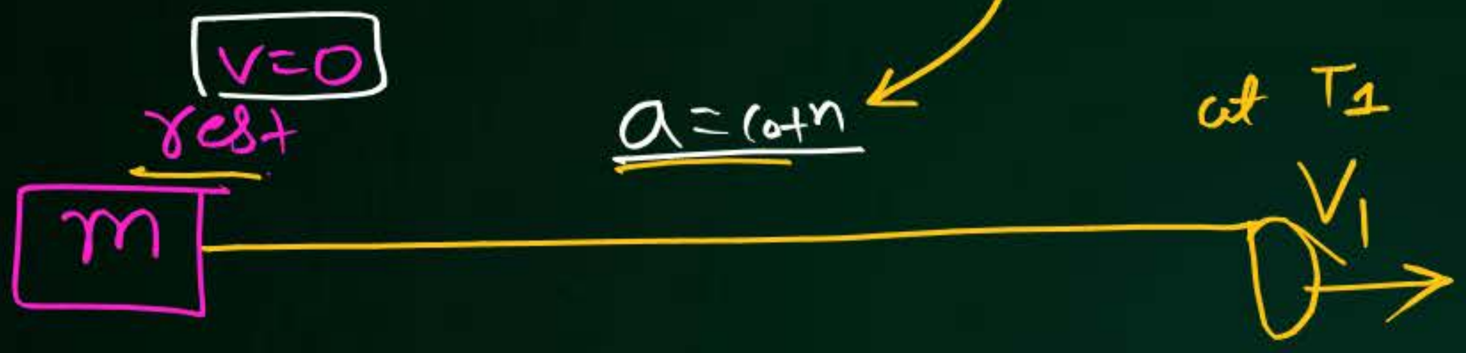
$P_{pump} = \frac{mgh}{t} \times \frac{100}{75}$

$= \frac{800 \times 10 \times 10}{80} \times \frac{100}{75}$

$= \frac{1000 \times 4}{3} = \frac{4}{3}\ kW$

QUESTION

A body of mass m accelerates uniformly from rest to velocity v_1 in time interval T_1. The instantaneous power delivered to the body as a function of time t is



Power at time 't'

Inst. $P = F_t \cdot v_t$

$= m a v_t$

$= m\left(\frac{v_1}{T_1}\right)\frac{v_1}{T_1}t = m\left(\frac{v_1}{T_1}\right)^2 t$ Ans

$a = \frac{\Delta v}{\Delta t} = \frac{v_1 - 0}{T_1 - 0} = \frac{v_1}{T_1}$

velocity at time 't'

$v = u + at$

$v = 0 + \frac{v_1}{T_1}t$

QUESTION

A particle of mass m is driven by a machine that delivers a constant power k watts. If the particle starts from rest+ the force on the particle at time t is

[AIPMT-2015]

(1) $\frac{1}{2}\sqrt{mk}\,t^{-1/2}$

(2) $\sqrt{\frac{mk}{2}}\,t^{-1/2}$ ✓ Ans

(3) $\sqrt{mk}\,t^{-1/2}$

(4) $\sqrt{2mk}\,t^{-1/2}$

$P = F \cdot V = K$ (const^n)

$F \cdot V = K$

$F = \frac{K}{V}$ ✗ $\qquad F\frac{dx}{dt} = K$ ✗

$F = ma$

$maV = K$

$V\left(\frac{dV}{dt}\right) = \frac{K}{m}$

$\int V\,dV = \frac{K}{m}\int dt$

$\frac{V^2}{2} = \frac{K}{m}t$

$V = \sqrt{\frac{2Kt}{m}}$ — (1)

diff^n w.r.t. time

$a = \frac{dV}{dt} = \sqrt{\frac{2K}{m}}\,\frac{dt^{1/2}}{dt}$

$a = \sqrt{\frac{2K}{m}}\,\frac{1}{2}t^{1-\frac{1}{2}}$

$F = ma = m \times \sqrt{\frac{2K}{m}}\left(\frac{1}{2}t^{-\frac{1}{2}}\right)$

$$P = F \cdot V$$

$$K = maV$$

$$K = m \frac{dv}{dt} v$$

$$\int \frac{K}{m} dt = \int v \, dv$$

$$\frac{K}{m} t = \frac{v^2}{2}$$

$$\frac{2Kt}{m} = v^2$$

$$V = \sqrt{\frac{2Kt}{m}}$$

$$v = \sqrt{\frac{2K}{m}} \, t^{1/2}$$

diff^n w.r.t time

$$a = \frac{dv}{dt} = \sqrt{\frac{2K}{m}} \frac{dt^{1/2}}{dt}$$

$$= \sqrt{\frac{2K}{m}} \, \frac{1}{2} t^{\frac{1}{2}-1}$$

$$F = ma = m\sqrt{\frac{2K}{m}} \times \frac{1}{2} t^{-1/2}$$

$$= \sqrt{\frac{m^2 \, 2K}{m \times 4}} \, t^{-1/2}$$

$$= \sqrt{\frac{mK}{2}} \, t^{-1/2}$$

QUESTION

A car of mass m starts from rest and accelerates so that the instantaneous power delivered to the car has a constant magnitude P_0. The instantaneous velocity of this car is proportional to

[AIPMT (Mains)-2012]

1. $t^2 P_0$
2. $t^{1/2}$
3. $t^{-1/2}$
4. $\frac{1}{\sqrt{m}}$

$P = F \cdot v$

$P_0 = mav$ — (1)

$P_0 = m\frac{dv}{dt}v$

$\frac{P_0}{m}\int dt = \int v\,dv$

$\frac{P_0 t}{m} = \frac{v^2}{2}$

$v^2 \propto t$ $\boxed{v \propto t^{1/2}}$

QUESTION

A particle of mass M starting from rest undergoes uniform acceleration. If the speed acquired in time T is V, the power delivered to the particle is

[AIPMT (Mains)-2010]

(1) $\frac{MV^2}{T}$

(2) $\frac{1}{2}\frac{MV^2}{T^2}$

(3) $\frac{MV^2}{T^2}$

(4) $\frac{1}{2}\frac{MV^2}{T}$

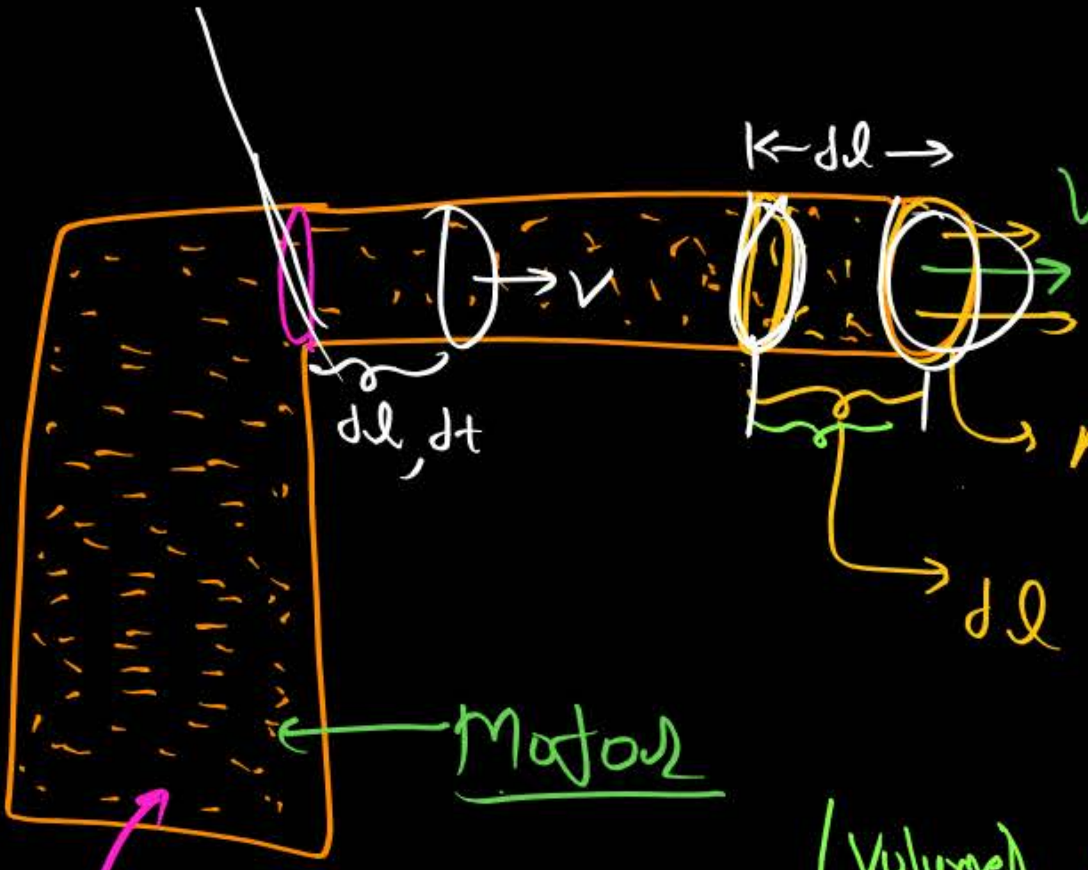
$u = 0$, at T → V

$P_{Avg} = \frac{W_{Total}}{\text{total Time}} = \frac{\Delta KE}{Time}$

$= \frac{\frac{1}{2}mv^2 - 0}{T}$

$\therefore = \frac{mv^2}{2T}$

Force applied by motor to eject liquid with constant velocity (v)



dl length travelled by liquid in time dt

$$dl = v\,dt \quad — (1)$$

(Volume) $dV = A\,dl$

$dV = A v\,dt$

mass transfer in time dt

$\Rightarrow dm = \rho\,dV = \rho A v\,dt$

In variable mass

$$F = v\,dm/dt = v[\rho A v] = \rho A v^2$$ → force acting on liquid of density ρ flowing with velocity v through cross-section Area A

Power of pump $= F \cdot v$
$= \rho A v^2 \cdot v$
$= \rho A v^3$

QUESTION

A pump is used to pump a liquid of density ρ continuously through a pipe of cross section area A. If liquid is flowing with speed *V*, then power of pump is

(1) $\frac{1}{3}\rho AV^2$

(2) $\frac{1}{2}\rho AV^2$

(3) $2\rho AV^2$

(4) $\frac{1}{2}\rho AV^3$

Ans – $P_{Avg} = \frac{\frac{1}{2}dm v^2}{dt}$

$= \frac{1}{2}\frac{\rho Av\,dt}{dt}v^2$

$= \frac{1}{2}\rho Av \times v^2$

$= \frac{1}{2}\rho Av^3$

QUESTION

The force required to row a boat at constant velocity is proportional to square of its speed. If a speed of v km/h requires 4 kW, how much power does a speed of $2v$ km/h require?

1. 8 kW
2. 16 kW
3. 24 kW
4. 32 kW

$F \propto v^2$ (given in question)

$P = F \cdot v$

$P = v^2 \cdot v = v^3$

$\frac{P_1}{P_2} = \frac{v_1^3}{v_2^3}$

$\frac{4\,kW}{P} = \frac{v^3}{(2v)^3} = \frac{1}{8}$

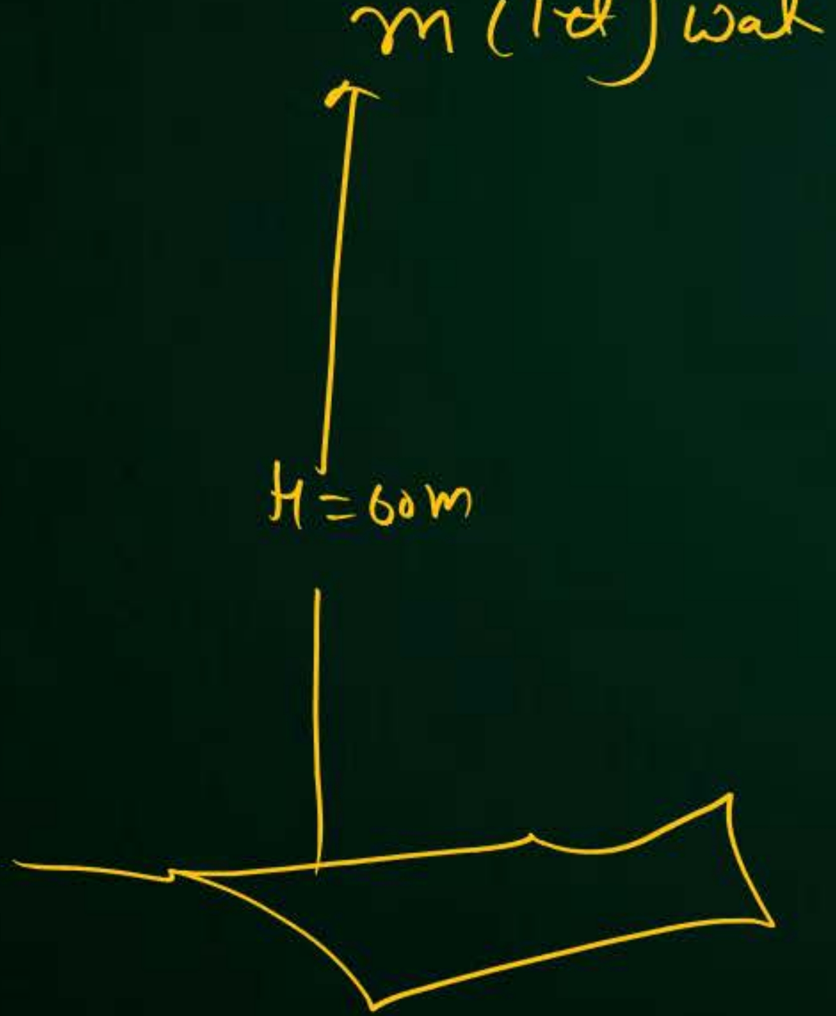
$32 = P$

QUESTION

Water falls from a height of 60 m at the rate of 15 kg/s to operate a turbine. The losses due to frictional forces are 10% of energy. How much power is generated by the turbine? ($g = 10\ m/s^2$)

[AIPMT (Prelims)-2008]

1. 7.0 kW
2. 8.1 kW
3. 10.2 kW
4. 12.3 kW



90% mgh / t = Power generated

$9 \times \frac{90}{100} \times 15 \times 60 =$ "

$10 \times 90 \times 9 = P$

$8100 W = P$

QUESTION

P_{inst} = Power of Pump = $\rho A v^3 = \lambda v^3$

* P_{Avg} = K.E imparted to water = $\frac{1}{2}\rho A v^3 = \frac{1}{2}\lambda v^3$

An engine pumps water continuously through a hose. Water leaves the hose with a velocity v and m is the mass per unit length of the water jet. What is the rate at which kinetic energy is imparted water ? **[AIPMT (Prelims)-2009]**

1. mv^2
2. $\frac{1}{2}mv^2$
3. $\frac{1}{2}m^2v^2$
4. $\frac{1}{2}mv^3$ ✓

(density) $\rho = \frac{m}{V} = \frac{m}{A\,dl}$

$\rho = \frac{m}{A\,dl}$

$\rho A = \frac{m}{dl}$ = mass per unit length = λ

$P_{Avg} = \frac{1}{2}\rho A v^3 = \frac{1}{2}\lambda v^3 = \frac{1}{2}mv^3$

In this question $\lambda = m$

QUESTION

An engine pumps water through a hose pipe. Water passes through the pipe and leaves it with a velocity of 2 m/s. The mass per unit length of water in the pipe is $\lambda =$ 100 kg/m. What is the power of the engine? [AIPMT (Prelims)-2010]

1. 800 W
2. 400 W
3. 200 W
4. 100 W

$A\rho = \lambda$

mass per unit length.

$P_{inst} = \rho A v^3 = \lambda v^3$

$P_{Avg} = \frac{1}{2}\rho A v^3 = \frac{\lambda v^3}{2}$

Power of Pump $= \lambda v^3$

$= 100 \times (2)^3$

$= 100 \times 8$

$= 800 W$


THANK YOU

YAKEEN 2.0

FOR NEET 2025

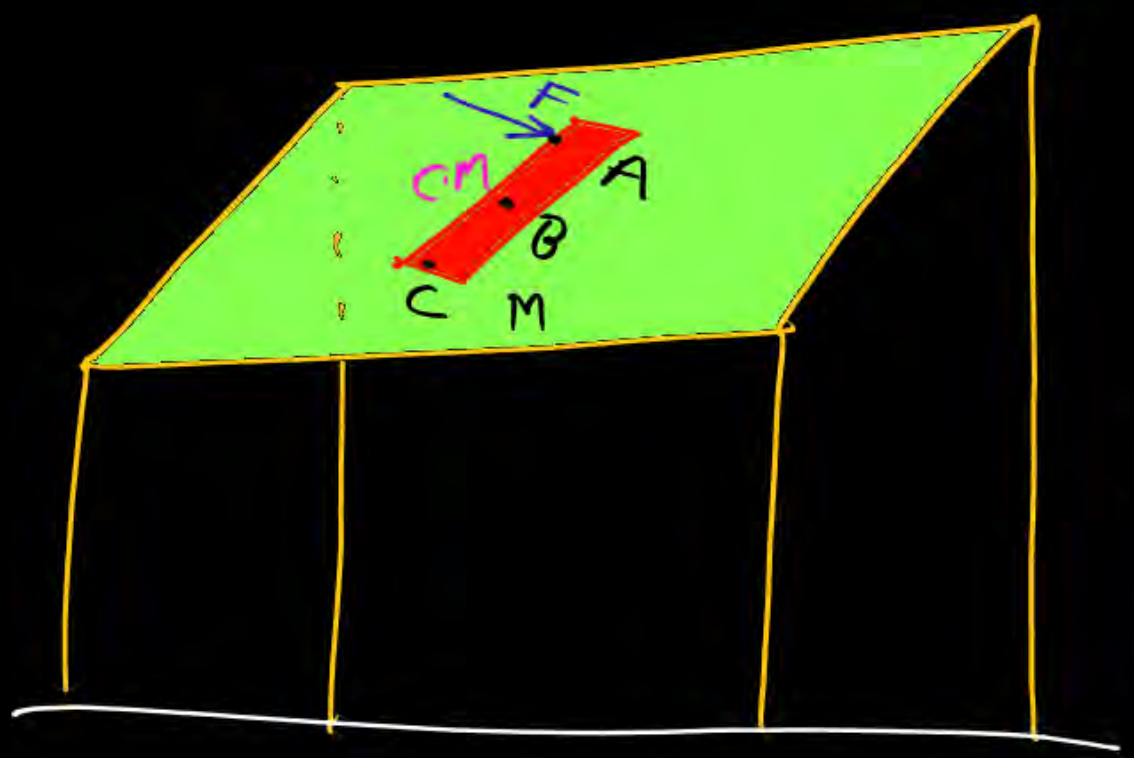
Lecture- 01 | Physics

Centre of mass and System of Particles, Collision

By- Dr. Manish Raj (MR SIR)



Todays Goal Position of centre of mass



$$a_A = \frac{F}{M} \;\}\; \times$$

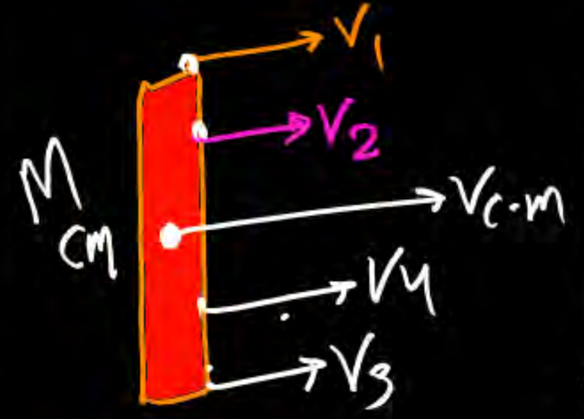
$$a_C = \frac{F}{M} \;\times$$

$$a_{c.m} = \frac{F}{M} \;✓$$

#



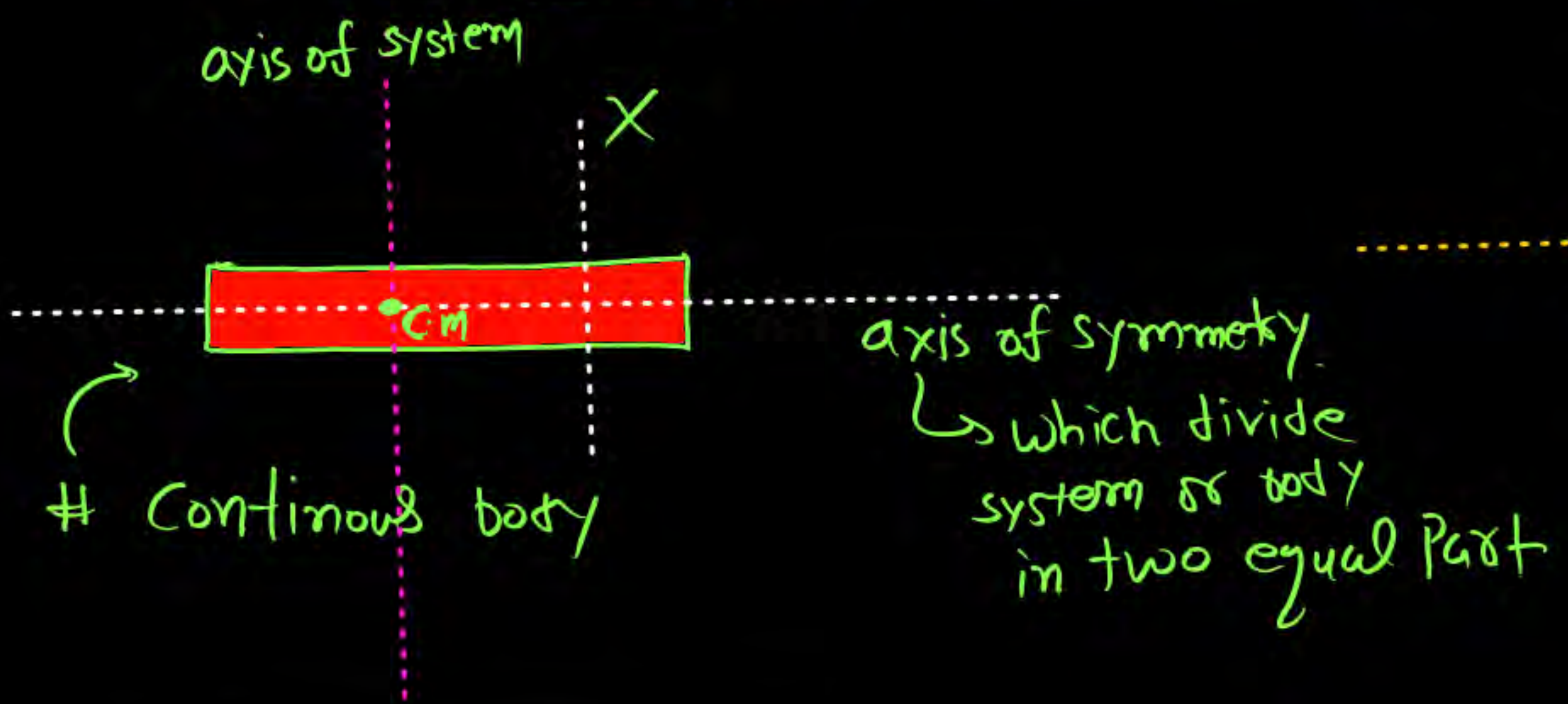
$$K.E = \frac{1}{2} m v^2$$

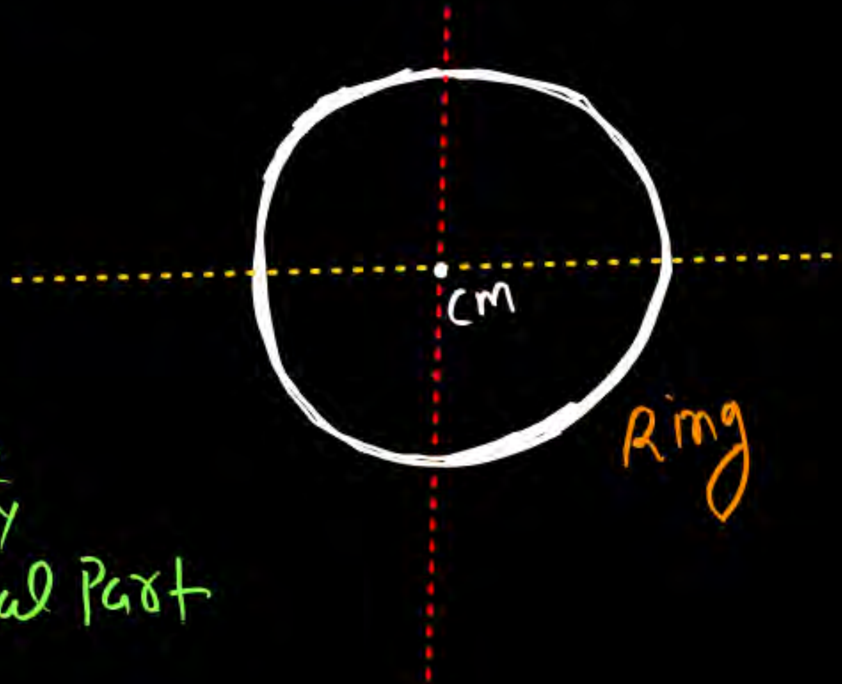


$$K.E = \frac{1}{2} m v_{c.m}^2$$

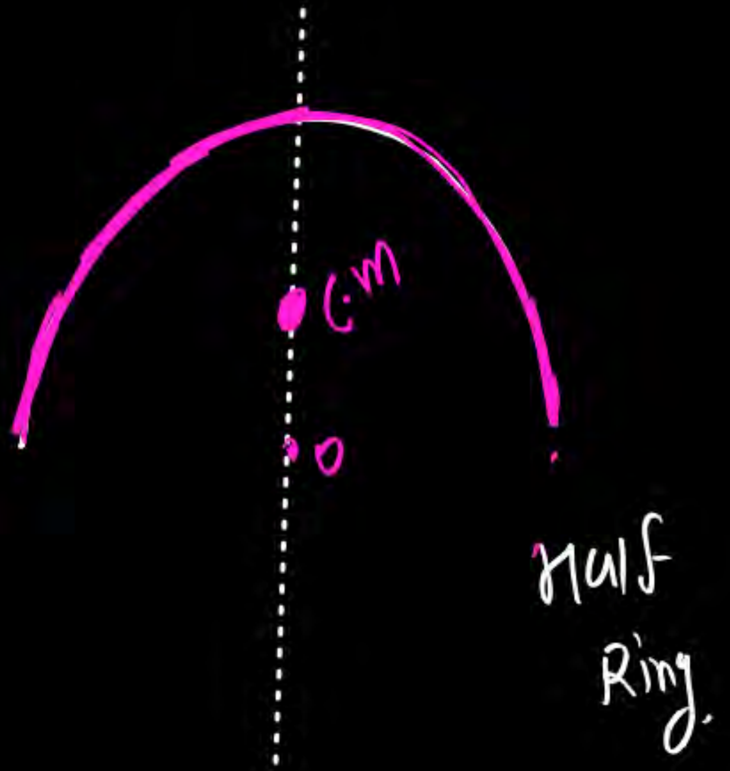
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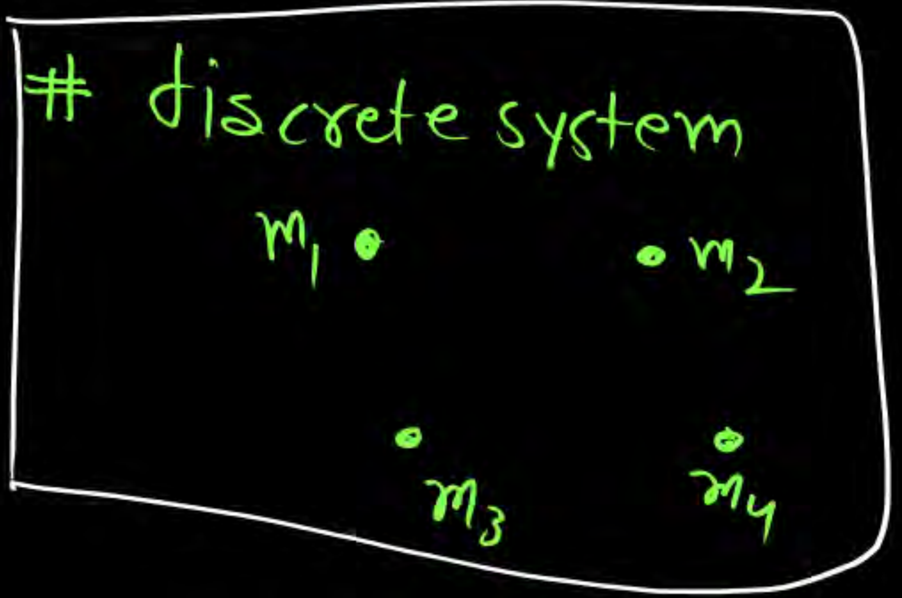
(#) centre of mass is a point where whole mass of the system can be assume there, and acc^n of the system is equal to $\vec{a}_{c.m}$. and $\vec{V}_{c.m}$ is a velocity of whole system.

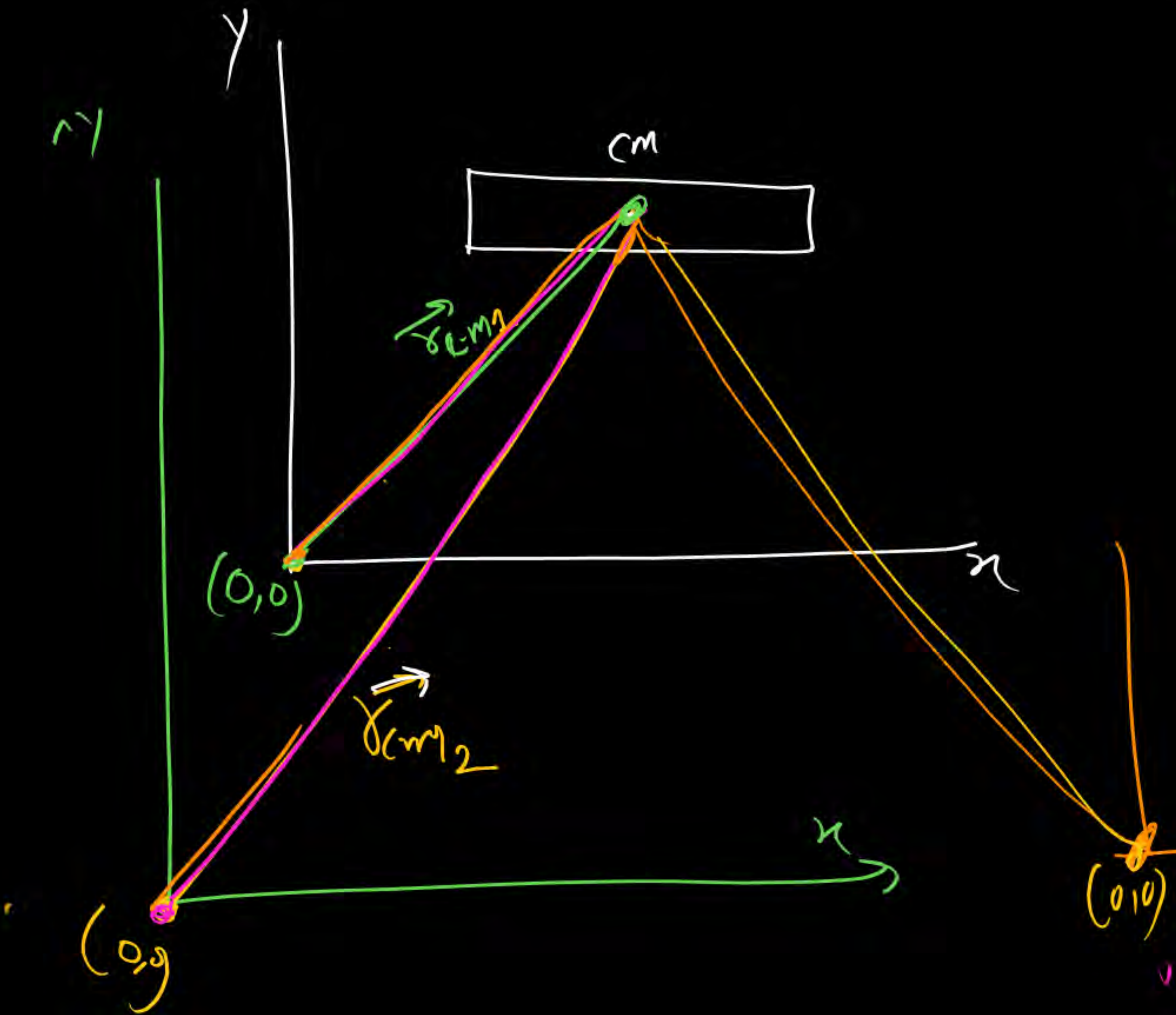












Position of centre of mass depends on choice of co-ordinate frame of refrence.

Position vector (co-ordinate of c.o.m) diff^n from these two origin.

but Location of c.o.m or physical presence of c.o.m does not depends on choice of co-ordinate.

- Centre of mass is a imaginary point where whole mass of the system or body can be assume there.
- It can be inside or outside the body.
- It always on the axis of symmetry
- Centre of mass lies at a point where two axis of symmetry cut each other.
- Centre of mass near to the heavier object.
- It divide moment of mass in equal part.
- COM and COG are at same point for smaller object.
- For large object COM lies above to COG.
- COM is a point and position of COM depends upon choice of origin but real meaning of COM independent upon origin.

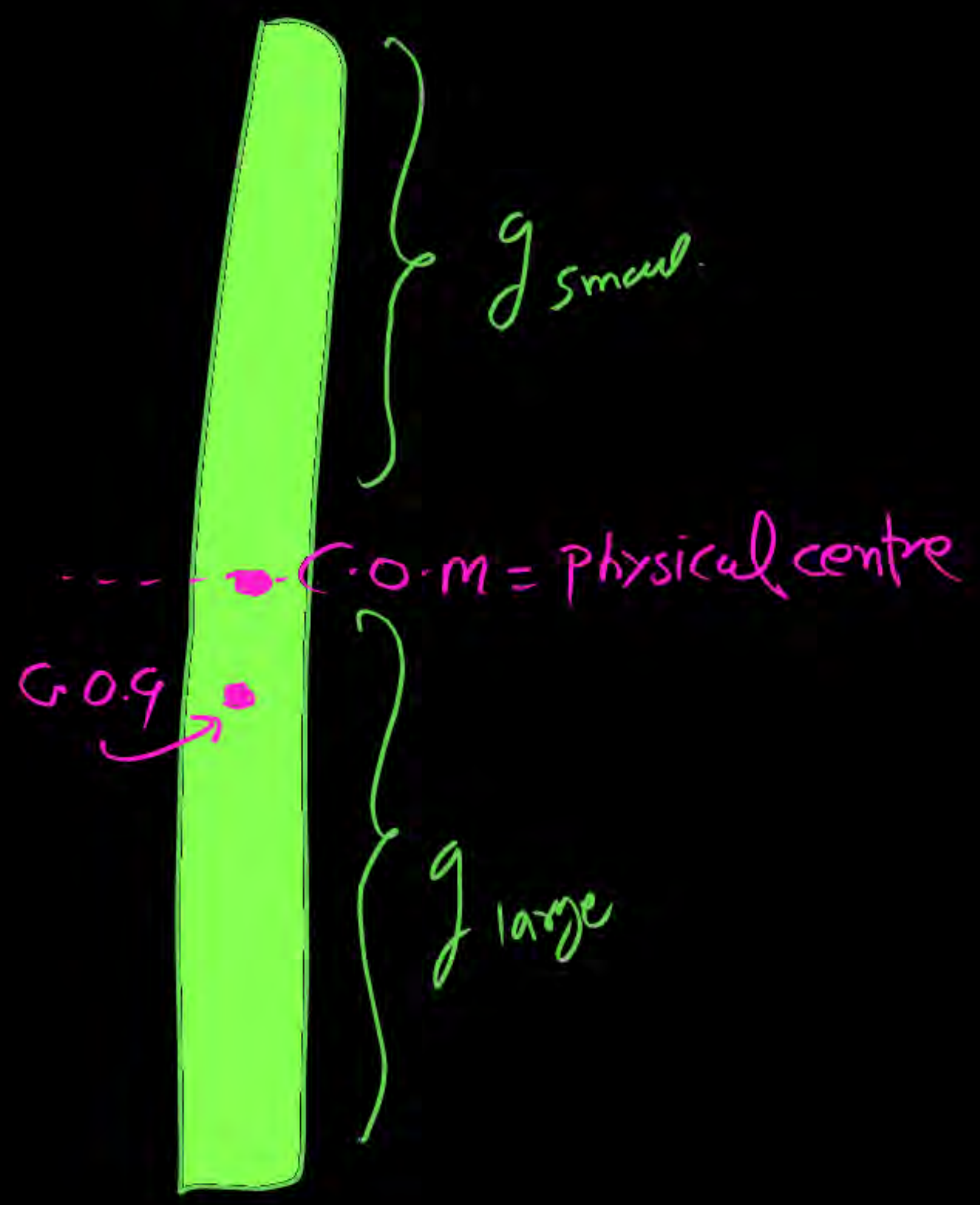


C.O.G → centre of gravity
→ where whole gravitation Force assume to be acting

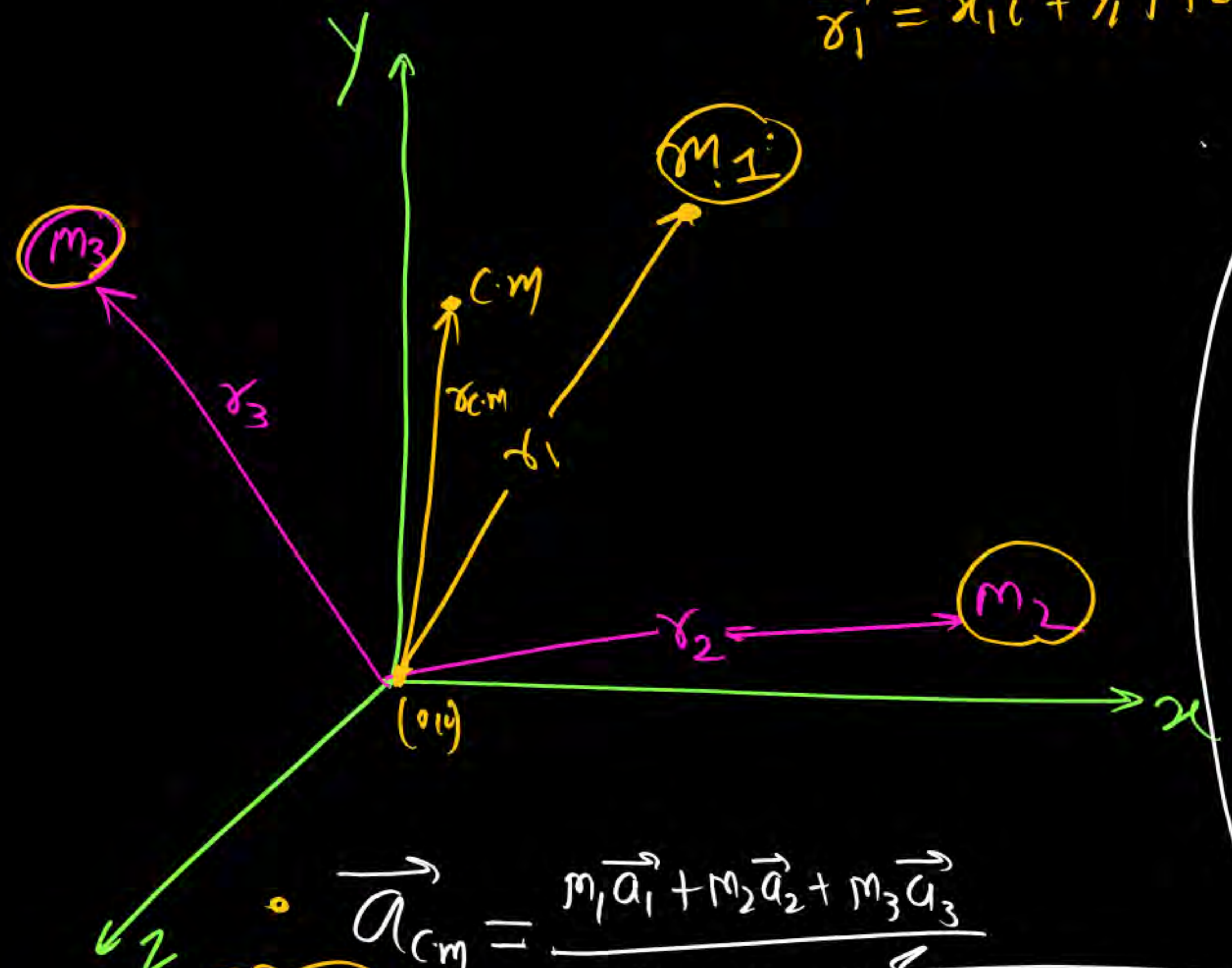
(Location)

$$g_{eef} = g_0'\left(1 - \frac{2h}{R}\right)$$

$$g_{eef} = \frac{g_0 R^2}{(R+h)2}$$



$$\vec{r}_1 = x_1\hat{i} + y_1\hat{j} + z_1\hat{k}$$



$$\vec{r}_{c.m} = \frac{m_1\vec{r}_1 + m_2\vec{r}_2 + m_3\vec{r}_3}{m_1 + m_2 + m_3}$$

→ Position of c.o.m.

$$\vec{r}_{c.m} = \frac{m_1x_1 + m_2x_2 + m_3x_3}{m_1 + m_2 + m_3}$$

diff^n w.r.t time

$$\vec{V}_{c.m} = \frac{m_1\vec{V}_1 + m_2\vec{V}_2 + m_3\vec{V}_3}{m_1 + m_2 + m_3}$$

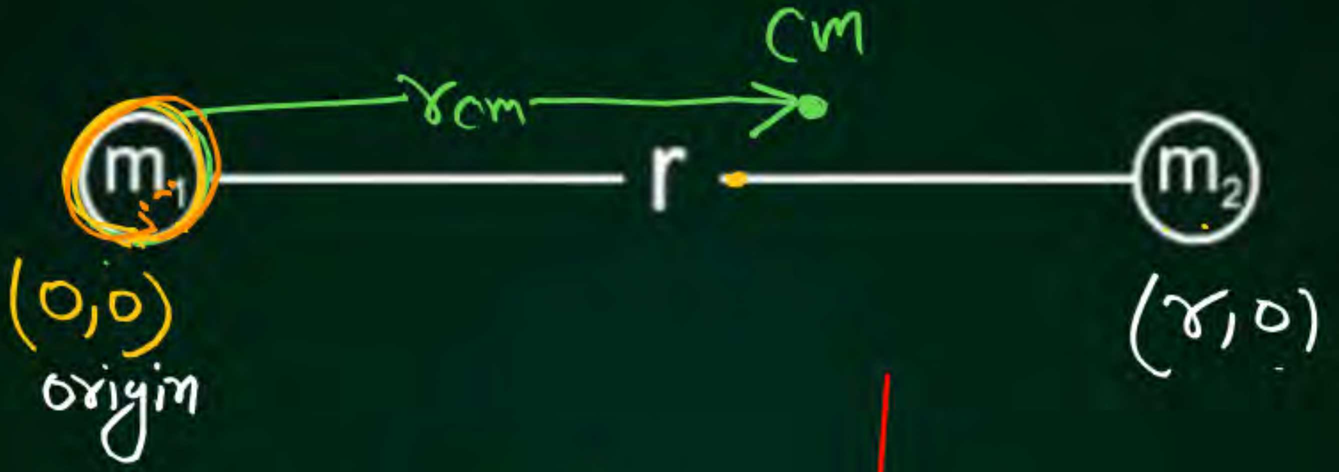
$$\vec{a}_{c.m} = \frac{m_1\vec{a}_1 + m_2\vec{a}_2 + m_3\vec{a}_3}{m_1 + m_2 + m_3}$$

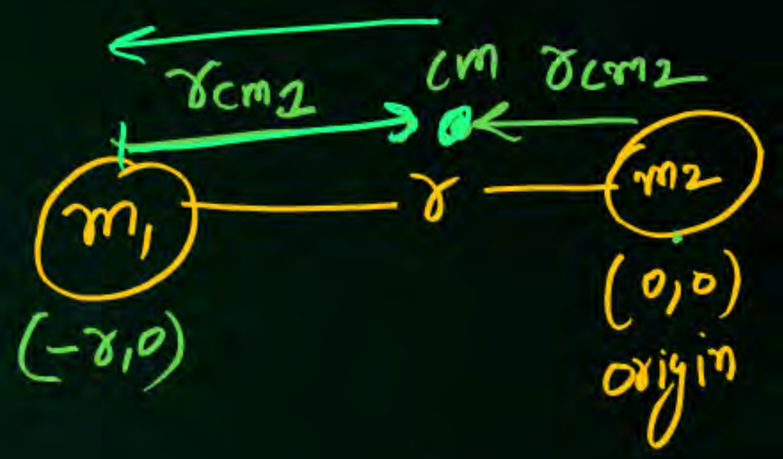
MR*

$$\square = \frac{m_1\square + m_2\square}{m_1 + m_2}$$

QUESTION

Find Position of Centre of Mass.





$$r_{c.m} = \frac{m_1 \times 0 + m_2 r \hat{i}}{m_1 + m_2}$$

$$\vec{r}_{c.m} = \frac{m_2 r \hat{i}}{(m_1 + m_2)} \quad \text{—— (1)}$$

Position of c.o.m from m_1.

MR* - 1
If $m_1 = m_2$
$r_{c.m} = r/2$

MR* - 2
If $m_1 = 0$
$r_{c.m} = r$

MR* - 3
If $m_2 = 0$
$r_{cm} = 0$

$$\vec{r}_{cm_2} = \frac{-m_1 r \hat{i} + m_2 \times 0}{m_1 + m_2}$$

$$\vec{r}_{c.m_2} = \frac{-m_1 r}{m_1 + m_2} \hat{i} \quad \text{—— (ii)}$$

① / ⑪ (magnitude)

$$\frac{r_{cm_1}}{r_{c.m_2}} = \frac{\frac{m_2 r}{m_1+m_2}}{\frac{m_1 r}{m_1+m_2}}$$

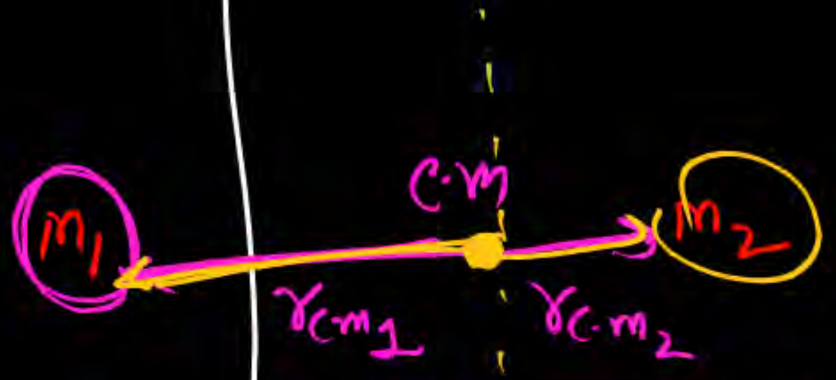
$$\boxed{\frac{r_{c.m_1}}{r_{c.m_2}}} = \frac{m_2}{m_2}$$

Position of c.o.m from mass Inversely Proportional to mass.

$$m_1 r_{cm_1} = m_2 r_{c.m_2}$$

(r_{cm_1}: dist^n of object from centre of mass)

Mass x dist^n of that mass from c.o.m = Const^n



$\uparrow M R\downarrow$ = Const^n



$$\underbrace{m_1 r_1}_{\text{moment of mass}} = m_2 r_2$$

$$m_1\vec{r_1} + m_2\vec{r_2} + m_3\vec{r_3} + m_4\vec{r_4} = 0$$

K.B.D.

QUESTION

The centre of mass of a system of particles does not depend on

1. Masses of the particles
2. Internal forces of the particles
3. Position of the particles
4. Relative distance between the particles

Ans (2)

$$\vec{r}_{c.m} = \frac{m_1\vec{r_1} + m_2\vec{r_2}}{m_1 + m_2}$$

QUESTION

Position of centre of mass of a body :

1. Depends on the choice of co-ordinate system
2. Is independent of the choice of co-ordinate system
3. May or may not depend on the choice of co-ordinate
4. None of the above

QUESTION

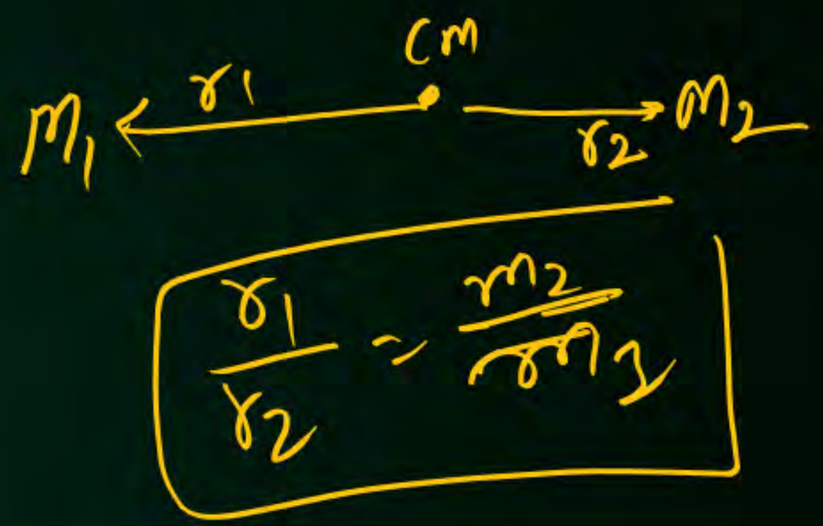
A system of consists of mass M and m (<<M). The centre of mass of the system is

1. At the middle
2. Nearer to M
3. Nearer to m
4. At the position of larger mass

QUESTION

The centre of mass of a system of two particles divides the distance between them

1. In inverse ratio of square of masses of particles
2. In direct ratio of square of masses of particles
3. In inverse ratio of masses of particles
4. In direct ratio of masses of particles



QUESTION

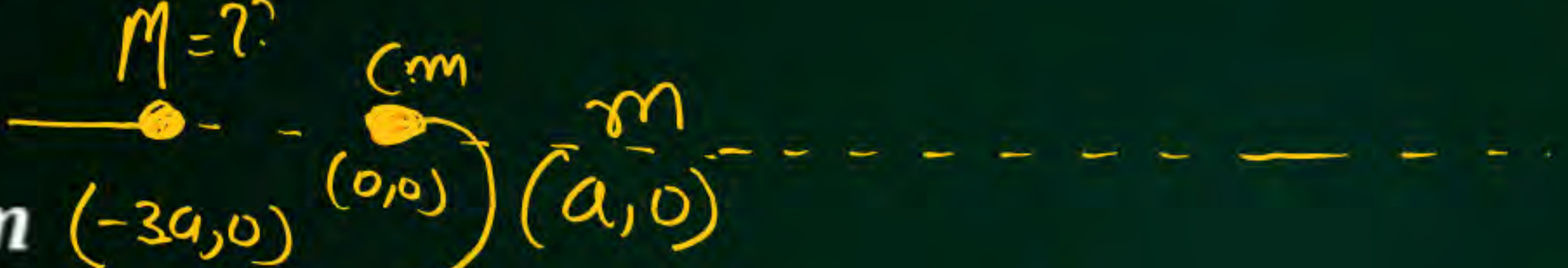
The centre of mass of a body

1. Lies always outside the body
2. May lie within, outside the surface of the body
3. Lies always inside the body
4. Lies always on the surface of the body

QUESTION

A point object of mass m is kept at $(a, 0)$ along x-axis. What mass should be kept at $(-3a, 0)$, so that centre of mass lies at origin.

1. m
2. $2m$
3. $m/3$
4. $3m$



$$\vec{r}_{c.m} = \frac{m_1\vec{r}_1 + m_2\vec{r}_2}{m_1 + m_2}$$

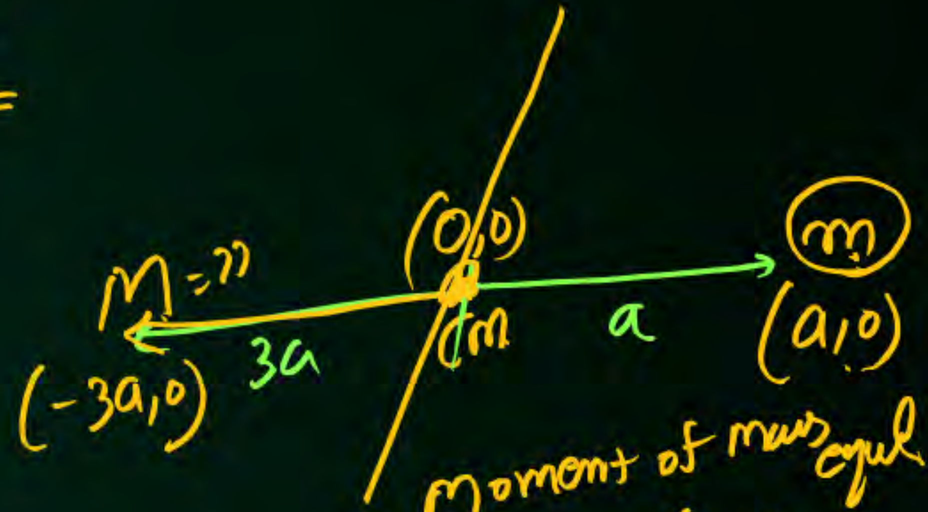
$$0 = \frac{ma - M3a}{m + M}$$

$$ma - 3Ma = 0$$

$$ma = 3Ma$$

$$M = \frac{m}{3}$$

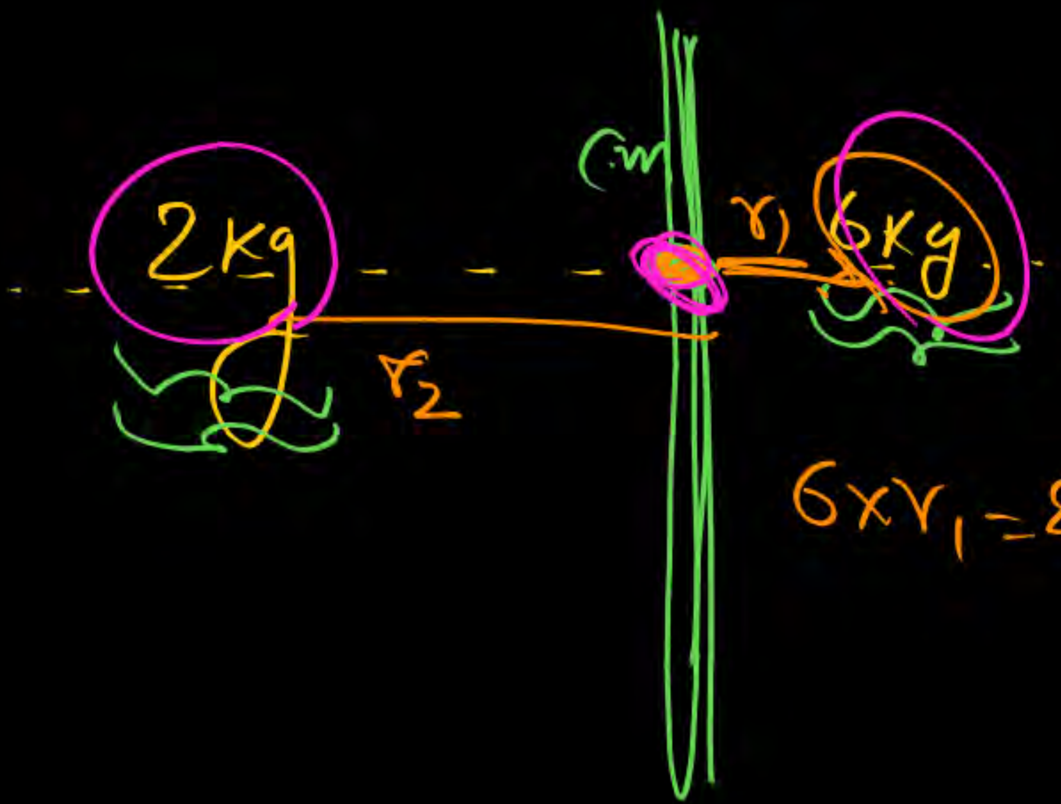
MR*



moment of mass equal

$$ma = 3aM$$

$$M = \frac{m}{3}$$

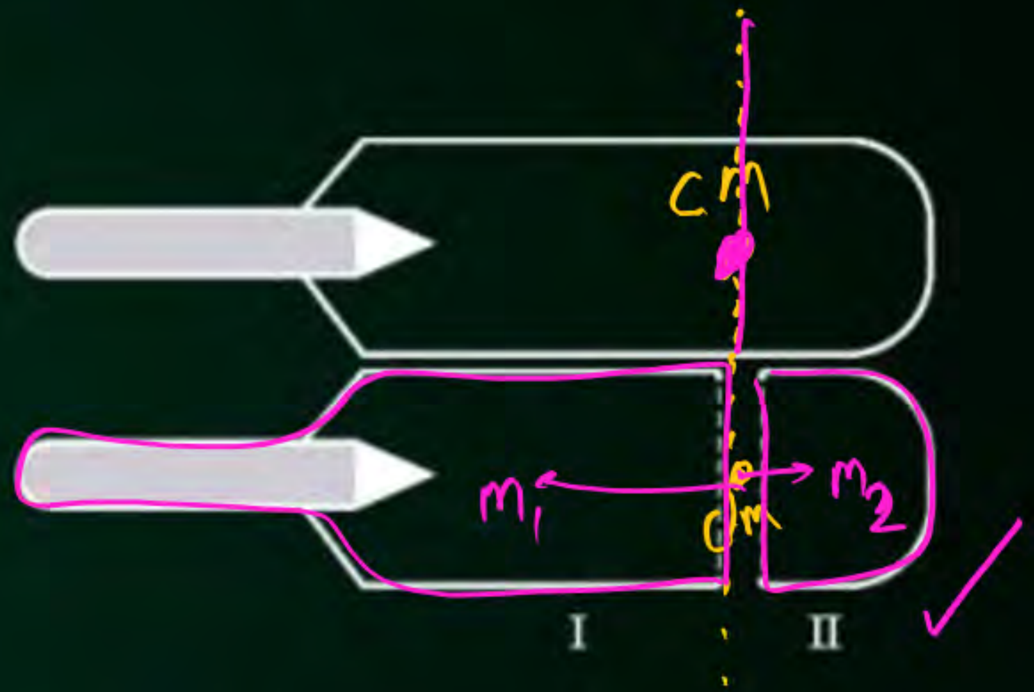


$6 \times r_1 = 2 \times r_2$

QUESTION

A cricket bat is cut at the location of its centre of mass as shown. Then

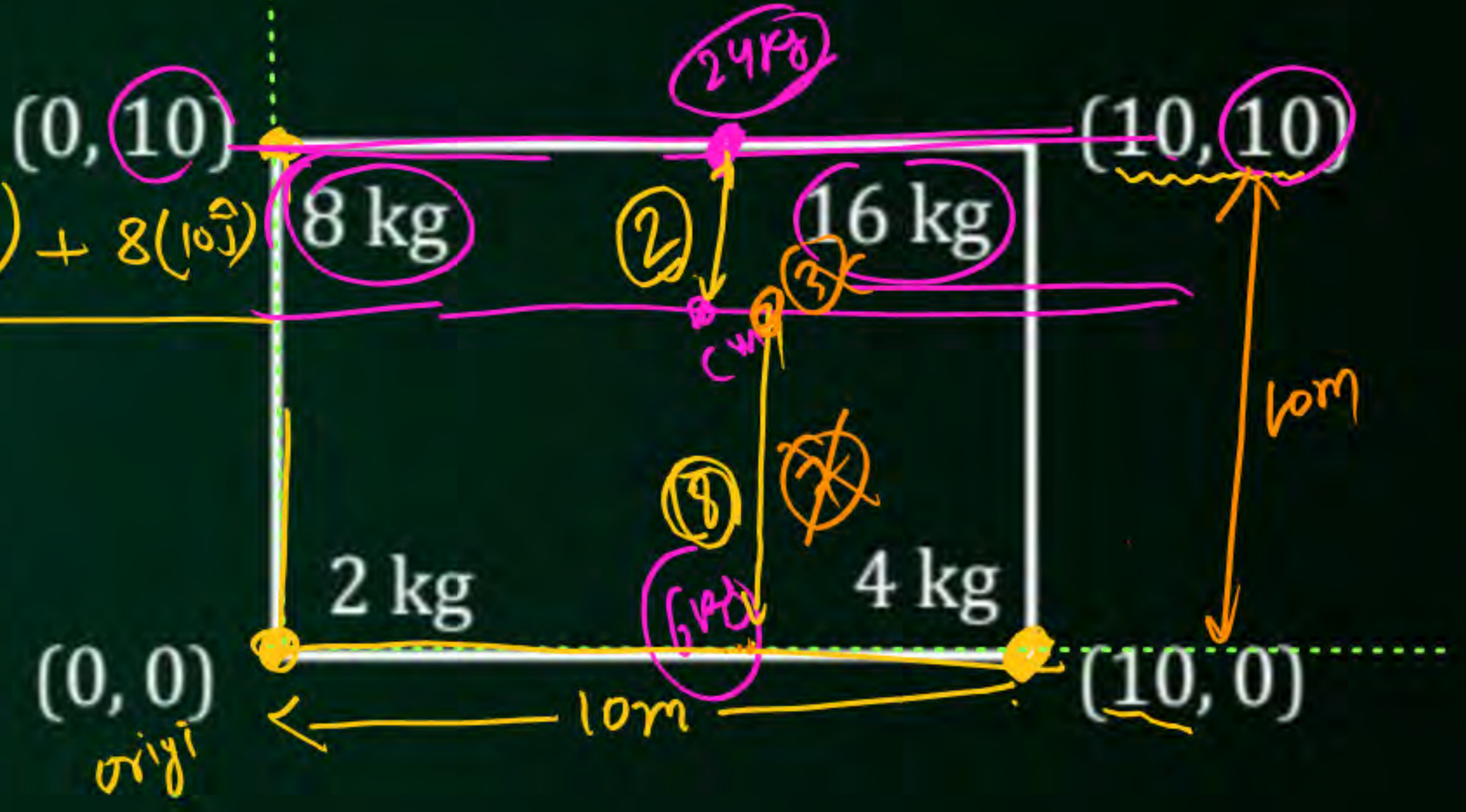
1. The two pieces will have the same mass
2. The bottom piece will have large mass
3. The handle piece will have larger mass
4. Mass of handle piece is double the mass of bottom piece



QUESTION

Find position of C.O.M.?

1. $\frac{20}{3}, 8$
2. $8, \frac{20}{3}$
3. $\frac{20}{3}, \frac{20}{3}$
4. $8, 4$



$$\vec{r}_{c.m} = \frac{2\times 0 + 4\times 10\hat{i} + 16(10\hat{i}+10\hat{j}) + 8(10\hat{j})}{2+4+8+16}$$

$$= \frac{40\hat{i} + 160\hat{i} + 160\hat{j} + 80\hat{j}}{30}$$

$$= \frac{200\hat{i} + 240\hat{j}}{30}$$

$$= \frac{20}{3}\hat{i} + 8\hat{j}$$

QUESTION

The position vector of three particle of mass $m_1 = 3kg$, $m_2 = 2$ kg, $m_3 = 5$ kg are $(\hat{i}, \hat{j}, \hat{k})$, $(2\hat{i} + \hat{j} + \hat{k})$ are $(\hat{i} - \hat{j} + \hat{k})$

1. $1.2\hat{i} + \hat{k}$ Ans

2. $\hat{i} + 1.2\hat{j} + 3\hat{k}$

3. $2\hat{i} + 3\hat{k} + \hat{j}$

4. $4\hat{j} + 1.2\hat{k}$

$$\vec{r}_{c.m} = \frac{3 \times \hat{i} + 2 \times 2\hat{i} + 5 \times \hat{i}}{3 + 2 + 5} = \frac{12\hat{i}}{10} = 1.2\hat{i}$$

MR*

QUESTION

Mass is non-uniformly distributed on the circumference of a ring of radius r and centre at origin. Let a be the distance of the centre of mass of the ring from origin. Then

1. $r = a$
2. $0 \leq a \leq r$
3. $a < r$
4. $a > r$



$r_{c.m} = a$





QUESTION

Two bodies of masses 1 kg and 2 kg are lying in *xy* plane at (–1, 2) and (2, 4) respectively. What are the coordinates of the centre of mass?

r_1 r_2

$$\vec{r}_{c.m} = \frac{1(-1\hat{i}+2\hat{j}) + 2(2\hat{i}+4\hat{j})}{1+2}$$

$$\vec{r}_{c.m} = \frac{-1\hat{i}+2\hat{j}+4\hat{i}+8\hat{j}}{3}$$

$$= \frac{3\hat{i}+10\hat{j}}{3}$$

$$= \hat{i}+\frac{10}{3}\hat{j}.$$

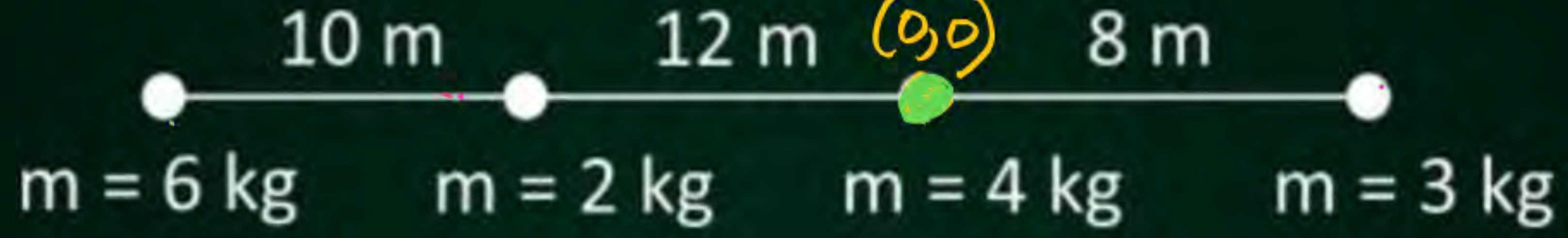
n particles of masses m2m, 3m... 4m grams are placed on the same line at distances *I*, 2*I*, 3*I*, ... 4*I* c.m. from a fixed point. The distance of centre of mass of the particles from the fixed point in centimeters is

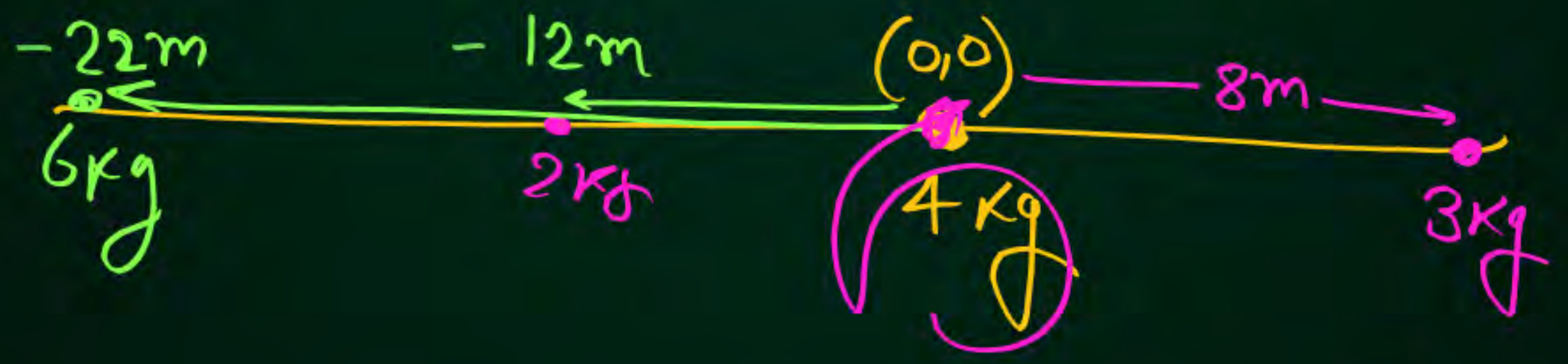
1. $\frac{(2n+1)I}{3}$
2. $\frac{I}{n}+I$
3. $\frac{n(n^2+1)I}{2}$
4. $\frac{I}{n}-I$



QUESTION

What is the distance of COM from 4 kg mass in the following arrangement

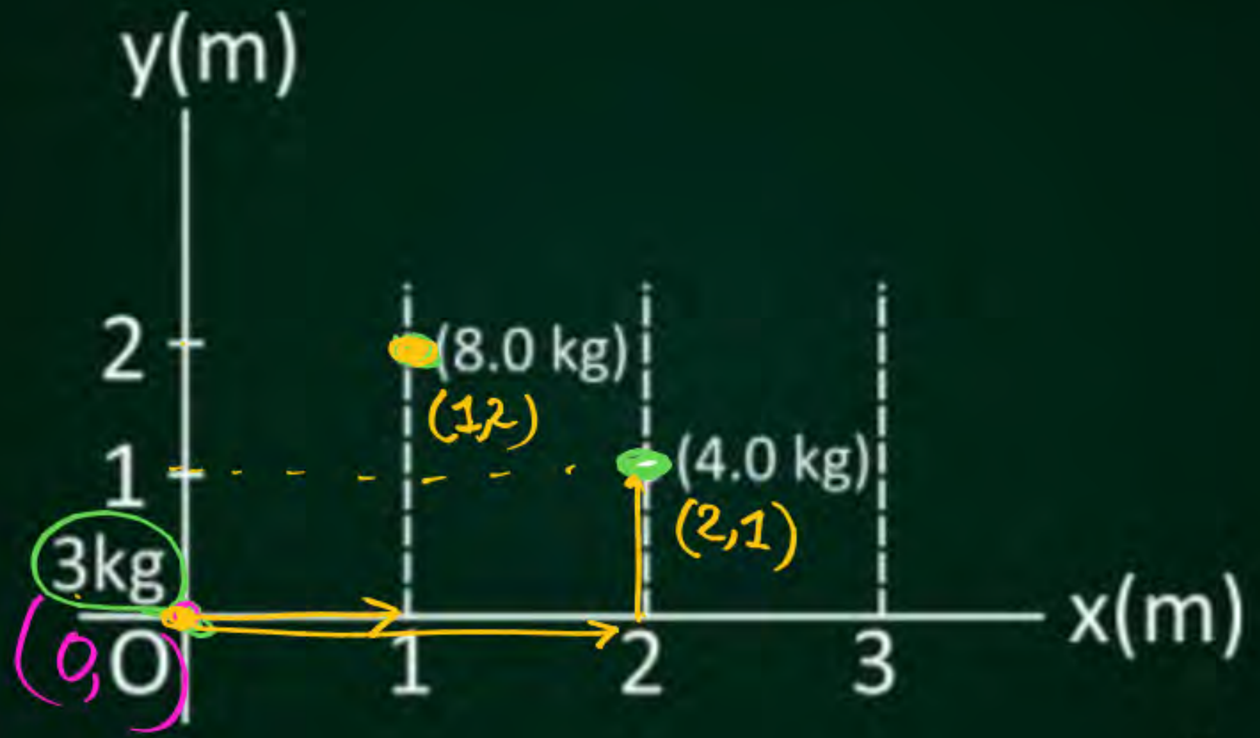




$$\vec{r}_{cm} = \frac{4\times 0 + 3\times 8 + 2\times(-12)\times 6(-22)}{4+3+2+6}$$

QUESTION

What are the coordinates of the centre of mass of the three particles system shown in figure?



$$\vec{r}_{c.m} = \frac{3\times 0 + 8(1\hat{i}+2\hat{j}) + 4(2\hat{i}+1\hat{j})}{3+8+4} = \frac{16\hat{i}+20\hat{j}}{15}$$

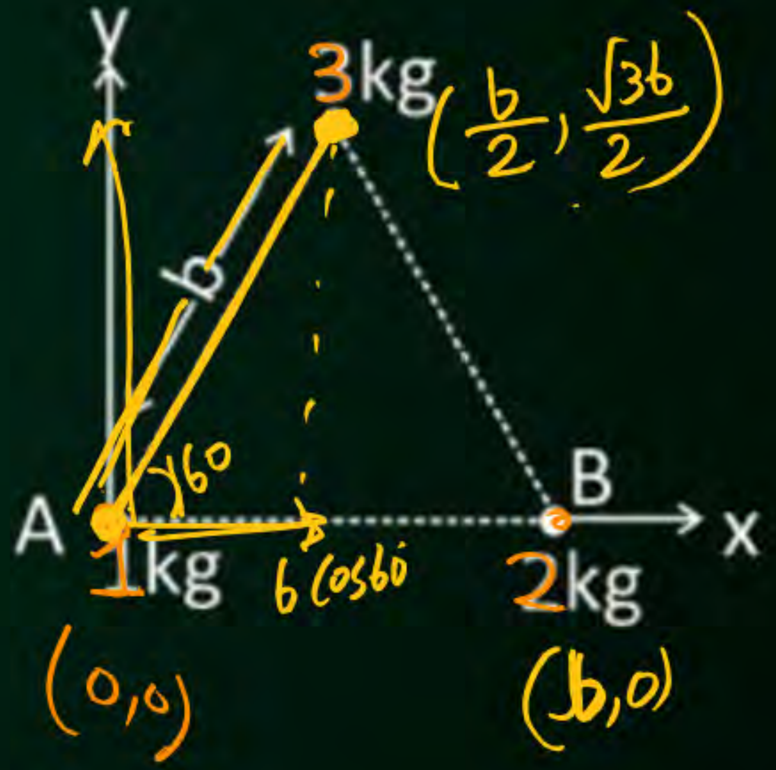
Ans

QUESTION

Locate the centre of mass of a system of particles of masses 1 kg, 2 kg and 3kg situated at the corners of an equilateral triangle of side b as shown in figure.

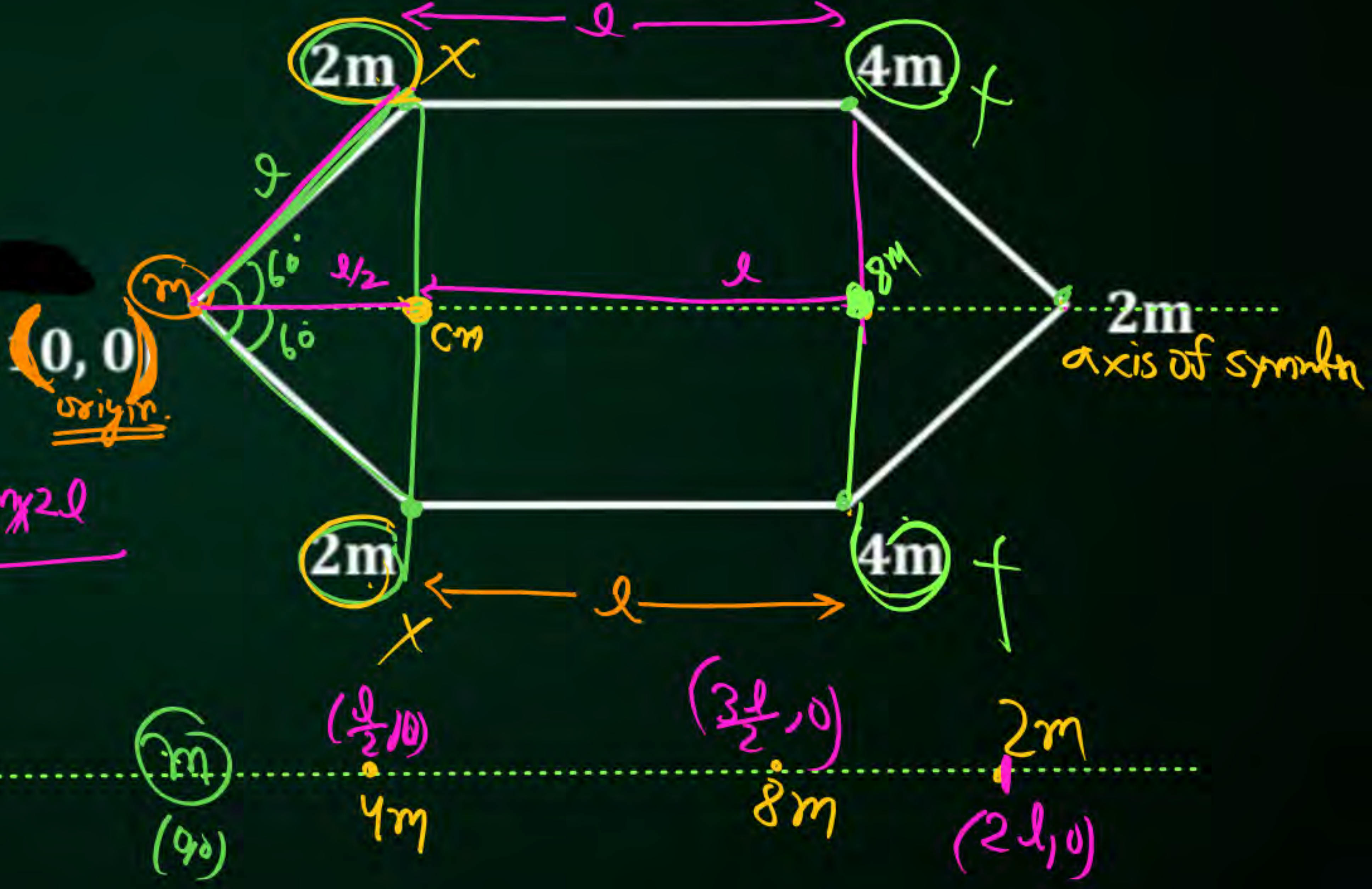
$$r_{cm} = \frac{1\times 0 + 2(b\hat{i}) + 3\left(\frac{b}{2}\hat{i} + \frac{\sqrt{3}b}{2}\hat{j}\right)}{1+2+3}$$

(Ans)



QUESTION

Find position of C.O.M.



$$x_{c.m} = \frac{m\times 0 + 4m\times \frac{l}{2} + 8m\times \frac{3l}{2} + 2m\times 2l}{m+4m+8m+2m}$$

QUESTION

Consider a system having two masses m_1 and m_2 in which first mass is pushed towards the centre of mass by a distance a. The distance by which the second mass should be moved to keep the centre of mass at same position

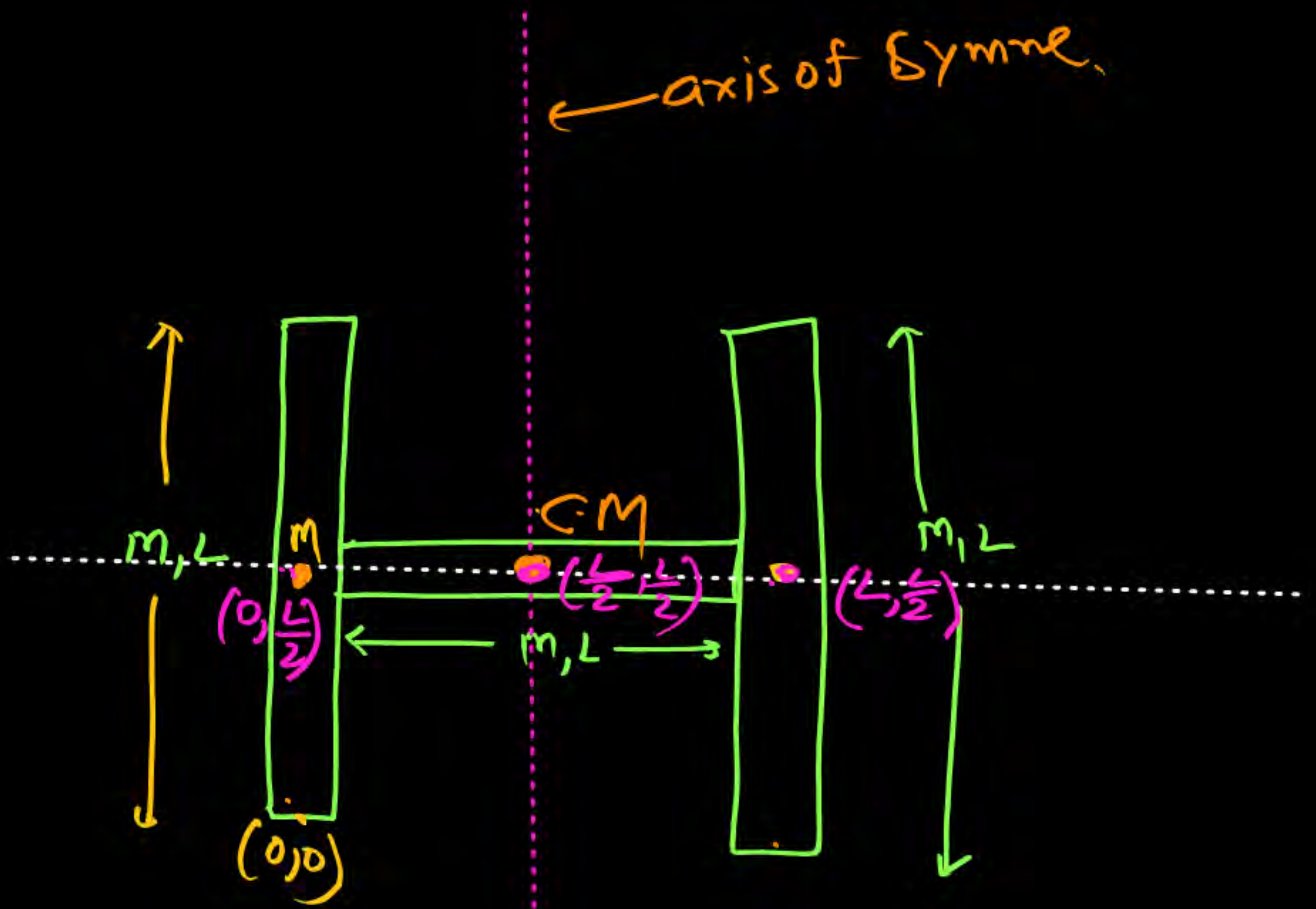
1. $\dfrac{m_1}{m_2}a$

2. $\left(\dfrac{m_1}{m_1+m_2}\right)a$

3. $\dfrac{m_2}{m_1}a$

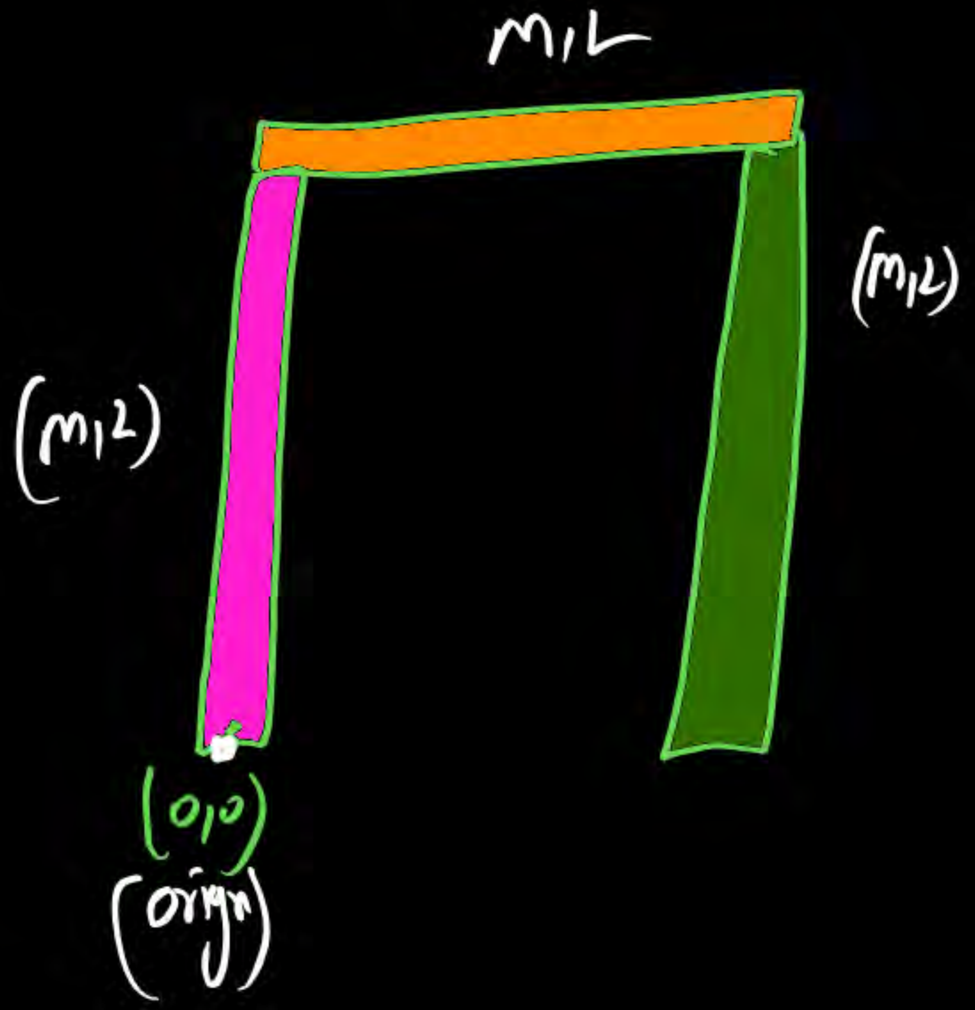
4. $\left(\dfrac{m_2}{(m_1+m_2)}\right)a$

COM OF CONTINUOUS MASS SYSTEM

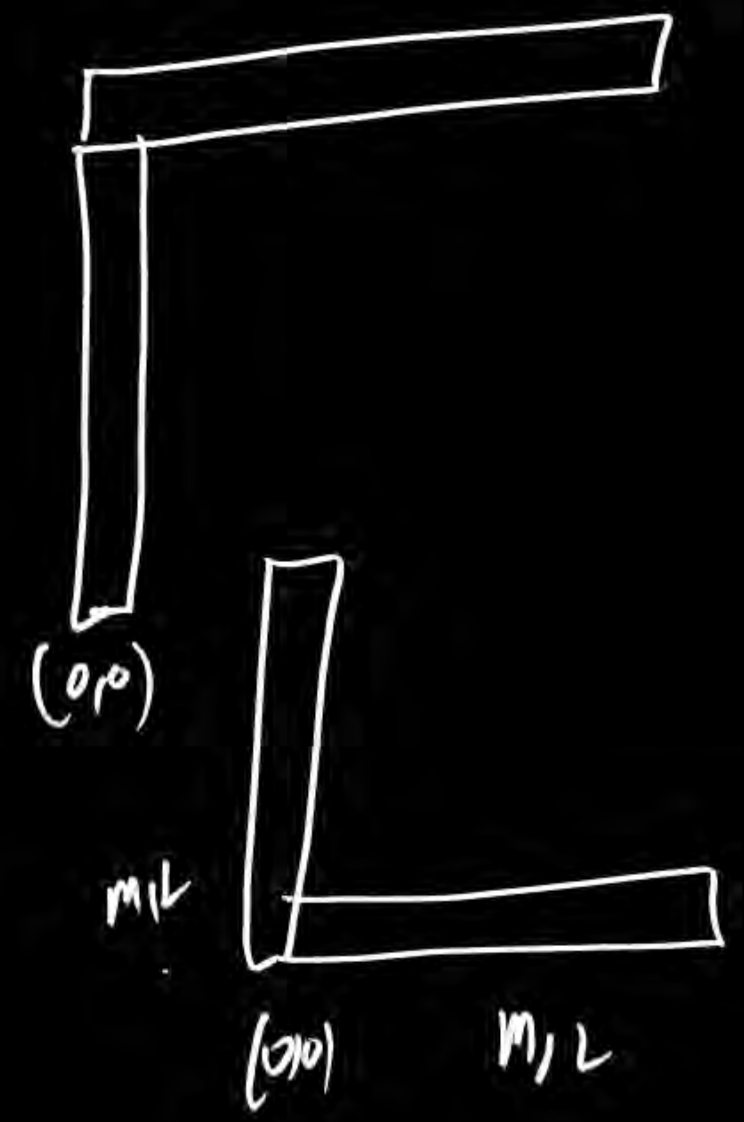


$$\vec{r}_{c.m} = \frac{L}{2}\hat{i} + \frac{L}{2}\hat{j}$$

Ans



$$\vec{r}_{c.m} = \frac{m_1 r_1 + m_2 r_2 + m_3 r_3}{m_1 + m_2 + m_3}$$


(0,0)
m, L
(0,0)
m, L

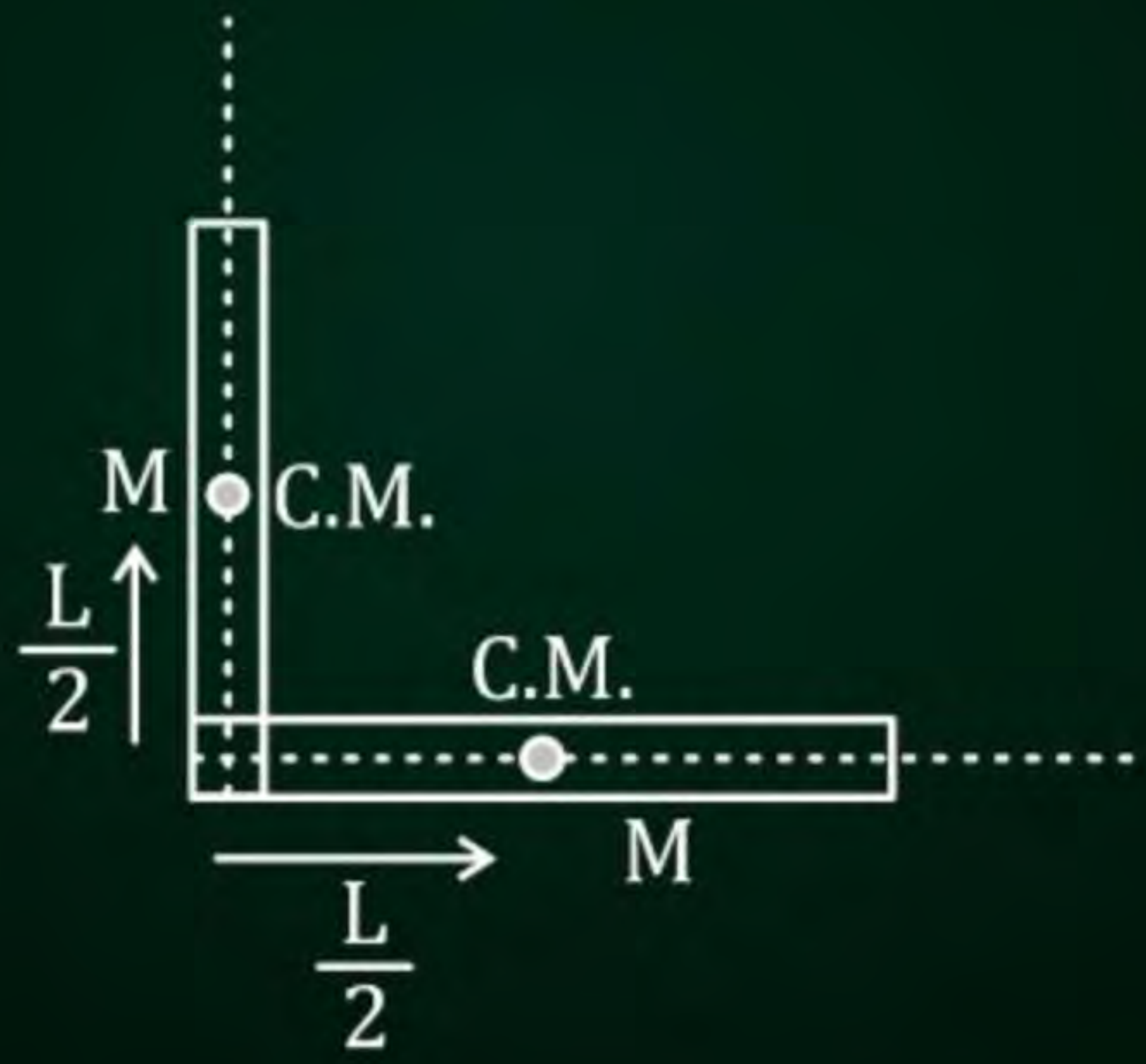
(Linear Mass density) $\lambda = \frac{M}{L} = \frac{dm}{dL}$

(Area mass density) $\sigma = \frac{M}{A} = \frac{dm}{dA}$

(Volume mass density) $\int = \frac{M}{V} = \frac{dm}{dV}$

QUESTION

Two identical rod (M, L) placed along x and y-axis as shown in figure. Then find location of COM.



QUESTION

A rod of length L placed along x-axis having linear mass density is proportional to x then distance of COM from one end.

1. L/2
2. 2L/3
3. L/4
4. 3L/2

QUESTION

If linear density of a rod of length 3m varies as $\lambda = 2 + x$, then the position of the center of gravity of the rod is

1. $\frac{7}{3}$ m
2. $\frac{12}{7}$ m
3. $\frac{10}{7}$ m
4. $\frac{9}{7}$ m

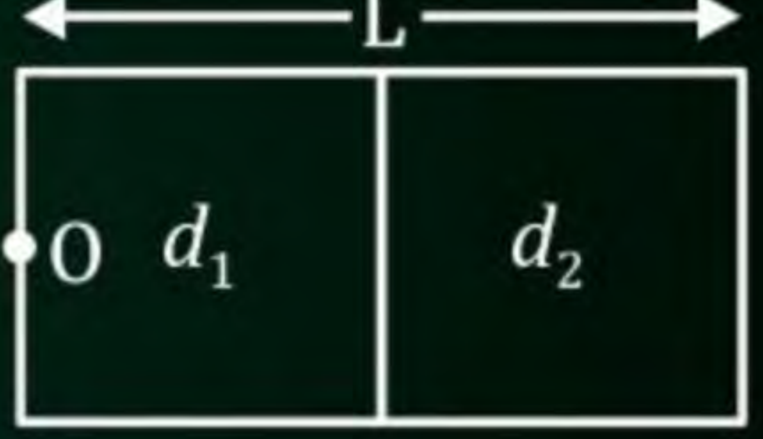
QUESTION

A rod of length is 3m and its mass acting per unit length is directly proportional to distance x from one of its end then its centre of gravity from that end will be at :-

1. 1.5 m
2. 2 m
3. 2.5 m
4. 3 m

QUESTION

Shows a rectangular plane of length L, the half of which is made of material of density d_1 and another half of density d_2. The distance of centre of mass from the origin O is



1. $\frac{d_1 + 2d_2}{2(d_1 + d_2)}L$

2. $\frac{(d_1 + 3d_2)L}{4(d_1 + d_2)}$

3. $\frac{(d_1 + 3d_2)L}{2(d_1 + d_2)}$

4. $\frac{(3d_1 + d_2)L}{4(d_1 + d_2)}$

QUESTION

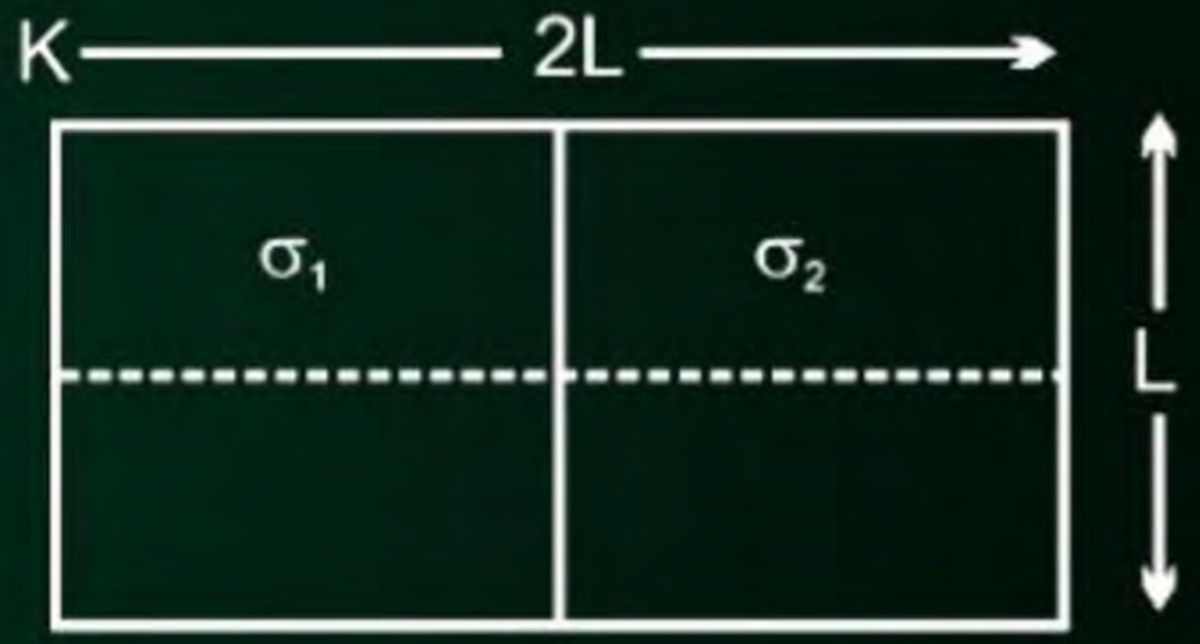
Find location of Centre of Mass of system

1. $\left(\frac{\sigma_1 + 3\sigma_2}{\sigma_1 + \sigma_2}\right)\frac{L}{2}$

2. $\left(\frac{3\sigma_1 + \sigma_2}{\sigma_1 + \sigma_2}\right)\frac{L}{2}$

3. $\left(\frac{\sigma_1 - 3\sigma_2}{\sigma_1 + \sigma_2}\right)L$

4. $\left(\frac{\sigma_1 + \sigma_2}{\sigma_1 + 3\sigma_2}\right)\frac{L}{2}$



QUESTION

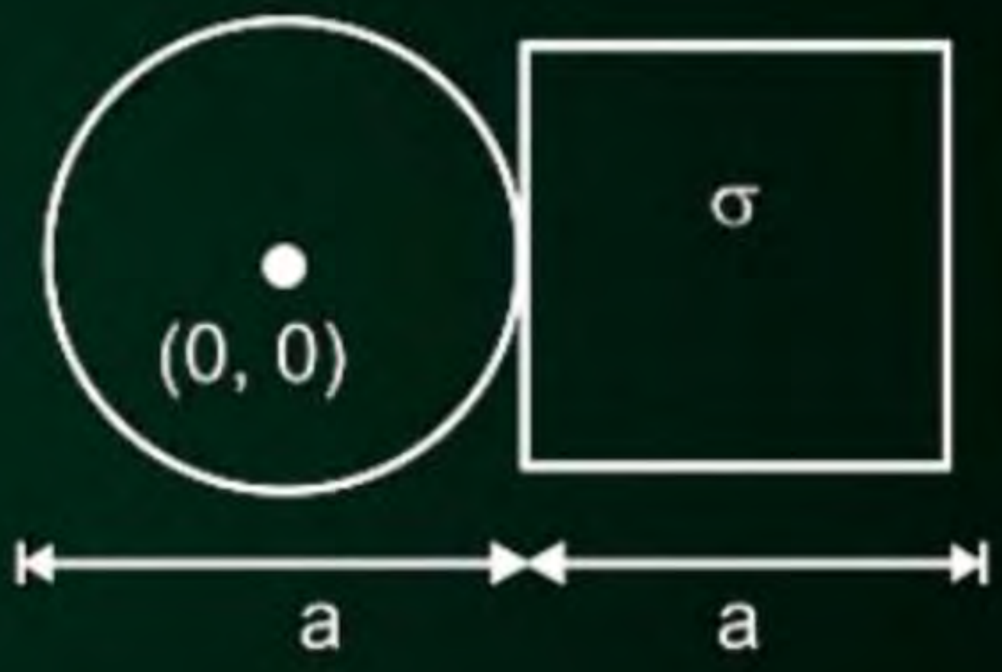
Find centre of mass from origin.

(1) $\frac{4a}{\pi + 4}$

(2) $\frac{4a}{\pi}$

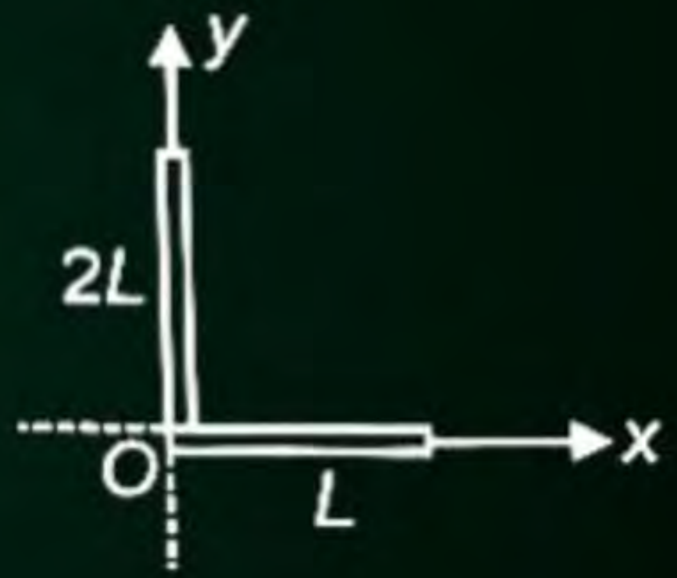
(3) $\frac{a}{\pi + 4}$

(4) $\frac{a}{4}$



QUESTION

Figure shows a composite system of two uniform rods of lengths as indicated. Then the coordinates of the centre of mass of the system of rods are



1. $\left(\frac{L}{2}, \frac{2L}{3}\right)$
2. $\left(\frac{L}{4}, \frac{2L}{3}\right)$
3. $\left(\frac{L}{6}, \frac{2L}{3}\right)$
4. $\left(\frac{L}{6}, \frac{L}{3}\right)$

QUESTION

The linear mass density (λ) of a rod of length L kept along x-axis varies as $\lambda = \alpha + \beta x$; where α and β are positive constants. The centre of mass of the rod is at

1. $\frac{(2\beta + 3\alpha L)L}{2(2\beta + \alpha L)}$

2. $\frac{(3\alpha + 2\beta L)L}{3(2\alpha + \beta L)}$

3. $\frac{(3\beta + 2\alpha L)L}{3(2\beta + \alpha L)}$

4. $\frac{(3\beta + 2\alpha L)L}{3\beta + 2\alpha}$

QUESTION

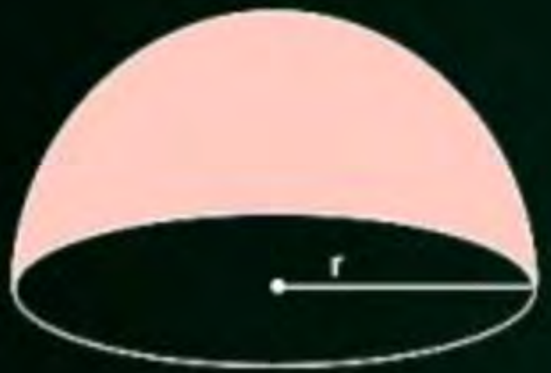
Find acceleration of centre of mass.

1. $\frac{2\pi}{R}$
2. $\frac{\pi R}{2}$
3. $\frac{2R}{\pi}$
4. $\frac{4R}{\pi}$

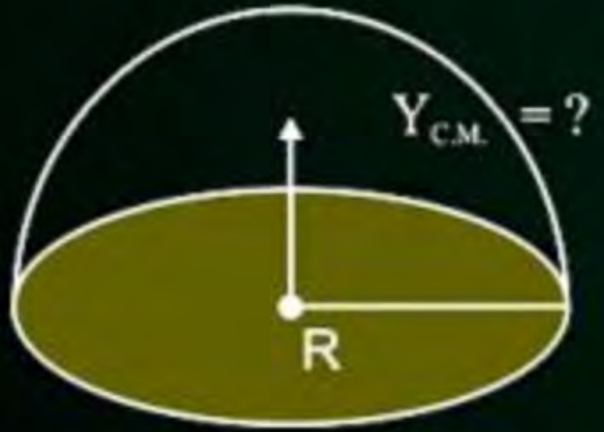




Half Disc



Hollow hemisphere



Solid hemisphere



Hollow cone



Solid cone

QUESTION

From a uniform square plate, one-fourth part is removed as shown. The centre of mass of remaining part will lie on

1. OC
2. OA
3. OB
4. OD



QUESTION

If Disc. of Radius R/2 is removed from a uniform disc of mass M and Radius R then find location of centre of mass of remains part.




THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 2 | Physics

Motion of System of particle and Com



By- Dr. Manish Raj (MR SIR)

Todays Goal

→ H/w

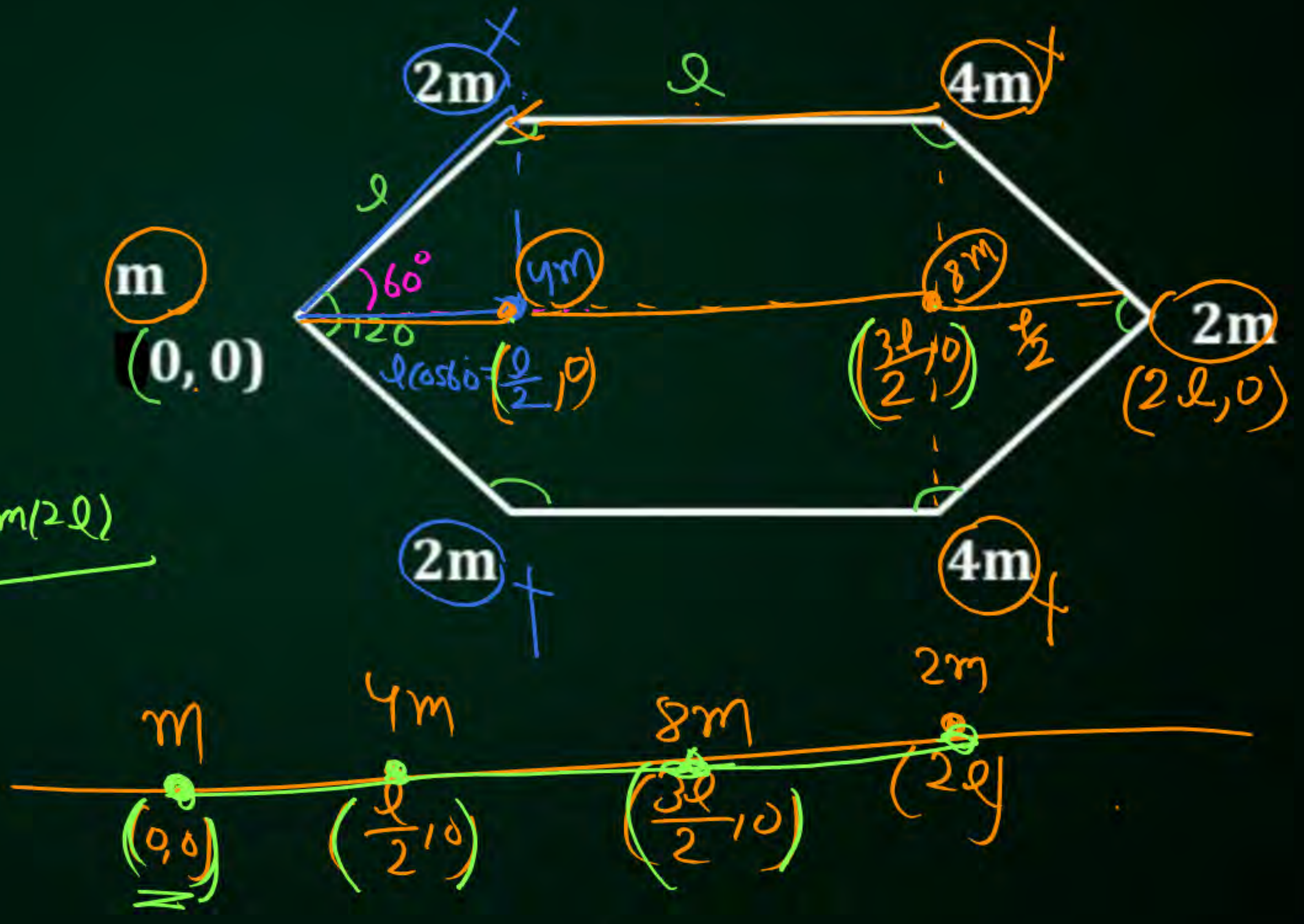
→ C.O.M of Continous body

→ C.O.M of remaing Portion

QUESTION

Find position of C.O.M.





$$x_{c.m} = \frac{m\times 0 + 4m\times\frac{l}{2} + 8m\frac{3l}{2} + 2m(2l)}{m+4m+8m+2m}$$

Shift in C.O.M



Shift in Position of m_2

Mass m_1 is shifted by Δx_1

Shift in C.O.M

$$\Delta \vec{x}_{c.m} = \frac{m_1 \Delta \vec{x}_1 + m_2 \Delta \vec{x}_2}{m_1 + m_2}$$

If C.O.M does not shift their position.

then $\Delta x_{c.m} = 0$

$$0 = m_1 \Delta \vec{x}_1 + m_2 \Delta \vec{x}_2$$

$$m_1 \Delta \vec{x}_1 = - m_2 \Delta \vec{x}_2$$

Shift in momonen of mass



cm

$$\underbrace{m_1 \Delta x_1}_{\text{पीछे}} = \underbrace{m_2 \Delta x_2}_{\text{आगे}}$$

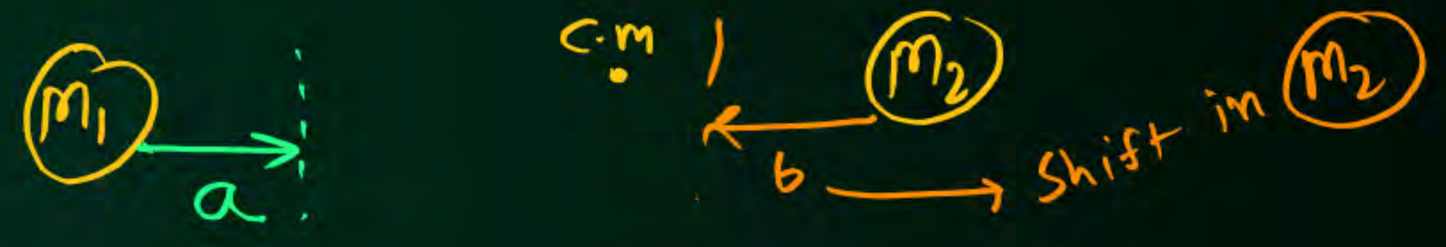
QUESTION

MR = moment of mass.

H/W

Consider a system having two masses m_1 and m_2 in which first mass is pushed towards the centre of mass by a distance a. The distance by which the second mass should be moved to keep the centre of mass at same position

1. $\frac{m_1}{m_2}a$ (Ans)
2. $\left(\frac{m_1}{m_1+m_2}\right)a$
3. $\frac{m_2}{m_1}a$
4. $\left(\frac{m_2}{(m_1+m_2)}\right)a$

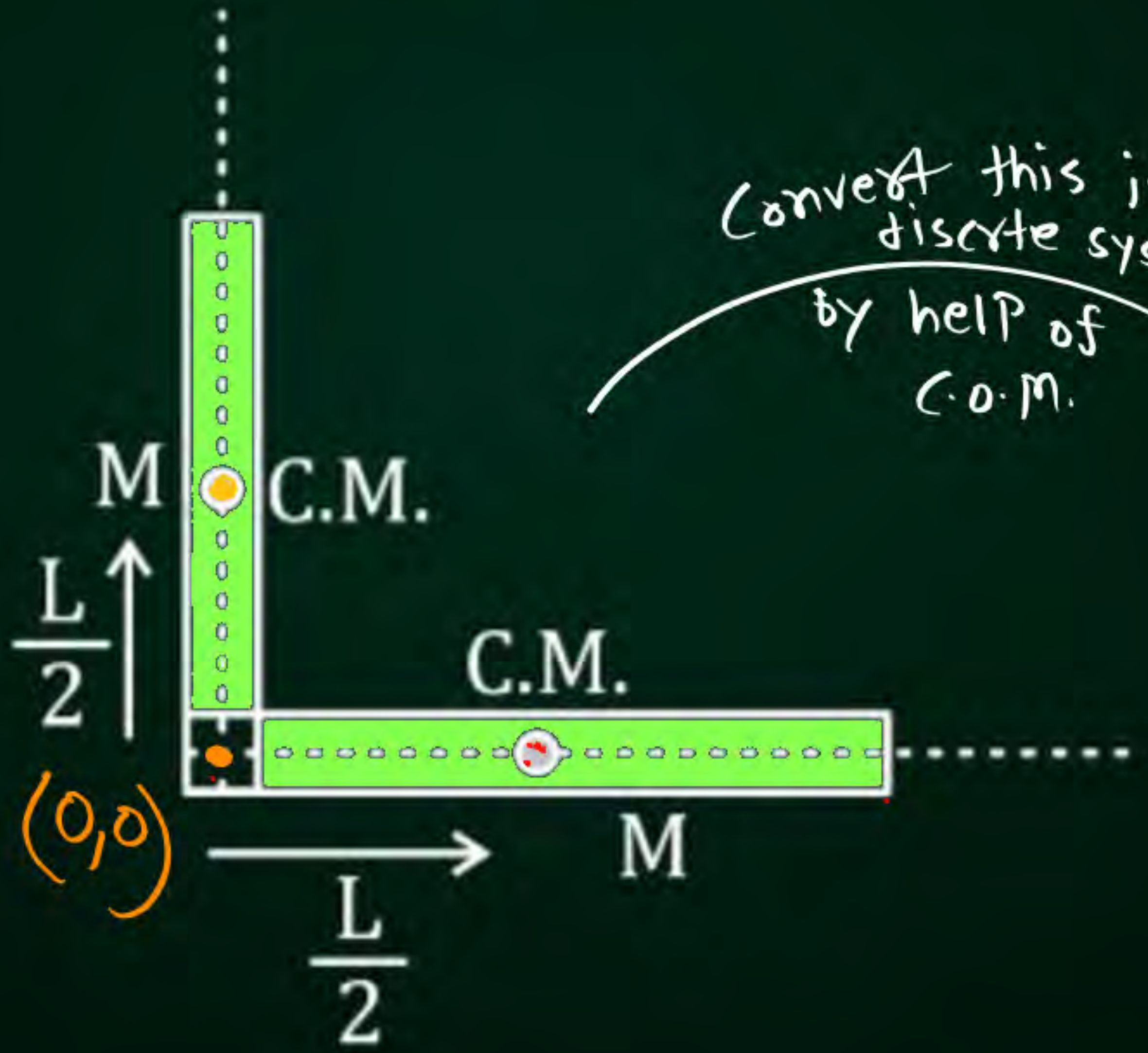


$$m_1 a = m_2 b$$

$$b = \frac{m_1 a}{m_2}$$

QUESTION

Two identical rod (M, L) placed along x and y-axis as shown in figure. Then find location of COM.



QUESTION

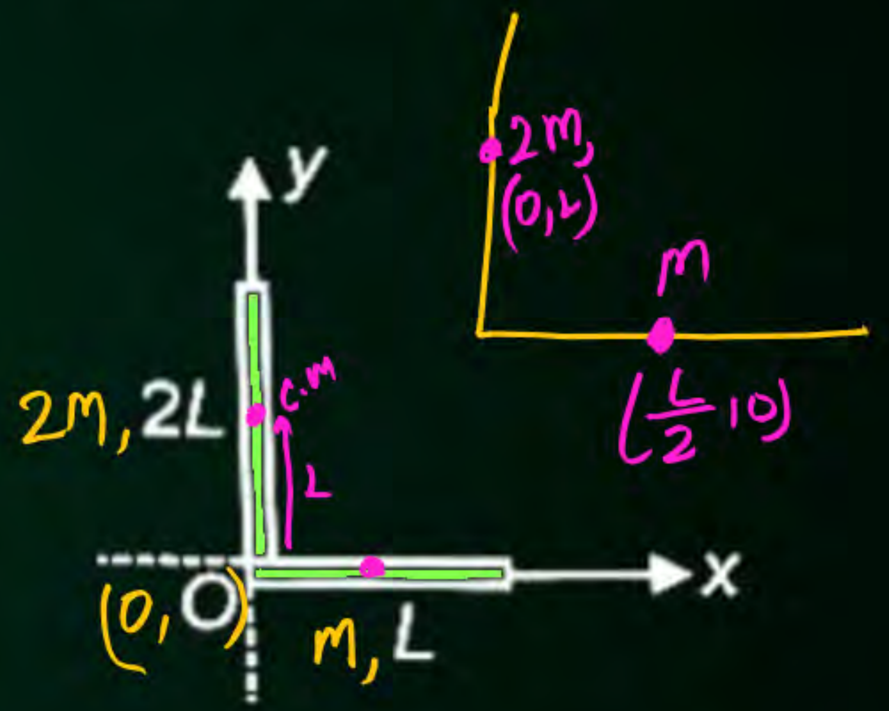
Figure shows a composite system of two uniform rods of lengths as indicated. Then the coordinates of the centre of mass of the system of rods are

1. $\left(\frac{L}{2}, \frac{2L}{3}\right)$

2. $\left(\frac{L}{4}, \frac{2L}{3}\right)$

3. $\left(\frac{L}{6}, \frac{2L}{3}\right)$ (Ans)

4. $\left(\frac{L}{6}, \frac{L}{3}\right)$



$$\vec{r}_{c.m} = \frac{m\frac{L}{2}\hat{i} + 2mL}{3m} = \frac{L}{6}\hat{i} + \frac{2L}{3}\hat{j}$$

QUESTION

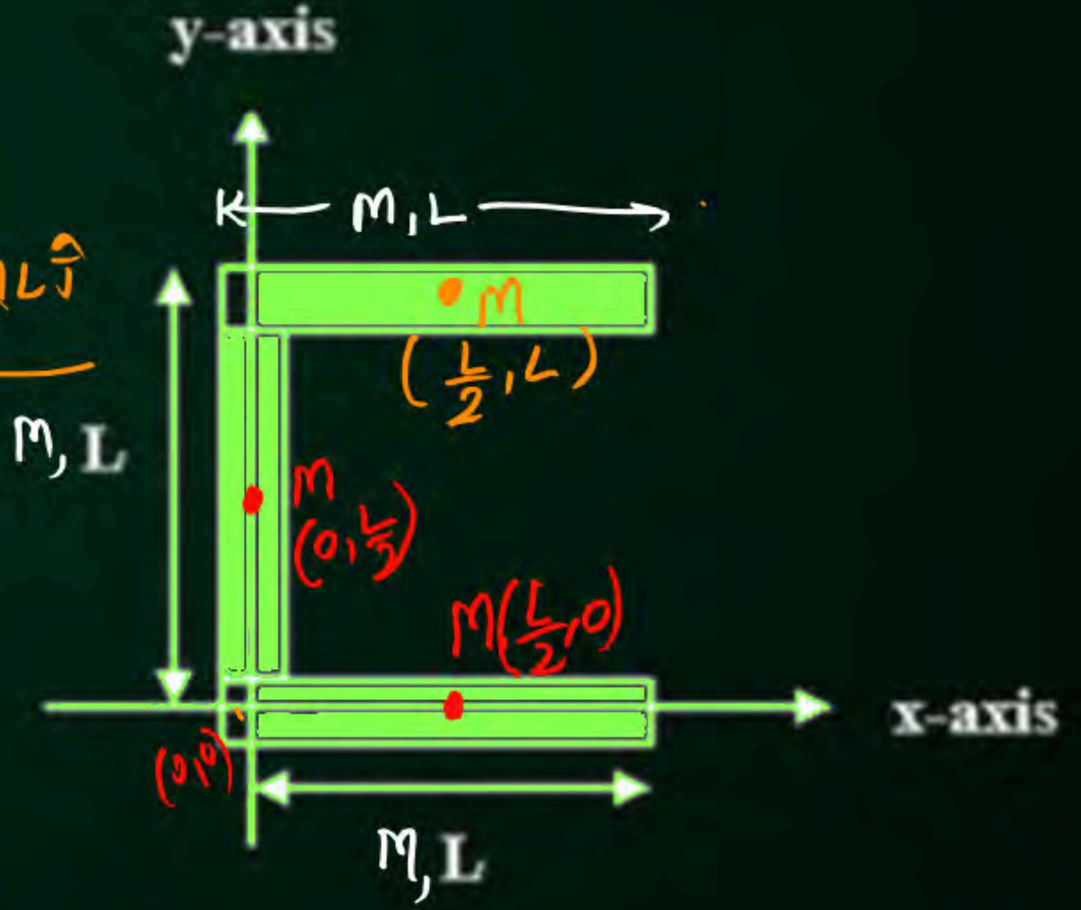
Locate the centre of mass of arrangement shown in figure. The three rods are identical in mass and length

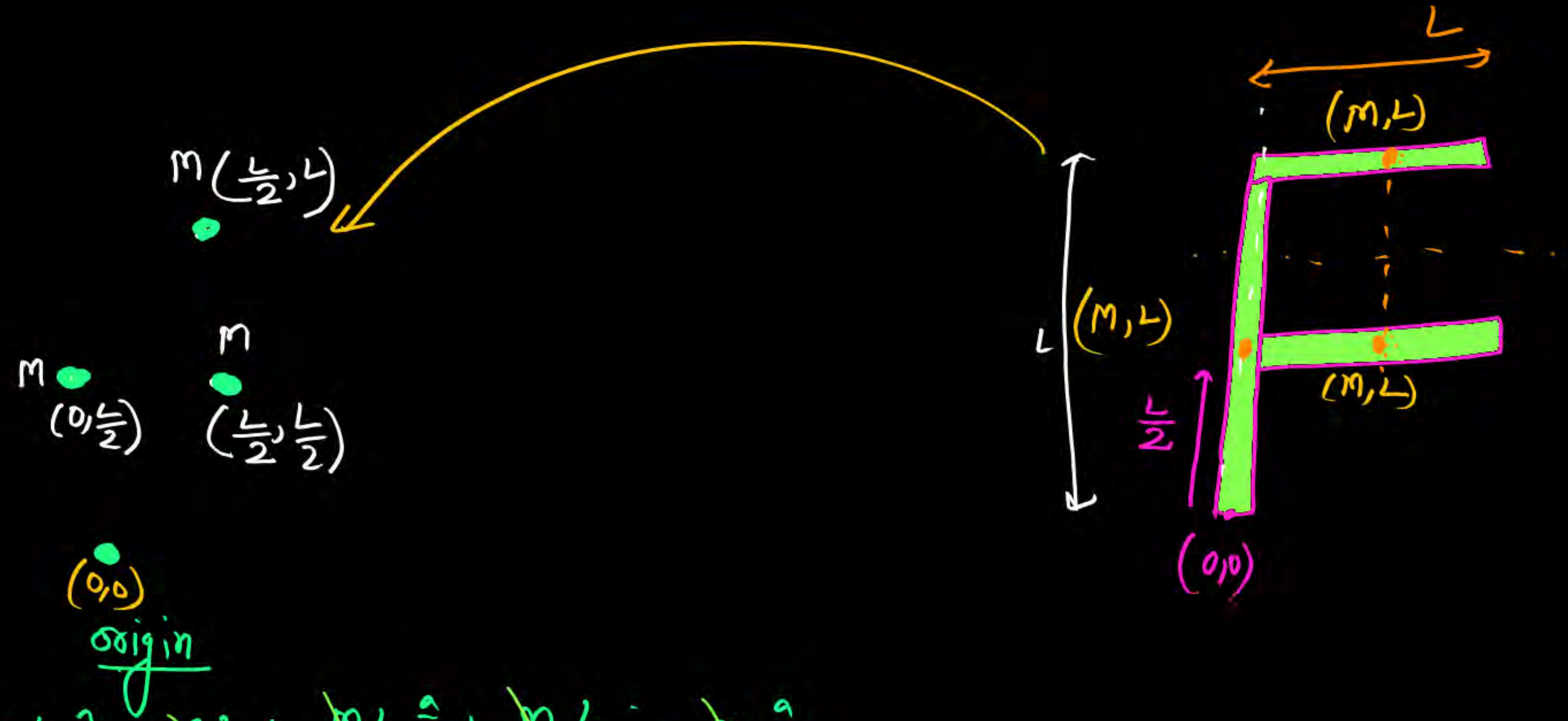
1. $\left(\frac{L}{2}, \frac{L}{2}\right)$
2. $\left(\frac{L}{3}, 0\right)$
3. $\left(\frac{L}{3}, \frac{L}{2}\right)$
4. $\left(0, \frac{L}{3}\right)$

$$r_{c.m} = \frac{m\frac{L}{2}\hat{i} + m\times\frac{L}{2}\hat{j} + m\frac{L}{2}\hat{i} + mL\hat{j}}{3m}$$

$$= \frac{L\hat{i} + \frac{3L}{2}\hat{j}}{3}$$

$$= \frac{L}{3}\hat{i} + \frac{L}{2}\hat{j}$$



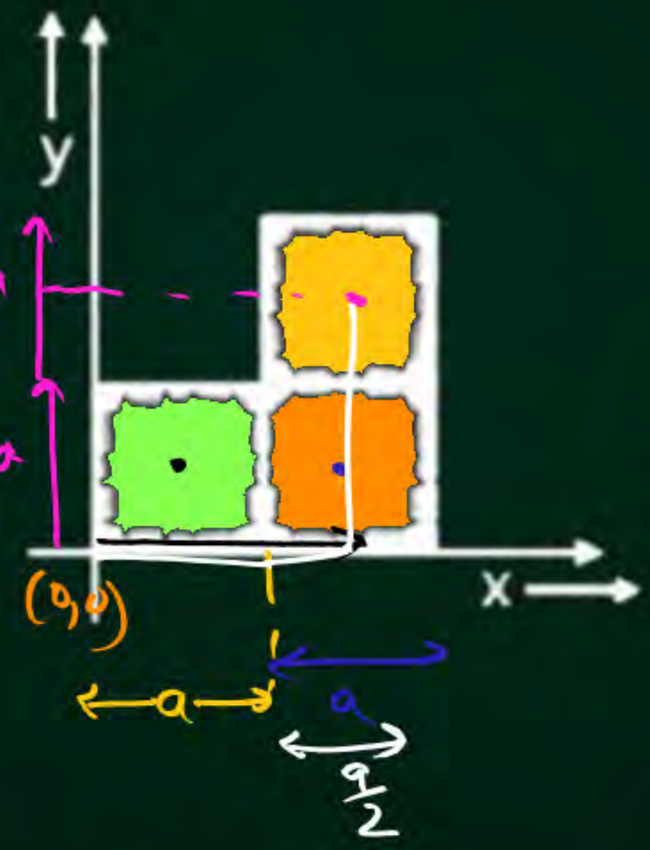


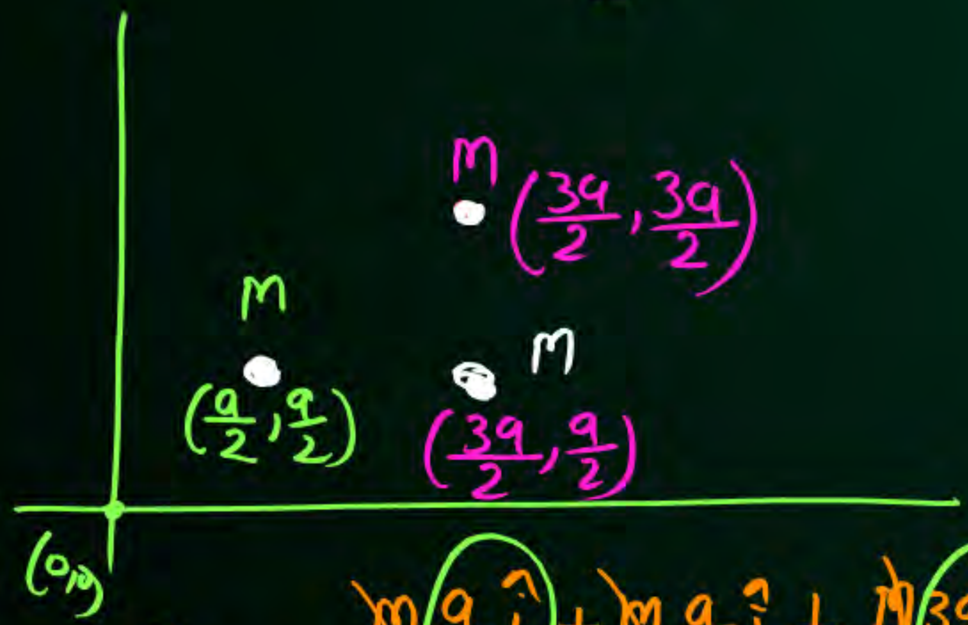
$$\vec{r}_{c.m} = \frac{m\frac{L}{2}\hat{j} + m\frac{L}{2}\hat{i} + m\frac{L}{2}\hat{j} + m\frac{L}{2}\hat{i} + mL\hat{j}}{3m}$$

$$\vec{r}_{c.m} = \frac{L}{3}\hat{i} + \frac{2L}{3}\hat{j}$$

QUESTION

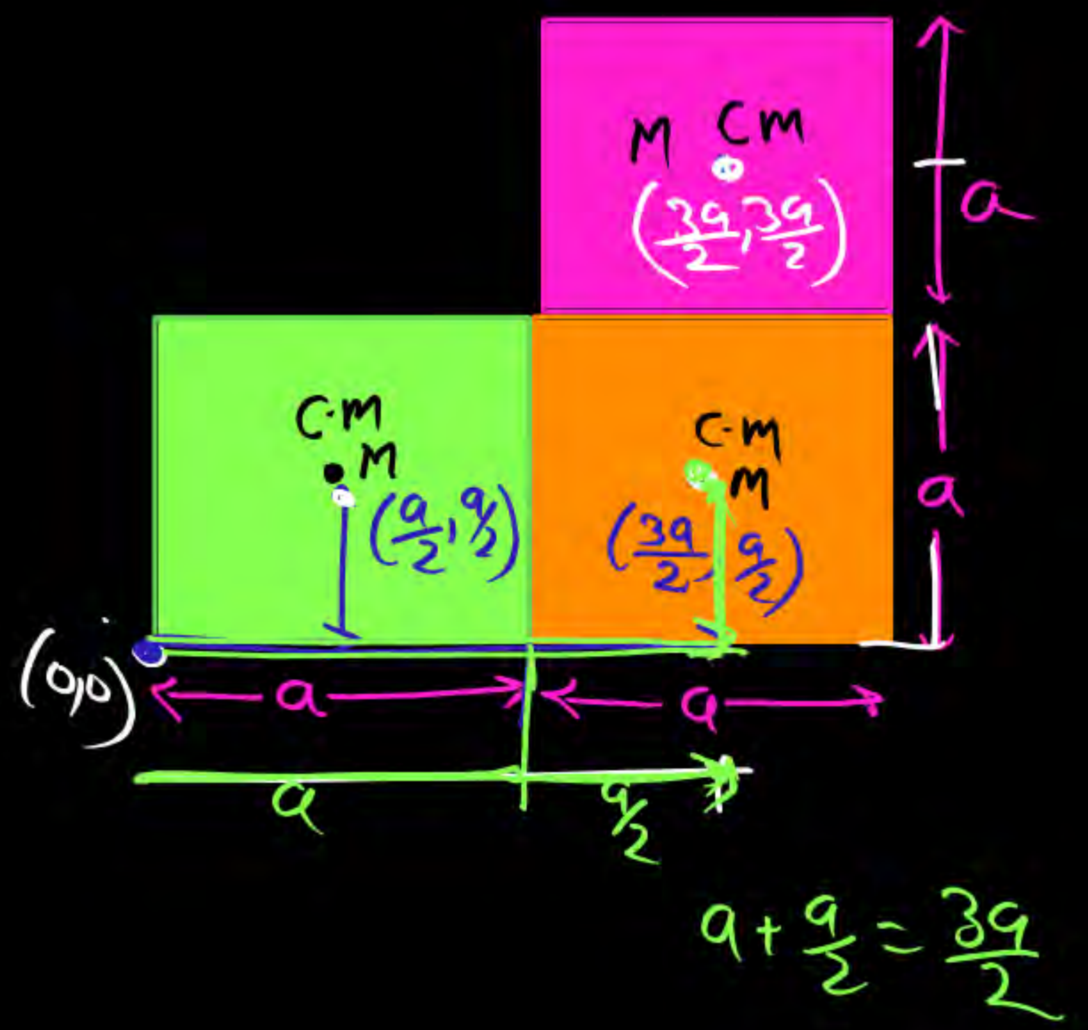
Find position of COM for given combination (each plate is square of side a and mass m).





$a + \frac{a}{2} = \frac{3a}{2}$

$$r_{c.m} = \frac{m\frac{a}{2}\hat{i} + m\frac{a}{2}\hat{j} + m\frac{3a}{2}\hat{i} + m\frac{a}{2}\hat{j} + m\frac{3a}{2}\hat{i} + m\frac{3a}{2}\hat{j}}{3m} = \frac{7a}{6}\hat{i} + \frac{5a}{6}\hat{j} \text{ (Ans)}$$


M CM
(3a/2, 3a/2)
a
CM
M
(a/2, a/2)
CM
M
(3a/2, a/2)
a
(0,0)
a
a
a
a/2
a + a/2 = 3a/2

COM OF CONTINUOUS MASS SYSTEM

1-D (linear mass)

Rod, Ring



$\lambda = \frac{m}{l}$ (only Vaid when λ = const Uniform Rod)

(linear mass density / Mass per unit length) $\boxed{\lambda = \frac{dm}{dl}}$ ✓ (for all rod) kg/meh.

$\boxed{M = \lambda l}$

$\lambda = \frac{m}{l}$ (Uniform Rod)

$dm = \lambda \, dl$

$\int dm = \int \lambda \, dl$

$M = \lambda \int dl$ (λ = const)

$m = \lambda l$

2-D (Area Mass desisity)

EX → disc, square plate

Areal mass density

$\sigma = \frac{dM}{dA}$ kg/m²

$\int dM = \int \sigma \, dA$

σ = uniform

$M = \sigma \int dA$

$M = \sigma A$

$\boxed{\sigma = \frac{M}{A} = \text{const}}$

3-D (volumetric mass.)

↳ solid spr / cube / cone.

Mass per unit volume

$\rho = \frac{dm}{dV}$ kg/m³

$\int dm = \int \rho \, dV$

ρ = const

$M = \rho V$

$\boxed{\rho = \frac{M}{V}}$ ✓

(Linear Mass density) $\lambda = \frac{M}{L} = \frac{dm}{dL}$ ✓

(Area mass density) $\sigma = \frac{M}{A} = \frac{dm}{dA}$ ✓

(Volume mass density) $\rho = \frac{M}{V} = \frac{dm}{dV}$ ✓

(Q) If $\lambda = \lambda_0 x$ then find mass of a rod of length L,



$dm = \lambda dx$

$\int dm = \int \lambda_0 x \, dx$

$M = \lambda_0 \left(\frac{x^2}{2}\right)_0^L = \frac{\lambda_0 L^2}{2}$ Kg.

Area of disc $= \pi R^2$

mR*

Areal object मे Mass Area मे distributed

σ = Areal mass Uniform.



Mass of disc (M)

$M = \sigma [\pi R^2]$

$M = \sigma \pi R^2$

$\left\{\sigma = \frac{M}{\pi R^2}\right\}$

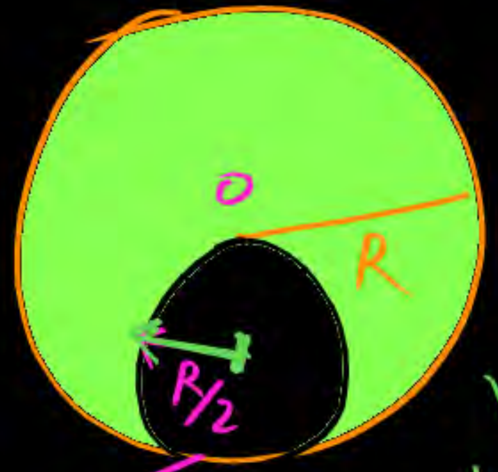
disc of Radius $\left(\frac{R}{2}\right)$ is removed as shown in figure.

* Mass of removed disc $M' = \sigma \pi \left(\frac{R}{2}\right)^2$

$= \frac{\sigma \pi R^2}{4} = \frac{M}{4}$

* Mass of remaining disc $= M - \frac{M}{4} = \frac{3M}{4}$

solid spr



$V = \frac{4}{3}\pi R^3$

$V' = \frac{4}{3}\pi\left(\frac{R}{2}\right)^3 = \frac{4}{3}\pi R^3\left(\frac{1}{8}\right)$

If uniform solid spr of mass m & radius R a solid spr of radius R/2 is Removed then mass Removed & Remaining part ??

Sol^n

ρ = Volume mass density $= \frac{m}{V}$

$$\left[\rho = \frac{m}{V} = \frac{m}{\frac{4}{3}\pi R^3}\right]$$

Mass of removed part $= \rho V'$

$$= \frac{m}{\frac{4}{3}\pi R^3} \times \frac{4}{3}\pi\left(\frac{R}{2}\right)^3 = \frac{m}{8}$$

Mass of remaining part $= m - \frac{m}{8} = \frac{7m}{8}$

mp*

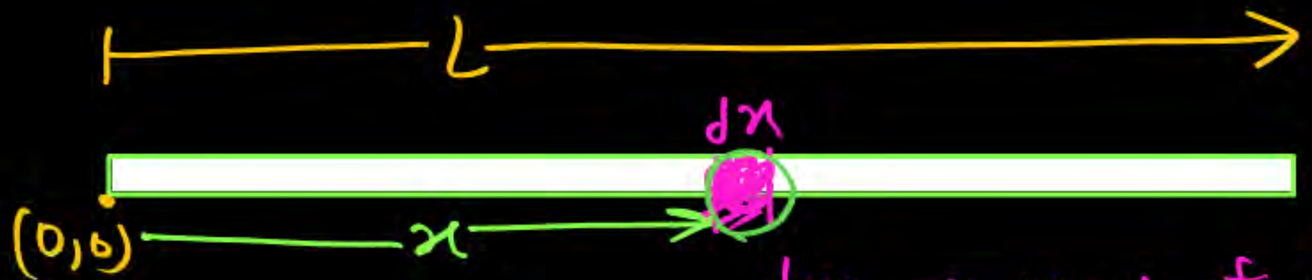
Volume $\propto R^3$

→ (Radius half, 8 times volume decr)

C.O.M of continual mass system

discrete system

$$\vec{r}_{c.m} = \frac{m_1x_1 + m_2x_2 + m_3x_3}{m_1 + m_2 + m_3}$$



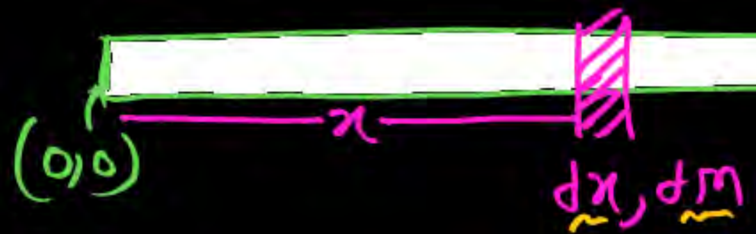
dm → mass of dx length

Continual system

$$\vec{r}_{c.m} = \frac{\int x\,dm}{\int dm}$$

$$y_{c.m} = \frac{\int y\,dm}{\int dm}$$

Uniform Rod (M, L)



$$\lambda = \frac{dm}{dx}$$

$$dm = \lambda\, dx$$

* Mass of L length is $= M$

" " Unit " $= \frac{M}{L}$

dm (" " dx " ") $= \frac{M}{L} dx$

$$x_{c.m} = \frac{\int x\, dm}{\int dm}$$

$$x_{c.m} = \frac{\int x \lambda\, dx}{\int \lambda\, dx} = \frac{\lambda \int x\, dx}{\lambda \int dx} = \frac{\left(\frac{x^2}{2}\right)_0^L}{(x)_0^L} = \frac{L^2}{2(L)} = \frac{L}{2}$$

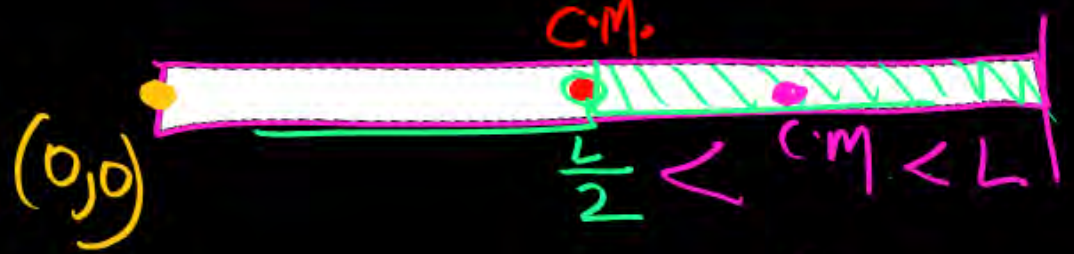
QUESTION

A rod of length L placed along x-axis having linear mass density is proportional to x then distance of COM from one end.

1. L/2
2. 2L/3
3. L/4
4. 3L/2



for uniform rod



$\frac{L}{2} < C.M < L$

$\lambda \propto x$

non-unif

$\lambda \propto x^2 \rightarrow$ C.O.M or aage shif

Physiey

QUESTION

If linear density of a rod of length 3m varies as $\lambda = 2 + x$, then the position of the center of gravity of the rod is

1. $\frac{7}{3}$ m
2. $\frac{12}{7}$ m
3. $\frac{10}{7}$ m
4. $\frac{9}{7}$ m

$$= \frac{\cancel{2}\left(\frac{x^2}{\cancel{2}}\right)_0^3 + \left(\frac{x^3}{3}\right)_0^3}{2(x)_0^3 + \left(\frac{x^2}{2}\right)_0^3}$$

$$= \left[\frac{9 + \frac{\cancel{27}^{9}}{\cancel{3}}}{2\times 3 + \frac{9}{2}}\right] = \frac{18}{\frac{21}{2}}$$

$$= \frac{\cancel{18}^{6}\times 2}{\cancel{21}_{7}}$$

$$= \frac{12}{7}\,m$$

QUESTION

A rod of length is 3m and its mass acting per unit length is directly proportional to distance *x* from one of its end then its centre of gravity from that end will be at :-

$\lambda \propto x$

(1) 1.5 m

(2) 2 m

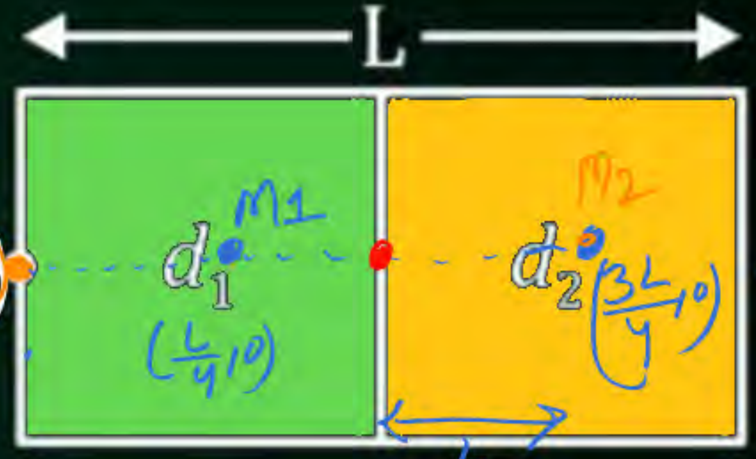
(3) 2.5 m



(4) 3 m

QUESTION

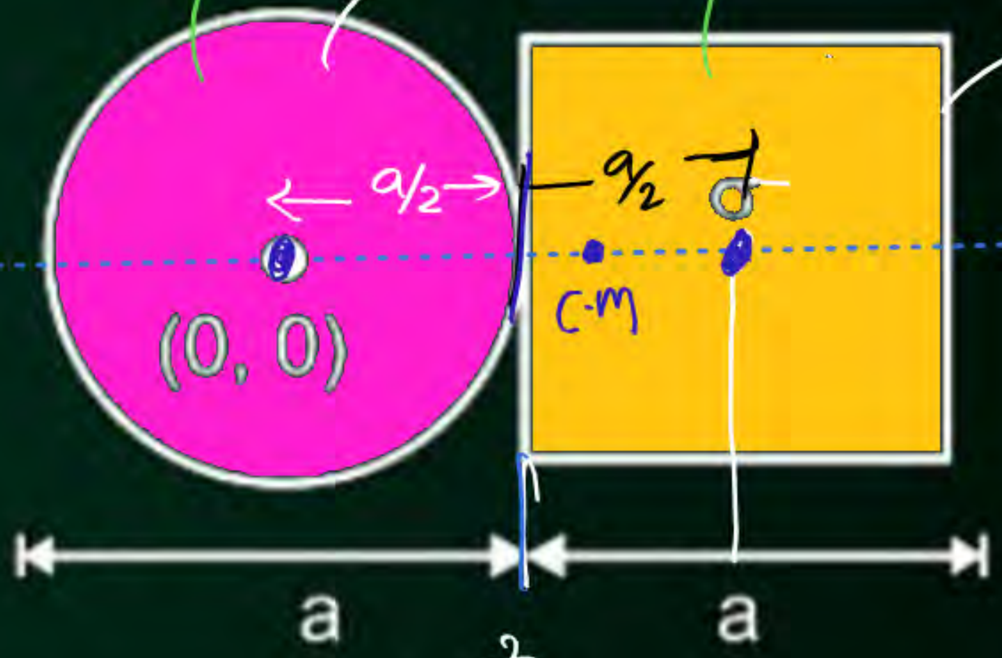
Shows a rectangular plane of length L, the half of which is made of material of density d_1 and another half of density d_2. The distance of centre of mass from the origin O is



1. $\dfrac{d_1 + 2d_2}{2(d_1 + d_2)}L$
2. $\dfrac{(d_1 + 3d_2)L}{4(d_1 + d_2)}$
3. $\dfrac{(d_1 + 3d_2)L}{2(d_1 + d_2)}$
4. $\dfrac{(3d_1 + d_2)L}{4(d_1 + d_2)}$

QUESTION

Find centre of mass from origin.



1. $\dfrac{4a}{\pi + 4}$

2. $\dfrac{4a}{\pi}$

3. $\dfrac{a}{\pi + 4}$

4. $\dfrac{a}{4}$

QUESTION

IIT → 2 page calcu

The linear mass density (λ) of a rod of length L kept along x-axis varies as $\lambda = \alpha + \beta x$; where α and β are positive constants. The centre of mass of the rod is at

1. $\dfrac{(2\beta + 3\alpha L)L}{2(2\beta + \alpha L)}$

2. $\dfrac{(3\alpha + 2\beta L)L}{3(2\alpha + \beta L)}$

3. $\dfrac{(3\beta + 2\alpha L)L}{3(2\beta + \alpha L)}$

4. $\dfrac{(3\beta + 2\alpha L)L}{3\beta + 2\alpha}$

$\lambda = \alpha + \beta x$ (variable)



$$x_{cm} = \frac{\int x\,dm}{\int dm} = \frac{\int x\lambda\,dx}{\int \lambda\,dx} = \frac{\int x(\alpha+\beta x)\,dx}{\int (\alpha+\beta x)\,dx} = \frac{\int_0^L (\alpha x + \beta x^2)\,dx}{\int_0^L (\alpha + \beta x)\,dx}$$

H/W

The MR*

$\lambda = \alpha + \beta x$

If $\beta = 0$ → $\lambda = \alpha$ (const)

$x_{c.m} = \frac{L}{2}$

QUESTION

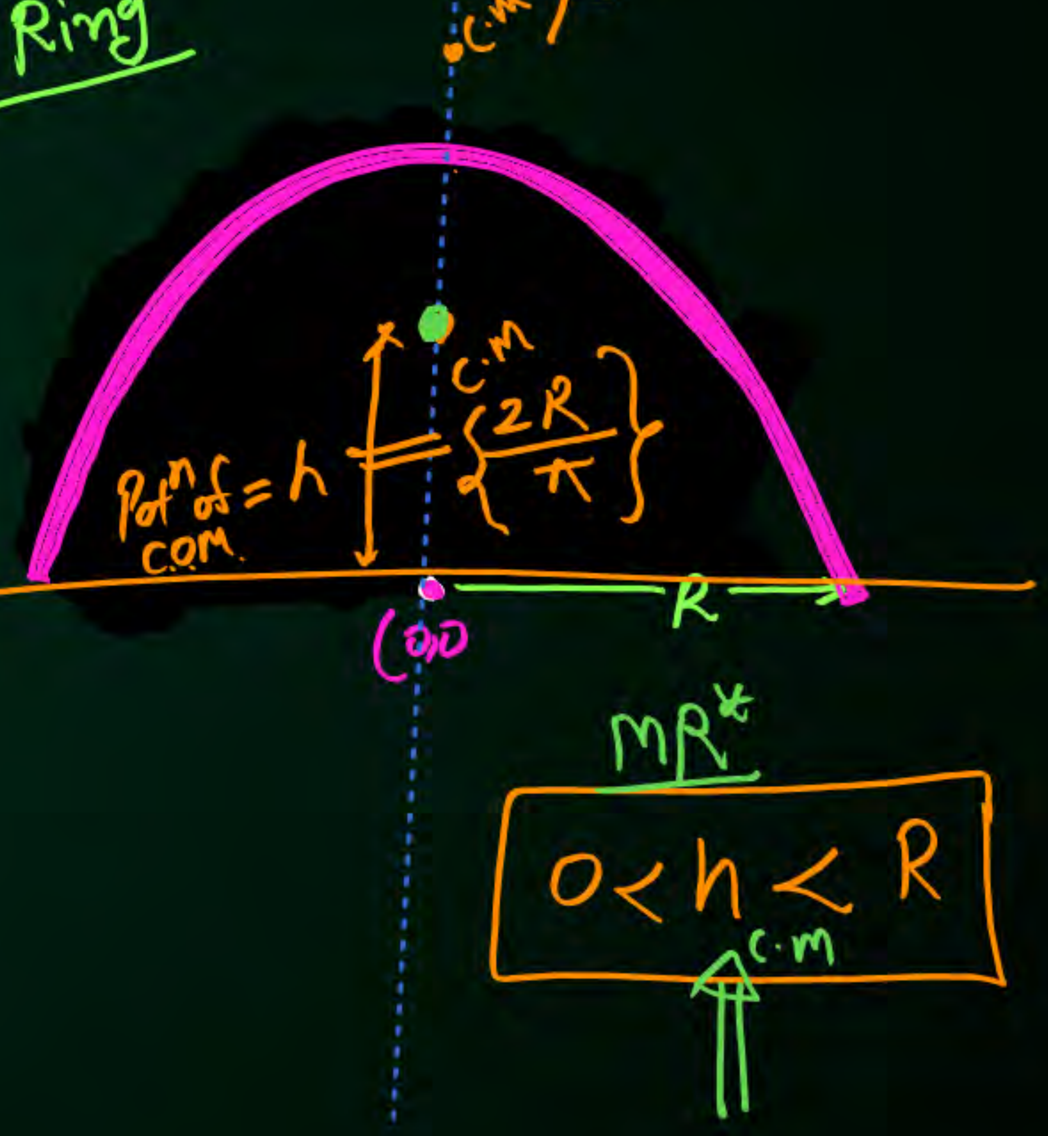
Find position of centre of mass of half ring.

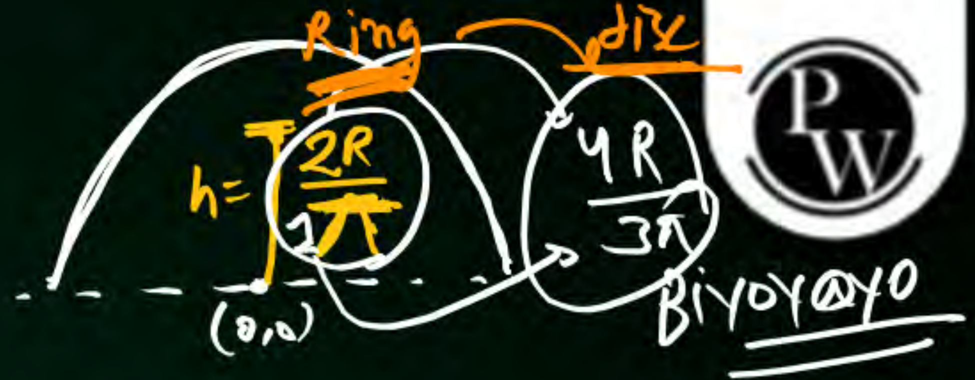
1. $\frac{2\pi}{R}$

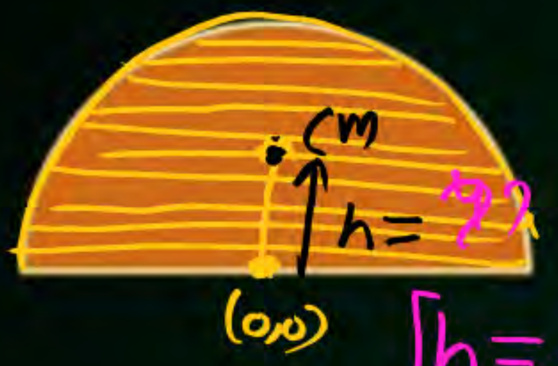
2. $\frac{\pi R}{2}$

3. $\frac{2R}{\pi}$

4. $\frac{4R}{\pi}$

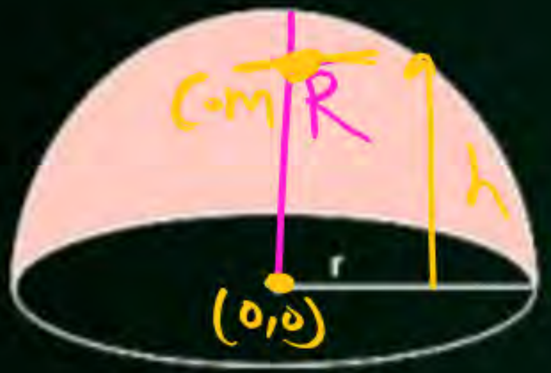






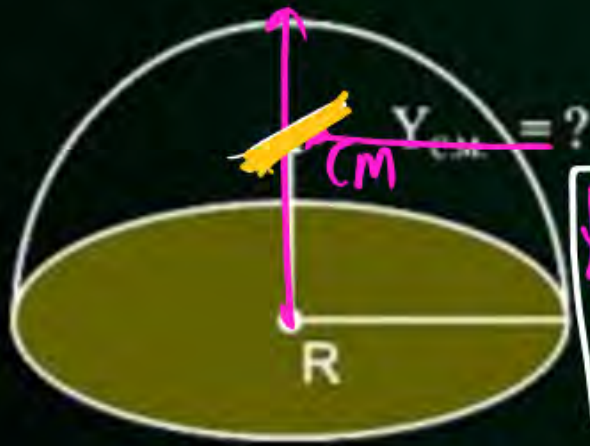
Half Disc

$\left[h = \frac{4R}{3\pi}\right]$ mR Ratta (Jai Biyoyoyoyoyoyoyo)



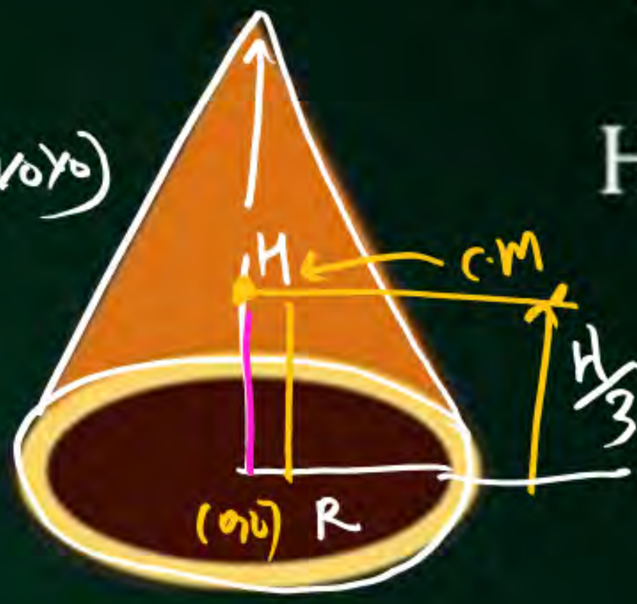
Hollow hemisphere

$h = \left[\frac{4R}{8}\right]$ (उपर) $= \frac{R}{2}$



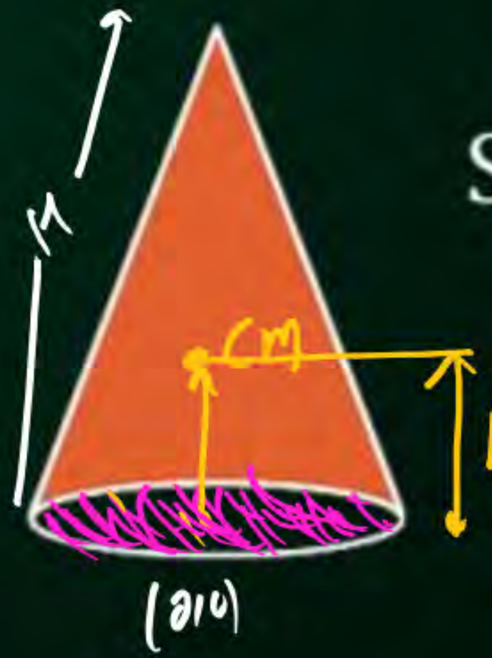
Solid hemisphere

$\left[h = \frac{3R}{8}\right]$ (नीचे)



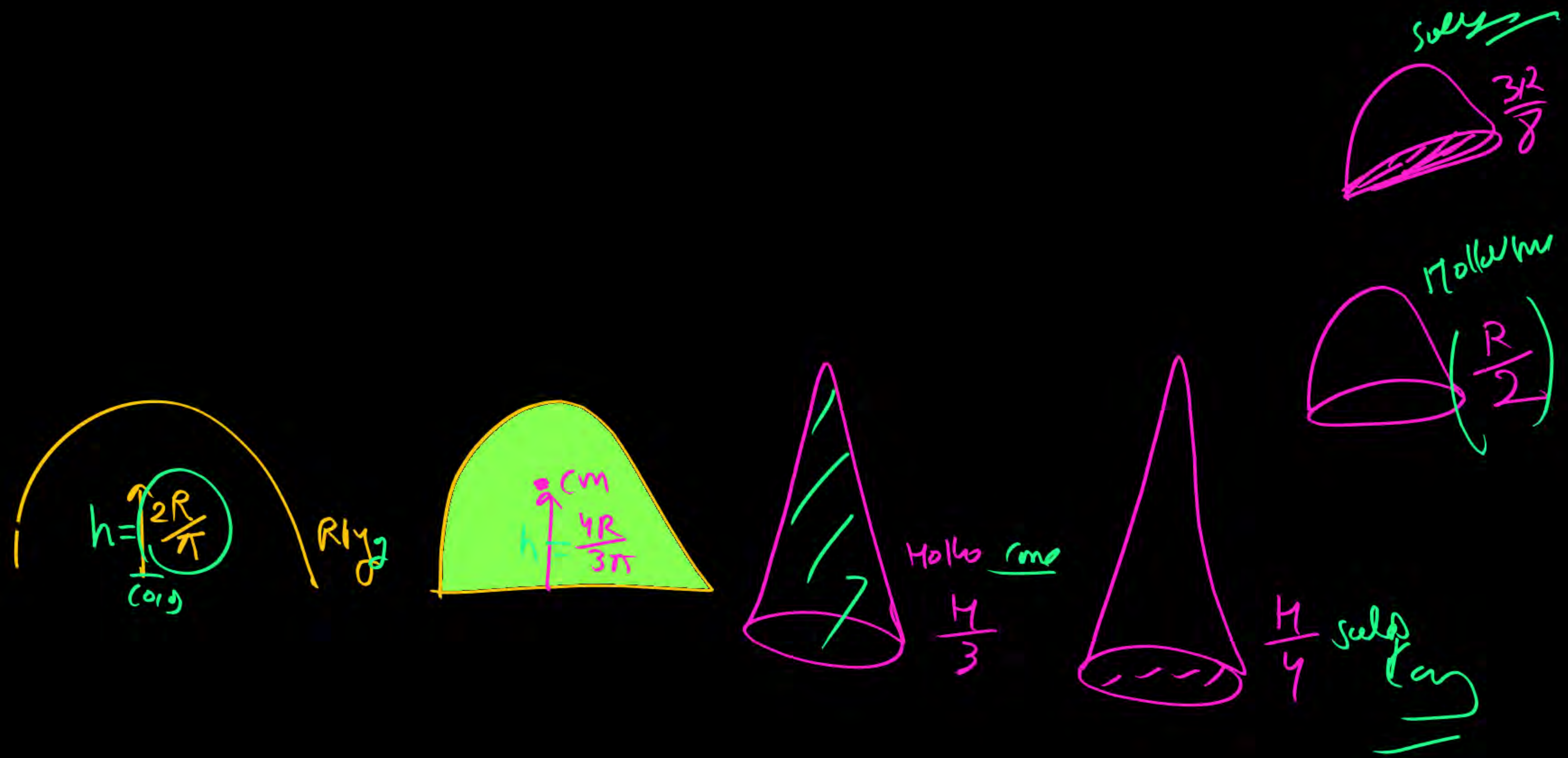
Hollow cone

$\frac{H}{3} = h$ (उपर)



Solid cone

$h = \frac{H}{4}$ } नीचे



h = 2R/π
CM
h = 4R/3π
H/3
H/4
3R/8
R/2


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 2 Part-B Physics

Motion of System of particle and Com

By- Dr. Manish Raj (MR SIR)



Todays Goal

→ H/W

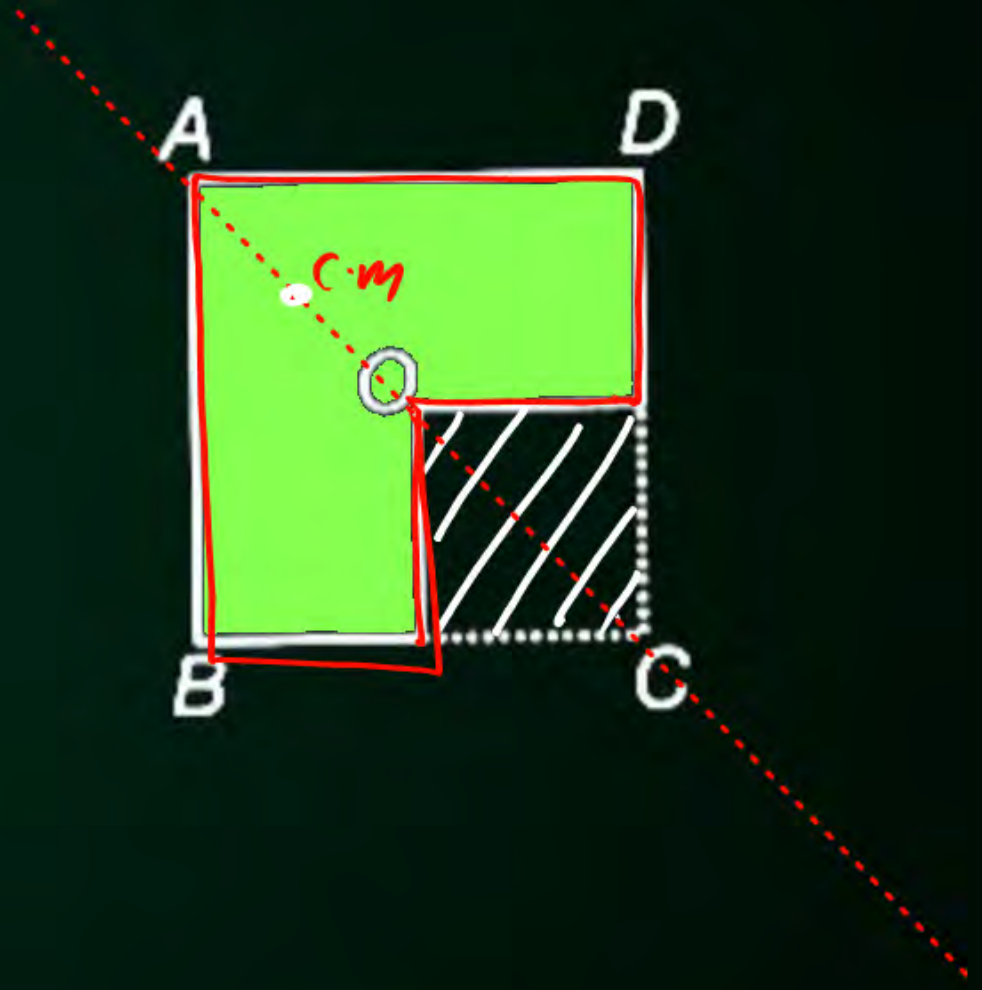
→ C.O.M of Continous body

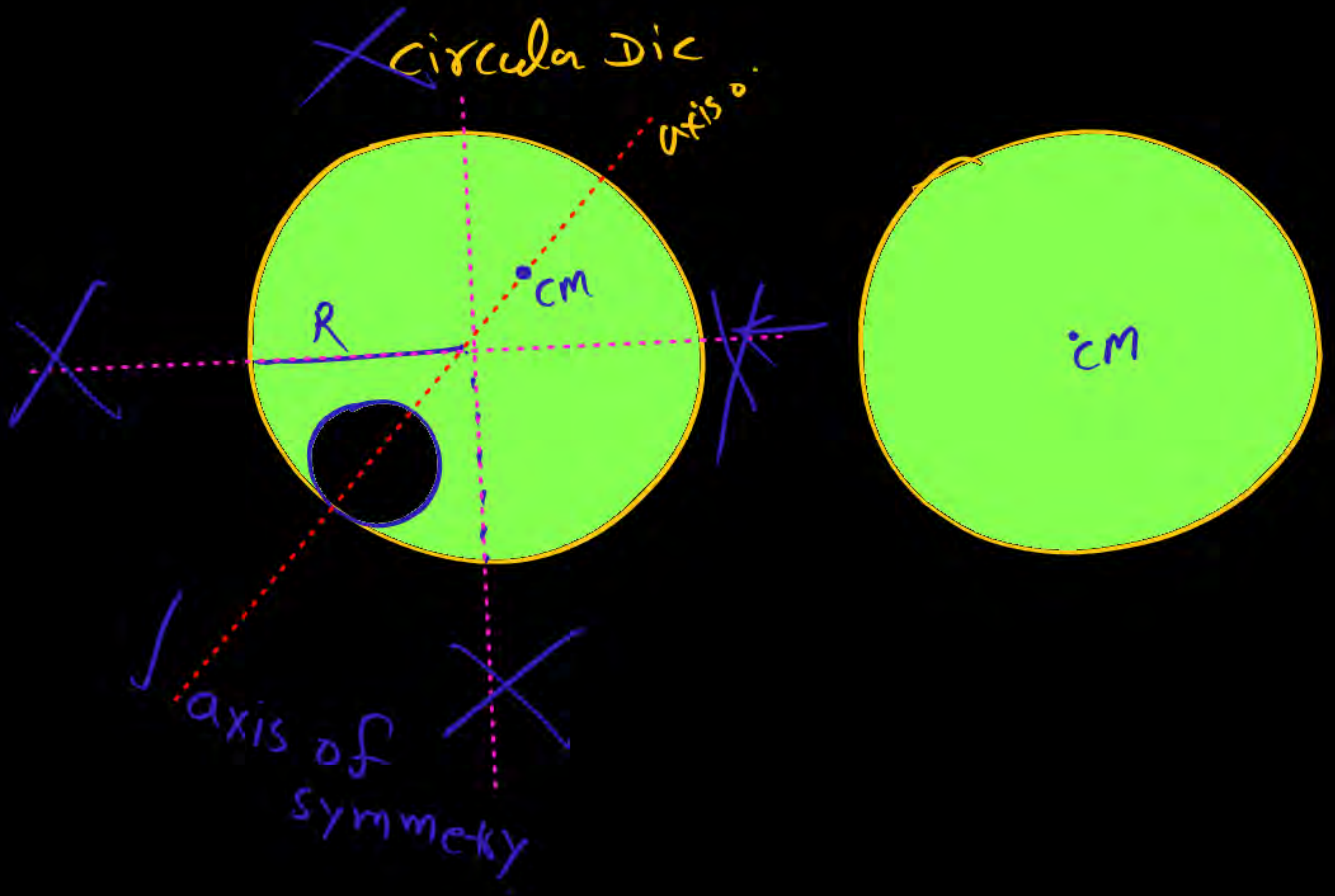
→ C.O.M of remaing Portion

QUESTION

From a uniform square plate, one-fourth part is removed as shown. The centre of mass of remaining part will lie on

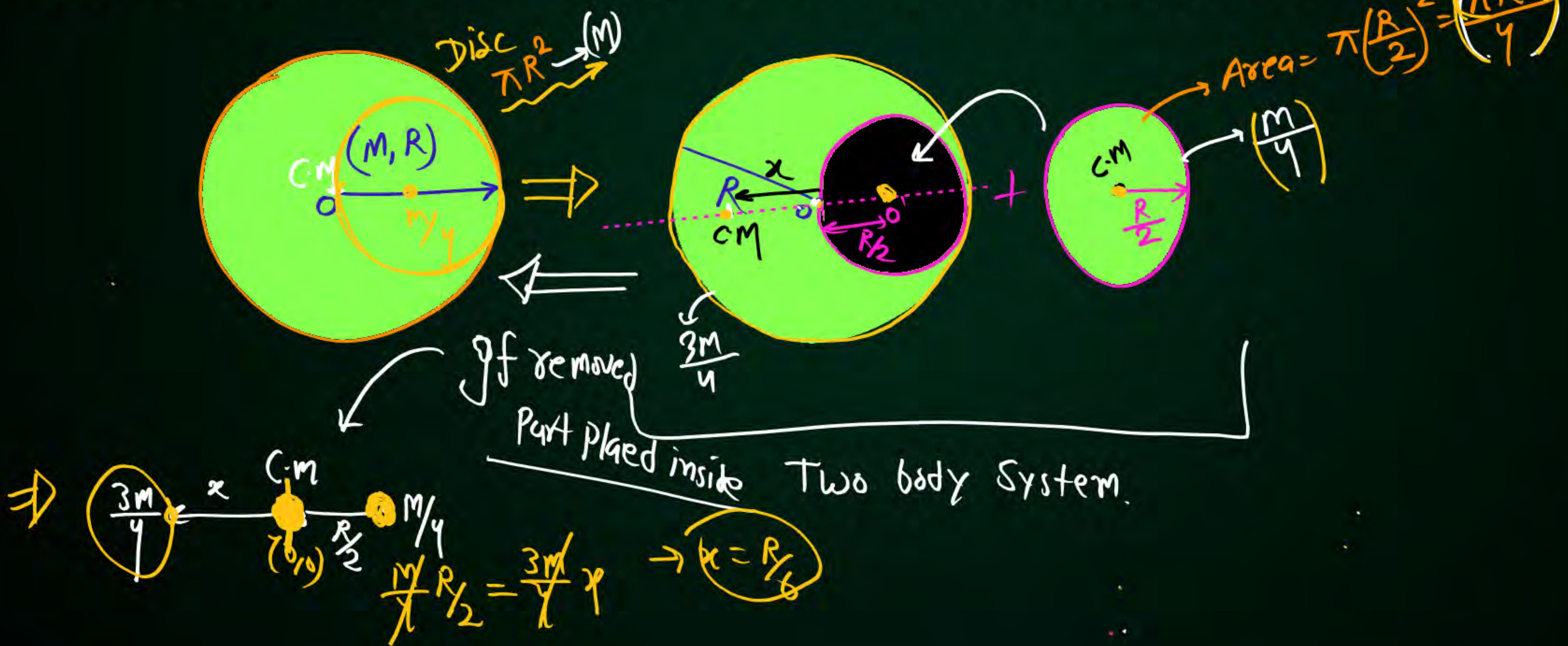
1. OC
2. OA
3. OB
4. OD




circula Dic
axis o.
cm
R
axis of
symmetry
cm

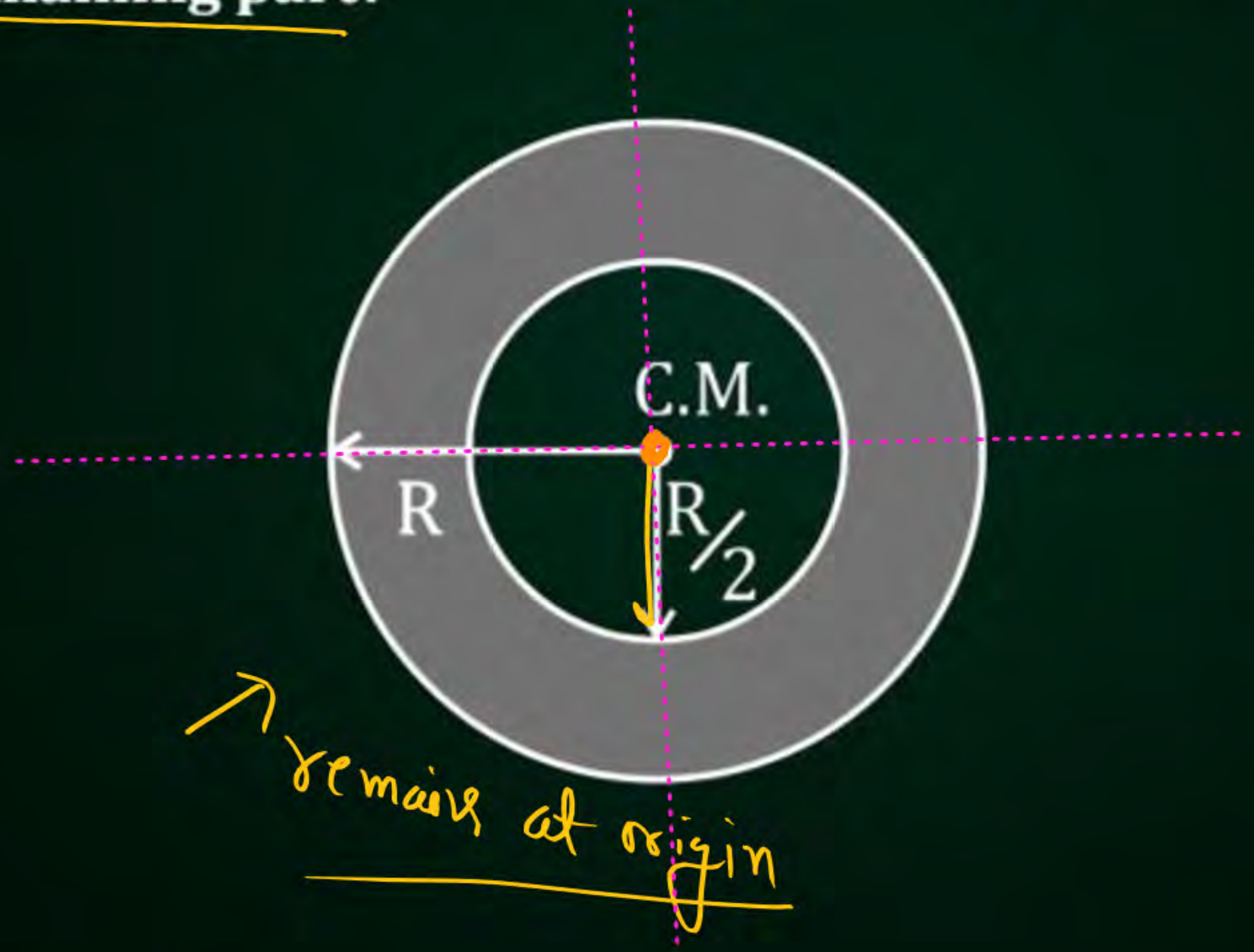
QUESTION

From a uniform circular disc of mass M and radius R a small circular disc of radius $R/2$ is removed in such a way that both have a common tangent. Find the distance of centre of mass, of remaining part from the centre of original disc.



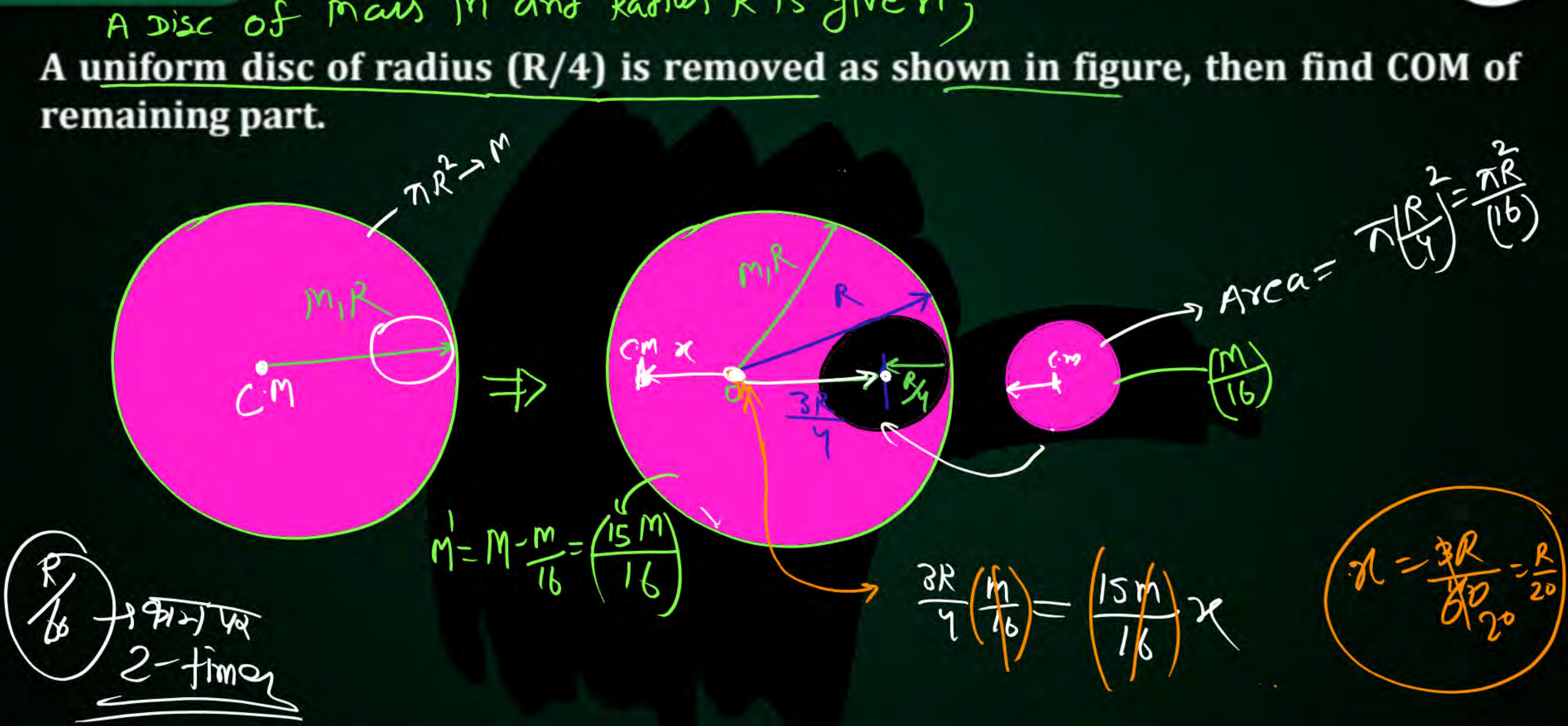
QUESTION

A disc of mass M and radius R given, a small disc of $\frac{R}{2}$ is removed as shown in figure then COM of remaining part?

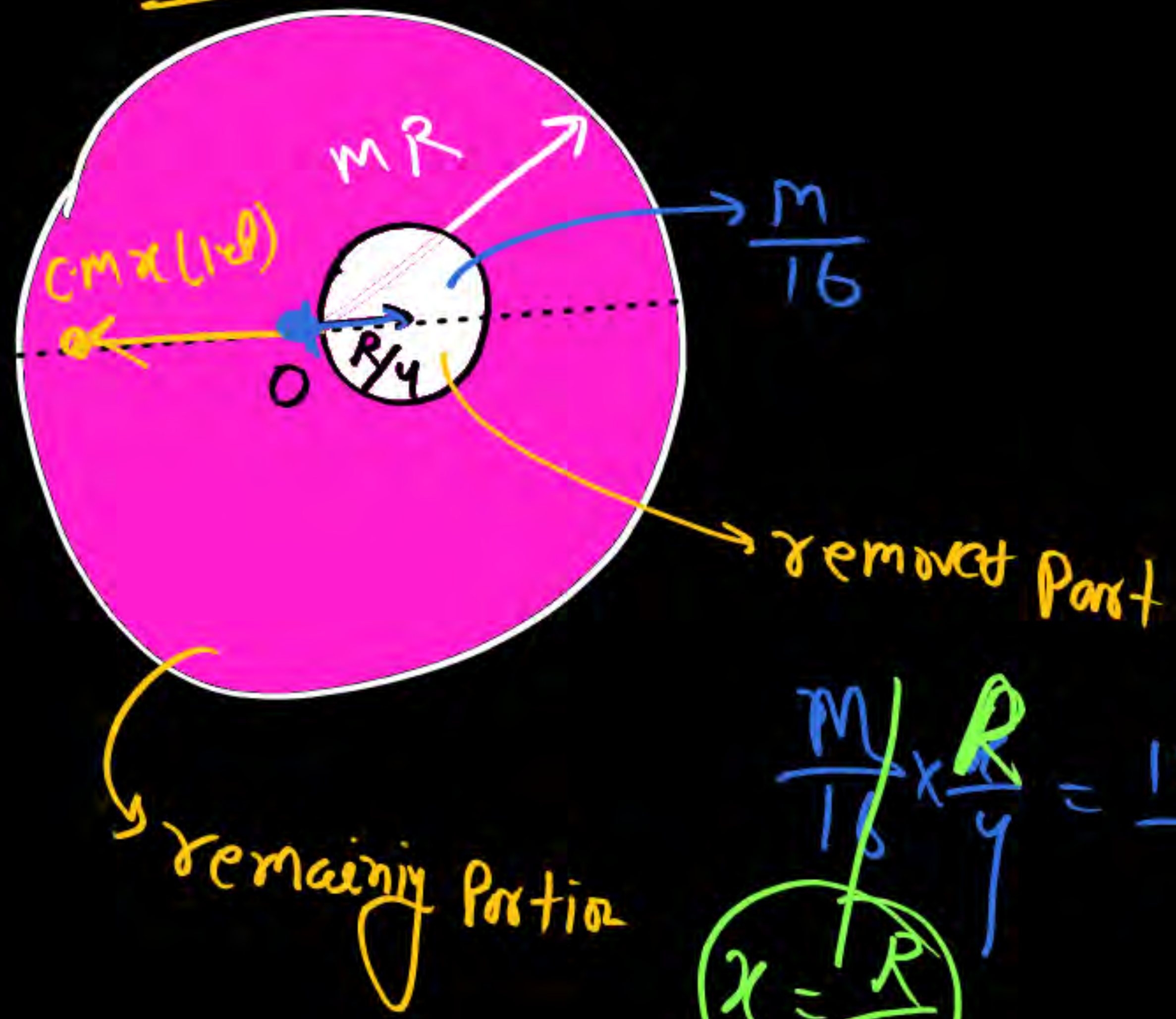


QUESTION

A uniform disc of radius (R/4) is removed as shown in figure, then find COM of remaining part.



Disc (M, R)

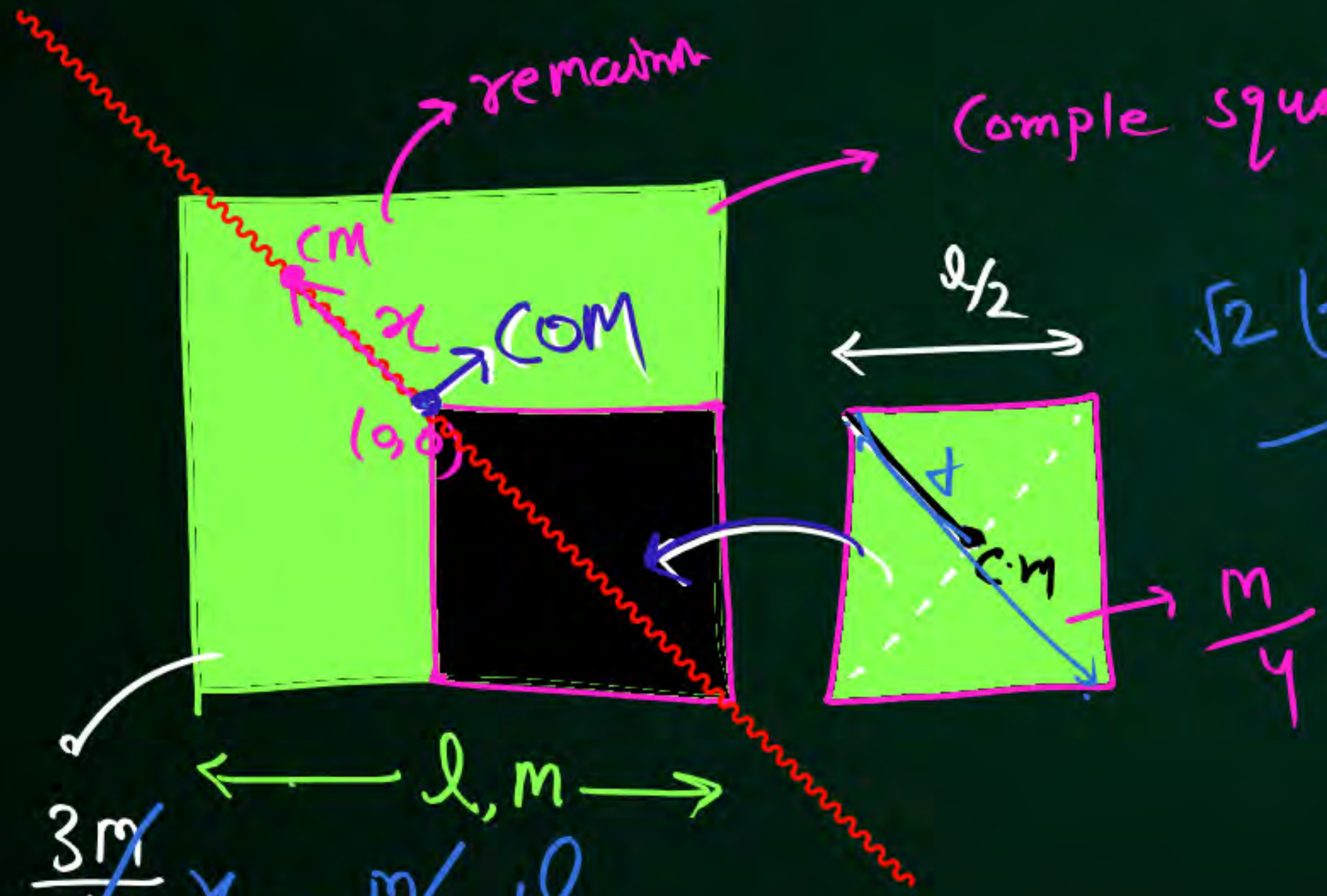


$$\frac{M}{16} \times \frac{R}{4} = \frac{15M}{16}\, x$$

$$x = \frac{R}{60}$$

QUESTION

A uniform square plate of mass M, side length *l*, if square plate of side length (*l*/2) is removed, then find COM of remaining part.



$\sqrt{2}\left(\frac{l}{2}\right)\times\frac{1}{2}=\frac{l}{2\sqrt{2}}$ (dist^n corner to centre)

$\frac{3m}{4}x=\frac{m}{4}\frac{l}{2\sqrt{2}}$

$x=\left(\frac{l}{6\sqrt{2}}\right)$ Ans

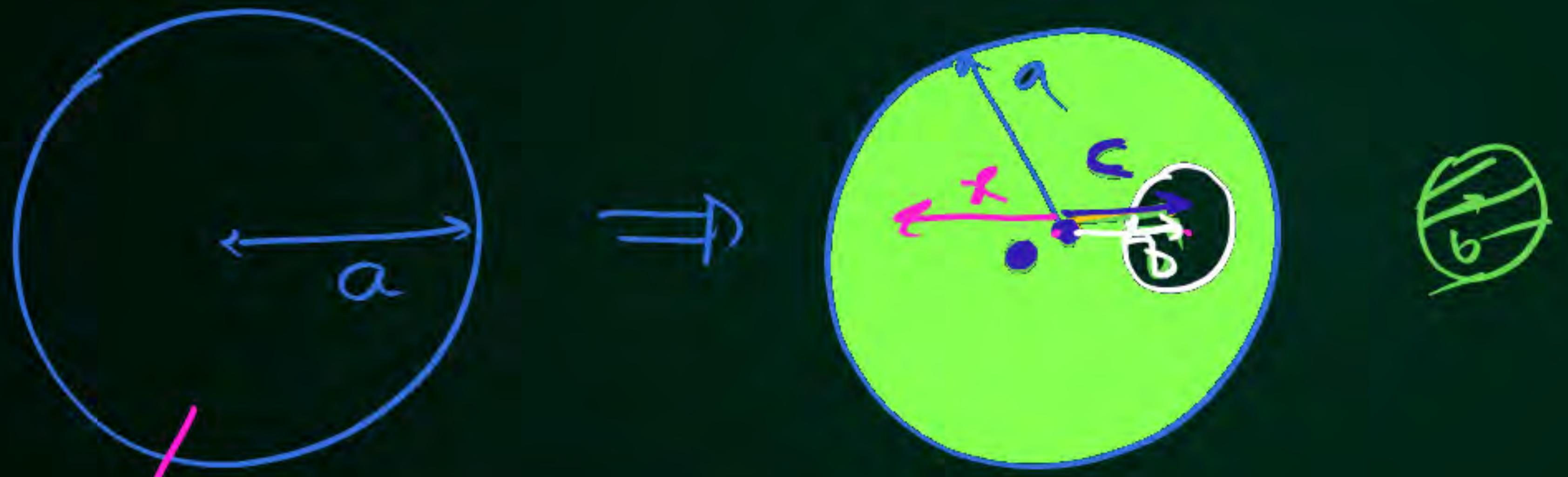




$d = \frac{l}{2\sqrt{2}}$

QUESTION

Find the centre of mass of a uniform disc of radius '*a*' from which a circular section of radius '*b*' has been removed. The centre of the hole is at a distance c from the centre of the disc.



Mass of remaining Part

$$M' = M - \frac{Mb^2}{a^2} = M\left(\frac{a^2-b^2}{a^2}\right)$$

Moment of mass

$$\frac{Mb^2}{a^2} \times c = M\left(\frac{a^2-b^2}{a^2}\right)x$$

$$x = \left(\frac{b^2c}{a^2-b^2}\right)$$

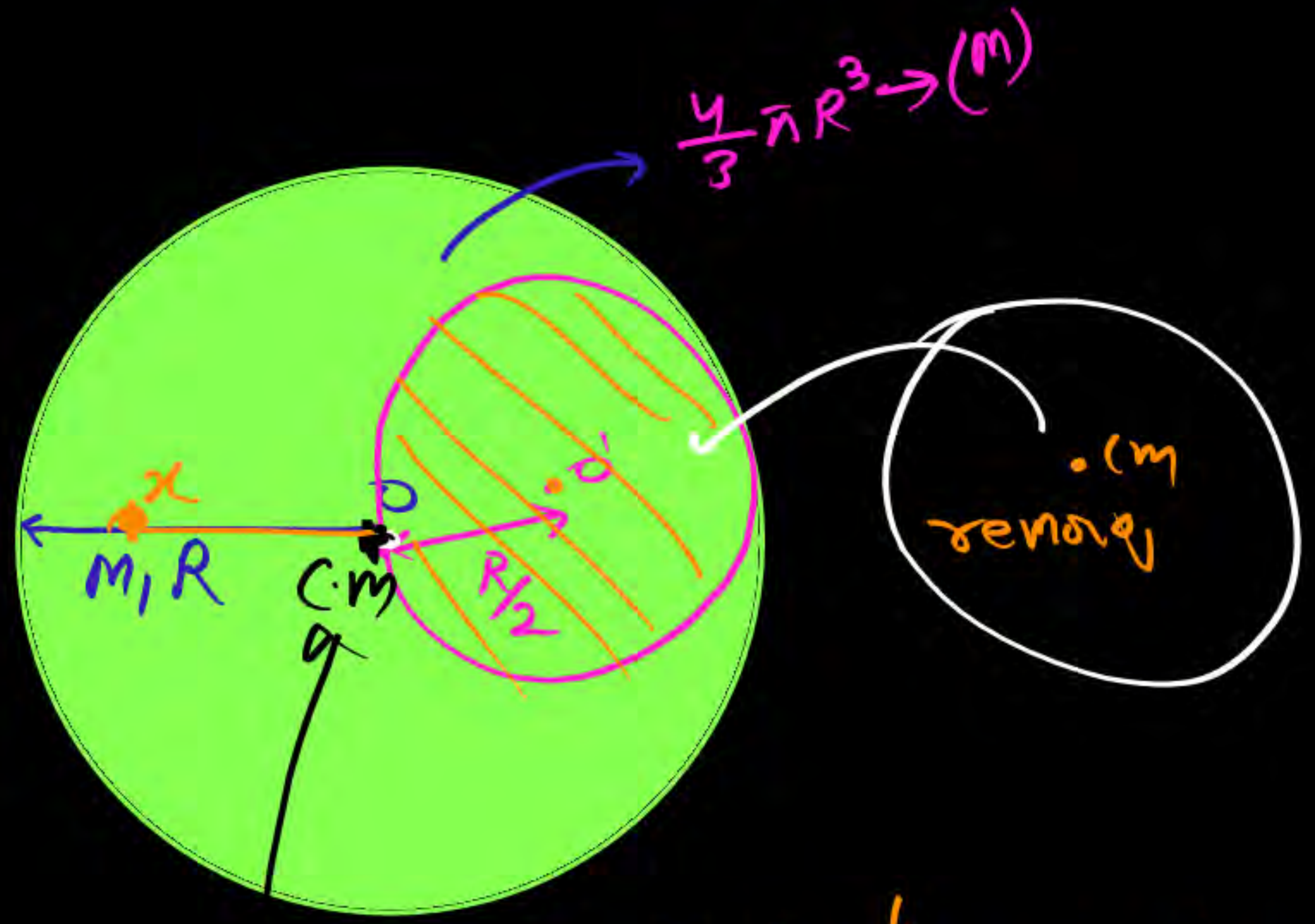
H/W

$\pi a^2 \rightarrow M$

1 unit area ka mass $= \frac{M}{\pi a^2}$

$\pi b^2 \longrightarrow M' = \frac{M}{\pi a^2} \times \pi b^2 \Rightarrow \frac{Mb^2}{a^2}$ → removed Part ka mass.

(Q) A uniform solid sphere (M, R) as shown in fig. A sphere of Radius $R/2$ is removed as given then find c.o.m of remaining portion.



$$\frac{R}{2}\left(\frac{M}{8}\right) = \frac{7M}{8}x$$

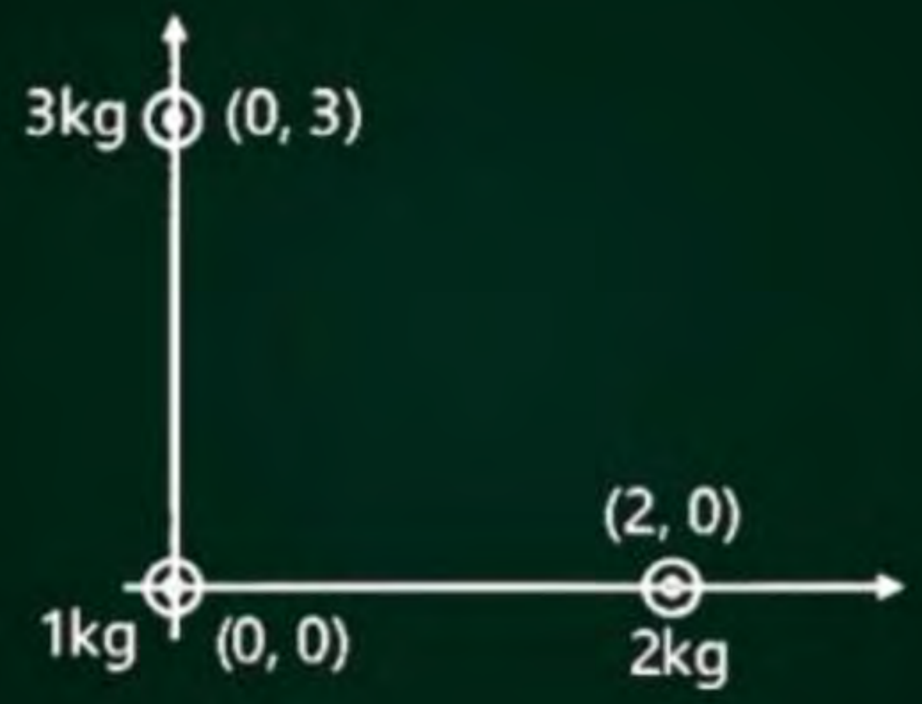
$$x = \frac{R}{14}$$

Velocity of C.O.M

$$\vec{v}_{c.m} = \frac{m_1\vec{v}_1 + m_2\vec{v}_2 + m_3\vec{v}_3}{m_1 + m_2 + m_3}$$

QUESTION

Find position of COM.



QUESTION

Two particles of masses 1 kg and 0.5 kg are moving in the same direction with speeds of 2 m/s and 6 m/s, respectively, on a smooth horizontal surface. Find the speed of the centre of mass of the system.

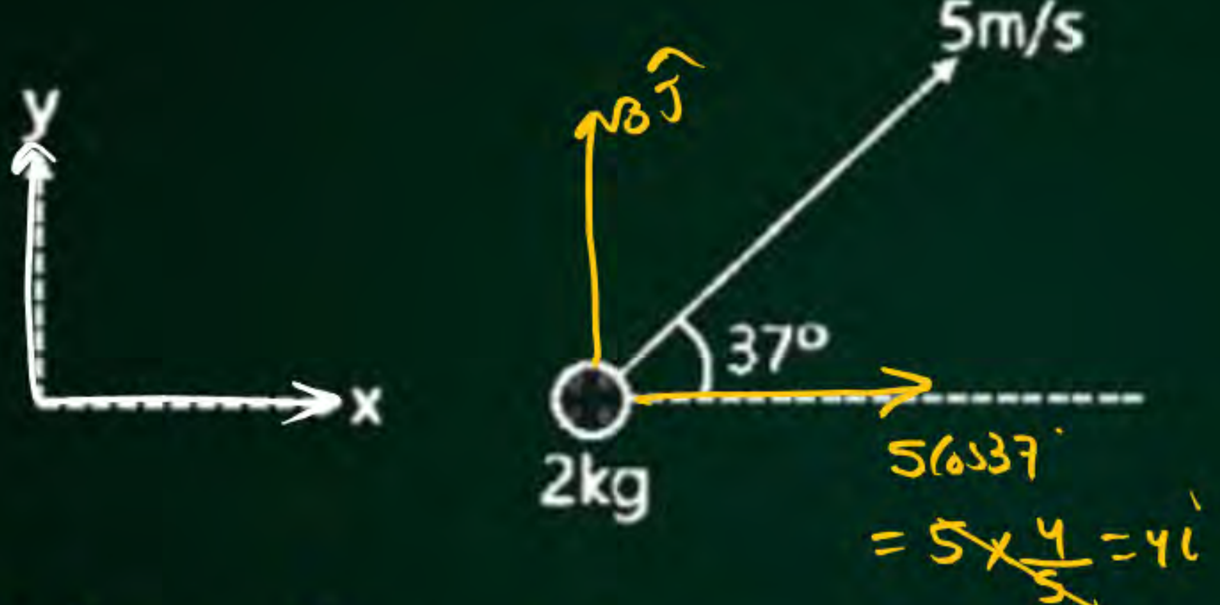
$$\vec{u}_{c.m} = \frac{1 \times 2\hat{i} + \frac{1}{2} \times 6\hat{i}}{1 + \frac{1}{2}}$$

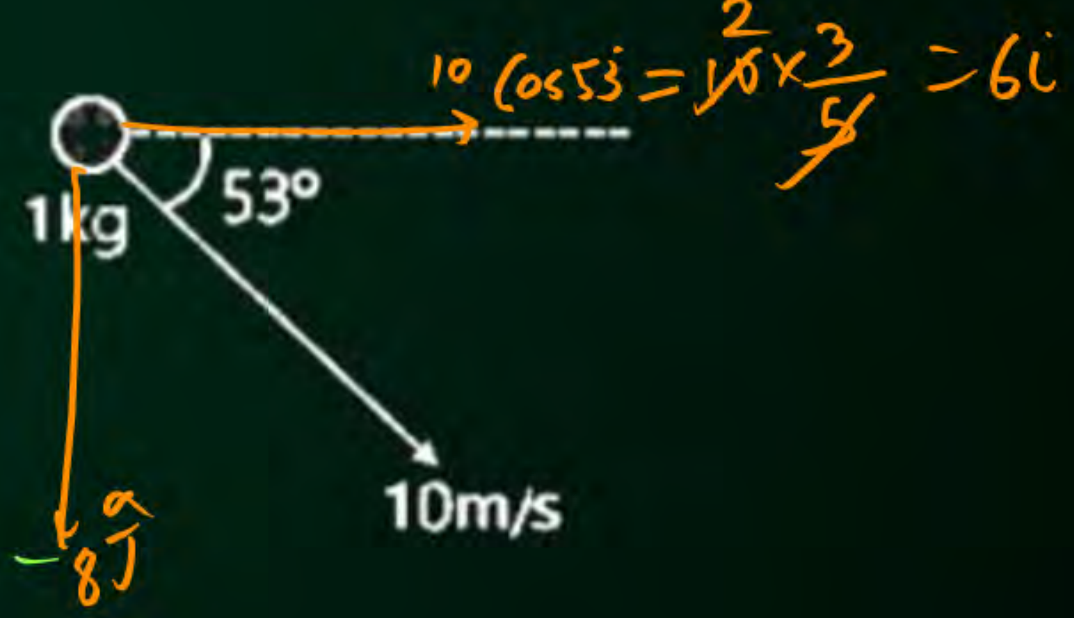
$$= \frac{2\hat{i} + 3\hat{i}}{3/2}$$

$$= \frac{5\hat{i}}{3/2} = \frac{10}{3}$$

QUESTION

Find velocity of COM.





$$\vec{v}_{c.m} = \frac{2(4\hat{i}+3\hat{j}) + 1(6\hat{i}-8\hat{j})}{3}$$

$$= \frac{14\hat{i}-2\hat{j}}{3}$$

QUESTION

Three particles of masses 1 kg, 2 kg and 3 kg are subjected to forces $(3\hat{i} - 2\hat{j} + 2\hat{k})$N, $(-\hat{i} + 2\hat{j} - \hat{k})$ N and $(\hat{i} + \hat{j} + \hat{k})$ N respectively. Find the magnitude of the acceleration of the CM of the system.

$$\vec{a}_{c.m} = \frac{m_1\vec{a}_1 + m_2\vec{a}_2 + m_3\vec{a}_3}{(m_1 + m_2 + m_3)}$$

MR*

$$\vec{a}_{c.m} = \frac{(m_1\vec{a}_1) + (m_2\vec{a}_2) + (m_3\vec{a}_3)}{m_1 + m_2 + m_3}$$

$$\vec{a}_{c.m} = \frac{[\vec{F}_1 + \vec{F}_2 + \vec{F}_3]}{(m_1 + m_2 + m_3)} = \frac{3\hat{i} - 2\hat{j} + 2\hat{k} - \hat{i} + 2\hat{j} - \hat{k} + \hat{i} + \hat{j} + \hat{k}}{6} = \frac{3\hat{i} + \hat{j} + 2\hat{k}}{6}$$

QUESTION

Two particles of mass 1 kg and 3 kg are having acceleration $(\hat{\imath} - 2\hat{\jmath} + 5\hat{k})$ m/s^2 and $(-2\hat{\imath} + \frac{4}{3}\hat{\jmath} - \hat{k})$ m/s^2. Find out $\vec{a}_{cm}$. = ??

$$\vec{a}_{c.m} = \frac{m_1\vec{a}_1 + m_2\vec{a}_2}{m_1 + m_2}$$

QUESTION

(NEET)

Find acceleration of centre of mass. $(m_2 > m_1)$



$$-\left(\frac{m_2-m_1}{m_2+m_1}\right)g = a \uparrow$$

$$\vec{a}_{C.M} = \frac{m_2\vec{a}_2 + m_1\vec{a}_1}{m_2+m_1}$$

$$= \frac{m_2\left(\frac{m_2-m_1}{m_2+m_1}\right)g - m_1\left(\frac{m_2-m_1}{m_2+m_1}\right)g}{m_1+m_2}$$

$$= \left(\frac{m_2-m_1}{m_2+m_1}\right)g\left(\frac{m_2-m_1}{m_1+m_2}\right) = \left(\frac{m_2-m_1}{m_2+m_1}\right)^2 g$$

cm ↓

$a_{cm} = \downarrow$ +ve (left)

$$\downarrow a = +\left(\frac{m_2-m_1}{m_2+m_1}\right)g$$

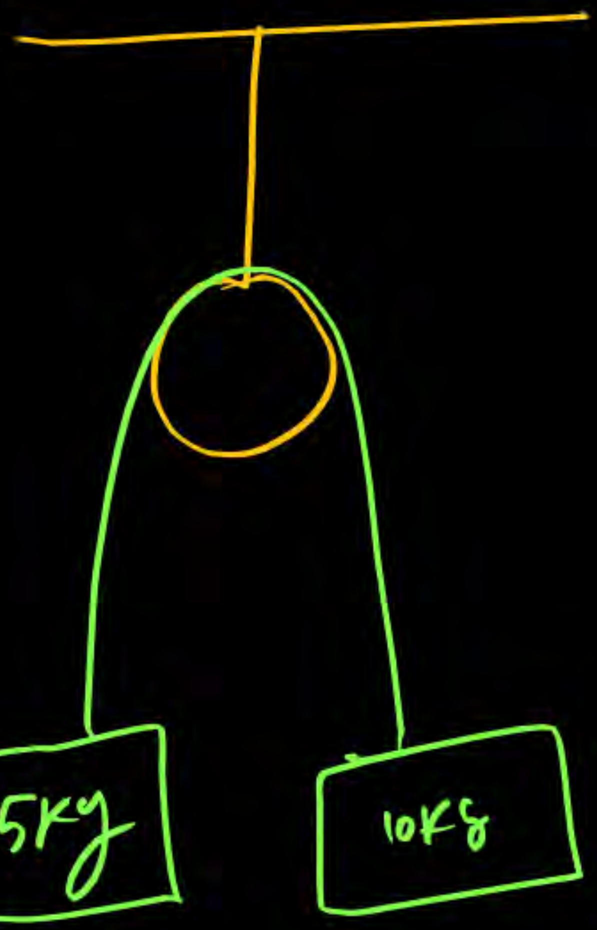
$$\vec{a}_{c.m} = \left(\frac{m_2-m_1}{m_2+m_1}\right)^2 g$$

MR Rasil (The Biyoyo)

$$\vec{a}_{c.m.} = \left(\frac{10-5}{10+5}\right)^2 g$$

$$= \left(\frac{5}{15}\right)^2 g$$

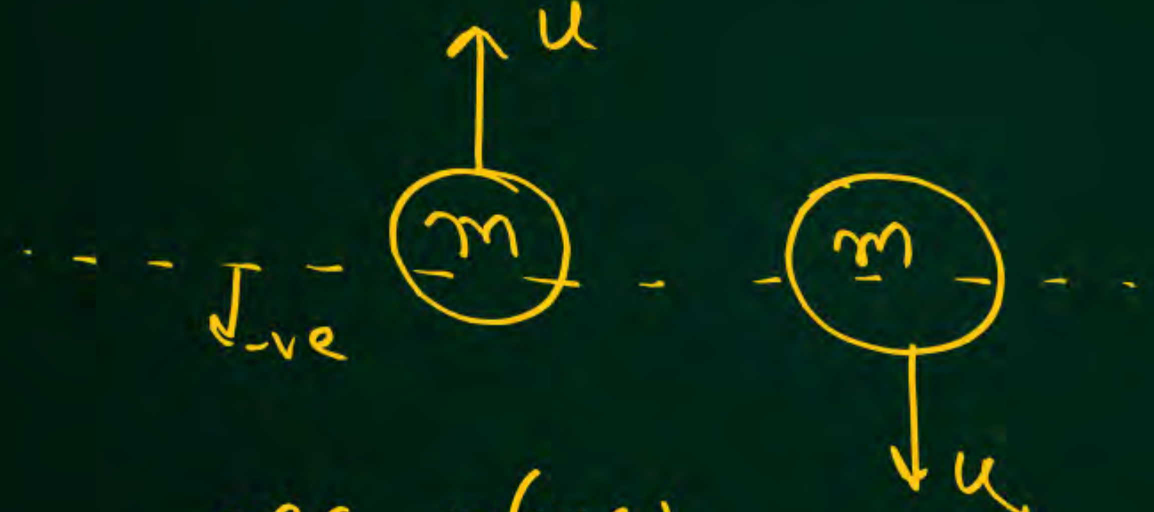
$$= \frac{g}{9} = \frac{10}{9}\, m/s^2$$



QUESTION

A ball of mass m is thrown upward and another ball of same mass is thrown downward so as to move freely under gravity. The acceleration of center of mass is

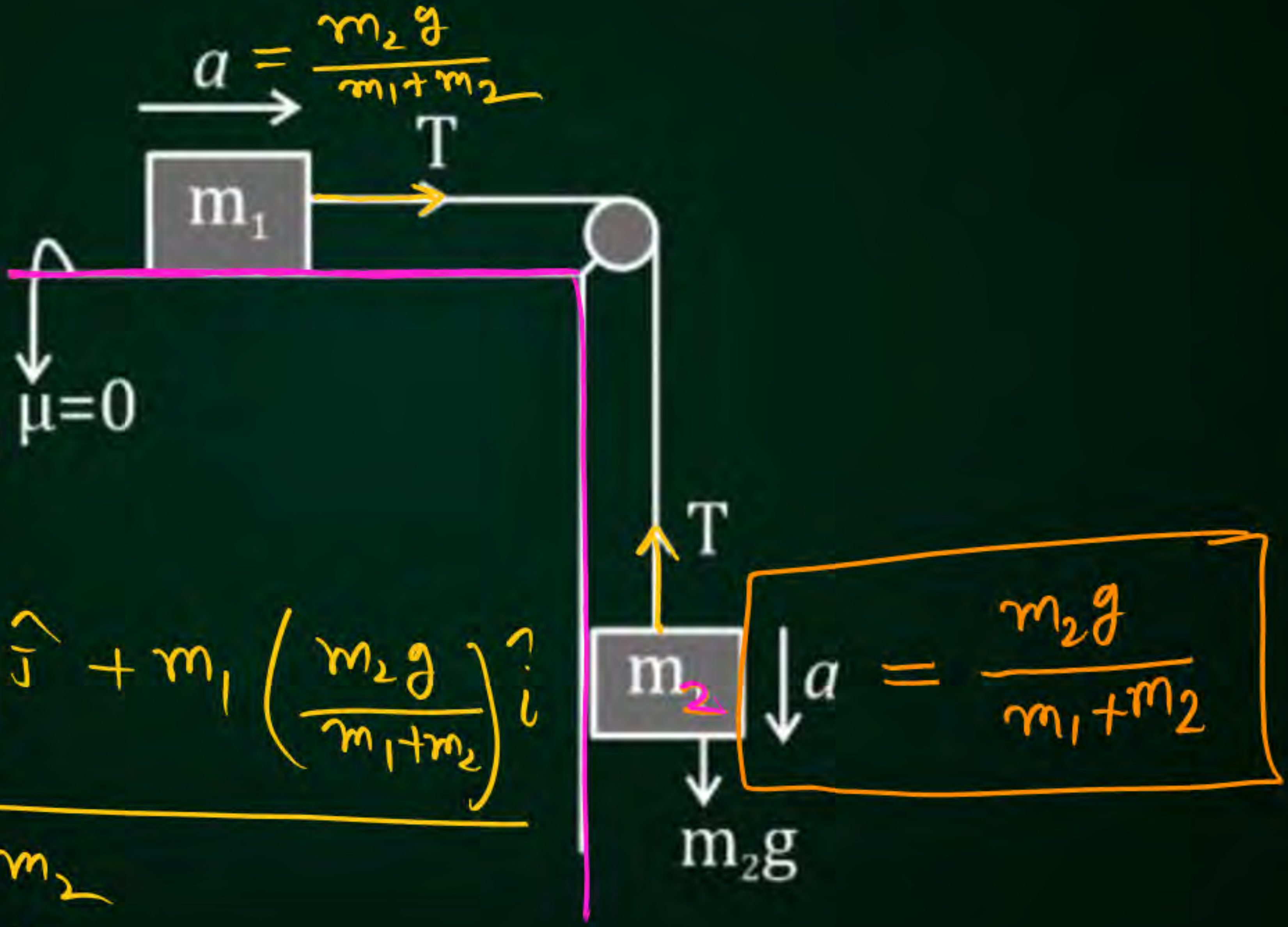
1. g
2. $9g/3$
3. $2g/3$
4. $g/2$



$$a_{c.m} = \frac{-mg + -(mg)}{m+m} = \frac{-2mg}{2m} = -g$$

QUESTION

Find acceleration of COM.



$$\vec{a}_{c.m} = \frac{-m_2\left(\frac{m_2 g}{m_1+m_2}\right)\hat{j} + m_1\left(\frac{m_2 g}{m_1+m_2}\right)\hat{i}}{m_1+m_2}$$

$$\vec{a}_{c.m} = \frac{m_1 m_2}{(m_1+m_2)^2}\hat{i} - \frac{m_2^2 g}{(m_1+m_2)^2}\hat{j}$$

QUESTION

Two blocks of masses 5 kg and 2 kg are connected by a spring of negligible mass and placed on a frictionless horizontal surface. An impulse provides a velocity of 7 m/s to the heavier block in the direction of the lighter block. The velocity of the center of mass is

1. 4 m/s
2. 5 m/s
3. 2 m/s
4. 3 m/s



$$\vec{v}_{c.m} = \frac{5\times 7\hat{i} + 2\times 0}{5+2} = \frac{35}{7} = 5\ m/s$$

THANK YOU



YAKEEN 2.0

FOR NEET 2025

Lecture- 3 | **Physics**

Centre of mass and System of Particles, Collision



By- Dr. Manish Raj (MR SIR)

Todays Goal

→ Conservation of momentum of system of particles

→ "Conservation of momentum of C.O.M"

QUESTION

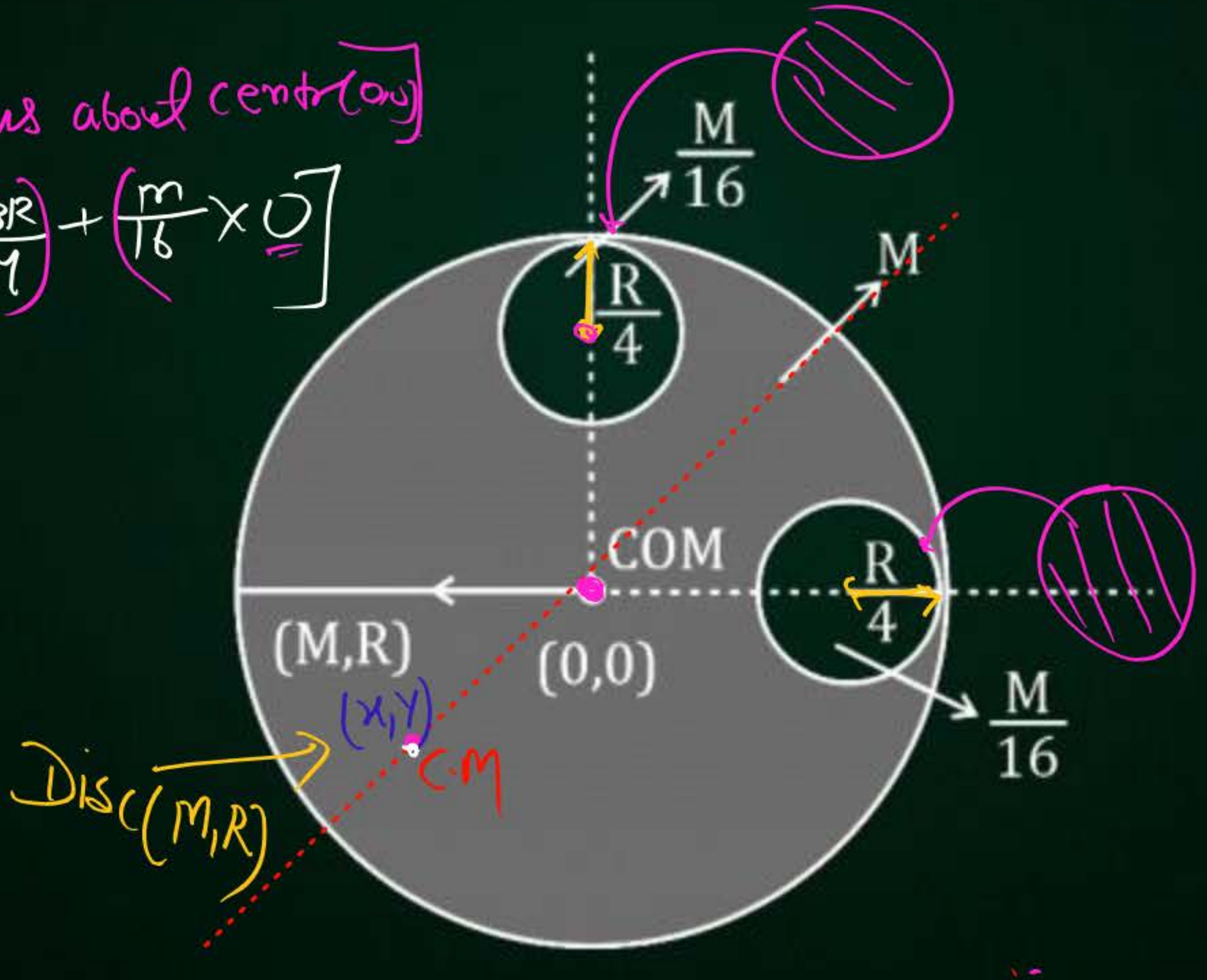
level (H/W)

A disc of mass (M, R). Two disc of radius R/4 is cut and removed as shown in figure then find COM of remaining part.

hint

(moment of mass about centre (0,0))

$$\left[x\left(\frac{7M}{8}\right) = \left(\frac{M}{16}\times\frac{3R}{4}\right) + \left(\frac{M}{16}\times 0\right)\right]$$



Conservation of liner momentum of a one particle (one object)

(In Newtons law of motion)

$$\vec{F}_{ext} = \frac{d\vec{P}}{dt} \quad \text{(on object)}$$

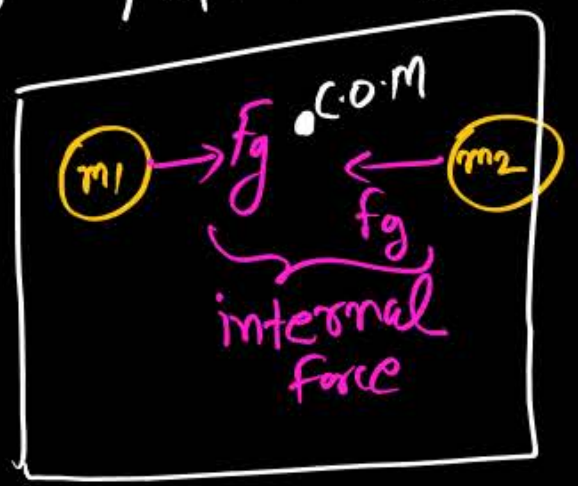
$$0 = \frac{d\vec{P}}{dt}$$

$$\vec{P}_{object} = cost^{n}$$

If $F_{ext} = 0$ acting on a object then its liner Momentum will Conserved.

$$\boxed{\vec{P} = mv = cost^{n}}$$

Conservation of liner momentum of a system of Particles.

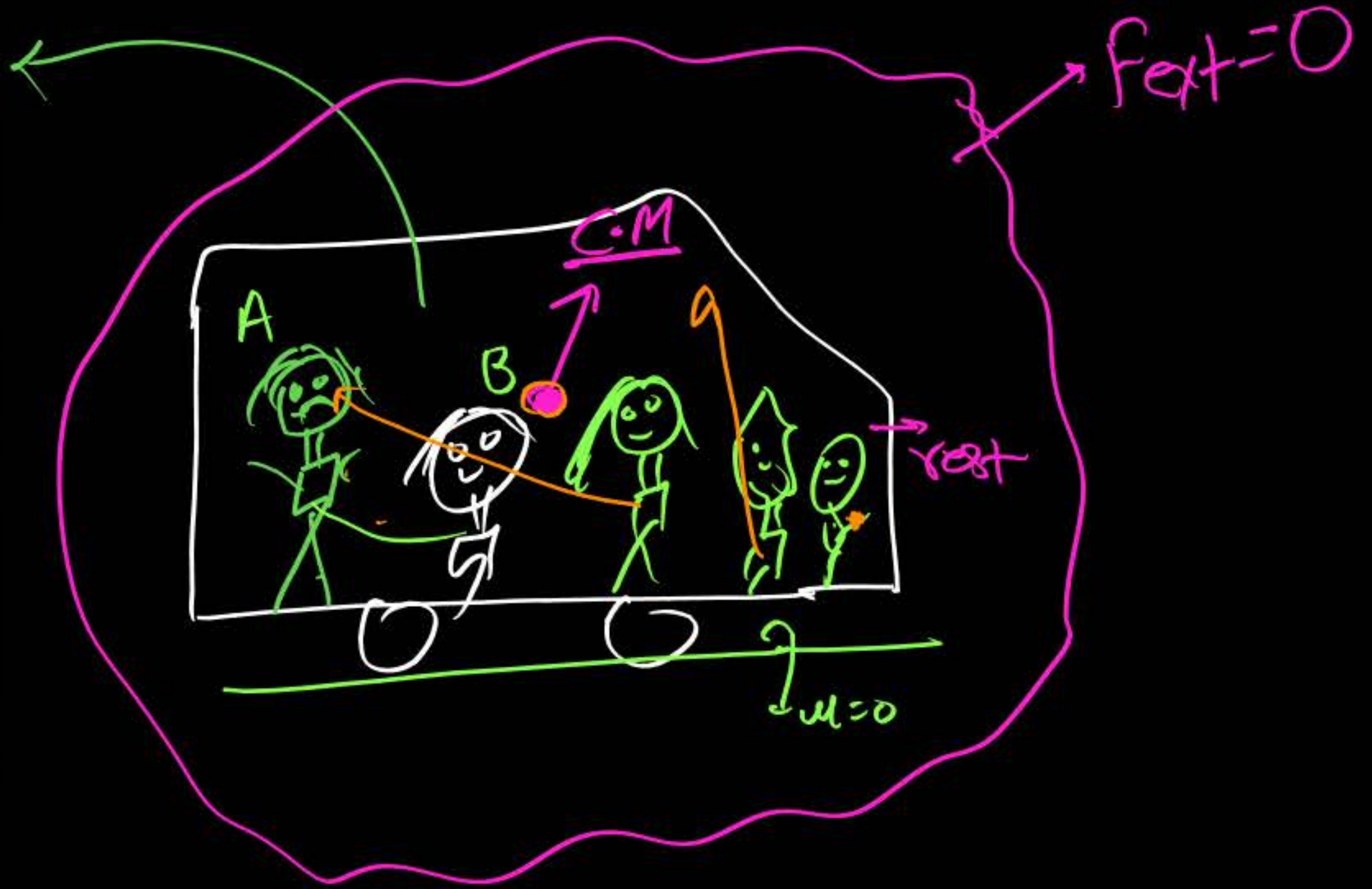


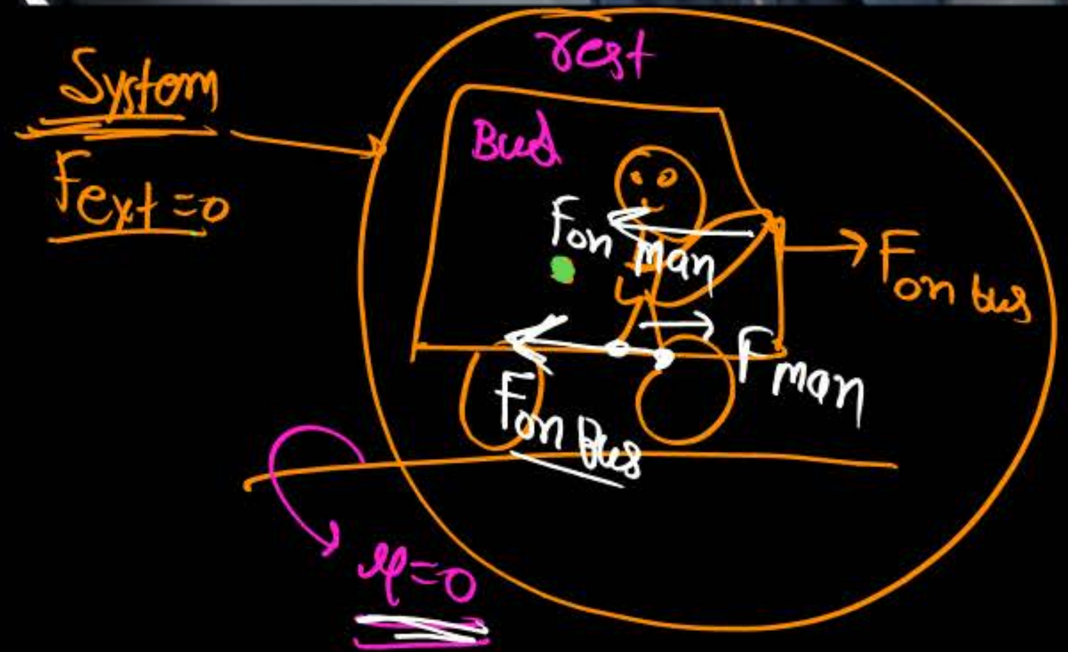
- If $(\vec{F}_{ext})_{net} = 0$ acting on system is zero then liner momentum of a system or momentum of C.O.M will be Conserved, momentum of Indivisual object may or may not be conserved.

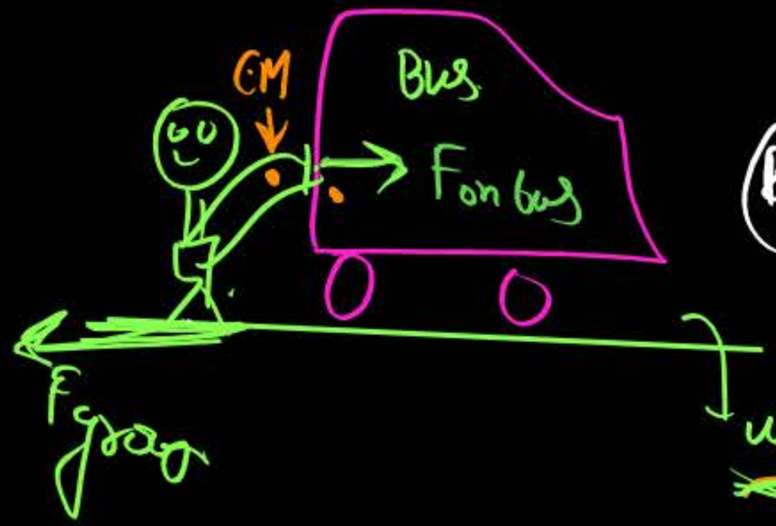
Internal force can't change momentum of system, it can change moment of one object

aag lage chahe Basti me.
C.O.M rahe apne masti *









(Bus Will Move)

For one object

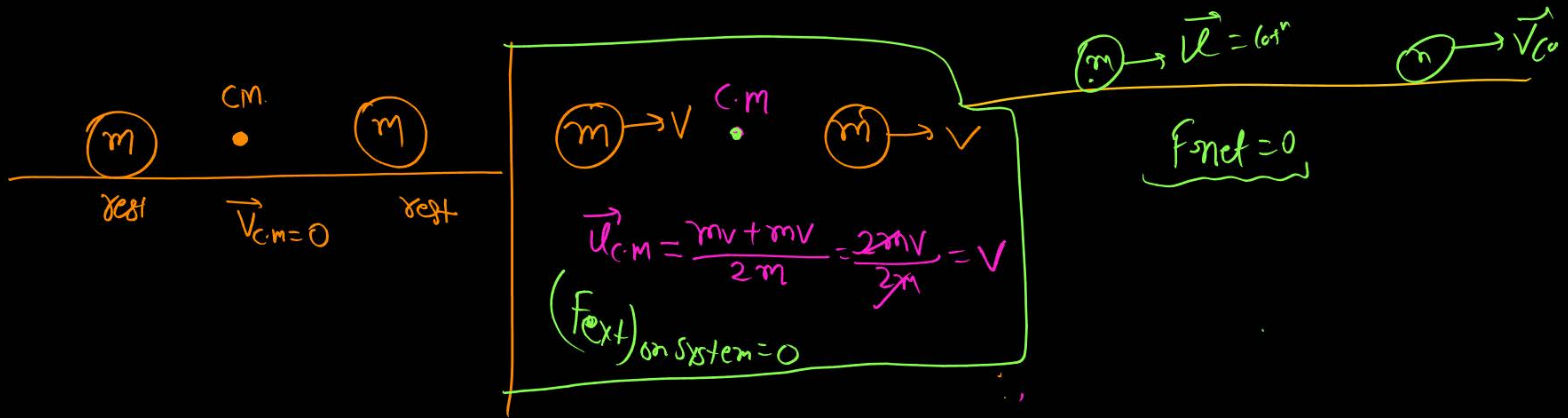
If external force acting on object is zero then momentum of that object will conserved.

For system of object

If net external force acting on system is zero, then momentum of system COM will conserved.

If F_{ext} acting on object is zero, then Position of object will not change

↳ false



S-1

- Position of COM will (only) change when external force will act. → a (True) ✗ / (b) false (51%)

S-2

- Momentum of system (C.O.M) will only change when external force will act. → True

S-3

- KE of system will only change when external force will act. → True (a) ✗ / false (b) ✓

$W_{intF} + W_{ext} = \Delta K.E$

Explation - (S-1)

$\vec{F}_{ext\ on\ system} = \frac{d\vec{P}_{c.m}}{dt}$

If $F_{ext} = 0 = \frac{d\vec{P}_{c.m}}{dt}$

$\vec{P}_{c.m} = \text{Cost}^n$

$M\vec{V}_{c.m} = \text{Cost}^n$

$\vec{V}_{c.m} = \text{Cost}^n$

$\vec{V}_{c.m} \neq 0$ — Fixed

$\vec{V}_{c.m} = 0$ then velocity remains Costr.

Internal force can change K.E. of the system but can't change momentum of the system.

(X) Law of Conservation of K.E. Nahi hota.

Work energy thm. for system.

$$W_{C.F} + W_{NC.F} + W_{\text{Inte force}} + W_{ext\,F} = \Delta K.E_{\text{System}}$$

$$\vec{F}_{ext} = \frac{d\vec{P}_{c.m}}{dt}$$

WORK ENERGY THEORM

K.E → scalar $\vec{P}$ = vector

S-1

➢ Internal force can change KE of system.

[Yes]

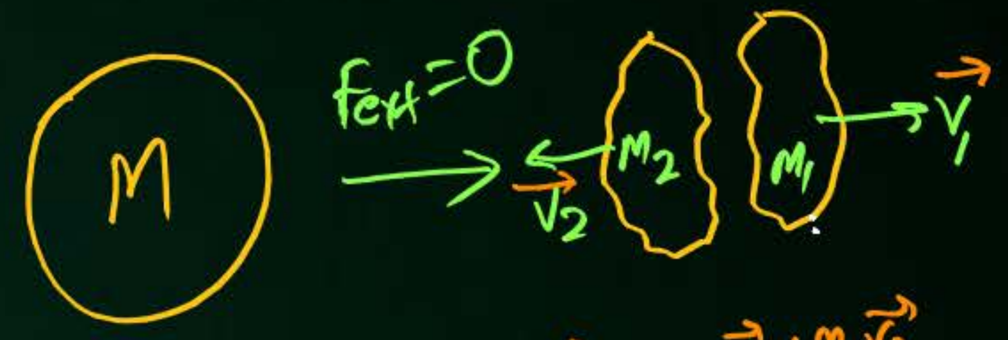
➢ Internal force can change momentum of system.

[No]

➢ Internal force can change moment of object.

[Yes]

explosion (Gun-bullet)



(rest)

$\vec{P_i} = 0$

$K.E_i = 0$

$\vec{P_f} = m_1\vec{v_1} + m_2\vec{v_2}$

$\vec{P_i} = \vec{P_f}$

$0 = m_1\vec{v_1} + m_2\vec{v_2}$

$m_1\vec{v_1} = -m_2\vec{v_2}$

but $K.E_f = \left(\frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2\right)$

↳ Non-zero

QUESTION

Internal forces can change for system.

1. the linear momentum but not the kinetic energy
2. the kinetic energy but not the linear momentum
3. linear momentum as well as kinetic energy
4. neither the linear momentum nor the kinetic energy

QUESTION

Which of the following statement is correct: -

1. Kinetic energy of a system can be changed without changing its momentum. (explosion)

2. Kinetic energy of a system cannot be changed without changing its momentum.

3. Momentum of a system cannot be changed without changing its kinetic energy. (wrong)

   $\vec{P}$ = vector, K.E = scalar

4. Body cannot have energy without having momentum.

   → Body can have other form of energy

   → Potential energy stored without having momentum

QUESTION

Two particles A and B initially at rest move towards each other under a mutual force of attraction. At the instant when velocity of A is v and that of B is $2v$, the velocity of center of mass of system

1. v
2. $2v$
3. $3v$
4. Zero

(63%)

$\vec{v}_{c.m\ \text{initial}} = 0$

only internal force is acting here

$\vec{F}_{ext} = 0$

$\vec{v}_{c.m} = \text{const}$

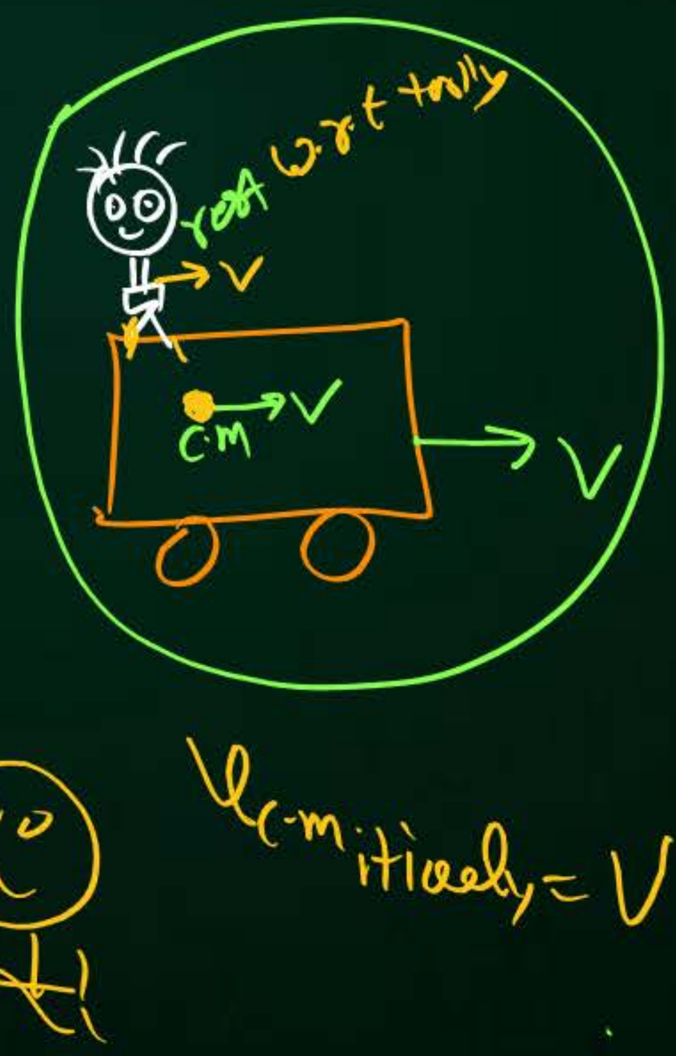
$\vec{v}_{c.m_i} = \vec{v}_{c.m\ \text{final}}$

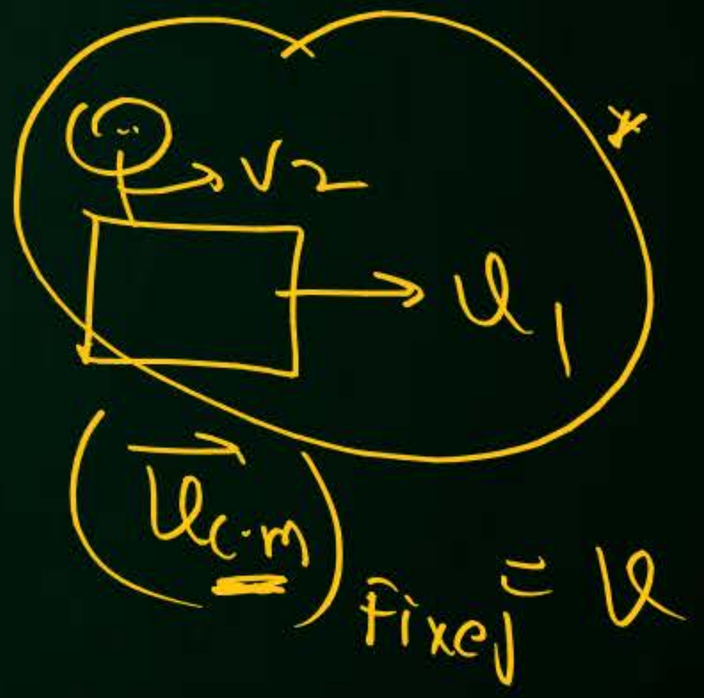
$0 = v_{c.m}$

QUESTION

A child is standing at one end of a long trolley moving with a speed v on a smooth horizontal track. If the child starts running towards the other end of the trolley with a speed u, the center of mass of the system (trolley + child) will move with a speed

1. Zero
2. $(v+u)$
3. v
4. $(v-u)$

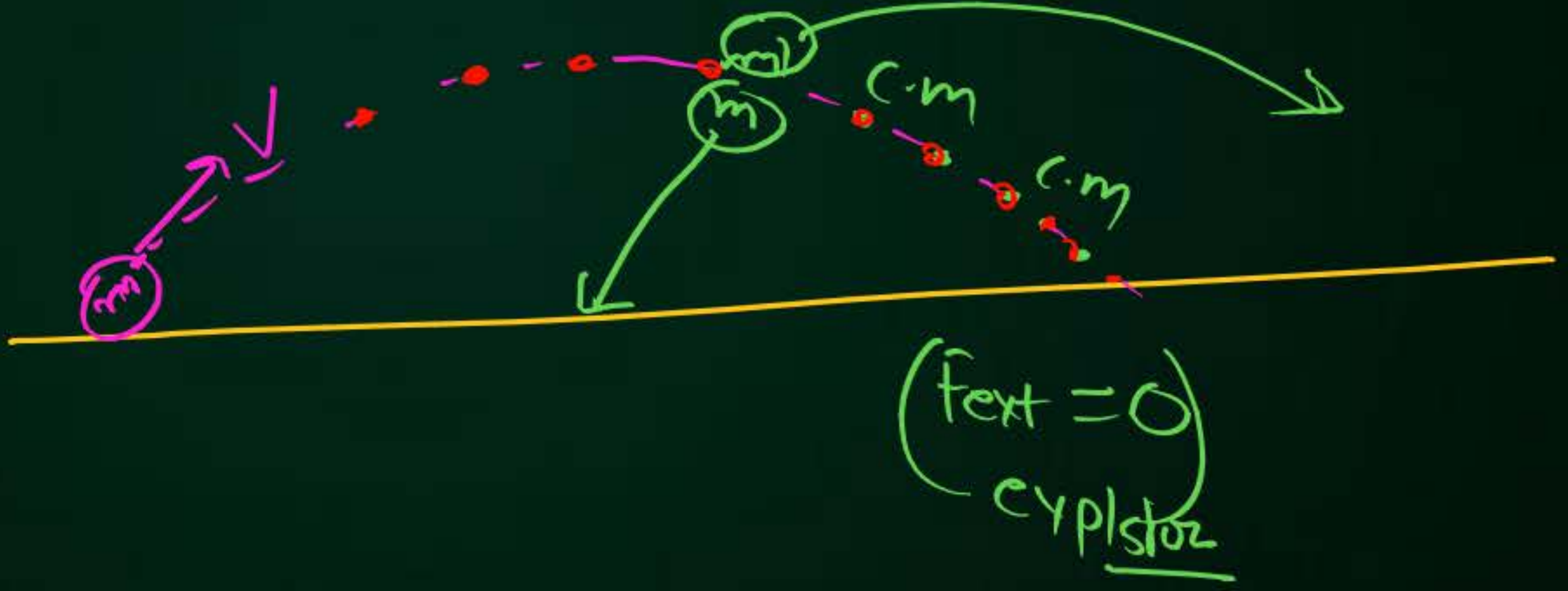




QUESTION

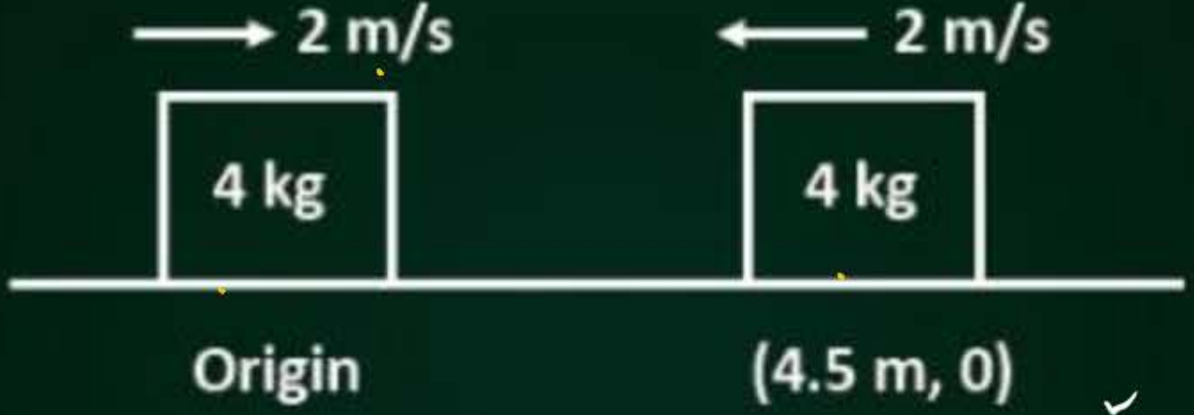
A shell following a parabolic path explodes somewhere in its flight. The centre of mass of fragments will move in

1. Vertical direction
2. Any direction
3. Horizontal direction
4. Same parabolic path



QUESTION

Blocks A and B kept on a smooth horizontal surface are given equal speeds of 2 m/s in opposite sense as shown in the figure.



At $t = 0$ the position of blocks are shown, then the coordinates of Centre of mass of system of two blocks, at $t = 3s$ will be:-

at $t=0$ $\vec{u}_{c.m} = \dfrac{4\times2 - 4\times2}{4+4} = 0$

$F_{ext} = 0$ → $(\vec{v}_{c.m})_{final} = 0$

Sol^n

(at $t=0$, at $t=3$ sec)

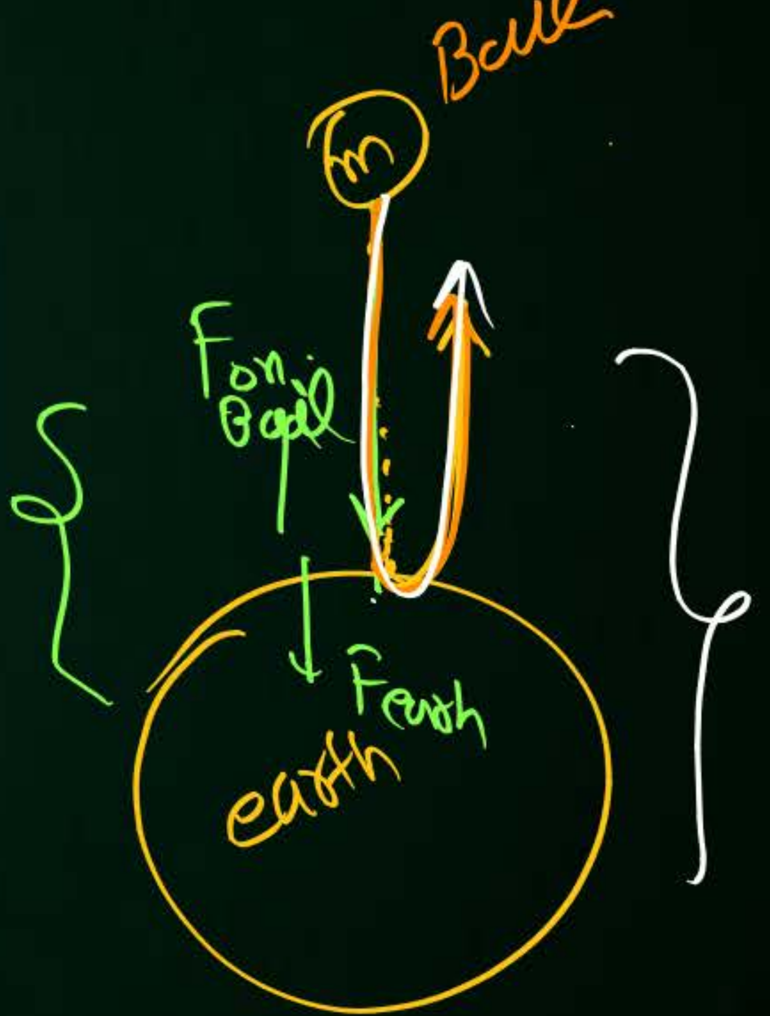
$$\vec{x}_{c.m} = \frac{4\times0 + 4\times4.5}{4+4}$$

$$= \frac{4\times4.5}{8} = 2.25\,m \text{ (Ans)}$$

QUESTION

A ball strikes the floor and after collision rebounds back. In this state -

1. Momentum of the ball is conserved
2. Mechanical energy of the ball is conserved
3. Momentum of ball-earth system is conserved
4. The kinetic energy of ball-earth system is conserved.



Object

System (Two or More than Two)

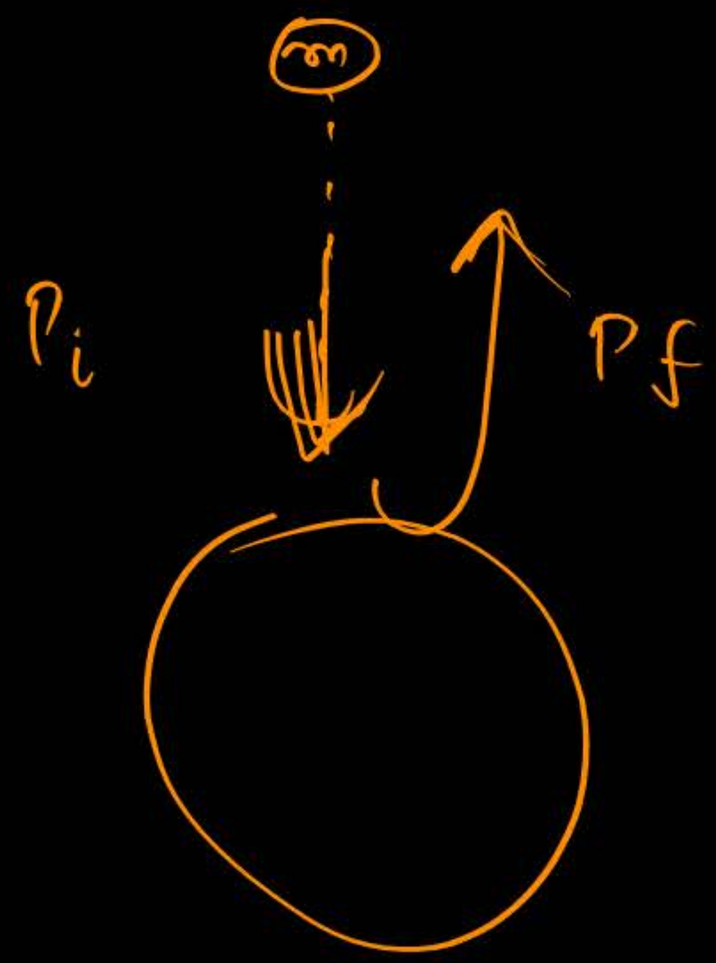
$$\vec{F}_{ext} = 0$$

syst^m

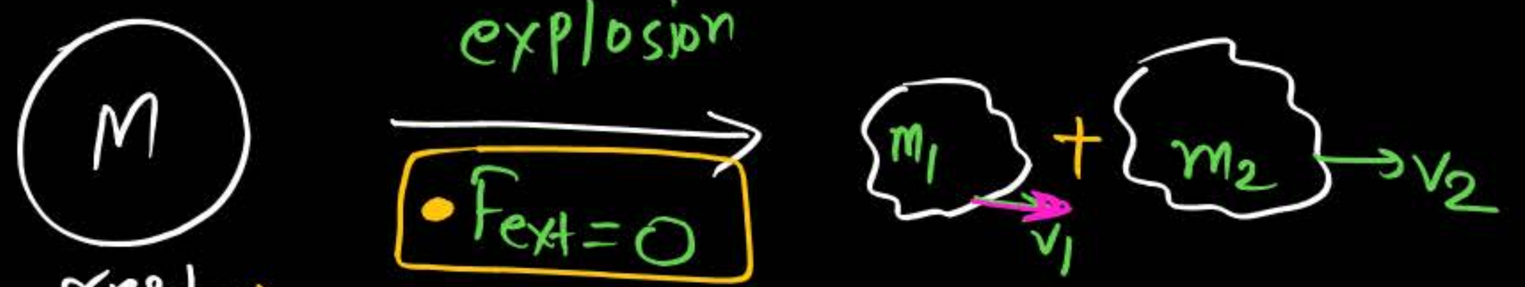
Momentum of C.O.M of system will conserved.

$$\vec{F}_{ext(system)} = 0$$

momentum of system (c·o·m) will conserved.



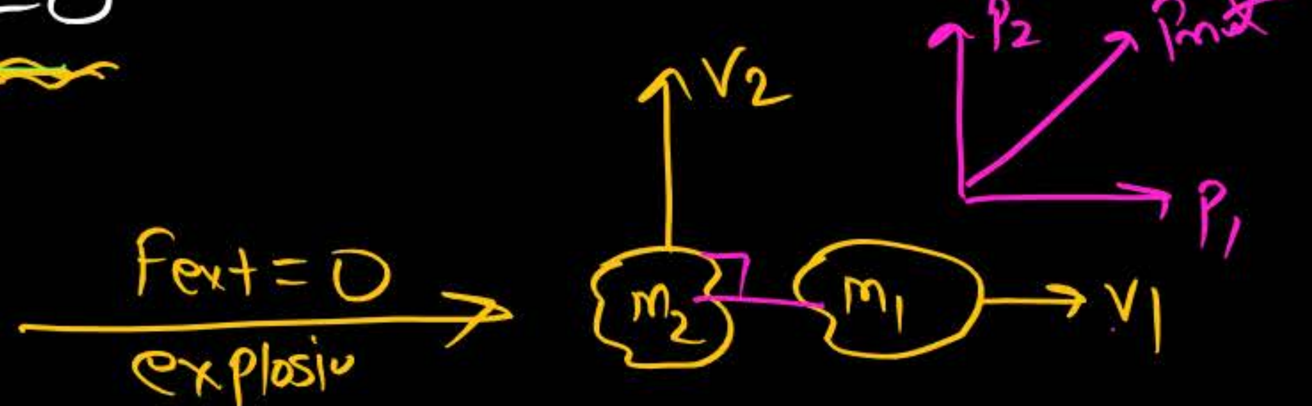
When $F_{net\,system} = 0$ then $P_{system} = \text{const}^n$.



rest

This is not Possille.

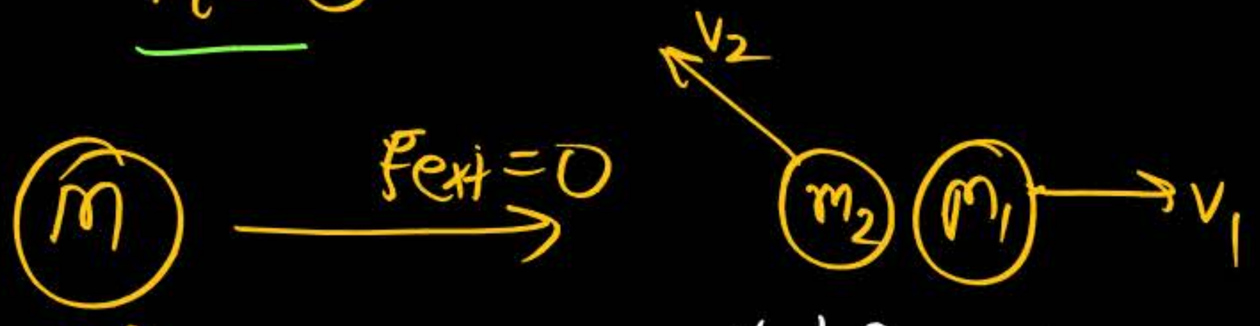
$P_{intial} = 0$



rest

$P_i = 0$

Not Possible



rest

$P_i = 0$

Not Possible



rest

$P_i = 0$

$mV = \text{const}^n$

$m_1 v_1 = m_2 v_2$

Possible

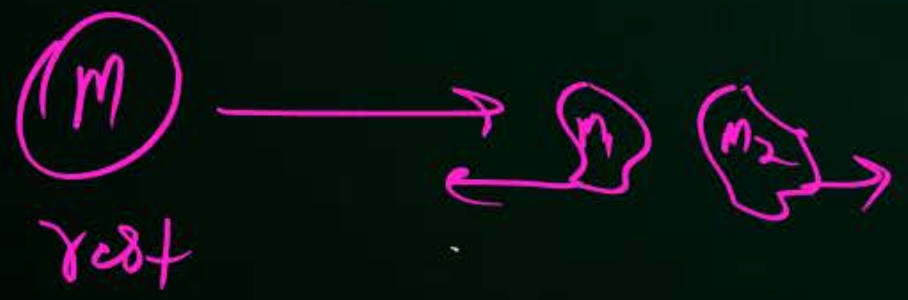
⊗ m_1 & m_2 have same mass then its it's speed will be same

if unequal mass then lower mass have larger velocity

QUESTION

A body at rest explodes into two pieces of unequal mass. The part will move

1. Arbitrarily
2. In the same direction
3. In opposite direction with equal speeds
4. In opposite direction with unequal speeds



QUESTION

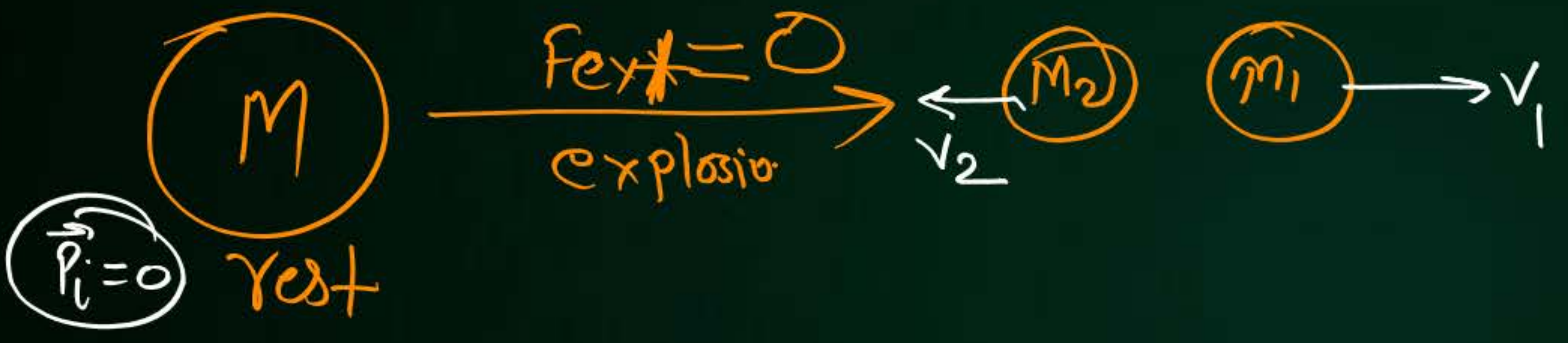
A body falling vertically downwards under gravity breaks in two parts of unequal masses. The center of mass of the two parts together.

1. Shifts horizontally towards heavier piece
2. Shifts horizontally towards light pieces
3. Doesn't shift horizontally
4. Shifts horizontally if initial speed is zero.



QUESTION

A stationary particle explode into two part in mass m_1 and m_2, then find the ratio of their kinetic energies.



$$\vec{P}_i = \vec{P}_f$$

$$0 = m_1\vec{v}_1 + m_2\vec{v}_2$$

$$m_1\vec{v}_1 = -m_2\vec{v}_2$$

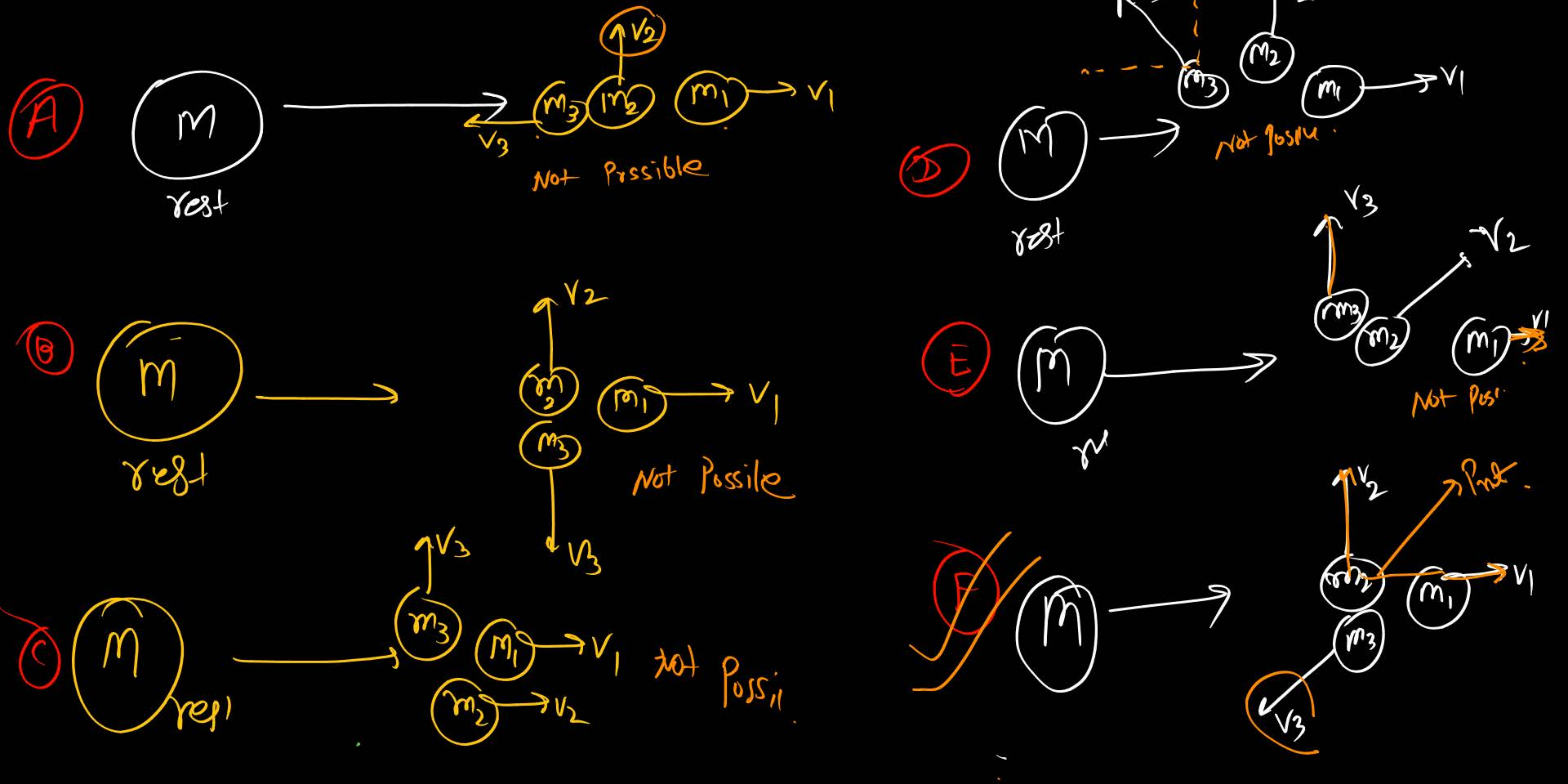
$\vec{P}_1 = -\vec{P}_2 \longrightarrow$ equal magnitude of momentum but opposite dirⁿ.

$$\frac{K.E_1 = \frac{P_1^2}{2m_1}}{K.E_2 = \frac{P_2^2}{2m_2}}$$

$$\frac{K.E_1}{K.E_2} = \frac{m_2}{m_1}$$

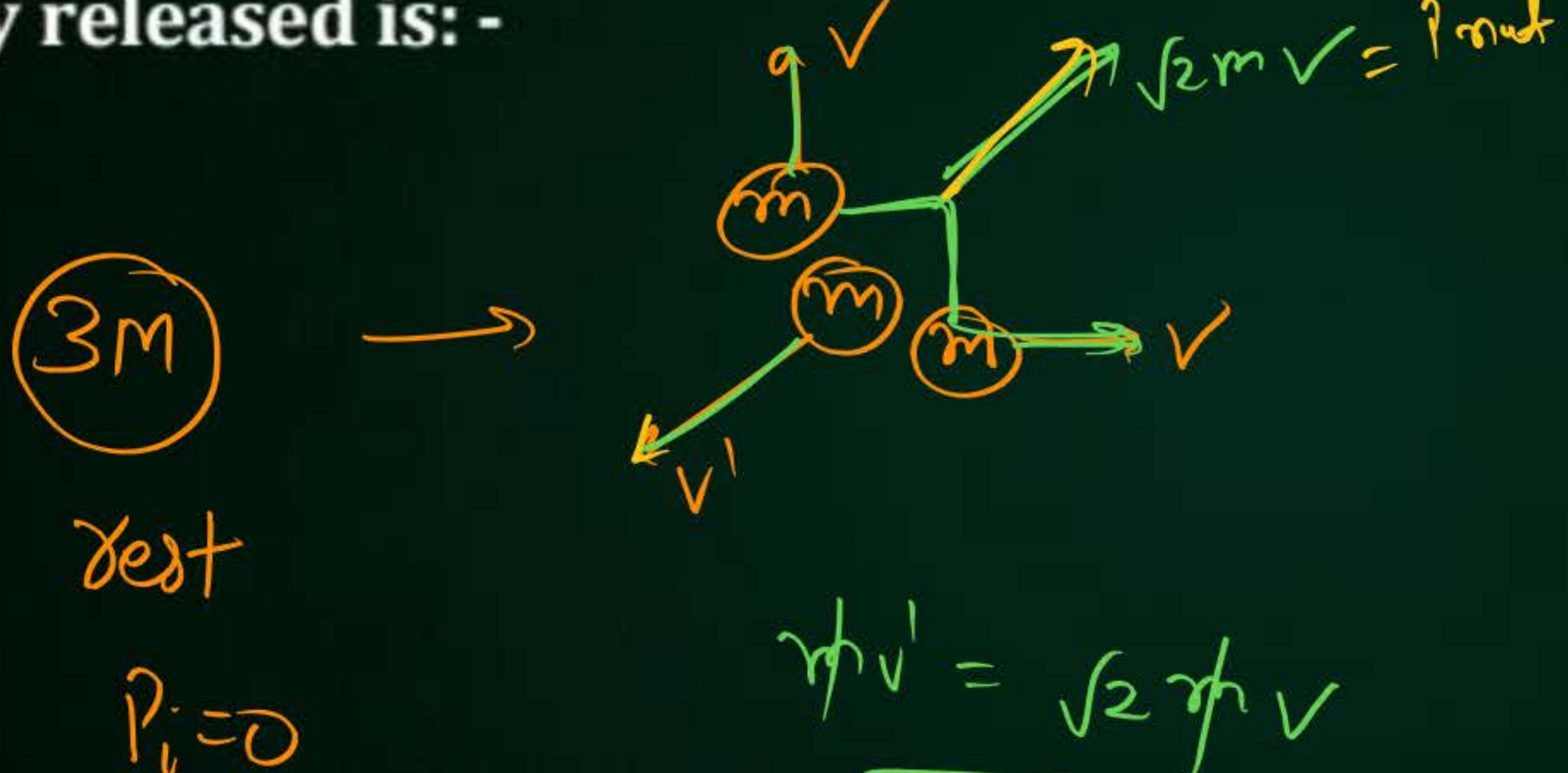
Work done by inter force $= \Delta K.E = \frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2$ *

If Breaks into 3-Part :-



QUESTION

A body of mass 3m at rest explodes into three-identical pieces. Two of the pieces move with a speed v each in mutually perpendicular directions. The total kinetic energy released is: -



$mv' = \sqrt{2}mv$

$v' = \sqrt{2}v$

$K.E_{Total} = \frac{1}{2}mv^2 + \frac{1}{2}mv^2 + \frac{1}{2}m\,2v^2$

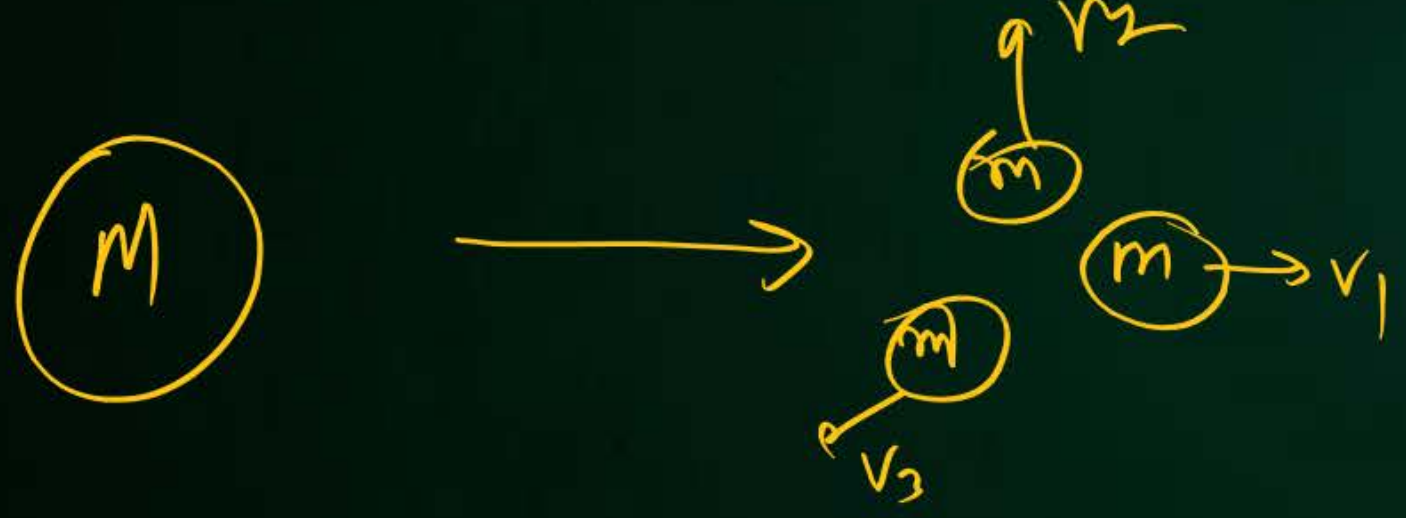
$= \frac{1}{2}m(4v^2)$

$= 2mv^2$

Ans

QUESTION

A bomb initially at rest explodes by itself into three equal mass fragments. The velocities of two fragments are $(2\hat{i} + 3\hat{j})$ m/s and $(\hat{i} - 2\hat{j})$ m/s. The velocity of the third fragment is (in m/s) :-



$$\vec{P}_1 + \vec{P}_2 + \vec{P}_3 = 0$$

$$\vec{V}_1 + \vec{V}_2 + \vec{V}_3 = 0$$

QUESTION

A bomb of mass 30 kg at rest explode into two parts of mass 18 kg and 12 kg. The velocity of the part of 18 kg is 6 m/s then KE of other mass is..?? **[AIPMT-2015]**

30 kg ⇒ 6 m/s ← 18 kg · 12 kg → v

$P_i = 0$

K.E = ??

$18 \times 6 = 12\,v$

$v = 9$

$K.E = \frac{1}{2} \times 12 \times (9)^2$

$= 6 \times 81$

$= 486\ J$

Concept

$K.E = \frac{(18\times 6)^2}{2\times 12} = \frac{p^2}{2m}$

$= \frac{18 \times 18 \times 6 \times 6}{2 \times 12}$

$= 9 \times 54$

$= 486\ J$

QUESTION

A bomb of mass 12 kg explodes into two pieces of 4 kg and 8 kg. The velocity of 4 kg piece is 24 m/s. The kinetic energy of 8 kg piece is :-

1. 192 J
2. 786 J
3. 576 J
4. 687 J

QUESTION

A bomb of mass $m = 1$ kg thrown vertically upwards with a speed $u = 100$ m/s explodes into two parts after $t = 5$s. A fragment of mass $m_1 = 400$ g moves downwards with a speed $v_1 = 25$ m/s, then speed v_2 and direction of another mass m_2 will be :-

1. 40 m/s downwards
2. 40 m/s upwards
3. 60 m/s upwards
4. 100 m/s upwards

QUESTION

A 1 kg stationary bomb is exploded in three parts having mass ratio 4 : 4 : 7. Parts having same mass move in perpendicular directions with velocity 70 m/s, then the velocity of bigger part will be :-

1. $40\sqrt{2}$ m/s
2. $40/\sqrt{2}$ m/s
3. $20\sqrt{2}$ m/s
4. $20/\sqrt{2}$ m/s


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 4 | Physics

Centre of mass and System of Particles, Collision

By- Dr. Manish Raj (MR SIR)



Topic To Be Covered

1. # Question on explosion & C.O.M
2. #
3. #
4. #



QUESTION

A man of 50 kg mass is standing in a gravity free space at a height of 10 m above the floor. He throws a stone of 0.5 kg mass downwards with a speed 2 m/s. When the stone reaches the floor, the distance of the man above the floor will be [NEET]

1. 9.9 m
2. 10.1 m
3. 10 m
4. 20 m

$F_{ext\ system} = 0 \rightarrow$ C.O.M will not shift

(Moment of Mass man ka shift) = (Moment of Mass Ball ka shift)

$(50\,kg\ x) = \left(\frac{5}{10} \times 10\right)$

$\left(x = \frac{1}{10} = 0.1\,m\right)$

मजदूरी



$F_{ext\,(man+Ball)} = 0$

$\vec{P_i} = 0$

$\vec{P_f} = 0$

$m\vec{v}_{man} = m_B \vec{v}_B$ (down)

$50 \times v_m = \frac{5}{10} \times 2 = 1$

$v_{man} = \frac{1}{50}$ m/s

$t = \frac{10}{2} = 5$ sec

$\therefore dist^n_{man} = v_M \times t = \frac{1}{50} \times 5 = \frac{1}{10} = 0.1\,m$

QUESTION

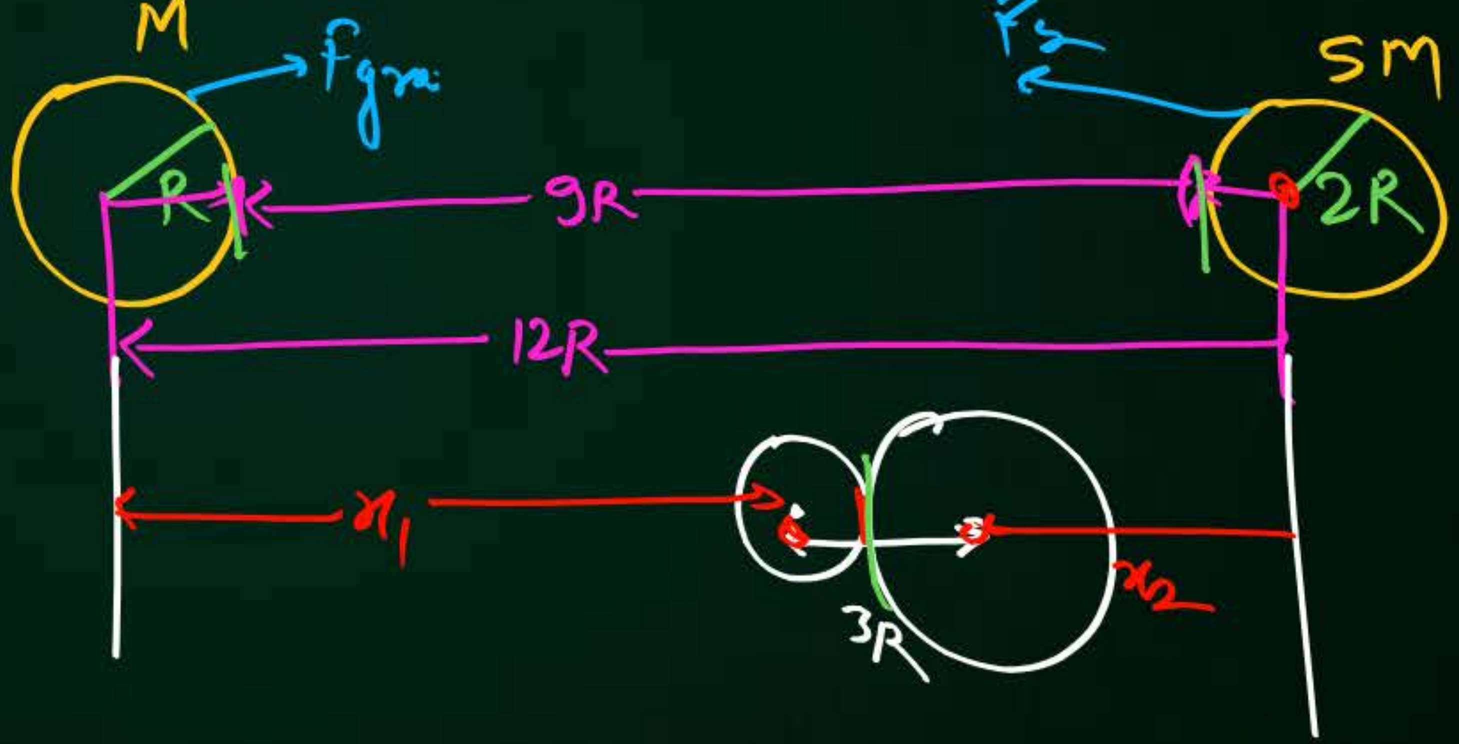
Two spherical bodies of mass M and 5 M and radii R and 2R respectively are released in free space with initial separation between their centers equal to 12 R. If they attract each other due to gravitational force only, then the distance covered by the smaller body just before collision is **[NEET]**

(1) 1.5 R

(2) 2.5 R

(3) 4.5 R

(4) 7.5 R



$x_1 + x_2 = 9R$

C.O.M will not shift

$Mx_1 = 5M \times x_2$

$x_1 = 5x_2$

$x_1 + \frac{x_1}{5} = 9R$

$\frac{6x_1}{5} = 9R \qquad x_1 = \frac{15}{2}R = 7.5R$

QUESTION

A bomb of mass 12 kg explodes into two pieces of 4 kg and 8 kg. The velocity of 4 kg piece is 24 m/s. The kinetic energy of 8 kg piece is :-

1. 192 J
2. 786 J
3. 576 J
4. 687 J

12 Kg → 4 Kg + 8 Kg

rest

V = 24 m/s

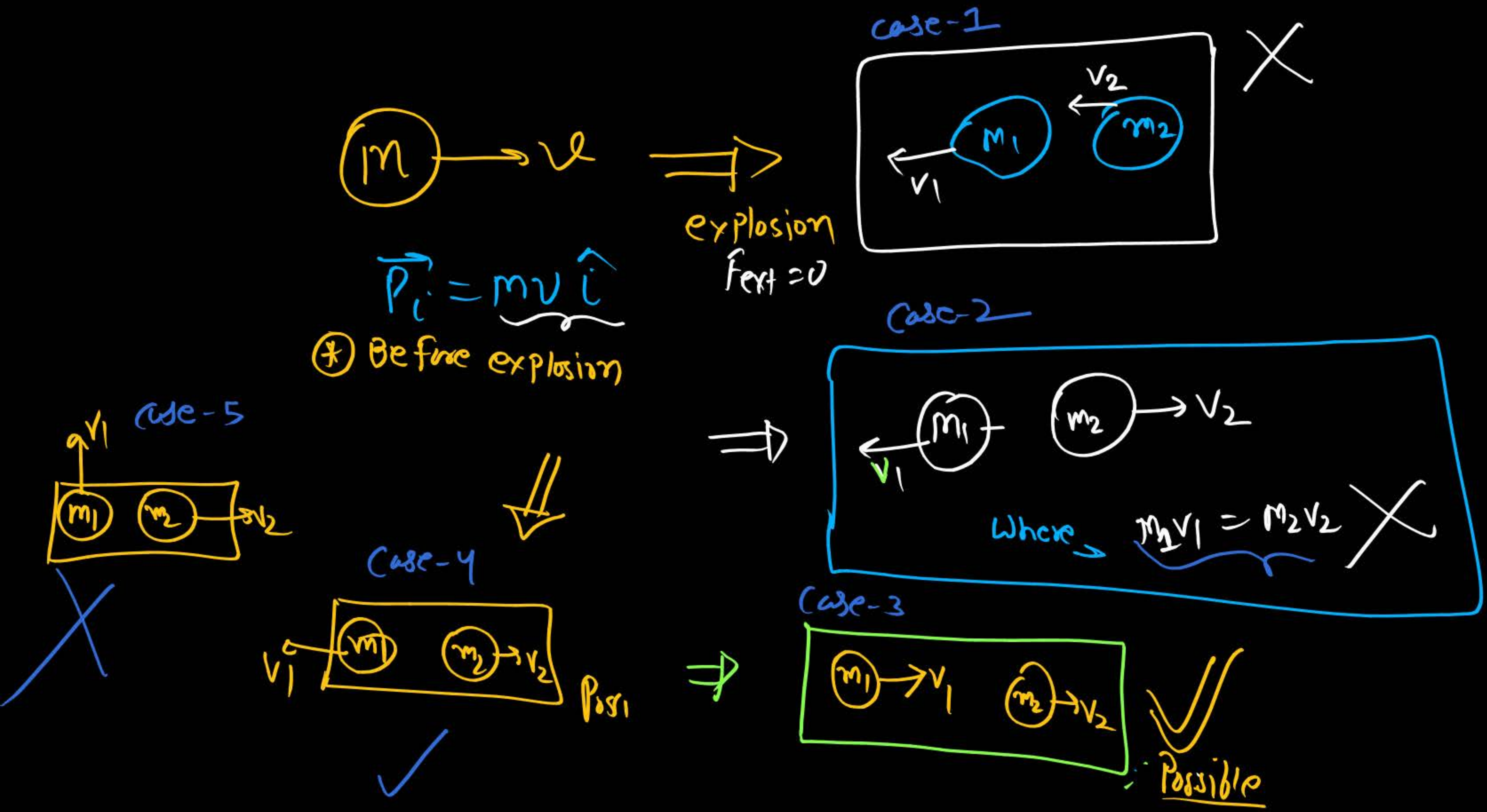
$(K.E)_{8kg} = \frac{p^2}{2 \times m} = \frac{(24 \times 4)^2}{2 \times 8}$

$= \frac{24 \times 24 \times 4 \times 4}{2 \times 8}$

=

25 × 25 = 625

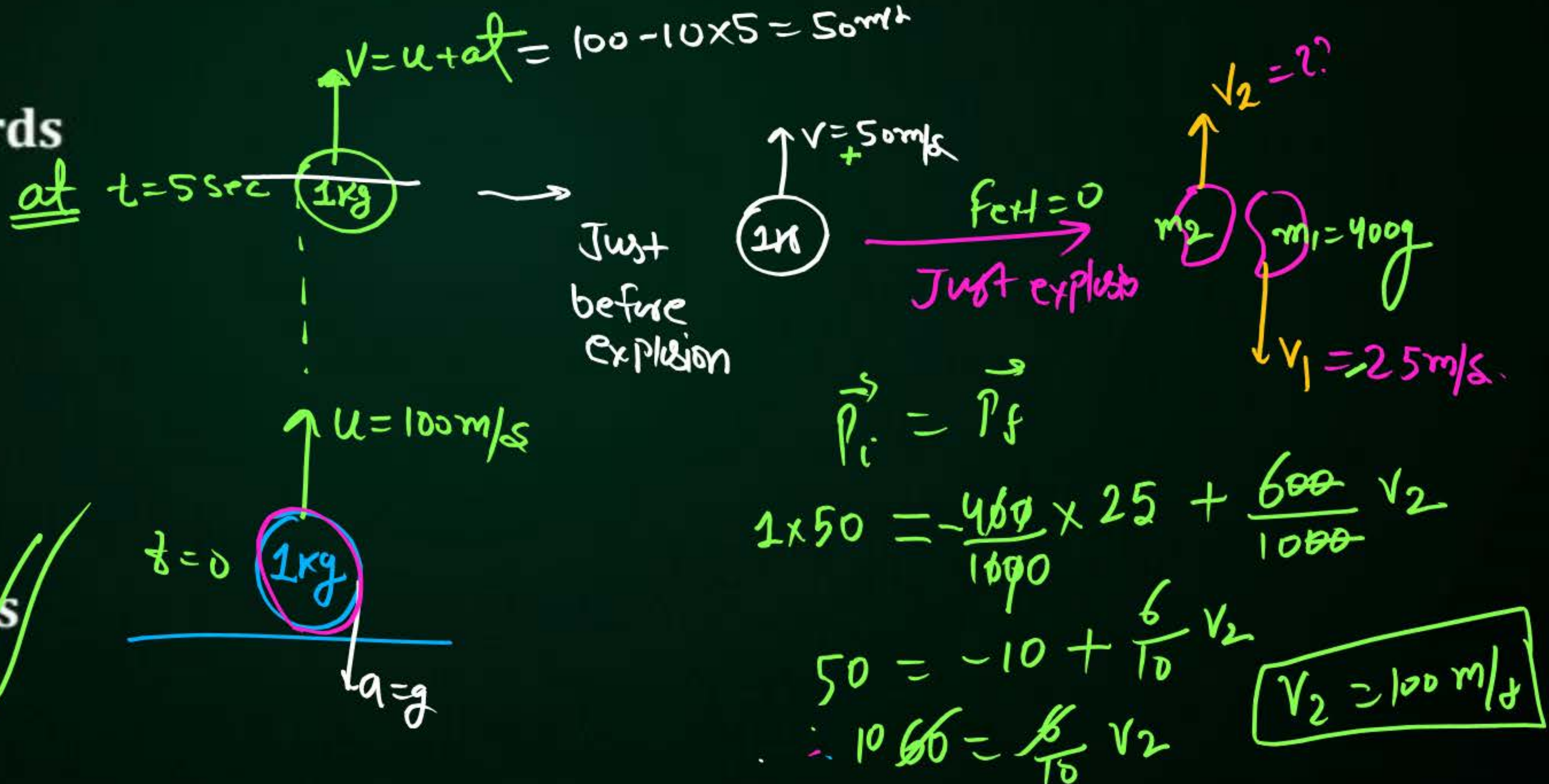
explosion of moving object



QUESTION

A bomb of mass $m = 1$ kg thrown vertically upwards with a speed $u = 100$ m/s explodes into two parts after $t = 5$s. A fragment of mass $m_1 = 400$ g moves downwards with a speed $v_1 = 25$ m/s, then speed v_2 and direction of another mass m_2 will be :-

1. 40 m/s downwards
2. 40 m/s upwards
3. 60 m/s upwards
4. 100 m/s upwards



QUESTION

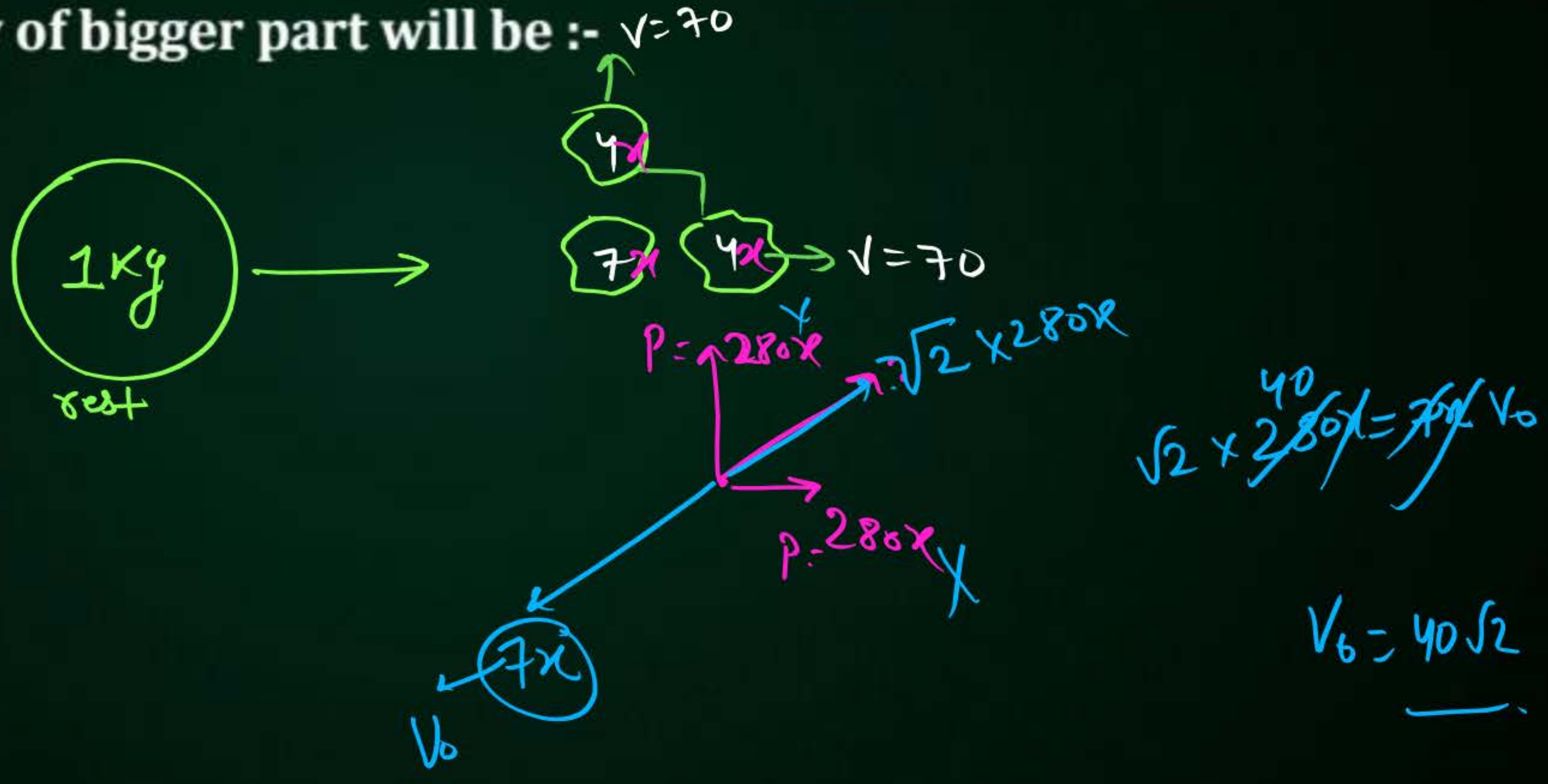
A 1 kg stationary bomb is exploded in three parts having mass ratio 4 : 4 : 7. Parts having same mass move in perpendicular directions with velocity 70 m/s, then the velocity of bigger part will be :-

(1) $40\sqrt{2}$ m/s

(2) $40/\sqrt{2}$ m/s

(3) $20\sqrt{2}$ m/s

(4) $20/\sqrt{2}$ m/s



QUESTION

A cannon ball is fired with a velocity 200 m/s at an angle of 60° with the horizontal. At the highest point of its flight, it explodes into 3 equal fragments, one going vertically upwards with a velocity 100 m/s, the second one falling vertically downwards with a velocity 100 m/s. The third fragment will be moving with a velocity ;

1. 100 m/s in the horizontal direction
2. 300 m/s in the horizontal direction
3. 300 m/s in a direction making an angle of 60° with the horizontal
4. 200 m/s in a direction making an angle of 60° with the horizontal



QUESTION

A mass of 16 kg moving with a speed of 5 m/s collides with another stationary mass of 4 kg. As a result of the collision, the two masses stick together. The kinetic energy of the composite mass will be: -

1. 200 J
2. 160 J
3. 320 J
4. 128 J



$$\vec{P}_i = \vec{P}_f$$

$$16 \times 5 + 4 \times 0 = 20 v_0$$

$$80 = 20 v_0$$

$$K.E = \frac{1}{2} \times 20 \times (4)^2$$

$$= 160 \text{ J}$$

QUESTION

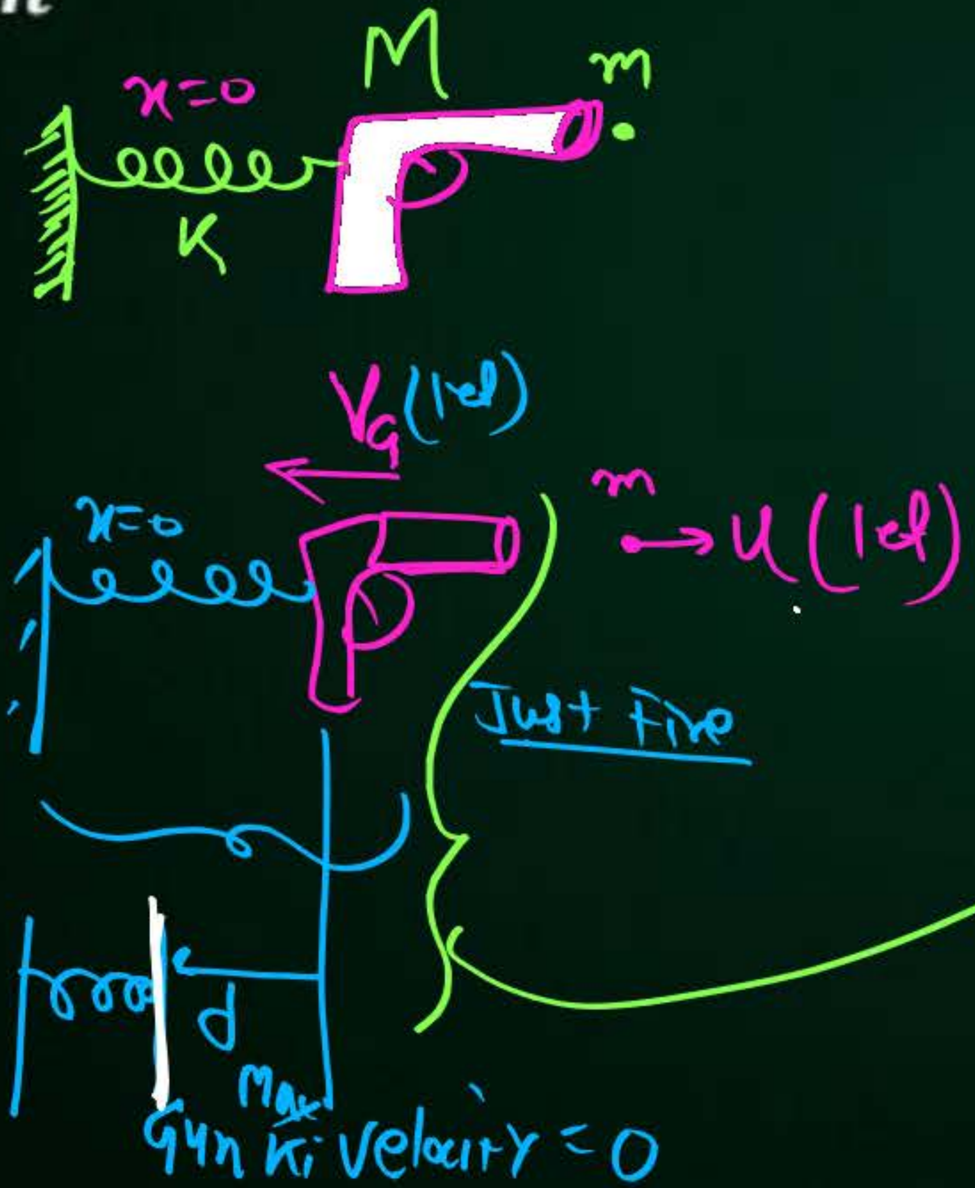
A bullet of mass m is fired from a gun of mass M. The recoiling gun compresses a spring of force constant k by a distance d. Then the velocity of the bullet is :-

(1) $kd\sqrt{M/m}$

(2) $\frac{d}{M}\sqrt{km}$

(3) $\frac{d}{m}\sqrt{kM}$ ✓

(4) $\frac{kM}{m}\sqrt{d}$



COM.E

$$\frac{1}{2}MV_g^2 + 0 = 0 + \frac{1}{2}Kd^2$$

K.E gun

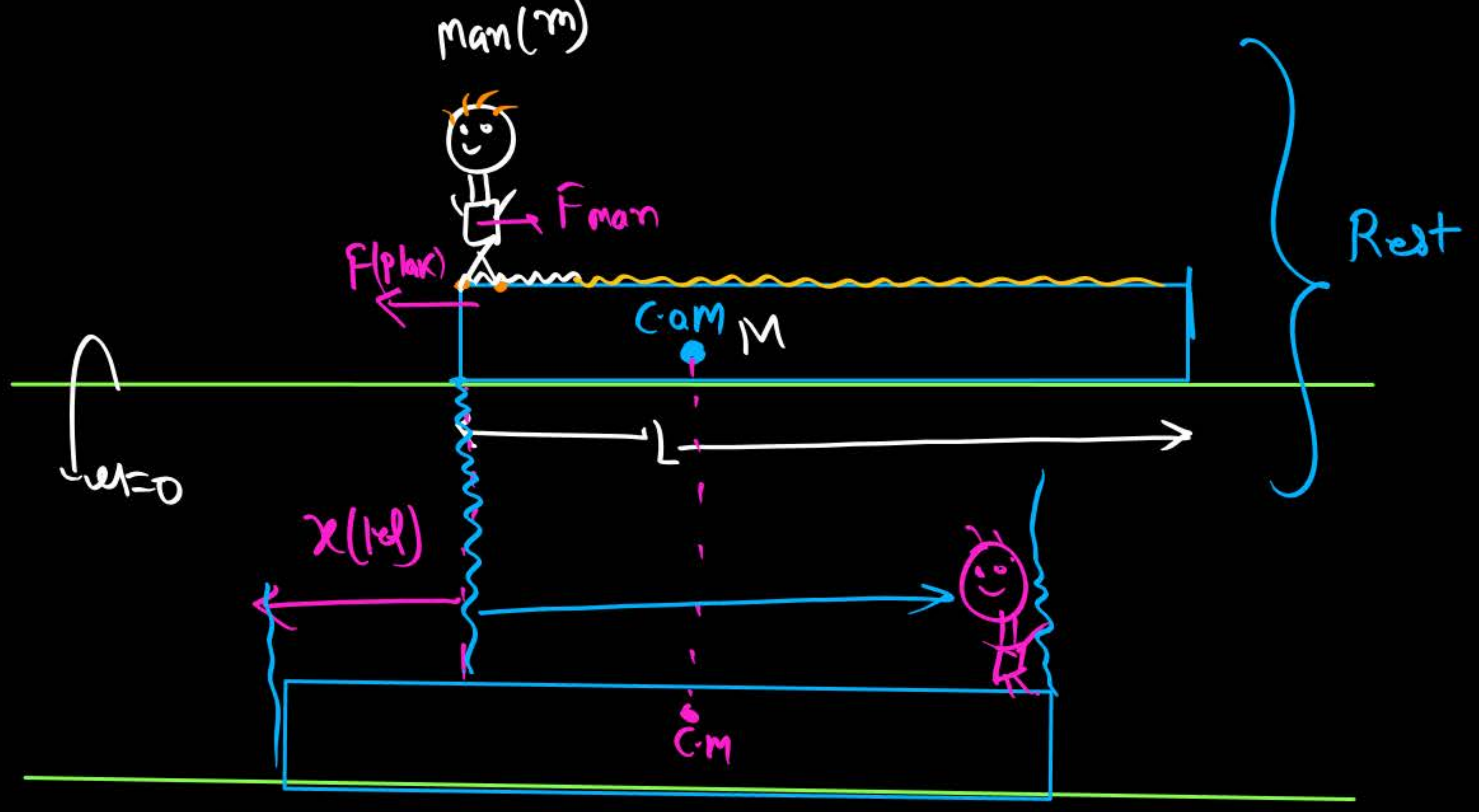
$$V_g^2 = \frac{Kd^2}{M} \quad \text{--- (1)}$$

$$M\vec{V_g} = mu_B$$

$$M\sqrt{\frac{Kd^2}{M}} = mu_B$$

$$u_B = \frac{M}{m}\sqrt{\frac{Kd^2}{M}}$$

$$u_{Bullet} = \frac{d}{m}\sqrt{MK}$$



When man walk on a plank. then force on plank is backward & force on man is forward but these are internal force

$F_{ext}(man + plank) = 0$

hence man will shift his position, plank will shift but C.o.M of system will not shift his position

$\Delta x_{c.o.m} = 0$

(Shif in moment of mass of Plank) = (Shift in Moment of Mass of man)

$Mx = (L-x)m$

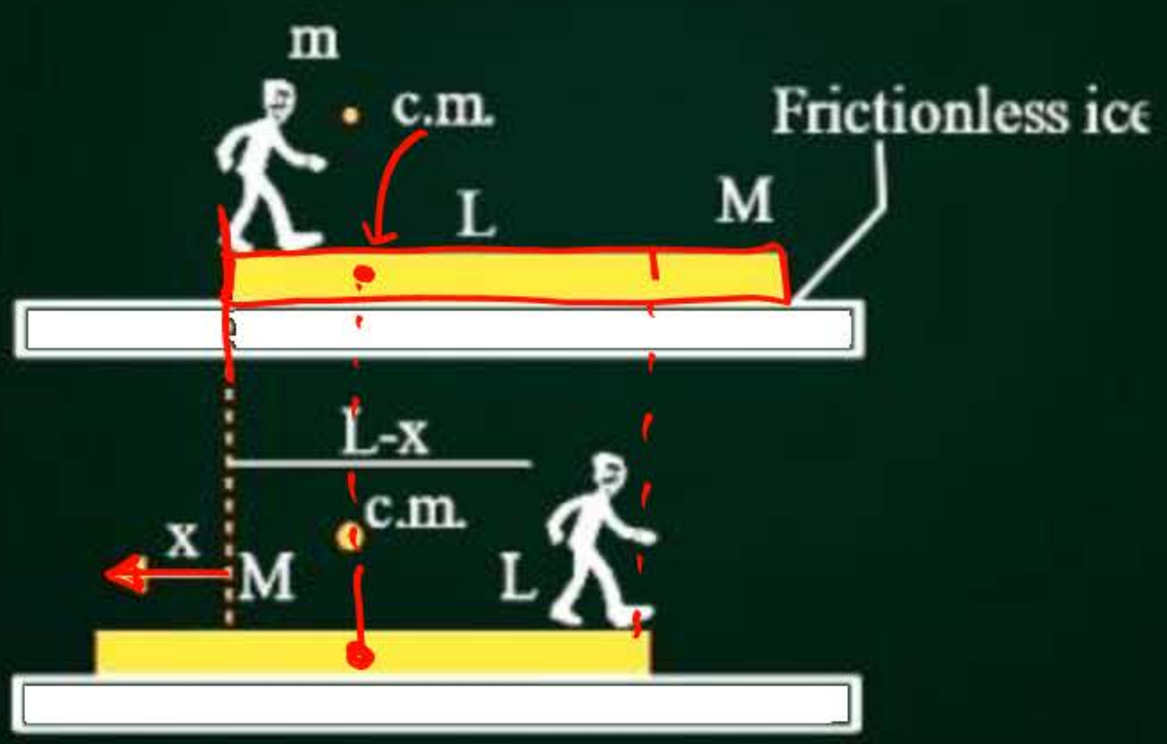
$Mx = mL - mx$

$x(M+m) = mL$

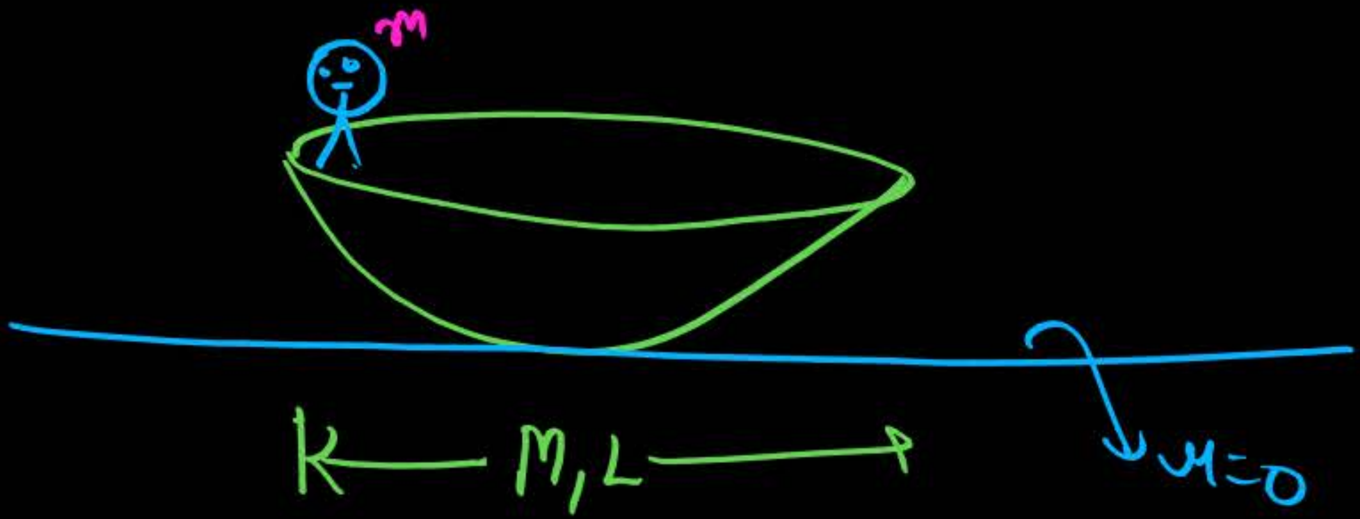
$x = \dfrac{mL}{M+m}$ Ans

QUESTION

A man of mass m stand at the left end of a uniform plank of length L and mass M, which lies on a frictionless surface of ice. If the man walks to the other end of the plank, then by what distance does the plank slide on the ice?

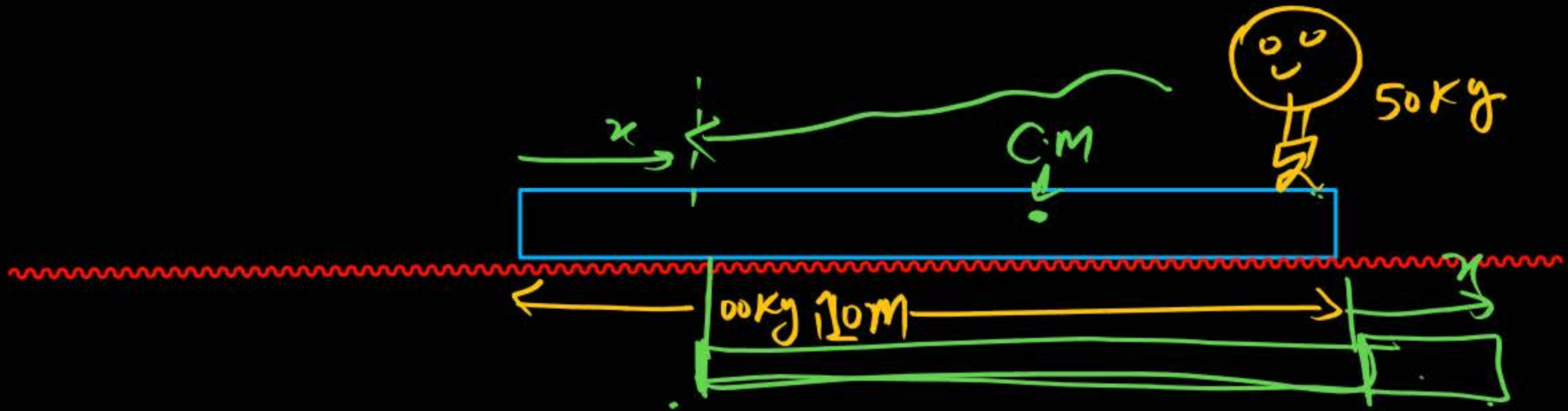






When man moves from one edge to other then find dist^n moved by C.O.M of system of (man + plank)

$$\Delta x_{C.O.M.} = 0$$



When man moves one edge to other then distⁿ moved by Plank ??

$$100(x) = 50(10-x)$$

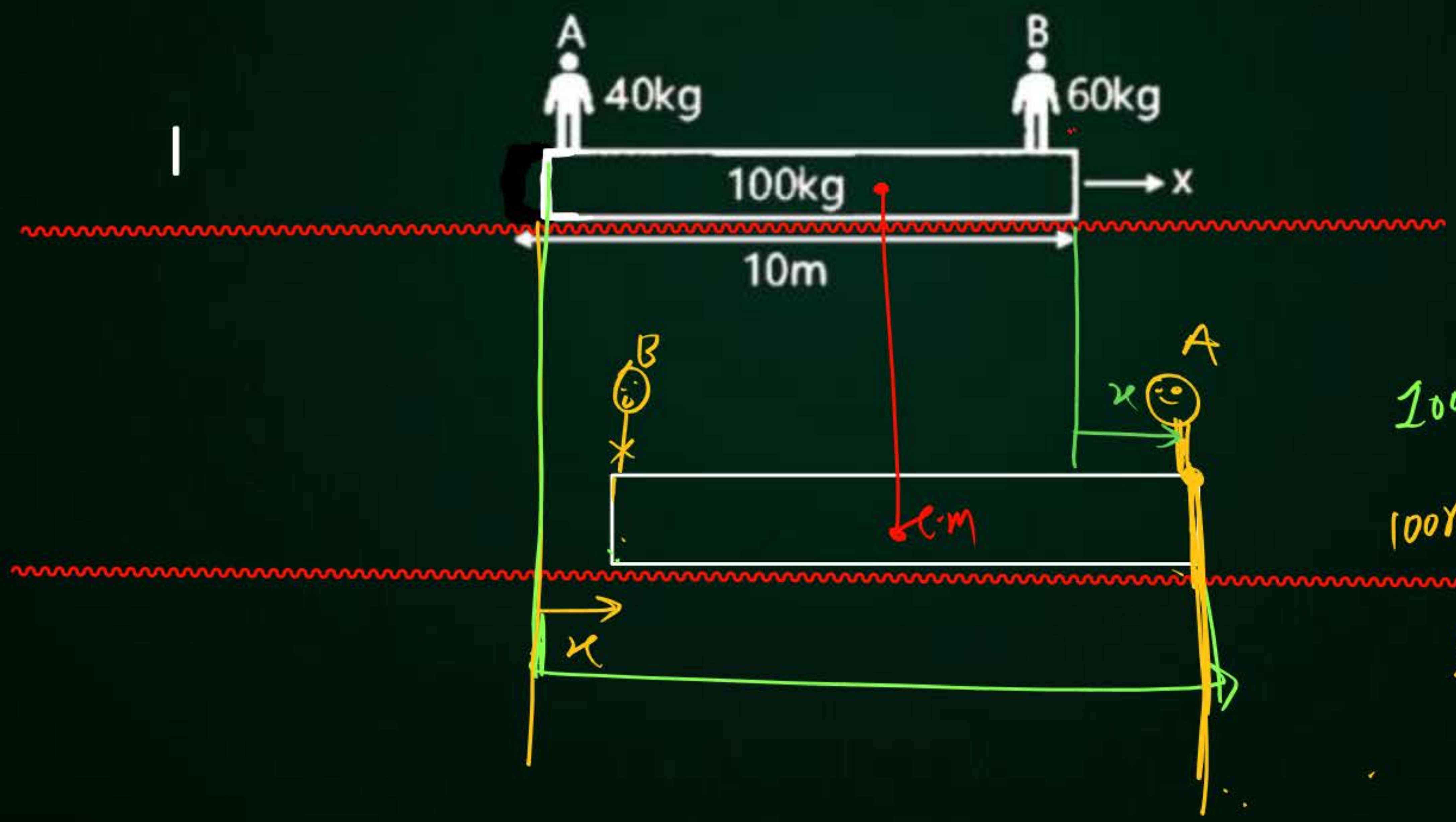
$$100x = 500 - 50x$$

$$150x = 500$$

$$x = \frac{500}{150}$$

QUESTION

Two persons A & B are standing on a plank as shown in figure. If A & B exchange their position find displacement of the plank.



(Shift in moment of mass)$_{+ve}$ = (Shift in moment of mass)$_{-ve}$

$$100x + 40(10+x) = 60(10-x)$$

$$100x + 400 + 40x = 600 - 60x$$

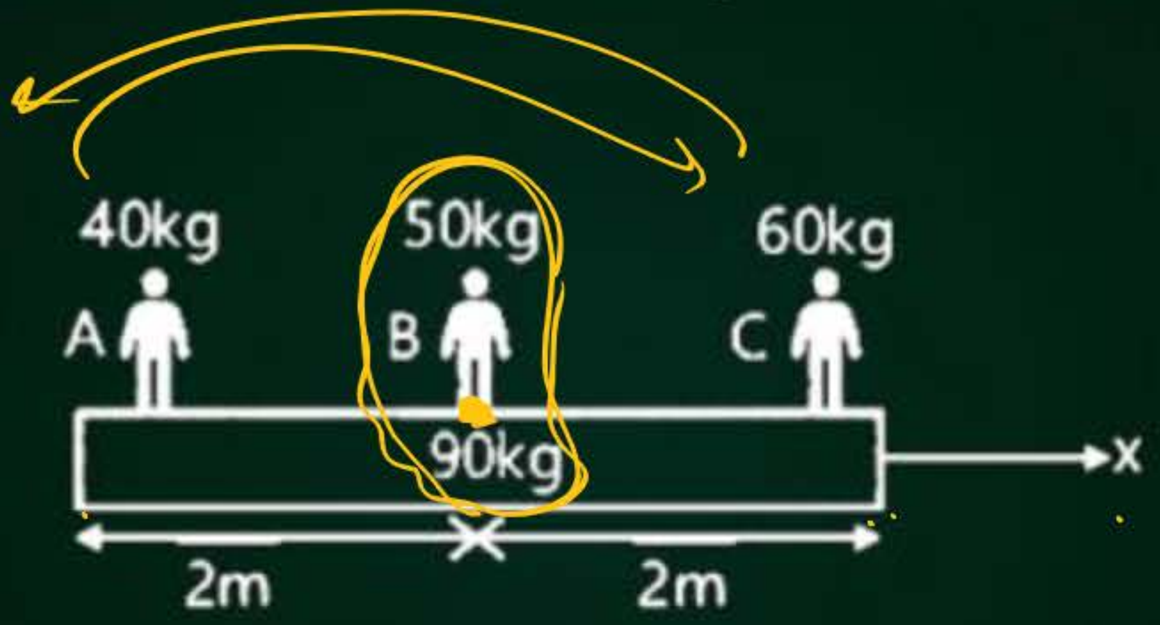
$$200x = 600 - 400$$

$$200x = 200$$

$$(x = 1\,m)$$

QUESTION

Three-man A, B, & C of masses 40 kg, 50 kg, 60 kg are standing on a plank of mass 90 kg. Which is kept on a smooth horizontal plane. If A & C exchange, their position then mass B will shift.




THANK YOU

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FOR NEET 2025

Lecture-5 | **Physics**

Centre of mass and System of Particles, Collision

By- Dr. Manish Raj (MR SIR)



Topics to be covered

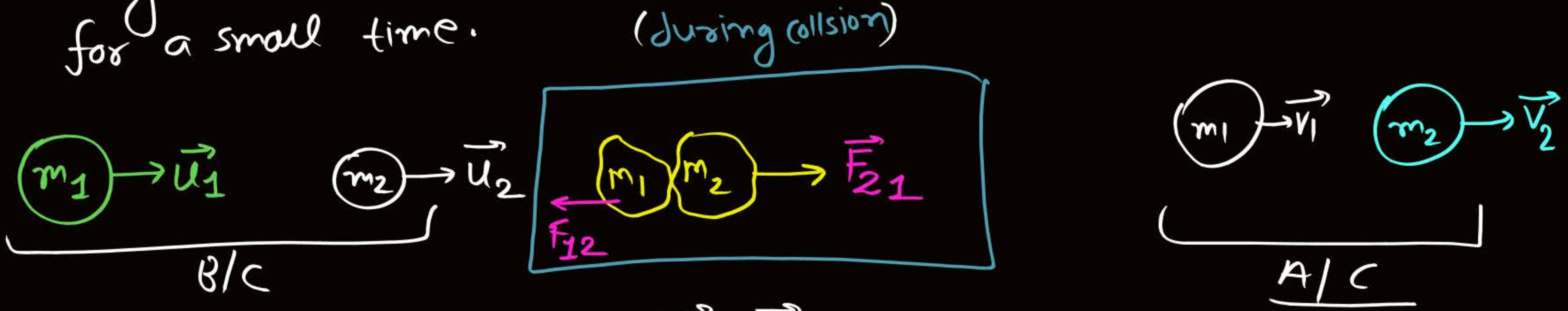
1. # feel of collsion

   टक्कर

2. #
3. #
4. #



Collision is an intraction B/w two or more than two body in which external force on the system is zero. but large amount Of internal force acts b/w them. for a small time.



relative velocity of apprach $= \vec{u}_1 - \vec{u}_2$

relative velocity of sepration $= \vec{v}_2 - \vec{v}_1$

e = coefficient of restitution = $\dfrac{\text{Relative velocity of sep}^n}{\text{Relative velocity of approach}} = \dfrac{\vec{v}_2 - \vec{v}_1}{\vec{u}_1 - \vec{u}_2}$

- elastic collsion $(e=1)$
- Perfectly inelastic $(e=0)$

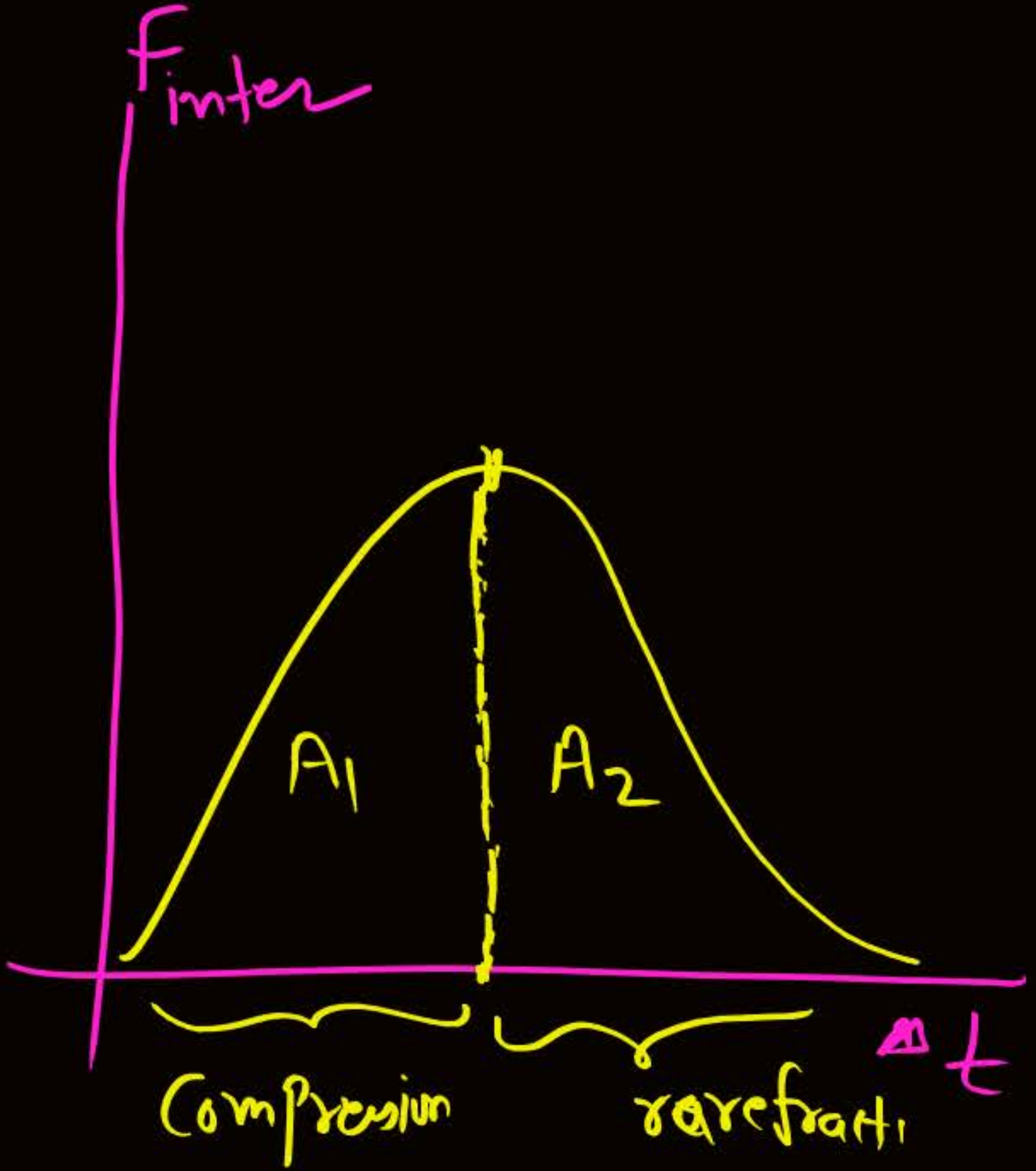
→ Inelastic collsion $(0<e<1)$

- In collsion momentum of m_1 is consered → (a) Yes (63%) / (b) NO (35%)

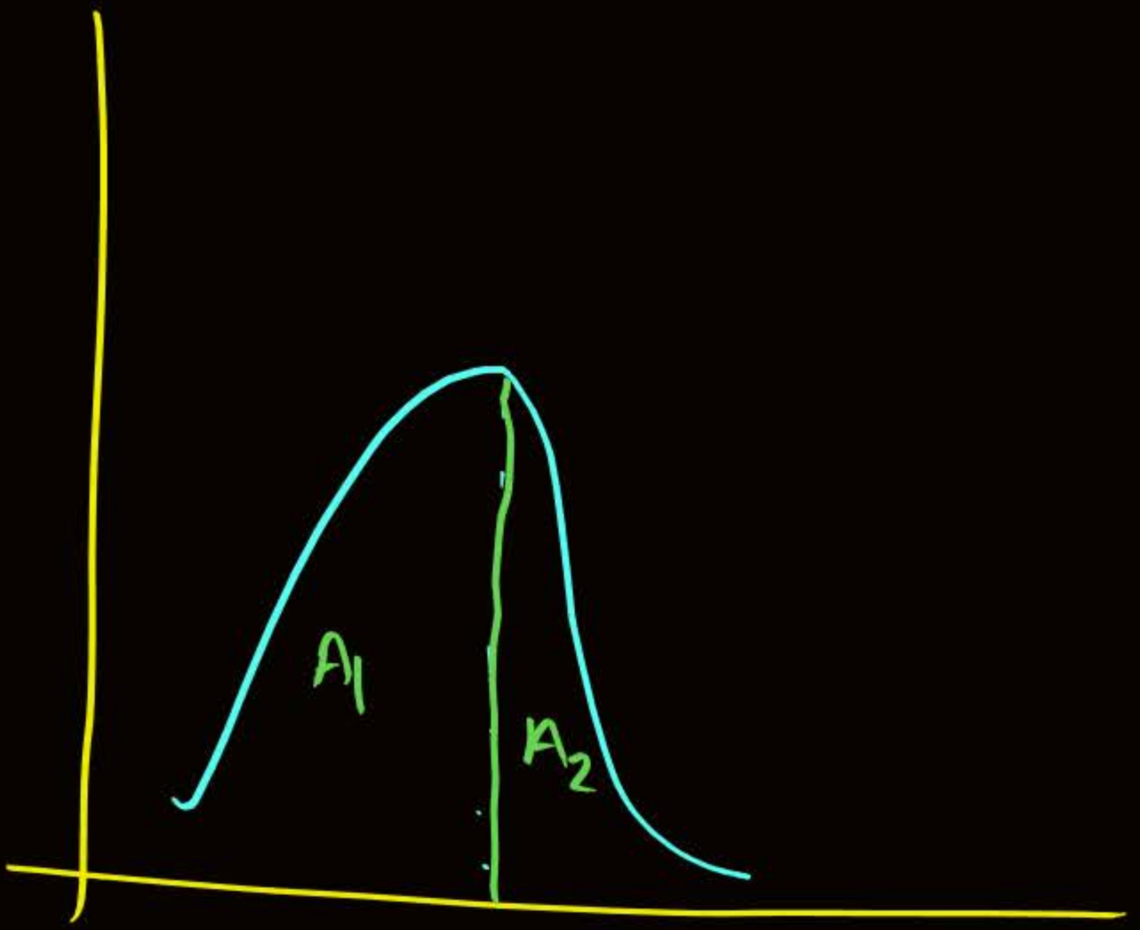
- In every collsion momentum of system (m_1+m_2) is conserved → correct

- K.E. is conserved in elastic collision → No, Not at all

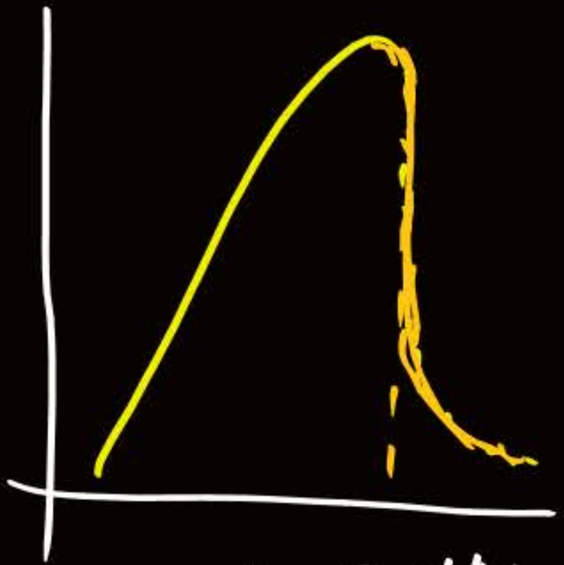
↳ $[(K.E)_{B/C} = (K.E)_{A/C}]$ elastic collsion. → during collsion K.E is converted into potential energy in every collsion Including elastic.



elastic collision



Inelastic



Perfectly inelastic

elastic collision

$$e = 1 = \frac{\vec{v}_2 - \vec{v}_1}{\vec{u}_1 - \vec{u}_2} = -\frac{(\vec{v}_2 - \vec{v}_1)}{(\vec{u}_2 - \vec{u}_1)} = -\frac{(\vec{v}_1 - \vec{v}_2)}{(\vec{u}_1 - \vec{u}_2)}$$

#

$$e = \frac{\text{Relative Velocity of sep}^n}{\text{Relative velocity of approach}}$$

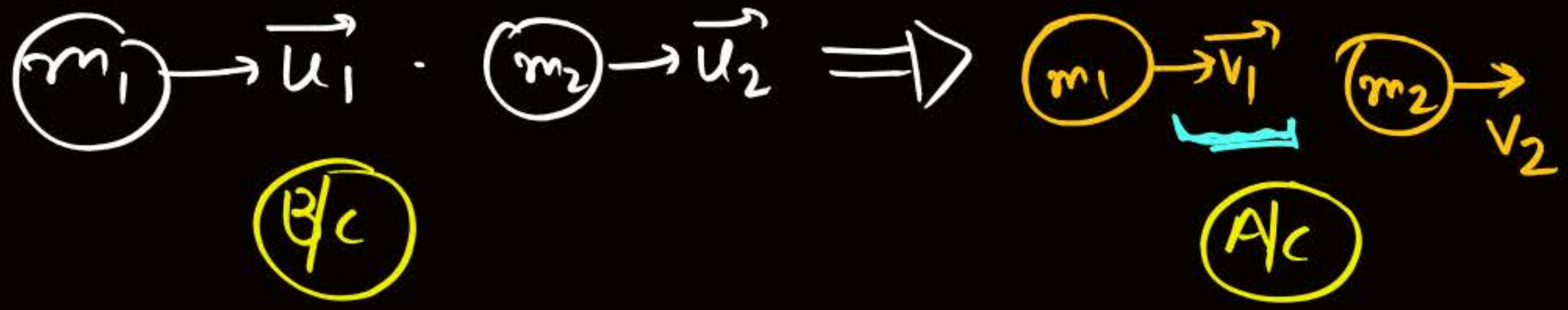
#



#

$$e = \frac{\vec{v}_2 - \vec{v}_1}{\vec{u}_1 + \vec{u}_2}$$

elastic collision



$e = 1 = \dfrac{\vec{v_2}-\vec{v_1}}{\vec{u_1}-\vec{u_2}}$ — (1)

$\vec{u_1}-\vec{u_2}+\vec{v_1} = \vec{v_2}$

$m_1\vec{u_1}+m_2\vec{u_2} = m_1\vec{v_1}+m_2\vec{v_2}$ — (II)

↳ momentum conservation

Puting value of v_2 from eqn (1) into (II)

$$m_1\vec{u_1}+m_2\vec{u_2} = m_1\vec{v_1}+m_2(\vec{u_1}-\vec{u_2}+\vec{v_1})$$

$$m_1\vec{u_1}+m_2\vec{u_2} = \vec{v_1}(m_1+m_2)+m_2(\vec{u_1}-\vec{u_2})$$

$$\vec{v_1}(m_1+m_2) = \vec{u_1}(m_1-m_2) + 2m_2\vec{u_2}$$

$$\vec{v_1} = \frac{(m_1-m_2)}{(m_1+m_2)}\vec{u_1} + \frac{2m_2\vec{u_2}}{(m_1+m_2)}$$

dimension check.

logically correct

* $\vec{V_1} = \frac{(m_1 - m_2)}{(m_1 + m_2)}\vec{u_1} + \frac{2m_2}{(m_1+m_2)}\vec{u_2}$

→ velocity of 1st object after Collsion

$$\vec{V_2} = \frac{(m_2 - m_1)\vec{u_2}}{(m_1+m_2)} + \frac{2m_1 \vec{u_1}}{(m_1+m_2)}$$

$$\left\{ \begin{aligned} \vec{V_1} &= \frac{(m_1 - m_2)}{(m_1 + m_2)} \vec{u_1} + \frac{2 m_2}{(m_1 + m_2)} \vec{u_2} \\ \vec{V_2} &= \frac{(m_2 - m_1)}{m_1 + m_2} \vec{u_2} + \frac{2 m_1}{m_1 + m_2} \vec{u_1} \end{aligned} \right\}$$

Perfectly Inelastic

$(e = 0)$ $\quad \vec{V_2} = \vec{v_1} = V$ साथ-साथ

$m_1 \rightarrow \vec{u_1}$ $\quad m_2 \rightarrow \vec{u_2}$ $\longrightarrow$ $(m_1 + m_2) \rightarrow V$ (c.m)

Momentum conserved

$$m_1\vec{u_1} + m_2\vec{u_2} = (m_1 + m_2)\vec{V}$$

Velocity After collision

$$\vec{V} = \frac{m_1\vec{u_1} + m_2\vec{u_2}}{m_1 + m_2}$$

MR* feel

$F_{ext} = 0$

$\vec{u}_{c.m} = \text{const}^n.$

$$\vec{V}_{c.m} = \frac{m_1\vec{u_1} + m_2\vec{v_2}}{m_1 + m_2}$$



elastic Collision (special case $e=1$)

→ p → conserved

→ - - - - -

$(K.E)_{B/C} = (K.E)_{A/C}$

→ $e = 1$

($e=1$)

$$\vec{V_1} = \left(\frac{m_1 - m_2}{m_1+m_2}\right)\vec{u_1} + \frac{2m_2u_2}{m_1+m_2}$$

$\vec{V_2} =$

($e=1$)

Inelastic

$0 < e < 1$

p → conserved

$(K.E)_{A/C} \neq (K.E)_{B/C}$

$$\vec{V_1} = \left(\frac{m_1 - em_2}{m_1+m_2}\right)\vec{u_1} + \frac{(e+1)m_2u_2}{m_1+m_2}$$

$$\vec{V_2} = \left(\frac{m_2 - em_1}{m_1+m_2}\right)u_2 + \frac{(e+1)m_1\vec{u_1}}{m_1+m_2}$$

Perfectly Inelastic (Special case → $e=0$)

$e = 0$

$v_1 = v_2 = V$

($e=0$)

$$V = \frac{m_1\vec{u_1} + (m_2\vec{u_2})}{m_1+m_2}$$

$(K.E)_{B/C} \neq (K.E)_{A/C}$

($e=0$)

COLLISION

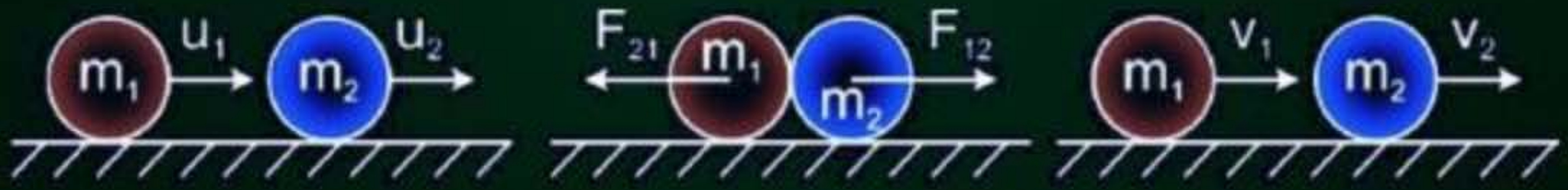
Interaction between two or more than two object in which external force is zero.
Momentum of system will always conserved.

ELASTIC COLLISION

INELASTIC COLLISION

PERFECT INELASTIC COLLISION

- Collision is a interaction in which ext. force is always zero but acts large amount of internal force for a small time.
- Physical contact is not necessary of [collision of α-particle by electrostatics and Nucleus].
- Total energy '*e*' momentum of the system is construed in every type of collision.
- But momentum and energy of a object is not conserved.
- In Elastic collision, K.E. Before collision and after collision remains same.
- at the time of collision K.E. is never conserved but momentum is conserved.



- Rel. velocity of approach = $u_1 - u_2$
- Rel. velocity of zero = $v_2 - v_1$

QUESTION

If collision is perfectly inelastic then find their velocity after collision.



QUESTION

A ball of mass m moving with velocity v collides head-on with the second ball of mass m at rest. If the coefficient of restitution is e and velocity of first ball after collision is v_1 and velocity of second ball after collision is v_2 then

1. $v_1 = \frac{(1-e)u}{2}, v_2 = \frac{(1+e)u}{2}$

2. $v_1 = \frac{(1+e)u}{2}, v_2 = \frac{(1-e)u}{2}$

3. $v_1 = \frac{u}{2}, v_2 = -\frac{u}{2}$

4. $v_1 = (1+e)\,u, v_2 = (1-e)\,u$

QUESTION

A ball of mass 4 kg moving on a smooth horizontal surface makes an elastic collision with another ball of mass m at rest in the line of motion of first ball. If after collision first ball moves in the same direction with one fourth of its velocity collision, then mass of second ball is

1. 4 kg
2. 4.4 kg
3. 2.4 kg
4. 2 kg

QUESTION

A ball of mass M moving with velocity u, suddenly break into two parts of ratio 2 : 3. If smaller comes at rest then find the velocity of other.

ELASTIC COLLISION

Between two object in which moss of one object is very much greater than other.

QUESTION

A heavy vehicle moving with velocity 15 m/s strikes an object of very small mass at rest head on elasticity. Velocity of object after collision is

1. 15 m/s
2. 25 m/s
3. 20 m/s
4. 30 m/s

ELASTIC COLLISION

Between two object in which moss of one object is very much greater than other.

QUESTION

A ball falls from a height such that it strikes the floor of lift at 10 m/s. If lift is moving in the upward direction with a velocity 1 m/s, then velocity with which the ball rebounds after elastic collision will be

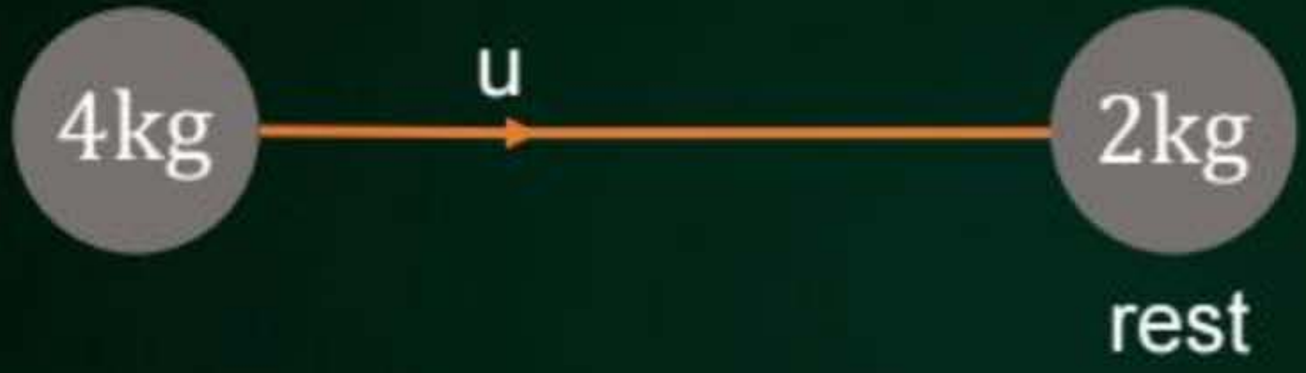
1. 11 m/s
2. 12 m/s
3. 13 m/s
4. 9 m/s

- **Fraction of transferred KE in elastic collision in which 2nd object is at rest.**

QUESTION

If collision is elastic then find fraction of transferred KE from 4 kg to 2 kg.

[NEET-2019]



QUESTION

A proton is moving with velocity u and collide with a nucleus of mass no. A at rest then find fraction of retained KE if collision is elastic. [AIPMT-2013]

QUESTION

A metal ball of mass 2 kg moving with speed of 36 km/h has a head on collision with a stationary ball of mass 3 kg. If after collision, both the balls move together, then the loss in K.E. due to collision is

1. 100 J
2. 140 J
3. 40 J
4. 60 J

HOMEWORK FROM YAKEEN MODULE


PHYSICS WALLAH
37
YEARS (2024-1988)
NEET UG
CHAPTER-WISE & TOPIC-WISE
SOLVED PAPERS
BOOK FEATURE
Updated as per Latest NMC Syllabus
Practice questions for newly added NEET Topics
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37 YEARS
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Chapter-wise & Topic-wise
Solved Questions
Chemistry


THANK YOU

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FOR NEET 2025

Lecture- 06 | Physics

Centre of mass and System of Particles, Collision

By- Dr. Manish Raj (MR SIR)



Topics to be covered

1. # head on collision
   diff^n Type of elastic collision
2. #
3. #
4. #



is physical contact is must for collision → NO (α-Particle scattering)

- ✡ Momentum of system is always at every time is conserved in every collision.
- ✡ Momentum & K.E of any one object is change → Yes in every type of collision.
- ✡ Identify type of collision this will decide soln

• elastic collision

$e = 1 = \dfrac{\vec{v}_2 - \vec{v}_1}{\vec{u}_1 - \vec{u}_2}$

P → conserved

• $m_1\vec{u}_1 + m_2\vec{u}_2 = m_1\vec{v}_1 + m_2\vec{v}_2$

$(K.E)_{B/C} = (K.E)_{A/C}$

• $\frac{1}{2}mu_1^2 + \frac{1}{2}mu_2^2 = \frac{1}{2}mv_1^2 + \frac{1}{2}mv_2^2$

$e=1$

• $\vec{V}_1 = \dfrac{m_1 - m_2}{m_1+m_2}\vec{u}_1 + \dfrac{2m_2}{m_1+m_2}\vec{u}_2$

• $\vec{V}_2 = \dfrac{(m_2 - m_1)\vec{u}_2}{m_1+m_2} + \dfrac{2m_1\vec{u}_1}{m_1+m_2}$

• $(\Delta K.E)_{\text{system loss}} = 0$

Inelastic collision

• $(0 < e < 1)$

• P – conserved.

• $m_1\vec{u}_1 + m_2\vec{u}_2 = m_1\vec{v}_1 + m_2\vec{v}_2$

(K.E is not consered)

$(K.E)_{B/C} \neq (K.E)_{A/C}$

$\vec{V}_1 = \dfrac{(m_1 - em_2)}{m_1+m_2}\vec{u}_1 + \dfrac{(e+1)m_2}{m_1+m_2}\vec{u}_2$

$\vec{V}_2 = \dfrac{(m_2 - em_1)\vec{u}_2}{m_1+m_2} + \dfrac{(e+1)m_1\vec{u}_1}{m_1+m_2}$

$\Delta K.E = \frac{1}{2}\dfrac{m_1m_2}{m_1+m_2}(u_{rel}^2)(1-e^2)$

Perfecty Inelastic collision

• $e = 0$ $(\vec{V}_1 = \vec{V}_2)_{A/C}$

• Both will stick.

$m_1\vec{u}_1 + m_2\vec{u}_2 = (m_1+m_2)V_c$

• $(\vec{V}_c)_{A/C} = \dfrac{m_1\vec{u}_1 + m_2\vec{u}_2}{m_1+m_2}$

$(e=0)$

(K.E is not consred)

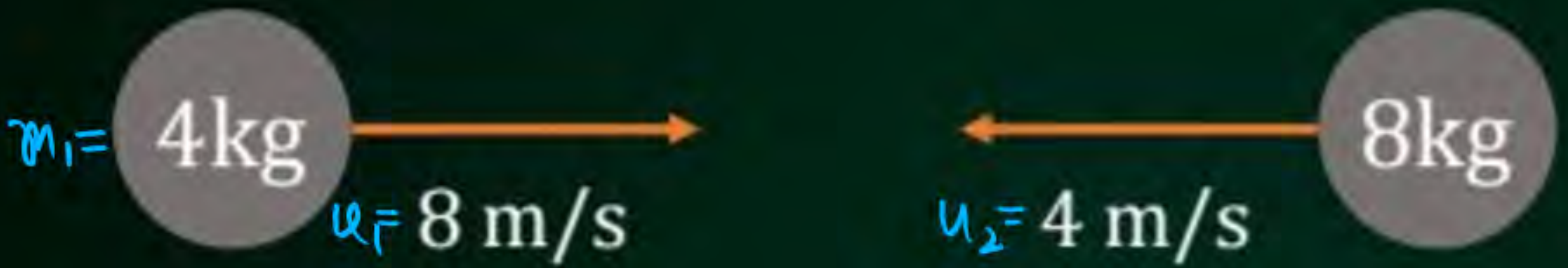
$(\Delta K.E) = \frac{1}{2}\dfrac{m_1m_2}{m_1+m_2}(u_{relative})^2_{B/C}$

$\Delta K.E = \frac{1}{2}\dfrac{m_1m_2}{m_1+m_2}(\vec{u}_1 - \vec{u}_2)^2_{B/C}$

MR Rafta.

QUESTION

If collision is perfectly inelastic then find their velocity after collision.
also find loss in K.E ??



Sol^n

$$\vec{u}_c = \frac{m_1 u_1 + m_2 u_2}{m_1 + m_2}$$

$$= \frac{4 \times 8 + 8 \times 4}{4 + 8}$$

$$= \frac{64}{12} \text{ m/s}$$

$$\vec{V}_c \text{ (After collision)} = \frac{4 \times 8 - 8 \times 4}{4 + 8} = 0$$

$(K.E)_{after\ collision\ system} = 0$

$(K.E)_{initial\ system} = \frac{1}{2} m u_1^2 + \frac{1}{2} m u_2^2 = \frac{1}{2} \times 4 (8)^2 + \frac{1}{2} \times 8 (4)^2 = 128 + 64 = 192\text{ J}$

$$\Delta K.E = \frac{1}{2} \frac{m_1 m_2}{m_1 + m_2} u_{rel}^2 = \frac{1}{2} \times \frac{8 \times 4}{8 + 4} (8 + 4)^2$$

$$= \frac{1}{2} \frac{32}{12} \times 12 \times 12$$

$$= 192\text{ J}$$

QUESTION

A ball of mass m moving with velocity v collides head-on with the second ball of mass m at rest. If the coefficient of restitution is e and velocity of first ball after collision is v_1 and velocity of second ball after collision is v_2 then

1. $v_1 = \frac{(1-e)u}{2}, v_2 = \frac{(1+e)u}{2}$
2. $v_1 = \frac{(1+e)u}{2}, v_2 = \frac{(1-e)u}{2}$
3. $v_1 = \frac{u}{2}, v_2 = -\frac{u}{2}$
4. $v_1 = (1+e)\,u, v_2 = (1-e)\,u$

QUESTION

A ball of mass 4 kg moving on a smooth horizontal surface makes an elastic collision with another ball of mass m at rest in the line of motion of first ball. If after collision first ball moves in the same direction with one fourth of its velocity collision, then mass of second ball is



1. 4 kg
2. 4.4 kg
3. 2.4 kg
4. 2 kg

QUESTION

A ball of mass M moving with velocity u, suddenly break into two parts of ratio 2 : 3. If smaller comes at rest then find the velocity of other.

$m_1 : m_2 = 2 : 3$



$\frac{m_1}{m_2} = \frac{2x}{3x}$

$m_1 + m_2 = M$

$2x + 3x = 5x = M$

$F_{ext} = 0$

$P_i = P_f$

$Mu = m_1 \times 0 + 3x V_0$

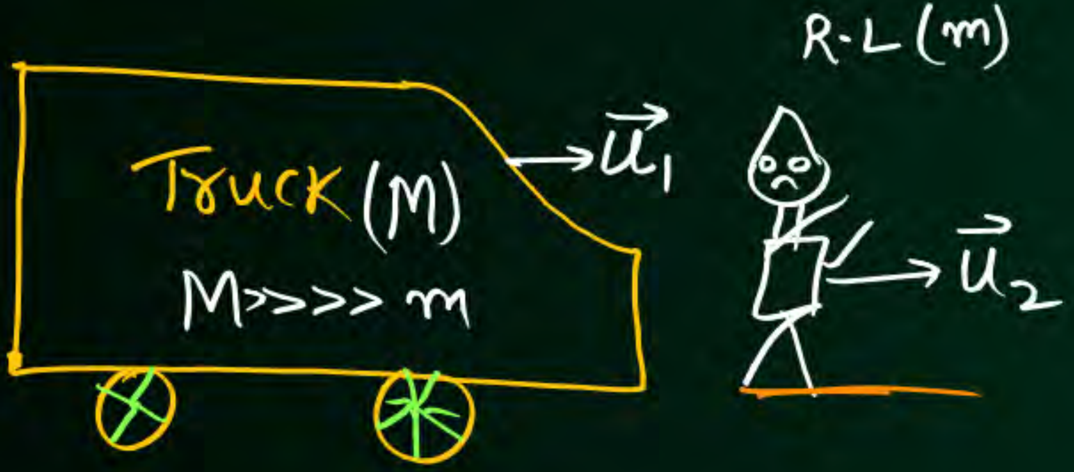
$5x u = 3x V_0$

$V_0 = \frac{5u}{3}$ Ans

ELASTIC COLLISION

Elastic collision

Between two object in which moss of one object is very much greater than other.







$$\vec{V}_1 = \frac{m_1 - m_2}{m_1 + m_2} u_1 + \frac{2m_2u_2}{m_1+m_2}$$

$$= \vec{u}_1 + \frac{2m_2u_2}{M} \to 0$$

$$\boxed{\vec{V}_1 = \vec{u}_1}$$

$$\vec{V}_2 = \frac{m_2 - m_1}{m_2 + m_1} u_2 + \frac{2m_1u_1}{m_1+m_2}$$

$$= -\vec{u}_2 + \frac{2M\vec{u}_1}{M}$$

$$= -\vec{u}_2 + 2\vec{u}_1$$

Case-2



Truck
M
$\vec{u}_1$
m
$-u_2$
B/C
$\vec{v}_1 = \vec{u}_1$
$\vec{v}_2 = 2\vec{u}_1 + \vec{u}_2$
Truck
Man

Case-3



m
$\vec{u}_1$
Truck(M)
$\vec{u}_2$
(Man)
B/C
M
$\vec{v}_2 = \vec{u}_2$
$\vec{v}_1 = 2\vec{u}_2 - \vec{u}_1$

QUESTION

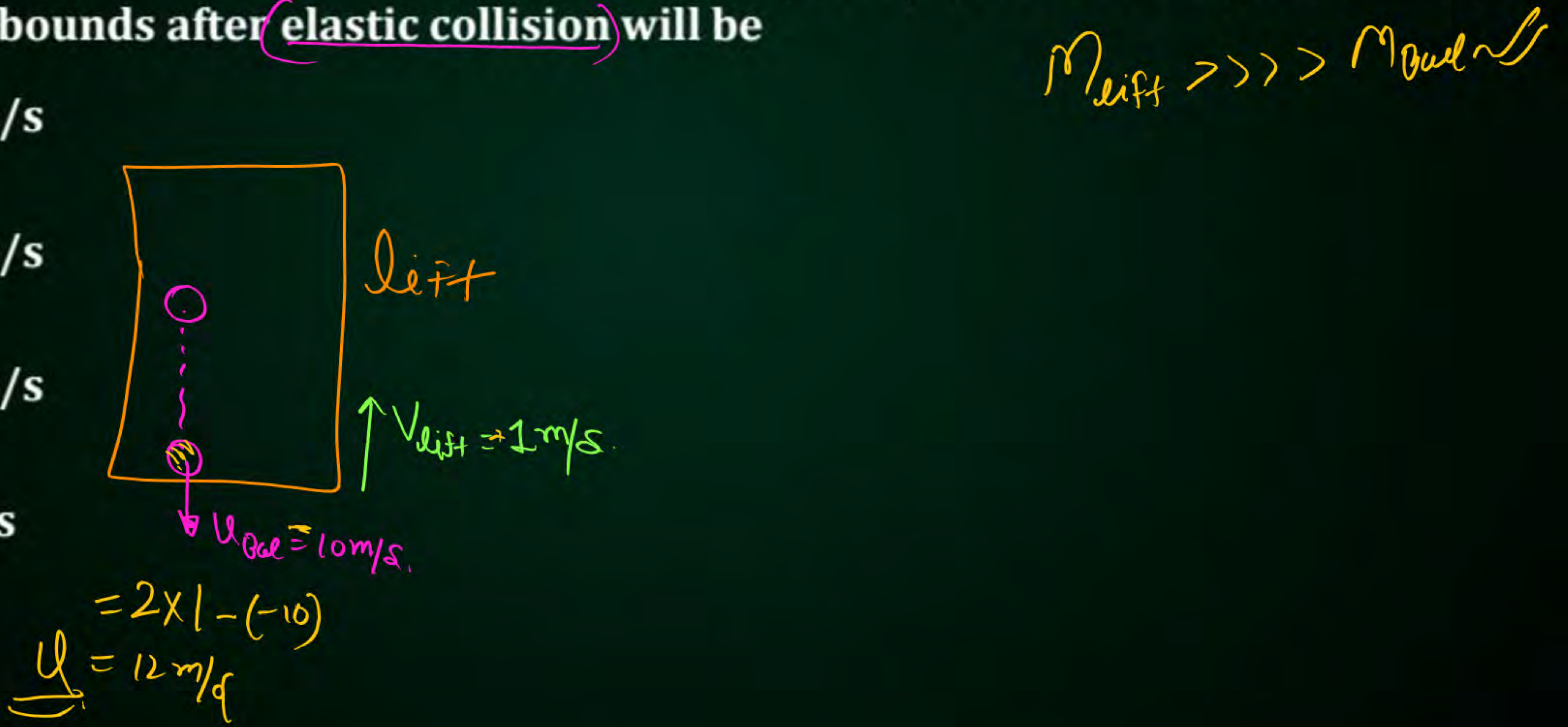
A heavy vehicle moving with velocity 15 m/s strikes an object of very small mass at rest head on elasticity. Velocity of object after collision is

1. 15 m/s
2. 25 m/s
3. 20 m/s
4. 30 m/s

QUESTION

A ball falls from a height such that it strikes the floor of lift at 10 m/s. If lift is moving in the upward direction with a velocity 1 m/s, then velocity with which the ball rebounds after elastic collision will be

1. 11 m/s
2. 12 m/s
3. 13 m/s
4. 9 m/s



Elastic collision B/W Two object of same mass



$$\vec{V_1} = \left(\frac{m-m}{2m}\right)u_1 + \frac{2m\,\vec{u_2}}{(m+m)}$$

(the first term is crossed out and marked 0)

$$\vec{V_1} = \vec{u_2}$$

↗ final velocity of 1st object

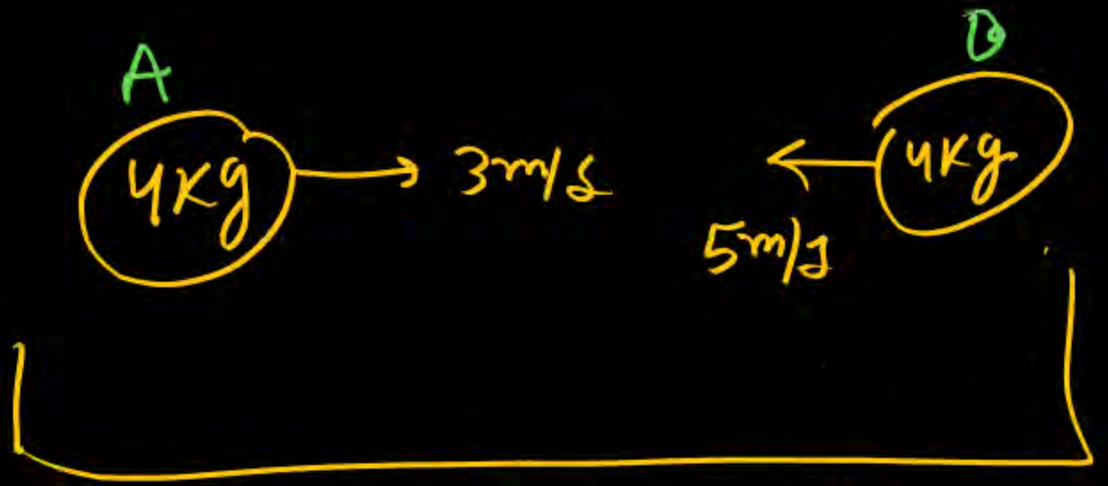
$$\vec{V_2} = \left(\frac{m-m}{m+m}\right)u_2 + \frac{2m\,u_1}{m+m}$$

(the first term is crossed out and marked 0)

$$\vec{V_2} = \vec{u_1}$$
$$\vec{V_1} = \vec{u_2}$$

→ They will exactly Interchange their velocity

(elastic collision b/w two same mass)



elastic collision
B/C

Sol^n



velocity A/C

➢ **Fraction of (transferred) KE in elastic collision in which 2nd object is at rest.**

$m_1 \longrightarrow u$ . . . . m_2

$K.E = \frac{1}{2} m_1 u^2$

rest $(K.E = 0)$, $v = 0$

(B/C)

$m_1 \longrightarrow v_1 = \left(\frac{m_1 - m_2}{m_1 + m_2}\right) u$

$m_2 \longrightarrow v_2 = \frac{2 m_1 u}{m_1 + m_2}$

elastic collisin

A/C

Let $m_2 = n\, m_1$

final velocity

$v_1 = \frac{m_1 - n m_1}{m_1 + n m_1} u$

- $v_1 = \left(\frac{1-n}{1+n}\right) u$

- $v_2 = \frac{2 m_1 u}{m_1 + n m_1} = \frac{2u}{(1+n)}$

$(K.E)_{\text{2nd object, final}} = \frac{1}{2} n m_1 v_2^2 = \frac{1}{2} n m_1 \left(\frac{2u}{1+n}\right)^2$

$\frac{(K.E)_{2nd}}{(K.E)_{inital}} = \frac{\frac{1}{2} n m_1 \left(\frac{2u}{1+n}\right)^2}{\frac{1}{2} m_1 u^2} = \frac{4 u^2 n}{(1+n)^2 u^2} = \frac{4n}{(1+n)^2}$

(K.E of 1st object)

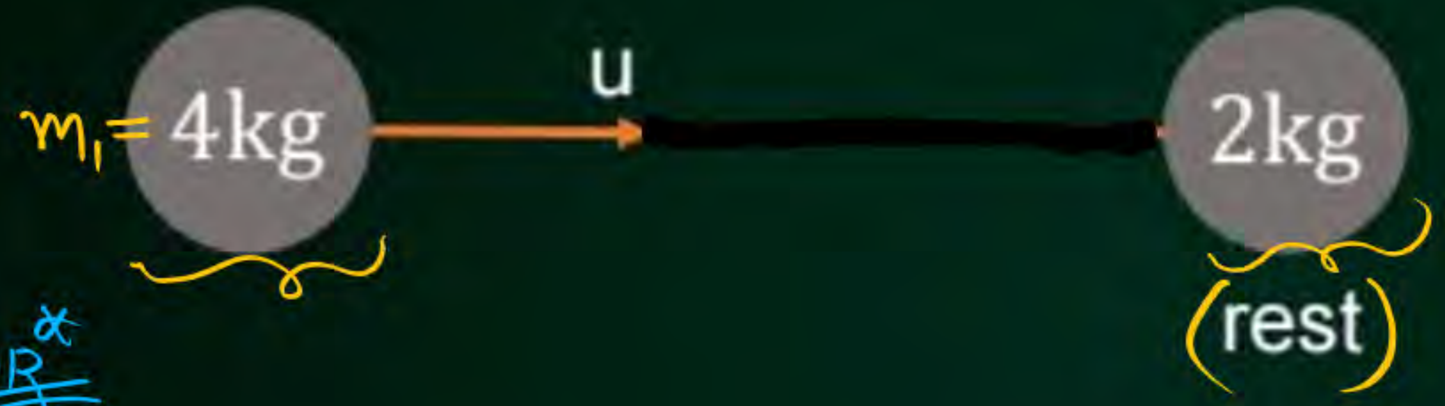
fraction of retained K.E by 1st object $= \left(\frac{1-n}{1+n}\right)^2 = 1 - \frac{4n}{(1+n)^2}$

MR Rafik

QUESTION

If collision is elastic then find fraction of transferred KE from 4 kg to 2 kg.

[NEET-2019]



$n = \frac{m_2}{m_1}$

$n = \frac{m_1}{m_2}$

$4 \times n = 2$

$n = \frac{1}{2}$

(a) zero

(b) Not zero

Sol^n

$$\frac{K.E_{\text{Transf to 2nd obj}}}{K.E \text{ of 1st obj}} = \frac{4n}{(1+n)^2} = \frac{4 \times 2}{(1+2)^2} = \frac{8}{9} \text{ Ans.}$$

Ans

QUESTION

A proton is moving with velocity u and collide with a nucleus of mass no. A at rest then find fraction of retained KE if collision is elastic. [AIPMT-2013]

$$= \left(\frac{1-A}{1+A}\right)^2$$

Ans

QUESTION

A metal ball of mass 2 kg moving with speed of 36 km/h has a head on collision with a stationary ball of mass 3 kg. If after collision, both the balls move together, then the loss in K.E. due to collision is

1. 100 J
2. 140 J
3. 40 J
4. 60 J

Perfecty Inelastic

$(\Delta K.E)_{lw} = \frac{1}{2} \frac{m_1 m_2}{m_1+m_2} u^2$


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 07 | **Physics**

Centre of mass and System of Particles, Collision



By- Dr. Manish Raj (MR SIR)

Topics to be covered

1. # Questions on collision

2. #

KOIN Banega DR.........

3. #

4. # Oblique collision (2-D)

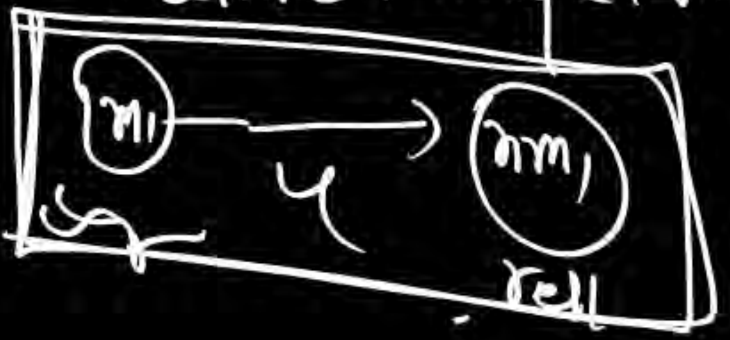


Elastic collision

m → u

$m \rightarrow 2\bar{u}_1 - \bar{u}_2$

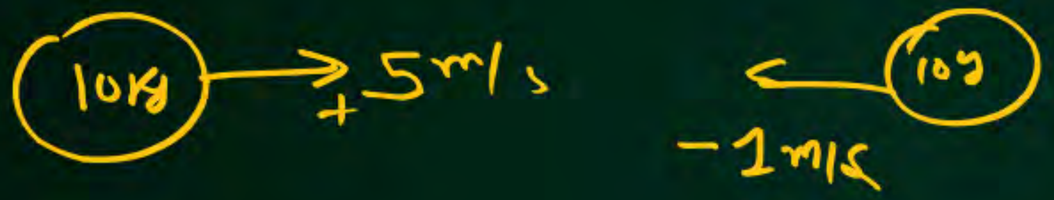
→ same mass elastic Colln



QUESTION

Two steel balls A and B of mass 10 kg and 10 g rolls towards each other with 5 m/s and 1 m/s respectively on a smooth floor. After collision; with what speed B moves [perfectly elastic collision]?

1. 8 m/s
2. 10 m/s
3. 11 m/s
4. Zero



$$\vec{V_2'} = 2\times 5 - (-1)$$

$$= 10 + 1 = 11.$$

QUESTION

A neutron makes a head on elastic collision with a stationary deuteron. The fractional energy loss of the neutron in the collision is :-

1. 16/82
2. 8/9
3. 8/27
4. 2/3

QUESTION

Two identical balls A and B collide head-on elastically. If velocities of A and B, before the collision, are + 0.5 m/s and −0.3 m/s respectively then their velocities, after the collision, are respectively

1. −0.5 m/s and +0.3 m/s
2. + 0.5 m/s and + 0.3 m/s
3. + 0.3 m/s and −0.5 m/s
4. −0.3 m/s and + 0.5 m/s

QUESTION

Two ivory balls are placed together at rest. A third identical ball moving with velocity u in line of first two bails; as shown in figure collide head on elastically then



1. Third ball comes to rest with second ball while first ball moves with speed u
2. Third bail comes to rest and other two move together with speed u/2
3. All three ball move together with speed u/3
4. All three ball move in such a manner each makes angle 120° to each other

QUESTION

A bullet weighing 10 g and moving with a velocity 300 m/s strikes a 5 kg block of ice and drop dead. The ice block is kept on smooth surface. The speed of the block after the collision is

1. 6 cm/s
2. 60 cm/s
3. 6 m/s
4. 0.6 cm/s



$$u = \frac{\frac{10}{1000} \times 300 + 0}{\frac{10}{1000} + 5} = \frac{3}{5} \text{ m/s} = \frac{300}{5} \text{ cm/s} = 60 \text{ cm/s}$$

QUESTION

A ball moving with velocity 2 m/s collides head on with another stationary ball of double the mass. If the coefficient of restitution is 0.5 then their velocities (in m/s) after collision will be ??

1. 0, 2
2. 0, 1 ✓
3. 1, 1 ✗
4. 1, 0.5 ✗

Inelastic

m, $u_1 = 2\,m/s$; $2m$ (rest), $u_2 = 0$; $e = 0.5$

A/C: $m \to v_1$, $2m \to v_2$

$\vec{V_1} = \frac{m - 0.5(2m)}{m + 2m} u_1 + 0$

$V_1 = 0$ ✓

Momentum Conservation

$m \times 2 = m \times 0 + 2m V_2$

$2m = 2m V_2$

$V_2 = 1\,m/s$

QUESTION

A bullet of mass m moving with a velocity u strikes a block of mass M at rest and gets embedded in the block. The loss of kinetic energy in the impact is

1. $\frac{1}{2}mMu^2$

2. $\frac{1}{2}(m+M)u^2$

3. $\frac{mMu^2}{2(m+M)}$

4. $\left(\frac{m+M}{2mM}\right)u^2$



QUESTION

Two balls of equal mass undergo head on collision while each was moving with speed 6 m/s. If the coefficient of restitution is 1/3, the speed of each ball after impact will be

1. 18 m/s (8%)
2. 2 m/s (30%)
3. 6 m/s (24%)
4. 4 m/s (38%)

$\left(e = \frac{1}{3}\right)$ Inelastic

$u_1 = 6$ m/s $u_2 = 6$ m/s

$$\vec{V_1} = \left(\frac{m - em}{2m}\right)\vec{u_1} + \frac{\left(1+\frac{1}{3}\right) m \times \vec{u_2}}{2m}$$

$$= \frac{\left(1-\frac{1}{3}\right)}{2} \times 6 - \frac{4 \times 6}{3 \times 2} = 2 - 4 = 2 \text{ m/s}$$

QUESTION

An object of mass 80 kg moving with velocity 2 ms^{-1} hit by collides with another object of mass 20 kg moving with velocity 4 ms^{-1}. Find the loss of energy assuming a perfectly inelastic collision

1. 12 J
2. 24 J
3. 30 J
4. 32 J

(20) → 4 m/s   (80) → 2 m/s

$$\Delta K.E = \frac{1}{2}\frac{20\times 80}{100}(2)^2$$

$= 8 \times 4$

$= 32 J$

QUESTION

A body of mass 10 kg moving with speed of 3 ms^{-1} collides with another stationary body of mass 5 kg. As a result, the two bodies stick together. The KE of composite mass will be

1. 30 J
2. 60 J
3. 90 J
4. 120 J

$v = \frac{10\times3+0}{15}$

$v_{fin} = 2\ m/s$

KE fin $= \frac{1}{2}\times15(2)^2 = \frac{15\times4}{2} = 30\ J$

$K.E_{initial} = \frac{1}{2}\times10(3)^2 = 5\times9 = 45\ J$

$\Delta K.E\ (loss) = \frac{1}{2}\,\frac{10\times5}{(15)}\times(3)^2 = 15\ J$

Drop dead
embedded
stick together
move together

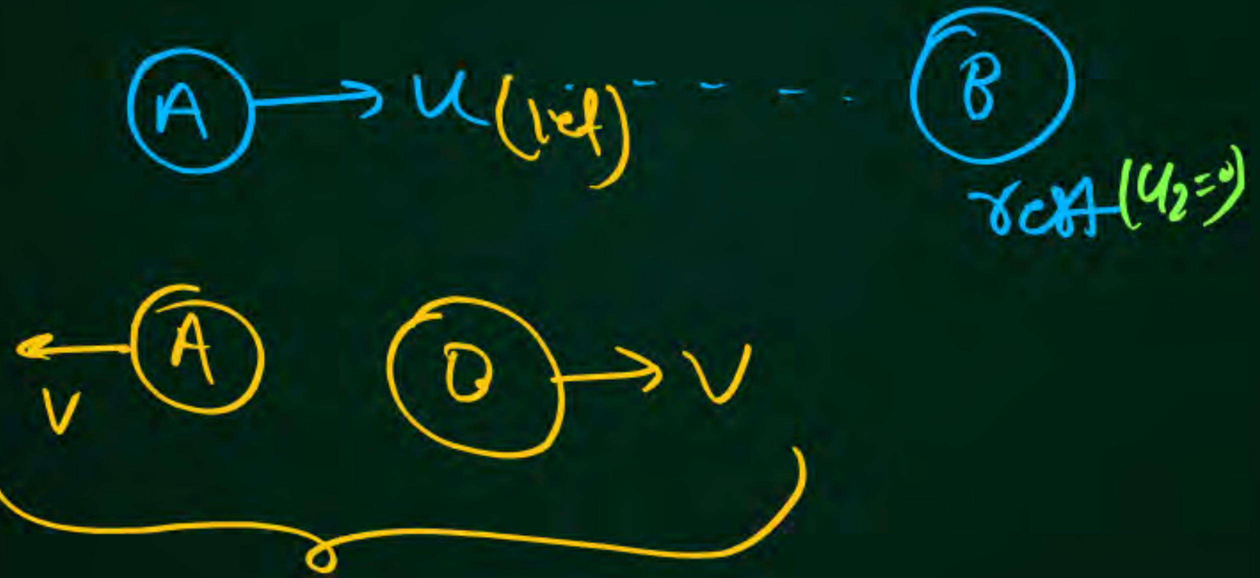
Perfectly inelastic.

QUESTION

Particle A makes a perfectly elastic collision with another particle B at rest. They fly apart in opposite direction with equal speeds. If their masses are m_A & m_B respectively, then

1. $2\,m_A = m_B$
2. $3\,m_A = m_B$
3. $4\,m_A = m_B$
4. $\sqrt{3}\,m_A = m_B$

Ans (99%)



$\vec{v}_1 = -v = \frac{(m_A - m_B)u}{m_A + m_B} + 0$ — (i)

$\vec{v}_2 = v = 0 + \frac{2 m_A u}{m_A + m_B}$ — (ii)

$\frac{-v}{v} = \frac{m_A - m_B}{2 m_A}$

$-2 m_A v = m_A v - m_B v$

$m_B v = 3 m_A v$

QUESTION

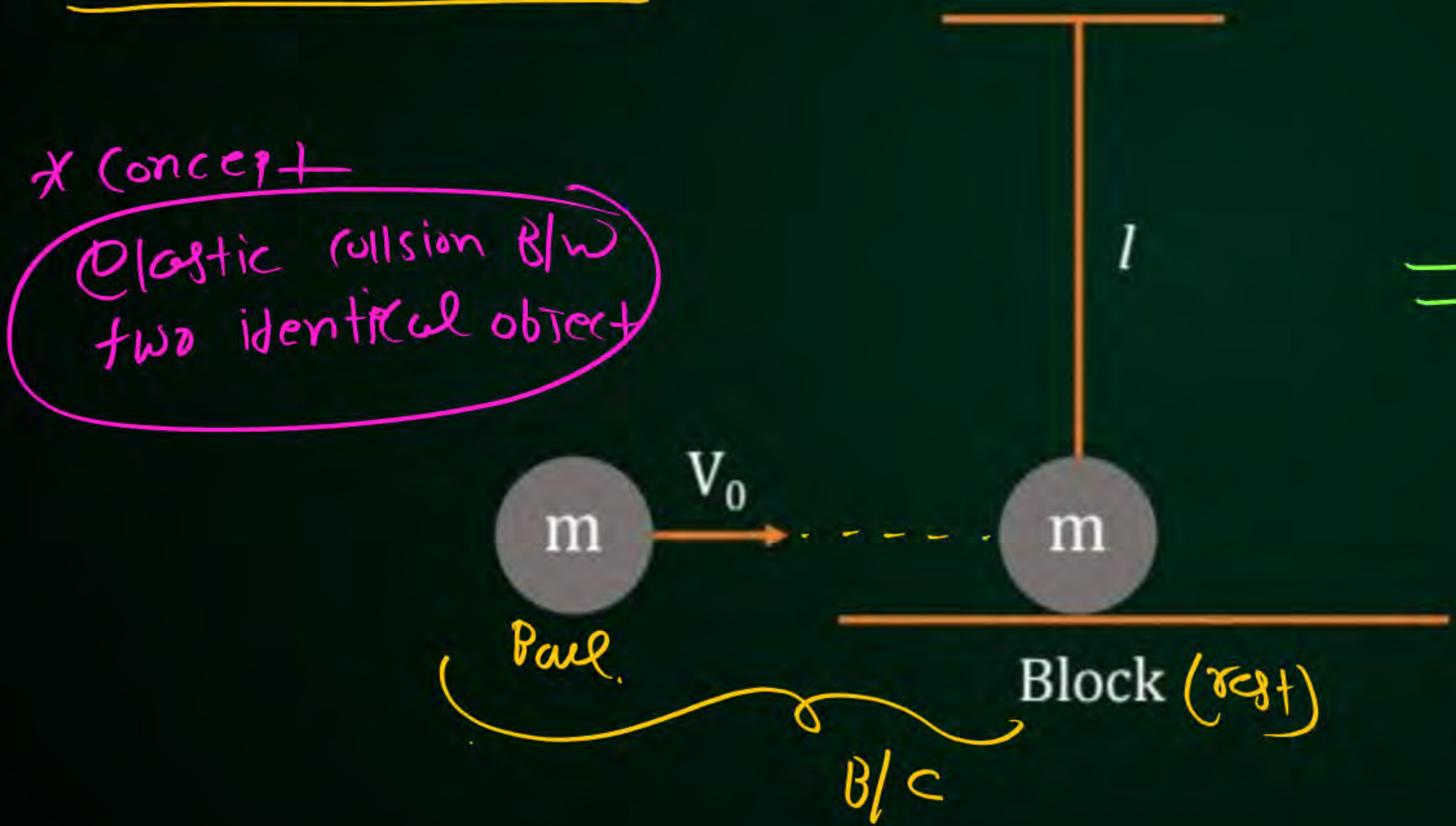
A ball of mass M moving with speed v collides perfectly inelastically with another ball of mass m at rest. The magnitude of impulse imparted to the first ball is

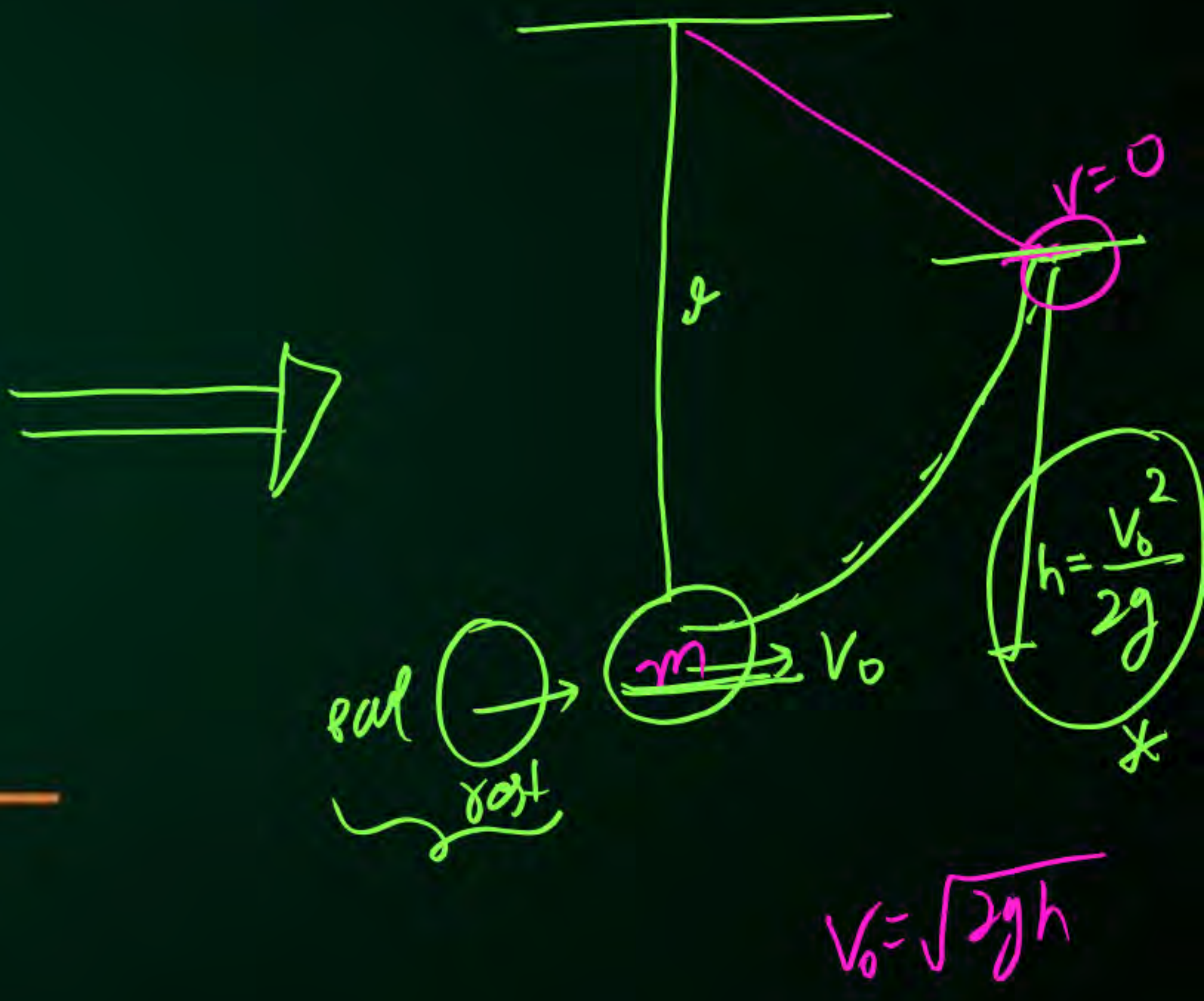
1. Mv
2. mv
3. $\frac{Mm}{M+m}v$
4. $\frac{M^2}{M+m}v$

QUESTION

If collision is elastic then find maximum height attained by block just after collision from mean position. (as shown in fig)

Both have same mass.





C.O.M.E B/W
Mean and Height Poin

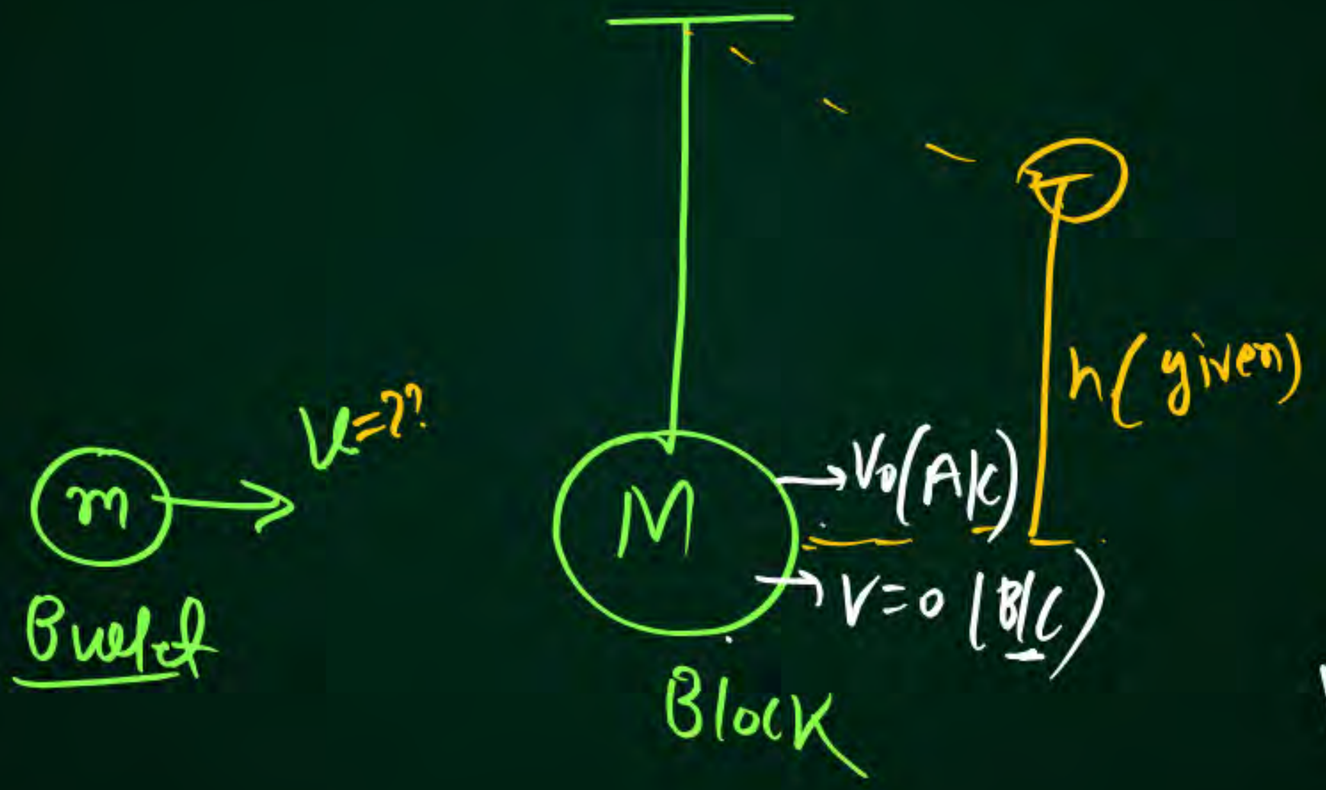
$$0 + \frac{1}{2} m v_0^2 = 0 + mgh$$

$$h = \frac{v_0^2}{2g}$$

QUESTION

A bullet of mass m moving with velocity v strikes a suspended wooden block of mass M. If the block rises to height h, the initial velocity of the bullet will be (collision is Perfectly Inelastic)

1. $\sqrt{2gh}$
2. $\frac{M+m}{m}\sqrt{2gh}$ (70%)
3. $\frac{m}{M+m}\sqrt{2gh}$
4. $\frac{M+m}{M}\sqrt{2gh}$



$$h = \frac{v_0^2}{2g}$$

$$v_0 = \sqrt{2gh} \quad \text{— (I)}$$

Perfectly Inelastic

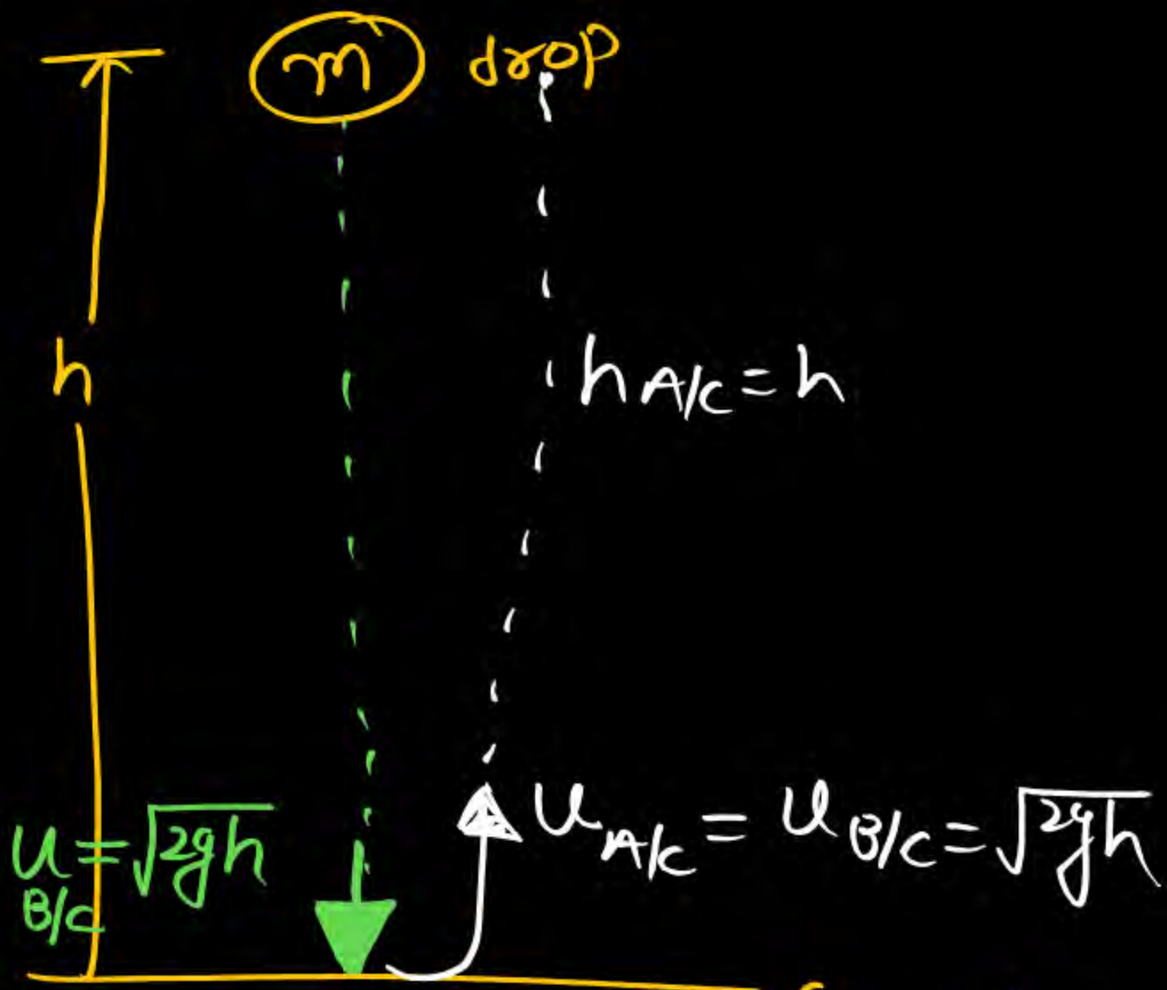
$$v_0 = \frac{mv + M \times 0}{m+M} \quad \text{— (II)}$$

(I) = (II)

$$\sqrt{2gh} = \frac{mv}{m+M}$$

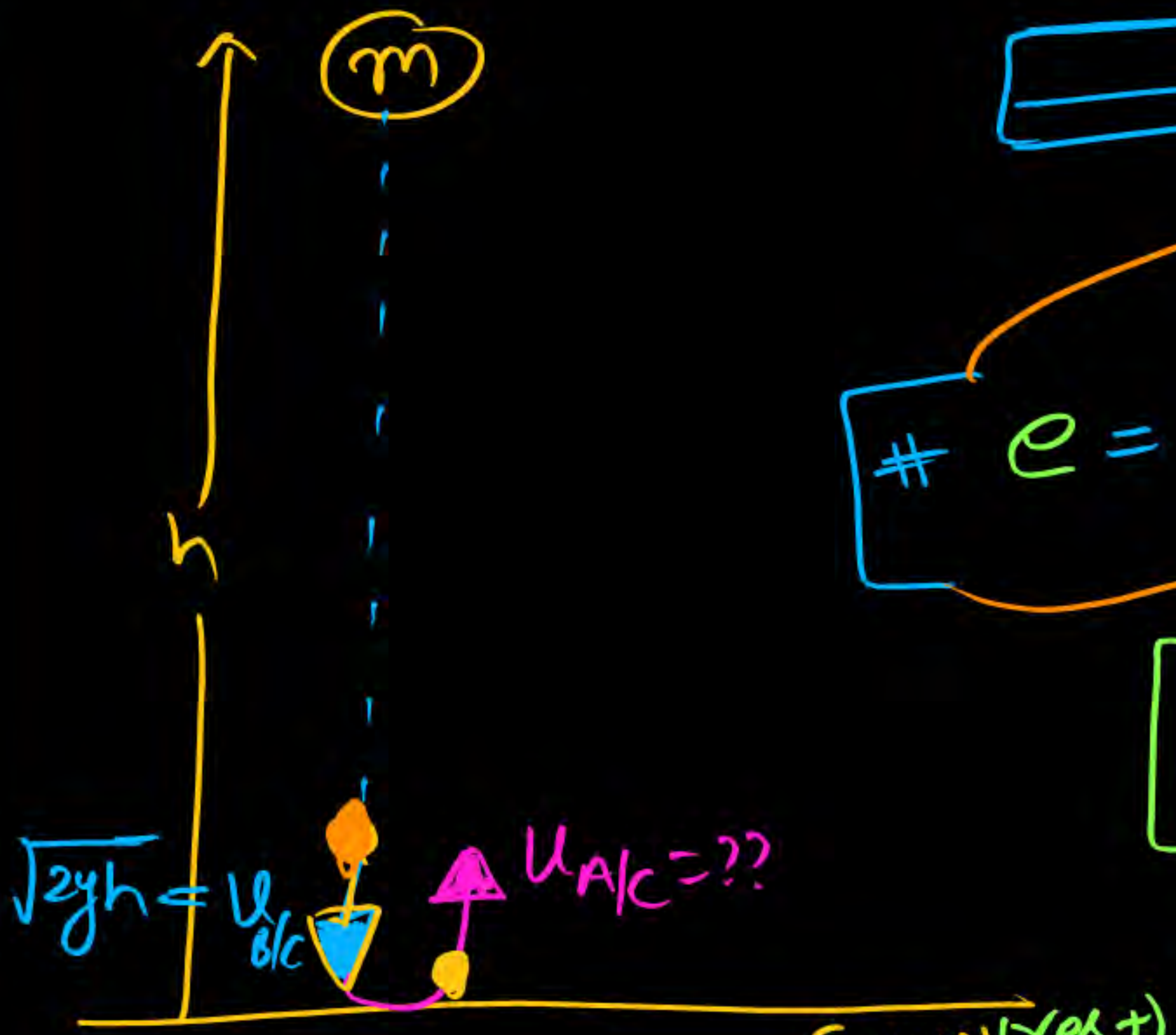
$$v = \frac{m+M}{m}\sqrt{2gh}$$

Ball / earth collision



elastic collision ($e = 1$)

If e was zero then Ball will stick with ground (X)



e = Inelastic collision.

$$\# \; e = \frac{V_{sep^n}}{V_{approach}} = \frac{u_{A/c}}{u_{B/c}}$$

$$u_{A/c} = e \times u_{B/c}$$

- change in velocity

$$\vec{u}_{A/c} - \vec{u}_{B/c}$$

$$= u_{A/c} - u_{B/c}$$

$$= e\,u_{B/c} - u_{B/c}$$

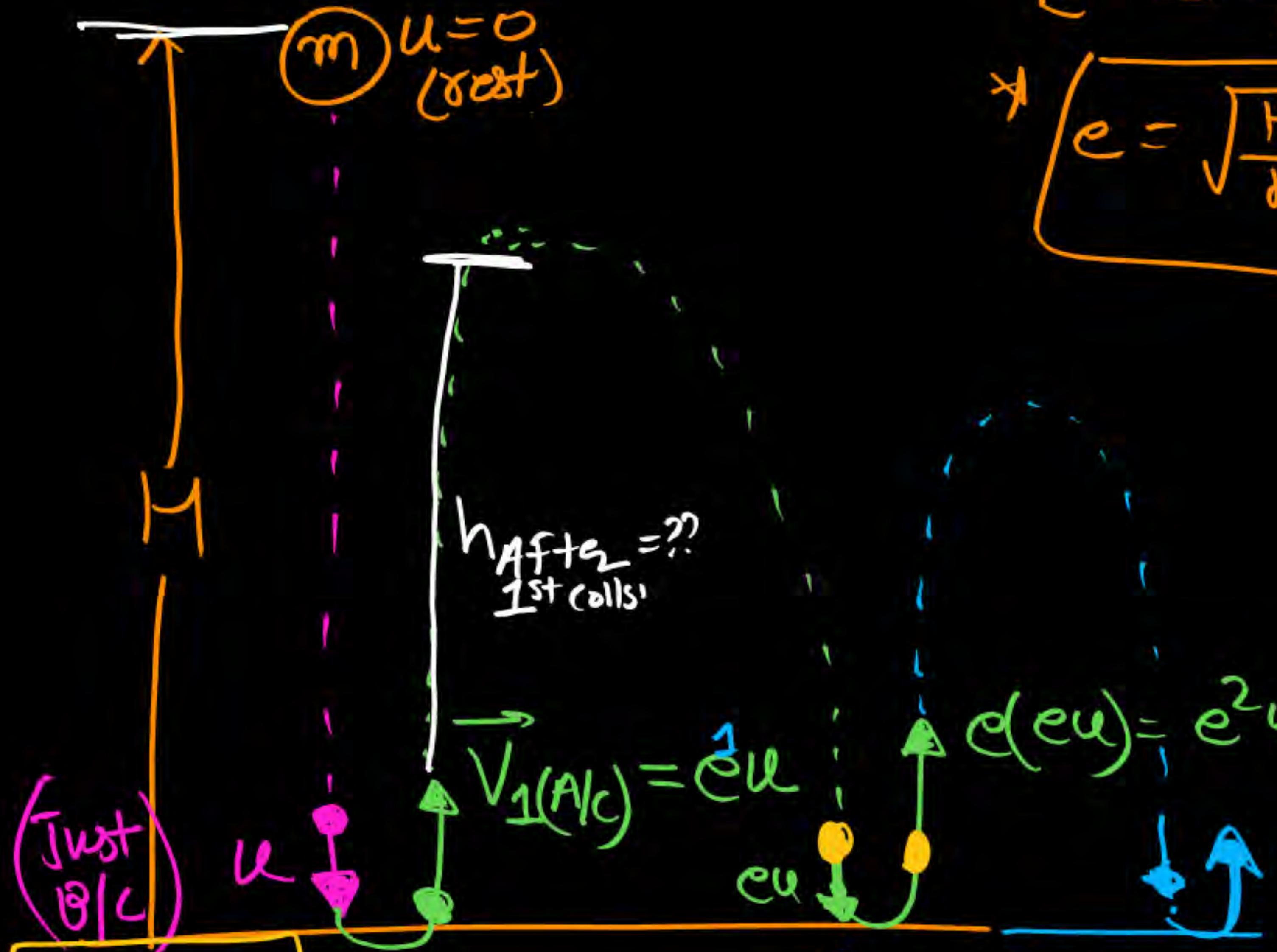
loss in velocity $(\vec{\Delta v}) = u_{B/c}(e-1)$

* fraction of loss in velocity in collision $= \dfrac{\vec{\Delta v}}{u_{B/c}}$

$$= \frac{u_{B/c}(e-1)}{u_{B/c}} = (e-1)$$

$$e^2 = \frac{H_{A/c}}{H_{B/c}}$$

* $$e = \sqrt{\frac{H_{A/c}}{H_{B/c}}}$$



$$\sqrt{2gH} = u$$

$$\vec{V}_{1(A/c)} = eu$$

$$e(eu) = e^2 u = \vec{V}_{after\ 2^{nd}\ collision}$$

$$\vec{V}_{after\ 3^{rd}\ collision} = e^3 u$$

* $$\vec{V}_{after\ n^{th}\ colls.} = e^n u$$

Maximum Height after 1st collision

$$h = \frac{V_{1A/c}^2}{2g} = \frac{e^2 u^2}{2g}$$

$$h = \frac{e^2 (2gH)}{2g}$$

$$h_{after\ 1^{st}\ colls} = e^2 H_{B/c}$$

$$h_{after\ 2^{nd}\ collsi} = e^4 H$$

* $$h_{after\ n^{th}\ collision} = e^{2n} H$$

QUESTION

A ball is dropped from height h on the ground level. If the coefficient of restitution is e then the height upto which the ball will go after nth jump will be:

1. $\frac{h}{e^{2n}}$
2. $\frac{e^{2n}}{h}$
3. he^{n}
4. he^{2n}

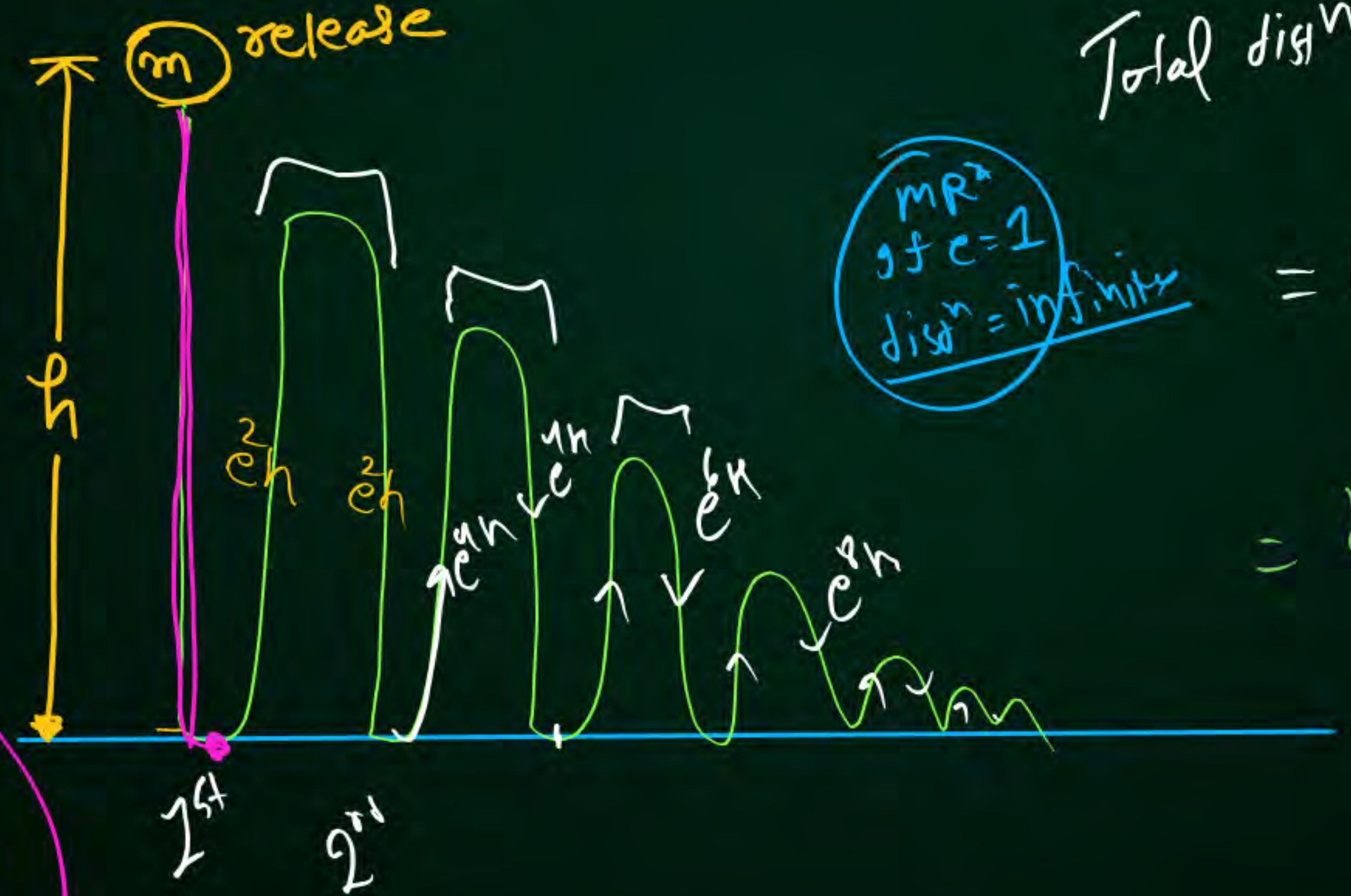


$h_{n^{th}\,coll} = e^{2n}h$

QUESTION

A body of mass m falls from height h on ground. If e be the coefficient of restitution of collision between the body and ground, then the distance travelled by body before it comes to rest is

1. $h\left\{\dfrac{1+e^2}{1-e^2}\right\}$
2. $h\left\{\dfrac{1-e^2}{1+e^2}\right\}$
3. $\dfrac{2eh}{1+e^2}$
4. $\dfrac{2eh}{1-e^2}$



MR* if $e=0$, dist $= h$

MR* if $e=1$, dist^n = infinite

Total dist^n $= h + 2e^2h + 2e^4h + 2e^6h + 2e^8h$

$= h + 2e^2h\left[1 + e^2 + e^4 + e^6 + e^8 + \dots\right]$

$= h + 2e^2h\left[\dfrac{1}{1-e^2}\right]$

$= h + \dfrac{2e^2h}{1-e^2} = h\left[\dfrac{1-e^2+2e^2}{1-e^2}\right]$

$= h\left[\dfrac{1+e^2}{1-e^2}\right]$

A stone is dropped from a height h. It hits the ground with a certain momentum P. If the same stone is dropped from a height 100% more than the previous height, the momentum when it hits the ground will change by

[AIPMT (Mains)-2012]

1. 68%
2. 41% ✓
3. 200%
4. 100%





$P = mv = m\sqrt{2gh}$ — (1)

$P \propto \sqrt{h}$

$p' = mv'$

$p' = m\sqrt{2g(2h)}$ — (1)

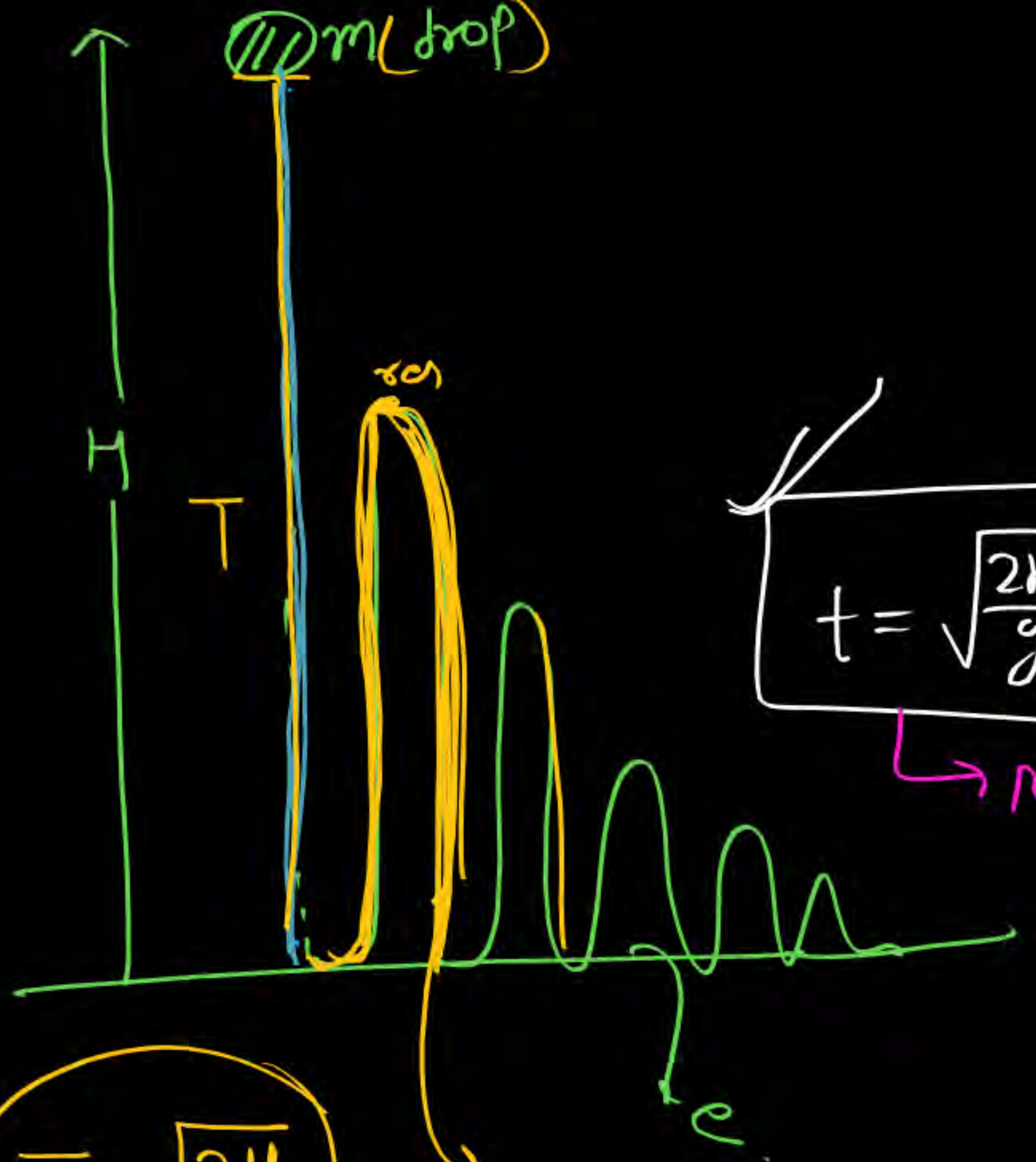
$p' = \sqrt{2}P$

$p' = 1.41P$

141%

Increased by 41%

Ball is droped from Heigh H then find total time of flight before coming to rest.



$$T = \sqrt{\frac{2H}{g}}$$

$$t_1 = 2\sqrt{\frac{2e^2H}{g}} = 2e\sqrt{\frac{2H}{g}}$$

$$t_2 = 2e^2\sqrt{\frac{2H}{g}}$$

$$t_3 = 2e^3\sqrt{\frac{2H}{g}}$$

$$t = \sqrt{\frac{2H}{g}}\left(\frac{1+e}{1-e}\right)$$

→ MR*

If $e = 1$

$t =$ infinite

$$\text{total time} = T_1 + t_1 + t_2 + t_3 + t_4 + \cdots$$

$$= \sqrt{\frac{2H}{g}} + 2e\sqrt{\frac{2H}{g}} + 2e^2\sqrt{\frac{2H}{g}} + 2e^3\sqrt{\frac{2H}{g}} + \cdots$$

$$= \sqrt{\frac{2H}{g}} + 2e\sqrt{\frac{2H}{g}}\left(1 + e + e^2 + e^3 + e^4\right)$$

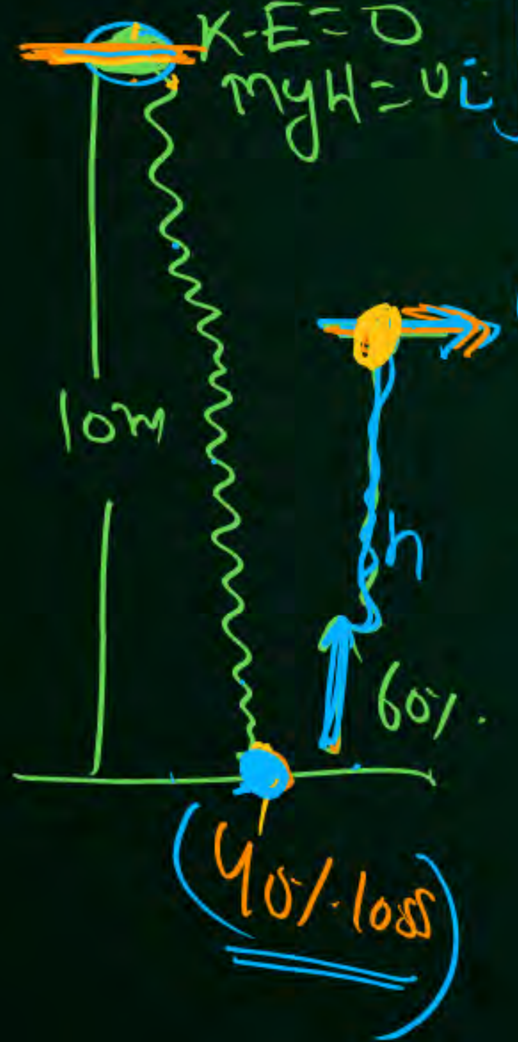
$$= \sqrt{\frac{2H}{g}} + 2e\sqrt{\frac{2H}{g}}\left(\frac{1}{1-e}\right)$$

$$= \sqrt{\frac{2H}{g}}\left(1 + \frac{2e}{1-e}\right) = \sqrt{\frac{2H}{g}}\left(\frac{1-e+2e}{1-e}\right)$$

QUESTION

A ball is allowed to fall from a height of 10 there is 40% loss of energy due to impact, after one impact ball will go up by

1. 10 m
2. 8 m
3. 4 m
4. 6 m



In inelastic collision final K.E of system always less intial K.E

(a) True

(b) false

⇒ May be some energy is releted in colsion which converted into K.E.

QUESTION

A 1 Kg ball falls from a height of 25 cm and rebounds upto a height of 9 cm. The coefficient of restitution is

1. 0.6 ✓
2. 0.32
3. 0.40
4. 0.56

$e = \sqrt{\frac{25}{9}}$ ✗

$e = \sqrt{\frac{H_{A/C}}{H_{B/C}}}$ ✓

$e = \sqrt{\frac{9}{25}} = \frac{3}{5} = 0.6$

QUESTION

A rubber ball is dropped from a height of 5 m on a plane, where the acceleration due to gravity is not known. On bouncing, it rises to 1.8 m. The ball loses its velocity on bouncing by a factor of

1. $\frac{3}{5}$
2. $\frac{2}{5}$
3. $\frac{16}{25}$
4. $\frac{9}{25}$

$e = \sqrt{\frac{1.8}{5}} = \sqrt{\frac{18}{50}}$

$e = \sqrt{\frac{9}{25}}$

$e = \frac{3}{5}$

$e = 0.6$

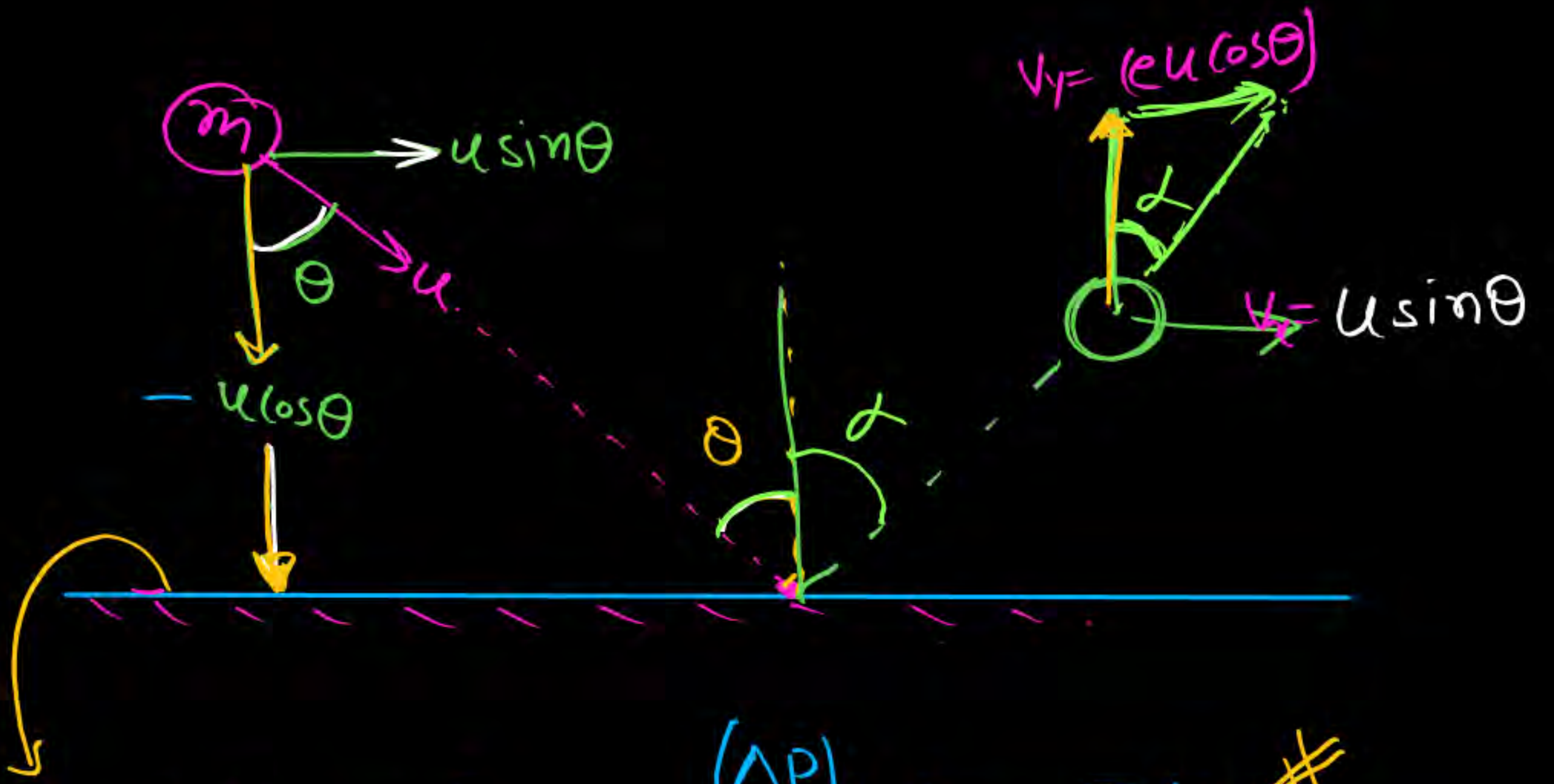
$R = (e - 1)$

$= 0.6 - 1$

$= 0.4$

$= \frac{2}{10} = 2/5$

oblique collision



e = coefficient of restitution

$(\Delta P)_{\text{Ball } x\text{-axis}} = 0$ #

$(\Delta P)_{\text{Ball } y} = meu\cos\theta - (-u\cos\theta\, m)$

$= mu\cos\theta\,(e+1)$ #

$\tan\alpha = \dfrac{u\sin\theta}{eu\cos\theta}$

$\boxed{\tan\alpha = \dfrac{\tan\theta}{e}}$ * NEET

Impulse $= \Delta p = mu\cos\theta\,(e+1)$

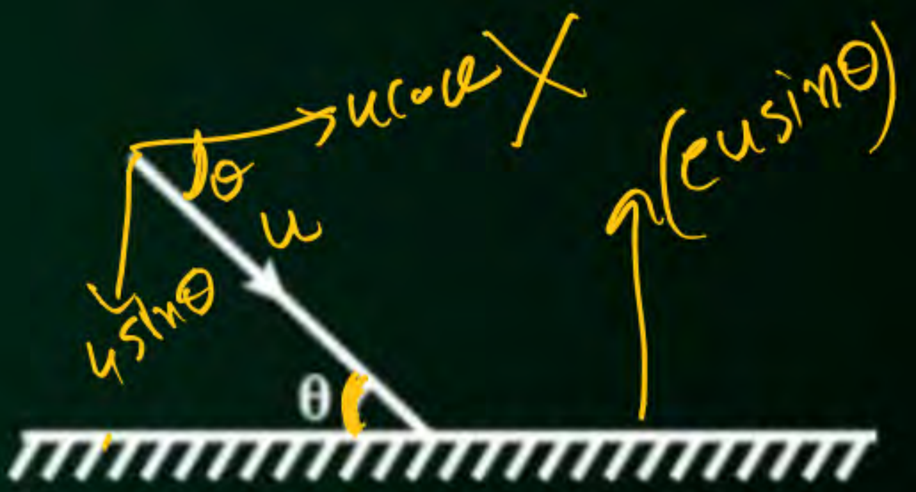
$\vec{V}_f = u\sin\theta\,\hat{i} + eu\cos\theta\,\hat{j}$

$\vec{V}_i = u\sin\theta\,i - u\cos\theta\,\hat{j}$

QUESTION

A ball of mass m moving with speed u collides with a smooth horizontal surface at angle θ with it as shown in figure. The magnitude of impulse imparted to surface by ball is [Coefficient of restitution of collision is e]

1. $mu(1 + e)\cos\theta$
2. $mu(1 - e)\sin\theta$
3. $mu(1 - e)\cos\theta$
4. $mu(1 + e)\sin\theta$

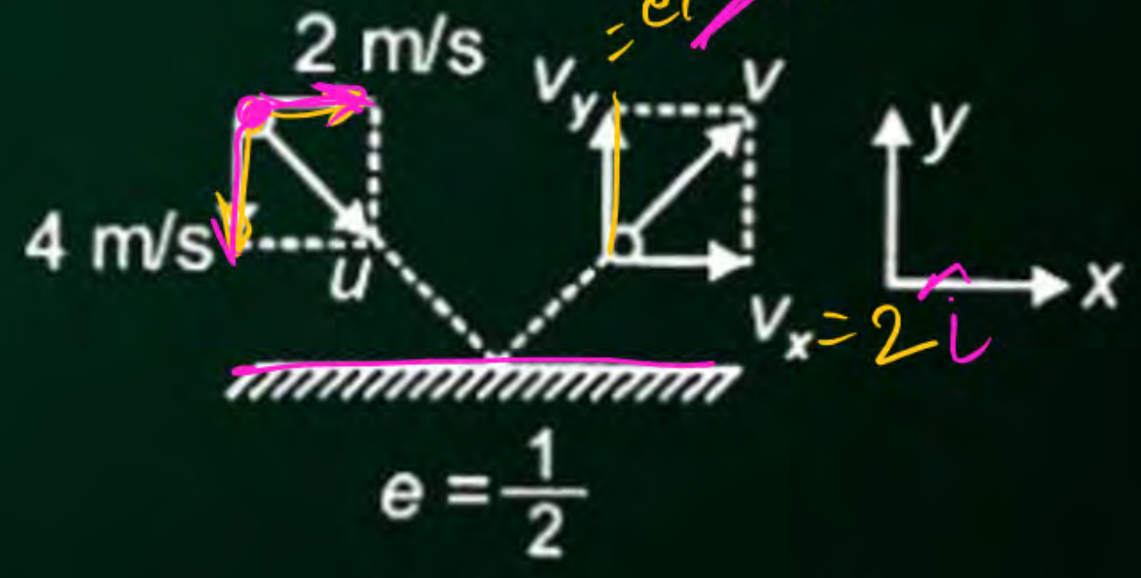


4th Ans

QUESTION

In the figure shown, a small ball hits obliquely a smooth and horizontal surface with speed u whose x and y components are indicated. If the coefficient of restitution is $\frac{1}{2}$, then its x and y components v_x and v_y just after collision are respectively

1. 4 m/s, 1 m/s
2. 2 m/s, 1 m/s
3. 2 m/s, 2 m/s
4. 4 m/s, 2 m/s



QUESTION

Two particles of masses mv m2 move with initial velocities u1 and u2. On collision, one of the particles get excited to higher level, after absorbing energy e. If final velocities of particles be v^ and v2 then we must have [AIPMT-2015]

1. $\frac{1}{2}m_1^2u_1^2 + \frac{1}{2}m_2^2u_2^2 + \varepsilon = \frac{1}{2}m_1^2v_1^2 + \frac{1}{2}m_2^2v_2^2$

2. $m_1^2u_1 + m_2^2u_2 - \varepsilon = m_1^2v_1 + m_2^2v_2$

3. $\frac{1}{2}m_1u_1^2 + \frac{1}{2}m_2u_2^2 = \frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2 - \varepsilon$

4. $\frac{1}{2}m_1u_1^2 + \frac{1}{2}m_2u_2^2 - \varepsilon = \frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2$


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 08 | Physics

Last lecture

Centre of mass and System of Particles, Collision

By- Dr. Manish Raj (MR SIR)



Topics to be covered

1. # Oblique collision
   (2-D collision)
2. #
3. #
4. #



Two particles of masses m_1 m_2 move with initial velocities u1 and u2. On collision, one of the particles get excited to higher level, after absorbing energy e. If final velocities of particles be v^ and v2 then we must have **[AIPMT-2015]**

1. $\frac{1}{2}m_1^2u_1^2 + \frac{1}{2}m_2^2u_2^2 + \varepsilon = \frac{1}{2}m_1^2v_1^2 + \frac{1}{2}m_2^2v_2^2$

2. $m_1^2u_1 + m_2^2u_2 - \varepsilon = m_1^2v_1 + m_2^2v_2$

3. $\frac{1}{2}m_1u_1^2 + \frac{1}{2}m_2u_2^2 = \frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2 - \varepsilon$

4. $\frac{1}{2}m_1u_1^2 + \frac{1}{2}m_2u_2^2 - \varepsilon = \frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2$

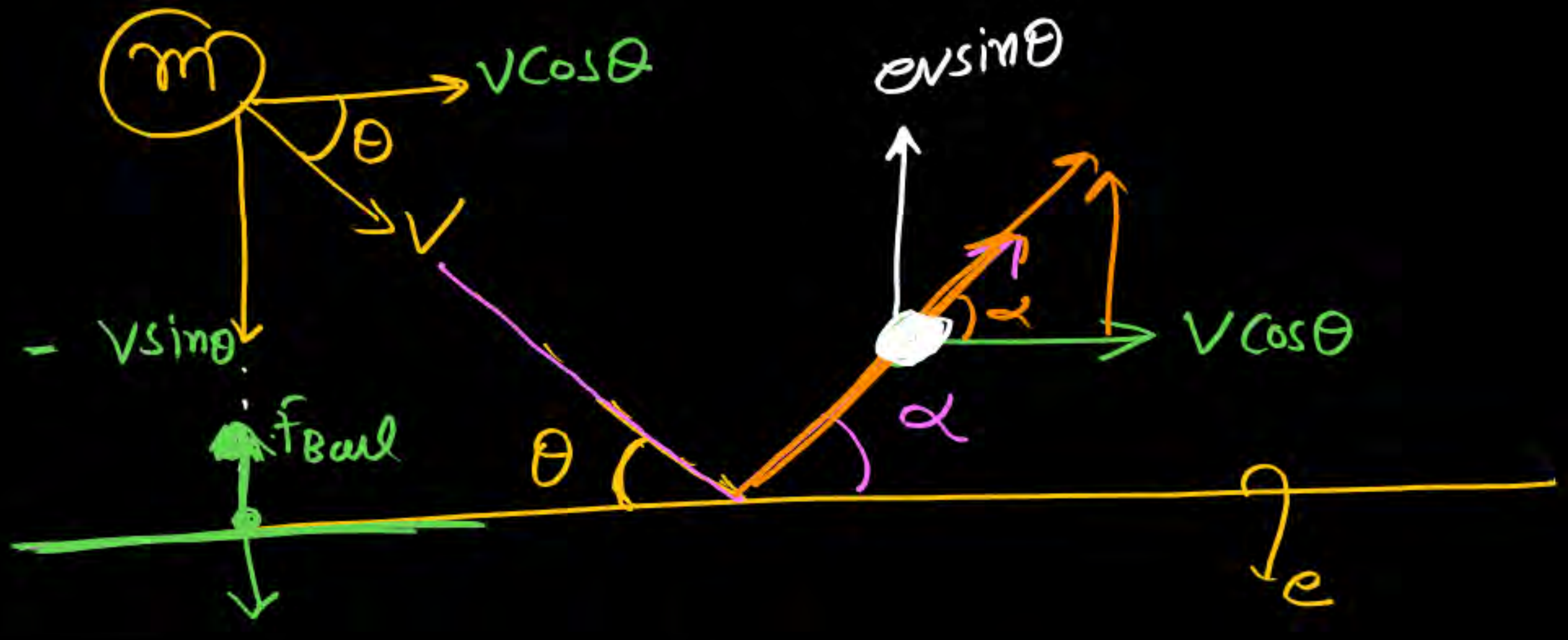
80%



Total energy in every collision is conserved.

$E_{Total\ initial} = E_{Total\ final}$

$\left[\frac{1}{2}m_1u_1^2 + \frac{1}{2}m_2u_2^2\right] = e + \frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2$



$\tan\alpha = \frac{\tan\theta}{e}$ ✗

$\vec{u}_{B/c} = v\cos\theta\,\hat{i} - v\sin\theta\,\hat{j}$

$\vec{V}_{A/c} = v\cos\theta\,\hat{i} + ev\sin\theta\,\hat{j}$

$\tan\alpha = \frac{e v\sin\theta}{v\cos\theta}$

• $\tan\alpha = e\tan\theta$

MR* Point
→ Collision always take place ⊥r to the contact surface

(*) In this collision momentum of Ball remains conserved in Horizontal dirn → (a) false (38%) (b) True (62%)

(*) Momentum of Ball is Conserved → false

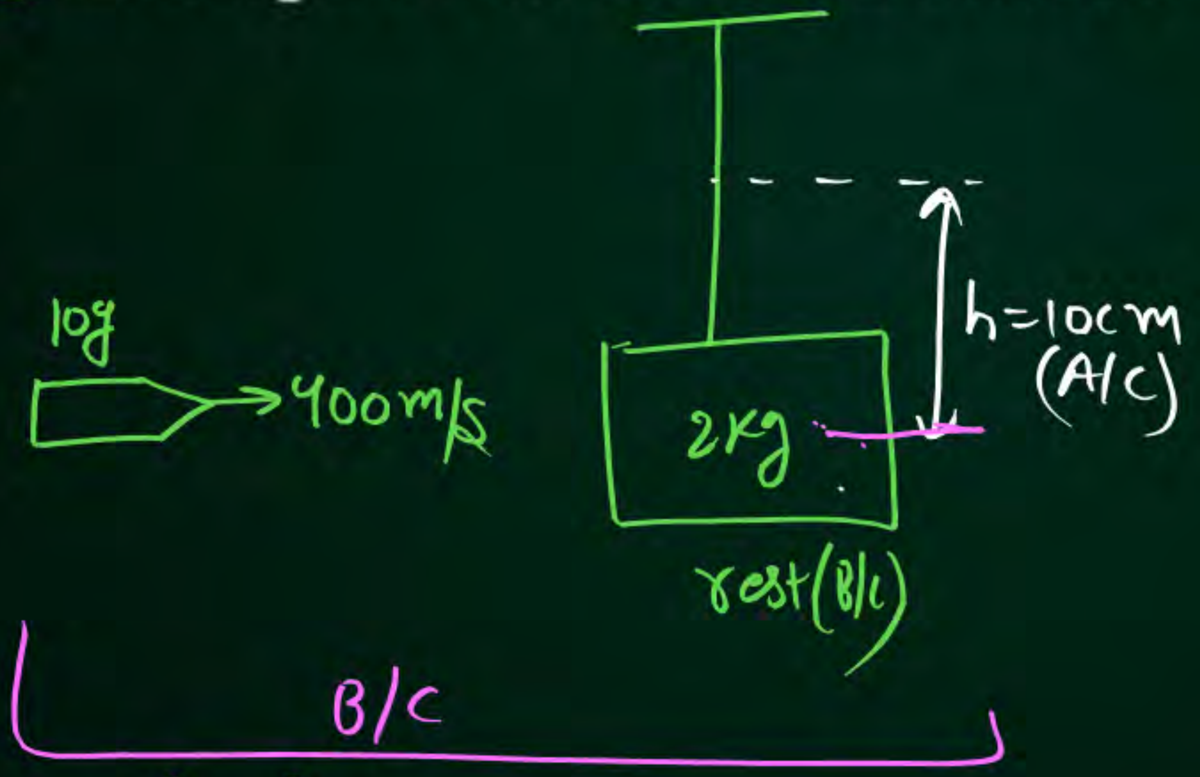
QUESTION

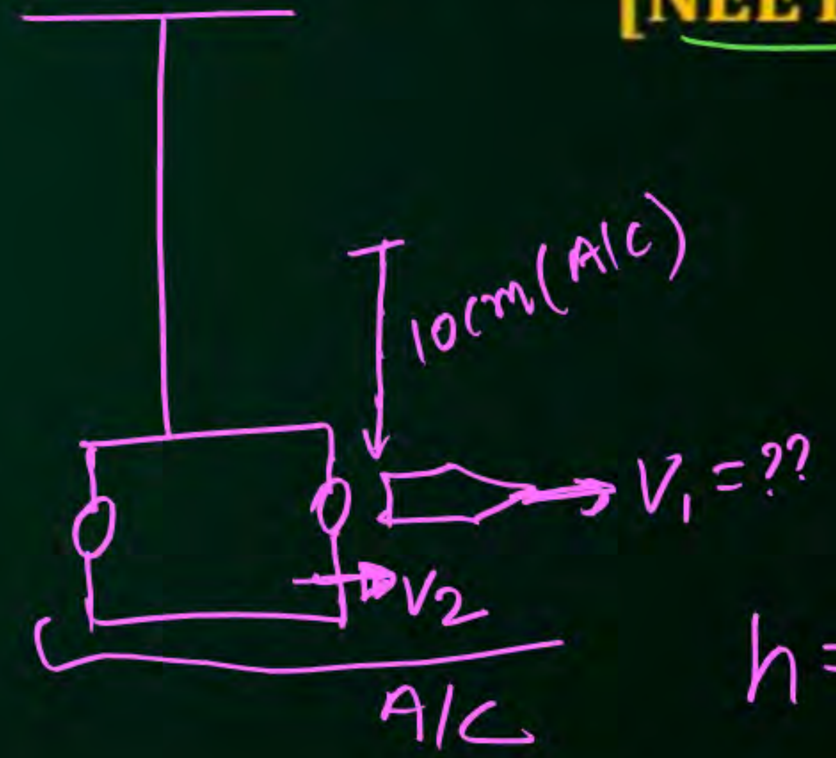
A bullet of mass 10 g moving horizontally with a velocity of 400 m/s strikes a wooden block of mass 2 kg which is suspended by a light inextensible string of length 5 m. As a result, the center of gravity of the block is found to rise a vertical distance of 10 cm. The speed of the bullet after it emerges out horizontally from the block will be:

[NEET-2016]

1. 120 m/s
2. 160 m/s
3. 100 m/s
4. 80 m/s

✗ Perfectly Inelastic
✓ Inelastic





$P_i = P_f$

$\frac{10}{1000} \times 400 + 0 = 2 \times V_2 + \frac{10}{1000} V_1$

$4 = 2(1.41) + \frac{1}{100} V_1$

$4 - 2.8 = \frac{V_1}{100}$

$h = \frac{V_2^2}{2g}$

$(V_2)_{Block\ A/C} = \sqrt{2gh} = \sqrt{\frac{2 \times 10 \times 10}{100}}$

QUESTION

A moving block having mass m, collides with another stationary block having mass 4 m. The lighter block comes to rest after collision. When the initial velocity of the lighter block is v, then the value of coefficient of restitution (e) will be

1. 0.8
2. 0.5
3. 0.4
4. 0.25 ✓

Before: (m) → v (4m) rest

After: (m) rest (4m) → v_0 (let)

$$[\vec{P_i} = \vec{P_f}]$$

$$mv + 0 = m \times 0 + 4mv_0$$

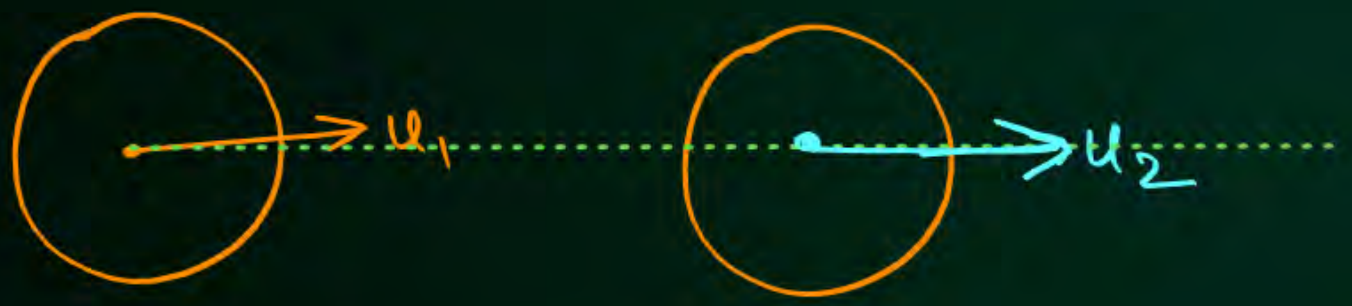
$$mv = 4mv_0$$

$$v_0 = \frac{v}{4}$$

$$e = \frac{\text{velocity of sep}^n}{\text{velocity of appr}^n} = \frac{v/4}{v} = \frac{1}{4} = 0.25$$

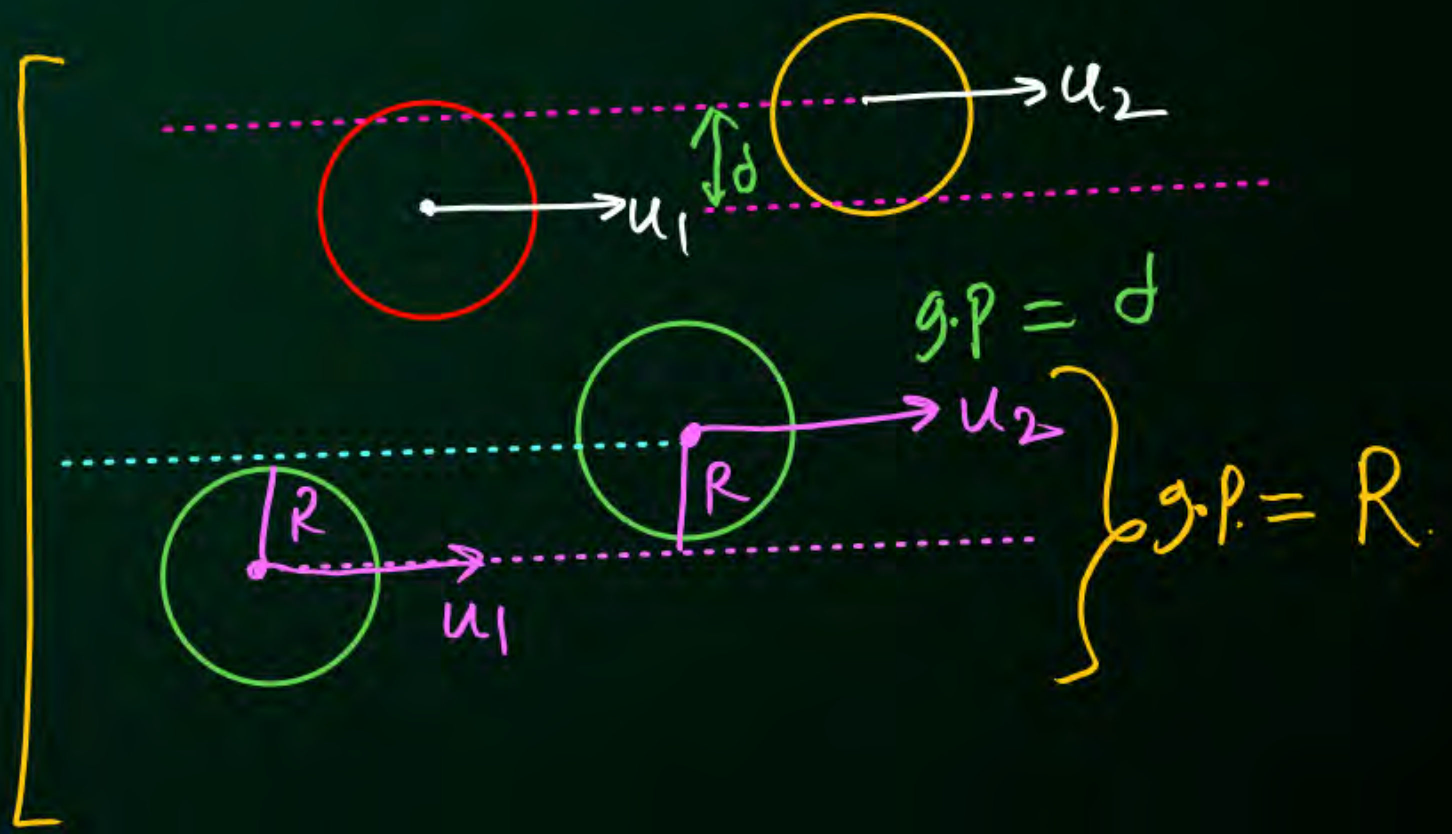
IMPACT PARAMETER

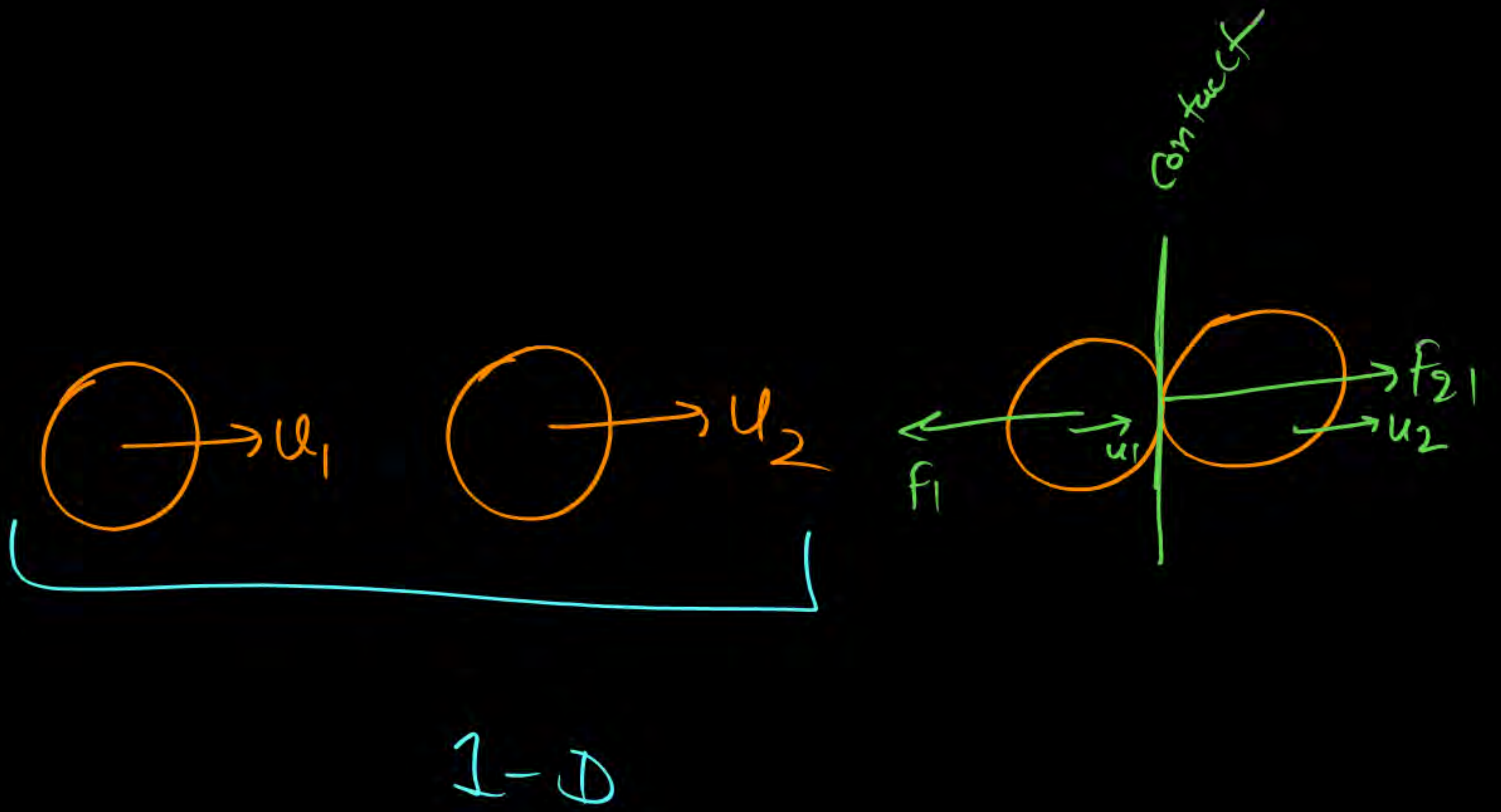
- Perpendicular distance between initial velocity vector of two object.



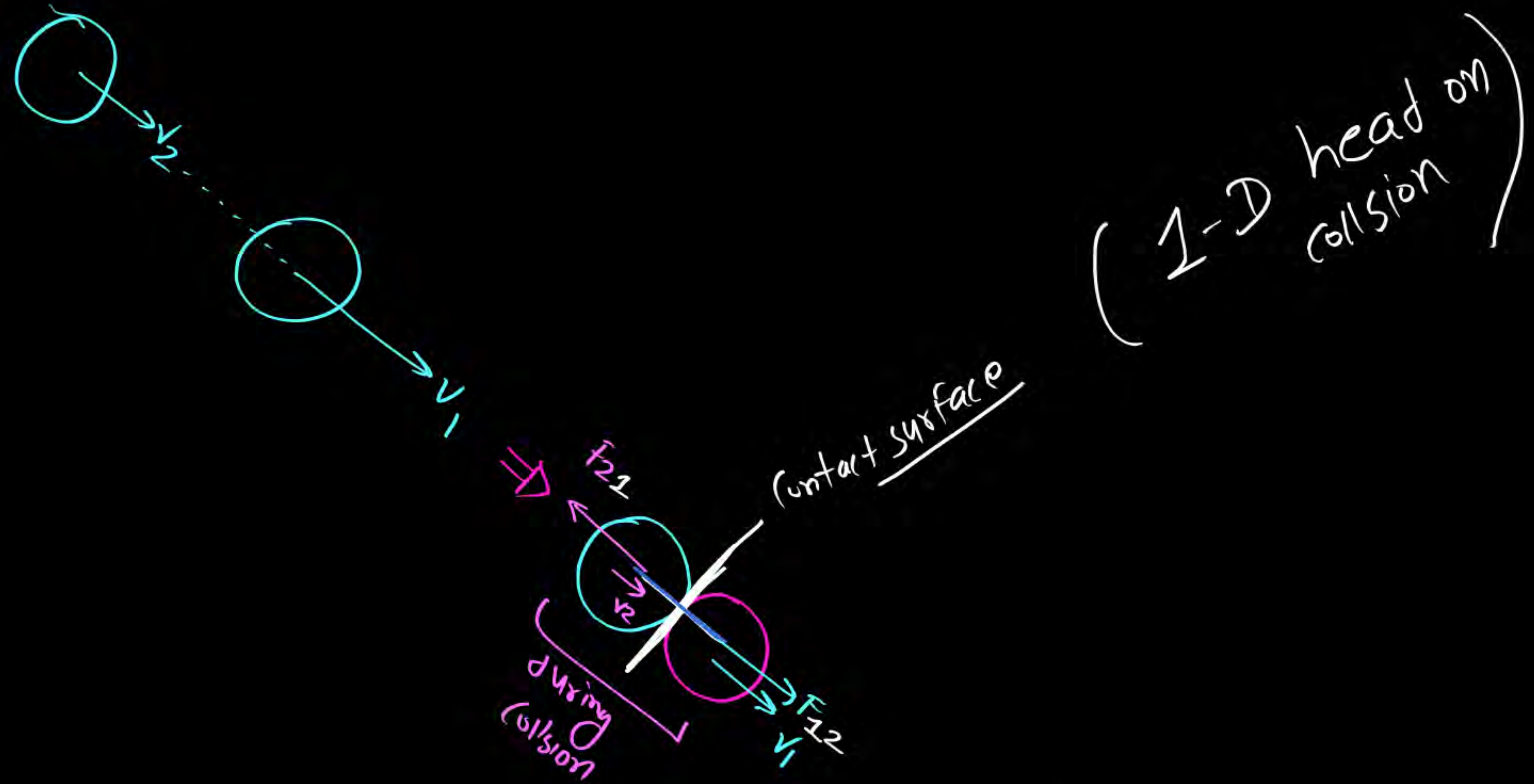
Impact Parametre = 0
head on collision
(1-D collision)

0 < I.P. then collision will be 2-D.

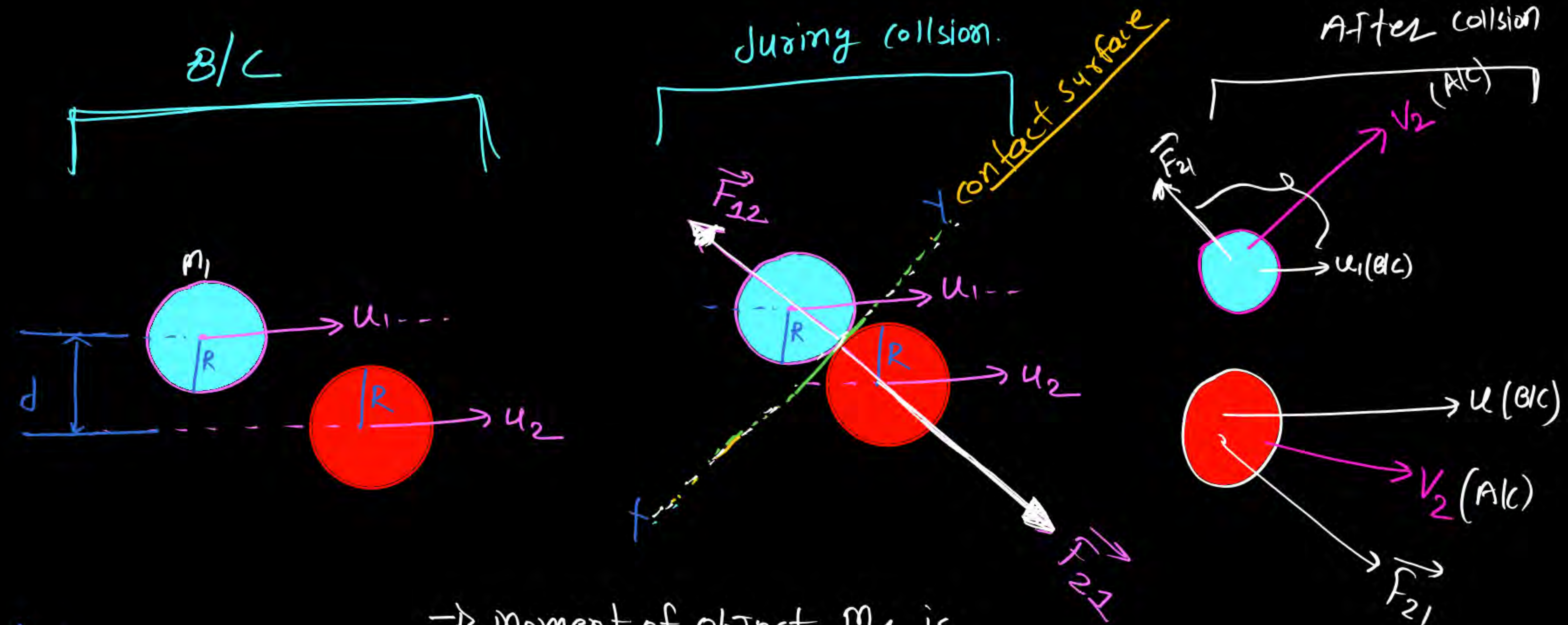




u1
u2
1-D
contact
f1
u1
f21
u2



v2
v1
F21
v2
contact surface
during collision
F12
v1
(1-D head on collision)



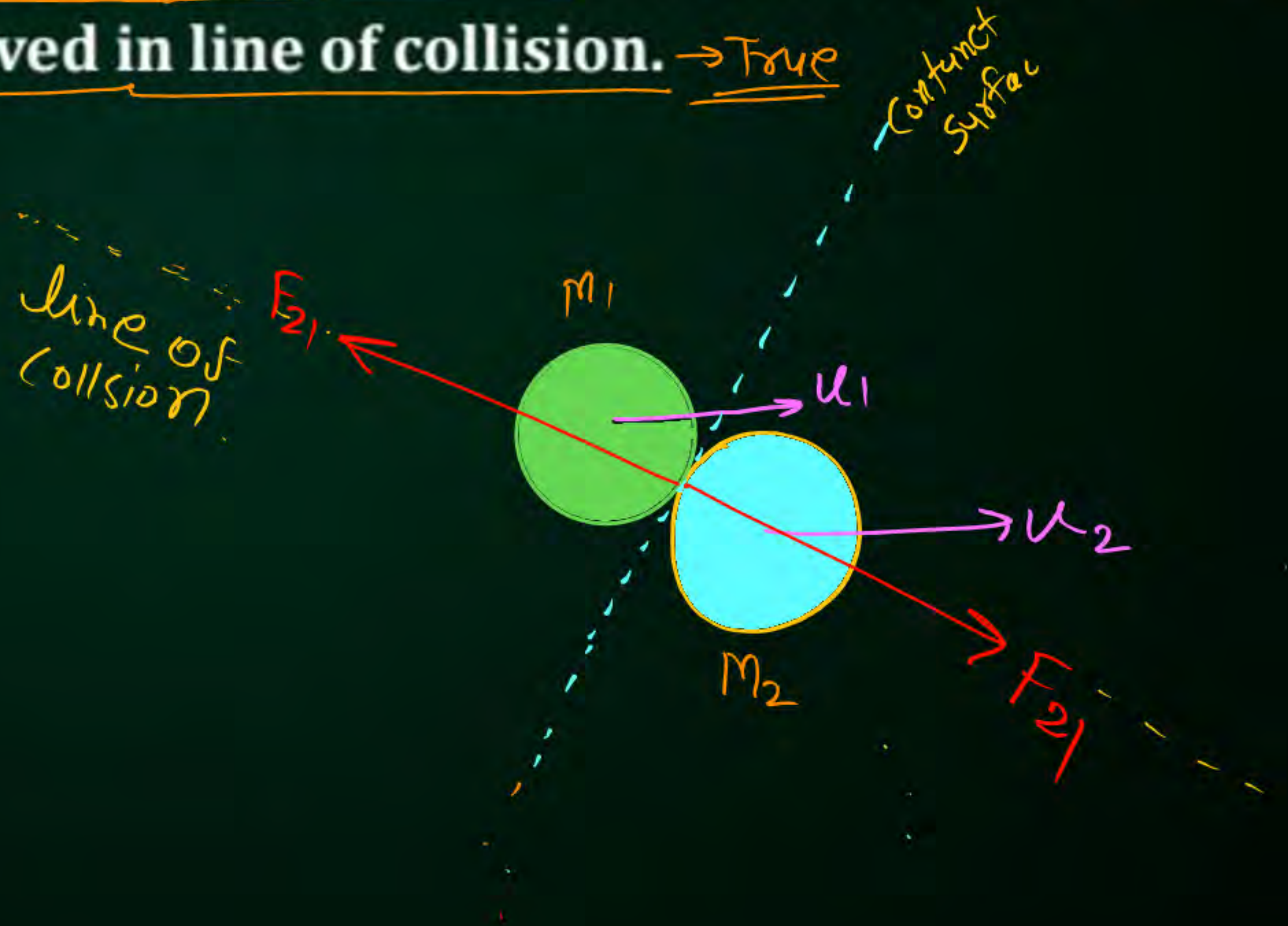
Impact Parametre = d

$$R < d < 2R$$

⇒ Moment of object m_1 is conserved along line xy. → True

$(\hat{F}_{ext})_{system} = 0$

- **Momentum of system will conserved in line of collision and** Perpendical **to line of collision.** → True
- **Momentum of object will conserved in parallel to line of collision.** → false
- **Moment of object will not conserved in line of collision.** → True



QUESTION

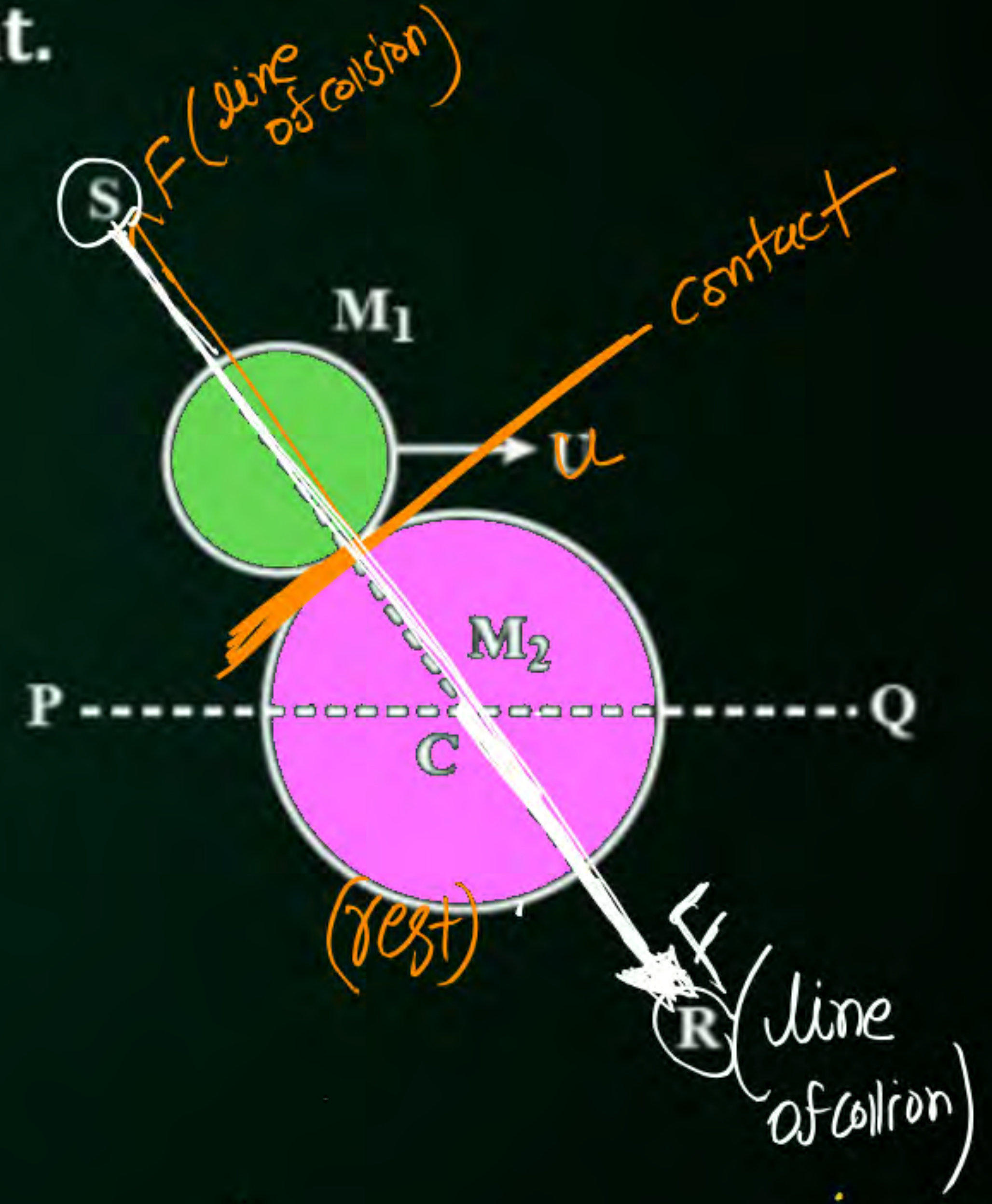
An object of mass M_1 moving horizontally with speed u collides elastically with another object of mass M_2 at rest. Select correct statement.

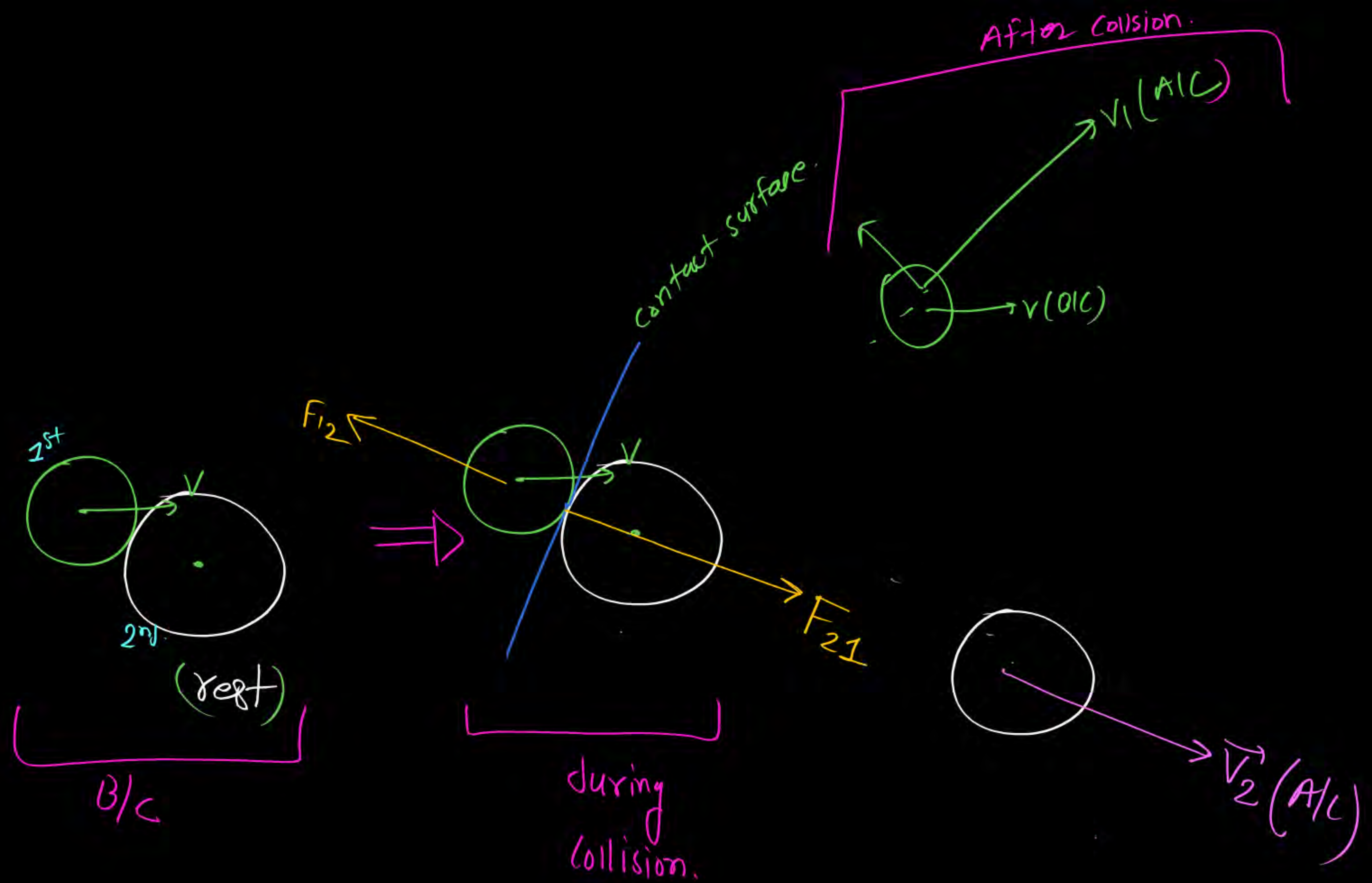
1. The momentum of system is conserved only in direction PQ $(F_{system})_{ext} = 0$ (false)

2. Momentum of M_1 is conserved in direction perpendicular to SR (76%)

3. Momentum of M_2 will change in direction normal to CR

4. All of these



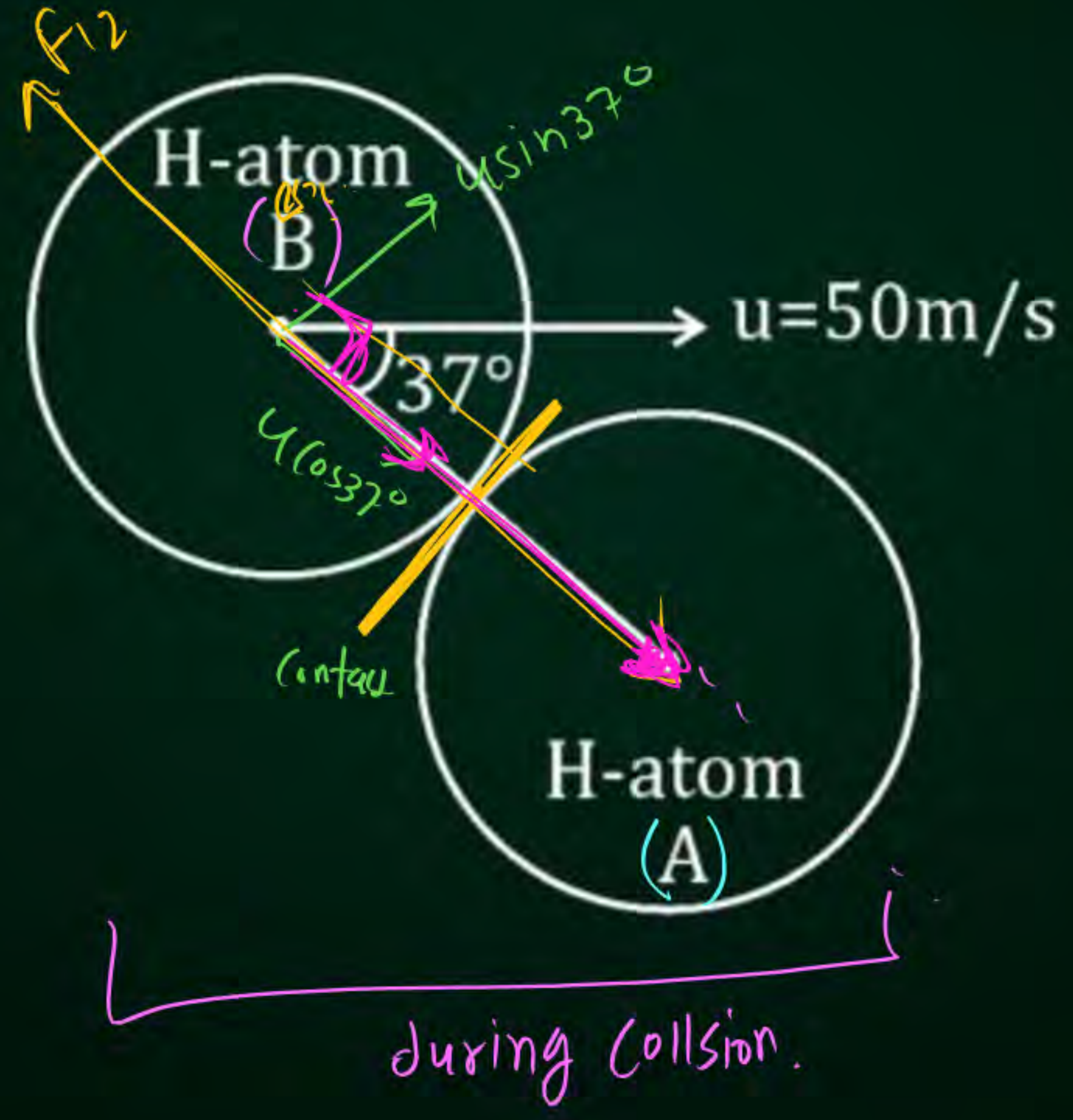


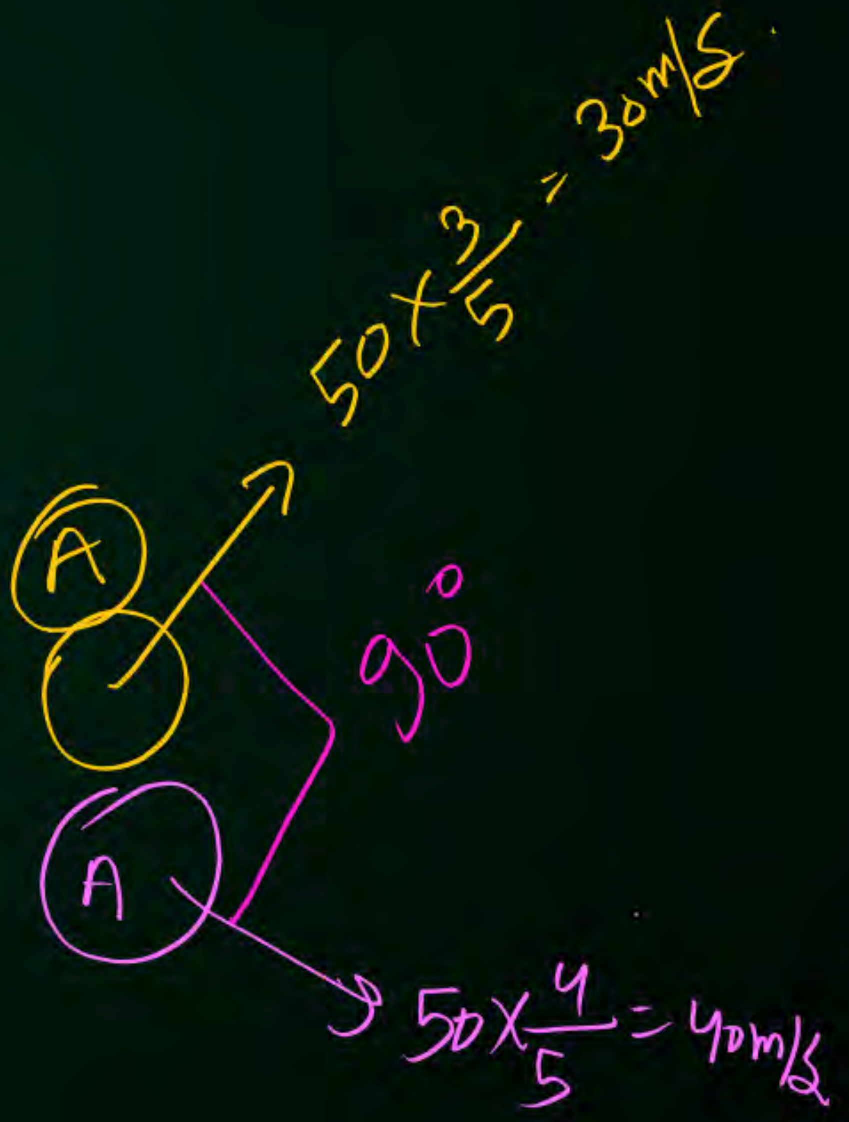
After collision.
v_1 (A/C)
v (B/C)
contact surface.
F_{12}
F_{21}
1st
2nd
v
(rest)
B/C
during collision.
$\vec{V_2}$ (A/C)

QUESTION

Two H-atom as shown in figure. A is at rest, then find velocity each atom after elastic collision.

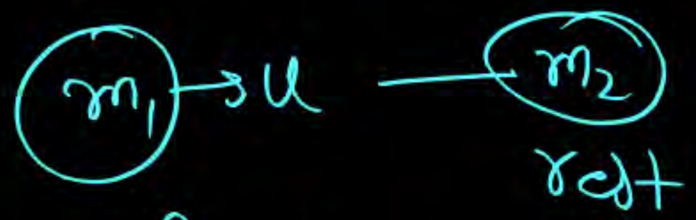
Both have a same mass and elastic collision then they will interchange their velocity along line of collision.





Q) head on elastic collision B/W m_1 & m_2 where m_2 is at rest then find ratio of $\frac{m_1}{m_2}$ so that maximum K.E will transf from m_1 to m_2.

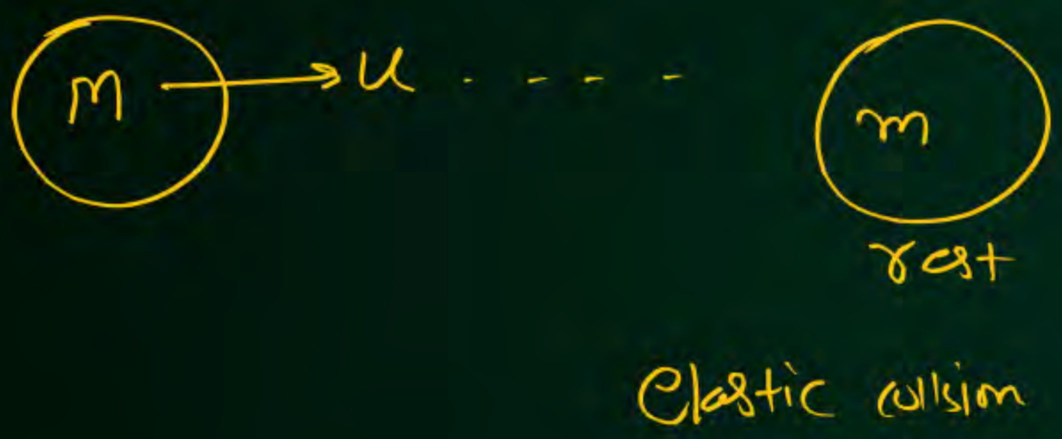
$$n = 1 = \frac{m_1}{m_2}$$

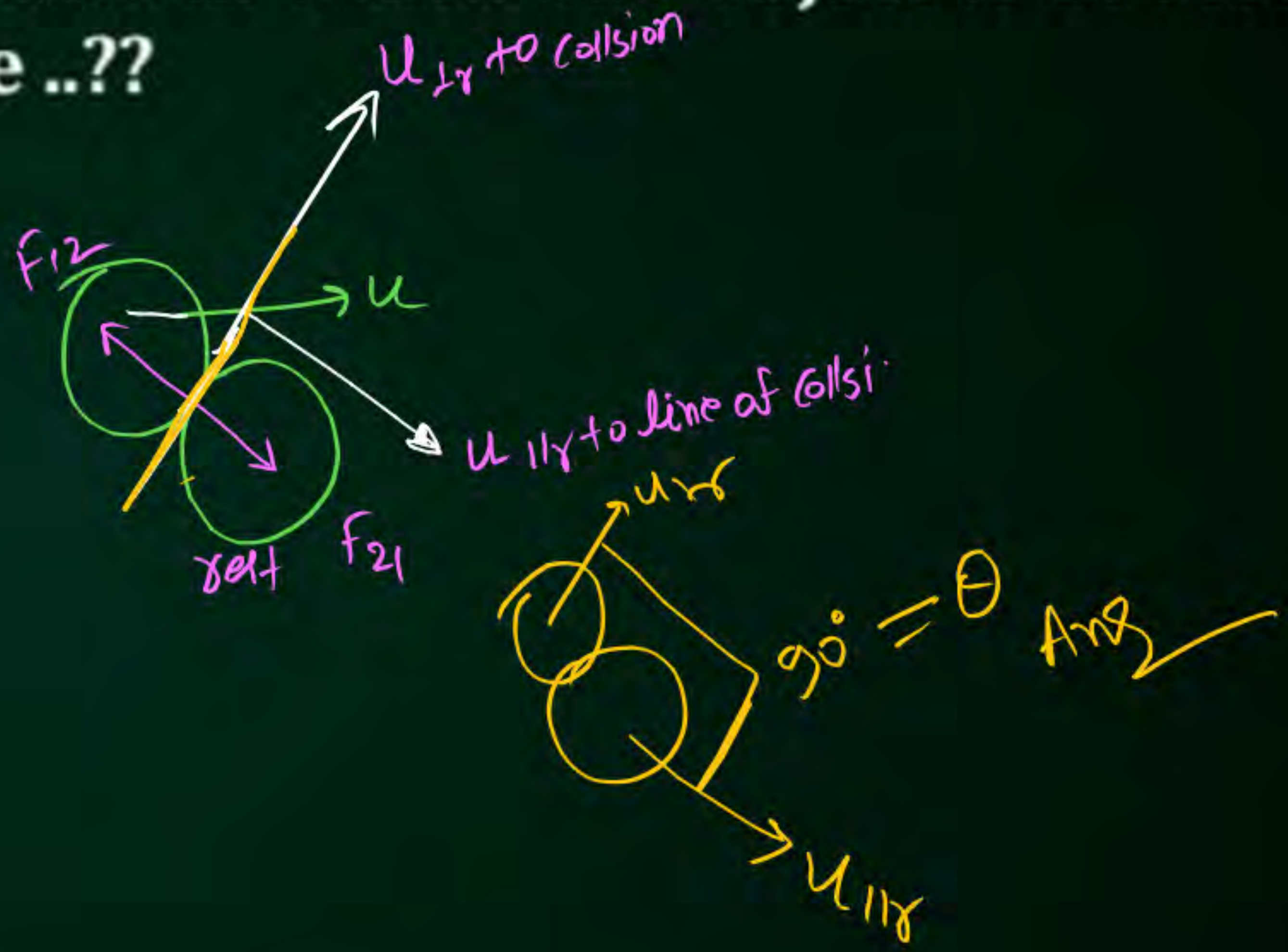


fract of transfr K.E $= \frac{4n}{(1+n)^2} = \frac{4\times 1}{(1+1)^2} = \frac{4}{4} = 1$

QUESTION

Oblique elastic collision between same mass in which one object is at rest then angle between final velocity vector will be ..??



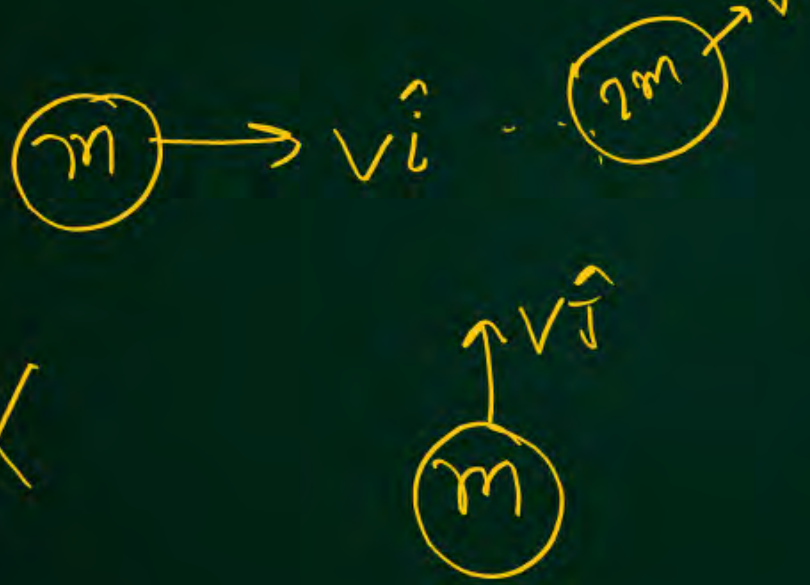


QUESTION

A particle of mass m moving eastward with a speed v collides with another particle of the same mass moving northwards with same speed v. The two particles coalesce on collision. The new particle of mass $2m$ will move with velocity

(Perfectly inelastic)

1. $\frac{v}{2}$ North–East
2. $\frac{v}{\sqrt{2}}$ = South–West
3. $\frac{v}{2}$ North–West
4. $\frac{v}{\sqrt{2}}$ = North–East



$$\vec{P_i} = \vec{P_f}$$

$$mv\hat{i} + mv\hat{j} = 2m\vec{v}$$

$$\frac{v\hat{i}+v\hat{j}}{2} = \vec{v}$$

$$\vec{v} = \frac{v}{2}(\hat{i}+\hat{j})$$

$$|\vec{v}| = \frac{v}{2}(\sqrt{2}) = \frac{v}{\sqrt{2}}$$

QUESTION

A particle of mass m moving towards west with speed v collides with another particle of mass m moving towards south. If two particles stich to each other, the speed of the new particle of mass 2 m will be

1. $v\sqrt{2}$
2. $\frac{v}{\sqrt{2}}$
3. $\frac{v}{2}$
4. v

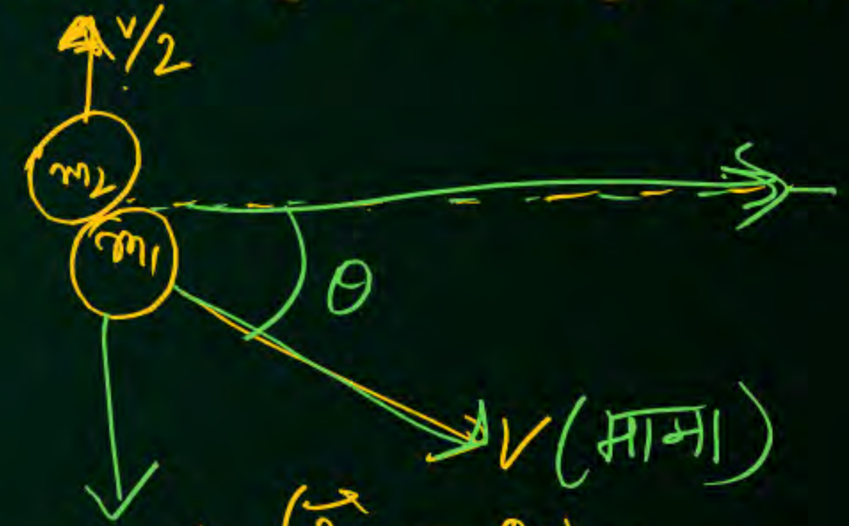
Same question

QUESTION

Two spheres A and B of masses m_1 and m_2 respectively collide. A is at rest initially and B is moving with velocity v along x-axis. After collision B has a velocity $\frac{v}{2}$ in a direction perpendicular to the original direction. The mass A moves after collision in the direction

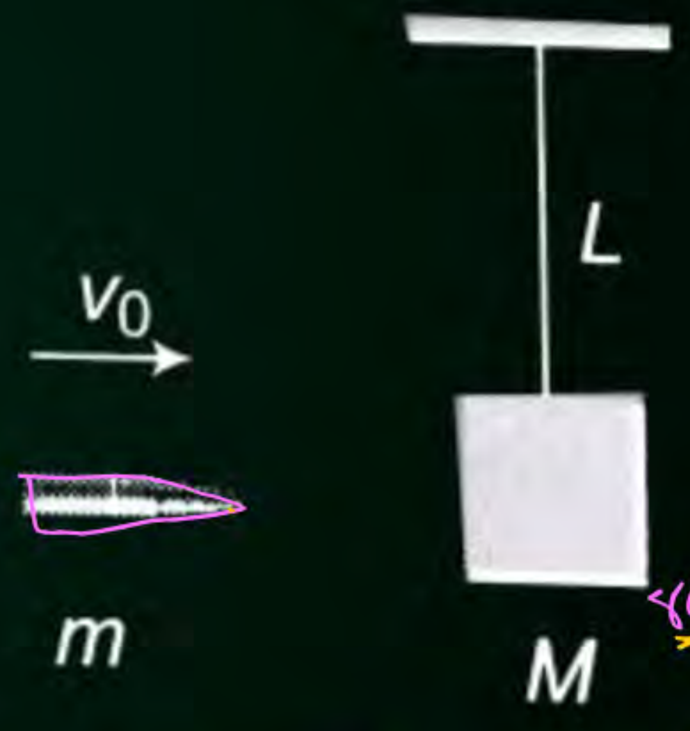
[AIPMT (Prelims)-2012]

1. $\theta = \tan^{-1}\left(\frac{1}{2}\right)$ to the x-axis
2. $\theta = \tan^{-1}\left(-\frac{1}{2}\right)$ to the x-axis
3. Same as that of B
4. Opposite to that of B



QUESTION

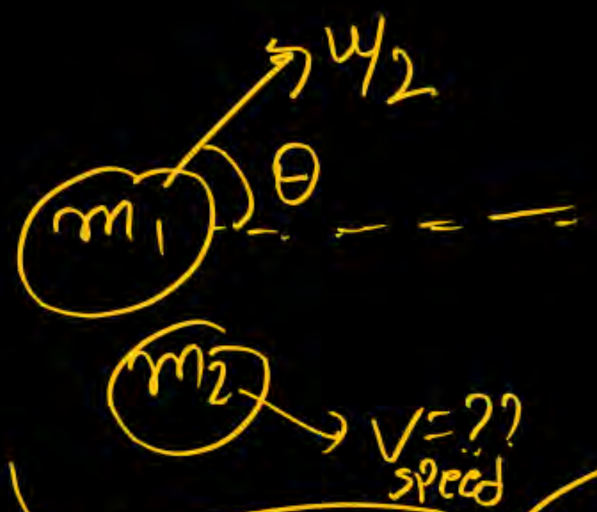
Consider the situation as shown in the diagram. The bullet penetrates the block and emerges with speed $v_0/3$. If after collision, the string becomes horizonal, v_0 will be



1. $\frac{m}{M}\sqrt{2gL}$
2. $\frac{2}{3}\frac{m}{M}\sqrt{2gL}$
3. $\frac{3}{2}\frac{M}{m}\sqrt{2gL}$
4. $\frac{m}{M}\sqrt{2gL}$



B/C



After oblique elastic collision

- Inelastic oblique Collision → Momentum conserved karenge
- Elastic oblique Collision → K·E - conserved karenge

K·E· Conservation

$$K.E_i = K.E_f$$

$$\frac{1}{2} m_1 u^2 = \frac{1}{2} m_1 \left(\frac{u}{2}\right)^2 + \frac{1}{2} m_2 v^2$$

$$m_1 u^2 = \frac{m_1 u^2}{4} + m_2 v^2$$

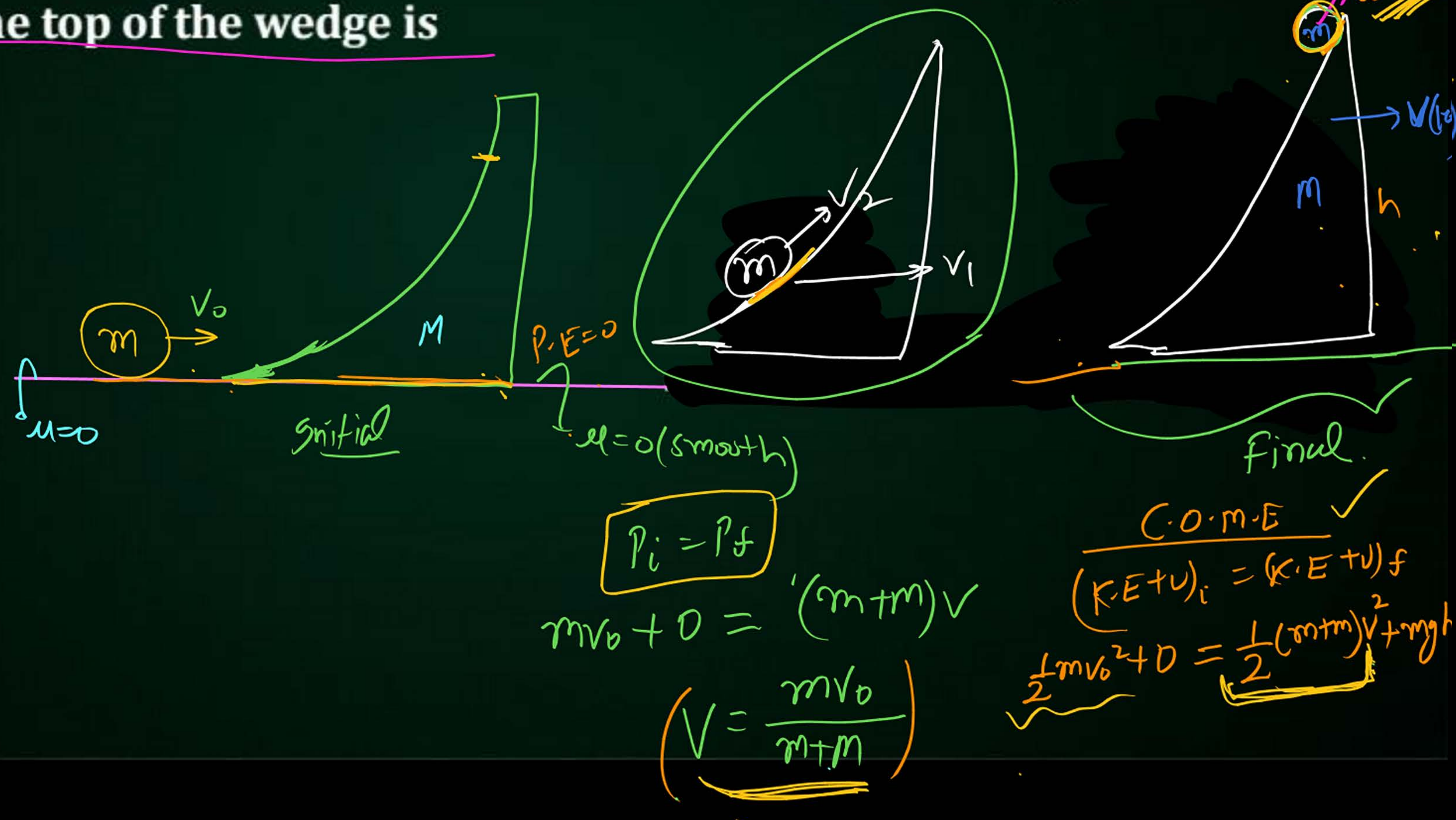
$$\sqrt{\frac{3 m_1 u^2}{4 m_2}} = v$$

(Ans)

QUESTION

A block of mass m is pushed towards the movable wedge of mass M and height h, with a velocity v_0. All surfaces are smooth. The minimum value of v_0 for which the block will reach the top of the wedge is

1. $\sqrt{2gh}$
2. $\sqrt{\frac{2ghm}{M}}$
3. $\sqrt{\frac{2gh(m+M)}{M}}$
4. $\sqrt{\frac{2ghM}{(m+M)}}$



$$\frac{1}{2} m v_0^2 = \frac{1}{2}(M+m)v^2 + mgh$$

Putting value of v

$$\frac{1}{2} m v_0^2 = \frac{1}{2}(M+m)\left(\frac{m v_0}{M+m}\right)^2 + mgh$$

$$\frac{1}{2} m v_0^2 - \frac{1}{2}\frac{m^2 v_0^2}{(M+m)} = mgh$$

$$\frac{v_0^2}{2}\left[1 - \frac{m}{M+m}\right] = gh$$

$$v_0^2\left(\frac{M+m-m}{M+m}\right) = 2gh$$

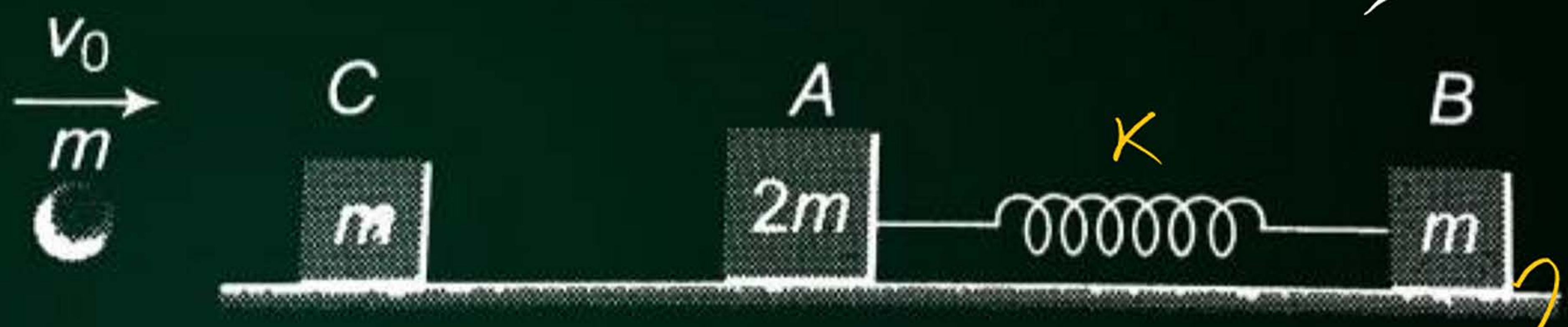
$$v_0 = \sqrt{\frac{M+m}{M}(2gh)}$$

QUESTION

Level up

The ball sticks to block *C*, then block *C* collides elastically, head-on with *A*. If the maximum compression is x_0, the spring constant *k* is

H/W



1. $\frac{2}{3}\frac{mv_0^2}{x_0^2}$

2. $\frac{mv_0^2}{2x_0^2}$

3. $\frac{mv_0^2}{3x_0^2}$

4. $\frac{mv_0^2}{6x_0^2}$

Collision B/w Ball & Block (C)

$mv_0 = 2mV$

$V = \frac{V_0}{2}$



max^m comp

final

$$P_i = P_f$$

$$\frac{2mv_0}{2} = (2m+m)\,v_c$$

$$mv_0 = 3m\,v_c$$

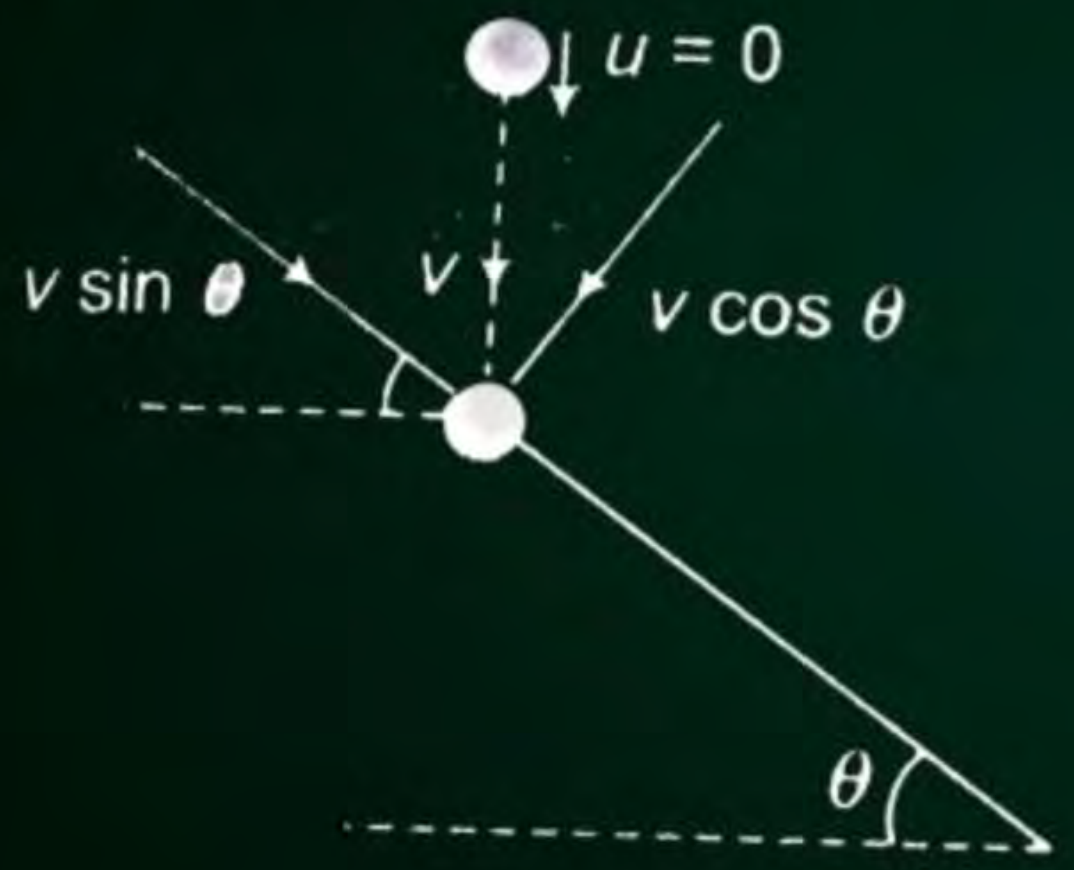
$$V_c = \frac{v_0}{3}$$

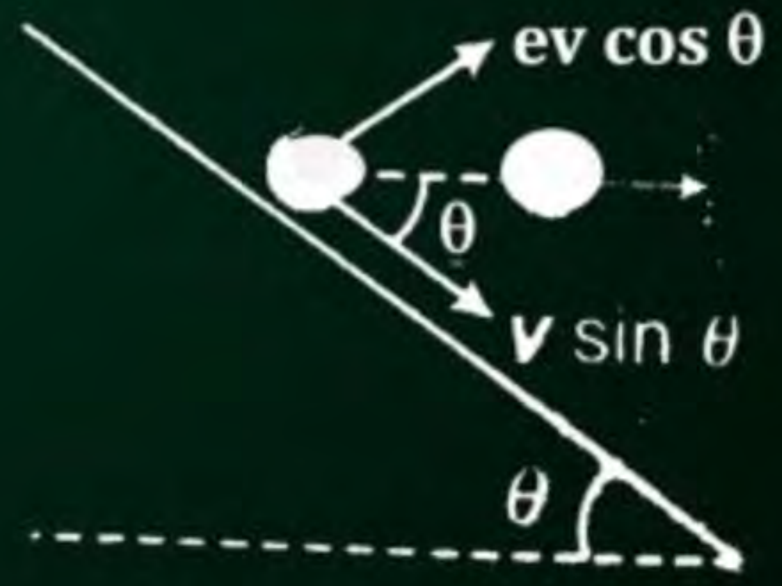
COME

$$\frac{1}{2}(2m)\left(\frac{v_0}{2}\right)^2 + 0 + 0 = \frac{1}{2}(3m)\,v_c^2 + \frac{1}{2}kx^2$$

QUESTION

A ball after falling a distance collides an inclined plane of inclination θ. If after the collision, the ball moves horizontally, find the coefficient of restitution.





H/W


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 01 | Physics

Rotational Motion

By- Dr. Manish Raj (MR SIR)



Topic To be Covered

1 # moment of inertia

2 #

3 #

4 #



Rotational motion

(1). Moment of Inertia *

(2) Torque ($\vec{\tau} = \vec{r} \times \vec{F}$) *

(3) Pure Rot^n Mot^n $F = ma$ *

$\tau = I\alpha$

(4) (Rolling mot^n)

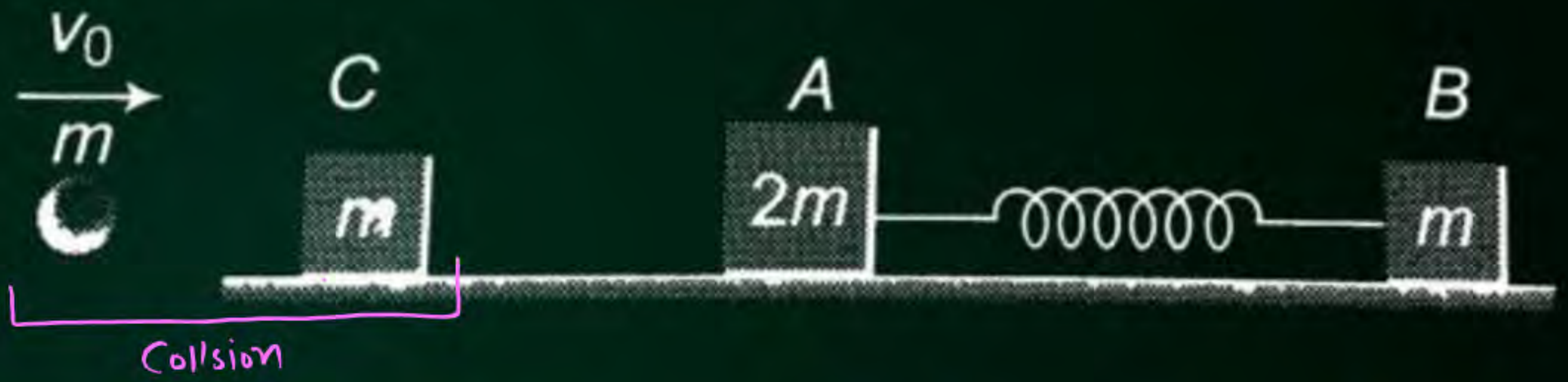
100% question without sol^n

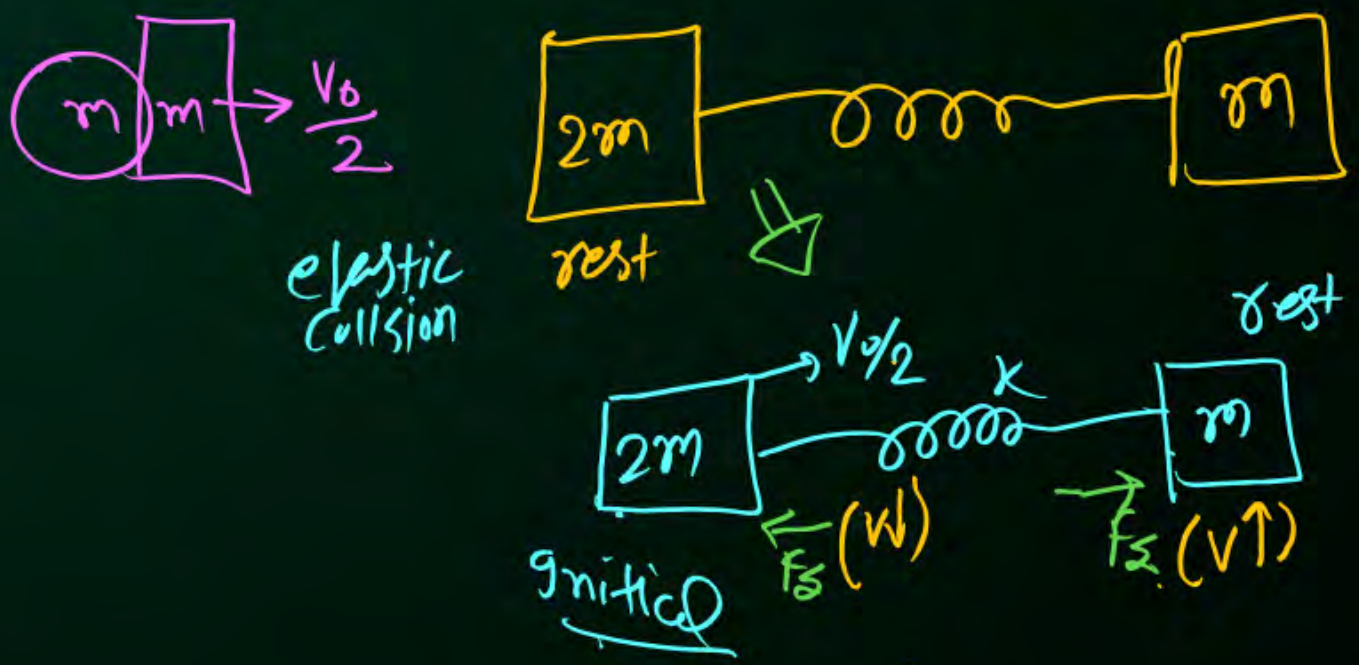
(5) Angular momentum. *

(6) Toppling

QUESTION

The ball sticks to block C, then block C collides elastically, head-on with A. If the maximum compression is x_0, the spring constant k is





(1) $\frac{2}{3}\frac{mv_0^2}{x_0^2}$

(2) $\frac{mv_0^2}{2x_0^2}$

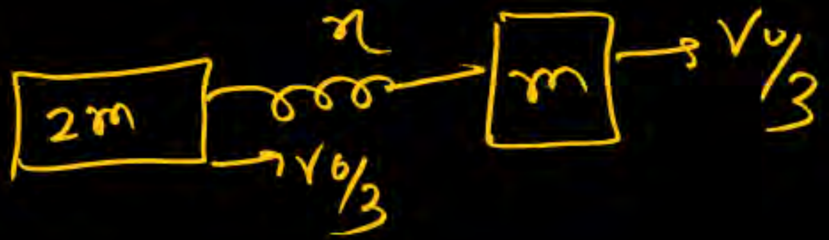
(3) $\frac{mv_0^2}{3x_0^2}$

(4) $\frac{mv_0^2}{6x_0^2}$

when velocity (2m) & (m) becomes equal then compression will stop.

$$2m\frac{v_0}{2} + 0 = 3m\,V_c$$

$$\boxed{V_c = \frac{v_0}{3}}$$



COME

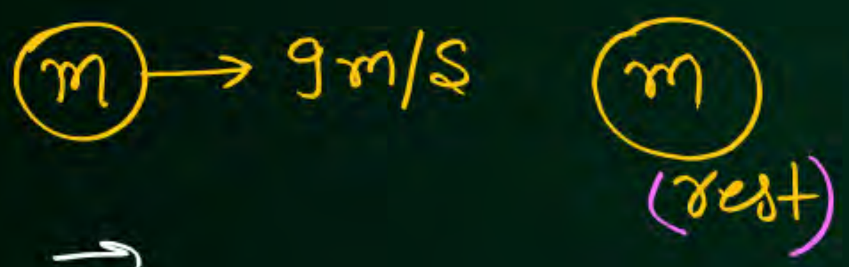
$$(K.E + U)_i = (K.E + U)_f$$

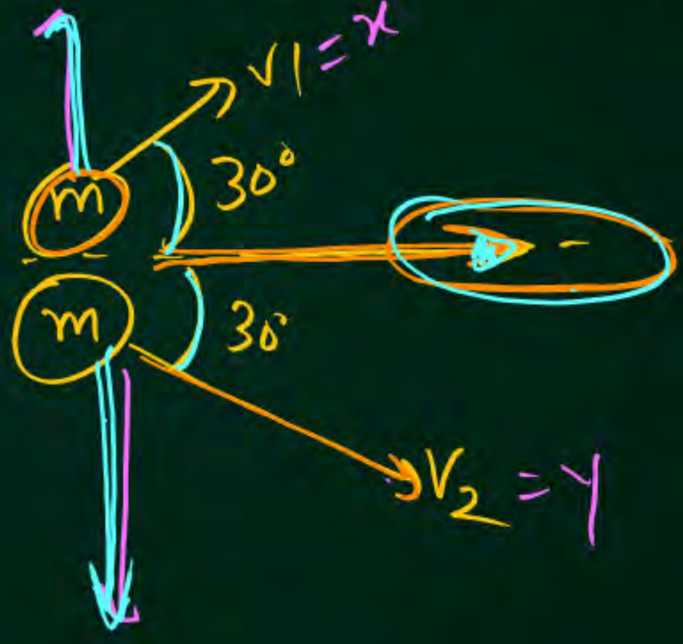
$$\frac{1}{2}2m\left(\frac{v_0}{2}\right)^2 + 0 + 0 = \frac{1}{2}(3m)\left(\frac{v_0}{3}\right)^2 + \frac{1}{2}Kx^2$$

Soln

QUESTION

A ball with a speed of 9 m/s collides with another identical ball at rest. After the collision, the direction of each ball makes an angle of 30° with the original direction. The ratio of velocities of the balls after collision is $x : y$, where x is ____.





$$\vec{P}_i\,y = \vec{P}_f\,y$$

$$0 + 0 = m v_1 \sin 30^\circ + m v_2 \sin 30^\circ$$

$$m v_1 \sin 30^\circ = - m v_2 \sin 30^\circ$$

$$\vec{v}_1 = -\vec{v}_2$$

$$\vec{P}_i\,x = (\vec{P}_f)\,x$$

$$m \times 9 + 0 = 2 m v_1 \cos 30^\circ$$

$$9 = 2 v_1 \frac{\sqrt{3}}{2}$$

$$v_1 = \frac{9}{\sqrt{3}} = 3\sqrt{3}$$

Ans

$$v_2 = 3\sqrt{3}$$

Law of Motion

translational state of motion.

(1) state of rest ($v = 0$)
(2) state of uniform motn ($\vec{v} = const^n$)

→ $F_{net} = 0$

When we apply ext^n force then there is change in state of Body,

Inharent Property of body by which it oppose the cause of change in state. that is (Inertia). [Inertia ∝ mass]

Rotational state of Body

(1) State of rest ($\vec{\omega} = 0$)
(2) state of uniform Rot^n ($\vec{\omega} = const^n$)

[No external / Torque is required to keep the body in the same Rotational state]

- When we Apply torque then it Rotatational state will change.

- Inharent Property of a body which it oppose the cause of change in Rotational state → [Moment of Inetia] → Rotational mass

Moment - Inertia

→ घुमाने का कष्ट है | या घूमते हुए को रोकने का कष्ट है|

$I \propto$ mass

$I \propto r^2$

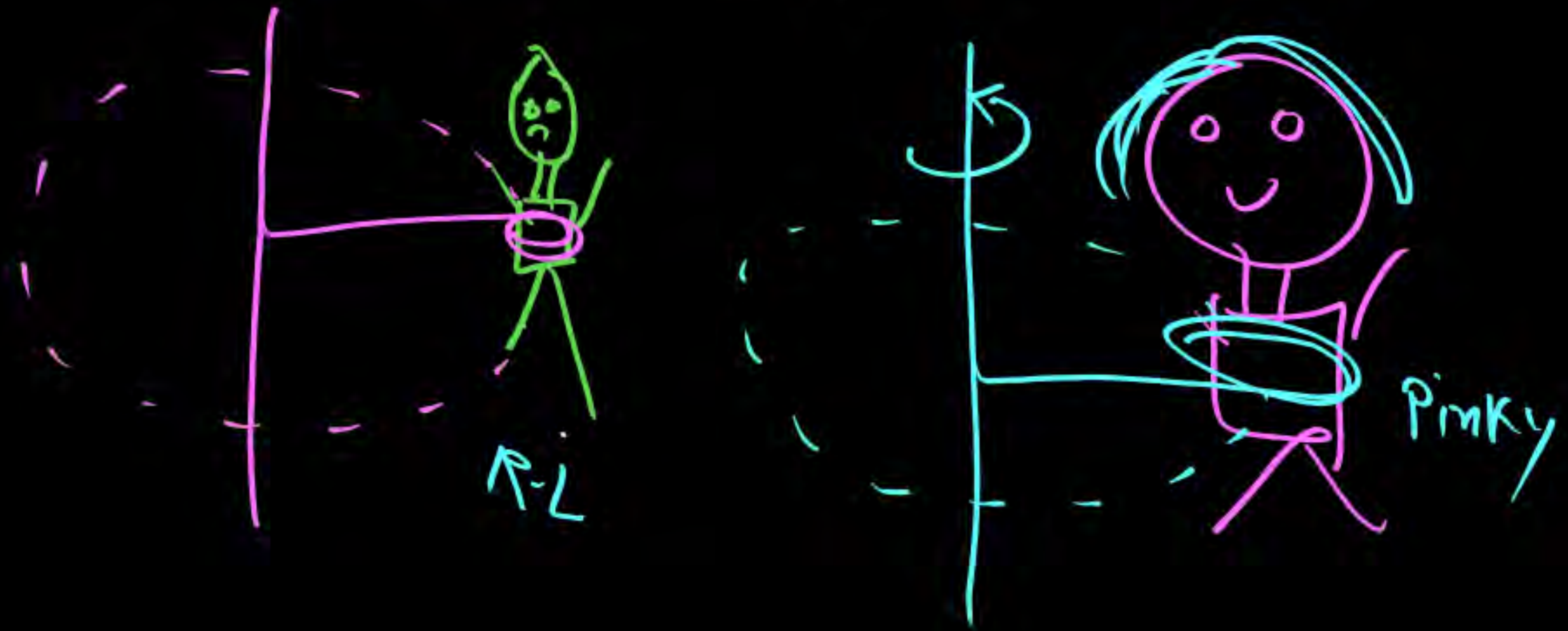
for Point object

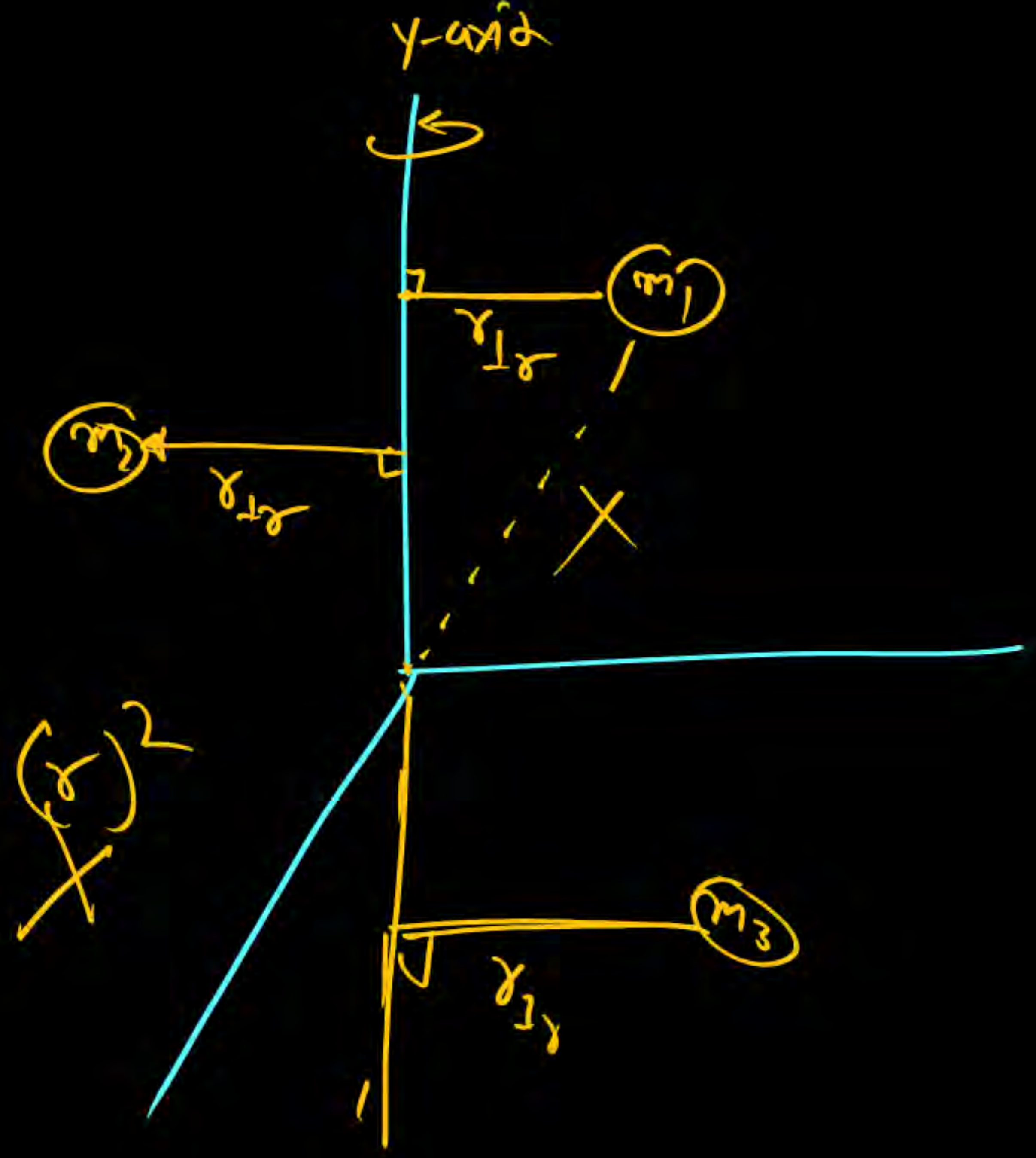
$\Rightarrow$ $I = mr^2$

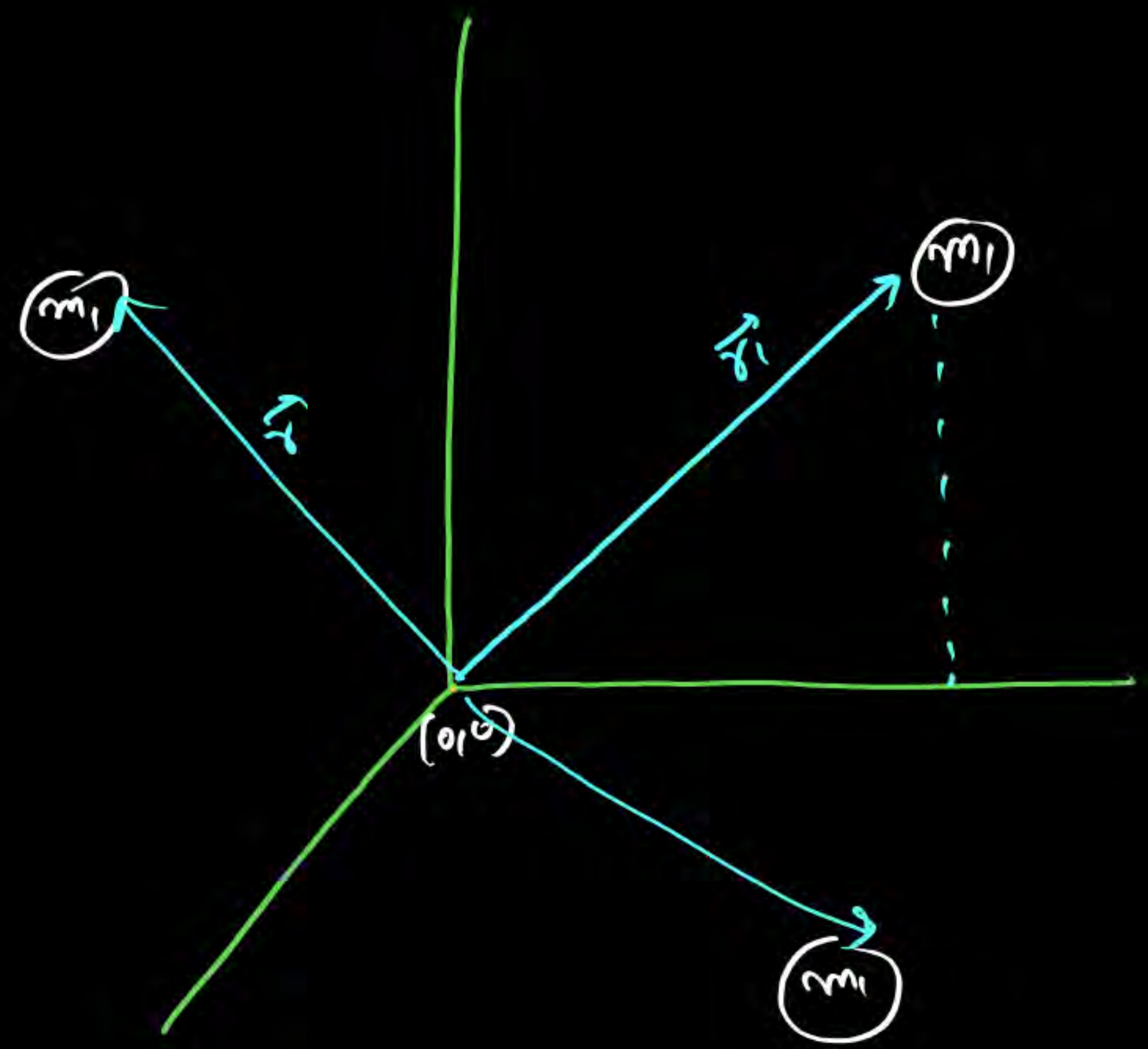
↳ dist^n of mass from axis of rot^n.

$I = (\text{कितना mass}) \times (\text{कितना दूर})^2$

- Scalar (No dir^n) [Tensor]
- Can't be −ve
- Can't subtract
- Unit $[kg \times m^2]$
- ML^2T^0
- depends on mass, & dist^n of mass from axis of Rot^n.




y-axis
m1
m2
m3


m1
m1
m1
(0,0)

MOMENT OF INERTIA

- Property of the body by virtue of which it opposes cause of change in rotational state of motion.
- Unit : kg - m²
- Dimension : $M^1 L^2 T^0$ → Scalar → Oppose torque.

(*) Depends upon → Mass and distribution of mass and axis of Rotational.

- **Not depend upon** → Torque, angular acceleration, *w* etc.

$F = ma \quad m = F/a$

Mass depend on Force ✗

$\tau = I\alpha$

does not depends on τ & α



$I = mr^2$

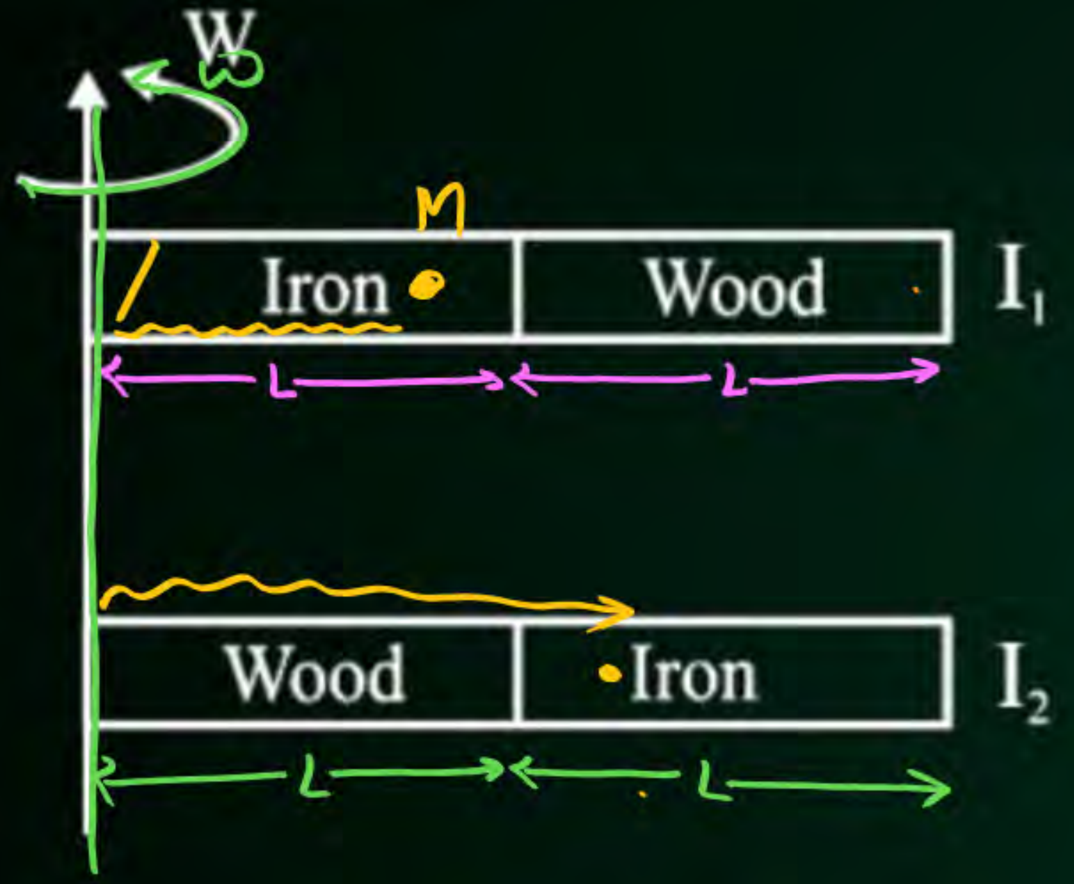
$= (3)(5)^2 = 3\times25 = 75$ ✗

$I = (3)(4)^2 = 16\times3 = 48\ kg\,m^2$ ✓

$\sin 53^\circ = \frac{r_{\perp r}}{5}$

$\frac{4}{5} = \frac{r_{\perp r}}{5}$

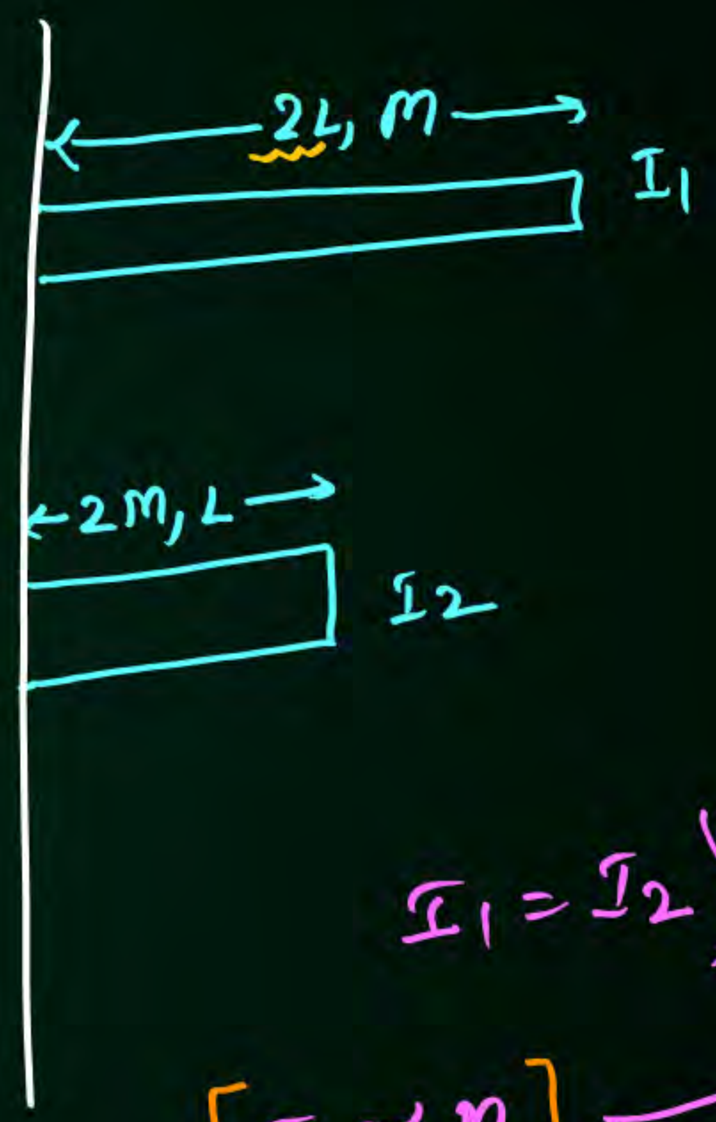
QUESTION



(i) $I_1 = I_2$

(ii) $I_1 > I_2$

(iii) $I_1 < I_2$

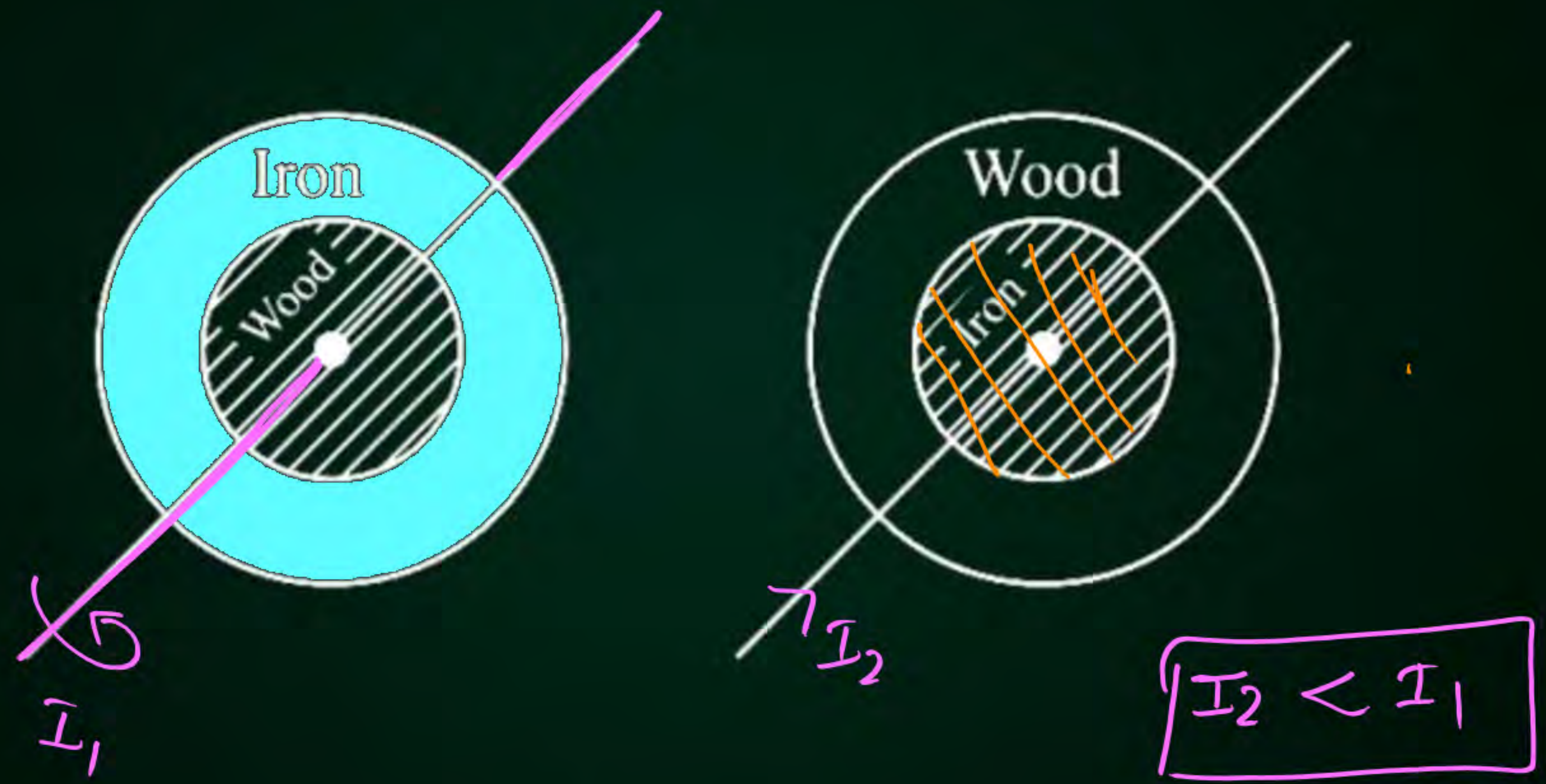


$I_1 = I_2$ ✗

$I \propto m$

$I \propto L^2$

$I_2 < I_1$



Iron
Wood
I_1
Wood
Iron
I_2
$I_2 < I_1$

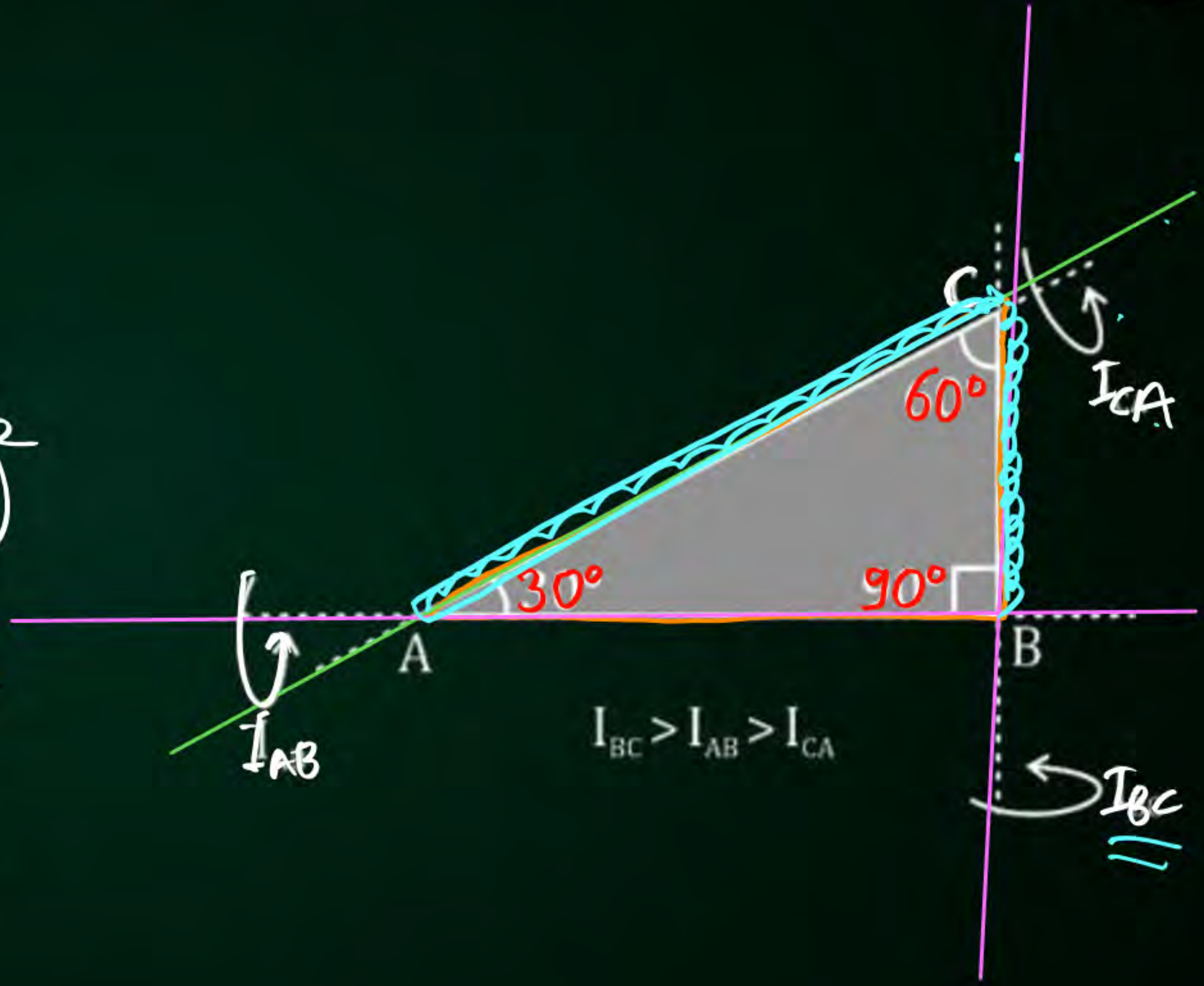
QUESTION

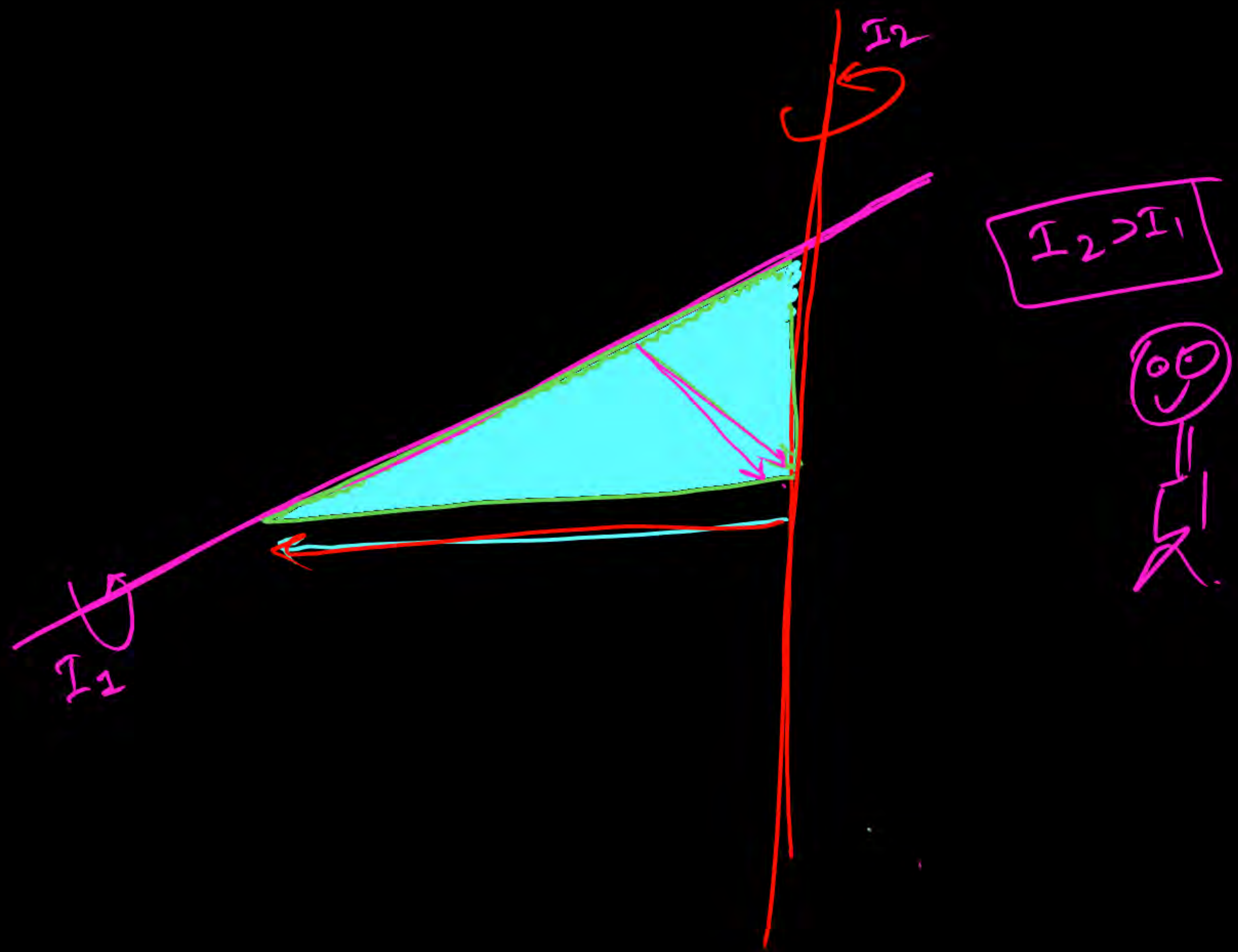
Which of the following is correct

1. $I_{AB} = I_{BC} = I_{CA}$
2. $I_{AB} > I_{BC} > I_{CA}$
3. $I_{AB} < I_{BC} < I_{CA}$
4. $I_{BC} > I_{AB} > I_{CA}$

$I \propto m(\text{कितना दूरी})^2$



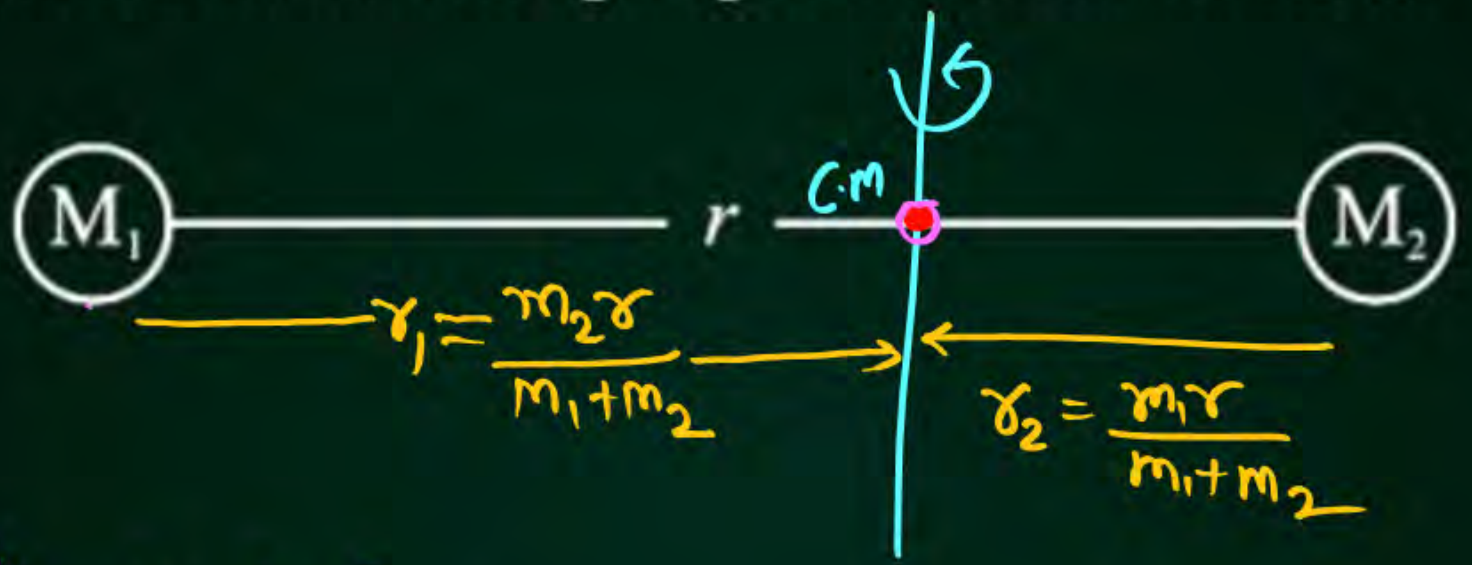




I2
I1
I2>I1

QUESTION

Find M.O.I. about Centre of Mass and perpendicular to line.

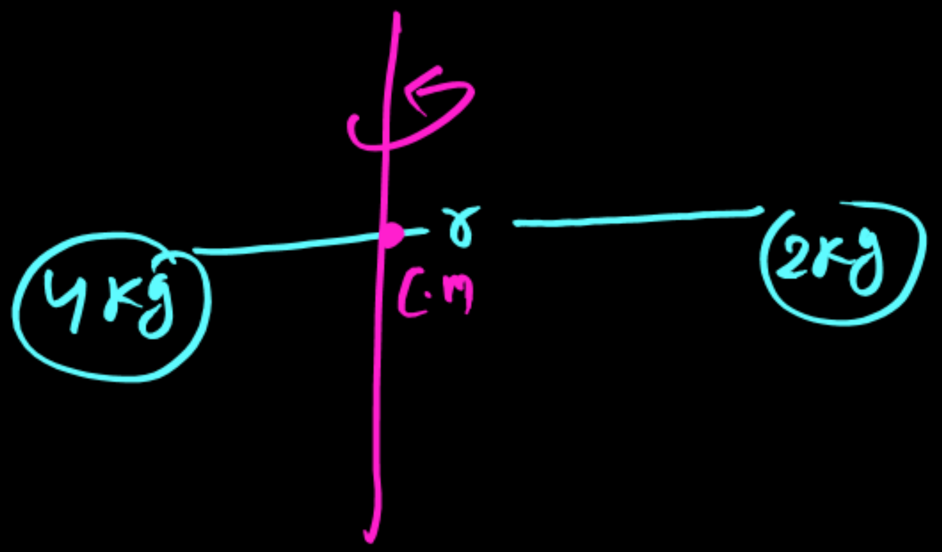


$$I_1 = m_1 (r_1)^2 + m_2 (r_2)^2$$

$$= m_1 \left(\frac{m_2 r}{m_1 + m_2}\right)^2 + m_2 \left(\frac{m_1 r}{m_1 + m_2}\right)^2$$

$$= \frac{m_1 m_2^2 r^2}{(m_1 + m_2)^2} + \frac{m_2 m_1^2 r^2}{(m_1 + m_2)^2} = \frac{m_1 m_2 r^2}{(m_1 + m_2)^2} (m_2 + m_1) = \left(\frac{m_1 m_2}{m_1 + m_2}\right) r^2$$

$$= \mu r^2$$

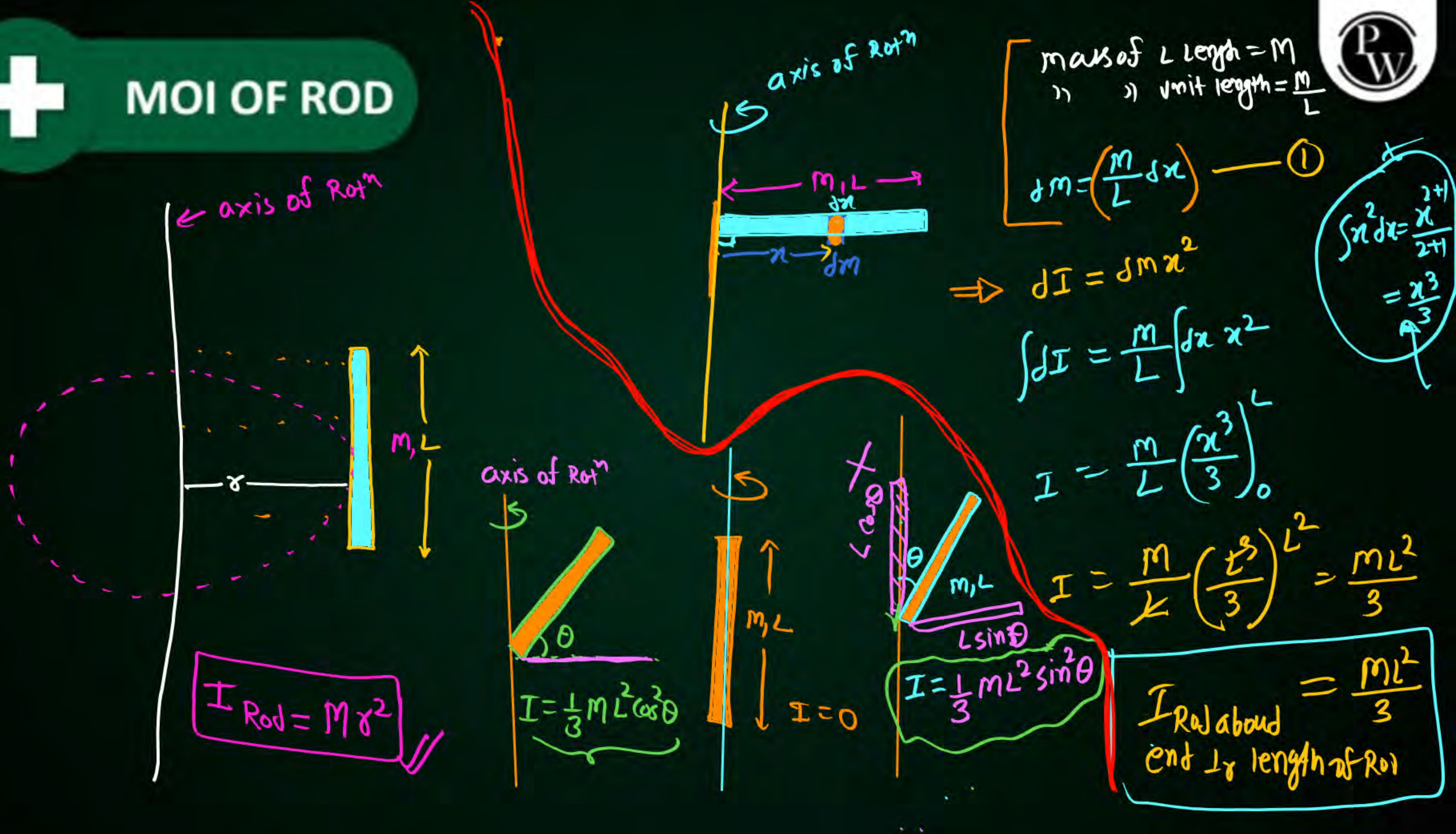


$$I = \frac{4\times 2}{4+2} r^2$$

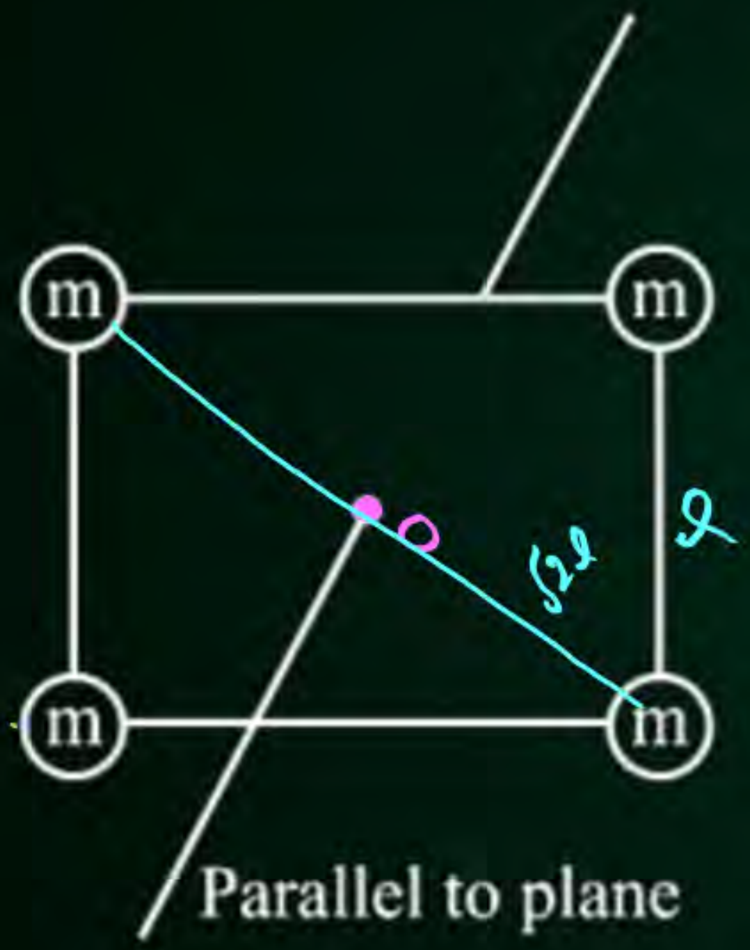
$$= \frac{8}{6} r^2 = \frac{4}{3} r^2$$

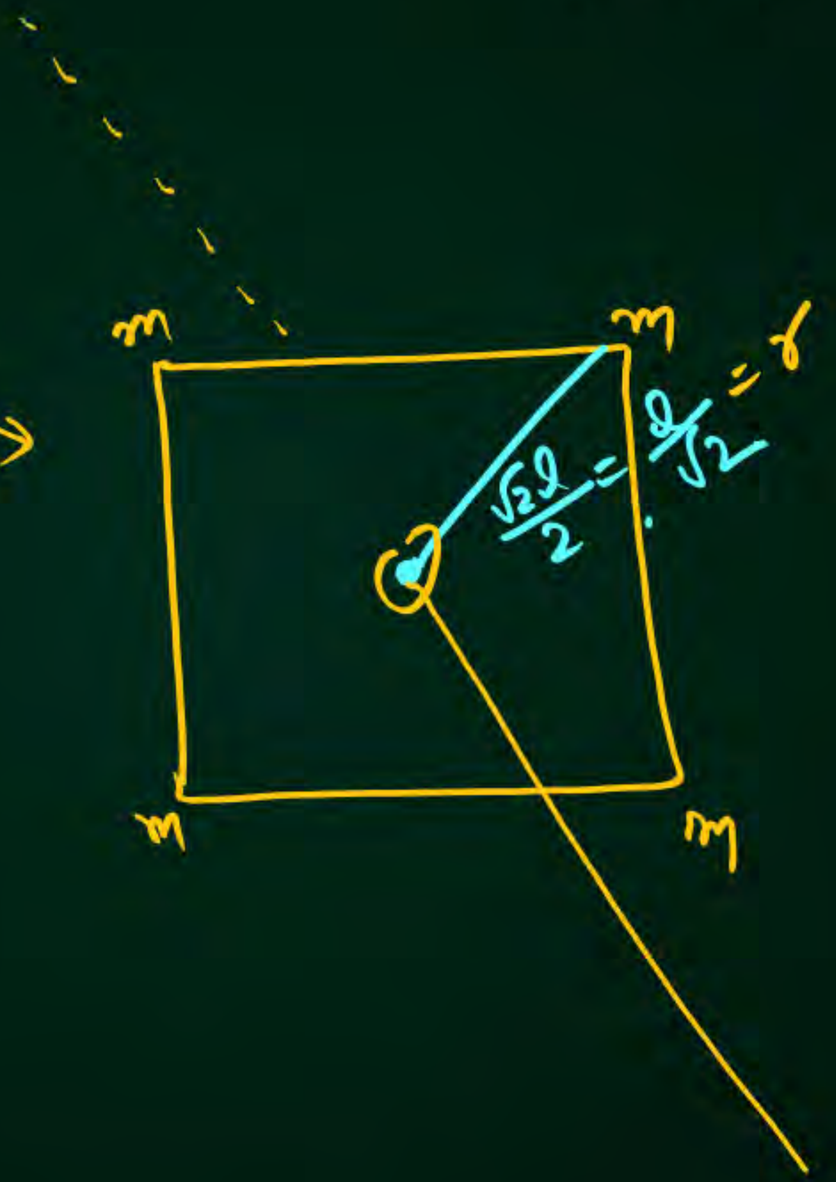
NEET-2016
2017

MOI OF ROD


axis of Rotn
r
M, L
I Rod = M r²
axis of Rotn
θ
I = 1/3 M L² cos² θ
axis of Rotn
M, L
dx
x
dm
M, L
I = 0
L cos θ
θ
M, L
L sin θ
I = 1/3 M L² sin² θ
mass of L length = M
" " unit length = M/L
dm = (M/L dx) —— ①
⇒ dI = dm x²
∫dI = M/L ∫dx x²
I = M/L (x³/3) from 0 to L
I = M/L (L³/3) = ML²/3
∫x² dx = x^(2+1)/(2+1) = x³/3
I Rod abood end ⊥r length of Rod = ML²/3

four point object (m) placed at corner of square. then find M.O.I about axis ⊥r to the plane.





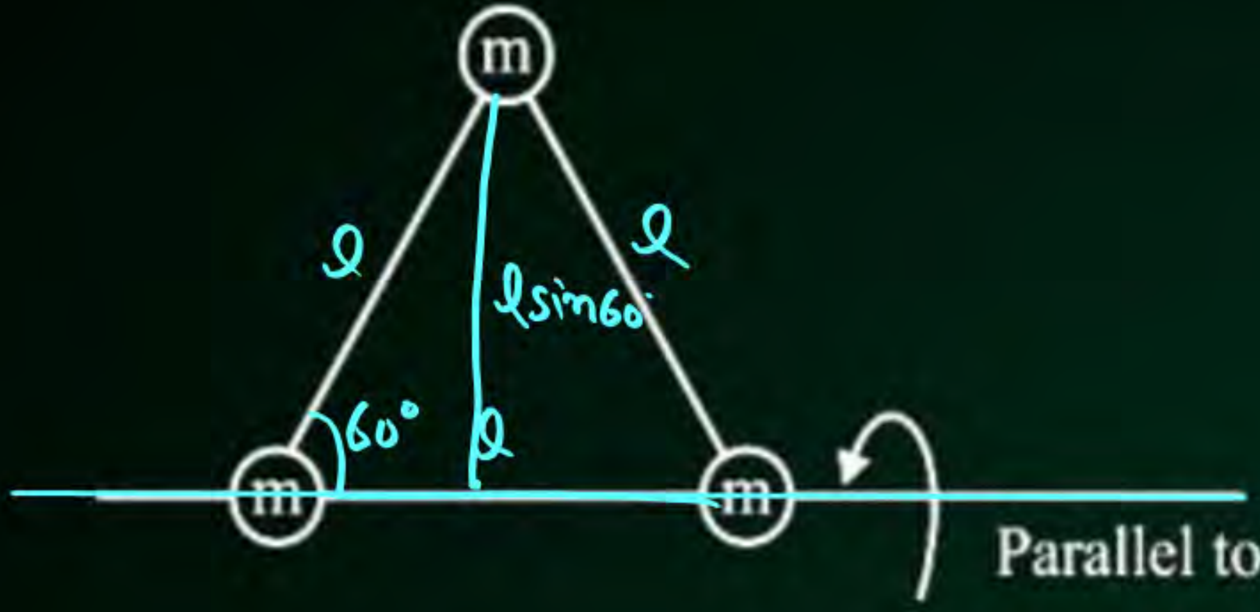
$$I = 4\left(I_{1\,object}\right)$$

$$= 4\left(m\left(\frac{l}{\sqrt{2}}\right)^2\right)$$

$$= 4\left[\frac{ml^2}{2}\right]$$

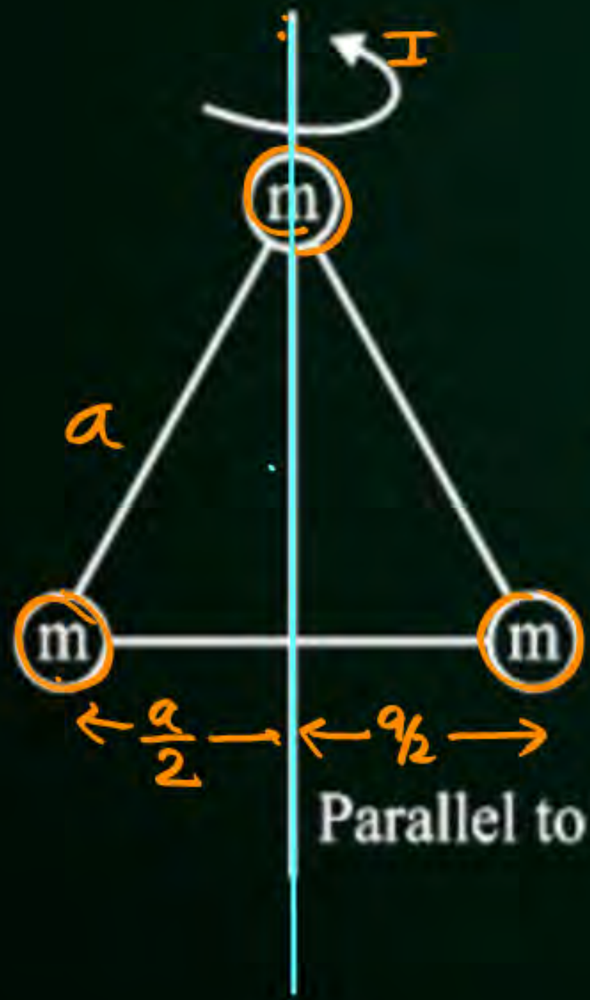
$$= 2ml^2$$

Ans



Parallel to Plane

$$I = 0 + 0 + m(l\sin 60^\circ)^2 = ml^2 \times \left(\frac{\sqrt{3}}{2}\right)^2 = \frac{3ml^2}{4}$$



Parallel to Plane

$$I = 0 + m\left(\frac{a}{2}\right)^2 + m\left(\frac{a}{2}\right)^2$$

$$= \frac{ma^2}{4} + \frac{ma^2}{4}$$

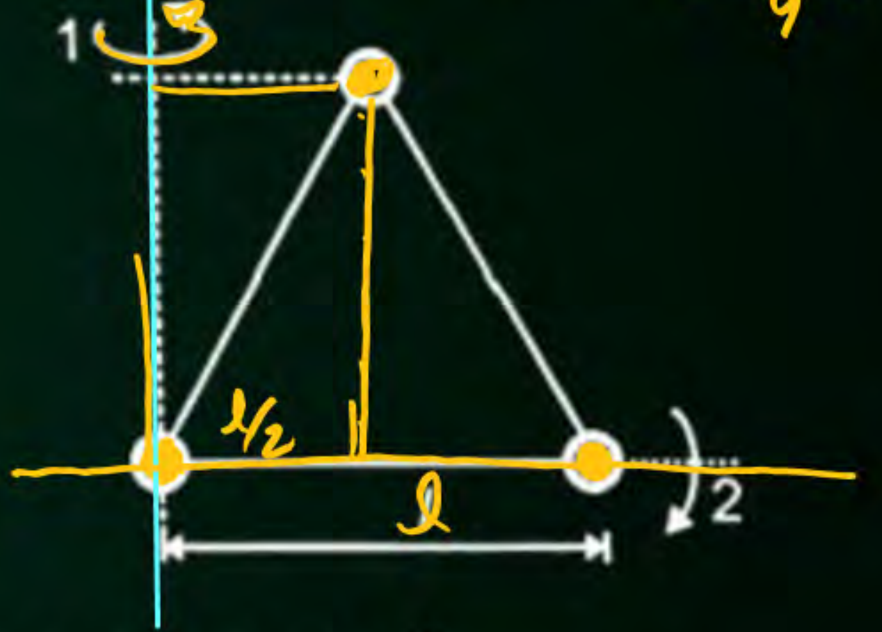
$$I = \frac{ma^2}{2}$$

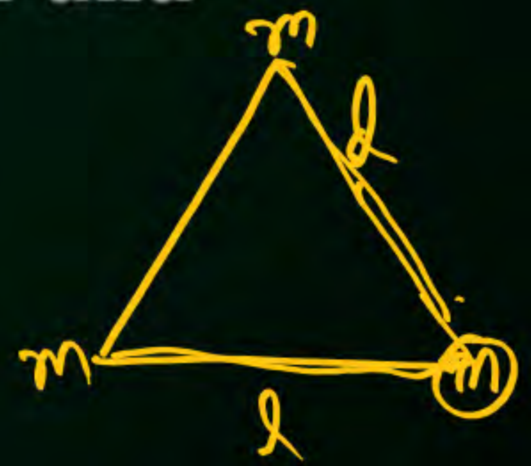
QUESTION

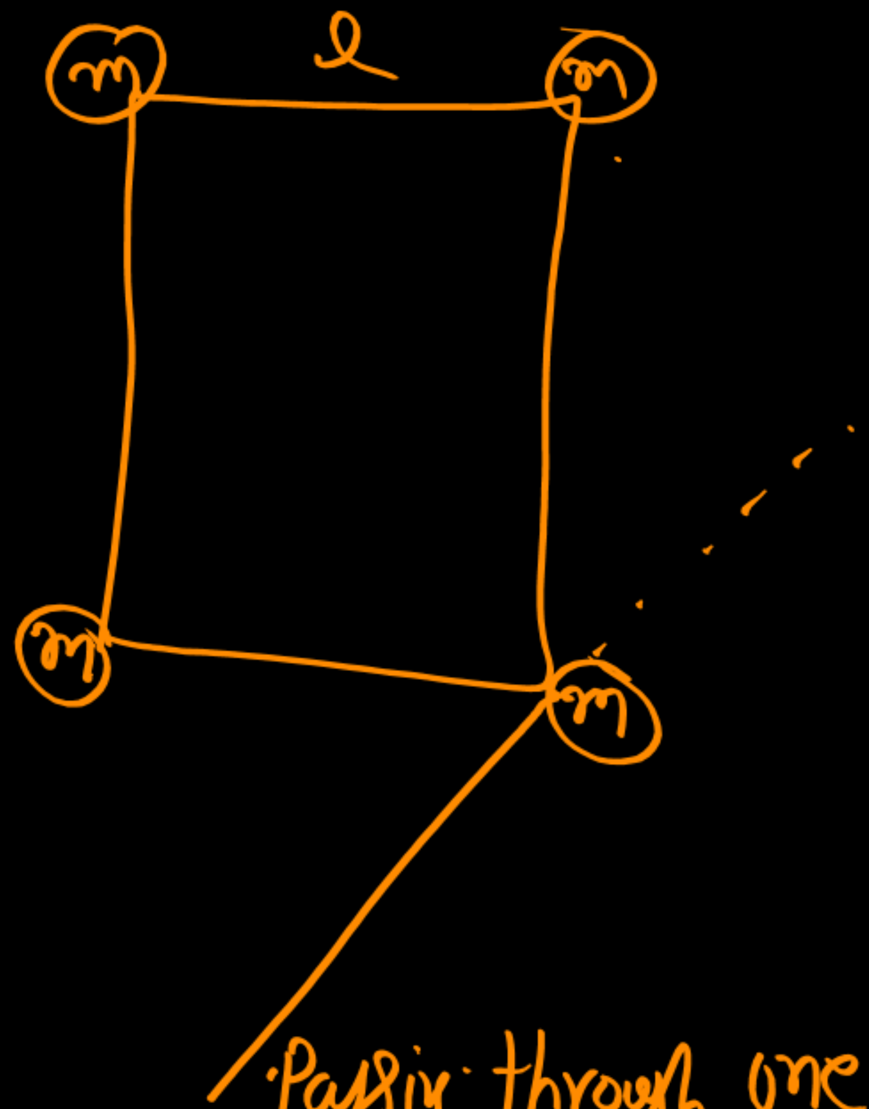
Three particles each of mass m are placed at the corners of equilateral triangle of side l

which of the following is/are correct ?

1. Moment of inertia about axis '1' is $\frac{5}{4}ml^2$
2. Moment of inertia about axis '2' is $\frac{3}{4}ml^2$
3. Moment of inertia about an axis passing through one corner and perpendicular to the plane is $2ml^2$
4. All of these

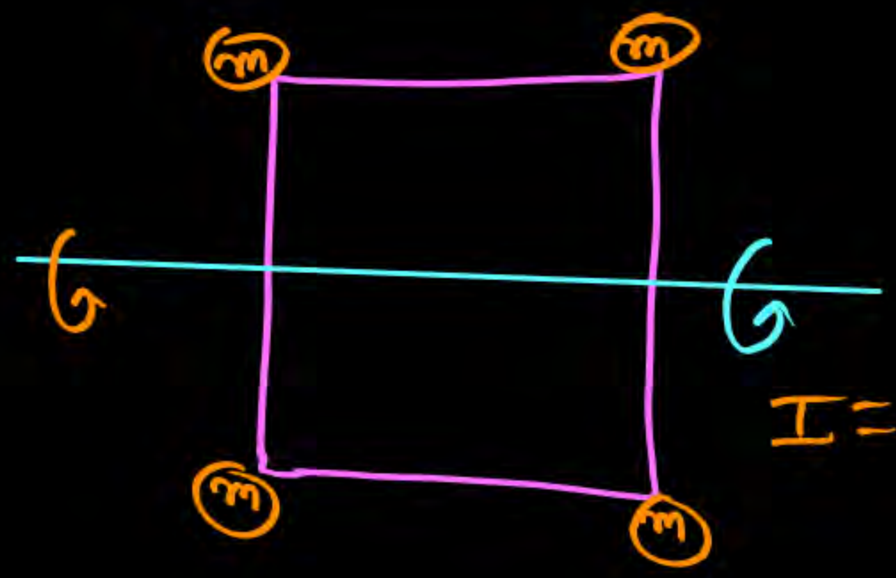




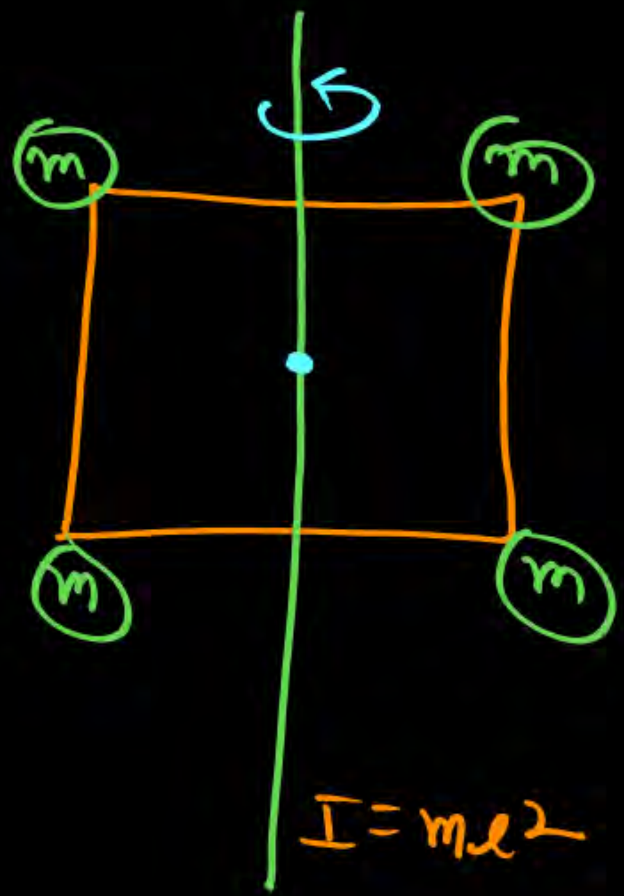


$$I = 0 + ml^2 + ml^2 + m(\sqrt{2}l)^2$$

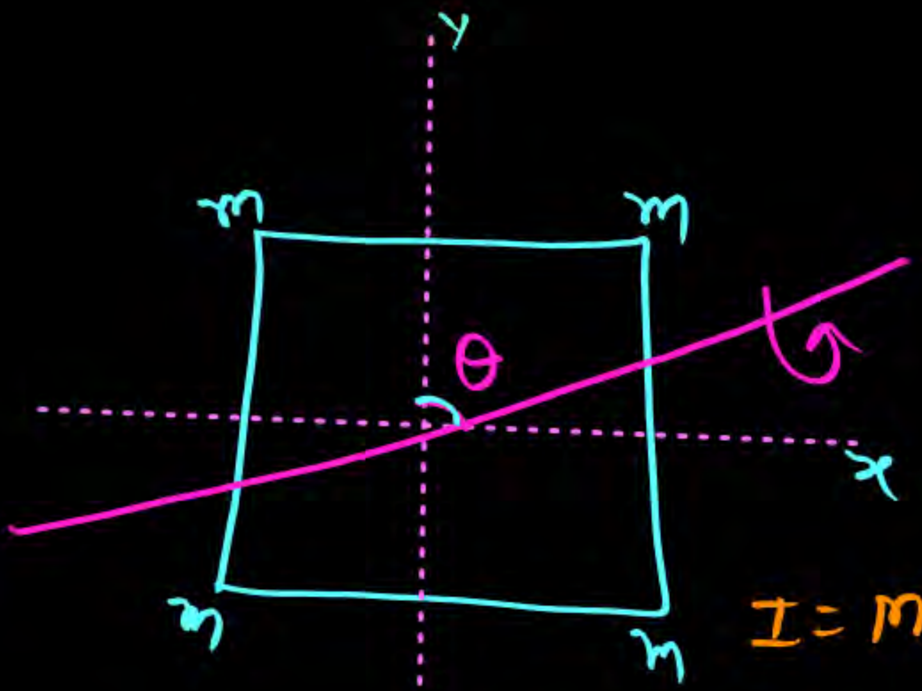
Passing through one end ⊥r to plane.



$I = ml^2$



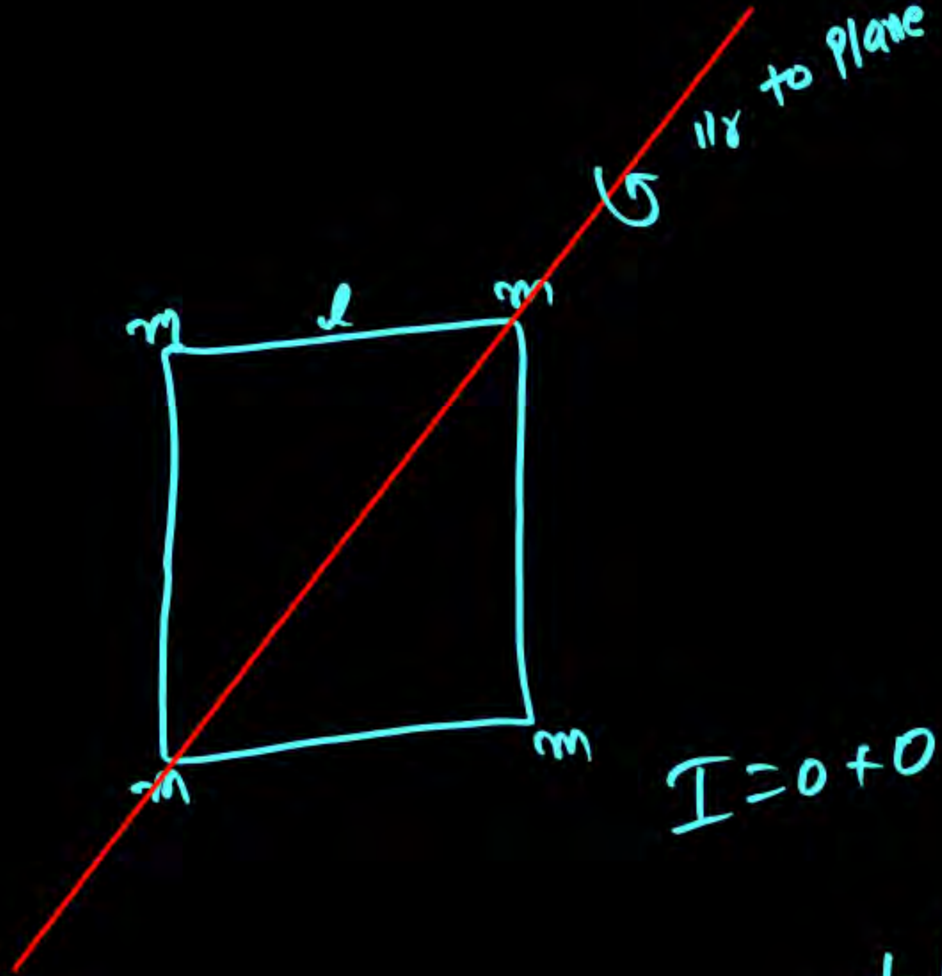
$I = ml^2$



$I = ml^2$

We will Prove it.



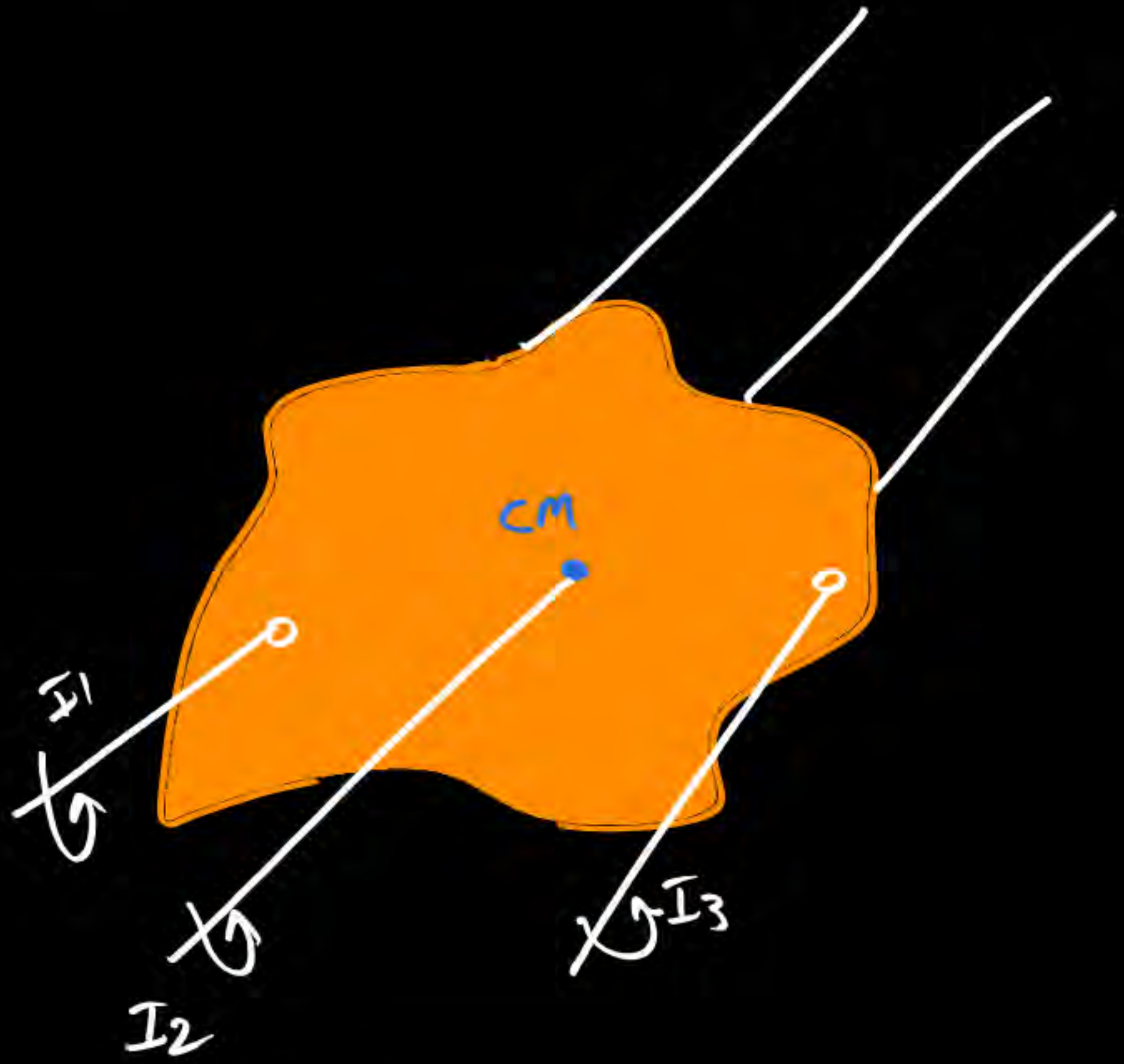


$$I = 0 + 0 + m\left(\frac{l}{\sqrt{2}}\right)^2 + m\left(\frac{l}{\sqrt{2}}\right)^2$$

$$I = \frac{ml^2}{2} + \frac{ml^2}{2}$$

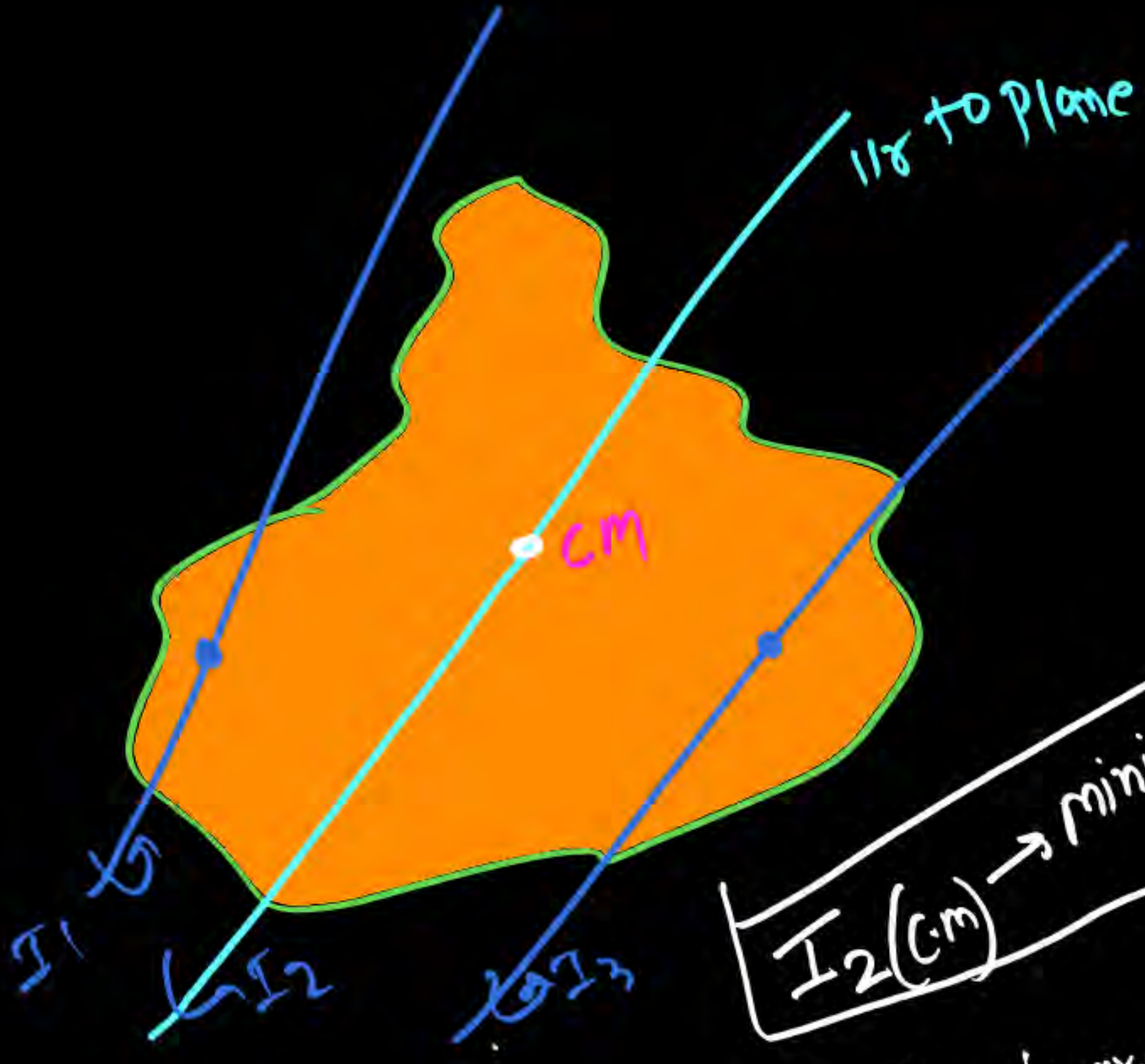
$$\boxed{I = ml^2}$$

Parallel axis theorem



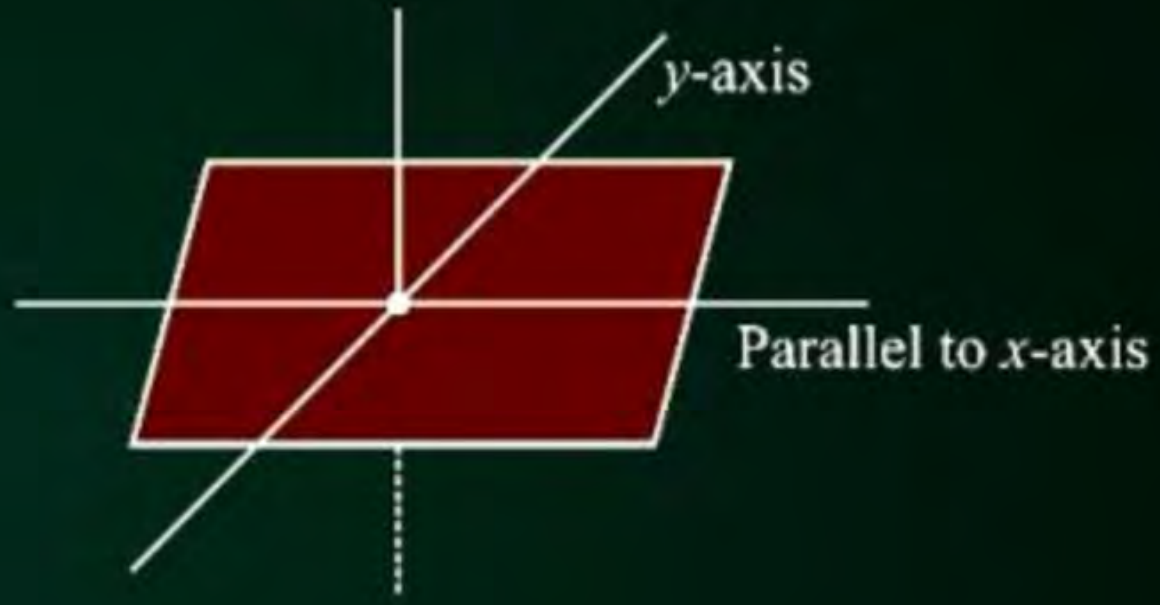
$I_2 \rightarrow$ minimum

all axis are ⊥r to plane (all axis are ||r to each other)



$I_2(cm) \rightarrow$ minimum

(all axis are ||r to each other)

Parallel axis Theorem	Perpendicular axis Theorem
➢ **Valid for all type of body.**	➢ **Valid for planes object.**
	

QUESTION

A thin rod of length L and mass M is bent at its midpoint into two halves so that the angle between them is 90°. The moment of inertia of the bent rod about an axis passing through the bending point and perpendicular to the plane defined by the two halves of the rod is [AIPMT (Prelims)-2003]

1. $\frac{\sqrt{2}ML^2}{24}$

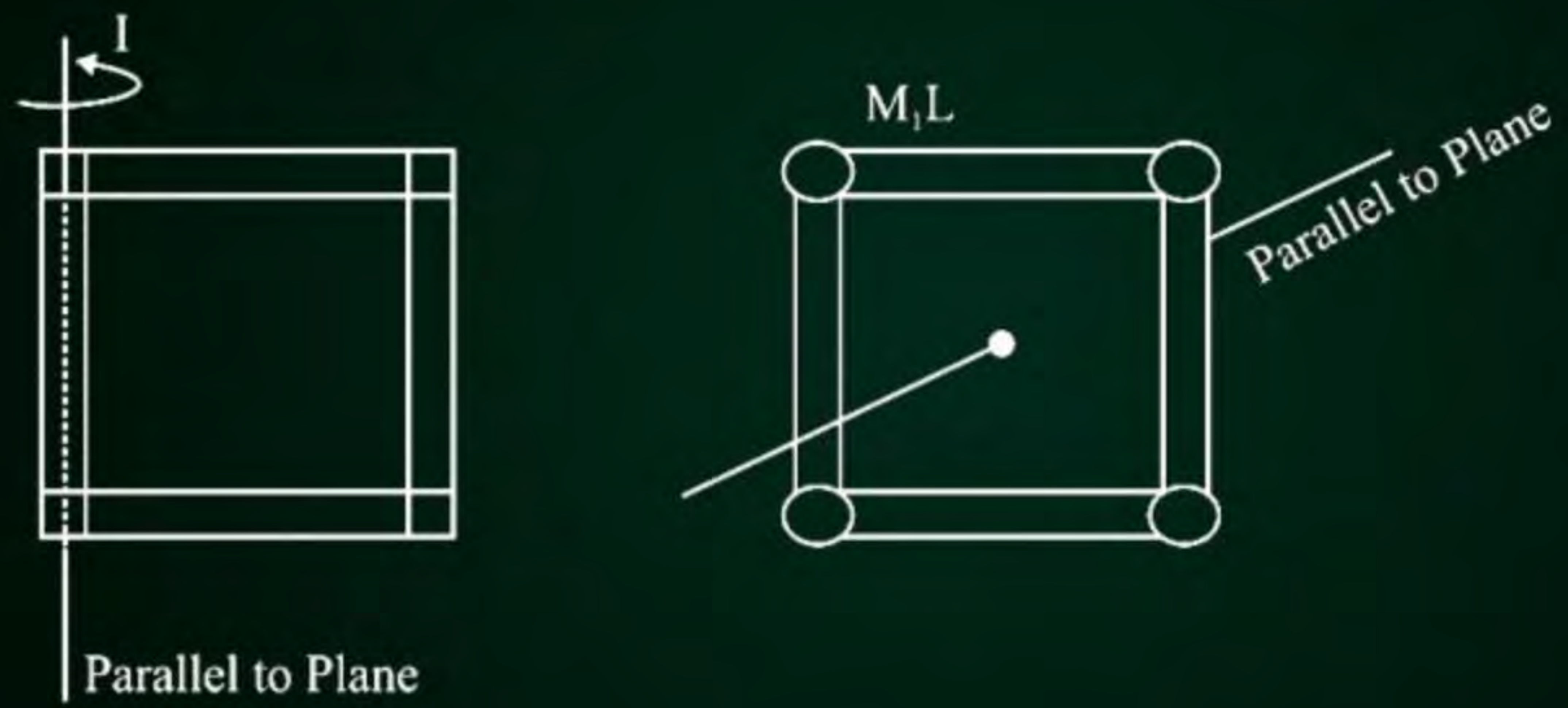
2. $\frac{ML^2}{24}$

3. $\frac{ML^2}{12}$

4. $\frac{ML^2}{6}$

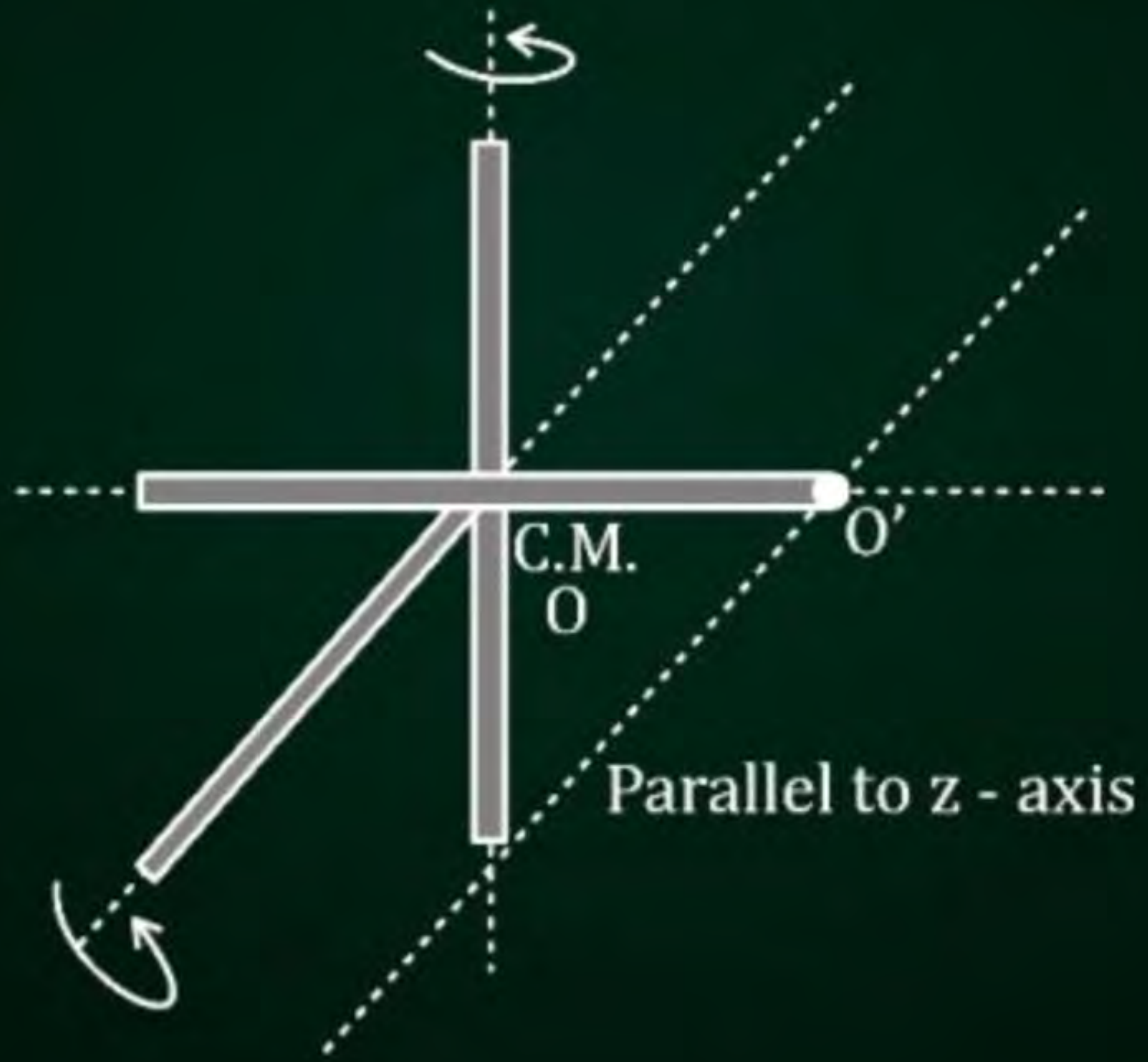
QUESTION

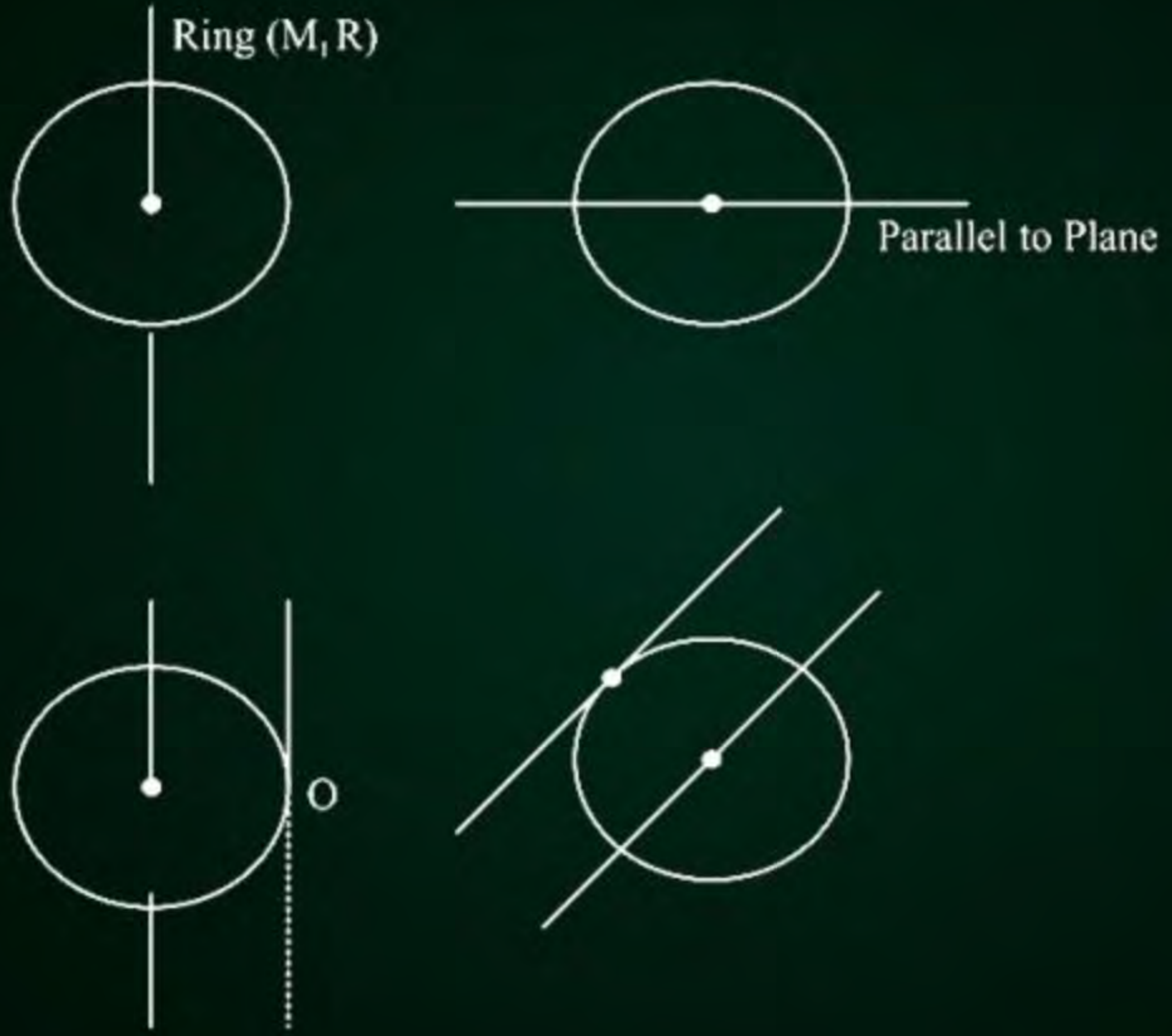
Four identical rod (M, L), placed as shown in figure. Find MOI.

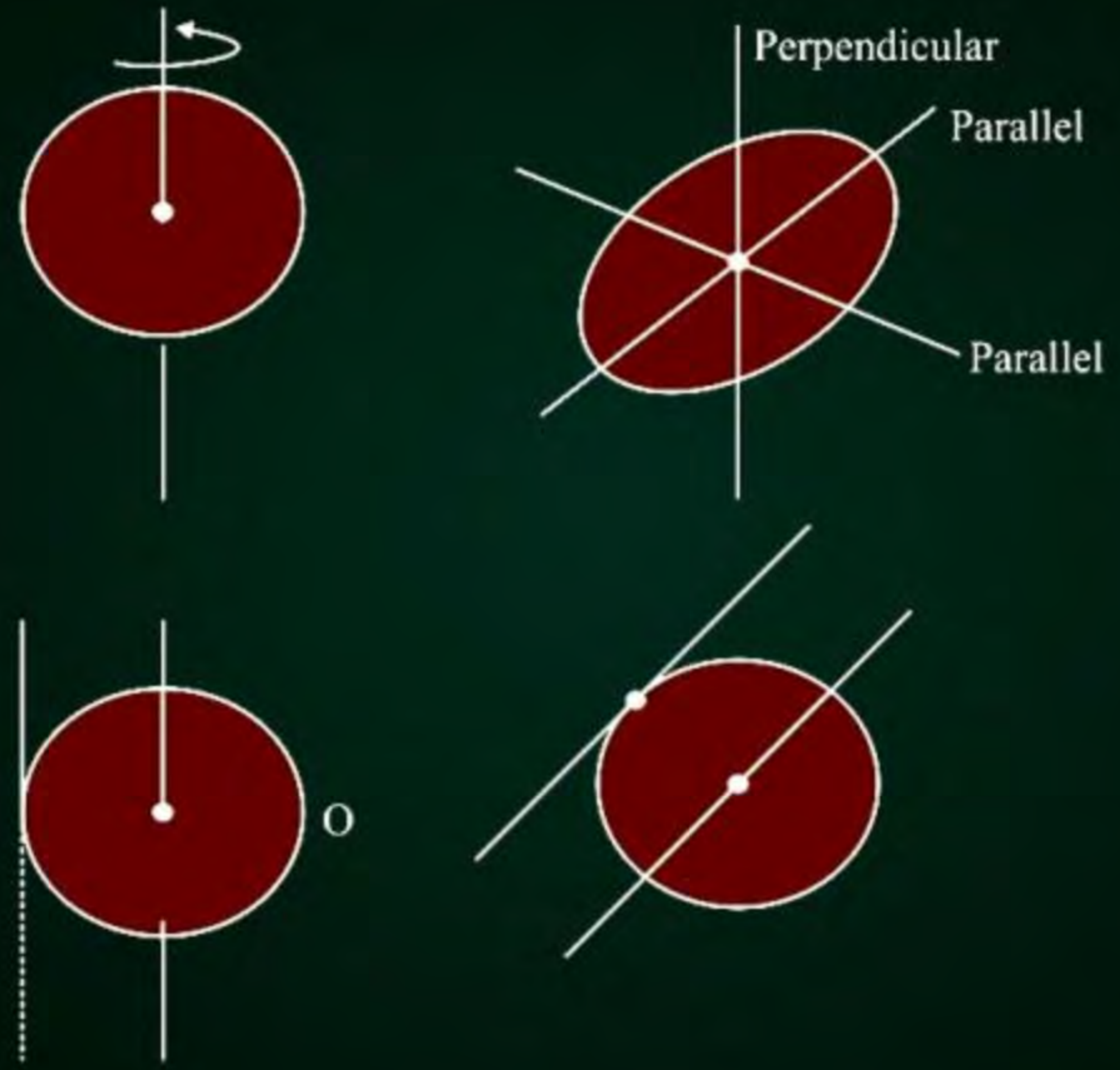


QUESTION

Three identical rod parallel to each other. Find MOI about y – axis.




Ring (M, R)
Parallel to Plane
O


Perpendicular
Parallel
Parallel
O

QUESTION

The moment of inertia of a thin uniform circular disc about one of its diameter is I. Its moment of inertia about an axis tangent to it and perpendicular to its plane is

1. $\frac{2I}{3}$
2. $2I$
3. $\frac{I}{2}$
4. $6I$

QUESTION

A thin uniform wire of mass m and length l is bent into a circle. The moment of inertia of the wire about an axis passing through its one end and perpendicular to the plane of the circle is

1. $\frac{2mL^2}{\pi^2}$

2. $\frac{mL^2}{\pi^2}$

3. $\frac{mL^2}{2\pi^2}$

4. $\frac{mL^2}{3\pi^2}$

QUESTION

A thin wire of length l and mass m is bent in the form of a semicircle as shown. Its moment of inertia about an axis joining its free ends will be

1. ml^2

2. Zero

3. $\frac{ml^2}{\pi^2}$

4. $\frac{ml^2}{2\pi^2}$



Hollow sphere (M_1R)



Solid sphere



QUESTION

The moment of inertia of a uniform circular disc of radius R and mass M about an axis passing from the edge of the disc and normal to the disc is

[AIPMT (Prelims)-2005]

1. $\frac{1}{2}MR^2$
2. MR^2
3. $\frac{7}{2}MR^2$
4. $\frac{3}{2}MR^2$

QUESTION

Two discs of same mass and same thickness have densities as 17 g/cm^3 and 51 g/cm^3. The ratio of their moment of inertia about their central axes is

1. $\frac{1}{3}$
2. $\frac{2}{3}$
3. $\frac{3}{1}$
4. $\frac{3}{2}$

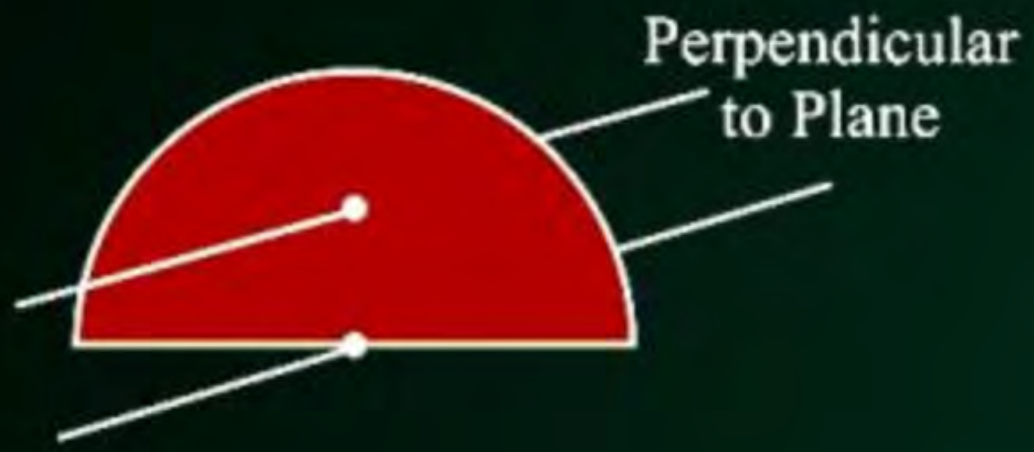
4-Hollow Sphere



2-Hollow Sphere

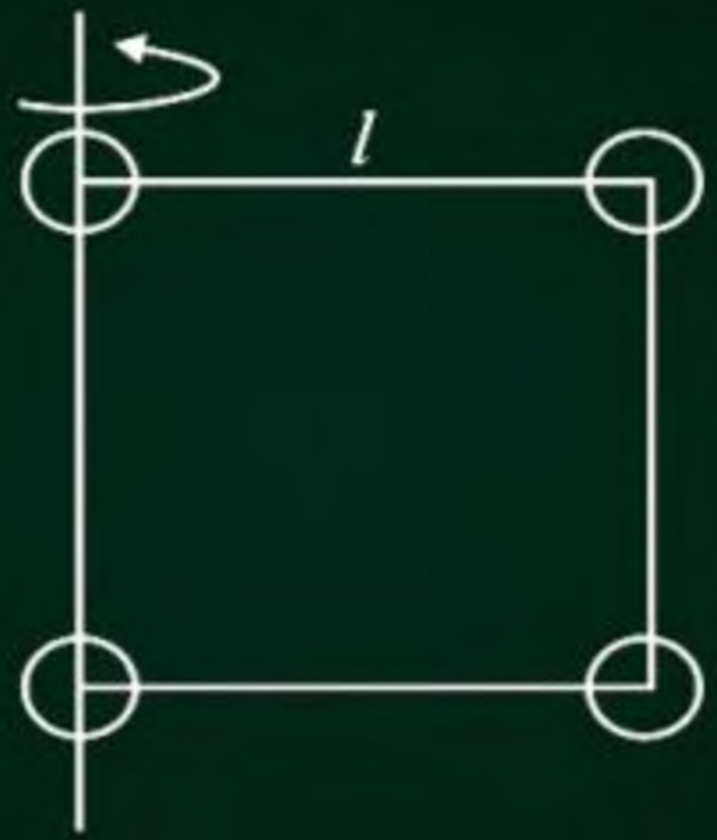


M.O.I. of Half Disc about C.O.M.



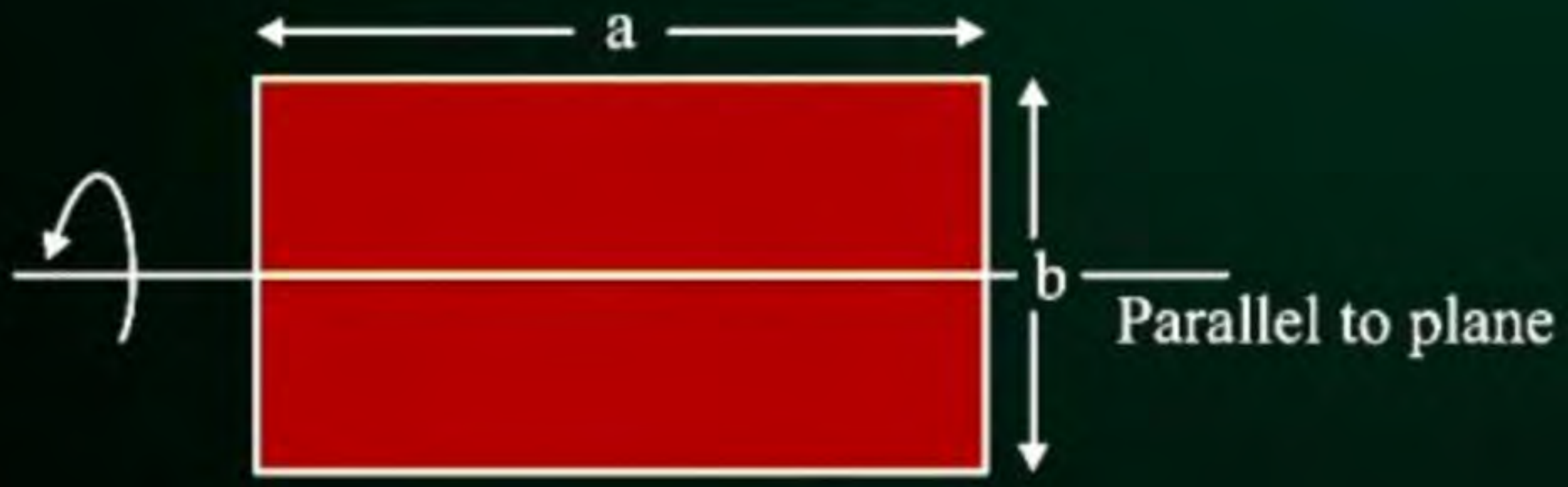
M.O.I. of Half Ring about C.O.M.

Four Solid sphere (M_1R)



RECTANGULAR PLATE





QUESTION

Four rings each of mass M and radius R are arranged as shown in the figure. The moment of inertia of the system about the axis yy' is

1. $2\,MR^2$
2. $3\,MR^2$
3. $4\,MR^2$
4. $5\,MR^2$



QUESTION

Four thin uniform rods each of length L and mass m are joined to form a square. The moment of inertia of square about an axis along its one diagonal is

1. $\frac{mL^2}{6}$

2. $\frac{2}{3}mL^2$

3. $\frac{3mL^2}{4}$

4. $\frac{4mL^2}{3}$

QUESTION

The two spheres, one of which is hollow and other solid, have identical masses and moment of inertia about their respective diameters. The ratio of their radii is given by

1. $5:7$
2. $3:5$
3. $\sqrt{3}:\sqrt{5}$
4. $3:7$

QUESTION

Three solid spheres each of mass P and radius Q are arranged as shown in figure. The moment of inertia of the arrangement about YY' axis



1. $\frac{7}{5}PQ^2$
2. $\frac{14}{5}PQ^2$
3. $\frac{16}{5}PQ^2$
4. $\frac{5}{14}PQ^2$

QUESTION

Four spheres of diameter $2a$ and mass M are placed with their centers on the four corners of a square of side b. The moment of inertia of the system about an axis about one of the sides of the square is

1. $Ma^2 + 2Mb^2$
2. Ma^2
3. $Ma^2 + 4Mb^2$
4. $\frac{8}{5}Ma^2 + 2Mb^2$


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture 2 | Physics

Rotational Motion

By- Dr. Manish Raj (MR SIR)



Todays Goal

→ Parallel axis therm.

→ Perpendicular axis theorm.

3:30hr+ to 4hr mini Dangal

5 hr+ → दंगल ✓

7-8hr maha Dangal ✓

10+ hr → Tandav ✓

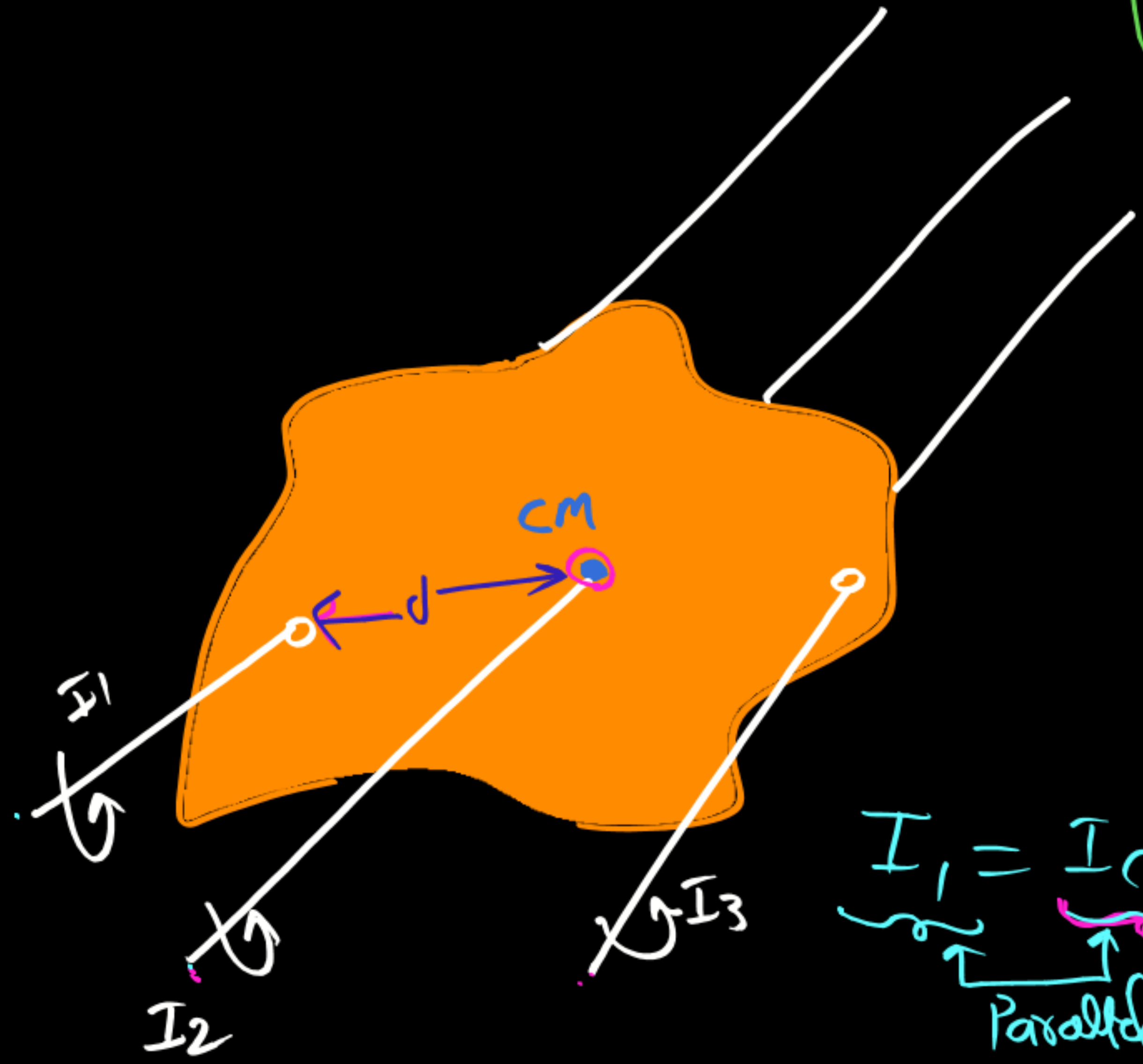
12 + hr → Mahatandav ✓

19thr end game ✓

Parallel axis theorem → Body ke plane se koi matlab nahi hai

→ axis must be parallel to each other

→ valid for
- 1-D body → Rod
- 2-D body → Ring, Disc, Plate
- 3-D → Sphere, cube



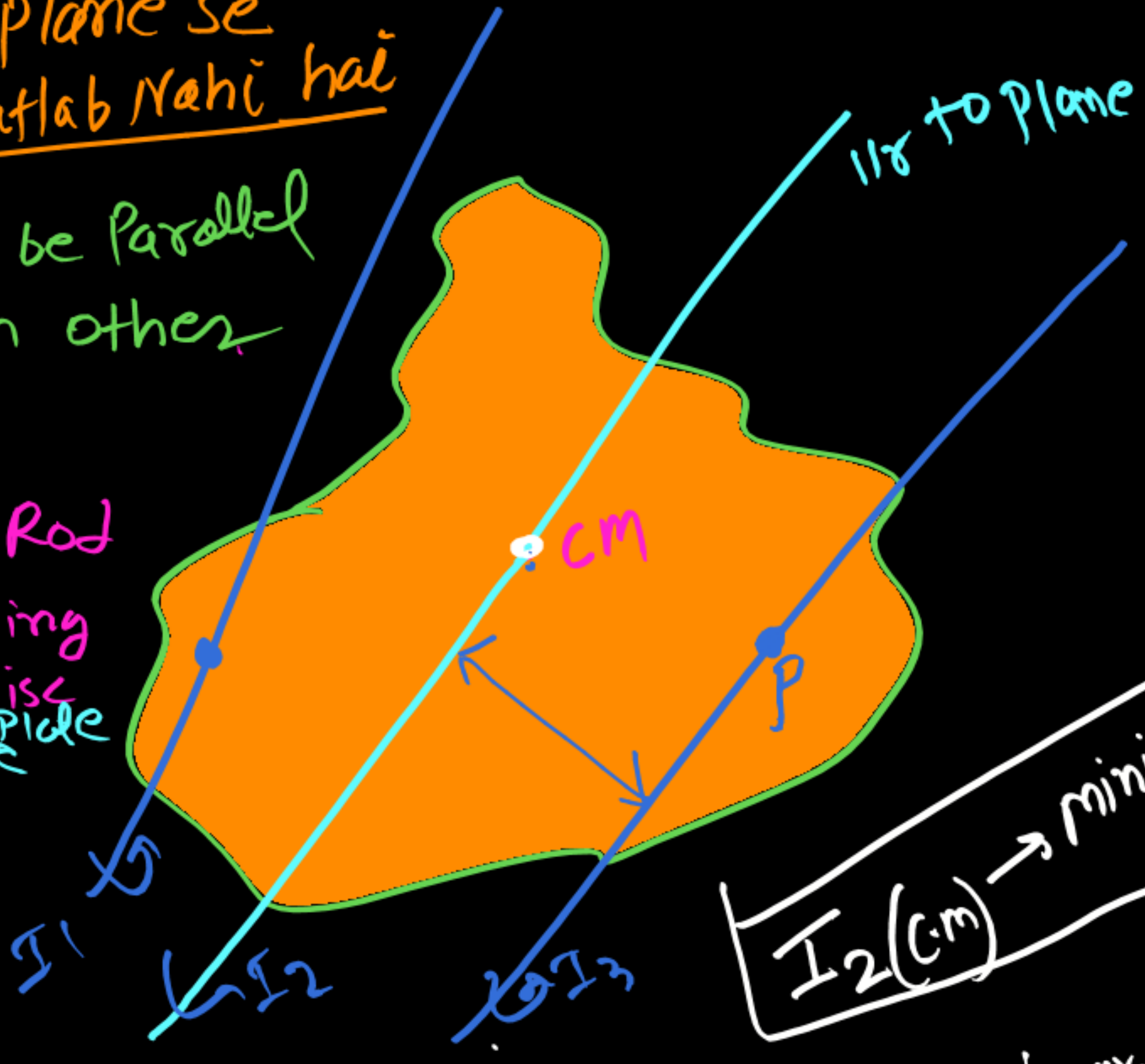
$$I_1 = I_{cm} + md^2$$

(I_1 and I_{cm}:) Parallel to each other

(d:) distance b/w these two parallel axis.

$I_2 \to$ minimum

all axis are ⊥r to plane (all axis are ||r to each other)

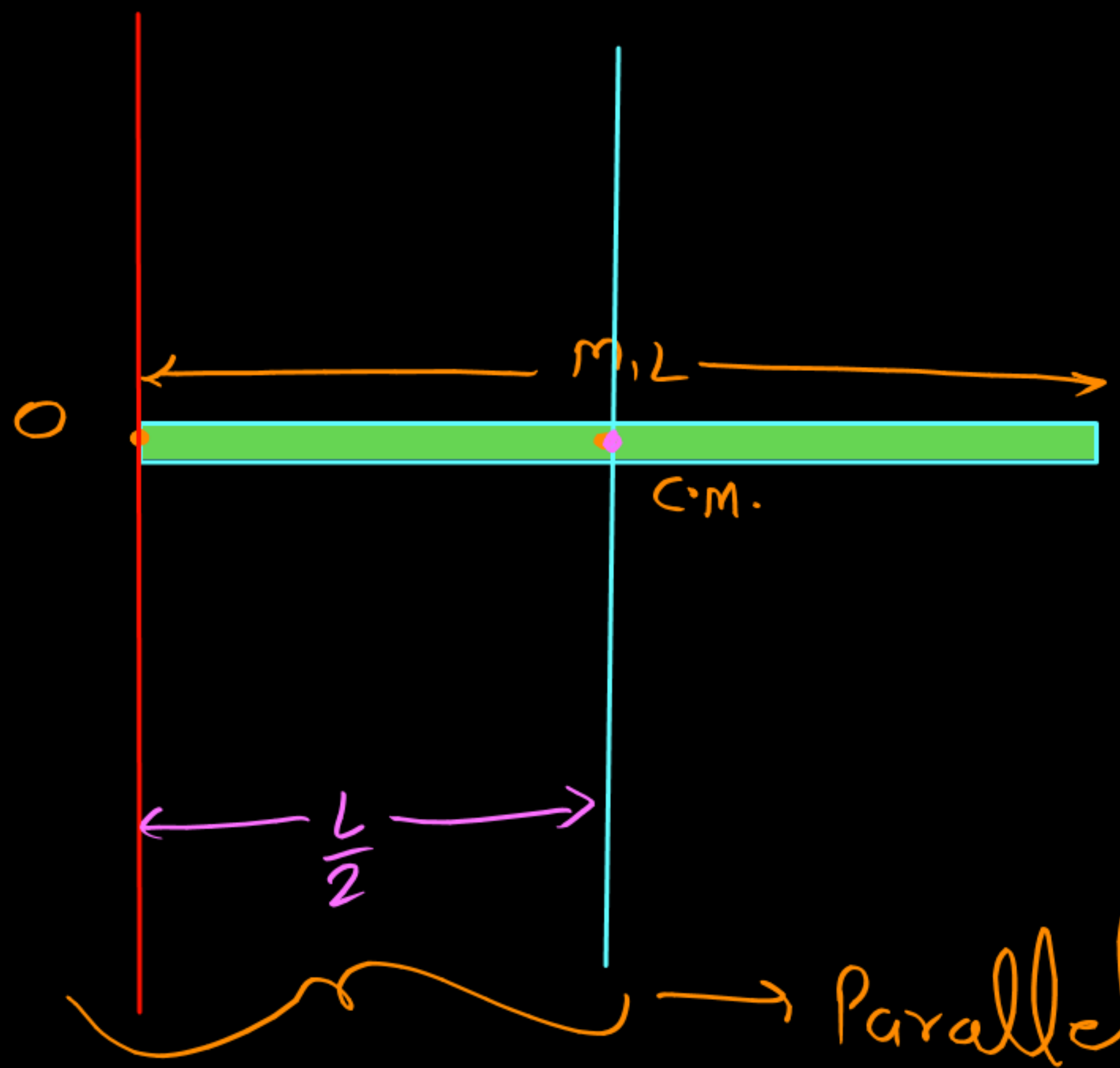


$I_2 (cm) \to$ minimum

(all axis are ||r to each other)

$$I_p = I_{cm} + md^2$$

M.O.I of Rod about C.O.M.



→ Parallel axis th^m.

~~$I_{c.m} = I_o + md^2$~~

Parallel axis th^m →

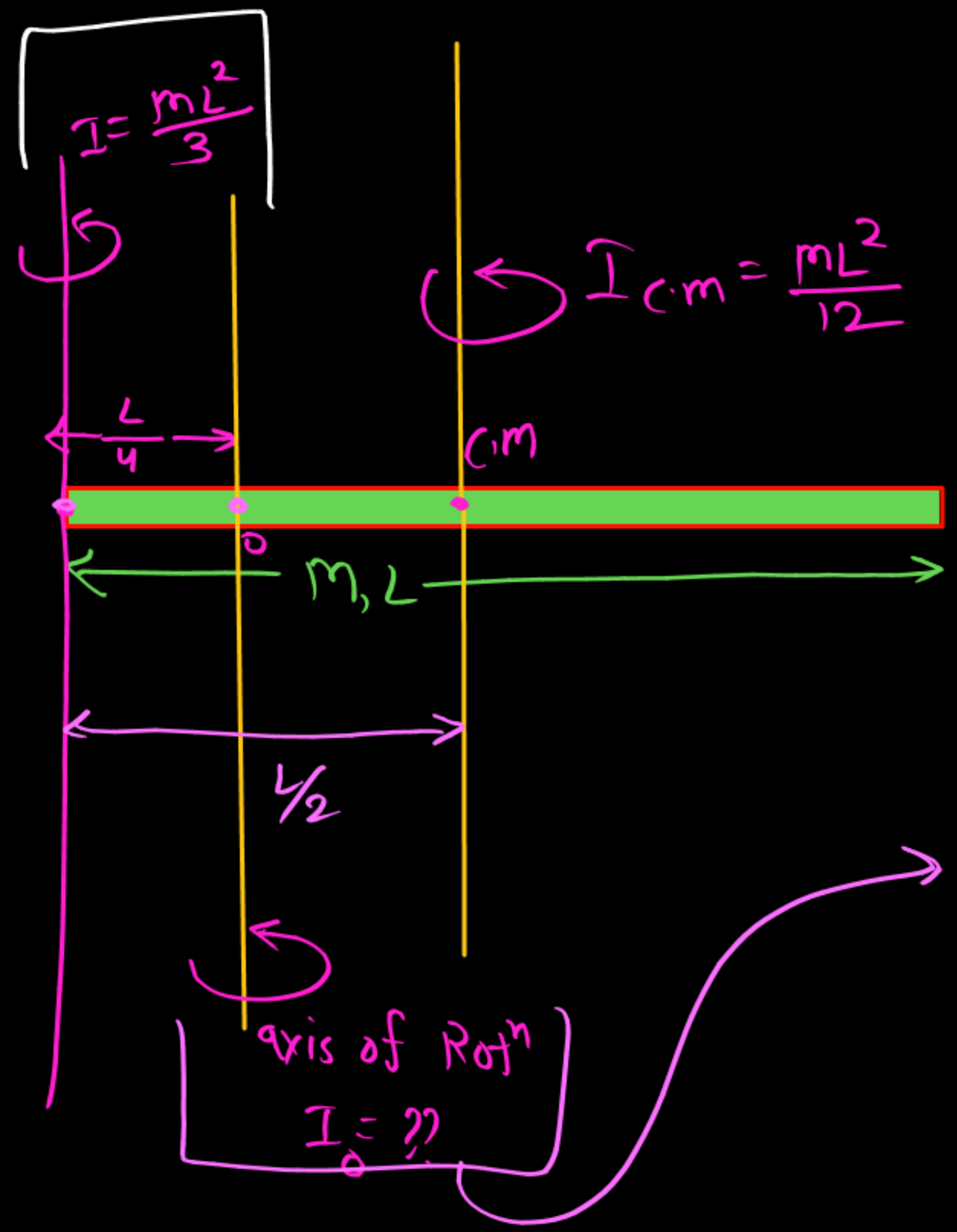
$$I_o = I_{cm} + md^2$$

$$\frac{1}{3}mL^2 = I_{cm} + m\left(\frac{L}{2}\right)^2$$

$$I_{cm} = \frac{1}{3}mL^2 - \frac{mL^2}{4} = \frac{4mL^2 - 3mL^2}{12}$$

$$I_{cm} = \left(\frac{mL^2}{12}\right)$$

||r axis Not applicable b/w these two axis.

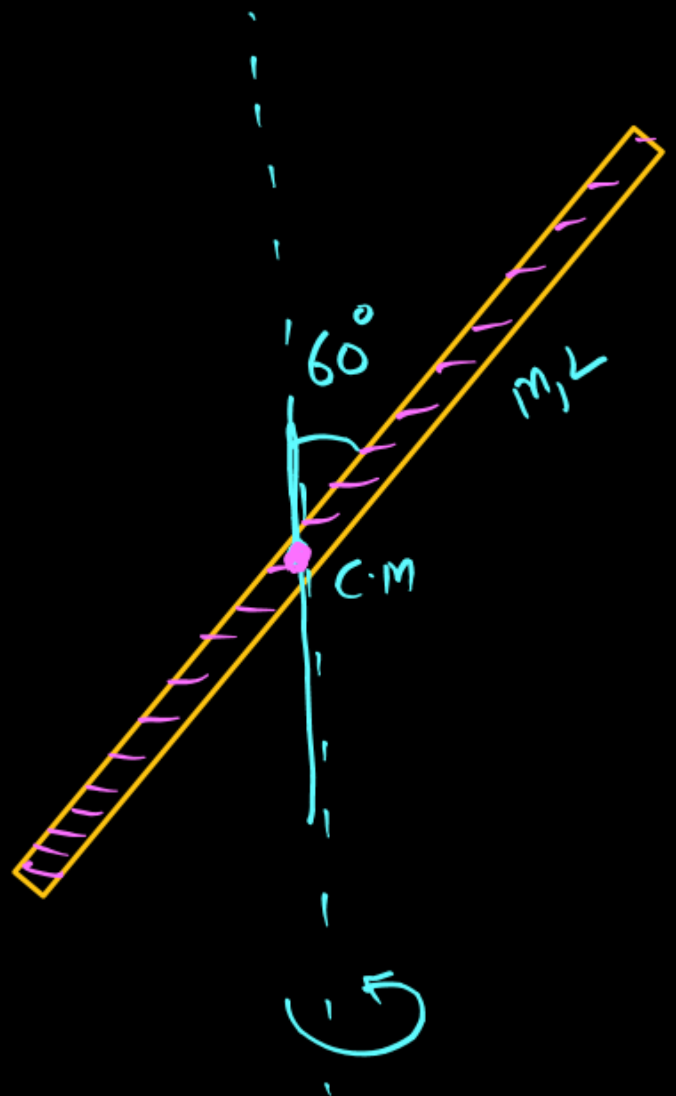


||r axis thᵐ

$$I_o = I_{cm} + md^2$$

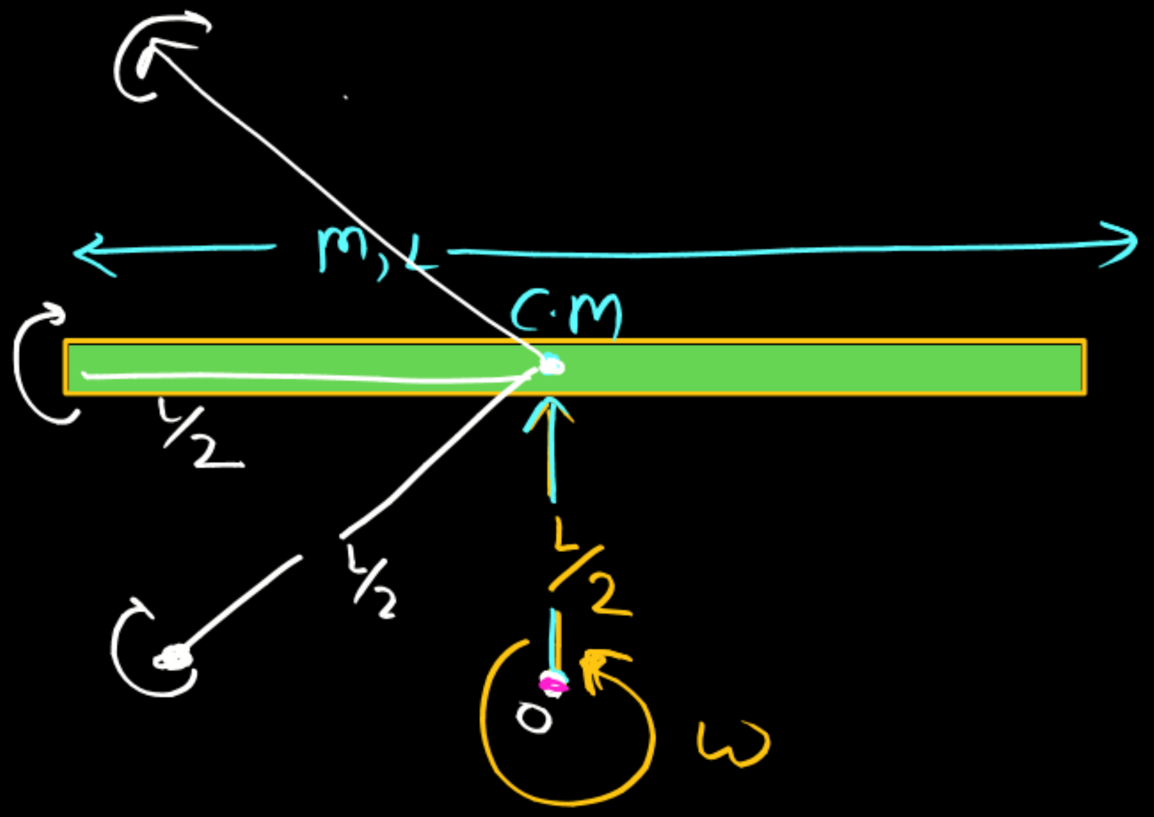
$$= \frac{mL^2}{12} + m\left(\frac{L}{4}\right)^2$$

$$= \frac{mL^2}{12} + \frac{mL^2}{16} = \frac{7mL^2}{48} \text{ Ans}$$



$$I = \frac{1}{12} m(L^2 \sin^2 60^\circ)$$

$$= \frac{1}{12} mL^2 \times \frac{3}{4} = \frac{3mL^2}{48}$$



axis of Rot^n ($\perp_r$ to the plane of Paper)

||$_r$ axis th^m

$$I_O = I_{C.M} + Md^2$$

$$I_O = \frac{1}{12}ML^2 + M\left(\frac{L}{2}\right)^2 = \frac{ML^2}{12} + \frac{ML^2}{4} = \frac{ML^2 + 3ML^2}{12} = \frac{4ML^2}{12} = \frac{1}{3}ML^2$$

Sabse Jayda usefuel.

Parallel axis Theorem	Perpendicular axis Theorem
➤ Valid for all type of body.	➤ Valid for planer object

→ Not Rod ✗
→ sphere ✗
→ valid for (Ring, Disc ✓, plate ✓)



$$I_o = I_{c.m} + md^2$$

For two axis

dist^n B/W axis

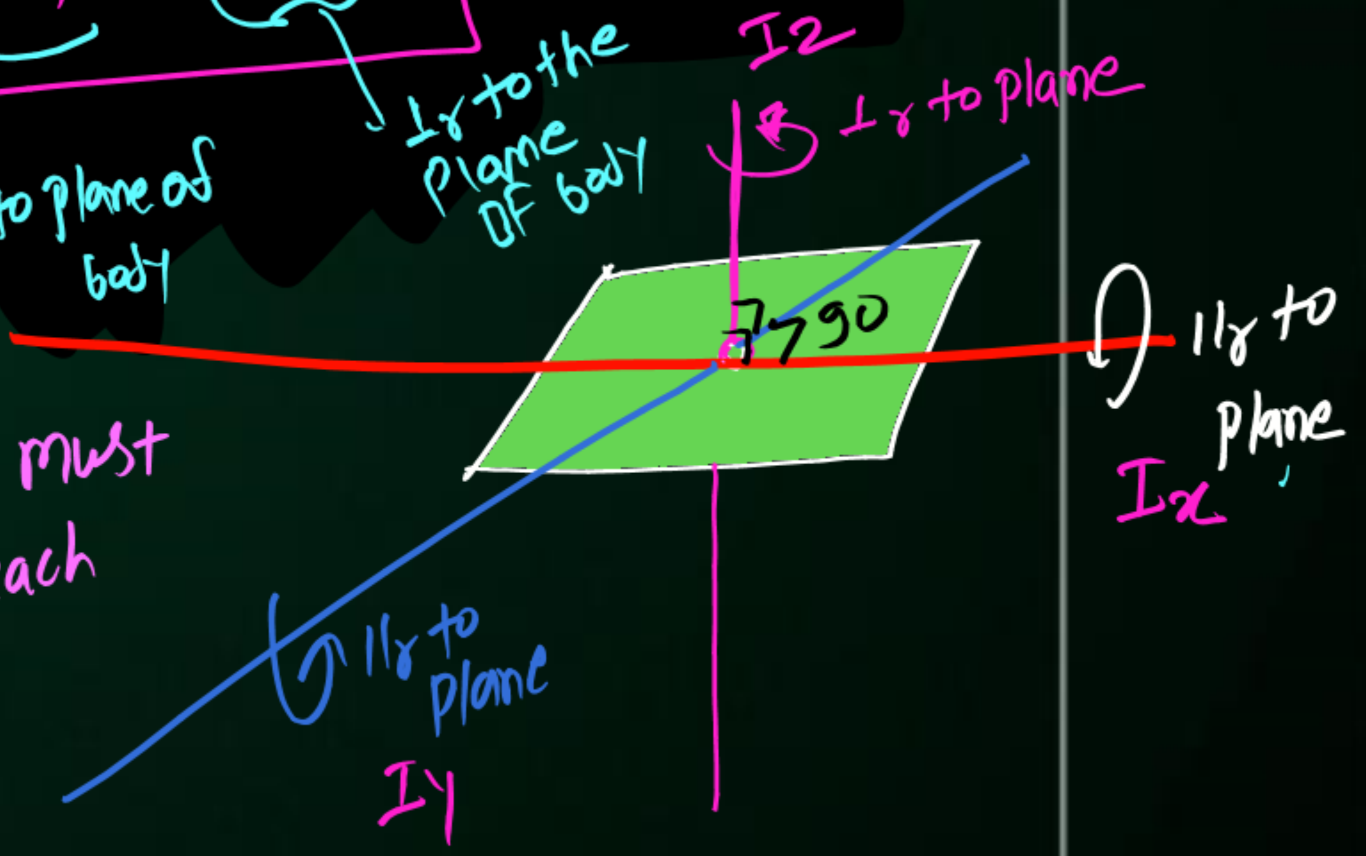
{Perpendicular axis th^m}

$$I_x + I_y = I_z$$

$I_x + I_y$: ‖r to plane of body

I_z: ⊥r to the plane of body

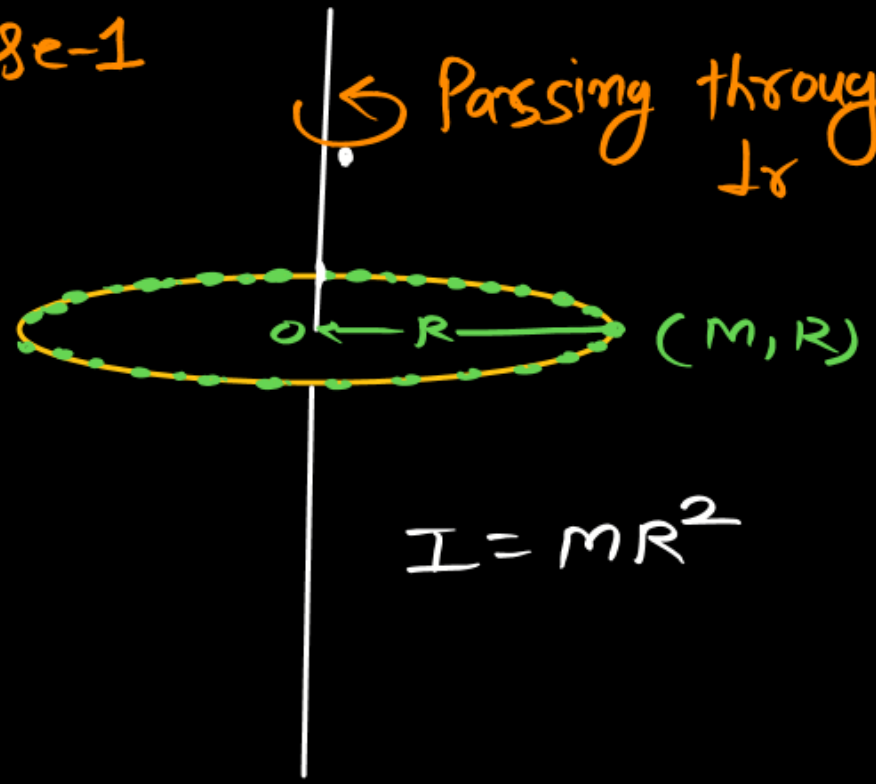
all three must be ⊥r to each other.



M.O.I of Ring

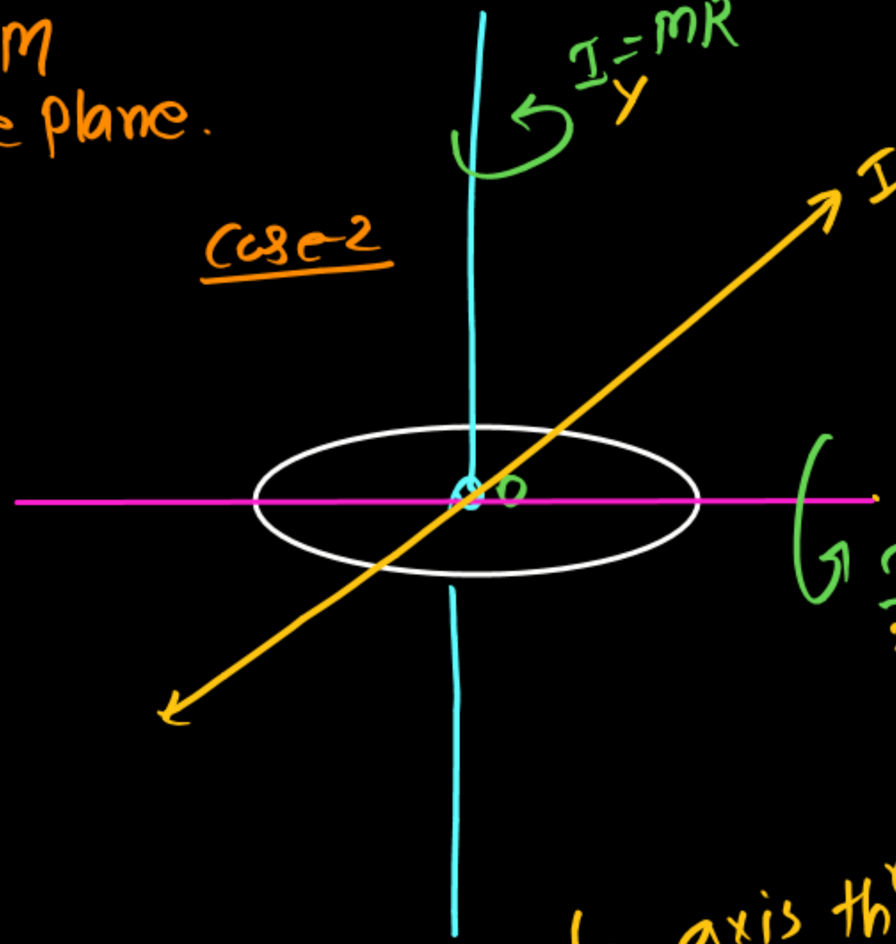
Case-1

Passing through C.O.M ⊥r to the plane.



$I = MR^2$

Case-2



$I_y = MR^2$

I_z (||r to plane)

$I_x = ??$ Diameter (||r to plane)

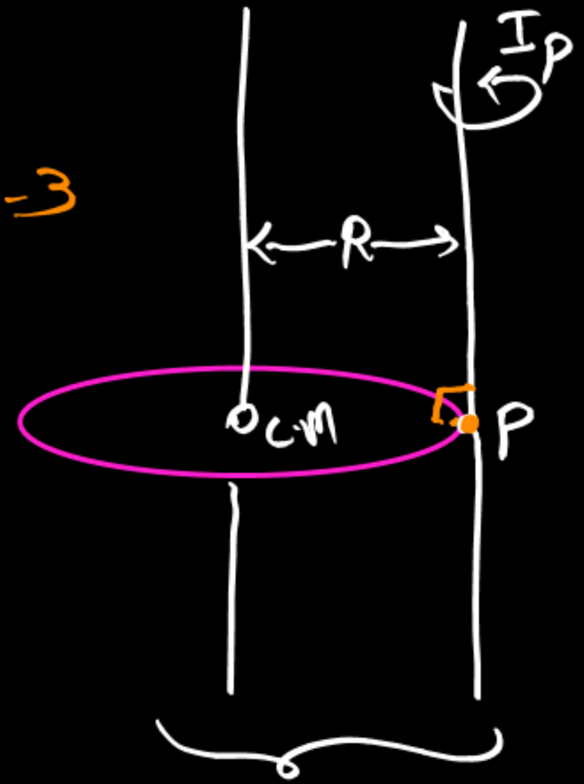
⊥r axis th^m → all axis passing through same point.

$I_x + I_z = I_y$

$2I_x = MR^2$

$I_x = \frac{MR^2}{2}$ = about diameter passing through C.O.M ||r to plane #

Case-3



I_p

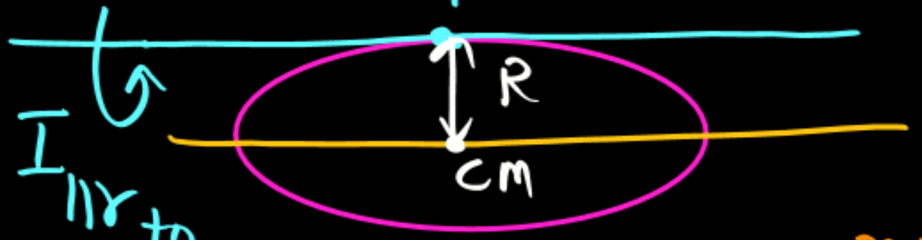
||r axis th^m

$I_p = I_{cm} + Md^2$

$= MR^2 + MR^2$

$I_p = 2MR^2$

Case-4



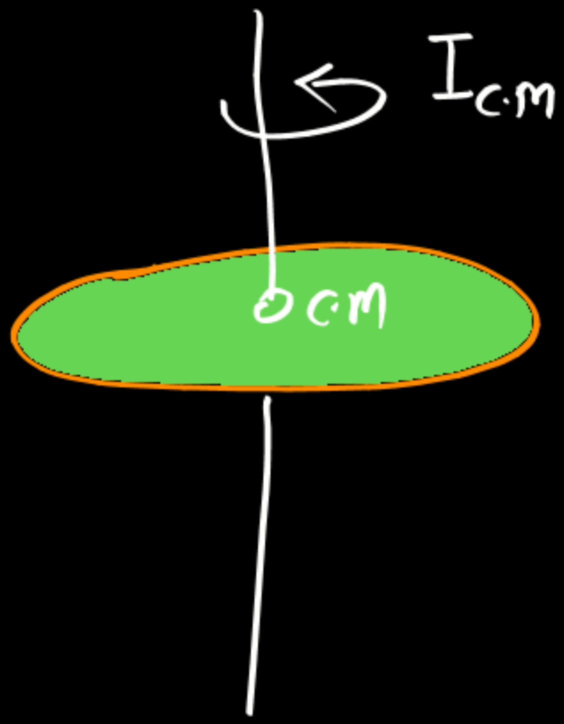
$I_{||r \text{ to Plane}}$

||r axis

$I_p = I_{cm} + Md^2$

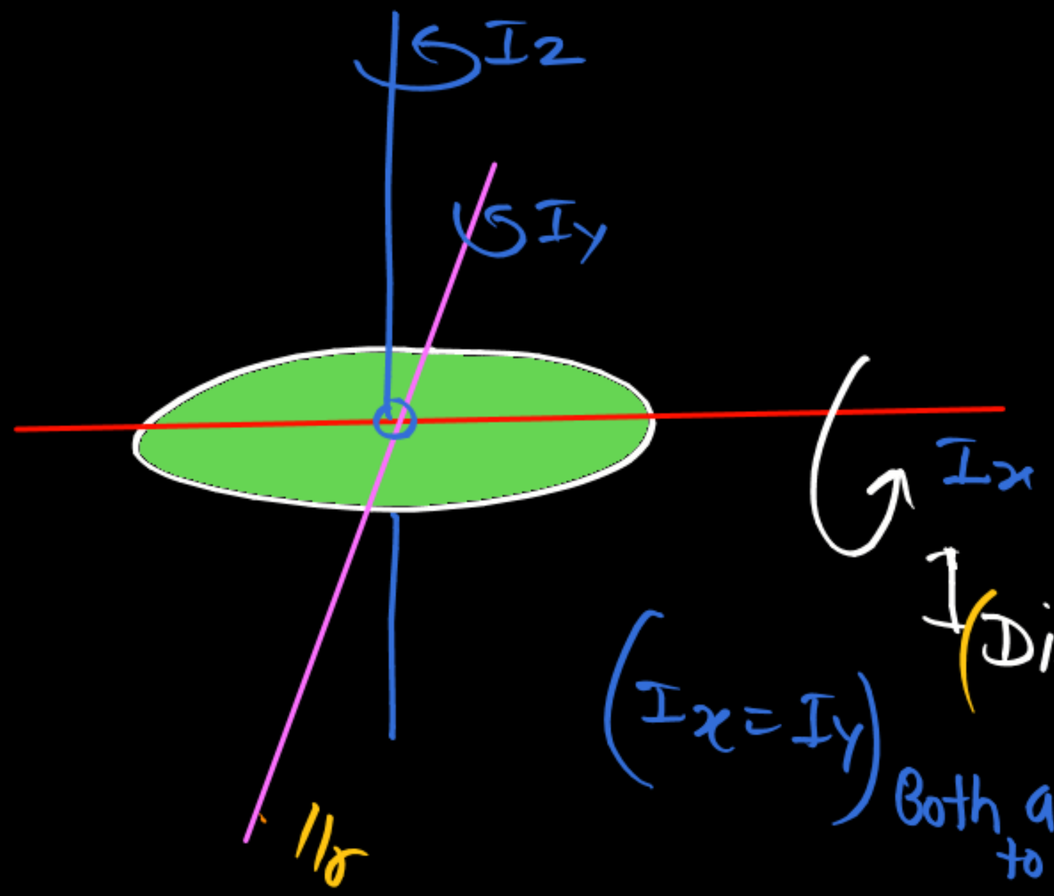
$= \frac{MR^2}{2} + MR^2 = \frac{3MR^2}{2}$

for Disc



$I_{c.m} = \frac{mR^2}{2}$ ⊥r to Plane

(m, R)



$(I_x = I_y)$ Both are ∥r to Plane

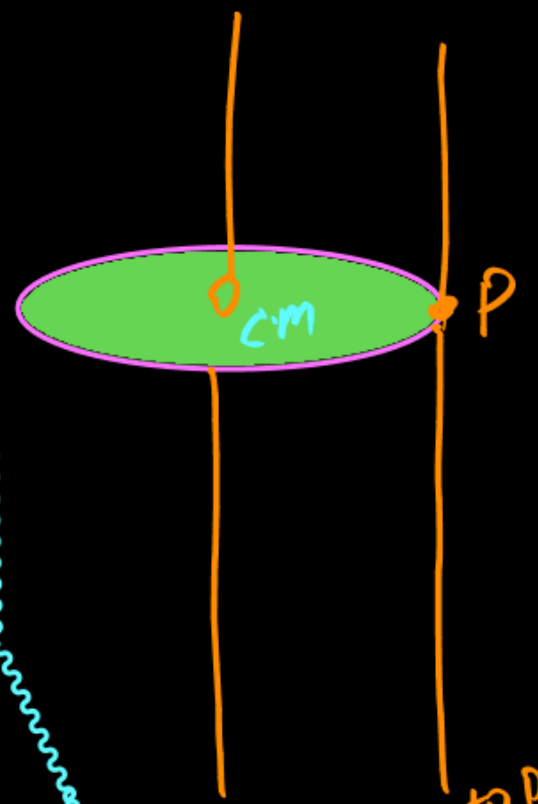
I (Diametre). ∥r to plane

⊥r axis thm

$I_x + I_y = I_z$

$2I_x = \frac{mR^2}{2}$

$I_x = \frac{mR^2}{4}$



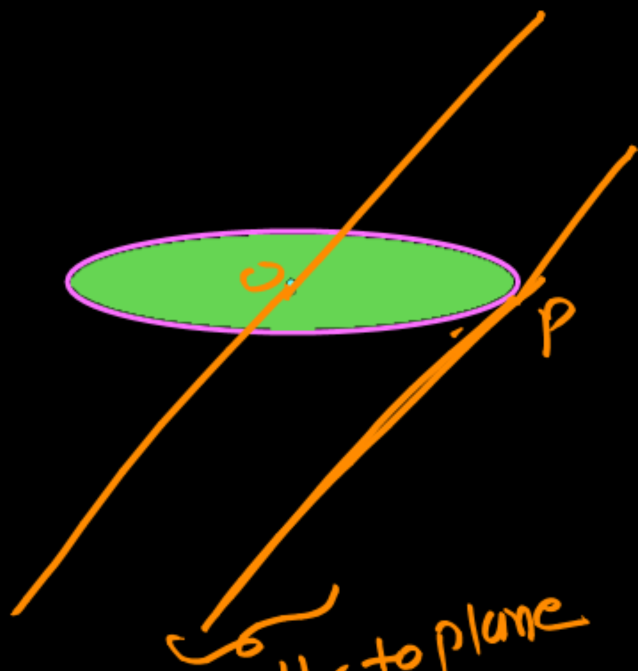
⊥r to plane

∥r axis thm

$I_p = I_{cm} + md^2$

$I_p = \frac{mR^2}{2} + mR^2$

$= \frac{3mR^2}{2}$



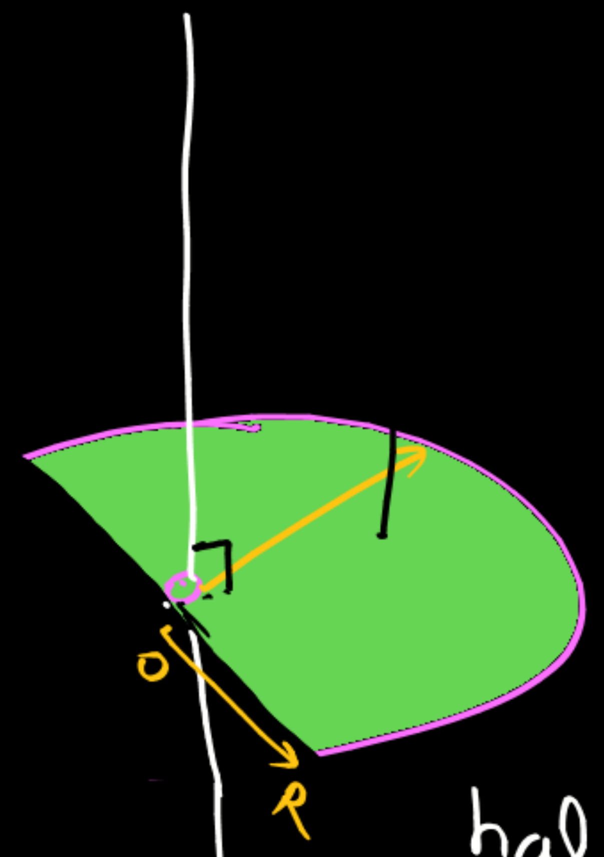
∥r to plane

∥r axis thm

$I_p = I_{cm} + md^2$

$= \frac{mR^2}{4} + 1mR^2$

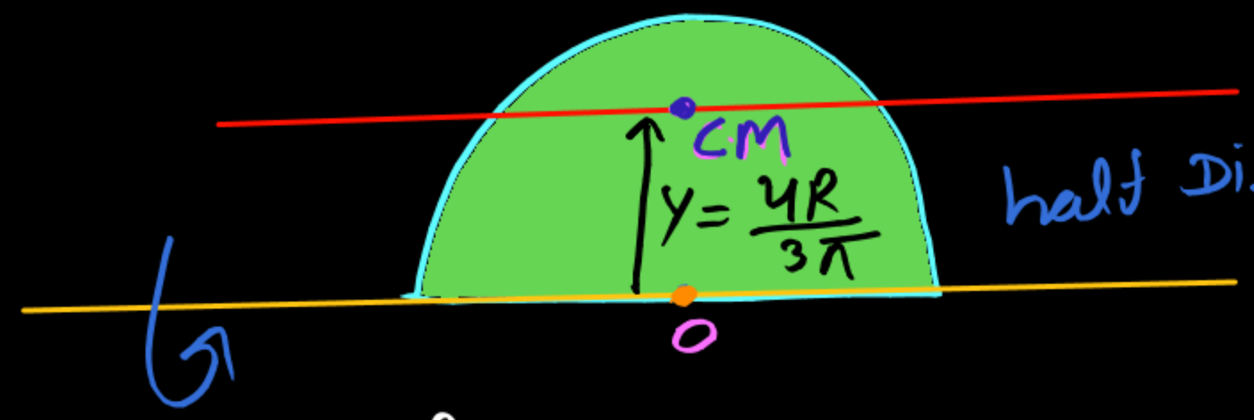
$= \frac{5mR^2}{4}$



half Disc (M, R)

$$I_o = \frac{MR^2}{2}$$

⊥r to Plane



half Disc (M,R)

(∥r to plane)

$$I = \frac{MR^2}{4}$$

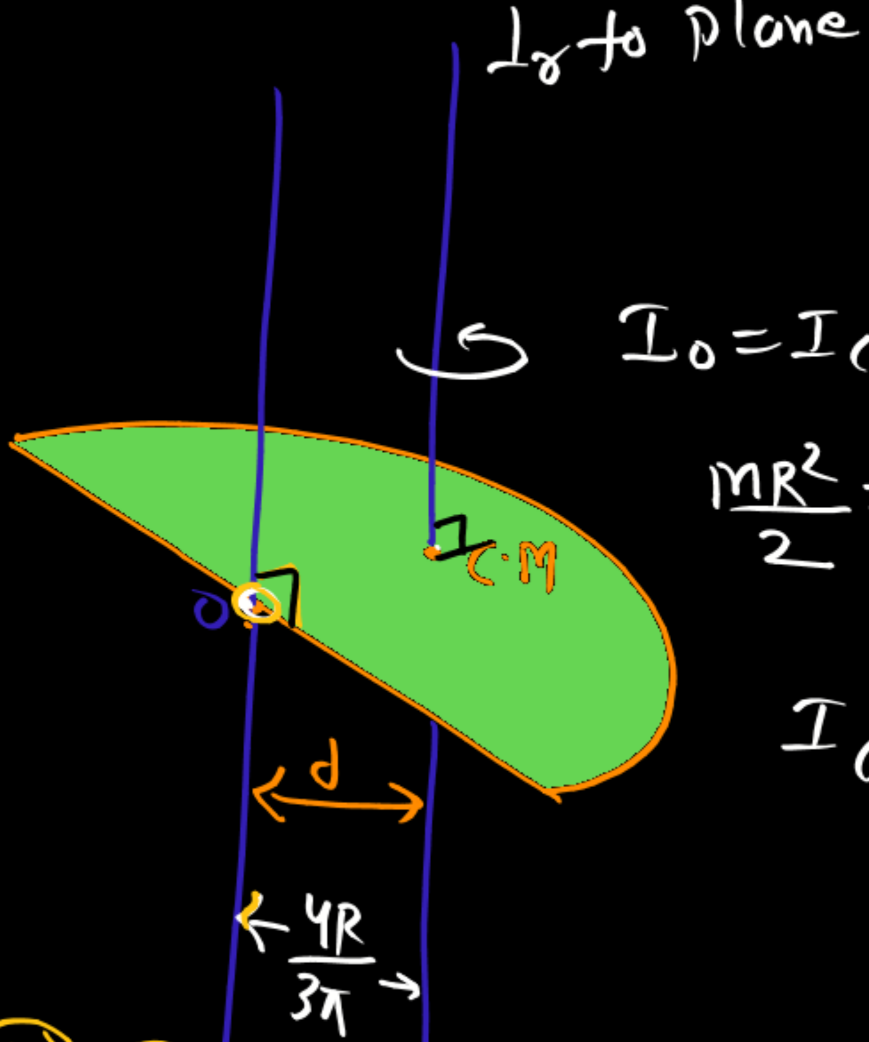
∥r axis thm

$$I_o = I_{c.m} + Md^2$$

$$\frac{MR^2}{4} = I_{cm} + m\left(\frac{4R}{3\pi}\right)^2$$

$$I_{cm} = \left(\frac{MR^2}{4} - \frac{16\,MR^2}{9\pi^2}\right)$$ Ans

find M.O.I of half Disc (M, R) about C.O.M & ⊥r to the plane ??



$$I_o = I_{cm} + md^2$$

$$\frac{MR^2}{2} = I_{cm} + M\left(\frac{4R}{3\pi}\right)^2$$

$$I_{cm} = \left(\frac{MR^2}{2} - \frac{16MR^2}{9\pi^2}\right)$$

Ans

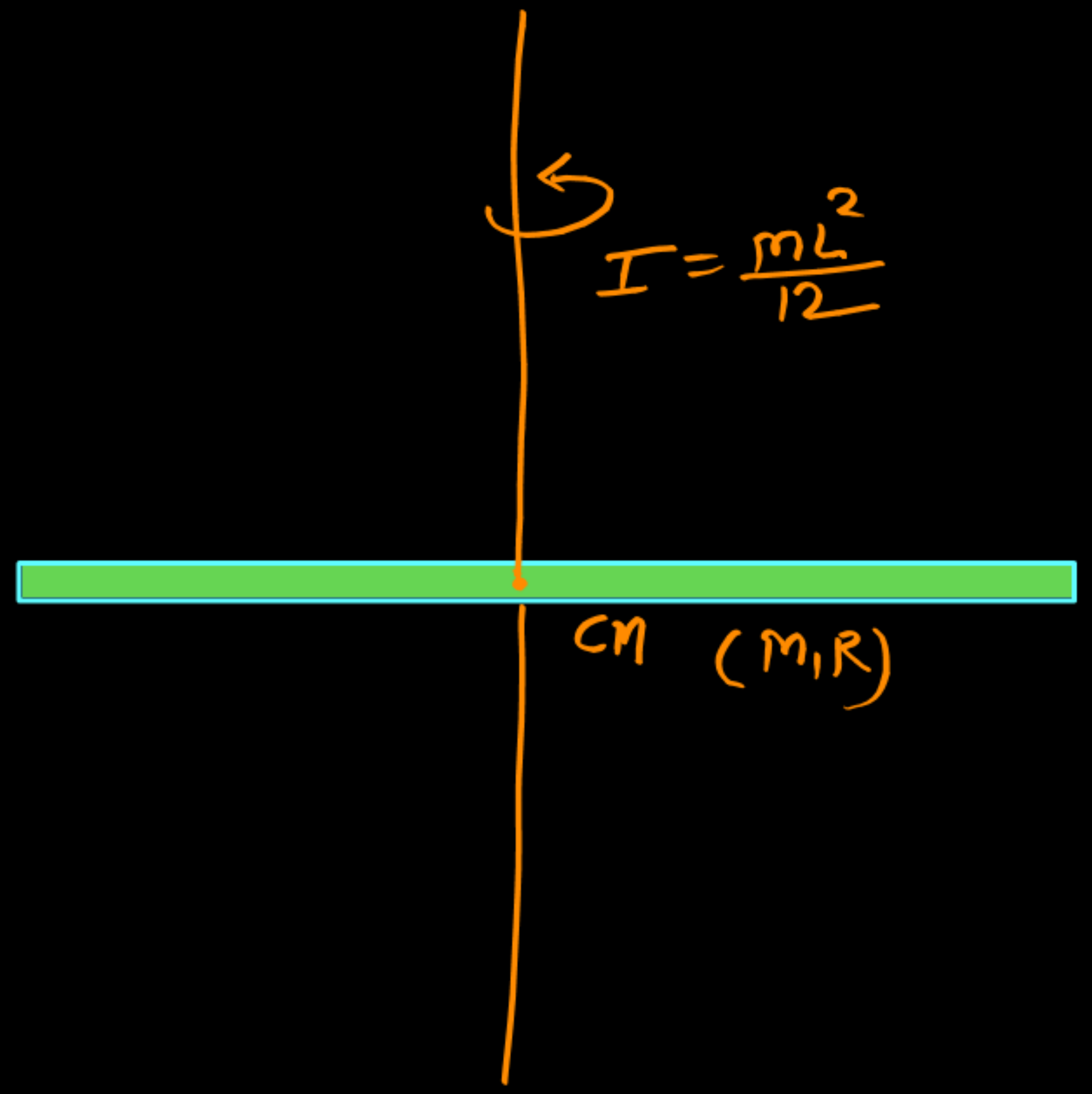


Half Ring

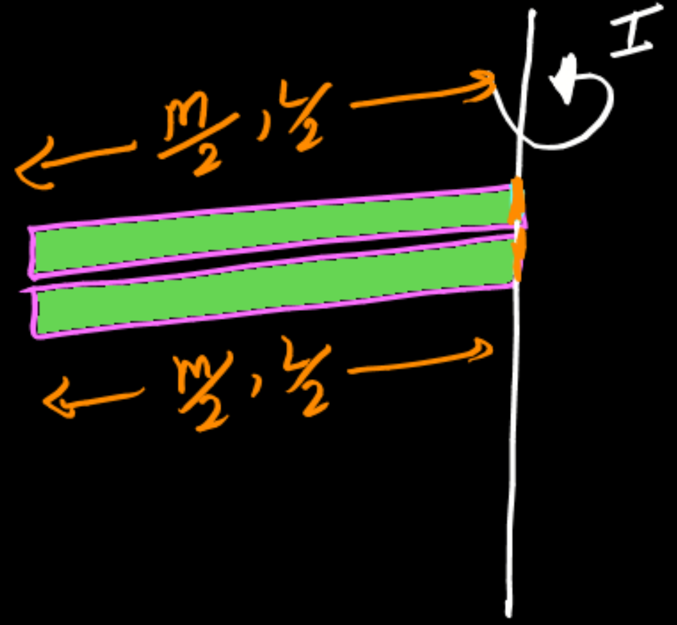


Disc

Rod is Broken from mid Point. and Placed togather as shown in figure.



$\Rightarrow$



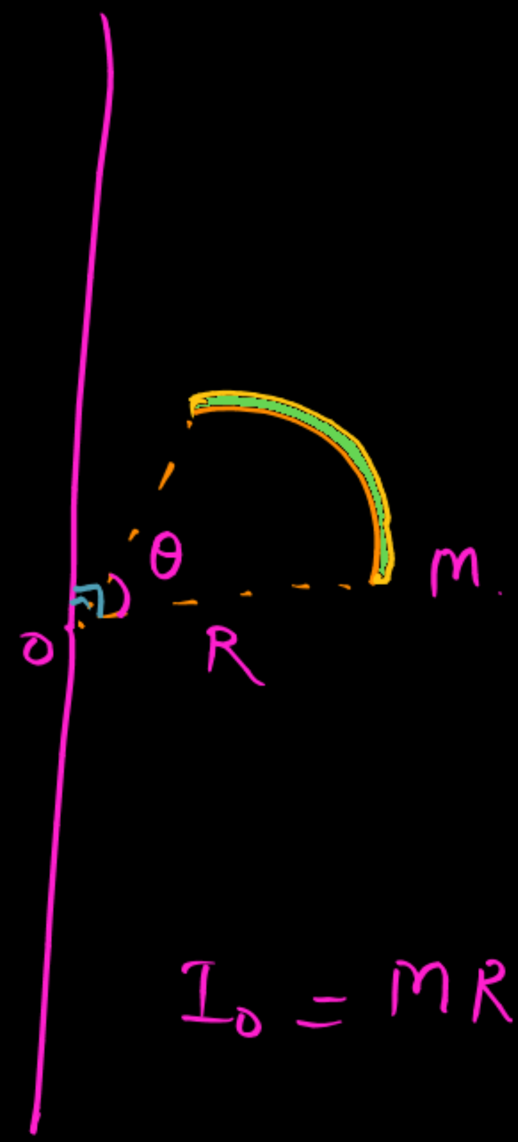
$$I = I_{one\,rod} + I_{one\,rod}$$

$$I = \frac{1}{3}\left(\frac{m}{2}\right)\left(\frac{L}{2}\right)^2 + \frac{1}{3}\frac{m}{2}\left(\frac{L}{2}\right)^2$$

$$= \frac{1}{3}\frac{m}{2} \times \frac{L^2}{4} + \frac{1}{3}\frac{m}{2}\frac{L^2}{4}$$

$$= \frac{mL^2}{24} + \frac{mL^2}{24}$$

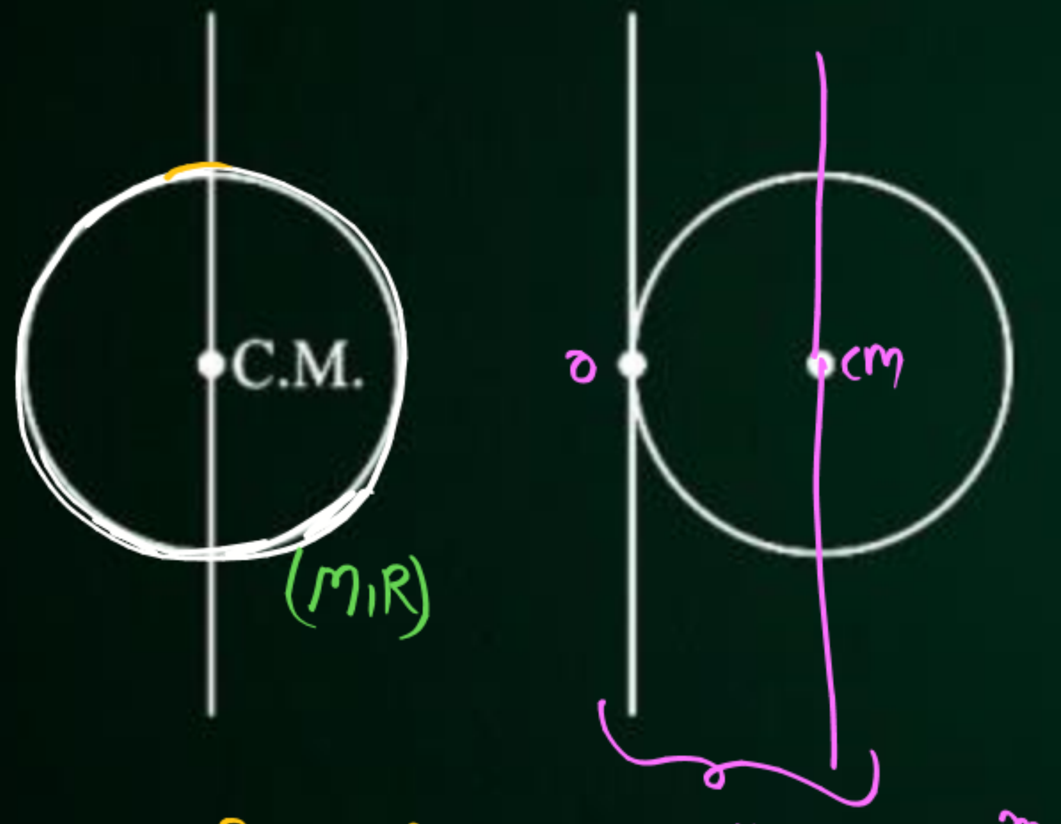
$$I = \frac{mL^2}{12} \text{ (same)}$$



$I_0 = mR^2$

(Ans)

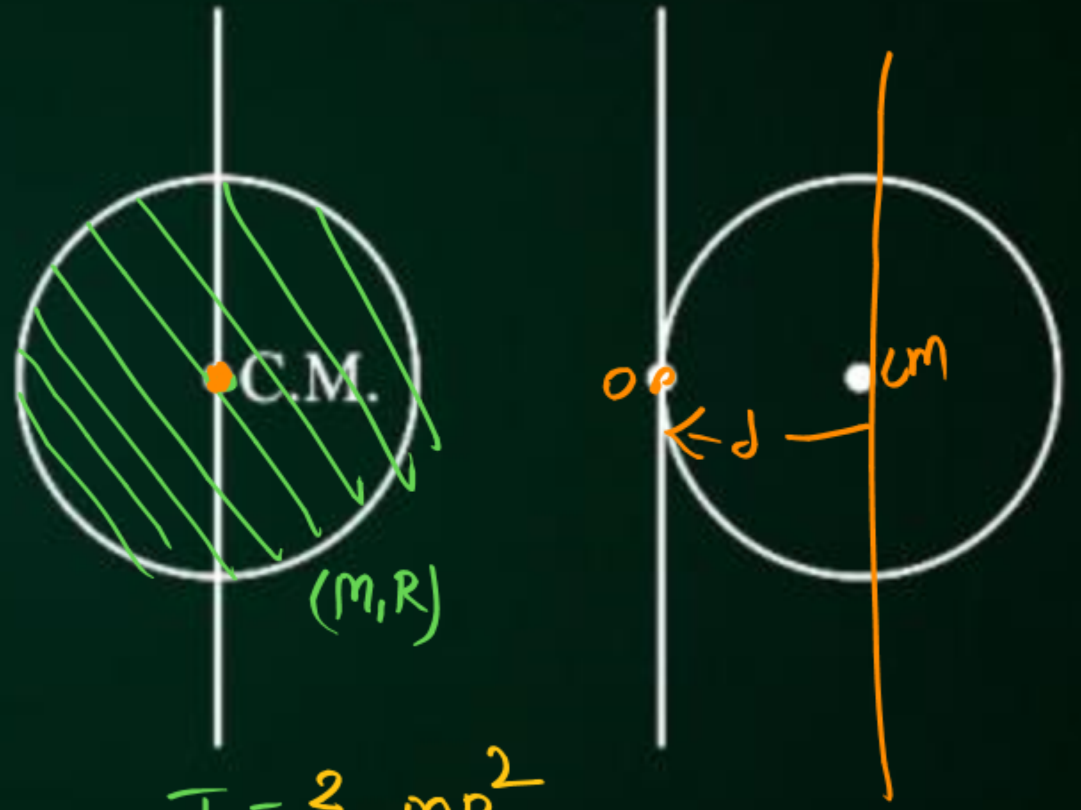
Hollow sphere (M, R)



$$I = \frac{2}{3}MR^2$$

$$I_o = I_{cm} + Md^2$$
$$= \frac{2}{3}MR^2 + MR^2 = \frac{5}{3}MR^2$$

Solid sphere



$$I = \frac{2}{5}MR^2$$

$$I_o = I_{cm} + Md^2$$
$$= \frac{2}{5}MR^2 + MR^2 = \frac{7MR^2}{5}$$

QUESTION

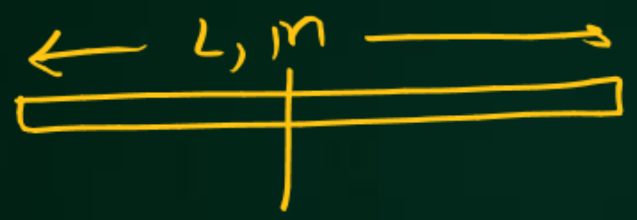
A thin rod of length L and mass M is bent at its midpoint into two halves so that the angle between them is 90°. The moment of inertia of the bent rod about an axis passing through the bending point and perpendicular to the plane defined by the two halves of the rod is **[AIPMT (Prelims)-2003]**

1. $\dfrac{\sqrt{2}ML^2}{24}$

2. $\dfrac{ML^2}{24}$

3. $\dfrac{ML^2}{12}$ ✓

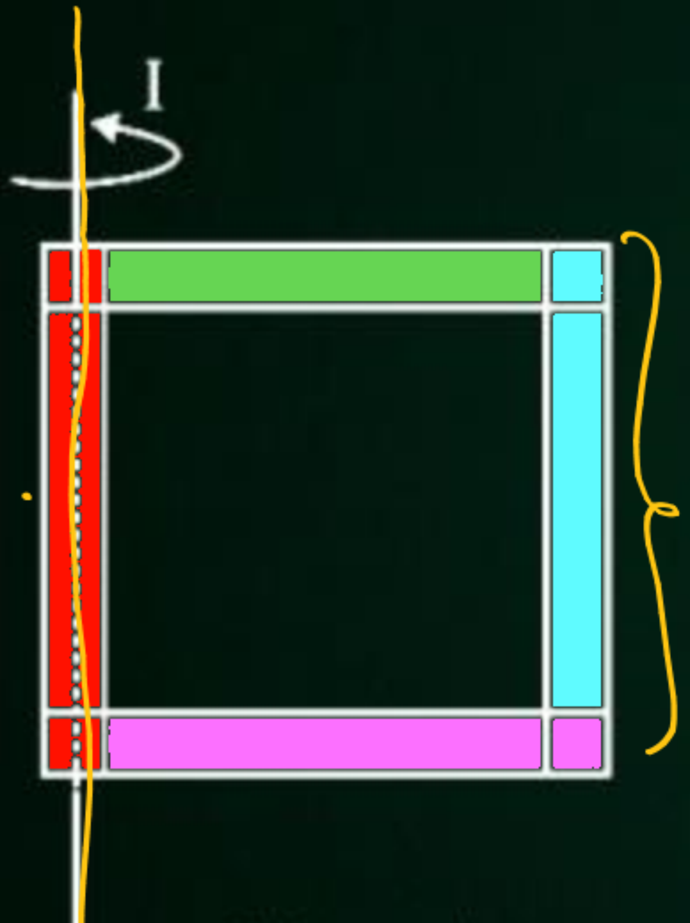
4. $\dfrac{ML^2}{6}$





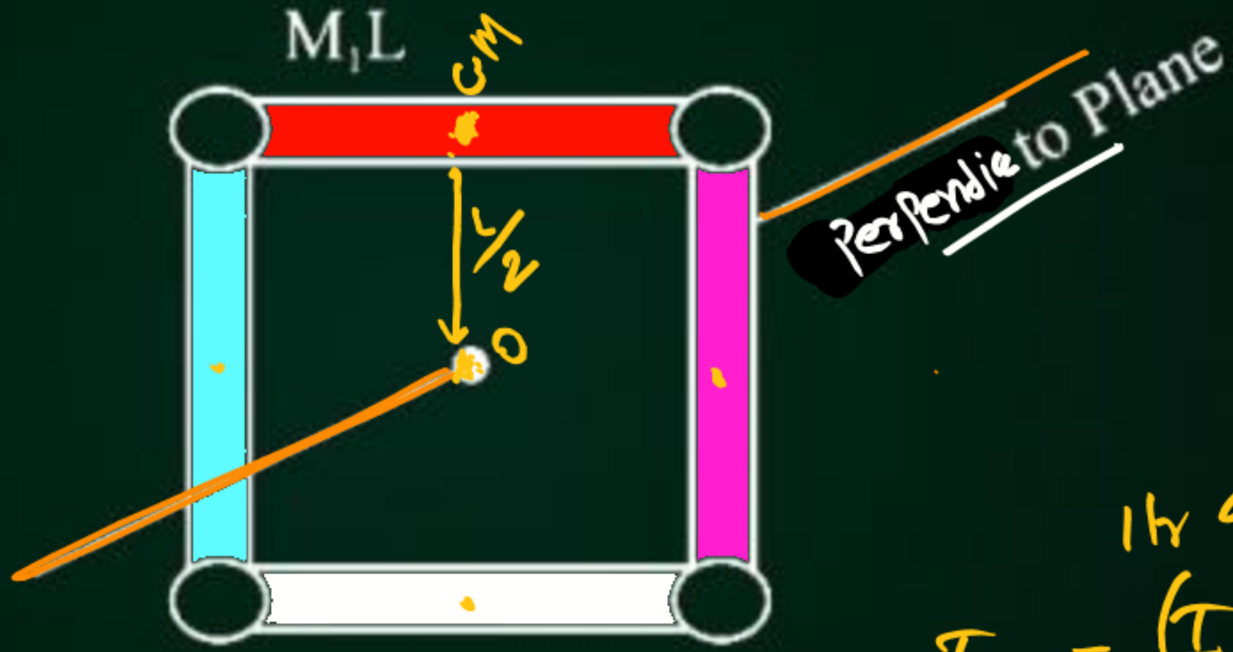
QUESTION

Four identical rod (M, L), placed as shown in figure. Find MOI.



Parallel to Plane

$$I = 0 + \frac{1}{3}ML^2 + \frac{1}{3}ML^2 + ML^2$$



⊥r axis th^m for one Rod

$$I_0 = \left(I_{c.m} + Md^2\right)_{\text{one Rod}}$$

$$I_0 = \frac{ML^2}{12} + \frac{ML^2}{4} = \frac{ML^2}{3}$$

$$I_{sys} = 4I_0 = \frac{4ML^2}{3}$$

QUESTION

The moment of inertia of a thin uniform circular disc about one of its diameter is I. Its moment of inertia about an axis tangent to it and perpendicular to its plane is

1. $\frac{2I}{3}$
2. $2I$
3. $\frac{I}{2}$
4. $6I$

QUESTION

A thin uniform wire of mass m and length l is bent into a circle. The moment of inertia of the wire about an axis passing through its one end and perpendicular to the plane of the circle is

1. $\frac{2mL^2}{\pi^2}$

2. $\frac{mL^2}{\pi^2}$

3. $\frac{mL^2}{2\pi^2}$

4. $\frac{mL^2}{3\pi^2}$

QUESTION

A thin wire of length l and mass m is bent in the form of a semicircle as shown. Its moment of inertia about an axis joining its free ends will be

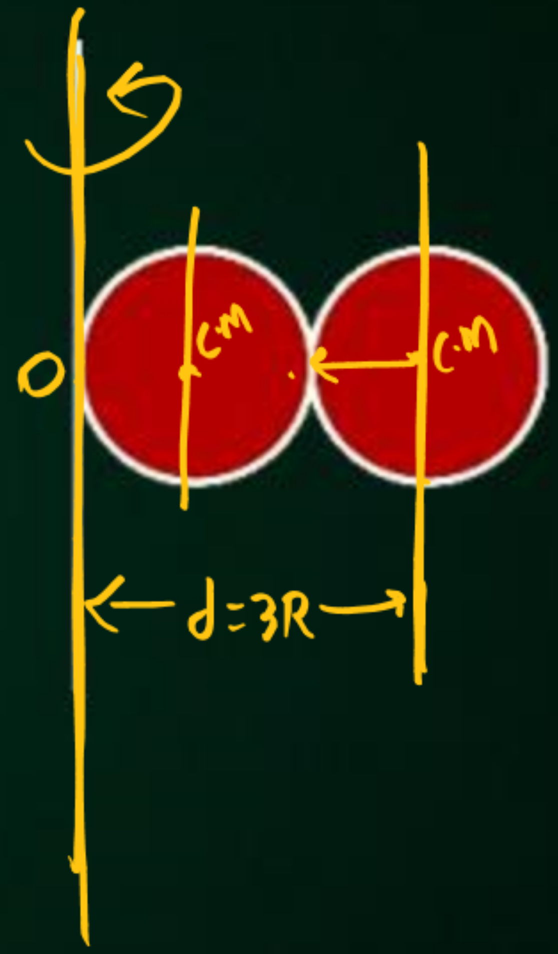
1. ml^2
2. Zero
3. $\frac{ml^2}{\pi^2}$
4. $\frac{ml^2}{2\pi^2}$



4-Hollow Sphere



2-Hollow Sphere



QUESTION

The moment of inertia of a uniform circular disc of radius R and mass M about an axis passing from the edge of the disc and normal to the disc is

[AIPMT (Prelims)-2005]

1. $\frac{1}{2}MR^2$
2. MR^2
3. $\frac{7}{2}MR^2$
4. $\frac{3}{2}MR^2$

QUESTION

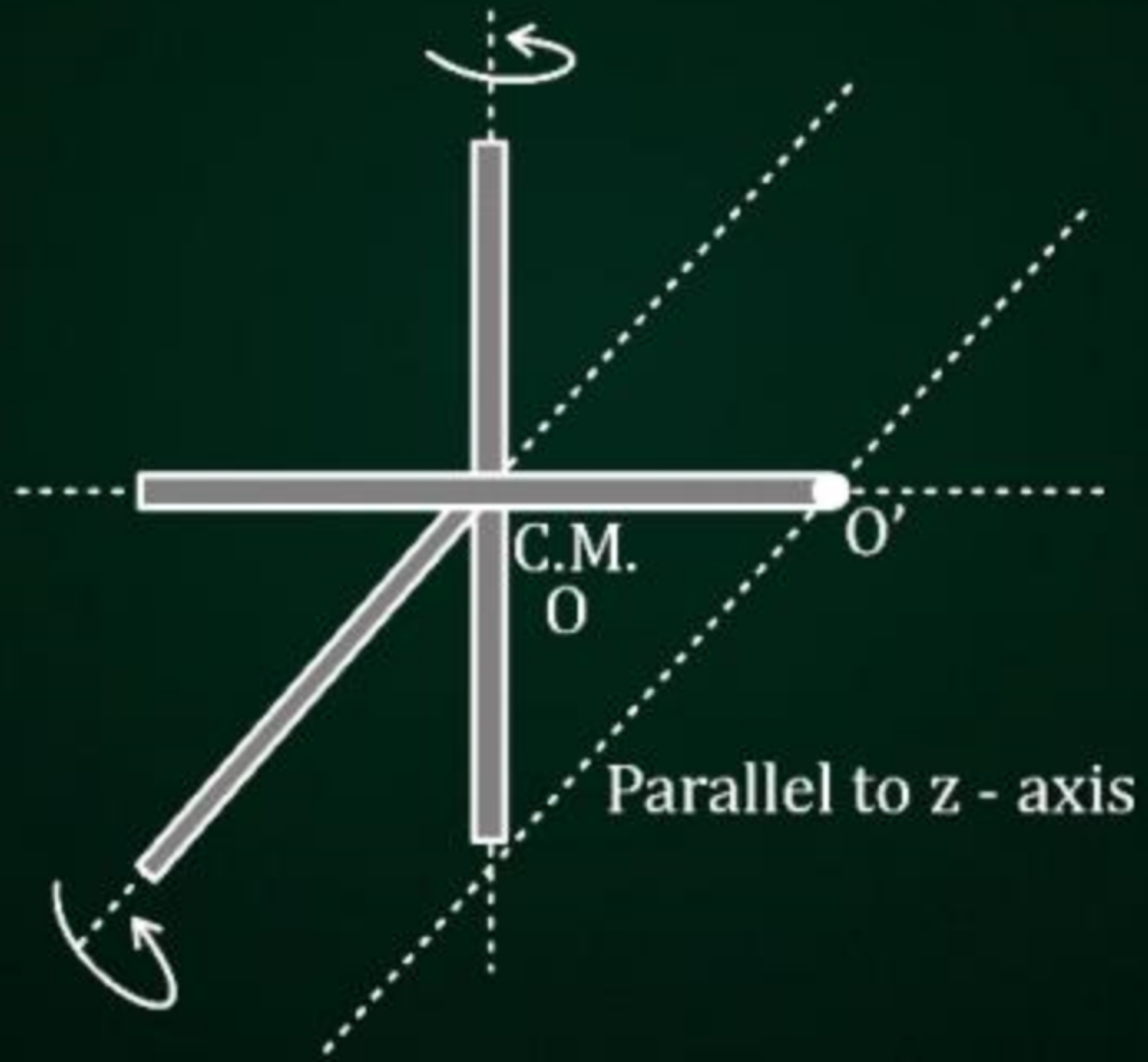
Two discs of same mass and same thickness have densities as 17 g/cm^3 and 51 g/cm^3. The ratio of their moment of inertia about their central axes is

1. $\frac{1}{3}$
2. $\frac{2}{3}$
3. $\frac{3}{1}$
4. $\frac{3}{2}$

H/W

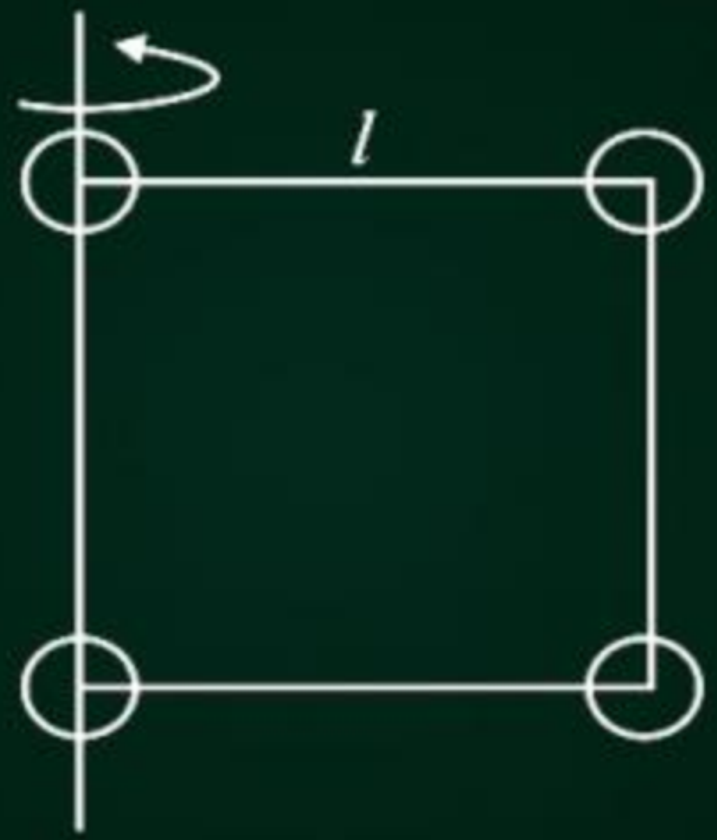
QUESTION

Three identical rod parallel to each other. Find MOI about y – axis.



M|W

Four Solid sphere (M_1R)



H/W

QUESTION

Four rings each of mass M and radius R are arranged as shown in the figure. The moment of inertia of the system about the axis yy' is

1. $2\,MR^2$
2. $3\,MR^2$
3. $4\,MR^2$
4. $5\,MR^2$



H/W

QUESTION

Four thin uniform rods each of length L and mass m are joined to form a square. The moment of inertia of square about an axis along its one diagonal is

1. $\frac{mL^2}{6}$
2. $\frac{2}{3}mL^2$
3. $\frac{3mL^2}{4}$
4. $\frac{4mL^2}{3}$

H/W

QUESTION

The two spheres, one of which is hollow and other solid, have identical masses and moment of inertia about their respective diameters. The ratio of their radii is given by

1. $5:7$
2. $3:5$
3. $\sqrt{3}:\sqrt{5}$
4. $3:7$

H/W

QUESTION

Three solid spheres each of mass P and radius Q are arranged as shown in figure. The moment of inertia of the arrangement about YY' axis

(1) $\frac{7}{5}PQ^2$

(2) $\frac{14}{5}PQ^2$

(3) $\frac{16}{5}PQ^2$

(4) $\frac{5}{14}PQ^2$



H|W


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 03 | Physics

Rotational Motion

By- Dr. Manish Raj (MR SIR)



Topic to be Covered

1. # Question on M.O.I
2. #
3. #
4. #



$\lambda = \frac{M_0}{2L^2} x$

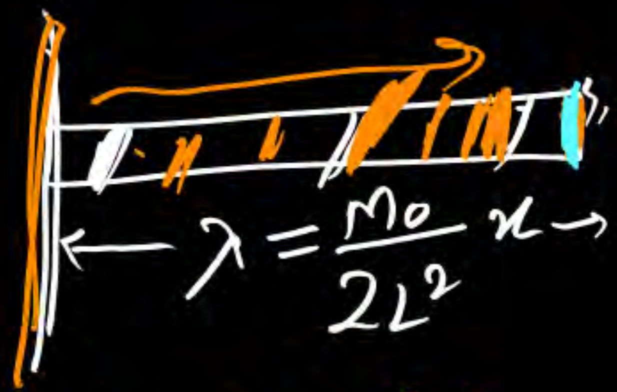


$$I = \frac{M_0 L^2}{8}$$

As

M_0 is not Mass of Rod

Mona aisa Chaiye tha.



Uniform Rod

$$I = \frac{ML^2}{3}$$

50% se Jada ko doubts

Doubt आ

(a) yes, doubt.

(b) No, doubt.

(c) confused.

$x = t - \sin(t)$ Position as a function of time (t)

→ Position then fin v, a, x with time

$x = t^2 + 2t$

fin(v)

dimⁿ wrong ??

How this is correct??

$\sin(\omega t)$ → $\omega = 1$ → $\sin(t)$

$x = t - \sin(t)$

→ wrong dimⁿ ??

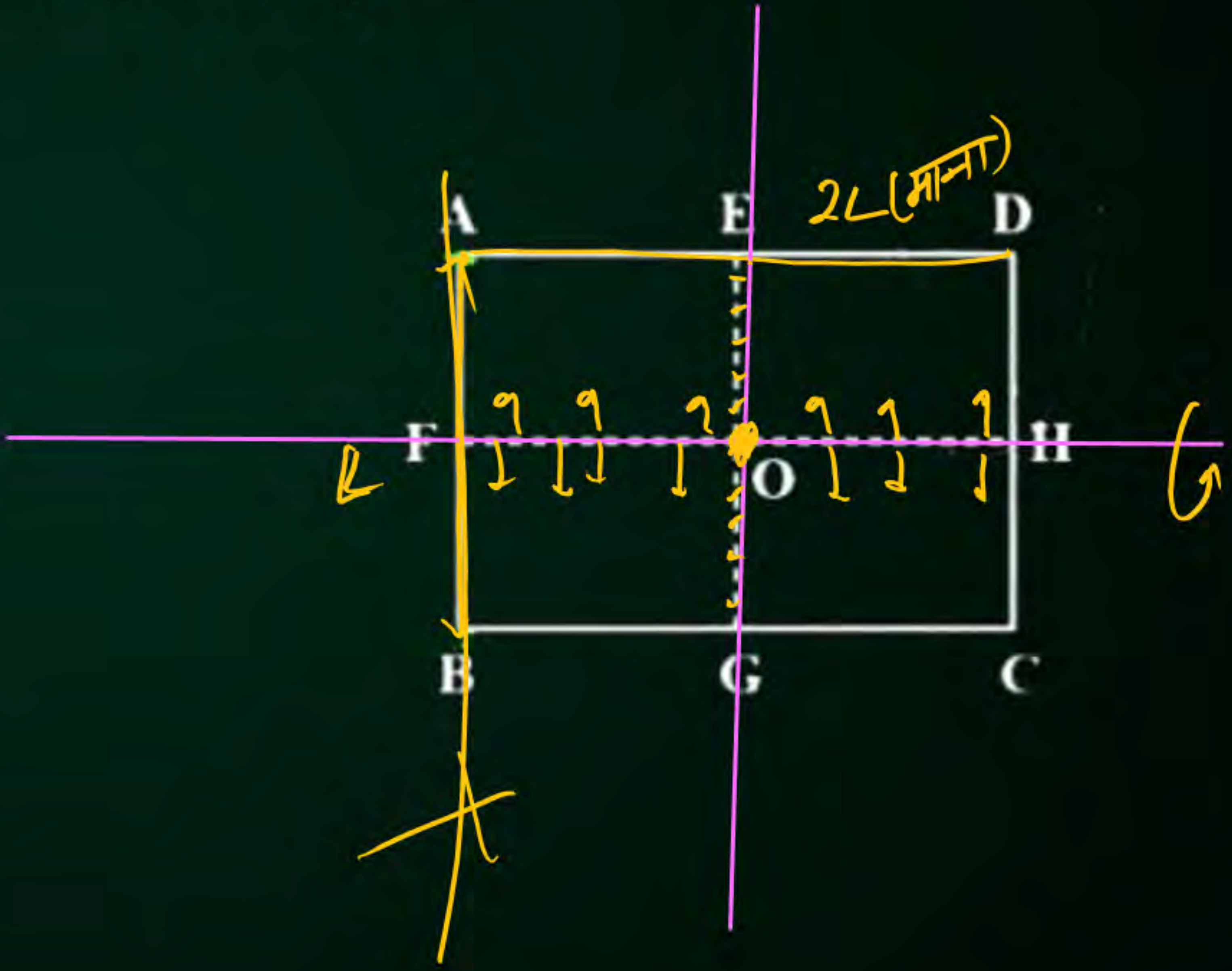
$\frac{dx}{dt} = v$

M.O.I

QUESTION

In the rectangular lamina shown in the figure, AB = BC/2. The moment of inertia of the lamina is minimum along the axis passing through :

1. AB
2. BC
3. EG
4. FH

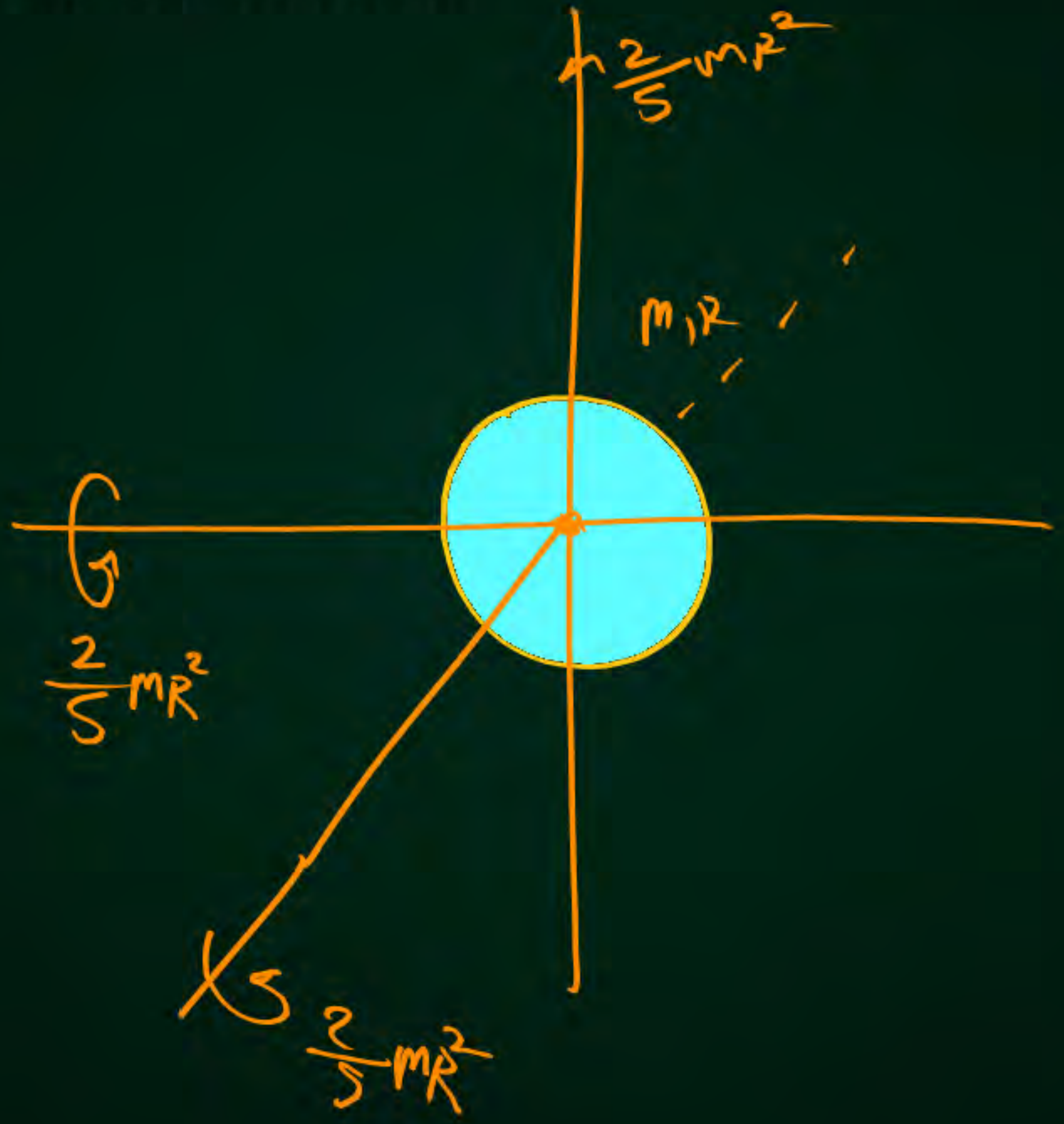


QUESTION

Perpendicular axis theorem is valid for...

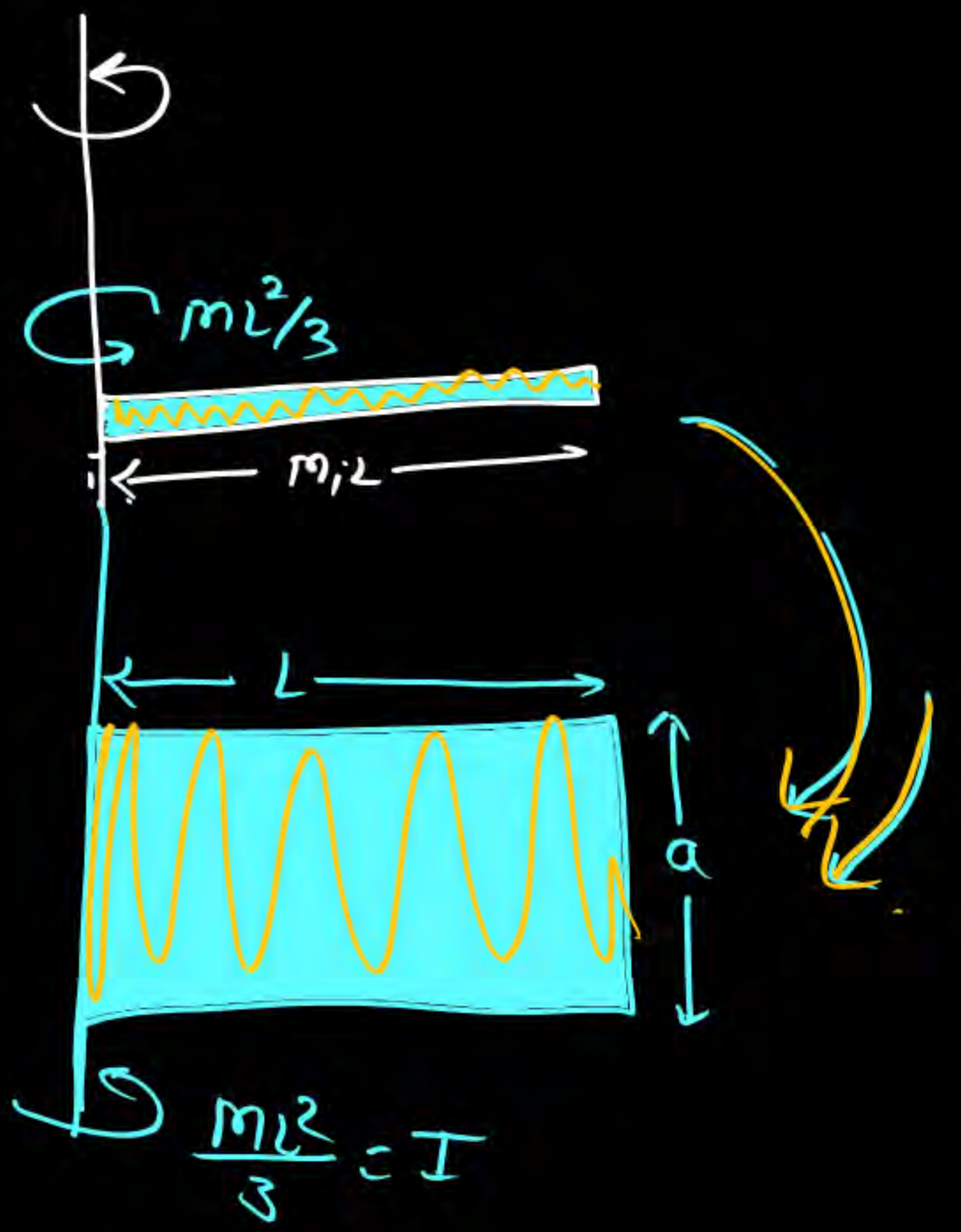
1. Disc
2. Solid sphere
3. Rod
4. None of these

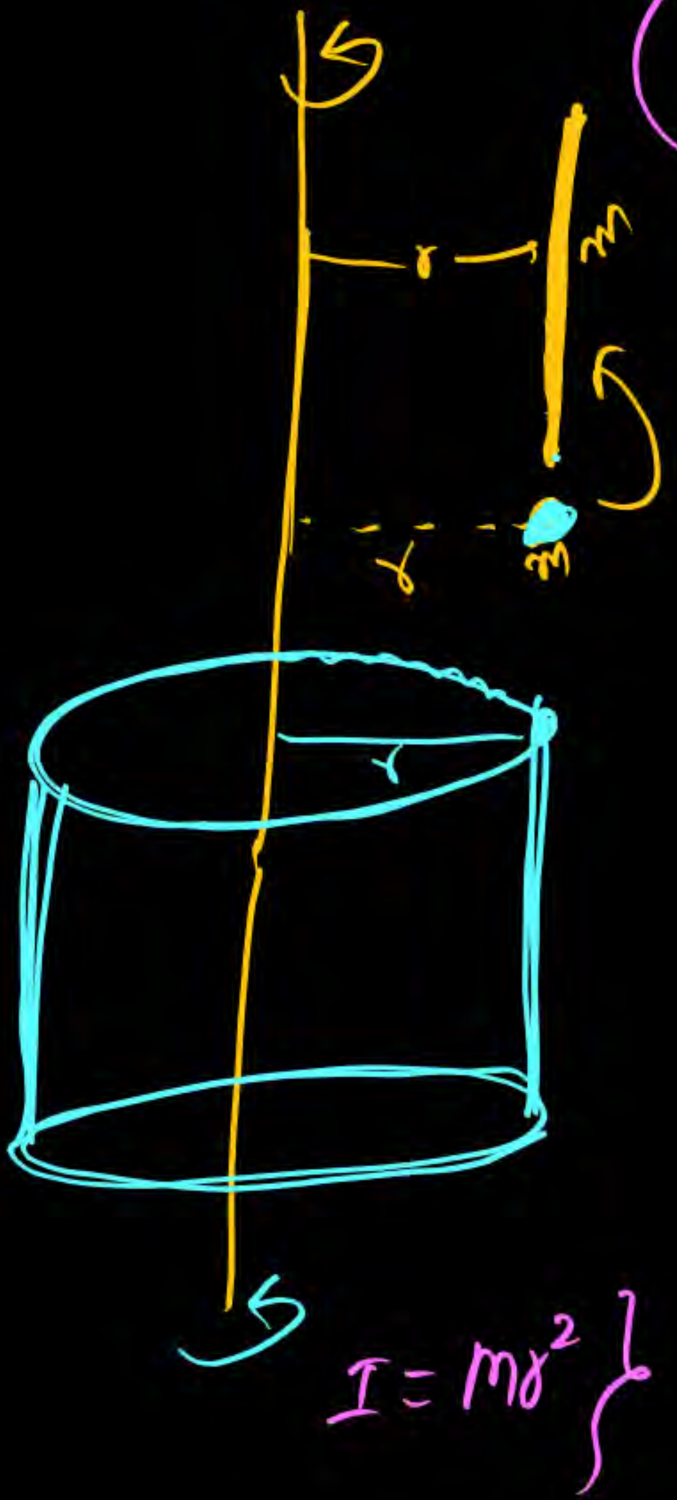


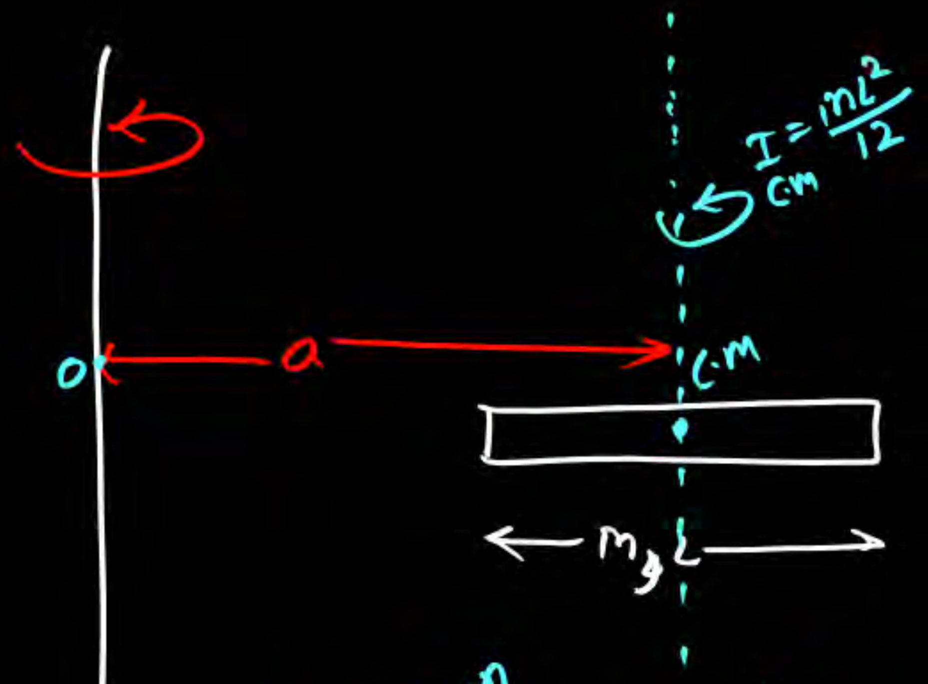


Moment of Inertia of Plate

Point mass → cylinder → M.O.I same
Ring → Rod





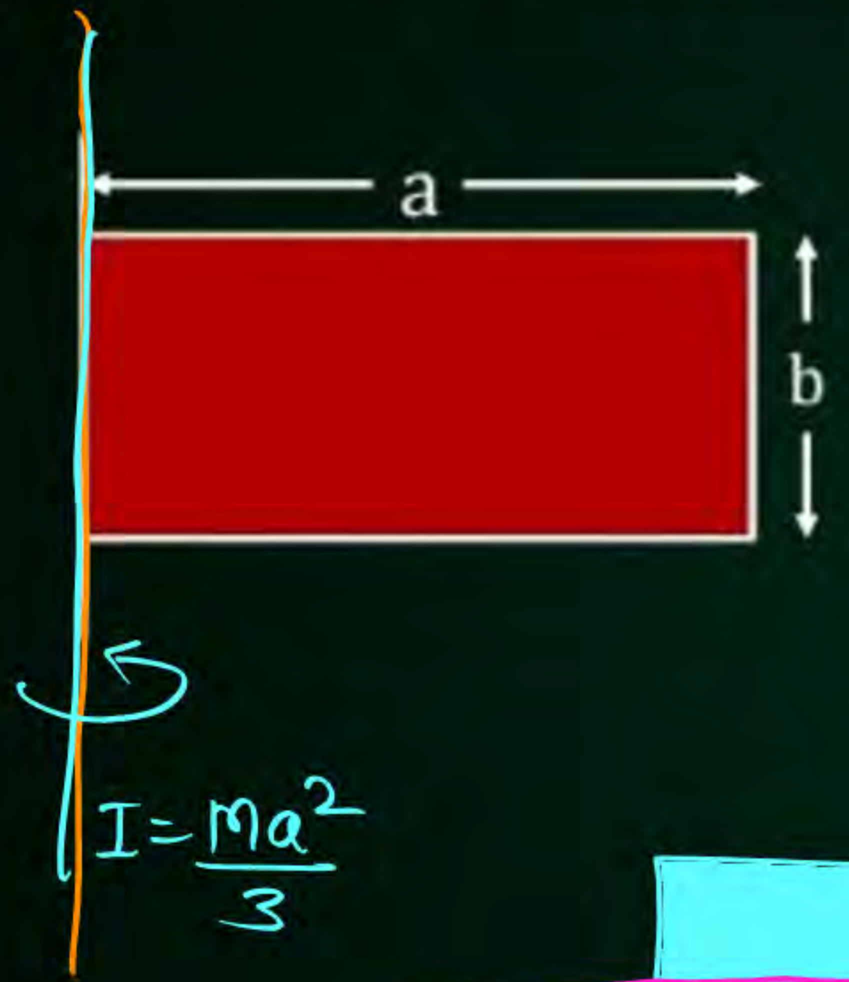


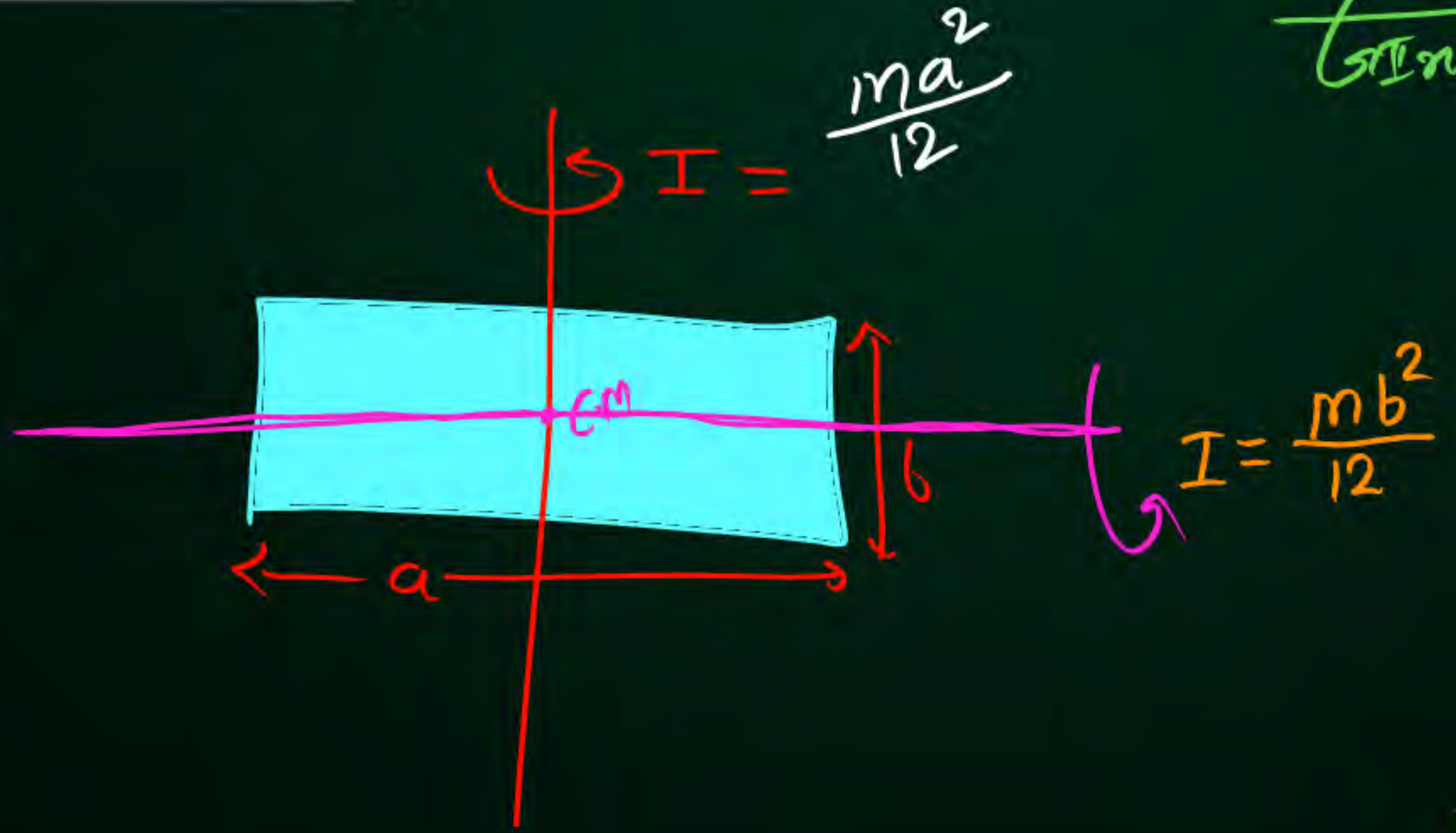
$\parallel_r$ axis thm

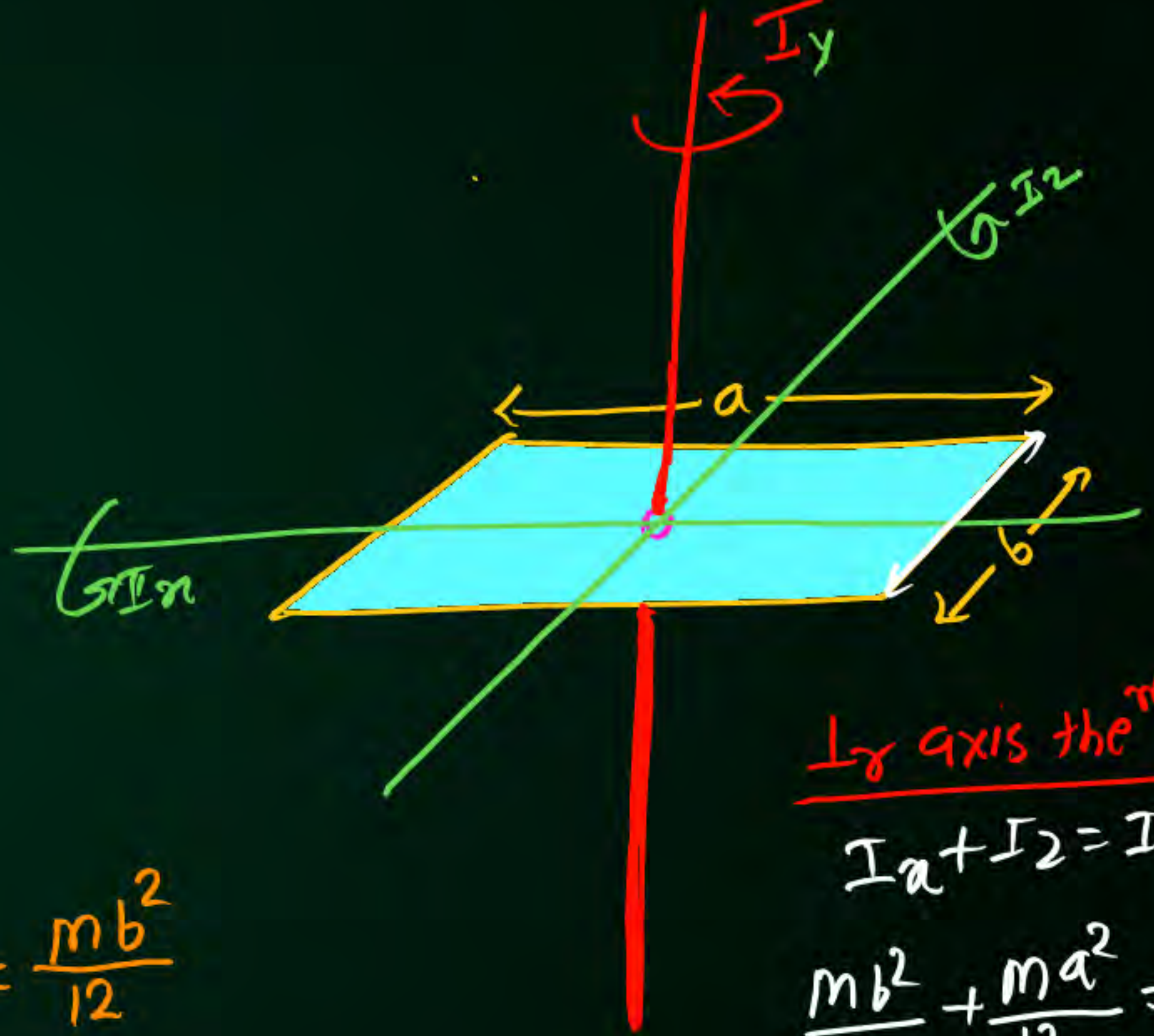
$$I_0 = I_{cm} + ma^2$$

$$I_0 = \frac{mL^2}{12} + ma^2$$

RECTANGULAR PLATE







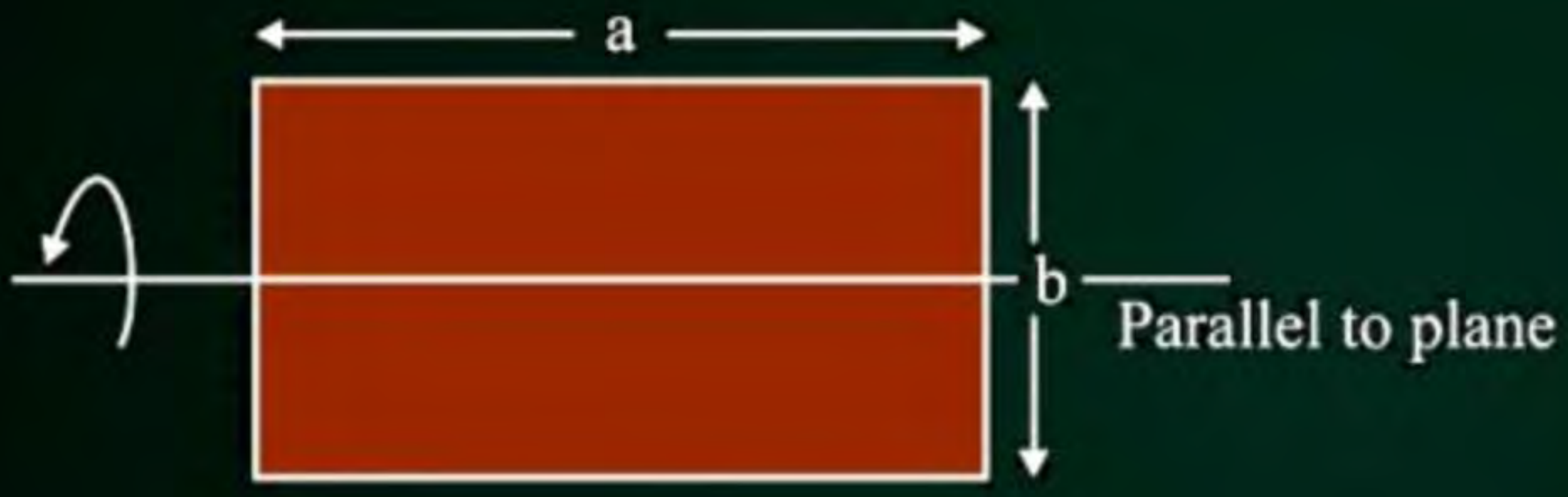
⊥r axis theᵐ

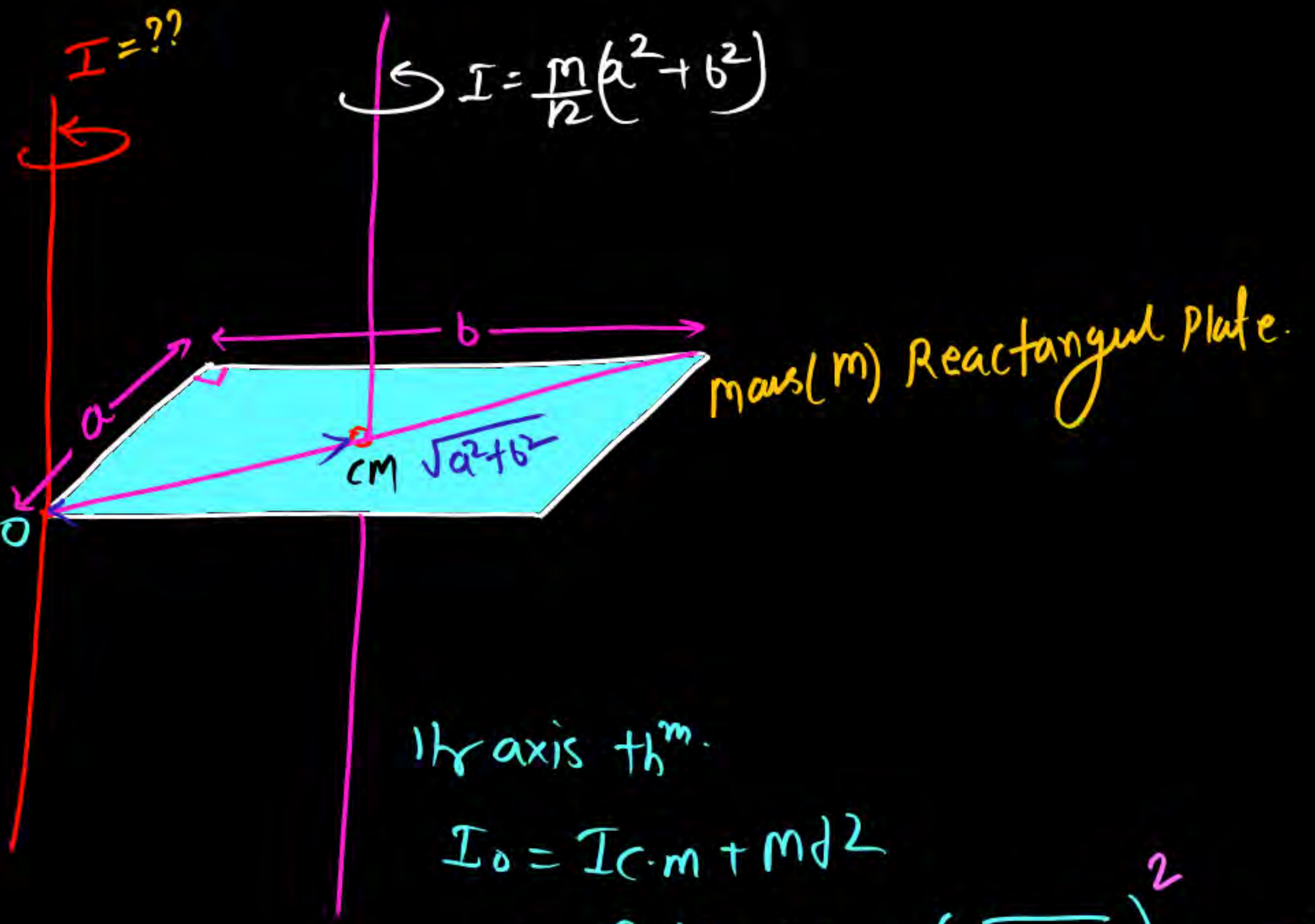
$$I_x + I_z = I_y$$

$$\frac{mb^2}{12} + \frac{ma^2}{12} = I_y$$

$$I_y = \frac{M}{12}(a^2 + b^2)$$

RECTANGULAR PLATE

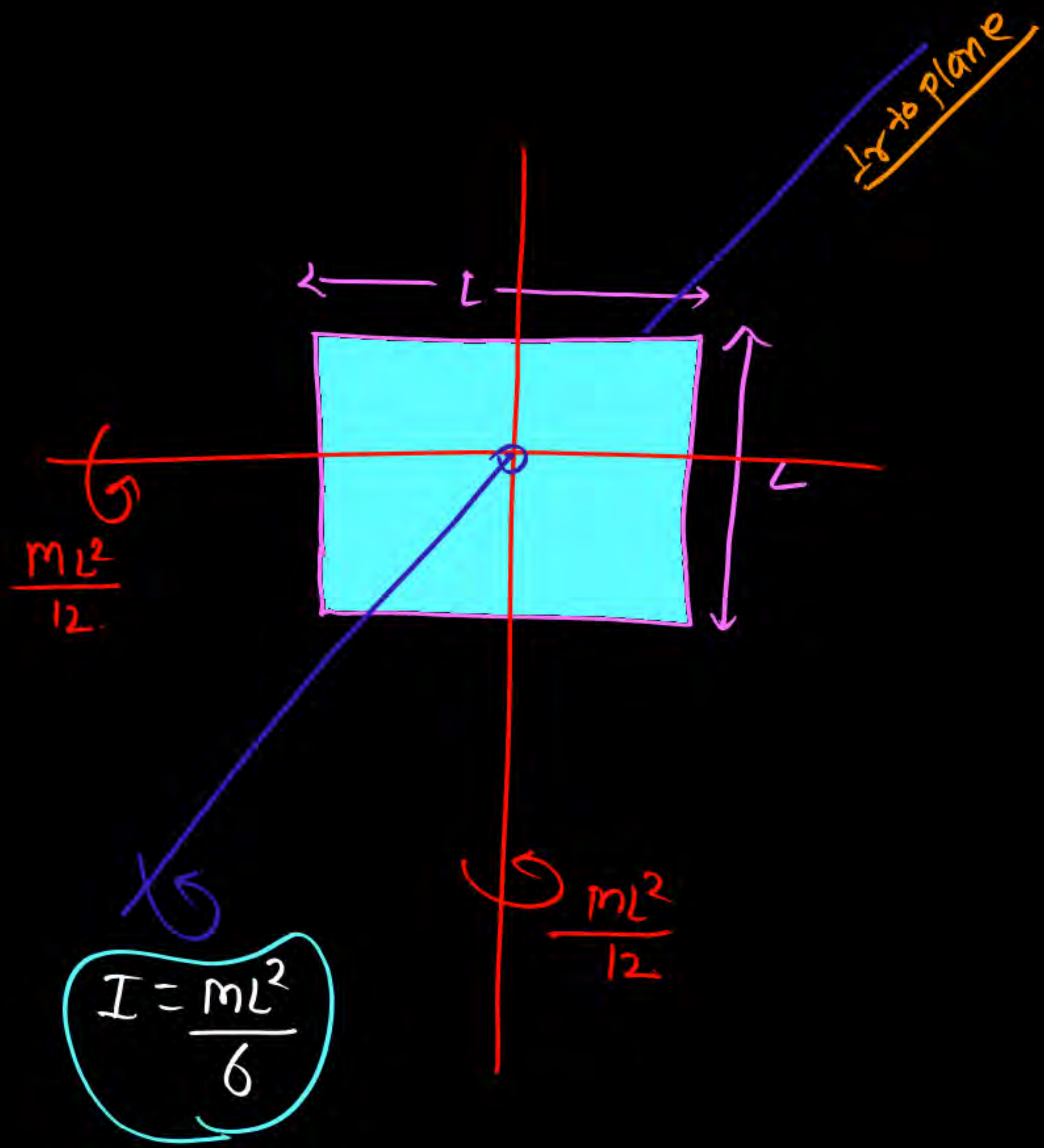


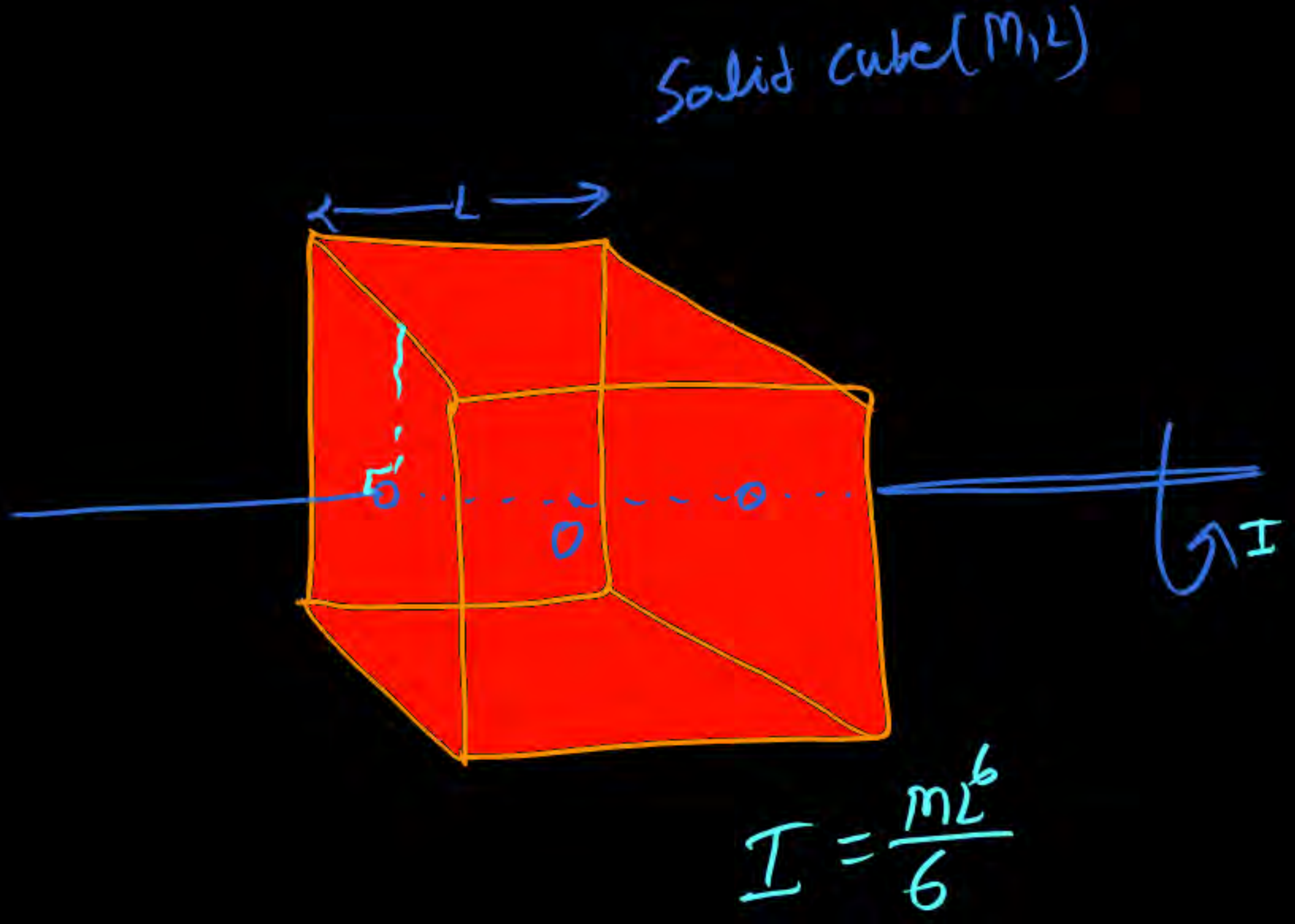


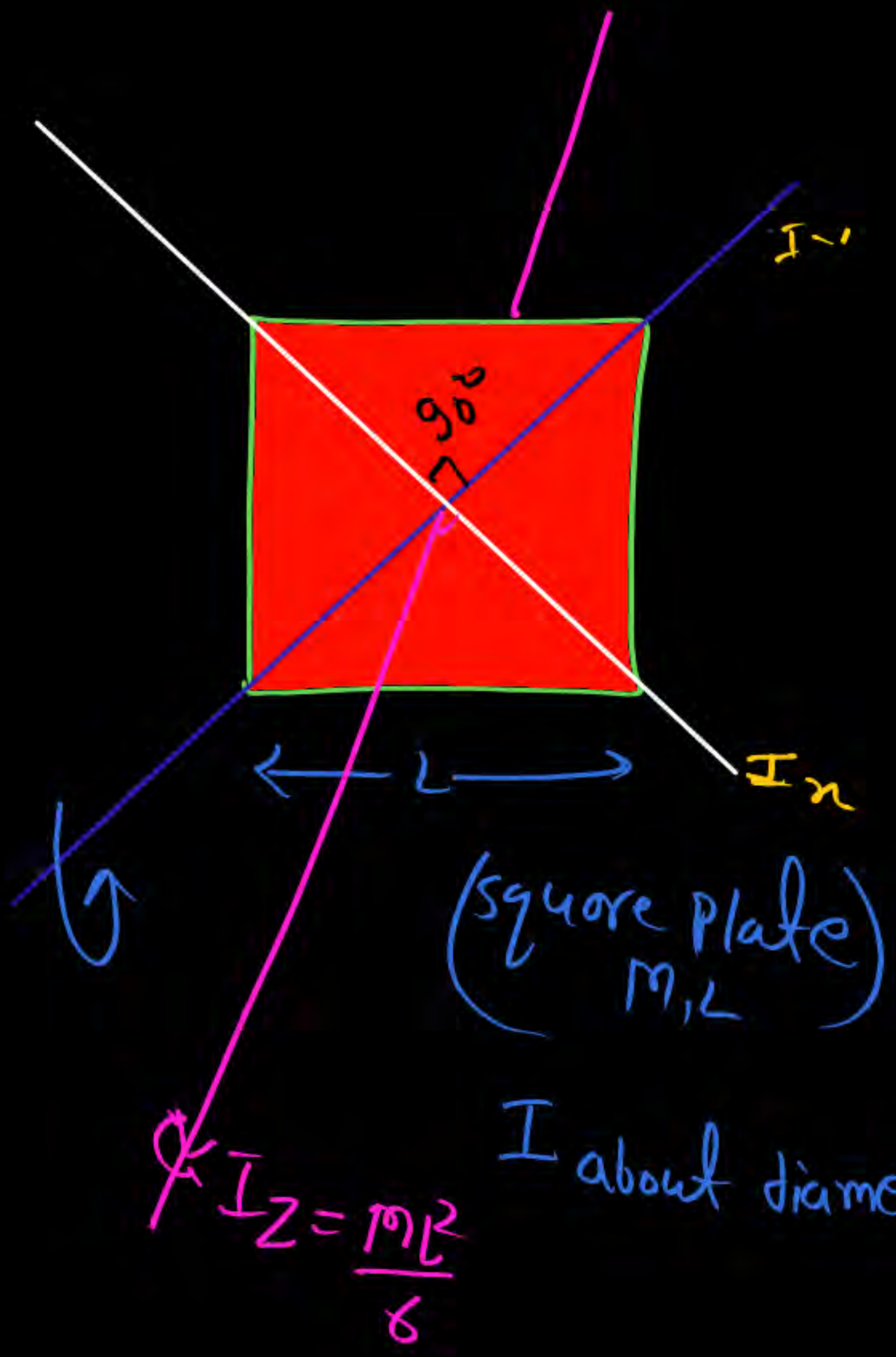
$\parallel$r axis thm.

$$I_0 = I_{C.M} + md^2$$

$$= \frac{m}{12}(a^2+b^2) + m\left(\frac{\sqrt{a^2+b^2}}{2}\right)^2 = m\left[\frac{a^2+b^2}{12} + \frac{a^2+b^2}{4}\right) \text{ Ans.}$$


⊥r to plane
L
L
mL²/12
mL²/12
I = mL²/6


Solid cube(M,L)
L
I
I = mL^6/6



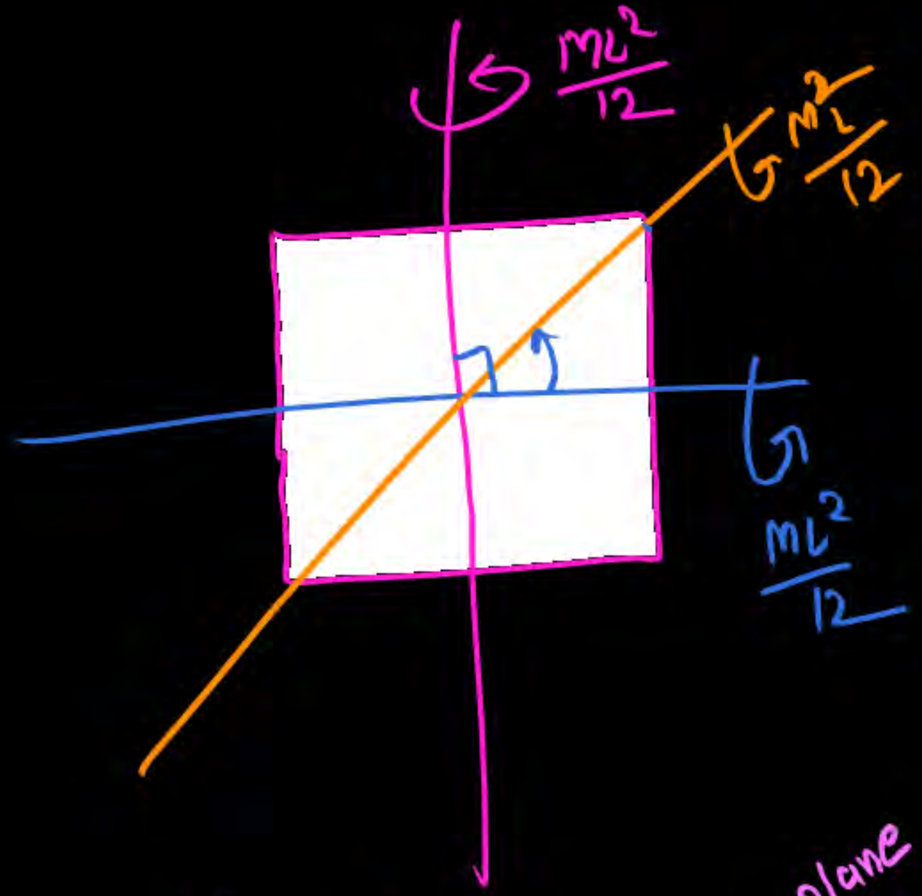
I about diameter = ??

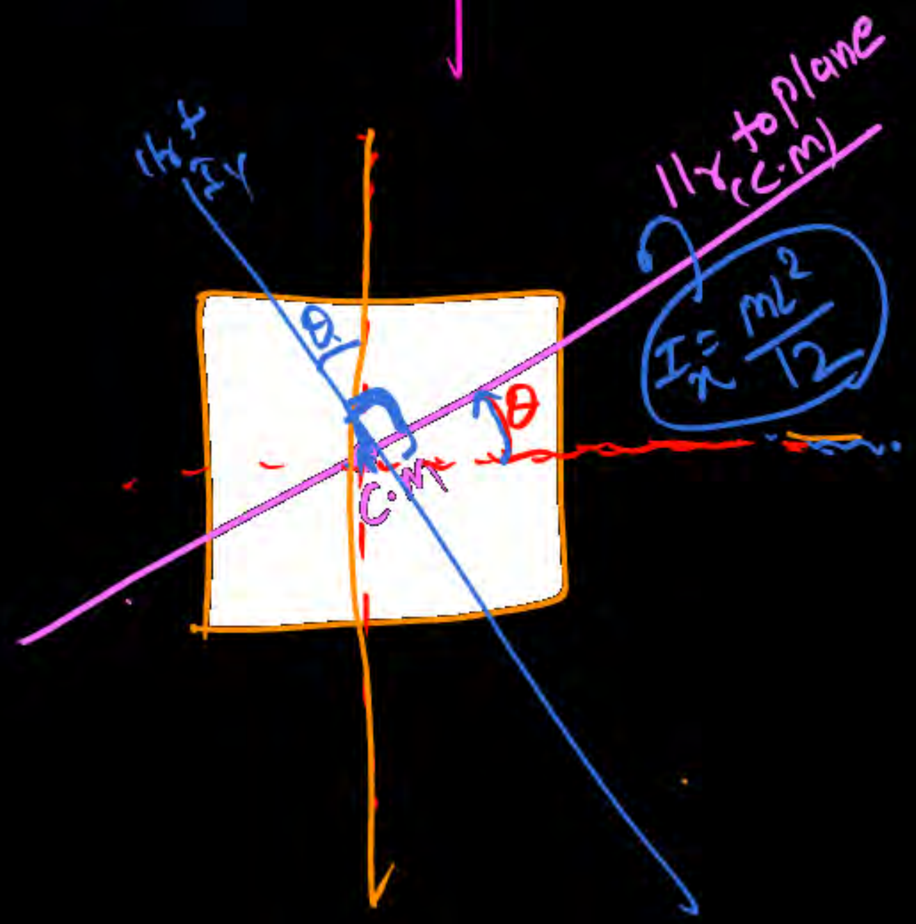
⊥r axis theorem

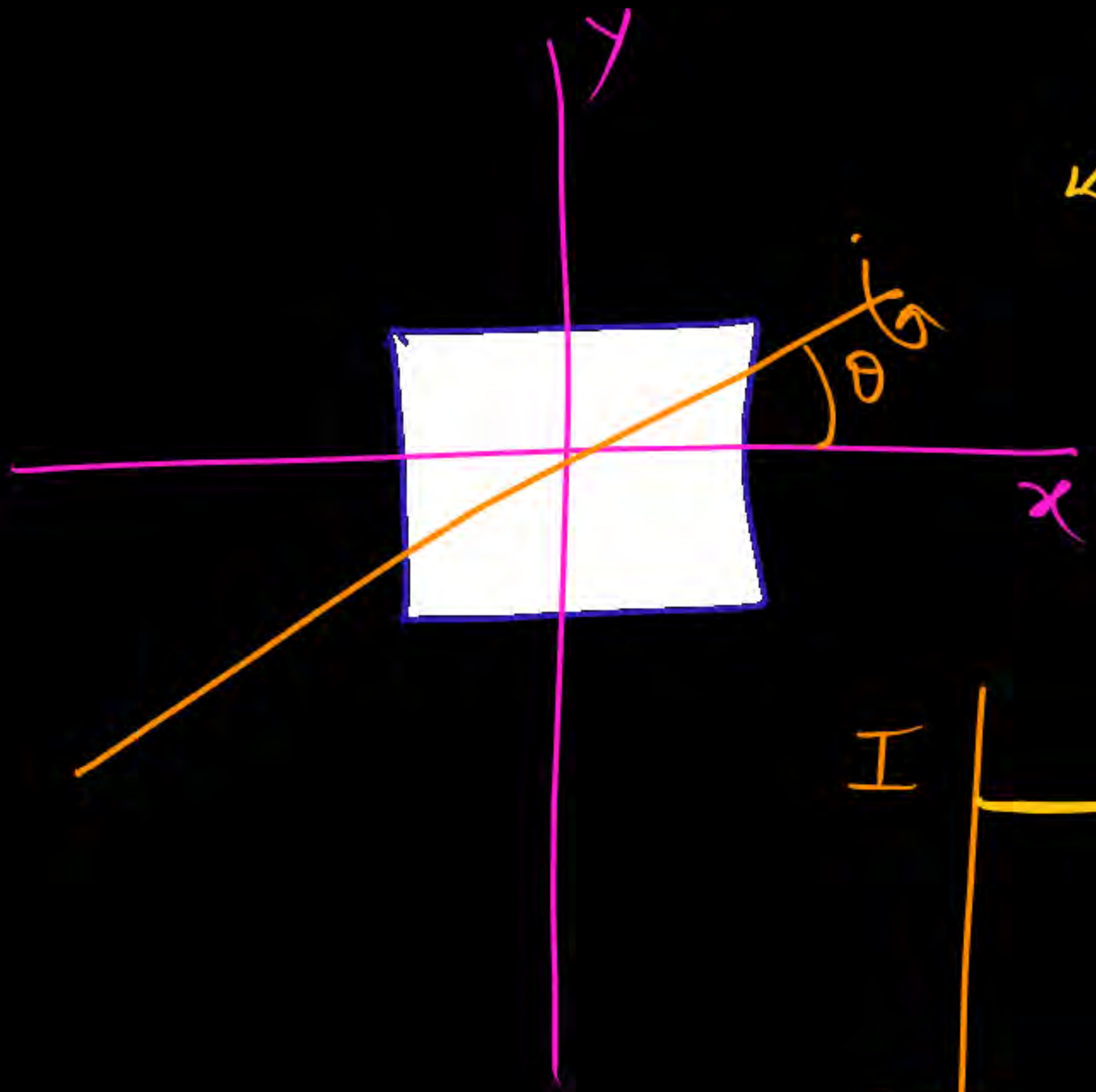
$$I_x + I_y = I_z$$

$$2I_x = \frac{ML^2}{6}$$

$$\boxed{I_x = \frac{ML^2}{12}}$$

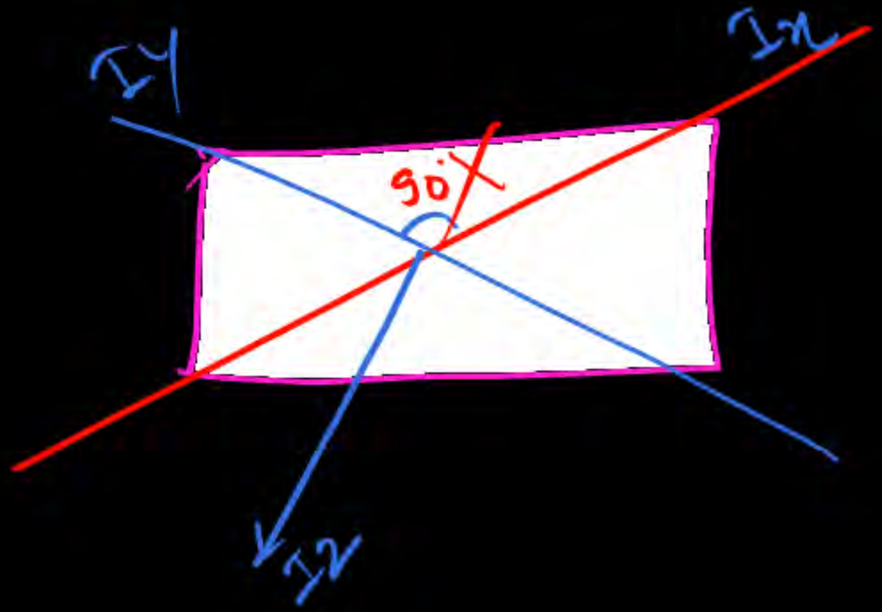






← for square plate





we can't apply ⊥r axis theorem

QUESTION

The figure shows a uniform solid block of mass M and edge lengths a, b and c. Its MOI about an axis through one edge and perpendicular (as shown) to the large face of the block is

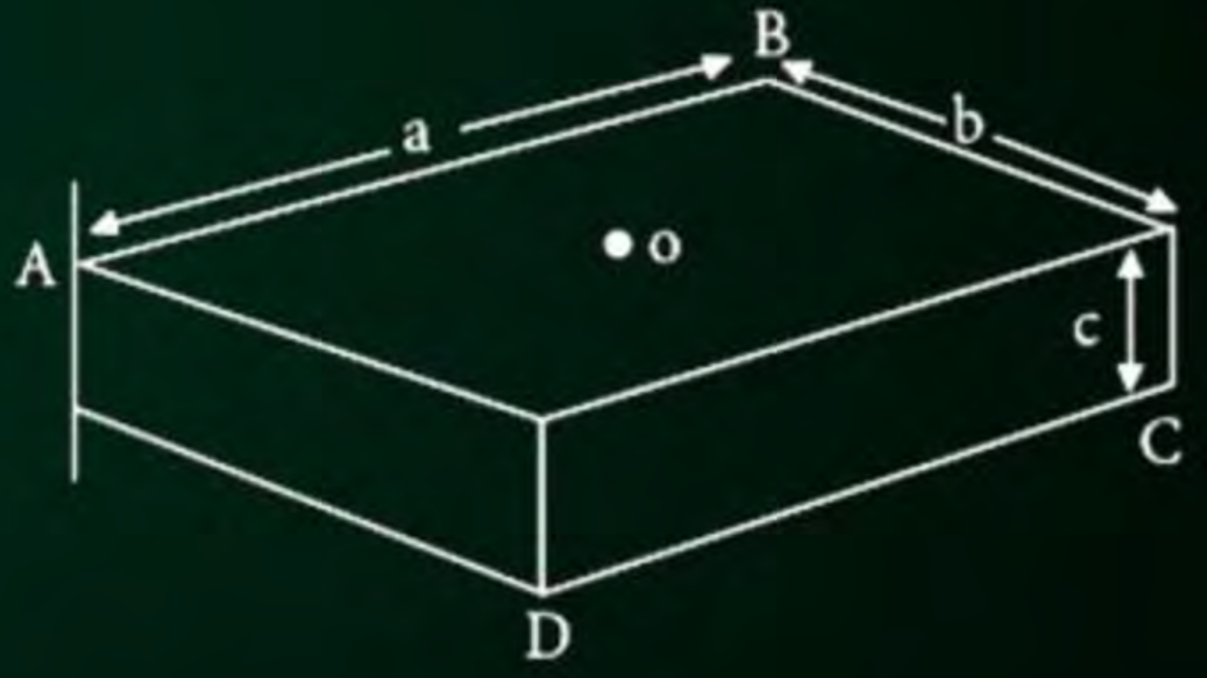
done

(1) $\frac{M}{3}(a^2 + b^2)$

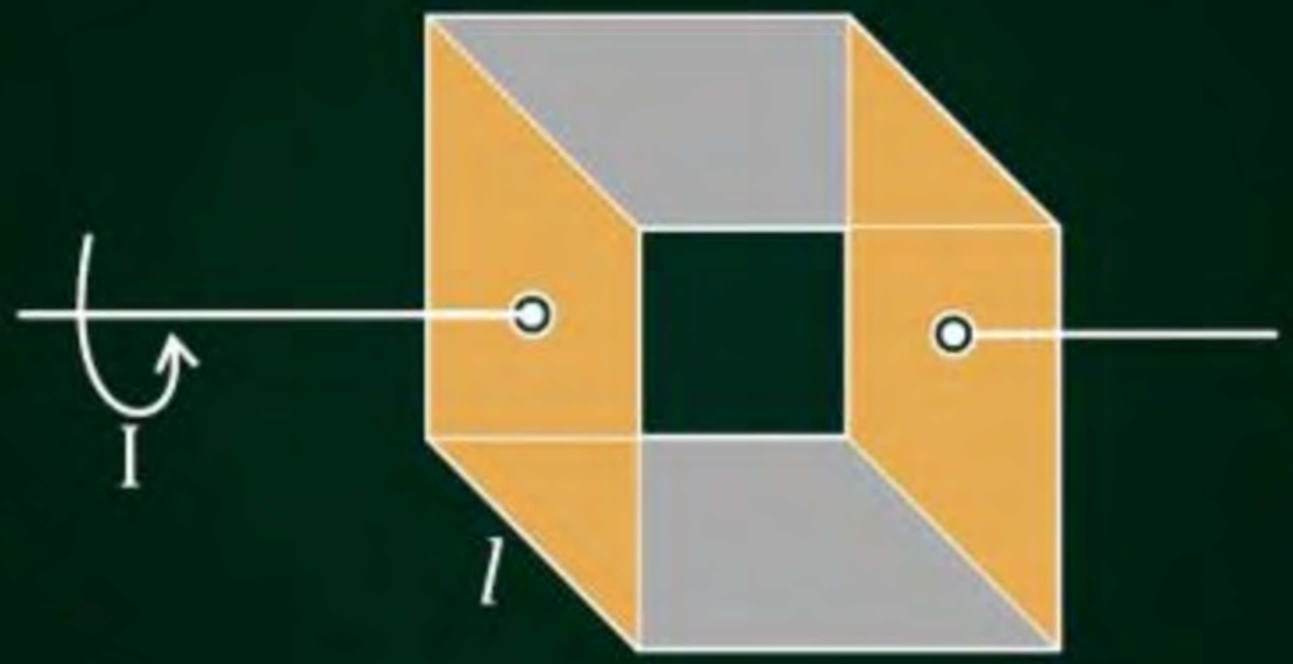
(2) $\frac{M}{4}(a^2 + b^2)$

(3) $\frac{7M}{12}(a^2 + b^2)$

(4) $\frac{M}{12}(a^2 + b^2)$

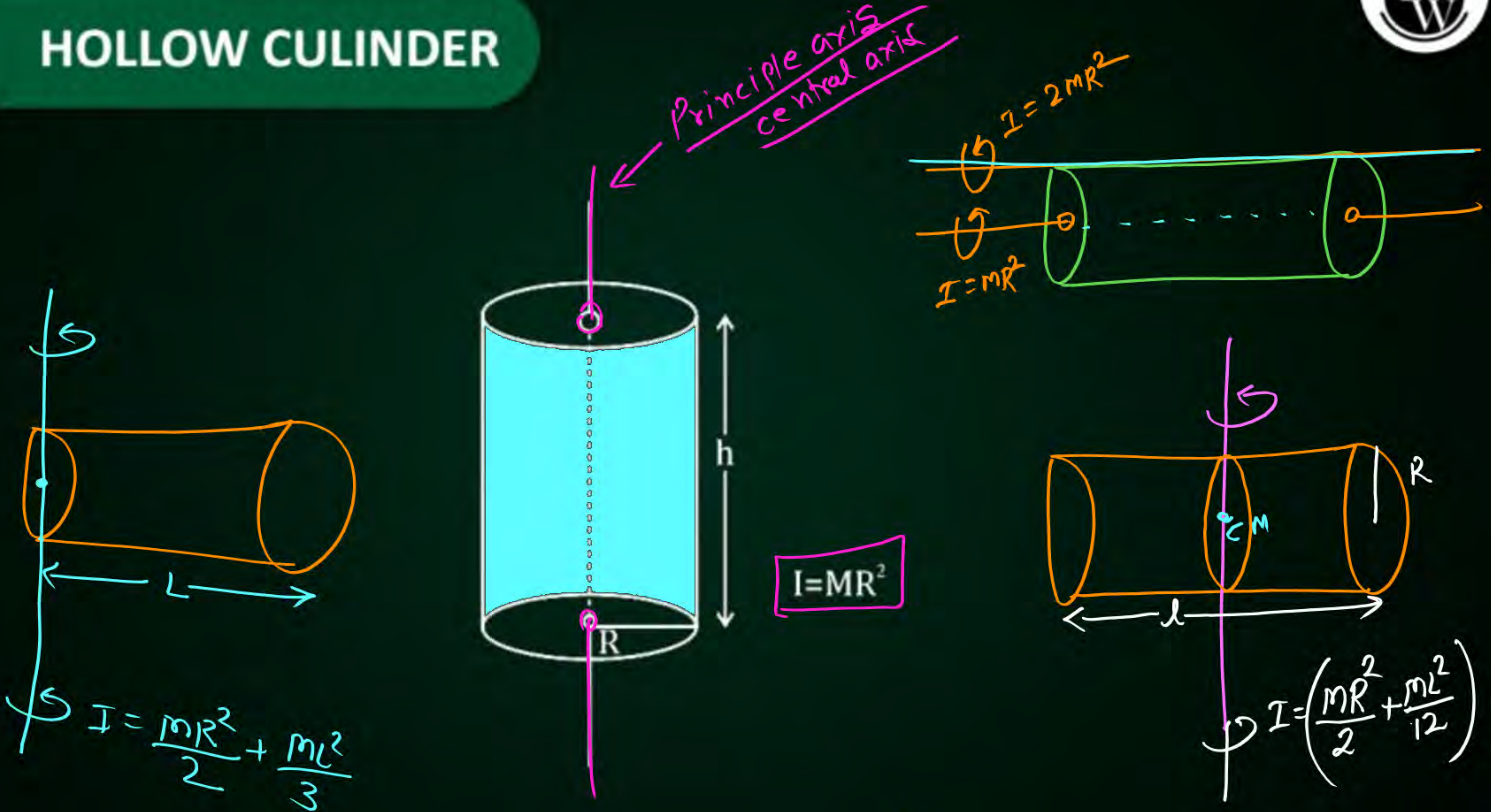


SOLID CUBE

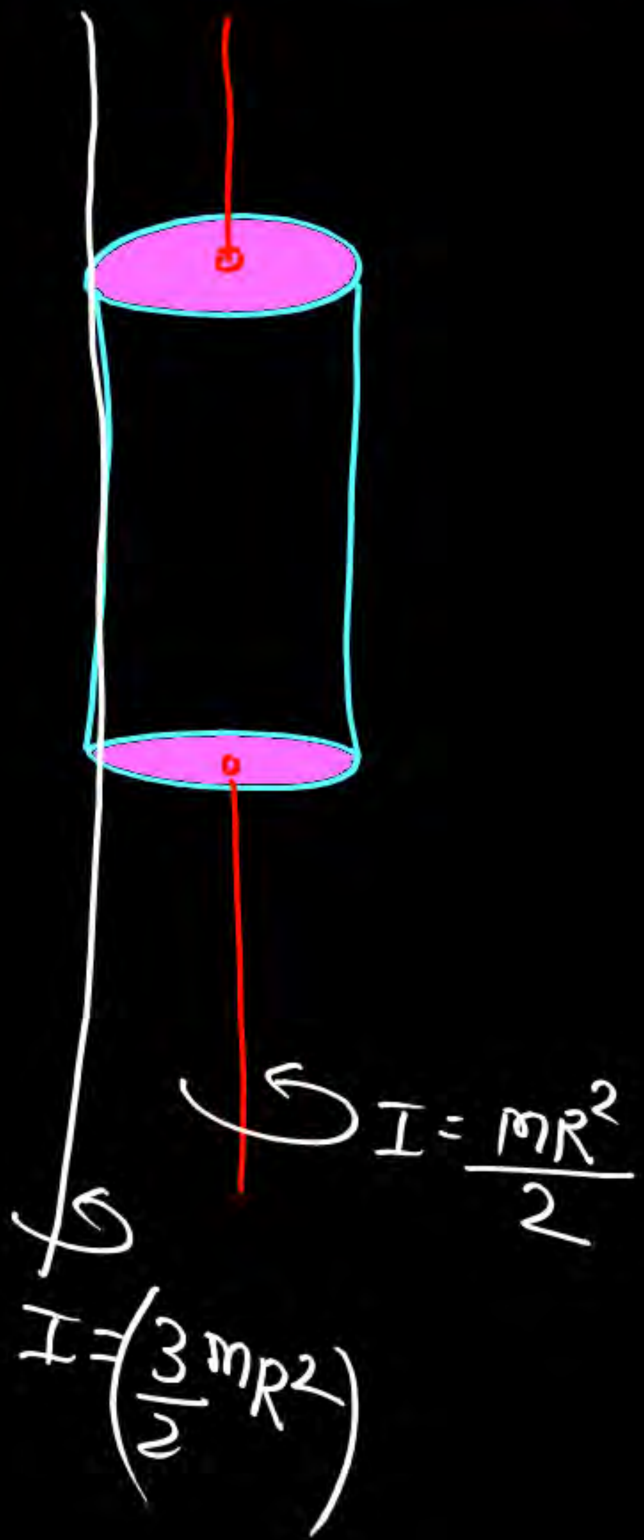


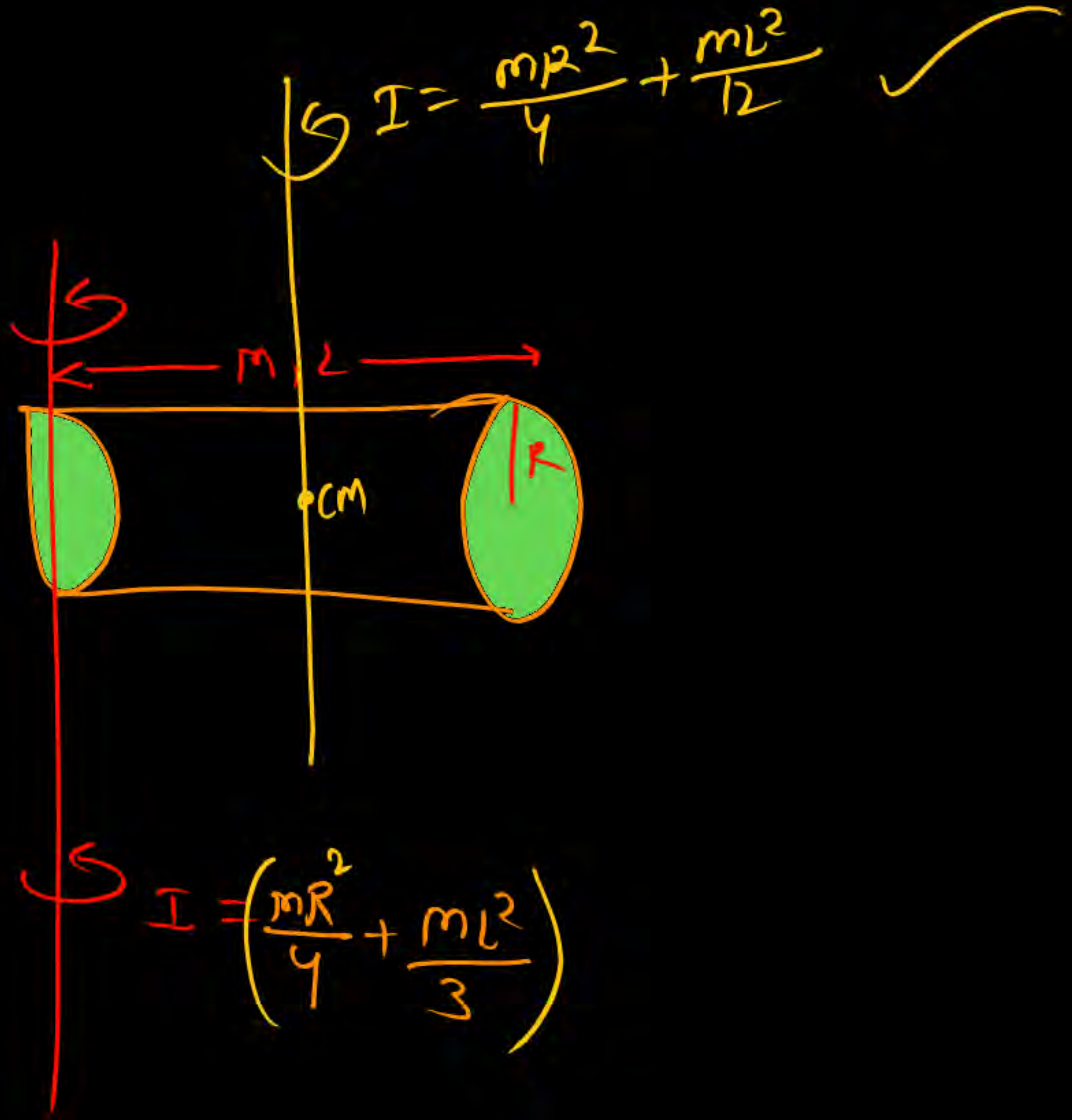
done

HOLLOW CULINDER



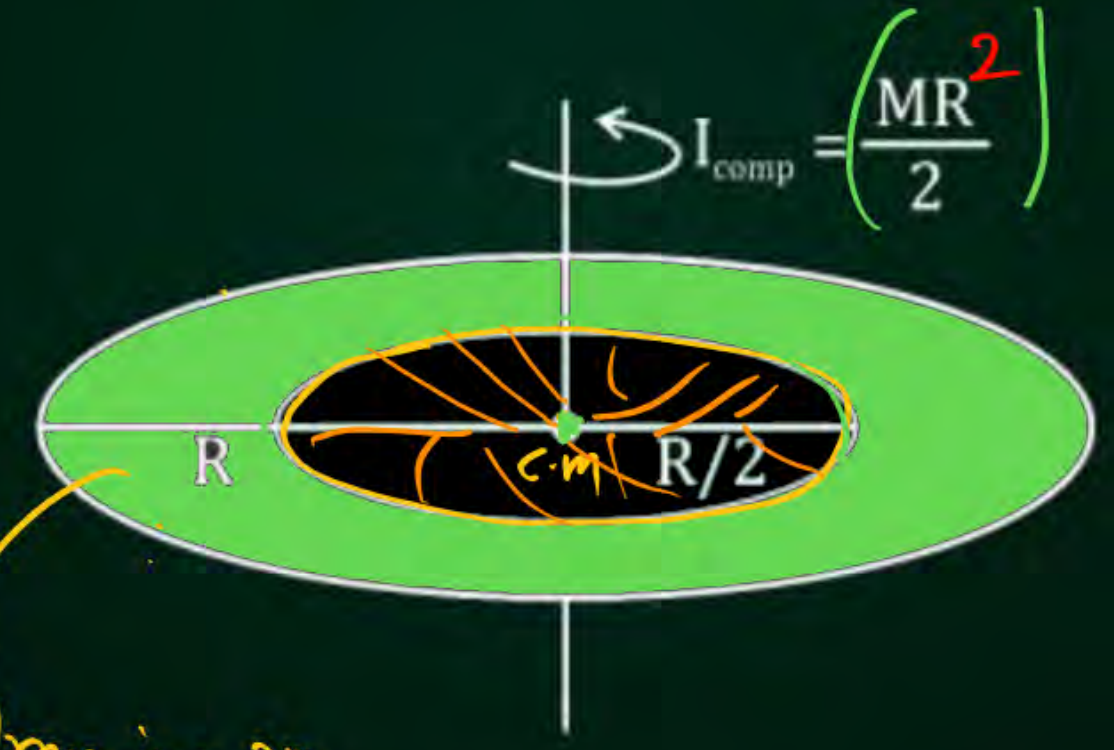
Solid cylinder





QUESTION

There is a disc of radius R as shown in the figure. A disc of radius $\left(\frac{R}{2}\right)$ is removed. Then find MOI of remaining part.



$M_{remain} = \frac{3M}{4}$

Mass of (πR^2) Area $= M$ — (i)

" " $\pi\left(\frac{R}{2}\right)^2 = \frac{M}{4}$ — (ii)

$I_{Remaining\ part} = ??$

$I_{Remain} = I_{Comp^t\ Dis} - I_{removed\ part}$

$= \frac{MR^2}{2} - \left(\frac{M'R'^2}{2}\right)$

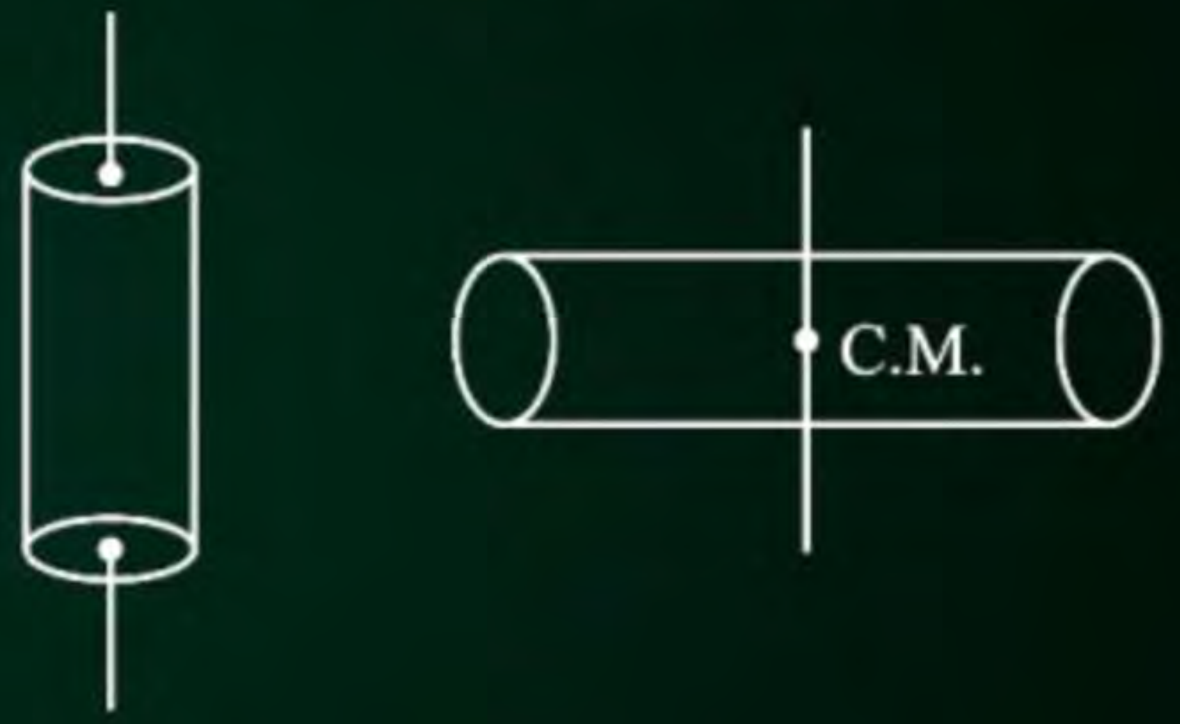
$= \frac{MR^2}{2} - \frac{M R^2}{32}$

$= MR^2\left(\frac{1}{2} - \frac{1}{32}\right) = \frac{15MR^2}{32}$

Hollow Cylinder



Solid cylinder

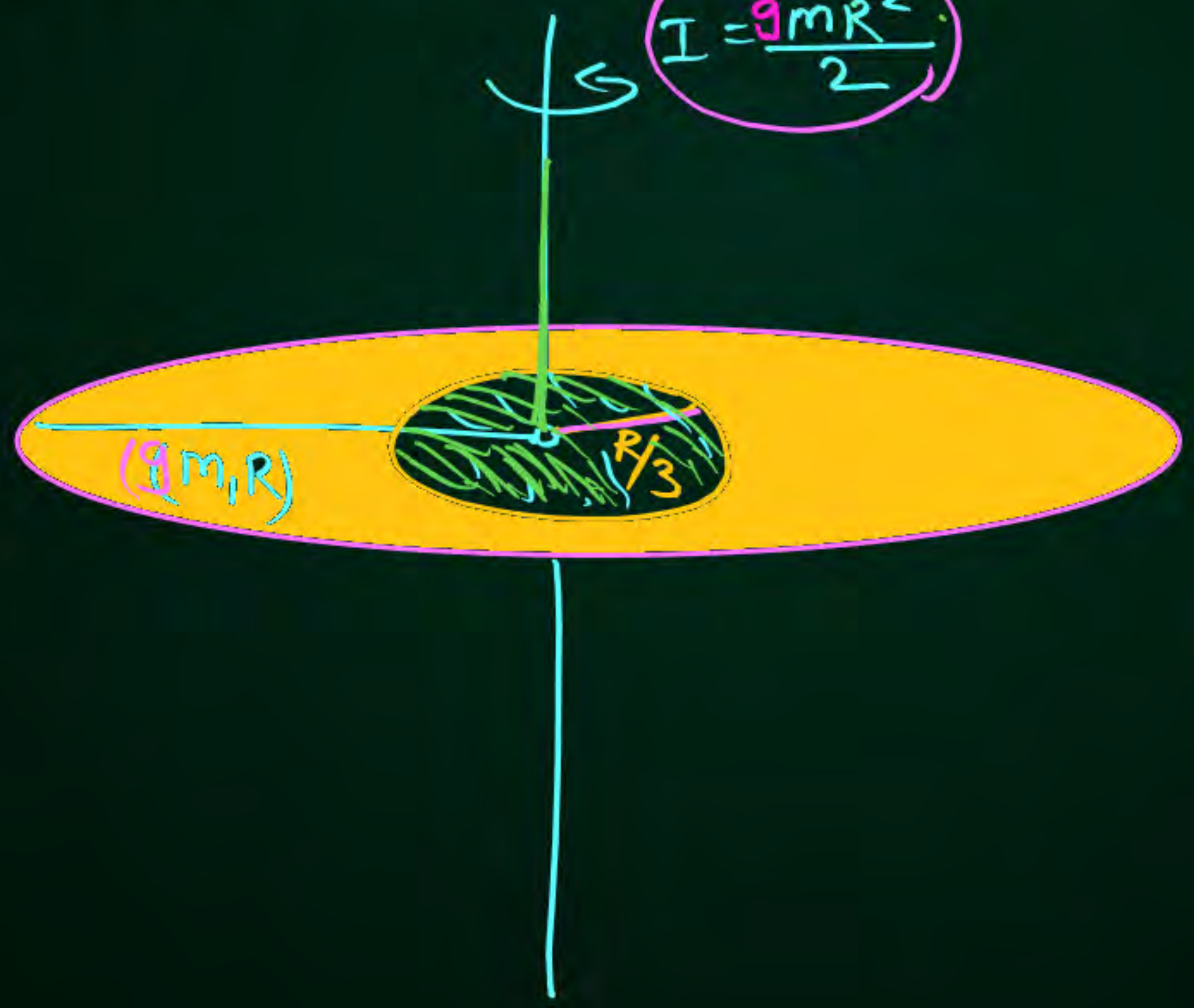


QUESTION

From a circular disc of radius R and mass $9M$, a small disc of mass M and radius $R/3$ is removed concentrically. The moment of inertia of the remaining disc about an axis perpendicular to the plane of the disc and passing through its center is

[Mains 2010]

1. $\frac{40}{9}MR^2$ Ans
2. MR^2
3. $4MR^2$
4. $\frac{4}{9}MR^2$



Mass of remove part $(A = \frac{\pi R^2}{9}) = \frac{9M}{9} = M$

$I_{remaining\ part} = I_{compt} - I_{removed}$

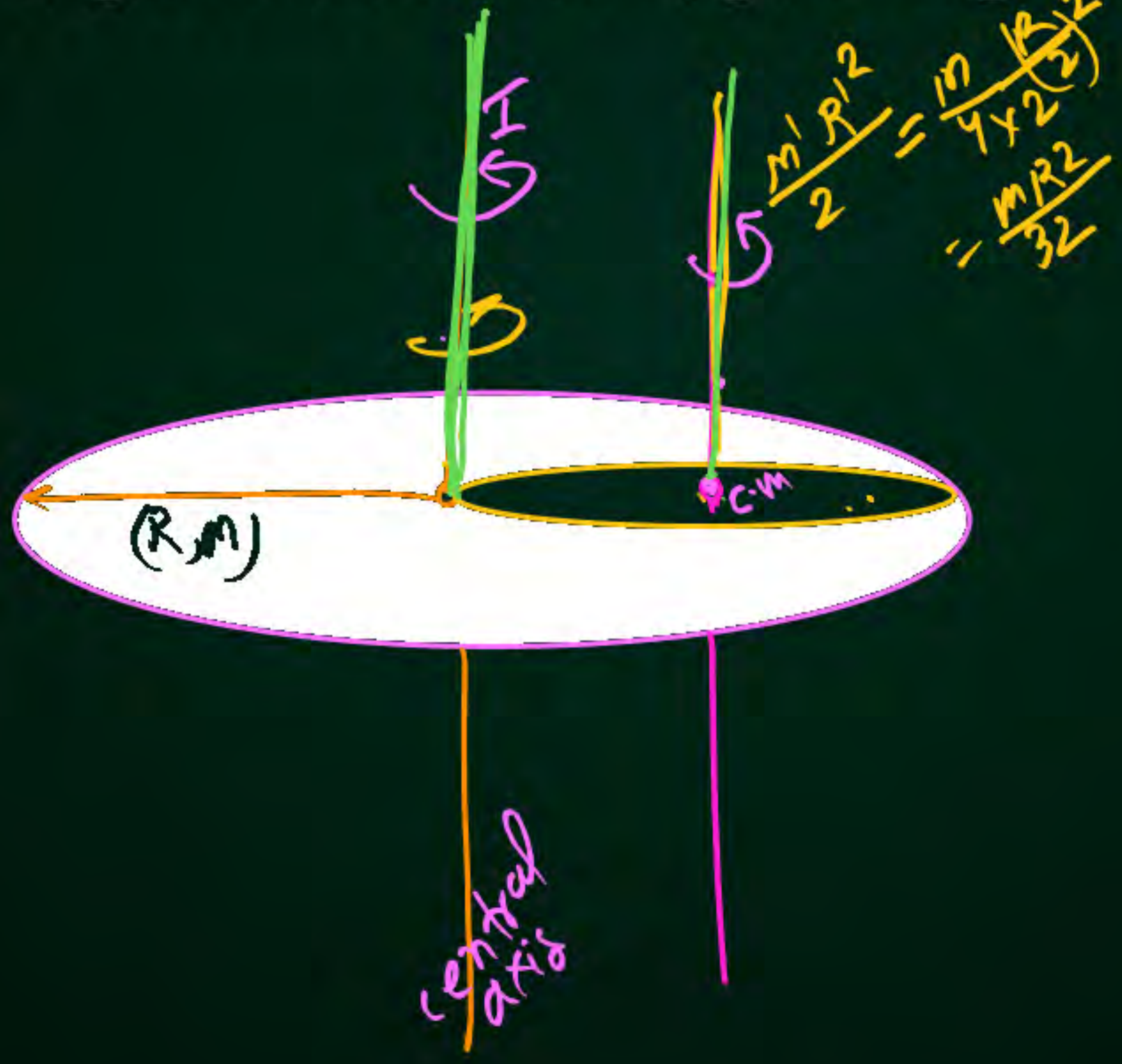
$= \frac{(9M)R^2}{2} - \frac{M}{2}\left(\frac{R}{3}\right)^2$

$= \frac{9MR^2}{2} - \frac{MR^2}{18}$

$= MR^2\left(\frac{81-1}{18}\right) = \frac{MR^2 80}{18}$

QUESTION

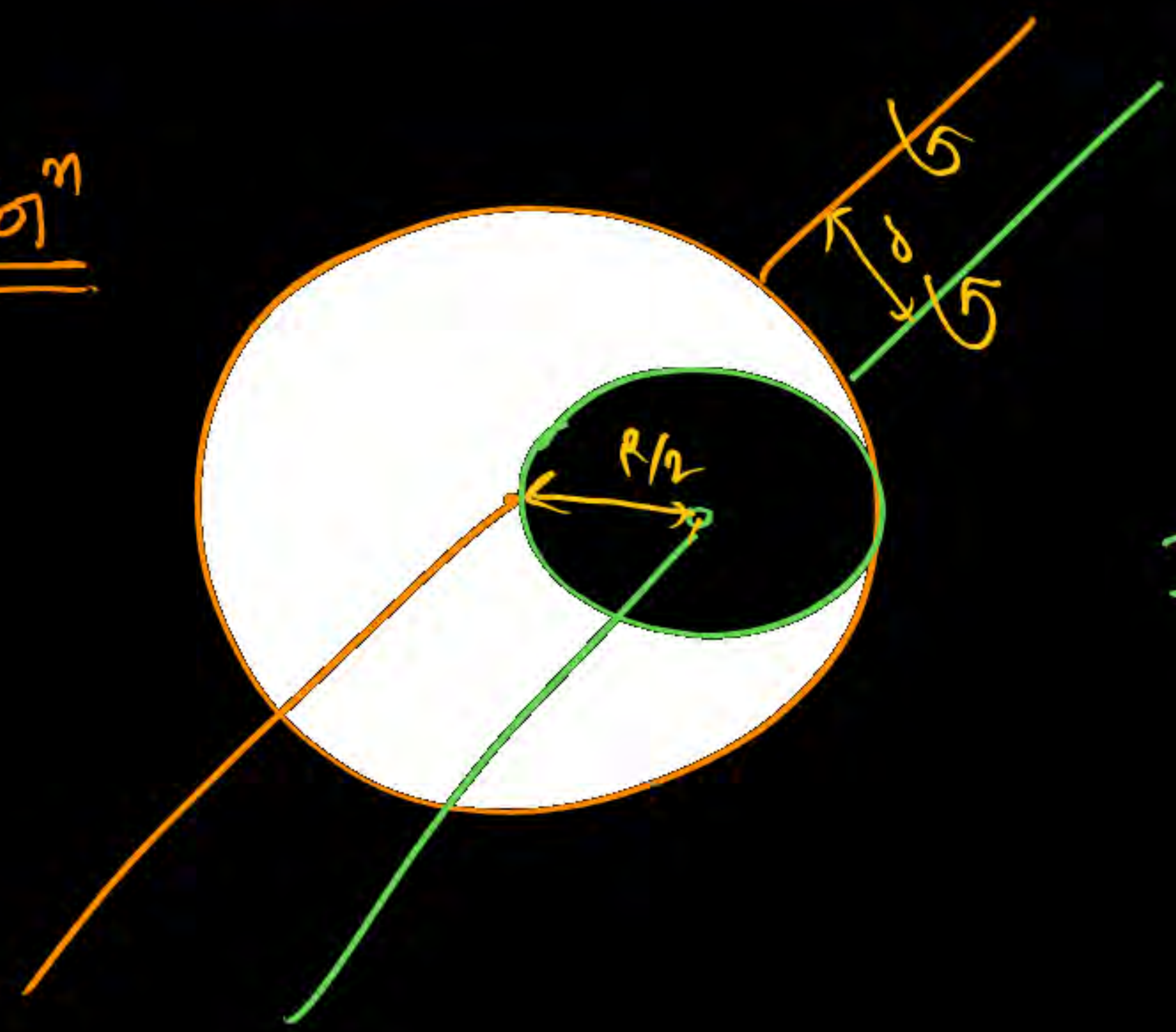
From a disc of radius R and mass M, a circular hole of diameter R, whose rim passes through the center is cut. What is the moment of inertia of the remaining part of the disc about a perpendicular axis, passing through center? **[NEET 2016]**



1. $15\,MR^2/32$
2. $13\,MR^2/32$
3. $11\,MR^2/32$
4. $9\,MR^2/32$

(Q) A solid sphere of Radius R/2 is Removed from a solid sphere of Mass M and radius R. then find M.O.I of remaining Part as shown in fig

Solⁿ



Solid sphere $\left(\frac{4}{3}\pi R^3\right) = M$

solid sphere remove $\left(\frac{4}{3}\pi \frac{R^3}{8}\right) = \frac{M}{8}$ (removed mass)

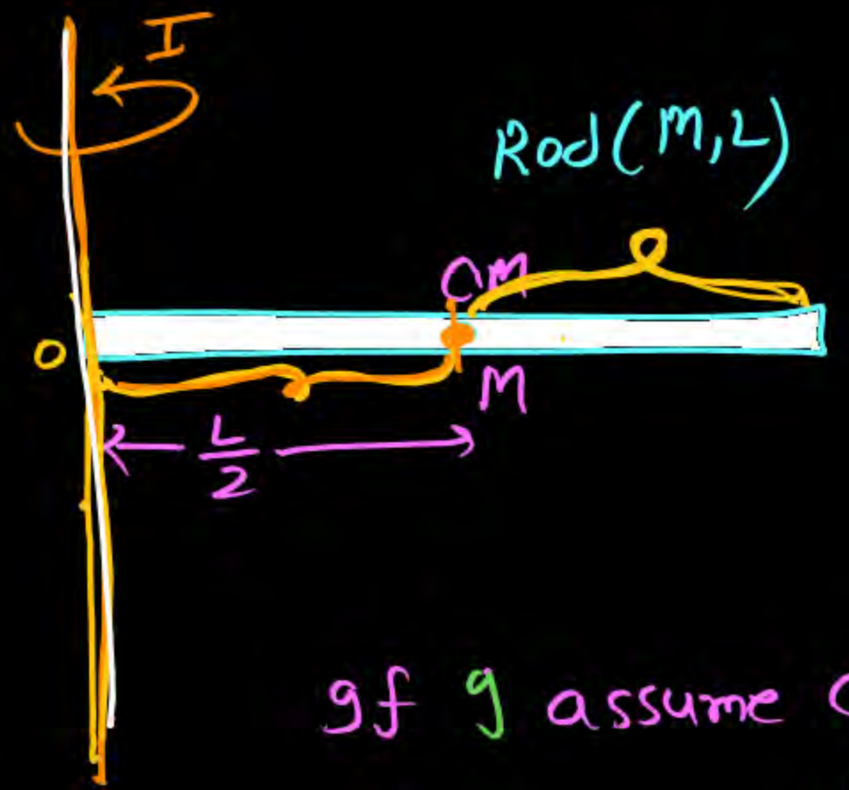
$I_{remaining} = I_{comp} - I_{removed}$

$= \frac{2}{5}MR^2 - \left[\frac{2}{5}M'R'^2 + M'd^2\right]$

$= \frac{2}{5}MR^2 - \left[\frac{2}{5}\frac{M}{8}\frac{R^2}{4} + \frac{M}{8}\left(\frac{R}{2}\right)^2\right] = MR^2\left[\frac{2}{5} - \frac{1}{80} - \frac{1}{32}\right]$

$= MR^2\left(\frac{64-2-5}{160}\right)$

$\frac{57MR^2}{160}$



If I assume comp^t mass of Rod at centre of mass.

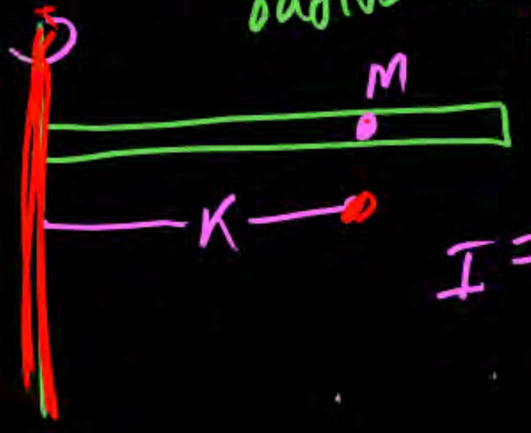
$I_0 = M\left(\frac{L}{2}\right)^2 = \frac{ML^2}{4}$ ✗

$I_0 = \frac{ML^2}{3}$ (correct)

We can't apply concept of C.O.M for the calculation of M.O.I ✓

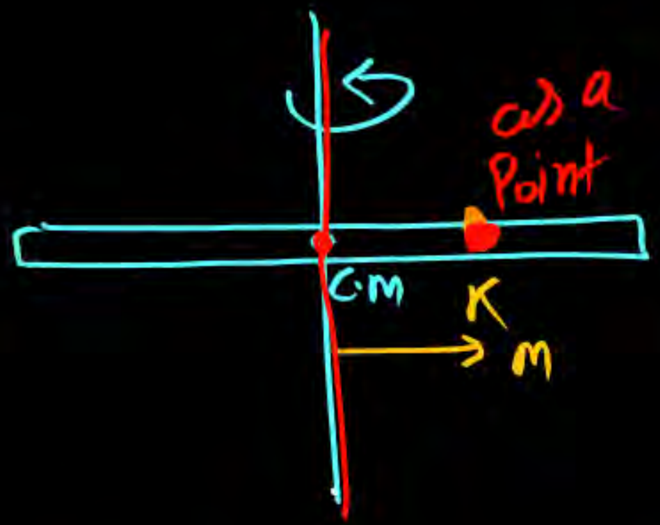
We define new concept for centre of mass for the calculation of M.O.I ✓

Radius of gyration = dist^n from the axis of Rot^n where whole mass of the system can be assume to calculate M.O.I. is called radius of gyration.



$I = MK^2 = \frac{1}{3}ML^2$

* $K = \frac{L}{\sqrt{3}}$ Ans



find radius of gyration of Rod about c.o.m.

$$I = mK^2 = \frac{mL^2}{12}$$

$$mK^2 = \frac{mL^2}{12}$$

$$K = \frac{L}{\sqrt{12}}$$ Ans.



$$I = mK^2 = \frac{mR^2}{4}$$

$$K = \sqrt{\frac{R^2}{4}} = \frac{R}{2}$$



$$I = \frac{mR^2}{2} = mK^2$$

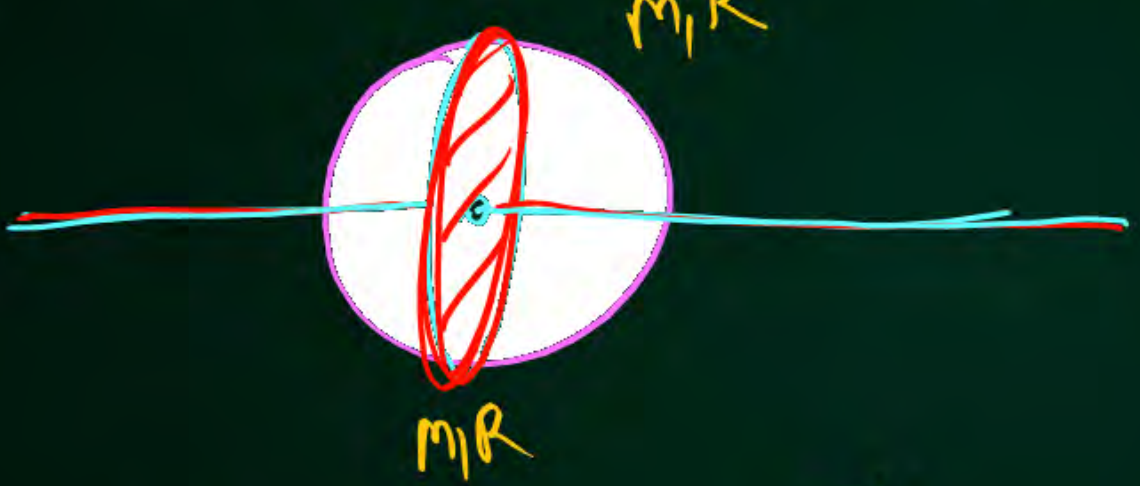
$$K = \left(\frac{R}{\sqrt{2}}\right)$$ Ans.

RADIUS OF GYRATION

QUESTION

Two rings of same mass and radius R are placed with their planes perpendicular to each other and centres at a common point. The radius of gyration of the system about an axis passing through the centre and perpendicular to the plane of one ring is

1. $2R$
2. $R/\sqrt{2}$
3. $\sqrt{\frac{3}{2}}R$ ← 44%
4. $\frac{\sqrt{3}R}{2}$ 34%





$I = (mR^2) + \left(\frac{mR^2}{2}\right) = \frac{3mR^2}{2} = 2mK^2$

$\frac{mR^2}{2} + mR^2 = \frac{3}{2}mR^2 = 2mK^2$

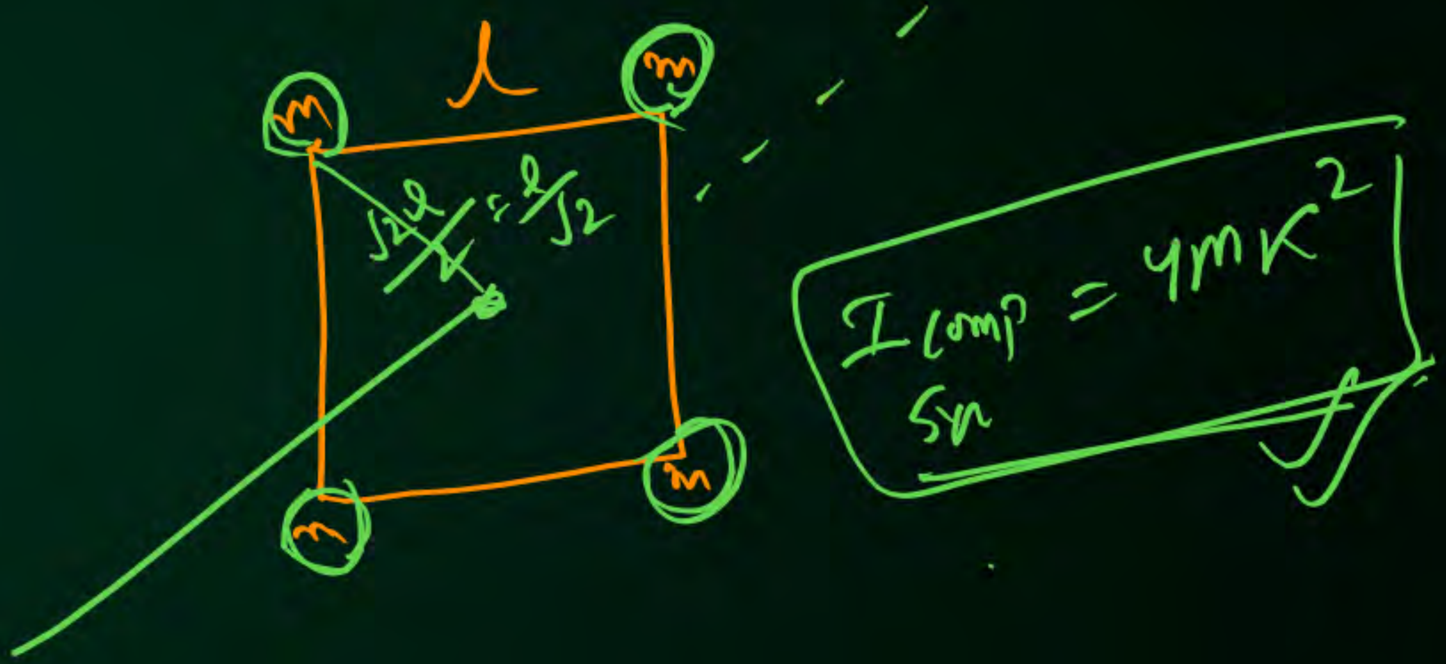
$K^2 = \frac{3R^2}{4}$

$K = \sqrt{\frac{3R^2}{4}}$

$= \frac{R}{2}\sqrt{3}$

QUESTION

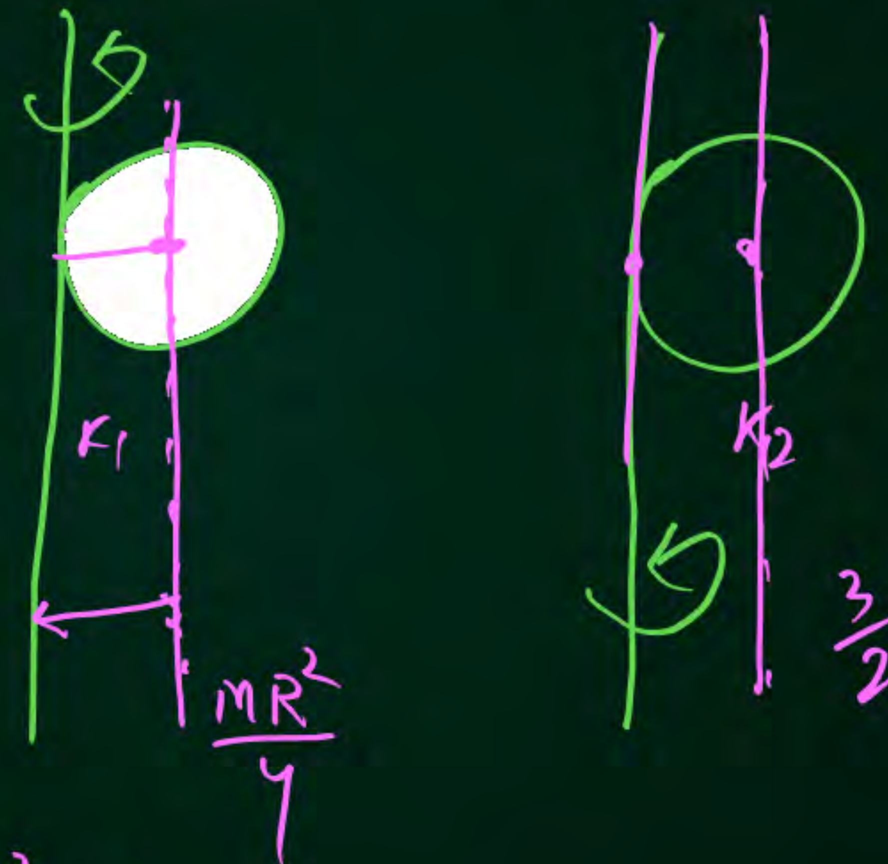
Four particles each of mass m are placed at the corners of a square of side length l. The radius of gyration of the system about an axis perpendicular to the square and passing through center is :



1. $\frac{l}{\sqrt{2}}$
2. $\frac{l}{2}$
3. l
4. $l\sqrt{2}$

QUESTION

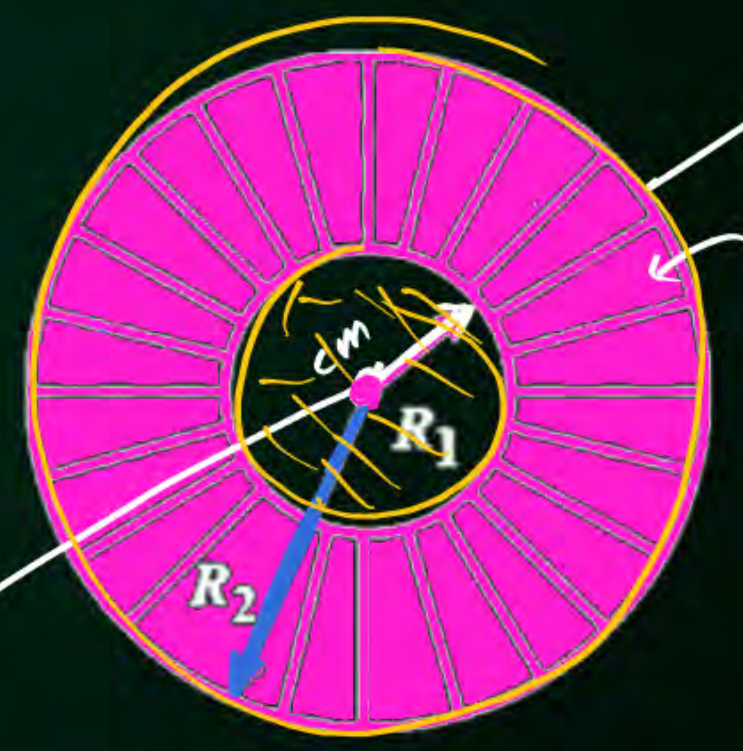
The ratio of the radii of gyration of a circular disc about a tangential axis in the plane of the disc and of a circular ring of the same radius about a tangential axis in the plane of the ring is



1. $2:1$
2. $\sqrt{5}:\sqrt{6}$
3. $2:3$
4. $1:\sqrt{2}$

A disc of radius R_1 is cut from a disc of radius R_2 as shown in figure. If the disc left has mass M then find the moment of inertia of the disc left about an axis passing through its center and perpendicular to its plane.

1. $\frac{M}{2}(R_1^2 - R_2^2)$
2. $\frac{M}{2}(R_1^2 + R_2^2)$
3. $\frac{M}{2}\left(\frac{R_2 + R_1}{2}\right)^2$
4. $\frac{MR_2^2}{2}$



mass of Area $\pi(R_2^2 - R_1^2) = M$

" " unit area $= \frac{M}{\pi(R_2^2 - R_1^2)}$

mass of compt disc $= \frac{M}{\pi(R_2^2 - R_1^2)}\pi R_2^2$

" " removed part $= \frac{M}{\pi(R_2^2 - R_1^2)}\pi R_1^2$

$(a^2 - b^2) = (a+b)(a-b)$

$I_{\text{remaining part}} = I_{\text{compt disc}} - I_{\text{removed part}}$

$= \frac{1}{2}m' R_2^2 - \frac{1}{2}m'' R_1^2 = \frac{1}{2}\left[\frac{M R_2^2}{(R_2^2 - R_1^2)} \times R_2^2 - \frac{M R_1^2}{(R_2^2 - R_1^2)} R_1^2\right] = \frac{M(R_2^4 - R_1^4)}{2(R_2^2 - R_1^2)}$

$= \frac{M}{2}\frac{(R_2^2 - R_1^2)(R_2^2 + R_1^2)}{(R_2^2 - R_1^2)}$

Neet ki tayari

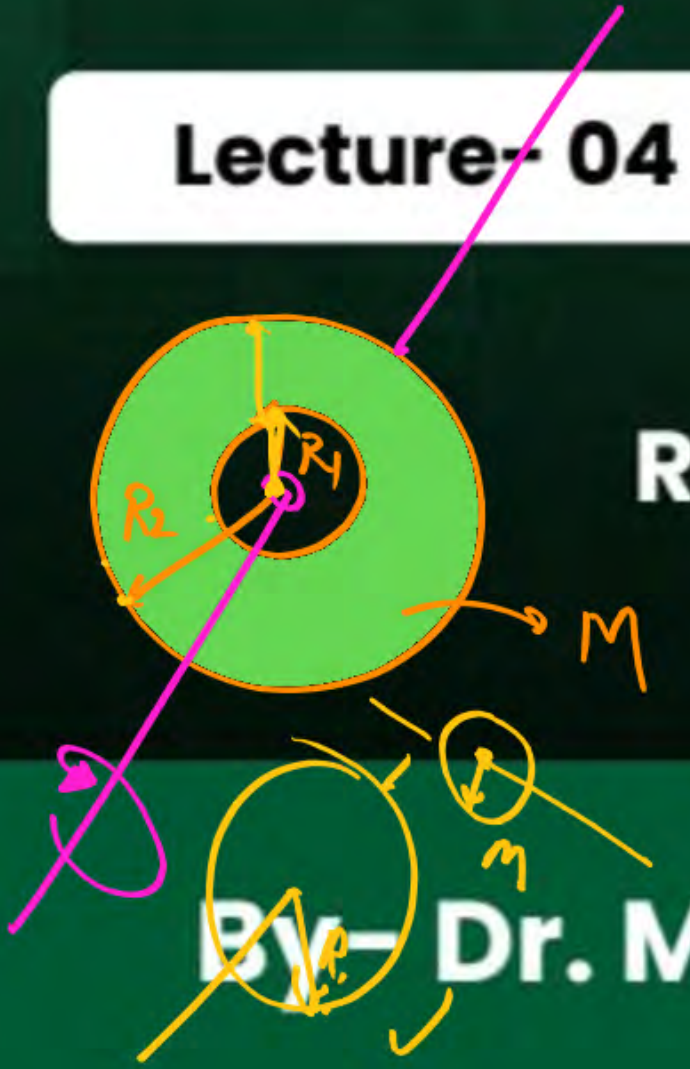

THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 04 | Physics

Rotational Motion



If $R_1 = 0$
$I = \frac{MR_2^2}{2}$

$I = MR^2 \ (R_1 = R_2)$

By- Dr. Manish Raj (MR SIR)



Topics to be covered

Yakeen+
↳ use as a assignment

Test+

100%

1. #
2. #
3. #
4. #

Feel of torque



force is not sufficient to change Rotational state of a body → we have to apply torque *

if line of force is passing through axis of Rot^n then troque will be zero.

if force is applied at axis of Rot^n then Torque will be zero



$\vec{r}$ = Position vector

जिसका मुड़ी वहाँ होगा जहाँ force लग रहा है

पूँछ वहाँ होगा जहाँ axis of rot^n है। या जिसके about torque लिखना है।

If Angle b/w $\vec{r}$ & $\vec{F}$ is 0° or 180°

$\tau = 0$ | τ_{max} at 90°

Moment of Force ← $\vec{\tau} = \vec{r} \times \vec{F} = rF\sin\theta$

turning effect ←

The cause of change Rotational state of body. ←

$\tau = rF\sin\theta$

$= r(F_{\perp r})$

$= r_{\perp r}(F)$

feel.

⇒ vector

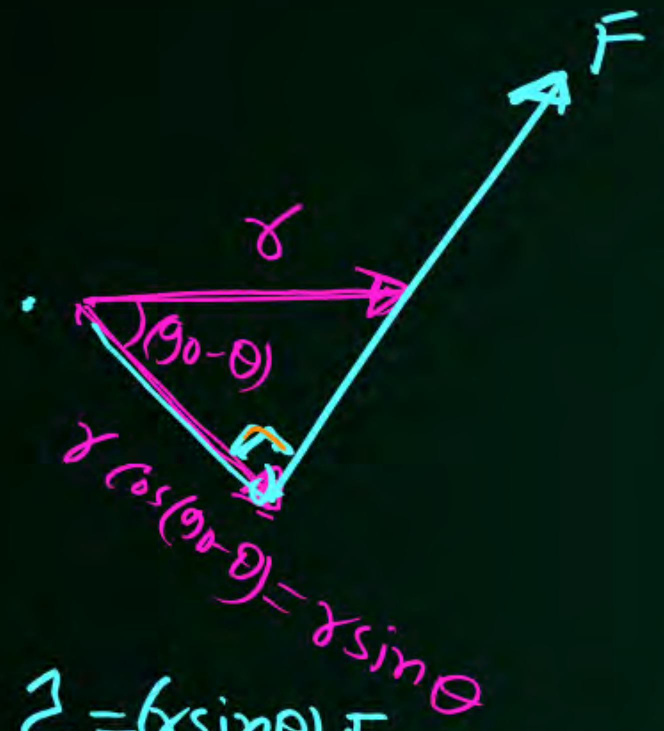
⇒ N m

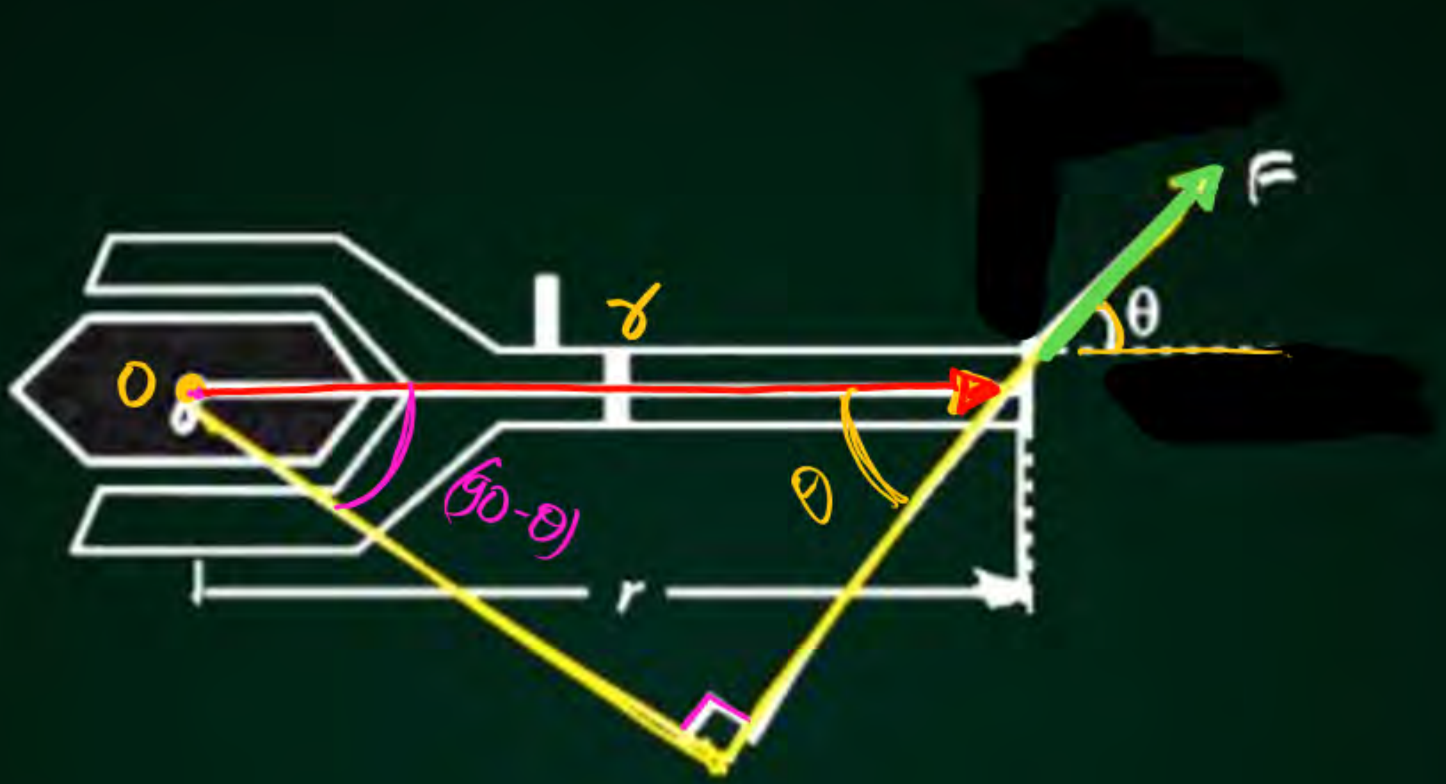
⇒ ML^2T^{-2}

dir^n ⊥r to the plane of r & F vector

$\vec{\tau} \perp r\ \vec{F}$ $\vec{\tau} \perp r\ \vec{r}$

$\vec{\tau} \cdot \vec{F} = 0$ | $\vec{\tau} \cdot \vec{r} = 0$





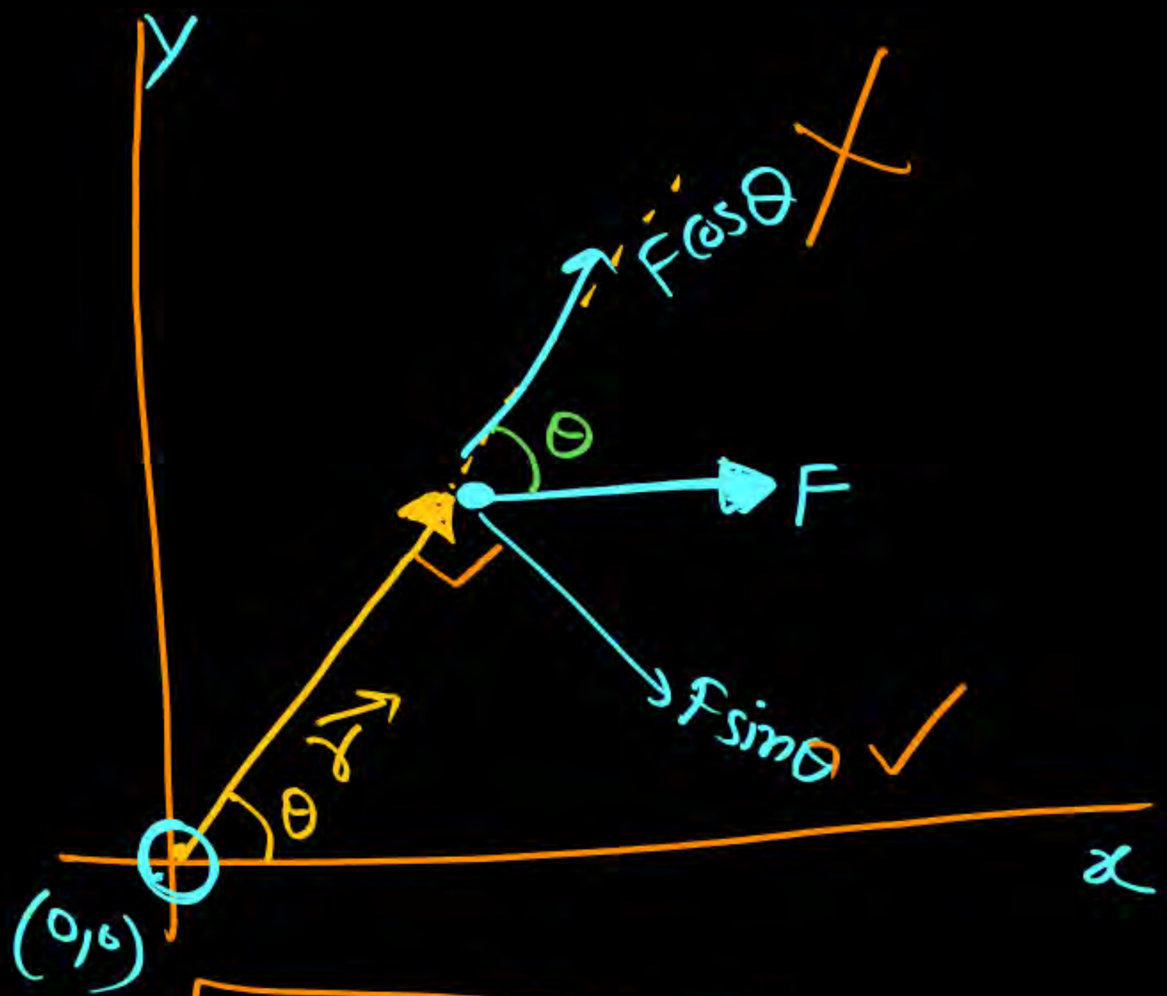
$\tau = (r\sin\theta)F$

$\vec{\tau}$ = (Perpendicular component of *F* to *r*) *r*

= (Perpendicular component of *r* to *F*) *F*

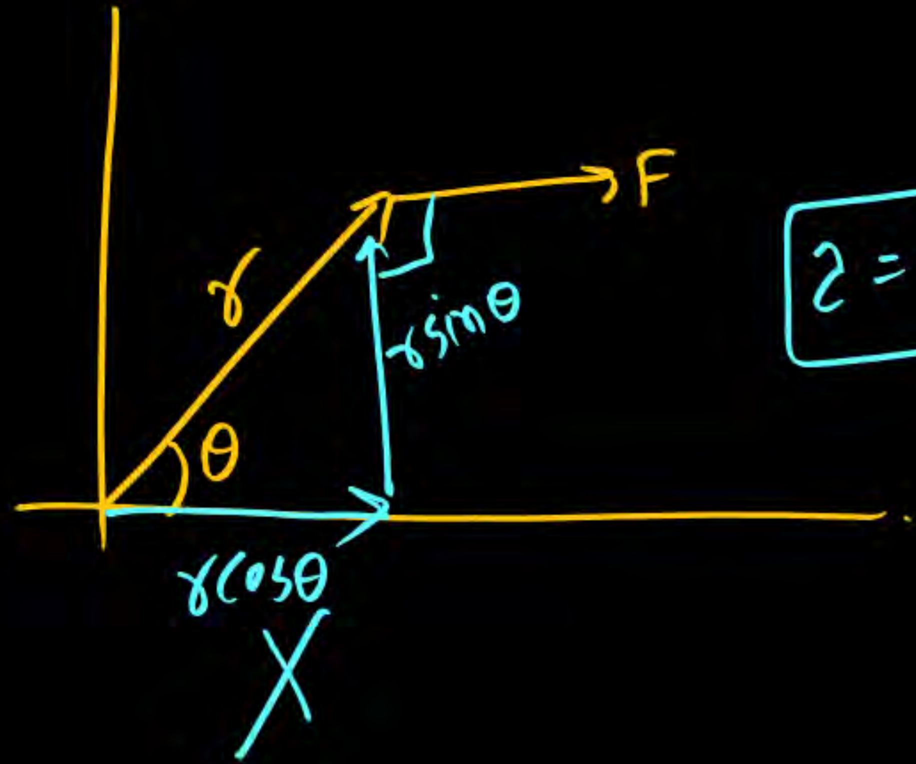
find Torque due to this force about origin.

→ जो Rot^n state में change लायगा



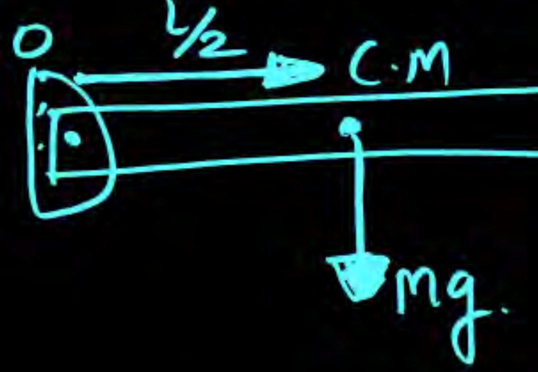
$$\tau = r F \sin\theta$$

for the feel



$$\tau = r \sin\theta F$$

MR*



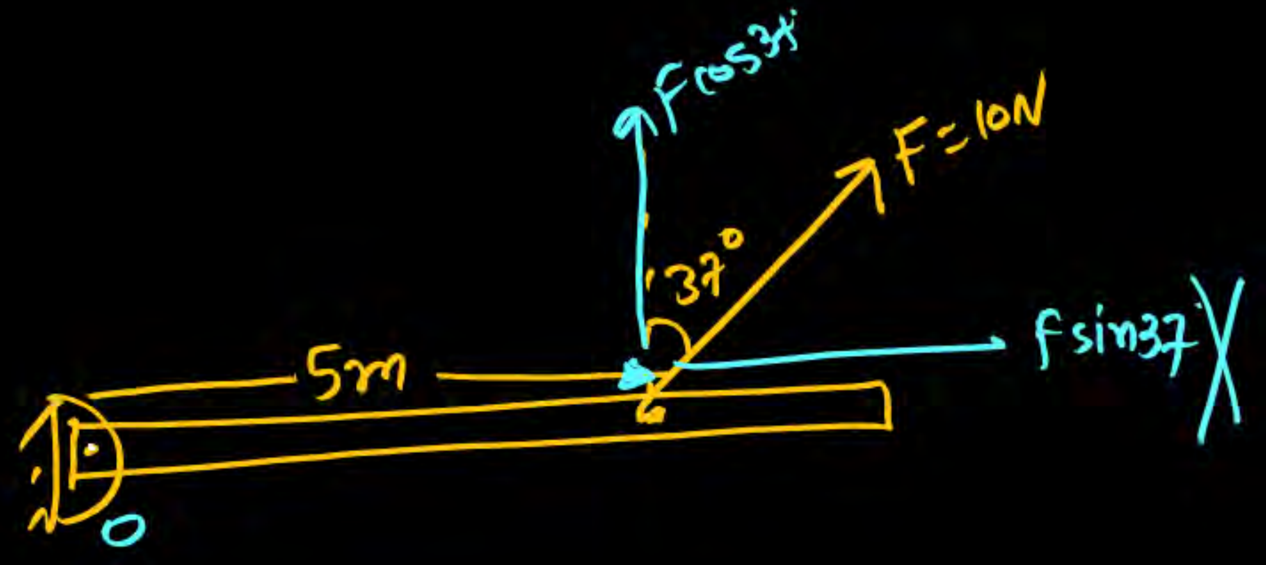
Find torque due to gravitational force

(i) about C.O.M.

$$\tau = mg \times \cancel{r}^{\,0} = 0$$

(ii) about 'O'

$$\tau_{gravity} = mg\frac{L}{2}$$



$$\tau = (5m) \times F\cos 37$$

$$= 5 \times \cancel{10}^{\,2} \times \frac{4}{\cancel{5}}$$

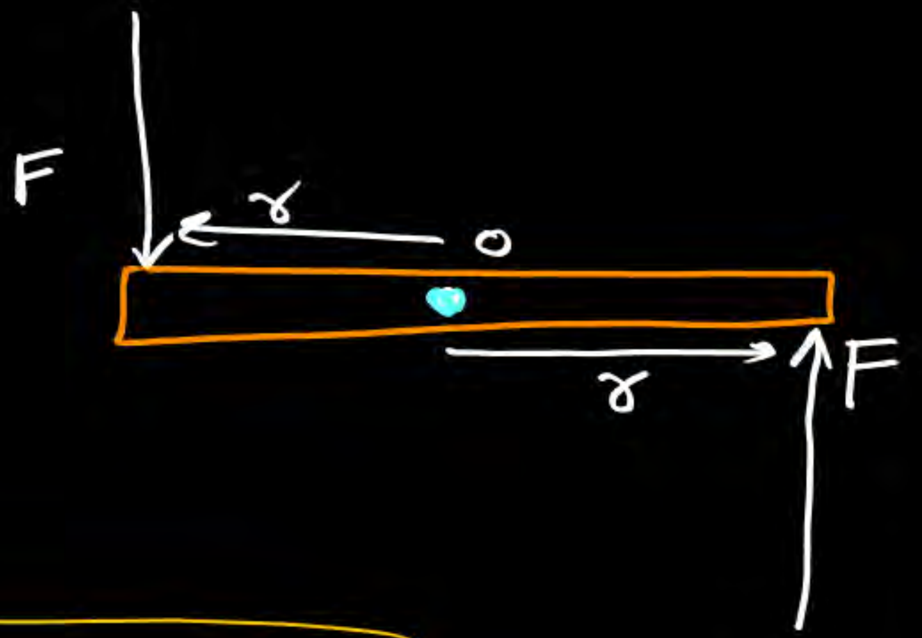
$$= 40\ Nm$$

outword ⊙ Anti-clock

inword ⊗ Clock-wise

diretion $\vec{\tau} = \vec{r} \times \vec{F}$

Place your four fingers of right hand in Position vecto (r), and slap force then thumb will represent dirⁿ of torque.



$F_{net\,ext} = 0$ → couple force ($F_{net} = 0$)

$(\vec{\tau}_{net})_O = rF \odot + rF \odot$
$= 2rF \odot$



$F_{net} = 0$
$\tau_{net} = 0$



$f_{ext} = F$

$\tau = rF$ ✓



$(F_{net})_{ext} = 2F$ ✓

$\tau_{net} = rF \odot + rF \otimes = 0$

~~$\vec{\tau}_{net} = \vec{r} \times \vec{F}_{net}$~~

$\vec{\tau}_{net} = \vec{r}_1 \times \vec{F}_1 + \vec{r}_2 \times \vec{F}_2 + \vec{r}_3 \times \vec{F}_3 + \vec{r}_4 \vec{F}_4 + \text{----}$

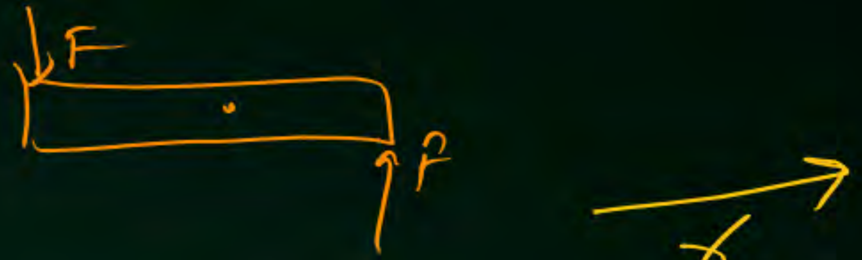
MOMENT OF FORCE (TORQUE)

- Always perpendicular to the plane of r and F.

$$\vec{\tau} = I\vec{\alpha}\left(\vec{F} = m\vec{a}\right)$$

$$\vec{\tau} = \frac{d\vec{\tau}}{dt}\left(F = \frac{dp}{dt}\right)$$

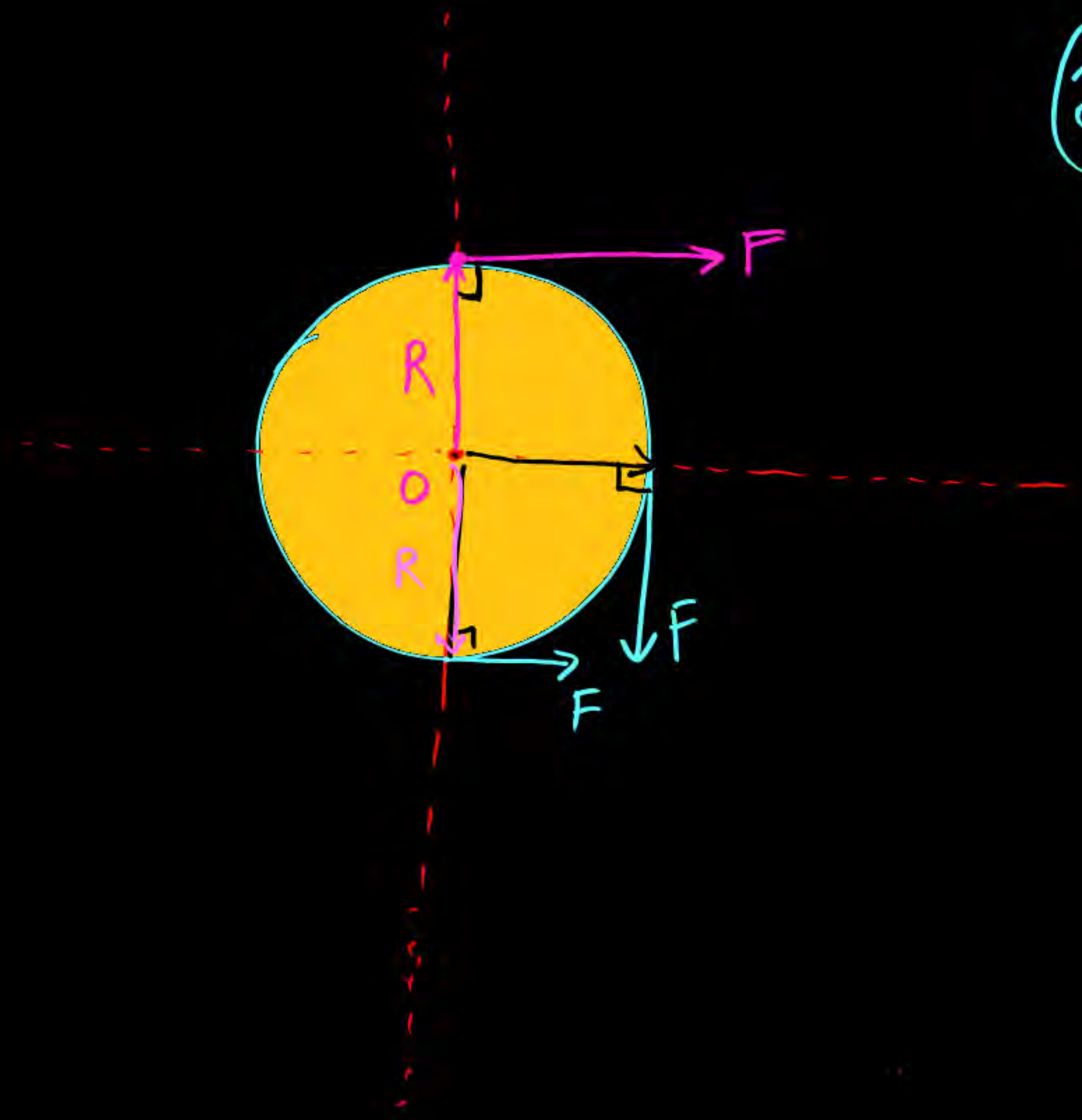
- Cause of change in Rotational state of the body.
- Moment of force.
- Turning effect : Force, Distance, Direction
- Vector
- Unit : [N – m][ML^2T^{-2}]



$$\vec{\tau}_{net} = \vec{F}_{net} \times \vec{r}_{net} = \vec{r}_{net} \times \vec{F}_{net}$$

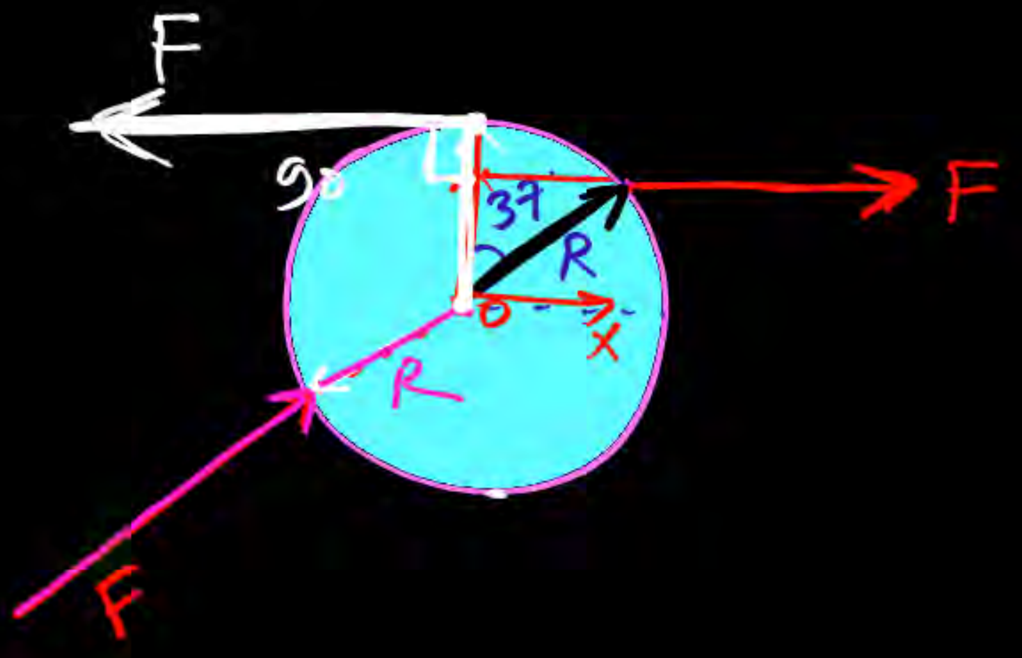
$$\vec{\tau}_{net} = \vec{r}_1 \times \vec{F}_1 + \vec{r}_2 \times \vec{F}_2 \ldots + \vec{r}_n \times \vec{F}_n$$

- If $\vec{F}_{net} = 0$, then $\vec{\tau}_{net}$ must be zero. [False]
- If $\vec{F}_{net} \neq 0$, then $\vec{\tau}_{net}$ must be zero. [False]
- If $\vec{\tau}_{net} = 0$, then $\vec{F}_{net}$ must be non – zero. [False]
- If $\vec{\tau}_{net} \neq 0$, then $\vec{F}_{net}$ must be non – zero. [False]
- If no force is acting on the body. Then $\vec{\tau}_{net}$ must be zero. [True]



$$(\tau_{net})_{about\ 'O'} = RF \otimes + FR \otimes + FR \odot$$

$$= FR.$$



$$(\tau_{net})_O = 0 + FR\cos 37^\circ \otimes + FR \odot$$

$$= -\frac{4FR}{5} + FR$$

$$|\tau_{net}| = \frac{FR}{5} \odot$$

QUESTION

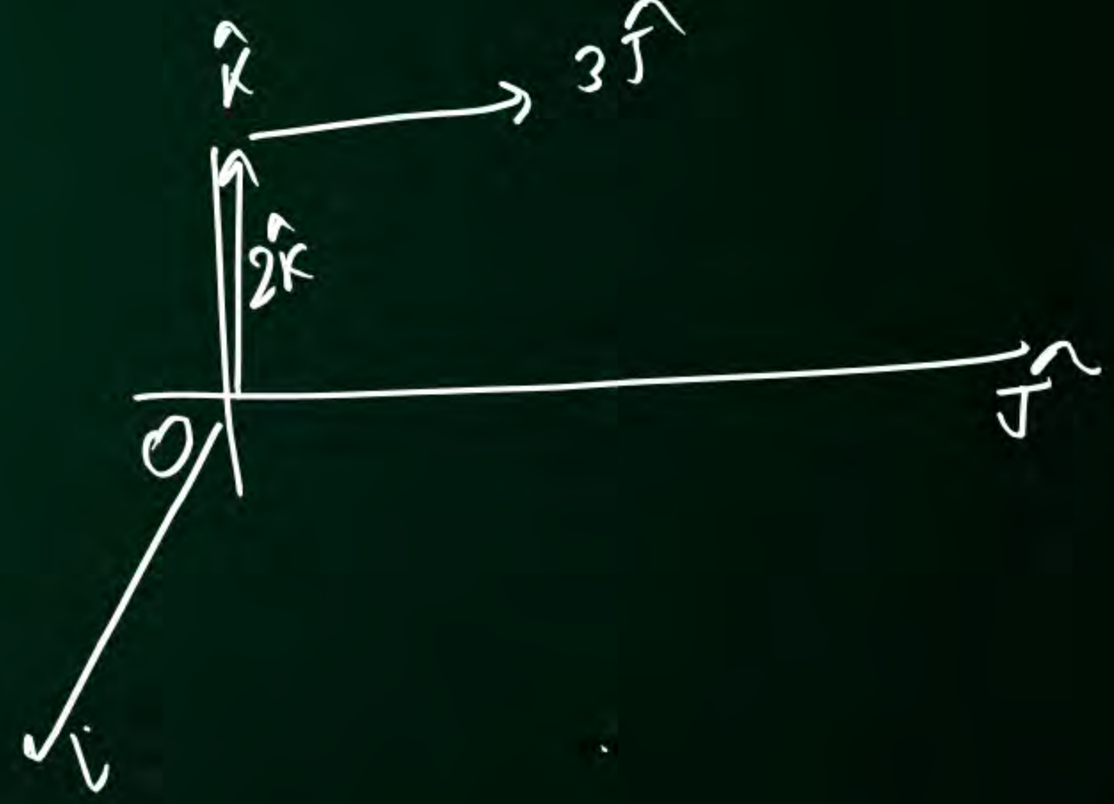
Find the torque about the origin when a force of $3\hat{j}$ N acts on a particle whose position vector is $2\hat{k}$ m. [NEET 2020]

1. $6\hat{i}$ Nm
2. $6\hat{j}$ Nm
3. $-6\hat{i}$ Nm
4. $6\hat{k}$ Nm

$\hat{i}\times\hat{i}=0$
$\hat{j}\times\hat{j}=0$
$\hat{k}\times\hat{k}=0$
$\vec{A}\times\vec{A}=0$

$\hat{i}\times\hat{j}=\hat{k}$
$\hat{j}\times\hat{i}=-\hat{k}$
$\hat{j}\times\hat{k}=\hat{i}$
$\hat{k}\times\hat{j}=-\hat{i}$
$\hat{i}\times\hat{k}=-\hat{j}$
$\hat{k}\times\hat{i}=\hat{j}$

$$\vec{\tau}=2\hat{k}\times3\hat{j}$$
$$=6(\hat{k}\times\hat{j})$$
$$=6(-\hat{i})$$

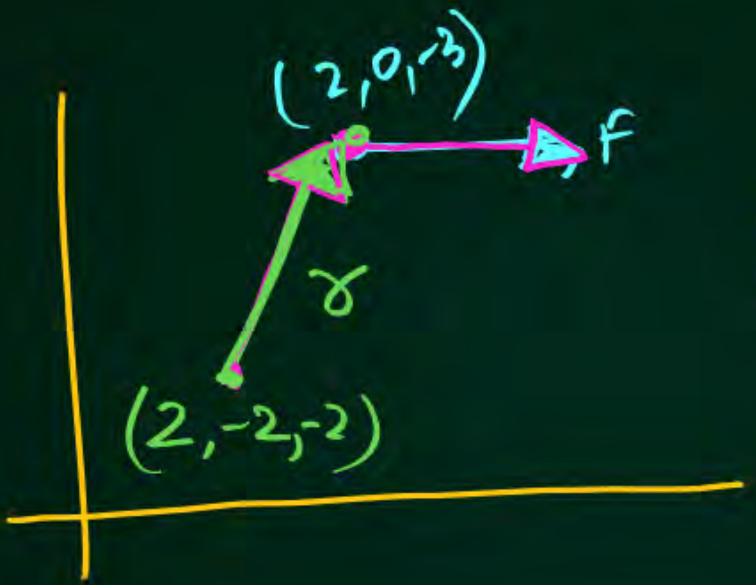


QUESTION

The moment of the force, $\vec{F} = 4\hat{i} + 5\hat{j} - 6\hat{k}$ at (2, 0, –3), about the point (2, –2, –2) is given by

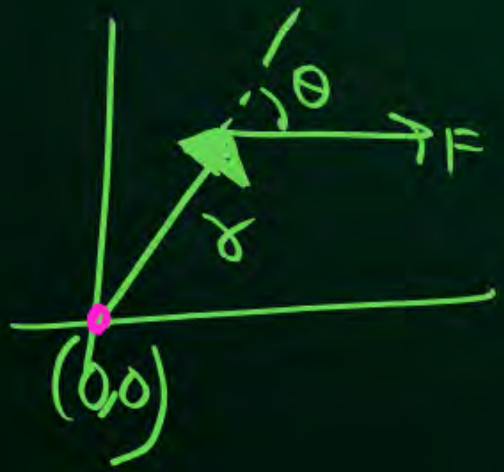
[NEET 2018]

1. $-8\hat{i} - 4\hat{j} - 7\hat{k}$
2. $-4\hat{i} - \hat{j} - 8\hat{k}$
3. $-7\hat{i} - 8\hat{j} - 4\hat{k}$
4. $-7\hat{i} - 4\hat{j} - 8\hat{k}$



$r = (0i + 2\hat{j} - \hat{k})$

$\vec{\tau} = r \times F = \begin{vmatrix} i & j & k \\ 0 & 2 & -1 \\ 4 & 5 & -6 \end{vmatrix}$



$= i[-12-(-5)] + \hat{j}(-4-0) + \hat{k}(-8)$

$= -7\hat{i} - 4\hat{j} - 8\hat{k}$

QUESTION

In a clockwise system

1. $\hat{k} \times \hat{\imath} = \hat{\jmath}$
2. $\hat{\jmath}.\hat{\imath} = 1$
3. $\hat{\imath} \times \hat{\jmath} = 1$
4. $\hat{\jmath}.\hat{\jmath} = 0$

QUESTION

The angle between vectors $(\vec{M} \times \vec{N})$ and $(\vec{N} \times \vec{M})$ is

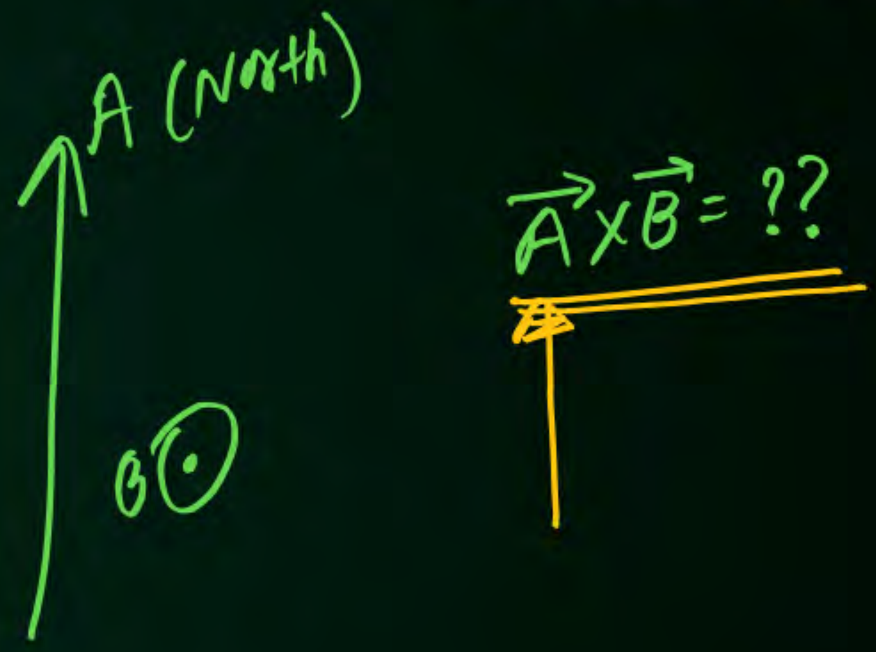
1. $0°$
2. $60°$
3. $90°$
4. $180°$ ✓

$\vec{A} \times \vec{B} = -\vec{B} \times \vec{A}$

QUESTION

Vector $\vec{A}$ points towards North and vector $\vec{B}$ points upwards then $\vec{A} \times \vec{B}$ points towards

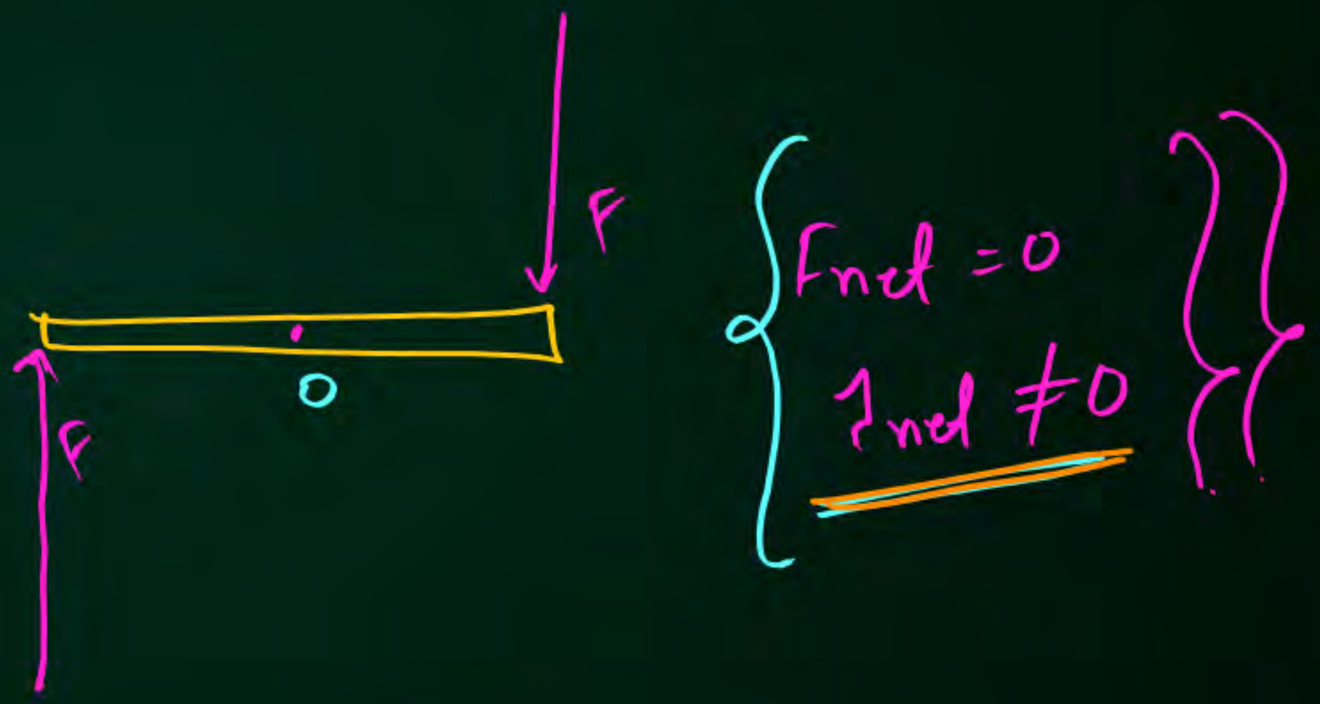
1. East
2. West
3. North
4. South

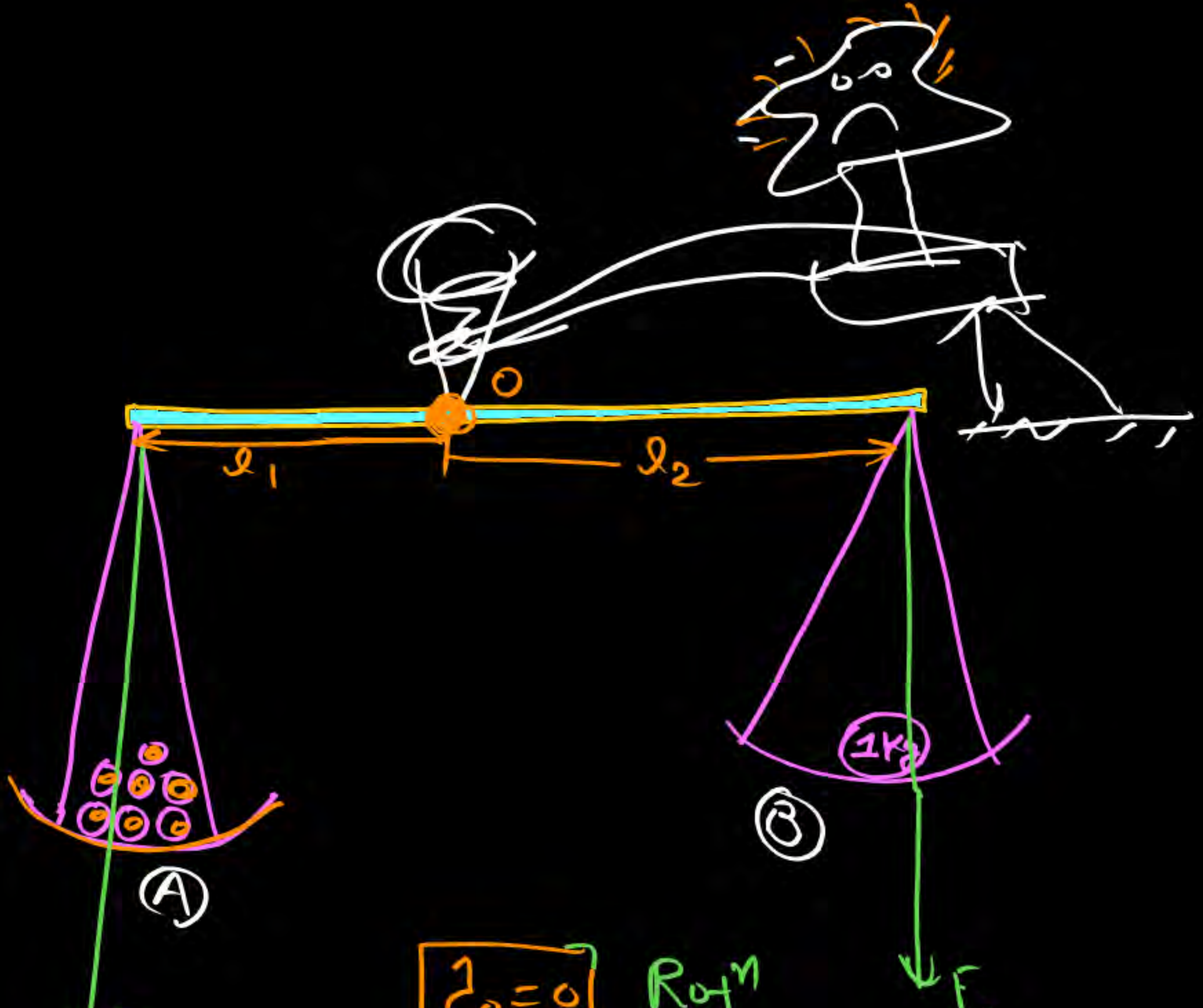


QUESTION

A couple produces ??

1. Linear and rotational motion
2. No motion
3. Purely linear motion
4. Purely rotational motion





Rotational equilibrium

→ $\sum \tau_{net} = 0$ (hinged)

If a body is at rest, then torque about any point will be zero

$\tau_o = 0$ — Rotⁿ equilibrium

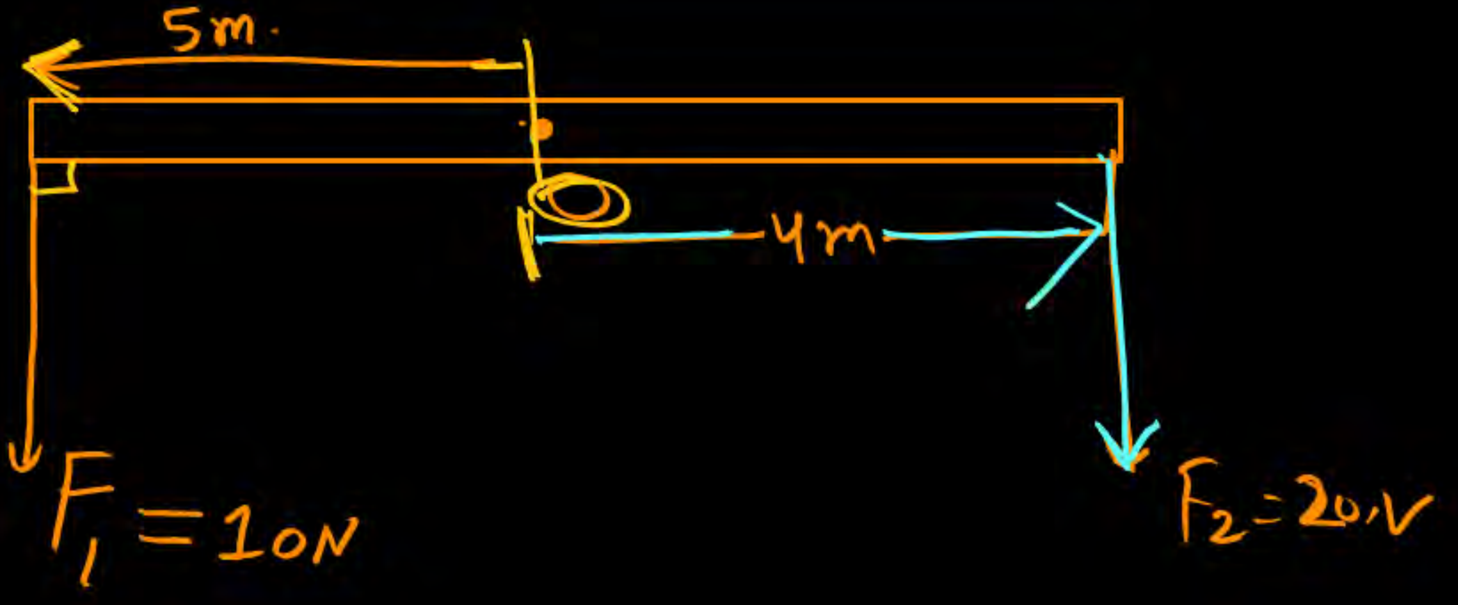
$F_1 l_1 = F_2 l_2$ (Moment of Force)

$(F_1 > F_2)$ $(l_1 < l_2)$

(Q) In which arm you will put Baigun, Baigun kam देने के लिए

(a) A — 34%

(b) B — 62%

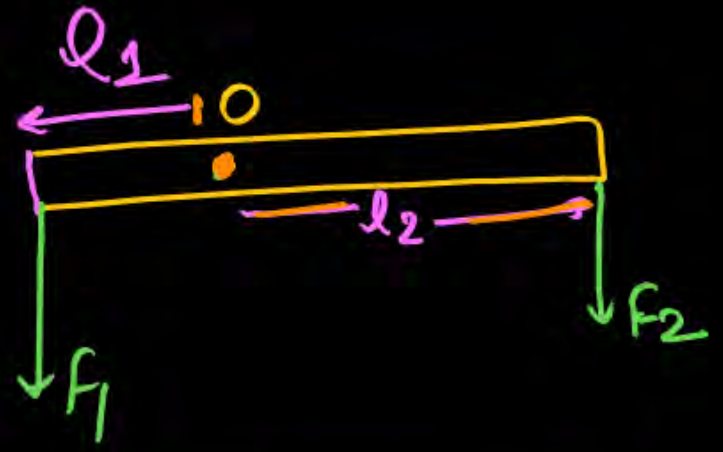


$(\tau_0) = ??$

$\tau_0 = 20 \times 4 \otimes + 50 \odot$

$= 80 \otimes + 50 \odot$

$= 30 \otimes$



If $(\tau_0)_{net} = 0$

$F_1 l_1 \odot + F_2 l_2 \otimes = 0$

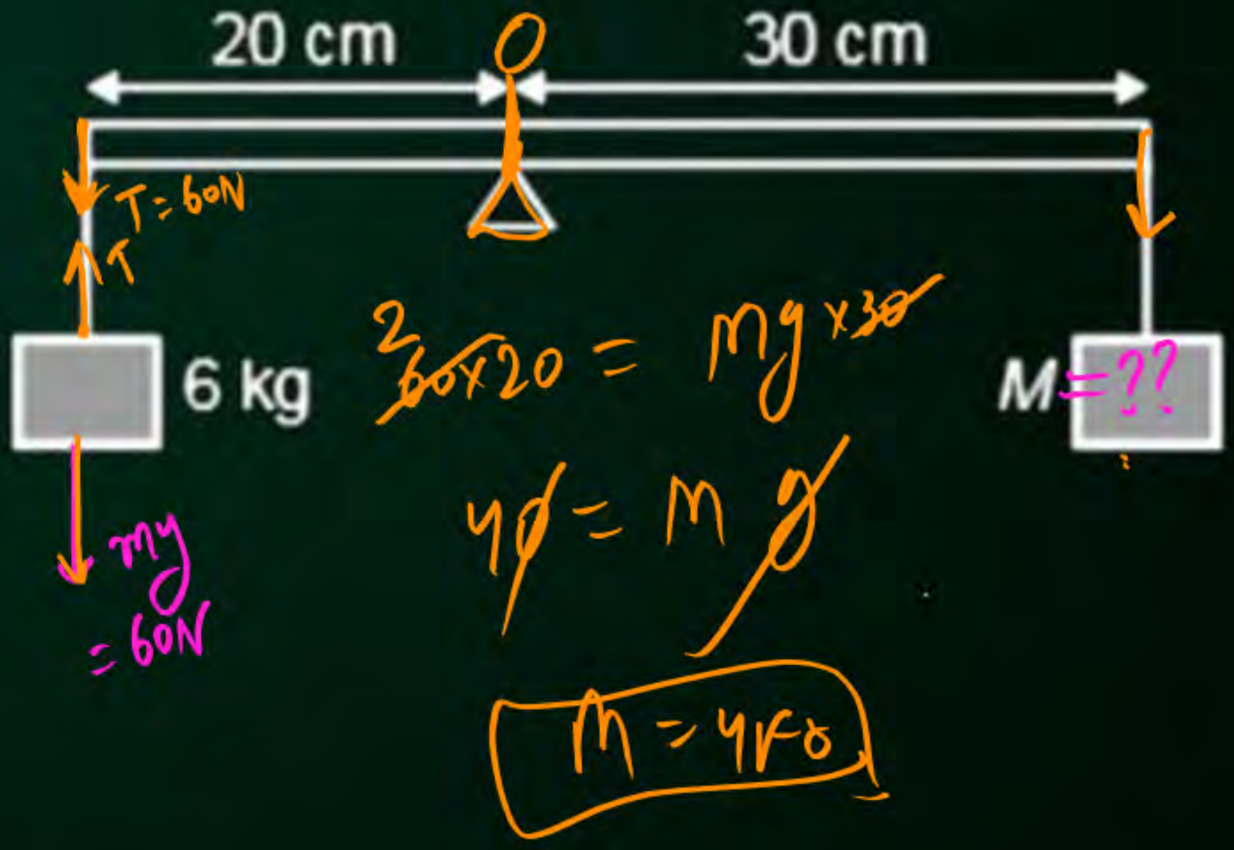
$F_1 l_1 = F_2 l_2$ (magnitude)

Mechanical Advantage $(M.A) = \frac{l_2}{l_1} = \frac{F_1}{F_2}$ $(l_2 > l_1)$ $(F_1 > F_2)$

QUESTION

The value of M, as shown, for which of the rod will be in equilibrium is (rod is massless)

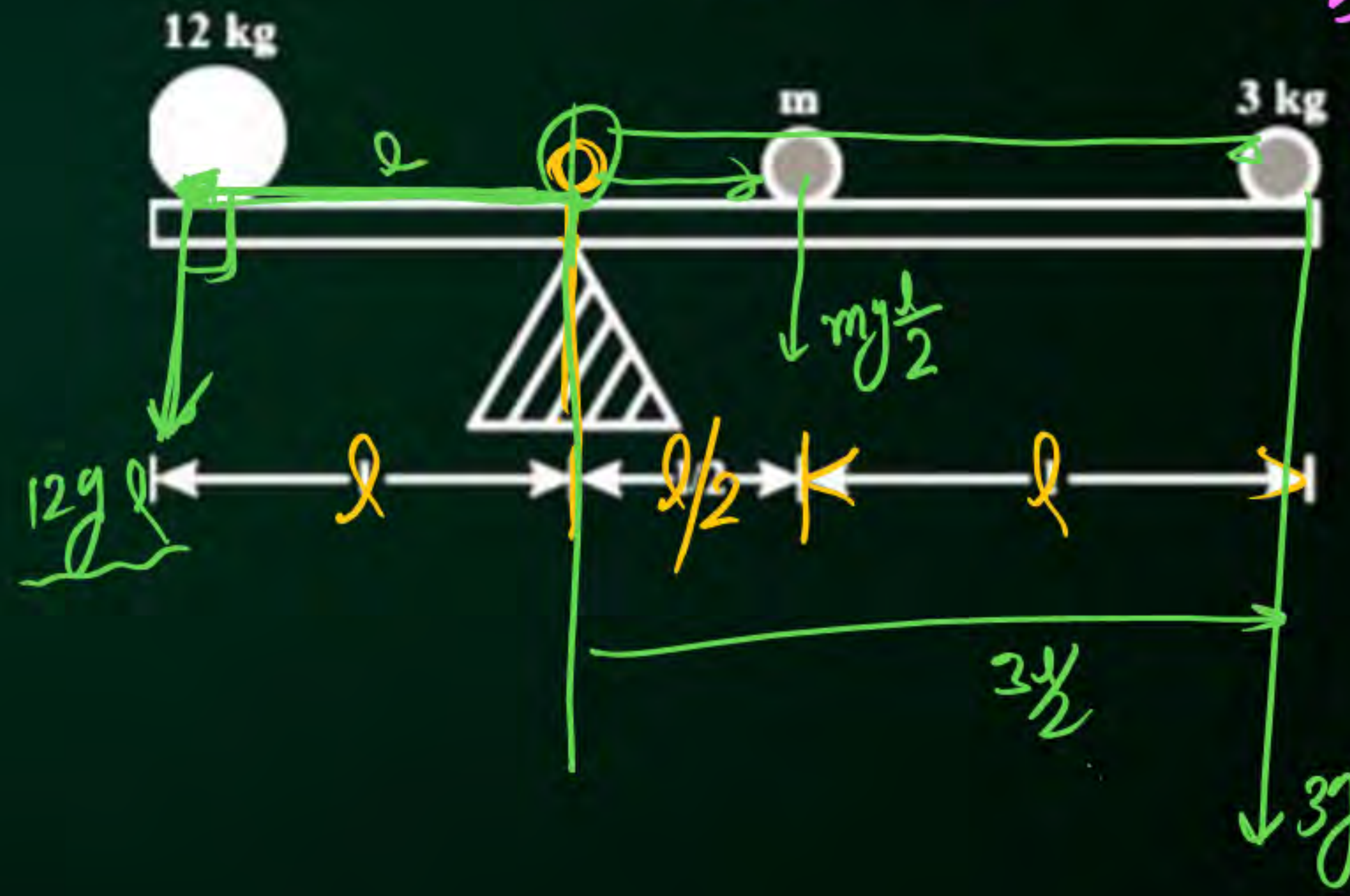
1. 1 kg
2. 2 kg
3. 4 kg
4. 6 kg



QUESTION

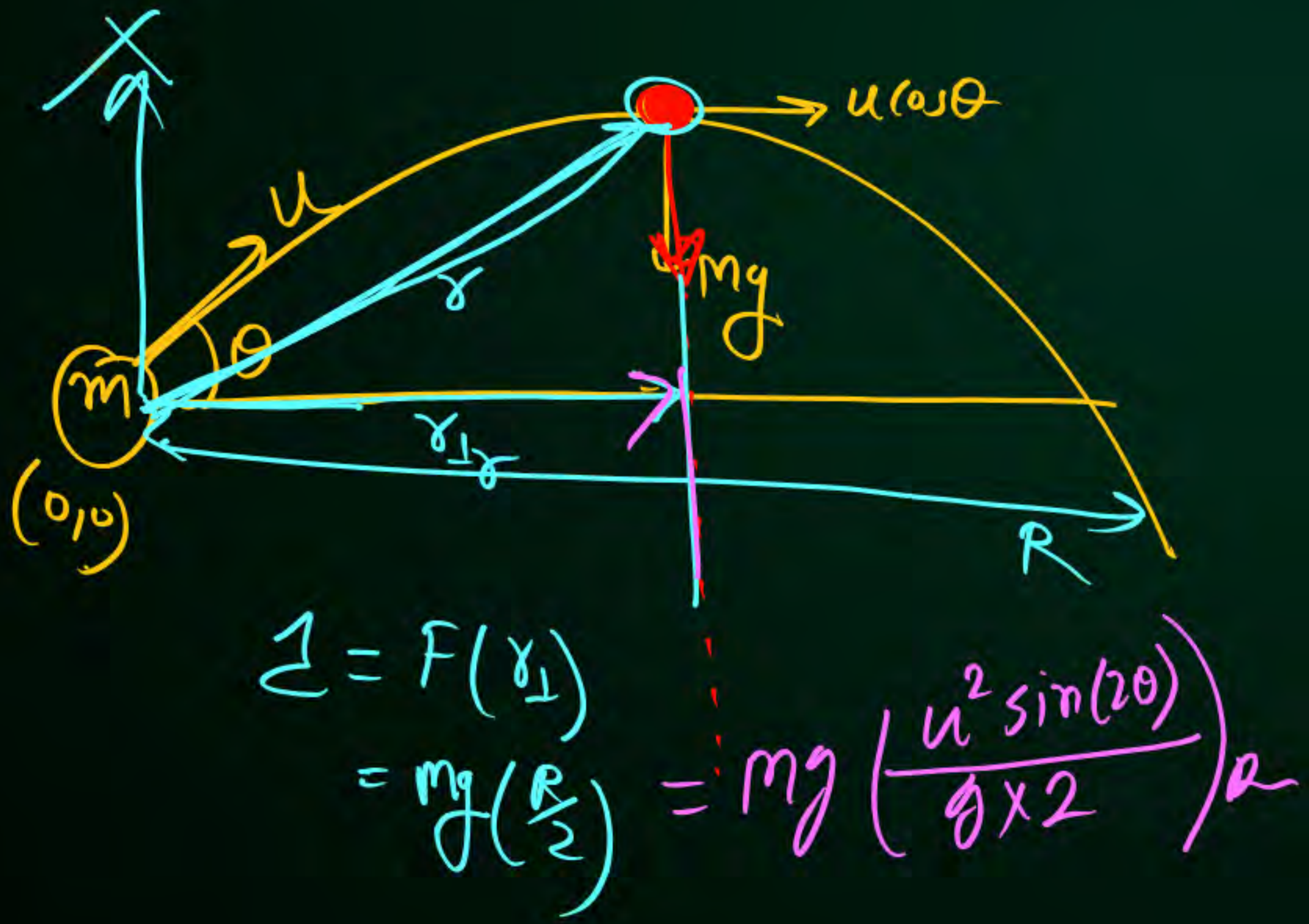
For equilibrium of the system, value of mass m should be

1. 9 kg
2. 15 kg
3. 21 kg
4. 1 kg



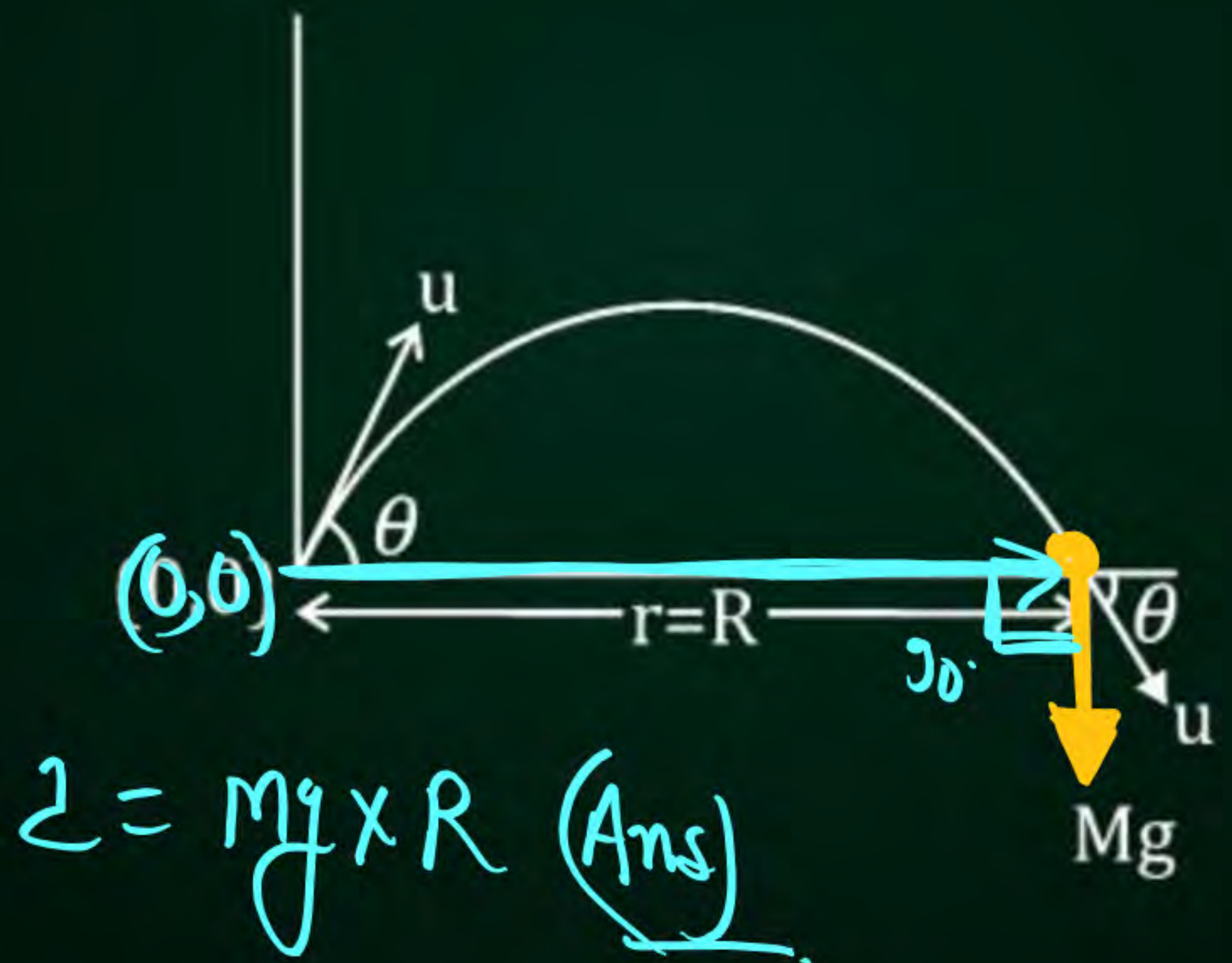
QUESTION

A particle of mass m has been thrown up with initial speed u making angle θ with the horizontal. Find the torque of its weight about the point of projection when it just reached the highest point.



QUESTION

Find torque due to gravitational force about original when particle is just about to collide.



QUESTION

A uniform rod of length 200 cm and mass 500 g is balanced on a wedge placed at 40 cm mark. A mass of 2 kg is suspended from the rod at 20 cm and another unknown mass 'm' is suspended from the rod at 160 cm mark as shown in the figure. Find the value of 'm' such that the rod is in equilibrium, ($g = 10\ m/s^2$)

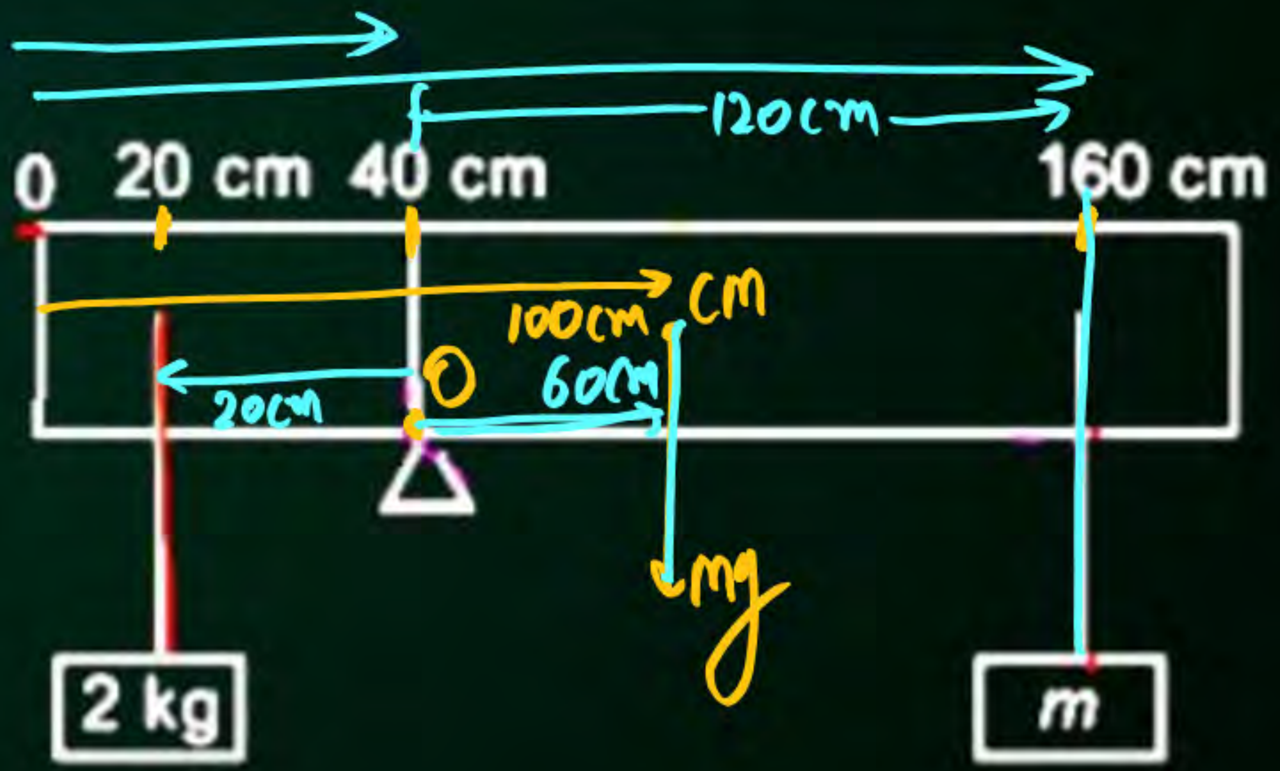
$$\tau_0 = 0$$

$$2 \times 20\,cm = \frac{1}{2} \times 60 + m(120)$$

$$40 = 30 + 120m$$

$$10 = 120m$$

$$m = \frac{10}{120} = \frac{1}{12}\,kg.$$



QUESTION

Moment of a force of magnitude 20 N acting along positive x - direction at point (3m, 0, 0) about the point (0, 2, 0) (in N-m) is

1. 20
2. 60
3. 40 ✓
4. 30

$r_{\text{force from axis of}} = 3\hat{i} - 2\hat{j}$ (position of force; origin)

$F = 20\hat{i}$

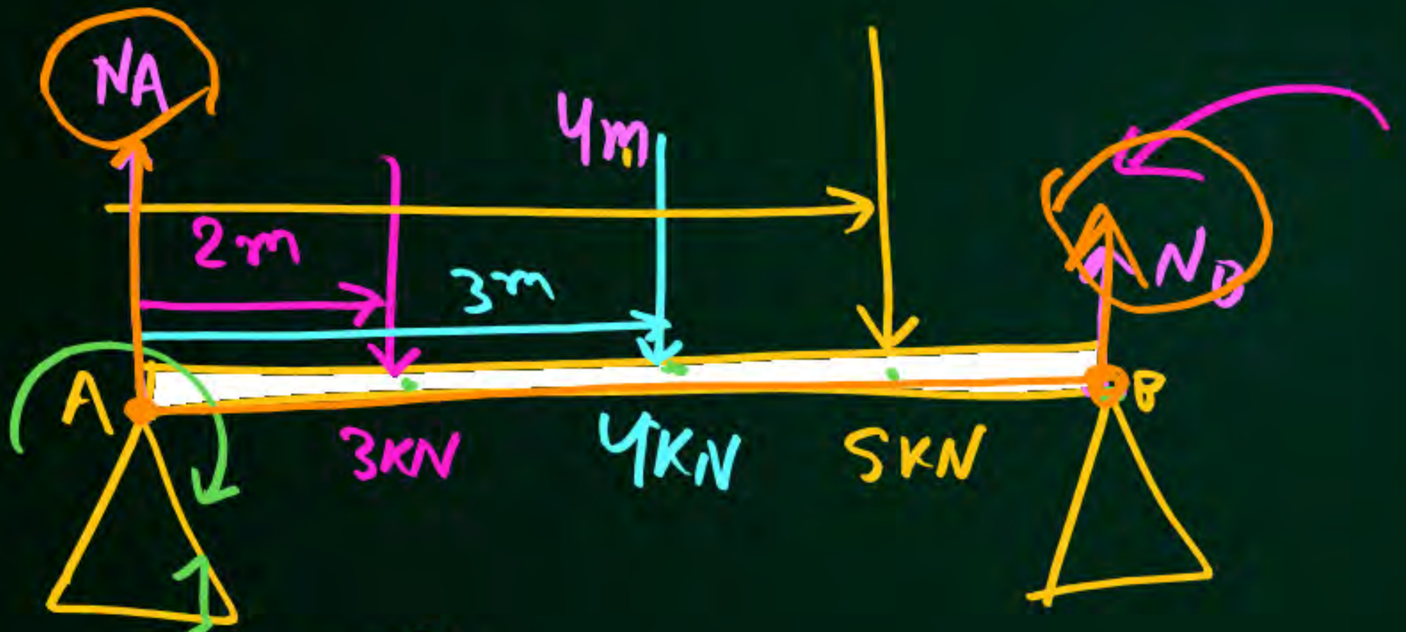
$\tau = r \times F$

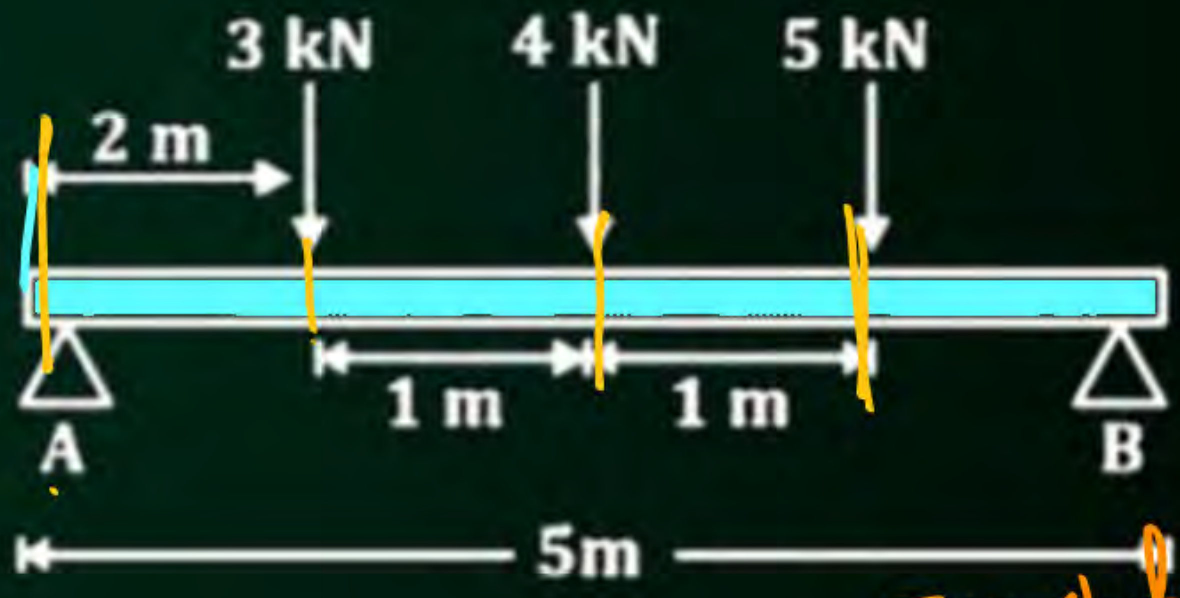
$= (3\hat{i} - 2\hat{j}) \times 20\hat{i}$

$= 40$

QUESTION

A massless beam of length 5 m is placed on two wedges A and B. If there forces 3 kN, 4 kN and 5 kN are applied on the beam as shown in the figure, then find normal reaction at A and B.





$\Sigma_A = 0$

$N_A \times 0 + (6 + 12 + 20)\,kNm = N_B \times 5$

$\frac{38\,kN}{5} = N_B$

Translational eqn.

$F_{net} = 0$

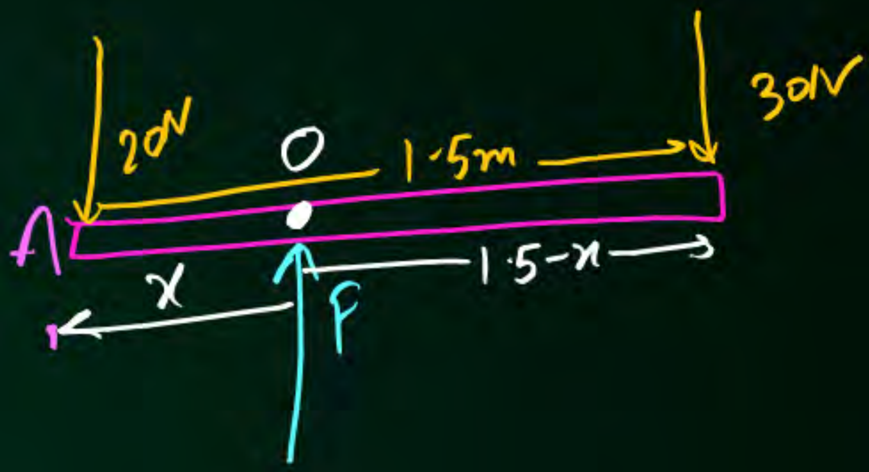
$N_A + N_B = 12\,kN$

$N_B = \left(12\,kN - \frac{38}{5}\,kN\right)$

QUESTION

Two like parallel forces 20 N and 30 N act at the ends A and B of a rod 1.5 m long. The resultant of the forces will act at the point

1. 90 cm from A
2. 75 cm from B
3. 20 cm from B
4. 85 cm from A



τ_0

$20x = 30(1.5 - x)$

$20x = 45 - 30x$

$50x = 45$

$x = \frac{45}{50} \times 100 = 90\,cm$

QUESTION

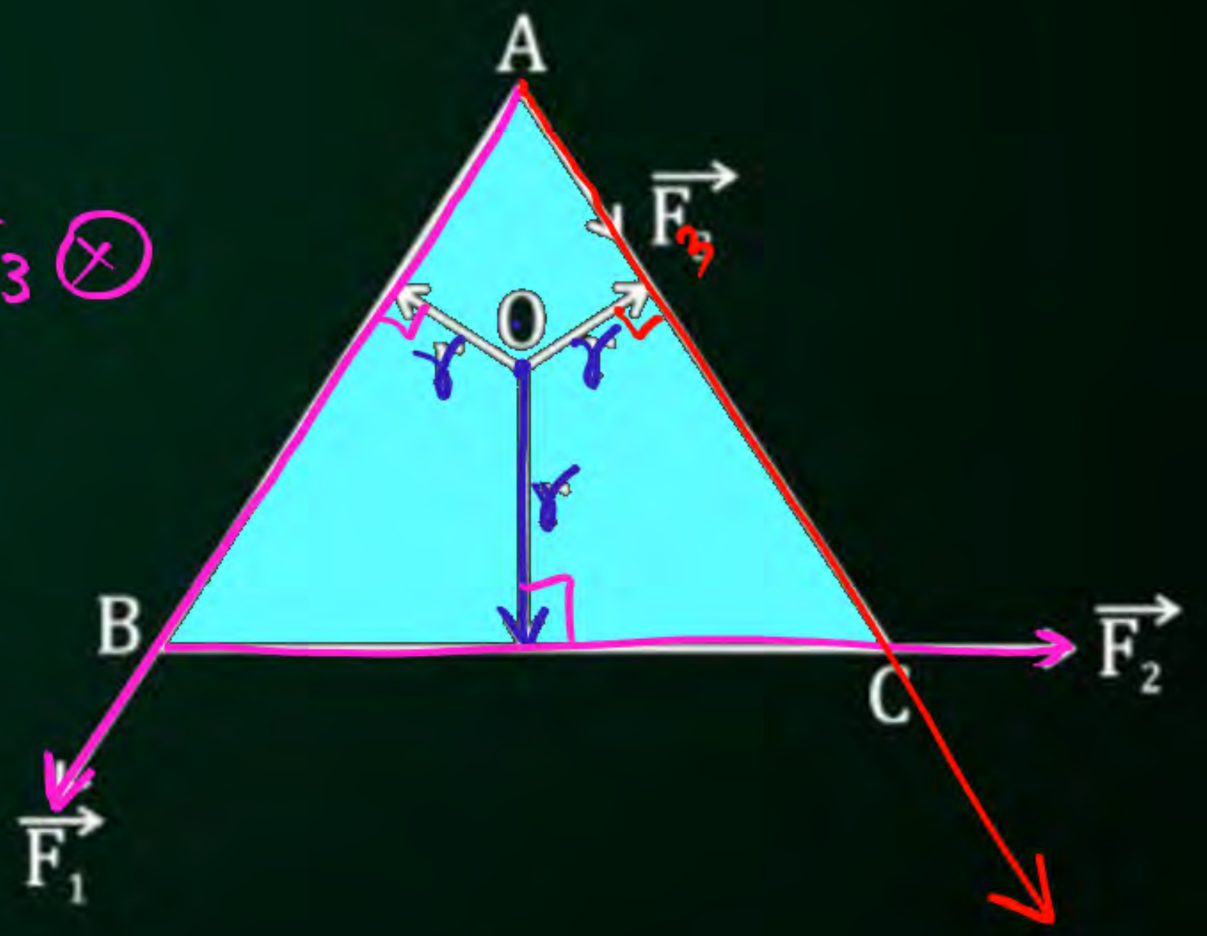
ABC is an equilateral triangle with O as its center $\vec{F}_1$, $\vec{F}_2$ and $\vec{F}_3$ represent three forces acting along the sides AB, BC and AC respectively. If the total torque about O is zero then the magnitude of $\vec{F}_3$ is

1. $\frac{F_1 + F_2}{2}$
2. $2(F_1 + F_2)$
3. $F_1 + F_2$
4. $F_1 - F_2$

$\tau_0 = 0$

$rF_1 \odot + rF_2 \odot = rF_3 \otimes$

$F_1 + F_2 = F_3$



QUESTION

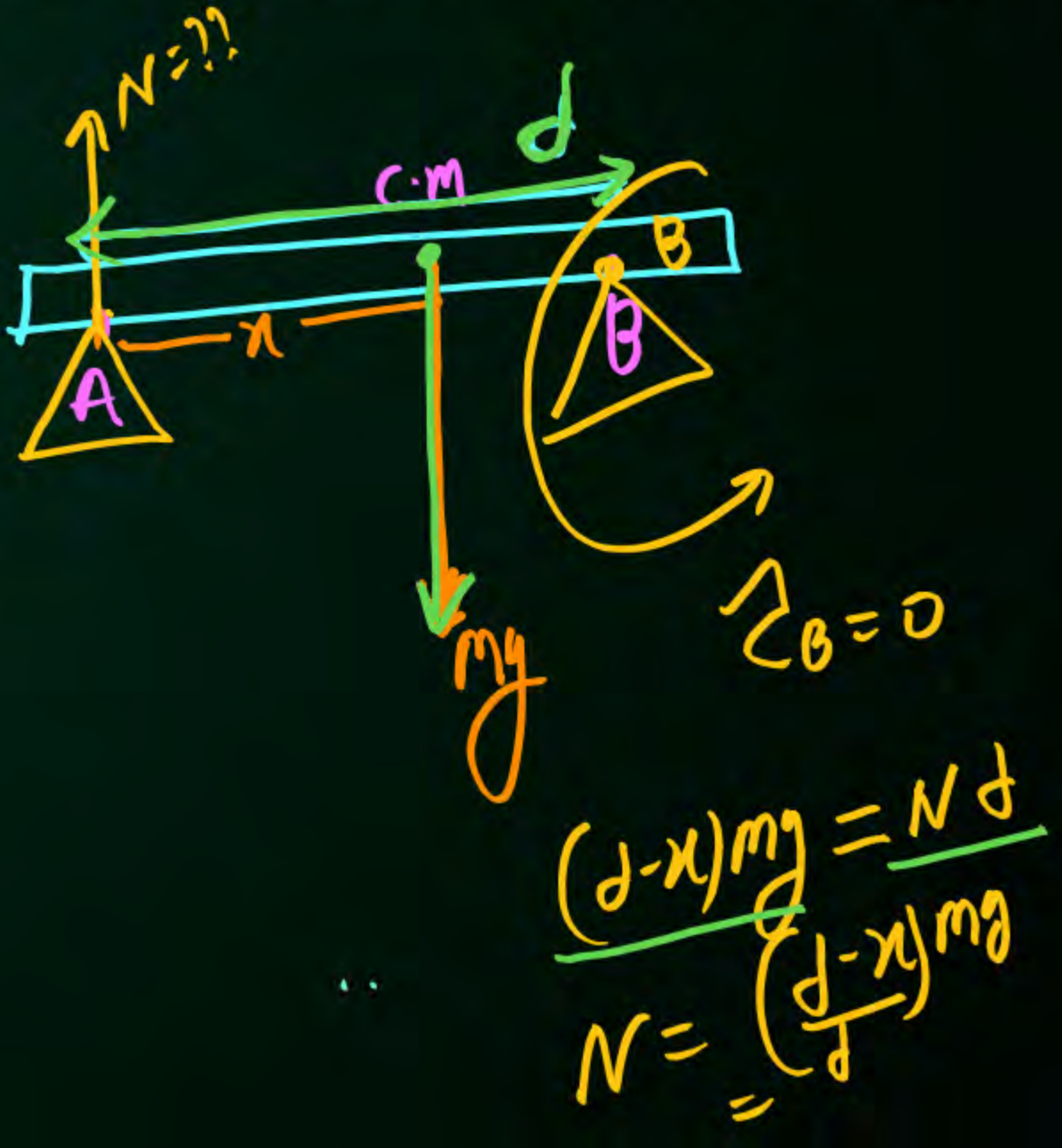
If body is not rotating about any point then torque about every point will be zero.....

1. True
2. False

QUESTION

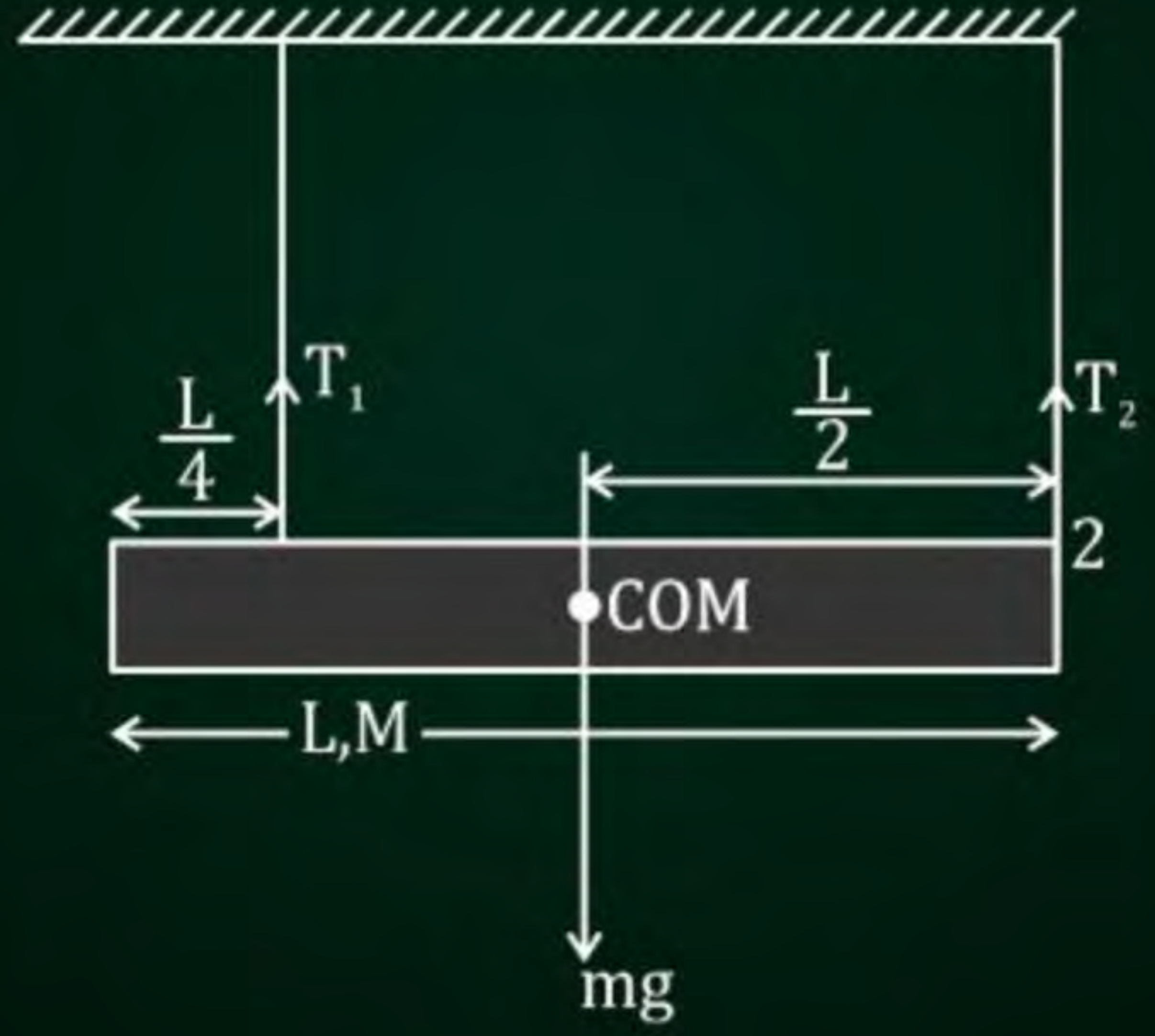
A rod of weight W is supported by two parallel knife edges A and B and is in equilibrium in a horizontal position. The knives are at a distance d from each other. The center of mass of the rod is at distance x from A. The normal reaction on A is

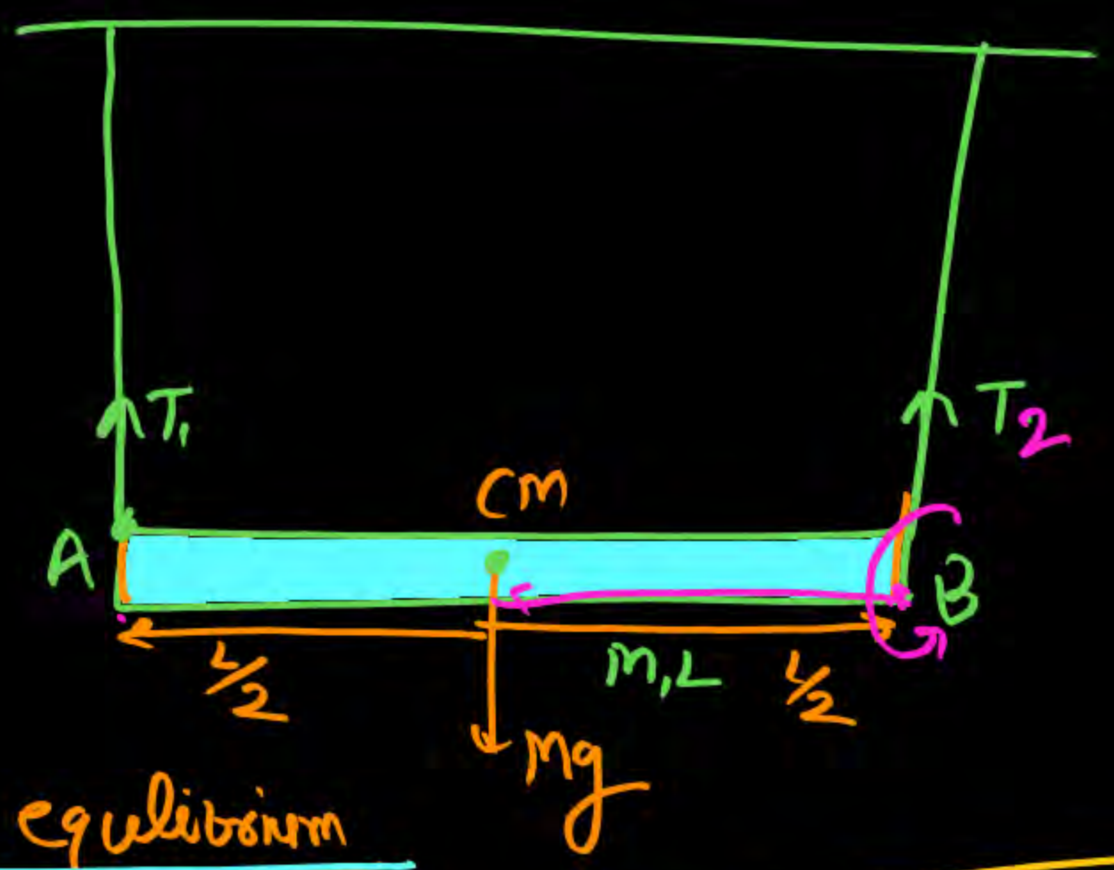
1. $\dfrac{W(d-x)}{d}$
2. $\dfrac{Wx}{d}$
3. $\dfrac{Wd}{x}$
4. $\dfrac{W(d-x)}{x}$



QUESTION

There is a rod (M, L) as shown in the figure then find T_1 & T_2.





Transl^n equilibrium

$$T_1 + T_2 = mg$$

$$(T_1 = T_2)$$

$$2T_1 = mg$$

$$\boxed{T_1 = mg/2}$$

$$\boxed{\tau_A = \tau_{c.m} = \tau_B = 0}$$

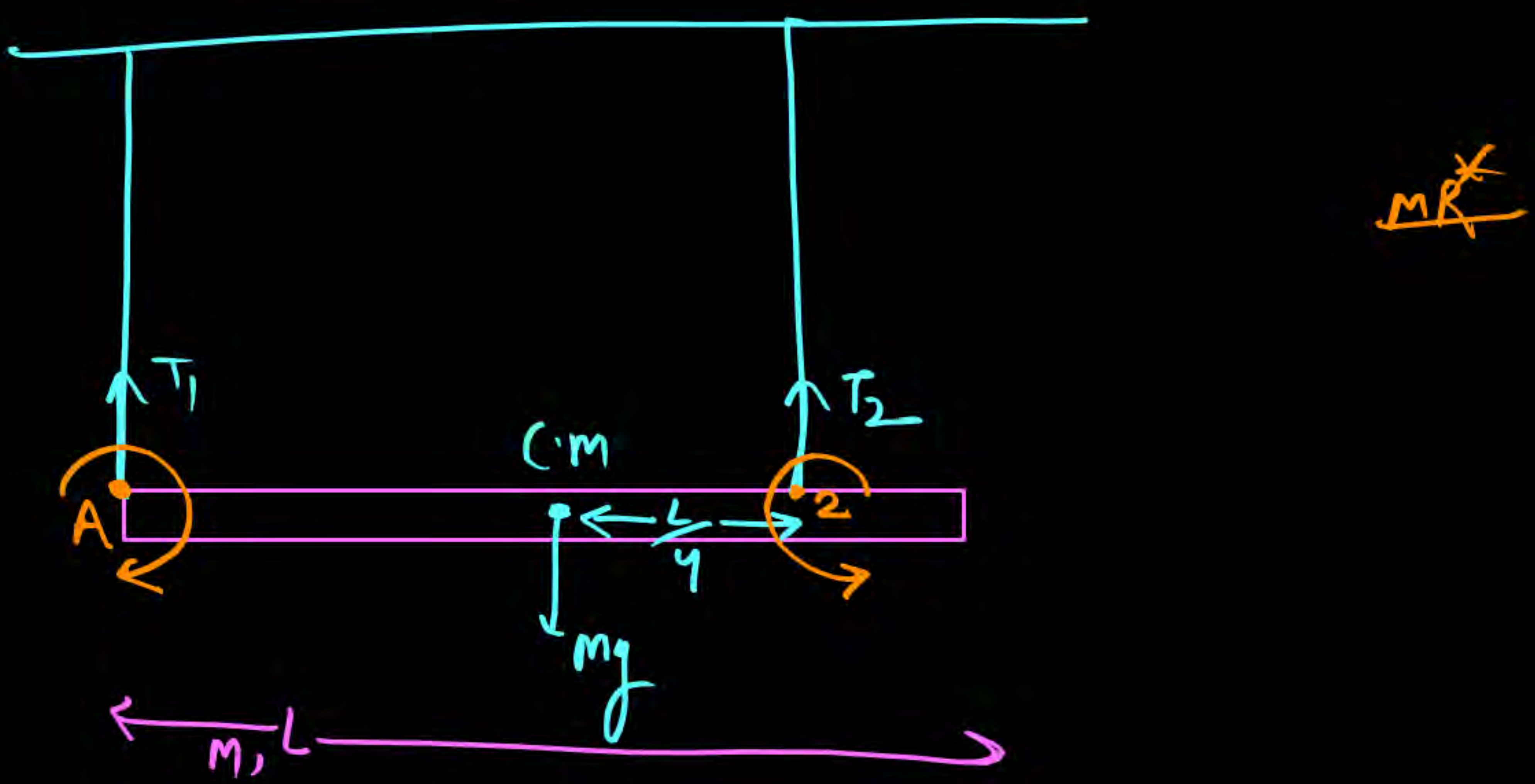
Rotational equilib^n

If $\tau_B = 0$

$$T_2 \times 0 + mg \times \frac{L}{2} \odot + T_1 L \otimes = 0$$

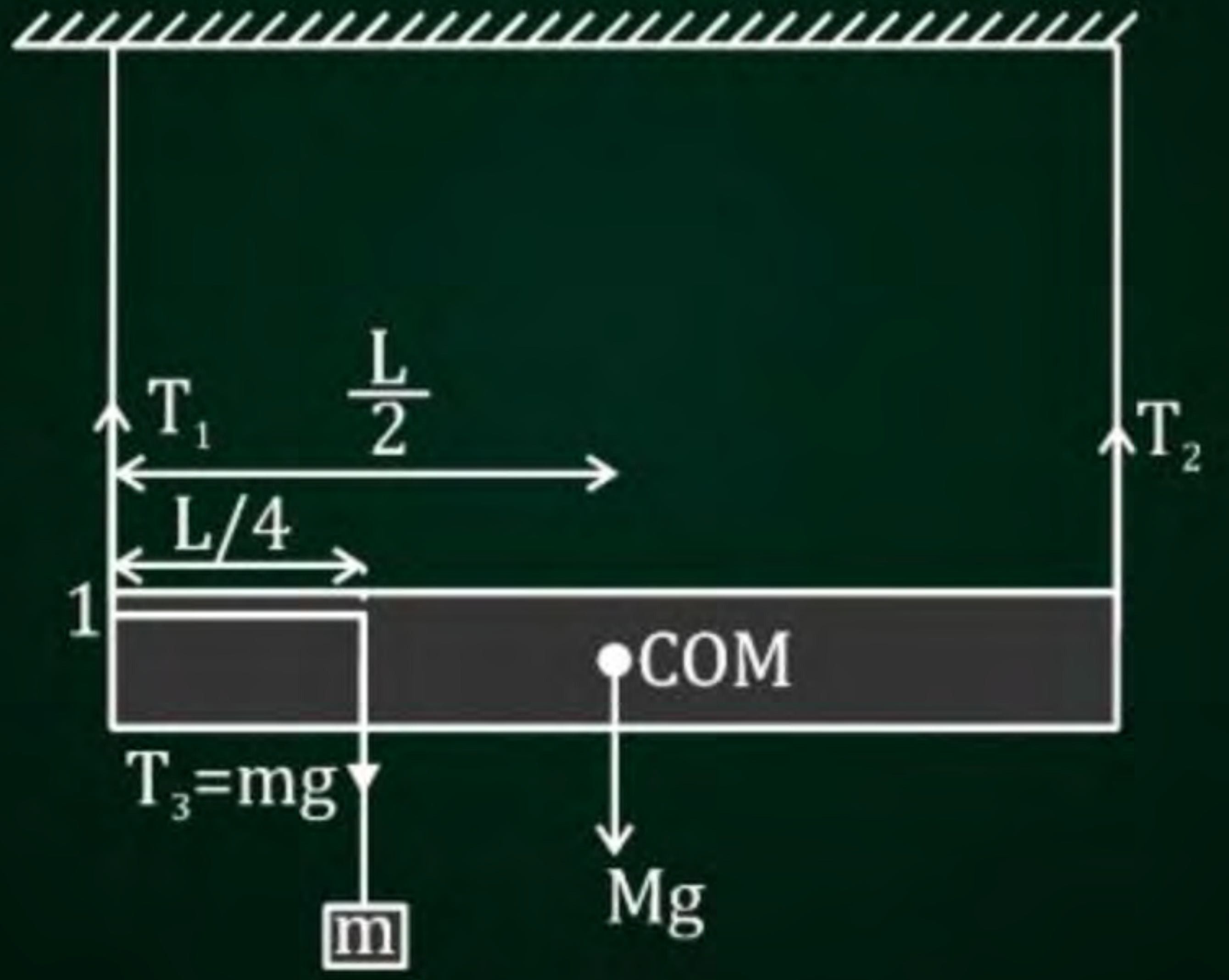
$$mg\frac{L}{2} = T_1 L$$

$$\boxed{T_1 = \frac{mg}{2}}$$


T1
T2
C·M
A
2
L/4
mg
M, L
MR

QUESTION

There is a rod (M, L) as shown in the figure then find T_1 & T_2.



QUESTION

(1) Center of gravity (C.G.) of a body is the point at which the weight of the body acts.

(2) Center of mass coincides with the center of gravity if the earth is assumed to have infinitely large radius.

(3) To evaluate the gravitational field intensity due to any body at an external point, the entire mass of the body can be considered to be concentrated at its C.G.

(4) The radius of gyration of any body rotating about an axis is the length of the perpendicular drawn from the C.G. of the body to the axis.

Which one of the following pairs of statements is correct? [Mains 2010]

1. (4) and (1)
2. (1) and (2)
3. (2) and (3)
4. (3) and (4)


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 2 | Physics

Lecture- 2 H/W solution video

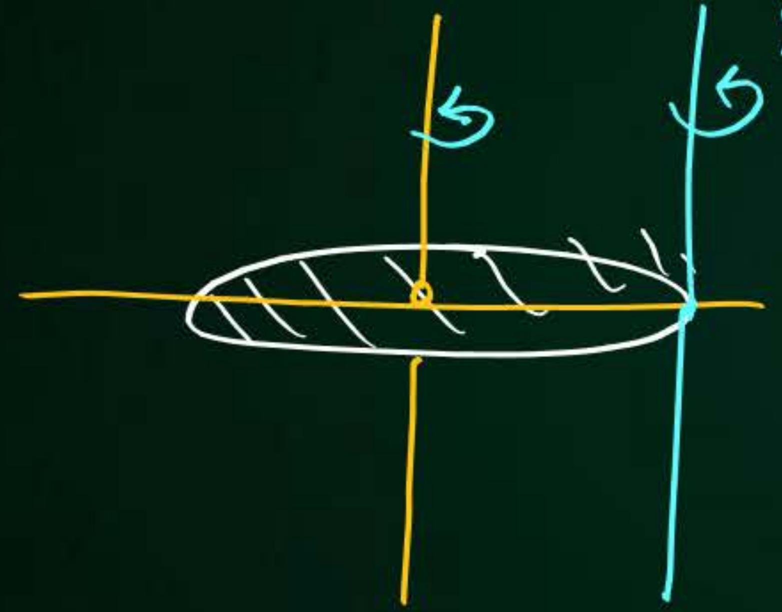
Rotational Motion

By- Dr. Manish Raj (MR SIR)



QUESTION

The moment of inertia of a thin uniform circular disc about one of its diameter is *I*. Its moment of inertia about an [redacted] circumference and perpendicular to its plane is



$I' = \frac{3}{2} mR^2 = \frac{3}{2} \times 4I = 6I$

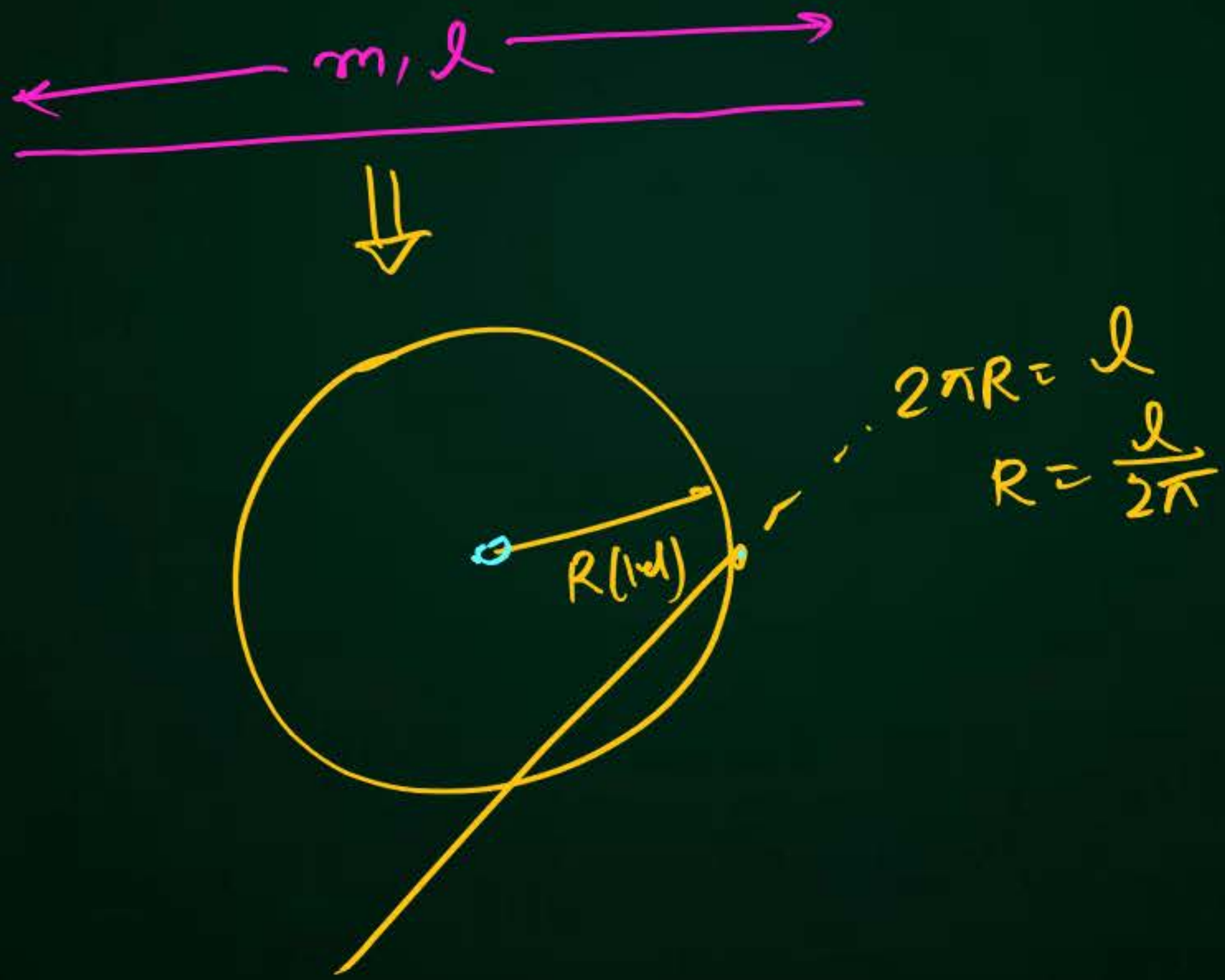
$I = \frac{mR^2}{4}$

1. $\frac{2I}{3}$
2. $2I$
3. $\frac{I}{2}$
4. $6I$ ✓

QUESTION

A thin uniform wire of mass m and length l is bent into a circle. The moment of inertia of the wire about an axis passing through its one end and perpendicular to the plane of the circle is

1. $\frac{2mL^2}{\pi^2}$
2. $\frac{mL^2}{\pi^2}$
3. $\frac{mL^2}{2\pi^2}$
4. $\frac{mL^2}{3\pi^2}$



$I' = 2mR^2$

$= 2m\left[\frac{l}{2\pi}\right]^2$

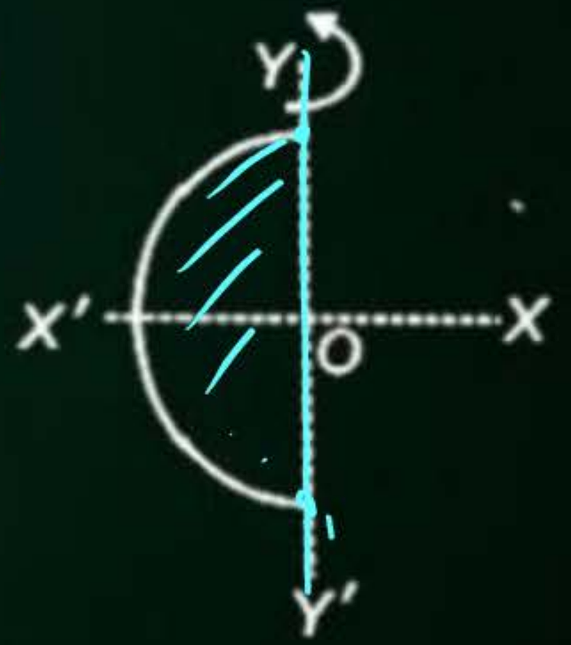
$= \frac{2ml^2}{4\pi^2} = \frac{ml^2}{2\pi^2}$

Ans

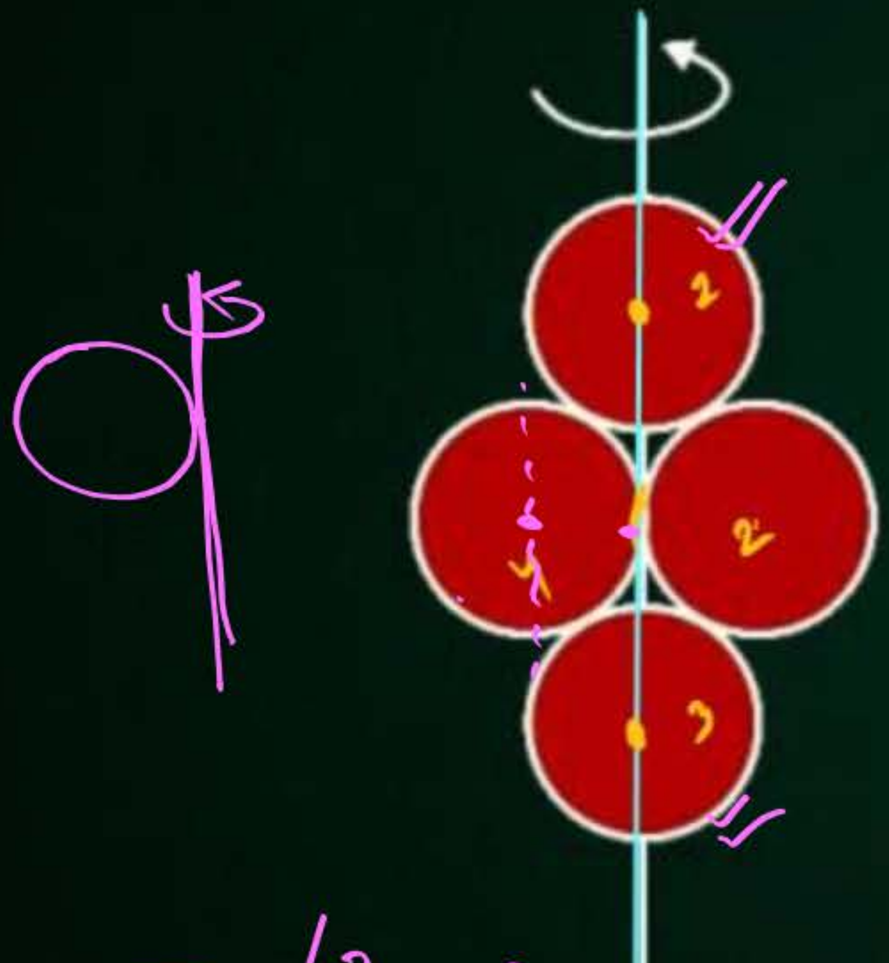
QUESTION

A thin wire of length l and mass m is bent in the form of a semicircle as shown. Its moment of inertia about an axis joining its free ends will be

1. ml^2
2. Zero
3. $\frac{ml^2}{\pi^2}$
4. $\frac{ml^2}{2\pi^2}$

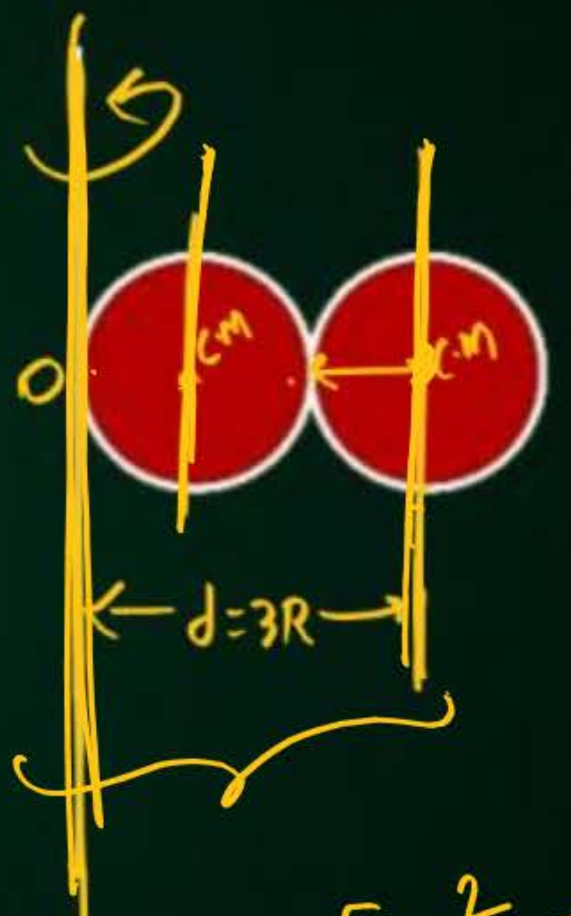


4-Hollow Sphere



$$I = \left(\frac{2}{3}mR^2 + \frac{2}{3}mR^2 + \frac{5}{3}mR^2 + \frac{5}{3}mR^2\right)$$

2-Hollow Sphere



$$I = \frac{5}{3}mR^2 + \left(\frac{2}{3}mR^2 + m(3R)^2\right)$$

$$= \frac{5}{3}mR^2 + \frac{2}{3}mR^2 + 9mR^2$$

QUESTION

The moment of inertia of a uniform circular disc of radius R and mass M about an axis passing from the edge of the disc and normal to the disc is

[AIPMT (Prelims)-2005]

(1) $\frac{1}{2}MR^2$

(2) MR^2

(3) $\frac{7}{2}MR^2$

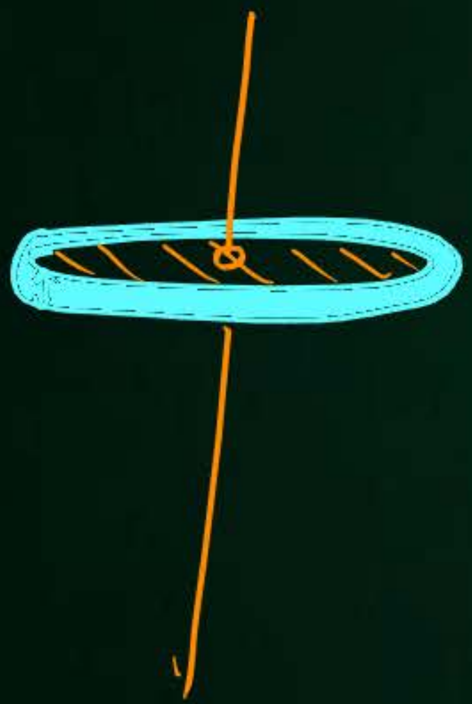
(4) $\frac{3}{2}MR^2$



QUESTION

Two discs of same mass and same thickness have densities as 17 g/cm^3 and 51 g/cm^3. The ratio of their moment of inertia about their central axes is

1. $\frac{1}{3}$
2. $\frac{2}{3}$
3. $\frac{3}{1}$ ✓
4. $\frac{3}{2}$





$\rho = \frac{m}{\pi R^2 d}$

$R^2 = \frac{m}{\pi d \rho}$

$I = \frac{mR^2}{2} = \frac{m}{2}\frac{m}{\pi d \rho}$

$I = \frac{m^2}{2\pi d \rho}$

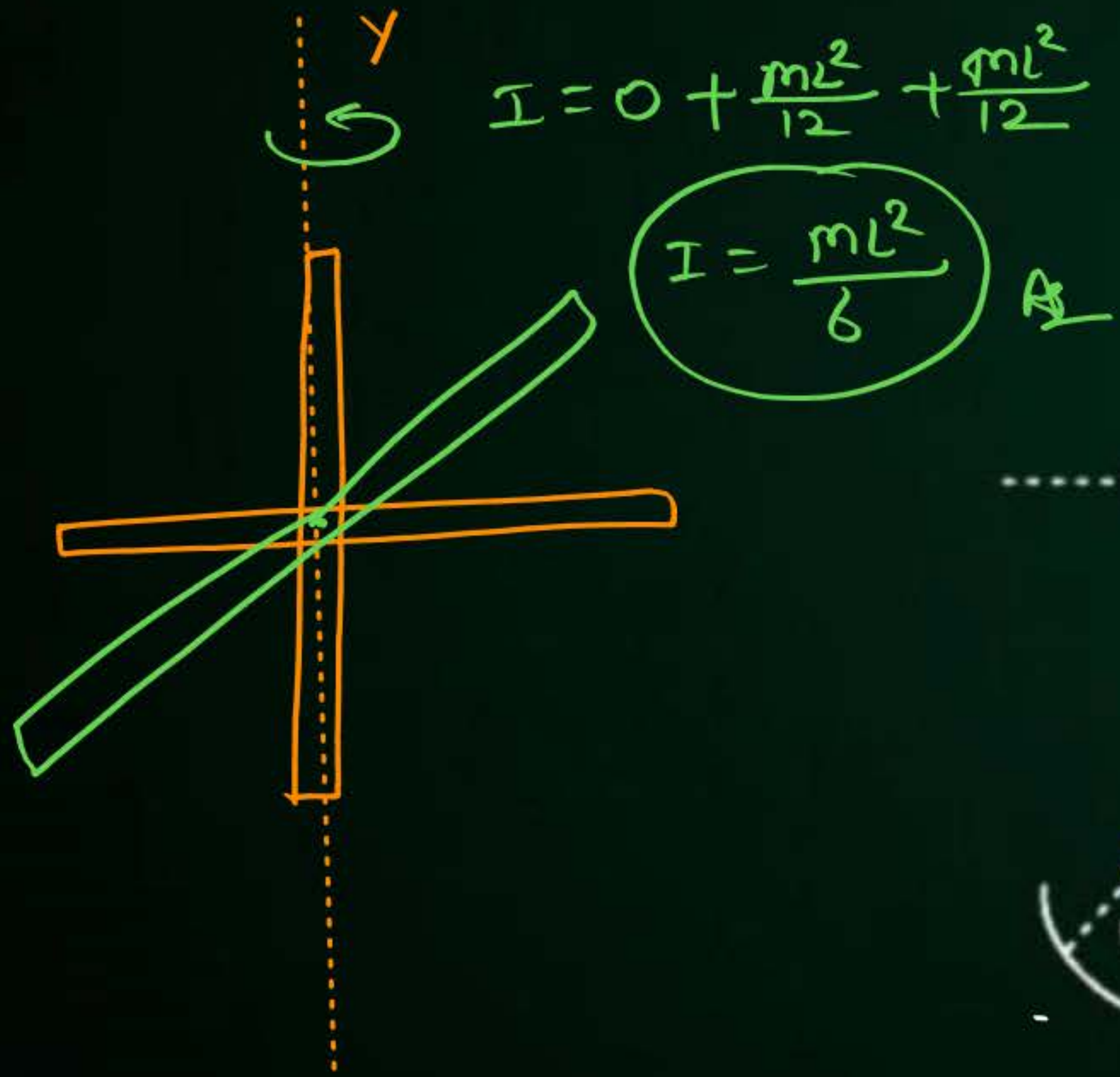
$I \propto \frac{1}{\rho}$

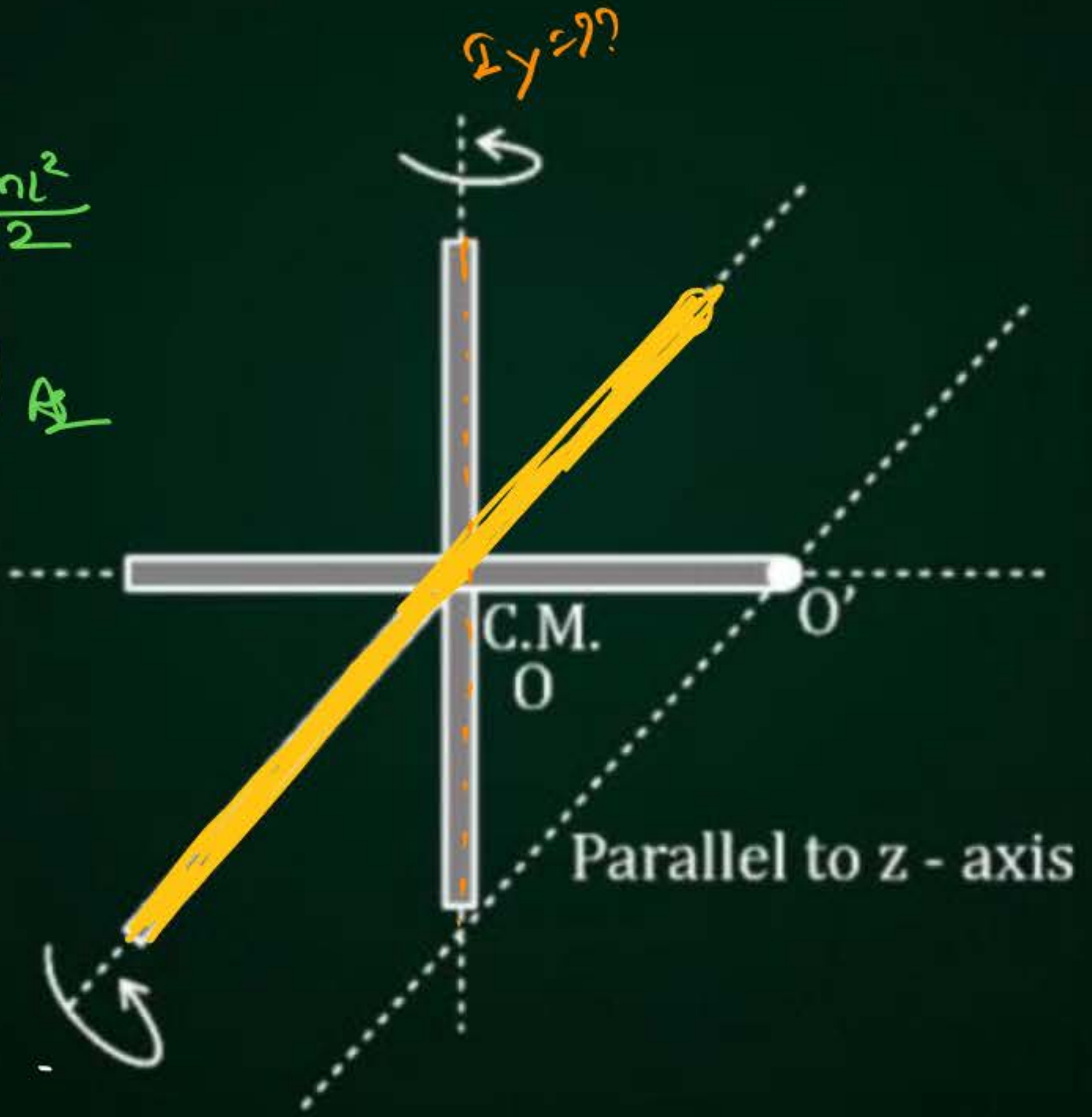
$\frac{I_1}{I_2} = \frac{\rho_2}{\rho_1} = \frac{51}{17} = \frac{3}{1}$

H/W

QUESTION

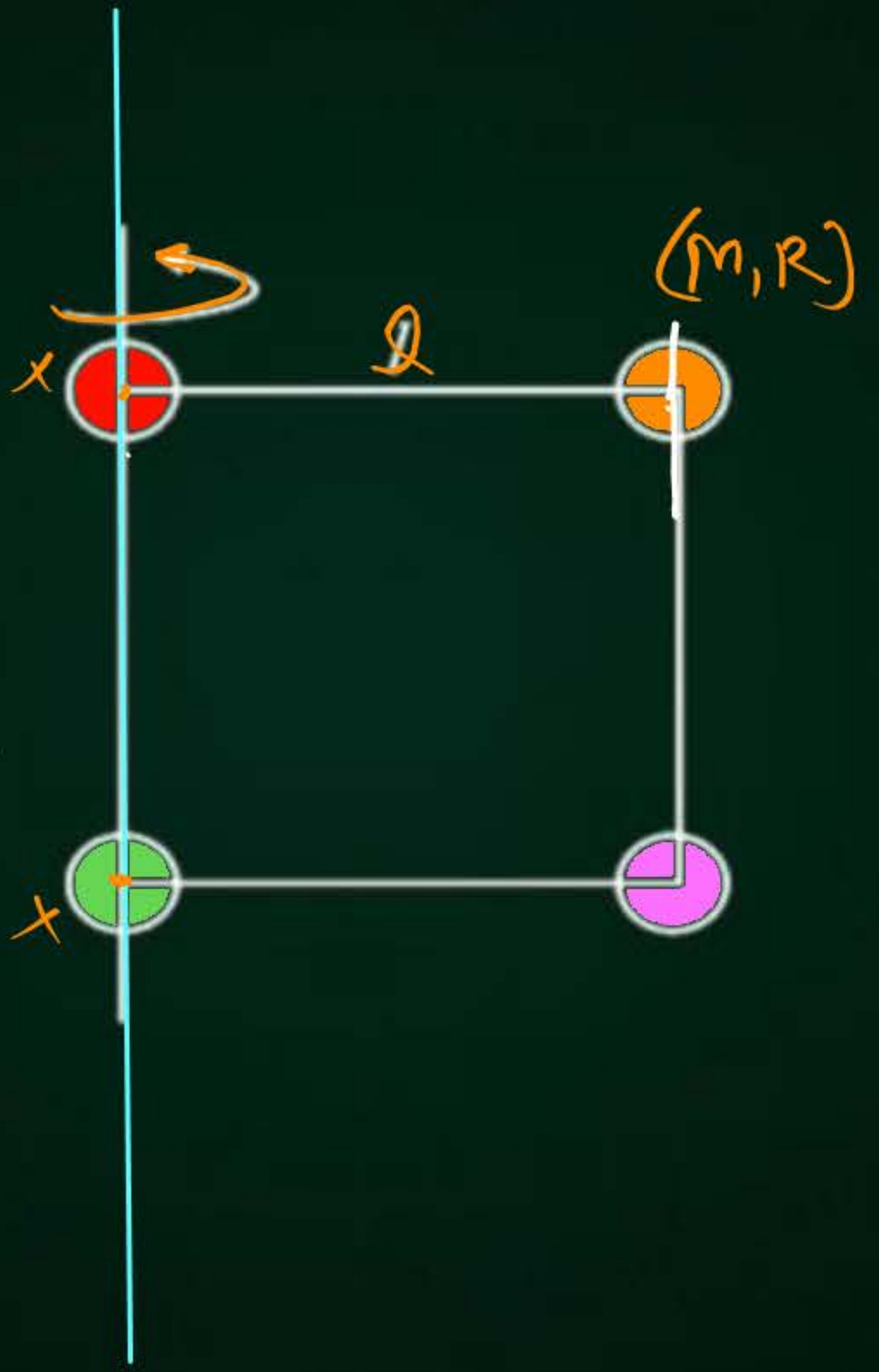
Three identical rod parallel to each other. Find MOI about y – axis.





H|W

$$\left(I_{c.m}\right)_{solid} = \frac{2}{5} mR^2$$

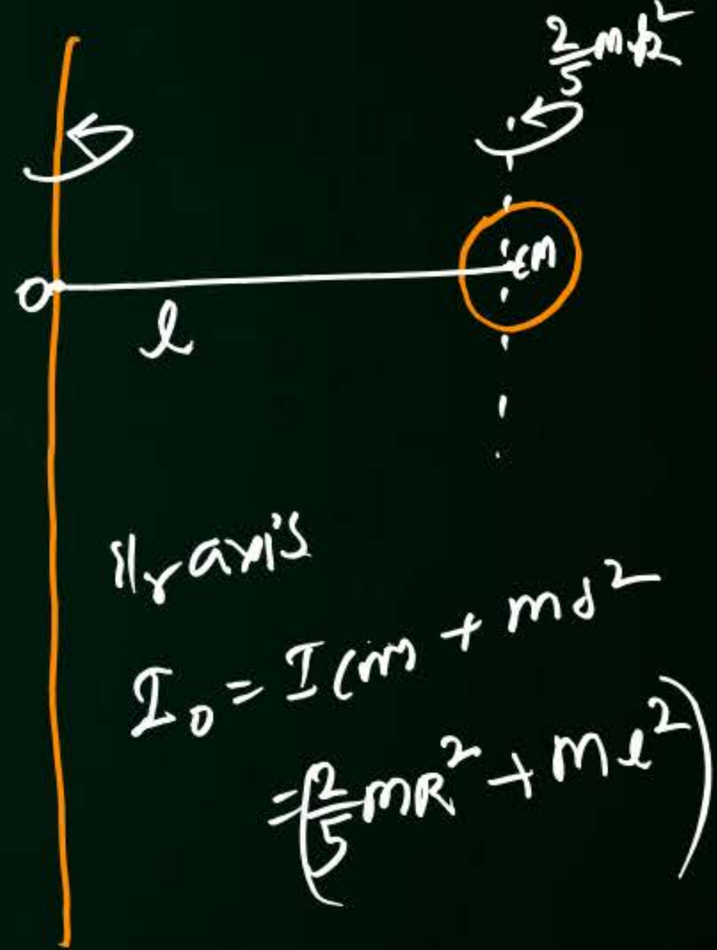


Four Solid sphere (M, R)

$$I = \left[\frac{2}{5} mR^2 \times 2\right] + \left(\frac{2}{5} mR^2 + ml^2\right) \times 2$$

$$= \left(\frac{8}{5} mR^2 + 2ml^2\right)$$

Ans



|| r axis

$$I_0 = I_{cm} + md^2$$

$$= \left(\frac{2}{5} mR^2 + ml^2\right)$$

=

H/W

QUESTION

Four rings each of mass M and radius R are arranged as shown in the figure. The moment of inertia of the system about the axis yy' is

1. $2\,MR^2$
2. $3\,MR^2$
3. $4\,MR^2$
4. $5\,MR^2$



$\frac{mR^2}{2}$



$\parallel r$ top

$I = \frac{mR^2}{2} + mR^2 = \frac{3mR^2}{2}$

$\frac{mR^2}{2} + \frac{mR^2}{2} + \frac{3}{2}mR^2 \times 2$

$I = mR^2 + 3mR^2$

$I = 4mR^2$

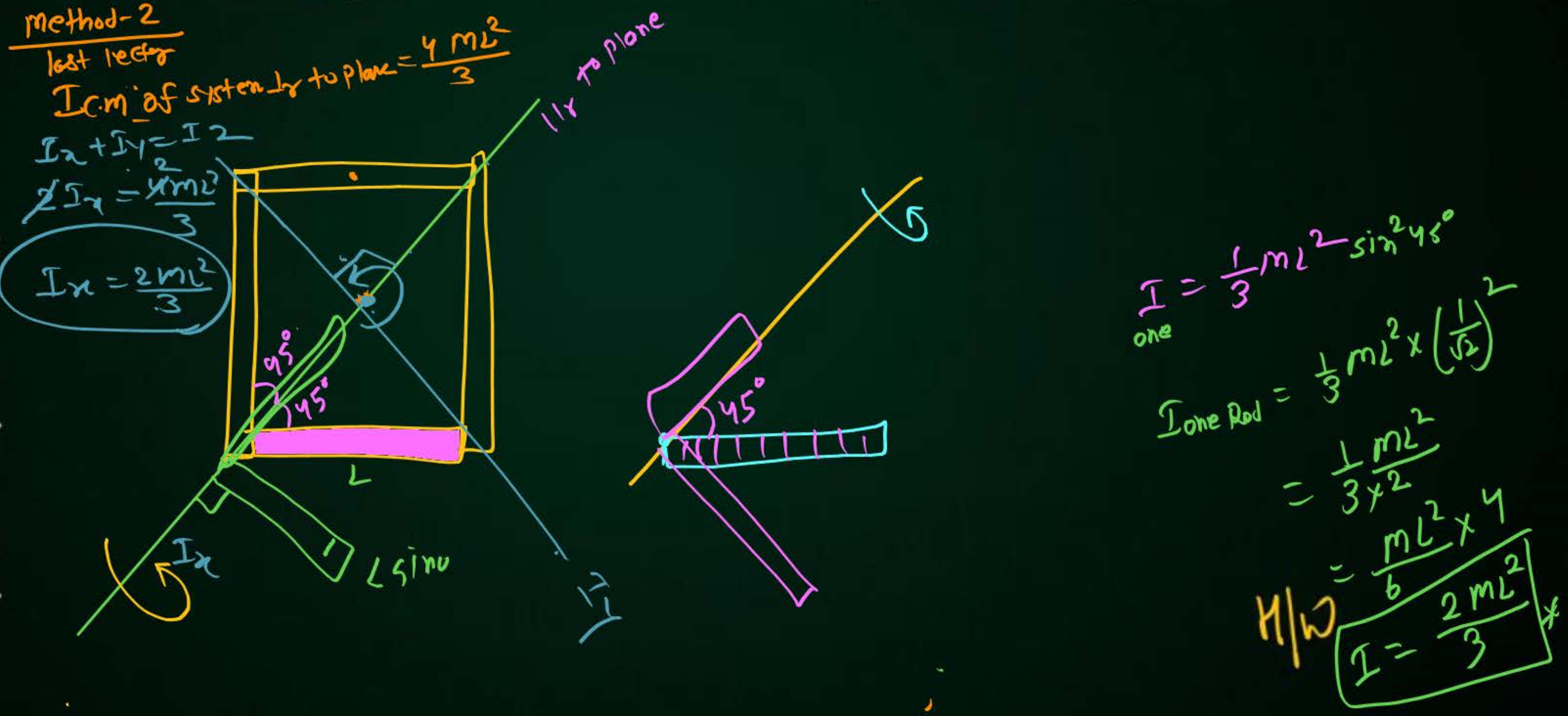


H/W

QUESTION

Four thin uniform rods each of length L and mass m are joined to form a square. The moment of inertia of square about an axis along its one diagonal is

1. $\frac{mL^2}{6}$
2. $\frac{2}{3}mL^2$
3. $\frac{3mL^2}{4}$
4. $\frac{4mL^2}{3}$



QUESTION

The two spheres, one of which is hollow and other solid, have identical masses and moment of inertia about their respective diameters. The ratio of their radii is given by

1. $5:7$
2. $3:5$
3. $\sqrt{3}:\sqrt{5}$ ✓
4. $3:7$

$$\frac{2}{3} m R_H^2 = \frac{2}{5} m R_S^2$$

$$\frac{R_H^2}{R_S^2} = \frac{3}{5}$$

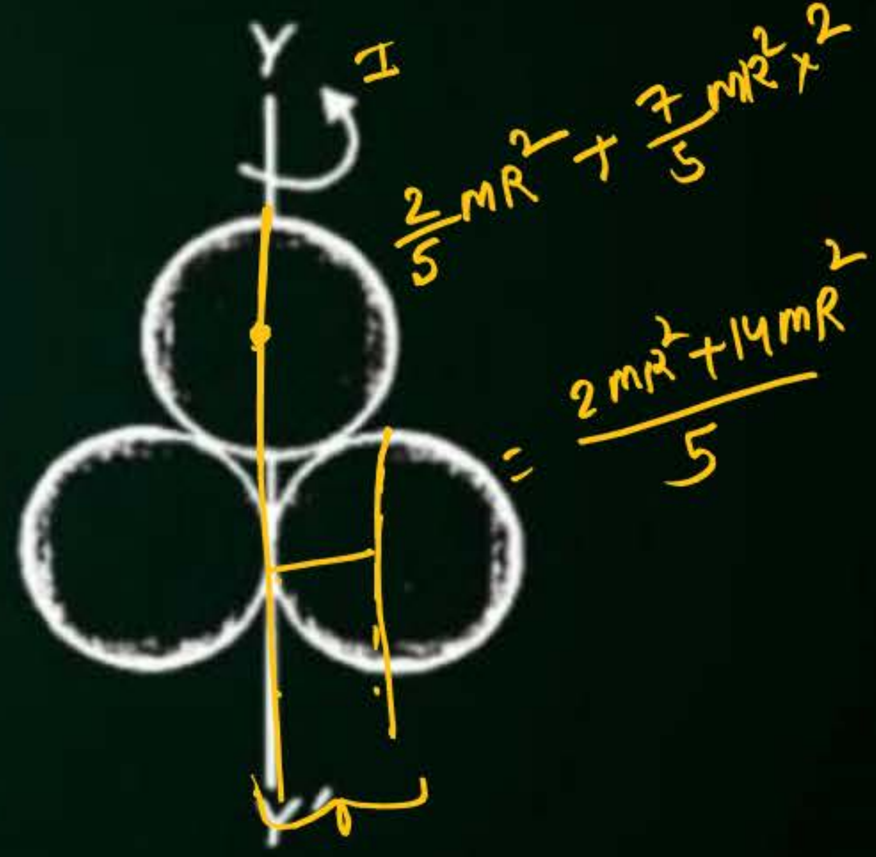
$$= \sqrt{3/5}$$

H/W

QUESTION

Three solid spheres each of mass P and radius Q are arranged as shown in figure. The moment of inertia of the arrangement about YY′ axis

1. $\frac{7}{5}PQ^2$
2. $\frac{14}{5}PQ^2$
3. $\frac{16}{5}PQ^2$ ✓
4. $\frac{5}{14}PQ^2$



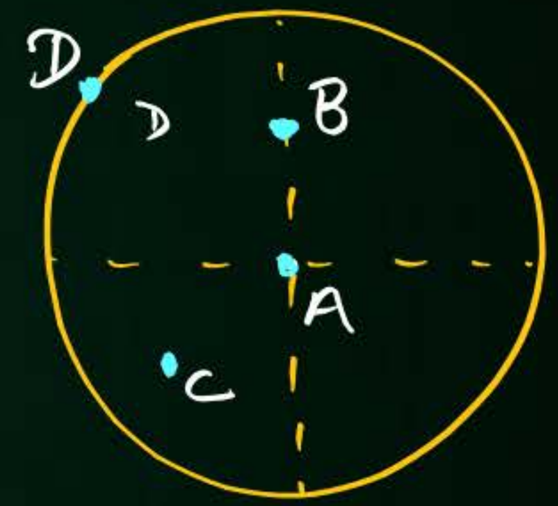
H|W

QUESTION

New question

The moment of inertia of a uniform circular disc is maximum about an axis perpendicular to the disc and passing through : [AIPMT Mains 2012]

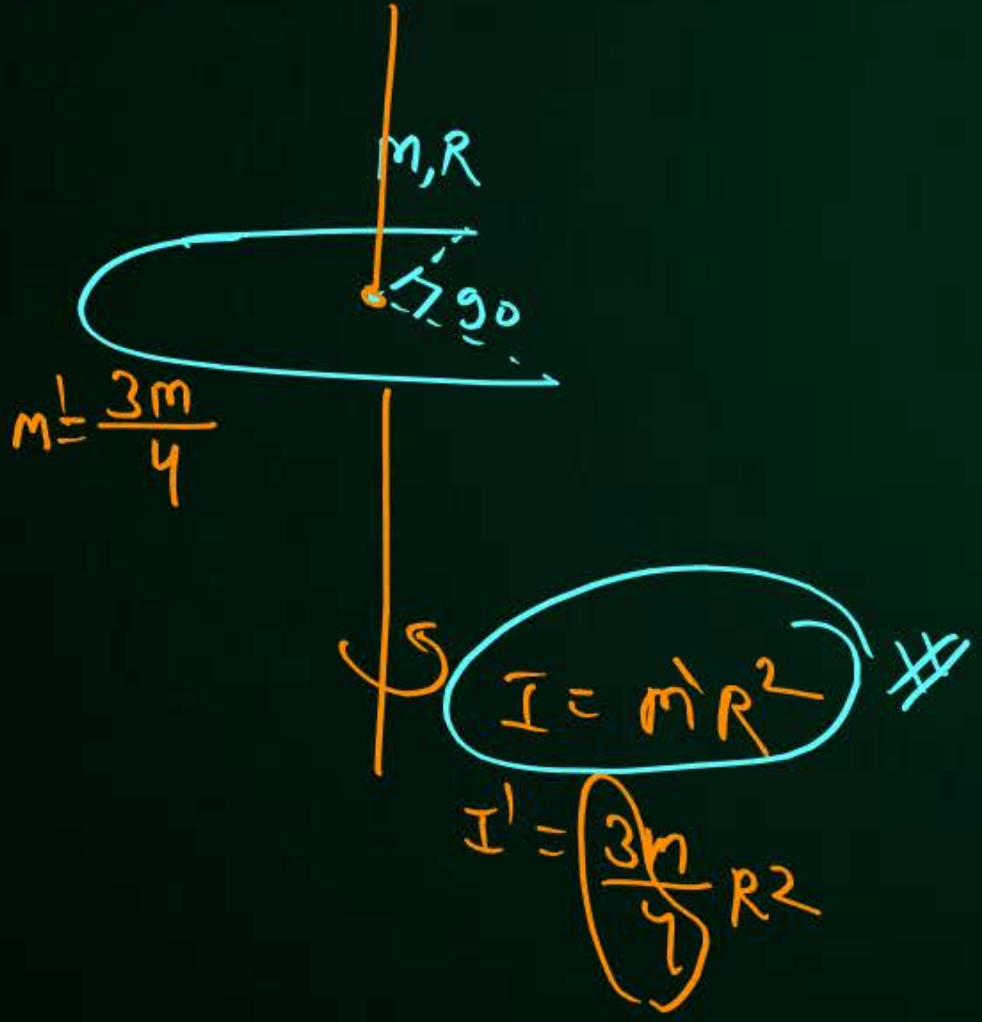
1. D
2. A
3. B
4. C



QUESTION

From a circular ring of mass M and radius R, an arc corresponding to a 90° sector is removed. The moment of inertia of the remaining part of the ring about an axis passing through the center of the ring and perpendicular to the plane of the ring is k times MR^2. Then the value of k is [NEET 2019]

1. $\frac{3}{4}$
2. $\frac{7}{4}$
3. $\frac{3}{2}$
4. $\frac{3}{5}$



QUESTION

A wheel comprises of a ring of radius R and mass M and three spokes of mass m each. The moment of inertia of the wheel about its axis is

1. $\left(M + \frac{m}{4}\right) R^2$

2. $(M + m) R^2$

3. $(M + 3m) R^2$

4. $\left(\frac{M + m}{2}\right) R^2$



$3\left(\frac{1}{3} m R^2\right) + M R^2$

$I = mR^2 + MR^2$

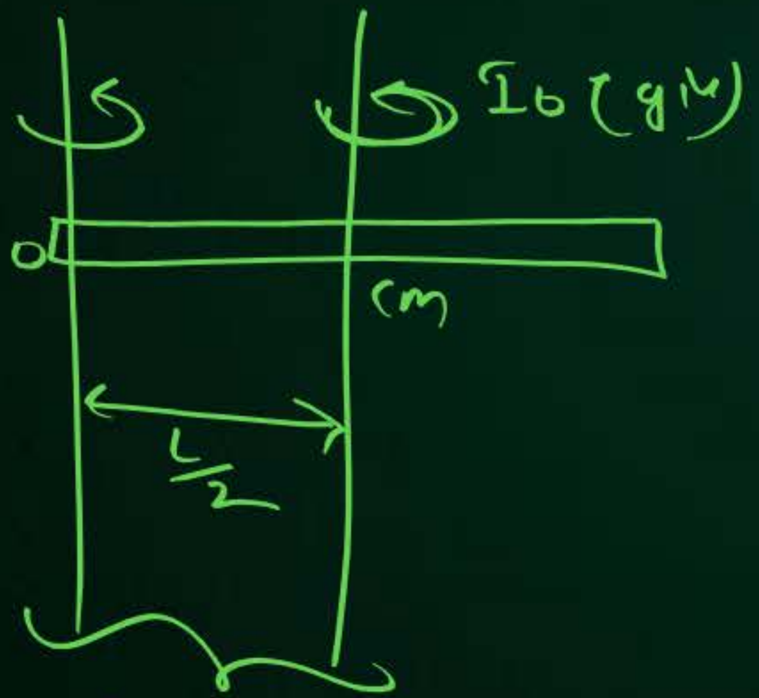


QUESTION

The moment of inertia of a thin uniform rod of mass M and length L about an axis passing through its midpoint and perpendicular to its length is I_0. Its moment of inertia about an axis passing through one of its ends and perpendicular to its length is

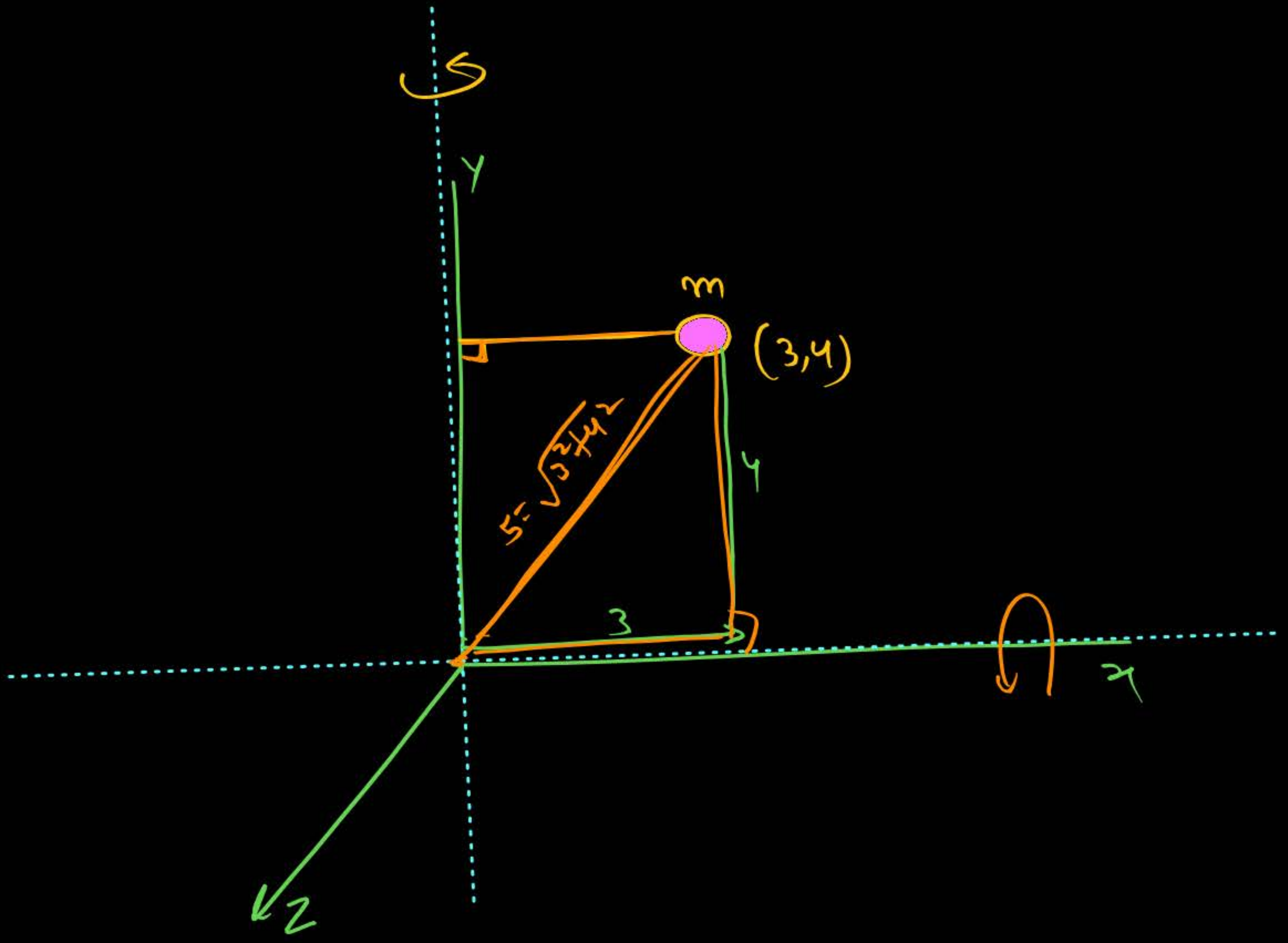
[AIPMT Pre. 2011]

1. $I_0 + ML^2/2$
2. $I_0 + ML^2/4$
3. $I_0 + 2ML^2$
4. $I_0 + ML^2$



$I'_0 = I_{cm} + m\left(\frac{L}{2}\right)^2$

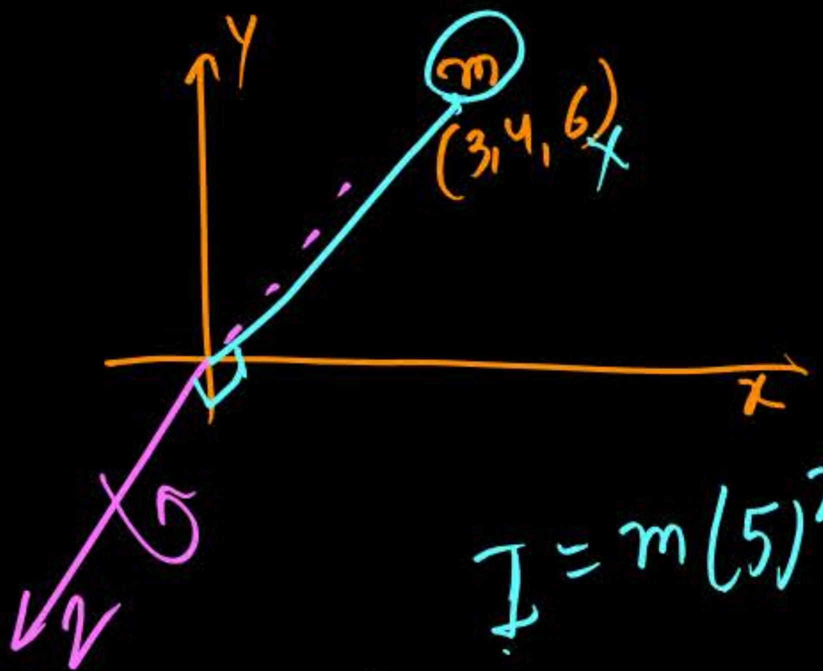
$I'_0 = I_0 + \frac{mL^2}{4}$



$$I_{y\text{-axis}} = m(3)^2$$

$$I_{x\text{-axis}} = m(4)^2$$

$$I_{z\text{-axis}} = m(5)^2$$



$$I = m(5)^2$$ ✓

QUESTION

A particle of mass 1 kg is kept at (1 m, 1 m, 1 m). The moment of inertia of this particle about z - axis would be [JEE Main]

1. $1\ kg - m^2$
2. $2\ kg - m^2$
3. $3\ kg - m^2$
4. None of these

$I = 1kg\left(\sqrt{x^2+y^2}\right)^2$

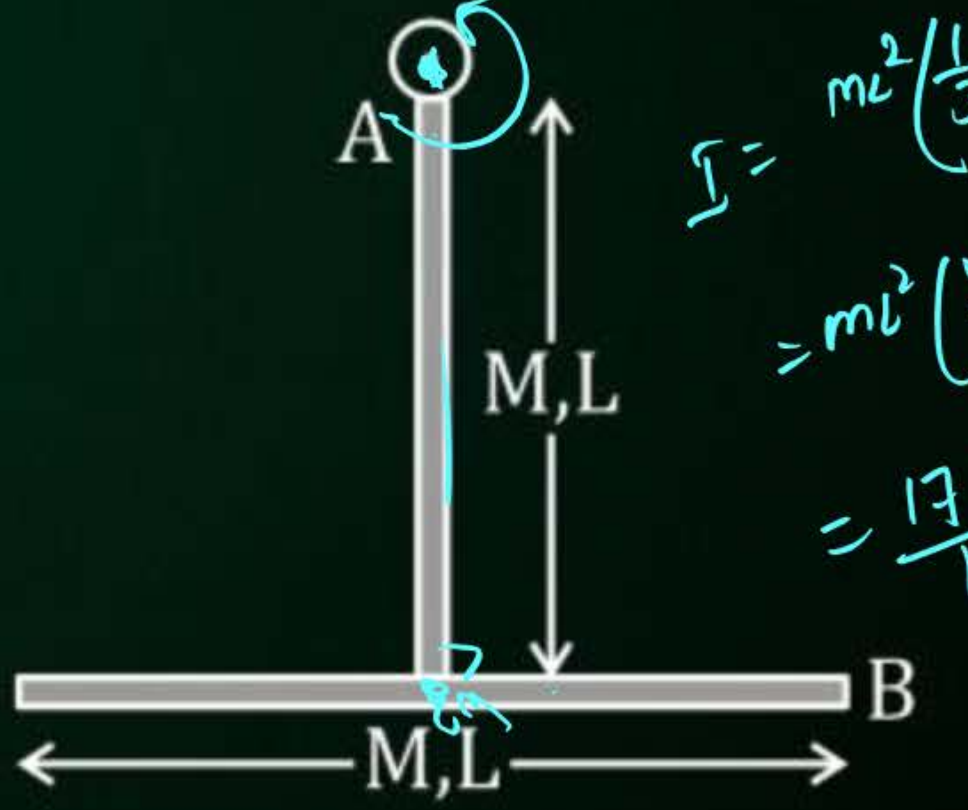
$= 1\left(\sqrt{2}\right)^2$

$= 2\ kg\text{-}m$

QUESTION

A T is joint is formed by two identical rods A and B each of mass m and length L in the XY plane as shown. Its moment of inertia about axis passing through end of rod perpendicular to the plane of the joint.

1. $\frac{2mL^2}{3}$
2. $\frac{mL^2}{12}$
3. $\frac{mL^2}{6}$
4. None of these



QUESTION

Four identical thin rods each of mass M and length l form a square frame. Moment of inertia of this frame about an axis through the center of the square and perpendicular to its plane is

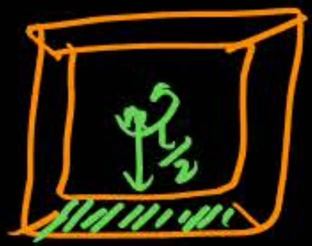
[AIPMT 2009]

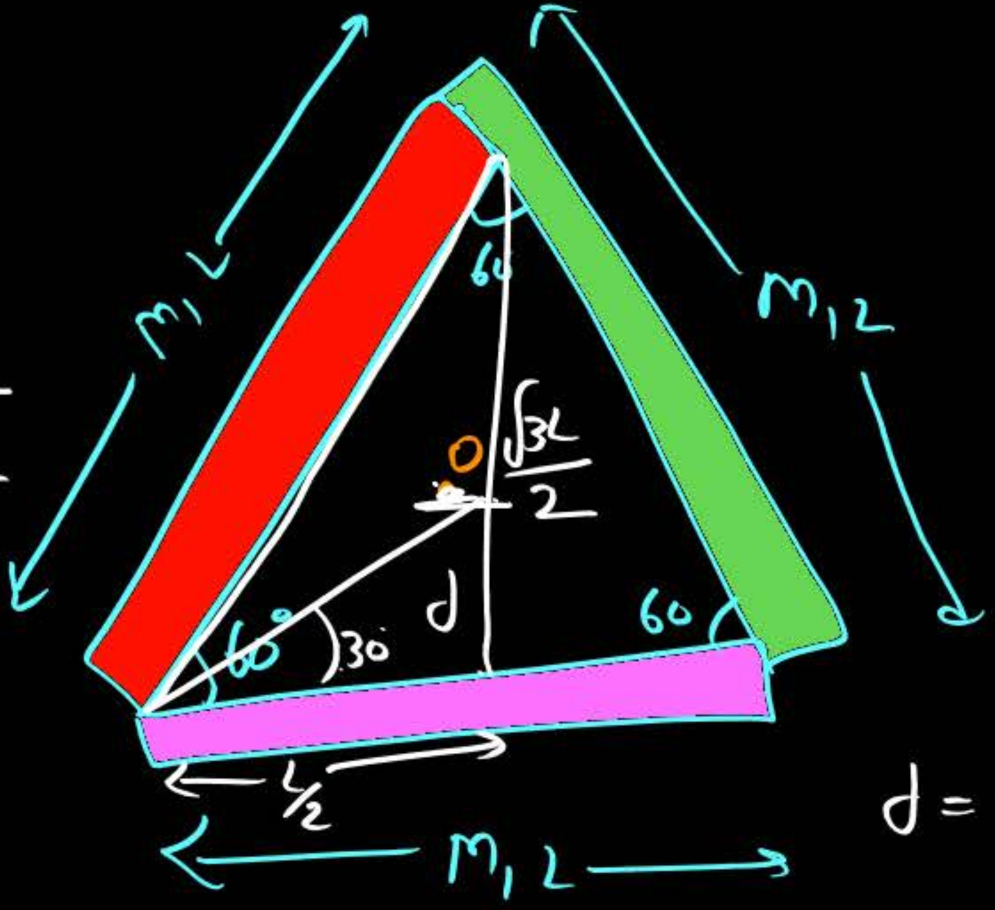
(1) $\frac{1}{3}Ml^2$

(2) $\frac{4}{3}Ml^2$

(3) $\frac{2}{3}Ml^2$

(4) $\frac{13}{3}Ml^2$



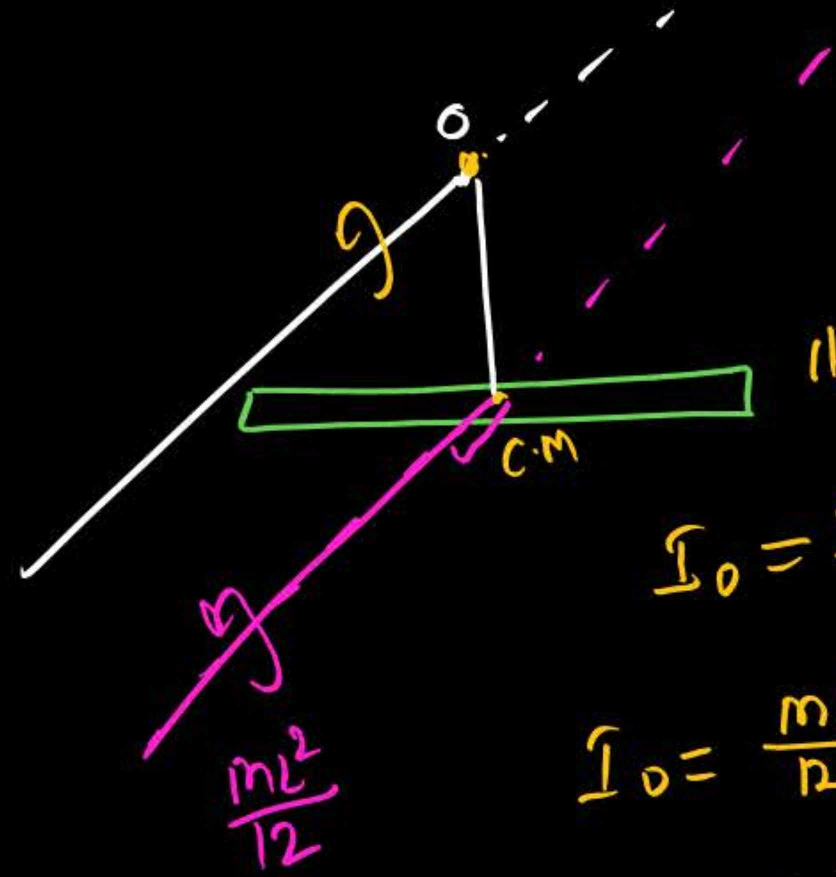


$\tan 30 = \frac{d}{L/2}$

$$\boxed{d = \frac{L}{2} \times \frac{1}{\sqrt{3}}}$$

$$d = \frac{1}{3}\left(\frac{\sqrt{3}L}{2}\right) = \frac{L}{\sqrt{3}\times 2}$$

find m.o.I about c.o.m of system ⊥r to plane ??



∥r axis thm for 1-Rod

$$I_0 = I_{cm} + md^2$$

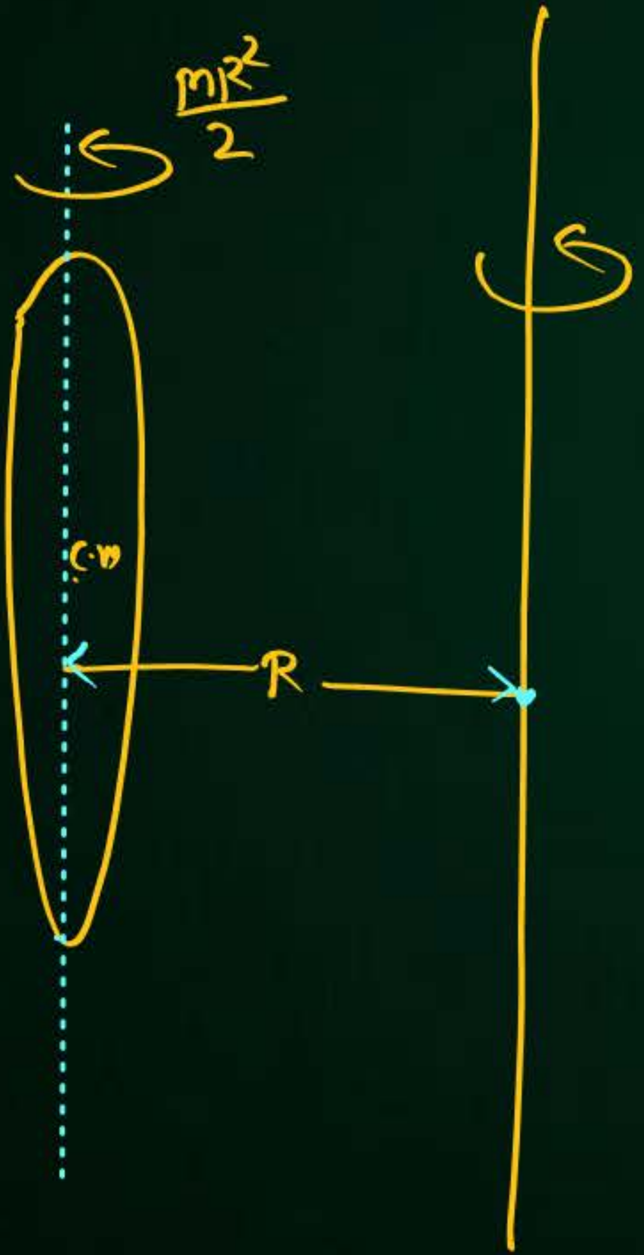
$$I_0 = \frac{mL^2}{12} + m\left(\frac{L}{2\sqrt{3}}\right)^2$$

$$= mL^2\left(\frac{1}{12} + \frac{1}{12}\right) = \frac{mL^2}{6}$$

$$I = 3I_{1Rod} = 3\left(\frac{mL^2}{6}\right) = \frac{mL^2}{2}$$

QUESTION

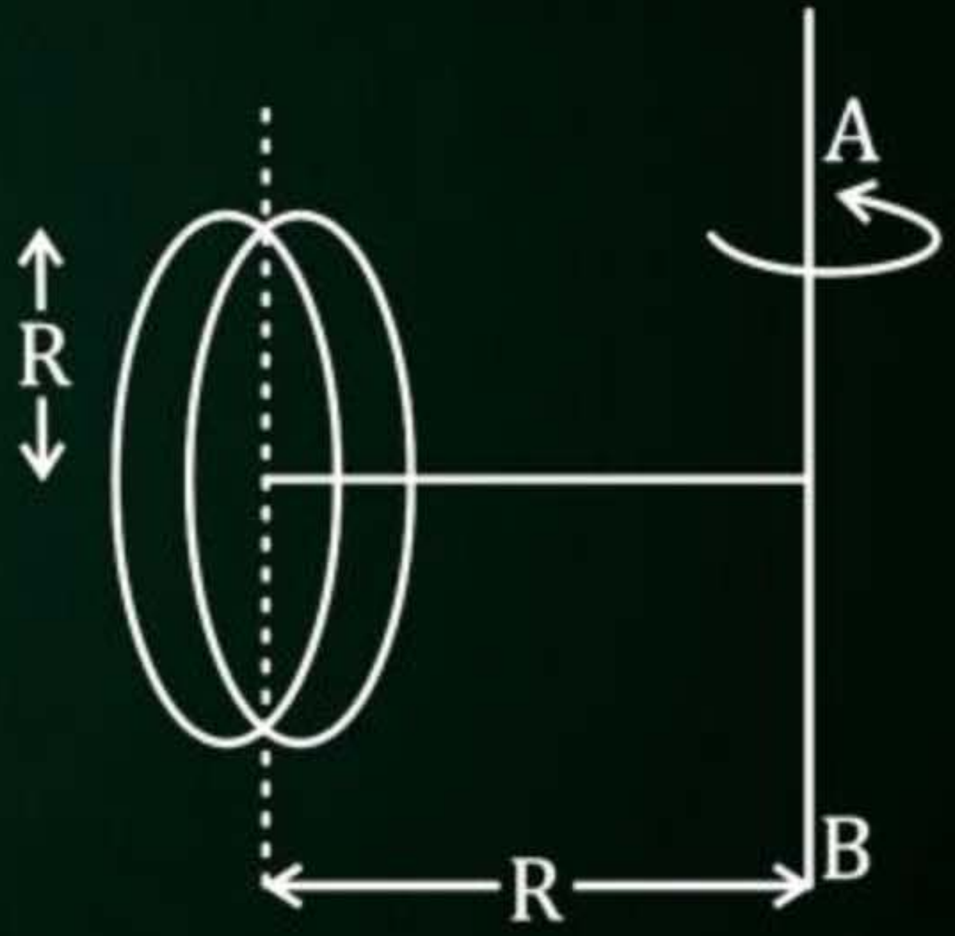
Find the moment of inertia of the ring shown in figure about the axis AB.



$\parallel_r$ axis th^m

$$I_0 = I_{cm} + md^2$$

$$= \frac{mR^2}{2} + mR^2$$



Ring, Disc, Hollow spr, solid spr all have same mass and Radius then arrange their m.o.I ??



Ring	Disc	Hollow sphere	Solid sphere
MR^2	$\frac{MR^2}{2}$	$\frac{2}{3}mR^2$ (H/spr)	$\frac{2}{5}mR^2 = 0.4mR^2$ (S/spr)
mR^2	$0.5mR^2$	$0.66\,mR^2$	

$$I_{solid\ spr} < I_{disc} < I_{Hollow\ spr} < I_{Ring}$$

QUESTION

Three objects A : (a solid sphere), B : (a thin circular disk) and C : (a circular ring), each have the same mass M and radius R. They all spin with the same angular speed ω about their own symmetry axes. The amounts of work (W) required to bring them to rest, would satisfy the relation [NEET 2018]

1. $W_C > W_B > W_A$
2. $W_A > W_B > W_C$
3. $W_B > W_A > W_C$
4. $W_A > W_C > W_B$

QUESTION

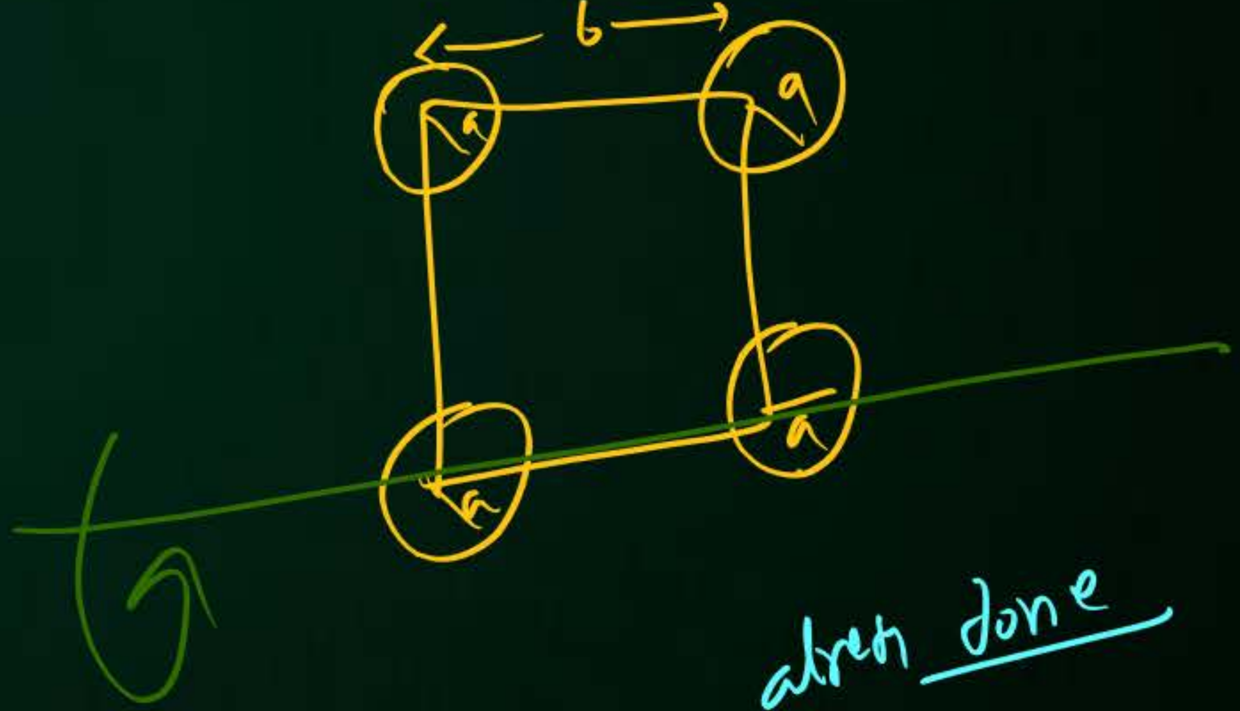
Four spheres of diameter $2a$ and mass M are placed with their centers on the four corners of a square of side b. The moment of inertia of the system about an axis about one of the sides of the square is

1. $Ma^2 + 2Mb^2$

2. Ma^2

3. $Ma^2 + 4Mb^2$

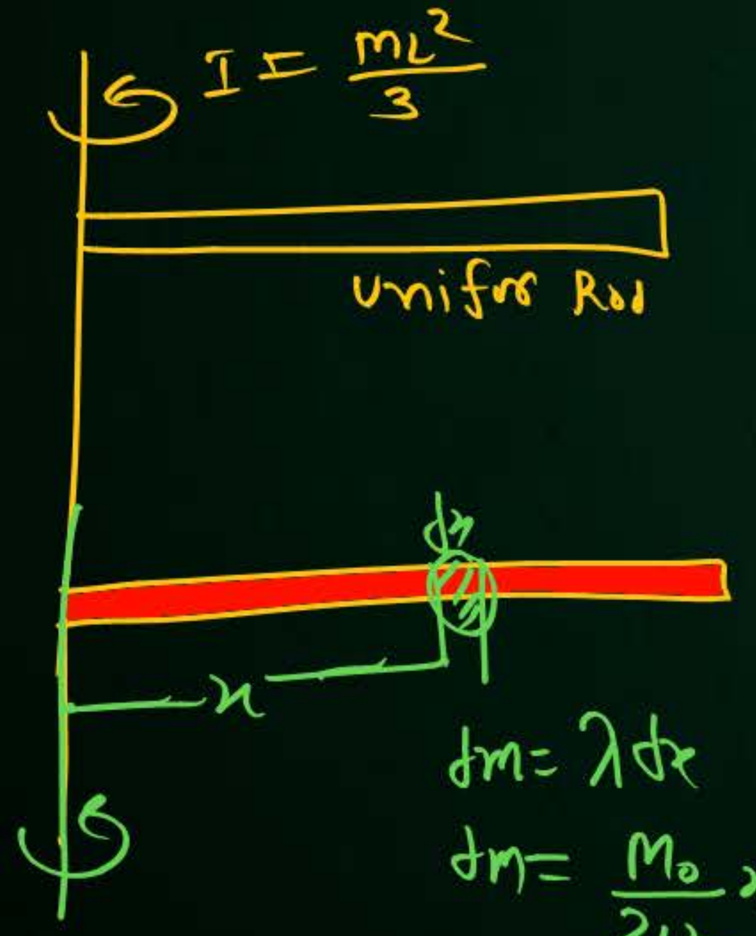
4. $\frac{8}{5}Ma^2 + 2Mb^2$



alrem done

QUESTION

The mass density of a rod at a distance x from its end is $\frac{M_0}{2L^2}x$. What is the MOI of the rod of length L about an axis passing through the end of the rod & perpendicular to the rod.



$dm = \lambda\, dx$

$dm = \frac{M_0}{2L^2} x\, dx$

$\lambda = \frac{M_0}{2L^2} x$

verify

$dI = x^2\, dm$

$dI = x^2 \left[\frac{M_0}{2L^2} x\, dx\right]$

$\int dI = \frac{M_0}{2L^2} \int x^3\, dx$

$I = \frac{M_0}{2L^2} \left[\frac{x^4}{4}\right]_0^L = \frac{M_0 L^2}{8}$ Ans


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 05 | **Physics**

Rotational Motion



By- Dr. Manish Raj (MR SIR)

Topics to be covered

1 # H/W

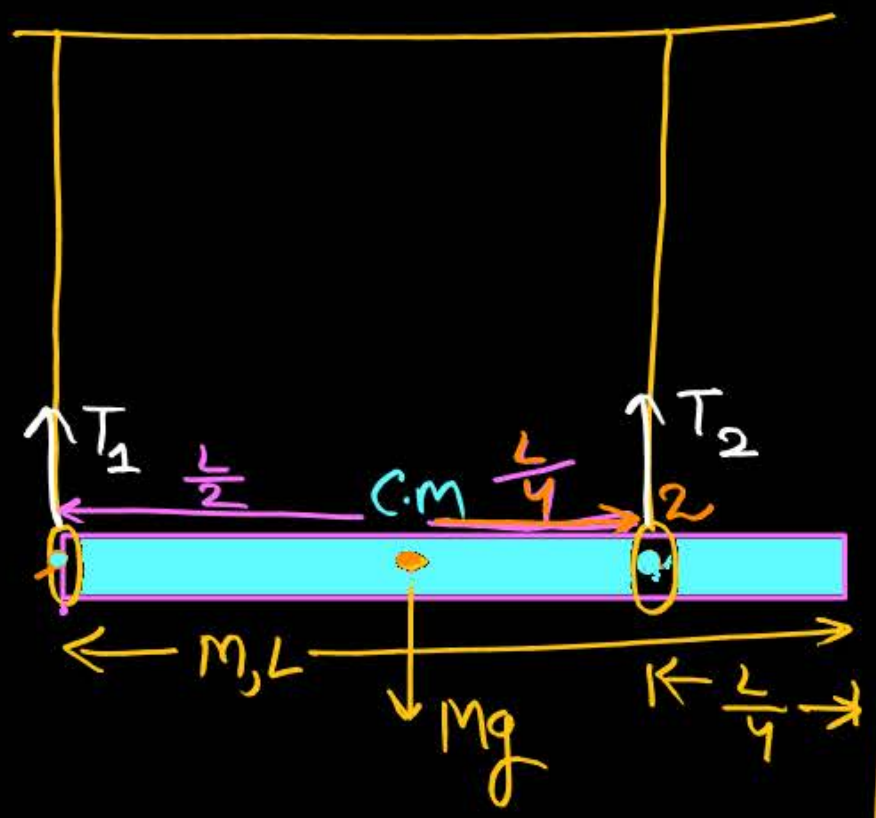
2 # Rotational Kinematics & Dynamics

3 #

4 #



find T_1 & T_2



[for translational equilibrium

$$T_1 + T_2 = mg \quad -(1)$$]

2nd method

$$\tau_2 = 0$$

$$\tau_{(T_2)} = 0$$

$$\frac{L}{4} mg \odot + T_1 \frac{3L}{4} \otimes = 0$$

$$T_1 \frac{3L}{4} = mg \frac{L}{4}$$

$$T_1 = \frac{mg}{3} \quad \text{Ans}$$

If I take

torque ($\tau_{c.m.} = 0$) about c.o.m

my root $T_1 \frac{L}{2} \otimes + \frac{T_2 L}{4} \odot = 0$

$$T_1 \frac{L}{2} = \frac{T_2 L}{4}$$

$$2T_1 = T_2 \quad -(II)$$

Putting value of T_2 in eqn (1)

$$T_1 + 2T_1 = mg$$

$$3T_1 = mg$$

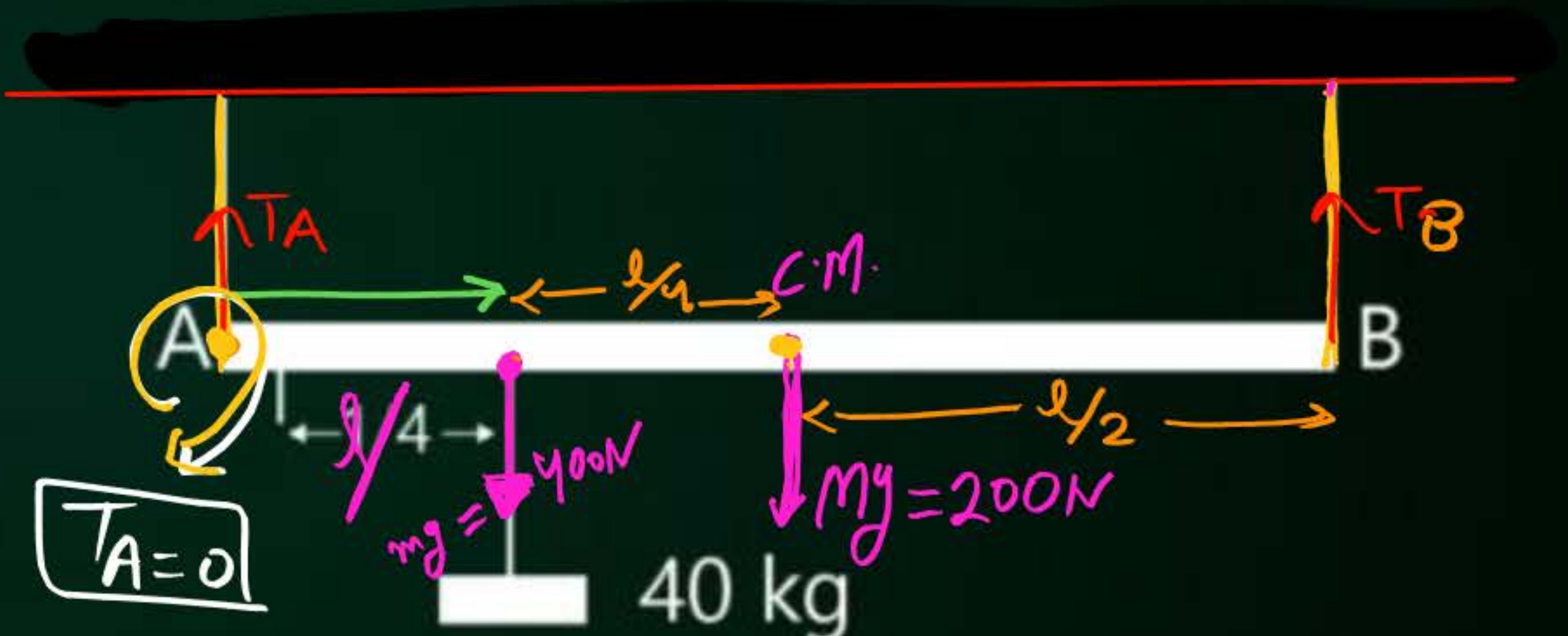
$$T_1 = \frac{mg}{3}$$

$$T_2 = \frac{2mg}{3}$$

QUESTION

A uniform rod of 20 kg is hanging in a horizontal position with the help of two threads. It also supports a 40-kg mass as shown in the figure. Find the tensions developed in each thread.

⟹ four force is acting ✓



Transl^n eq^n

$T_A + T_B = 400 + 200N$

$T_A + 200 = 600$

$T_A = 600 - 200 = 400N$

$T_A \times 0 + 400 \times \frac{l}{4} + 200 \times \frac{l}{2} - T_B \times l = 0$

$100 + 100 = T_B$

$T_B = 200N$

QUESTION

Find torque acting on disc about 'O'.

$(\tau_{net})_O = ??$

- $\tau_1 = FR$ ⊗

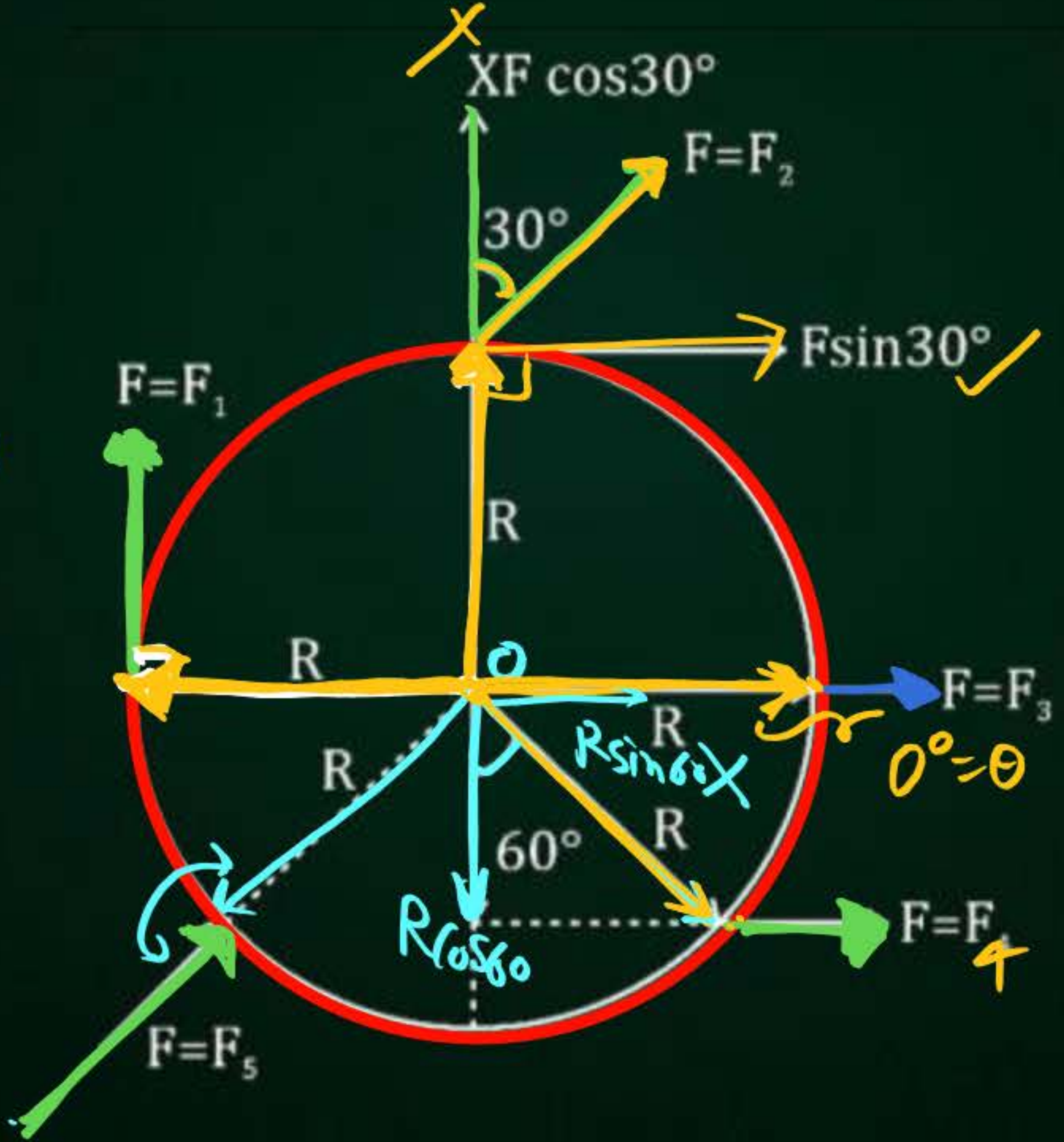
$\tau_2 = RF\sin 30^\circ = \frac{FR}{2}$ ⊗

$\tau_3 = 0$

$\tau_4 = FR\cos 60^\circ = \frac{FR}{2}$ ⊙

$\tau_5 = 0$

$\tau_{net} = FR$

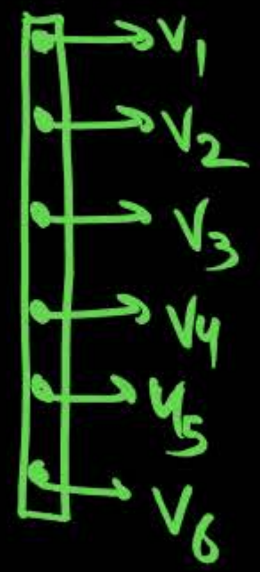


जिसके about torque निकालना है।

head वहाँ होगा जहाँ force लग रहा है।

Translational motⁿ

→ When all the Particle | Point of rigid body moving with same velocity then body is in Pure Translational motion.



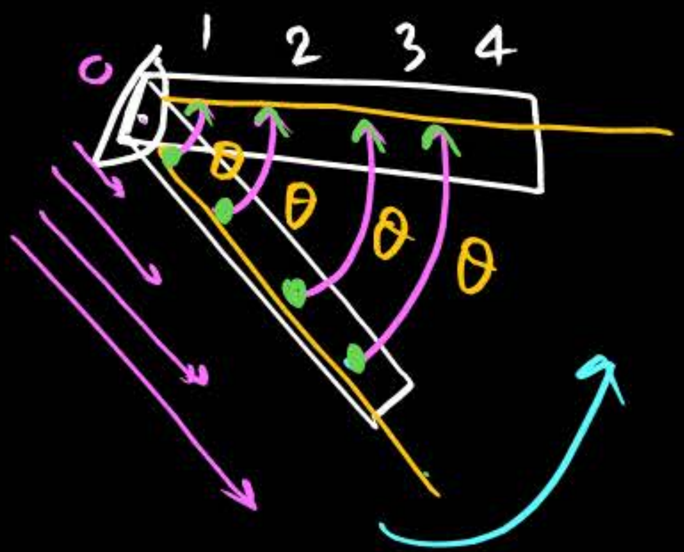
$\{ v_1 = v_2 = v_3 = v_4 = v_5 = v_6 \}$

• Circular motⁿ

→ A Particle moving on the circumference of circle

Pure Rotational motⁿ

When all the Particle | Point of rigid body is moving on a circular path of different radius but about a common centre with same angular speed & diffⁿ linear velocity. Axis of Rotⁿ will pass through that common centre.



$\{ \omega_1 = \omega_2 = \omega_3 = \omega_4 \}$

$v_1 \neq v_2 \neq v_3 \neq v_4$

$V = r\omega$

Speed ↑ diffⁿ ↑ Same

Rolling motⁿ → Combine Tralⁿ + Rotⁿ

Translational Motion

- displacement → S
- Velocity → $\vec{V} = \frac{ds}{dt}$
- Acceleration → $a = \frac{dv}{dt}$
- Force → $\vec{F} = \frac{d\vec{p}}{dt} = m\vec{a}$
- Momentum ($\vec{p}$) = mv
- work = F.S. = $\int$ F. ds.

Angular disp^n (θ)

$\vec{\omega} = \frac{d\theta}{dt}$

$\alpha = \frac{d\omega}{dt}$

$\vec{\tau} = I\vec{\alpha} = \frac{dL}{dt}$ ← Angular momentum

$L = I\vec{\omega}$

$W = \vec{\tau} \cdot \vec{\theta} = \int \tau \, d\theta$

- K.E. = $\frac{1}{2}mv^2 = \frac{P^2}{2m}$

$K.E = \frac{1}{2}I\omega^2 = \frac{L^2}{2I}$

- Power P = $\vec{F}.\vec{V}. = \frac{F.S}{T} = \frac{W}{T}$

$P = \vec{\tau} \cdot \vec{\omega}$

- impulse = $m\Delta\vec{v} = \int F \, . \, dt$ ⇒

ΔL = Angular Impulse = $I\Delta\omega$

Rotational Motion

- angular displacement $\rightarrow \theta$
- angular velocity $\rightarrow w = \frac{d\theta}{dt}$
- angular acceleration $\rightarrow \propto = \frac{dw}{dt}$
- angular force (torque) $\rightarrow \tau = I \propto = \frac{dL}{dt}$
- angular momentum $= L = I\omega$
- work $= \tau . \theta = \int \tau \, d\theta$

- K.E. $= \frac{1}{2} I w^2 = L^2/2I$
- Power $P = \vec{\tau} . \vec{w} = \frac{\tau . \theta}{T}$
- impulse $= \Delta L = I \Delta w = \int \tau . dt.$

Equation of Motion ($\vec{a}$ = const.)

- $\vec{S} = \vec{u}t + \frac{1}{2}\vec{a}t^2$
- $\vec{v} = \vec{u} + \vec{a}t$
- $v^2 = u^2 + 2as$
- $S_n\text{th} = u + \frac{a}{2}(2n - 1)$
- * $S = \left(\frac{u+v}{2}\right)T$
- $S = \frac{1}{2}\left(\frac{\alpha\beta}{\alpha+\beta}\right)T^2$ (rest to rest)

$v_{max} = \frac{\alpha\beta}{\alpha+\beta}T$

$\vec{F}_{ext} = \frac{d\vec{P}}{dt}$

$S(\text{stopping}) = \frac{u^2}{2a}$

Motion starts from rest & const^n acc^n

$S_{1st} : S_{2nd\,sec} : S_{3rd\,sec} = 1:3:5:7:9$

$S_{1s} : S_{2sec} : S_{3sec} = 1:4:9:16$

$\alpha = \text{const}^n$

$\vec{\omega}_f = \vec{\omega}_i + \alpha t$

$\theta = \omega_i t + \frac{1}{2}\alpha t^2$

$\theta_{nth} = \omega_i + \frac{\alpha}{2}(2n-1)$

$\theta_{\text{stopping Angle}} = \frac{\omega_i^2}{2\alpha}$

Rest to Rest^n

α = Angul acc^n

β = Angu Ret^n.

$\theta = \frac{1}{2}\frac{\alpha\beta}{\alpha+\beta}T^2$

$\theta = \left(\frac{\omega_i + \omega_f}{2}\right)T$ (α = const)

$$u_{mid} = \sqrt{\frac{u_i^2 + u_f^2}{2}}$$

$$\vec{\omega}_{mid} = \sqrt{\frac{\omega_i^2 + \omega_f^2}{2}}$$

#

$\alpha = \text{const}$

$$\vec{\omega}_{Avg} = \frac{\vec{\omega}_i + \vec{\omega}_f}{2}$$

$\alpha = \text{const}$

$a = \text{const}$

$$\vec{V}_{Avg} = \frac{\vec{u}_i + \vec{V}_f}{2}$$

QUESTION

Object starts from rest and constant angular acceleration then ratio of angle?

$\theta_{1sec} : \theta_{2sec} : \theta_{3sec} = 1 : 4 : 9 : 16 : x$

$\theta_{1^{st}} : \theta_{2^{nd}} : \theta_{3^{rd}} = 1 : 3 : 5 : 7 : 9 : 11$

लिखना मत

Pen नीचे रख दो

QUESTION

What is the angular acceleration of a particle if the angular velocity of a particle becomes 4 times of its initial angular velocity 1 rad/s in 2 seconds?

$\omega_i = 1$ rad/se

$t = 2$ sec

$* \omega_f = 4$ rad/sec

$$\alpha = \frac{\omega_f - \omega_i}{t}$$

$$= \frac{4-1}{2}$$

$$\alpha = \frac{3}{2} \text{ rad/s}^2$$

QUESTION

A particle moving with an angular velocity of 200 rad S^{-1}, starts de-accelerating at a rate of 2 rad s^{-2}. Calculate the time in which it will come to rest.

$\omega = 200$ rad/s

$\alpha = -2$ rad/s^2

$\omega_f = \omega_i + \alpha t$

$0 = 200 - 2t$

$t = 100$ sec

QUESTION

A fan is rotating with a speed of 450 rev/minute. After being switched off it comes to rest in 10s. Assuming constant angular deceleration, calculate the number of revolutions made by it before coming to rest.

$f = 450\ rev/mint$

$f = 450\ rev / 60\ sec$

$f = \frac{450\ revs}{60}$

$f = \frac{15}{2}\ Hz$

$\omega_i = 2\pi f = 2\pi \frac{15}{2} = 15\pi$

$\omega_f = 0$

$\omega_f = 0$

$T = 10\ sec$

$\theta = \left(\frac{\omega_i + \omega_f}{2}\right) T$

$= \left(\frac{15\pi + 0}{2}\right) \times 10$

$\theta = 75\pi = n 2\pi$

$no.\ of\ Rot^n = \frac{75\pi}{2\pi} = 37.5$

QUESTION

A disc rotating about its axis from rest, acquires the angular speed 100 reve/s in 4 second. The angle rotated by it during these four seconds (in radian) is

1. 100π
2. 200π
3. 300π
4. 400π

$\omega_i = 0$

$f = 100$ rev/sec

$\omega = 2\pi f$

$= 2\pi 100$

$\theta = \left(\frac{\omega_i + \omega_f}{2}\right) T$

$= \left(\frac{0 + 2\pi \times 100}{2}\right) 4$

$= 400\pi$

QUESTION

The instantaneous angular position of a point on a rotating wheel is given by the equation $\theta(t) = 2t^3 - 6t^2$. The torque on the wheel becomes zero at:-

[AIPMT Pre. 2011]

1. $t = 1s$
2. $t = 0.5\ s$
3. $t = 0.25\ s$
4. $t = 2s$

$\theta = 2t^3 - 6t^2$

$\omega = \frac{d\theta}{dt} = 2(3t^2) - 12t$

$\omega = 6t^2 - 12t$

$\alpha = \frac{d\omega}{dt} = 12t - 12 = 0$

$12t = 12$

$t = 1s.$

$\tau = I\alpha = 0$

QUESTION

A body rotating with uniform angular acceleration covers 100π (radian) in the first 5 s after the start. Its angular speed at the end of 5 s (in radian/s) is

1. 40π
2. 30π
3. 20π
4. 10π

$\alpha = \text{const}$

$\omega_i = 0$

$$\theta = \omega_i t + \frac{1}{2}\alpha t^2$$

$$100\pi = 0 + \frac{1}{2}\alpha (5)^2$$

$$100\pi = \frac{1}{2}\alpha\, 25$$

$$8\pi = \alpha \quad (1)$$

$$\omega_f = \omega_i + \alpha t$$

$$= 8\pi \times 5$$

$$\omega_f = 40\pi$$

$$\theta = \left(\frac{\omega_i + \omega_f}{2}\right) \times T$$

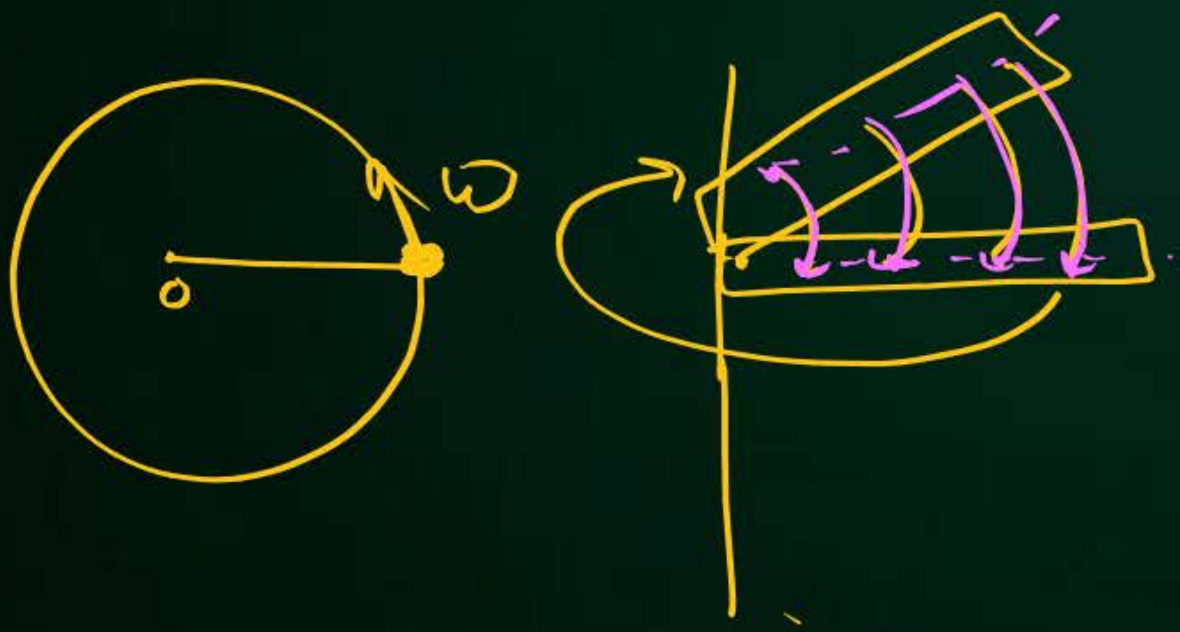
$$100\pi = \left(\frac{0 + \omega_f}{2}\right) 5$$

$$40\pi = \omega_f$$

QUESTION

A body rotates about a fixed axis with an angular acceleration of 3 rad/s^2. The angle rotated by it during the time when its angular velocity increases from 10 rad/s to 20 rad/s (in radian) is

1. 50
2. 100
3. 150
4. 200



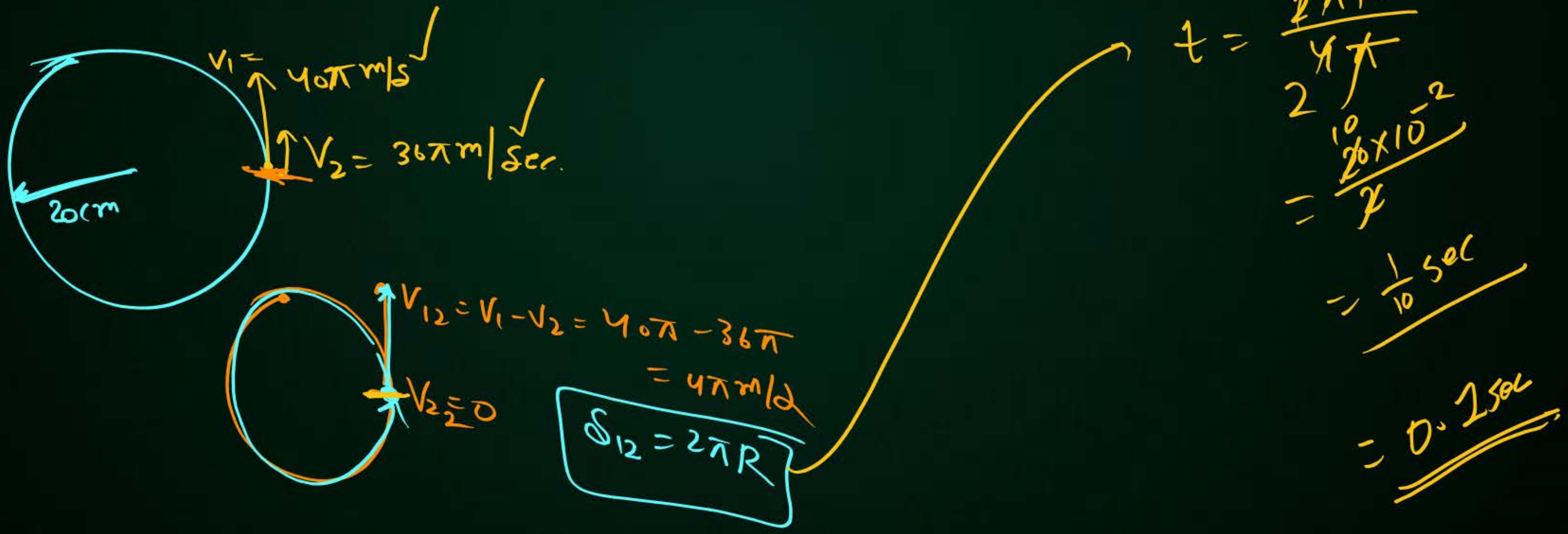
QUESTION

A wheel starting from rest is uniformly accelerated at 2 rad/s^2 for 20 seconds. It is allowed to rotate uniformly for the next 10 seconds and is finally brought to rest in next 20 seconds. The total angle rotated by the wheel (in radian) is

1. 600
2. 1200
3. 1800
4. 300

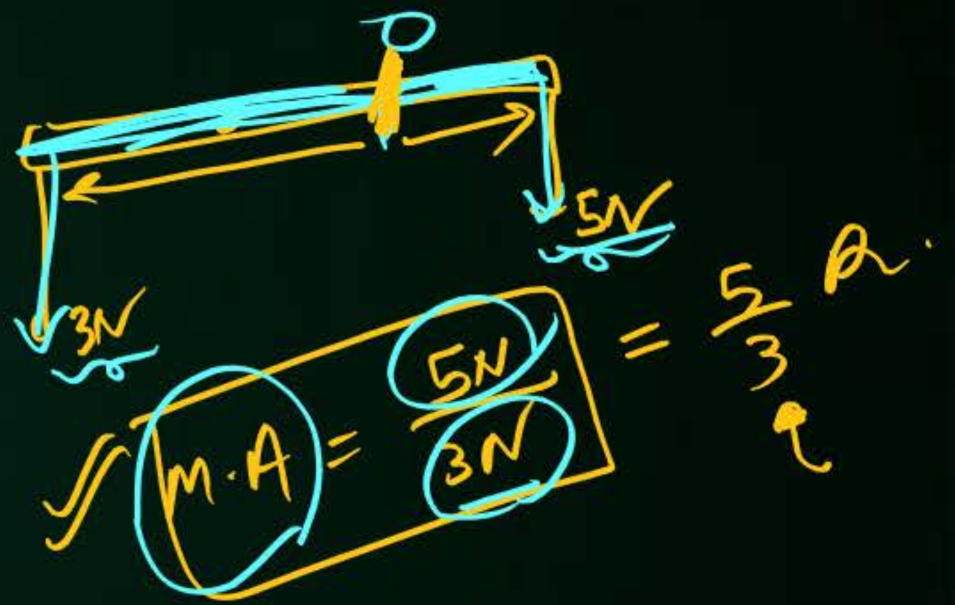
QUESTION

Two particles start moving from same position on a circle of radius 20 cm with speed 40π m/s and 36π m/s respectively in the same direction. Find the time after which the particles will meet again.



QUESTION

If the parallel forces acting on a lever are in the ratio 3 : 5 then what is the mechanical advantage of the lever ?



QUESTION

The grinding stone of a flour mill is rotating at 600 rad/sec, for this power is 1.2 k watt Is used. The effective torque on stone in N-m will be

86%

1. 1
2. 2 ✓
3. 3
4. 4

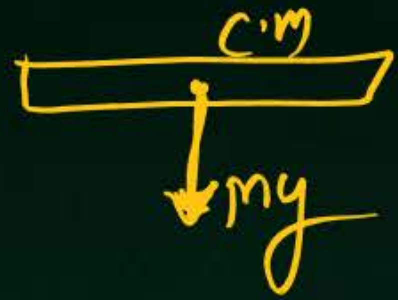
$P = \tau \cdot \omega$

$1.2 \times 10^3 = \tau\, 600$

$1200 = \tau\, 600$

$\tau = 2$

QUESTION



Which of the following statements are correct ?

(1) Centre of mass of a body always coincides with the centre of gravity of the body.

(2) Centre of mass of a body is the point at which the total gravitational torque on the body is zero.

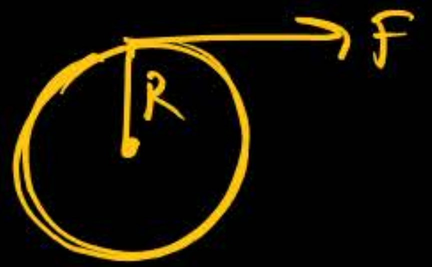
(3) A couple on a body produce both translational and rotational motion in a body.

(4) Mechanical advantage greater than one means that small effort can be used to lift a large load.

[NEET-2017]

1. (2) and (4)
2. (1) and (2)
3. (2) and (3)
4. (3) and (4)

questions on Rotational dynamics



$$\tau = I\alpha$$

$$\alpha = \tau / I$$

Basic Torque

(M.O.I)



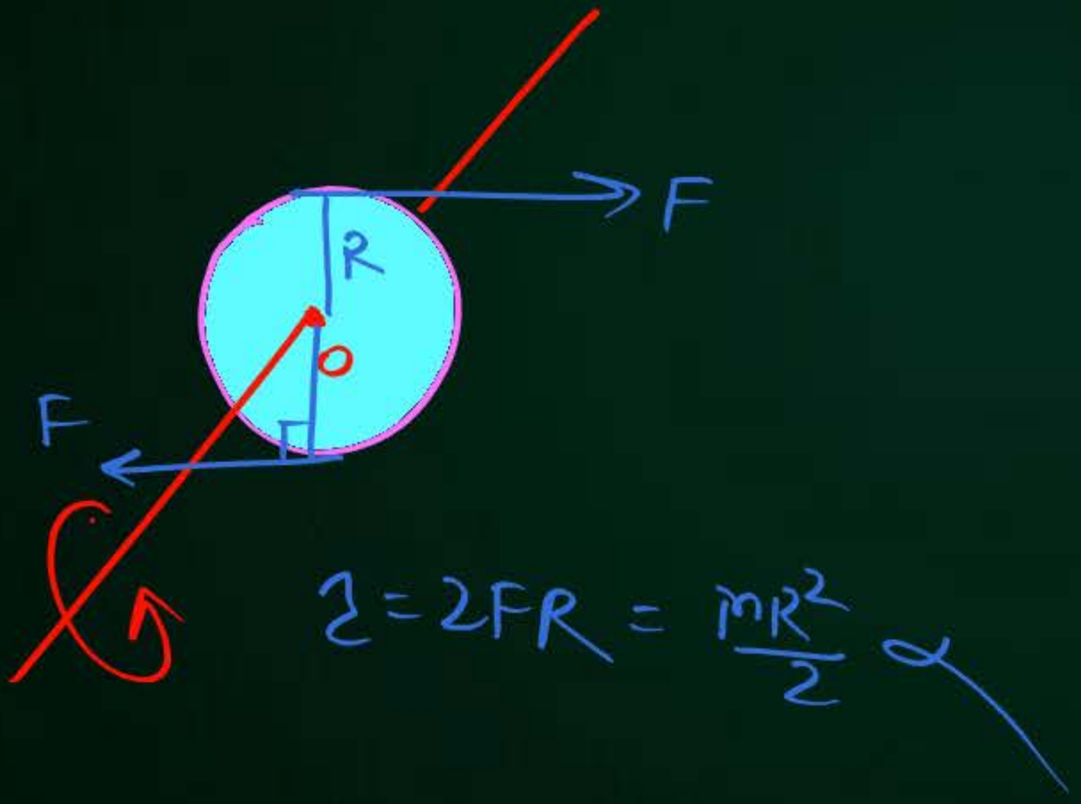
$$a = \frac{F}{m} = \frac{20}{5} = 4\, m/s^2$$

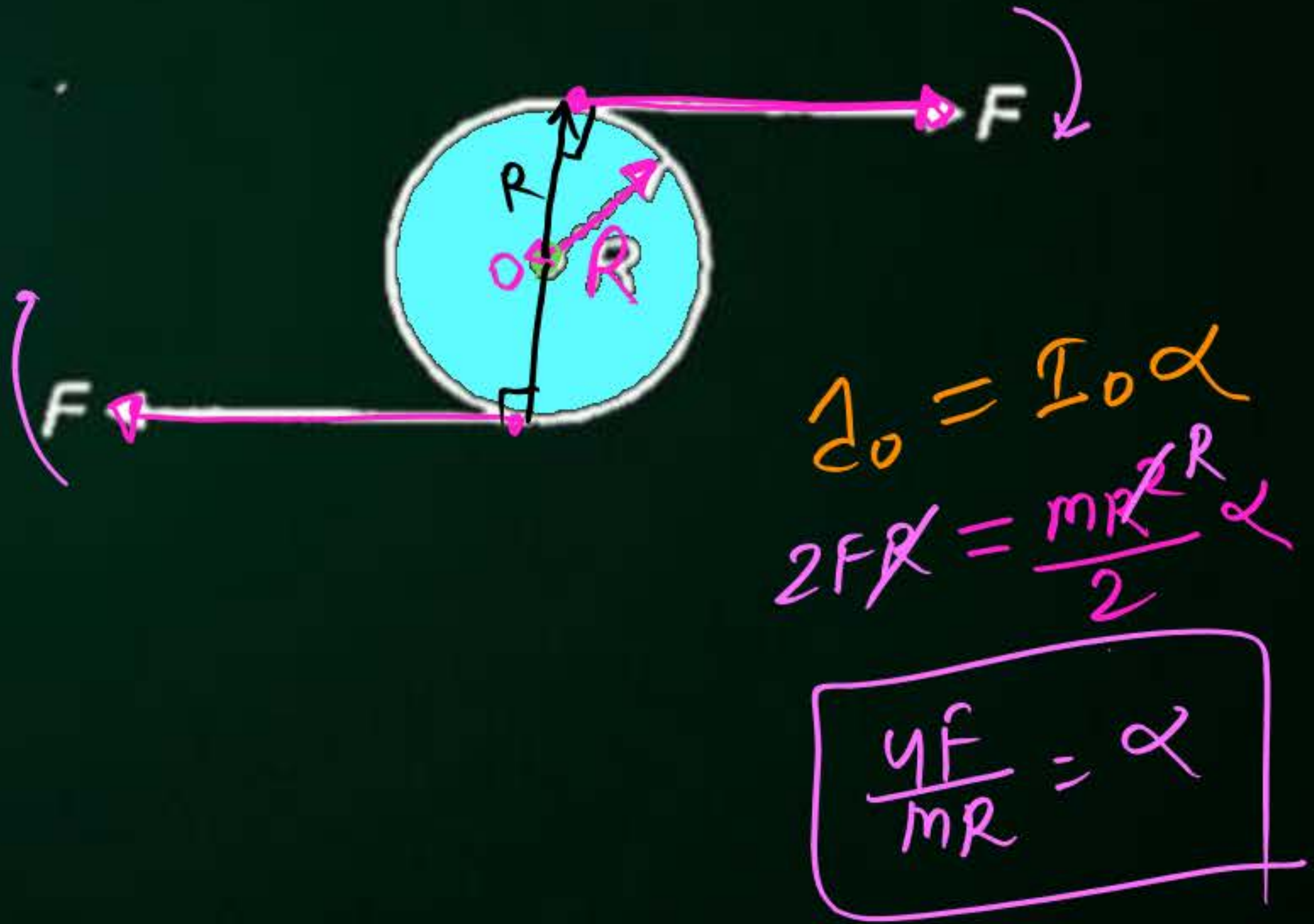


QUESTION

Two equal and opposite forces are applied tangentially to a uniform disc of mass M and radius R as shown in the figure. If the disc is pivoted at its center and free to rotate in its plane, the angular acceleration of the disc is

1. $\frac{F}{MR}$
2. $\frac{2F}{3MR}$
3. $\frac{4F}{MR}$
4. zero





QUESTION

A wheel having moment of inertia $4\ \text{kg m}^2$ about its symmetrical axis, rotates at rate of 240 rpm about it. The torque which can stop the rotation of the wheel in one minute is

1. $\frac{5\pi}{7}$ Nm
2. $\frac{8\pi}{15}$ Nm (Ans)
3. $\frac{2\pi}{9}$ Nm
4. $\frac{3\pi}{7}$ Nm

$f = 240$ rpm

$= \frac{240}{60}$ rps

$f = 4$ rps

$\omega = 2\pi(f)$

$\omega_i = 8\pi$

$\omega_f = 0$

$\alpha = \frac{\omega_f - \omega_i}{\Delta t}$

$\alpha = \frac{0 - 8\pi}{60}$

$\alpha = -\frac{8\pi}{60}$

$\tau = I\alpha$

$= 4 \times \frac{8\pi}{60}$

$= \frac{8\pi}{15}$ Nm

QUESTION

JEE main

A wheel has moment of inertia 5×10^{-3} kg m^2 and is making 20 rev/sec. The torque needed to stop it in 10 sec is.......... $\times 10^{-2}$ N-m :

1. 2π
2. 2.5π
3. 4π
4. 4.5π

$I = 5 \times 10^{-3}$ kg m^2

$f = 20$ rev/sec

$\omega_i = 2\pi f$

$\omega_i = 40\pi$

$t = 10$ sec

$\omega_f = 0$

$\alpha = \frac{0 - 40\pi}{10} = -4\pi$

$\tau = I\alpha$

$= 5 \times 10^{-3} \times (-4\pi)$

$= 20\pi \times 10^{-3}$

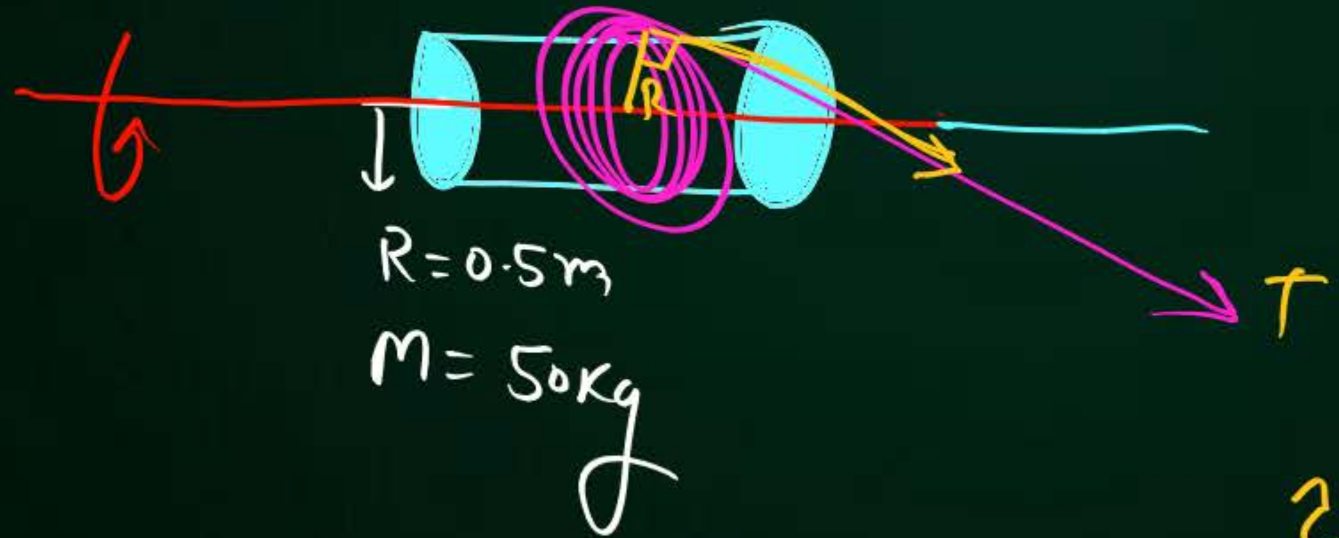
$= 2\pi \times 10^{-2}$

QUESTION



A solid cylinder of mass 50 kg and radius 0.5 m is free to rotate about the horizontal axis. A massless string is wound round the cylinder with one end attached to it and other hanging freely. Tension in the string required to produce an angular acceleration of 2 revolutions S^{-2} is : [AIPMT 2014]

1. 25 N
2. 50 N
3. 78.5 N
4. 157 N



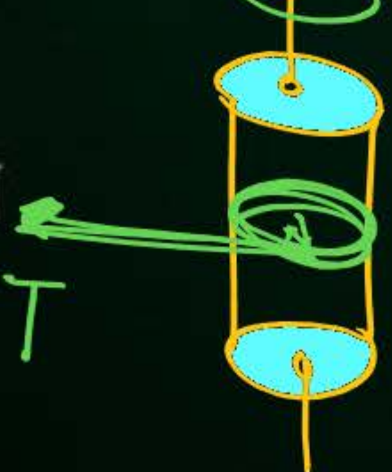


QUESTION

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1. 25 N
2. 50 N
3. 78.5 N
4. 157 N





$I = \frac{MR^2}{2} = \frac{50 \times 1}{2 \times 4} = \frac{50}{8}$

$\tau = TR = I\alpha$

$TR = \frac{50}{8} \times 2(2\pi)$

$T \frac{1}{2} = \frac{50}{8} \times 2 \times 2\pi$

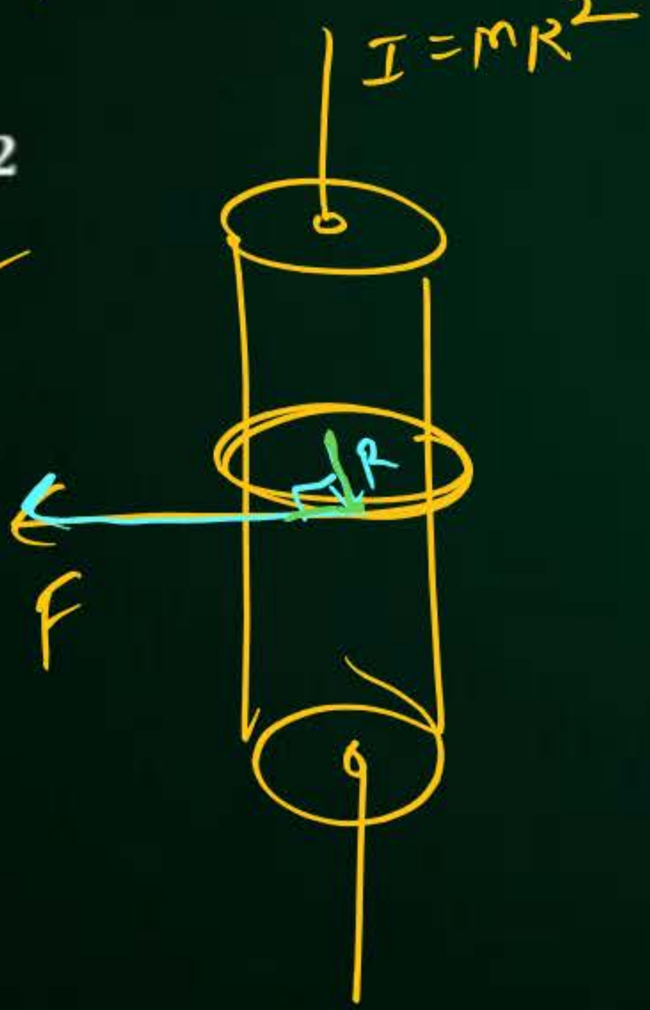
$T = 50\pi = 50 \times 3.14$

QUESTION

A rope is wound around a hollow cylinder of mass 3 kg and radius 40 cm. What is the angular acceleration of the cylinder if the rope is pulled with a force of 30 N?

[NEET - 2017]

1. 25 m/s^2
2. 0.25 rad/s^2
3. 25 rad/s^2
4. 5 m/s^2



$\tau = I\alpha$

$FR = MR^2\alpha$

$30 = MR\alpha$

$\alpha = \frac{30}{MR} = \frac{30}{3 \times \frac{40}{100}} = \frac{300}{3 \times 4} = 25$

QUESTION

A uniform circular disc of radius 50 cm at rest is free to turn about an axis which is perpendicular to its plane and passes through its center. It is subjected to a torque which produces a constant angular acceleration of 2.0 rad s^{-2}. Its net acceleration in ms^{-2} at the end of 2.0 s is approximately:

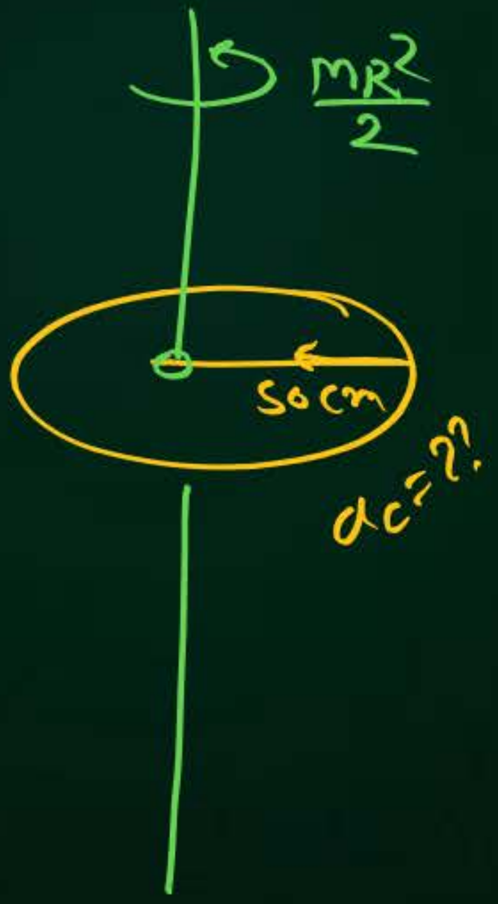
[NEET - 2016]

(1) 8.0

(2) 7.0

(3) 6.0

(4) 3.0



QUESTION

A wheel has angular acceleration of 3 rad/sec^2 and an initial angular speed of 2 rad/sec. In a time of 2 sec it has rotated through an angle (in radian) of

[AIPMT (Prelims)-2007]

1. 4
2. 6
3. 10
4. 12

done

$$\theta = \omega_i t + \frac{1}{2}\alpha t^2$$

QUESTION

A solid body rotates about a fixed axis such that its angular velocity depends on θ as $\omega = k\theta^{-1}$ where k is a positive constants. At $t = 0$, $\theta = 0$, then time dependence of θ is given as

(1) $\theta = kt$

(2) $\theta = 2kt$

(3) $\theta = \sqrt{kt}$

(4) $\theta = \sqrt{2kt}$

$$\omega = k\theta^{-1}$$

$$\frac{d\theta}{dt} = \frac{k}{\theta}$$

$$\theta\, d\theta = k\, dt$$

$$\int \theta\, d\theta = \int k\, dt$$

$$\frac{\theta^2}{2} = kt$$

$$\theta = \sqrt{2kt}$$

QUESTION

A solid cylinder of mass 2 kg and radius 4 cm is rotating about its axis at the rate of 3 rpm. The torque required to stop it after 2π revolutions is [NEET 2019]

1. 2×10^{6} N m
2. 2×10^{-6} N m
3. 2×10^{-3} N m
4. 12×10^{-4} N m

Disc

$\omega = 2\pi\,(3\,rpm)$

$= 2\pi\left(\frac{3}{60}\,rps\right)$

$\omega = \frac{6\pi}{60} = \frac{\pi}{10}$

H/W

no. of Rotⁿ = 2π

total Ang = $(2\pi) \times 2\pi$

$\theta = 4\pi^2$

$\omega_i = \frac{\pi}{10}$

$\omega_f = 0$

$\omega_f^2 - \omega_i^2 = 2\alpha\theta$

$\alpha = ??$

$\tau = I\alpha$

QUESTION

A rod PQ of mass M and length L is hinged at end P. The rod is kept horizontal by a massless string tied to point Q as shown in figure. When string is cut, the initial angular acceleration of the rod is [NEET 2013]

1. $\frac{2g}{L}$
2. $\frac{2g}{2L}$
3. $\frac{3g}{2L}$
4. $\frac{g}{L}$


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 06 | Physics

Rotational Motion

By- Dr. Manish Raj (MR SIR)



Topic To Be Covered

1. # Connected body Rotational motion
2. #
3. #
4. #



QUESTION

A solid cylinder of mass 2 kg and radius 4 cm is rotating about its axis at the rate of 3 rpm. The torque required to stop it after 2π revolutions is [NEET 2019]

(1) 2×10^{6} N m

(2) 2×10^{-6} N m

(3) 2×10^{-3} N m

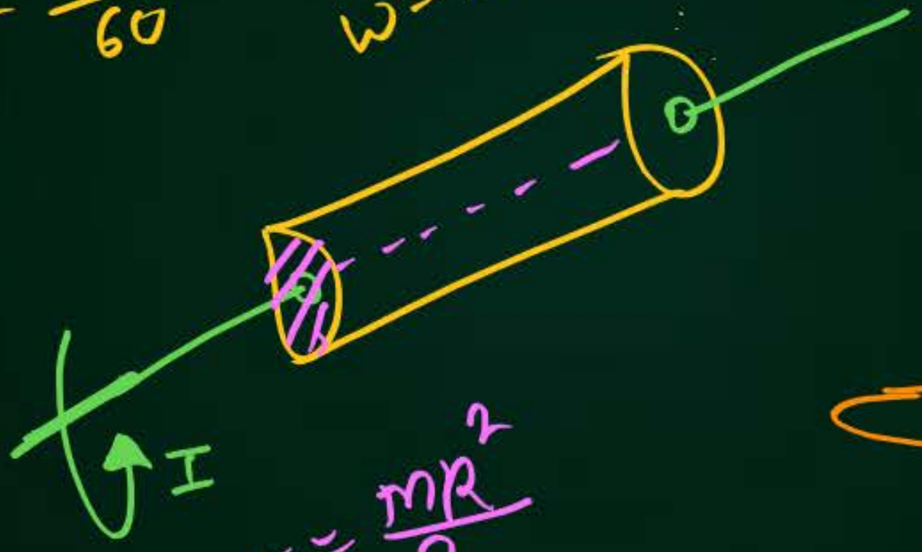
(4) 12×10^{-4} N m

$f = 3$ rpm $= \frac{3 \text{ rps}}{60} = \frac{1}{20}$ r

$\omega = 2\pi \nu$

no of revolution

no. of revolution $= 2\pi$ $= (2 \times 3.14)$



$I = \frac{mR^2}{2}$



Total Angle $= n(2\pi)$

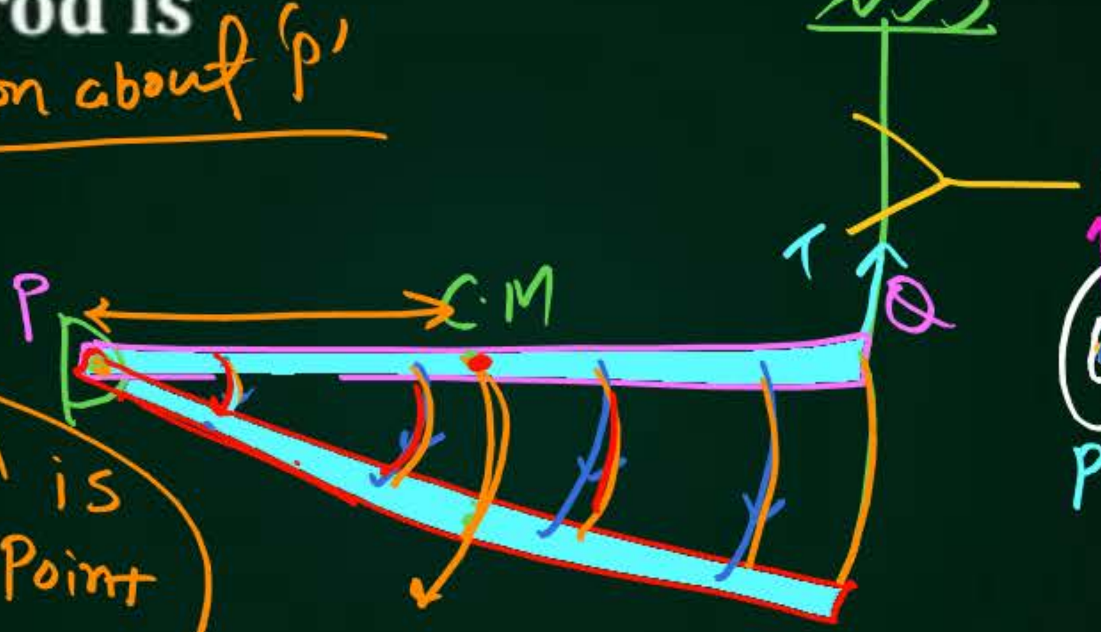
$\theta = 2 \times 3.14 \times 2\pi$

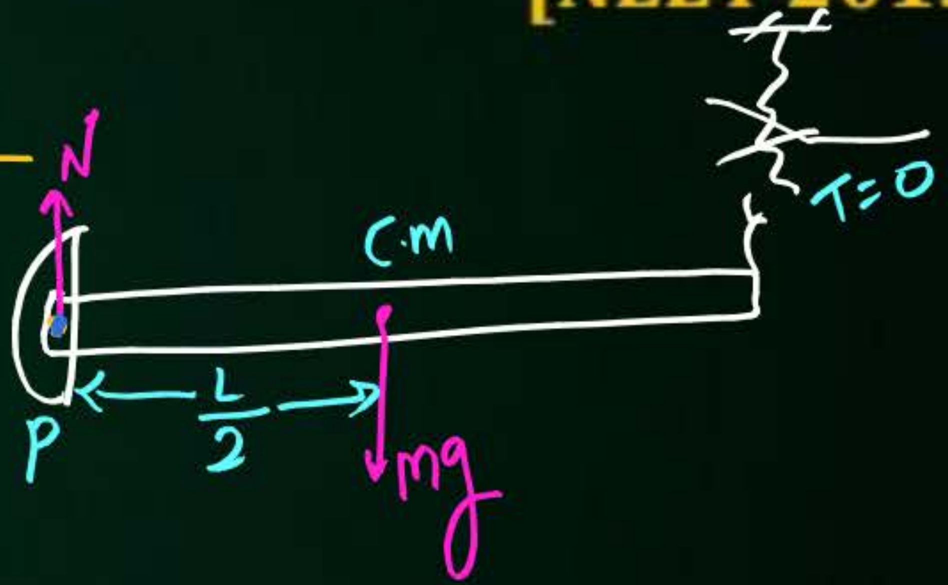
$\omega_f^2 - \omega_i^2 = 2\alpha\theta$

$I\alpha = ?$

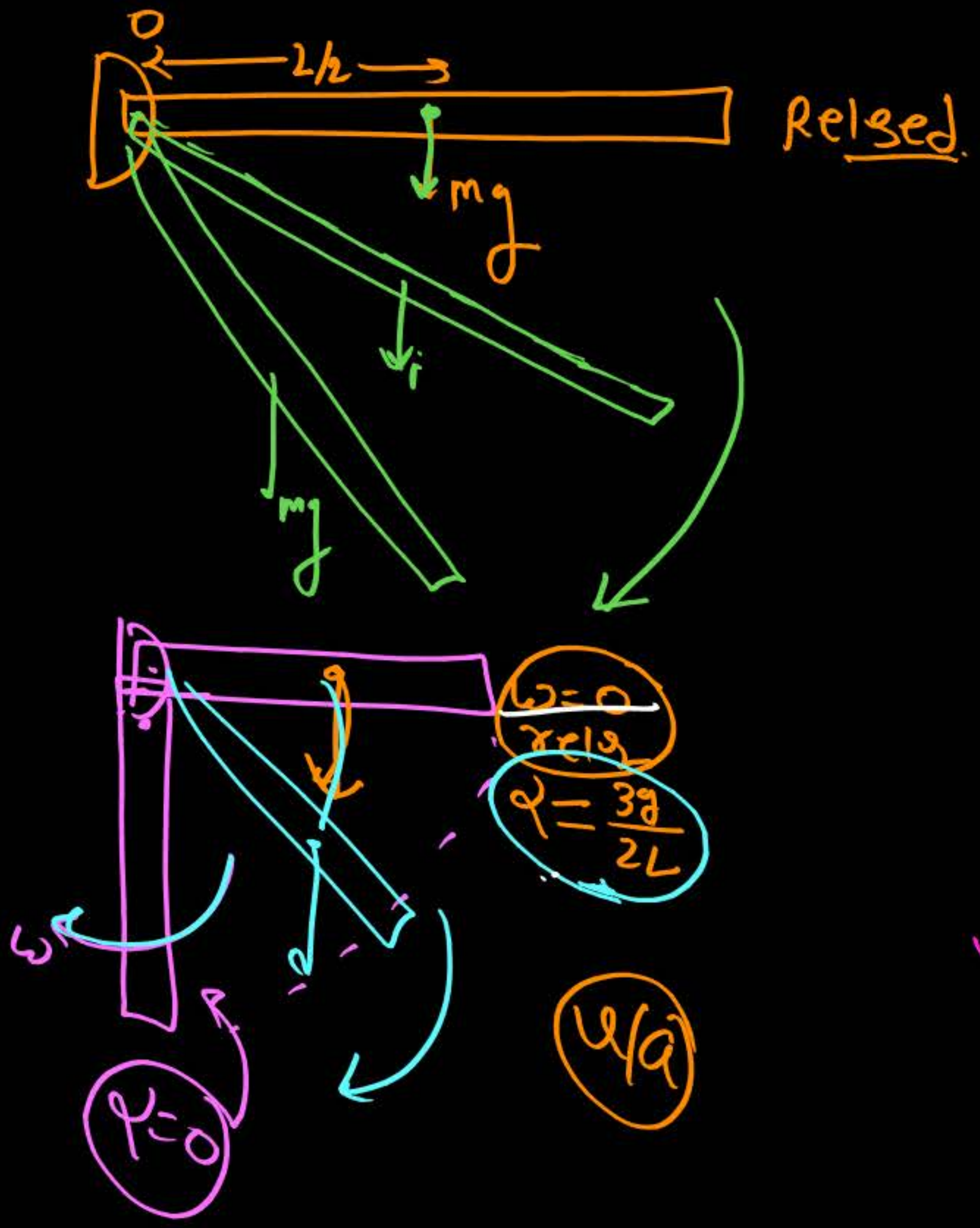
QUESTION

A rod PQ of mass M and length L is hinged at end P. The rod is kept horizontal by a massless string tied to point Q as shown in figure. When string is cut, the initial angular acceleration of the rod is [NEET 2013]





1. $\frac{2g}{L}$
2. $\frac{2g}{2L}$
3. $\frac{3g}{2L}$
4. $\frac{g}{L}$



Rod is relesed from Horizontal position then its Angulr acc^n will varry with time??

$\tau = I\alpha$

(a) Increasing

✓ (b) decreasing (29%)

(c) ✗ remains same (50%)

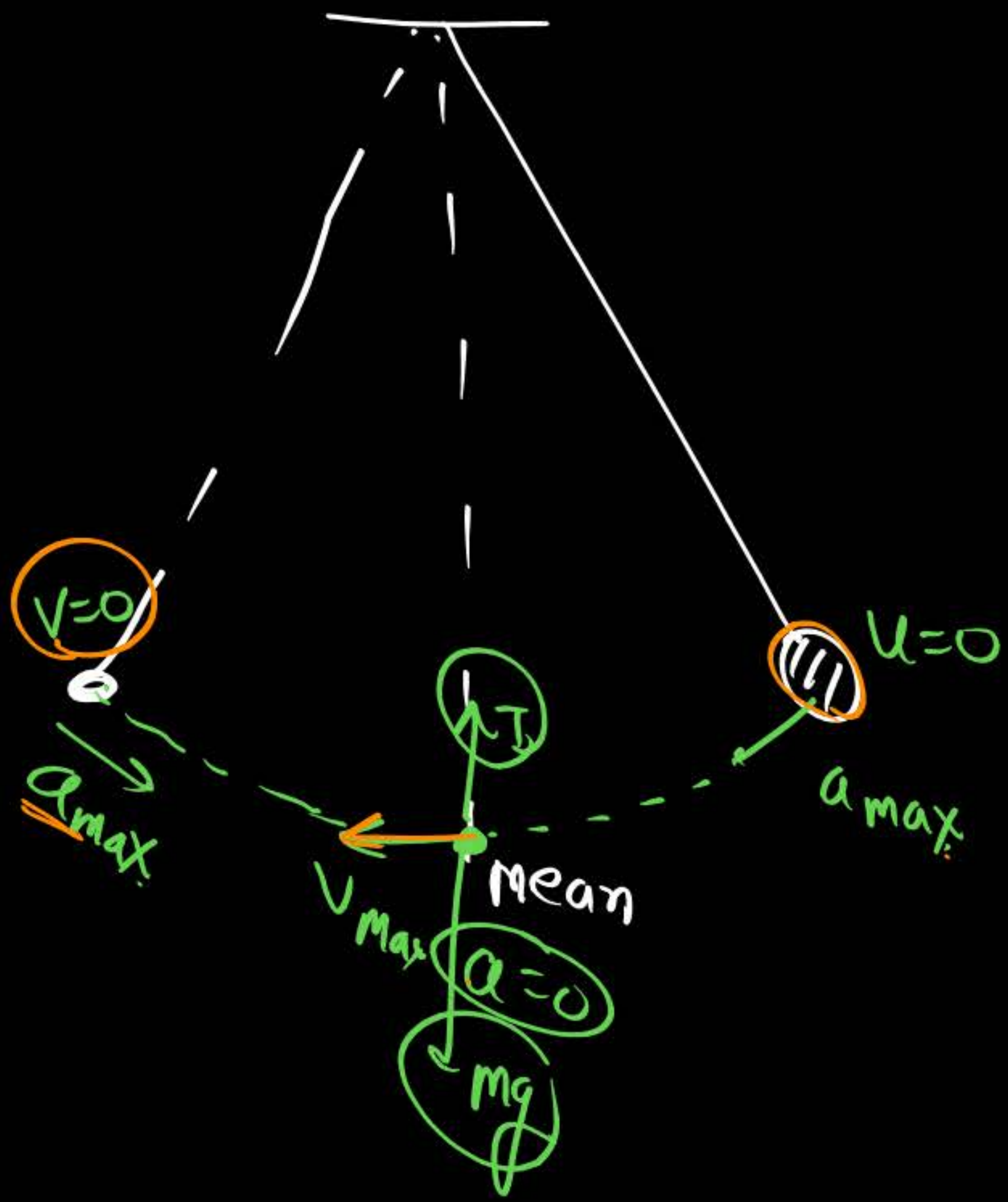
what about angular speed in same question

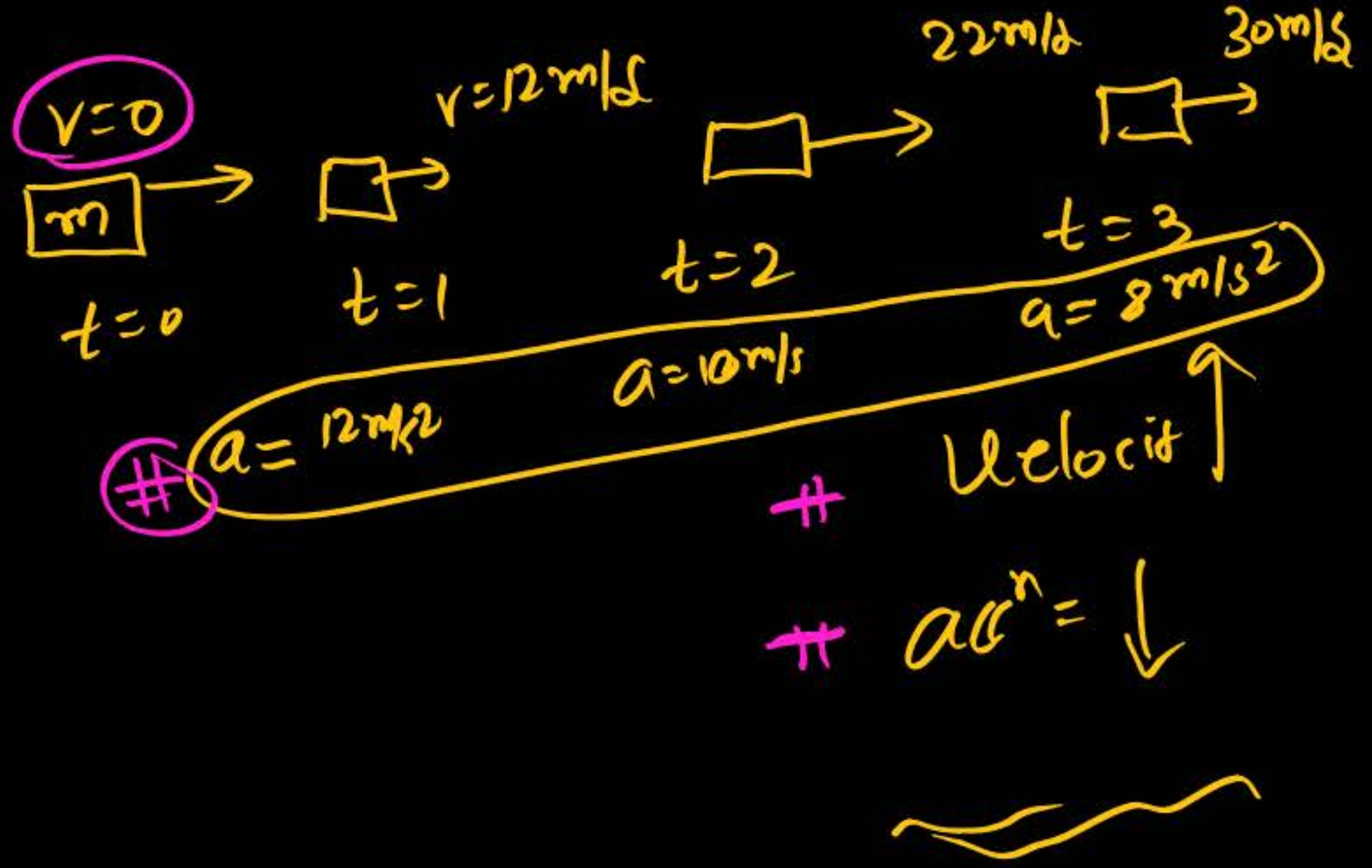
✓ (a) Increasing

(b) decresing

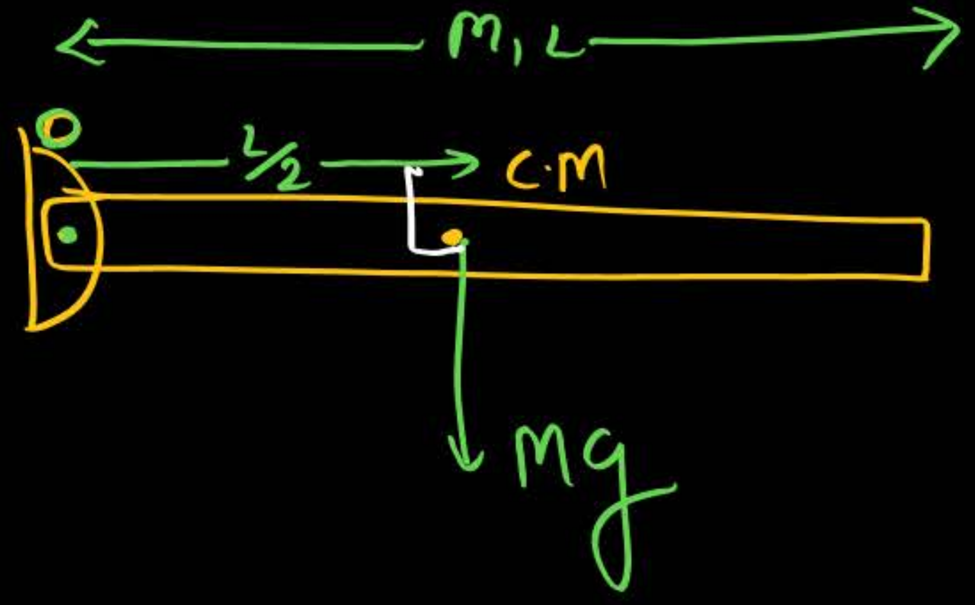
(c) remain same.

$\downarrow \tau = I \alpha \downarrow$ (I same)


V=0
U=0
a_{max}
a_{max}
V_{max}
Mean
T
a=0
mg


V=0
m
v=12 m/s
22 m/s
30 m/s
t=0
t=1
t=2
t=3
a= 12 m/s2
a=10 m/s
a= 8 m/s2
Velocity ↑
accⁿ = ↓

Case-2

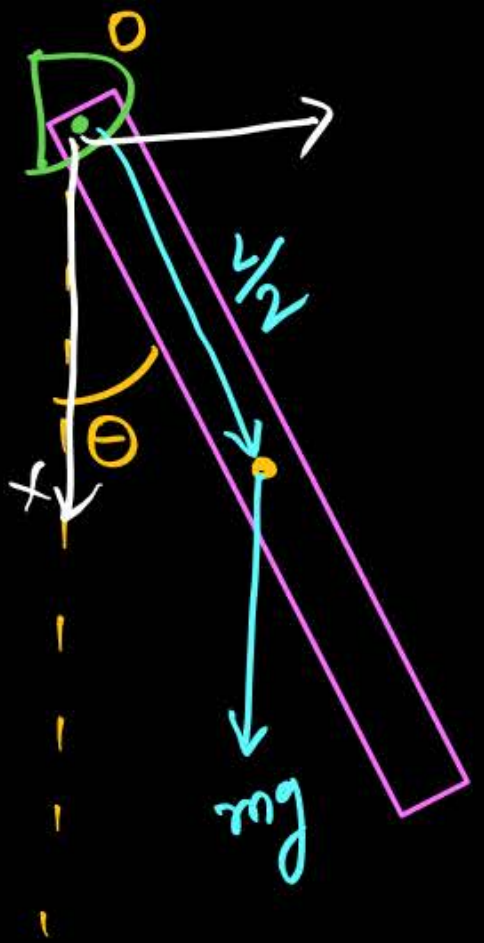


$$(\tau_0)_{\text{due to gravity}} = mg\left(\frac{L}{2}\right)$$

$$\tau = I\alpha$$

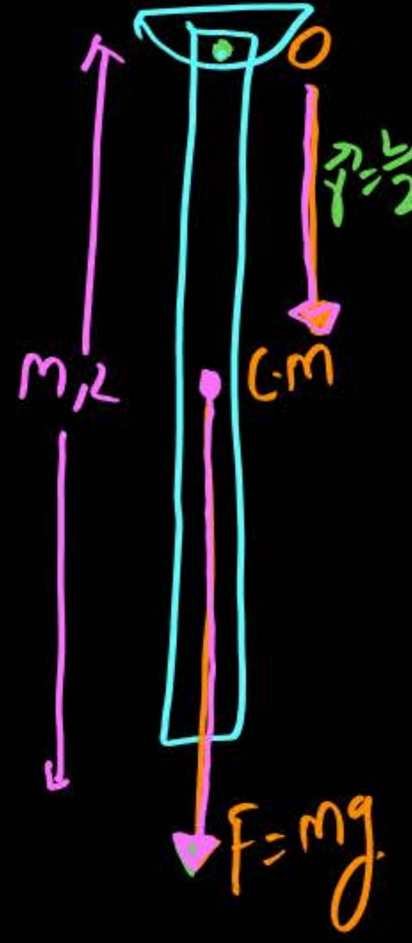
$$mg\frac{L}{2} = \frac{mL^2}{3}\alpha$$

$$\boxed{\alpha = \frac{3g}{2L}}$$



$$(\tau_0)_{\text{due to gravity}} = mg\left(\frac{L}{2}\sin\theta\right)$$

$$\alpha = \frac{3g\sin\theta}{2L}$$



$$\tau = mg\frac{L}{2}\sin 0^\circ$$

$$\boxed{\tau = 0}$$

$$\tau = I\alpha$$

$$\boxed{\alpha = 0}$$

QUESTION

Find acceleration of COM and point Q when rod is just released, also find normal relaxation at that point. 'P'.

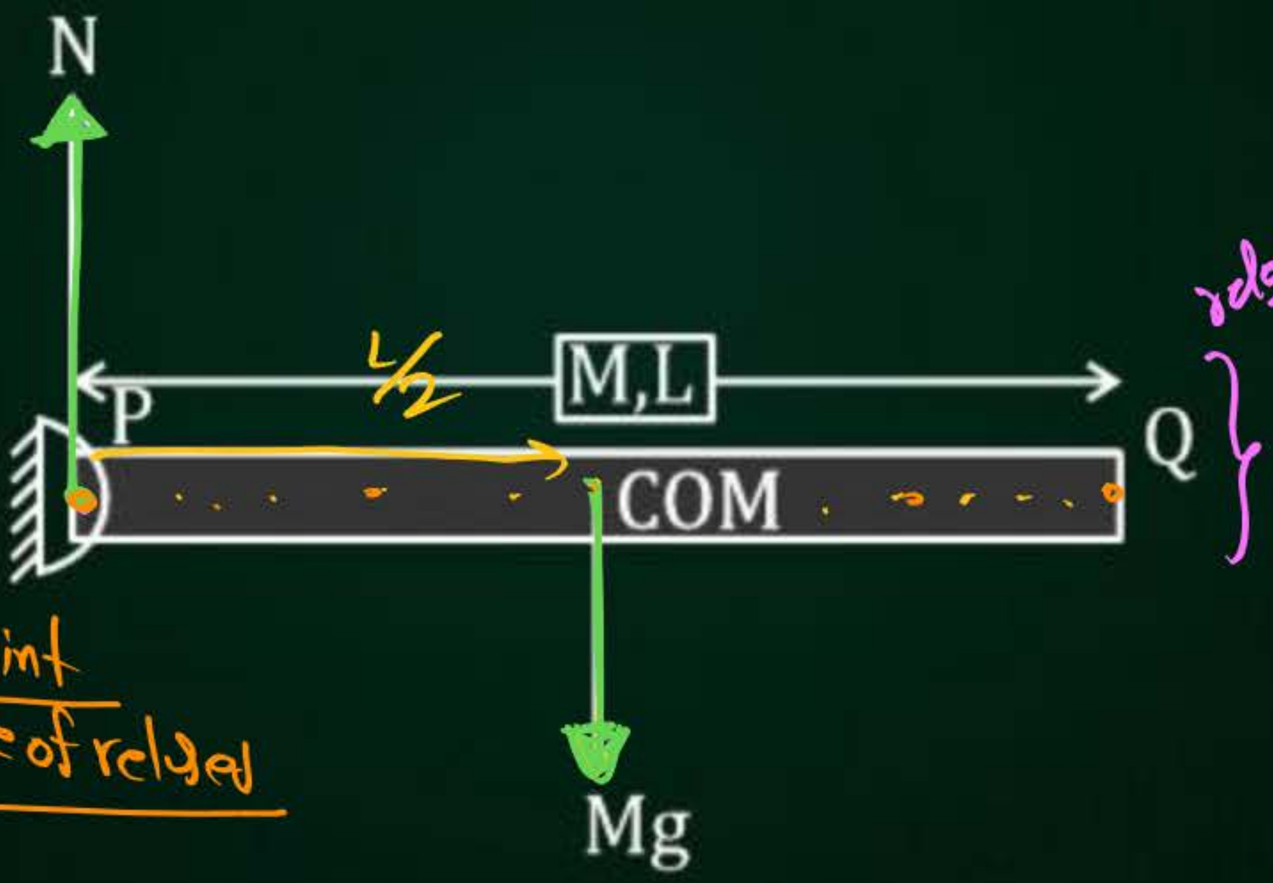
Rotational motⁿ about 'P'

(1) $\tau_p = I\alpha$

$Mg\frac{L}{2} = \frac{mL^2}{3}\alpha$

(2) $\alpha = \frac{3g}{2L}$ — same for all point at the time of release

(3) $a_{c.m} = r\alpha = \frac{L}{2}\cdot\frac{3g}{2L} = \frac{3g}{4}$ — (11)



(Q) Can g directly find $a_{c.m}$ without calculating α = ??

Ans ⟶ Not Possible

$F_{net} = m a_{c.m}$

$(mg - N) = m a_{c.m}$

Putting value of $a_{c.m}$ from eq (11)

$mg - N = m\frac{3g}{4}$

$N = mg - \frac{3mg}{4} = \frac{mg}{4}$

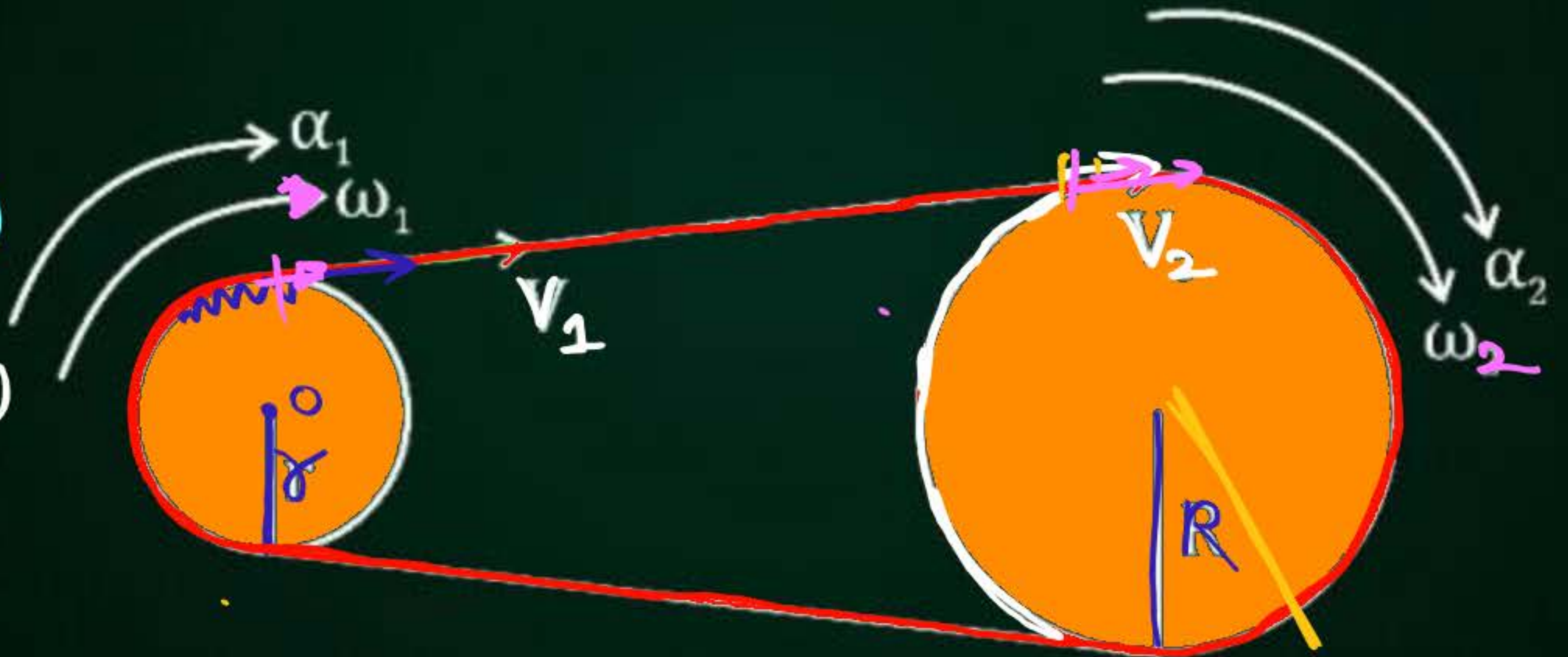
QUESTION

Find relation between ω_1 & ω_2.

(a) $\omega_1 = \omega_2$ (20%)

(b) $\omega_1 > \omega_2$ (62%)

(c) $\omega_1 < \omega_2$ (15%)



Sol^n

$V_1 = V_2$

$r\omega_1 = R\omega_2$

$R > r$

$\omega_1 > \omega_2$ Ans



$a_{string} = a = a_{Tangential}$ acc^n of Pulley

(I, M, R)

$\mu \rightarrow$ sufficient To stop sliding

for Rot^n mot^n of Pulley about 'O'

$\tau_0 = I\alpha$

$$TR = I\alpha \quad \text{— (ii)}$$

$$a = R\alpha \quad \text{— (iii)}$$

what to do now?? gayl Bhaisya Pani Me.

released $\rightarrow$ for Tr^{l}a^n Mot^n of Object

$$mg - T = m\vec{a} \quad \text{— (i)}$$

$M \rightarrow kg\,(M^1)$

$I = kg\,m^2\,(M^1 L^2)$

$mg - T = ma$ — (i)

$T = \dfrac{Ia}{R^2}$ — (ii)

$+ \quad + \quad +$

$mg = ma + \dfrac{Ia}{R^2}$

$mg = a\left(m + \dfrac{I}{R^2}\right)$

$$a = \frac{(mg)}{\left(m + \frac{I}{R^2}\right)}$$

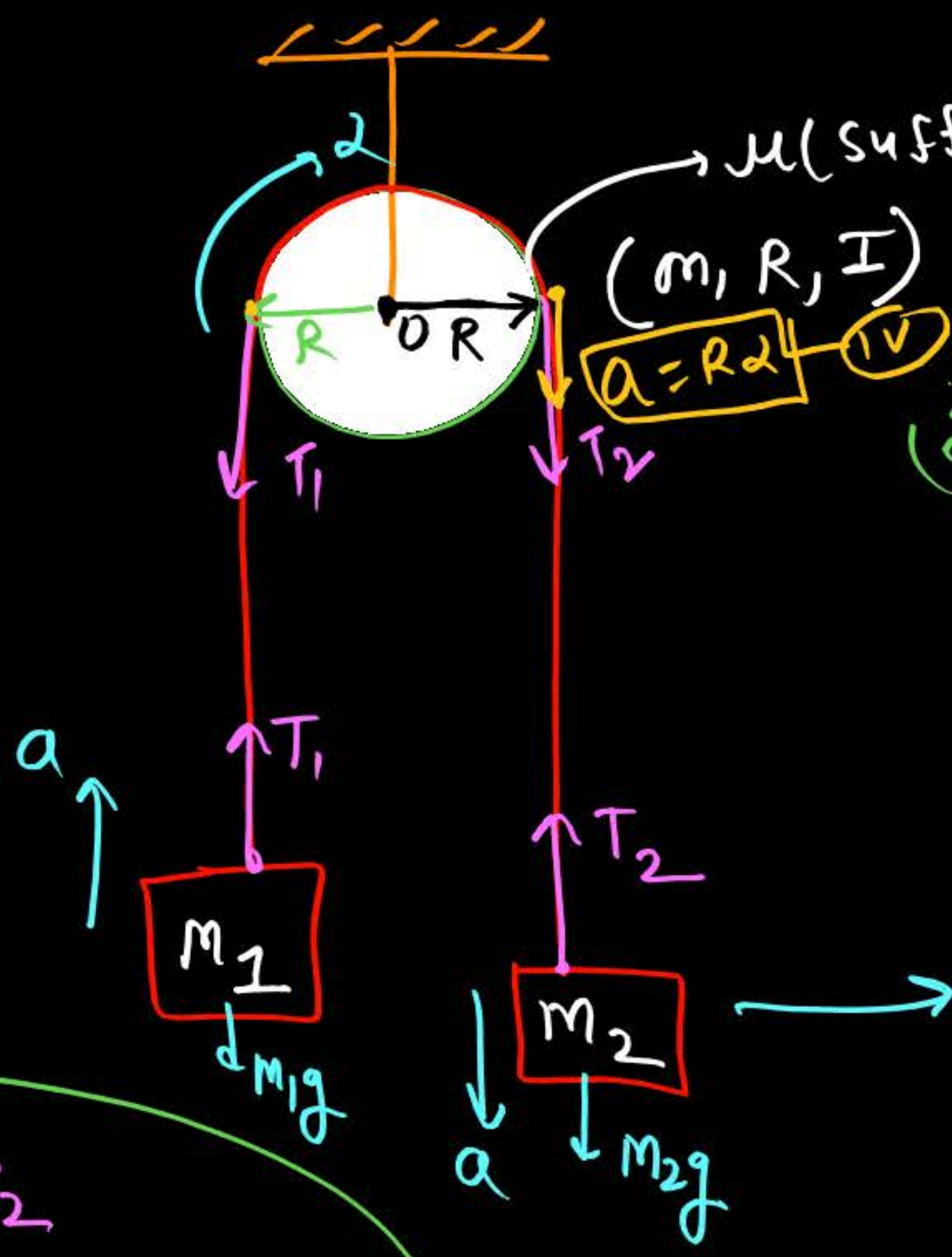
(acc^n of Block.)

using eq^n (iii) $a = R\alpha$

$$a = \frac{\text{net Pulling force}}{\text{net mass}}$$

$$a = \frac{(mg)}{M + I/R^2}$$

Transl^n Rot^n of mass



→ μ (sufficient friction to stop sliding)

$a = R\alpha$ — (IV)

using (I), (II), (III), (IV)

MR*

Rotn motn of Pully

$(\tau_0)_{Pulley} = T_2 R \otimes - T_1 R \odot$

$I\alpha = (T_2 R - T_1 R) \otimes$ — (III)

$\frac{I\alpha}{R} = T_2 - T_1$ — (III)

m2 ka Transn motn

$m_2 g - T_2 = m_2 a$ — (I)

$T_1 - m_1 g = m_1 a$ — (II)

$$a = \frac{(m_2 g - m_1 g)}{\left(m_1 + m_2 + \frac{I}{R^2}\right)}$$

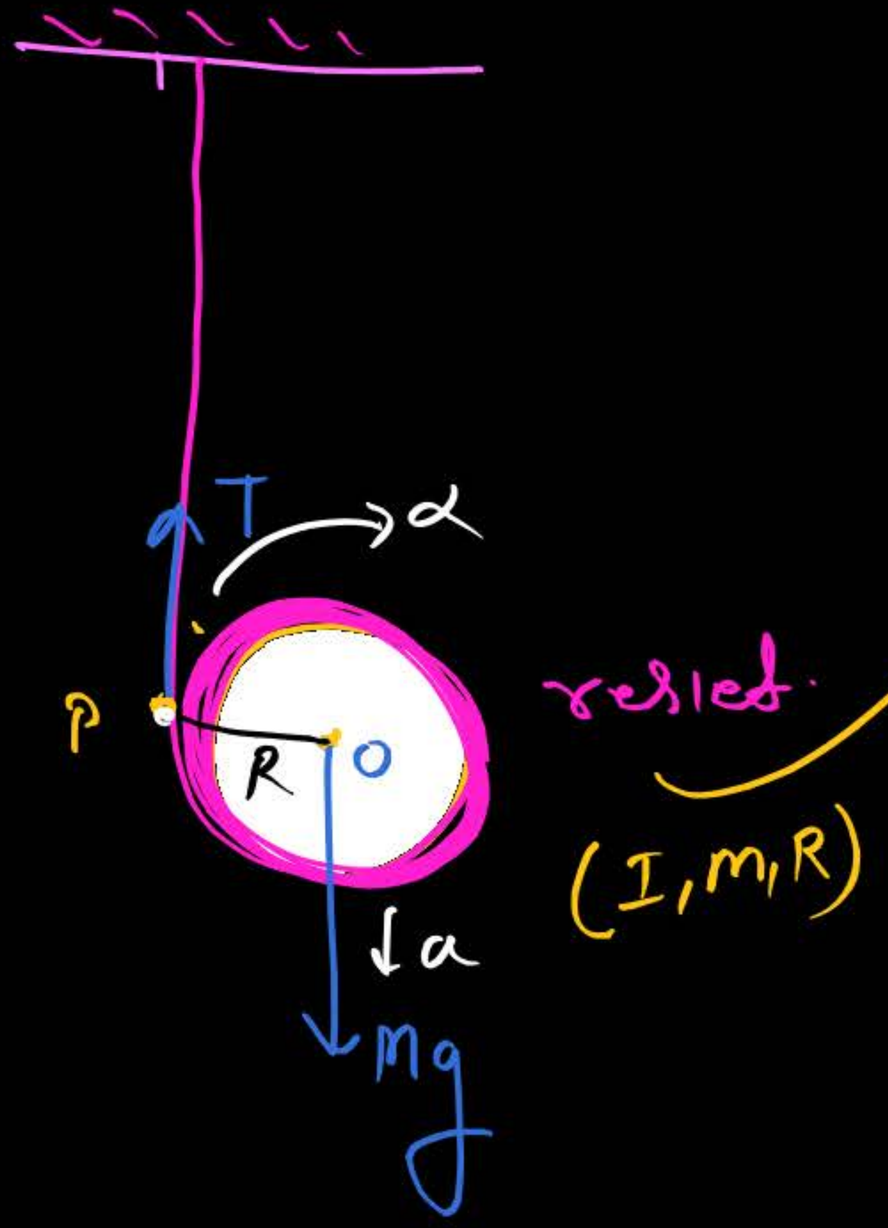
MR*

T_1 & T_2 will same or diffn

(a) ✗ (b) ✓

let $(T_2 > T_1)$

becoz $m_2 > m_1$



for Tral^n mot^n

$$mg - T = ma \quad \text{— (I)}$$

for Rot^n mot^n about (O)

$$\tau = I\alpha$$

$$RT = I\alpha \quad \text{— (II)}$$

$$mg - T = ma$$

$$T = \frac{I\alpha}{R}$$

$$mg = ma + \frac{I\alpha}{R}$$

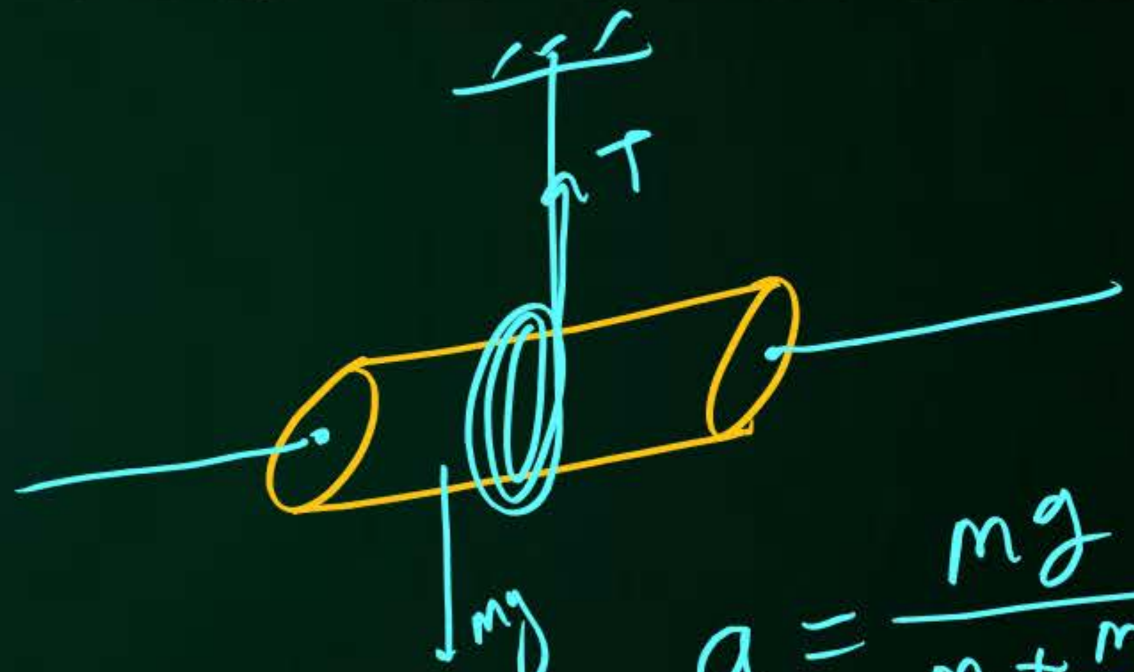
$$mg = ma + \frac{Ia}{R^2}$$

$$a = \frac{mg}{\left(m + I/R^2\right)}$$

QUESTION

A solid cylinder of M has a string wrapped several times around its circumference. The free end of string is attached to the ceiling and the cylinder is released from rest. Find the acceleration of the cylinder and the tension in the string.

1. $a = \frac{2}{3}\text{g}$ and $\text{T} = \frac{Mg}{3}$
2. $a = \frac{2}{3}\text{g}$ and $\text{T} = \frac{2Mg}{3}$
3. $a = \frac{5}{3}\text{g}$ and $\text{T} = \frac{2Mg}{3}$
4. $a = \frac{5}{3}\text{g}$ and $\text{T} = \frac{Mg}{3}$



$$a = \frac{mg}{m + \frac{m}{2}} = \frac{mg}{\frac{3m}{2}} = \frac{2g}{3}$$

$$mg - T = m a_{c.m}$$

$$mg - T = m\frac{2g}{3}$$

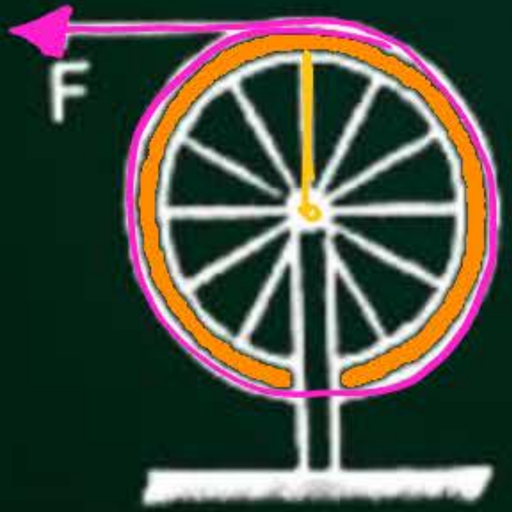
$$T = mg - \frac{2mg}{3} = \frac{mg}{3}$$

QUESTION

A string is wrapped around the rim of a wheel of moment of inertia 0.20 kg-m^2 and radius 20 cm. The wheel is free to rotate about its axis. Initially the wheel is at rest. The string is now pulled by a force of F = 20 N. Find the angular velocity of the wheel after 5 s.

$I = 0.2\ kg\text{-}m^2$

$R = 20\,cm = 20 \times 10^{-2}\,m$



Sol^n

$\tau = I\alpha$

$FR = \frac{20}{100}\alpha$

$20 \times \frac{20}{100} = \frac{20}{100}\alpha$

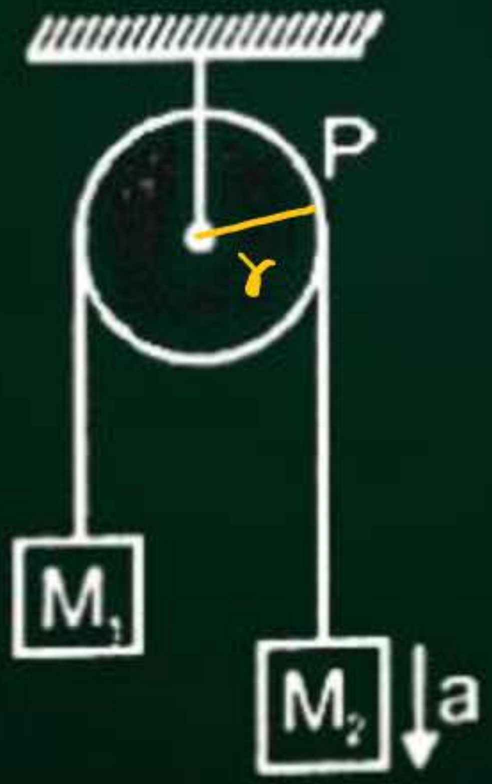
$\alpha = 20$

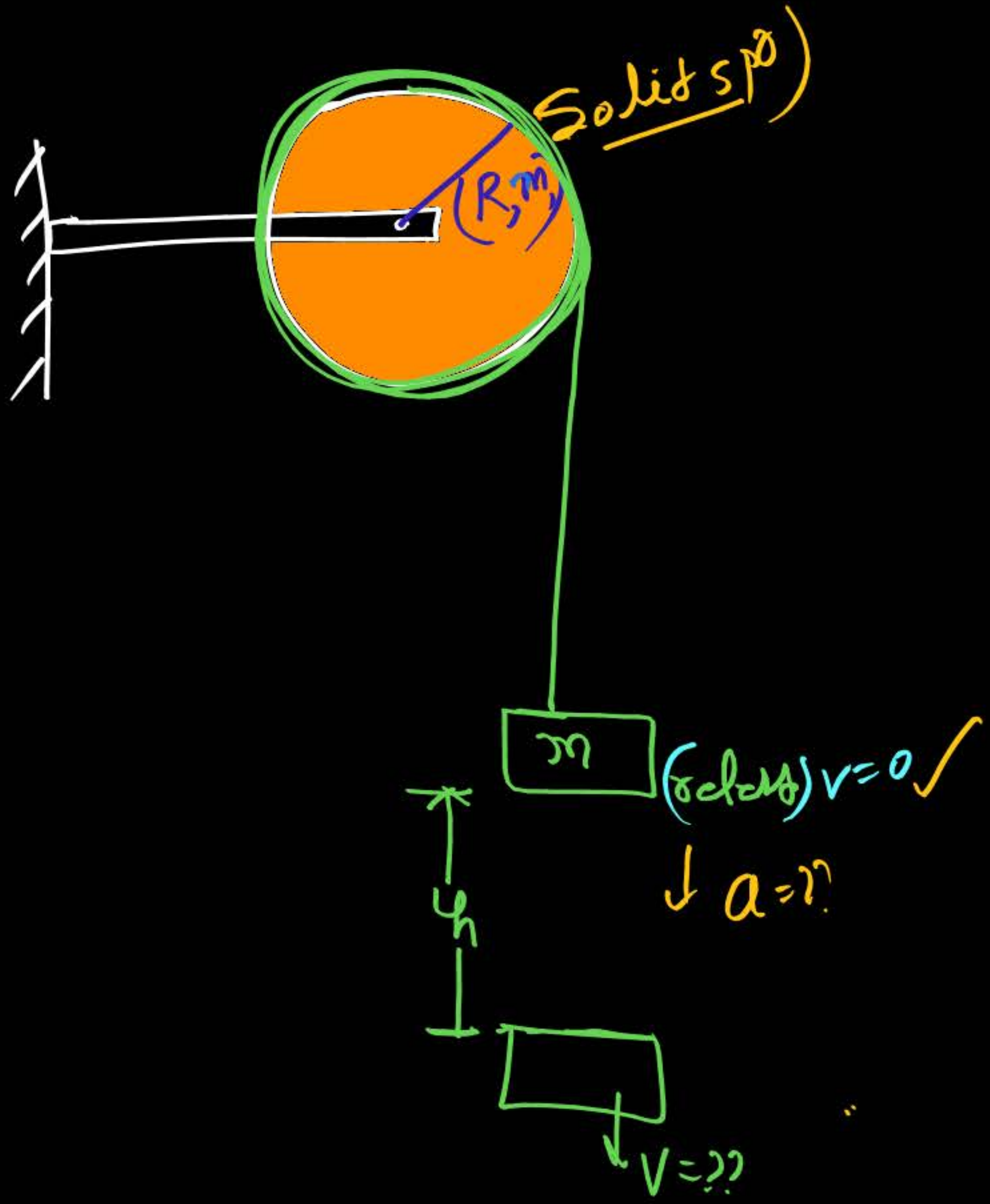
$\omega_f = \omega_i + \alpha t = 100$ rad/se

QUESTION

In the figure, the blocks have unequal masses m_1 and m_2 ($m_1 < m_2$). M_2 has a downward acceleration a. The pulley P has a radius r, and some mass. The string does not slip on the pulley. Find the acceleration of block and angular acceleration of pulley. (I = momentum of inertia of pulley)

$$a = \frac{(m_2 - m_1)g}{m_1 + m_2 + I/R^2}$$





$$a = \frac{mg}{m + I/R^2} = \frac{mg}{m + \frac{2}{5}\frac{mR^2}{R^2}} = \frac{mg}{m + \frac{2m}{5}}$$

$$= \frac{5mg}{7m}$$

$$= \frac{5g}{7}$$

3rd eqn of motn

$$v^2 - u^2 = 2as \quad (u = 0)$$

$$v^2 = 2\left(\frac{5g}{7}\right)h$$

$$v = \sqrt{\frac{10gh}{7}}$$

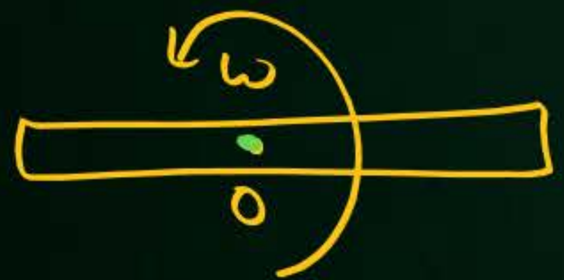
KINETIC ENERGY IN PURE ROTATIONAL MOTION



$$K.E = \frac{1}{2}mv^2 = \frac{p^2}{2m}$$

Pure Translation motⁿ

Pure Rotⁿ motⁿ

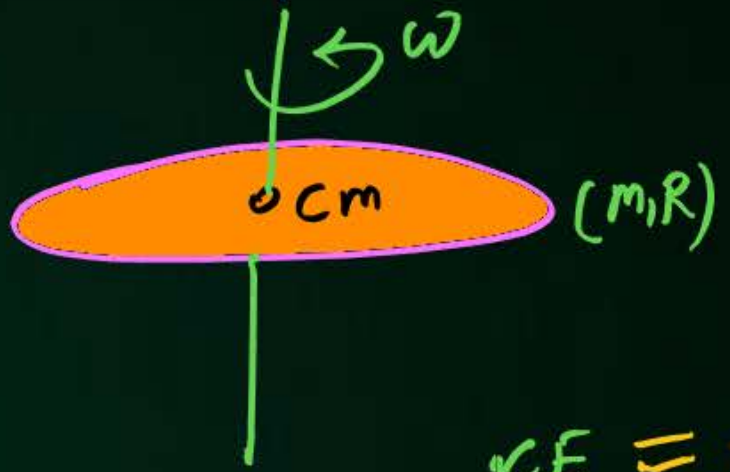


$$\left(L = I\omega\right)$$

Angular Moment

$$K.E = \frac{1}{2}I\omega^2$$

$$K.E = \frac{1}{2}I\omega^2 \times \frac{I}{I} = \frac{L^2}{2I}$$



$$K.E = \frac{1}{2}I\omega^2$$

$$= \frac{1}{2}\left(\frac{mR^2}{2}\right)\omega^2$$



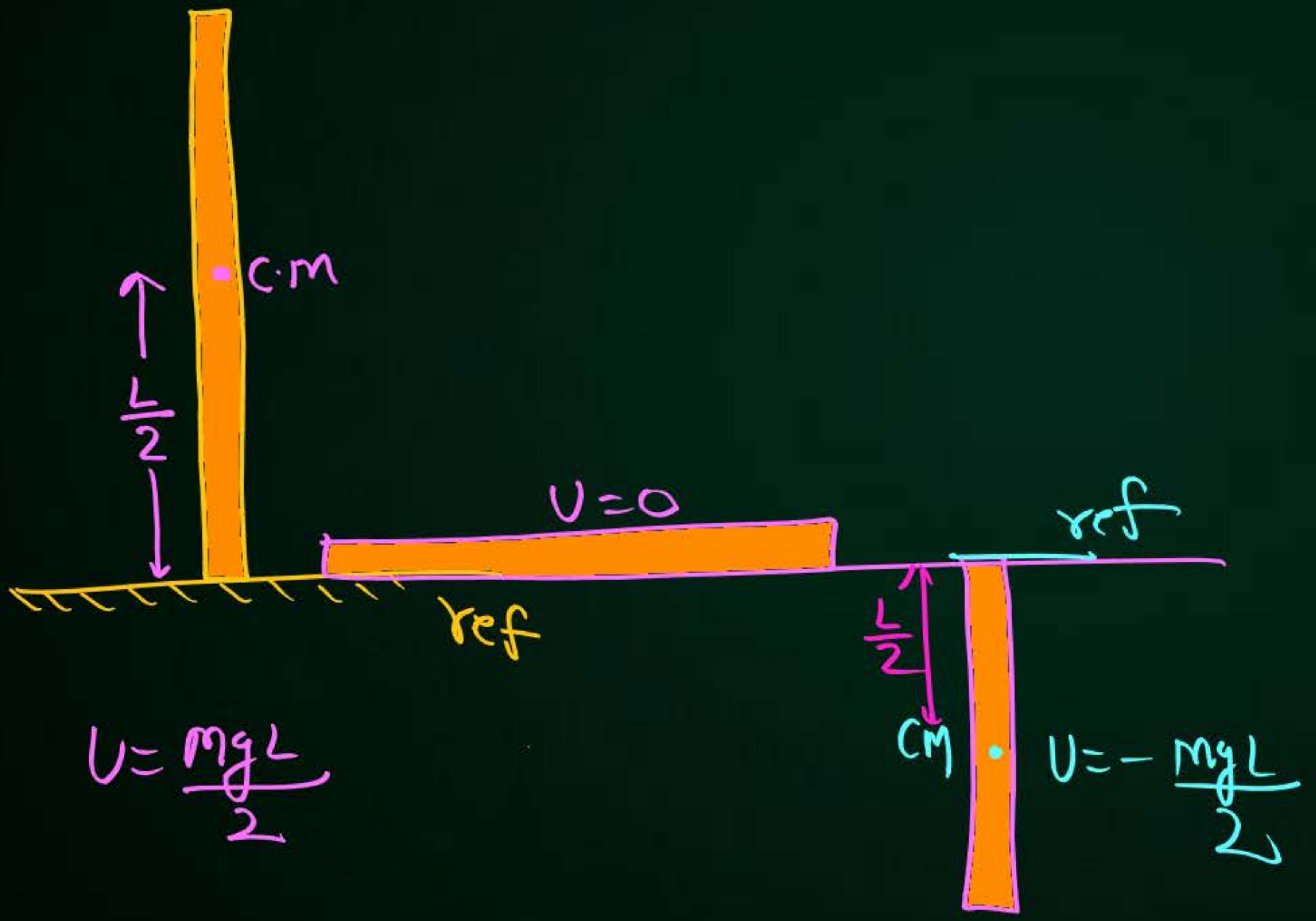
Disc (m,R)

$$I = \frac{1}{2}I\omega^2$$

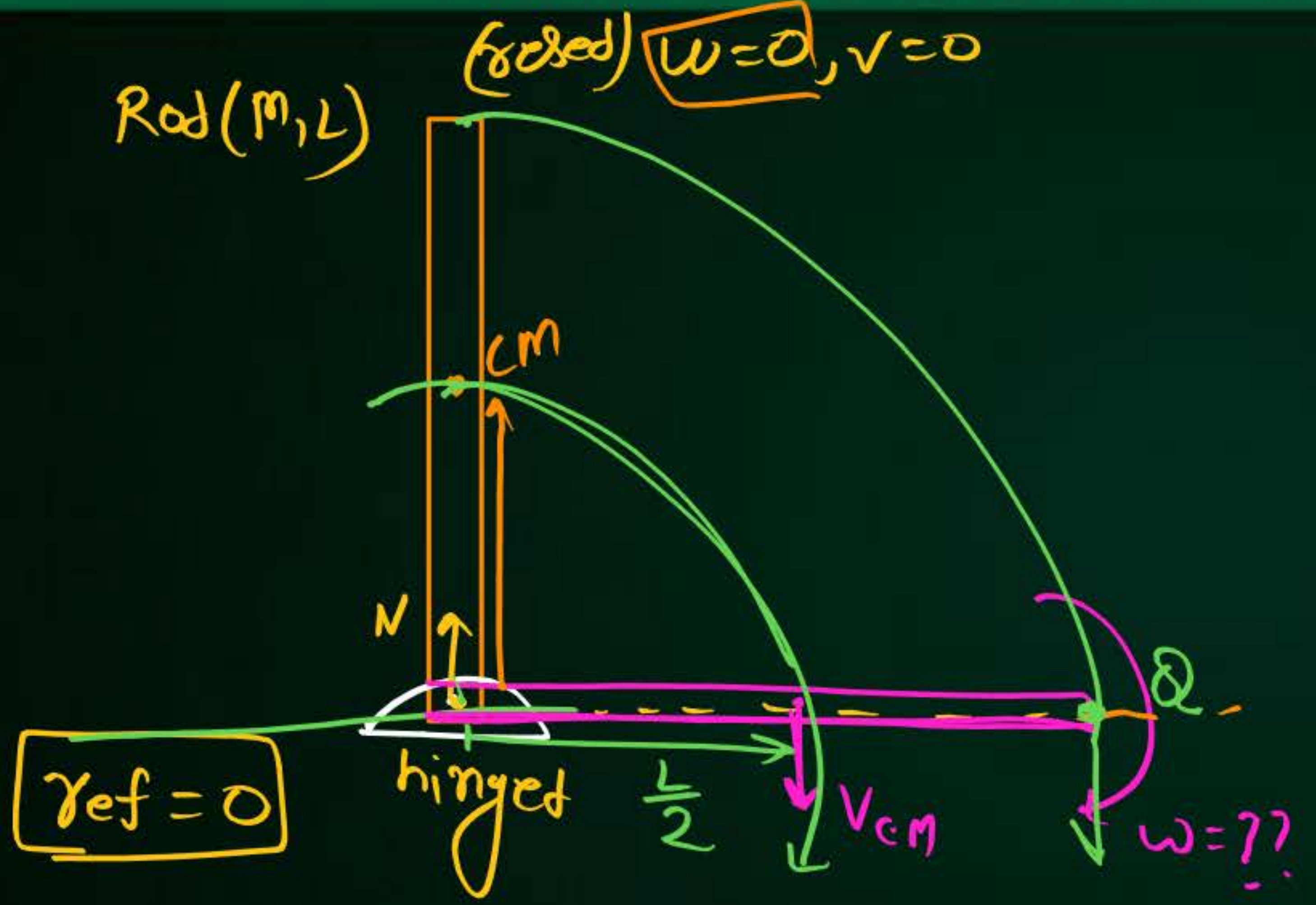
$$= \frac{1}{2}\frac{mR^2}{4}\omega^2$$

(Ans)

GRAVITATIONAL POTENTIAL ENERGY OF RIGID BODY



CONSERVATION OF MECHANICAL ENERGY IN PURE ROTATIONAL MOTION



C.O.M.E

$$(K.E + U)_i = (K.E + U)_f$$

$$0 + \frac{mgL}{2} = \frac{1}{2} I\omega^2 + 0$$

$$mgL = \frac{mL^2}{3}\omega^2$$

$$gL = \frac{L^2}{3}\omega^2$$

$$\frac{3g}{L} = \omega^2$$

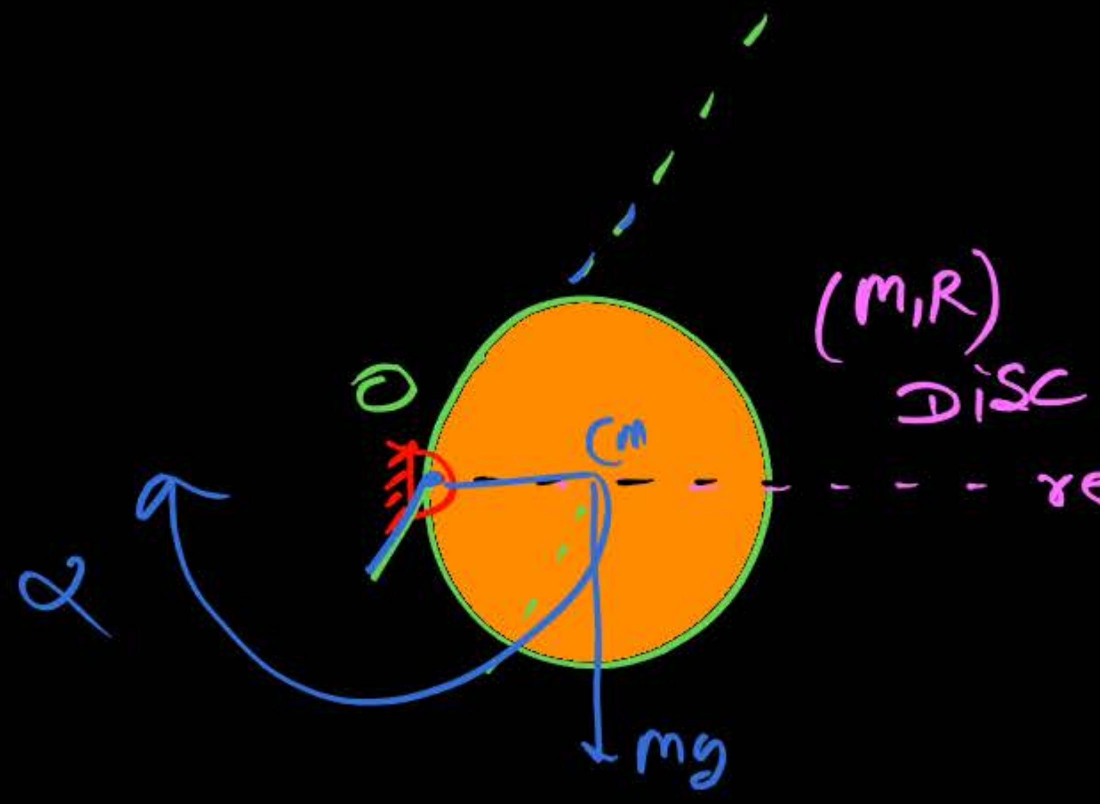
$$\omega = \sqrt{\frac{3g}{L}}$$

at point of Rod

Work done by Normal = 0

$$V_Q = r\omega = L\omega$$

$$V_{cm} = r\omega = \frac{L}{2}\sqrt{\frac{3g}{L}} = \sqrt{\frac{3gL}{4}}$$



released from here then find its initial angular acc^n

⊥r Plane

$$I_0 = \frac{mR^2}{2} + mR^2$$

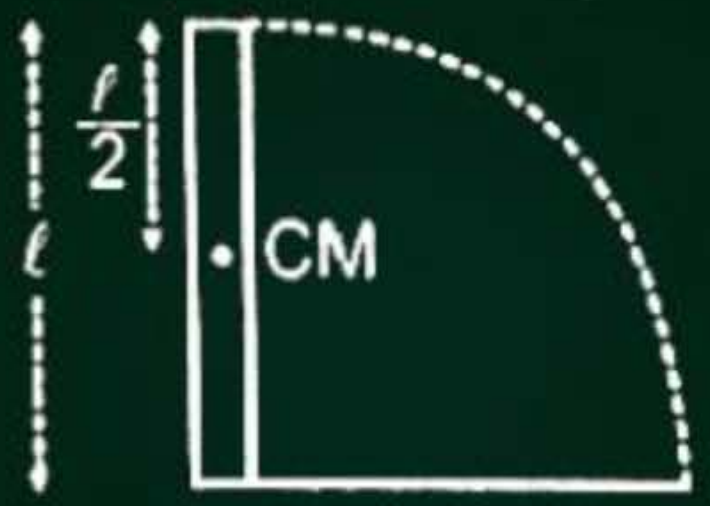
$$I = \frac{3}{2} mR^2$$

$$\tau = I\alpha$$

$$mgR = \frac{3}{2} mR^2 \alpha$$

QUESTION

A thin meter scale is kept vertical by placing its lower end hinged on floor. It is allowed to fall. Calculate the velocity of its upper end when it hits the floor.



QUESTION

A uniform rod smoothly pivoted at one of its ends is released from rest. If it swings in vertical plane, the maximum speed of the end P of the rod is:

(1) $2\sqrt{3g\ell}$

(2) $\sqrt{3g\ell}$

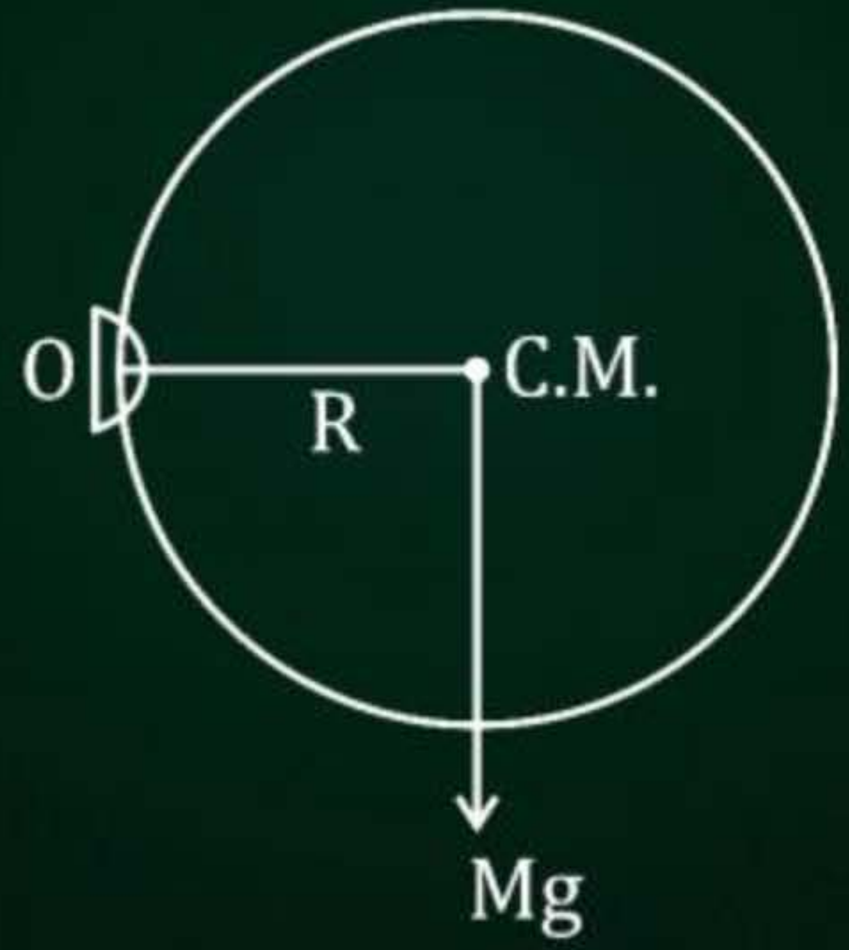


(3) $2\sqrt{2g\ell}$

(4) $\sqrt{g\ell}$

QUESTION

A ring (M, R) is hinged as shown then initial angular acceleration just after released..





PHYSICS WALLAH
37
YEARS (2024-1988)
NEET UG
CHAPTER-WISE & TOPIC-WISE
SOLVED PAPERS
BOOK FEATURE
Updated as per Latest NMC Syllabus
Practice questions for newly added NEET Topics
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37 YEARS 2024-1988
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Solved Questions
Physics
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THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 7 | Physics

Rotational Motion

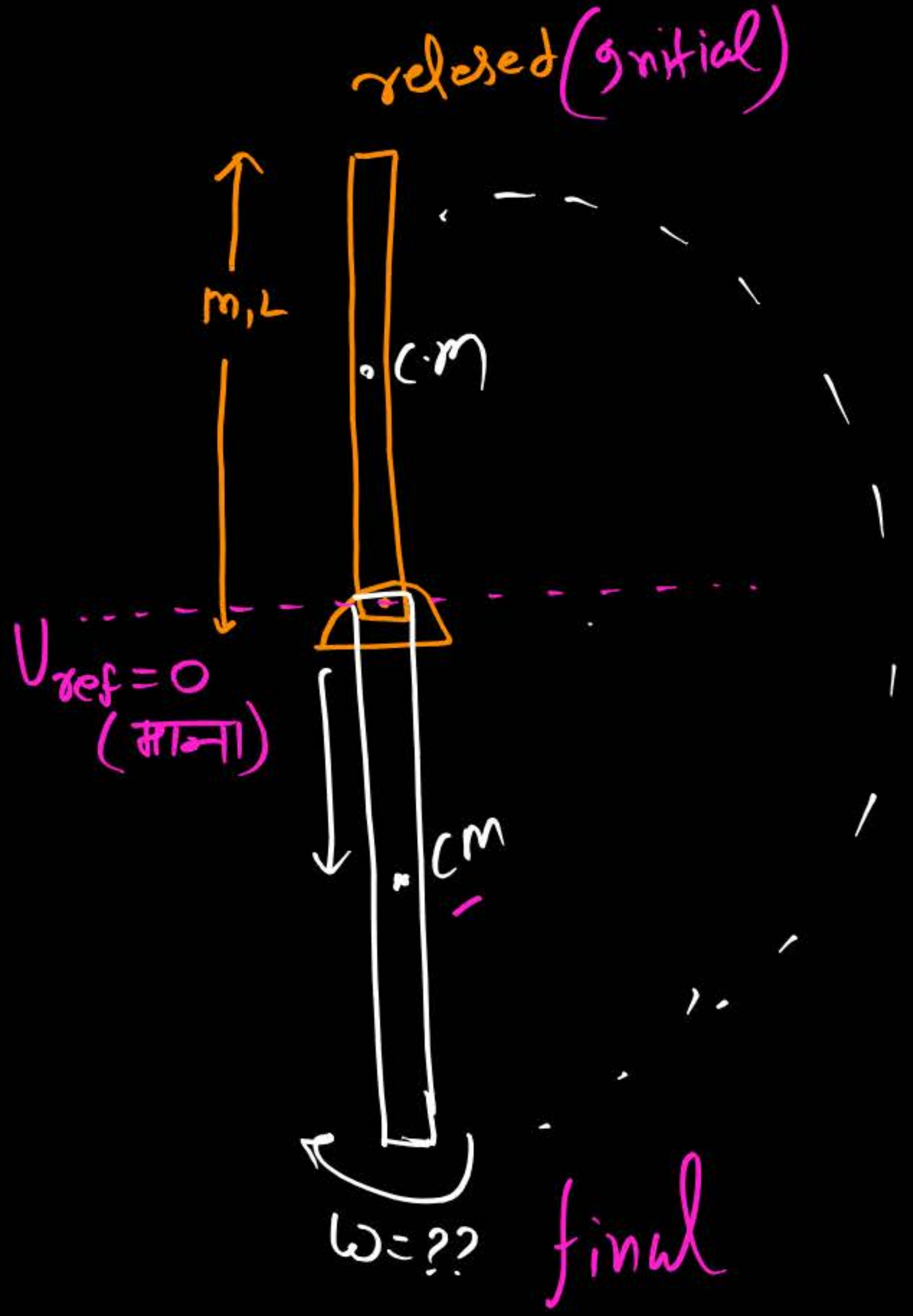


By- Dr. Manish Raj (MR SIR)

Topics to be covered

1. # Rolling motion → Basic se padh liya Jay
2. #
3. #
4. #





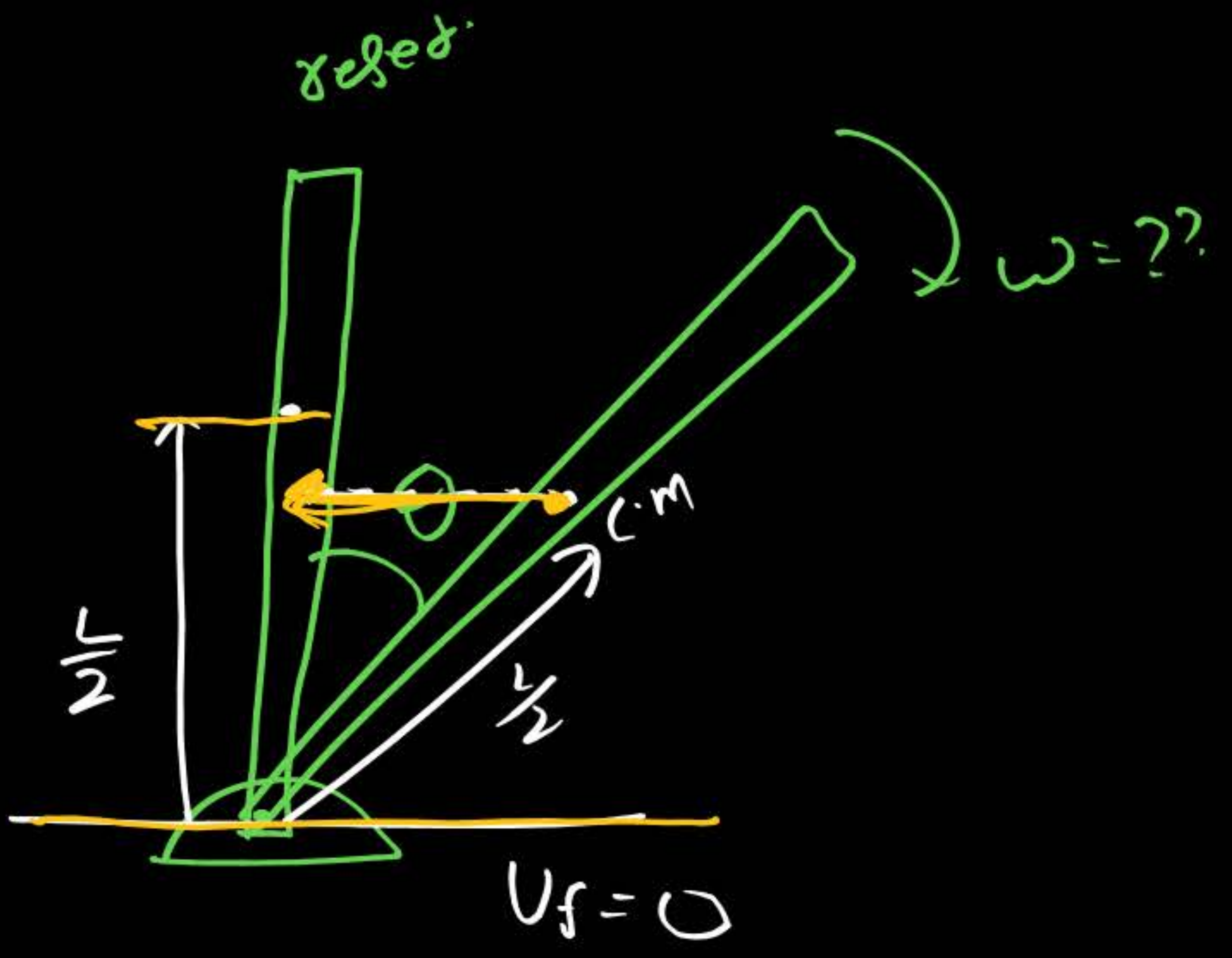
C.O.M.E

$$(K.E + U)_i = (K.E + U)_f$$

$$0 + \frac{mgL}{2} = \frac{1}{2} I \omega^2 - \frac{mgL}{2}$$

$$mgL = \frac{1}{2}\left(\frac{mL^2}{3}\right)\omega^2$$

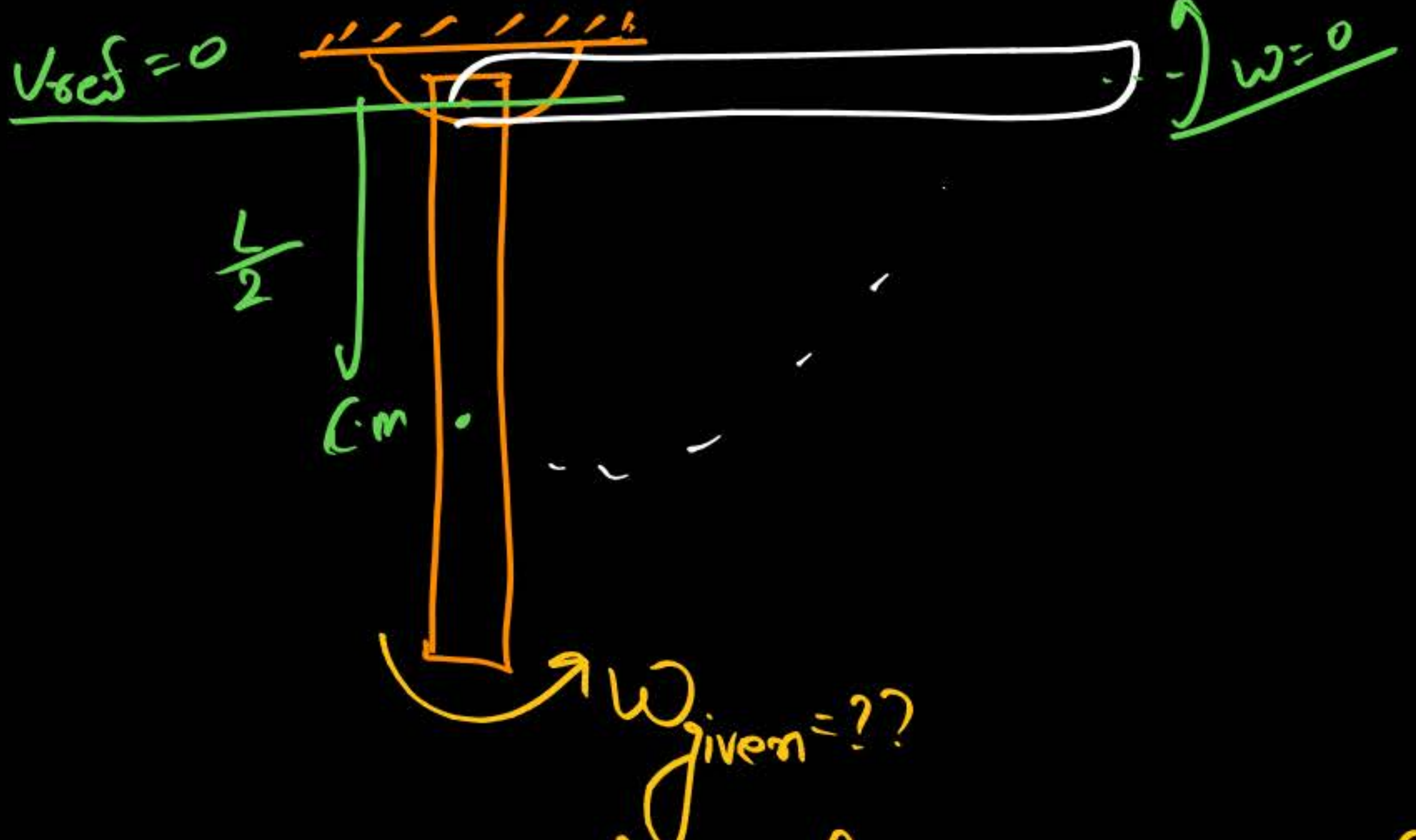
find this ω



$$\left[\, 0 + \frac{mgL}{2} = \frac{1}{2} I \omega^2 + \frac{mgL\cos\theta}{2} \,\right]$$

$$\frac{mgL}{2}(1-\cos\theta) = \frac{1}{2} I \omega^2$$

solve for ω = ??



what should be given angular speed so that rod becomes Horizontal.

C.O.M.E

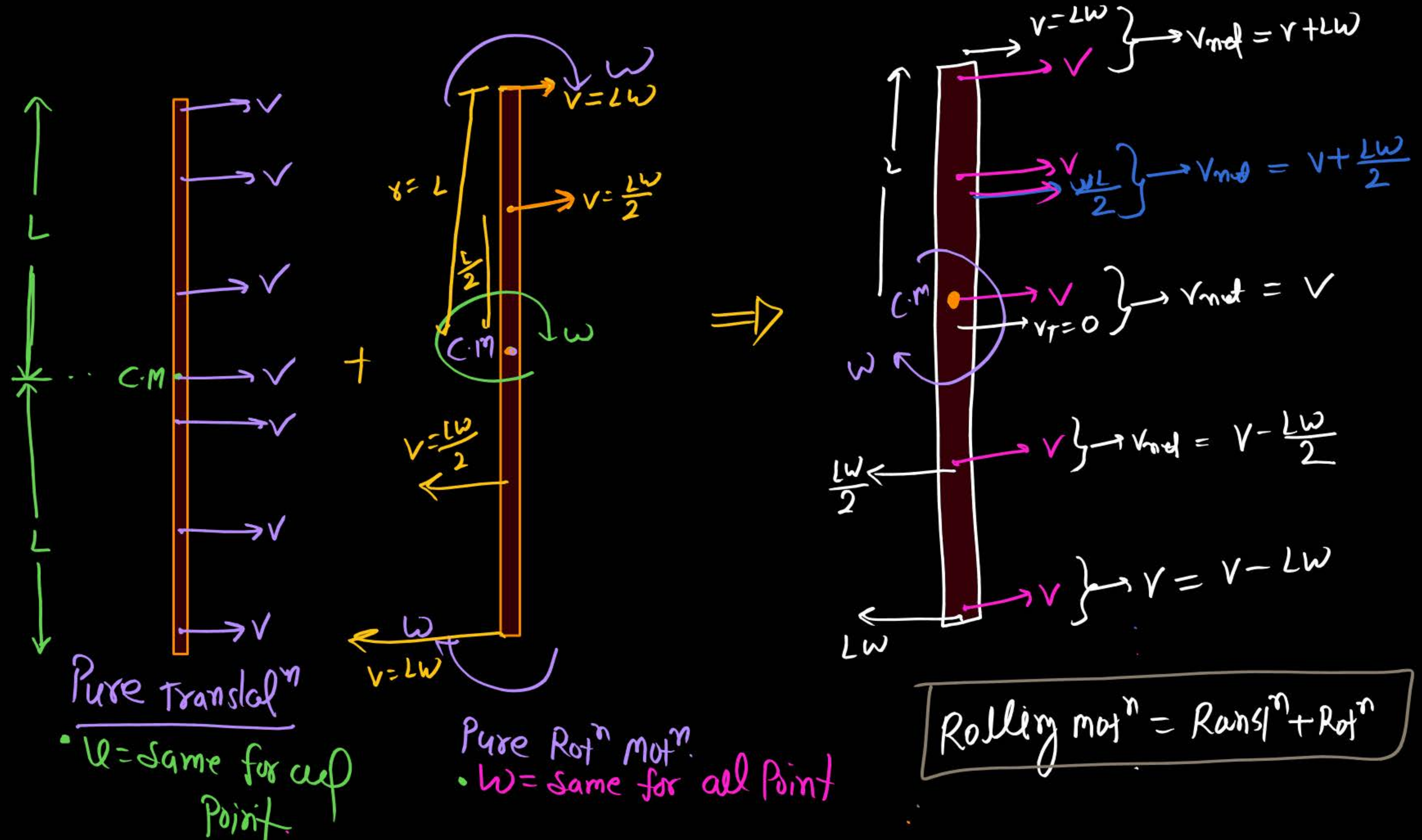
$$(K.E + U)_i = (K.E + U)_f$$

$$\frac{1}{2} I \omega_g^2 - \frac{mgL}{2} = 0 + 0$$

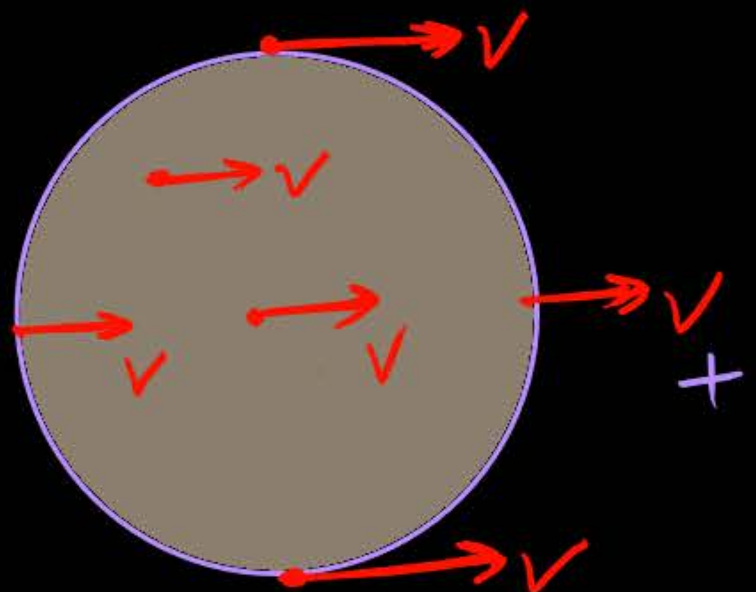
$$\omega_{g}^2 = \frac{mgL}{I}$$

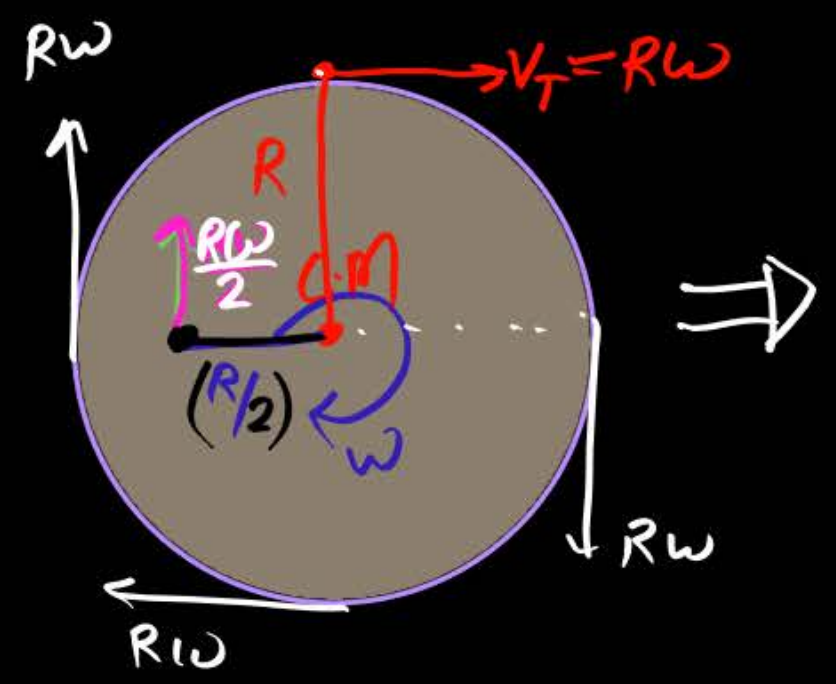
$$\omega_{give} = \sqrt{\frac{mgL}{\frac{1}{3} mL^2}}$$

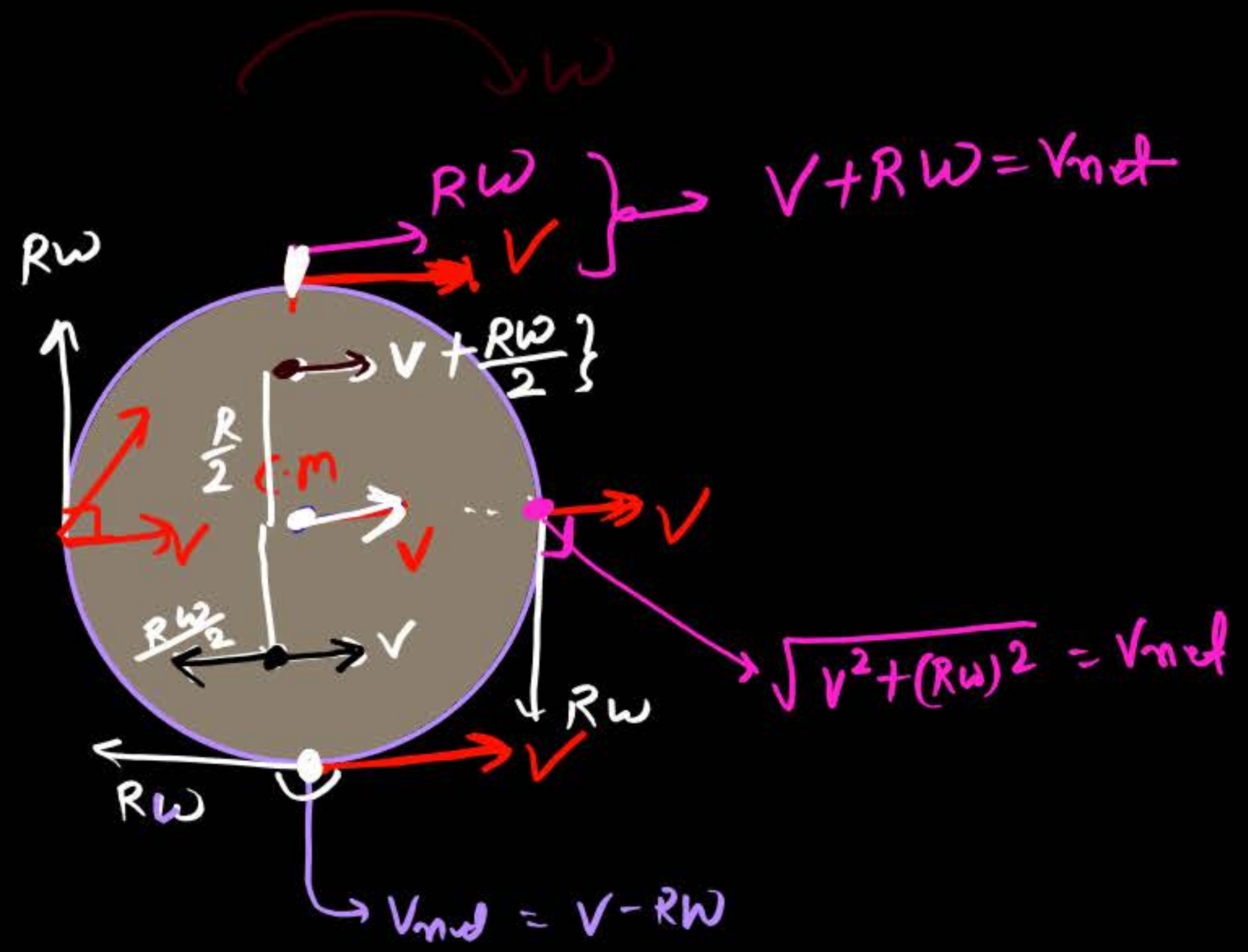
(Ans)



L
L
C·M
v
Pure Translatⁿ
• v = same for all Point
+
ω
v = Lω
r = L
L/2
v = Lω/2
C·M
ω
v = Lω/2
ω
v = Lω
Pure Rotⁿ motⁿ
• ω = same for all Point
v = Lω
v_net = v + Lω
L
ωL/2
v_net = v + Lω/2
C·M
v_T = 0
v_net = v
ω
Lω/2
v_net = v − Lω/2
v = v − Lω
Lω
Rolling motⁿ = Translⁿ + Rotⁿ







Pure Transl

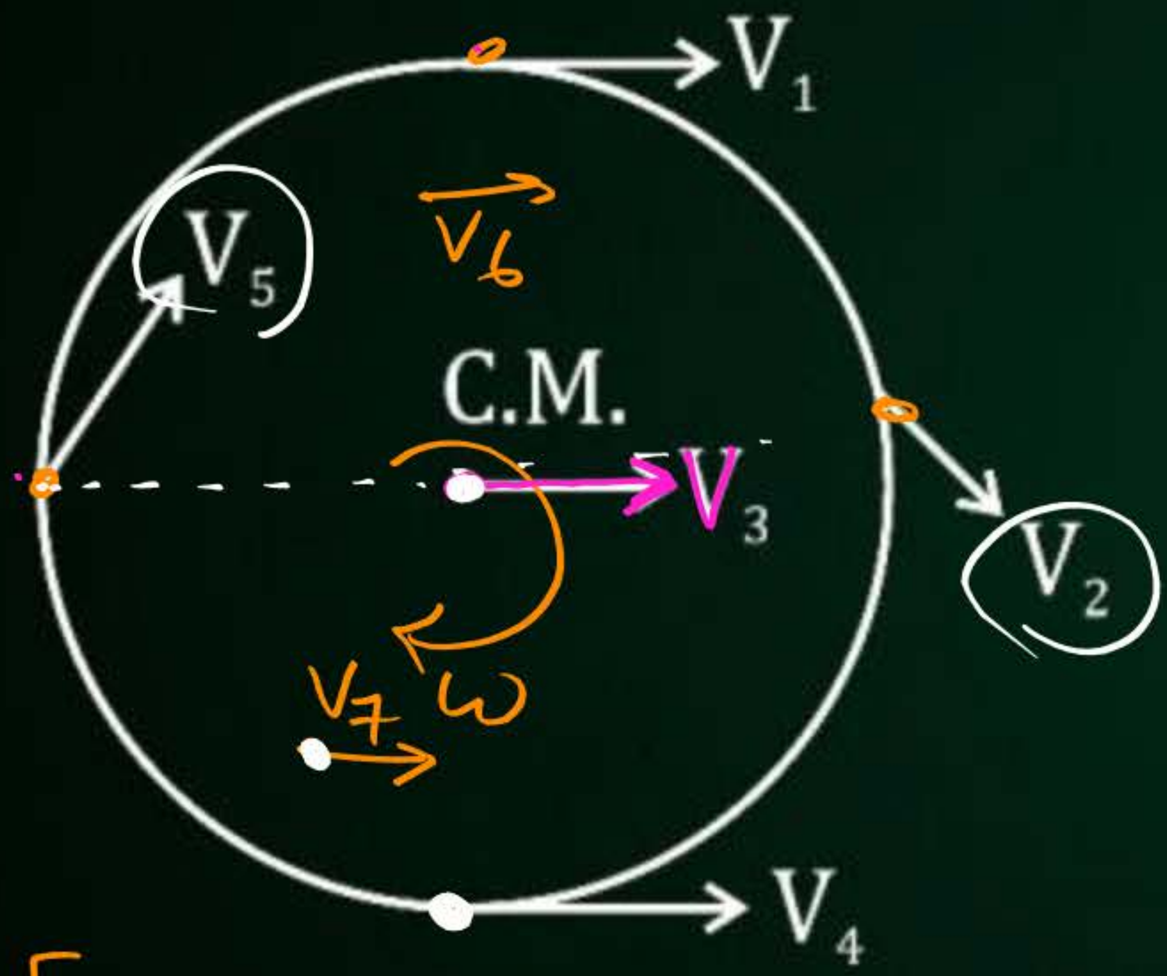
Pure Tran^n Motion

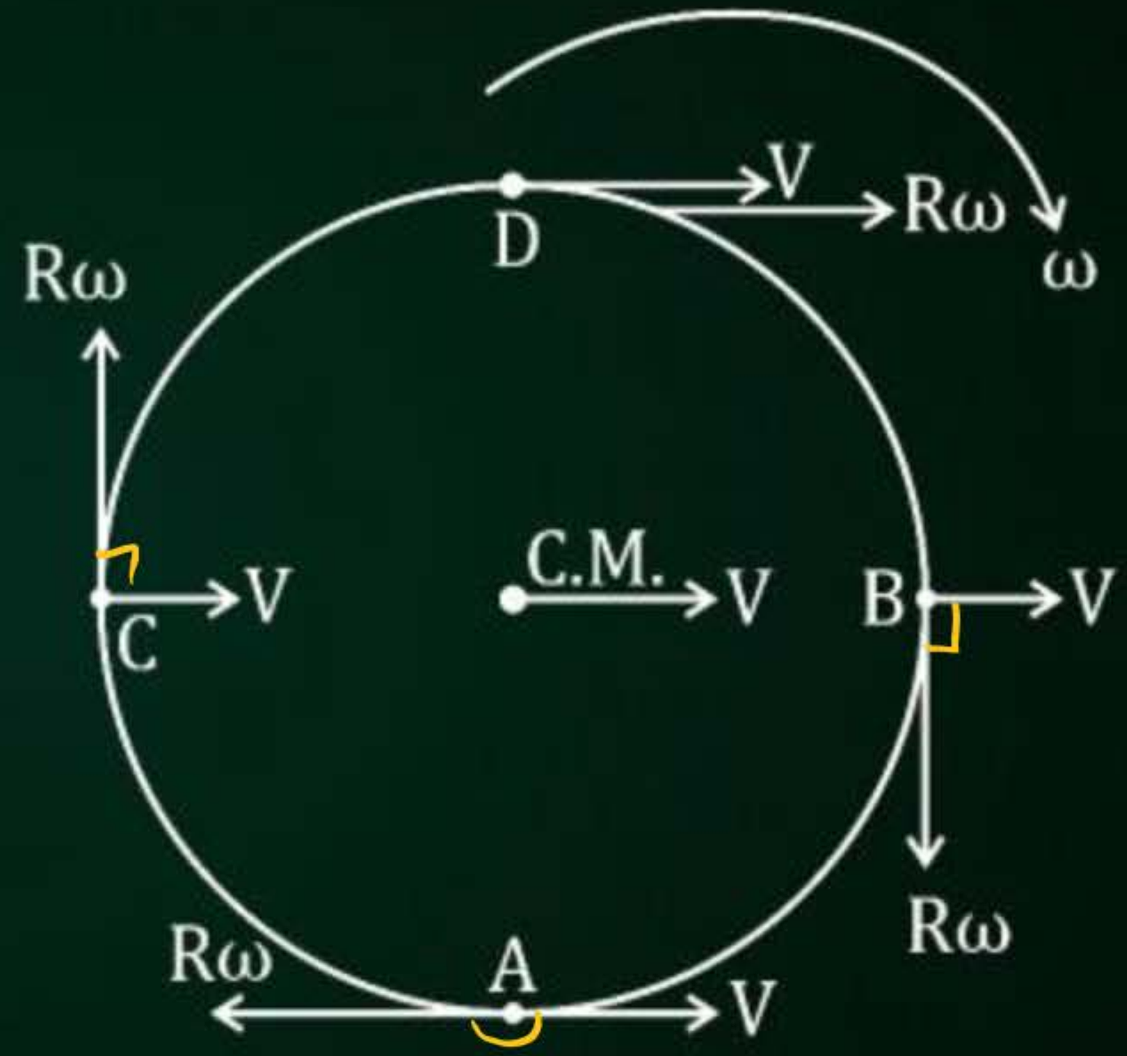
v = Same for all Point.

Pure Rolling about C.O.M

ω = same for all point.

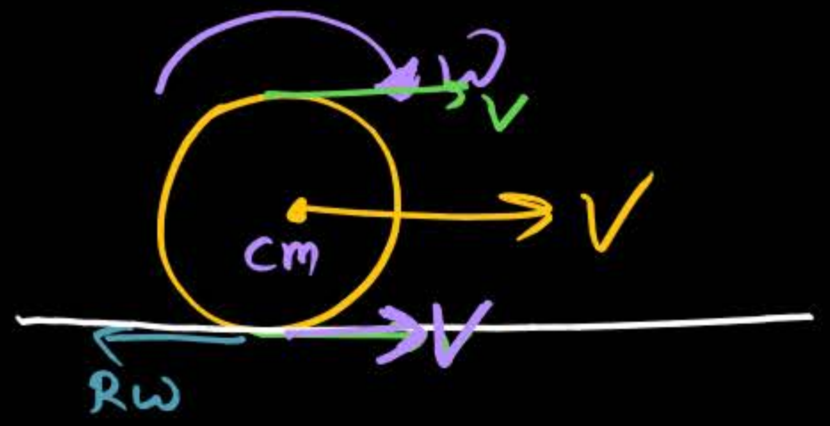
Rolling mot^n





$[V_4 < V_7 < V_3 < V_2 \simeq V_5 < V_6 < V_1]$

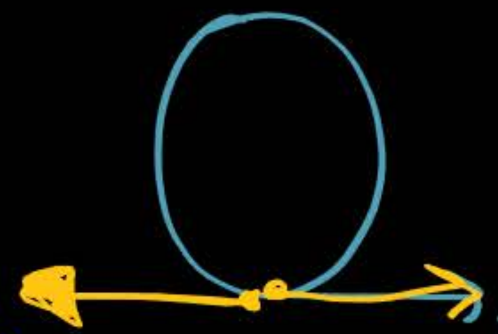
Rolling motn



$V > R\omega$

↑ due to Transⁿ.

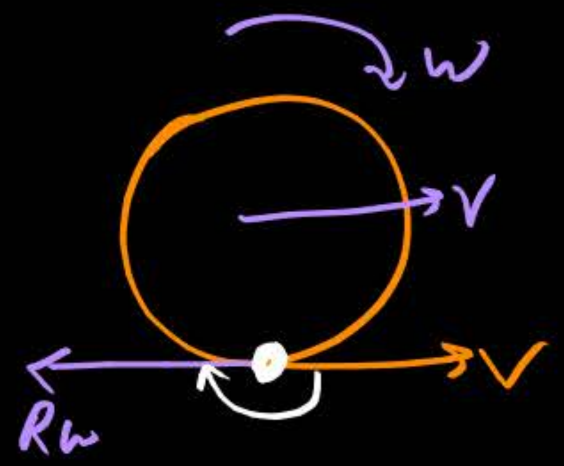
Tangential velocity due to Rotⁿ.



$V_{rel} = V - R\omega$

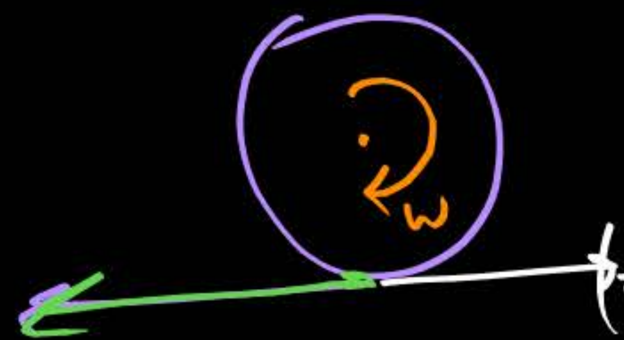
f kinetic Backward

forward slipping.



If $R\omega > V$

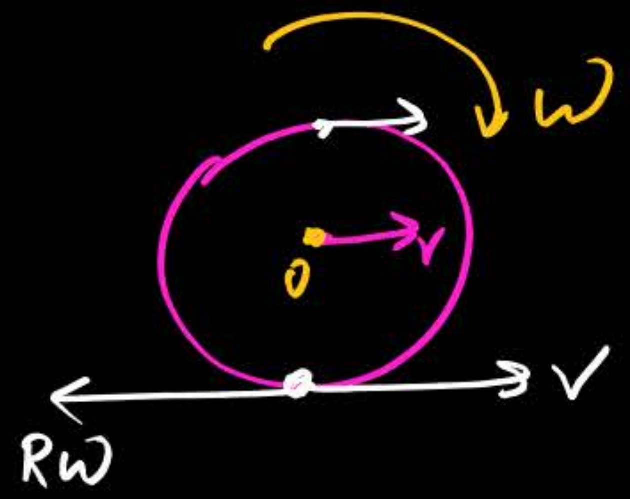
Backward slipping.



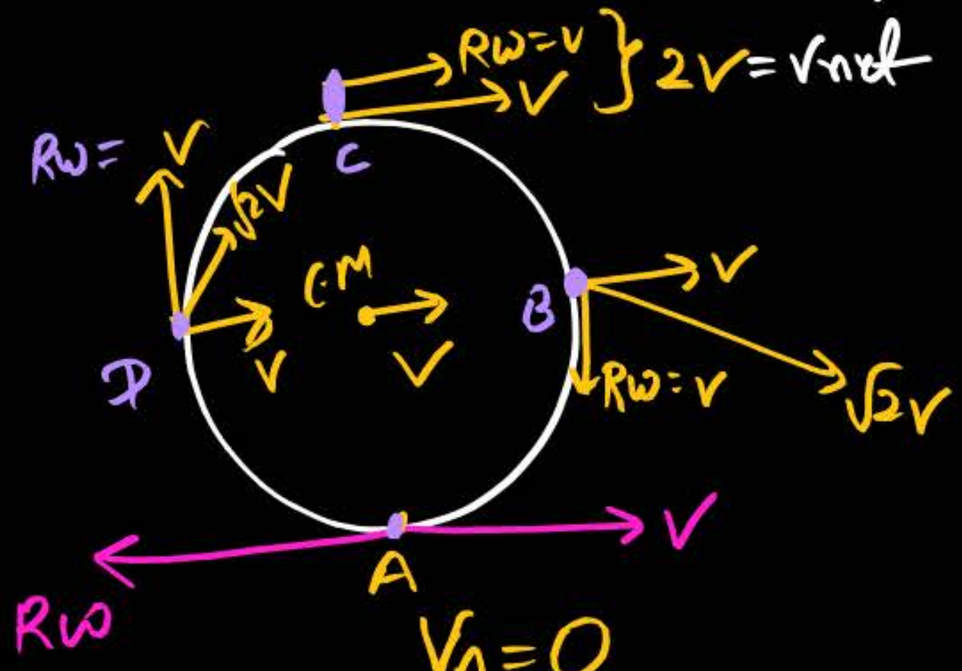
$V_{rel} = R\omega - V$

Backward slipping

(fr) forward kinetic friction.



If $V = R\omega$ (Pure Rolling motⁿ)



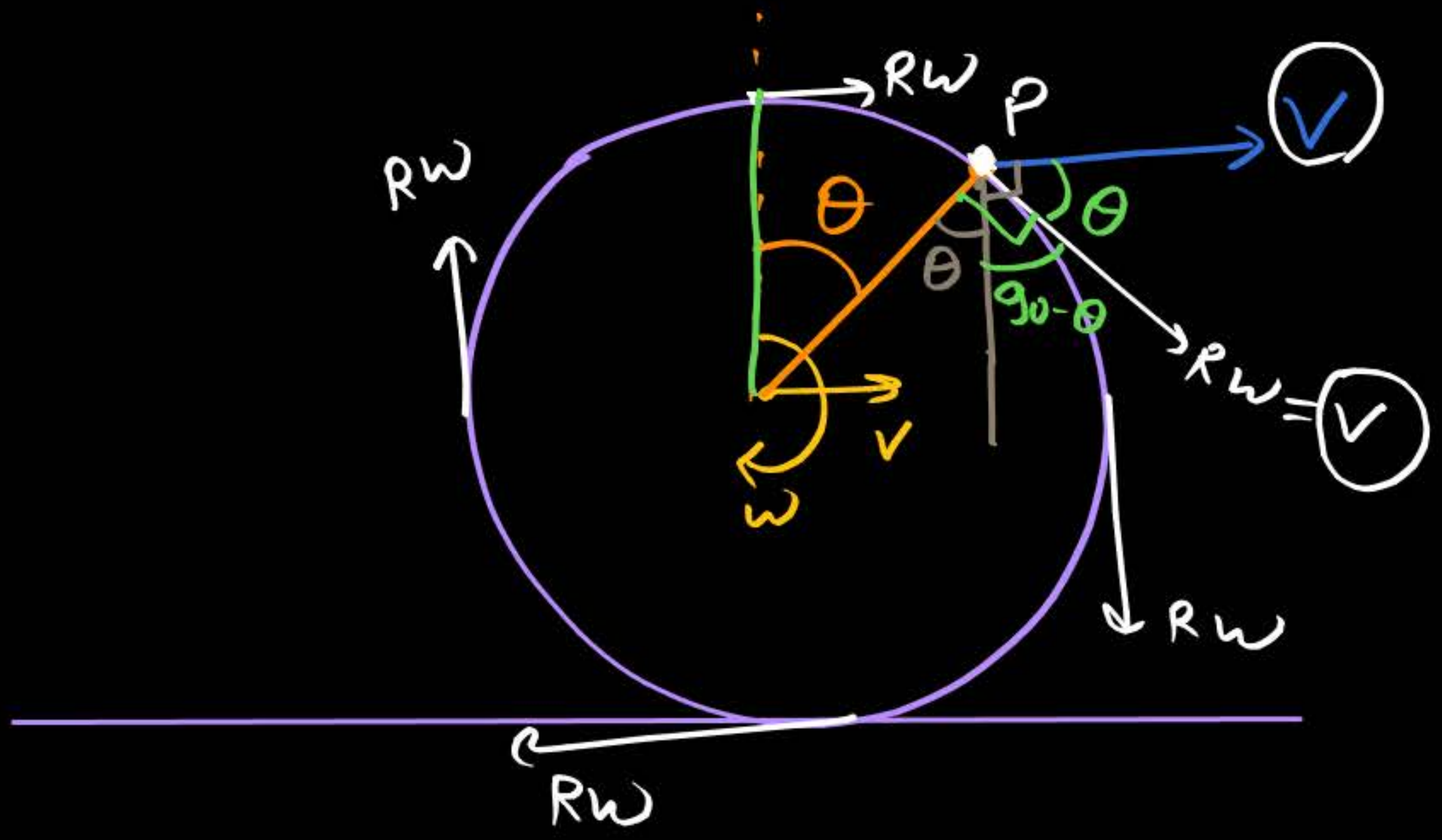
$V_A = 0$

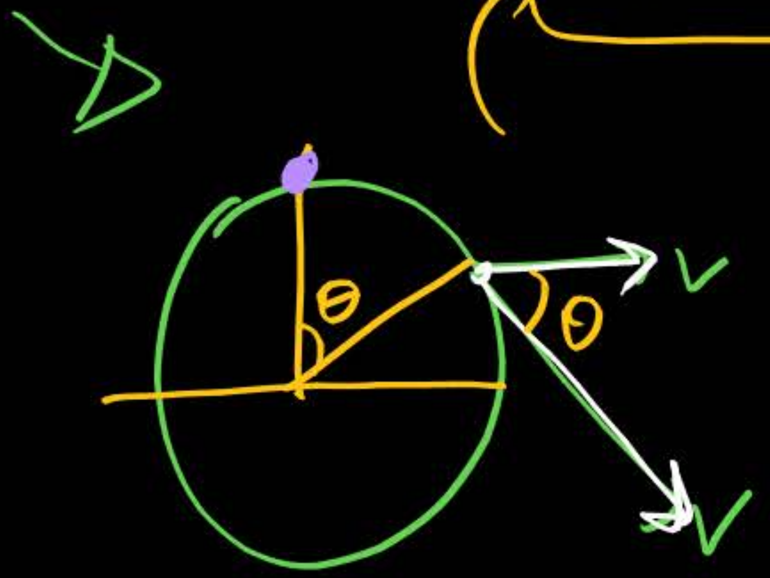
$V_A = 0$

$V_B = \sqrt{2}V = V_D$

$V_C = 2V$

Pure Rolling ($v = R\omega$)





$$v_P = 2v\cos\left(\frac{\theta}{2}\right)$$

MR*

If $\theta = 0$

$V_P = 2V$

$\theta = 90^\circ$

$V_P = \sqrt{2}\,V$

If $\theta = 180$

$V_{Bottom} = 0$

ROLLING

➢ **Total Energy In Rolling Motion**

$$K.E._{Total} = K.E._{Total} + K.E._{Rotion}$$

$$K.E._{Translation} = \frac{1}{2} MV^2 + \frac{1}{2} IW^2$$

K.E in Pure Rolling motion

$\left(V_{c.m} = R\omega \right)$

K = Radius of gyration

$$K.E_{Total} = K.E_{Tran^n} + K.E_{Rot^n}$$

$$K.E_{Total} = \frac{1}{2} m V_{c.m}^2 + \frac{1}{2} I \omega^2$$

$$K.E_{Total} = \frac{1}{2} m V_{c.m}^2 + \frac{1}{2} m K^2 \left[\frac{V_{cm}}{R}\right]^2$$

$$K.E_{Total} = \frac{1}{2} m V_{c.m}^2 + \frac{1}{2} m V_{c.m}^2 \frac{K^2}{R^2}$$

$$K.E_{Total} = \frac{1}{2} m V_{c.m}^2 \left[1 + \frac{K^2}{R^2}\right]$$

$$K.E_{Total} = \frac{K.E_{Tran^n}}{\beta}$$

$$\beta = \frac{1}{\left(1 + \frac{K^2}{R^2}\right)}$$

$$\beta_{Ring} = \frac{1}{1 + \frac{R^2}{R^2}} = \frac{1}{2} \quad (K_{Ring} = R)$$

$$\beta_{Disc} = \frac{1}{1 + \frac{R^2}{2R^2}} = \frac{2}{3} \quad \left(K_{Ring} = \frac{R}{\sqrt{2}}\right)$$

$$\beta_{Hollow\,sp} = \frac{1}{1 + \frac{2}{3}\frac{R^2}{R^2}} = \frac{3}{5} \quad \left(K_{H/s} = \sqrt{\frac{2}{3}}R\right)$$

$$\beta_{solid\,sp} = \frac{1}{1 + \frac{2}{5}} = \frac{5}{7} \quad K_{solid} = \sqrt{\frac{2}{5}}$$

$\beta_{Ring} = \frac{1}{2} = 0.5$ (does not depend on radius & mass) only depends on Geometry

$\beta_{Disc} = \frac{2}{3} = 0.66$

$\beta_{Hollow\ spr} = 3/5 = 0.6$

$\beta_{solid\ spr} = 5/7 = 0.71$

$\beta_{Ring} < \beta_{Hollow\ spr} < \beta_{Dis} < \beta_{solid\ spr}$

0.5 (1/2) 0.6 (3/5) 0.66 (2/3) 0.71 (5/7)

$\beta (K.E_{Total}) = K.E_{Tran}$

$\frac{K.E_{Tran}}{K.E_{Total}} = \beta = 0.5$
$= 0.6$
$= 0.66$
$= 0.71$

$\frac{K.E_{Rotn}}{K.E_{Tu}} = 1 - \beta$

Physical quantity	Ring Hollow cylinder	Hollow sphere	Disc/solid cylinder	Solid sphere
β	$\frac{1}{2} = 0.5$	$0.6 = 3/5$	$\frac{2}{3} = 0.66$	$0.71 = 5/7$
K.E. $_{Translation}$ / K.E. $_{Total}$	$\frac{1}{2} = 50\%$	60%	66%	71%
K.E. $_{Rotion}$ / K.E. $_{Total}$	0.5 50%	0.4 40%	0.33 33%	0.28 28%
K.E. $_{Translation}$ / K.E. $_{Rotation}$	$\frac{\beta}{1-\beta} \Rightarrow 1:1$	3:2	2:1	(5:2)
Acceleration on Inclined				
Time taken to come down				

$\frac{K.E_{Rota}}{K.E_{Total}} \times 100$

Velocity at bottom Inclined				
H_{max} attained by particle				
Friction on inclined plane				
μ_{min} to start Pure Rolling				

QUESTION

When a body is under pure rolling, the fraction of its total kinetic energy which is the purely rotational is $\frac{2}{5}$. Identify the body.

$\Rightarrow \frac{2}{5} = 0.4$

40%

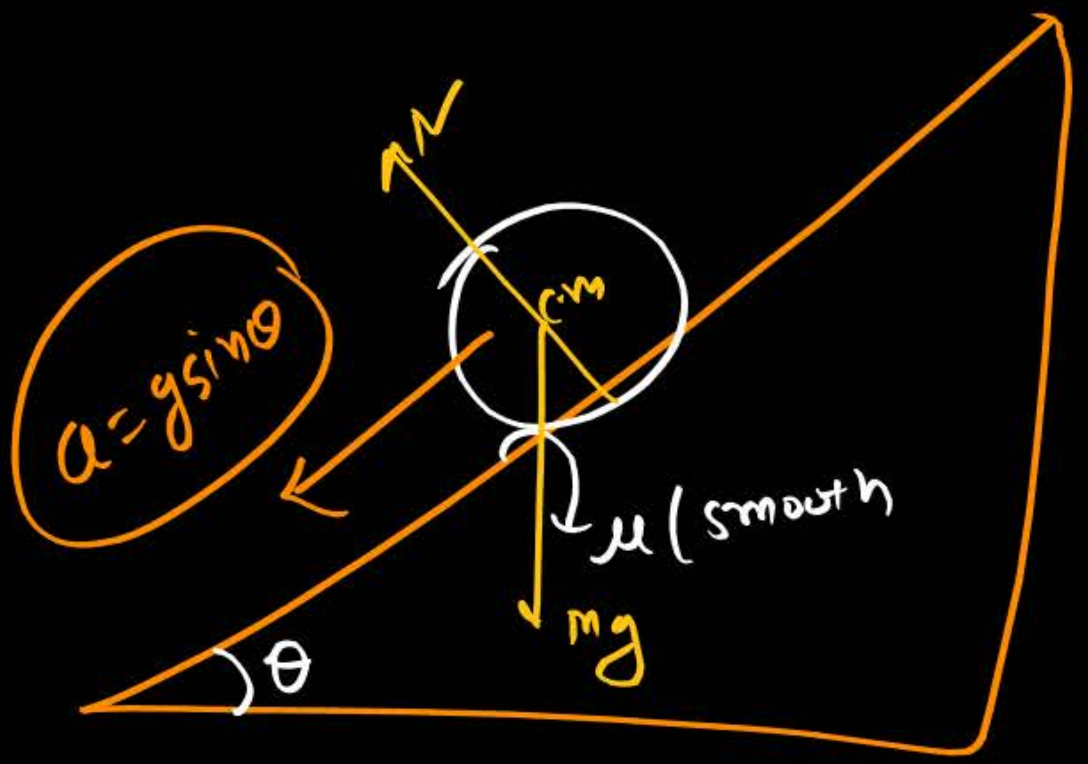
One Page sofus

Hollow sp

→ 50% 60% 66% 71%

→ 50% 40% 33% 28%

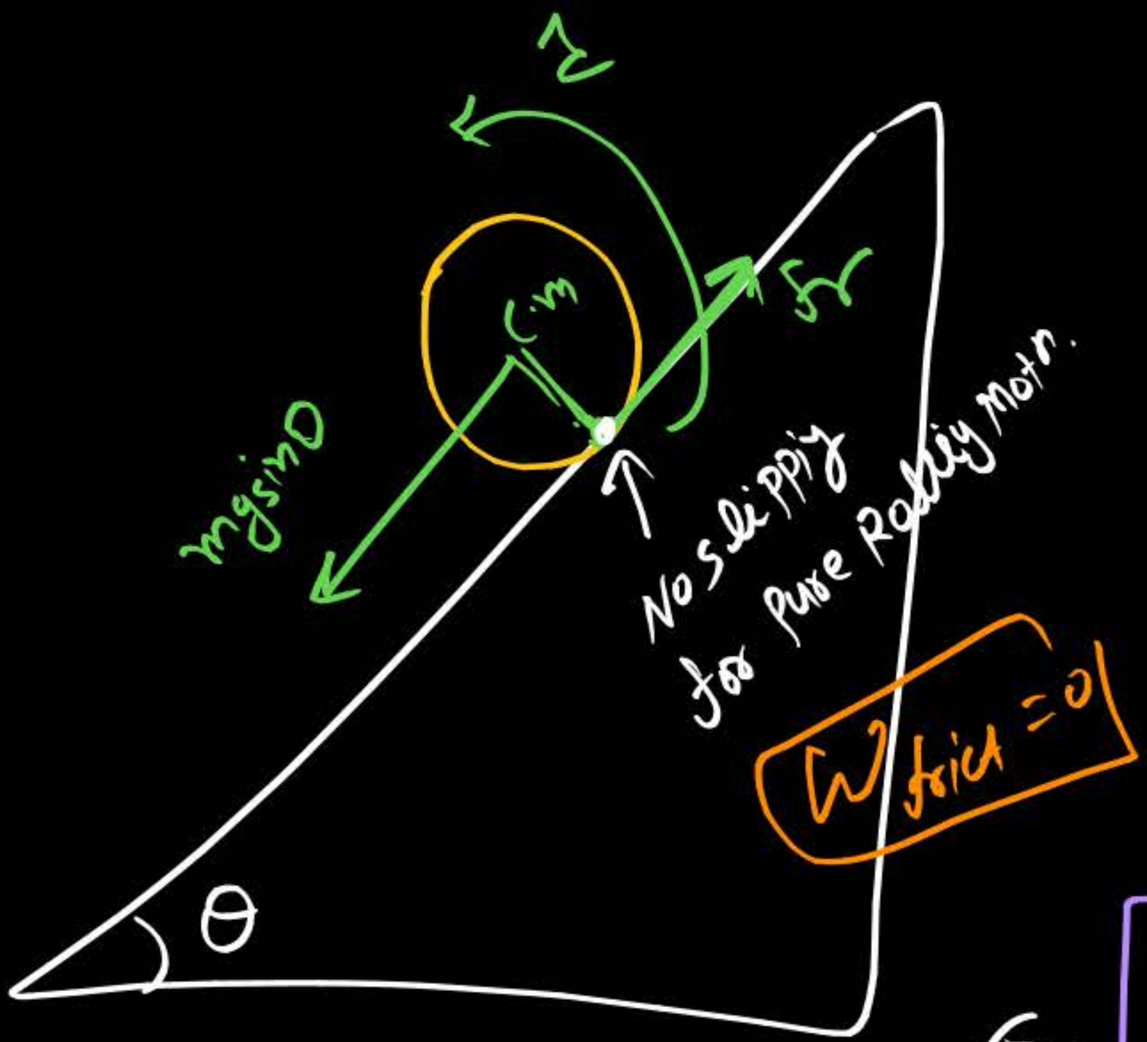
Pure Rolling motion on Inclined Plane



$$a_{Ring} = a_{Sphere} = a_{Disc} = a_{Poly} = g\sin\theta$$

To start Rolling motion is not Possible on smooth Incline Plane. ✓

$$(\tau_N)_{cm} = 0$$
$$(\tau_{mg})_{cm} = 0$$
$$\Rightarrow \tau_{net} = 0$$



$$\tau = I\alpha$$

$$f_r \times R = I\alpha \quad \text{— Rot}^n\text{. motion}$$

$$mg\sin\theta - f_r = ma \quad \text{— (ii)} \quad \text{Trans}^n\text{ Mo.}$$

$$a = \frac{(mg\sin\theta)}{\left(m + I/R^2\right)} = \frac{mg\sin\theta}{m + \frac{mK^2}{R^2}}$$

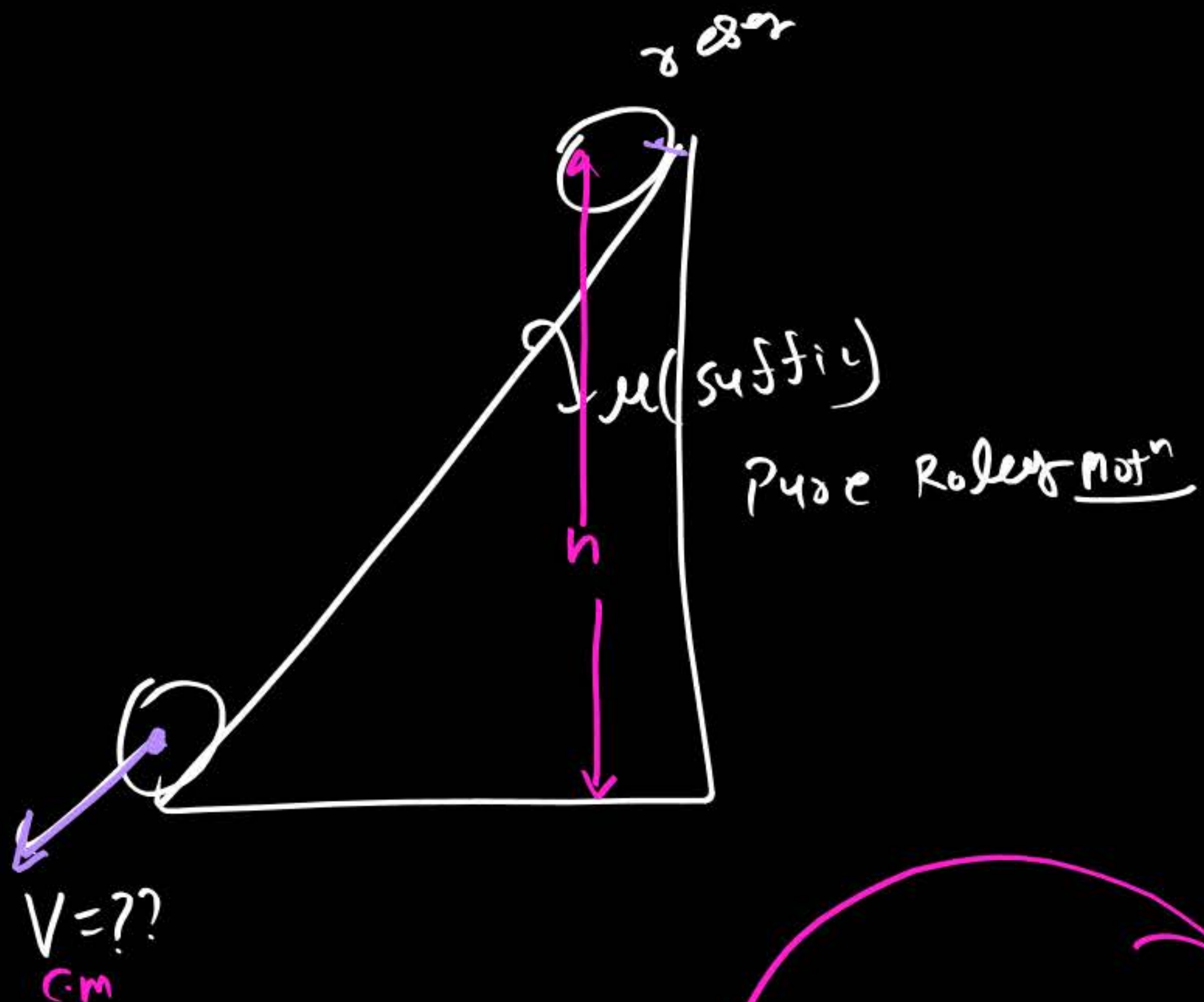
$$a = \frac{m\, g\sin\theta}{m\left(1 + K^2/R^2\right)}$$

$$a = g\sin\theta \times (\beta)$$

$$a_{py} = \frac{g\sin\theta}{2}$$

(★) $a_{\text{solid spr}} > a_{\text{Disc}} > a_{\text{Hollow}} > a_{\text{Ring}}$

$t_{\text{Solid sph}} < t_{\text{Disc}} < a_{\text{Hollow}} < t_{\text{Ring}}$

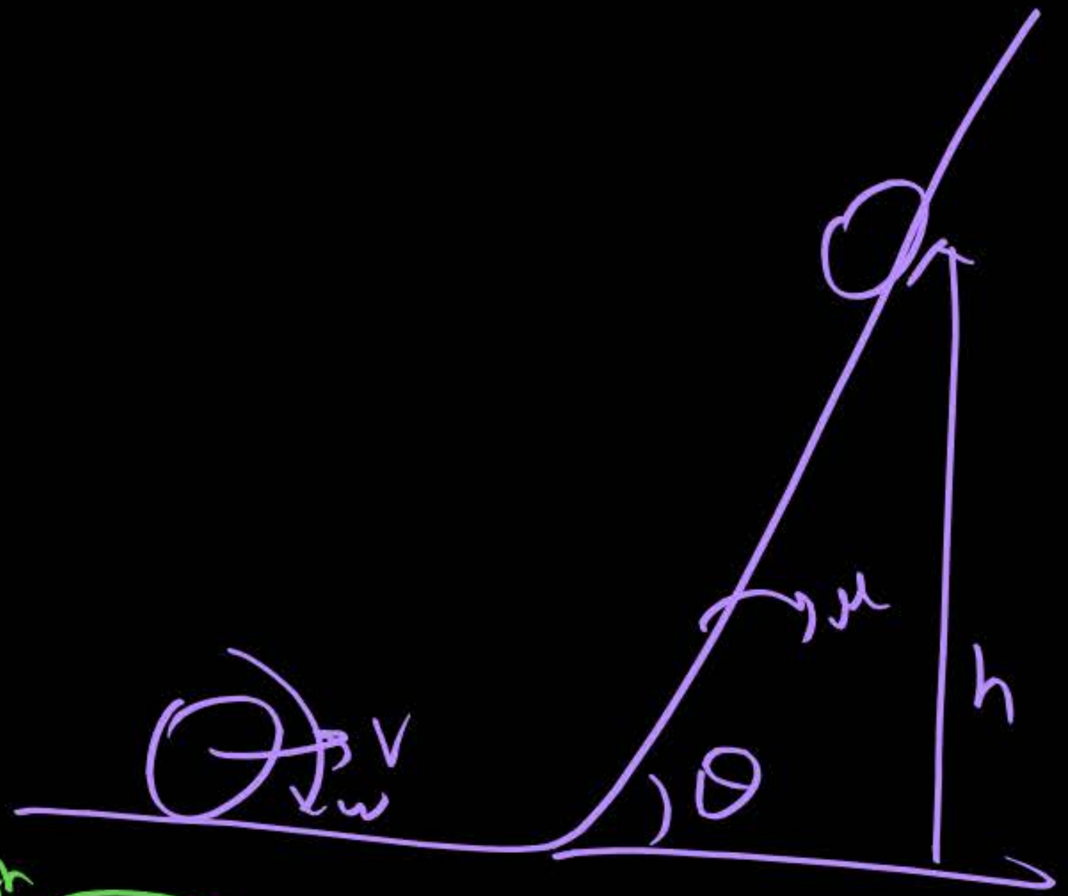


$v = \sqrt{2gh}$ ✓

Smooth surf

Work ens-Pe

$V_{c.m} = \sqrt{2gh(\beta)}$ Ae



Smooth

$\mu = 0$

$h = \left(\frac{v^2}{2g}\right)$

$h = \frac{v^2}{2g\beta}$

$\mu \neq 0$

roy

QUESTION

The kinetic energy of a rolling solid cylinder of mass 4 kg about its axis of rotation is 20 kg m^2 s^{-2}. Calculate the velocity with which it is moving.

QUESTION

Which of the following (if mass and radius are assumed to be same) have maximum percentage of total K.E. in rotational form while pure rolling?

1. Disc
2. Sphere
3. Ring
4. Hollow sphere

$\frac{K.E_{rot}}{K.E_{total}} \times 100 = 50\%$ 60% 66 71

(50) 40 33 28

QUESTION

A spherical shell rolls on a table without slipping. What is the percentage of its K.E. which is rotational ?

1. 50%
2. 40%
3. 70%
4. 90%

QUESTION

When a sphere of moment of inertia I rolls down on an inclined plane the percentage of total energy which is rotational, is approximately

1. 28%
2. 72%
3. 100%
4. None of these

QUESTION

A disc is rolling on an inclined plane without slipping then what fraction of its total energy will be in form of rotational kinetic energy:

1. 1 : 3
2. 1 : 2
3. 2 : 7
4. 2 : 5

$$\frac{K.E_{Rot}}{K.E_{Total}} = 1 - \beta$$

$$= 1 - \frac{2}{3} = \frac{1}{3}$$

QUESTION

If rotational kinetic energy is 50% of total kinetic energy then the body will be:

1. Ring
2. Cylinder
3. Hollow sphere
4. Solid sphere

HOMEWORK FROM YAKEEN MODULE

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THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 8 | **Physics**

Rotational Motion



By- Dr. Manish Raj (MR SIR)

Topics to be covered

1. # Questions on Rolling mot^n
2. # Angular momentum.
3. #
4. #



Pure Rolling motion

$$K.E_{Total} = K.E_{Trans^n} + K.E_{Rot^n}$$

$$K.E_{Total} = K.E_{Tran^n} + K.E_{Rot^n}$$

$$K.E_{Total} = \frac{1}{2} m v_{c.m}^2 + \frac{1}{2} I \omega^2$$

Total K.E. — Translational K.E — Rot^n.

- $K.E_{Total} = \frac{1}{2} m u_{c.m}^2 + \frac{1}{2} I \omega^2$

- $K.E_{Total} = \frac{\frac{1}{2} m u_{c.m}^2}{\beta}$ $\left(\beta = \frac{1}{1 + K^2/R^2}\right)$

m R ~~feel~~ $\beta < 1$

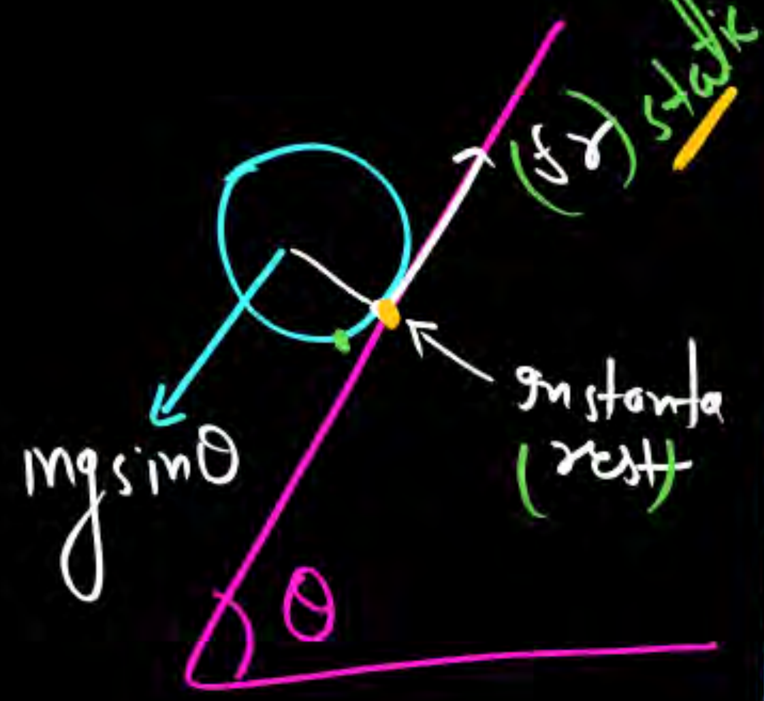
$\frac{K.E_{Tran^n}}{K.E_{Total}} = \beta$

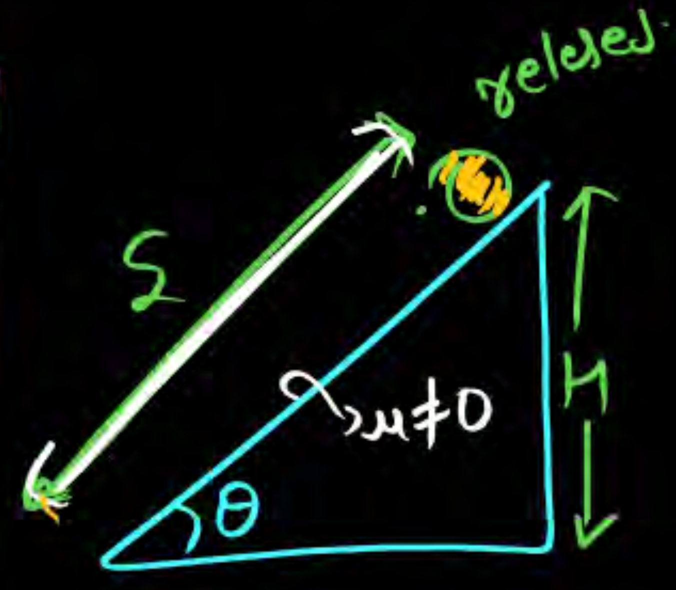
$\frac{K.E_{Rot^n}}{K.E_{Total}} = 1 - \beta$

$\frac{K.E_{Tran^n}}{K.E_{Rot^n}} = \frac{\beta}{1-\beta}$

acc^n of object on rough Inclined $= \{ g\sin\theta \times \beta \}$

does not depends on mass and Radius of object)





$S = \frac{1}{2} g\sin\theta \beta t^2$

$t = \sqrt{\frac{2S}{g\sin\theta\beta}}$

$\sin\theta = \frac{H}{S}$

$t = \sqrt{\frac{2H}{g\sin^2\theta\beta}}$

Work done by friction $= 0$

$mg\sin\theta - f_r = ma_{c.m.}$

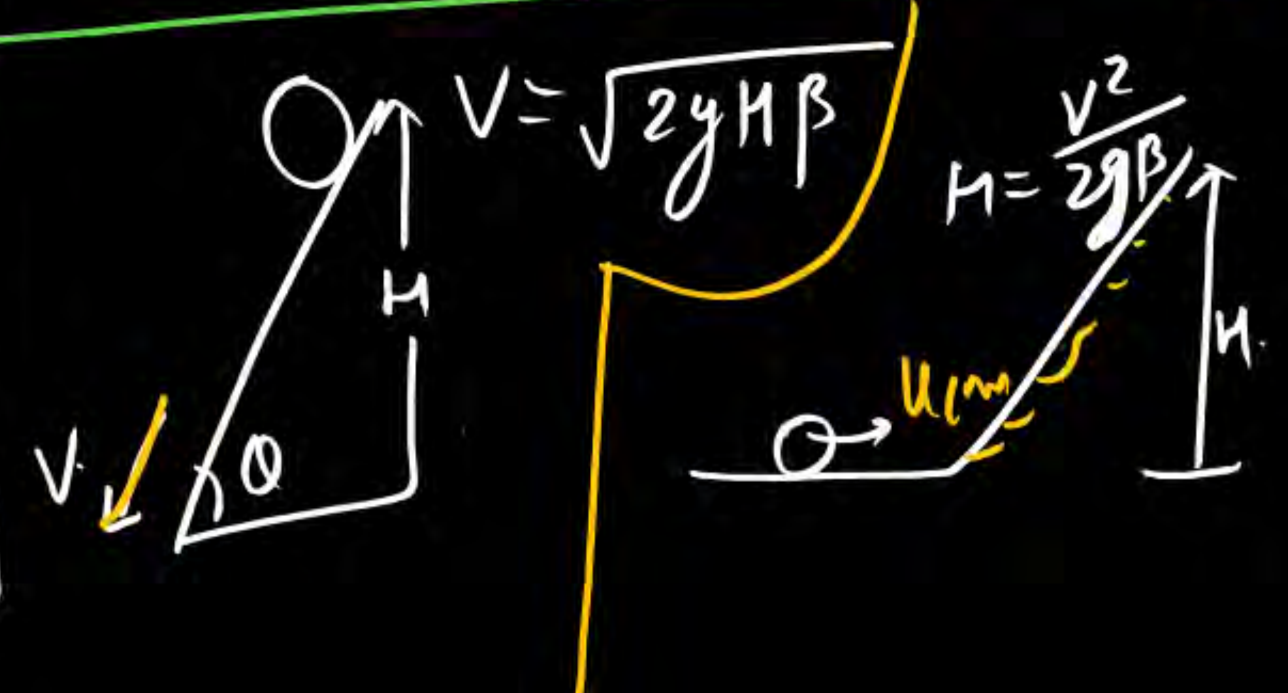
Find friction by putting value of $a_{c.m.}$

$(f_r)_{static} = mg\sin\theta(1-\beta)$

minimum value of coefficient friction for pure Rolling motion

$\mu = \tan\theta(1-\beta)$

mR Rolling



Physical quantity	Ring (Hollow cylinder)	Hollow sphere	Disc (solid cylinder)	Solid sphere
β	$\frac{1}{2} = 0.5$	$0.6 = \frac{3}{5}$	$0.66 = \frac{2}{3}$	$0.71 = \frac{5}{7}$
K.E. $_{Translation}$ / K.E.$_{Total}$	0.5 50%	0.6 60%	0.66 66%	0.71 71%
K.E.$_{Rotion}$ / K.E.$_{Total}$	0.5 50%	0.4 40%	0.33 33%	.28% $\left(1-\frac{5}{7}\right) = \frac{2}{5}$
K.E.$_{Translation}$ / K.E.$_{Rot^n}$ $\frac{\beta}{1-\beta}$	$= 1:1$	$3:2$	$2:1$	$5:2$
Acceleration on Inclined $g\sin\theta\,\beta$	$\frac{g\sin\theta}{2}$	$g\sin\theta \times \frac{3}{5}$	$g\sin\theta\left(\frac{2}{3}\right)$	$g\sin\theta\left(5/7\right)$
Time taken to come down	$t = \sqrt{\frac{2S}{g\sin\theta\,\beta}}$	$t = \sqrt{\frac{2S \times 5}{g\sin\theta\, 3}}$		

$S =$ length

$\sqrt{2gH(\beta)}$

Velocity at bottom Inclined	$\sqrt{2gH\frac{1}{2}} = \sqrt{gH}$	$V = \sqrt{2gH\frac{3}{5}} = \sqrt{\frac{6gH}{5}}$	$V = \sqrt{2gH\frac{2}{3}}$	$V = \sqrt{2gH(5/7)}$
H_{max} attained by particle $H = \frac{v^2}{2g\beta}$	$H = \frac{v^2}{2g(\frac{1}{2})}$	$\frac{v^2}{2g(\frac{3}{5})} = \frac{5v^2}{6g}$ Hollow	$\frac{v^2}{2g(\frac{2}{3})} = \frac{3v^2}{4g}$	$H = \frac{v^2}{2g(5/7)} = \frac{7v^2}{10g}$
Friction on inclined plane $mg\sin\theta(1-\beta)$	$\Rightarrow mg\sin\theta\left(\frac{1}{2}\right)$	$mg\sin\theta\left(\frac{2}{5}\right)$	$mg\sin\theta\left(\frac{1}{3}\right)$	$mg\sin\theta\left(\frac{2}{7}\right)$
μ_{min} to start Pure Rolling $\mu = \tan\theta(1-\beta)$	$\frac{\tan\theta}{2}$	$\frac{2}{5}\tan\theta$	$\frac{\tan\theta}{3}$	$\tan\theta\,\frac{2}{7}$
Work energy theorem $W_{Total} = \Delta K.E$			Work done to stop the Rolling object	
$W_{Total} = \frac{1}{2}mv^2$ $W_{total} = \frac{1}{2}I\omega^2$	$W_{Total} = K.E_T + K.E_{Rot}$			$W_{Total} = K.E_{Total} = \frac{K.E_{Train}}{\beta}$

QUESTION

A disc of radius 2 m and mass 100 kg rolls on a horizontal floor. Its center of mass has speed of 20 m/s. How much work is needed to stop it? [NEET 2019]

1. 3 J
2. 30 kJ
3. 2 J
4. 1 J

QUESTION

A solid sphere is in rolling motion. In rolling motion a body possesses translational kinetic energy (K_t) as well as rotational kinetic energy (K_r) simultaneously. The ratio $K_t : (K_t + K_r)$ for the sphere is : [NEET 2018]

1. $10 : 7$ ✗
2. $7 : 10$ ✗
3. $2 : 5$ ✗
4. $5 : 7$ ✓

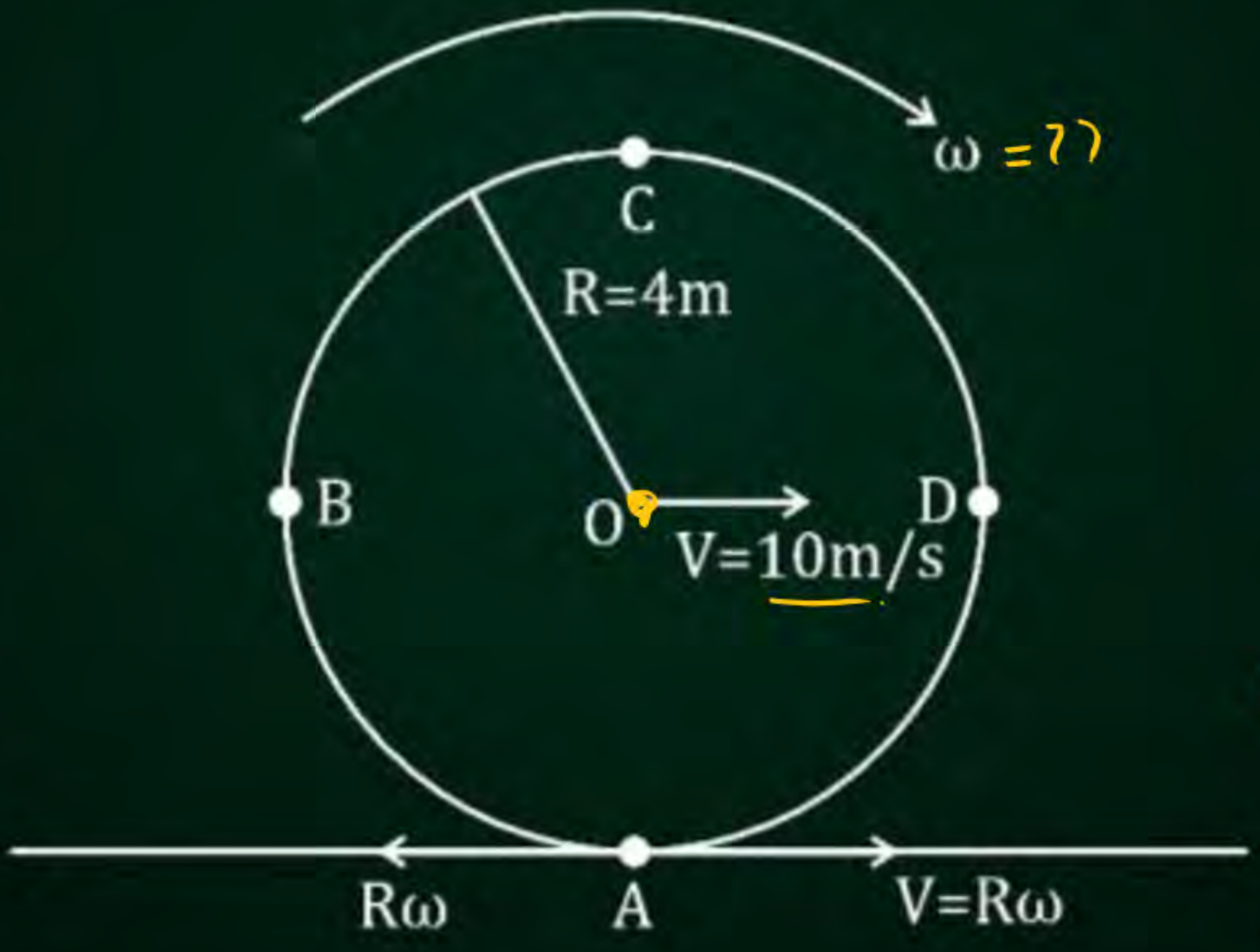
QUESTION

A circular disc of mass 2 kg and radius 10 cm rolls without slipping with a speed 2 m/s. The total kinetic energy of disc is :

$$K.E_{Total} = \frac{\frac{1}{2}mv^2}{\beta}$$

QUESTION

Find ω and velocity of point A, B, C and D if body is in pure rolling motion.



253 old edition

same content

Page → 298 ≃ 348

50 Page add

Pure Rolling

$V_{c.m} = R\omega$

$10 = 4\omega$

$\omega = \frac{10}{4}$ rad/s

$V_A = 0$

$V_D = 10\sqrt{2}$ m/s

$V_B = 10\sqrt{2}$ m/s

$V_C = 2V$

QUESTION

A solid cylinder of mass 20 kg rotates about its axis with angular speed 100 rad s^{-1}. The radius of the cylinder is 0.25 m. What is the kinetic energy associated with the rotation of the cylinder and total energy?

Rotational $K.E = \frac{1}{2} I \omega^2$

$K.E_{Total} = \frac{1}{2} m v^2 + \frac{1}{2} I \omega^2$

QUESTION

The kinetic energy of a rolling solid cylinder of mass 4 kg about its axis of rotation is 20 kg m² s⁻². Calculate the velocity with which it is moving.

$K.E = \frac{1}{2}mv^2 = 20 = \frac{1}{2} 4 v^2$

$\sqrt{10} = v$

$K.E = \frac{\frac{1}{2}mv^2}{\beta}$

$20 \times \frac{3}{3} = \frac{1}{2} 4 v^2$

$V = \sqrt{\frac{20}{3}}$ m/s.

QUESTION

Two disc having masses in the ratio 1 : 2 and radii in the ratio 1 : 8 roll down without slipping one by one from an inclined plane of height *h*. The ratio of their linear velocities on reaching the ground is

1. $1:16$
2. $1:128$
3. $1:8\sqrt{2}$
4. $1:1$

$V = \sqrt{2gH\beta}$

QUESTION

Which of the following (if mass and radius are assumed to be same) have maximum percentage of total K.E. in rotational form while pure rolling?

1. Disc
2. Sphere
3. Ring
4. Hollow sphere

0.5 0.6 0.66 0.71%

0.5 0.4 0.33 0.28

QUESTION

Disc ($v=\sqrt{2gh \times \frac{2}{3}}$

Ring Hollow So Disc Solid
$\frac{2}{3}$

A solid cylinder of mass M and radius R rolls down an inclined plane of height h. The angular velocity of the cylinder when it reaches the bottom of the plane will be

1. $\frac{1}{2R}\sqrt{gh}$ ×
2. $\frac{2}{R}\sqrt{gh}$ ×
3. $\frac{2}{R}\sqrt{\frac{gh}{3}}$ ✓
4. $\frac{2}{R}\sqrt{\frac{gh}{2}}$ ×

$v=R\omega \quad \omega=\frac{v}{R}$

→ K.E is conserved in (elastic collision) (True)

QUESTION

The speed of a uniform solid cylinder after rolling down an inclined plane of vertical height H, from rest without sliding is

1. $\sqrt{\frac{gH}{3}}$
2. $\sqrt{\frac{2gH}{3}}$
3. $\sqrt{gh}$
4. $\sqrt{\frac{4gH}{3}}$

QUESTION

A thin uniform circular ring is rolling down an inclined plane of inclination 30° without slipping. Its linear acceleration along the inclined plane is

1. g
2. $\frac{g}{2}$
3. $\frac{g}{3}$
4. $\frac{g}{4}$

$$a = g\sin\theta\,\beta$$
$$= g\sin 30^\circ \times \frac{1}{2}$$
$$= g \times \frac{1}{2} \times \frac{1}{2} = \frac{g}{4}$$

QUESTION

solid

A cylinder of radius R and M rolls without slipping down a plane inclined at an angle θ. Coefficient of friction between the cylinder and the plane is μ. For what maximum-inclination θ will the cylinder roll without slipping?

1. $\tan^{-1} \mu$
2. $\tan^{-1} 2\mu$
3. $\tan^{-1} 3\mu$ ✓
4. $\tan^{-1} \mu/3$

$\mu = \tan\theta\,(1-\beta)$

$\mu = \frac{\tan\theta}{3}$

$\theta = \tan^{-1}(3\mu)$ Ans

QUESTION

Two solid spheres of different mass, radii and density roll down a rough inclined plane under identical situation. Their time to come down is independent of their

1. Mass
2. Radius
3. Density
4. All of these

{Same} $a = \frac{g\sin\theta}{\beta}$

$t = $ same.

QUESTION

A thin circular ring first slips down a smooth incline then rolls down a rough incline of identical geometry from same height. Ratio of time taken in the two motion is

1. $\frac{1}{2}$
2. 1
3. $\frac{1}{\sqrt{2}}$
4. $\frac{1}{4}$

$$t_1 = \sqrt{\frac{2s}{g\sin\theta}}$$

$$t_2 = \sqrt{\frac{2s}{g\sin\theta\,\beta}}$$



$$\frac{t_1}{t_2} = \frac{1}{\frac{1}{\sqrt{\beta}}} = \sqrt{\beta}$$

QUESTION

When a body is rolling without slipping on a rough horizontal surface, the work done by friction is

1. Always zero
2. May be zero
3. Always positive
4. Always negative

QUESTION

A solid spherical ball is rolling without slipping down an inclined plane. The fraction of its total energy associated with rotation is

1. $\frac{2}{5}$
2. $\frac{2}{7}$
3. $\frac{3}{5}$
4. $\frac{3}{7}$

QUESTION

An inclined plane makes an angle of 30° with the horizontal. A solid sphere rolling down this inclined plane from rest without slipping has a linear acceleration equal to

1. $\frac{g}{3}$
2. $\frac{2g}{3}$
3. $\frac{5g}{7}$
4. $\frac{5g}{14}$

$a = g\sin\theta \times \beta$

$= g \times \frac{5}{7} \times \sin 30^\circ$

QUESTION

What is the minimum coefficient of friction for a solid sphere to roll without slipping on an inclined plane of inclination θ?

$\mu = (1-\beta)\tan\theta$

1. $\frac{2}{7}\tan\theta$ ✓

2. $\frac{1}{3}g\tan\theta$

3. $\frac{1}{2}\tan\theta$

4. $\frac{2}{5}\tan\theta$

Angular momentum.

→ Rotafation motion contain momentum by a body is Angular

→ $\vec{L} = I\vec{\omega}$ (Pure Rot^n mot^n)

→ dir^n along ($\vec{\omega}$)

→ axial vector

→ unit → kg m^2/sec.

→ (ML^2T^{-1})

→ depend on frame of refrence.

$\tau = \frac{dL}{dt}$ → Torque

$K.E = \frac{1}{2} I \omega^2$

$K.E. = \frac{1}{2} I \omega^2 \times \left[\frac{I}{I}\right]$

$K.E = \frac{L^2}{2I}$





$\vec{P} = m\vec{v}$

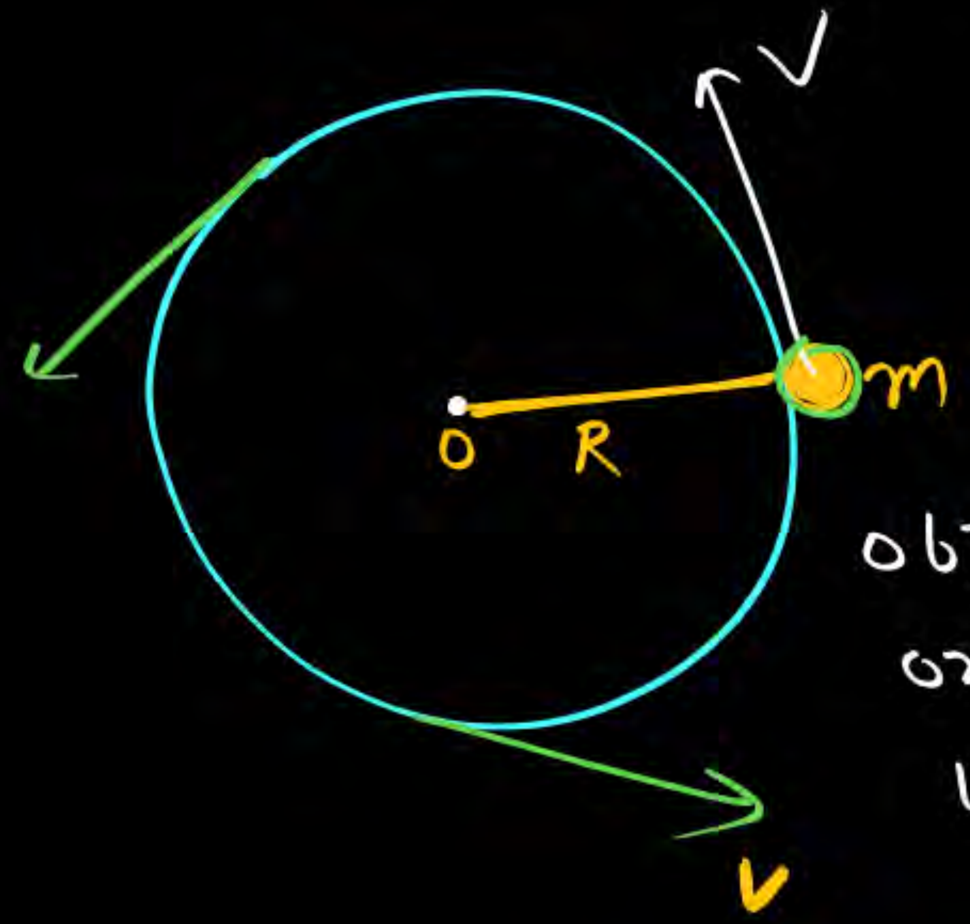
→ vector

→ dir^n along velocity.

→ kg m/sec

$F = \frac{dP}{dt}$

Pure Rotation



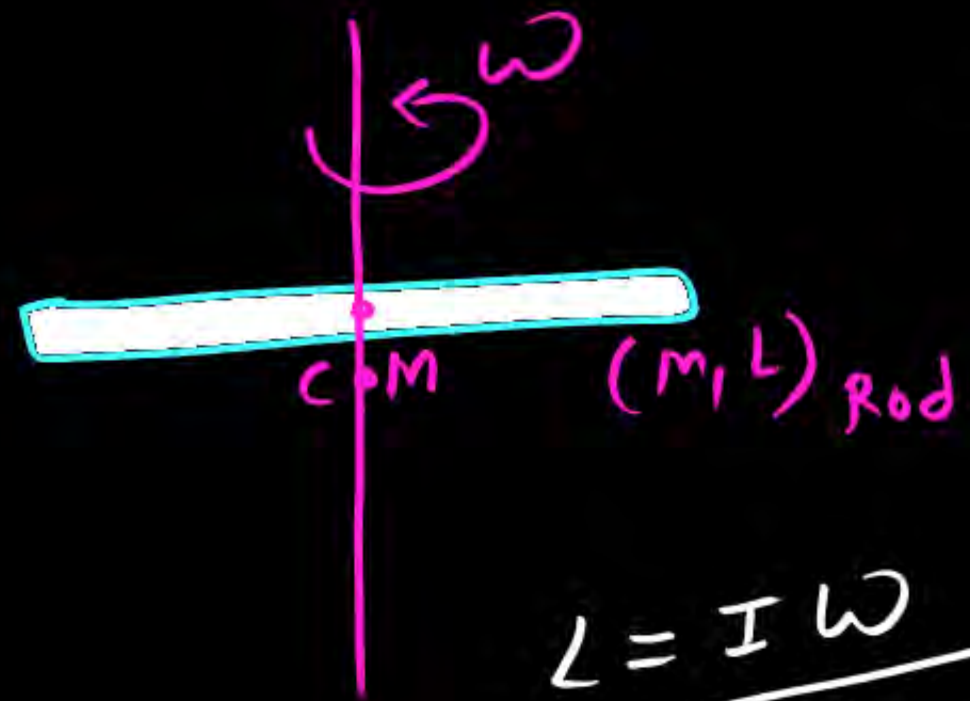
object is moving on circular Path with speed v of Radius 'R'

$v = R\omega$ $\quad$ $I = mR^2$

$L = I\omega$ ✓

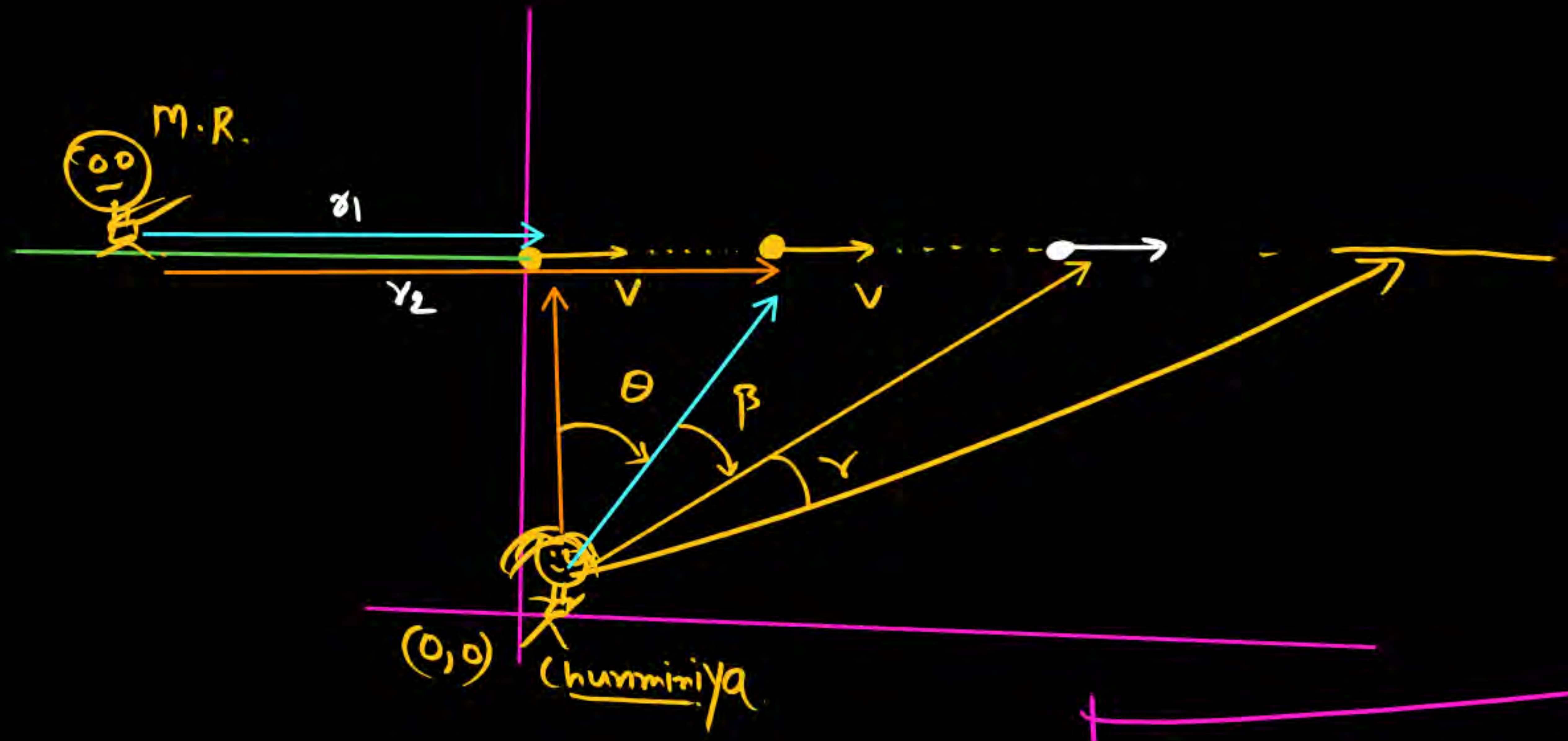
$= mR^2\left[\frac{v}{R}\right]$

→ $L = mvR$



$L = I\omega$

$$L = \frac{mL^2}{12}\omega$$



- Object is in Pure Translational motion w.r.t. (M.R.) because only length of Position vector is changing.

$(L_{object})_{MR} = 0$

$(L_{object})_{chumm} \neq 0$ (feel)

Object is in (Rotational motⁿ + Tralⁿ) w.r.t. Chummuriya.
because dirⁿ of Position vector is also changing.

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FOR NEET 2025

Lecture- 9 | **Physics**

Rotational Motion

By- Dr. Manish Raj (MR SIR)



Topics to be covered

1 # • Angular momentum & conservation of Angular momentum

2 # • Angular momentum

3 #

4 #

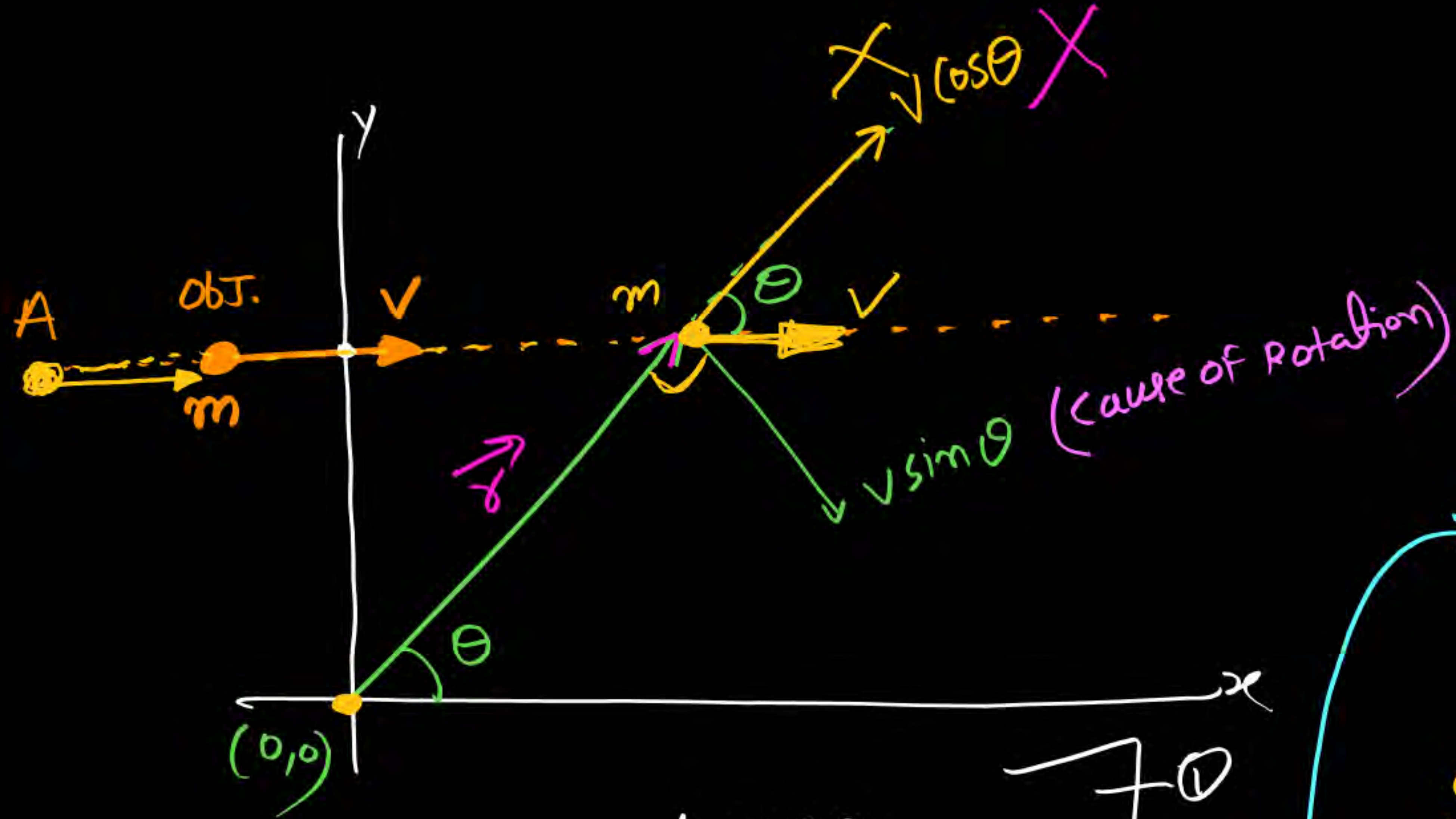
→ Important for NEET

① M.O.I

② Torque $\alpha I = 1$

③ Angular momentum





$\vec{P} = m\vec{v}$

$(L_{object})_A = 0$

$L_{(0,0)} \neq 0$

$L \propto m$ (i)

$L \propto v\sin\theta$ (ii)

$L \propto r$ (radius) (iii)

$L = mvr\sin\theta$

$L = rp\sin\theta$

Rel^n B/w Angular & Linear moment.

$$\vec{L} = \vec{r} \times \vec{p}$$

$L = rp\sin\theta$

object is in Pure Transl^n Mot^n then Angular Momentum may not be zero.

Pure Rot^n. (circular motion of point obj)



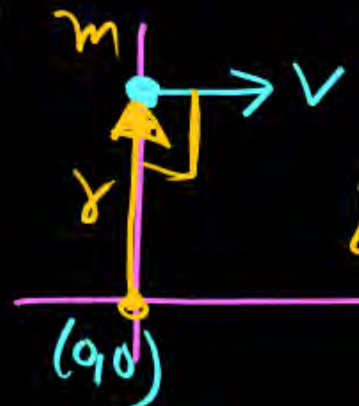
$L = rp\sin 90^\circ$

$L = rmv$

$= rm[r\omega]$

$= mr^2\omega$

$$\vec{L} = I\vec{\omega}$$



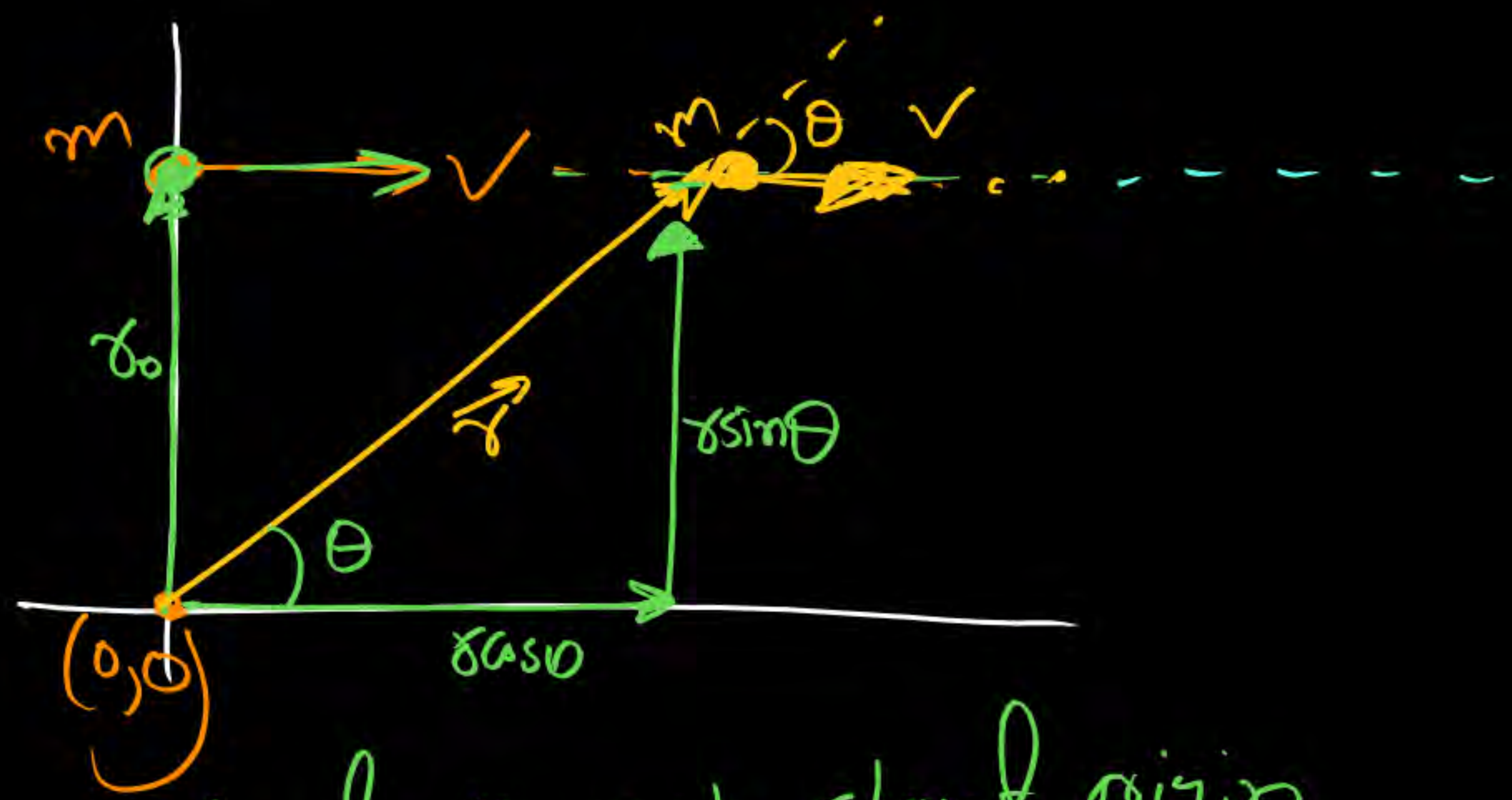
$L_{(0,0)} = mvr\sin 90$

$= (mvr)$

$$\vec{L} = \vec{r}_{1r} \times \vec{P}_{1r}$$

$$L_{t=0} = mv_0 r$$

$$L_{at\ t} = mv(r\sin\theta)$$
$$= mvr_0$$

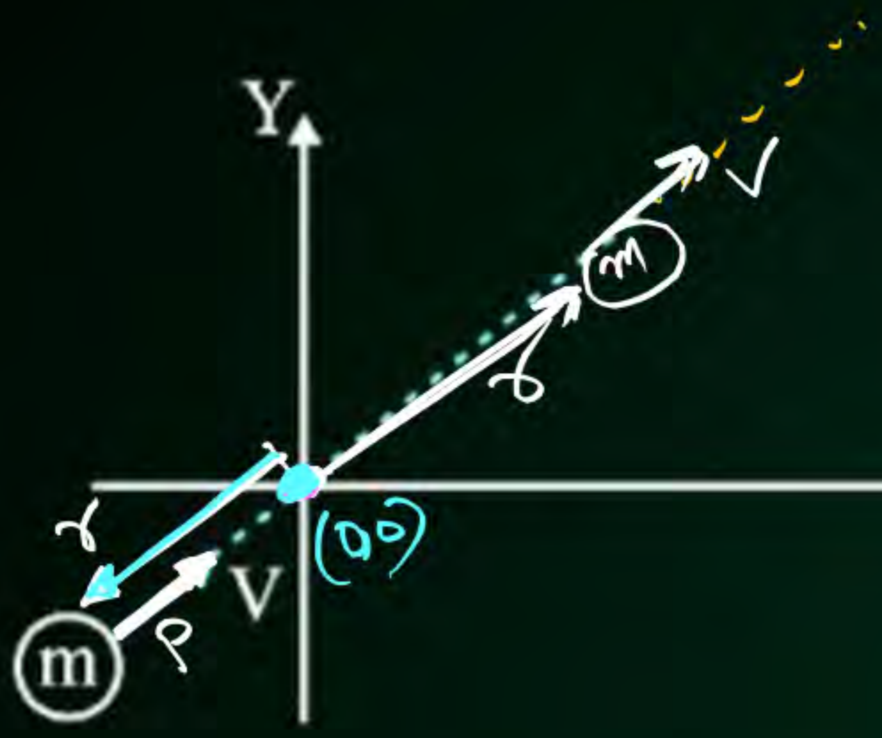


Angular moment about origin.

(i) Increase 40%

(ii) Constant (40%)

(iii) decrease



Angular momentum about origin. = ??

(a). decresing, zero then Incresing

(b) zero, & Incrsiy

(c) always zero ✓ (48%)

(d) zero & decrsiy

$L = I\omega$

$\vec{L} = \vec{r} \times \vec{P} = rp\sin\theta$

Position vector from reference.

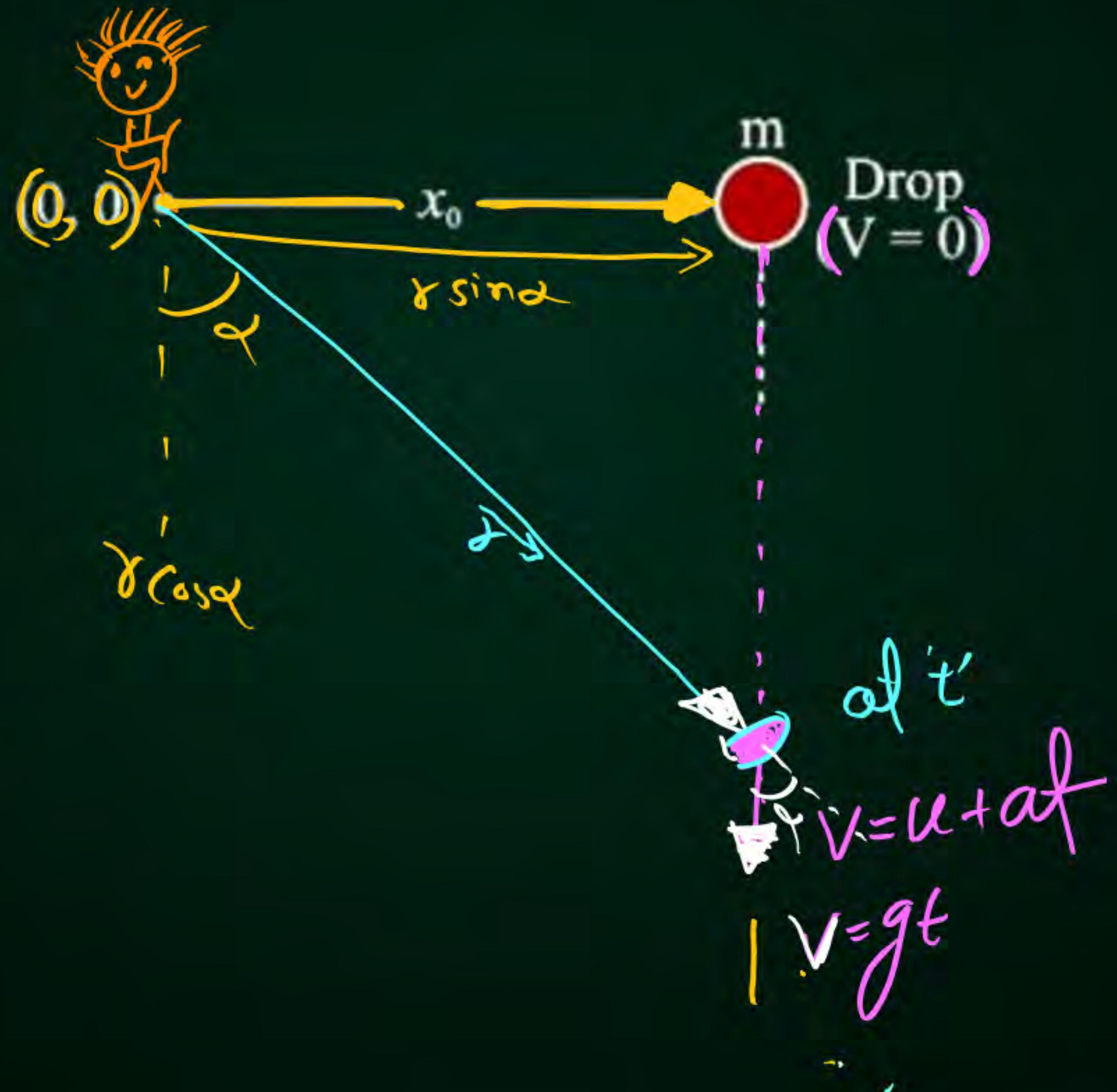
$= (r_{\perp r})(\vec{P})_{\perp r}$

$L = rp\sin\theta$

Angle b/w $\vec{r}$ & $\vec{P}$

QUESTION

Find angular momentum. After time ‘t’.



$$L = rp\sin\theta$$

$$L = (r_{\perp r})(P_{\perp r})$$

$$= (mv) \times (r\sin\alpha)$$

$$= mv x_0$$

$$\boxed{L = mgt x_0}$$

$$\vec{L} = \vec{r} \times \vec{P}$$

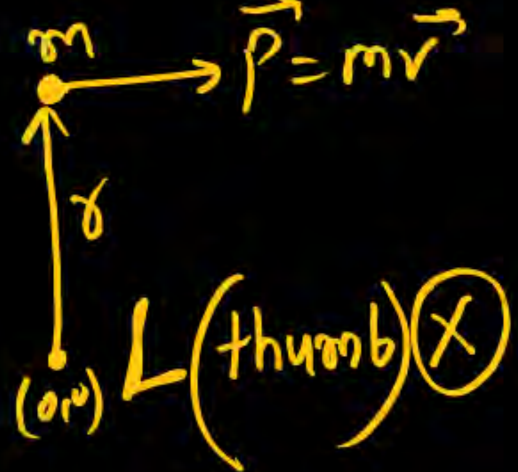
dir^n of L is ⊥r to $\vec{r}$ & $\vec{P}$

$$\vec{L} \cdot \vec{r} = 0$$

$$\vec{L} \cdot \vec{P} = 0$$

$$\vec{L} = I\vec{\omega}$$

→ dir^n ∥r to $\vec{\omega}$



Place your four finger of right hand along $\vec{r}$ & slap down momentum p then thumb will represent angular momentum.

QUESTION

$\vec{\tau} = \vec{r} \times \vec{F}$ ✓

The position of a panicle is given by $\vec{r} = (\hat{\imath} + 2\hat{\jmath} - \hat{k})$ and momentum $\vec{P} = (3\hat{\imath} + 4\hat{\jmath} - 2\hat{k})$. The angular momentum is perpendicular to

1. X-axis ✓
2. Y-axis
3. Z-axis
4. Line at equal angles to all the three axes

$\vec{L} = \vec{r} \times \vec{P}$

$L = \vec{P} \times \vec{r}$ ✗

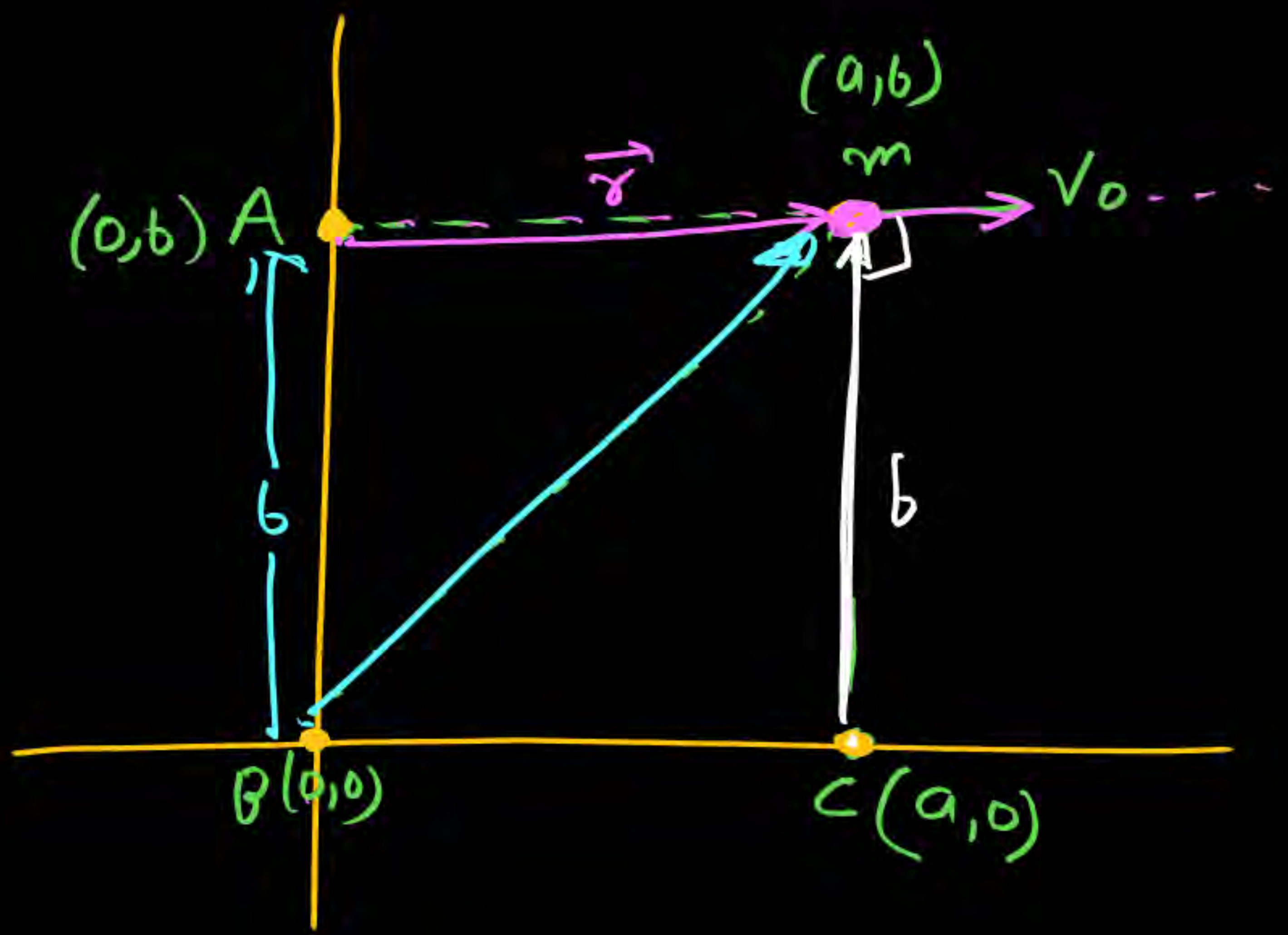
$$\vec{L} = \vec{r} \times \vec{p} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & 2 & -1 \\ 3 & 4 & -2 \end{vmatrix}$$

$$= \hat{i}(-4+4) + \hat{j}(-3+2) + \hat{k}(4-6)$$

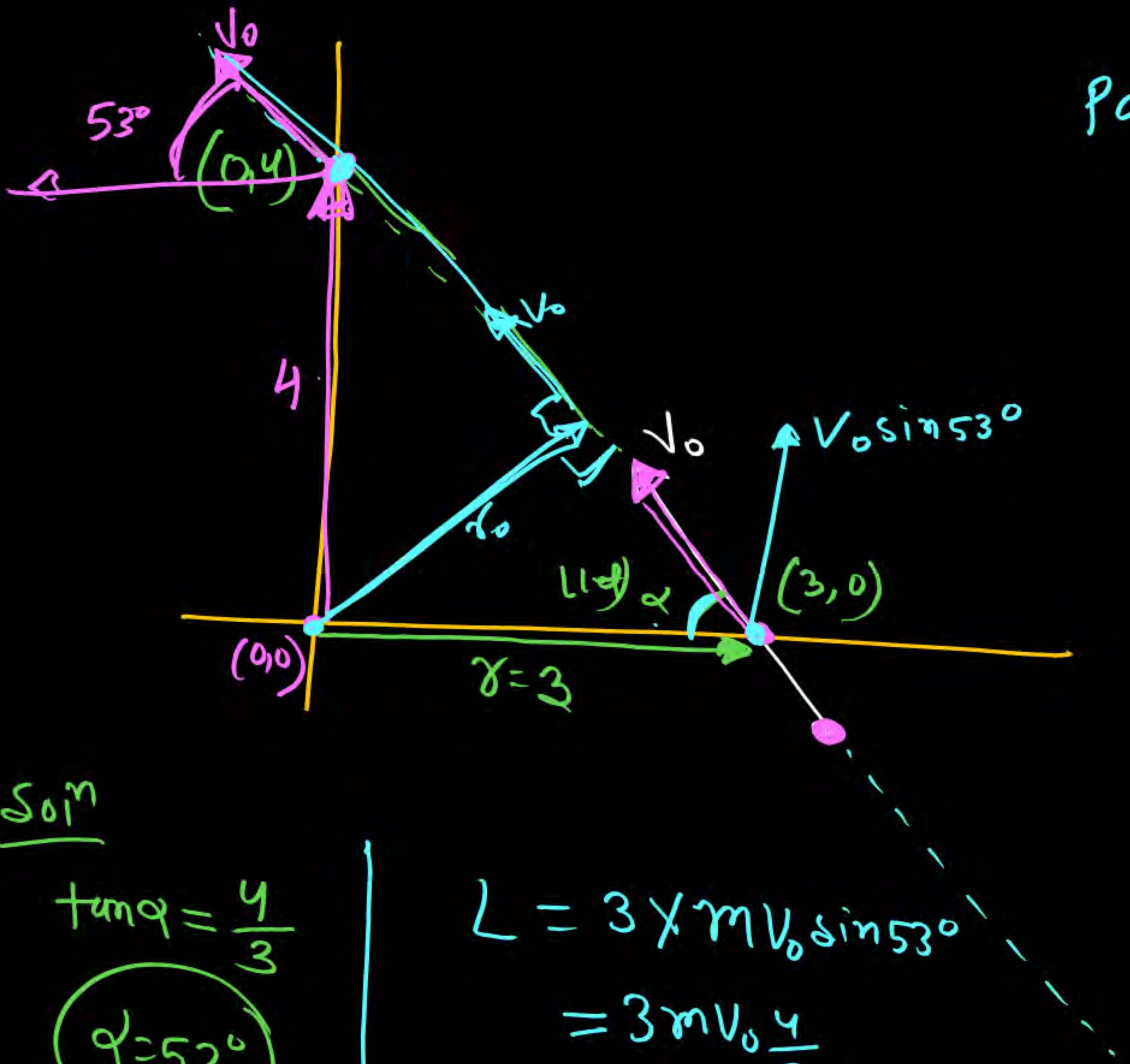


$$= 0 - \hat{j} - 2\hat{k}$$ (Ans)

object is at (a, b) then find its angular momentum about A, B & C.



$(L_A) = 0$ | $(L_B)_{origin} = (mV_0)b$ | $(L_C) = (mV_0 b)$



Particle is moving on straight line path. as shown in fig.

L will be same about origin, when particle is moving on straight line

Solⁿ

$\tan\varphi = \frac{4}{3}$

$\varphi = 53°$

$L = 3 \times mV_0 \sin 53°$

$= 3mV_0 \frac{4}{5}$

$= \frac{12 mV_0}{5}$

$L = (r_\perp) P_{\perp}$

$= 4 \left[mV_0 \cos 53° \right]$

$= 4 mV_0 \times \frac{3}{5} = \left(\frac{12 mV_0}{5}\right)$

QUESTION

A particle of mass m is rotating in a plane in circular path of radius r. Its angular momentum is L. The centripetal force acting on the particle is

1. L^2/mr
2. L^2m/r^2
3. L^2/m^2r^2
4. L^2/mr^3 ✓

$L = I\omega = mvr$ — (1)

$v = \frac{L}{mr}$

Putting value of v from eqn (1) + (2) (v)

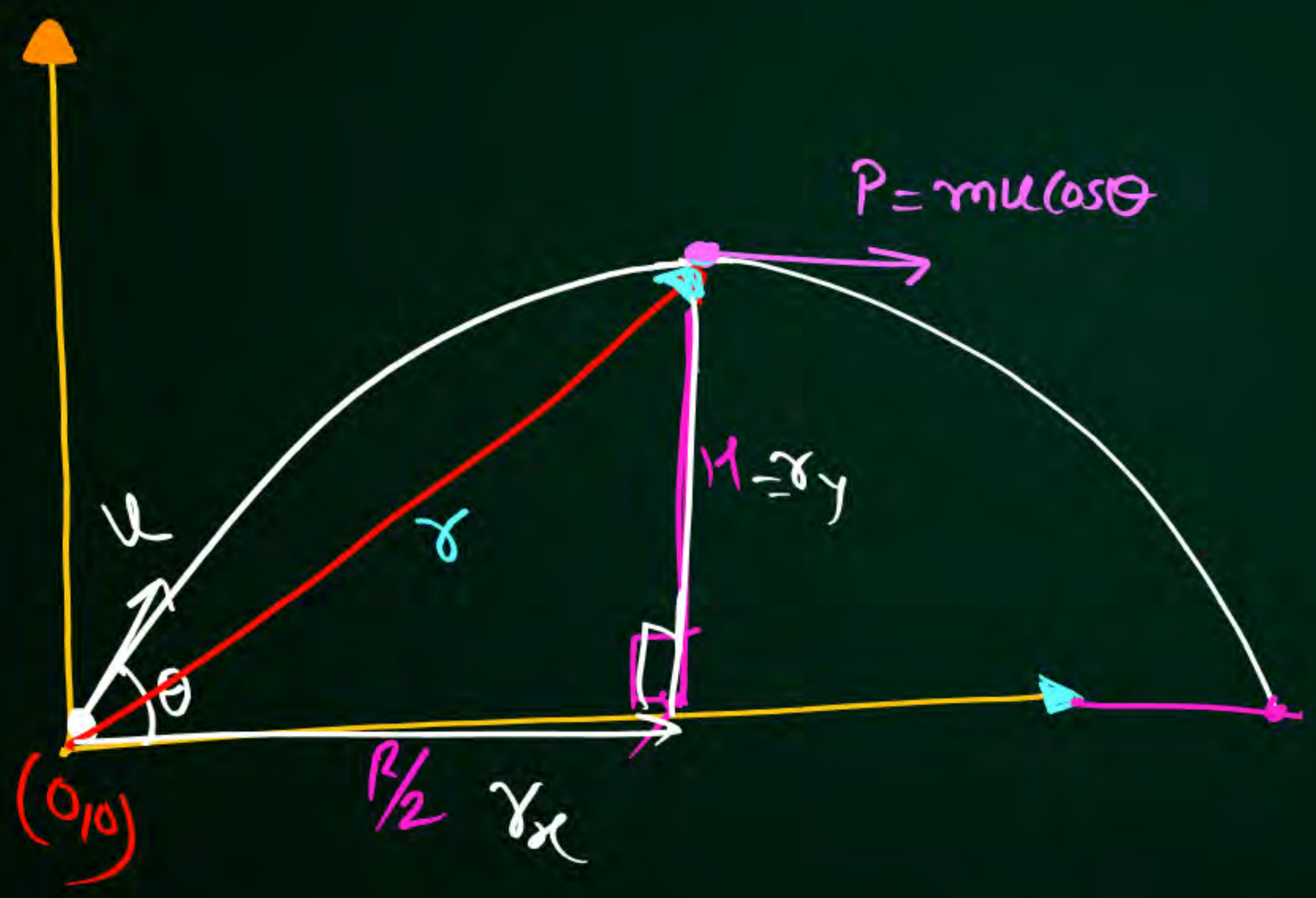
$F = \frac{mv^2}{r}$ — (2)

$= \frac{m}{r}\left[\frac{L^2}{m^2r^2}\right]$

$= \frac{L^2}{mr^3}$

QUESTION

Object is projected with speed u at an angle θ then find Angular [redacted]omentum [redacted] When it is at maximum height.



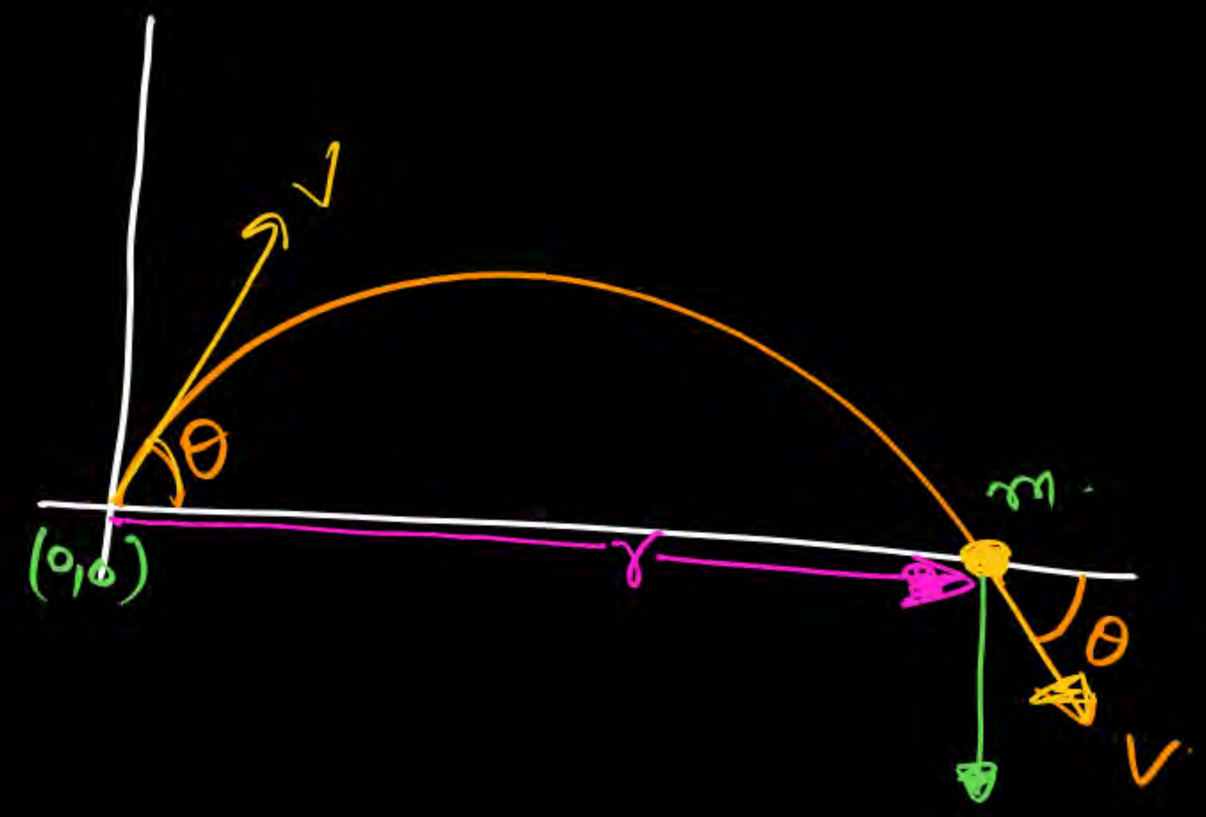
$$L = rp\sin\theta$$

$$L = (r_{\perp r})(p_{\perp r})$$

$$L = (mu\cos\theta)_x H_y$$

$$\boxed{L = muH\cos\theta}$$

Ans



$L = H\,[\,mv\cos\theta\,]$

$= \dfrac{v^2\sin^2\theta}{2g} \times mv\cos\theta$

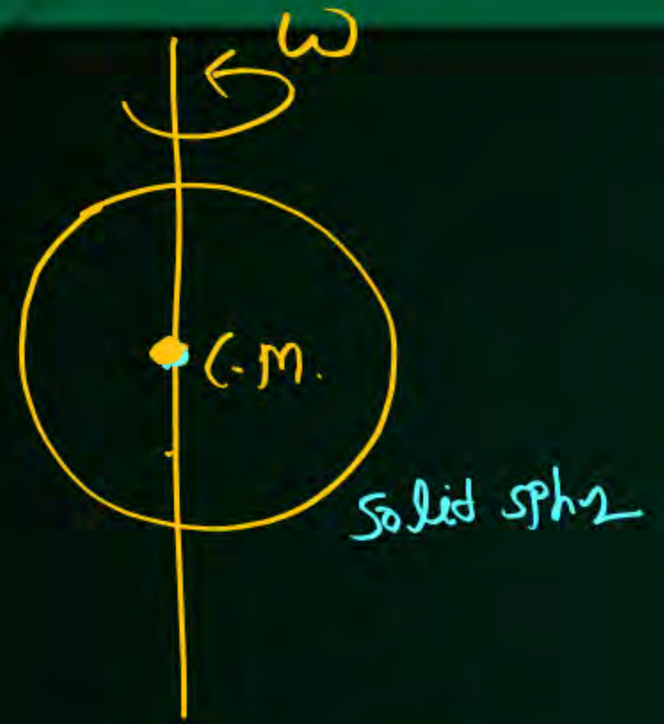
$L_{\text{at max}^m\text{ Heigh.}} = \dfrac{mv^3\sin^2\theta\cos\theta}{2g}$

L (about to collide w.r.t. origin) $= (r+r)_x \times (P)_y$

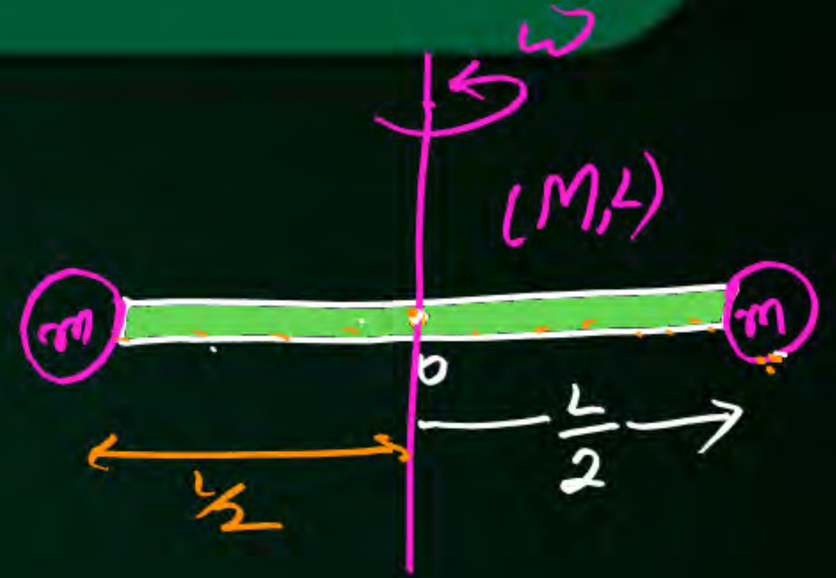
$= R\, mv\sin\theta$

$= mv\sin\theta R = mv\sin\theta\left[\dfrac{v^2\, 2\sin\theta\cdot\cos\theta}{g}\right] = \left[\dfrac{2mv^3\sin^2\theta\cdot\cos\theta}{g}\right]$

ANGULAR MOMENT IN PURE ROTATIONAL MOTION OF RIGID BODY







$L = I\omega$

$L = \frac{2}{5} mR^2 \omega$

dirn along axis of Rotation

Axis of Rotn is ⊥r to plane of Paper.

$I_O = I_{cm} + mR^2$

$= \frac{2}{5} mR^2 + mR^2 = \frac{7}{5} mR^2$

$L = I_O \omega = \frac{7}{5} mR^2 \omega$

$L = I_{Rod_O} \omega + (L)_{\text{Two point object}}$

$= \left[\frac{ML^2}{12}\omega\right] + \left[m\left(\frac{L}{2}\right)^2 \omega\right] \times 2$

$= \left[\frac{ML^2\omega}{12} + \frac{mL^2\omega}{2}\right]$

Angular momentum of Pure Rolling motion



- Sphere is in Pure Rot^n Motion about C.O.M

$$L_{\text{about } c \cdot m} = \frac{2}{5} m R^2 \omega$$



Pure Rolling mot^n ($V = R\omega$)

$$L_{\text{about } (c \cdot m)} = I_{cm}\,\omega$$

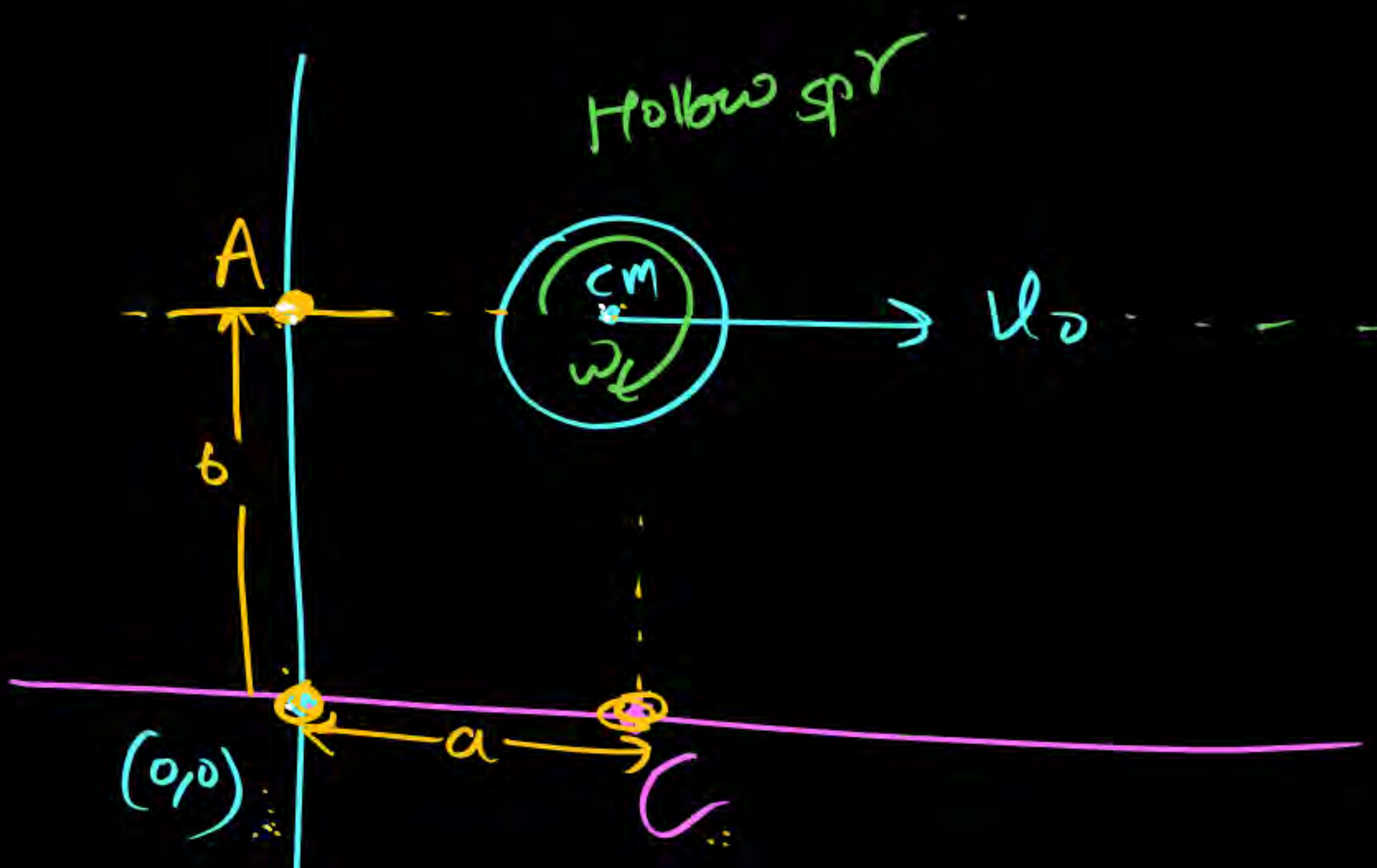
$$= \frac{2}{5} m R^2 \omega \quad (x)$$

Pure Rot^n Pure Tran^n

$$L_{\text{about } (O)} = I_{c \cdot m}\,\omega + m V R$$

$$= \left[\frac{2}{5} m R^2 \omega + m V R\right] (x)$$

(Ans)

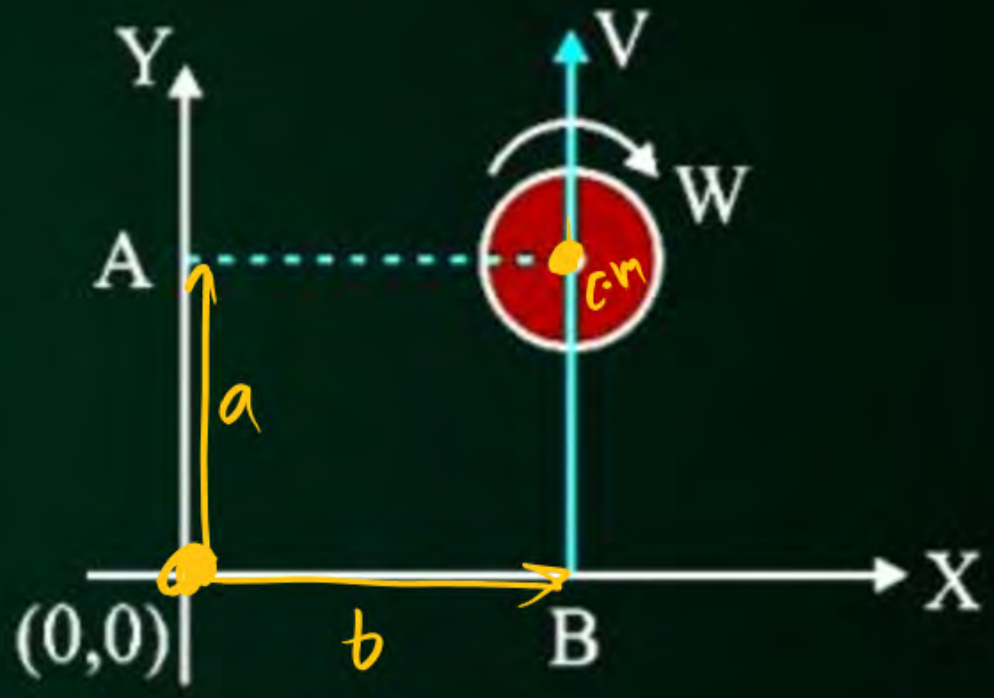


$$L_C = L_{Tra^n} + L_{rot^n}$$
$$= m v_0 b \otimes + \frac{2}{3} M R^2 \omega \otimes$$

Angular momentum due Rot^n does not depends upon choise of co-ordinate.

$$_{about}L_A = L_{Tra^n} + L_{rot^n}$$
(with L_{Tra^n} struck out $\rightarrow 0$)
$$= I_{cm}\omega$$
$$= \frac{2}{3} M R^2 \omega$$

$$L_{(0,0)} = L_{Tra^n} + L_{rot^n}$$
$$= [m v_0 b] + I_{cm}\omega$$
$$= m v_0 b \otimes + \frac{2}{3} M R^2 \omega \otimes$$


Y
V
W
A
c.m
a
X
(0,0)
b
B

QUESTION

If MOI $I_1 > I_2$ and kinetic energy is same for both. then correct option is for angular momentum : [NEET 2016]

1. $L_1 > L_2$
2. $L_1 < L_2$
3. $L_1 = L_2$
4. None of these

$L = I\omega$

$K.E = \frac{L^2}{2I}$

same

$L^2 \propto I$

$L \propto \sqrt{I}$

CONSERVATION OF LINEAR MOMENTUM

If $F_{ext} = 0$
then $\vec{P} = \text{const}^n$

CONSERVATION OF ANGULAR MOMENTUM

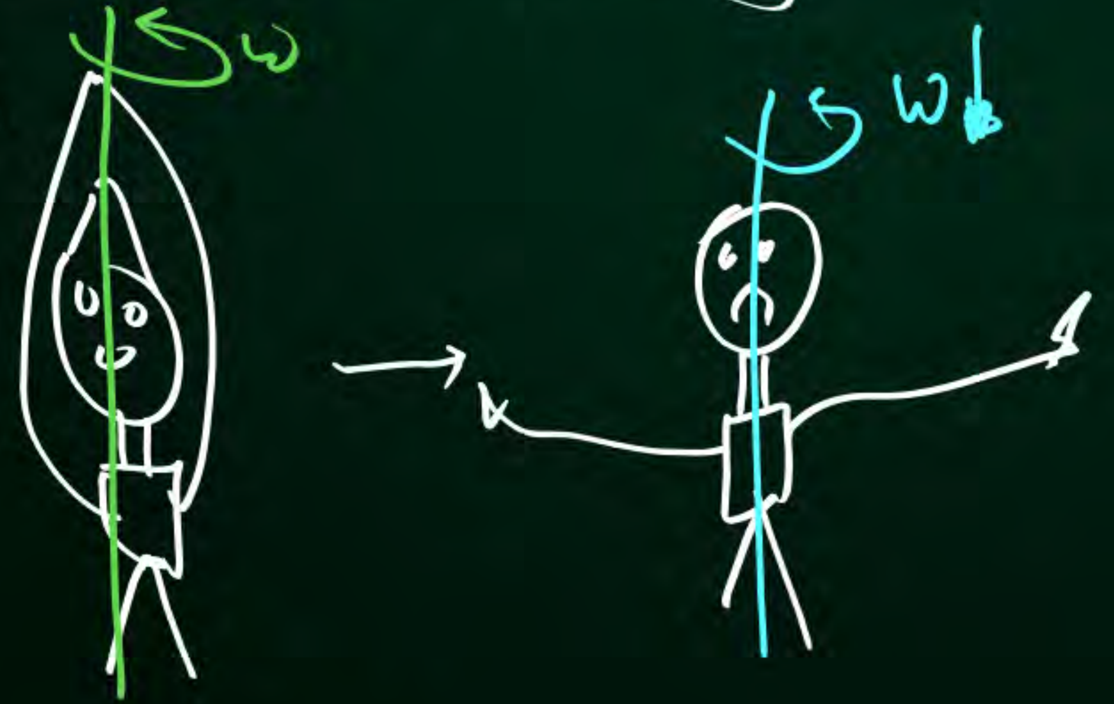
If $\tau_{net} = 0$ then $\vec{L} = const^n$

$\Rightarrow \quad \vec{\tau} = \frac{d\vec{L}}{dt} = 0$

$\Rightarrow \quad \vec{L} = \text{constant}$

We know, $I\omega = \text{constant}$ (Pure Rotation)

Hence, $I_1\omega_1 = I_2\omega_2$



$L = const^n$

$\uparrow I \omega = const^n$ ↓

Do not solve todays d.p.p.



duration of day & nigh

due to this Harkat of Ramu

$\uparrow I \, \omega_{\downarrow} = \text{const}$

slow

duration of day - nigh ↑

QUESTION

A swimmer while jumping into river from a height easily forms a loop in air if

1. He pulls his arms and legs in
2. He spreads his arms and legs
3. He keeps himself straight
4. None of these

QUESTION

A force $\vec{F} = \alpha\hat{i} + 3\hat{j} + 6\hat{k}$ is acting at a point $\vec{r} = 2\hat{i} - 6\hat{j} - 12\hat{k}$. The value of α for which angular momentum about origin is conserved is [NEET 2015]

1. 0
2. 1
3. –1
4. 2

QUESTION

A horizontal disc rotating freely about a vertical axis through its centre makes 90 revolutions per minute. A small piece of wax of mass m falls vertically on the disc and sticks to it at a distance r from the axis. If the number of revolutions per minute reduce to 60, then the moment of inertia of the disc is

1. mr^2
2. $\frac{3}{2}mr^2$
3. $2\,mr^2$
4. $3\,mr^2$

QUESTION

A thin circular ring of mass M and radius r is rotating about its axis with constant angular velocity ω. Two object each of mass m are attached gently to the opposite ends of a diameter of the ring. The ring now rotates with angular velocity given by

1. $\frac{(M + 2m)\omega}{2m}$
2. $\frac{2M\omega}{M + 2m}$
3. $\frac{(M + 2m)\omega}{M}$
4. $\frac{M\omega}{M + 2m}$

n|ω


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 10 | Physics

Rotational Motion

By- Dr. Manish Raj (MR SIR)



Topics to be covered

1. # Questions on conservation of Angular moment-
   → toppling.
2. #
3. #
4. #



$\vec{L} = I\vec{\omega}$ (Pure Rotion)

↳ dirn along $(\vec{\omega})$ → along axial of Rotn

$L = mvr$ — (1)
Point obj

$\vec{L} = \vec{r} \times \vec{P}$

$= rP\sin\theta$

$L = (r_{\perp r})(\vec{P}_{\perp r})$

Pure Rolling

$L = I\omega + \vec{r} \times \vec{P}$

Pure Roll   Pure Transn

Conservation of Angular momentum

if $\tau = 0$ then L = constant

force may or may not be zero

QUESTION

When a mass is rotating in a plane about a fixed point, its angular momentum is directed along

1. The radius
2. The tangent to orbit
3. Line at an angle of 45° to the plane of rotation
4. The axis of rotation



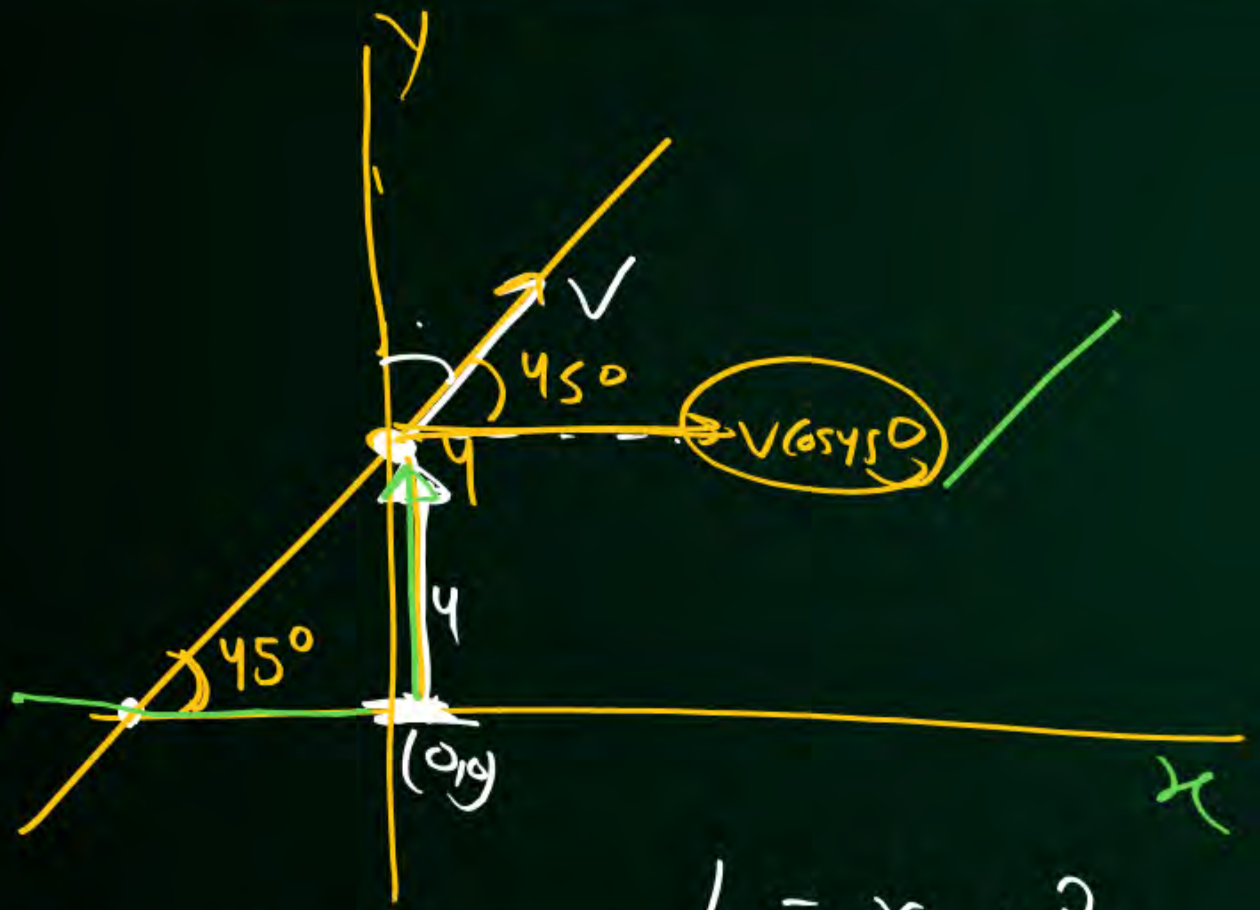
QUESTION

A force $\vec{F} = \alpha\hat{i} + 3\hat{j} + 6\hat{k}$ is acting at a point $\vec{r} = 2\hat{i} - 6\hat{j} - 12\hat{k}$. The value of α for which angular momentum about origin is conserved is [NEET 2015]

1. 0
2. 1
3. –1
4. 2

QUESTION

Object is moving with velocity $40\sqrt{2}$ m/s on a straight line of equation $y = x + 4$ then find angular momentum about origin. [NEET 2014]



$y = mx + c$

$m = 1$
$\tan\theta = 1$
$\theta = 45°$

$L = r_{\perp r} \times P_{r}$
$= 4 \times mv\cos 45°$
$= 4m\, 40\sqrt{2} \times \frac{1}{\sqrt{2}} = 160m$ (Ans)

QUESTION

A swimmer while jumping into river from a height easily forms a loop in air if

1. He pulls his arms and legs in
2. He spreads his arms and legs
3. He keeps himself straight
4. None of these

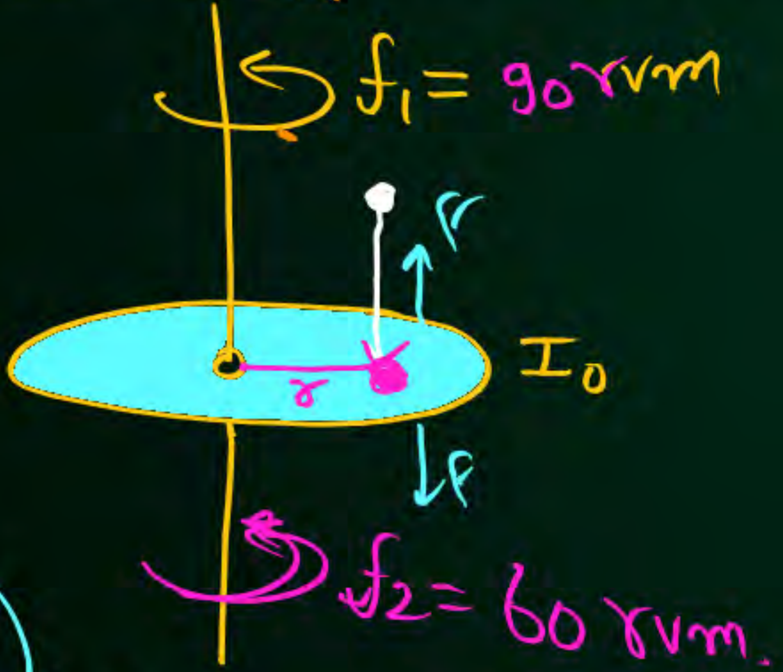
QUESTION

$\omega = 2\pi f$

$L = I\omega = I 2\pi f$

A horizontal disc rotating freely about a vertical axis through its centre makes 90 revolutions per minute. A small piece of wax of mass m falls vertically on the disc and sticks to it at a distance r from the axis. If the number of revolutions per minute reduce to 60, then the moment of inertia of the disc is

1. mr^2
2. $\frac{3}{2} mr^2$
3. $2\, mr^2$ (Ans.)
4. $3\, mr^2$



$L_{system} = 0$

$L_i = L_f$

$I_0 2\pi f_1 = (I_0 + mr^2) 2\pi f_2$

$I_0 \cdot 3 = (I_0 + mr^2) \cdot 2$

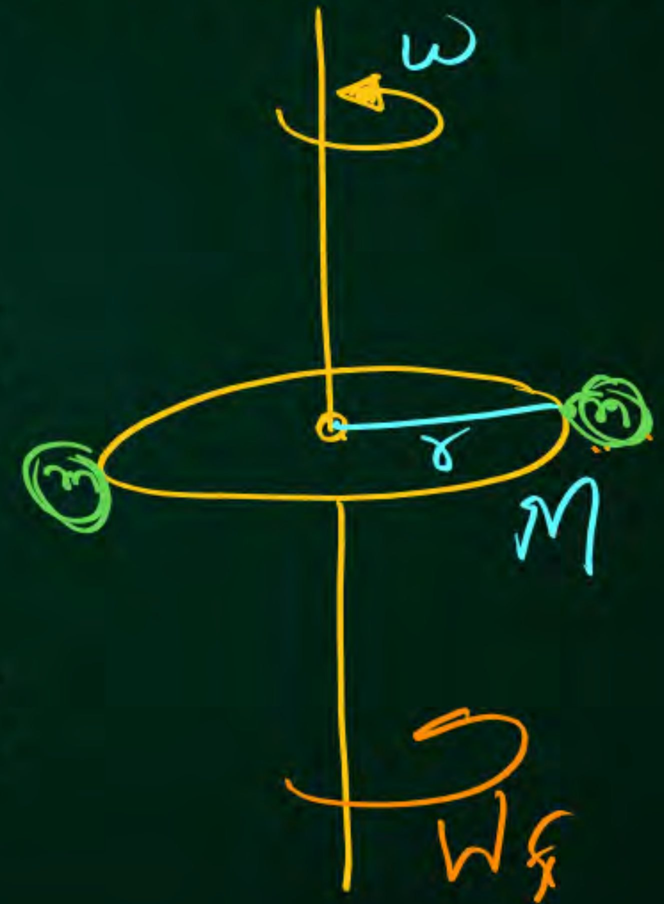
$3I_0 = 2I_0 + 2mr^2$

$I_0 = (2mr^2)$

QUESTION

A thin circular ring of mass M and radius r is rotating about its axis with constant angular velocity ω. Two object each of mass m are attached gently to the opposite ends of a diameter of the ring. The ring now rotates with angular velocity given by

1. $\dfrac{(M + 2m)\omega}{2m}$
2. $\dfrac{2M\omega}{M + 2m}$
3. $\dfrac{(M + 2m)\omega}{M}$
4. $\dfrac{M\omega}{M + 2m}$



$L_i = L_f$

$Mr^2\omega = (Mr^2 + mr^2 2)\omega_f$

intial angular momentum

$\dfrac{M\omega}{M+2m} = \omega_f$

QUESTION

$\Delta K.E = \frac{1}{2}\frac{I_1 I_2}{I_1 + I_2}(\omega_{rel})^2$

If two discs of moment of inertia I_1 and I_2 rotating about collinear axis passing through their centres of mass and perpendicular to their plane with angular speeds ω_1 and ω_2 respectively in opposite directions are made to rotate combinedly along same axis, then the magnitude of angular velocity of the system is

1. $\dfrac{I_1\omega_1 + I_2\omega_2}{I_1 + I_2}$

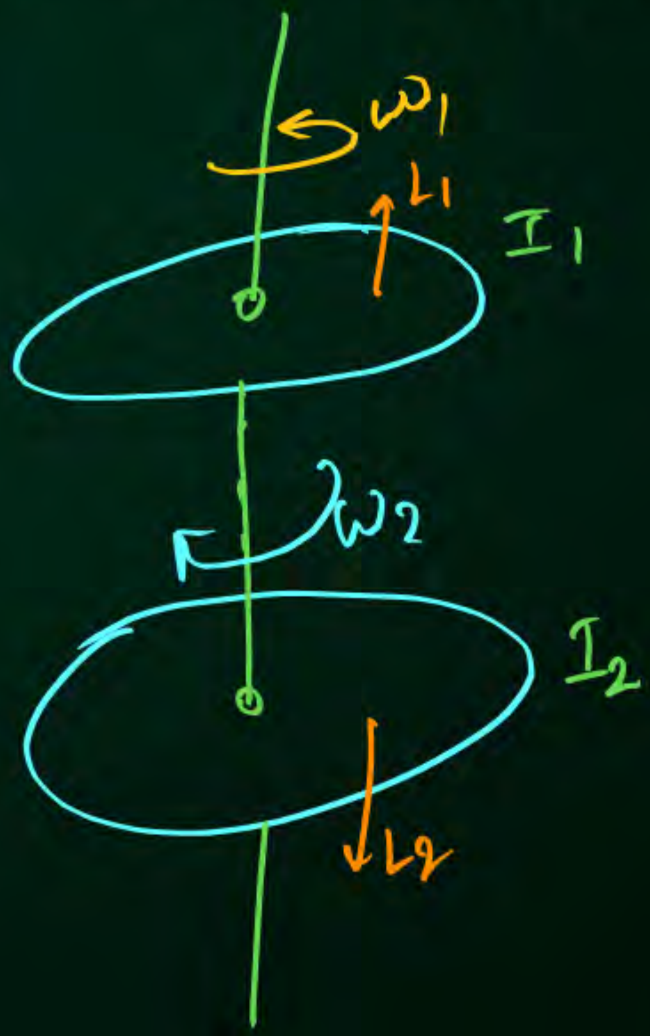
2. $\dfrac{I_1\omega_1 - I_2\omega_2}{I_1 + I_2}$

3. $\dfrac{I_1\omega_1 + I_2\omega_2}{\omega_1 + \omega_2}$

4. $\dfrac{I_1\omega_1 - I_2\omega_2}{\omega_1 - \omega_2}$

MR* (dim^n wrong)

dim^n wrong



τ on 1 disc $\neq 0$

τ on both disc $= 0$

$\tau_{net} = 0$

L_{system} = conserved

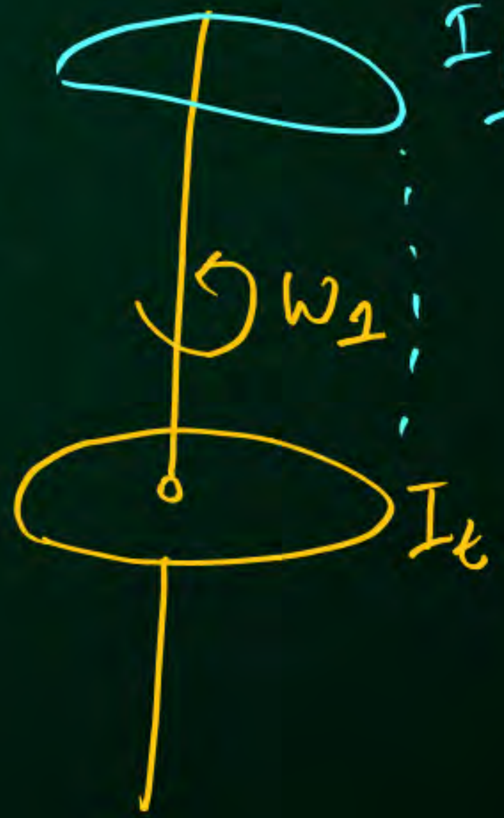
$I_1\omega_1 - I_2\omega_2 = (I_1 + I_2)\omega$

$\omega = \dfrac{I_1\omega_1 - I_2\omega_2}{I_1 + I_2}$

QUESTION

A circular disk of moment of inertia I_t is rotating in a horizontal plane, about its symmetry axis, with a constant angular speed ω_1. Another disk of moment of inertia I_b is dropped coaxially onto the rotating disk. Initially the second disk has zero angular speed. Eventually both the disks rotate with a constant angular speed ω_f. The energy lost by the initially rotating disc to friction is:

1. $\frac{1}{2}\frac{l_b^2}{(l_t + l_b)}\omega_1^2$
2. $\frac{1}{2}\frac{l_t^2}{(l_t + l_b)}\omega_1^2$
3. $\frac{l_b - l_t}{(l_t + l_b)}\omega_1^2$
4. $\frac{1}{2}\frac{l_b \cdot l_t}{(l_t + l_b)}\omega_1^2$

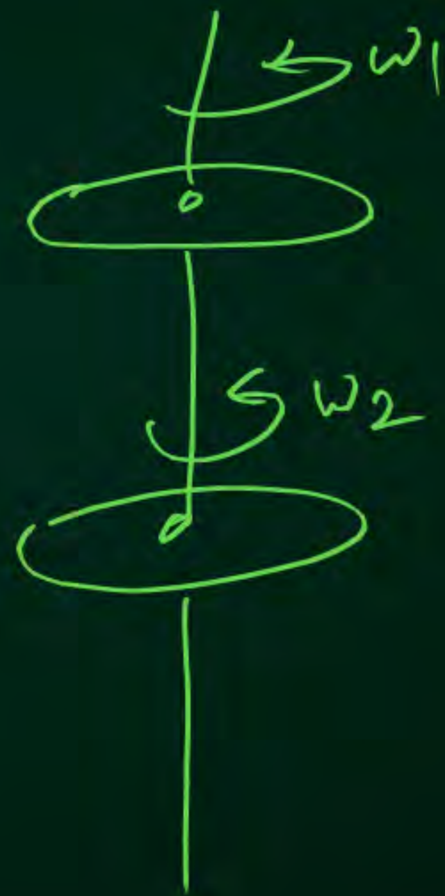


$\Delta K.E = \frac{1}{2}\frac{I_1 I_2}{I_1 + I_2}\omega_1^2$

QUESTION

Two disc of same M.O.I. is rotating with ω_1 and ω_2 about axis perpendicular to plane. They brought into contact face to face. Then loss in K.E. will be

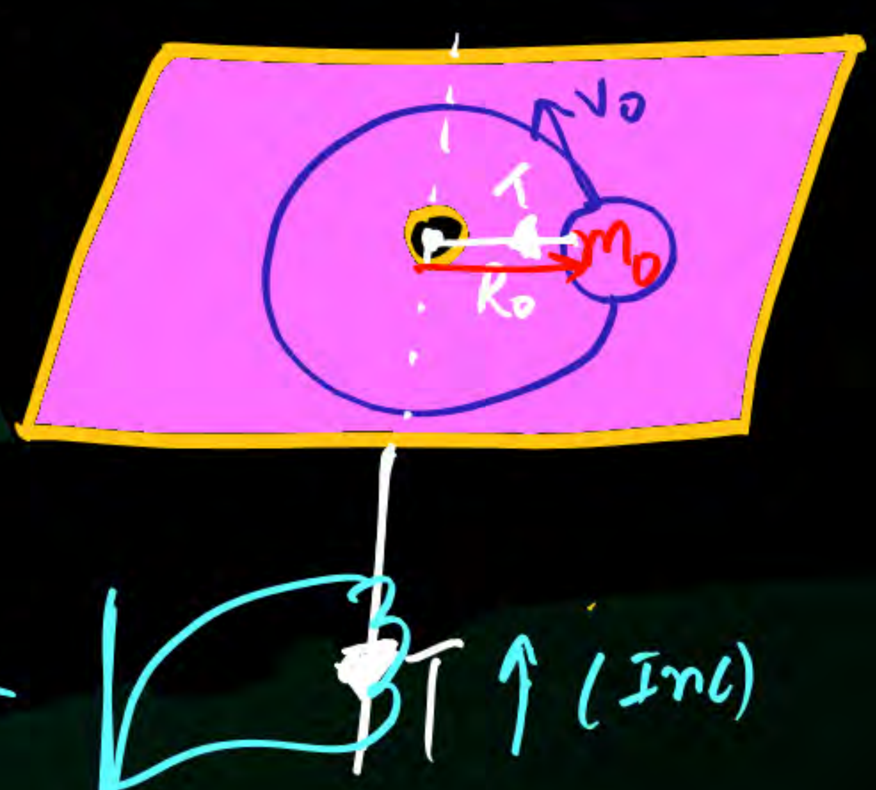
1. $\frac{1}{2}I(\omega1 + \omega2)2$
2. $\frac{1}{4}I(\omega1 - \omega2)2$
3. $I(\omega_1 + \omega_2)^2$
4. $\frac{I}{8}(\omega_1 - \omega_2)^2$



QUESTION

A mass m moves in a circle on a smooth horizontal plane with velocity v_0 at a radius R_0. The mass is attached to a string which passes through a smooth hole in the plane as shown.

The tension in the string is increased gradually and finally m moves in a circle of radius $R_0/2$. The final value of the kinetic energy is

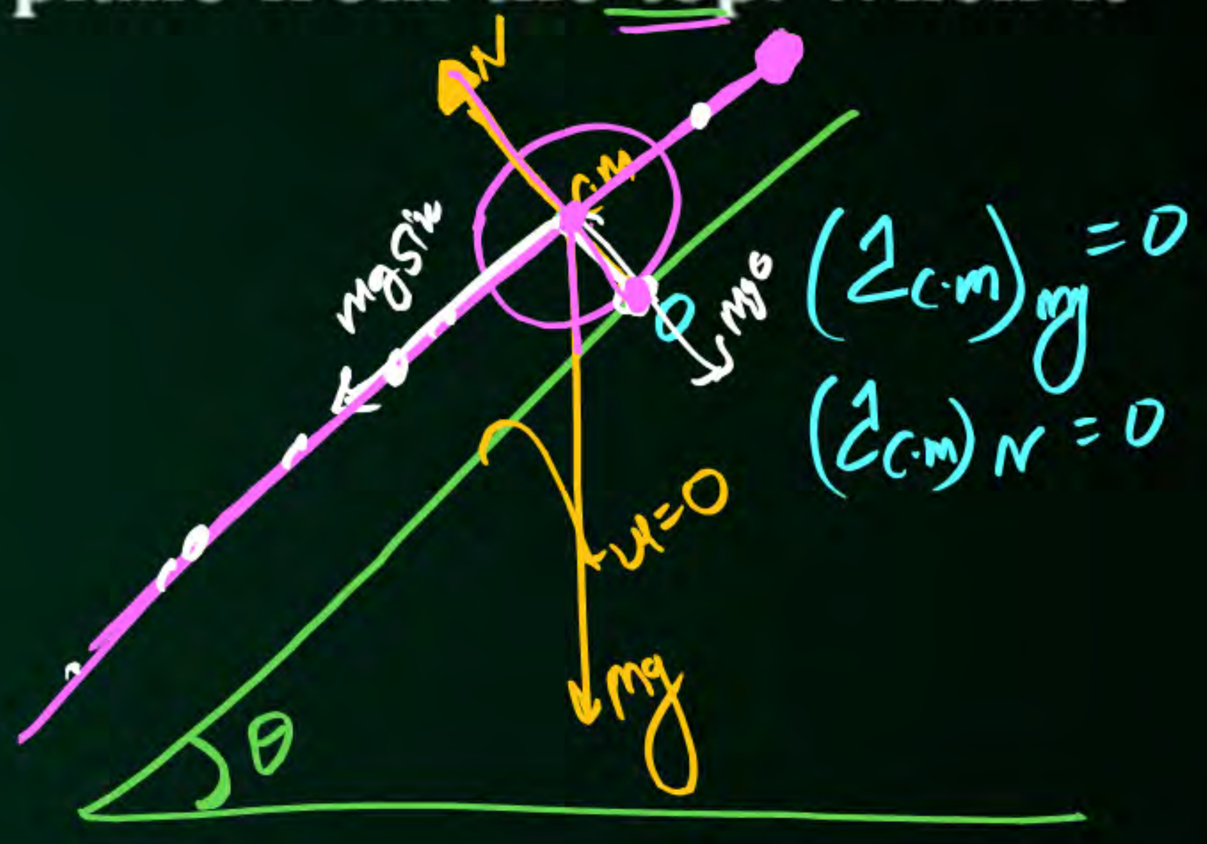


1. $\frac{1}{2} m v_0^2$
2. $m v_0^2$
3. $\frac{1}{4} m v_0^2$
4. $2 m v_0^2$

QUESTION

A uniform sphere is released on a smooth inclined plane from the top. When it moves down its angular momentum is:

1. Conserved about every point
2. Conserved about the point of contact only
3. Conserved about the centre of the sphere only
4. Conserved about any point on a fixed line parallel to the inclined plane and passing through the centre of the ball.



Ans (4)

Not for all

QUESTION

An ant is sitting at the edge of a rotating disc. If the ant reaches the other end, after moving along the diameter, the angular velocity of the disc will:-

1. Remain constant
2. First decreases and then increases
3. First increases, then decrease
4. Increase continuously





$\Sigma \tau_{ext} = 0$

$L_i = L_f$

$I\omega = $ const.

1st $I \downarrow$ $\omega \uparrow$

then $I \uparrow$ $\omega \downarrow$

QUESTION

A solid sphere is rotating freely about its symmetry axis in free space. The radius of the sphere is increased keeping its mass same. Which of the following physical quantities would remain constant for the sphere? **[NEET 2018]**

$K.E = \frac{1}{2} I \omega^2$



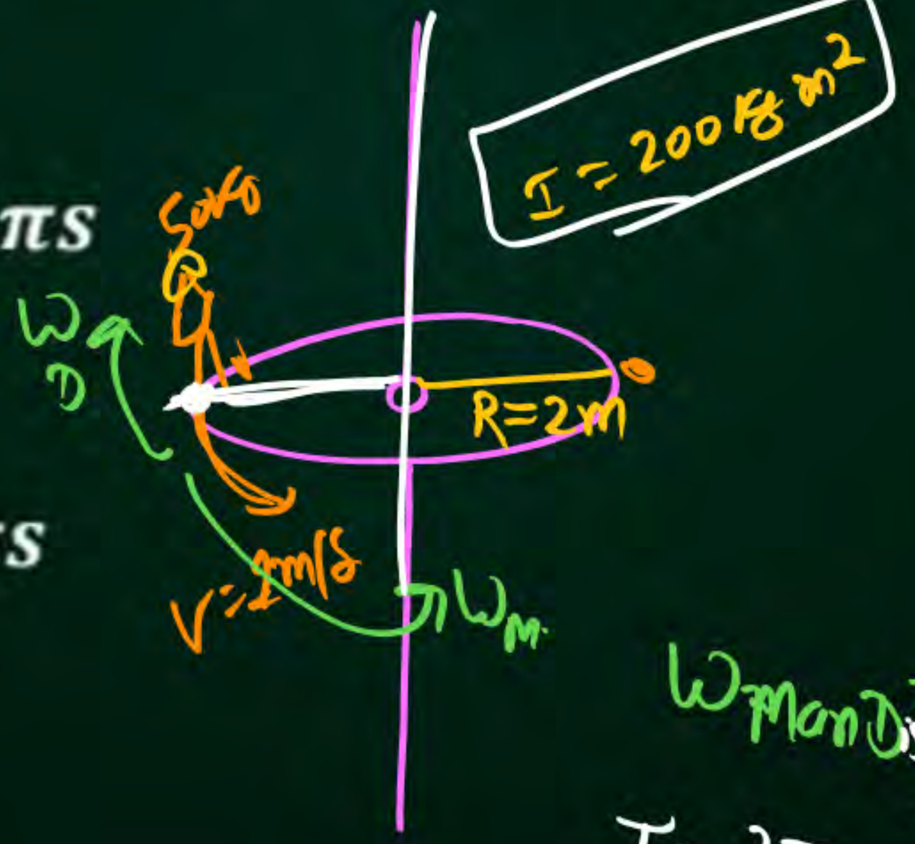
1. Rotational kinetic energy
2. Angular velocity
3. Angular momentum
4. Moment of inertia

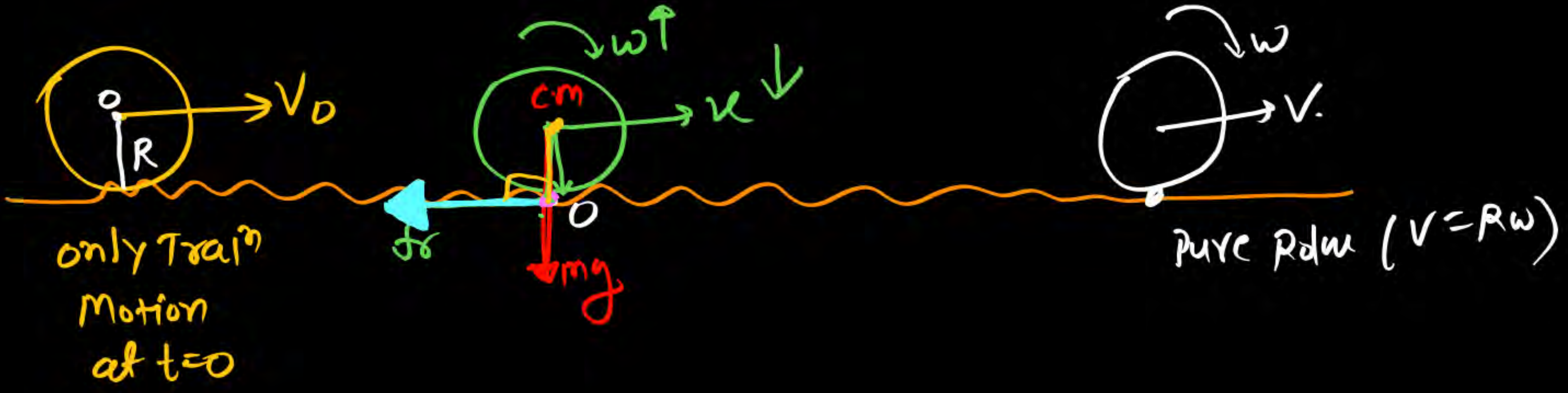
QUESTION

A circular platform is mounted on a frictionless vertical axle. Its radius $R = 2$ m and its moment inertia about the axle is 200 kgm^2. It is initially at rest. A 50 kg man stands on the edge of the platform and begins to walk along the edge at the speed of 1 ms^{-1} relative to the ground. Time taken by the man to complete one revolution is

[NEET 2016]

1. $\frac{3\pi}{2}s$
2. $2\pi s$
3. $\frac{\pi}{2}s$
4. πs





Angular moment of sphere is conserved about 'O' = ??

Ans → (Yes) $(\tau_{net})_{about\ O} = 0$

Q Angular moment of sphere is conserved about c.m –

(Ans) No $(\tau_{net})_{about\ c.m} \neq 0$ $(\tau_{c.m})_{fric} \neq 0$ $(\tau_{mg})_{c.m} = 0$ ✓

QUESTION

A heavy solid sphere is thrown on a horizontal rough surface with initial velocity u without rolling. What will be its speed, when it starts pure rolling motion?

1. $\frac{3u}{5}$
2. $\frac{2u}{5}$
3. $\frac{5u}{7}$
4. $\frac{2u}{7}$

Not for NEET



$V_0 = R\omega_0$

Pure Rolling Mot.

$(\tau_0) = 0$

$(L_0)_i = (L_0)_f$

$I\omega^{0} + muR = I\omega_0 + mv_0R$

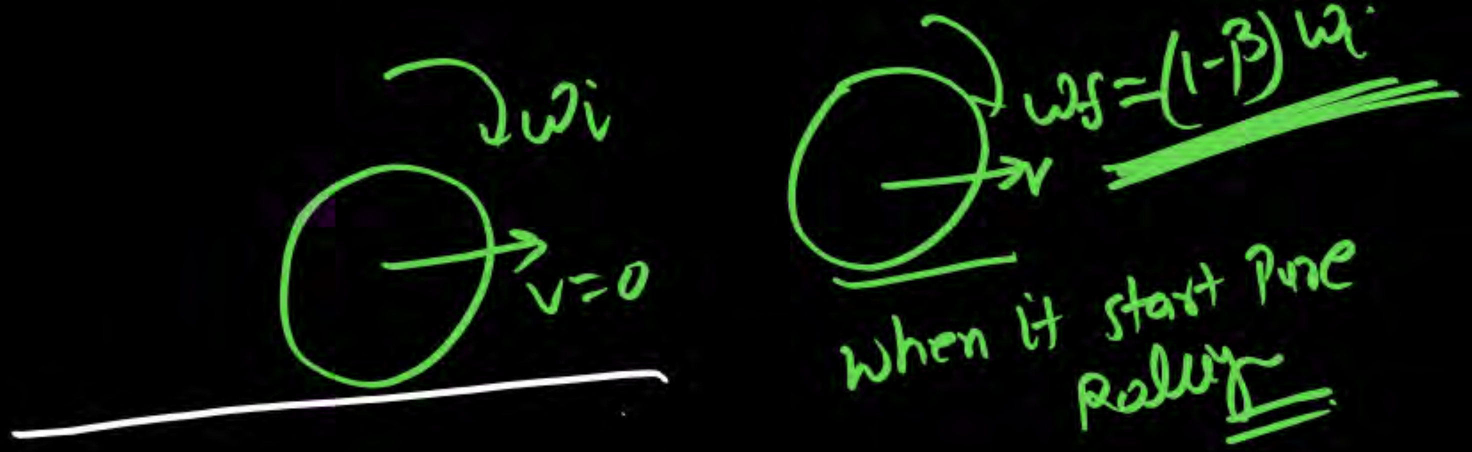
$muR = \frac{2}{5}mR^2\omega_0 + mv_0R$

$mu = \frac{2}{5}mv_0 + mv_0$

$u = \frac{7v_0}{5}$

$V_0 = \frac{5u}{7}$

$V_0 = \beta u = \frac{5}{7}u$ As


ωi
v=0
ωf = (1-β) ωi
v
When it start Pure Rolling

QUESTION

The rod is hinged at A and can rotate freely in a vertical plane. Only conservation of angular momentum can be applied as the rod is fixed at A.

$$mua = \left[\frac{ML^2}{3} + ma^2\right]\omega \qquad \text{(Particle sticks to the rod)}$$

QUESTION

A hollow sphere is in Pure Rotational Motion with angular speed ω. Placed on rough horizontal surface, then find its angular speed when it will starts Pure Rolling Motion.

mR^2 ✗

$\omega_f = \left(1 - \frac{3}{5}\right)\omega_i$

$\omega_f = \frac{2}{5}\omega_i$

Ans

QUESTION

A round disc of moment of inertia I_1 about its axis perpendicular to its plane and passing through its centre is placed over another disc of moment of inertia I_2 rotating with an angular velocity co about the same axis. The final angular velocity of the combination of discs is

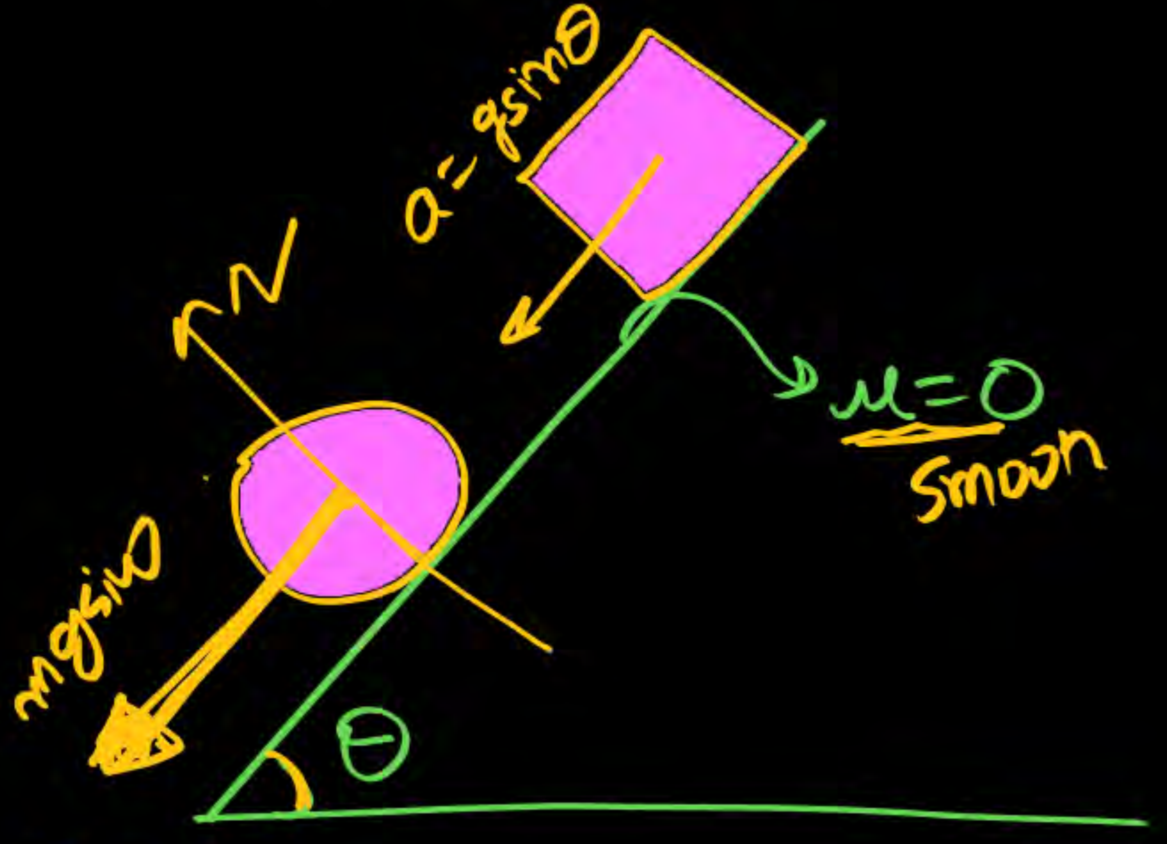
1. $\dfrac{I_2\omega}{I_1+I_2}$

2. ω

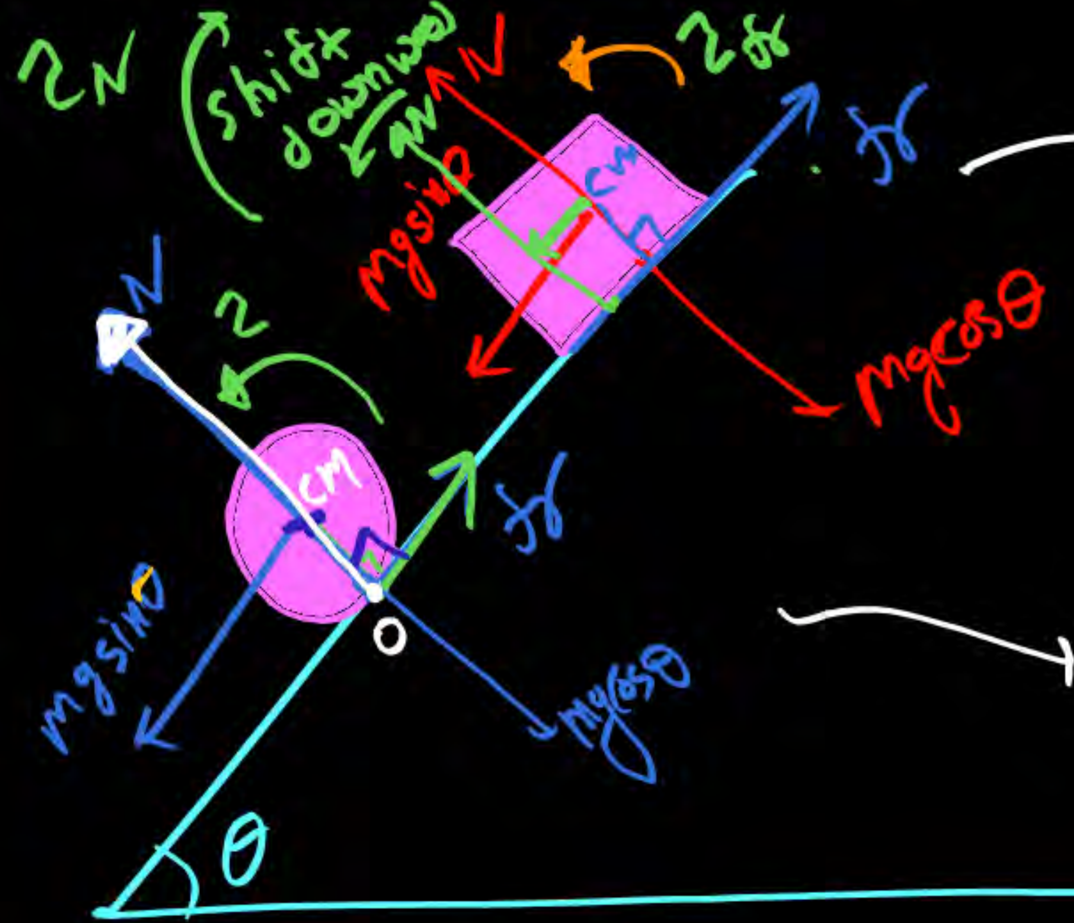
3. $\dfrac{I_1\omega}{I_1+I_2}$

4. $\dfrac{(I_1+I_2)\omega}{I_1}$

Toppling



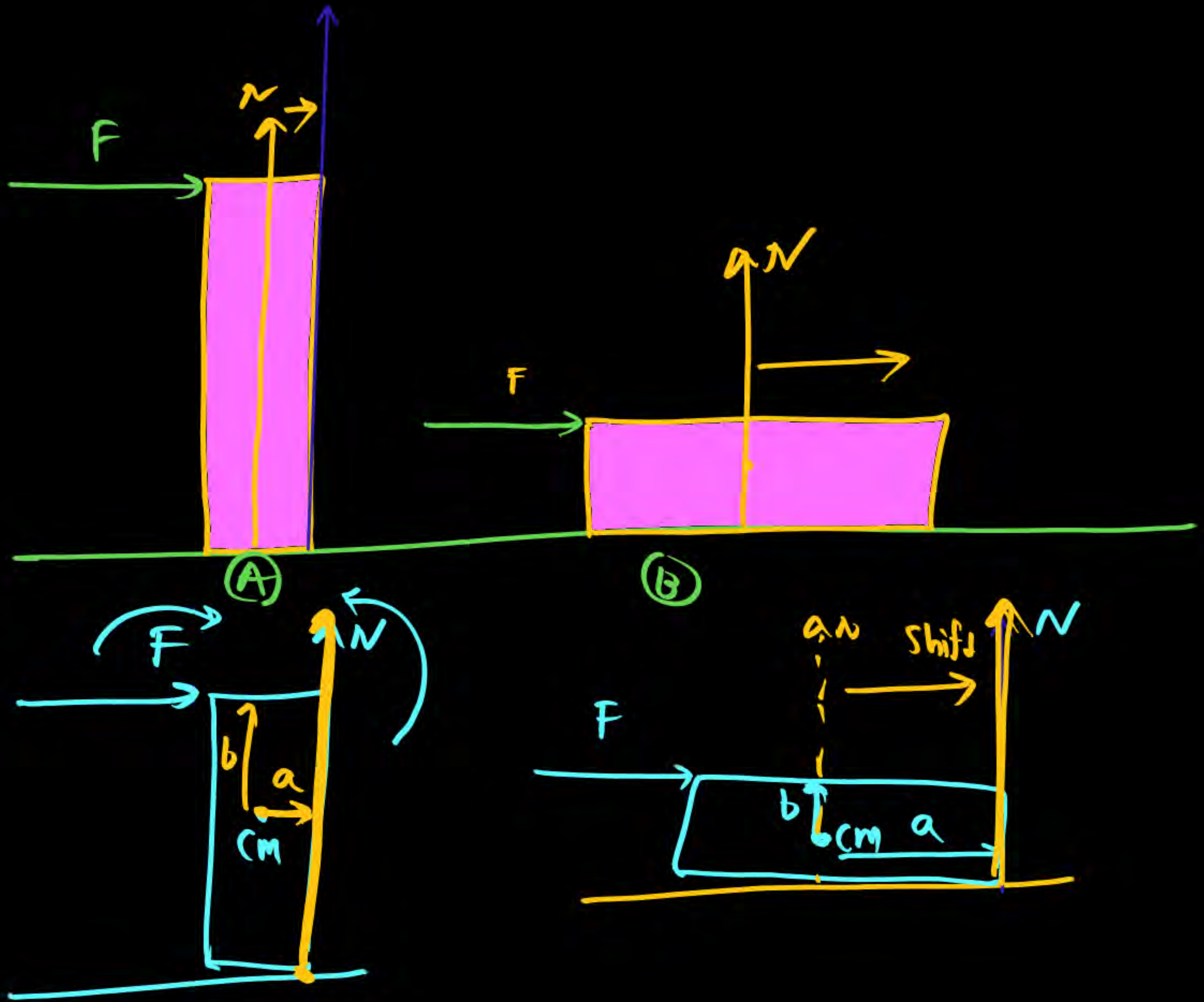
a = gsinθ



$a = \frac{mg\sin\theta - fr}{m}$

$a = (g\sin\theta)\beta$

Pure Rolln



Probability of toppling is high in

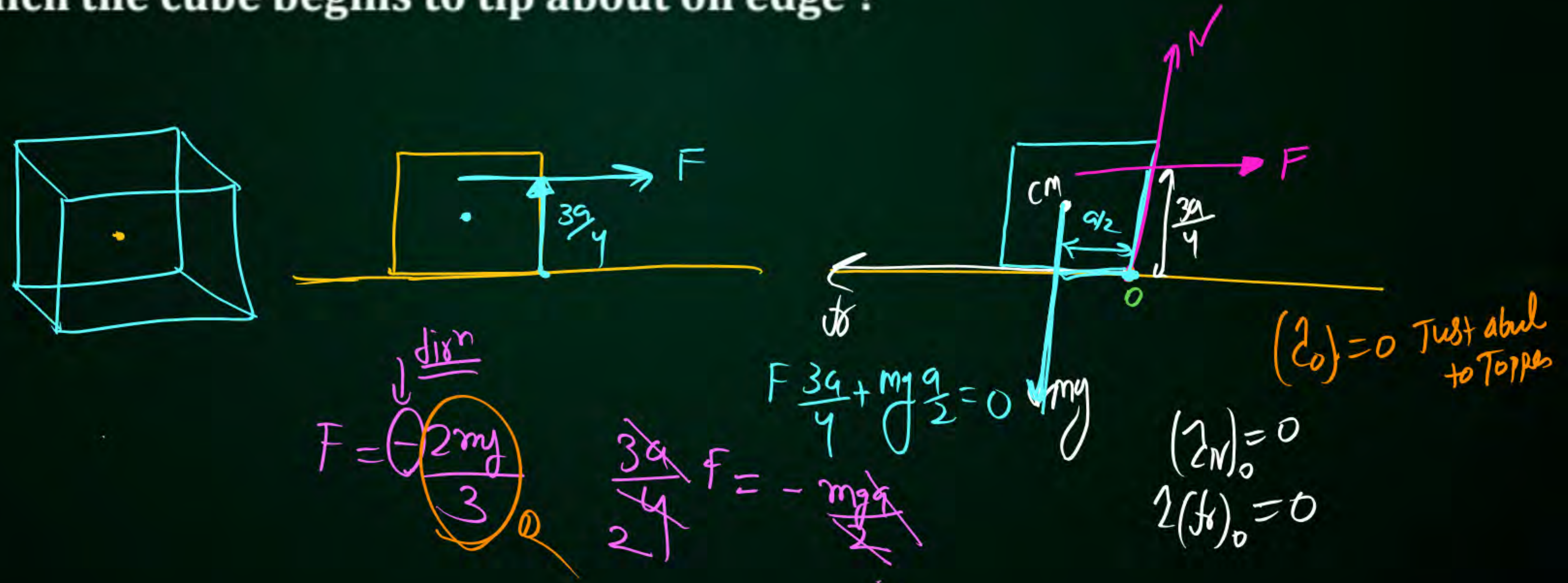
(a) A

(b) B

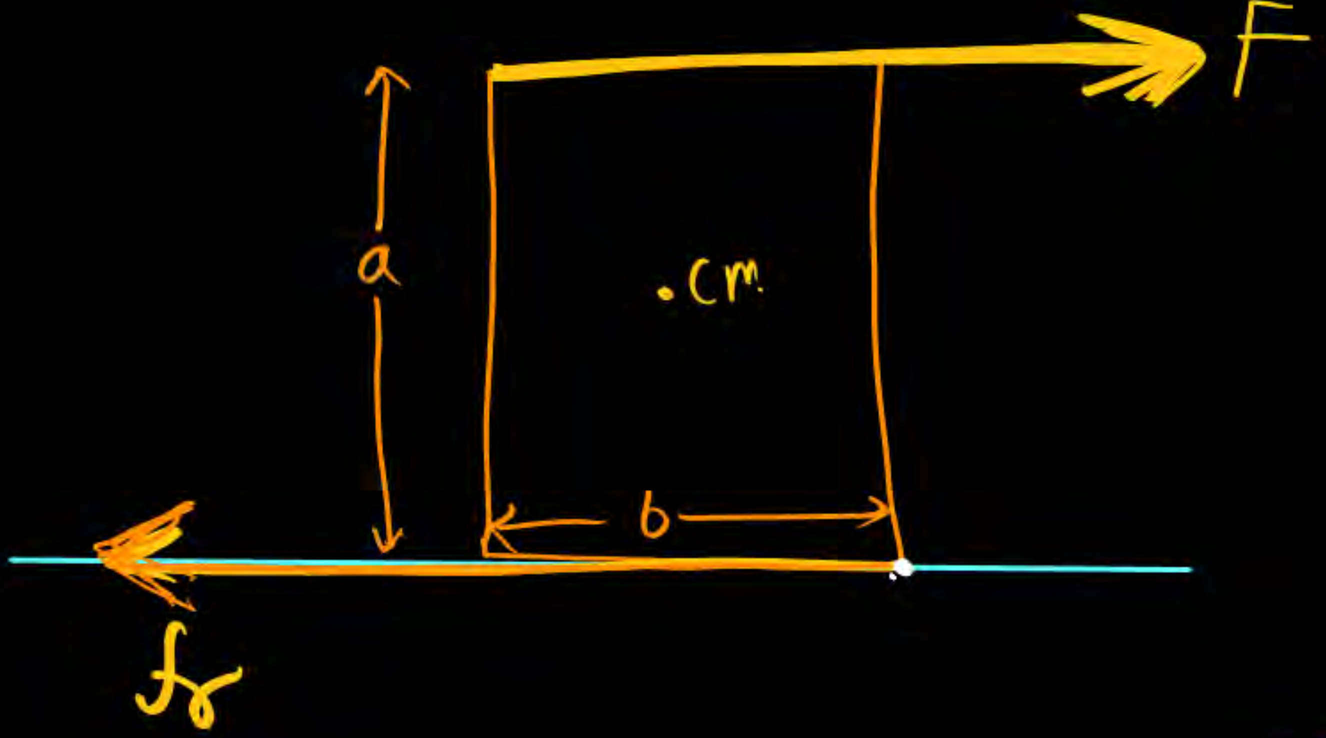
(c) Same.

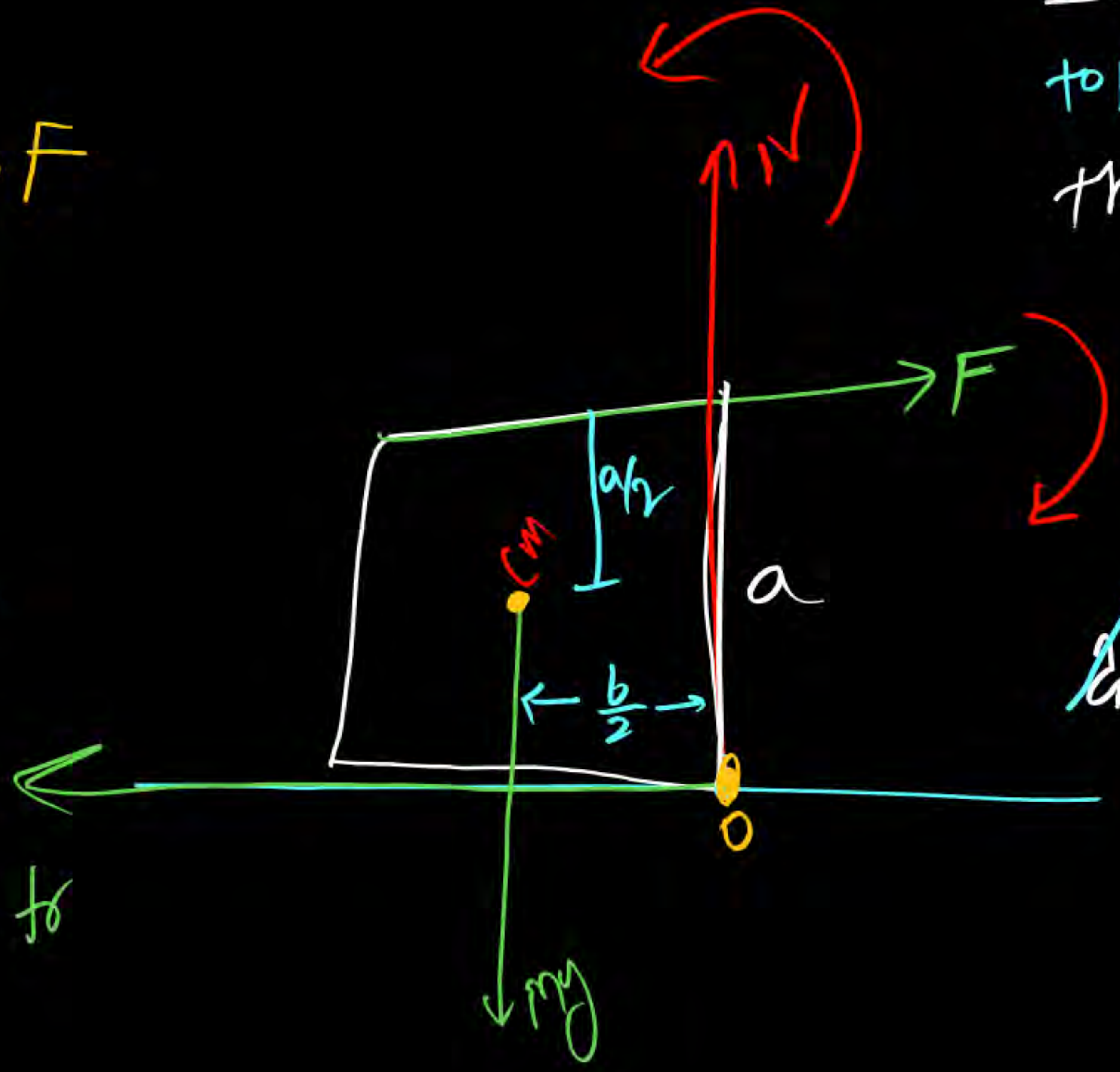
QUESTION

A uniform cube of side 'a' and mass m rests on a rough horizontal table. A horizontal force F is applied normal to one of the faces at a point directly above the center of the face, at a height $\frac{3a}{4}$ above the base. What is the minimum value of F for which the cube begins to tip about on edge ?



(a)





friction is sufficient such that it will topple before sliding.
then find F so that it will topple ??

$$\sum(\tau_O) = 0$$

$$\tau_N^{\,0} + \tau_{f_s}^{\,0} + \tau_{mg} + \tau_F = 0$$

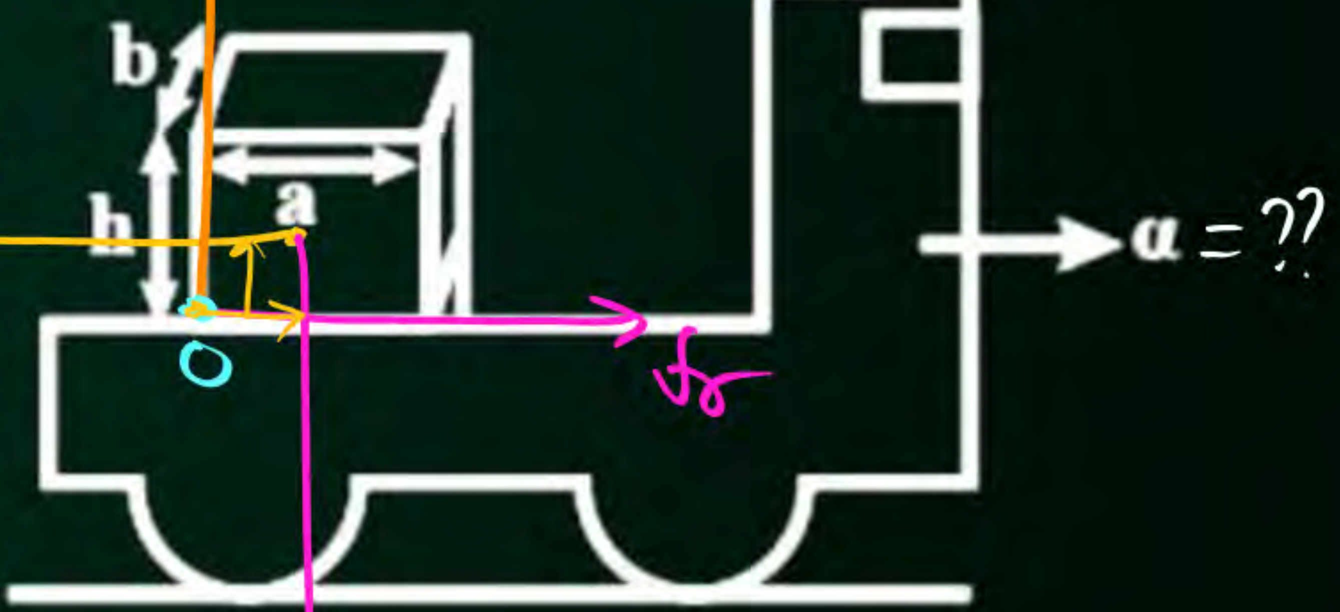
$$mg\frac{b}{2} + Fa = 0$$

$$F = \frac{mgb}{2a} \quad \text{Ans}$$

QUESTION

What will be the value of maximum acceleration of the truck in the forward direction so that the block kept on the back does not topple?

1. Ag/h
2. hg/h
3. Ag/2h
4. h/bg



Next chapter

Gravitation



20 साल → Kan Pared ka utna bura h naal Ki

GRAVITATION

Mass :

- Case of gravitation force
- Property of body due to which it apply and experience

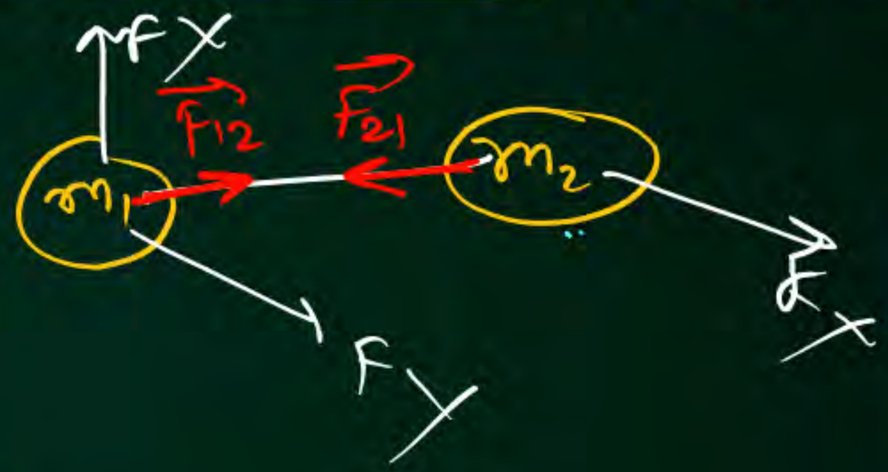
Gravitational force :

- Every matter is this universe attracts every other matter by a force, c/d G.F.

$$F_g << F_{\text{electro}}$$

NEWTON'S LAW OF GRAVITATION

- Only valid for point mass and spherical symmetrical. mass → Newtons law of gravitation ka formula
- can't be proved but can verify only.
- (always attractive)
- weakest force in nature
- follow inverse square law $F \propto \frac{1}{r^2}$
- long – range
- central (conservation)
- does not depend or medium
- mediated by ({graviton} [redacted])
- reason of stability of universe. (due to gravity)
- (from action reaction pair.)

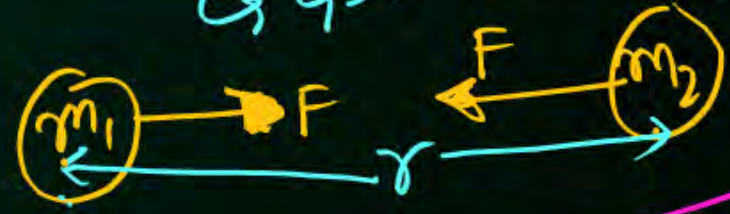




$F = \frac{G m m}{r^2}$ ✗

$$F = G\frac{m_1 m_2}{r^2}$$

G = universal gravitation const



$$G = 6.67 \times 10^{-11} \frac{Nm^2}{kg^2}$$

QUESTION

Gravitation is the phenomenon of interaction between

1. Point masses only
2. Any arbitrary shaped masses
3. Planets only
4. None of these

QUESTION

Force of gravitation between two masses is found to be F in vacuum. If both the masses are dipped in water at same distance then, new force will be

1. $> F$
2. $< F$
3. F
4. Cannot say

QUESTION

Two point masses m and $4m$ are separated by a distance d on a line. A third point mass m_0 is to be placed at a point on the line such that the net gravitational force on it is zero.

The distance of that point from the m mass is

1. $\frac{d}{2}$
2. $\frac{d}{4}$
3. $\frac{d}{3}$
4. $\frac{d}{5}$

SUPERPOSITION THEOREM

QUESTION

The dimensional formula for gravitational constant is :

1. $[M^{-1} L^{3} T^{-2}]$
2. $[M^{3} L^{-1} T^{-2}]$
3. $[M^{-1} L^{2} T^{3}]$
4. $[M^{-2} L^{3} T^{1}]$

QUESTION

Find force on one mass m due to other two point masses.

QUESTION

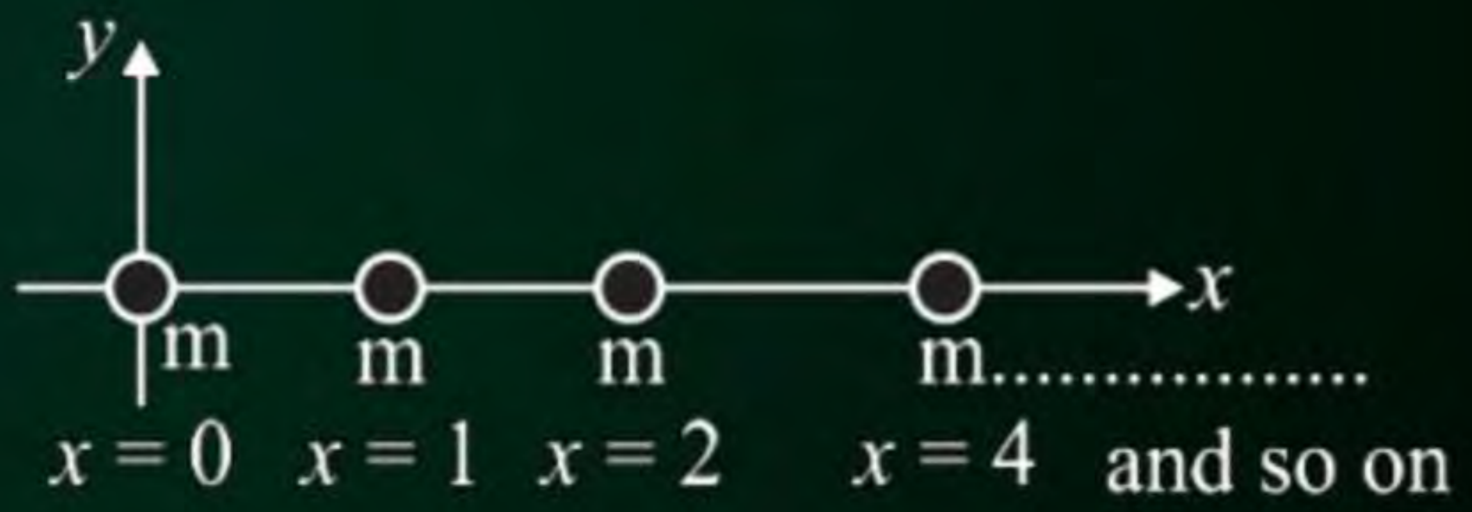
Find gravitational force on one object due to other three objects.

QUESTION

G.P sony

A large number of identical point masses m are placed along x-axis, at $x = 0, 1, 2, 4, ...$ The magnitude of gravitational force on mass at origin ($x = 0$), will be:

1. $Gm2$
2. $\frac{4}{3}Gm^2$
3. $\frac{2}{3}Gm^2$
4. $\frac{5}{4}Gm^2$




THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 01 | **Physics**

last Lecture मे 10 mint gravition. पढ़ाया था |

Gravitation



By- Dr. Manish Raj (MR SIR)

Topics to be covered

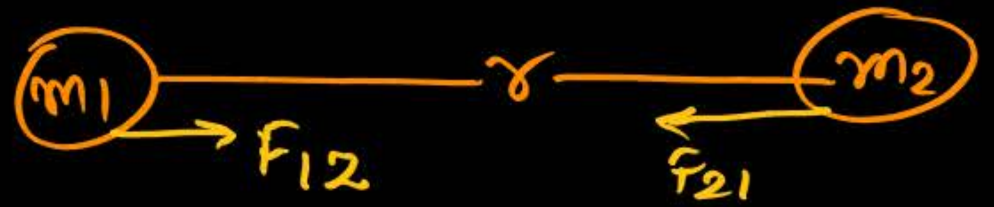
1 # Questions on Newtons Law of gravition

2 #

3 #

4 #



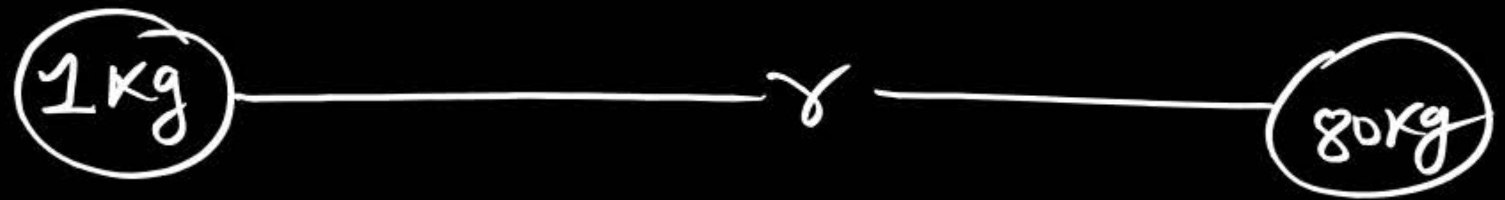


- $|\vec{F}_{12}| = |\vec{F}_{21}|$
- $\vec{F}_{12} \neq \vec{F}_{21}$ (action-reaction pair)
  - → Equal magnitude & opposite dirn.
  - → central force (dirn along the line joining of centre)
  - → long range
  - → follow inverse square law $F \propto m_1 m_2$, $F \propto \frac{1}{r^2}$
  - → conservative force
  - → work done does not depends Path
  - → does not depend on medium $\left(F = G\frac{m_1 m_2}{r^2}\right)$
  - → attractive.
  - → mediated by graviton. (last left)

* Valid for Point mass & spherical mass symmetry
* Reason of stability of inverse.
* weakest force in nature.

$$F = G\frac{(m_1 m_2)}{r^2}$$

$$G = 6.67 \times 10^{-11}\ N\,m^2/kg^2$$



$$\frac{F(\text{on } 80\text{kg})_{\text{due to } 1\text{kg}}}{F(\text{on } 1\text{kg})_{\text{due to } 80\text{kg}}} = ??$$

(a) 80 : 1 ✗

(b) 1 : 80 ✗

(c) 1 : 1 ✓ (80%)

(d) 2 : 8

$$F_{\text{on } 80\text{kg}} = \frac{G \, 80\text{kg} \times 1\text{kg}}{r^2}$$

$$F_{\text{on } 1\text{kg}} = \frac{G \, 1\text{kg} \times 80\text{kg}}{r^2}$$

QUESTION

Force of gravitation between two masses is found to be F in vacuum. If both the masses are dipped in water at same distance then, new force will be

1. $> F$
2. $< F$
3. F
4. Cannot say

95% same

1st edition 253

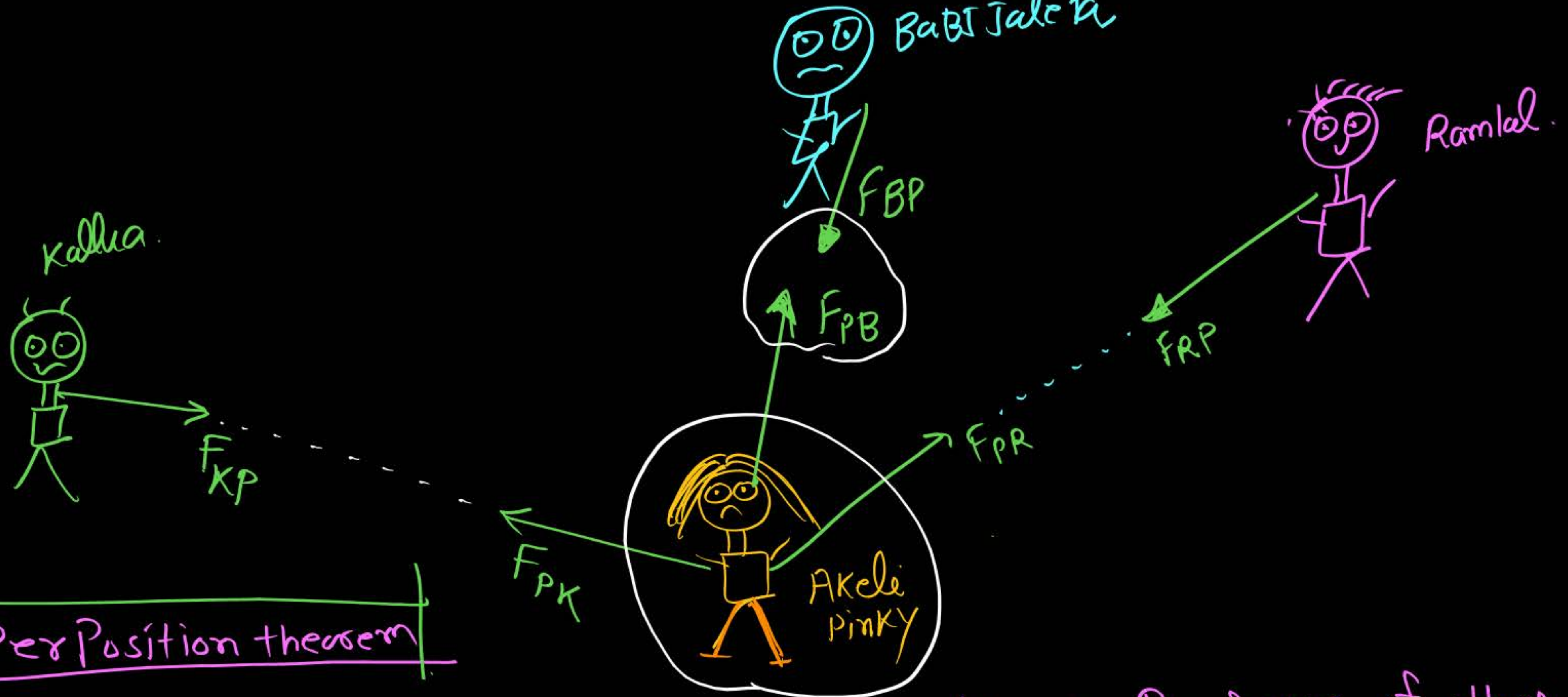
2nd edn → 296

new print → 340 page

same content

after 6 days from now

25-26 sept



SuperPosition theorem

→ force b/w any two Object does not depends on Presence of other object and medium. but net force on any object is vector sum of all the force due to all other object.

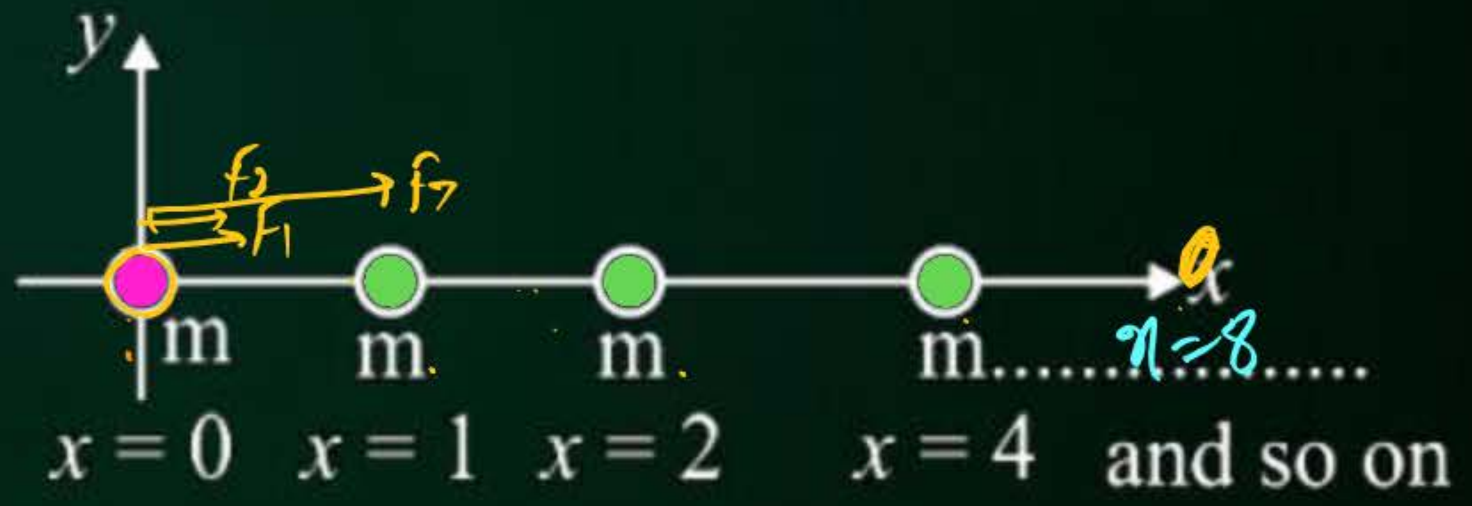
→ $\vec{F}_{net} = \vec{F}_1 + \vec{F}_2 + \vec{F}_3 + \vec{F}_4 + \dots$

SUPERPOSITION THEOREM

QUESTION

A large number of identical point masses m are placed along x-axis, at $x = 0, 1, 2, 4, \ldots\ldots$ The magnitude of gravitational force on mass at origin ($x = 0$), will be:

1. $Gm2$
2. $\frac{4}{3}Gm^2$
3. $\frac{2}{3}Gm^2$
4. $\frac{5}{4}Gm^2$



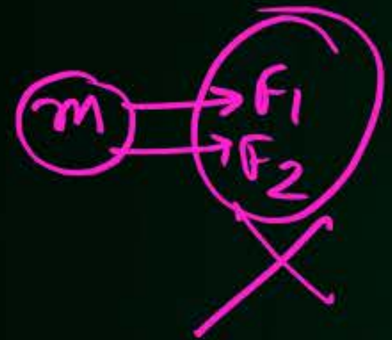
$F_{\text{on object at origi}} = \vec{F_1} + \vec{F_2} + \vec{F_3}$

$= \frac{Gm^2}{(1)^2} + \frac{Gm^2}{(2)^2} + \frac{Gmm}{(4)^2} + \ldots$

$= Gm^2\left(1 + \frac{1}{4} + \frac{1}{16} + \frac{1}{64} + \ldots\right) = Gm^2\left[\frac{1}{1-\frac{1}{4}}\right] = \frac{Gm^2 4}{3}$

QUESTION

find x so that force on m is zero





$$\left(\frac{m_2}{m_1}\right) = \frac{nM}{M} = n$$

Ratio of mass

$$\boxed{F_{net} = 0}$$

$$F_1 = F_2$$

$$\frac{GmM}{x^2} = \frac{GmnM}{(r-x)^2}$$

$$\frac{(r-x)^2}{x^2} = n$$

$$\left(\frac{r-x}{x}\right)^2 = n$$

$$\frac{r-x}{x} = \sqrt{n}$$

$$r-x = \sqrt{n}\,x$$

$$r = (\sqrt{n}+1)x$$

$$x = \left[\frac{r}{\sqrt{n}+1}\right]$$

from small mass

MR

QUESTION

Two point masses m and $4m$ are separated by a distance d on a line. A third point mass m_0 is to be placed at a point on the line such that the net gravitational force on it is zero.

The distance of that point from the m mass is

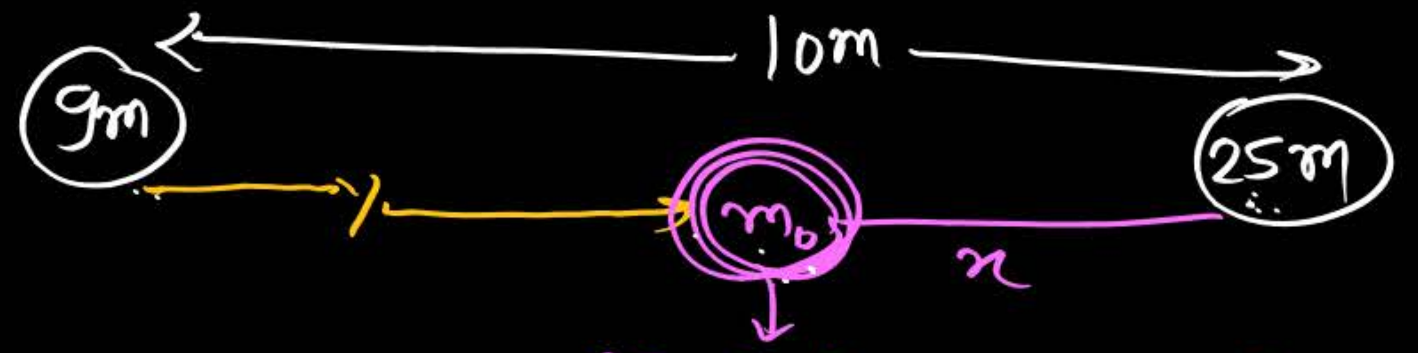
1. $\frac{d}{2}$

2. $\frac{d}{4}$

3. $\frac{d}{3}$

4. $\frac{d}{5}$





If $F_{net} = 0$ then find $x = ??$

Sol^n

$$y = \frac{10m}{\sqrt{\frac{25}{9}} + 1}$$

$$= \frac{10}{\frac{5}{3}+1} = \frac{10}{\frac{8}{3}} = \frac{30}{8} = \frac{15}{4}$$

$$x = 10 - y = 10 - \frac{15}{4} = \frac{25}{4} = 6.25m$$ Ans.

2nd method / Basic method

$$F_1 = F_2$$

$$\frac{G\,25m\,m_0}{x^2} = \frac{G\,9m\,m_0}{(10-x)^2}$$

$$\frac{25}{9} = \frac{x^2}{(10-x)^2}$$

$$\sqrt{\frac{25}{9}} = \frac{5}{3} = \frac{x}{10-x}$$

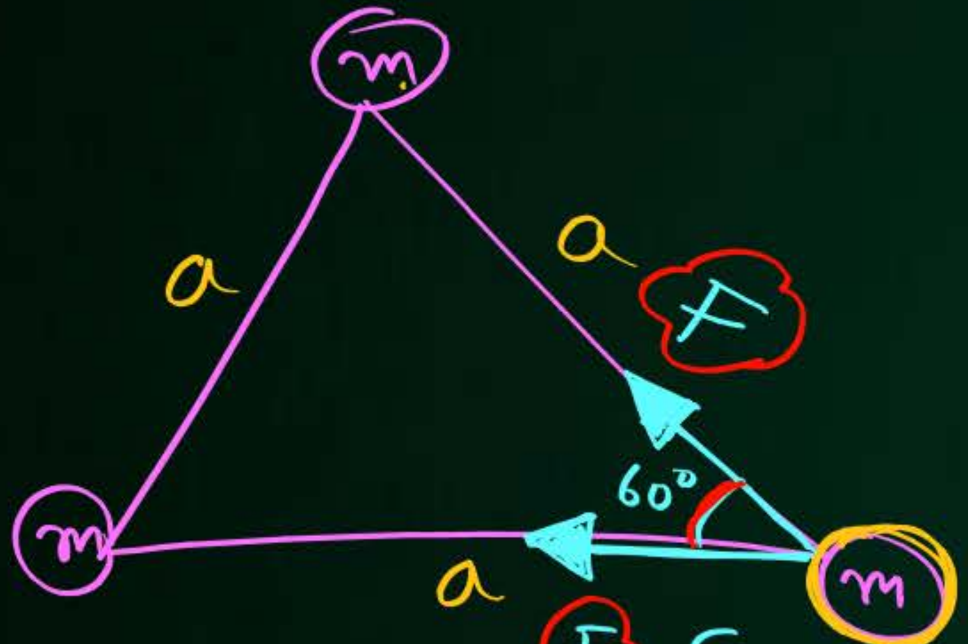
$$50 - 5x = 3x$$

$$50 = 8x$$

$$x = \frac{50}{8} = \frac{25}{4}$$

QUESTION

Find force on one mass m due to other two point masses.



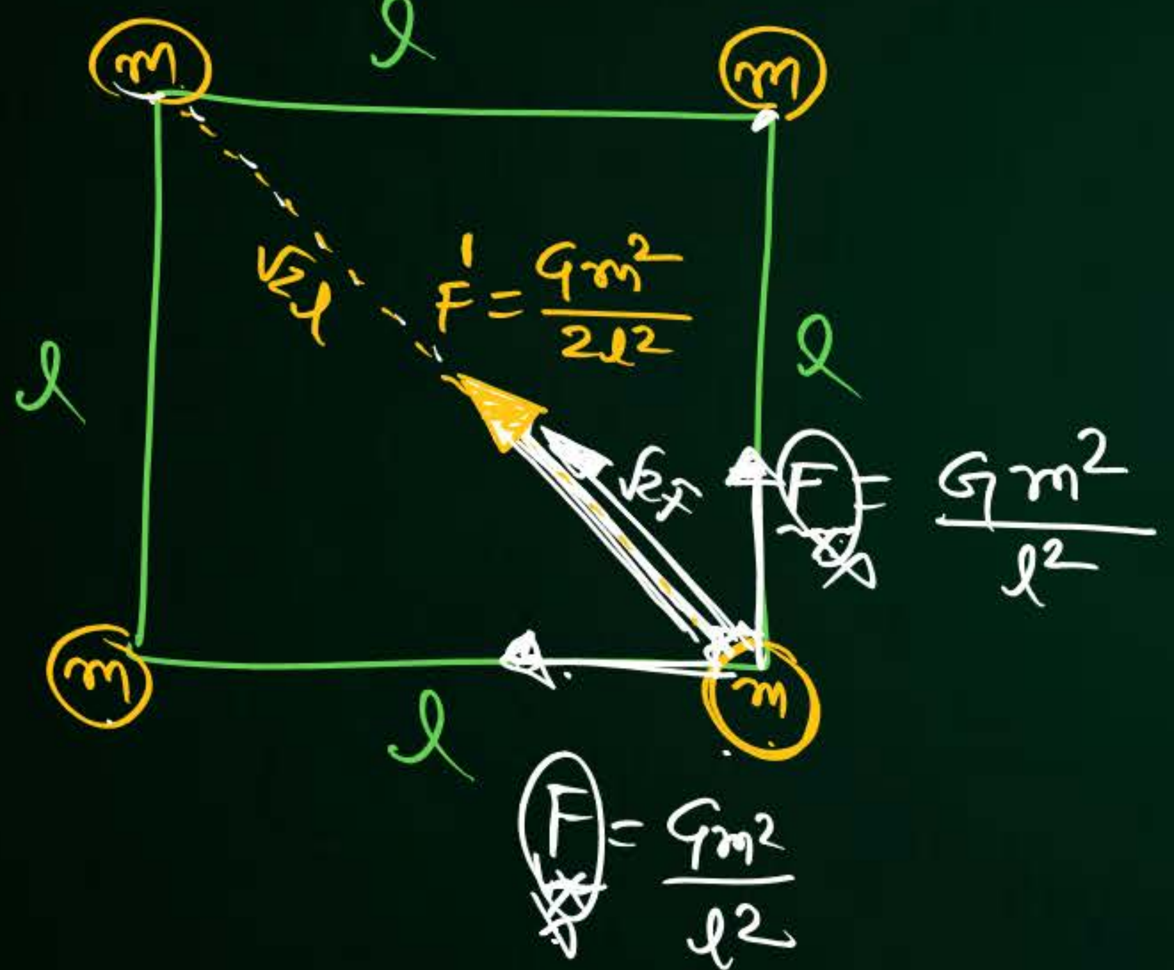
$$F = \frac{G\,m \times m}{a^2}$$

$$F_{net} = \sqrt{3}F$$

$$= \sqrt{3}\,\frac{Gm^2}{a^2} \quad \text{Ans}$$

QUESTION

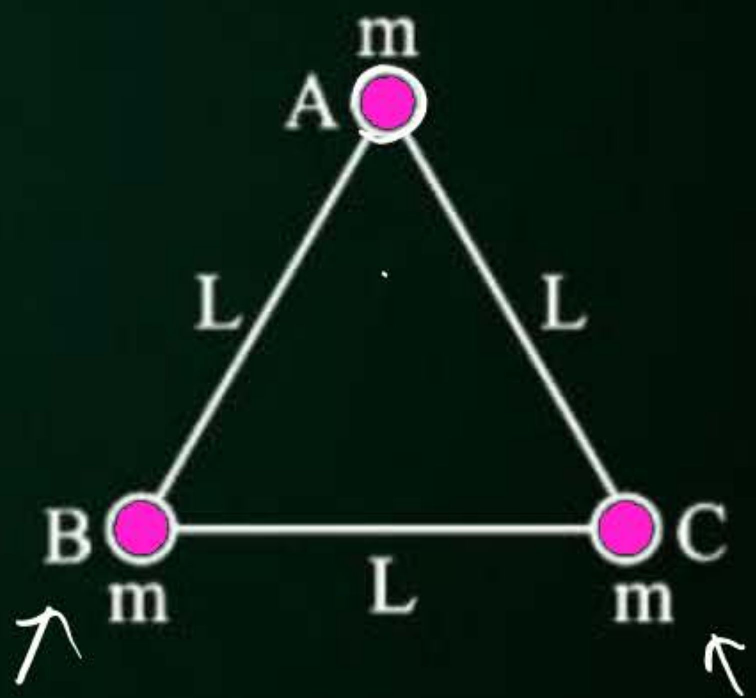
Find gravitational force on one object due to other three objects.



$$F_{net} = \sqrt{2}F + F' = \sqrt{2}\frac{Gm^2}{l^2} + \frac{Gm^2}{2l^2} = \frac{Gm^2}{l^2}\left(\sqrt{2} + \frac{1}{2}\right) = \frac{Gm^2}{l^2}\left(\frac{2\sqrt{2}+1}{2}\right) \text{ Ans}$$

QUESTION

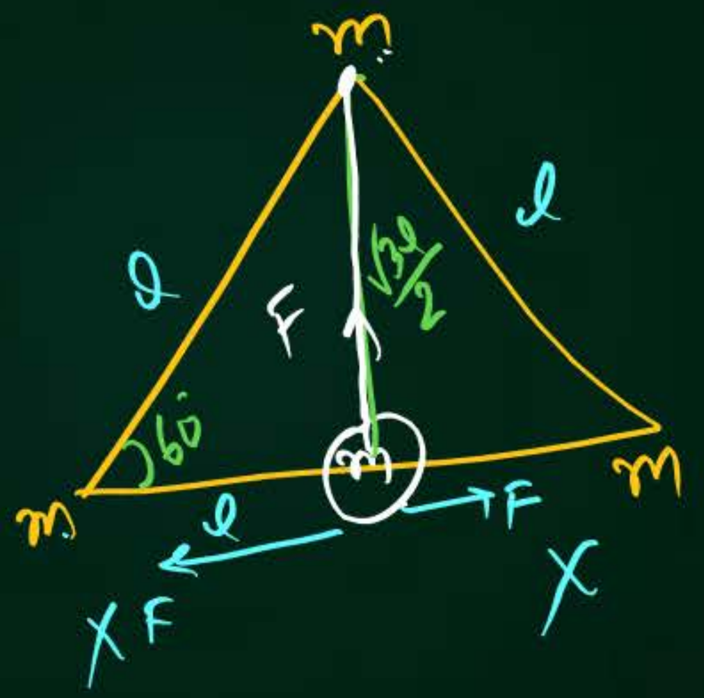
Three particles A, B and C each of mass m are lying at the corners of an equilateral triangle of side L. If the particle A is released keeping the particles B and C fixed, the magnitude of instantaneous acceleration of A is



1. $\sqrt{3}\dfrac{Gm^2}{L^2}$
2. $\sqrt{2}\dfrac{Gm^2}{L^2}$
3. $\sqrt{2}\dfrac{Gm}{L^2}$
4. $\sqrt{3}\dfrac{Gm}{L^2}$

QUESTION

Three particles, each of mass m, are kept at the corners of an equilateral triangle of side 'ℓ'. Force exerted by this system on another particle of mass m placed at the midpoint of any side will be :



(1) $\dfrac{5Gm^2}{\ell^2}$

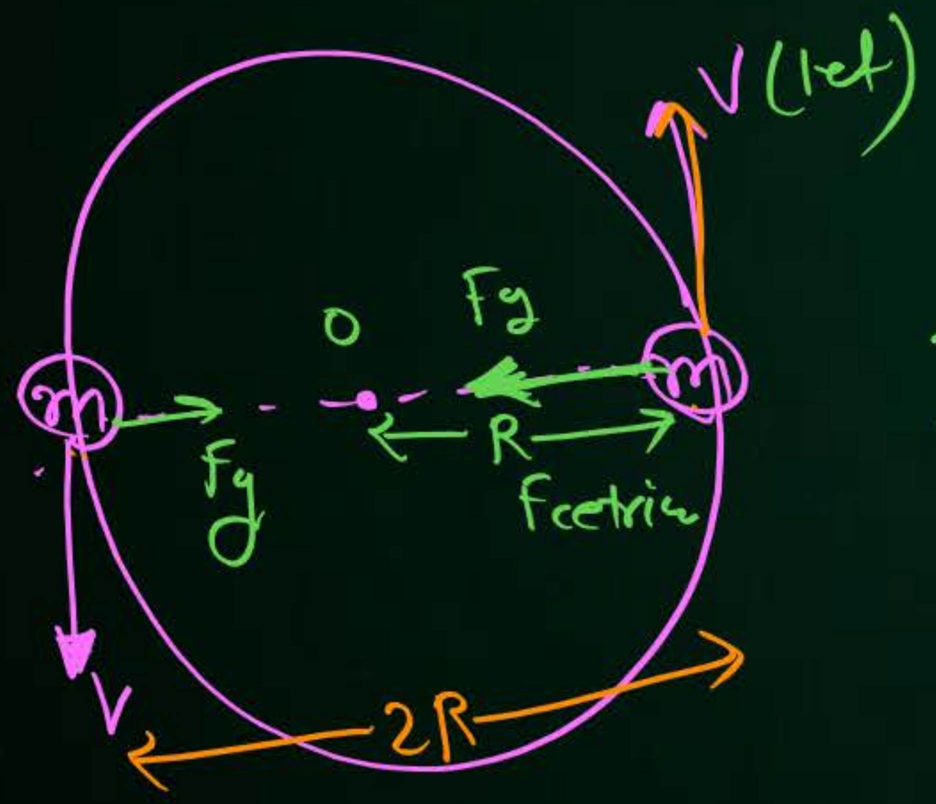
(2) $\dfrac{Gm^2}{2\ell^2}$

(3) $\dfrac{4Gm^2}{3\ell^2}$

(4) $\dfrac{5Gm^2}{3\ell^2}$

QUESTION

Two particle of equal mass m are moving round a circle of radius r due to their mutual gravitational interaction. Find the time period of each particle.



$$\frac{mv^2}{R} = \frac{Gm^2}{(2R)^2}$$

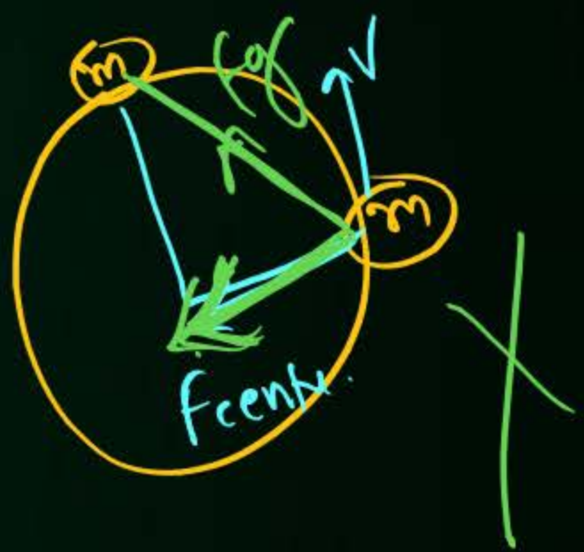
$$\frac{v^2}{R} = \frac{Gm}{4R^2 R}$$

$$v = \sqrt{\frac{Gm}{4R}}$$

$$v = r\omega$$

$$\omega = \frac{v}{R} = \sqrt{\frac{Gm}{4R^3}}$$

$$\frac{2\pi}{T} = \sqrt{\frac{Gm}{4R^3}} \quad \text{Ans}$$

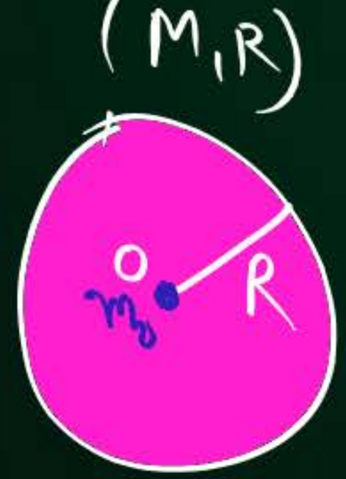


QUESTION

Find force between solid sphere and point mass *m*.



$$F = \frac{G m_0 M}{r^2}$$



m_0 placed at centre of solid sph

$F = 0$

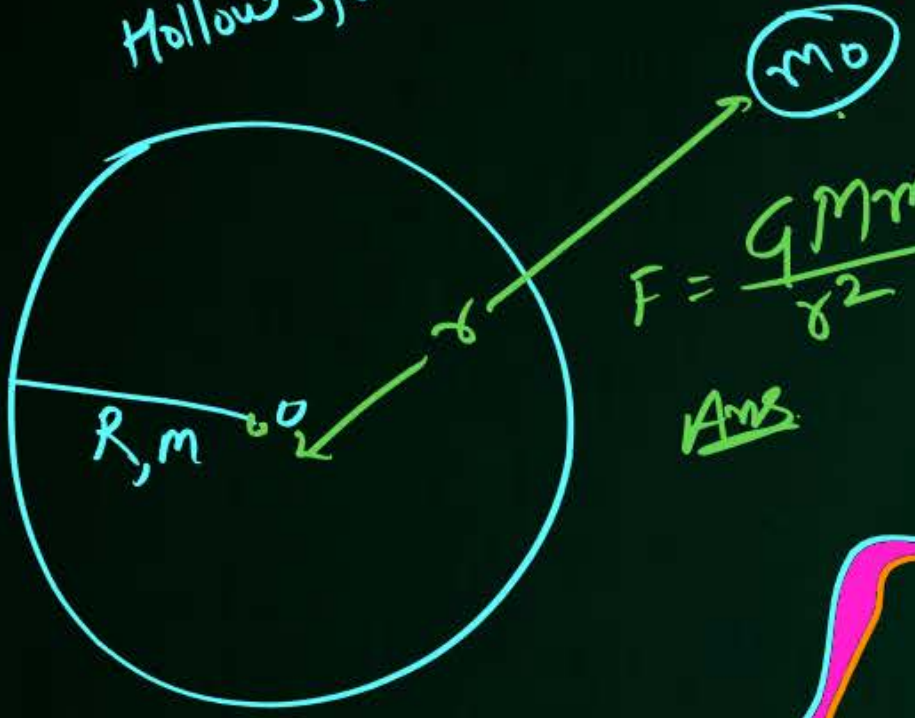
B/w sphere & point mass



$F_{\text{b/w sphere \& point mass}} = \frac{G m_0 M}{R^2}$



Hollow sph

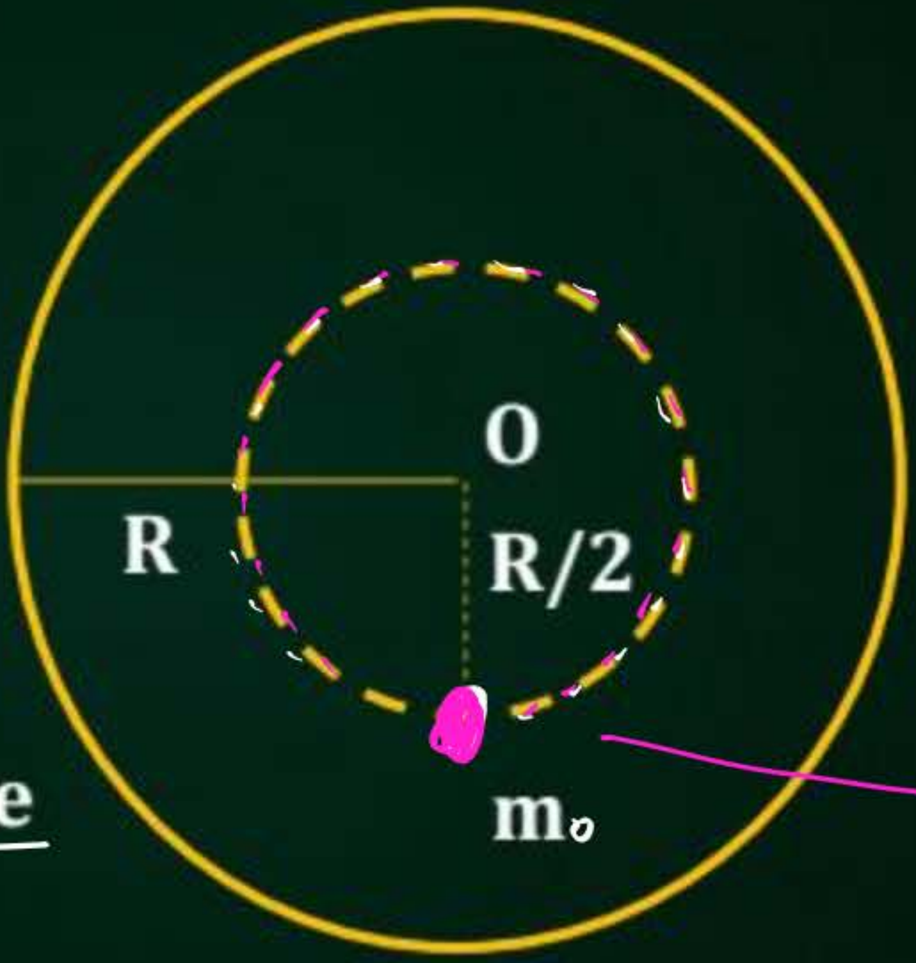


$$F = \frac{GMm_0}{r^2}$$

Ans.

(M, R)

Hollow sphere

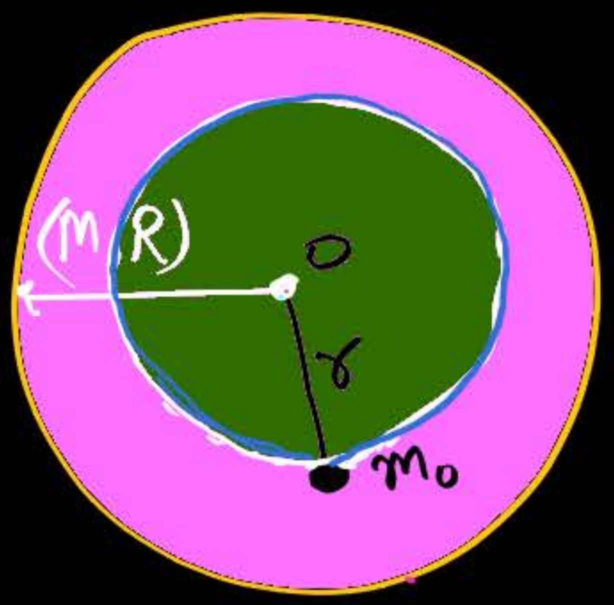


$F = 0$

b/w point mass & Hollow sph.

Shell theorem

uniform solid sphere (M, R)



$\rho = \frac{\text{Mass}}{\text{Volume}}$ = Mass per unit volume

$\rho = \frac{M}{\frac{4}{3}\pi R^3}$ (uniform)

$m' = \rho v' = \frac{M}{\frac{4}{3}\pi R^3} \times \frac{4}{3}\pi r^3 = \frac{M r^3}{R^3}$

Inner sph

$F = \frac{G M r^3 m_0}{R^3 \, r^2} = \frac{G M m_0 \, r}{R^3}$ → dimn

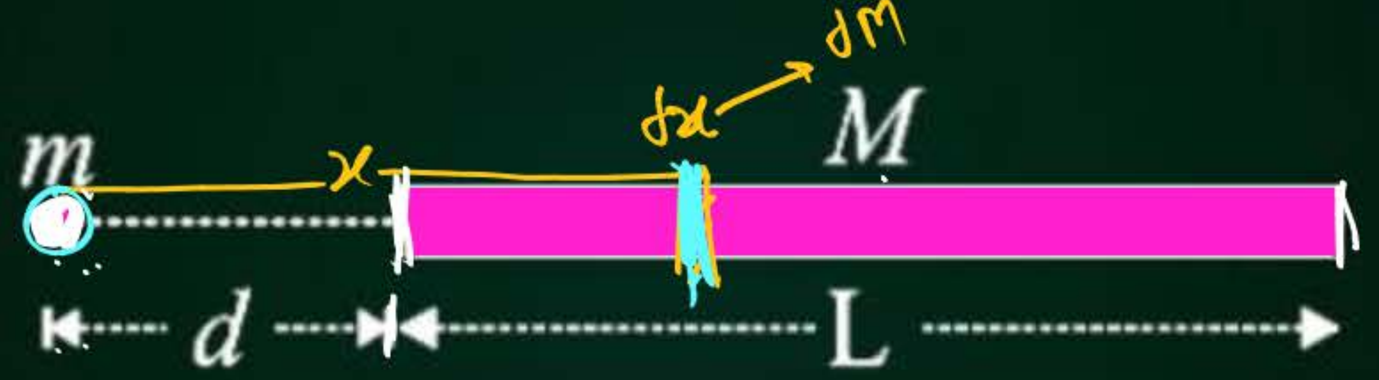
$(r = R)$: $F = \frac{G M m_0}{R^2}$ (MR*)

If $r = 0$: $F = 0$ (A28)

$\int \frac{1}{x^2}dx = -\frac{1}{x}$

QUESTION

A particle of mass m is placed at a distance d from one end of a uniform rod with length L and mass M as shown in the figure. Find the magnitude of the gravitational force on the particle due to the rod.



$\lambda = \frac{M}{L}$

$dm = \lambda dx$

$dm = \frac{M}{L} dx$

$dF = \frac{G m\, dm}{x^2}$

$\int dF = \int \frac{G m M}{x^2 L} dx$

$F = \frac{GMm}{L} \int_d^{(d+L)} \frac{1}{x^2} dx$

solve by yours

$F = \frac{GMm}{d(d+L)}$ Ans

QUESTION

If distance between two object decreases by 50% then percentage change in gravitational force of object :

1. 100%
2. 200%
3. 300% — Ans
4. 400%

Sol $\rightarrow r' = r \times 50\% = \left(\frac{r}{2}\right)$

$$\frac{F_f - F_i}{F_i} \times 100 = \%\ \text{Change in force}$$

$$F_i = \frac{Gm^2}{r_i^2}$$

$$F_f = \frac{Gm^2}{\left(\frac{r}{2}\right)^2} = \frac{4Gm^2}{r^2}$$

$$F_f = 4F_i$$

$$\%\ \text{change} = \frac{4F_i - F_i}{F_i} \times 100$$

$$= \frac{3F_i}{F_i} \times 100 = 300\%$$

MR* $r' = 50\% \, r_i = \frac{r_i}{2}$

$$F \propto \frac{1}{(r)^2}$$

$$F' = (4) F_i$$

400%

QUESTION

If distance increase by 300%, then find percentage change in force.

$r_f = 400\% \cdot r_i$

$= \frac{400}{100} r_i$

$F \propto \frac{1}{r^2}$

$F' \propto \frac{1}{16r^2}$

$F' = \frac{F}{16} \times 100$ (6.25%)

% change (93.75%)

$r_f = r_i + 300\% \cdot r_i$

$= r_i + \frac{300}{100} r_i$

$r_f = 4r_i$ — (1)

$F_i = \frac{Gm^2}{r_i^2}$ $F_f = \frac{Gm^2}{(4r_i)^2}$

$F_f = \frac{Gm^2}{16 r_i^2} = \frac{F_i}{16}$

$\%\ \text{change} = \frac{\frac{F_i}{16} - F_i}{F_i} \times 100 = \frac{\frac{(1-16)}{16} F_i}{F_i} \times 100$

$= \frac{15 \times 100}{16}$

$= 93.75$

QUESTION

Two bodies of equal masses are some distance apart. If 20% of mass is transferred from the first body to the second body, then the gravitational force between them

1. Increases by 4%
2. Increases by 14%
3. Decreases by 4%
4. Decreases by 14%

m → (20% transf) → m

$80\% \, m = \frac{8}{10} m$ $\quad$ $120\% \, m = \frac{12 m}{10}$

$$F = G \frac{8 \times 12}{10 \times 10} \frac{m^2}{r^2} = \frac{96}{100} \frac{G m^2}{r^2}$$

$$F' = F_i \, 0.96$$

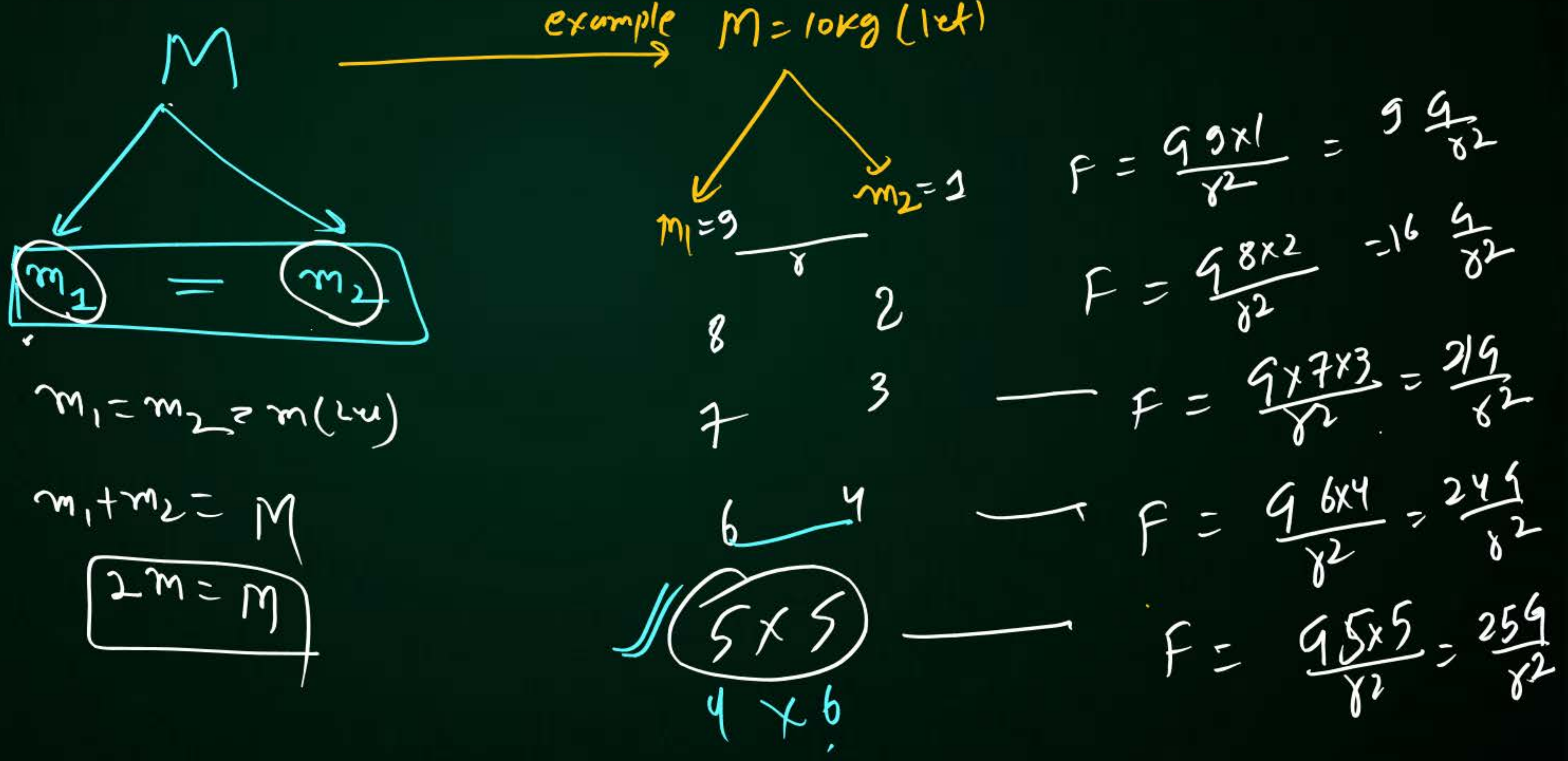
$0.96 \times 100 = 96\%$ final force

decrease by 4%

QUESTION

A mass M is broken into two parts of masses m_1 and m_2. How are m_1 and m_2 related so that force of gravitational attraction between the two parts is maximum ?

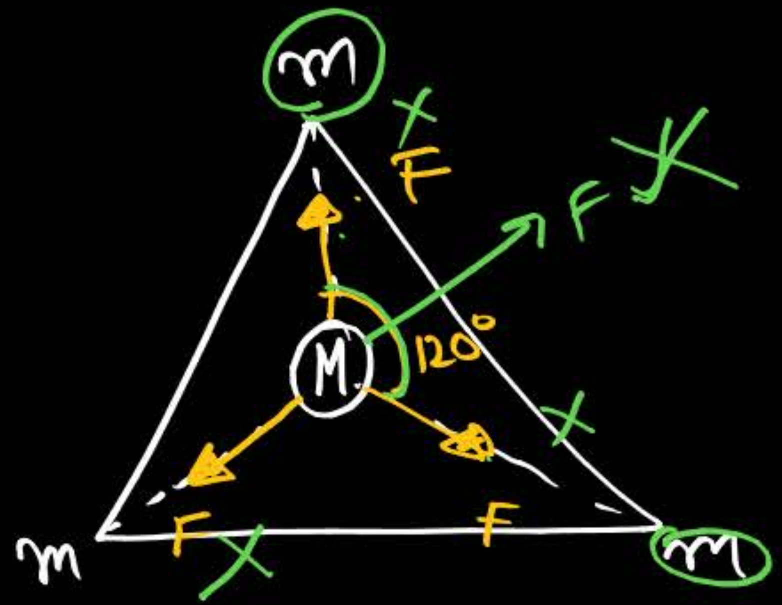
1. $M = 2m$
2. $M = m/2$
3. $M = 3/2m$
4. $M = m$



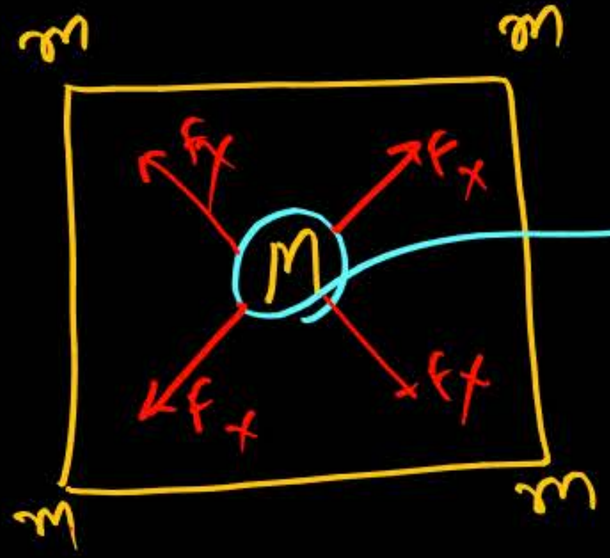
QUESTION

A mass M is split into two parts m_0 and $M - m_0$. These two masses are then separated by a distance D. IF the gravitational force between the parts is maximum, then the ratio $\left(\frac{m_0}{M}\right)$ is

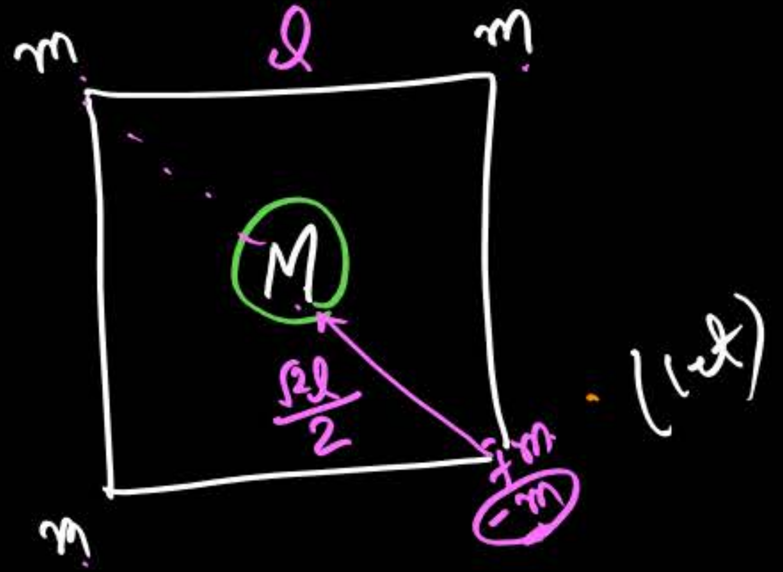
1. 0.2
2. 0.4
3. 0.5
4. 0.6



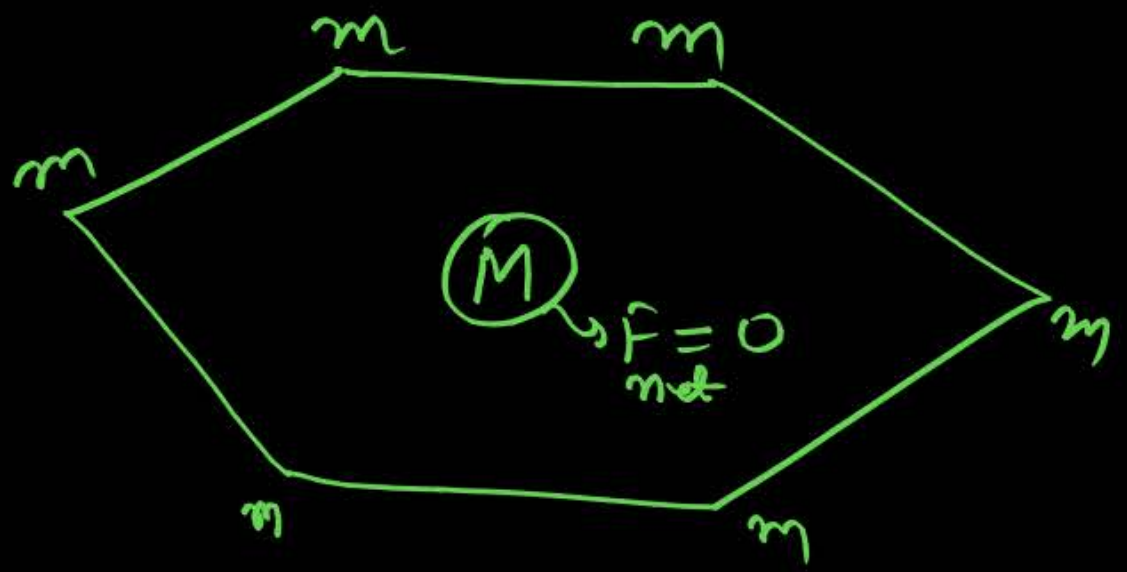
F_{net} force on $M = 0$

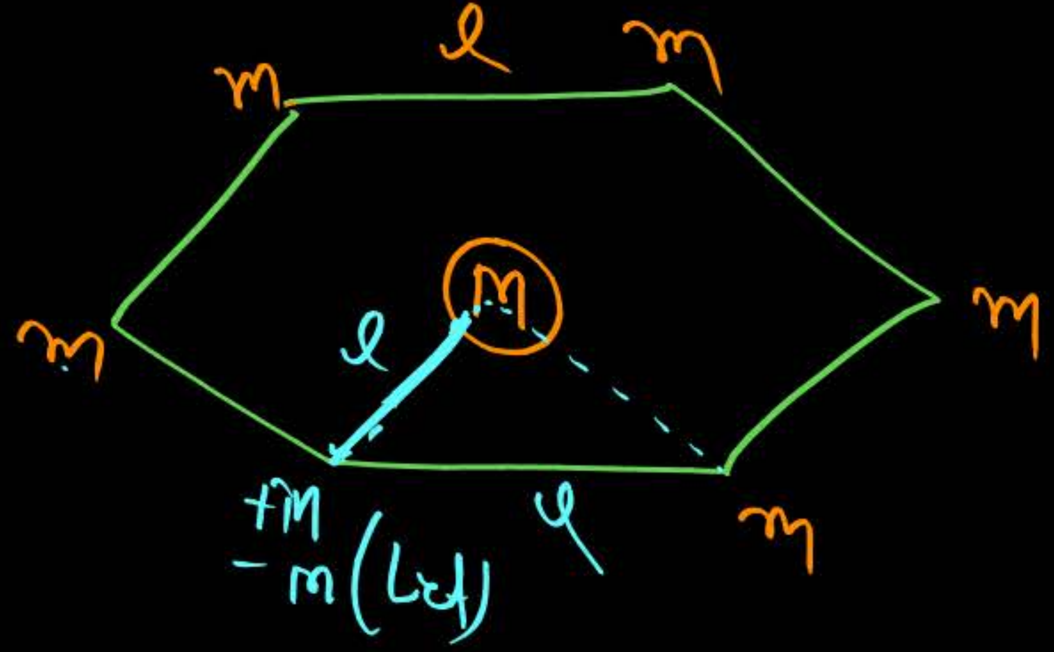


F_{net} on $M = 0$



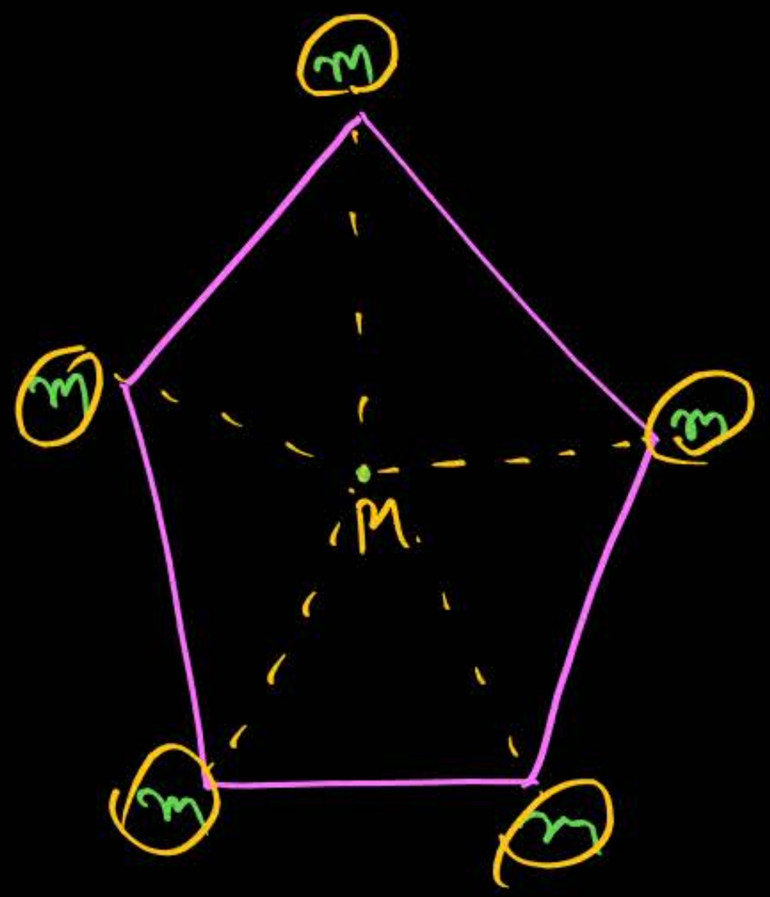
$$F = \frac{GMm}{\left(\frac{\sqrt{2}l}{2}\right)^2} = \frac{GMm}{\frac{2l^2}{2}} = \frac{2GMm}{l^2}$$

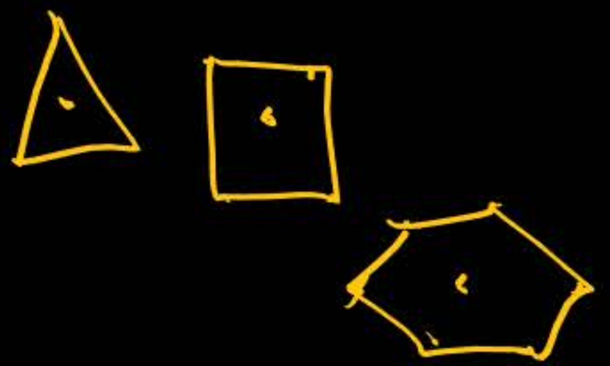




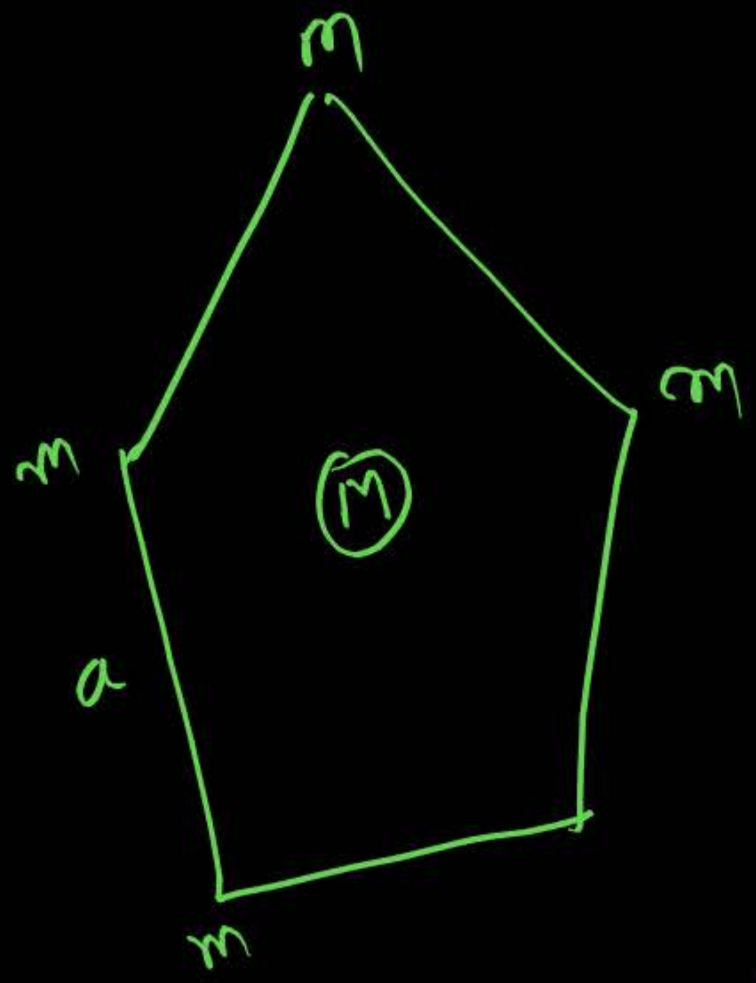
Find net force on (M) = ??

$$F_{net} = \frac{GmM}{l^2}$$





$(F_{net}\ m = 0)$



find net force on M due to all 4-mass

$F_{??} =$

QUESTION

Two identical sphere as are placed in contact with each other. If r is the radius of each sphere, then gravitational attraction between the two is proportional to :

1. r^2
2. r^4
3. $1/r^2$
4. $1/r^4$

QUESTION

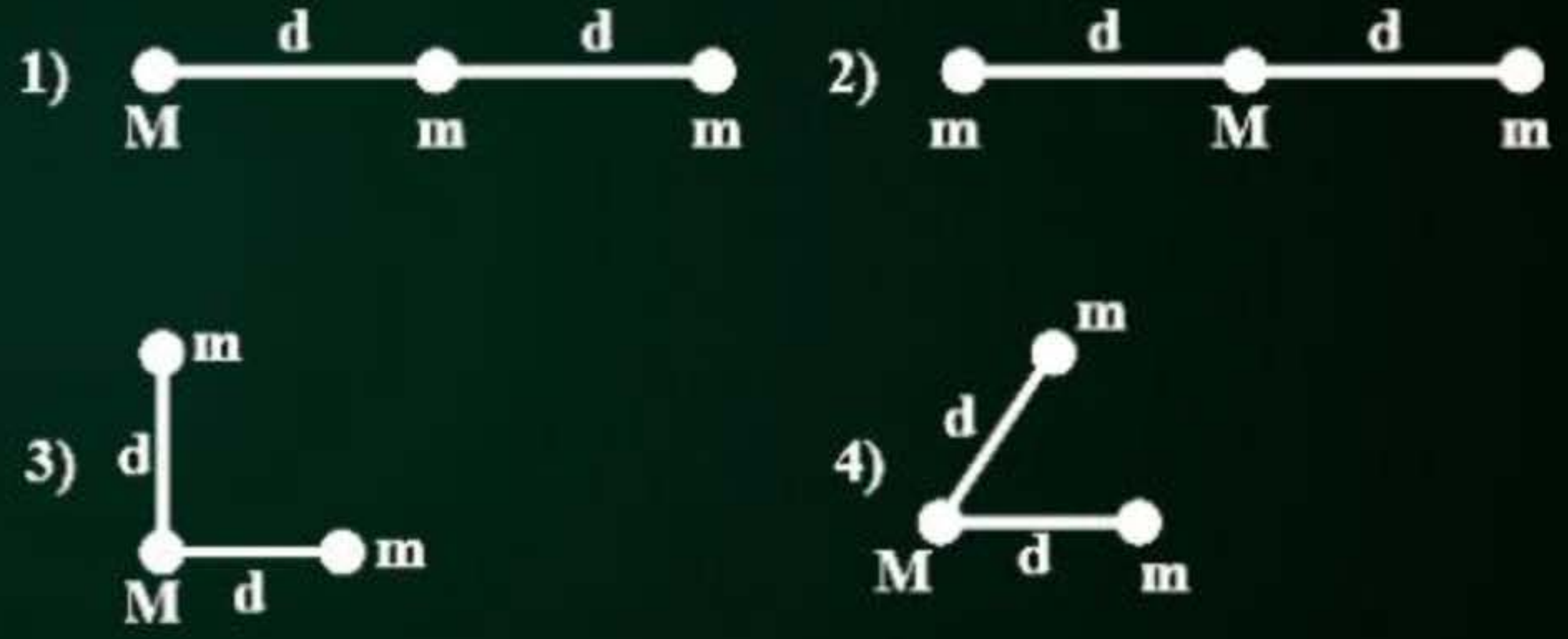
Net force on m_0 which is at center :

1. Zero
2. $\frac{q_m m_0}{a_2}$
3. $\frac{2q_m m_0}{a_2}$
4. None of these

QUESTION

Three particles, two with masses m and one with mass M, might be arranged in any if the four configurations shown below. Rank the configuration according to the magnitude of the gravitational force on M, least to greatest.

1. 1, 2, 3, 4
2. 2, 1, 3, 4
3. 2, 1, 3, 4
4. 2, 3, 4, 1



QUESTION

Force between solid sphere (M,R) and m is F as shown in figure. If sphere of radius $\left(\frac{R}{2}\right)$ concentric removed then new force between remaining part of sphere and mass m. [IIT 2022]

GRAVITATIONAL FIELD INTENSITY

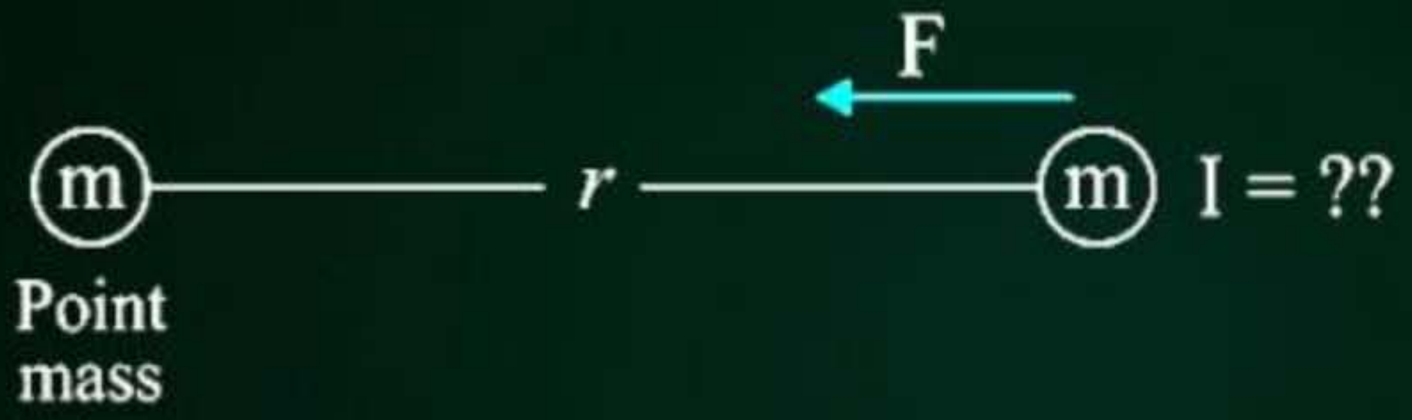
- **Gravitational force per unit mass is called field intensity.**

$$I = \lim_{m \to 0} \frac{F}{m}$$

- **Unit → N/kg**
- **dimension →** $\frac{MLT^{-2}}{N} \Rightarrow M^{\circ}L^{1}T^{-2}$

- **Vector**
- **Direction parallel to force.**

(i) **Gravitational field Intensity due to point mass:**



QUESTION

Two point masses having mass m and $2m$ are placed at distance d. The point on the line joining point masses, where gravitational field intensity is zero will be at distance

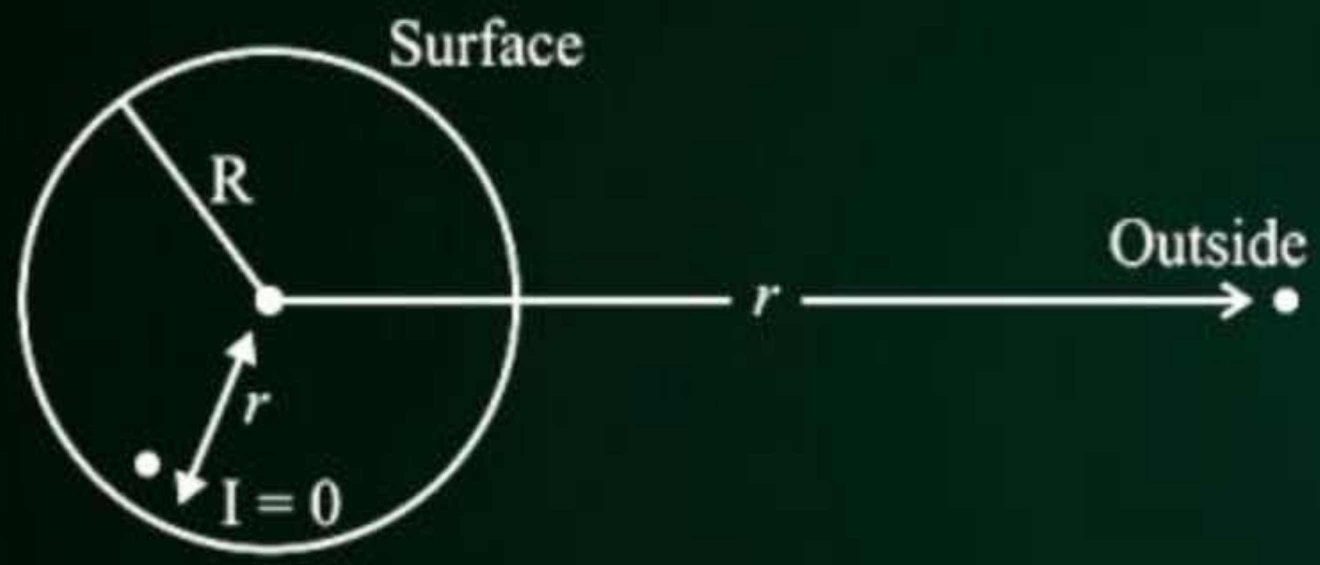
(1) $\frac{2d}{\sqrt{3}+1}$ from point mass "$2m$"

(2) $\frac{2d}{\sqrt{3}-1}$ from point mass "$2m$"

(3) $\frac{d}{1+\sqrt{2}}$ from point mass "m"

(4) $\frac{d}{1-\sqrt{2}}$ from point mass "m"

(ii) Gravitational field Intensity due to hollow sphere:



$$I_{outside}\,(r > R) = \frac{\vec{F}}{m} = \frac{GMm}{r^2 m} \Rightarrow \frac{GM}{r^2}\hat{r}$$

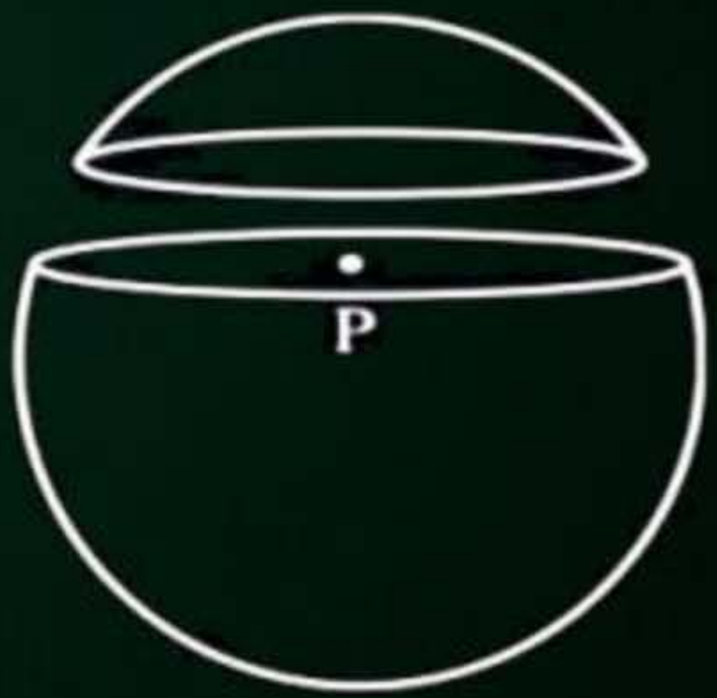
$$I_{surface}\,(r = R) = \frac{GM}{R^2}$$

$$I_{inside}\,(r < R) = 0$$

QUESTION

A spherical shell is cut into two pieces along a chord as shown in the figure. 'P' is a point on the plane to the chord. The gravitational field at 'P' due to the upper part is I_1 and that due to the lower part is I_2. What is the relation between them?

1. $I_1 > I_2$
2. $I_2 > I_1$
3. $I_1 = I_2$
4. No definite relation



QUESTION

The force between a hollow sphere and a point mass at P inside it as shown in figure.

1. Is attractive and constant.
2. Is attractive and depends on the position of the point with respect to centre C
3. 10 km
4. 7.5 km




THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 02 | **Physics**

Gravitation

By- Dr. Manish Raj (MR SIR)



Todays Goal

- H/W
- Gravitational field Intensity
- acceleration due to gravity

same unit & dim^n

$I = \left(\frac{F}{m}\right)$

$a = \left(\frac{F}{m}\right)$

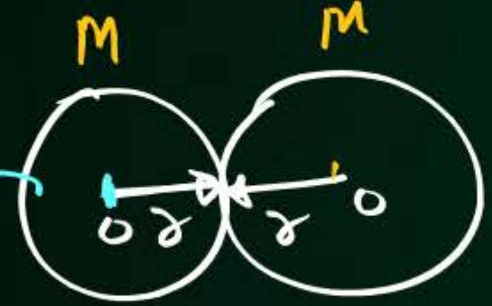
QUESTION

Two identical sphere as are placed in contact with each other. If r is the radius of each sphere, then gravitational attraction between the two is proportional to :

1. r^2
2. r^4 (36%)
3. $1/r^2$ (42%)
4. $1/r^4$

same material

$\rho = \frac{m}{V}$



$F = \frac{GM^2}{(2r)^2} = \frac{GM^2}{4r^2}$

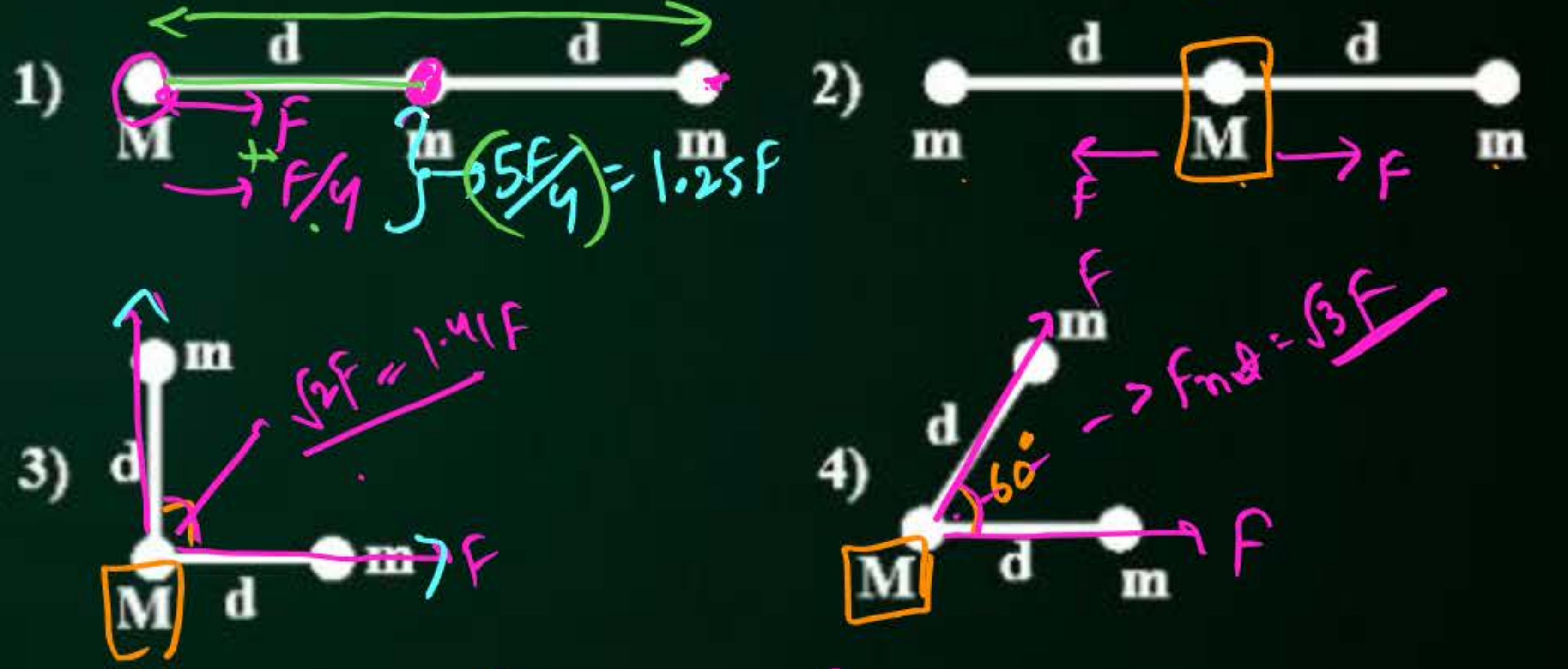
$F = \frac{G\left(\rho \frac{4}{3}\pi r^3\right)^2}{4r^2} = \frac{\rho G \frac{16}{9}\pi^2 r^6}{4 r^2}$ (const.) r^4

$F \propto (r)$

QUESTION

Three particles, two with masses m and one with mass M, might be arranged in any if the four configurations shown below. Rank the configuration according to the magnitude of the gravitational force on M, least to greatest.

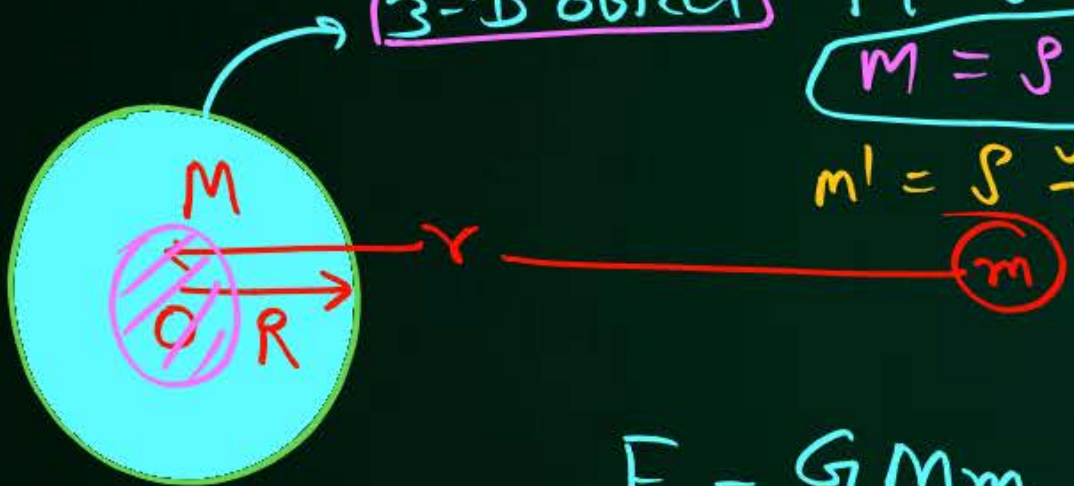
1. 1, 2, 3, 4
2. 2, 1, 3, 4
3. 2, 1, 3, 4
4. 2, 3, 4, 1



QUESTION

Force between solid sphere (M,R) and m is F as shown in figure. If sphere of radius $\left(\frac{R}{2}\right)$ concentric removed then new force between remaining part of sphere and mass m.

[IIT 2022]



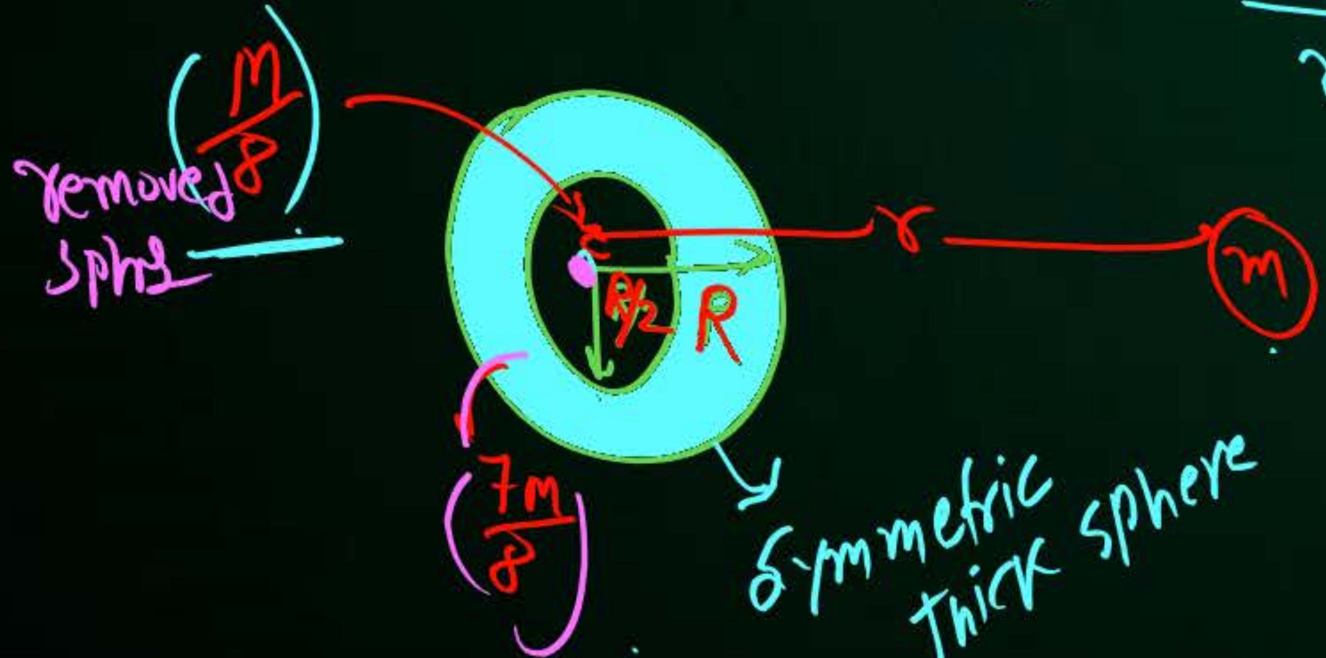
$M = \rho\,\text{volume}$

$M = \rho\left(\frac{4}{3}\pi R^3\right)$

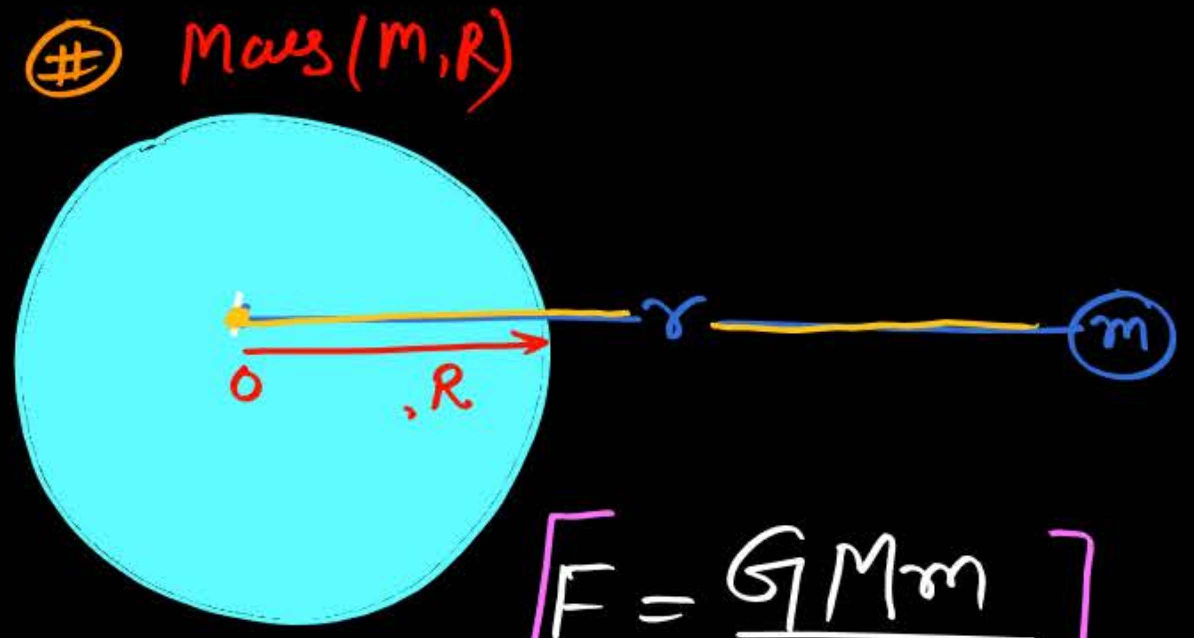
$m' = \rho\,\frac{4}{3}\pi\left(\frac{R}{2}\right)^3 = \frac{\rho\frac{4}{3}\pi R^3}{8} = \frac{M}{8}$

$\frac{M}{8}$ नहीं समझ आया → class से निकल जाओ

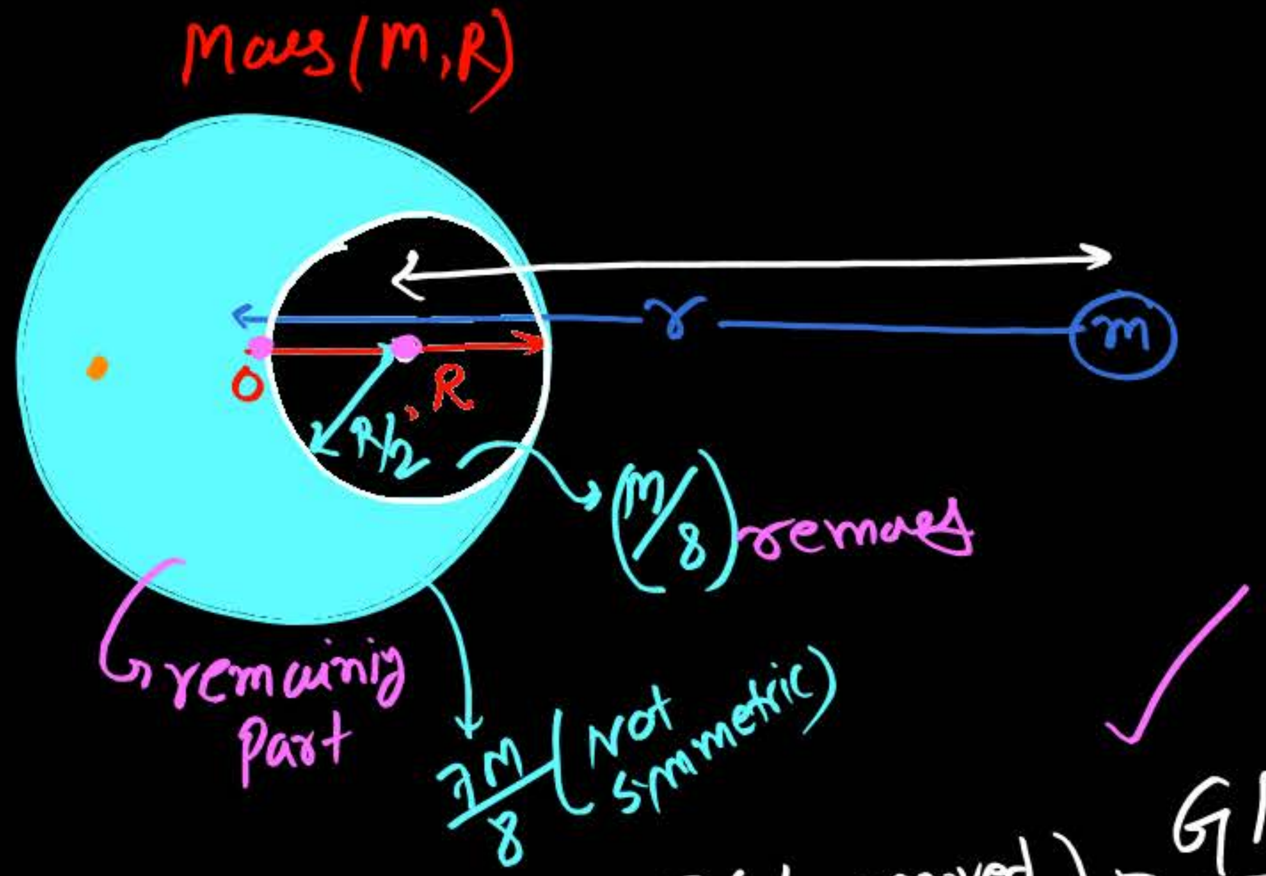
$F = \frac{GMm}{r^2}$



$F' = \frac{G\,7Mm}{8r^2}$ Ans $= \frac{7}{8}F$ Ans



$$F = \frac{GMm}{r^2}$$



$$F\,(\text{B/w removed part \& point mass}) = \frac{GMm}{8\left(r-\frac{R}{2}\right)^2}$$

If force B/w compt sphere and point mass is 'F' then find force B/w remaining part & point mass, if sphere of radius R/2 is removed, such that their circumference is common (as shown in fig.)

$$F' = F_{compt\ spr} - F_{removed\ part}$$

$$= \left[\frac{GMm}{r^2} - \frac{GMm}{8\left(r-\frac{R}{2}\right)^2}\right]$$

$M \xrightarrow{r} m$ (test mass)

$F = \frac{GMm}{r^2}$

⑤ $F = \frac{Gm(5)}{r^2}$

③ $F = \frac{Gm(3)}{r^2}$

① $F = \frac{Gm(1)}{r^2} = \frac{GM}{r^2} \Rightarrow$

② $F = \frac{Gm(2)}{r^2}$

same

$\vec{I} = \frac{\vec{F}}{m} = \frac{GMm}{r^2 m} = \left(\frac{GM}{r^2}\right)$

→ vector

Gravitational force per unit mass is called gravitational field intensity.

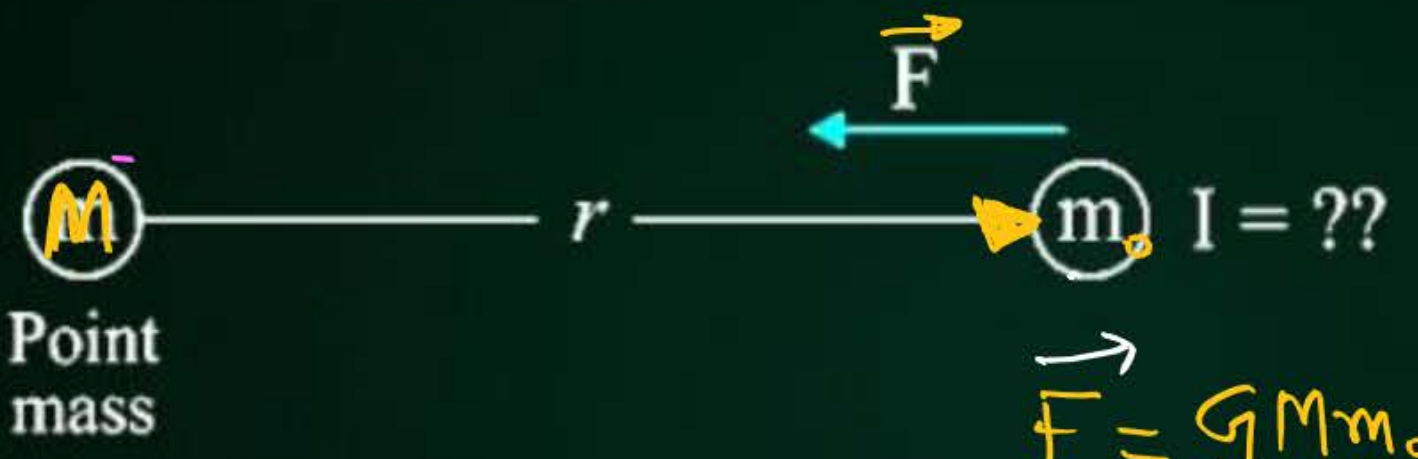
GRAVITATIONAL FIELD INTENSITY

- Gravitational force per unit mass is called field intensity.

$$\vec{I} = \lim_{m \to 0} \frac{\vec{F}}{m}$$

- Unit → N/kg
- dimension → $\frac{MLT^{-2}}{M} \Rightarrow M^{0}L^{1}T^{-2}$
- Vector
- Direction parallel to force.

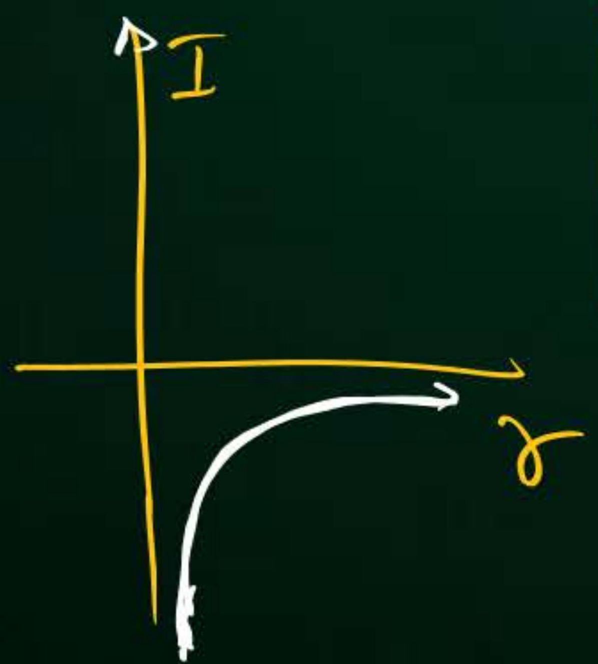
(i) Gravitational field Intensity due to point mass:



$$\vec{F} = \frac{GMm_0}{r^2}(-\hat{r})$$

$$\left[\vec{F} = -\frac{GMm_0}{r^2}\hat{r}\right]$$

Gravitational force always attractive



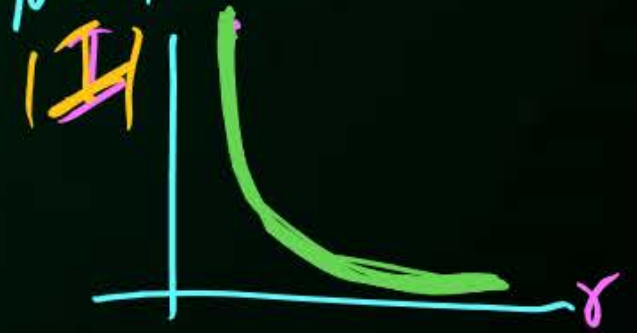
$$\vec{I} = \frac{\vec{F}}{m_0}$$

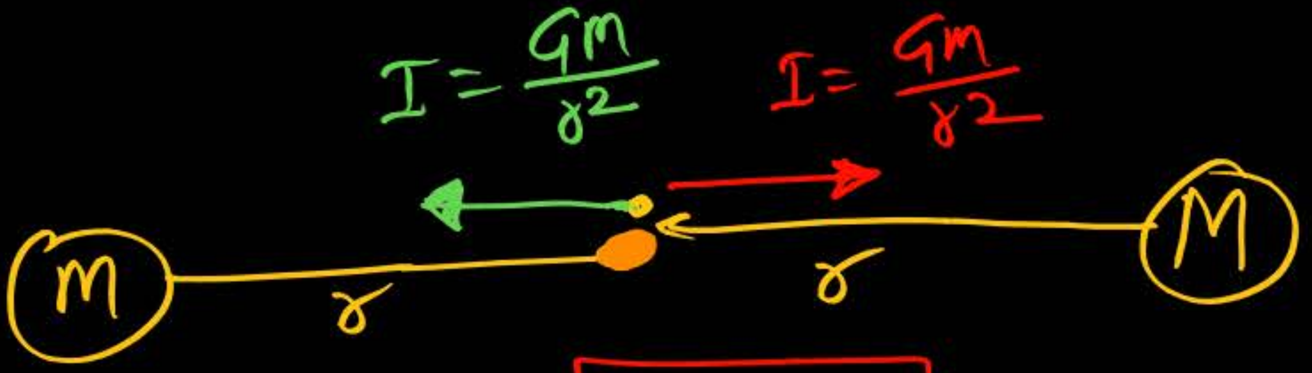
$$\vec{I} = -\frac{GMm_0}{r^2 m_0}\hat{r}$$

$$\boxed{\vec{I} = -\frac{GM}{r^2}\hat{r}}$$

(– → dirn.)

Gravitational field Intensity due to Point Mass M at distn (r)





$$I_{net} = 0$$

Find x at which gravitational field intensity is zero.



$F_{net} = 0$

$I = 0$

$$x = \frac{r}{\sqrt{n}+1}$$

MR*

If $n = 1$

$x = r/2$

MR*

$x < r$

QUESTION

The gravitational force on a body of mass 1.5 kg situated at a point is 45 N. The gravitational field intensity at that point is

(1) 30 N/kg ✓

(2) 67.5 N/kg

(3) 46.5 N/kg

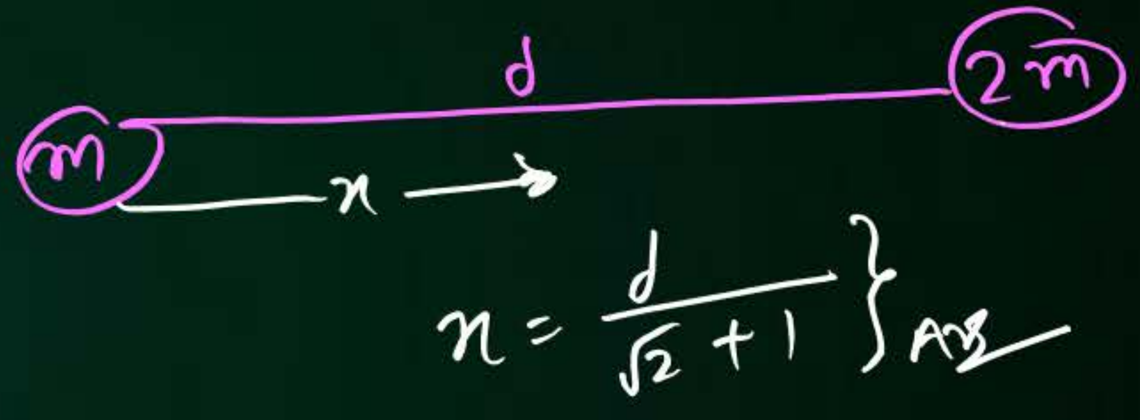
(4) 43.5 N/kg

$I = \frac{F_m}{m} = \frac{45}{1.5} = \frac{45}{3/2} = 30\ N/kg$

$I = \frac{F}{m}$ Ans

QUESTION

Two point masses having mass m and $2m$ are placed at distance d. The point on the line joining point masses, where gravitational field intensity is zero will be at distance



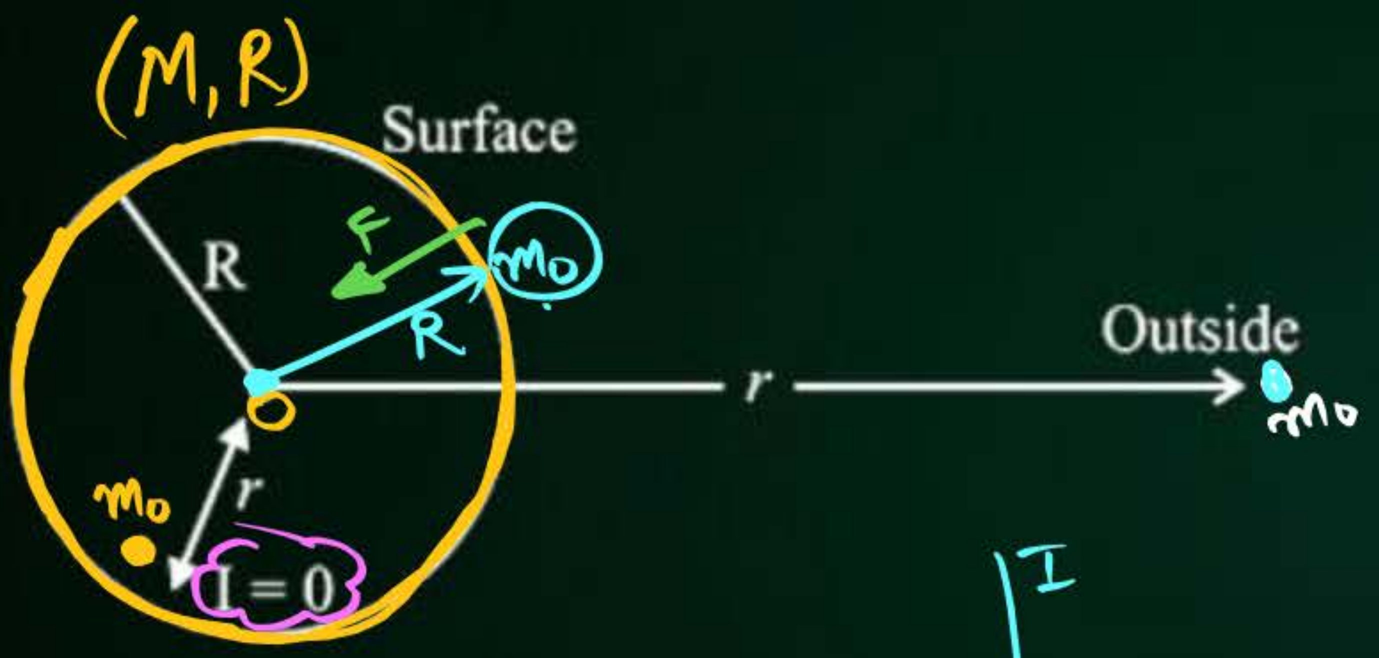
1. $\frac{2d}{\sqrt{3}+1}$ from point mass "$2m$"

2. $\frac{2d}{\sqrt{3}-1}$ from point mass "$2m$"

3. $\frac{d}{1+\sqrt{2}}$ from point mass "m"

4. $\frac{d}{1-\sqrt{2}}$ from point mass "m"

(ii) Gravitational field Intensity due to hollow sphere:



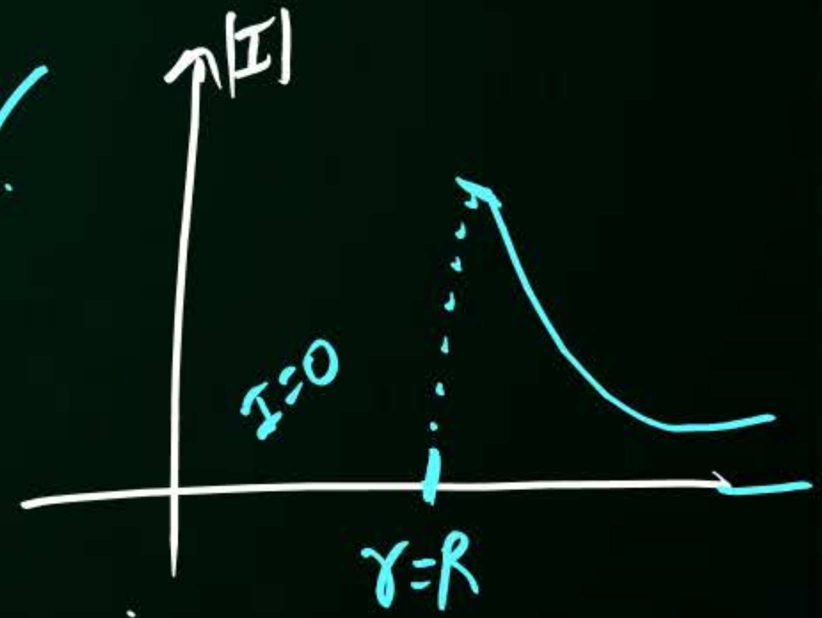
$$I_{outside}\ (r > R) = \frac{F_{m_0}}{m_0} = \frac{GMm_0}{r^2 m_0} = -\frac{GM}{r^2}\hat{r}$$

$$I_{surface}\ (r = R) = \frac{\vec{F}}{m_0} = \frac{GMm_0}{R^2 m_0} = -\frac{GM}{R^2}\hat{R}$$

$$\vec{I}_{inside}\ (r < R) = 0$$

$I = 0$ (Hollow sph)

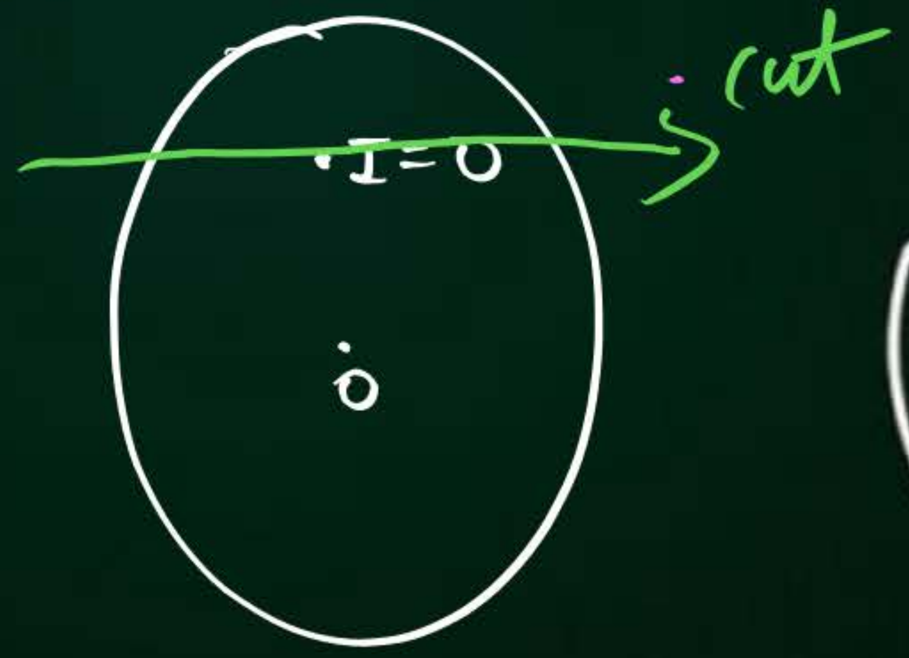


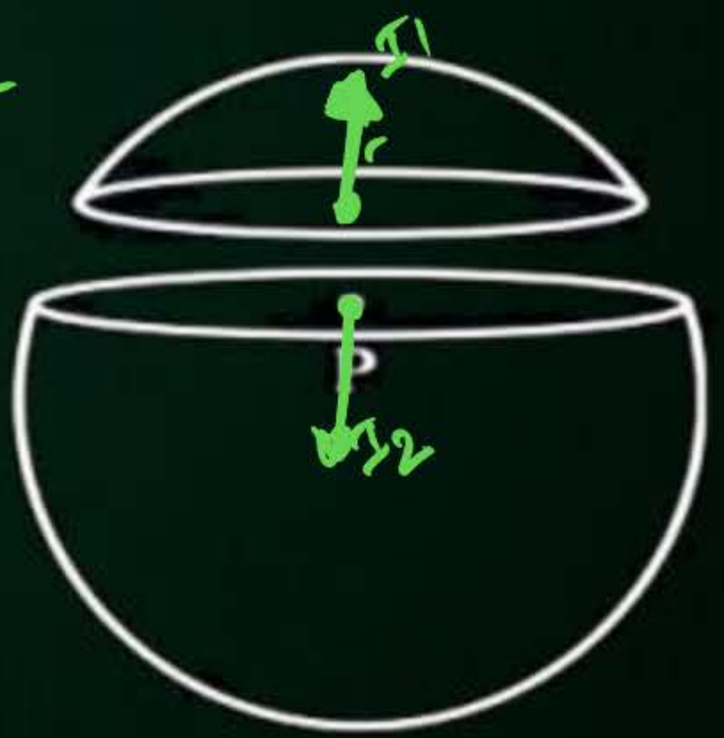


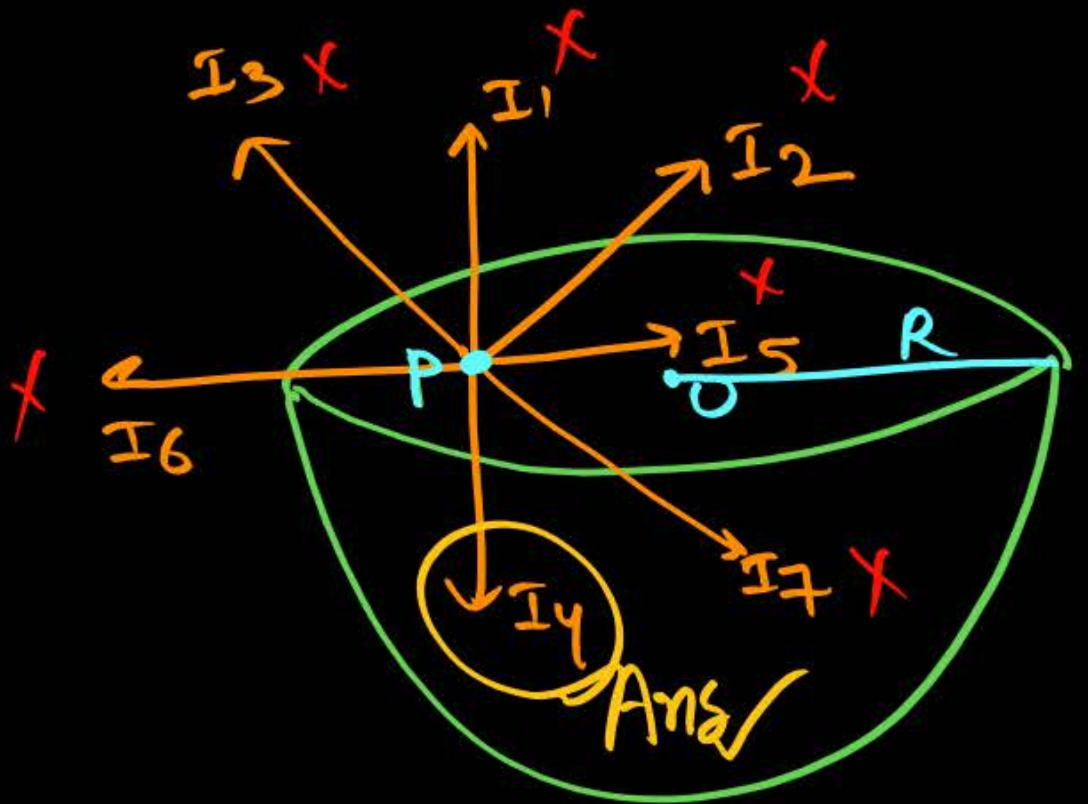
QUESTION

A spherical shell is cut into two pieces along a chord as shown in the figure. 'P' is a point on the plane to the chord. The gravitational field at 'P' due to the upper part is I_1 and that due to the lower part is I_2. What is the relation between them?

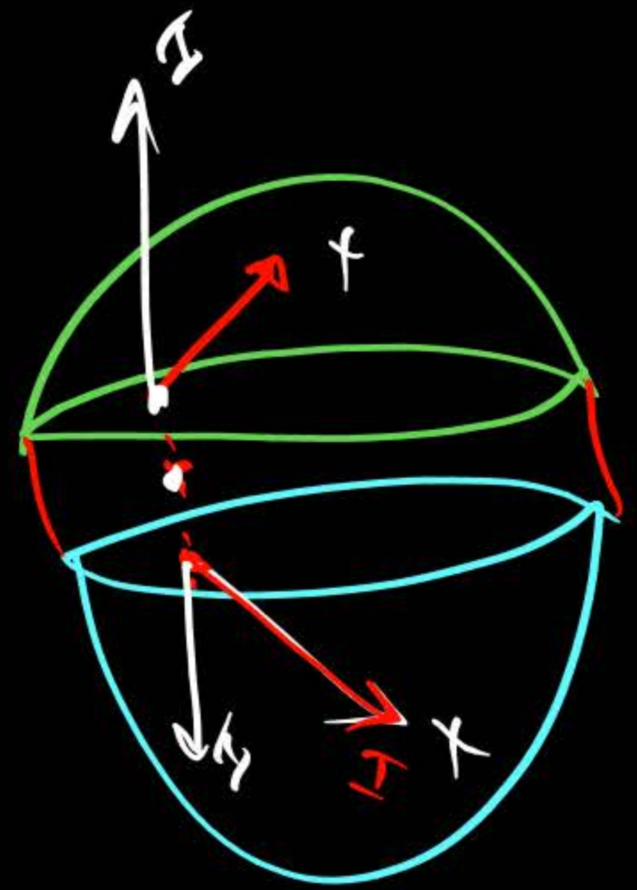
1. $I_1 > I_2$
2. $I_2 > I_1$
3. $I_1 = I_2$
4. No definite relation

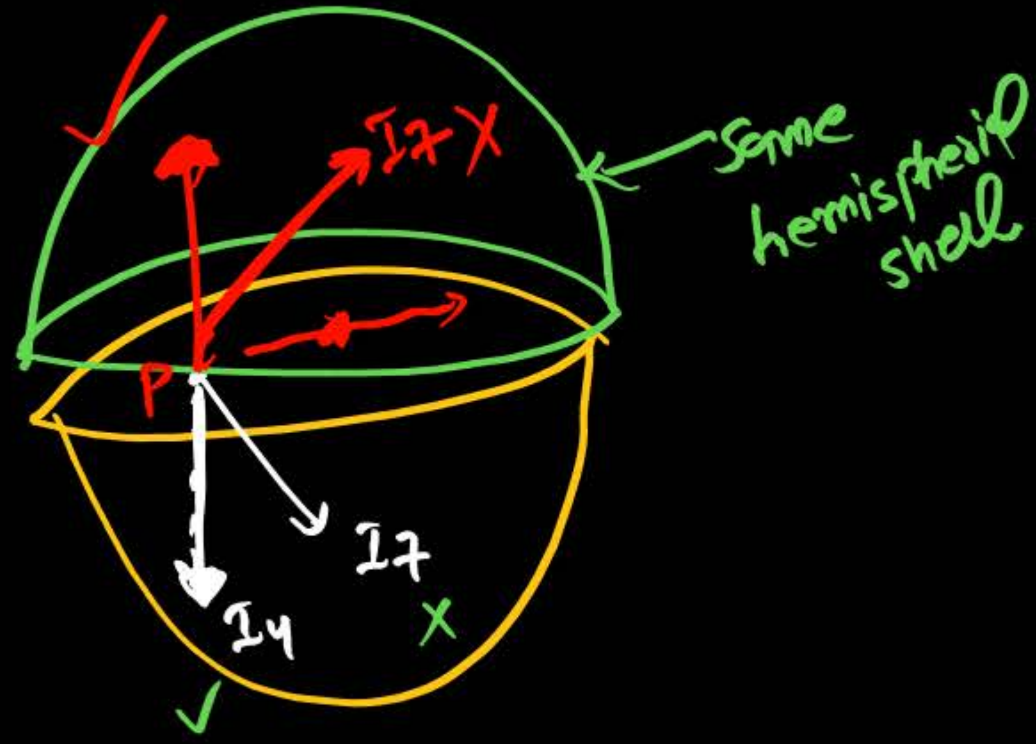


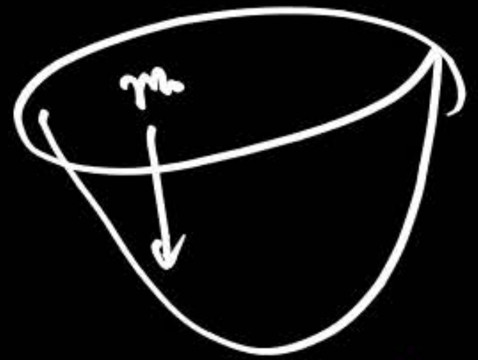




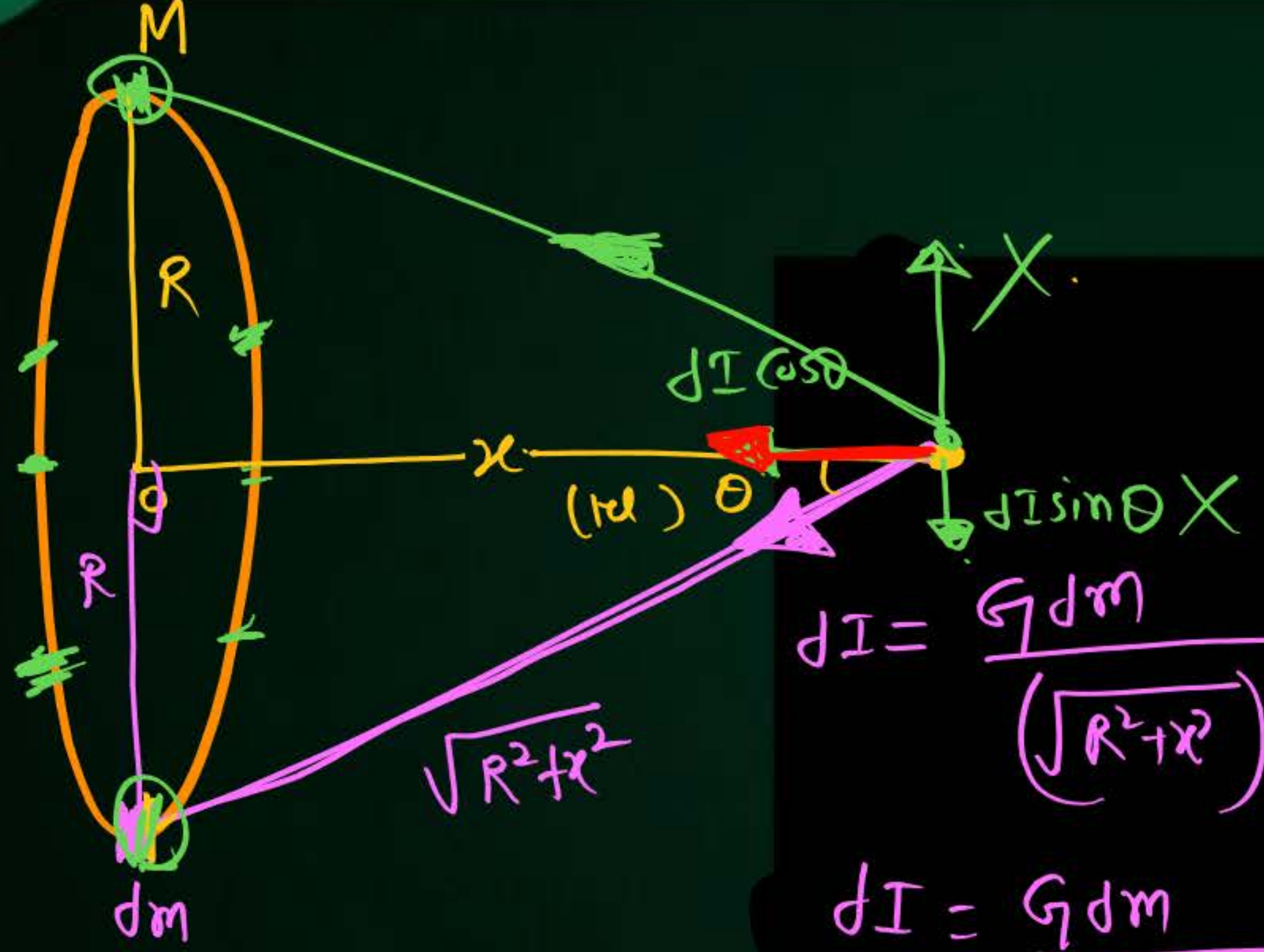
Hemispherical
Hollow sphere.







GRAVITATIONAL FIELD DUE TO RING OF MASS 'M'



$$dI = \frac{G\,dm}{\left(\sqrt{R^2+x^2}\right)^2}$$

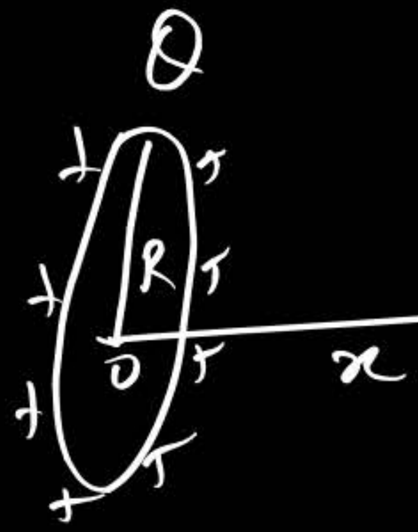
$$dI = \frac{G\,dm}{(R^2+x^2)}$$

$$(dI)_{net} = dI\cos\theta$$

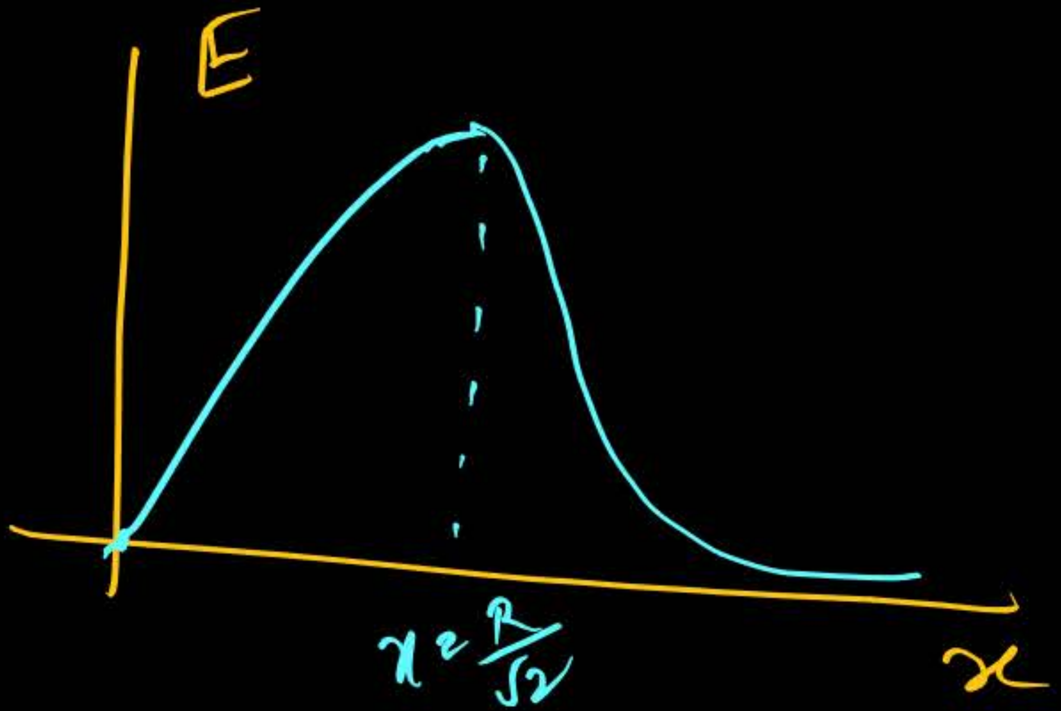
$$dI = \frac{G\,dm}{(R^2+x^2)} \times \frac{x}{(R^2+x^2)^{1/2}}$$

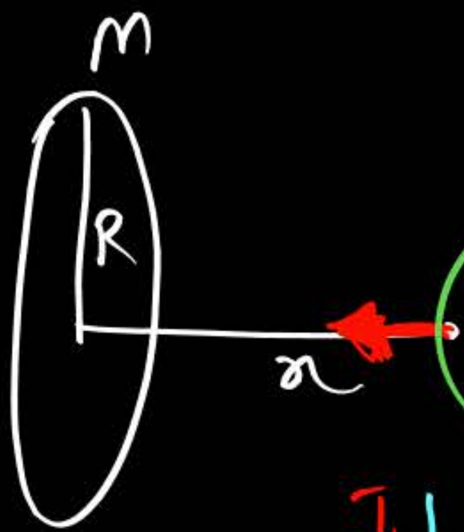
$$\int dI = \int \frac{Gx\;dm}{(R^2+x^2)^{3/2}}$$

$$I = \frac{GxM}{(R^2+x^2)^{3/2}} = \frac{GMx}{(R^2+x^2)^{3/2}}$$



$$E = \frac{kQx}{(R^2+x^2)^{3/2}}$$





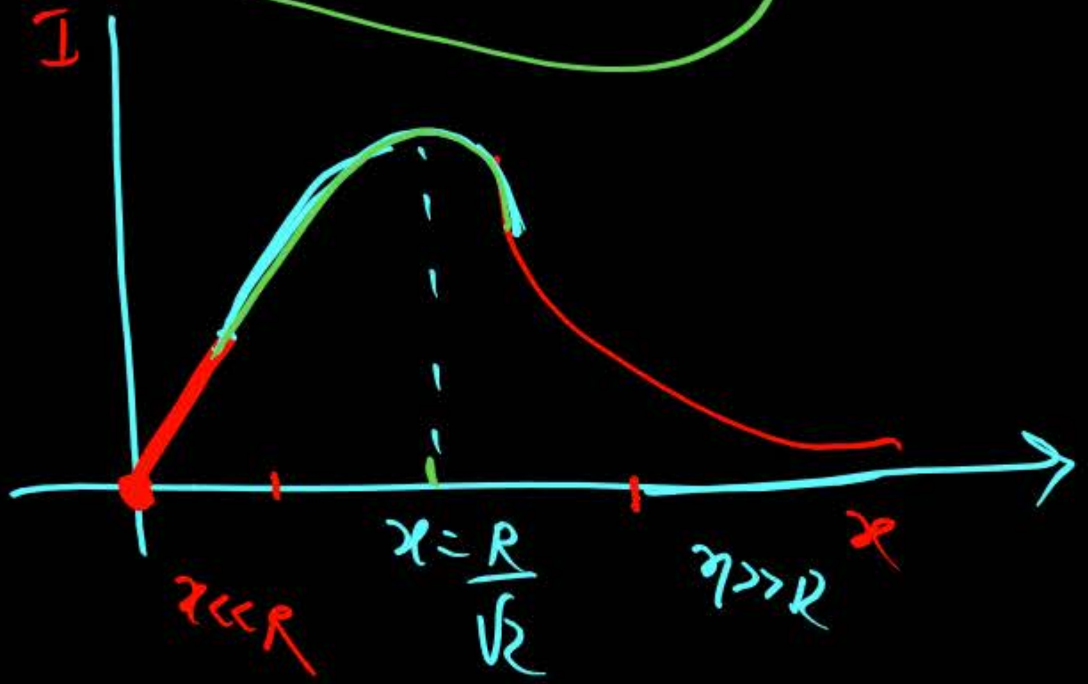
$$I = \frac{Gmx}{(R^2+x^2)^{3/2}}$$

→ If $x = 0$, $I = 0$

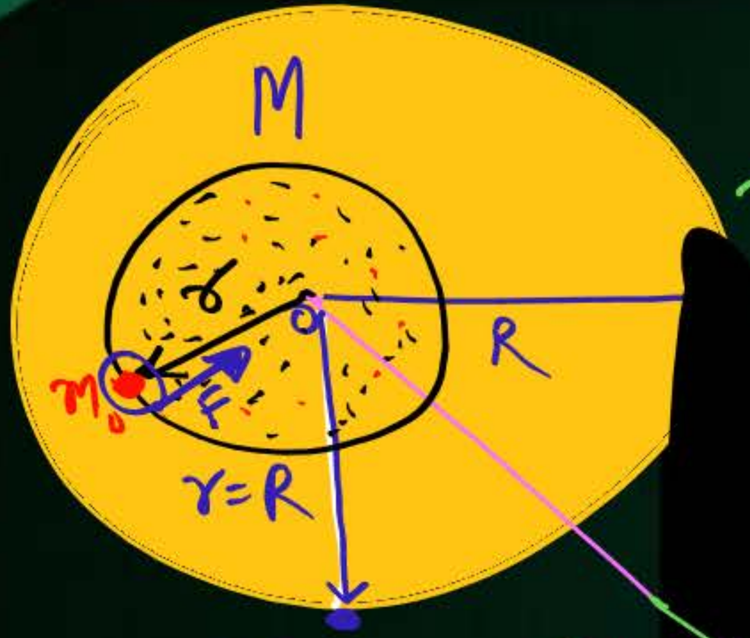
$x <<< R$: $I = \frac{Gmx}{R^3}$, $I \propto x$

$x >>> R$: $I = \frac{Gmx}{x^3} = \frac{Gm}{x^2}$ (as point mass)

$I \propto \frac{1}{x^2}$



GRAVITATIONAL FIELD INTENSITY FOR SOLID SPHERE



Inside ($r < R$)

$$I = \frac{F}{m_0} = \frac{GMm_0 r}{R^3 m_0} = \frac{GMr}{R^3}$$

Insir

$$I = \left[-\frac{GMr}{R^3}\right]\hat{r}$$

$|I| \propto r$

$I_{surface} = -\frac{GM}{R^2}$ ($r=R$)

[redacted]

r

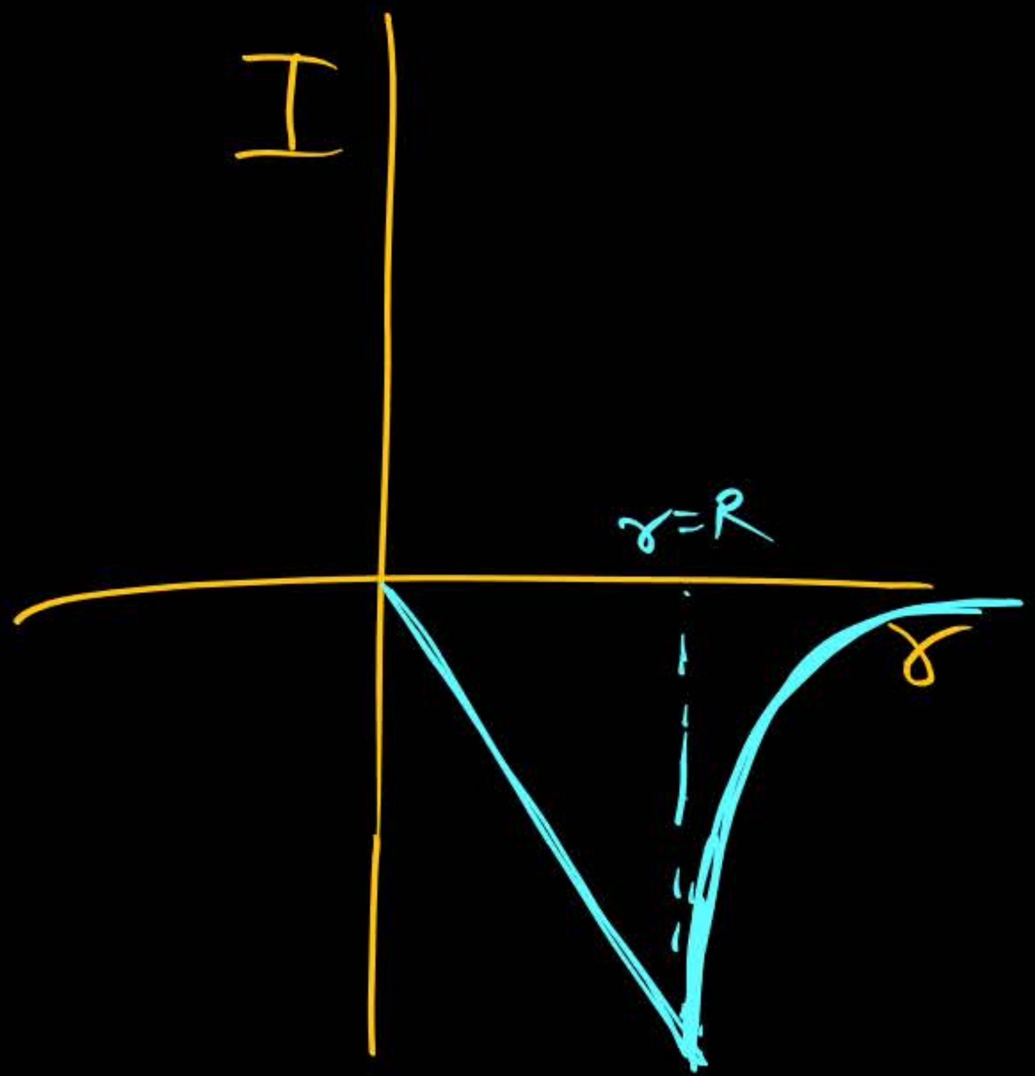
$I = \left(-\frac{GM}{r^2}\hat{r}\right)$ (outside) $r > R$

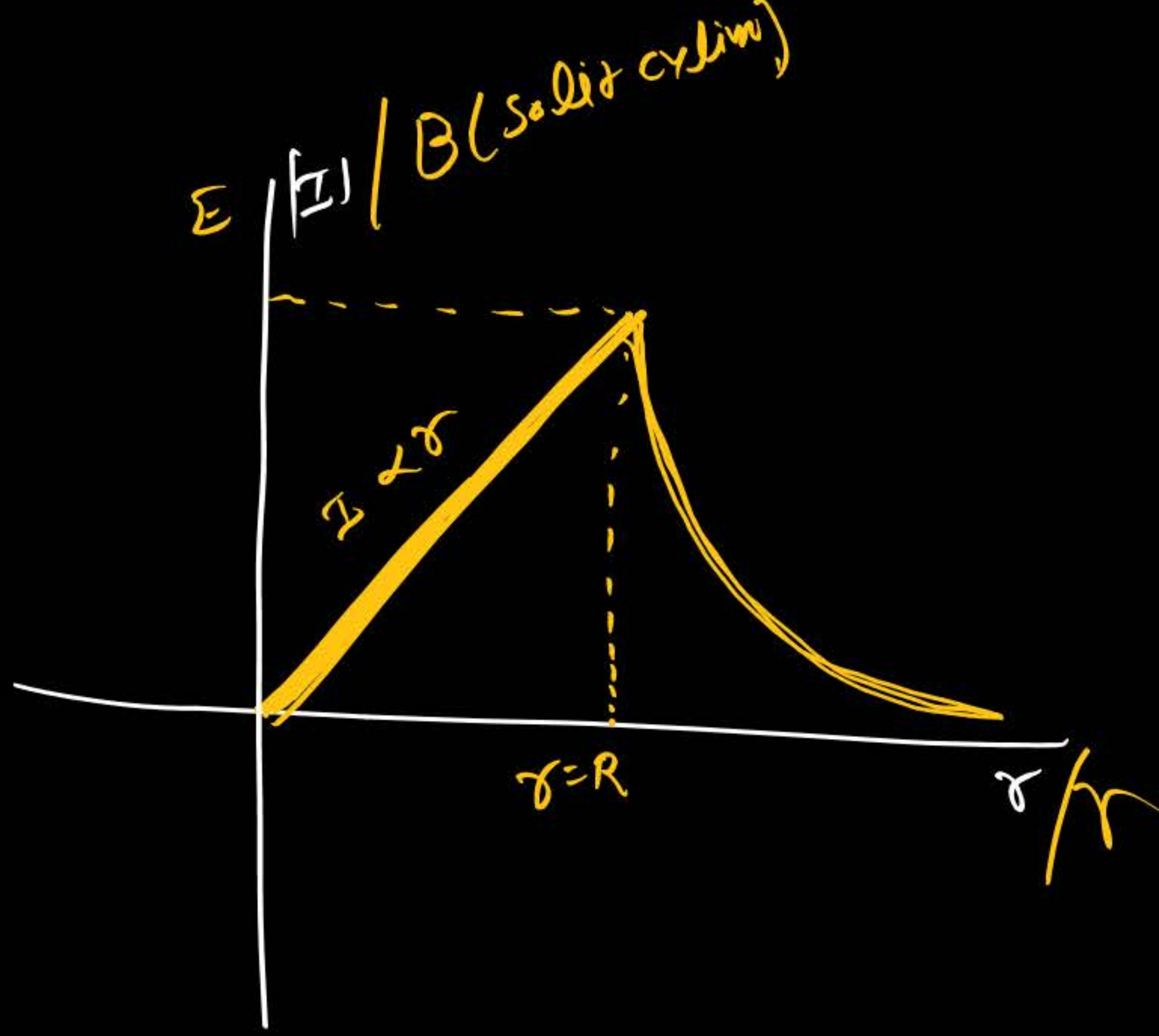
$\frac{M}{r^2}\hat{r}$

MR* gravitational field, electric field, magnetic field

Induced electric & magnetic field

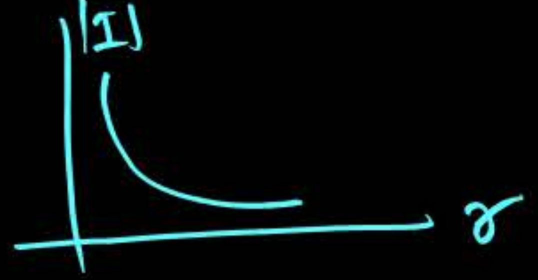
(solid) thick soure ke ander directly Proportional to r hota hai → Soure ke Bahar Inversaly ($E \propto \frac{1}{r^2}$)

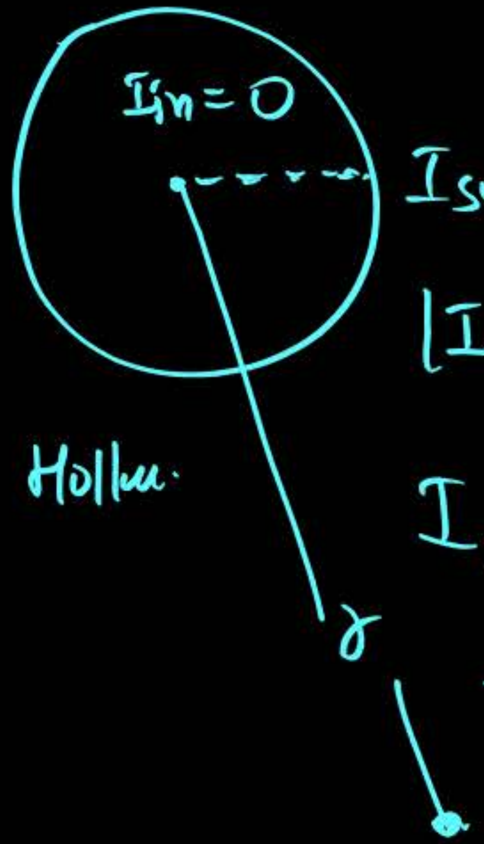

I
r=R
r


E / |I| / B(solid cylin)
I ∝ r
r=R
r / r



$\vec{I} = -\frac{GM}{r^2}\hat{r}$





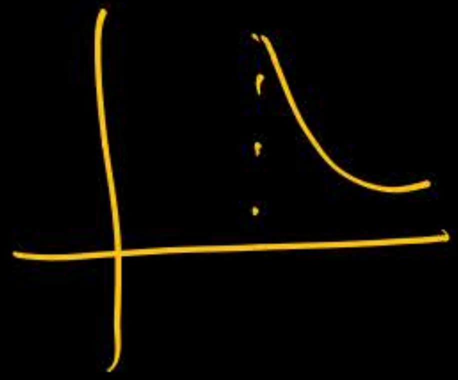
Hollow.

$I_{surf} = -\frac{GM}{R^2}\hat{R}$

$|I|_{sur} = \frac{GM}{R^2}$

$I_{out\,sur} = \frac{GM}{r^2}$

$\vec{I} = -\frac{GM}{r^2}\hat{r}$

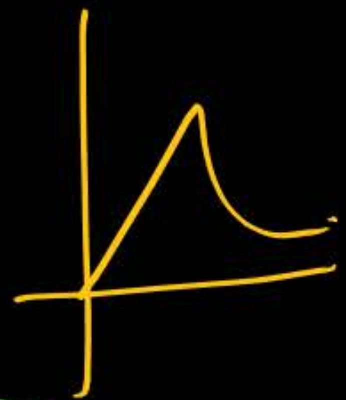




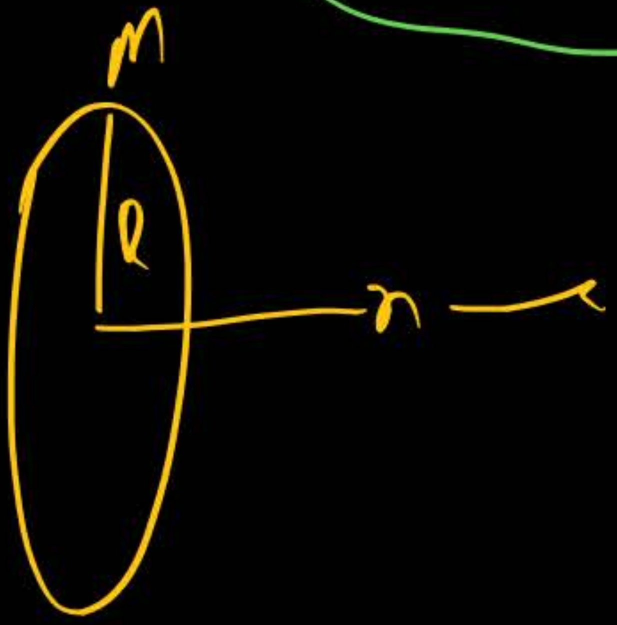
$I_{centre} = 0$

$I_{in} = \frac{GMr}{R^3}$

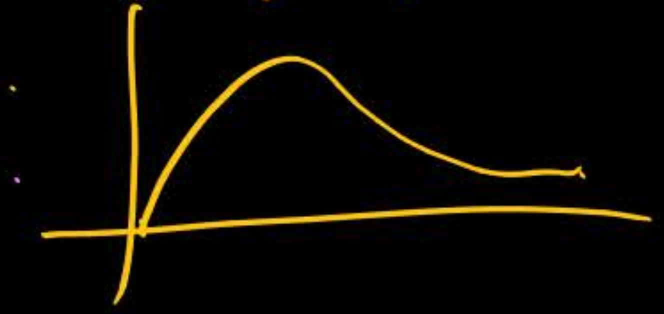
$\vec{I}_{in} = -\frac{GMr}{R^3}\hat{r}$



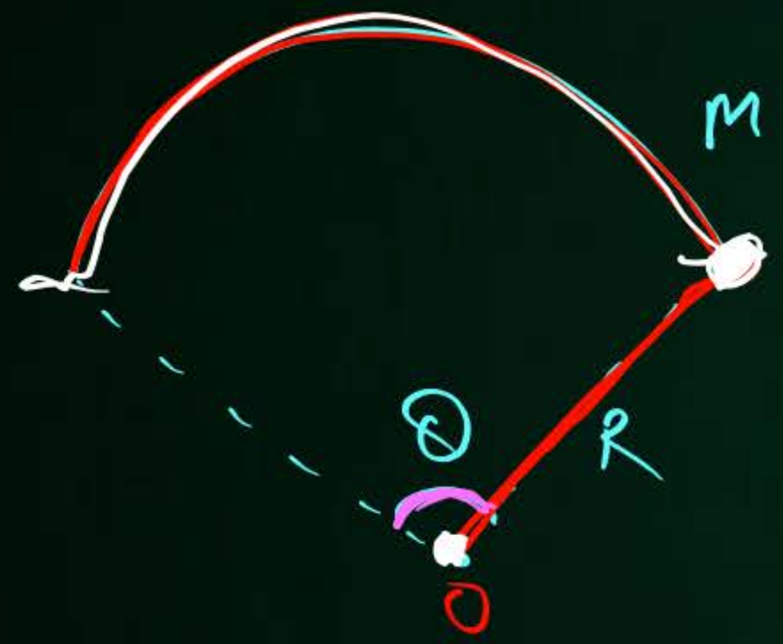
$I_{out} = -\frac{GM}{r^2}\hat{r}$



$I = \frac{GMx}{(R^2+x^2)^{3/2}}$



GRAVITATIONAL FIELD DUE TO CIRCULAR ARC



$$I_0 = \frac{GM}{R^2}\left[\frac{\sin\theta/2}{\theta/2}\right]$$



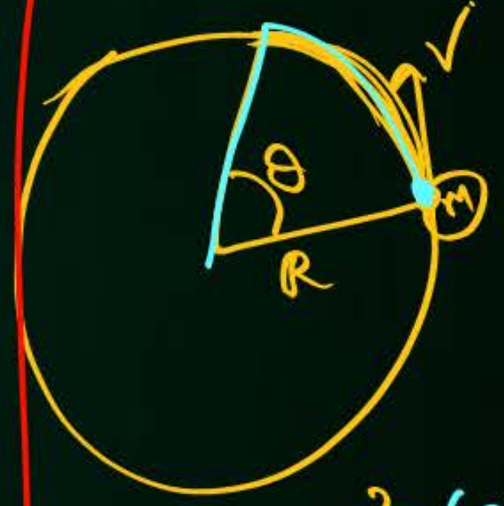
$$I = \frac{GM}{R^2}\,\frac{\sin(\pi/2)}{\pi/2}$$

$$I = \frac{2GM}{\pi R^2}$$

→ gravitational field intensity due to half ring.

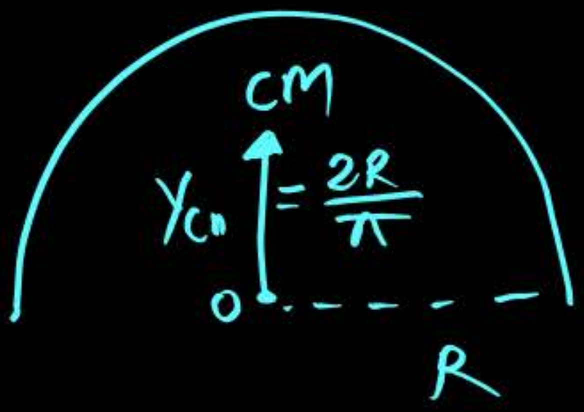
$$\left[\,|\vec{F_c}|_{gen} = mv^2/R\right.$$

$$\left.(F_{Avg}) = \frac{mv^2}{R}\,\frac{\sin\theta/2}{\theta/2}\right]$$



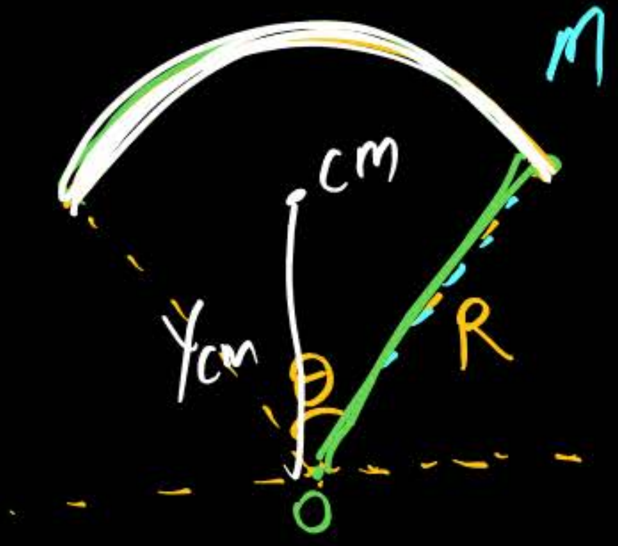
$$a_c = \frac{v^2}{R}$$ (at point instantaneous)

$$(a_c)_{Avg} = \frac{v^2}{R}\left(\frac{\sin\theta/2}{\theta/2}\right)$$



Half Ring

Position of c.o.m due to circular Arc.



$$Y_{c.m} = (R)\frac{\sin \theta/2}{(\theta/2)}$$

half ring

$\theta = \pi$

$$Y = \frac{2R}{\pi} = R\frac{\sin(\pi/2)}{\pi/2} = \frac{2R}{\pi}$$



GRAVITATIONAL FIELD DUE TO HALF RING

gravity word is only defined for Planet and earth. ✓

gravity free space → different

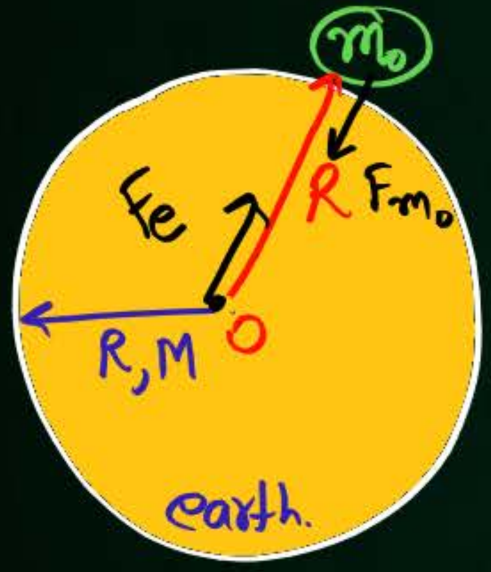
↳ gravitational force due to plane will be zero

other gravitational force may be acting.

gravitational free space

→ (any gravitational force will be zero.)

ACCELERATION DUE TO GRAVITY of earth



force b/w earth & m_0

$$F = \frac{GMm_0}{R^2} \quad \text{(force on } m_0)$$

accn of m_0

$$a = \frac{F}{m_0} = \frac{GMm_0}{R^2 m_0}$$

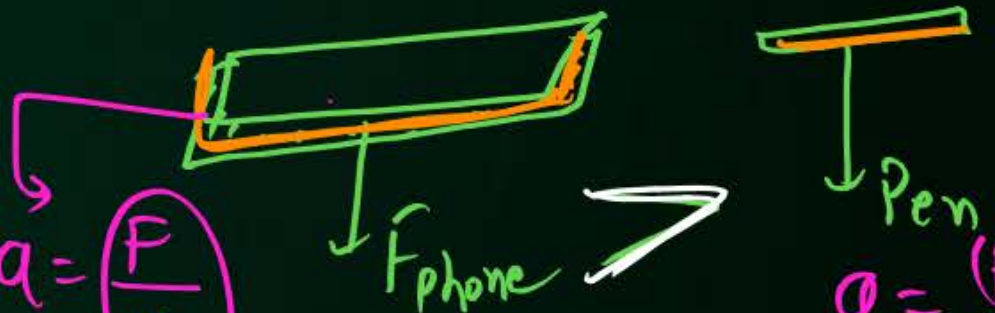
$$a = \frac{GMm_0}{R^2 m_0}$$

$$a = \frac{GM}{R^2}$$

$$g_0 = \frac{GM}{R^2} \quad \text{(acceleration of } m_0 \text{ due to earth)}$$

$g_0 = \frac{GM}{R^2}$ accn due to gravity of mass m_0

↳ does not depends on (m_0), depends on mass of earth & Radius of earth.



$a = \frac{F}{M_p}$ $F_{phone} > F_{pen}$ $a = \frac{(F_{pen})}{(M_{pen})}$

(a) same 63%

(b) diffn 30%

$a_{phone} = a_{pen}$



$$g_0 = \frac{GM}{R^2} = \frac{G\frac{4}{3}\pi R^3 \rho}{R^2}$$

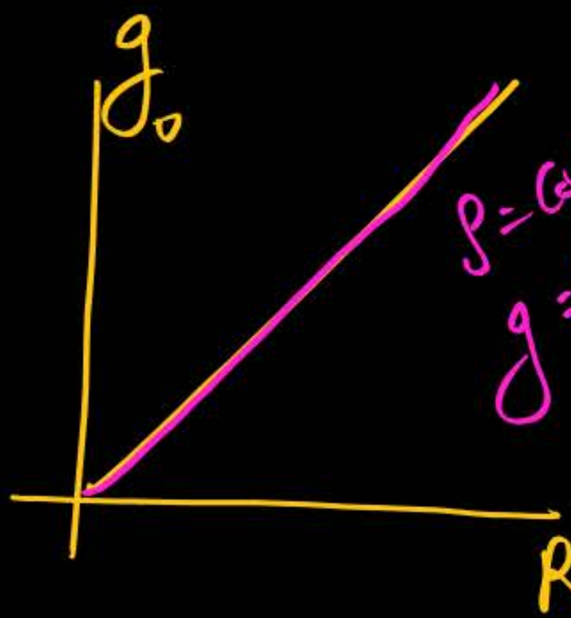
$$g_0 = \frac{4}{3} G \pi \rho R$$

(ρ = density of earth; R = Radius of earth.)

$M = \rho$ volume (Mass of earth)

$= \rho \frac{4}{3}\pi R^3$

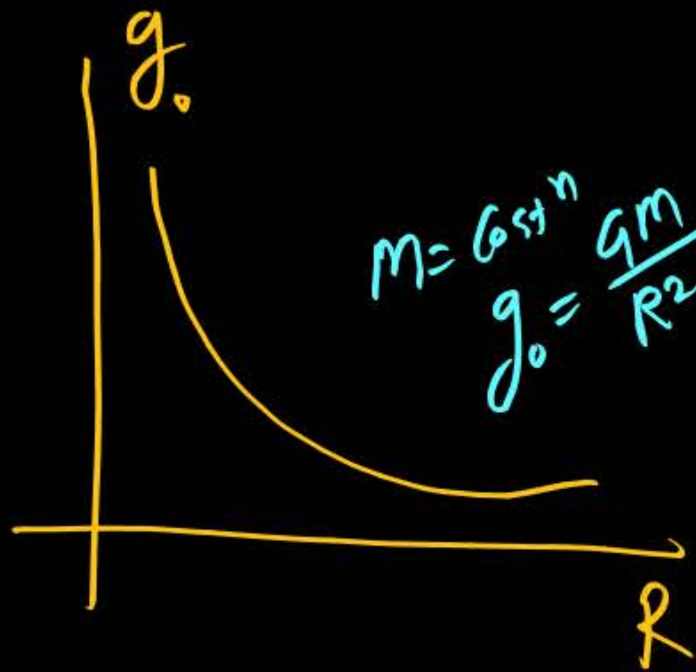
$= \frac{4\rho\pi R^3}{3}$



$\rho = \text{Cst}^n$

$g = \frac{4}{3}\pi G\rho R$

$g \propto R$



$M = \text{Cst}^n$

$g_0 = \frac{Gm}{R^2} \propto \frac{1}{R^2}$

$g_0 = \frac{GM}{R^2}$

small change

Small % Change in acc^n due to gravity on earth surface

$\frac{\Delta g_0}{g_0} = -2\frac{\Delta R}{R} \times 100$

$g_0 = \frac{4}{3}\pi G\rho R$

$\frac{\Delta g_0}{g_0} = \left[\frac{\Delta R}{R} \times 100\right]$

- **Gravity free space does not mean gravitational free space.**

↳ True

QUESTION

If density of a planet is double that of the earth and the radius 1.5 times that of the earth, the acceleration due to gravity on the surface of the planet is

1. 3/4 times that on the surface of the earth
2. 3 times that on the surface of the earth
3. 4/3 times that on the surface of the earth
4. 6 times that on the surface of the earth

$\rho_p = 2\rho_e$

$R_p = 1.5 R_e$

$g_p = ??$

$g_0 = \frac{GM}{R^2} = \frac{4}{3}\pi G \rho R$

$\frac{g_p}{g_e} = \frac{\rho_p R_p}{\rho_e R_e} = \frac{2\rho_e}{\rho_e} \times \frac{3R_e}{2R_e}$

$g_p = 3 g_e$

QUESTION

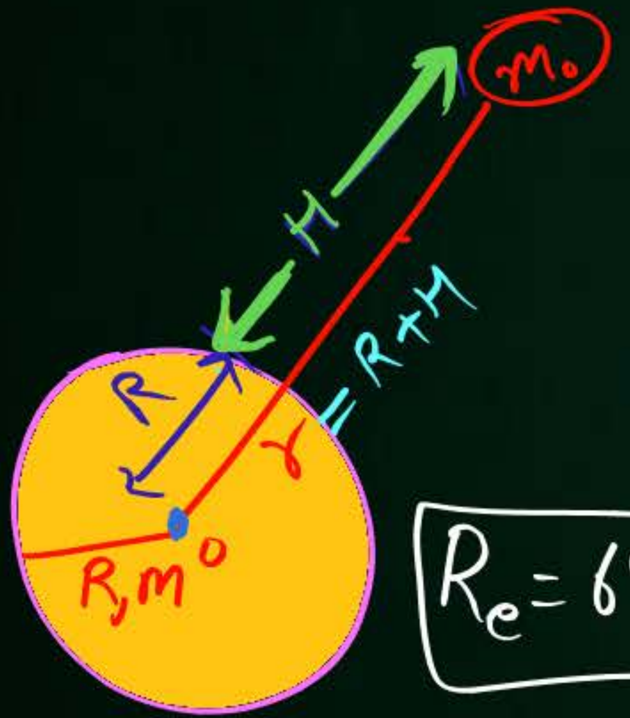
Two planets have same density but different radii. The acceleration due to gravity would be

1. Same on both planets
2. Greater on the smaller planet
3. Greater on the larger planet
4. Dependent on the distance of planet from the sun

$g \propto R$

ACCELERATION DUE TO GRAVITY OF EARTH

➢ **At height H from surface**



$R_e = 6400\,km$

$$F = \frac{GMm_0}{r^2} = \frac{GMm_0}{(R+H)^2}$$

$$g_H = \frac{F}{m_0} = \frac{GMm_0}{(R+H)^2\, m_0}$$

$$g_H = \frac{GM}{(R+H)^2}$$

$$g_H = \frac{g_0 R^2}{(R+H)^2}$$

Rel^n B/W g_H & g_0

← always valid or applied

आरती

On surface $g_0 = \frac{GM}{R^2}$

$GM = g_0 R^2$ → MR Rafta

$(H << R)$

using Binomial th^n

$$g_H = g_0\left(1 - \frac{2H}{R}\right)$$

↳ for (small hight)

0 km < H < 500 km


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 03 | Physics

Gravitation

By- Dr. Manish Raj (MR SIR)



Topics to be covered

1. # PhD on acceleration due to gravity.
2. #
3. #
4. #

g_0 on earth surfa

g on height from earth surfa

* g at depth from earth surface

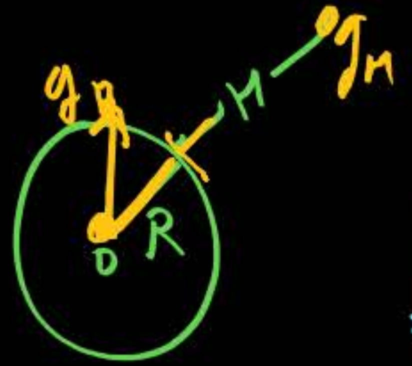
* g due to rotn of earth



$$g_0 = \frac{GM}{R^2} = \frac{4}{3}G\pi\rho R$$

→ acc^n due to gravity on earth surface or at surface of any planet.

$$g_H = \frac{GM}{(R+H)^2} = \frac{g_0 R^2}{(R+H)^2}$$



$$g_H = g_0 \frac{R^2}{(R+H)^2}$$

→ असली (always valid)

$g_H < g_0$

Case-1 $H \simeq 0$ to 2 Km around

$g_H \simeq g_0$

$H \approx$ 32 Km ke around and above upto 500 Km then there 1% change in acc^n due to grav

$$g_H = g_0\left(1 - \frac{2H}{R}\right)$$

← नकली formula. only valid $H << R$

$H \rightarrow$ 32 Km to 500 Km

$$g_h = g_0 - g_0 \frac{2H}{R}$$

$$g_h - g_0 = -g_0 \frac{2H}{R}$$

$$\left[100 \times \frac{\Delta g}{g}\right] = -\frac{2H}{R} \times 100$$

→ % change in acc^n due to gravit. valid for 0% to 8–10%

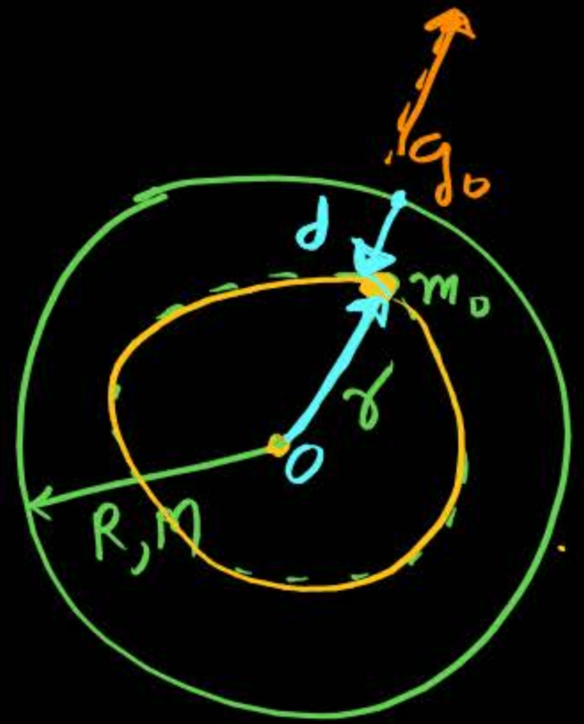
acc^n due to gravity at depth(d) from earth surf

$$g_d = g_0\left(1 - d/R\right)$$

always valid

$$100 \times \frac{\Delta g}{g} = -\frac{d}{R} \times 100$$

Acceleration due to gravity at depth d from surface of earth.



force on m_0 due to earth (solid sp^r)

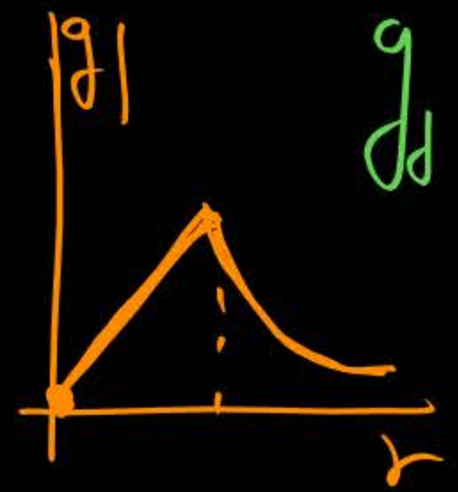
$$F = \frac{GMm_0 r}{R^3}$$

$$g_r = \frac{F}{m_0} = \frac{GMm_0 r}{R^3 m_0}$$

I $\boxed{= g_r = \frac{GMr}{R^3}}$

$\boxed{R - d = r}$

$\boxed{GM = g_0 R^2}$



$$g_d = \frac{GM(R-d)}{R^3} = \frac{g_0 R^2}{R^3}(R-d)$$

$$g_d = g_0\left(\frac{R}{R} - \frac{d}{R}\right)$$

(असली)

$$\boxed{g_d = g_0\left(1 - \frac{d}{R}\right)}$$

↳ acc^n due to gravity at depth 'd' from surface of earth

[always valid for all depth.]

$$g_d - g_0 = -g_0 \frac{d}{R}$$

$$\left[100 \times \frac{\Delta g}{g_0}\right] = -\frac{d}{R} \times 100$$

$$\boxed{\text{\% change in acc}^n \text{ due to gravity} = -\frac{d}{R} \times 100}$$

→ कहाँ pe (g) ??

→ height → H large आयेगा।

→ H small नहीं

depth → all consider

mass of object is 12 kg on earth surface then mass of that object at centre of earth will be

(a) 6 kg

(b) zero (49%) → गधे

(c) 12 kg (43%)

(d) None of these

Mass → same

Weight = mg

W = mg

$\uparrow$

const^n

$W \propto g$ (acc^n due to gravity)

weight ke question me g ko solve karo

QUESTION

Acceleration due to gravity becomes $[g/2]$ at a height equal to

1. $4R$
2. $R/4$ (30%)
3. $2R$
4. $R/2$
5. $(\sqrt{2}-1)R$ (65%)

$g_H = g/2$

$g_H = \frac{g_0 R^2}{(R+h)^2}$

$\frac{g_0}{2} = \frac{g_0 R^2}{(R+h)^2}$

$\frac{1}{\sqrt{2}} = \frac{R}{R+h}$

$R+h = \sqrt{2}R$

$h = (\sqrt{2}-1)R$ Ans.

$h = (\sqrt{2}-1)R = (1.414-1)R$

$h = 0.41R$ Ans.

QUESTION

The height at which weight of the body become $\frac{1}{16}$ its weight on the surface of earth, is

1. 5 R
2. 15 R
3. 3 R
4. 4 R

$g_h = \frac{g_0}{16}$

असली $g_h = \frac{g_0 R^2}{(R+H)^2}$

$\frac{g_0}{16} = \frac{g_0 R^2}{(R+H)^2}$

$\frac{1}{4} = \frac{R}{R+H}$

$R+H = 4R$

$H = 4R - R$

$H = 3R$

QUESTION

If mass of object is 12 kg on the surface of earth then its mass on surface of moon :

(1) 6 kg

(2) 2 kg

(3) 12 kg

(4) Zero

$$g_m = \frac{g_e}{6}$$

QUESTION

Density of newly discovered planet is twice that of earth. The acceleration due to gravity at the surface of the planets is equal to that at the surface of the earth. If the radius of earth is R, then the radius of the planet would be

1. $2R$
2. $4R$
3. $R/4$
4. $R/2$

$$g_0 = \frac{GM}{R^2} \times$$

$$g_0 = \frac{4}{3}\pi G \rho R$$

$4/3$

QUESTION

If the radius of earth shrinks by 1.5% mass remaining same, then the value of gravitational acceleration changes by

1. 2%
2. -2%
3. 3%
4. -3%

QUESTION

If the radius of the earth is R, then the height h above the surface of the earth at which the values of g becomes one fourth, will be

1. $R/8$
2. $3R/8$
3. $3R/4$
4. $R/2$

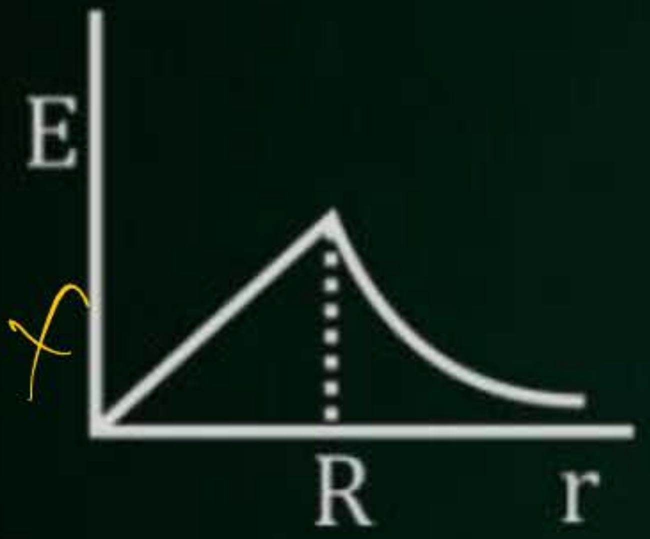
असली

$g_h = \frac{g_0}{4} = \frac{g_0 R^2}{(R+h)^2}$

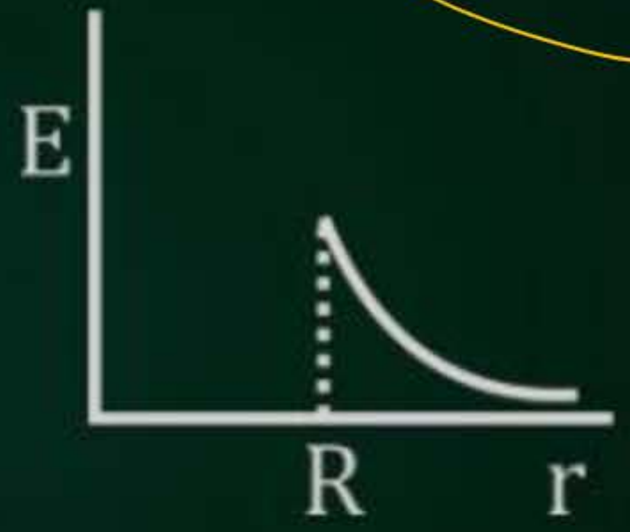
QUESTION

Which one of the following plots represents the variation of gravitational field [redacted] r due to thin spherical shell of radius R?

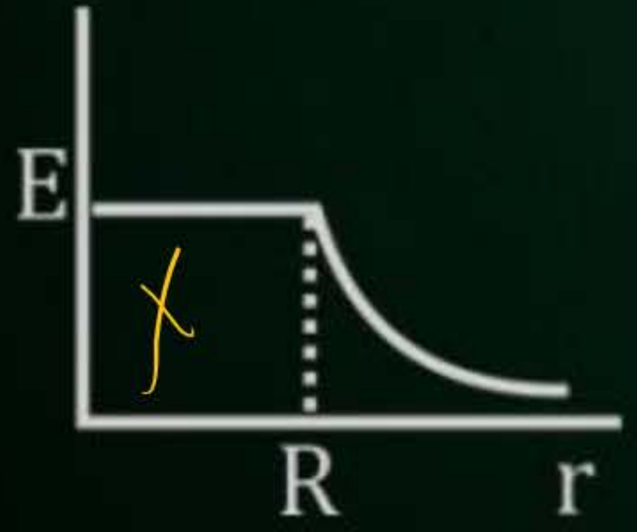
1



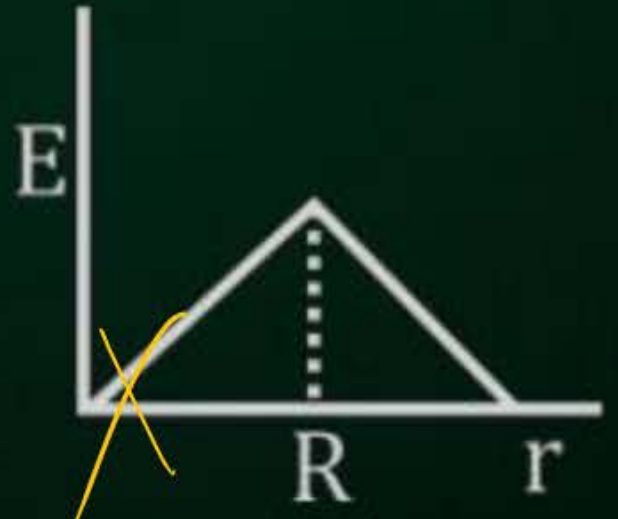
2



3



4



QUESTION

A body weighs 144 N at the surface of earth. When it is taken to a height of $h = 3R$, where R is radius of earth, it would weigh

1. 48 N
2. 36 N
3. 16 N
4. 9 N ✓

असली

$$mg_H = \frac{(mg_0)R^2}{(R+H)^2}$$

$$W_H = \frac{144 R^2}{(4R)^2}$$

$$W_H = \frac{144 R^2}{16 R^2}$$

असली

QUESTION

At what depth below the surface of earth, the value of g is the same as that at a height of 5 km?

नकली

1. 1.25 km
2. 2.5 km
3. 10 km ✓
4. 7.5 km

$g_H = g_0\left(1 - \frac{2H}{R}\right)$ at $H = 5$ km

$g_d = g_0\left(1 - d/R\right)$

$g_0\left(1 - \frac{2H}{R}\right) = g_0\left(1 - d/R\right)$

$\frac{2 \times 5}{R} = d/R$

$d = 10$ km

$\frac{\Delta g}{g_H} = \frac{2H}{R} = \frac{d}{R}$

$d = 2H$

g same at d & H

QUESTION

Find height where acceleration due to gravity decrease by 2%.

$$\boxed{\frac{\Delta g}{g} \times 100 = -2\%}$$

$$\frac{\Delta g}{g} \times 100 = -\frac{2H}{R} \times 100$$

$$-2\% = -\frac{2H}{6400} \times 100$$

$$\boxed{H = 64\ \text{km}}$$

QUESTION

Find height where acceleration due to gravity decrease by 75%.

H = ??

$\Rightarrow g_0$

$\Rightarrow g_H = 25\% \, g_0 = \frac{g_0}{4} = \frac{g_0 R^2}{(R+H)^2}$

$100 \times \frac{\Delta g}{g} = -\frac{2H}{R} \times 100$

$\frac{R}{R+H} = \frac{1}{\sqrt{4}} = \frac{1}{2}$

$2R = R + H$

$H = R$

$H = 6400 \text{ km}$

QUESTION

Find height where acceleration due to gravity decrease to 75%.

$$g_H = 75\%\, g_0$$

$$g_H = \frac{3}{4} g_0$$

$$\frac{3}{4} g_0 = \frac{g_0 R^2}{(R+H)^2}$$

$$\frac{R}{R+H} = \sqrt{\frac{3}{4}}$$

$$2R = \sqrt{3}R + \sqrt{3}H$$

$$H = \frac{(2-\sqrt{3})R}{\sqrt{3}}$$

Ans.

$$100 \times \frac{\Delta g}{g} = -\frac{2H}{R} \times 100$$

QUESTION

At what height from the ground will the value of ‘g’ be the same as that in 10km deep mine below the surface of earth-

1. 20 km
2. 10 km
3. 15 km
4. 5 km

d = 2H
10 = 2 × H
H = 5km

QUESTION

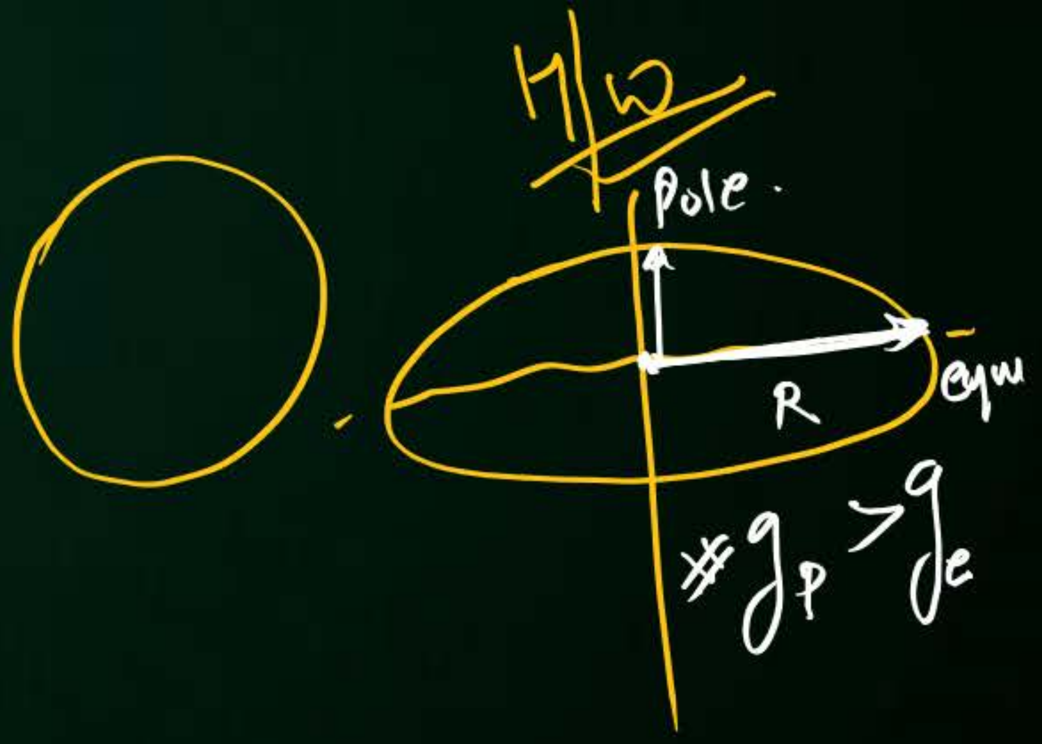
The moon's radius is ¼ that of the earth and its mass is 1/80 times that of the earth. If g represents the acceleration due to gravity on the surface of the earth, that on the surface of the moon is-

1. g/4
2. g/5
3. g/6
4. g/8

QUESTION

Radius of earth is around 6000 km. The weight of body at height of 6000 km from earth surface becomes-

1. Half
2. One-fourth
3. One third
4. No change



Variation of g due to shape of the Earth

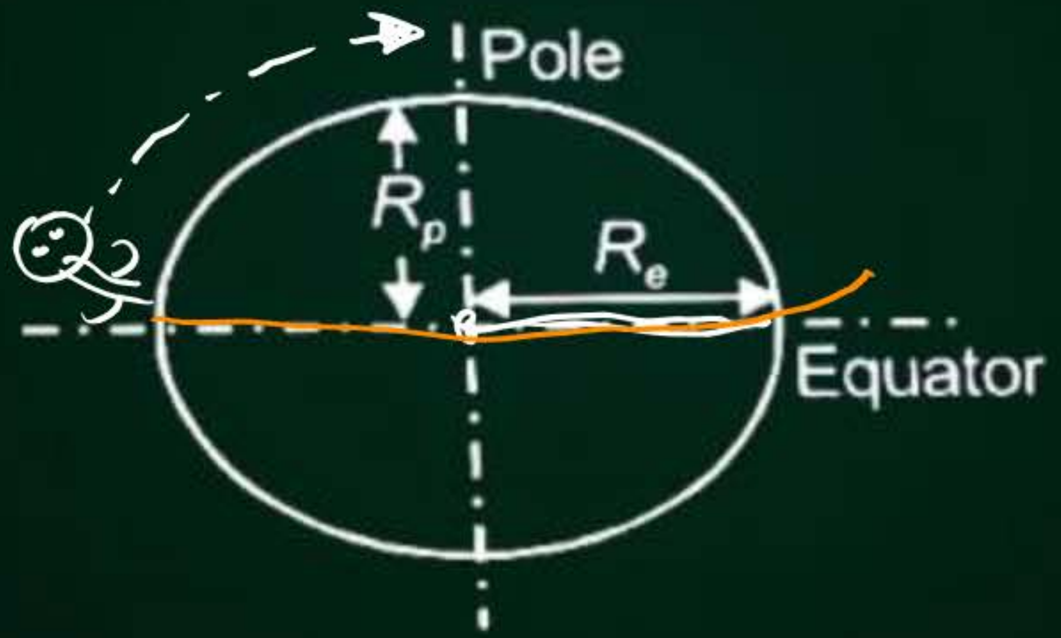
In reality, the Earth does not have pure spherical shape. It has oval shape. Its equatorial radius (R_e) is higher than its polar radius (R_ρ). (Approximately, $R_e = R_\rho + 21$ km)

$R_e = 21 + R_p$

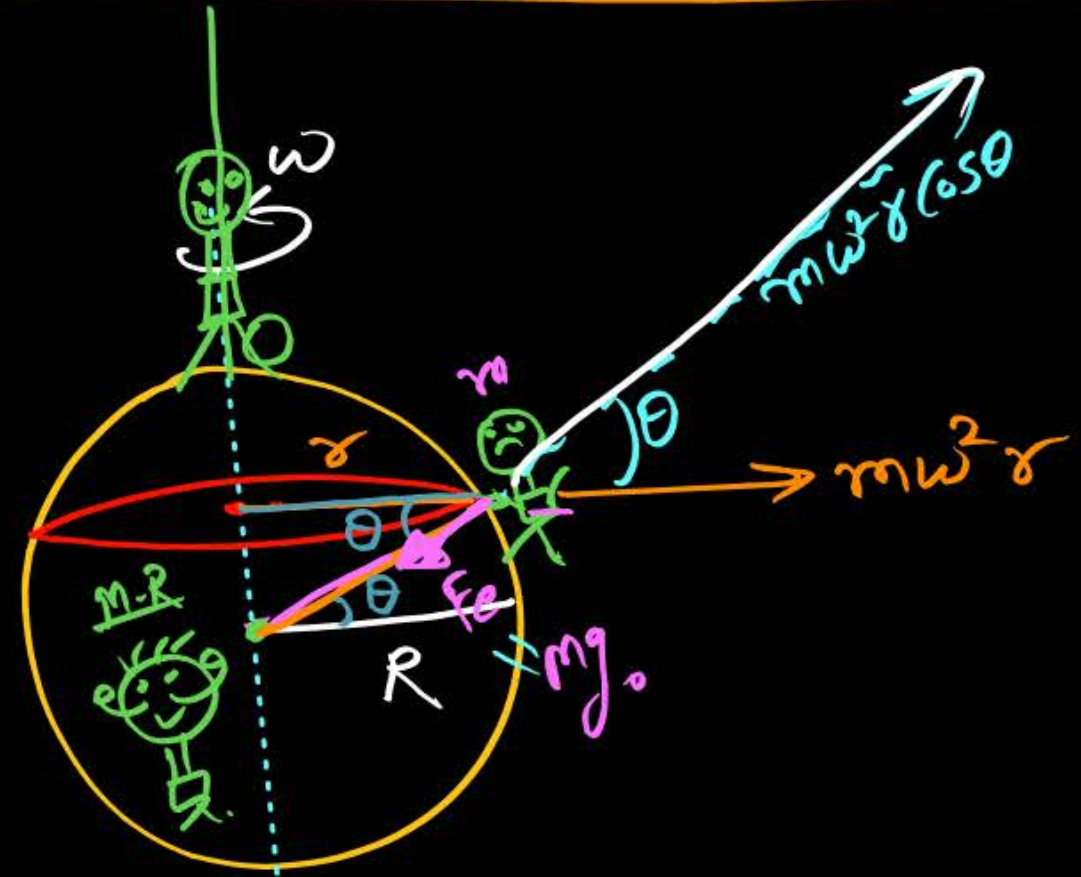
- $R_e > R_p$

$g_e < g_p$

$g = \frac{Gm}{R^2}$



effect on g due to rotation of earth



① — $R\cos\theta = r$

Find force on man along the encte

$$f_{net} = F_e - m\omega^2 r\cos\theta$$

$$mg' = mg_0 - m\omega^2 R\cos^2\theta$$

$$g' = g_0 - \omega^2 R\cos^2\theta$$

→ acc^n due to gravity ↓ due to rotation of earth

at $\theta = 0$

$$g_e = g_0 - \omega^2 R$$

→ % change in g is 0.34%

at Pole $\theta = 90°$

$$g' = g_0 - 0$$

$$g'_p = g_0$$

QUESTION

Which of the following statements are true about acceleration due to gravity?

(i) 'g' decreases in moving away from the centre if $r > R$.

(ii) 'g' decreases in moving away from the centre if $r < R$.

(iii) 'g' is zero at the centre of earth

(iv) 'g' decreases if earth stops rotation on its axis



1. (i,ii)
2. (i, iii)
3. (ii,iii)
4. (i, ii, iv)

QUESTION

What will happen to the weight of the body at the south pole if the earth stops rotating about its polar axis?

1. No change (70%)
2. Increase
3. Decreases but no zero
4. Reduces to zero



QUESTION

If earth suddenly stop rotating, then the weight of an object of mass m at equator will [ω is angular speed of earth and R is its radius]

1. Decreases by $m\omega^2R$
2. Increases by $m\omega^2R$
3. Decreases by $m\omega^2R$
4. Increases by $m\omega^2R$

QUESTION

The radius of earth is 6400 km and $g = 9.8\ \text{m/sec}^2$. If the body placed at the equator has to become weightless the earth should make one complete ration in:

1. 12 hour
2. 1.4 hour
3. 6 hour
4. 24 hour

QUESTION

At some planet 'g' is 1.96 m sec^{-2}. if it is safe to jump from a height of 2m on earth, then what should be corresponding safe height for jumping on that planet:

1. 5m
2. 2m
3. 10m
4. 20m

H/w.

QUESTION

An object is placed at a distance of R/2 from the centre of earth. Knowing mass is distributed uniformly, acceleration of that object due to gravity at that point is: (g = acceleration due to gravity on the surface of earth and R is the radius of earth)

1. g
2. 2 g
3. g/2
4. None of these

H/W

QUESTION

What is the percentage change in the value of 'g' on shifting from equator to poles on the earth's surface?

1. 4.5%
2. 0.343%
3. 0.05%
4. 1.5%

H/W

QUESTION

When the radius of earth is reduced by 1% without changing the mass, then the acceleration due to gravity will

1. Increase by 2%
2. Decrease by 1.5%
3. Increase by 1%
4. Decrease by 1%

QUESTION

Find height at which acceleration due to gravity decreases to 64% of initial value.

1. $\frac{R}{2}$
2. $\frac{R}{4}$
3. $\frac{2R}{3}$
4. $\frac{3R}{2}$


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 04 | **Physics**

Gravitation

By- Dr. Manish Raj (MR SIR)



Topics to be covered

1 # Gravitational Potential

2 # Work energy ka backlog Hai ??

→ (a) NO (WEP compt) → 80%

3 # (b) Yes → 20% → WEP compt kar ke aaiye

4 #



QUESTION

At some planet 'g' is 1.96 m sec^{-2}. if it is safe to jump from a height of 2m on earth, then what should be corresponding safe height for jumping on that planet:

1. 5m
2. 2m
3. 10m
4. 20m

$a = 2 m/s^2$

$u_{safe} = \sqrt{2gH}$

$u_{safe}^2 = 2gH = const^n$

$g_e H_e = g_p H_p$

$10 \times 2 = 2 H_p$

$H_p = 10m$

QUESTION

An object is placed at a distance of R/2 from the centre of earth. Knowing mass is distributed uniformly, acceleration of that object due to gravity at that point is: (g = acceleration due to gravity on the surface of earth and R is the radius of earth)

1. g
2. 2 g
3. g/2
4. None of these

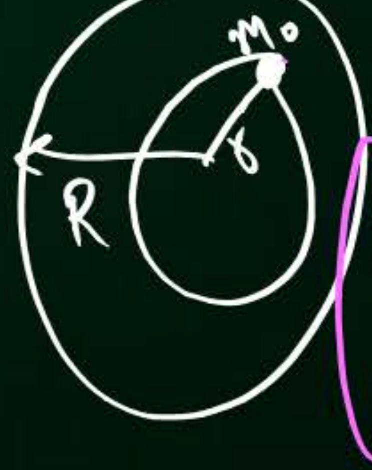
$$g_d = g_0\left(1 - \frac{d}{R}\right)$$



$$g_{R/2} = g_0\left(1 - \frac{R}{2 \times R}\right) = \frac{g_0}{2}$$

g of r from centre of earth $= \left(\frac{g_0 r}{R}\right)$ → Yes correct

→ No, sir Samjh nahi aaya



$$F = \frac{GMm_0 r}{R^3}$$

$$\frac{F}{m_0} = g_r = \frac{GMr}{R^3} = \frac{g_0 r}{R}$$

QUESTION

Altitude at which acceleration due to gravity decreases by 0.1% approximately:
(Radius of earth = 6400 km)

1. 3.2 km (Ans)
2. 6.4 km
3. 2. 4 km
4. 1.6 km



$$\left[100 \times \frac{\Delta g}{g}\right] = \frac{-2h}{R} \times 100$$

$$+0.1 = +\frac{2h}{R} \times 100$$

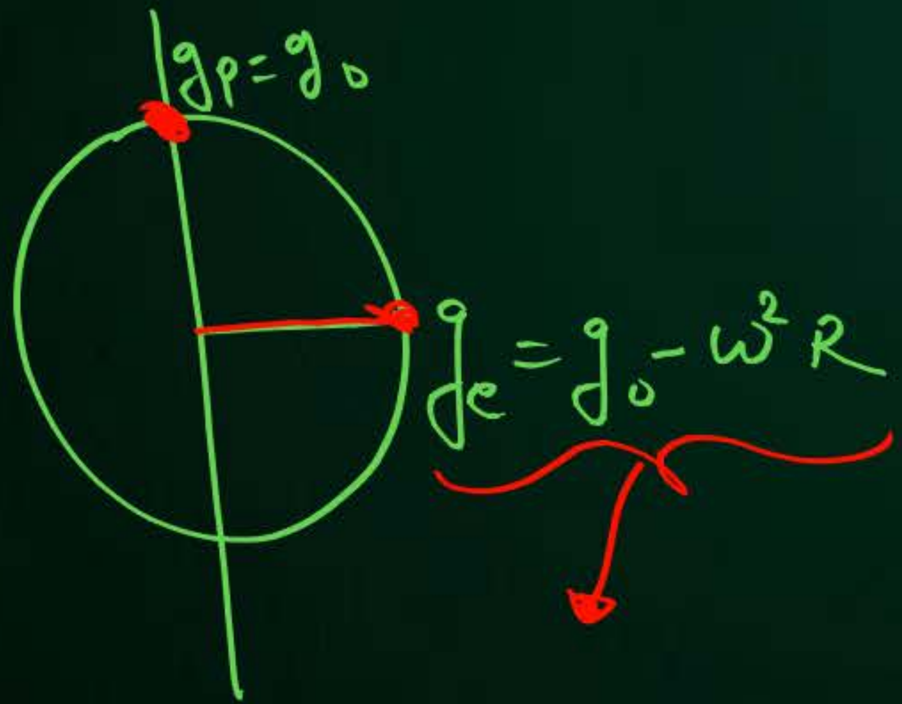
$$\frac{1}{10} = \frac{2h}{6400} \times 100$$

$$h = \frac{32}{10} = 3.2\ \text{km}$$

QUESTION

What is the percentage change in the value of 'g' on shifting from equator to poles on the earth's surface?

1. 4.5%
2. 0.343%
3. 0.05%
4. 1.5%



QUESTION

The depth at which the value of acceleration due to gravity becomes $\frac{1}{N}$ times the value at the surface is

(1) $\frac{R}{n}$

(2) $\frac{R}{n^2}$

(3) $\frac{R[n-1]}{n}$

(4) $\frac{Rn}{n-1}$

$g_d = \frac{g_0}{N}$

$g_d = g_0\left(1 - \frac{d}{R}\right)$

$\frac{g_0}{N} = g_0\left(1 - \frac{d}{R}\right)$

$\frac{1}{N} = 1 - \frac{d}{R}$

$\frac{d}{R} = 1 - \frac{1}{N} = \frac{(N-1)R}{N}$

d

QUESTION

Find height at which acceleration due to gravity decreases to 64% of initial value.

1. $\frac{R}{2}$
2. $\frac{R}{4}$
3. $\frac{2R}{3}$
4. $\frac{3R}{2}$

$g_h = 64\% \, g_0$ ← given

$g_h = \frac{64}{100} g_0 = \frac{g_0 R^2}{(R+H)^2}$

$\sqrt{\frac{64}{100}} = \frac{R}{R+H}$

$\frac{8}{10} = \frac{4}{5} = \frac{R}{R+H}$

$4R + 4H = 5R$

$4H = R$

$H = \frac{R}{4}$

QUESTION

Find height at which acceleration due to gravity decreases by 64% of initial value.

1. $\frac{R}{2}$
2. $\frac{R}{4}$
3. $\frac{2R}{3}$
4. $\frac{3R}{2}$

$g'_h = 36\% \, g_0$

$g_h = \frac{36}{100} g_0 = \frac{g_0 R^2}{(R+H)^2}$

change in gravitational Potential energy = $-W_{gravity}$

#

$\Delta U = -W_{gravity}$

$U_f - U_i = -W_{gravity}$

ΔU (does not depends on ref^n)

(ref^n assume at infinity)

$U_f - 0_{ref} = -W_{gravity\ force}$

$U_f = -W_{g.f.}$

Gravitational Potential energy → negative work done in moving a mass m from infinity to the Point by gravitation force is called Potential energy at that point stored in mass m.

→ Work done in moving mass m from infinity to the Point slowly ($\Delta K.E = 0$) is called gravitational Potential energy stored in mass (m).

$\Delta U = W_{N.C.F(ext\ force)}$

↳ $\Delta K.E = 0$

Gravitational Potential

Gravitational Potential energy Per unit mass is called gravitational Potential.

$$\frac{F}{m} = I$$

$$\frac{U}{m} = V$$

Work done in moving unit mass from infinity to the point slowly is called gravitational Potential.

$$V = \frac{U}{m} \qquad \Delta V = \frac{\Delta U}{m}$$

- scalar
- unit J/kg
- depends on ref'n.

$\left[F = -\frac{dU}{dr}\hat{r}\right]$

divided by 'm' both side

$$\frac{F}{m} = -\frac{d\,U/m}{dr}$$

$$\vec{I} = -\left(\frac{dV}{dr}\right) \rightarrow \text{(gravitational potential gradiant. (vector))}$$

$$I = -\left[\frac{\partial V}{\partial x}\hat{i} + \frac{\partial V}{\partial y}\hat{j} + \frac{\partial V}{\partial z}\hat{k}\right]$$

$$-dV = I \cdot dr$$

$$\int dV = -\int I \cdot dr$$

$$\Delta V = -\int I \cdot dr$$

GRAVITATIONAL POTENTIAL

$\Delta V = \frac{W_{ext}}{m}$

Work done in bringing unit mass from infinity to the point is called Gravitational Potential at that point.

OR

#* Negative work done in bringing unit mass from infinity to the point by Gravitational force is called Gravitational Potential.

$\Delta V = -\frac{W_{gravity}}{m}$

QUESTION

If gravitational potential $V = xy^2 + yz^2 + zx^2$, then find gravitational field intensity at (1, 1, 1).

$$V = xy^2 + yz^2 + zx^2$$

$$I = -\left[\frac{\partial V}{\partial x}\hat{i} + \frac{\partial V}{\partial y}\hat{j} + \frac{\partial V}{\partial z}\hat{k}\right]$$

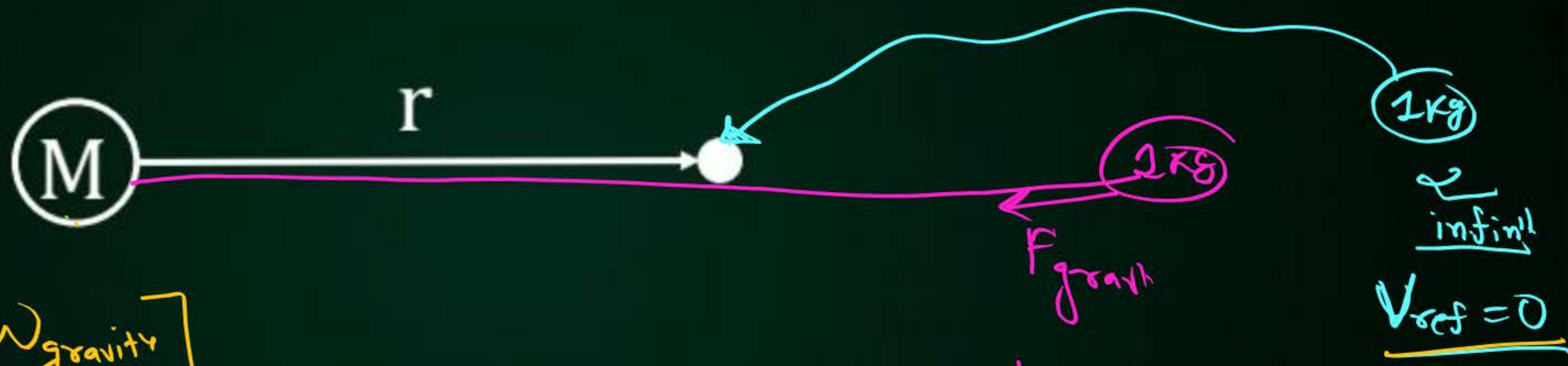
$$I = -\left\{[y^2 + 2zx]\hat{i} + [x2y + z^2]\hat{j} + [y2z + x^2]\hat{k}\right.$$

$$I = -\left[y^2 + 2zx\right]\hat{i} + (z^2 + 2xy)\hat{j} + [x^2 + 2zy]\hat{k}$$

$$I = -\left[3\hat{i} + 3\hat{j} + 3\hat{k}\right]$$

$$|I| = 3\sqrt{3}$$ Ans

GRAVITATIONAL POTENTIAL DUE TO POINT MASS



$V = -\left[\frac{W_{gravity}}{m}\right]$ infinity to that Point

$W_{gravity} = +ve$

$$V = -\frac{GM}{r}$$

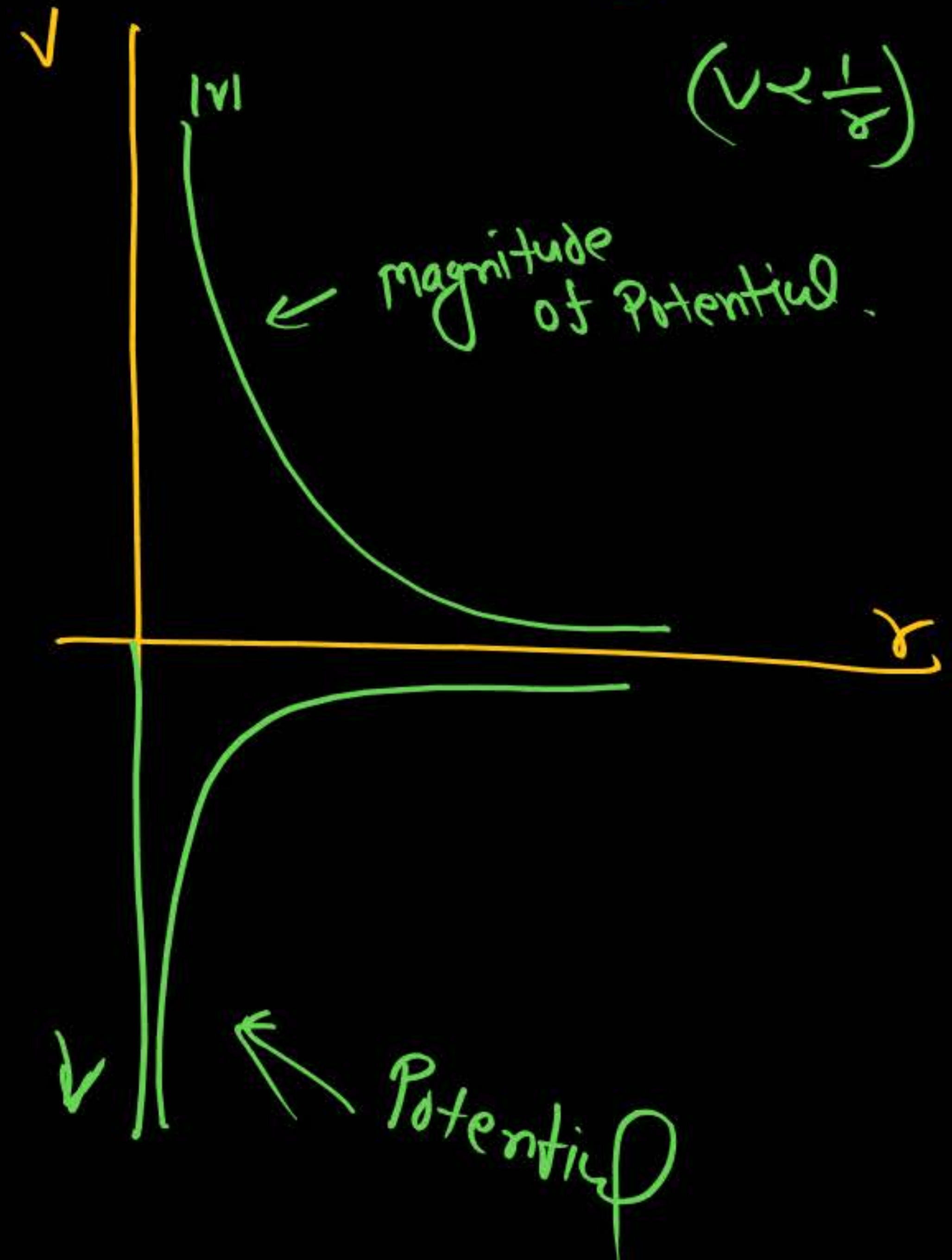
→ at r distance from Point mass.

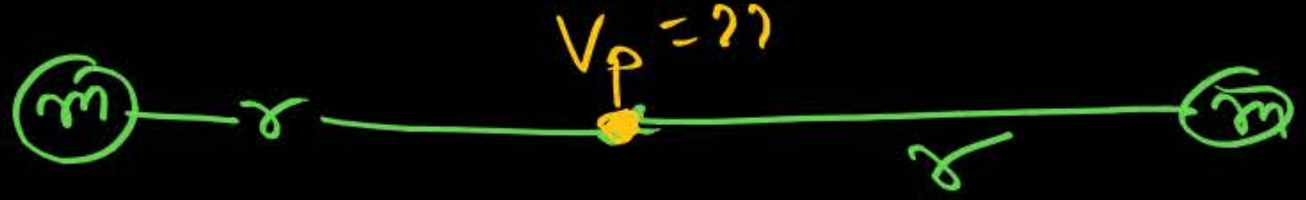
⊛ gravitational Potential depends on refrence Point
it may be +ve or −ve depends on ref. if ref^n at infinity is zero then at r distance from Point mass $\left[V = -\frac{Gm}{R}\right]$.



$$\left\{ V = -\frac{Gm}{r} \right\}$$

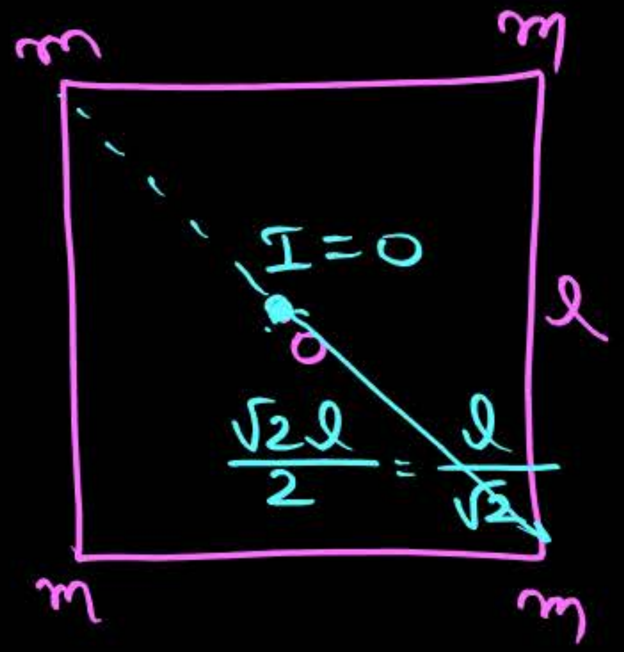
$$\left(V \propto \frac{1}{r} \right)$$





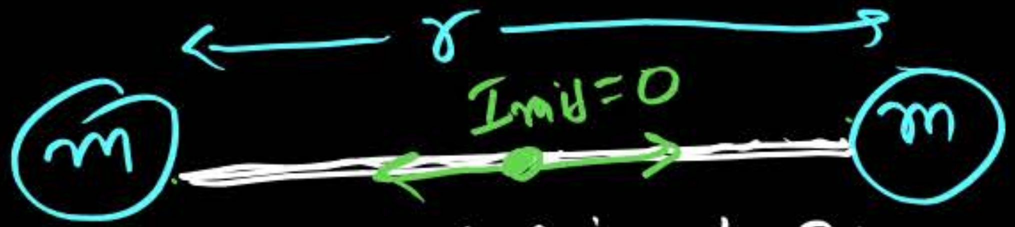
$$V_P = -\frac{Gm}{r} - \frac{Gm}{r} = -\frac{2Gm}{r}$$

↳ scalar



$$V_0 = -\frac{4Gm}{\frac{l}{\sqrt{2}}} = -\frac{4\sqrt{2}\,Gm}{l} \quad \text{Ans}$$

$$\boxed{I_0 = 0}$$



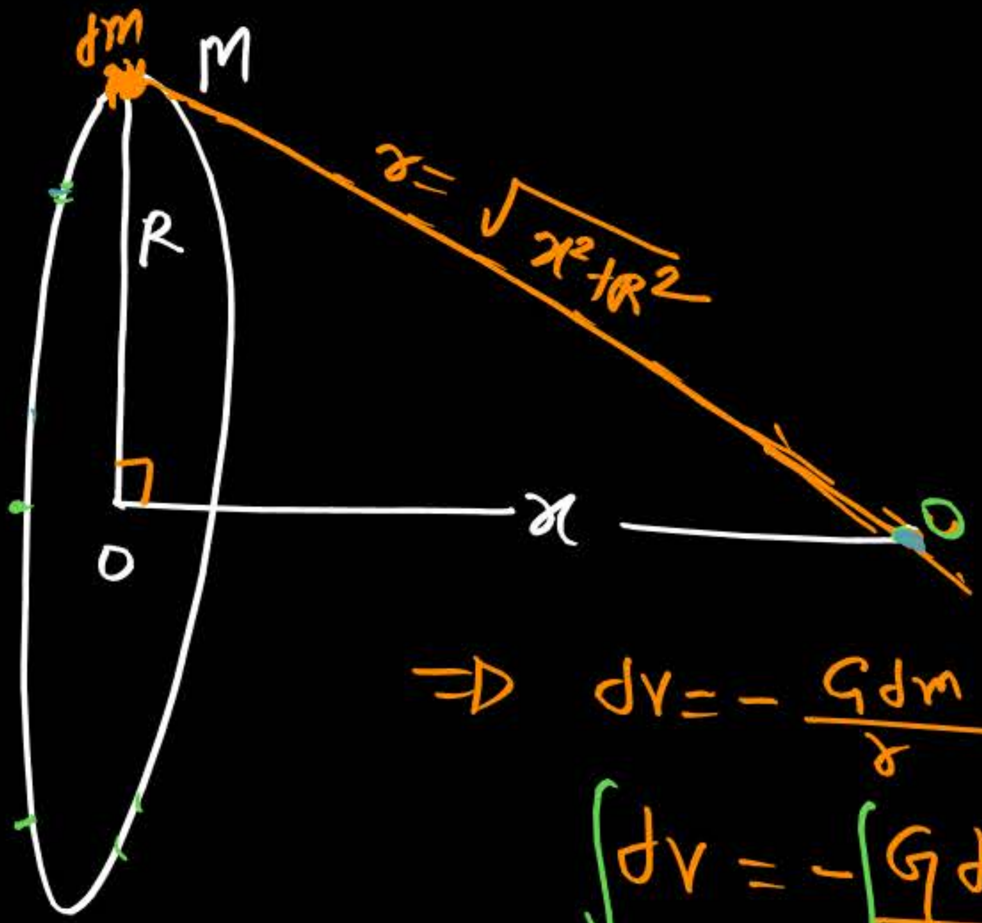
Potential is not zero at finite point.



$$x = \frac{r}{\sqrt{n}+1}$$

Potential is not zero at finite point.

Gravitational Potential due to Ring



$\Rightarrow dV = -\frac{G\,dm}{r}$ (scalar)

$\int dV = -\int \frac{G\,dm}{\sqrt{R^2+x^2}}$

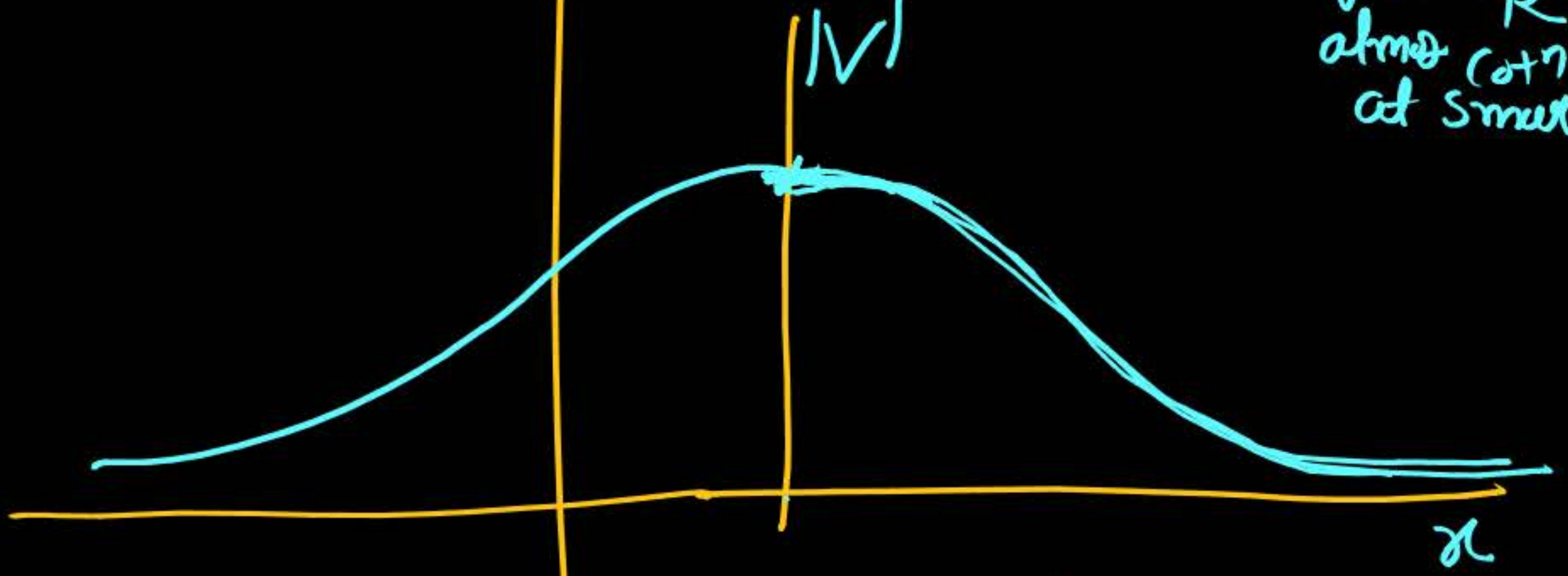
• $V = \frac{-G}{\sqrt{R^2+x^2}} \int dm = \frac{-GM}{(R^2+x^2)^{1/2}}$ Ans

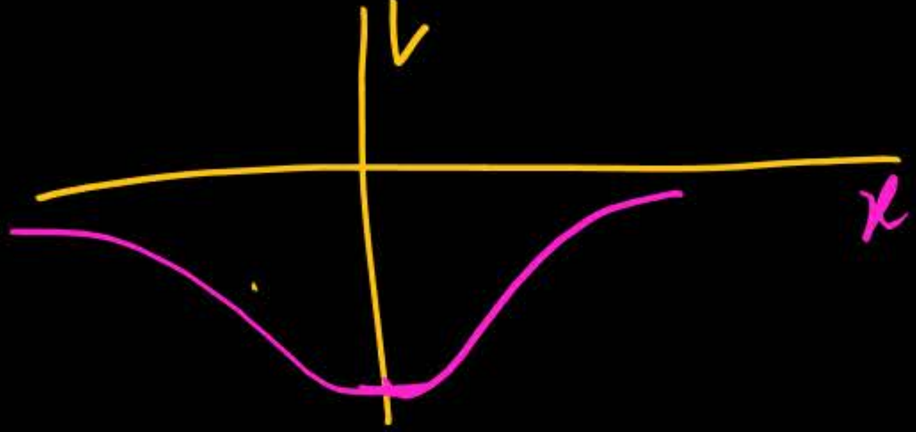


$V_{Ring} = -\frac{GM}{(R^2+x^2)^{1/2}}$

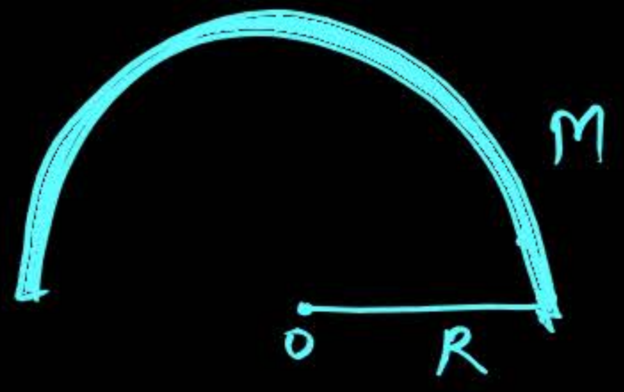
$V_{centre} = -\frac{GM}{R}$
$x = 0$

If $(x << R)$
$V = -\frac{GM}{R}$
almost const at small x





Circular Arc



$$V = -\frac{Gm}{R}$$



$$V_0 = -\frac{Gm}{R}$$

QUESTION

Two point mass M and 4 M at distance r. Find gravitational potential where gravitational field is zero.



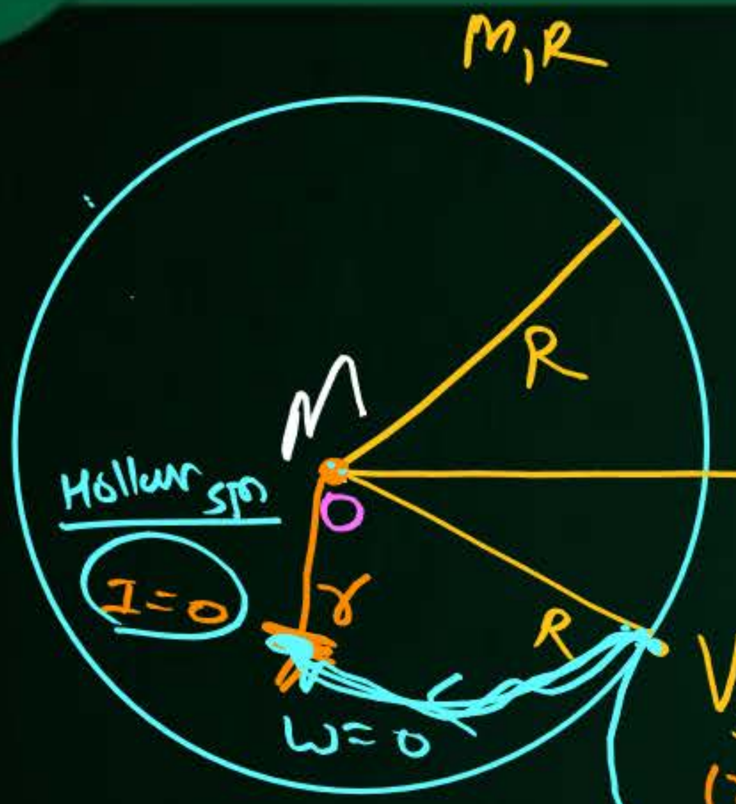
$$x = \frac{r}{\sqrt{4}+1} = \frac{r}{2+1} = \frac{r}{3}$$

$$r - \frac{r}{3} = \frac{2r}{3}$$

$$V_P = -\frac{GM}{r/3} - \frac{G(4M)}{2r/3}$$

$$= -\frac{3GM}{r} - \frac{6GM}{r} = -\frac{9GM}{r}$$

GRAVITATIONAL POTENTIAL DUE TO HOLLOW SPHERE



unit mass 1 kg — infinity

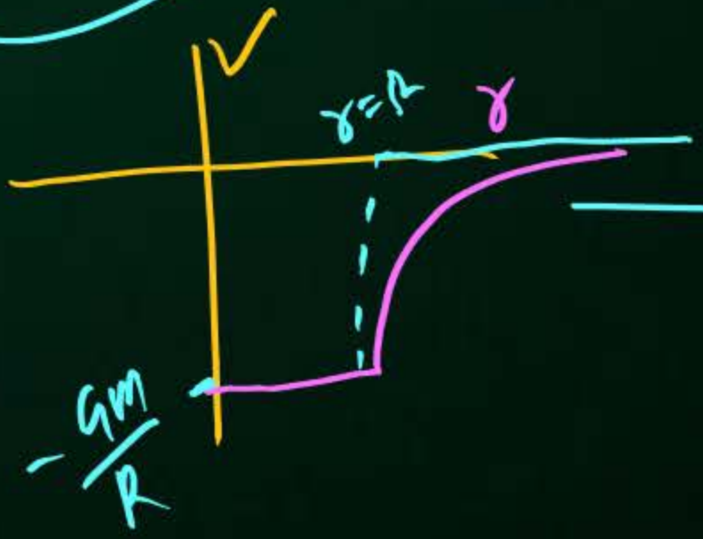
m = 1 kg

$V_{out} = -\frac{GM}{r}$ $(r > R)$

$V_{surface} = -\frac{GM}{R}$ $(r = R)$

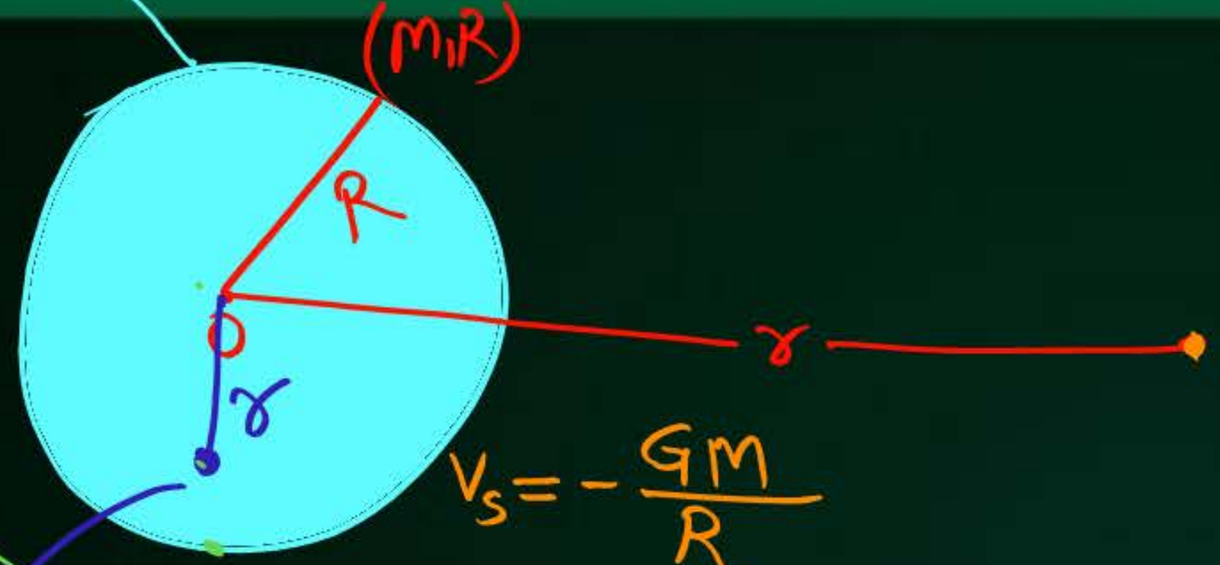
$V_{in} = -\frac{GM}{R} = V_{centre}$ $(r < R)$

[V inside at all the point $= -\frac{GM}{R}$]





GRAVITATIONAL POTENTIAL DUE TO SOLID SPHERE



$V_s = -\frac{GM}{R}$

$V_{out} = -\frac{GM}{r}$ $(r > R)$

$V_{inside} = -\frac{GM(3R^2 - r^2)}{2R^3}$ $(r < R)$

dim^n correct

If $r = R$: $V_s = -\frac{GM}{R}$

$(r = 0)$: $V = -\frac{GM\,3R^2}{2R^3}$ → $V_{cent} = -\frac{3}{2}\frac{GM}{R}$

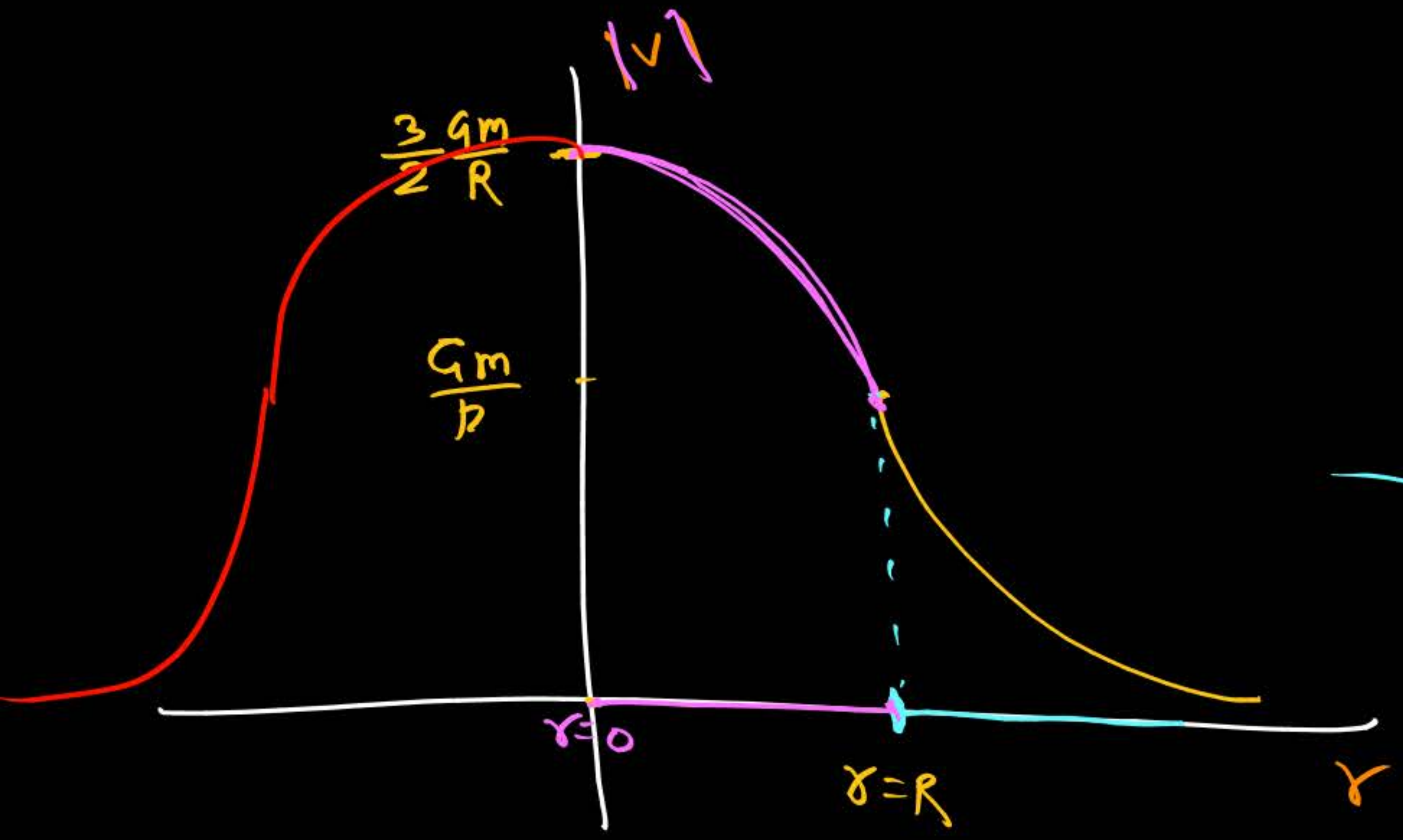
$V_{centre} = \frac{3}{2} V_{surface}$

$V_{out} = -\frac{GM}{r}$

$V_{surface} = -\frac{GM}{R}$

$V_{inside} = \frac{-GM(3R^2 - r^2)}{2R^3}$

Biyoyoya





$$V_{out} = -\frac{Gm}{r} \quad (r>R)$$

• Rectangular hyperbola

$$V_{in} = -\frac{Gm(3R^2 - r^2)}{2R^3}$$

→ Parabolic

$V_{in} \propto r^2$

QUESTION

If gravitational potential taken to be zero at surface of solid sphere then find potential at infinity.

1. Zero
2. $-\dfrac{qm}{R}$
3. $+\dfrac{qm}{R}$
4. $-\dfrac{3}{2}\dfrac{qm}{R}$

QUESTION

If potential at the surface of earth is assigned zero value, then potential at center of earth will be (Mass = M, Radius = R)

1. 0
2. $-\frac{GM}{2R}$
3. $-\frac{3GM}{2R}$
4. $\frac{3GM}{2R}$

Solid sph

$(V_s - V_c)_{\text{initial}} = (V_s - V_c)_{\text{final}}$

$-\frac{Gm}{R} + \frac{3}{2}\frac{Gm}{R} = 0 - V_c$

$\frac{Gm}{2R} = -V_c$

$V_c = -\frac{Gm}{2R}$ Ans

GRAVITATIONAL POTENTIAL ENERGY OF TWO MASS SYSTEM

$V = \frac{U}{m}$

$U = Vm$



$V = -\frac{Gm}{r}$ ✓

$U = -\frac{G m_1 m_2}{r}$



U = ??
Stored P.E.

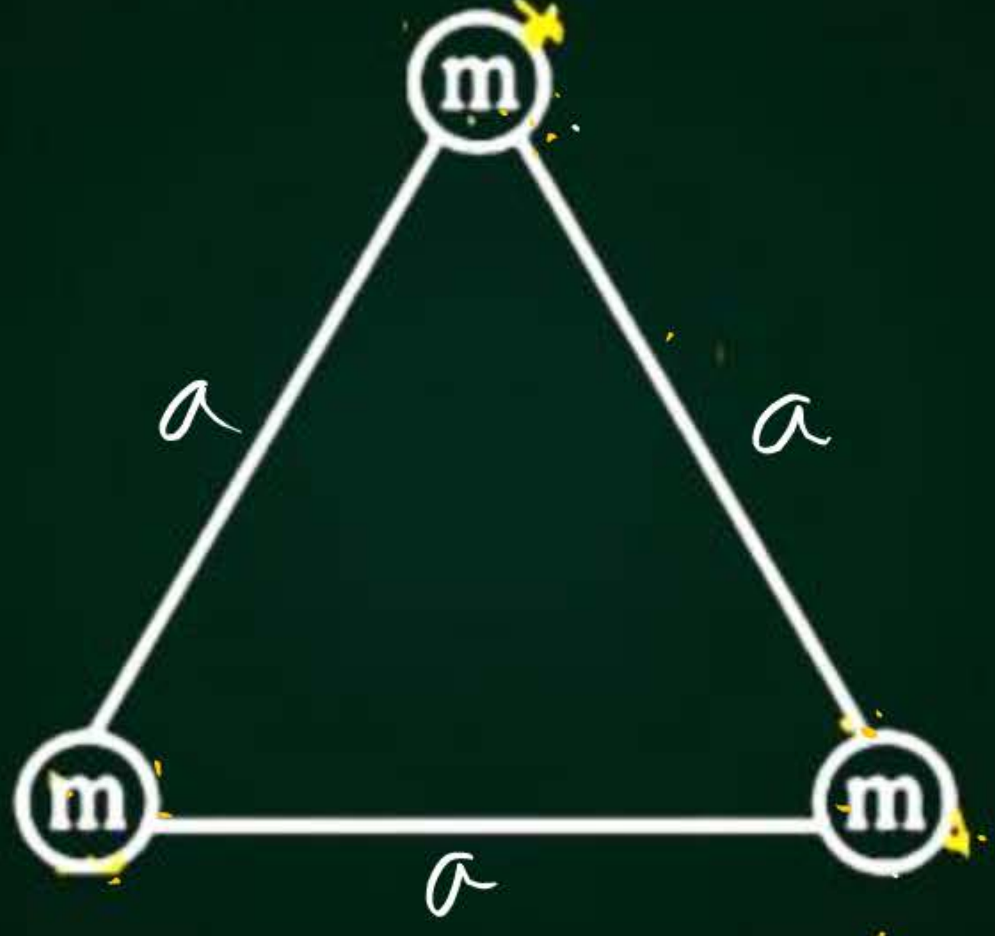
$U = mV$

$U = -\frac{GMm}{r}$

→ Two point mass-system ka potential energy.

QUESTION

Find potential energy of the system.

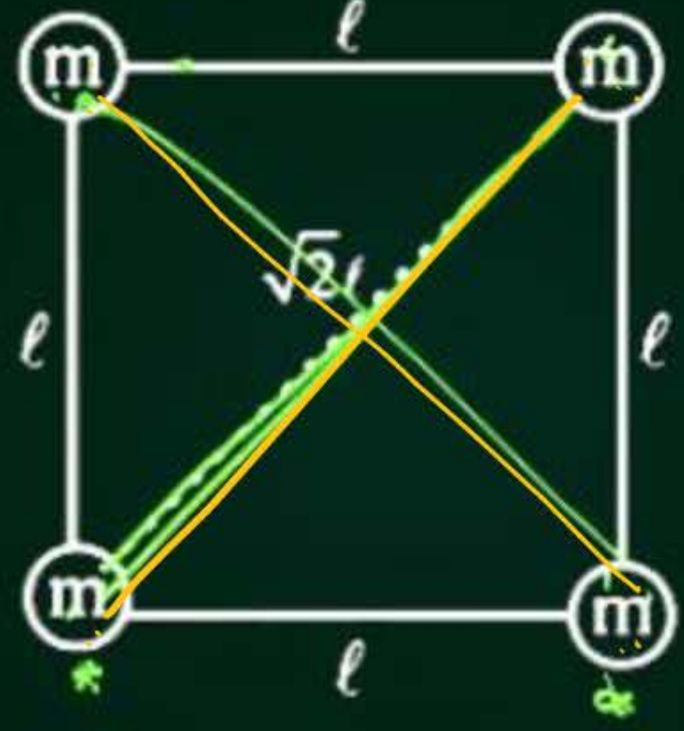


$$U = \left(-\frac{Gm\times m}{r}\right)\times 3$$

$$U = \frac{-3Gm^2}{r}$$

QUESTION

Find potential energy of the system.



Terms of Potential energy for N mass system $= \frac{N(N-1)}{2}$

$= \frac{4(4-1)}{2} = 2 \times 3$

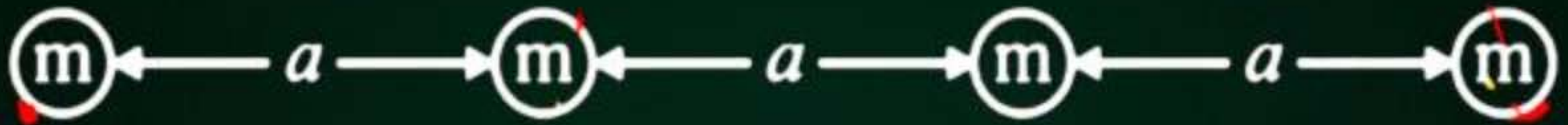
$= 6$ term

$$U = -\frac{4Gm^2}{l} - \frac{2Gm^2}{\sqrt{2}\,l}$$

Ans

QUESTION

Find potential energy of the system.

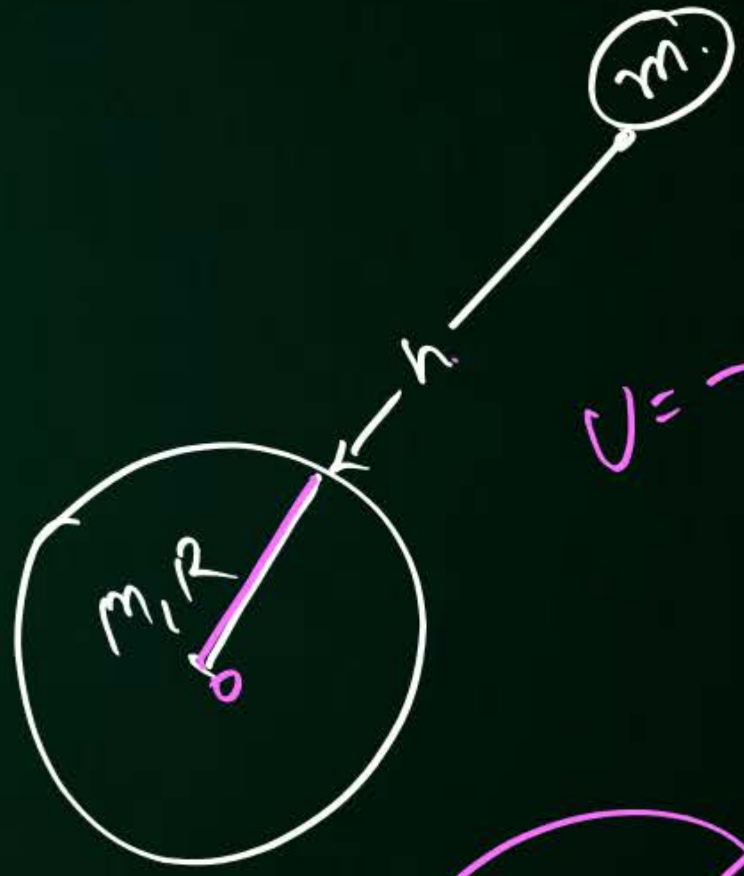


H/W

GRAVITATIONAL POTENTIAL ENERGY OF EARTH MASS SYSTEM



$$U = \frac{-GMm}{R}$$



$$U = -\frac{GMm}{(R+H)}$$



mass is placed at centre of earth.

$$U = \frac{-3GMm_0}{2R}$$


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 05 | **Physics**

Gravitation

By- Dr. Manish Raj (MR SIR)



Topics to be covered

1. # PhD on Potential energy
2. # escape velocity. (C.O.M.E)
3. #
4. #



gravitational potential

$$V = \frac{U}{m}$$

$$\Delta V = \frac{\Delta U}{m}$$

ΔV → does not depend on ref

→ scalar

→ depend on refⁿ

→ unit J/kg

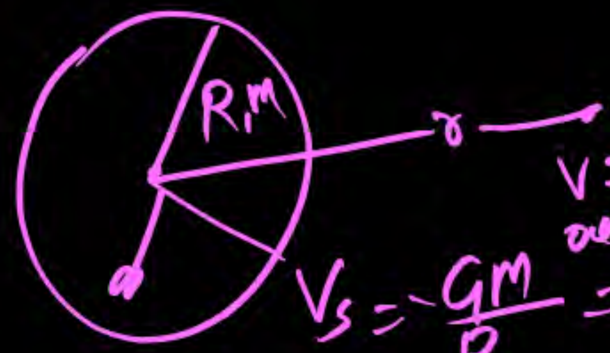
$$\Delta V = -\int I \cdot dr$$ → Area of I/r graph is $(-\Delta V)$

$$I = -\frac{dV}{dr}$$ — (-ve slope of V/r graph is gravitational Intensity)

$$I = -\left[\frac{\partial V}{\partial x}\hat{i} + \frac{\partial V}{\partial y}\hat{j} + \frac{\partial V}{\partial z}\hat{k}\right]$$



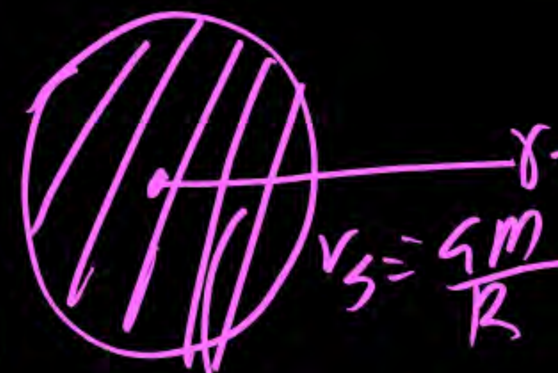
$$V = -\frac{GM}{r}$$



$$V = -\frac{GM}{r}$$

$$V_s = -\frac{GM}{R} = V_{inside}$$





$$V_{out} = -\frac{GM}{r}$$

$$V_s = -\frac{GM}{R}$$

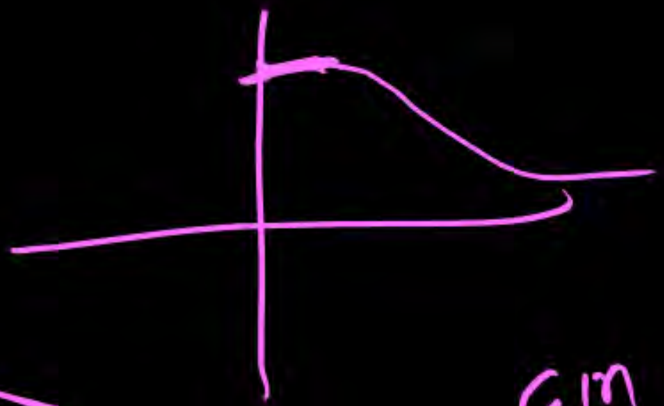
$$V_{in} = -\frac{GM(3R^2 - r^2)}{2R^3}$$

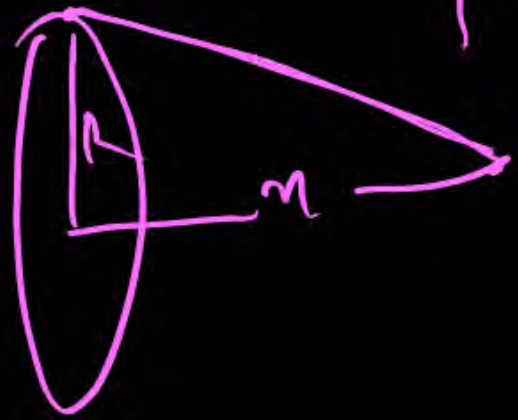
$$V_0 = \frac{3}{2} V_{surface}$$

#

$G \to K$

$M \to Q$

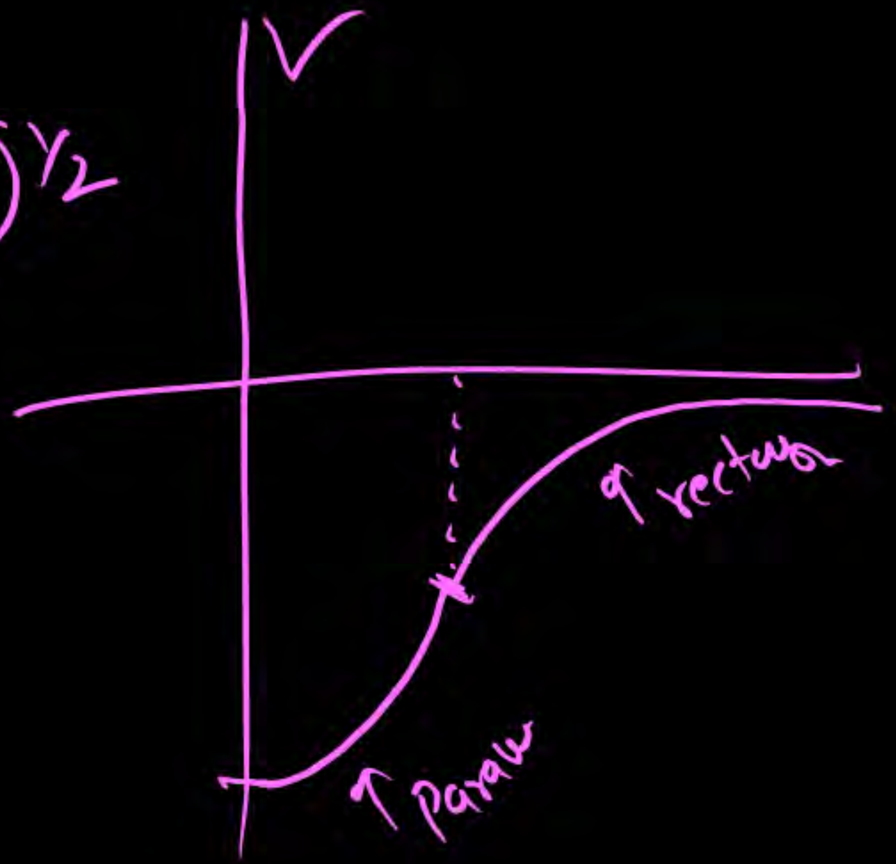




$$V = -\frac{GM}{(R^2+x^2)^{1/2}}$$



$$V_0 = -\frac{GM}{R}$$



gravitational P.E

$$F = -\frac{\partial U}{dr}\hat{r}$$

$$\int dU = -\int F \cdot dr$$

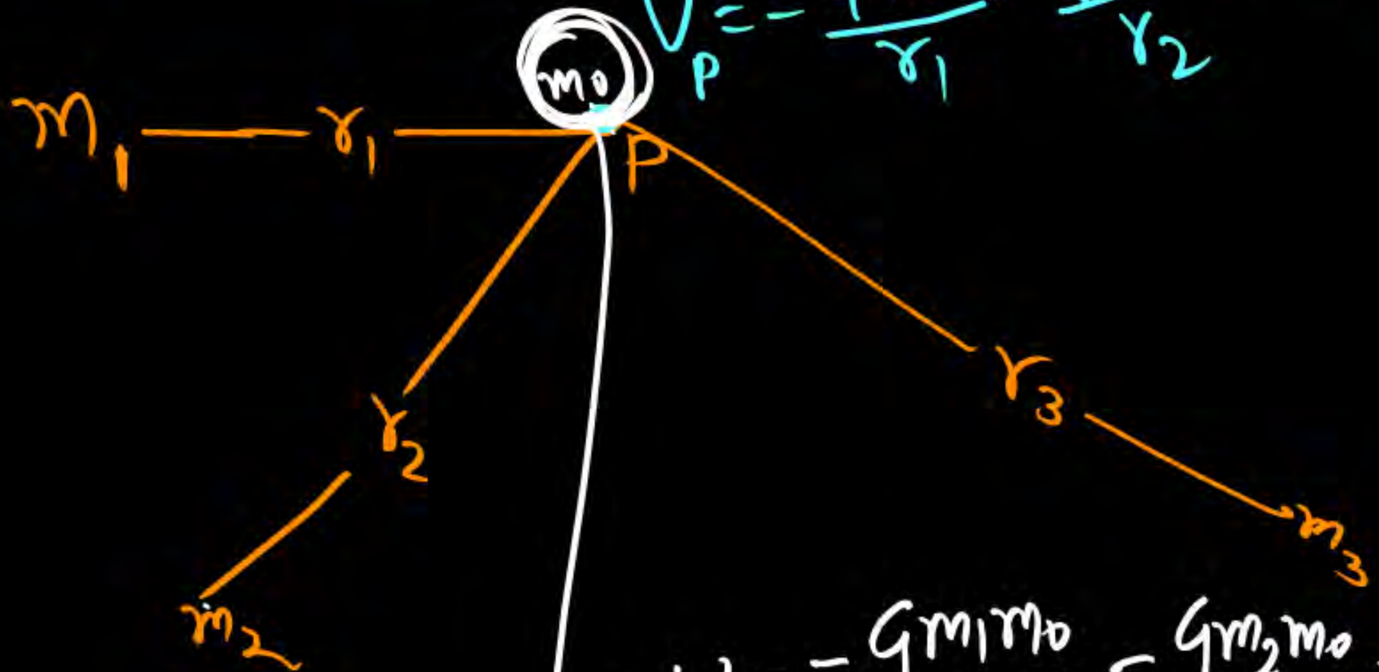
$$\Delta U = -\int \vec{F} \cdot \vec{dr}$$

$$\Delta U = -W_{\text{graviti}\text{onl force}}$$ → always valid असली

$$\Delta U = W_{\text{ext force}}$$ → K.E = const, ΔK.E = 0

$$U = mV$$

$$V_P = -\frac{Gm_1}{r_1} - \frac{Gm_2}{r_2} - \frac{Gm_3}{r_3}$$



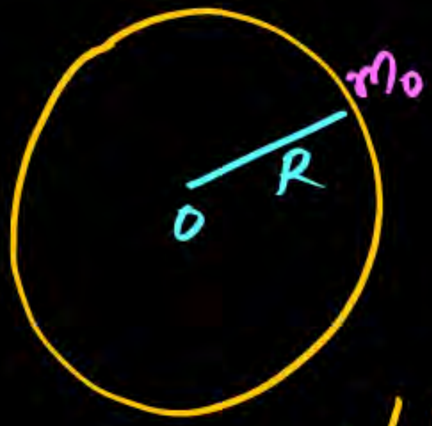
$$U = -\frac{Gm_1m_0}{r_1} - \frac{Gm_2m_0}{r_2} - \frac{Gm_3m_0}{r_3}$$

m_1 —— r —— m_2

$$U = -\frac{G m_1 m_2}{r}$$

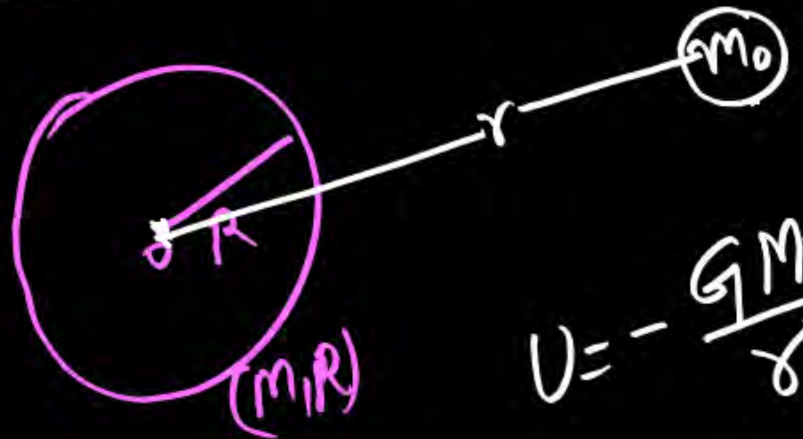
→ energy stored in the system of m_1 & m_2

*



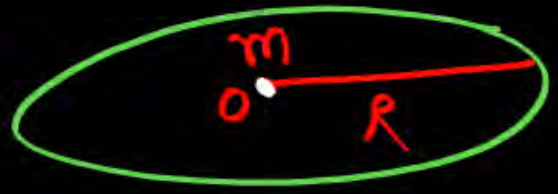
$$U = -\frac{G M m_0}{R}$$

Hollow sph (M, R)



$$U = -\frac{G M m_0}{r}$$

#5



Ring (M, R)

$$U = -\frac{G M m}{R}$$ (Ring & Point Mass-system ka Potential energy)

Solid spher (M, R)



$U_{\text{solid spr } \& \, m_1} = -\frac{GMm_1}{R}$

$U_{\text{solid spr } \& \, m_2} = -\frac{3GMm_2}{2R}$

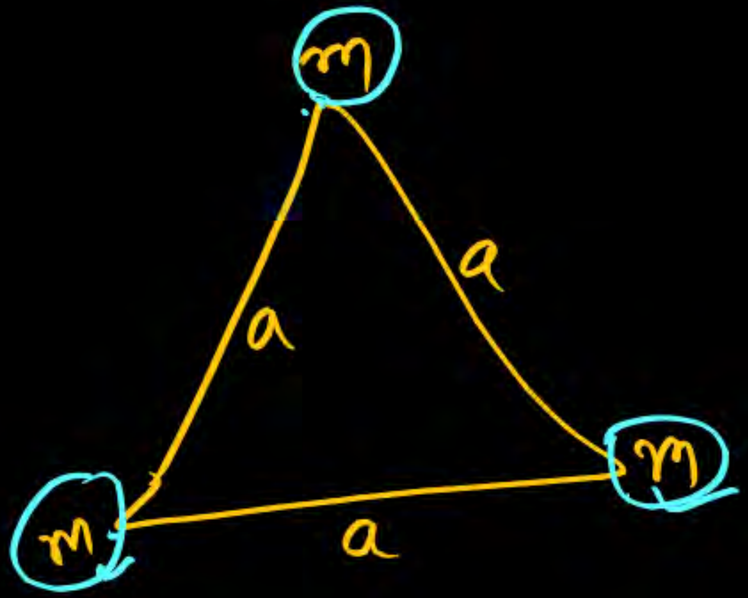
V → define for one point mass or one sphere or one ring

U → defined for Pair two mass

Potential energy of system



$$\left[U = -\frac{Gm^2}{a} - \frac{Gm^2}{a} - \frac{Gm^2}{(2a)}\right] \text{Ans}$$

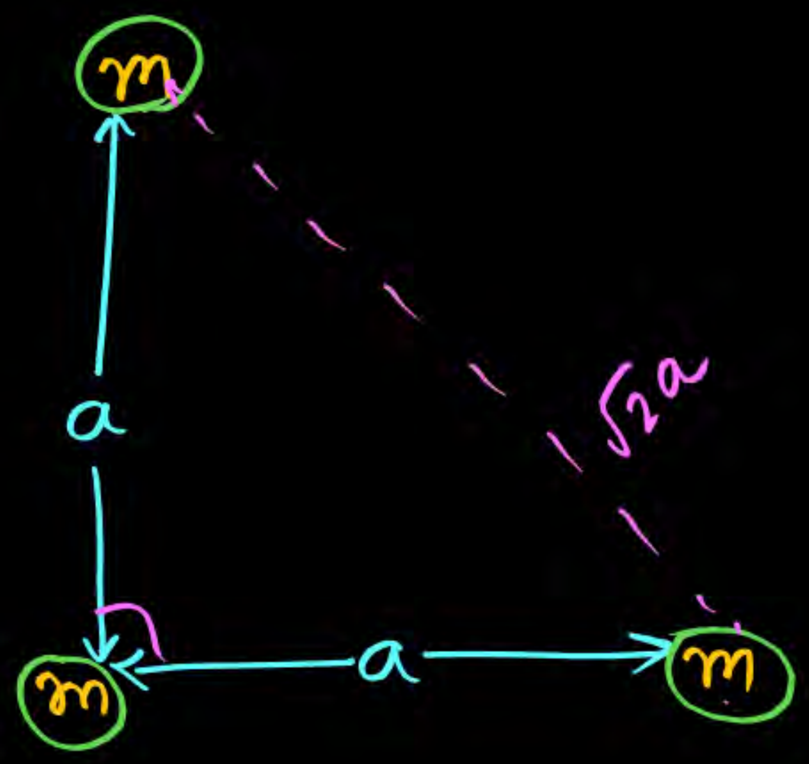


$$V = -\frac{Gm^2}{a} - \frac{Gm^2}{a} - \frac{Gm^2}{a}$$

$$V = -\left(\frac{Gm^2}{a}\right)3$$

(*) No. of Pair or No of terms of Potential energy $= \dfrac{N(N-1)}{2}$

Q,



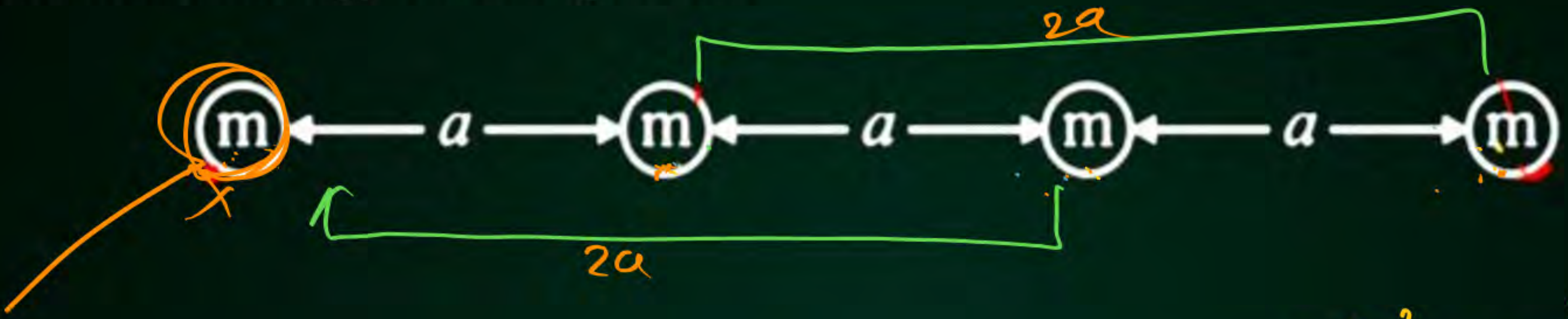
$$U_{system} = -\frac{Gm^2}{a} - \frac{Gm^2}{a} - \frac{Gm^2}{\sqrt{2}a}$$

Ans.

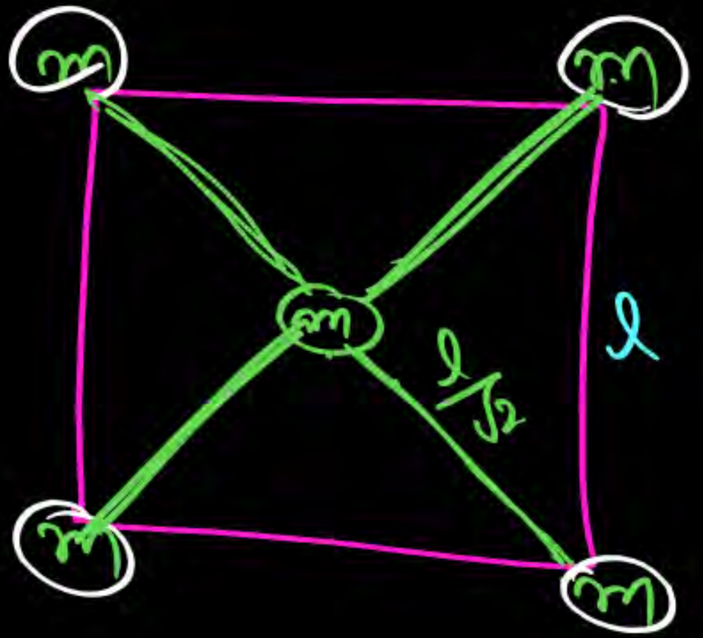
$$\frac{N(N-1)}{2} = \text{No of term}$$

QUESTION

Find potential energy of the system.



$$V = -\frac{3Gm^2}{a} - \frac{2Gm^2}{2a} - \frac{Gm^2}{3a}$$



$$U = -\frac{4Gm^2}{l} - \frac{2(Gm^2)}{\sqrt{2}l} - 4\left(\frac{Gm^2}{l/\sqrt{2}}\right)$$

$$U = -\frac{4Gm^2}{l} - \sqrt{2}\frac{Gm^2}{l} - 4\sqrt{2}\frac{Gm^2}{l}$$

Ag

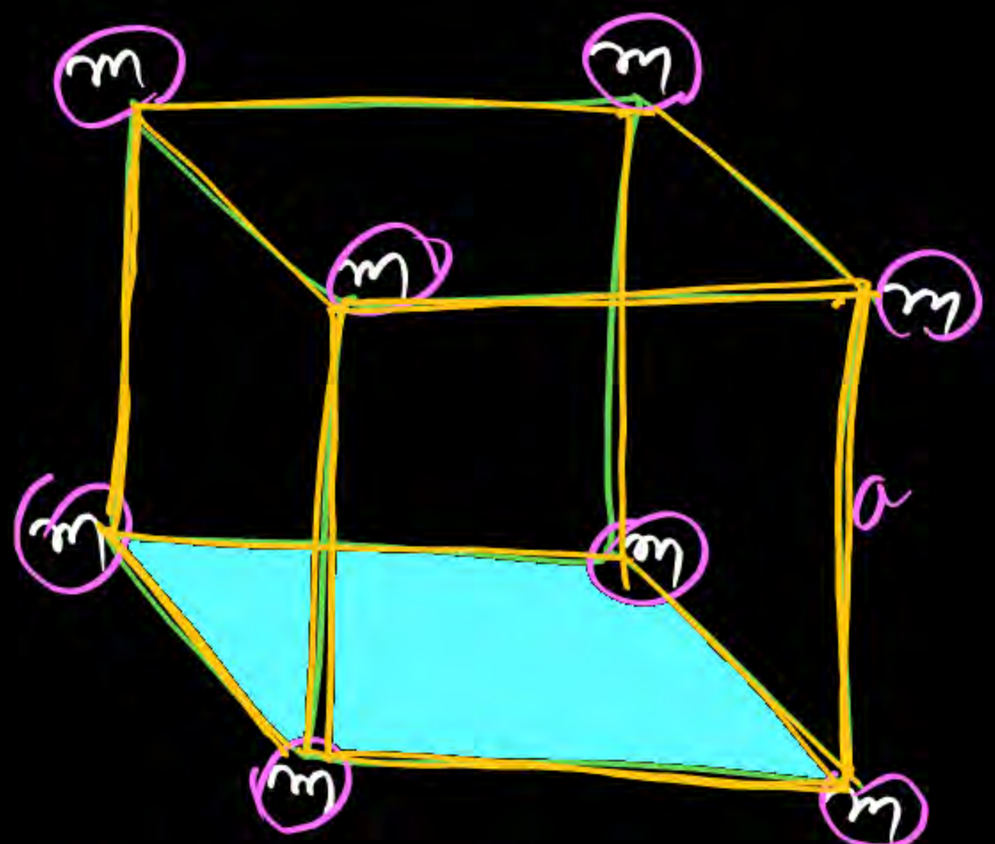
Potential energy of this system $U = ??$

No of terms $= \frac{5(5-1)}{2} = \frac{5\times 4}{2} = \underline{\underline{10}}$

Not for all

No of terms $= \frac{N(N-1)}{2} = \frac{8(8-1)}{2}$

$= 28$



$U = -\frac{12 G m^2}{a} - \frac{12 G m^2}{\sqrt{2} a} - \frac{4 G m^2}{\sqrt{3} a}$

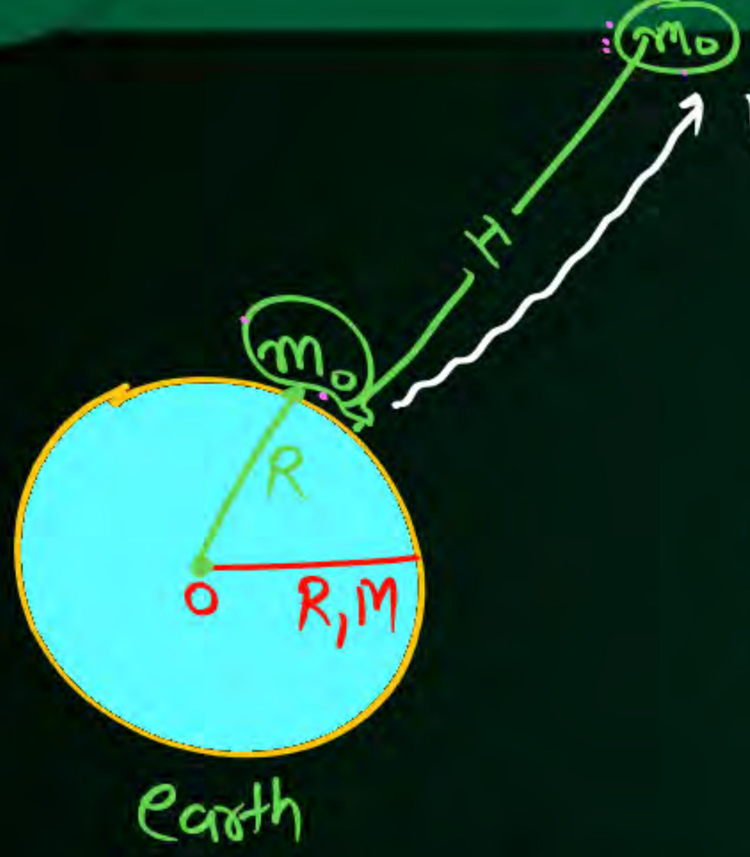
Body diagonal



GRAVITATIONAL POTENTIAL ENERGY OF EARTH MASS SYSTEM

* In natural process P.E ↓

$GM = g_0 R^2$ → MR Ratta



U (Potential energy) ↑

(a) Physoso

(b) Byoxoxa

ΔU (surface to Height H) $= U_f - U_i$

$$= -\frac{GMm_0}{(R+H)} + \frac{GMm_0}{R}$$

$$= GMm_0\left[\frac{1}{R} - \frac{1}{R+H}\right]$$

$$= GMm_0\left[\frac{R+H-R}{R(R+H)}\right] = \frac{GMm_0H}{R(R+H)}$$

$$\Delta U = \frac{g_0R^2m_0H}{R^2\left(1+\frac{H}{R}\right)} = \frac{m_0g_0H}{1+\frac{H}{R}}$$

MR Ratta

$$U_{surface} = -\frac{GMm_0}{R}$$

$$U_{at\ Height\ H} = -\frac{GMm_0}{(R+H)}$$

$$\Delta U = \left[\frac{mg_0H}{1+H/R}\right]$$

Biyolors

QUESTION

An object is taken to height $2R$ above the surface of earth, the increase in potential energy if [R is radius of earth]

(1) $\frac{mgR}{2}$

(2) $\frac{mgR}{3}$

(3) $\frac{2mgR}{3}$

(4) $2mgR$

Phydoso

$\Delta U = -\frac{GMm}{3R} + \frac{GMm}{R}$

$= \frac{-GMm + 3GMm}{3R} = \frac{2GMm}{3R}$

$= \frac{2}{3} gRm$

method → 2

$\Delta U = \frac{mg(2R)}{1 + \frac{2R}{R}} = \frac{2mgR}{3}$

Ans

QUESTION

The charge in potential energy when a body or mass m is raised to height nR from the earth's surface is [R is radius of earth]

1. $mgR\left(\frac{n}{n-1}\right)$
2. $nmgR$
3. $mgR\left(\frac{n}{n+1}\right)$
4. $mgR\left(\frac{n^2}{n^2+1}\right)$

change

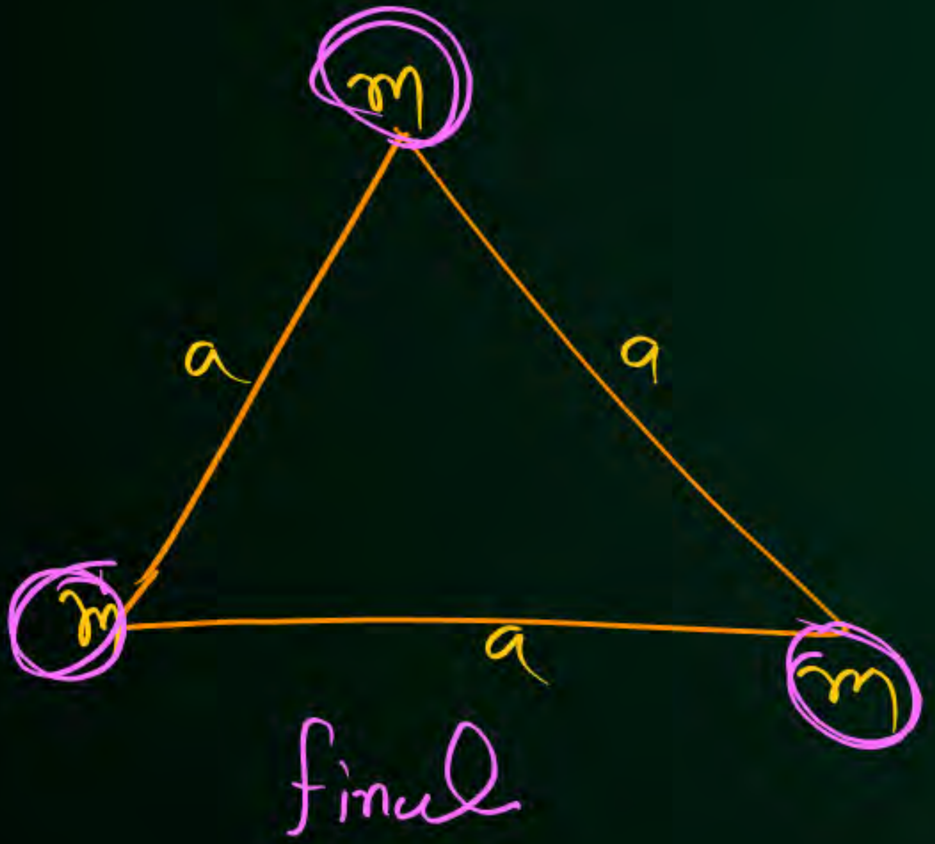
$H = nR$

$\Delta U = \frac{mgnR}{1+\frac{nR}{R}}$

$= \frac{mgRn}{n+1}$

QUESTION

Find work done in taking three point mass from infinity to corner of equilateral triangle of side a.



$$W_{ext} = \Delta U$$

$$= U_f - U_i$$

$$W_{ext} = -\frac{3Gm^2}{a} - 0$$

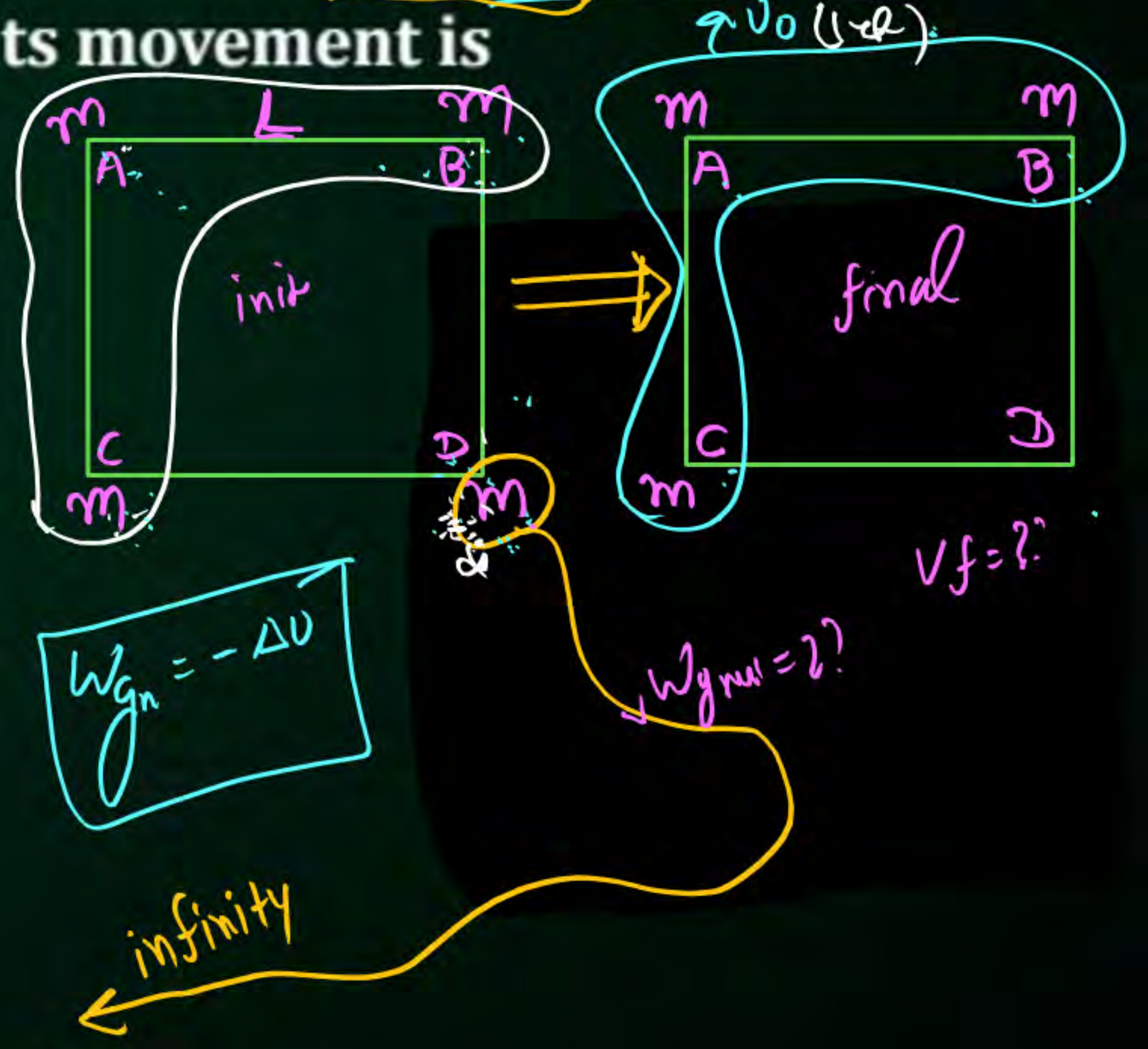
$$\boxed{W_{ext} = -\frac{3Gm^2}{a}}$$

Ans

QUESTION

Four particles A, B, C and D each of mass m are kept at the corners of a square of side L. Now the particle D is taken to infinity by an external agent keeping the other particles fixed at their respective position. The work done by the gravitational force action on the particle D during its movement is

1. $2\frac{Gm^2}{L}$
2. $-2\frac{Gm^2}{L}$
3. $\frac{Gm^2}{L}\left(\frac{2\sqrt{2}+1}{\sqrt{2}}\right)$
4. $-\frac{Gm^2}{L}\left(\frac{2\sqrt{2}+1}{\sqrt{2}}\right)$



sol^n

$W_{grav} = -\Delta U = -[U_f - U_i] = U_i - U_f$

$= -\frac{Gm^2 2}{L} - \frac{Gm^2}{\sqrt{2}L} + U_0 - U_0$

QUESTION

Four identical particles m placed on the corner of square of side length a, then find work to move 5th mass M from center of square to infinity?

$$W_{gr} = -\Delta U$$

$$W_{ext} = \Delta U$$

$$W_{ext} = U_f - U_i$$

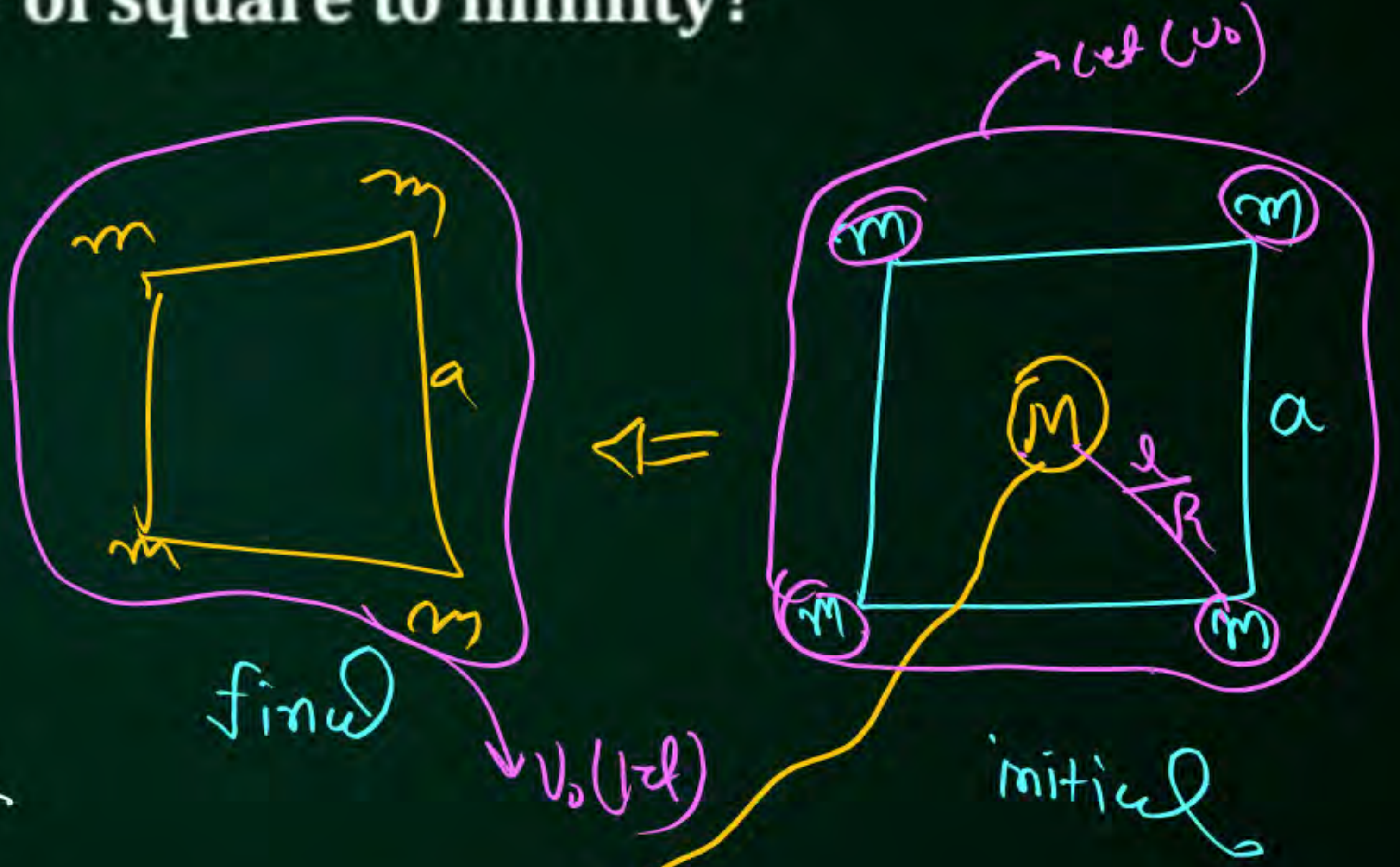
$$= U_0 - \left[U_0 - \frac{4GmM}{l/\sqrt{2}}\right]$$

$$= U_0 - U_0 + \frac{4GMm\sqrt{2}}{l}$$

$$W_{ext} = +\frac{4\sqrt{2}GMm}{l}$$

Ans

infinity

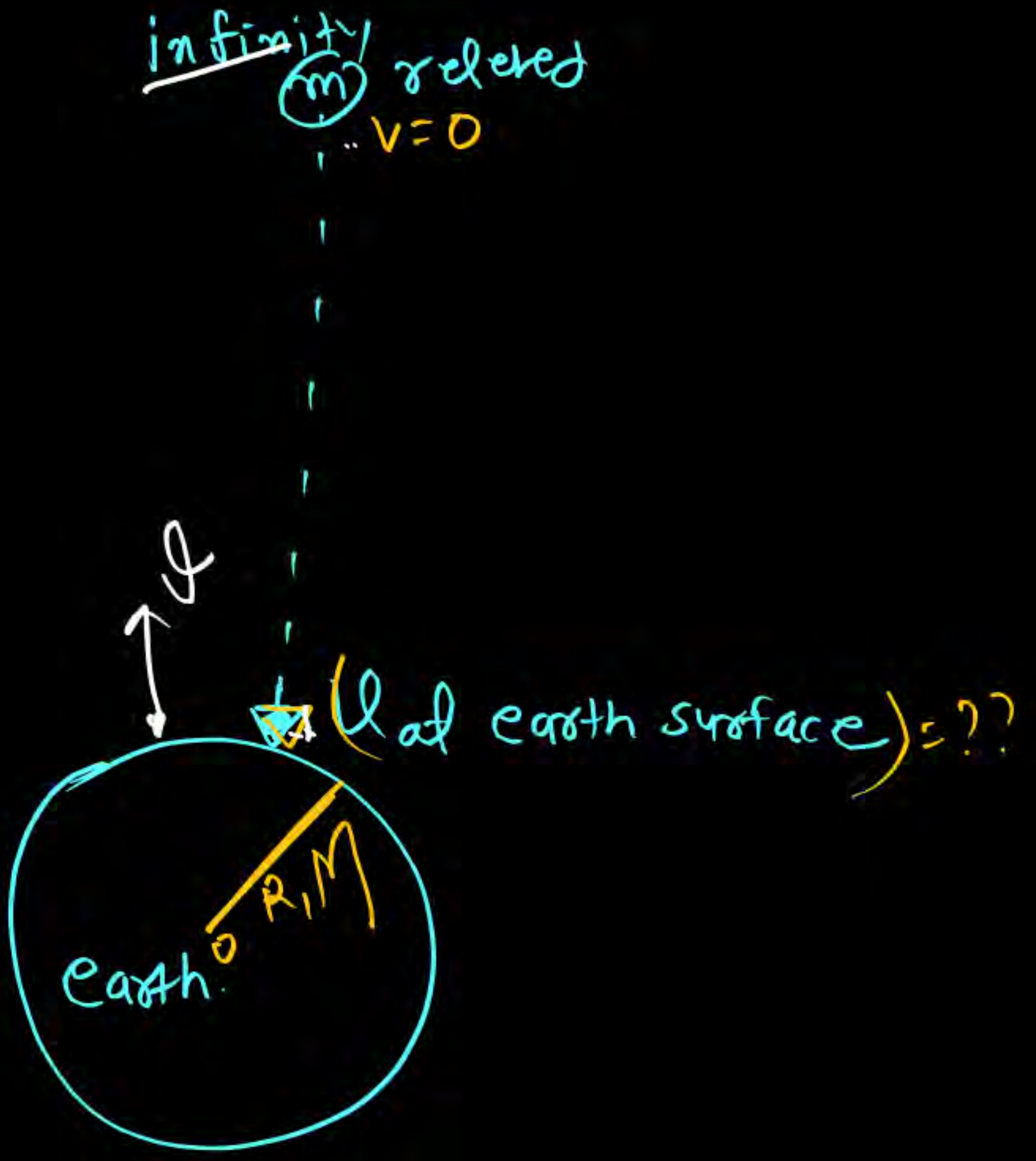


QUESTION

A stationary object is released from a point P at a distance $3R$ from the center of the moon which has radius R and mass M. Which of the following gives the speed of the object on hitting the moon?

1. $\left(\frac{2GM}{3R}\right)^{\frac{1}{2}}$
2. $\left(\frac{4GM}{3R}\right)^{\frac{1}{2}}$
3. $\left(\frac{GM}{3R}\right)^{\frac{1}{2}}$
4. $\left(\frac{GM}{R}\right)^{\frac{1}{2}}$





object is relesed from infinity then find its speed at earth surface??

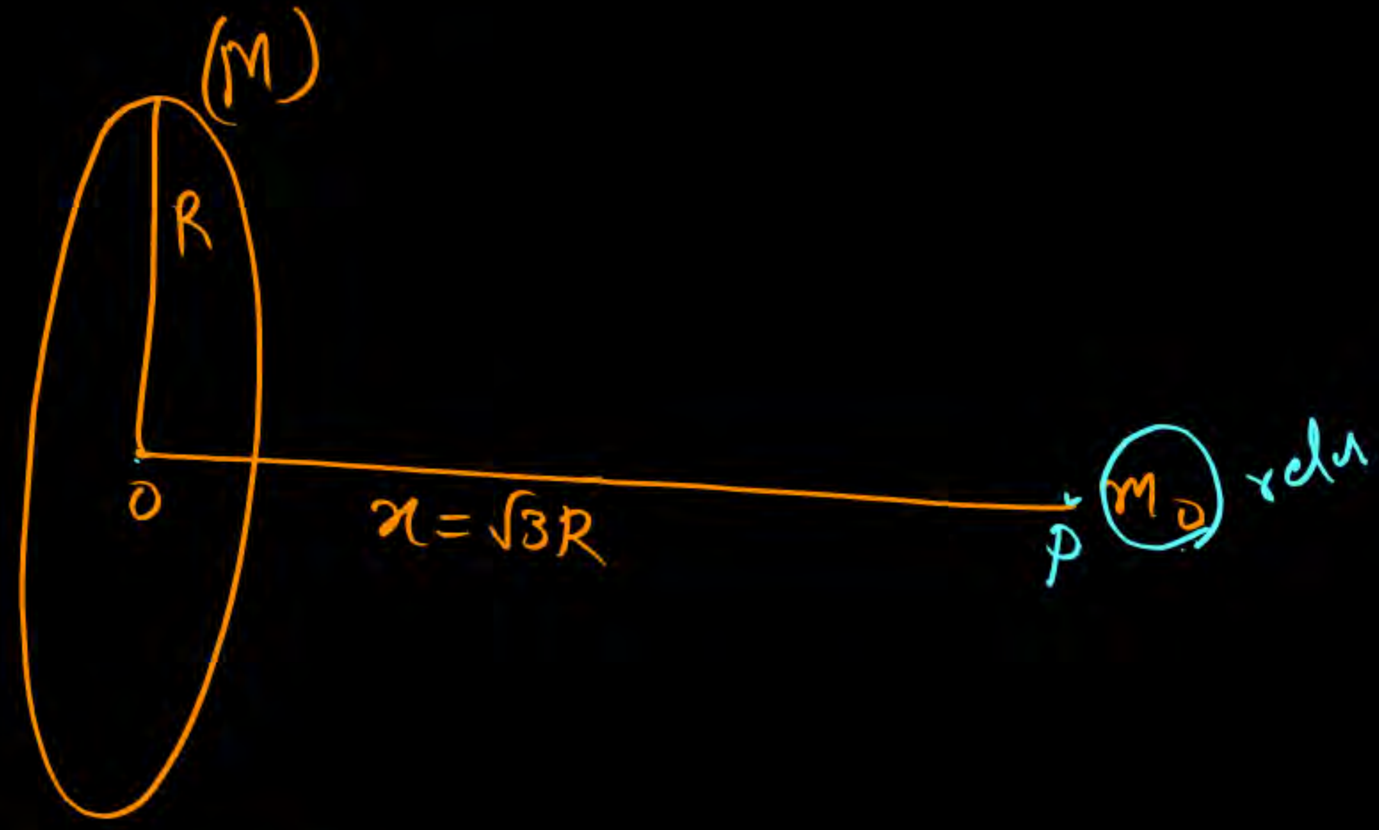
C.O.M.E

$$(K.E+U)_{\infty} = (K.E+U)_{at\ surf}$$

$$[0+0] = \frac{1}{2}mv^2 - \frac{GMm}{R}$$

$$\frac{GMm}{R} = \frac{1}{2}mv^2$$

$$v = \sqrt{\frac{2GM}{R}}$$



Ring (M, R)

m_0 is relesed from Point (P) then find its speed at the centre of (Ring)$_0$

Sol^n

C.O.M.E

$$(K.E + U)_P = (K.E + U)_{\text{centre of Ring}}$$

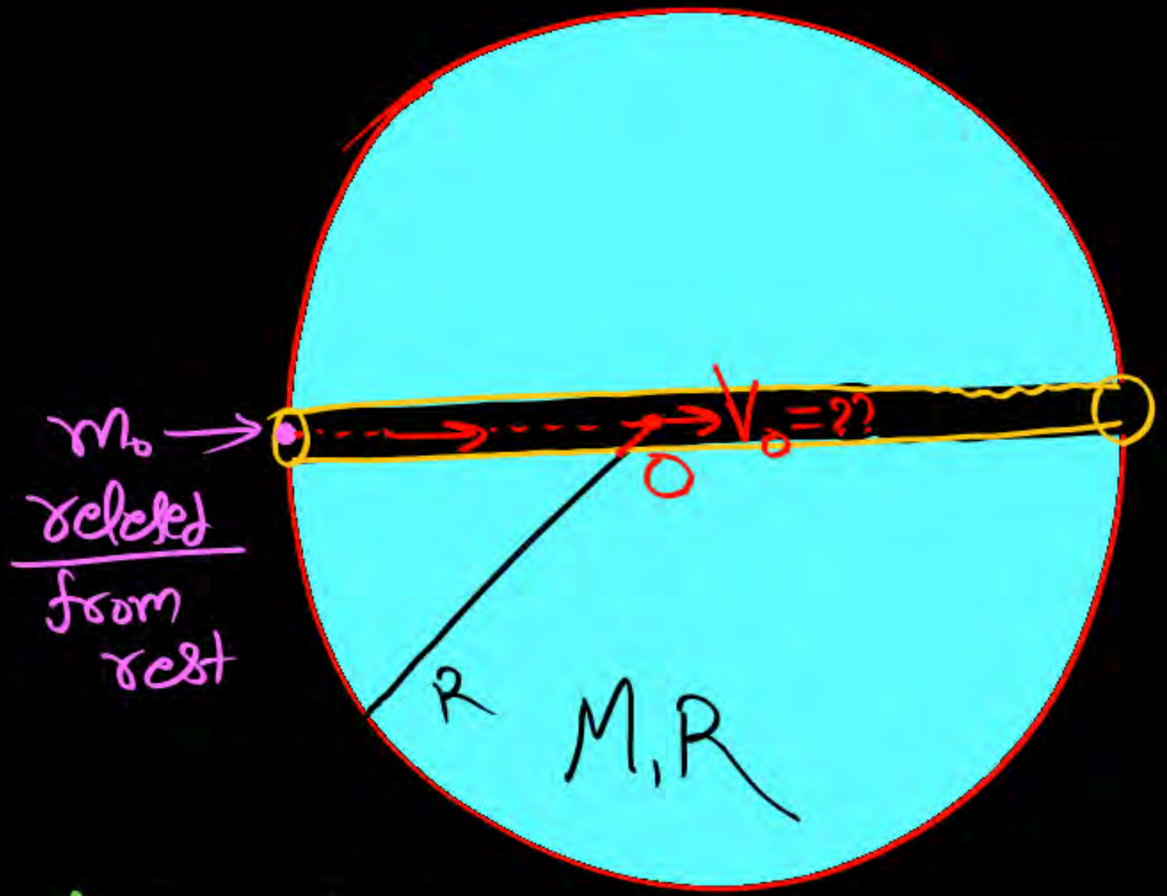
$$0 - \frac{GMm_0}{\sqrt{R^2 + (\sqrt{3}R)^2}} = \frac{1}{2}m_0 v^2 - \frac{GMm_0}{R}$$

$$-\frac{GMm_0}{2R} = \frac{1}{2}m_0 v^2 - \frac{GMm_0}{R}$$

$$\frac{GM}{R} - \frac{GM}{2R} = \frac{1}{2}v^2$$

$$\frac{GM}{2R} = \frac{1}{2}v^2$$

$$v = \sqrt{\frac{GM}{R}}$$



A small point mass m_0 is released from surface of earth as shown in fig. then find its speed at centre of earth ??

C.O.M.E

$$(K.E + U)_{surface} = (K.E + U)_{centre}$$

$$0 - \frac{GMm_0}{R} = -\frac{3GMm_0}{2R} + \frac{1}{2}m_0v^2$$

Solve it . . .

(escape velociti) कहाँ निकाला

(infinity)

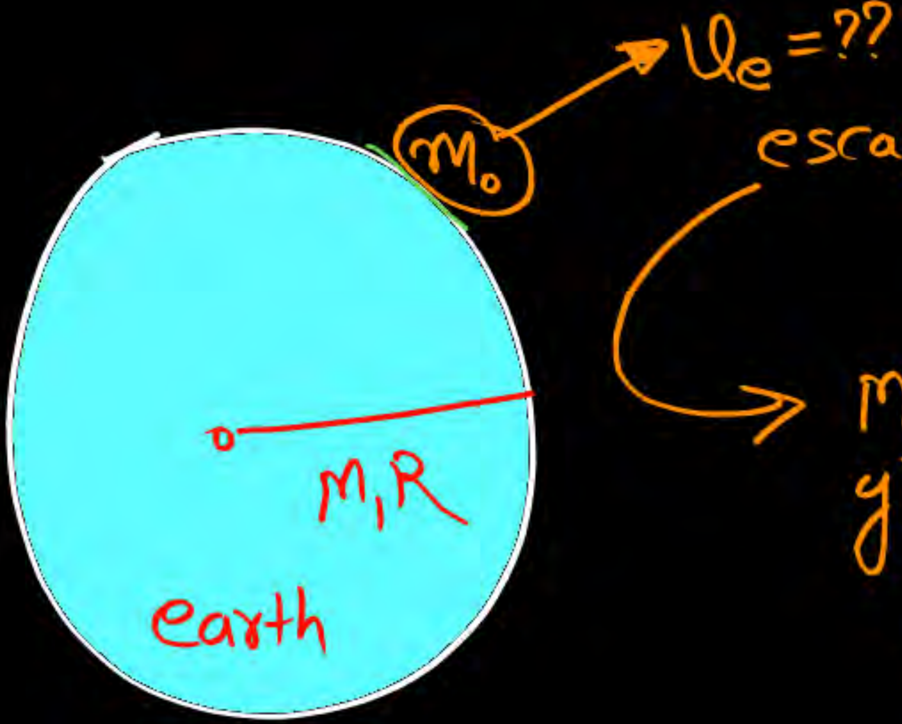
$m_o \rightarrow V = 0$ (let)

(COME)

$(K.E + U)_{initial} = (K.E + U)_{final}$ at infi

$$\frac{1}{2} m_o v_e^2 - \frac{G M m_o}{R} = 0 + 0$$

at earth   at infy



escape velocity → Minimum required velocity given to object so that it Just escape the gravitational field of earth.

$$\frac{1}{2} m_o v_e^2 = \frac{G M m_o}{R}$$

$$v_e = \sqrt{\frac{2GM}{R}}$$

(*) $$v_e = \sqrt{\frac{2GM}{R}} = \sqrt{2 g_o R}$$

$$v_e = \sqrt{\frac{2G}{R} \cdot \frac{4}{3}\pi R^3 \rho}$$

$$v_e = \sqrt{\frac{8}{3} G \pi \rho R^2}$$

Total M.E. given to the object so that it scape the gravitation field of earth = 0

$$v_e = \sqrt{\frac{2GM}{R}} = 11.2\ \text{km/sec}$$

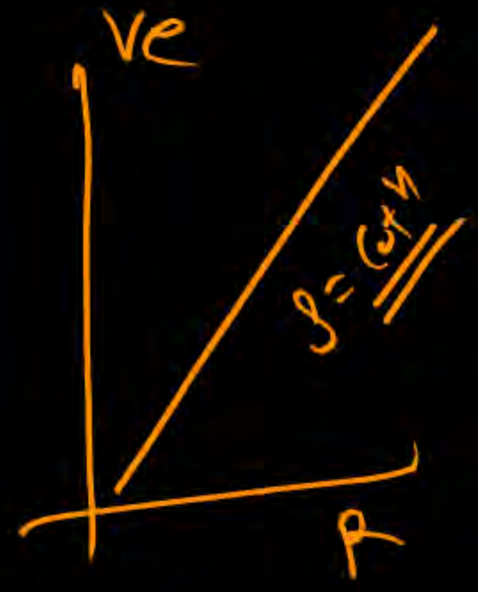
→ does not depend on Mass of object.

→ does not depend on angle of project

$$v_e = \sqrt{\frac{2GM}{R}} \propto \frac{1}{\sqrt{R}}$$

$$v_e = \sqrt{\frac{8}{3}G\pi\rho R^2} \propto R$$





ESCAPE VELOCITY

- Depends upon mass of planet and radius.
- Does not depends upon mass of object and angle of projection.

$v_e \propto m^\circ$

$ve \propto \theta^\circ$

QUESTION

The total mechanical energy of an object of mass m projected from surface of earth with escape speed is

1. Zero
2. Infinite
3. $-\frac{GMm}{2R}$
4. $-\frac{GMm}{3R}$

If given velocity $V_0 > V_e$



[C.O.M.E] surface & infinity

$$\frac{1}{2}m_0 V_0^2 - \frac{GMm_0}{R} = \frac{1}{2}m_0 V_\alpha^2 + 0$$

$$\frac{V_0^2}{2} - \frac{2GM}{2R} = \frac{1}{2}V_\alpha^2$$

$$V_0^2 - \frac{2GM}{R} = V_\alpha^2$$

$$V_0^2 - V_e^2 = V_\alpha^2$$

$$V_\alpha = \sqrt{V_{giv}^2 - V_e^2}$$

MR Ratta

If given veloci $V_g < V_e$

object will return back from some Height



(C.O.M.E) B/w surface to Height

$$\frac{1}{2}m_0 V_g^2 - \frac{GMm_0}{R} = 0 - \frac{GMm_0}{R+H}$$

$$\frac{V_g^2}{2} - \frac{GM}{R} = -\frac{GM}{R+H}$$

$$V_g^2 - \frac{2GM}{R} = -\frac{2GM}{(R+H)}$$

or

$$V_g^2 - V_e^2 = \frac{-2GM}{(R+H)}$$

solve it

solve & prove it

$$H = \frac{R}{\left[\frac{V_e^2}{V_g^2} - 1\right]}$$

dimn correct

MP: $V_e = V_g$

$H = \infty$

$$H = \frac{R}{\left(\frac{V_e^2}{V_g^2} - 1\right)}$$

Only valid when $V_g < V_e$

$$H = \frac{R}{\left(\frac{V_g^2}{V_e^2} - 1\right)}$$

H will be -ve

QUESTION

The escape velocity of a body from earth is about 11.2 km/s. Assuming the mass and radius of the earth to be about 81 and 4 times the mass and radius of the moon, the escape velocity in km/s from the surface of the moon will be

1. 0.54
2. 2.48
3. 11
4. 49.5

QUESTION

If M is mass of planet and R is its radius then in order to become black hole [c is speed of light]]

(1) $\sqrt{\frac{GM}{R}} \leq c$

(2) $\sqrt{\frac{GM}{2R}} \geq c$

(3) $\sqrt{\frac{2GM}{R}} \geq c$

(4) $\sqrt{\frac{2GM}{R}} \leq c$

QUESTION

The atmosphere on a planet is possible only if [where v_{rms} is root mean square speed of gas molecules on planet and v_e is escape speed on its surface]

1. $v_{rms} = v_e$
2. $v_{rms} > v_e$
3. $v_{rms} \leq v_e$
4. $v_{rms} < v_e$

QUESTION

A body of projected vertically upwards with a speed of $\sqrt{\frac{GM}{R}}$ [M is mass and R is radius of earth.]. The body will attain a height of

1. $\frac{R}{2}$
2. R
3. $\frac{5}{4}R$
4. $\frac{3R}{2}$

$v_y < v_e$

$H = \frac{R}{\frac{v_e^2}{v_y^2} - 1}$

QUESTION

A body is throw with a velocity equal to n times the escape velocity (v_e). Velocity of the body at a large distance away will be

1. $v_e\sqrt{n^2 - 1}$
2. $v_e\sqrt{n^2 \mp 1}$
3. $v_e\sqrt{1 - n^2}$
4. None of these

QUESTION

If gravitational field intensity is E at distance $R/2$ outside from then surface of a thin shell of radius R, the gravitational field intensity at distance $R/2$ from its center is

[NEET 2018]

1. Zero
2. $2E$
3. $\frac{2E}{3}$
4. $\frac{3E}{2}$

QUESTION

The ratio of escape velocity at earth (v_e) to the escape velocity at a planet (v_p) whose radius and mean density are twice as that of earth is

(1) $1 : \sqrt{2}$

(2) $1 : 2$

(3) $1 : 2\sqrt{2}$

(4) $1 : 4$

QUESTION

The radius of a planet is twice the radius of earth. Both have almost equal average mass-densities. V_P and V_E are escape velocities of the planet and the earth, respectively, then [Karnataka NEET 2013]

1. $V_P = 1.5\ V_E$
2. $V_P = 2\ V_E$
3. $V_E = 3\ V_P$
4. $V_E = 1.5\ V_P$

QUESTION

If an object is projected vertically upwards with speed, half the escape speed of earth, then the maximum height attained by it is [R is radius of earth]

1. R
2. $R/2$
3. $2R$
4. $R/3$

QUESTION

Let escape velocity of a body kept at surface of a planet is u. If it is projected at a speed of 200% more than the escape speed, then its speed in interstellar space will be

1. u
2. $\sqrt{3}u$
3. $2u$
4. $2\sqrt{2}u$

QUESTION

What should be the angular speed with which the earth have to rotate on its axis so that a person on the equator would weigh $\frac{3}{5}$ th as much as present?

1. $\sqrt{\frac{2g}{5R}}$
2. $\sqrt{\frac{2R}{5g}}$
3. $\frac{2\sqrt{R}}{\sqrt{5g}}$
4. $\frac{2g}{5R}$

QUESTION

A particle is projected vertically up with velocity $v = \sqrt{\frac{4gR_e}{3}}$ from earth surface. The velocity of particle at height equal to half of the maximum height reached by it

(1) $\sqrt{\frac{gR_e}{2}}$

(2) $\sqrt{\frac{gR_e}{3}}$

(3) $\sqrt{gR_e}$

(4) $\sqrt{\frac{2gR_e}{3}}$

H/W


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 06 | Physics

Gravitation

By- Dr. Manish Raj (MR SIR)



Topics to be covered

1 # Koin Baneya Dr.... (KBD)

2 # Keplers Law → 1. Law of orbit
2. law of Area
3, law of time period.

3 # Statellite motion.

4 #



solid → 1 question

K.B.D.

QUESTION

1. If gravitational field intensity is E at distance $R/2$ outside from then surface of a thin shell of radius R, the gravitational field intensity at distance $R/2$ from its center is

[NEET 2018]

(1) Zero (77%)

(2) $2E$

(3) $\frac{2E}{3}$

(4) $\frac{3E}{2}$



$E = \left(\frac{GM}{\frac{3R}{2}}\right)$

$I_{insire} = 0$

QUESTION

2.

The ratio of escape velocity at earth (v_e) to the escape velocity at a planet (v_p) whose radius and mean density are twice as that of earth is

(1) $1 : \sqrt{2}$

(2) $1 : 2$

(3) $1 : 2\sqrt{2}$

(4) $1 : 4$

$\frac{V_e}{V_p} = ??$

$V_e = \sqrt{\frac{2GM}{R}} = \sqrt{\frac{8}{3}G\pi\rho R^2}$

M = Not given in question.

$R_p = 2R_e$

$\rho_p = 2\rho_e$

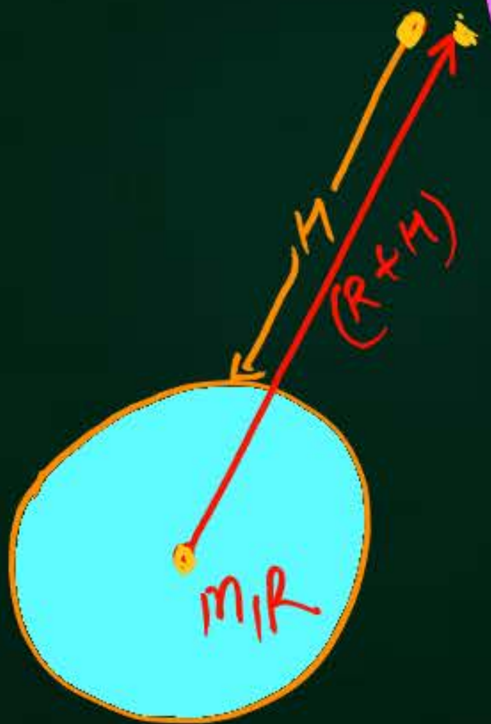
$V_e \propto R\sqrt{\rho}$

QUESTION

At what height from the surface of earth the gravitation potential and the value of g are $-5.4 \times 10^7\ kg^{-1}$ and $6.0\ ms^{-2}$ respectively? Take the radius of earth as 6400 km

[NEET 2016]

1. 2000 km
2. 2600 km ✓
3. 1600 km
4. 1400 km



$V = \frac{-GM}{(R+H)}$

$g_h = \frac{GM}{(R+H)^2}$

$g_h = \frac{GM}{(R+H)(R+H)}$

$g_h = \frac{-V}{(R+H)}$

$6 = \frac{5.4 \times 10^7}{(R+H)}$

$R+H = 0.9 \times 10^7\ m$

$6400\ km + H = 0.9 \times 10^4 \times 10^3\ m$

$6400\ km + H = 9000\ km$

$H = 9000\ km - 6400$

$= 2600\ km$

QUESTION

The radius of a planet is twice the radius of earth. Both have almost equal average mass-densities. V_P and V_E are escape velocities of the planet and the earth, respectively, then **[Karnataka NEET 2013]**

1. $V_P = 1.5\, V_E$
2. $V_P = 2\, V_E$ ✓ 87%
3. $V_E = 3\, V_P$
4. $V_E = 1.5\, V_P$

$R_p = 2 R_e$

$V_e = \sqrt{\frac{8}{3}\pi G \rho R^2} \propto R$ (const)

$\frac{V_e}{V_p} = \frac{R_e}{R_p} = \frac{R_e}{2R_e}$

$2V_e = V_p$

$v_e = \sqrt{\frac{GM}{R^2}}$

QUESTION

gravity free space. *
gravitational free space *

Two astronauts are floating in gravitational free space after having lost contact with their spaceship. The two will [NEET 2017]

No gravitational force will act.

1. Move towards each other (24%)
2. Move away from each other
3. Will become stationary
4. Keep floating at the same distance between them. (Ans) (64%)

(gravity free space)
Nota to ans (a)

QUESTION

98%

The atmosphere on a planet is possible only if [where v_{rms} is root mean square speed of gas molecules on planet and v_e is escape speed on its surface]

1. $v_{rms} = v_e$
2. $v_{rms} > v_e$
3. $v_{rms} \leq v_e$
4. $v_{rms} < v_e$

Ans

$v_e > v_{r.m.s}$ → on earth

$V_{r.m.s}$ of molecule $\geq v_e$ (moon) → for moon.

Black hole

light ka Project



QUESTION

If M is mass of planet and R is its radius then in order to become black hole [c is speed of light]]

1. $\sqrt{\frac{GM}{R}} \leq c$
2. $\sqrt{\frac{GM}{2R}} \geq c$
3. $\sqrt{\frac{2GM}{R}} \geq c$
4. $\sqrt{\frac{2GM}{R}} \leq c$

for Black hole.

$V_e \geq C$

$\sqrt{\frac{2GM}{R}} \geq C$

$E = PC$

$E = MC^2$

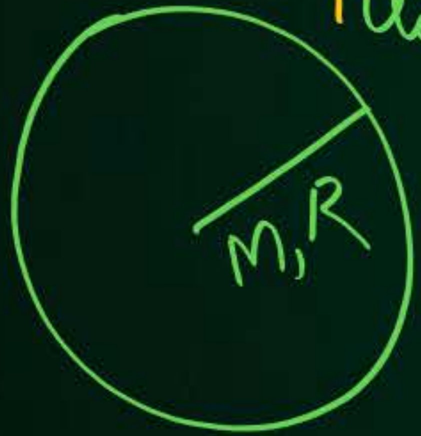
$M = \frac{E}{C^2}$

(Mass of Photon)

QUESTION

A black hole is an object whose gravitational field is so strong that even light cannot escape from it. To what approximate radius would earth (mass = 5.98×10^{24} kg) have to be compressed to be a black hole? [AIPMT 2014]

1. 10^{-9} m
2. 10^{-6} m
3. 10^{-2} m
4. 100 m



$v_e = \sqrt{\frac{2GM}{R}} = c$

$\sqrt{\frac{2GM}{R}} = c$

$\frac{2 \times 6.67 \times 10^{-11} \times 6 \times 10^{24}}{R} = 9 \times 10^{16}$

$R = \frac{4 \times 6.67 \times 10^{-3}}{3}$

$= 8 \times 10^{-3} = 10^{-2}$ m $= 1$ cm

QUESTION

If an object is projected vertically upwards with speed, half the escape speed of earth, then the maximum height attained by it is [R is radius of earth]

1. R
2. $R/2$
3. $2R$
4. $R/3$ ✓

case-1

$u_{give} = v_e$

esape to infinity

case-2

$v_{y_{men}} > v_e$

$v_\alpha = \sqrt{v_g^2 - v_e^2}$

case

$u_{g} < v_e$

$$H = \frac{R}{\left(\frac{v_e^2}{v_g^2}\right) - 1} = \frac{R}{\frac{v_e^2}{\left(\frac{v_e}{2}\right)^2} - 1}$$

$$H = \frac{R}{\frac{v_e^2}{v_e^2/4} - 1} = \frac{R}{3}$$

QUESTION

Let escape velocity of a body kept at surface of a planet is u. If it is projected at a speed of 200% more than the escape speed, then its speed in interstellar space will be

1. u
2. $\sqrt{3}u$
3. $2u$
4. $2\sqrt{2}u$

Ans

$v_g = v_e + 200\% \cdot v_e$

$= 300\% \cdot v_e$

$= \frac{300}{100} v_e$

$= 3v_e$

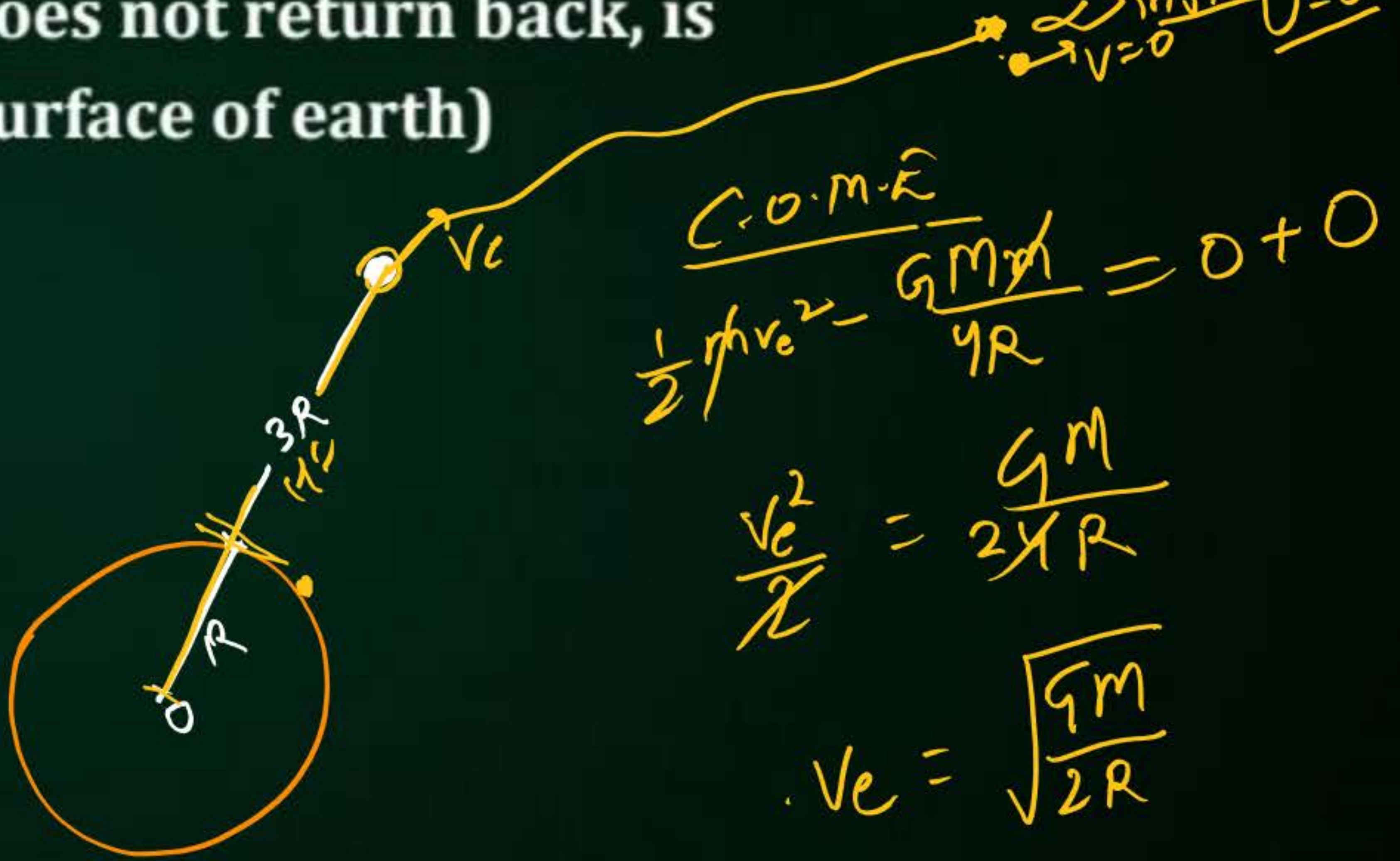
$v_L = \sqrt{v_g^2 - v_e^2}$

$= \sqrt{9v_e^2 - v_e^2} = v_e 2\sqrt{2}$

QUESTION

A particle of mass 'm' is kept at rest at a height $3R$ from the surface of earth, where 'R' is radius of earth and 'M' is mass of earth. The minimum speed with which it should be projected, so that it does not return back, is (g is acceleration due to gravity on the surface of earth)

1. $\left(\frac{GM}{R}\right)^{1/2}$
2. $\left(\frac{GM}{2R}\right)^{1/2}$
3. $\left(\frac{gM}{4}\right)^{1/2}$
4. $\left(\frac{2g}{R}\right)^{1/2}$



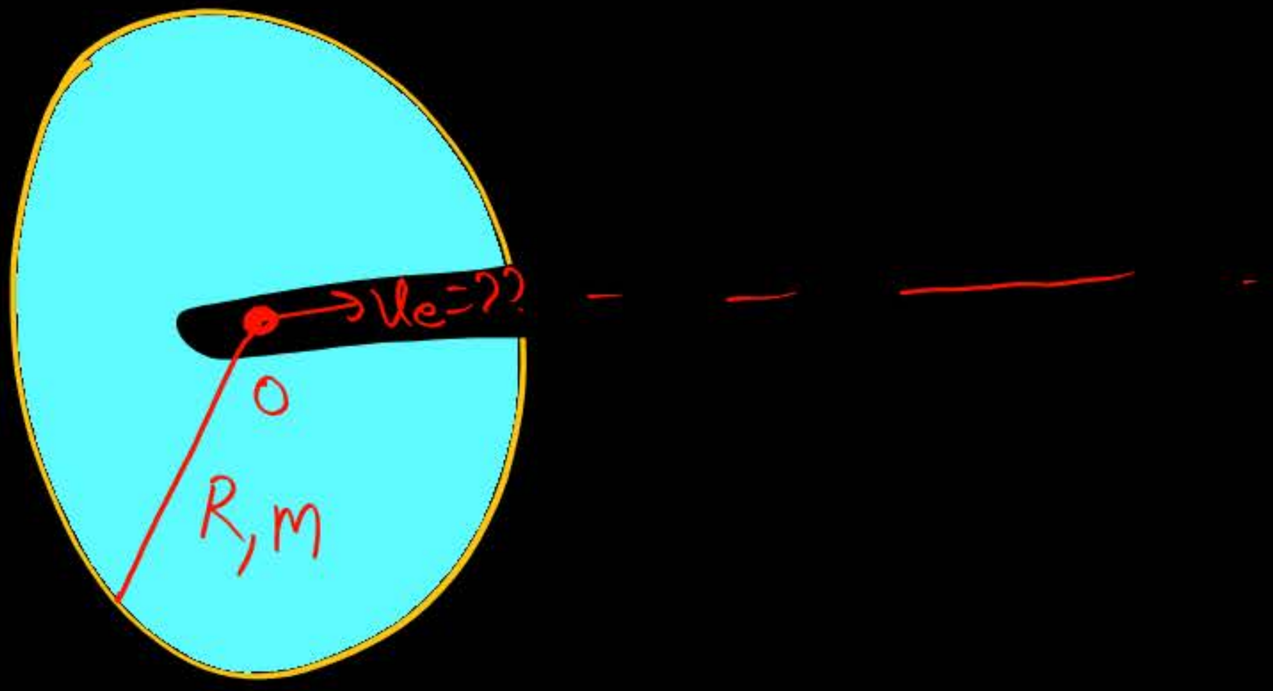
C.O.M.E

$\frac{1}{2} m v_e^2 - \frac{GMm}{4R} = 0 + 0$

$\frac{v_e^2}{2} = \frac{GM}{4R}$

$v_e = \sqrt{\frac{GM}{2R}}$

find scape velocity from centre of earth.



C.O.M.E

$$\frac{1}{2} m v_e^2 - \frac{3GMm}{2R} = 0 + 0$$

$$V_e = \sqrt{\frac{3GM}{R}}$$

QUESTION

Level up

What should be the angular speed with which the earth have to rotate on its axis so that a person on the equator would weigh $\frac{3}{5}$ th as much as present weight

1. $\sqrt{\frac{2g}{5R}}$ ✓
2. $\sqrt{\frac{2R}{5g}}$
3. $\frac{2\sqrt{R}}{\sqrt{5g}}$
4. $\frac{2g}{5R}$

appt weight $= \frac{3}{5}mg$



$mg' = mg_0 - m\omega^2 R$

$\frac{3}{5}mg = mg - m\omega^2 R$

$m\omega^2 R = mg\left(1 - \frac{3}{5}\right)$

$\omega^2 = \frac{g}{R}\left(\frac{2}{5}\right) \Rightarrow \omega = \sqrt{\frac{2g}{5R}}$

QUESTION

Three particles of masses $m, 2m$ and $3m$ are placed at the corners of an equilateral triangle of side a. Calculate:

(i) The potential energy of the system

(ii) The work done on the system if the side of the triangle is changed from a to $2a$. Assume the potential energy to be zero when the separation is infinity.



$$U = -\frac{G2m^2}{a} - \frac{G6m^2}{a} - \frac{G3m^2}{a}$$

$$U = -\frac{Gm^2}{a}(2+6+3)$$

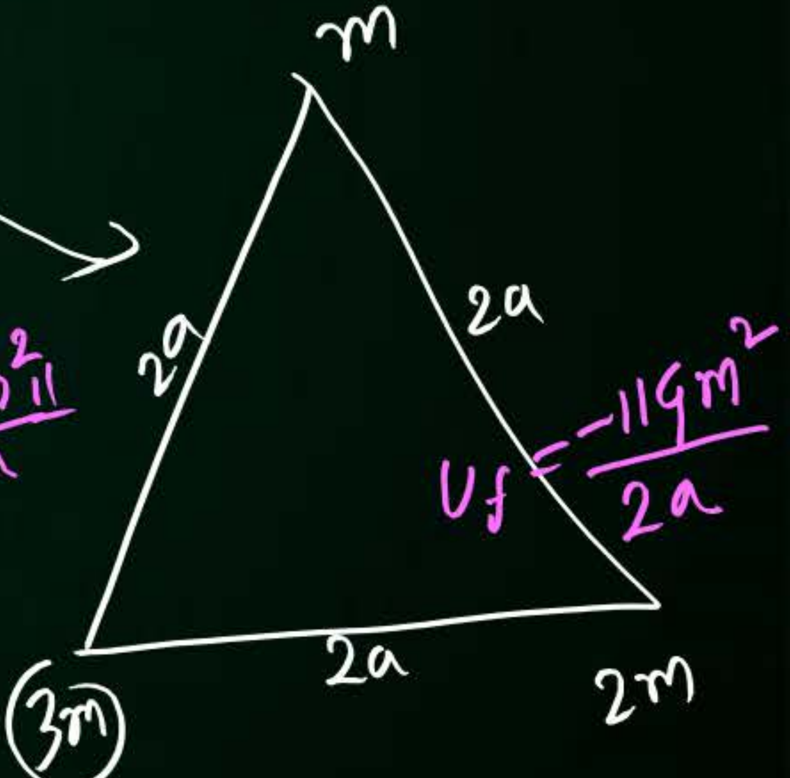
(a) $$U = \frac{-11Gm^2}{a}$$

$$W_{ext} = \Delta U$$

$$= U_f - U_i$$

$$= \frac{-11Gm^2}{2a} + \frac{Gm^2 11}{a}$$

$$W = \frac{11Gm^2}{2a}$$



$$U_f = \frac{-11Gm^2}{2a}$$

QUESTION

A particle is projected vertically up with velocity $v = \sqrt{\frac{4gR_e}{3}}$ from earth surface. The velocity of particle at height equal to half of the maximum height reached by it

1. $\sqrt{\frac{gR_e}{2}}$
2. $\sqrt{\frac{gR_e}{3}}$

$$\frac{4gR}{3} - \frac{2Gm}{R} + \frac{Gm}{R} = v^2$$

$$\frac{4gR}{3} - \frac{Gm}{R} = v^2$$

$$\frac{4gR}{3} - gR = v^2$$

$$= \frac{gR}{3} = v^2$$

$$\boxed{v = \sqrt{gR/3}}$$

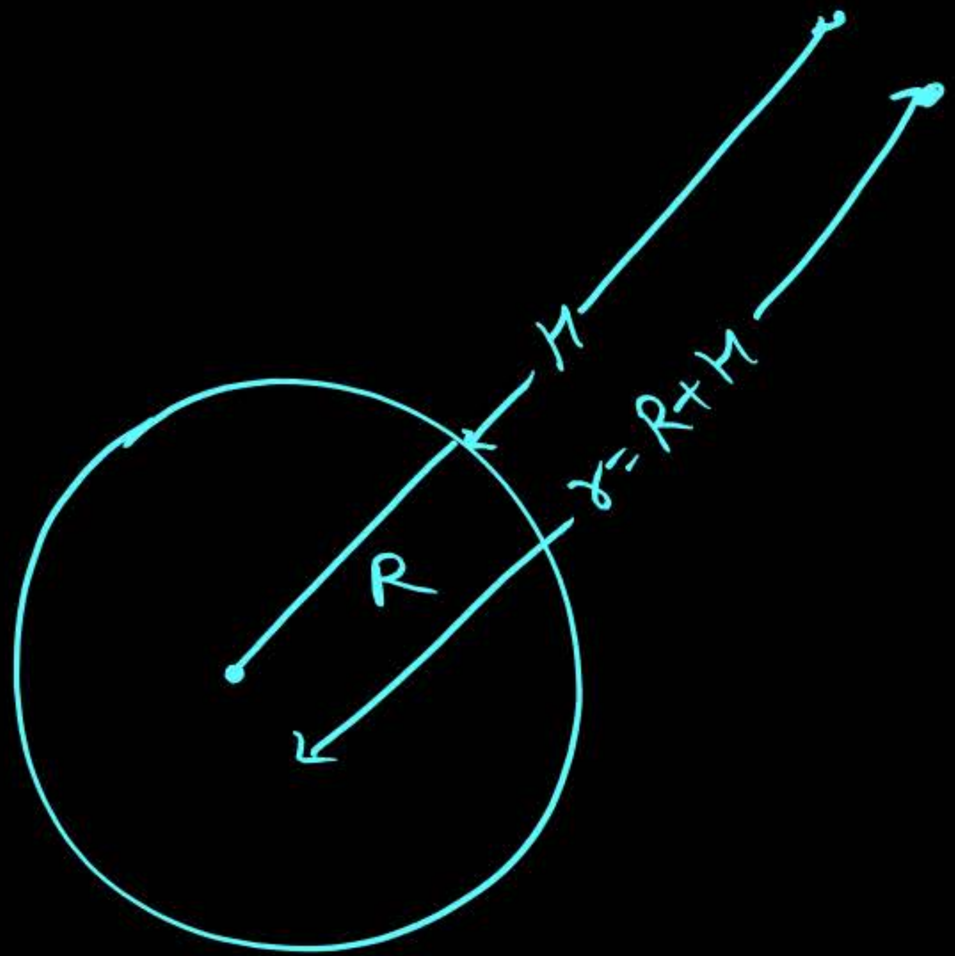
QUESTION

The escape velocity of a body from earth is about 11.2 km/s. Assuming the mass and radius of the earth to be about 81 and 4 times the mass and radius of the moon, the escape velocity in km/s from the surface of the moon will be

1. 0.54
2. 2.48
3. 11
4. 49.5

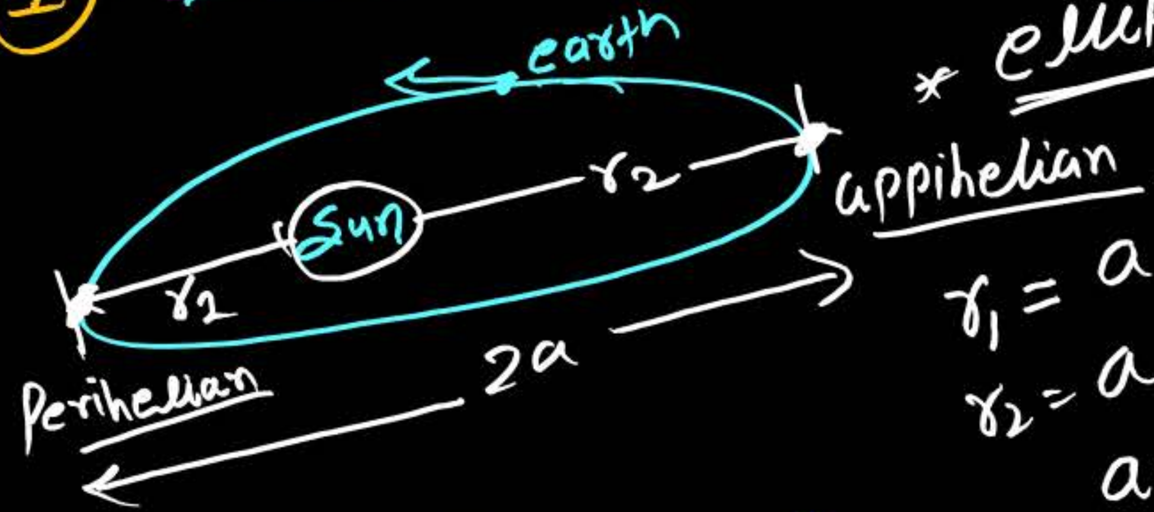
$$V_e = \sqrt{\frac{GM}{R}}$$

$$V_m = \sqrt{\frac{GM_m}{R_m}}$$



Kepler

① Law of orbit for the planet
Not for satellite.



* elliptical.

$r_1 = a(1-e)$

$r_2 = a(1+e)$

a = mean radi

e = eccentricity

② Law of Area.
planet sweeps equal area in equal intraval of time arnd sun

$$\left[\frac{dA}{dt} = \text{const}^n\right]$$

③ $T^2 \propto R^3$

KEPLER'S LAWS

The three basic laws of planetary motion given by Kepler can be stated as follows:

1. **Law of orbits :** All planets move in elliptical orbits, with the sun at the foci of the ellipse.

$$r_1 = a(1-e)$$

$$r_2 = a(1+e)$$

$$r_1 + r_2 = 2a$$

$$\frac{r_1}{r_2} = \frac{1-e}{1+e}$$

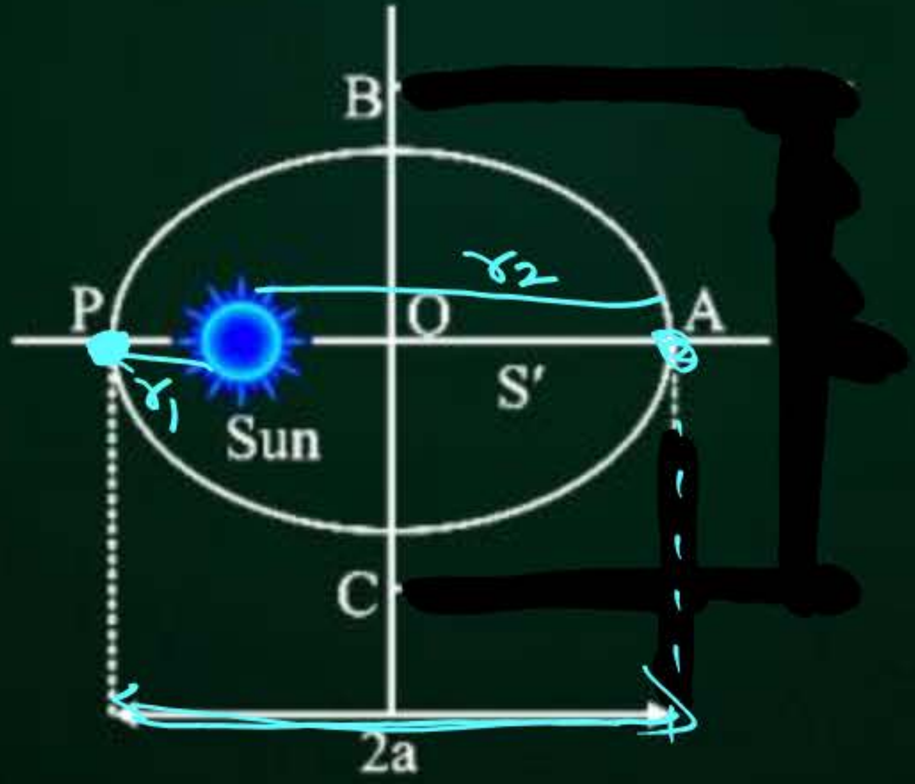


Fig.: An ellipse traced out by a planet around the sun. The closest point as P (Perihelion) and the farthest point is A (Aphelion).

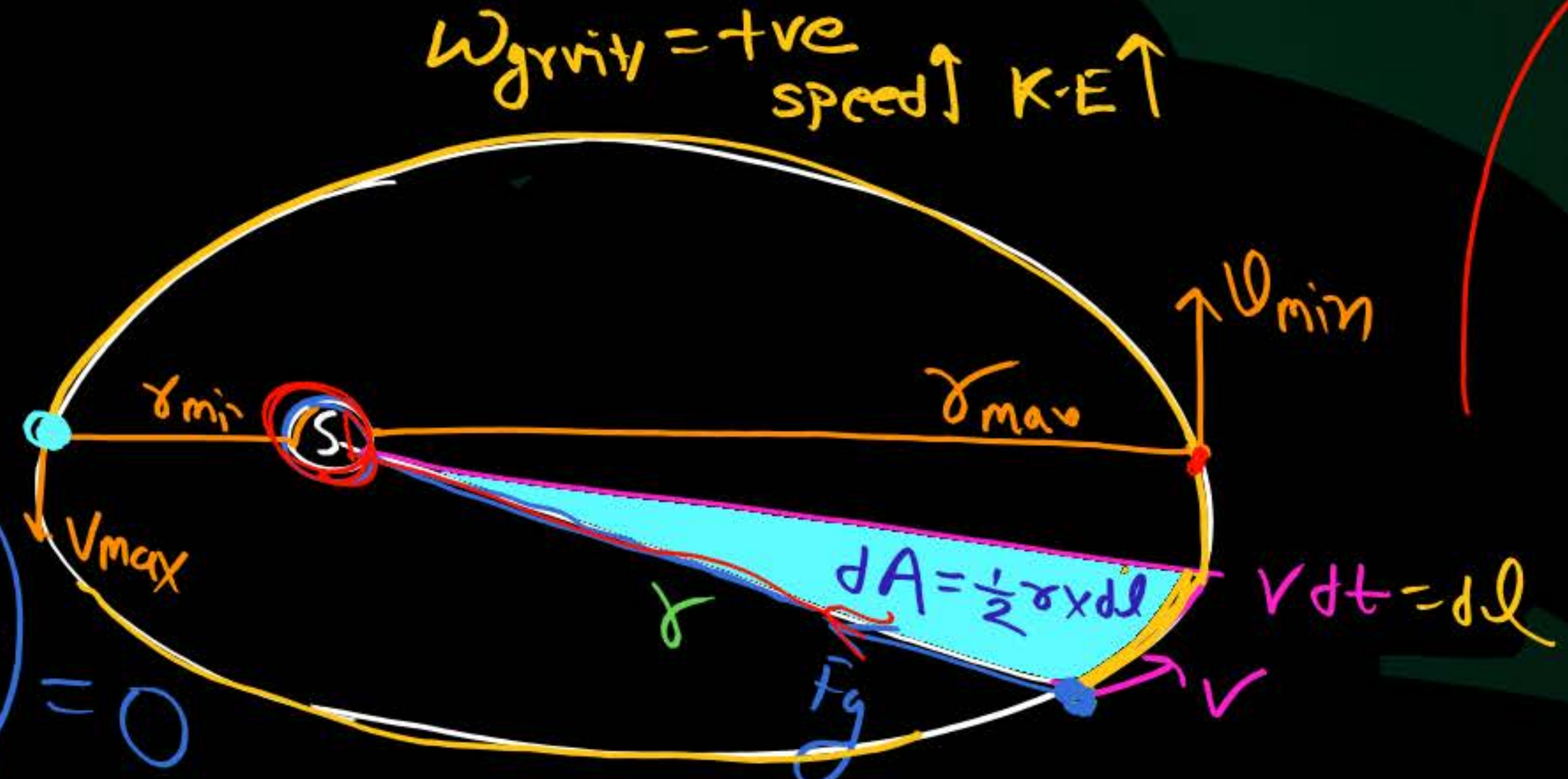
r = varible
$\vec{v}$ = varible
speed = varib
K.E = varble

work ≠ 0

$\frac{dA}{dt}$ = Cont^n

L = Cont^n rv = Cont^n

2. **Law of Areas :** The line that joins any planet to the sun sweeps out equal areas in equal intervals of time.



τ on planet due to sun about sun = 0

$\tau = \frac{dL}{dt} = 0$

L = Cont^n

$W_{total\ grav} = 0$

$dA = \frac{1}{2} \times r\,dl$

$dA = \frac{1}{2} r v\,dt$

$\left(\frac{dA}{dt}\right) = \frac{1}{2} r v$ = Cont^n.

Keppler Law

$\frac{1}{2} r v$ = Cont^n.

$r v$ = Cont^n

$\frac{mvr}{2m}$ = Cont^n → $\frac{\vec{L}}{2m}$ = Cont^n

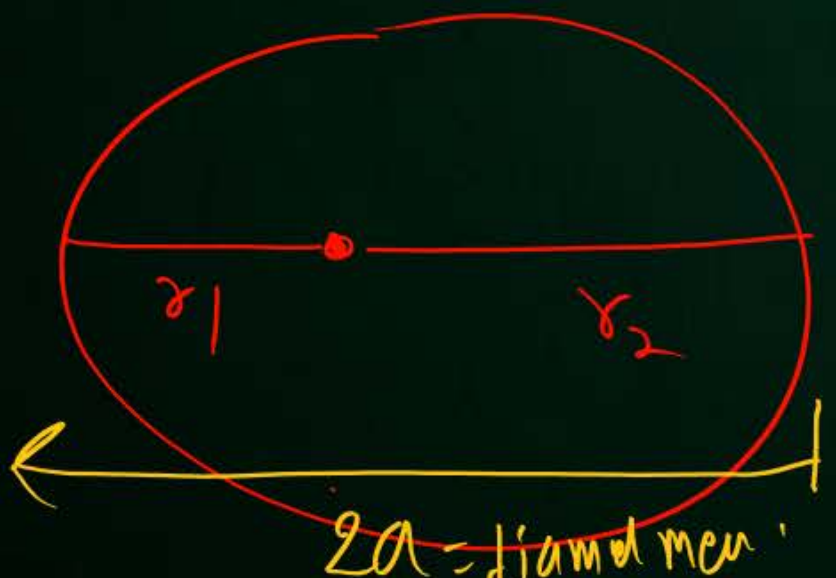
3. **Law of Periods :** The square of the time period of revolution of a planet is proportional to the cube of the semi-major axis of the ellipse traced out by the planet.

$$\boxed{T^2 \propto a^3}$$

a = mean radii

T = Time period of revolution of a planet.

a = Semi-major axis of the elliptical orbit traced out by the planet.



$$a_{Avg} = \frac{r_1 + r_2}{2}$$

$$T^2 \propto a^3 = \left(\frac{r_1 + r_2}{2}\right)^3$$

$$\boxed{T \propto (r_1 + r_2)^{3/2}}$$

QUESTION

The torque on a planet about the centre of sun is

1. Zero ✓
2. Negative
3. Positive
4. Depend on mass of planet

QUESTION

The kinetic energies of a planet in an elliptical orbit about the Sun, at positions A, B and C are K_A, K_B and K_C, respectively. AC is the major axis and SB is perpendicular to AC at the position of the sun S as shown in the figure. Then

1. $K_A < K_B < KC$
2. $K_A > KB > KC$
3. $K_B > KA > KC$
4. $K_B < K_A < K_C$



$Vr = const$

(speed) $\uparrow v \propto \frac{1}{r\downarrow}$

QUESTION

The time period of a geostationary satellite is 24 h, at a height 6R, where R is radius of earth) from surface of earth. The time period of another satellite whose height is 2.5R from surface will be

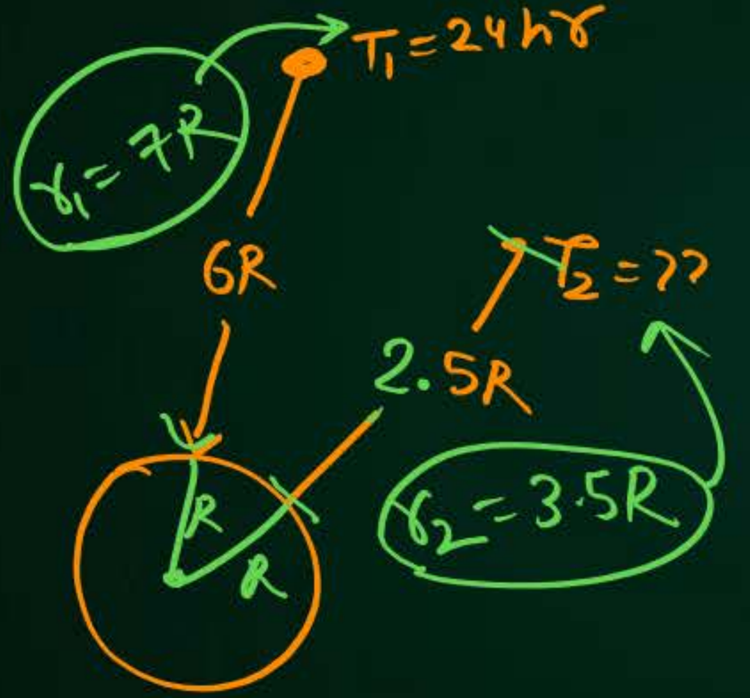
[NEET-2019 (Odisha)]

(1) $\frac{12}{2.5}h$

(2) $6\sqrt{2}h$

(3) $12\sqrt{2}h$

(4) $\frac{24}{2.5}h$



QUESTION

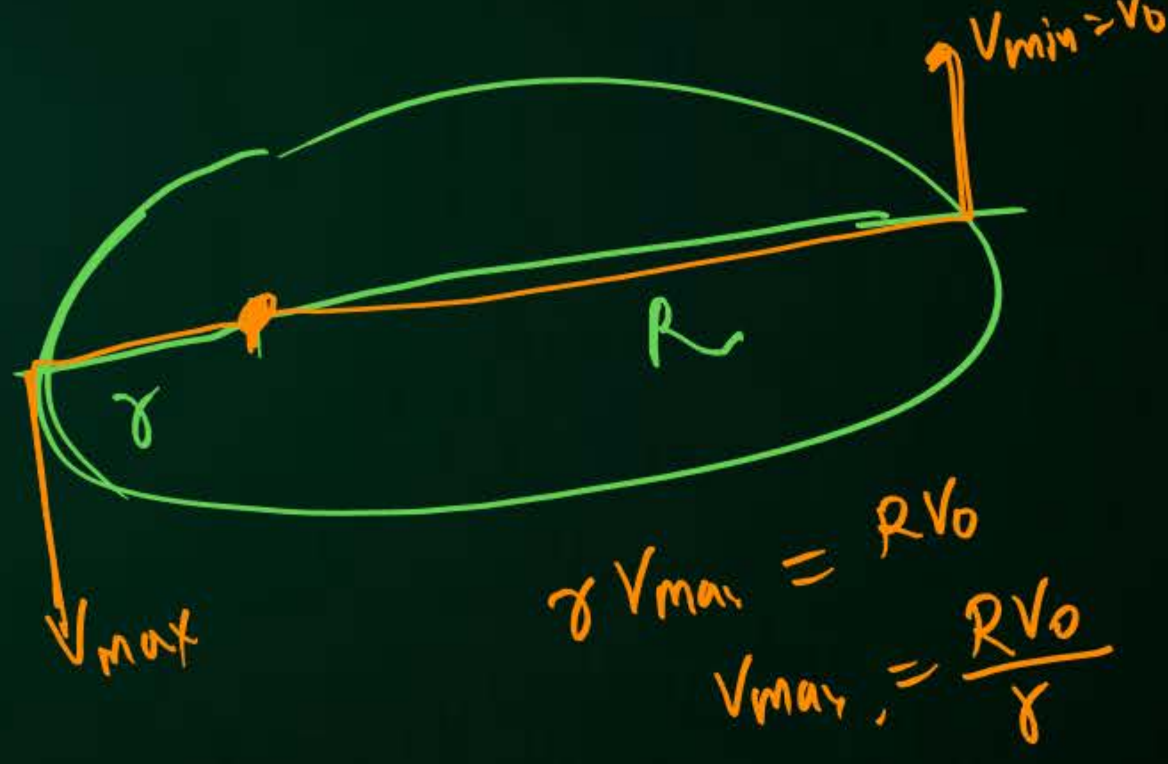
According to Kepler, planets move in

1. Circular orbits around the sun
2. Elliptical orbits around the sun with sun at exact centre
3. Straight lines with constant velocity
4. Elliptical orbits around the sun with sun at one of its foci

QUESTION

The minimum and maximum distances of a planet revolving around sun are r and R. If the minimum speed of planet on its trajectory is v_0, its maximum speed will be

1. $\frac{v_0 R}{r}$ ✓ 64%
2. $\frac{v_0 r}{R}$ 25%
3. $\frac{v_0 R^2}{r^2}$
4. $\frac{v_0 r^2}{R^2}$



QUESTION

A planet of mass m moves around the sun of mass M in an elliptical orbit. The maximum and minimum distances of the planet from the sun are r_1 and r_2 respectively. The time period of the planet is proportional to

1. $r_1^{3/2}$
2. $r_2^{3/2}$
3. $(r_1 + r_2)^{3/2}$
4. $(r_1 - r_2)^{3/2}$

$a = \frac{r_1 + r_2}{2}$



$T^2 \propto a^3$

$T^2 \propto \left(\frac{r_1 + r_2}{2}\right)^3$

$T^2 \propto (r_1 + r_2)^3$

$T \propto (r_1 + r_2)^{3/2}$

QUESTION

3rd Law same for satellite & planet $T^2 \propto R^3$

The time period of a satellite in a circular orbit of radius R is T. The period of another satellite in a circular orbit of radius 4R is

1. 4T
2. $\frac{T}{2}$
3. 8T ✓
4. $\frac{T}{8}$

$$\frac{T^2 \propto R^3}{T'^2 \propto 4R^3}$$

$$\frac{T^2}{T'^2} = \left(\frac{1}{4}\right)^3$$

$$\left(\frac{T}{T'}\right)^2 = \frac{1}{64}$$

$$\frac{T}{T'} = \frac{1}{\sqrt{64}} = \frac{1}{8}$$

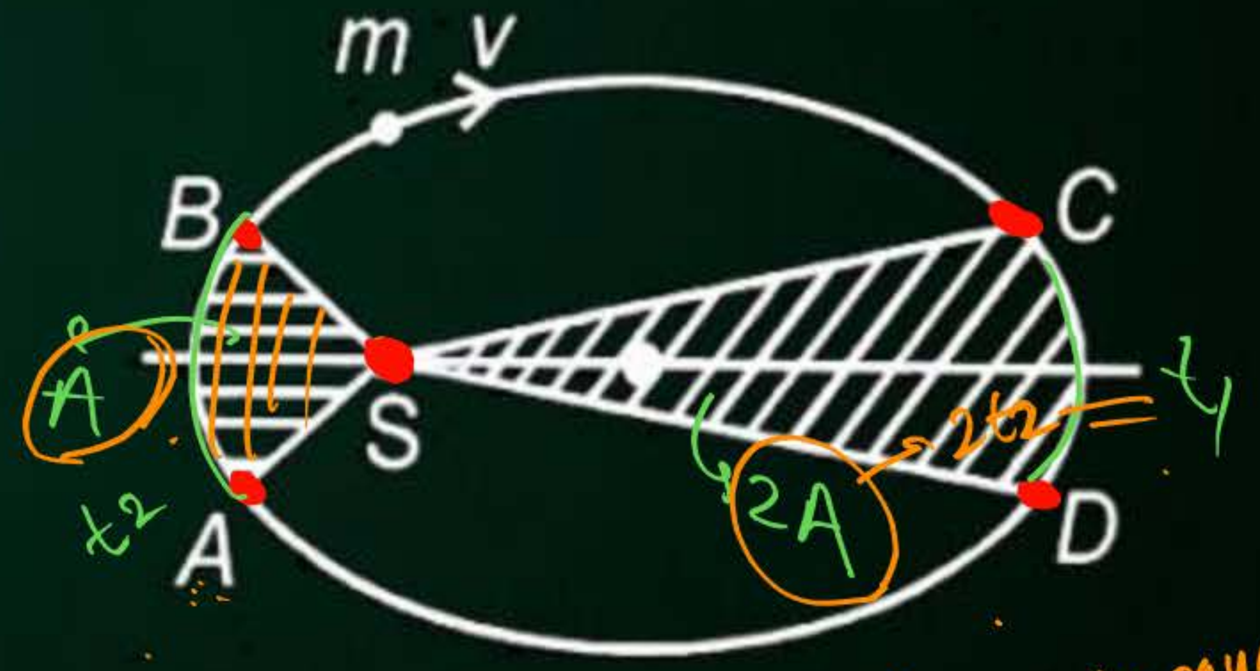
$$T' = 8T$$

QUESTION

The figure shows elliptical orbit of a planet m about the sun S. The shaded area SCD is twice the shaded area SAB. If t_1 is the time for the planet to move from C to D and t_2 is the time to move from A to B then

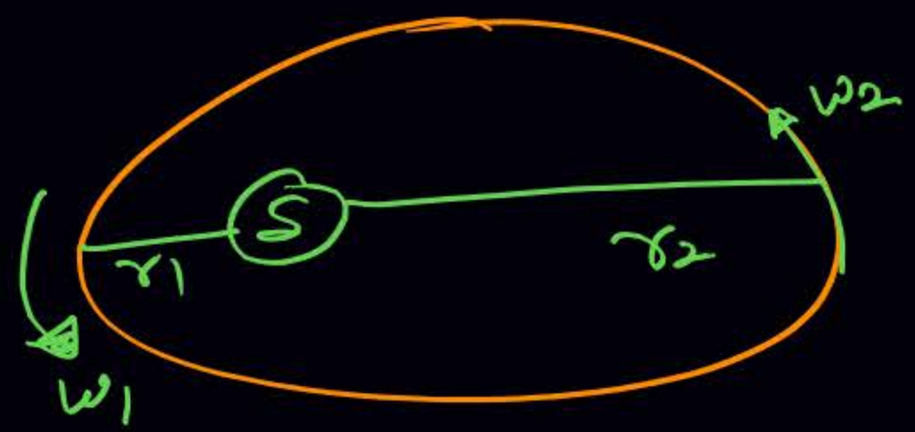
$2t_2 = t_1$

1. $t_1 = 4t_2$
2. $t_1 = 2t_2$
3. $t_1 = t_2$
4. $t_1 > t_2$



equal area in equal time intraval.

find ratio of Angular speed at r_1 & r_2.



$$vr = const^n.$$

$$v \propto \frac{1}{r}$$

$\boxed{\dfrac{v_1}{v_2} = \dfrac{r_2}{r_1}}$

Sol^n ⟹

$$rv = const^n$$

$$r(r\omega) = const.$$

$$r^2\omega = const^n$$

$$\omega \propto \frac{1}{r^2}$$

$$\frac{\omega_1}{\omega_2} = \left(\frac{r_2}{r_1}\right)^2$$

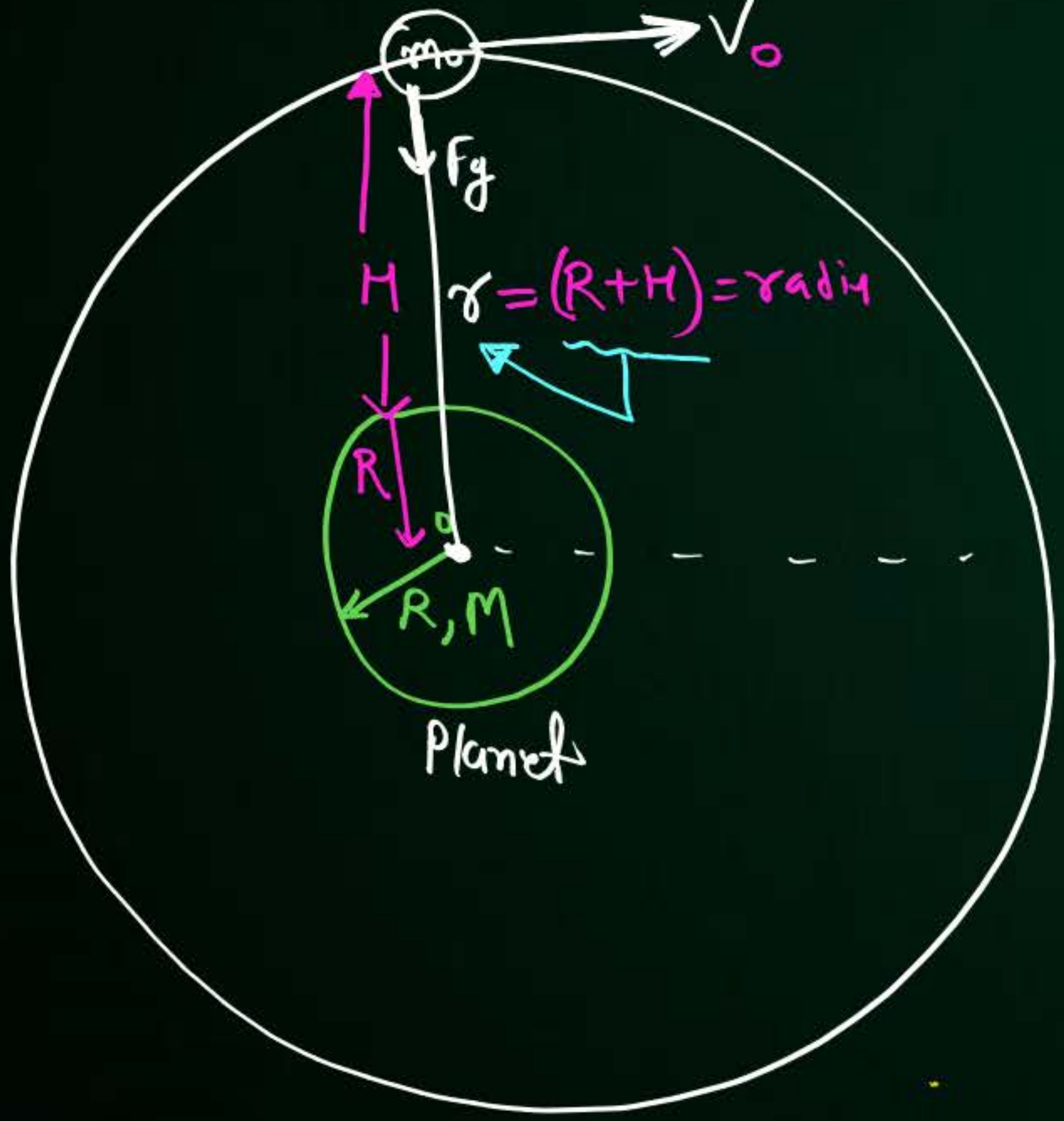
~~$\omega = rv$~~

$v = r\omega$ ✓

SATELLITE MOTION

Satellite

- **On the circular path**



$F_{gravitational}$ force b/w satellite & planet $= \frac{m v_0^2}{r}$

$$G\frac{M m_0}{(R+H)^2} = \frac{m_0 v_0^2}{(R+H)}$$

$$v_0^2 = \frac{GM}{(R+H)} = \frac{GM}{r}$$

$$V_0 = \sqrt{\frac{GM}{(R+H)}} = \sqrt{\frac{GM}{r}}$$

$$T = \frac{2\pi(R+H)}{V_0} = \frac{2\pi (R+H)}{\frac{(GM)^{1/2}}{(R+H)^{1/2}}}$$

- $T = \frac{2\pi}{\sqrt{GM}}(R+H)^{3/2}$

Square both side

$$T^2 = \frac{4\pi^2}{GM}(R+H)^3$$

$T^2 \propto r^3 \Rightarrow T^2 = K r^3$

Keplr Law

Keplr Const^n $K = \frac{4\pi^2}{GM}$

$$V_0 = \sqrt{\frac{GM}{(R+H)}} = \sqrt{\frac{gm}{r}}$$

r → radius of circular orbit.

Scape velocity from Height H

$$V_e = \sqrt{\frac{2gm}{(R+H)}}$$

$$V_0 = \sqrt{\frac{gm}{(R+H)}}$$

If Satellite is revolving vary near to earth surface

$(H = 0)$

orbital velocity

$$V_0 = \sqrt{\frac{gm}{R}}$$

② $$V_e = \sqrt{\frac{2gm}{R}}$$

$$V_e = \sqrt{2}\sqrt{\frac{gm}{R}}$$

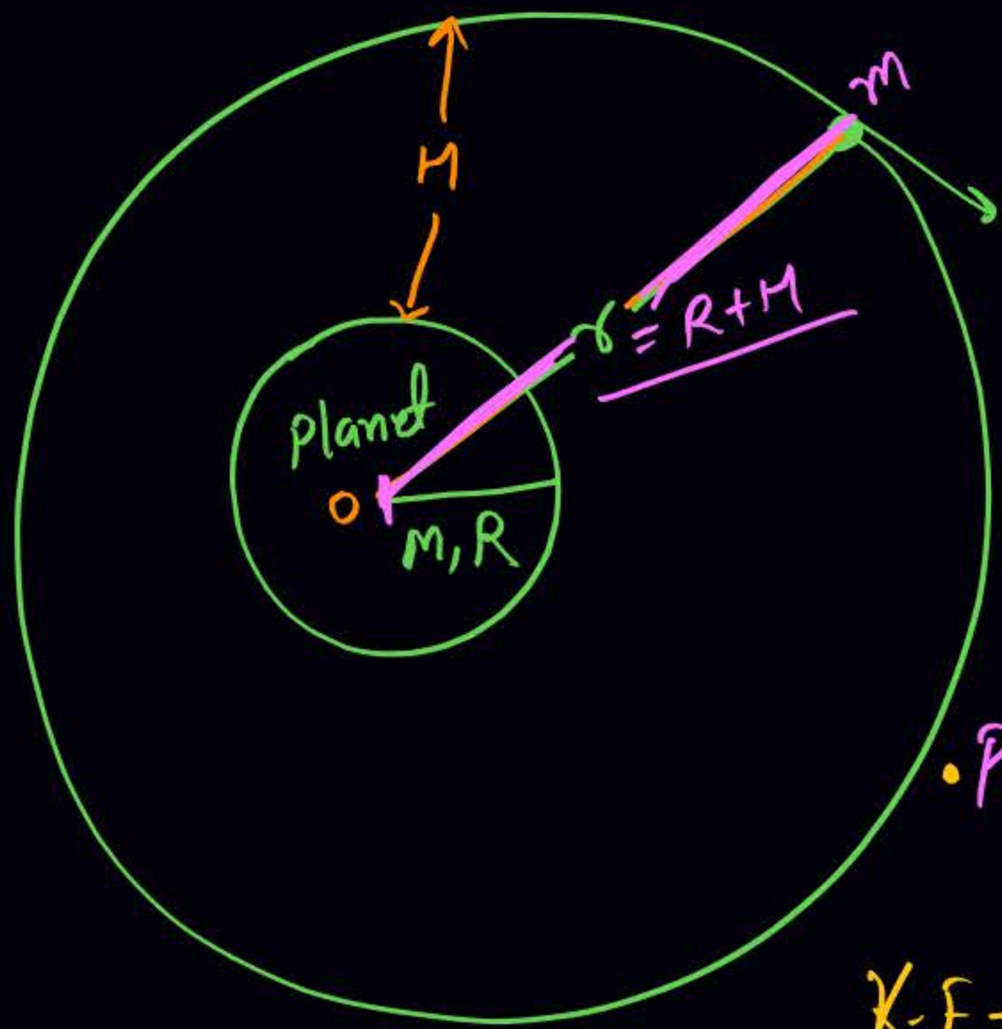
$$V_e = \sqrt{2}\, V_0$$

$$V_e > V_0$$

$$V_e = 1.41\, V_0$$

Scape velocity is 41% more than orbital velocity.

Energy of satellite



$$V_0 = \sqrt{\frac{GM}{r}} = \sqrt{\frac{GM}{(R+H)}}$$

• $P.E = -\frac{GMm}{(R+H)}$

$K.E = \frac{1}{2} m V_0^2$

$K.E = \frac{1}{2} m \frac{GM}{(R+H)}$

• $K.E = \frac{GMm}{2(R+H)}$

$K.E = \frac{GMm}{2(R+H)}$ $\quad P.E = -\frac{GMm}{(R+H)}$

$$\boxed{K.E = -\frac{P.E}{2}} \Leftarrow \boxed{K.E = \frac{|P.E|}{2}}$$

$T.E. (M.E.) = K.E + P.E$

$= -\frac{P.E}{2} + P.E$

$$\boxed{T.E = \frac{P.E}{2} = -K.E}$$

$$\boxed{T.E = \frac{-GMm}{2(R+H)}}$$

$$P.E = -\frac{GMm}{(R+H)}$$

$$T.E = \frac{P.E}{2} = -\frac{GMm}{2(R+H)}$$

$$K.E = |T.E| = \frac{GMm}{2(R+H)}$$

$$K.E : T.E = P.E = 1 : -1 : -2$$

Ans

$$K.E : P.E = 1 : -2$$

$$K.E : T.E = 1 : -1$$

$$K.E : |T.E| = 1 : 1$$

Topic is repeted

Binding energy of salerlite

$$B \cdot E = |T \cdot E|$$

QUESTION

A satellite A of mass m is at a distance of r from the center of the earth. Another satellite B of mass $2m$ is at a distance of $2r$ from the earth's center. Their time periods are in the ratio of [1993]

1. $1:2$
2. $1:16$
3. $1:32$
4. $1:2\sqrt{2}$

$$\frac{T_A^2}{T_B^2} = \left(\frac{r}{2r}\right)^3$$

$$\frac{T_A}{T_B} = \left(\frac{1}{8}\right)^{1/2}$$

$$\frac{T_A}{T_B} = \frac{1}{2\sqrt{2}}$$

QUESTION

If a satellite of mass 400 kg revolves around the earth in an orbit with speed 200 m/s then its potential energy is

1. −1.2 MJ
2. −8.0 MJ
3. −16 MJ
4. −2.4 MJ

$K.E = \frac{1}{2}mv^2$

$= \frac{1}{2} \times 400 \times (200)^2$

$= 200 \times 200 \times 200$

$K.E = 8 \times 10^6 \text{ J}$

$P.E = -2K.E$

$= -16 \times 10^6 \text{ J}$

QUESTION

An artificial satellite revolves around a planet for which gravitational force (F) varies with distance r from its center as $F \propto r^2$. If v_0 its orbital speed, then

[redacted]

(2) $v_0 \propto r^{3/2}$

[redacted]

$F_{gravitational} \propto r^2$ —— (1)

$\frac{m v_0^2}{r} = F_{gn}$

$\left[\frac{m v_0^2}{r}\right] \propto r^2$

$v_0^2 \propto r^3$

$v_0 \propto r^{3/2}$ Ans.

Normal condition

$F_g = \frac{m v_0^2}{r}$

$\frac{1}{r^2} = \frac{m v_0^2}{r}$

$v_0 \propto \frac{1}{\sqrt{r}}$

QUESTION

Assume that the force of gravitation $F \propto \frac{1}{r^n}$. Then show that the orbital speed in a circular orbit of radius r is proportional to $\frac{1}{r^{(n-1)/2}}$, while its time period T is proportional to $r^{(n+1)/2}$.

$$F \propto \frac{1}{r^n}$$

$$F_g = \frac{m v_0^2}{r}$$

$$\frac{1}{r^n} = \frac{m v_0^2}{r}$$

$$v_0^2 \propto \frac{r}{r^n}$$

$$v_0^2 = \frac{1}{r^{n-1}}$$

$$v_0 \propto \frac{1}{r^{\left(\frac{n-1}{2}\right)}}$$

F_g = centripetal for

$$\frac{1}{r^n} = \frac{m v_0^2}{r}$$

$$v_0^2 \propto \frac{r}{r^n}$$

$$v_0^2 \propto \frac{1}{r^{n-1}}$$

$$v_0 \propto \frac{1}{r^{(n-1/2)}}$$

QUESTION

Two satellites A and B go round the planet P in circular orbits having radii 4R and R respectively If the speed of the satellite A is $3v$, the speed of satellite B will be

1. $12v$
2. $6v$
3. $\frac{4v}{3}$
4. $\frac{3v}{2}$


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 07 | **Physics**

Gravitation



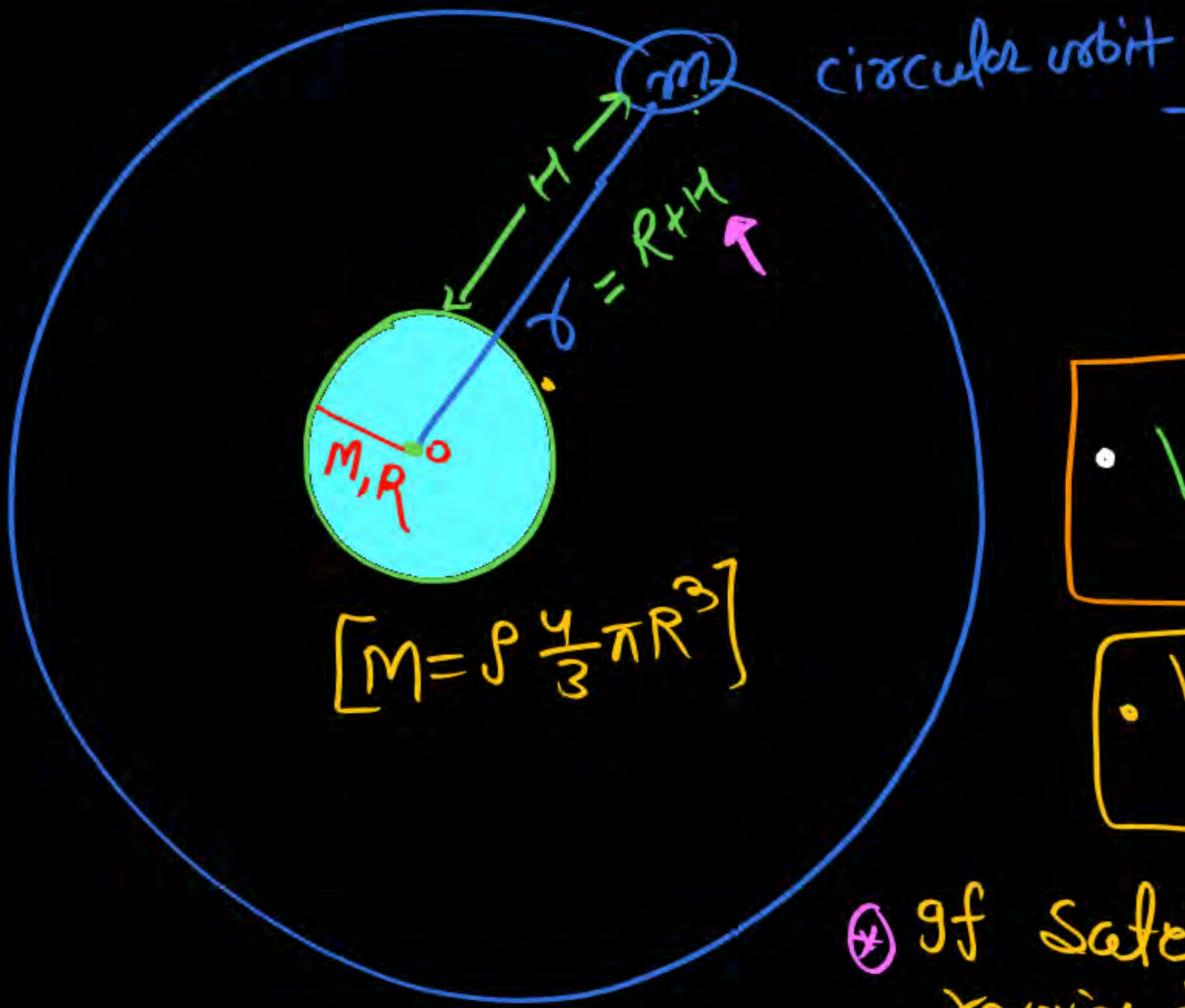
By- Dr. Manish Raj (MR SIR)

Topics to be covered

1. # PhD on satellite
2. #
3. #
4. #



orbital velocity



$$V_e = \sqrt{2}\, V_o$$

$$V_o = \frac{V_e}{\sqrt{2}} = \sqrt{\frac{2GM}{2r}} = \sqrt{\frac{GM}{r}}$$

$$V_o = \sqrt{\frac{GM}{r}} = \sqrt{\frac{\left(G\rho \frac{4}{3}\pi R^3\right)}{r}}$$

↳ orbital velocity does not depends on mass of satellite
depends on mass of planet
depends on & r = radius of circular path

- $V_o = \frac{1}{\sqrt{r}}$ ($M = \text{const}^n$ planet)

- $V_o = \sqrt{\frac{GM}{r}} = \sqrt{\frac{4G\rho\pi R^3}{3\ r}}$

⊛ If Satellite is revolving just on the surface of earth. ($H <<<< R$)

$(r = R)$ $V_o = \sqrt{\frac{GM}{R}} = \frac{V_e}{\sqrt{2}} = \frac{11.2\,\text{Km/s}}{1.41} = \underline{8.1\,\text{Km/s}}$

ENERGY OF SATELLITE

$K.E = \frac{1}{2} m v_0^2$ $\quad v_0 = \sqrt{\frac{GM}{r}}$

$K.E = \frac{1}{2} m \frac{GM}{r}$

$$K.E = \frac{GMm}{2r}$$

$$P.E = -\frac{GMm}{r}$$

$$T.E = -K.E$$

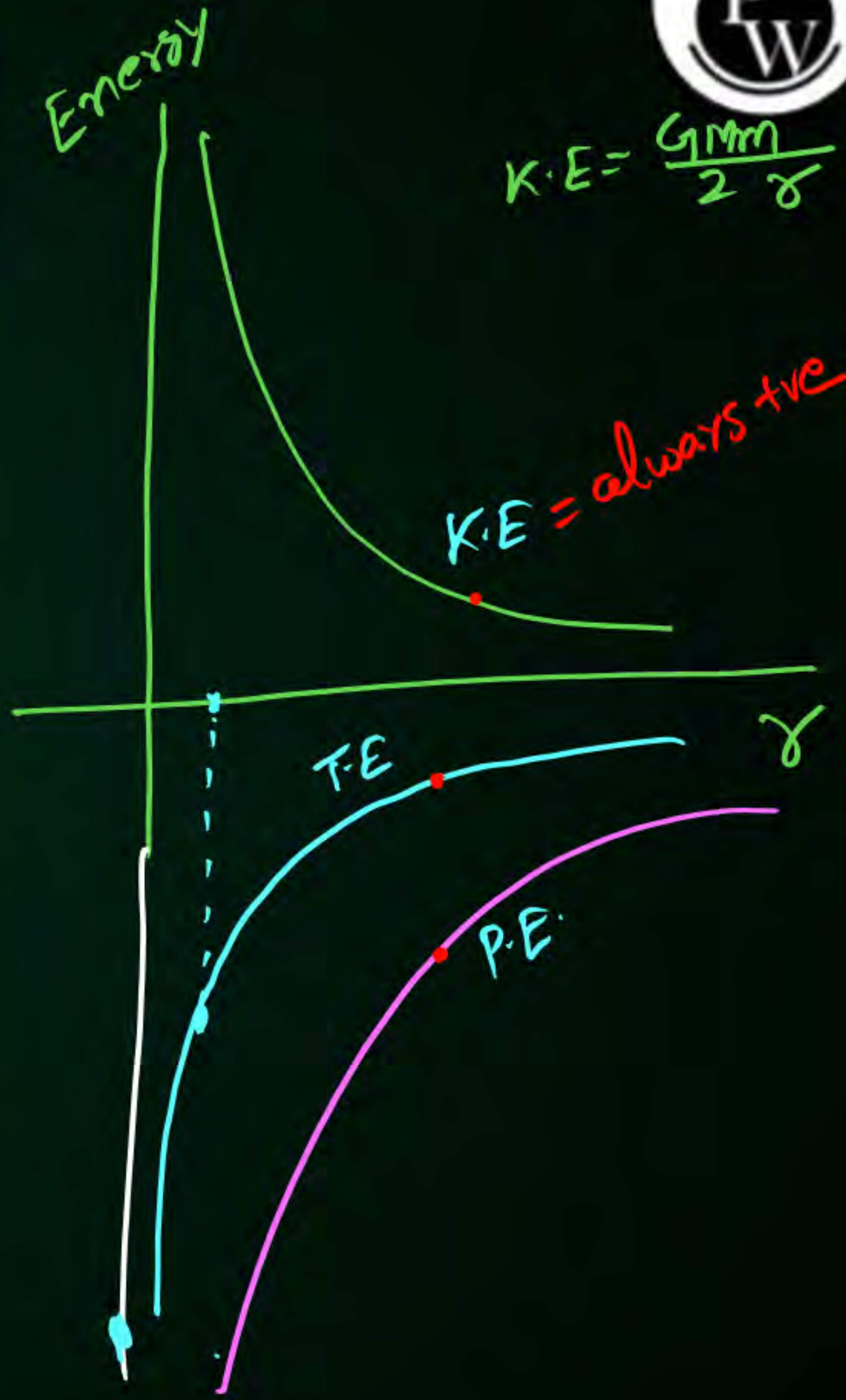
$T.E = -\frac{GMm}{2r}$

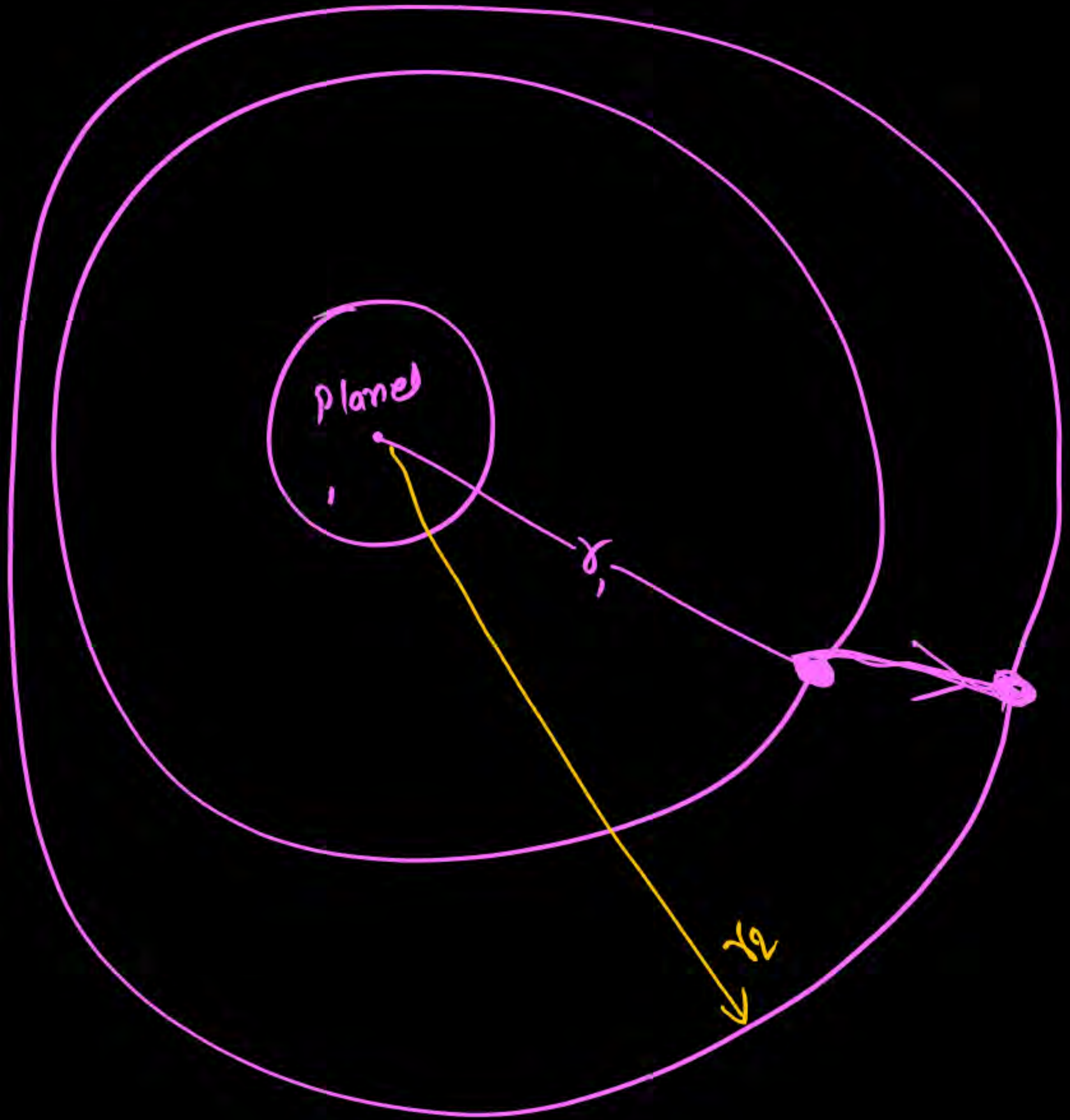
$B.E = |T.E|$

If $T.E = -ve$ [Bounded system] Stable.

If $T.E = 0$ (free system)

$T.E = +ve$ (free system)





If radius of satellite is increasing.

speed ↓ $v_0 = \sqrt{\frac{GM}{r}}$

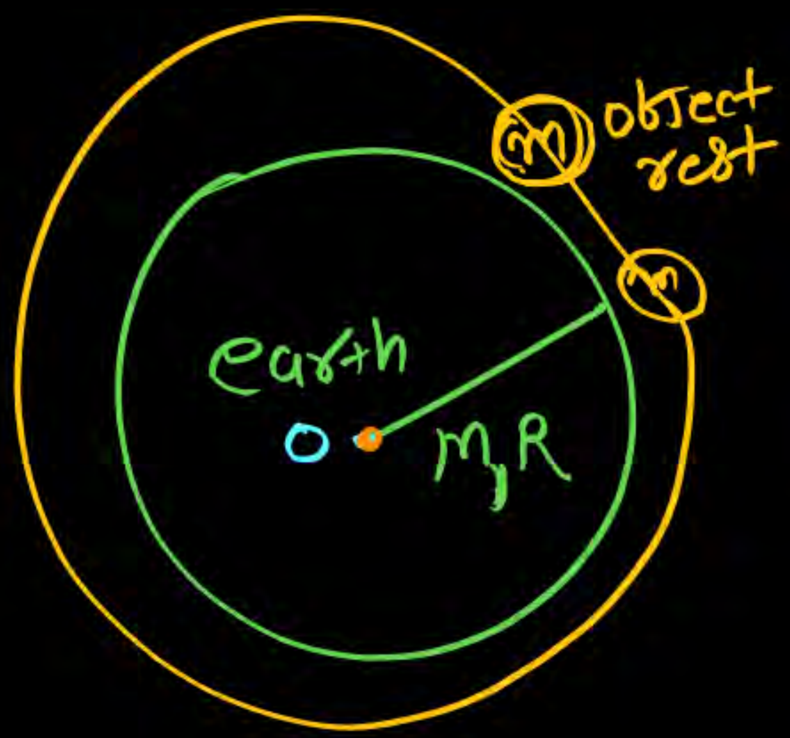
K.E ↓

P.E ↑

T.E ↑



Binding energy of object placed at surface of earth.



$$B.E = |T.E|$$

In this question

K.E = 0

$$P.E = -\frac{GMm}{R}$$

$$T.E = -\frac{GMm}{R}$$

• $B.E = |T.E|$

$$BE = \frac{GMm}{R}$$

If satellite is revolving around near to earth surface $r = R$

$$T.E = K.E + P.E$$

$$T.E = -\frac{GMm}{2r}$$

$$B.E = \frac{GMm}{2r}$$

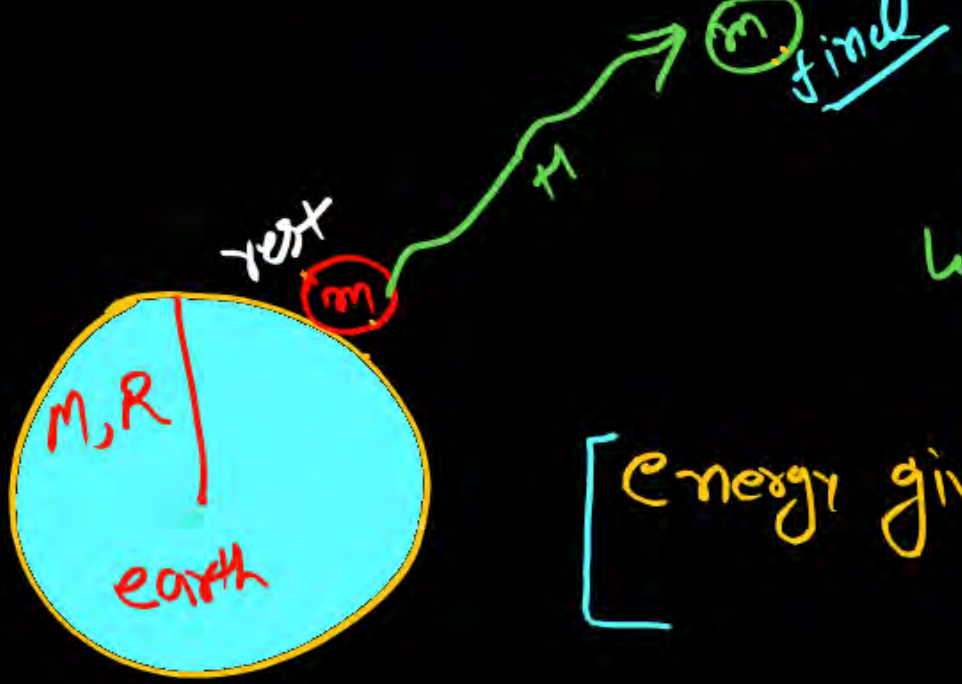
✓ (a) $\frac{GMm}{R}$ (28%)

✗ (b) $\frac{GMm}{2R}$ (46%)

(c) $-\frac{GMm}{R}$ ✗

(d) $-\frac{GMm}{2R}$ ✗

If work done to move the object of mass m from surface of earth to heigh (H).



$$W_{ext} = \Delta U = U_f - U_i$$

$$= -\frac{GMm}{(R+H)} - \left(-\frac{GMm}{R}\right) = \frac{GMm}{R} - \frac{GMm}{(R+H)}$$

[energy given to object to shift from surface to height H] $= W = \frac{GMm}{R} - \frac{GMm}{(R+H)}$ Ans

\# find (work done) or energy given to the object which is at the surface of earth to rotate in the circular orbit at heigh H $(r = R+H)$

Soln $\Delta E_{given} = (T.E_{final} - T.E_{initial}) = \frac{-GMm}{2(R+H)} - \left[-\frac{GMm}{R}\right] = \frac{GMm}{R} - \frac{GMm}{2(R+H)}$

BINDING ENERGY OF A SATELLITE

Binding energy is the minimum energy given to a satellite so that it escapes away from the gravitational field of the planet around which it is revolving. The binding energy of the Earth-satellite system is $E_B = \frac{GMm}{2r}$, where r is the radius of the circular orbit.

1. The binding energy $E_B = \frac{GMm}{2r}$ is the negative of the total mechanical energy $E = \frac{-GMm}{2r}$
2. The binding energy of a particle of mass m placed on the Earth is $E_B = \frac{GMm}{R}$, where R is the radius of the Earth.
3. The binding energy of a body at rest on the Earth's surface is twice the binding energy of a satellite of same mass around the Earth very near to its surface (*i.e.* $r = R$)

QUESTION

Calculate the energy required to put a satellite of mass m from earth surface into a orbit of radius $4R_E$, where R_E is radius of earth.

Sol^n

$$\Delta E_{required} = T.E_f - (T.E_i)$$

$$= -\frac{GMm}{2(4R_e)} - \left(-\frac{GMm}{R}\right) = \frac{GMm}{R}\left(1 - \frac{1}{8}\right)$$

$$= \frac{7GMm}{8R}$$

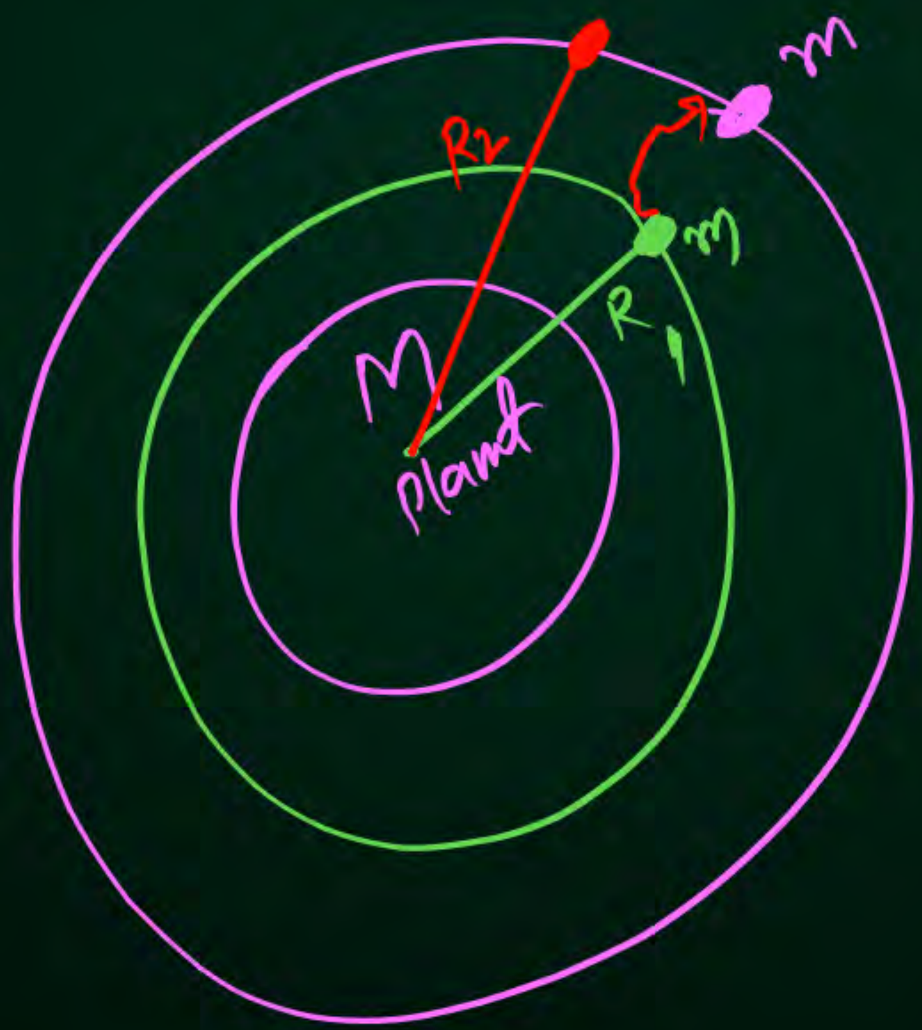
Ans.

QUESTION

(NEET)

The addition kinetic energy to be provided to a satellite of mass m revolving around a planet of mass M, at transfer it from a circular orbit of radius R_1 to another of radius R_2 ($R_2 > R_1$) is

1. $GmM\left(\frac{1}{R_1^2}-\frac{1}{R_2^2}\right)$
2. $GmM\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$
3. $2GmM\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$
4. $\frac{1}{2}GmM\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$



SATELLITE ON CIRCULAR PATH

- # In a same orbit
- # KE = Constant.
- # PE = Constant
- # ME = Constant

$$\therefore \tau = \frac{dL}{dt}, F = \frac{dp}{dt}$$

$\vec{L}$ = constant.

(Torque)$_{mg}$ $\vec{\tau}$ = 0

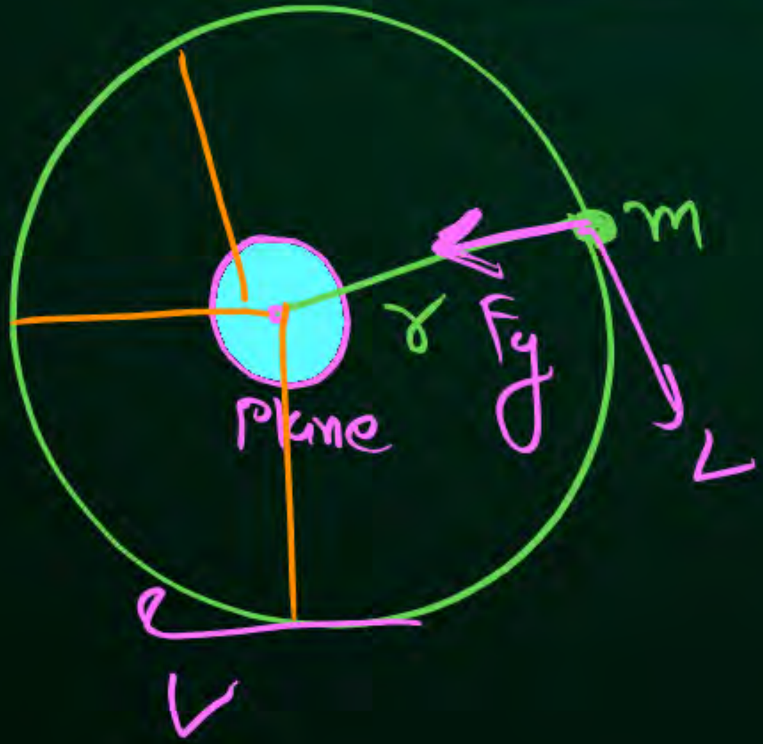
$\vec{P}$ = variable

$\vec{V}$ = variable (velocity)

Total Work = 0   K.E = Const

Speed = constant

Due to circular path radius is fixed



SATELLITE ON ELLIPTICAL ORBIT

K.E = varible
P.E = varibe
* T.E = const^n
• $\vec{L}$ = conserved
• $(\vec{v})$ = 0
velocity

speed = varible
rv = const^n

$$T.E\,(M.E) = \frac{-GMm}{2a}$$

total energy of satellite in elliptical path remains constant



Work in 1 loop = 0

Not NEET

$V_{giv} <<< V_0$ → (Protectile motion) (Parabolic)

→ elliptical Path (Path open)

$V_{gin} < V_0$

*

MR fed

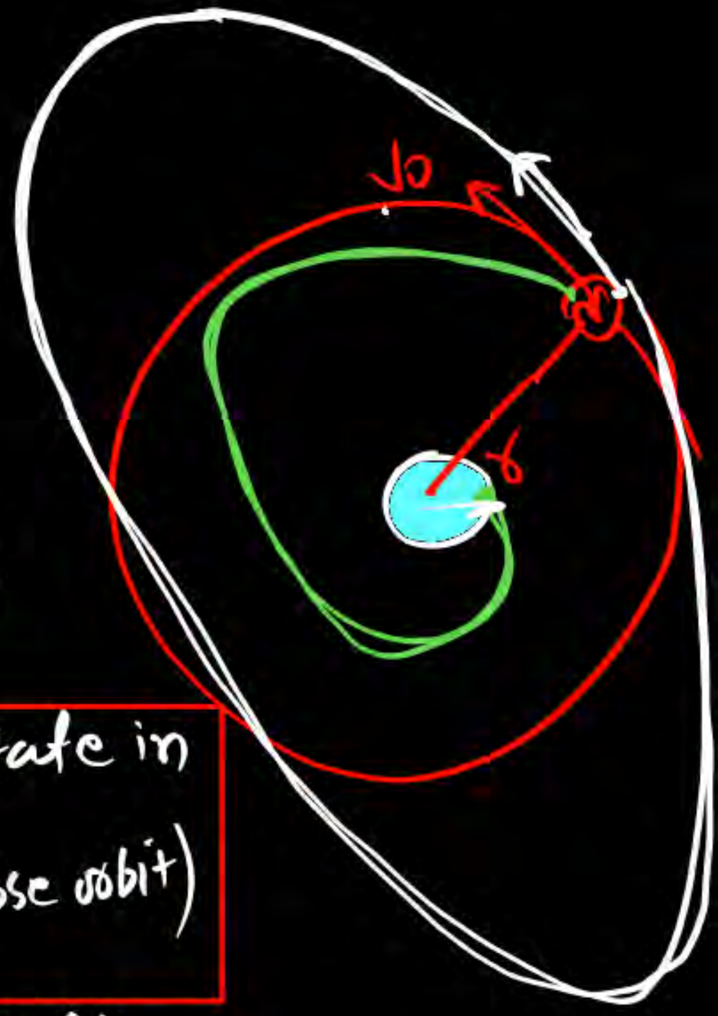
$V_{given} = V_0$ → Satellite will rotate in circular Path, (close orbit)

$V_e > V_{given} > V_0$ → elliptical orbit (close Path)

Biyoyoyo

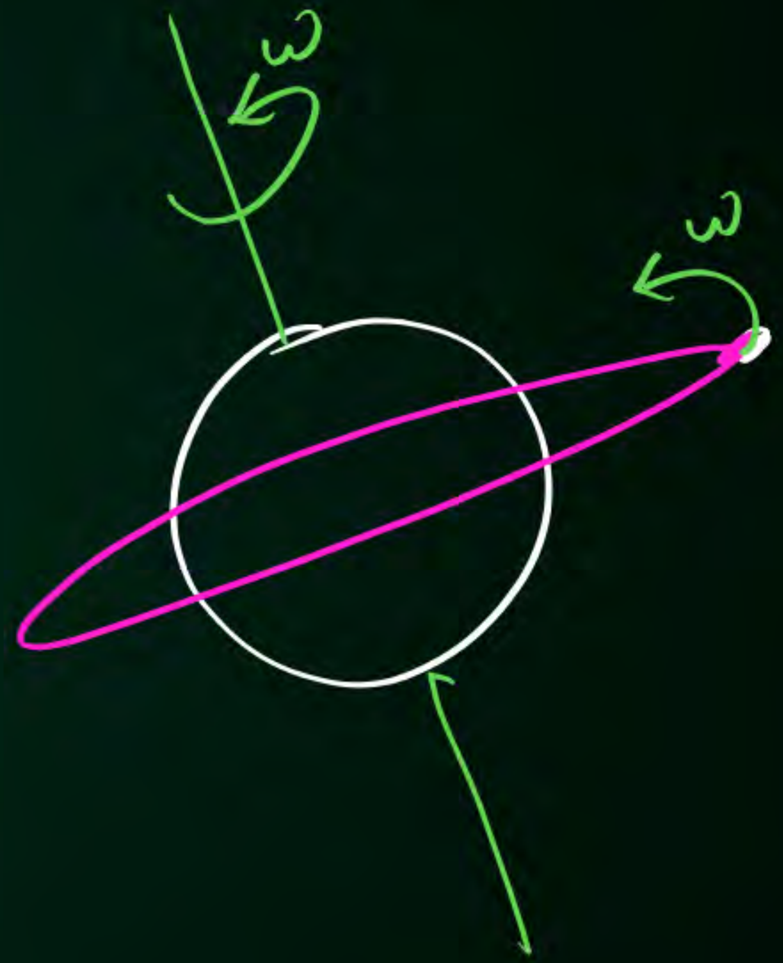
$V_{given} = V_e$ (K.E = 0) → Parabolic Path

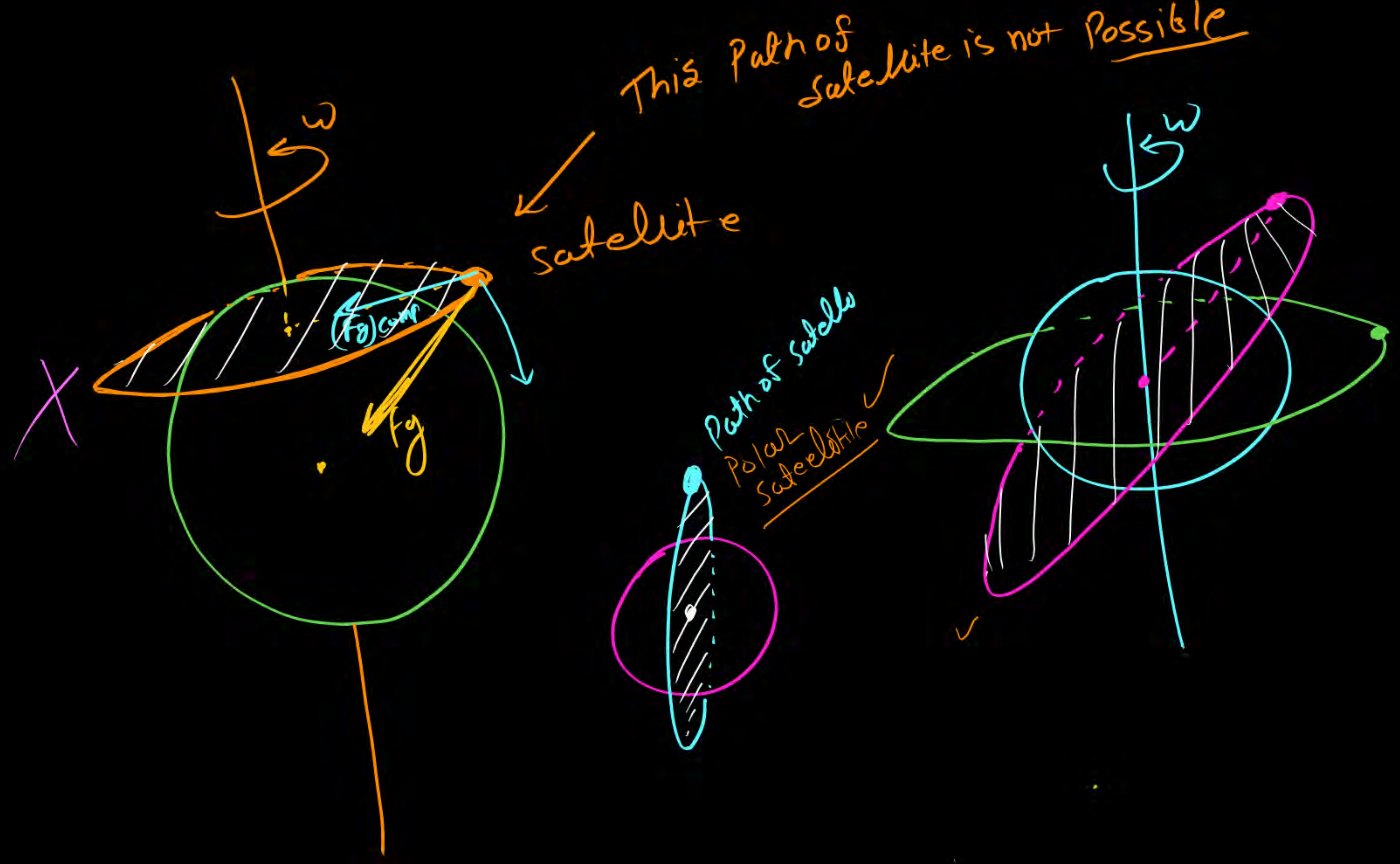
$V_g >>> V_e$ → scape to the infinity & path will be (hyperbola)



GEOSTATIONARY SATELLITE

- h = 6R from surface
  = 36000 km
- h = 7R from centre of earth.
- T = 24 hr.
- V_0 = 3.1 km/hr
- equatorial plane
- west to east
- 1 satellite cover $\frac{1}{3}$rd Area of earth.
- communication, Parking
- Relay satellite
- Angular speed, time point; direction of rotation same as earth.
- Remains at same position of earth.




This Path of satellite is not Possible
ω
satellite
X
(Fg)comp
Fg
Path of satelle
Polar satellite
ω

POLAR SATELLITE

- ✓ about pole
- time period = 100 min (about)



QUESTION

If the gravitational force between two objects were proportional to $1/R$ (and not as $1/R^2$), where R is the distance between them, then a particle in a circular path (under such a force) would have its orbital speed v, proportional to

1. R
2. R^0 (independent of R)
3. $\frac{1}{R^2}$
4. $\frac{1}{R}$

$F_g = \frac{mv^2}{R}$

$\frac{1}{R} = \frac{mv^2}{R}$

V = does not depend on R

QUESTION

An artificial satellite is moving around earth in a circular orbit with speed equal to one fourth the escape speed of a body from the surface of earth. The height of satellite above earth's surface is (R is radius of earth)

1. $3R$
2. $5R$
3. $7R$
4. $8R$

$V_0 = \sqrt{\frac{Gm}{r}} = \frac{1}{4}\sqrt{\frac{2Gm}{R}}$

Squar both site

$\frac{Gm}{r} = \frac{1}{16}\frac{2Gm}{R}$

$r = 8R$

Hey = 7R

QUESTION

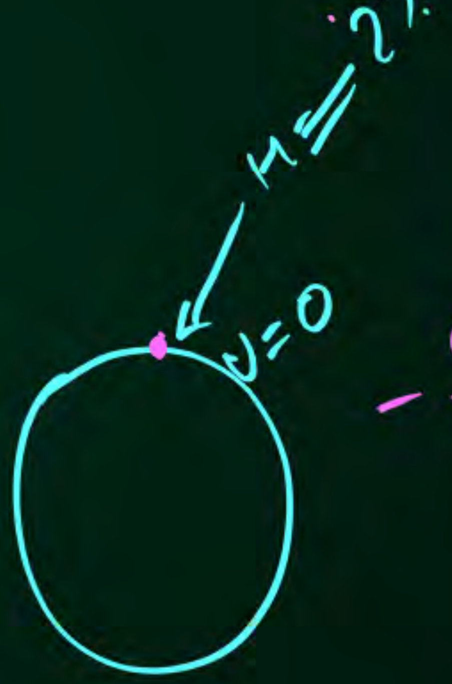
If potential energy of a body of mass m on the surface of earth is taken as zero then its potential energy at height h above the surface of earth is [R is radius of earth and M is mass of earth]

1. $\dfrac{-GMm}{R+h}$

2. $\dfrac{-GMm}{h}$

3. $\dfrac{GMmh}{R(R+h)}$

4. $\dfrac{GMmh}{h+2R}$



$\Delta U =$ const.

$U_S - U_H = (U_S - U_H)'$

$-\dfrac{GMm}{R} + \dfrac{GMm}{R+H} = 0 - U_H$

$U_H = \dfrac{GMm}{R} - \dfrac{GMm}{R+H}$

$= GMm\left(\dfrac{H}{R(R+H)}\right)$

QUESTION

When energy of a satellite-planet system is positive then satellite will

1. Move around planet in circular orbit
2. **Move around planet in elliptical orbit**
3. Escape out with minimum speed
4. Escape out with speed greater than escape velocity

QUESTION

JEE main 2023

An object is projected horizontally with speed $\frac{1}{2}\sqrt{\frac{GM}{R}}$, from a point at height $3R$ [where R is radius and M is mass of earth, then object will]

$r = 4R$

$v_0 = \sqrt{\frac{GM}{4R}} = \frac{1}{2}\sqrt{\frac{GM}{R}}$

1. Fall back on surface of earth by following parabolic path
2. Fall back on surface of earth by following hyperbolic path
3. Start rotating around earth in a circular orbit
4. Escape from gravitational field of earth

QUESTION

The orbital speed of a satellite revolving around a planet in a circular orbit is v_0. If its speed is increased by 10%, then

1. It will escape from its orbit
2. It will start rotating in an elliptical orbit
3. It will continue to move in the same orbit
4. It will move in a circular orbit of radius 20% more than radius of initial orbit

QUESTION

If L is the angular momentum of a satellite revolving around earth is a circular orbit of radius r with speed v, then

1. $L \propto v$
2. $L \propto r$
3. $L \propto \sqrt{r}$ Ans.
4. $L \propto \sqrt{v}$

$L = mvr$ (m: const.)

$L \propto vr$

$v = \sqrt{\frac{Gm}{r}}$

$L \propto \frac{1}{\sqrt{r}} r$

$L \propto \sqrt{r}$

QUESTION

When speed of a satellite is increased by x percentage, it will escape from its orbit, where the value of x is

1. 11.2%
2. 41.4% (Ans)
3. 27.5%
4. 34.4%

QUESTION

In an orbit if the time of revolution of a satellite is T, then PE is proportional to

1. $T^{1/3}$
2. T^3
3. $T^{-2/3}$ Ans
4. $T^{-4/3}$

$T^2 \propto r^3$

$T^{2/3} \propto r$

$P.E = -\frac{GMm}{r}$

$P.E \propto \frac{1}{r} \propto \frac{1}{T^{2/3}}$

$P.E \propto T^{-2/3}$

Ans

QUESTION

A small satellite is revolving near earth's surface. Its orbital velocity will be nearly

$V_0 = \frac{V_e}{\sqrt{2}}$

1. 8 km/s ✓
2. 11.2 km/s
3. 4 km/s
4. 6 km/s

QUESTION

The time period of polar satellite is about

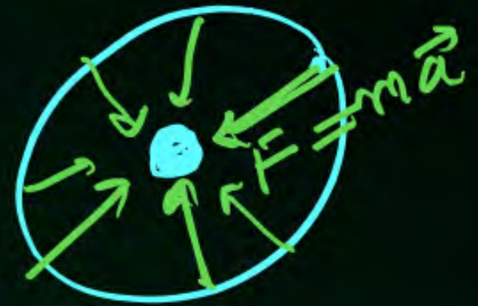
1. 24 hr
2. 100 min ✓
3. 84.6 min
4. 6 hr

QUESTION

When energy of a satellite-planet system is positive then satellite will

1. Move around planet in circular orbit
2. Move around planet in elliptical orbit
3. Escape out with minimum speed
4. Escape out with speed greater than escape velocity

QUESTION



A satellite S is moving in an elliptical orbit around the earth. The mass of the satellite is very small compared to the mass of the earth. Then

1. The acceleration of S is always directed towards the centre of the earth
2. The angular momentum of S about the centre of the earth changes in direction, but its magnitude remains constant
3. The total mechanical energy of S varies periodically with time
4. The linear momentum of S remains constant in magnitude

QUESTION

Two satellites of earth S_1 and S_2 are moving in the same orbit. The mass of S_1 is four times the mass of S_2. Which one of the following statements is true?

1. The potential energies of earth and satellite in the two cases are equal
2. S_1 and S_2 are moving with the same speed ✓ $V_0 = \sqrt{\frac{Gm}{r}}$ → does not depend on mass of satellite
3. The kinetic energies of the two satellites are equal → K.E depend on mass.
4. The time period of S_1 is four times that of S_2

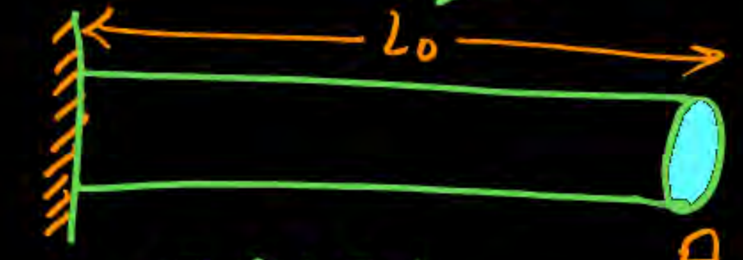
Next chapter

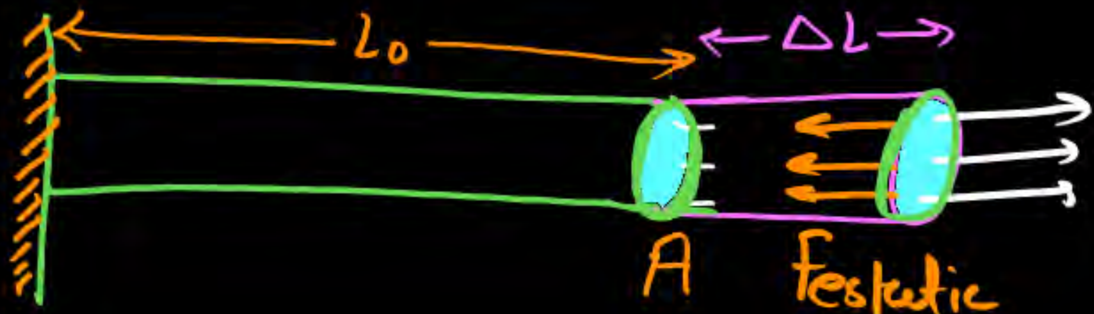
→ mechanical Properties of solid

Body

- Perfect elastic
  - (1) Compltly regain its shape after deformation
- Inelastic
  - Partially shape regain after deformation.
- Perfectly Inelastic (Plastic)







$$\text{Strain} = \left(\frac{\Delta L}{L_0}\right)$$

↳ unit & dimⁿ less

(1) Stress ∝ strain

(2) Strain ∝ stress

(a) 1st correct

(b) 2nd correct

(c) Both are correct

under equilibrium condⁿ

$$F_{ext} = F_{elastic}$$

$$\text{Stress} = \left[\frac{\text{elastic force}}{\text{Area}}\right]$$

↳ scalar

↳ unit = N/m^2

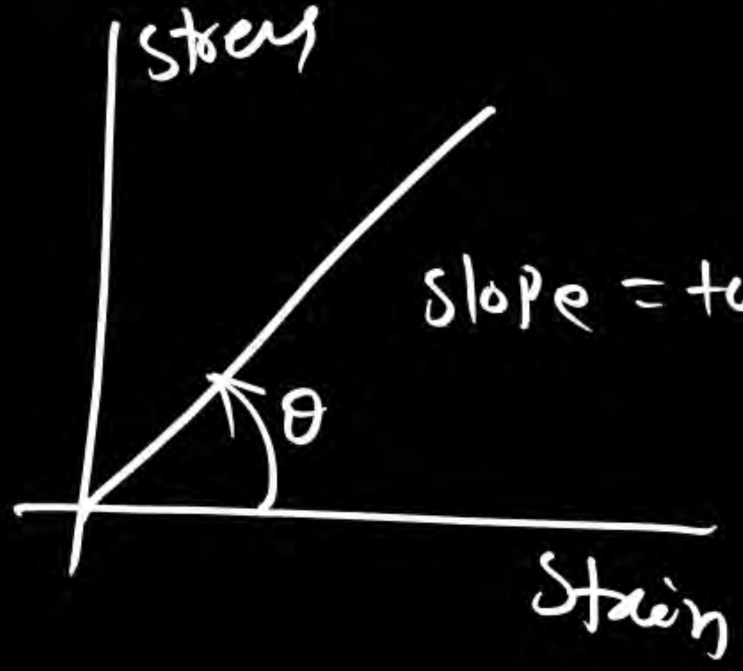
$$\text{Stress} = \frac{F_{ext}}{\text{Area}}$$

HOOKS चाचा ka Law

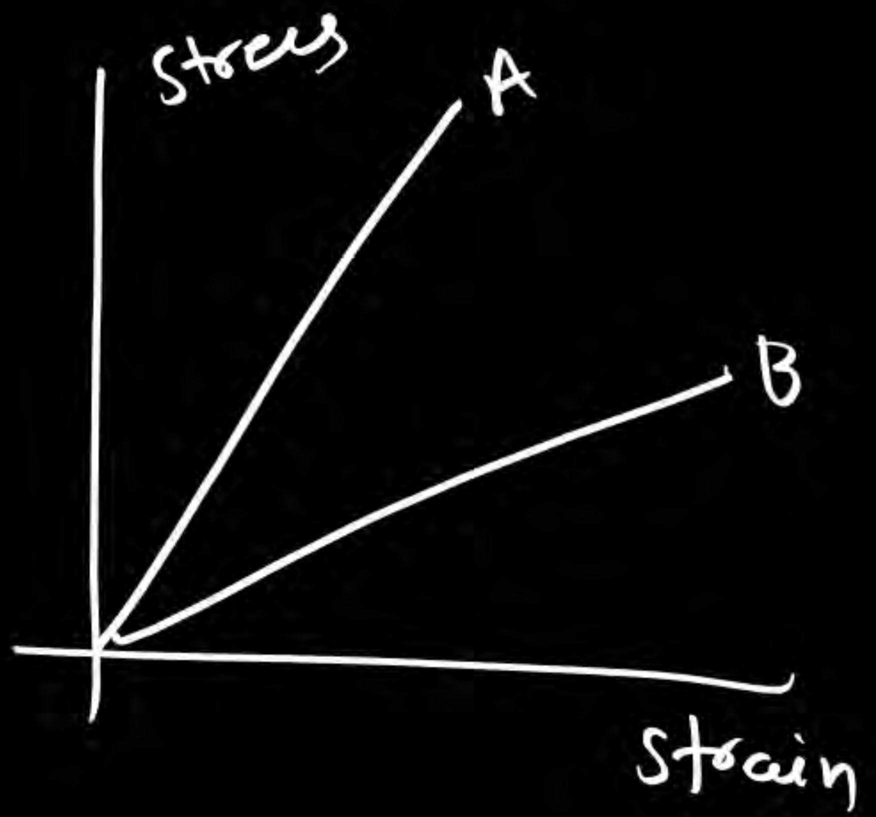
Stress $\propto$ strain

Stress $= Y$ strain

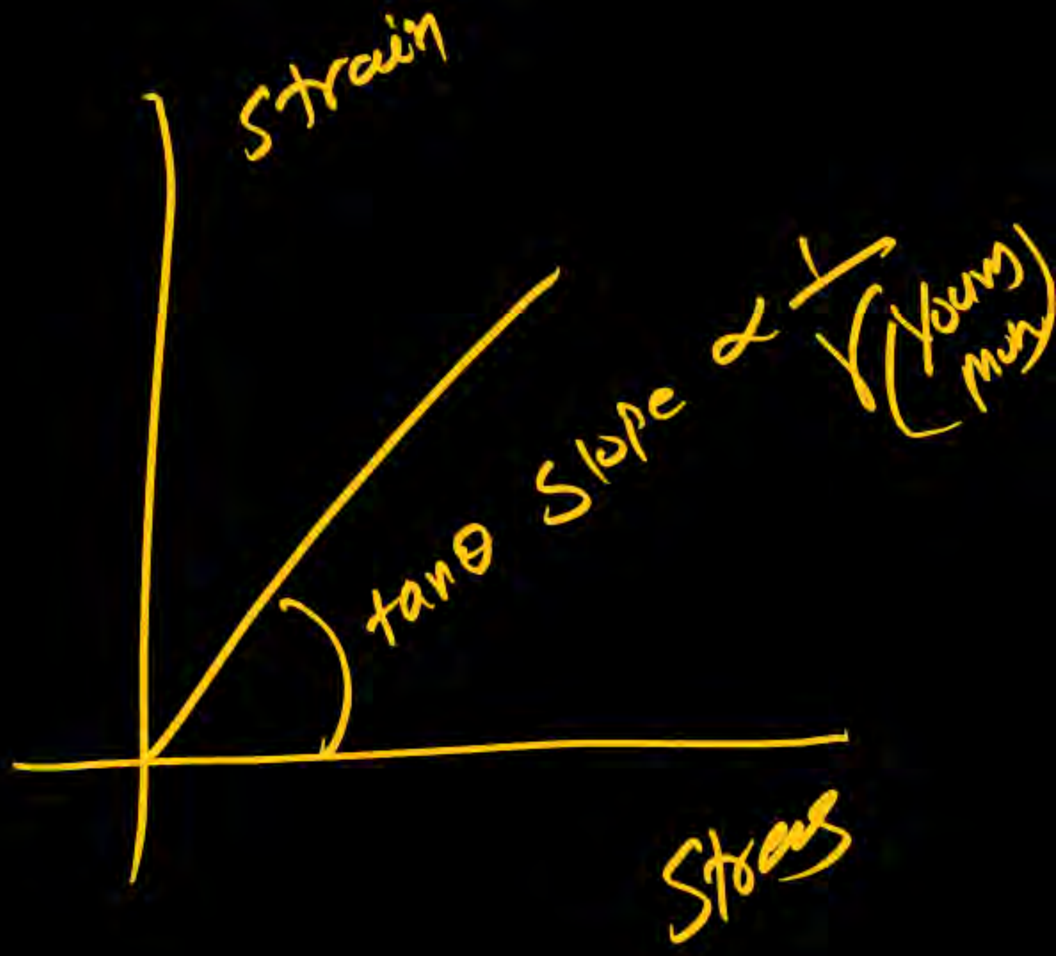
↳ depend upon nature of material.



slope $= \tan\theta = Y$



$$Y_A > Y_B$$




THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 01 | Physics

Mechanical Properties of Solids

By- Dr. Manish Raj (MR SIR)



Topics to be covered

1. # Normal / longitudinal stress
2. # Shear / tangential stress / strain
3. # Volumetric stress / strain
4. #

→ 70% question in Neet from this chapter asked on this topic



Rigid Body

A body in which distance between any two point remains same.

→ No body is perfectly rigid practically.

Body

# Elastic	Inelastic	Perfectly Inelastic/ Plastic
# Regain its shape after removing deforming force.	# Partially regain its shape	Does not regain its shape after removing deforming force.

Rubber is less elastic than steel → True

→ [redacted]



External Force

Compressive force



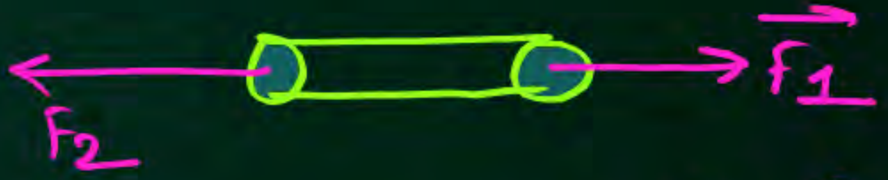
F_1 & F_2 are compressive



(#) $F_{net} = 0 \rightarrow a = 0$

F_{net} compressive $= 2F$

Elongative/Tensite force



Net elongative force $= \vec{F_1} + \vec{F_2}$

$F_{net} = 0$



$F_{net} = 20N$ ✓

$F_{elongative\ force} = 0$

This rod will accelerate but shape will not change



$F_{net} = 25N$

elongative fr = 5N



$F_{net} = 30N$

compressive = 10N

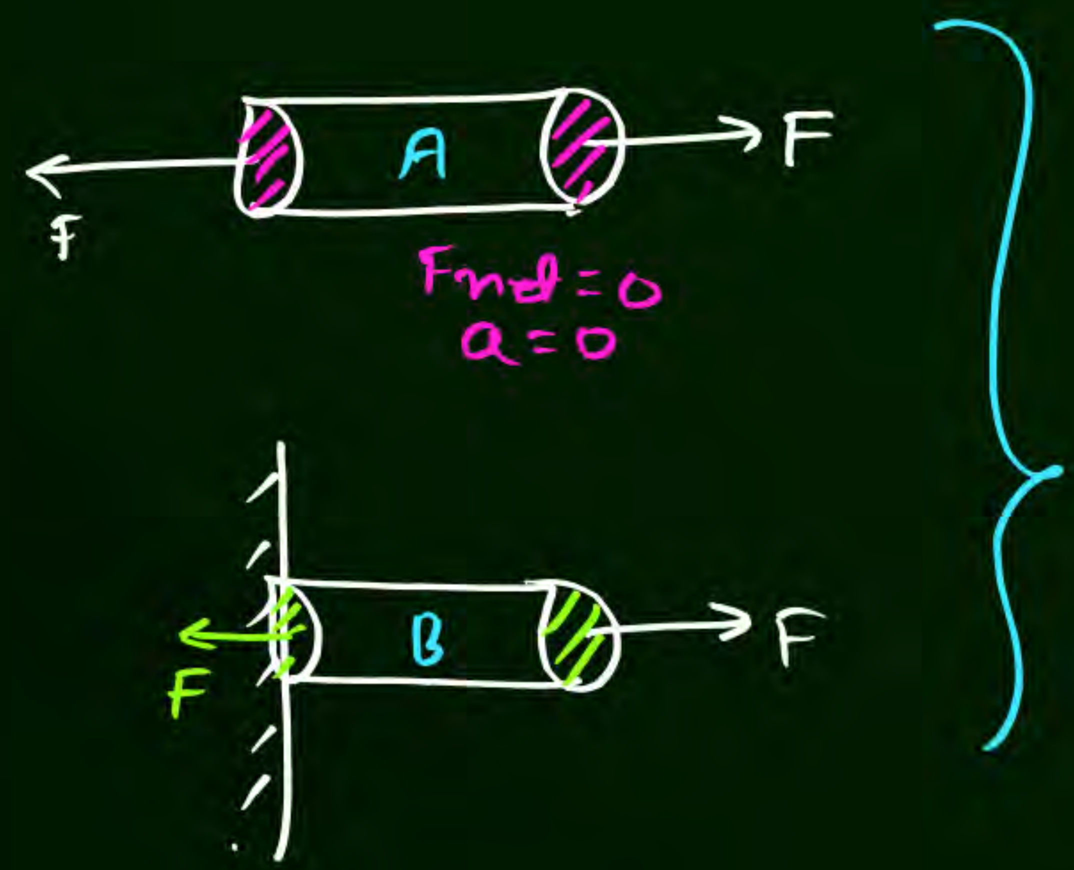
Balance force ($F_{net} = 0$) can change shape and size of object.

If $F_{net} = 0$ then $a_{net} = 0$
but shap can can change.



$F_{net} = 0$

- पिचका कैसे ??



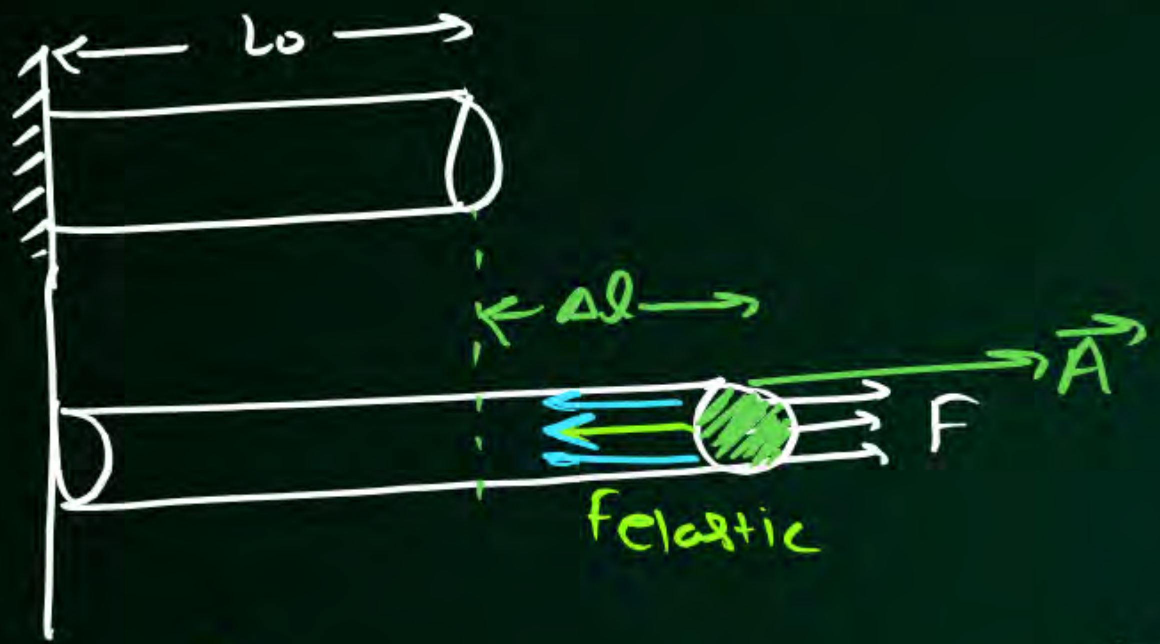
- Both are same rod then elongation will be → same.

(A) A = B

(B) A > B

(C) A < B

Normal/Longitudinal Stress



Normal stress / longitudinal stress = $\frac{F_{elastic}}{A}$

al Strain (longitudinal strain) = $\frac{\Delta L}{L}$

Hooks चाया law   stress ∝ strain

$\frac{F}{A} \propto \frac{\Delta l}{l}$

$\frac{F}{A} = Y\left(\frac{\Delta l}{l}\right)$

→ Young modulus
  ↳ Nature of solid

Y → higher the value of Young modulus higher will be elasticity

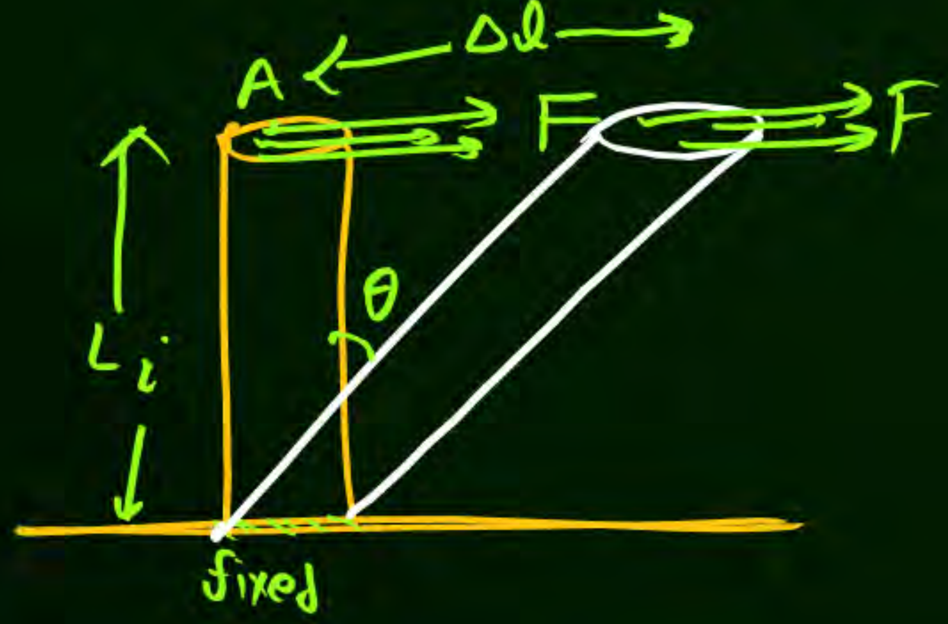
• Young modulus for liquid & gas will be zero.

$$\frac{F}{A} = Y \frac{\Delta l}{l}$$

→ only for solid.

* $$\frac{F}{\pi r^2} = Y \frac{(L_f - L_i)}{L_i}$$

Tangential stress
(Shear stress) $= \frac{F}{A}$



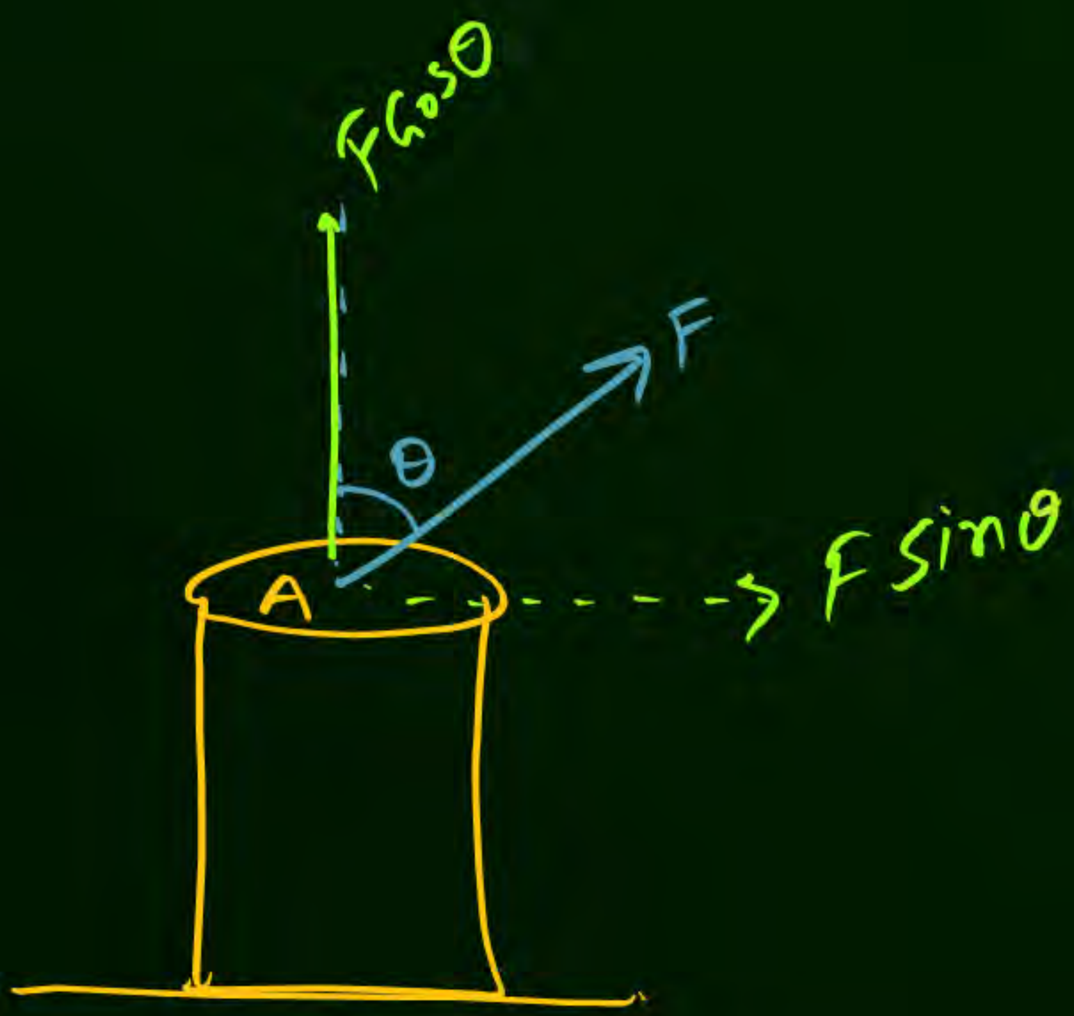
strain $= \theta = \tan\theta = \left[\frac{\Delta l}{l_i}\right]$

Hooks चाचा

$\frac{F}{A} \propto$ strain

$$\frac{F}{A} = \eta\,\theta$$

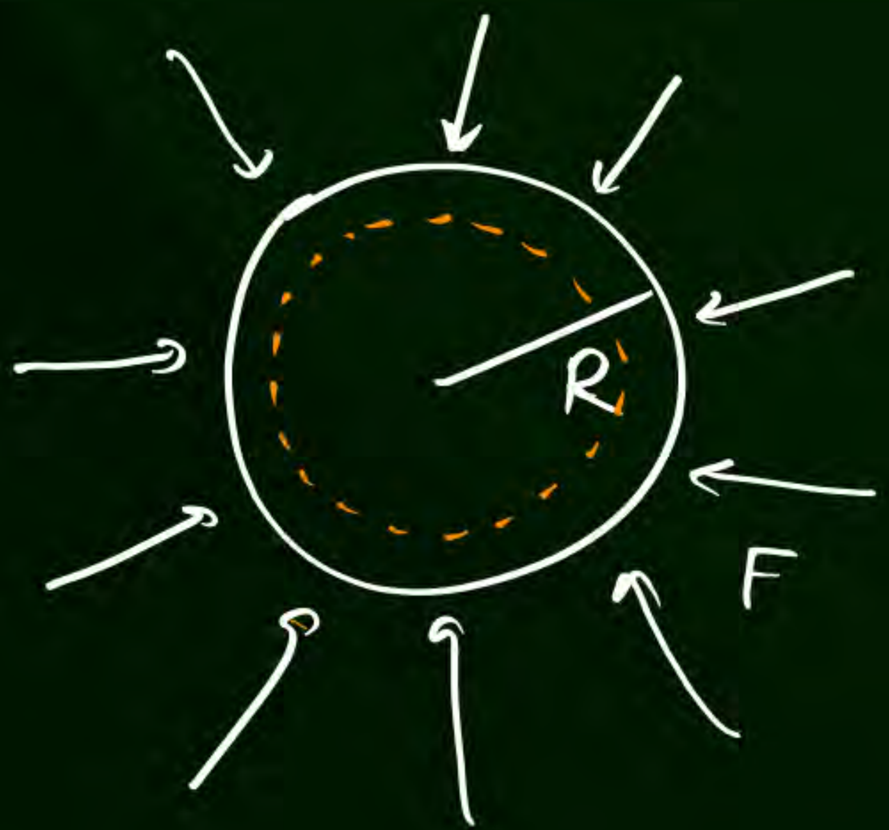
(Coffiient of rigiditiy)
only definded for Solid.



Shear (Tangential) stress $= \dfrac{F\sin\theta}{A}$

Normal (longitudinal) stress $= \dfrac{F\cos\theta}{A}$

Volumetric stress



Volumetric stress = $\frac{F}{A}$

Volumetric strain = $\frac{\Delta V}{V_i}$

Hooks चाचा

$$\frac{F}{A} \propto \frac{\Delta V}{V_i}$$

$$\frac{F}{A} = -\beta \frac{\Delta V}{V_i}$$

[$\beta \rightarrow$ Bulk modulus]

↳ defined for all liquid solid & gas

$$[\beta_{solid} > \beta_{liquid} > \beta_{gas}]$$

MECHANICAL PROPERTIES OF SOLID

- **Elasticity :** It is a property of body (solid) due to which it try to region it's original shape after removing deforming force.

- **Perfectly Elastic Body:** After removing deforming force. It exactly region it's shape then, that is called perfectly Elastic Body.

- **Plastic Body:** Which do not region their shape.

- **Inelastic body:** partially region their shape.

- Value of η, γ and β for perfectly elastic body is infinite.
- η and γ is not defined for fluid (liquid and gas)
- Value of γ and η for gas is zero.
- $\beta_{solid} > \beta_{liquid} > \beta_{gas}$
- $\gamma \propto \frac{1}{Tempr}$
- Young modulus may increase or decrease by adding impurities.

QUESTION

The ratio of radii of two wires of same material is 2 : 1. If these wires are stretched by equal force, the ratio of stresses produced in them is

1. 2 : 1
2. 1 : 2
3. 1 : 4
4. 4 : 1

Young modulus same.

$\frac{r_1}{r_2} = \frac{2}{1}$

Force = same

$\text{Stress} = \frac{F}{\text{Area}} = \frac{F}{\pi r^2}$

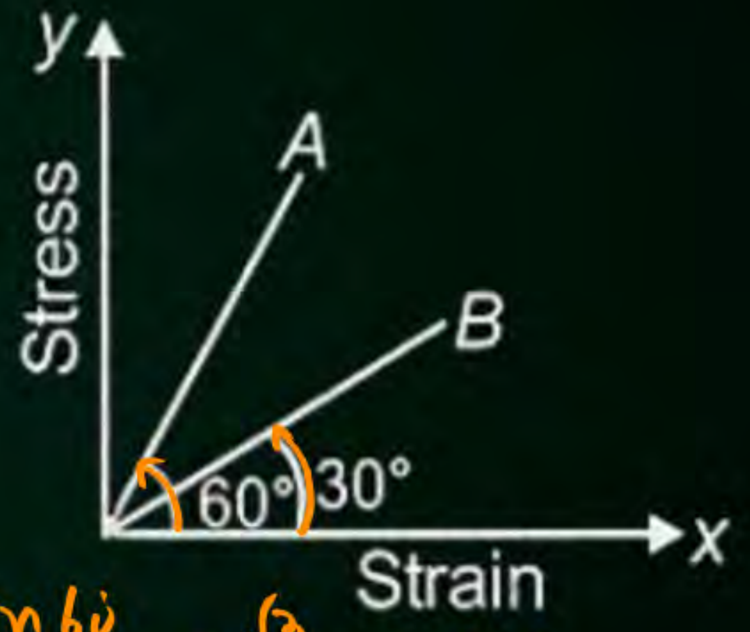
$\text{Stress} = \frac{1}{r^2}$

$\frac{S_1}{S_2} = \frac{r_2^2}{r_1^2} = \left(\frac{1}{2}\right)^2 = 1:4$

QUESTION

The stress versus strain graph for wires of two materials A and B are as shown in the figure. If Y_A and Y_B are the Young's moduli of the materials, then

1. $Y_B = 2Y_A$
2. $Y_A = 3Y_B$ ✓
3. $Y_B = 3Y_A$
4. $Y_A = Y_B$



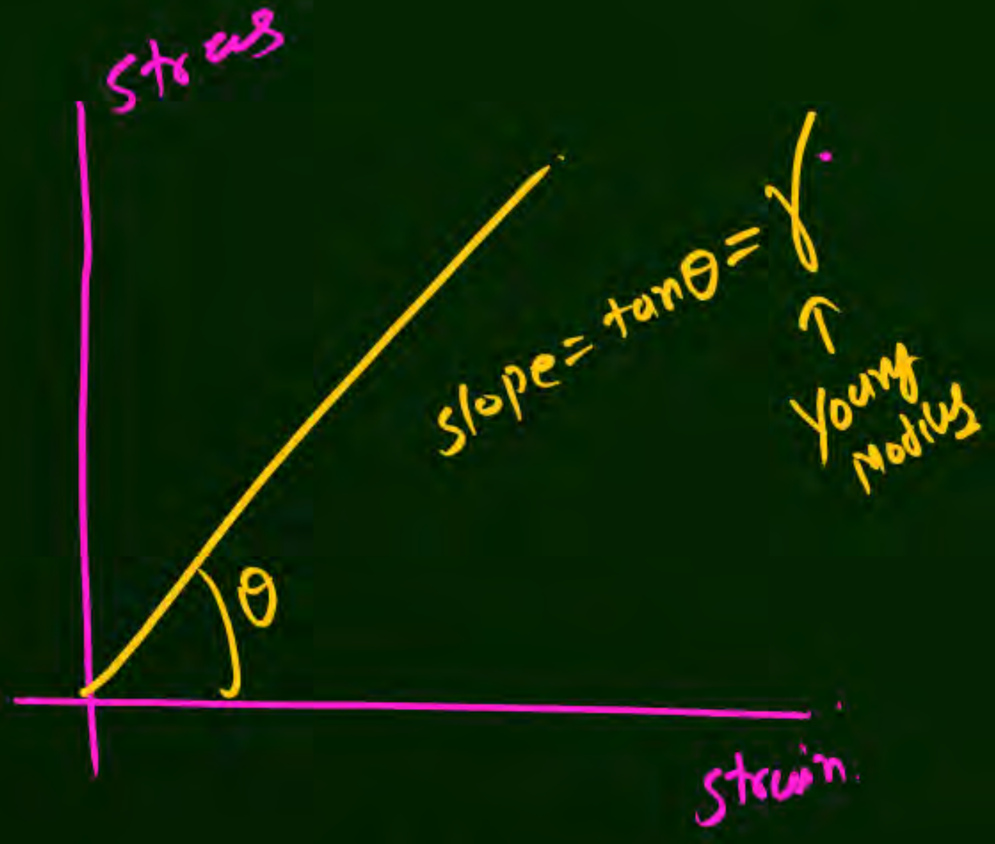
Slope of stress/strain graph is young modulus.

$$\frac{Y_A}{Y_B} = \frac{\tan\theta_A}{\tan\theta_B} = \frac{\tan 60^\circ}{\tan 30^\circ} = \frac{\sqrt{3}}{1/\sqrt{3}} = 3:1$$

$$\frac{Y_A}{Y_B} = \frac{3}{1}$$

- Young modulu $\propto \frac{1}{\text{Tempr}}$

Stress = Y strain



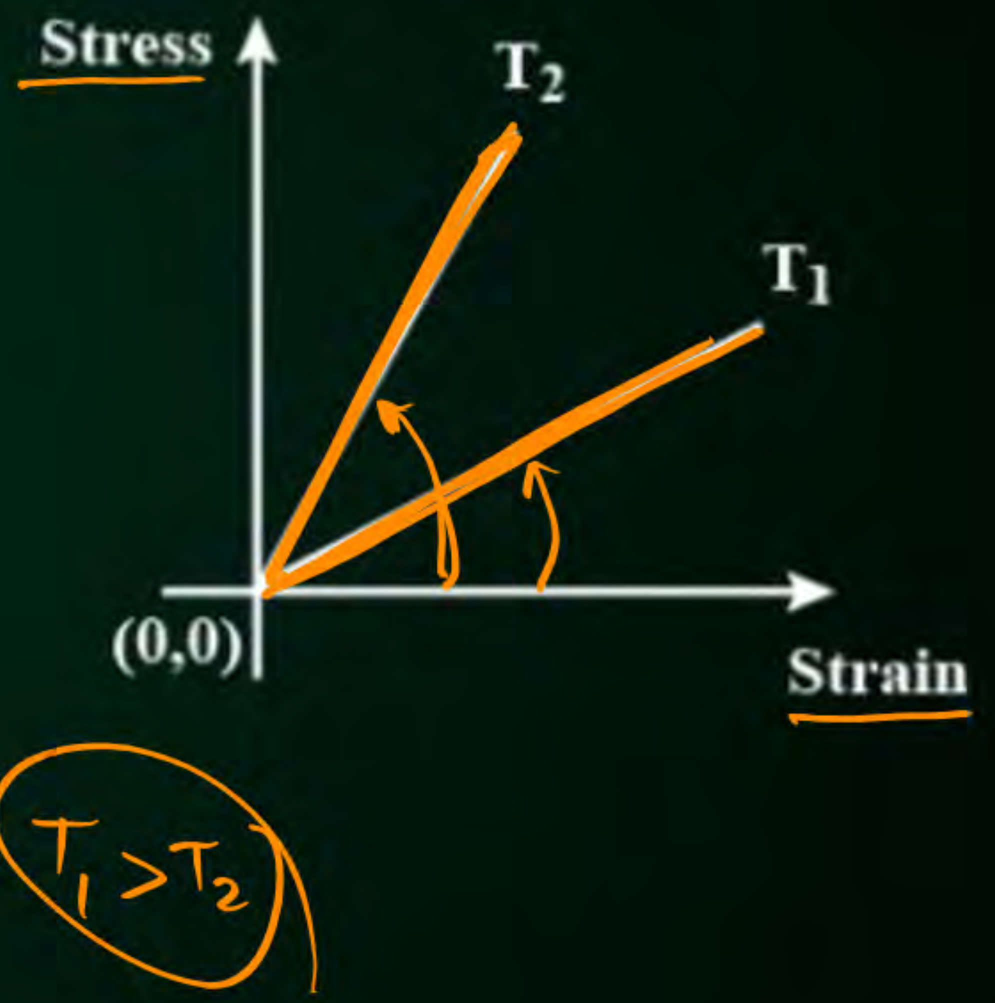
If Tempr of Solid is ↑

then slope of this graph will → decrease

QUESTION

Figure shows graph between stress and strain for a uniform wire at two different temperatures. Then

1. $T_1 > T_2$ (78%)
2. $T_2 > T_1$
3. $T_1 = T_2$
4. None of these



QUESTION

The load versus elongation graph for four wires of same length and the same material is shown in figure. The thinnest wire is represented by line .

1. OC
2. OD
3. OA
4. OB



$\frac{F}{A} = Y \frac{\Delta l}{l}$ → same (const)

$\frac{F}{\Delta l} \propto \text{Area} (\pi r^2)$

$\left(\frac{\text{Load}}{\text{elongation}}\right) \propto r^2$

OA → ley

QUESTION

Two wires are made of the same material and have the same volume. The first wire has cross-sectional area A and the second wire has cross-sectional area 3A. If the length of the first wire is increased by Δl on applying a force F, how much force is needed to stretch the second wire by the same amount?

1. 9F
2. 6F
3. F
4. 4F

(Δl) elongation same

$Y \rightarrow$ same.

Hook नियम

$$\frac{F}{A} = Y\frac{\Delta l}{l}$$

$$F = AY\frac{\Delta l}{l}$$ — same

$$F \propto \frac{A \times A}{(l \times A)}$$ → volume → sa.

$$F \propto A^2$$

$$F' = (3A)^2 = 9A^2$$

9F

QUESTION

The Young's modulus of steel is twice that of brass. Two wires of same length and of same area of cross-section, one of steel and another of brass are suspended from the same roof. If we want the lower ends of the wires to the steel and brass wires must be in the ratio of

1. 1 : 1
2. 1 : 2
3. 2 : 1
4. 4 : 1

QUESTION

The following four wires of length L and radius r are made of the same material. Which of these will have the largest extension, when the same tension is applied?

1. $L = 400 \text{ cm}, r = 0.8 \text{ mm}$
2. $L = 300 \text{ cm}, r = 0.6 \text{ mm}$
3. $L = 200 \text{ cm}, r = 0.4 \text{ mm}$
4. $L = 100 \text{ cm}, r = 0.2 \text{ mm}$

H/W

QUESTION

A wire of length L and radius r fixed at one end and a force F applied to the other end produces an extension l. The extension produced in another wire of the same material of length $2L$ and radius $2r$ by a force $2F$, is

1. l
2. $2l$
3. $4l$
4. $l/2$

H|ω

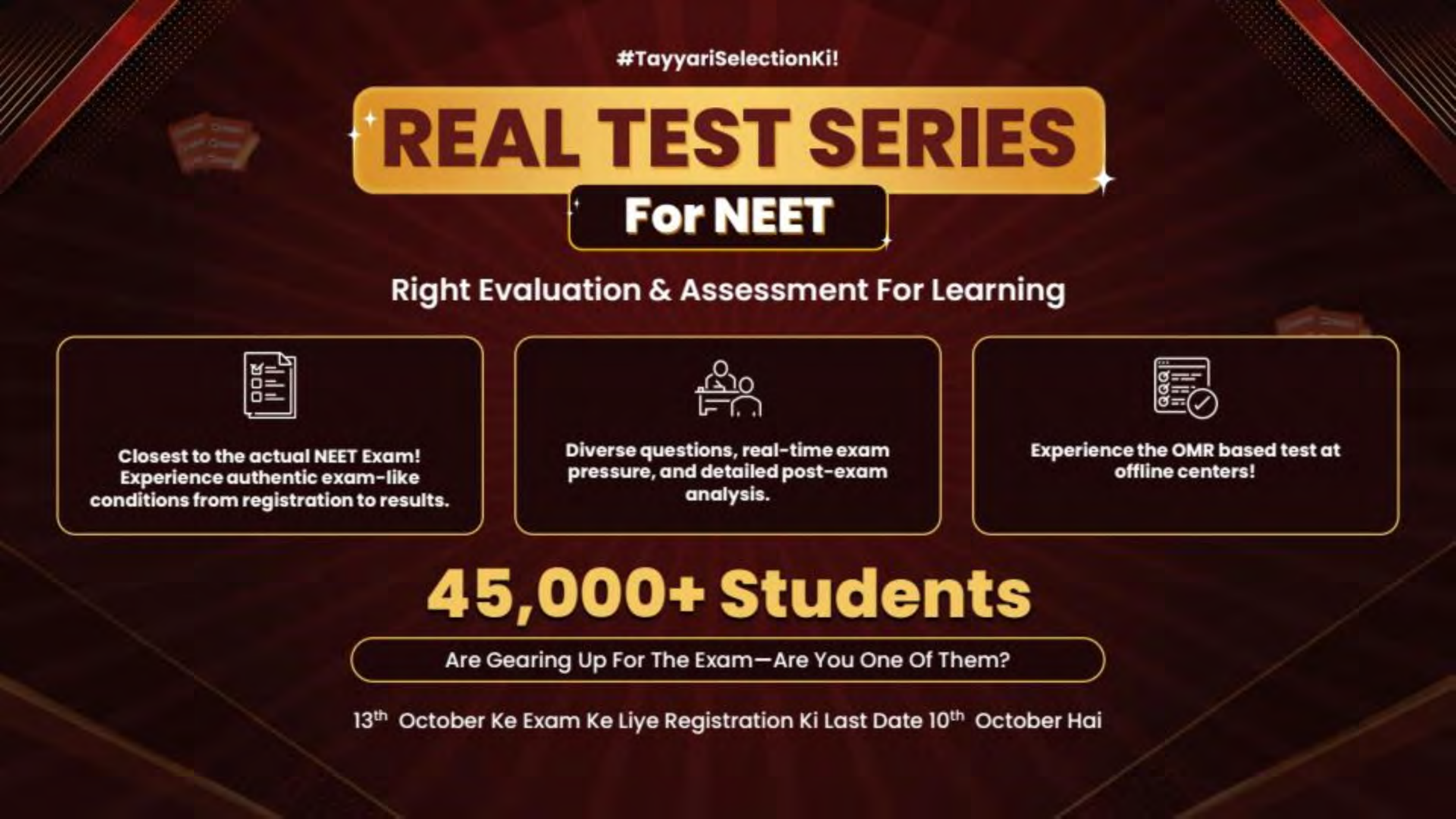
QUESTION

Two wire A and B are stretched by same force. If, for A and B, $Y_A : Y_B = 1 : 2$, $r_A : r_B = 3 : 1$ and $l_A : l_B = 4 : 1$, then ratio of their extension $\left(\frac{\Delta l_A}{\Delta l_B}\right)$ will be

1. 10 : 13
2. 11 : 7
3. 8 : 9
4. 6 : 5

Kal Test Ke
Bad Saro H/W
Kar lena.

H/W



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FOR NEET 2025

Lecture- 02 | Physics

Mechanical Properties of Solid



By- Dr. Manish Raj (MR SIR)

Topics to be covered

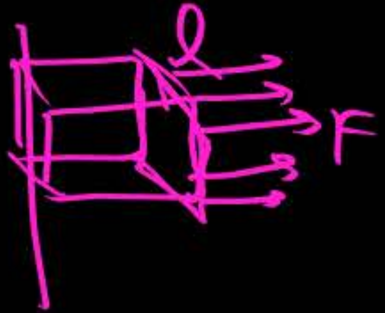
K.B.D

1. Elongation in different case
2. Graph between Stress - Strain
3. Series and Parallel Combination of wire

- Breaking stress



✡ Hooks नियम



$$\frac{F}{A} = Y \frac{(\Delta l)}{l_i}$$ → elongation / compn

l_i = initial length

l_f = final length

Δl = elongation.

Strain = $\frac{\Delta l}{l}$

Stress = F/A

F = Force / load

A = Area

r = radius

Stress = Y Strain

Y = Young modulus

✱ $\frac{F}{A} = \eta\theta$

$\frac{F}{A} = \Delta p = -\beta \frac{\Delta V}{V}$



✡ [compressibility $\sigma = \frac{1}{\beta}$]

% change in length = $\frac{\Delta l}{l} \times 100$

$$\frac{F}{l \times A} = Y \frac{\Delta l}{l \times l}$$

$$\left[\frac{F}{\text{Volume}}\right] = Y \frac{\Delta l}{l^2}$$

Kitne logone kal Yakeen+ ka lecture dekha hai??

(a) yes dekha hai (10%)??

(b) NO, Nahi dekha hai (64%)

(c) 2-3 lecture dekha hair; kal wala dekhenge (25%)

→ what is the reason???

(a) Backlog hai 18%

~~(b) tough lag raha hai~~ 7%

(c) Hamko dekha hi Nahi hain (6%)

(d) time manage Nahi horaha

→ 69%

Yakeen+ → Hamse alg Hai

Yakeen 2.0 ka Part hai

→ Yakeen+

QUESTION

Two wire A and B are stretched by same force. If, for A and B, $Y_A : Y_B = 1 : 2$, $r_A : r_B = 3 : 1$ and $l_A : l_B = 4 : 1$, then ratio of their extension $\left(\frac{\Delta l_A}{\Delta l_B}\right)$ will be

1. 10 : 13
2. 11 : 7
3. 8 : 9
4. 6 : 5

$$\frac{F}{A} = Y \frac{\Delta l}{l}$$

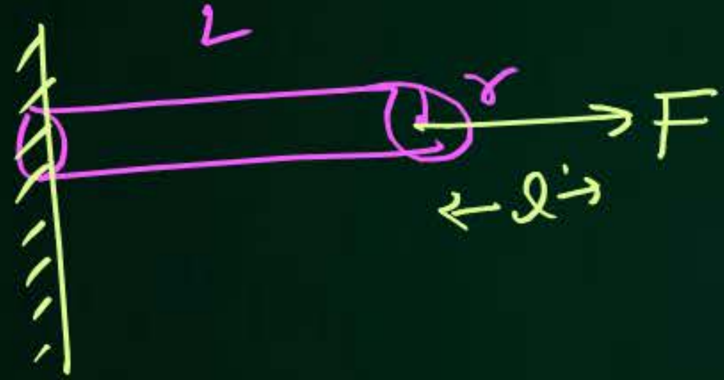
$$\Delta l \propto \frac{l}{AY} \propto \frac{l}{r^2 Y}$$

$$\frac{\Delta l_1}{\Delta l_2} = \frac{l_1}{l_2} \times \left(\frac{r_2}{r_1}\right)^2 \frac{Y_2}{Y_1} = \frac{4}{1} \times \left(\frac{1}{3}\right)^2 \times \frac{2}{1} = \frac{8}{9}$$

QUESTION

A wire of length L and radius r fixed at one end and a force F applied to the other end produces an extension l. The extension produced in another wire of the same material of length $2L$ and radius $2r$ by a force $2F$, is

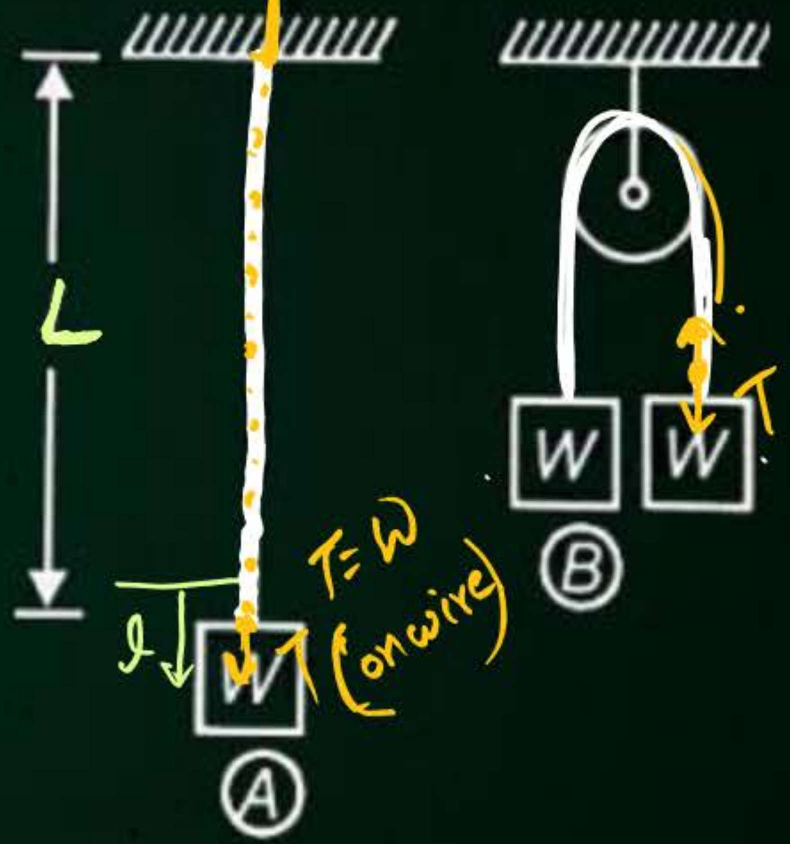
1. l
2. $2l$
3. $4l$
4. $l/2$



QUESTION

If in case A, elongation in wire of length L is l, then for same wire elongation in case B will be

1. $4l$
2. $2l$
3. l
4. $l/2$

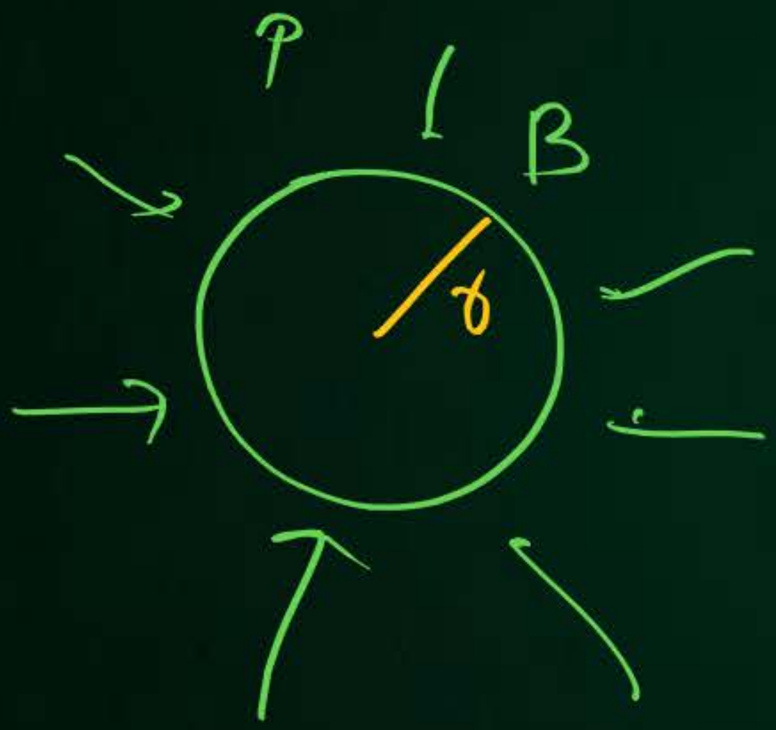


QUESTION

fractional change in volume $= \frac{\Delta V}{V}$

The bulk modulus of a spherical object is B. If it is subjected to uniform pressure p, the frictional decrease in radius is

1. $\frac{p}{B}$
2. $\frac{B}{3p}$
3. $\frac{3p}{B}$
4. $\frac{p}{3B}$



$$\Delta P = \beta \left[\frac{\Delta V}{V}\right]$$

$$p = \beta \frac{\Delta V}{V}$$

$$\frac{\Delta V}{V} = \frac{p}{\beta}$$

$$3\frac{\Delta r}{r} = \frac{p}{\beta}$$

$$V = \frac{4}{3}\pi r^3$$

$$\frac{\Delta V}{V} = 3\frac{\Delta r}{r}$$

$$\frac{\Delta r}{r} = \frac{p}{3\beta}$$

Ans

QUESTION

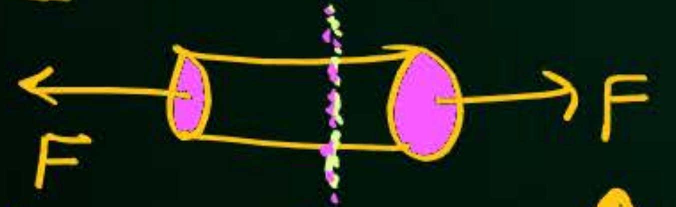
Find elongation.

$$\frac{F}{A} = Y\frac{\Delta l}{l}$$

$$\boxed{(\Delta l) = \frac{Fl}{AY}}$$

Case -1

Tension = F



elongative

[$F_{net} = 0$]

$a = 0$

elongative

$\Delta l = \frac{2Fl}{AY}$ ✗

$\Delta l = \frac{Fl}{AY}$ ✓

case-2



$$\# \ \Delta l = \left(\frac{F_1+F_2}{2}\right)\frac{l}{AY}$$

case-3



elongation

$F_2 > F_1$

$F_{net} = F_2 + F_1$

$$\Delta l = \left(\frac{F_2 - F_1}{2}\right)\frac{l}{AY}$$

case-4



$$\underbrace{\Delta l}_{\text{compn}} = \left(\frac{F_1+F_2}{2}\right)\frac{l}{AY}$$

case-5



$(F_2 > F_1)$ $\Delta l = \left(\frac{F_2 - F_1}{2}\right)\frac{l}{AY}$

case-6

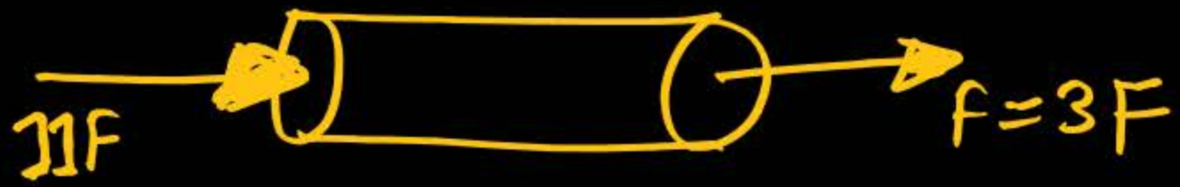


$\Delta l = 0$

case-7



$$\Delta l = \left(\frac{F+F}{2}\right)\frac{l}{AY} = Fl/AY$$



$$(\Delta l)_{comp^n} = \left(\frac{11F-3F}{2}\right)\frac{l}{AY}$$

$$= \frac{4Fl}{AY}$$

(Ans)



$$\Delta l = \frac{Fl}{AY}$$

(Q)



find elongat in this rod (Not massless)

(a) zero (70%)

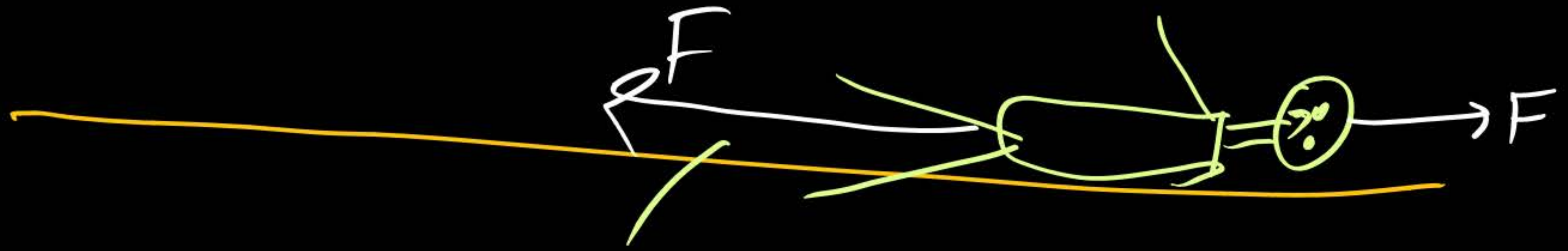
(b) $\frac{Fl}{2AY}$ (12%) correct

(c) $\frac{Fl}{AY}$

(d) infinite (6%)

$$\Delta l = \left(\frac{F+0}{2}\right)\frac{l}{AY}$$

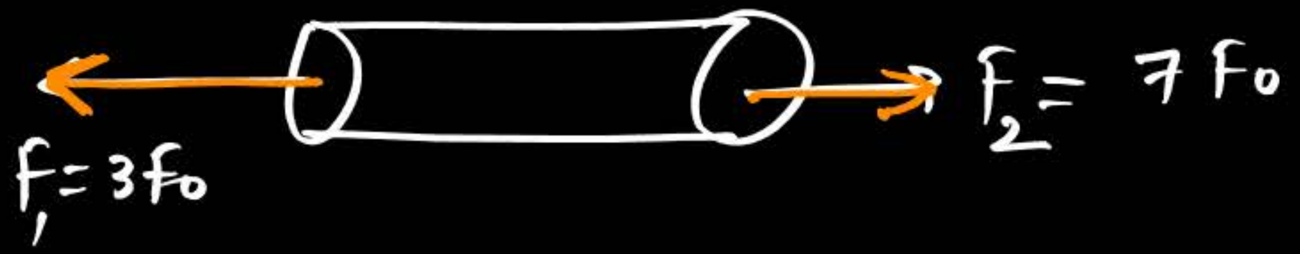
$$\Delta l = \frac{Fl}{2AY} \text{ Ans}$$


F
F

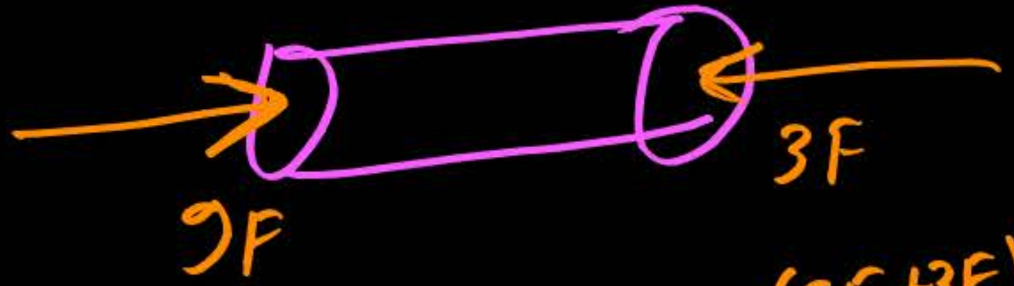
QUESTION

Find elongation.





$$\Delta l = \left(\frac{7F_0+3F_0}{2}\right)\frac{l}{AY} = \frac{5F_0 l}{AY}$$



$$\Delta l = \left(\frac{9F+3F}{2}\right)\frac{l}{AY}$$

$$= \frac{12Fl}{2AY}$$

$$= \frac{6Fl}{AY}$$



$$\Delta l = \left(\frac{8F-3F}{2}\right)\frac{l}{AY} = \frac{5Fl}{2AY}$$

QUESTION

Compression

A spherical ball contracts in volume by 0.01% when subjected to a normal uniform pressure of 100 atm. The Bulk modulus of its material is

1. 1.01×10^{11} N m^{-2} ✓
2. 1.01×10^{12} N m^{-2}
3. 1.01×10^{10} N m^{-2}
4. 1.0×10^{13} N m^{-2}

$\Rightarrow \frac{\Delta V}{V} \times 100 = -0.01$

$P = 100$ atm

$= 100 [10^5]$ Pascal

$P = 100 \times 10^5$ Pa

$P = -\beta \frac{\Delta V}{V}$

$100 \times 10^5 = \beta \left(\frac{0.01}{100} \right)$

$10^7 = \beta\, 10^{-4}$

$\beta = 10^{11}$

1 atm $= 1.01 \times 10^5$ Pa

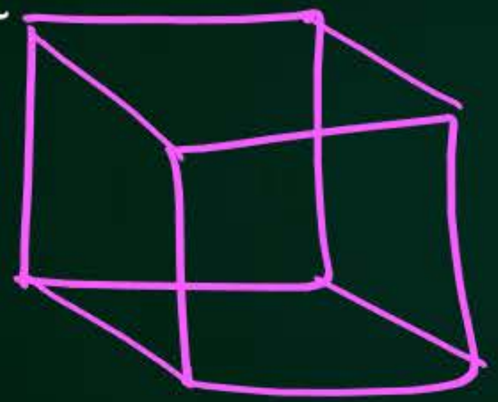
QUESTION

A uniform cubical block is subjected to volumetric compression, which decreases its each side by 2%. The bulk strain produced in it is

1. 0.03
2. 0.02
3. 0.06
4. 0.12

$\frac{\Delta V}{V}$ = Bulk Strain

$\frac{\Delta l}{l} \times 100 = 2\%$



$V = l^3$

$\frac{\Delta V}{V} \times 100 = 3\left(\frac{\Delta l}{l} \times 100\right)$

$= 3 \times 2$

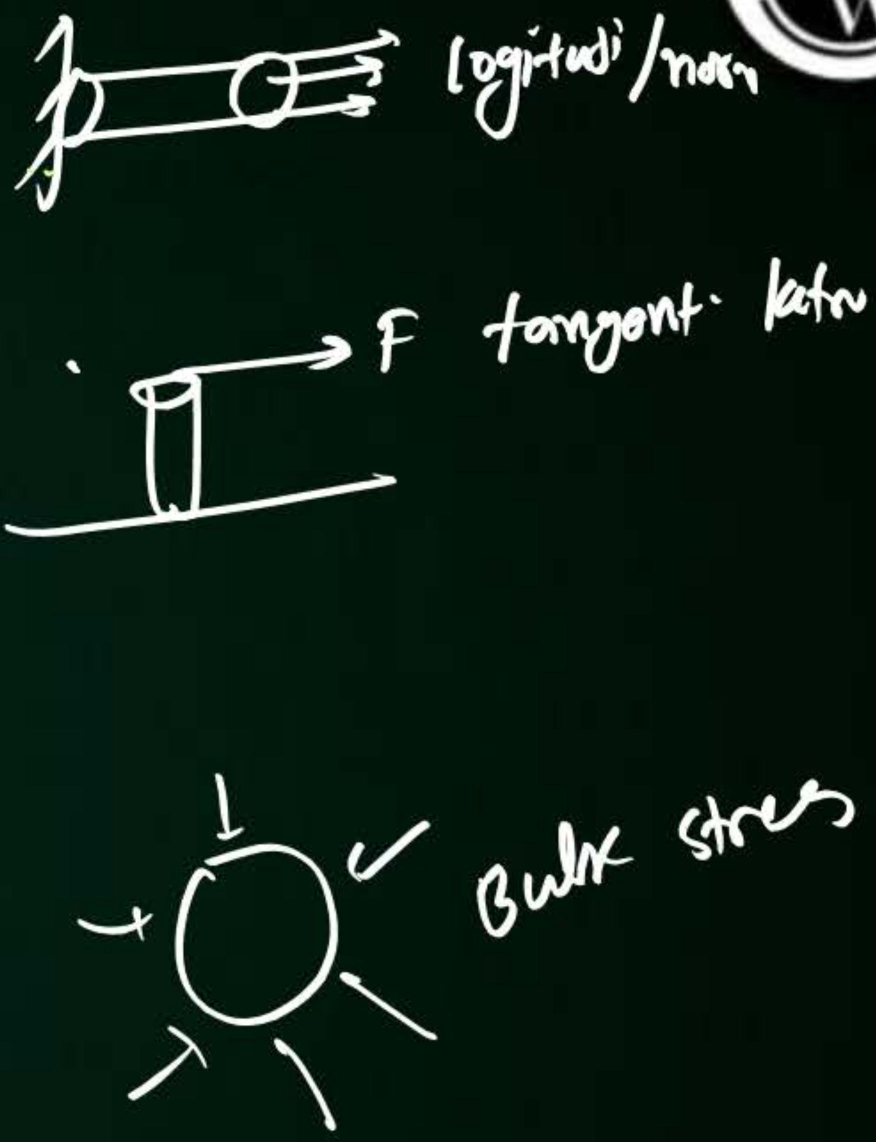
$\frac{\Delta V}{V} \times 100 = 6$

$\frac{\Delta V}{V} = \frac{6}{100}$

QUESTION

Correct pair is

1. Change in shape – Longitudinal strain
2. Change in volume – Shear strain
3. Change in length – Bulk strain
4. Reciprocal of Bulk modulus - Compressibility



QUESTION

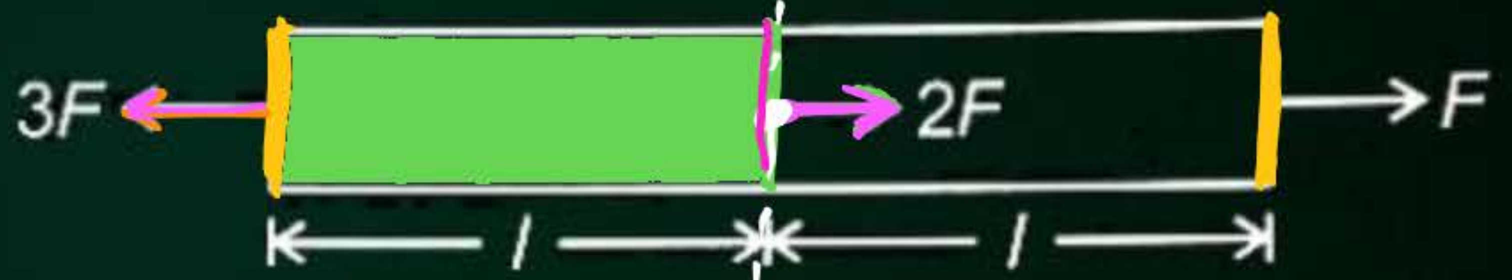
Find elongation.



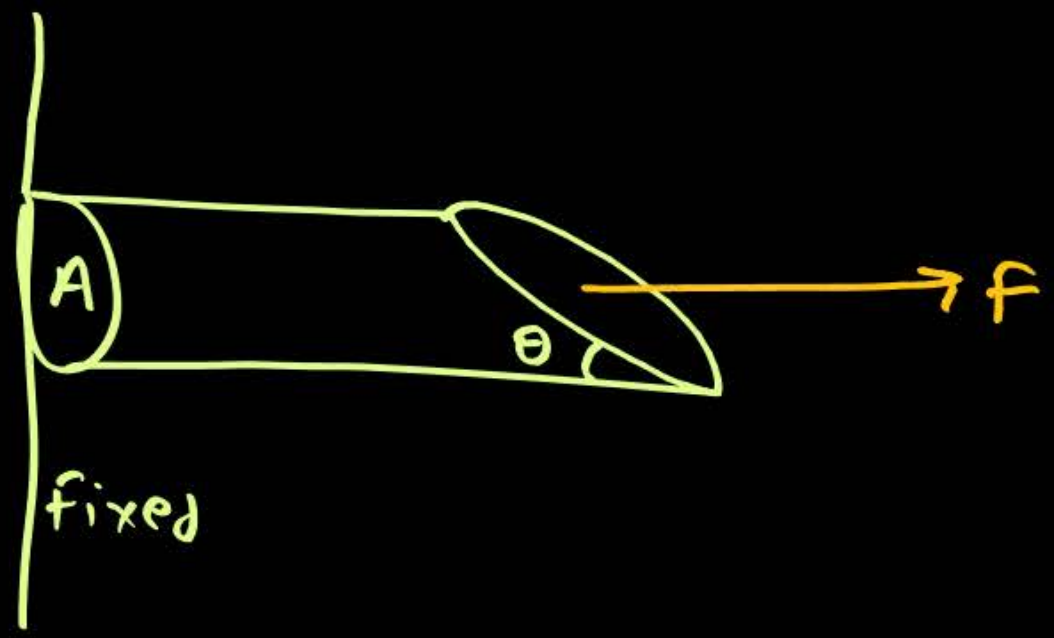
QUESTION

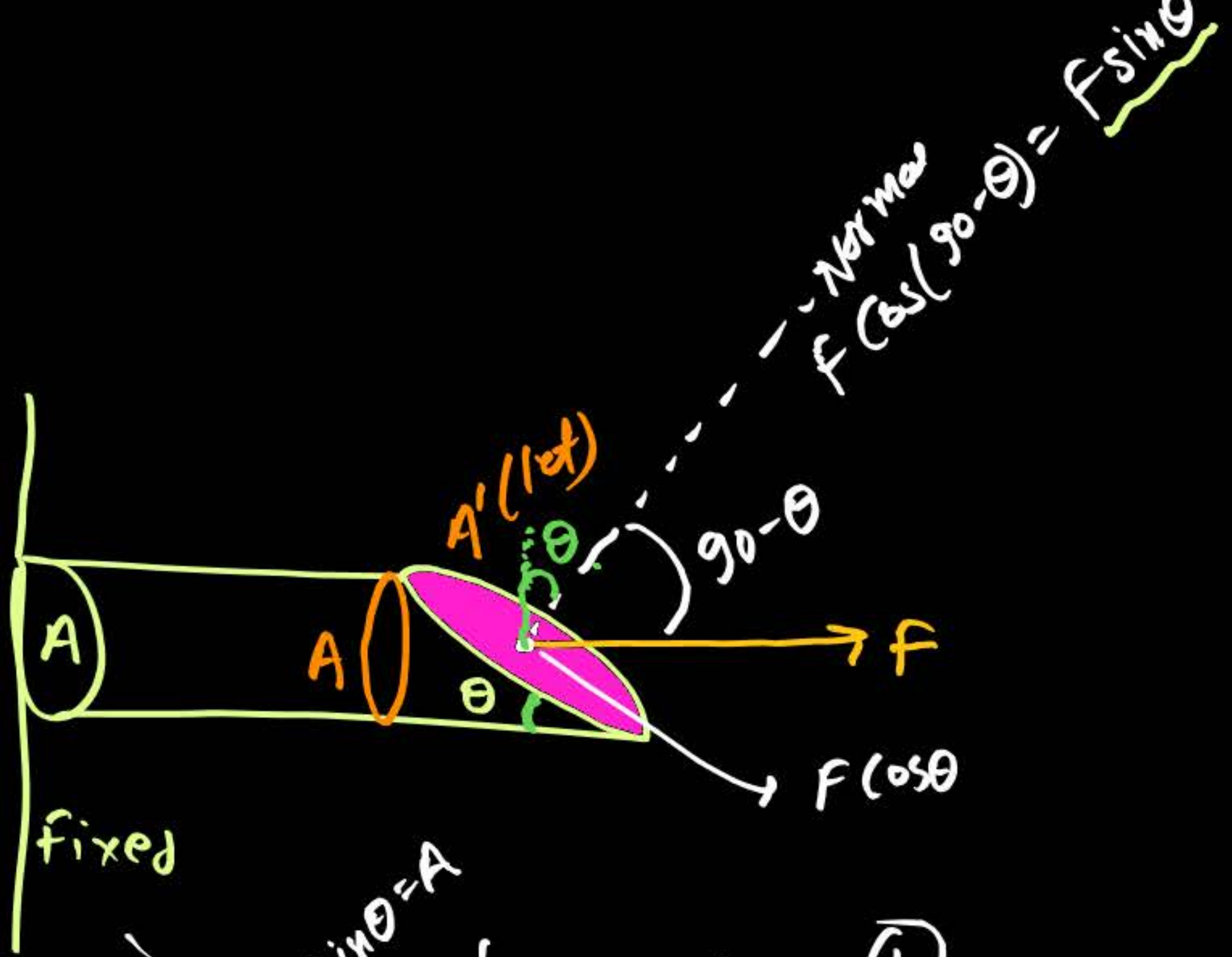
A bar is subjected to axial forces as shown. If E is the modulus of elasticity of the bar and A is its cross-section area. Its elongation will be

1. $\frac{Fl}{AE}$
2. $\frac{2Fl}{AE}$
3. $\frac{3Fl}{AE}$
4. $\frac{4Fl}{AE}$



Find normal / longitudinal stress in given Rod ??







$$A' \sin\theta = A \quad \text{— (1)}$$

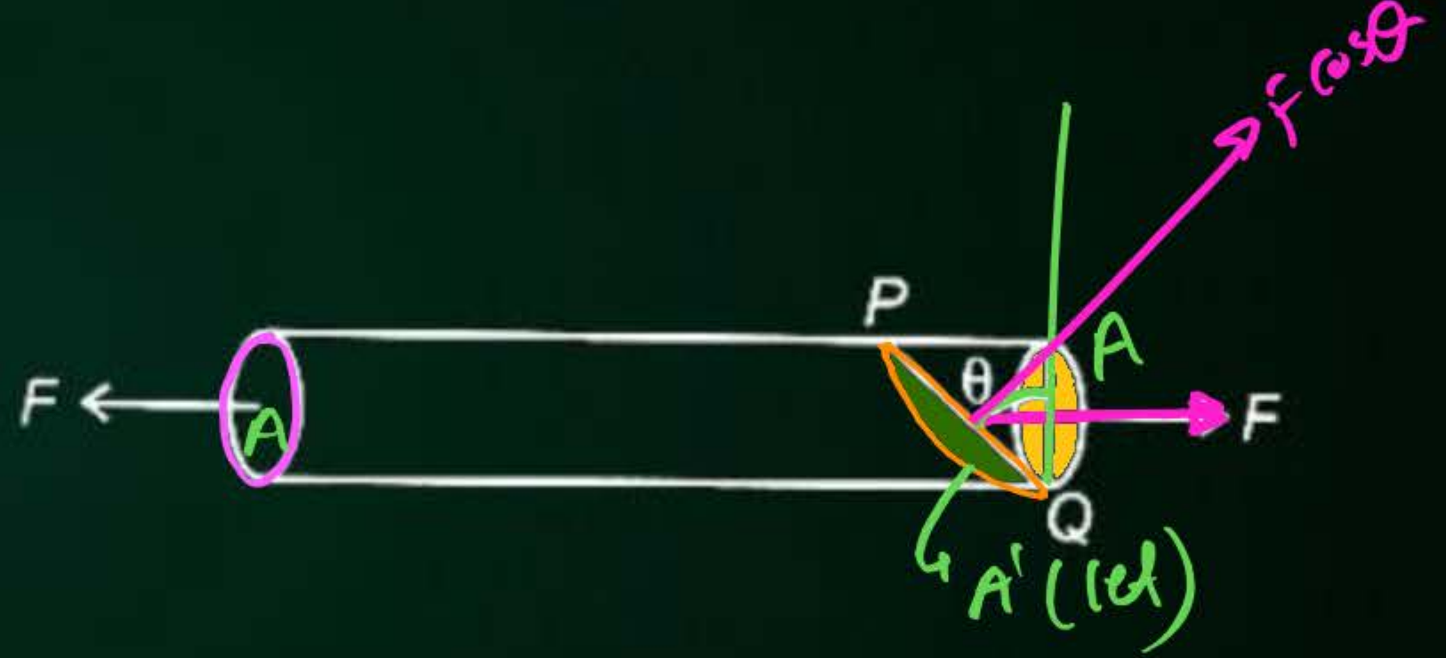
$$\text{Stress} = \frac{F\sin\theta}{A'} = \frac{F\sin\theta}{\frac{A}{\sin\theta}}$$

$$\text{stress} = \frac{F}{A}\sin^2\theta$$

QUESTION

Two equal and opposite forces each of magnitude F is applied along a rod of transverse sectional area A. The normal stress to a section PQ inclined to transverse section is

1. $\frac{F\sin\theta}{A}$



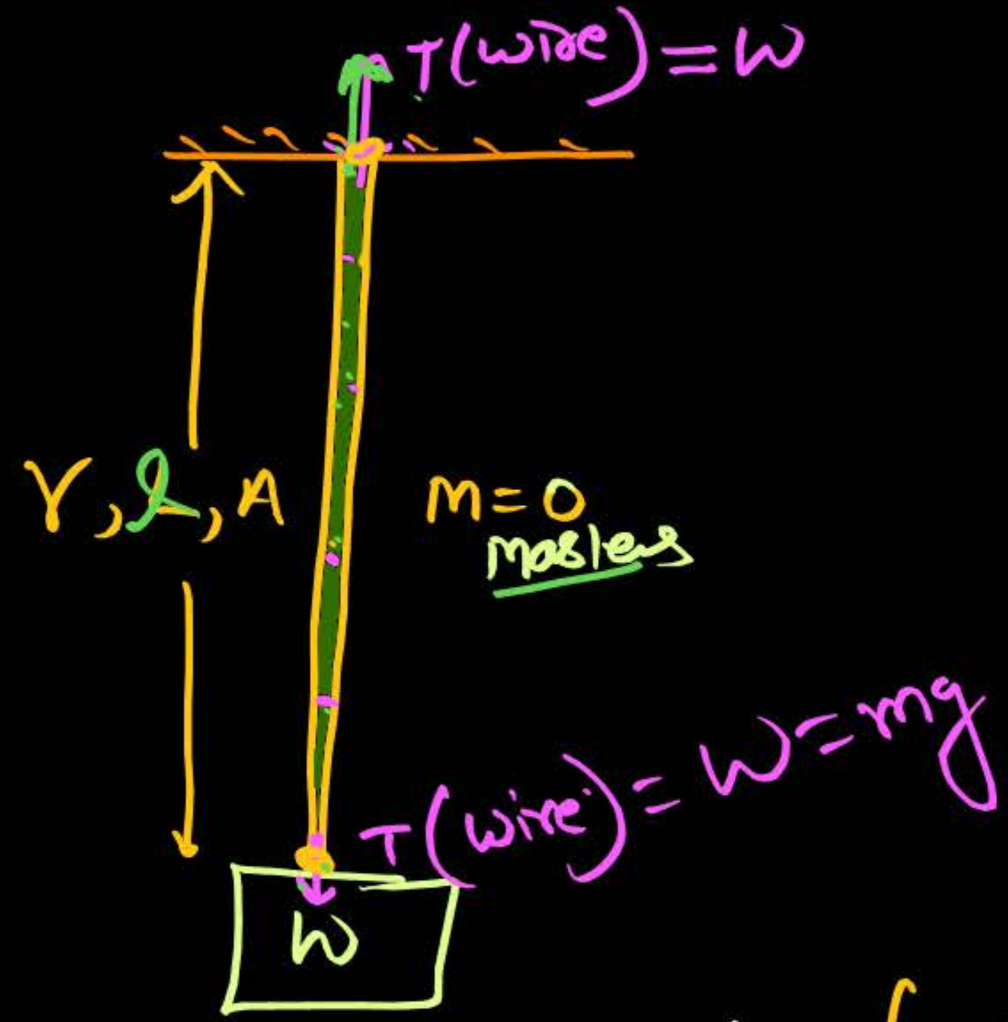
2. $\frac{F}{A}\cos\theta$

3. $\frac{F}{2A}\sin 2\theta$

4. $\frac{F}{A}\cos^2\theta$

Ans

elongation in a massless wire due to attached weight (W)





$$\Delta l = \frac{Fl}{AY} = \frac{Wl}{AY} = \frac{mgl}{AY}$$

$$\Delta l = \frac{mg\, l \times l}{A Y \times l} = \frac{mg\, l^2}{VY} \propto l^2$$

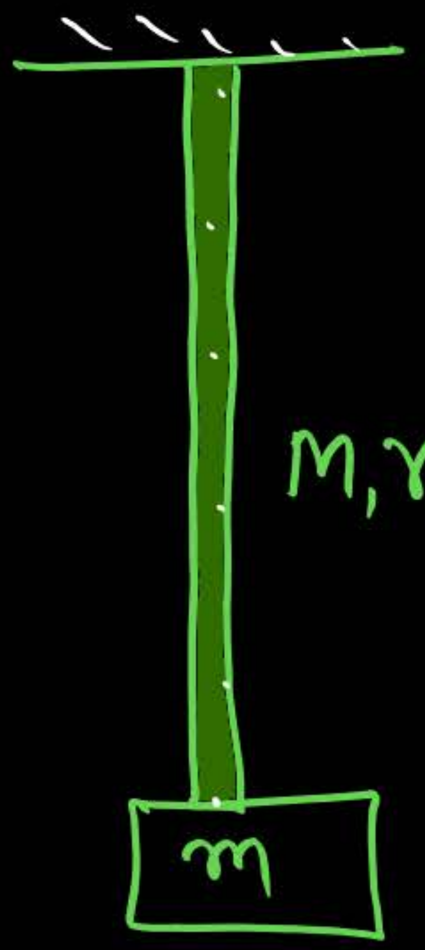
(elongation)

elongation in massive Rod due to its own weight



$$\boxed{\Delta l = \frac{Mgl}{2AY}}$$

$$\Delta l = \left(\frac{0 + Mg}{2}\right)\frac{l}{AY} = \frac{Mg}{2AY}$$

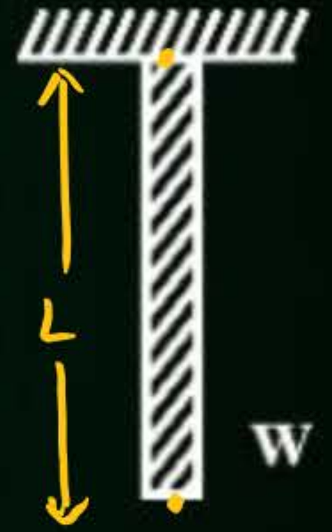


$$\Delta l = \left(\frac{M}{2} + m\right)\frac{gl}{Ar}$$ Ans.

QUESTION

A rod of uniform cross sectional area A and length L has a weight W. It is suspended vertically from a fixed support. If Young's modulus for rod is Y, then elongation produced in rod is

1. $\frac{WL}{YA}$
2. $\frac{WL}{2YA}$
3. $\frac{WL}{4YA}$
4. $\frac{3WL}{4YA}$





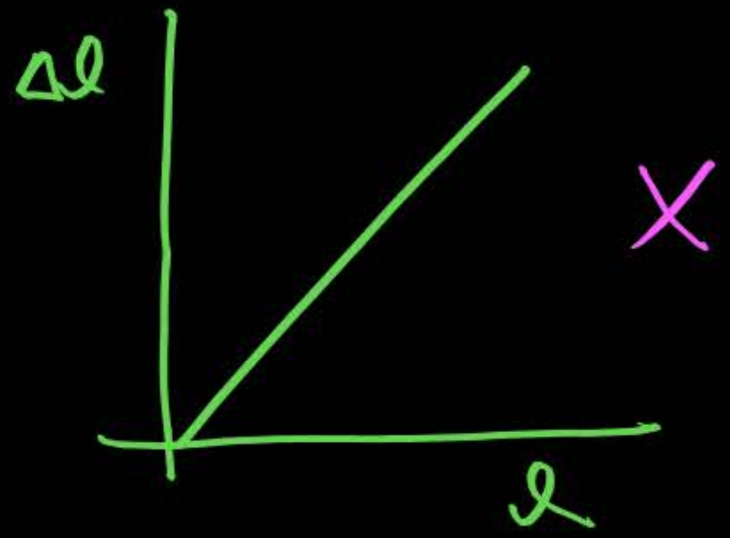
← elongation in a rod due to it own weight (W) is Δl

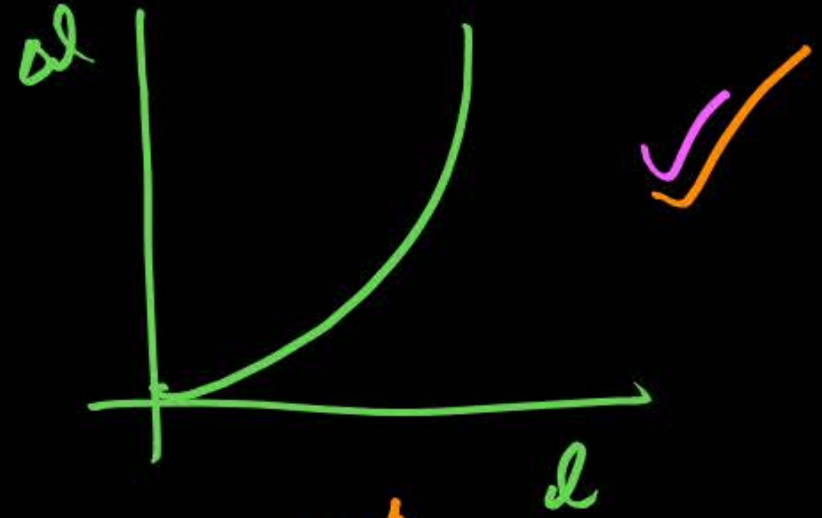
$$\Delta l = \frac{mgl}{2AY} \times \left(\frac{l}{l}\right)$$

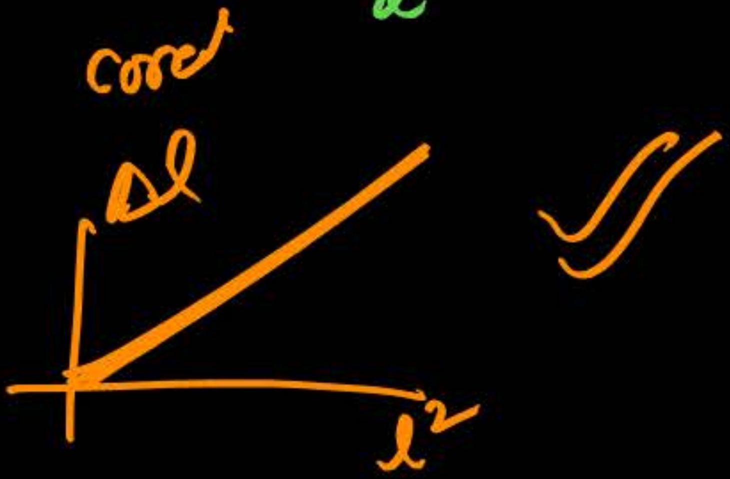
$$\Delta l = \frac{mgl^2}{2VY}$$

Const

$$\boxed{\Delta l \propto l^2}$$



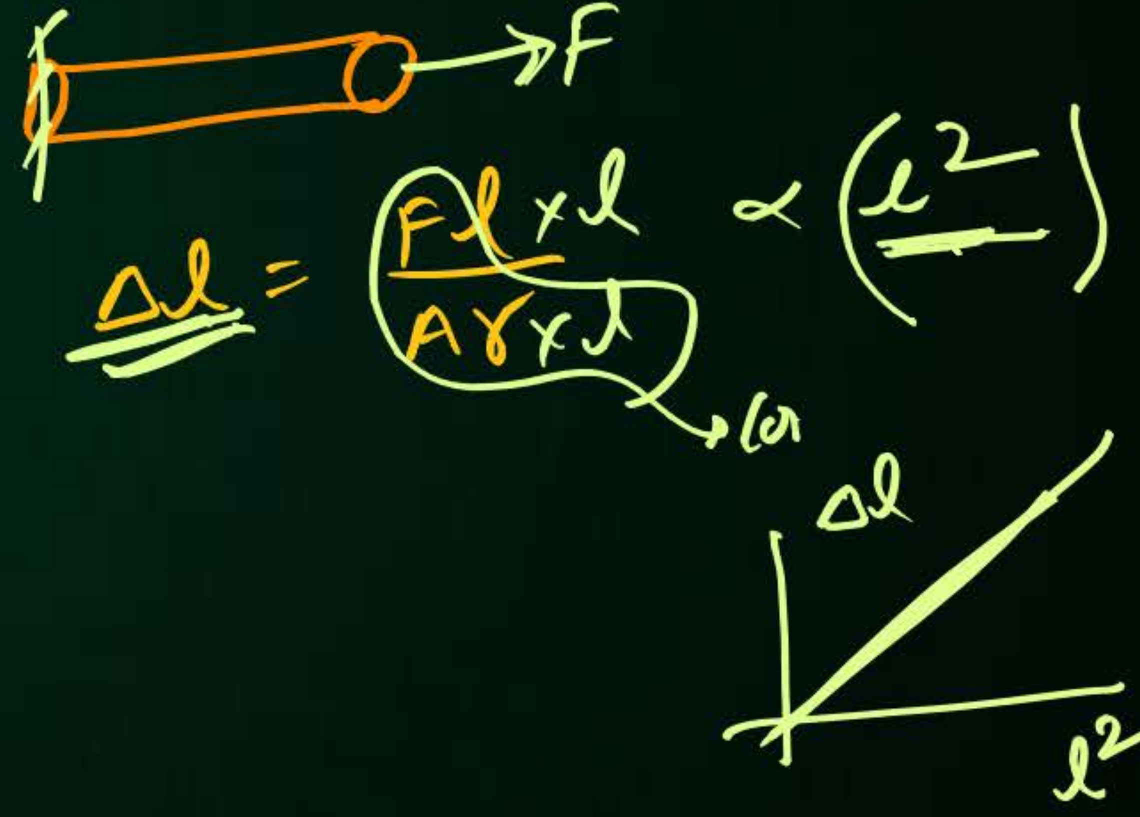




QUESTION

Copper of fixed volume V is drawn into wire of length l. When this wire is subjected to a constant force F, the extension produced in the wire is Δl. Which of the following graphs is a straight line?

1. Δl versus $\frac{1}{l}$
2. Δl versus l^2
3. Δl versus $\frac{1}{l^2}$
4. Δl versus l



QUESTION

The length of wire, when M_1 is hung from it, is l_1 and is l_2 with both M_1 and M_2 hanging. The natural length of wire is

(1) $\frac{M_1}{M_2}(l_1 - l_2) + l_1$ ✓

(2) $\frac{M_2 l_1 - M_1 l_2}{M_1 + M_2}$

(3) $\frac{l_1 + l_2}{2}$

(4) $\sqrt{l_1 l_2}$

l_1 → final length

elongation $= l_1 - l_0$

l_2 = final length

$l_1 - l_0 = \frac{m_1 g l_0}{AY}$ — (1)

$l_2 - l_0 = \frac{(m_1+m_2) g l_0}{AY}$

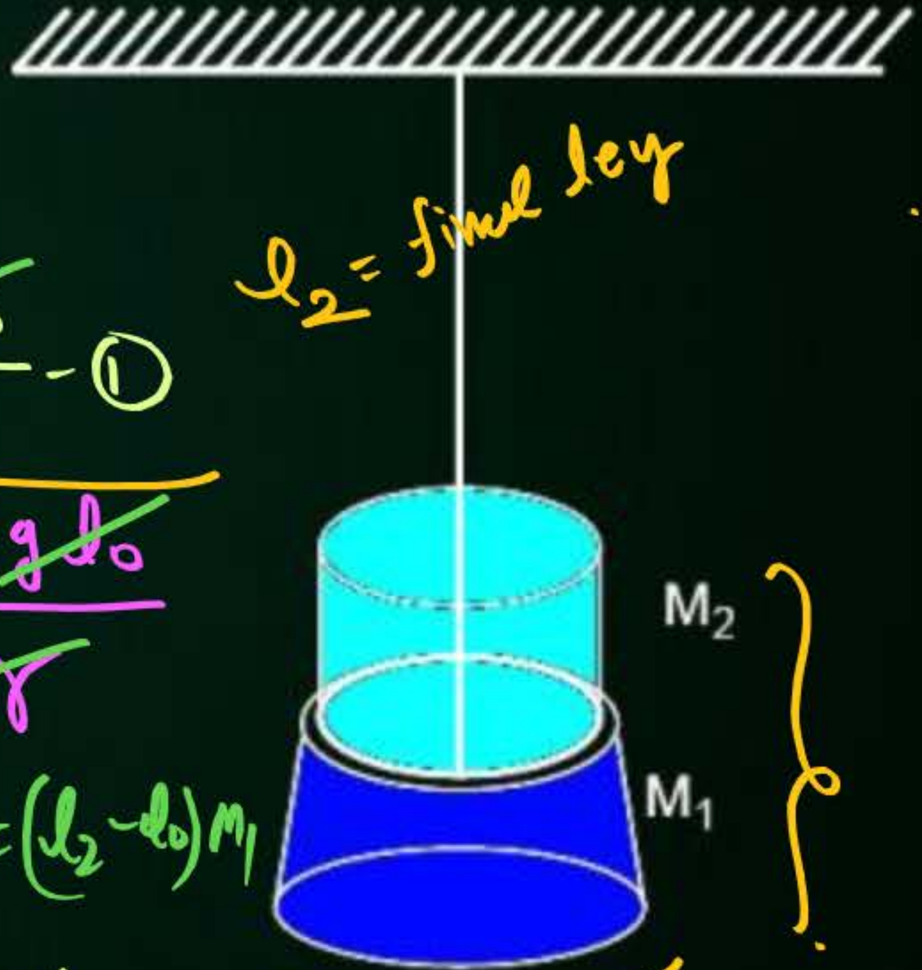
$(l_1 - l_0)(m_1+m_2) = (l_2 - l_0) m_1$

$m_1 l_1 + m_2 l_1 - m_1 l_0 - m_2 l_0 = l_2 m_1 - l_0 m_1$

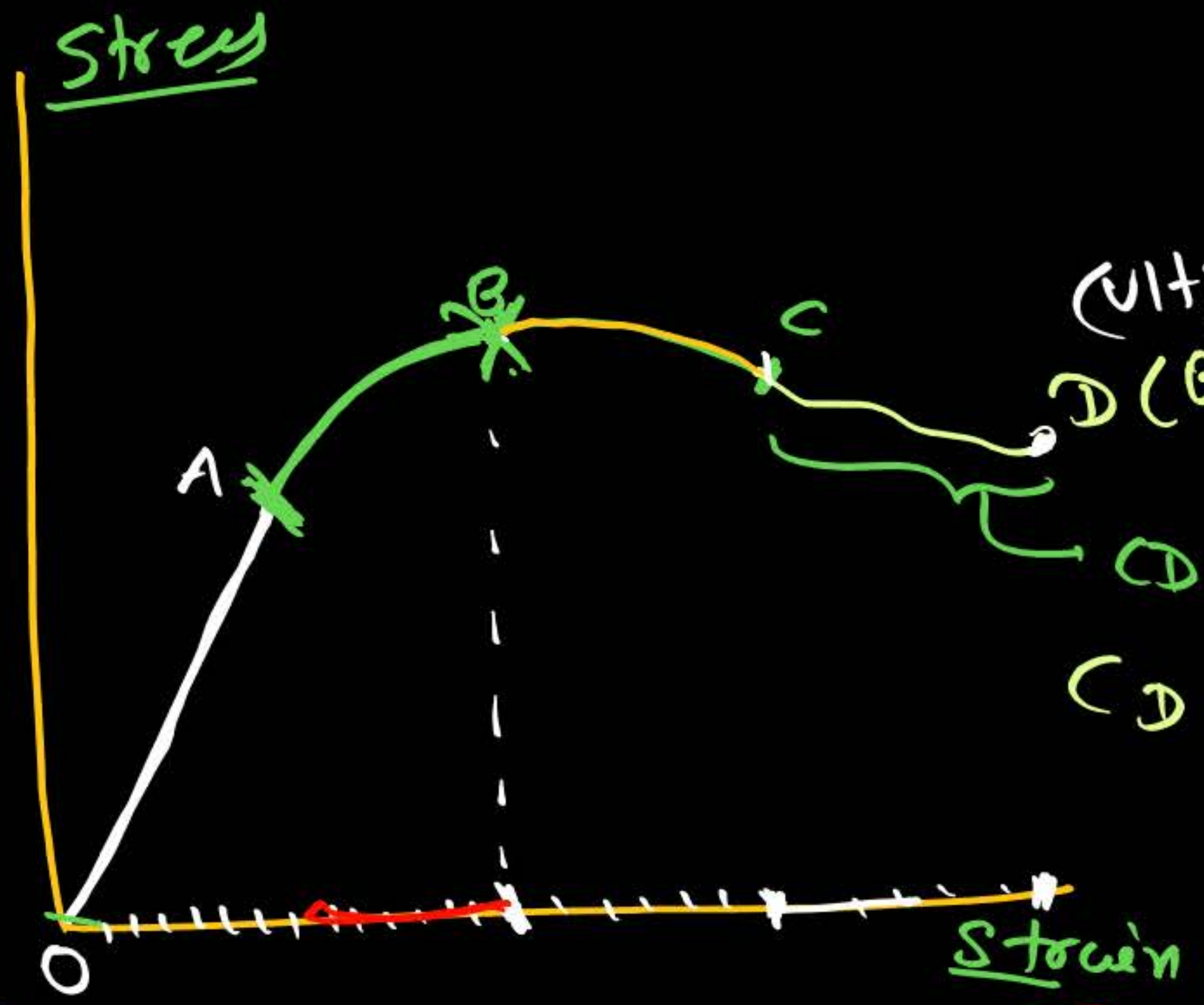
$m_1 l_1 + m_2 l_1 - l_2 m_1 = m_2 l_0$

$l_0 = \frac{m_1}{m_2} l_1 + l_1 - l_2 \frac{m_1}{m_2}$

$= \frac{m_1}{m_2}(l_1 - l_2) + l_1$



Stress-strain curve



CD → large → Ductile.
CD → small → Brittle.

BC → Inelastic limit
→ Hooks law not valid
→ elastic force Non conservative
→ shape Partially regain.

CD → Plastic regain
→ shape Not regain.

D → Breaking Point

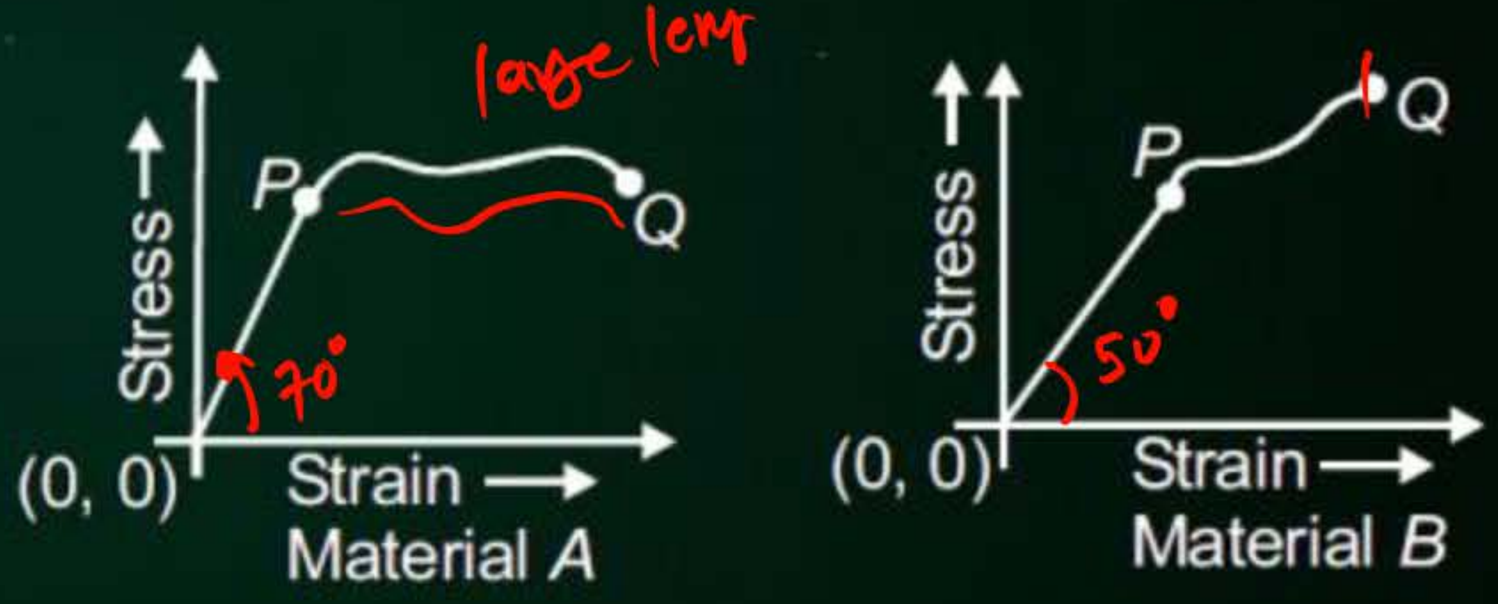
OA → Propotional limit
→ Hooks चाचा Valid
→ elastic force Conservative
→ Shape compt regain.

AB → elastic limit
→ Hooks चाचा Ka law not valid
→ elastic force Conservative
→ Shape compt regain.

QUESTION

The stress-strain graphs for two materials A and B are shown in figure. The graphs are drawn to the same scale. Select the correct statement

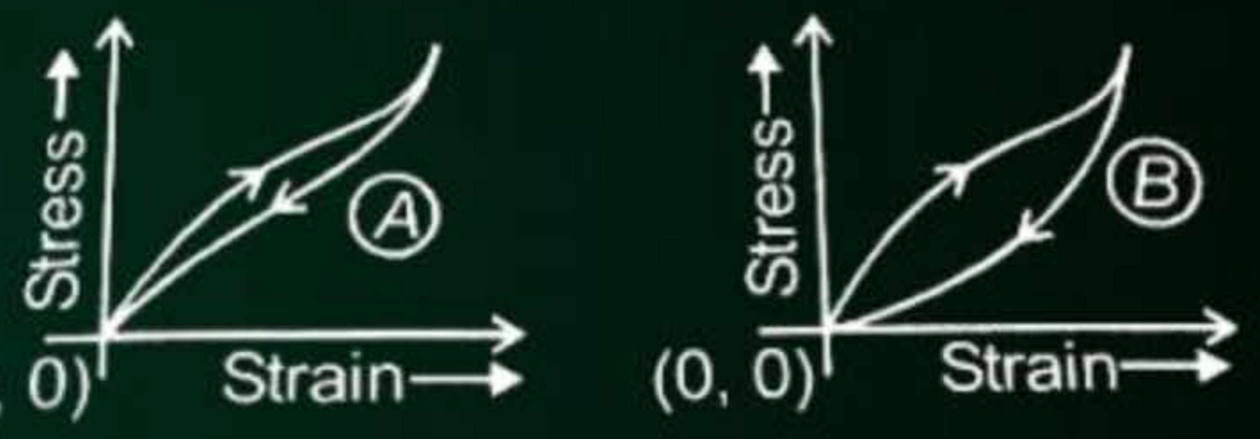
1. Material A has greater Young's Modulus
2. Material A is ductile
3. Material B is brittle
4. All of these



QUESTION

Two different types of rubber are found to have the stress-strain curves as shown. Then

1. A is suitable for shock absorber
2. B is suitable for shock absorber
3. B is suitable for car tyres
4. None of these



QUESTION

The stress-strain curves are down for two different materials X and Y. It is observed that the ultimate strength point and the fracture point are close to each other for material X but are far apart for material Y. We can say that materials X and Y are likely to be (respectively)

1. Plastic and ductile
2. Ductile and brittle
3. Brittle and ductile
4. Brittle and plastic

QUESTION

A rope 1 cm in diameter breaks, if the tension in it exceeds 500 N. The maximum tension that may be given to similar rope of diameter 3 cm is

1. 500 N
2. 3000 N
3. 4500 N
4. 2000 N


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 03 | Physics

Mechanical Properties of Solid

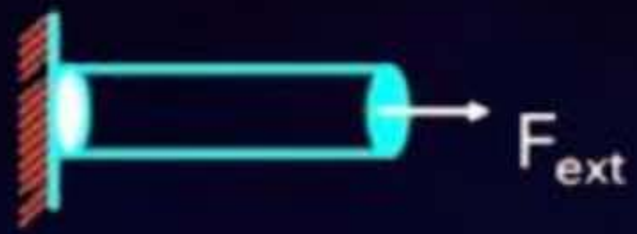
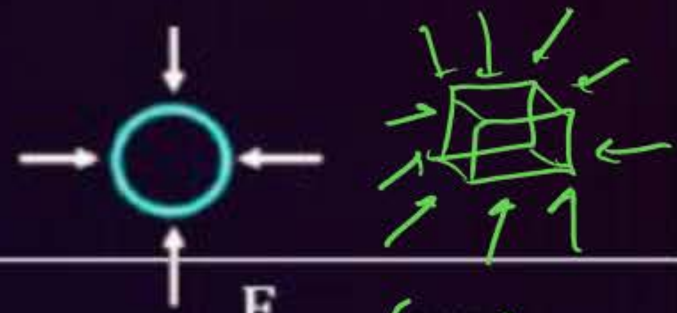


By- Dr. Manish Raj (MR SIR)

Topics to be covered

1. Breaking stress
2. Elastic potential energy
3. Twist & shear angle



Normal/longitudinal stress → strain	[redacted] Tangential / shear stress & strain	[redacted] volumetric stress / Bulk stress
		
$\text{Stress} = \frac{F}{A}$	shear $\text{Stress} = \frac{F}{A}$	$\text{Stress} = \frac{F}{A} = (\Delta P)$
• Scalar; • N/m^2	shear $\text{Strain}(\theta) = \frac{\Delta \ell}{\ell}$	$\text{Strain} = \frac{-\Delta V}{V}$
$\text{Strain} = \frac{\Delta \ell}{\ell}$	$\frac{F}{A} = \eta\theta$	$\frac{F}{A} = -\beta \frac{\Delta V}{V}$
$\frac{F}{A} = Y \frac{\Delta \ell}{\ell}$ (Young modulus)	$\eta \rightarrow$ modulus of rigidity	β = Bulk modulus for solid,
# only for solid	only for solid	liquid and gas.
$Y \propto \frac{1}{\text{Temp}}$		compressibility $\propto 1/\beta$

$\beta_{solid} > \beta_{liq} > \beta_{gas}$

QUESTION

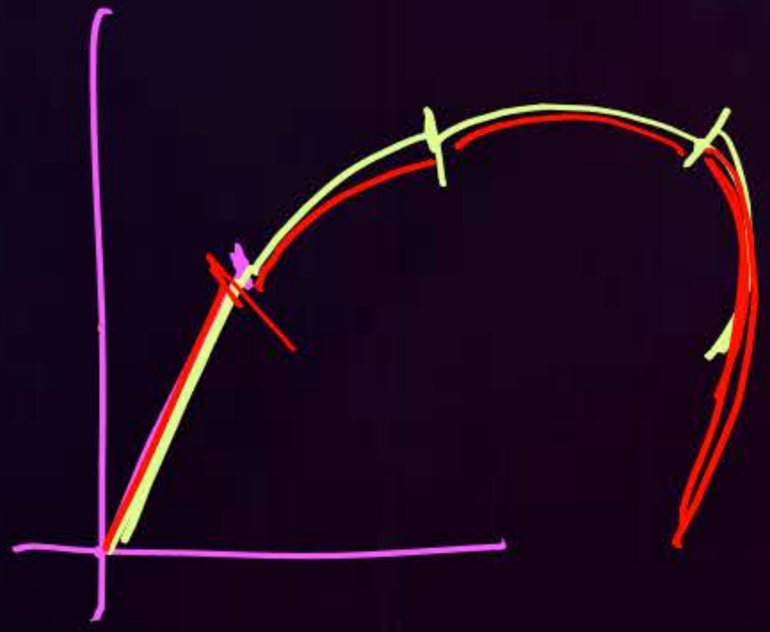
The stress-strain curves are drawn for two different materials X and Y. It is observed that the ultimate strength point and the fracture point are close to each other for material X but are far apart for material Y. We can say that materials X and Y are likely to be (respectively) **[Odisha NEET 2019]**

(A) ductile and brittle

(B) brittle and ductile

(C) brittle and plastic

(D) plastic and ductile



QUESTION

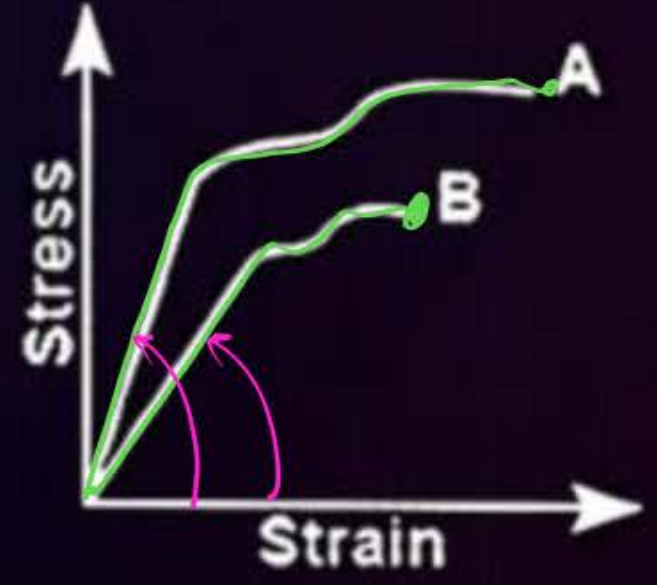
The stress-strain curve for two materials A and B are as shown in the figure. Select the correct statement-

(A) Material A is less brittle and less elastic as compared to B

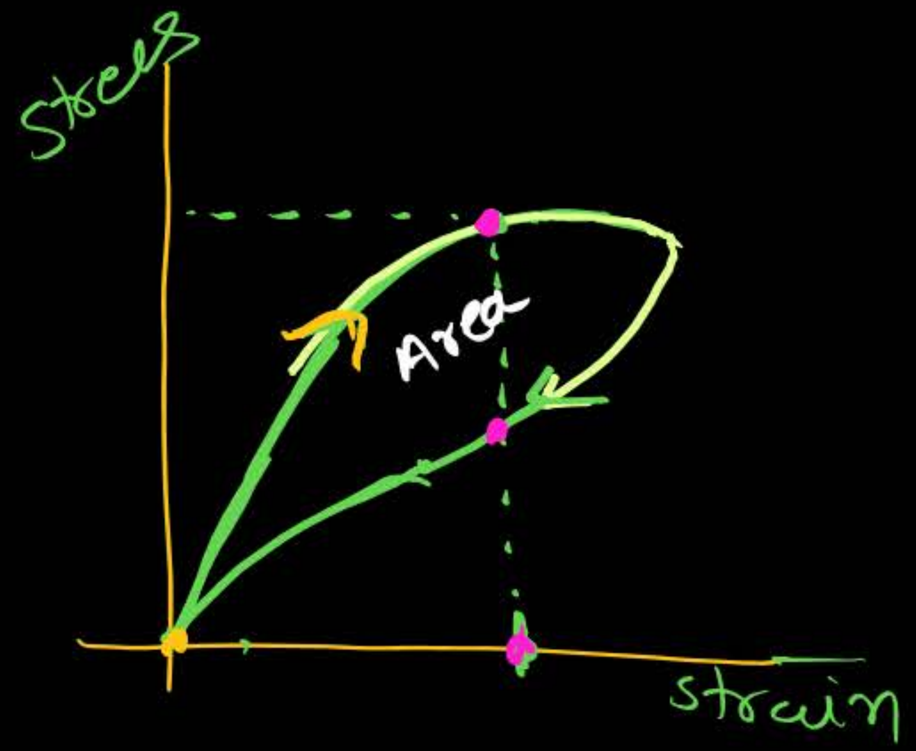
(B) Material A is more ductile and less elastic as compared to B

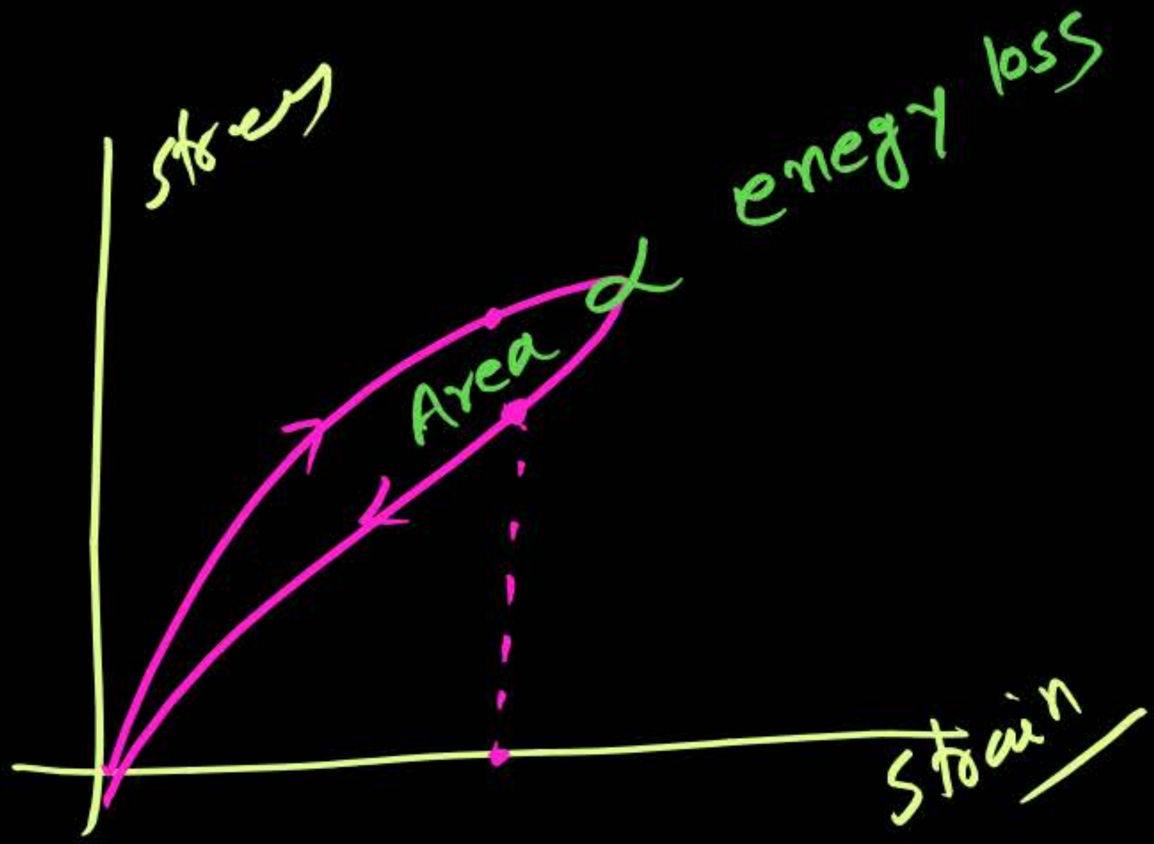
(C) Material A is less brittle and more elastic than B

(D) Material B is more brittle and more elastic than A



elongation - & - compression



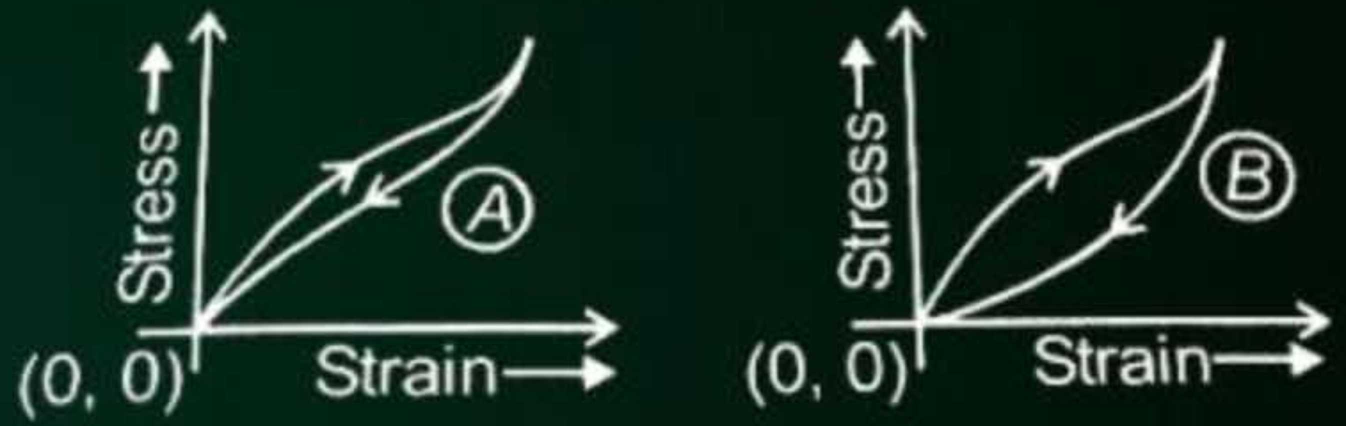


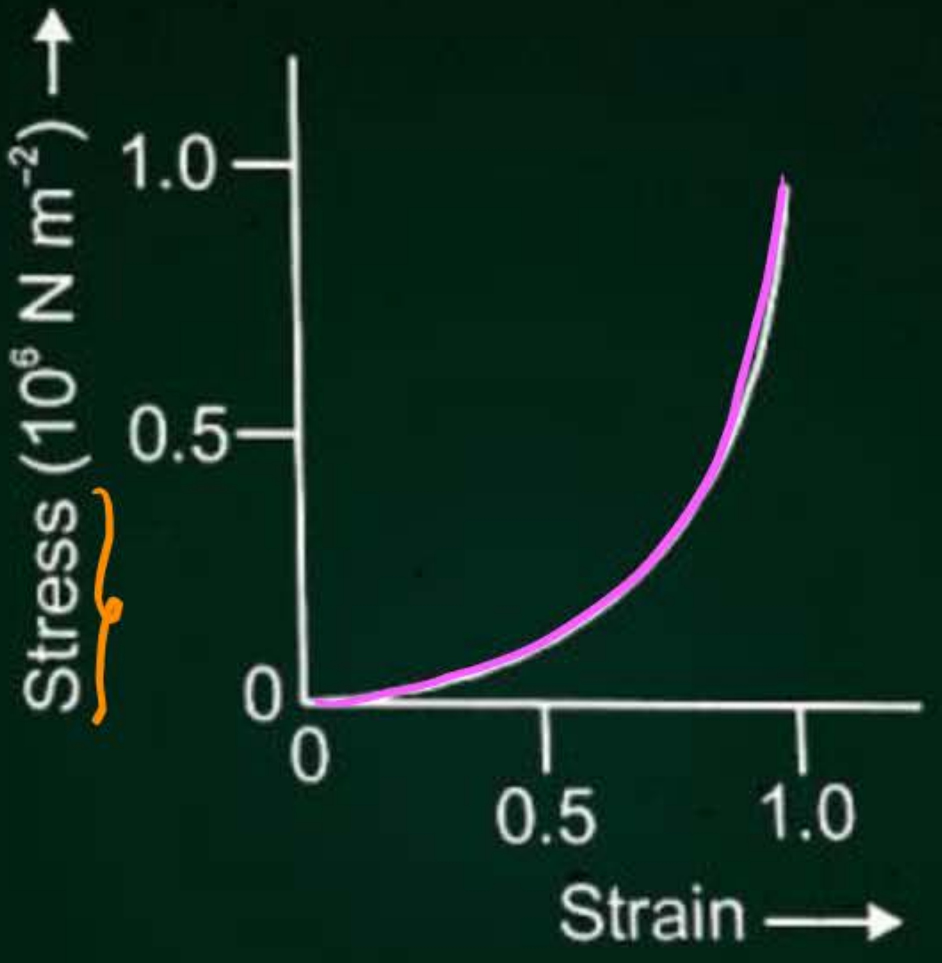
Stress → Strain ke karan aata hai

QUESTION

Two different types of rubber are found to have the stress-strain curves as shown. Then

1. A is suitable for shock absorber
2. B is suitable for shock absorber
3. B is suitable for car tyres
4. None of these





[redacted] Stress-strain curve for the elastic tissue of Aorta, the large tube (vessel carrying blood from the heart).

Bulk Modulus of gas in different Process

$$\beta = -\frac{\Delta P}{\left(\frac{\Delta V}{V}\right)}$$

① Isobaric Process

$P = \text{Const}^n$

$\Delta P = 0$

$$\beta = -\frac{\Delta P}{\left(\frac{\Delta V}{V}\right)} = 0$$

② Isochoric Process

$V = \text{Const}^n$

$\Delta V = 0$

$$\beta = -\frac{\Delta P V}{(\Delta V) \to 0} = \text{infinite}$$

③ Isothermal Process

$T = \text{Const}^n$

$PV = \text{Const}^n$

$$\frac{\Delta P}{P} + \frac{\Delta V}{V} = 0$$

$$\frac{\Delta P}{P} = -\frac{\Delta V}{V}$$

$$\left\{\frac{\Delta P}{-\frac{\Delta V}{V}}\right\} = P$$

$$\boxed{\beta = P \text{ (Pressure)}}$$

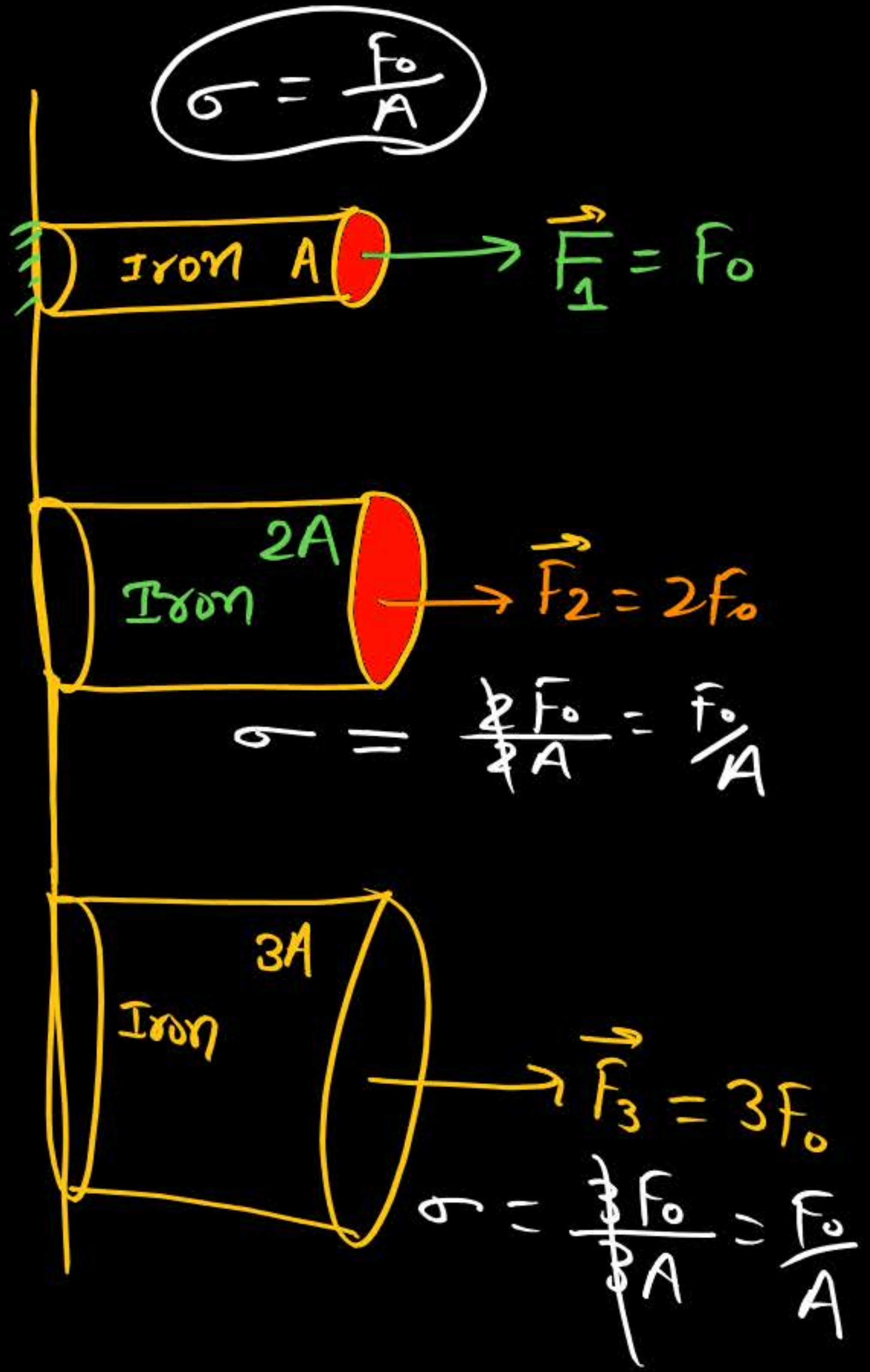
④ adibatic pross

$PV^\gamma = \text{Const}^n$

$$\frac{\Delta P}{P} + \gamma\frac{\Delta V}{V} = 0$$

$$-\frac{\Delta P}{P} = \gamma\frac{\Delta V}{V}$$

$$-\frac{\Delta P}{\frac{\Delta V}{V}} = \boxed{\gamma P = \beta}$$



Breaking force $\propto$ Area

Breaking force $= \sigma A$

σ → Proportional const^n. → depends on nature of material

$$\sigma = \frac{\text{Breaking force}}{\text{Area}}$$

σ → Breaking stress

σ does not depends on Area.

Breaking Stress

QUESTION

A force F is needed to break a copper wire having radius R. The force needed to break a copper wire of radius 2R will be:

1. F/2
2. 2F
3. 4F ✓
4. F/4

$F \propto \text{Area} \propto \pi R^2$

$F \propto R^2$

$\frac{F}{F'} = \frac{R^2}{(2R)^2} = \frac{R^2}{4R^2}$

$4F = F'$

- **Breaking Force → Minimum force required to break the rod.**
- **Breaking ~~Force~~ stress → Minimum stress at which rod will break** = depend on nature

Breaking force ∝ Area

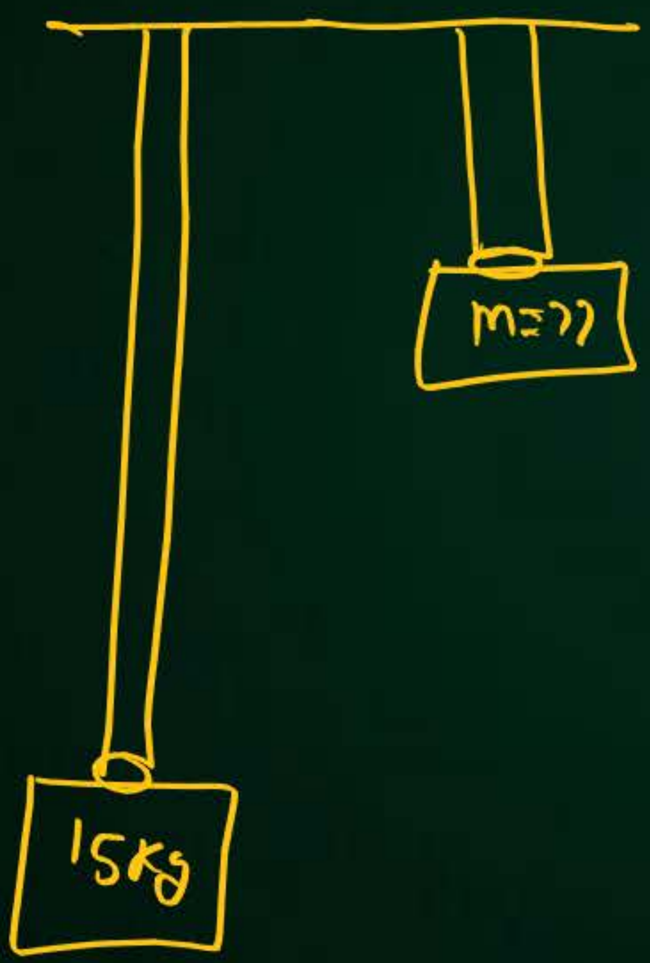
Breaking force = σ Area

$$\sigma = \frac{F}{Area}$$

QUESTION

A wire can sustain a weight of 15 kg. If it cut into four equal parts, then each part can sustain a weight

1. 5 kg
2. 45 kg
3. 15 kg (80%)
4. 30 kg



QUESTION

A rod is hung vertical then find minimum length of which it will break due to its own weight.

Breaking force $= \sigma A$

$$Mg = \sigma A$$

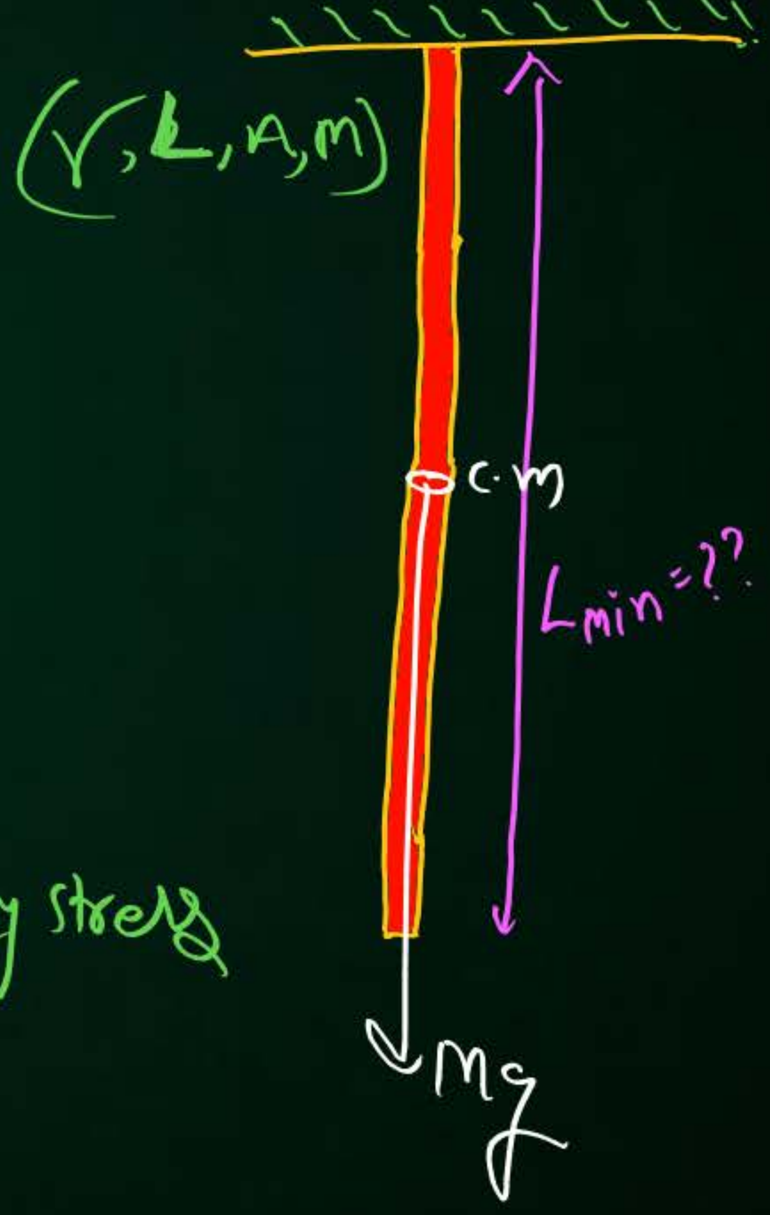
$$\rho A L g = \sigma A$$

density

$$L_{min} = \frac{\sigma}{\rho g}$$

σ ← Breaking stress

ρ ← density



QUESTION

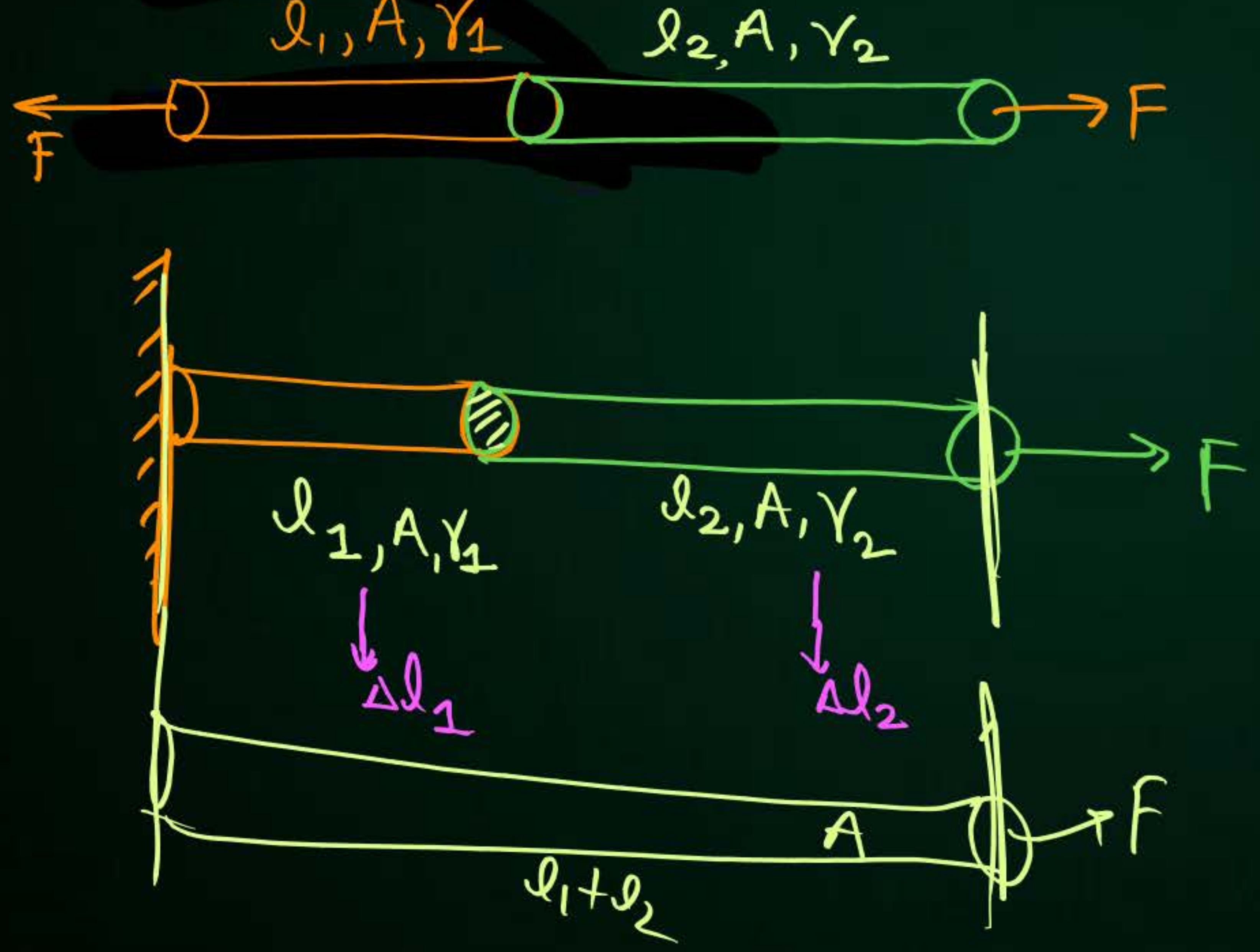
The breaking stress of aluminium is 7.5×10^{7} N m^{-2}. The greatest length of aluminium wire that can hang vertically without breaking is
(Density of aluminium is 2.7×10^{3} kg m^{-3}

1. 283×10^{3} m
2. 28.3×10^{3} m
3. 2.83×10^{3} m
4. 0.0283×10^{3} m

$L_{max} = \frac{\sigma}{\rho g} = \frac{7.5 \times 10^{4}}{2.7 \times 10}$

$= 2.8 \times 10^{3}$

Series Combination of Wire



✡ Stress = F/A will be same in both wire

✡ elongatation (strain) will be different

Hooks नियम

$$\left(\frac{F}{A}\right) = Y \frac{\Delta l}{l}$$

Total elongation

$$\Delta l = \Delta l_1 + \Delta l_2$$

$$\frac{F(l_1+l_2)}{A\, Y_{eq}} = \frac{F l_1}{A Y_1} + \frac{F l_2}{A Y_2}$$

$$\frac{l_1+l_2}{Y_{eq}} = \frac{l_1}{Y_1} + \frac{l_2}{Y_2}$$

If $l_1 = l_2 = l$

$$\frac{2\ell}{Y_{eq}} = \frac{\ell}{Y_1} + \frac{\ell}{Y_2}$$

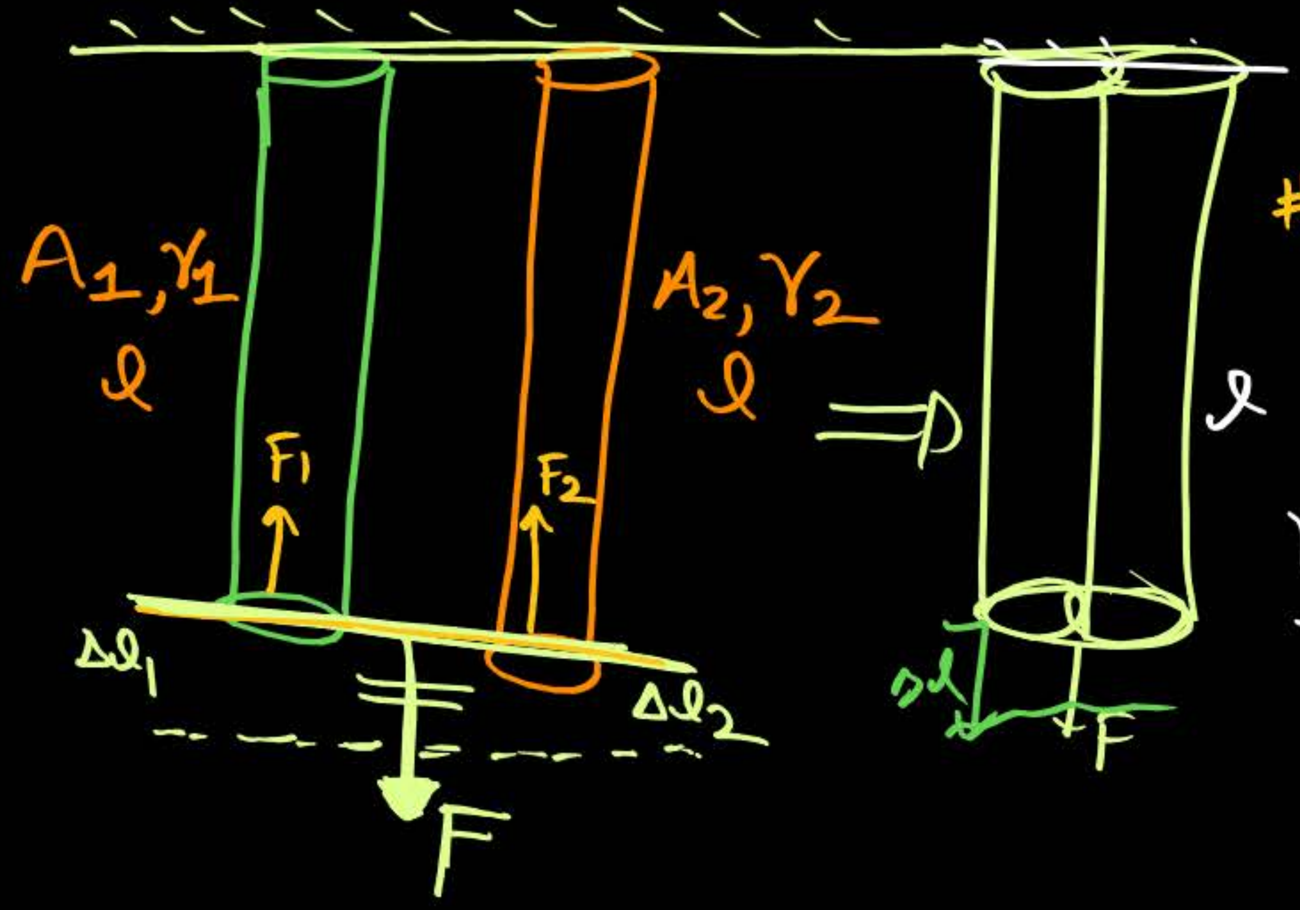
$$\frac{2}{Y_{eq}} = \frac{1}{Y_1} + \frac{1}{Y_2}$$

$$\frac{2}{Y_{eq}} = \frac{Y_1 + Y_2}{Y_1 Y_2}$$

$$Y_{eq} = \frac{2Y_1Y_2}{Y_1 + Y_2}$$ Ans

→ equivalent Young modulus in series comp

equivalent young modulus in Parallel comb^n of Rod.



elongation and strain will be same

$[\Delta l_1 = \Delta l_2]$

Stress will be diff^n.

$F = F_1 + F_2$ (concept of law of mot^n)

$$\frac{Y_{eq}(A_1+A_2)\Delta l}{l} = \frac{A_1 Y_1 \Delta l}{l} + \frac{A_2 Y_2 \Delta l}{l}$$

$$Y_{eq} = \frac{A_1Y_1 + A_2Y_2}{A_1+A_2}$$ → equivalent young modu.

(Stress) $\frac{F}{A} = Y\frac{\Delta l}{l}$

If $A_1 = A_2 = A$

$$Y_{eq} = \frac{A(Y_1+Y_2)}{2A} = \left[\frac{Y_1+Y_2}{2}\right]$$

As

Parallel combination of Rod

Tension $\rightarrow$ Different

Elongation Same

QUESTION

Series conn

A copper wire and a steel wire of the same diameter and length are connected end to end a force is applied, which stretches their combined length 1 cm. The two wires will have

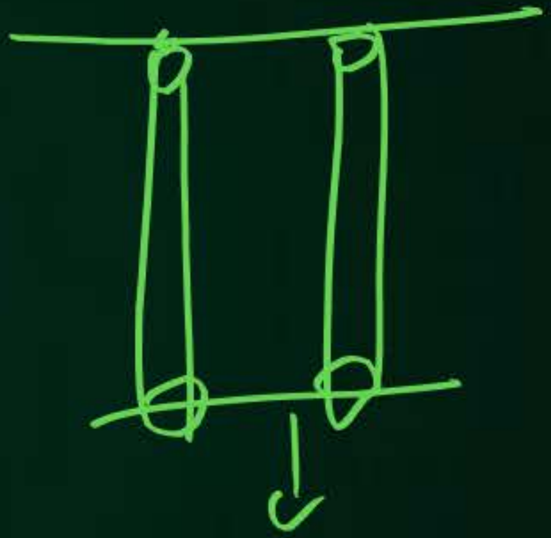
[JEE main]



1. Different stresses and strains
2. The same stress and strain
3. The same strain but different stresses
4. The same stress but different strains

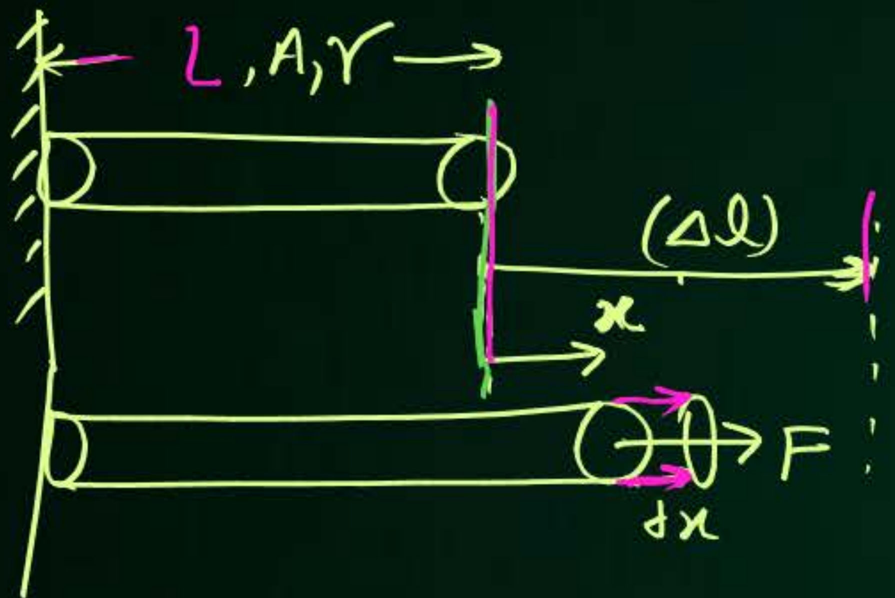
QUESTION

Wires of equal length and cross-sectional area are suspended as shown in figure. Their Young's moduli are Y, and Y, respectively. The equivalent Young's moduli will be



1. $Y_1 + Y_2$
2. $\frac{Y_1 Y_2}{Y_1 + Y_2}$
3. $\frac{Y_1 + Y_2}{2}$
4. $\sqrt{Y_1 Y_2}$

ELASTIC POTENTIAL ENERGY



$$\frac{F}{A} = \frac{Y\Delta l}{l}$$

$$F = \frac{AY}{l}x$$

force ∝ elongation

find work done by force F to elongate the Rod from mean to Δl (elongation)

$$dW = F\,dx$$

$$\int dW = \int \frac{AY}{l} x\,dx$$

$$\Rightarrow W = \frac{AY}{l}\int_0^{\Delta l} x\,dx$$

$$W = \frac{AY}{l}\left(\frac{x^2}{2}\right)_0^{\Delta l} = \frac{1}{2}\frac{AY\Delta l^2}{l}$$

$$\text{Work}(\Delta U) = \frac{1}{2}\frac{AY\Delta l}{l} \times \Delta l$$

$$\text{Work} = \Delta U = \frac{1}{2}F\Delta l$$

force, elongation

$$\frac{U}{AL} = \frac{1}{2}\frac{F \cdot \Delta l}{AL}$$

$$\frac{U}{\text{volume}} = \frac{1}{2}\text{stress} \times \text{strain}$$

$$(\text{energy per unit volume}) = \frac{1}{2}\text{stress} \times \text{strain}$$

Energy

$U = \frac{1}{2} F \cdot \Delta l$

$\frac{U}{Volum} = \frac{1}{2}$ stress × strain.

$U = \frac{1}{2}$ stress × strain × volume ← Total energy

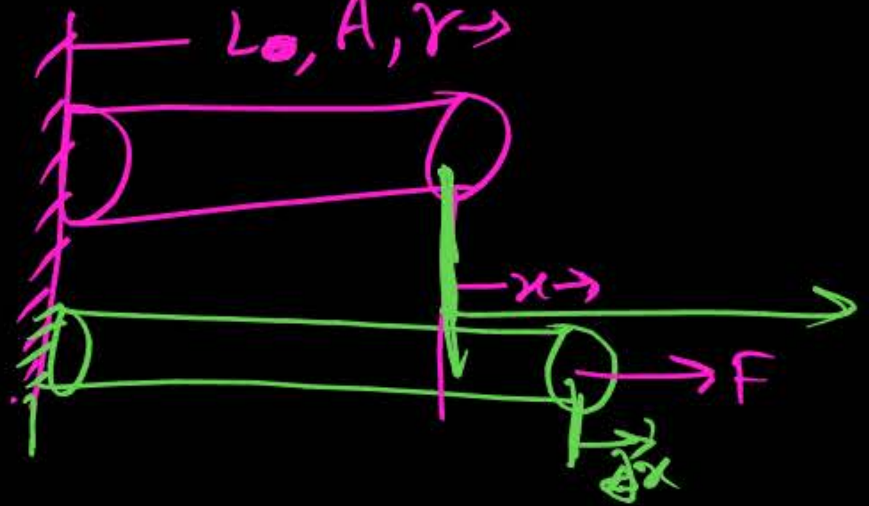
$\text{energy densit} = \frac{1}{2}$ stress × strain ✓

Hook Law
stres = Y (strain)

$\text{energy densit} = \frac{1}{2} Y \times (\text{strain})^2$ ✓

$\text{enegy densit} = \frac{1}{2} \frac{(\text{stres})^2}{Y}$ ✓

MR* → dim^n of stress, (energy densit) & young modulus is same & strain is dim^n less.



$$\frac{F}{A} = Y\frac{x}{L}$$

$$F = \frac{AY}{L}x$$

$$dw = F\,dx$$

$$\int dw = \frac{AY}{L}\int x\,dx$$

$$W = \frac{AY}{L}\left(\frac{x^2}{2}\right)_0^{\Delta l} = \frac{1}{2}\frac{AY}{L}\Delta l^2$$

QUESTION

A 5 metre long wire is fixed to the ceiling. A weight of 10 kg is hung at the lower end and is 1 metre above the floor. The wire was elongated by 1 mm. The energy stored in the wire due to stretching is:

1. Zero
2. 0.05 joule
3. 100 joule
4. 500 joule



$\Delta l = 10^{-3}$ m

$U = \frac{1}{2} F \Delta l$

$= \frac{1}{2} \times 10 \times 10 \times 10^{-3}$

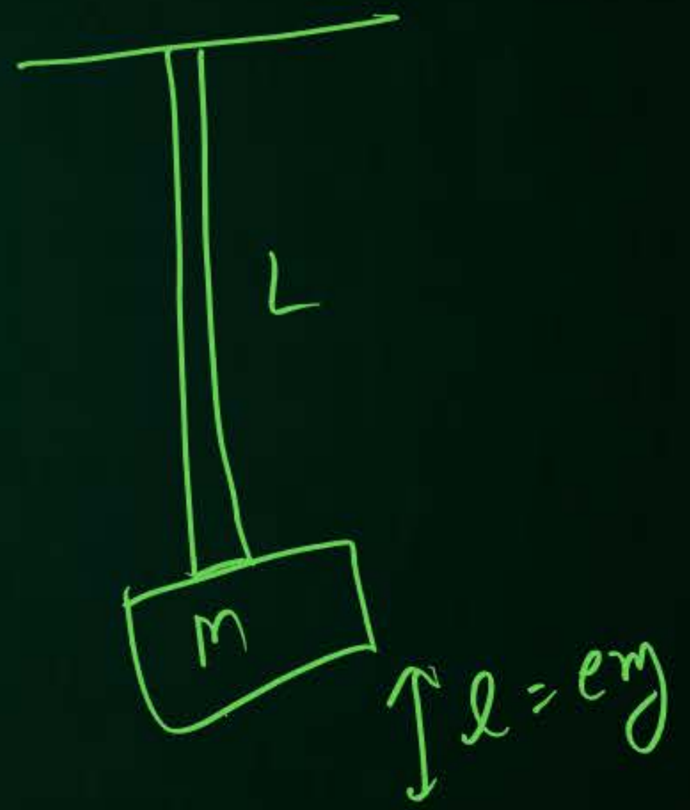
$= 5 \times 10^{-2}$

$= 0.05$ J

QUESTION

When a block of mass M is suspended by a long wire of length L, the length of the wire becomes $(L + l)$. The elastic potential energy stored in the extended wire is:

1. $\frac{1}{2}MgL$
2. Mgl
3. MgL
4. $\frac{1}{2}Mgl$



QUESTION

If E is the energy stored per unit volume in a wire having Young's modulus of the material Y, then stress applied is:

(1) $\sqrt{2EY}$

(2) $2\sqrt{EY}$

(3) $\frac{1}{2}\sqrt{EY}$

(4) $\frac{3}{2}\sqrt{EY}$

QUESTION

The work done per unit volume to stretch the length of area of cross-section 2 mm^2 by 2% will be [$Y = 8 \times 10^{10}\ N/m^2$]

1. 40 MJ/m^3
2. 16 MJ/m^3 (Ans)
3. 64 MJ/m^3
4. 32 MJ/m^3

$\frac{\Delta l}{l} \times 100 = 2$

$W = \frac{1}{2} Y \left(\frac{\Delta l}{l}\right)^2$

$= \frac{1}{2} \times 8 \times 10^{10} \times \left(\frac{2}{10^2}\right)^2$

$= 4 \times 10^{10} \times \frac{4}{10^4}$

$= 16 \times 10^6$

QUESTION

Energy stored per unit volume in a stretched wire having Young's modulus Y and stress 'σ' is

1. $\frac{Y\sigma}{2}$

2. $\frac{\sigma^2 Y}{2}$

3. $\frac{\sigma^2}{2Y}$

4. $\frac{\sigma}{2Y}$

QUESTION

When a uniform metallic wire is stretched the lateral strain produced in it is β. If v and Y are the Poisson's ratio and Young's modulus for wire, then elastic potential energy density of wire is

1. $\dfrac{Y\beta^2}{2}$

2. $\dfrac{Y\beta^2}{2v^2}$

3. $\dfrac{Yv\beta^2}{2}$

4. $\dfrac{Yv^2}{2\beta}$

Poissone ratio = lateral strain / logintudinal strain

$\sigma = \dfrac{(\Delta R/R)}{(\Delta l/l)}$

Not in syllabus

QUESTION

A wire 2 m in length suspended vertically stretches by 10 mm when mass of 10 kg is attached to the lower end. The elastic potential energy gain by the wire is (take $g = 10\ m/s^2$)

H/W

do not write in

1. 0.5 J
2. 5 J
3. 50 J
4. 500 J

QUESTION

If a rubber ball is taken at the depth of 200 m in a pool, its volume decreases by 0.1%. If the density of the water is 1×10^3 kg/m^3 and g = 10 m/s^2, then the volume elasticity in will be

→ Bulk Modulus = ??

1. 10^8
2. 2×10^8
3. 10^9
4. 2×10^9 ✓

$$\frac{\Delta V}{V} \times 100 = 0.1$$

$$P = \rho g h$$

$$\Delta P = -\frac{\Delta V}{V} \beta$$

$$\beta = \frac{\Delta P}{\left(\frac{\Delta V}{V}\right)} = \frac{\rho g h}{\left(\frac{0.1}{100}\right)}$$

$$= 10^3 \times 10 \times 200 \times 10^3$$

$$= 2 \times 10^9$$

QUESTION

What is the percentage increase in length of a wire of diameter 2.5 mm, stretched by a force of 100 kg wt? Young's modulus of elasticity of wire = 12.5×10^{11} dyne/cm^2

1. 0.16%
2. 0.32%
3. 0.08%
4. 0.12%

Hooks law

1 kg wt = 10N

H/w

QUESTION

Select the incorrect statement about Bulk modulus of elasticity.

1. It is defined for solids, liquids and gases. ✓
2. $B_{solid} > B_{liquid} > B_{gas}$ ✓
3. The bulk of gas is different for different processes. ✓
4. Almost for all materials, the bulk modulus increases with the rise in temperature ✗ → Ans (4)

QUESTION

A wire of length L, area of cross section A is hanging from a fixed support. The length of the wire changes to L_1 when mass M is suspended from its free end. The expression for Young's modulus is [NEET 2020]

initial length — final length

1. MgL_1/AL
2. $Mg(L_1 - L)/AL$ (35%)
3. MgL/AL_1
4. $MgL/A(L_1 - L)$ ✓ 52%

$$\frac{Mg}{A} = \frac{(L_1 - L)Y}{L}$$

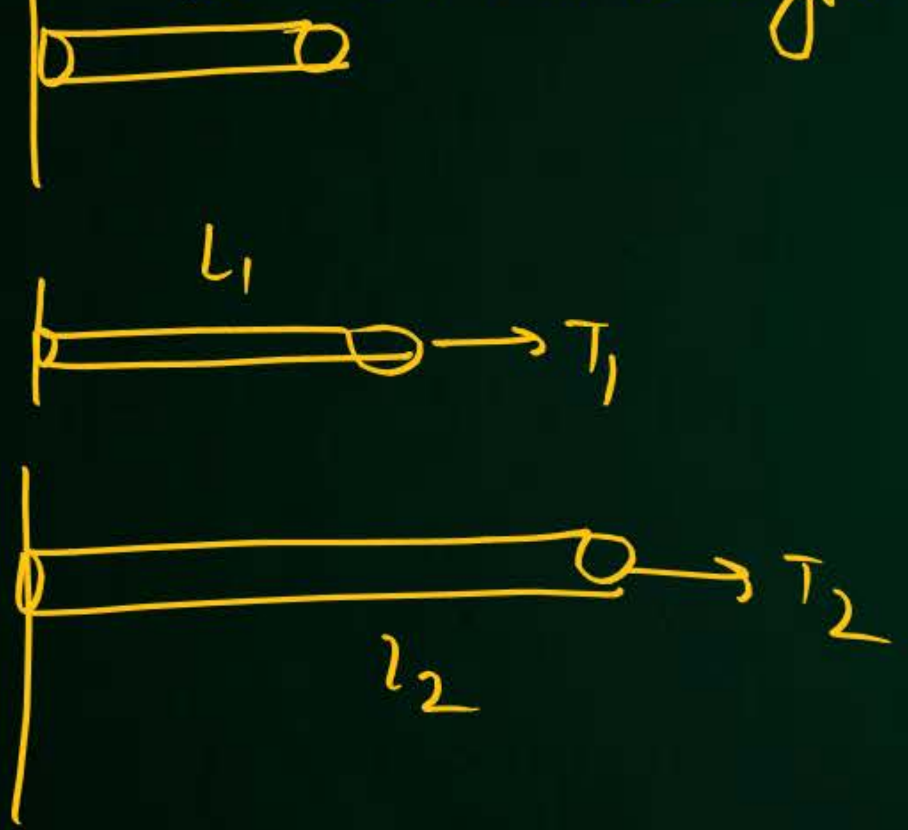
$$Y = \frac{MgL}{A(L_1 - L)}$$

QUESTION

The lengths of a metallic wire are L_1 and L_2 when the tensions in the wire are T_1 and T_2 respectively. Find the natural length of the wire.

Hook नियम

L_0 = Let initial length.



$$\frac{T_1}{A} = \frac{Y(L_1 - L_0)}{L_0} \quad \text{— (i)}$$

$$\frac{T_2}{A} = \frac{Y(l_2 - l_0)}{l_0} \quad \text{— (ii)}$$

$$\frac{T_1}{T_2} = \frac{L_1 - l_0}{l_2 - l_0}$$

QUESTION

The length of an elastic string is X m when the tension is 8N, and Y m when the tension is 10 N. The length in metres when the tension is 18 N is

(Z = let)

1. 4X – 5Y
2. 5Y – 4X
3. 9X – 4Y
4. 4Y – 9X

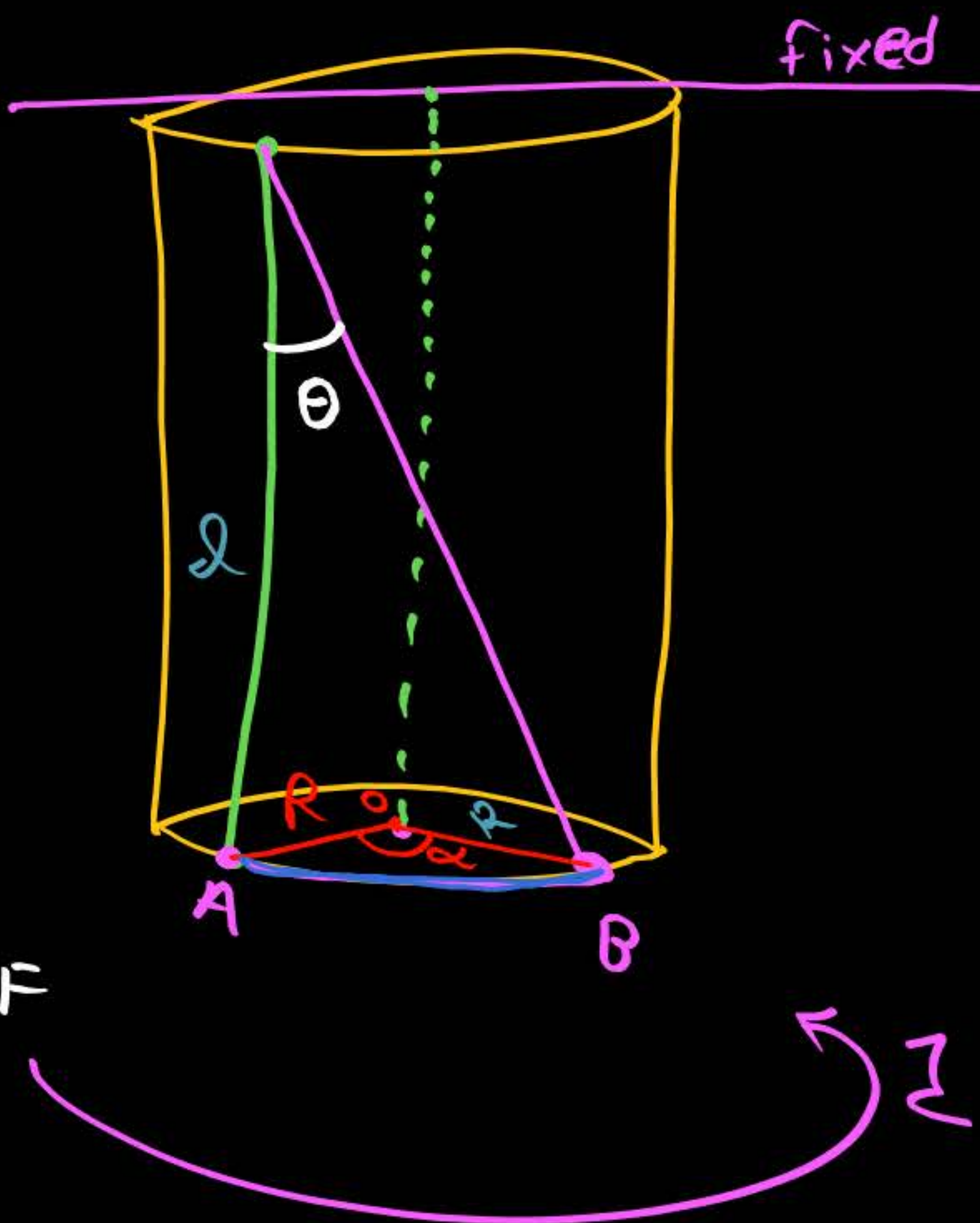
L_0 = let initial length

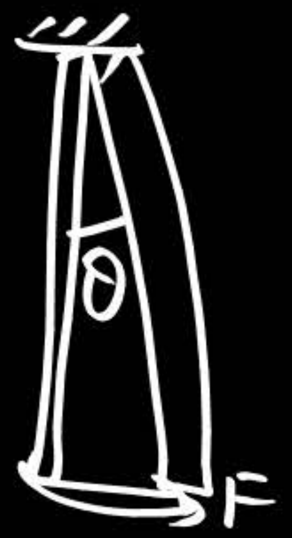
$$\frac{8}{A} = \frac{Y}{L_0}(X - L_0) \quad \text{— (I)}$$

$$\frac{10}{A} = \frac{Y}{L_0}(Y - L_0) \quad \text{— (II)}$$

$$\boxed{\frac{18}{A} = \frac{Y}{L_0}(Z - L_0)} \quad \text{— (III)}$$

Rel^n B/w shear Angle and twist Angle





$$Arc_{AB} = R\alpha = l\theta$$

$$R\alpha = l\theta$$

- R → Radius
- α → twist Angle
- l → length of cylinder
- θ → shear Angle.

$$\tau = c\alpha$$

c → torisonal coeff.

$$C = \frac{8\eta r^4}{\pi l}$$

$$C \propto \frac{r^4}{l}$$

MR Rafta

TORSION OF A CYLINDER OR TWISTING OF A WIRE

In the figure,

l = Length of the cylinder

r = Radius of the cylinder

ϕ = Angle of twist

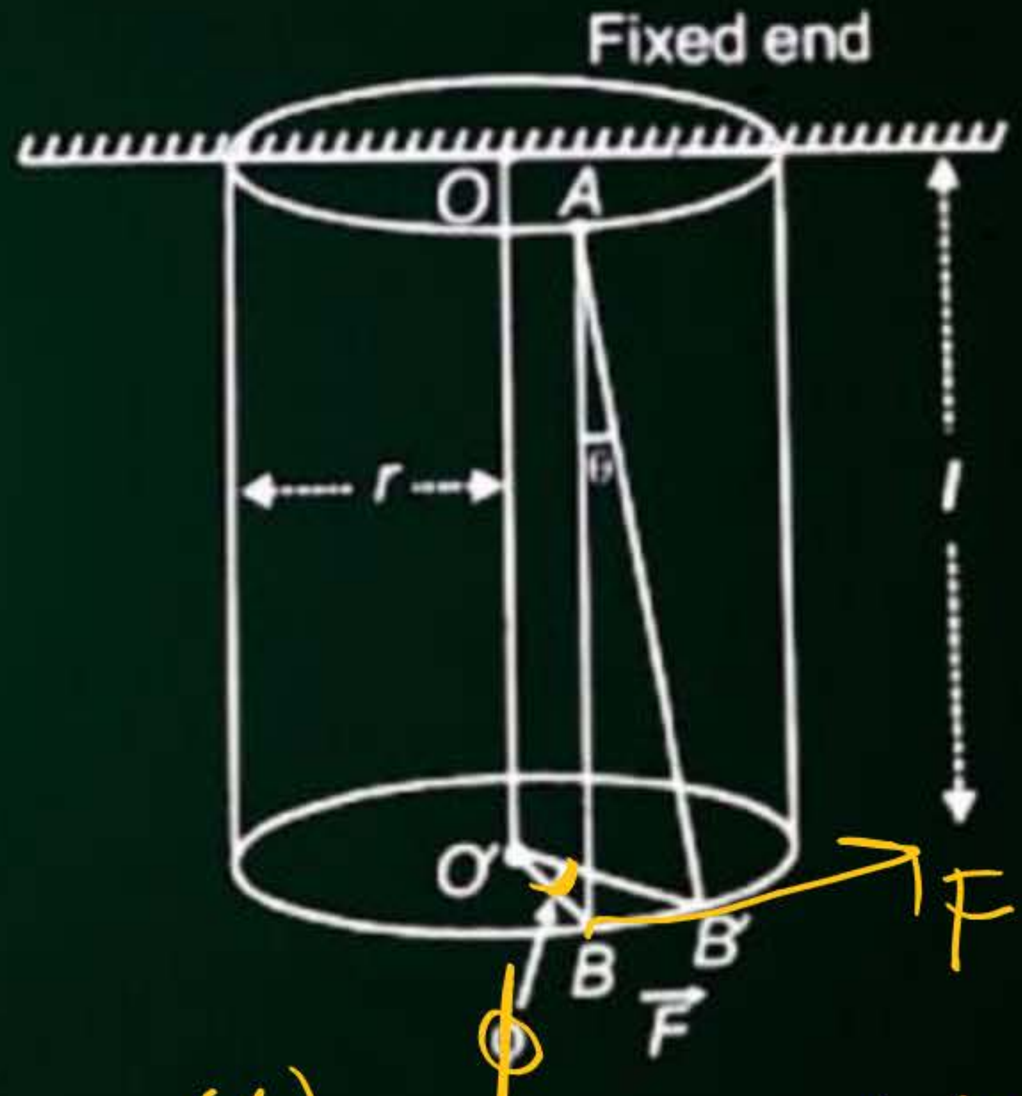
θ = Angle of shear

F = Tangential force applied at the free end

η = Modulus of rigidity

τ = Restoring torque

c = Restoring couple per unit twist

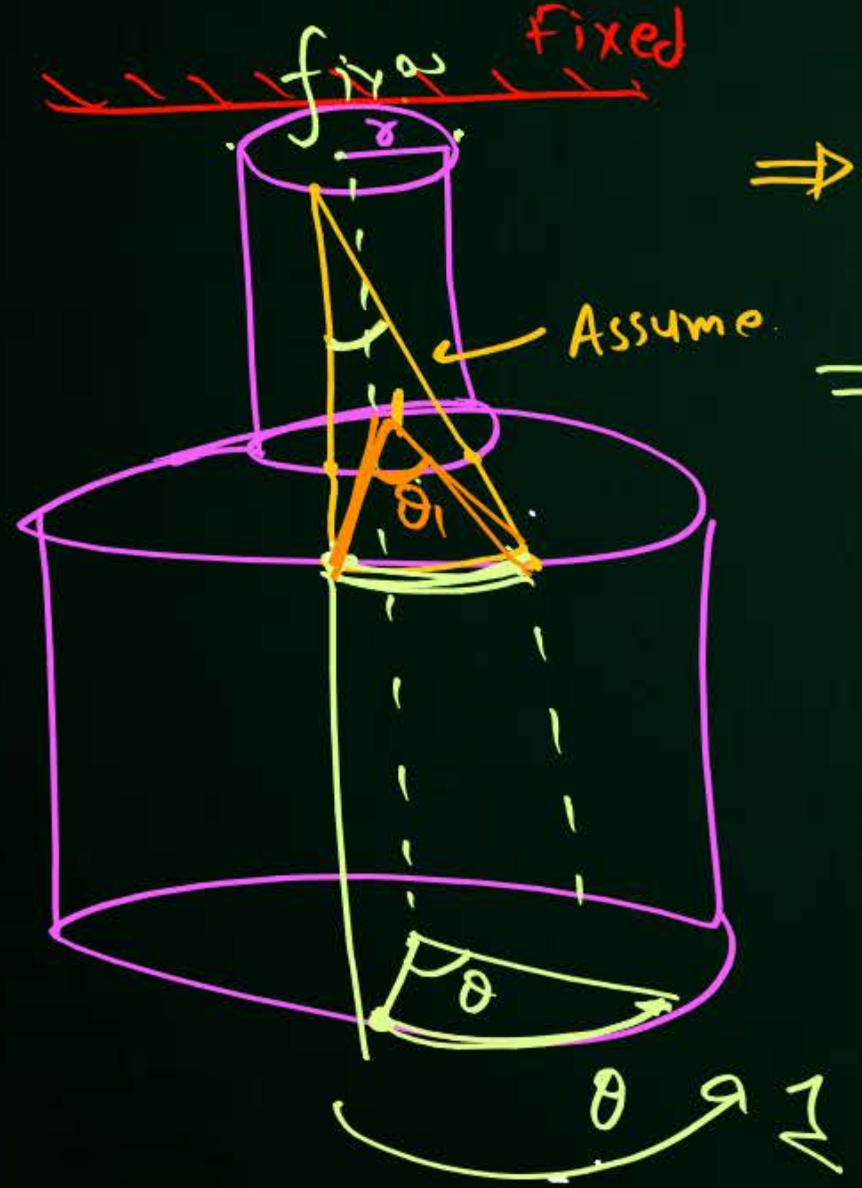


Twist Angle

QUESTION

Level up → (only for Test / Not for NEET)

Two metallic cylinder made of same material and radii r and $2r$ are joined as shown in figure. If top end is fixed and lower end of cylinder B is twisted by angle θ, then angle of twist for cylinder A is (both cylinder have same length).



⇒ twist angle of cylinder B is θ → false

⇒ twist Angle of cylinder A is θ_1

twist Angle of cylinder B is $(\theta - \theta_1) = \theta_2$ ⇐

$\tau_A = \tau_B$

$c_1 \theta_1 = c_2 (\theta - \theta_1)$

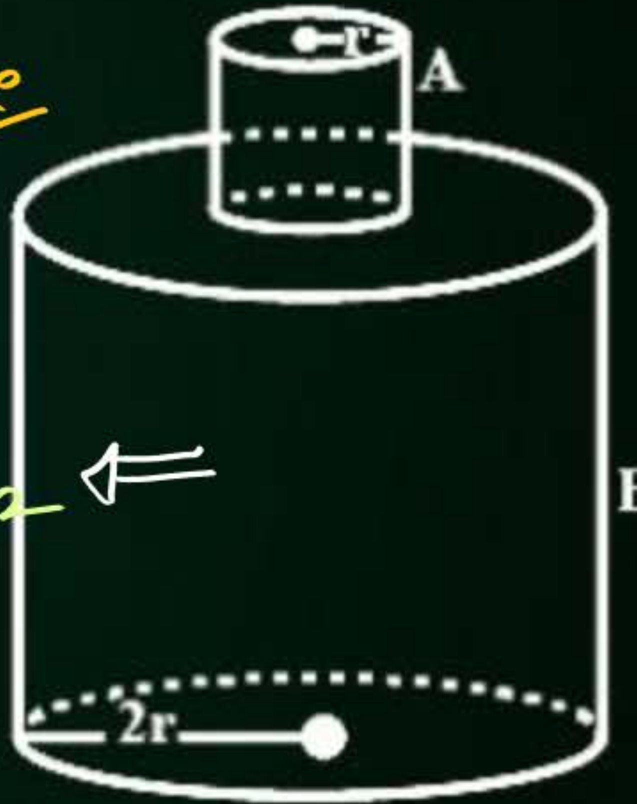
$\frac{r^4}{\ell} \theta_1 = \frac{(2r)^4}{\ell} (\theta - \theta_1)$

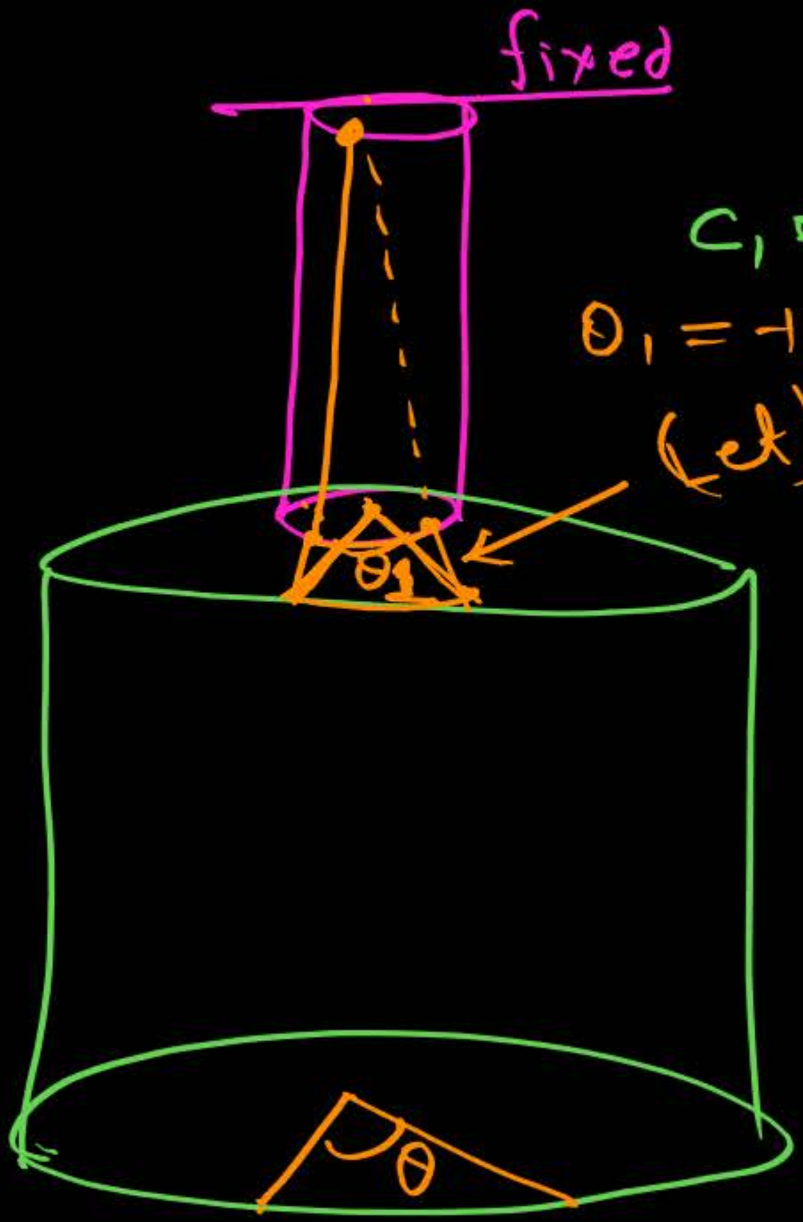
$\theta_1 = 16(\theta - \theta_1)$

$\theta_1 = 16\theta - 16\theta_1$

$17\theta_1 = 16\theta$

$\theta_1 = \left(\frac{16\theta}{17}\right)$





$c_1 \propto \frac{r^4}{l}$

θ_1 = twist Angle of A (let)

$c_2 \propto \frac{(2r)^4}{l}$

$(\theta - \theta_1)$ = twist Angle of cylinder

τ = same.

$\tau = c\theta$

$c_1\theta_1 = c_2(\theta - \theta_1)$

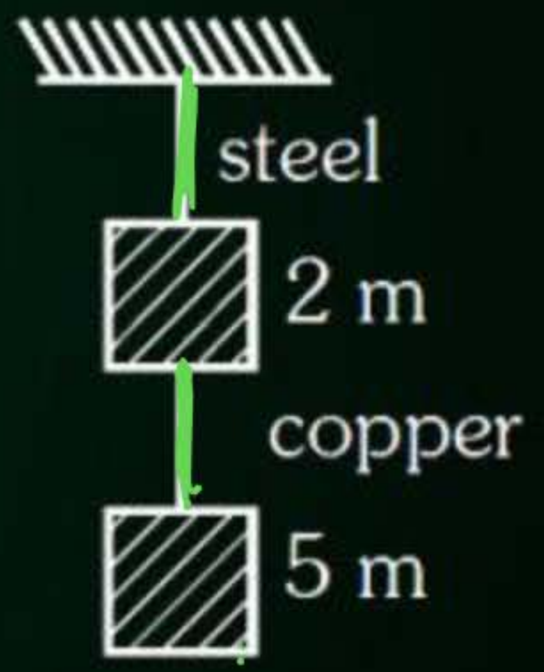
$\frac{r^4}{l}\theta_1 = \frac{(2r)^4}{l}(\theta - \theta_1)$

Soln

Hollow cylinder is more rigid than Solid Cylinder for same mass & radius

QUESTION

If the ratio of diameters, lengths and Young's modulus of steel and coper wires shown in the figure are p, q and s respectively, then the corresponding ratio of increase in their lengths would be [Karnataka NEET 2013]



1. $5q/(7sp^2)$
2. $7q/(5sp^2)$
3. $2q/(5sp)$
4. $7q/(5sp)$

QUESTION

A 100 m long wire having cross-sectional area $6.25 \times 10^{-4}\ m^2$ and Young's modulus is $10^{10}\ Nm^{-2}$ is subjected to a load of 250 N, then the elongation in the wire will be

[JEE Mains-2023]

A. 6.25×10^{-3} m

B. 4×10^{-4} m

C. 6.25×10^{-6} m

D. 4×10^{-3} m

QUESTION

The bulk modulus of a liquid is 3×10^{10} Nm^{-2}. The pressure required to reduce the volume of liquid by 2% is :

[JEE Mains-2022]

A 3×10^{8} Nm^{-2}

B 9×10^{8} Nm^{-2}

C 6×10^{8} Nm^{-2}

D 12×10^{8} Nm^{-2}

QUESTION

A 5 metre long wire is fixed to the ceiling. A weight of 10 kg is hung at the lower end and is 1 metre above the floor. The wire was elongated by 1 mm. The energy stored in the wire due to stretching is:

(A) Zero

(B) 0.05 joule

(C) 100 joule

(D) 500 joule

QUESTION

The approximate depth of an ocean is 2700 m. The compressibility of water is 45.4×10^{-11} Pa^{-1} and density of water is 103 kg/m^3. What fractional compression of water will be obtained at the bottom of the ocean?

[2015 Cancelled]

(A) 1.2×10^{-2}

(B) 1.4×10^{-2}

(C) 0.8×10^{-2}

(D) 1.0×10^{-2}

QUESTION

The Young's modulus of steel is twice that of brass. Two wires of same length and of same area of cross section, one of steel and another of brass are suspended from the same roof. If we want the lower ends of the wires to be at the same level, then the weights added to the steel and brass wires must be in the ratio of [2015]

A) 4 : 1

B) 1 : 1

C) 1 : 2

D) 2 : 1

QUESTION

For a solid rod, the Young's modulus of elasticity is 3.2×10^{11} Nm^{-2} and density is 8×10^{3} kg m^{-3}. The velocity of longitudinal wave in the rod will be.

[JEE Mains-2023]

A. 145.75×10^{3} ms^{-1}

B. 3.65×10^{3} ms^{-1}

C. 18.96×10^{3} ms^{-1}

D. 6.32×10^{3} ms^{-1}

QUESTION

A string of area of cross-section $4\ mm^2$ and length 0.5 is connected with a rigid body of mass 2 kg. The body is rotated in a vertical circular path of radius 0.5 m. The body acquires a speed of $5\ m/s$ at the bottom of the circular path. Strain produced in the string when the body is at the bottom of the circle is _____ $\times 10^{-5}$. (Use Young's modulus $10^{11}\ N/m^2$ and $g = 10\ m/s^2$) **[JEE Mains-2022]**

QUESTION

If the length of a wire is made double and radius is halved of its respective values. Then, the Young's modules of the material of the wire will:

[JEE Mains-2022]

A. Remains same

B. Become 8 times its initial value

C. Become 1/4 of its initial value

D. Become 4 times its initial value

QUESTION

The force required to stretch a wire of cross section $1\ \text{cm}^2$ to double its length will be: (Given Young's modulus of the wire $= 2 \times 10^{11}\ \text{N/m}^2$) [JEE Mains-2022]

(A) 1×10^7 N

(B) 1.5×10^7 N

(C) 2×10^7 N

(D) 2.5×10^7 N

QUESTION

A cube of metal is subjected to a hydrostatic pressure of 4 GPa. The percentage change in the length of the side of the cube is close to (Given bulk modulus of metal, $B = 8 \times 10^{10}$ Pa)

[JEE Mains-2020]

(A) 0.6

(B) 20

(C) 1.67

(D) 5

QUESTION

Given below are two statements: One is labelled as Assertion (A) and the other is labelled as Reason (R).

Assertion (A): The stretching of a spring is determined by the shear modulus of the material of the spring.

Reason (R): A coil spring of copper has more tensile strength than a steel spring of same dimensions. In the light of the above statements, choose the most appropriate answer from the options given below

[2022]

1. Both (A) and (R) are true and (R) is not the correct explanation of (A)
2. (A) is true but (R) is false
3. (A) is false but (R) is true
4. Both (A) and (R) are true and (R) is the correct explanation of (A)

QUESTION

Dimensions of stress are: [2020]

1. $[ML^0T^{-2}]$
2. $[ML^{-1}T^{-2}]$
3. $[MLT^{-2}]$
4. $[ML^2T^{-2}]$

F / Area


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 04 | **Physics**

Mechanical Properties of Solid

Solid H/W Solution

By- Dr. Manish Raj (MR SIR)



Topics To be Covered

Homework Solution

QUESTION

A wire 2 m in length suspended vertically stretches by 10 mm when mass of 10 kg is attached to the lower end. The elastic potential energy gain by the wire is (take $g = 10\ m/s^2$)

1. 0.5 J ✓
2. 5 J
3. 50 J
4. 500 J

$U = \frac{1}{2} F \Delta x$

$= \frac{1}{2} 100 \times 10\ mm$

$= 5 \times 10^2 \times 10^{-3}\ m$

$= 0.5\ J$

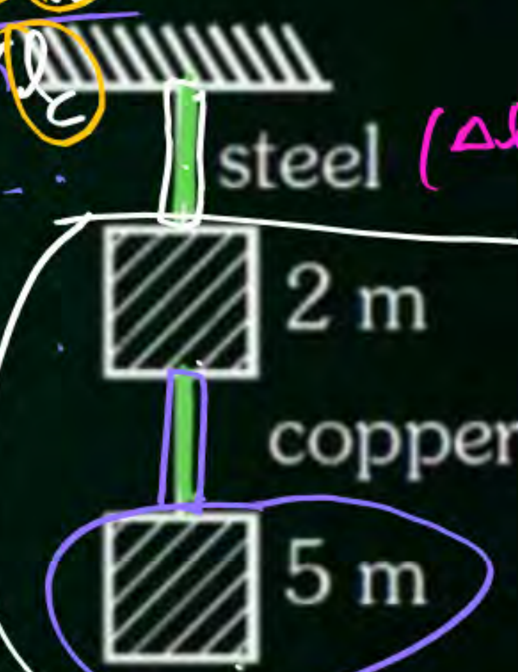
H/W

do not writing

QUESTION

If the ratio of diameters, lengths and Young's modulus of steel and coper wires shown in the figure are p, q and s respectively, then the corresponding ratio of increase in their lengths would be [Karnataka NEET 2013]

1. $5q/(7sp^2)$
2. $7q/(5sp^2)$
3. $2q/(5sp)$
4. $7q/(5sp)$



QUESTION

A 100 m long wire having cross-sectional area $6.25 \times 10^{-4}\ m^2$ and Young's modulus is $10^{10}\ Nm^{-2}$ is subjected to a load of 250 N, then the elongation in the wire will be

[JEE Mains-2023]

(A) 6.25×10^{-3} m

(B) 4×10^{-4} m

(C) 6.25×10^{-6} m

(D) 4×10^{-3} m

Ans

$A = 6.25 \times 10^{-4}$

$Y = 10^{10}$ $l = 100$

$F = 250N$

HOOKS वाला OP

$\frac{F}{A} = Y \frac{\Delta l}{l}$

$\frac{250}{6.25 \times 10^{-4}} = 10^{10} \times \frac{\Delta l}{100}$

$\frac{250}{6.25} \times 10^{4} = 10^{8}\, \Delta l$

$4 = 10^{3}\, \Delta l$

QUESTION

The bulk modulus of a liquid is $3 \times 10^{10}\ Nm^{-2}$. The pressure required to reduce the volume of liquid by 2% is :

[JEE Mains-2022]

(A) $3 \times 10^{8}\ Nm^{-2}$

(B) $9 \times 10^{8}\ Nm^{-2}$

(C) $6 \times 10^{8}\ Nm^{-2}$ ✓

(D) $12 \times 10^{8}\ Nm^{-2}$

$100 \times \frac{\Delta V}{V} = 2$

$-\frac{\Delta V}{V} = \frac{2}{100}$

$\Delta P = -\beta \frac{\Delta V}{V}$

$\Delta P = 3 \times 10^{10} \times \frac{2}{10^2}$

$= 6 \times 10^{8}\ Pa$

QUESTION

JEE main

A 5 metre long wire is fixed to the ceiling. A weight of 10 kg is hung at the lower end and is 1 metre above the floor. The wire was elongated by 1 mm. The energy stored in the wire due to stretching is:

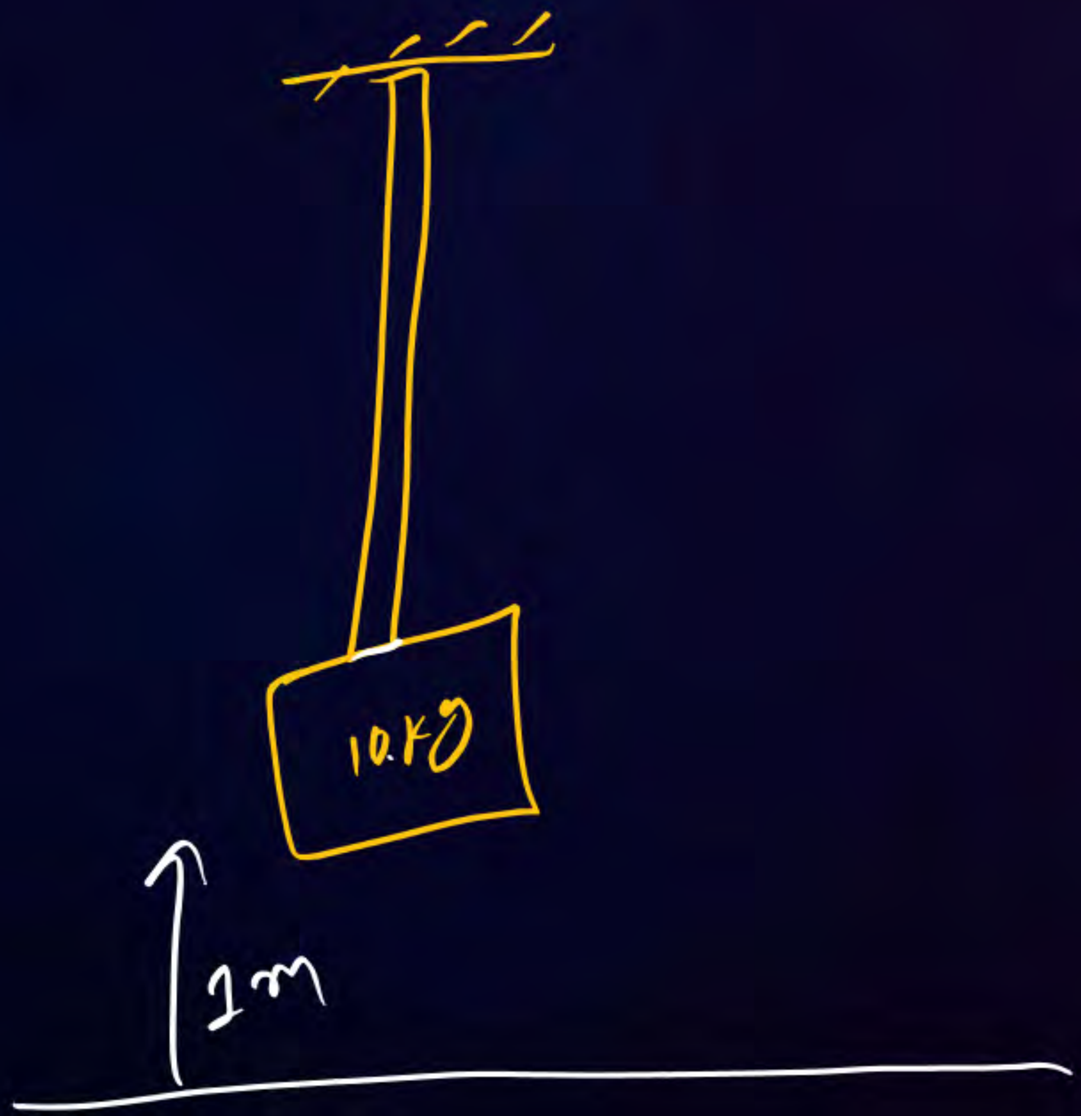
$\Delta l = 10^{-3}\,m$

A Zero

B 0.05 joule ✓

C 100 joule

D 500 joule



$U = \frac{1}{2} F \Delta l$

$= \frac{1}{2} \times 10 \times 10 \times 10^{-3}$

$= 5 \times 10^{-2} = 0.05\,J$

QUESTION

The approximate depth of an ocean is 2700 m. The compressibility of water is $45.4 \times 10^{-11}\ Pa^{-1}$ and density of water is $10^{3}\ kg/m^3$. What fractional compression of water will be obtained at the bottom of the ocean?

[2015 Cancelled]

(A) 1.2×10^{-2}

(B) 1.4×10^{-2}

(C) 0.8×10^{-2}

(D) 1.0×10^{-2}

$H = 2700\ m$

$K = \frac{1}{B} = 45.4 \times 10^{-11}$

$\Delta P = B\left(\frac{-\Delta V}{V}\right)$

$-\frac{\Delta V}{V} = \frac{\Delta P}{B} = \rho g H \left(\frac{1}{B}\right)$

$= 10^3 \times 10 \times 2700 \times 45.4 \times 10^{-11}$

$= 27 \times 45.4 \times 10^{-5}$

$= 2.7 \times 4.5 \times 10^{-3}$

$27 \times 45 = 135 + 1080 = 1215$

QUESTION

The Young's modulus of steel is twice that of brass. Two wires of same length and of same area of cross section, one of steel and another of brass are suspended from the same roof. If we want the lower ends of the wires to be at the same level, then the weights added to the steel and brass wires must be in the ratio of [2015]

(A) 4 : 1

(B) 1 : 1

(C) 1 : 2

(D) 2 : 1



QUESTION

For a solid rod, the Young's modulus of elasticity is $3.2 \times 10^{11}\ \text{Nm}^{-2}$ and density is $8 \times 10^{3}\ \text{kg m}^{-3}$. The velocity of longitudinal wave in the rod will be.

[JEE Mains-2023]

(A) $145.75 \times 10^{3}\ \text{ms}^{-1}$

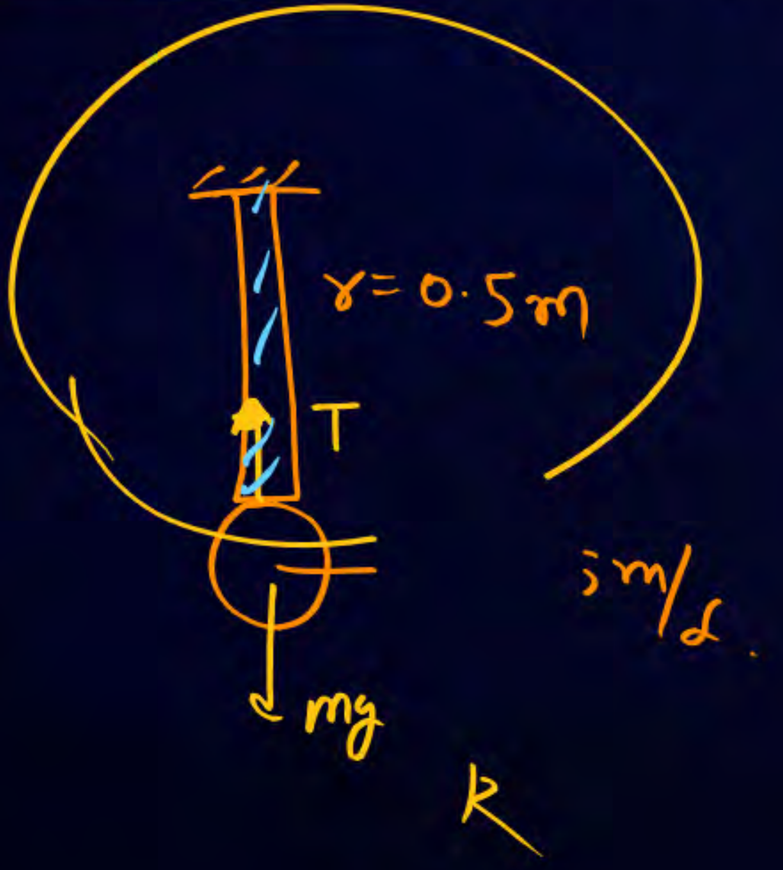
(B) $3.65 \times 10^{3}\ \text{ms}^{-1}$

(C) $18.96 \times 10^{3}\ \text{ms}^{-1}$

(D) $6.32 \times 10^{3}\ \text{ms}^{-1}$

QUESTION

A string of area of cross-section 4 mm^2 and length 0.5 is connected with a rigid body of mass 2 kg. The body is rotated in a vertical circular path of radius 0.5 m. The body acquires a speed of 5 m/s at the bottom of the circular path. Strain produced in the string when the body is at the bottom of the circle is ____ $\times 10^{-5}$. (Use Young's modulus 10^{11} N/m^2 and $g = 10$ m/s^2) **[JEE Mains-2022]**



$$T = mg + \frac{mv^2}{R}$$

$$T = 20 + \frac{2(5)^2}{1/2}$$

$$T = 20 + 4 \times 25 = 120\text{ N}$$

$$\frac{F}{A} = Y \left(\frac{\Delta l}{l}\right)$$

QUESTION

If the length of a wire is made double and radius is halved of its respective values. Then, the Young's modules of the material of the wire will:

[JEE Mains-2022]

A Remains same

B Become 8 times its initial value

C Become 1/4 of its initial value

D Become 4 times its initial value

QUESTION

The force required to stretch a wire of cross section 1 cm^2 to double its length will be: (Given Young's modulus of the wire = 2×10^{11} N/m^2) **[JEE Mains-2022]**

A. 1×10^7 N

B. 1.5×10^7 N

C. 2×10^7 N ✓ AY

D. 2.5×10^7 N

$l_f = 2l_0$

$l_i = l_0$

$\Delta l = 2l_0 - l_0 = l_0$

$\frac{F}{A} = Y \frac{\Delta l}{l}$

$F = AY$

$= 1 \times 10^{-4} \; 2 \times 10^{11}$

QUESTION

A cube of metal is subjected to a hydrostatic pressure of 4 GPa. The percentage change in the length of the side of the cube is close to (Given bulk modulus of metal, $B = 8 \times 10^{10}$ Pa)

[JEE Mains-2020]

(A) 0.6

(B) 20

(C) 1.67

(D) 5

4×10^{9} Pa

$B = 8 \times 10^{10}$ Pa

$\frac{\Delta V}{V} = 3\frac{\Delta l}{l}$

$4 \times 10^{9} = 8 \times 10^{10} \cdot 3\frac{\Delta l}{l}$

$\frac{10^{9}}{6} = 10^{10} \frac{\Delta l}{l}$

QUESTION

Given below are two statements: One is labelled as Assertion (A) and the other is labelled as Reason (R).

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QUESTION

Dimensions of stress are: [2020]

1. $[ML^0T^{-2}]$
2. $[ML^{-1}T^{-2}]$ ✓
3. $[MLT^{-2}]$
4. $[ML^2T^{-2}]$

$$F/\text{Area} = \frac{MLT^{-2}}{L^2}$$

$$= ML^{-1}T^{-2}$$


THANK YOU

YAKEEN 2.0

500 mlitr = $\frac{1}{2}$ kg

FOR NEET 2025

1000ml = 1 kg

Lecture- 01 | Physics

Mechanical Properties of Fluids

By- Dr. Manish Raj (MR SIR)



Topics to be covered

1. # Mass, volume, density ✓
2. # Pressure (liquid) ✓
3. #





$\frac{1}{2}$ litre = 500 ml = 500×10^{-3} litre

= $\frac{500}{1000}$ litre = $\frac{1}{2}$ litre.

1 kg = 1 litre ✓

$\frac{1}{2}$ kg = $\frac{1}{2}$ litre ✓

(a) gain

(b) loss

Mechanical Properties of Fluid

Static Fluid

- Pressure (Pascal law)
- ~~Archimedes Principle~~ (Not in syllabus)

Dynamic fluid

- Equation of continuity ($AV = const$)
- Bernoulli's Equation ($P + \frac{1}{2}\rho v^2 + \rho gh ...$)

Properties of fluid

- Viscosity ✓
- Surface Tension ✓
- Cappillary rise.

Ideal fluid
- Incompressible
- Non-viscous
- No surface tension

QUESTION

The term ‘fluid’ is used for

1. Liquids only
2. Gases only
3. A mixture of liquid and gas only
4. Both liquid and gases

substance that can flow is called fluid

liquid & gas

Mass → quantity of matter contains in a body.

→ scalar

→ S.I unit (kg)

$1\ kg = 10^3\ grm$

Volume = 3-D space occupied by object is called volume

S.I unit → m^3

$1\ liter = 10^{-3}\ m^3$

↳ Unit of volume

scalar



$V = \frac{4}{3}\pi R^3$



$V = l^3$



$V = \pi R^2 H$

linear mass density $\lambda = \frac{dm}{dl}$ (kg/m)

Areal mass density $\sigma = \frac{dm}{dA}$ (kg/m²)

volume mass density $\rho = \frac{dm}{dV}$

→ uniform object

$\rho = \frac{Mass}{Volume}$

$\rho_{water} = 1\ grm/cm^3 = 10^3\ kg/m^3$

$\rho_{Ice} = 0.9\ grm/cm^3 = 0.9 \times 10^3\ kg/m^3$ → kg/m³

$\rho_{oil} = 0.8\ grm/cm^3 = 0.8 \times 10^3\ kg/m^3$

$\rho_{milk} = 1.04\ gm/cm^3 = 1.04 \times 10^3\ kg/m^3$

$\rho_{Hg} = 13.6 \times 10^3\ kg/m^3 = 13.6\ gram/cm^3$.

Realive density

$R.D = \frac{\text{density of liquid}}{\text{density of water}}$ = specific gravity

↳ unit & dim^n less

$R.D > 1$

↳ liquid is denser than water

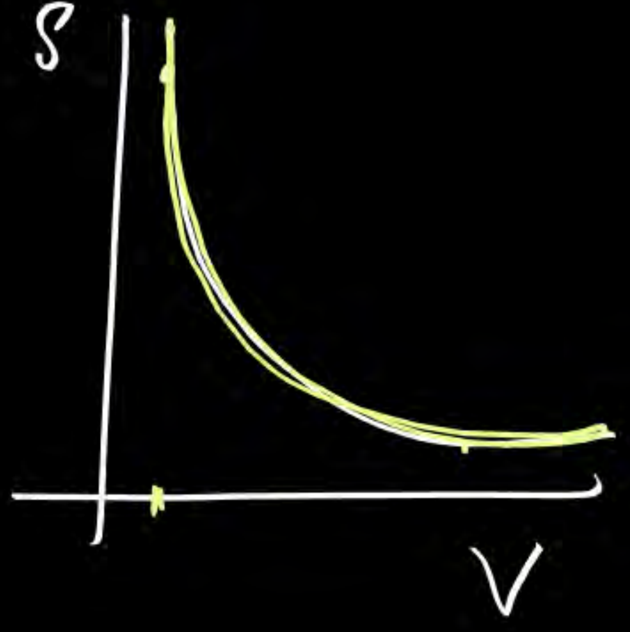
(Q) If R.D is 2 then find density of liquid.

$R.D = \frac{\text{density of liquid}}{\text{density of water}}$

density of liquid $= 2 \times 10^3\ kg/m^3$

#

$\rho = \frac{m}{V}$ — m: const^n



QUESTION

Find mass of 1 litre water?

Sol^n $V = 1 \text{ liter} = 10^{-3} m^3$

$\rho_w = \frac{m}{V}$

$\text{Mass} = \rho_w V$

$= 10^3 \text{ kg/m}^3 \times 10^{-3} m^3$

$\text{Mass} = 1 \text{ kg}$

QUESTION

Find mass of 1 litre milk?

1 kg → 1 litre milk

Soln

$V = 1 \text{ litre} = 10^{-3} m^3$

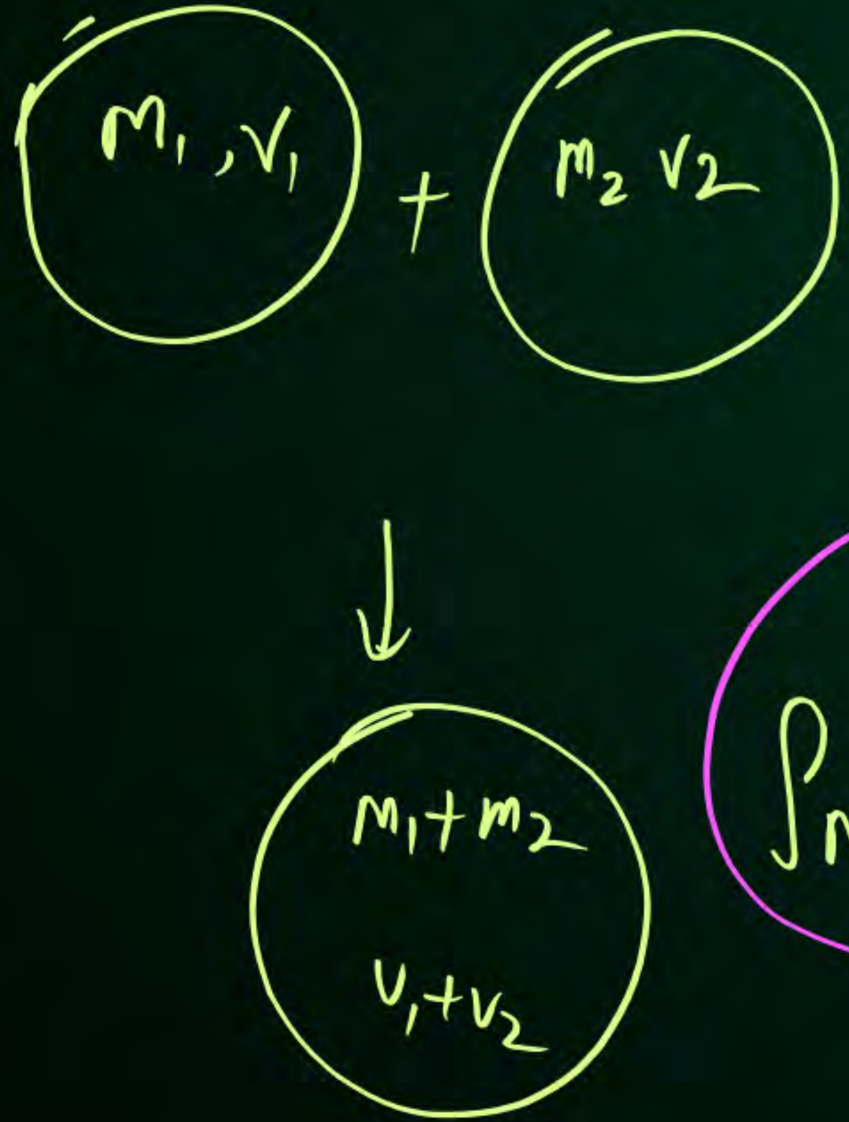
$\rho_m = \frac{m}{V}$

Mass of milk for 1 litre $= \rho_m V$

$= 1.04 \times 10^{3} kg/m^3 \times 10^{-3} m^3$

$M = 1.04 \text{ kg}$

Density of Mixture of two Liquids



$$\rho_{mixe} = \frac{m_1 + m_2}{V_1 + V_2}$$

QUESTION

Two liquid of mass m_1 & m_2 and having same density, then find density of mixed.

$\rho_{mixture} = \rho$

$\rho = \frac{m}{V}$

QUESTION

$\rho = \frac{m}{V}$

When two liquid of same mass but different densities ρ_1 and ρ_2 are mixed together, then the density of the mixture is

1. $\frac{\rho_1 + \rho_2}{2}$

2. $\rho_1 + \rho_2$

3. $\frac{2\rho_1\rho_2}{\rho_1 + \rho_2}$

4. $2\rho_1 + 2\rho_2$

ρ_1, m ρ_2, m

Avg speed $= \frac{d_1 + d_2}{t_1 + t_2}$

MR*

$\rho_1 < \rho_{mix} < \rho_2$

$\rho_{mix} = \frac{m_1 + m_2}{V_1 + V_2}$

$\rho_{mixture} = \frac{m + m}{V_1 + V_2} = \frac{2m}{\frac{m}{\rho_1} + \frac{m}{\rho_2}}$

$= \frac{2m}{m\left[\frac{\rho_1 + \rho_2}{\rho_1 \rho_2}\right]}$

$\rho_{mix} = \frac{2\rho_1\rho_2}{\rho_1 + \rho_2}$

QUESTION

When two liquid of same volume but different densities ρ_1 and ρ_2 are mixed together, then the density of the mixture is

1. $\dfrac{\rho_1 + \rho_2}{2}$ ✓
2. $\rho_1 + \rho_2$ ✗
3. $\dfrac{2\rho_1\rho_2}{\rho_1 + \rho_2}$ ✗
4. $2\rho_1 + 2\rho_2$ ✗



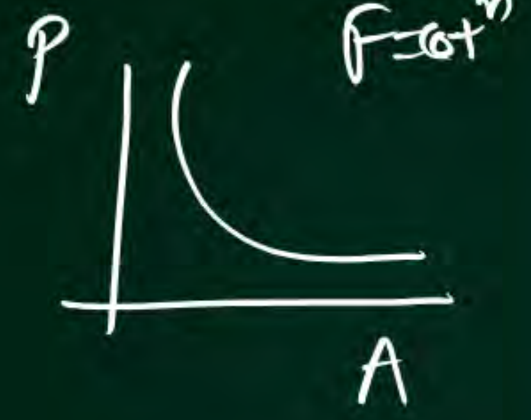
$$\rho_{liquid} = \frac{m_1 + m_2}{V_1 + V_2} = \frac{\rho_1 V + \rho_2 V}{2V} = \frac{\rho_1 + \rho_2}{2}$$

Pressure

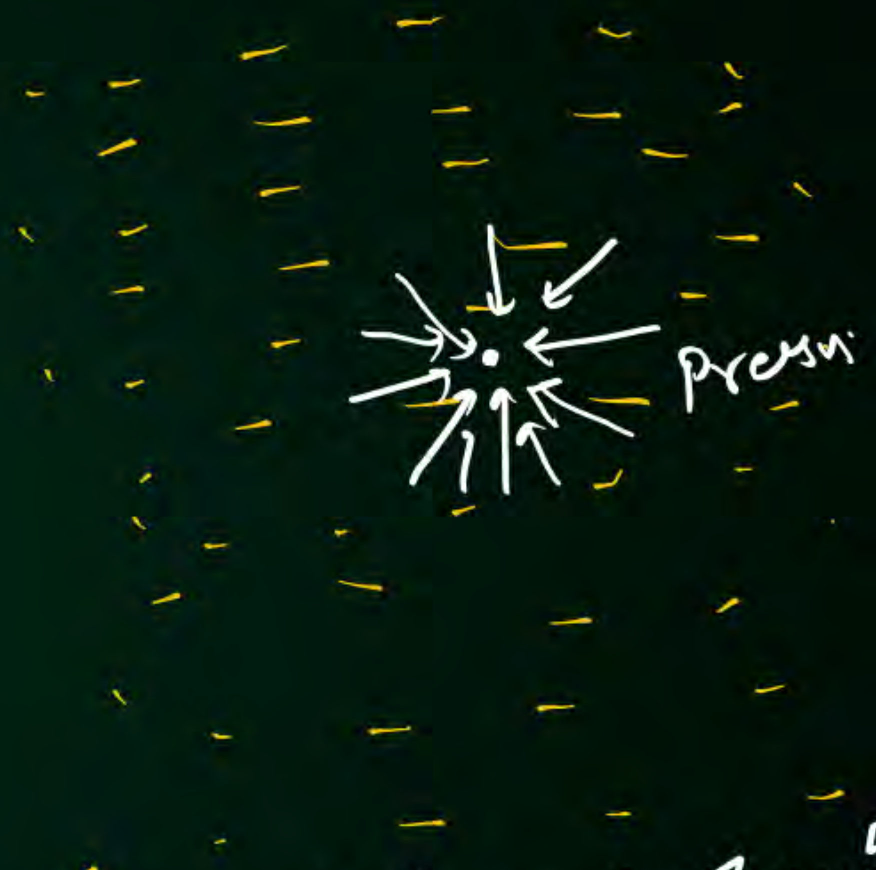
Pressure → force per unit Area

$$P = \frac{F}{A}$$

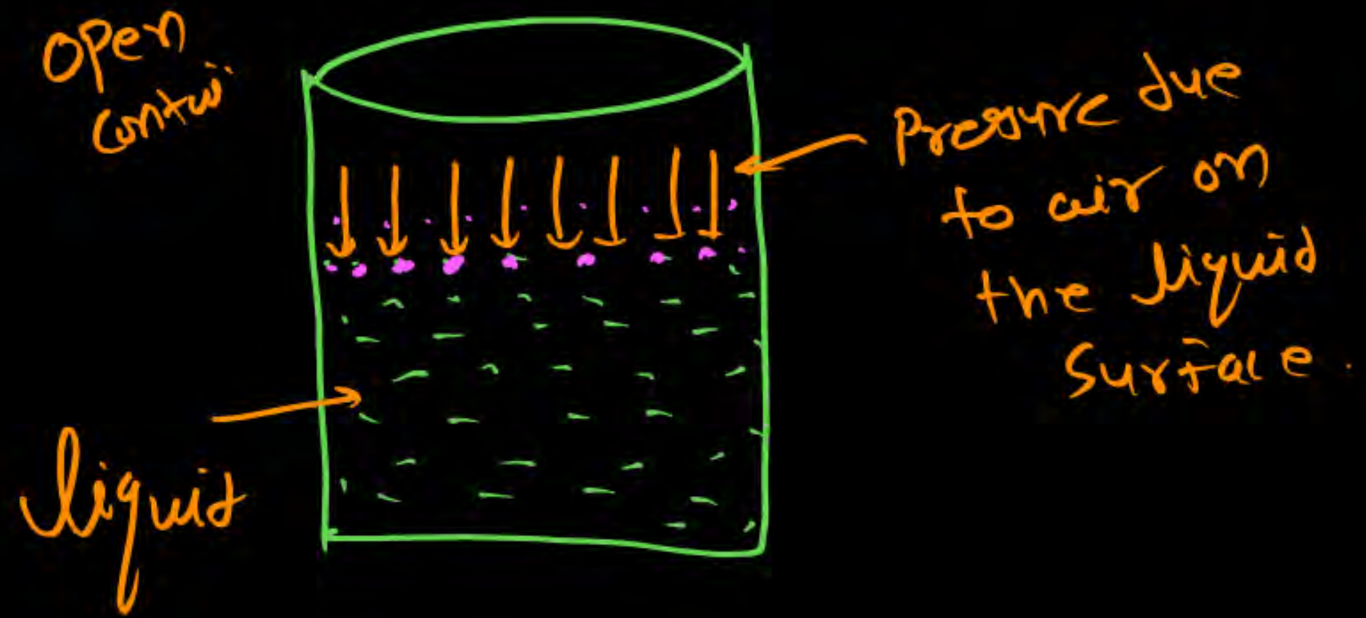
- → Scalar
- → {N/m² = Pascal}
- → Pressure (Pain)

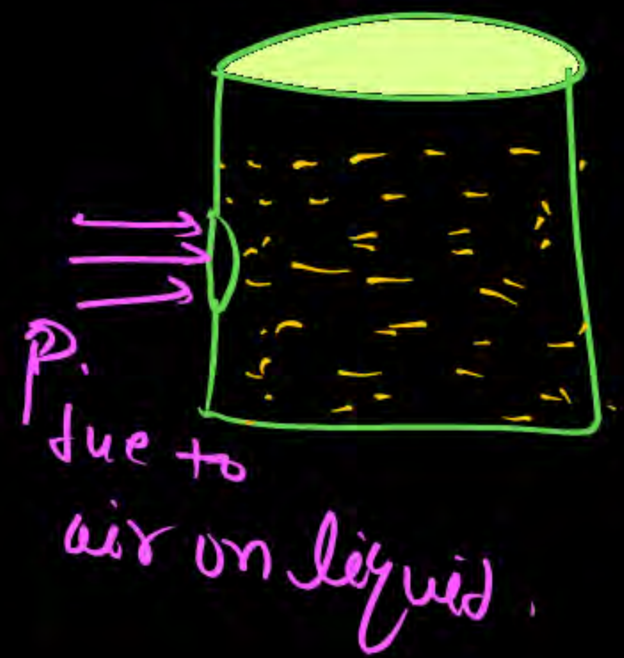


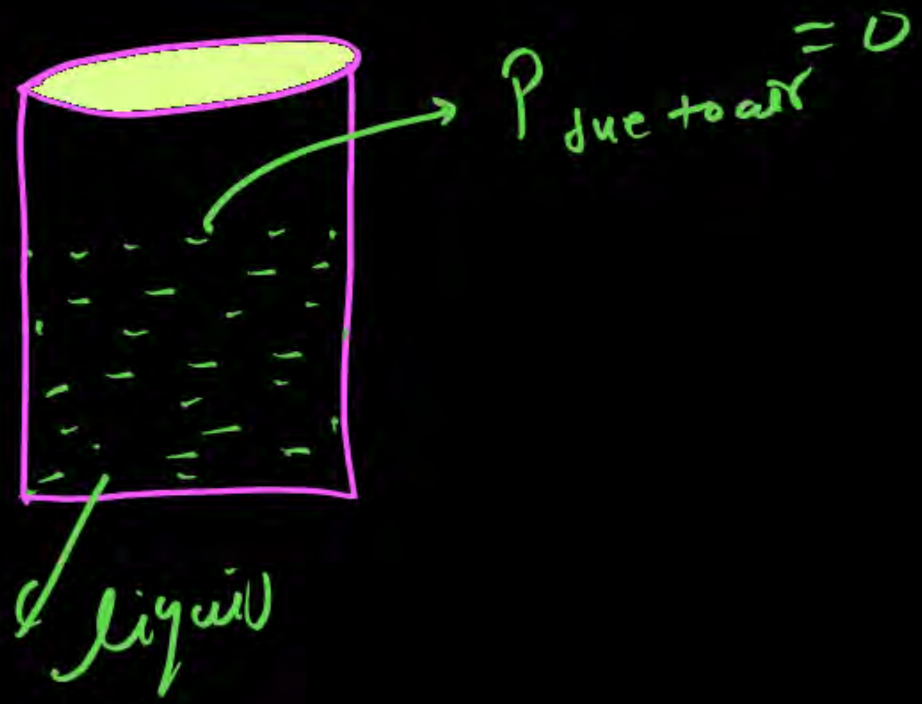
air pressure



(due to air at ground) = 1 atm = $1.01 \times 10^5\ N/m^2$

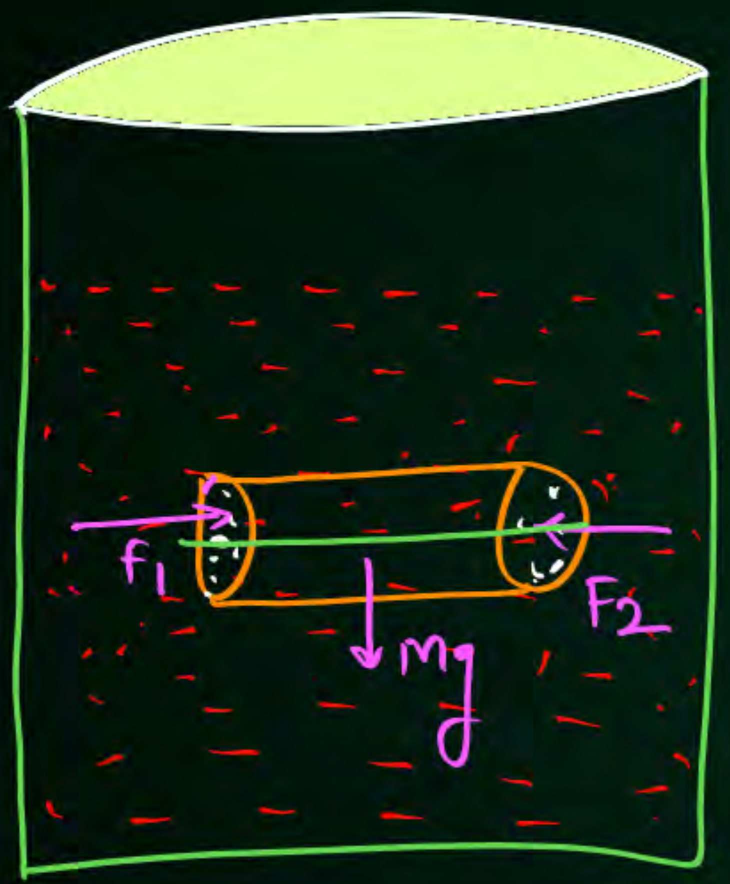

open
Pressure due to air on the liquid surface.
liquid


P due to air on liquid.


P due to air = 0
liquid

Pressure due to liquid coloum.

⇒ **F.B.D of Imaginary cylinder of liquid along horizontal direction only**



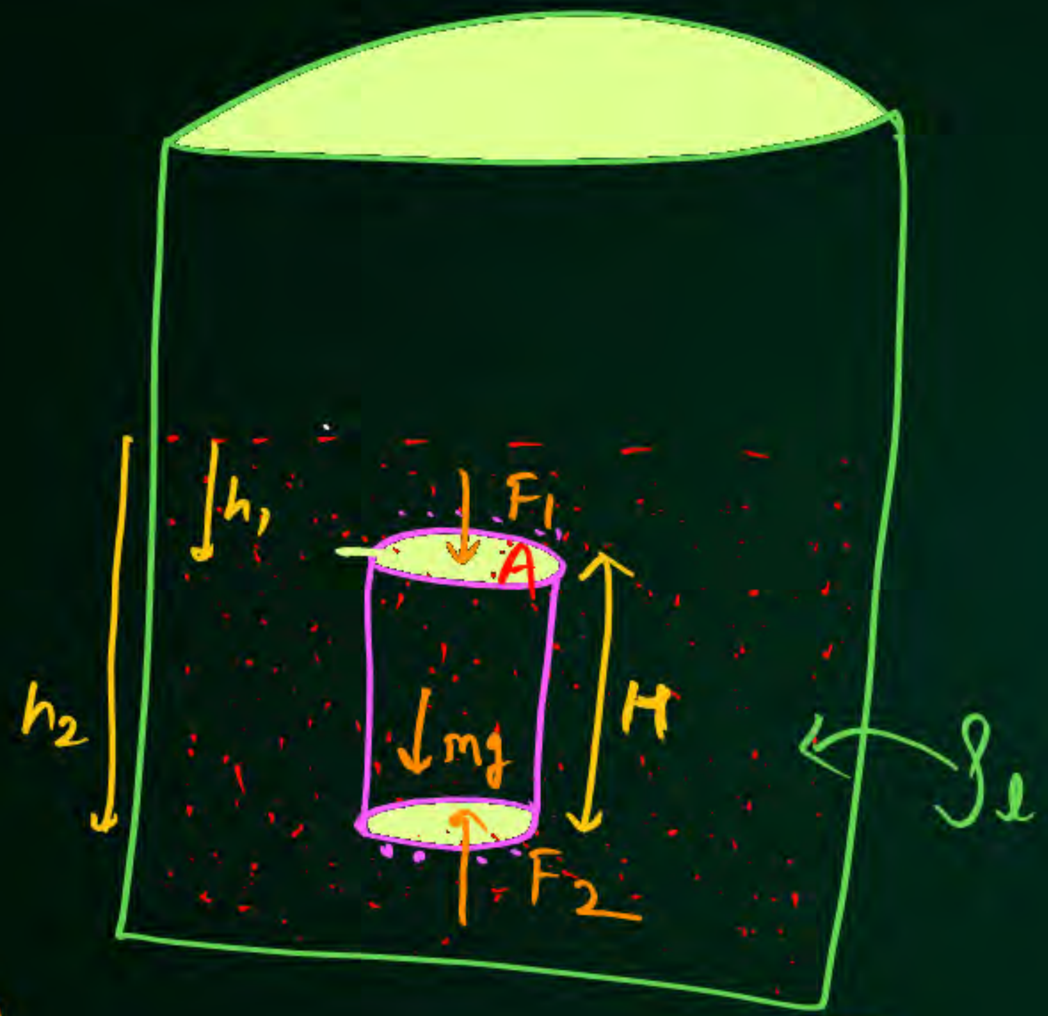
$F_1 = F_2$

$(F_{net})_{along\ Horizontal} = 0$

$\frac{F_1}{A} = \frac{F_2}{A} \Rightarrow P_1 = P_2$

→ liquid Pressure is Same in a same Horizontal line.

⇒ F.B.D in y-axis of Imaginary cylinder of liquid



$$(F_{net})_y = 0$$

$$F_1 + mg = F_2$$

$$h_2 - h_1 = H$$

$$F_2 - F_1 = mg \quad — (1)$$

$$F_2 - F_1 = \rho H A g$$

$$\frac{F_2}{A} - \frac{F_1}{A} = \rho g H$$

$$(P_2 - P_1) = \rho g H$$

$$\Delta P = \rho g H$$

$$P_2 - P_1 = \rho g (h_2 - h_1)$$

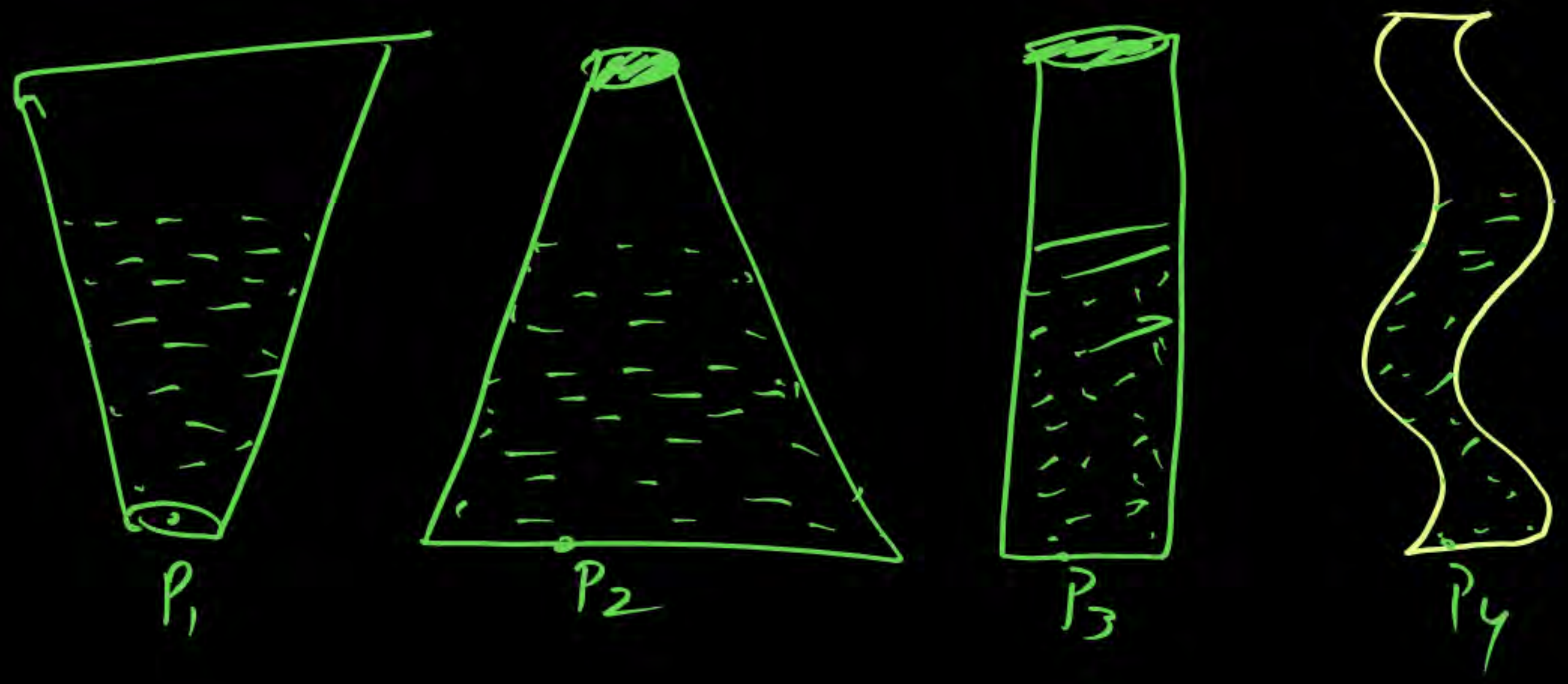
$$P_2 - P_1 = \rho g h_2 - \rho g h_1$$

If $h_1 = 0$
upper end
$P_1 = 0$

$$\boxed{P = \rho g h}$$

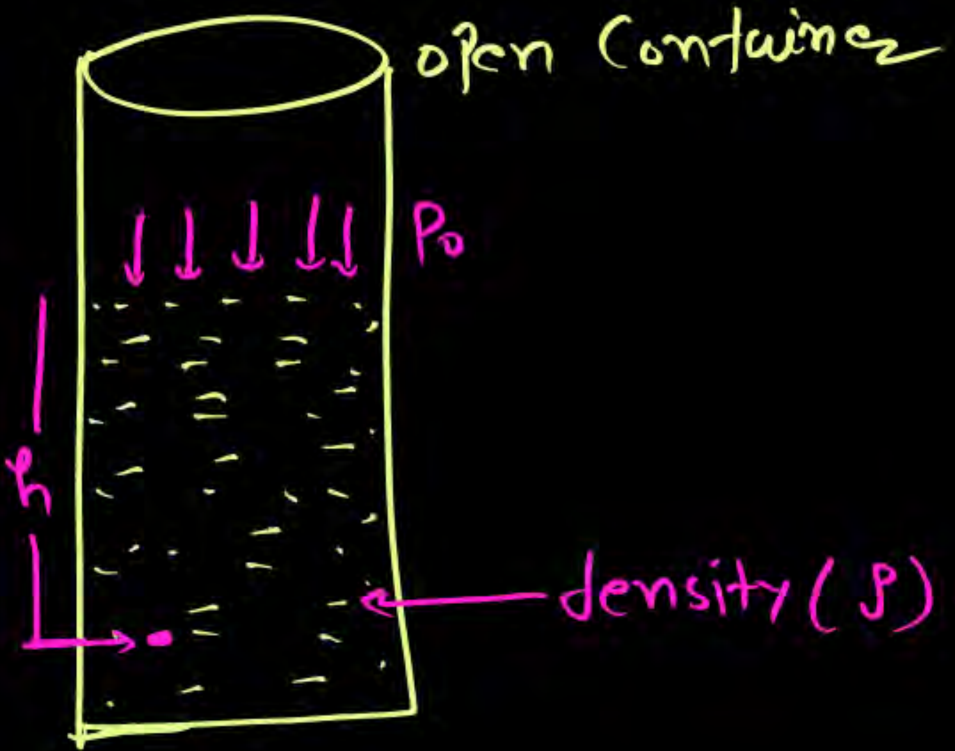
h → depth of a point from upper surface of liquid

→ depends on density of liquid, accn due to gravity & depth.
does not depend on Area

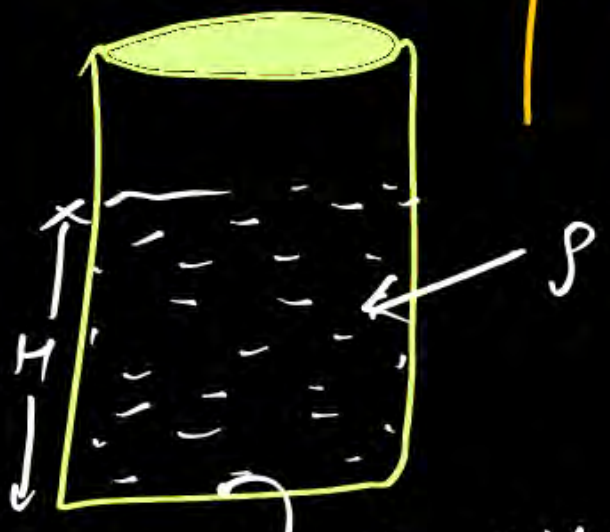


$P_1 = P_2 = P_3 = P_4$

↳ same liquid upto same height.



$$P_{net} = \rho g h + P_0$$



$P = \rho H g_{eff}$

$\uparrow a_{lift} = a_0 \Rightarrow P = \rho(g+a)h$

$\downarrow a_{lift} = a_0 \Rightarrow P = \rho(g-a)h.$

If container is falling freely.

$$P = \rho H(g-g)$$

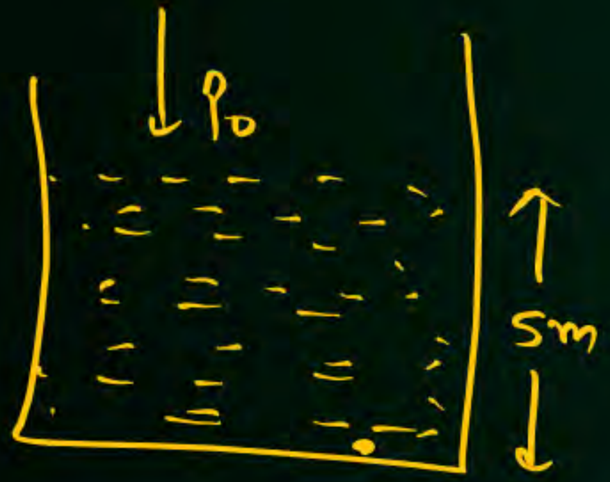
$$P_{net} = 0$$

Ans

QUESTION

Find the pressure exerted below a column of water, open to the atmosphere, at depth,

(i) 5m



$$P = P_0 + \rho g h$$

$$= 1.01 \times 10^5 \, Pa + 10^3 \times 10 \times 5$$

$$\simeq 10^5 + 5 \times 10^4 = 15 \times 10^4$$

QUESTION

At a depth of 500 m in an ocean, what is the absolute pressure? Given that the density of sea water is 1.03×10^3 kg/m^3 and $g = 10$ m s^{-2}.

P_{net} ($P_{air} + P_{liquid}$)

$P_{absolute} = P_{net}$

$P_{gauge\ pressure} = P_{liquid}$ (No air pressure considers)

$P = P_0 + \rho g h$

$= 1.01 \times 10^5 + 1.03 \times 10^3 \times 10 \times 500\,m$

$= 10^5 + 1.03 \times 50 \times 10^5$

$\simeq 51 \times 10^5$

QUESTION

What is the pressure on a swimmer 20m below the surface of water?

1. 1 atm
2. 2 atm
3. 3 atm ✓
4. 4 atm

$P_{net} = P_0 + P_{water}$

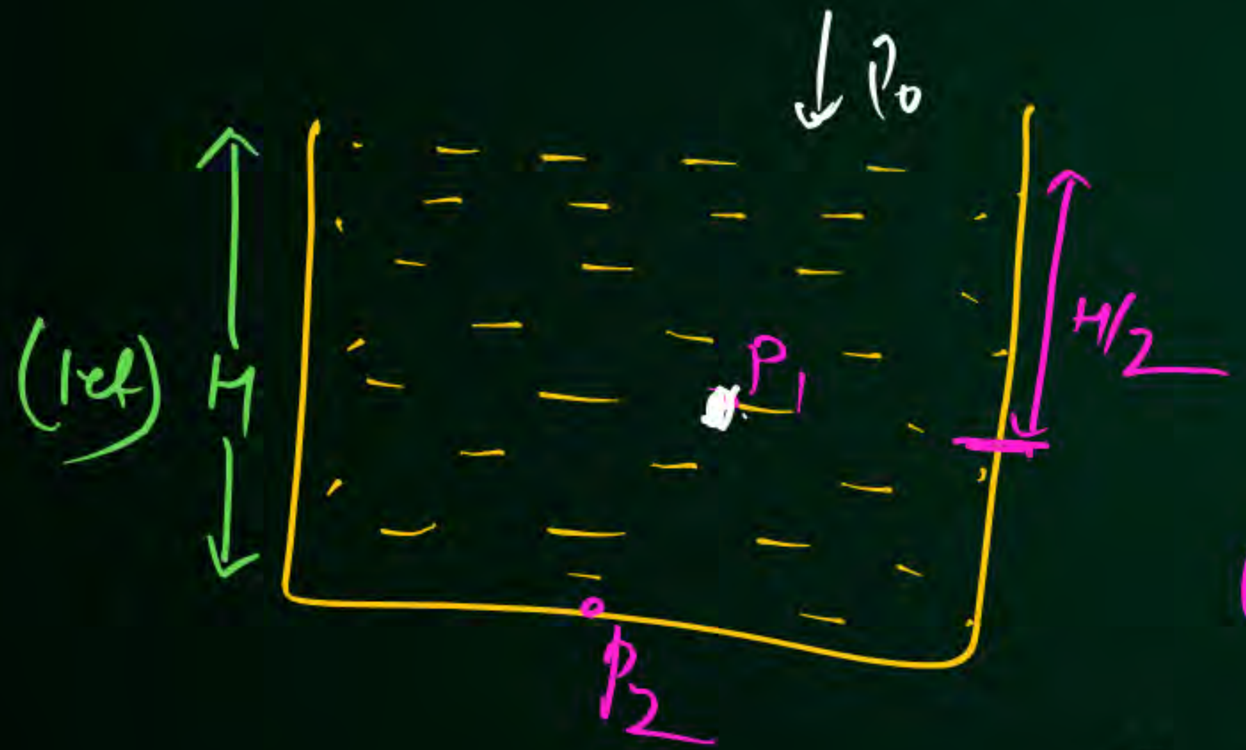
$= 1\,atm + 10^3 \times 10 \times 20$

$= 1\,atm + 2 \times 10^5$

$= 3\,atm$

QUESTION

If pressure at the half depth of a lake is equal to $\frac{3}{4}$ times the pressure at its bottom, then find the depth of the lake. [Take $g = 10\ \text{m/s}^2$]



$$P_1 = \frac{3}{4} P_2$$

$$P_0 + \frac{\rho g H}{2} = \frac{3}{4}(P_0 + \rho g H)$$

$$4P_0 + 2\rho g H = 3P_0 + 3\rho g H$$

$$4P_0 - 3P_0 = 3\rho g h - 2\rho g h$$

$$P_0 = \rho g h$$

$$10^5 = 10^3 \times 10\, h$$

$$h = 10\ \text{m}$$

Ans

QUESTION

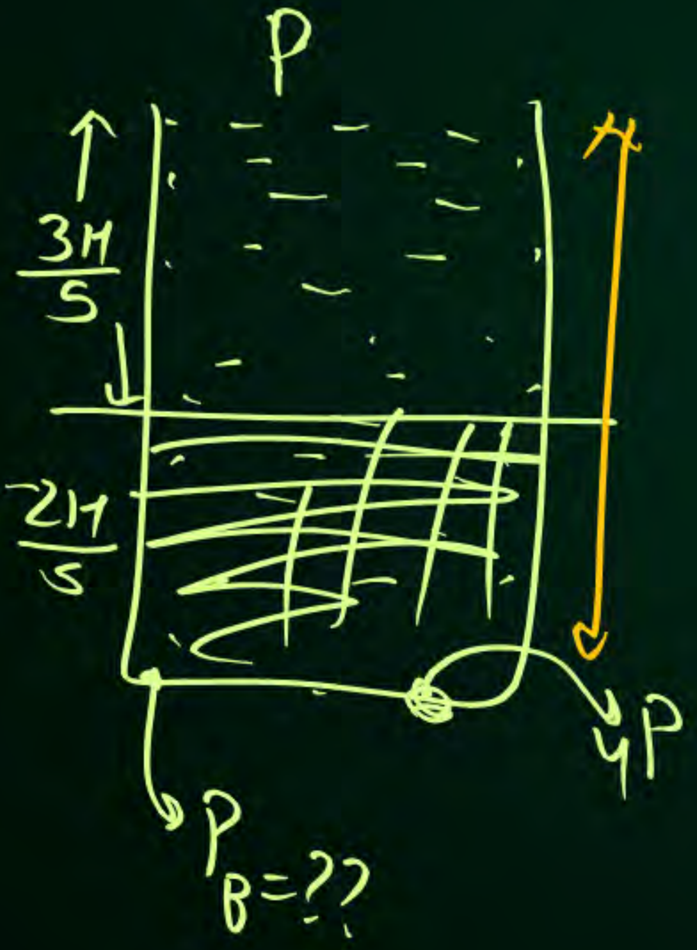
The pressure at the bottom of a water tank is $4P$, where P is atmospheric pressure. If water is drawn out till the water level decreases by $\frac{3}{5}$th, then pressure at the bottom of the tank is

(1) $\frac{3P}{8}$

(2) $\frac{7P}{6}$

(3) $\frac{11P}{5}$

(4) $\frac{9P}{4}$



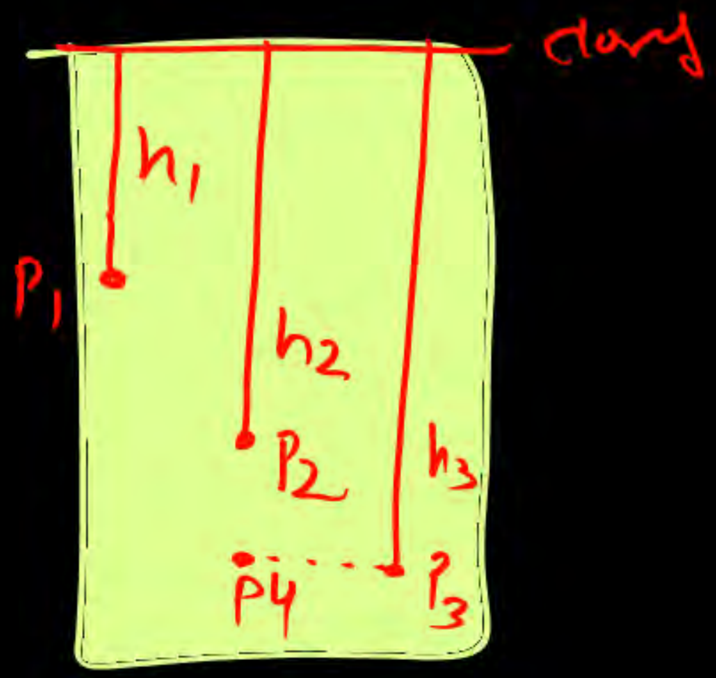
$4P = P + \rho g H$

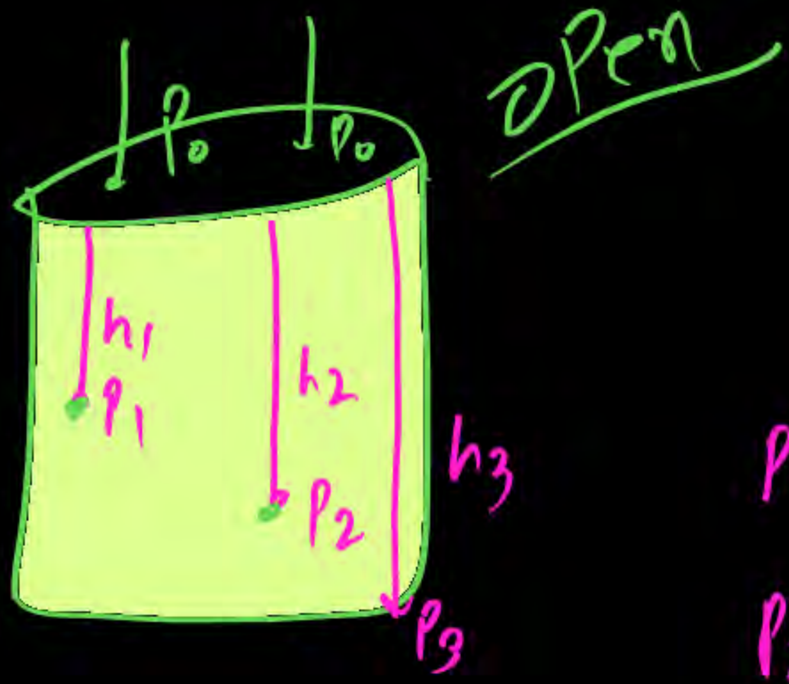
$3P = \rho g H$ — (1)

$P_{\text{net Bot}} = P + \frac{2}{5}\rho g H$

$= P + \frac{2}{5} \times 3P$

$= \frac{5P + 6P}{5} = \frac{11P}{5}$





$$P_1 = P_0 + \rho g h_1$$

$$P_2 = P_0 + \rho g h_2$$

$$P_3 = P_0 + \rho g h_3$$

$$P_1 < P_2 < P_3 = P_4$$

$$P_1 = \rho g h_1$$

$$P_2 = \rho g h_2$$

$$P_3 = \rho g h_3$$

याद

QUESTION

A air bubble rises from bottom of a lake to surface. If its radius increases by 200% and atmospheric pressure is equal to water column of height H, then depth of lake is

1. 21 H
2. 8 H
3. 9 H
4. 26 H



QUESTION

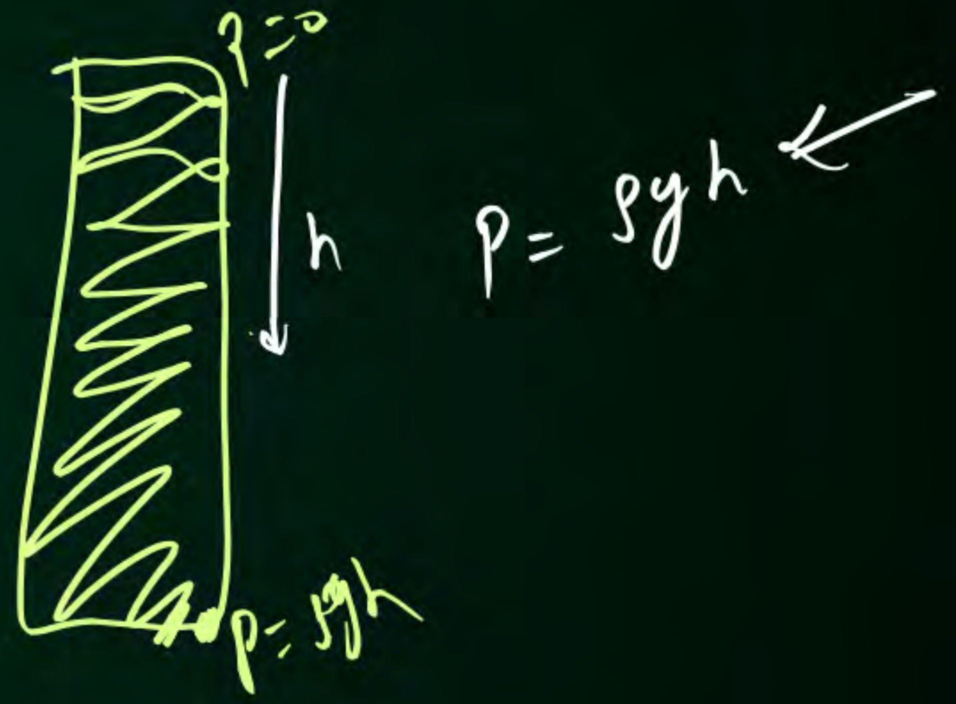
A tank is filled by liquid of density ρ upto height H. The average pressure on the walls of container is

(1) $\frac{\rho g H}{2}$

(2) $-\rho g H$

(3) $\frac{1}{4}\rho g H$

(4) $\frac{1}{8}\rho g H$




THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 02 | **Physics**

Mechanical Properties of Fluid

By- Dr. Manish Raj (MR SIR)

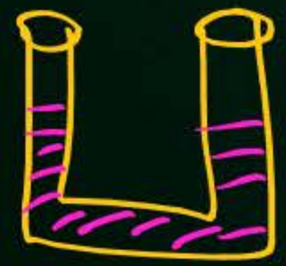


Topics to be covered

1. # * Liquid Pressure
2. # Pascal law

U-tube

3. #





QUESTION

$P_{atm} = 10^5 N/m^2$

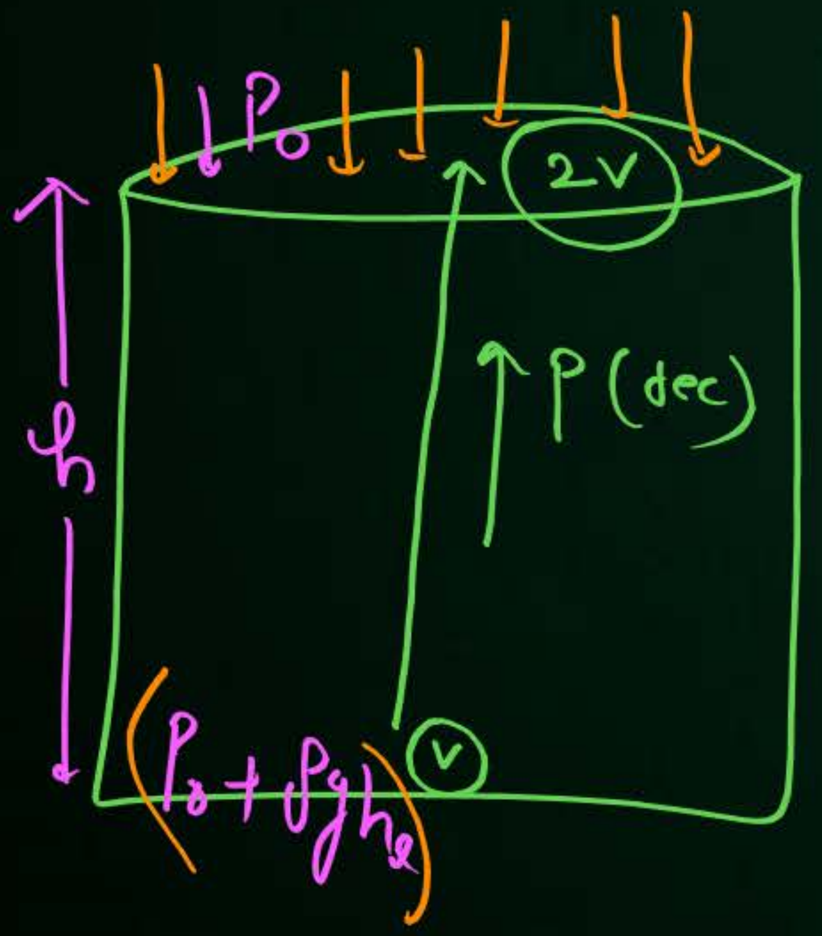
Select wrong statement about pressure ??

1. Pressure is a scalar quantity ✓
2. Pressure is always compressive in nature (wrong)
3. Pressure at a point is same in all directions ✓
4. None of these

Ans – 2

QUESTION

The volume of an air bubble is doubled as it rises from the bottom of lake to its surface. The atmospheric pressure is 75 cm of mercury. The ratio of density of mercury to that of lake water is $\frac{40}{3}$. The depth of the lake in metre is



$(P_0 + \rho g h_l) = 2(P_0)$

$\rho g h_l = 2P_0 - P_0$

$\rho_w g h_l = P_0$

$\rho_w g h_l = \rho_{Hg} g H_m$

$h_l = \frac{40}{3} \times 75\text{ cm} = 1000\text{ cm} = 10\text{ m}$

$P_0 = P_{\text{due to 75 cm of Hg}}$

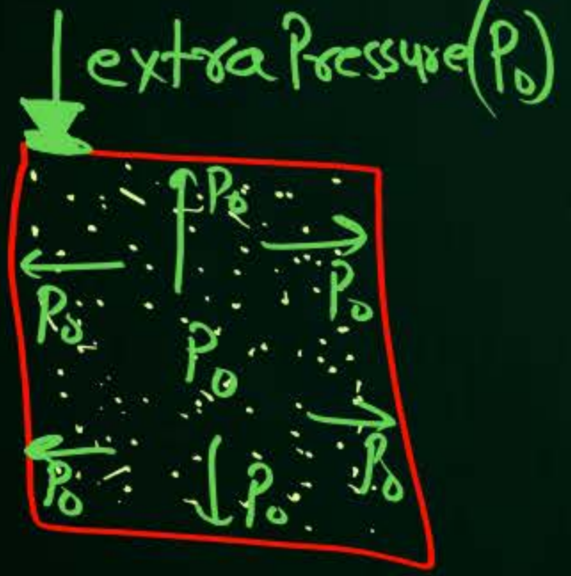
$P_0 = \rho_{Hg} g H$

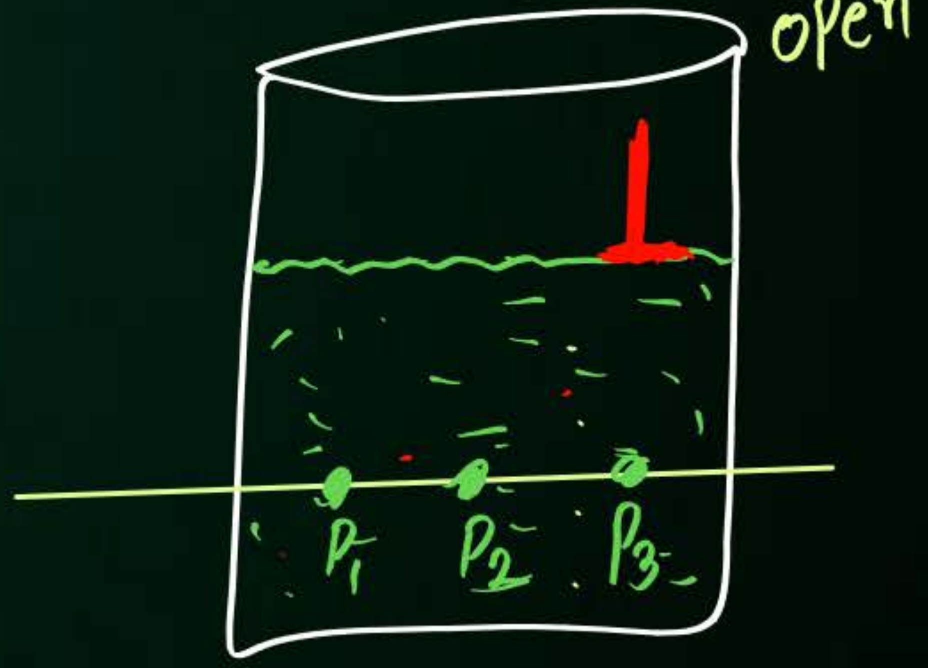
$\left(\frac{\rho_{Hg}}{\rho_w}\right) = \frac{40}{3}$

Pascal Law

1. **Pressure in a fluid at rest is same at all points which are at same height.** (horizontal line)

2. **A extra pressure applied at any point of enclosed fluid is transmitted undiminished to every point of the fluid and the walls of the containing vessel.**



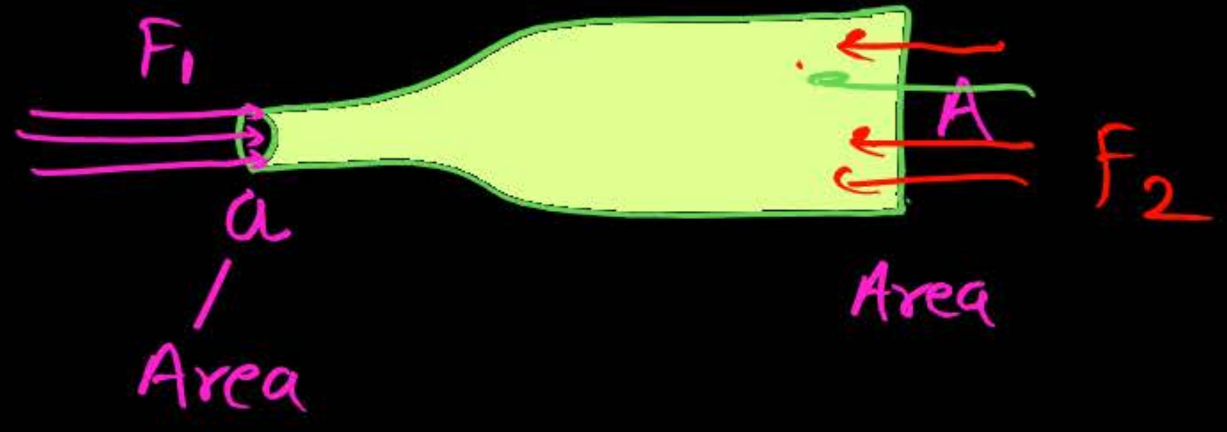


$$\text{Pressure} = \frac{F}{A}$$

(Pressure → const)

$$F = P A$$

(P → const)



Pressure Balance

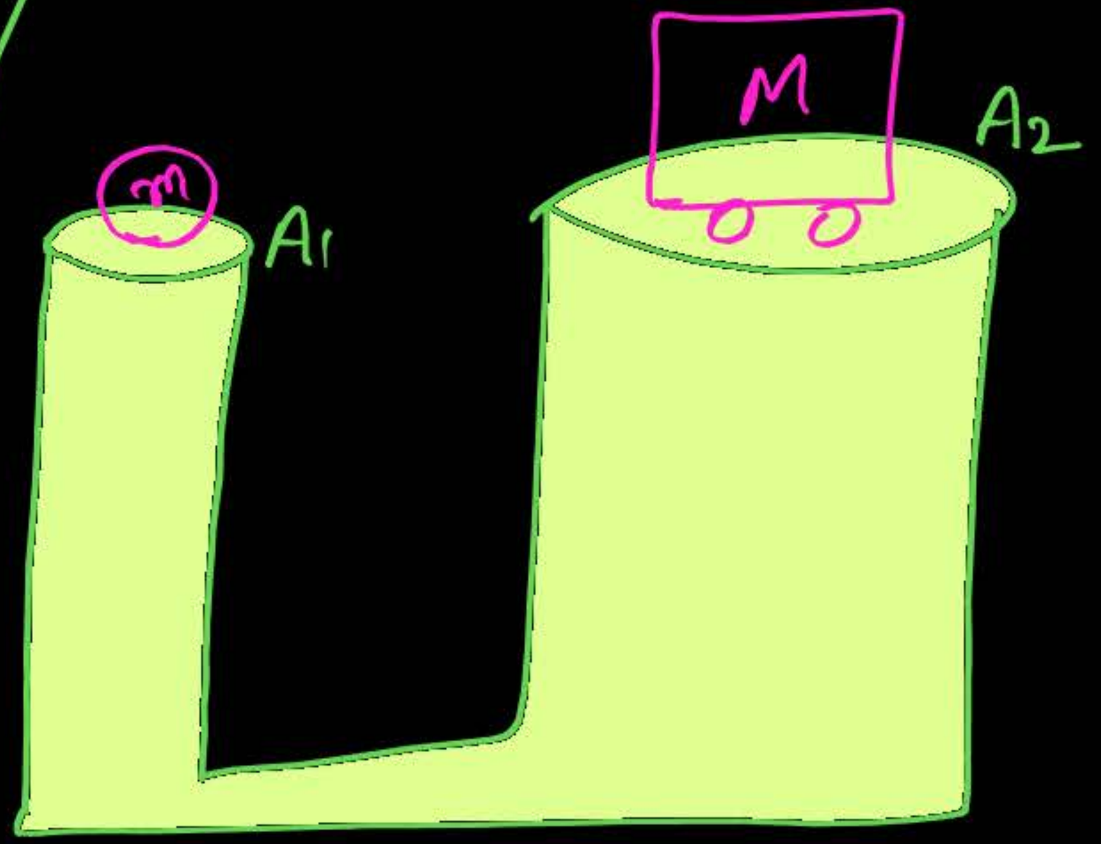
$$P_1 = P_2$$

$$\frac{F_1}{a} = \frac{F_2}{A}$$

Hydraulic lift

$$P_1 = P_2$$

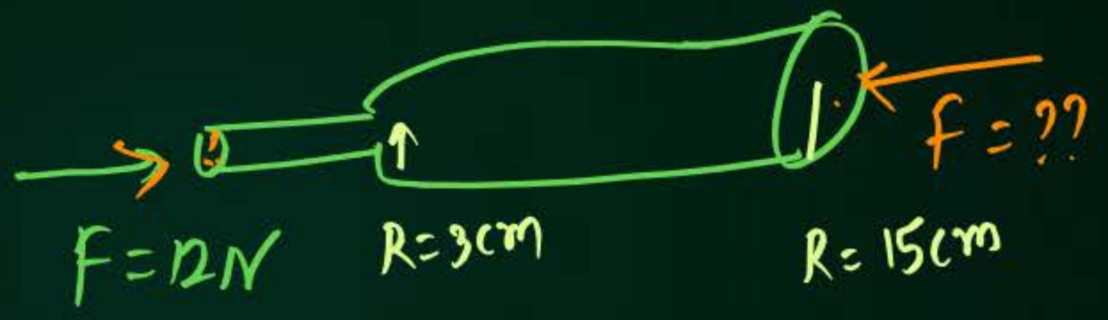
$$\frac{mg}{A_1} = \frac{mg}{A_2}$$



QUESTION

The neck and bottom of a bottle are 3 cm and 15 cm in radius respectively. If the cork is pressed with a force 12 N in the neck of the bottle, then force exerted on the bottom of the bottle is

1. 30 N
2. 150 N
3. 300 N (79%)
4. 600 N



$P_1 = P_2$

$\frac{12}{\pi(3)^2} = \frac{F}{\pi(15)^2}$

$\frac{12}{9} = \frac{F}{15 \times 15}$

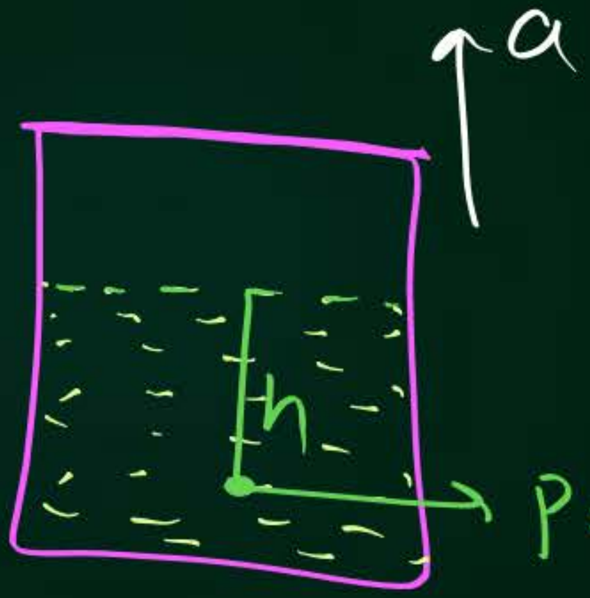
$F = 60 \times 5$

$F = 300 N$

QUESTION

A beaker containing a liquid of density ρ moves up with an acceleration 'a'. The pressure due to the liquid at a depth h below free surface of the liquid is

1. $h\rho g$
2. $h\rho(g-a)$
3. $h\rho(g+a)$
4. $2h\rho g\left(\frac{g+a}{g-a}\right)$



$P = \rho g_{eff} h$

$= \rho(g+a)h$

QUESTION

In a hydraulic jack as shown, mass of the car $W = 800\ \text{kg}$, $A_1 = 10\ \text{cm}^2$, $A_2 = 10\ m^2$. The minimum force F required to lift the car is

mass

(1) 1 N

(2) 0.8 N

Ans

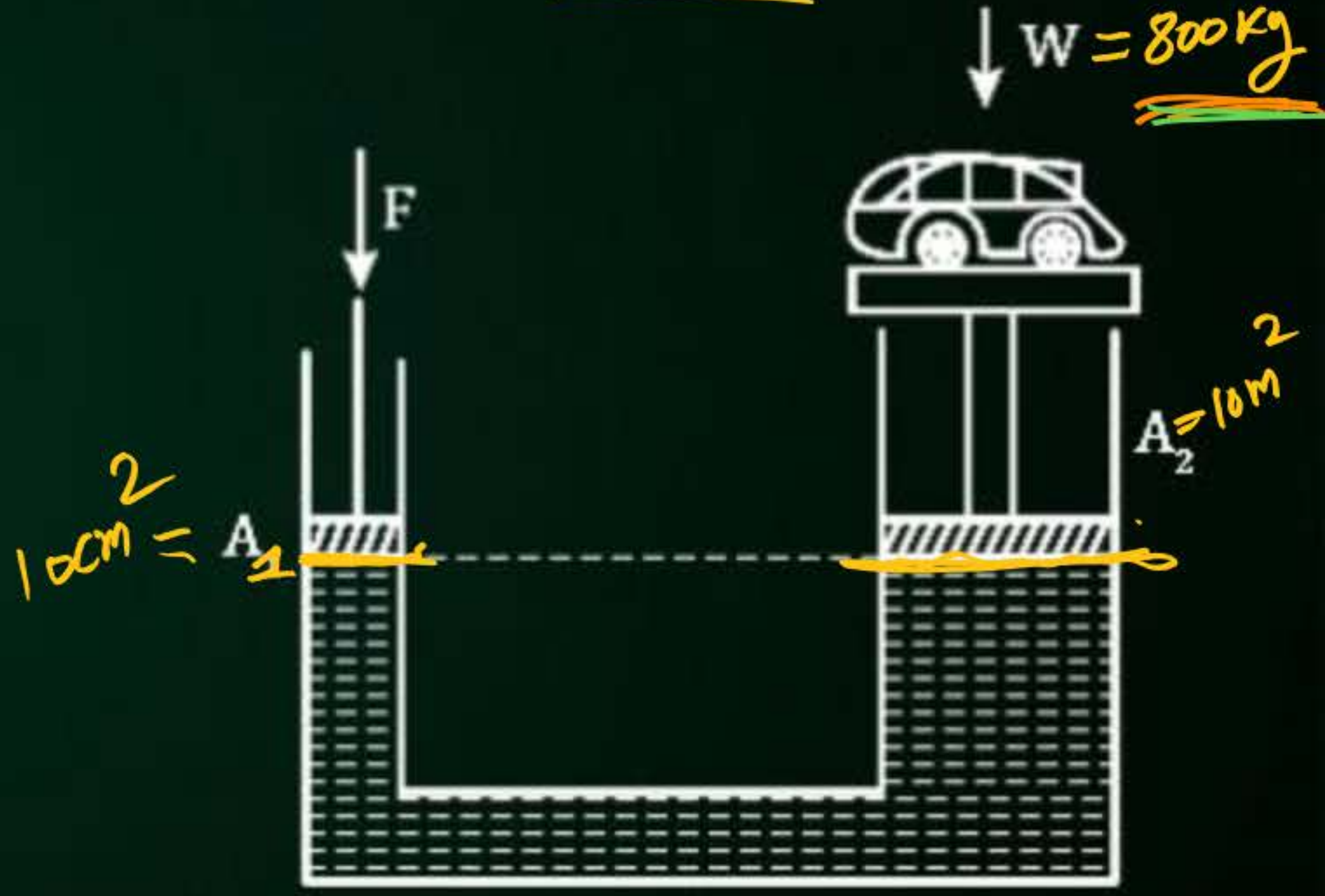
(3) 8 N

(4) 16 N

$$\frac{F}{10\ cm^2} = \frac{800 \times 10}{10\ m^2}$$

$$\frac{F}{1\ cm^2} = \frac{800 \times 10}{10^4\ cm^2}$$

Ans $F = 0.8\ N$







$P_A = P_B$

$P = \rho g h$

QUESTION

A large vessel of height H, is filled with a liquid of density ρ, upto the brim. A small hole of radius r is made at the side vertical face, close to the base. The horizontal force is required to stop the gushing of liquid is

(1) $2(\rho g H)\pi r^2$

(2) $\rho g H$

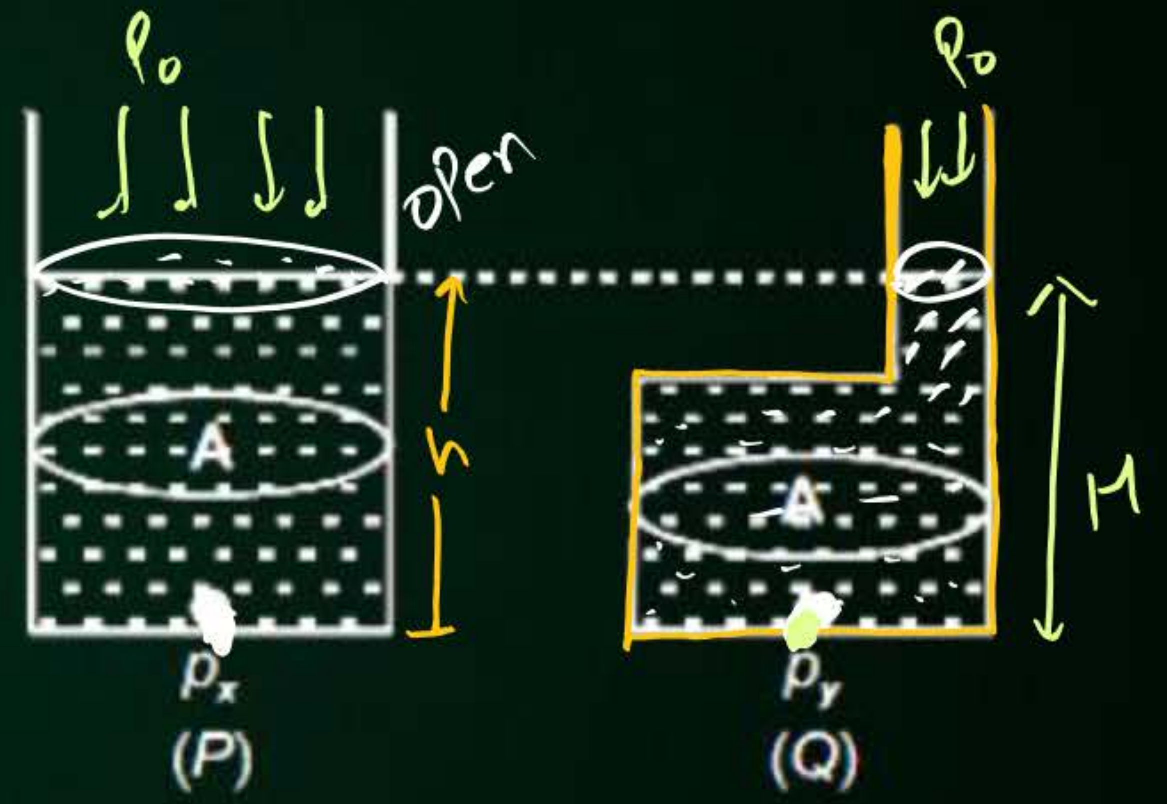
(3) $\rho g H \pi r^2$

(4) $\rho g \pi r^2$

QUESTION

Figure shows two containers P and Q with same base area A and each filled upto same height with same liquid. Select the correct alternative.

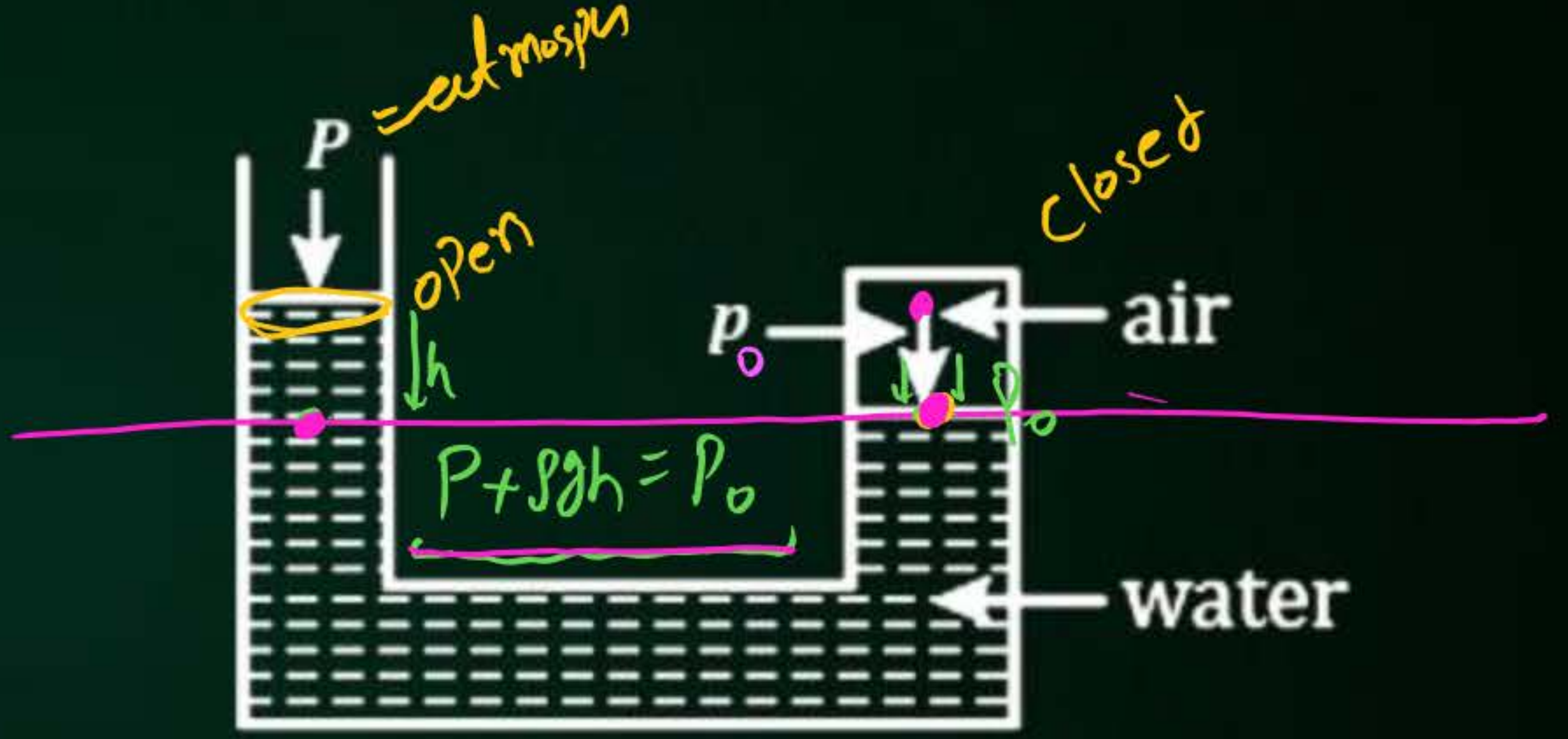
1. $p_x = p_y$ (70%)
2. $p_x > p_y$
3. $p_y > p_x$
4. Can't say



QUESTION

The pressure of confined air is p. If the atmospheric pressure is P, then

1. P is equal to p
2. P is less than p
3. P is greater than p
4. P may be less or greater than p depending on the mass of the confined air



QUESTION

Gauge pressure

1. May be positive
2. May be negative
3. May be zero
4. all of these

$$P_{net} = \underbrace{P_{liquid}}_{P_{gauge}} + P_{atm}$$

$$P_{net} = P_{gauge} + P_{atm}$$

$$P_{gauge} = P_{net} - P_{atm}$$

QUESTION

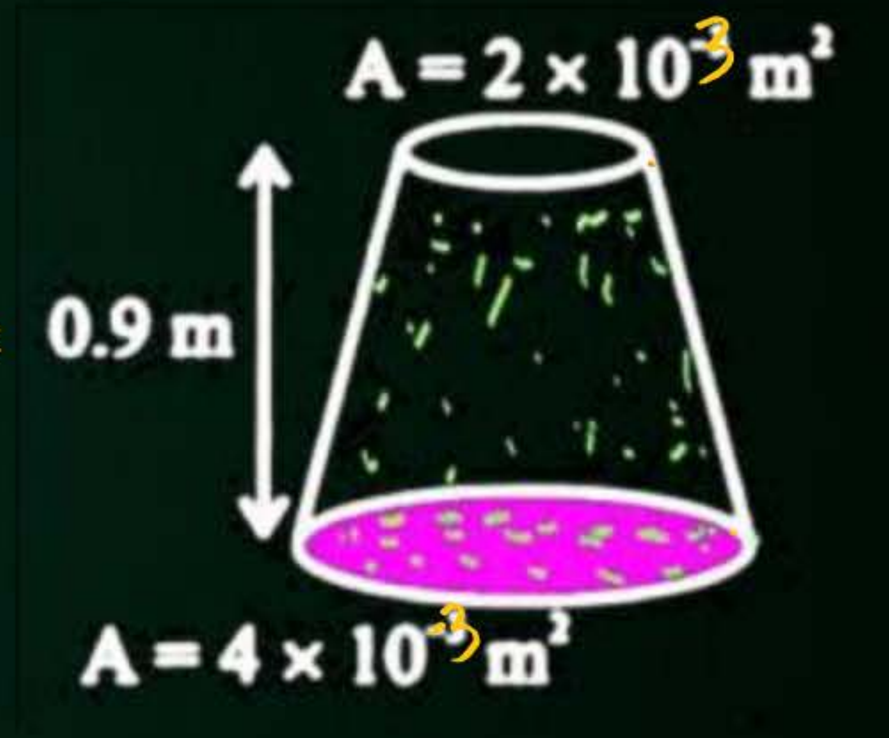
A uniform tapering vessel is filled with a liquid of density of $1000\ kg/m^3$. What is the force acting on the base of the vessel due to the liquid?

1. 15 N
2. 30 N
3. 35 N (Ans.)
4. 40 N



$P_1 = P_2$

$F_1 \neq F_2$



Force = Pressure × Area

$= \rho g h \times A$

$= 10^3 \times 10 \times \frac{9}{10} \times 4 \times 10^{-3}$

$= 36\ N$

QUESTION

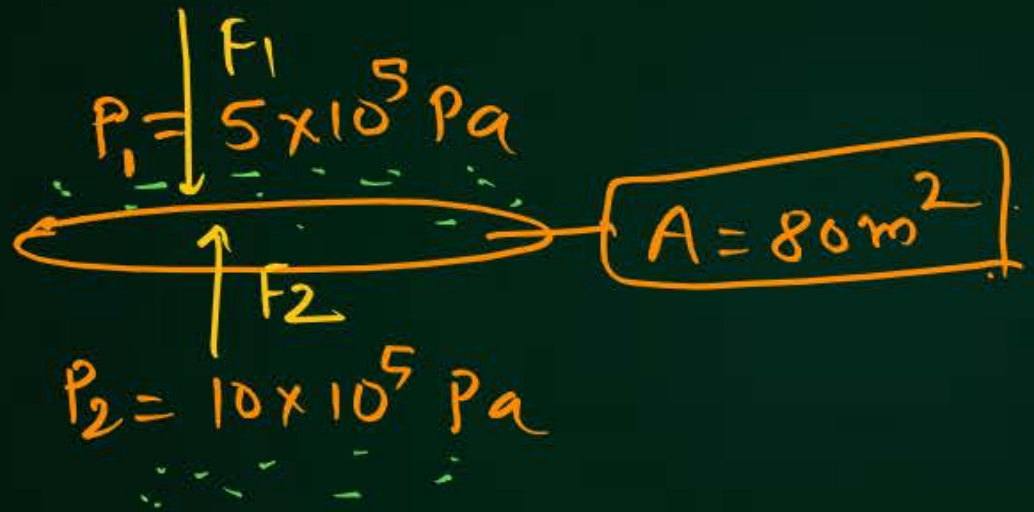
In a wind tunnel experiment, the pressure on the upper and lower surface of the wings are 5×10^5 Pa and 10×10^5 Pa respectively. If the area of the wing is $80\ m^2$, the net lifting force on the wing is

(1) 4×10^7 N ✓

(2) 5×10^7 N

(3) 3×10^7 N

(4) 2×10^7 N



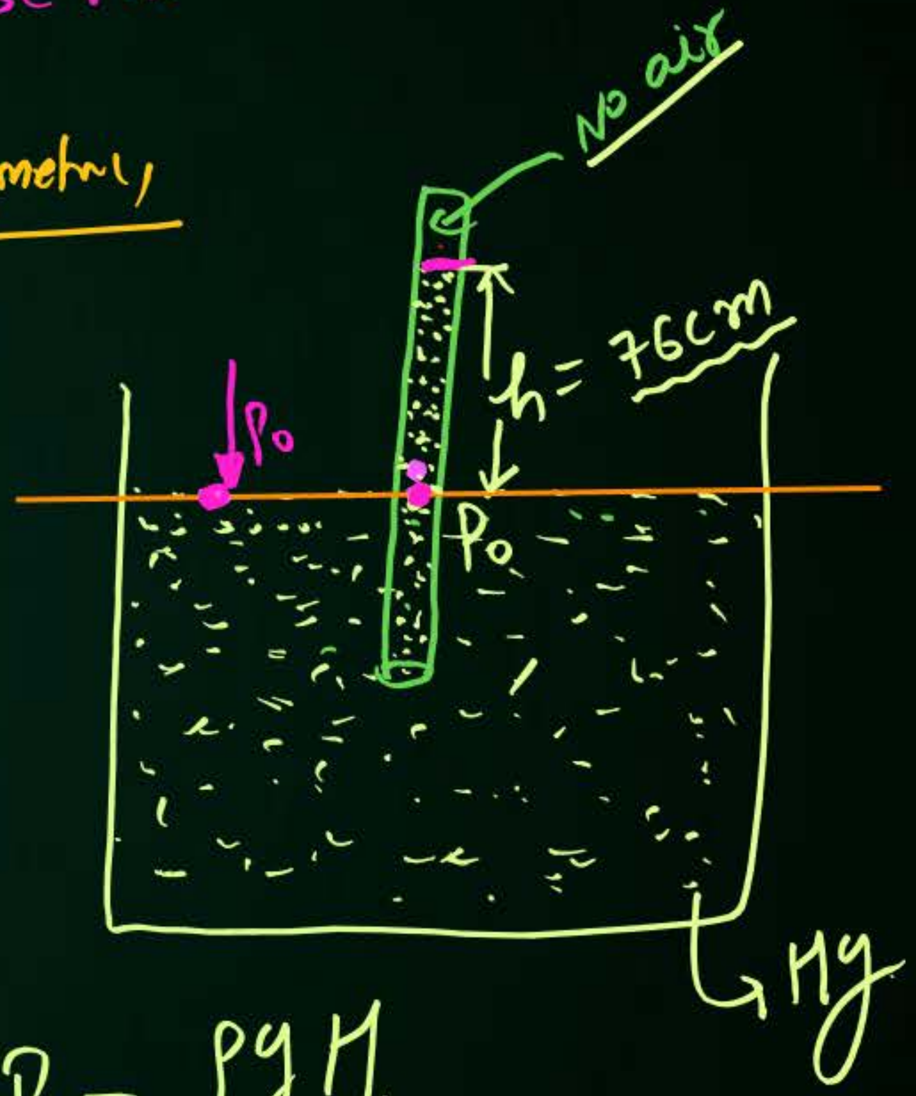
$$\text{force}_{net} = F_2 - F_1$$
$$= P_2A - P_1A$$
$$= A(P_2 - P_1) = 5\times10^5 \times 80$$
$$= 40\times10^5$$

Barometre

Pascal chacha ka Izzat Bachane ke liye Hg rise karta hain

Instrument use to measure atmospheric pressure is called Barometer

Mercury Barometre



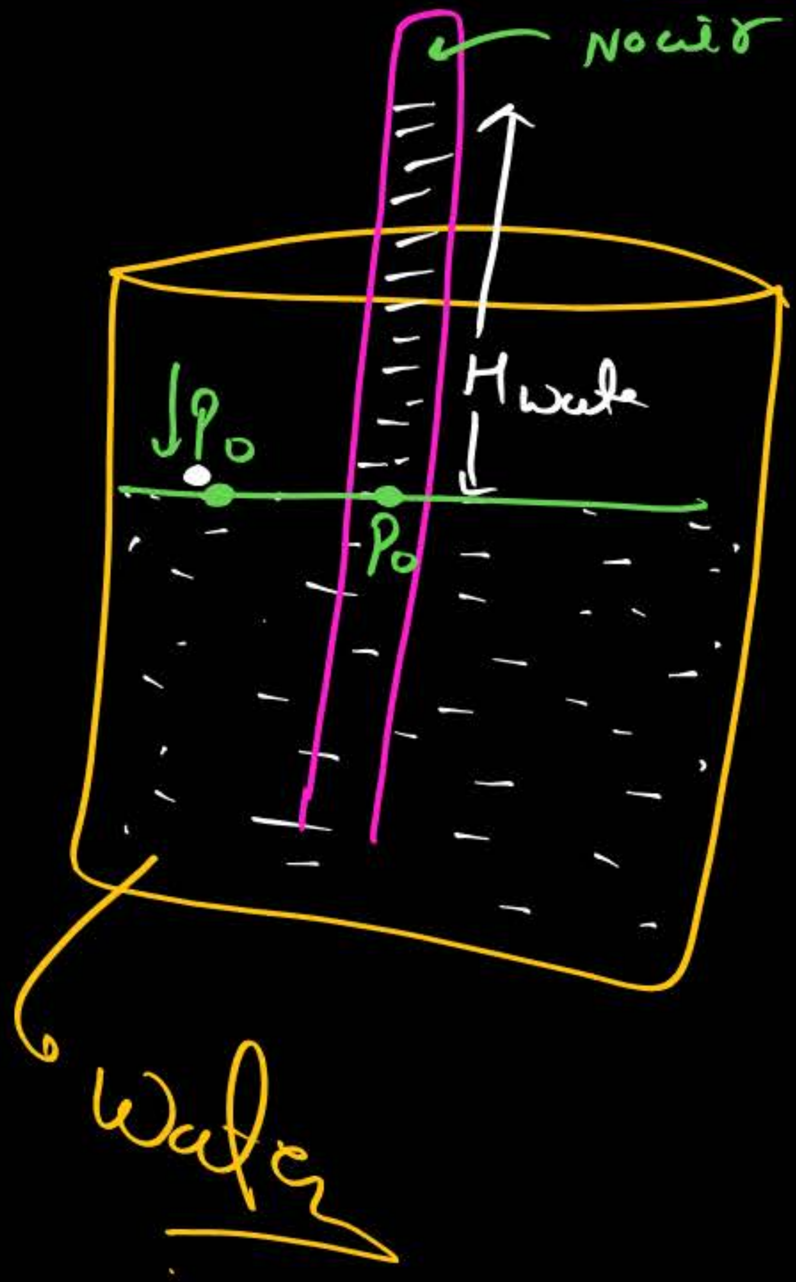
$$P_0 = \rho_{Hg} g H$$

$$= [13.6 \times 10^3 \times 10 \times 76 \times 10^{-2} m]$$

$$P_0 = 1.01 \times 10^5 \ N/m^2$$

Ramlal (the Garib आदमी)

→ use water in Barometer



$$P_0 = \rho_w g H$$

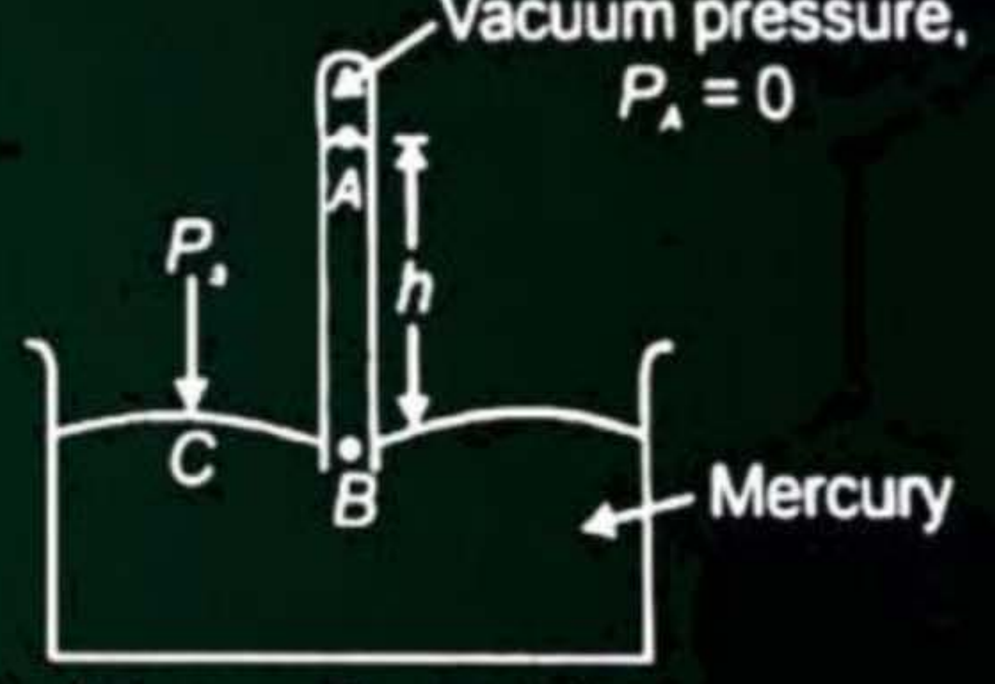
$$10^5 = 10^3 \times 10 \times H$$

$$H \simeq 10 m$$

$$H = 10.1 \text{ (exact)}$$

Measurement of Atmospheric Pressure

Italian scientist Evangelista Torricelli (1608-1647) measured first time atmospheric pressure at a point using a simple instrument called mercury barometer. A long glass tube, closed at one end is filled with mercury. It is then inverted over a trough containing mercury. Mercury in the tube slides down, till it becomes stable at a level. When the level of the mercury becomes stable in the tube, we say, that pressure exerted by mercury column in tube is same as the atmospheric pressure.



Mercury Barometer

QUESTION

The atmospheric pressure at a place is 10^5 Pa. If tribromomethane (specific gravity = 2.9) be employed as the barometric liquid, the barometric height is

1. 3.52 m

Ans.

2. 1.52 m

$R.D = 2.9 = \frac{\rho_l}{\rho_w}$

$10^5 = \rho_l g H$

3. 4.52 m

2.9×10^3 kg/m³ $= \rho_l$

4. 2.52 m

QUESTION

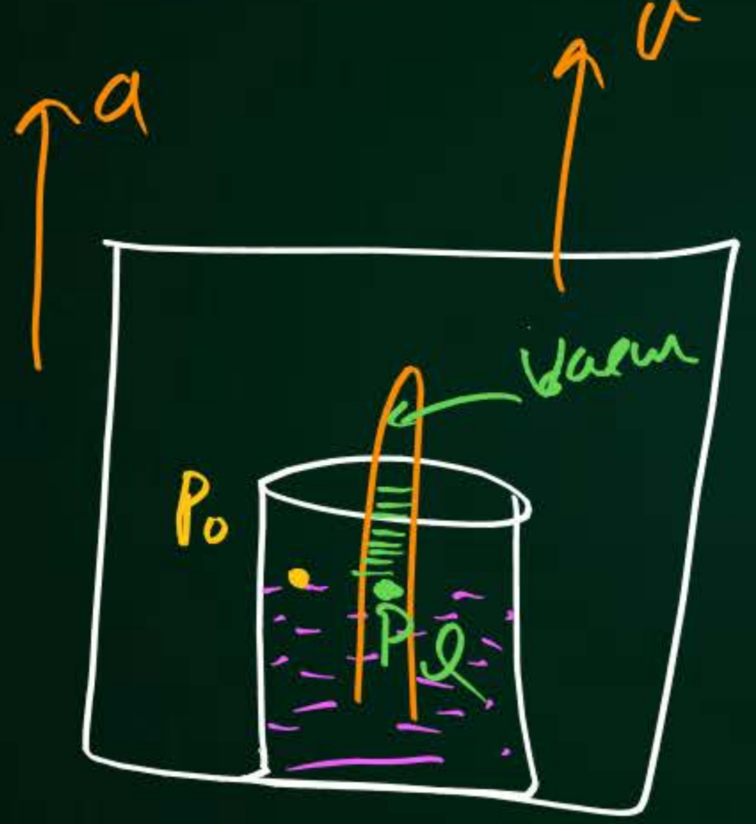
A barometer is constructed using a liquid (density $= 760\ \text{kg/m}^3$). What would be the height of the liquid column, when a mercury barometer reads 76 cm? (density of mercury $= 13600\ \text{kg/m}^3$). [2020 Covid]

1. 13.6 m (Ans)
2. 136 m
3. 0.76 m
4. 1.36 m

QUESTION

A barometer kept in an elevator reads 76 cm when it is at rest. If the elevator goes up with some acceleration, the reading will be

1. 76 cm
2. > 76 cm
3. < 76 cm (31%)
4. zero



at rest: $P_0 = \rho g H (76\,cm) = \rho (g+a) h = P_0$ (acc^n)

$H > h$

$P_0 = P_l$

at rest: $\rho g \times 76\,cm = P_0 = \rho_{Hg} (g+a) h$

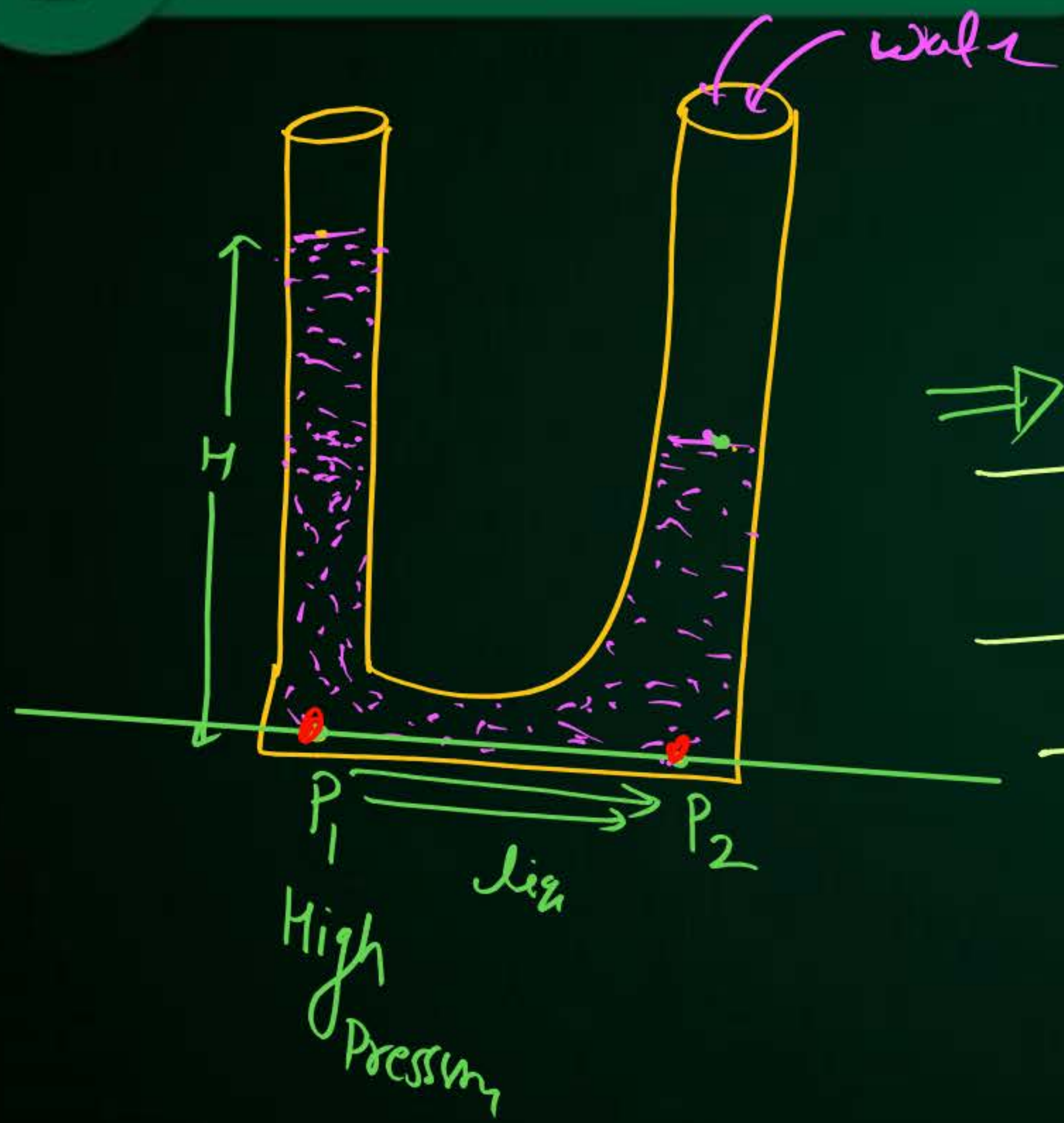
QUESTION

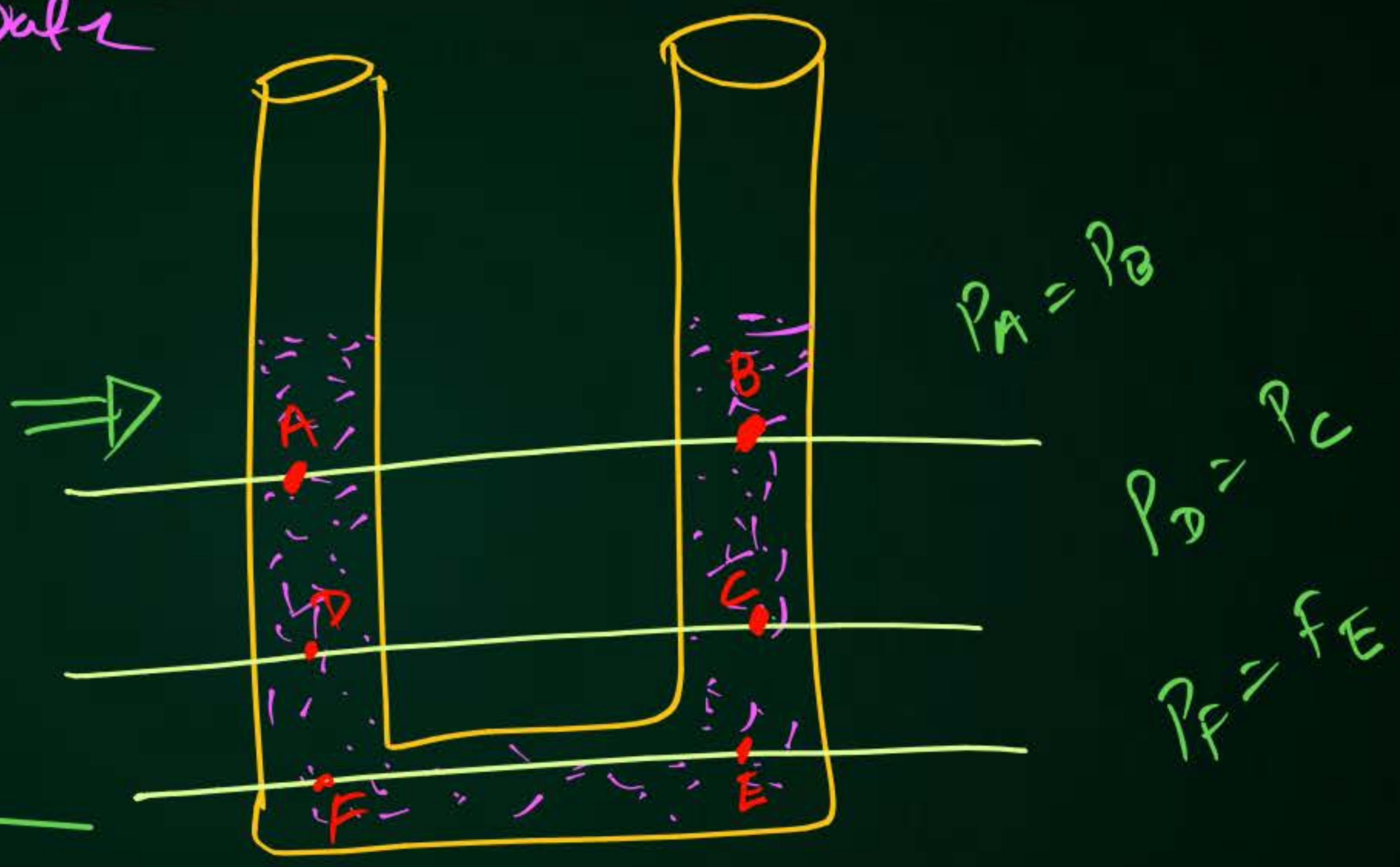
A barometer kept in an elevator reads 76 cm when the elevator is accelerating upwards. The most likely pressure inside the elevator (in cm of Hg) is

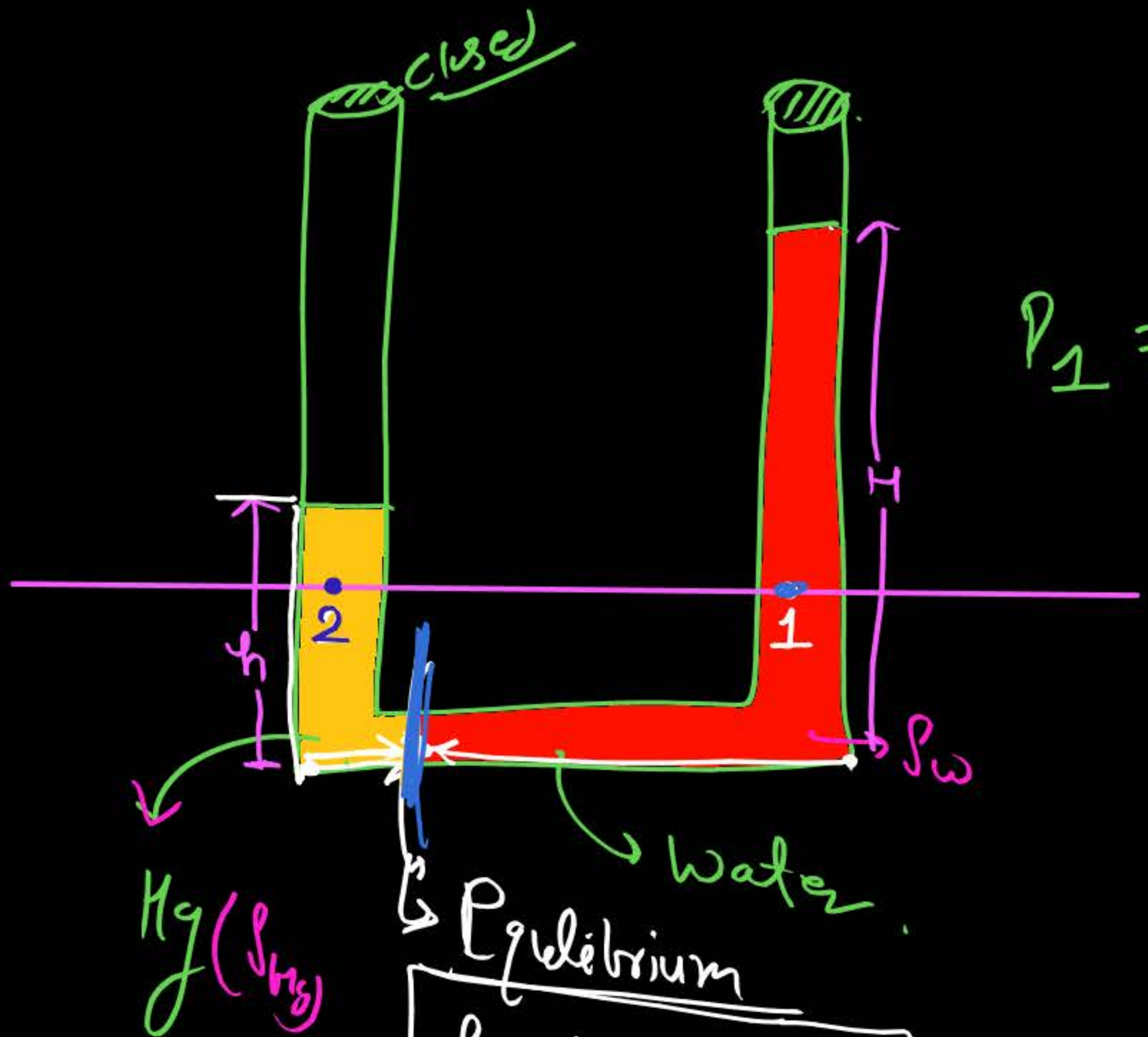
1. 74
2. 75
3. 76
4. 77

Questions on U-tube

for (NEET)

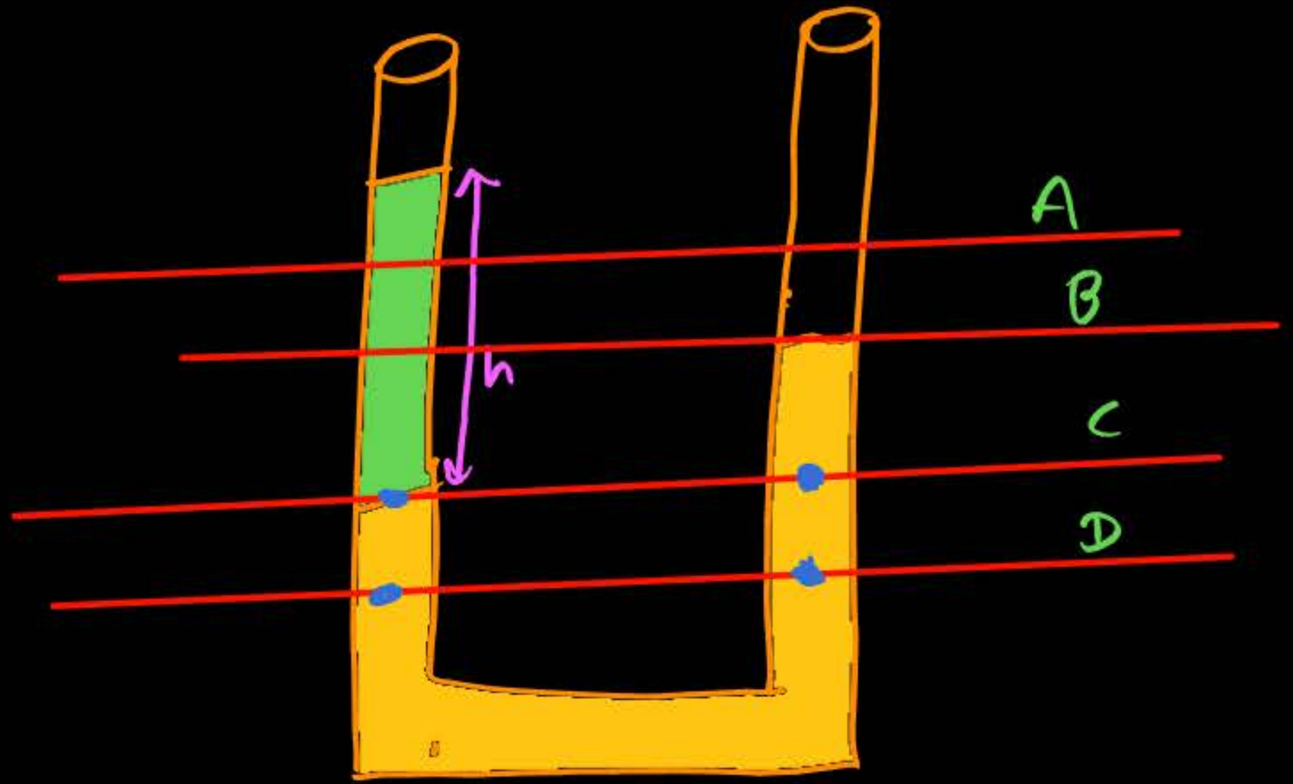






$P_1 \neq P_2$ ✓

$$\rho_{Hg}\, g\, h = \rho_w\, g\, H$$



on which horizontal line Pressure will be same

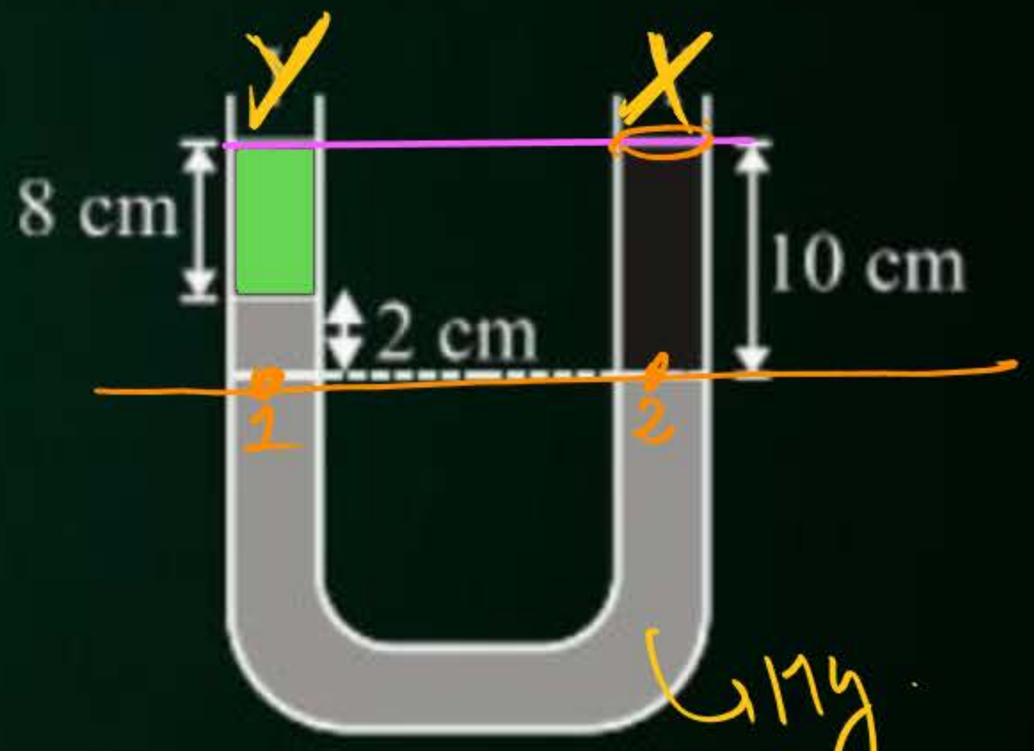
Ans (C & D)

QUESTION

NEET

A liquid X of density 3.36 g cm^{-3} is poured in a U-tube, which contains Hg. Another liquid Y is poured in left arm with height 8 cm, upper levels of X and Y are same. What is density of Y?

1. 0.8 gcc^{-1} ✓
2. 1.2 ✗
3. 1.4 ✗
4. 1.6 ✗



$$3.36 \times 10 = \rho_Y \times 8 + 13.6 \times 2$$

$$33.6 - 27.2 = \rho_Y 8$$

$$7.4 = \rho_Y 8$$

$$P_0 + \rho_X g\, 10\,cm = P_0 + \rho_Y g\, 8\,cm + \rho_{Hg} g\, 2\,cm$$

QUESTION

In a u-tube as shown in the figure water and oil are in the left side and right side of the tube respectively. The heights from the bottom for water and oil columns are 15 cm and 20 cm respectively. The density of the oil is

[take $\rho_{water} = 1000\ kg/m^3$]

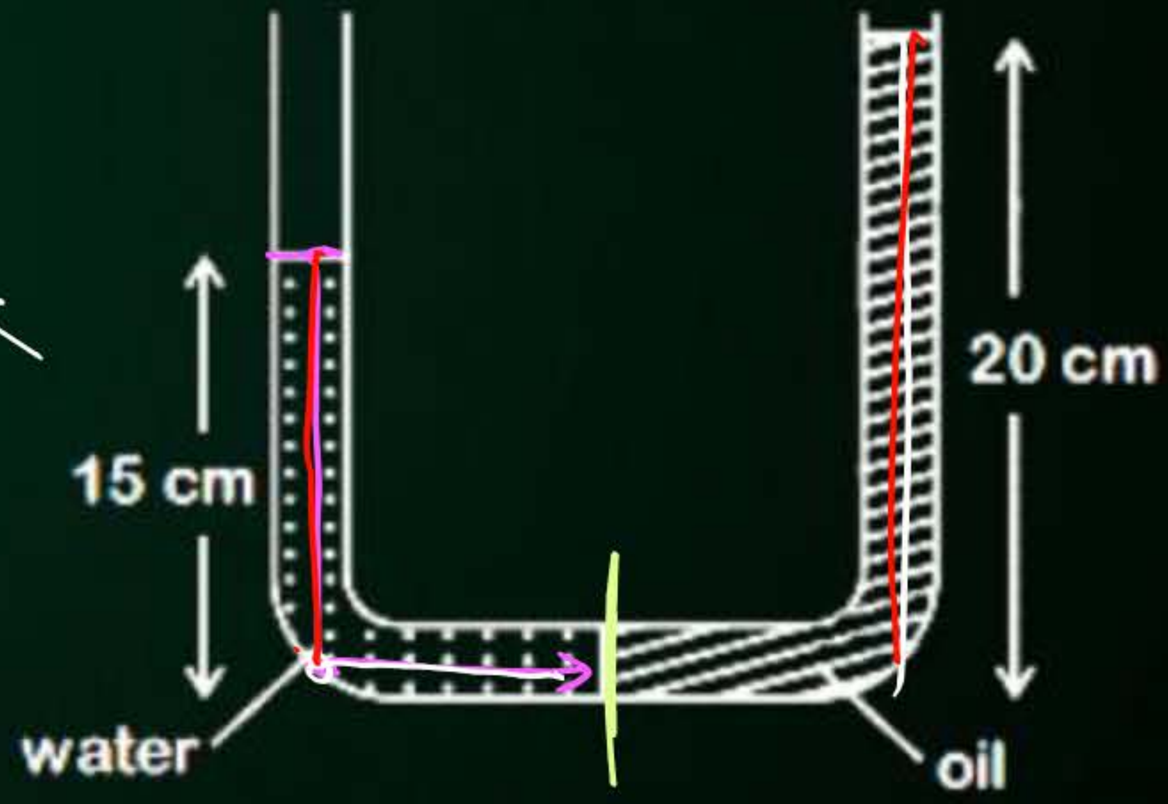
[NEET - 2019 (Odisha)]

1. $1333\ kg/m^3$
2. $1200\ kg/m^3$
3. $750\ kg/m^3$
4. $1000\ kg/m^3$

$\rho_w g\ 15\,cm = 20\,\rho_o g$

$10^3 \times 15 = 20\,\rho_o$

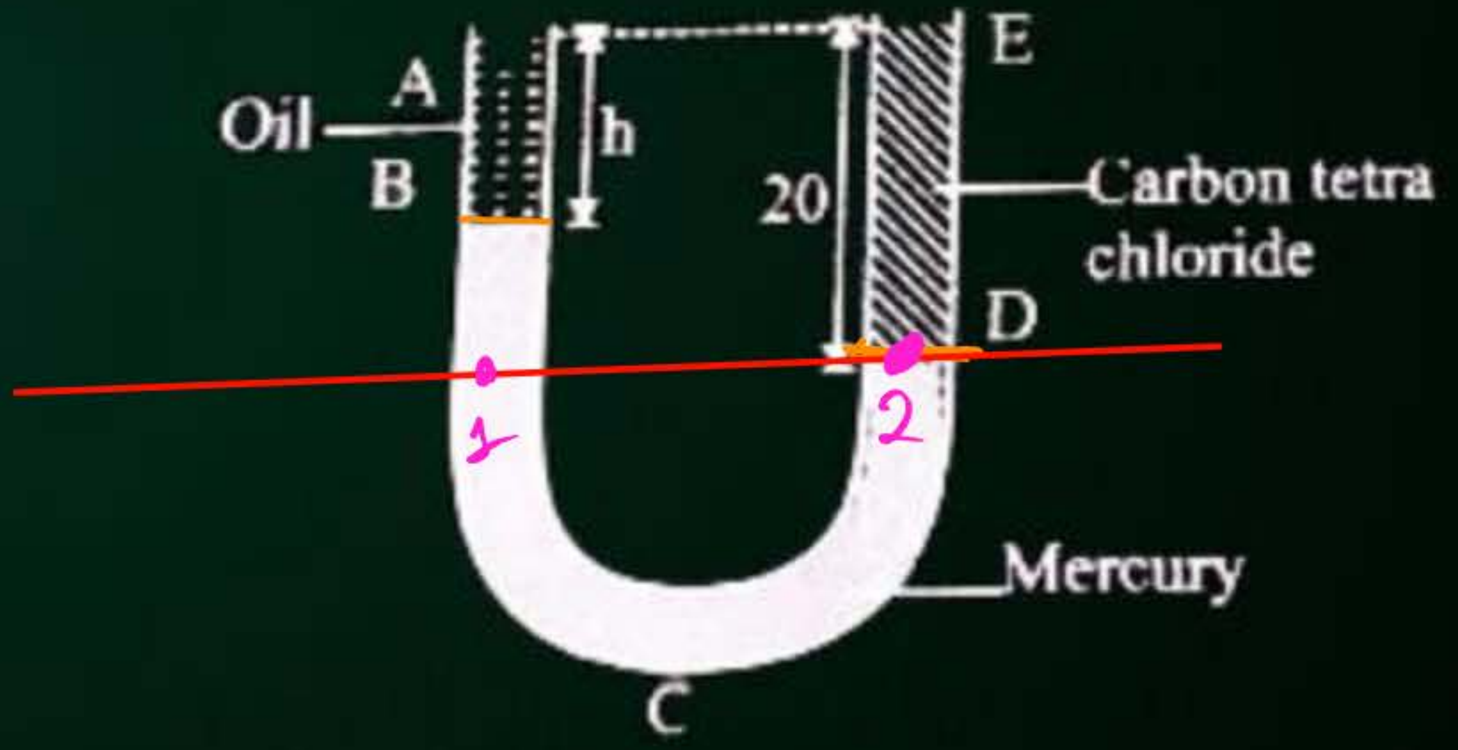
$\frac{3}{4} \times 10^3 = \rho_o$



QUESTION

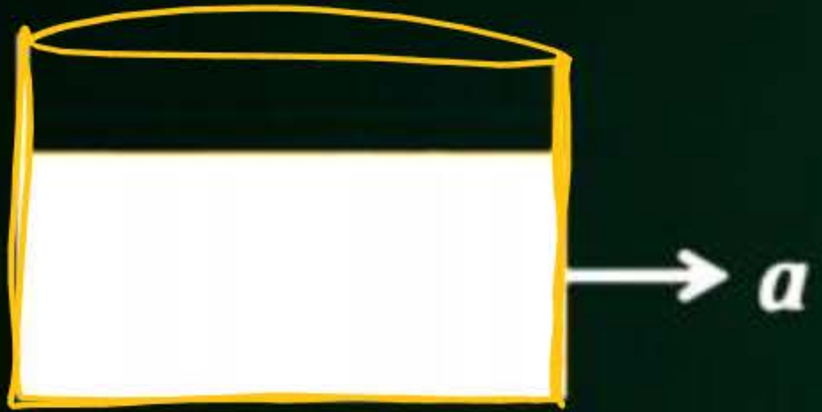
Calculate the value of h in U-tube shown in the following figure.
Density of oil $= 0.9\ g/cm^3$
Density of carbon tetra chloride $= 1.6\ g/cm^3$
Density of mercury $= 13.6\ g/cm^3$

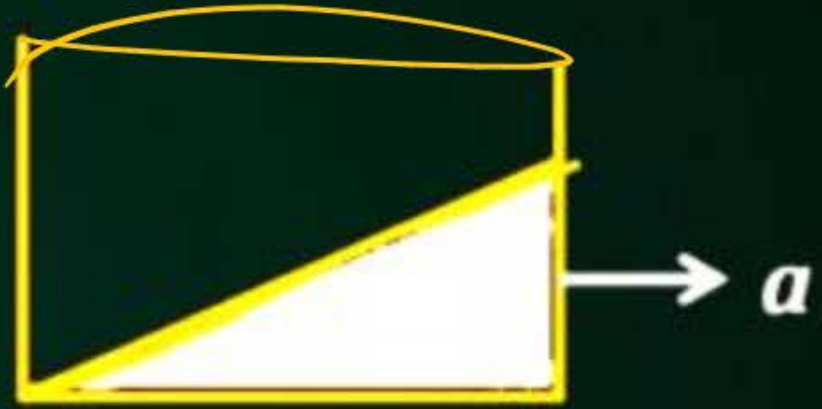
1. 18.9 cm
2. 20.9 cm
3. 169
4. 14.9

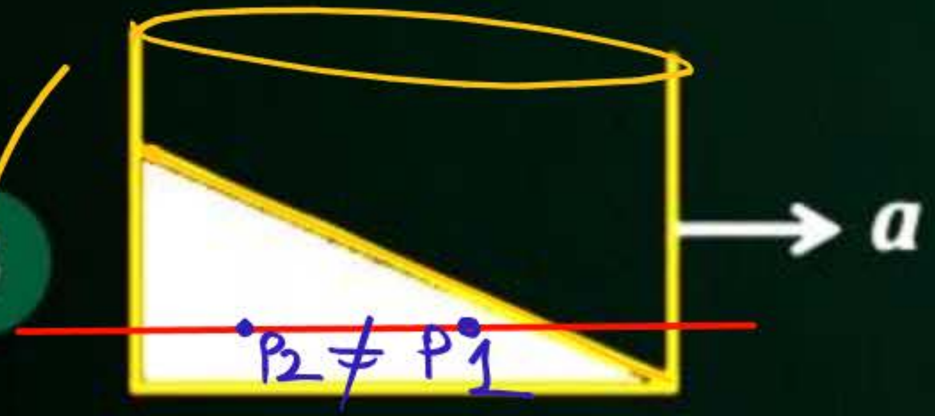


QUESTION

A vessel containing water is given a constant acceleration a towards the right along a straight horizontal path. Which of the following diagrams represents the surface of the liquid?

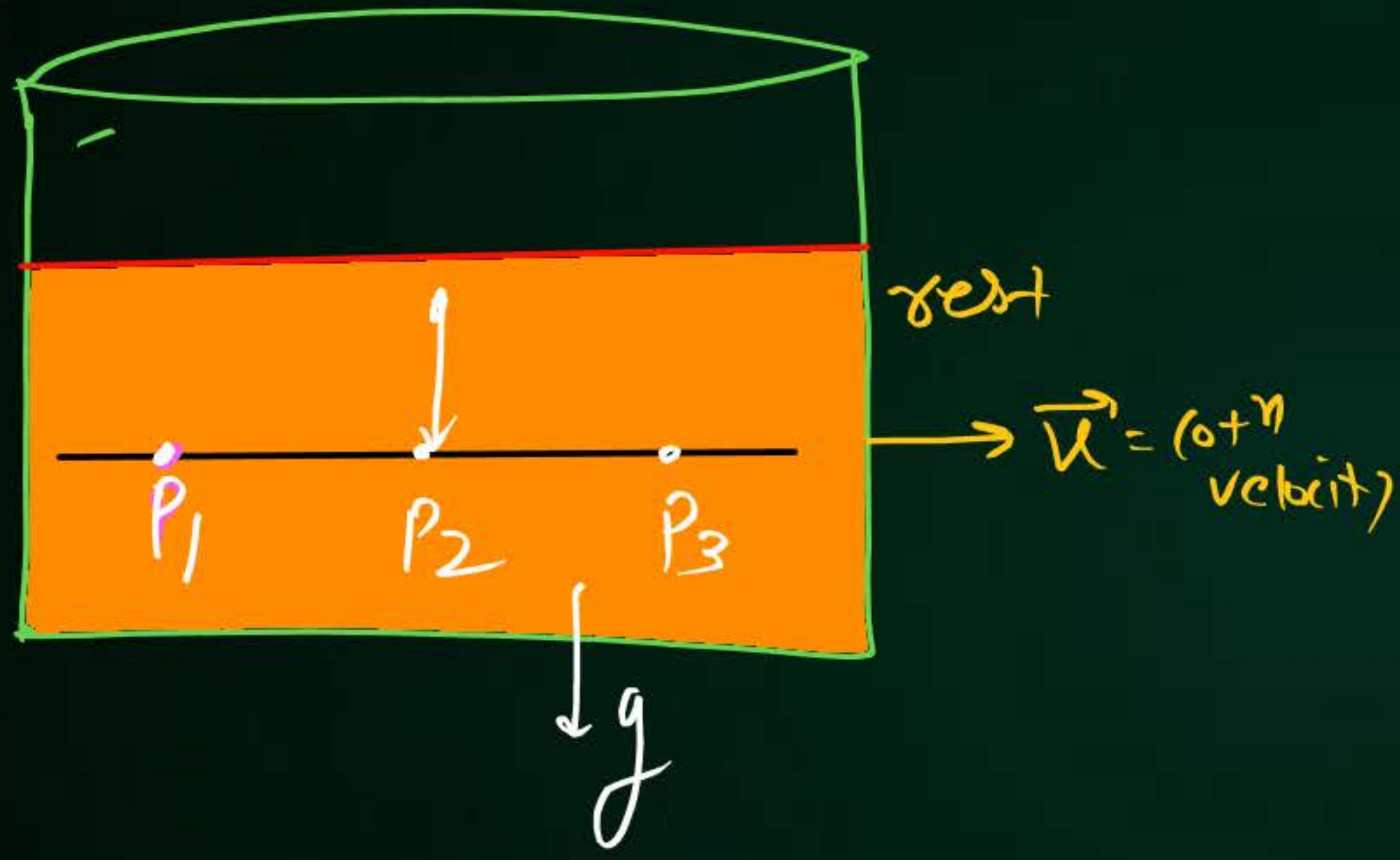
(1)


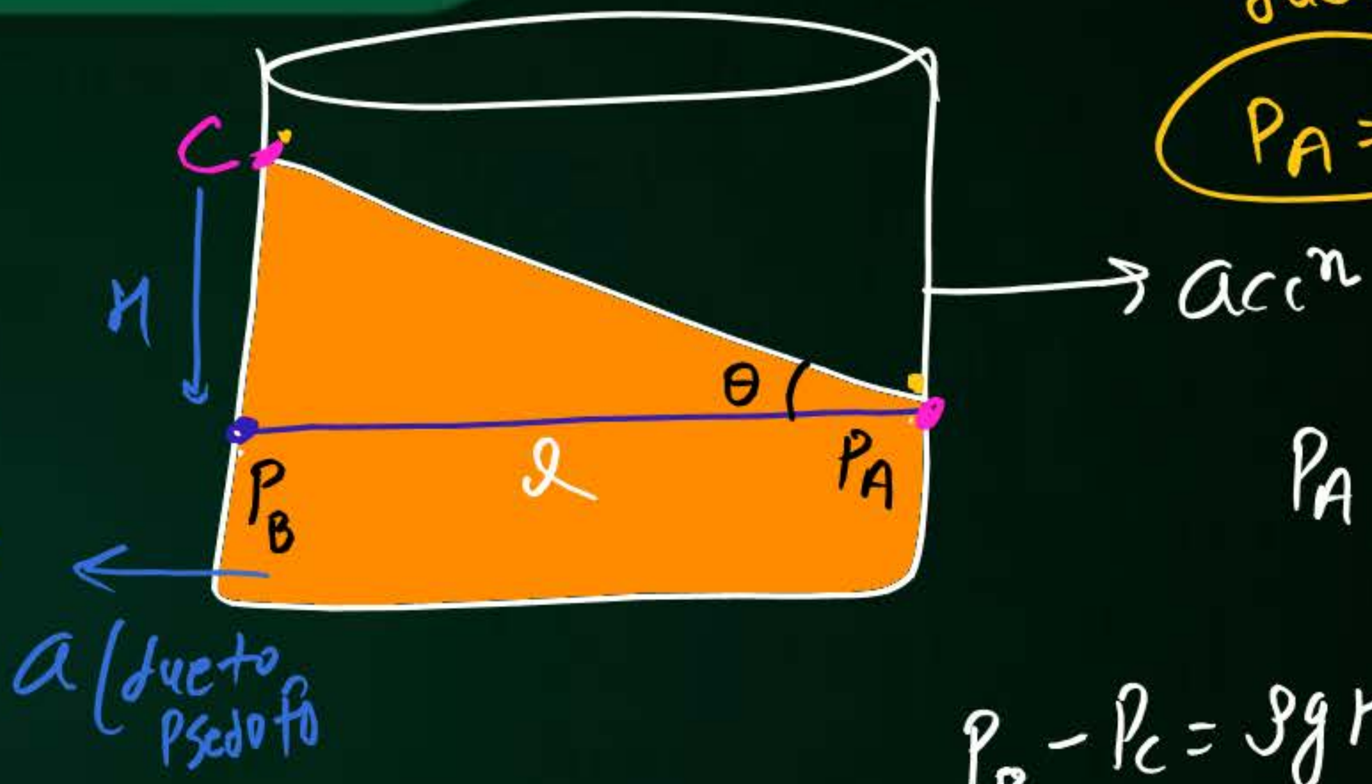
(2)


(3)


(4) None of these

Horizontal Accelerating Container





due to open to atmos

$P_A = P_C$

$P_A \neq P_B$

$P_B - P_C = \rho g H$ — (I)

$P_B - P_A = \rho a l$ — (II)

(I) = (II)

$\rho g H = \rho a l$

$\tan\theta = \left(\frac{H}{l}\right) = \frac{a}{g}$

QUESTION

A vessel contain a liquid has a constant acceleration $19.6 \, m/s^2$ in horizontal direction. The free surface of water get sloped with horizontal at angle

(1) $\tan^{-1}\left[\frac{1}{2}\right]$

(2) $\sin^{-1} 2$

(3) $\tan^{-1}[\sqrt{2}]$

(4) $\sin^{-1}\left[\frac{2}{\sqrt{5}}\right]$

$20 \, m/s^2$

$\tan\theta = \frac{a}{g} = \left[\frac{P}{B}\right]$

$\tan\theta = \frac{20}{10} = 2$

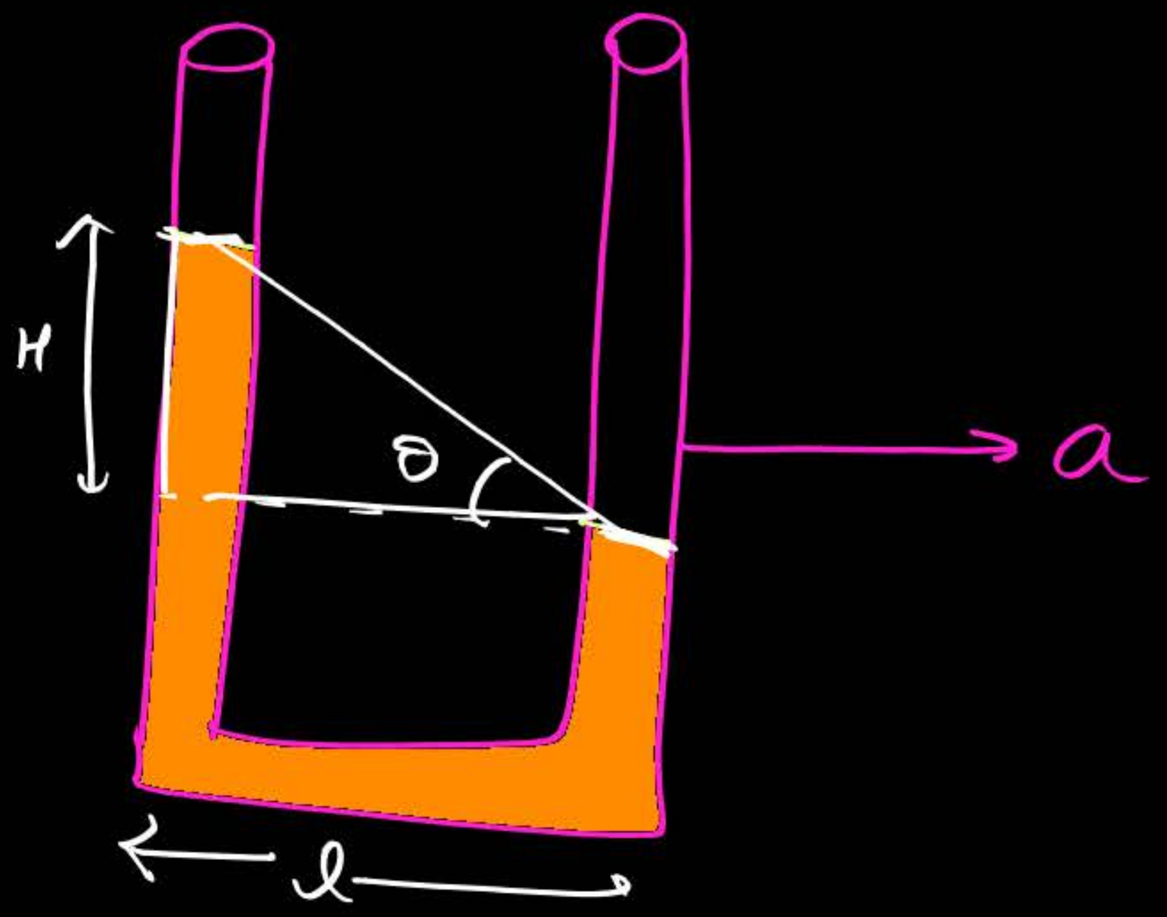
$\tan\theta = 2$

$\sin\theta = \frac{2}{\sqrt{2^2+1^2}} = \frac{2}{\sqrt{5}}$

$H = \sqrt{P^2+B^2}$ — (1)

$H = \sqrt{a^2+g^2}$

$\sin\theta = \frac{a}{\sqrt{a^2+g^2}}$



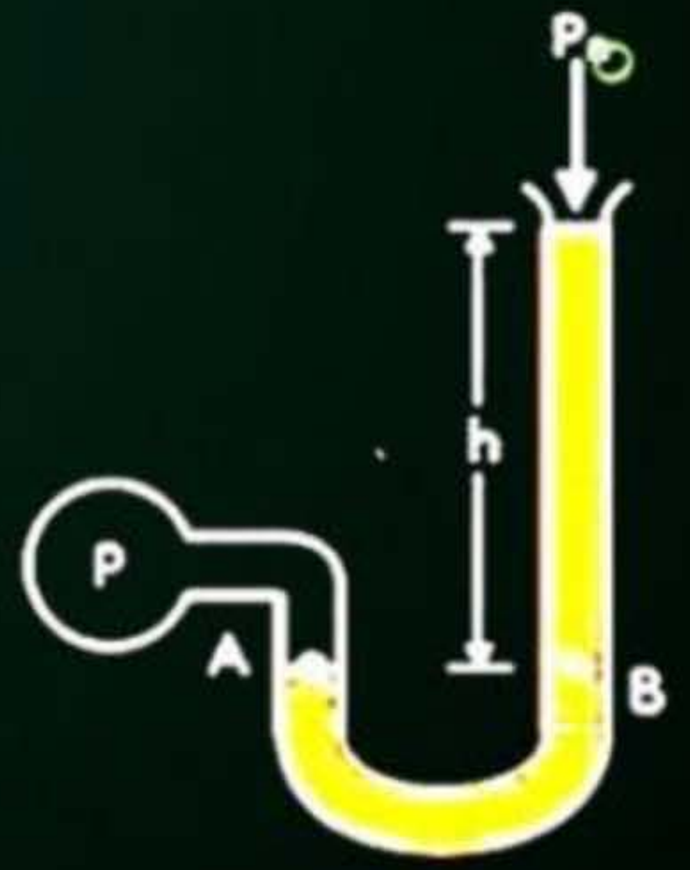
$$\tan\theta = \frac{H}{l} = \frac{a}{g}$$

MANOMETER

Is an instruments use to measure gas pressure.

OPEN-TUBE MANOMETER

An open-tube manometer is used for measuring pressure differences, or to measure the pressure of a gas enclosed in a vessel. It consists of a U-shaped tube open at both ends. A liquid of density p is filled in the tube. One end of the tube is left open to the atmosphere. The other end is connected to the system whose pressure is to be measured.



QUESTION

The lower portion of a U-tube of uniform bore having both limbs vertical and open to atmosphere, is initially filled with a liquid of specific gravity $3S$. A lighter liquid of specific gravity S is then poured into one of the limbs such that the length of column of lighter liquid is x. what is the resulting movement of the meniscus of the heavier liquid in the other limb?

1. x
2. $\frac{x}{2}$
3. $\frac{x}{3}$
4. $\frac{x}{6}$


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 3 | Physics

Mechanical Properties of Fluid

By- Dr. Manish Raj (MR SIR)



Topics to be covered

→ Manometre

→ Dynamics of fluid

- eqn of continuity
- Bernoulli's eqn

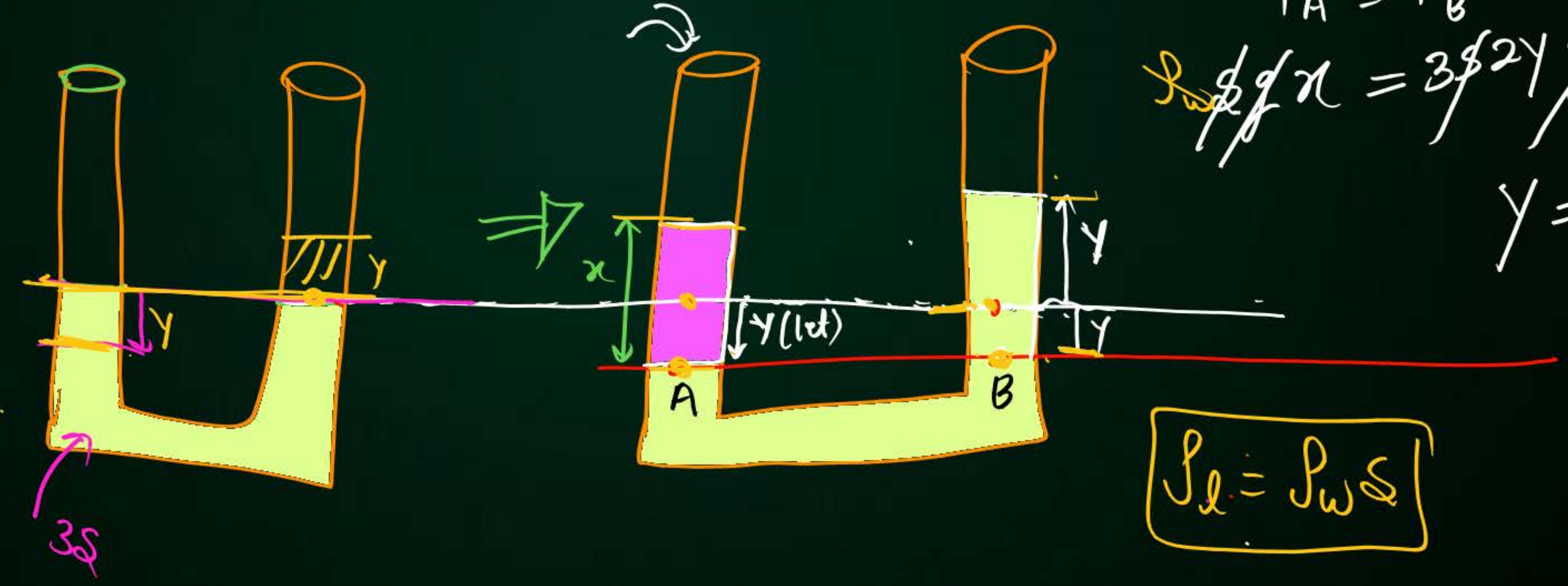
Archmedies Principle
Not in syllabus
NEET-25

QUESTION

Level up.

The lower portion of a U-tube of uniform bore having both limbs vertical and open to atmosphere, is initially filled with a liquid of specific gravity 3S. A lighter liquid of specific gravity S is then poured into one of the limbs such that the length of column of lighter liquid is x. what is the resulting movement of the meniscus of the heavier liquid in the other limb?

1. x
2. $\frac{x}{2}$
3. $\frac{x}{3}$
4. $\frac{x}{6}$



$P_A = P_B$

$\rho_w S g x = 3S\, 2y\, g\, \rho_w$

$y = \frac{x}{6}$

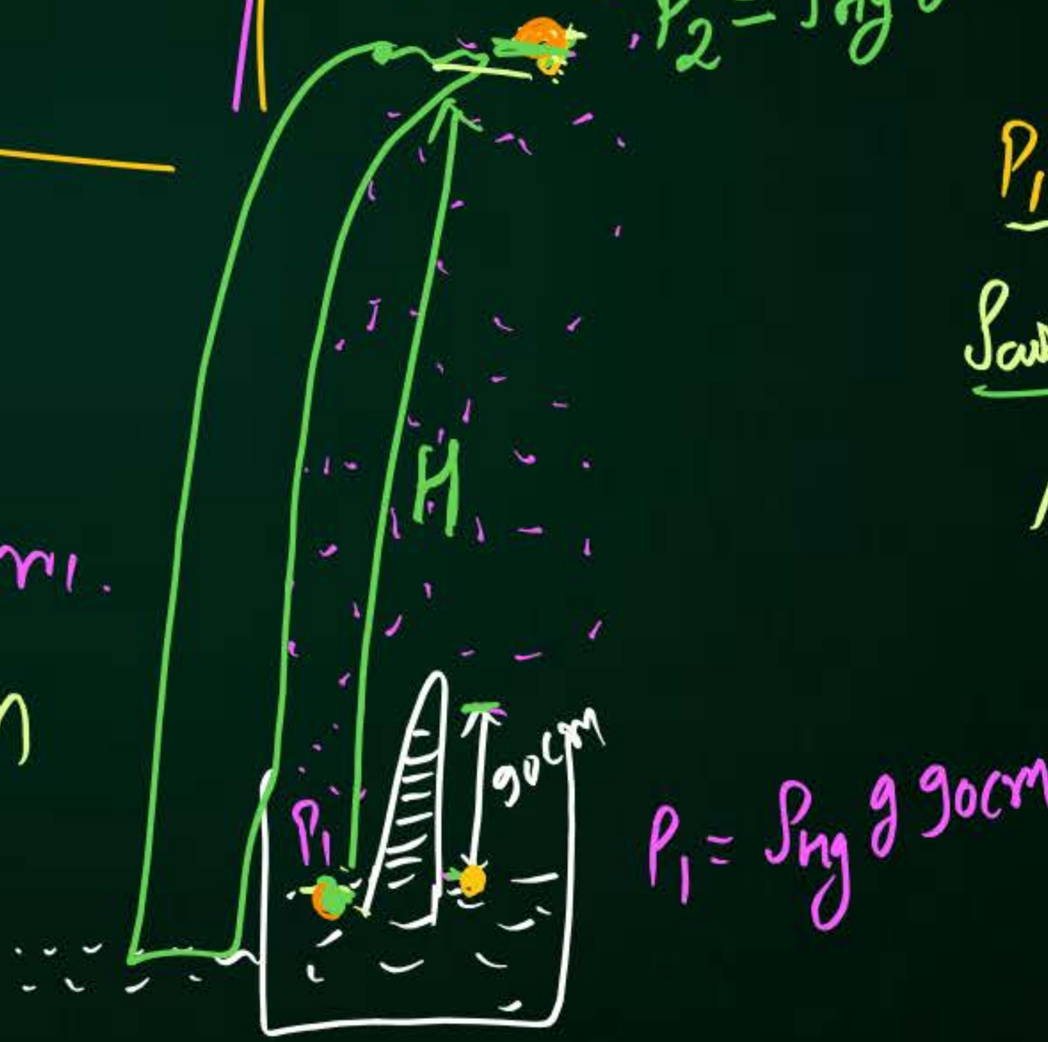
$\rho_l = \rho_w S$

QUESTION

The height of a mercury barometer is 90 cm at sea level and 60 cm at the top of a hill. The ratio of density of mercury to that of air is 10^4. The height of the hill is

1. 2 km
2. 3 km
3. 4 km
4. 5 km

$$\frac{\rho_{Hg}}{\rho_{air}} = 10^4$$



$P_2 = \rho_{Hg}\, g\, 60\,cm$

$P_1 = \rho_{Hg}\, g\, 90\,cm$ —(1)

$P_1 - P_2 = \rho_{Hg}\, g\,(90-60)\,cm$

$\rho_{air}\, g\, H = \rho_{Hg}\, g\,(30\,cm)$

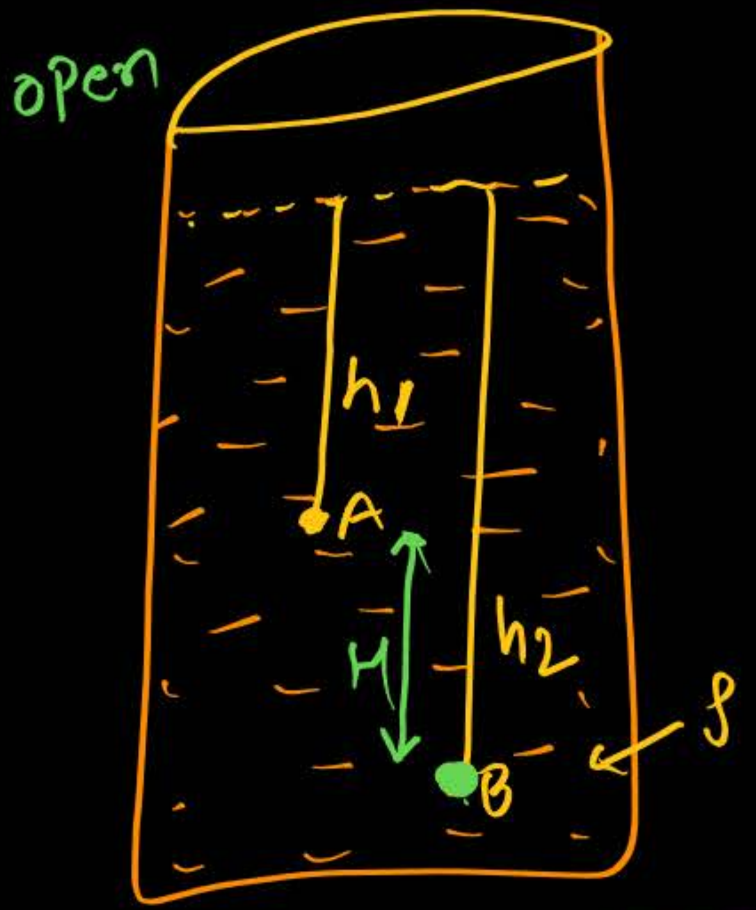
$H = 10^3 \times 30\,cm$

$= 3\,Km$

$H = 30 \times 10^4\,cm$

$= 30 \times 10^2\,m$

$= 3\,Km$



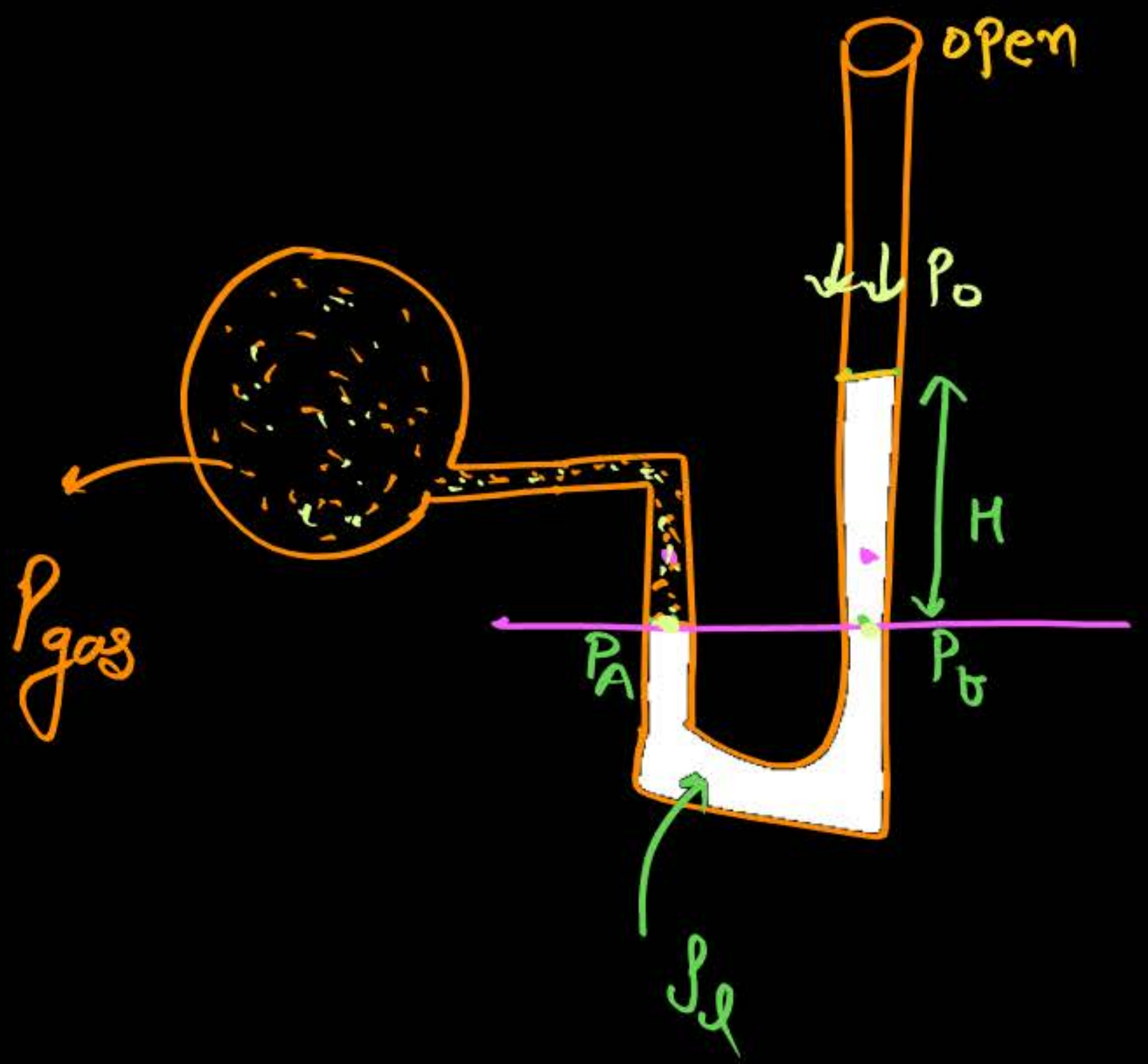
$$P_B = P_0 + \rho g h_2$$

$$P_A = P_0 + \rho g h_1$$

$$P_B - P_A = \rho g (h_2 - h_1)$$

✡ Manometre :→ Instrument use to measure gas pressure.

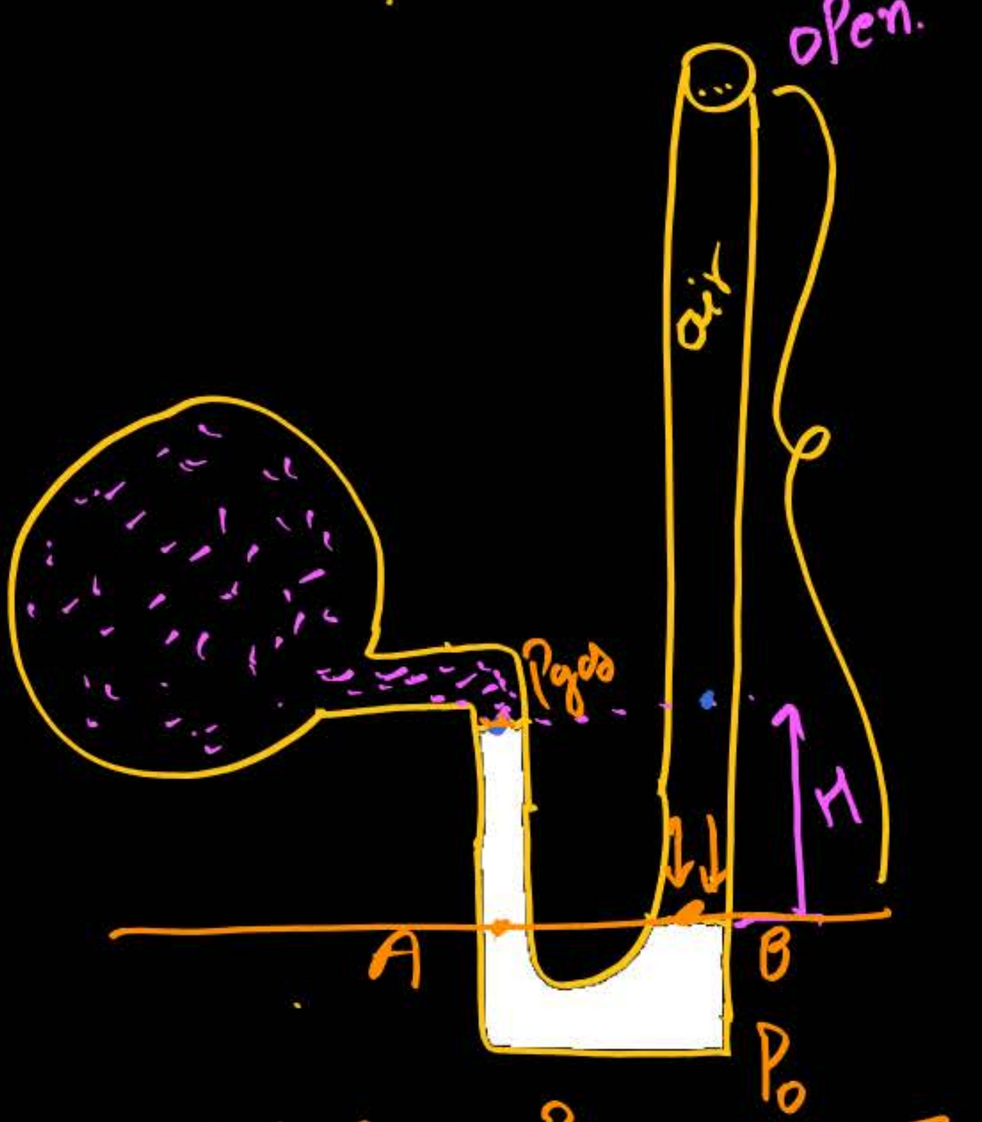
case



$P_A = P_B$

$$P_{gas} = P_0 + \rho_l g H$$

P_0 ✓

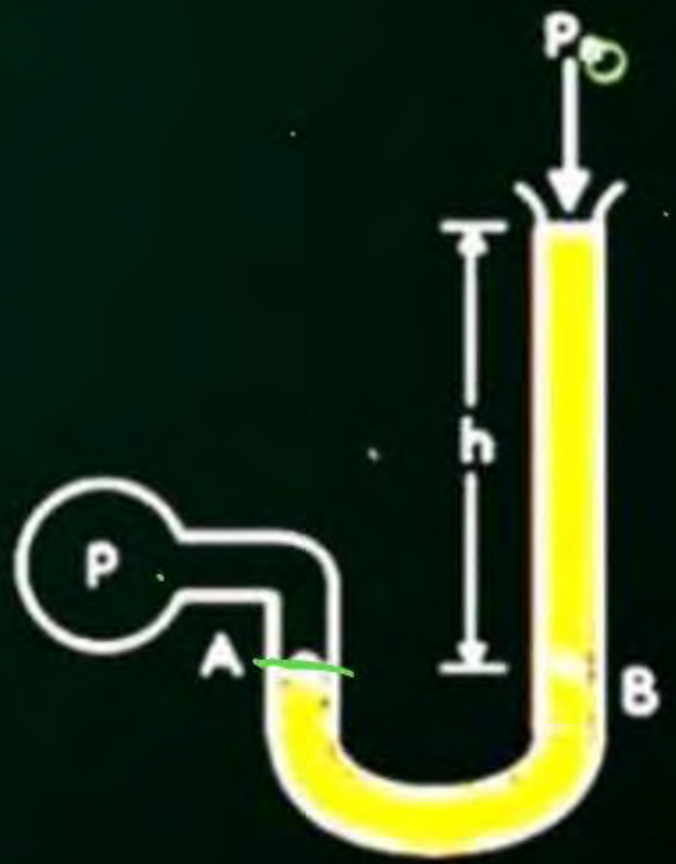


$P_{gas} + \rho_l g H = P_0$

$$P_{gas} = P_0 - \rho_l g H$$

OPEN-TUBE MANOMETER

An open-tube manometer is used for measuring pressure differences, or to measure the pressure of a gas enclosed in a vessel. It consists of a U-shaped tube open at both ends. A liquid of density ρ is filled in the tube. One end of the tube is left open to the atmosphere. The other end is connected to the system whose pressure is to be measured.



MANOMETER

Case-1

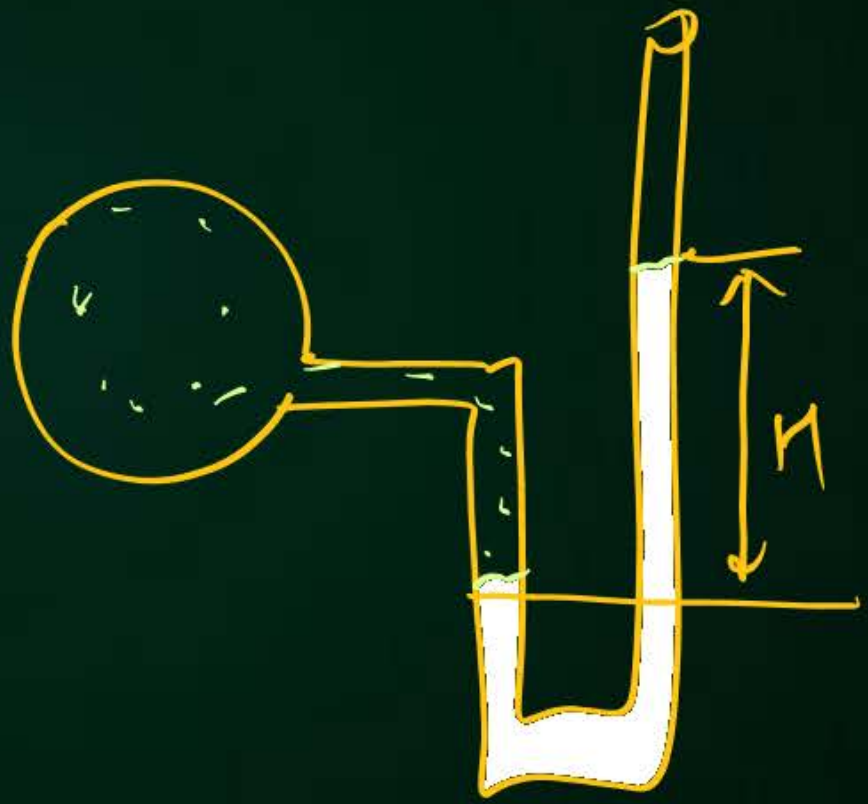
Case-2

QUESTION

A manometer tube contains mercury of density 13.6×10^3 kg/m^{-3}. What difference in the levels of mercury in the two arms is indicated by a gauge pressure of 1.03×10^5 Pa?

$P_{Hg} = 1.03 \times 10^5$ Pa

$\rho_{Hg} g H = 1.03 \times 10^5$ Pa



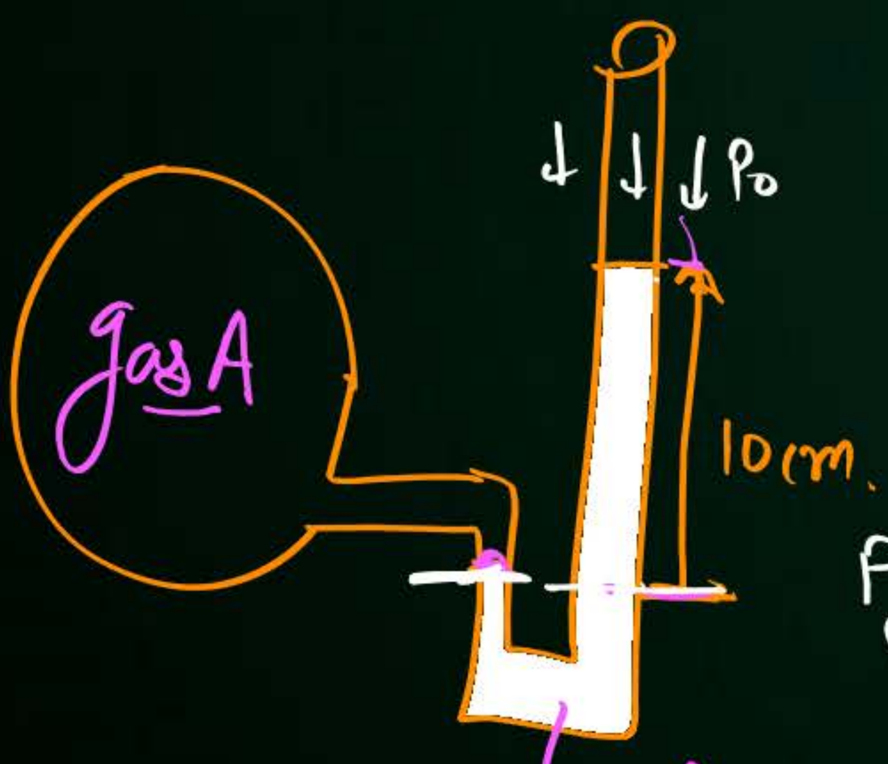
ignore atmospheric pres

QUESTION

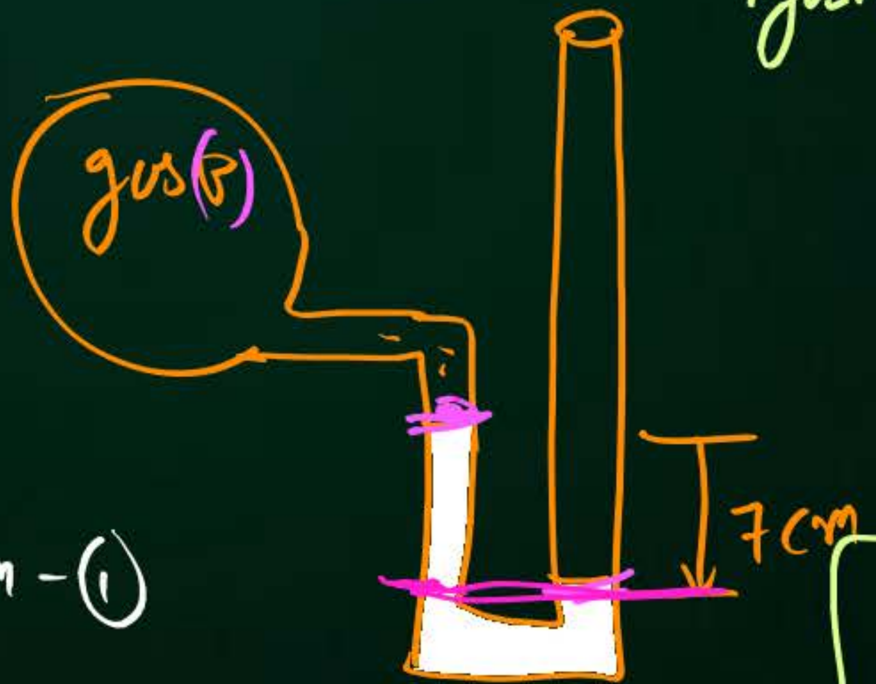
(NCERT)

A manometer tube contains a liquid of density $\left(3 \times 10^{3}\ \mathrm{kg\ m^{-3}}\right)$ When connected to a vessel containing a gas, the liquid level in the other arm of the tube is higher by 10 cm. When connected to another sample of enclosed gas, the liquid level in the other arm of the manometer tube falls 7 cm below the liquid level in the first arm. Which of the two samples exerts more pressure and by what amount?

$P_{gas A} > P_{gas B}$



$P_{gas A} = P_0 + \rho g\, 10\,cm$ — (i)



$P_{gas B} + \rho g\, 7\,cm = P_0$ — (ii)

$P_{gas A} - P_{gas B} = P_0 + \rho g\, 10\,cm - (P_0 - \rho g\, 7\,cm)$

$= P_0 + \rho g\, 10\,cm - P_0 + \rho g\, 7\,cm$

$= \rho g\,(10\,cm + 7\,cm)$

$P_{gA} - P_{gB} = 3\times10^3 \times 10 \times 17\,cm$

Dynamics of fluid

Ideal fluid

- Incompressible
- Non-viscous (friction = 0)
- Irrotation →

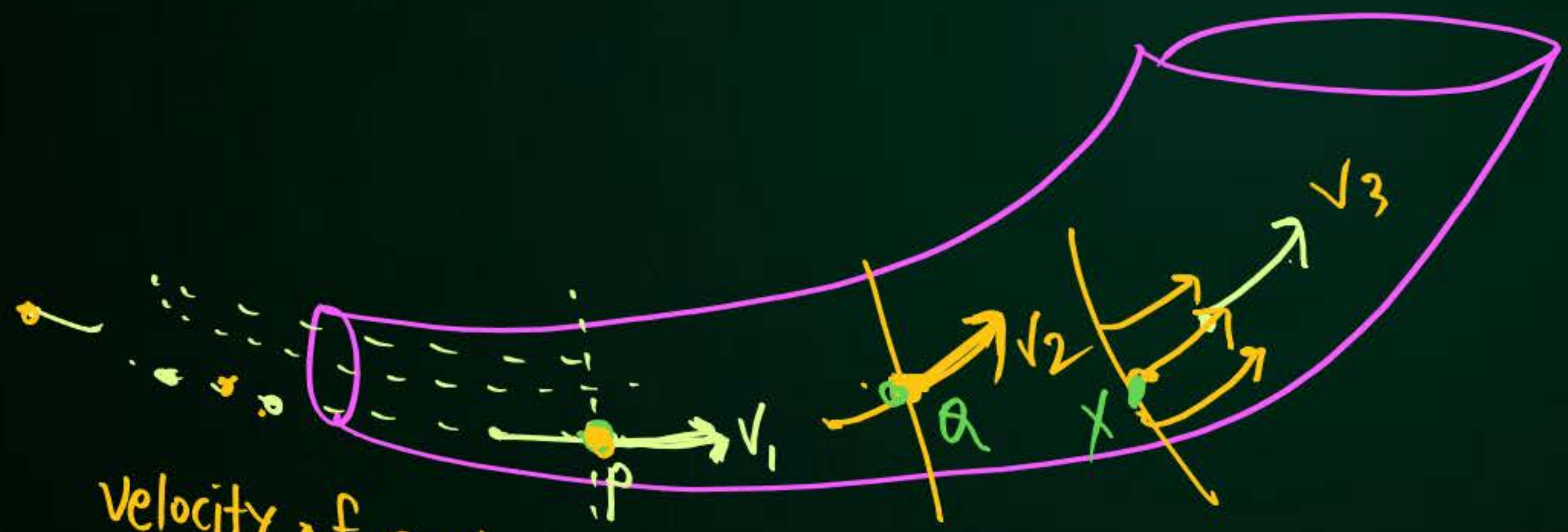
QUESTION

Which of the following is not the property of an ideal fluid?

1. Fluid flow is irrational
2. Fluid flow is streamline
3. Fluid is incompressible
4. Fluid is viscous

FLUIDS AND DYNAMICS

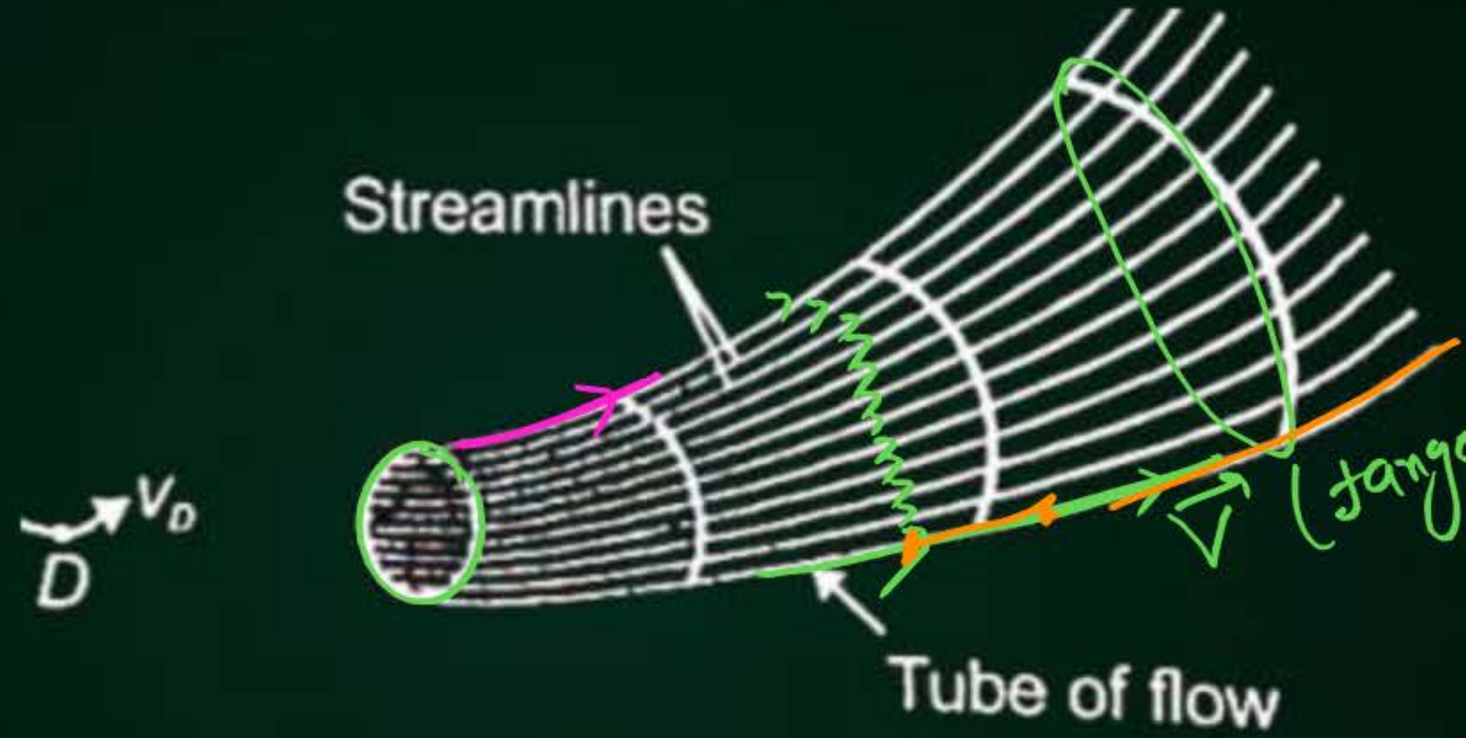
when a liquid flows such that each particle of the liquid passing a given point moves along the same path and has the same velocity as its predecessor had at that point, the flow is called streamlined or steady flow.



Velocity of each atom will be same at a given point.

each atom ki velocity each point par same Hogi → IVO

$v_1 \neq v_2 \neq v_3$



(b)

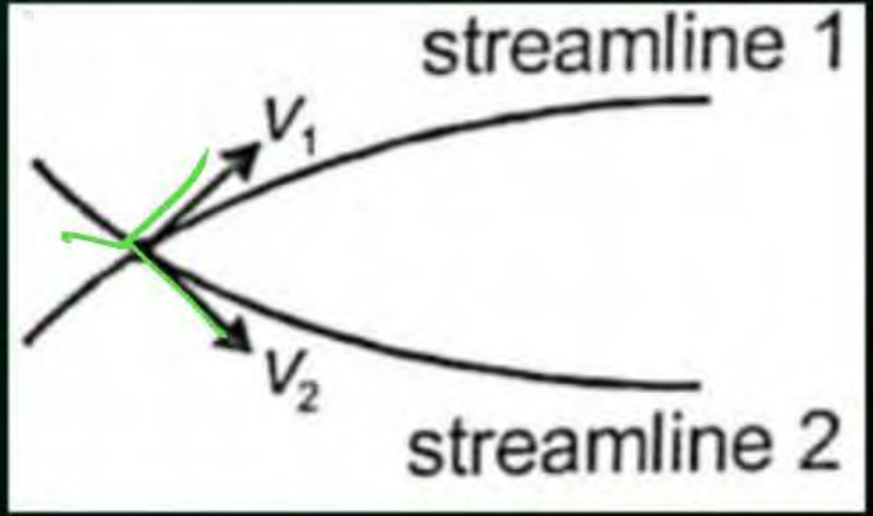
$\vec{v}$ (tangen drawn on stream line gives the dir^n of velocity.



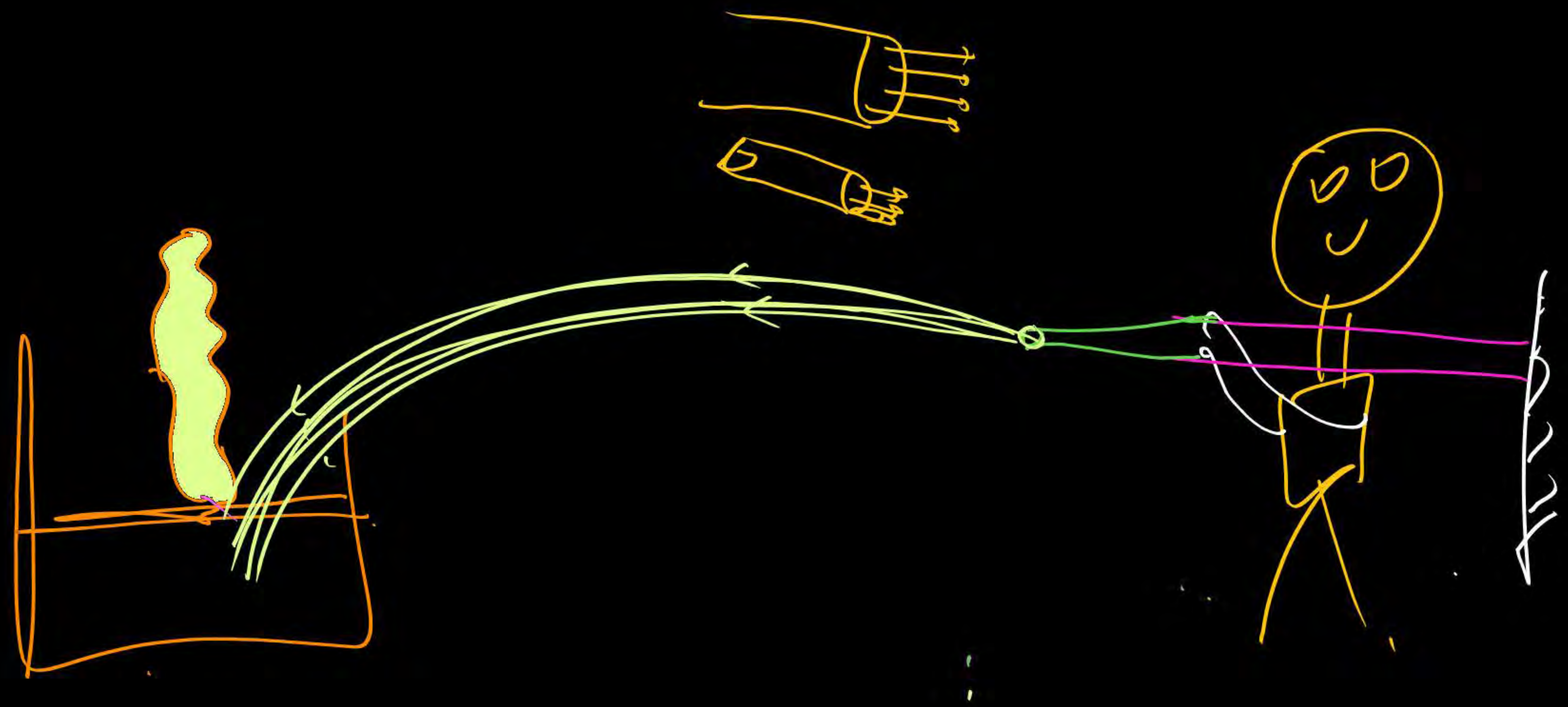
Two steam line nem cut each other.

PROPERTIES OF STREAMLINES

- The tangent at any point of a streamline gives the direction of flow of fluid particle at that point.
- In a steady flow, no two streamlines can cross each other, for if they do so, two tangents can be drawn at the point of intersection. If means the oncoming fluid particle can go either one way or the other. Thus, the flow would not be steady
- Fluid velocity remains constant at any point of a streamline, but it may be different at different points of the same streamline.



- Fluid velocity is greater at the regions where streamlines are closely spaced. This can be proved from the equation of continuity that we discuss in the upcoming section.

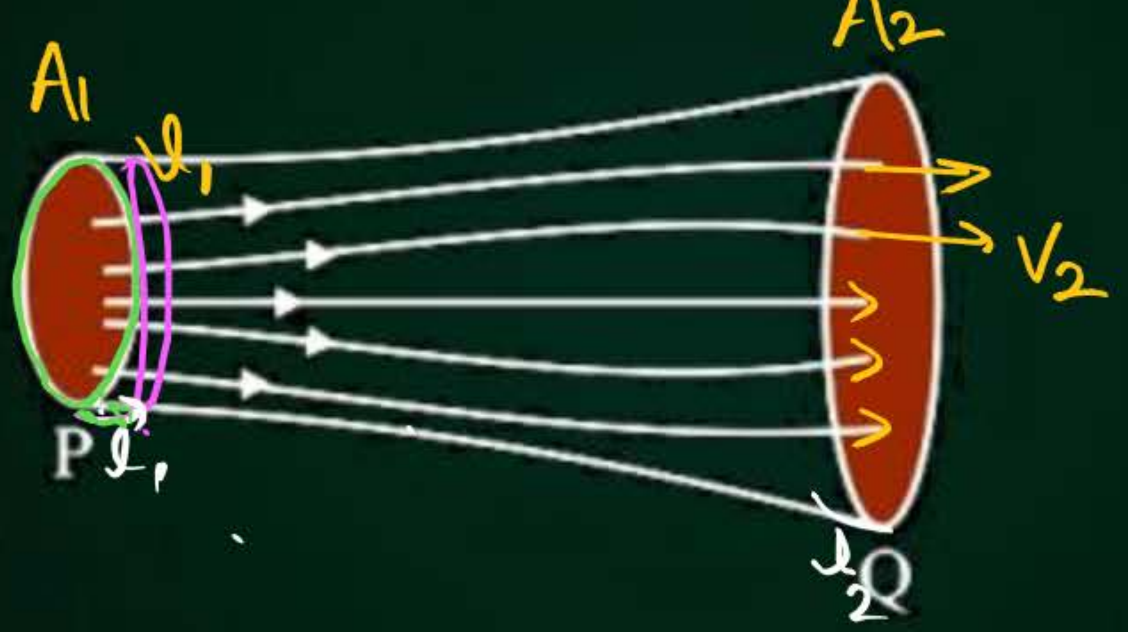


milk pipe line



EQUATION OF CONTINUITY

Conservation of mass :



$\left(\frac{dM}{dt}\right)_P = \left(\frac{dm}{dt}\right)_Q$

Rate of Mass Flow

Per-sec remains constant

$\left(\frac{d\rho V_1}{dt}\right)_P = \left(\frac{d\rho V_2}{dt}\right)_Q$

ρ = same

$\left(\frac{dV_1}{dt}\right)_P = \left(\frac{dV_2}{dt}\right)_Q$ = The Rate of volume flow will remain same

(volume)

$\frac{d(A_1 l_1)}{dt} = \frac{dA_2 l_2}{dt}$

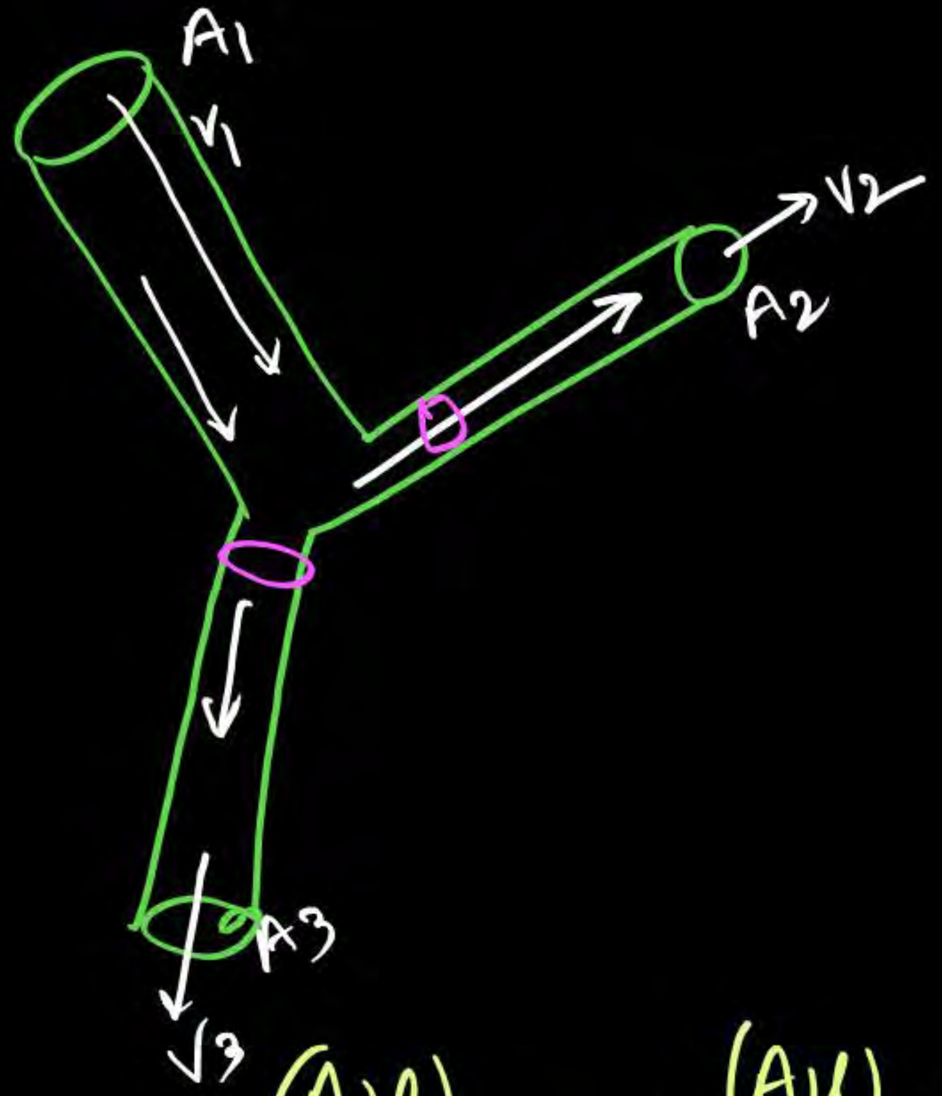
$A_1\left(\frac{dl_1}{dt}\right) = A_2\frac{dl_2}{dt}$

$A_1 v_1 = A_2 v_2$ = The Rate of volume flow

Av = const



$v_1 < v_2$



$$(Av)_{Incom} = (Av)_{out}$$

$$\Rightarrow A_1v_1 = A_3v_3 + A_2v_2$$

Milk Pipe Line

QUESTION

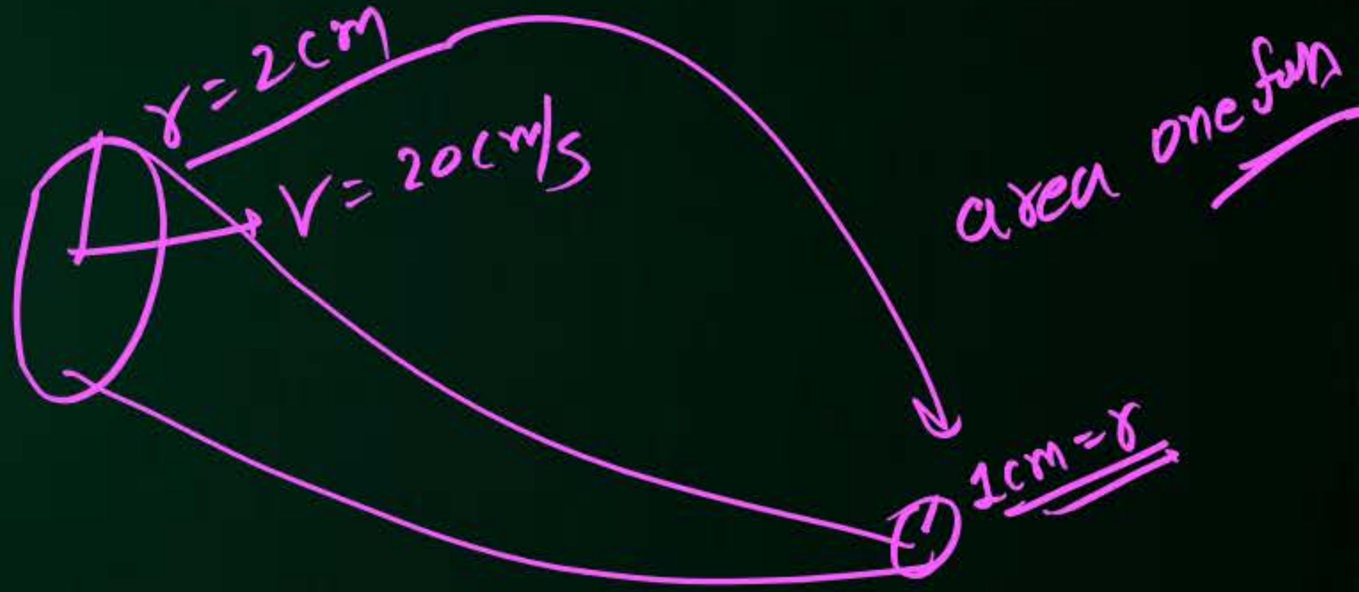
Equation of continuity is based on

1. Low of conservation of momentum
2. Law of conservation of mass
3. Law of conservation of energy
4. Low of conservation of density

QUESTION

An incompressible liquid is flowing steadily through a pipe of variable circular cross section. Velocity of fluid is found to be 20cms^{-1} through a cross-section of radius 2 cm. Velocity of fluid through another cross section of radius 1 cm nearly equals to

1. 5 cms^{-1}
2. 20 cms^{-1}
3. 40 cms^{-1}
4. 80 cms^{-1}



QUESTION

NEET

A liquid flows in the tube from left to right as shown in figure. A_1 and A_2 are the cross-section of the portions of the tube as shown. The ratio of speed $\frac{v_1}{v_2}$ will be

1. $\frac{A_1}{A_2}$
2. $\frac{A_2}{A_1}$ ✓✓ (88%)
3. $\sqrt{\frac{A_2}{A_1}}$ ✗
4. $\sqrt{\frac{A_1}{A_2}}$ ✗

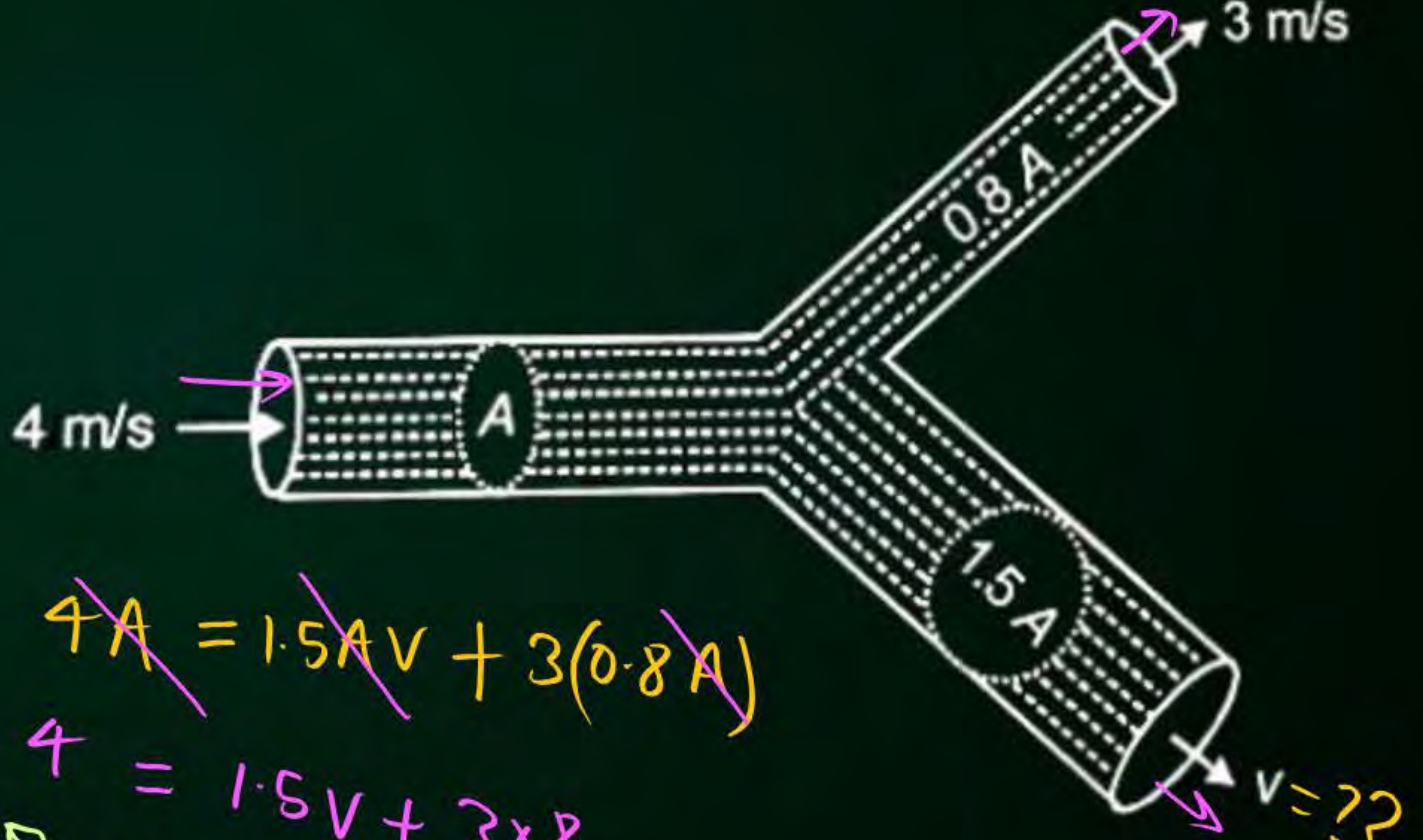


$A_1 V_1 = A_2 V_2$

$\frac{V_1}{V_2} = \frac{A_2}{A_1}$

QUESTION

An incompressible liquid is flowing through a horizontal pipe as show in figure. Find the value of v.



$$4A = 1.5AV + 3(0.8A)$$

$$4 = 1.5V + \frac{3\times 8}{10}$$

$$4-2.4 = 1.5V$$

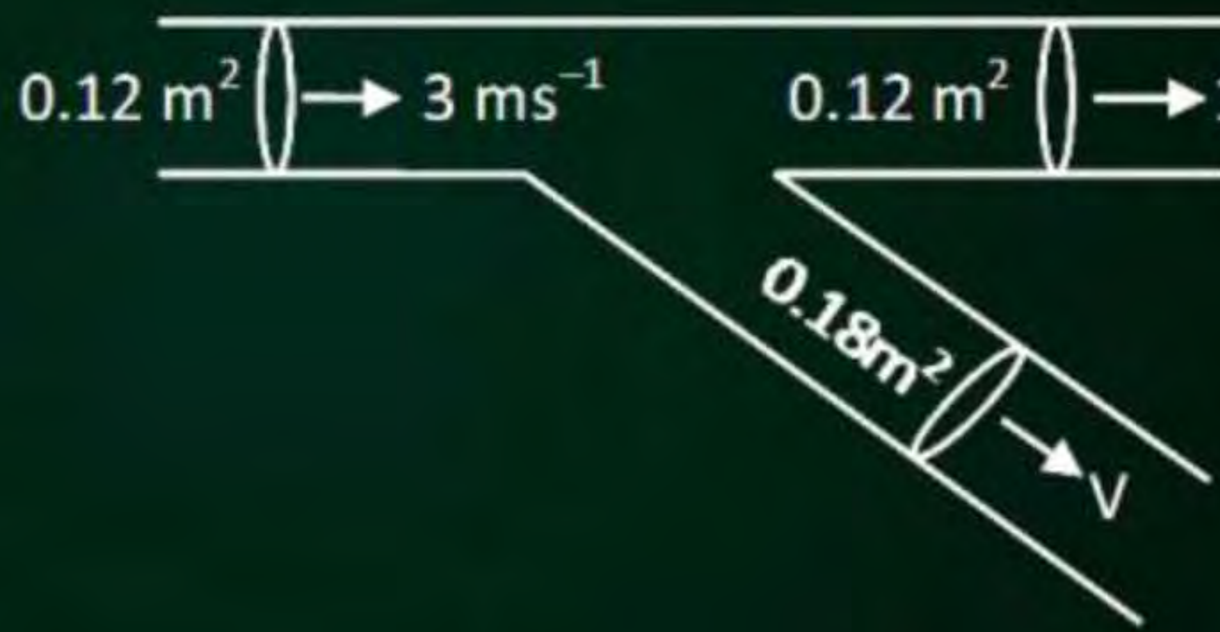
$$\frac{1.6}{1.5} = V$$

$$\frac{16}{15}$$

QUESTION

An incompressible liquid travels as shown in the figure. The speed v of the liquid in the lower ranch is

1. $1\ ms^{-1}$
2. $1.5\ ms^{-1}$
3. $2.25\ ms^{-1}$
4. $3\ ms^{-1}$



QUESTION

NEET

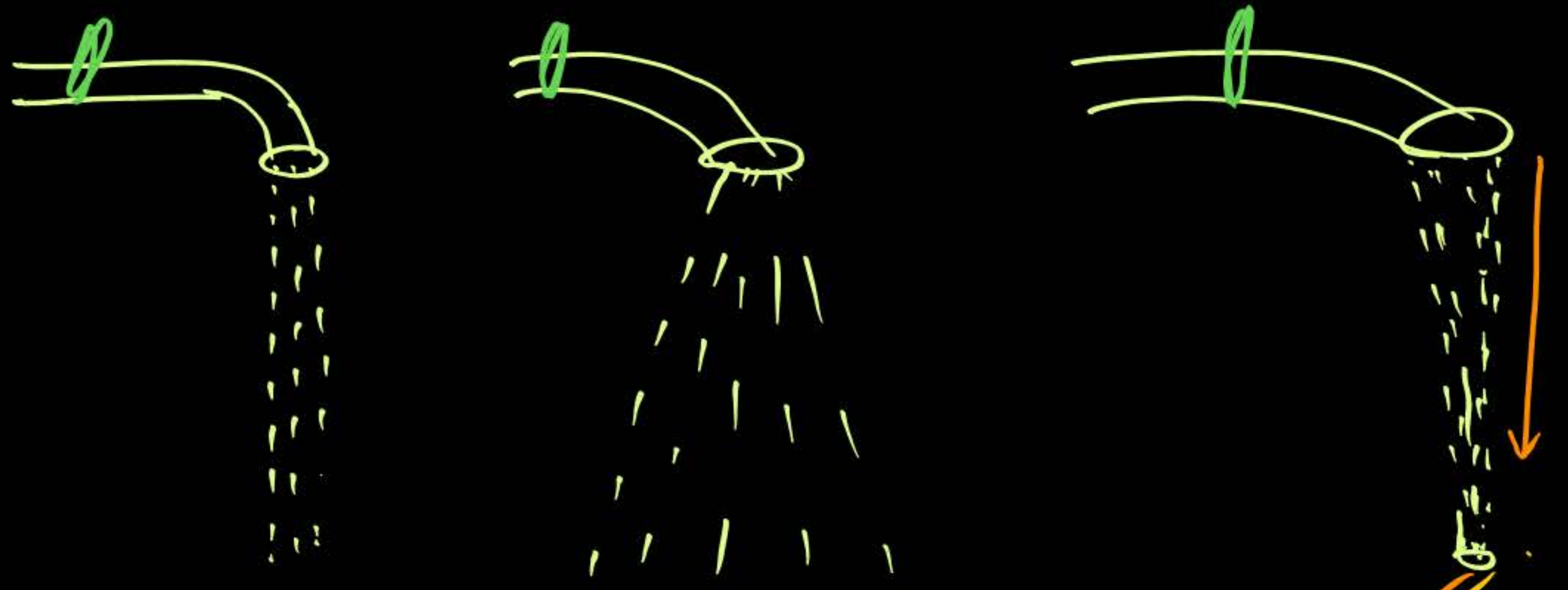
The cylindrical tube of a spray pump has radius R, one end of which has n fine holes, each of radius r. If the speed of the liquid in the tube is V, the speed of the ejection of the liquid through the holes is



$$\pi R^2 V = \pi r^2 n v$$

$$\frac{VR^2}{nr^2} = v$$

1. $\frac{V^2R}{nr}$
2. $\frac{VR^2}{n^2r^2}$
3. $\frac{VR^2}{nr^2}$ ✓
4. $\frac{VR^2}{n^3r^2}$



A B C ✓

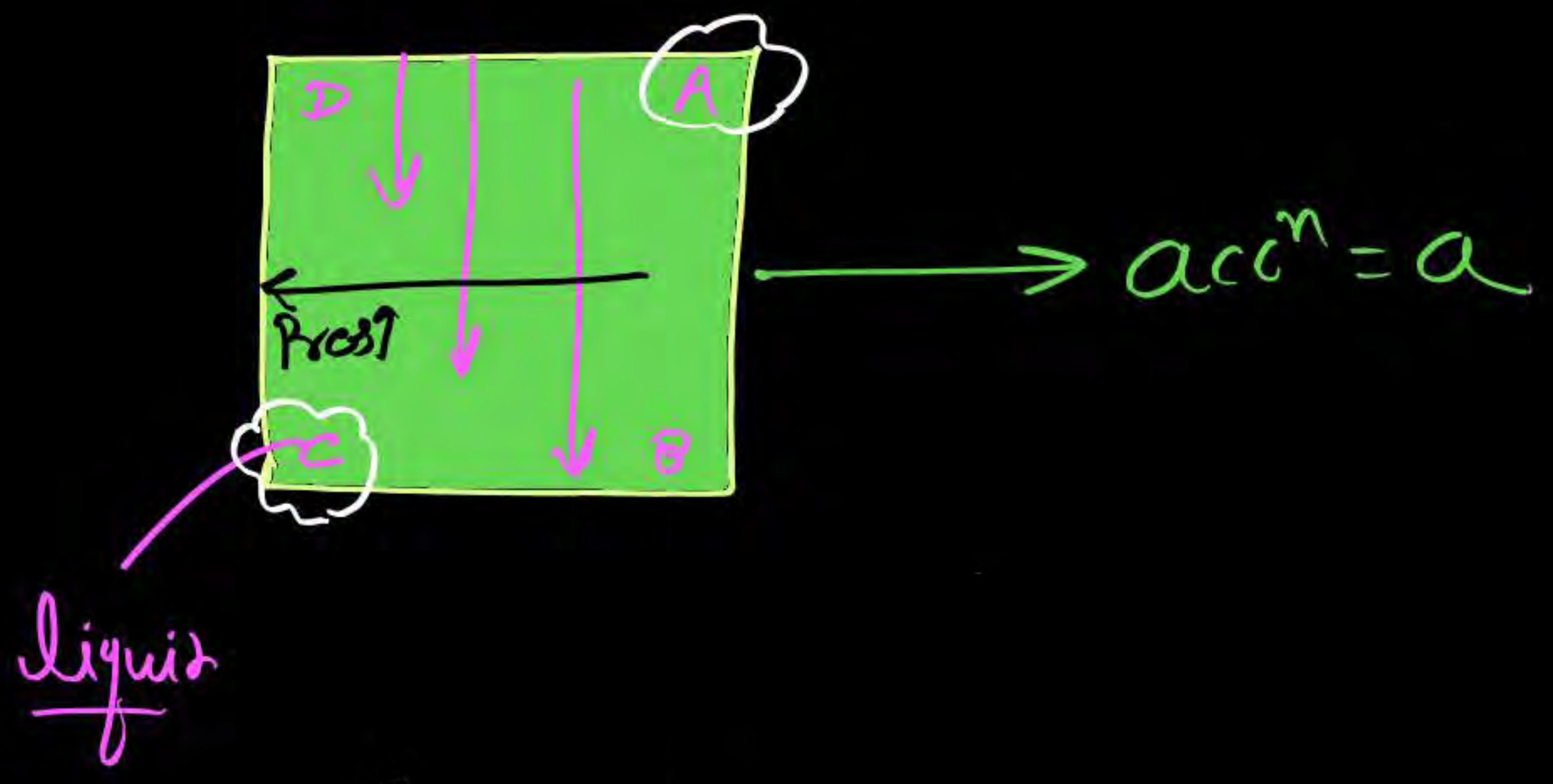
(35%)

⊛ Due to eqn of continuity.

Velocity → Increase.

Cross-Section Area decrease.

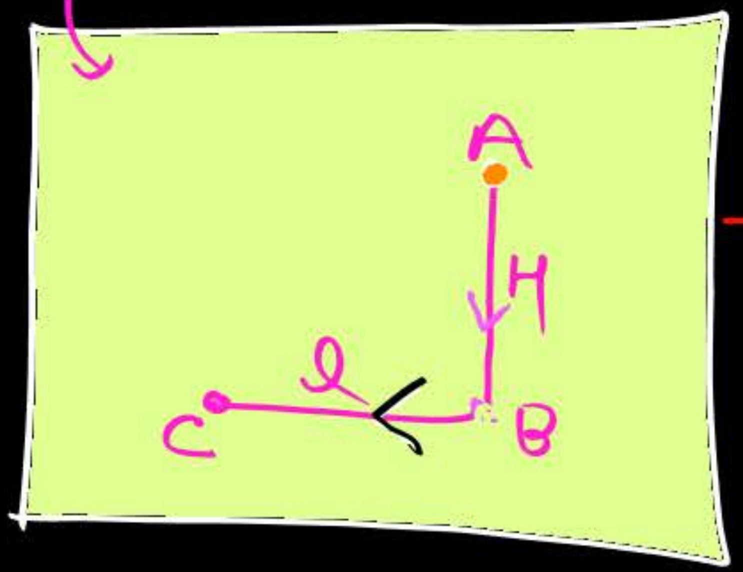
Contain completly filled with liquid & moving in Horizontal direction.



$$P_{max} = P_C$$

$$P_{min} = P_A.$$

ρ_l = density of liquid



$\rightarrow$ $acc^n = a$

$$P_C > P_B > P_A$$

$$P_A + \rho g H = P_B$$

$$P_B - P_A = \rho g H \quad \text{— (I)}$$

$$P_B + \rho a l = P_C$$

$$P_C - P_B = \rho a l \quad \text{— (II)}$$

(I) + (II)

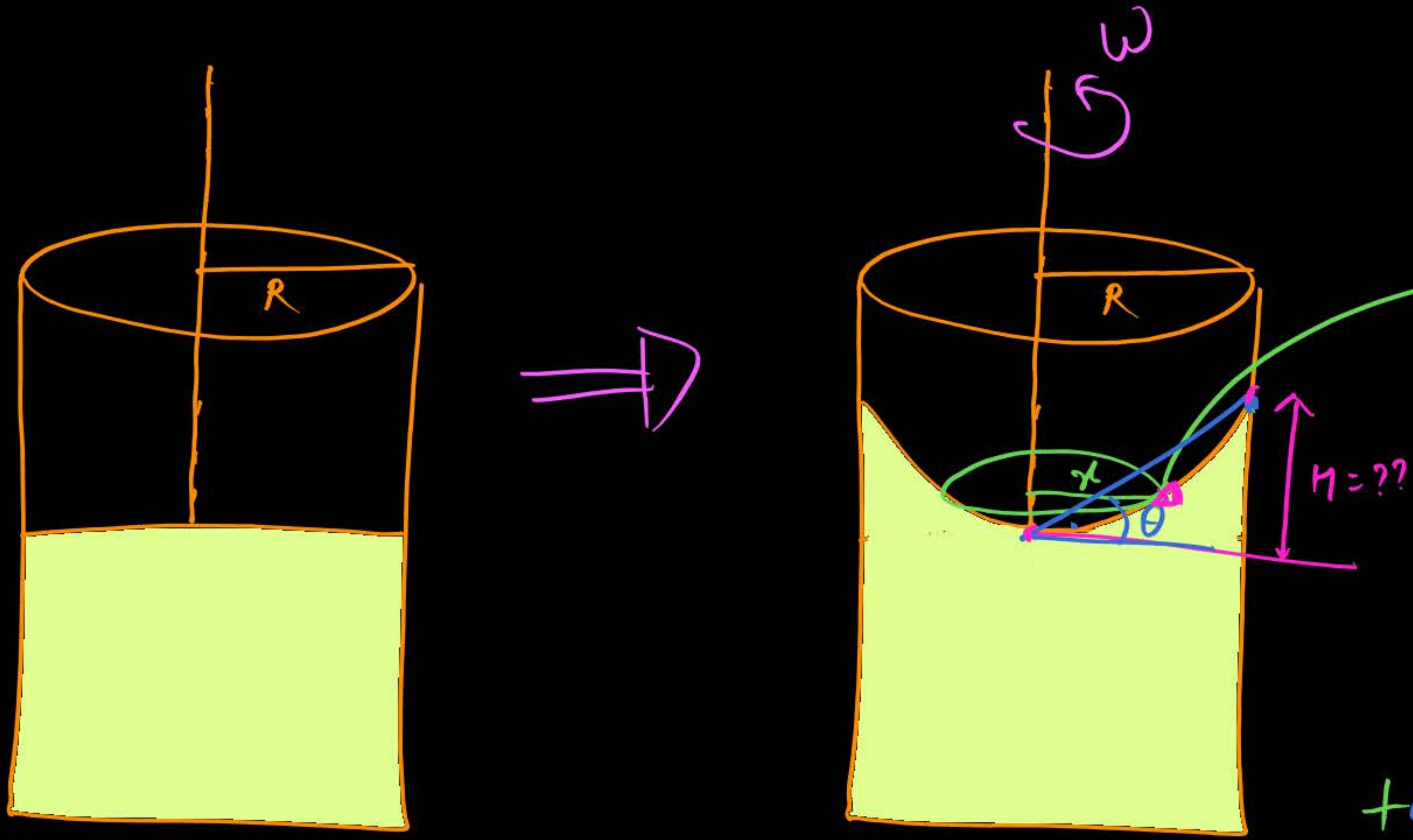
$$P_B - P_A = \rho g H$$

$$P_C - P_B = \rho a l$$

$$P_C - P_A = \rho g H + \rho a l$$

$$P_C - P_A = \rho (gH + al)$$

Ans



rest

$a_c = \omega^2 R$

$a_c = (\omega^2) x$ (varying linearly)

$(a_c)_{Avg} = \frac{0 + \omega^2 R}{2}$

$(a_c)_A = \frac{\omega^2 R}{2}$

$\tan\theta = \frac{H}{R} = \frac{a}{g} = \frac{\omega^2 R}{2g}$

$\frac{H}{R} = \frac{\omega^2 R}{2g}$

* $H = \frac{\omega^2 R^2}{2g}$


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 4 | Physics

Mechanical Properties of Fluid

By- Dr. Manish Raj (MR SIR)

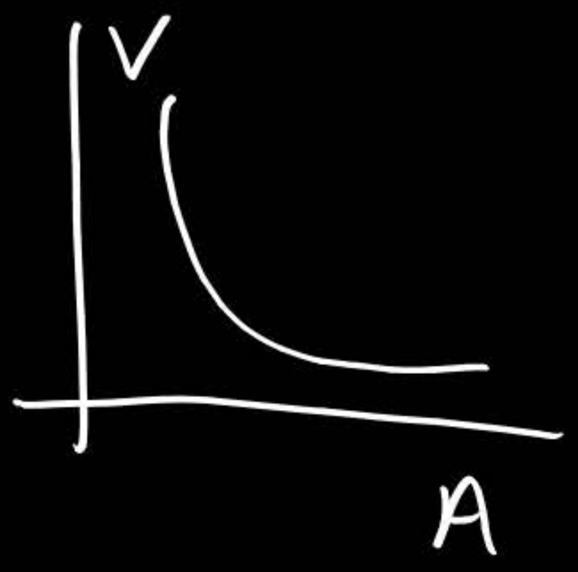


To days Goal

→ PhD. on Bernoulli's equation

(*) valid for steady flow

$Cost^n = AU$ = Rate of volume flow



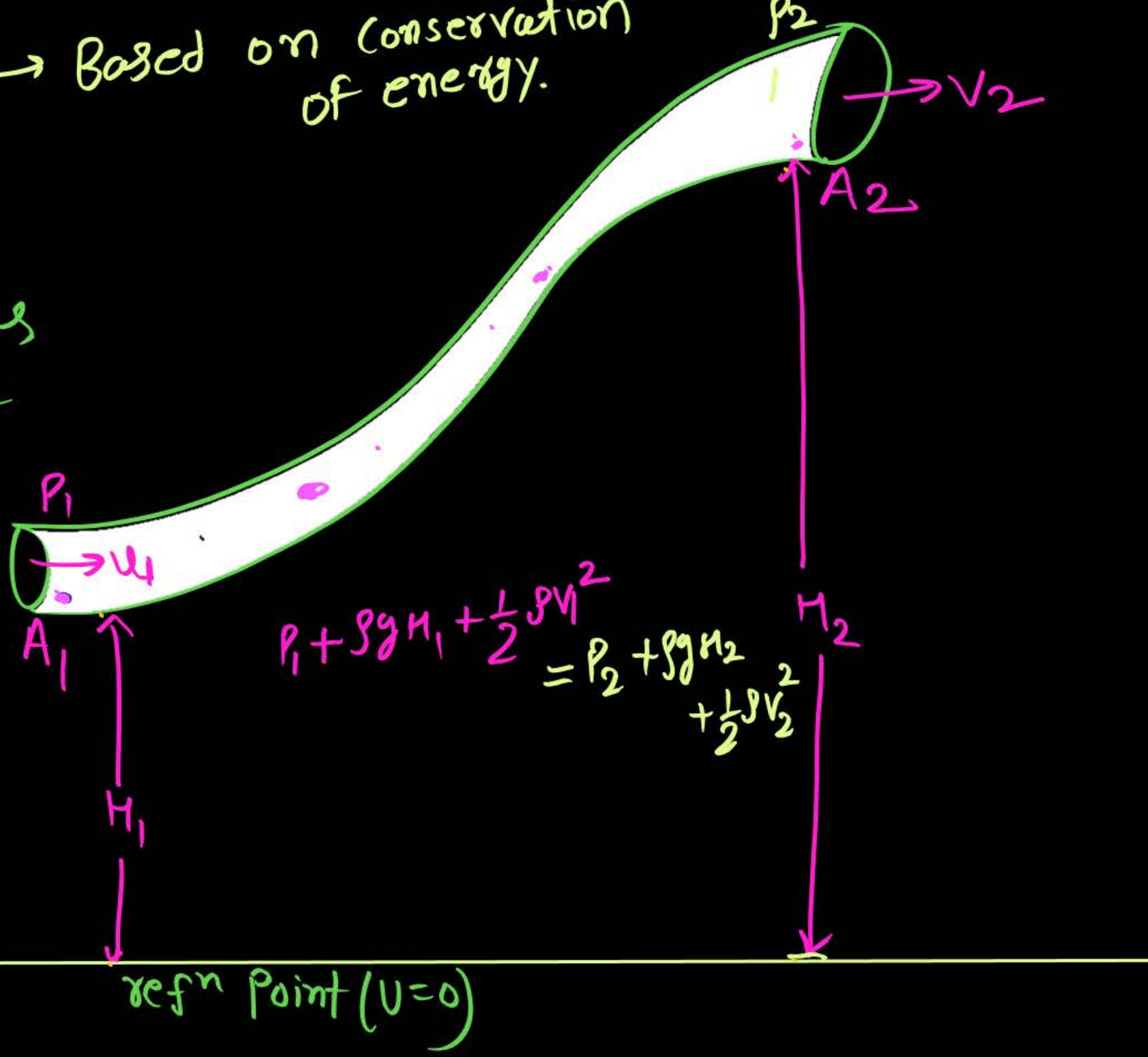
$$P + \frac{MgH}{V} + \frac{1}{2}\frac{mv^2}{V} = \text{const}^n$$

→ Based on conservation of energy.

⇒ for any steady flow of liquid sum of Pressure, K.E per unit volume & Potential energy per unit volume remains constant at every point

$$P + \rho g H + \frac{1}{2}\rho v^2 = \text{const}^n$$

↑ Pressure of flowing fluid.



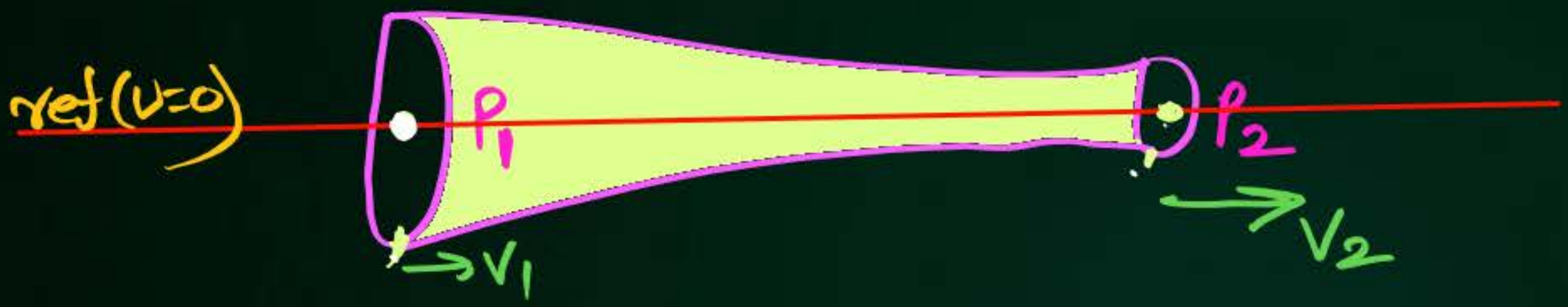
Bernoullies Equation

Which is correct for given Horizontal Pipe

X (a) $P_1 = P_2$

✓ (b) $P_1 > P_2$ (23%)

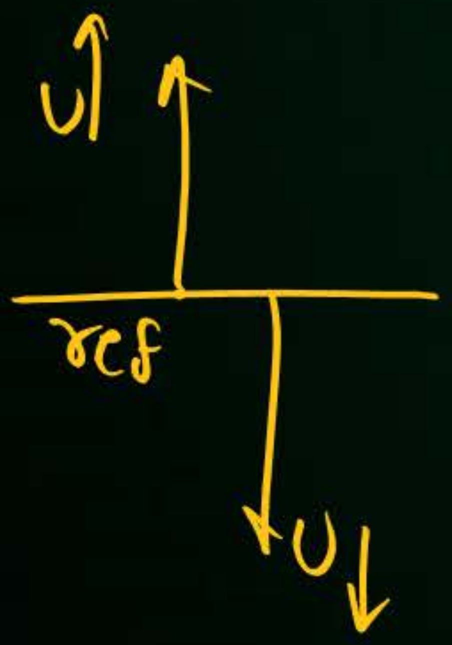
X (c) $P_1 < P_2$ (52%)



Horizontal Pipe.

$$P + \frac{1}{2}\rho v^2 + \rho g H = \text{const}^n$$

($\rho g H$ → same)



from eqn of continuity ($V_2 > V_1$)

$$P_1 > P_2$$

QUESTION

Consider the following equation of Bernouilli's theorem.

$$P + \frac{1}{2}\rho V^2 + \rho g h = K \text{ (constant)}$$

The dimensions of K/P are same as that of which of the following

dim^n less

$P = \frac{1}{2}\rho v^2 = \rho g h = K$

1. Thrust
2. Pressure
3. Angle
4. Viscosity

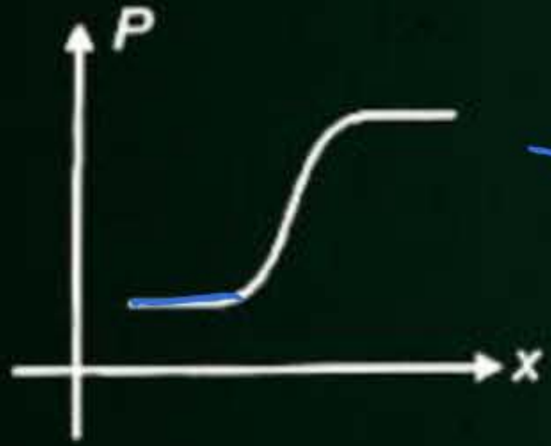
QUESTION

A non viscous liquid is flowing through a frictionless duct, with cross-section varying as shown in figure.

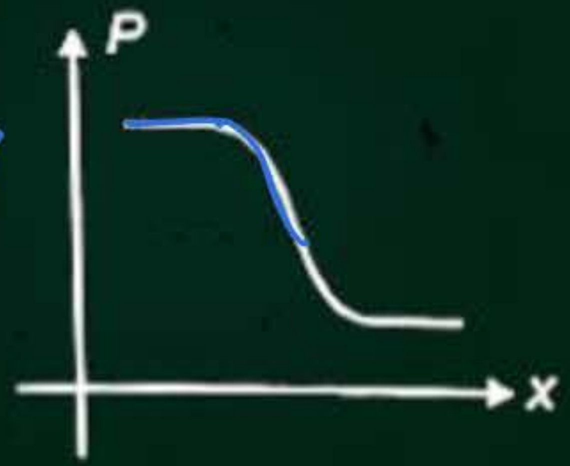
Which of the following graph represents the variation of pressure P along the axis of tube?

$P + \frac{1}{2}\rho v^2 = \text{const}$

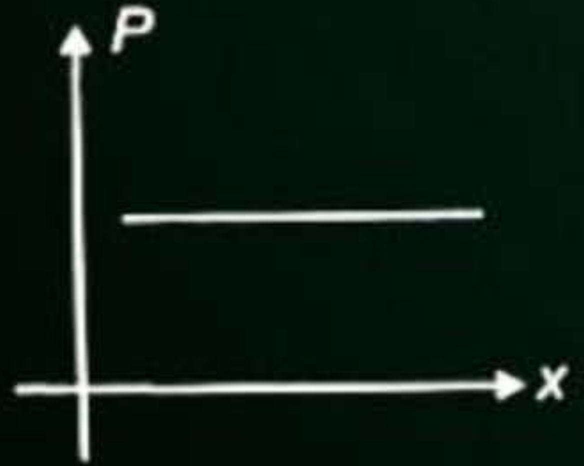
(1)



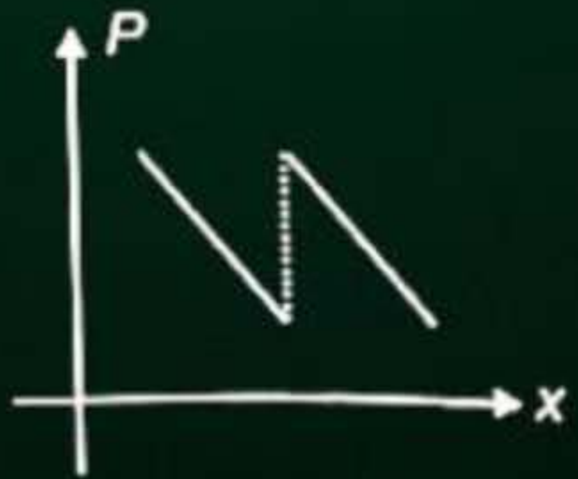
(2)

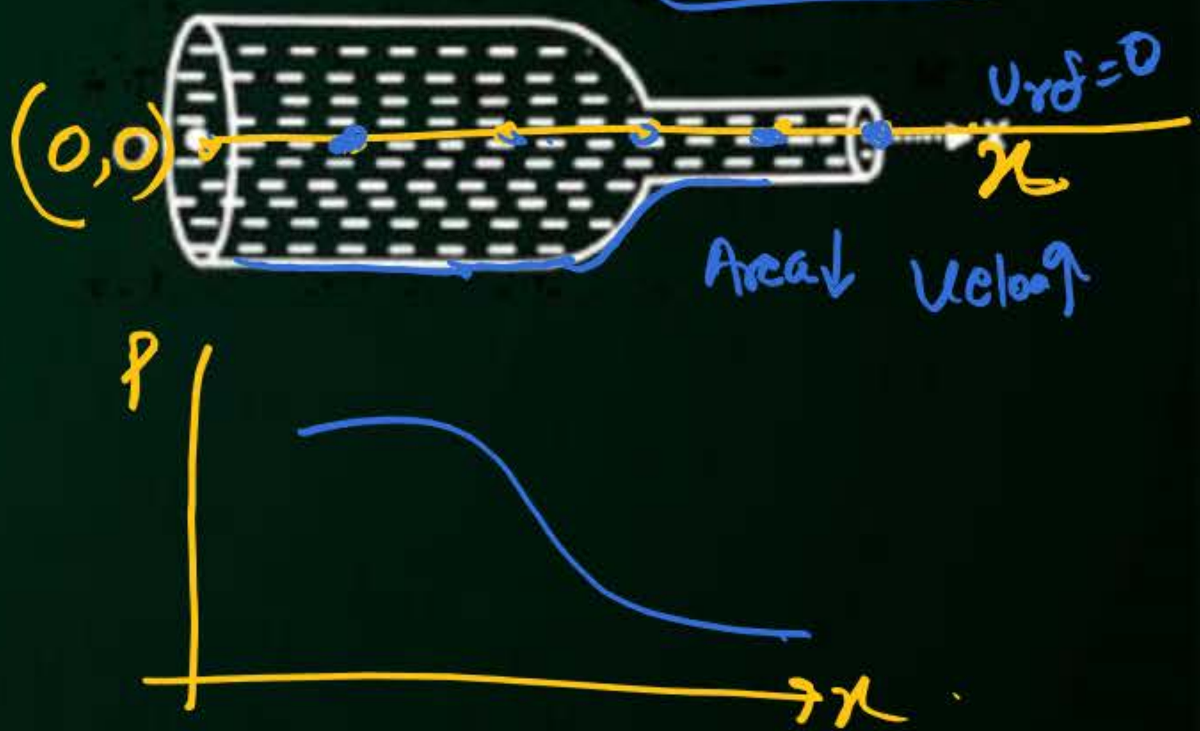


(3)



(4)



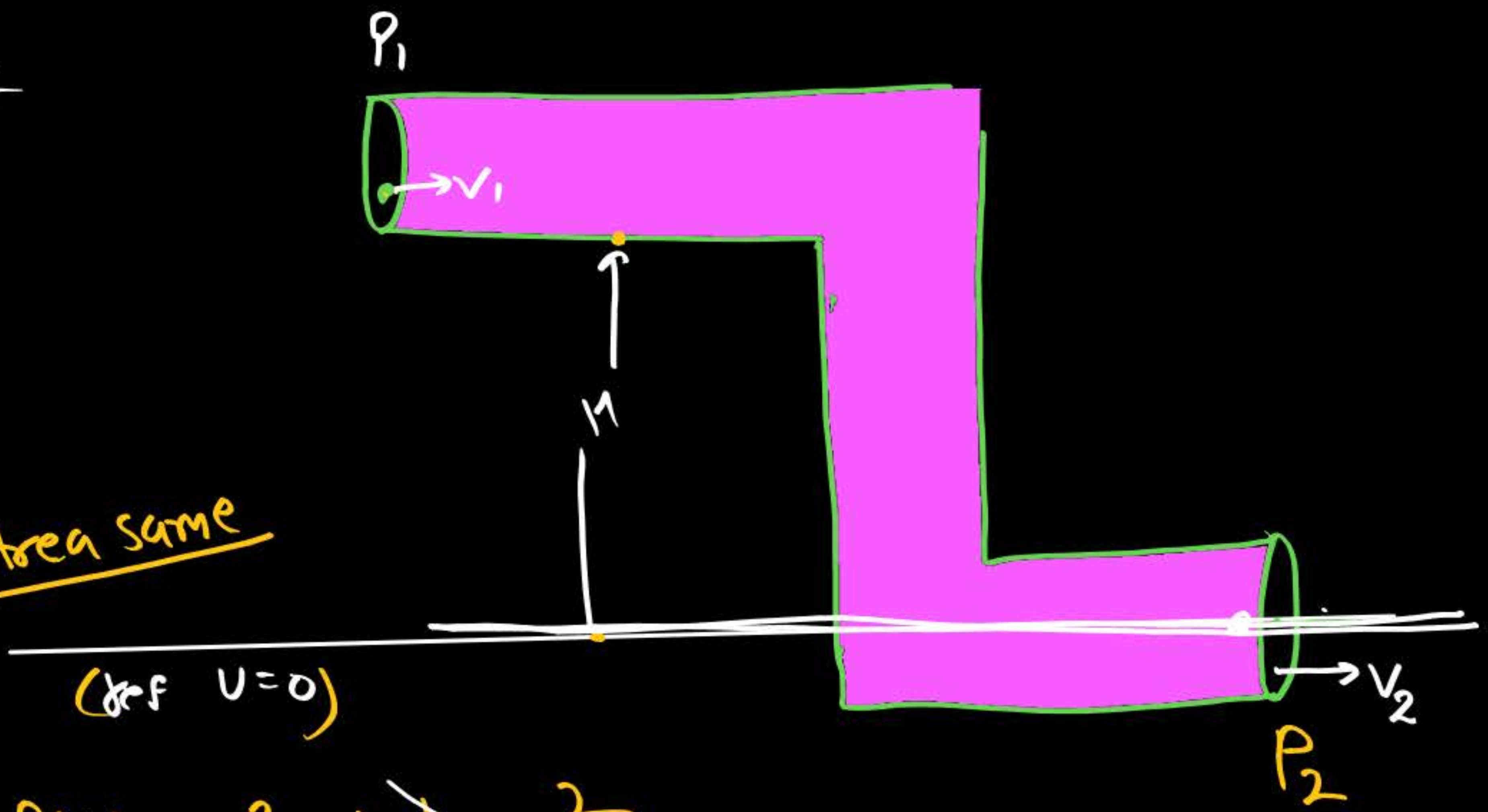


Which of the following is correct

(a) $P_1 = P_2$ (16%)

(b) $P_1 > P_2$ (16%)

(c) $P_1 < P_2$ ✓

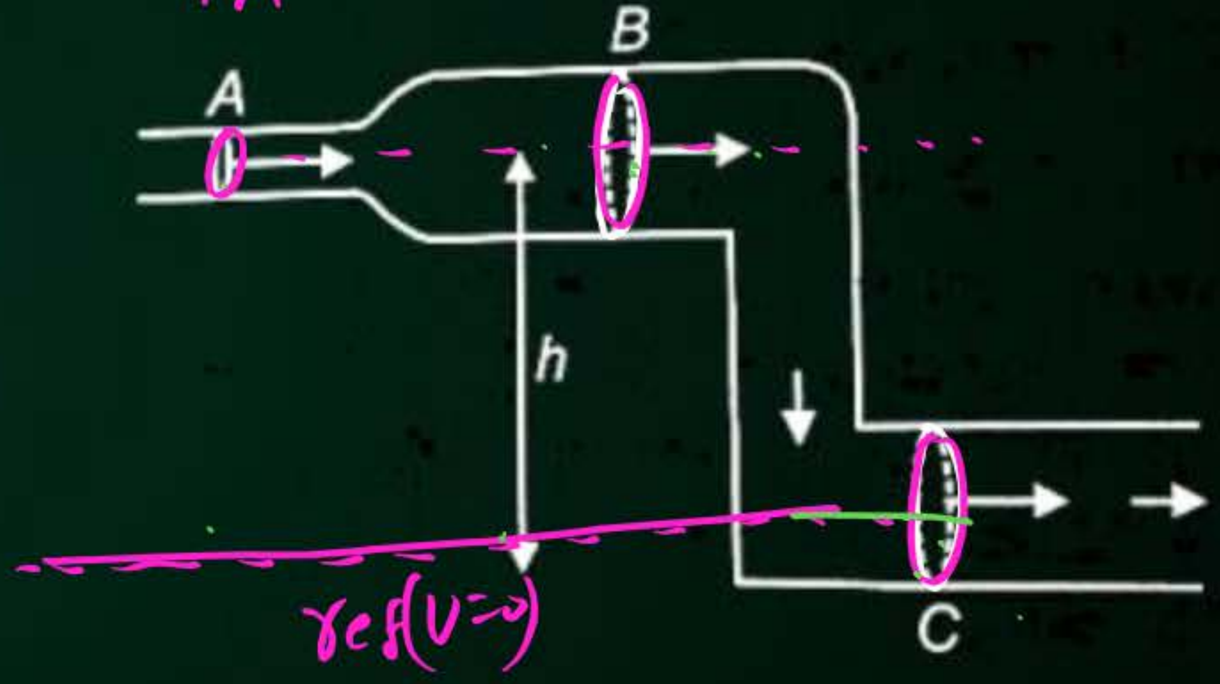


$$P_1 + \frac{1}{2}\rho v^2 + \rho g H = P_2 + \frac{1}{2}\rho v^2 + 0$$

$$P_1 + \rho g H = P_2$$

QUESTION

Water is flowing through a channel (lying in a vertical plane) as shown in the figure. Three sections A, B and C are shown. Sections B and C have equal area of cross-section. If P_A, P_B and P_C are the pressure at A, B and C respectively then

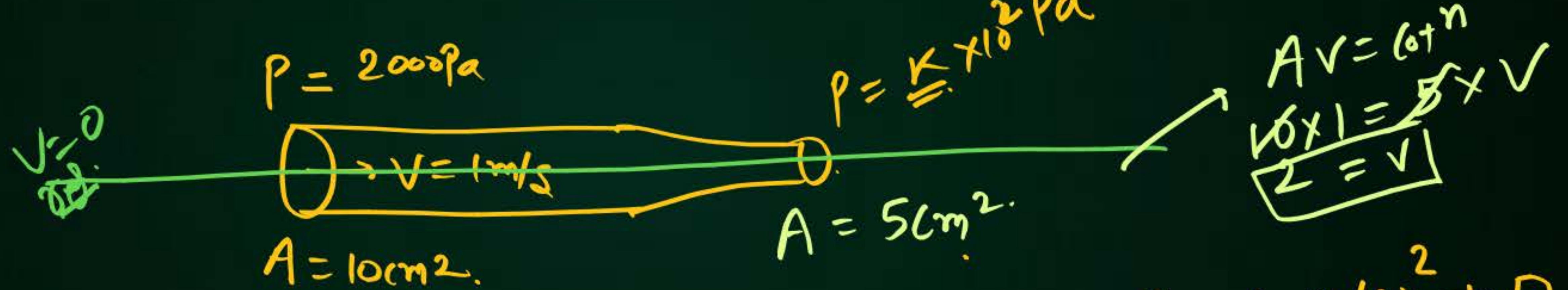


1. $P_A > P_B = P_C$
2. $P_A < P_B < P_C$
3. $P_A < P_B = P_C$
4. $P_A > P_B > P_C$

QUESTION

A horizontal pipeline carries water in a streamline flow. At a point along the pipe, where the cross-sectional area is 10 cm^2, the water velocity is 1 m/s and pressure is 2000 Pa. The pressure of water at another point where cross-sectional area is 5 cm^2, is $k \times 10^2$ Pa, the value of k is then

1. 700 Pa
2. 5 ✓
3. 600 Pa
4. 800 Pa



$$2000 + \frac{1}{2}\rho \times (1)^2 + 0 = K \times 10^2 + \frac{1}{2}\rho (2)^2 + 0$$

$$2000 + \frac{1000}{2} = K \times 10^2 + \frac{1000}{2} \times 4$$

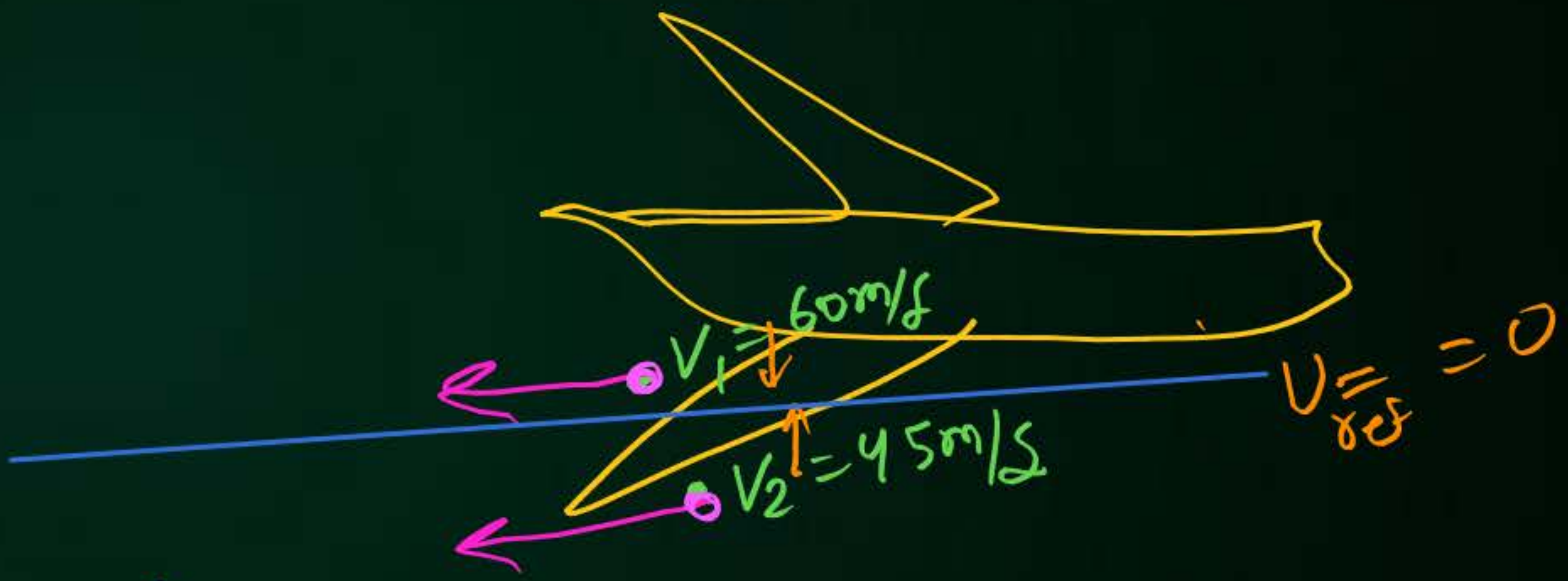
$$500 = K \times 100$$

$$K = 5 \text{ Ans.}$$

QUESTION

Air streams horizontally past an air plane. The speed over the top surface is 60 m/s and that under the bottom surface is 45 m/s. The density of air is $1.293\ \mathrm{kg/m^2}$, then the difference in pressure is

1. $1018\ \mathrm{N/m^2}$
2. $516\ \mathrm{N/m^2}$
3. $1140\ \mathrm{N/m^2}$
4. $2250\ \mathrm{N/m^2}$



$$P_1 + \frac{1}{2}\rho v_1^2 = P_2 + \frac{1}{2}\rho v_2^2$$

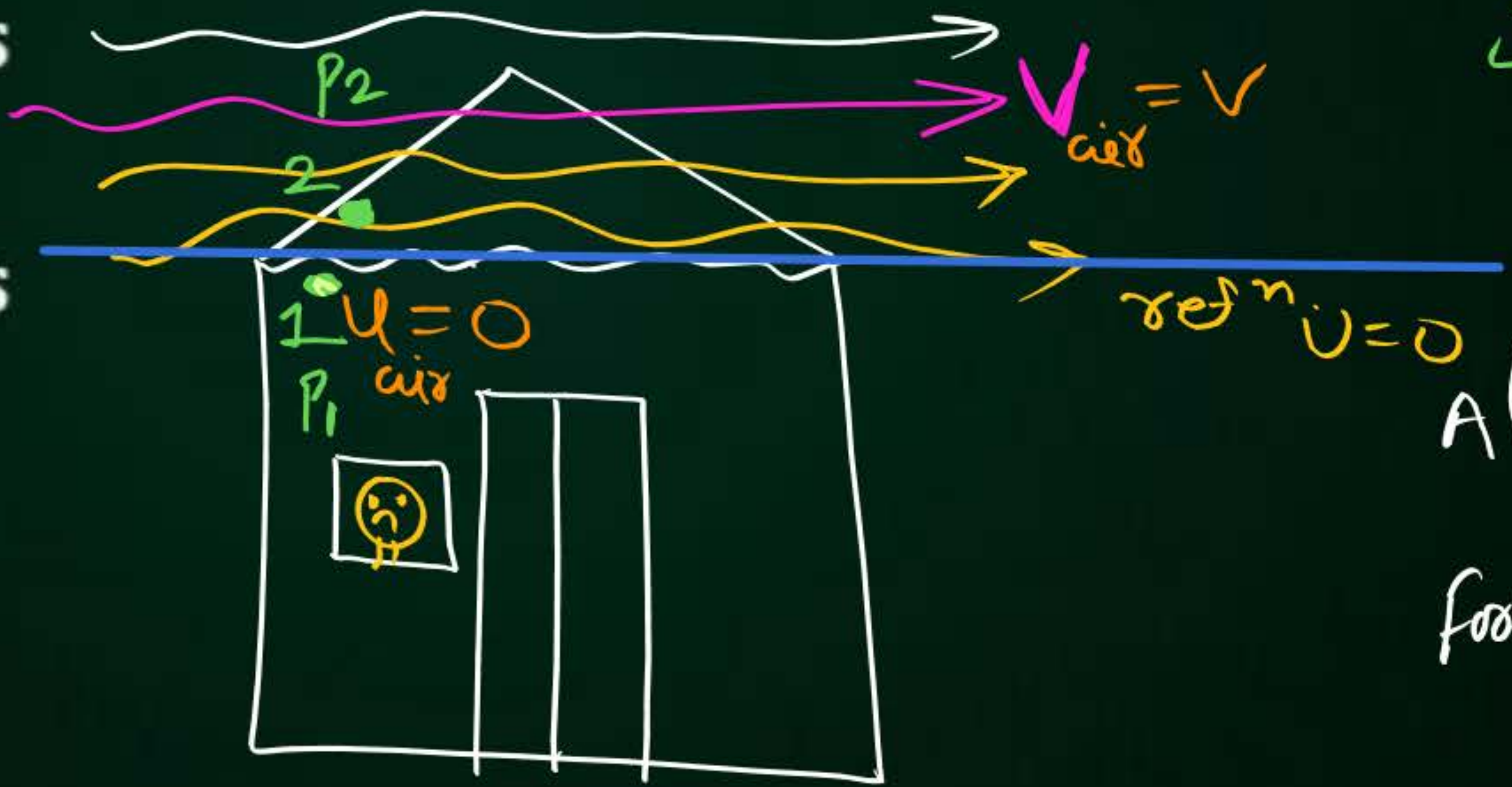
$$\Rightarrow P_2 - P_1 = \frac{1}{2}\rho\left(v_1^2 - v_2^2\right) = \frac{1}{2}\,1.29 \times \left(60^2 - 45^2\right)$$

QUESTION

NEET-2015

A wind with speed 40 m/s blows parallel to the roof of a house. The area of the roof is 250 m^2. Assuming that the pressure inside the house is atmospheric pressure, the force exerted by the wind on the roof and the direction of the force will be ($\rho_{air} = 1.2\ kg/m^3$)

1. 2.4×10^5 N, downwards
2. 4.8×10^5 N, downwards
3. 4.8×10^5 N, upwards
4. 2.4×10^5 N, upwards



$P_1 + 0 + 0 = P_2 + \frac{1}{2}\rho v^2 + 0$

$P_1 = P_2 + \frac{1}{2}\rho v^2$

$A(P_1 - P_2) = \frac{1}{2}\rho v^2 A$

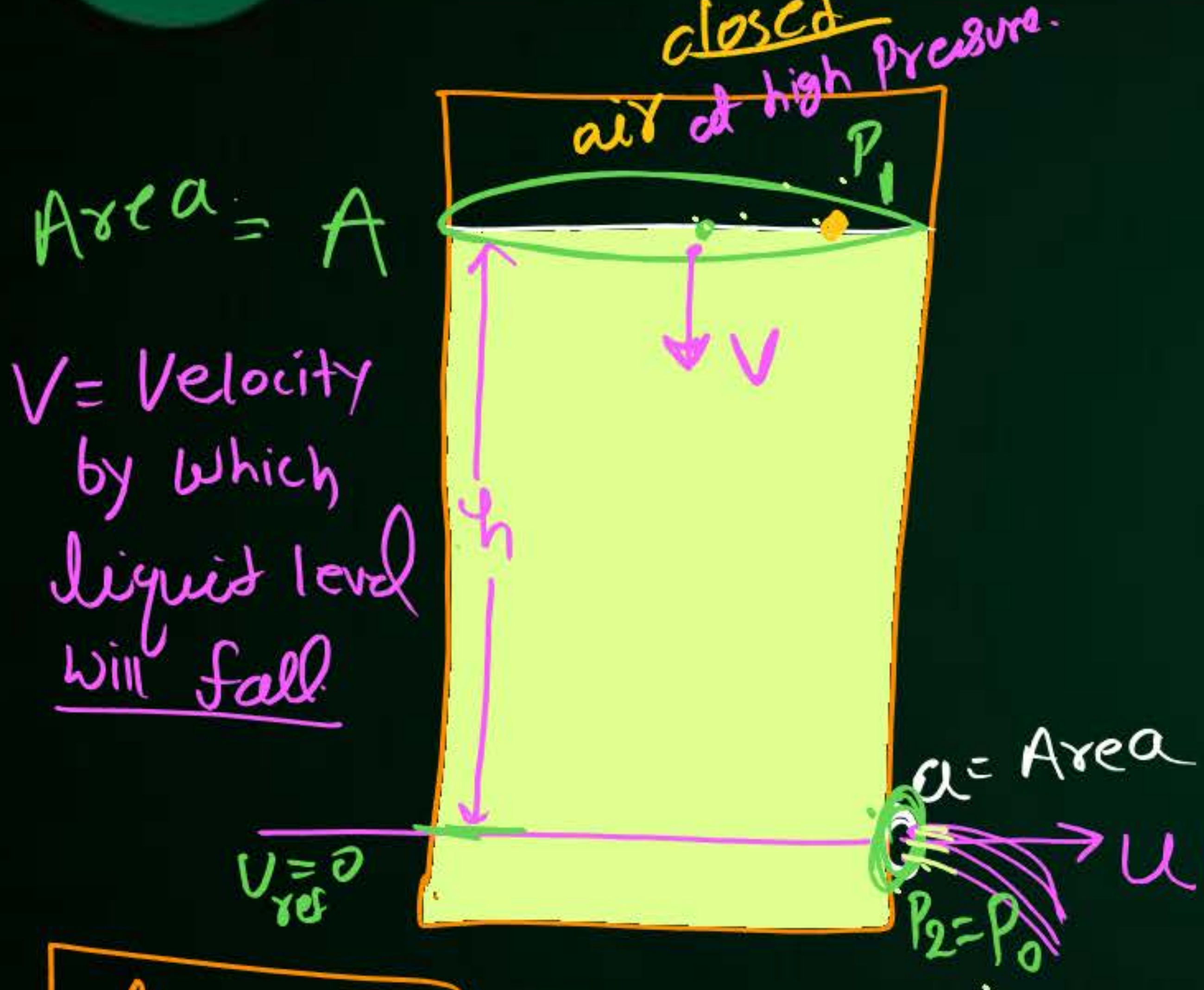
Force (upward) $= \frac{1}{2} 1.2 \times (40)^2 \times 250$

$= \frac{1600 \times 250 \times 1.2}{2}$

$= 200 \times 10^3 \times 1.2$

$= 2.4 \times 10^5$

VELOCITY OF EFFLUX



$$Av = au$$

eq^n of Continuity

$a <<< A$

$u >>> V$

Bernoullies eq^n b/w '1' & '2'

$$P_1 + \frac{1}{2}\rho v^2 + \rho g h = P_0 + \frac{1}{2}\rho u^2 + 0$$

$$(P_1 - P_0) + \rho g h = \frac{1}{2}\rho u^2 - \frac{1}{2}\rho v^2$$

$$(P_1 - P_0) + \rho g h = \frac{1}{2}\rho (u^2 - v^2)$$

$(v <<< u)$, $v^2 \to 0$

$$(P_1 - P_0) + \rho g h = \frac{1}{2}\rho u^2$$

$$\frac{2(P_1 - P_0)}{\rho} + \frac{2\rho g h}{\rho} = u^2$$

$$\sqrt{\frac{2(P_1 - P_0)}{\rho} + 2gh} = u$$

↑ velocity of efflux

Torricelli प्रमेय

Container open कर दो $(P_1 = P_0)$

$$u = \sqrt{2gh}$$

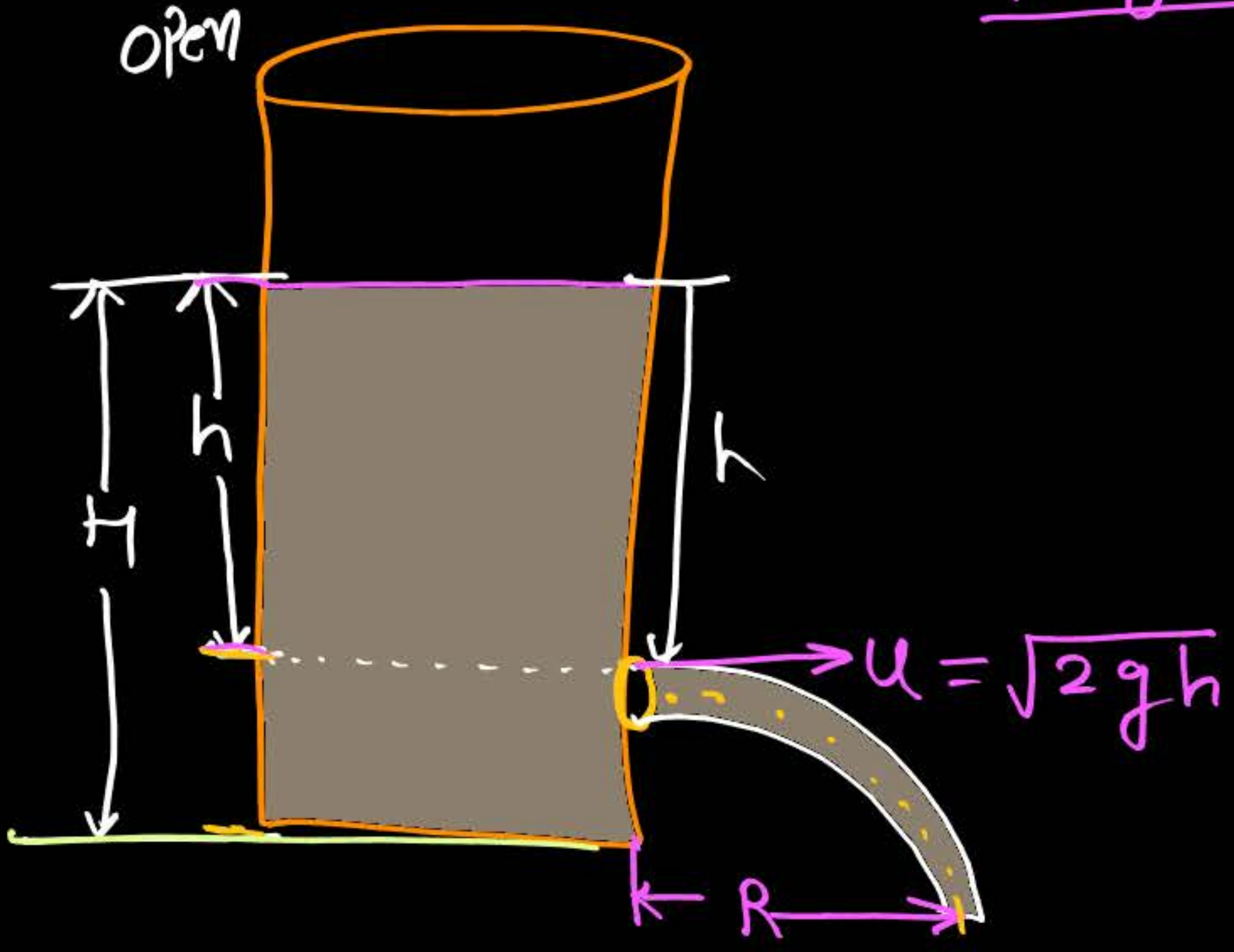
QUESTION

Water ($\rho = 1000\ kg/m^3$) and kerosene ($\sigma = 800\ kg/m^3$) are filled in two identical cylindrical vessels. Both vessels have small holes at their bottom. The speed of the water and kerosene coming out of their holes are v_1 and v_2 respectively. Select the correct alternative

1. $v_1 = v_2$
2. $v_1 = 0.8 v_2$
3. $0.8 v_1 = v_2$
4. $v_1 = \sqrt{0.8}\, v_2$

$u = \sqrt{2gh}$

Range of liquid steam



$$T_f = \sqrt{\frac{2(H_{vert})}{g}}$$

$$T_f = \sqrt{\frac{2(H-h)}{g}}$$

$$R = u_x T_f$$

$$= \sqrt{2gh}\sqrt{\frac{2(H-h)}{g}}$$

$$R = \sqrt{2h}\sqrt{2(H-h)}$$

$$R = \sqrt{4h(H-h)}$$

$$R = 2\sqrt{(H-h)h}$$

Find Position of hole so that Range will be max^m

$$\left(\frac{R}{2}\right)^2 = (H-h)h$$

$$\left(\frac{R^2}{4}\right) = Hh - h^2$$

$$\frac{d(R^2/4)}{dh} = 0 \text{ for max}^m \text{ Range}$$

$$\frac{dHh}{dh} - \frac{dh^2}{dh} = 0$$

$$H\cdot 1 - 2h = 0$$

$$2h = H$$

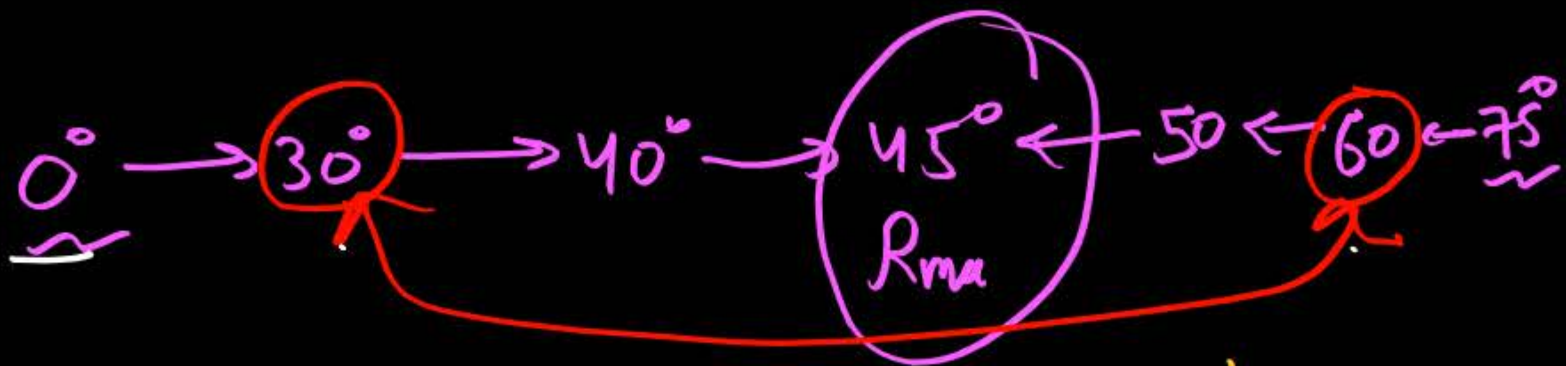
Posit^n of hole for R_{max} →

$$h = H/2$$

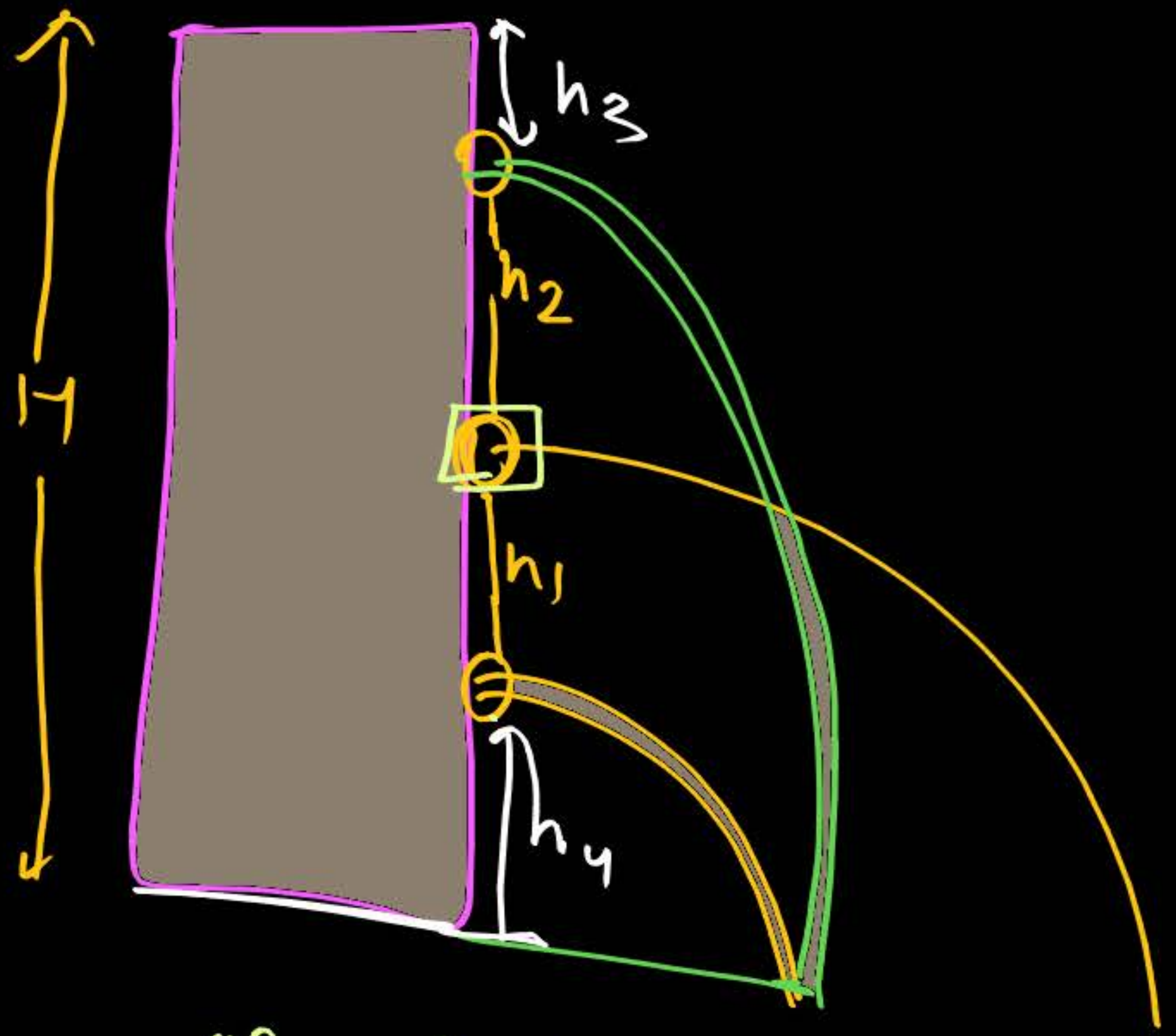
$$(R_{max})_{h=H/2} = 2\sqrt{(H-h)\,h} = 2\sqrt{\left(H-\frac{H}{2}\right)\frac{H}{2}} = 2\sqrt{\frac{H}{2}\times\frac{H}{2}}$$

$$= 2\,\frac{H}{2}$$

$$\boxed{R_{m} = H}$$



find Rel^n B/w h_1 & h_2 so that Range will be same.



If $h_1 = h_2$

$h_3 = h_4$ then Range will be same.

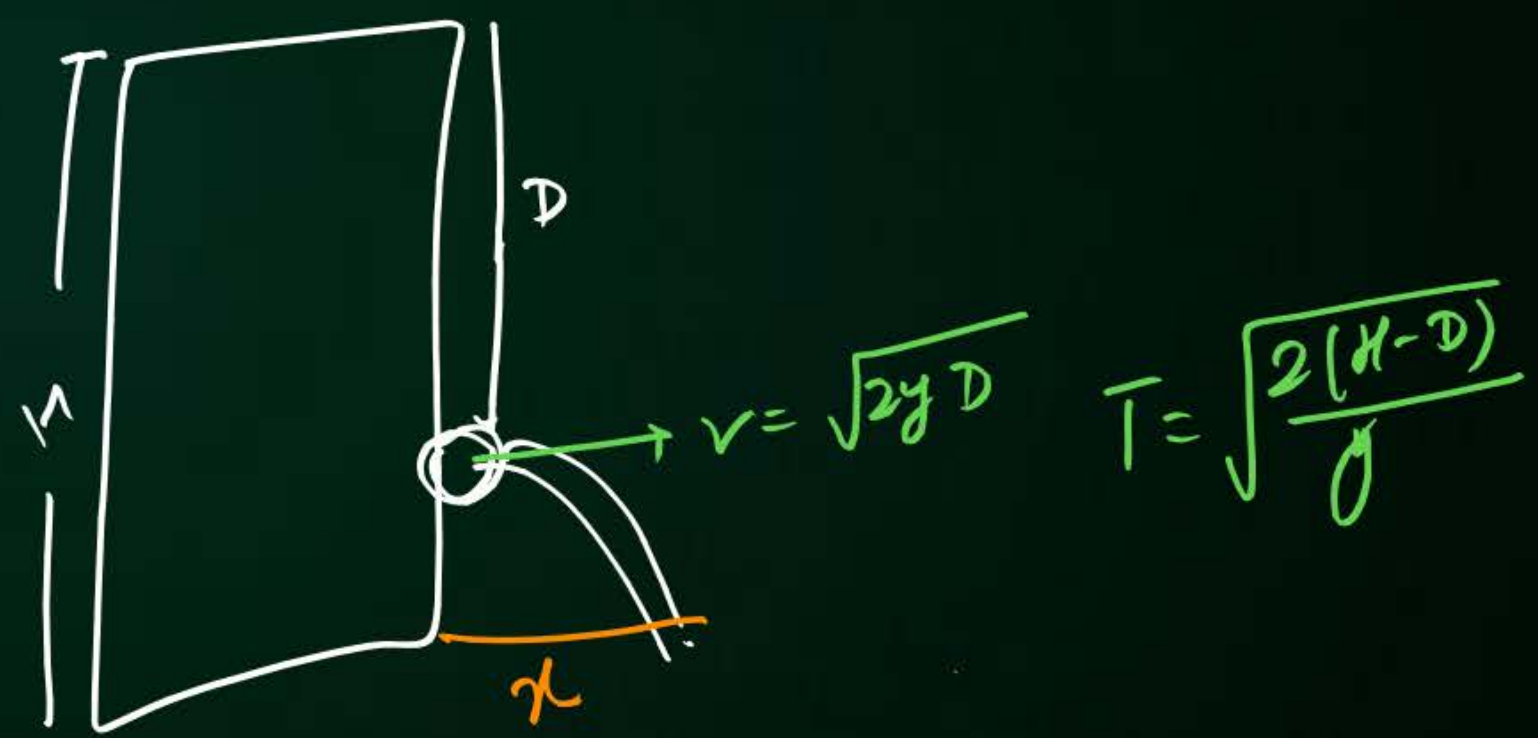
QUESTION

Position of hole from ground so that horizontal range will be maximum.

QUESTION

A tank is filled with water to a height H. A hole is made on one of the walls at a depth D below the water surface. The distance x from the foot of the wall at which the stream of water coming out of the tank strikes the ground is given by

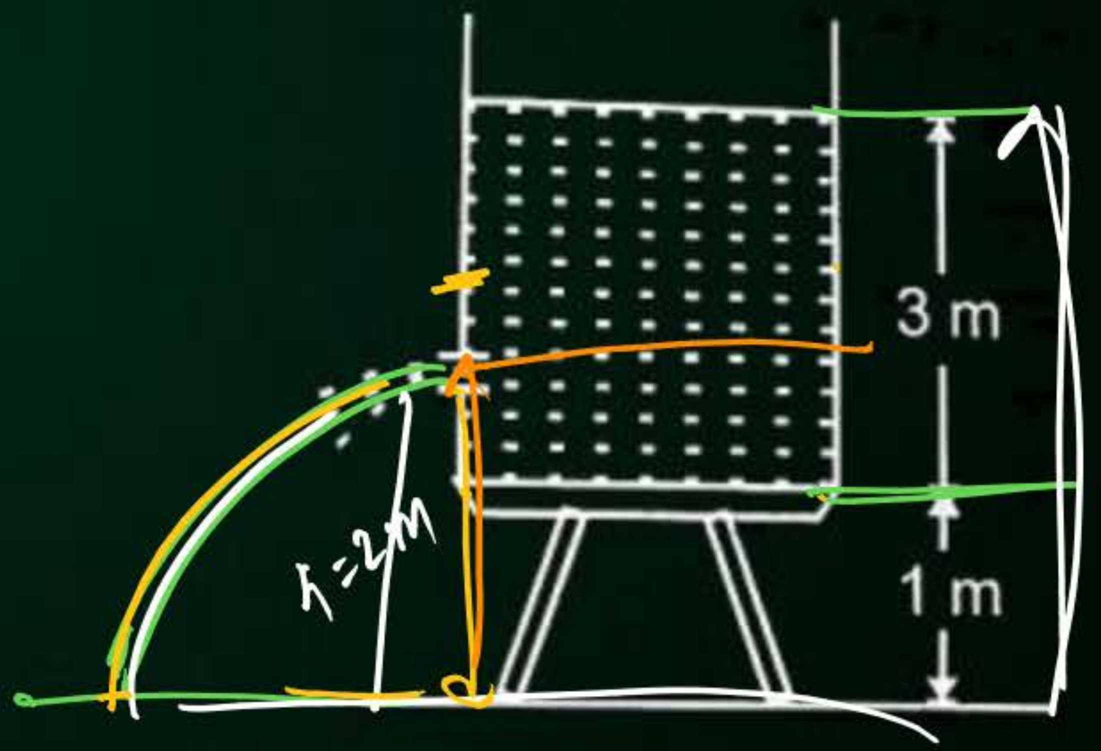
1. $x = 2[D(H - D)]^{1/2}$
2. $x = 2(gD)^{1/2}$
3. $x = 2[D(H + D)]^{1/2}$
4. None of these



QUESTION

Water is filled in a tank upto 3 m height. The base of the tank is at height 1m above the ground. What should be the height of a hole made in it, so that water cane be sprayed upto maximum horizontal distance on ground?

1. 3m from ground
2. 1.5 m from ground
3. 1.5 m from base of tank
4. 2 m from ground ✓ (56%)



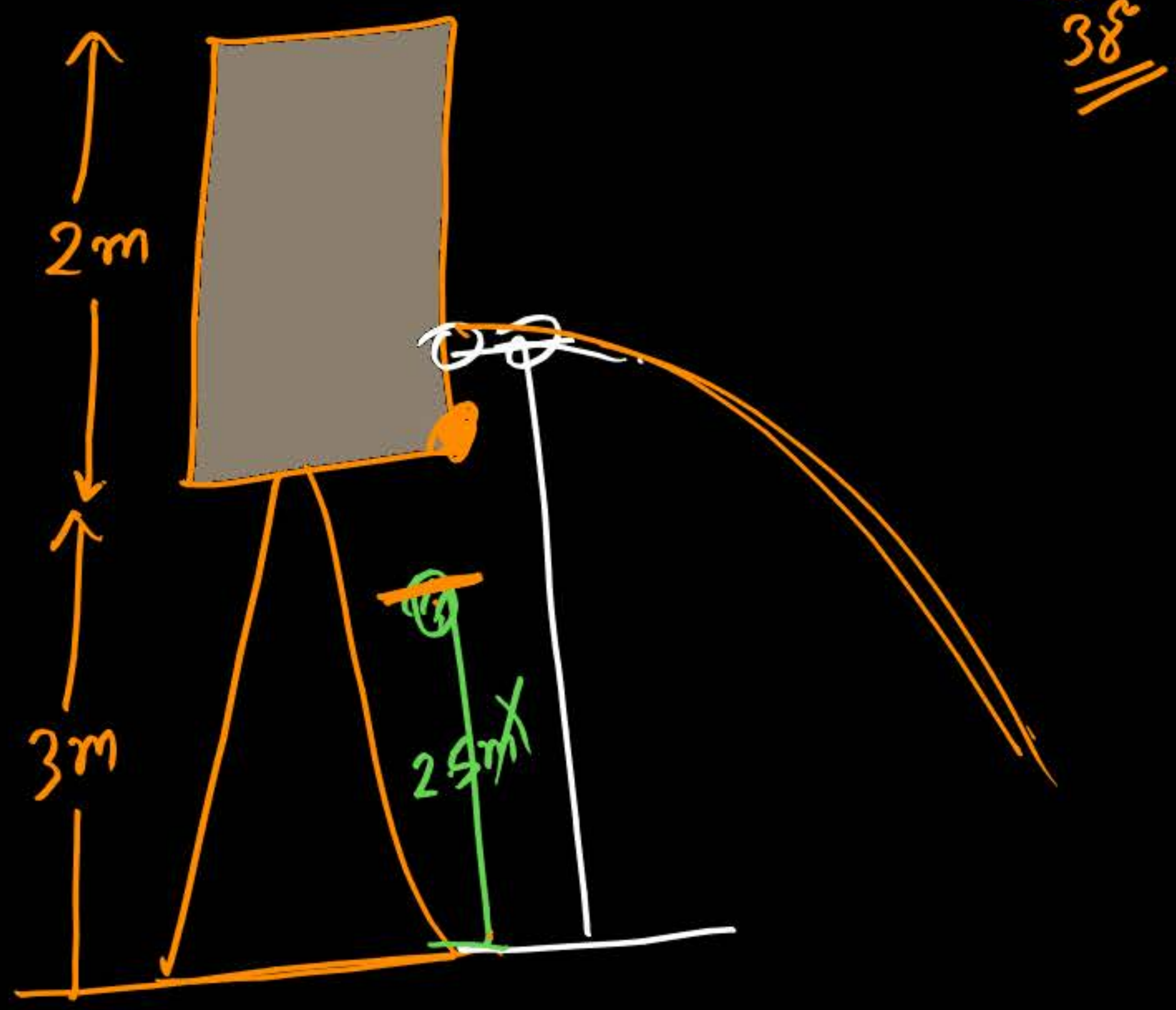
MR# Sarwal.

Heigh of hole from ground for Maximum Range ??

(a) 2.5m (48%)

(b) 3m

(c) 4m (18%)




THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 5 | Physics

Mechanical Properties of Fluid



By- Dr. Manish Raj (MR SIR)

yakeen

N.L.M. → Plus.

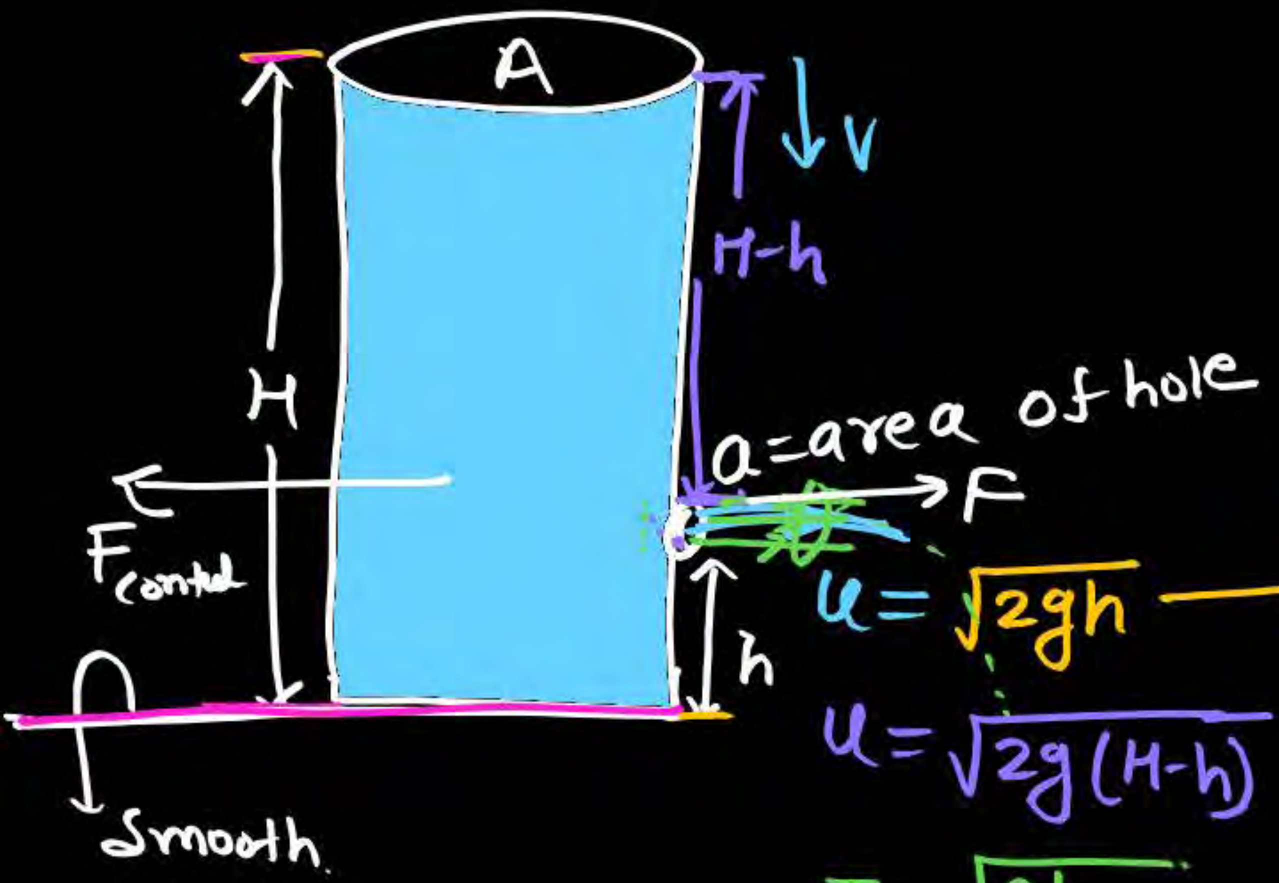
Todays Goal

Question on Bernoullie's

→ PYQ – JEE main.

→ Ventrimetre

→ Magnus effect



$u = \sqrt{2gh}$ — ✗

$u = \sqrt{2g(H-h)}$

$T = \sqrt{\frac{2h}{g}}$

Range $= uT = \sqrt{2g(H-h)} \times \sqrt{\frac{2h}{g}}$

• $R = 2\sqrt{(H-h) \times h}$

Range will be Maximum at Position of hole $y = \frac{H}{2}$

$R_{Max} = H$

* Rate of Volume flow = Area × velocity

$= a\sqrt{2g(H-h)}$

* Velocity of liquid level in contair

$VA = au$

$V = \frac{au}{A} = \frac{a}{A}\sqrt{2g(H-h)}$

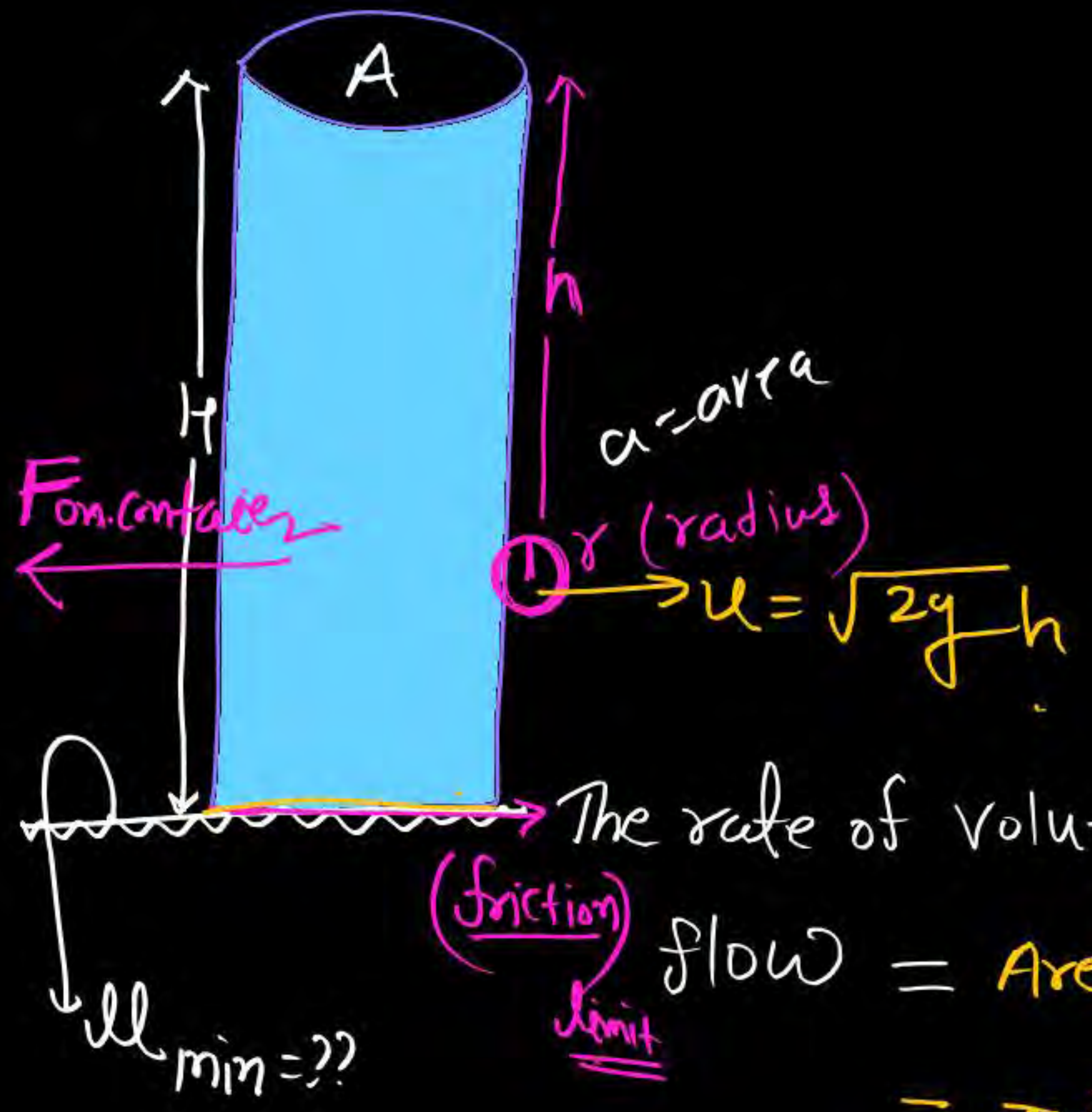
* force on a liquid stream which is coming out from container

$= \rho a u^2$

$= \rho a \, 2g(H-h)$

according to Newton 3rd Law

force on container $= \rho a 2g(H-h)$



The rate of volume flow = Area × Velocity

$$= \pi r^2 (\sqrt{2gh})$$

Find minimum coefficient of friction so that container will not slip

(Container is massless)

$$\text{Force on container} = \rho a u^2$$

$$= \rho a (2gh)$$

$$\text{Force} = 2\rho a g h$$

$$(\text{friction})_{lim} = \mu N = \mu M g$$

$$f_{lim} = \mu \rho A H g$$

at equilibrium

$$\mu \rho A H g = 2 \rho a g h$$

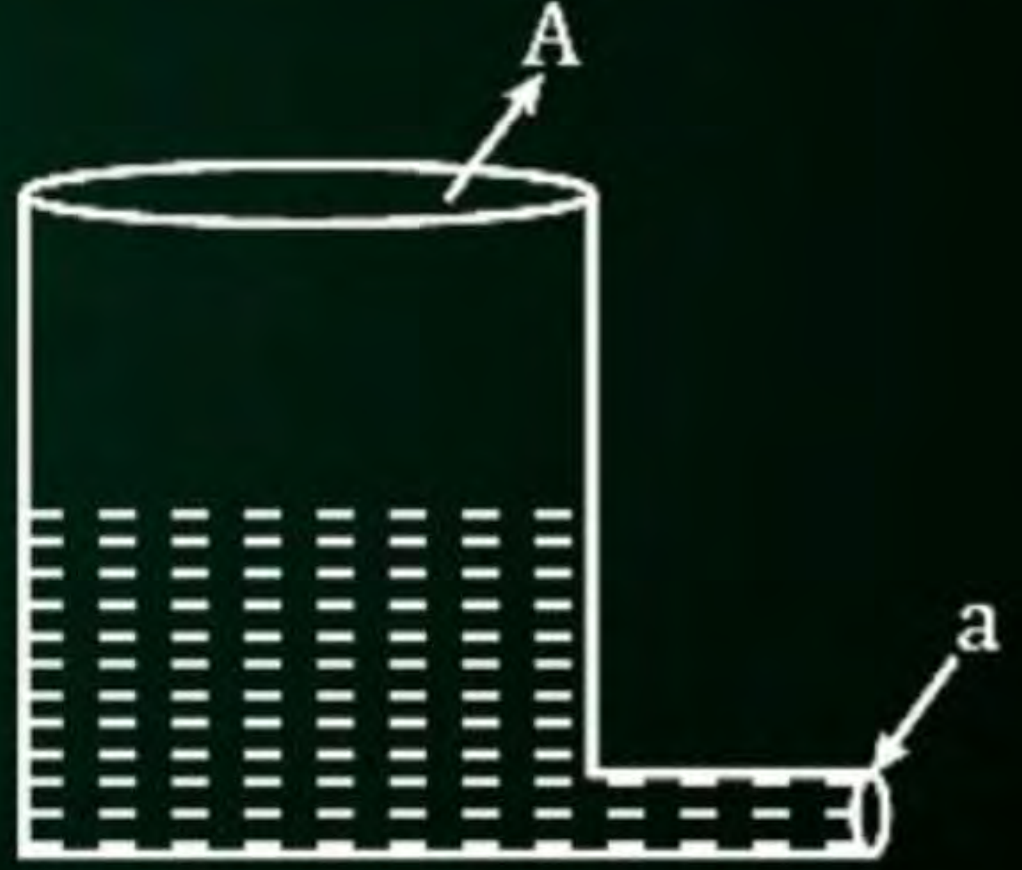
$$\boxed{\mu = \frac{2ah}{AH}}$$

If position of hole is at base of container.

$$\left\{ \mu = \frac{2aH}{AH} = \frac{2a}{A} \right\}$$

QUESTION

A light cylindrical vessel is kept on a horizontal surface. Area of base is A. A hole of cross-sectional area 'a' is made just at its bottom side. The minimum coefficient of friction necessary to prevent sliding the vessel due to the impact force of the merging liquid is ($a << A$): [27 July, 2021 (Shift-I)]

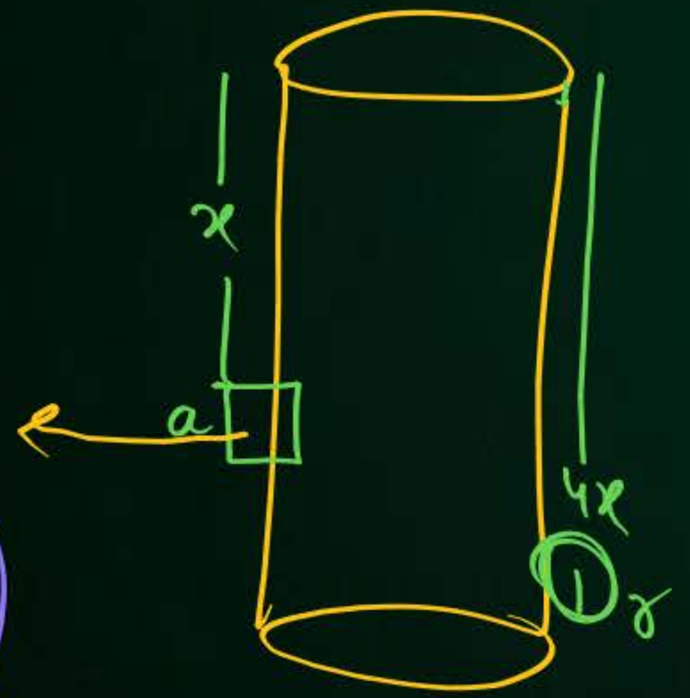


1. None of these
2. $\frac{2a}{A}$ (Ans)
3. $\frac{A}{2a}$
4. $\frac{a}{A}$

QUESTION

A large open tank has two holes in its wall. One is a square of side a at a depth x from the top and the other is a circular hole of radius r at depth $4x$ from the top. When the tank is completely filled with water, the quantities of water flowing out per second from both holes are the same. Then r is equal to (JEE main)

1. $2\pi a$
2. a
3. $\frac{a}{\sqrt{2\pi}}$ Ans.
4. $\frac{a}{\pi}$



Rate of volume flow same from Both hole.

$$\sqrt{2gx}\,(a^2) = \pi r^2 \sqrt{2g4x}$$

$$a^2 = \pi r^2 2$$

$$r^2 = \frac{a^2}{2\pi}$$

$$r = \sqrt{\frac{a^2}{2\pi}} = \frac{a}{\sqrt{2\pi}}$$

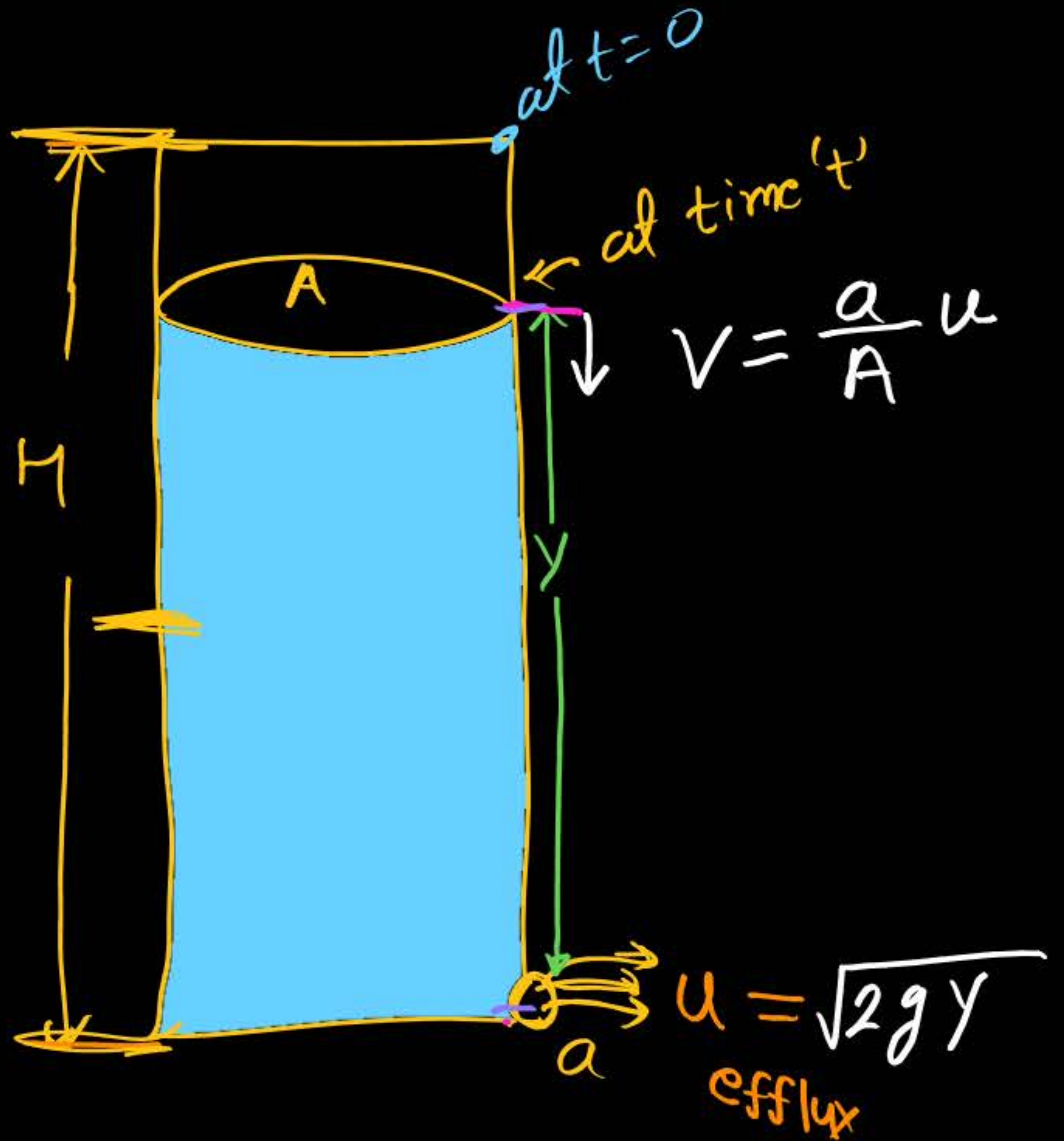
QUESTION

If container is massless and placed on rough surface then find minimum coefficient of friction of surface so that container will not slide?

done

$\mu = \frac{2a}{A}$

Find time to fall liquid level from Height H to zero



hint $\int \frac{1}{\sqrt{x}}dx = \int x^{-\frac{1}{2}}dx$

$= \frac{x^{-\frac{1}{2}+1}}{-\frac{1}{2}+1} = \frac{x^{\frac{1}{2}}}{\frac{1}{2}}$

$= 2\sqrt{x}$

$$V = \frac{a}{A}\sqrt{2gy}$$

$$-\frac{dy}{dt} = \frac{a}{A}\sqrt{2gy}$$

$$\int -\frac{dy}{\sqrt{2gy}} = \int \frac{a}{A}dt$$

$$-\frac{1}{\sqrt{2g}}\int_H^0 \frac{dy}{\sqrt{y}} = \frac{a}{A}\int_0^t dt$$

$$-\frac{1}{\sqrt{2g}}\left[2\sqrt{y}\right]_H^0 = \frac{a}{A}t$$

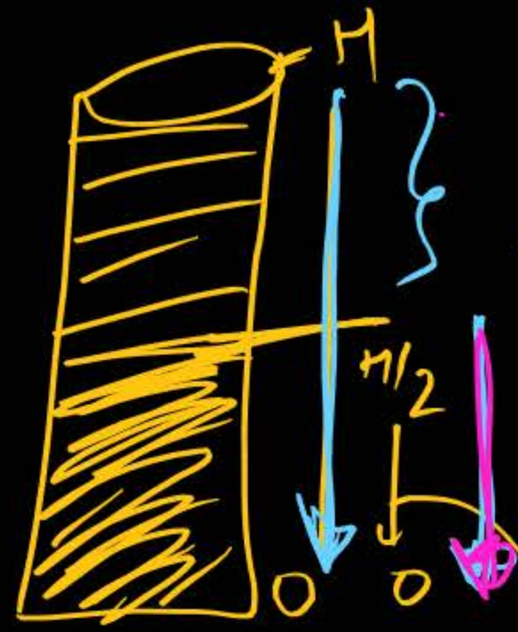
$$-\frac{2}{\sqrt{2g}}\left(0-\sqrt{H}\right) = \frac{a}{A}t$$

$$\sqrt{\frac{2H}{g}} = \frac{a}{A}t$$

$$t = \frac{A}{a}\sqrt{\frac{2H}{g}}$$

$$t = \frac{A}{a}\sqrt{\frac{2H}{g}}$$ → H to 0

↳ liquid level fall from H to 0



$$T = \frac{A}{a}\sqrt{\frac{2H}{g}}$$

$$t_1 = \frac{A}{a}\sqrt{\frac{2H}{2g}}$$

$$t_1 = \frac{A}{a}\sqrt{\frac{H}{g}}$$

time taken to fall from H to H/2

$$t_1 = \frac{A}{a}\sqrt{\frac{2}{g}}\left(\sqrt{H} - \sqrt{\frac{H}{2}}\right)$$

time taken to fall from $\left(\frac{H}{2}\right)$ to 0

$$t_2 = \frac{A}{a}\sqrt{\frac{2H}{2g}} = \frac{A}{a}\sqrt{\frac{H}{g}}$$

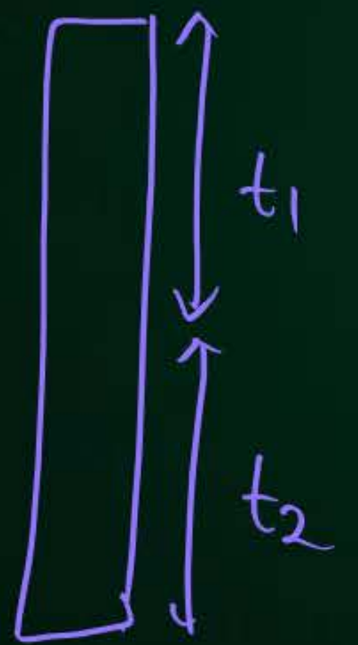
$$\frac{T}{t_1} = \frac{\frac{A}{a}\sqrt{\frac{2H}{g}}}{\frac{A}{a}\sqrt{\frac{2H}{2g}}} = \sqrt{2}$$

$$\frac{T}{t_1} = \sqrt{2} : 1$$

QUESTION

A large tank filled with water to a height 'h' is to be emptied through a small hole at the bottom. The ratio of time taken for the level of water to fall from h to $\frac{h}{2}$ and from $\frac{h}{2}$ to bottom is

1. $\sqrt{2}$
2. $1/2$
3. $\sqrt{2}-1$
4. $\frac{1}{\sqrt{2}-1}$ (20%)



$T = \frac{A}{a}\sqrt{\frac{2H}{g}}$

$t_2 = \frac{A}{a}\sqrt{\frac{2H}{2g}} = \frac{A}{a}\sqrt{\frac{H}{g}}$

$t_1 = T - t_2 = \frac{A}{a}\sqrt{\frac{H}{2}}\,(\sqrt{2}-1)$

Ans

QUESTION

An ideal fluid flows (laminar flow) through a pipe of non-uniform diameter. The maximum and minimum diameters of the pipes are 6.4 cm and 4.8 cm, respectively. The ratio of the minimum and the maximum velocities of fluid in this pipe is: [07 Jan, 2020 (Shift-II)]

(1) $\frac{3}{4}$

(2) $\frac{81}{256}$

(3) $\frac{\sqrt{3}}{2}$ ✗

(4) $\frac{9}{16}$ (11%)

$A_{max} v_{min} = A_{min} V_{max}$

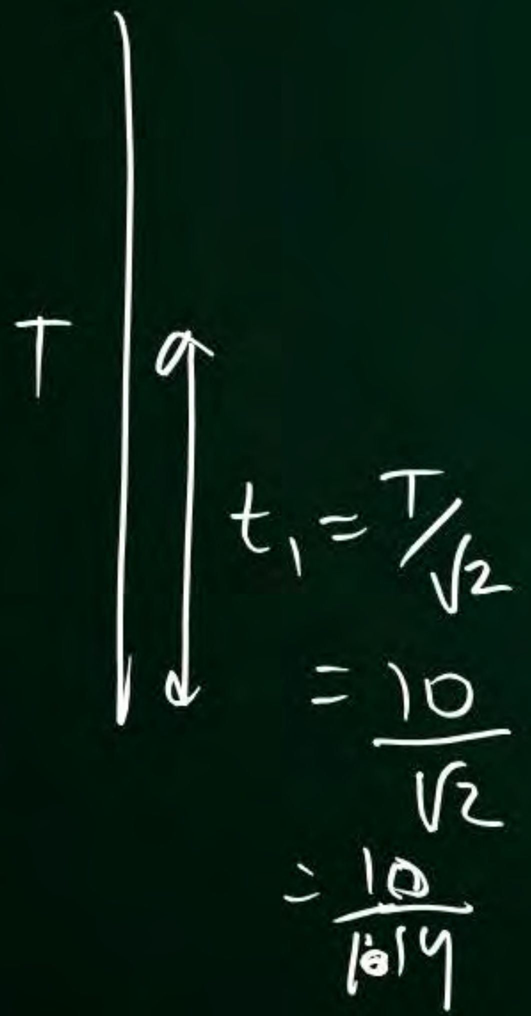
$\frac{V_{min}}{V_{max}} = \frac{A_{min}}{A_{max}} = \left(\frac{24}{32}\right)^2 = \left(\frac{3}{4}\right)^2$

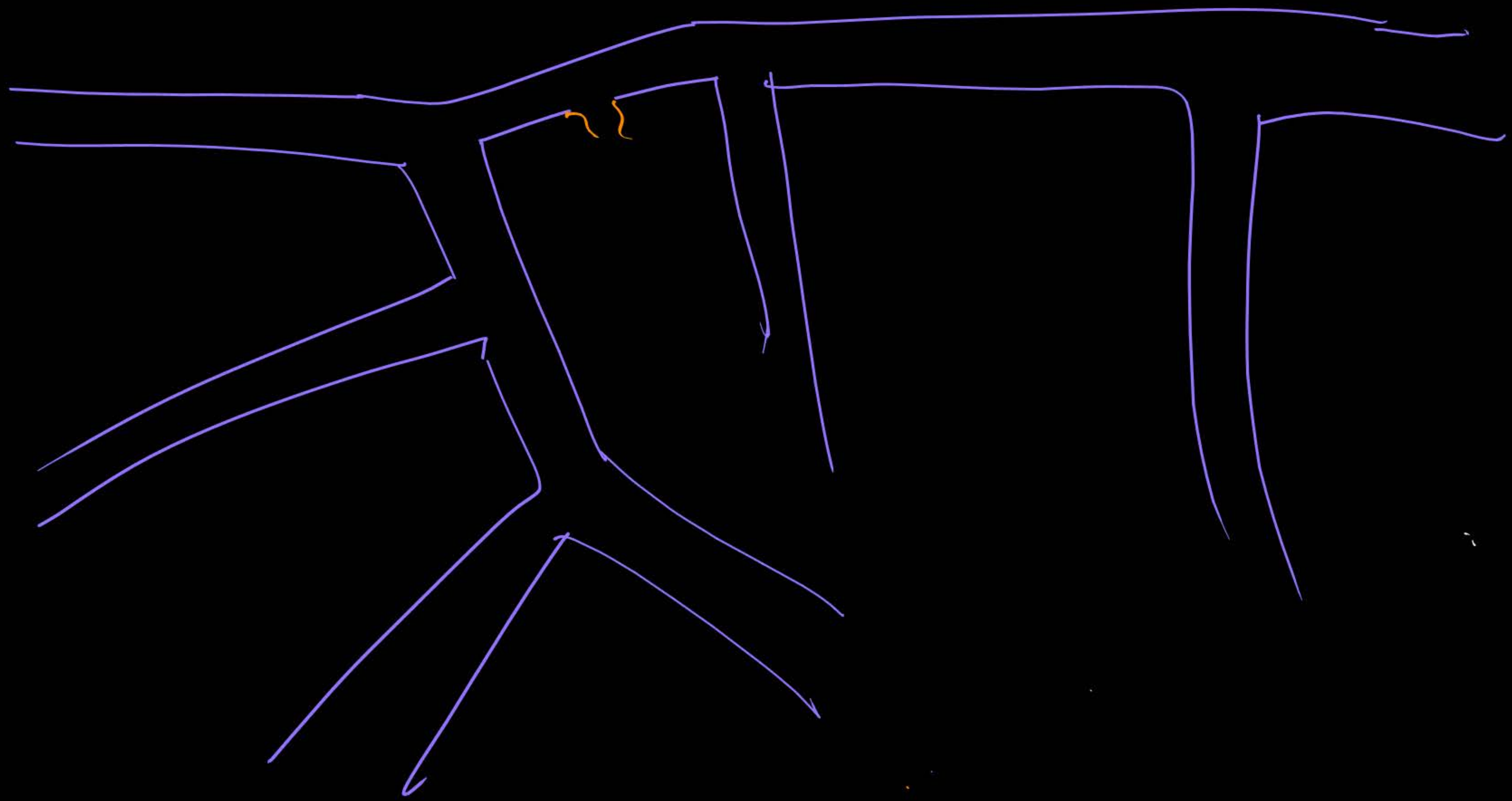
$= \frac{9}{16}$ Ans.

QUESTION

A rectangular vessel when full of water, takes 10 min to be emptied through an orifice in its bottom. How much time will it take to be emptied when half filled with water?

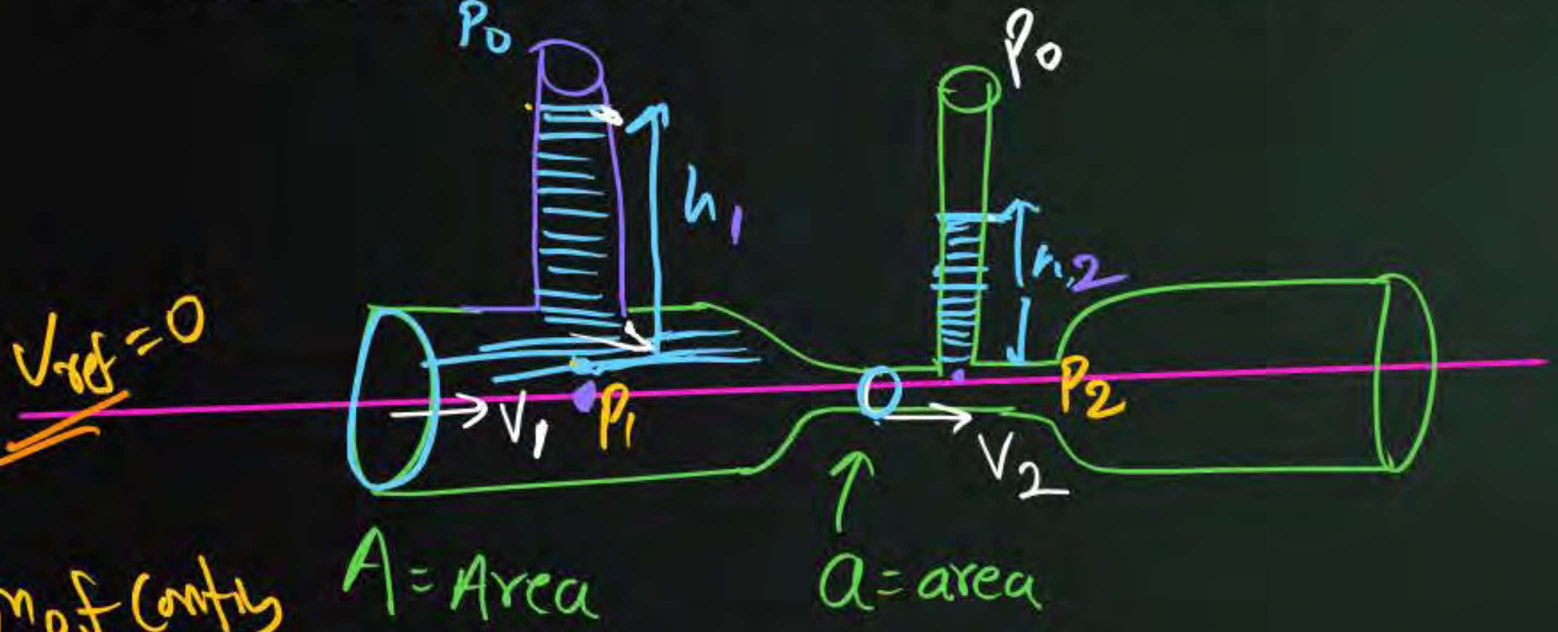
1. 9 mm
2. 7 min
3. 5 min
4. 3 min





Venturimetre

* Instrument use measure rate of volume flow.
* Works on the principle of Bernoullies equation



eq^n of contin.

$$\boxed{Av_1 = av_2 = V_0} \text{ (Rate of volume flow)}$$

$$\Rightarrow v_1 = \frac{V_0}{A} \quad v_2 = \frac{V_0}{a}$$

Bernoullies eq^n

$$0 + P_1 + \frac{1}{2}\rho v_1^2 = P_2 + \frac{1}{2}\rho v_2^2 + 0$$

$$P_1 - P_2 = \frac{1}{2}\rho (v_2^2 - v_1^2)$$

$$P_0 + \rho g h_1 - (P_0 + \rho g h_2) = \frac{1}{2}\rho \left[\frac{V_0^2}{a^2} - \frac{V_0^2}{A^2}\right]$$

$$\rho g (h_1 - h_2) = \frac{1}{2}\rho V_0^2 \left[\frac{1}{a^2} - \frac{1}{A^2}\right]$$

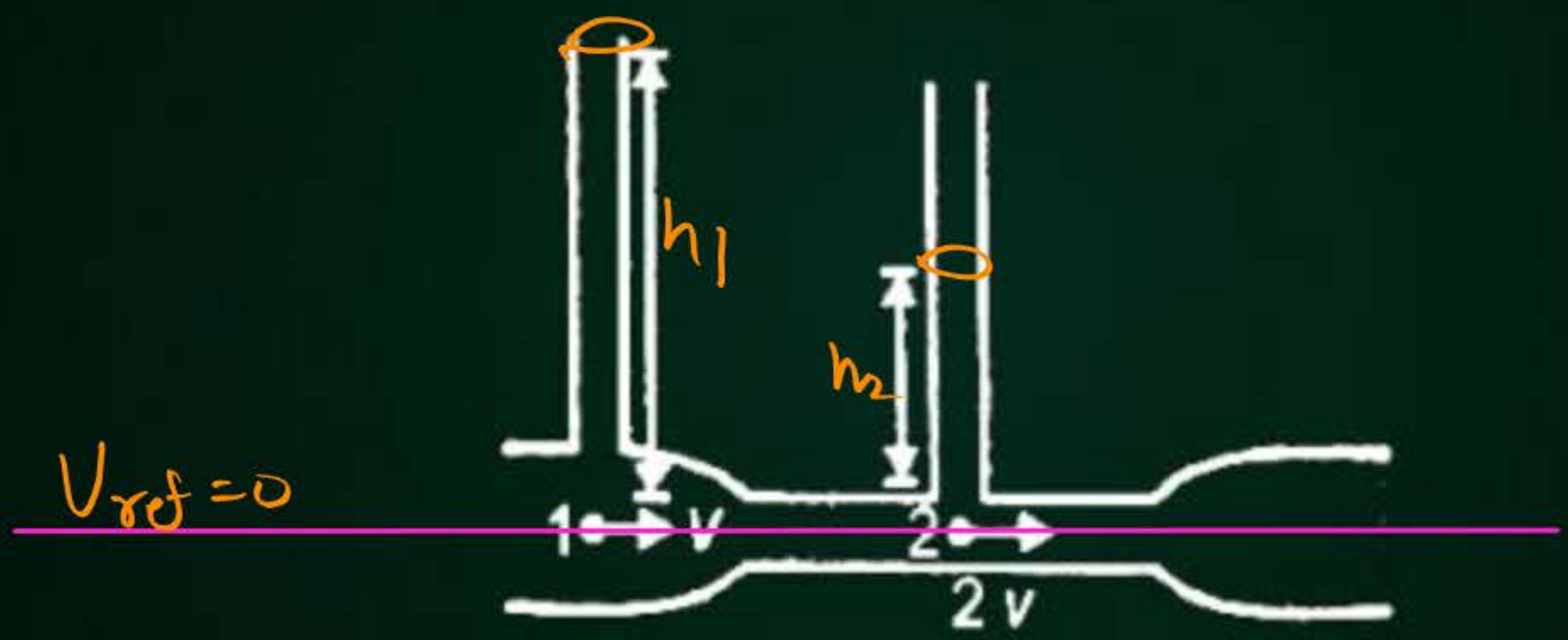
$$\boxed{2g(h_1 - h_2) = V_0^2 \left(\frac{1}{a^2} - \frac{1}{A^2}\right)}$$

V_0 → Rate of volume flow

A, a

QUESTION

In the show Venturimeter, fluid velocities at two points are indicated. What is the difference in the levels of liquid in tube at the two points? [Given density of the liquid = ρ]



$h_1 - h_2 = \frac{3v^2}{2g}$ Ans

$\Rightarrow 0 + P_1 + \frac{1}{2}\rho v^2 = 0 + P_2 + \frac{1}{2}\rho (2v)^2$

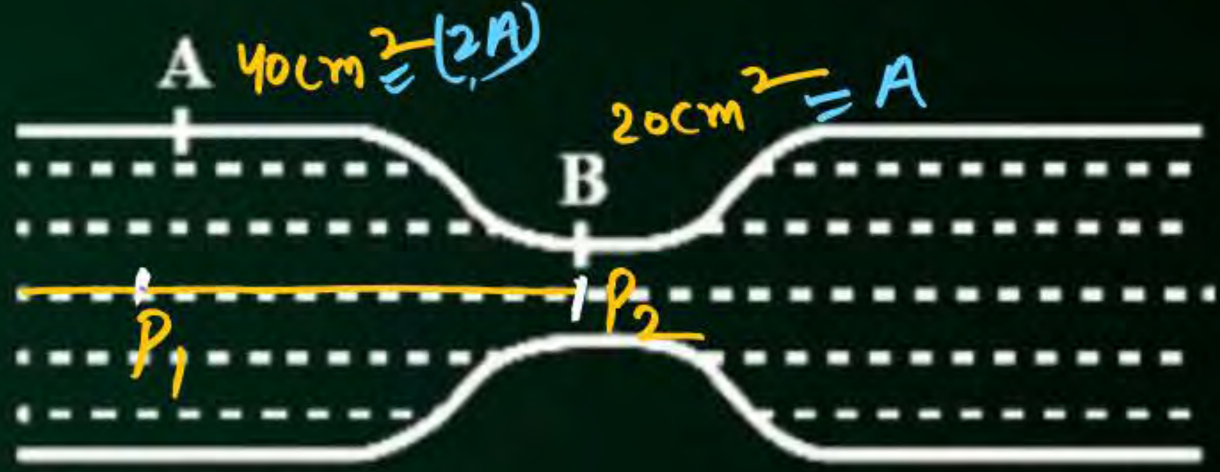
$\Rightarrow \rho g (h_1 - h_2) = \frac{1}{2}\rho (3v^2)$

QUESTION

Water flows in a horizontal tube (see figure). The pressure of water changes by 700 Nm^{-2}, respectively. Find the rate of flow of water through the tube. (density of water = 1000 kg m^{-3})

[09 Jan, 2020 (Shift-I)]

1. $1810\ cm^3/s$
2. $2420\ cm^3/s$
3. $2720\ cm^3/s$
4. $3020\ cm^3/s$



$0 + P_1 + \frac{1}{2}\rho v_1^2 = P_2 + \frac{1}{2}\rho v_2^2$

$P_1 - P_2 = \frac{1}{2}\rho(v_2^2 - v_1^2)$

$700 = \frac{1}{2}10^3\left(\frac{V_0^2}{A^2} - \frac{V_0^2}{4A^2}\right)$

$\frac{14}{10} = V_0^2\left[\frac{1}{A^2} - \frac{1}{4A^2}\right]$

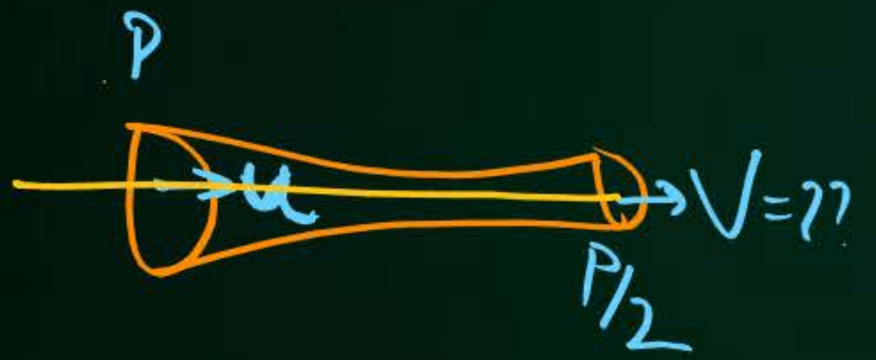
$\frac{14}{10} = \frac{V_0^2}{A^2}\left(\frac{3}{4}\right)$

$\frac{14}{10} \times \frac{4}{3} = \frac{V_0^2}{(20\times10^{-4})^2}$

QUESTION

A fluid is flowing through a horizontal pipe of varying cross-section, with speed $v\ \mathrm{ms}^{-1}$ at a point where the pressure is P Pascal. At another point where pressure is $\frac{P}{2}$ Pascal its speed is $V\ \mathrm{ms}^{-1}$. If the density of the fluid is $\rho\ \mathrm{kg}\ m^{-3}$ and the flow is streamline, then V is equal to: [6 Sep, 2020 (Shift-II)]

1. $\sqrt{\frac{P}{p}+v}$



2. $\sqrt{\frac{2P}{p}+v^2}$

3. $\sqrt{\frac{P}{2p}+v^2}$

4. $\sqrt{\frac{P}{\rho}+v^2}$

$P+\frac{1}{2}\rho u^2=\frac{P}{2}+\frac{1}{2}\rho V^2$

$\frac{P}{2}+\frac{1}{2}\rho u^2=\frac{1}{2}\rho V^2$

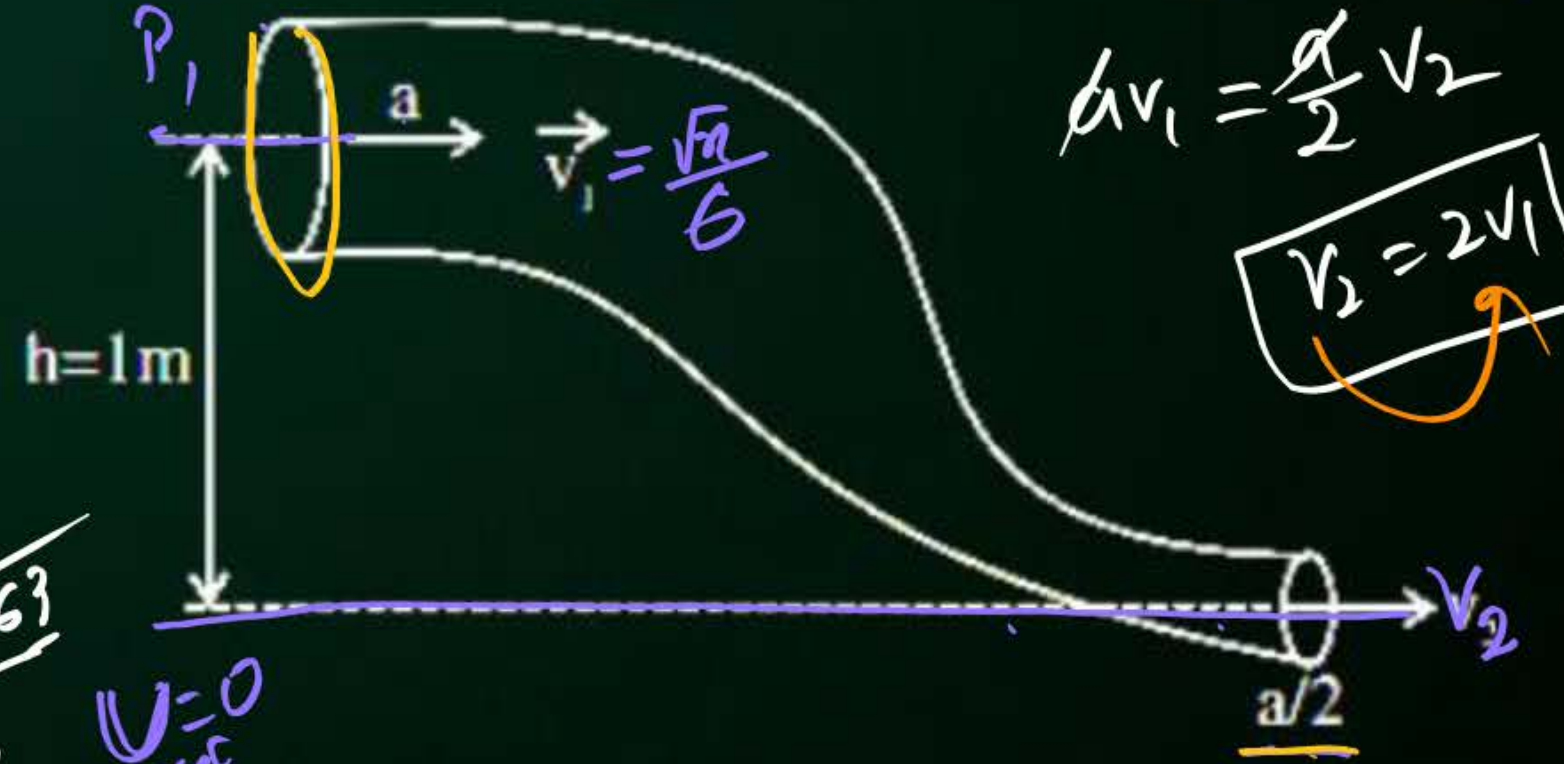
$\sqrt{\frac{P}{\rho}+u^2}=V$

Ans.

QUESTION

An ideal fluid of density $800\,kgm^{-3}$, flows smoothly through a bent pipe (as shown in figure) that tapers in cross-sectional area from a to $a/2$. The pressure difference between the wide and narrow sections of pipe is 4100 Pa. At wider section, the velocity of fluid is $\left(\frac{\sqrt{x}}{6}\right)ms^{-1}$ for $x =$ ______. (Given $g = 10\ \mathrm{ms}^{-2}$)

[26 June, 2022 (Shift-I)]



Bernoulli's eqn

$P_1 + \rho g h_1 + \frac{1}{2}\rho v_1^2 = P_2 + 0 + \frac{1}{2}\rho v_2^2$

$a v_1 = \frac{a}{2} v_2$

$v_2 = 2v_1$

$P_1 - P_2 + \rho g h_1 = \frac{1}{2}\rho(2v_1)^2 - \frac{1}{2}\rho v_1^2$

$4100 + 8000 = \frac{1}{2}\rho\left[4v_1^2 - v_1^2\right]$

$12100 = \frac{800}{2} 3v_1^2$

$121 \times 2 = 24 v_1^2$

$v_1 = \sqrt{\frac{121 \times 3}{12 \times 3}} = \frac{\sqrt{363}}{6}$

$$\frac{121 \times \cancel{4}}{\cancel{8}_{4} \times 3} = v^2$$

$$\frac{3}{3} \times \frac{121}{12} = v^2$$

$$\frac{363}{36} = v^2$$

$$v = \sqrt{\frac{363}{36}} = \frac{\sqrt{363}}{6} = \frac{\sqrt{x}}{6}$$

$$\boxed{x = 363}$$

QUESTION

The water is filled up to height of 12 m in a tank having vertical sidewalls. A hole is made in one of the walls at a depth '*h*' below the water level. The value of '*h*' for which the emerging steam of water strikes the ground at the maximum range is ______ m.

(2021 JEE main)



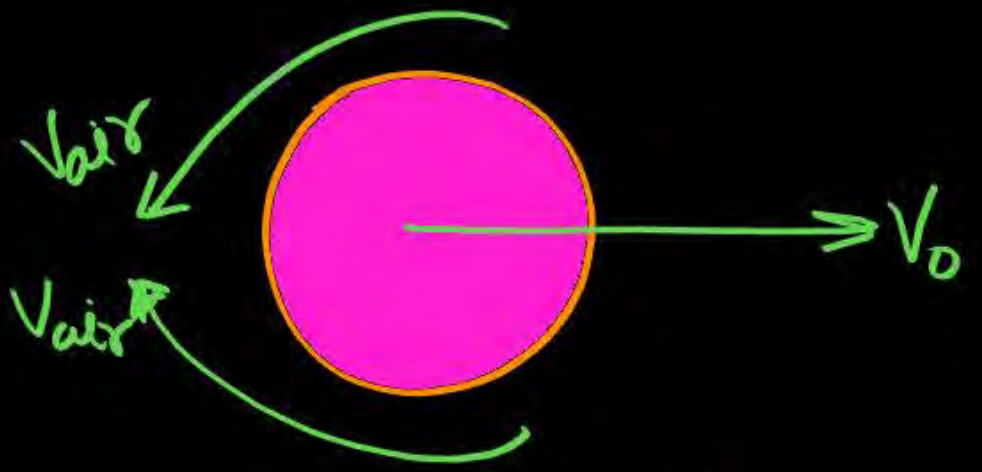
h = 6m Ans

QUESTION

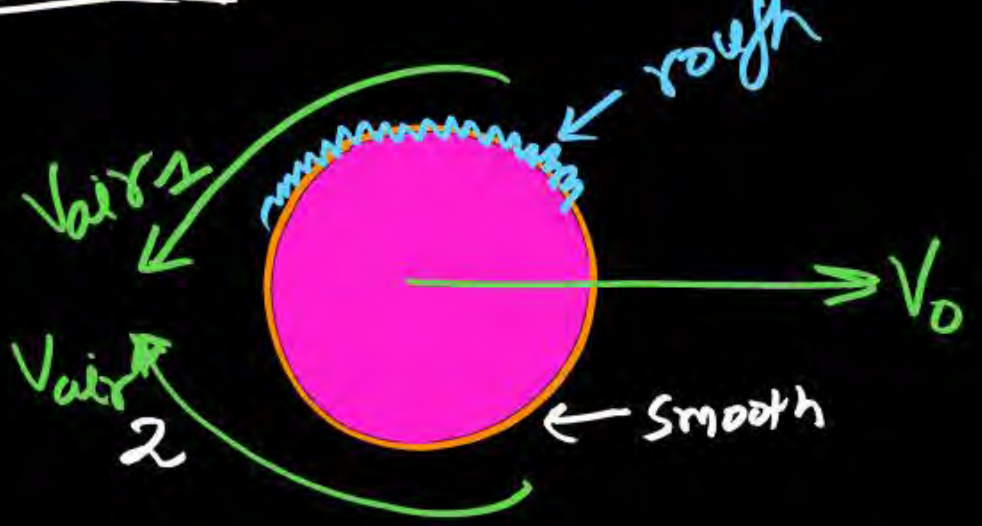
The working of venturimeter is based on (NEET 2023)

1. Torricelli's law
2. Pascal's law
3. Bernoulli's principle
4. Archimede's principle

Magnus effect



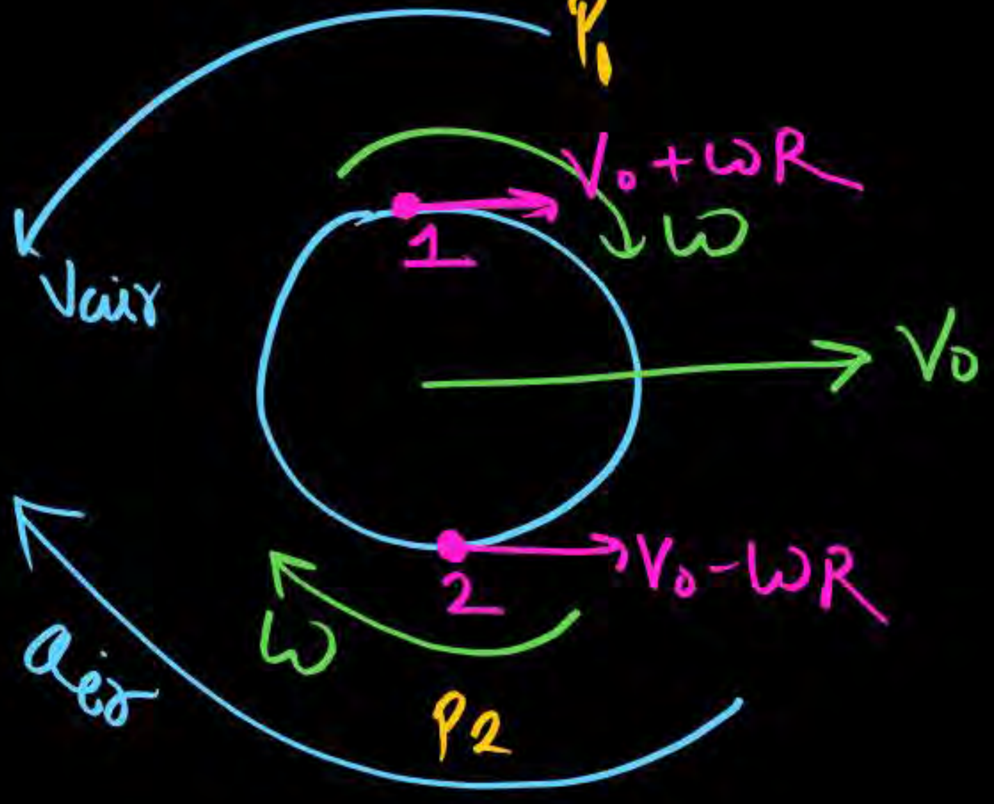
fast balling



$V_{air_2} > V_{air_1}$

$P_2 < P_1$

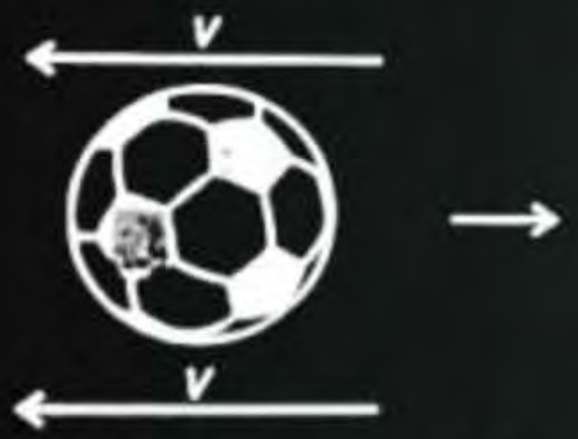
spiner



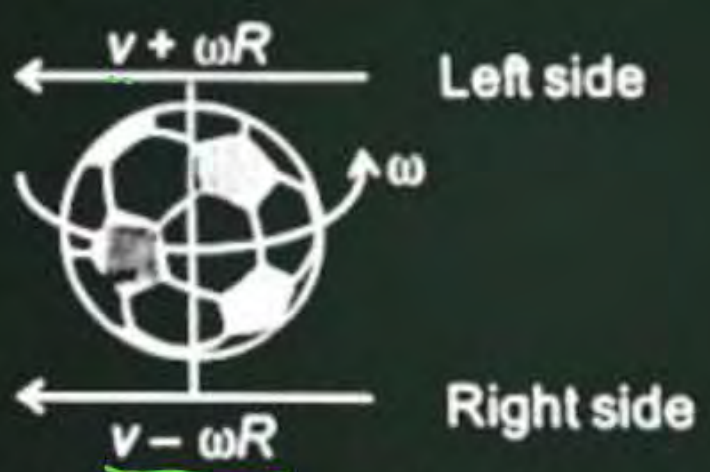
V relat velocity of air at 2 is less than air velocity at 1 (TOP)

$P_2 > P_1$

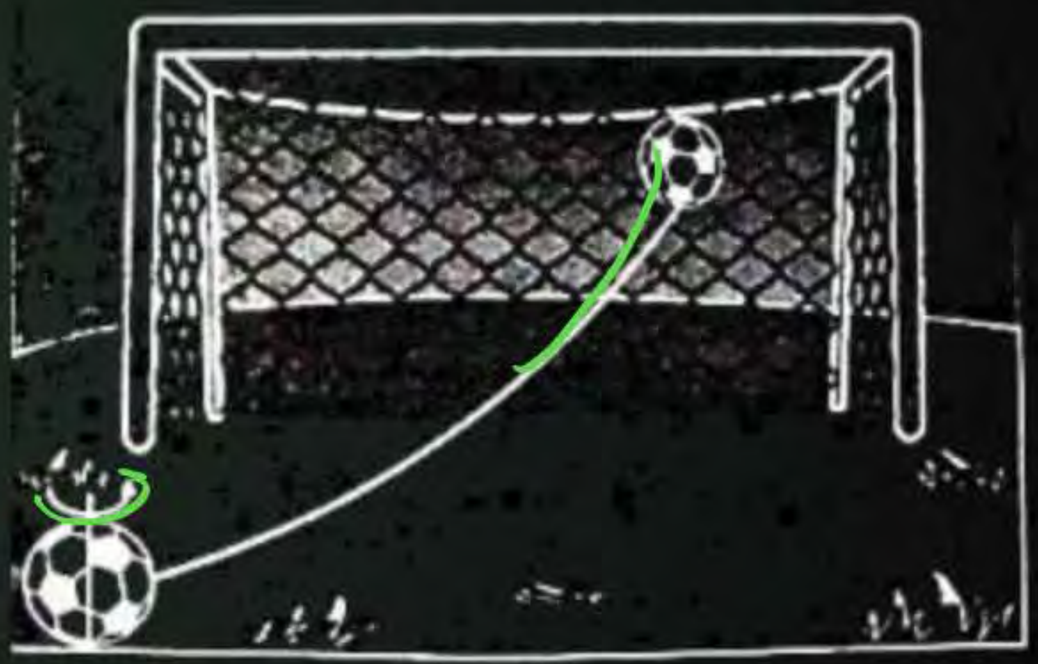
DYNAMIC LIFT AND MAGNUS EFFECT



(a) Football without spinning



(b) Football spinning about vertical axis



Properties of fluid

(Non-Ideal fluid)

- viscocity of Fluid
  - fluid will apply friction
    - fluid friction B/w lays of fluid or liquid #
      → b/w layer of liquid)
    - fluid friction B/w liquid & solid #
- Surface Tension / excess pressure / capillary rise


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture-6 | **Physics**

Mechanical Properties of Fluid



By- Dr. Manish Raj (MR SIR)

Topics to be covered

1. # viscosity
   Terminal velocity
2. #
3. #

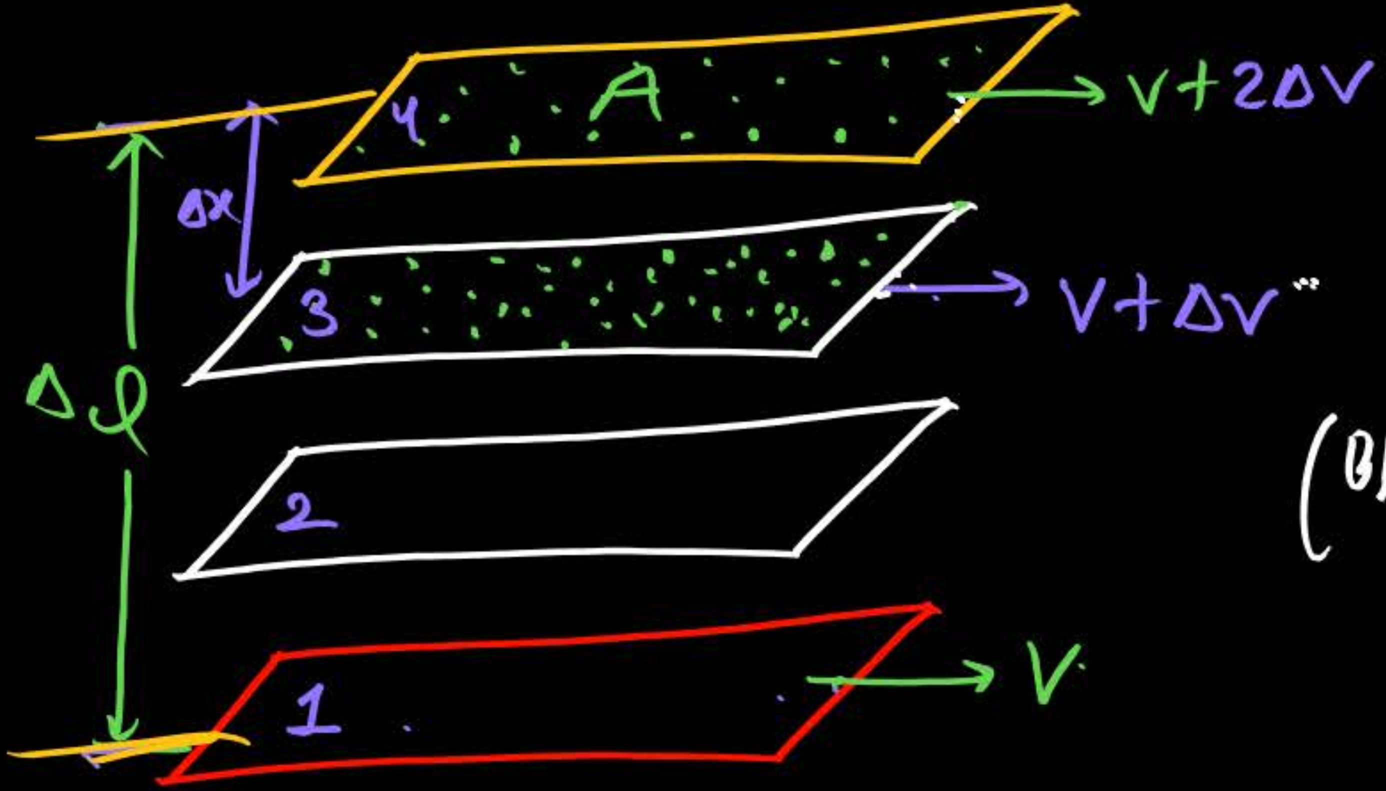


Cohesive force → Attractive force b/w same nature of atom.

→ cause of viscosity is cohesive force.

Viscosity → friction force B/w layers of liquid when there is relative motion or tendensity of relative B/w the ayers of liquid.





$F \propto Area$ — (i)

$F \propto \frac{\Delta v}{\Delta x}$ — (ii)

(B/w 3rd & 4th layer)
$$F = \eta A \left(\frac{\Delta v}{\Delta x}\right)$$

$$F = \eta A \frac{2\Delta v}{\Delta l}$$
1st & 4th

η = coefficient of viscosity

↳ unit $\left(\frac{N\text{-}sec}{m^2}\right)$

S.I 1PI = 1 Poussiulie
= 10 Poise

$$\eta_{liquid} \propto \frac{1}{Tempr}$$

$$\eta_{gas} \propto Tempr$$

S.I unit η → 1 Pousullies

= 10 Poise

↑ C.G.S unit

Viscosity

When fluid (gas/liquid) flows then there a viscous friction force between parallel layer of fluid due to relative motion between layer like friction between two solid acts to oppose relative motion in N.L.M

- Due to Cohesive Force

QUESTION

A layer of glycerin of thickness 3 mm is present between a large surface area and a surface area of 0.2 m^2, with what force the small surface is to be pulled, so that it can move with a velocity of 5 m/s? ($\eta = 0.09\ kgm^{-1}\ s^{-1}$).

1. 10 N
2. 30 N
3. 40 N
4. 50 N

$F = \eta A \frac{\Delta v}{\Delta l}$

$= \frac{9}{100} \times \frac{2}{10} \times \frac{5}{3 \times 10^{-3}}$

$F = 30N$

QUESTION

A flat plate of area 0.1 m^2 is placed on a flat surface and is separated from it by a film of oil 10^{-5} m thick whose coefficient of viscosity is 1.5 N sm^{-2}. The force required to cause the plate to slide on the surface at constant speed of 1 mm s^{-1} is

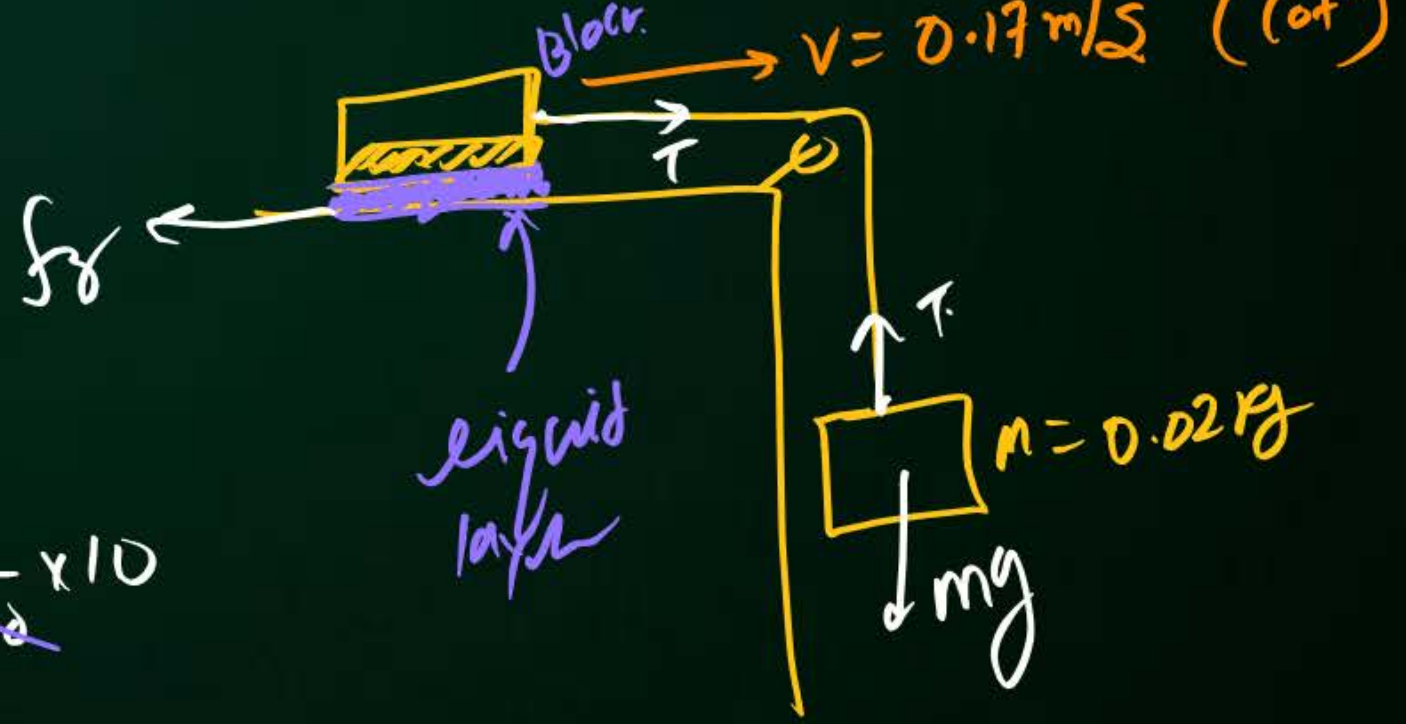
1. 10 N
2. 15 N
3. 20 N
4. 25 N

QUESTION

A metal block of base area 0.2 m^2 is connected to a 0.02 kg mass via a string that passes over an ideal pulley as shown in figure. A liquid film of thickness 0.6 mm is placed between the block and the table. When released the block moves to the right with a constant speed of 0.17 m/s. The coefficient of viscosity of the liquid is:

(2017-Gujarat)

1. 3.45×10^{3} Pa-s
2. 3.45×10^{-2} Pa-s
3. 3.45×10^{-3} Pa-s
4. 3.45×10^{2} Pa-s



QUESTION

A metal plate of area 10^3 cm^2 rests on a layer of oil 6 mm thick. A tangential force 10^{-2} N is applied on it to move it with a constant velocity of 6 cms^{-1}. The coefficient of viscosity of the liquid is

1. 0.1 poise (90%)
2. 0.5 poise
3. 0.7 poise
4. 0.9 poise

$$10^{-2} = \eta \, \frac{10^{3} \times 10^{-4} \times 6 \times 10^{-2}}{6 \times 10^{-3}}$$

$$\eta = 10^{-2}$$

$$= 10^{-2} \text{ Poiseuille}$$

$$\eta = 10^{-2} \times 10 \text{ Poise}$$

$$= 10^{-2} \times 10 \text{ Poise}$$

$$= 0.1 \text{ Poise}$$

DIFFERENCE VISCOSITY AND SOLID FRICTION

Viscosity	Solid Friction
(a) The viscous force is directly proportional to the surface area of contact of fluid layers.	(a) It is independent of the area of contact.
(b) The viscous force is directly proportional to the relative velocity between the two layers in contact.	(b) It is independent of the relative velocity of the contact surface.
(c) The viscous force does not depend on the normal reaction between the two layers of the fluid.	(c) It is directly proportional to the normal reaction between the surfaces in contact.
(d) The viscous force on a solid moving in a fluid depends on the shape and size of the solid.	(d) It is independent of the shape and size of the bodies in contact.

COEFFICIENT OF VISCOSITY



$$F = \eta A \frac{\Delta v}{l}$$

$$\left(\frac{F}{A}\right) = \eta \frac{\Delta v}{l}$$

The ratio of shearing stress and the strain rate is called the coefficient of viscosity.

Shear stress $= \eta \frac{\Delta l}{\Delta t \, l}$

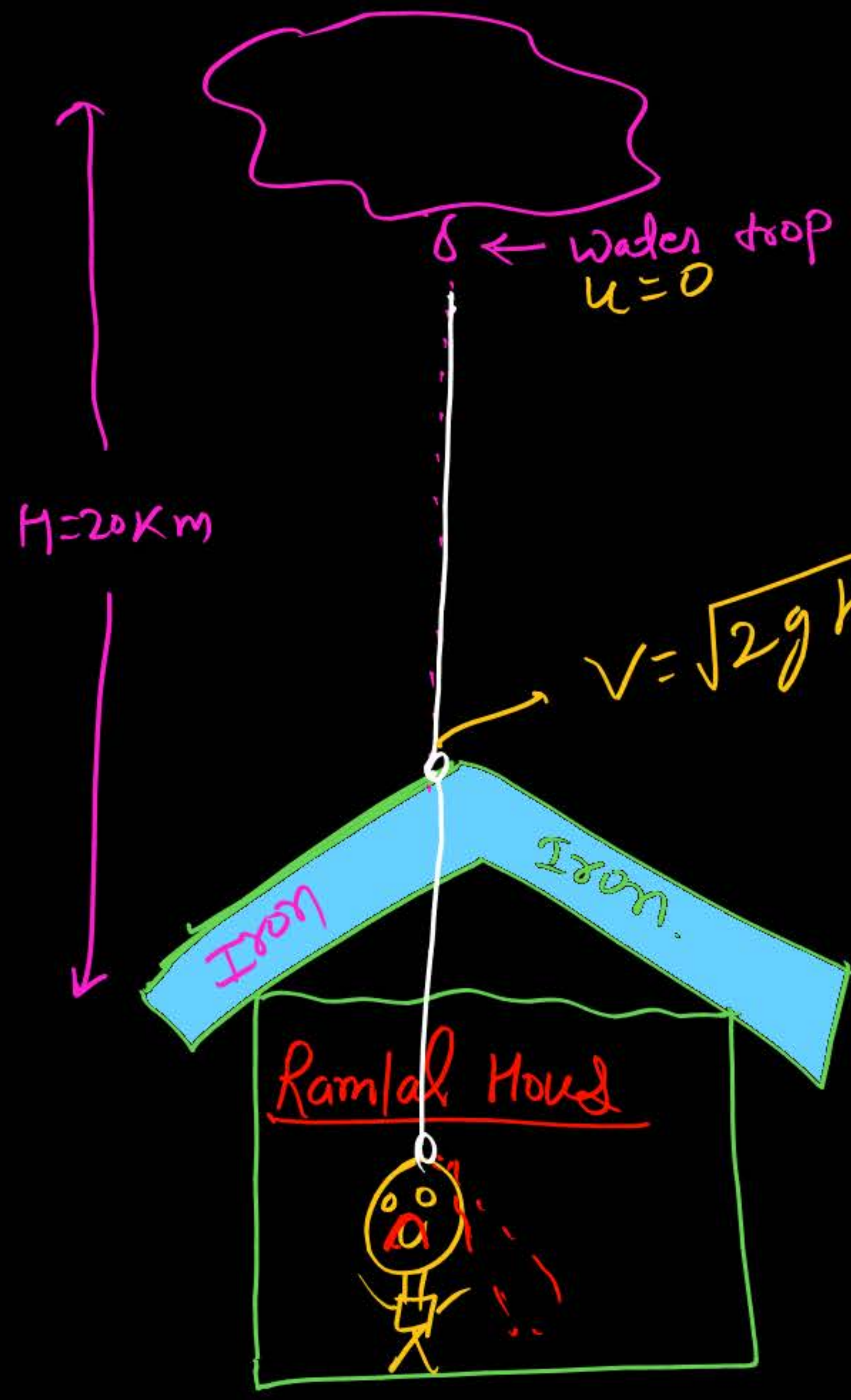
Shear stress $= \eta \left[\frac{\text{strain}}{\Delta t}\right]$

Thus, coefficient of viscosity = [redacted]

$$\eta = \frac{\text{shear stress}}{(\text{strain rate})}$$

If F = 1 N, *l* = 1 m, *v* = 1m s^{-1} and A = 1 m^2, then the value of η becomes 1 PI.

$$\eta = \frac{F}{A\left(\frac{\Delta v}{l}\right)} =$$



$$V=\sqrt{2gh}=\sqrt{2\times 10\times 20\,km}$$

$$=\sqrt{400\times 10^3}$$

$$=\sqrt{4\times 10^4\times 10}$$

$$=2\ 10^2\times 3.1$$

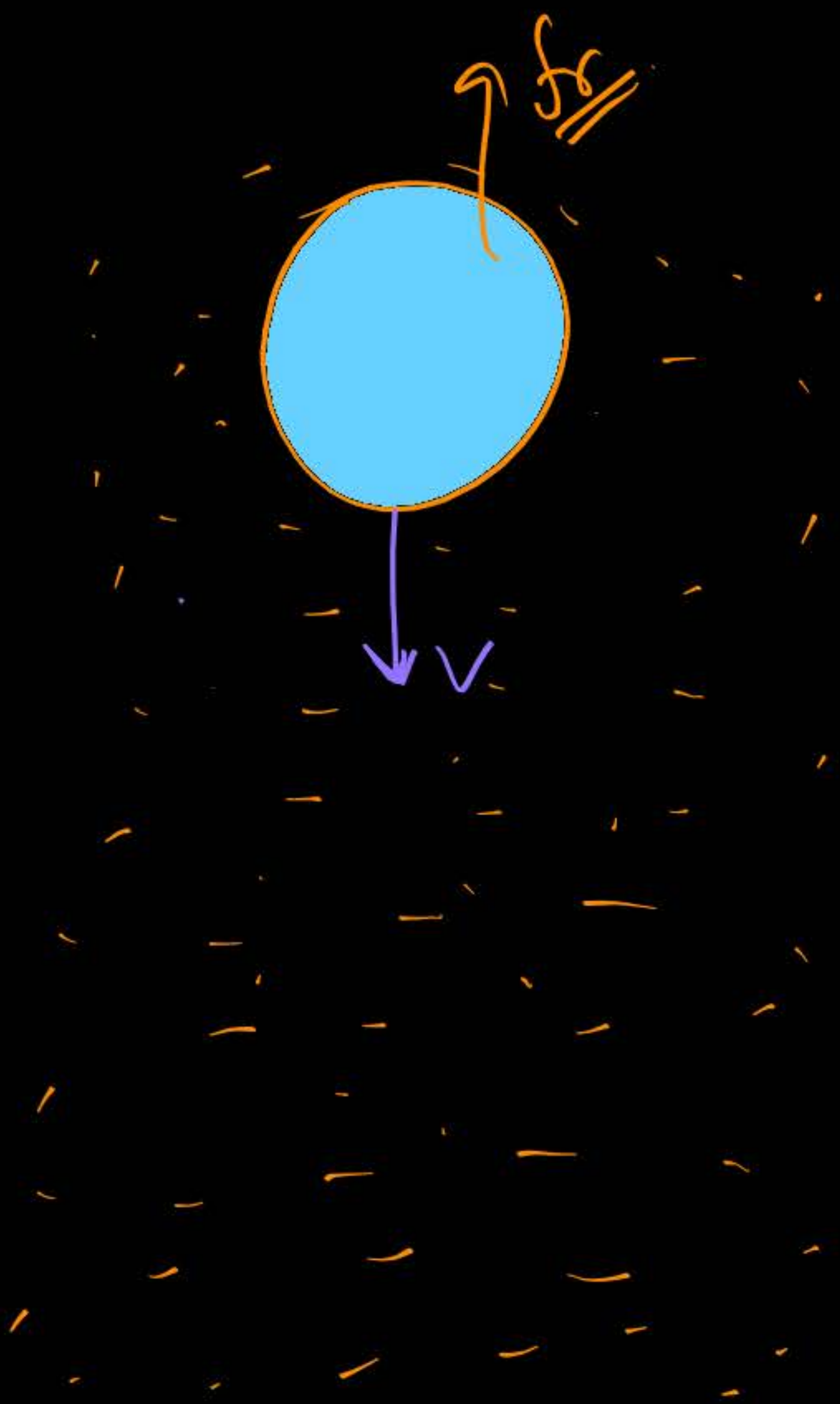
$$=6.2\times 100$$

$$u=620\ m/s$$ theoretically

$$V_{rain\,drop}=2\ m/s\simeq 1\ m/s$$

Practilly

Stocks law → only defind for spherical law



friction $\propto V$ (velocity)
B/w solid & liquid

$\propto$ Radius (Radius)

$\propto \eta$ (Coefficient of viscosity)

$$f_r = 6\pi\eta R V$$

→ friction force acting on moving solid sphere Inside liquid.

$$\vec{f_r} = -6\pi\eta r\vec{V}$$

→ dir^n of force opposite to velocity

STOKES' LAW

This law gives an expression for the viscous force experienced by a body (a sphere say) moving through a fluid. This expression was given by an English scientist Sir George G. Stokes.

When a spherical ball is dropped in a liquid, he observed that the viscous force F experienced by the ball is proportional to the

velocity of the object through the fluid, v

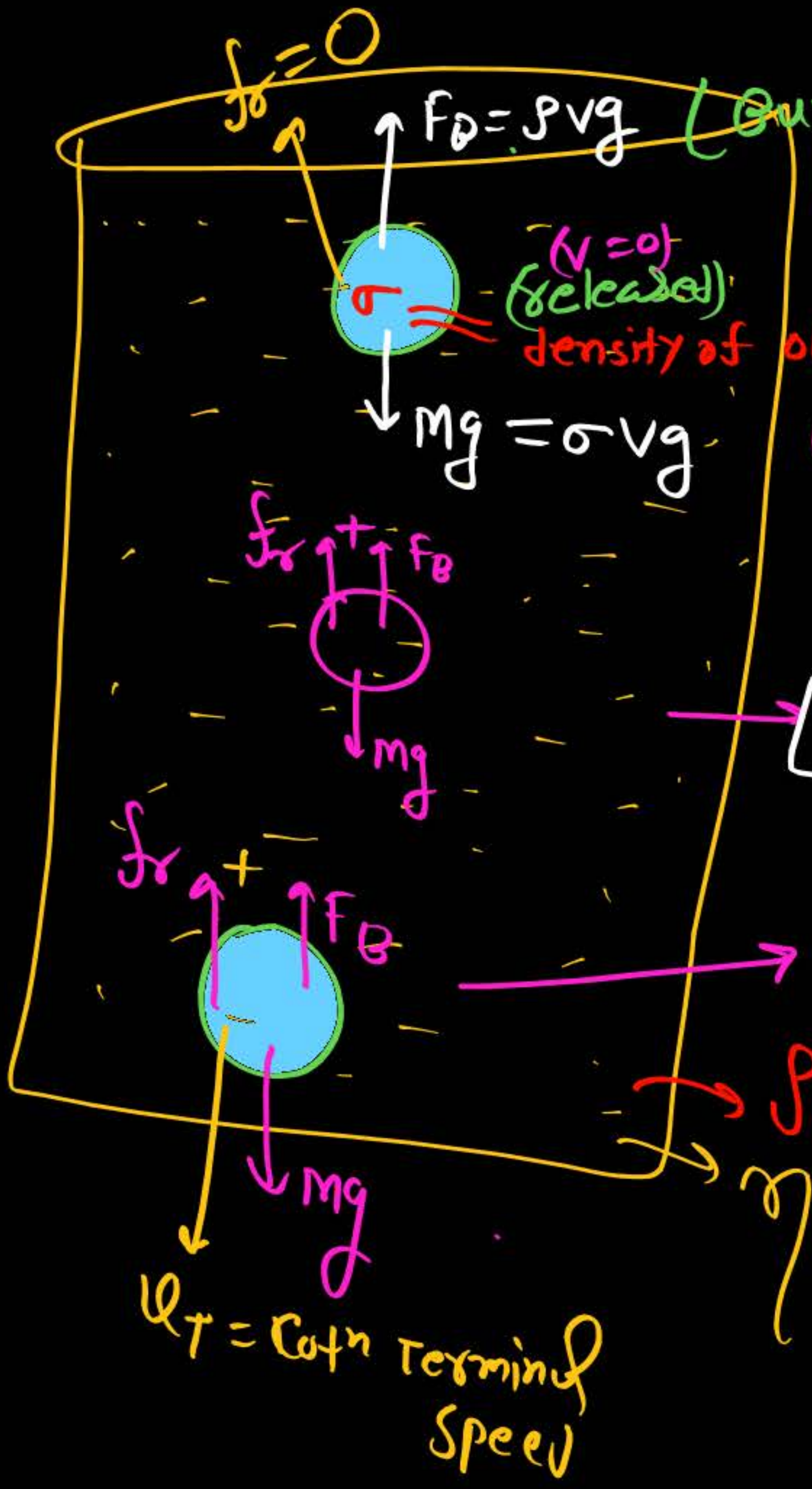
viscosity of the fluid, η

radius of the sphere, a

Thus, $F \propto \eta a v$

Here, the constant of proportionality is found to be 6π.

Thus $F = -6\pi\eta a v$ ← Stokes' law.



$(F_B < mg)$

Object will move downward with increasing speed.

$f_r + F_B < mg$ → accn ↓ (F_{net} ↓)

speed will increase further

$(f_r + F_B = mg)$ → $F_{net} = 0$

$a = 0$

$V = $ Cotn → Terminal Velocity

ρ (density of liquid)

η (coefficient of viscosity)

fluid → gas & liquid combinedly called as fluid

$\eta_{liquid} > \eta_{gas}$

$$f_r + F_B = mg$$

$$6\pi\eta r v_T + \rho v g = \sigma v g$$

$$6\pi\eta r v_T = (\sigma - \rho) v g$$

$$6\pi\eta r v_T = (\sigma - \rho)\frac{4}{3}\pi r^3 g$$

$$v_T = \frac{4 r^2 (\sigma - \rho) g}{3 \times 6\eta}$$

$$V_T = \frac{{}^{2}\cancel{4} r^2 (\sigma - \rho) g}{3 \times \cancel{6}_{3}\, \eta}$$

$$V_T = \frac{2 r^2 (\sigma - \rho) g}{9 \eta}$$

*mR feel

If $\sigma = \rho$

$V_T = 0$

$V_T \propto \frac{1}{\eta}$

$V_T \propto r^2$

$$V_T = \frac{2 r^2 (\sigma - \rho) g}{9 \eta}$$

Terminal Velocity

The maximum constant velocity acquired by a body while falling through a viscous medium is called its terminal velocity. It is usually denoted by V_T.

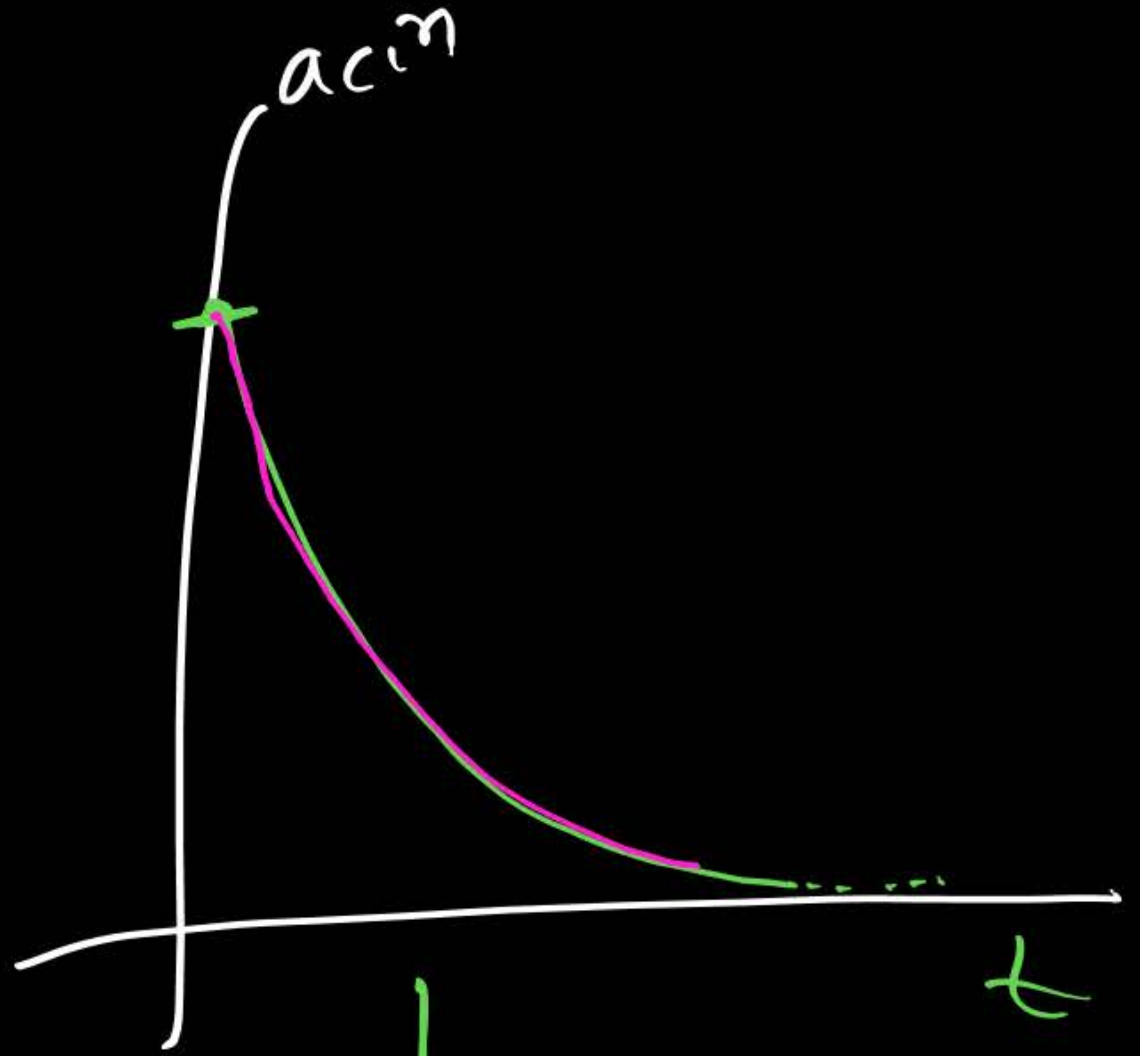
- The terminal velocity is directly proportional to the square of the radius of the body. That is why bigger rain drops fall with a larger velocity as compared to the smaller drops.
- It is inversely proportional to the viscosity of the medium.
- if is directly proportional to the difference of the densities of the body and the fluid.

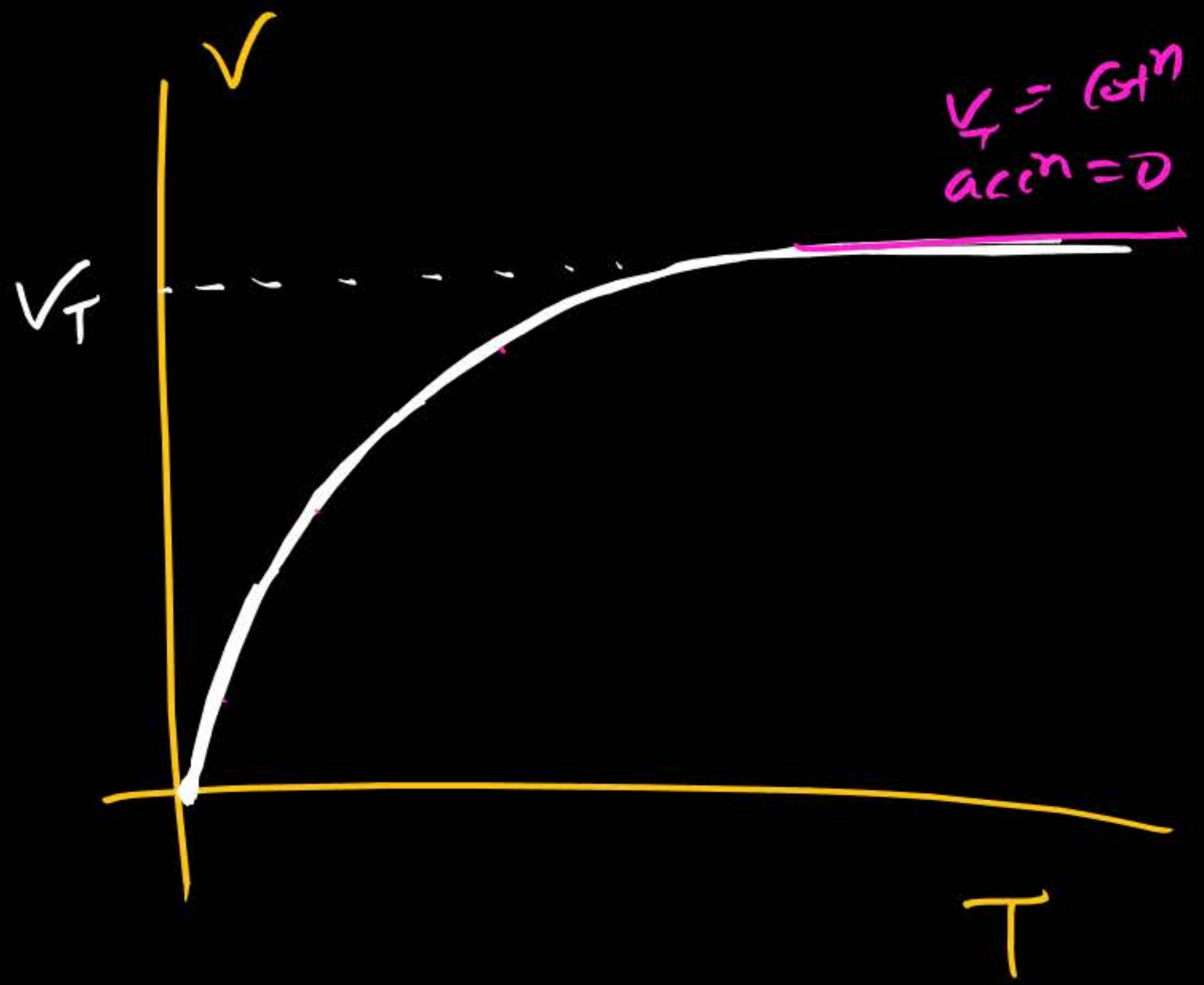
QUESTION

A spherical body falling through a viscous liquid of infinite extent ultimately attains a constant value, when

1. Upthrust + weight = viscous drag
2. Weight + viscous drag = upthrust
3. Viscous drag + upthrust = weight
4. Viscous drag + upthrust > weight




acin
t


V
V_T
acin = 0
T


a
t
x
x
x
x

QUESTION

$r_1 : r_2 = \frac{4}{3}$

Two small spherical drops having radii in the ratio 4 : 3 fall from a height through the atmosphere. Their momenta on reaching the earth are in the ratio

1. 4 : 4
2. 1 : 2
3. 4 : 2
4. 5 : 1

$V_T \propto r^2$

$P = m\,velo$

$= \sigma \frac{4}{3}\pi r^3 \times r^2$

$P \propto r^5$

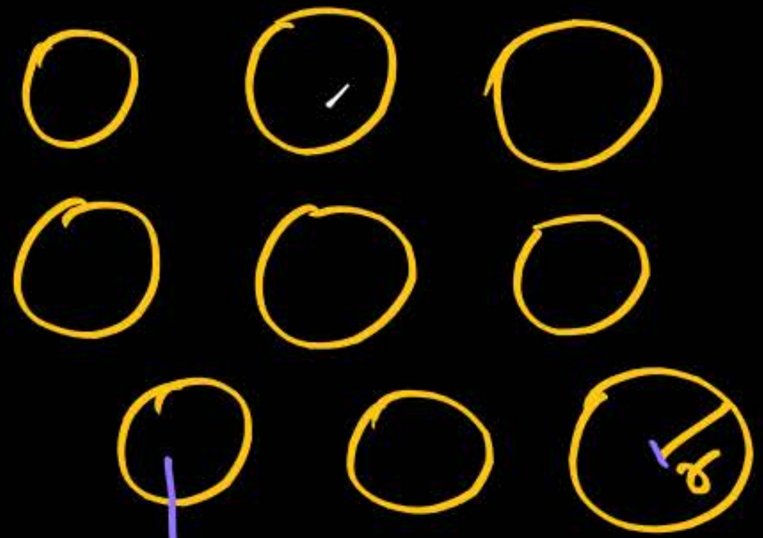
$\frac{P_1}{P_2} = \left(\frac{r_1}{r_2}\right)^5 = \left(\frac{4}{3}\right)^5$

$V_T \propto r^2$

$P = mass \times velocity$

$nr = R$ ✗

radius conserved

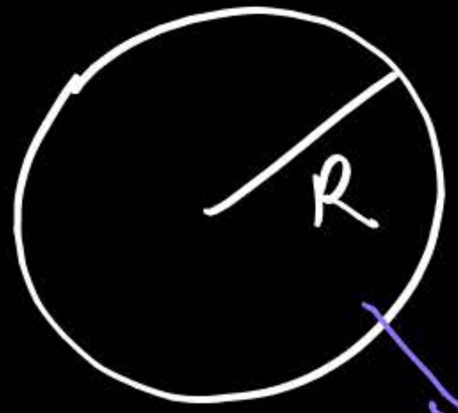


n-sphere

$V_T \propto r^2$

surfa Area ↓

Volume = const^n



$V'_T \propto R^2$

$$\frac{4}{3}\pi r^3 n = \frac{4}{3}\pi R^3$$

$$R = n^{1/3} r$$

MR Rafter.

$$\frac{V'_T}{V_T} = \frac{R^2}{r^2} = \left(\frac{R}{r}\right)^2$$

$$\frac{V'_T}{V_T} = \left(\frac{n^{1/3} r}{r}\right)^2 = n^{2/3}$$

MR Rafter →

$$V'_T = n^{2/3} V_T$$

Bigger, smaller sph.

QUESTION

A drop of water of radius 0.0015 mm is falling in air. If the co-efficient of viscosity of air is 1.8×10^{-5} kg m^{-1} s^{-1}. What will be the terminal velocity of the drop? (density of air can be neglected).

H/W

QUESTION

Two equal drops are falling through air with a steady velocity of 5 cm/second. If two drops coalesce, then new terminal velocity will be

1. $5 \times (4)^{1/3}$ cm/s
2. $5\sqrt{2}$ cm/s
3. $5/\sqrt{2}$ cm/s
4. 5×2 cm/s

H/W

QUESTION

A ball of density σ and radius r is dropped on the surface of a liquid of density ρ from certain height. If speed of ball does not change even on entering in liquid and viscosity of liquid is η, then the height from which ball dropped is

(1) $2g\left[\dfrac{(\sigma-\rho)r}{9\eta}\right]^2$

(2) $\dfrac{2g(\sigma-\rho)^2 r^2}{9\eta}$

(3) $\dfrac{2(\sigma-\rho)gr^2}{9\eta}$

(4) $2g\left[\dfrac{(\sigma-\rho)r^2}{9\eta}\right]^2$

QUESTION

The terminal velocity of a small sized spherical body of radius r falling vertically in a viscous liquid is given by the proportionality

(1) $v \propto \frac{1}{r^2}$

(2) $v \propto r^2$

(3) $v \propto \frac{1}{r}$

(4) $v \propto r$

QUESTION

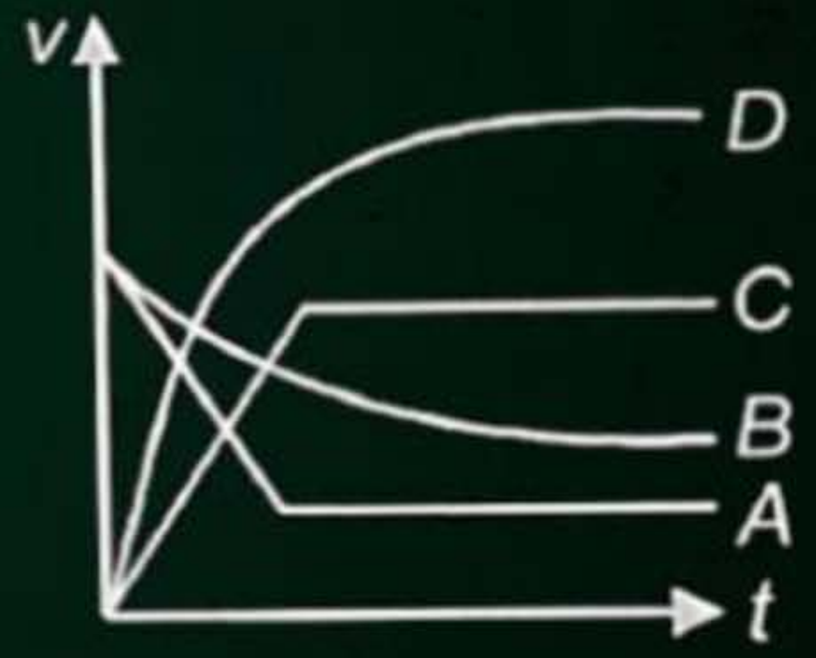
A small hole of area of cross-section 2 mm^2 is present near the bottom of a fully filled open tank of height 2 m. Taking $g = 10\ m/s^2$, the rate of flow of water through the open hole would be nearly [NEET-2019]

1. $12.6 \times 10^{-6}\ m^3/s$
2. $8.9 \times 10^{-6}\ m^3/s$
3. $2.23 \times 10^{-6}\ m^3/s$
4. $6.4 \times 10^{-6}\ m^3/s$

QUESTION

A ball is thrown downward with some velocity, greater than terminal speed into a viscous liquid. Which of the following curves represents correct variation for velocity versus time ?

1. A
2. B
3. C
4. D



QUESTION

Two equal drops are falling through air with a steady velocity of 5 cm/second. If two drops coalesce, then new terminal velocity will be

1. $5 \times (4)^{1/3}$ cm/s
2. $5\sqrt{2}$ cm/s
3. $5/\sqrt{2}$ cm/s
4. 5×2 cm/s

QUESTION

If the terminal speed of a sphere of gold (density $19.5\ kg/m^3$) is $0.2\ m/s$ in a viscous liquid (density $= 1.5\ kg/m^3$), find the terminal speed of a sphere of silver (density $= 10.5\ kg/m^3$) of the same size in the same liquid.

1. $0.2\ m/s$
2. $0.4\ m/s$
3. $0.1\ m/s$
4. $0.133\ m/s$

QUESTION

A small sphere of radius r falls from rest in a viscous liquid. As a result, heat is produced due to viscous force. The rate of production of heat when the sphere attains its terminal velocity, is proportional to [NEET- 2018]

1. r^3
2. r^2
3. r^4
4. r^5

QUESTION

Two small spherical metal balls, having equal masses, are made from materials of densities ρ_1 and ρ_2 ($\rho_1 = 8\rho_2$) and have radii of 1 mm and 2 mm, respectively, they are made to fall vertically (from rest) in a viscous medium whose coefficient of viscosity equals η and whose density is 0.1 ρ_2. The ratio of their terminal velocities would be,

[NEET-2019 (Odisha)]

1. $\frac{79}{36}$
2. $\frac{79}{72}$
3. $\frac{19}{36}$
4. $\frac{39}{72}$

·H/W

QUESTION

Eight equal drops of water are falling through air with a steady velocity of $10\ cm^{-1}$. If the drops combine to form a single drop big in size, then the terminal velocity of this big drop is

1. $80\ cms^{-1}$
2. $30\ cms^{-1}$
3. $10\ cms^{-1}$
4. $40\ cms^{-1}$

H/W


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 7 H/W **Physics**

Mechanical Properties of Fluid



By- Dr. Manish Raj (MR SIR)

Topics to be covered

1. Homework Solution
2.
3. #



$$V_T = \frac{2 \cancel{4} r^2(\sigma - \rho)g}{3 \times \cancel{6}_3\, \eta}$$

(*) $$V_T = \frac{2r^2(\sigma - \rho)g}{9\eta}$$

* mR feel

If $\sigma = \rho$ → $V_T = 0$

$V_T \propto \frac{1}{\eta}$

$V_T \propto r^2$

$$V_T = \frac{2r^2(\sigma - \rho)g}{9\eta}$$

QUESTION

$15 \times 10^{-4} \times 10^{-3}\, m = 15 \times 10^{-7}$

A drop of water of radius 0.0015 mm is falling in air. If the co-efficient of viscosity of air is 1.8×10^{-5} kg m^{-1} s^{-1}. What will be the terminal velocity of the drop? (density of air can be neglected).

H/W

$r = 0.0015$

$\eta = 1.8 \times 10^{-5}$ kg $m^{-1} s^{-1}$

$V_T = ??$

$\rho = 10^3$ kg/m³

$$V_T = \frac{2}{9} \frac{r^2 (\sigma - \rho) g}{\eta}$$

$$V_T = \frac{2 (15 \times 10^{-7})^2 (10^3) \times 10}{9 (1.8) \times 10^{-5}} = \frac{2 \times 15 \times 15 \times 10^{-14} \times 10^4}{9 \times \frac{18}{10} \times 10^{-5}}$$

$$= \frac{2 \times 15 \times 15}{9 \times 18} 10^{-5} \times 10 = \frac{25}{9} \times 10^{-4}$$

$\Rightarrow 2.8 \times 10^{-4} = V_T$

QUESTION

Two equal drops are falling through air with a steady velocity of 5 cm/second. If two drops coalesce, then new terminal velocity will be

1. $5 \times (4)^{1/3}$ cm/s
2. $5\sqrt{2}$ cm/s
3. $5/\sqrt{2}$ cm/s
4. 5×2 cm/s

$v_T = 5$ cm/s

$V_T' = (n)^{2/3} v_T$

$= (2)^{2/3} \times 5$ cm/s

$= (2^2)^{1/3} \times 5$

$= (4)^{1/3} \times 5$

H|W

QUESTION

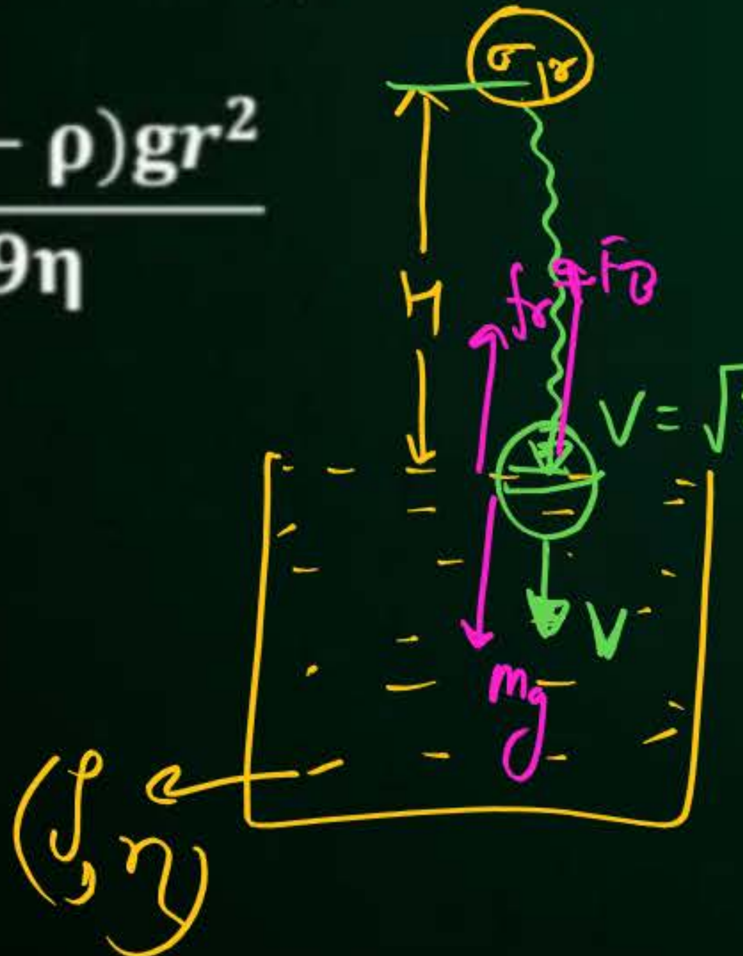
A ball of density σ and radius r is dropped on the surface of a liquid of density ρ from certain height. If speed of ball does not change even on entering in liquid and viscosity of liquid is η, then the height from which ball dropped is

(1) $2g\left[\frac{(\sigma-\rho)r}{9\eta}\right]^2$

(2) $\frac{2g(\sigma-\rho)^2r^2}{9\eta}$

(3) $\frac{2(\sigma-\rho)gr^2}{9\eta}$

(4) $2g\left[\frac{(\sigma-\rho)r^2}{9\eta}\right]^2$



$v = \sqrt{2gH} = \frac{2r^2(\sigma-\rho)g}{9\eta}$

$2gH = \left[\frac{2r^2(\sigma-\rho)g}{9\eta}\right]^2$

$v_T = 2g\left[\frac{r^2(\sigma-\rho)}{9\eta}\right]^2$

H/W

QUESTION

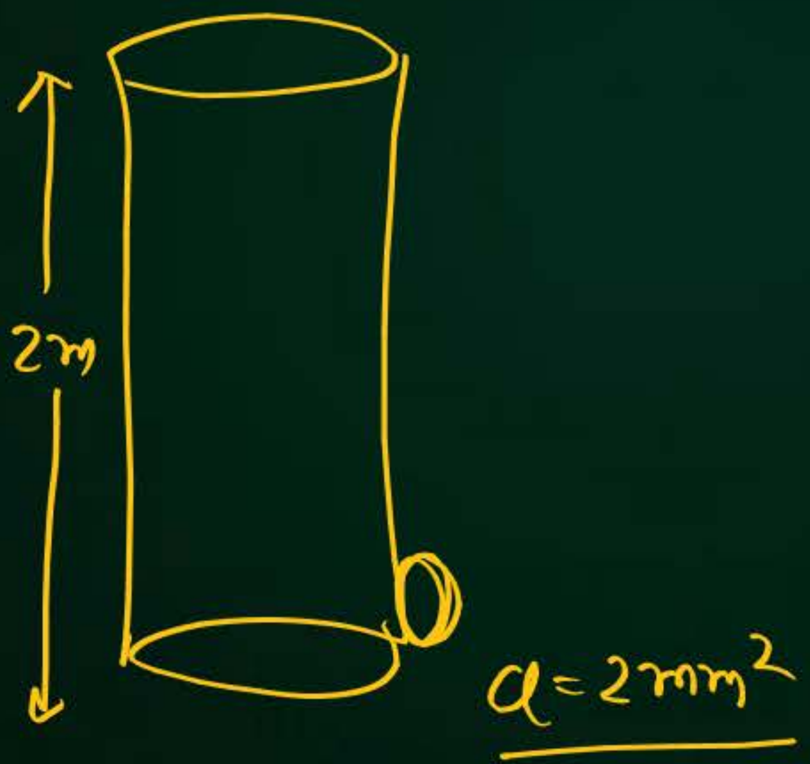
The terminal velocity of a small sized spherical body of radius r falling vertically in a viscous liquid is given by the proportionality

1. $v \propto \frac{1}{r^2}$
2. $v \propto r^2$
3. $v \propto \frac{1}{r}$
4. $v \propto r$

QUESTION

A small hole of area of cross-section 2 mm^2 is present near the bottom of a fully filled open tank of height 2 m. Taking $g = 10\ m/s^2$, the rate of flow of water through the open hole would be nearly [NEET-2019]

1. $12.6 \times 10^{-6}\ m^3/s$
2. $8.9 \times 10^{-6}\ m^3/s$
3. $2.23 \times 10^{-6}\ m^3/s$
4. $6.4 \times 10^{-6}\ m^3/s$



$$\frac{dv}{dt} = Av$$

$$= 2\,mm^2 \times \sqrt{2gh}$$

$$= 2 \times 10^{-6} \times \sqrt{2 \times 10 \times 2}$$

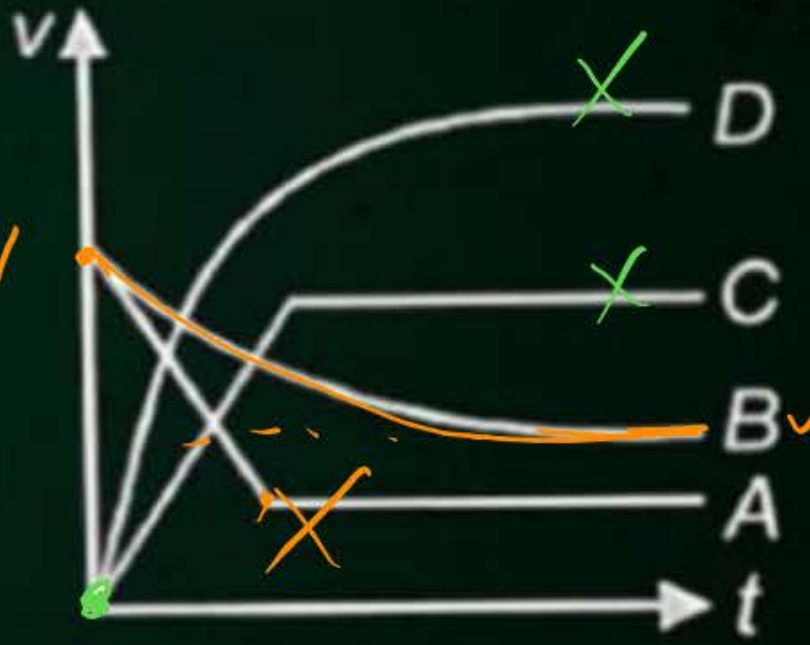
$$= 2 \times 10^{-6} \times 2 \times \sqrt{10}$$

$$= 12. \times 10^{-6}$$

QUESTION

A ball is thrown downward with some velocity, greater than terminal speed into a viscous liquid. Which of the following curves represents correct variation for velocity versus time ?

1. A
2. B
3. C
4. D



QUESTION

Two equal drops are falling through air with a steady velocity of 5 cm/second. If two drops coalesce, then new terminal velocity will be

1. $5 \times (4)^{1/3}$ cm/s
2. $5\sqrt{2}$ cm/s
3. $5/\sqrt{2}$ cm/s
4. 5×2 cm/s

QUESTION

If the terminal speed of a sphere of gold (density 19.5 kg/m^3) is 0.2 m/s in a viscous liquid (density = 1.5 kg/m^3), find the terminal speed of a sphere of silver (density = 10.5 kg/m^3) of the same size in the same liquid.

1. 0.2 m/s
2. 0.4 m/s
3. 0.1 m/s ✓ Ans
4. 0.133 m/s

$$\frac{V_{Tg} = \frac{2r^2(19.5-1.5)g}{9\eta}}{V_{Ts} = \frac{2r^2(10.5-1.5)g}{9\eta}} = \frac{18}{9} = 2$$

$$\frac{V_{Tg}}{V_{Ts}} = 2$$

QUESTION

A small sphere of radius r falls from rest in a viscous liquid. As a result, heat is produced due to viscous force. The rate of production of heat when the sphere attains its terminal velocity, is proportional to [NEET- 2018]

1. r^3
2. r^2
3. r^4
4. r^5 ✓

$F_r = 6\pi\eta v_T r$

$\frac{dH}{dt} = P = F \cdot v$

$= vr \cdot v$

$P = r v^2$

$P = r \times r^4$

$P \propto r^5$

$V_T \propto r^2$

QUESTION

Two small spherical metal balls, having equal masses, are made from materials of densities ρ_1 and ρ_2 ($\rho_1 = 8\rho_2$) and have radii of 1 mm and 2 mm, respectively, they are made to fall vertically (from rest) in a viscous medium whose coefficient of viscosity equals η and whose density is $0.1\ \rho_2$. The ratio of their terminal velocities would be,

[NEET-2019 (Odisha)]

(1) $\frac{79}{36}$ (Ans)

(2) $\frac{79}{72}$

(3) $\frac{19}{36}$

(4) $\frac{39}{72}$

$$v_{T_1} = \frac{2(1\,mm)^2(\rho_1 - \sigma)g}{9\eta}$$

$$v_{T_2} = \frac{2(2\,mm)^2(\rho_2 - \sigma)g}{9\eta}$$

$$= \frac{(8\rho_2 - 0.1\rho_2)}{4(\rho_2 - 0.1\rho_2)} = \frac{7.9\rho_2}{4\ 0.9\rho_2} = \frac{79}{4\times 9} = \frac{79}{36}$$

H/W

QUESTION

Eight equal drops of water are falling through air with a steady velocity of 10 cm^{-1}. If the drops combine to form a single drop big in size, then the terminal velocity of this big drop is

1. 80 cms^{-1}
2. 30 cms^{-1}
3. 10 cms^{-1}
4. 40 cms^{-1} ✓

$v_T' = (n)^{2/3} v_T$

$= (8)^{2/3} \cdot 10$ cm/s

$= [2^3]^{2/3} \times 10$

$= 4 \times 10 = 40$

H/W


THANK YOU

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FOR NEET 2025

Lecture- 08 | **Physics**

Mechanical Properties of Fluid



By- Dr. Manish Raj (MR SIR)

Topic to be Covered :

1 # Pousullies equation

2 # Surface Tension & surface energy

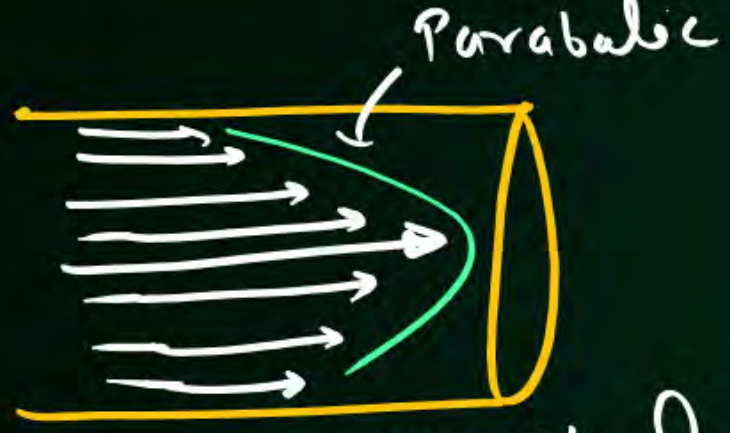
3 #

4 #



Poiseullies Equation

The rate of volume flow of viscous liquid through pipe $= Q = Au$





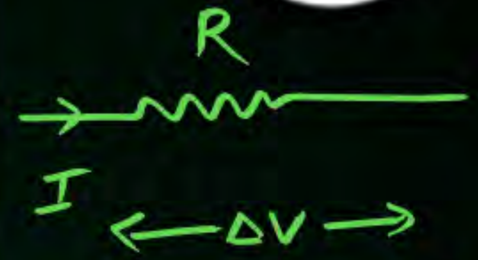


$Q = Au \propto \Delta P$

↑ fluid current

$$Q = Au = \frac{\pi \Delta P r^4}{8 \eta l}$$

$$Q = \frac{\Delta P}{\left(\frac{8\eta l}{\pi r^4}\right)}$$ ← fluid resistance of the pipe



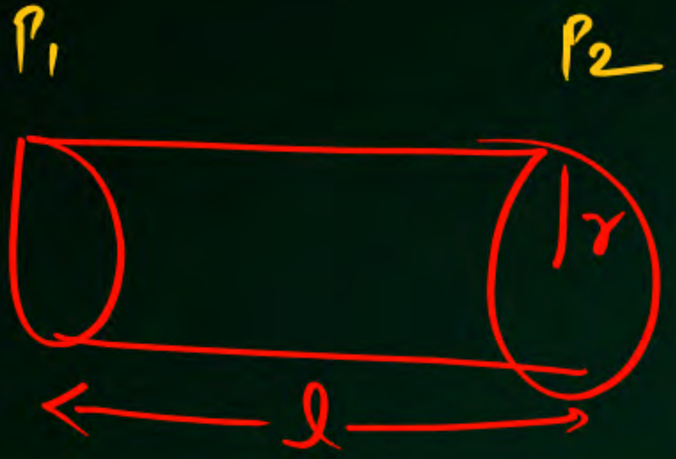
$$I = \frac{\Delta V}{R}$$

$$I = \frac{\Delta V}{\left(\rho \frac{l}{A}\right)}$$

electrical resistor

$R \propto l$

$R \propto \frac{1}{\text{Area}}$



$$Q = Au = \frac{\pi \Delta p r^4}{8\eta l}$$

↑ Rate of volume flow

$$Q = \frac{\Delta p}{\left(\frac{8\eta l}{\pi r^4}\right)} = \frac{\Delta p}{R_{\text{fluid Resista}}}$$

Fluid Resistance

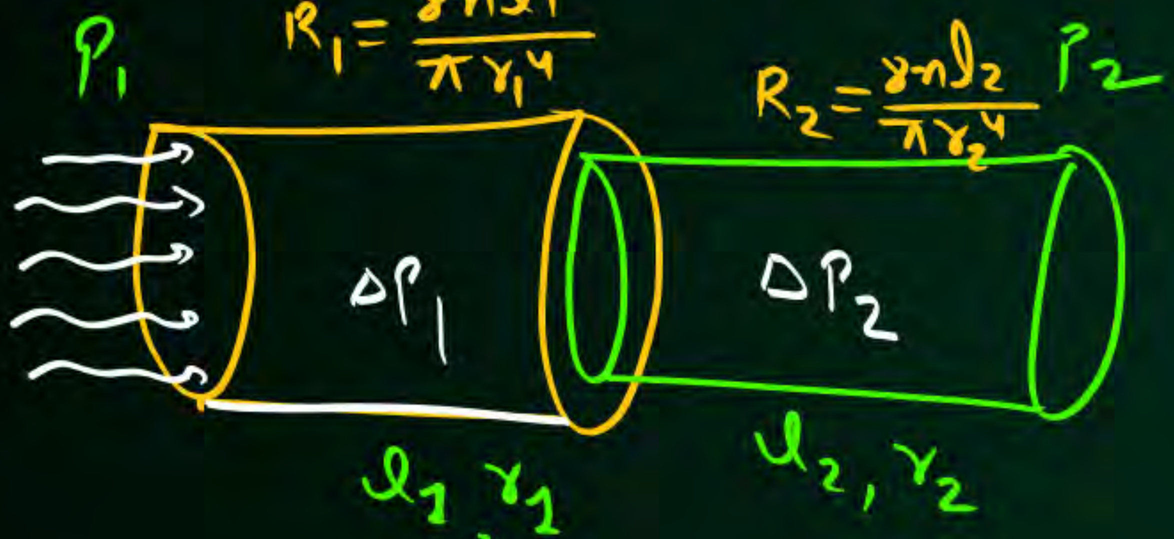
$$R = \frac{8\eta l}{\pi r^4}$$

$$R \propto l$$

$$R \propto \frac{1}{r^4}$$

Combination of Pipe

(i) Series Combination of Pipe



*. $Q_{net} = \frac{\Delta P}{R_{eq}} = \frac{\Delta P}{\frac{8\eta l_1}{\pi r_1^4} + \frac{8\eta l_2}{\pi r_2^4}}$



$V = I R$

$V \propto R$ (I same)

$I = \frac{\Delta V}{R_1 + R_2}$ (Same through Both resistance)

☆ Q will be same through both the pipe.

$$\frac{\Delta P_1}{\Delta P_2} = \frac{R_1}{R_2} = \frac{l_1}{r_1^4} \times \frac{r_2^4}{l_2}$$

$\Delta P \propto$ Resistance

ΔP_1 = pressure diffⁿ across 1st pipe

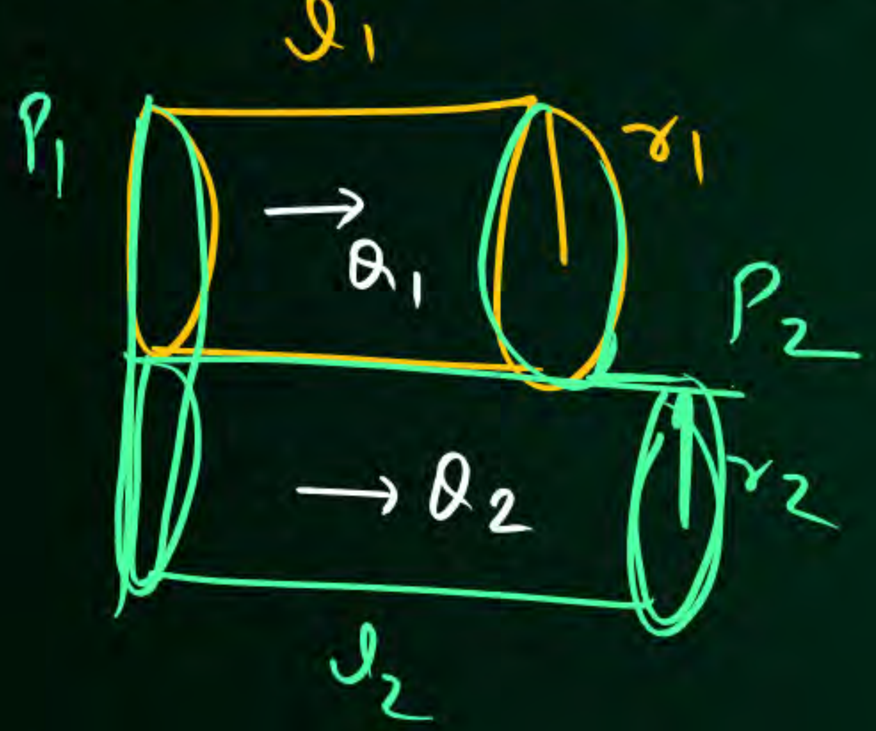
ΔP_2 = Pressure diffⁿ across 2nd pipe

$I = \frac{V}{R}$ → same

Combination of Pipe

$$Q_{net} = Q_1 + Q_2$$

(i) Parallel Combination of Pipe



$$\frac{Q_1}{Q_2} = \frac{R_2}{R_1}$$

$$Q \propto \frac{\Delta P}{R}$$ (ΔP → same)

(1) ΔP = Same across both the wire

QUESTION

Water flows in a stream line manner through a capillary tube of radius a. The pressure difference being P and the rate of flow is Q. If the radius is reduced to $a/4$ and the pressure is increased to 4P, then the rate of flow becomes

1. $4Q$
2. $\frac{Q}{2}$
3. Q
4. $\frac{Q}{64}$ ✓



$$Q = \frac{\pi \Delta P r^4}{8 \eta l}$$

const^n.

$$Q \propto \Delta P\, r^4$$

$$Q' \propto 4\Delta P \left(\frac{r}{4}\right)^4 = \frac{4\Delta P r^4}{4^2 \times 4^2}$$

$$Q' = \frac{\Delta P r^4}{64}$$

QUESTION

A capillary tube of radius R and length L is connected in series with another tube of radius $R/2$ and length $L/4$. If the pressure across the two taken together is P, then the ratio of pressure difference across the first tube to that across the second tube is :

(70%)

(1) 1 : 4 ✓

(2) 1 : 1

(3) 4 : 1 ✗

(4) 2 : 1



$R = \frac{\eta l}{r^4}$

$R_2 = \frac{L \cdot 16}{4 R^4}$

$R_2 = 4R$

$\frac{\Delta P_1}{\Delta P_2} = \frac{R_1}{R_2} = \frac{1}{4}$

$$P + \rho g h + \frac{1}{2}\rho v^2 = \text{Const}^n.$$

divided by ρg each side

$$\frac{P}{\rho g} + h + \frac{v^2}{2g} = \text{C}.$$

$\frac{P}{\rho g}$ → Pressure head

h → gravitational head

$\frac{v^2}{2g}$ → velocity head

QUESTION

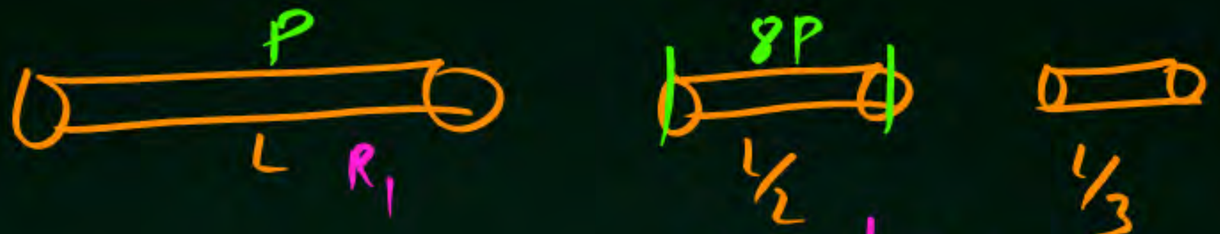
Under a constant pressure head, the rate of flow of orderly volume flow of liquid through a capillary tube is V. If the length of the capillary is doubled and the diameter of the bore is halved, the rate of flow would become :

(r/2)

1. $V/4$
2. $V/8$
3. $16V$
4. $V/32$ ✓

$$Q = \frac{r^4}{2 \times 16}$$

QUESTION



Three capillaries of length $L, \frac{L}{2}$ and $\frac{L}{3}$ are connected in series. Their radii are $r, \frac{r}{2}$ and $\frac{r}{3}$ respectively. Then if stream-line flow is to be maintained and the pressure across the first capillary is P then:

1. The pressure difference across the ends of second capillary is $8P$
2. The pressure difference across the third capillary is $43P$
3. The pressure difference across the ends of second capillary is $16P$
4. The pressure difference across the third capillary is $59P$

QUESTION

When water flows at a rate Q through a tube of radius r placed horizontally, a pressure difference P develops across the ends of the tube. If the radius of the tube is doubled and the rate of flow halved, the pressure difference will be:

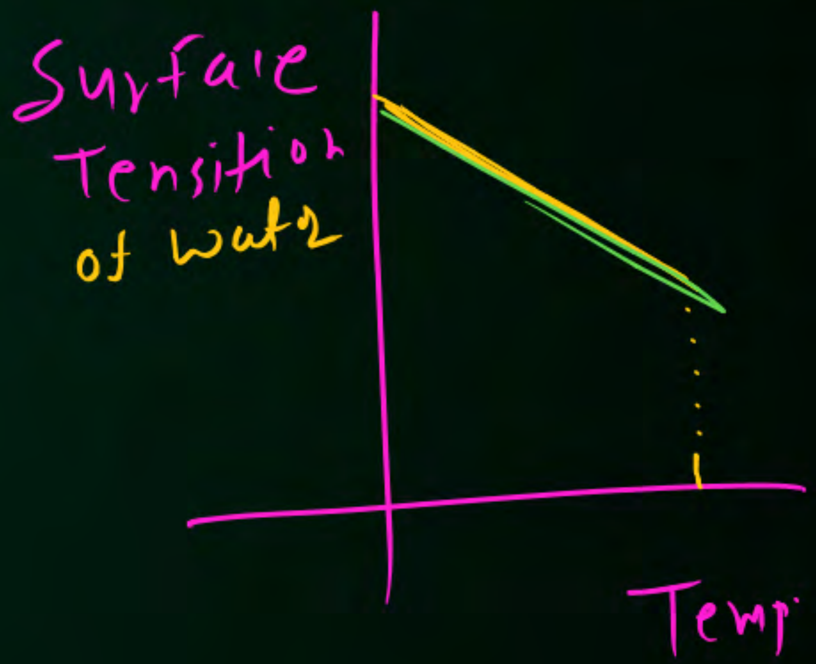
1. $8P$
2. P
3. $P/8$
4. $P/32$

→ Pi ke mar Jata hai (a) 25%

→ Dub ke mar Jata hai (b) 71%

A lling

$S \propto \frac{1}{\text{Tempr}}$



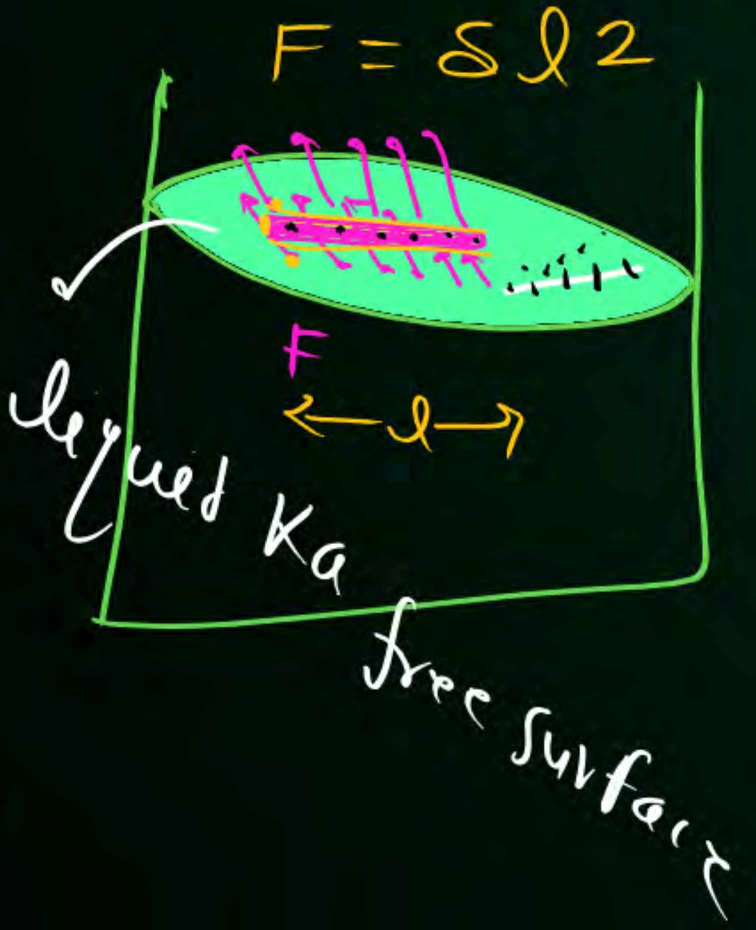
Surface Tension → Property of free surface of stationary liquid. (Not a flowing liquid)

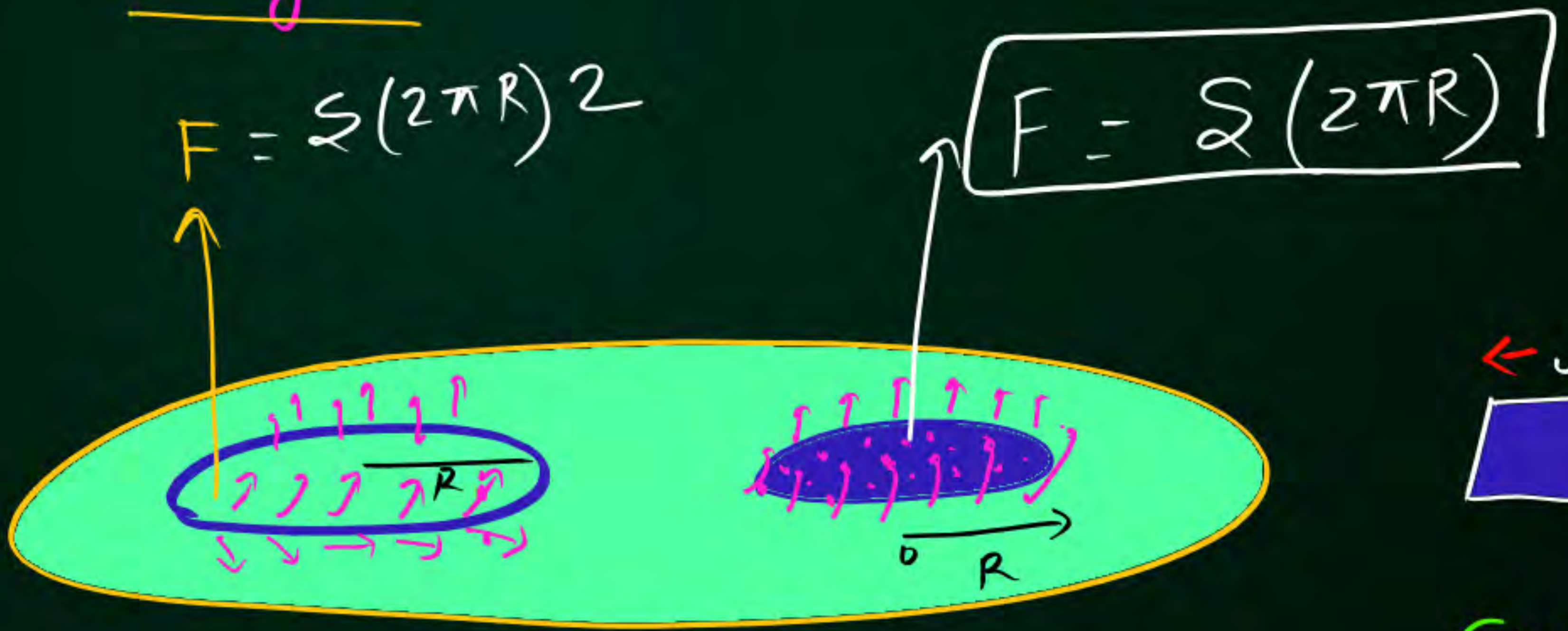
↳ due to cohesive force.

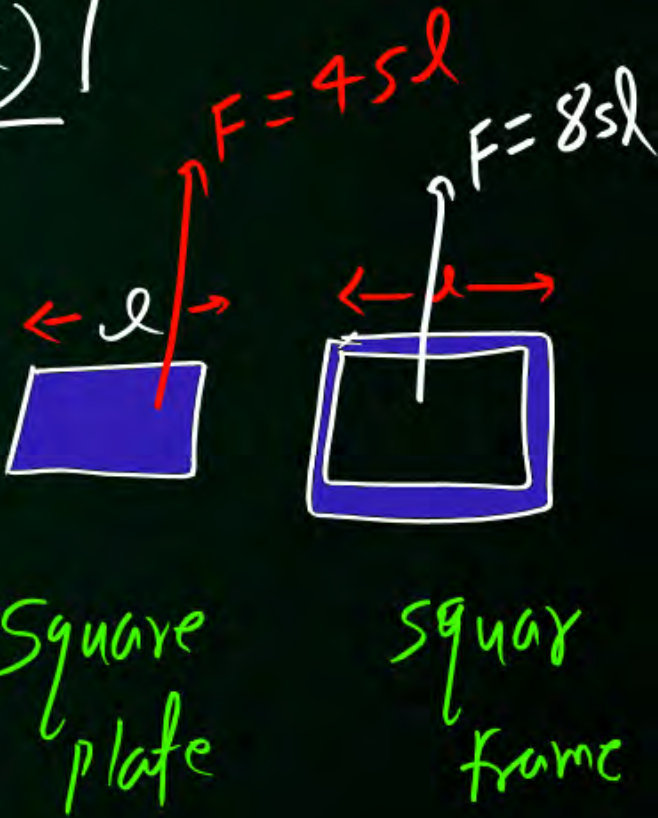
↳ due to surface Tension free surface of stationary liquid behave as streached memberance.

S = Force Acting Per unit length.

↳ N/m (scalar)



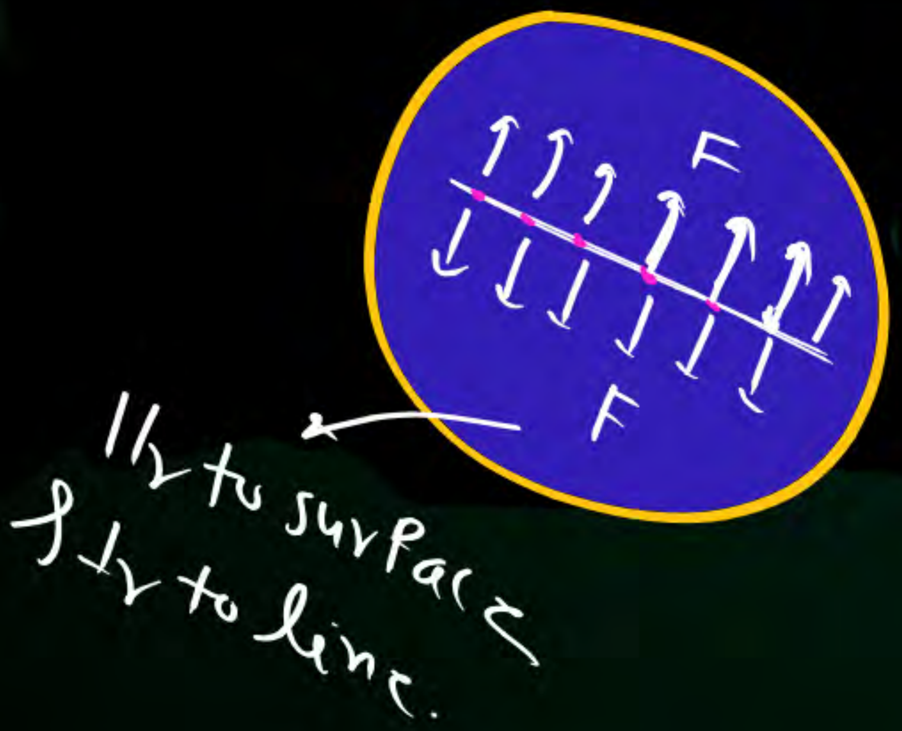




Note :-

1. The surface tension arises due to intermolecular cohesive forces.
2. It is surface tension due to which the surface of the liquid tends to contract and occupy surface area.
3. The surface tension acts along the tangent to the surface and is measured by the normal force per unit length on an imaginary line drawn in the plane of the liquid surface, acting at right angles to this line.

[redacted]



QUESTION

A square wire frame of side l is floating on the surface of liquid of surface tension T. The force required to pull out the frame from the liquid is

1. Tl
2. $2\ Tl$
3. $4\ Tl$ ✗ 20%
4. $8\ Tl$ (71%)

QUESTION

A thin flat circular disc of radius 4.5 cm is placed gently over the surface of water. If surface tension of water is 0.07 N m^{-1}; then the excess force required to take it away from the surface is: [NEET (UG) 2024]

1. 19.8 mN
2. 198 N
3. 1.98 mN
4. 99 N

$F = 2\pi R S$

$= 2\pi \frac{45}{10} \times 10^{-2} \times \frac{7}{100}$

$= \frac{90\pi \times 7 \times 10^{-2}}{10 \times 100}$

$= \frac{9 \times 22 \times 7}{7} 10^{-4} = 198 \times 10^{-4} = 19.8 \times 10^{-3}$

QUESTION

The length of a needle floating on water is 5 cm. Calculate the added force required to pull the needle out of water. ($T = 7.2 \times 10^{-2}$ N/m)

1. 7.2 mN
2. 3.6 mN
3. 1.8 mN
4. None of these

$F = Sl$

$= 7.2 \times 10^{-2} \times 5 \times 10^{-2}$ ✗

$F = S(2l)$

$= 7.2 \times 10^{-2} \times 10 \times 10^{-2}$

$= 7.2 \times 10^{-3}$

QUESTION

A thin soap film between a U-shaped wire and a light slider supports a weight of 1.5×10^{-1} N, as shown in the figure. The length of the slider is 15 cm and its weight negligible. The surface tension of the liquid film is :

(1) $0.25\ \text{Nm}^{-1}$

(2) $0.2\ \text{Nm}^{-1}$

(3) $0.1\ \text{Nm}^{-1}$

(4) $0.50\ \text{Nm}^{-1}$ // (63%)

$2ls = W$

$s = \frac{W}{2l}$

$= \frac{1.5 \times 10^{-1}}{2 \times 15 \times 10^{-2}}$

$= \frac{1}{2} = 0.5$

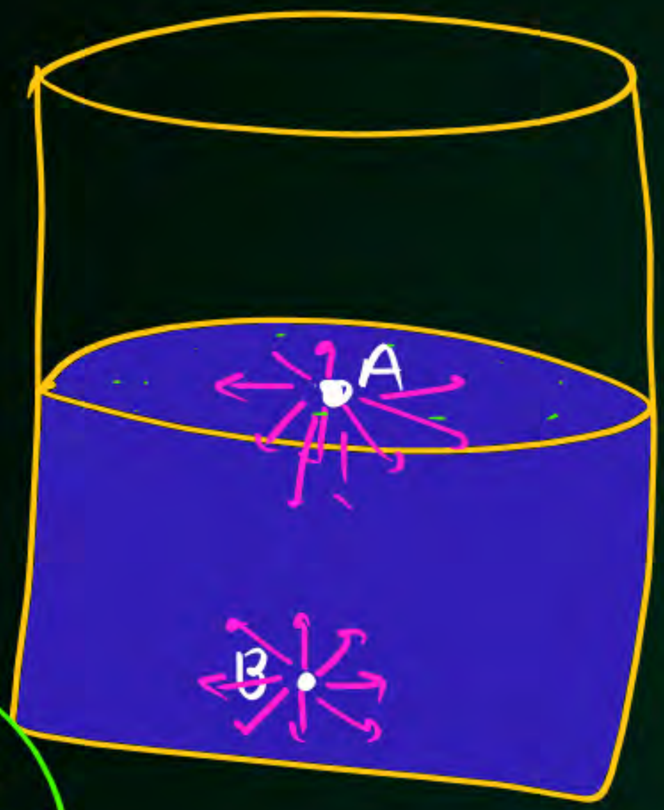


Two atom of liquid, where A is at free surface & B is inside liquid.

Which atom is more stable ??

(a) A ← unstable

(b) B ✓



A atom have some excess energy than atom 'B'

☆ **Surface energy** is stored on the free surface of liquid due to its surface tension.

$S = \frac{F}{l}$

Energy $\propto$ Area

$S = \frac{E}{A}$

energy stored per unit Area

Total Energy = S Area

$S = \frac{\text{Total energy}}{\text{free surface area}}$

A_i = initial free surface Area

A_f = final free surface Area

If $A_f > A_i$

$E_i = SA_i$

$E_f = SA_f$

$\Delta E = E_f - E_i$

$= SA_f - SA_i$

$$\text{Work} = \Delta E = S(A_f - A_i)$$

drop ✗ → Bubble



drop
one free surface Area.



Two free Surface Area

(Q.) find work done to increase the Radius of spherical drop from R_1 to R_2, where S is surface tension.

Sol^n



$E_i = S(4\pi R_1^2)$ $\quad E_f = S(4\pi R_2^2)$

$W = E_f - E_i$

$= S(4\pi R_2^2) - S(4\pi R_1^2)$

$= 4\pi S(R_2^2 - R_1^2)$

QUESTION

→ Two free surface Area.

A rectangular film of liquid is extended from (4 cm × 2 cm) to (5 cm × 4 cm). If the work done is 3×10^{-4} J, the value of the surface tension of the liquid is

[NEET - 2016 Phase II]

1. $0.250\ Nm^{-1}$
2. $0.125\ Nm^{-1}$ ✓
3. $0.2\ Nm^{-1}$
4. $8.0\ Nm^{-1}$

$A_f = 20 \times 10^{-4}$

$A_i = 8 \times 10^{-4}$

$W = 2S\Delta A$

$3 \times 10^{-4} = 2S(12 \times 10^{-4})$

$S = \frac{3}{24}$

QUESTION

The amount of energy required to form a bubble of radius 2 cm from a soap solution is nearly: (Surface tension of soap solution = $0.03\ N\ m^{-1}$) [NEET 2023]

1. 50.1×10^{-4} J
2. 30.1×10^{-4} J
3. 5.06×10^{-4} J
4. 3.01×10^{-4} J

$W = 4\pi R^2 S \times 2$

$= 4(3.14)\, 4 \times 10^{-4} \times 2 \times \frac{3}{100}$

$= \frac{96 \times 3.14 \times 10^{-4}}{100}$

$= 0.96 \times 3.14 \times 10^{-4}$

QUESTION

Calculate the work done against surface tension in blowing a soap bubble from a radius 10 cm to 30 cm if the surface tension of soap solution is 25×10^{-3} N/m.

1. 8π mJ
2. 16π mJ
3. 32π mJ
4. None of these

QUESTION

If T is surface tension of soap solution, the amount of work done in blowing a soap bubble from a diameter D to a diameter $2D$ is:

H/W

1. $2\pi D^2 T$
2. $4\pi D^2 T$
3. $6\pi D^2 T$
4. $3\pi D^2 T$

QUESTION

By blowing air in a soap bubble, the radius is increased from r to $2r$. Then the percentage increase in the surface energy of the bubble is:

1. 100%
2. 400%
3. 800%
4. 300%

QUESTION

If work done in blowing a bubble of volume V is W, then the work done in blowing another bubble of volume $2V$ will be:

1. $2W$
2. W
3. $\sqrt{2}\,W$
4. $2^{2/3}\,W$

QUESTION

A bubble of 8mm diameter is formed in the air. The surface tension of soap solution is 30 dyne/cm. The excess pressure inside the bubble is:

1. $150\ \text{dyne/cm}^2$
2. $300\ \text{dyne/cm}^2$
3. $3 \times 10^3\ \text{dyne/cm}^2$
4. $12\ \text{dyne/cm}^2$

QUESTION

The radius of a spherical drop of water is 1 mm. If surface tension of water be 70×10^{-3} Nm^{-1}, the pressure difference inside and outside the drop will be:

1. $70\ Nm^{-2}$
2. $140\ Nm^{-2}$
3. $280\ Nm^{-2}$
4. zero

QUESTION

A copper's ball of radius r is moving with a uniform velocity u in the mustard oil. The dragging force acting on the ball is F. The dragging force on the copper ball of radius $2r$ moving with uniform velocity $2u$ in the mustard oil is :

1. F
2. $2F$
3. $4F$
4. $8F$

QUESTION

A square wire frame of side l is floating on the surface of liquid of surface tension T. The force required to pull out the frame from the liquid is

1. Tl
2. $2\,Tl$
3. $4\,Tl$
4. $8\,Tl$

QUESTION

Soap helps in cleaning clothes, because

1. It attracts the dirt particles
2. It decreases the surface tension of water
3. It increases the cohesive force between water molecules
4. It increases the angle of contact

QUESTION

On increasing temperature of a liquid, its surface tension generally

1. Increases
2. Decreases
3. Remains constant
4. First increases and then decreases

QUESTION

Which is more stable A or B?

SURFACE ENERGY

- Energy store to the molecules at the surface have extra energy as compared to the molecules in the interior is called surface energy.

Note :-

1. The surface tension arises due to intermolecular cohesive forces.
2. It is surface tension due to which the surface of the liquid tends to contract and occupy surface area.
3. The surface tension acts along the tangent to the surface and is measured by the normal force per unit length on an imaginary line drawn in the plane of the liquid surface, acting at right angles to this line.
4. Surface tension is numerically equal to the work done in enlarging the surface area by unity under isothermal condition. Hence its unit is also written as J/m^2. In actual practice, in enlarging the surface the temperature decreases and hence heat is absorbed by the surface, so the energy per unit area is more than surface tension.

QUESTION

The radius of a soap bubble is r. The surface tension of soap solution is 'S'. Keeping temperature constant, the radius of the soap bubble is doubled. The energy necessary for this will be

1. $24\pi r^2 S$
2. $8\pi r^2 S$
3. $16\pi r^2 S$
4. $12\pi r^2 S$

QUESTION

What will be the work done in increasing the radius of soap bubble from $\frac{r}{2}$ to $2r$, if surface tension of soap solution is T?

1. $3\pi r^2 T$
2. $30\pi r^2 T$
3. $9\pi r^2 T$
4. $12\pi r^2 T$

QUESTION

The surface tension of a liquid is 5 N/m. If a film is held on a ring of area $0.02\ m^2$, its surface energy is about

1. 5×10^{-2} J
2. 2.5×10^{-2} J
3. 2×10^{-1} J
4. 3×10^{-1} J

QUESTION

A rectangular film of liquid is extended from (4 cm × 2 cm) to (5 cm × 4 cm). If the work done is 3×10^{-4} J, the value of the surface tension of the liquid is

[NEET - 2016 Phase II]

1. 0.250 Nm^{-1}
2. 0.125 Nm^{-1}
3. 0.2 Nm^{-1}
4. 8.0 Nm^{-1}

QUESTION

The work done in blowing a soap bubble of 10 cm radius is (surface tension of soap solution is 0.03 N/m).

1. 37.68×10^{-4} J
2. 75.36×10^{-4} J
3. 126.82×10^{-4} J
4. 75.36×10^{-3} J

QUESTION

Two water droplets merge with each other to form a larger droplet. In this process

1. Energy is liberated
2. Energy is absorbed
3. Energy is neither liberated nor absorbed
4. Some mass is converted into energy

QUESTION

The work done to break a spherical drop of radius R in n drops of equal size is proportional to

1. $\frac{1}{n^{2/3}} - 1$

2. $\frac{1}{n^{1/3}} - 1$

3. $n^{1/3} - 1$

4. $n^{4/3} - 1$

QUESTION

If T is the surface tension of a fluid, then the energy needed to break a liquid drop of radius R into 64 equal drops is

1. $6\pi R^2T$
2. πR^2T
3. $12\pi R^2T$
4. $8\pi R^2T$

DROP AND BUBBLES

Excess Pressure Inside a liquid drop :-



$$= P_i > P_o$$

$$\Delta P \text{ (liquid drop)} = P_i - P_0 = \frac{2S}{R}$$

Soap bubble/Air bubble $\Delta P = \frac{4S}{R}$

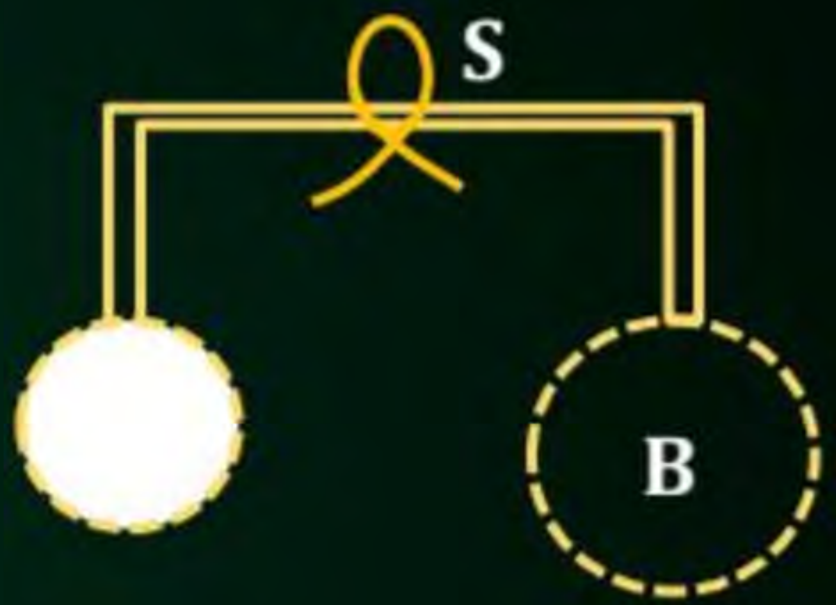
QUESTION

The excess pressure in a soap bubble is double that in other one. The ratio of their volume is

1. 1 : 2
2. 1 : 8
3. 1 : 4
4. 1 : 1

QUESTION

Two soap bubbles are connected by a tube as shown in figure. What happens when stopper S is removed ?



1. Size of bubble A increases
2. Size of bubble B decreases
3. Both bubble take the same size
4. Size of bubble A decreases and size of bubble B increases

QUESTION

Pressure inside two soap bubbles are 1.02 atm and 1.05 atm respectively. The ratio of their surface area is

1. $\frac{125}{8}$
2. $\frac{25}{4}$
3. $\frac{5}{2}$
4. $\frac{2}{5}$

QUESTION

The excess pressure a spherical drop of water is four times that of another drop. Then their respective mass ratio is

1. $1:16$
2. $1:64$
3. $1:4$
4. $1:8$

QUESTION

Two soap bubbles of radii 2 cm and 4 cm join to form a double bubble In air. men radius of curvature of interface is

1. $2\sqrt{5}$ cm
2. 2 cm
3. 4 cm
4. $2\sqrt{3}$ cm

QUESTION

Two liquid drop of radius R_1 & R_2 is colease to form a single liquid drop. In isothermal condition, then find radius of that drop?

QUESTION

A spherical drop of water has 1 mm radius. If the surface tension of water is 75×10^{-3} N/m, then difference of pressure between inside and outside of the drop is

1. $35\ N/m^2$
2. $70\ N/m^2$
3. $140\ N/m^2$
4. $150\ N/m^2$

CONTACT ANGLE

The angle of contact is defined as the angle that the tangent to the liquid surface at the point of contact makes with the solid surface inside the liquid. The angle of contact depends on the nature of the solid and the liquid in contact. At the point of contact, the surface forces between the three media must be in equilibrium. See Bio figure given next.

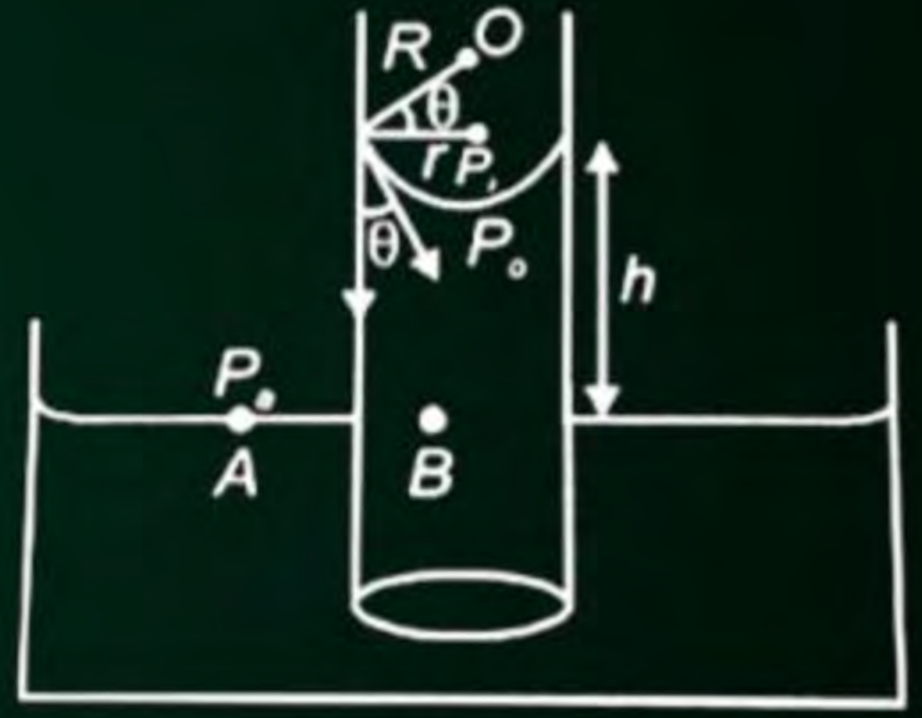


Fig.: Different shapes of water drops with interfacial tensions (a) on a lotus leaf (b) on a clean plastic plate.

QUESTION

A capillary tube of radius r is immersed in a liquid and mass of liquid, which rises up in it is M. If the radius of tube is doubled, then the mass of liquid which will rise in capillary tube will be

1. 2M
2. M
3. M/2
4. M/4



R
O
θ
r
P_1
θ
P_0
h
P_0
A
B

QUESTION

A capillary tube is dipped in water and it is 20 cm outside water. The water rises upto 8 cm. If the entire arrangement is put in freely falling elevator the length of water column in the capillary tube will be

1. 20 cm
2. 4 cm
3. 10 cm
4. 8 cm

QUESTION

Three liquids of densities ρ_1, ρ_2 and ρ_3 (with $\rho_1 > \rho_2 > \rho_3$), having the same value of surface tension T, rise to the same height in three identical capillaries. The angles of contact θ_1, θ_2 and θ_3 obey

1. $\frac{\pi}{2} > \theta_1 > \theta_2 > \theta_3 \geq 0$

2. $0 \leq \theta_1 < \theta_2 < \theta_3 < \frac{\pi}{2}$

3. $\frac{\pi}{2} < \theta_1 < \theta_2 < \theta_3 < \pi$

4. $\pi > \theta_1 > \theta_2 > \theta_3 > \frac{\pi}{2}$

QUESTION

Surface tension of a liquid, at critical temperature is

1. Maximum
2. Unchanged
3. Zero
4. None of these

QUESTION

The raincoats are made water proof by coating it with a material, which

1. Absorb water
2. Increase surface tension of water
3. Increase the angle of contact
4. Decreases the density of water

QUESTION

A soap bubble, having radius of 1 mm, is blown from a detergent solution having a surface tension of 2.5×10^{-2} N/m. The pressure inside the bubble equals at a point ZQ below the free surface of water in a container. Taking $g = 10\ m/s^2$, density of water = $10^3\ kg/m^3$, the value of Z_0 is: [NEET-2019]

1. 100 cm
2. 10 cm
3. 1 cm
4. 0.5 cm

#TayyariSelectionKi!

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REAL TEST SERIES

Registration Closing Date for Test 01 – 10 Oct 2024

Exam Date - 13 Oct 2024 (online)

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NEET REAL TEST 01 SYLLABUS

11th NEET REAL TEST SERIES SYLLABUS

Cohort	Class	Name of the Test	Exam Date	Mode	Physics	Chemistry	Botany	Zoology
NEET	11	Test 1	13-Oct-2024	Online	Basic Maths & Calculus (Mathematical Tools) Vectors Units and Measurements Motion in a straight line	Structure of Atom Some Basic Concepts of Chemistry Classification of Elements and Periodicity in Properties	Cell - The Unit of Life Cell Cycle and Cell Division	Structural Organization in Animals Breathing and Exchange of Gases

12th NEET REAL TEST SERIES SYLLABUS

Cohort	Class	Name of the Test	Exam Date	Mode	Physics	Chemistry	Botany	Zoology
NEET	12	Test 1	13-Oct-2024	Online	Electric Charges and Fields Electrostatic Potential and Capacitance	Solution Electrochemistry	Sexual Reproduction in Flowering Plant	Human Reproduction

DROPPER NEET REAL TEST SERIES SYLLABUS

Cohort	Class	Name of the Test	Exam Date	Mode	Physics	Chemistry	Botany	Zoology
NEET	Dropper	Test 1	13-Oct-2024	Online	Basic Maths & Calculus (Mathematical Tools) Vectors Units and Measurements Motion in a straight line Motion in a plane Circular motion Laws of motion	Some Basic Concept of Chemistry Redox Reaction Solutions Thermodynamics Equilibrium Electrochemistry	Cell - The Unit of Life Cell Cycle and Cell Division The Living World Biological Classification Plant Kingdom Morphology of Flowering Plants	Structural Organization in Animals Breathing and Exchange of Gases Body Fluids and Circulation Excretory Products & their Elimination

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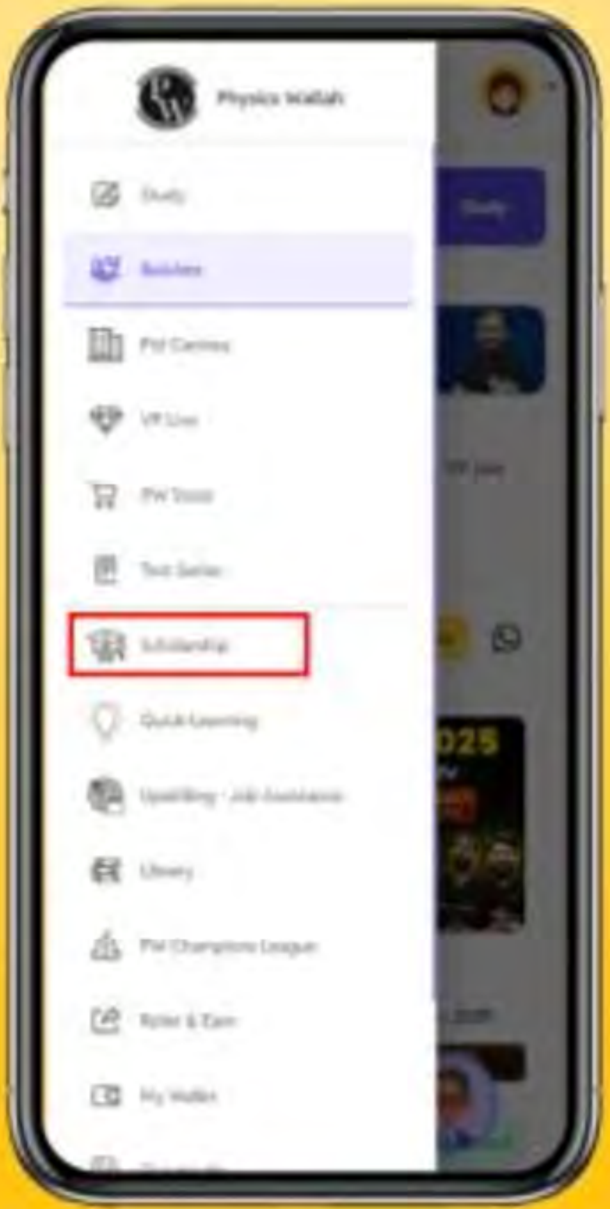
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  Offline (10:00 to 11:00 AM & 04:00 to 05:00 PM)
- **Exam Duration:** 60 Minutes

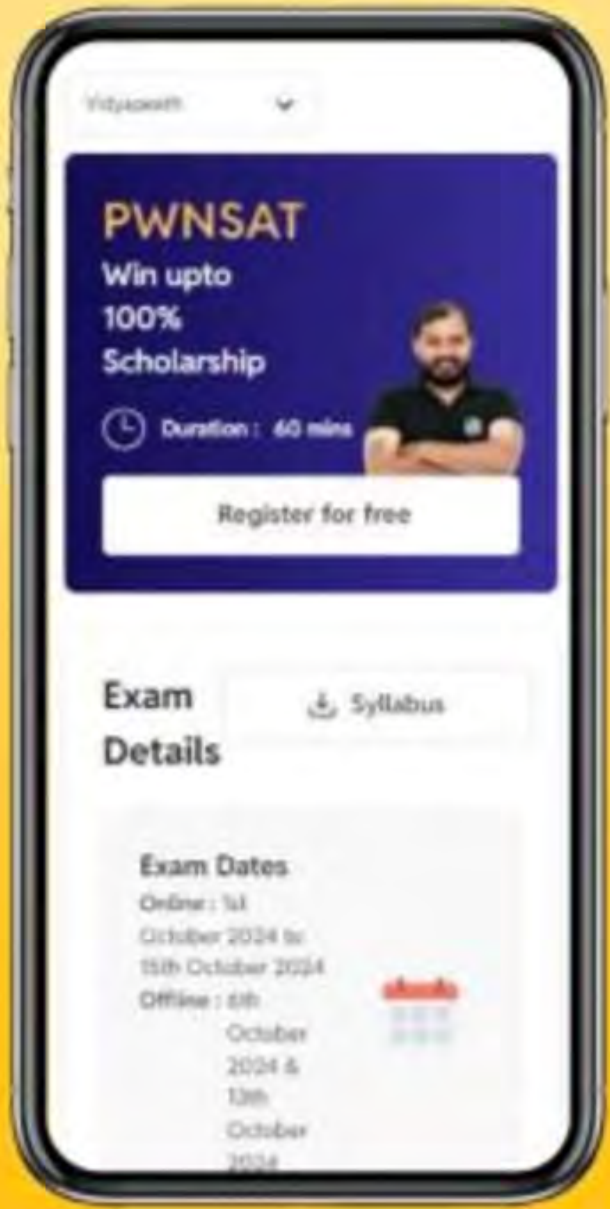
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THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 9 | Physics

Mechanical Properties of Fluid



By- Dr. Manish Raj (MR SIR)



$P_0 \uparrow$ $(P_{in} - P_0) = \frac{2S}{R}\downarrow$

Topics to be covered

(33%) (a) Black to yellow

53% (b) yellow to Black

(c) No air will flow

1. #
2. #
3. #

Excess pressure
contact angle



QUESTION

By blowing air in a soap bubble, the radius is increased from r to $2r$. Then the percentage increase in the surface energy of the bubble is:

1. 100%
2. 400%
3. 800%
4. 300%

$E \propto r^2$

$E_f = 4E_i$

$E_i = 2S(4\pi r^2)$

$E_f = 2S[4\pi(2r)^2]$

$= 4(2S\,4\pi r^2)$

$E_f = 4E_i$

% change in energy $= \frac{E_f - E_i}{E_i} \times 100$

$= \frac{4E_i - E_i}{E_i} \times 100 = \frac{3E_i}{E_i} \times 100 = 300\%$

QUESTION

If work done in blowing a bubble of volume V is W, then the work done in blowing another bubble of volume $2V$ will be:

1. $2W$
2. W
3. $\sqrt{2}\,W$
4. $2^{2/3}\,W$

$V \mid r \Rightarrow V = \frac{4}{3}\pi r_i^3 \qquad r \propto V^{1/3}$

Area $= 4\pi r^2$

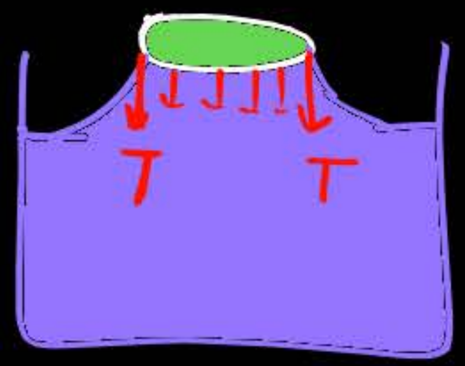
$E_i = 4\pi r_i^2$

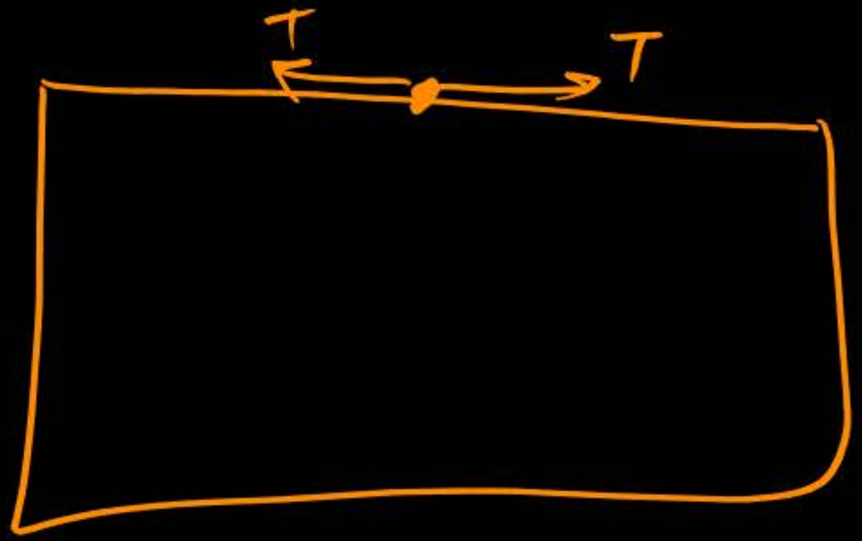
$E_i \propto (r_i)^2$

$E_i \propto (V)^{\frac{1}{3}\times 2}$

$E_i \propto (V)^{2/3}$

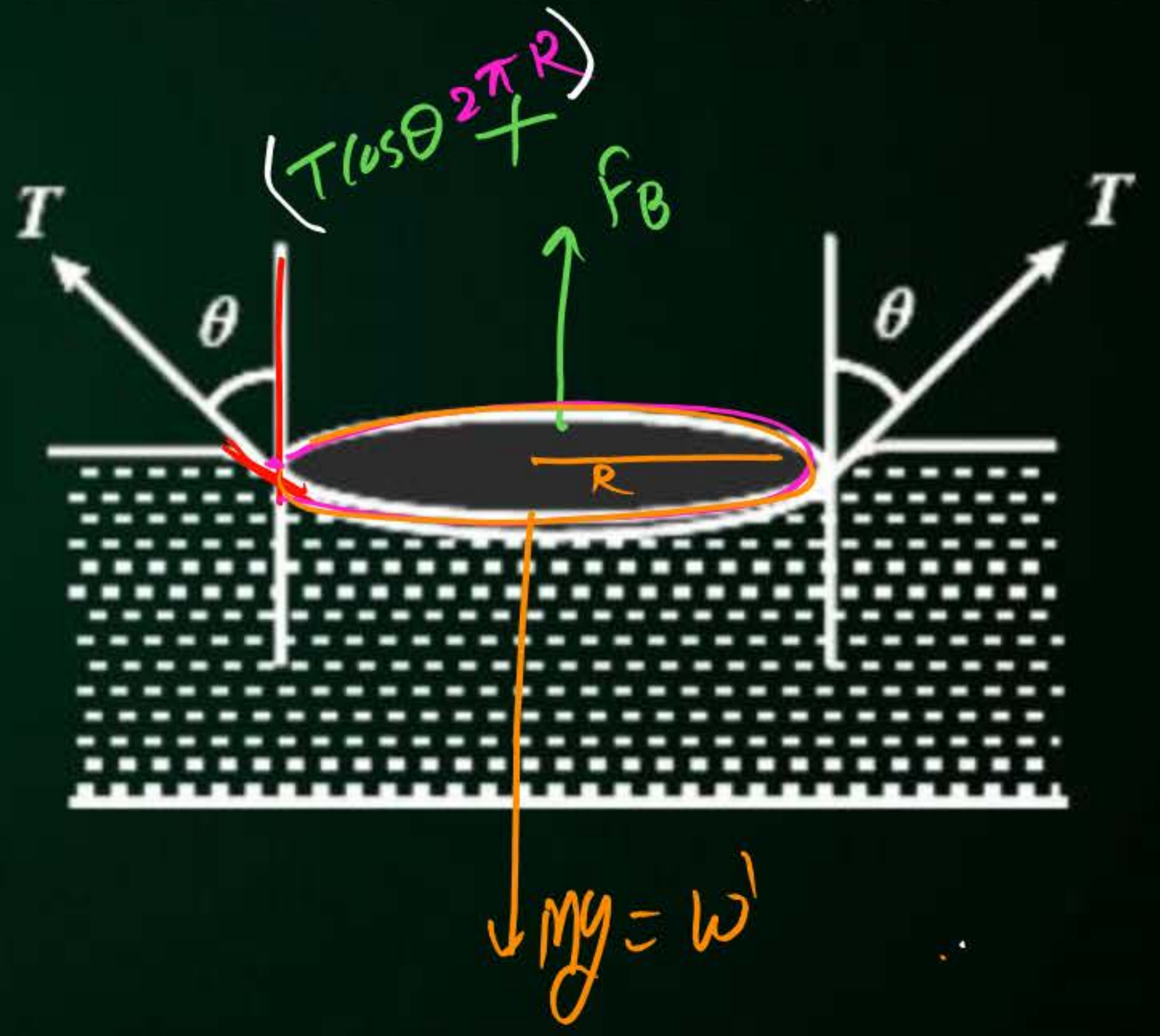
Work $\propto$ energy $\propto (V)^{2/3}$


T
T


T
T

QUESTION

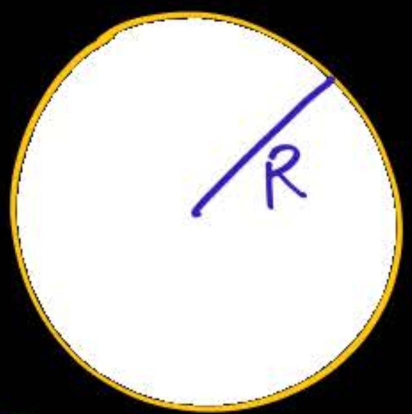
A thin metal disc of radius r floats on water surface and bends the surface downwards along the perimeter making an angle with vertical edge of disc. If the disc displaces a weight of water W and surface tension of water is T, then the weight of metal disc is



1. $2\pi rT + W$
2. $2\pi rT\cos\theta - W$
3. $2\pi rT\cos\theta + W$
4. $W - 2\pi rT\cos\theta$
5. Weight of metal disc = total upwards force

one Liquid (drop) sphere of radius R is Break into n-small liquid drop of radius 'r'

- $A_i = 4\pi R^2$
- $V_i = \frac{4}{3}\pi R^3$



surface Area → Increse

volume → const



surface energy → Incrse

energy → absorbed

Tempr → may decrse

Heat energy → converted Surface energy

Tempr decre

$R = n^{1/3} r$

$n^{1/3} = \frac{R}{r} \Rightarrow \frac{1}{r} = \frac{n^{1/3}}{R}$

$n = \left(\frac{R}{r}\right)^3$

Work / energy given $= S[A_f - A_i]$

$= S[n 4\pi r^2 - 4\pi R^2]$

$= 4\pi S\left[\left(\frac{R}{r}\right)^3 r^2 - R^2\right]$

$W = 4\pi S\left[\frac{R^3}{r} - \frac{R^2 \cdot R}{R}\right]$

$W = 4\pi S R^3\left[\frac{1}{r} - \frac{1}{R}\right]$

$W = 3VS\left[\frac{1}{r} - \frac{1}{R}\right]$

$\Rightarrow W = 4\pi S R^3\left[\frac{n^{1/3}}{R} - \frac{1}{R}\right]$

$W = 4\pi S R^2\left[n^{1/3} - 1\right]$

↳ If soap Bubble is there

$W = \left[4\pi S R^2 (n^{1/3} - 1)\right] \times 2$

If there is a bubble in a place of drop?


drop

$$W_{\text{drop}} = 4\pi S R^2 \left[n^{1/3} - 1 \right]$$

$$W_{\text{for buble}} = 2 \times 4\pi S R^2 \times \left[n^{1/3} - 1 \right]$$



#

$$W = 4\pi S R^2 (n^{1/3} - 1)$$

work.

If heat energy absorbed by drop to break into n-equal part then find decrease in tempr. (JEE)

$$\rho \frac{4}{3}\pi R^3 C \Delta T = 4\pi S R^2 (n^{1/3} - 1)$$

$$mc\,\Delta t = 4\pi S R^2 (n^{1/3} - 1)$$

loss in heat eng — gain in surface eng

(C = specific heat capacity)

$$\Delta T = \frac{3S}{\rho C R}\left[n^{1/3} - 1\right]$$

ρ = density

MR

n- Small drop (colease) to form a single drop:-



n- liquid drop

volume = const

Area ↓ decrese

Surface energy → decrse

energy → Relesed

Tempr → Incrse



Surface enegy $\xrightarrow{\text{conv}}$ Heat energy

$*\ \Delta E = S\,[E_i - E_f]$

Relesed energy

$\Delta E = S\,[4\pi r^2 n - 4\pi R^2]$

$r^2 = \dfrac{R^2}{n^{2/3}}$

$\Delta E = S4\pi\,[r^2 n - R^2] = 4\pi S R^2 (n^{1/3} - 1)$

$\dfrac{E_{i\,total}}{E_{f\,final}} = \dfrac{4\pi r^2 S n}{S\,4\pi R^2} = \dfrac{n r^2}{R^2}$

$\dfrac{E_{i\,total}}{E_{f\,total}} = \dfrac{n R^2}{n^{2/3} R^2} = n^{1/3}$

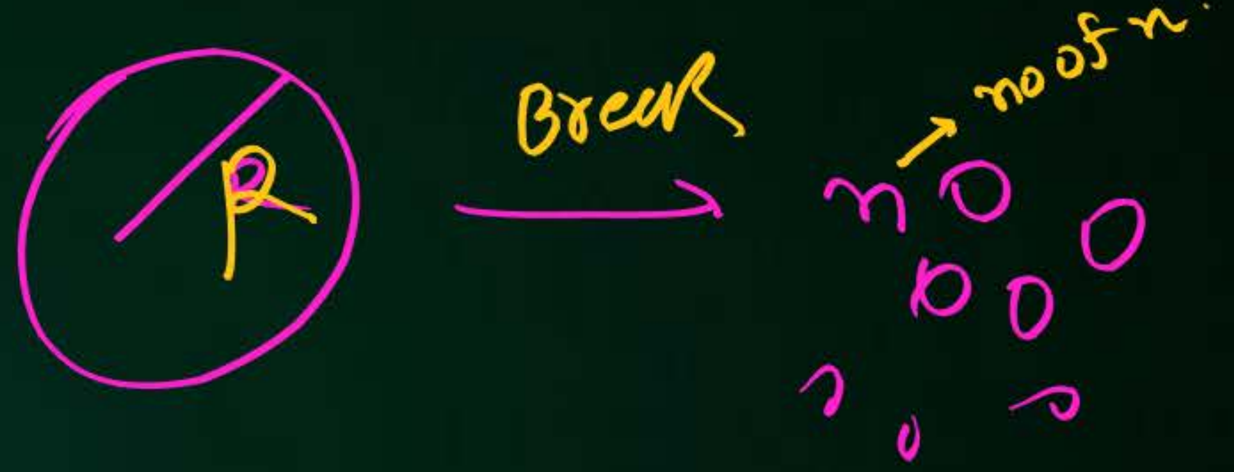
$\%\ \text{loss in energy} = \dfrac{\Delta E}{E_i} = \dfrac{E_f - E_i}{E_i} \times 100$

$= \left(\dfrac{E_f}{E_i} - \dfrac{E_i}{E_i}\right) \times 100$

$\%\ \text{loss in enegy} = \left(\dfrac{1}{n^{1/3}} - 1\right) \times 100$

QUESTION

The work done to break a spherical drop of radius R in n drops of equal size is proportional to



1. $\frac{1}{n^{2/3}} - 1$
2. $\frac{1}{n^{1/3}} - 1$
3. $n^{1/3} - 1$
4. $n^{4/3} - 1$

QUESTION

If T is the surface tension of a fluid, then the energy needed to break a liquid drop of radius R into 64 equal drops is

1. $6\pi R^2 T$
2. $\pi R^2 T$
3. $12\pi R^2 T$
4. $8\pi R^2 T$

$R \rightarrow 64$

$$W = 4\pi S R^2 (n^{1/3} - 1)$$
$$= 4\pi S R^2 [(64)^{1/3} - 1]$$
$$= 4\pi S R^2 [4 - 1]$$

QUESTION

A certain number of spherical drops of a liquid of radius r coalesce to form a single drop of radius R and volume V. If T is the surface tension of the liquid, then

[AIPMT-2014]



1. Energy $= 4VT\left(\frac{1}{r}-\frac{1}{R}\right)$ is released
2. Energy $= 3VT\left(\frac{1}{r}+\frac{1}{R}\right)$ is absorbed
3. Energy $= 3VT\left(\frac{1}{r}-\frac{1}{R}\right)$ is released
4. Energy is neither released nor absorbed

QUESTION

Two water droplets merge with each other to form a larger droplet. In this process

1. Energy is liberated ✓
2. Energy is absorbed ✗
3. Energy is neither liberated nor absorbed ✗
4. Some mass is converted into energy ✗



QUESTION

Soap helps in cleaning clothes, because

1. It attracts the dirt particles
2. It decreases the surface tension of water
3. It increases the cohesive force between water molecules
4. It increases the angle of contact

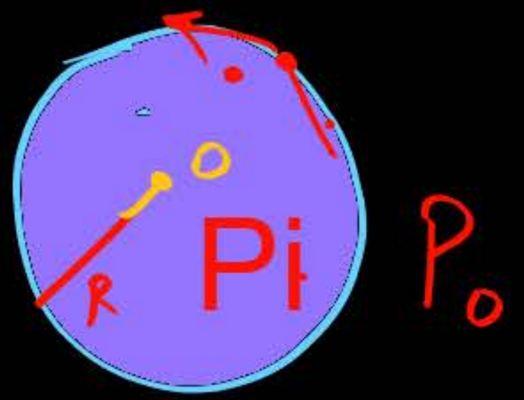
QUESTION

On increasing temperature of a liquid, its surface tension generally

1. Increases
2. Decreases
3. Remains constant
4. First increases and then decreases

Excess Pressure

→ Pressure is always higher in concave side of liquid drop, or bubble



$P_i = P_o + \frac{2S}{R}$

$$P_i - P_o = \frac{2S}{R}$$

extra prs in case of drop

$$\Delta P \propto \frac{1}{R}$$

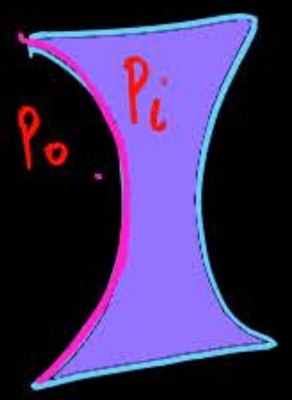
bubble



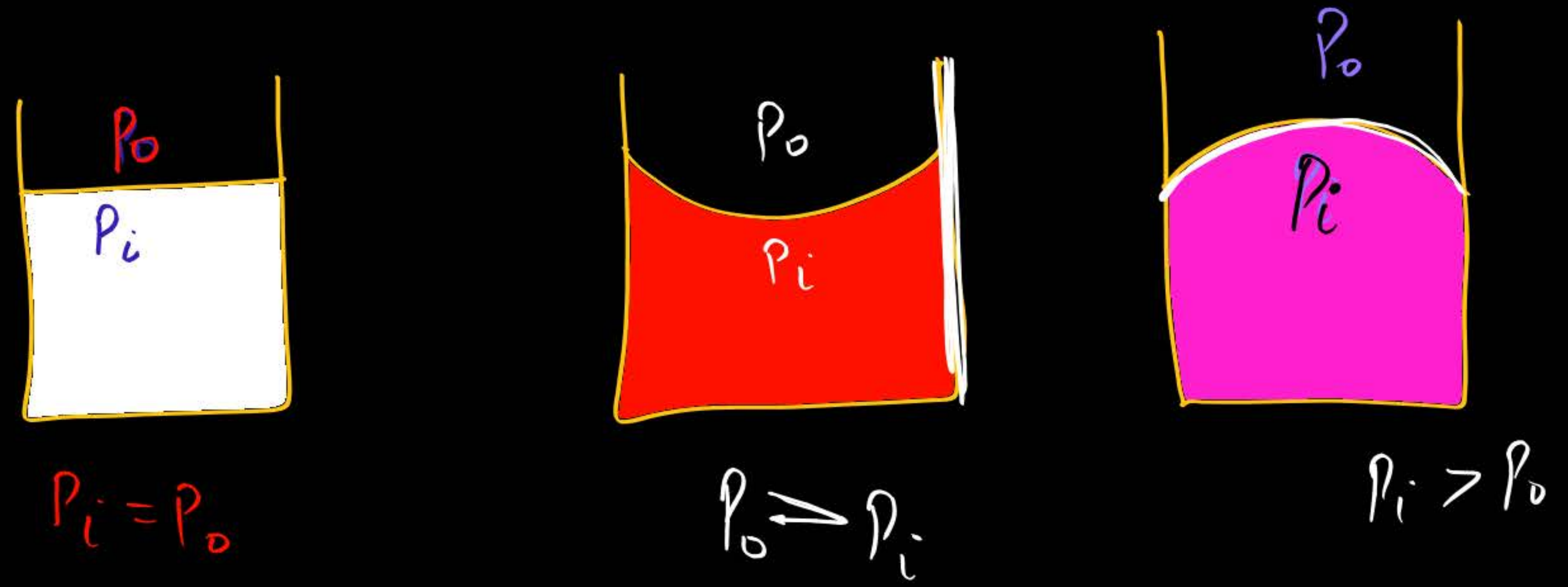
$$P_i - P_o = \frac{4S}{R}$$



$P_i > P_o$

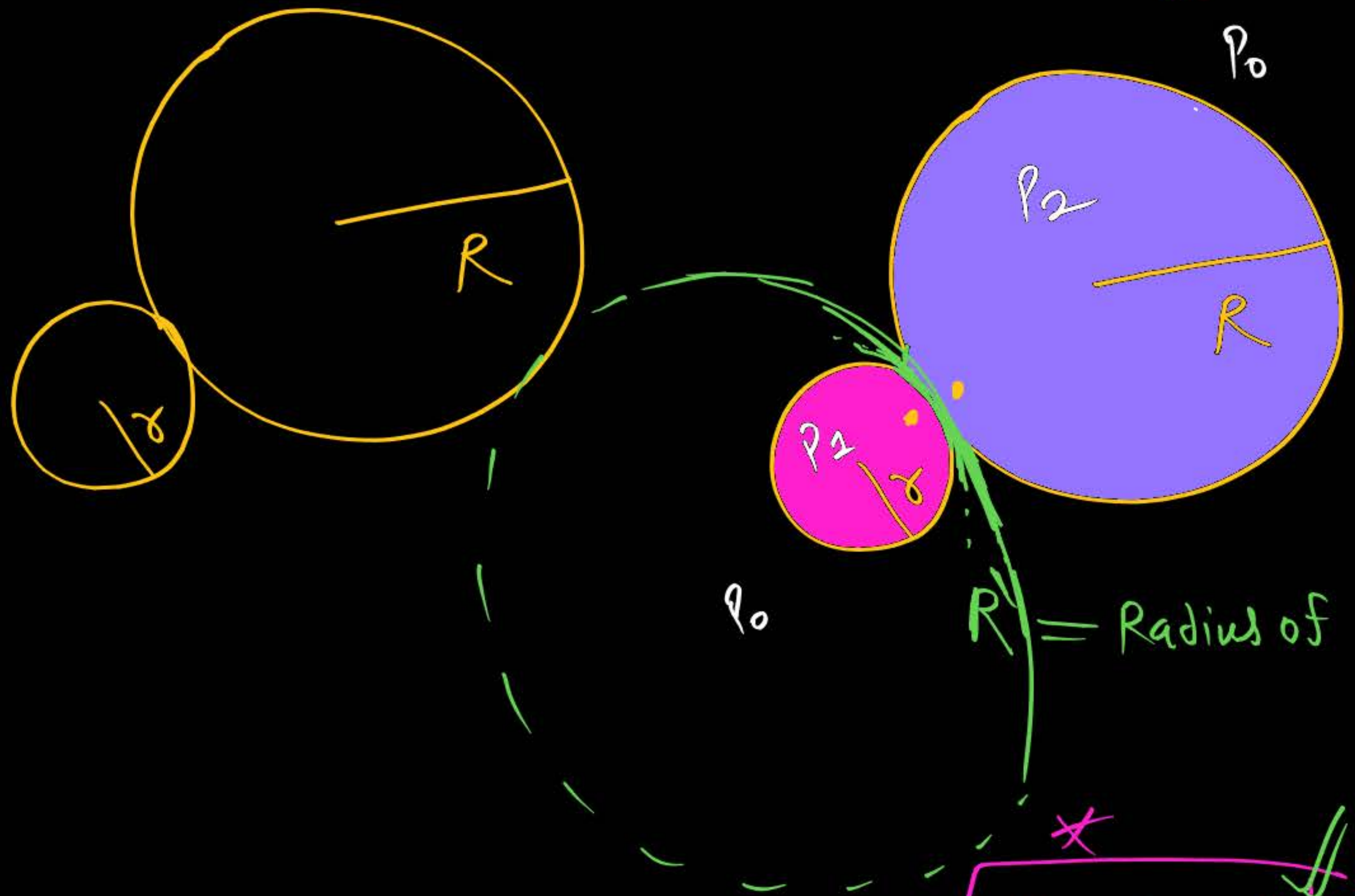


$P_o > P_i$



Po
Pi
Pi = Po
Po
Pi
Po ⇀ Pi
Po
Pi
Pi > Po

Pressure always higher in concave side.



R' = Radius of Interface.

$$P_0 < P_2 < P_1$$

$$P_1 - P_0 = \frac{2S}{r} \quad \text{--- (I)}$$

$$P_2 - P_0 = \frac{2S}{R} \quad \text{--- (II)}$$

$$P_1 - P_2 = \frac{2S}{R'} \quad \text{--- (III)}$$

(I) − (II)

$$P_1 - \cancel{P_0} - P_2 + \cancel{P_0} = \frac{2S}{r} - \frac{2S}{R}$$

$$\frac{\cancel{2S}}{R'} = \frac{\cancel{2S}}{r} - \frac{\cancel{2S}}{R}$$

radius of Intf → $$\boxed{\frac{1}{R'} = \frac{1}{r} - \frac{1}{R}}$$

QUESTION

The excess pressure in a soap bubble is double that in other one. The ratio of their volume is

1. 1 : 2
2. 1 : 8
3. 1 : 4
4. 1 : 1

$$\frac{\Delta P_1}{\Delta P_2} = \frac{2}{1} = \frac{4S}{R_1} \times \frac{R_2}{4S}$$

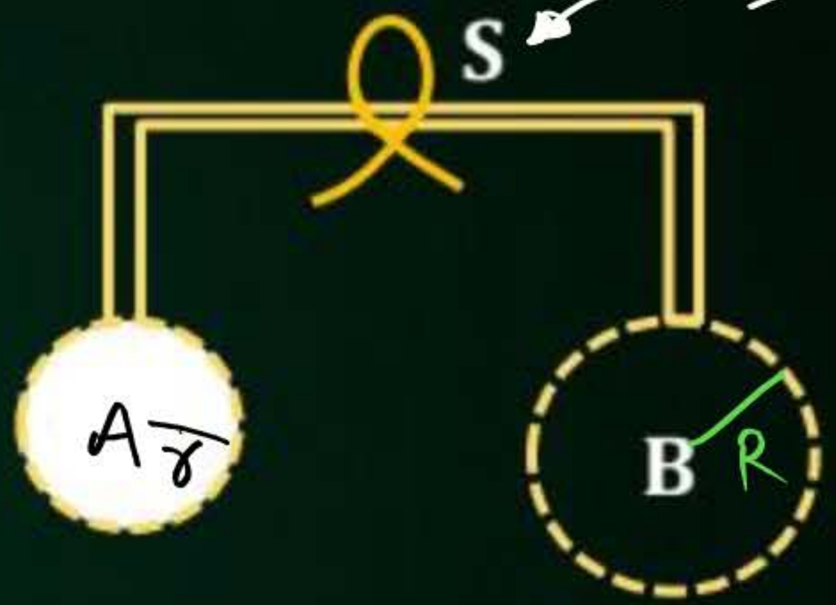
$$\frac{2}{1} = \frac{R_2}{R_1}$$

$$\frac{R_1}{R_2} = \frac{1}{2}$$

Volu $\propto R^3$

QUESTION

Two soap bubbles are connected by a tube as shown in figure. What happens when stopper S is removed ?



1. Size of bubble A increases
2. Size of bubble B decreases
3. Both bubble take the same size
4. Size of bubble A decreases and size of bubble B increases

83.5%

QUESTION

A bubble of 8mm diameter is formed in the air. The surface tension of soap solution is 30 dyne/cm. The excess pressure inside the bubble is:

1. 150 dyne/cm^2
2. 300 dyne/cm^2
3. 3×10^3 dyne/cm^2
4. 12 dyne/cm^2

$R = 4 \times 10^{-3}$ m

$1\ N = 10^5$ dyne

$\Delta P = \frac{4S}{R} = \frac{4 \times \frac{30 \times 10^{-5}}{10^{-2}}}{4 \times 10^{-3}}$

$= 30 \frac{N}{m^2}$

$= 30 \frac{N}{m^2}$

$= \frac{30 \times 10^5\ Dn}{10^4}$

$= 300$

QUESTION

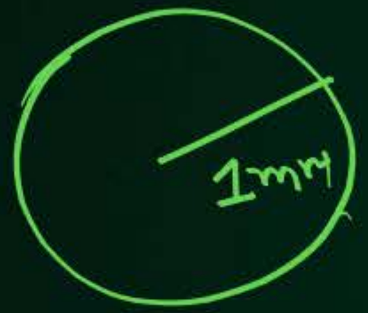
The radius of a spherical drop of water is 1 mm. If surface tension of water be $70 \times 10^{-3}\ \text{Nm}^{-1}$, the pressure difference inside and outside the drop will be:

(1) $70\ \text{Nm}^{-2}$

(2) $140\ \text{Nm}^{-2}$ ✓

(3) $280\ \text{Nm}^{-2}$

(4) zero



$S = 70 \times 10^{-3}$

$\Delta P = \frac{2S}{R} = \frac{2 \times 70 \times 10^{-3}}{10^{-3}}$

$= 140$

QUESTION

Pressure inside two soap bubbles are 1.02 atm and 1.05 atm respectively. The ratio of their surface area is

(1) $\frac{125}{8}$

(2) $\frac{25}{4}$

(3) $\frac{5}{2}$

(4) $\frac{2}{5}$

$P_i - P_0 = \frac{4S}{R}$

$$\frac{1.02\text{ atm} - 1\text{ atm} = \frac{4S}{R_1}}{1.05\text{ atm} - 1\text{ atm} = \frac{4S}{R_2}}$$

$\frac{2}{5} = \frac{R_2}{R_1}$

Area $\propto R^2$ $\left[\frac{R_1}{R_2} = \frac{5}{2}\right]$

QUESTION

The excess pressure a spherical drop of water is four times that of another drop. Then their respective mass ratio is

1. $1:16$
2. $1:64$
3. $1:4$
4. $1:8$

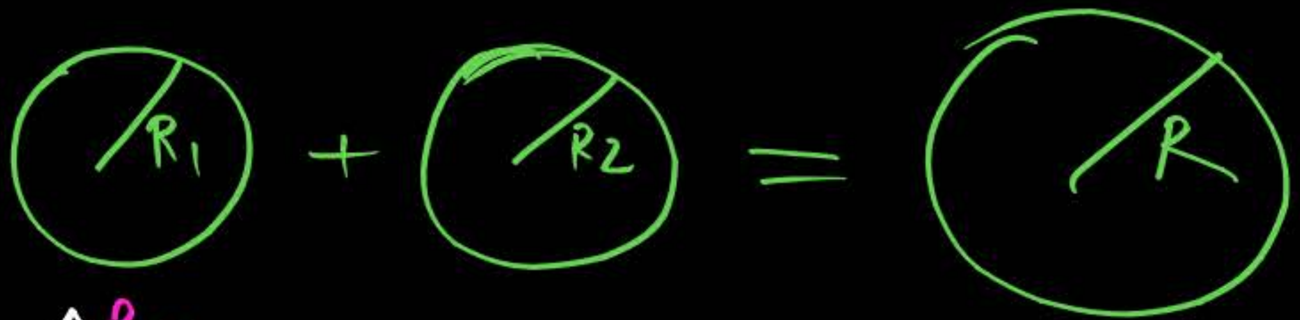
H/W

$M = \rho V$

$\frac{M_1}{M_2} = \frac{V_1}{V_2} \propto \left(\frac{R_1}{R_2}\right)^3$

H/W

Two liquid of Radius R_1 and R_2 is colease to form a single drop in a isothermal condition, then find radius of drop.



Temp^r = const.

$PV = \text{const}$

$$\Delta P_1 V_1 + \Delta P_2 V_2 = \Delta P\, V$$

$$\frac{2S}{R_1}\frac{4}{3}\pi R_1^3 + \frac{2S}{R_2}\frac{4}{3}\pi R_2^3 = \frac{2S}{R}\frac{4}{3}\pi R^3$$

$$R_1^2 + R_2^2 = R^2$$

$$R = \sqrt{R_1^2 + R_2^2}$$

MR Rafta

QUESTION

Two soap bubbles of radii 2 cm and 4 cm join to form a double bubble In air. men radius of curvature of interface is

1. $2\sqrt{5}$ cm
2. 2 cm
3. 4 cm ✓
4. $2\sqrt{3}$ cm

$\frac{1}{R} = \frac{1}{R_1} - \frac{1}{R_2}$

$\frac{1}{R} = \frac{1}{2} - \frac{1}{4} = \frac{2-1}{4}$

$\frac{1}{R} = \frac{1}{4}$

QUESTION

A spherical drop of water has 1 mm radius. If the surface tension of water is 75×10^{-3} N/m, then difference of pressure between inside and outside of the drop is

1. $35\ N/m^2$
2. $70\ N/m^2$
3. $140\ N/m^2$
4. $150\ N/m^2$

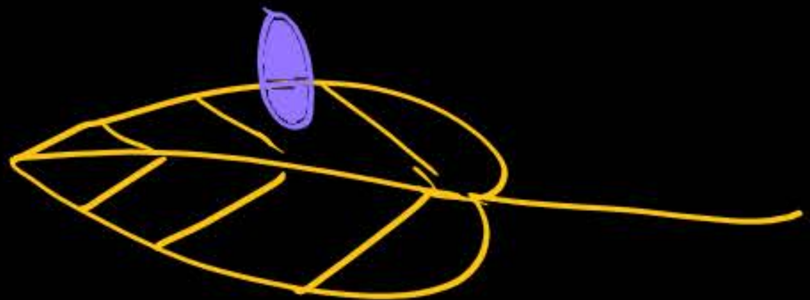
Contact Angle

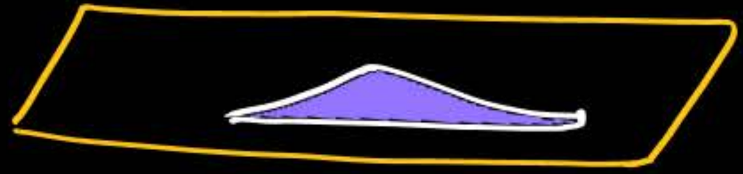
→ Angle B/w Solid surface & liquid surface Inside liquid is called contact angle.

↳ due to surface Tension

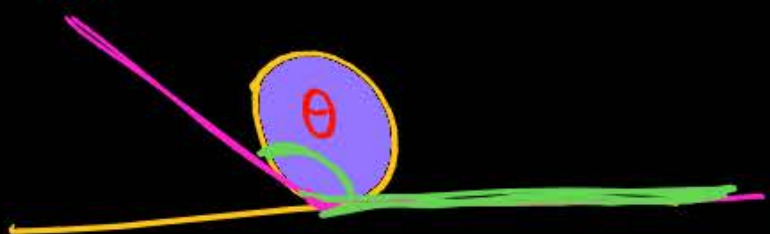
(cohesive & adhasive force)

- cohesive: afftartive force B/w same atom
- adhasive: attractive force B/w diffⁿ atom





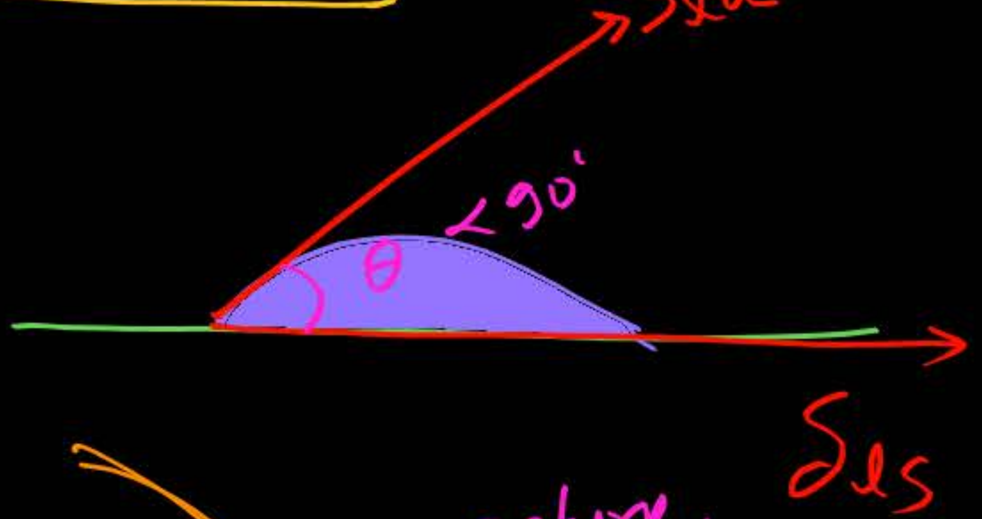
S_{la} = Surface b/w liquid air



S_{ls} = Surface of liquid Solid

θ > 90°
surface will not wet

Cohesive force > adhasive force

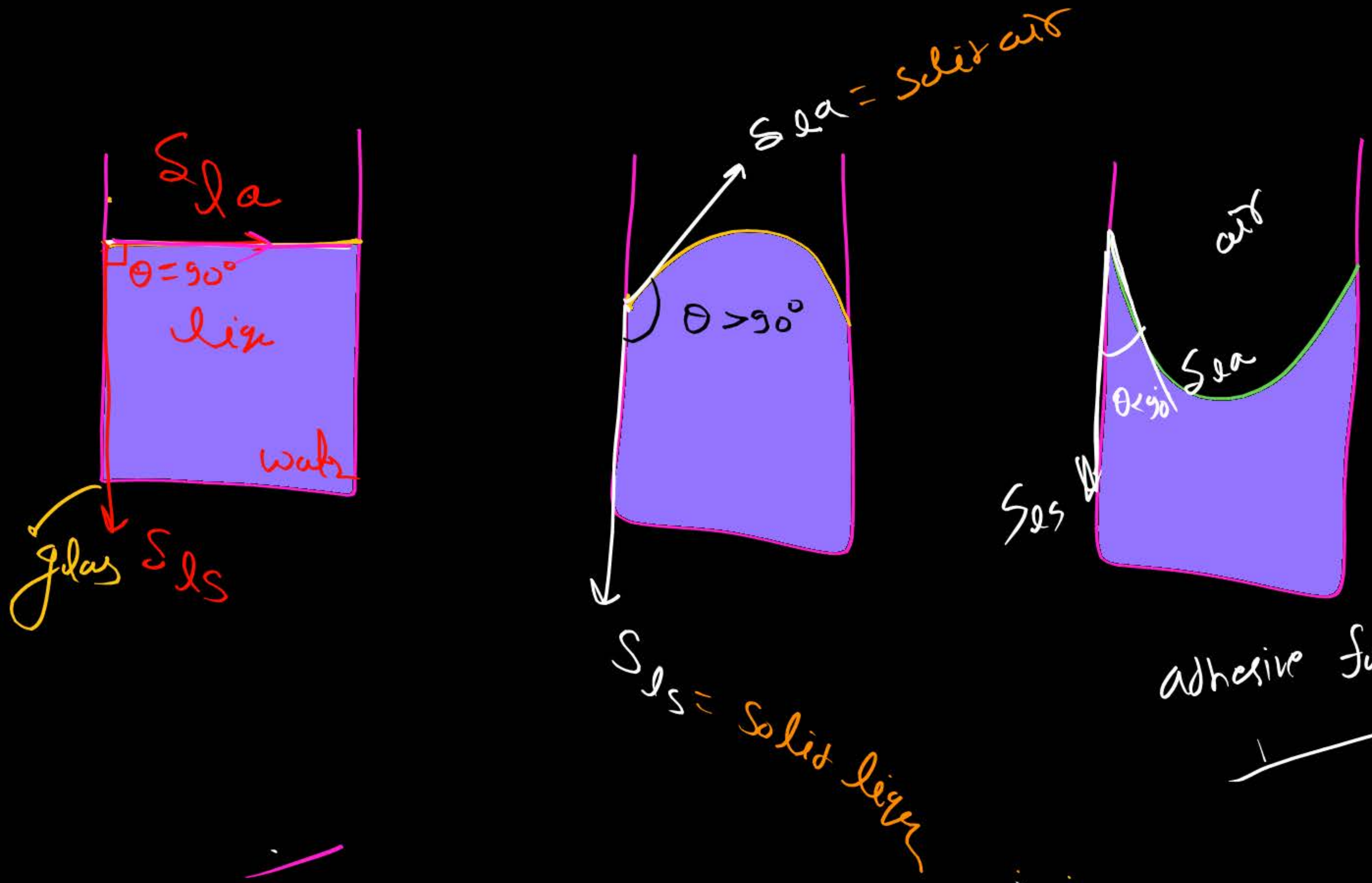


acture Angle

θ < 90°

Cohesive < adhasive

Surface will wet

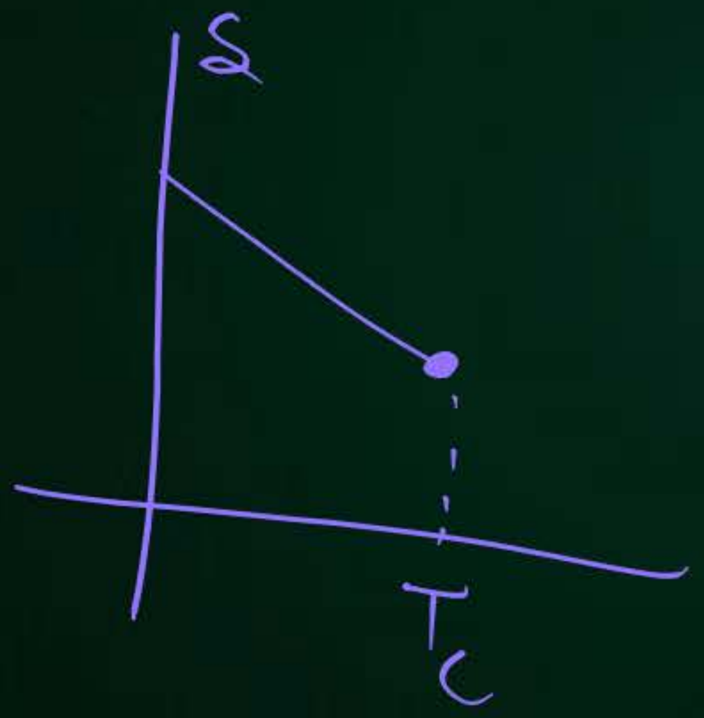


adhesive force > cohesion

QUESTION

Surface tension of a liquid, at critical temperature is

1. Maximum
2. Unchanged
3. Zero
4. None of these



QUESTION

The wettability of a surface by a liquid depends primarily on: [NEET-2013]

1. Surface tension
2. Density
3. Angle of contact between the surface and the liquid
4. Viscosity

QUESTION

A soap bubble, having radius of 1 mm, is blown from a detergent solution having a surface tension of 2.5×10^{-2} N/m. The pressure inside the bubble equals at a point Z_0 below the free surface of water in a container. Taking $g = 10$ m/s^2, density of water = 10^3 kg/m^3, the value of Z_0 is: **[NEET-2019]**

1. 100 cm
2. 10 cm
3. 1 cm
4. 0.5 cm

$P_0 + \rho g h = P_0 + \frac{4S}{R}$

$10^3 \times 10 Z_0 = \frac{4 \times 2.5 \times 10^{-2}}{10^{-3}}$

$10^2 \times 10 Z_0 = 10$

$Z_0 = \frac{1}{10^2} = 10^{-2}$ m

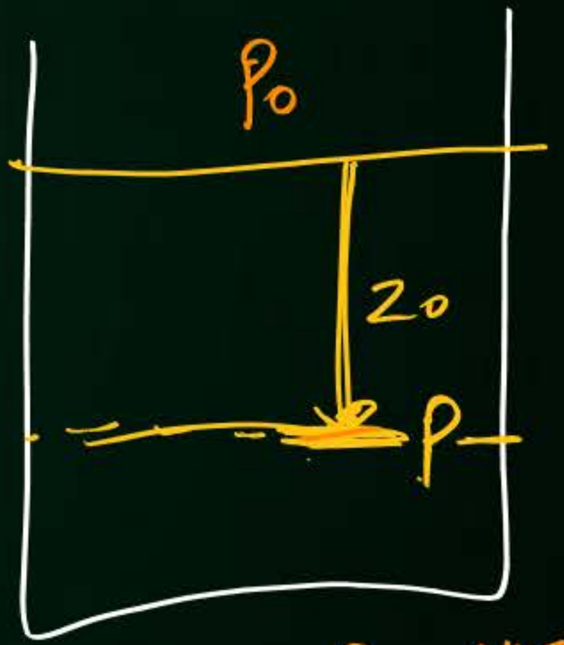
P_0, P_i, 1 mm

$S = 2.5 \times 10^{-2}$

Soap Bubble

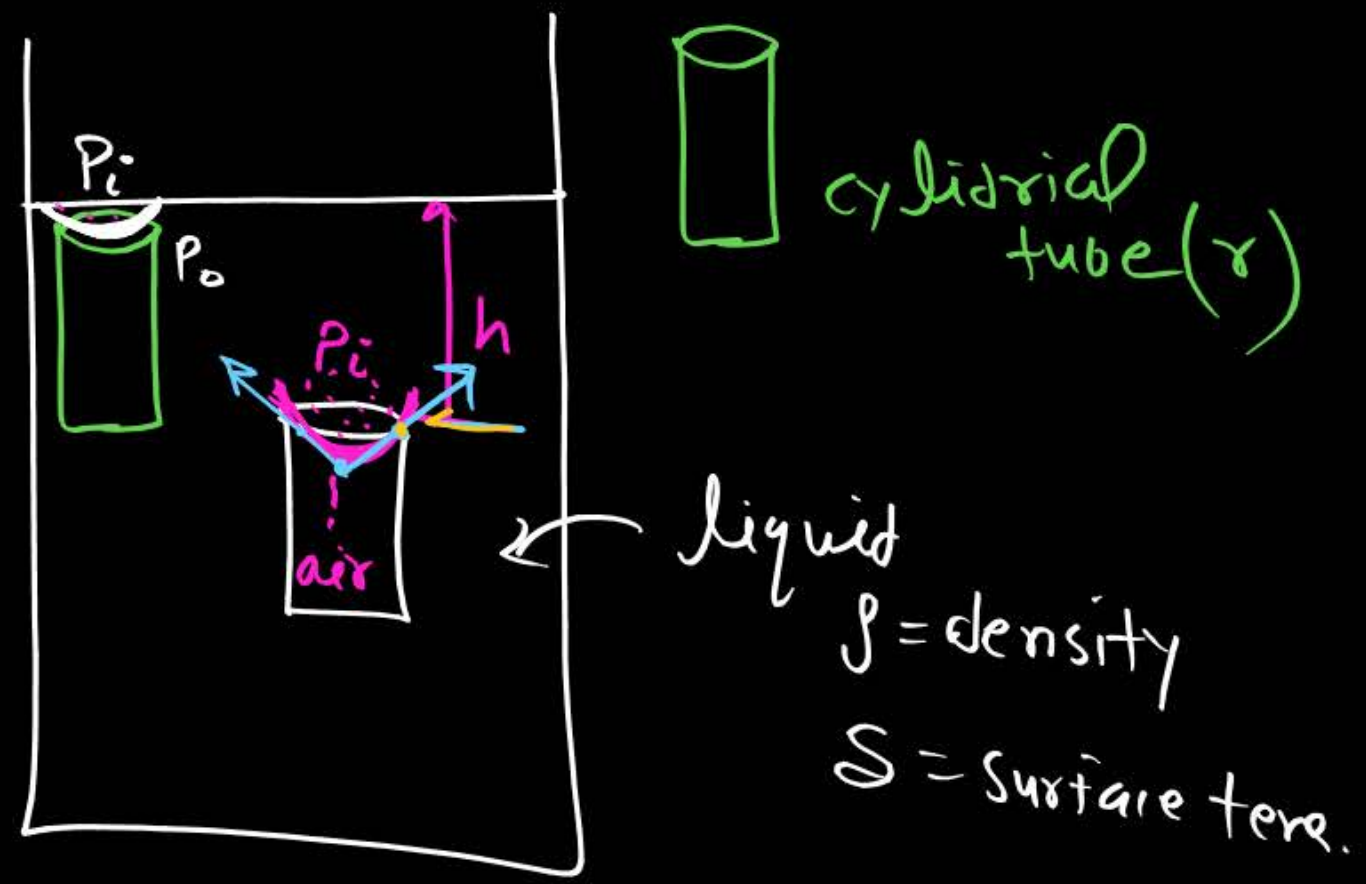
$P_i - P_0 = \frac{4S}{R}$

$P_i = P_0 + \frac{4S}{R}$



$P = P_0 + \rho g z_0$

find depth from liquid surface when liquid Just start to fill (enter) inside cylindric contain

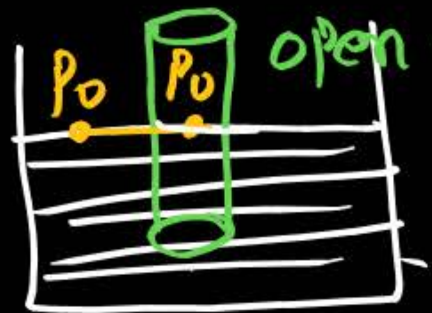


$$\rho g h = \frac{2S}{R}$$

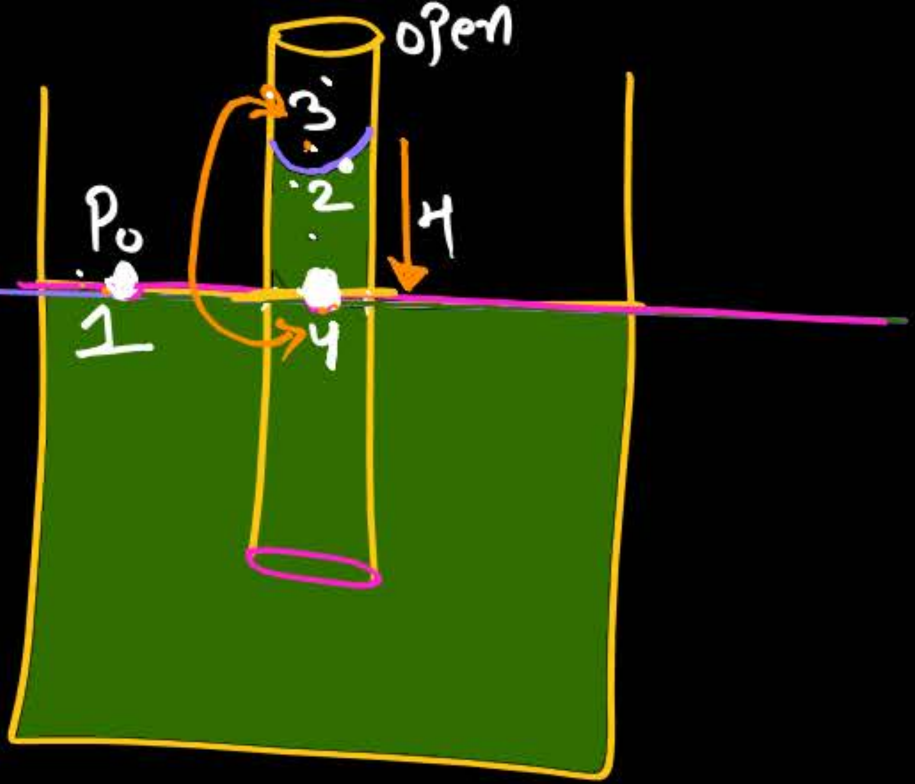
$$h = \frac{2S}{\rho g R}$$

Cappilary rise

Barometre → Ideal fluid (does not consider surface tension)



case-1



According to Pascal law

Pressure must be same on Horizontal line $(P_1 = P_4)$

$$P_4 = P_1 = P_3 = P_0 \quad \text{— (I)}$$

$$P_3 - P_2 = \frac{2S}{R} \quad \text{— (II)}$$

$$P_3 - P_2 = \frac{2S}{R} \quad \text{— (I)}$$

$$P_2 + \rho g h = P_0 \quad \text{— (II)}$$

$$P_0 - P_2 = \frac{2S}{R} \quad \text{— (I)}$$

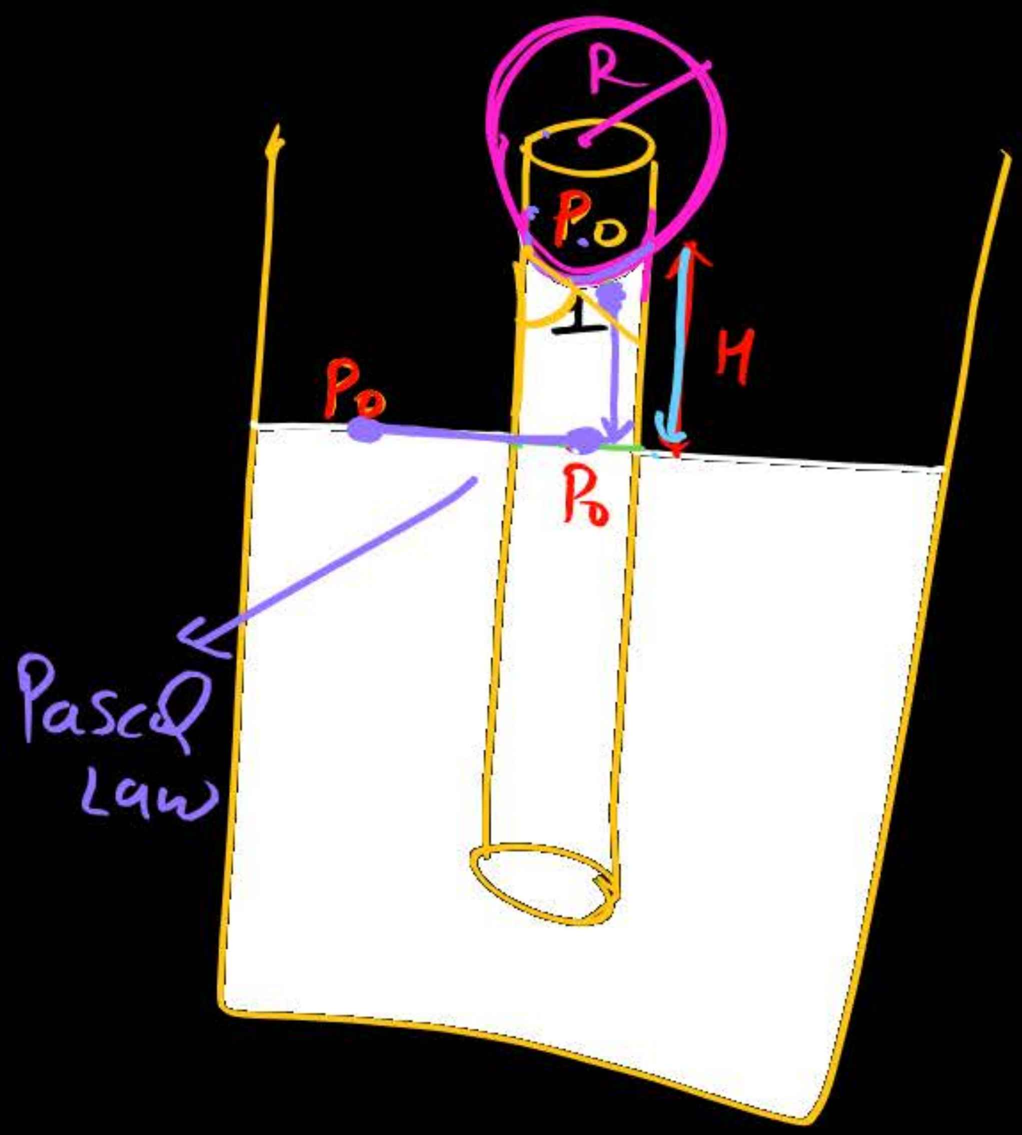
$$P_0 - P_2 = \rho g h \quad \text{— (II)}$$

$$\text{(I)} = \text{(II)}$$

$$\rho g h = \frac{2S}{R}$$

$$h = \frac{2S}{\rho g R}$$

↑ Radius of curve of surface



If contact angle is less than 90° then liquid level will rise

$$P_0 - P_1 = \frac{2S}{R} \quad \text{— (I)}$$

$$P_1 + \rho g h = P_0 \quad \text{— (II)}$$

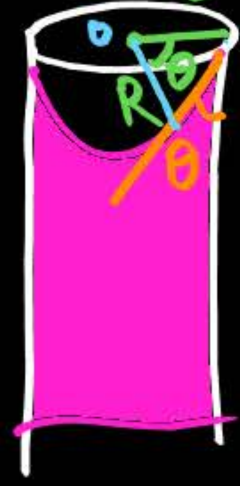
$$\rho g h = P_0 - P_1 \quad \text{— (II)}$$

(I) = (II)

$$\frac{2S}{R} = \rho g h$$

$$h = \frac{2S}{\rho g R}$$

r = radius of tube



$$R\cos\theta = r$$

$$R = \frac{r}{\cos\theta}$$

$$H = \frac{2S}{\rho g R}$$

contact angle

$$H = \frac{2S\cos\theta}{\rho g r}$$

$$H = \frac{2S\cos\theta}{\rho g r}$$

\# $$H \propto \frac{1}{r}$$

$H \propto \cos\theta$

$H \propto S$

$H \propto \frac{1}{\rho}$

Mass of liquid rise in the tube $= \rho V$

$= \rho \pi r^2 (H)$

$= \rho \pi r^2 \frac{1}{r}$

$$m \propto r$$

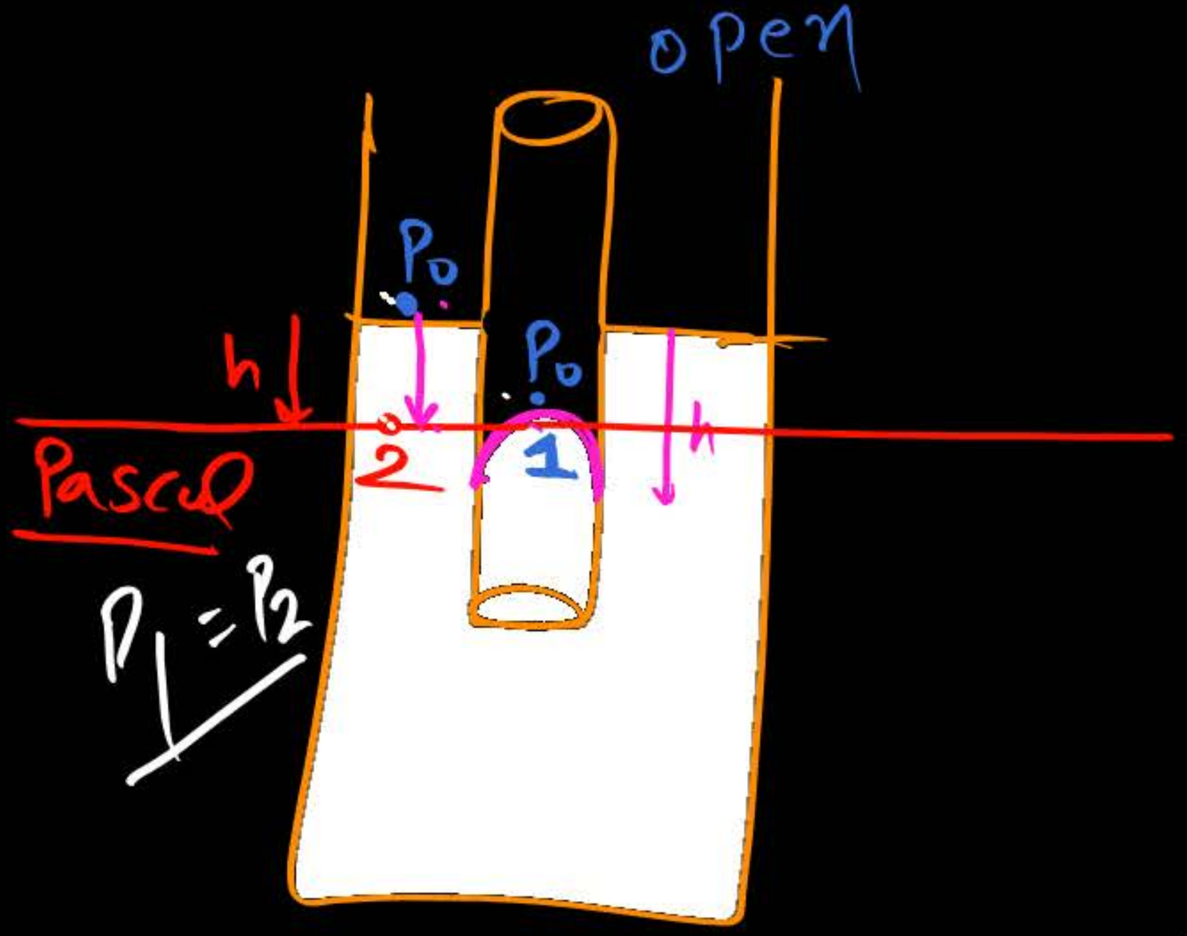


Capillary fall





If contact angle is greater than 90° liquid level will fall



$$P_0 + \rho g h = P_2 \quad \text{—(I)}$$

$$P_1 - P_0 = \frac{2S}{R} \quad \text{—(II)}$$

$$P_2 - P_0 = \rho g h$$

$$P_1 - P_0 = \frac{2S}{R}$$

If $P_1 = P_2$

$$\boxed{\rho g h = \frac{2S}{R}}$$

h height level will fall

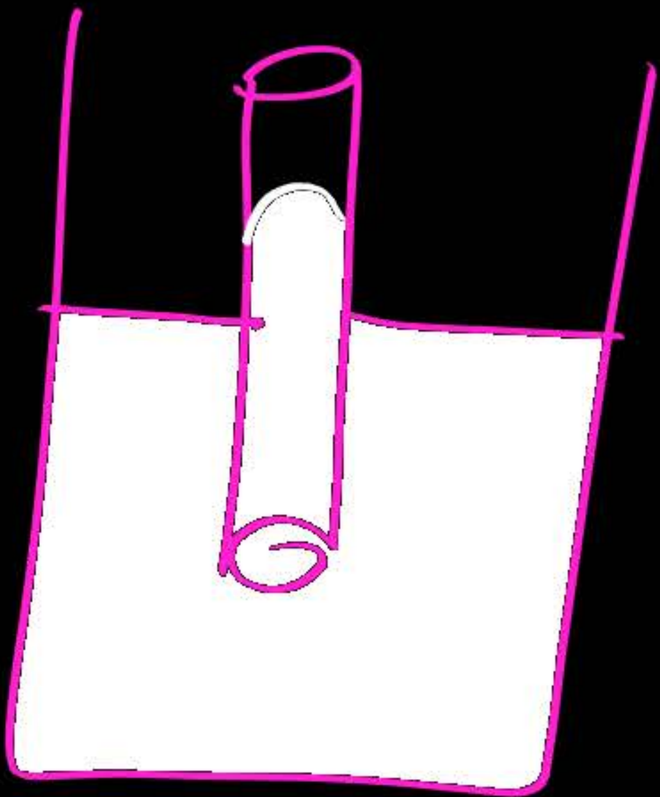


fig-1

✗

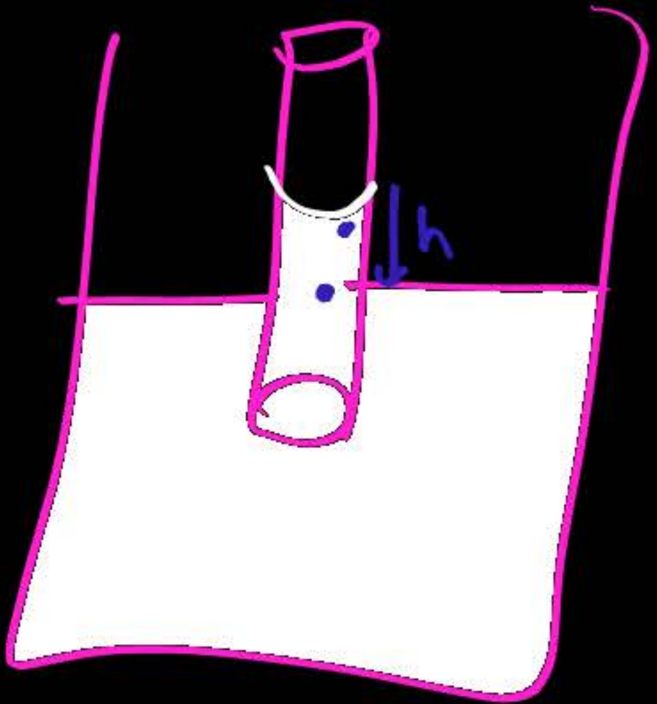


fig-2

✓

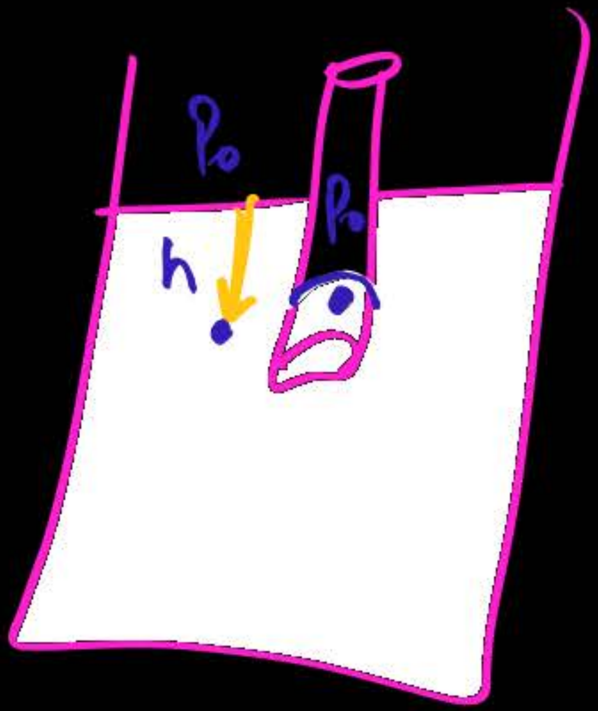


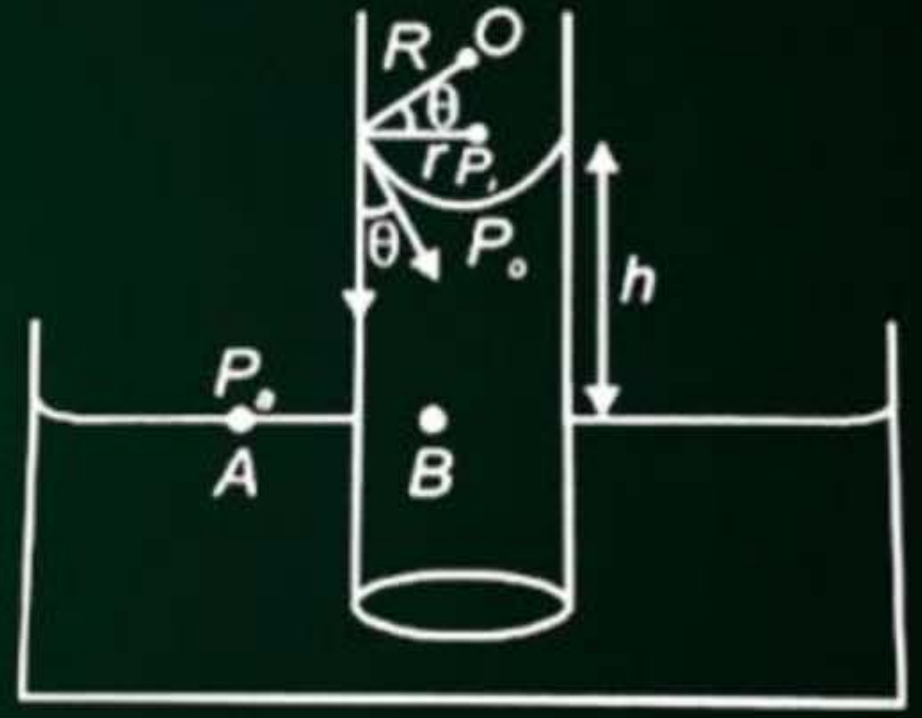
fig-3

✓



fig-4

✗


R
O
θ
r
P_1
θ
P_0
h
P_0
A
B

QUESTION

A capillary tube is dipped in water and it is 20 cm outside water. The water rises upto 8 cm. If the entire arrangement is put in freely falling elevator the length of water column in the capillary tube will be

1. 20 cm
2. 4 cm
3. 10 cm
4. 8 cm

QUESTION

A capillary tube of radius r is immersed in a liquid and mass of liquid, which rises up in it is M. If the radius of tube is doubled, then the mass of liquid which will rise in capillary tube will be

1. 2M
2. M
3. M/2
4. M/4

QUESTION

Three liquids of densities ρ_1, ρ_2 and ρ_3 (with $\rho_1 > \rho_2 > \rho_3$), having the same value of surface tension T, rise to the same height in three identical capillaries. The angles of contact θ_1, θ_2 and θ_3 obey

1. $\frac{\pi}{2} > \theta_1 > \theta_2 > \theta_3 \geq 0$

2. $0 \leq \theta_1 < \theta_2 < \theta_3 < \frac{\pi}{2}$

3. $\frac{\pi}{2} < \theta_1 < \theta_2 < \theta_3 < \pi$

4. $\pi > \theta_1 > \theta_2 > \theta_3 > \frac{\pi}{2}$

QUESTION

The raincoats are made water proof by coating it with a material, which

1. Absorb water
2. Increase surface tension of water
3. Increase the angle of contact
4. Decreases the density of water

QUESTION

A capillary tube of radius R and length L is connected in series with another tube of radius $R/2$ and length $L/4$. If the pressure across the two taken together is P, then the ratio of pressure difference across the first tube to that across the second tube is :

1. 1 : 4
2. 1 : 1
3. 4 : 1
4. 2 : 1

QUESTION

By blowing air in a soap bubble, the radius is increased from r to $3r$. Then the percentage increase in the surface energy of the bubble is-

1. 90%
2. 80%
3. 800%
4. 900%

QUESTION

A liquid does not wet the surface of a solid, if the angle of contact is

1. Obtuse
2. 90°
3. Acute
4. Zero

QUESTION

A capillary tube of radius r is immersed in a liquid and mass of liquid, which rises up in it is M. If the radius of tube is doubled, then the mass of liquid which will rise in capillary tube will be

1. 2M
2. M
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4. M/4

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2. 4 cm
3. 10 cm
4. 8 cm

QUESTION

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1. 100 cm
2. 10 cm
3. 1 cm
4. 0.5 cm

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2. $0 \leq \theta_1 < \theta_2 < \theta_3 < \frac{\pi}{2}$
3. $\frac{\pi}{2} < \theta_1 < \theta_2 < \theta_3 < \pi$
4. $\pi > \theta_1 > \theta_2 > \theta_3 > \frac{\pi}{2}$

QUESTION

Kerosene oil in a latem and melted wax in a candle, rise in the capillaries in the cotton wick.

QUESTION

The water from the soil rises in capillaries in the stems of planets and trees and reaches the branches and leaves.

QUESTION

In a gravity free space, a liquid in a capillary tube will rise to full length of the tube.

QUESTION

If the excess pressure inside a soap bubble is balanced by an oil column of height 2 mm, then the surface tension of soap solution will be ($r = 1$ cm, density of oil = $0.8\ g/cm^3$)

1. $3.9\ N/m$
2. $3.9 \times 10^{-2}\ N/m$
3. $3.9 \times 10^{-3}\ N/m$
4. $3.9 \times 10^{-1}\ N/m$

QUESTION

There is small hole in a hollow sphere. The water enters in it when it is taken to a depth of 40 cm under water. The surface tension of water is 0.07 N/m. The diameter of hole is?

1. 7 mm
2. 0.07 mm
3. 0.0007 mm
4. 0.7 m

QUESTION

Water rises to a height h in capillary tube. If the length of capillary tube above the surface of water is made less than h, then [Re-AIPMT+2015]

1. Water does not rise at all
2. Water rises upto the tip of capillary tube and then starts overflowing like a fountain
3. Water rises upto to top of capillary tube and stays there without overflowing
4. Water rises upto a point a little below the top and stays there

QUESTION

When a glass capillary tube of radius 0.015 cm is dipped in water, the water rises to a height of 15 cm within it. Assuming contact angle between water and glass to be 0°, the surface tension of water is [$\rho_{water} = 1000\ kg\ m^{-3}$, $g = 9.81\ ms^{-2}$]

1. $0.11\ Nm^{-1}$
2. $0.7\ Nm^{-1}$
3. $0.072\ Nm^{-1}$
4. None of these


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 01 | **Physics**

Thermal Properties Of Matter



By- Dr. Manish Raj (MR SIR)

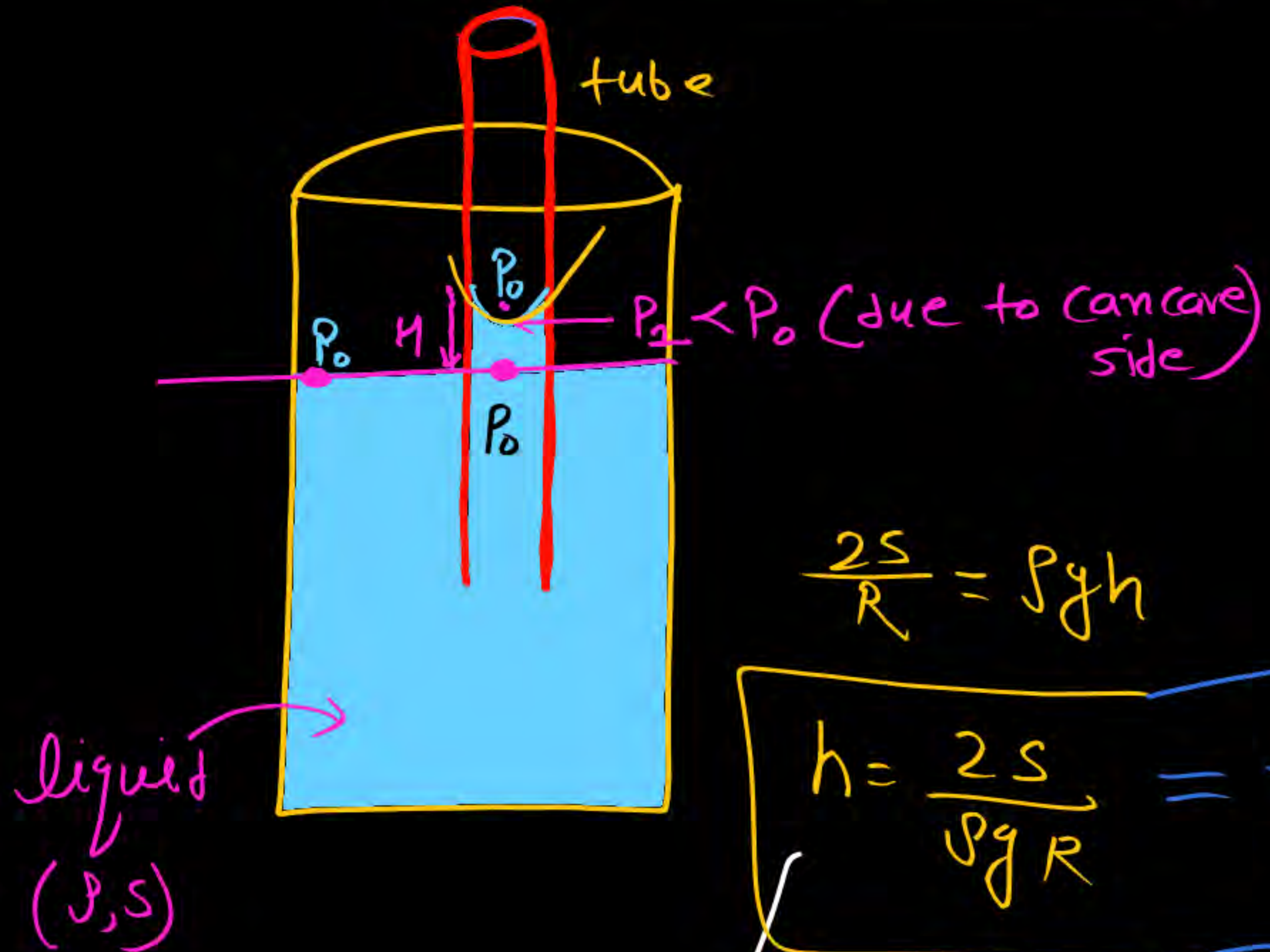
Todays Goal

→ Capillary tube ✓

→ Measurment of temprature ✓

Capillary rise → Cause is Surface Tension

contact angle $\theta < 90^\circ$



$$\frac{2S}{R} = \rho g h$$

$$h = \frac{2S}{\rho g R} = \frac{2S\cos\theta}{\rho g r}$$

→ Height of liquid in capillary tube.



$$R\cos\theta = r$$

$$R = \frac{r}{\cos\theta}$$

$(\cos\theta \downarrow \rightarrow \theta \uparrow)$

$h \propto S$

$h \propto \frac{1}{r}$

$h \propto \frac{1}{g}$

$h \propto \frac{1}{\rho}$

$h \propto \cos\theta$

$h \propto \frac{1}{\theta}$ *



lift $\uparrow a$ $\quad h = \frac{2S\cos\theta}{\rho(g+a)r}$

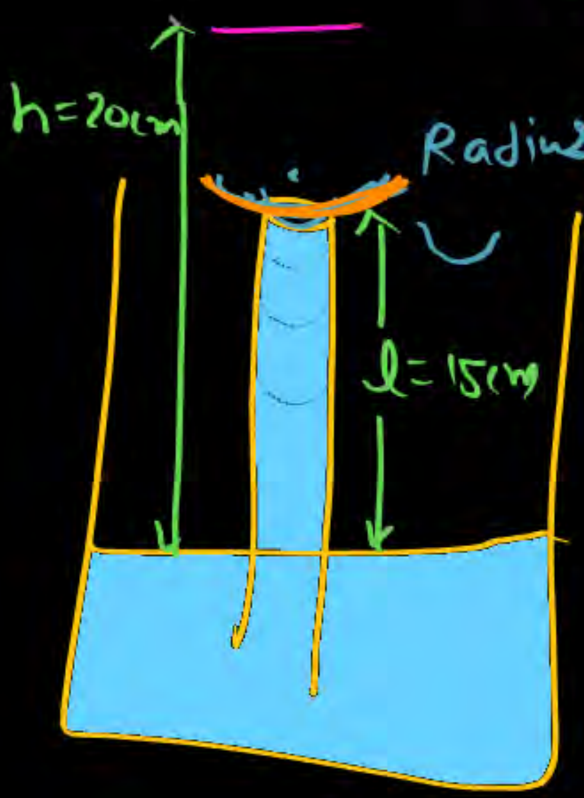
$\downarrow$ lift a $\quad h = \frac{2S\cos\theta}{\rho(g-a)r}$

Capillary tube of Insufficient length

$$h = \frac{2S\cos\theta}{\rho g r}$$

→ formula (h = 20cm) Left

but length of tube is only l = 15cm then what will have ??



$\Delta p = \frac{2S}{R\uparrow}$

~~(a) will over flow~~

(b) No over flow (80%) tube will compt fill & no overflow

Mass of liquid rise in capillary tube = $m = \rho \, \text{volume}$

$$M = \rho \pi r^2 H$$



$$m \propto r^2 \frac{1}{r} \propto r$$

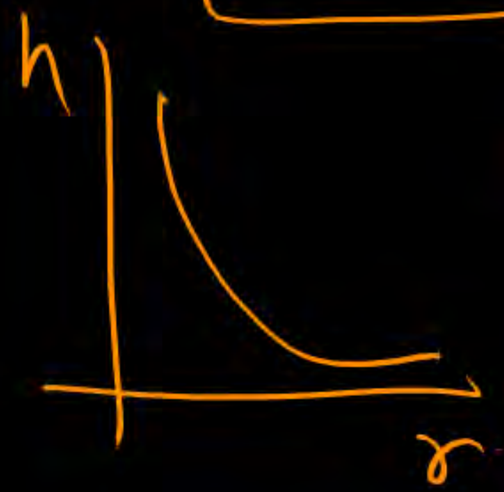
Potential energy of mass rise in a capillary tube

$$U = mgh$$

$$U \propto r \frac{1}{r}$$

$$U = r^0$$

$$h \propto \frac{1}{r}$$



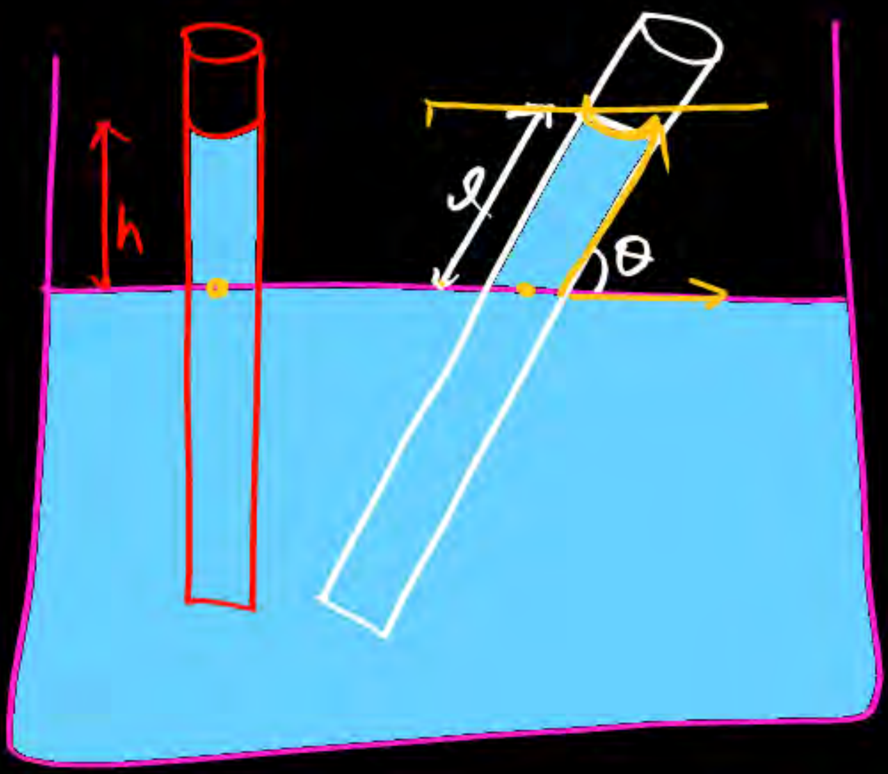


QUESTION

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1. 2M
2. M
3. M/2
4. M/4

Jourines law



$$\rho g h = \rho g l \sin\theta$$

$$h = l \sin\theta$$

$$l = \frac{h}{\sin\theta}$$

QUESTION

A capillary tube is dipped in water and it is 20 cm outside water. The water rises upto 8 cm. If the entire arrangement is put in freely falling elevator the length of water column in the capillary tube will be

1. 20 cm
2. 4 cm
3. 10 cm
4. 8 cm
5. infinity

$$h = \frac{2S\cos\theta}{\rho(g-g)h} = \frac{1}{0} = \infty$$

QUESTION

When a glass capillary tube of radius 0.015 cm is dipped in water, the water rises to a height of 15 cm within it. Assuming contact angle between water and glass to be 0°, the surface tension of water is [$\rho_{water} = 1000 \text{ kg m}^{-3}$, $g = 9.81 \text{ ms}^{-2}$]

1. 0.11 Nm^{-1}
2. 0.7 Nm^{-1}
3. 0.072 Nm^{-1}
4. None of these

$$h = \frac{2S\cos\theta}{\rho g r}$$

$$15\times10^{-2} = \frac{2\times S\cos0^\circ}{10^3\times10\times15\times10^{-5}}$$

$$15\times10^{-3}\times15 = 2S$$

QUESTION

Water rises to a height h in capillary tube. If the length of capillary tube above the surface of water is made less than h, then [Re-AIPMT+2015]

1. Water does not rise at all
2. Water rises upto the tip of capillary tube and then starts overflowing like a fountain
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3. $\frac{\pi}{2} < \theta_1 < \theta_2 < \theta_3 < \pi$
4. $\pi > \theta_1 > \theta_2 > \theta_3 > \frac{\pi}{2}$

$\theta_1 < \theta_2 < \theta_3$

$h = \frac{2S}{\rho g r \theta}$

$\rho\theta = \cos\theta$

$\theta \propto \frac{1}{\rho}$

QUESTION

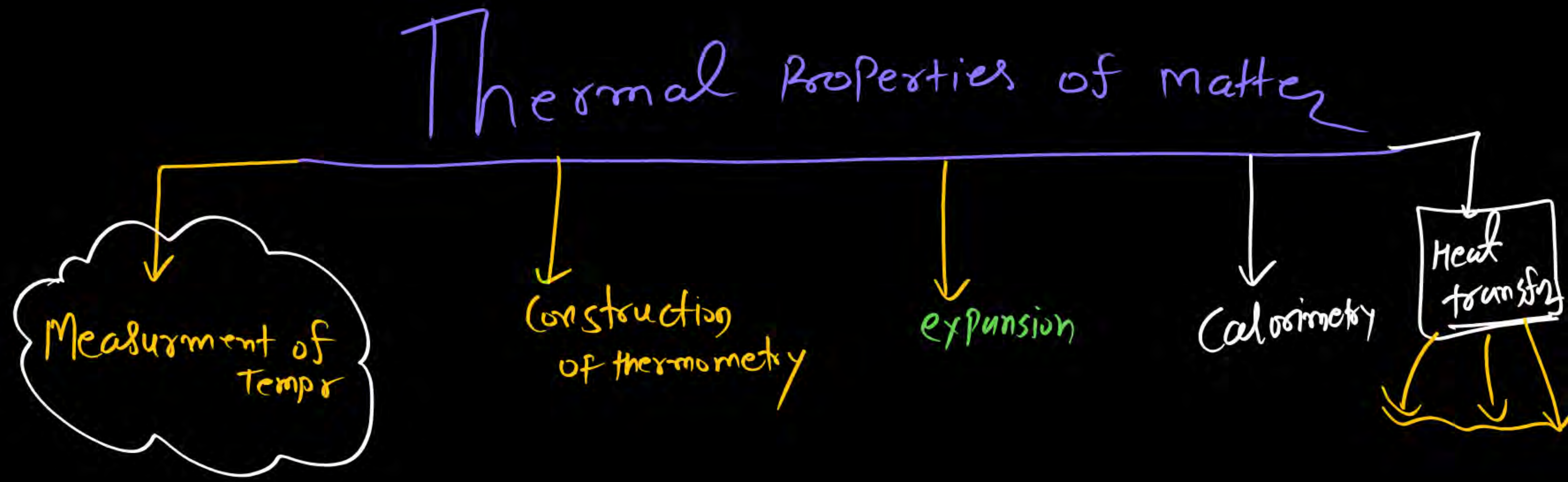
In a gravity free space, a liquid in a capillary tube will rise to full length of the tube.

→ True ✓

→ false ✗

$$H = \frac{2S\cos\theta}{\rho r g}$$

$H \propto$ infinite



Thermal Properties of matter
Measurment of Tempr
Construction of thermometry
expansion
Calorimetry
Heat transfr

QUESTION

Is 10 N force stored in a body?



due to this force velocity of object will chage

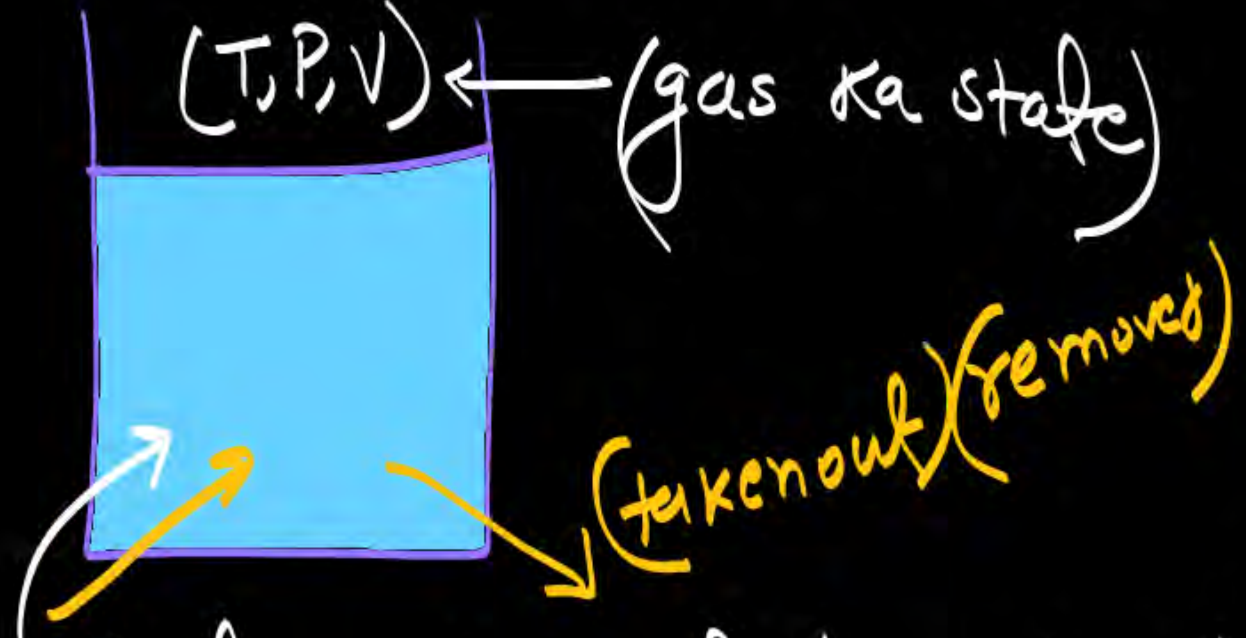
Ans: Force is an external cause of change in state, when we apply force on the body then, force does not stored in the body it only change in state of the body.

Thermodynamics

Heat — cause of change in state of gas. ✓

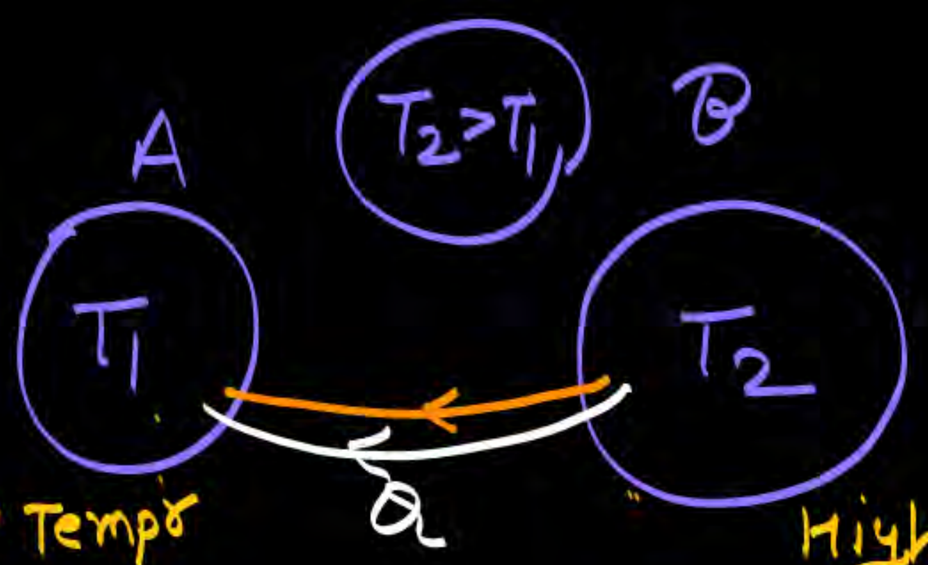
→ Can't stores in the gas.

→ Heat is a form of energy which is in transition state, due to Tempr differnce.



Heat → Cause of change in state (P, V, T) of gas.

#



Low Tempr — High Tempr ✓

✗ Low heat — High heat ✗ (heat does not store)

Heat will flow from B to A due this

- B will loss some heat & its Tempr will decrs
- A will gain some heat & its Tempr will Incrse

QUESTION

If heat is give to the body, then body will store that heat → NO

due to heat Tempr may Increase

QUESTION

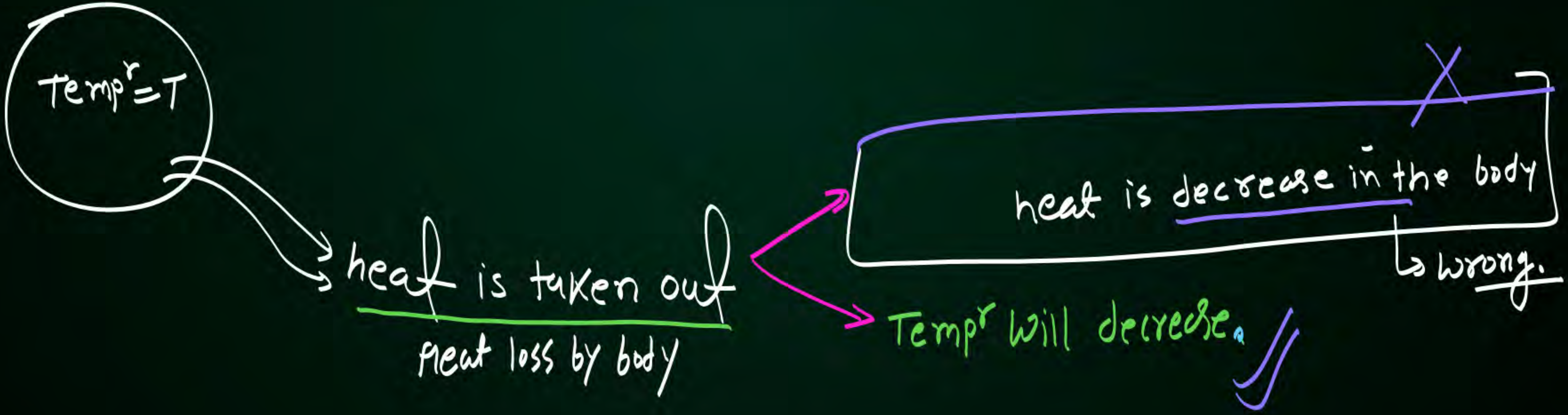
If heat is given to the body, then body will gain some heat → yes

↳ but heat will not store

QUESTION

If temperature of the body is decreasing hence some temperature loss by the body → NO

(Temp^r ↓ → Heat loss)





If $T_1 > T_2$

A have more heat → wrong.

→ but due to high tempr A will lose some heat & decr in Tempr & B gain some & its Tempr T_2 will Incrse.

QUESTION

If some heat is removed then, heat decrease in a body (NO)

Tempr decrse

Thermal Properties of Matter

Temperature:-

- Measure of hotness and coldness is called temperature.
- It define physical state of matter
- Unit Kelvin (K) SI unit
- Practical unit °C/F/Rankine.

Heat:-

- Energy which flow from one-body to other due to temperature difference
- It can not store by the body
- Not define state of a body
- Unit (J) [redacted]

1. Heat can loss by body ⟶ Yes
2. Heat can gain by body ⟶ Yes
3. Heat can Increse in body → NO
4. Heat can decreses in body after ejecting heat ⟶ NO
5. Heat removed then heat dect → NO
6. heat remove then Tempr dec → Yes

7. Heat given then Tempr Incs

Yes

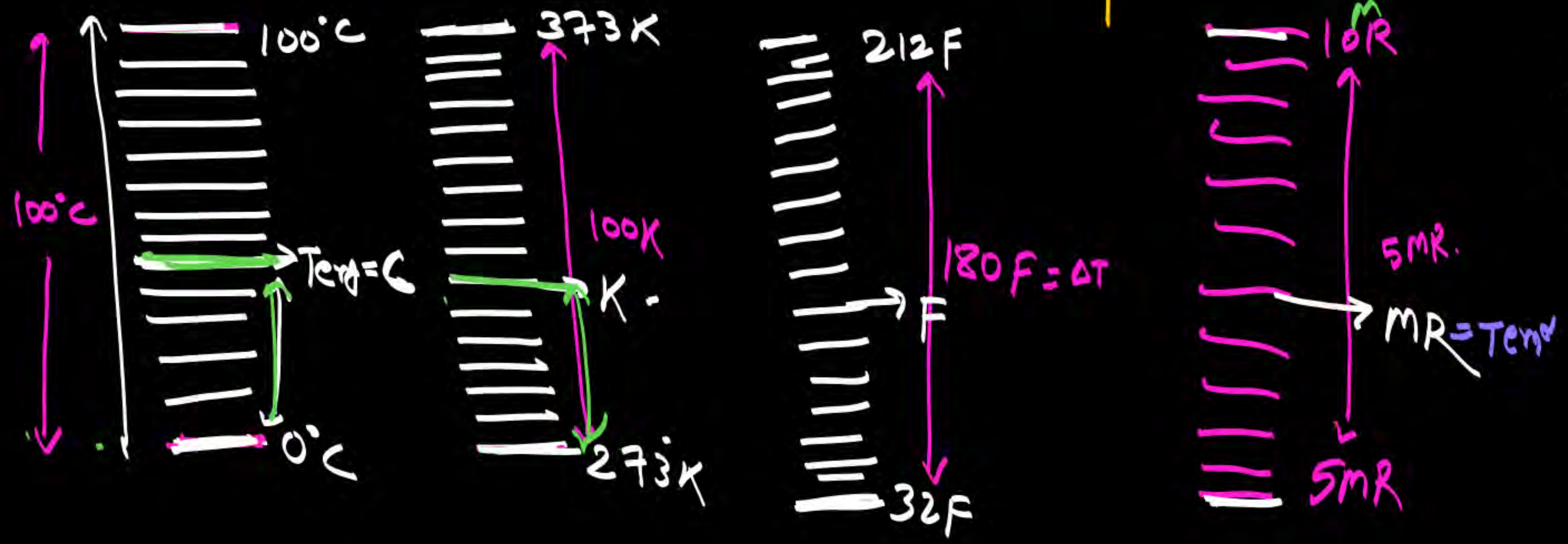
If Tempr is given then heat will Incres → false

Measurment of Tempr

Ramlal

M.F.P

Boiling wate →	100°c	373 K	212 F	10 MR
frezig point of wate →	0°c	273 K	32 F	5 MR



$$\frac{T-0}{100-0} = \frac{K-273}{373-273} = col^n$$

$$\frac{\text{Temp}^r - L.F.P}{U.F.P - L.F.P} = \text{Constn.}$$

Tempr in M.R-scale

$$\frac{C - 0}{100 - 0} = \frac{K - 273}{373 - 273} = \frac{F - 32}{212 - 32} = \frac{T_{MR} - 5}{10 - 5}$$

		Ice point	Boiling point
Scale	Symbol	L.E.P.	U.F.P.
Celsius	°C	0°C	100°C
Kelvin	K	273K	373K
Fahrenheit	°F	32°F	212°F
Rankine	Ra	492° RA	672° RG
Reaumer	Re	0° Re	80° Re

Measurement of Temperature

$$\frac{\text{Temp.} - \text{L. E. P (melting point of ice)}}{\text{U. F. P (upper fixed point). (B. P. of water)} - \text{L. F. P}} = \cos^{\circ}$$

$$\frac{C - 0}{100 - 0} = \frac{F - 32}{212 - 32} = \frac{K - 273}{373 - 273} = \cos t^{n}$$

Relation between Kelvin and Celsius

$$\frac{C-0}{100-0} = \frac{K-273}{373-273}$$

$$\frac{C}{100} = \frac{K-273}{100}$$

$$\boxed{C = K - 273}$$

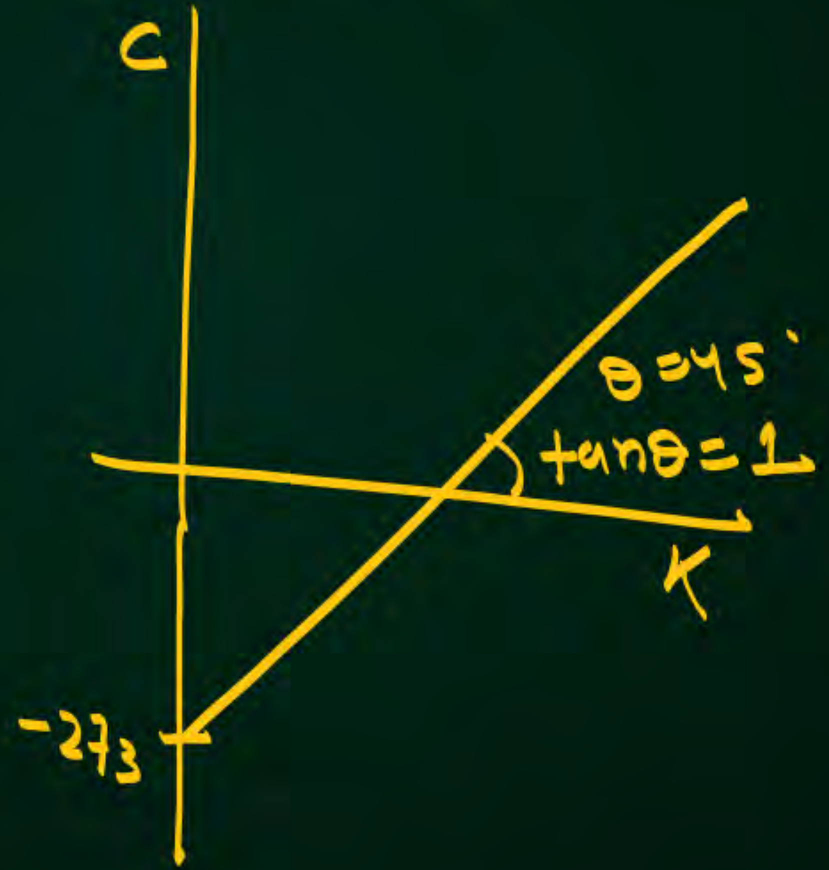
$$\boxed{K = 273 + C}$$

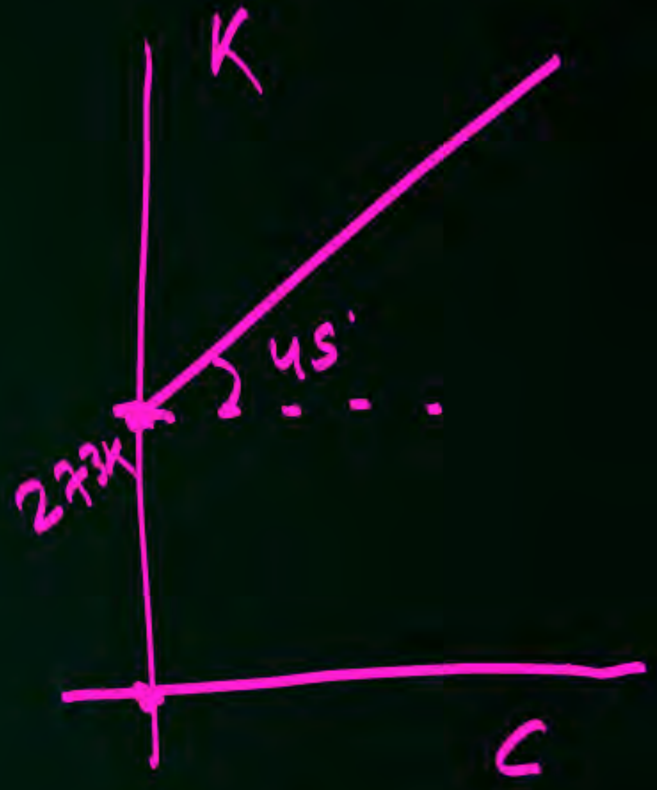
$y = mx + c$

$K = m\,C + 273$

$C = 1K - 273$

$y = mx + c$





$K = C + 273$

$$\boxed{\Delta K = \Delta C}$$

→ change in Tempr in Kelvin = Change in Tempr in °C

QUESTION

If temperature of an object is 27°C, then its temperature in kelvin?

1. 27K
2. 273K
3. 300K
4. 246K

$\Delta C = \Delta K$

$27^\circ = K$

$K = C + 273$

$= 27 + 273$

$= 300K$

QUESTION

If temperature of object raised by 27°C. Then raise temperature in kelvin?

Ans

27 K

Ans

Relation between Fahrenheit and Celsius

$$\frac{F-32}{212-32} = \frac{C-0}{100-0}$$

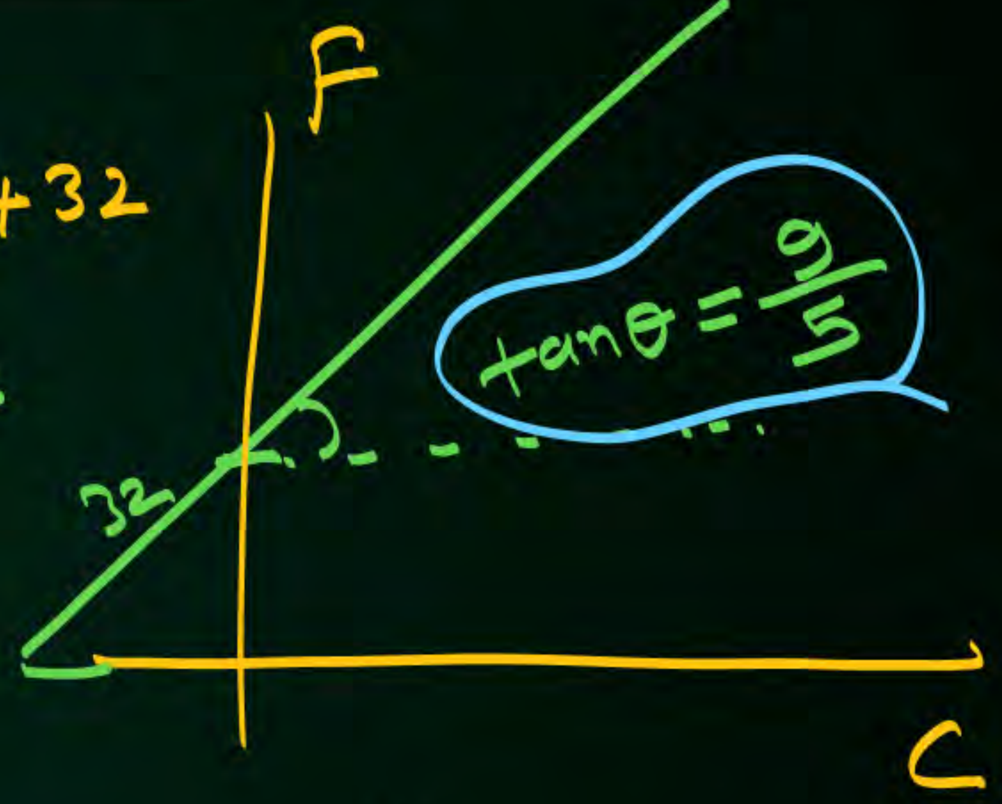
$$\frac{F-32}{180} = \frac{C}{100}$$

$$\frac{F-32}{9} = \frac{C}{5}$$

$$F-32 = \frac{9C}{5}$$

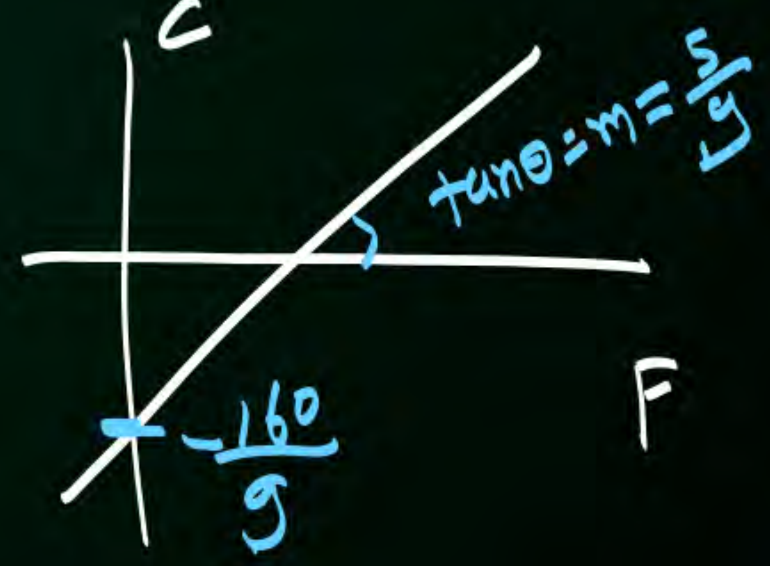
$$F = \frac{9C}{5} + 32$$

$$y = mx + c$$



$$\frac{5F-160}{9} = C$$

$$C = \frac{5F}{9} - \frac{160}{9}$$



$$\frac{F-32}{\cancel{180}\,9} = \frac{C}{\cancel{100}\,5}$$

$$\boxed{\frac{F-32}{9} = \frac{C}{5}}$$

C & F graph

$$C = \frac{5F}{9} - \frac{160}{9}$$

$$\boxed{F = \frac{9C}{5} + 32}$$

F & C graph

$$F = \frac{9C}{5} + 32$$

diffⁿ

$$\Delta F = \frac{9}{5}\Delta C + 0$$

$$\boxed{\Delta F = 1.8\,\Delta C}$$

Change in Tempʳ °F

Tempʳ change in °C

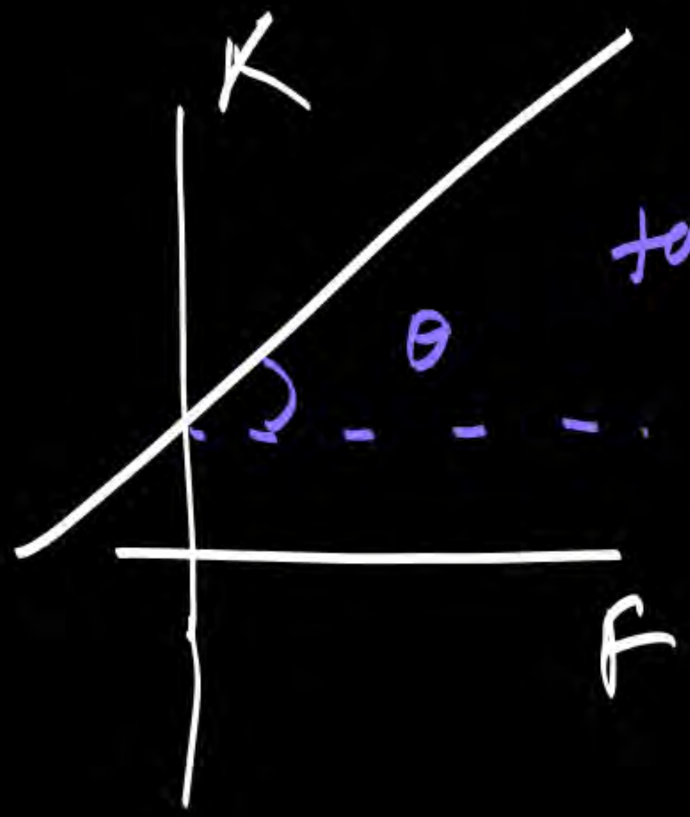
Relⁿ b/w K & F

$$\frac{K-273}{\cancel{100}\;5} = \frac{F-32}{\cancel{180}\;9}$$

$$\frac{K-273}{5} = \frac{F-32}{9}$$

$$K - 273 = \frac{5F}{9} - \frac{160}{9}$$

$$K = \frac{5F}{9} + \underbrace{\left(273 - \frac{160}{9}\right)}_{+ve}$$



$\tan\theta = \frac{5}{9}$

QUESTION

A temperature different of 5°C on Celsius scale corresponds to the following temperature difference in the Fahrenheit scale:

1. 9° ✓ 74%
2. 41°
3. 2.8°
4. 15°

$1.8\,\Delta C = \Delta F$

$1.8 \times 5 = \Delta F$

QUESTION

At what temperature, the centigrade (Celsius) and Fahrenheit readings are the same?

1. -40°
2. 40°
3. 36.6°
4. -37°

QUESTION

0°C is equivalent to the following:

1. 273.15 K
2. 273 K
3. 0 K
4. 32 K

$0°C \rightarrow 32°F \rightarrow 273K$

QUESTION

If temperature of patient is 40°C his temperature in the Fahrenheit scale will be

1. 72°F
2. 96°F
3. 100°F
4. 104°F

$$\frac{C-0}{100} = \frac{F-32}{180}$$

$$\frac{40}{5} = \frac{F-32}{9}$$

$$72 = F - 32$$

$$F = 72 + 32 = 104\,F$$

QUESTION

The freezing point on a thermometer is marked as 20° and the boiling point as 150°. A temperature of 60°C on this thermometer will be read as in new scale.

1. #
2.
3.
4.

$$\frac{C-0}{100-0} = \frac{T-20}{150-20}$$

$$\frac{60}{100} = \frac{T-20}{130}$$

$$78 = T-20$$

$$T = 98°$$

QUESTION

L.F.P U.F.P

A faulty thermometer has its fixed points marked at 60° and 96°. What is the correct temperature on the Centigrade scale when this thermometer reads 85°?

1. 83°C
2. 93°C
3. 90°C
4. 85°C
5. 69.44

$$\frac{85-60}{96-60} = \frac{C}{100}$$

$$\frac{25}{36} = \frac{C}{100}$$

$$C = \frac{25 \times 25}{9}$$

QUESTION

Ona new scale of temperature (which is linear) and called the W scale, the freezing and boiling points of water are 39° W and 239° W respectively. What will be the temperature on the new scale, corresponding to a temperature of 39°C on the Celsius scale?

1. 78° W
2. 117° W
3. 200° W
4. 139° W

QUESTION

A centrigrade and a Fahrenheit thermometer are dipped in boiling water. The water temperature is lowered until the Fahrenheit thermometer registers 140°F. What is the fall in temperature as registered by the centrigrade thermometer.

1. 40°
2. 80°
3. 50°
4. 90°

Construction of thermometre

Ex → Resistance thermometre

- ✓ Pressure "
- ✓ Volume "
- length "

- length of Rod at 0°c → L_0
- length of Rod at 100°c → L_{100}
- Length of Rod at t°c = L_t



Change in length when Tempr change from 0° to 100°c $= L_{100} - L_0$

Change in length when Tempr change from 0°c to t°c $= L_t - L_0$

Change in length per unit raise in Tempr

$$\# \quad \frac{L_{100} - L_0}{100} = \frac{L_t - L_0}{t}$$

$$t = \frac{L_t - L_0}{L_{100} - L_0} \times 100$$

Construction of Thermometer

- Length of Rod at 0°C is L_0

  Length of Rod at 100°C is = L_{100}

  Length of Rod at temperature t°C = L_t

Change in length when temperature changes from 0°C to 100°C

Change in length per unit raise in temperature

Thermal Properties of Matter

If resistance at 0°C is R_0

If resistance at T°C is R_t

If resistance at 100°C is R_{100}

- Change in resistance, when temperature change from 0°C to 100°C = $R_{100} - R_0$
- Change is resistance, when temperature changes from 0°C to t°C = $R_{t°C} - R_{0°C}$
- Change in resistance per unit raise in temperature.

Pressure thermometer

Volume thermometer

Resistance thermometer

QUESTION

Resistance at $25°C$ is 50Ω and at $100°C$ is 80Ω, then find resistant at $60°C$.

#TayyariSelectionKi!

HURRY UP!

REGISTRATION CLOSING SOON FOR NEET REAL TEST 01!

REAL TEST SERIES

Registration Closing Date for Test 01 – 10 Oct 2024

Exam Date - 13 Oct 2024 (online)

#TayyariSelectionKi!

NEET REAL TEST 01 SYLLABUS

11th NEET REAL TEST SERIES SYLLABUS

Cohort	Class	Name of the Test	Exam Date	Mode	Physics	Chemistry	Botany	Zoology
NEET	11	Test 1	13-Oct-2024	Online	Basic Maths & Calculus (Mathematical Tools) Vectors Units and Measurements Motion in a straight line	Structure of Atom Some Basic Concepts of Chemistry Classification of Elements and Periodicity in Properties	Cell - The Unit of Life Cell Cycle and Cell Division	Structural Organization in Animals Breathing and Exchange of Gases

12th NEET REAL TEST SERIES SYLLABUS

Cohort	Class	Name of the Test	Exam Date	Mode	Physics	Chemistry	Botany	Zoology
NEET	12	Test 1	13-Oct-2024	Online	Electric Charges and Fields Electrostatic Potential and Capacitance	Solution Electrochemistry	Sexual Reproduction in Flowering Plant	Human Reproduction

DROPPER NEET REAL TEST SERIES SYLLABUS

Cohort	Class	Name of the Test	Exam Date	Mode	Physics	Chemistry	Botany	Zoology
NEET	Dropper	Test 1	13-Oct-2024	Online	Basic Maths & Calculus (Mathematical Tools) Vectors Units and Measurements Motion in a straight line Motion in a plane Circular motion Laws of motion	Some Basic Concept of Chemistry Redox Reaction Solutions Thermodynamics Equilibrium Electrochemistry	Cell - The Unit of Life Cell Cycle and Cell Division The Living World Biological Classification Plant Kingdom Morphology of Flowering Plants	Structural Organization in Animals Breathing and Exchange of Gases Body Fluids and Circulation Excretory Products & their Elimination

Opportunity For Class 6th to 12th Students

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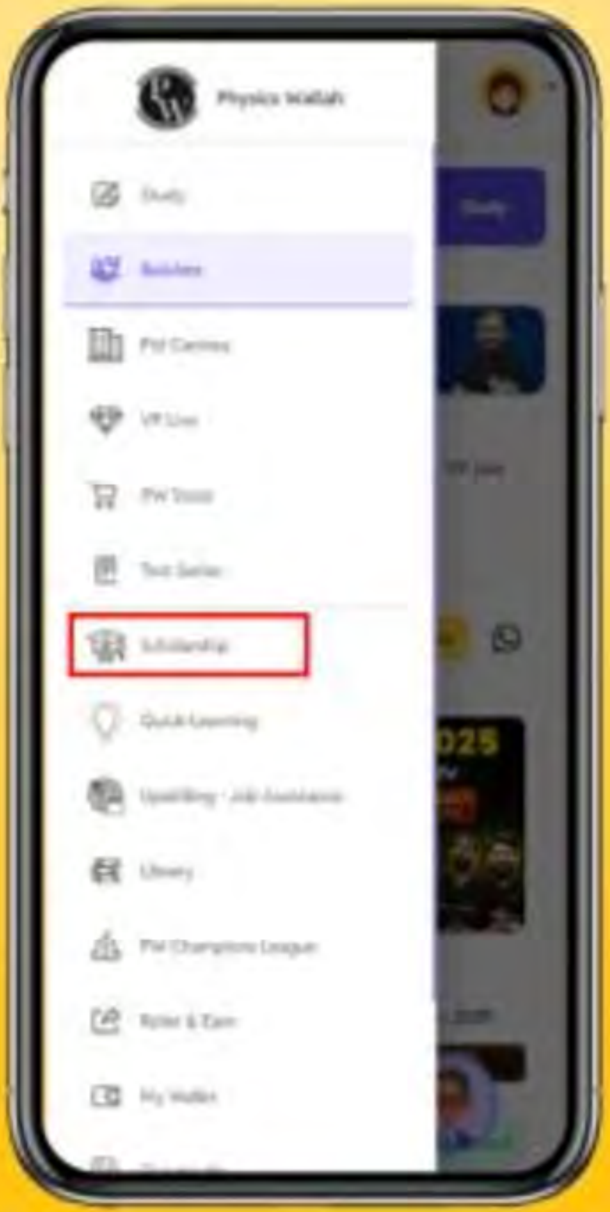
12 Lakh+ Students Already Registered for PWNSAT

- **Exam Mode:** Online & Offline
- **Exam Time:** Online 1st to 15th Oct (Daily)
  Offline 6th & 13th Oct
- **Exam Timing:** Online Any time on Exam Day (24 Hr. Window)
  Offline (10:00 to 11:00 AM & 04:00 to 05:00 PM)
- **Exam Duration:** 60 Minutes

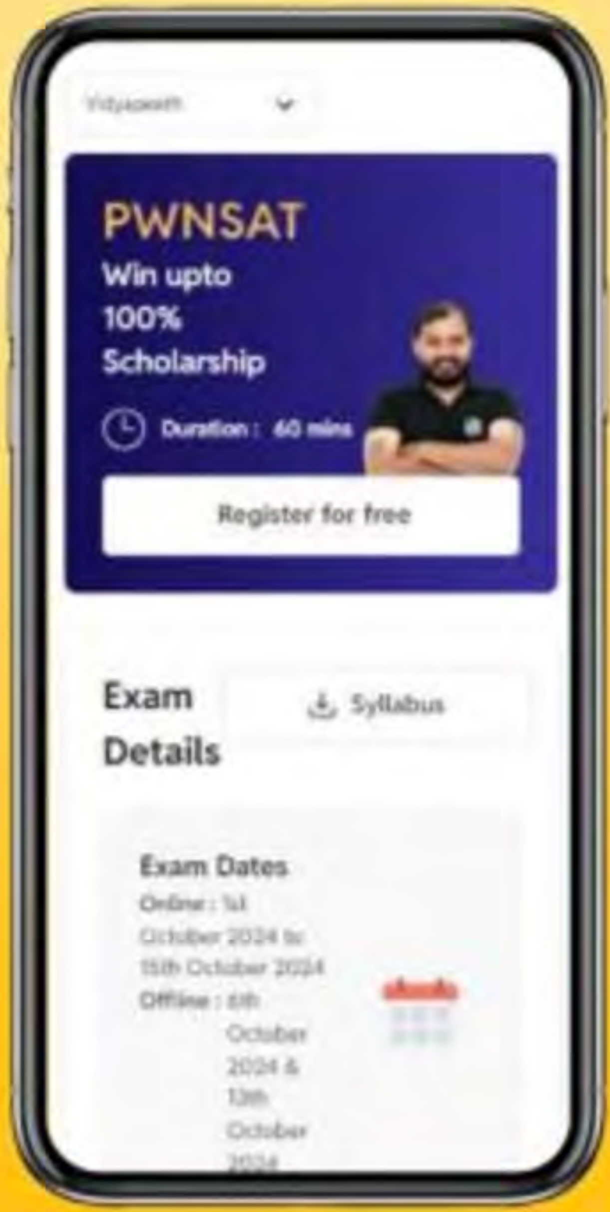
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PHYSICS WALLAH

Why PW AITS 2025 ?

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PHYSICS WALLAH
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THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 2 | Physics

Thermal Properties Of Matter

By- Dr. Manish Raj (MR SIR)



Topics to be covered

1. # expansion
2. #
3. #



Thermal Properties of Matter

If resistance at 0°C is R_0

If resistance at T°C is R_t

If resistance at 100°C is R_{100}

- Change in resistance, when temperature change from 0°C to 100°C = $R_{100} - R_0$
- Change is resistance, when temperature changes from 0°C to t°C = $R_{t°C} - R_{0°C}$
- Change in resistance per unit raise in temperature.

QUESTION

Resistance at 25°C is 50Ω and at 100°C is 80Ω, then find resistant at 60°C.

$t_1 = 25^\circ C \rightarrow R_1 = 50\,\Omega$ — (i)

$t_2 = 100^\circ C$ — $R_2 = 80\,\Omega$ — (ii)

$t_3 = 60^\circ C \rightarrow R = ??$

MR* $50\,\Omega < R < 80\,\Omega$

$$\Rightarrow \frac{80-50}{75} = \frac{R_{60}-50}{60-25}$$

$$\frac{30}{75} = \frac{R-50}{35}$$

$$14 = R - 50$$

$$R = 50 + 14$$

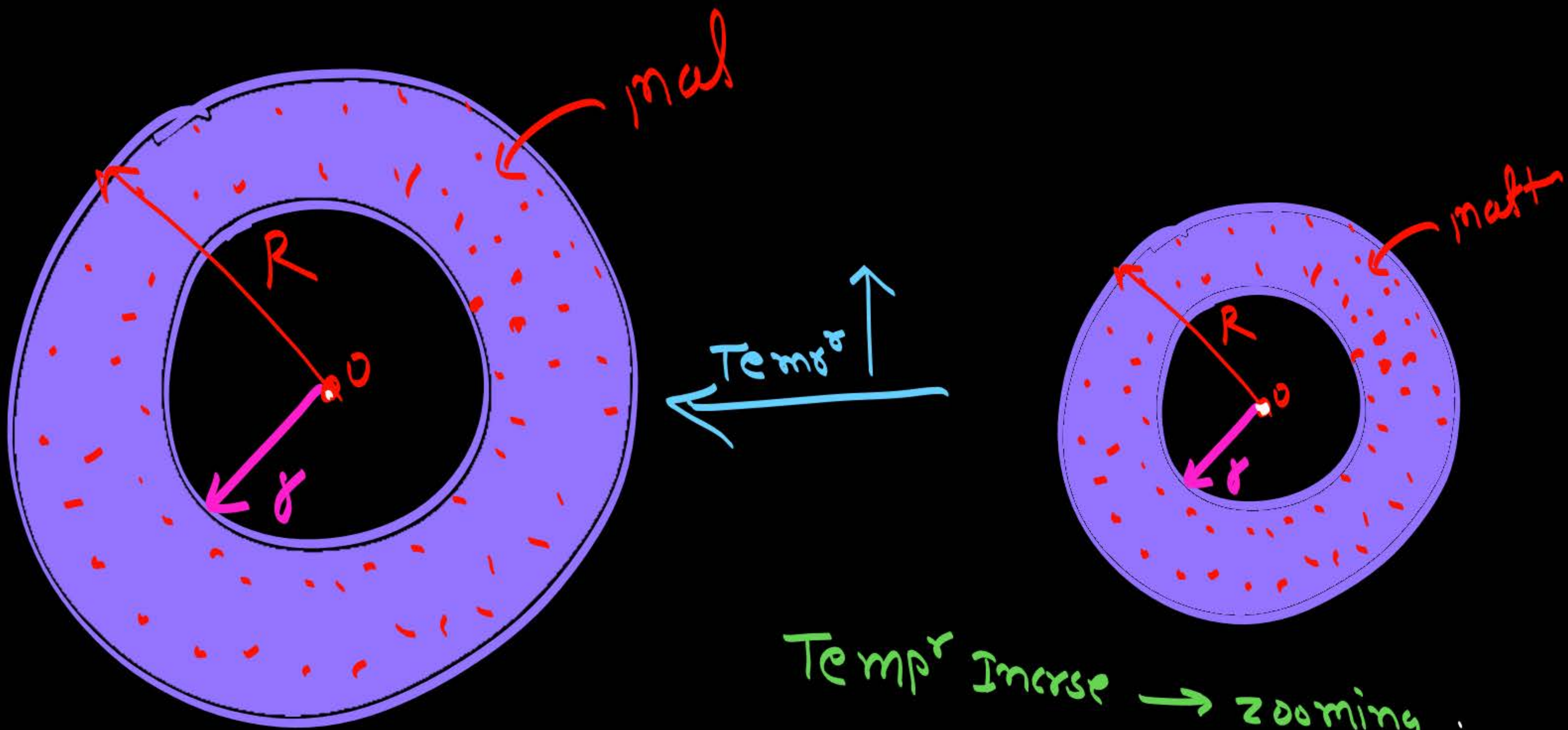
$$R = 64\,\Omega$$

Thermal Expansion

Temperature ↑ Increase

(Inter molecular force) ↓ Cohesive force

Inter molecular distance ↑ (expansion)



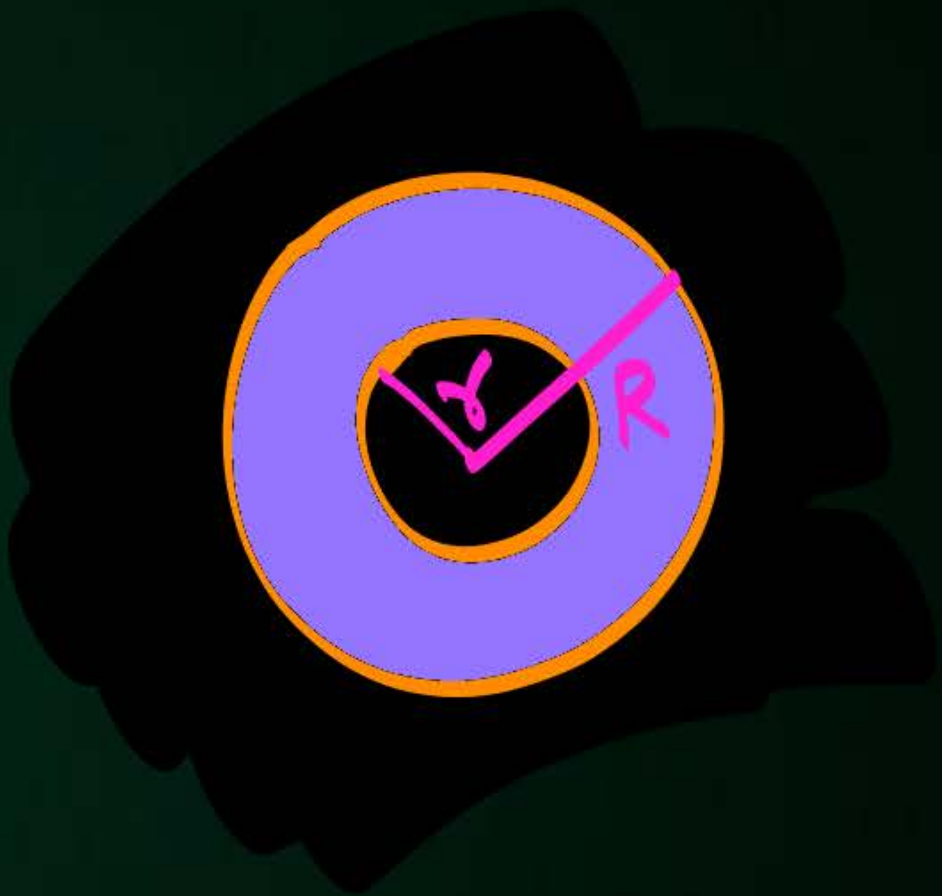
Tempr Incrse → zooming

$R\uparrow, r\uparrow$

QUESTION

Angular disc; when temperature increases then

1. R↑, r↓
2. R↓, r↑
3. R↑, r↑
4. R↓, r↓



When isotropic material is heated then all linear dimension increases but not angular dimension; its just a photographic enlargement.



Solid
- → Linear expansion (1-D, 2D & 3D)
- → Areal expansion or superficial expansion (2D & 3D)
- → Volume expansion (only 3-D)

for Liquid and gas → only volume expansion. (is defined)

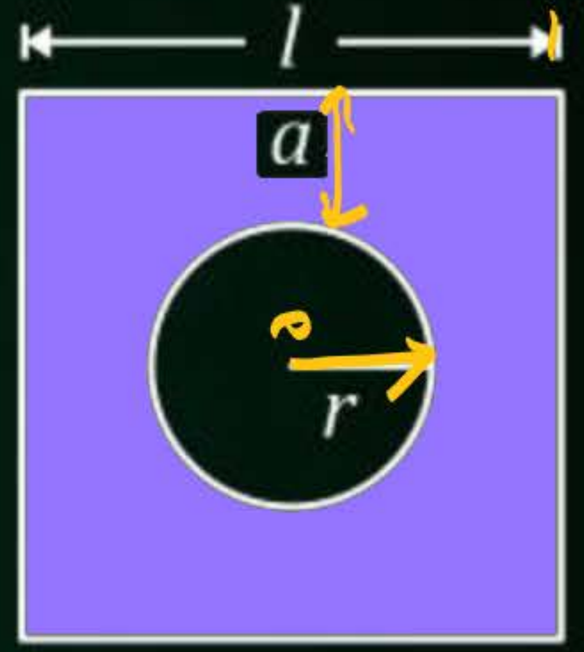


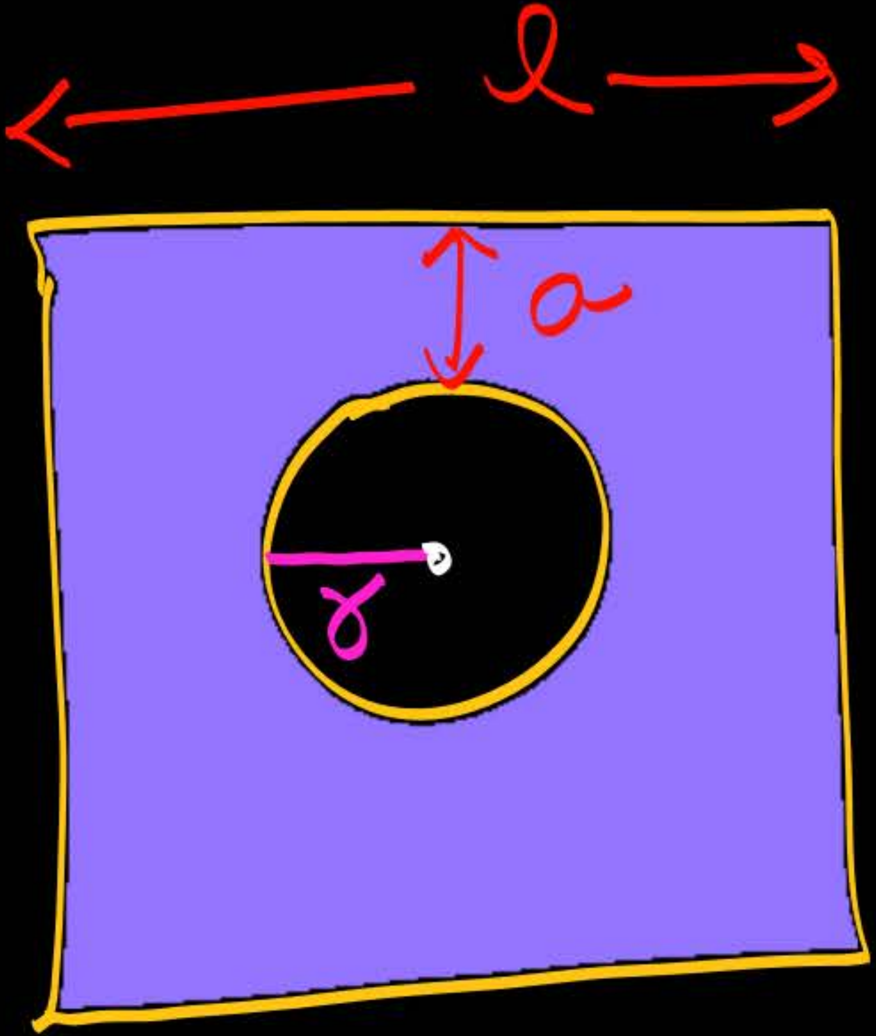

Ramlal
gold, silver
winter
Tempr ↑
Summer में sell

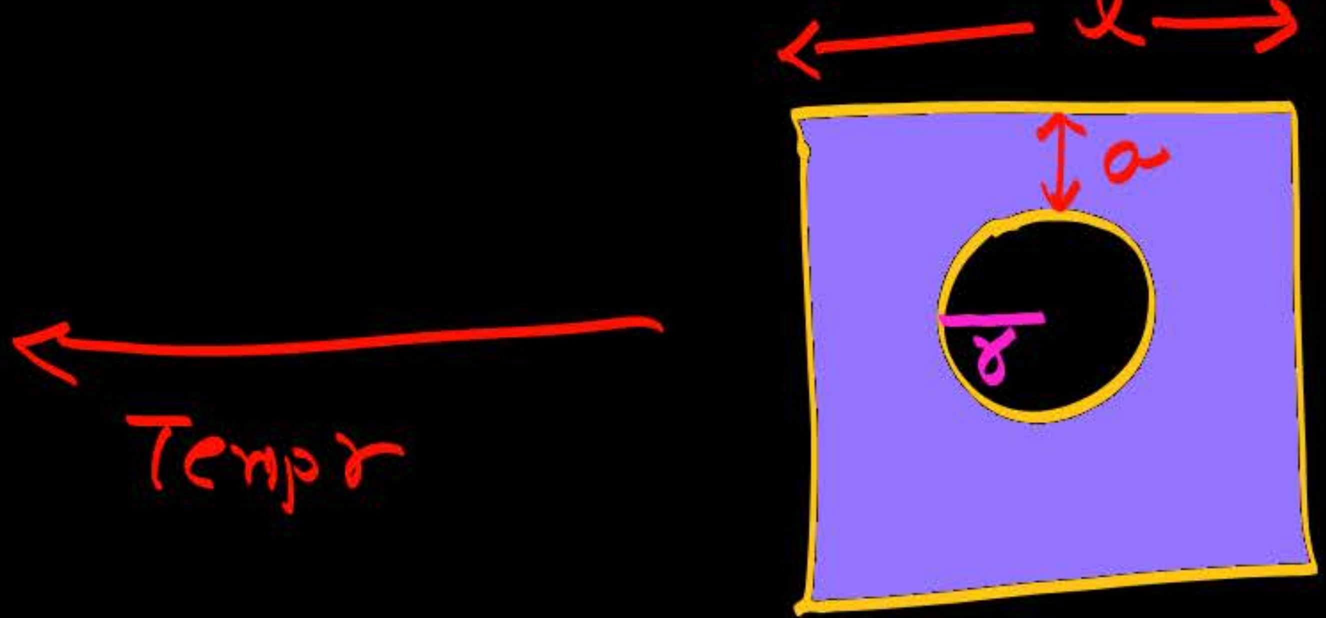
QUESTION

If temperature increases.

1. $l\uparrow, r\uparrow, a\downarrow$
2. $l\uparrow, r\downarrow, a\downarrow$
3. $l\uparrow, r\uparrow, a\uparrow$
4. $l\uparrow, r\downarrow, a\uparrow$





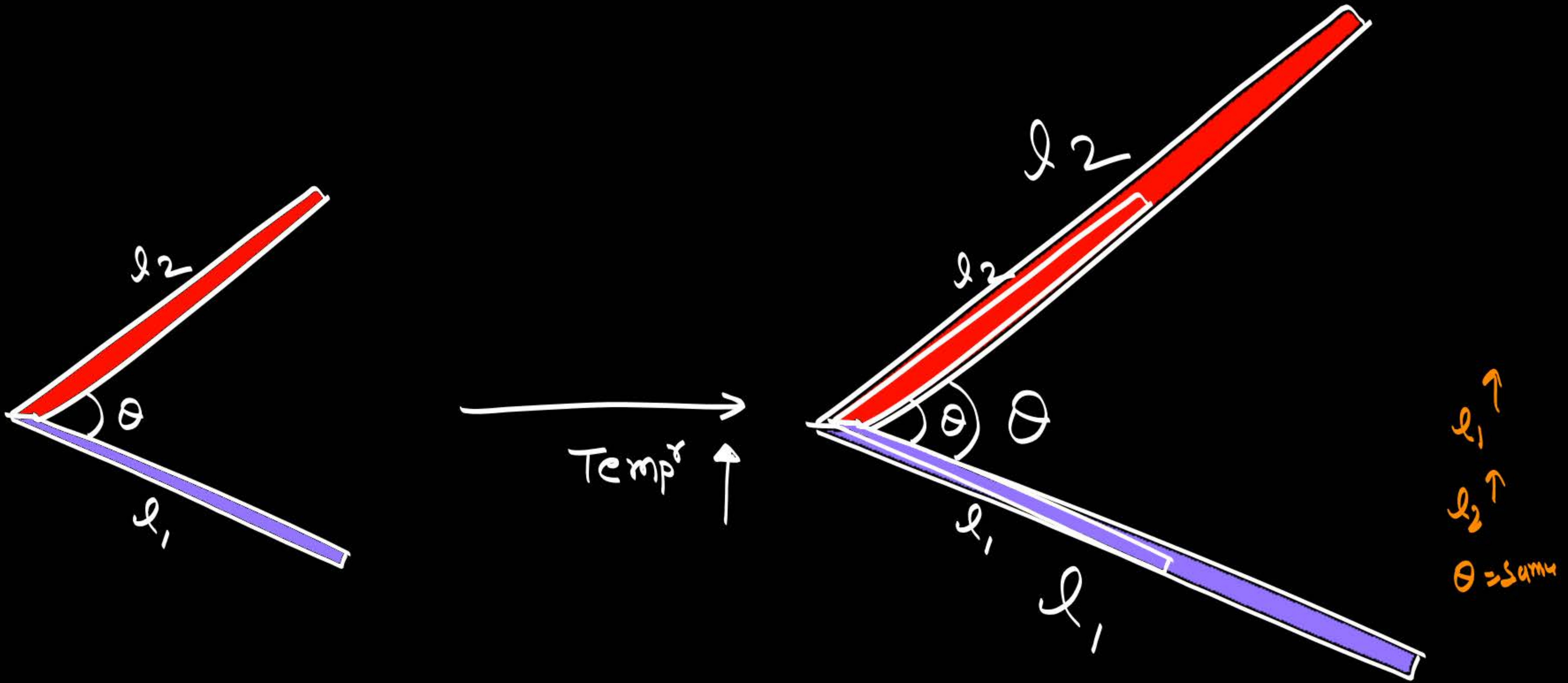


r ↑ ✓

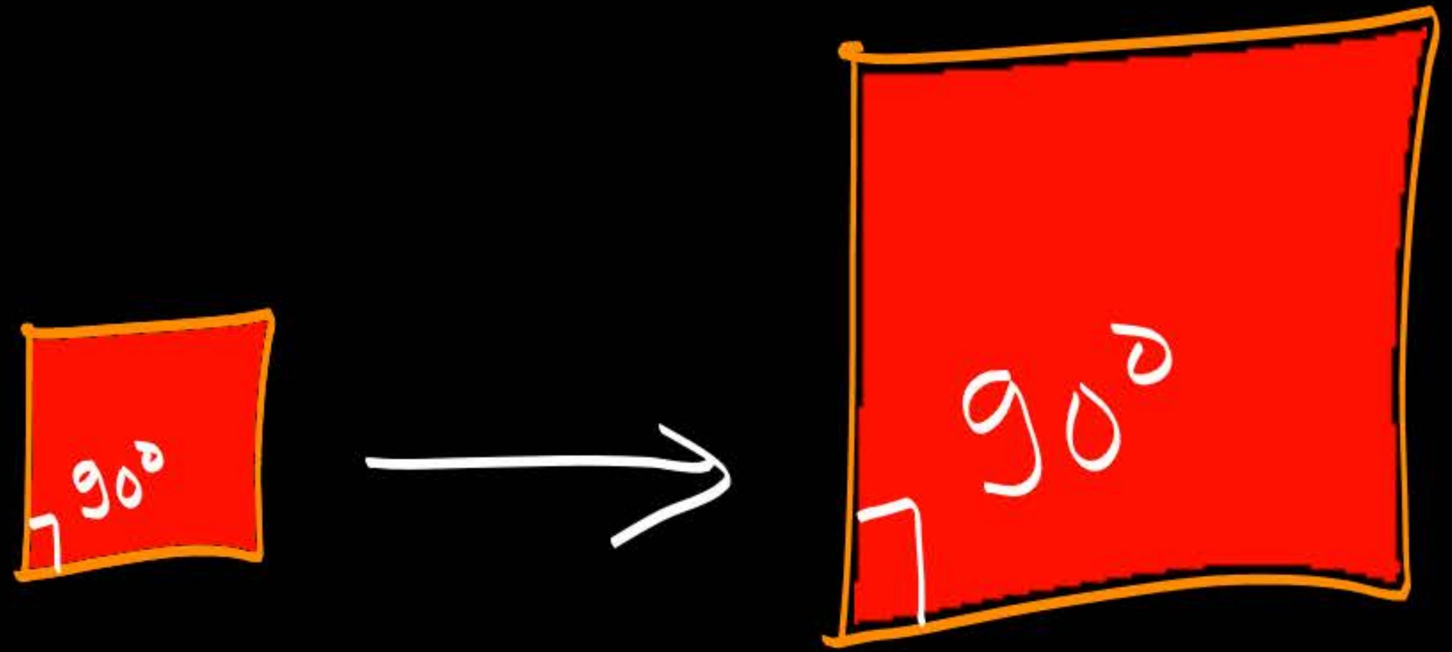
l ↑ ✓

a ↓ (decrse) X

a ↑ ✓



l2
θ
l1
Temp^r ↑
l2
l2
θ
θ
l1
l1
l1 ↑
l2 ↑
θ = same


90°
90°

QUESTION

As temperature decrease then change in length.

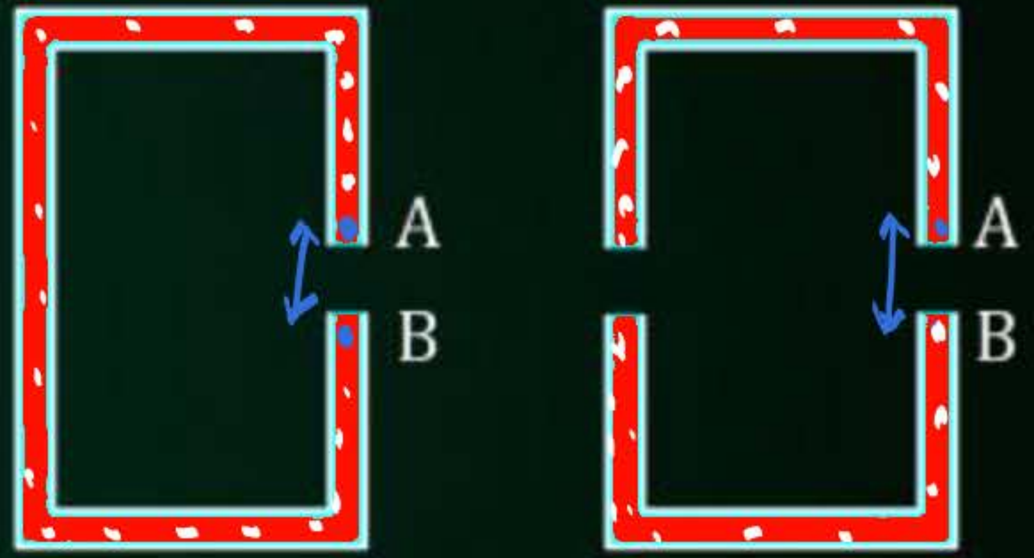


$L\downarrow$, $l\downarrow$

QUESTION

Distance between A and B will increase or decrease as temperature increases.

1. In both figure increase
2. In both figure decrease
3. In figure 1 increase & figure 2 decrease
4. In figure 1 decrease & figure 2 increase



Thermal Expansion:- Linear expansion ✓

$\Delta l \propto l_0$ (initial length)

$\Delta l \propto \Delta T$ (Temp^r Increase)

$$\Delta l = \alpha_T l_0 \Delta T$$

α_T = Coefficient of linear expansion

→ Property of crystal

initial length = l_0 (Temp^r = t_i)



$$\Delta l = \alpha_T l_0 \Delta T$$

$l_f - l_0 = l_0 \alpha_T \Delta T$

$l_f = l_0 + l_0 \alpha_T \Delta T$

$$l_f = l_0 (1 + \alpha_T \Delta T)$$

↑ final length

l_0 = initial length

$$\frac{\Delta l}{l_0 \Delta T} = \alpha_T$$

fractional change in length per unit raise in Temp^r $= \alpha_T$

$$\frac{\Delta l}{l_0 \Delta T} = \alpha_T$$

$$100 \times \frac{\Delta l}{l_0} = \alpha_T \Delta T \times 100$$

% change in length $= \alpha_T \Delta T$

Time Period of clock-Tower Based on oscillation of simple pendulum

$$T = 2\pi\sqrt{\frac{l}{g}}$$

→ Temp ↑ → length ↑ (Time period) ↑ (clock - slow) loss in time (summer)

→ Temp ↓ → length ↓ (Time period) ↓ (clock fast) → gain in time

$$\Delta T = \frac{1}{2}\alpha T \Delta\theta$$

ΔT → loss / gain in time in Time (T)

α = coeffici of lin. expn.

T = time

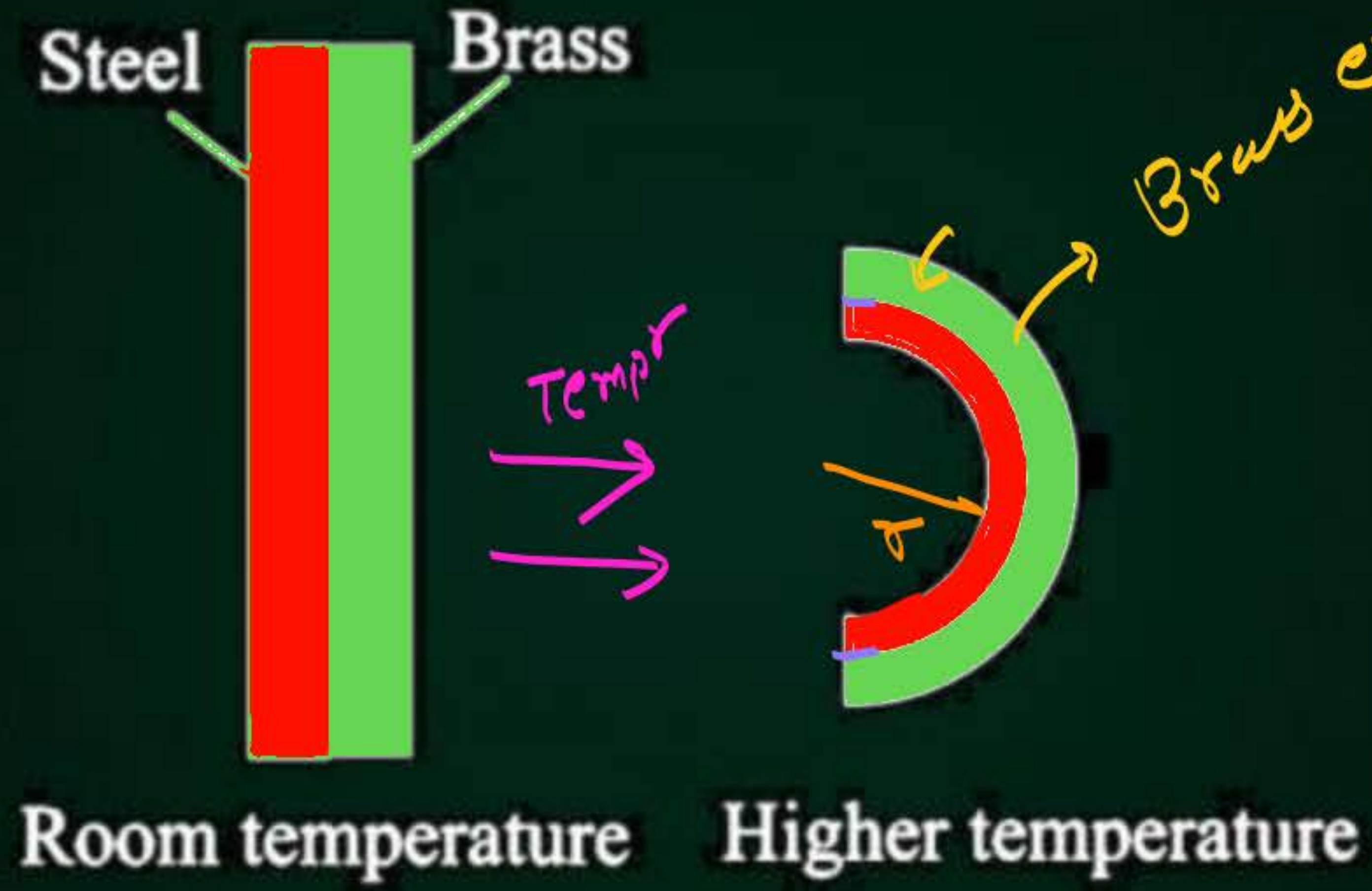
$\Delta\theta$ = change in Temp

⇓ error analysis

$$\frac{\Delta T}{T} = \frac{1}{2}\frac{\Delta l}{l}$$

$$\frac{\Delta T}{T} = \frac{1}{2}\alpha\,\Delta\theta$$

Bi-metalic strip



Brass expant more

$\alpha_B > \alpha_{steel}$

Thermal stress



If Temp^r is Increas by ΔT then due to which fraction change in length

$$\frac{\Delta l}{l} = \alpha \Delta T \quad \text{— (I)}$$

Hook नियम

$$\frac{F}{A} = Y \frac{\Delta l}{l}$$

$$\boxed{\frac{\Delta l}{l} = \frac{F}{AY}} \quad \text{— (II)}$$

(I) = (II)

$$\frac{F}{AY} = \alpha \Delta T$$

$$\boxed{\frac{F}{A}} = Y \alpha \Delta T$$

$\frac{F}{A}$ → Thermal stress

Y → Young modulus

α = Coefficient of linear exp^n

QUESTION

A metallic bar is heated form $0°C$ to $100°C$. The coefficient of linear expansion is $10^{-5}\ K^{-1}$. What will be the percentage increase in length -

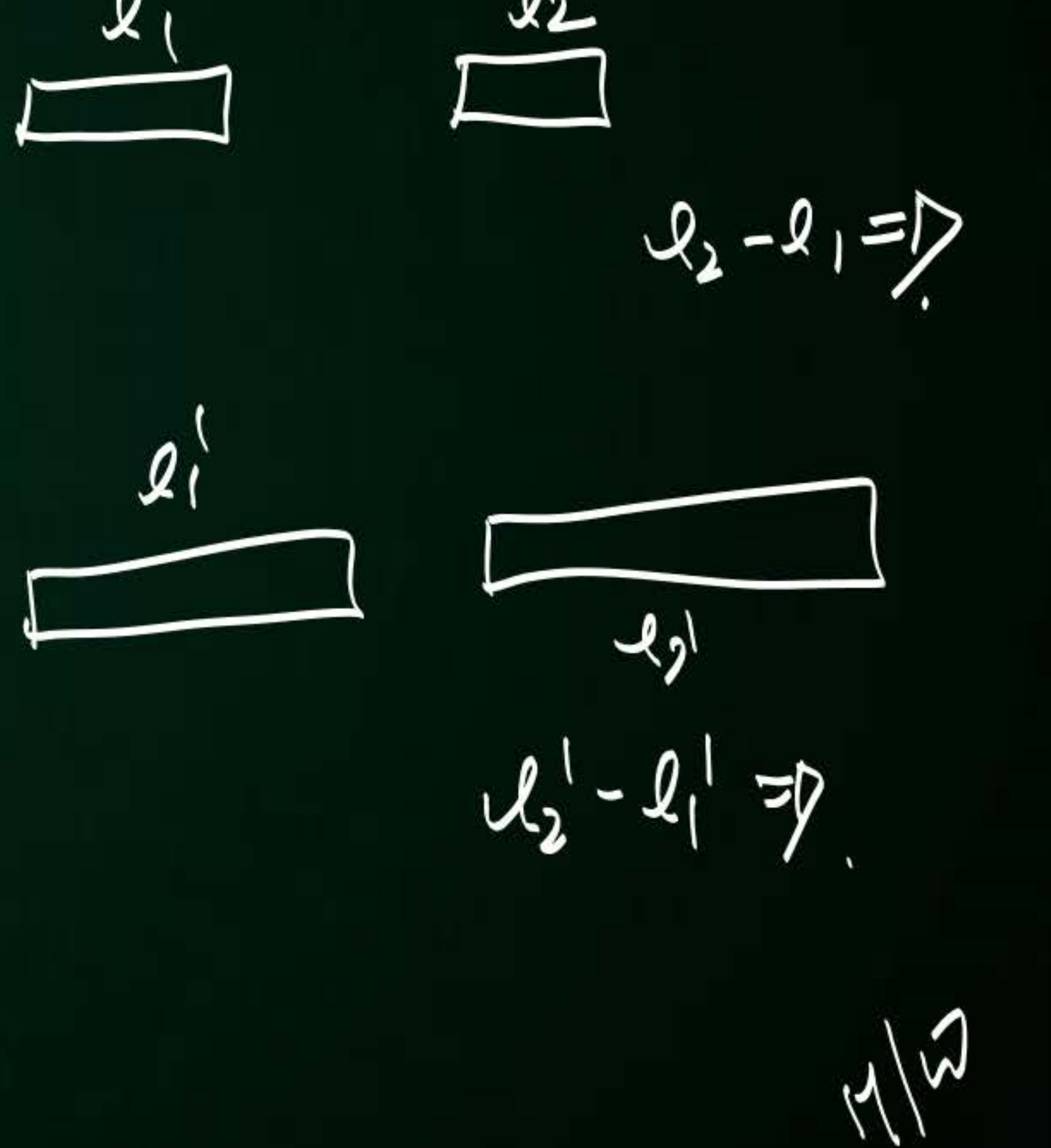
1. 0.01%
2. 0.1%
3. 1%
4. 10%

H.W

QUESTION

A copper rod of 88 cm and an aluminium rod of unknown length have their difference in length independent of increase in temperature. The length of aluminium rod is:

($\alpha_{Cu} = 1.7 \times 10^{-5}\ K^{-1}$ and $\alpha_{Al} = 2.2 \times 10^{-5}\ K^{-1}$)



1. 6.8 cm
2. 113.9 cm
3. 88 cm
4. 68 cm

QUESTION

A metal of length l and area of cross-section A is fixed between rigid supports at negligible tension. If this is cooled, the tension in the wire will be

1. Proportional to l
2. Inversely proportional to l
3. Independent of l
4. Independent of A

H/W

QUESTION

A rod is fixed between two points at 50°C. The coefficient of linear expansion of material of rod is $2 \times 10^{-5}/°C$ and young's modulus is $1.5 \times 10^{11}\ N/m^2$. What is the stress developed in the rod if temperature of rod becomes 70°C?

1. $3 \times 10^4\ N/m^2$
2. $6 \times 10^7\ N/m^2$
3. $9 \times 10^{12}\ N/m^2$
4. $11 \times 10^{11}\ N/m^2$

H/W

QUESTION

The temperature of a pendulum, the time period of which is t, is raised by ΔT. The change in its time period is-

1. $\frac{1}{2}\alpha t\Delta T$

2. $2\alpha t\Delta T$

3. $\frac{1}{2}\alpha\Delta T$

4. $2\alpha\Delta T$

H/W

QUESTION

A pendulum clock keeps correct time at 20°C. The correction to be made during summer per day where the average temperature is 40°C, (= 10^{-5}/°C) will be:

1. 5.64 sec
2. 6.64 sec
3. 7.64 sec
4. 8.64 sec

H/W

QUESTION

If two metal rods of coefficient of linear expansion α_1 and α_2 have same length at t_1°C and t_2°C respectively, then the common temperature at which they have again the same length is t.

H/W


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 03 | **Physics**

Thermal Properties Of Matter



By- Dr. Manish Raj (MR SIR)

Todaye goal

Padhenge

K·B·D

Questions on Expansion

linear expansion

→ for solid



$\Delta l \propto l_0 \quad \Delta l \propto \Delta T$

$$\Delta l = \alpha_T l_0 \Delta T$$

α_T = Temp^r coefficient of lines eaxp^n

$\alpha_T = \frac{\Delta l}{l_0 \Delta T}$ = Relative/fractional change in length per unit raise in Tempr

Unit → K^{-1}

$\left[100 \times \frac{\Delta l}{l_0}\right] = [\alpha \Delta T \times 100]$ = % change in length.

$$l_f = l_0 [1 + \alpha \Delta T]$$

Areal expanision

→ Not for liquid & gas only for solid



$\Delta A \propto A_0 \quad \Delta A \propto \Delta T$

$$\Delta A = \beta A_0 \Delta T$$

β = Tempr coefficient of Areal expn. unit (K^{-1})

$\beta = \frac{\Delta A}{A_0 \Delta T}$ = Relative change in Area per unit raise in Temp^r

$100 \times \frac{\Delta A}{A} = \beta \Delta T \times 100$ = % change in Are

$A_f - A_0 = \beta A_0 \Delta T$

$$A_f = A_0 [1 + \beta \Delta T]$$

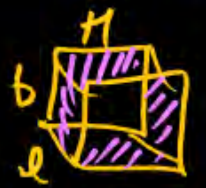
$A = l \times b$

$\frac{\Delta A}{A \Delta T} = \frac{\Delta l}{l \Delta T} + \frac{\Delta b}{b \Delta T}$

$\beta = \alpha_x + \alpha_y$

volumetric expansion

→ for all, liquit, solid & gas



$\Delta V \propto V_0 \quad \Delta V \propto \Delta T$

$$\Delta V = \gamma V_0 \Delta T$$

γ = coeffin to volume expansion unit (K^{-1})

$\gamma = \frac{\Delta V}{V_0 \Delta T}$ = Relative change in volume per unit rais in Temp^r

$100 \times \frac{\Delta V}{V_0} = \gamma \Delta T \times 100$ = % change in volume

$$V_f = V_0 (1 + \gamma \Delta T)$$

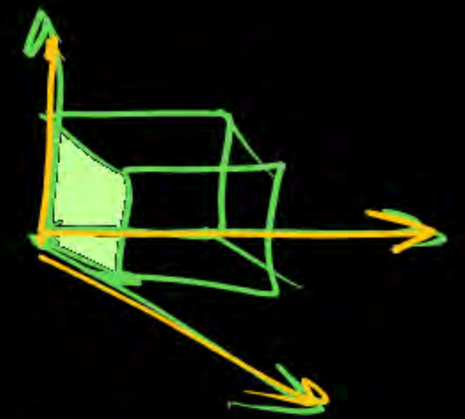
$V = l b H$

$\frac{\Delta V}{V \Delta T} = \frac{\Delta l}{l \Delta T} + \frac{\Delta b}{b \Delta T} + \frac{\Delta H}{H \Delta T}$

$\gamma = \alpha_x + \alpha_y + \alpha_z$

Rel^n B/w α, β & γ

$$\gamma = \alpha_x + \alpha_y + \alpha_z$$



Isotropic Body

$$\alpha_x = \alpha_y = \alpha_z = \alpha$$

$$\gamma = 3\alpha$$

$$\alpha = \gamma/3$$

$$\beta = \alpha_y + \alpha_z$$

$$\boxed{\beta = 2\alpha}$$

MR*

$$\frac{\alpha}{1} = \frac{\beta}{2} = \frac{\gamma}{3}$$

$$\boxed{\alpha = \beta/2}$$

$$\boxed{\alpha = \gamma/3}$$

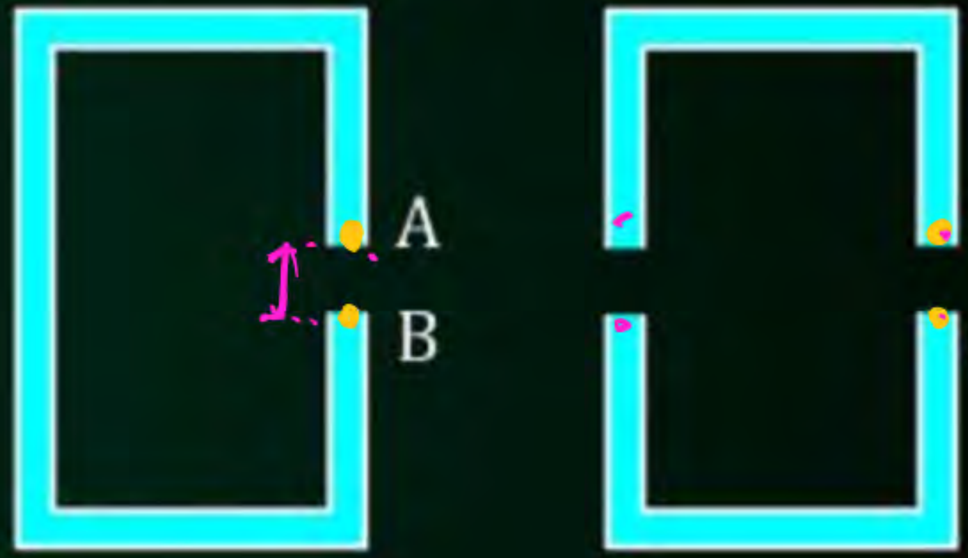
$$\beta/2 = \gamma/3$$

$$\boxed{\beta = \frac{2}{3}\gamma}$$

QUESTION

Distance between A and B will increase or decrease as temperature increases.

1. In both figure increase
2. In both figure decrease
3. In figure 1 increase & figure 2 decrease
4. In figure 1 decrease & figure 2 increase



QUESTION

A metallic bar is heated form 0°C to 100°C. The coefficient of linear expansion is 10^{-5} K^{-1}. What will be the percentage increase in length -

1. 0.01%
2. 0.1%
3. 1%
4. 10%

0°C ⟶ 100°C

$$\frac{\Delta l}{l} \times 100 = \alpha \Delta T \times 100$$

$$= 10^{-5} \times 10^{2} \times 10^{2}$$

$$= \frac{1}{10}$$

QUESTION

A copper rod of 88 cm and an aluminium rod of unknown length have their difference in length independent of increase in temperature. The length of aluminium rod is:

$(\alpha_{Cu} = 1.7 \times 10^{-5}\ K^{-1}$ and $\alpha_{Al} = 2.2 \times 10^{-5}\ K^{-1})$



(1) 6.8 cm

(2) 113.9 cm

(3) 88 cm

(4) 68 cm ✓

$l = ??$

$l_c - l_a = l_c' - l_a'$

$l_a' - l_a = l_c' - l_c$

$\alpha_a l_a \Delta T = \alpha_c l_c \Delta T$

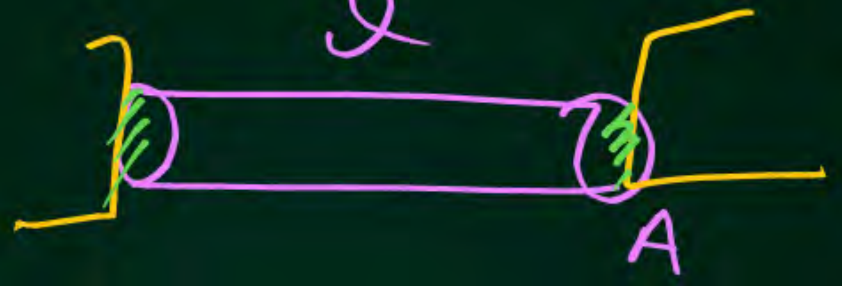
$2.2 \times 10^{-5}\, l_a = 1.7 \times 10^{-5} \times 88$

$l_a = \frac{17}{22} \times 88 = 68$

QUESTION

A metal of length l and area of cross-section A is fixed between rigid supports at negligible tension. If this is cooled, the tension in the wire will be

1. Proportional to l
2. Inversely proportional to l
3. Independent of l
4. Independent of A



$$\frac{\Delta l}{l} = \alpha \Delta T \quad \text{— (i)}$$

$$\frac{\Delta l}{l} = \frac{F}{YA} \quad \text{— (ii)}$$

$$\alpha \Delta T = \frac{F}{YA}$$

$$\text{Tension} = Y A \alpha \Delta T$$

Kitne log last lecture (Lec-2) theorem kar rahe

(a) No sir, lec-2 Nahi de

(b) Yes (complete) 85%

QUESTION

A rod is fixed between two points at 50°C. The coefficient of linear expansion of material of rod is $2 \times 10^{-5}/°C$ and young's modulus is $1.5 \times 10^{11}\ N/m^2$. What is the stress developed in the rod if temperature of rod becomes 70°C?

1. $3 \times 10^{4}\ N/m^2$
2. $6 \times 10^{7}\ N/m^2$
3. $9 \times 10^{12}\ N/m^2$
4. $11 \times 10^{11}\ N/m^2$



QUESTION

The temperature of a pendulum, the time period of which is t, is raised by ΔT. The change in its time period is-

(1) $\frac{1}{2}\alpha t\Delta T$ ✓

(2) $2\alpha t\Delta T$

(3) $\frac{1}{2}\alpha\Delta T$

(4) $2\alpha\Delta T$

$$t = 2\pi\sqrt{\frac{l}{g}}$$

$$\frac{\Delta t}{t} = \frac{1}{2}\left[\frac{\Delta l}{l}\right]$$

$$\Delta t = \left[\frac{1}{2}t\,\alpha\,\Delta\theta\right]$$

QUESTION

Relation between linear, Areal and volumetric expansion α, β and γ.

QUESTION

The volume of a solid decrease by 0.6% when it is cooled through 50°C. Its coefficient of linear expansion is

1. $4 \times 10^{-6}\ K^{-1}$
2. $5 \times 10^{-5}\ K^{-1}$
3. $6 \times 10^{-4}\ K^{-1}$
4. $4 \times 10^{-5}\ K^{-1}$ ✓

$\frac{\Delta V}{\Delta T\, V} \times 100 = \frac{0.6}{\Delta T}$

$\gamma \times 100 = \frac{0.6}{\Delta T}$

$3\alpha \times 100 = \frac{0.6}{\Delta T}$

$\alpha = \frac{6}{10 \times 50 \times 100 \times 3} = \frac{10^{-3}}{25} = 4 \times 10^{-5}$

Repeat

$\frac{\Delta V}{V} \times 100 = 0.6$

divide by ΔT both side

$\frac{\Delta V}{V \times \Delta T} \times 100 = \frac{0.6}{\Delta T}$

$3\alpha \times 100 = \frac{0.6}{\Delta T}$

QUESTION

A pendulum clock keeps correct time at 20°C. The correction to be made during summer per day where the average temperature is 40°C, (α = 10^{-5}/°C) will be:

1. 5.64 sec
2. 6.64 sec
3. 7.64 sec
4. 8.64 sec

$T = 24\ hr = 24 \times 60\ mint$

$T = 24 \times 60 \times 60\ sec$

$T = 86400\ sec$

$\frac{\Delta T}{T} = \frac{1}{2} \alpha \Delta \theta$

$\Delta T = \frac{1}{2} 10^{-5} \times 86400 \times 20$

$= 8.64\ sec$

QUESTION

If the coefficient of cubical expansion is x times of the coefficient of superficial expansion, then value of x is-

1. 3
2. 2.5
3. 1.5
4. 2

volume exe.

Area expansion

$\gamma = x\beta$

$\frac{\gamma}{3} = \frac{\beta}{2}$

$\gamma = \frac{3}{2}\beta$

QUESTION

Relation between Bulk Modulus of elasticity and thermal coefficient of volume expansion.

β $\qquad$ γ_T

$$\Delta P = \beta \frac{\Delta V}{V} \Rightarrow \frac{\Delta V}{V} = \frac{\Delta P}{\beta} \quad \text{— (I)}$$

$$\gamma = \frac{\Delta V}{V \Delta T} \Rightarrow \frac{\Delta V}{V} = \gamma \Delta T \quad \text{— (II)}$$

$$\frac{\Delta P}{\beta} = \gamma \Delta T$$

$$\boxed{\Delta P = \beta \gamma \Delta T}$$

Level up

QUESTION

A pendulum clock is 5s fast at a temperature of 15°C and 10s slow at a temperature of 30°C. At what temperature does it give the correct time?

1. 10°C
2. 20°C
3. 15°C
4. 25°C

$(\Delta t)_{fast} = 5$ sec

$T_1 = 15°C$

$(\Delta t)_{slow} = 10$ sec

$T_2 = 30°C$

माना T_0

$15°C < T_0 < 30°$

$\Delta T = t \frac{1}{2} \alpha \Delta \theta$

$5s = \frac{1}{2}\alpha t [15 - T_0]$

$-10s = \frac{1}{2}\alpha t [30 - T_0]$

QUESTION

If two metal rods of coefficient of linear expansion α_1 and α_2 have same length at t_1°C and t_2°C respectively, then the common temperature at which they have again the same length is t.

1st Rod: l_0, α_1, t_1°C

2nd Rod: l_0, α_2, t_2°C

at t: $l_{f_1} = l_{f_2}$

change in length in Both Rod will be same

$\Delta l = l_0 \alpha \Delta T$

$\frac{\Delta l}{l} = \alpha \Delta T \rightarrow$ same

$\alpha_1 (t - t_1) = \alpha_2 (t - t_2)$

$\alpha_1 t - \alpha_1 t_1 = \alpha_2 t - \alpha_2 t_2$

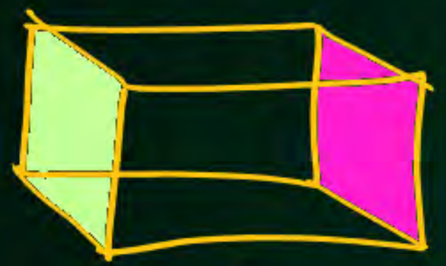
$(\alpha_1 - \alpha_2) t = \alpha_1 t_1 - \alpha_2 t_2$

$t = \frac{\alpha_1 t_1 - \alpha_2 t_2}{\alpha_1 - \alpha_2}$

QUESTION

A rectangular block is heated from 0°C to 100°C. The percentage increase in its length is 0.10%. What will the percentage increase in it volume?

1. #0.03%
2. 0.10%
3. 0.30%
4. None of these



$0°C \longrightarrow 100°C$

$$\left[\frac{\Delta l}{l} \times 100 = 0.1\%\right]$$

$$\frac{\Delta V}{V} \times 100 = 3\frac{\Delta l}{l} \times 100$$

expantion in density of Atorq

$$Mass = \rho V$$

Tempr change

mass = const

$$\frac{\Delta m}{m} = \frac{\Delta \rho}{\rho} + \frac{\Delta V}{V}$$

(Δm crossed out, marked → 0)

$$\frac{\Delta V}{V_0 \Delta T} = -\frac{\Delta \rho}{\rho_0 \Delta T}$$

Now divided by ΔT both side

$$\gamma_T = -\frac{\Delta \rho}{\rho_0 \Delta T}$$

$$\Delta \rho = -\rho_0 \gamma_T \Delta T$$

$$\rho_f - \rho_0 = -\rho_0 \gamma_T \Delta T$$

$$\rho_f = \rho_0 - \rho_0 \gamma_T \Delta T$$

$$\Rightarrow \rho_f = \rho_0 \left(1 - \gamma_T \Delta T\right)$$

$$V_f = V_0 \left(1 + \gamma_T \Delta T\right)$$

QUESTION

The value of coefficient of volume expansion of glycerin is $5 \times 10^{-4}\ K^{-1}$. The fractional change in the density of glycerin for a rise of 40°C in its temperature is:

1. 0.010
2. 0.015
3. 0.020
4. 0.025

$$\frac{\Delta \rho}{\rho} = -\frac{\Delta V}{V} = \gamma \Delta T = 5 \times 10^{-4} \times 40$$

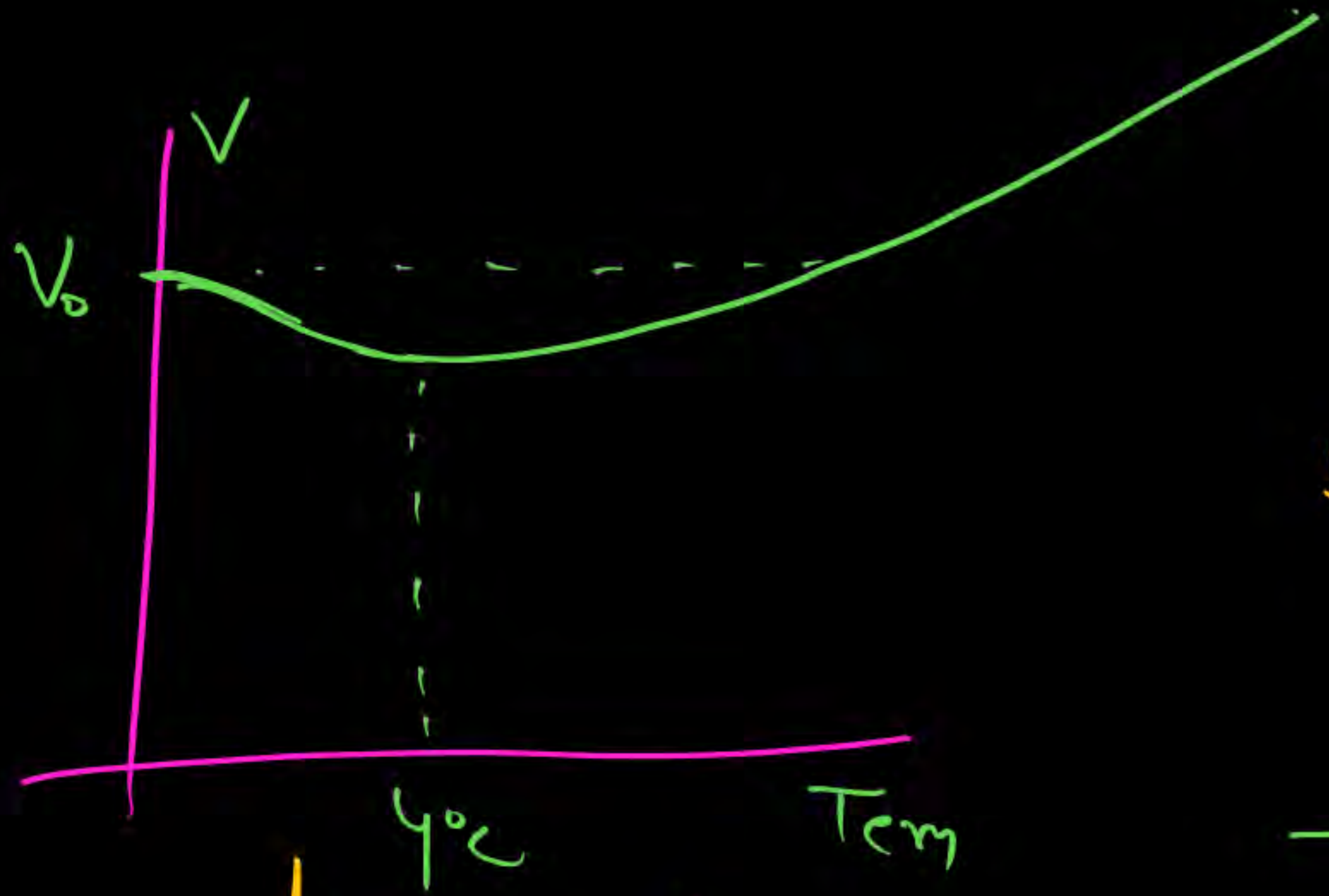
$$= 200 \times 10^{-4}$$

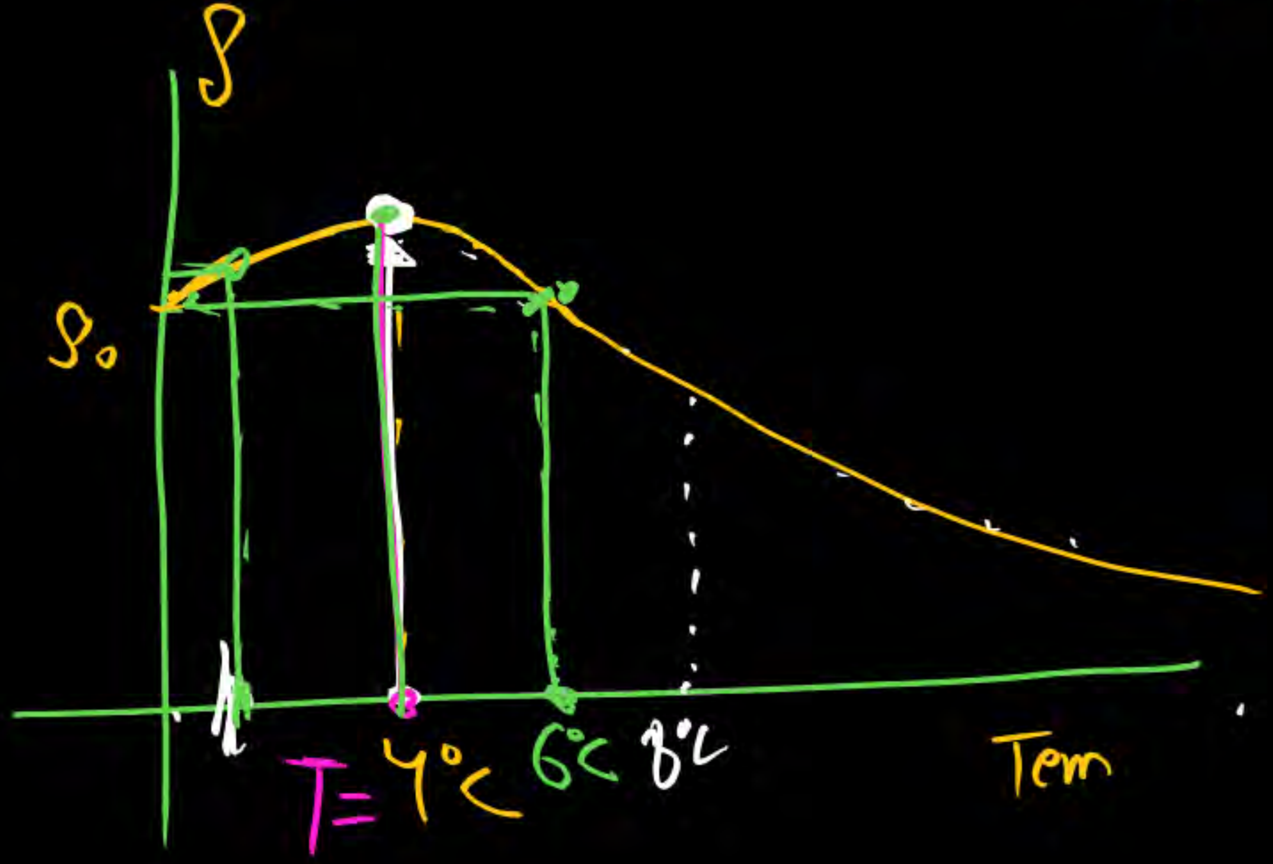
$$= 0.02$$

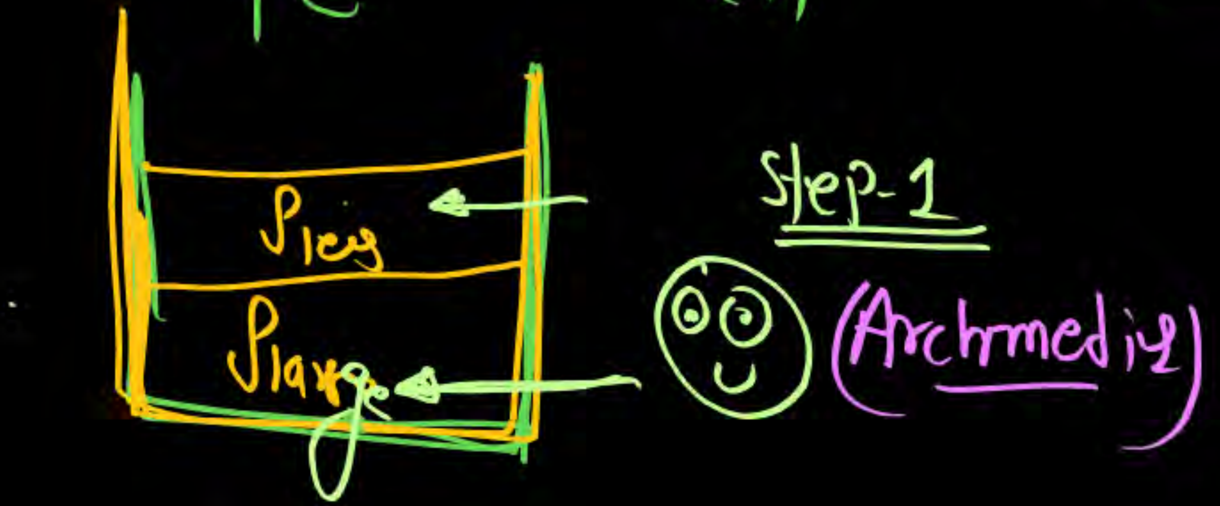
Volume of liquid always Incrse with Incrse in Tempr.

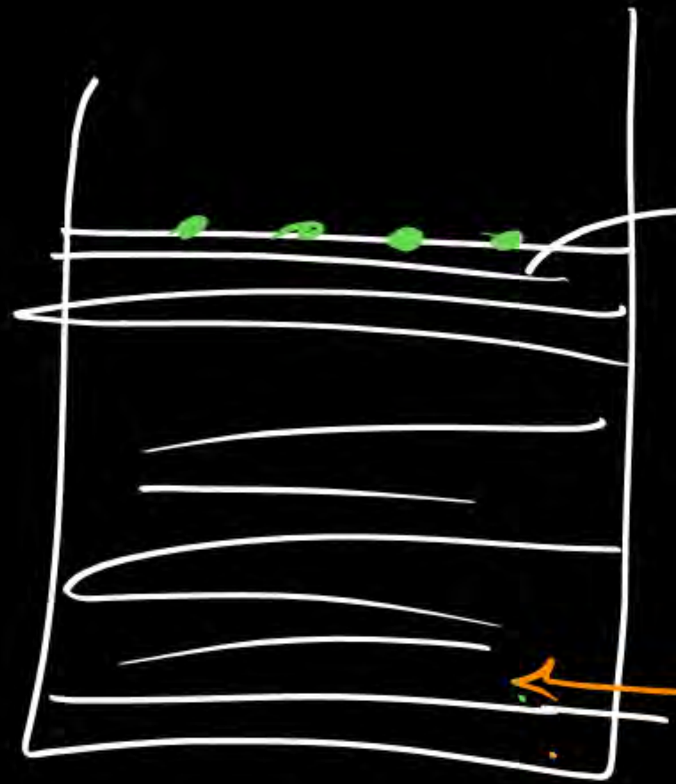
→ True (a)

→ false (b) 80%









$T_{surface} = 4°C$ (density max^n)

winter

$T_{Bottom} > 4°C$ ✗

$T_{Bottom} < 4°C$ ✗

$T_{Bottom} = 4°C$ ✓

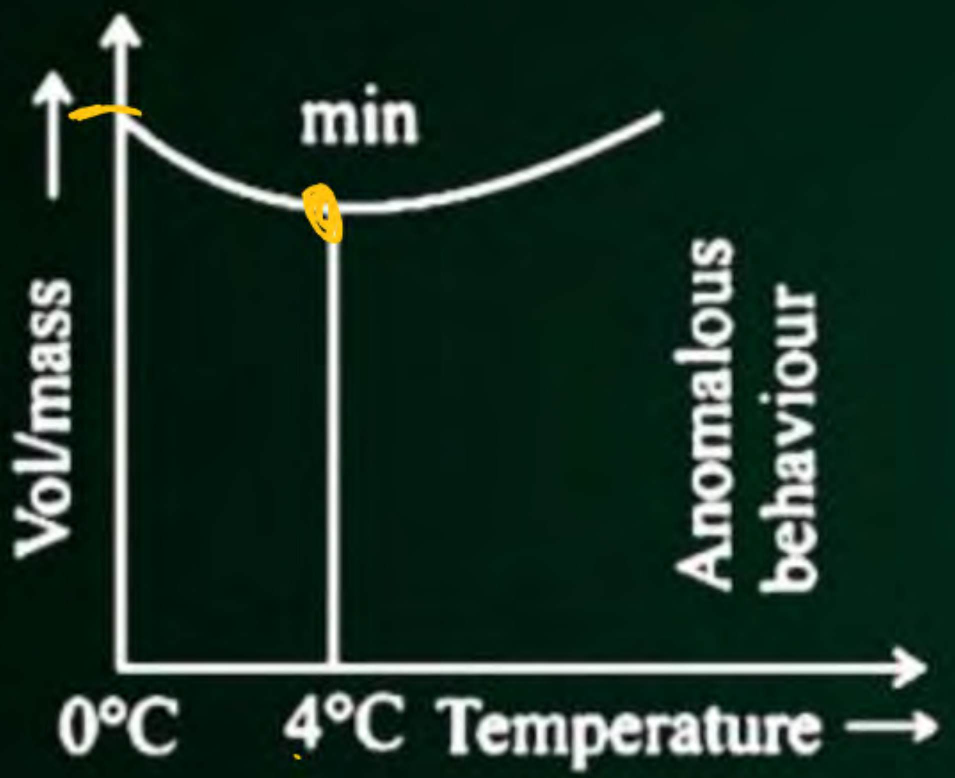
ρ of water max at $= 4°C$ ✓

ρ higher density निचे

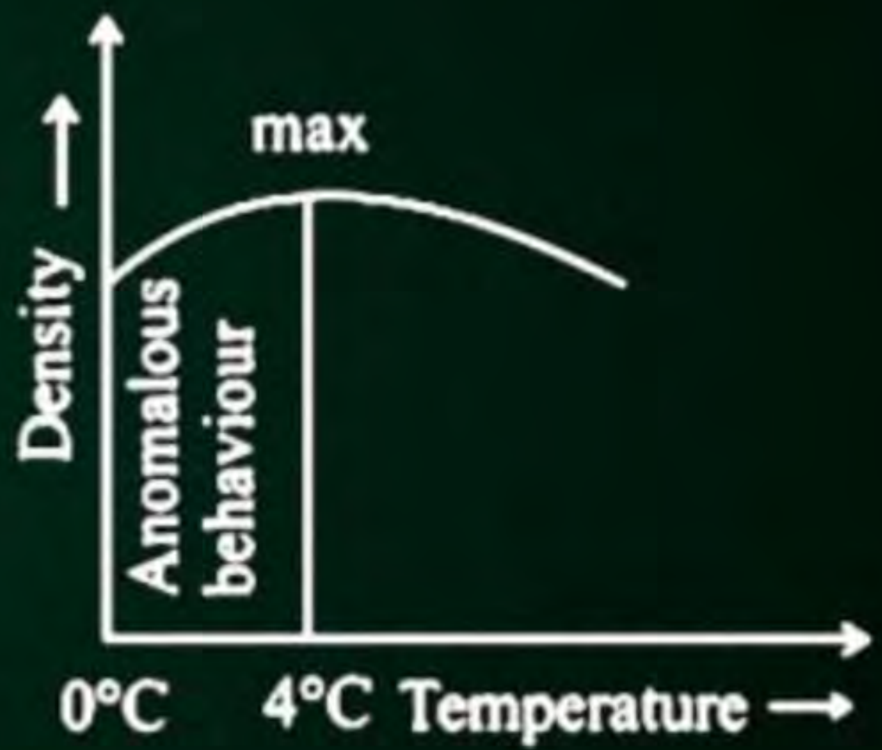
ρ lower upper

92%

~~5-7%~~

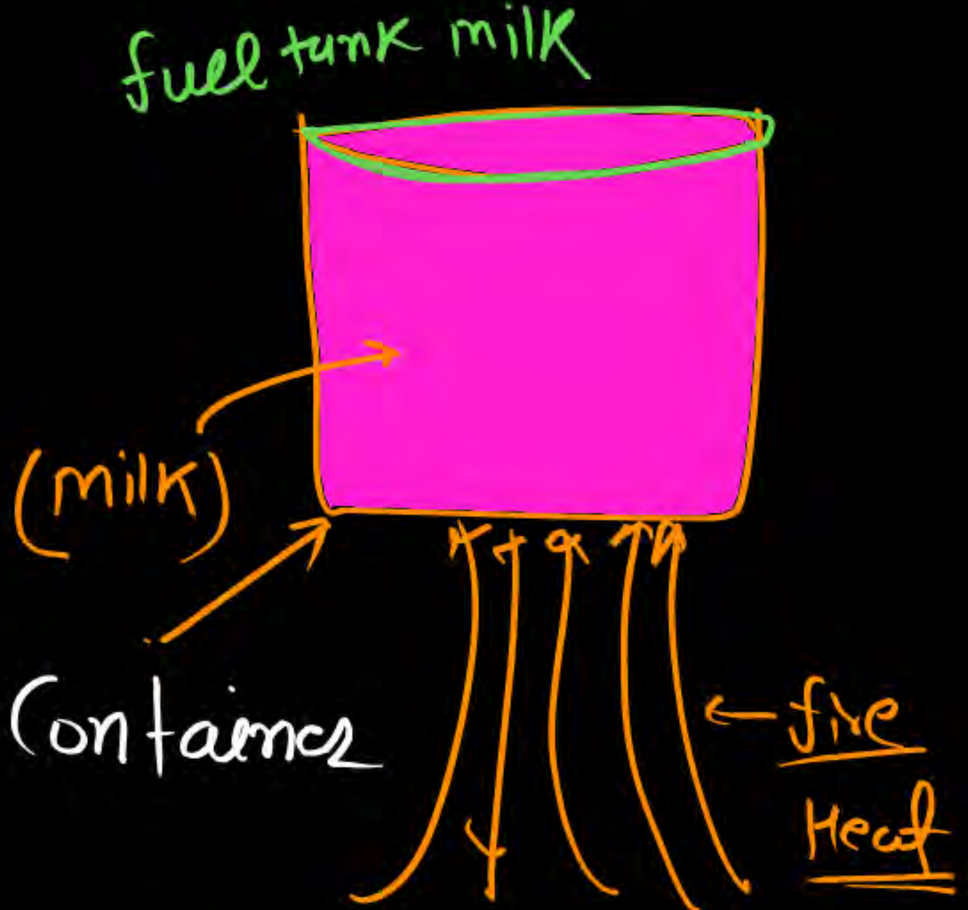


min
Vol/mass
Anomalous behaviour
0°C
4°C
Temperature



max
Density
Anomalous behaviour
0°C
4°C
Temperature

Relⁿ B/w coeffint of liner expansion of container & volume expansion of liquid.



α_c = liner expansion of container

$\gamma_c = 3\alpha_c$ = coeffⁿ volume expⁿ of container

γ_l = coeffⁿ of volume expansion of liquid

Case-1 If $\gamma_l = \gamma_c$ then $\gamma_l' = 0$ (Appᵗ coefficit of volume expⁿ of liquid = 0)

level of liquid unchanged

Case-2 If $\gamma_l > \gamma_c$ $\Rightarrow$ $\gamma_l' = \gamma_l - \gamma_c$

Level of liquid will overflow

Case-3 If $\gamma_l < \gamma_c$, liquid level will fall

$\gamma_l' = \gamma_l - \gamma_c = -ve$

$\gamma_l' = \gamma_l - 3\alpha_c$

$$\gamma_l' = \gamma_l - \gamma_c = \gamma_l - 3\alpha_c$$

Appᵗ volume expⁿ of liquid

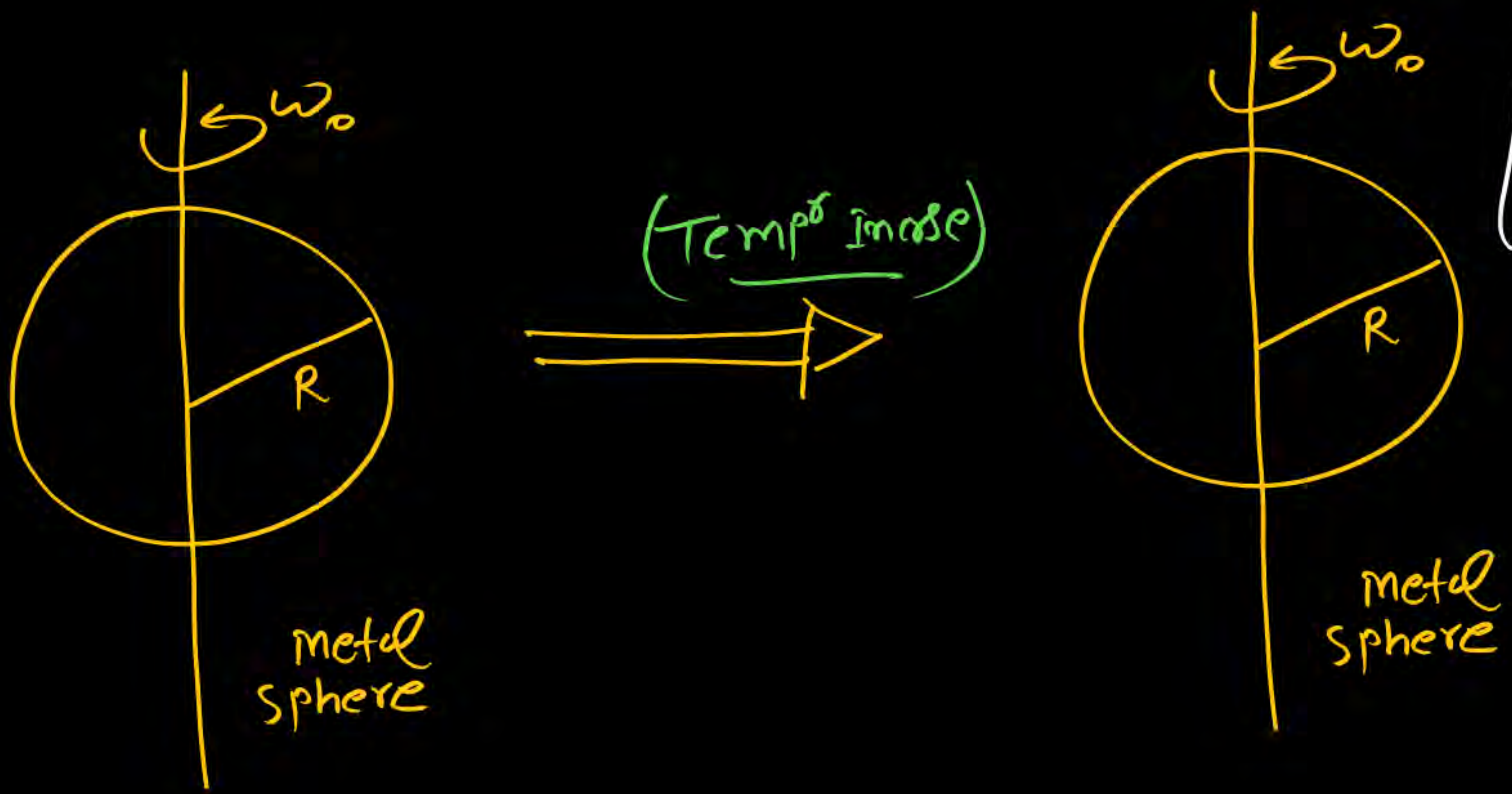
QUESTION

The coefficient of apparent expansion of a liquid in a copper vessel is C and in a silver vessel S. The coefficient of volume expansion of copper is γ_c. What is the coefficient of linear expansion of silver

1. $(C + \gamma_c + S)/3$
2. $(C - \gamma_c + S)/3$
3. $(C + \gamma_c - S)/3$
4. $(C - \gamma_c - S)/3$

H/W

#



Tempr ↑

→ expansion

Radius ↑

conservation of Angular Mom

$\omega_0 \downarrow$

QUESTION

The density of water at 20°C is 998 kg/m^3 and at 40°C 992 kg/m^3. The coefficient of volume expansion of water is

1. $10^{-4}/°C$
2. $3 \times 10^{-4}/°C$
3. $2 \times 10^{-4}/°C$
4. $6 \times 10^{-4}/°C$


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture-04 | **Physics**

Thermal Properties Of Matter

By- Dr. Manish Raj (MR SIR)



Todays Goal

- Specific heat
- Law of calorimetry

7:10 AM
8:10 AM
Green Jue
8:30 PM
8:30
10 mint

QUESTION

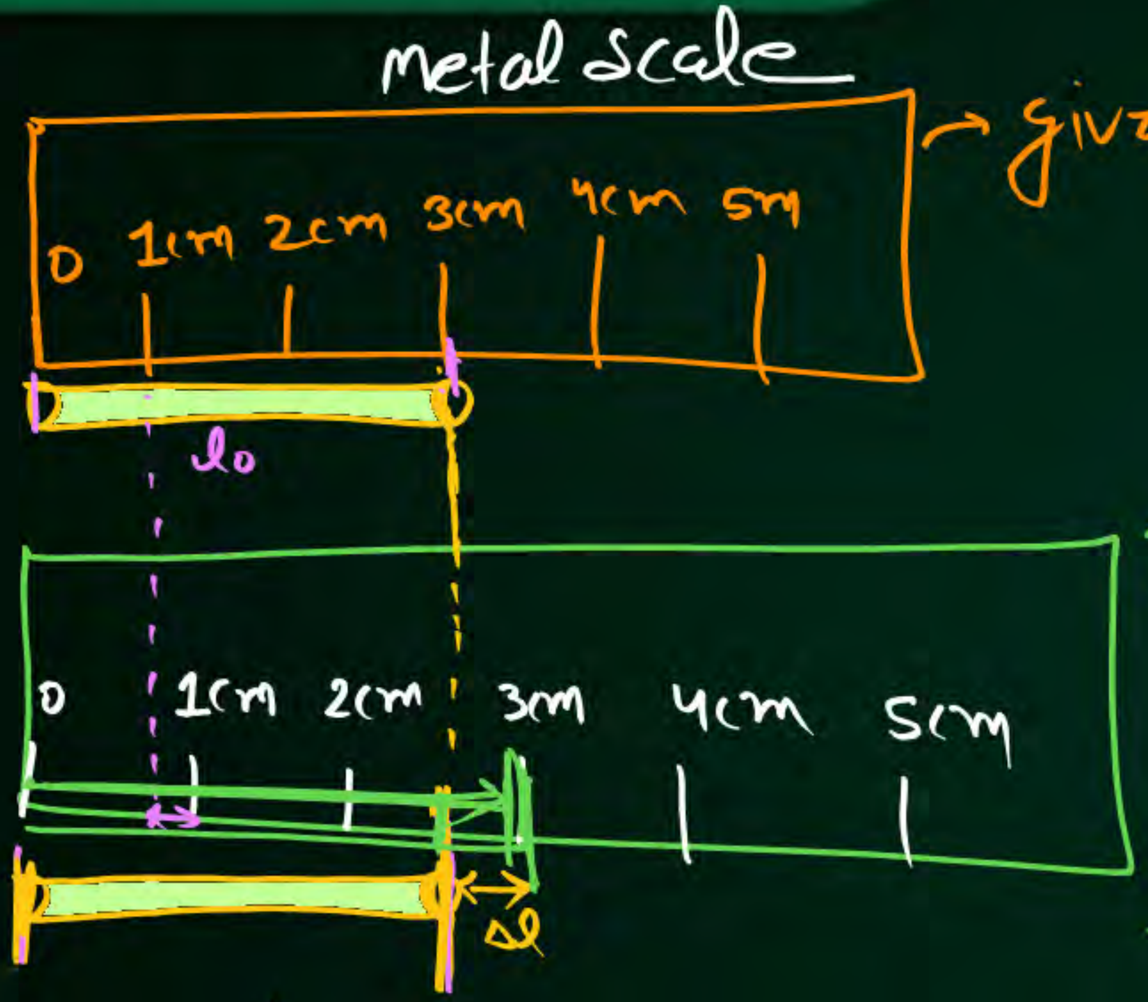
Why is it advisable to allow telephone lines to sag when stringing them between poles in summer?

at high Tempr

↳ because wires are metallic at Lower Tempr, Thermal compression take place in winter.



Expansion Scale



→ gives correct reading at Tempr (T_0)

app^t reading (Higher Tempr)

Taking reading at higher Tempr of a wood (Rod) exp^n of Rod is negligible, then reading at higher Tempr will be;

(a) More than true reading.

31% (b) less than true reading.

52% (c) Same as True reading

True reading = (app^t reading) + $(\Delta l)_{exp^n}$

= (app^t reading) + $l_0 \alpha \Delta T$

QUESTION

A scale which is calibrated at 10°C measures the length of a stick to be 60 cm, at temperature 30°C. If thermal coefficient of linear expansion of the scale is $2 \times 10^{-5}/°C$, the correct length of the stick in cm is:

1. 60.015
2. 60.024 Ans
3. 60.400
4. 60.600

True reading at T = 10°C

$T_{thing} = 30°C$ $\quad$ $l = 60\text{ cm}$ (App. length)

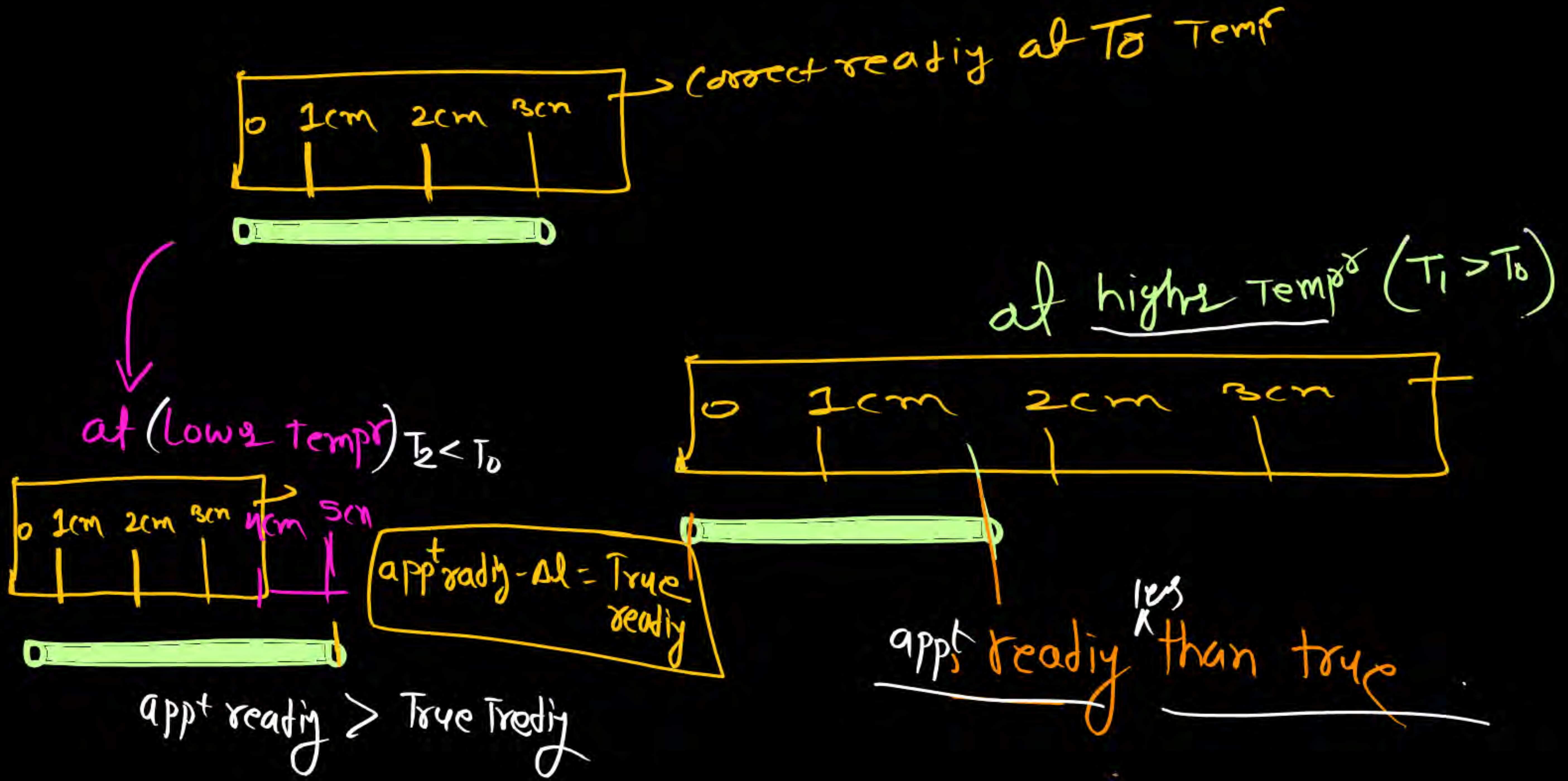
Correct reading = app. reading + Δl

$= 60\text{ cm} + 60\text{ cm} \times 2 \times 10^{-5} \times 20$

$= 60\text{ cm} + 24 \times 10^{-3}$

$= 60\text{ cm} + 0.024\text{ cm}$

$= 60.024\text{ cm}$


0 1cm 2cm 3cm
correct readig at T0 Tempr
at (lower Tempr) T2 < T0
0 1cm 2cm 3cm 4cm 5cm
appt readig - Δl = True readig
appt readig > True readig
at higher Tempr (T1 > T0)
0 1cm 2cm 3cm
appt less readig than true

QUESTION

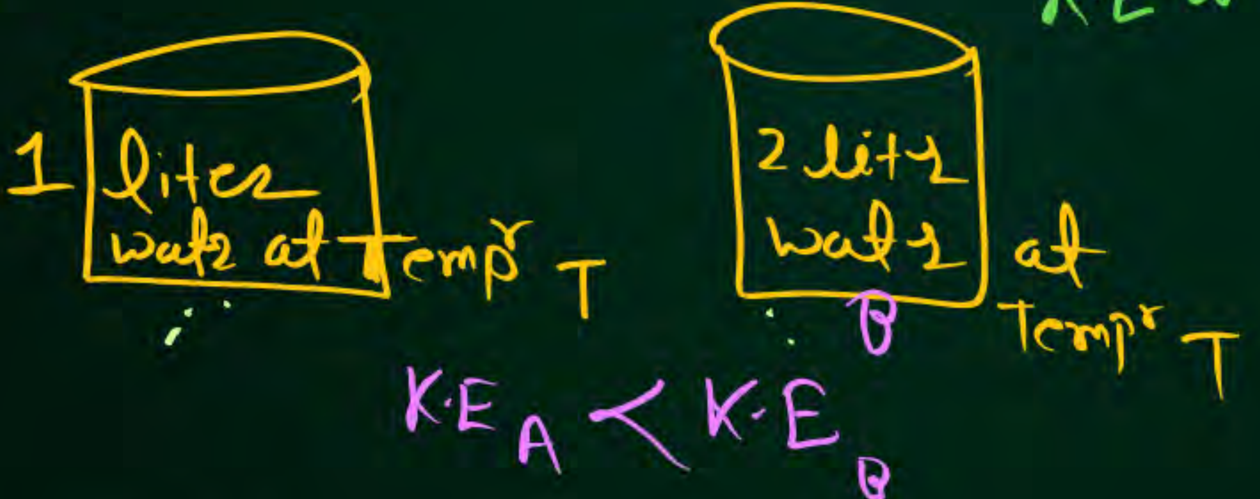
True or False?

Temperature is a measure of the total kinetic energy in a substance.

(a) True 57%

(b) false 42%

at 0 K (absolute zero Tempr)
K.E of molecule = 0



$K.E_A < K.E_B$

internal energy gas = K.E + U (of molecule)

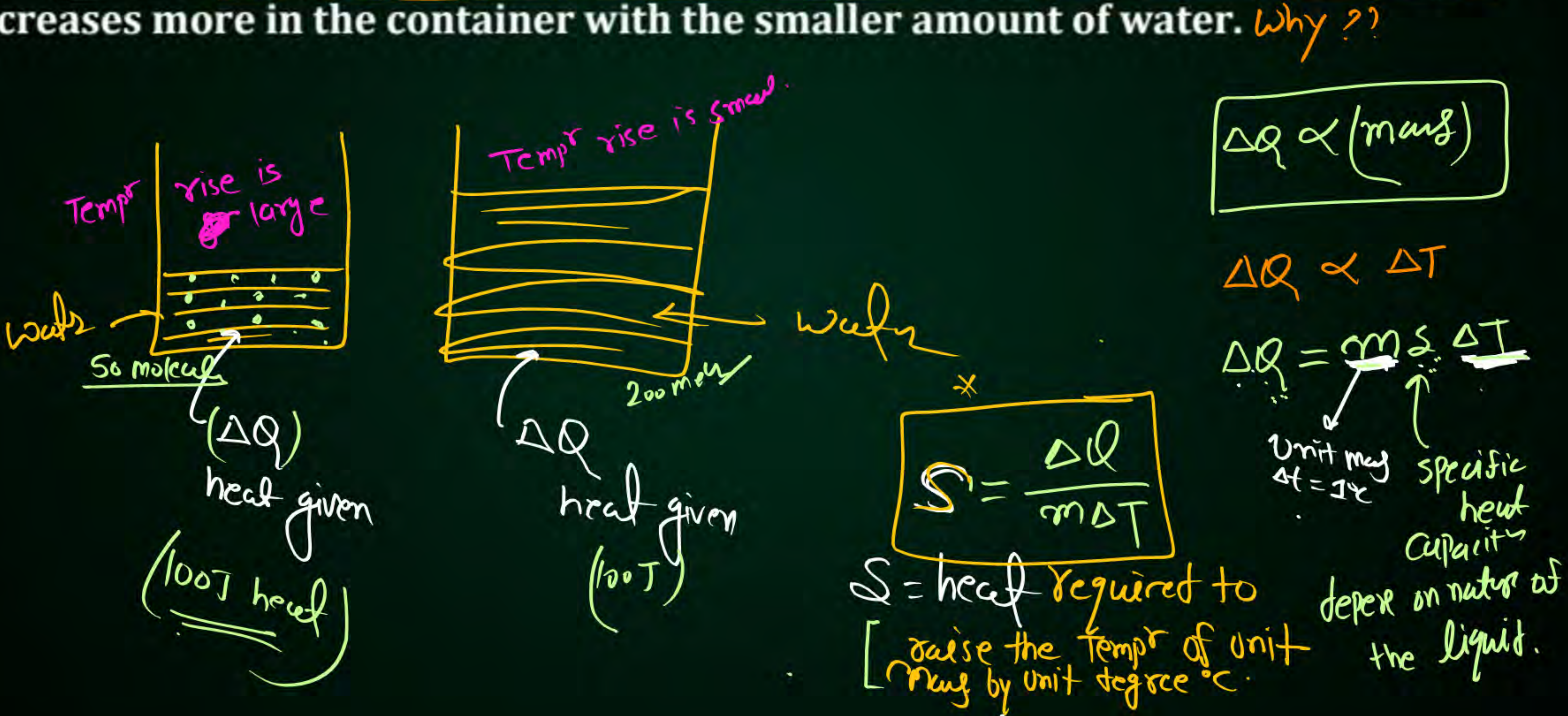
internal energy = K.E

internal energy = K.E ∝ Tempr

Tempr is a measure of the Avg. K.E of molecule $= \frac{\text{total K.E}}{\text{no. of molecule}}$

QUESTION

Although the same quantity of heat is added to both containers, the temperature increases more in the container with the smaller amount of water.



$\Delta Q = S \rightarrow$ 1 unit mass ka temp 1°c Incre.

$\Delta Q = mS \rightarrow$ m mass ka tempr 1°c से Incr

$$\Delta Q = ms\Delta T$$

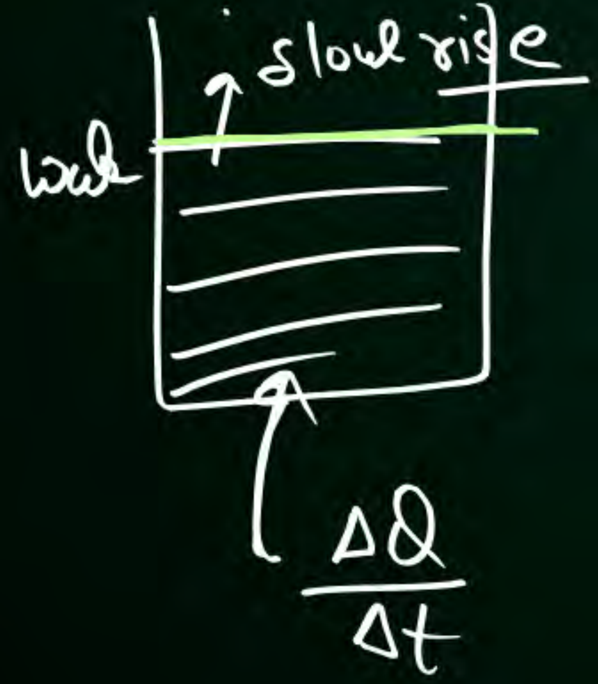
$\Delta Q \rightarrow$ given to gas | liqu $T \uparrow$

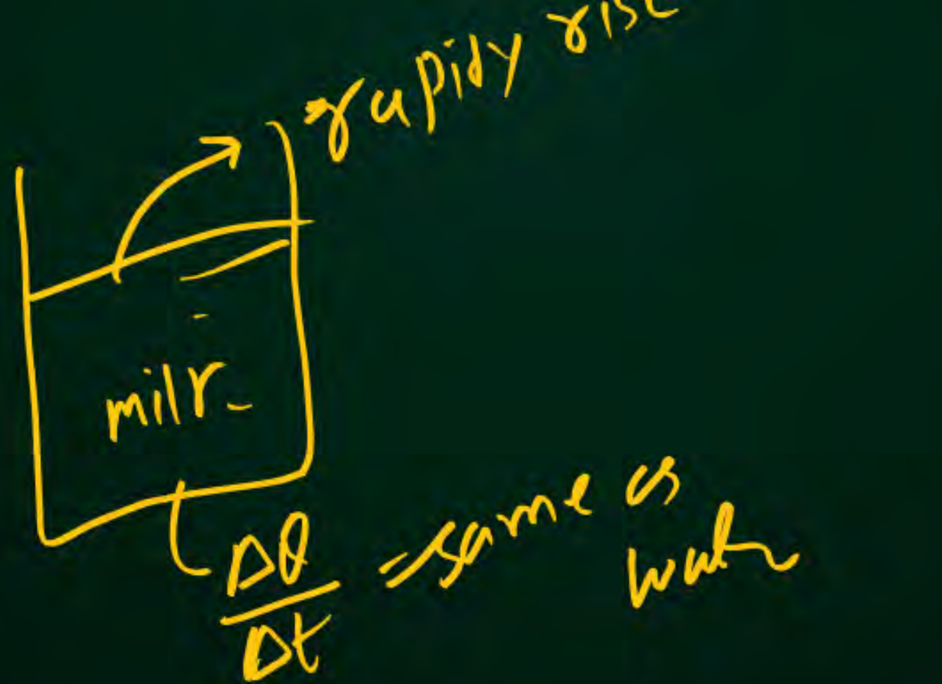
$\Delta Q \rightarrow$ eject out then Temp $\downarrow$

QUESTION

Why does a piece of watermelon stay cool for a longer time than sandwiches do when both are removed from a picnic cooler on a hot day?

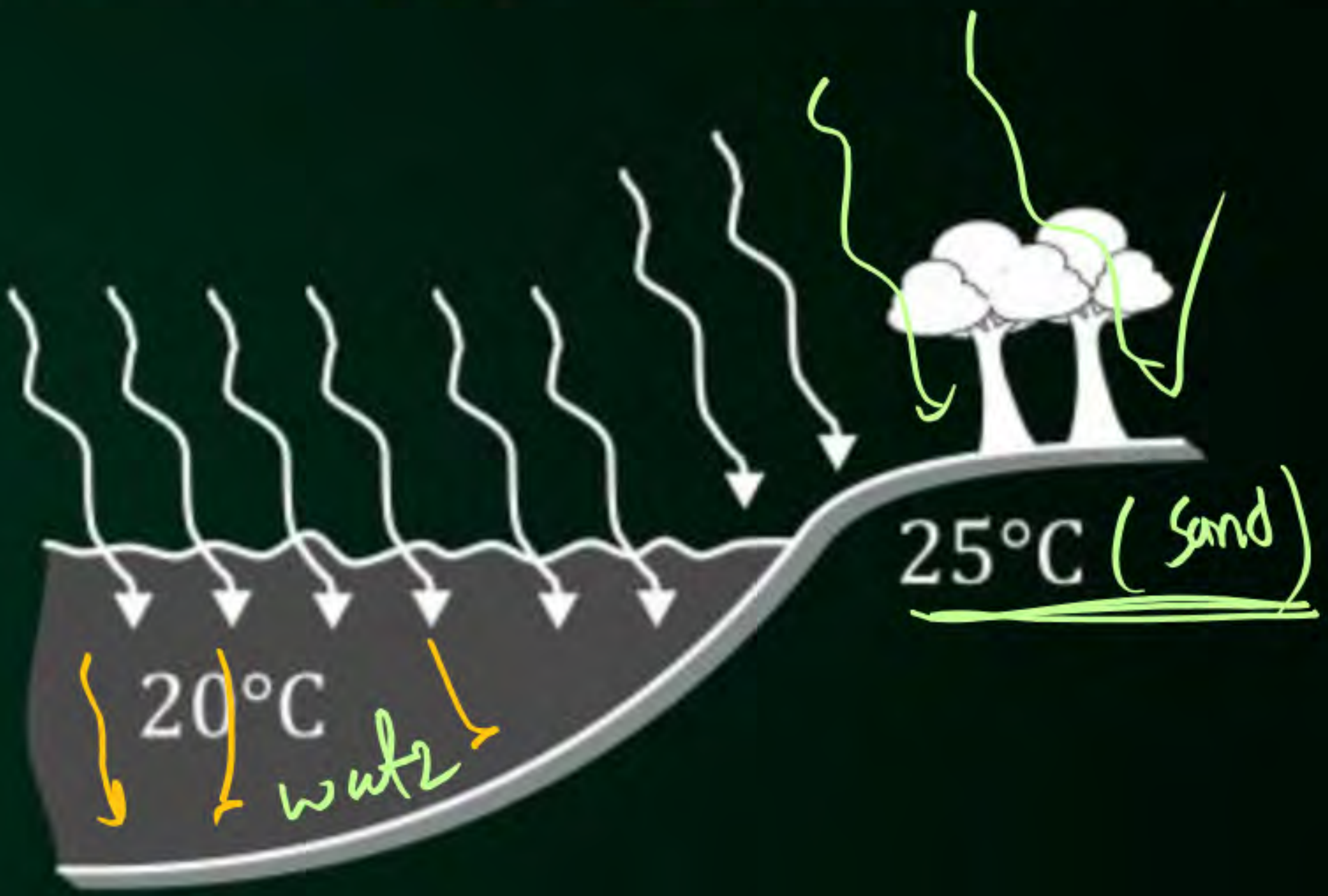
$$S_{\text{water melon}} > S_{\text{sandwich}}$$





QUESTION

Because water has a high specific heat capacity and it transparent, it takes more energy to warm the water.





Water is king when it comes to specific heat capacity.

$$S = \frac{dQ}{m\Delta T}$$

$$S = \frac{1\,cal}{1\,grm\,1^\circ C} = \frac{1\,cal}{1\,gm\,1\,K}$$

$$S = 1\,cal\,grm^{-1}\,{}^\circ C^{-1} = 1\,cal\,gm^{-1}\,K^{-1}$$

$$S = \frac{4.2\,J}{10^{-3}\,kg\,1^\circ C}$$

$$S = 4.2\times10^{3}\,J\,kg^{-1}\,{}^\circ C^{-1}$$

$$\boxed{S = 4200\,J\,kg^{-1}\,{}^\circ C^{-K}}$$

$$S_{Ice} = 0.5\,cal\,gm^{-1}\,{}^\circ C^{-1}$$

$$\boxed{S_{oil} < 1\,cal\,gm^{-1}\,{}^\circ C^{-1}}$$

QUESTION

Suppose you apply a flame to 1 L of water for a certain time and its temperature rises by 2°C. If you apply the same flame for the same time to 2 L of water, by how much will its temperature rise?

(a) 2°C

(b) 1°C (Ans)

(c) 4°C

(d) data is insufficient

$$\Delta Q = m s \Delta T$$

$$\Rightarrow \Delta Q = 2 m s \Delta T'$$

$$2 \Delta T' = \Delta T$$

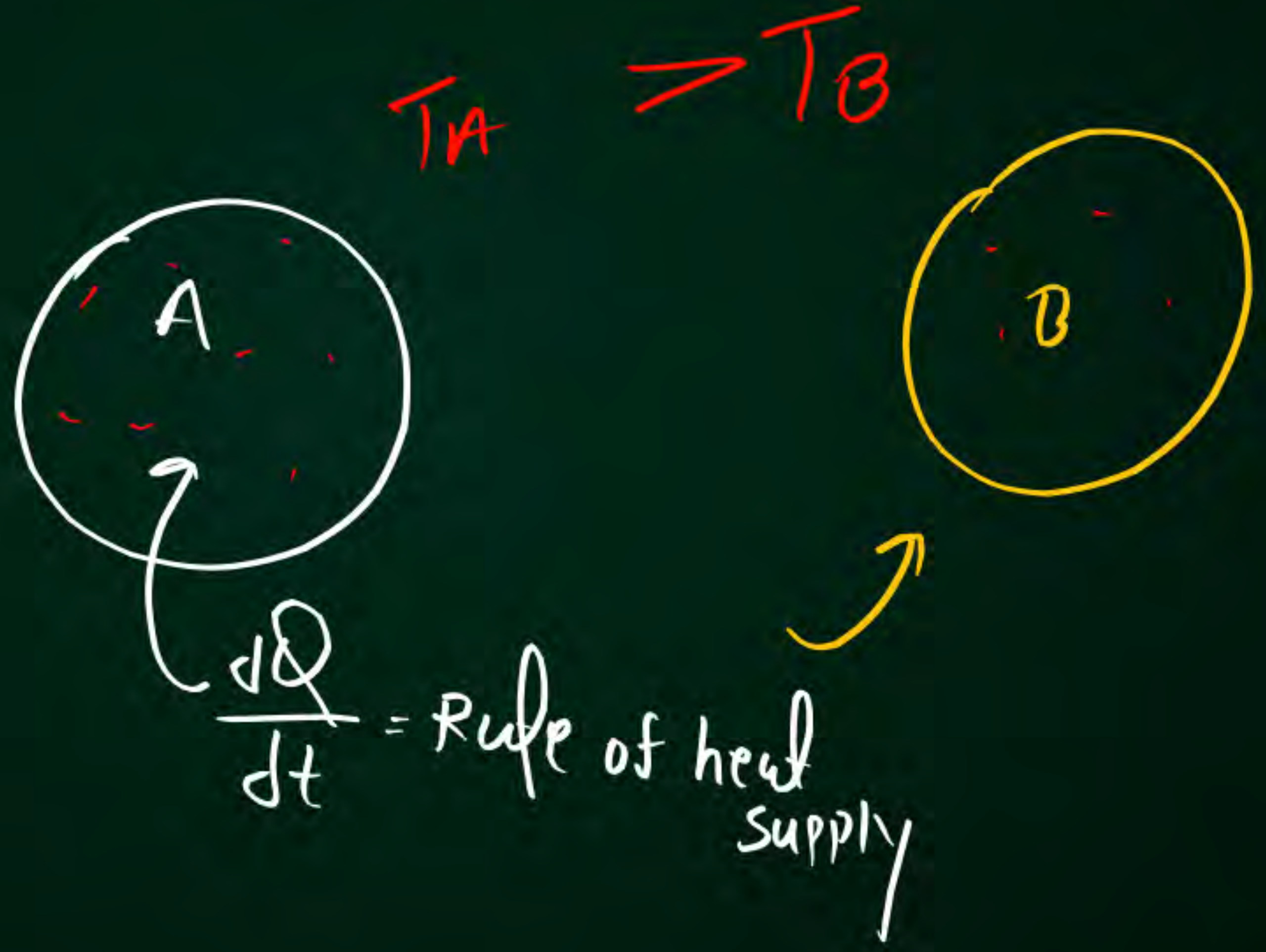
$$2 \Delta T' = 2°C$$

$$1°C$$

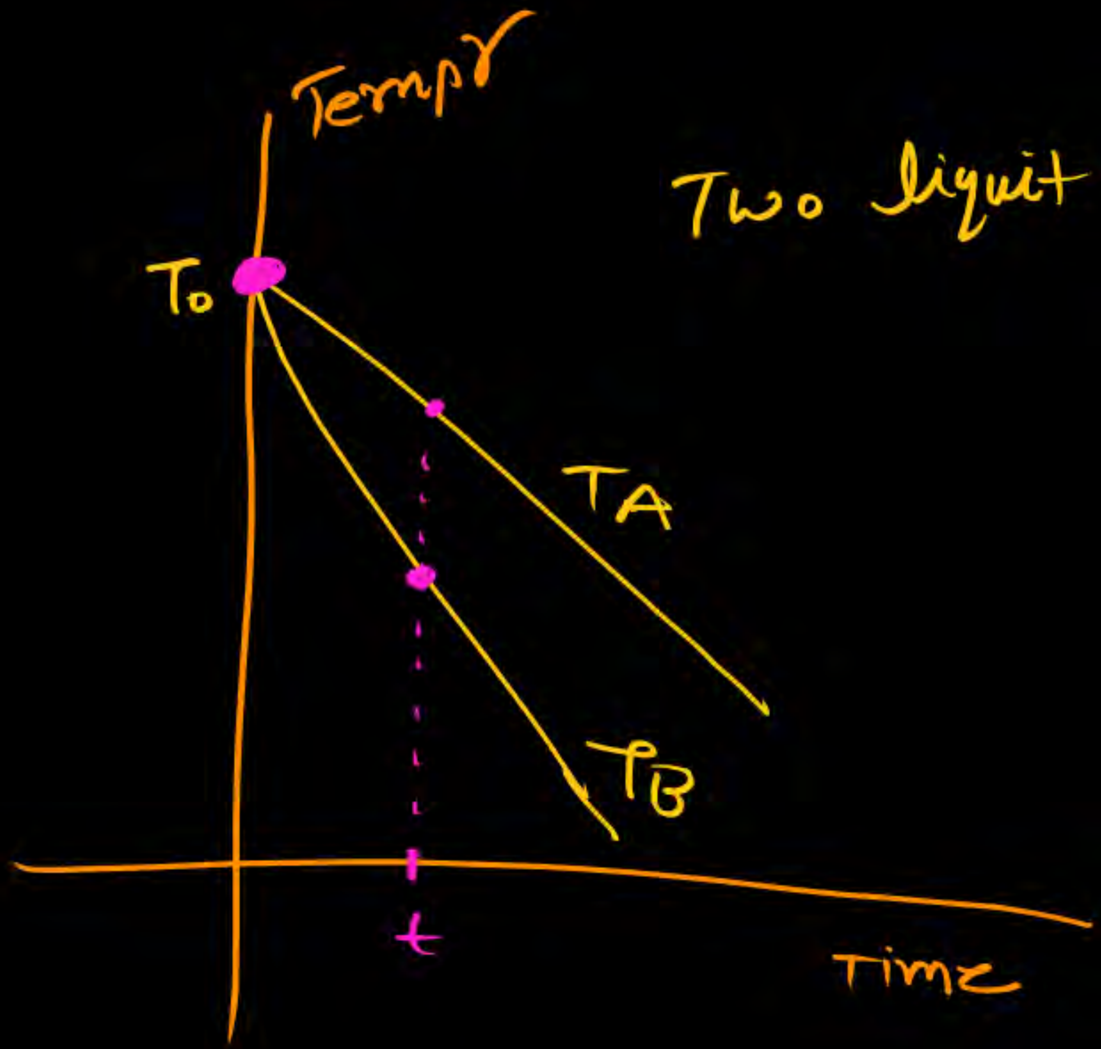
QUESTION

The rate of heat supply is same to both the liquid after some time $T_A > T_B$, then their specific heat will be (Amount of liquid also same)

1. $S_A = S_B$
2. $S_A > S_B$
3. $S_A < S_B$
4. Can't say



Two liquit have initial Tempr Tempr (T_0)
& decrease in Tempr as show.



(a) $S_A = S_B$

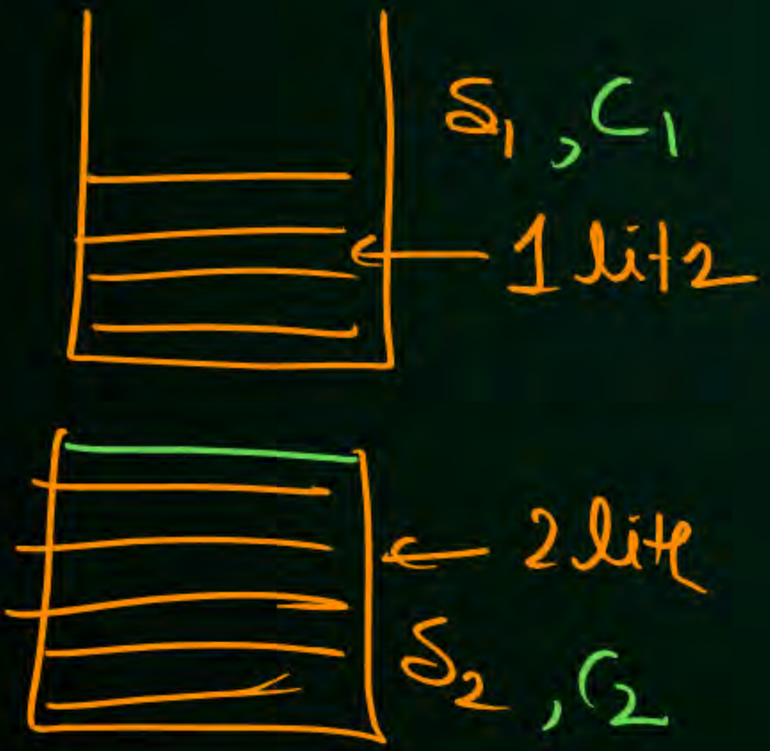
(b) $S_A < S_B$

(c) $S_A > S_B$ (92%)

S ⇒ does not depend on mass

Heat Capacity

Heat capacity (C) = Heat require to change the Temp by unit °C of given mass.



$S_1 = S_2$

$C_1 < C_2$

$$dQ = C \cdot \Delta t \quad \text{— (1)}$$

$$d\theta = m s \Delta t \quad \text{— (1)}$$

$$ms = C$$

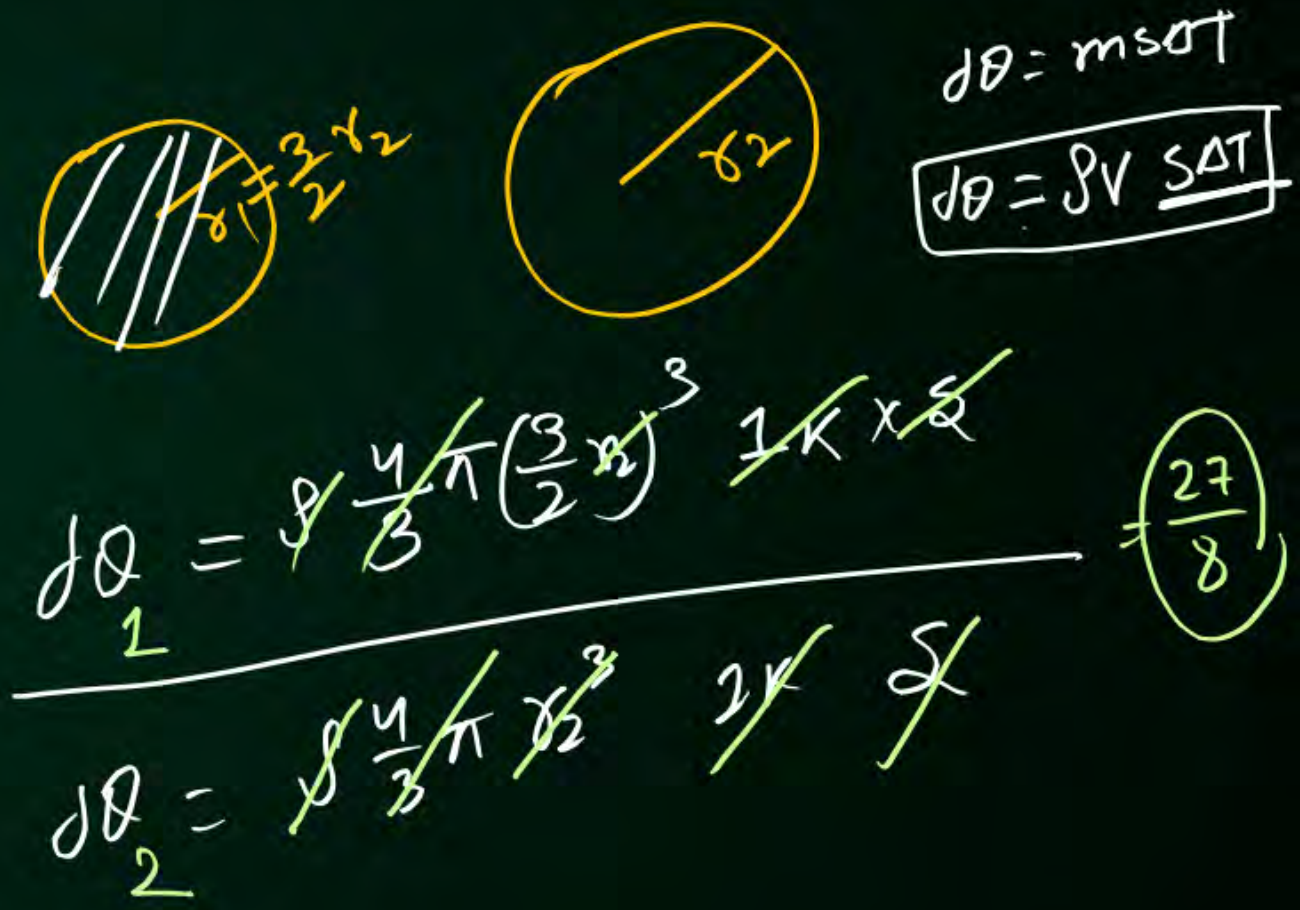
specific heat capacity (s), heat capacity (C)

C_m = molar heat capacity $\longrightarrow$ Heat required to raise the Tempr of 1-mole by 1°C.

QUESTION

The quantities of heat required to raise the temperature of two solid copper spheres of radii r_1 and r_2 ($r_1 = 1.5\,r_2$) through 1 K are in the ratio [NEET 2020]

1. $\frac{27}{8}$
2. $\frac{9}{4}$
3. $\frac{3}{2}$
4. $\frac{5}{3}$



QUESTION

Thermal capacity of 40 g of aluminium ($s = 0.2$ cal/g K) is [1990]

1. 168 J/K
2. 672 J/K
3. 840 J/K
4. 33.6 J/K

Heat

33%

$C = s m$

$= 40 g \times 0.2 \frac{cal}{g K}$

$= 40 \times \frac{2}{10} \frac{cal}{K}$

$= 8 \frac{cal}{K} = \frac{8 \times 4.2 J}{K}$

$= 33.6 J/K$

Molar heat capacity

Amount of heat require to raise the temperature of 1 mole substance by 1°C.

$$C = \frac{\Delta\theta}{\Delta t n} = \frac{\mathrm{J}}{\mathrm{Kgmol}}$$

$(S_{max})_{water} = 1\ Cal/gm\ °C = \frac{4.2\ J}{10^{-3} kgk}$

$= 4200\ J/kgk$

$(S_{ice}) = 0.5\ Cal/gm\ °C = 2100\ J/kgK$

$(S_{steam}) = 0.5\ cal/gm\ °C = 2100\ J/kgK$

$= 1\ Cal = 4.2\ J$



Heat is given to liquid it Tempr must Increse??

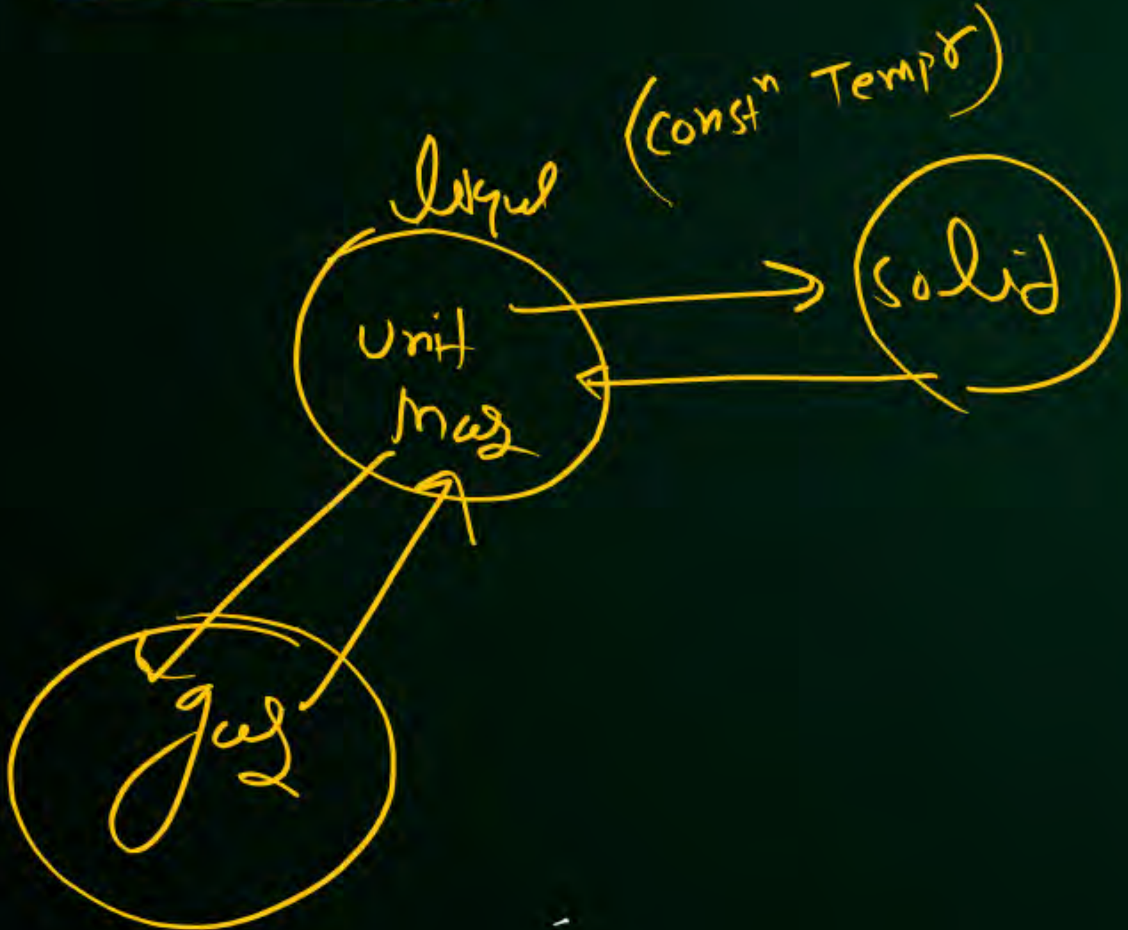
~~(a)~~ True (27%)

✓(b) false (70%)

✡ Phase may change due to exchange of heat at $const^n$ Tempr.

Latent Heat

The amount of heat required to change the unit mass of a substance completely from one state to another at constant temperature is called latent heat of the substance.



$dQ \propto$ mass

$dQ = L\,m$

$L = \dfrac{dQ}{m}$ [J/kg]

Latent heat of fusion = 80 cal/grm

Latent heat of vaporisation = 540 cal/g

Water at $-1°C$ ⟶ Not Possibe

Ice at $0.5°C$ ⟶ Not Possile

$100°C$ → water ⟶ Posibe

$101°C$ → water ⟶ Not Possible



at $0°C$
[Water + Ice] ka mixture Possible

at $100°$
water + steam ka mixture Possible

	A	B	C
1	Ice at 0.5°C ✗	Water at –2°C ✗	Steam at 100°C ✓
2	Ice at –0.5°C ✓	Water at 10°C ✓	Steam at 90°C ✗
3	Ice at 1°C ✗	Water at 0°C ✓	Steam at 101°C ✓
4	Ice at 0°C ✓	Water at 0.5°C ✓	Steam at 105°C ✓
5	Ice at 10°C ✗	Water at –0.1 °C ✗	Steam at 99°C ✗
6	Ice at –10°C ✓	Water at 100°C ✓	

Tempr of Ice $\leq 0°C$

tempr of steam $\geq 100°C$

Tempr of water $0° \leq T_w \leq 100°$

QUESTION

If temperature of 20 gm water fall from 80°C to 20°C. Find heat release by water.

Sol^n

20 grm

$T_1 = 80°$ $T_2 = 20°C$

$$dQ = ms(T_f - T_i)$$

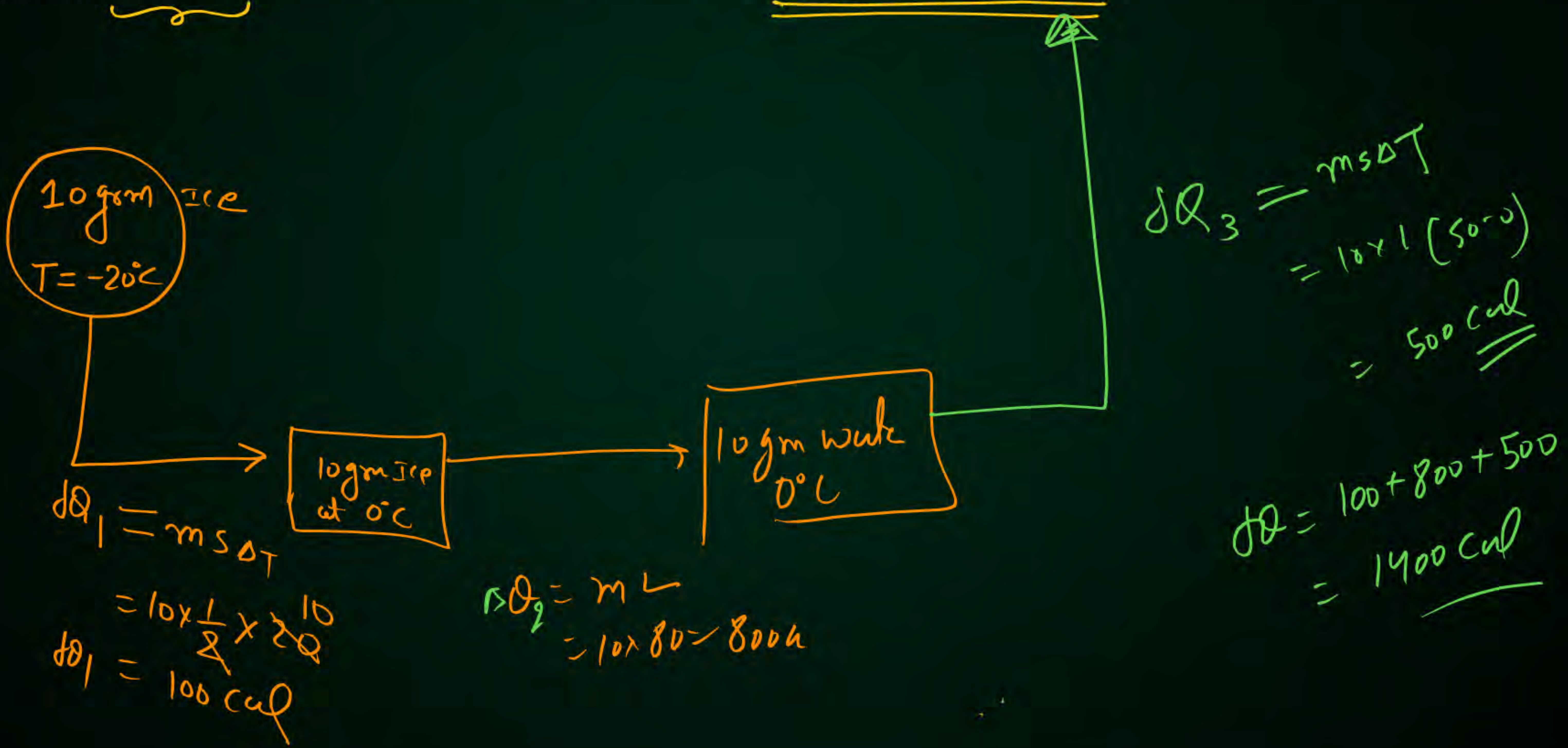
$$= 20 \times 1 [20 - 80]$$

$$= -60 \times 20$$

$$= -1200 \text{ cal}$$

QUESTION

$$10 \text{ gm ice } -20°C \xrightarrow{\Delta Q_{not} = \Delta Q_1 + \Delta Q_2 + \Delta Q_3} 10 \text{ gm water } 50°C$$



QUESTION

Find heat required to convert 20 gram ice at –30°C to (5 gram ice + 15 gram water) at 10°C

Question is worng

QUESTION

Find heat required to convert 20 gram ice at –30°C to (5 gram ice + 15 gram water) at 0°C

Sol^n

20 grm Ice at –30°C → 20 gm Ice at 0° → 5 grm Ice 0°C

→ 15 grm Ice → water

$$\Delta Q_1 = m s \Delta T$$

$$= 20 \times \frac{1}{2} \times (0+30)$$

$$= 300 \text{ cal}$$

$$\Delta Q_2 = 15 \times 80$$

$$= 1200 \text{ cal}$$

$$\Delta Q_2 = [1200 + 300] \text{ cal}$$

QUESTION

Amount of heat required to convert 20 gm ice from –20°C to steam at 100°C.

20 gram

Sol^n

20 gm at –20°C

$\Delta Q = 20 \times \frac{1}{2} \times 20$

$= 200$ cal

20 gm Ice at 0°C

$\Delta Q_2 = mL$

$= 20 \times 80$

$= 1600$ cal

20 gm wal 0°C

$\Delta Q_3 = ms\Delta T$

$= 20 \times 1 \times 100 = 2000$ cal

20 gm wal 100°

$Q = mL$

$= 20 \times 540 = 10800$ cal

20 gm stm at 100°C

QUESTION

$$10 \text{ gm water } 100^\circ C \xrightarrow[\Delta Q = ??]{} 10 \text{ gm vapour } 100^\circ C$$

$dQ = mL$

Heat given to 1 grm Ice at −20°C with a cost^n rate then draw graph B/W Temp^r & time:

1 grm Ice at −20°C

$\Delta Q_1 = ms\Delta T = 1 \times \frac{1}{2} \times 20 = 10$ cal

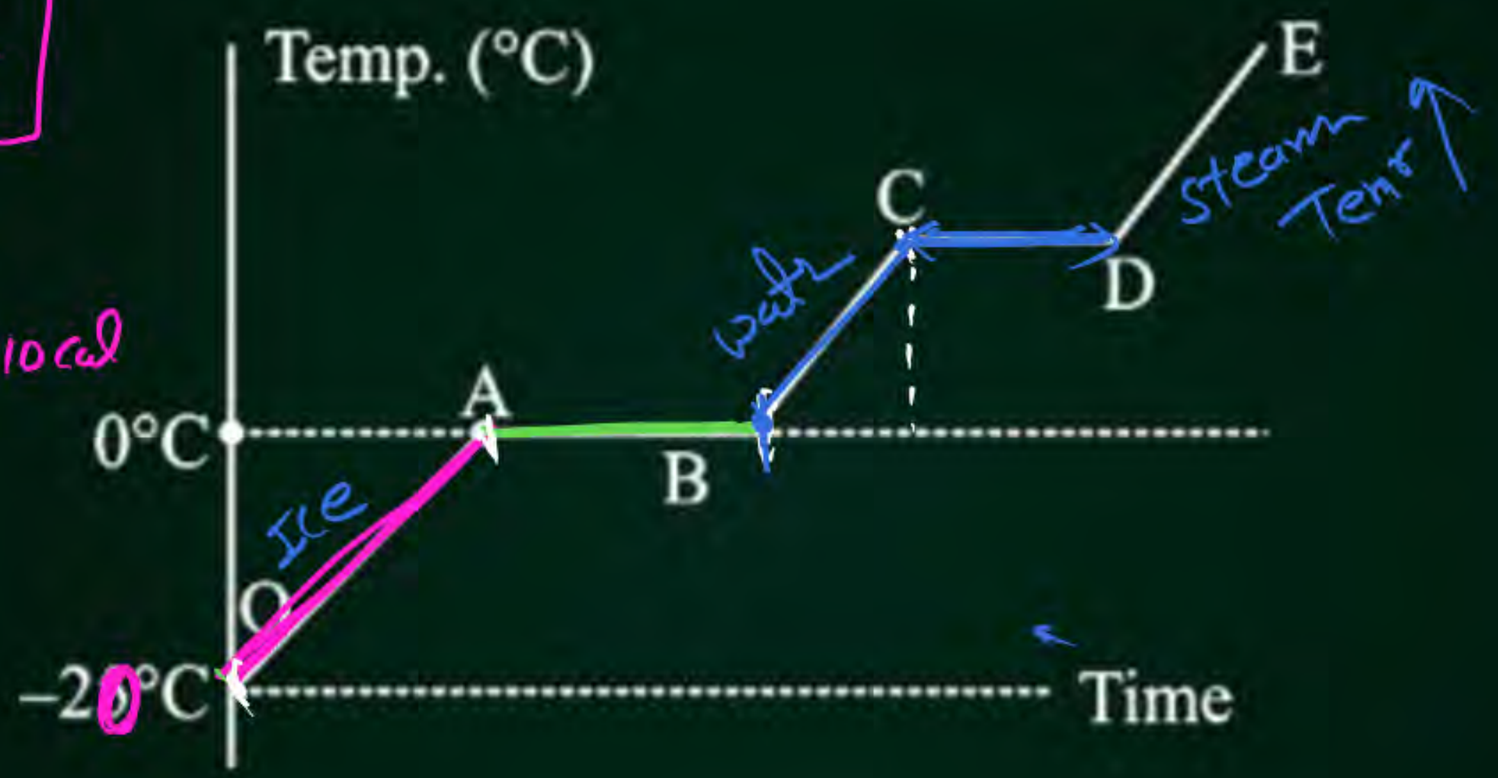
1 gm Ice at 0°C

$dQ_2 = mL$ $(T = \text{cst}^n)$
$= 1 \times 80$ cal

1 gm water 0°C

$dQ_3 = ms\Delta T = 1 \times 1 \times 100 = 100$ cal

1 gm water 100°C



Slope of Temp^r−time graph OA & BC

(a) $S_{OA} = S_{BC}$

✓(b) $S_{OA} > S_{BC}$

(c) $S_{OA} < S_{BC}$

$\left[\frac{dQ}{dt}\right] = ms\left[\frac{\Delta T}{dt}\right]$

(cst^n) (sm)

$\frac{\Delta T}{dt}$ (slope) $\propto \frac{1}{S}$


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture-5 | **Physics**

Thermal Properties Of Matter



By- Dr. Manish Raj (MR SIR)

Topics to be covered

1 # mixture of [liquid + liquid]

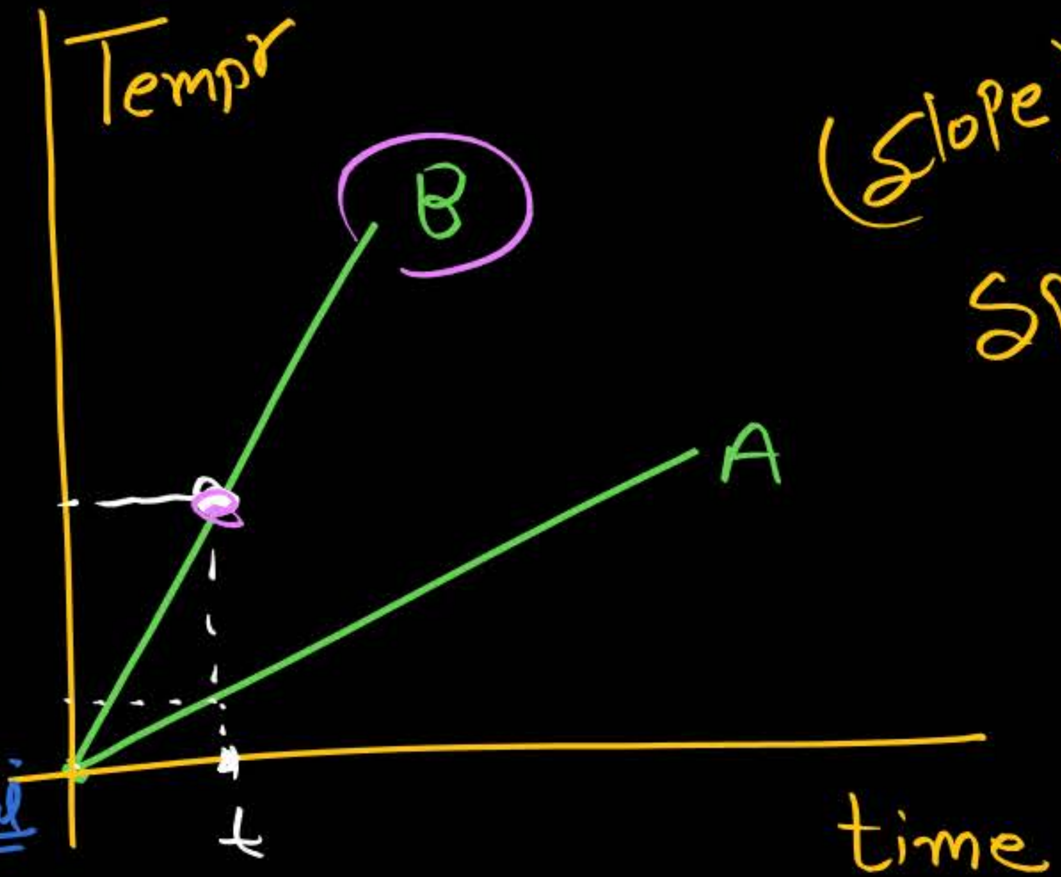
2 # Mixture of [Ice + water]

mixture of (Ice + steam)

3 # (water + steam)

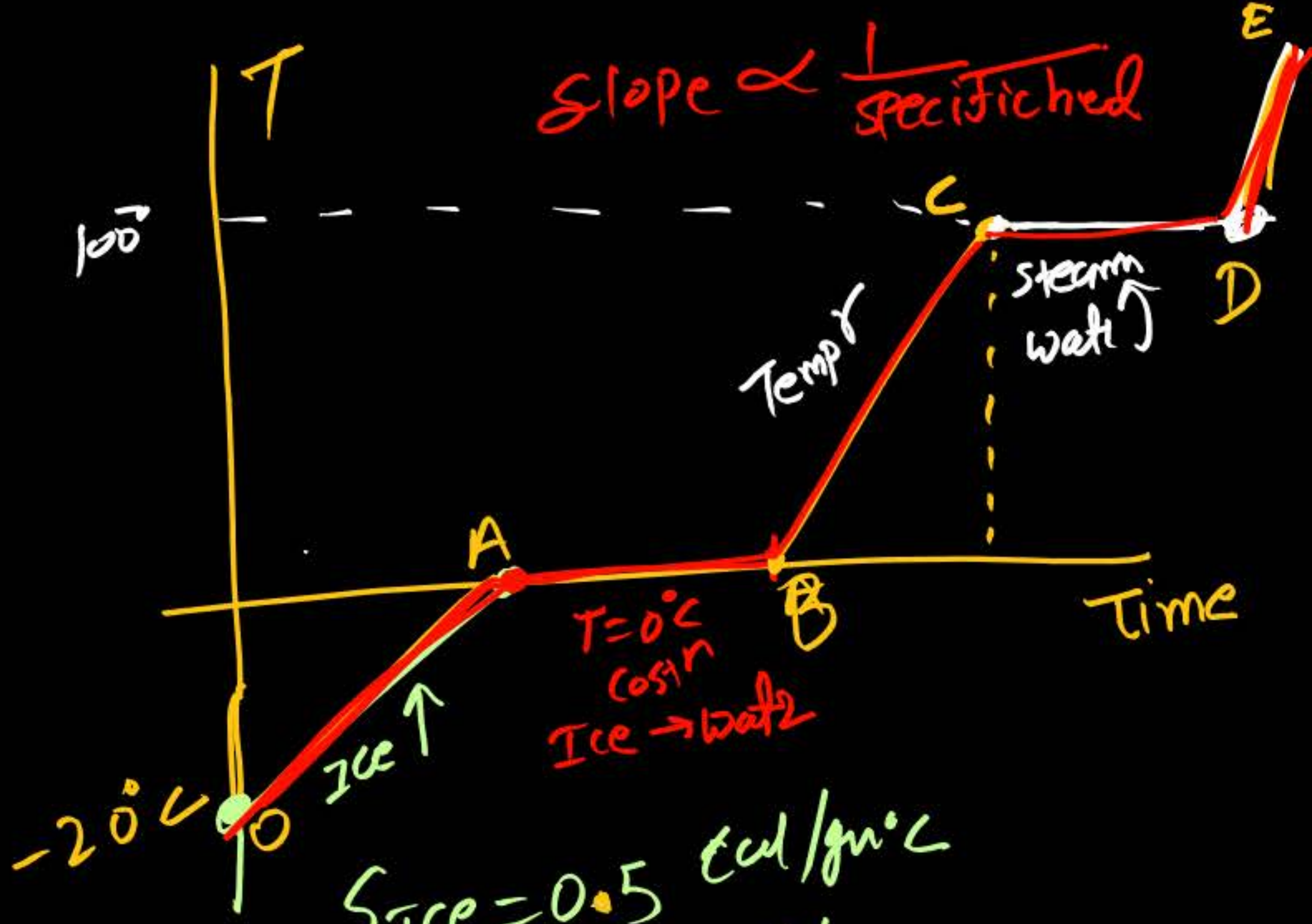


MR*
Jiska [S] kam hai wo Jaldi gram or Jaldi dhanda hota hai



$(\text{Slope})_B > (\text{Slope})_A$

Specific h $\propto \frac{1}{\text{slope}}$



$S_{Ice} = 0.5$ cal/gm°C

$S_{water} = 1$ cal/gm°C

$S_{steam} = 0.48 \simeq 0.5$ cal/gm°C

$[\text{Slope}]_{OA} = (\text{Slope})_{DE}$

(Q) Constant Rate of heat given to diffn liquid of same mass. Its Tempr time graph given.

(a) $S_A = S_B$

(b) ✓ $S_A > S_B$

(c) $S_A < S_B$

QUESTION

Heat is supplied to a ice at a constant rate temperature variation with time is as shown in figure, then –

(A) During AB volume of substance increases

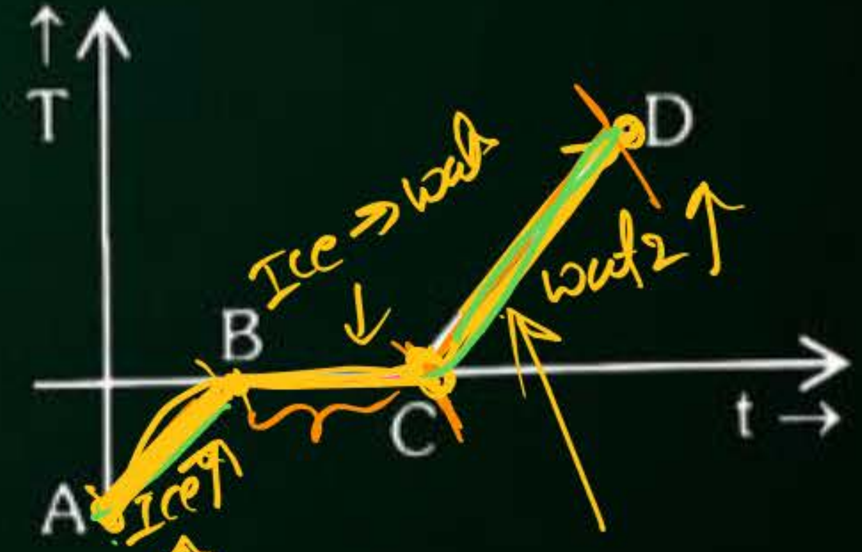
(B) During BC volume of substance decreases

(C) Specific heat of substance in liquid phase is proportional to reciprocal of slope of portion AB of graph

(D) Latent heat of fusion of substance is independent of portion AB of graph.

Then correct option is -

1. A, C
2. B, C
3. A, C, D
4. B, D



Rate of Heat loss & Rate of Colling.

(a) same (45%) ✗

(b) diffⁿ ✓

$\frac{dT}{dt}$ = Rate of colling / Rate of Heating

$\frac{dQ}{dt}$ = Rate of Heat loss or Rate of Heat gain.

$\frac{dQ}{dt} = ms\frac{dT}{dt}$

$\frac{dQ}{dt}$ → Rate of Heat loss/gain

$\frac{dT}{dt}$ → Rate of cooling / Rate of Heating

QUESTION

The rate of ~~Heat loss~~ of a sphere of thermal capacity 1000 cal/K is 400 J/s, its rate of fall of temperature is

1. 0.095 K/min
2. 0.62 K/min
3. 2.8 K/min
4. 5.7 K/min

$C = 1000\ \text{cal/K}$

$\frac{dQ}{dt} = 400\ \text{J/sec}$

$\frac{dT}{dt} = ??\ \text{K/sec}$

$\frac{dQ}{dt} = ms\left[\frac{dT}{dt}\right]$

$400\ \text{J/s} = 1000\ \text{cal}\left[\frac{dT}{dt}\right]$

$400\ \text{J/s} = 4.2 \times 10^{3}\ \text{J}\ \frac{dT}{dt}$

$\frac{4}{42} = \frac{dT}{dt}$

$\frac{dT}{dt} = \frac{4}{42}\ \text{K/sec} = \frac{4 \times 60}{42}\ \text{K/min}$

$= 0.09$

QUESTION

A refrigerator convert 100 gram of water at 10°C into ice at 0°C in one hours then find heat removed per minutes?

100 gm water at 10°C → 100 gm ice at 0°C

Temp ↓

$dQ = ms\Delta T = 100 \times 1 (10 - 0)$

$dQ = 1000$ cal

$dQ_2 = mL = 100 \times 80 = 8000$ cal (Removed)

$dQ = 8000 + 1000 = 9000$ cal

$\frac{[dQ]}{[dT]} = \frac{9000 \text{ cal}}{60 \text{ min}}$

$= 150$ cal/min

QUESTION

Which is more dangerous

(i) Burn by 100°C water

(ii) Burn by 100°C steam. (more dangerous)

QUESTION

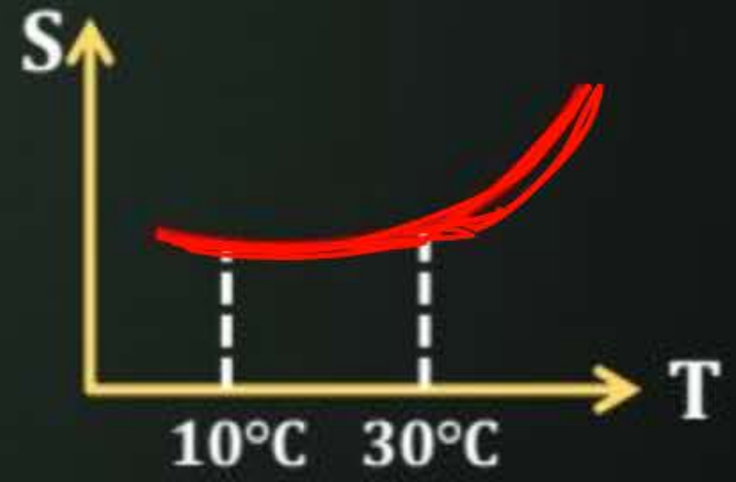
S → specific Heat generally const for a liquid at lower Temp but it Incrs at higher Temp

Graph for specific heat ?

1


2

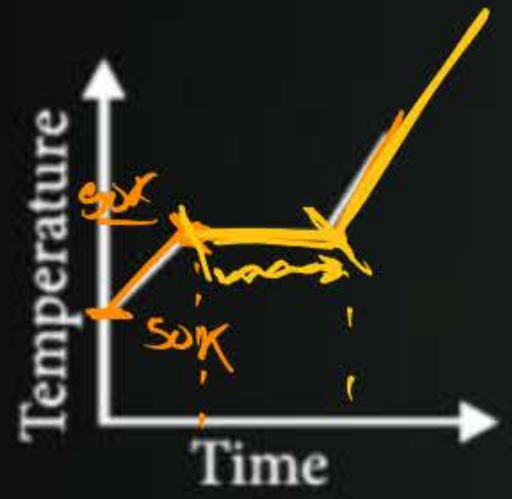

3


4


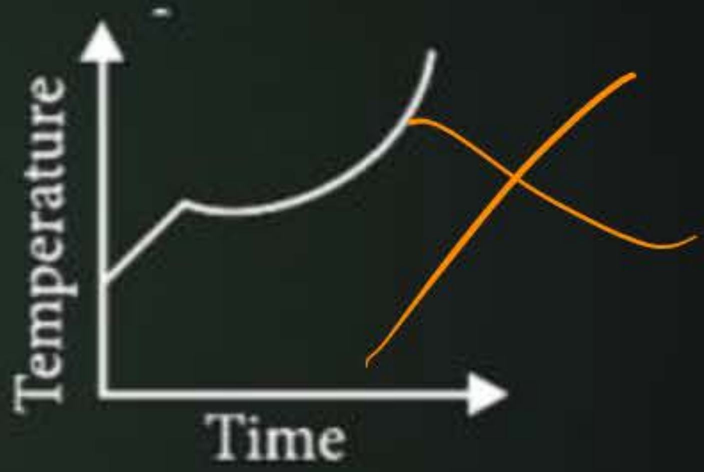
QUESTION

Liquid oxygen at 50 K is heated to 300 K at constant pressure of 1 atm. The rate of heating is constant. Which one of the following graphs represents the variation of temperature with time ?

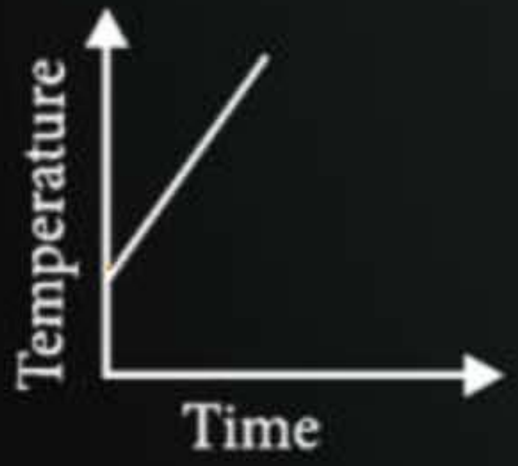
1



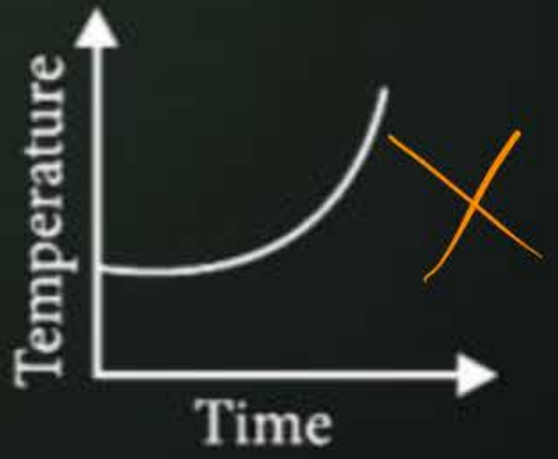
2



3



4

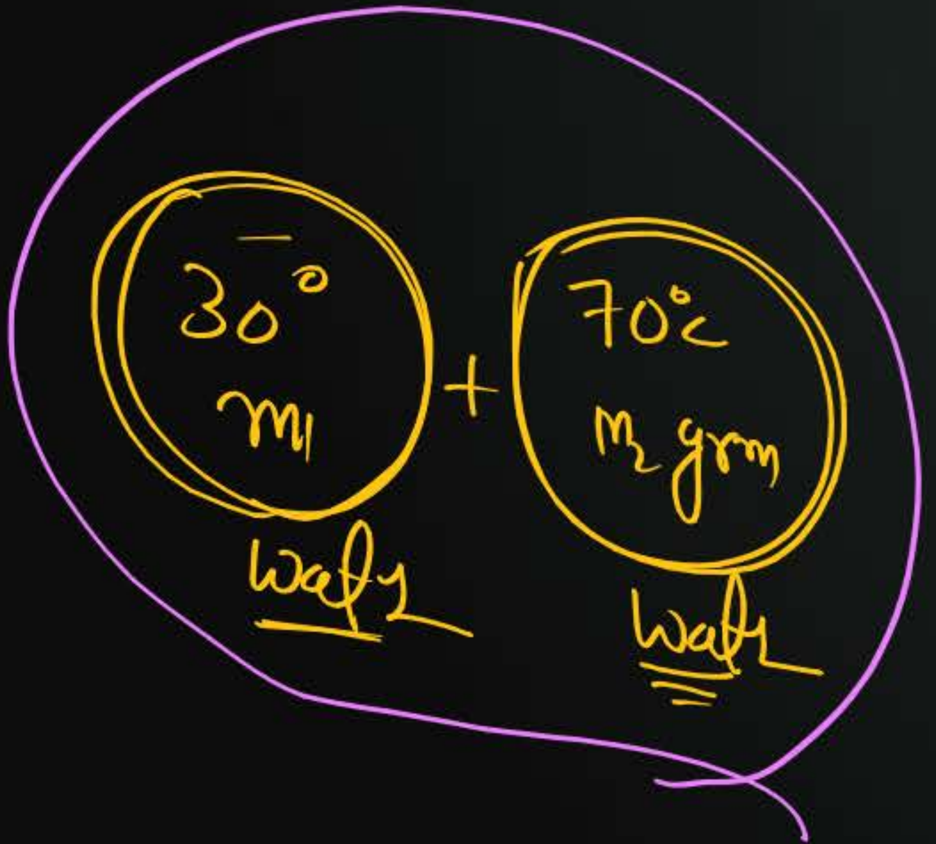


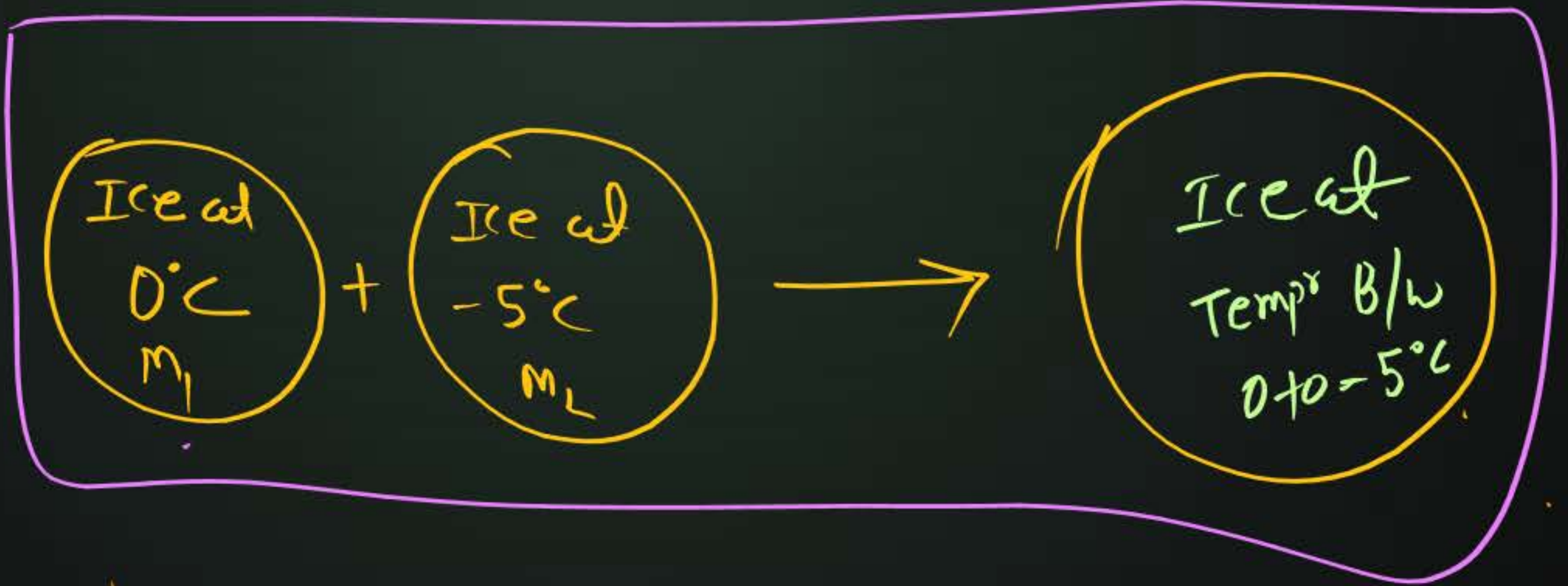
Mixture of two Liquid



When we mix two substance of same phase then only temperature will change of both the substance. phase will not change.

Heat → Energy flows due to temperature difference.





QUESTION

Two liquid of mass m_1 and m_2 of specific heat capacity S_1 & S_2 at temperature T_1 & T_2 find temperature of mixture.

$T_1 < T_2$

$(m_1, S_1, T_1) + (m_2, S_2, T_2) \Rightarrow$ mixture: $T_m = ??$, $(m_1 + m_2)$, T_m (let)

Law of calorimetry

Heat gain = Heat loss

$$(\Delta Q_1)_{gain} = (\Delta Q_2)_{loss}$$

$$m_1 S_1 [T_m - T_1] = m_2 S_2 [T_2 - T_m]$$

$$m_1 S_1 T_m - m_1 S_1 T_1 = m_2 S_2 T_2 - m_2 S_2 T_m$$

$$m_1 S_1 T_m + m_2 S_2 T_m = m_2 S_2 T_2 + m_1 S_1 T_1$$

$$T_m [m_1 S_1 + m_2 S_2] = m_1 S_1 T_1 + m_2 S_2 T_2$$

$$T_m = \frac{m_1 S_1 T_1 + m_2 S_2 T_2}{(m_1 S_1 + m_2 S_2)}$$

dimⁿ

$$T_{mix} = \frac{m_1 s_1 T_1 + m_2 s_2 T_2}{m_1 s_1 + m_2 s_2}$$

→ diff^n nature of liquid but same mass.

$$T_{mix} = \frac{m[s_1T_1 + s_2T_2]}{m(s_1+s_2)}$$

$$T_{min} = \frac{s_1T_1 + s_2T_2}{s_1+s_2}$$

MR^t $T_1 < T_{mix} < T_2$

(liquid + liq)
(Ice + Ice)
(Steam + Steam)

→ Same nature of liquid
$[s_1 = s_2]$

$$T_{mix} = \frac{m_1T_1 + m_2T_2}{m_1+m_2}$$

→ Same nature of liquid & also mass same

$$T_{mix} = \frac{m(T_1+T_2)}{2m} = \frac{T_1+T_2}{2}$$

QUESTION

20 gram water at 30°C mixed with 40 gram water at 10°C then find temperature.

Same nature of liquid

$s_1 = s_2 = 1$

$T_{mix} = \frac{m_1 T_1 + m_2 T_2}{m_1 + m_2}$

$= \frac{20 \times 30 + 40 \times 10}{20 + 40}$

$= \frac{600 + 400}{60} = \frac{1000}{60} = 16.6°C$

QUESTION

Two liquid of same mass at 20°C and 60°C mixed then temperature of mixture is 30°C, then find ratio of their specific heat.

$$T_{mix} = \frac{S_1 \times 20 + S_2 \times 60}{S_1 + S_2} = 30$$

$$20 S_1 + 60 S_2 = 30 S_1 + 30 S_2$$

$$30 S_2 = 10 S_1$$

$$\frac{S_1}{S_2} = \frac{3}{1}$$

QUESTION

A liquid of mass m and specific heat c is heated to a temperature $2T$. Another liquid of mass $m/2$ and specific heat $2c$ is heated to a temperature T. If these two liquids are mixed, the resulting temperature of the mixture is ??

1. (2/3)T
2. (8/5)T
3. (3/5)T
4. (3/2)T

$m, c, 2T$

$\frac{m}{2}, 2c, T$

$T_{mix} =$

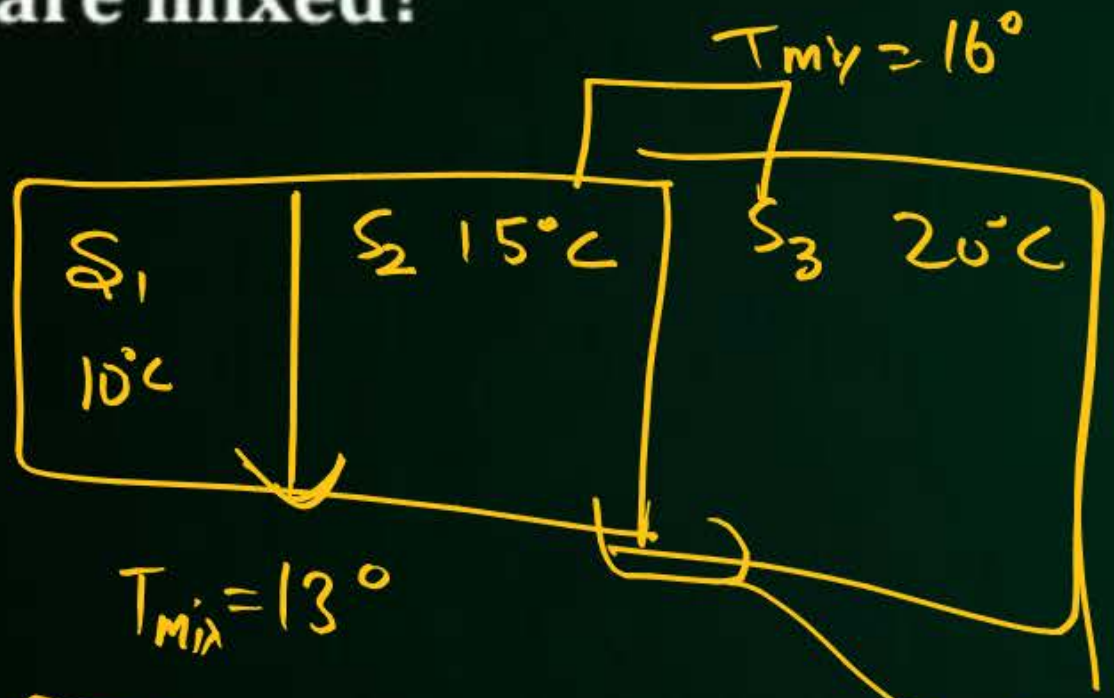
$$T_{mix} = \frac{mc2T + \frac{m}{2}2cT}{mc + \frac{m}{2}2c}$$

$$= \frac{3mcT}{2mc} = \frac{3T}{2}$$

QUESTION

The temperature of equal masses of three different liquids A, B and C are 10°C, 15°C and 20°C respectively. The temperature when A and B are mixed is 13°C and when B and C are mixed, it is 16°C. What will be the temperature when A and C are mixed?

(JIT-main)



$T_{mix} = \frac{S_1 10 + S_2 15}{S_1 + S_2} = 13$

$\frac{S_2 15 + S_3 20}{S_2 + S_3} = 16$

$3S_1 = 2S_2$ $\quad S_1 = \frac{2}{3}S_2$

$S_2 = 4S_3$

$\frac{10 S_1 + 20 S_3}{S_1 + S_3} = T_{mix}$

H|W

QUESTION

Two identical bodies are made of a material for which the heat capacity increases with temperature. One of these is at 100°C, while the other one is at 0°C. If the two bodies are brought into contact, then, assuming no heat loss, the final common temperature is

[NEET-II 2016]

1. 50°C
2. more than 50°C
3. less than 50°C but greater than 0°C
4. 0°C

$S \propto$ Tempr

$S_1 < S_2$ → slowly Temp down

$$T_{mix} = \frac{S_1 T_1 + S_2 T_2}{S_1 + S_2}$$

$$T_{mix} = \frac{S_1 \times 0 + S_2 \times 100}{S_1 + S_2}$$

Specific heat capacity (औकात)

high specific heat capacity mine

More heat loss in less decrease in Tempr

QUESTION

[Water + Ice]

Ultimate goal: Temp' same

40 gram water at 10°C is mixed with 10 gram ice at 0°C then find temperature of mixture?

40 gram water at 10°C → 0° water

\+

10 gram ice at 0°C

Heat loss

$dQ_2 = msΔT$

$= 40 \times 1 \times (10 - 0)$

$= 400$ cal

Heat supply by water when it comes to the 0°C

Heat gain

$dQ_1 = mL$

$= 10 \times 80 = 800$ cal

Heat required to convert Ice at 0°C into water

$T_{mix} = 0°C$

Concept: Ice will not melt.

Q_{gain} by Ice $= Q_{water\ loss}$

$m'L = 400$

$m' = \frac{400}{80} = 5$ gm

$M_{Total\ water} = 45$ g

$M_{Ice\ rem.} = 5$ gm Ice

QUESTION

80 gram water at 20°C is mixed with 15 gram ice at 0°C then temperature of mixture and mass of ice and water in mixture?

80 grm water 20°C

$dQ_{supply} = ms\Delta T$

$= 80 \times 1 \times 20$

$= 1600$ cal

80 grm water at 0°C

15 gram Ice at 0°C

15 grm water 0°C

$dQ_{require} = mL$

$= 15 \times 80$

$= 1200$ cal

80 gm + 15 g = 95 gm, $\Delta T = 400$ cal

$T = \left(\frac{400}{95}\right) = 4.2°C$



(Honesty is his policy)

M.R मुखिया →

1 ही नारा Temp और Pose same ho hamara

MIXTURE OF ICE AND WATER

m grm ice at 0°C

(heat require to convert ice to water) at 0°C

$Q_1 = mL$

W grm water at T°C

heat given by water to decrease temperature from T°C to 0°C of water = $WT = Q_2$

Case-1

$Q_1 = Q_2$

$(mL)_{req} = (WT)_{sw}$

पुरा पानी हो जायगा

$T_{mix} = 0$

Case-2

$Q_1 > Q_2$

$mL > WT$

Some Ice will melt

$T_{mix} = 0^\circ$

$m'L = WT$

Case-3

$Q_1 < Q_2$

Compt meltn

$(WT - mL) = (W+m) \times S\,(T_f - 0)$

(WT − mL): un used heat

$T_f = \left(\frac{WT - mL}{W+m}\right)$

Case – 1 If $mL = WT$

Case – 2 If $mL > WT$

Case – 3

If $mL < WT$

QUESTION

If 10 g of ice at 0°C is mixed with 10 g of water at 40°C, the final mass of water in the mixture is -

1. 10 g
2. 15 g
3. 18 g
4. 20 g

10 gm Ice at 0°C

$\# \; mL = 10 \times 80$

$= 800 \, W$

Compt Ice Not mv

10 grm water 0°C

$ms\Delta T = 10 \times 1 \times (40-0)$

$= 400 \, W$

$m' L = 400$

78%

QUESTION

One kg of ice at 0°C is mixed with 1 kg of water at 10°C. The resulting temperature will be-

1. between 0°C and 10°C
2. 0°C
3. less than 0°C
4. greater than 0°C

1 kg Ice 0°C

$Q = 80 \times 1000$

$= 8 \times 10^4$ cal

msΔT

QUESTION

5 g of water at 30°C and 5 g of ice at –20 C are mixed together in a calorimeter. Neglect the water equivalent of the calorimeter. The final temperature of the mixture is –

(Specific heat of ice = 0.5 cal g^{-1} °C^{-1})

1. 0°C
2. -20°C
3. -10°C
4. +1.2°C

5 grm water 30°C — loss

$dQ_{supply\ loss} = msΔT$

$= 5 \times 1 (30-0)$

$= 150$ cal

Heat supply when water comes from 30° to 0°C



5 grm Ice at -20°C — gain

$dQ_{gain} = msΔT$

$= 5 \times \frac{1}{2}(0-(-20))$

$= 5 \times \frac{1}{2} \times 20 = 50$ cal

Ice at 0°C

$Q_2 = mL = 5 \times 80 = 400$ cal (required)

Compt Ice will melt into water at 0°C

in 150 cal → 50 cal heat will use to incrs Temp of Ice & only 100 cal will use to melt Ice

$m'L = 100$

$m' = \frac{100}{80} = 1.2$ gm

QUESTION

One gram of ice (at 0°C) is mixed with one gram of steam (at 100°C). After thermal equilibrium, the temperature of the mixture is-

1. 0°C
2. 100°C
3. 55°C
4. 80°C

1 grm Ice 0°C

$Q_1 = mL = 1 \times 80 = 80$ cal

$Q_2 = ms\Delta = 1 \times 1 \times 100 = 100$ cal

1 gm Water at 100°C = 180 cal

1 gm steam 100°C → 1 gm wat at 100°C

(Heat loss) $dQ = mL = 1 \times 540 = 540$ cal

QUESTION

If 1 g of steam is mixed with 1 g of ice, then resultant temperature of the mixture is [1999]

1. 100°C
2. 230°C
3. 270°C
4. 50°C

QUESTION

Temperature of 100 grm water increases from 24°C to 90°C by adding steam then mass of steam require is ?

$T_{steam} = 100°C$

100 grm water

$T_i = 24°C \longrightarrow 90°C$ (T_{mix})

m grm steam 100°C → m gm water at 90°C

$dQ_{gain\ by\ water} = msΔT$

$= 100 \times 1 (90-24)$

$= 6600$ cal

$Q_{Heat\ loss} = mL + msΔT$

$= m540 + m \times 1 \times (100-90)$

$= 540m + 10m$

$= 550m$

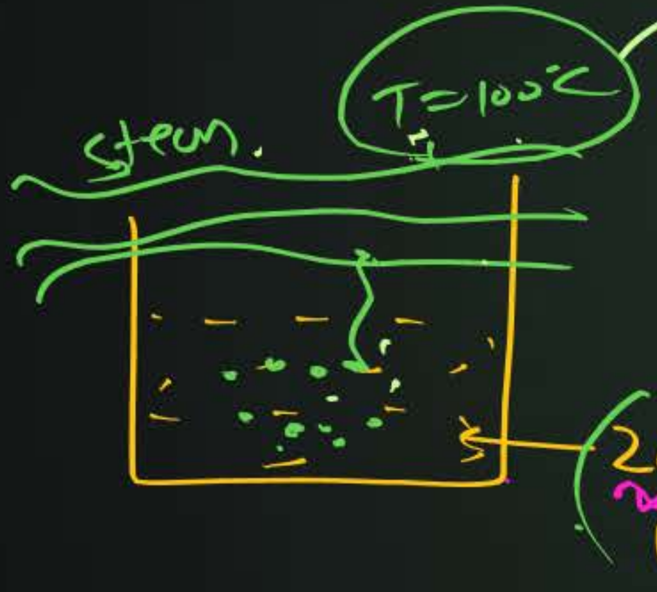
$6600 = 550m$

$\frac{66}{5}\cdot\frac{60}{5} = m$

m = 12 gm

QUESTION

Steam at 100°C is passed into 20 g of water at 10°C. When water acquires a temperature of 80°C, the mass of water present will be [Take specific heat of water = 1 cal g^{-1} °C^{-1} and latent heat of steam = 540 cal g^{-1}] (2014)



1. 24 g
2. 31.5 g
3. 42.5 g
4. 22.5 g

QUESTION

A piece of ice falls from a height h so that it melts completely. Only one-quarter of the heat produced is absorbed by the ice and all energy of ice gets converted into heat during its fall. The value of h is [Latent heat of ice is 3.4×10^5 J/ kg and $g = 10$ N/kg]

(NEET-I 2016)

1. 136 km
2. 68 km
3. 34 km
4. 544 km



QUESTION

An electric heater rated as 2 kW is used to heat 200 kg of water from 10°C to 70°C. Assuming no heat losses, the time taken is-

1. 25.2 s
2. 6×10^3 s
3. 25.2×10^3 s
4. 25.2×10^6 s

$P = \frac{E}{t}$

$E_{loss} = Pt = ms\Delta T$

hint

17/w

QUESTION

Two identical masses of 5 kg each fall on a wheel from height of 10m. The wheel disturbs a mass of 2 kg water, the rise in temperature of water will be:

1. 2.6°C
2. 1.2°C
3. 0.32°C
4. 0.12°C

$2[mgh] = ms\Delta T$

↑ for 2-obj   for water

QUESTION

A block of mass 2.5 kg is heated to temperature of 500°C and placed on large ice block. What is the maximum amount of ice that can melt (approx.). Specific heat for the body = 0.1 cal/g°C.

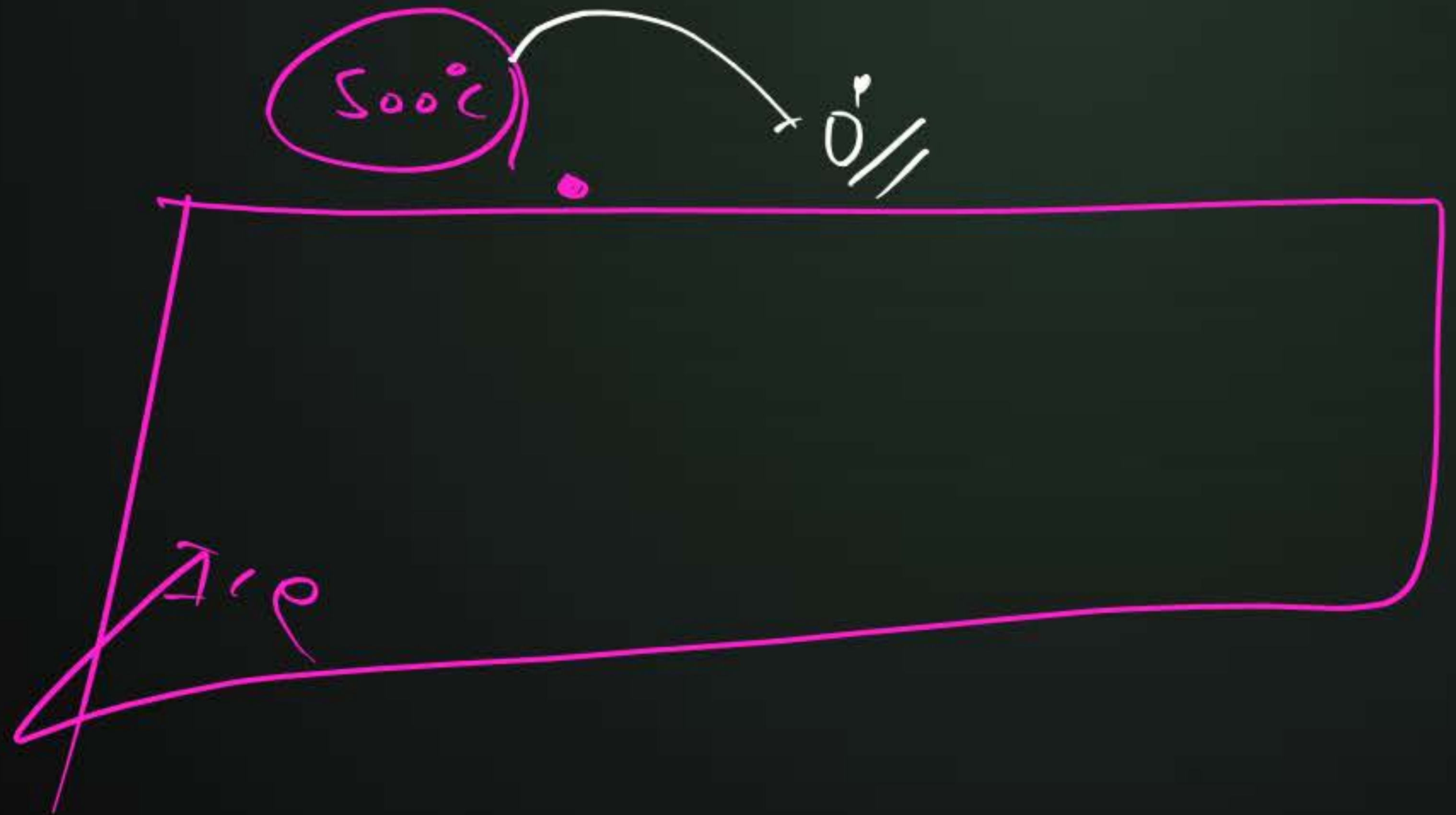
1. 1 kg
2. 1.5 kg
3. 2 kg
4. 2.5 kg

$Q_{loss} = ms\Delta T$ (500°C → 0°C)

$m_{Ice} L = dQ_{loss}$ by block

$m_{Ice} L = (ms\Delta T)_{\text{of Block}}$

500°C → 0°C



QUESTION

When M_1 gram of ice at $-10^{\circ}C$ (specific heat $= 0.5 \, cal \, g^{-1} \, {}^{\circ}C^{-1}$) is added to M_2 gram of water at $50^{\circ}C$, finally no ice is left and the water is at $0^{\circ}C$. The value of latent heat of ice, in cal g^{-1} is:

[12 April, 2019 (Shift-I)]

1. $\frac{5M_1}{M_2} - 50$

2. $\frac{50M_2}{M_1}$

3. $\frac{50M_2}{M_1} - 5$

4. $\frac{5M_2}{M_1} - 5$

QUESTION

M grams of steam at 100°C is mixed with 200 g of ice at its melting point in a thermally insulated container. If it produces liquid water at 40°C [heat of vaporization of water is 540 cal/g and heat of fusion of ice is 80cal/g], the value of M is ________. [7 Jan, 2020 (Shift-II)]

H|W

QUESTION

The specific heat of water $= 4200\ \text{J kg}^{-1}\text{K}^{-1}$ and the latent heat of ice $= 3.4 \times 10^5\ \text{J kg}^{-1}$. 100 grams of ice at 0°C is placed in 200 g of water at 25°C. The amount of ice that will melt as the temperature of water reaches 0°C is close to (in grams)

[4 Sep, 2020 (Shift-1)]

1. 69.3
2. 63.8
3. 64.6
4. 61.7

H/w

QUESTION

A calorimeter of water equivalent 20 g contains 180 g of water at 25°C. 'm' grams of steam at 100°C is mixed in it till the temperature of the mixture is 31°C. The value of 'm' is close to (Latent heat of water $= 540 \text{cal} \text{g}^{-1}$, Specific heat of water $= 1 \text{ cal g}^{-1} {}^{\circ}\text{C}^{-1}$]

[3 Sep, 2020 (Shift-II)]

1. 2
2. 3.2
3. 2.6
4. 4

QUESTION

The height of Victoria falls is 63m. What is the difference in temperature of water at the top and at the bottom of fall? [Given 1 cal = 4.2 J and specific heat of water = 1 cal g^{-1} $°C^{-1}$]

[27 Aug, 2021 (Shift-II)]

1. 0.147 °C
2. 14.76 °C
3. 1.476 °C
4. 0.014 °C

t/w

QUESTION

A block of ice of mass 120 g at temperature $0^{\circ}C$ is put in 300 g of water at $25^{\circ}C$. The xg of ice melts as the temperature of the water reaches $0^{\circ}C$. The value of x is ________.

[Use specific heat capacity of water $= 4200\,\text{Jkg}^{-1}\,\text{K}^{-1}$, Latent heat of ice $= 3.5 \times 10^{5}\,\text{Jkg}^{-1}$]

[25 July, 2022 (Shift-II)]

H/W

QUESTION

A lead bullet penetrates into a solid object and melts. Assuming that 40% of its kinetic energy is used to heat it, the initial speed of bullet is:
(Given, initial temperature of the bullet = $127^\circ C$,
Melting point of the bullet = $327^\circ C$,
Latent heat of fusion of lead = $2.5 \times 10^4 J kg^{-1}$,
Specific heat capacity of lead = 125 J/kgK) [27 June, 2022 (Shift-II)]

1. $125\ ms^{-1}$
2. $500\ ms^{-1}$
3. $250\ ms^{-1}$
4. $600\ ms^{-1}$

7/2


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 07 | Physics

Thermal Properties Of Matter



By- Dr. Manish Raj (MR SIR)

Topics to be covered

1. # K.B.D on thermal properties of Matter.
2. # Heat Transfer → Conduction
3. #



QUESTION

(1) 10 grm water at 80°C mixed with a liquid of 20 grm at 40°C having specific heat capcity $\frac{1}{2}$ cal/g then find temperature of mixture.

Soln

No Phase change

$$T_{mix} = \frac{10 \times 1 \times 80 + 20 \times \frac{1}{2} \times 40}{10 \times 1 + 20 \times \frac{1}{2}}$$

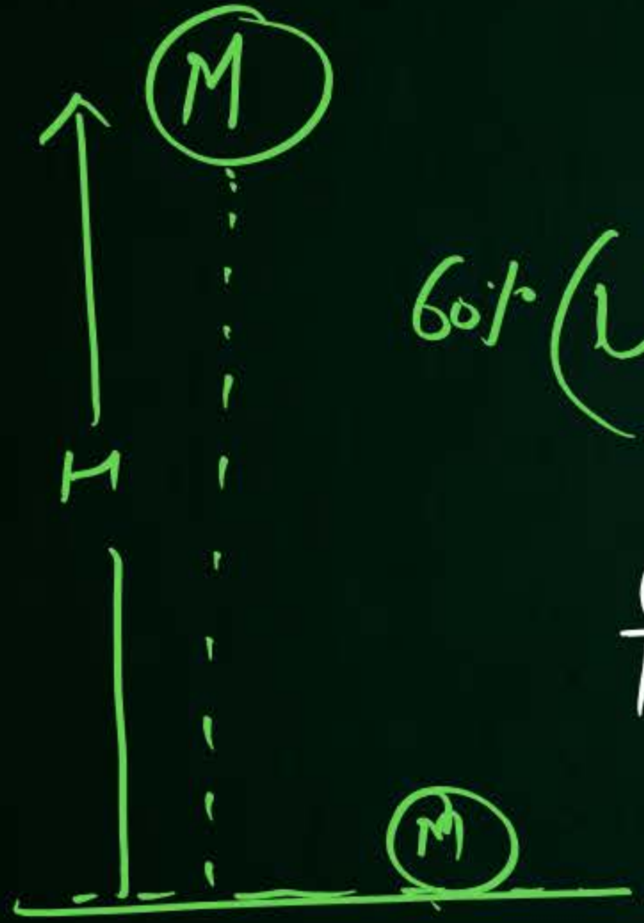
$$= \frac{800 + 400}{20} = \frac{1200}{20}$$

$$= 60^\circ C$$

Ans

QUESTION

2. M grm object is released from height H then find, raise in temperature. If 60% of loss in potential energy, transfer to heat energy.



$$60\% \left(U_{\text{Potential energy loss}}\right) = Q_{\text{Heat}}$$

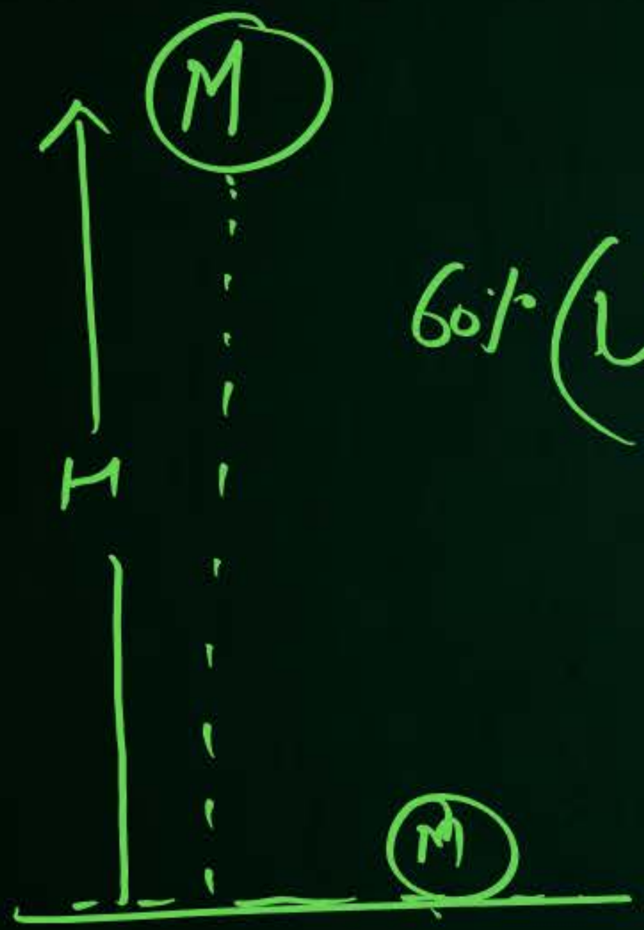
$$\frac{60}{100} mgh = M S \Delta T$$

$$\Delta T = \frac{6gh}{10S} = \frac{3gh}{5S} \text{ Ans} = \frac{6h}{5} \text{ (Putting value of g)}$$

QUESTION

3. M grm object is released from height H then find, [redacted] If 60% of loss in potential energy, transfer to heat energy.

(Mass of object which will melt.)



$$60\% \left(U_{\text{Potential energy loss}}\right) = Q_{\text{Heat}}$$

$$\frac{60}{100} m_{\text{Total}} g h = m' L$$

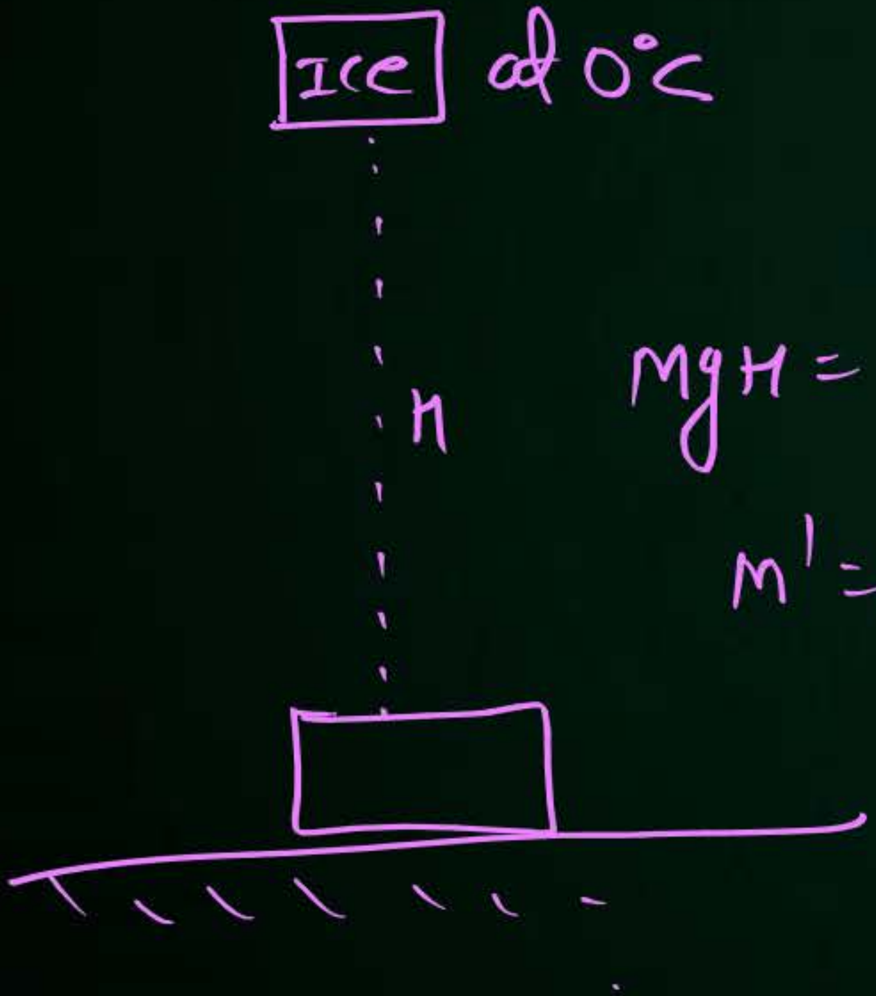
$$m' = \frac{6 M_{\text{Total}}\, g h}{10 L} = \frac{6 M_{\text{Total}}\, h}{L}$$

↑ Amount of mass which will melt

QUESTION

Conversion of mechanical energy into heat.

A block of Ice of mass *m* drop from height H, and its potential energy converted into heat, then find mass of ice that will melt temperature of ice 0°C.



$$mgH = m'L$$

$$m' = \frac{mgH}{L}$$ Ans

QUESTION

If $(V_f < V_i)$, loss in K.E. is converted into heat then find raise in temperature of that object.



$$\Delta K.E_{loss} = Q_{gain}$$

$$\frac{1}{2} m u_i^2 - \frac{1}{2} m v_i^2 = m s \Delta T$$

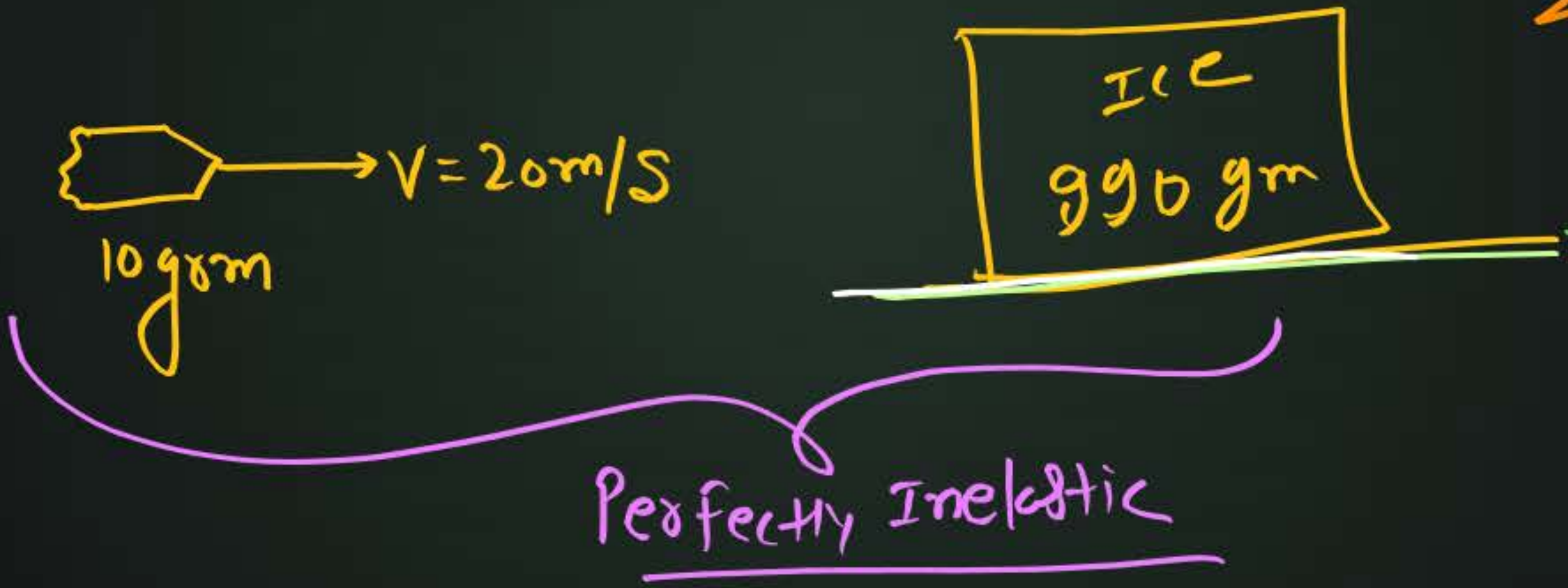
$$\frac{1}{2s}\left[u_i^2 - v_f^2\right] = \Delta T$$

QUESTION

6 A bullet of mass 10 g moving with a speed of 20 m/s hits an ice block of mass 990 g kept on a frictionless floor and gets stuck in it. How much ice will melt if 50% of the lost KE goes to ice?

(Initial temperature of the ice block and bullet = 0°C)

1. 0.001 g
2. 0.002 g
3. 0.003 g
4. 0.004 g



QUESTION

7 Velocity of 10 kg object reduced from 4 m/s to 2 m/s and 60% loss kinetic energy converted into heat then find rise in temperature of object if specific heat of object is 0.4 cal/grm°C

10 kg → u = 4 m/s ..... 10 kg → v = 2 m/s

Sol^n

$$60\% \left[\frac{1}{2} 10 (4)^2 - \frac{1}{2} 10 (2)^2\right] = m s \Delta T$$

$$\frac{60}{100}\left[\frac{1}{2}[16-4]\right] = \frac{4}{10} \times \frac{4.2}{10^{-3}} \Delta T$$

$$\Delta T = \left\{\frac{6 \times 10^{-2}}{4 \times 4.2}\right\} \times \frac{3}{5}$$

QUESTION

(8) 30 grm water at 80°C mixed with 10 grm ice at 0°C then find mass of ice and water in mixture and temperature of mixture.

$T = 80°C$
30 grm water

$Q = ms\Delta T$
$= 30 \times 1 (80 - 0) = 2400$ cal

30 grm water at 0°C

10 grm Ice at 0°C

$Q_{required} = mL = 10 \times 80 = 800$ cal

to make 10 grm water at 0°C

excess heat remaining

$ms\Delta T = 1600$ cal

$40 \times 1 \Delta T = 1600$

$T - 0 = 40°$

$T_{mix} = 40°$

$m_{Ice} = 0$

$m_{wat} = 40$ gm

Q) If M grm Ice at 0°c is mixed with m grm steam at 100°c if Tempr of mixture is 0°c & compt Ice & steam becomes water then find ratio of $\frac{M}{m} = ??$

Soln

M grm Ice at 0°c

$Q_{required\ heat} = ML$

$= 80M$

M grm water at 0°c

m grm steam at 100°c

$Q_{released} = mL = m\,540\,cal$

$Q_{released} = ms\Delta T = m \times 1 \times 100$

$Q_{release\ heat} = 640m$ cal.

total heat released when steam comes to at (0°c and compt in water)

If $M_{ste} = 1gm$

$M_{Ice} = 10gm$

$T_{mix} = 0°$

let $M_{ste} = 1g$

$M_{Ice} = 8gm.$

$80M = \frac{640m}{8}$

$M_{Ice} = 8m_{stea.}$

$\frac{M_{Ice}}{m_{steo}} = \frac{8}{1}$

$= 10:1$

$= 9:1 \rightarrow T_{mix} = 0°C$

$M_{Ice} : m_{sten} = 8:1 \rightarrow T = 0°$ Just

$= 7:1$

$= 6:1$

$= 5:1$

$= 4:1$

$\rightarrow T_{mix} =$ B/w 0 to 100°C

compt wat

$M_{Ice} : M_{sten} = 3:1 \rightarrow T_{mix} = 100°C$ (compt wat)

$= 2:1$

$= 1:1$

If M grm Ice at 0°c is mixed with m grm steam at 100°c if Tempr of mixture is 100°c & compt Ice & steam becomes water then find ratio of $\left(\frac{M}{m}\right) = ??$

Soln

M grm Ice at 0°c

$Q_1 = ML = 80M$

$Q_2 = MS\Delta T = M \times 1 \times 100$

$Q_{required} = 180M.$

m grm steam at 100°c

$Q_{release} = mL = 540m$

$Q_{required} = Q_{released}$

$180M = 540m$

$T_{mix} = 100°$

$\frac{M}{m} = 3:1$

$M_{ice} : m_{ste} = 8:1$ ($T = 0°c$)

= 15:1

= 10:1

= 9:1

= 7:1

= 6:2

= 5:1

= 4:2

$0° < T < 100°$

3:1

2:1

1:1

100° (T_{mix})

QUESTION

15 grm ice at 0°C mixed with 6 grm steam at 100°C then temperature of mixture ??

15 grm : 6 gm.

$$\frac{m_{Ice}}{m_{st}} = \frac{15}{6} = 2.5$$

$$T_{mix} = 100°C$$

QUESTION

80 gram ice at 0°C is mixed with 20 gram steam at 100°C. Temperature of mixture?

$$\frac{m_{Ice}}{m_{steam}} = \frac{80}{20} = 4:1$$

Just less than 100°

10 : 2

9 : 2

8 : 1 → 0°C

7 : 1 →

9 : 1

4 : 2 → steam

3 : 1 → $T_m = 100$

2 : 1 →

1 : 1 →

QUESTION

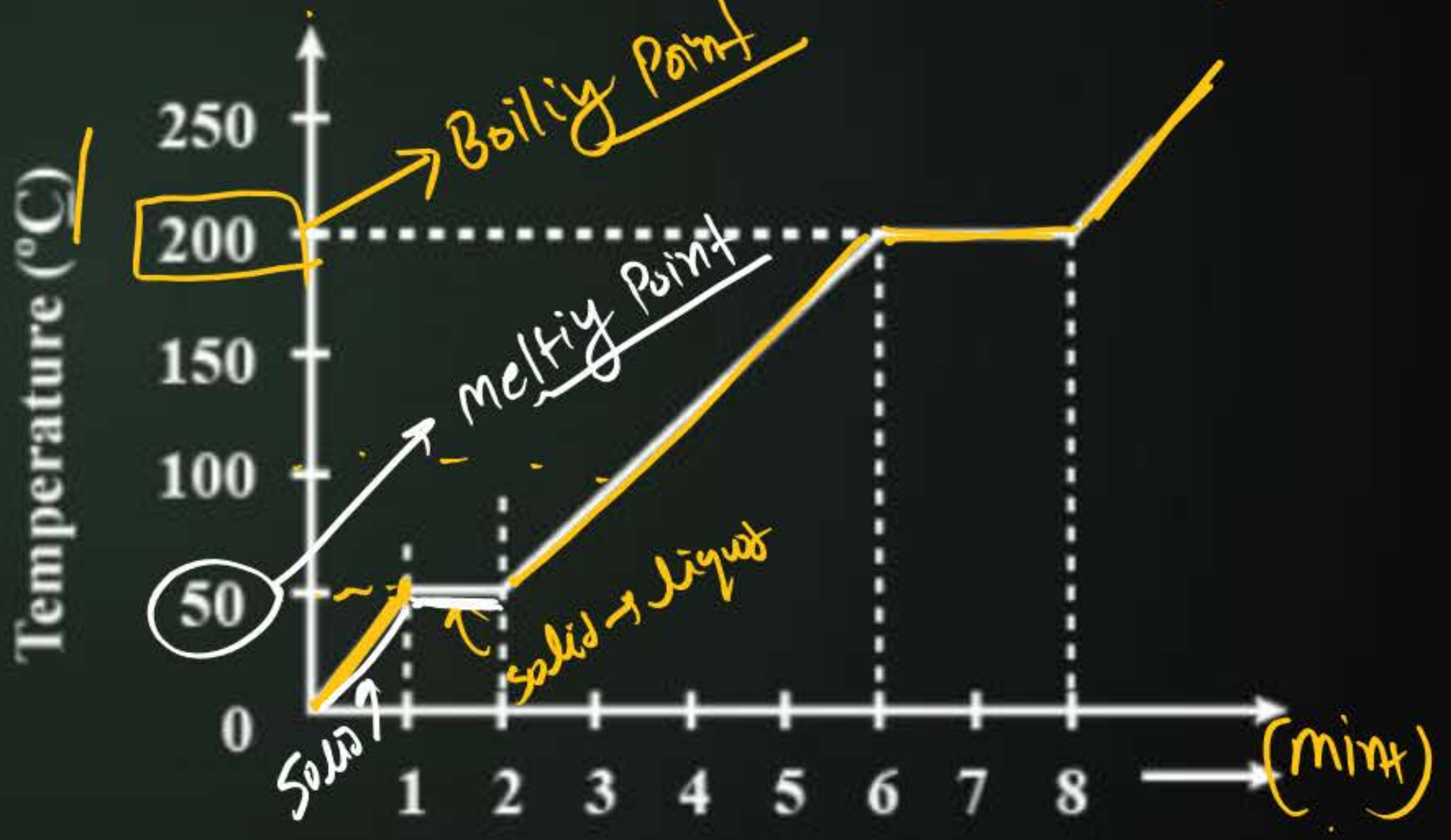
540 grm ice at 0°C mixed with 540 grm water at 80°C then find final temperature. of mixture

T = 0°

QUESTION

A student takes 50 gm wax (specific heat = 0.6 kcal/kg°C) and heat sit till it boils. The graph between temperature and time is as follows. Heat supplied to the wax per minute and boiling point are respectively.

1. 500 cal, 50°C
2. 1000 cal, 100°C
3. 1500 cal, 200°C
4. 1400 cal, 100°C



WATER EQUIVALENT

The water equivalent of a body is the mass of water that will gain or loss same amount of heat to change same change in temperature as body of mass *m* of specific heat S.

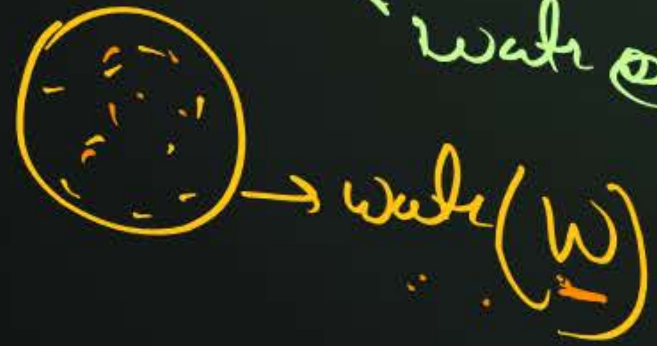
$$\Delta Q_{M.R} = \Delta Q_{water}$$

$$m s \Delta T = W \times 1 \Delta T$$

$$m s = W$$

W → water equivalent of M.R





QUESTION

A liquid of mass 40 gram specific heat $\frac{1}{8}$ cal/gm°C then, find it's water equivalent.

$m \times s = W \times 1$

$40 \times \frac{1}{8} = W$

$W = 5\ gm$

QUESTION

10 gm of ice cubes at 0°C are released in a tumbler (water equivalent 55 g) at 40°C. Assuming that negligible heat is taken from the surroundings, the temperature of water in the tumbler becomes nearly (L = 80 cal/g) [1988]

1. 31°C
2. 22°C
3. 19°C
4. 15°C

$Q_{rels} = msΔT$

$= 55 \times 1 \times 40$

$= 2200$ cal

$Q = mL$

$= 10 \times 80 = 800$ cal

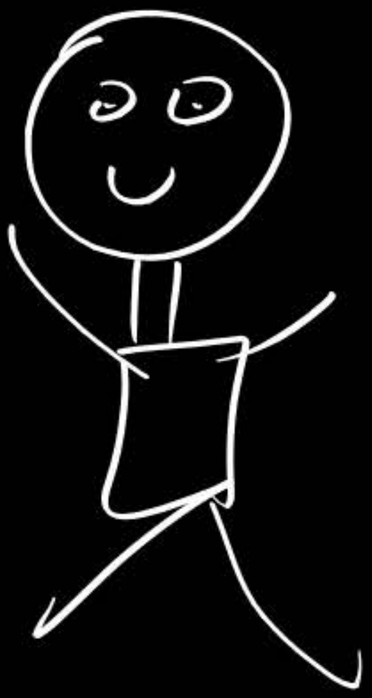
$(55+10) \times 1 \times (T-0) = 1400$

$65T = 1400$

$T = \frac{1400}{65}$

If 1 grm Ice at 0°c & 1 grm steam at 100°c mixted then find Sabkuchh.

Soln



1 grm water at 100°c

$Q = mL + ms\Delta T$

$= 1 \times 80 + 1 \times 1 \times 100$

$Q_{reqd} = 180$ cal

1 gra steam steam at 100°c

$Q_{gn} = 1 \times 540$

$= 540$ cal

$m'L = 180$ cal

$m' \, 540 = 180$

$m' = \frac{1}{3}$ grm → stem will melt

20 gm Ice at 0°C & 40 gm water at 5°C

$Q_{melt} = 20 \times 80$

$= 1600\,cal$

required

$T = 0°C$

$Q_{rel} = ms\theta = 40 \times 1 (5-0)$

$= 200\,cal$

$T = 0°C$

20 gm Ice at 0°C mixed with 200gm water at 0°C

Soln

No heat transfer

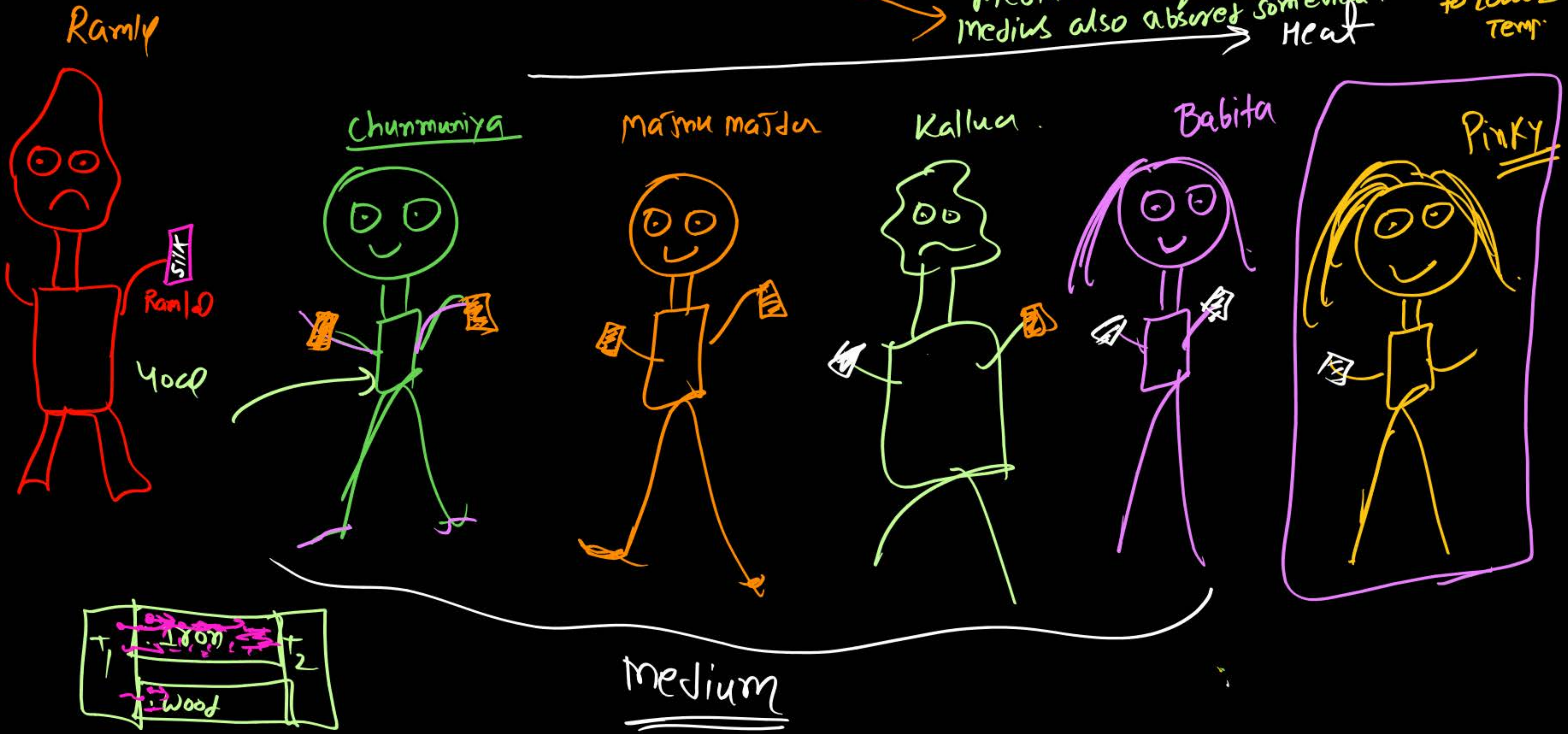
$T_{mix} = 0°C$

$m_{Ice} = 20g$

Wat = 20gm.

Heat Transfer → Conduction

- Source (Higher Tempr)
- Heat Transfer due to Tempr diff^n from Higher to Lower Temp
- medium is required
- Medium also absorbs some Heat → Heat



Heat Transfer → Convection

→ medium required

→ Medium particle Travel from one Position to Other.

Ramlu





Heat Transfer → Radiation → Possible in vacuume

(No medium Required)

fastest mode of heat Transfer

→ medium particle does not absorbed heat





Heat Radiation in terms of EM wave

Infrared radiation.

QUESTION

Fastest mode of heat transfer?

1. Conduction
2. Convection
3. Radiation (fastest)

QUESTION

In which case of heat transfer medium is required?

1. Conduction ✓
2. Radiation ✗
3. Convection ✓
4. Both (1) & (3) ✓

Ans (4)

Heat Transfer

Conduction:

- Heat flows from hot end to cold end. Particles of the medium simply oscillate but do not leave their place.
- Medium is necessary for conduction it is a slow process.
- Path of heat flow may be zig-zag conduction takes place in solids
- The temperature of the medium increases through which heat flows.

Convection:

- Each particle absorbing heat is mobile Medium is necessary for convection.
- It is also a slow process
- Path may be zig-zag or curved
- Convection takes place in fluids (not in solid)
- In this process also the temperature of medium increases.

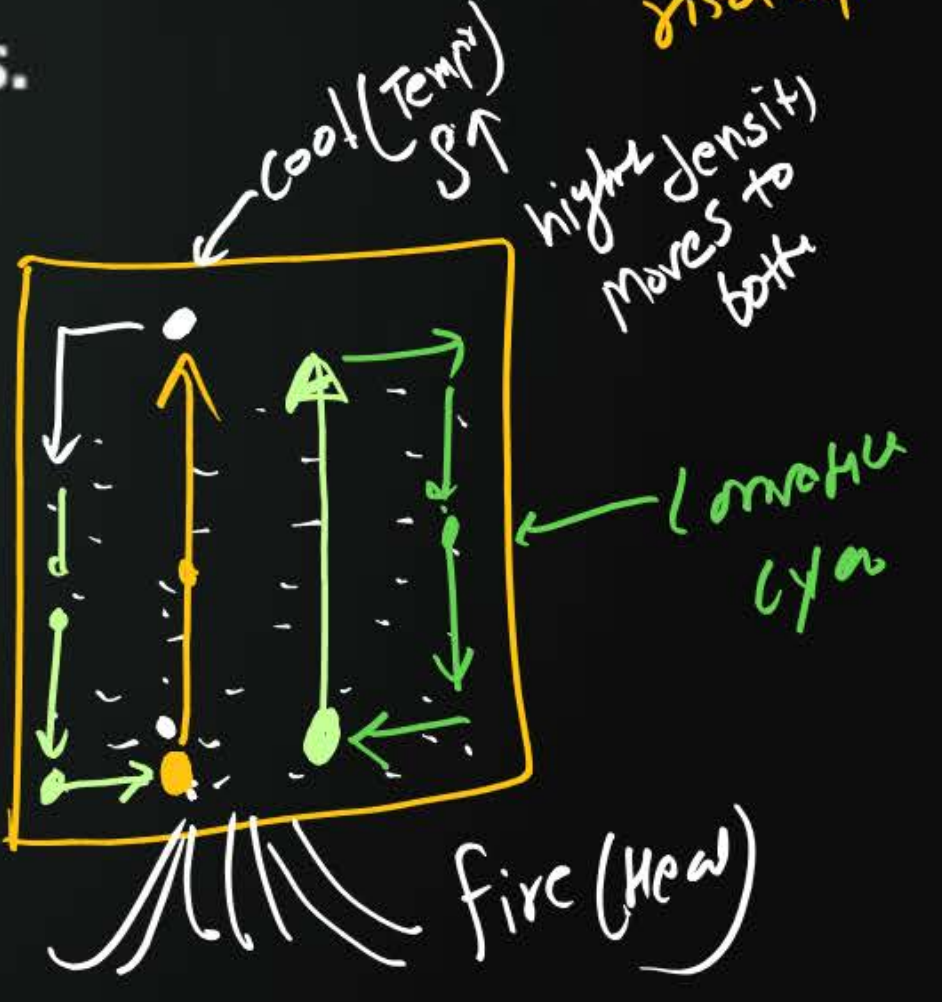
> gravity plays important Role in convection.

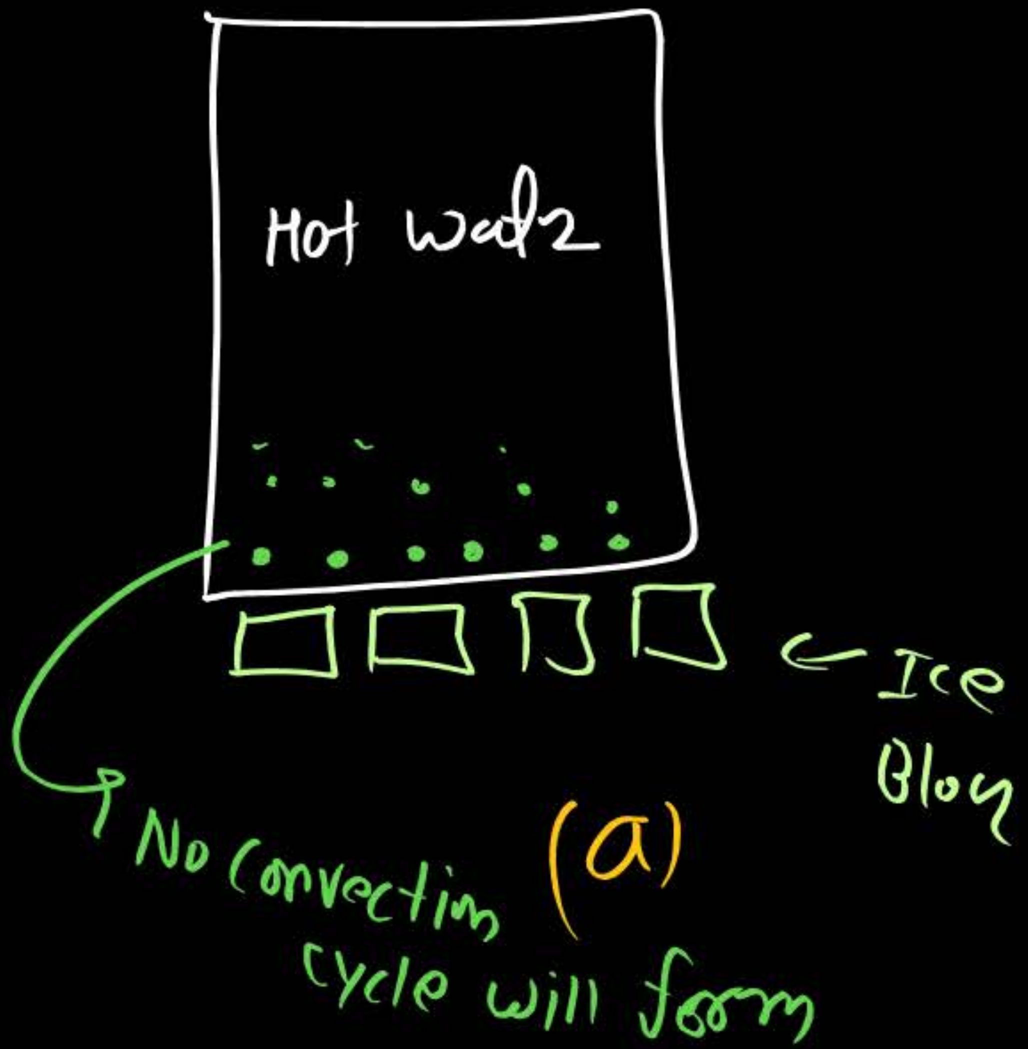
Heat given → expand → ρ ↓

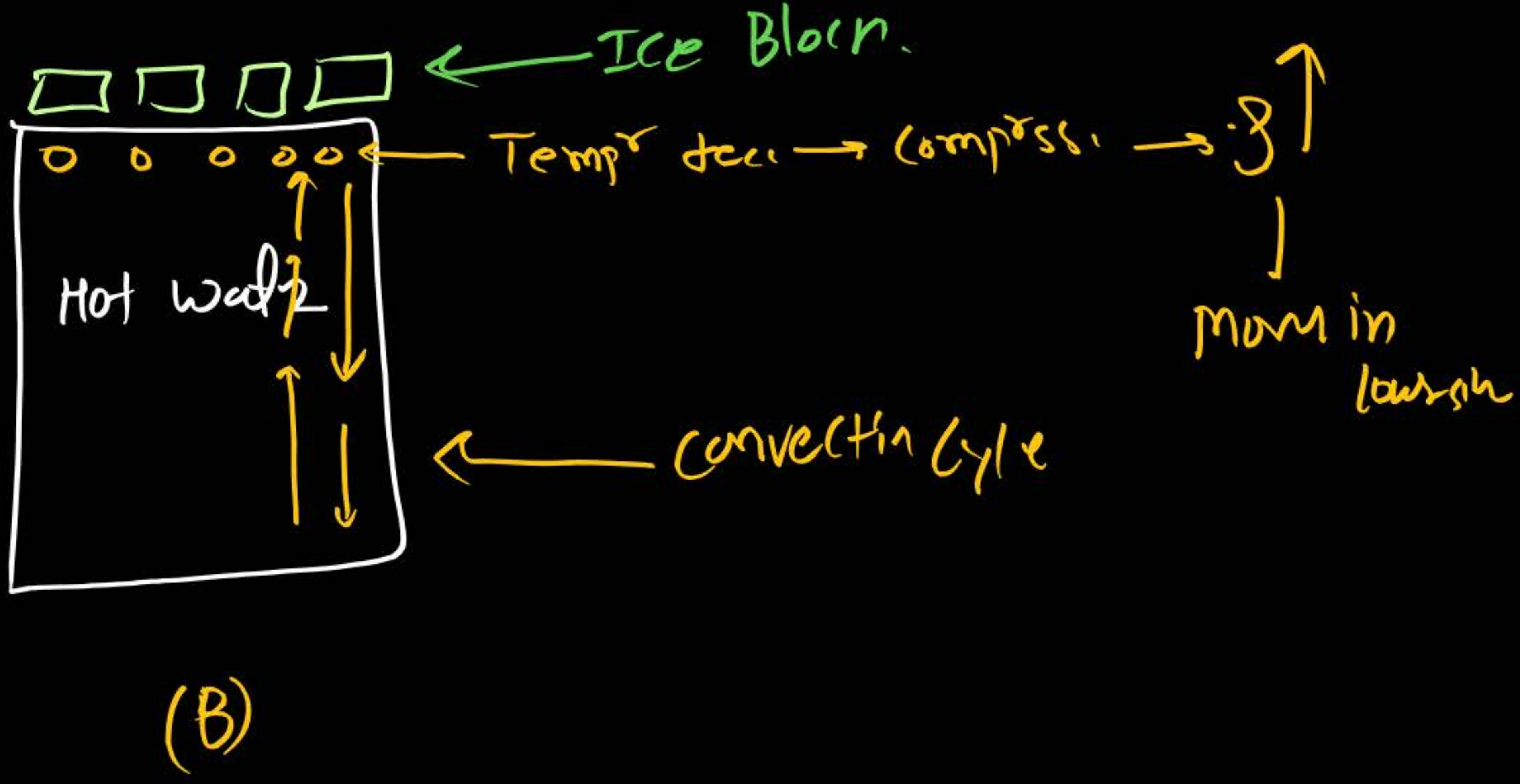
Lower density rises up

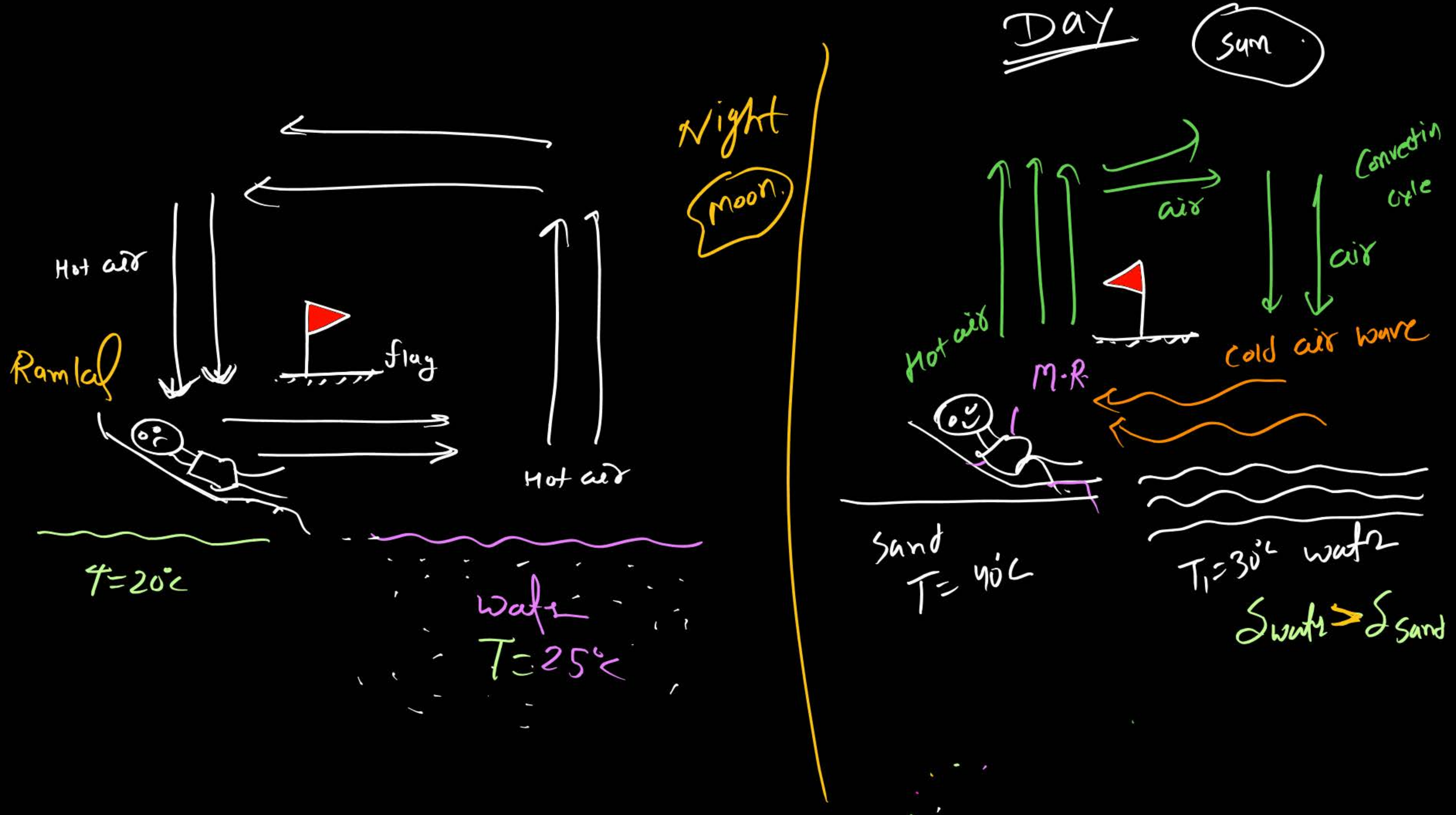






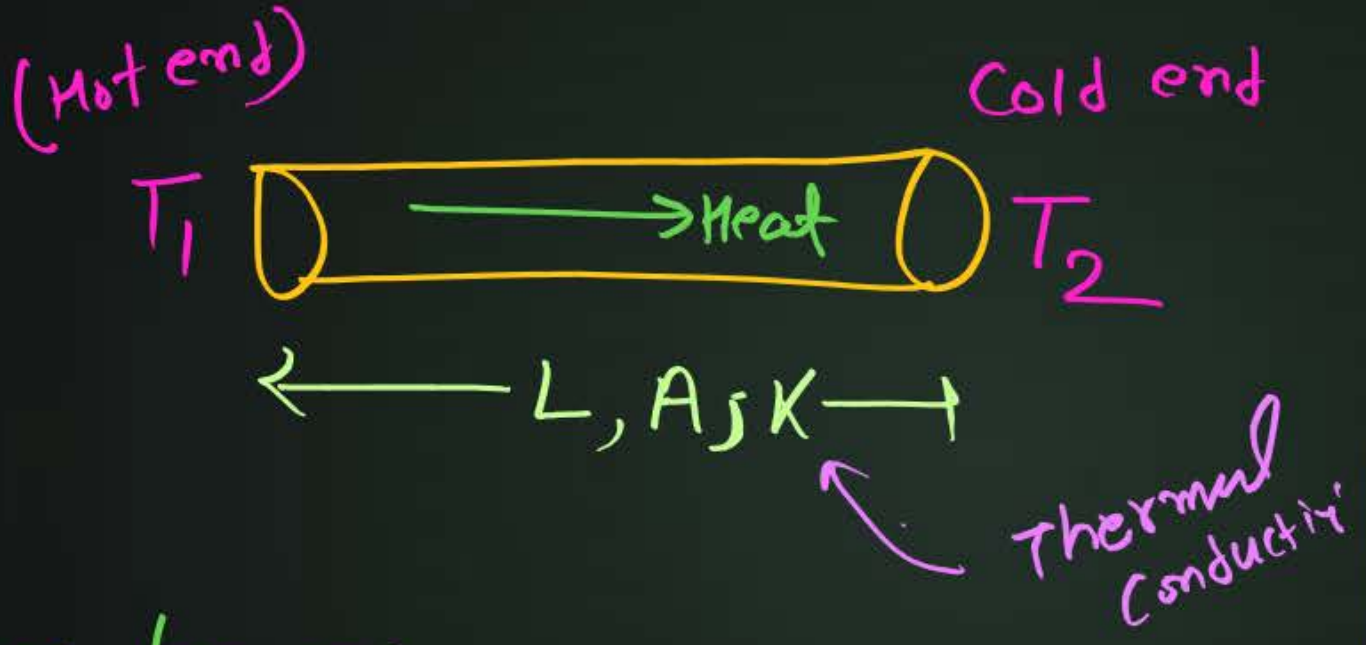

Hot water
Ice Block
No convection cycle will form
(a)


Ice Block.
Hot water
Temp dec → compress → ρ↑
convection cycle
(B)



Day
sun
Night
moon.
Hot air
Ramlal
flag
Hot air
T=20°c
water
T=25°c
Convection cycle
air
air
Hot air
cold air wave
M.R.
sand
T= 40°C
T1=30°c water
S water > S sand

Heat Transfer {conduction}



$$\frac{dH}{dt} \propto (T_1 - T_2)$$

Rate of Heat flow = Heat current

$$\frac{dH}{dt} \propto \text{Area}$$

$$\frac{dH}{dt} \propto \frac{1}{L}$$

$$I = \frac{\Delta V}{R}$$

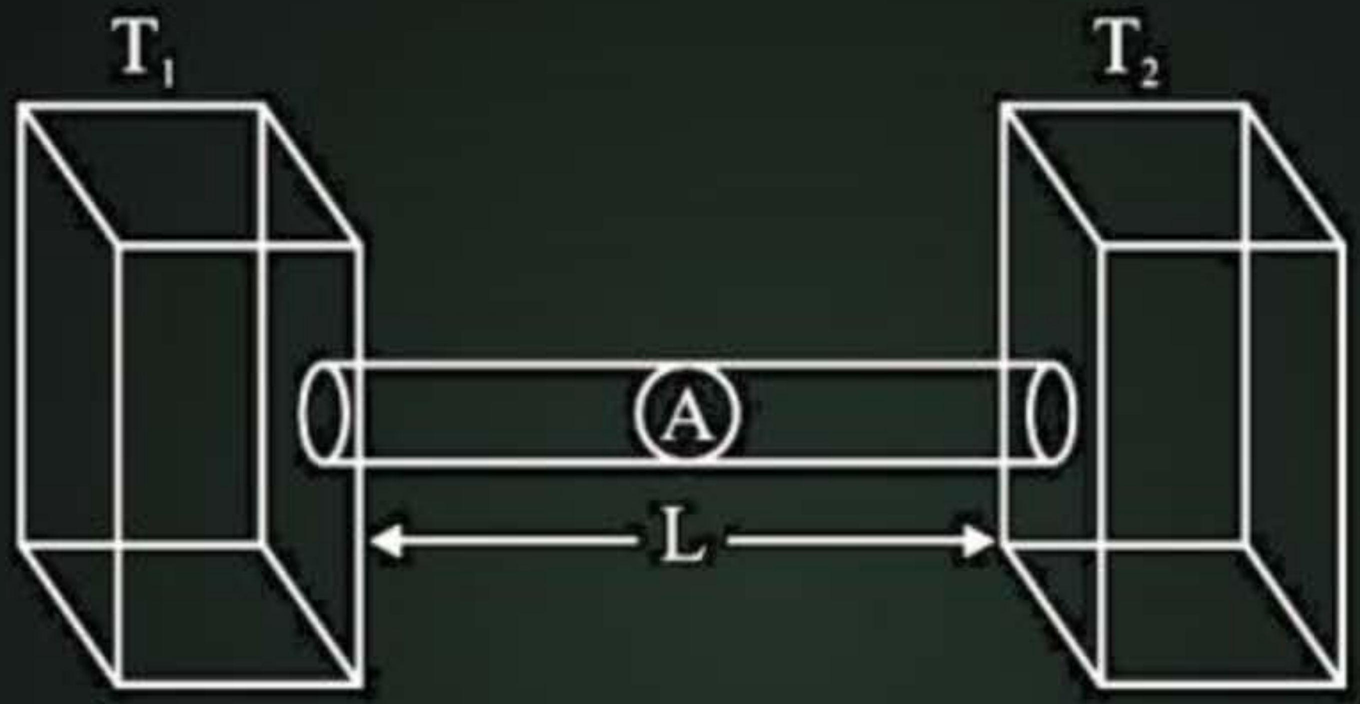
$$\frac{dH}{dt} = \frac{KA(T_1 - T_2)}{L}$$

K → thermal conductivity

$$\frac{dH}{dt} = \frac{\Delta T}{R_{Heat\ res}} = \frac{\Delta T}{\left(\frac{L}{KA}\right)}$$

→ Nature of material

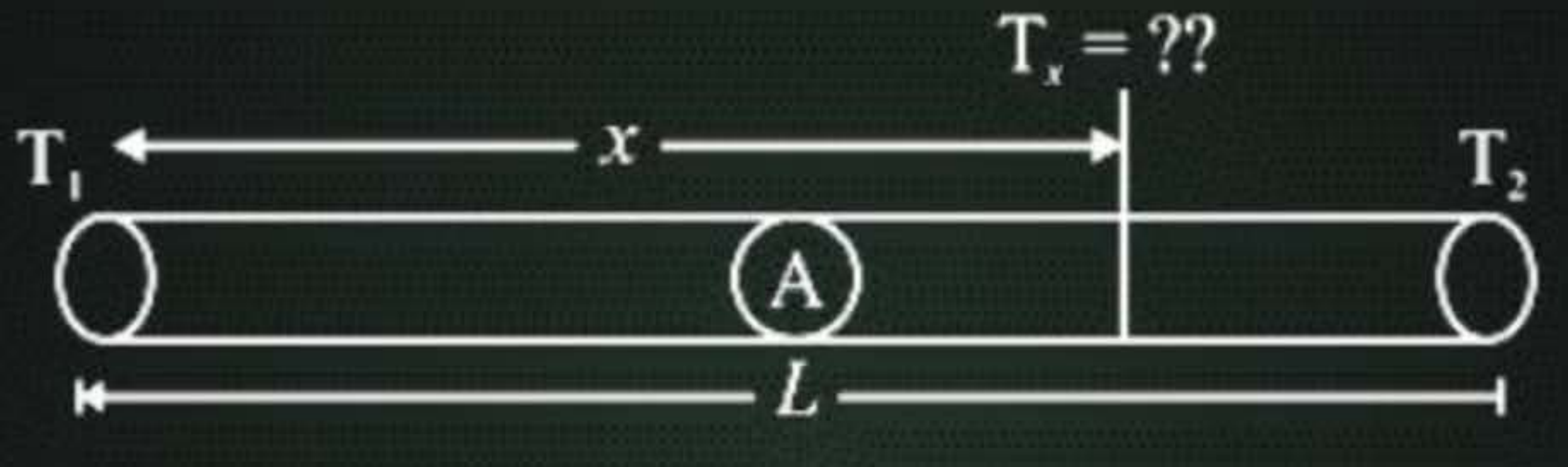
$$\left[R_{for\ a\ Rod} = \frac{L}{KA}\right]$$ ← Heat resist



$$H = \frac{d\theta}{dt} \text{ (Heat current)}$$

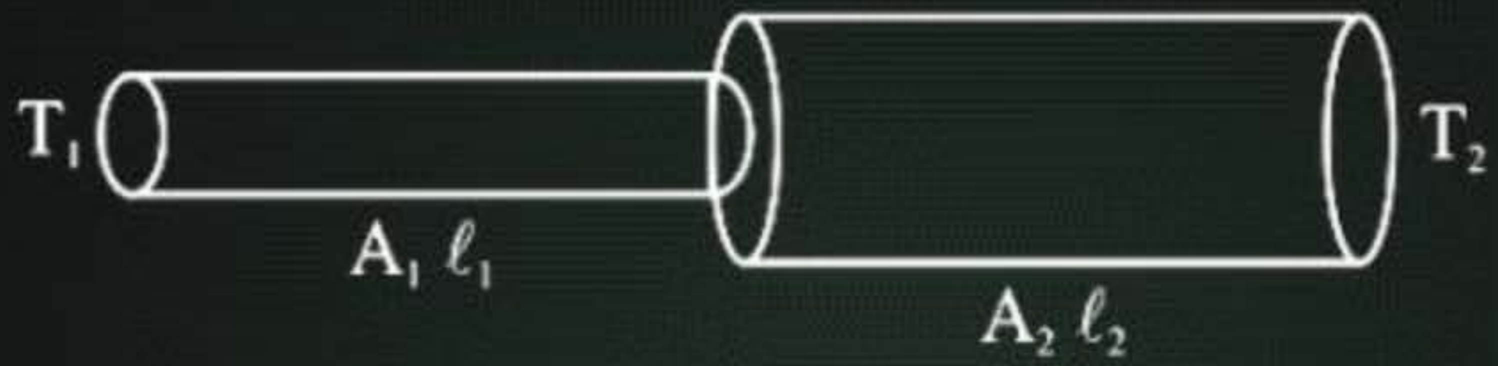
QUESTION

Find $T_x = ??$



QUESTION

Series combination of conductor .



(i) Find R_{eq}

(ii) K_{eq}

(iii) $T_{mid} = ??$

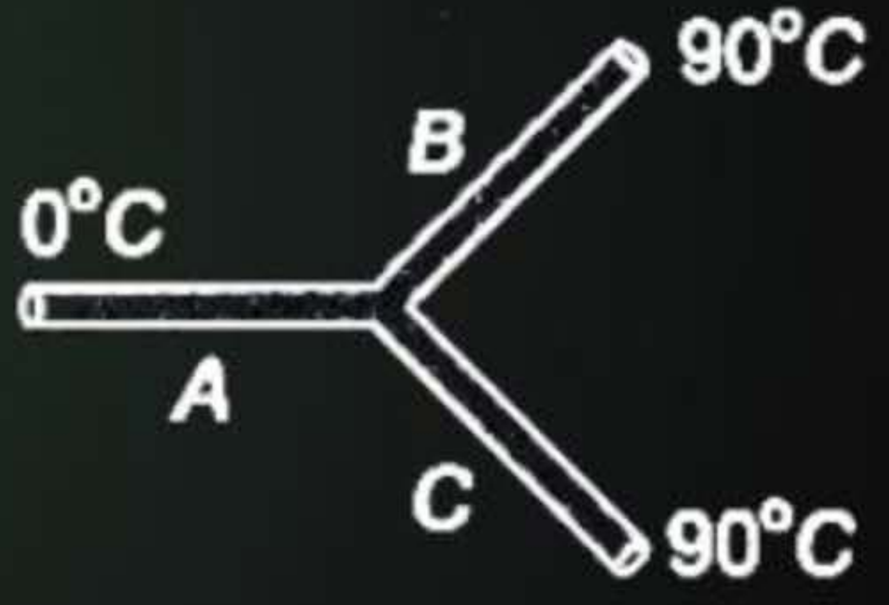
(iv) Total Heat current.

QUESTION

Three rods made of the same material and having the same cross section have been joined as shown in the figure. Each rod is of the same length. The left and right ends are kept at 0°C and 90° respectively.

The temperature of the junction of the three rods will be

1. 45 °C
2. 60 °C
3. 30 °C
4. 20 °C



Series Combination of Rod

QUESTION

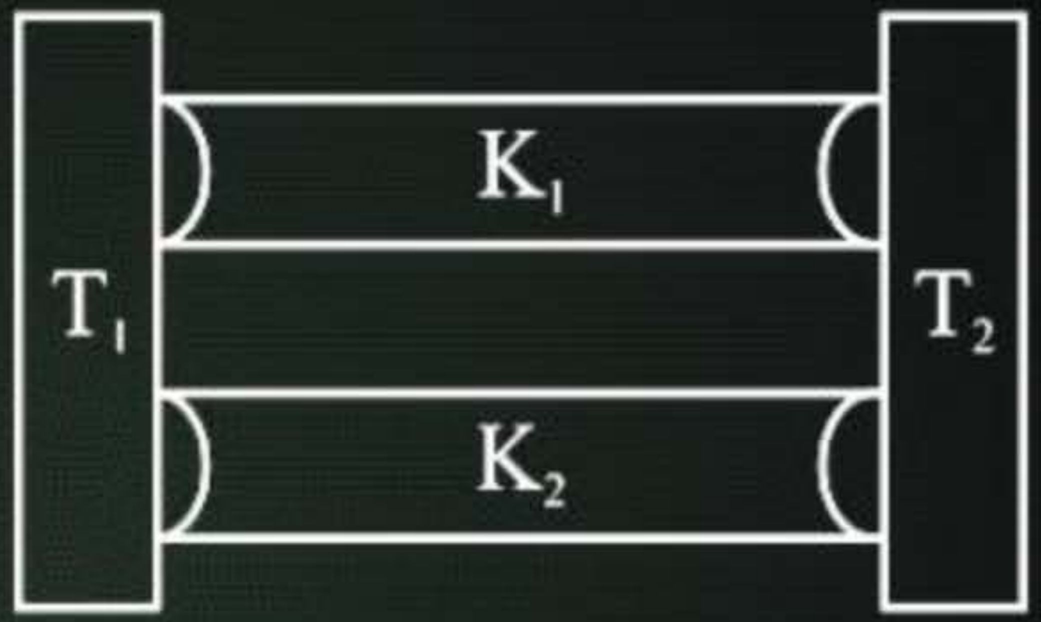
Parallel Combination :-

Find :-

(i) R_{eq}

(ii) K_{eq}

(iii) $H_{eq.}$



QUESTION

Two rods A and B of different materials are welded together as shown in figure. Their thermal conductivities are k_1 and k_2. The thermal conductivity of the composite rod will be:

[NEET-2017]

1. $\dfrac{k_1 + k_2}{2}$
2. $\dfrac{3(k_1 + k_2)}{2}$
3. $k_1 + k_2$
4. $2(k_1 + k_2)$


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture-08 | Physics

Thermal Properties of Matter

By- Dr. Manish Raj (MR SIR)

Saturday # 8 AM to 10 AM

Monday # 7:15 AM or 7:30 AM to 9 AM only



Topics to be covered

1. # Conduction (Part-02)
2. #
3. #



- Natural convection takes place from bottom to top while forced convection in any direction. In Natural convection gravity plays important role.

- In case of natural convection, convection-currents move warm air upwards and cool air downwards.
That is why heating is down from base, while cooling from the top.

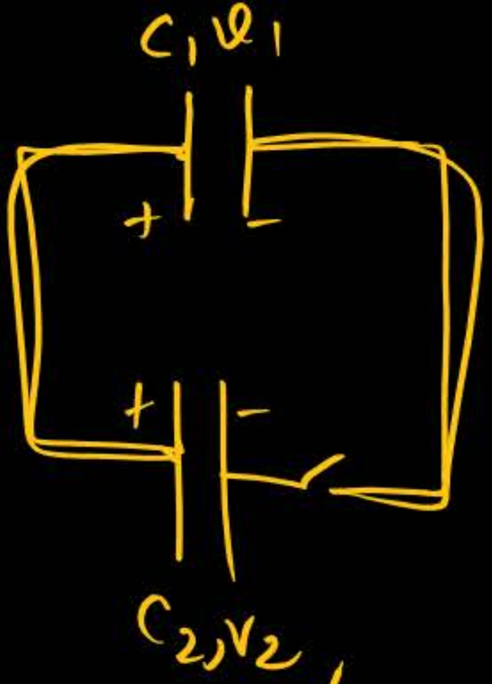
- Natural convection plays an important role in ventilation, in changing climate and weather and in forming land and sea breezes and trade winds.





$ms\Delta T$

$$\left[T_{mix} = \frac{m_1 s_1 T_1 + m_2 s_2 T_2}{m_1 s_1 + m_2 s_2}\right]^*$$



$$V_{com} = \frac{C_1 V_1 + C_2 V_2}{C_1 + C_2}$$

$q = CV$

$$\vec{r}_{c.m} = \frac{m_1 \vec{r}_1 + m_2 \vec{r}_2}{m_1 + m_2}$$

Moment of mass
mr = Same
dimension corr

$$\vec{a}_{c.m} = \frac{m_1 \vec{a}_1 + m_2 \vec{a}_2}{m_1 + m_2}$$

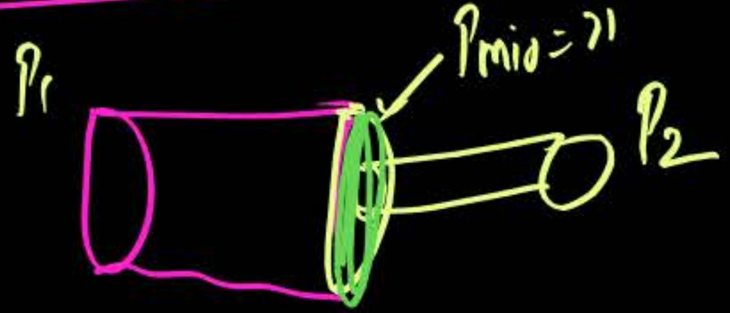


$$V_{mid} = \frac{V_1 R_1 + V_2 R_2}{R_1 + R_2} \text{ [wrong]}$$

$I = [V/R]$ same

$$V_{mid} = \frac{\frac{V_1}{R_1} + \frac{V_2}{R_2}}{\frac{1}{R_1} + \frac{1}{R_2}}$$ correct

NH NEET

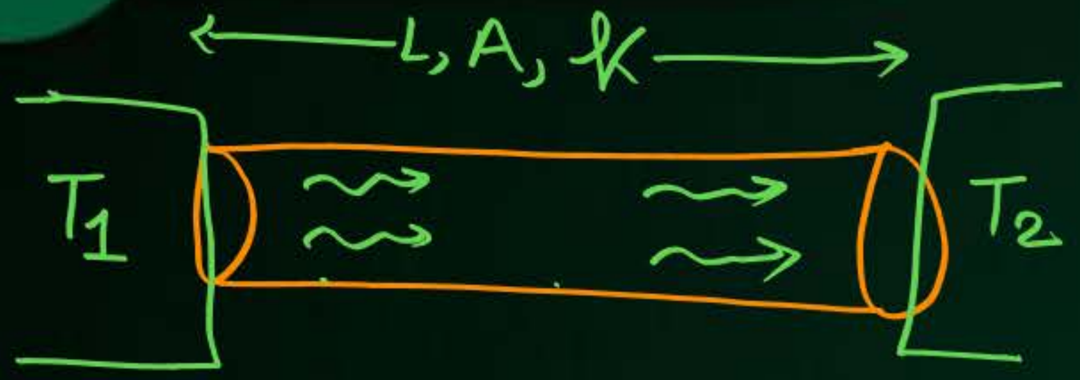


Poisseuille eq.

$$Q = \frac{\pi P r^4}{8 \eta l} = \text{same}$$

$$P_{mid} = \frac{\frac{P_1 r_1^4}{l_1} + \frac{P_2 r_2^4}{l_2}}{\frac{r_1^4}{l_1} + r_2^4/l_2}$$

Conduction



$\frac{dQ}{dt}$ = Rate of heat flow
= Same throughout the Rod.
= J/sec or cal/sec
= scalar

$$H = \left(\frac{dQ}{dt}\right) = \frac{AK(T_1 - T_2)}{L} = \frac{(\Delta T)}{\left(\frac{L}{KA}\right)}$$

$$K = \frac{J}{\text{sec m Kelvin}} = W m^{-1} K^{-1}$$

electric current $I = \frac{\Delta V}{R}$

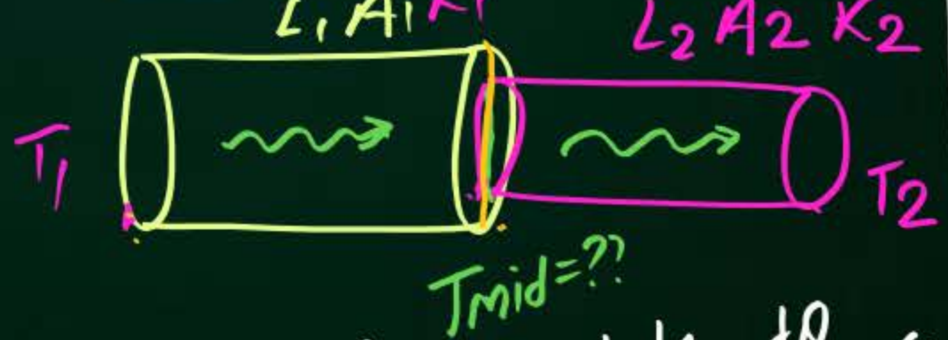
$$\frac{dQ}{dt} = \frac{\Delta T}{R_{\text{Heat Resistance}}}$$

$$R_{\text{Heat Resistor}} = \frac{L}{KA}$$

→ K sec/Joule

unit of R = Kelvin/watt

Series Combination



Heat current $H = \frac{dQ}{dt}$ = same

$$\frac{A_1K_1(T_1 - T_{mid})}{L_1} = \frac{(T_m - T_2)A_2K_2}{L_2}$$

$$\frac{A_1K_1T_1}{L_1} + \frac{A_2K_2T_2}{L} = \left(\frac{A_1K_1}{L_1} + \frac{A_2K_2}{L_2}\right)T_m$$

$$T_{mid} = \frac{\frac{A_1K_1T_1}{L_1} + \frac{A_2K_2T_2}{L_2}}{\frac{A_1K_1}{L_1} + \frac{A_2K_2}{L_2}}$$

→ If L = same

$$T_{mid} = \frac{A_1K_1T_1 + A_2K_2T_2}{A_1K_1 + A_2K_2}$$

L = same A = same

$$T_{mid} = \frac{K_1T_1 + K_2T_2}{K_1 + K_2}$$

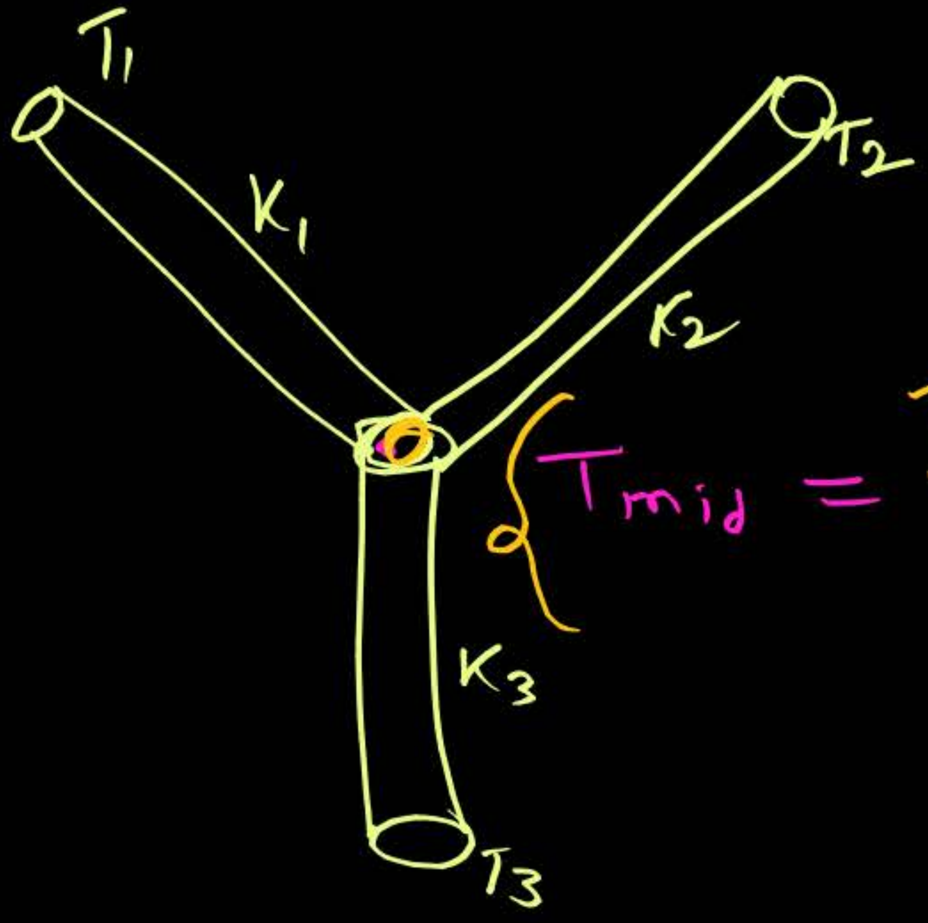
$K_1 = K_2$

$L_1 = L_2$

$A_1 = A_2$

$$T_{mid} = \frac{\cancel{K}(T_1 + T_2)}{2\cancel{K}}$$

$$\boxed{T_{mid} = \frac{T_1 + T_2}{2}}$$



$$T_{mid} = \frac{T_1K_1 + T_2K_2 + T_3K_3}{K_1 + K_2 + K_3}$$

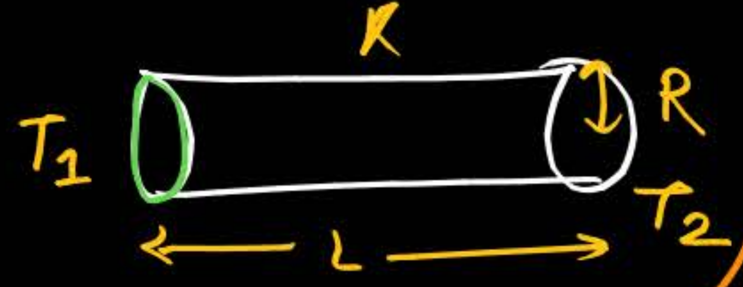
(Q) If Rate of heat flow is Q through the Rod of Radius R and Length L, Tempr at one end T_1 & other end T_2, K = thermal conductivity, find Rate of heat flow if

(i) R and L doubled

(ii) R, & ΔT doubled

(iii) Tempr at both ends doubled

(iv) K - half, $L \to$ doubled, R = same



Soln

(i)
$$Q = \frac{KA(T_1 - T_2)}{L}$$

$$Q = \frac{K\pi R^2 (T_1 - T_2)}{L}$$

$$Q \propto \frac{R^2}{L}$$

$$Q' \propto \frac{(2R)^2}{2L} = \frac{4R^2}{2L}$$

$$Q' = 2Q$$

(ii) $Q \propto R^2 \Delta T$

$$Q' \propto (2R)^2\, 2\Delta T = 8Q$$

(iii) $Q \propto (T_1 - T_2)$

$$Q' \propto (2T_1 - 2T_2) = 2Q$$

(iv) $Q \propto \frac{K R^2}{L}$ (R^2 → same)

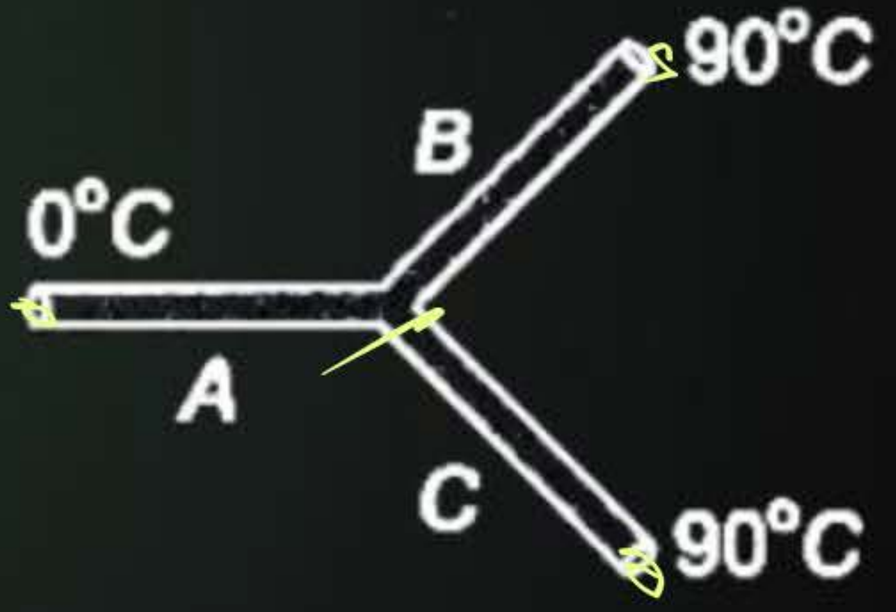
$$Q' \propto \frac{K}{2 \times 2L} = \frac{Q}{4}$$

QUESTION

Three rods made of the same material and having the same cross section have been joined as shown in the figure. Each rod is of the same length. The left and right ends are kept at 0°C and 90° respectively.

The temperature of the junction of the three rods will be

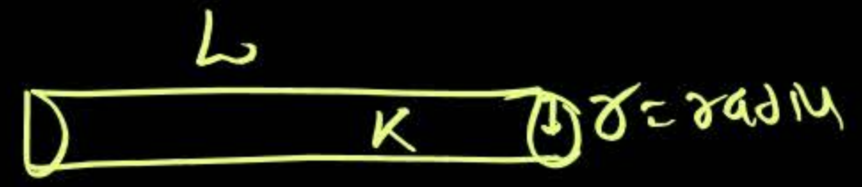
1. 45 °C
2. 60 °C
3. 30 °C
4. 20 °C



K = Same

$$T_{Junction} = \frac{0 + 90 + 90}{3} = \frac{180}{3} = 60°$$

#



$$R = \frac{L}{K\pi r^2}$$

(i) If L, R Both becomes double then find new Resistance

$$R' = \frac{2L}{K\pi(2r)^2} = \frac{2L}{4_2 K\pi r^2} = \frac{R}{2}$$

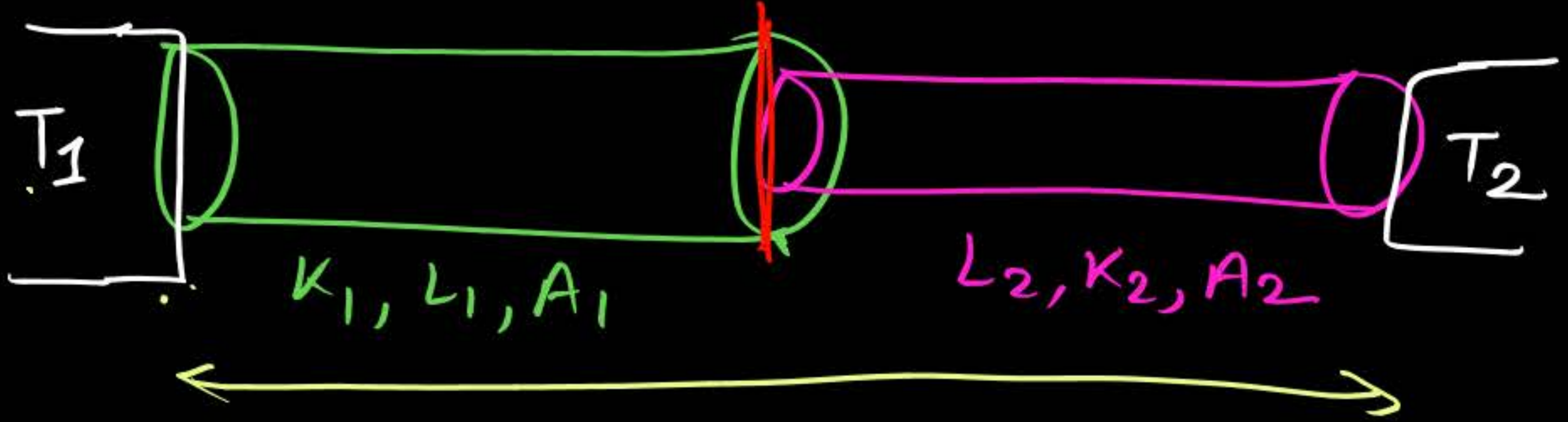
(ii) if $r \rightarrow$ half
$L \rightarrow$ double

$$R' = \frac{2L}{K\pi\left(\frac{r}{2}\right)^2} = 8R$$

(iii) if $r \rightarrow$ double
$L \rightarrow$ Half.

$$R' = \frac{L}{2\pi K(2r)^2} = \frac{R}{8}$$

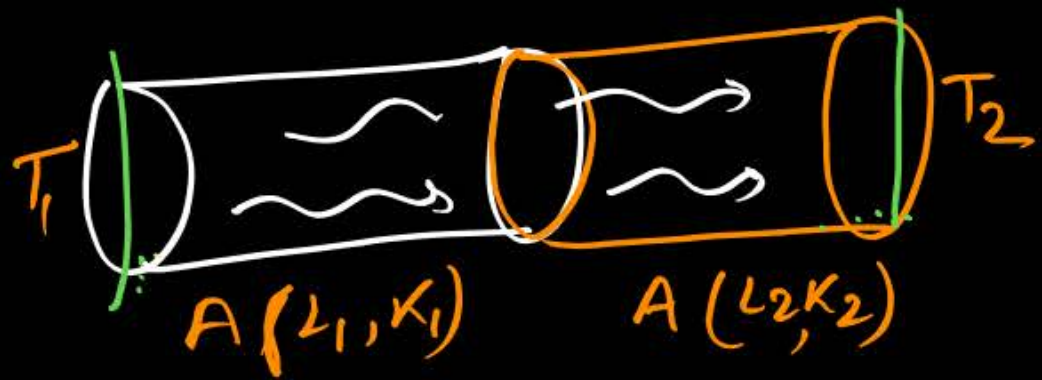
Series combination



(ii) $$\frac{dQ}{dt} = \frac{(T_1 - T_2)}{R_{eq}} = \frac{(T_1 - T_2)}{R_1 + R_2}$$

$$\frac{dQ}{dt} = \frac{(T_1 - T_2)}{\frac{L_1}{K_1 A_1} + \frac{L_2}{K_2 A_2}}$$

find equivalent thermal conductivity in series combination

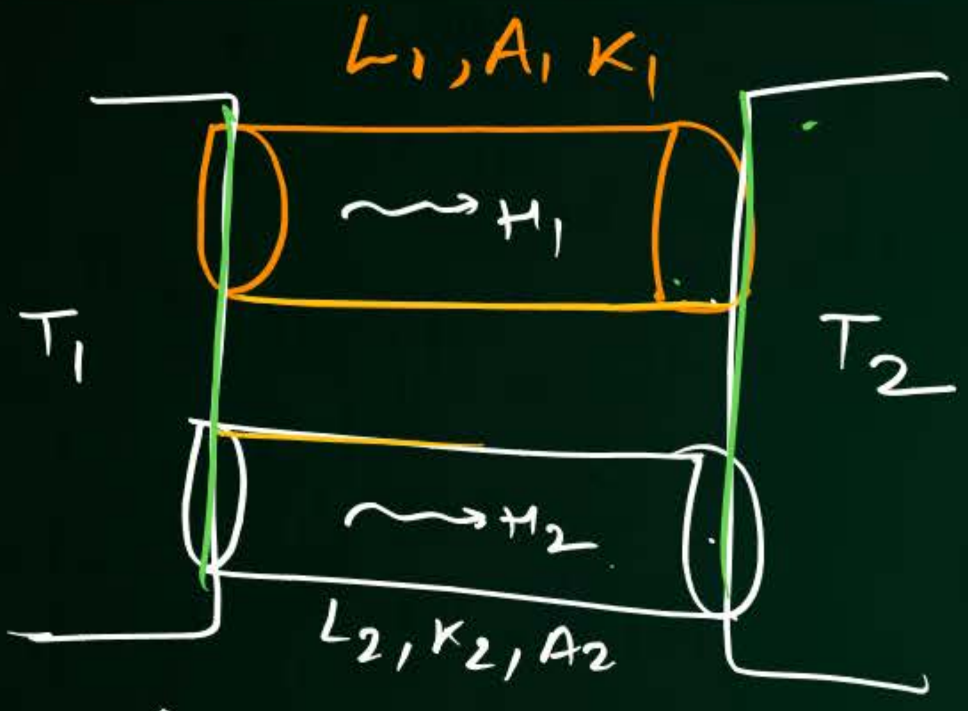


$$\frac{A K_{eq}(T_1 - T_2)}{L_1 + L_2} = \frac{(T_1 - T_2)}{\frac{L_1}{AK_1} + \frac{L_2}{AK_2}} = \frac{dQ}{dt}$$

$$K_{eq} = \frac{L_1 + L_2}{\frac{L_1}{K_1} + \frac{L_2}{K_2}} \quad \{ \text{if } (L_1 = L_2)$$

$$K_{eq} = \frac{2L}{L\left(\frac{1}{K_1} + \frac{1}{K_2}\right)} = \frac{2K_1K_2}{K_1 + K_2}$$

Parallel Combination



Total Rate of heat flow = ??

$$\left(\frac{dQ}{dt}\right)_{Total} = \left(\frac{dQ}{dt}\right)_1 + \left(\frac{dQ}{dt}\right)_2$$

$$\frac{dQ}{dt} = \frac{(T_1 - T_2) A_1 K_1}{L_1} + \frac{(T_1 - T_2) A_2 K_2}{L_2}$$

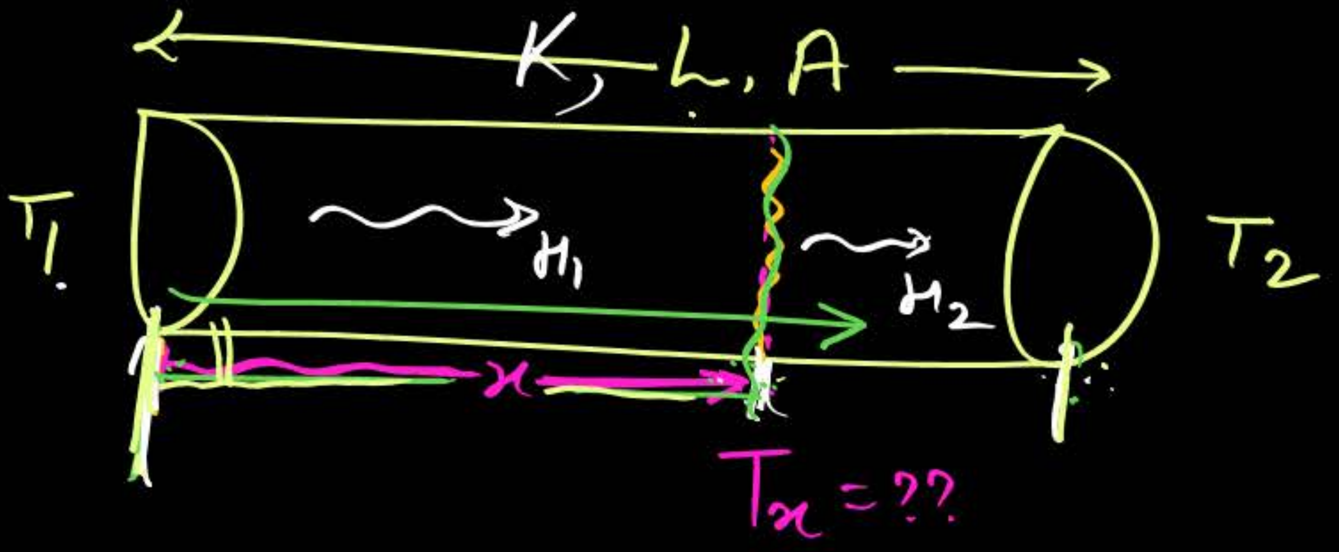
equivalent thermal conductivity $(l_1 = l_2)$

$$\# \frac{(A_1 + A_2)(T_1 - T_2) K_{eq}}{l} = \frac{(T_1 - T_2) A_1 K_1}{l_1} + \frac{A_2 K_2 (T_1 - T_2)}{l_2}$$

$$K_{eq} = \frac{A_1 K_1 + A_2 K_2}{A_1 + A_2}$$

$$K_{eq} = \frac{A(K_1 + K_2)}{2A}$$

$$* \boxed{K_{eq} = \frac{K_1 + K_2}{2}}$$



find Tempr in a given Rod.
at distance x from one end.

Soln

$$(H_1)_{1^{st}\text{ half up to } x} = H_{\text{Total Rod}}$$

$$\frac{\cancel{AK}(T_1 - T_x)}{x} = \frac{(T_1 - T_2)\cancel{AK}}{L}$$

Tempr decr along length is linear

$$T_1 - T_x = \frac{x}{L}(T_1 - T_2)$$

$$\boxed{T_1 - (T_1 - T_2)\frac{x}{L} = T_x}$$

$$T_x = T_1 - \frac{(T_1 - T_2)x}{L}$$

The MR* Tempr decr per unit length $= \frac{T_1 - T_2}{L}$

$$T_x = T_1 - \left(\frac{T_1 - T_2}{L}\right)x$$

$A, K = \text{same}$

$$T_{mid} = \frac{\frac{T_1}{x} + \frac{T_2}{L-x}}{\frac{1}{x} + \frac{1}{L-x}}$$

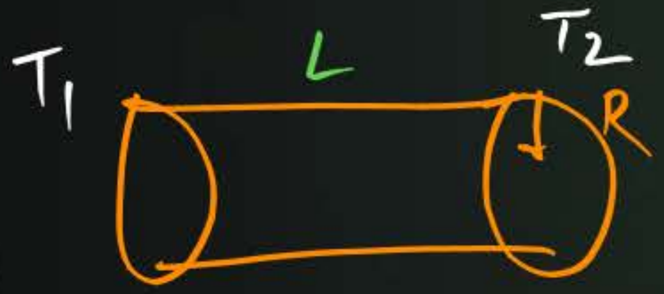
$$T_{mid} = \frac{\frac{A_1 K_1 T_1}{L_1} + \frac{A_2 K_2 T_2}{L_2}}{\frac{A_1 K_1}{L_1} + \frac{A_2 K_2}{L_2}}$$

QUESTION

Volume = const

A cylindrical metallic rod in thermal contact with two reservoirs of heat at its two ends conducts an amount of heat Q in time t. The metallic rod is melted and the material is formed into a rod of half the radius of the original rod. What is the amount of heat conducted by the new rod, when placed in thermal contact with the two reservoirs in time t?

(AIPMT (Pre)-2010)



$\pi R^2 L = \pi \left(\frac{R}{2}\right)^2 L'$

$4L = L'$

$\frac{dQ'}{dt} = \frac{\pi R^2 (\Delta T) K}{4 \times 4L} = \frac{Q}{16}$

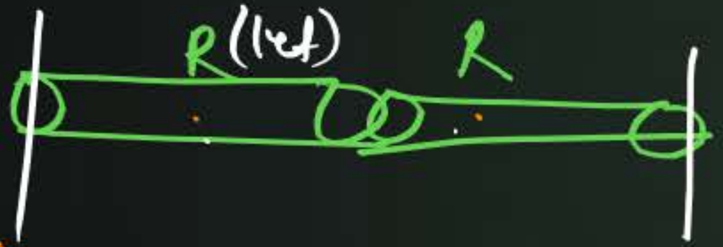
1. $Q/4$
2. $Q/16$ ✓ (62%)
3. $2Q$
4. $Q/2$



QUESTION

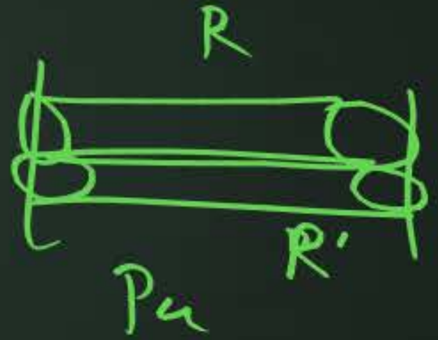
Two rods of same length and material transfer a given amount of heat in 12 seconds, when they are joined end to end. But when they are joined lengthwise, then they will transfer same heat in same conditions in

1. 24 s
2. 3 s
3. 1.5 s
4. 48 s



$$\frac{dQ}{dt} = \frac{(T_1 - T_2)}{2R}$$

$$dQ = \frac{(T_1 - T_2)}{2R} dt_1$$



$$dQ = \frac{(T_1 - T_2)}{R/2} dt_2$$

$$\frac{dt_1}{2R} = \frac{2 dt_2}{R}$$

$$3\text{ sec} = \frac{dt_1}{4} = dt_2$$

QUESTION

The two ends of a metal rod are maintained at temperatures 100°C and 110°C. The rate of heat flow in the rod is found to be 4.0 J/s. If the ends are maintained at temperature 200°C and 210°C, the rate of heat flow will be: (AIPMT-2015)



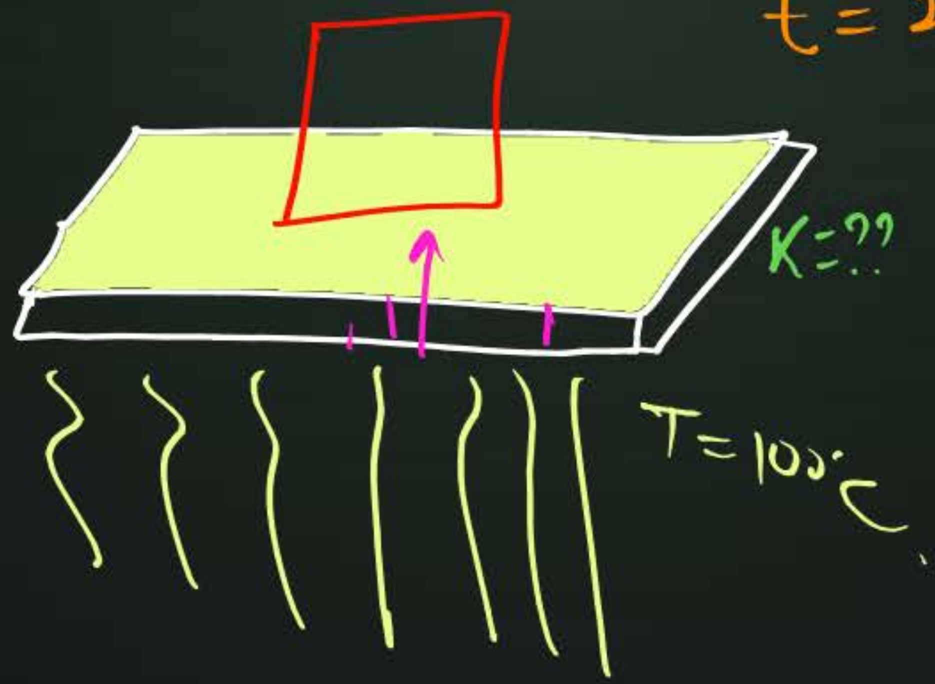
1. 16.8 J/s
2. 8.0 J/s
3. 4.0 J/s
4. 44.0 J/s

QUESTION

A slab of stone of area $0.36\ m^2$ and thickness 0.1 is exposed on the lower surface to steam at 100°C. A block of ice at 0°C rests on the upper surface of the slab. In one hour 4.8 kg of ice is melted. The thermal conductivity of slab is-

(Given latent heat of fusion of ice = $3.36 \times 10^5\ J\ kg^{-1}$) **(AIPMT Mains 2012)**

1. 1.29 J/ m/s/°C
2. 2.05 J/ m/s/°C
3. 1.02 J/ m/s/°C
4. 1.24 J/ m/s/°C



0.1 m

$t = 1\ hr = 60\ mint = 60 \times 60\ sec.$

$\frac{d\theta}{dt} = \frac{AK(T_1 - T_2)}{L}$

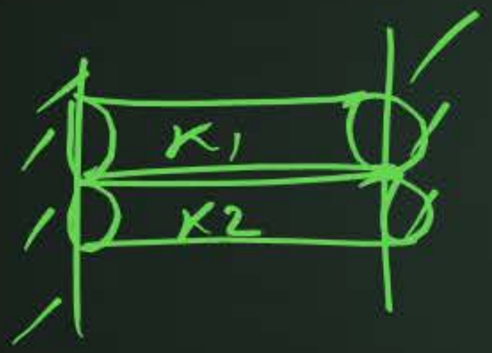
$d\theta = \frac{AK(T_1 - T_2)}{L} dt$

$mL = \frac{AK(T_1 - T_2)}{L} dt$

QUESTION

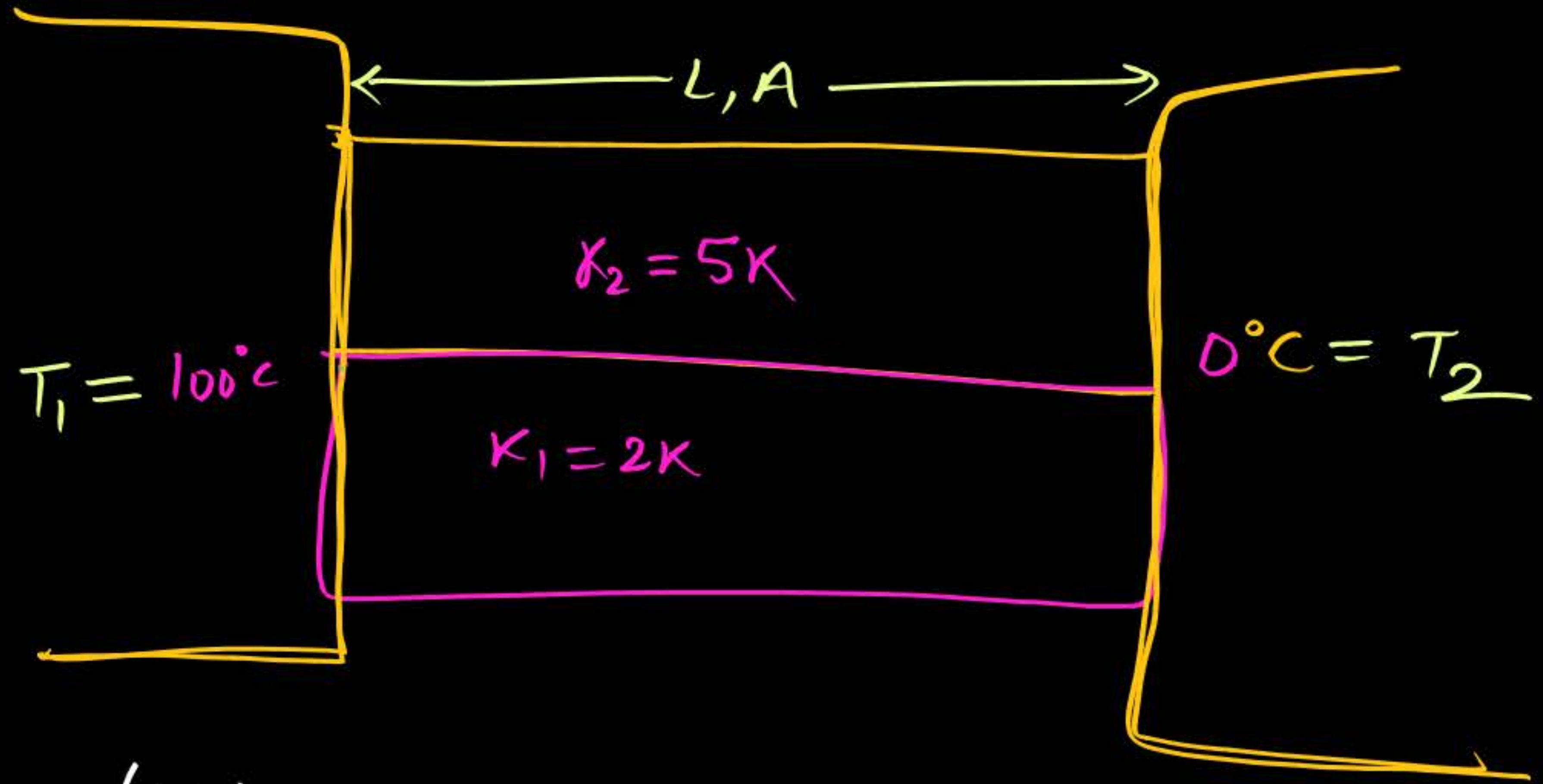
Two rods A and B of different materials are welded together as shown in figure. Their thermal conductivities are k_1 and k_2. The thermal conductivity of the composite rod will be: [NEET-2017]

1. $\frac{k_1 + k_2}{2}$



2. $\frac{3(k_1 + k_2)}{2}$
3. $k_1 + k_2$
4. $2(k_1 + k_2)$

find total Rate of Heat flow



$$K_{eq} = \frac{5K + 2K}{2}$$

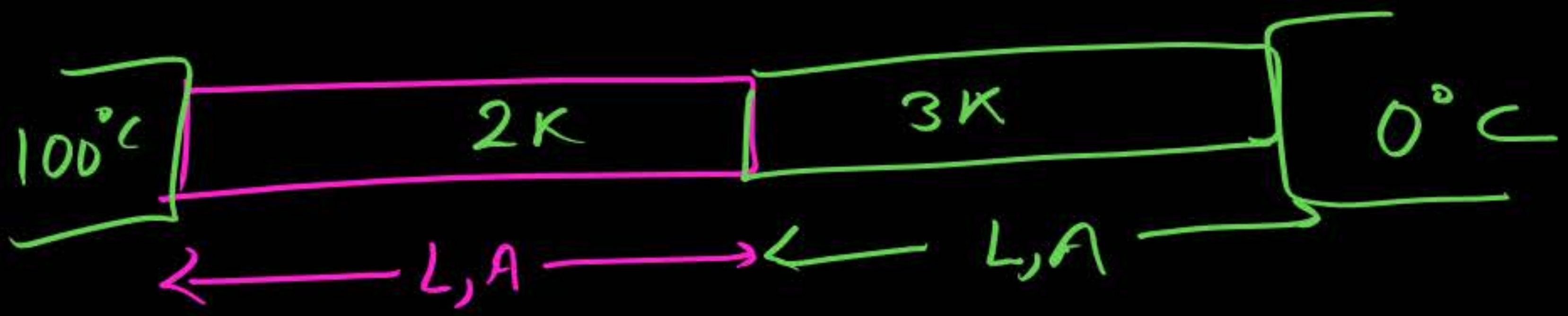
$$K_{eq} = 3.5K$$ ✗

$$\left(\frac{dQ}{dt}\right)_{total} = \frac{dQ_1}{dt} + \frac{dQ_2}{dt}$$

$$= \frac{(100-0)A5K}{L} + \frac{(100-0)A2K}{L} = \frac{700AK}{L}$$ Ans.

easy

find Rate of Total Heat flow and Tempr of Junction and K_{eq}:



$$K_{eq} = \frac{2 \times 3 \times 2}{3+2}$$

$$K_{eq} = \frac{12}{5} K$$

Sol^n

$$\frac{dQ}{dt} = \frac{(T_1 - T_2)}{R_1 + R_2} = \frac{100-0}{\frac{L}{A2K} + \frac{L}{A3K}} = \frac{100}{\frac{L}{AK}\left(\frac{1}{2}+\frac{1}{3}\right)} = \frac{\overset{20}{\cancel{100}} AK}{L\left[\frac{\cancel{5}}{6}\right]}$$

$$\left(\frac{dQ}{dt}\right)_{net} = \frac{120AK}{L}$$

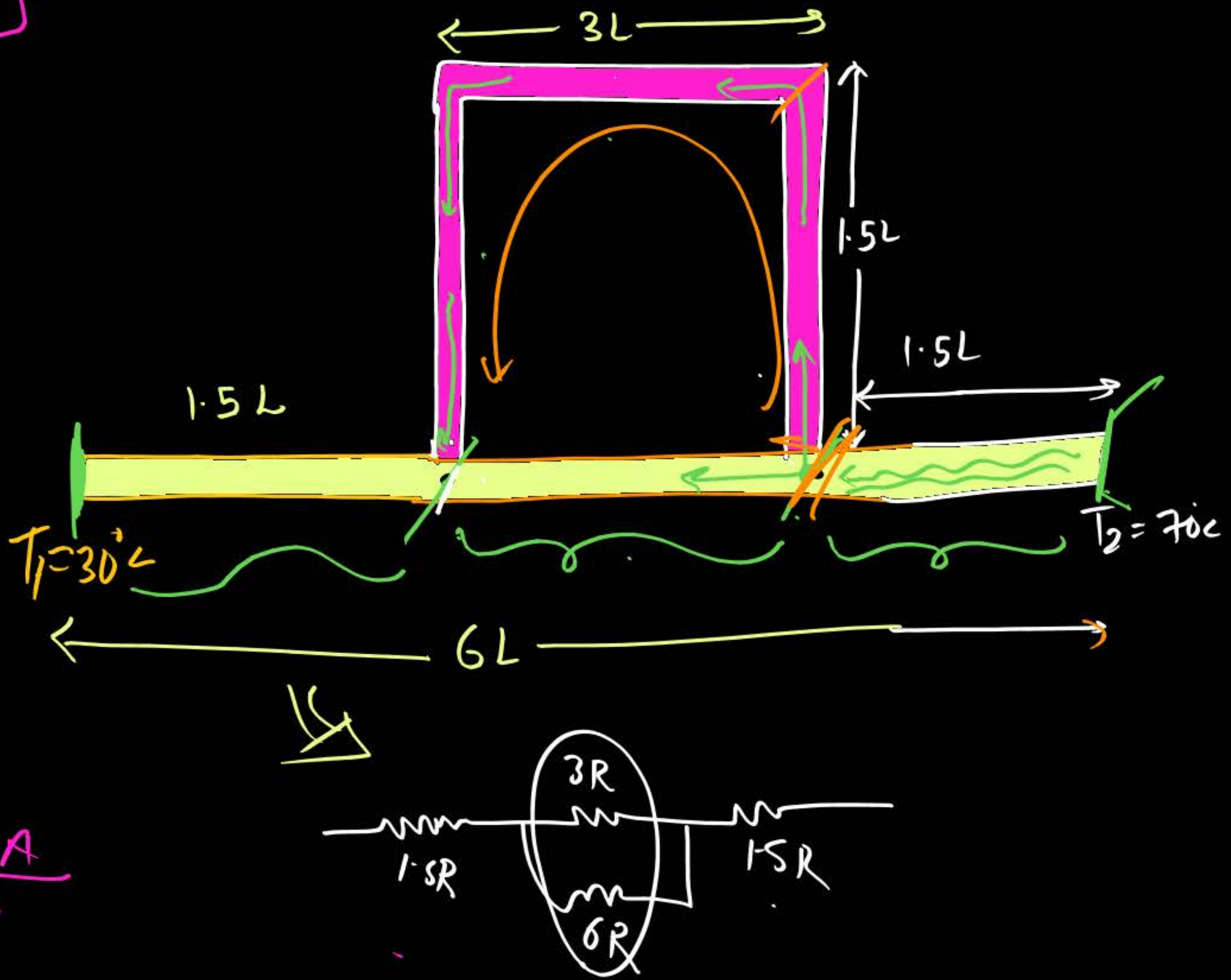
$$T_{mid} = \frac{2K \times 100 + 3K \times 0}{5K}$$

$$T_m = \frac{200}{5} = 40°$$

$$R = \frac{L}{KA}$$

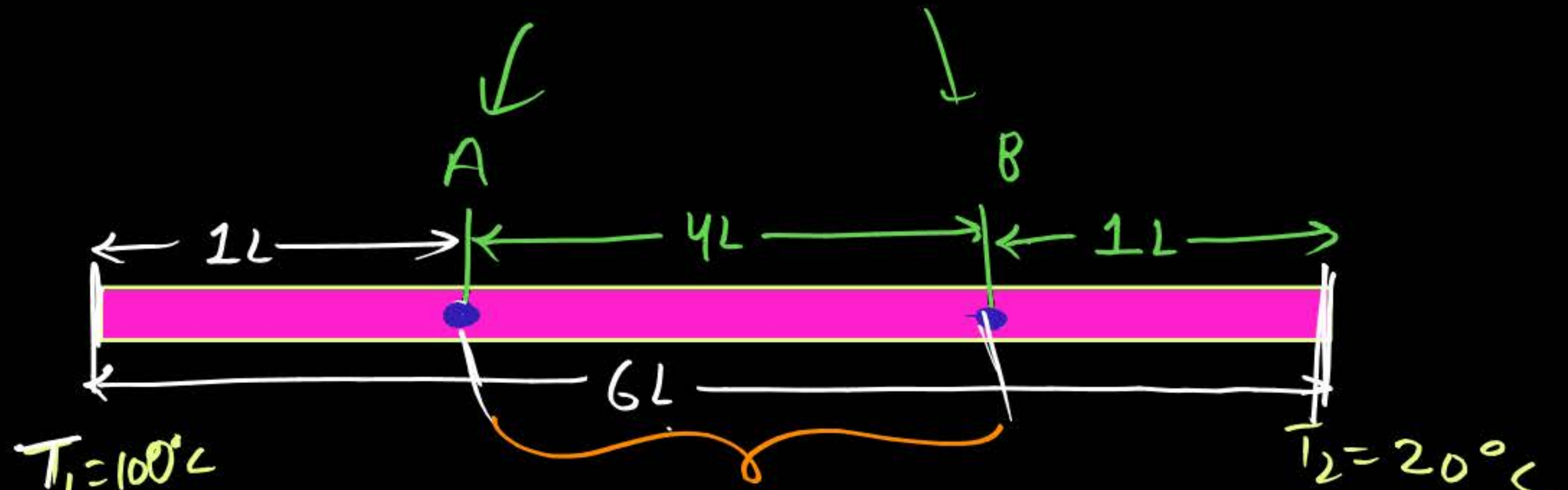
[K is same for all
A is same for all]

[Q] Total Rate of Heat from from end T_2 to end T_1



$$\frac{dQ}{dt} = \frac{(T_2 - T_1)}{(R_{eq})_{B/w\ ends}} \Rightarrow \frac{(70-30)}{5R} = \frac{40}{5\left[\frac{L}{KA}\right]} = \frac{8KA}{L}$$

find Tempr diffⁿ B/w A & B



Soln

Tempr decr in 6L length $(100-20)$
$= 80$

Per unit len. $= \frac{80}{6L}$

$= \frac{80}{6L} \times 4L$

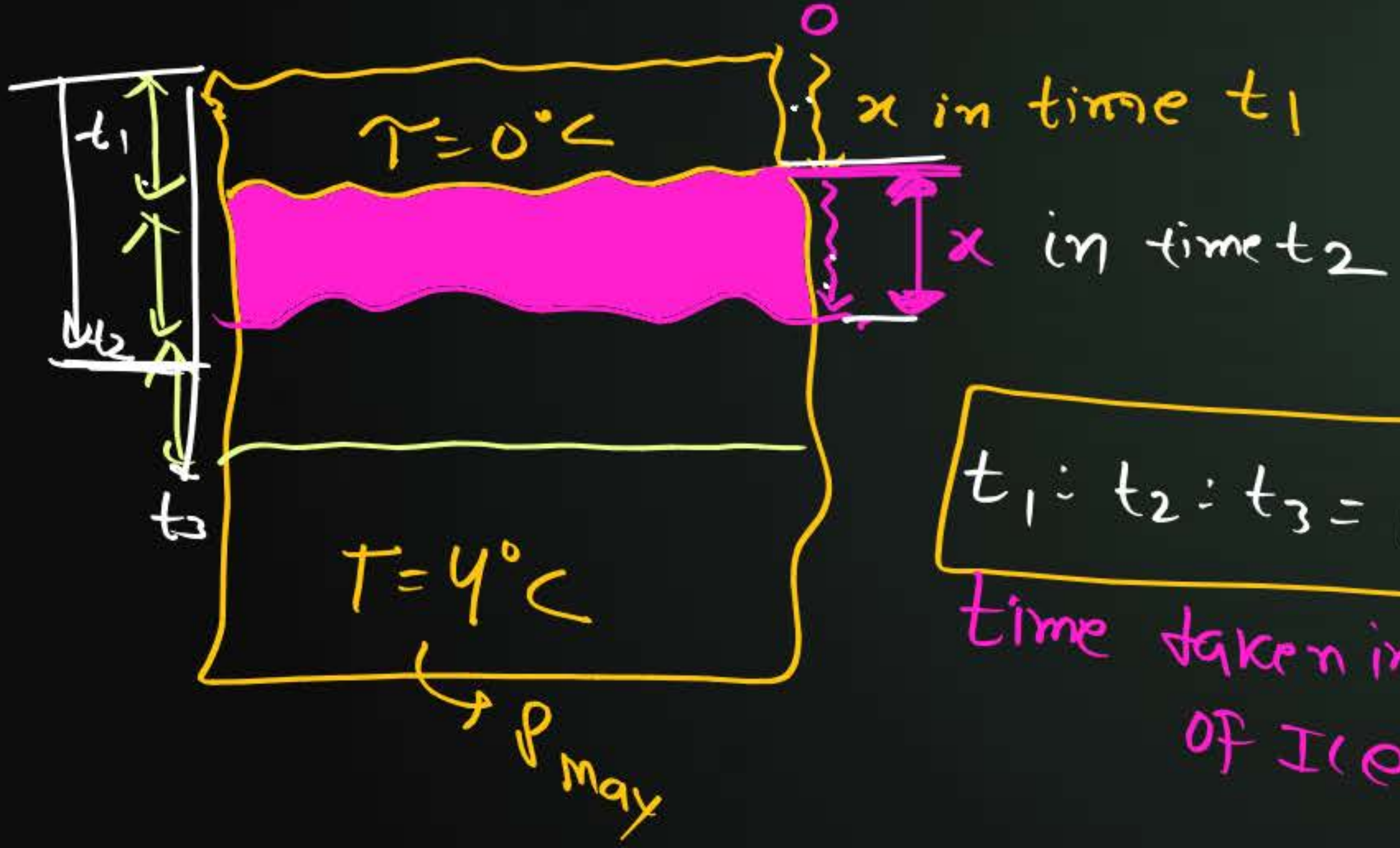
$= \frac{160}{3}\ °C$

QUESTION

A cylinder of radius R made of a material of thermal conductivity K_1 is surrounded by a cylindrical shell of inner radius R and outer radius 2R made of material of thermal conductivity K_2. The two ends of the combined system are maintained at two different temperatures. There is no loss of heat across the cylindrical surface and the system is in steady state. The effective thermal conductivity of the system is

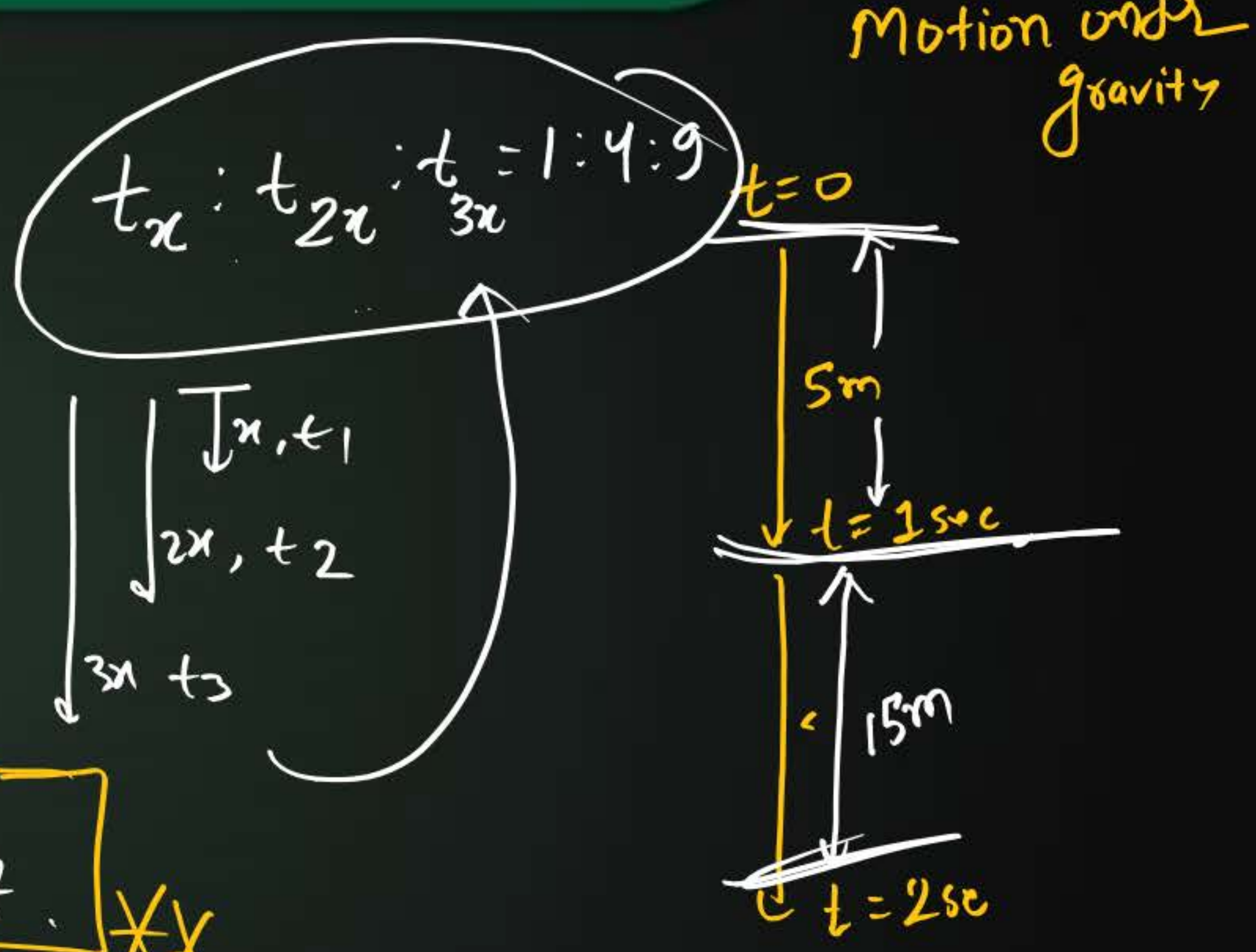
1. $K_1 + K_2$
2. $\dfrac{K_1 K_2}{K_1 + K_2}$
3. $\dfrac{K_1 + 3K_2}{4}$
4. $\dfrac{3K_1 + K_2}{4}$

Formation of ice slab on the surface of lake



$t_1 : t_2 : t_3 = 1 : 3 : 5 : 7$ ✗✗

time taken in equal thickness formed of Ice.



QUESTION

Ice starts forming in lake with water at 0°C and when the atmospheric temperature is –10°C. If the time taken for 1 cm of ice be 7 hrs, then the time taken for the thickness of ice to change from 1 cm to 2 cm is

1. 7 hrs
2. 14 hrs
3. Less than 7 hrs
4. More than 7 hrs

Newtons Law of Cooling



T_2 = Outside Tempr

$\frac{dT}{dt}$ = Rate of colling $\propto (T_1 - T_2)$

$70^\circ \xrightarrow{t_1} 60^\circ \xrightarrow{t_2} 50^\circ \xrightarrow{t_3} 40^\circ$

$t_1 < t_2 < t_3$

AIIMS-2017

$T_0 = 30^\circ$

The Newtons Law of Cooling becomes

QUESTION

An object kept in a large room having air temperature of 25°C takes 12 minutes to cool from 80°C to 70°C. The time taken to cool for the same object from 70°C to 60°C would be nearly: (ODISHA-2019)

1. 10 min
2. 12 min
3. 20 min
4. 15 min

QUESTION

A body from a temperature 3T to 2T in 10 minutes. The room temperature is T. Assume that Newton's law of cooling is applicable. The temperature of the body at the end of next 10 minutes will be: (NEET-2016)

1. 4/3 T
2. T
3. 7/4 T
4. 3/2 T

QUESTION

A body initially at 80°C cools to 64°C in 5 min and to 52°C in 10 min. The temperature of the surrounding is (AIIMS-2017)

1. 26°C
2. 16°C
3. 36°C
4. 40°C

QUESTION

Certain quantity of water cools from 70 nC to 60°C in the first 5 minutes and to 54°C in the next 5 minutes. The temperature of the surroundings is (NEET-2014)

1. 42°C
2. 10°C
3. 45°C
4. 20°C


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 09 | **Physics**

Thermal Properties Of Matter



By- Dr. Manish Raj (MR SIR)

Topics to be covered

1 # Newtons law of colling

2 # Thermal radiation

3 # ↳ Stefens Law, Krichhofss law

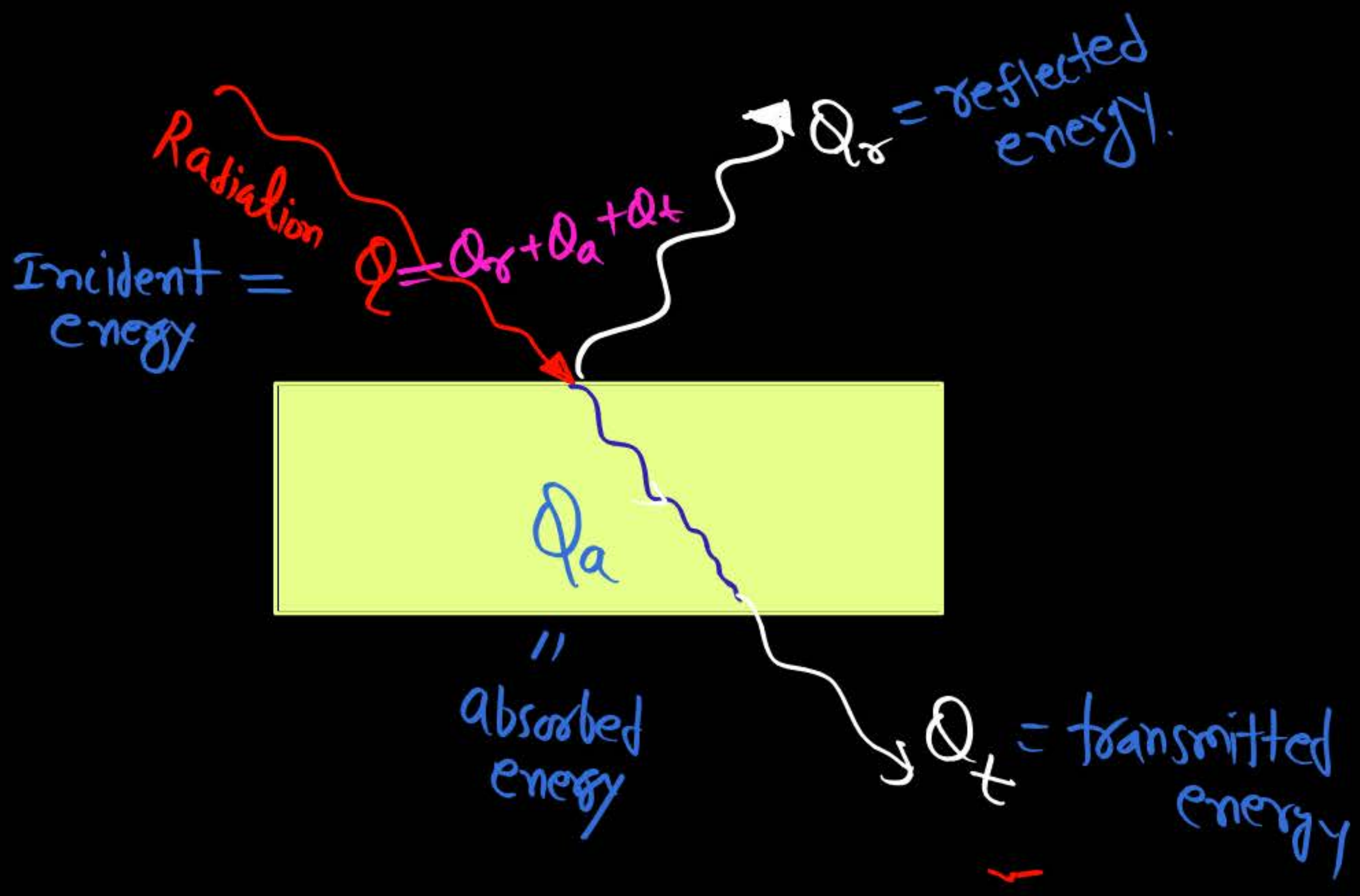
Stefens-Boltzman law

Winer disp^n law.



Radiation is a fastest mode of Heat Transfer.

→ I.R. Radiation. (Thermal radiation)



$$r \text{ (reflectance)} = \frac{Q_r}{Q} \quad \text{— (i)}$$

$$a \text{ (absorbtance)} = \frac{Q_a}{Q} \quad \text{— (ii)}$$

$$t \text{ (transmittance)} = \frac{Q_t}{Q} \quad \text{— (iii)}$$

$$r + a + t = \frac{Q_r}{Q} + \frac{Q_a}{Q} + \frac{Q_t}{Q}$$

$$r + a + t = \frac{Q_r + Q_a + Q_t}{Q} = 1$$

* $r + a + t = 1$

Perfect White Body

$r = 1$

$a + t + r = 1$

$a = 0$
$t = 0$

Perfect Black Body

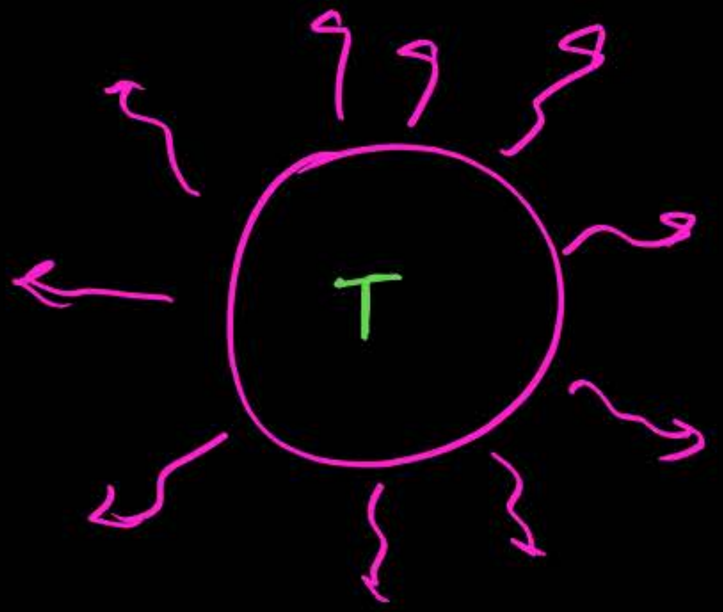
$a = 1$

$r = 0, \ t = 0$

emissivity for Black Body $e = 1$

Stefens law

[for a black Body at any Tempr T radiats energy per-unit Area Persec is fourth Powr of its Tempr.]



Surface Area = A

- total energy radiate through Area A in time 't' is "E".

energy radiates per unit Area per sec. $\propto T^4$

$$\left\{\frac{E}{At}\right\} \propto T^4$$

$$\frac{E}{At} = \sigma T^4$$

$$E = \sigma A t T^4$$

E: Total energy; t: time

σ = stefens constn

$\sigma = 5.67 \times 10^{-8}$

Unit $\frac{J}{s\,m^2 K^4} = \left[\frac{watt}{m^2 K^4}\right]$

$E = \sigma A t T^4$

R = Radius of object

$E = \sigma \pi R^2 t T^4$

$e = \dfrac{\text{(emissivity of any body)}}{\text{emissivity of Black Body}}$

emissivity

emissive Power

emissity of any body = e emissivity of Black body

- Steffen law for Black Body $E = \sigma A t T^4$

Stefen law any body

$E = \sigma A t T^4 e$

Krichhoffs Law

→ good emitter (emissivity) is a good absorber.

Heat incident → reflectance, transmittance, absorbtance

Heat radiation emission → emissivity (e)

Provost Theory → If Black body is at Tempr T, placed in a environment where Tempr is T_0 then emits radiation & absorbed some radiation simultaneously.

$Q_{net} = Q_{emit} - Q_{absorbed}$

$Q_{net} = \sigma A t T^4 - \sigma A t T_0^4 = \sigma A t (T^4 - T_0^4)$

- Stefens - Boltzmann Law

QUESTION

Heat is flowing through two cylindrical rods of same material. The diameters of the rods are in the ratio 1 : 2 and their lengths are in the ratio 2 : 1. If the temperature difference between their ends is same, then the ratio of amounts of heat conducted through them per unit time will be

1. 1 : 1
2. 2 : 1
3. 1 : 4
4. 1 : 8

$\frac{d\theta}{dt} \propto \frac{R^2}{L}$

$\frac{D_1}{D_2} = \frac{1}{2}$

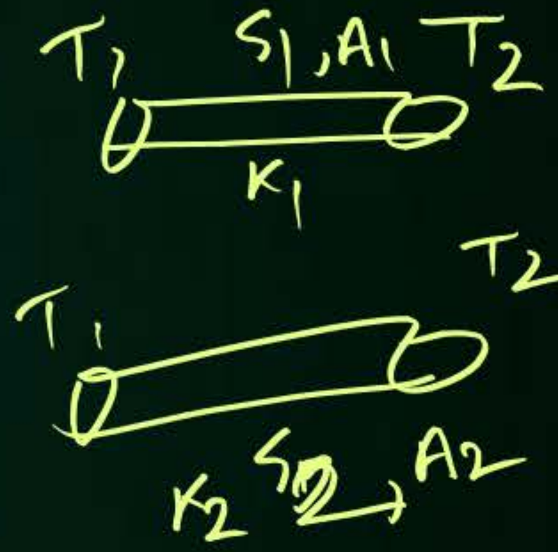
$\frac{2r_1}{2r_2} = \frac{1}{2}$

$\frac{r_1}{r_2} = \frac{1}{2}$

QUESTION

Consider two rods of same length and different specific heats (S_1 and S_2), conductivities K_1 and K_2 and area of cross section (A_1 and A_2) and both having temperature T_1 and T_2 at their ends. If the rate of heat loss due to conduction is equal then

1. $K_1A_1 = K_2A_2$
2. $K_2A_1 = K_1A_2$
3. $\frac{K_1A_1}{S_1} = \frac{K_2A_2}{S_2}$
4. $\frac{K_2A_1}{S_2} = \frac{K_1A_2}{S_1}$



QUESTION

The energy that will be ideally radiated by a 100 kW transmitter in 1 hour is :

1. 1×10^5 J
2. 36×10^7 J
3. 36×10^4 J
4. 36×10^5 J

$P = 100\text{ kW}$

$\frac{E}{t} = 100 \times 10^3$

$= 100 \times 10^3 \times 60 \times 60$

$= 36 \times 10^7$

QUESTION

Emissive power of any surface (e), Absorptive power (a), Reflecting power (r) and transmission power (t) are related as -

1. $a + e + t = 1$
2. $a + r + t = 1$
3. $r + e + t = 1$
4. $r + e + a = 1$

QUESTION

Unit of σ?

1. Watt m^2/K^4
2. Watt$/m^2K^4$
3. $\frac{J}{Sm^2K^4}$
4. $\frac{Js}{m^2K^4}$

σ = stefes constn

Both are corre.

QUESTION

Energy radiated from a body in time t is? When A is area of the body.

1. $\sigma T^4 t$
2. $\sigma T^4 t A$
3. σT^4
4. $\dfrac{\sigma T^4}{At}$

QUESTION

Two body of same nature and same dimension at temperature 50°C & 100°C then energy radiation per unit time from per unit area will be

1. 1 : 2
2. 1 : 16
3. 16 : 1
4. None of these

Ans

$d\theta$ = $ms\Delta T$ change in temp

S.I unit, C.G.S unit

$\frac{E}{At} = \sigma T^4$ ← kelvin

$\frac{\left(\frac{E}{At}\right)_{1\,body}}{\left(\frac{E}{At}\right)_{2nd\,body}} = \frac{(T_1+273)}{(T_2+273)}{}^4$

$\frac{E}{A,t} = \sigma T^4$

$\propto T^4$

$E_1 = (50+273)^4 = \left(\frac{323}{373}\right)^4$

$E_2 = (100+273)^4$

Prevost Theory

A body at temperature T_B placed in atmosphere where temperature of atmosphere is T_0 then body will radiate and absorbs radiation simultaneously.

QUESTION

Two identical metal balls at temperature 200°C and 400°C kept in air at 27°C. The ratio of net heat loss by these bodies is

1. 1/4
2. 1/2
3. 1/16
4. $\dfrac{473^4 - 300^4}{673^4 - 300^4}$

473 673 300 K radiation

$\frac{E}{At} \propto (T - T_0)^4$

$\frac{E}{At} \propto T^4 - T_0^4$

QUESTION

Two body of same material at same temperature as shown then find ratio of heat loss per unit time per unit area will be:



1. 1 : 1
2. 1 : 2
3. 2 : 1
4. 4 : 1

Wines Displacement Law

QUESTION

Two spheres made of same material have radii in the ratio 1 : 2. Both are at same temperature. Ratio of heat radiation energy emitted per second by them is

1. 1 : 2
2. 1 : 8
3. 1 : 4
4. 1 : 16

QUESTION

Two black metallic spheres of radius 4m, at 2000 K and 1m at 4000 K will have ratio of energy radiation as

1. 1 : 1 ✓
2. 4 : 1
3. 1 : 4
4. 2 : 1

$$\frac{E_1}{E_2} = \frac{\sigma A_1 t_1 T_1^4}{\sigma A_2 t_2 T_2^4} = \frac{16}{1} \times \left(\frac{2000}{4000}\right)^4$$

QUESTION

If transmission power of a surface is 1/6 and reflective power is 1/3, then its absorptive power will be-

1. 1/3
2. 1/2
3. 1/6
4. 1/12

$t = \frac{1}{6}$, $r = \frac{1}{3}$, $a = ??$

$\frac{1}{6} + \frac{1}{3} + a = 1$

$a = 1 - \frac{1}{6} - \frac{1}{3}$

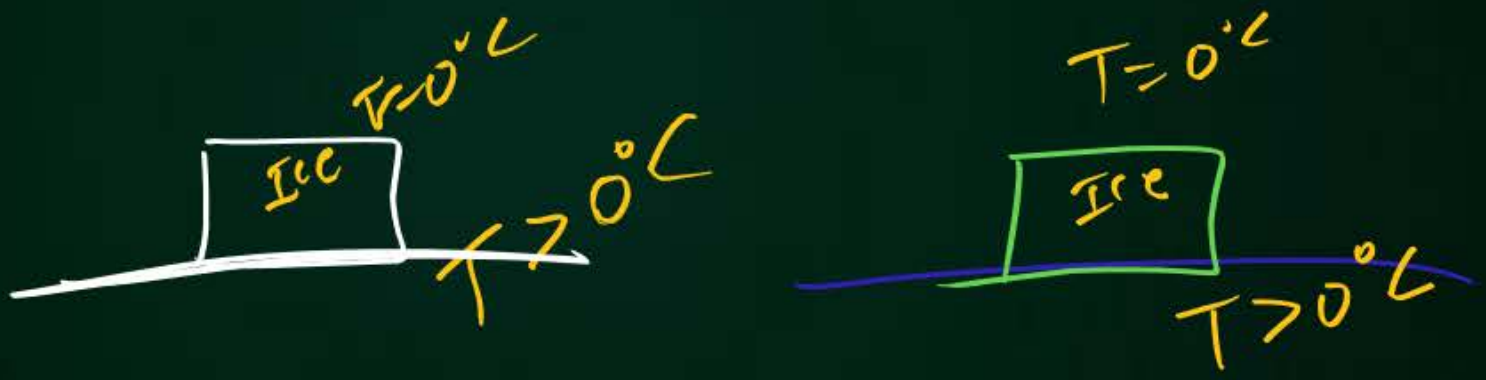
$= \frac{6-1-2}{6}$

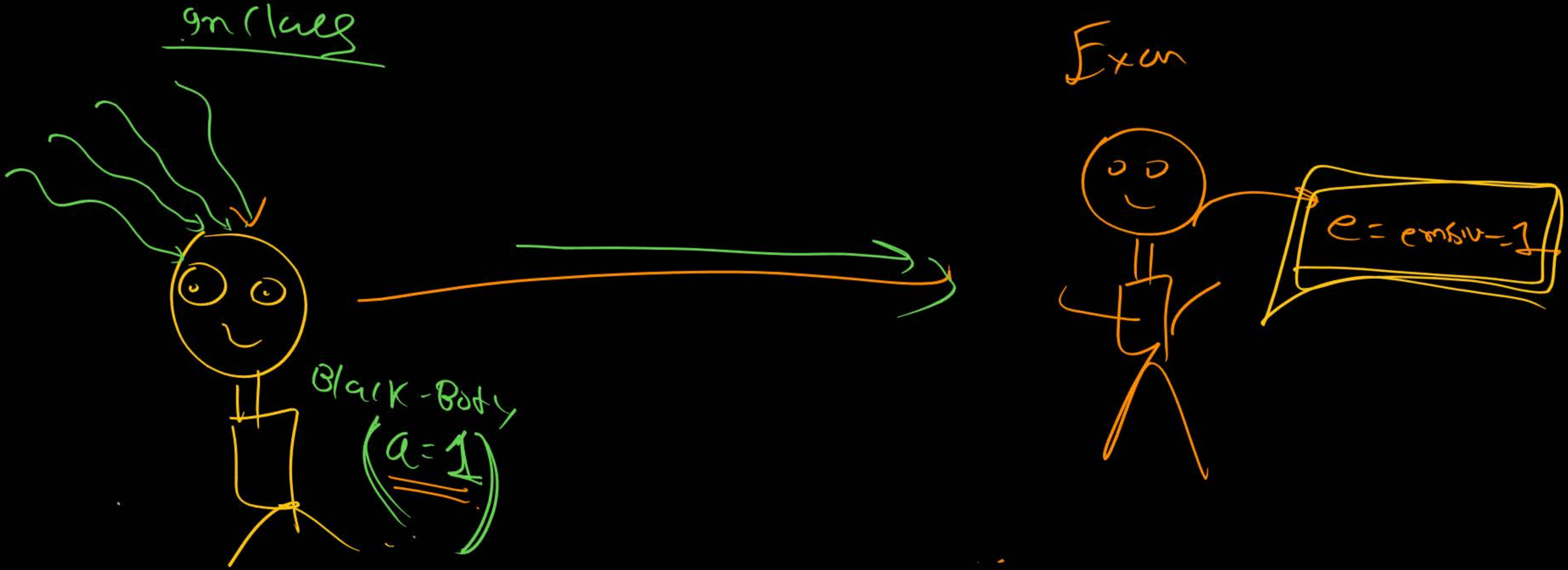
$= \frac{3}{6} = \frac{1}{2}$

QUESTION

If same amount of ice in placed in black and white cloth then ice in black cloth will

1. Melt more
2. Melt less
3. Melt equal
4. Not melt at all




In class
Exam
Black-Body
a=1

QUESTION

Temperature of a piece of metal is increased from 27°C to 327°C. The rate of emission of radiation by a metal will become-

1. Double
2. Four times
3. Eight times
4. Sixteen times (Ans)

$T_1 = 27 + 273$

$T_1 = 300K$

$T_2 = 327°C$

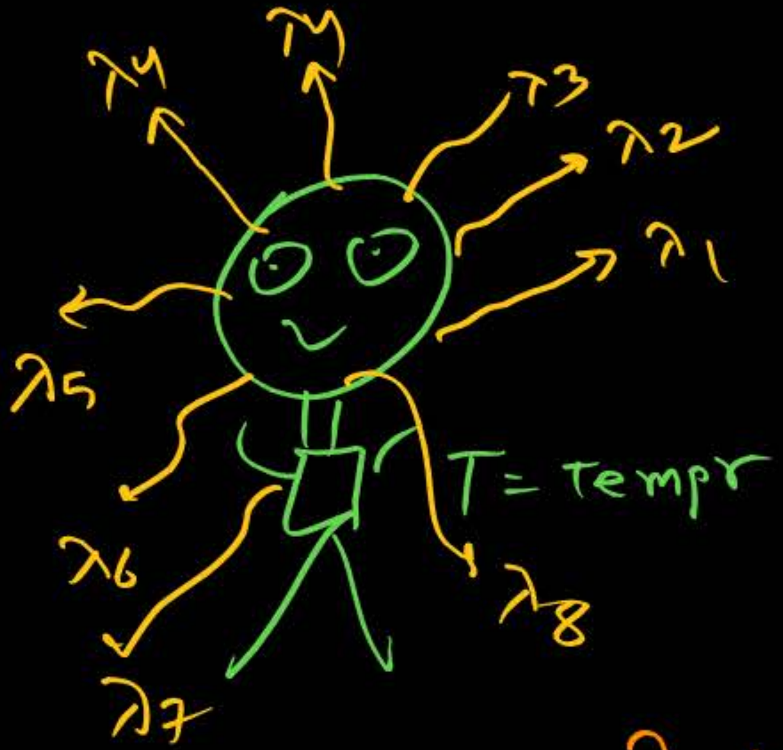
$T_2 = 327 + 273$

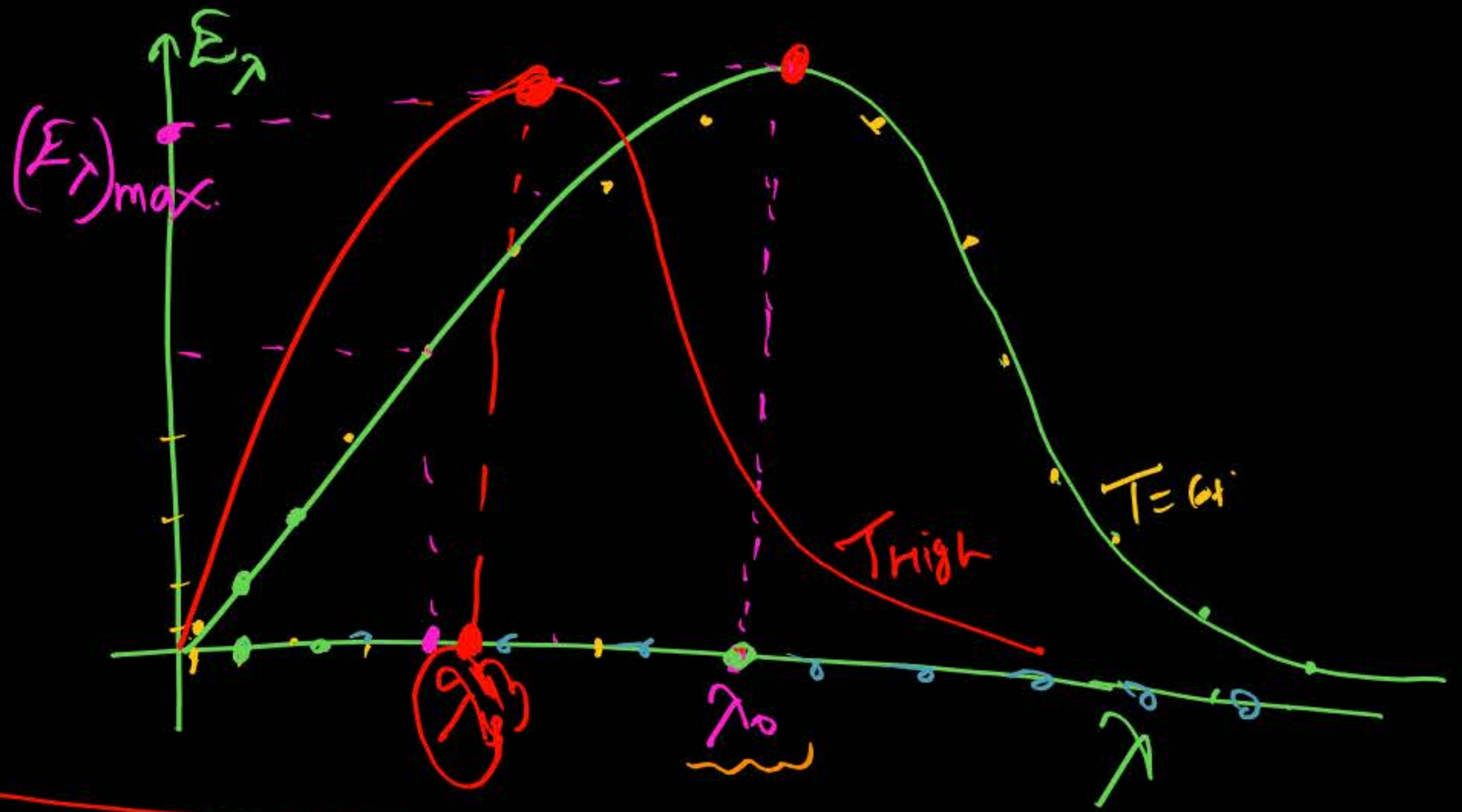
$T_2 = 600K$

$$\frac{Q_1 \propto T_1^4}{Q_2 \propto T_2^4}$$

Wines displacement Law :

If Body is at Tempr T then it emits a radiation of all Possible wavelength.





Radiation at wavelength λ_0 is maximum

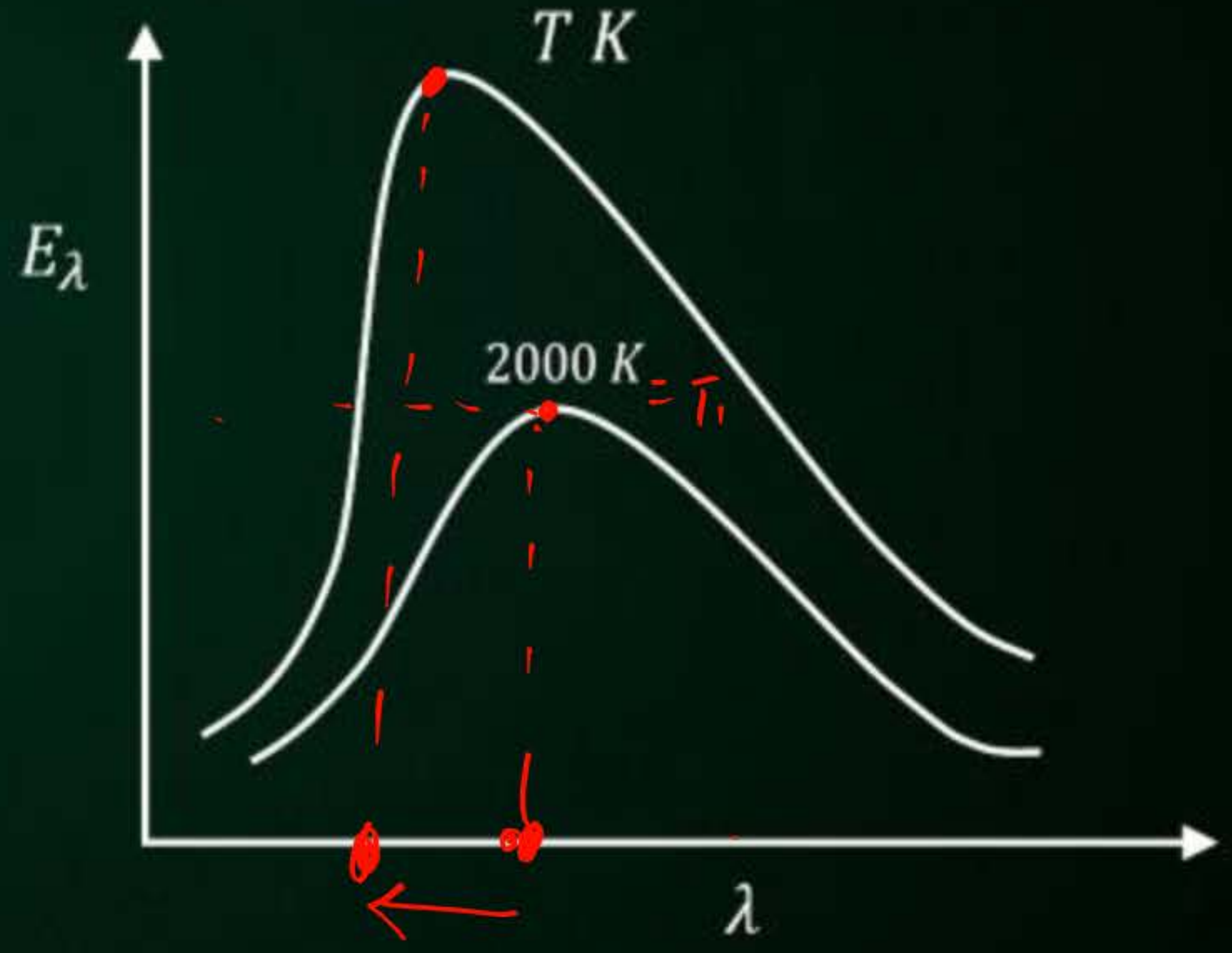
$$\lambda_0 \propto \frac{1}{T}$$

$$\lambda_0 = \frac{b}{T}$$

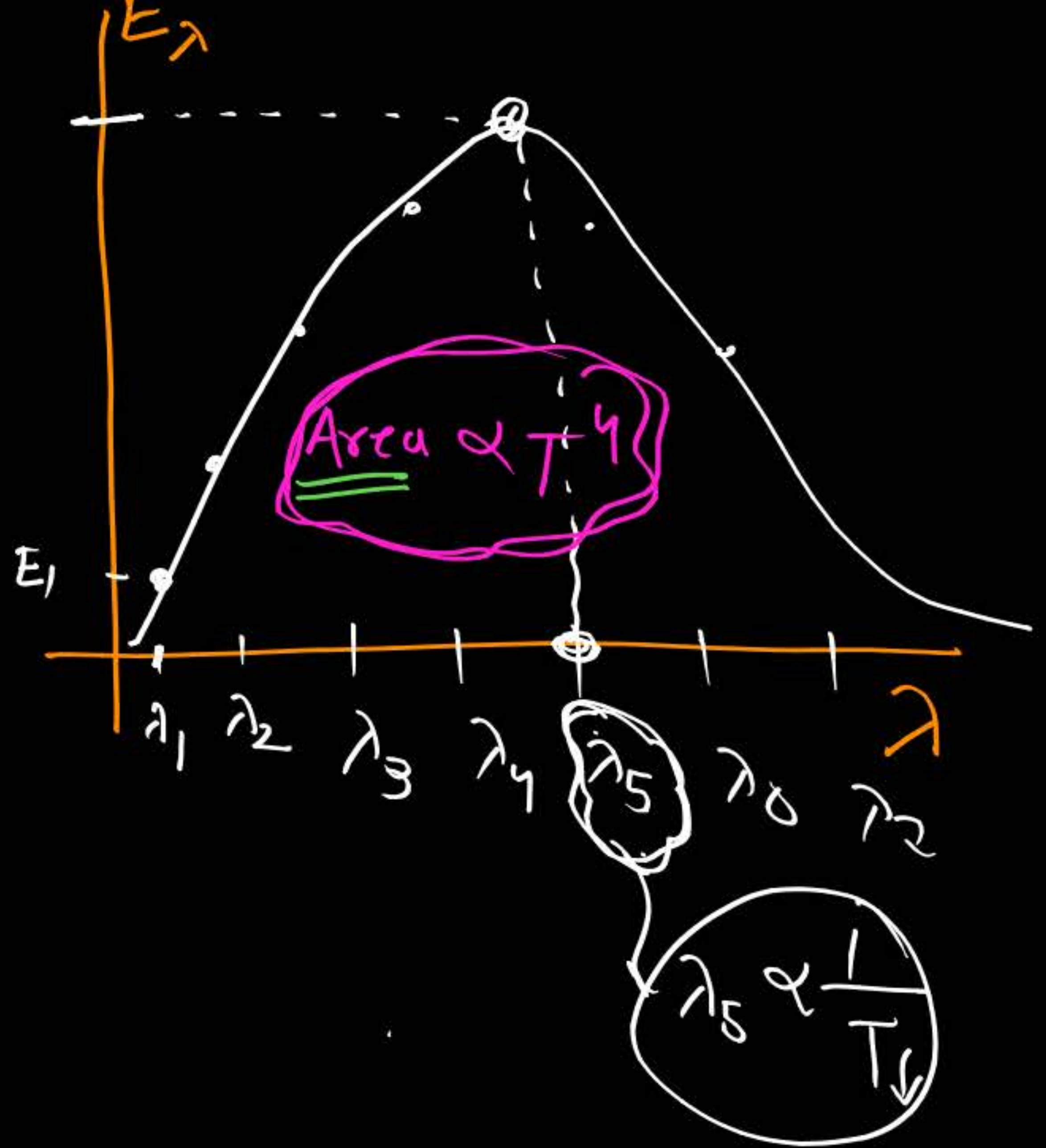
Area Under the Curve of E_λ & λ $\propto T^4$

QUESTION

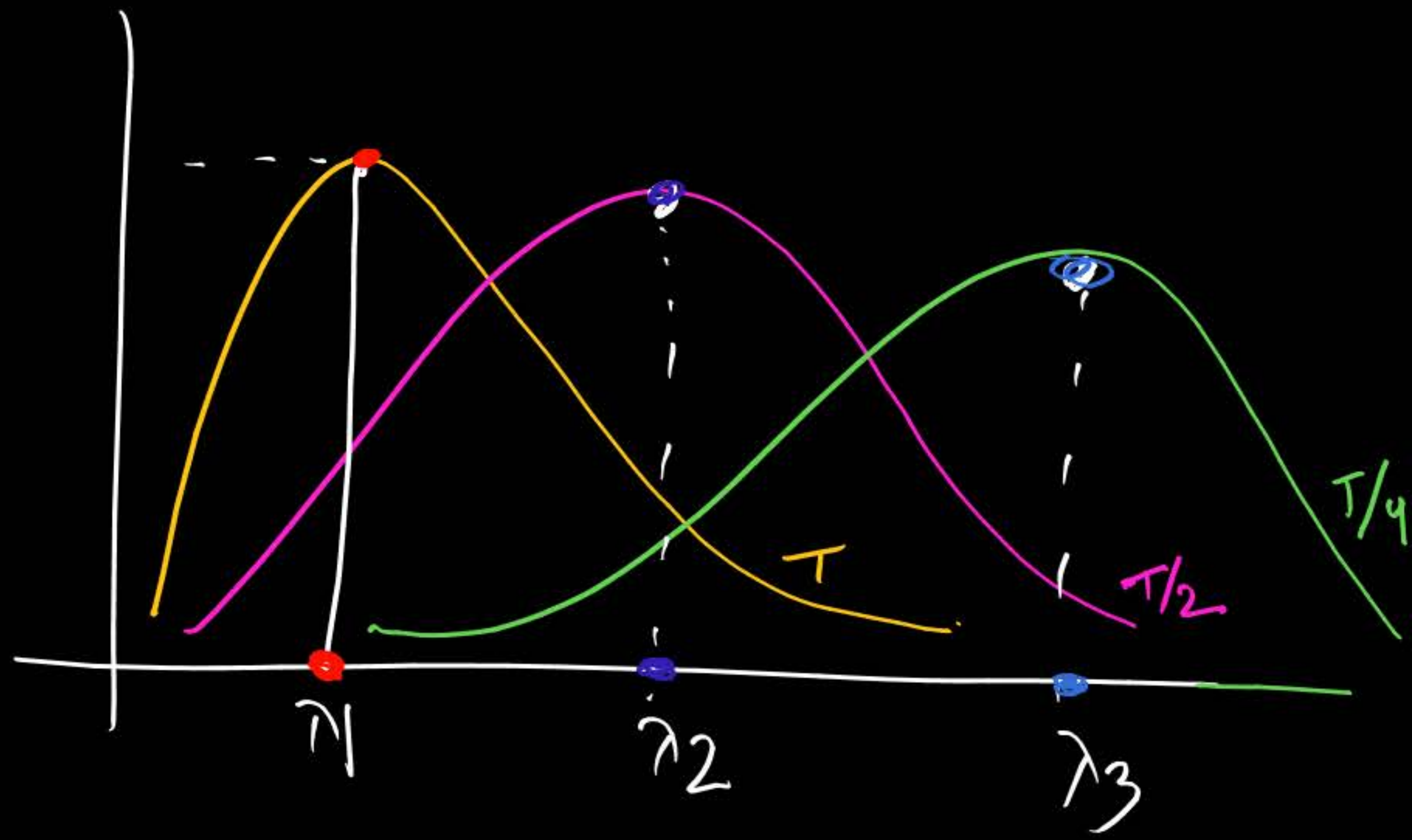
The adjoining diagram shows the spectral energy density distribution of a black body at two different temperatures. If the areas under the curves are in the ratio 16 : 1, the value of temperature T is



1. 32000 K
2. 16000 K
3. 8000 K
4. 4000 K



E_λ
E_1
Area $\alpha\ T^4$
λ_1 λ_2 λ_3 λ_4 λ_5 λ_6 λ_7
λ
$\lambda_5\ \alpha\ \frac{1}{T}$



T
T/2
T/4
λ_1 λ_2 λ_3

QUESTION

Two wavelength of maximum energy released during an atomic explosion was 2.93×10^{-10} m. Given that Wien's constant is 2.93×10^{-3} m-K. The maximum temperature attained must be of the order of

1. 10^{-7} K
2. 10^{7} K
3. 10^{-13} K
4. 5.86×10^{7} K

QUESTION

Two bodies A and B are kept in an evacuated chamber at 27°C. The temperature of A and B are 327°C and 427°C respectively. The ratio of rates of loss of heat from A and B will be:

1. 0.52
2. 0.25
3. 1.52
4. 2.52

QUESTION

If the temperature of a black body is increased by 50% then the amount of radiation emitted by it will-

1. Increase by 400%
2. Decrease by 400%
3. Decrease by 50%
4. Increase by 50%

QUESTION

A copper ball 2 cm in radius is heated in a furnace to 327°C. If its emissivity is 0.3, at what rate does it radiate energy? [AIIMS-2015]

1. 1.72 W
2. 2..73 W
3. 11.0 W
4. 2.15 W

QUESTION

The temperature of a body is increased from −70°C to 327°C. Then the ratio of emissive power is

1. 1/9
2. 1/27
3. 27
4. 81

QUESTION

A spherical black body with a radius of 12 cm radiates 450 watt power at 500 K. If the radius were halved and the temperature doubled the power radiated in watt would be: [NEET-2017]

1. 125
2. 450
3. 1000
4. 1800

QUESTION

On observing light from three different stars, P, Q and R, it was found that intensity of violet color is maximum in the spectrum of P, the intensity of green colour is maximum in the spectrum of R and the intensity of red colour is maximum in the spectrum of Q, If T_P, T_Q and T_R are the respective absolute temperature of P. Q and R, then it can be concluded from the above observation that: [NEET-2015]

1. $T_P > T_R > T_Q$
2. $T_P < T_R < T_Q$
3. $T_P < T_Q < T_R$
4. $T_P > T_Q > T_R$

QUESTION

The condition under which a microwave oven heats up a food item containing water molecules most efficiently is: [NEET-2013]

1. Infra-red waves produce heating in a microwave oven
2. The frequency of the microwaves must match the resonant frequency of the water molecules
3. The frequency of the microwaves has no relation with natural frequency of water molecules
4. Microwaves are heatwaves, so always produce heating

QUESTION

The total radiant energy per unit area, normal to the direction of incidence, received at a distance R from the centre of a star of radius r, whose outer surface radiates as a black body at a temperature TK is given by-

(where σ is Stefan's constant) [AIPMT (Pre)-2010]

1. $\sigma r^2 T^4 / R^2$
2. $\sigma r^2 T^4 / 4\pi r^2$
3. $\sigma r^4 T^4 / r^4$
4. $4\pi r^2 T^4 / R^2$

QUESTION

If the radius of a star is R and it acts as a black body, what would be the temperature of the star, in which the rate of energy production is Q?

(σ stands for Stefan's constant) [AIPMT (Pre)-2012]

1. $(4\pi R^2 Q/\sigma)^{1/4}$
2. $(Q/4\pi R^2 \sigma)^{1/4}$
3. $Q/4\pi R^2 \sigma$
4. $(Q/4\pi R^2 \sigma)^{-1/2}$

WIEN'S DISPLACEMENT LAW

According to Wien's law the product of wavelength corresponding to maximum intensity of radiation and temperature of body (in Kelvin) is constant,

i.e. $\lambda_m T = b = \text{constant}$

Where b is Wien's constant and has value

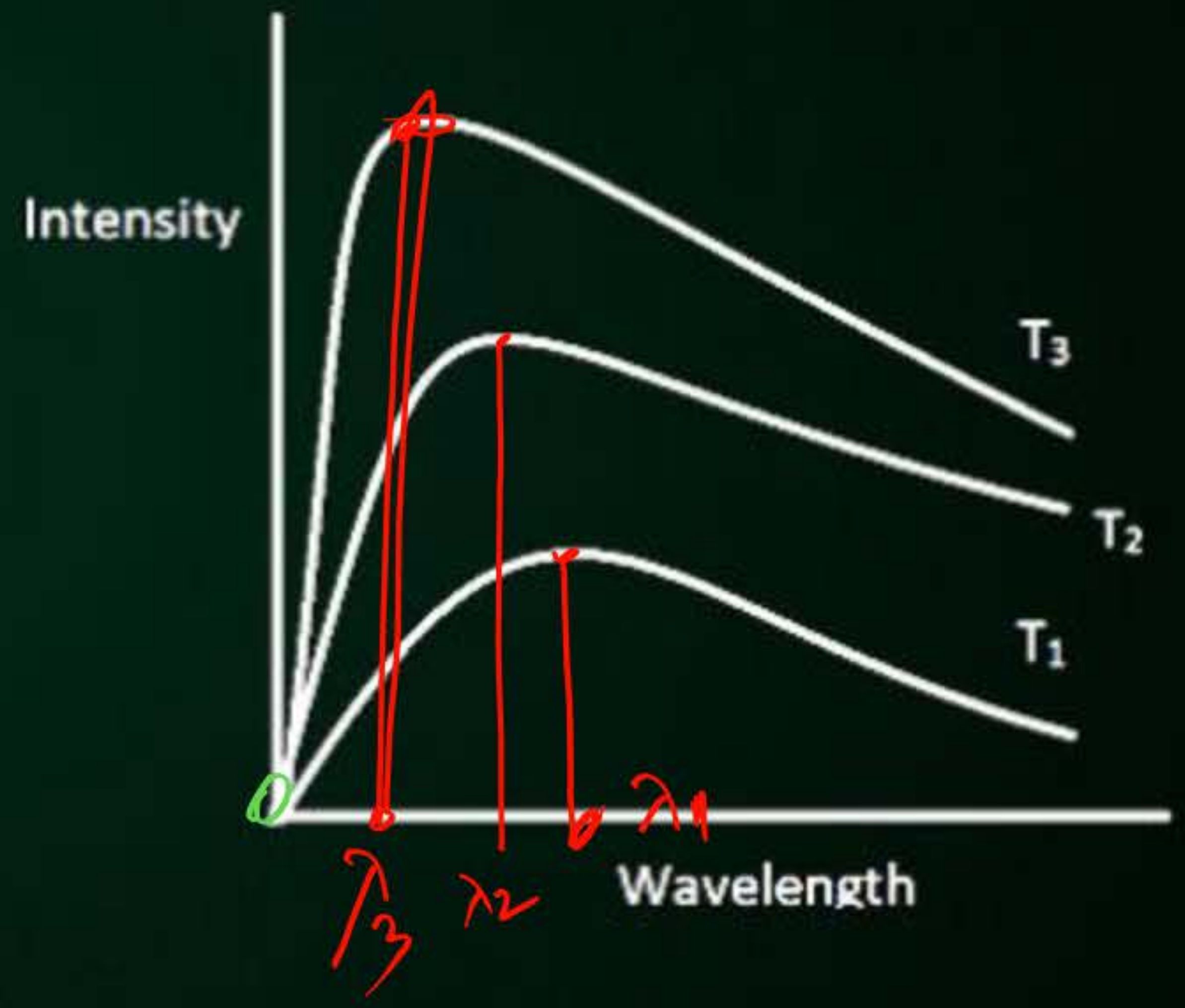
$$2.89 \times 10^{-3} \text{ m-K}$$

This law is of great importance in 'Astrophysics' as through the analysis of radiations coming from a distant star, by finding λ_m the temperature of the star T $(= b/\lambda_m)$ is determined.

QUESTION

If for a black body the graph of change is emissive power at different temperatures T_1, T_2 and T_3 with wavelength is according to the figure then -

1. $T_1 = T_2 = T_3$
2. $T_3 > T_2 > T_1$
3. $T_1 > T_2 > T_3$
4. $T_3 > T_1 > T_2$



QUESTION

A spherical black body with a radius of 12 cm radiates 450 watt power at 500 K, If the radius were halved and the temperature doubled the power radiated in watt would be: [NEET - 2017]

1. 125
2. 450
3. 1000
4. 1800

QUESTION

A black body is at a temperature of 5760 K. The energy of radiation emitted by the body at wavelength 250 nm is U_1, at wavelength 500 nm is U_2 and that at 1000 nm is U_3. Wien's constant, $b = 2.88 \times 10^6$ nmK. Which of the following is correct?

[NEET-2016]

1. $U_1 = 0$
2. $U_3 = 0$
3. $U_1 > U_2$
4. $U_2 > U_1$

QUESTION

A cylinder of radius R made of a material of thermal conductivity K_1 is surrounded by a cylindrical shell of inner radius R and outer radius 2R made of material of thermal conductivity K_2. The two ends of the combined system are maintained at two different temperatures. There is no loss of heat across the cylindrical surface and the system is in steady state. The effective thermal conductivity of the system is

1. $K_1 + K_2$
2. $\dfrac{K_1 K_2}{K_1 + K_2}$
3. $\dfrac{K_1 + 3K_2}{4}$
4. $\dfrac{3K_1 + K_2}{4}$

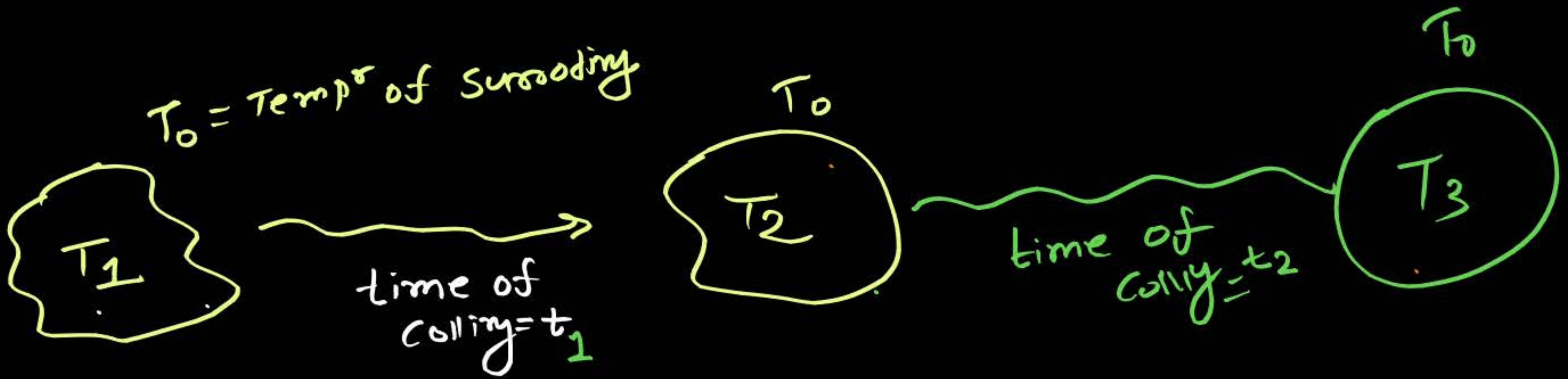
Newtons Law

- Rate of colling ∝ Temp^r difference.

$70°C \xrightarrow{t_1} 60° \xrightarrow{t_2} 50° \xrightarrow{t_3} 40° \ldots$

$T_0 = 30°C$

Time in collision ⇒ $t_1 < t_2 < t_3$



$$\frac{T_1 - T_2}{t_1} = K\left(\frac{T_1 + T_2}{2} - T_0\right)$$

$$\frac{T_2 - T_3}{t_2} = K\left(\frac{T_2 + T_3}{2} - T_0\right)$$

QUESTION

An object kept in a large room having air temperature of 25°C takes 12 minutes to cool from 80°C to 70°C. The time taken to cool for the same object from 70°C to 60°C would be nearly: (ODISHA-2019)

$T = 25°C$

1. 10 min
2. 12 min
3. 20 min
4. 15 min

$$\frac{80° - 70°}{12} = K\left(\frac{80+70}{2} - 25\right)$$

$$\frac{70-60}{t} = K\left(\frac{60+70}{2} - 25\right)$$

$$\frac{\frac{10}{12}}{\frac{10}{t}} = \frac{(75-25)}{(65-25)} = \frac{t}{12}$$

$$\frac{5}{4} = \frac{t}{12}$$

$$15 = t$$

$t = 15$ min

QUESTION

A body from a temperature 3T to 2T in 10 minutes. The room temperature is T. Assume that Newton's law of cooling is applicable. The temperature of the body at the end of next 10 minutes will be: (NEET-2016)

1. 4/3 T
2. T
3. 7/4 T
4. 3/2 T Ans

Soln

$$\frac{3T - 2T}{10} = K\left(\frac{3T + 2T}{2} - T\right)$$

$$\frac{2T - T'}{10} = K\left(\frac{2T + T'}{2} - T\right)$$

$$\frac{T}{2T - T'} = \frac{\left(\frac{5T - 2T}{2}\right)}{\frac{2T + T' - 2T}{2}} = \frac{3T}{T'}$$

$$TT' = 6T^2 - 3TT'$$

$$4TT' = 6T^2$$

$$T' = \frac{6T}{4}$$

$$T' = \frac{3T}{2}$$

QUESTION

A body initially at 80°C cools to 64°C in 5 min and to 52°C in 10 min. The temperature of the surrounding is (AIIMS-2017)

1. 26°C
2. 16°C
3. 36°C
4. 40°C

$$\frac{80-64}{5} = K\left(\frac{80+64}{2} - T_0\right)$$

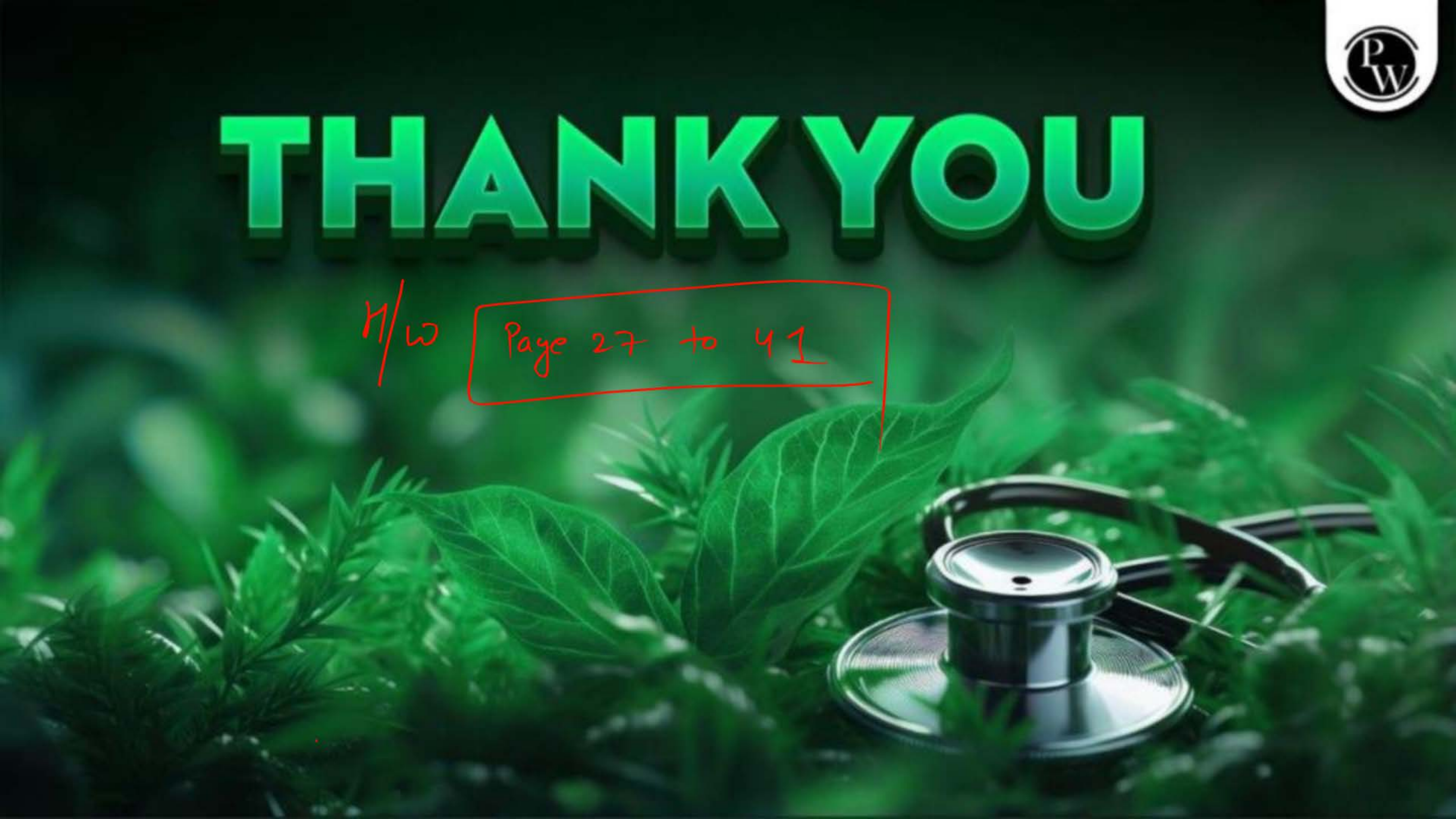
$$\frac{64-52}{5} = K\left(\frac{64+52}{2} - T_0\right)$$

QUESTION

Certain quantity of water cools from 70 nC to 60°C in the first 5 minutes and to 54°C in the next 5 minutes. The temperature of the surroundings is (NEET-2014)

done

1. 42°C
2. 10°C
3. 45°C
4. 20°C


THANK YOU
H/W Page 27 to 41

YAKEEN 2.0

FOR NEET 2025

Lecture- 01 | Physics

Kinetic Theory of Gases and Thermodynamics



By- Dr. Manish Raj (MR SIR)

Topics to be covered

1. # H/W
2. # Revision.
3. # Work.
   - → Internal enegy



QUESTION

Solid sphere and solid cube of same material and of same volume at same temperature then rate of heat loos per sec?

1. More in solid sphere
2. More in cube
3. Equal
4. None

Sphere Cube



Same volume

Stenfen law

$$\frac{E}{At} \propto T^4$$

$$E \propto A t T^4$$

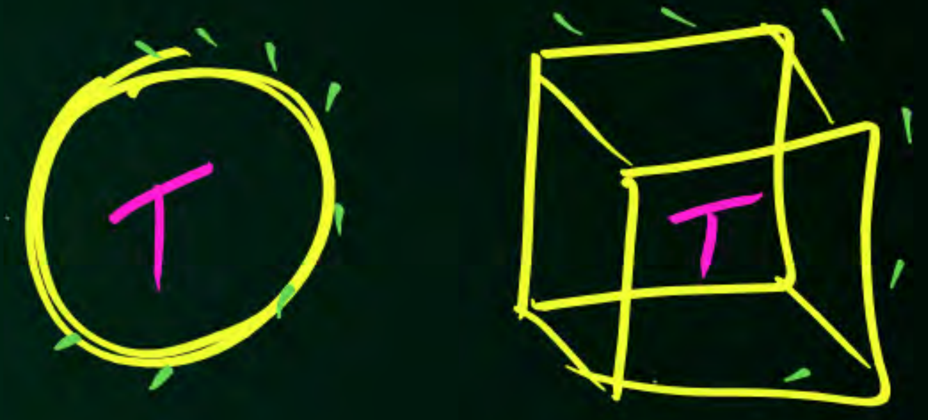
$$E \propto \text{Area}$$ — (1)

for same volume
Area is minimum for sphere.

QUESTION

Solid sphere and solid cube of same material and of same area at same temperature then rate of heat loss??

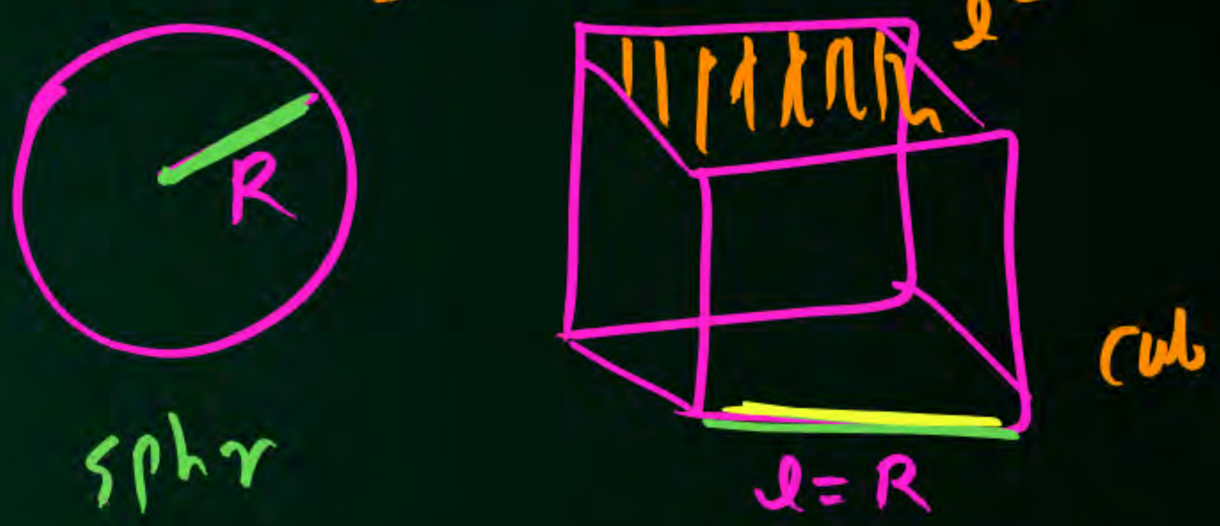
1. More in solid sphere
2. More in cube
3. Equal
4. None



QUESTION

Solid sphere and solid cube of same material and at same temperature then rate of heat loss??

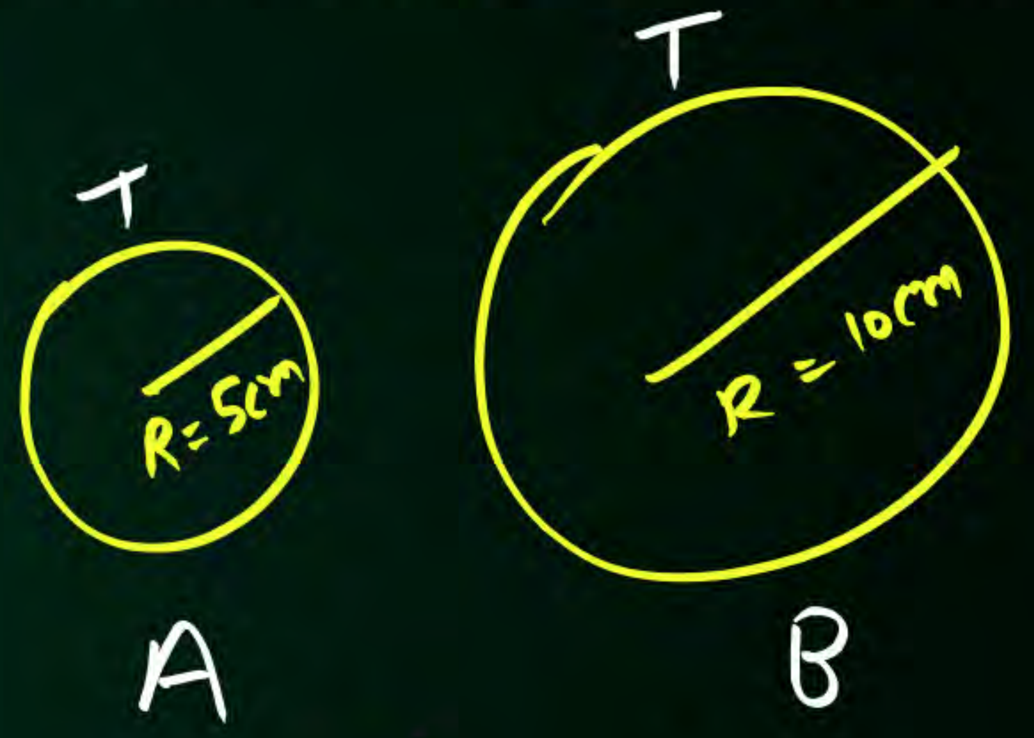
1. More in solid sphere
2. More in cube
3. Equal
4. None



QUESTION

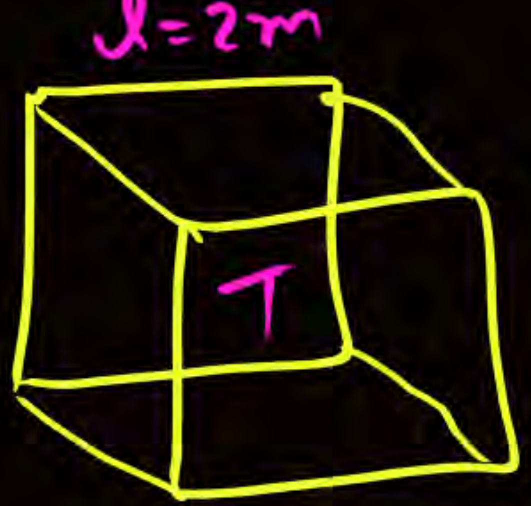
Two sphere of same material at same temperature of different size, then rate of colling:

1. Fast in A sphere
2. Fast in B sphere
3. Same
4. None



Same material at Same Tempr

then find Ratio of Rate of colling





Rate of Heat loss $\propto$ Area

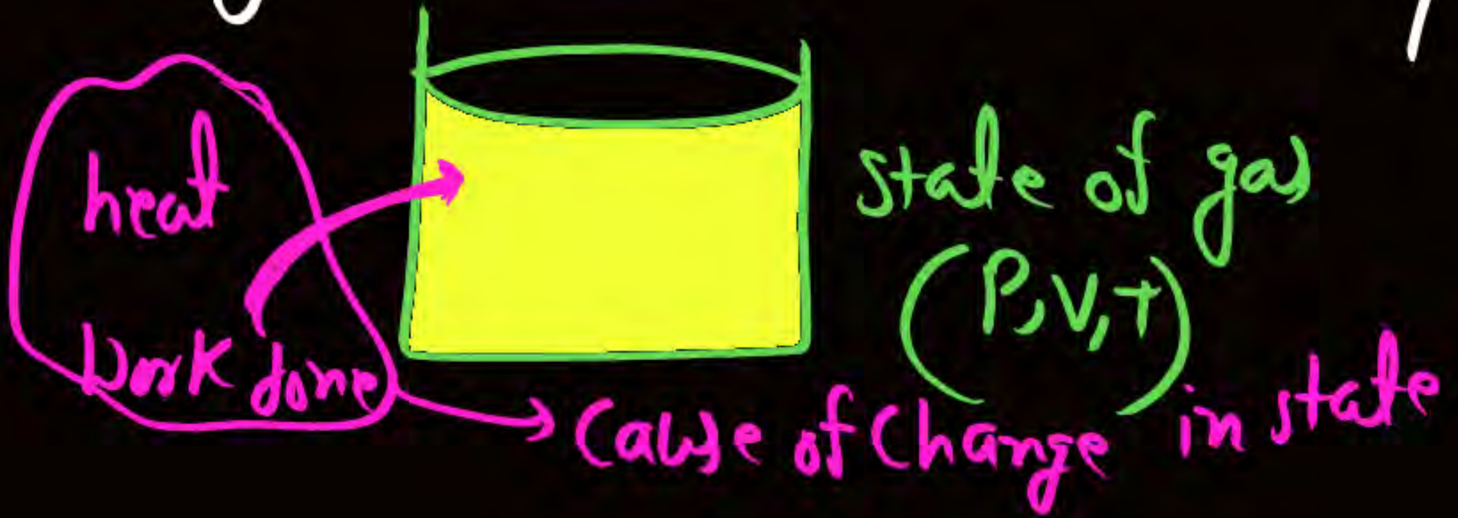
Rate of Kolling $\propto \dfrac{\text{Area}}{\text{Volume}}$

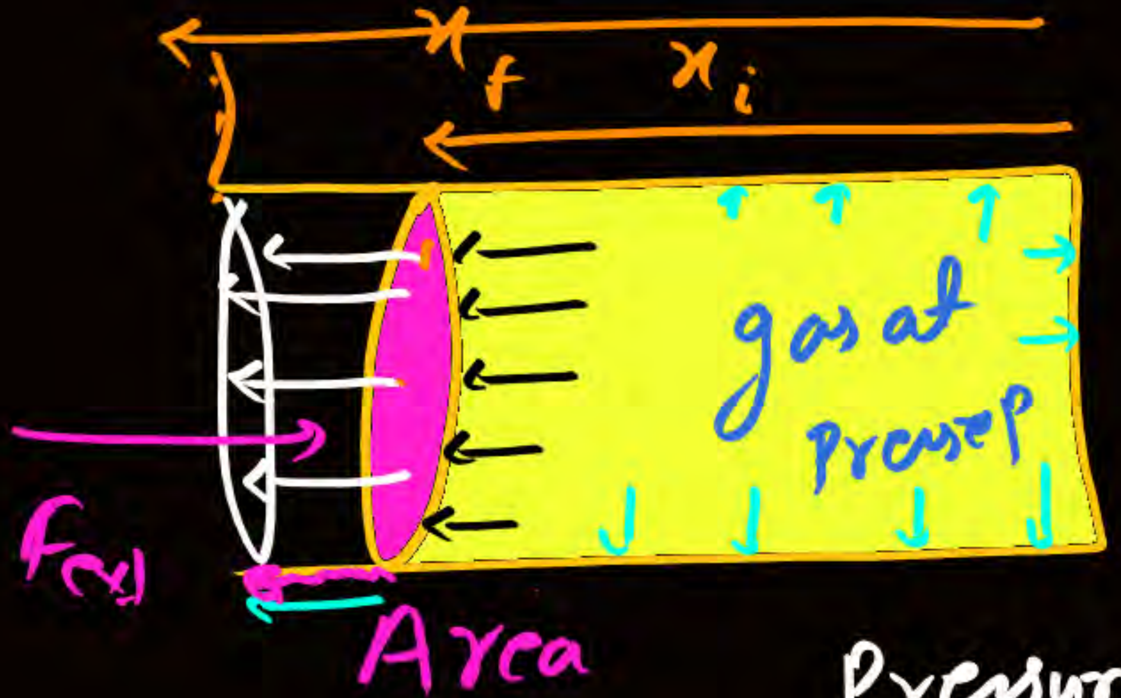
Thermodynamics

Work.

- gas have 5J work → NO
- gas have 5J heat → NO

gas have 5J internal energy → yes





$$\text{Pressure} = \frac{F}{A} \quad -(1)$$

Work done by 'F'

$$W = F \cdot [x_f - x_i]$$

$$= PA\,[x_f - x_i]$$

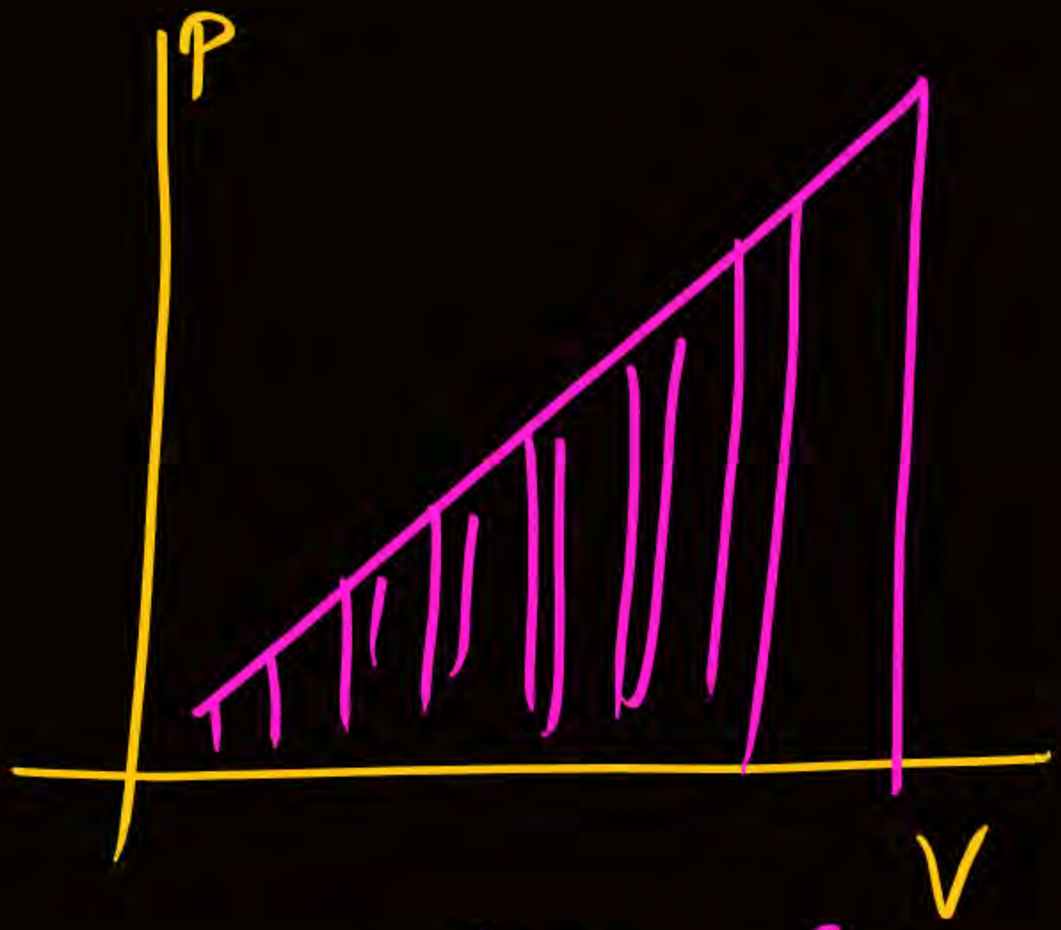
$$= P\,[Ax_f - Ax_i]$$

$$\text{Work}_i = P\,[V_f - V_i]$$

$$Work = P[V_f - V_i] = P\Delta V$$

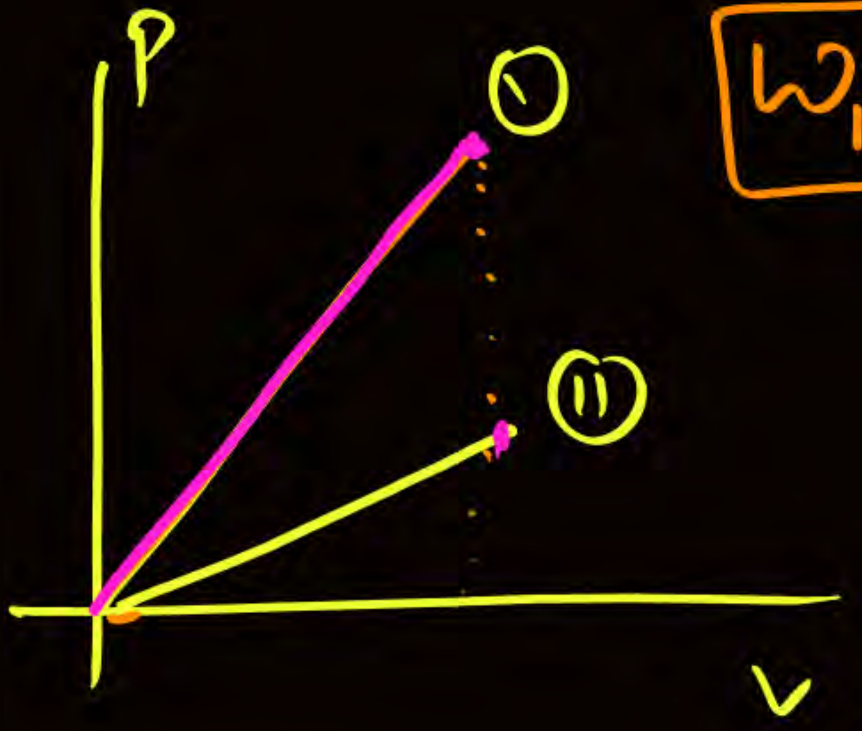
If $V_f > V_i$	If $V_f < V_i$
• expansion.	→ Compression
⊕ Work = +ve	Work = −ve
⊗ Work done by gas is positive.	* Work done by gas = −ve

Indicator diagram (graph b/w pressure & volume)



Area = $\int P\,dV$

Area = Work



$W_1 > W_2$

================ Work =================

QUESTION

In the following figure A certain mass of gas traces three paths 1, 2 and 3 from state A to state B. If the work done by the gas along these paths are W_1, W_2 and W_3 respectively. Then -

(1) $W_1 < W_2 < W_3$ ✓

(2) $W_1 > W_2 > W_3$

(3) $W_1 = W_2 = W_3$

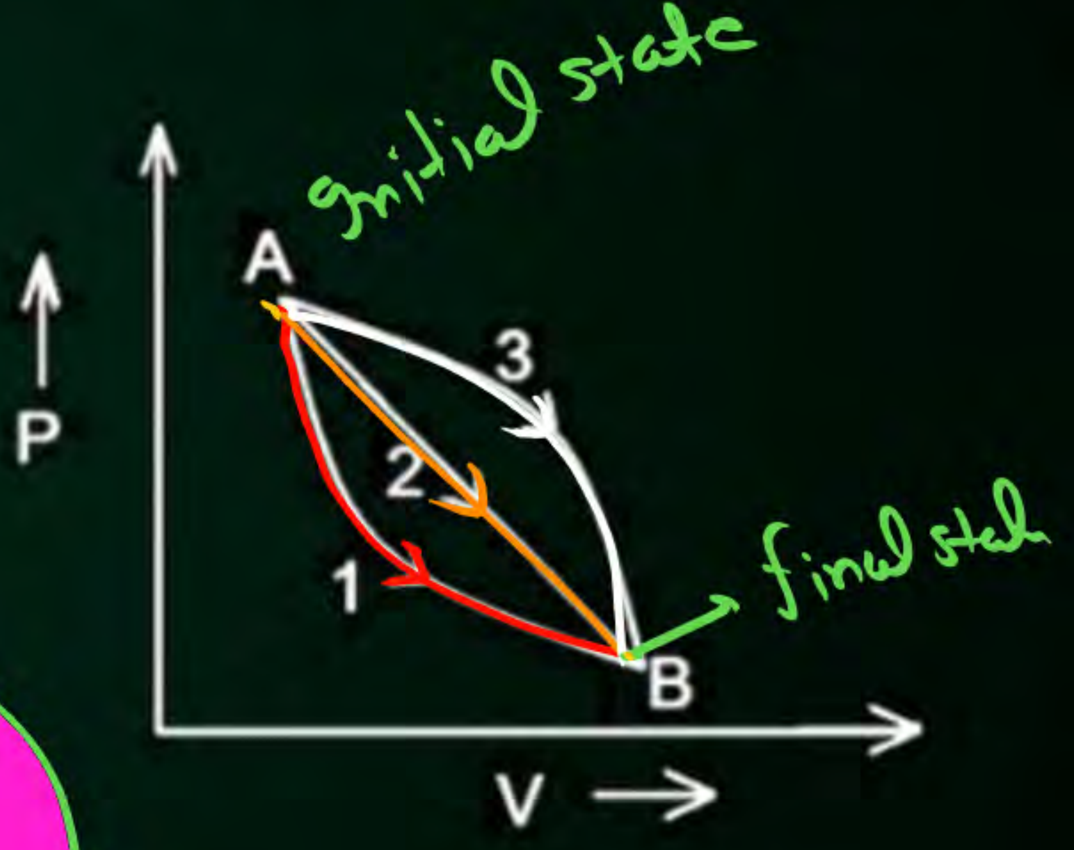
(4) $W_1 < W_2$ but $W_3 < W_2$

Work done is Path dependent

$W = P(\Delta V)$





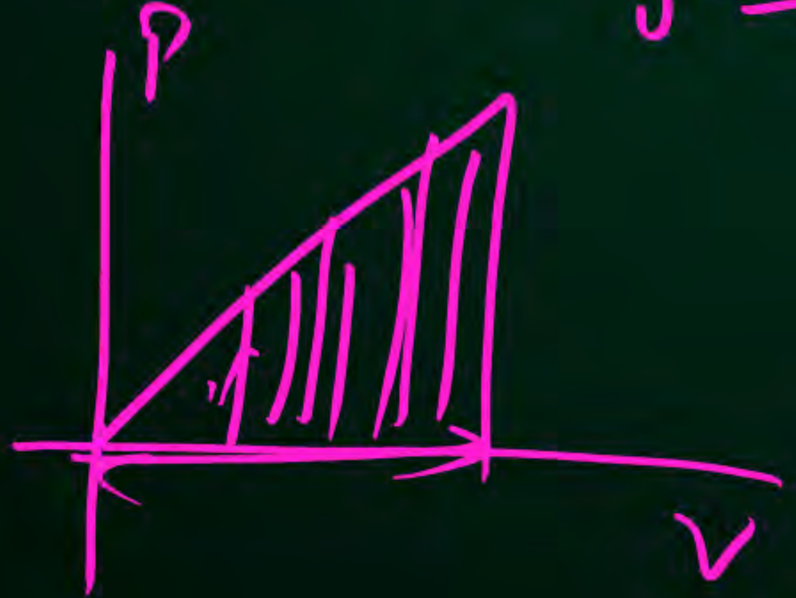


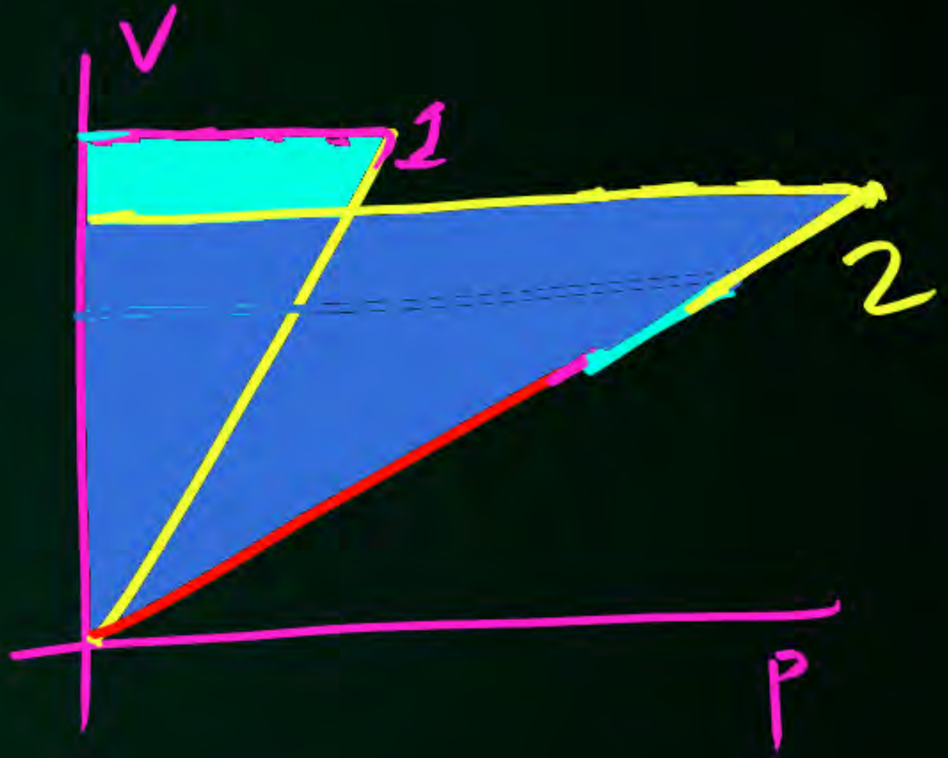
QUESTION

Which of the following option is correct

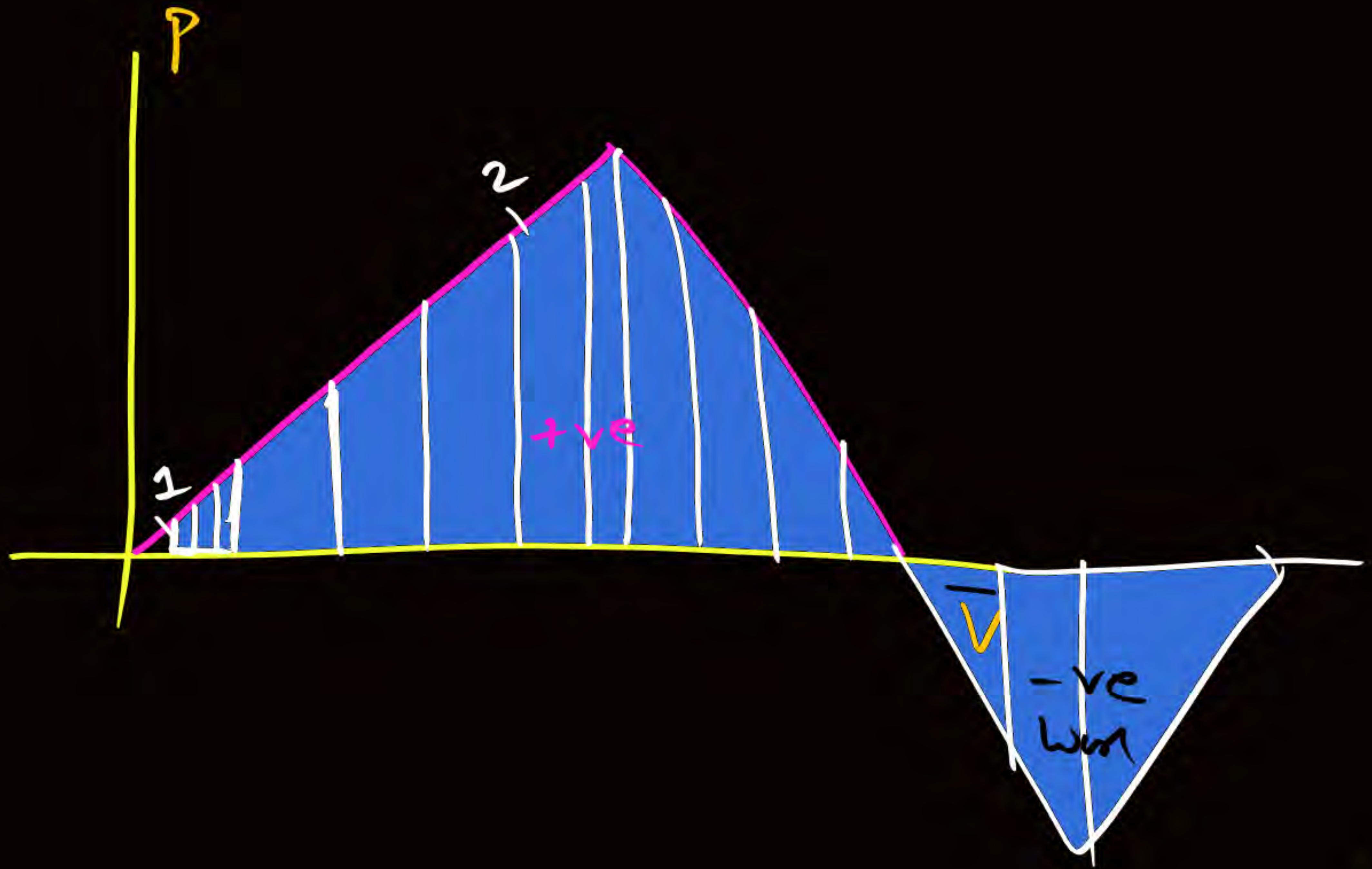
1. $W_1 = W_2$
2. $W_1 > W_2$
3. $W_1 < W_2$
4. Can't say

Area $= \int P\,dV$





Work ∝ Area under the PV curve (along V)

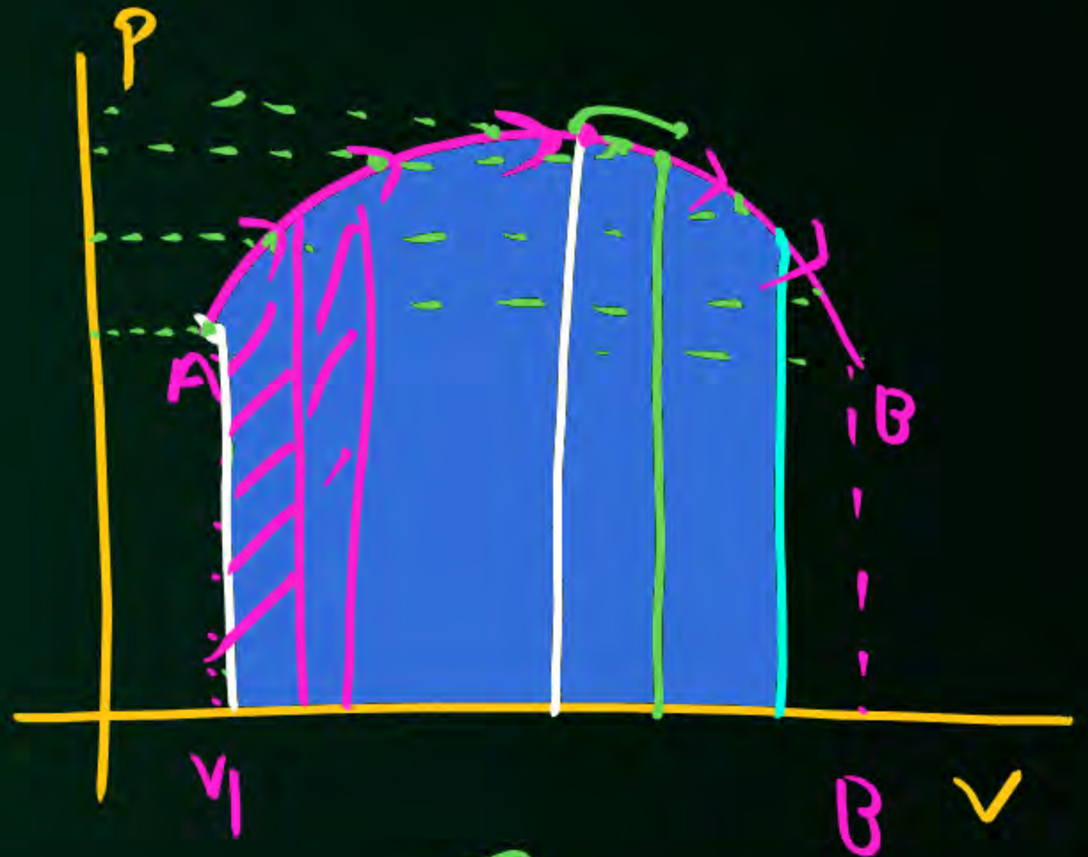

P
1
2
+ve
V
-ve
Wm

QUESTION

Which of the following option is correct for the work.

1. Continuously increasing
2. Continuously decreasing
3. $1^{st} \uparrow$ then $\downarrow$
4. $1^{st} \downarrow$ then $\uparrow$

Work = Area under the curve





* Pressure is 1st Increasing the decreasing → correct

Volume is continuously increasing → ✓

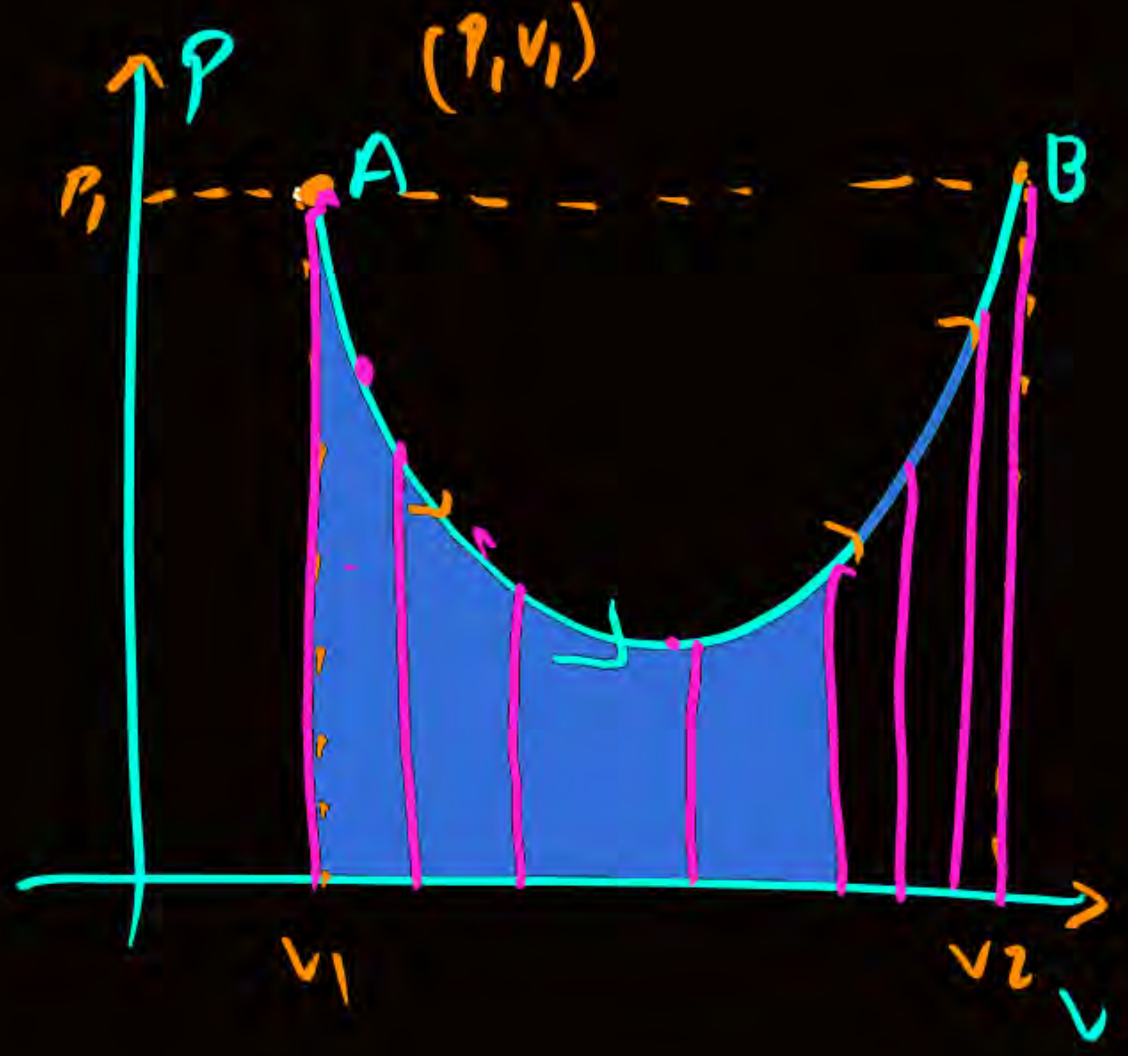
Q find Work when gas change its state from A to B through Phath as shown in graph.

(a) 1st ↓ then ↑

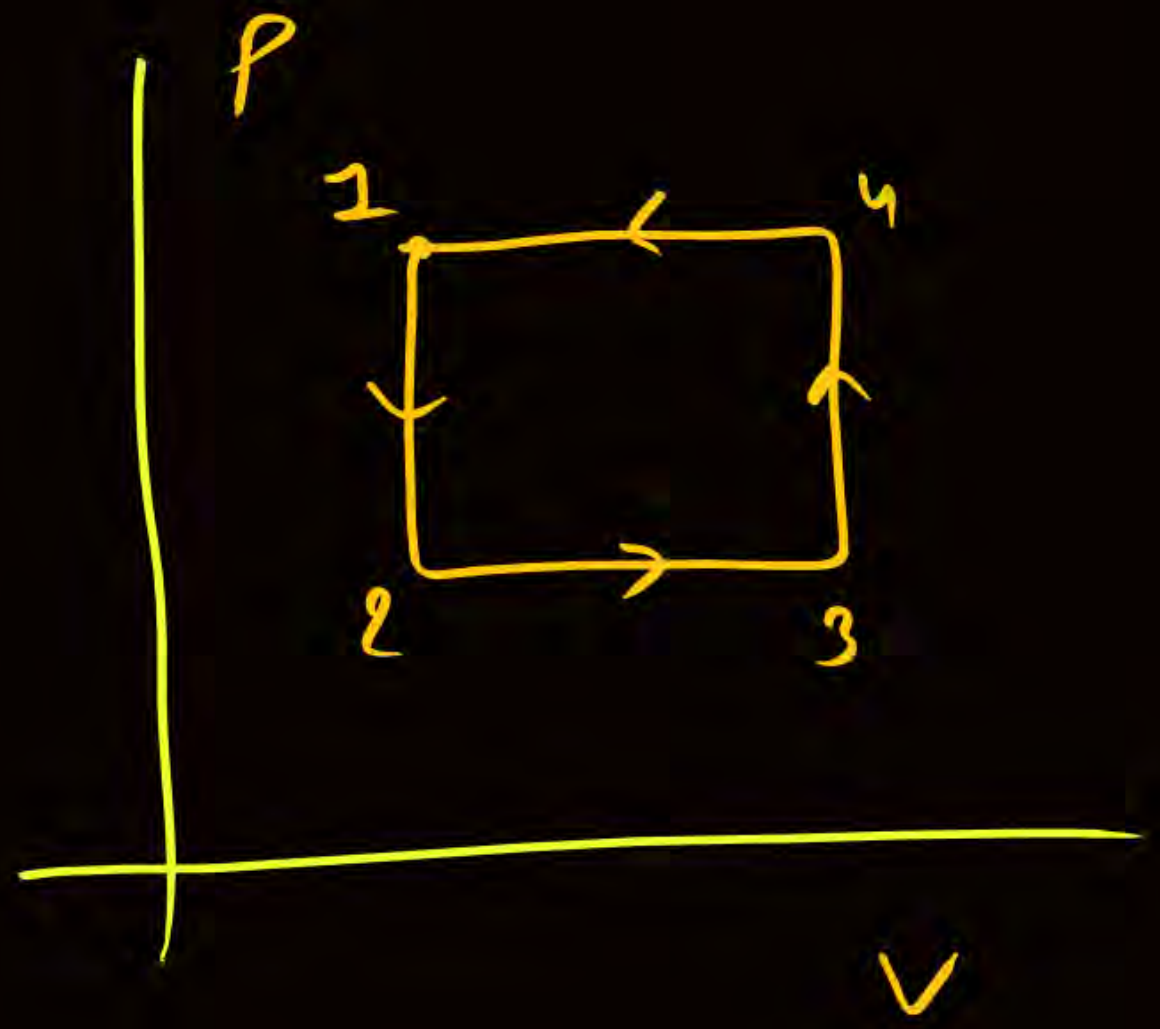
(b) 1st ↑ then ↓

(c) Continously Inc ✓✓

(d) Continously dec.



Work = Area under curve of PV graph.



Work = Area of loop

QUESTION

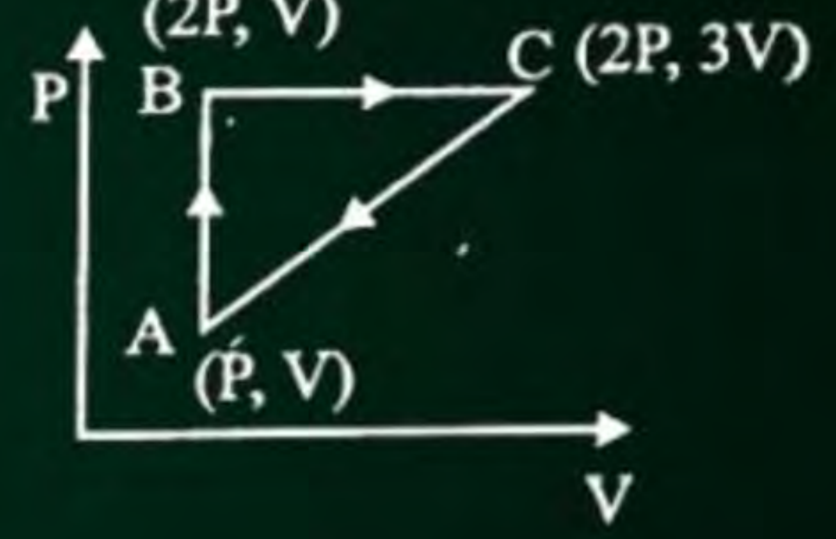
An ideal gas is taken through a cycle ABCA as shown in the P - V diagram. The work done during the cycle is:

(1) 2 PV

(2) 3 PV

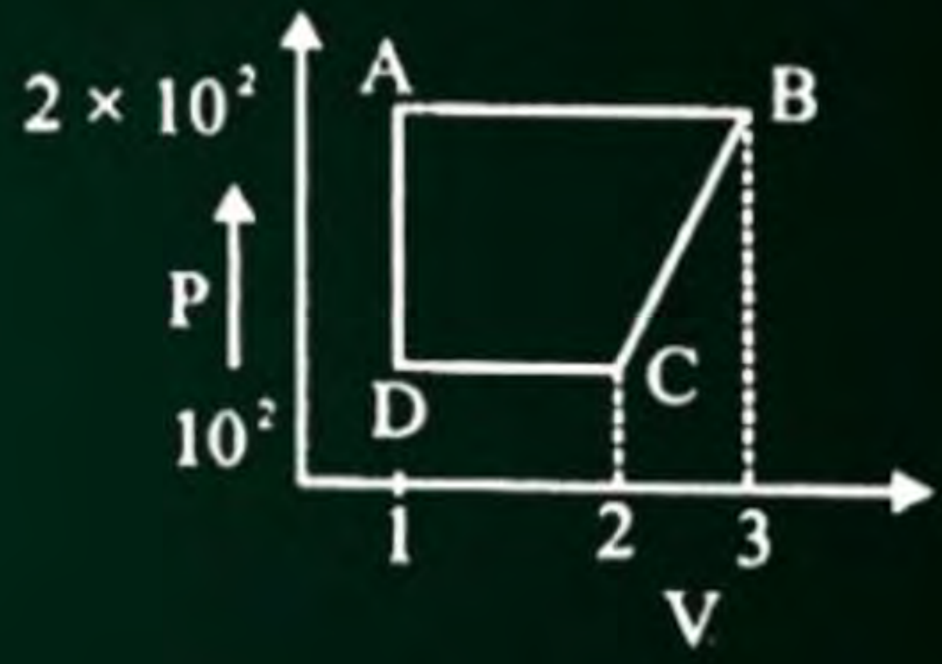
(3) PV

(4) PV/3



QUESTION

A cyclic process is shown in the figure. Work done during the cyclic process ABCDA



(1) 150 J

(2) 163 J

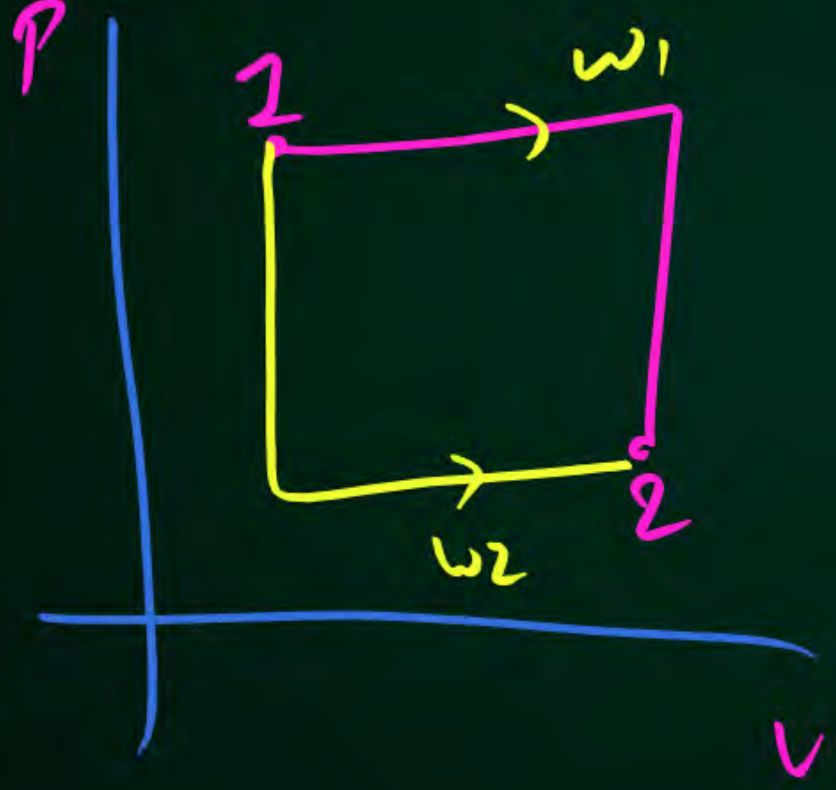
(3) 145 J

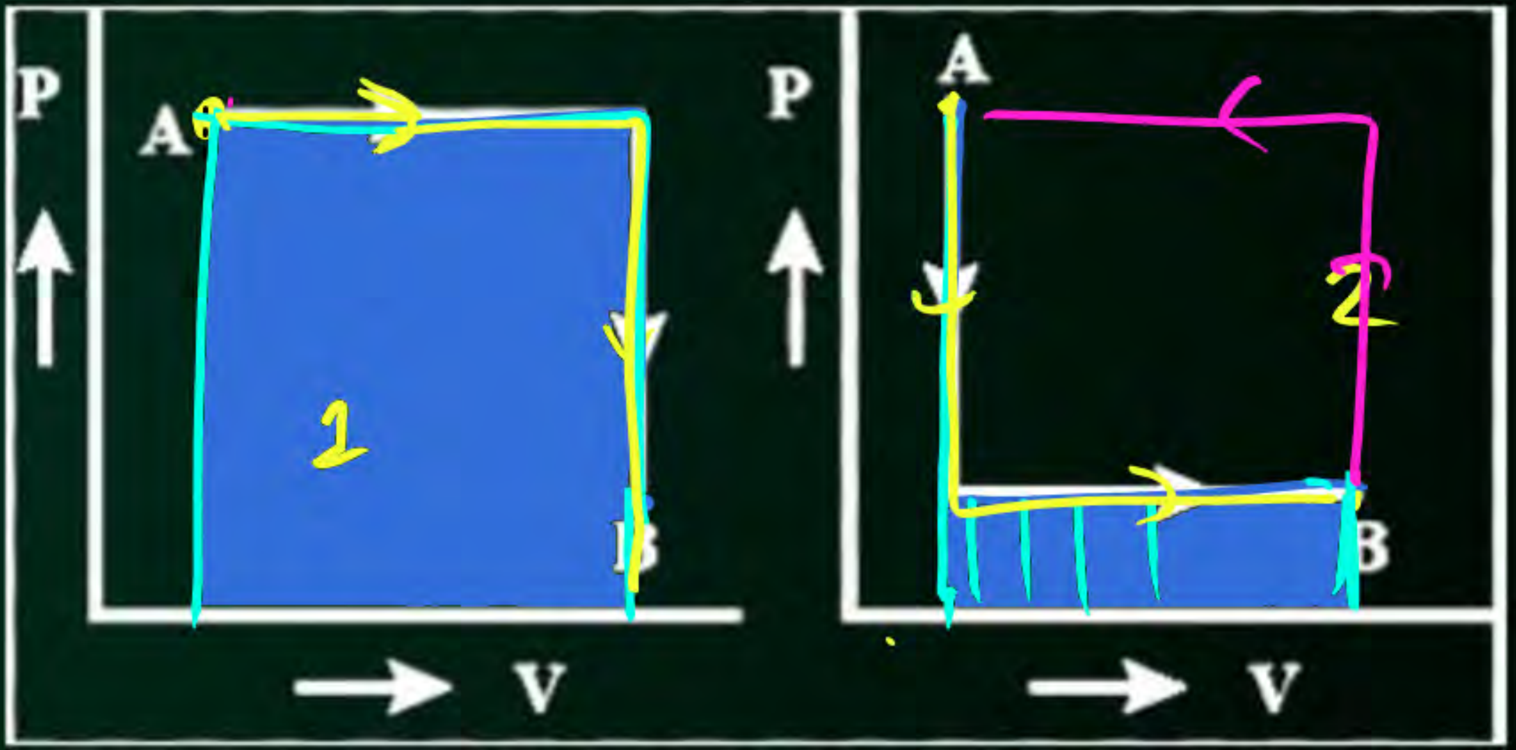
(4) 166 J

QUESTION

In the following figure two indicator diagrams are shown. If the amounts of work done in them are W_1 and W_2 respectively, then -

1. $W_1 > W_2$
2. $W_1 < W_2$
3. $W_1 = W_2$
4. $W_1 = W_2/4$





H/W

emisivity → $e = \frac{\text{emissive Power of Body}}{\text{emission Power of Black body}}$

Stefens law for Black body

Total energy/heat readiation from Surface Area A in time t (E)

[Total Energy radiated Per unit Area Per sec is directly Propotional to tempr ka Power Four]

for Black body $(e = 1)$

$$\frac{E}{At} \propto T^4$$

$$\frac{E}{t} = \sigma A T^4$$

$\frac{E}{t}$ → emissive Power.

for a body

$$\left(\frac{E}{t}\right) = \sigma A T^4 e$$

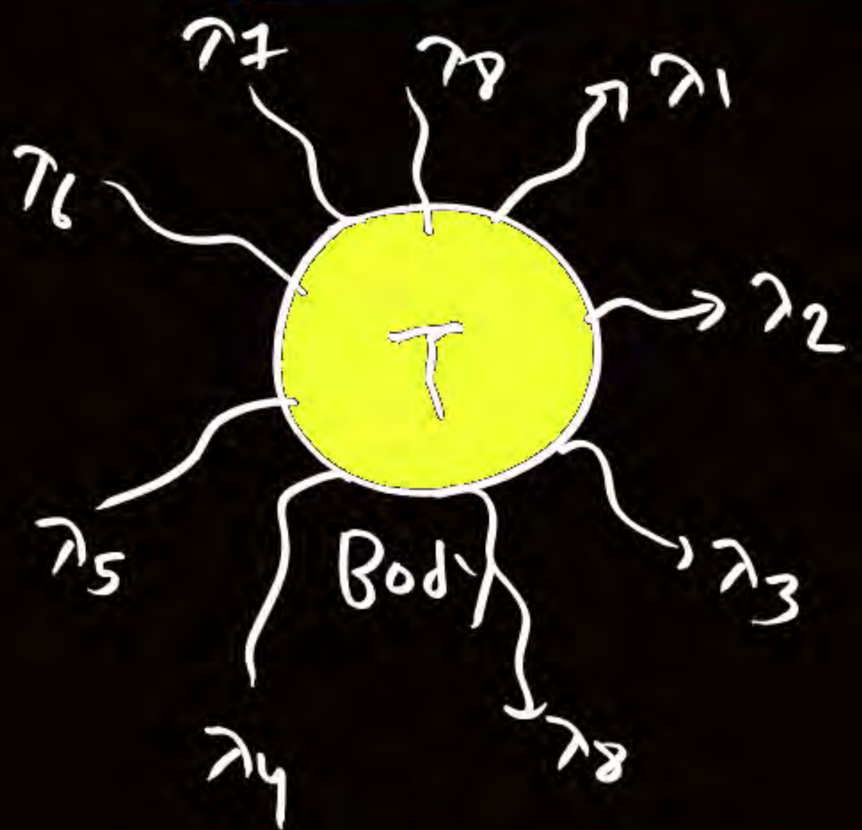
e ← emissivity

$\frac{E}{t}$ → emissiv Power.

Stefens - Boltzman

$E_{net\ radiation}$ per sec per unit Area for a body $= \sigma e \left[T_{Body}^4 - T_0^4\right]$

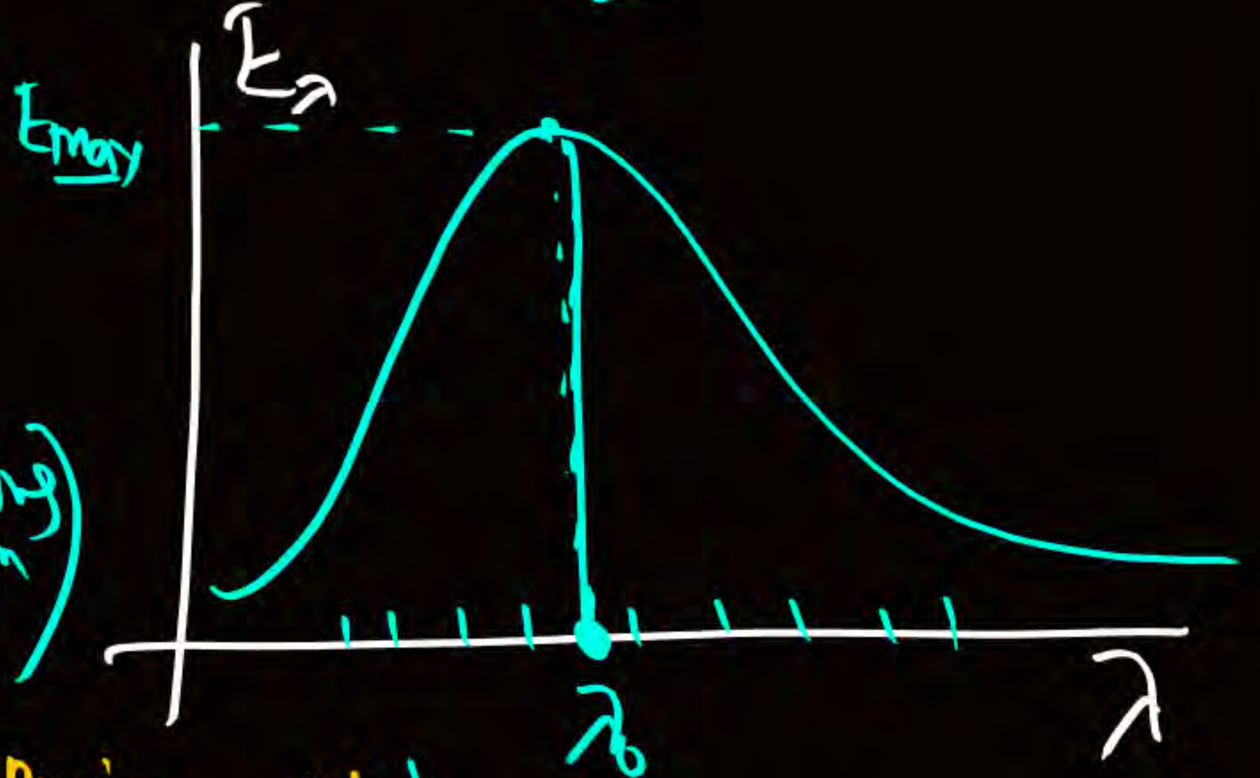
Wins dispm Law



Spectral emissive Power → Heat radiation per sec from per-unit Area per unit wavelength

$$\frac{E_\lambda}{A t d\lambda} \propto T^4$$

$$E_\lambda = \sigma T^4 A t d\lambda$$



Area under curve

$$\int E_\lambda d\lambda = \text{Area.}$$

$\sigma T^4 A t d\lambda$ = Area

Area $\propto T^4$

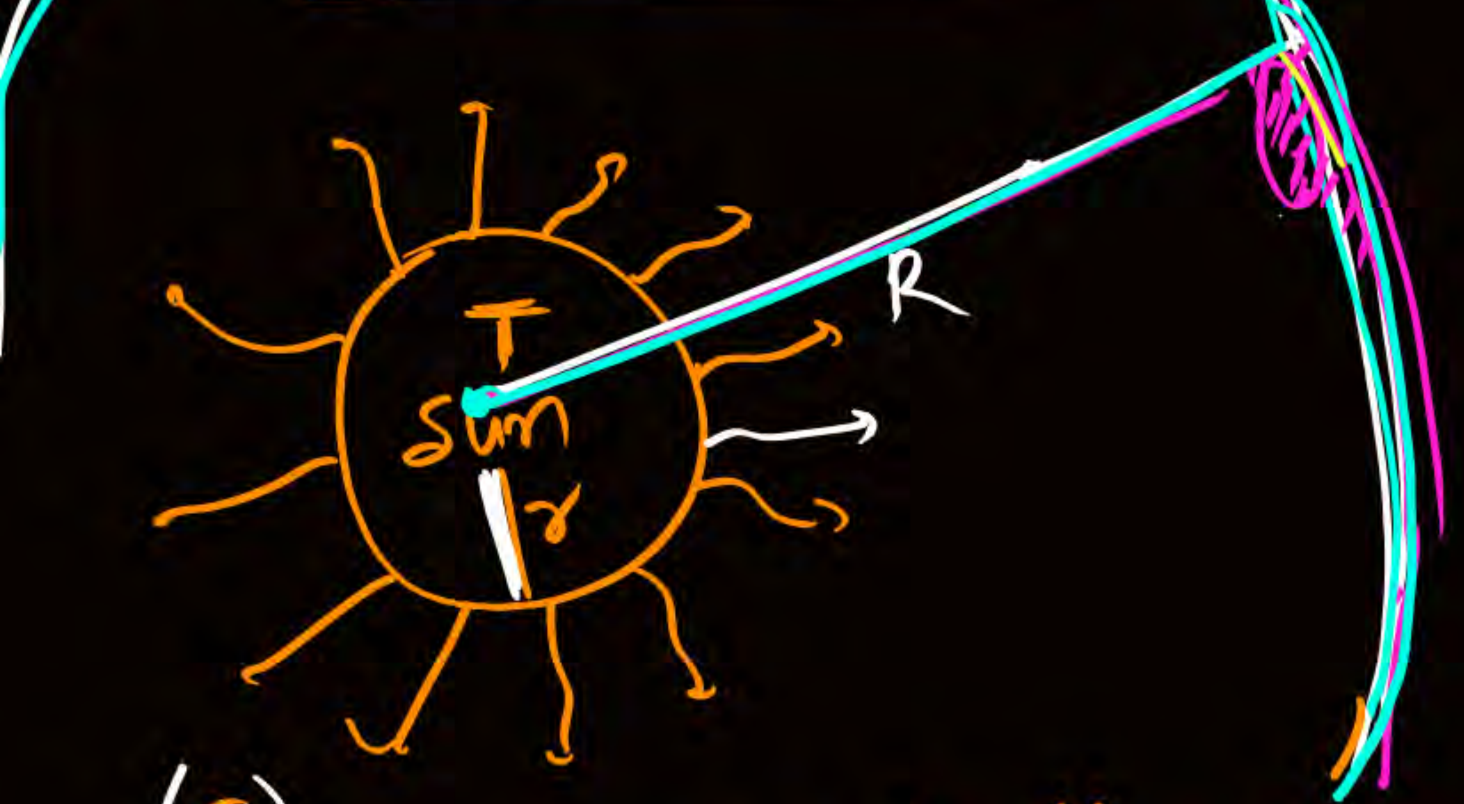
↑ Temp

$$\lambda_0 \propto \frac{1}{\text{Tempr}}$$

$\lambda_0 = \frac{b}{\text{Temp}}$ (b = Wins constn)

→ λ_0 (wavelength corresponding to which Maxm energy emitted)

Solar Constant



$$\left(\frac{E}{t}\right) = e\sigma 4\pi r^2 T^4 \quad -(1)$$

↳ Total Power (energy per sec radiated by sun,)

If I consider a sphere of Radius R concentric to Sun

Solar Constⁿ → energy falling per unit Area per-sec at distⁿ R from the centre of sun.

total energy per-sec falling on sphere of Radius R $= \frac{E}{t} = e\sigma 4\pi r^2 T^4$

Energy falling per sec - on per unit Area $= \frac{e\sigma \cancel{4\pi} r^2 T^4}{\cancel{4\pi} R^2}$

(Solar constⁿ.) $S = \sigma e T^4 \left(\frac{r}{R}\right)^2$

Tempr of sun using solar const"

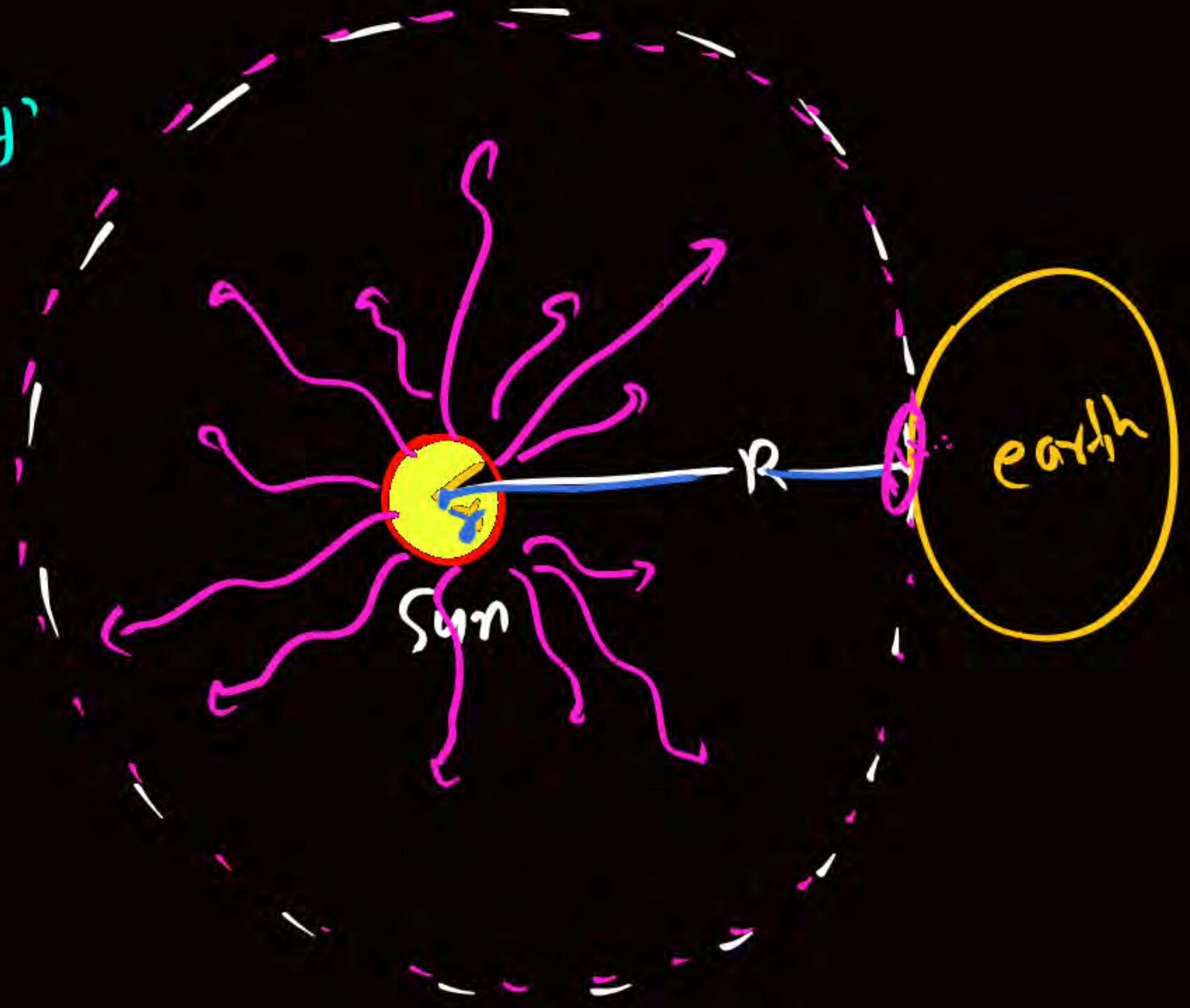
$$S = \sigma e T^4 \left(\frac{r}{R}\right)^2$$

$$T^4 = \frac{S}{\sigma e}\left(\frac{R}{r}\right)^2$$

$$\text{Temp}^r = \left(\frac{S}{\sigma e}\right)^{1/4}\left(\frac{R}{r}\right)^{\cancel{2/4}\,2}$$

r = Radius of sun

R = distn b/w sun & earth



QUESTION

Two black metallic spheres of radius 4m, at 2000 K and 1m at 4000 K will have ratio of energy radiation as

1. 1 : 1
2. 4 : 1
3. 1 : 4
4. 2 : 1

QUESTION

The wavelength of maximum energy released during an atomic explosion was 2.93×10^{-10} m. Given that Wien's constant is 2.93×10^{-3} m-K. The maximum temperature attained must be of the order of

1. 10^{-7} K
2. 10^{7} K
3. 10^{-13} K
4. 5.86×10^{7} K

$$\lambda = 2.93 \times 10^{-10} \text{m}$$

$$b = 2.93 \times 10^{-3}$$

$$\lambda = \frac{b}{T}$$

$$\text{temp}^r = \frac{b}{\lambda} = \frac{2.93 \times 10^{-3}}{2.93 \times 10^{-10}} = 10^{7} \text{ K}$$

QUESTION

A black body is at a temperature of 5760 K. The energy of radiation emitted by the body at wavelength 250 nm is U_1, at wavelength 500 nm is U_2 and that at 1000 nm is U_3. Wien's constant, $b = 2.88 \times 10^6$ nmK. Which of the following is correct ?

[NEET-2016]

1. $U_1 = 0$
2. $U_3 = 0$
3. $U_1 > U_2$
4. $U_2 > U_1$

QUESTION

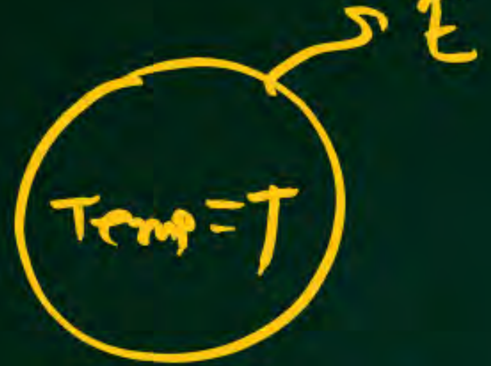
If transmission power of a surface is 1/6 and reflective power is 1/3, then its absorptive power will be-

1. 1/3
2. 1/2
3. 1/6
4. 1/12

QUESTION

If the temperature of a black body is increased by 50% then the amount of radiation emitted by it will-

1. Increase by 400%
2. Decrease by 400%
3. Decrease by 50%
4. Increase by 50%



$E \propto T^4$

$T' = 150\% \, T = \frac{150}{100} T = \frac{3T}{2}$

$E' \propto T'^4 = \left(\frac{3T}{2}\right)^4 = \left(\frac{3}{2}\right)^4 T^4$

$E' = \frac{3\times3\times3\times3}{4\times4} E$

$E' = \frac{81}{16} E \approx 5E$

$= 500\% \, E$

QUESTION

A copper ball 2 cm in radius is heated in a furnace to 327°C. If its emissivity is 0.3, at what rate does it radiate energy? [AIIMS-2015]

273

1. 1.72 W
2. 2..73 W
3. 11.0 W
4. 2.15 W

$$\left[\frac{E}{t}\right] = e\sigma T^4 \text{ Area}$$

$$\frac{E}{t} = \frac{3}{10} \times 5.67\times10^{-8} \times (600)^4 \times 4\pi(2\times10^{-2})^2$$

QUESTION

emissive Powe = $\left\{\frac{E}{t}\right\}$

e = emisivity = $\frac{\text{emisive Powe of Body}}{\text{emisiv Powe of ideal body}}$

The temperature of a body is increased from -70°C to 327°C. Then the ratio of emissive power is

1. 1/9
2. 1/27
3. 27
4. 81

$T_1 = 273 - 70°$

$T_1 = 203$

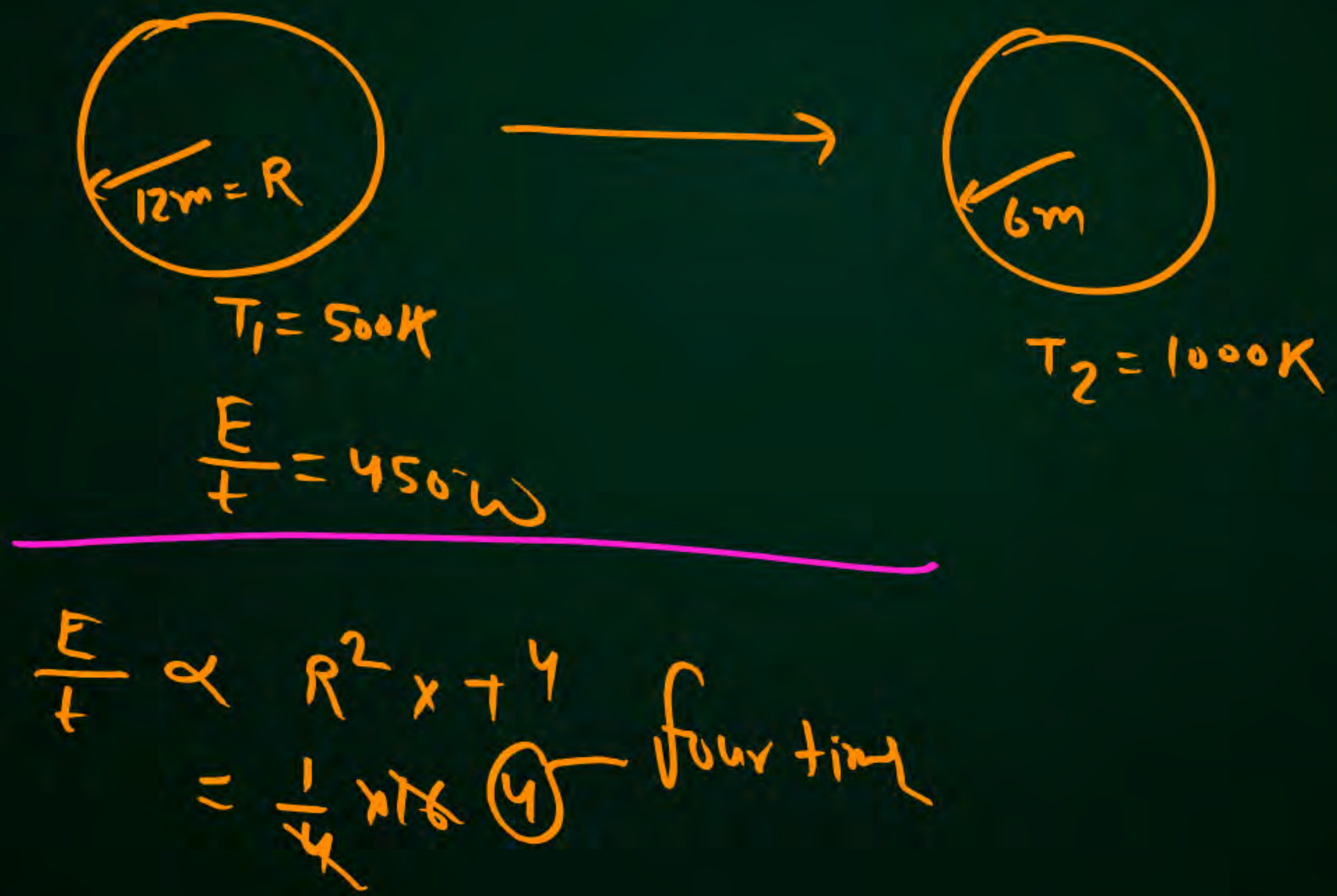
$T_2 = 600K$

$\frac{\varepsilon_1}{\varepsilon_2} \propto \left(\frac{T_1}{T_2}\right)^4$

QUESTION

A spherical black body with a radius of 12 cm radiates 450 watt power at 500 K. If the radius were halved and the temperature doubled the power radiated in watt would be: [NEET-2017]

1. 125
2. 450
3. 1000
4. 1800

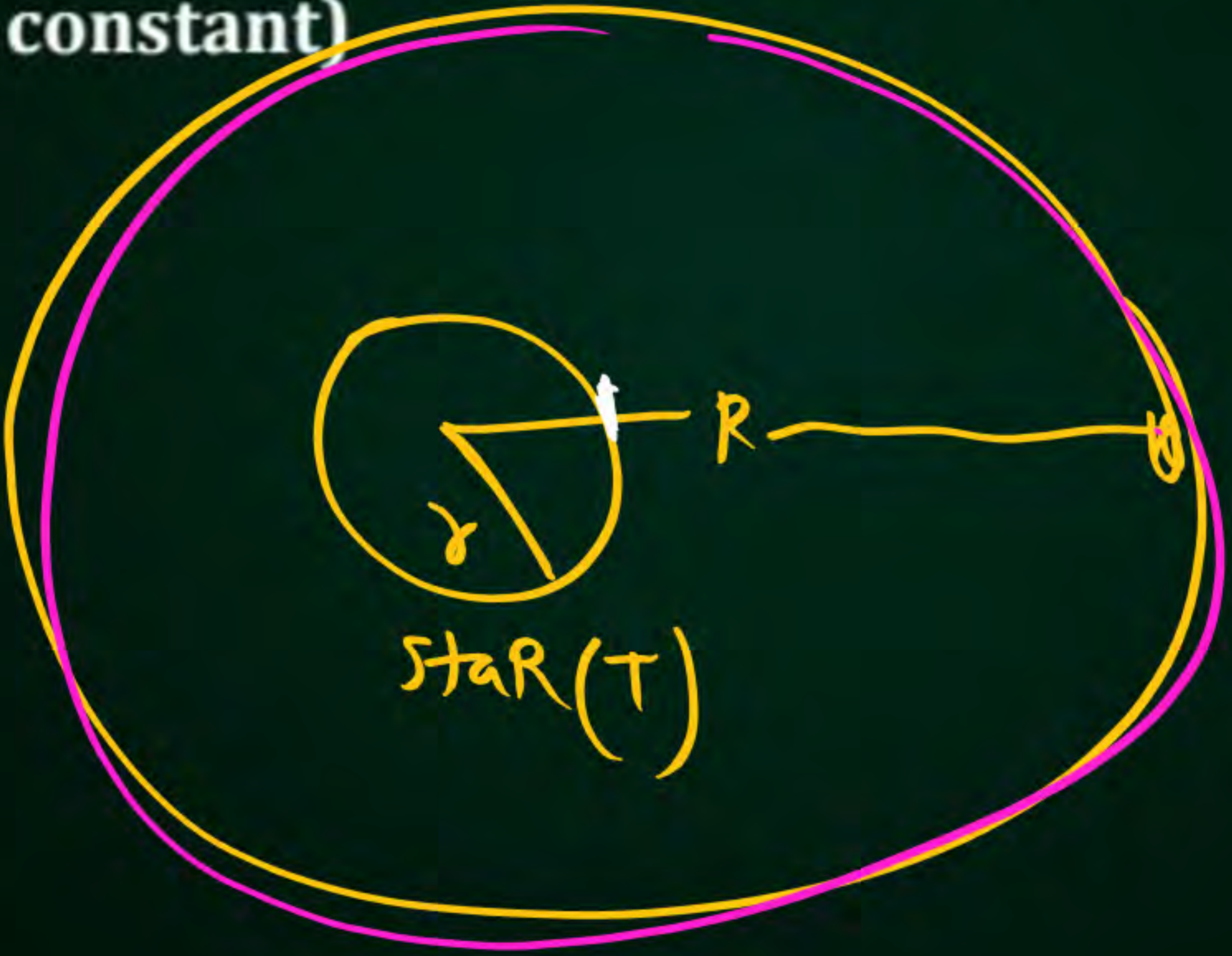


QUESTION

The total radiant energy per unit area, normal to the direction of incidence, received at a distance R from the centre of a star of radius r, whose outer surface radiates as a black body at a temperature TK is given by-

(where σ is Stefan's constant)

[AIPMT (Pre)-2010]



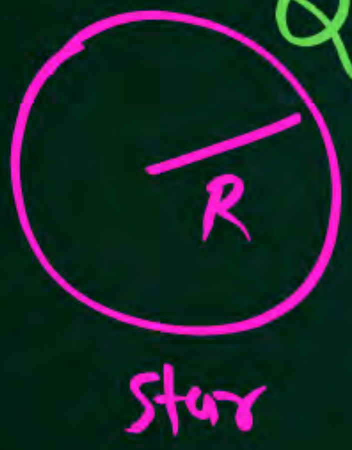
1. $\sigma r^2 T^4/R^2$
2. $\sigma r^2 T^4/4\pi r^2$
3. $\sigma r^4 T^4/r^4$
4. $4\pi r^2 T^4/R^2$

QUESTION

If the radius of a star is R and it acts as a black body, what would be the temperature of the star, in which the rate of energy production is Q?

(σ stands for Stefan's constant) **[AIPMT (Pre)-2012]**

1. $(4\pi R^2 Q/\sigma)^{1/4}$
2. $(Q/4\pi R^2 \sigma)^{1/4}$ ✓
3. $Q/4\pi R^2 \sigma$
4. $(Q/4\pi R^2 \sigma)^{-1/2}$



$$Q = \frac{E}{t} = \sigma \pi 4 R^2 T^4$$

$$Q = \sigma \pi 4 R^2 T^4$$

$$T^4 = \frac{Q}{\sigma 4 \pi R^2}$$

$$T = \left(\frac{Q}{\sigma 4 \pi R^2}\right)^{1/4}$$

QUESTION

The power radiated by a block body is P and it radiates maximum energy at wavelength λ_0. If the temperature of the black body is now changed so that it radiates maximum energy at wavelength $3\lambda_0/4$, the power radiated by it becomes nP. The value of n is [NEET-2018]

1. 3/4
2. 4/3
3. 256/81
4. 81/256

Power = P (T_1)

λ_0 → E_{max} ⟶ $\frac{3\lambda_0}{4}$ → E_{max} (T_2)

$P_2 = nP$

Wins dispn Law

$\frac{\lambda_0}{\frac{3\lambda_0}{4}} \propto \frac{T_2}{T_1}$

$\frac{4T_1}{3} = T_2$

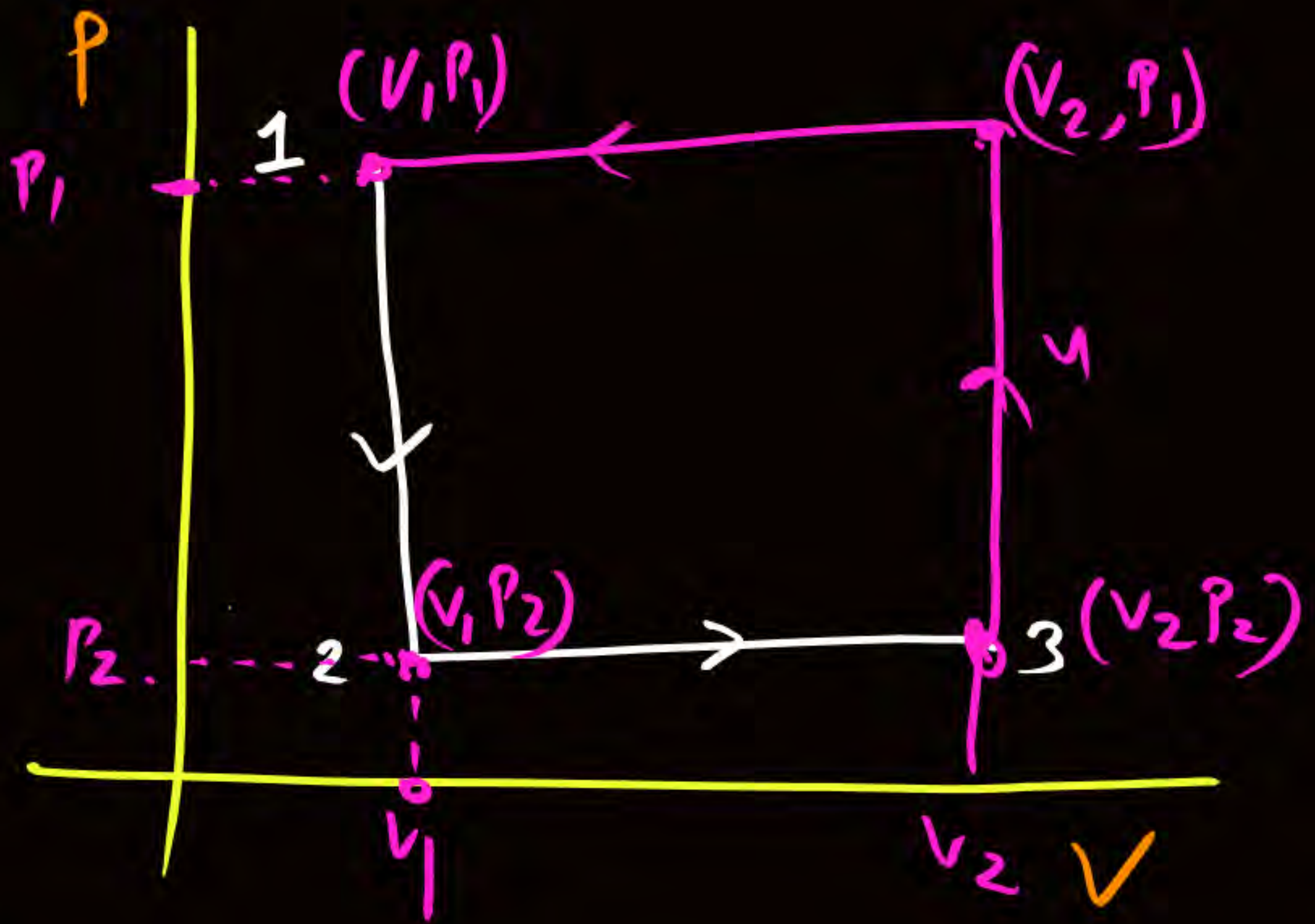
Stefan law

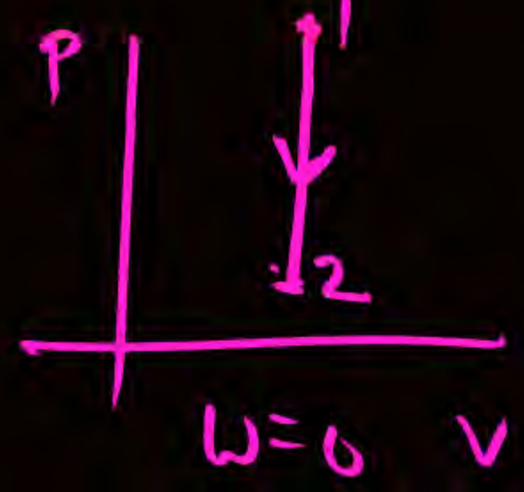
$P_1 \propto T_1^4$

$P_2 = \left(\frac{4T_1}{3}\right)^4 = \frac{256}{81} T_1^4 = \frac{256}{81} P_1$

$1 \to 2 \to 3 \to 4 \to 1$

~~$W = 0$~~





Work = Area of loop

$W_{12} = 0$

$W_{23} =$

$W_{34} = 0$

$341 =$

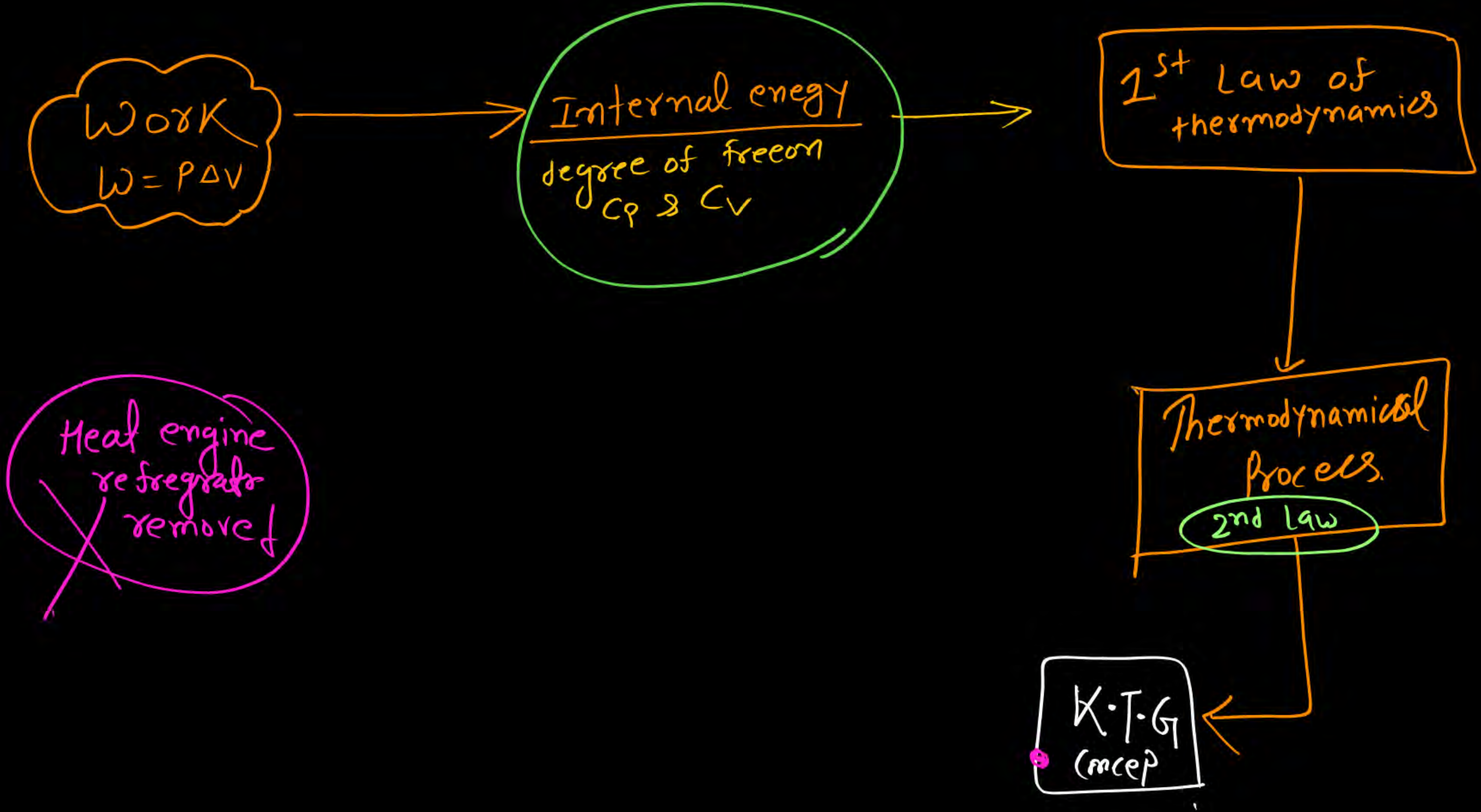

THANK YOU


YAKEEN 2.0
FOR NEET 2025
Lecture- 02
Physics
Kinetic Theory of Gases and Thermodynamics
By- Dr. Manish Raj (MR SIR)

Topics to be covered

1. # d.o.f
   Internal enegy
2. #
3. #




Work
W = PΔV
Internal enegy
degree of freeon
Cp & Cv
1st Law of thermodynamics
Thermodynamical Process
2nd law
K.T.G
(mcep)
Heat engine
refregrafo
removed

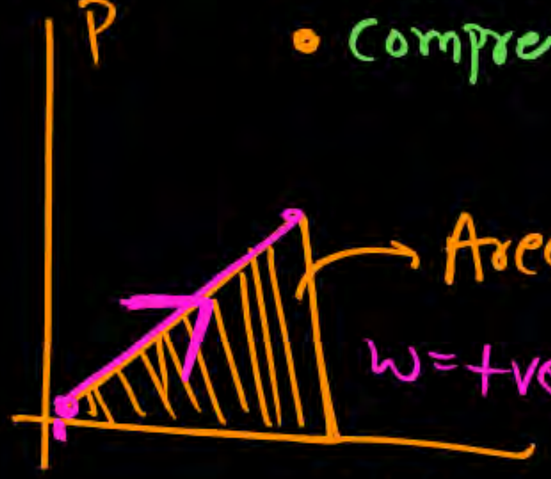
Work = $P\Delta V$ {P = const^n}

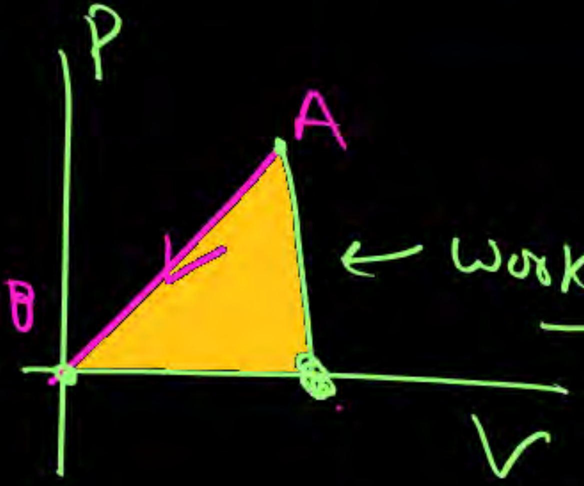
= $P(V_f - V_i)$

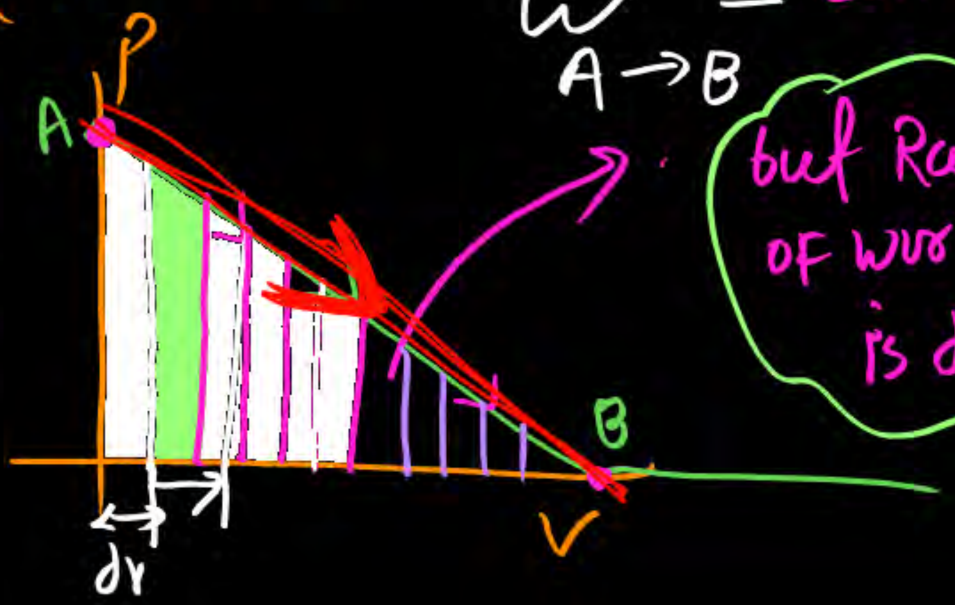
(#) Work = $\int P\,dV$ (P = variable)

= Area of P-V graph under volume-axis

- expansion (volume incre) → Work done by gas +ve, work done by gas
- compression (volume decr) → work done by gas is -ve
  → work done on gas



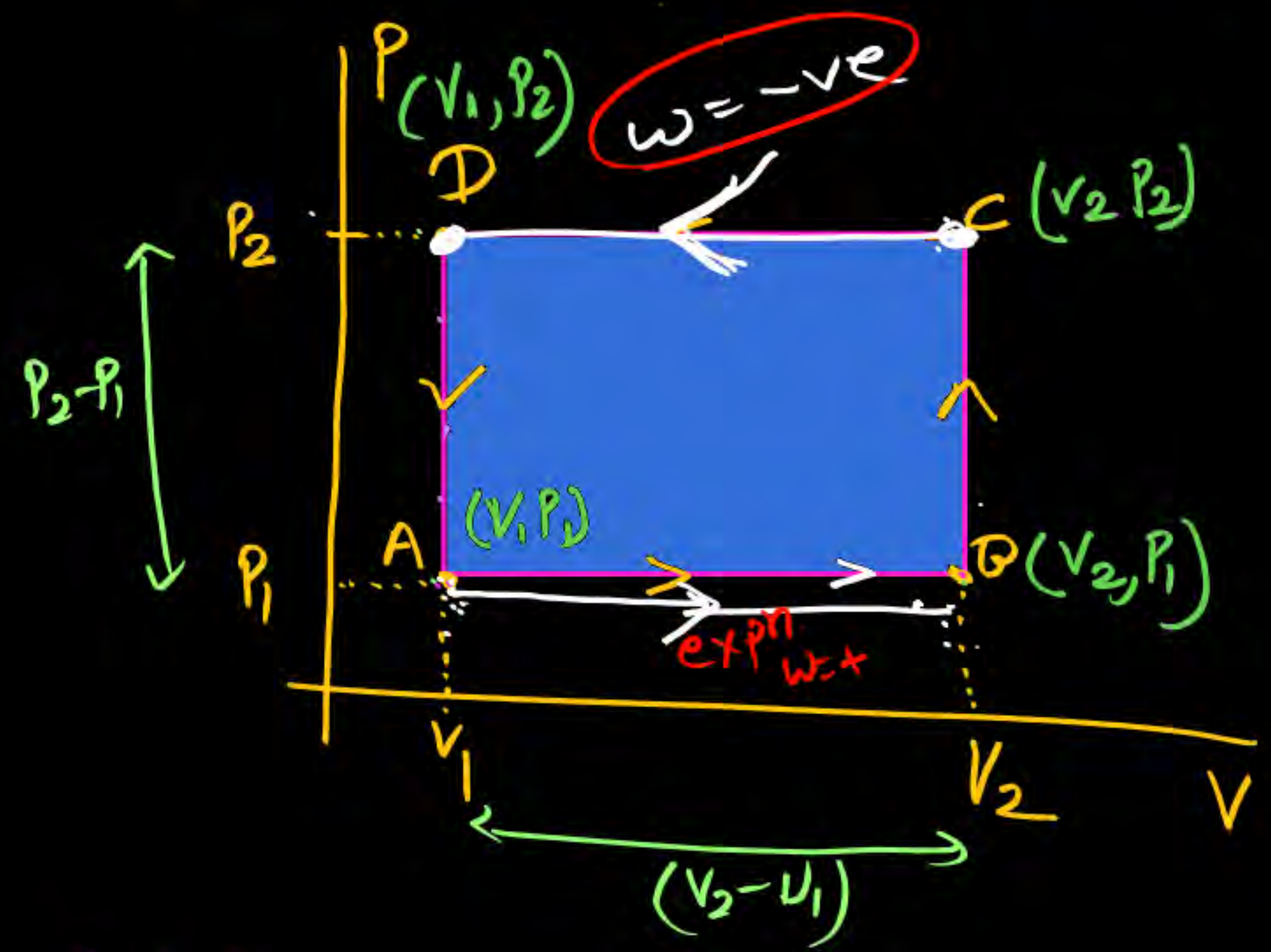




$W_{A\to B}$ = Continuously Incresing

but Rate of work done is decrse

Work in Path $A \to B \to C \to D \to A$ (cyclic Process)



$$[\text{Work}]_{A \to B} = P_1 (V_2 - V_1) = +ve$$

$P = \text{cost}^n$

$$[\text{Work}]_{B \to C} = 0 \qquad [\text{Work}]_{DA} = 0$$

Volume = cost^n.

$$[\text{Work}]_{C \to D} = P_2 (V_1 - V_2) = -P_2 (V_2 - V_1)$$

$$W_{total} = P_1 (V_2 - V_1) - P_2 (V_2 - V_1)$$

$$W_{Total} = (V_2 - V_1)(P_1 - P_2) = -ve \text{ (for Anti-clock loop)}$$

= Area of loop

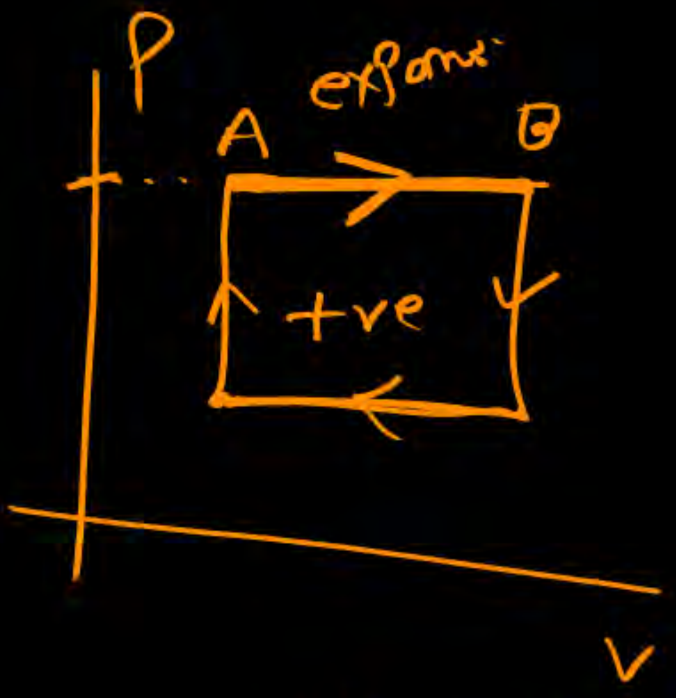
$\Rightarrow +ve \to$ for clockwise loop.

MR* feel

Low press. $A \to B \to$ expansion (w +ve)

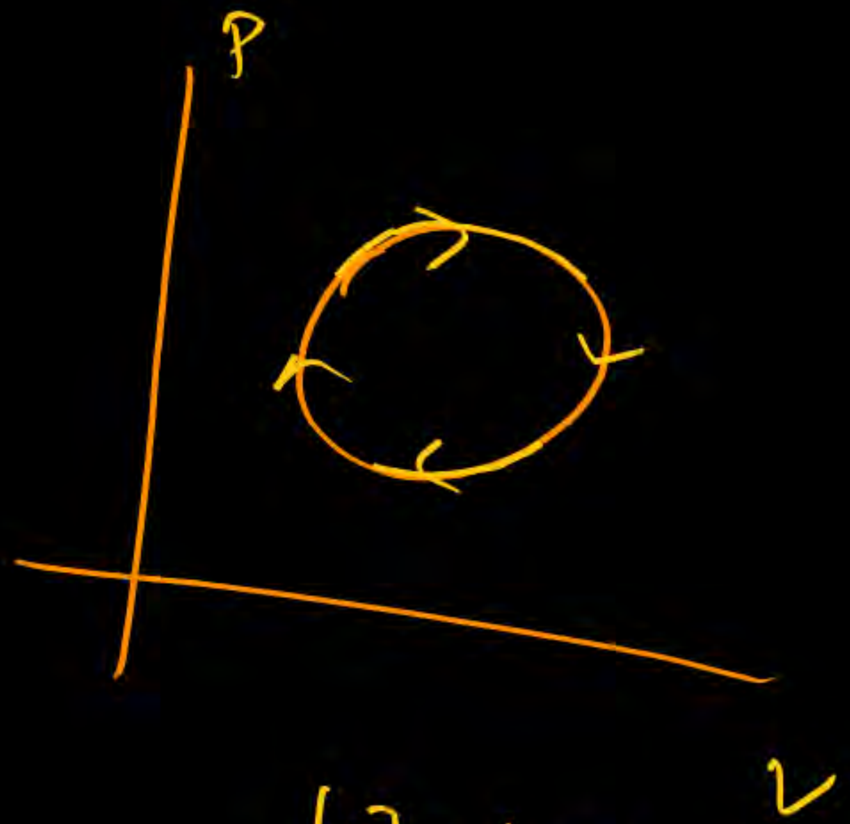
High press. $C - D \to$ compress (w -ve)

$W = -ve$

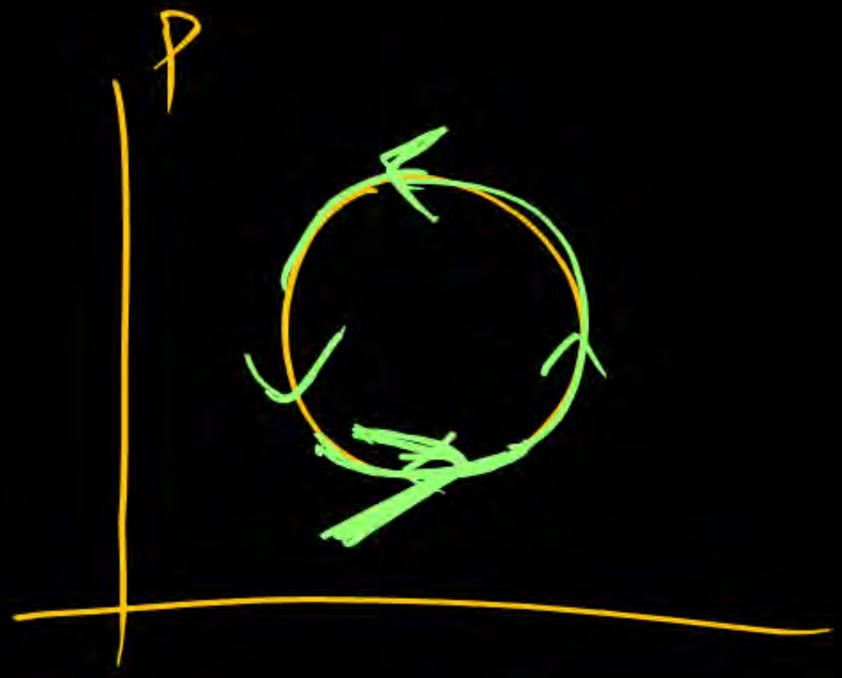


W = +ve

Clock wise

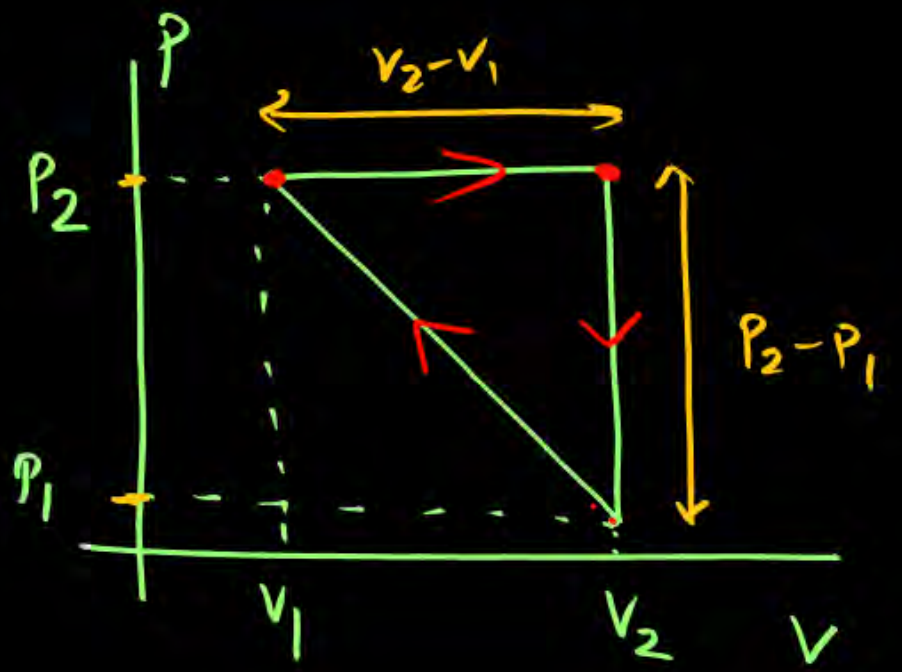


W = +ve



W = -ve ✓

Anti clock loop ✓



$$\text{Area} = \frac{1}{2} \times B \times H = \text{Work}$$

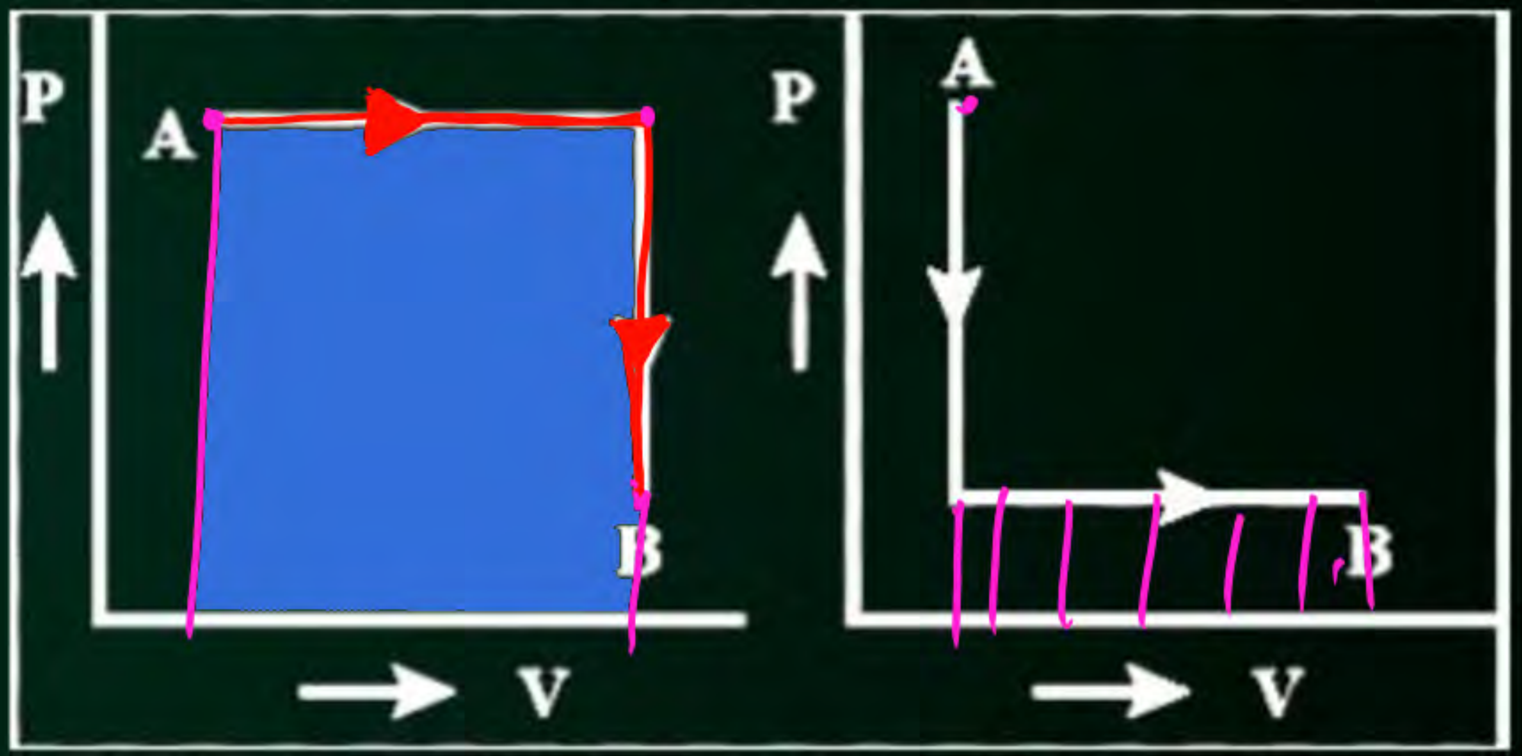
$$W = \left\{ \frac{1}{2} (V_2 - V_1) \times (P_2 - P_1) \right\} +ve$$

Clockwise

QUESTION

In the following figure two indicator diagrams are shown. If the amounts of work done in them are W_1 and W_2 respectively, then -

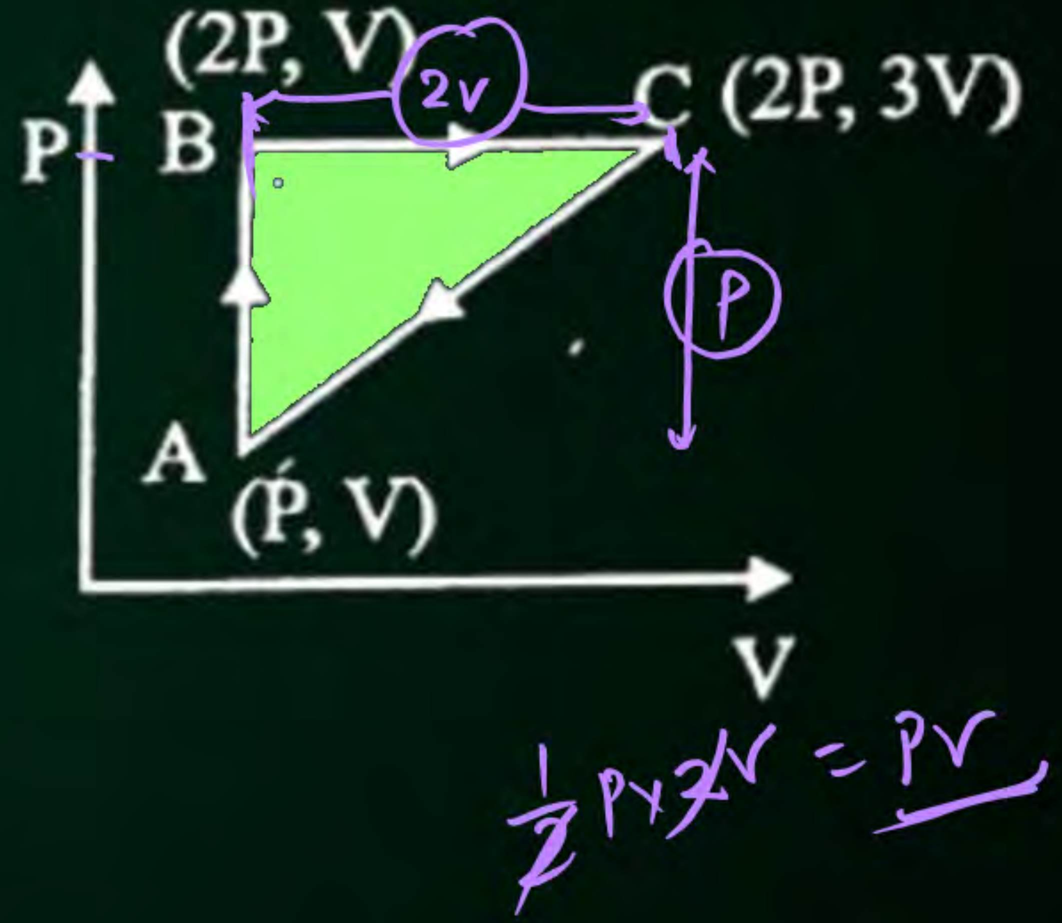
1. $W_1 > W_2$
2. $W_1 < W_2$
3. $W_1 = W_2$
4. $W_1 = W_2/4$



QUESTION

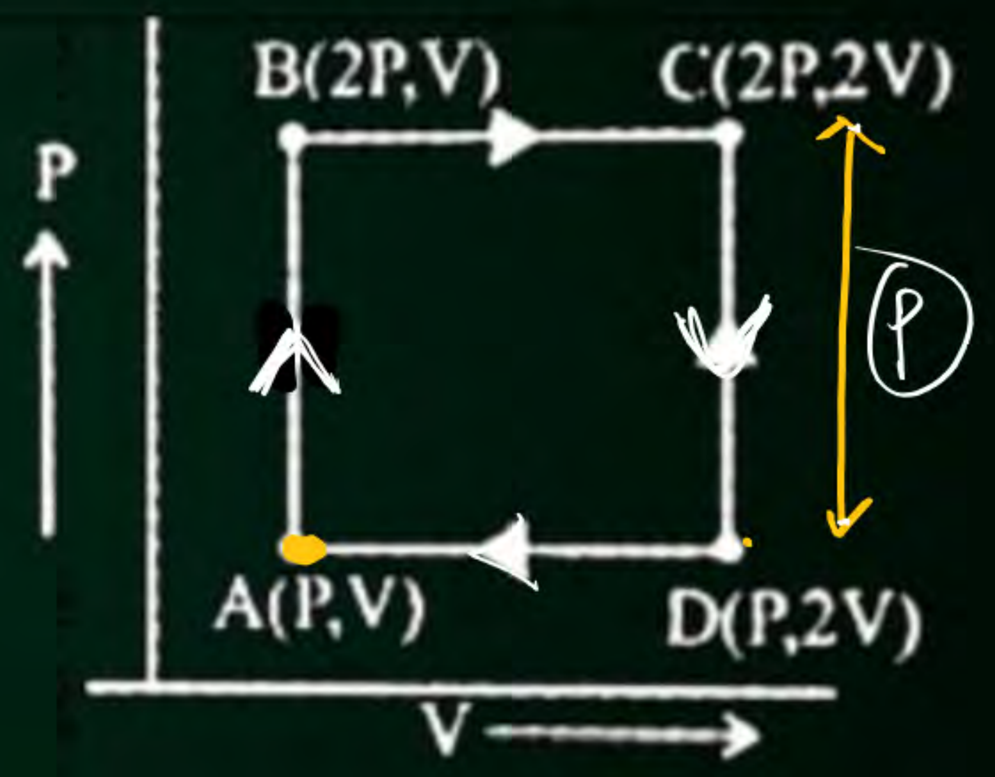
An ideal gas is taken through a cycle ABCA as shown in the P - V diagram. The work done during the cycle is:

1. 2 PV
2. 3 PV
3. PV ✓
4. PV/3



QUESTION

An ideal gas undergoes a thermodynamic process ABCDA as shown in the diagram. Total work done during the cycle ABCDA is



1. 4 PV
2. Zero
3. PV
4. 0.5 PV

QUESTION

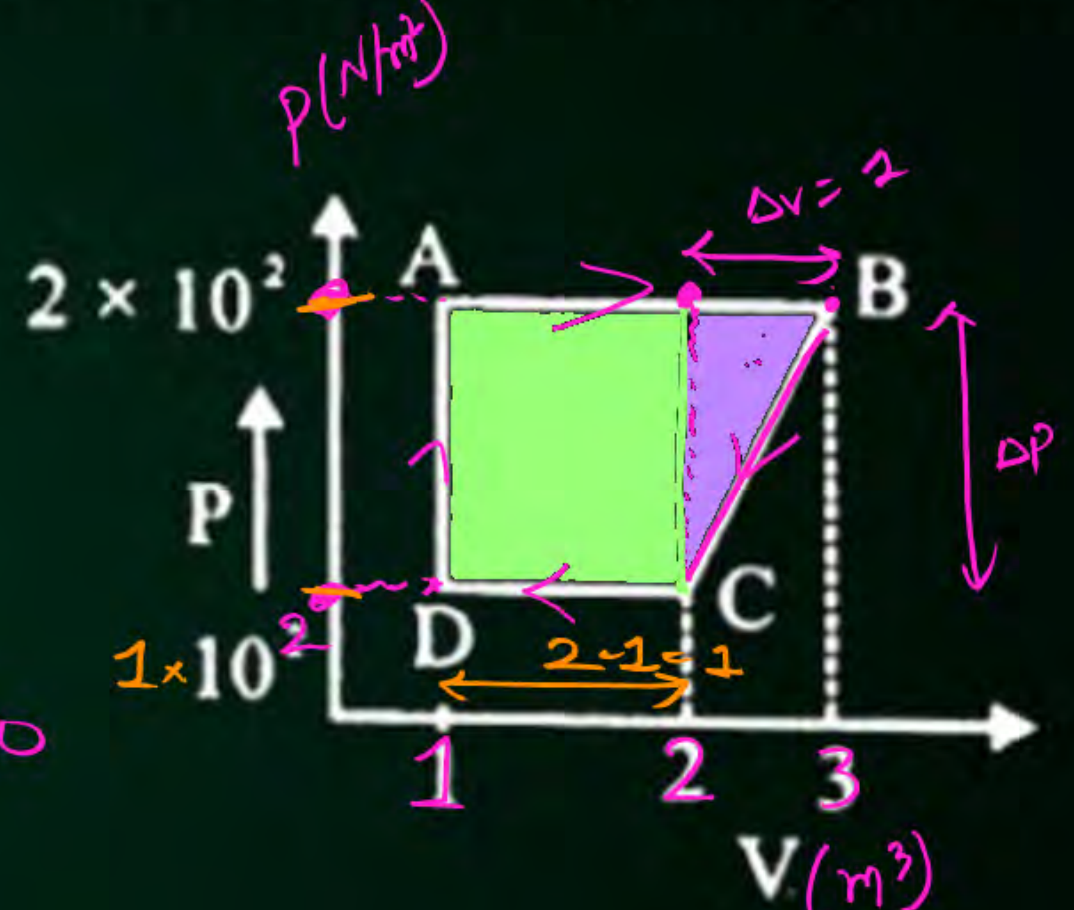
A cyclic process is shown in the figure. Work done during the cyclic process ABCDA

(1) 150 J

(2) 163 J

(3) 145 J

(4) 166 J



$\text{Area} = A_1 + A_2$

$= (2-1) \times (2\times10^2 - 10^2) + 50$

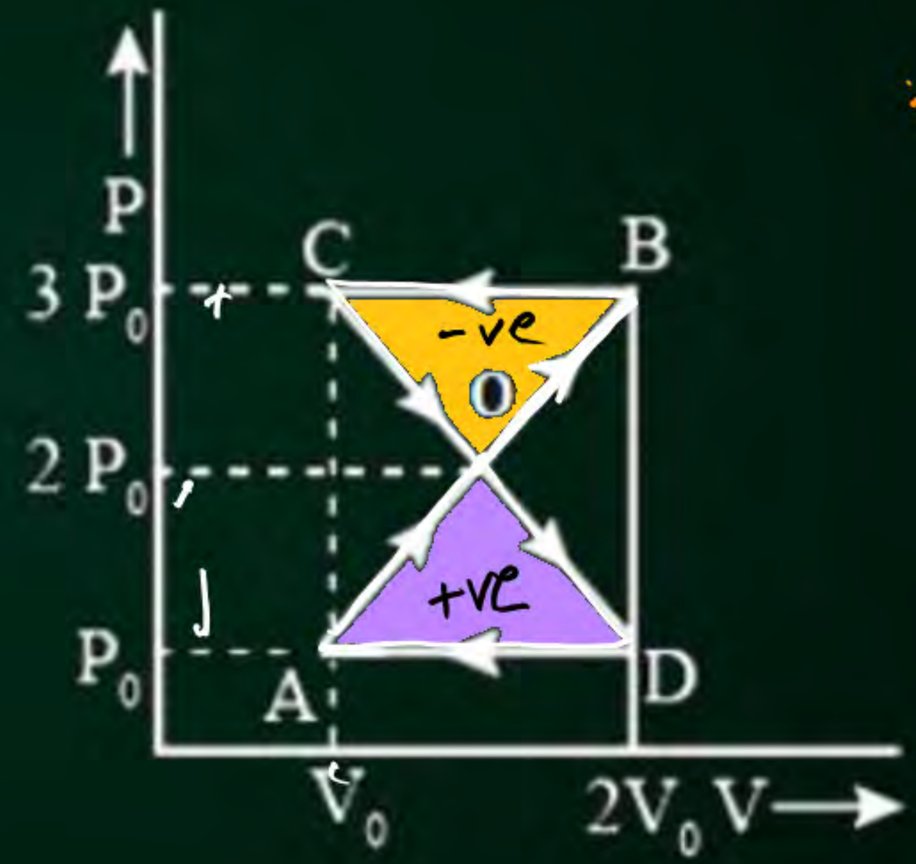
$= 1 \times 10^2 (1) + 50$

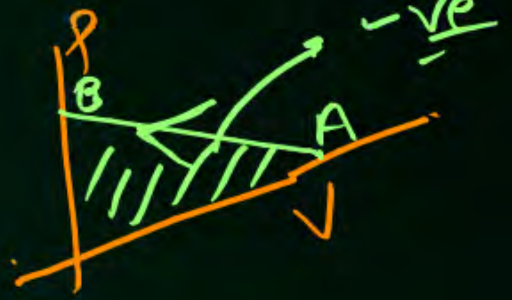
$= 100 + 50$

QUESTION

A thermodynamics system undergoes cyclic process ABCDA as shown in fig. The work done by the system in the cycle is -

1. P_0V_0
2. $2P_0V_0$
3. $P_0V_0/2$
4. Zero





THERMODYNAMIC



System : → container

- Open → energy & mass can exchange
- Closed → energy can exchange but mass can not.
- Isolated → energy & mass both can't exchange.

container

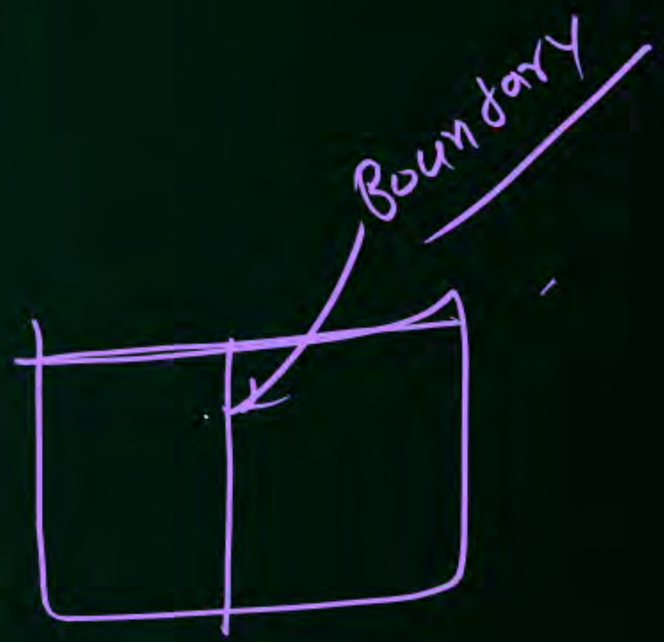
Types :

Through a Boundary mass can't be interaction of :

Boundaries

- Adiabatic ⟹ energy (Heat) can't exchange
- Diathermal ⟶ Heat (energy) can Exchange

Wall (Boundary)

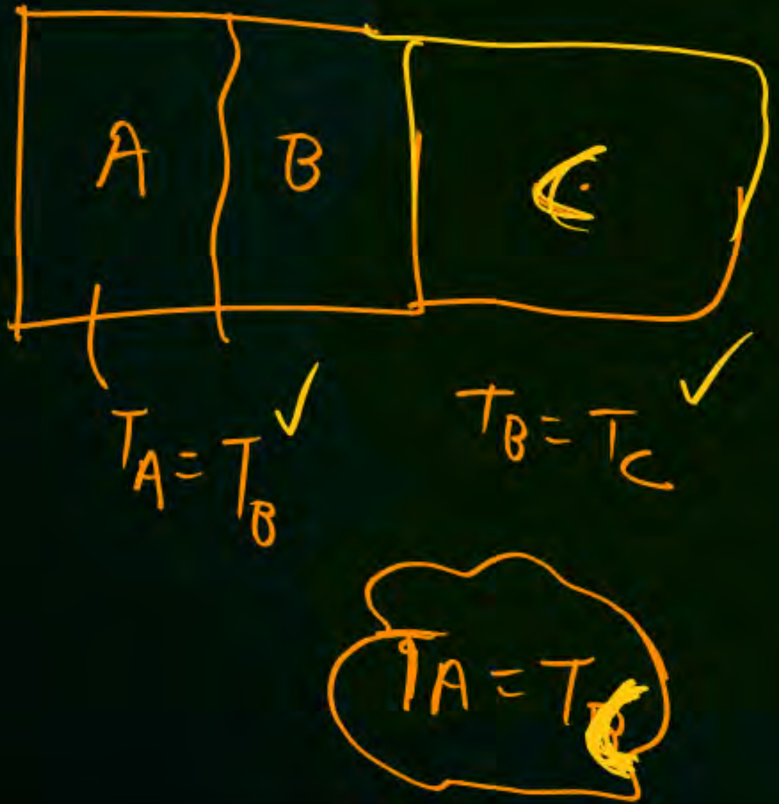


Thermal Equilibrium :-

⇒ If Heat transfer between 2 system is not in process *i.e.* their temperature is same then the 2-system are said to be in thermal equilibrium (तापीय साम्यअवस्था)

Zeroth law of Thermodynamics (ZLOTh) :-

According to ZLOTh if A and B are in thermal equation B & C are in thermal equilibrium then A and C will also be in thermal equilibrium

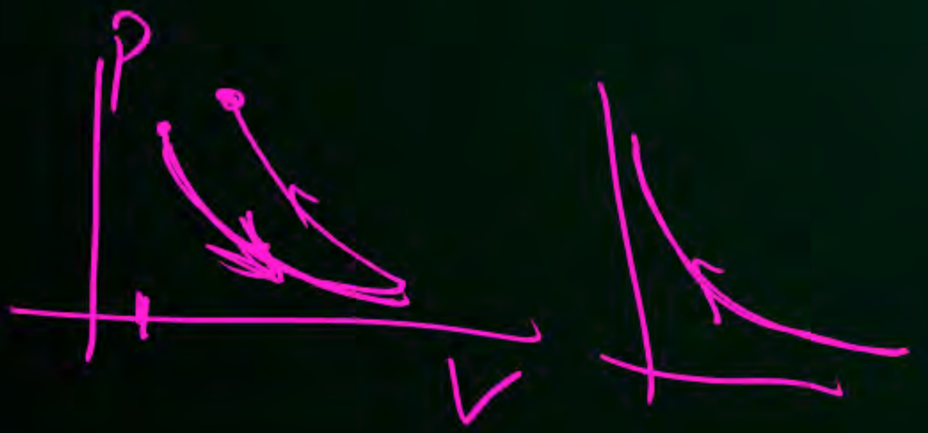


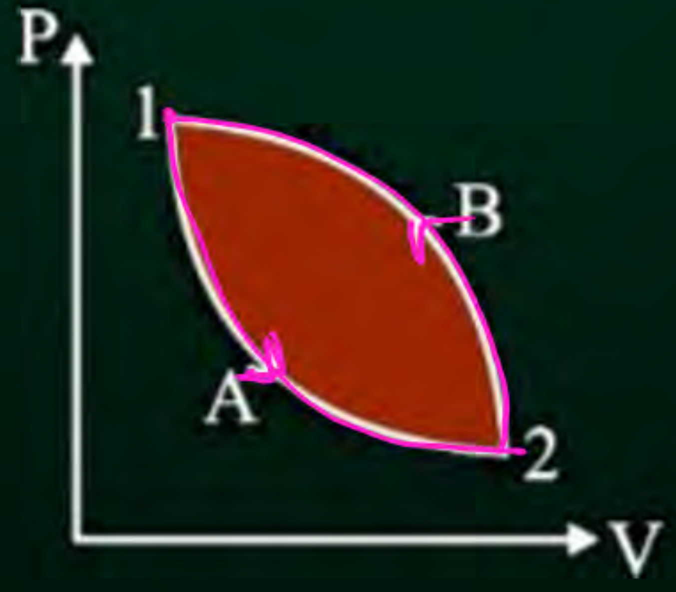
Reversible and Irreversible Process :-

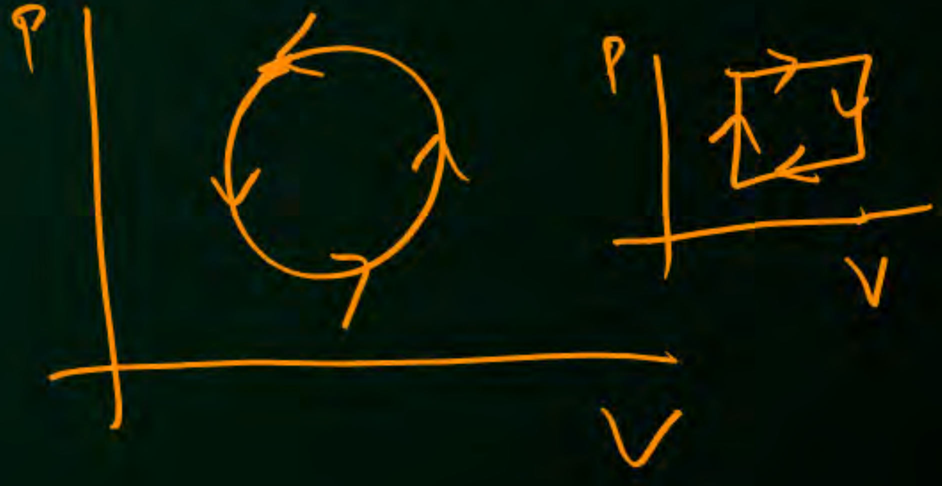
- If a process changes the states of the system, and if the path followed by the process can be release back then the process is said to be riverside.
- If the path followed can't be retrace back then the process is said to be irreversible.

Cyclic Process :-

- If the initial and find state of the system is some then the process is said to be cyclic.



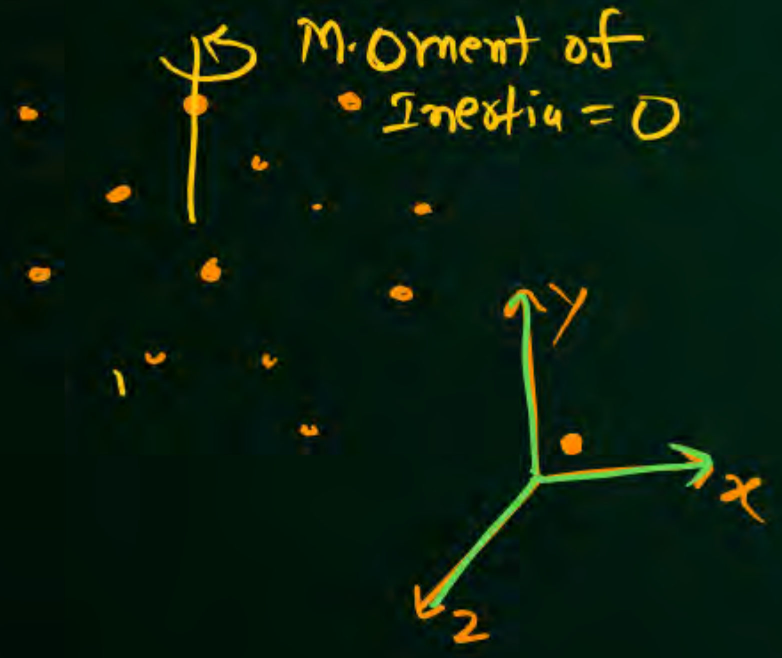




DEGREE OF FREEDOM

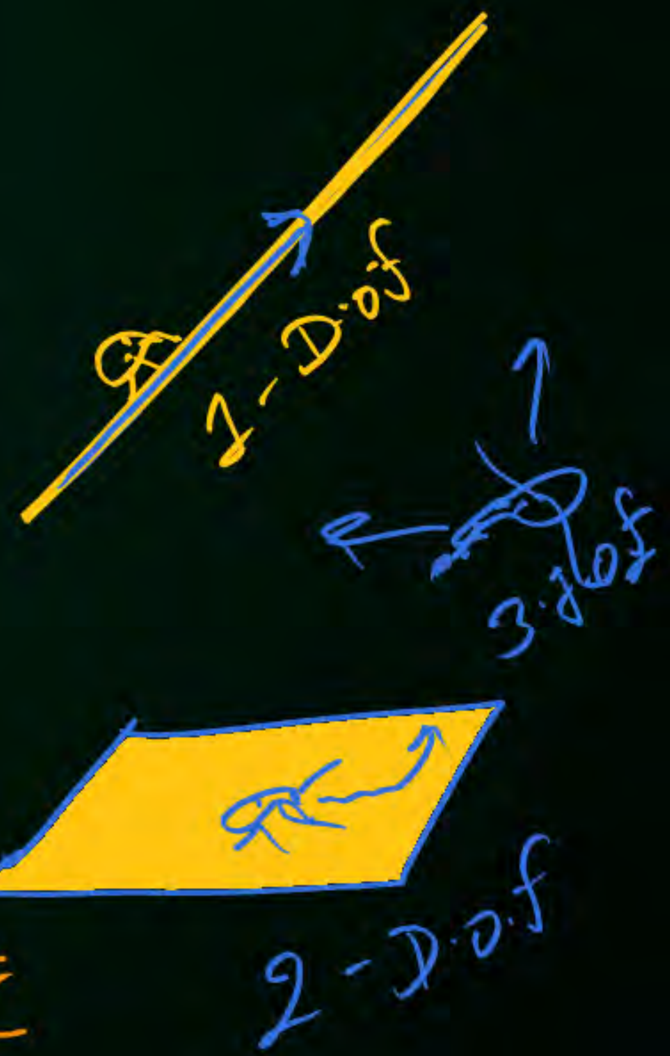
- **Degree of freedom is the number of independent ways in which K.E. of molecule define.**

Monoatomic gas (ex.: Ne, He, Ar)



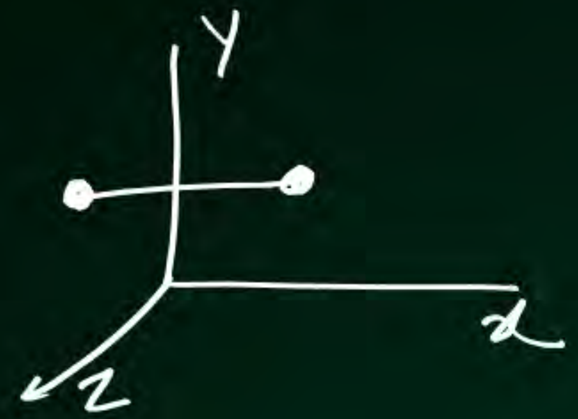
- 3 - Translational d.o.f.
- Zero Rotational d.o.f
- Zero vibrational d.o.f.

→ No vibrational d.o.f at any Tempr



- **Diatomic :**

  (N_2, O_2, H_2)



At normal Tempr

3 → Translational d.o.f
2 – Rotational d.o.f.

(d.o.f) = 5

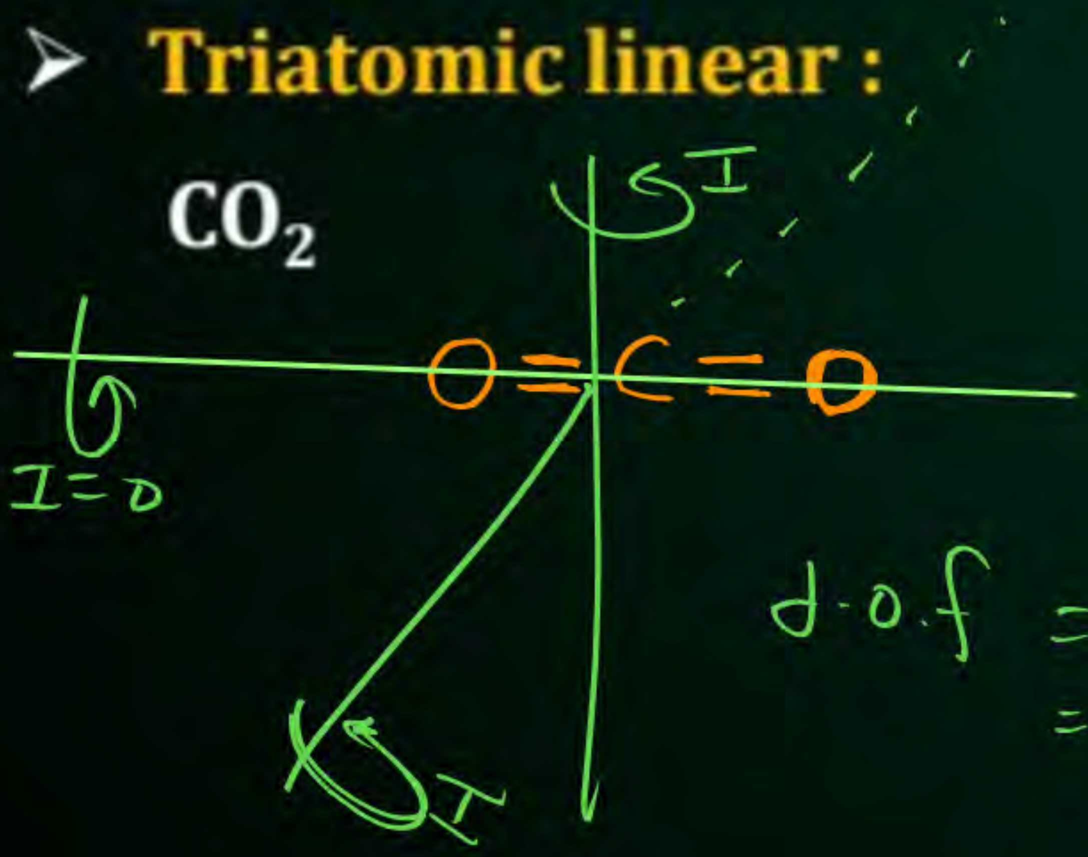
At very high Tempr

3 → Translation d.o.f.
2 → Rotational d.o.f
2 → vibrational

d.o.f = 7 at very high Tempr

- **Triatomic linear :**

  CO_2

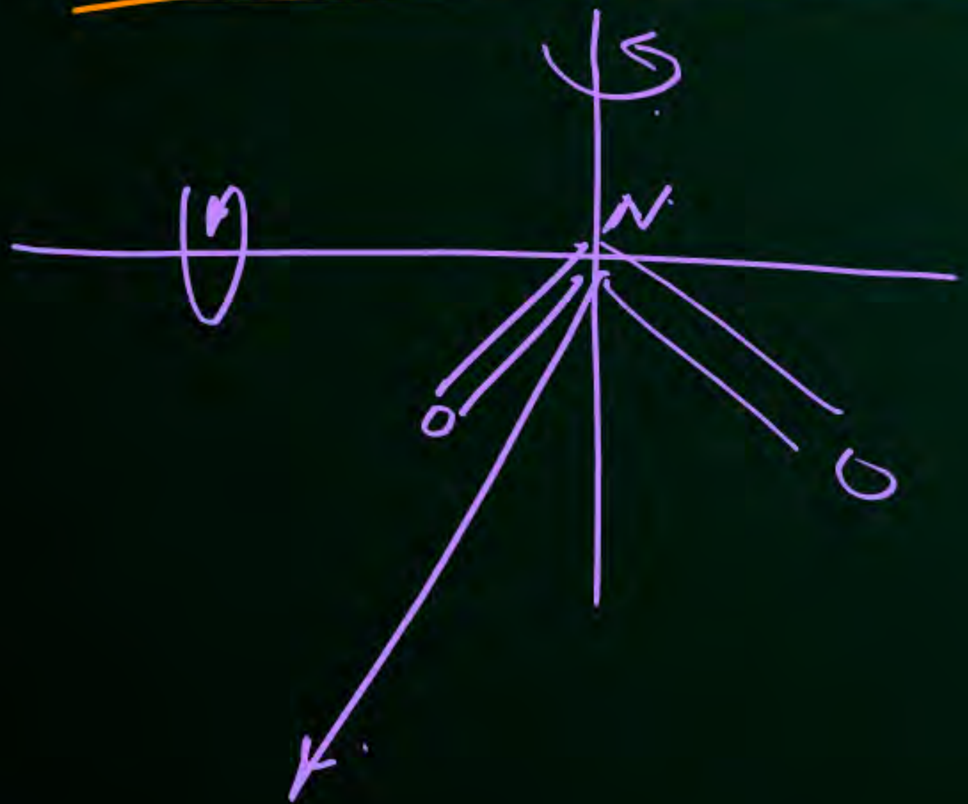


d.o.f = 3 Tranl^n
= 2 Rot^n

- **Polyatomic gas :**

(SO_2, CH_4, NH_3)

- **Triatomic – Non-linear :**



at normal Tempr

3 – Tran^n
$3 \rightarrow$ Rot^n
d.o.f = 6

at high Tempr

3 – Tran^n
$3 \rightarrow$ Rot^n
n = vibrational d.o.f.
n = as given in question

✡ Internal energy $U = K.E + P.E$ {sum of K.E & P.E of all the molecule}

for Ideal gas: $P.E = 0$

Internal energy $U = K.E$ of all molecule (only depends on Temp)

Internal energy of 1 Molecule, due to 1 d.o.f is ∝ Temp

$$U = \frac{K_B}{2}T$$ ← Internal energy of one molecule due to 1 d.o.f.

Internal energy of N molecule, due to 1 d.o.f $= \frac{1}{2} N K_B T$

Internal energy of N Molecule due to f d.o.f $= \frac{1}{2} N f K_B T$

$$K_B = \frac{R}{N_A}$$

$$U = \frac{1}{2}\frac{NfR}{N_A}T = \frac{1}{2} nfRT$$

$$U = \frac{1}{2} nRfT$$

n = no. of mole T = Temp

f = total d.o.f R = gas const.

$$U = \frac{1}{2} nRfT$$

$$\Delta U = \frac{1}{2} nRf\Delta T$$

- $\Delta U = nC_v\Delta T$

$$C_v = \frac{fR}{2}$$

$$\frac{C_p}{C_v} = \gamma$$

$$C_p - C_v = R$$

$$\gamma = 1 + \frac{2}{f}$$

γ: adibadic exponent

f: degree of freedom

INTERNAL ENERGY

- It depends upon state
- does not depends upon path.
- U = K.E. + P.E.

  For ideal (P.E = 0)

Maxwell Law :

U = K.E. (Σ K.E. of all molecule due to all type of degree of freedom)

Gas have heat

gas have work

gas have internal energy

Specific heat capacity $s = \frac{dQ}{m\,dT}$

m = mass of gas

Heat Capacity

$$C = \frac{dQ}{dT}$$

molar heat capacity ↓ , Heat capacity ↓

$$C_M = \frac{dQ}{n\,dT} = \frac{C}{n}$$

Molar heat capacity

$$C_M = \frac{dQ}{n\,dT}$$

⇒ Heat Required to raise the Tempr by unit °C Per mole.

$$dQ = C_M\, n\, dT$$

$$C_M = \frac{dQ}{n\,dT} = \frac{[m]s}{[n]}$$

$$C_M = M s$$

↳ molar mass

$$C_m = \frac{dQ}{n\,dT}$$

$$dQ = C_m n\,dT$$

Heat supply at Volume = const^n

Molar heat capacity at constant Volume

$$dQ = C_v n\,dT \quad \text{— (1)}$$

1st Law of thermodynamics

$$dQ = dW + dU$$

Volume = const^n $(dW = 0)$

$$dQ = dU$$

If heat supplied at constant Pressure

$$dQ = C_p n\,dT$$

at constant volume $(dW = 0)$

$$dQ = dU$$

$$C_v n\,dT = \frac{1}{2} n R f\,dT$$

$$C_v = \frac{fR}{2}$$

$$C_p - C_v = R$$

$$C_v = \frac{fR}{2}$$

$$C_p = \frac{fR}{2} + R$$

$$\frac{C_p}{C_v} = \gamma$$

$$\gamma = 1 + \frac{2}{f}$$

QUESTION

Find ratio of internal energy of dia-atomic and monoatomic gas both at temperature T, for translational d.o.f.

1. 3/5
2. 5/3
3. 2/3
4. 1/1

45%

$U = \frac{1}{2} nRfT = \frac{3nRT}{2}$

$U = \frac{3nRT}{2}$

↑ diatomic

QUESTION

Find ratio of internal energy per d.o.f. of dia-atomic and monoatomic gas both at temperature T.

1. 3/5
2. 5/3 (76%)
3. 2/3
4. 1/1 (11%) correct

$U = \frac{1}{2} nRfT$

Total internal energy of monoatomic gas: $U = \frac{1}{2} nR\,3\,T$

Internal energy of monoatomic gas per d.o.f.: $\frac{U}{3} = \frac{1}{2} nRT$

Internal energy of diatomic gas per degree of freedom $= \frac{\frac{1}{2} nR5T}{5}$

$\gamma = 1 + \frac{2}{f} = 1 + \frac{2}{3}$

$\gamma = \frac{5}{3}$

gas	DOF	$C_V = \frac{fR}{2}$	$C_P = C_V + R$	$\gamma = \frac{C_P}{C_V}$
1. **Monoatomic**	3T + 0R = 3 (+0V)	C_V = 3R/2	C_P = 5R/2	5/3 ≈ 1.66
2. **Diatomic**	3T + 2R = 5	5R/2	7R/2	7/5 ≈ 1.4
3. **Triatomic (linear)** (CO_2)	3T + 2R = 5	5R/2	7R/2	7/5 ≈ 1.4
4. **Triatomic (non-linear)**	3T + 3R = 6	3R = $\frac{fR}{2}$	4R	4/3 ≈ 1.33
5. **Diatomic (at higher temperature)**	3T + 2R + 2Y = 7 (vibration)	7R/2	9R/2	9/7

Triatomic at higher → (3T + 3R + n vibration) *

n = given in question

(Q) If n_1 mole of gas having d.o.f f_1 at Tempr T_1 is mixed with another gas of n_2 mole of gas having d.o.f f_2 at Tempr T_2 is mixed. then find Tempr of mixture ??

$$T_{mixture} = \frac{n_1 f_1 T_1 + n_2 f_2 T_2}{n_1 f_1 + n_2 f_2}$$

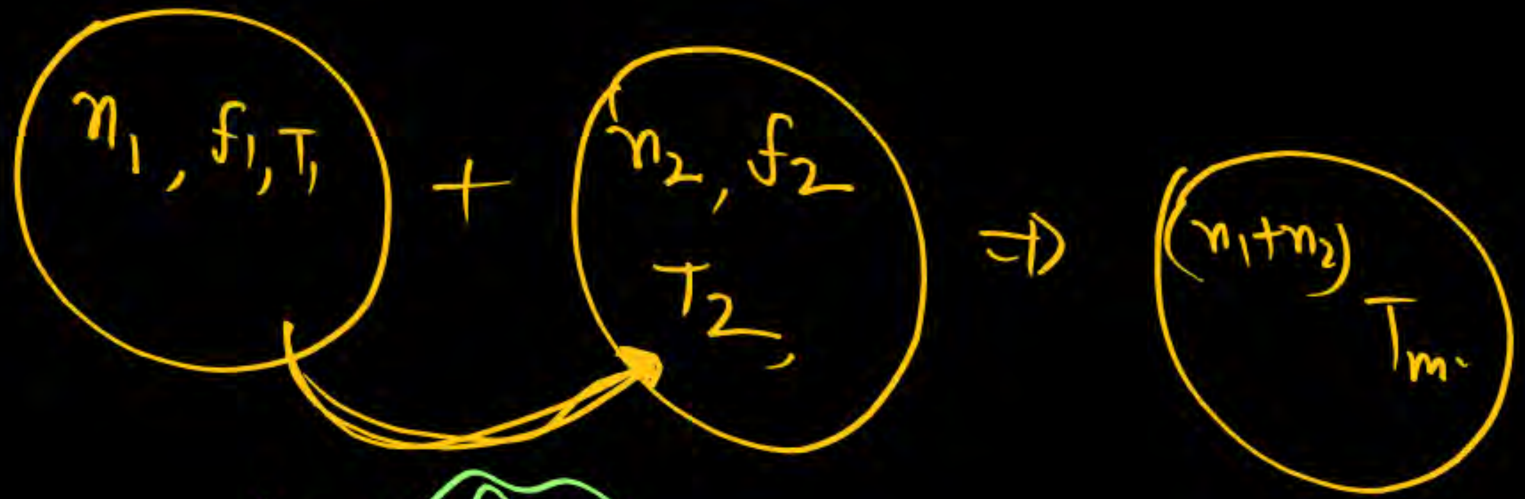
$$(C_V)_{mix} = \frac{n_1 C_{V1} + n_2 C_{V2}}{n_1 + n_2}$$

$$f_{mix} = \frac{n_1 f_1 + n_2 f_2}{n_1 + n_2}$$

$$(C_P)_{mix} = \frac{n_1 C_{P1} + n_2 C_{P2}}{n_1 + n_2} \quad \text{— wrong}$$

$$\gamma_{mix} = \frac{n_1 \gamma_1 + n_2 \gamma_2}{n_1 + n_2} \quad ✗$$

$$\gamma_{mix} = 1 + \frac{2}{f_{mix}}$$



$$U = \frac{1}{2} nRfT$$

GAS MIXTURE

$$(C_V)_{mix} = \frac{n_1 C_{V_1} + n_2 C_{V_2}}{n_1 + n_2}$$

$$(C_P)_{mix} = \frac{n_1 C_{P_1} + n_2 C_{P_2}}{n_1 + n_2}$$

$$f_{mix} = \frac{n_1 f_1 + n_2 f_2}{n_1 + n_2}$$

$$\gamma_{mix} = \frac{n_1 \gamma_1 + n_2 \gamma_2}{n_1 + n_2}$$ → wrong

$$\gamma_{mix} = \frac{(C_P)_{mix}}{(C_V)_{mix}} = 1 + \frac{2}{f_{mix}}$$

QUESTION

If one mole of a monoatomic gas $\left(\gamma_1 = \frac{5}{3}\right)$ is mixed with one mole of a diatomic gas $\left(\gamma_2 = \frac{7}{5}\right)$, the value of γ for the mixture is

1. 3.07
2. 1.5 ✓ Ans
3. 1.40
4. 1.53

$\gamma = 1 + \frac{2}{f}$

$\frac{5}{3} - 1 = \frac{2}{f}$

$\Rightarrow \frac{2}{3} = \frac{2}{f}$

$f_1 = 3$

$\frac{7}{5} = 1 + \frac{2}{f}$

$\frac{7}{5} - 1 = \frac{2}{f}$

$\frac{2}{5} = \frac{2}{f}$

$f_2 = 5$

$$f_{mix} = \frac{1 \times 3 + 1 \times 5}{1 + 1} = \frac{8}{2} = 4$$

$$\gamma_{mix} = 1 + \frac{2}{4} = 1 + \frac{1}{2} = \frac{3}{2}$$

QUESTION

The degrees of freedom of a triatomic gas is [1999]

1. 6 ✓
2. 4
3. 2
4. 8

QUESTION

The average thermal energy for a mono-atomic gas is (k_B is Boltzmann constant and T, absolute temperature) [NEET 2020]

1. $\frac{1}{2}k_BT$
2. $\frac{3}{2}k_BT$
3. $\frac{5}{2}k_BT$
4. $\frac{7}{2}k_BT$

Avg internal energy $= \frac{U}{N} = \frac{\text{total internal energy}}{\text{no. of mo.}}$

$U = \frac{\frac{1}{2} N k_B T \times 3}{N} = \frac{3k_BT}{2}$

QUESTION

The number of translational degrees of freedom for a diatomic gas is [1993]

1. 2
2. 3
3. 5
4. 6

QUESTION

A polyatomic gas with n degrees of freedom has a mean energy per molecule given by [1989]

1. $\frac{nkT}{N}$
2. $\frac{nkT}{2N}$
3. $\frac{nkT}{2}$
4. $\frac{3kT}{2}$

51%

$U = \frac{1}{2} k_B T$

$U = \frac{1}{2} N k_B T f$

$\frac{U}{N} = \frac{1}{2} \frac{N k_B T n}{N} = \frac{1}{2} n k_B T$

⇒ internal energy of 1 molecule due to 1 d.o.f $= \frac{1}{2}KT$

internal energy of N molecule due to 1 d.o.f $= \frac{1}{2}KTN$

internal energy of N molecule due to f d.o.f $= \frac{1}{2}KTNf$

$K = \frac{R}{N_A}$

$U = \frac{1}{2}NKfT = \frac{1}{2}N\frac{R}{N_A}fT = \frac{1}{2}nRfT = U$

QUESTION

The value of $\gamma\left(=\frac{C_P}{C_v}\right)$, for hydrogen, helium and another ideal diatomic gas X (whose molecules are not rigid but have an additional vibrational mode), are respectively equal to [Odisha NEET 2019]

1. $\frac{7}{5}, \frac{5}{3}, \frac{9}{7}$
2. $\frac{5}{3}, \frac{7}{5}, \frac{9}{7}$
3. $\frac{5}{3}, \frac{7}{5}, \frac{7}{5}$
4. $\frac{7}{5}, \frac{5}{3}, \frac{7}{5}$

for hydron ($f=5$)

$\gamma = 1 + \frac{2}{f}$

for helium

d.o.f $= 3$

for X

d.o.f $= 5+2$
$= 7$

QUESTION

A gas mixture consists of 2 moles of O_2 and 4 moles of Ar at temperature T. Neglecting all vibrational modes, the total internal energy of the system is

(NEET 2017)

1. $15\,RT$
2. $9\,RT$
3. $11\,RT$
4. $4\,RT$

$U = \frac{1}{2} nRfT$

$n_1 = 2$

$U = \frac{1}{2} n_1 R f_1 T_1 + \frac{1}{2} n_2 R f_2 T_2$

$= \frac{1}{2} \times 2 \times R \times 5T + \frac{1}{2} \times 4 \times 3 \times RT$

$= 11\,RT$

QUESTION

The amount of heat energy required to raise the temperature of 1 g of Helium at N_1P, from T_2K is [NEET 2013]

1. $\frac{3}{4}N_a k_B(T_2 - T_1)$

2. $\frac{3}{4}N_a k_b\left(\frac{T_2}{T_1}\right)$

3. $\frac{3}{8}N_a k_B(T_2 - T_1)$

4. $\frac{3}{2}N_a k_B(T_2 - T_1)$

QUESTION

The molar specific heat at constant pressure of an ideal gas is $(7/2)R$. The ratio of specific heat at constant pressure to that at constant volume is (2006)

1. $9/7$
2. $7/5$
3. $8/7$
4. $5/7$

QUESTION

To find out degree of freedom, the expression is [2000]

1. $f = \frac{2}{\gamma - 1}$

2. $f = \frac{\gamma + 1}{2}$

3. $f = \frac{2}{\gamma + 1}$

4. $f = \frac{1}{\gamma + 1}$

QUESTION

For hydrogen gas $C_P - C_V = a$ and for oxygen gas $C_P - C_V = b$, so the relation between a and b is given by [1991]

1. $a = 16b$
2. $16b = a$
3. $a = 4b$
4. $a = b$

$C_P - C_V = R$

QUESTION

For a certain gas the ratio of specific heats is given to be $\gamma = 1.5$. For this gas [1990]

1. $C_V = 3R/J$
2. $C_P = 3R/J$
3. $C_P = 5R/J$
4. $C_V = 5R/J$

QUESTION

First law of thermodynamics is consequence of conservation of (1988)

1. work
2. energy
3. heat
4. all of these

QUESTION

The ratio of the specific heats $C_P/C_V = \gamma$ in terms of degree of freedom (n) is given by : [AIPMT-2013]

1. $\left(1+\frac{n}{3}\right)$
2. $\left(1+\frac{2}{n}\right)$
3. $\left(1+\frac{n}{2}\right)$
4. $\left(1+\frac{1}{n}\right)$

1^{ST} LAW OF THERMODYNAMICS

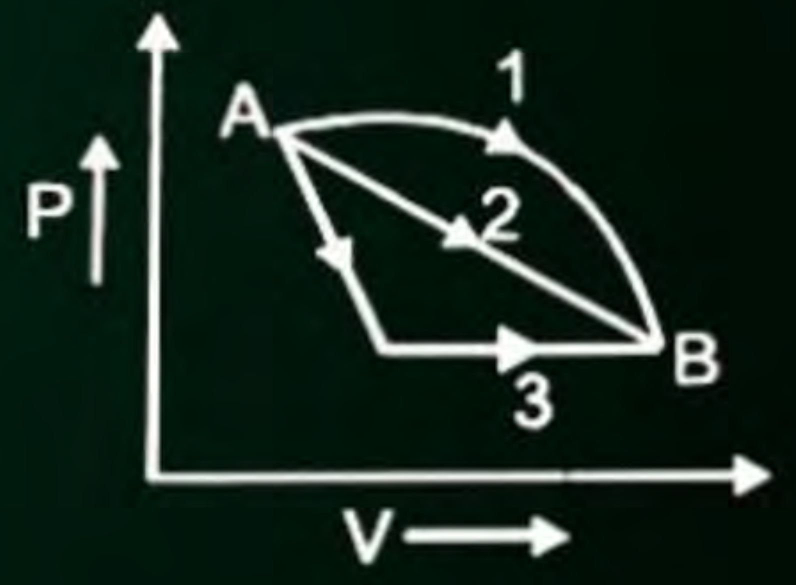
$$d\theta = dU + dW$$

$d\theta = +ve$	heat given to system
$d\theta = -ve$	heat taken from system
$dU = +ve$	Increase in internal energy
$dU = -ve$	decrease in internal energy
$dW = +ve$	work done by gas
$dW = -ve$	work done on gas

QUESTION

An ideal gas goes from state A to state B via three different processes as indicated in the P-V diagram -

If Q_1, Q_2, Q_3 indicate the heat absorbed by the gas along the three processes and U_1, U_2, U_3 indicate the change in internal energy along the three processes respectively, then -



1. $Q_3 > Q_2 > Q_1$ and $\Delta U_1 = \Delta U_2 = \Delta U_3$
2. $Q_1 = Q_2 = Q_3$ and $\Delta U_1 > \Delta U_2 > \Delta U_3$
3. $Q_3 > Q_2 > Q_1$ and $\Delta U_1 > \Delta U_2 > \Delta U_3$
4. $Q_1 > Q_2 > Q_3$ and $\Delta U_1 = \Delta U_2 = \Delta U_3$

1^{ST} LAW OF THERMODYNAMICS

$$d\theta = dU + dW$$

$d\theta = +ve$	heat given to system
$d\theta = -ve$	heat taken from system
$dU = +ve$	Increase in internal energy
$dU = -ve$	decrease in internal energy
$dW = +ve$	work done by gas
$dW = -ve$	work done on gas

QUESTION

If temperature is increase of a given amount of a gas then internal energy must increases →

First Law for cyclic process :

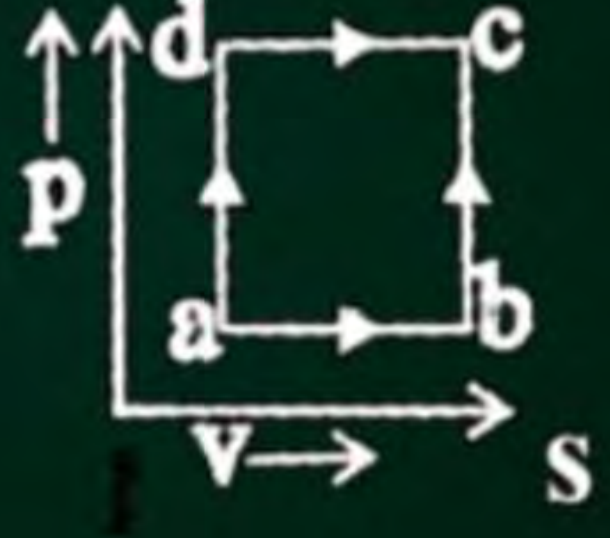
During the cyclic process Net heat transfer is equal to net work done.

$$\Sigma Q = \Sigma W \qquad \text{as} \qquad \Delta U = 0$$

QUESTION

When a system is taken through the process *a b c*, 80 cal of heat is absorbed by the system and 60 cal of work is done by it if the system is taken through the process adc, 30 cal of heat is absorbed, then work done by the system is

1. 10 cal
2. 20 cal
3. 30 cal
4. 4 cal



QUESTION

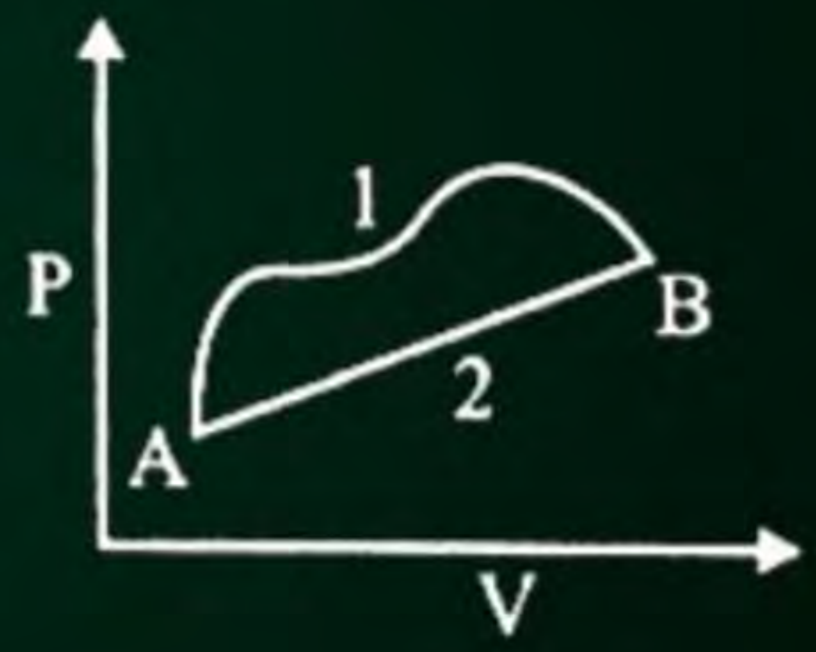
If 110 J of heat are added to a gaseous system, whose internal energy is 40 J, then the amount of external work done is -

1. 40 J
2. 70 J
3. 110 J
4. 150 J

QUESTION

A system is taken from state A to state B along two different paths 1 and 2. The heat absorbed and work done by the system along these two paths are Q_1, Q_2 and W_1, W_2 respectively then

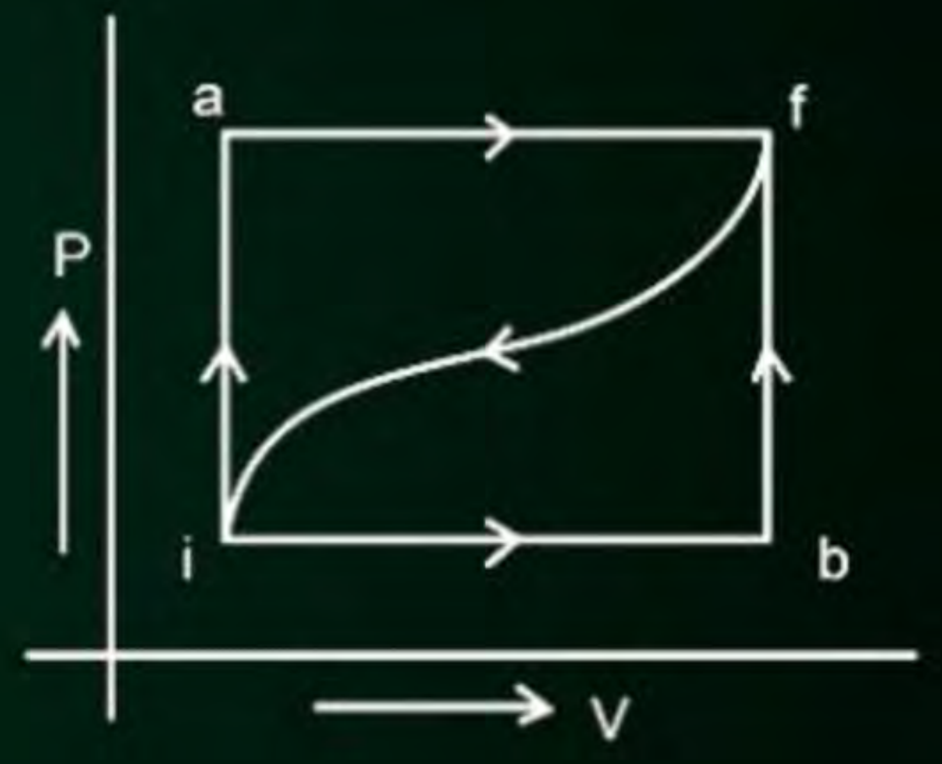
1. $Q_1 - W_1 = Q_2 - W_2$
2. $Q_1 = Q_2$
3. $W_1 = W_2$
4. None



QUESTION

When a system is taken from state *i* to state *f* along the path *iaf*, it is found that Q = 50 cal and W = 20 cal. Along the path *ibf*. Q = 36 cal. W along path *ibf* is -

1. 30 cal
2. 16 cal
3. 6 cal
4. 14 cal



QUESTION

A gas is compressed at a constant pressure of $50 N/m^2$ from a volume of $10\ m^3$ to volume of $4\ m^3$. Energy of 100 joule is thus added to gas by heating. Its internal energy is:

1. 450
2. 400
3. 350
4. 410

QUESTION

Consider the following two statements and choose the correct answer.

(I) If heat is added to a system, its temperature must always increase.

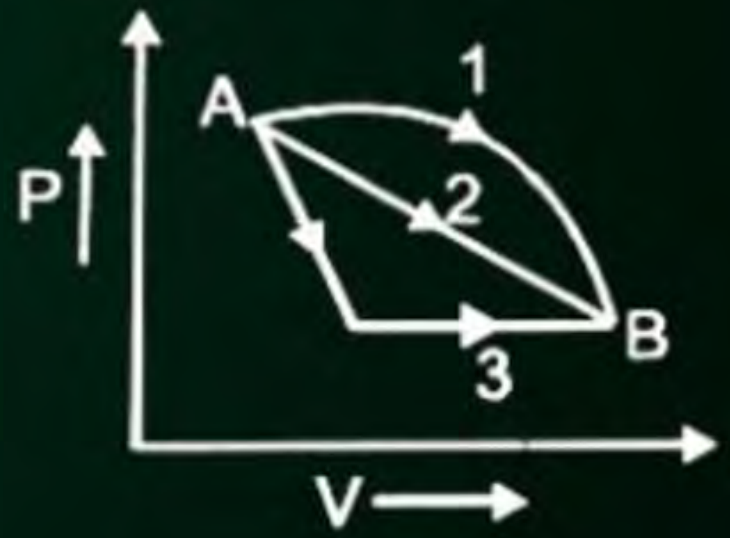
(II) If positive work is done by a system in thermodynamic process, its volume must increase

1. I
2. II
3. Both
4. None

QUESTION

An ideal gas goes from state A to state B via three different processes as indicated in the P–V diagram -

If Q_1, Q_2, Q_3 indicate the heat absorbed by the gas along the three processes and U_1, U_2, U_3 indicate the change in internal energy along the three processes respectively, then -



1. $Q_3 > Q_2 > Q_1$ and $\Delta U_1 = \Delta U_2 = \Delta U_3$
2. $Q_1 = Q_2 = Q_3$ and $\Delta U_1 > \Delta U_2 > \Delta U_3$
3. $Q_3 > Q_2 > Q_1$ and $\Delta U_1 > \Delta U_2 > \Delta U_3$
4. $Q_1 > Q_2 > Q_3$ and $\Delta U_1 = \Delta U_2 = \Delta U_3$

QUESTION

If Q, E and W denote respectively the heat added, change in internal energy and the work done in a closed cyclic process then which of these will follow:

1. $\Delta W = 0$
2. $\Delta Q = 0$
3. $\Delta E = 0$
4. None of these

QUESTION

A system is provided with 200 cal of heat and the work done by the system on the surrounding is 40 J. Then its internal energy

1. Increases by 600 J
2. Decreases by 800 J
3. Increases by 800 J
4. Decreases by 50 J

QUESTION

An ideal gas is taken through a cycle thermodynamic process through four steps. The amounts of heat involved in these steps arc $Q_1 = 5960$ J, $Q_2 = -5585$ J, $Q_3 = -2980$ J, $Q_4 = 3645$ J, respectively. The corresponding works involved are $W_1 = 2200$ J, $W_2 = -825$ J, $W_3 = -1100$ J, and W_4 respectively, the value of W_4 is:

(1) 780

(2) 775

(3) 765

(4) 760

QUESTION

In a thermodynamic process, pressure of a fixed mass of a gas is changed in such a manner that the gas molecules gives out 20 J of heat and 10 J of work is done on the gas. If the initial internal energy of the gas was 40 J, then the final internal energy will be

1. 30 J
2. 20 J
3. 60 J
4. 40 J

THERMODYNAMIC PROCESS

GRAPH FOR ISOCHORIC PROCESS

QUESTION

When an ideal diatomic gas is heated at constant pressure then what fraction of heat given is used to increase internal energy of gas ?

1. 5/7
2. 3/7
3. 3/5
4. 2/5


THANK YOU


YAKEEN 2.0
FOR NEET 2025
Lecture- 3
Physics
Kinetic Theory of Gases and Thermodynamics
By- Dr. Manish Raj (MR SIR)

Topics to be covered

Revision

1. # 1st Law of thermodynamics
2. # Thermodynamical Process
3. #



If C_P and C_V denote the specific heats of nitrogen per unit mass at constant pressure and constant volume respectively, then

(A) $C_P - C_V = \frac{R}{28}$

(B) $C_P - C_V = \frac{R}{14}$

(C) $C_P - C_V = R$ (41%)

(D) $C_P - C_V = 28R$

* Molar heat capacity

We know that $C_p - C_v = R$

$M s_p - M s_v = R$

$s_p - s_v = \frac{R}{M} = \frac{R}{28}$

$C_p - C_v = \left(\frac{R}{28}\right)$ ✓

$C_p = M s_p$

The Molar heat capacities of nitrogen at constant pressure and constant volume are 29.11kJ/k mole K and 20.81 kJ/kmole K, respectively. When 5 gram of nitrogen is heated from 290 to 310 K (i) the decrease in its internal energy and (ii) the external work done are, (Molecular weight of nitrogen = 28)

A 74.32 J, 29.64 J

B 29.64 J, 74.32 J

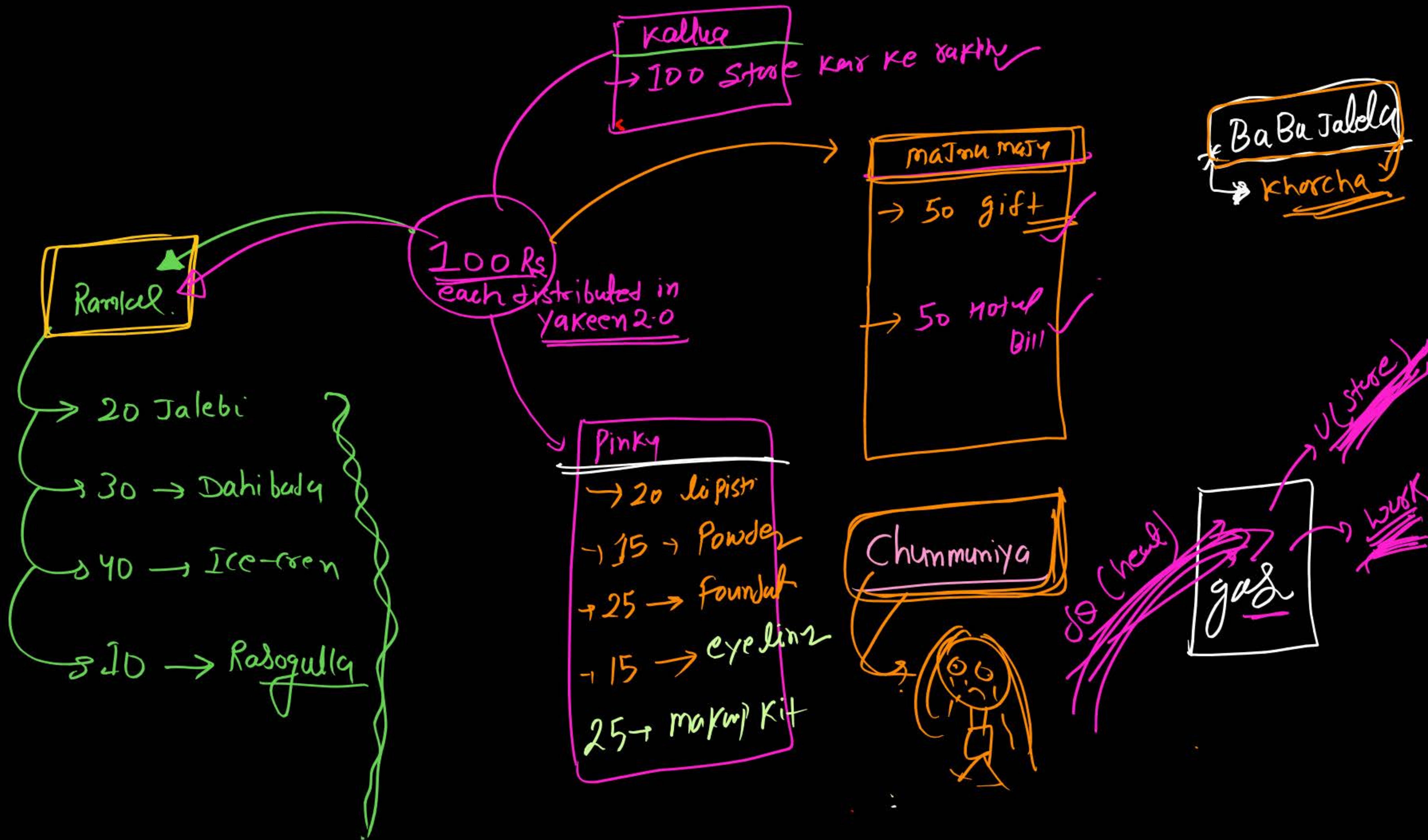
C 64.32 J, 19. 64 J

D 94.32 J , 39.64 J

$C_p - C_v = R$

molar heat capacity per mol

H/W



Kallua
→ 100 Store kar ke rakhe
Majnu Mary
→ 50 gift
→ 50 Hotel Bill
BaBu Jalela
Kharcha
100 Rs
each distributed in
Yakeen 2.0
Ramlal
20 Jalebi
30 → Dahi bada
40 → Ice-cream
10 → Rasogulla
Pinky
→ 20 lipsti
15 → Powder
25 → Foundat
15 → eyeliner
25 → makup Kit
Chummuniya
do (cheat)
gas
U(store)
work

1ST LAW OF THERMODYNAMICS

Based on conservation of energy

$$d\theta = dU + dW$$

$$\Delta Q = \Delta U + \Delta W$$

$d\theta = +ve$ → heat given to system

$d\theta = -ve$ → heat taken from system

$dU = +ve$ → Increase in internal energy (temp ↑)

$dU = -ve$ → decrease in internal energy (temp ↓)

$dW = +ve$ → work done by gas (expansion)

$dW = -ve$ → work done on gas (compression)

ΔQ: given +ve | taken −ve

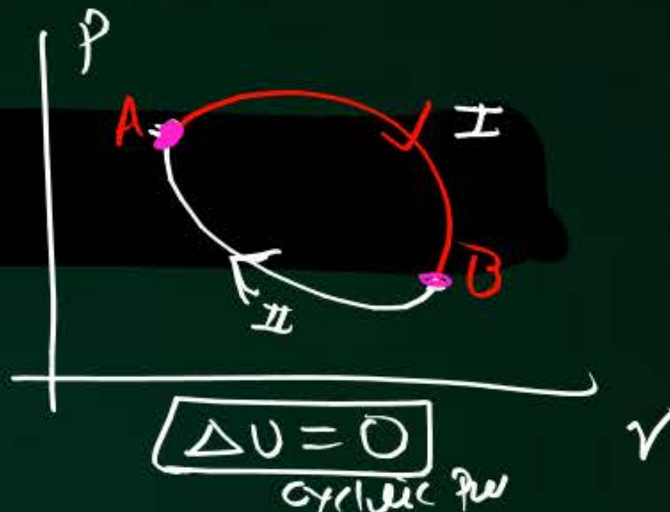
ΔU: Increase (+ve) or decrease (−ve)

ΔW: By gas (+ve), on gas (−ve)

First Law for cyclic process :

During the cyclic process Net heat transfer is equal to net work done,

[redacted]



$\Delta U = 0$

cyclic pro

→ initial state = final state

→ Internal enegy = state function (depends on state)
does not depends on Path.

Work = depends on Path

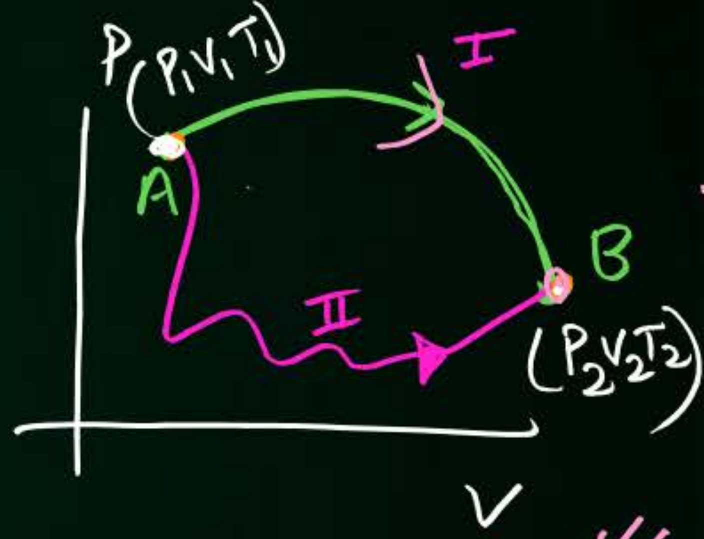
If initial state = Final state
$\Delta U = 0$

Cyclectric Proces $\Delta U = 0$

$\Delta Q = \Delta U + \Delta W$ ($\Delta U = 0$)

$\Delta Q = \Delta W$

for cyclic Path



* $(\Delta U)_{I, A\to B} = (\Delta U)_{II, A\to B}$

* $W_{I, A\to B} \neq W_{II, A\to B}$

$dQ_I \neq dQ_2$

QUESTION

If 110 J of heat are added to a gaseous system, whose internal energy is increase by 40 J, then the amount of [redacted] work done is -

1. 40 J
2. 70 J ✓
3. 110 J
4. 150 J

$dQ = 110\,J$

$dQ = dU + dW$

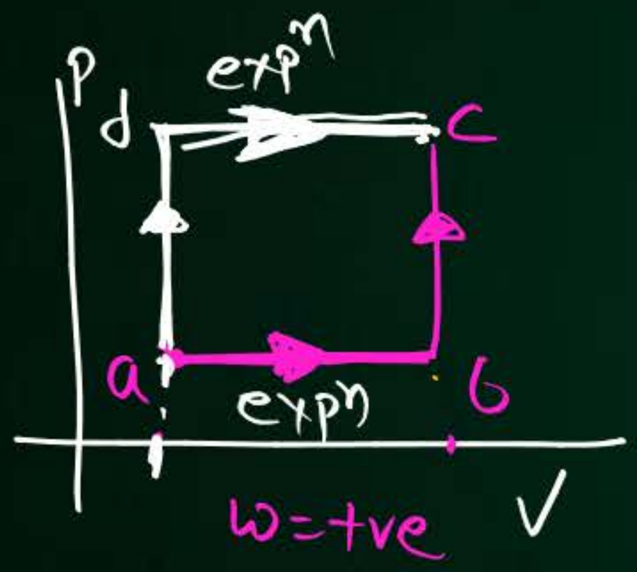
$110 = 40 + dW$

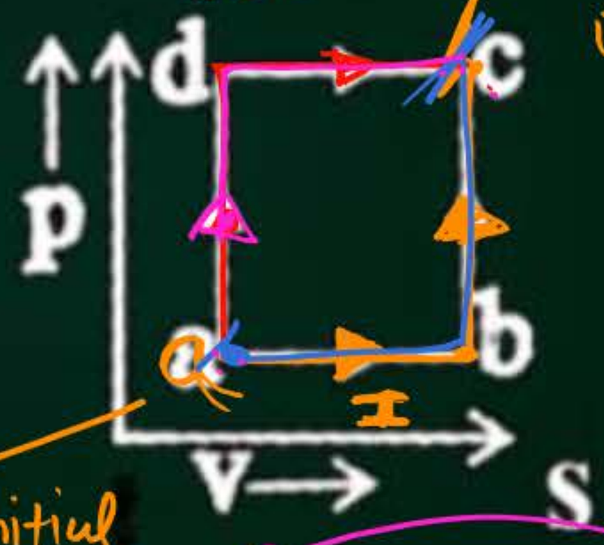
$dW = 110 - 40 = 70\,J$

QUESTION

When a system is taken through the process *a b c*, 80 cal of heat is absorbed by the system and 60 cal of work is done by it if the system is taken through the process adc, 30 cal of heat is absorbed, then work done by the system is

1. 10 cal
2. 20 cal
3. 30 cal
4. 4 cal





$dQ = dU + dW$

$80 = dU + 60$

$dU = 80 - 60 = 20\text{ cal}$ — (1)

$dQ = +80\text{ cal}$

$dW = 60\text{ cal}$

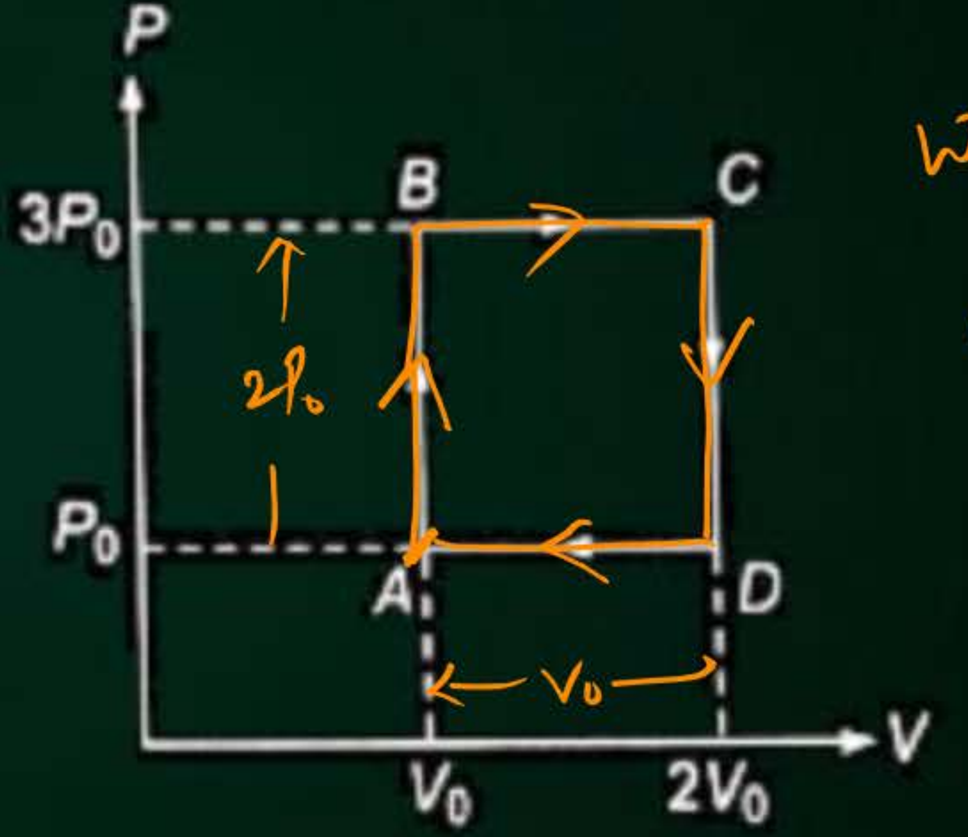
$d\theta = dU + dW$

$30 = 20 + dW$

$dW = 30 - 20 = 10\text{ cal}$

QUESTION

An ideal monatomic gas is carried along the cycle ABCDA as shown in the figure. The total heat absorbed during this process is



1. $10.5\ p_0V_0$
2. $7.5\ p_0V_0$
3. ~~$2.5\ p_0V_0$~~ $2P_0V_0$
4. $1.5\ p_0V_0$

Work = +Area of loop

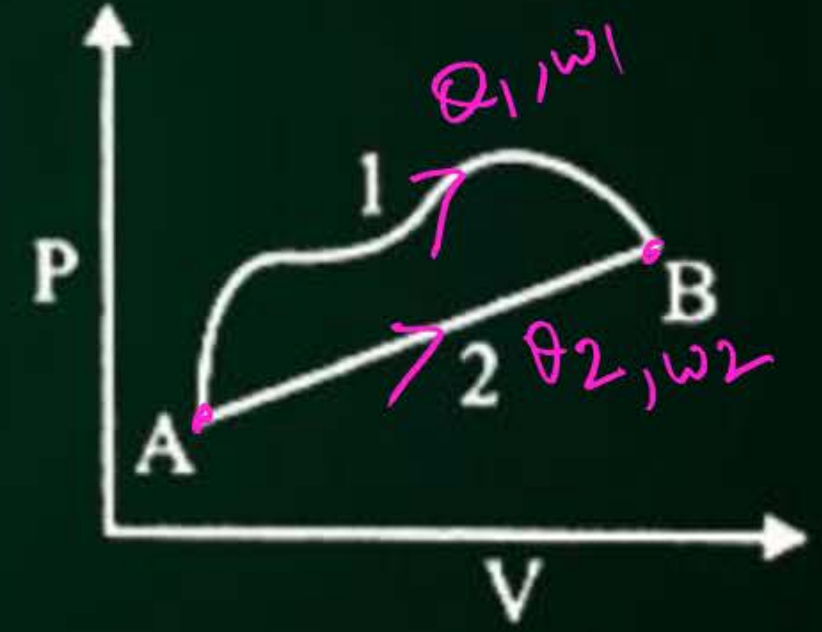
$W = 2P_0V_0$

$dQ = dU + dW$

$dQ = 2P_0V_0$

QUESTION

A system is taken from state A to state B along two different paths 1 and 2. The heat absorbed and work done by the system along these two paths are Q_1, Q_2 and W_1, W_2 respectively then

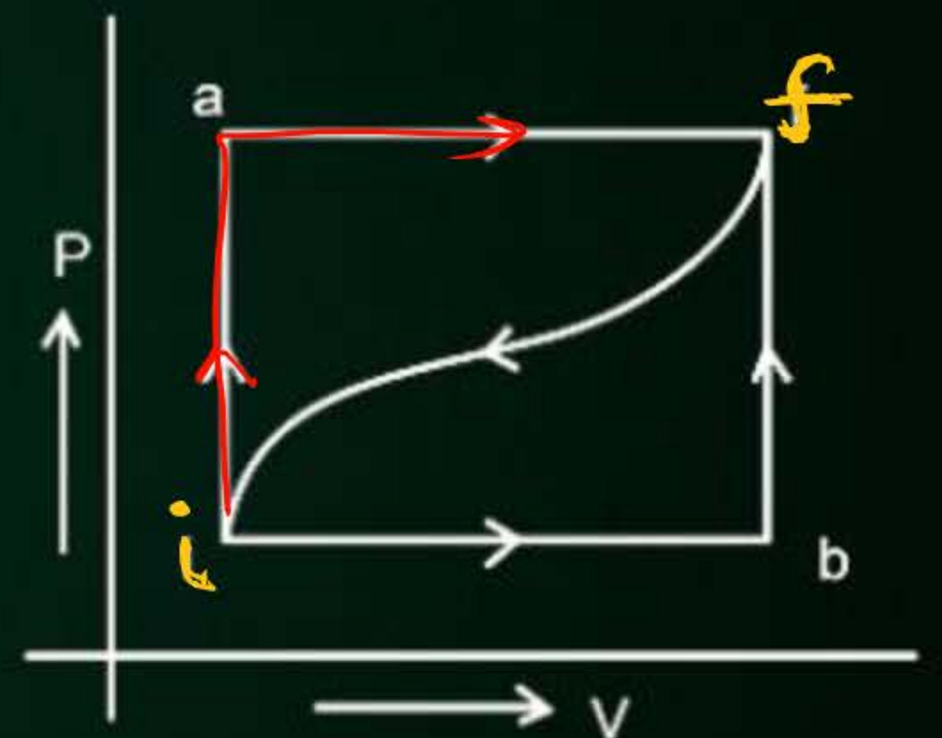


1. $Q_1 - W_1 = Q_2 - W_2$
2. $Q_1 = Q_2$
3. $W_1 = W_2$
4. None

QUESTION

When a system is taken from state *i* to state *f* along the path *iaf*, it is found that Q = 50 cal and W = 20 cal. Along the path *ibf*. Q = 36 cal. W along path *ibf* is –

1. 30 cal
2. 16 cal
3. 6 cal
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QUESTION

Consider the following two statements and choose the correct answer.

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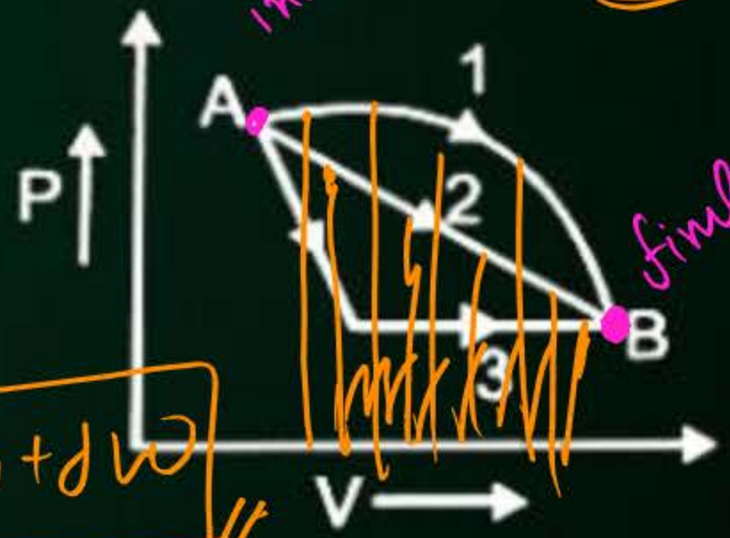
(II) If positive work is done by a system in thermodynamic process, its volume must increase

1. I
2. II
3. Both
4. None

QUESTION

An ideal gas goes from state A to state B via three different processes as indicated in the P–V diagram –

If Q_1, Q_2, Q_3 indicate the heat absorbed by the gas along the three processes and U_1, U_2, U_3 indicate the change in internal energy along the three processes respectively, then -



1. $Q_3 > Q_2 > Q_1$ and $\Delta U_1 = \Delta U_2 = \Delta U_3$
2. $Q_1 = Q_2 = Q_3$ and $\Delta U_1 > \Delta U_2 > \Delta U_3$
3. $Q_3 > Q_2 > Q_1$ and $\Delta U_1 > \Delta U_2 > \Delta U_3$
4. $Q_1 > Q_2 > Q_3$ and $\Delta U_1 = \Delta U_2 = \Delta U_3$

QUESTION

If Q, E and W denote respectively the heat added, change in internal energy and the work done in a closed cyclic process then which of these will follow:

1. $\Delta W = 0$
2. $\Delta Q = 0$
3. $\Delta E = 0$
4. None of these

QUESTION

A system is provided with 200 cal of heat and the work done by the system on the surrounding is 40 J. Then its internal energy

1. Increases by 600 J
2. Decreases by 800 J
3. Increases by 800 J
4. Decreases by 50 J

$dW = 40\,J$

$dQ = 200\ cal = 200 \times 4.2\,J$

$= 200 \times \frac{42}{10}$

$= 840$

$840 = 40 + dU$

$dU = 800$

QUESTION

An ideal gas is taken through a cycle thermodynamic process through four steps. The amounts of heat involved in these steps arc Q_1 = 5960 J, Q_2 = –5585 J, Q_3 =-2980 J, Q_4 = 3645 J, respectively. The corresponding works involved are W_1 = 2200 J, W_2 = –825 J, W_3 = –1100 J, and W_4 respectively, the value of W_4 is:

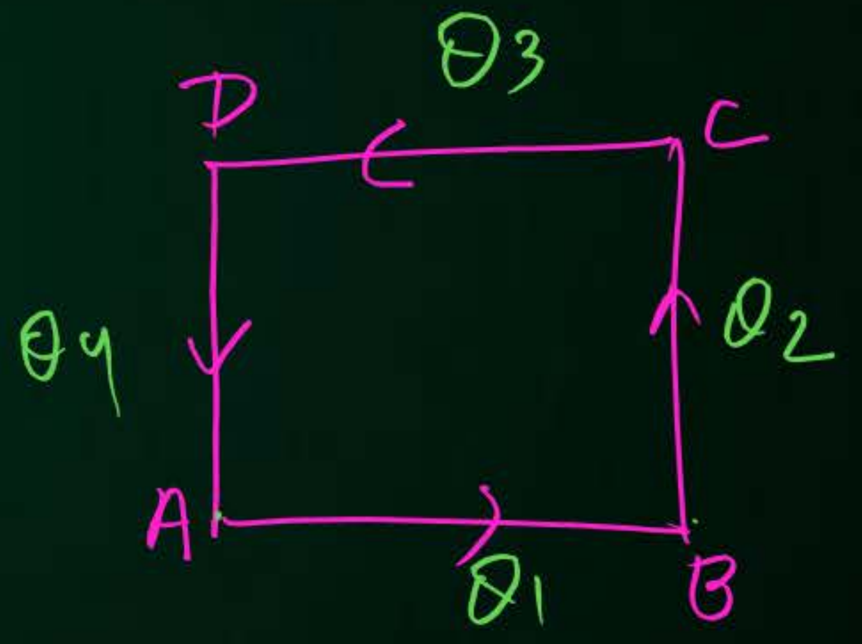
1. 780
2. 775
3. 765
4. 760

$Q_{net} = Q_1 + Q_2 + Q_3 + Q_4$

$Work = W_1 + W_2 + W_3 + W_4$

$dU_{total} = 0$

$Q_{net} = W_{net} + dU$ ↗ 0



THERMODYNAMIC PROCESS

(1) Isothermal Process

(2) Isobaric Process

(3) Isochoric Process

(4) adiabatic Process

(5) Polytropic Process

Isothermal Process (slow process)

→ dQ → slowly heat supply → (reversible Process)

Temp^r = cost^n → $\Delta T = 0$

$U = \text{cost}^n \rightarrow \Delta U = 0$

→ Boyls चाचा Ka Law

↙ 1st Law of thermodynamics

$\Delta Q = \Delta U^{0} + \Delta W$

$\boxed{\Delta Q = \Delta W}$

↘ Ideal gas eq^n.

$PV = nRT$ → cost^n for a given gas

$PV = \text{cost}^n$

$\frac{P_1}{P_2} = \left(\frac{V_2}{V_1}\right) \Leftarrow \boxed{P \propto \frac{1}{V}}$

$\boxed{P_1 V_1 = P_2 V_2}$ *

$\Delta W = P\Delta V$ ✗

$PV = nRT$

$\boxed{P = \frac{nRT}{V}}$

$dW = PdV$

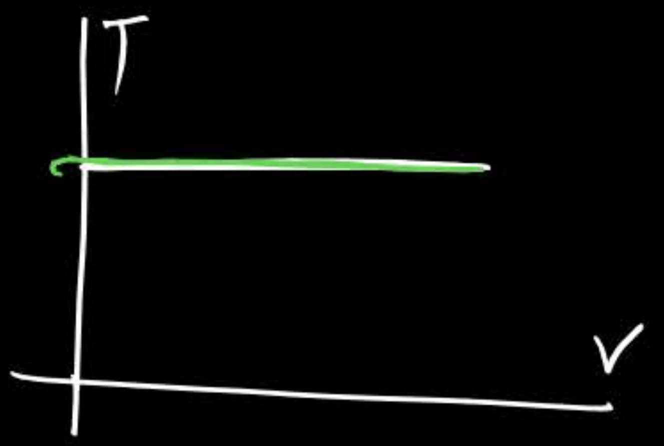
$\int dW = \int \frac{nRT}{V} dV$

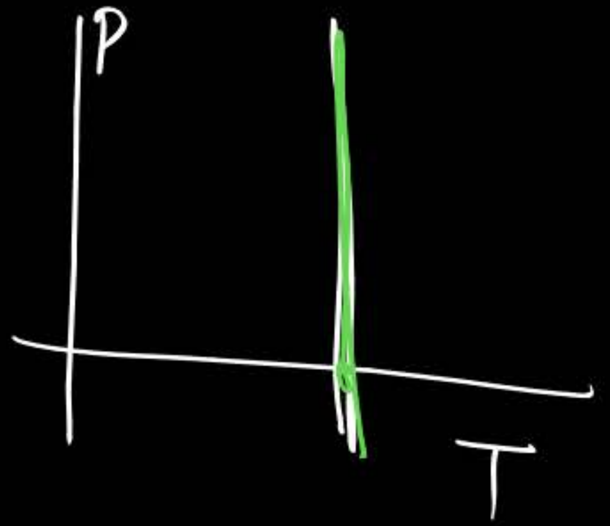
$W = nRT \int_{V_1}^{V_2} \frac{1}{V} dV$

$= nRT \log_e\left(\frac{V_2}{V_1}\right) = nRT \log_e\left(\frac{P_1}{P_2}\right)$

$$W = 2.303\, nRT \log_{10}\left(\frac{V_2}{V_1}\right)$$ #

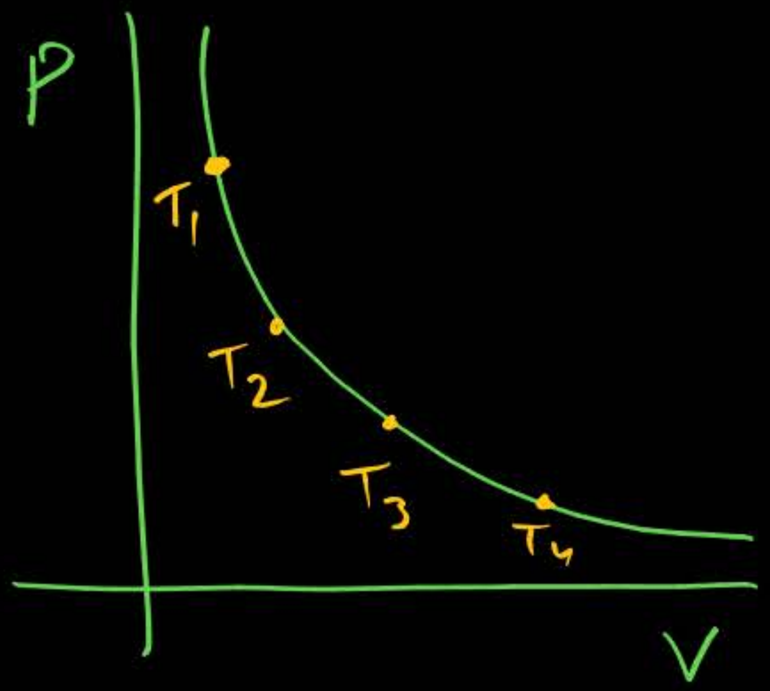
graph for $T = cot^n$





$$P = \frac{nRT}{V}$$ (nRT → cot^n)

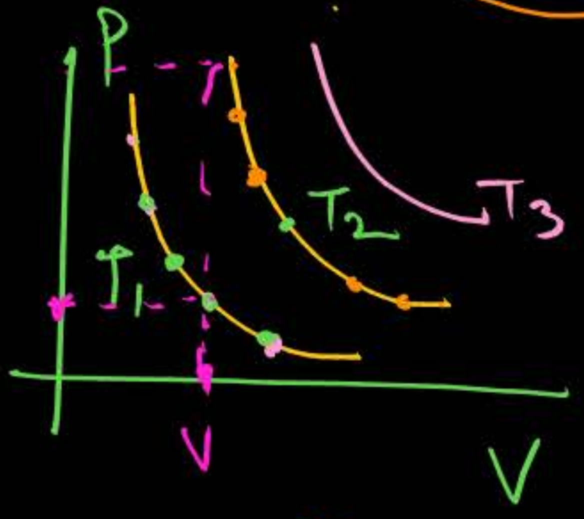
$$P \propto \frac{1}{V}$$



$$PV = nRT$$ (nRT → cot)

Isothermal curved

$$T_1 = T_2 = T_3 = T_4$$



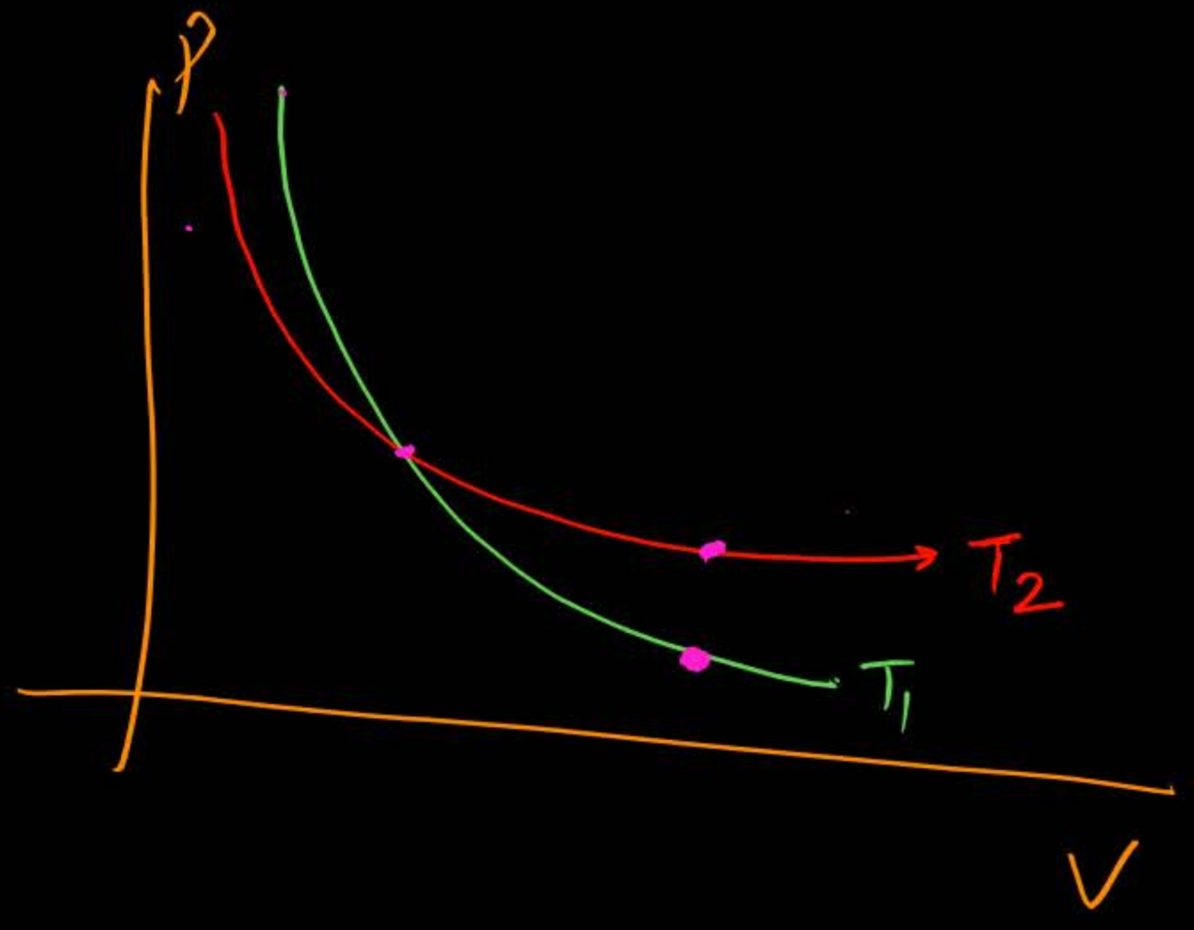
$$T_3 > T_2 > T_1$$

$$PV = nRT_1$$

$$P = \frac{nRT_1}{V}$$

$$PV = nRT_2$$

$$P = \frac{nRT_2}{V}$$



Which of the follow is corr for given two isothermal curve

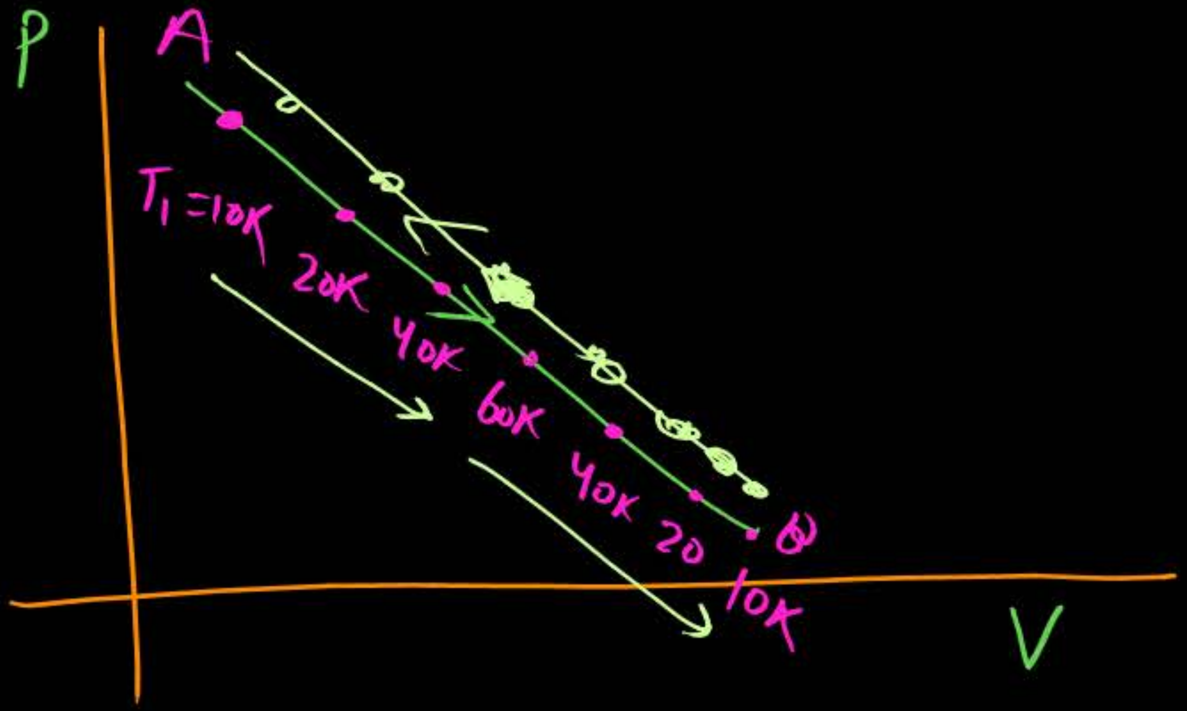
(a) $T_1 > T_2$

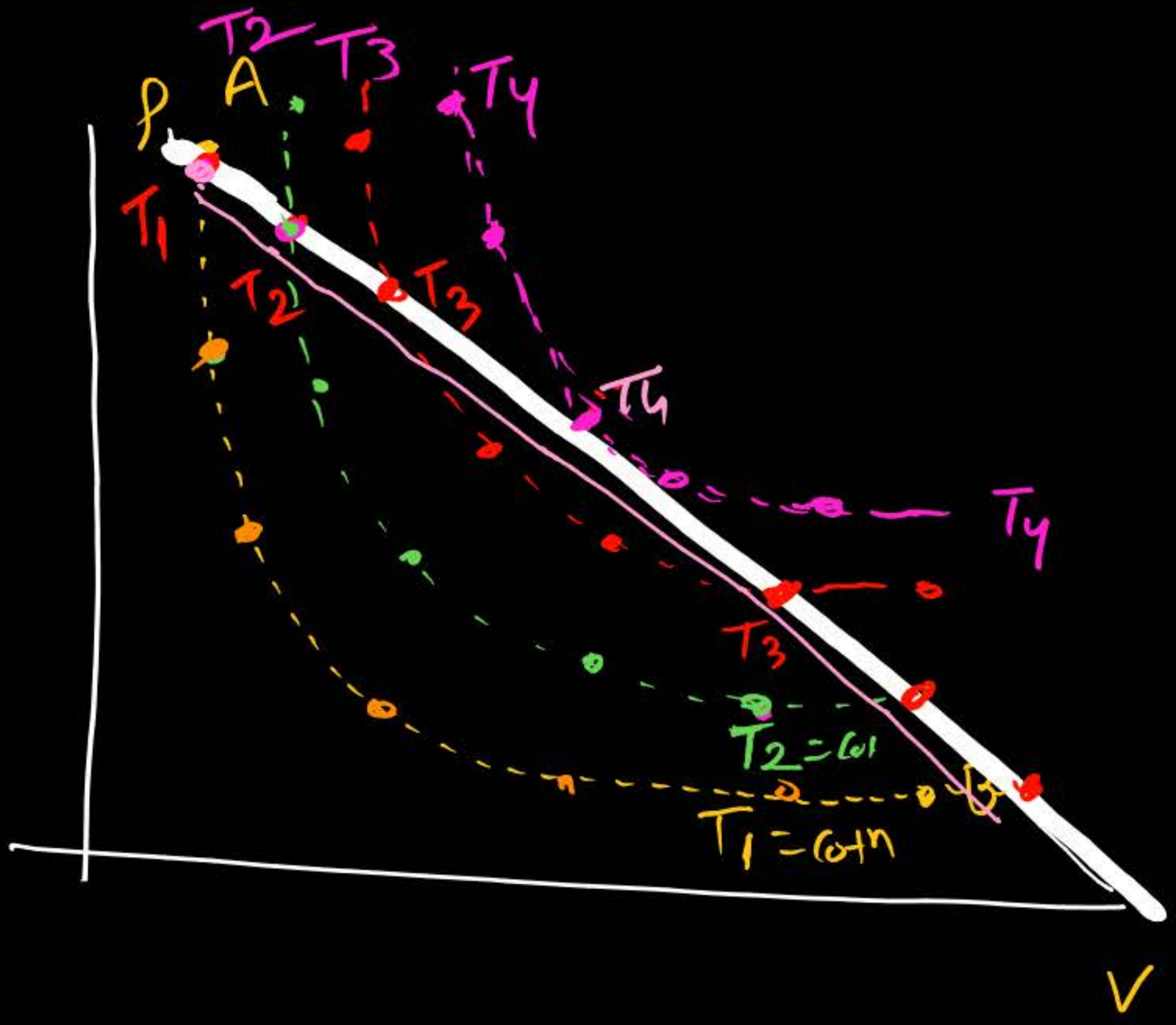
(b) $T_1 < T_2$ (51%)

(c) $T_1 = T_2$

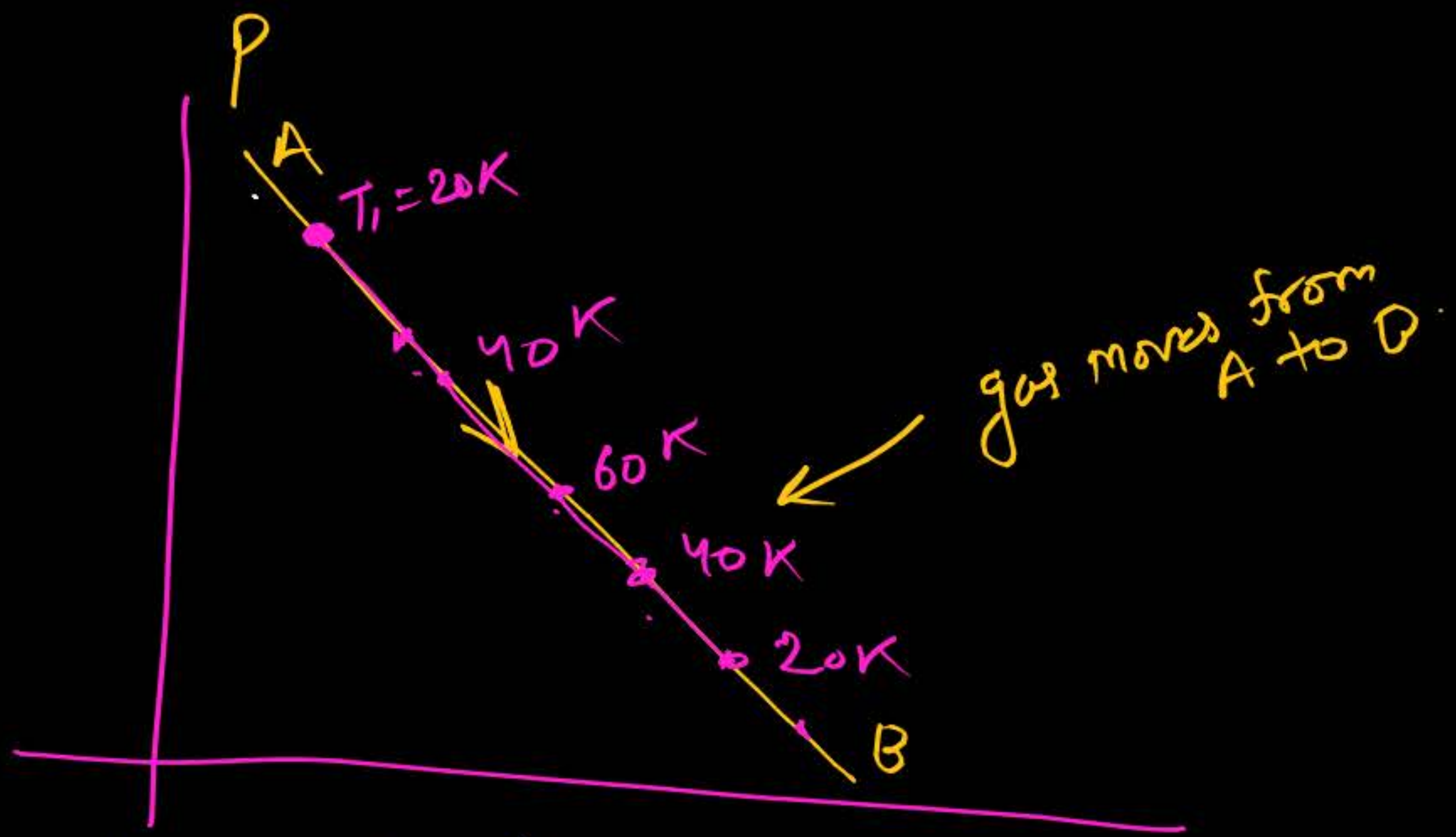
~~(d) Non of those~~ (24%)

Two isothermal curve at diff^n Temp^r Never intersect each other





Temp^r 1st Incr then dec



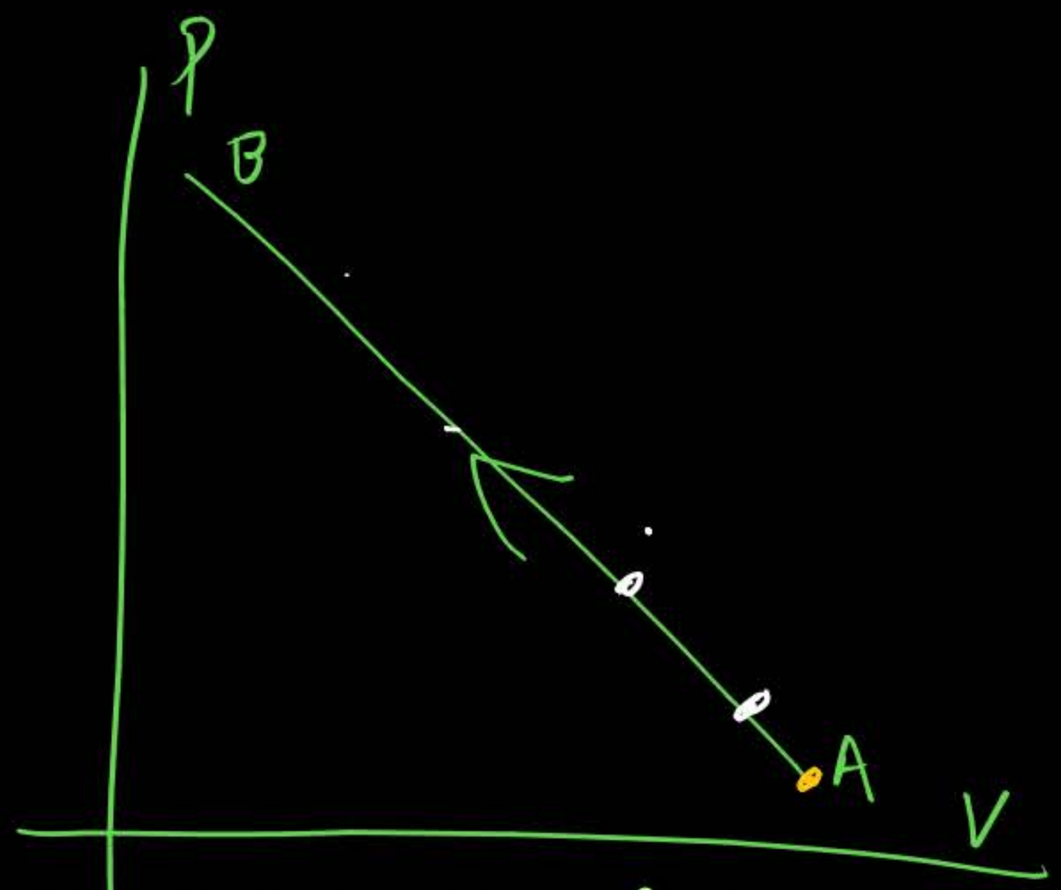
1. Correct option for Tempr for given graph.

(A) Tempr always Incrs.

(B) tempr always decreas (61%)

(C) Temp 1st ↓ then ↑

(d) Tempr 1st ↑ then ↓ (10%)



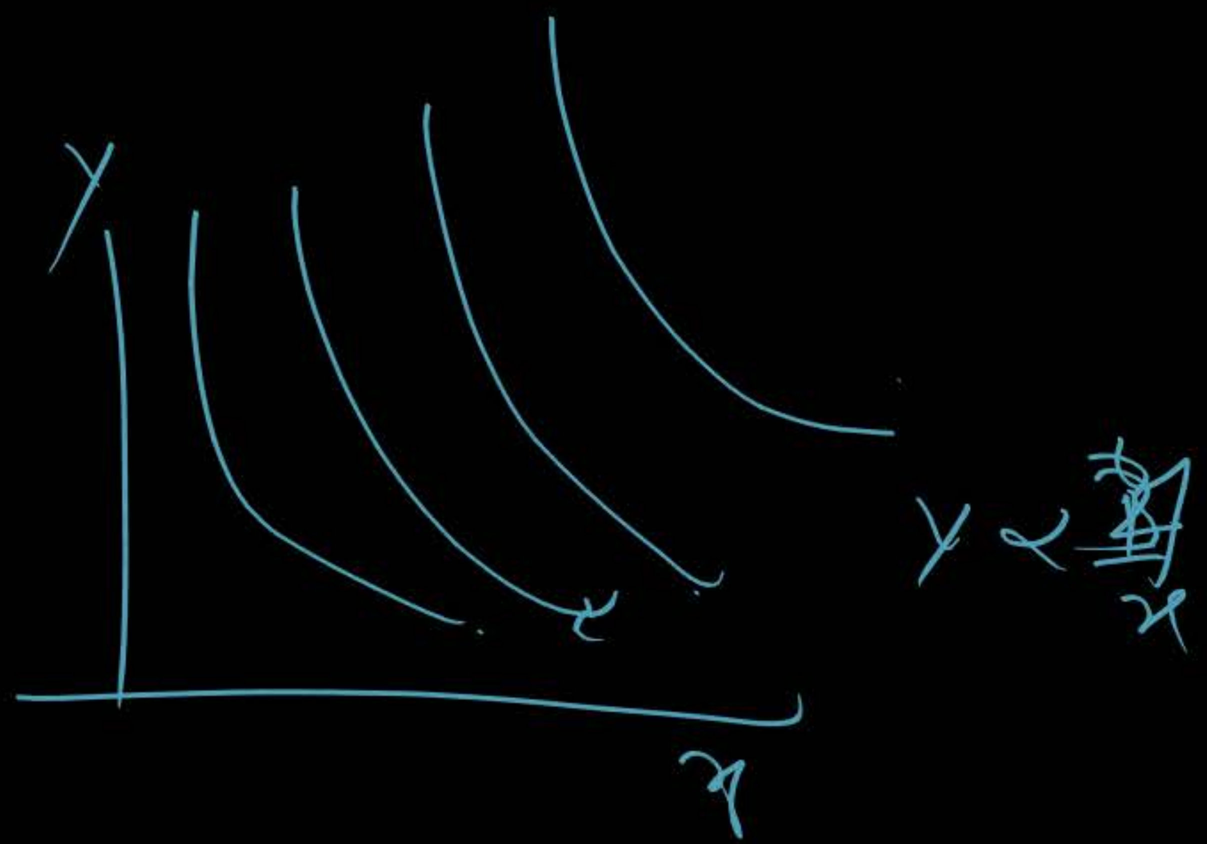
2. Correct option for Tempr for given graph.

(A) Tempr always Incrs.

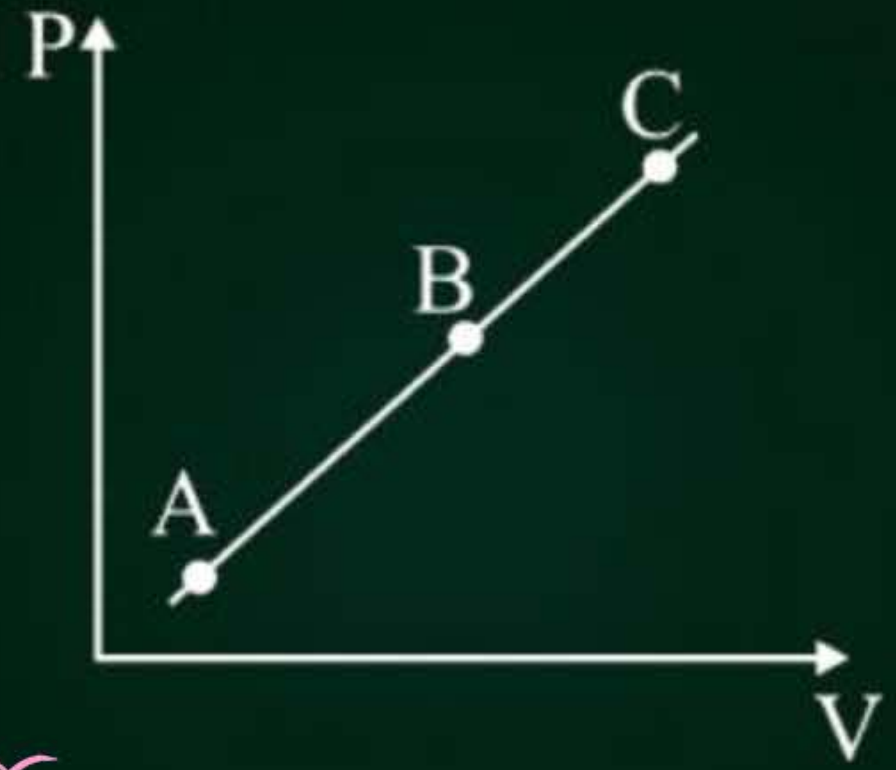
(B) tempr always decreas

(C) Temp 1st ↓ then ↑ (70%)

(d) Tempr 1st ↑ then ↓ (15%)


y
x

Which point is at higher Tempr.

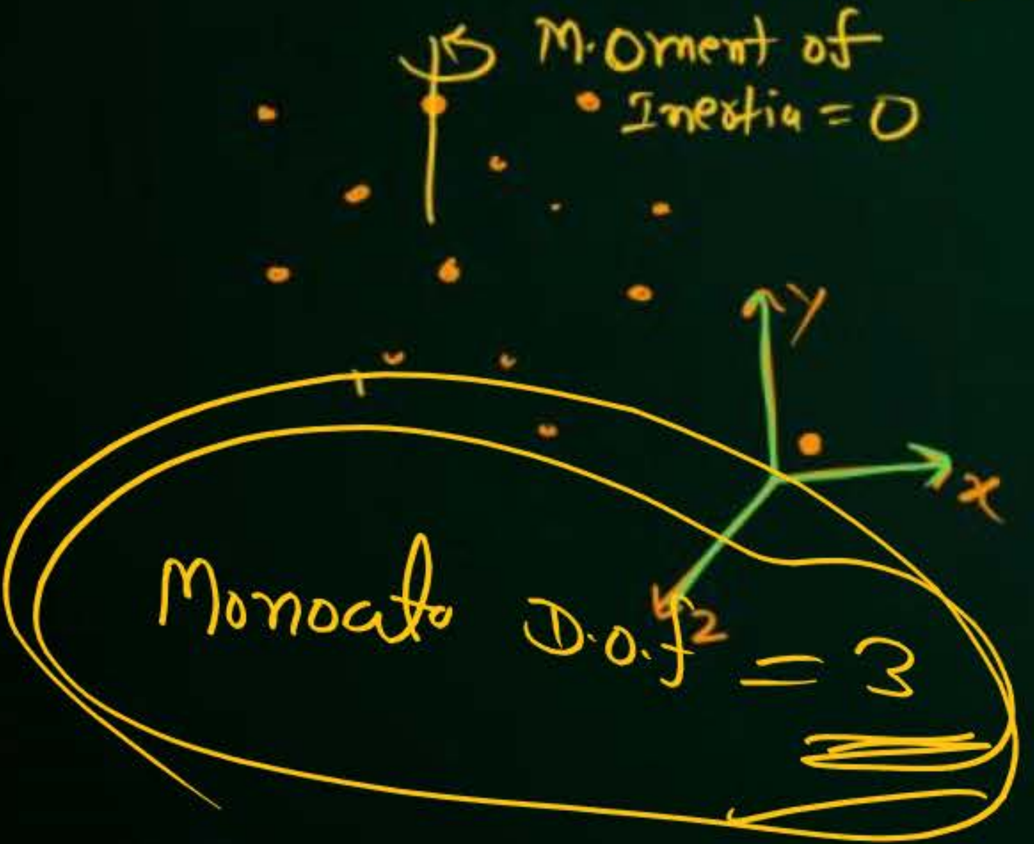


Revision of last lecture

DEGREE OF FREEDOM

➢ Degree of freedom is the number of independent ways in which K.E. of molecule define.

Monoatomic gas (ex.: Ne, He, Ar)

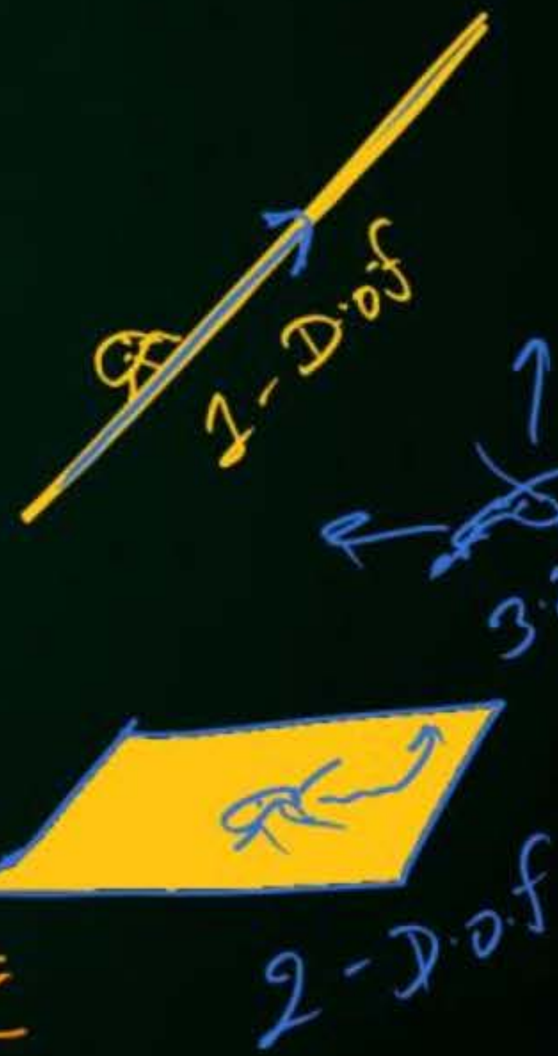


3 - Translational d.o.f.

Zero Rotational d.o.f

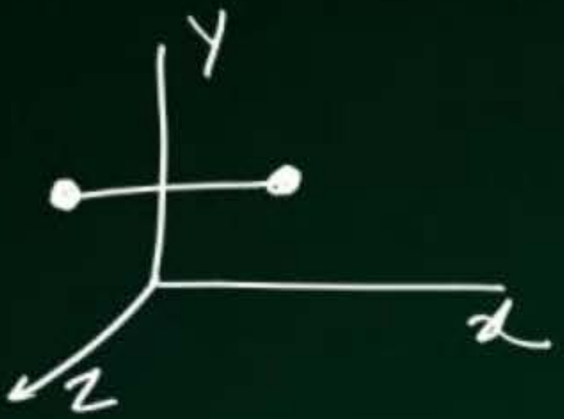
Zero vibrational d.o.f.

→ No vibrational d.o.f at any Tempr



➢ **Diatomic :**

(N_2, O_2, H_2)



At normal Tempr

3 → Translational d.o.f
2 – Rotational d.o.f

(d.o.f) = 5

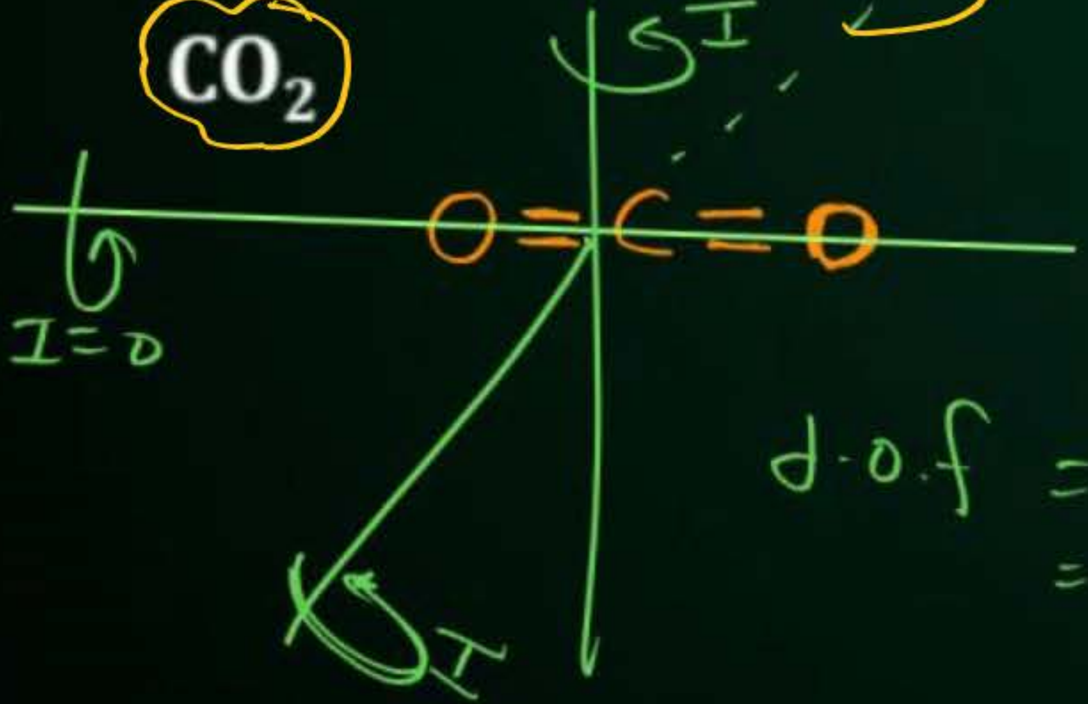
At very high Tempr

3 → Translation d.o.f
2 → Rotational d.o.f
2 → vibrational

d.o.f = 7 at very high Tempr

➢ **Triatomic linear :**

CO_2

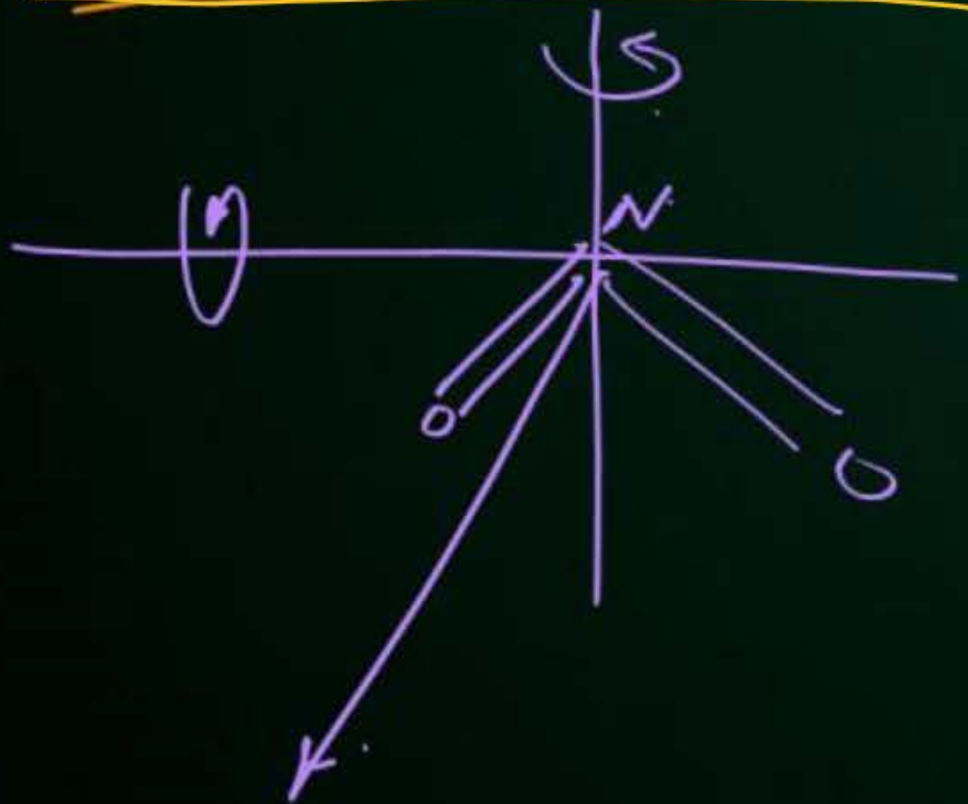


d.o.f = 3 Tran^n
= 2 Rot^n

- **Polyatomic gas :**

(SO_2, CH_4, NH_3)

- **Triatomic – Non-linear :**



at normal Tempr

→ 3 - Tran^n

→ 3 → Rot^n

d.o.f = 6

at high Tempr

⇒ 3 - Tran^n

⇒ 3 → Rot^n

n = vibrational d.o.f

n = as given in question

$U \propto K.E \propto$ Tempr

U (Intl energy) Per unit Molecule Per d.o.f $= \frac{1}{2} K_B T$

Internal energy of 1 molecule due to 1 d.o.f $= \frac{1}{2} K_B T$

Internal energy of N Molecule due to per d.o.f $= \frac{1}{2} K_B T N$

Intr energy of N Molecule due f degree $= \frac{1}{2} K_B N T f$

$$U = \frac{1}{2} N K f T$$

$$K_B = \frac{R}{N_A}$$

$$U = \frac{1}{2} N \frac{R}{N_A} f T$$

$$U = \frac{1}{2} n f R T$$

$$U = \frac{1}{2} n f R T = \frac{1}{2} N K f T$$

$$\Delta U = \frac{1}{2} n f R \Delta T$$

$$du = \frac{1}{2} n f R dT$$

$$\frac{fR}{2} = C_V$$

$$dU = n C_V dT$$

$$C_p - C_V = R$$

Molar heat capacity

$$\frac{C_p}{C_V} = \gamma$$

$$\gamma = 1 + \frac{2}{f}$$

$$\gamma - 1 = \frac{2}{f}$$

$$C_V = \frac{fR}{2} = \frac{R}{\gamma - 1}$$

$$du = \frac{1}{2} n f R dT$$

$$dU = \frac{n R dT}{\gamma - 1}$$

$$\Rightarrow S = \frac{dQ}{m\, dT}$$ = specific heat capacity per unit mass.

$$C = \frac{dQ}{dT}$$ Heat capacity

$$C_m = \frac{dQ}{n\, dT} = \frac{1}{n} m S$$

$$C_m = MS$$

molar heat capacity

C_P | C_V

$$C_V = \frac{fR}{2} = \frac{R}{\gamma - 1}$$

☆ Internal energy $U = K.E + P.E$ {sum of K.E & P.E of all the molecule}

for Ideal gas
$P.E = 0$

Internal energy $U = K.E$ of all molecule (only depend on Tempr)

Internal energy of 1 Molecule, due to 1 d.o.f is $\propto$ Tempr

$$U = \frac{K_B}{2} T$$

← Internal energy of one molecule due to 1 d.o.f.

Internal energy of N molecule due to 1 d.o.f $= \frac{1}{2} N K_B T$ ✓ ⊛

Internal energy of N Molecule due to f d.o.f $= \frac{1}{2} N f K_B T$

$$K_B = \frac{R}{N_A}$$

$$U = \frac{1}{2} \frac{N f R}{N_A} T = \frac{1}{2} n f R T$$

$$U = \frac{1}{2} n R f T$$

n = no. of mole T = Tempr
f = total d.o.f R = gas const.

$$U = \frac{1}{2} nRfT$$

$$\Delta U = \frac{1}{2} nRf \Delta T$$

- $$\Delta U = n C_v \Delta T$$

$$C_v = \frac{fR}{2}$$

$$\frac{C_p}{C_v} = \gamma$$

$$C_p - C_v = R$$

$$\gamma = 1 + \frac{2}{f}$$

γ — adibadic exponent

f — degree of freedom

Specific heat capacity $s = \frac{dQ}{m\,dT}$

m = mass of gas **

Heat Capacity

$$C = \frac{dQ}{dT}$$

molar heat capacity ↓ · Heat Capacity ↓

$$C_M = \frac{dQ}{n\,dT} = \frac{C}{n}$$

$$C_m = \frac{dQ}{n\,dT} = \frac{[m]s}{[n]}$$

$$C_m = Ms$$

↳ molar mass

Molar heat capacity

$$C_M = \frac{dQ}{n\,dT}$$

⇒ Heat Required to raise the Tempr. by unit °C per mole.

$dQ = C_m n\,dT$

$$C_m = \frac{dQ}{n\,dT}$$

$$dQ = C_m n\,dT$$

Heat supply at Volume = const^n

Molar heat capacity at constant Volume

$$dQ = C_v n\,dT \quad \text{—— (1)}$$

1st Law of thermodynamics

$$dQ = dW + dU$$

Volume = const^n (dW = 0)

$$dQ = dU$$

If heat supplied at constant Pressure

$$dQ = C_p n\,dT$$

at constant volume (dW = 0)

$$dQ = dU$$

$$C_v n\,dT = \frac{1}{2} n R f\,dT$$

$$C_v = \frac{fR}{2}$$

$$C_p - C_v = R$$

$$C_v = \frac{fR}{2}$$

$$C_p = \frac{fR}{2} + R$$

$$\frac{C_p}{C_v} = \gamma$$

$$\gamma = 1 + \frac{2}{f}$$

QUESTION

Find ratio of internal energy of dia-atomic and monoatomic gas both at temperature T, for translational d.o.f.

1. 3/5
2. 5/3
3. 2/3
4. 1/1

$U = \frac{1}{2} nRfT = \frac{3nRT}{2}$

$U = \frac{3nRT}{2}$

diatomic

45%

QUESTION

Find ratio of internal energy per d.o.f. of dia-atomic and monoatomic gas both at temperature T.

1. 3/5
2. 5/3 (76%)
3. 2/3
4. 1/1 (11%) correct

$U = \frac{1}{2} n R f T$

Total internal energy of monoatomic gas

$U = \frac{1}{2} n R 3 T$

Internal energy of monoatomic gas per d.o.f. $\frac{U}{3} = \frac{1}{2} n R T$

Internal energy of diatomic gas per degree of freedom $= \frac{\frac{1}{2} n R 5 T}{5}$

$\gamma = 1 + \frac{2}{f}$

$\gamma = 1 + \frac{2}{f} = 1 + \frac{2}{3}$

$\gamma = \frac{5}{3}$

gas	DOF	$C_V = \frac{fR}{2}$	$C_P = C_V + R$	$\gamma = \frac{C_P}{C_V}$
1. **Monoatomic**	3T + 0R = 3 (+0V)	C_V = 3R/2	C_P = 5R/2	5/3 ≈ 1.66
2. **Diatomic**	3T + 2R = 5	5R/2	7R/2	7/5 ≈ 1.4
3. **Triatomic (linear)** CO_2	3T + 2R = 5	5R/2	7R/2	7/5 ≈ 1.4
4. **Triatomic (non-linear)** Polyatomic	3T + 3R = 6	$3R = \frac{fR}{2}$	4R	4/3 ≈ 1.33
5. **Diatomic (at higher temperature)**	3T + 2R + 2Y = 7 (vibration)	7R/2	9R/2	9/7

Triatomic at higher → (3T + 3R + n vibration)*

n = given in question

(Q) If n_1 mole of gas having d.o.f f_1 at Tempr T_1 is mixed with another gas of n_2 mole of gas having d.o.f f_2 at Tempr T_2 is mixed then find Tempr of mixture ??

$$T_{mixture} = \frac{n_1 f_1 T_1 + n_2 f_2 T_2}{n_1 f_1 + n_2 f_2}$$

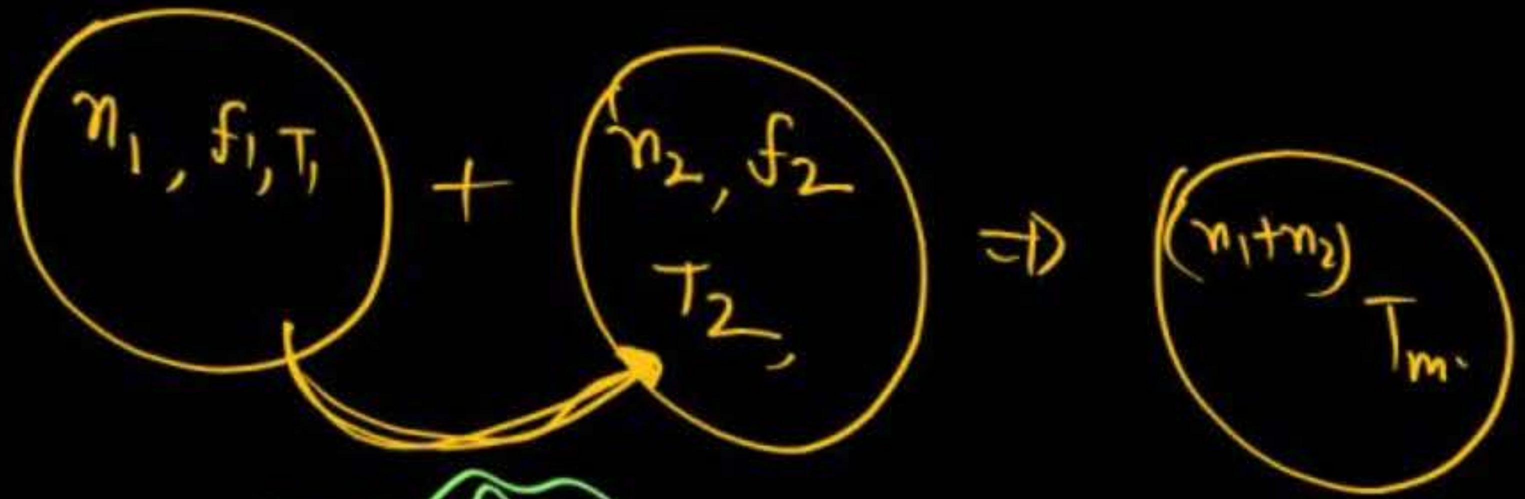
$$(C_V)_{mix} = \frac{n_1 C_{V_1} + n_2 C_{V_2}}{n_1 + n_2}$$

$$f_{mix} = \frac{n_1 f_1 + n_2 f_2}{n_1 + n_2}$$

$$(C_P)_{mix} = \frac{n_1 C_{P_1} + n_2 C_{P_2}}{n_1 + n_2}$$

$$\gamma_{mix} = \frac{n_1 \gamma_1 + n_2 \gamma_2}{n_1 + n_2} \quad \times \text{ — wrong}$$

$$\gamma_{mix} = 1 + \frac{2}{f_{mix}}$$



$$U = \frac{1}{2} n R f T$$

GAS MIXTURE

$(C_V)_{mix} = \dfrac{n_1 C_{V_1} + n_2 C_{V_2}}{n_1 + n_2}$

$(C_P)_{mix} = \dfrac{n_1 C_{P_1} + n_2 C_{P_2}}{n_1 + n_2}$

$f_{mix} = \dfrac{n_1 f_1 + n_2 f_2}{n_1 + n_2}$

$\gamma_{mix} = \dfrac{n_1 \gamma_1 + n_2 \gamma_2}{n_1 + n_2}$ → wrong

$\gamma_{mix} = \dfrac{(C_P)_{mix}}{(C_V)_{mix}} = 1 + \dfrac{2}{(f_{mix})}$

QUESTION

A polyatomic gas with n degrees of freedom has a mean energy per molecule given by [1989]

1. $\frac{nkT}{N}$
2. $\frac{nkT}{2N}$
3. $\frac{nkT}{2}$
4. $\frac{3kT}{2}$

51%

$U = \frac{1}{2} k_B T$

$U = \frac{1}{2} N k_B T f$

$\frac{U}{N} = \frac{1}{2} \frac{N k_B T n}{N} = \frac{1}{2} n k_B T$

QUESTION

The amount of heat energy required to raise the temperature of 1 g of Helium at N_1P, from T_2K is

[NEET 2013]

1. $\frac{3}{4}N_a k_B(T_2 - T_1)$
2. $\frac{3}{4}N_a k_b\left(\frac{T_2}{T_1}\right)$
3. $\frac{3}{8}N_a k_B(T_2 - T_1)$
4. $\frac{3}{2}N_a k_B(T_2 - T_1)$

$U = \frac{1}{2} N k_B f T = \frac{1}{2} N \frac{R}{N_A} f T$

$= \frac{1}{2} n R f T = \frac{1}{2} n k_B N_A T$

H/W

$U = \frac{1}{2} n f R T$

$n =$

$U = \frac{1}{2} n f R T$

$= \frac{1}{2} n f (k_B N_A) T$

$K_B = \frac{R}{N_A}$

$\Delta U \Rightarrow \frac{1}{2} \frac{1}{4} \times 3 (k_B N_A)(T_f - T_i)$

$N_A k_B = R$

no of mo-

$$U = \frac{1}{2} nRfT$$

$$U = \frac{1}{2} n k_B N_A f T$$

$$k_B = \frac{R}{N_A}$$

$$R = k_B N_A$$

QUESTION

To find out degree of freedom, the expression is [2000]

1. $f = \dfrac{2}{\gamma - 1}$
2. $f = \dfrac{\gamma + 1}{2}$
3. $f = \dfrac{2}{\gamma + 1}$
4. $f = \dfrac{1}{\gamma + 1}$

$\gamma = 1 + \dfrac{2}{f}$

$\gamma - 1 = \dfrac{2}{f}$

$\dfrac{1}{\gamma - 1} = \dfrac{f}{2}$

$f = \dfrac{2}{\gamma - 1}$

QUESTION

molar heat cap.

For hydrogen gas $C_P - C_V = a$ and for oxygen gas $C_P - C_V = b$, so the relation between a and b is given by [1991]

1. $a = 16b$
2. $16b = a$
3. $a = 4b$
4. $a = b$

$C_P - C_V = R$

QUESTION

For a certain gas the ratio of specific heats is given to be $\gamma = 1.5$. For this gas [1990]

1. $C_V = 3R/J$
2. $C_P = 3R/J$ ✓
3. $C_P = 5R/J$
4. $C_V = 5R/J$

$$C_V = \frac{R}{\gamma - 1} = \frac{fR}{2}$$

$$= \frac{R}{\frac{3}{2} - 1} = \frac{R}{1/2}$$

$$C_V = 2R$$

$$C_P - C_V = R$$

$$C_P = R + C_V = 3R$$

QUESTION

First law of thermodynamics is consequence of conservation of (1988)

1. work
2. energy
3. heat
4. all of these

QUESTION

The ratio of the specific heats $C_P/C_V = \gamma$ in terms of degree of freedom (n) is given by :

[AIPMT-2013]

1. $\left(1+\frac{n}{3}\right)$
2. $\left(1+\frac{2}{n}\right)$
3. $\left(1+\frac{n}{2}\right)$
4. $\left(1+\frac{1}{n}\right)$

$\gamma = 1 + \frac{2}{f}$


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 4 | Physics

Kinetic Theory of Gases and Thermodynamics

By- Dr. Manish Raj (MR SIR)



Topics to be covered

1 # Isothermal

→ Isochoric Process

2 # → Isobaric Process

→ adiabatic Process

3 # → Polytropic Process



Isothermal Process

(Boyls Law)

$Temp^r = cost^n$

$\Delta T = 0$

$dU = nC_v dT = 0$

* Internal energy = cst^n

slow process, reversible

$\Delta Q = \Delta U + \Delta W$ ($\Delta U = 0$)

$\Delta Q = \Delta W$

$PV = nRT = C$

$P \propto \frac{1}{V}$

$P_1V_1 = P_2V_2$

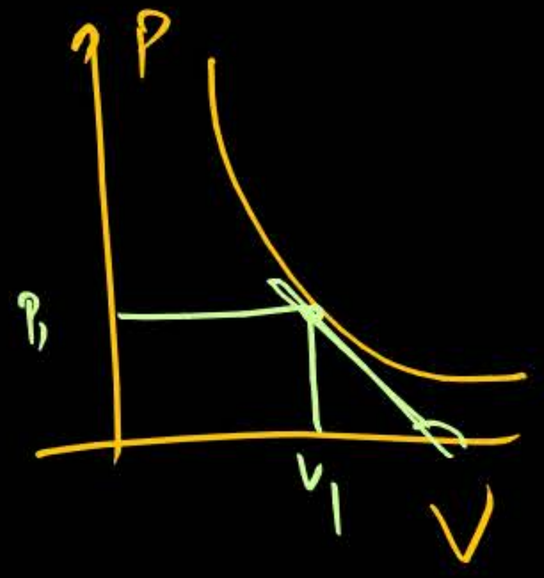
* $\frac{P_1}{P_2} = \frac{V_2}{V_1}$

$W = 2.303\, nRT \log_{10}\left(\frac{V_2}{V_1}\right)$

$= 2.303\, nRT \log_{10}\left(\frac{P_1}{P_2}\right)$

slope of PV graph for Isothermal Process

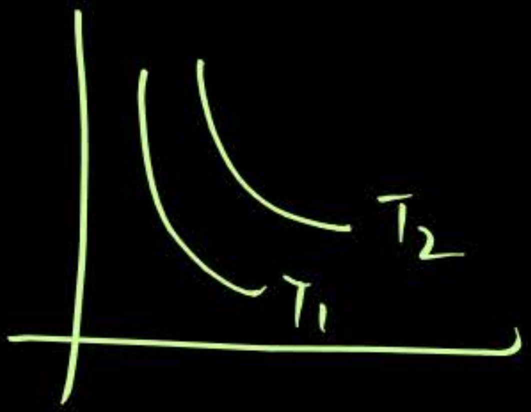
slope $\frac{dP}{dV} = ??$

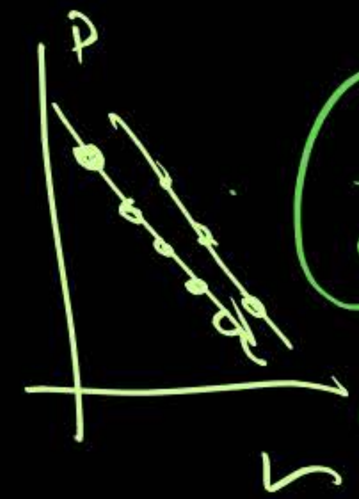


$PV = nRT$

$\frac{dP}{P} + \frac{dV}{V} = 0$

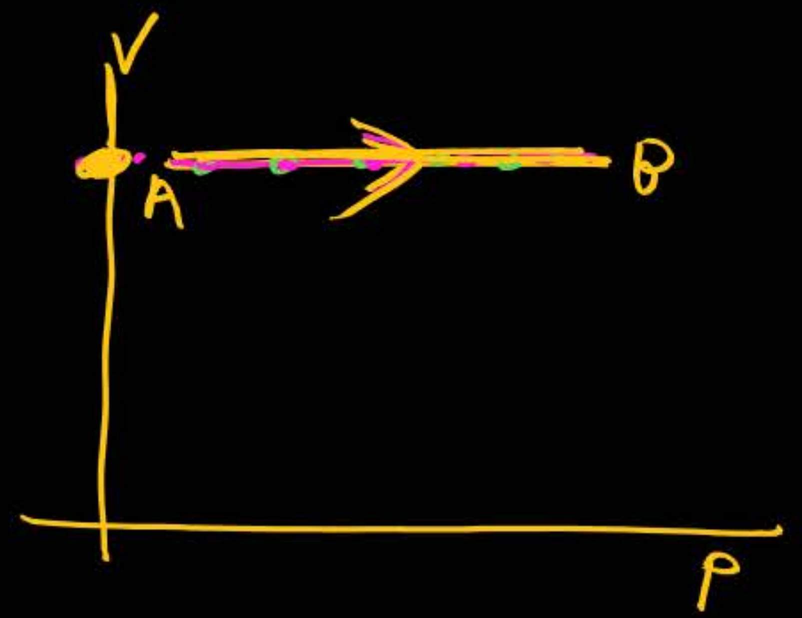
$\frac{dP}{P} = -\frac{dV}{V}$





$\frac{dP}{dV} = -\frac{P}{V}$

slope $= -\frac{P}{V}$



Isochoric Process

Variation of Tempr for given Volume - Pressure graph.

(a) Increase ✓

(b) decrease

(c) 1st ↑ then ↓

(d) 1st ↓ then ↑

$PV = nRT$

$\uparrow P\,V = nR\,T\uparrow$

(V and nR: const^n)

THERMODYNAMIC PROCESS

Isochoric Process
(Gay-Lussac Law)

Volume of gas = const

change in volume = $\Delta V = 0$

Work = 0



1st Law of thermo

$dQ = dU + dW^{0}$

$dQ = dU$

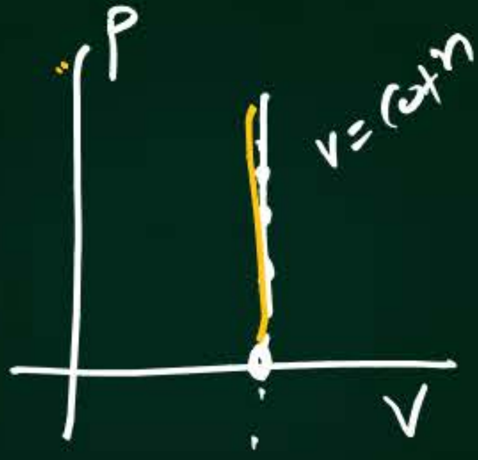
gas eqn

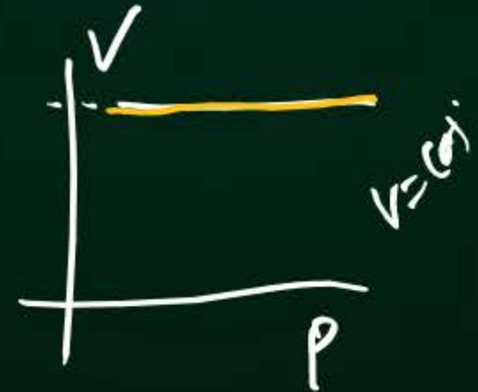
$PV = nRT$

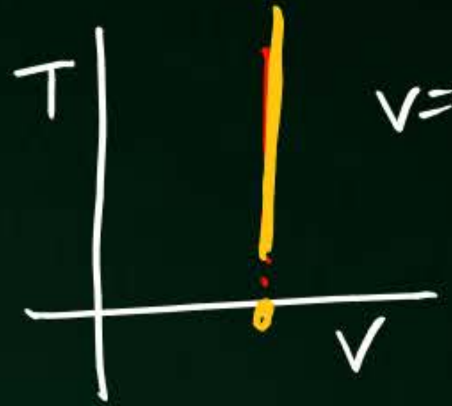
const

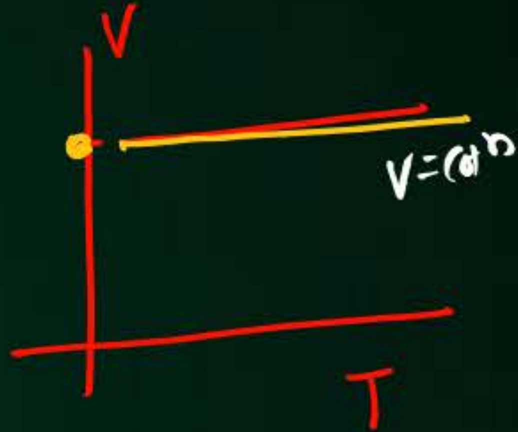
$P \propto T$

$$\frac{P_1}{P_2} = \frac{T_1}{T_2}$$









$P = \left(\frac{nR}{V}\right)T$

$P \propto T$

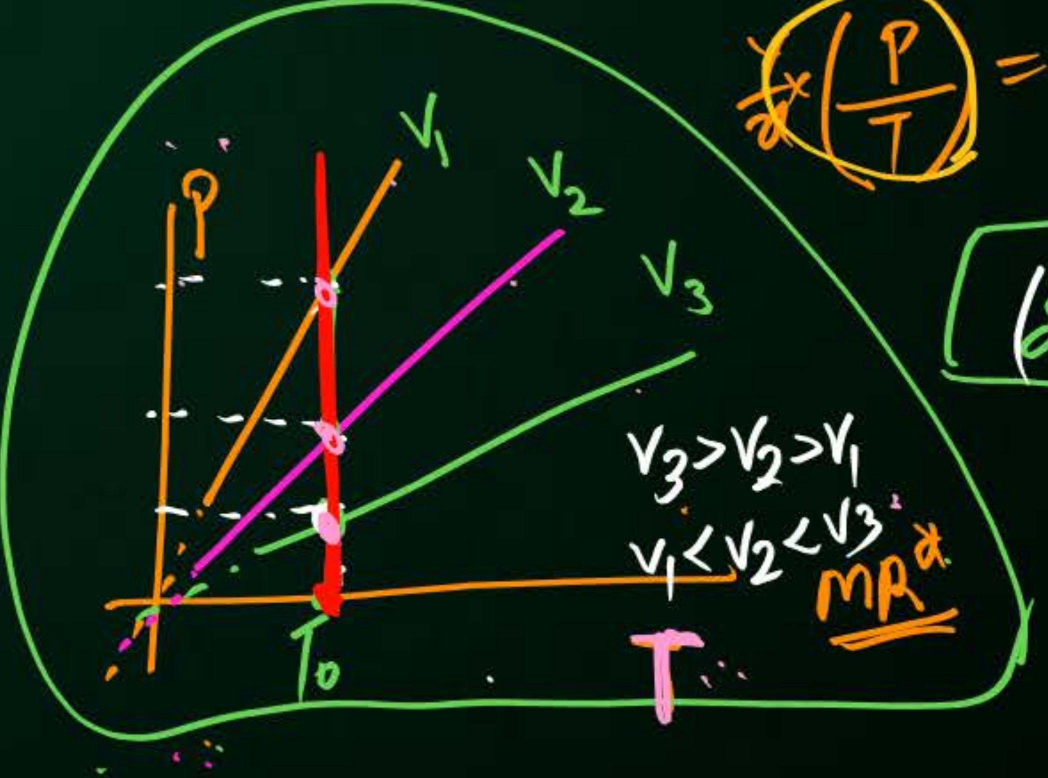


Pressure ∝ Temp

$PV = nRT$

$\left(\frac{P}{T}\right) = \frac{nR}{V}$ = slope

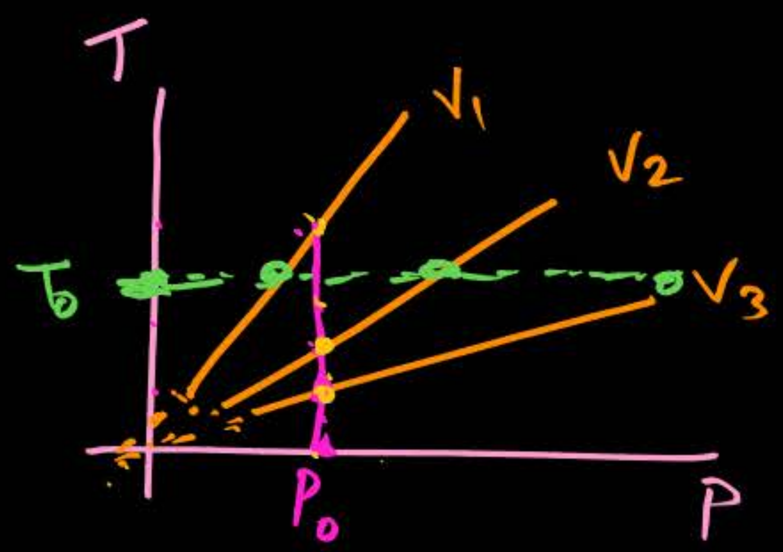
$(\text{slope})_{PT} \propto \frac{1}{\text{volume}}$



$V_3 > V_2 > V_1$

$V_1 < V_2 < V_3$

$m_R \propto$



$V_3 < V_2 < V_1$

The MR*

at const Pressure P_0 if we move up tempr ↑ hence V ↑

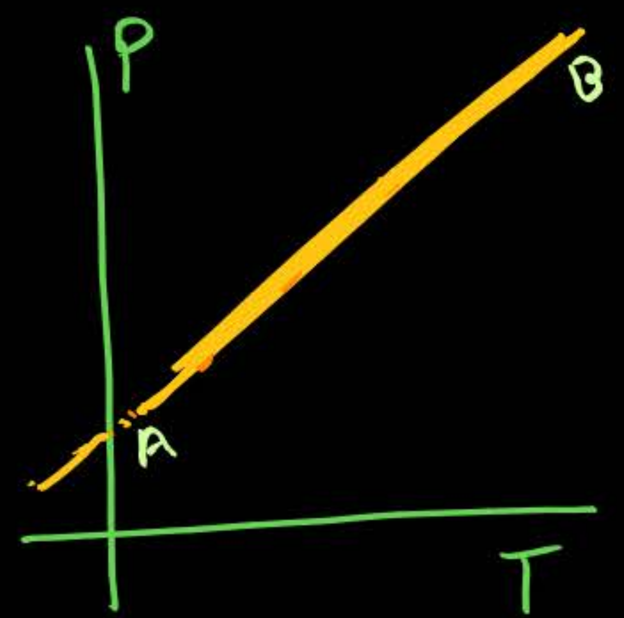
$PV \uparrow = nRT \uparrow$

(P) → const

$PV = nRT$

$V = nR \frac{T}{P}$

(T/P) → slope ∝ V



This graph is not representing Isochoric process

In this graph ??

(a) Volume constn. ✗

(b) Volume variable ✓

(c) Pressure is directly proportional to Tempr. ✗

(d) Pressure is linearly varying with tempr. ✓

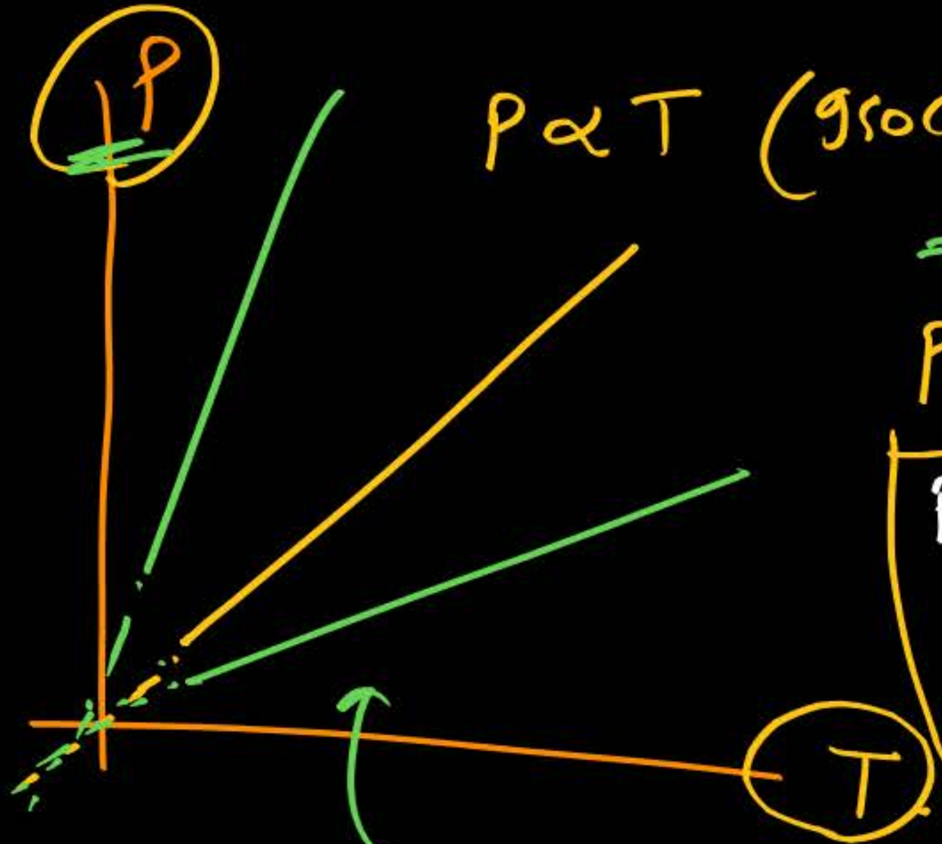
Correct option

(i) a, c ✗

(ii) b, c, d ✗

(iii) a, c, d ✗ 53%

(iv) b, d ✓ (16%)



all are for Isochoric Process

$P \propto T$ (Isochoric Process)

* gas equation

$PV = nRT$ ($V = \text{const}^n$)

$$P = \left(\frac{nR}{V}\right) T$$

$$y = mx + C$$

Compare

$$m(\text{slope}) = \frac{nR}{V}$$

$$C = 0$$

directly Proportional

$P \propto T$

$C = 0$

$$P = KT + C$$

Relⁿ B/W Press & Temp is linear

Q) If frequency of photon becomes double then K.E. of e^-s will be ??

(a) double ✗

(b) Less than double ✗

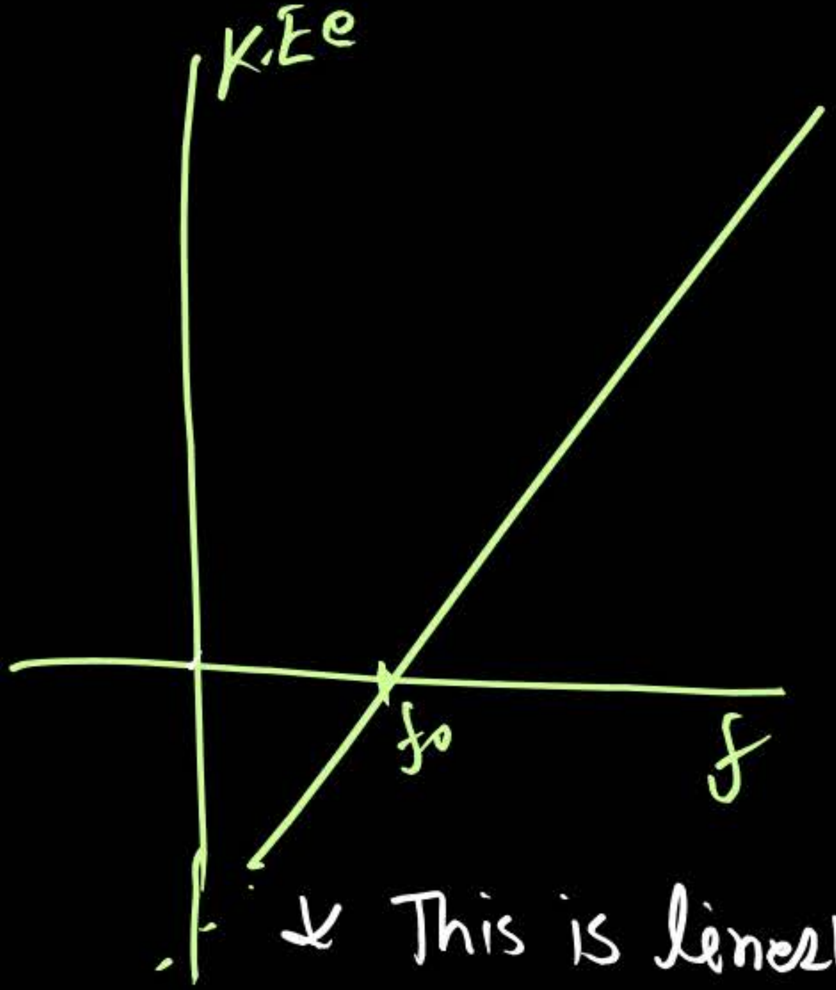
(c) Same ✗

(d) more than double ✓

(44%)

No Battery charge wait for 10 mint

$E = hf$ → 2 time



This is linearly dependent b/w K.E & frequency but not directly proportional

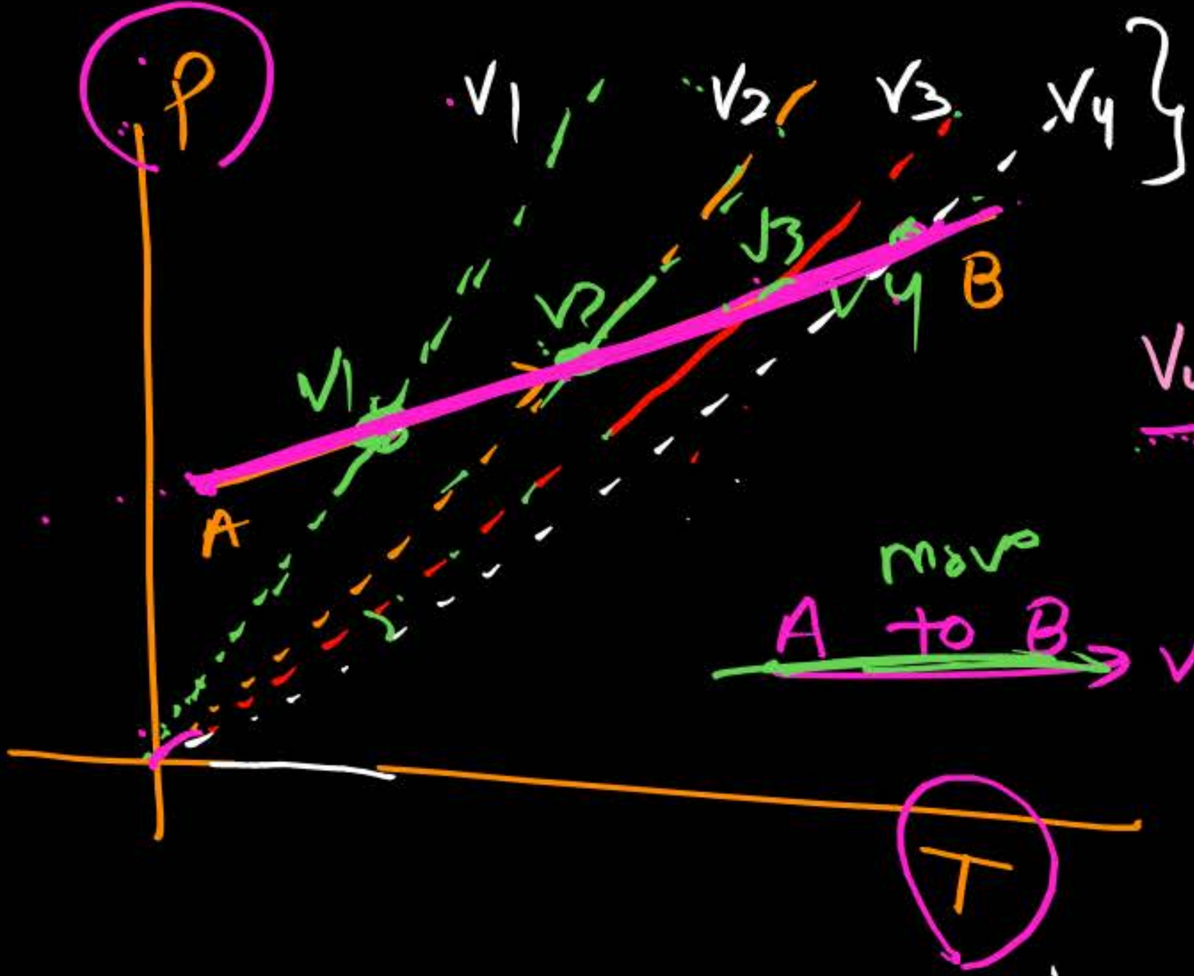
$E_p = \phi + K.E_e$

$K.E_e = E_p - \phi$

$K.E_e = hf - \phi$

Ex $E_p = 10eV$, $\phi = 7eV$, $K.E_e = 3eV$

frequ = double → $E_p = 20eV$, $\phi = 7eV$, $K.E_e = 13eV$



} these all are isochoric curve.

$V_4 > V_3 > V_2 > V_1$

move A to B → volume ↑ ⇐ slope

What about volume in given graph as gas moves from A to B.

~~(a) V = const~~

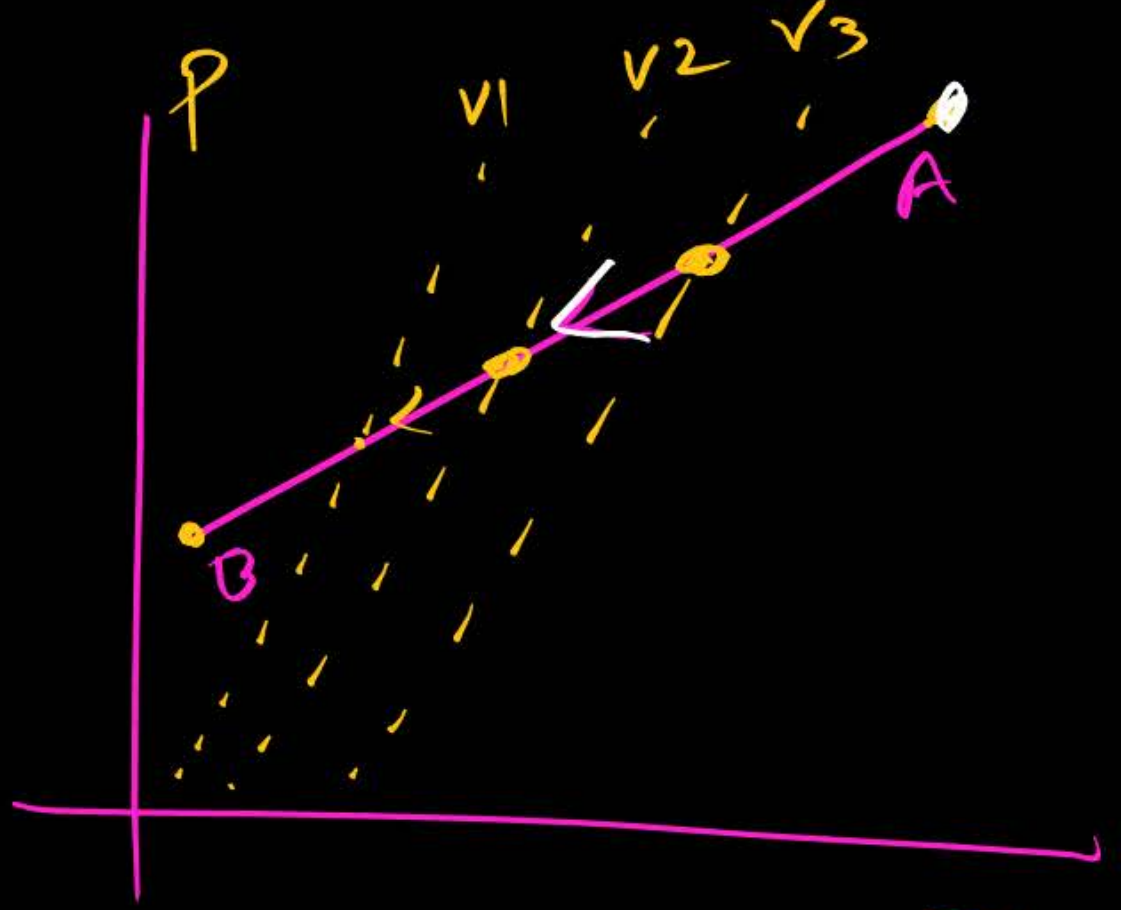
(b) V → continuously increases ✓✓ (b)

(c) V → continuous decrease

(d) 1st ↑ then ↓

(e) 1st ↓ then ↑

This graph not representing isochoric process. hence volume variable.



$V_1 < V_2 < V_3$

Slope $\propto \frac{1}{\text{Volu.}}$

A ⟶ B

volume decreas

GRAPH FOR ISOCHORIC PROCESS

focus Se Padho → voice samjhne ke liye must Nahi hai

Isobaric Process

→ Charls Law

- Pressure = cot^n

1st Law

$dQ = dU + dW$

given heat ka kuch part work and kuch part Internal enegy me Jayga.

Nothing is zero here.

$$\frac{dQ}{\gamma} = dU$$

$$dQ\left(1 - \frac{1}{\gamma}\right) = dW$$

gas equation

$PV = nRT$

→ $P = cost^n$ ✓

$V = \left(\frac{nR}{P}\right) T$ — cot^n

$V \propto T$

follow same flow/ patern

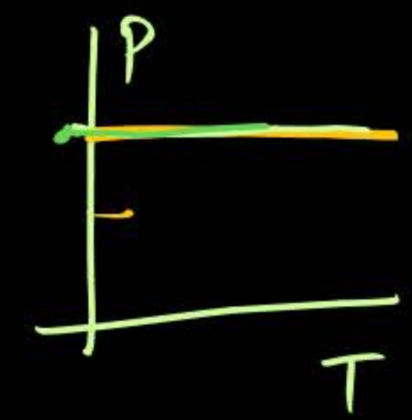
$Work = P \Delta V$

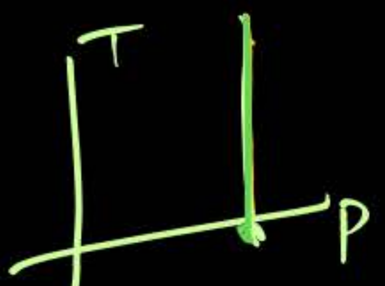
$= P(V_f - V_i)$

$P = cot^n$

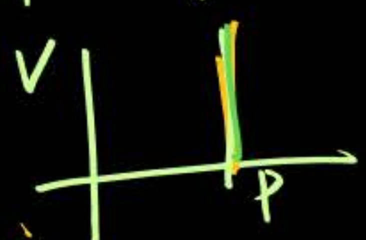
$$\frac{V_1}{V_2} = \frac{T_1}{T_2}$$

$P = cot^n$







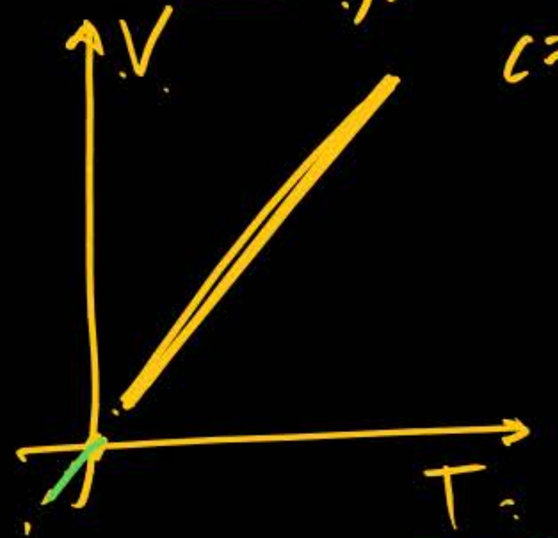


- $PV = nRT$

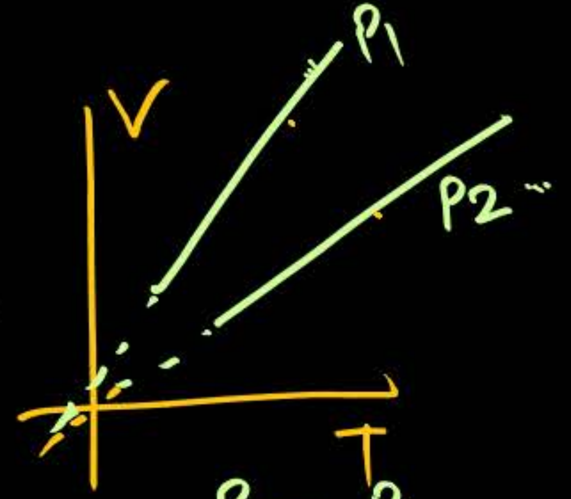
$V = \left(\frac{nR}{P}\right) T$

$y = mx + c$

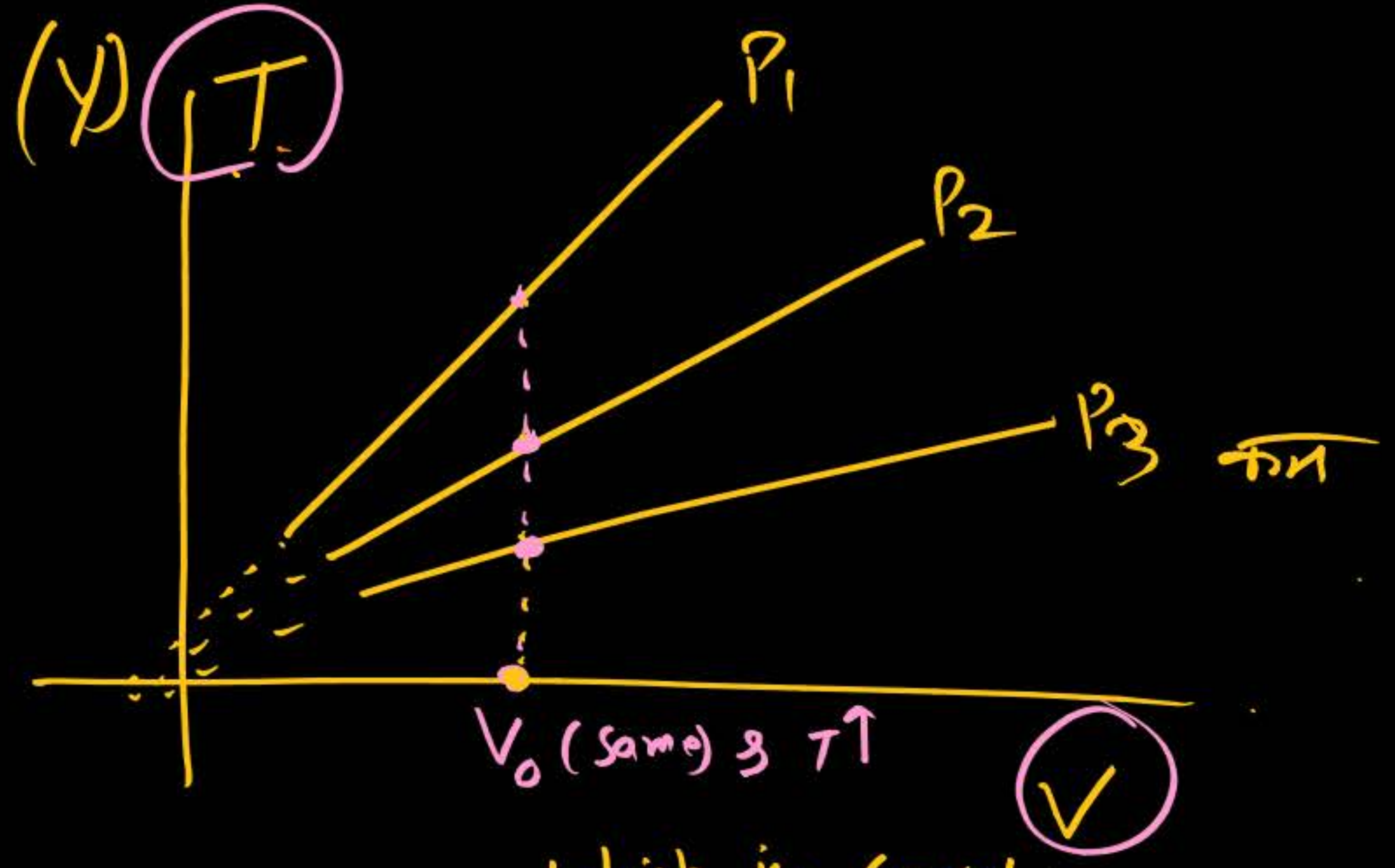
$c = 0$



$$slope \propto \frac{1}{P}$$



$P_2 > P_1$



Which is correct ??

(a) $P_1 < P_2 < P_3$ (20)

(b) ✓ $P_1 > P_2 > P_3$ (77%)

nR$^\alpha$ $V_0 \rightarrow$ same

T ↑

$\uparrow P \textcircled{V} = \textcircled{nR} T \uparrow$

मजदूरी

Slope ∝ Pressure

$PV = nRT$

$P = \frac{nR T}{V}$ (slope)

$\frac{T}{V} = \frac{P}{nR}$

Slope ∝ Pressure

for Isobaric Process

$P = \text{const}^{n}$

heat given at Constant Pressure

1st Law of thermodynamics

$$\frac{C_P}{C_V} = \gamma$$

$dU = \frac{1}{2} nRf\Delta t$

$$dU = nC_V dT$$

$$dQ = dU + dW$$

divided by dQ both side

$$\frac{dQ}{dQ} = \frac{dU}{dQ} + \frac{dW}{dQ}$$

$$1 = \frac{nC_V dT}{nC_P dT} + \frac{dW}{dQ}$$

$$1 = \frac{1}{\gamma} + \frac{dW}{dQ}$$

$$\left(\frac{dW}{dQ}\right) = 1 - \frac{1}{\gamma} = \frac{\gamma - 1}{\gamma}$$

Now question is (given heat ka kitna work hoga or kitne heat ke karan internal energy change hoga.

$$\frac{dW}{dQ} = \left(1 - \frac{1}{\gamma}\right) *$$

$$1 = \frac{dU}{dQ} + \frac{dW}{dQ}$$

$$1 = \frac{dU}{dQ} + 1 - \frac{1}{\gamma}$$

$$\frac{dU}{dQ} = \frac{1}{\gamma}$$

$$dU = \frac{dQ}{\gamma}$$

nR

QUESTION

$\gamma = \frac{7}{5}$ $\quad$ $\gamma = 1 + \frac{2}{f} = 1 + \frac{2}{5} = \frac{7}{5}$

When an ideal diatomic gas is heated at constant pressure then what fraction of heat given is used to increase internal energy of gas ?

1. 5/7 (90%)
2. 3/7
3. 3/5
4. 2/5

$$dU = \frac{dQ}{\gamma}$$

adiabatic Process

heat exchange = 0

$dQ = 0$

fast Process

→ Not reversible

1st Law of thermodynamics

$dQ = dU + dW$ (with $dQ \to 0$)

$dU = -dW$

$dU + dW = \text{const}^n$

$dW = -dU$

$dQ = 0$

$dU = -dW$

expansion (volume ↑)

$dW = +ve$ ✓

$dU = -dW$ (with $dW \to +ve$)

$dU = -ve$

U ↓

Temp ↓

Cool - Cool.

---

compression

volume ↓

$dW = -ve$

for adiabatic: $dU = -dW$

$dU = +ve$

U ↑

Temp ↑

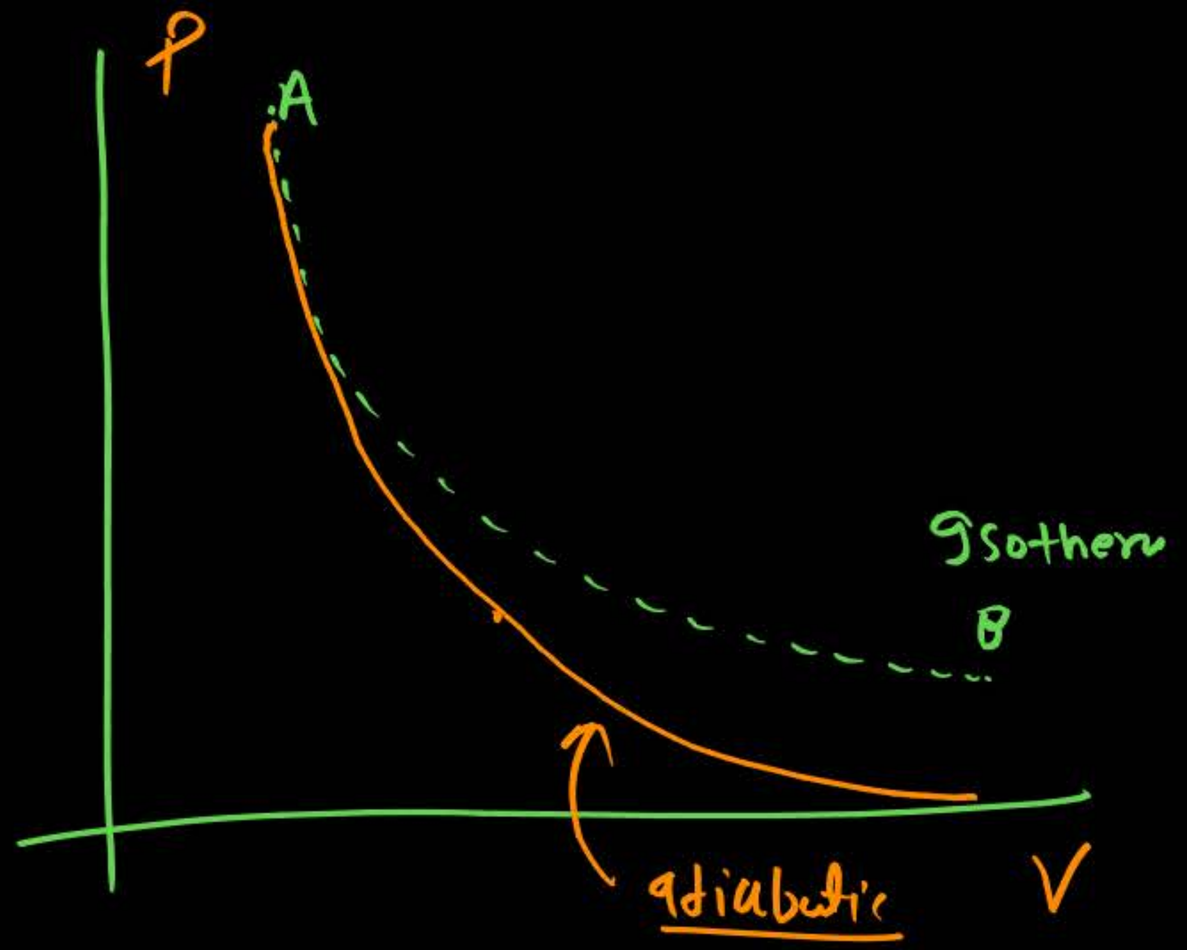
Hot_Hot

gas eq^n

$$PV^{\gamma} = \text{const}^n.$$

$$P_1 V_1^{\gamma} = P_2 V_2^{\gamma}$$

γ = adiabatic exponent



$$PV^{\gamma} = \text{const}^n$$

Partial diff^n

$$\frac{dP}{P} + \gamma \frac{dV}{V} = 0$$

$$\frac{dP}{P} = -\gamma \frac{dV}{V}$$

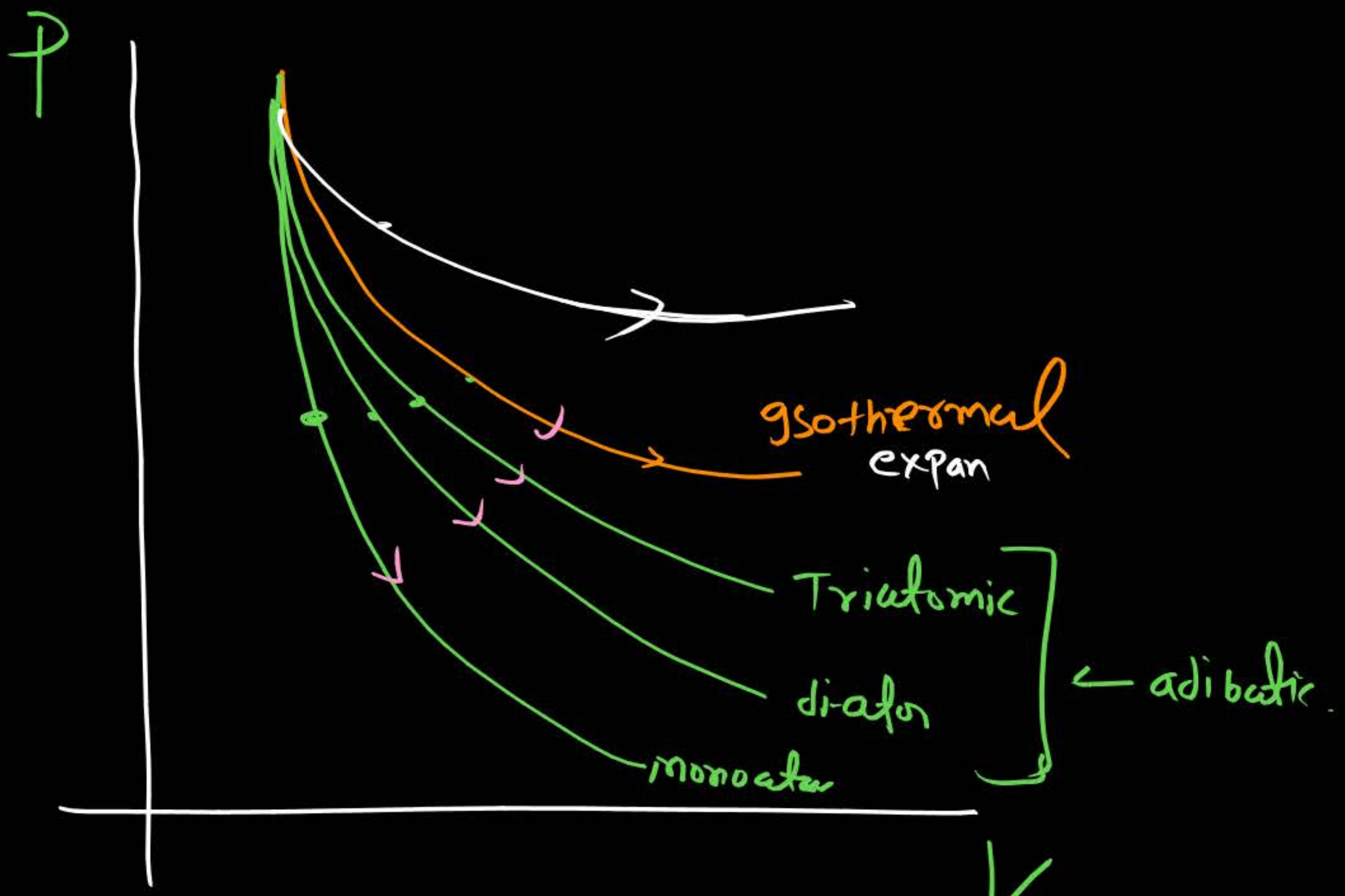
$$\frac{dP}{dV} = -\gamma \left(\frac{P}{V}\right)$$

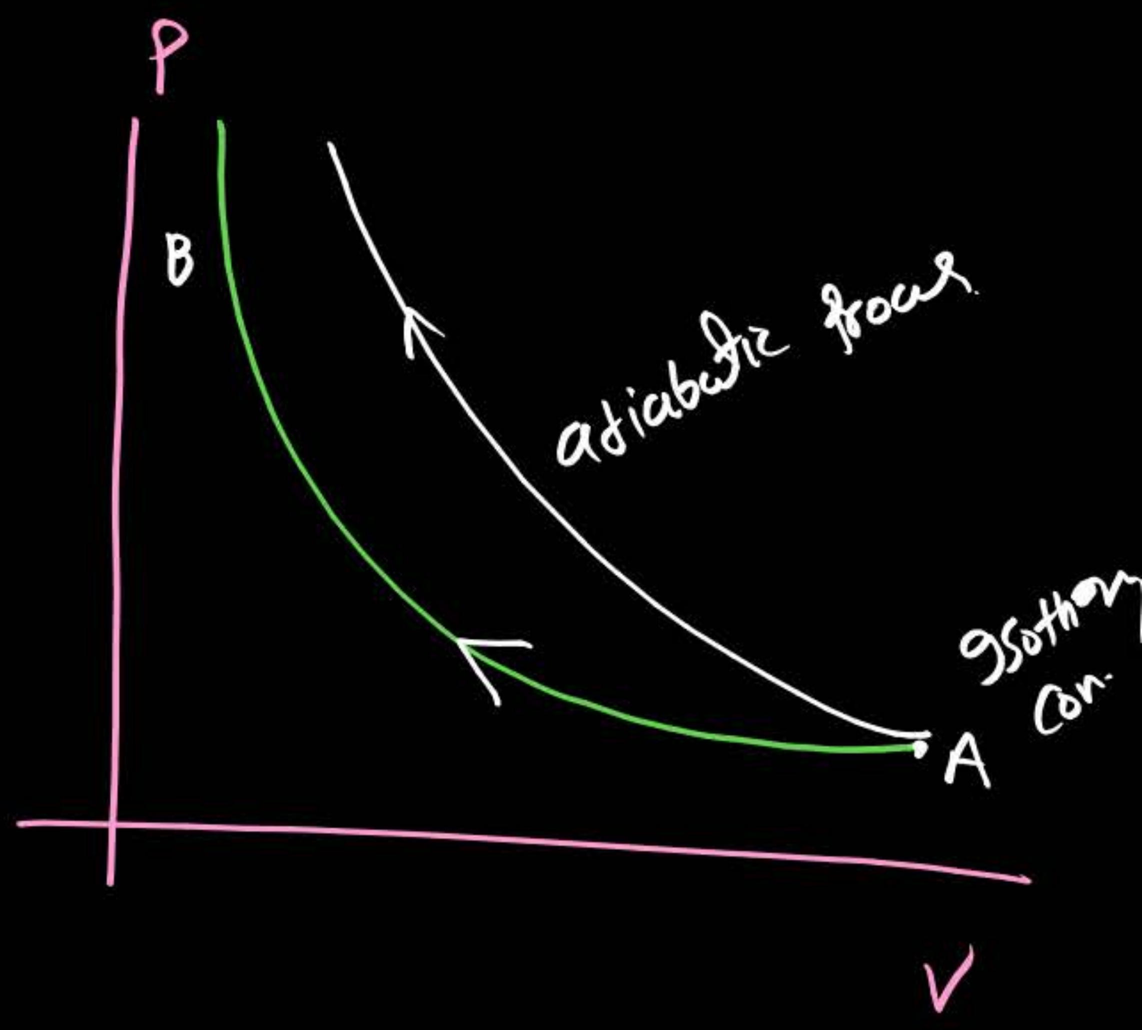
$$PV^{\gamma} = \text{const}^n$$

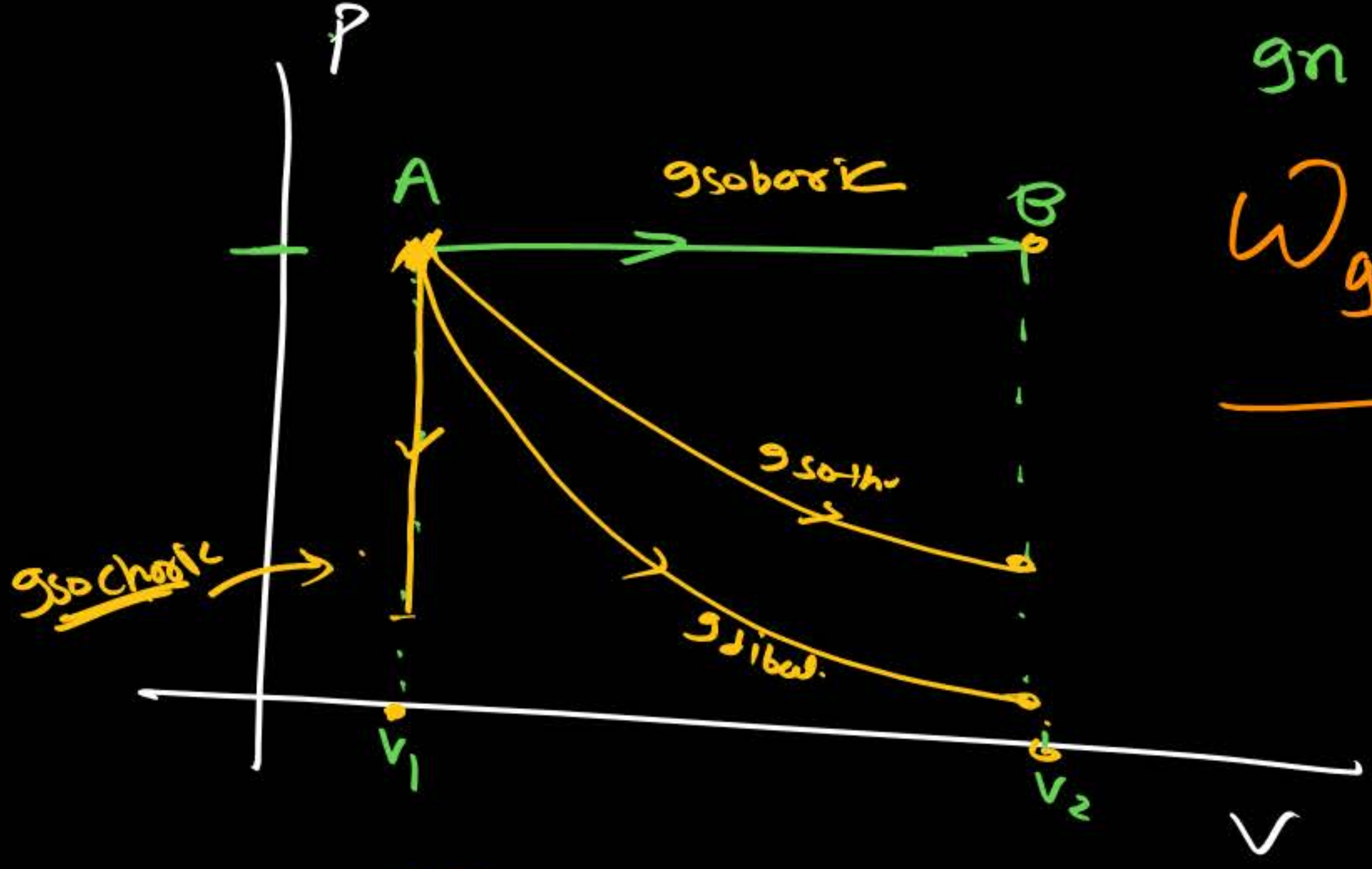
$$P = \frac{c}{V^{\gamma}}$$

$$\gamma_{\text{monoatomic}} > \gamma_{\text{diatomic}} > \gamma_{\text{triatomic}}$$

Slope of adiabatic = γ (slope of isothermal)


P
gsothermal
expan
Triatomic
diaton
monoatom
adibatic
V

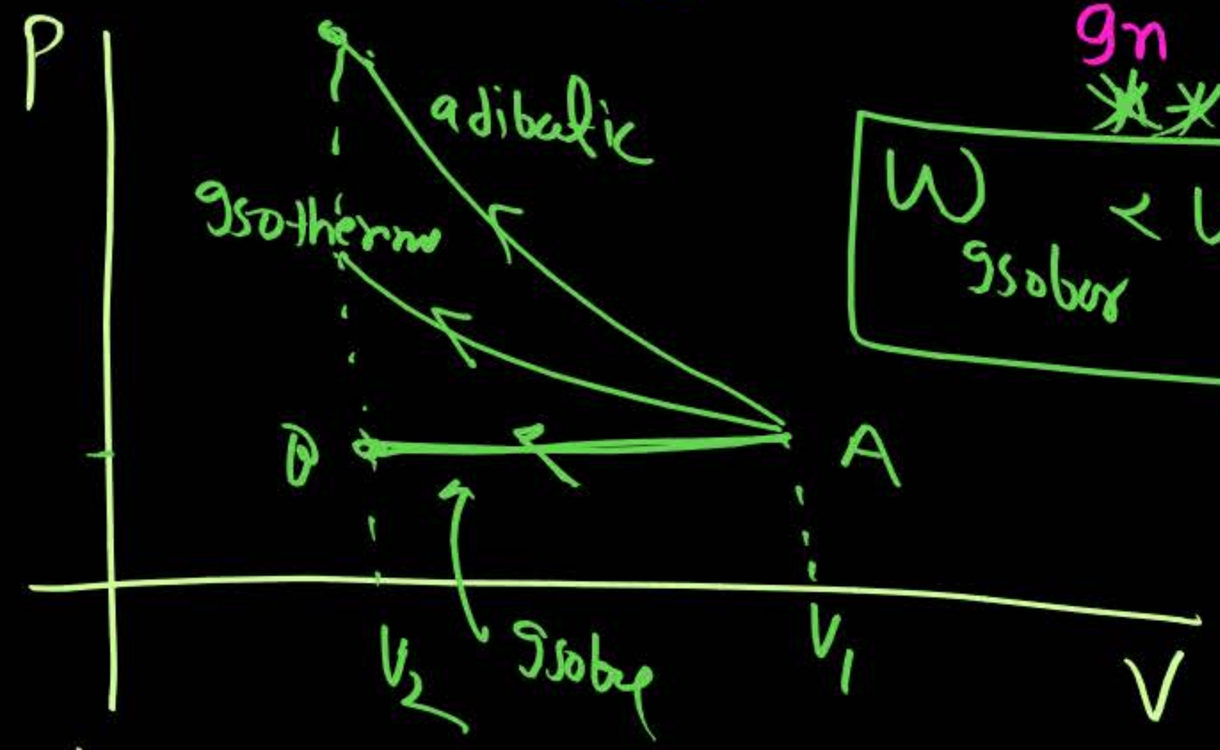

P
B
adiabatic proces
gsotherm
con.
A
V



In a case of expansion

$W_{Isobaric} > W_{Isotherm} > W_{adiabatic}$

$W_{Isochoric} = 0$



In Compression **

$W_{Isobar} < W_{Isotherm} < W_{adiabatic}$

(Q) If we move from one gaseous state to other state then work done is maximum in??

X (a) Isobaric 62%

X (b) adiabatic

X (c) Isothermal.

✓ (d) can't say (19%)

Work in adiabatic process

$$P_1V_1 = nRT_1$$

$$dQ^{\nearrow 0} = dU + dW$$

$$dW = -dU$$

$$dW = -nC_v dT$$

$$C_v = \frac{fR}{2} = \frac{R}{\gamma - 1}$$

$$dW = -nC_v dT$$

$$dW = -n\frac{R}{\gamma-1}dT$$

$$dW = \frac{nR}{1-\gamma}dT$$

$$dW = \frac{nR(T_2 - T_1)}{1-\gamma} = \frac{nRT_2 - nRT_1}{1-\gamma}$$

$$dW = \frac{P_2V_2 - P_1V_1}{1-\gamma}$$ **

QUESTION

The ratio of the slopes of adiabatic and isotherm is -

1. $1 : \gamma$
2. $1 : 1$
3. $\gamma : 1$
4. $1 : 4$

$$\frac{\text{Slop}}{(\text{Slop})_{\text{iso}}} = \frac{+\gamma \, P/V}{+P/V}$$

QUESTION

In an isothermal reversible expansion, if the volume of 96 gm of oxygen at 27°C is increased from 70 litres to 140 litres, then the work done by the gas will be

1. $300\,R\log_{10}2$
2. $81\,R\log_{e}2$
3. $900\,R\log_{10}2$
4. $2.3\times 900\,R\log_{10}2$

volum = double

$dW = 2.303\,nRT\log_{10}\left(\frac{V_2}{V_1}\right)$

$= 2.303\,nR(300)\log_{10}\left(\frac{140}{70}\right)$

$= 2.303\times 3\,R\times 300\log_{10}2$

QUESTION

During an adiabatic process, the pressure of a gas is found to be proportional to the cube of its temperature. The ratio of C_P/C_V for the gas is: [NEET-2013]

1. 3/2
2. 4/3
3. 2
4. 5/3

QUESTION

Which of the following is correct in terms of increasing work done for the same initial and final state?

1. Adiabatic < Isothermal < Isobaric
2. Isobaric < Adiabatic < Isothermal
3. Adiabatic < Isobaric < Isothermal
4. None of these

QUESTION

The molar specific heat at constant pressure of an ideal gas is $(7/2)R$. The ratio of specific heat at constant pressure to that at constant volume is (2006)

1. $9/7$
2. $7/5$
3. $8/7$
4. $5/7$

QUESTION

IIT-Adv 2016

Match the following ?

Column-I		Column-II	
(i)	Adiabatic expansion	(a)	No work done
(ii)	Isobaric expansion	(b)	Constant internal energy
(iii)	Isothermal expansion	(c)	Increase in internal energy
(iv)	Isochoric expansion	(d)	Decrease in internal energy

1. (i) – (a), (ii) – (d), (iii) – (b), (iv) – (c)
2. (i) – (d), (ii) – (a), (iii) – (c), (iv) – (b)
3. (i) – (d), (ii) – (c), (iii) – (b), (iv) – (a)
4. (i) – (a), (ii) – (b), (iii) – (d), (iv) – (c)

QUESTION

Identify the wrong statement

1. For isothermal process, $\Delta T = 0$ ✓
2. For isochoric process, $\Delta P = 0$ ✗
3. For adiabatic process, $\Delta Q = 0$ ✓
4. For cyclic process, $\Delta W = 0$ ✗

$\Delta U = 0$ ✓

Ans (3, 4) Both are wrong

Rel^n B/w P & V for adiabatic

$$PV^{\gamma} = \text{cost}^n$$

Rel^n B/w P & Tempr (T) for adiabatic process

$$PV^{\gamma} = \text{cont}^n$$

$$PV = nRT$$

$$V = \frac{nRT}{P}$$

$$P\left[\frac{T}{P}\right]^{\gamma} = \text{cont}^n$$

$$\frac{P^1 T^{\gamma}}{P^{\gamma}} = \text{cont}^n$$

$$P^{1-\gamma}T^{\gamma} = \text{cont}^n$$

$$T^{\gamma} = \frac{c}{P^{1-\gamma}}$$

$$T^{\gamma} = c\,P^{\gamma-1}$$

$$T^{\gamma} = c\,P^{\gamma-1}$$

($\gamma > 1$ always)

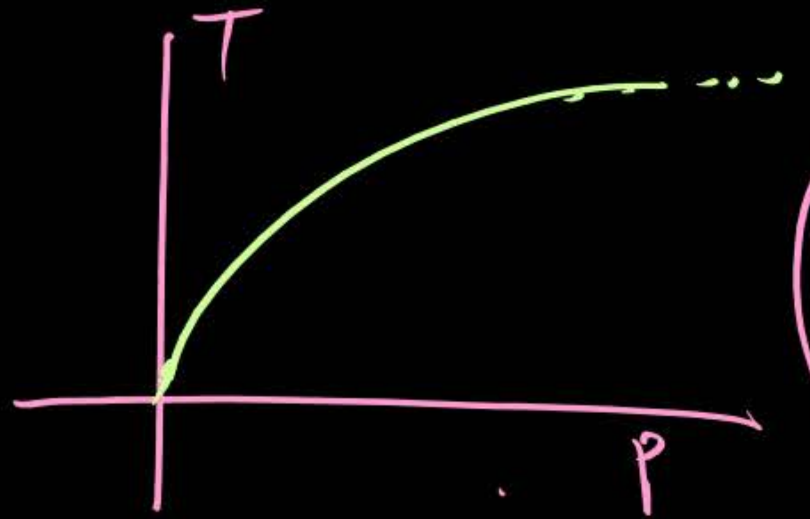
$$T^{1.5} = C\,P^{0.5}$$

$\gamma = 1.5$

If $\gamma = 2$

$$T^2 = c\,P^1$$

$$T \propto \sqrt{P}$$



graph B/w T & P for adiabatic curve

Rel^n b/w Temp^r & volume

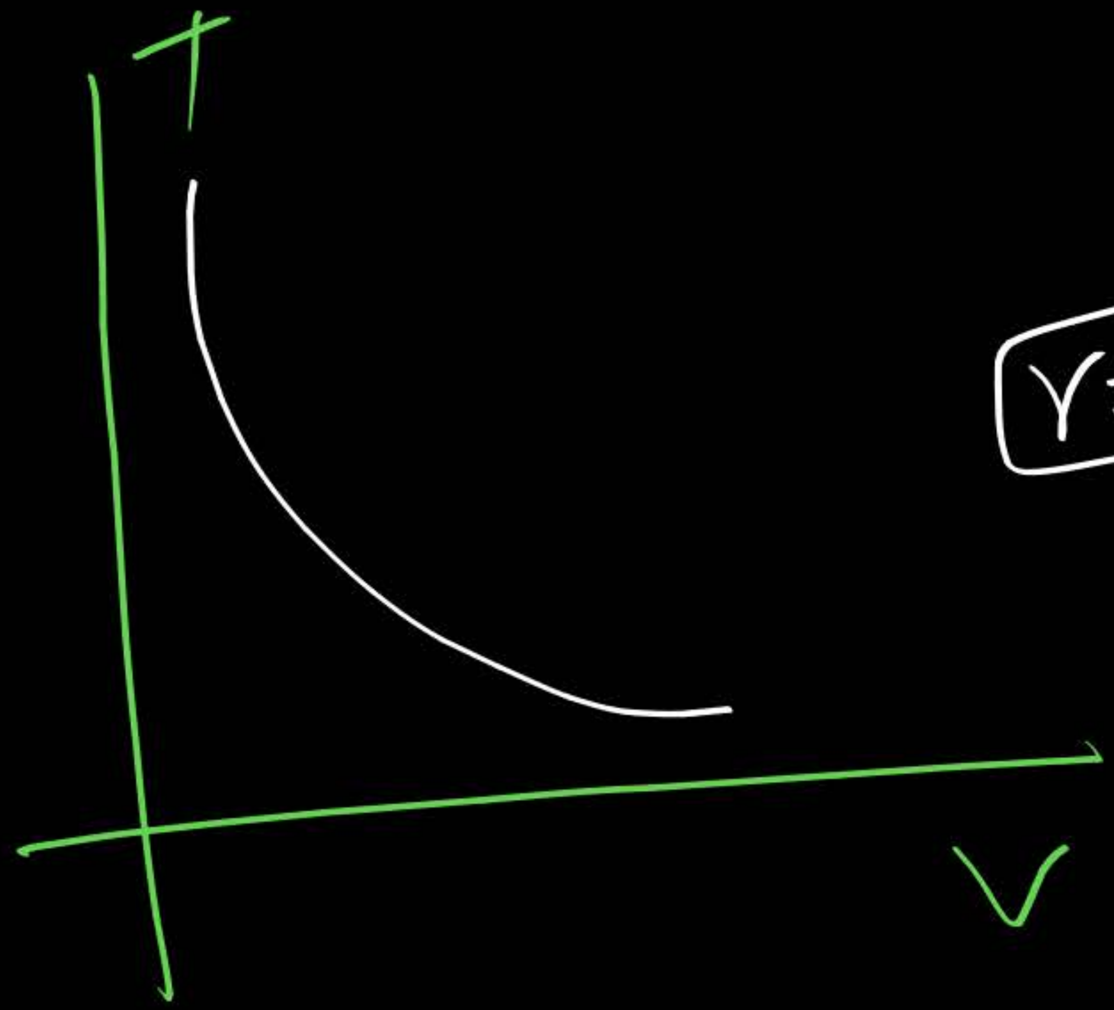
$PV^{\gamma} = \text{const}$ $PV = nRT$

$\frac{nRT}{V} V^{\gamma} = \text{const}$

$\frac{T}{V} V^{\gamma} = \text{const}$

$T V^{\gamma-1} = \text{const}$

$$T = c V^{1-\gamma}$$



$\gamma > 1$


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 05 | **Physics**

Kinetic Theory of Gases and Thermodynamics



By- Dr. Manish Raj (MR SIR)

Topics to be covered

1 #

2 #

3 #

Revision → 1 Page

Polytropic Process

graph → conversion

Heat engine/refrig → Not in Syllabus

K.T.G



Thermo^n. Process	Cont^n	zero	1st Law	slope P-V graph	Law	gas eqn	work
Isothermal (slow/reversible)	Temp^r cot^n	$\Delta T = 0$ $\Delta U = 0$	$\Delta Q = \Delta W$	$-P/V$	Boyls Law	$PV = cot^n$ $P_1V_1 = P_2V_2$	$W = 2.303 nRT \log_{10}\left(\frac{V_2}{V_1}\right)$
Isobaric process C_p	Pressure cont^n	$\Delta P = 0$	$\Delta W = dQ\left(1-\frac{1}{\gamma}\right)$ $\Delta Q = \Delta U + \Delta W$ $\Delta U = \frac{\Delta Q}{\gamma}$	slope = 0	Charls law	$PV = nRT$ $V \propto T$ $\frac{V_1}{V_2} = \frac{T_1}{T_2}$	$W = P\Delta V$ $= P(V_f - V_i)$
Isochoric process C_v	Volume Constant	$\Delta V = 0$ $W = 0$	$\Delta Q = \Delta U$	infinite slope of PV graph	gaylussac Law	$P \propto T$ $\frac{P_1}{P_2} = \frac{T_1}{T_2}$	$W = 0$
adiabatic process • fast / irreversible	heat = cot^n $PV^\gamma = cot^n$	$\Delta Q = 0$	$0 = \Delta U + \Delta W$ $\Delta W = -\Delta U$	$-\gamma P/V$	—	$PV = nRT$ $PV^\gamma = cost^n$	$W = -\Delta U$ $= -nC_v\Delta T$ $= -\frac{nR\Delta T}{\gamma - 1}$ $W = \frac{nR\Delta T}{1-\gamma}$
# Polytropic Process	$PV^x = cot^n$						

$\rightarrow C_m = C_v + \frac{R}{1-x}$

↳ Molar heat capacity only Polytropic

$W = \frac{nR\Delta T}{1-x}$

POLYTROPIC PROCESS

$$PV^{x} = \text{const}^n$$

$$P^{1-x}T^{x} = \text{const}^n$$

$$TV^{x-1} = \text{const}^n$$

adiabatic Process

$$PV^{\gamma} = \text{const}^n$$

$$P\left(\frac{T}{P}\right)^{\gamma} = \text{const}^n$$

$$\left(PV = nRT \quad V = \frac{nRT}{P}\right)$$

$$P^{1-\gamma}T^{\gamma} = \text{const}^n$$

$$\frac{T}{V}V^{\gamma} = \text{const}^n$$

$$TV^{\gamma-1} = \text{const}^n$$

$$C_m = C_v + \frac{R}{1-x}$$

$$C_m = \frac{R}{\gamma-1} + \frac{R}{1-x}$$

$$C_m = \frac{R}{1-x} - \frac{R}{1-\gamma}$$

$$C_m = \frac{R}{\gamma-1} - \frac{R}{a-1}$$

$$C_m = -\frac{R}{1-\gamma} - \frac{R}{a-1}$$

POLYTROPIC PROCESS

$PV^{x} = \cos t^{n}$ → $P \propto \frac{1}{V^{x}} \propto V^{-x}$

Work (W) $= \frac{nRdT}{1-x}$

Molar heat capacity $= C_V + \frac{R}{1-x}$

$C_M = \frac{R}{\gamma - 1} + \frac{R}{1-x}$

QUESTION

If Pressure is proportions to $(\text{Volume})^2$ then find molar heat capacity for monoatomic gas.

Sol^n

$$C_M = C_V + \frac{R}{1-x}$$

$$= \frac{fR}{2} + \frac{R}{1-(-2)}$$

$$= \frac{3R}{2} + \frac{R}{3}$$

$$= \frac{9R + 2R}{6} = \frac{11R}{6} \text{ Ans.}$$

$C_V =$

$P \propto V^2$

$PV^{-2} = \text{const}^n$

*

$PV^x = \text{const}^n$

$C_m = C_V + \frac{R}{1-x}$

$W = \frac{nR\Delta T}{1-x}$

increasing work

W_{gs} W_{ad} W_{gsol}

expansion

$W_{gsob} > W_{gsio}$

$C_p - C_v = a$

$C_p - C_v = b$

$C_p - C_v = R$

QUESTION

During an adiabatic process, the pressure of a gas is found to be proportional to the cube of its temperature. The ratio of C_P/C_V for the gas is: [NEET-2013]

1. 3/2
2. 4/3
3. 2
4. 5/3

$P \propto T^3$

$\frac{\gamma}{\gamma-1} = 3$

$\gamma = 3\gamma - 3$

$3 = 3\gamma - \gamma$

$3 = 2\gamma$

$\gamma = 3/2$

$PV^\gamma = \text{const}$

$P\left(\frac{T}{P}\right)^\gamma = C$

$P^{1-\gamma} T^\gamma = \text{const}$

$P^{1-\gamma} = T^{-\gamma}$

$P = T^{\frac{-\gamma}{1-\gamma}} = T^{\frac{\gamma}{\gamma-1}}$

QUESTION

For hydrogen gas $C_P - C_V = a$ and for oxygen gas $C_P - C_V = b$. So, the relation between a and b is given by

1. $a = 16b$
2. $16a = b$
3. $a = 4b$
4. $a = b$

QUESTION

An ideal gas has volume V_0 at 27 °C. It is heated at constant pressure so that its volume becomes $2V_0$. The final temperature is

1. 54 °C
2. 32.6 °C
3. 327 °C
4. 150 K

Isobaric (P = const)

$V \propto$ Tempr

V_0, 27°C → 300K

$2V_0$, $T_f = ?$

$V \propto T$

$$\frac{V_1}{V_2} = \frac{T_1}{T_2}$$

$$\frac{V_0}{2V_0} = \frac{300}{T_f}$$

$T_f = 600\,K$

$T_f = 600 - 273$

$= 327$

Rel^n

$$C_m = \frac{dQ}{n\,dT} \quad \text{—— (1)}$$

$$S = \frac{dQ}{m\,dT}$$

(A) $$C_m = MS$$

molar heat cap

$$C_p - C_v = R$$

$$MS_p - MS_v = R$$

$$S_p - S_v = \frac{R}{M}$$

QUESTION

If C_P and C_V denote the specific heats of nitrogen per unit mass at constant pressure and constant volume respectively, then

1. $C_P - C_V = \frac{R}{28}$

2. $C_P - C_V = \frac{R}{14}$

3. $C_P - C_V = R$

4. $C_P - C_V = 28R$

QUESTION

If $P \propto V^2$ then find molar heat capacity for monoatomic gas?

QUESTION good ques

If T^2V is constant then find molar heat capacity of 2 mole of diatomic gas and heat require to increase temperature by 20°C

$\Rightarrow T^2V = \text{const}^n$

→ taking Root both side

$\sqrt{T^2V} = \sqrt{\text{Kcal}}$

$TV^{1/2} = \text{const}^n$

we know that

$PV^{x} = \text{const}^n$

$\frac{T}{V}V^{x} = \text{const}^n$ (using Ideal gas $PV = nRT$, $P = \frac{T}{V}$)

$TV^{x-1} = \text{const}^n$

compare

$x - 1 = \frac{1}{2}$

$x = \frac{1}{2} + 1 = \frac{3}{2}$

$C_m = C_V + \frac{R}{1-x}$

$= \frac{5R}{2} + \frac{R}{1-\frac{3}{2}}$

$= \frac{5R}{2} - \frac{2R}{1}$

$C_m = \frac{5R - 4R}{2} = \frac{R}{2}$

$C_m = \frac{dQ}{n\Delta T}$

$dQ = nC_m\Delta T$

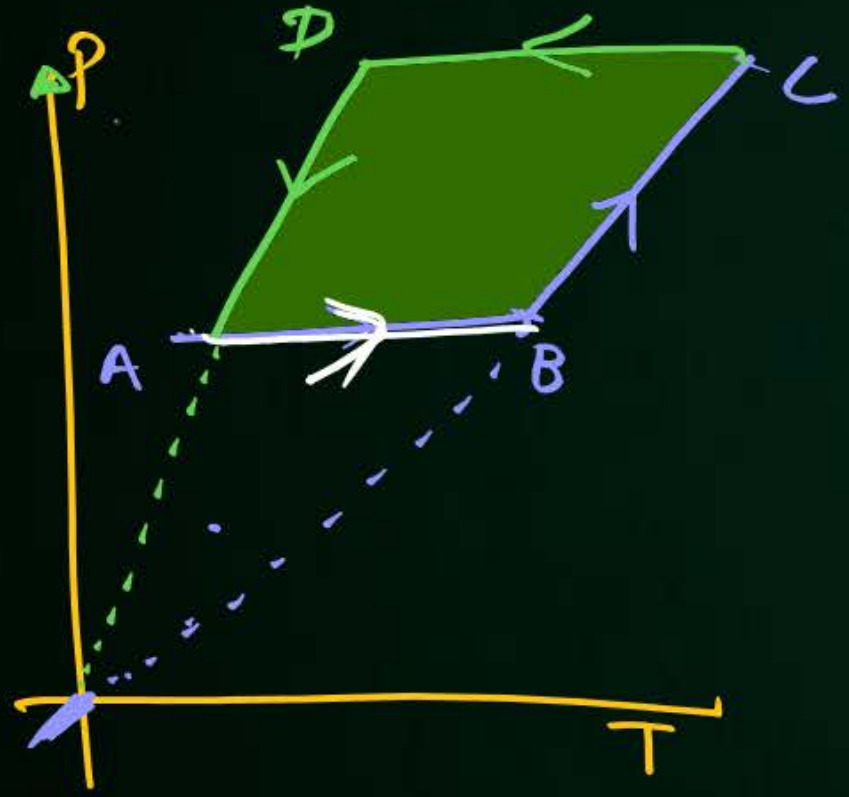
$= 2 \times \frac{R}{2} \times 20 = 20R$

Graph Conversion

In thermodynamics graph converted by the hellp of concept of Process.

mpt wrong graph fint

Convert PV graph into PT graph

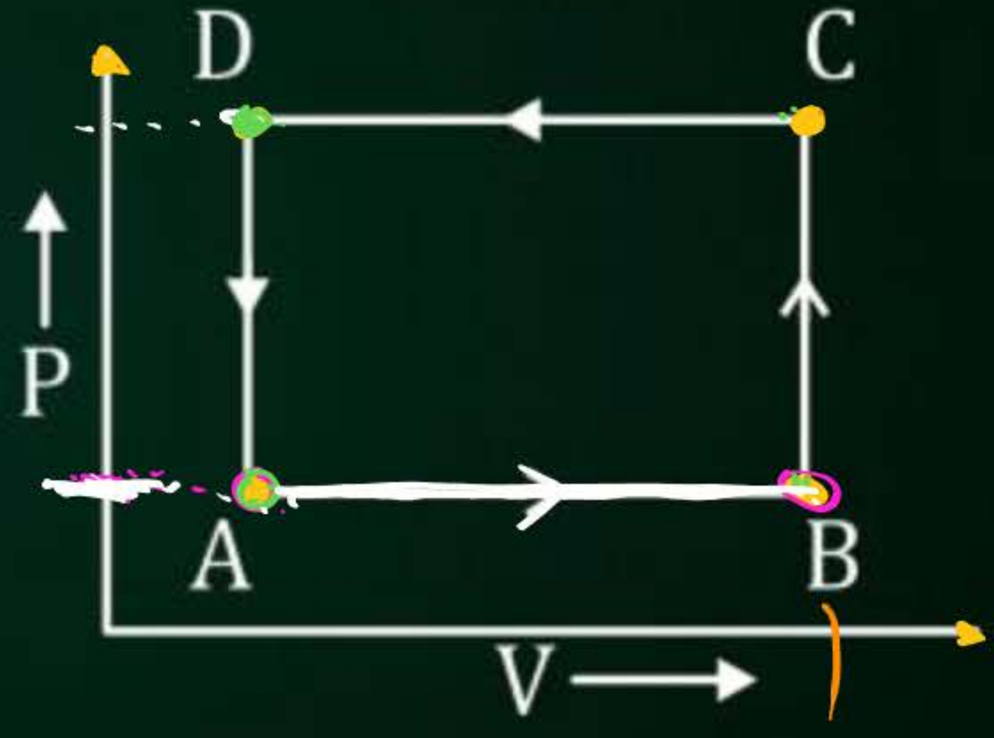


AB →
P = const^n
Isobaric
↑V ∝ T↑

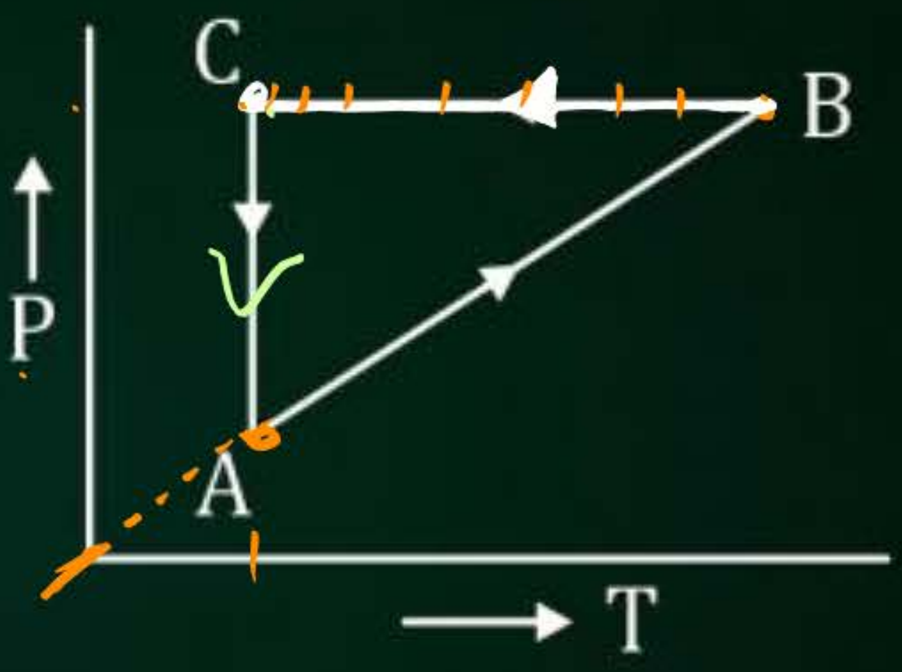
B → C
V = const^n Isochr
↑P ∝ T↑

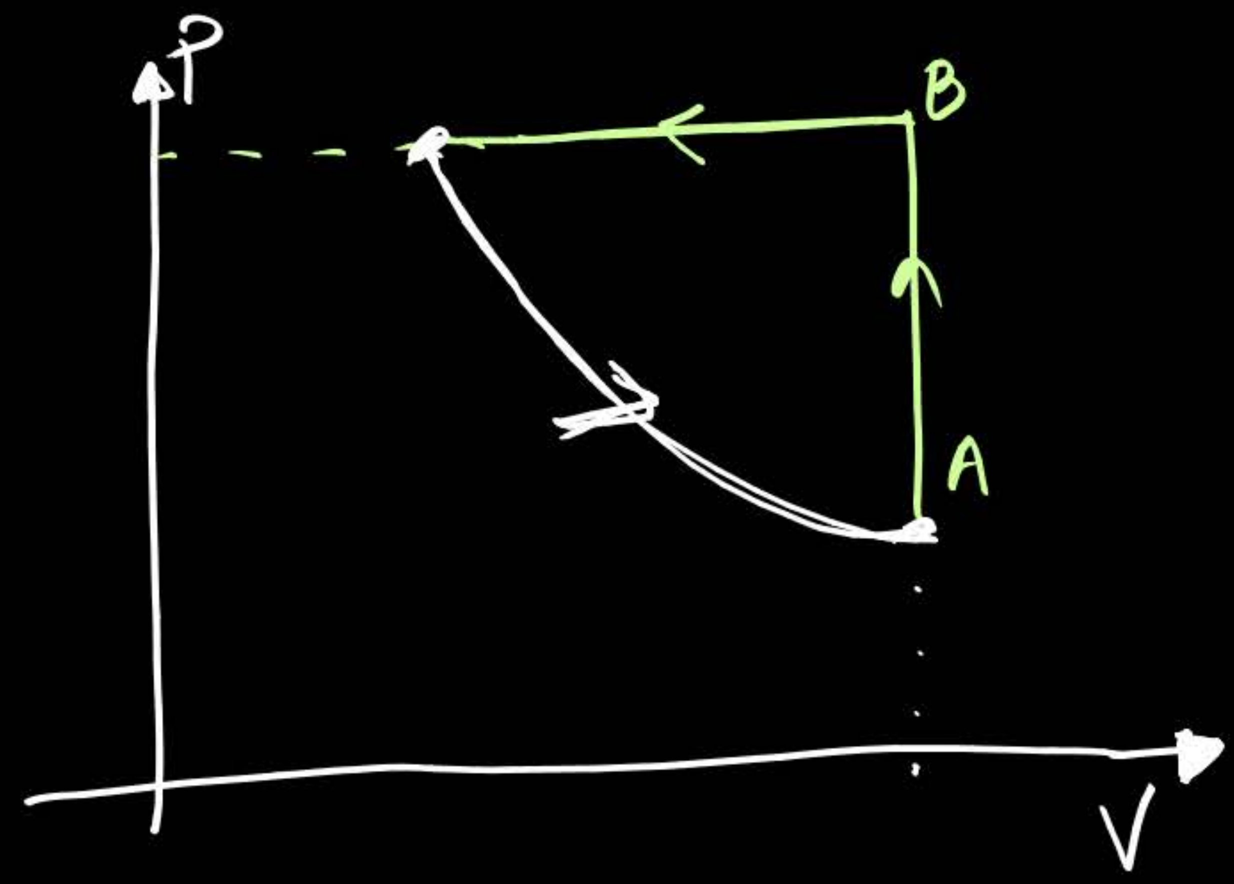
C − D (P = const^n)
↓V ∝ T↓

D → A
P↓ (V = const^n)
T↓



Convert this graph in PV





A → B

Isochoric Process ✓

↑$P \propto T$↑

$V = const^n$.

B → C

T↓ $P = const^n$ ✓

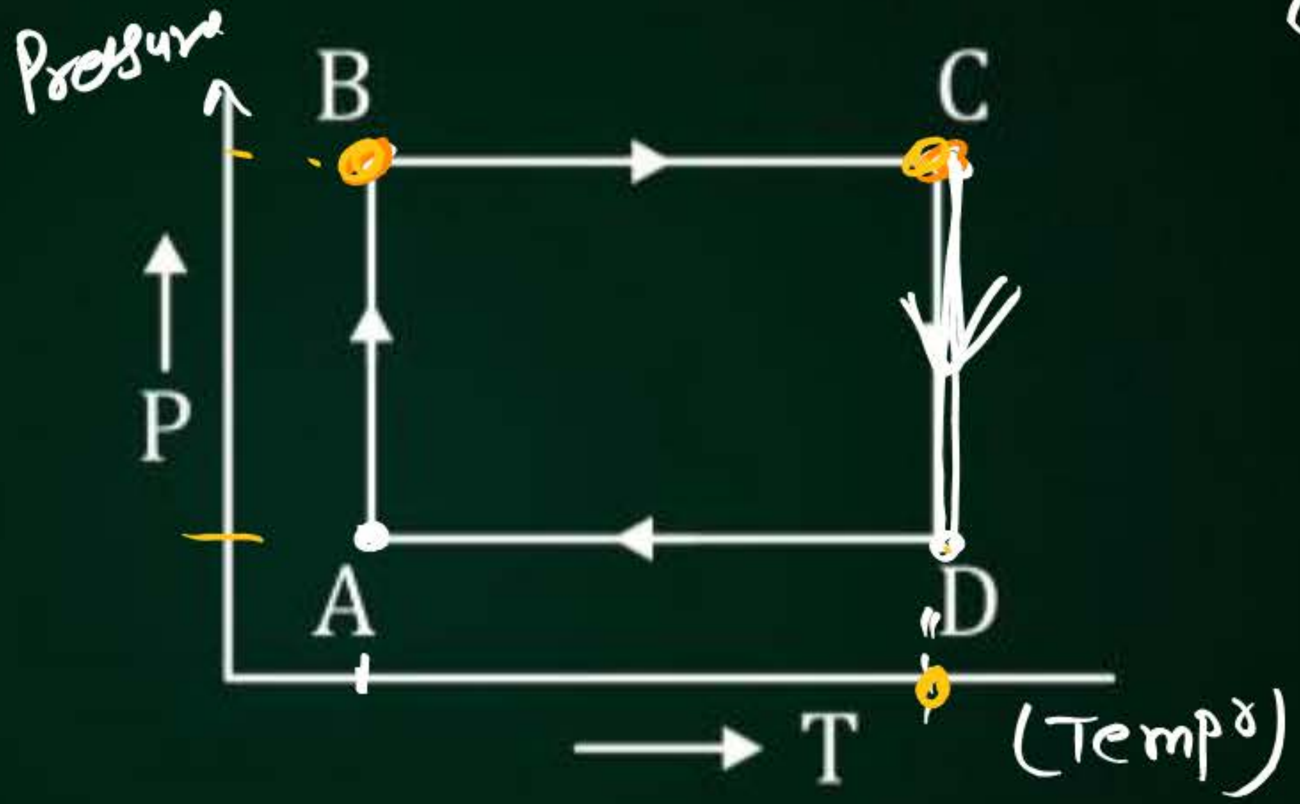
U↓ $V \propto T$

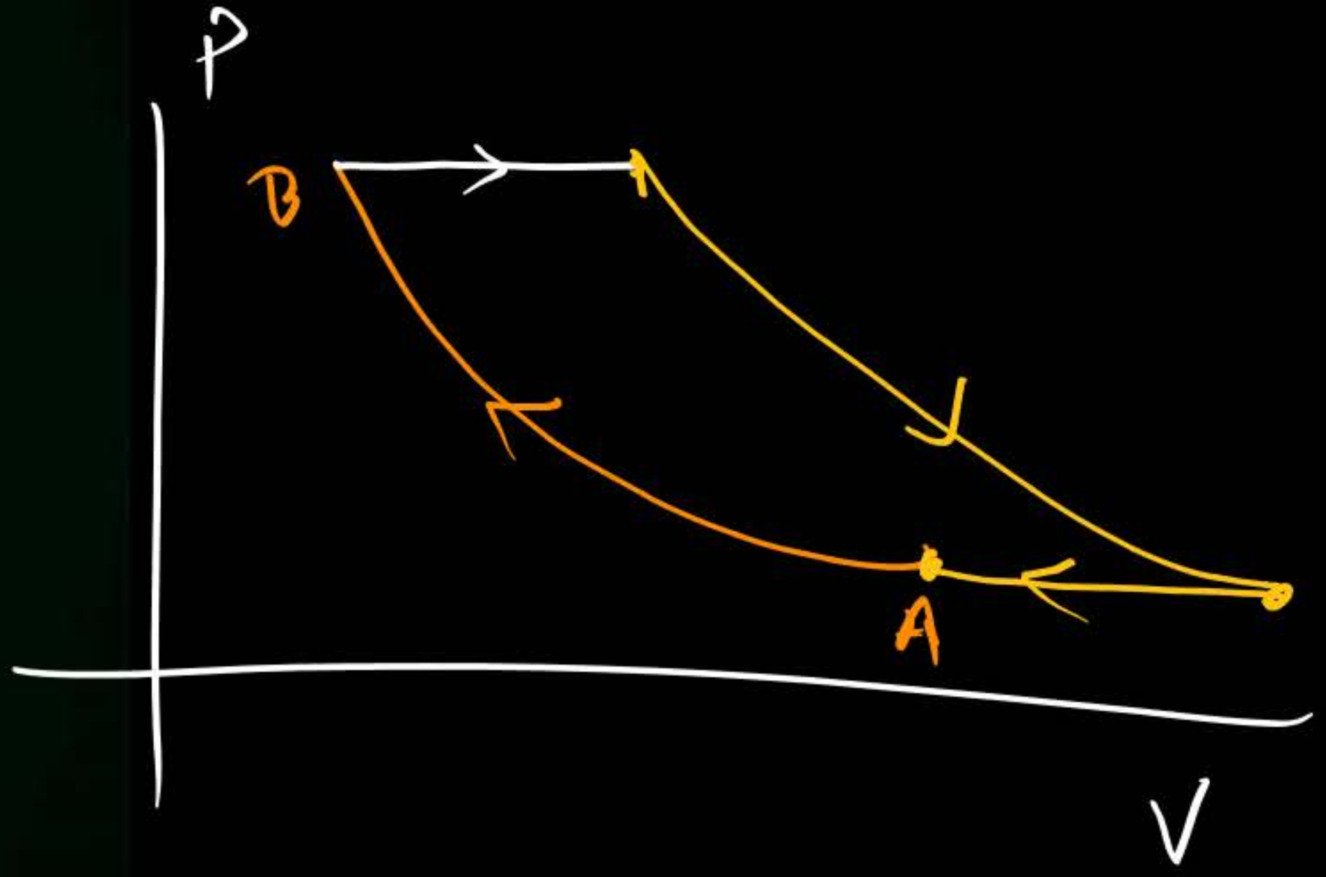
C A → Isothermal ✓

$T = const^n$

↑↓ $PV = const$

Convert this PT into PV graph.





A → B

T = constn

↑ $P \propto \frac{1}{V}$ ↓

Isothm

B → C

Tempr ↑

P = constn

↑ $V \propto T$ ↑

C → D

Tempr = constn

↓ $P \propto \frac{1}{V}$ ↑

D → A

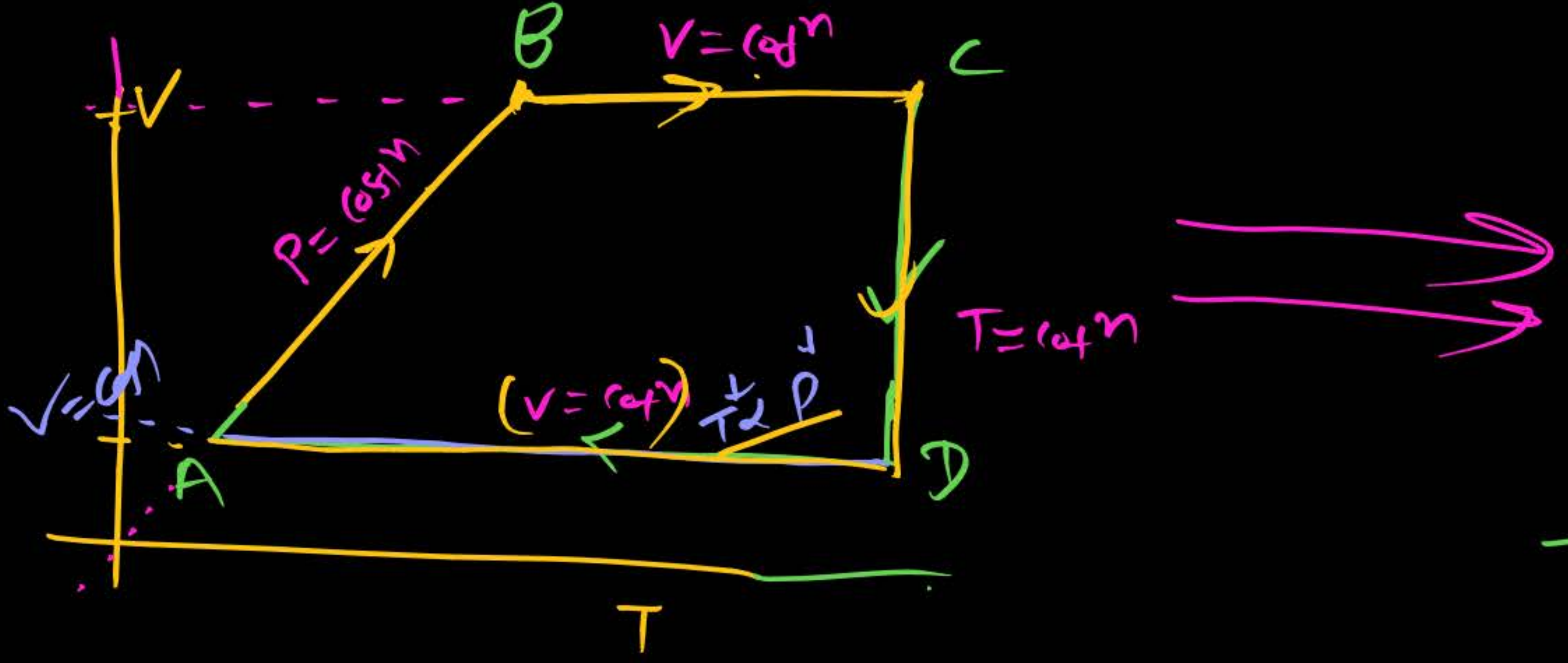
P = constn

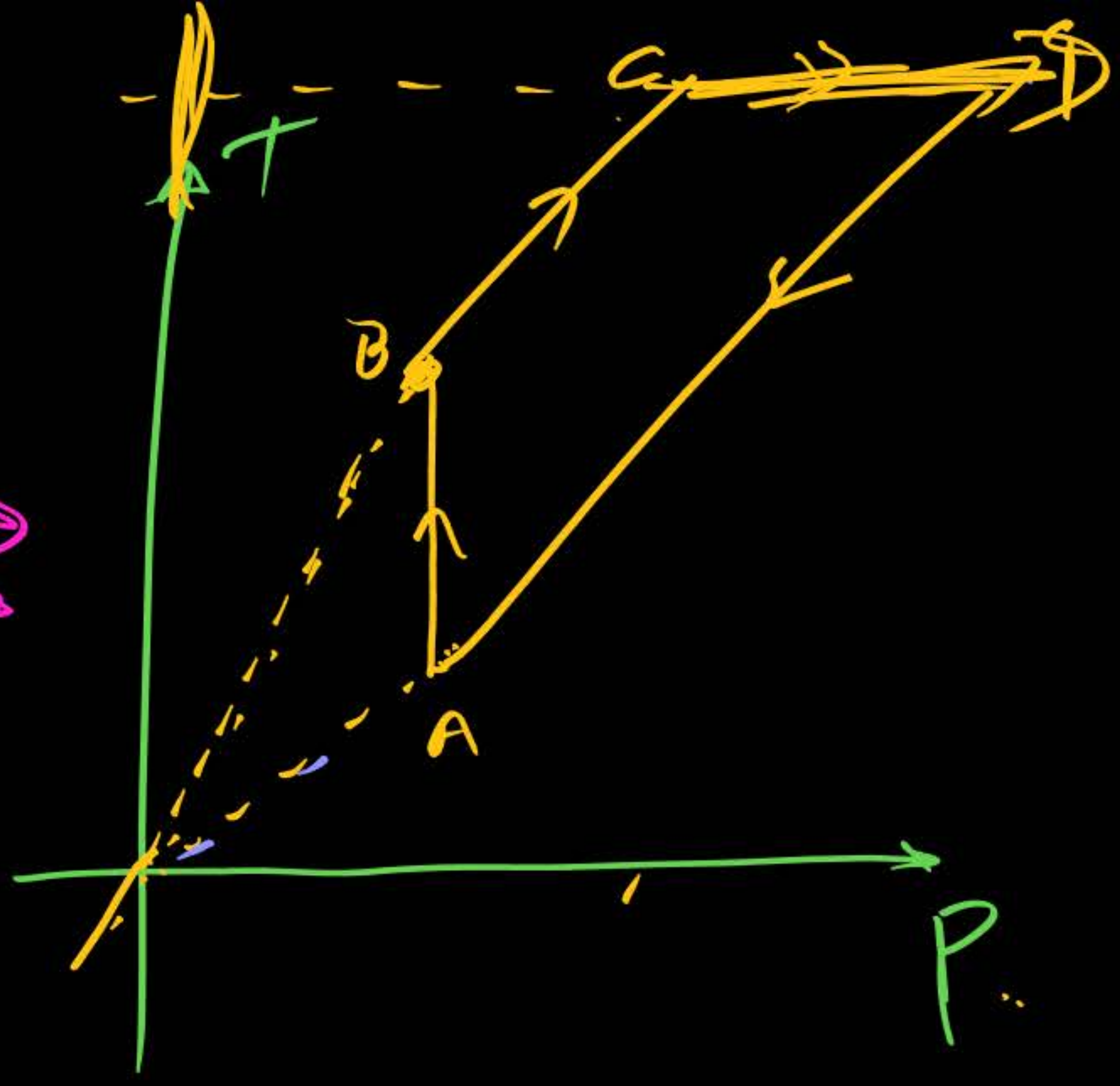
T ↓

↓ $V \propto T$ ↓

$T \propto P$

Convert this TV → TP





QUESTION

In which of the following processes, heat is neither absorbed nor released by a system?

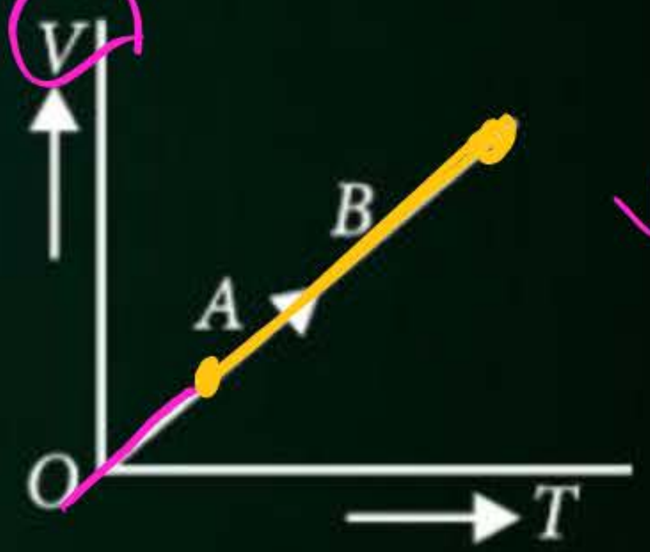
[NEET 2019]

1. Isothermal
2. Isobaric
3. Adiabatic
4. Isochoric

QUESTION

The volume (V) of a monatomic gas varies with its temperature (T), as shown in the graph. The ratio of work done by the gas, to the heat absorbed by it, when it under goes a change from state A to state B, is- **[NEET 2018]**

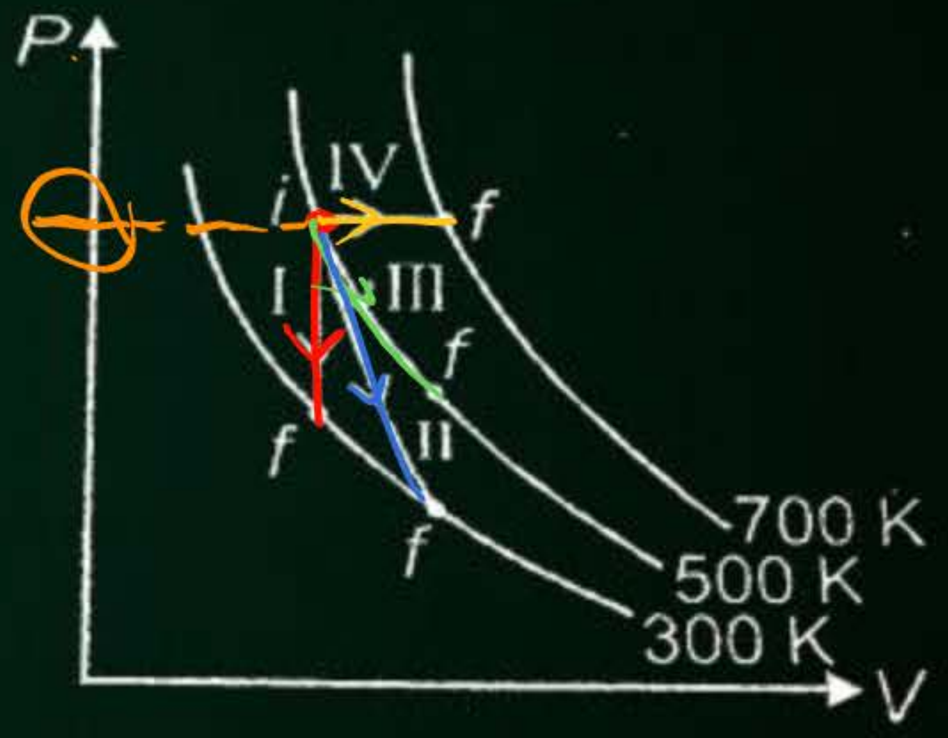
1. 1/3
2. 2/3
3. 2/5
4. 2/7



QUESTION

Thermodynamic processes are indicated in the following diagram. Match the following [NEET-2017]

Column-1	Column-2
P. Process I	A. Adiabatic
Q. Process II	B. Isobaric
R. Process III	C. Isochoric
S. Process IV	D. Isothermal



1. $P \rightarrow C, Q \rightarrow A, R \rightarrow D, S \rightarrow B$
2. $P \rightarrow C, Q \rightarrow D, R \rightarrow B, S \rightarrow A$
3. $P \rightarrow D, Q \rightarrow B, R \rightarrow A, S \rightarrow C$
4. $P \rightarrow A, Q \rightarrow C, R \rightarrow D, S \rightarrow B$

QUESTION

One mole of an ideal monatomic gas undergoes a process described by the equation PV^3 = constant. The heat capacity of the gas during this process is

[NEET-II, 2016]

1. $\frac{3}{2}R$
2. $\frac{5}{2}R$
3. $2R$
4. R ✓

$PV^3 = $ const

$x = 3$

$C_m = \frac{3R}{2} + \frac{R}{1-3}$

$= \frac{3R}{2} - \frac{R}{2}$

$= \frac{3R - R}{2} = R$

QUESTION

A gas is compressed isothermally to half its initial volume. The same gas is compressed separately through an adiabatic process until its volume is again reduced to half. Then [NEET-I, 2016]

1. Compressing the gas isothermally or adiabatically will require the same amount of work.

2. Which of the case (whether compression through isothermal or through adiabatic process) requires more work will depend upon the atomicity of the gas.

3. Compressing the gas isothermally will require more work to be sone.

4. Compressing the gas through adiabatic process will require more work to be done.


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 06 | **Physics**

Kinetic Theory of Gases and Thermodynamics



By- Dr. Manish Raj (MR SIR)

Topics to be covered

1 # K.B.D

2 # Vrms / Vmp (K.T.G)

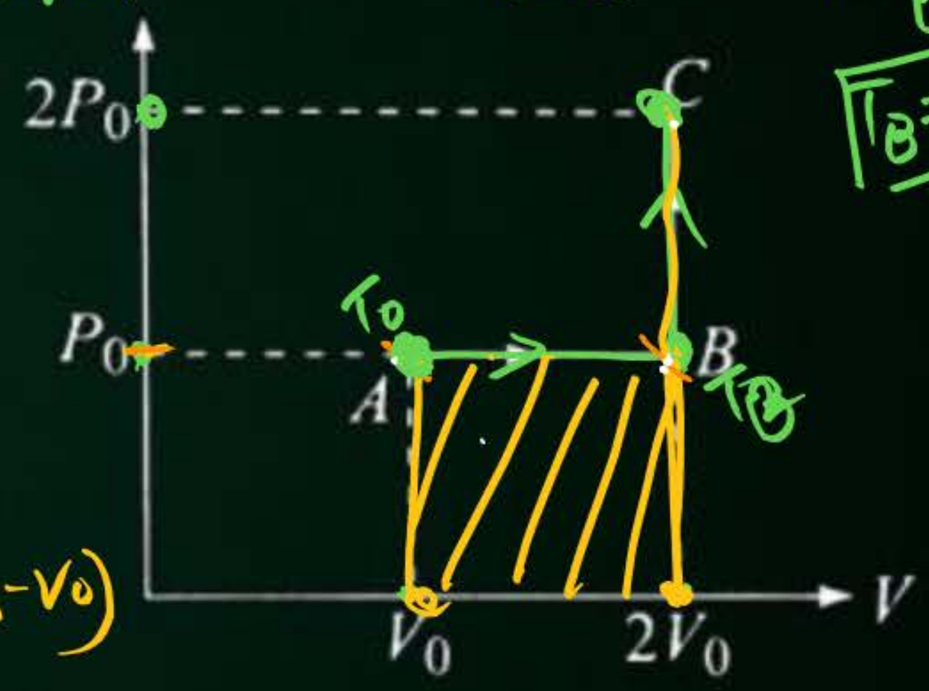
3 #

Heat engine Not in syllabus



QUESTION

1. One mole of an ideal monatomic gas is taken from A to C along the path ABC. The temperature of the gas at A is T_0. For the process ABC,

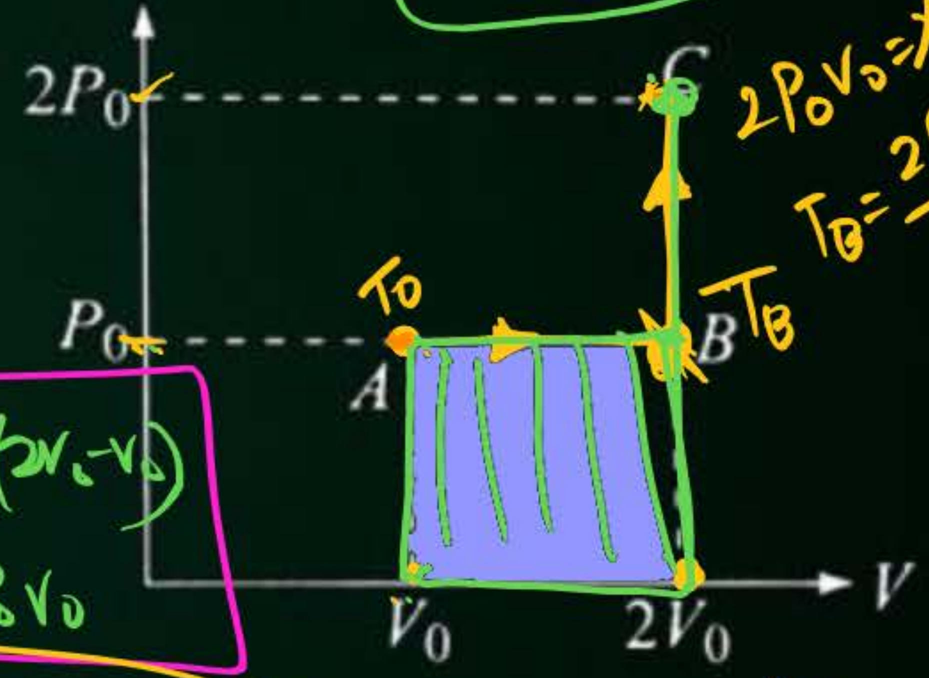


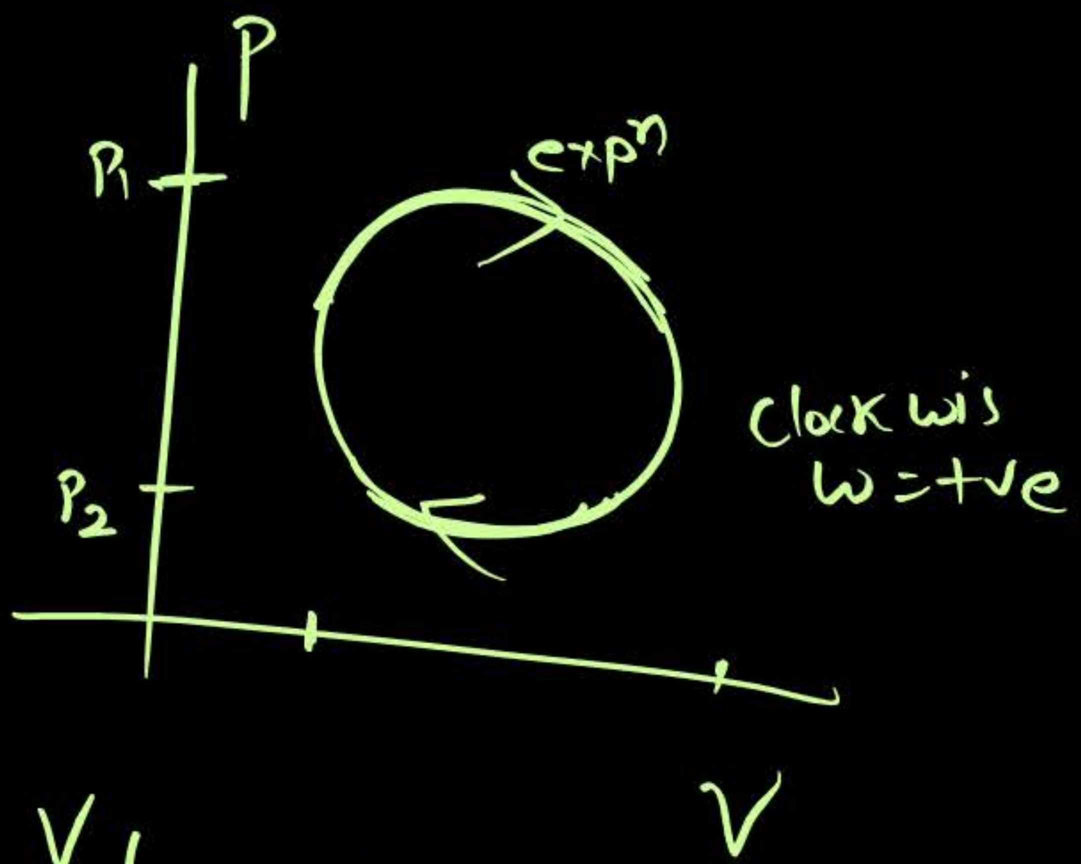
1. Work done by the gas is RT_0
2. Change in internal energy of the gas is $11/2\ RT_0$
3. Heat absorbed by the gas is $11/4\ RT_0$
4. Heat absorbed by the gas is $13/2\ RT_0$

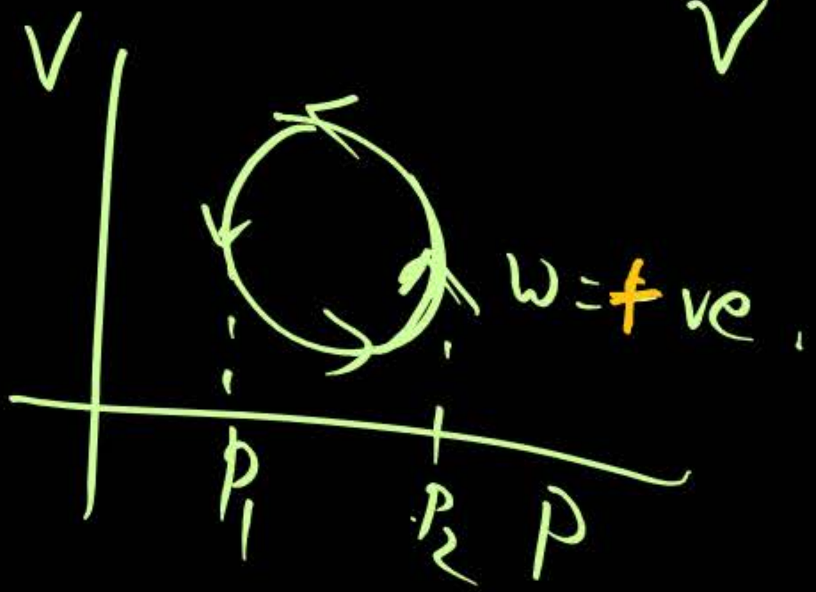
QUESTION

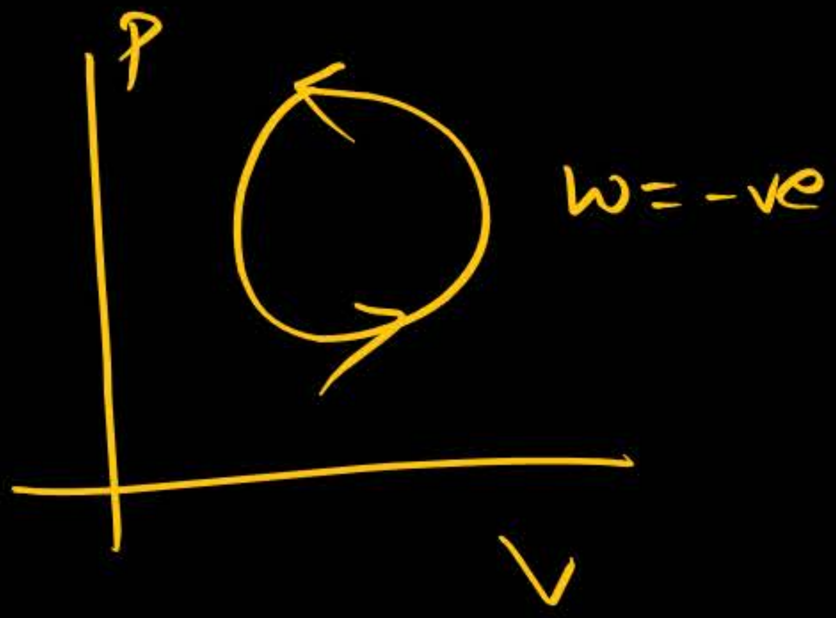
1. One mole of an ideal monatomic gas is taken from A to C along the path ABC. The temperature of the gas at A is T_0. For the process ABC,

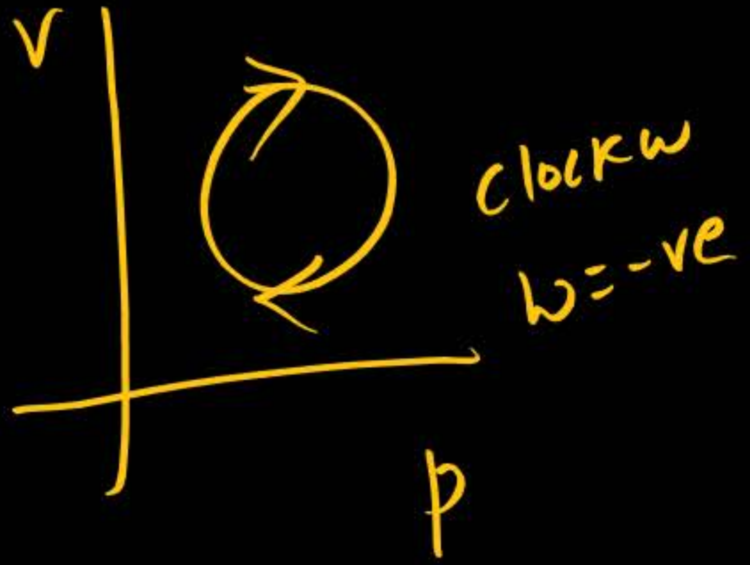
1. Work done by the gas is RT_0
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4. Heat absorbed by the gas is $13/2\ RT_0$




P
P_1
P_2
expn
Clockwis
w=+ve
V


V
w=+ve
P_1
P_2
P

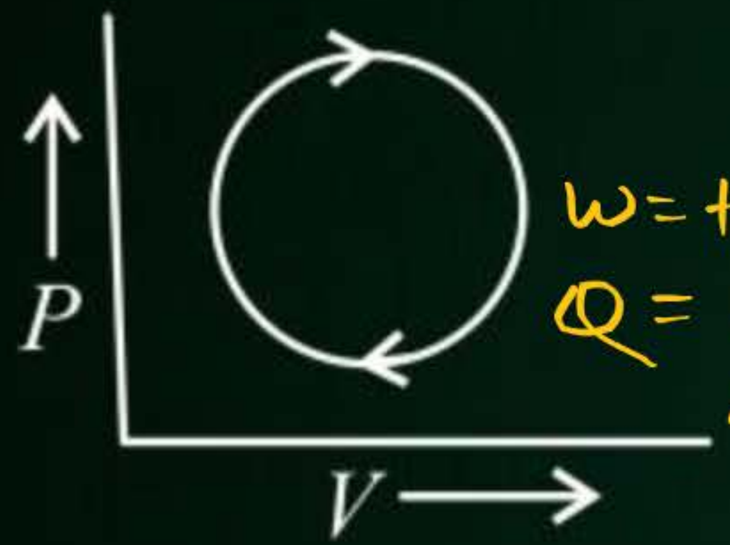

P
w=-ve
V


V
clockw
w=-ve
P

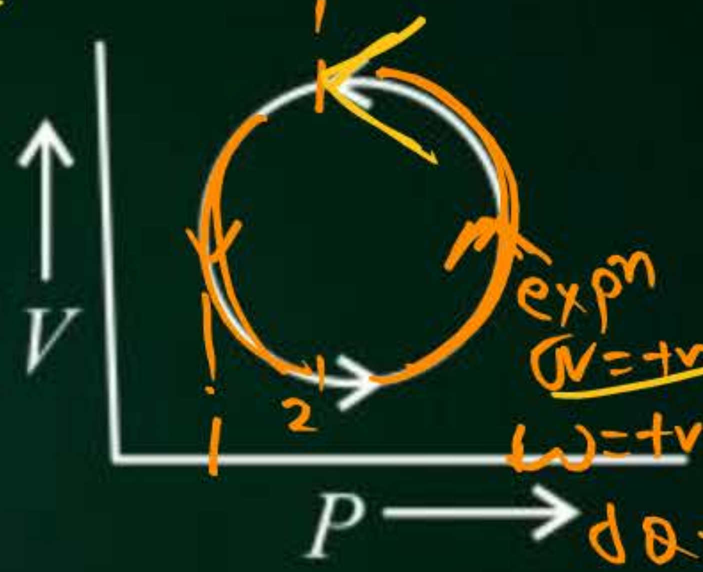
QUESTION

The following are the P-V diagrams for cyclic processes for a gas. In which of these processes heat is not absorbed by the gas?

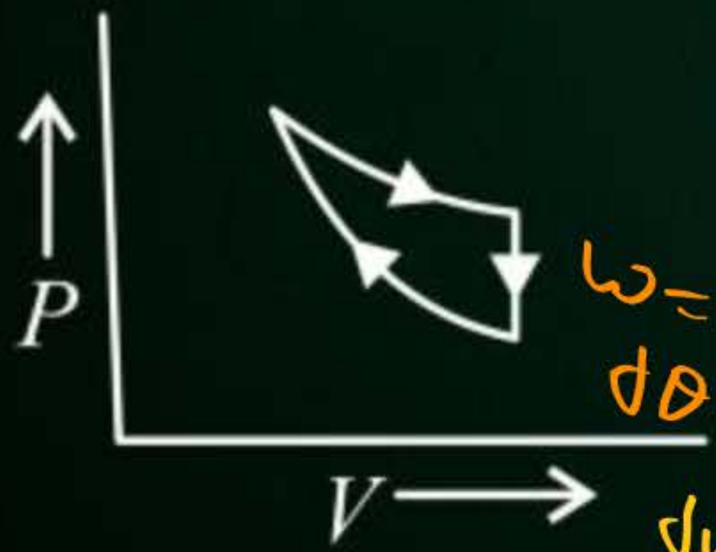
(1)



(2)



(3)



(4)



$dU = 0$ *

$dQ = dU + dW$

$dQ = dW$

If $dW = +ve$: $dQ = +ve$, Heat absorbed

$dW = -ve$: $dQ = -ve$, Heat releas

$dQ = dW$

$dQ = -ve$ Heat rel

13%

QUESTION

A monoatomic gas at a pressure P, having a volume V expands isothermally to a volume $2V$ and then adiabatically to a volume $16V$. The final pressure of the gas is (take $\gamma = 5/3$)

1. $64P$
2. $32P$
3. $P/64$
4. $16P$

69%

Ans

$$P'' = \frac{P}{2}\left(\frac{1}{8}\right)^{5/3} = \frac{P}{2}\frac{1}{(8)^{5/3}} = \frac{P}{2}\frac{1}{(2)^{3\times\frac{5}{3}}} = \frac{P}{2}\frac{1}{32} = \frac{P}{64}$$

P, V monoatomic → Isothermal → $2V$, $P' = \frac{P}{2}$

$PV = 2VP'$

$P' = \frac{P}{2}$

adiabatic ↓

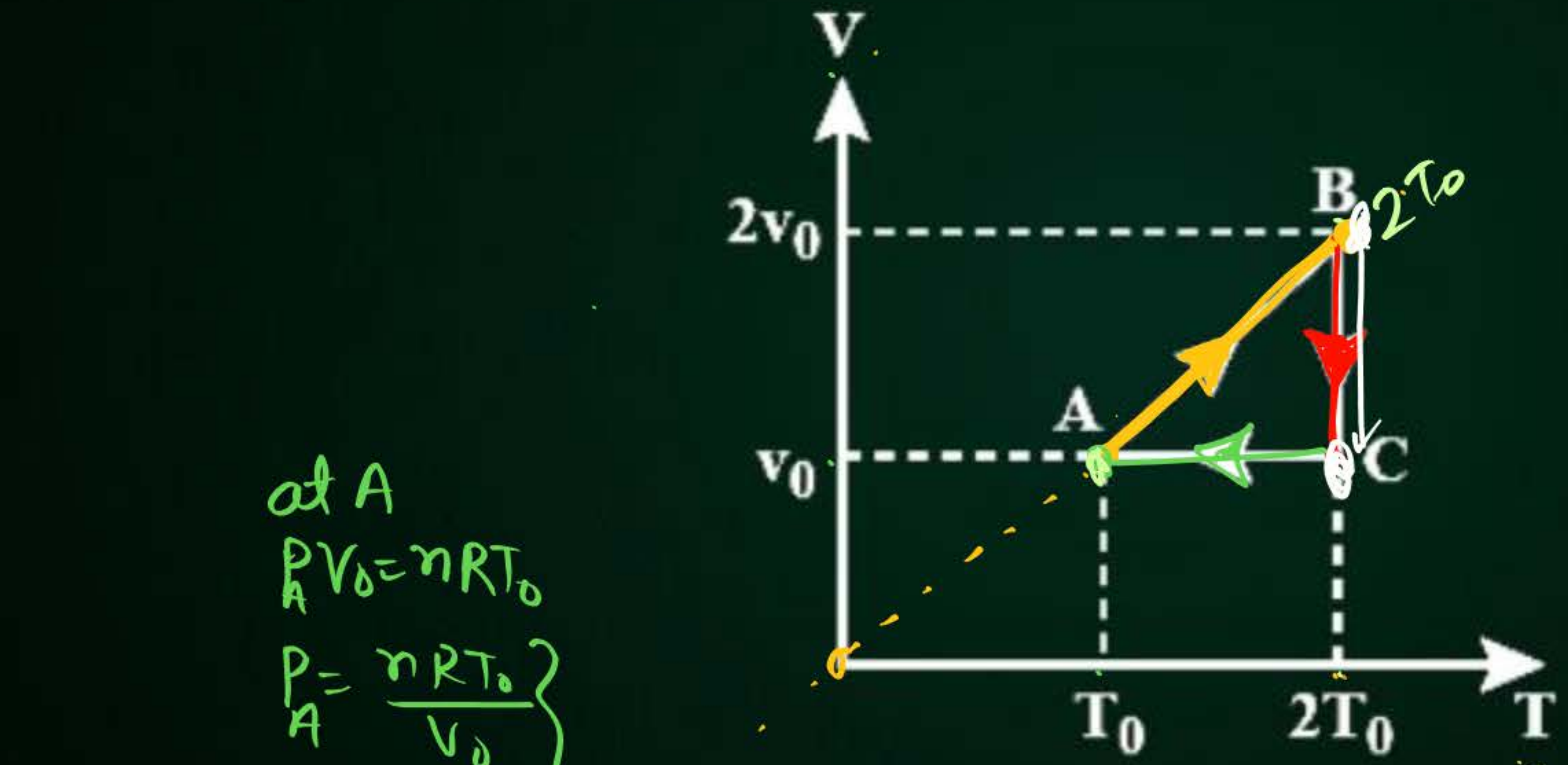
$16V$, $P'' = ?$

$$\frac{P}{2}(2V)^{\gamma} = P''(16V)^{\gamma}$$

$$P'' = \frac{P}{2}\left(\frac{2V}{16V}\right)^{5/3} = \frac{P}{2}\left(\frac{1}{(2^3)}\right)^{5/3} = \frac{P}{2\times 32} = \frac{P}{64}$$

QUESTION

An ideal monoatomic gas undergoes a cycle process $ABCA$, as shown in the figure. The ratio of heat absorbed during AB to the work done on the gas during BC is



QUESTION

An ideal monoatomic gas undergoes a cycle process *ABCA*, as shown in the figure. The ratio of heat absorbed during *AB* to the work done on the gas during *BC* is

$dU = nC_v dT$

$C_p = C_v + R$

$A \to B$ = Isobaric ($P = \text{const}$)

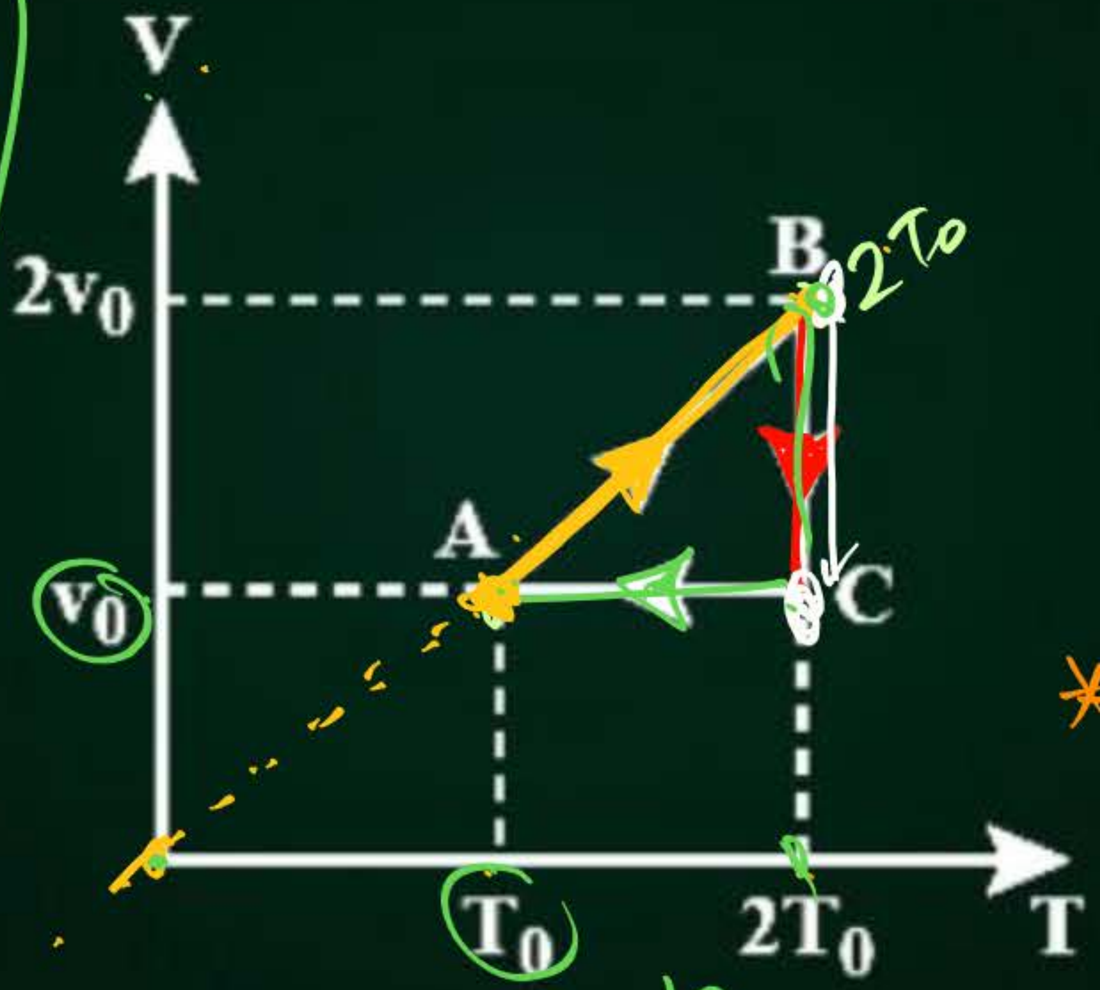
$V \propto T$

$PV = nRT$

$BC \to$ Isothermal

$2T_0 = \text{const}$

CA = Isochoric Process



$dQ_{AB} = nC_p dT$ (Isobaric)

$= n\frac{5R}{2}(2T_0 - T_0)$

$= n\frac{5RT_0}{2}$ — (1)

$dW_{BC} = nRT \ln\left(\frac{V_2}{V_1}\right)$ (Isothermal)

$= nR2T_0 \ln\left(\frac{V}{2V}\right)$

$= 2nRT_0 \ln(1/2)$

$\Rightarrow \frac{dQ}{dW} = \frac{5}{2}\frac{nRT_0}{2nRT_0 \ln(1/2)}$

$= \frac{5}{4\ln(1/2)}$

QUESTION

$5n$, n and $5n$ moles of a monatomic, diatomic and non-linear polyatomic gases (which do not react chemically with each other) are mixed at room temperature. The equivalent degree of freedom of the mixture is

1. 25/7
2. 48/11
3. 52/11
4. 50/11

$$f = \frac{n_1 f_1 + n_2 f_2 + n_3 f_3}{n_1 + n_2 + n_3}$$

$$= \frac{5n \times 3 + n \times 5 + 5n \times 6}{5n + 5n + n}$$

$$= \frac{50n}{11n} = \frac{50}{11}$$

QUESTION

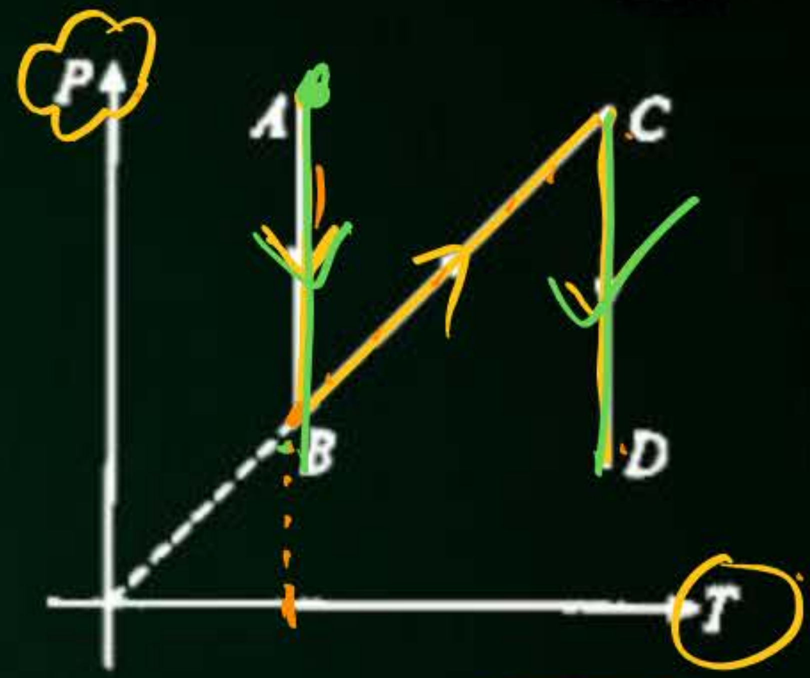
1 g of H_2 at 27°C is mixed with 16 g of O_2 at 37°C. The temperature of the mixture is about

1. 32°C
2. 27°C
3. 37°C
4. 45°C

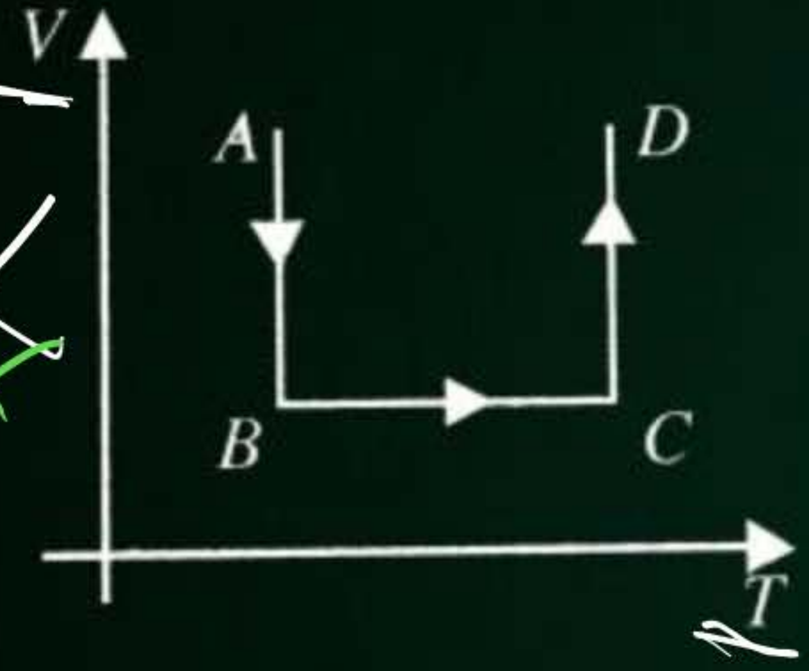
$$T_{mix} = \frac{n_1 f_1 T_1 + n_2 f_2 T_2}{n_1 f_1 + n_2 f_2}$$

QUESTION

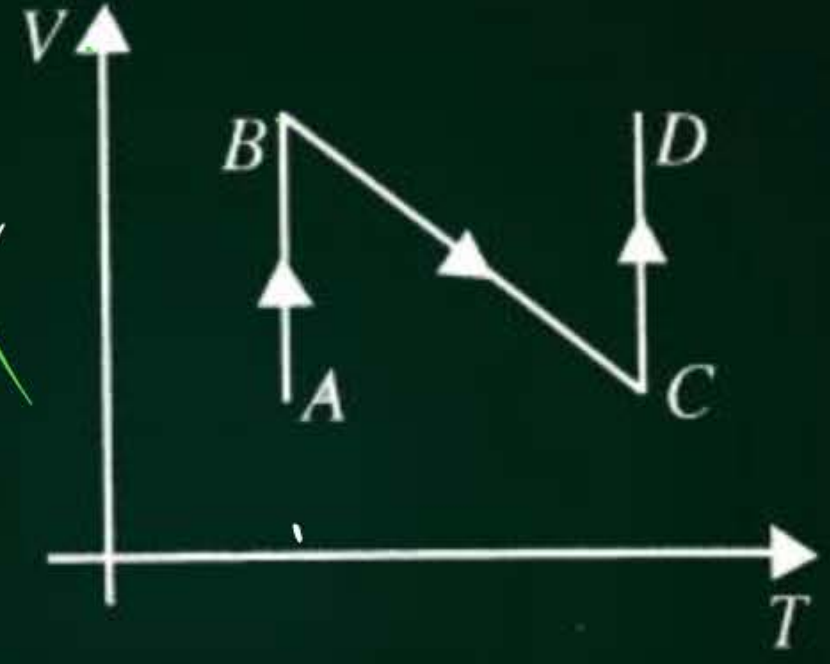
Choose the corresponding V-T diagram for P-T diagram.



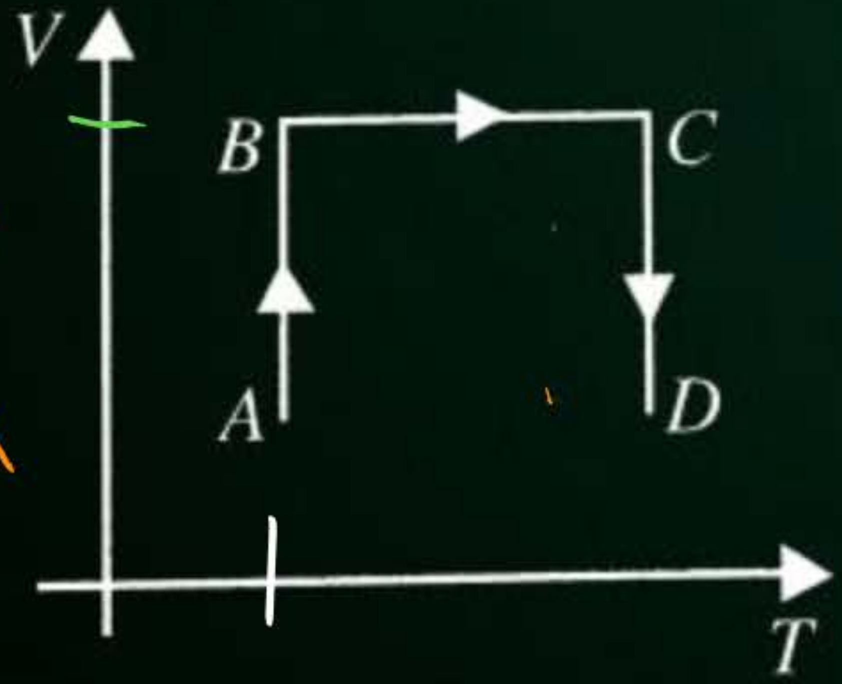
(1)



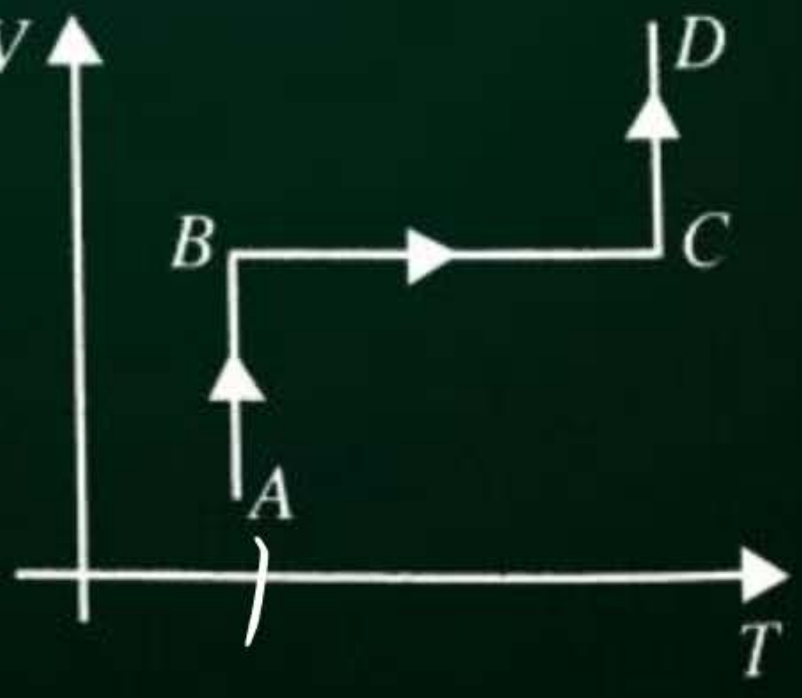
(2)



(3)



(4)



QUESTION

Jab increase or decrease
To °C or K

Find the amount of work required to be done to increase the temperature of one mole of an ideal gas by 30°C if it is expanding under the condition $P \propto V^{2/3}$.

1. 150 J
2. 100 J
3. 50 J
4. 200 J

$P \propto V^{2/3}$

$PV^{-2/3} = \text{const}$

$x = -2/3$

$W = \frac{nR\Delta T}{1-x} = \frac{1R[30]}{1-(-\frac{2}{3})} = \frac{30R}{1+2/3} = \frac{30R}{5/3} = 18 \times R$

$= 18 \times 8.3$

$= 150$

QUESTION 5

Heat energy absorbed by a system in going through a cyclic process, shown in the figure, is

1. $10^2\ \pi J$
2. $10^3\ \pi J$
3. $10^4\ \pi J$
4. $10\ \pi J$

$dU = 0$

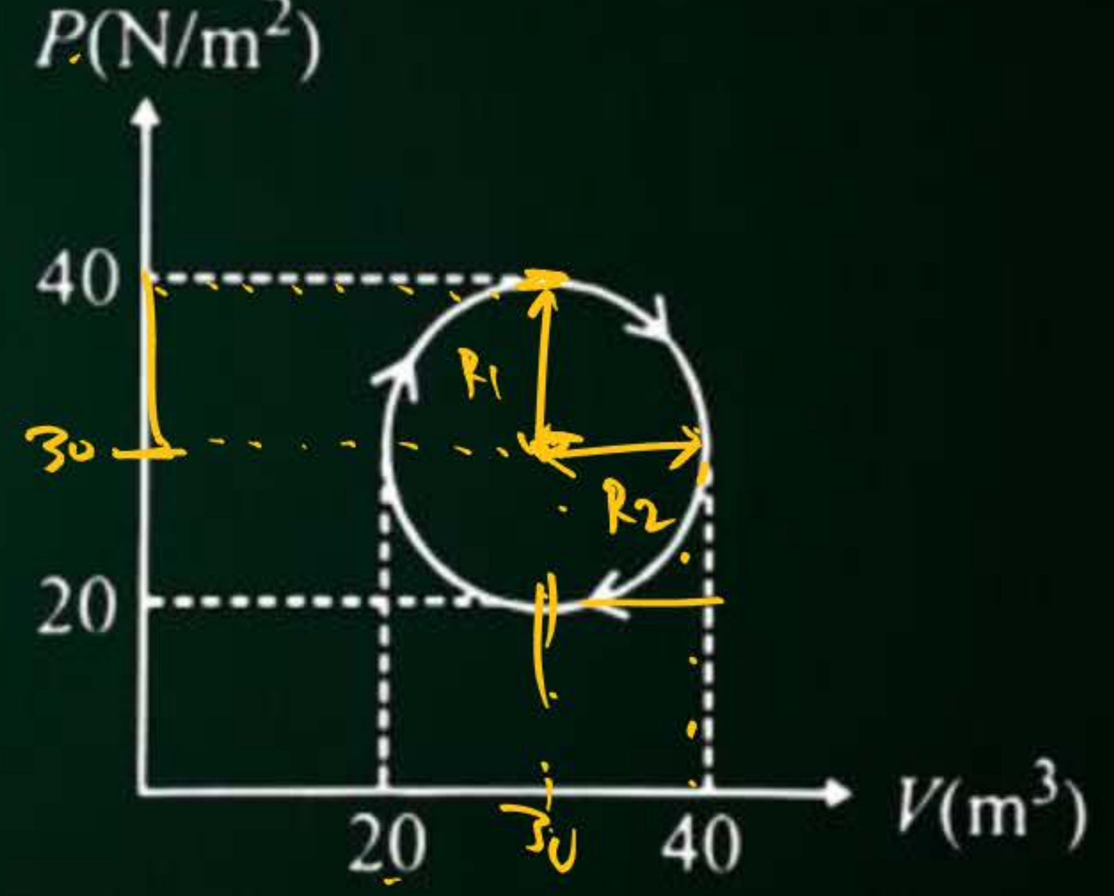
$dQ = dW$

= Area under (PV)

$= \pi R_1 \times R_2$

$= \pi \times 10 \times 10$

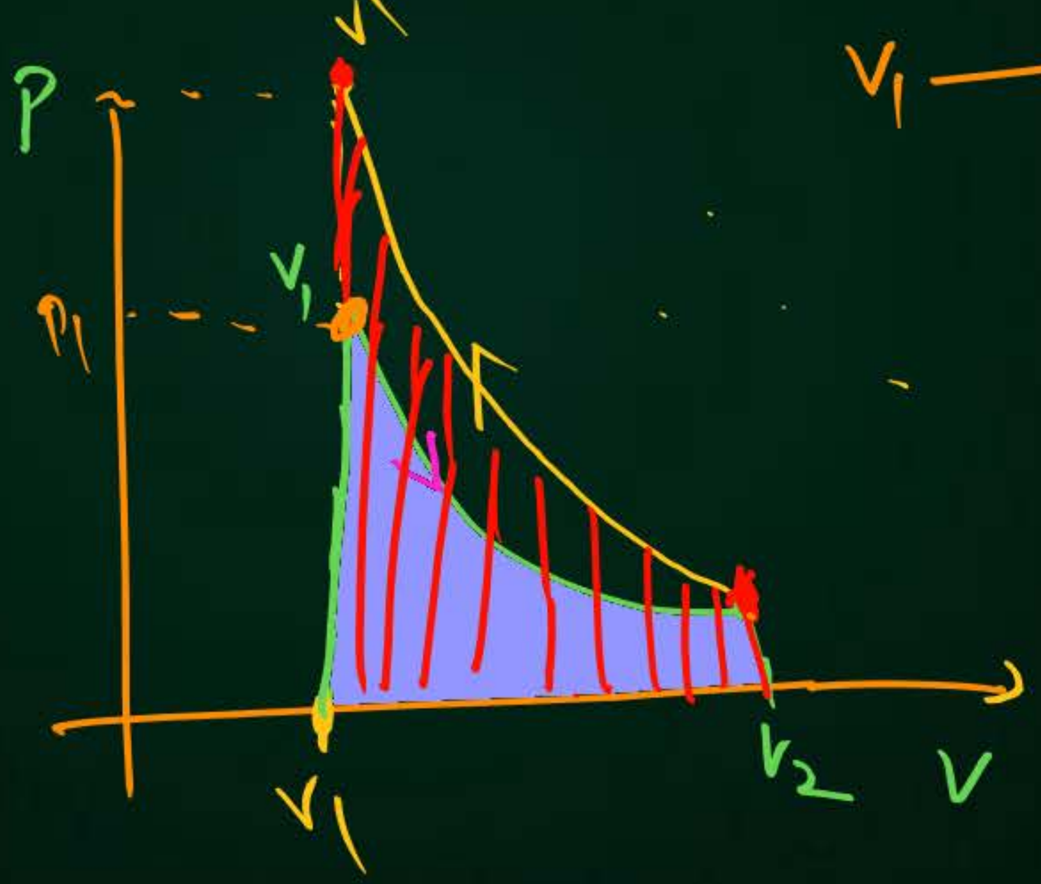
$= 10^2 \pi J$



QUESTION

An ideal gas expands isothermally from a volume V_1 to V_2 and then compressed to original volume V_1 adiabatically. Initial pressure is P_1 and final pressure is P_3. the total work done is W. Choose the correct option.

1. $P_3 > P_1, W > 0$
2. $P_3 < P_1, W < 0$
3. $P_3 > P_1, W < 0$ (23%)
4. $P_3 = P_1, W = 0$



$V_1 \xrightarrow{\text{isothermally}} V_2 \xrightarrow{\text{adiabatically}} V_1$

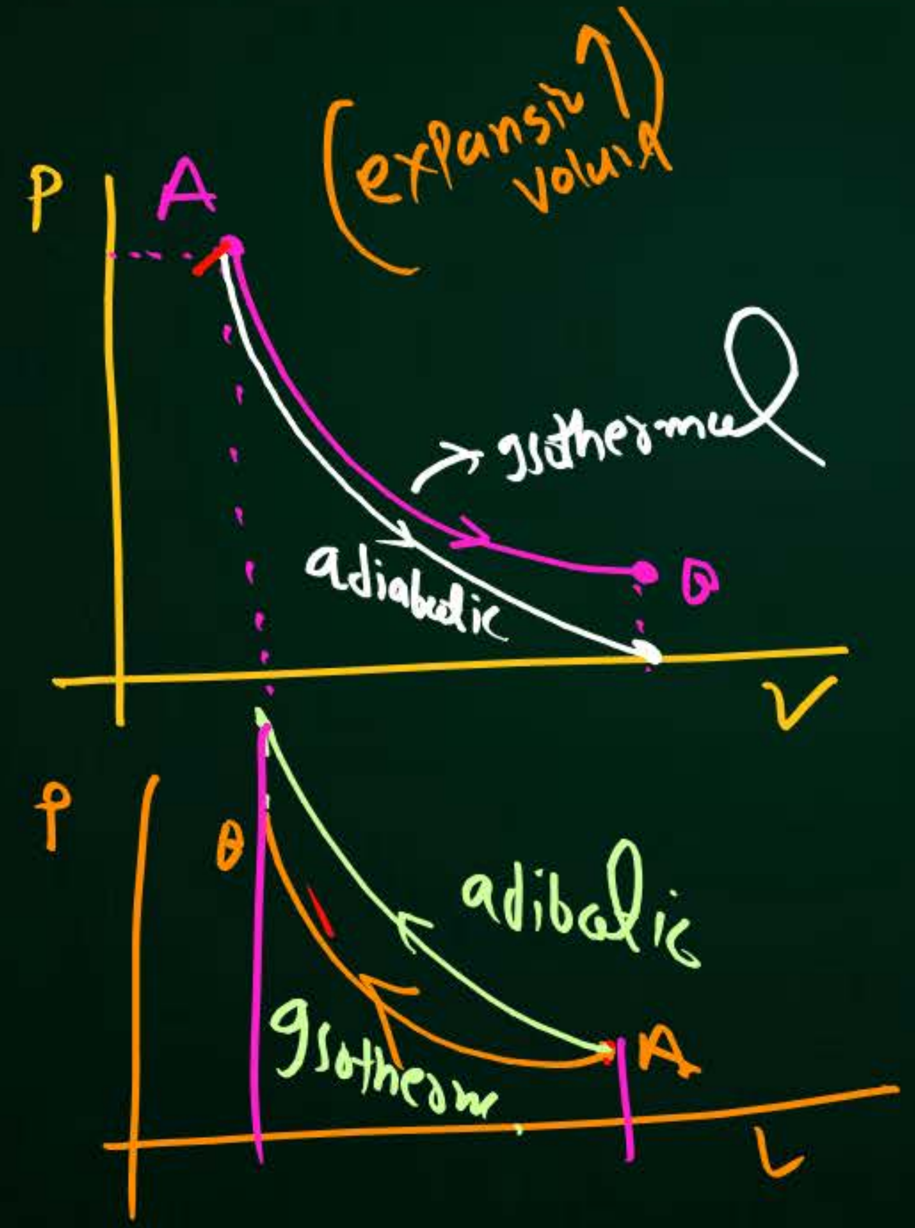
$W_{tot} = -ve$

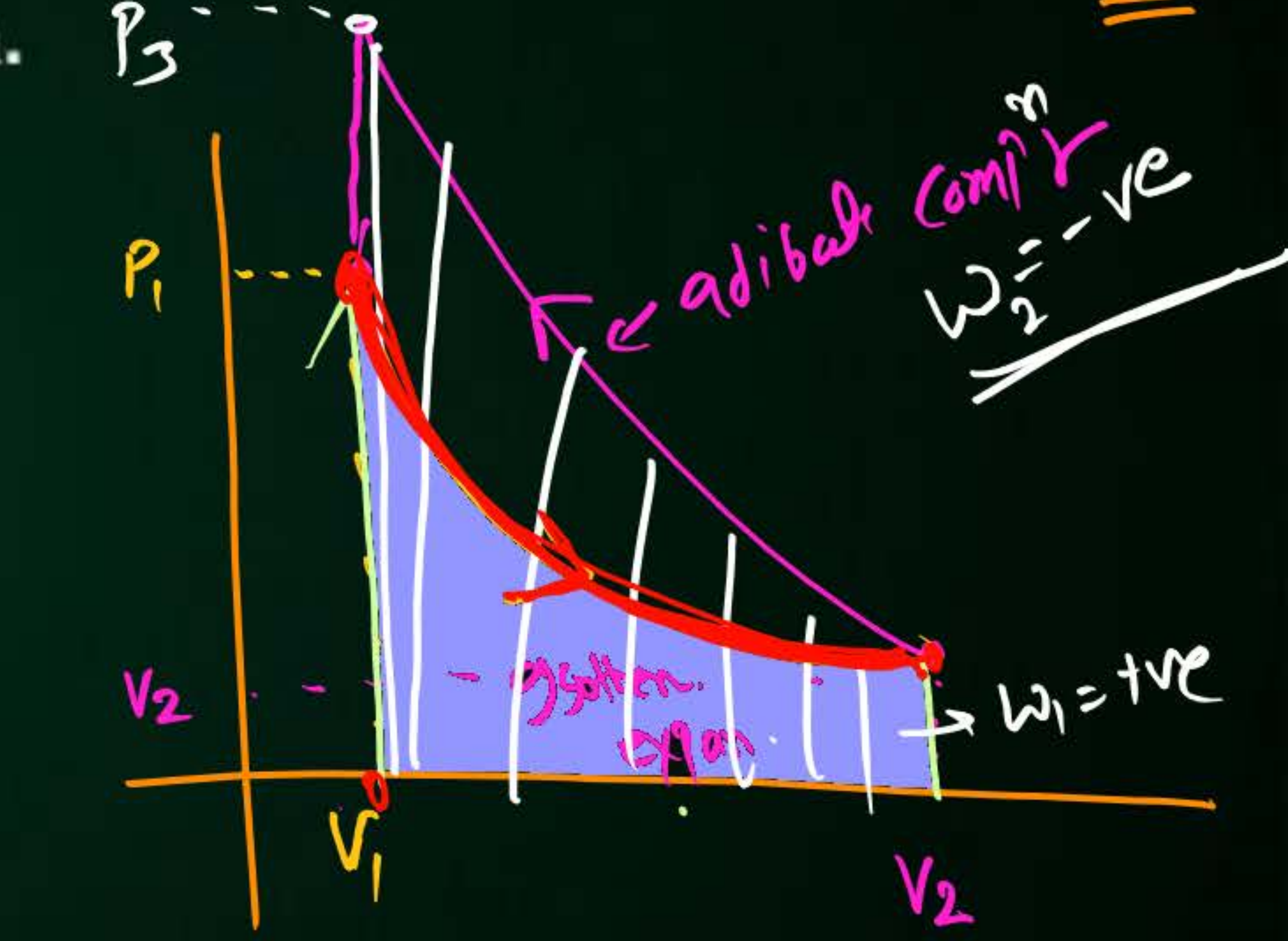
$P_3 > P_1$

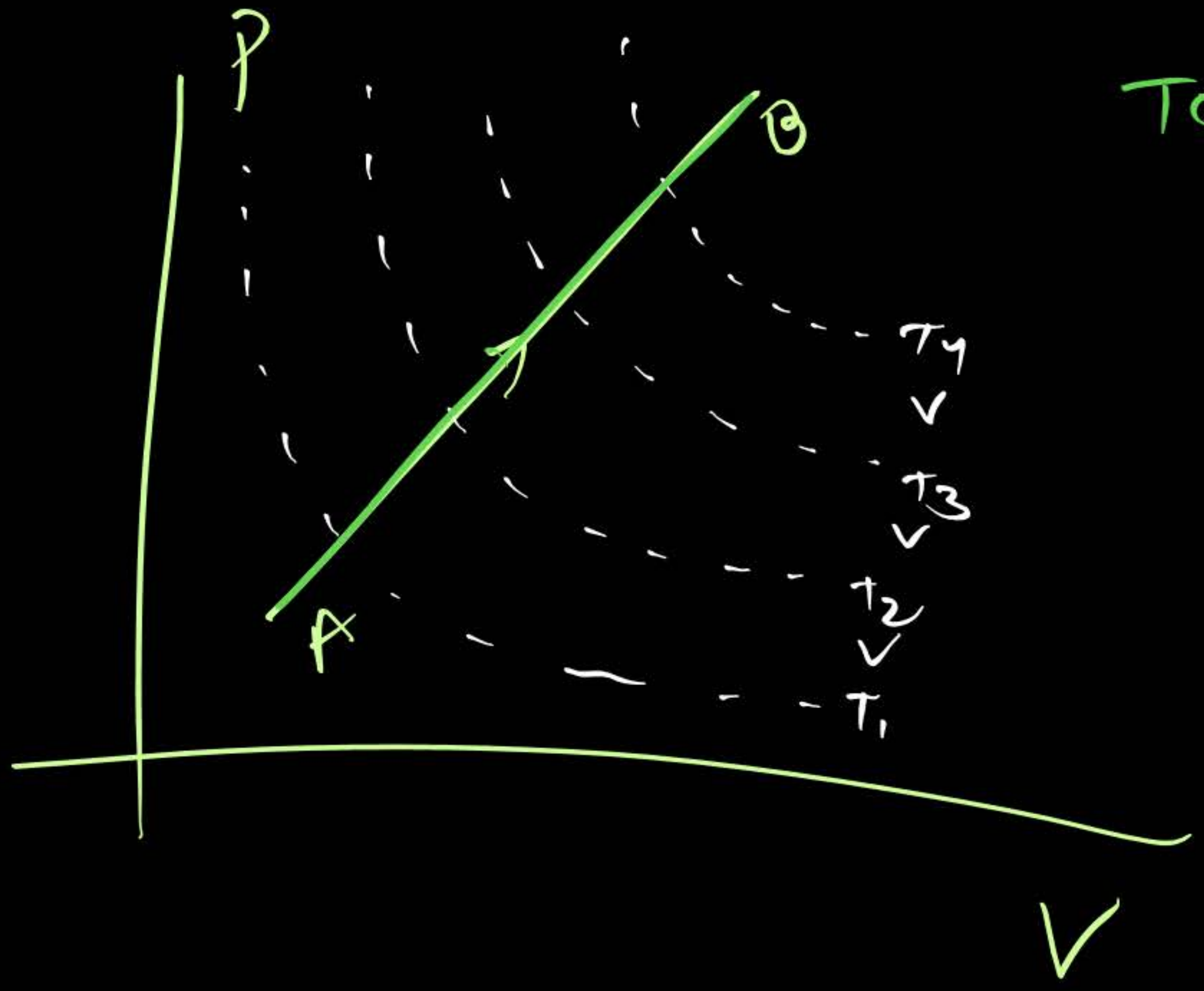
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1. $P_3 > P_1, W > 0$
2. $P_3 < P_1, W < 0$
3. $P_3 > P_1, W < 0$ (23%)
4. $P_3 = P_1, W = 0$







Tempr ↑

QUESTION

$n = \frac{1}{2}$

$dU = nC_v dT$

The P-V diagram of 2g of helium gas for a certain process A → B is shown in the figure. What is the heat given to the gas during the process A → B?

1. $4P_0V_0$
2. $6P_0V_0$
3. $4.5P_0V_0$
4. $2P_0V_0$

Polytropic

$P \propto V$

$PV^{-1} = \text{const}^n$ (compare)

$PV^x = \text{const}^n$

$x = -1$

$C_m = C_v + \frac{R}{1-x}$

$C_m = \frac{3R}{2} + \frac{R}{1-(-1)} = \frac{3R}{2} + \frac{R}{2} = \frac{3R+R}{2} = \frac{4R}{2} = 2R$

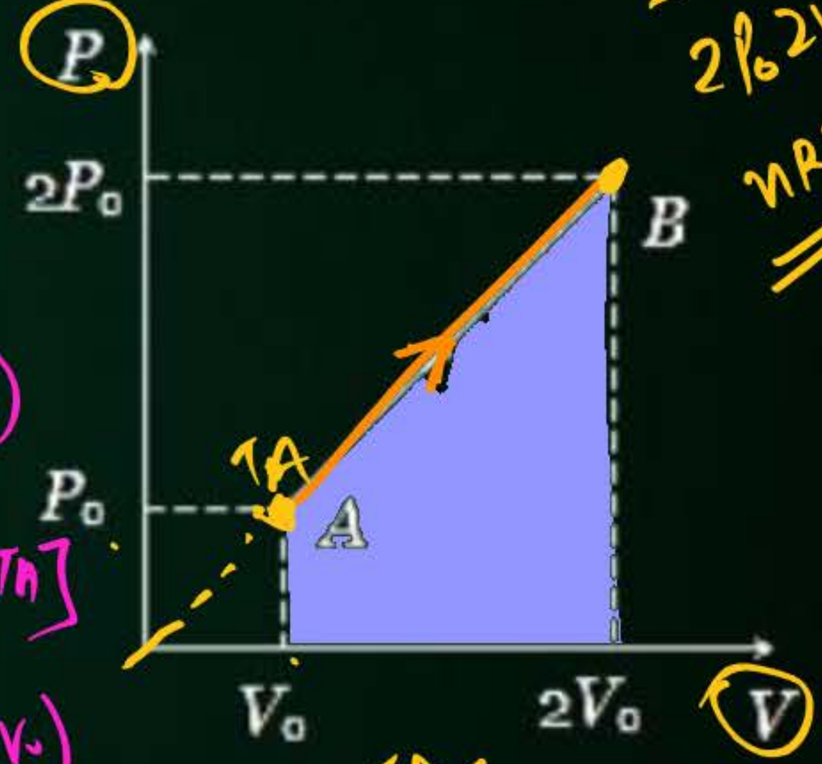
$dQ = nC_m \Delta T$

$= n2R(T_B - T_A)$

$= 2[nRT_B - nRT_A]$

$= 2[4P_0V_0 - P_0V_0]$

$= 6P_0V_0$



at T_B

$2P_0 2V_0 = nRT_B$

$nRT_B = 4P_0V_0$

at T_A

$P_0V_0 = nRT_A$ — (1)

$nRT_A = P_0V_0$

$(Work)_{Total} = A_1 + A_2$

$dU = nC_v dT$

$$dQ = dU + dW$$

$$dQ = nC_p dT$$

$$dQ = nC_v dT$$

$$dQ = nC_m dT$$

QUESTION

In an adiabatic process, if the temperature of a gas is increased by $\frac{2}{3}\%$, $\left(\frac{C_P}{C_V} = \frac{3}{2}\right)$, then the volume decreases by

1. $\frac{4}{3}\%$
2. $\frac{3}{4}\%$
3. $\frac{2}{3}\%$
4. $\frac{3}{2}\%$

$PV^{\gamma} = \text{const}$

$\left(\frac{T}{V}\right) V^{\gamma} = \text{const}$

$TV^{\gamma-1} = \text{const}$

$\frac{\Delta T}{T} + (\gamma-1)\frac{\Delta V}{V} = 0$

$\frac{\Delta T}{T} = (1-\gamma)\frac{\Delta V}{V}$

$\frac{\Delta T}{T} \times 100 = \frac{2}{3}$

$\frac{\Delta V}{V} = ??$

$\frac{\Delta V}{V} = \frac{1}{1-\gamma}\left(\frac{\Delta T}{T}\right) = \frac{2}{3}\left(\frac{1}{1-\frac{3}{2}}\right) = \frac{2}{3}\left(\frac{2}{-1}\right) = \frac{4}{-3}$

QUESTION

5.6 L of helium gas at STP is adiabatically compressed to 0.7 L. Taking the initial temperature to be T_1, the work done in the process is

1. $\frac{9}{8}RT_1$ (Ans)
2. $\frac{3}{2}RT_1$
3. $\frac{15}{8}RT_1$
4. $\frac{9}{2}RT_1$

no of mole $= \frac{1}{4}$

$f = 3$

$V_i = V$ (let)

$V_f = \frac{V}{8}$

$TV^{\gamma-1} = \text{const}$

$T_1 (V)^{\gamma-1} = T_2 (V/8)^{\gamma-1}$

$T_2 = T_1 \left(\frac{V}{V/8}\right)^{\gamma-1} = T_1 (8)^{\gamma-1} = T_1 (8)^{5/3-1} = T_1 (8)^{2/3} = T_1 (2)^{3\times\frac{2}{3}} = 4T_1$

$dW = -\Delta U = -nC_v dT = -\frac{nR}{\gamma-1} dT$

$dW = \frac{nR\,dT}{1-\gamma} = \frac{1}{4}\frac{R(4T_1 - T_1)}{1-5/3}$

$= \frac{1}{4}\frac{R\,3T_1}{\frac{3-5}{3}}$

$= \frac{9RT_1}{-8}$

$PV = nRT$

← no of mole (n)

Pressure of gas (P)

volume of containing (V)

* Boltzmann constant

$K = \frac{R}{N_A}$

$R = 8.31 \ J/mol\,K$

$= \frac{25}{3} \ J/mol\,K$

$= \frac{8.31}{4.2} \ cal/mol\,K$

$R = 2 \ cal/mol\,K$

$\rho = \frac{P M_m}{RT}$ ← density of gas

M_m = Molar mass

$\Rightarrow \ P M_m = \rho RT$

$M = Nm$

$M_m = N_A m$

m = mass of 1 molecule

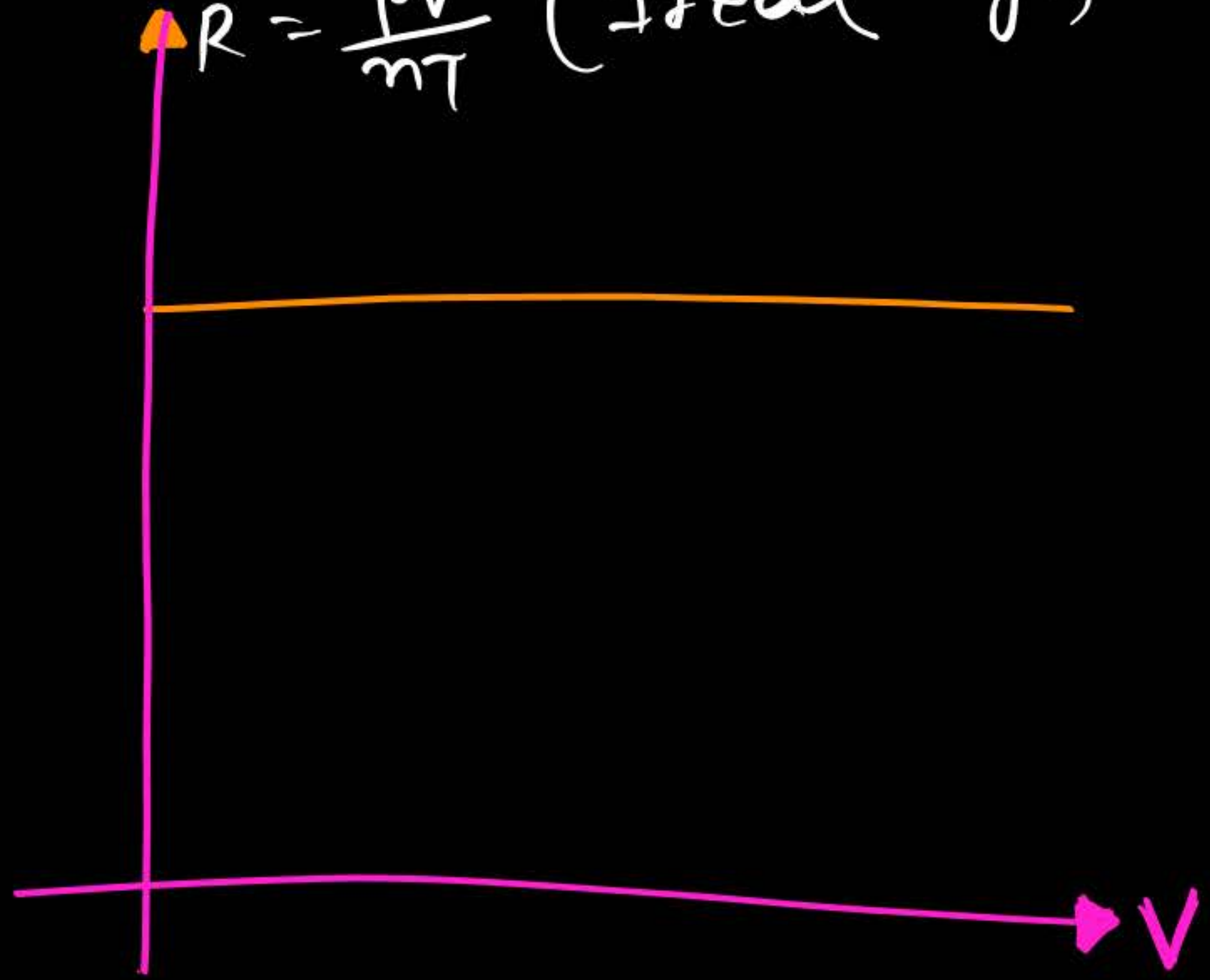
M_m = molar mass

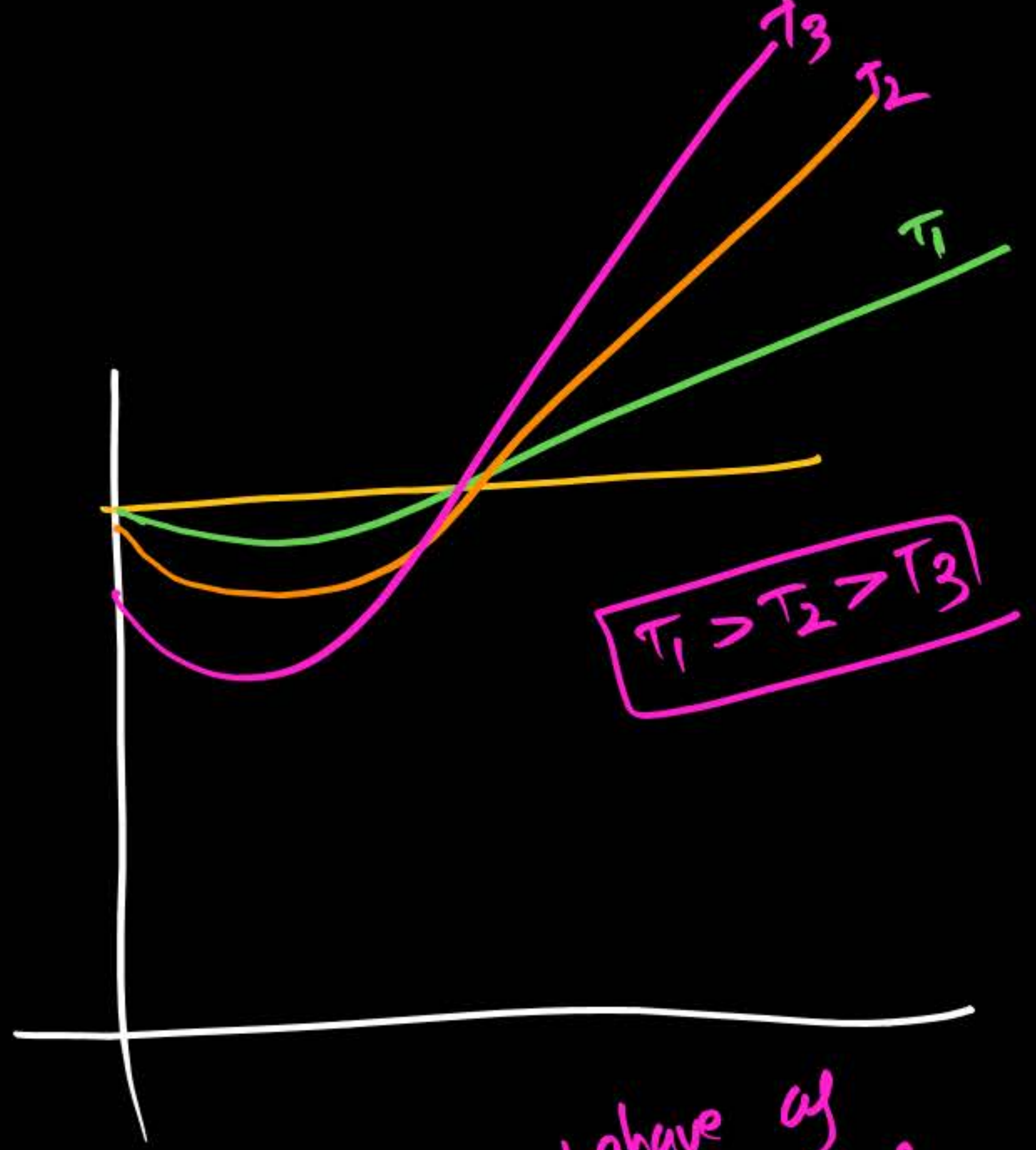
M = mass of gas of N = molecule

no of mole = $n = \frac{M}{M_m} = \frac{N}{N_A}$

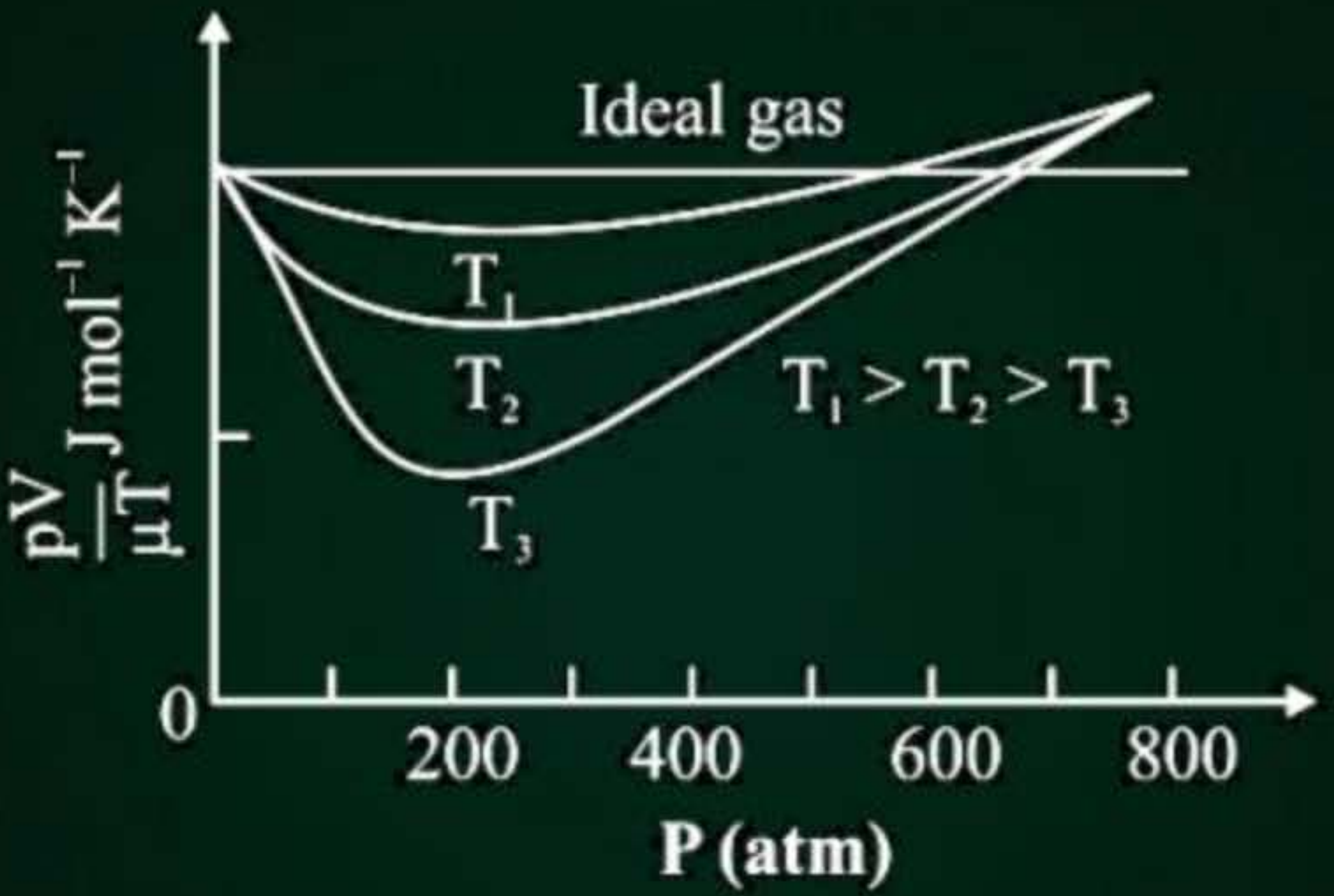
$PV = nRT$

$R = \frac{PV}{nT}$ (Ideal gas





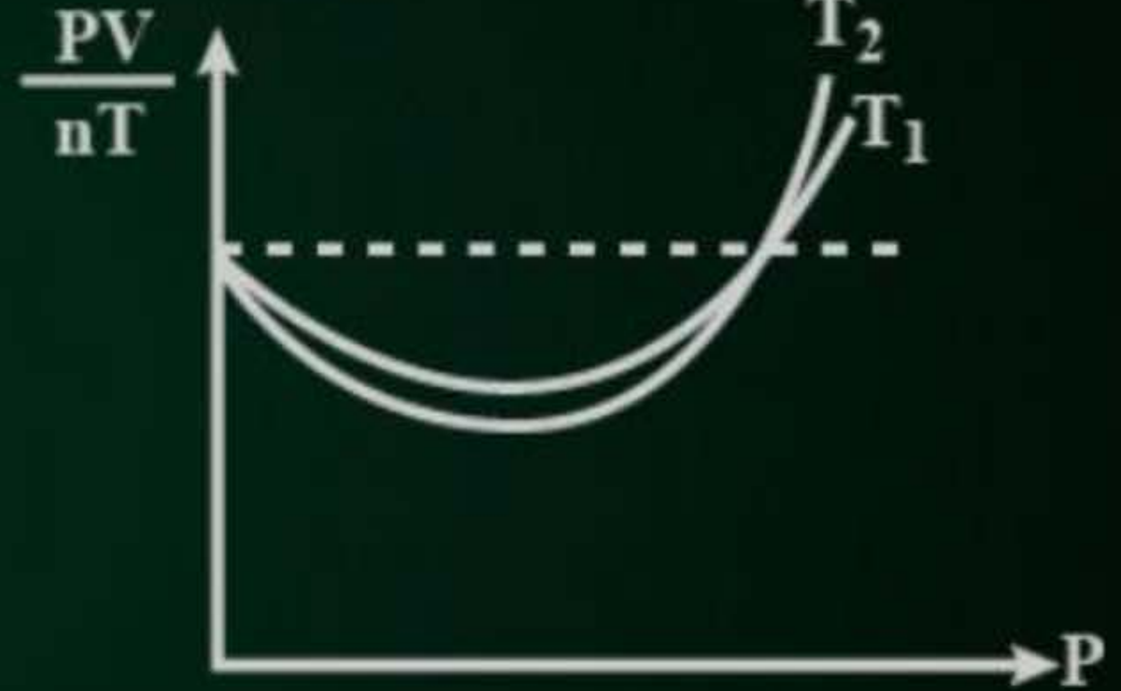
Real gas behave as Ideal gas at Low press & high Tempr



Real gases approach ideal gas behavior at low pressures and high temperature.

QUESTION

The figure shows the plot of $\frac{PV}{nT}$ vs P, for oxygen gas at two different temperatures then



(a) $T_1 > T_2$

(b) $T_2 > T_1$

(c) $T_1 = T_2$

(d) May be (a) and (b)

QUESTION

A real gas behaves as an ideal gas at

(a) Very low pressure and high temperature

(b) High pressure and low temperature

(c) High pressure and high temperature

(d) Low pressure and low temperature

Average speed (Mean speed):

$$V = \frac{v_1 + v_2 + v_3 + \ldots v_n}{n}$$

Mean square speed:

QUESTION

Four molecules of a gas have speeds 1, 2, 3 and 4 km/s. The value of the r.m.s. speed of the gas molecules is

(a) $\frac{1}{2}\sqrt{15}$ km/s

(b) $\frac{1}{2}\sqrt{10}$ km/s

(c) 2.5 km/s

(d) $\sqrt{\frac{15}{2}}$ km/s

KINETIC THEORY OF AN IDEAL GAS

Kinetic theory of gases is based on the molecules picture of matter. According to which

(1) A given amount of gas is a mixture of very large number of identical molecules of the order of Avogadro's number.

(2) The molecules are moving randomly in all directions.

(3) At ordinary temperature and pressure, the size of the molecules is very small as compared to the distances between them. Thus, the interaction between them is negligible. Hence, they move according to Newton's laws of motion.

(4) The molecules do not exert any force of attraction or repulsion on each other, except during collisions.

(5) The collisions of molecules against each other or with the walls of the container are perfectly elastic. Such that the momentum and the kinetic energy of the molecules are conserved during collisions, though their velocities change.

QUESTION

Select the appropriate property of an ideal gas

(a) Its molecules are infinitesimally small

(b) There are no forces of interaction between i molecules

(c) It strictly obeys the ideal gas laws

(d) All of these

PRESSURE OF AN IDEAL GAS

QUESTION

The average velocity of gas molecules is

(a) Proportional to $\sqrt{T}$

(b) Proportional to T

(c) Zero

(d) Not possible to determine

QUESTION

The r.m.s. speed of the molecules of enclosed gas is V. What will be the r.m.s. speed if pressure is doubled keeping the temperature same?

(a) $\frac{V}{2}$

(b) V

(c) 2V

(d) 4V

QUESTION

At constant pressure the r.m.s. velocity c is related to density d as

(a) $c \propto d$

(b) $c \propto \frac{1}{d}$

(c) $c \propto \sqrt{d}$

(d) $c \propto \frac{1}{\sqrt{d}}$

QUESTION

Temperature of ideal gas is increased from 27°C to 927°C, the rms speed of molecule will become

(a) Twice

(b) Half

(c) Four times

(d) One fourth

QUESTION

Which of the following gas possesses maximum rms velocity ? All being at same temperature

(a) Oxygen

(b) Carbon dioxide

(c) Hydrogen

(d) Helium

QUESTION

If the pressure remains constant, find the temperature at which root mean square speed of a gas is half of its value at 27°C.

KINETIC INTERPRETATION OF TEMPERATURE

QUESTION

A jar has a mixture of hydrogen and oxygen gases in the ratio 1 : 5, the ratio of mean kinetic energy of hydrogen and oxygen molecule is

(a) 1 : 16
(b) 1 : 4
(c) 1 : 5
(d) 1 : 1

QUESTION

The ratio of average translator kinetic energy of He gas molecules to O_2 gas molecules is

(a) $\frac{25}{21}$

(b) $\frac{21}{25}$

(c) $\frac{3}{2}$

(d) 1

QUESTION

If E is the energy density in an ideal gas, then the pressure of the ideal gas is

(a) $P = \frac{2}{3}E$

(b) $P = \frac{3}{2}E$

(c) $P = \frac{5}{2}E$

(d) $P = \frac{2}{5}E$

QUESTION

The percentage change in the pressure of a given mass of a gas filled in a container at constant temperature is 100%. Calculate the percentage change in its volume.

QUESTION

A gas is filled in a vessel at a certain temperature and at a pressure of 80 cm of mercury. At the same temperature, more gas is filled in the vessel so that its mass increases by 60%. Determine the resultant pressure in the vessel.

QUESTION

A gas at a pressure P_0 is contained in a vessel. If the masses of all the molecules are halved and their velocities doubled, then the resulting pressure P will be

(a) $4P_0$

(b) $2P_0$

(c) P_0

(d) $P_0/2$

QUESTION

A gas is filled in a vessel at 27°C. To what temperature should it be heated in order that $\frac{1}{3}$ rd of the gas may escape out of the vessel?

QUESTION

A sample of gas in a box is at pressure P_0 and temperature T_0. If number of molecules is doubled and total kinetic energy of the gas is kept constant, then final temperature and pressure will be

(a) T_0, P_0

(b) $T_0, 2P_0$

(c) $\frac{T_0}{2}, 2P_0$

(d) $\frac{T_0}{2}, P_0$

QUESTION

Boyle's law is obeyed by

(a) Real gas of constant mass and temperature

(b) Ideal gas of constant mass and temperature

(c) Both ideal and real gases at constant temperature and variable mass

(d) Both ideal and real gases of constant mass and variable temperature

QUESTION

The raise in the temperature of a given mass of an ideal gas at constant pressure and at temperature 27° to double its volume is

(a) 327°C

(b) 54°C

(c) 300°C

(d) 600°C

FREE EXPANSION

- Ideal gas at some temperature T in thermally insulated bottle, with stopcock connect this to another insulated bottle which is evacuated. When we suddenly open stopcock gas will rush from the one to other bottle until pressure equalized, but temperature does not change, $du = 0$, $Q = 0$ hence $dw = 0$,

QUESTION

The mean free path of molecules of a gas, (radius r) is inversely proportional to

[AIPMT-2014]

(a) r^3

(b) r^2

(c) r

(d) $\sqrt{r}$

QUESTION

For a molecule of an ideal gas $n = 3 \times 10^8$ cm^{-3} and mean free path is 10^{-2} cm. Calculate the diameter of the molecule.

QUESTION

Two thermally insulated vessels 1 and 2 are filled with air at temperatures (T_1, T_2), volume (V_1, V_2) and pressure (P_1, P_2) respectively. If the valve joining the two vessels is opened, the temperature inside the vessel at equilibrium will be

(a) $T_1 + T_2$

(b) $\frac{(T_1 + T_2)}{2}$

(c) $\frac{T_1 T_2 (P_1 V_1 + P_2 V_2)}{P_1 V_1 T_2 + P_2 V_2 T_1}$

(d) $\frac{T_1 T_2 (P_1 V_1 + P_2 V_2)}{P_1 V_1 T_1 + P_2 V_2 T_2}$

QUESTION

E_0 and E_H respectively represents the average kinetic energy of a molecule of oxygen and hydrogen. If the two gases are at the same temperature, which of the following statement is true?

(a) $E_0 > E_H$

(b) $E_0 = E_H$

(c) $E_0 < E_H$

(d) Data insufficient

QUESTION

14 g of CO at 27°C is mixed with 16 g of O_2 at 47°C. The temperature of mixture is (vibration mode neglected)

(a) -5°C
(b) 32°C
(c) 37°C
(d) 27°C

QUESTION

When one mole of monatomic gas is mixed with one mole of a diatomic gas, then the equivalent value of γ for the mixture will be (vibration mode neglected)

(a) 1.33

(b) 1.40

(c) 1.50

(d) 1.6

QUESTION

A given sample of an ideal gas occupies a volume V at a pressure P and absolute temperature T. The mass of each molecule of the gas is m. Which of the following gives the density of the gas? [NEET(Phase-2)-2016]

(a) $\frac{P}{(kT)}$

(b) $\frac{Pm}{(kT)}$

(c) $\frac{P}{(kTV)}$

(d) mkT

QUESTION

The molecules of a given mass of a gas have r.m.s. velocity of 200 ms^{-1} at 27°C and 1.0×10^5 Nm^{-2} pressure. When the temperature and pressure of the gas are respectively, 127°C and 0.05×10^5 Nm^{-2}, the r.m.s. velocity of its molecules in ms^{-1} is

[NEET-2016]

(a) $\frac{100}{3}$

(b) $100\sqrt{2}$

(c) $\frac{400}{\sqrt{3}}$

(d) $\frac{100\sqrt{2}}{3}$

QUESTION

Two container A and B are partly filled with water and closed. The volume of A is twice that of B and it contains half the amount of water in B. If both are at same temperature, the water vapour in the container will have pressure in the ratio of

(a) 1 : 2

(b) 1 : 1

(c) 2 : 1

(d) 4 : 1

QUESTION

Two vessels separately contain two ideal gases A and 8 at the same temperature, the pressure of A being twice that of 8. Under such conditions, the density of A is found to be 1.5 times the density of a The ratio of molecular weight of A and B is

[Re-AIPMT-2015]

(a) $\frac{1}{2}$

(b) $\frac{2}{3}$

(c) $\frac{3}{4}$

(d) 2

QUESTION

A vessel contains a non-linear triatomic gas. If 50% of gas dissociate into individual atom, then find new value of degree of freedom by ignoring the vibrational mode and any further dissociation.

(a) 2.15
(b) 3.75
(c) 5.25
(d) 6.35


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 7 | Physics

Kinetic Theory of Gases and Thermodynamics

By- Dr. Manish Raj (MR SIR)



Topics to be covered

K.T.G

1. #
2. # Vrms | Vmp | Vavg
3. # Maxwell Boltzmann distribution curve

Pressure of gas / Dalton law

mean free path.

all PYQ



$$PV = nRT$$ ← Tempr

- P → Pressure of gas
- V → Volume of Container
- n → no. of mole Jiska pressure liya hai

$$\rho_{gas} = \frac{m}{V}$$

$$V = \frac{m}{\rho}$$

$$n = \frac{N}{N_A} = \frac{M}{M_m}$$

→ no. of mole

N = Total No of molecule of gas.

N_A = Avogardo no.

m = mass of 1 moleculel.

$$P\frac{M}{\rho} = \frac{M}{M_m} RT$$

$$PM_m = \rho RT$$

$$\rho = \frac{PM_m}{RT} = \frac{PN_A m}{N_A K_B T}$$

ρ → density of gas

$$\rho = \frac{Pm}{K_B T}$$

$$PV = nRT$$

$$PV = \frac{N}{N_A} N_A K_B T$$

$PV = NK_B T$

$PV = nRT$

$PM_m = \rho RT$

$$n = \frac{M}{M_m} = \frac{Nm}{N_A m}$$

$M_{\text{total mass of gas}} = Nm$

$M_m = N_A m$

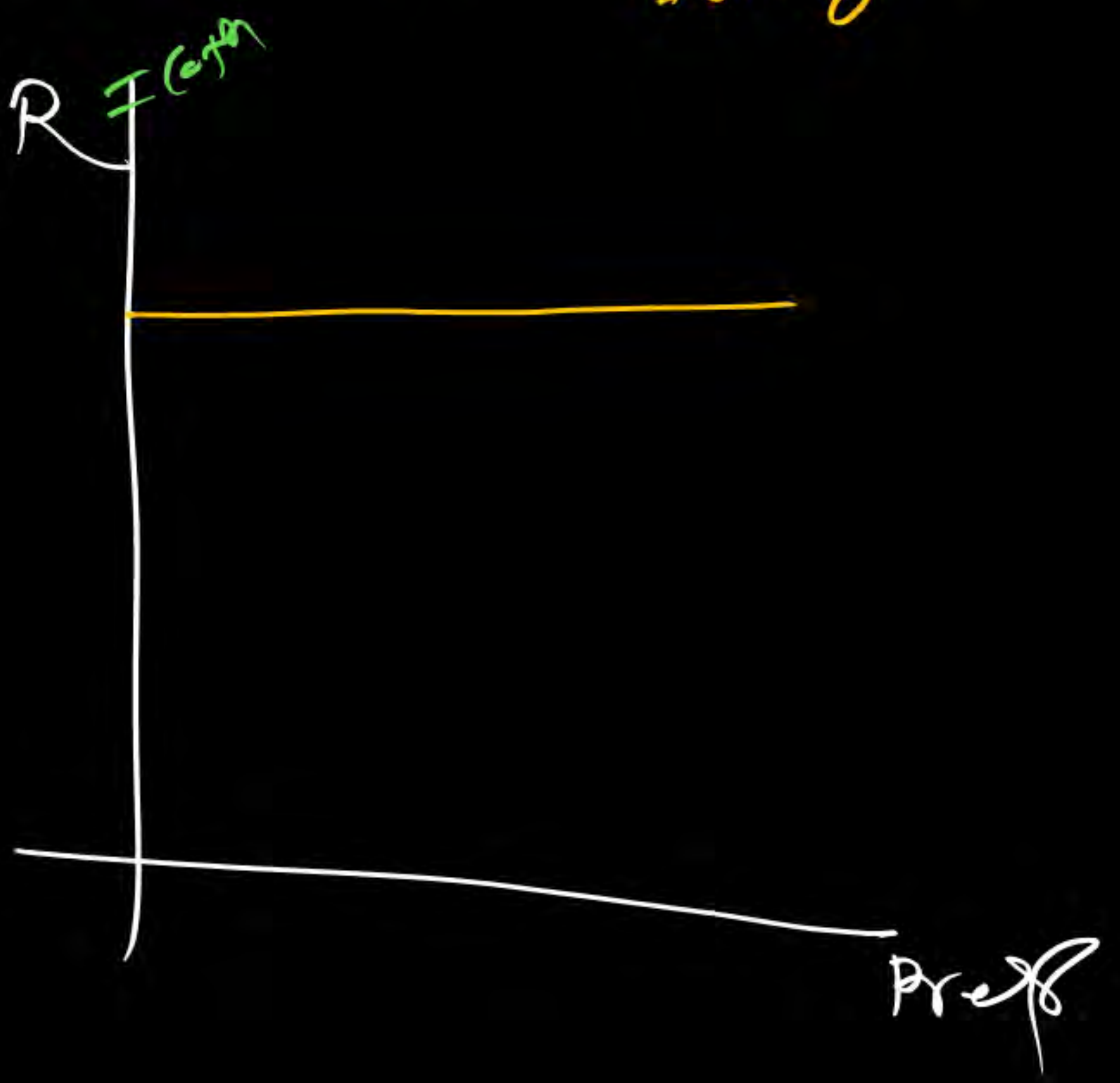
$$K_B = \frac{R}{N_A}$$

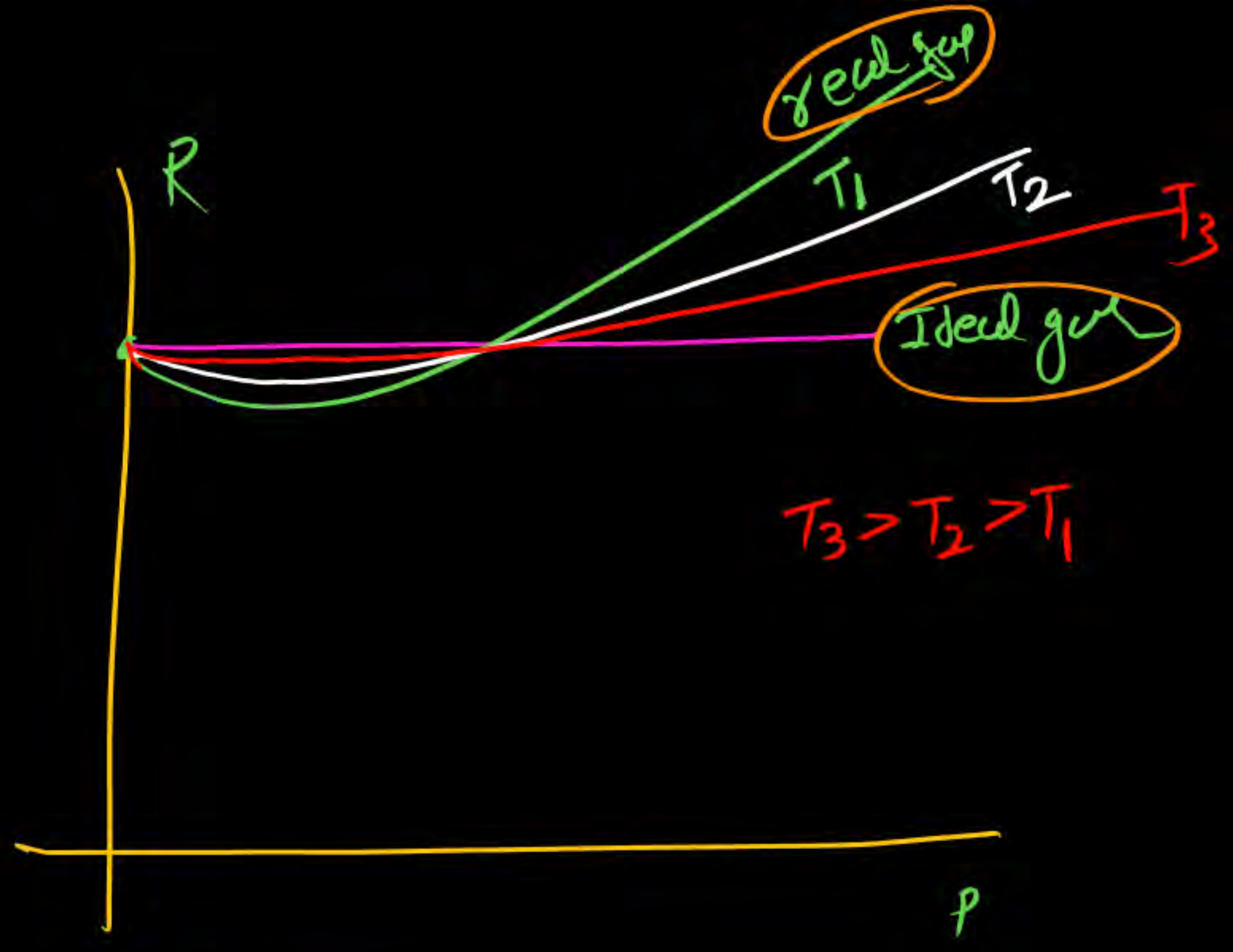
$$R = N_A K_B$$

Graph B/w R & P

Ideal gas

$\frac{PV}{nT} = R$





As Temp Increases real gas approaches to Ideal gas

Real gas behave as Ideal gas at low pressure & high Temp

QUESTION

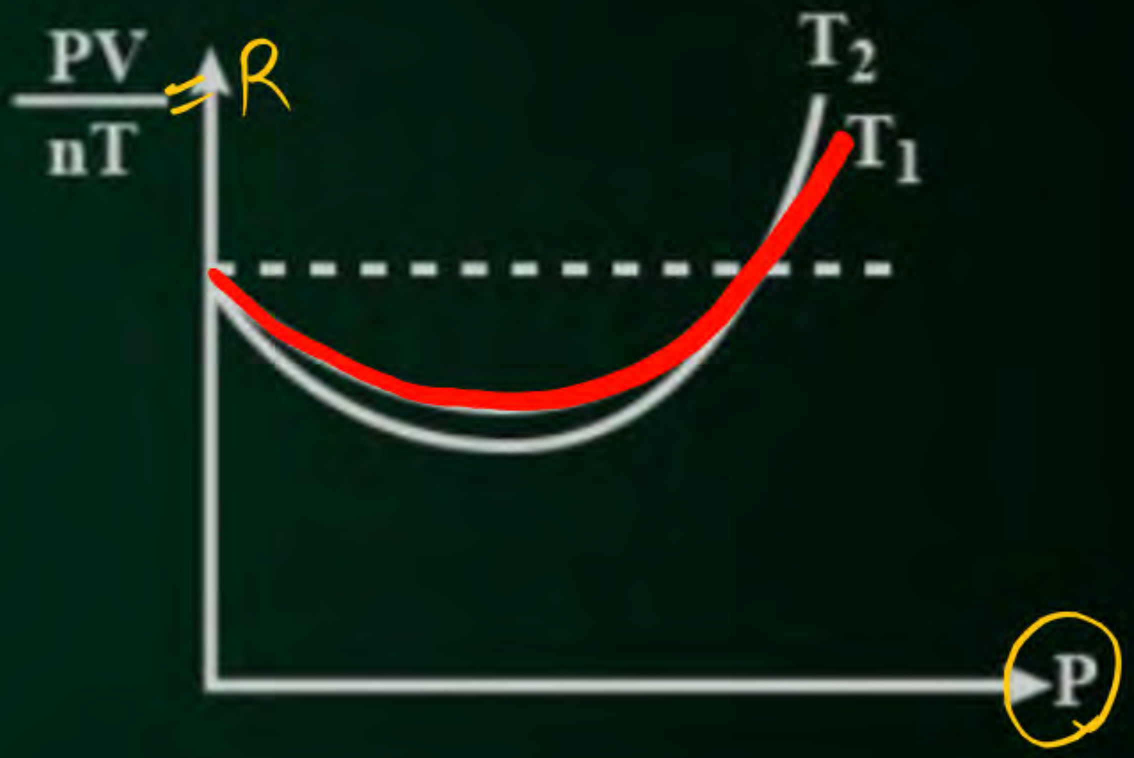
The figure shows the plot of $\frac{PV}{nT}$ vs P, for oxygen gas at two different temperatures then

(a) $T_1 > T_2$

(b) $T_2 > T_1$

(c) $T_1 = T_2$

(d) May be (a) and (b)



QUESTION

A real gas behaves as an ideal gas at

(a) Very low pressure and high temperature

(b) High pressure and low temperature

(c) High pressure and high temperature

(d) Low pressure and low temperature

QUESTION

A given sample of an ideal gas occupies a volume V at a pressure P and absolute temperature T. The mass of each molecule of the gas is m. Which of the following gives the density of the gas? [NEET(Phase-2)-2016]

(a) $\frac{P}{(kT)}$

(b) $\frac{Pm}{(kT)}$

(c) $\frac{P}{(kTV)}$

(d) mkT

$\rho = \frac{PM_m}{RT} = \frac{PN_A m}{K_B N_A T} = \frac{Pm}{KT}$

$K_B = K$

Average speed (Mean speed):

n = no of Particle

for 1- Particle

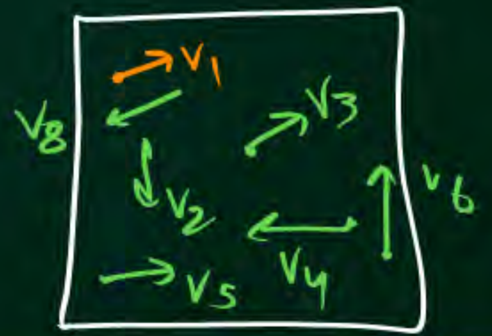
Avg. speed = $\frac{\text{total dist}^n}{\text{total time}}$

$$V = \frac{v_1 + v_2 + v_3 + \dots v_n}{n}$$

n = no of molecule

Avg velocity = 0 → due random motion

Mean square speed:



V_{rms} — root Avg square of speed

$$\sqrt{V^2_{Avg}} = \sqrt{\frac{v_1^2 + v_2^2 + v_3^2 + v_4^2 + \dots v_n^2}{n}}$$

$$v_{rms} = \sqrt{\frac{v_1^2 + v_2^2 + \dots + v_n^2}{n}}$$

QUESTION

Four molecules of a gas have speeds 1, 2, 3 and 4 km/s. The value of the r.m.s. speed of the gas molecules is

(a) $\frac{1}{2}\sqrt{15}$ km/s

(b) $\frac{1}{2}\sqrt{10}$ km/s

(c) 2.5 km/s

(d) $\sqrt{\frac{15}{2}}$ km/s

$V_{Avg} \le V_{r.m.s}$

$V_{Avg\,speed} = \frac{1+2+3+4}{4} = \frac{10}{4} = 2.5$ m/s

$V_{rms} = \sqrt{\frac{1^2+2^2+3^2+4^2}{4}} = \sqrt{\frac{1+4+9+16}{4}} = \sqrt{\frac{30}{4}} = \sqrt{\frac{15}{2}} = \sqrt{7.5} = 2.73$

KINETIC THEORY OF AN IDEAL GAS

Kinetic theory of gases is based on the molecules picture of matter. According to which

(1) A given amount of gas is a mixture of very large number of identical molecules of the order of Avogadro's number.

(2) The molecules are moving randomly in all directions.

(3) At ordinary temperature and pressure, the size of the molecules is very small as compared to the distances between them. Thus, the interaction between them is negligible. Hence, they move according to Newton's laws of motion.

(4) The molecules do not exert any force of attraction or repulsion on each other, except during collisions.

(5) The collisions of molecules against each other or with the walls of the container are perfectly elastic. Such that the momentum and the kinetic energy of the molecules are conserved [redacted] collisions, though their velocities change.

QUESTION

Select the appropriate property of an ideal gas

(a) Its molecules are infinitesimally small

(b) There are no forces of interaction between i molecules

(c) It strictly obeys the ideal gas laws

(d) All of these

PRESSURE OF AN IDEAL GAS

$\rho = \frac{M}{V} \Rightarrow M = \rho V$

$$\rho = \frac{P M_m}{RT} = \frac{Pm}{KT}$$

MR Ratta ←

$$P = \frac{1}{3} n m \bar{v}_{rms}^2$$

Pressure

M = mass of gas.

n = no. density $= \frac{N}{V}$

m = mass of each Molecule

$\bar{V}_{rms}$ = rms. speed

$$P = \frac{1}{3}\frac{Nm}{V}\bar{V}_{rms}^2 = \frac{1}{3}\frac{M}{V}v_{rms}^2$$



$$V_{rms} = \sqrt{\frac{3PV}{M}} = \sqrt{\frac{3P}{\rho}} = \sqrt{\frac{3\rho RT}{\rho M_m}}$$

$$\sqrt{\frac{3\rho KT}{\rho m}} = \sqrt{\frac{3KT}{m}}$$

$$\# \; V_{rms} = \sqrt{\frac{3PV}{M}} = \sqrt{\frac{3RT}{M_m}} = \sqrt{\frac{3KT}{m}}$$

M ↑ Total Mass of the gas

M_m ↓ molecular mass

m ↑ mass of each molecule

$$V_{rms} = \sqrt{\frac{3PV}{M}} = \sqrt{\frac{3P}{\rho}} = \sqrt{\frac{3RT}{M_m}} = \sqrt{\frac{3KT}{m}}$$

$$\tilde{V}_{mp} = \sqrt{\frac{8PV}{\pi M}} = \sqrt{\frac{8P}{\pi \rho}} = \sqrt{\frac{8RT}{\pi M_m}} = \sqrt{\frac{8KT}{\pi m}}$$ → velocity Posses by largest no of molecule.

$$V_{Avg} = \sqrt{\frac{2PV}{M}} = \sqrt{\frac{2P}{\rho}} = \sqrt{\frac{2RT}{M_m}} = \sqrt{\frac{2KT}{m}}$$

R > A > M

Rms > Avg > Max probley

$V_{rms} \propto \sqrt{3}$ ✓

$V_{Avg} = \sqrt{2}$

$V_{mp} = \sqrt{\frac{8}{\pi}} = \sqrt{\frac{8}{3.4}} \simeq 2.5$

5 m/s
1 m/s
2 m/s
4 m/s
3 m/s
8 m/s
2 m/s
3 m/s
2 m/s
4 m/s
2 m/s

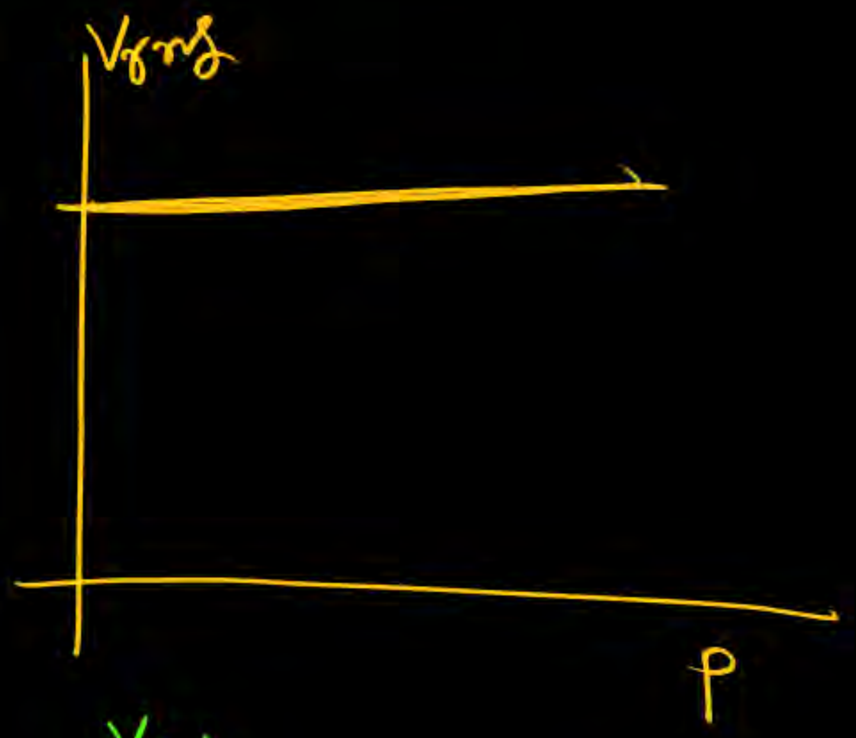
$$V_{R_{ms}} = \sqrt{\frac{3RT}{M_m}} = \sqrt{\frac{3P}{\rho}}$$

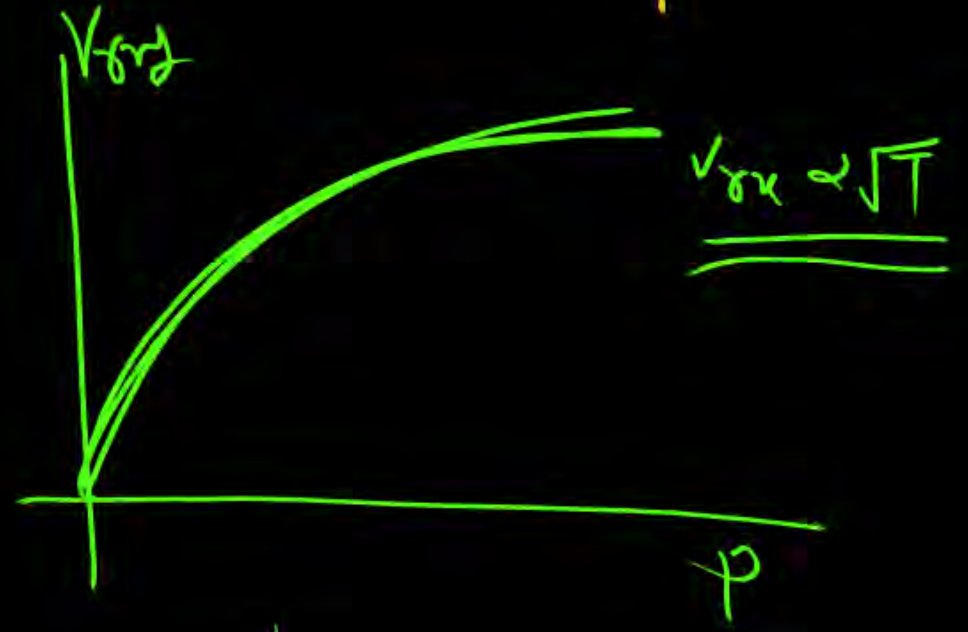
$$V_{R_{Avg}} = \sqrt{\frac{2RT}{M_m}}$$

$$V_{R_{mp}} = \sqrt{\frac{8RT}{M_m}}$$

$$\frac{V_{Rms}}{V_{Avg}} = \sqrt{\frac{3}{2}}$$

$$V_{rms} \propto \sqrt{P/\rho}$$





QUESTION

The average velocity of gas molecules is

(a) Proportional to $\sqrt{T}$

(b) Proportional to T

(c) Zero

(d) Not possible to determine

QUESTION

The r.m.s. speed of the molecules of enclosed gas is V. What will be the r.m.s. speed if pressure is doubled keeping the temperature same?

(a) $\frac{V}{2}$

(b) V

(c) 2V

(d) 4V

QUESTION

At constant pressure the r.m.s. velocity c is related to density d as

(a) $c \propto d$

(b) $c \propto \frac{1}{d}$

(c) $c \propto \sqrt{d}$

(d) $c \propto \frac{1}{\sqrt{d}}$

$V_{rms} = \sqrt{\frac{3P}{\rho}}$

(Q) at const^n density pressure becomes double ?? then rms will be

Sol^n $V_{rms} = \sqrt{\frac{3P}{\rho}} \propto \sqrt{P}$

V_{rms} becomes $\sqrt{2}$ times

Same

QUESTION

$d\theta = ms\Delta T$

$v_{rms} \propto \sqrt{\text{Tempr (Kelvin)}}$

Temperature of ideal gas is increased from 27°C to 927°C, the rms speed of molecule will become

+273   273   1200

(a) Twice ✓

(b) Half

(c) Four times

(d) One fourth

$$\frac{v_1 \propto \sqrt{T_1}}{v_1 \propto \sqrt{T_2}}$$

$$\frac{v_1}{v_2} = \sqrt{\frac{300}{1200}}$$

$$v_1 2 = v_2$$

QUESTION

Which of the following gas possesses maximum rms velocity ? All being at same temperature

(a) Oxygen

(b) Carbon dioxide

(c) Hydrogen

(d) Helium

$V_{rms} = \sqrt{\frac{3RT}{M_m}}$

QUESTION

If the pressure remains constant, find the temperature at which root mean square speed of a gas is half of its value at 27°C.

KINETIC INTERPRETATION OF TEMPERATURE

due to monoatomic gas (Translational d.o.f)

$$P = \frac{1}{3} n m \bar{v}_{rms}^2$$

$$= \frac{1}{3}\frac{N}{V} m v_{r.m.s}^2$$

$$P = \frac{2}{3V} K.E$$

$$K.E_{gas} = \frac{3PV}{2}$$

(*) $$K.E = \frac{3PV}{2} = \frac{3}{2} N K_B T$$

K.E of one molecule $= \frac{1}{2} m v_{rms}^2$

$$n = \frac{N}{V}$$

$$K.E_{gas} = \frac{1}{2} N m v_{rms}^2$$

this this value in main eqn

$U_{Intl} \propto K.E \propto \frac{1}{2} K_B T$

Per molecule / Per d.o.f

K.E of 1 molecule due to 1 d.o.f $= \frac{1}{2} K_B T$

K.E of N molecule due to f d.o.f $= \frac{1}{2} f N K_B T$

$$K.E \left(U_{monoatomic} = \frac{3}{2} N K_B T \right)$$

d.o.f = 3

QUESTION

A jar has a mixture of hydrogen and oxygen gases in the ratio 1 : 5, the ratio of mean kinetic energy of hydrogen and oxygen molecule is

(a) 1 : 16

(b) 1 : 4

(c) 1 : 5

(d) 1 : 1

QUESTION

The ratio of average translator kinetic energy of He gas molecules to O_2 gas molecules is

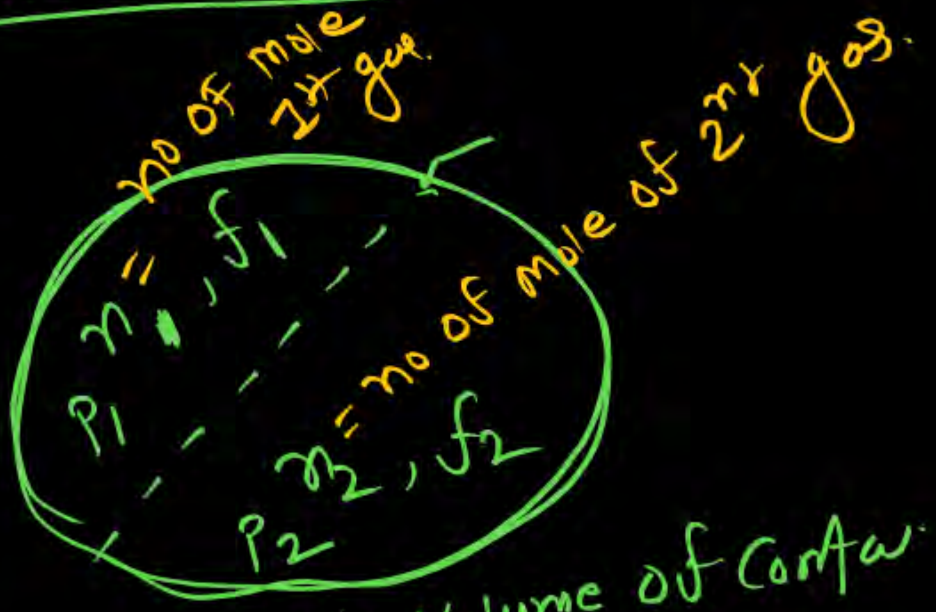
(a) $\frac{25}{21}$

(b) $\frac{21}{25}$

(c) $\frac{3}{2}$

(d) 1

Daltons Law



V = Volume of Contain.

T = Tempr

$$P_1 V = n_1 RT \quad - (1)$$

$$P_2 V = n_2 RT \quad - (1)$$

$$P_{mix} V = (n_1 + n_2) RT \quad - (11)$$

$$PV = nRT$$

QUESTION

If E is the energy density in an ideal gas, then the pressure of the ideal gas is

(a) $P = \frac{2}{3}E$ ✓

(b) $P = \frac{3}{2}E$

(c) $P = \frac{5}{2}E$

(d) $P = \frac{2}{5}E$

$K.E = \frac{3}{2}PV$

$\frac{K.E}{V} = \frac{3}{2}P$

$E =$ energy density $= \frac{3}{2}P$

$P = \frac{2E}{3}$

QUESTION

The percentage change in the pressure of a given mass of a gas filled in a container at constant temperature is 100%. Calculate the percentage change in its volume.

Isothermal Process

$PV = nRT$ → const

$P_i = P_0$

$P_f = P_0 + 100\% \cdot P_0$

$P_f = 2P_0$

$P_0 V_0 = 2P_0 V_f$

$V_f = \frac{V_0}{2}$

$\frac{V_f - V_i}{V_i} \times 100$

$\frac{\frac{V_0}{2} - V_0}{V_0} \times 100$

$= -\frac{V_0}{2V_0} \times 100$

$= 50\%$

$PV = nRT$

$PV = \text{Const}$

$\frac{\Delta P}{P} + \frac{\Delta V}{V} = 0$

$100 \times \frac{\Delta P}{P} = -\frac{\Delta V}{V} \times 100$



QUESTION

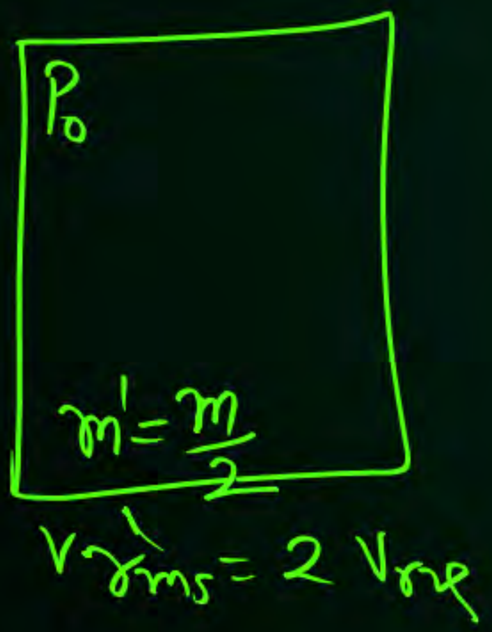
A gas at a pressure P_0 is contained in a vessel. If the masses of all the molecules are halved and their velocities doubled, then the resulting pressure P will be

(a) $4P_0$

(b) $2P_0$

(c) P_0

(d) $P_0/2$



$$P = \frac{1}{3} n \frac{m}{2} (2v_{rms})^2$$

QUESTION

A sample of gas in a box is at pressure P_0 and temperature T_0. If number of molecules is doubled and total kinetic energy of the gas is kept constant, then final temperature and pressure will be

(a) T_0, P_0

(b) $T_0, 2P_0$

(c) $\frac{T_0}{2}, 2P_0$

(d) $\frac{T_0}{2}, P_0$

$P = \frac{1}{3}\frac{N}{V}\frac{m v_{rms}^2}{2} \times 2$

$K.E_{gas} = \frac{1}{2} m N v_{rms}^2$

$P = \frac{2\, K.E_{gas}}{3V}$

P_0, T_0

$N' = 2N$

$K.E_{gas} = \text{Const}$

$K.E_{gas} = \frac{1}{2} m N v_{rms}^2 = \text{Const}$

$\text{Same} = \frac{1}{2} m N \left(\frac{3RT}{m}\right)$

QUESTION

Boyle's law is obeyed by

(a) Real gas of constant mass and temperature

(b) Ideal gas of constant mass and temperature

(c) Both ideal and real gases at constant temperature and variable mass

(d) Both ideal and real gases of constant mass and variable temperature

QUESTION

The raise in the temperature of a given mass of an ideal gas at constant pressure and at temperature 27° to double its volume is

(a) 327°C

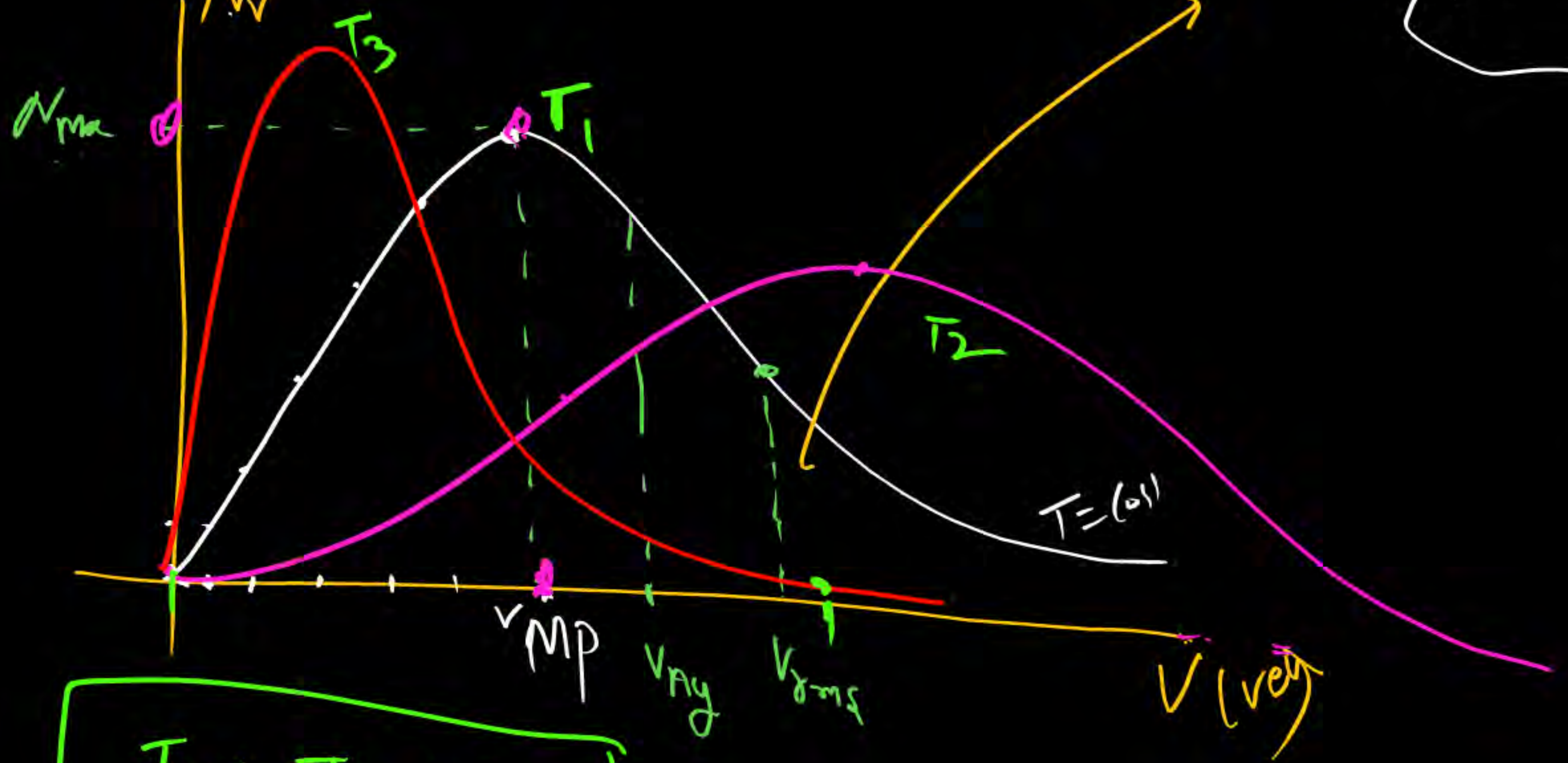
(b) 54°C

(c) 300°C

(d) 600°C

Boltzman distribution curve

N_v = No of partic per unit velo



$$T_3 < T_1 < T_2$$

$\int N_v \, dv$ = Area = No of particle

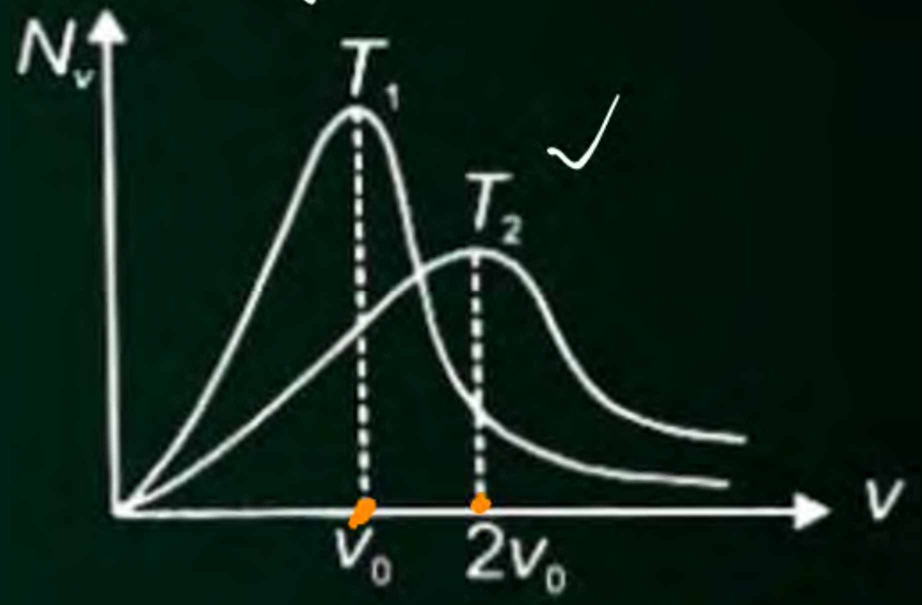
Area under curve does not depends on Tempr

Tempr ↑ Karne पर graph आगे और निचे जाता है

QUESTION

The figure shows Maxwell's speed distribution of a given amount of an ideal gas at two different temperatures. Choose the correct option.

1. $T_1 = 2T_2$
2. $T_2 = 2T_1$
3. $T_2 = 4T_1$
4. $T_2 = \sqrt{2}T_1$



QUESTION

Match Column I and Column II and choose the correct match from the given choices.

Column-I		Column-II	
(A)	Root mean square speed of gas molecules	(P)	$\frac{1}{3}nmv^{-2}$
(B)	Pressure exerted by ideal gas	(Q)	$\sqrt{\frac{3RT}{M}}$
(C)	Average kinetic energy of a molecule, Monoatic.	(R)	$\frac{5}{2}RT$
(D)	Total internal energy of 1 mole of a diatomic gas	(S)	$\frac{3}{2}k_BT$

1. A-R, B-P, C-S, D-Q
2. A-Q, B-R, C-S, D-P
3. A-Q, B-P, C-S, D-R
4. A-R, B-Q, C-P, D-S

QUESTION

An ideal gas equation can be written as

$$P = \frac{\rho RT}{M_0}$$

$\rho = \frac{Pm}{RT}$

where ρ and M_0 are respectively,

[2020 Phase II]

1. Number density, mass of gas
2. Mass density, mass of the gas
3. Number density, molar mass
4. Mass density, molar mass

Mean free Path


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 8 | **Physics**

Kinetic Theory of Gases and Thermodynamics

By- Dr. Manish Raj (MR SIR)



Topics to be covered

K.T.G

1. #
2. # Vrms | Vmp | Vavg
3. # # Maxwell Boltzmann distribution curve

Pressure of gas / Dalton law

mean free path.

all PYQ



QUESTION

The molecules of a given mass of a gas have r.m.s. velocity of 200 ms^{-1} at 27°C and 1.0×10^5 Nm^{-2} pressure. When the temperature and pressure of the gas are respectively, 127°C and 0.05×10^5 Nm^{-2}, the r.m.s. velocity of its molecules in ms^{-1} is [NEET-2016]

(a) $\frac{100}{3}$

(b) $100\sqrt{2}$

(c) $\frac{400}{\sqrt{3}}$

(d) $\frac{100\sqrt{2}}{3}$

QUESTION

E_0 and E_H respectively represents the average kinetic energy of a molecule of oxygen and hydrogen. If the two gases are at the same temperature, which of the following statement is true?

(a) $E_0 > E_H$

(b) $E_0 = E_H$

(c) $E_0 < E_H$

(d) Data insufficient

$= \frac{1}{2} k_B T f$

QUESTION

Two vessels separately contain two ideal gases A and B at the same temperature, the pressure of A being twice that of B. Under such conditions, the density of A is found to be 1.5 times the density of B. The ratio of molecular weight of A and B is

[Re-AIPMT-2015]

(a) $\frac{1}{2}$

(b) $\frac{2}{3}$

(c) $\frac{3}{4}$ ✓

(d) 2

$P_A = 2P_B$ — (i)

$\rho_A = 1.5\rho_B$ — (ii)

$\frac{M_{m1}}{M_{m2}} = ??$

Temp

$PV = nRT$

$PM_m = \rho RT$ (RT same)

$M_m \propto \frac{\rho}{P}$

$\frac{M_{m1}}{M_{m2}} = \frac{\rho_A}{\rho_B} \times \frac{P_B}{P_A}$

$= \frac{3\rho_B}{2\rho_B} \times \frac{P_B}{2P_B} = \frac{3}{4}$

mean free Path → Avg. distn B/w two collision (mean free Path)

$l_{Avg} = v_{Avg} t$

t = relaxation time

= Avg. time B/w two collisn

MR Rufta

$$\langle l \rangle_{Avg} = \frac{1}{\sqrt{2}\pi n d^2}$$

$$\frac{l_{mean\,free}}{t} = v_{Avg}$$

d = dimmetre

n = no density = $\frac{N}{V}$ = total no. of molecul per unit Volum.



$$\langle l \rangle = \frac{KT}{\sqrt{2}\pi d^2 P}$$

mean free Path ∝ Tempr

∝ $\frac{1}{\text{Pressure}}$

$PV = NKT$

$\frac{P}{KT} = \frac{N}{V} = n$

QUESTION

The mean free path for a gas, with molecular diameter d and number density n can be expressed as [2020 Phase I]

1. $\dfrac{1}{\sqrt{2}n^2\pi^2 d^2}$ ✗

2. $\dfrac{1}{\sqrt{2}n\pi d}$

3. $\dfrac{1}{\sqrt{2}n\pi d^2}$ ✓✓

4. $\dfrac{1}{\sqrt{2}n^2\pi d^2}$

$d = 2r$

$\langle l \rangle = \dfrac{1}{\sqrt{2}\,n\pi d^2} = \dfrac{1}{\sqrt{2}\,n\pi (2r)^2} \propto \dfrac{1}{r^2}$

QUESTION

The mean free path l for a gas molecule depends upon diameter, d of the molecule as [2020 Phase II]

1. $l \propto \frac{1}{d}$
2. $l \propto \frac{1}{d^2}$ ✓
3. $l \propto d$
4. $l \propto d^2$

QUESTION

The mean free path of molecules of a gas, (radius r) is inversely proportional to

[AIPMT-2014]

(a) r^3

(b) r^2

(c) r

(d) $\sqrt{r}$

QUESTION

$1\,cm = 10^{-2}\,m$

For a molecule of an ideal gas $n = 3 \times 10^8\ cm^{-3}$ and mean free path is 10^{-2} cm. Calculate the diameter of the molecule.

$$n = \frac{3\times10^8}{cm^3} = \frac{3\times10^8}{(10^{-2})^3\, m^3}$$

$$l = \frac{1}{\sqrt{2}\pi n d^2}$$

$$d^2 = \frac{1}{\sqrt{2}\pi n l}$$

$$d = \sqrt{\frac{1}{\sqrt{2}\pi n l}}$$

QUESTION

A gas is filled in a vessel at a certain temperature and at a pressure of 80 cm of mercury. At the same temperature, more gas is filled in the vessel so that its mass increases by 60%. Determine the resultant pressure in the vessel.

$P = 80$ cm of Hg

$P = \rho_{Hg} g H$

$PV = nRT$ → same

$P \propto n$

$\frac{P_1}{P_2} = \frac{n_1}{n_2}$

$\frac{(80 \text{ cm of Hg})}{P} = \frac{n_0}{160\% \, n_0} = \frac{100}{160}$

$P = \frac{8}{5}(80 \text{ cm of Hg})$

$= (16 \times 8)$ cm Hg

QUESTION

Two thermally insulated vessels 1 and 2 are filled with air at temperatures (T_1, T_2), volume (V_1, V_2) and pressure (P_1, P_2) respectively. If the valve joining the two vessels is opened, the temperature inside the vessel at equilibrium will be

(a) $T_1 + T_2$

(b) $\frac{(T_1 + T_2)}{2}$

(c) $\frac{T_1T_2(P_1V_1 + P_2V_2)}{P_1V_1T_2 + P_2V_2T_1}$ ✓

(d) $\frac{T_1T_2(P_1V_1 + P_2V_2)}{P_1V_1T_1 + P_2V_2T_2}$

$P_1V_1 = n_1RT_1$

$$T_{mix} = \frac{n_1f_1T_1 + n_2f_2T_2}{n_1f_1 + n_2f_2}$$

$$= \frac{n_1T_1R + n_2T_2R}{n_1R + n_2R} = \frac{P_1V_1 + P_2V_2}{\frac{P_1V_1}{T_1} + \frac{P_2V_2}{T_2}} = \frac{P_1V_1 + P_2V_2}{\frac{P_1V_1T_2 + P_2V_2T_1}{T_1T_2}} = \frac{T_1T_2(P_1V_1 + P_2V_2)}{P_1V_1T_2 + P_2V_2T_2}$$

A2

QUESTION

14 g of CO at 27°C is mixed with 16 g of O_2 at 47°C. The temperature of mixture is (vibration mode neglected)

(a) -5°C

(b) 32°C

(c) 37°C

(d) 27°C

$T_{mix} = \frac{n_1 T_1 + n_2 T_2}{n_1 + n_2}$

$= \frac{T_1 + T_2}{2}$

QUESTION

When one mole of monatomic gas is mixed with one mole of a diatomic gas, then the equivalent value of γ for the mixture will be (vibration mode neglected)

(a) 1.33
(b) 1.40
(c) 1.50
(d) 1.6

$\gamma_{mix} = 1 + \frac{2}{f_{mix}}$ ✓

FREE EXPANSION

$dQ + dU = dW$

$dU = 0$

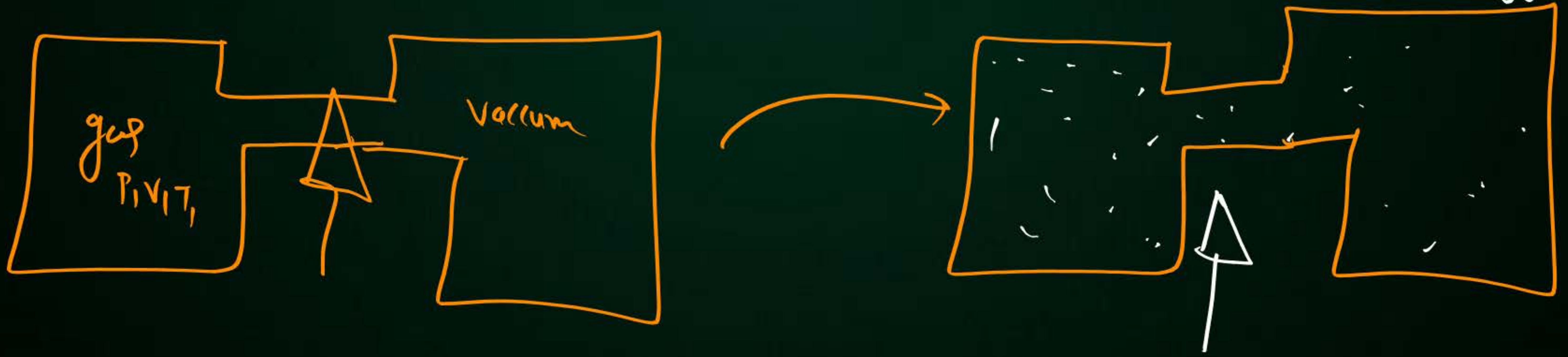
$T = \text{Const}^n$ (isothermal)

- Ideal gas at some temperature T in thermally insulated bottle, with stopcock connect this to another insulated bottle which is evacuated. When we suddenly open stopcock gas will rush from the one to other bottle until pressure equalized, but temperature does not change, $du = 0$, $Q = 0$ hence $dw = 0$,

$P_1V_1 = P_2V_2$

work done = 0

$dQ = 0$



n - mole dia-atomic gas ⟶ Breaks into 2n mole monoatomic

n - mole triatom gas ⟶ Break into 3n mone monoatomic

n → mole triaatomic ⟶ Break in $\frac{3n}{2}$ dia-atomic

Braks → disosiatio

QUESTION

A vessel contains a non-linear triatomic gas. If 50% of gas dissociate into individual atom, then find new value of degree of freedom by ignoring the vibrational mode and any further dissociation.

(a) 2.15

(b) 3.75

(c) 5.25

(d) 6.35

$f_{mix} = \frac{n_1 f_1 + n_2 f_2}{n_1 + n_2}$

Let n mole triatomic

$\frac{n}{2}$ (triatomic)

$\left(\frac{n}{2}\right)(3)$ monoatom

$f_{mix} = \frac{\frac{n}{2} \times 6 + \frac{3n}{2} \times 3}{\frac{n}{2} + \frac{3n}{2}} = \frac{6n + 9n}{4n} = \frac{15n}{4n} = \frac{15}{4}$ = 3.75

QUESTION

Hydrogen and helium, each having volume V temperature T and same pressure P, are mixed to have same volume V. The resulting pressure of the mixture will be

1. $P/2$
2. P
3. $2P$
4. depend on the relative mass of the gases

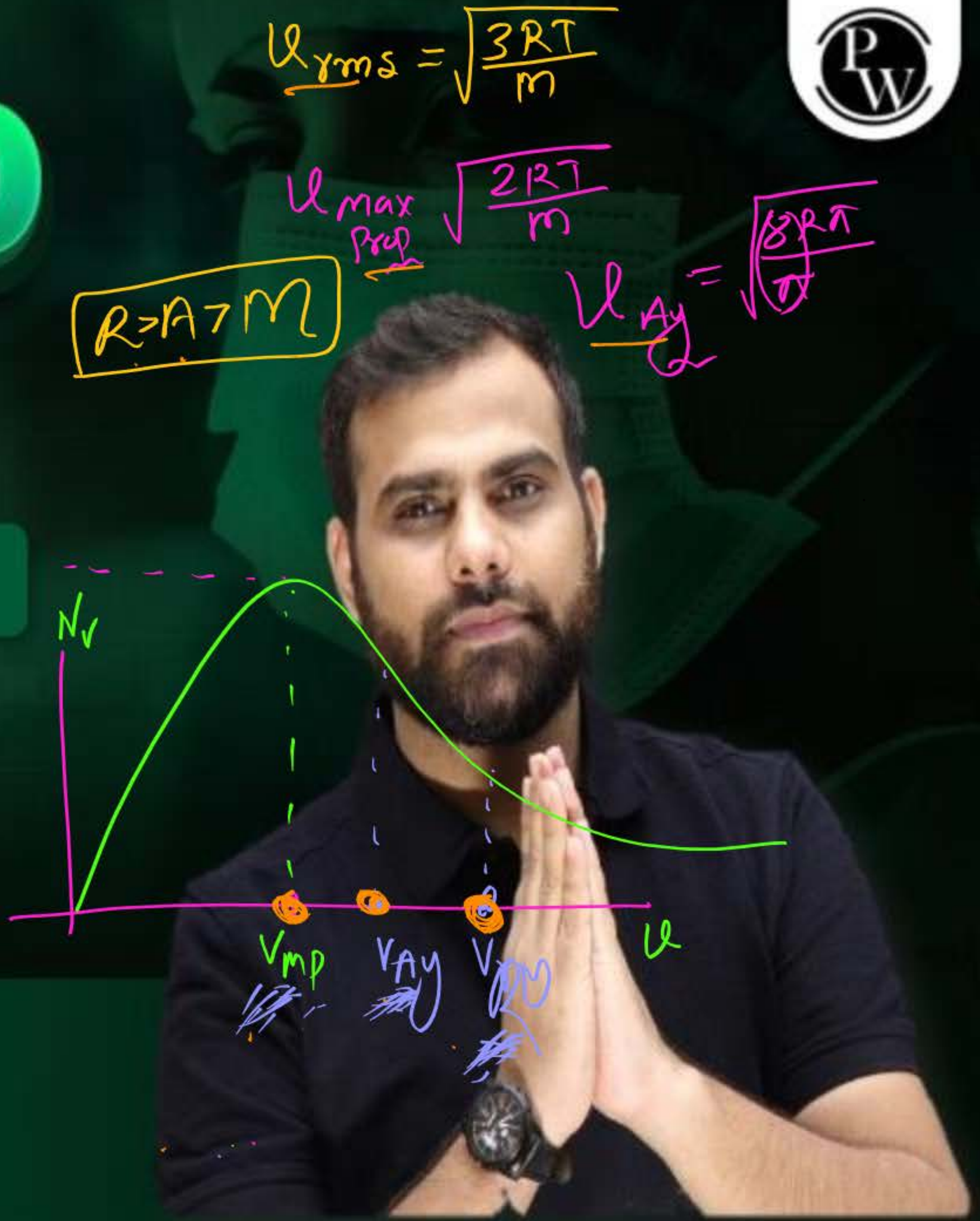

THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 01 | Physics

Oscillations



By- Dr. Manish Raj (MR SIR)

Topics to be covered

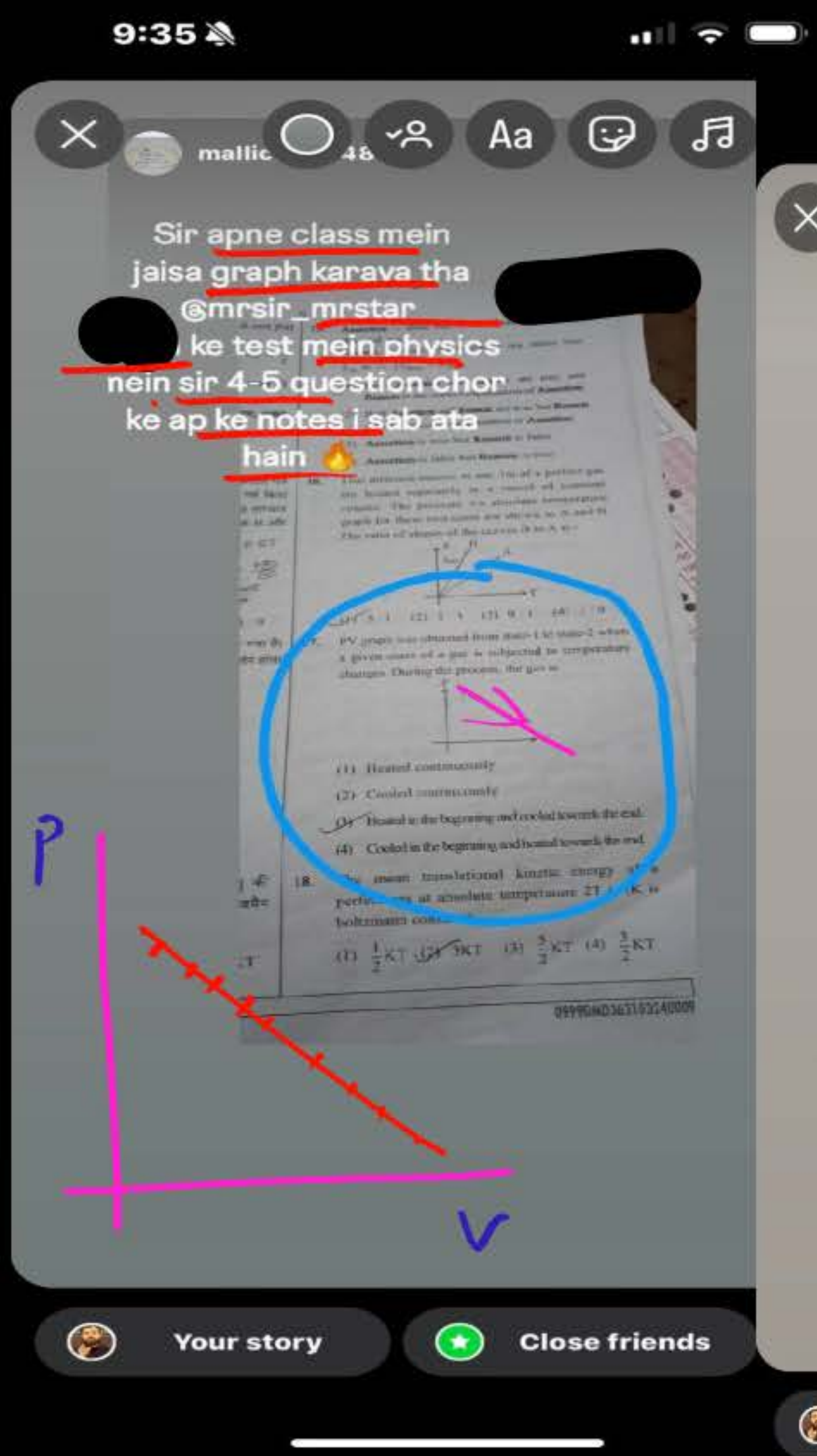
Kinematics → Starting ke 5 cls (concept complete करो)।

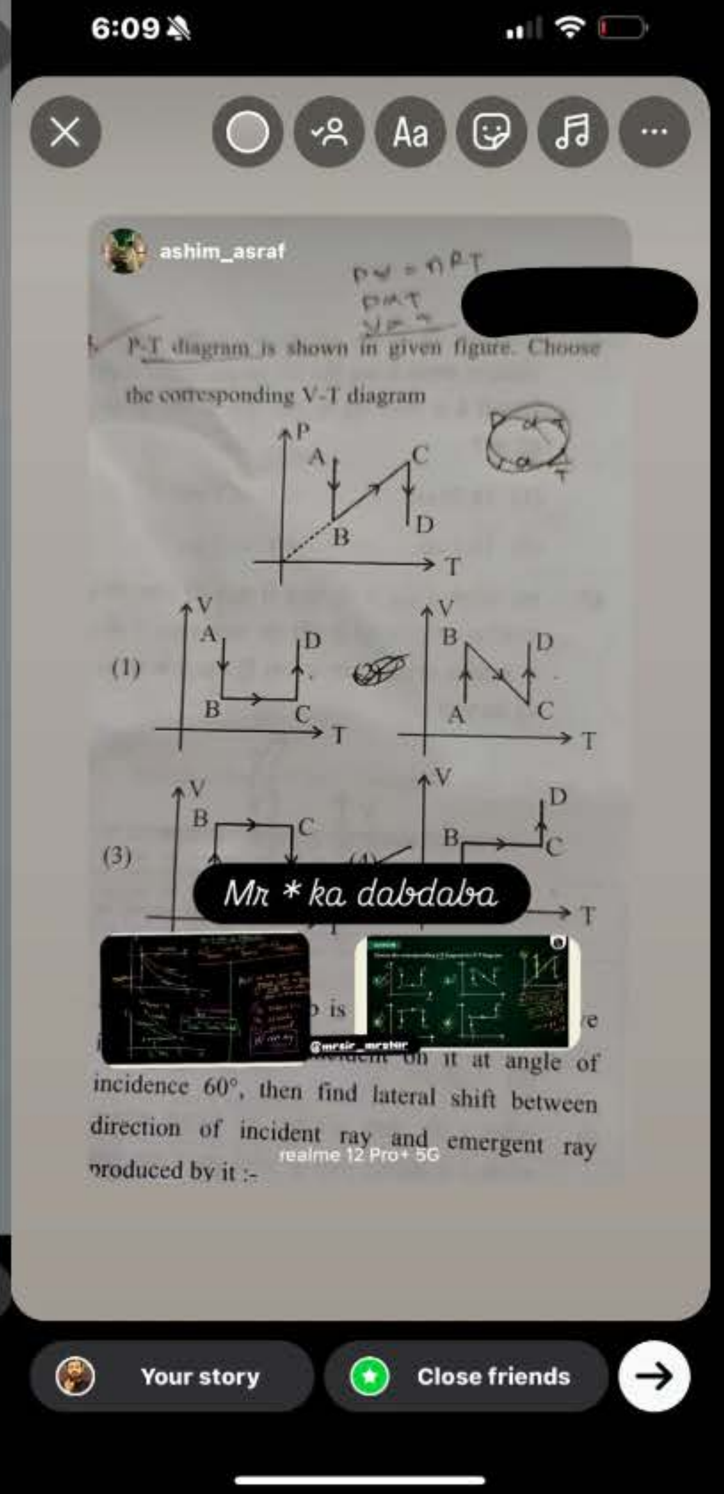
1 # feel of simple harmonic. motⁿ

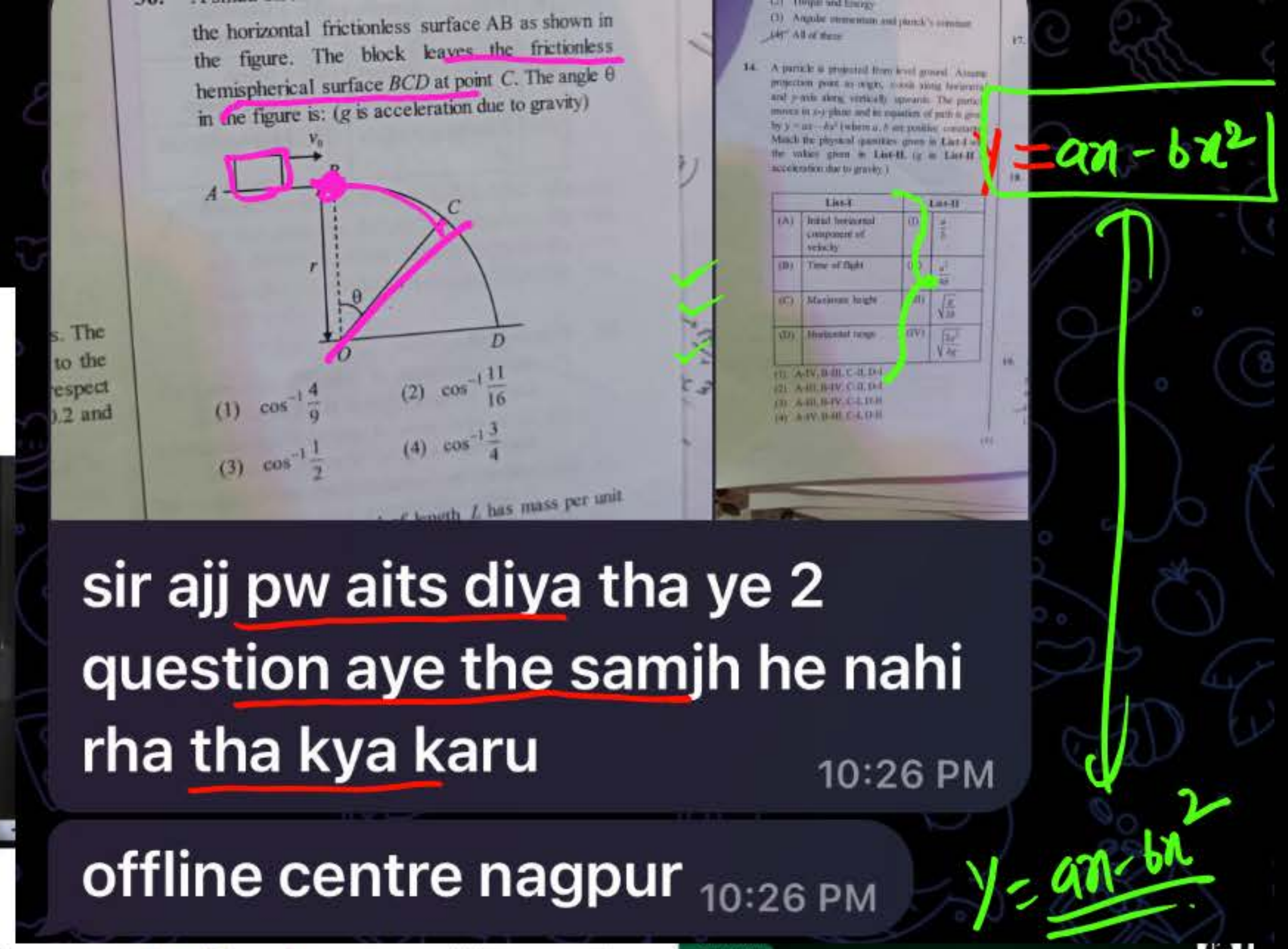
2 # S.H.M is not a new chapter

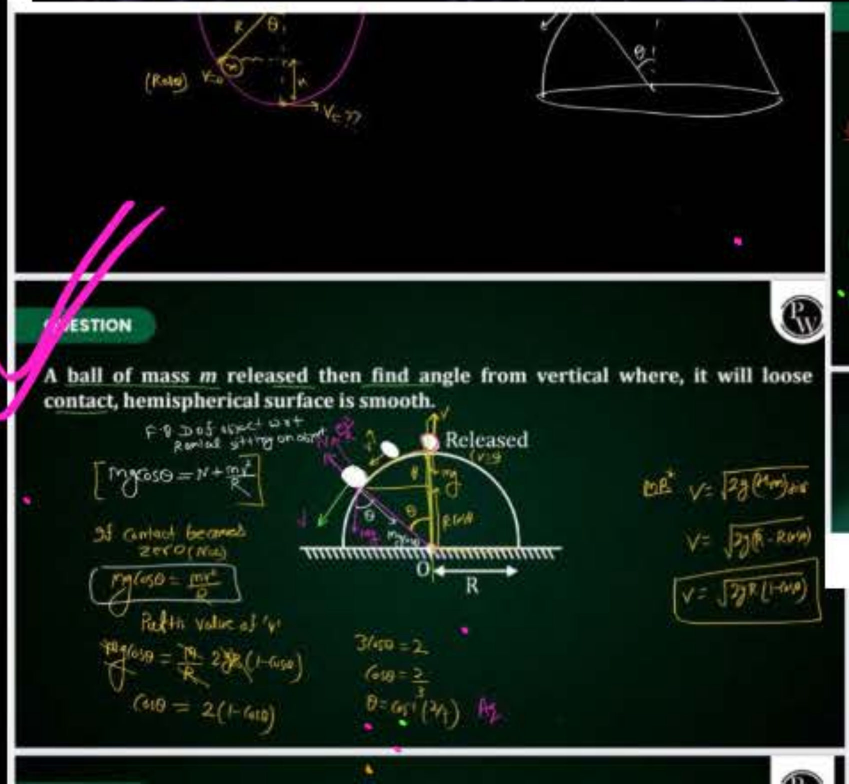
3 # S.H.M is a good question of Kinematics.

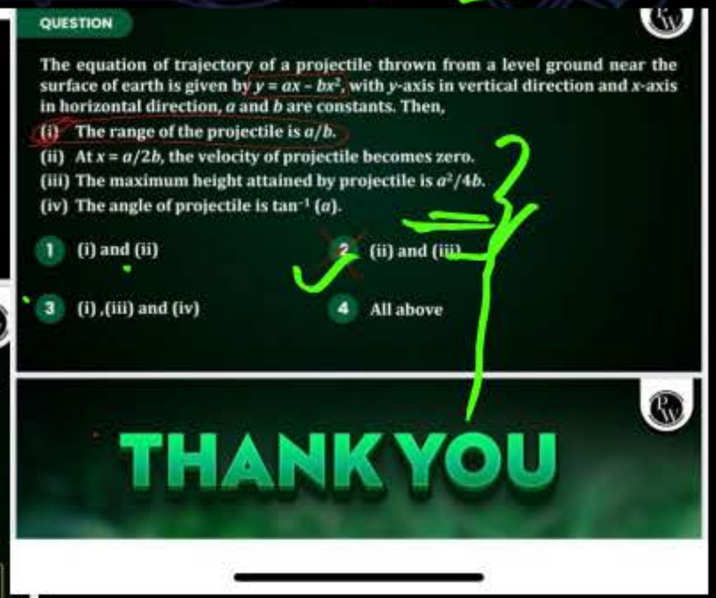


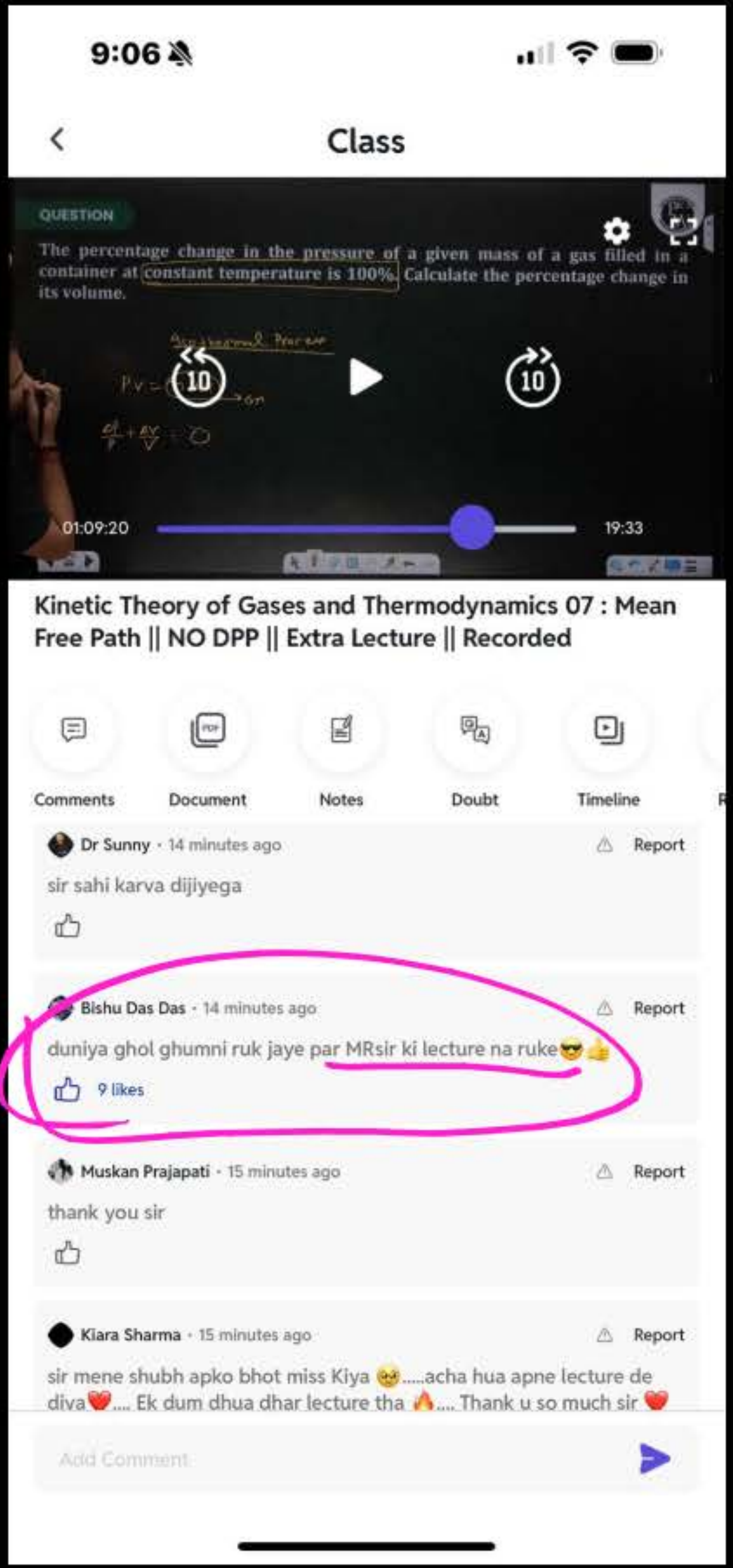

9:35
Sir apne class mein
jaisa graph karava tha
@mrsir_mrstar [redacted]
[redacted] ke test mein physics
nein sir 4-5 question chor
ke ap ke notes i sab ata
hain
P
V
Your story
Close friends

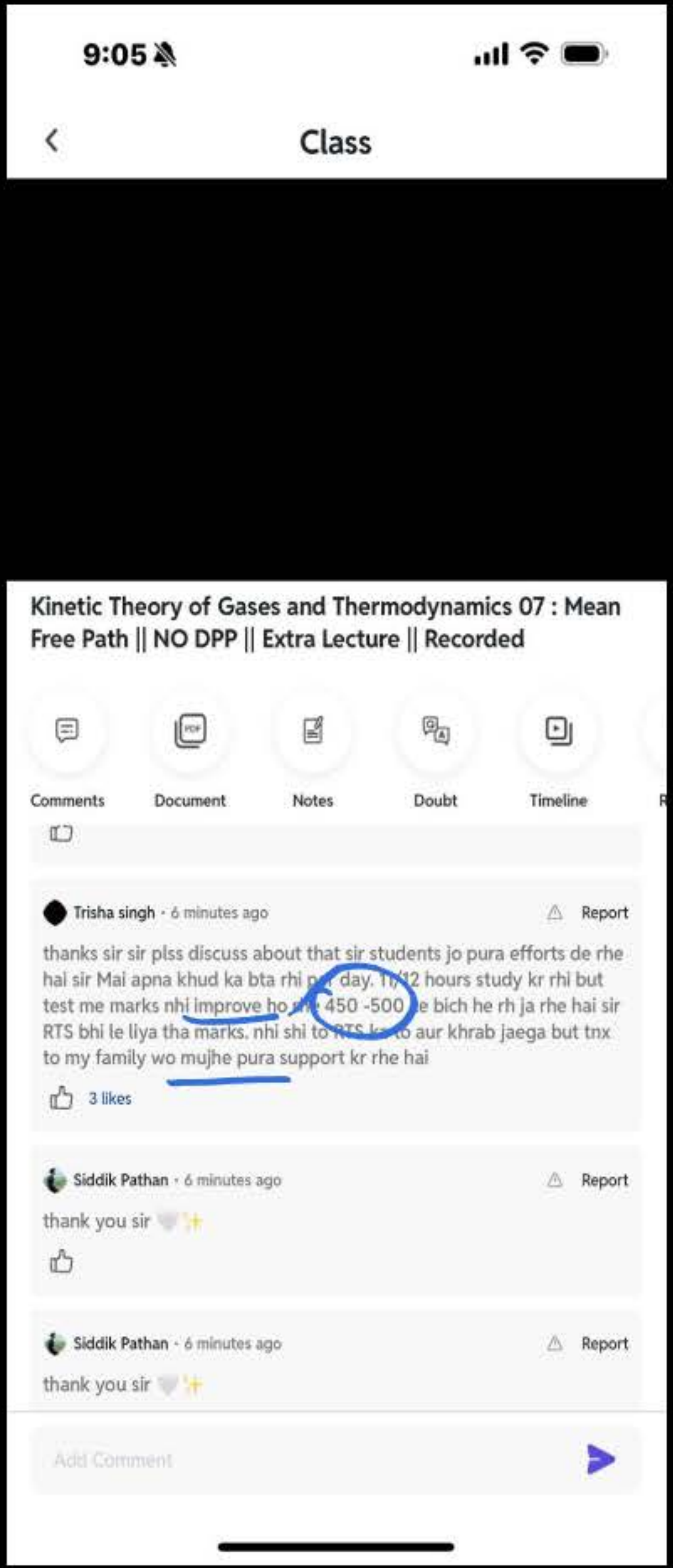

6:09
ashim_asraf [redacted]
P-T diagram is shown in given figure. Choose the corresponding V-T diagram
Mr * ka dabdaba
@mrsir_mrstar
incidence 60°, then find lateral shift between direction of incident ray and emergent ray produced by it :-
realme 12 Pro+ 5G
Your story
Close friends

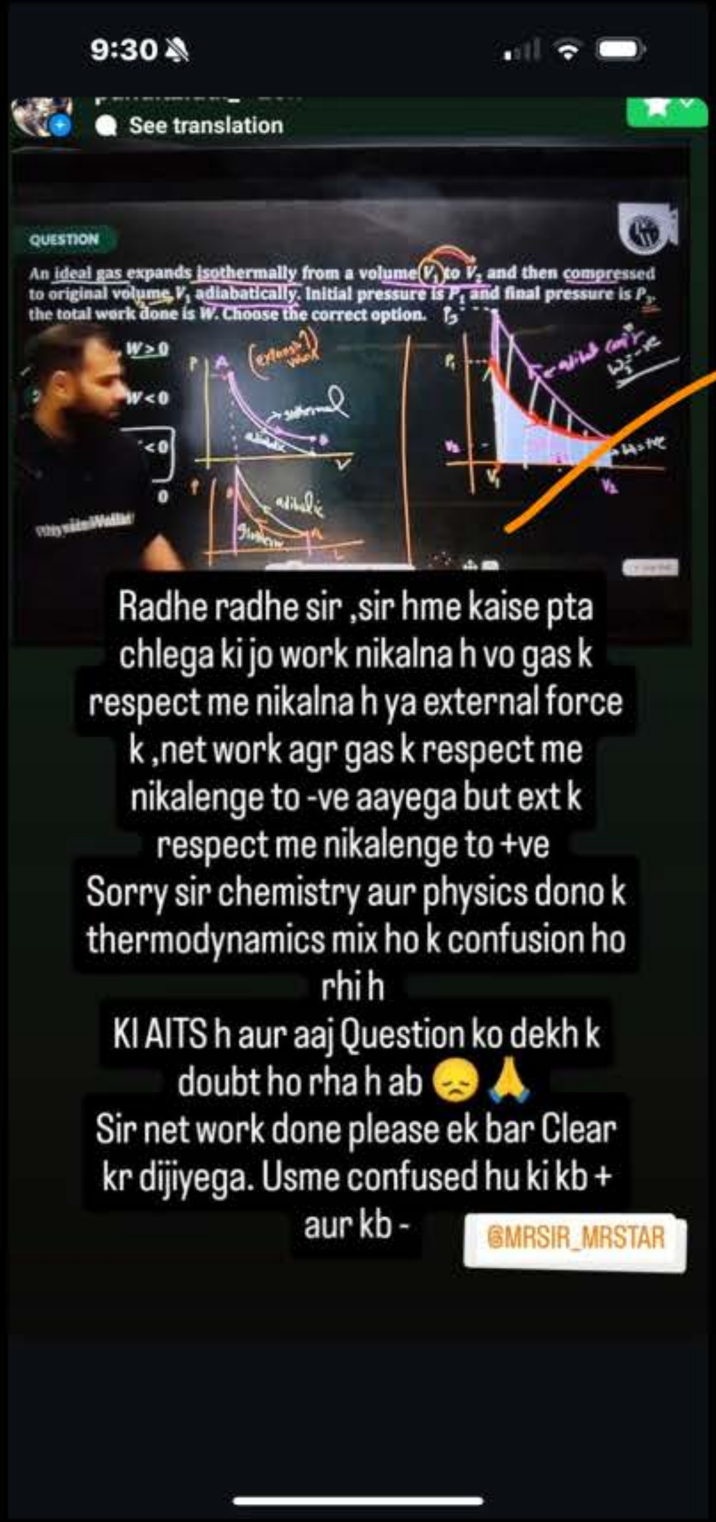

the horizontal frictionless surface AB as shown in the figure. The block leaves the frictionless hemispherical surface BCD at point C. The angle θ in the figure is: (g is acceleration due to gravity)
(1) cos⁻¹ 4/9
(2) cos⁻¹ 11/16
(3) cos⁻¹ 1/2
(4) cos⁻¹ 3/4
sir ajj pw aits diya tha ye 2 question aye the samjh he nahi rha tha kya karu
10:26 PM
offline centre nagpur
10:26 PM
y = ax - bx²
y = ax - bx²

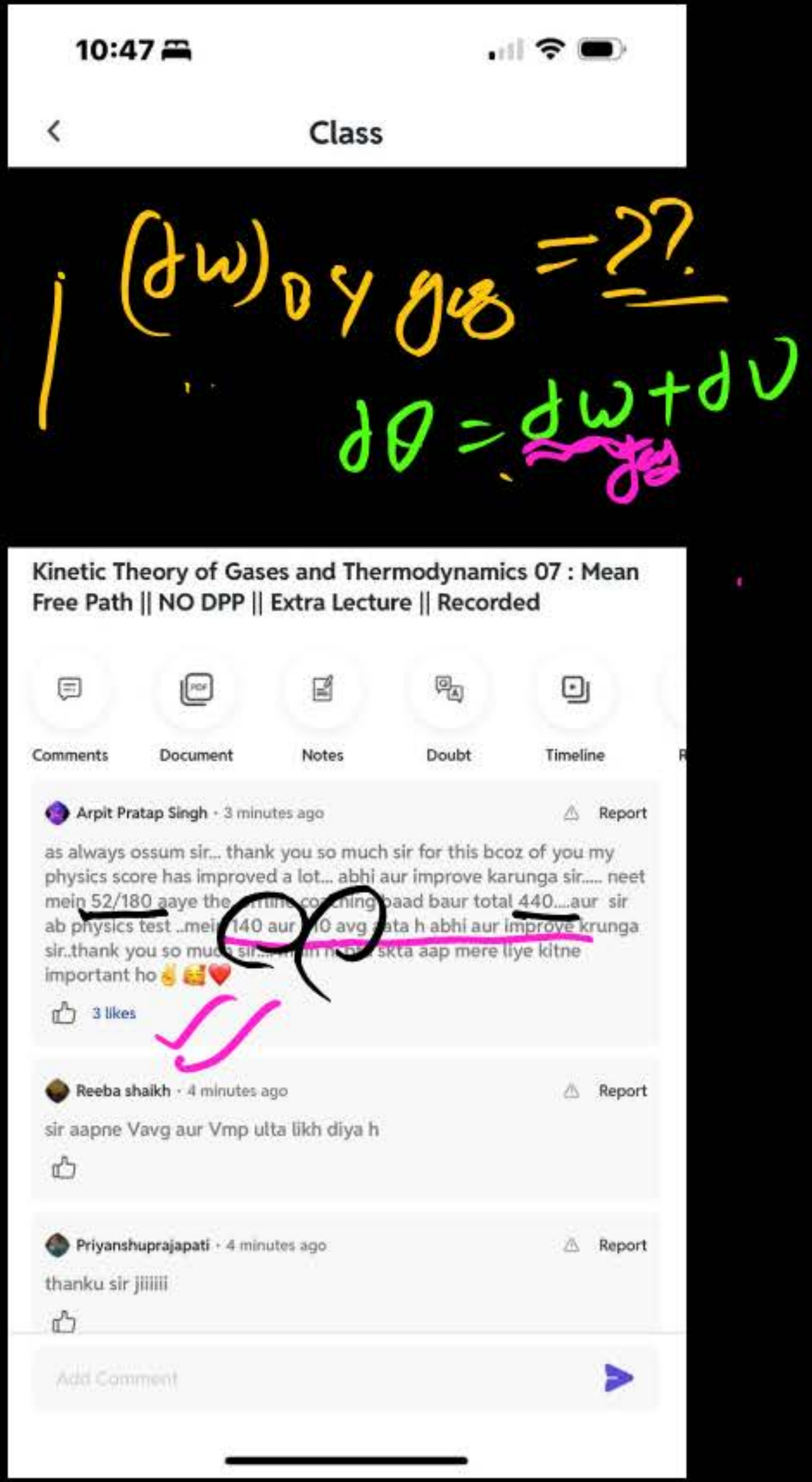

QUESTION
A ball of mass m released then find angle from vertical where, it will loose contact, hemispherical surface is smooth.
Released
R


QUESTION
The equation of trajectory of a projectile thrown from a level ground near the surface of earth is given by y = ax − bx², with y-axis in vertical direction and x-axis in horizontal direction, a and b are constants. Then,
(i) The range of the projectile is a/b.
(ii) At x = a/2b, the velocity of projectile becomes zero.
(iii) The maximum height attained by projectile is a²/4b.
(iv) The angle of projectile is tan⁻¹ (a).
1 (i) and (ii)
2 (ii) and (iii)
3 (i), (iii) and (iv)
4 All above
THANK YOU


9:06
Class
QUESTION
The percentage change in the pressure of a given mass of a gas filled in a container at constant temperature is 100%. Calculate the percentage change in its volume.
01:09:20
19:33
Kinetic Theory of Gases and Thermodynamics 07 : Mean Free Path || NO DPP || Extra Lecture || Recorded
Comments
Document
Notes
Doubt
Timeline
Dr Sunny · 14 minutes ago
Report
sir sahi karva dijiyega
Bishu Das Das · 14 minutes ago
Report
duniya ghol ghumni ruk jaye par MRsir ki lecture na ruke😎👍
9 likes
Muskan Prajapati · 15 minutes ago
Report
thank you sir
Kiara Sharma · 15 minutes ago
Report
sir mene shubh apko bhot miss Kiya 🥹.....acha hua apne lecture de diya❤️.... Ek dum dhua dhar lecture tha 🔥.... Thank u so much sir ❤️
Add Comment


9:05
Class
Kinetic Theory of Gases and Thermodynamics 07 : Mean Free Path || NO DPP || Extra Lecture || Recorded
Comments
Document
Notes
Doubt
Timeline
Trisha singh · 6 minutes ago
Report
thanks sir sir plss discuss about that sir students jo pura efforts de rhe hai sir Mai apna khud ka bta rhi per day. 11/12 hours study kr rhi but test me marks nhi improve ho rhe 450 -500 ke bich he rh ja rhe hai sir RTS bhi le liya tha marks. nhi shi to RTS ka to aur khrab jaega but tnx to my family wo mujhe pura support kr rhe hai
3 likes
Siddik Pathan · 6 minutes ago
Report
thank you sir 🤍✨
Siddik Pathan · 6 minutes ago
Report
thank you sir 🤍✨
Add Comment


9:30
See translation
QUESTION
An ideal gas expands isothermally from a volume V_1 to V_2 and then compressed to original volume V_1 adiabatically. Initial pressure is P_1 and final pressure is P_3, the total work done is W. Choose the correct option.
Radhe radhe sir ,sir hme kaise pta chlega ki jo work nikalna h vo gas k respect me nikalna h ya external force k ,net work agr gas k respect me nikalenge to -ve aayega but ext k respect me nikalenge to +ve
Sorry sir chemistry aur physics dono k thermodynamics mix ho k confusion ho rhi h
KI AITS h aur aaj Question ko dekh k doubt ho rha h ab 😞🙏
Sir net work done please ek bar Clear kr dijiyega. Usme confused hu ki kb + aur kb -
@MRSIR_MRSTAR


10:47
Class
(dw) by gas = ??
dQ = dw + dU
Kinetic Theory of Gases and Thermodynamics 07 : Mean Free Path || NO DPP || Extra Lecture || Recorded
Comments
Document
Notes
Doubt
Timeline
Arpit Pratap Singh · 3 minutes ago
Report
as always ossum sir... thank you so much sir for this bcoz of you my physics score has improved a lot... abhi aur improve karunga sir..... neet mein 52/180 aaye the coaching baad baur total 440....aur sir ab physics test ..mei 140 aur 10 avg ata h abhi aur improve krunga sir..thank you so much sir.....skta aap mere liye kitne important ho✌️🥰❤️
3 likes
Reeba shaikh · 4 minutes ago
Report
sir aapne Vavg aur Vmp ulta likh diya h
Priyanshuprajapati · 4 minutes ago
Report
thanku sir jiiiiii
Add Comment

(Q). If acceleration of object is $a = -2x$ then find velocity at x_0 if intial velocity is u_0 at $x = 0$ (Position = 0)

$$a = -2x$$

$$v\frac{dv}{dx} = -2x$$

$$\int_{u_0}^{v} v\,dv = -\int_{x=0}^{x_0} 2x\,dx$$

$$\left[\frac{v^2}{2}\right]_{u_0}^{v} = -2\left[\frac{x^2}{2}\right]_0^{x_0}$$

$$\frac{1}{2}\left[v^2 - u_0^2\right] = -x_0^2$$

$$v^2 - u_0^2 = -2x_0^2$$

$$v^2 = u_0^2 - 2x_0^2$$

$$v = \sqrt{u_0^2 - 2x_0^2}$$

If $x = A\sin(\omega t)$

$$\frac{dx}{dt} = v = A\cos(\omega t) \times \omega$$

$$v = A\omega\cos(\omega t)$$

$$a = \frac{dv}{dt} = -A\omega^2\sin(\omega t)$$

$$a = -\omega^2 x$$

20% SHM

प्रश्न



Periodic Motion

(A motion repeat its path after (fixed intraval of time) = T,)

(aage-pichhe dolte ho about (mean position))

{oscillation}



Amplitude large
Not S.H.M.

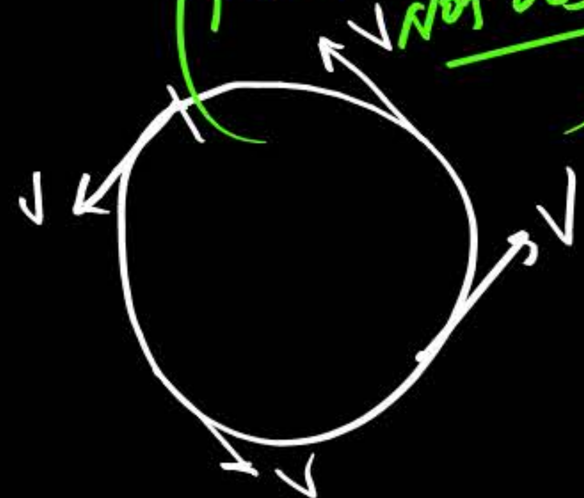
Small amplity
(S.H.M)
enegy conserved

High frequecy → vibration

Ex → Uniform circular motⁿ ✓
→ physical class (8:45 Am) ✗
→ Rotⁿ of earth ✓
→ Satellite motⁿ ✓
→ simple pendulum ✓
→
→ Bouncing of Ball b/w two wall. ✓ (elastic)

Periodic but No aage-pichhe (about mean position.)

(preiodic but Not oscillation)



there is no mean positin

PERIODIC MOTION

Periodic Motion: Motion which repeats itself after equal intervals of time. [redacted] The interval of time is called periodic motion and period of periodic motion.

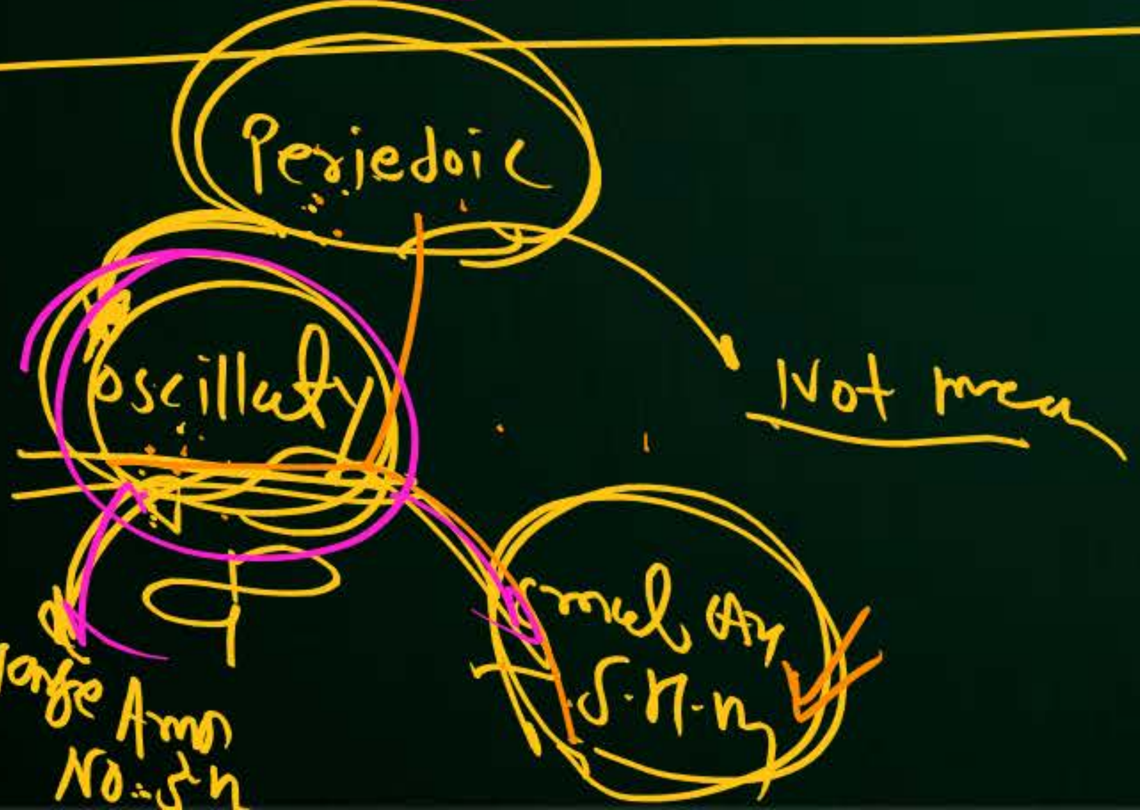
Oscillation: Oscillation or vibration motion is refined as a periodic and bounded motion of a body about fixed point.

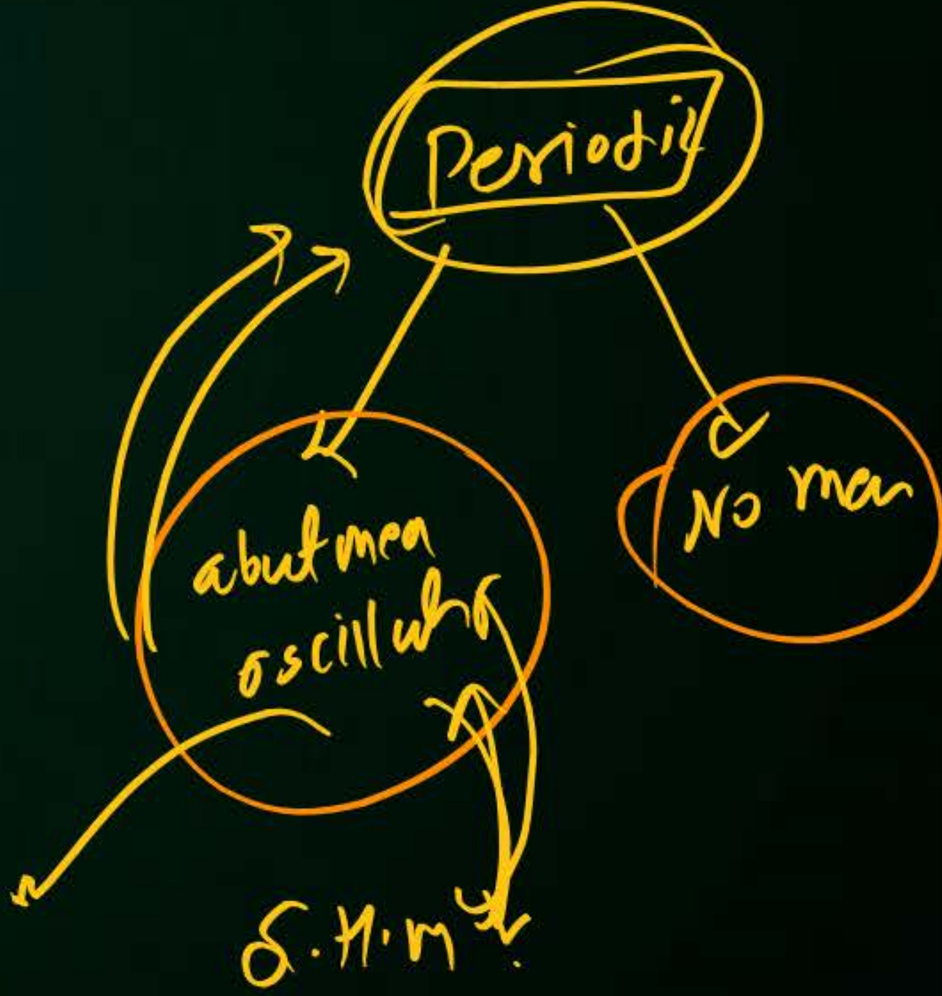
Vibration → High frequency

➢ Some Example of Periodic Motion

➢ True / False

1. Periodic motion must be oscillatory motion → false
2. Periodic motion may be oscillatory motion → yes
3. Oscillatory motion must be periodic → yes (True)
4. SHM must be periodic and oscillatory → True
5. Oscillation must be simple harmonic → false
6. Oscillation may be simple harmonic → True

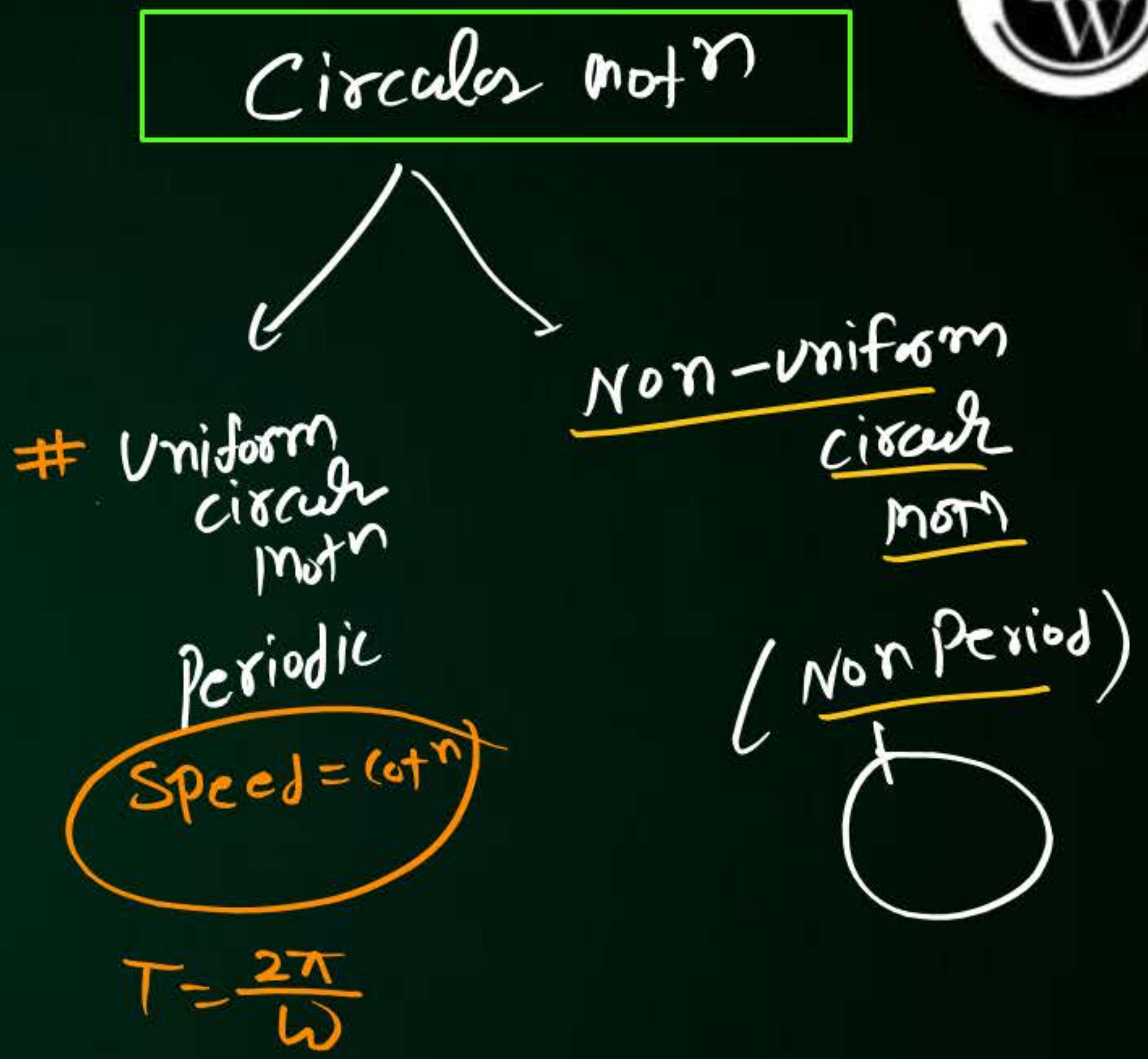




QUESTION

Circular motion is an example of?

1. Periodic motion
2. Non-periodic
3. Oscillatory
4. May be periodic or non-periodic



QUESTION

The circular motion of a particle with constant speed is

U.C.M
Periodic

1. Periodic but not simple harmonic
2. Simple harmonic but not periodic
3. Period and simple harmonic
4. Neither periodic nor simple harmonic

PERIOD AND FREQUENCY

frequency is scalar

Period is the smallest interval of time after which the motion is repeated. It is denoted by the (T)

Frequency is defined as the number of oscillations per unit time. It is the reciprocal of time period T. It is represented by the symbol ν.

The relation between ν and T is

$$\nu = \frac{1}{T}$$

$$f = \frac{1}{T} \text{ Hz}$$

$$\text{Hz} = \frac{1}{\text{sec}}$$

(Angular frequency) $\omega = \frac{2\pi}{T} = 2\pi f$

unit (rad/sec)

QUESTION

If frequency of object is π rad/sec then find time period. ??

ω

$T = \frac{1}{f} = \frac{1}{\pi}$ sec Ans ✗

$\omega = \pi$ rad/sec

$\omega = \frac{2\pi}{T}$

$T = \frac{2\pi}{\omega} = \frac{2\pi}{\pi} = 2$ sec

Ans

QUESTION

A nurse in a hospital, noted for a patient the heart was beating 75 times a minute. Find its frequency and time period.

75 time a minute

$f = \frac{75}{60}$ Hz $= \frac{5}{4} = 1.25$ Hz

$T = \frac{60}{75} = \frac{4}{5} = 0.8$ sec

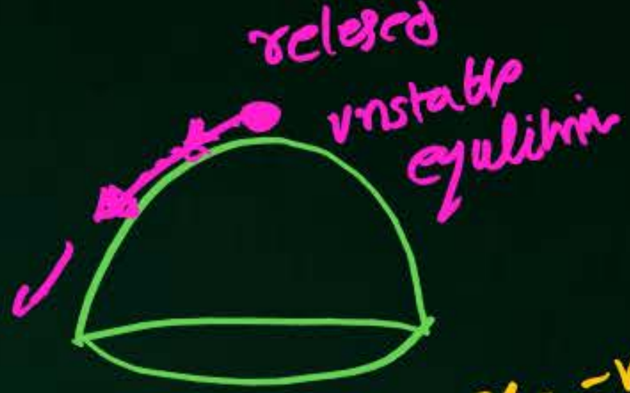
Condition of SHM

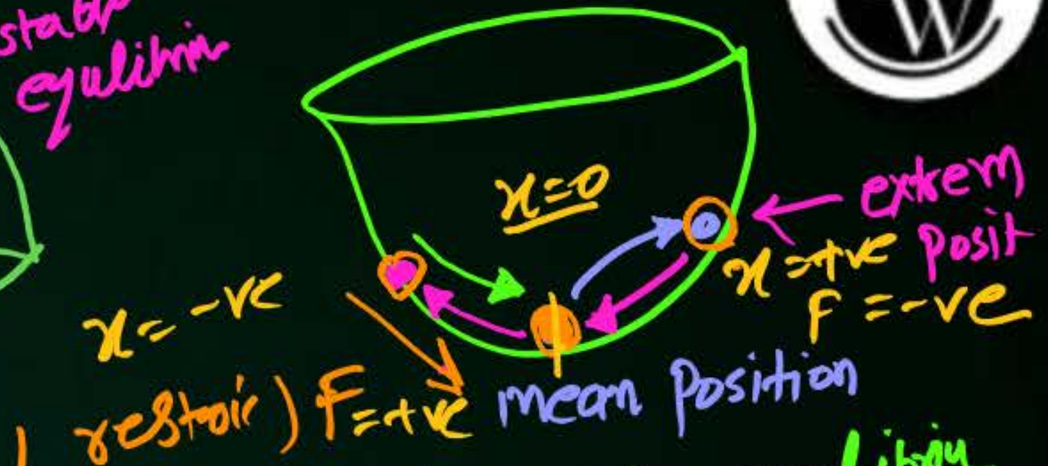
S.H.M is a, which type of motion??

X (a) Uniform motion (24%)

X (b) Non uniform motⁿ with uniform accⁿ

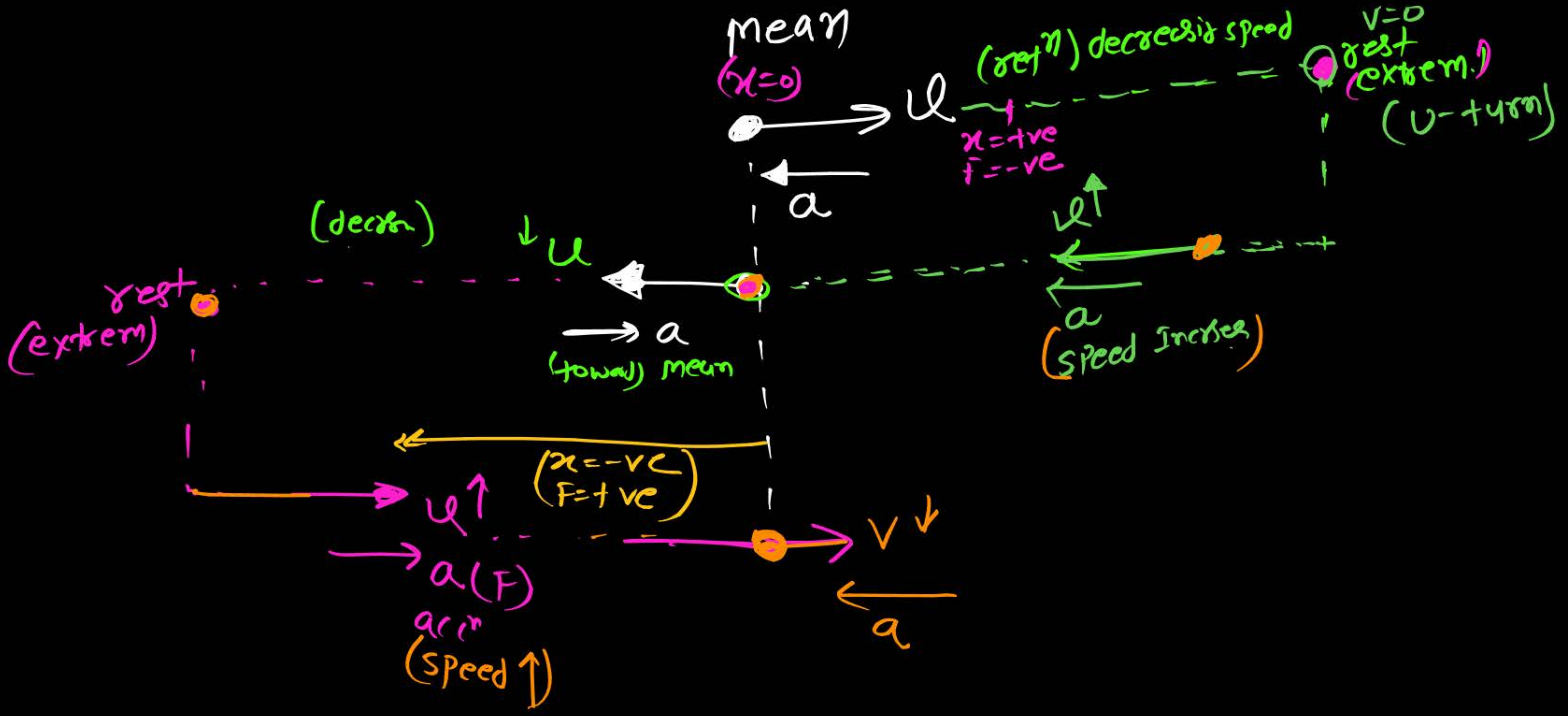
(c) ✓ Non uniform with Non uniform accⁿ (only 34%)





* Stable equilibrium
* S.H.M only happen about stable equilibrium

S.H.M →
- energy conserved
- Amplitude small
- dirⁿ of motⁿ change.
- about (stable equilibrium)
- F (restoring force) always directed towards mean Position.
- acceleration always towards the mean Position.


mean
(x=0)
u
a
decreasig speed
v=0
rest
(extrem.)
(U-turn)
x=+ve
F=-ve
u↑
a
(speed Incrses)
(decrn)
↓u
rest
(extrem)
a
(toward) mean
(x=-ve
F=+ve)
u↑
V↓
a(F)
(speed ↑)
a

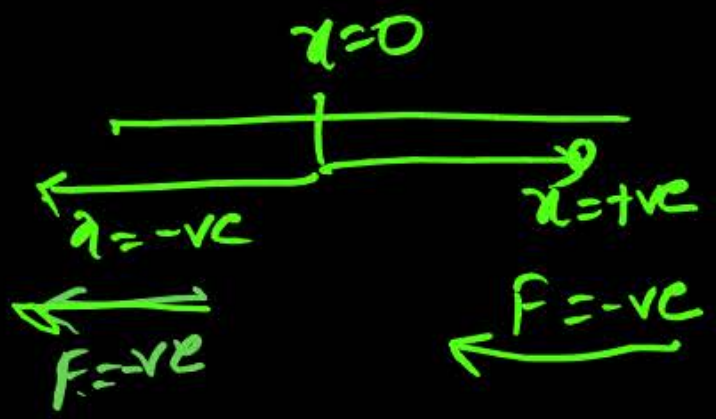
$\vec{F} \propto -\vec{x}$ ← Codition

only eqⁿ for S.H.M

→ restoring force

$F = +kx$ ← liner motⁿ but Not S.H.M

unstable eqⁿ



$F = kx^2$ ← NO SHM. Tralⁿ.

$F = -k(x)^2$ → only Tranlational, NO SHM, NO oscillatio

$F = -(x-4)^2$

→ NO S.H.M

$F = -kx^3$ → oscillatio but no S.H.M

$F = -(2-x)$ → $F = -2+x$ ← NO SHM only Tranlⁿ

$F = -(x-4)$ → $F = -x+4$ ← S.H.M about mean Position at ($x=4$)

Diwali

1, 2, 3 Nov.

QUESTION

If force $F = -4x + 8$, then due to this force motion

1. oscillation but not periodic
2. SHM with equilibrium at 2m
3. SMM with equilibrium at 1/2m
4. Oscillation but not SHM

($F_{equlib} = 0$)

$F = -4x + 8$

31 oct ko class

32, 33, 34, 35, 1, 2, 3

oct (nov)

7 - Din ki chutti

SIMPLE HARMONIC MOTION

$acc^n \propto -x$ (Position)

$a \propto -x \rightarrow$ (less amplitude/energy conserved stable equilibrium)

[redacted]

$a \propto (-x)^n$ ← oscillation

$n = 1, 3, 5, 7$

$a \propto -x$
$a \propto (-x)^3$
$a \propto (-x)^5$
} oscillation

$a \propto (-x)^n$
$n = 2, 4, 6, 8$
only translation

QUESTION

A particle moves under force $F = -5(x-2)^3$. Motion of the particle is

1. Translatory
2. Oscillatory
3. SHM
4. both 1 & 2

$F = -5(x-2)^3$ → $x > +2$: $F = -ve$; $x < +2$: $F = +ve$; equilibrium

$F \propto -(x)^3$

Ans – 4

Diwali ki chutti
1, 2, 3

chath puja
7, 8

M.P. chutti
17 Nov to 23 Nov

QUESTION

For a particle showing motion under the forces $F = -5(x - 2)^2$, the motion is

1. Translatory
2. Oscillatory
3. SHM
4. All of these

QUESTION

For a particle showing motion under the forces $F = -5(x - 2)$, the motion is

1. Translatory
2. Oscillatory
3. SHM
4. Both (2) and (3)

$F = -5x + 10$

S.H.M

Ans (4)

QUESTION

If a particle is executing simple harmonic motion, then acceleration of particle

1. Is uniform
2. Varies linearly with time
3. Is no uniform
4. Both (2) and (3)

$\vec{F} \propto -\vec{x}$ (Cond^n of S.H.M.)

$$\boxed{\vec{F} = -K\vec{x}}$$ (K = force cst^n)

$\Rightarrow ma = -Kx$

$$\vec{a} = -\frac{K}{m}\vec{x}$$

$$\frac{K}{m} = \omega^2$$
$$K = m\omega^2$$

$$\boxed{\vec{a} = -\omega^2 \vec{x}}$$

ω = Angular freq^n.

Position as a function of time which satisfy condition of SHM ($a = -\omega^2 x$)



A = Amplitude dis^m B/W mean & extrem.

$$x = A\sin(\omega t + \phi)$$ ϕ = initial phase

↑ Position at time t

at $t=0$ gf $x=0$

hence mot^n starts from mean.

$0 = A\sin(0+\phi)$

$0 = \sin(\phi)$

$\phi = 0$

$$\boxed{x = A\sin(\omega t)}$$

↳ only valid when mot^n starts from mean Position

$x = A\sin(\omega t + \phi)$ ⟵ general eqn

x → Position at time t

ϕ → Initial phase

If $\phi = 0$ if motion starts from mean.

- $x = A\sin(\omega t)$

If motn start from +ve extrem.

$t = 0$, $x = A$

$A = A\sin(\omega t + \phi)$

$1 = \sin(0 + \phi) = \sin\phi$

$\Rightarrow \phi = \pi/2$

$x = A\sin(\omega t + \pi/2) = A\cos(\omega t)$

If motn starts from $x = +A/2$ at $t = 0$

$\frac{A}{2} = A\sin(\omega \times 0 + \phi)$

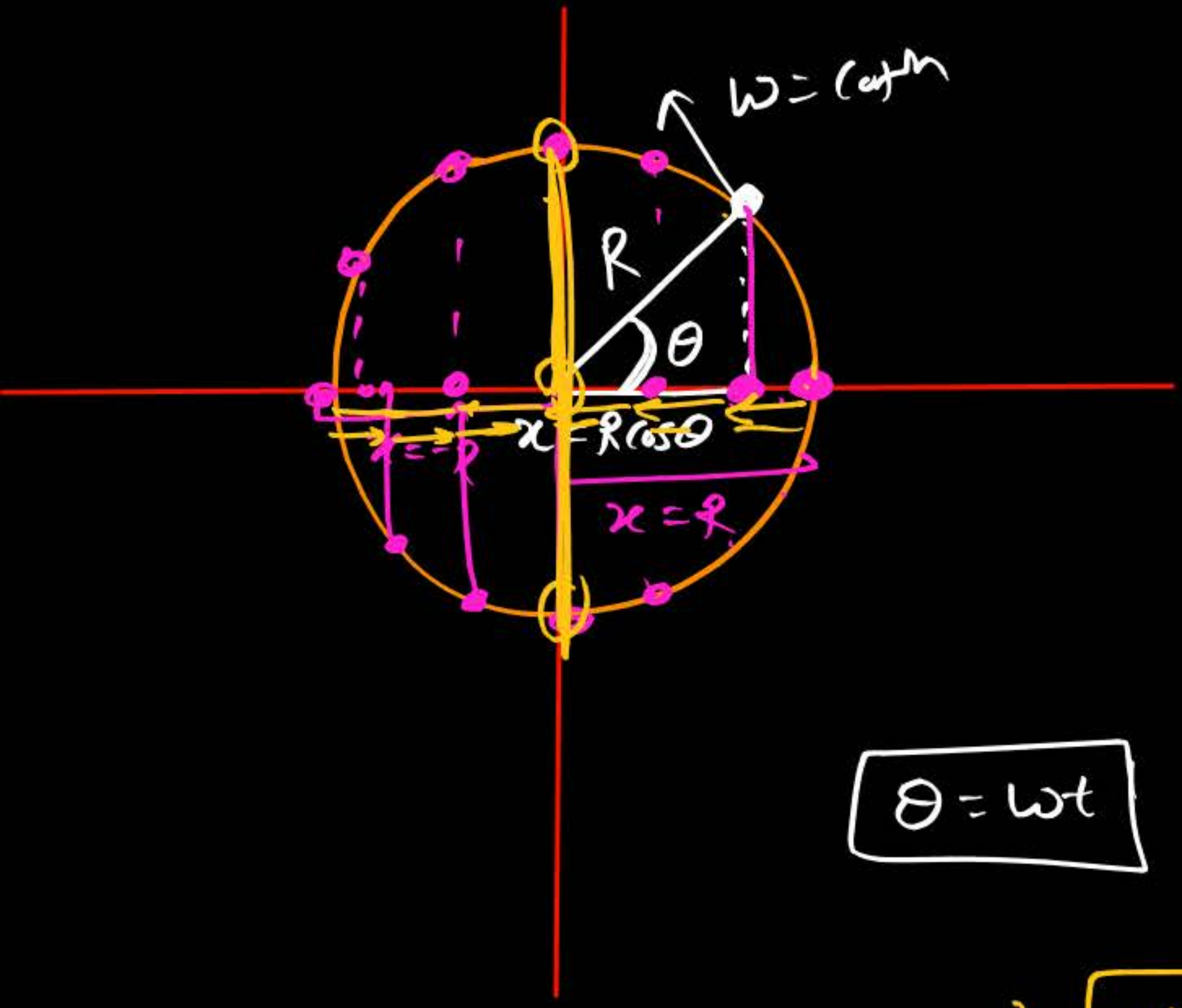
$\frac{1}{2} = \sin\phi$

$\phi = \pi/6$

$x = A\sin(\omega t + \pi/6)$

If motn starts from $x = \frac{A}{\sqrt{2}}$, $\phi = \pi/4$

$x = A\sin(\omega t + \pi/4)$



$$\theta = \omega t$$

$$x = R\cos\theta$$

$$x = R\cos(\omega t)$$

$$y = R\sin(\omega t)$$

QUESTION

A particle moves such that acceleration is given by a = –4x. The period of oscillation is

1. π ✓ Ans
2. $\frac{2}{\pi}$
3. $\frac{1}{\pi}$
4. 2π

$a = -4x$

$a = -\omega^2 x$

$\omega^2 = 4$

$\omega = \sqrt{4} = \frac{2\pi}{T}$

$2 = \frac{2\pi}{T}$

$T = \pi$ sec

QUESTION

If motion started from positive extream then, find ϕ.

$\phi = \pi/2$

QUESTION

If motion started from positive $x = +\frac{A}{2}$ then, find ϕ.

$\phi = \pi/6$

QUESTION

If motion started from positive $x = +\frac{A}{\sqrt{2}}$ then, find ϕ.

$\phi = \pi/4$

$x = A\sin(\omega t + \phi)$

If mot^n starts from mean.

$$x = A\sin(\omega t + \phi) \rightarrow t = 0,\ \phi = 0$$

$$x = A\sin(\omega t)$$

$t = 0, x = 0$ mean.

diff^n w.r.t. time

$$V = \frac{dx}{dt} = A\cos(\omega t) \times \omega$$

$$V = A\omega\cos(\omega t)$$

$v_{max} = A\omega$

$t = 0$ (at mean)

extrem

$v = 0$

$$a = -A\omega\sin(\omega t) \times \omega$$

$$a = -A\omega^2\sin(\omega t)$$

$$a = -\omega^2 x$$

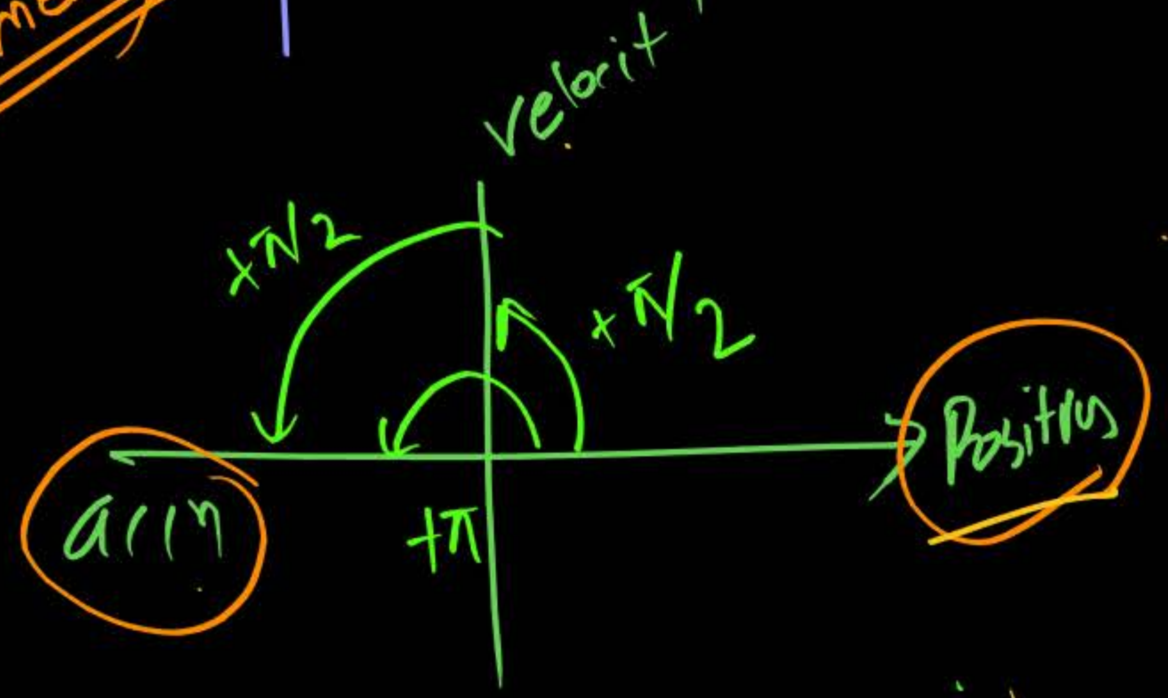
$t = 0$

$a = 0$ (At mean)

$x = A\sin(\omega t)$

$V = A\omega\cos(\omega t)$ → Amplitude of velo

$a = -A\omega^2\sin(\omega t)$ → Amplitude of acc



Time t	0	$\frac{T}{4}$	$\frac{2T}{4}$	$\frac{3T}{4}$	$\frac{4T}{4}$
Displacement, x	0 (min)	A (max)	0 (min)	–A (max)	0 (min)
Velocity, v	$A\omega$ (max)	0 (min)	$-A\omega$ (max)	0 (min)	$A\omega$ (max)
Acceleration, A	0 (min)	$-A\omega^2$ (max)	0 (min)	$A\omega^2$ (max)	0 (min)

Note :

(a) Displacement, velocity and acceleration show harmonic variation with time having same period.

(b) The velocity amplitude is ω times the displacement amplitude.

(c) The acceleration amplitude is ω^2 times the displacement amplitude.

(d) In S.H.M. velocity is ahead of displacement by phase angle of $\frac{\pi}{2}$.

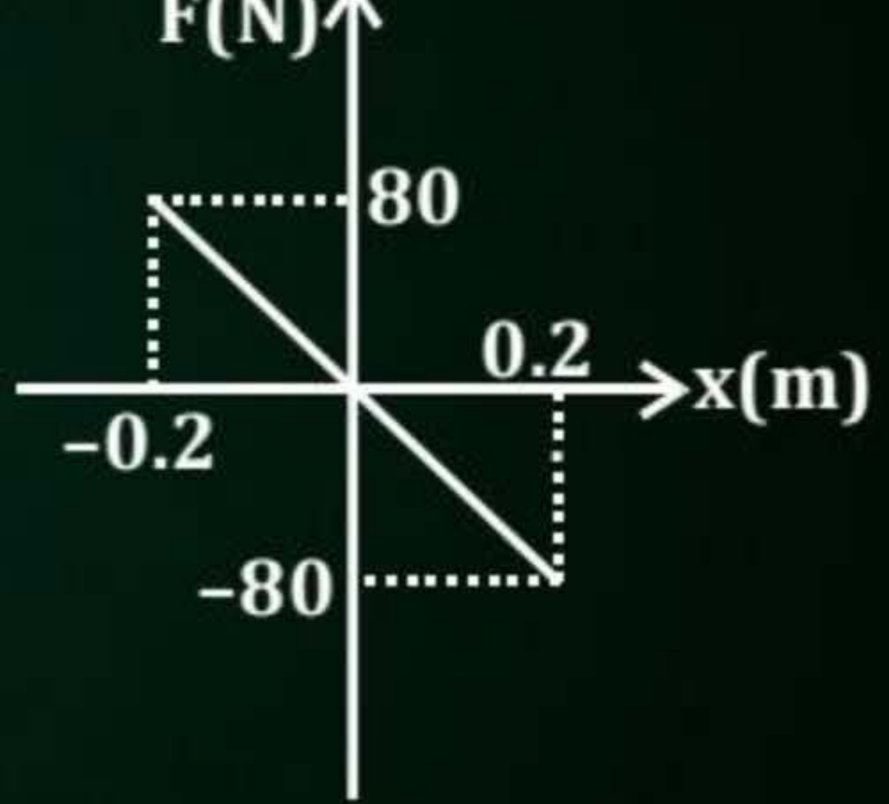
(e) In S.H.M. acceleration is ahead of velocity by phase angle of $\frac{\pi}{2}$.

(f) In S.H.M. acceleration is ahead of displacement by phase angle of π.

QUESTION

A body of mass 0.01 kg executes simple harmonic motion about $x = 0$ under the influence of a force as shown in figure. The time period of SHM is

1. 1.05 s
2. 0.52 s
3. 0.25 s
4. 0.03 s




THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 02 | Physics

Oscillations

By- Dr. Manish Raj (MR SIR)



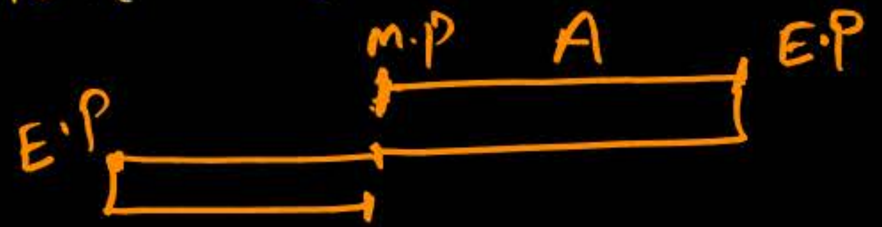
Topics to be covered

1. #
2. #
3. #

Phase of S.H.M
Time period,
Velocity, Positio acc^n PePhD



1. If position of Particle in S.H.M $y = 10\sin(4\pi t + \pi/6)$ m then find subkuchh.



Sol^n

Amplitude = 10m

frequency = ?? $\omega = 4\pi = 2\pi f$

$f = 2$ Hz

Angular freque $\omega = 4\pi$

Time Period $= T = \frac{1}{f} = \frac{1}{2}$ sec

Initial Phase $(\phi) = \pi/6$

At t=0 motion starts from half of extreme.

Total dist^n in one oscilltion = 40m



dip^m = 0

1-oscil^n

$y = A\sin(\omega t + \phi)$

⇒ phase at t = 1sec

$\phi_t = 4\pi t + \frac{\pi}{6}$

$\phi_{1sec} = 4\pi \times 1 + \pi/6$

$= \frac{25\pi}{6}$

Initial velocity at (t=0)

$V = \frac{dx}{dt} = 10 \times 4\pi \cos(4\pi t + \pi/6)$

$= 40\pi \cos(\pi/6) = \frac{40\pi\sqrt{3}}{2}$

$= 20\sqrt{3}\pi$

Max^m velocity

$V_{max} = A\omega$

$= 10 \times 4\pi$

$= 40\pi$ m/s

Max^m acc^n

$a_{max} = A\omega^2$

$= 10(16\pi^2)$

$= 160\pi^2$ m/s^2

If motion (S.H.M) starts from given position then find initial phase & eqⁿ of position.

At $t=0$

$-E.P$ — M.P — $+E.P$, A

$x = A\sin(\omega t)$ $\phi = 0$

$-EP$ — m.P — At $t=0$, $\frac{\sqrt{3}A}{2}$ — EP

$\phi = \pi/3$

$x = A\sin(\omega t + \pi/3)$

$-EP$ — m.P — $\pi/2$, $t=0$, $\pi/2$

$\phi = \pi$

$x = A\sin(\omega t + \pi)$

$-EP$ — M.P — At $t=0$, $A/2$ — $+EP$; 30°, 60°

$x = A\sin(\omega t + \phi)$

$\phi = \pi/6$ (initial)

$x = A\sin(\omega t + \pi/6)$

m.P — At $t=0$, $A/2$ — EP

$x = A\sin(\omega t + \pi/6)$

$\phi = 90 + 60^\circ$

$\phi = 150^\circ = \frac{5\pi}{6}$

$-EP$ — $t=0$, $A/2$, 30° — M.P

$\phi = 180^\circ + 30^\circ = 210^\circ$

$-EP$ — M.P — At $t=0$, $\frac{A}{\sqrt{2}}$ — E.P

$x = A\sin(\omega t + \pi/4)$

$(\phi = \pi/4)$

m.P — At $t=0$, $\frac{A}{\sqrt{2}}$ — E.P; 45°, 45°

$\phi = 135^\circ$

$\phi = 3\pi/4$

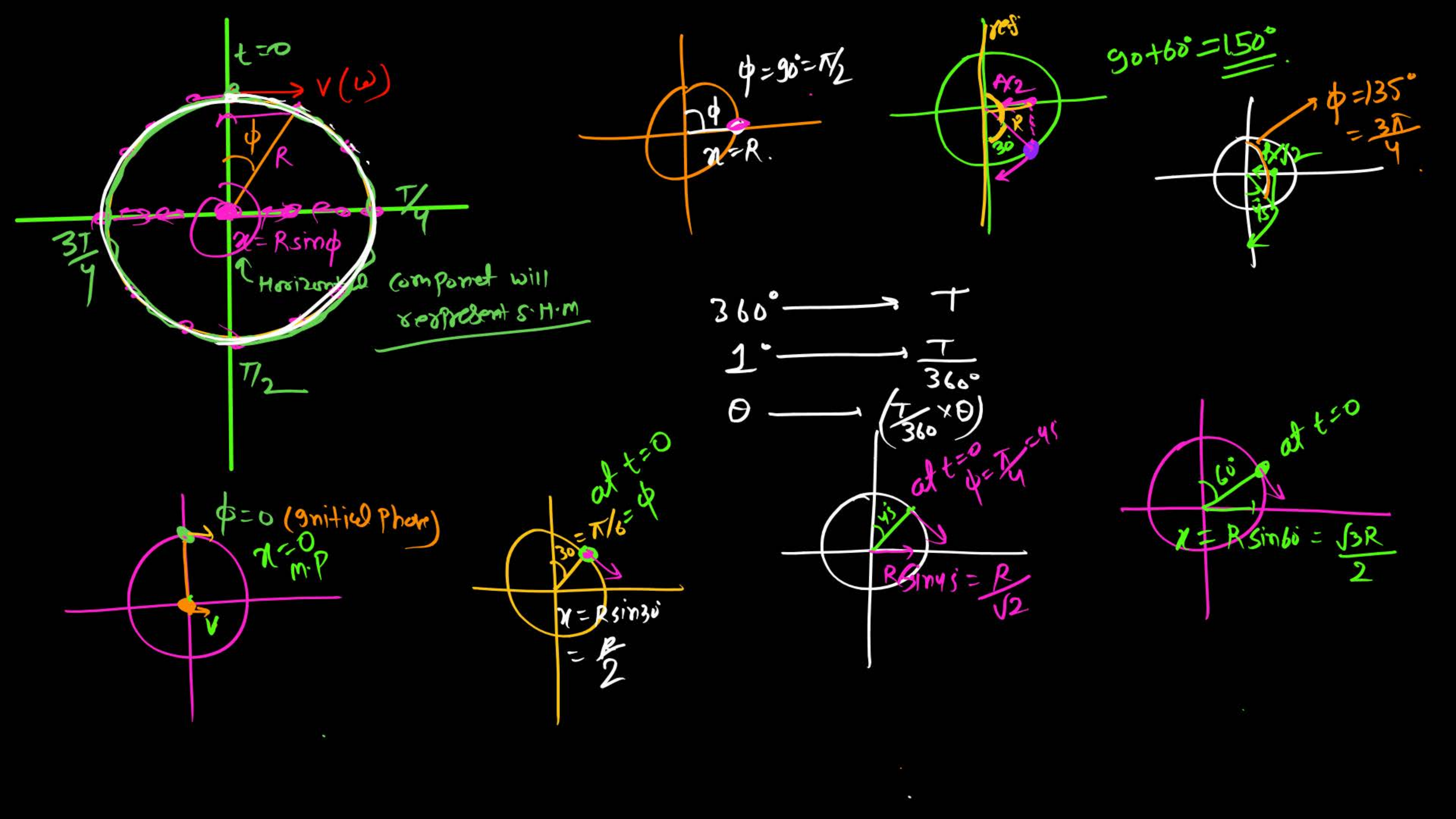
$t=0$

M.P — E.P (At $t=0$)

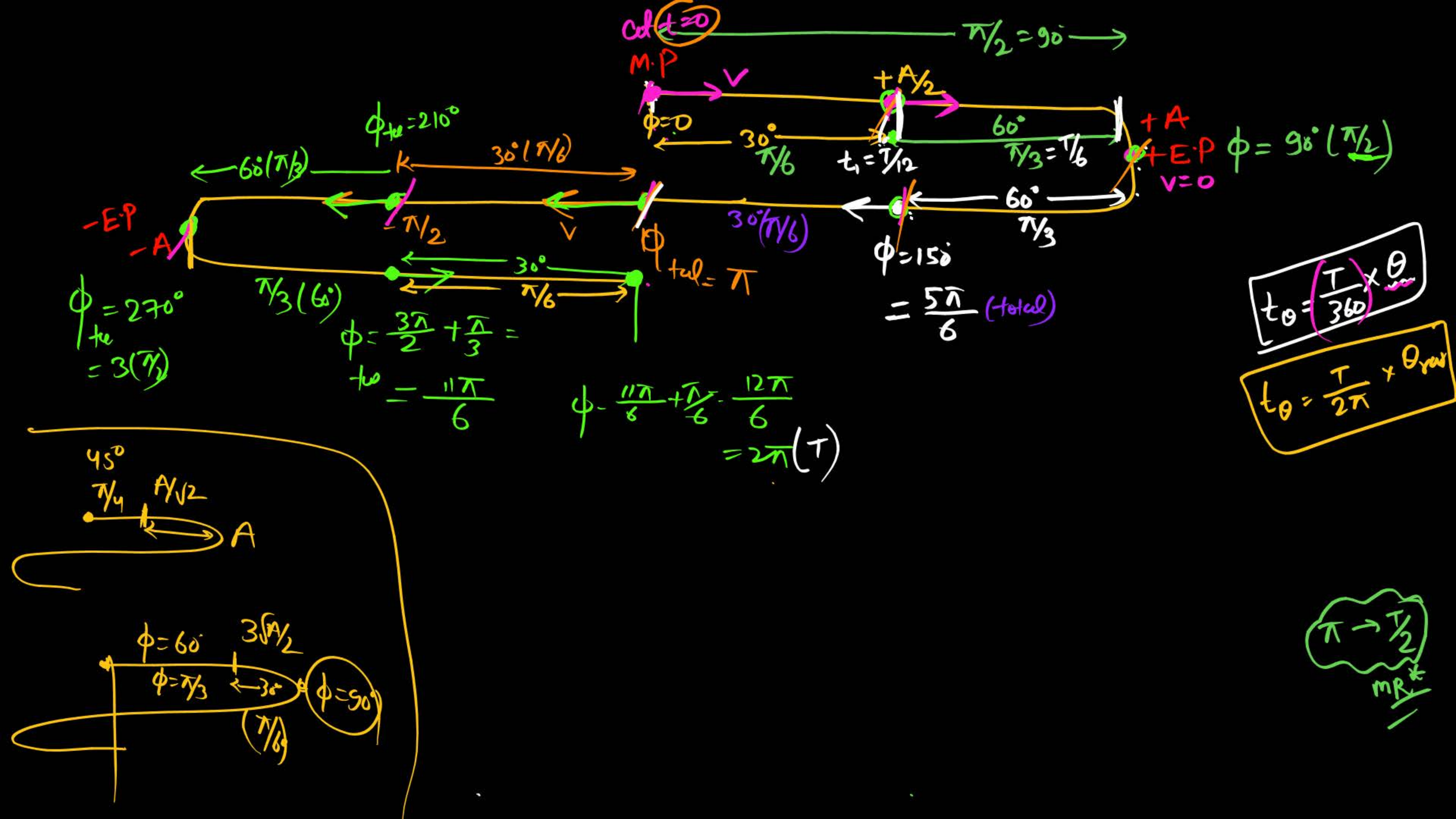
$x = A\sin(\omega t + \pi/2)$

$x = A\cos(\omega t)$

$\phi = \pi/2$

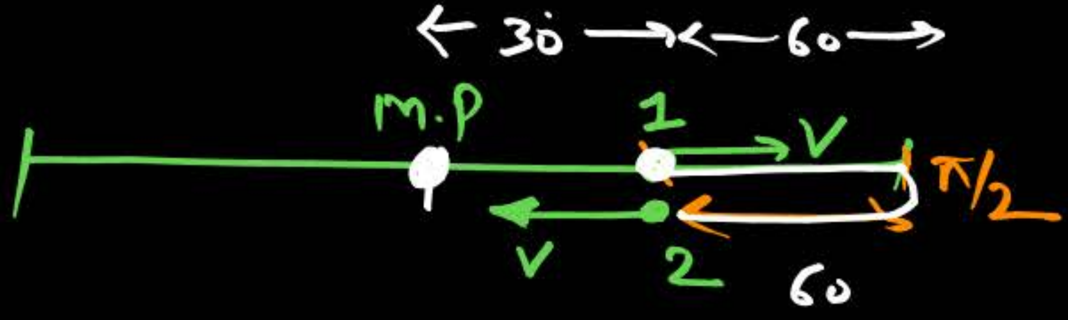


t = 0
V (ω)
φ
R
x = R sin φ
T/4
3T/4
T/2
Horizontal component will represent S.H.M
φ = 90° = π/2
x = R.
90 + 60° = 150°
R/2
R
30
φ = 135°
= 3π/4
45
360° → T
1° → T/360°
θ → (T/360 × θ)
φ = 0 (Initial Phase)
x = 0
M.P
V
at t = 0
30
= π/6 = φ
x = R sin 30°
= R/2
at t = 0
φ = π/4 = 45
45
R sin 45 = R/√2
at t = 0
60°
x = R sin 60 = √3R/2



at t=0
π/2 = 90°
M.P
V
+A/2
φ=0
30° π/6
t₁ = T/12
60°
π/3 = T/6
+A
+E.P φ = 90° (π/2)
V=0
φ_te = 210°
60°(π/3)
30°(π/6)
-E.P
-A
π/2
V
30°(π/6)
60° π/3
φ=150°
= 5π/6 (total)
φ_tal = π
30°
π/6
π/3 (60°)
φ_te = 270° = 3(π/2)
φ = 3π/2 + π/3 = 11π/6
φ = 11π/6 + π/6 = 12π/6 = 2π (T)
t_θ = (T/360) × θ
t_θ = T/2π × θ_rad
45°
π/4
A/√2
A
φ=60°
3√A/2
φ=π/3
30°
π/6
φ=90°
π → T/2
mR

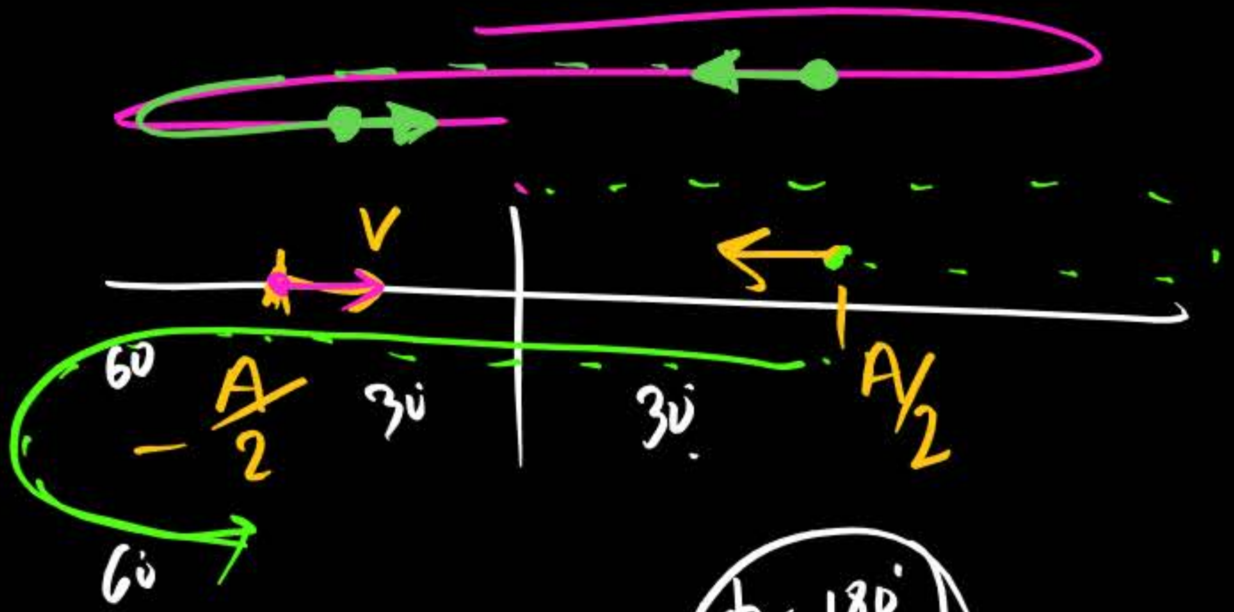
Two Particle at half of the extrem one is moving towards extrem & other is moving towards mean then φ (phase diff)..



$$\phi = \frac{\pi}{6} - \frac{5\pi}{6}$$

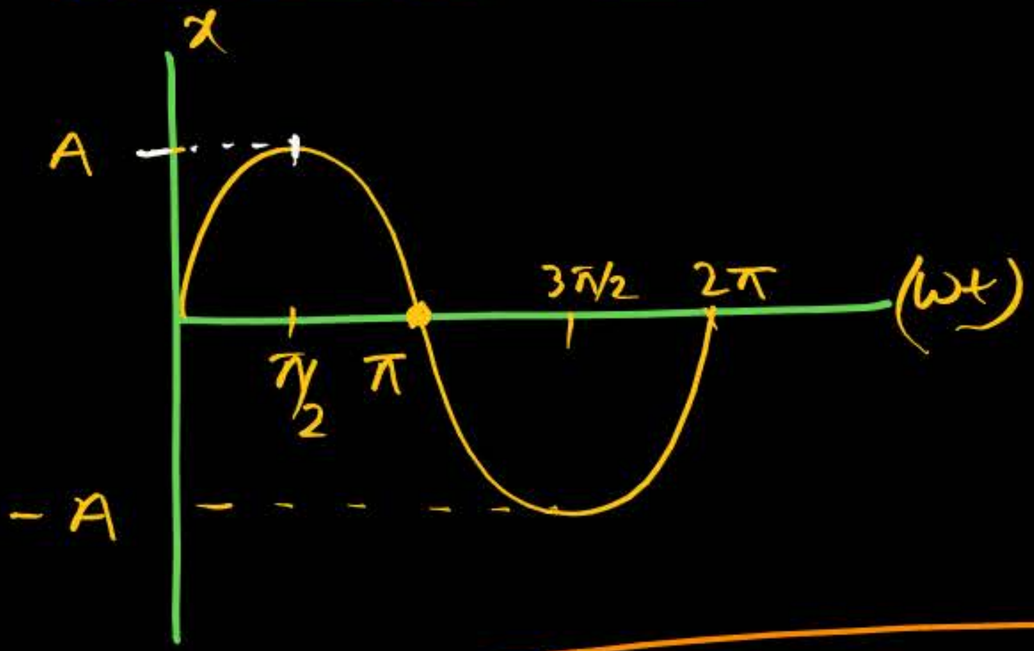
$$= \frac{-4\pi}{6}$$

$$\boxed{\phi = \frac{2\pi}{3}}$$ → mp ✗



$\phi = 180°$

$$x = A\sin(\omega t)$$

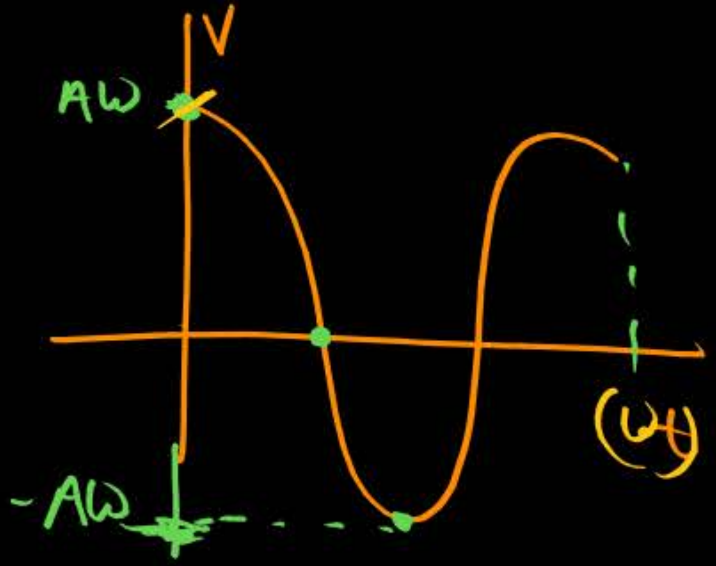


$$v = A\omega\cos(\omega t)$$

$$v = \omega A\sqrt{1-\sin^2(\omega t)}$$

$$v = \omega\sqrt{A^2 - A^2\sin^2\omega t}$$

$$v = \omega\sqrt{A^2 - x^2}$$



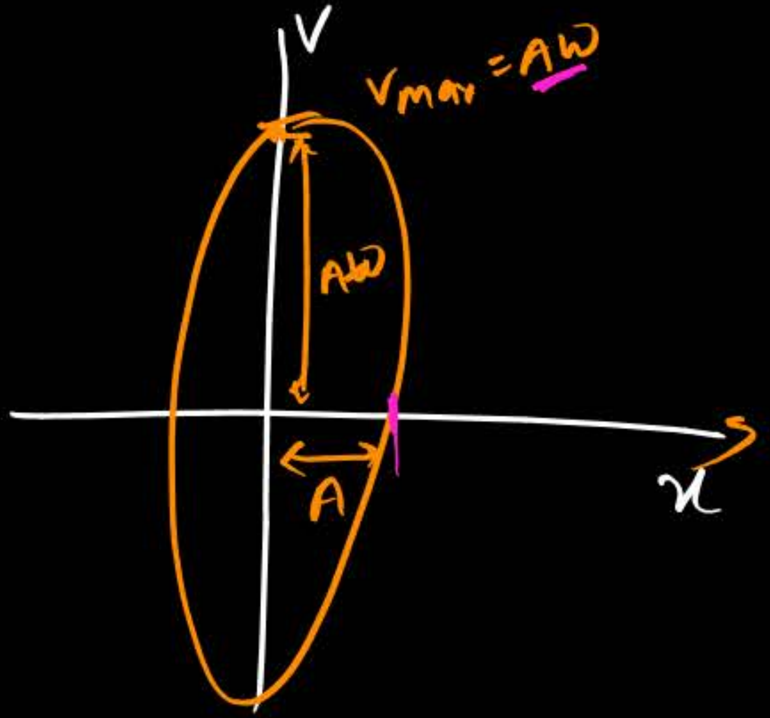
$$\frac{v^2}{\omega^2} = A^2 - x^2$$

$$\frac{v^2}{\omega^2} + x^2 = A^2$$

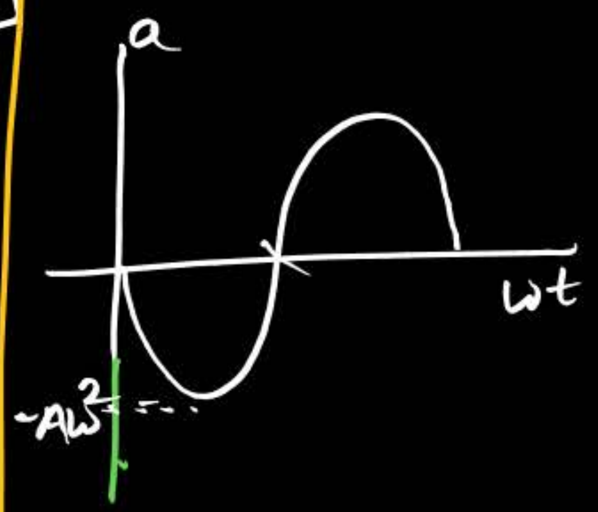
$$\frac{v^2}{A^2\omega^2} + \frac{x^2}{A^2} = 1$$

$$\frac{y^2}{a^2} + \frac{x^2}{b^2} = 1$$

ellipse.

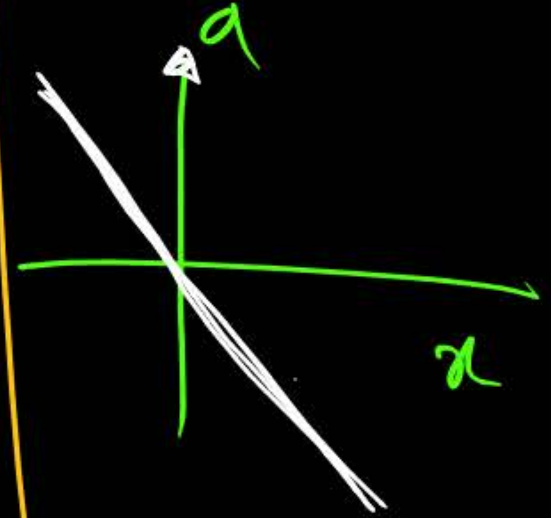


$$a = -\omega^2 A\sin(\omega t)$$



$$a = -\omega^2 x$$

$y = mx + c$



graph b/w velocity & acc^n for S.H.M.

$$\frac{v^2}{A^2\omega^2} + \frac{a^2}{A^2\omega^4} = 1$$

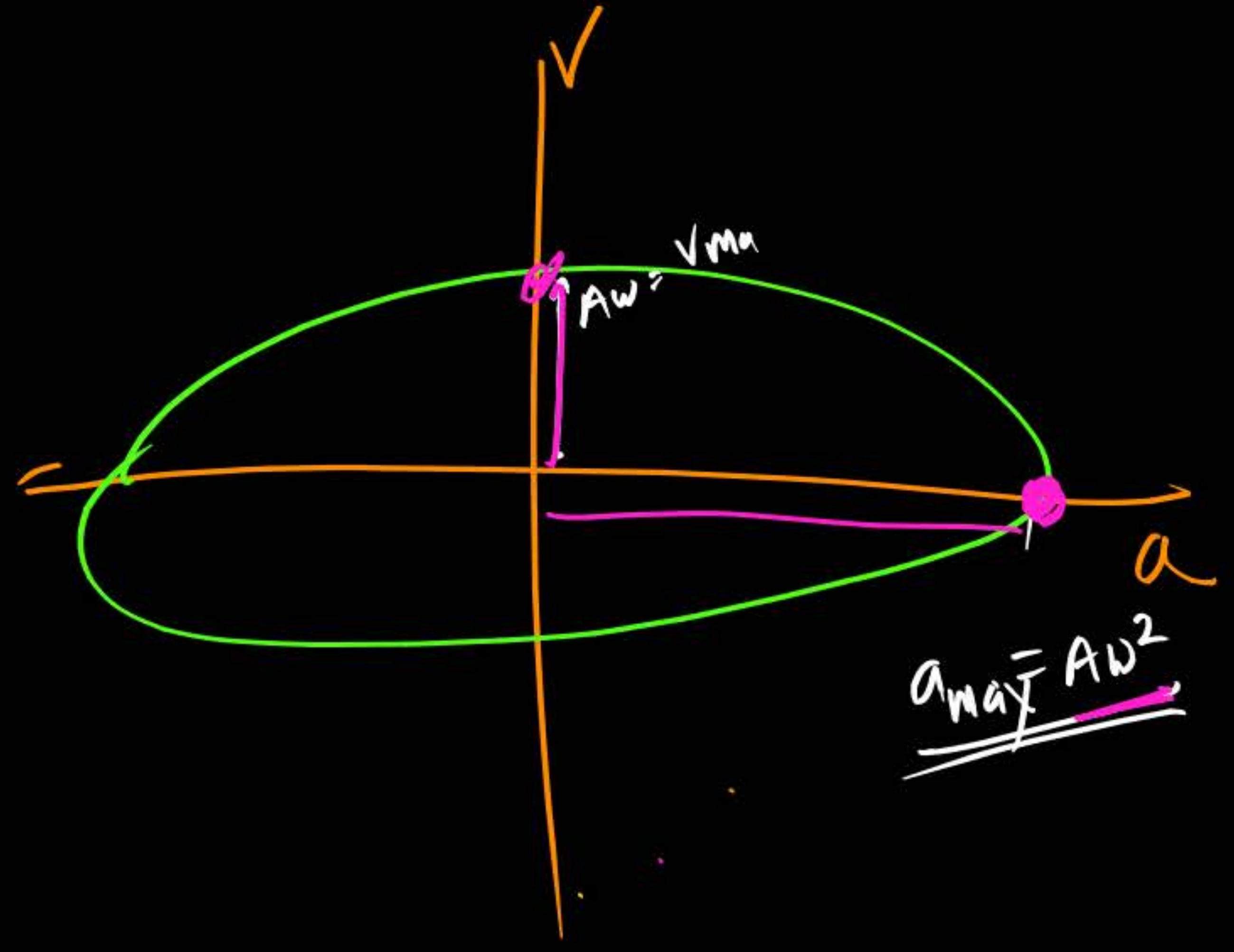
dim^n $a_{max} = A\omega^2$

(a) straight line

(b) ellipse ✓

(c) circular

(d) Parabola.



we know this.

$$\frac{v^2}{A^2\omega^2} + \frac{x^2}{A^2} = 1$$

$a = -\omega^2 x$

$x = \frac{-a}{\omega^2}$ (square)

$$x^2 = \frac{a^2}{\omega^4}$$



dim^n correct

K. B. D.

QUESTION

A particle executing SHM along y-axis, which is described by $y = 10\sin\frac{\pi t}{4}$, phase of particle at t = 2s is

1. $\frac{\pi}{4}$
2. $\frac{\pi}{2}$
3. $\frac{\pi}{8}$
4. π

phase

$\phi = \frac{\pi t}{4}$

$y = A\sin(\omega t + \phi)$

$\phi = \frac{\pi \times 2}{4}$

$\phi_{t=1} = \omega \times 2 + \phi$

$= \pi/2$

QUESTION

A particle is performing SHM with A, ω s.t at $t = 0$ particle is at $x = \frac{A\sqrt{3}}{2}$ moving away from m.p. Find equal of SHM.

$$x = A\sin(\omega t + \pi/3)$$

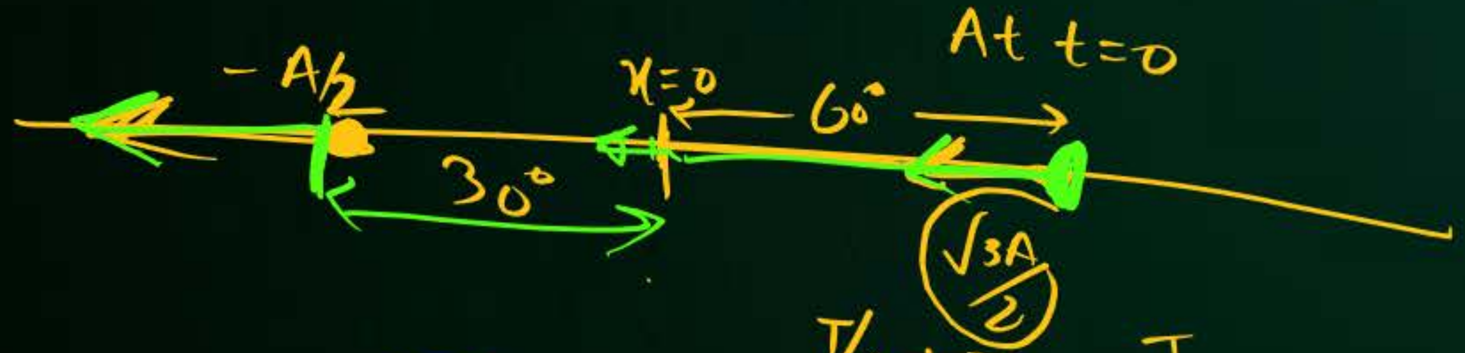


QUESTION

In SHM if at $t = 0$, $x = \frac{A\sqrt{3}}{2}$ moving towards M.P. Find when it will reach $x = -A/2$ moving away from MP.

time taken by it

$t = \frac{T}{360^\circ} \times 90^\circ = T/4$



$T/6 + T/12 = \frac{T}{4}$

$t = T/4$

QUESTION

A particle is performing SHM with A, ω s.t at $t = 0$ particle is at $x = -A/\sqrt{2}$ moving away from m.p. Find equal of SHM.

$$\pi + \frac{\pi}{4} = \frac{5\pi}{4}$$

$$x = A \sin\left(\omega t + \frac{5\pi}{4}\right)$$

QUESTION

A particle is performing SHM having amplitude A, angular frequency ω s.t. at $t = 0$ particle is at $x = +A/2$ moving towards from m.p. Find equation of SHM.

QUESTION

Two simple harmonic motions of angular frequency 100 and 1000 rad S^{-1} have the same displacement amplitude. The ratio of their maximum accelerations is:

1. $1:10^3$
2. $1:10^4$
3. $1:110$
4. $1:10^2$

QUESTION

A particle is in linear simple harmonic motion between two points A and B, 10 cm apart. Take the direction from A to B as the positive direction and given the signs of velocity, acceleration and force on the particle when it is. origin is at mean pos.

(a) At the end A. ($v = 0$, $a_{max} = +\omega^2 A$, $F = +ve$, $x = -A$)

(b) At the end B. ($v = 0$, $a_{max} = -\omega^2 A$, $F = -ve$, $x = +A$)

(c) At the mid-point of AB going towards A.

(d) At 2 cm away from B going towards A.

(e) At 3 cm away from A going towards B.

(f) At 4 cm away from A going towards A.

Sol^n (c): $v_{max} = -ve$ (ωA), $a = 0$, $F = 0$, $x = 0$

Sol^n (d): $v = -ve$, $a = -ve$, $x = +ve$

Sol^n (e): $x = -ve$, $v = +ve$, $a = +ve$

(f): $v = -ve$, $a = +ve$, $x = -ve$, $F = +ve$

QUESTION

A particle execute simple harmonic motion according to equation $4\frac{d^2x}{dt^2} + 320\,x = 0$. Its time period of oscillation is

(1) $\frac{2\pi}{5\sqrt{3}}$ s

(2) $\frac{\pi}{3\sqrt{2}}$ s

(3) $\frac{\pi}{2\sqrt{5}}$ s   Ans

(4) $\frac{2\pi}{\sqrt{3}}$ s

$4\frac{d^2x}{dt^2} + 320x = 0$

$4a = -320x$

$a = -80x \quad (a = -\omega^2 x)$

$\omega^2 = 80$

$\omega = \frac{2\pi}{T} = \sqrt{80}$

$T = \frac{2\pi}{\sqrt{16\times5}} = \frac{2\pi}{2\times2\sqrt{5}}$

QUESTION

If a simple harmonic oscillator has got a displacement of 0.02 m and acceleration equal to 2.0 ms^{-2} at any time, the angular frequency of the oscillator is equal to

1. 10 rad s^{-1}
2. 0.1 rad s^{-1}
3. 100 rad s^{-1}
4. 1 rad s^{-1}

QUESTION

A particle is executing a simple harmonic motion. Its maximum acceleration is α and maximum velocity is β. Then, its time period of vibration will be

[Re-AIPMT-2015]

1. $\frac{2\pi\beta}{\alpha}$
2. $\frac{\beta^2}{\alpha^2}$
3. $\frac{\alpha}{\beta}$
4. $\frac{\beta^2}{\alpha}$

$T = \frac{v}{a}$

$a = \frac{\Delta v}{T}$

$T = \frac{v}{a}$

$\alpha = A\omega^2$

$\beta = A\omega$

$\frac{\alpha}{\beta} = \omega = \frac{2\pi}{T}$

$T = \frac{2\pi\beta}{\alpha}$

QUESTION

The distance covered by a particle undergoing SHM in one time period is (amplitude = A),

1. 4A
2. Zero
3. A
4. 2A

QUESTION

$v = A\omega\cos(\omega t)$

$v = \omega\sqrt{A^2 - x^2}$

A particle is executing S.H.M. with amplitude A and has maximum velocity v_0. Its speed at displacement $\frac{3A}{4}$ will be $v = ??$

$x = \frac{3A}{4}$

1. $\frac{\sqrt{7}}{4} v_0$ Ans
2. $\frac{v_0}{\sqrt{2}}$
3. v_0
4. $\frac{\sqrt{3}}{2} v_0$

$v = \omega\sqrt{A^2 - \frac{9A^2}{16}}$

$= \omega A\sqrt{1 - \frac{9}{16}}$

$= v_0\sqrt{\frac{16-9}{16}}$

$= \frac{v_0\sqrt{7}}{4}$

QUESTION

Which one of the following statements is true for the velocity v and the acceleration a of a particle executing simple harmonic motion?

1. When v is maximum, a is zero. (at mean)
2. When v is zero, a is zero.
3. When v is maximum, a is maximum.
4. Value of a is zero, whatever may be the value of v.

QUESTION

For a particle executing simple harmonic motion, the amplitude is A and time period is T. The maximum speed will be

1. $4AT$

2. $\frac{2A}{T}$

3. 2π

4. $\frac{2\pi A}{T}$

$v_{max} = A\omega$

$= \frac{A 2\pi}{T}$

QUESTION

A body is executing SHM when its displacement from the mean position is 4 cm and 5 cm the corresponding velocity of the body is 10 cm/sec and 8 cm/sec. Then the time period of the body is

1. 2π sec
2. $\pi/2$ sec
3. π sec
4. $3\pi/2$ sec

$$v_1 = \omega\sqrt{A^2 - x_1^2}$$

$$v_2 = \omega\sqrt{A^2 - x_2^2}$$

H/W

QUESTION

H/w → hint

A particle is executing SHM along a straight line. Its velocities at distance x_1 and x_2 from the mean position are V_1 and V_2 respectively. Its time period is

[AIPMT-2015]

(1) $2\pi\sqrt{\dfrac{V_1^2-V_2^2}{x_1^2-x_2^2}}$

(2) $2\pi\sqrt{\dfrac{x_1^2+x_2^2}{V_1^2+V_2^2}}$

(3) $2\pi\sqrt{\dfrac{x_1^2-x_2^2}{V_1^2-V_2^2}}$

(4) $2\pi\sqrt{\dfrac{V_1^2+V_2^2}{x_1^2+x_2^2}}$

$x_1 \to v_1$

$x_2 \to v_2$

$v_1 = \omega\sqrt{A^2-x_1^2}$

$\left(\frac{v_1}{\omega}\right)^2 = A^2 - x^2$

$\left(\frac{v_1}{\omega}\right)^2 + x_1^2 = A^2 = \left(\frac{v_2}{\omega}\right)^2 + x_2^2$

H/w

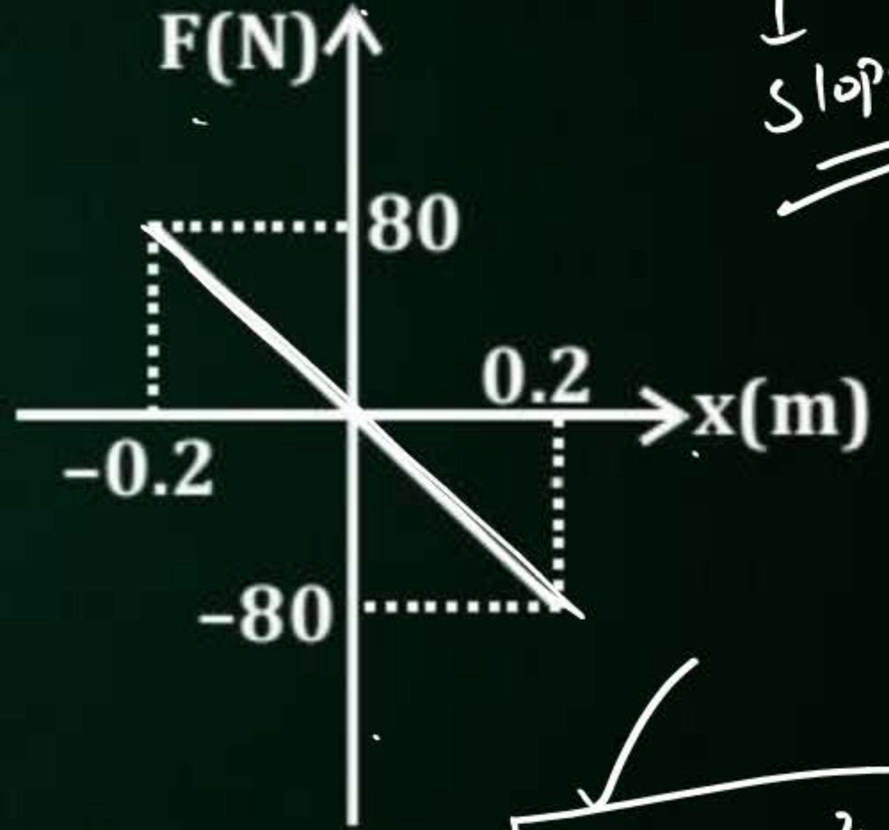
$\frac{v_1^2}{\omega^2} - \frac{v_2^2}{\omega^2} = x_2^2 - x_1^2$

$\frac{v_1^2 - v_2^2}{x_2^2 - x_1^2} = \omega^2 = \left(\frac{2\pi}{T}\right)^2$

$T = 2\pi\sqrt{\frac{x_2^2 - x_1^2}{v_1^2 - v_2^2}}$

QUESTION

A body of mass 0.01 kg executes simple harmonic motion about $x = 0$ under the influence of a force as shown in figure. The time period of SHM is



(1) 1.05 s

(2) 0.52 s

(3) 0.25 s

(4) 0.03 s

$F = -kx$
slope

$\frac{k}{m} = \omega^2$

hint.

QUESTION

A particle is executing SHM about $y = 0$ along y-axis. Its position at an instant is given by $y(m) = 5(\sin 3\pi t + \sqrt{3}\cos 3\pi t)$. The amplitude of oscillation is

(1) 10 m

(2) 5 m

(3) $5(1 + \sqrt{3})$ m

(4) $5\sqrt{3}$ m

QUESTION

Particle executing SHM along y-axis has its motion described by the equation $y = 2 + 10 \sin 5\pi t$. Amplitude of SHM is

1. 2
2. 12
3. 10
4. $\sqrt{104}$

QUESTION

A simple pendulum performs simple harmonic motion about x= 0 with an amplitude a and time period t. The speed of the pendulum at $x = \frac{a}{2}$ will be

[AIPMT-2009]

1. $\frac{\pi a}{T}$
2. $\frac{3\pi^2 a}{T}$
3. $\frac{\pi a\sqrt{3}}{T}$
4. $\frac{\pi a\sqrt{3}}{2T}$

QUESTION

A particle executes linear simple harmonic motion with an amplitude of 3 cm. When the particle is at 2 cm from the mean position, the magnitude of its velocity is equal to that of its acceleration. Then its time period in seconds is

[NEET - 2017]

1. $\frac{\sqrt{5}}{\pi}$
2. $\frac{\sqrt{5}}{2\pi}$
3. $\frac{4\pi}{\sqrt{5}}$
4. $\frac{2\pi}{\sqrt{3}}$

QUESTION

The displacements of two particles executing SHM on the same line are given as $y_1 = a \sin\left(\frac{\pi}{2}t + \theta\right)$ and $y_2 = b \sin\left(\frac{2\pi}{3}t + \theta\right)$. The phase difference between them at $t = 1s$ is

1. π
2. $\frac{\pi}{2}$
3. $\frac{\pi}{4}$
4. $\frac{\pi}{6}$

QUESTION

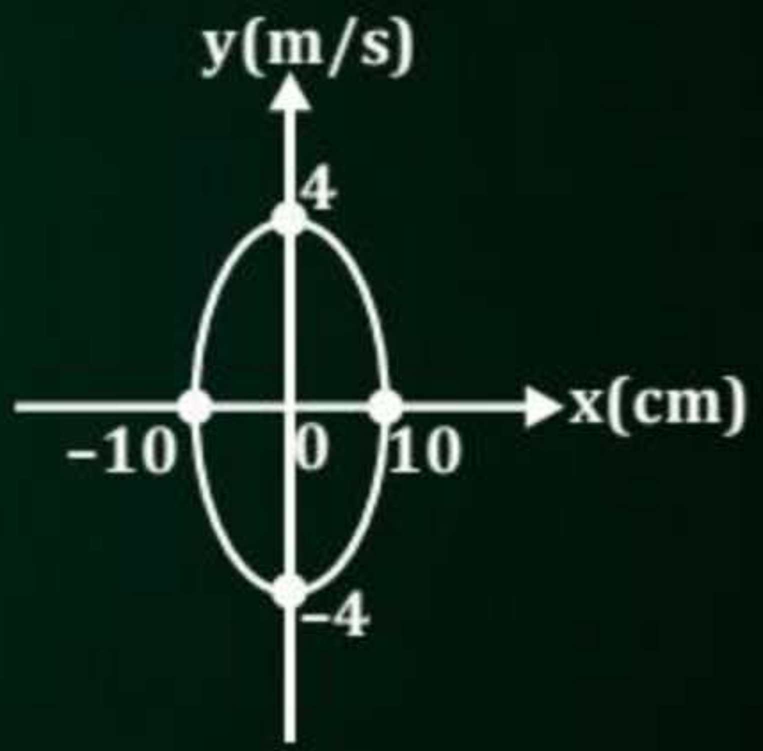
The plot of velocity (v) versus displacement (x) of a particle executing simple harmonic motion is shown in figure. The time period of oscillation of particle is

(1) $\frac{\pi}{2}$ s

(2) π s

(3) 2π s

(4) 3π s



QUESTION

The shape of graph plotted between velocity and position of a particle executing simple harmonic motion is

1. A straight line
2. An ellipse
3. A parabola
4. A hyperbola

Graph Velocity and Acceleration

QUESTION

Motion starts from mean position then find time taken from $x = 0$ to $x\frac{A}{2}$.

QUESTION

Displacement of a particle executing SHM is represented by $Y = 0.08 \sin(3\pi t + \pi/4)$ metre. Then calculate:

(a) Time period

(b) Initial phase

(c) Displacement from mean position at $t = 7/36$ sec.

QUESTION

Motion starts from mean position then find time taken from $x = \frac{A}{2}$ to $x = A$.

QUESTION

Object moves mean half of the extreme ($x = A/2$) then phase of that time 't'.

QUESTION

Find time taken from mean to $x = \frac{A}{\sqrt{2}}$

QUESTION

A particle is executing S.H.M. between $x = \pm A$. The time taken to go from 0 to $\frac{A}{2}$ is T_1 and to go from $\frac{A}{2}$ to A is T_2; then

1. $T_1 < T_2$
2. $T_1 > T_2$
3. $T_1 = T_2$
4. $T_1 = 2T_2$

QUESTION

A particle is executing SHM with time period T. Starting from mean position, time taken by it to complete $\frac{5}{8}$ oscillations, is

1. $\frac{T}{12}$

2. $\frac{T}{6}$

3. $\frac{5T}{12}$

4. $\frac{7T}{12}$

QUESTION

Two particles executing SHM of same frequency, meet at $x = +A/2$, while moving in opposite directions. Phase difference between the particles is

1. $\frac{\pi}{6}$
2. $\frac{\pi}{3}$
3. $\frac{5\pi}{6}$
4. $\frac{2\pi}{3}$

QUESTION

The potential energy of a particle of mass 100 g moving along x-axis is given by U = $5x(x - 4)$, where x is in metre. The period of oscillation is

1. 0.2π s
2. 0.1π s
3. π s
4. $\frac{1}{\pi}$ s

QUESTION

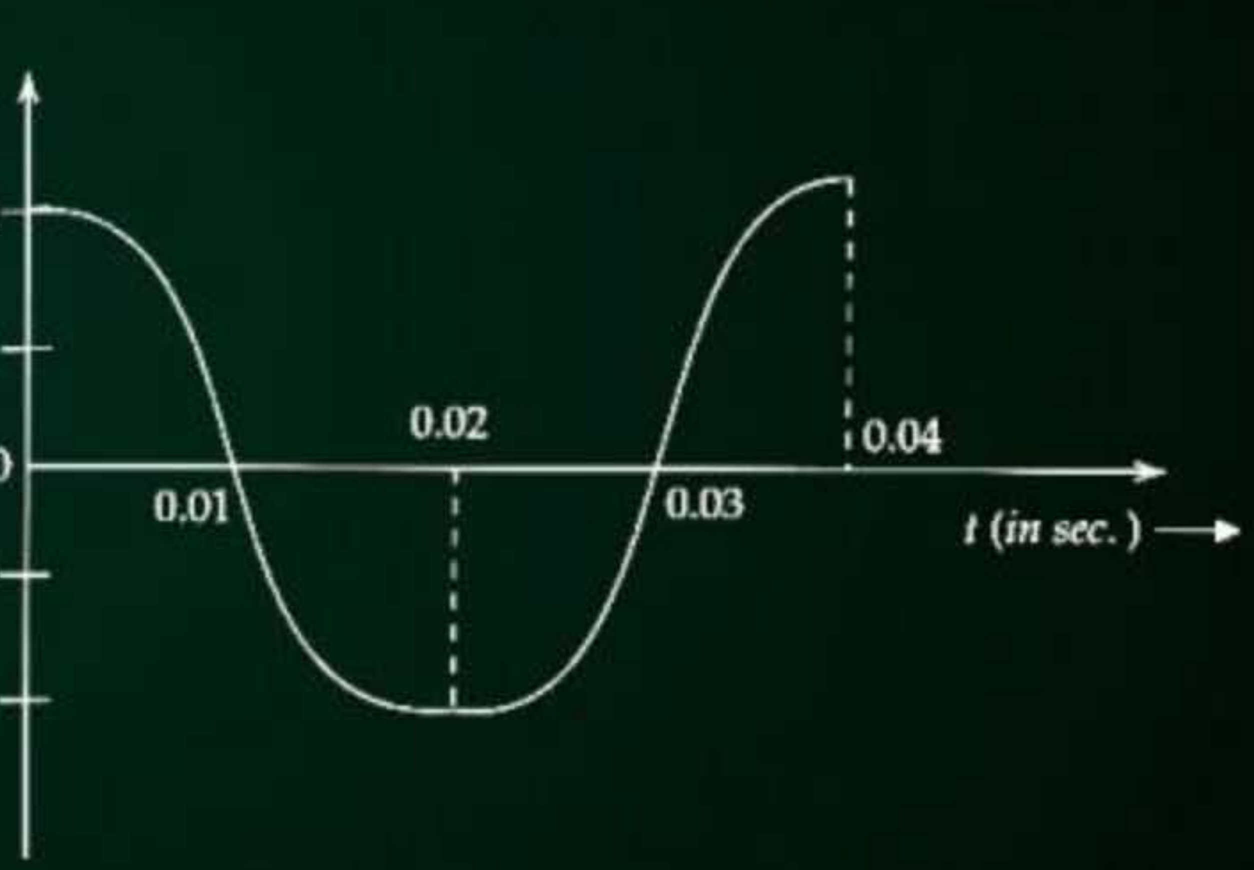
The velocity-time diagram of a harmonic oscillator is shown in the adjoining figure. The frequency of oscillation is:

(1) 25 Hz

(2) 50 Hz

(3) 12.25 Hz

(4) 33.3 Hz



QUESTION

The displacement of a particle in SHM is indicated by equation $y = 10 \sin (20t + \pi/3)$ where y is in metres. The value of time period of vibration will be (in seconds):

1. $10/\pi$
2. $\pi/10$
3. $2\pi/10$
4. $10/2\pi$

QUESTION

A particle oscillates along the x-axis according to equation $x = 0.05 \sin(5t - \pi/6)$ where x is in metre and t is in second. Find its velocity at $t = 0$ second.

H/W

Soln

DPP


THANK YOU

YAKEEN 2.0

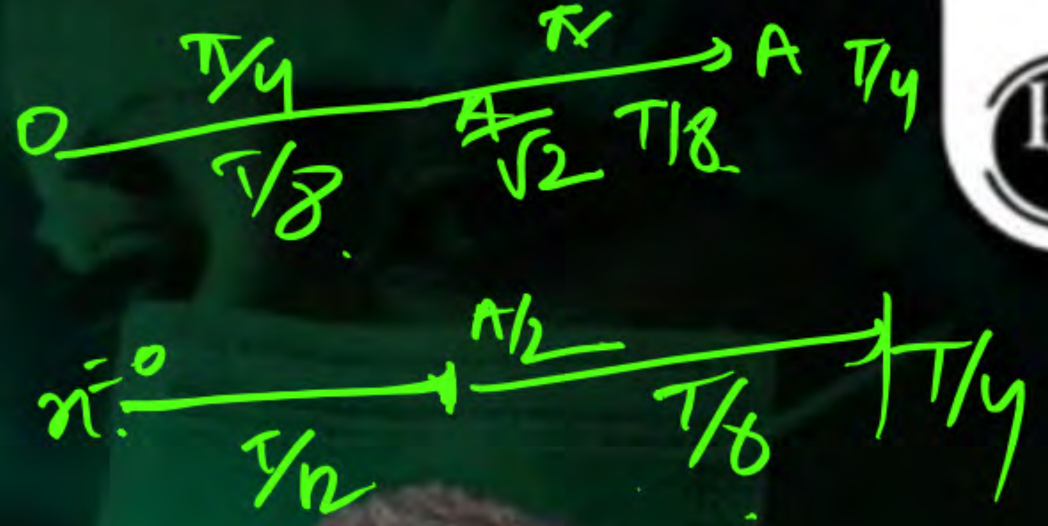
FOR NEET 2025

Lecture- 03 | Physics

Oscillations

Lecture-2 H/W solution

By- Dr. Manish Raj (MR SIR)





Topics to be covered

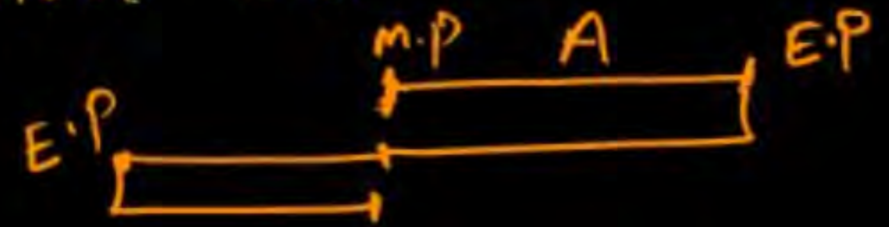
1 # Phase of S.H.M
Time period,
Velocity, Positio acc^n PePhD

2 #

3 # Homework Solution



1. If position of Particle in S.H.M $y = 10\sin(4\pi t + \pi/6)\,m$ then find subkuchh.



Sol^n

Amplitude = 10m

frequency = ?? $\omega = 4\pi = 2\pi f$

$f = 2\,Hz$

Angular frequ $\omega = 4\pi$

Time Period = $T = \frac{1}{f} = \frac{1}{2}$ sec

Initial Phase $(\phi) = \pi/6$

At t=0 motion starts from half of extreme.

Total dist^n in one oscilltion = 40m



disp^n = 0
1-oscil^n

$y = A\sin(\omega t + \phi)$

⇒ Phase at t = 1 sec

$\phi_t = 4\pi t + \frac{\pi}{6}$

$\phi_{1sec} = 4\pi \times 1 + \pi/6$

$= \frac{25\pi}{6}$

Initial velocity at (t=0)

$V = \frac{dx}{dt} = 10 \times 4\pi\cos(4\pi t + \pi/6)$

$= 40\pi\cos(\pi/6) = 40\pi\frac{\sqrt{3}}{2}$

$= 20\sqrt{3}\pi$

Max^m velocity

$V_{max} = A\omega$

$= 10 \times 4\pi$

$= 40\pi\ m/s$

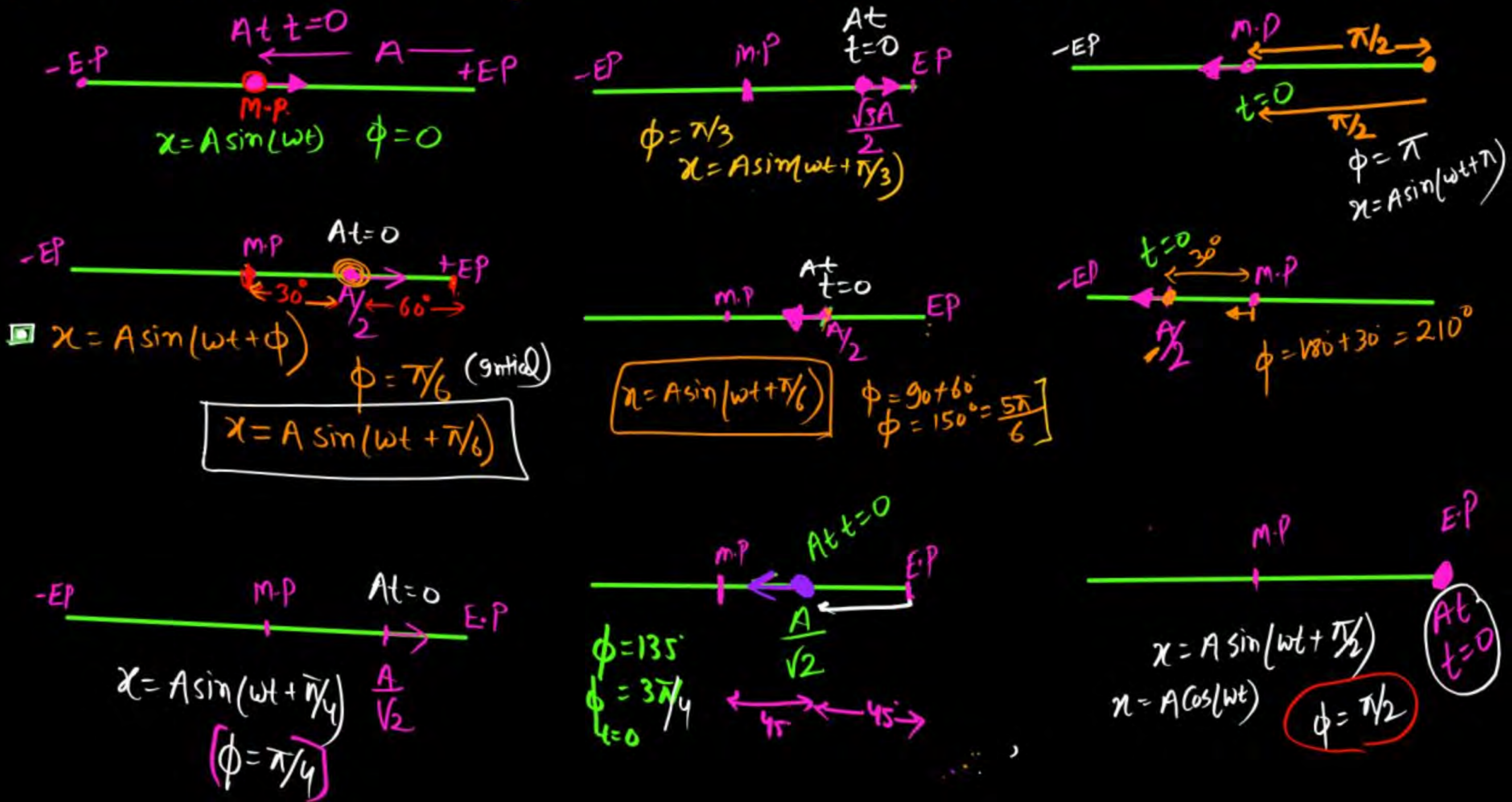
Max^m acc^n

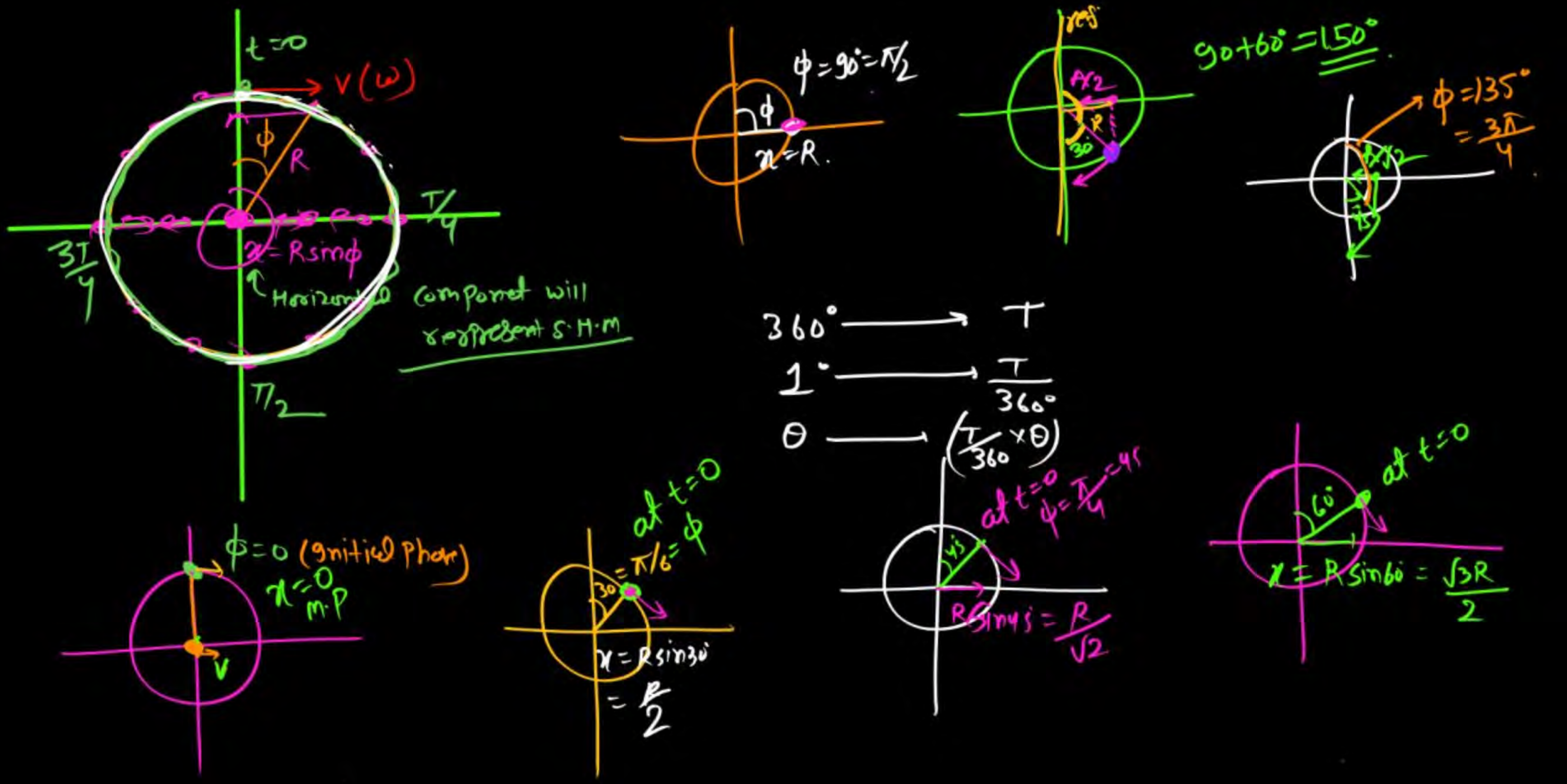
$a_{max} = A\omega^2$

$= 10(16\pi^2)$

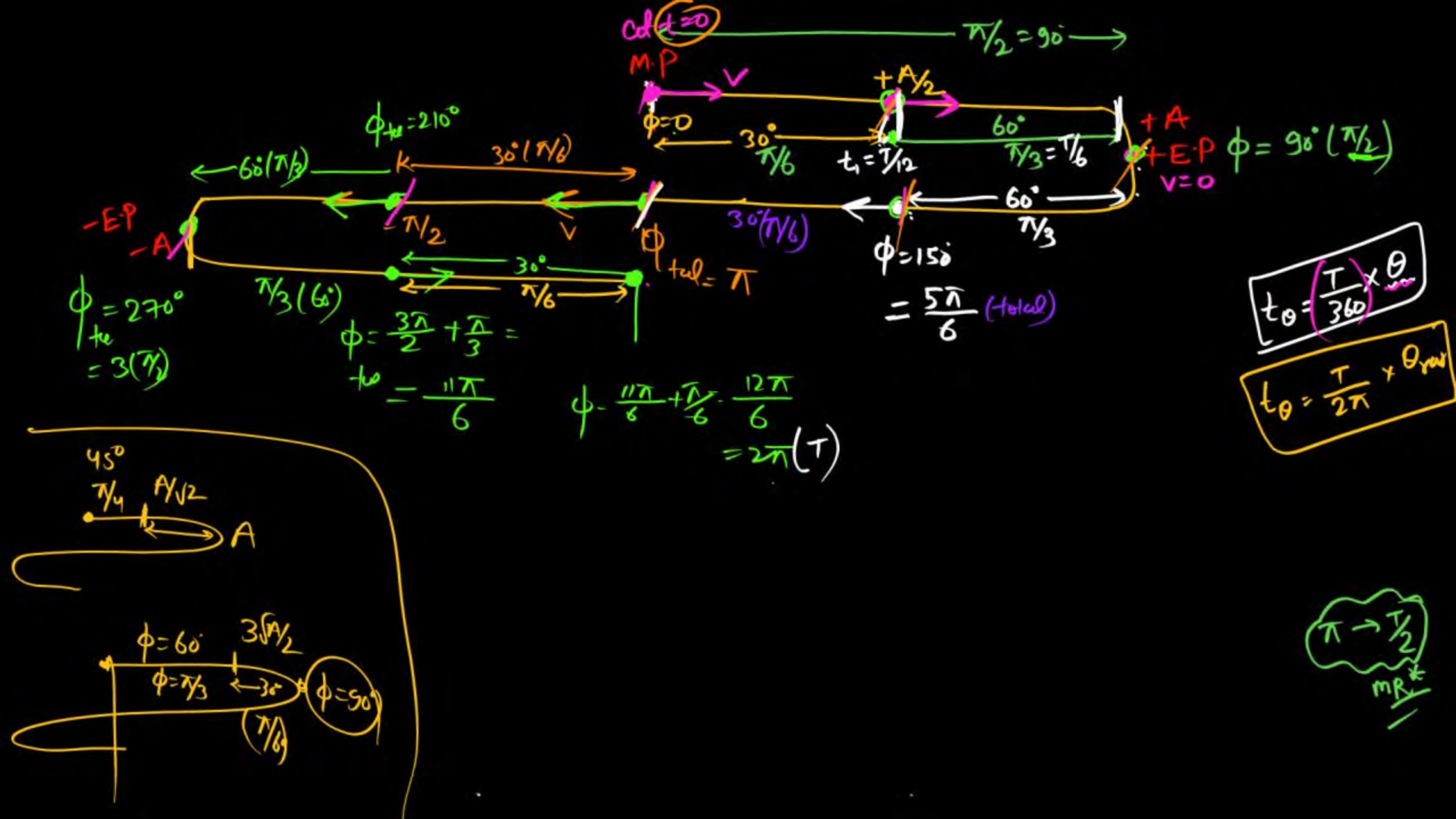
$= 160\pi^2\ m/s^2$

If motion (S.H.M) starts from given position then find initial phase & eqn of position.



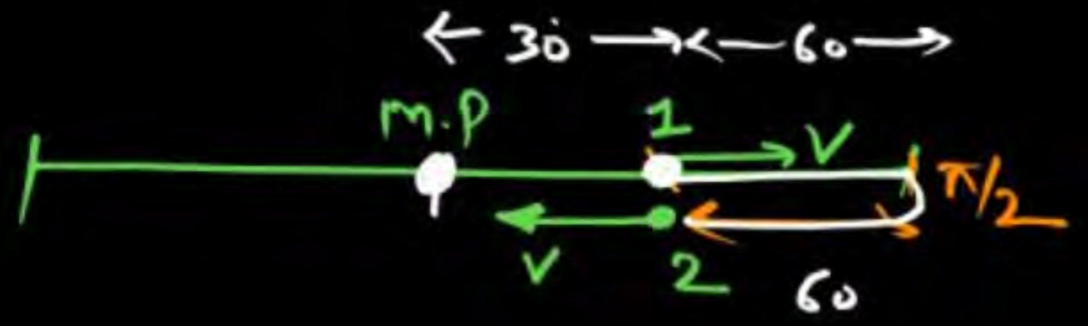


t=0
V (ω)
φ
R
T/4
3T/4
T/2
x = R sin φ
Horizontal component will represent S.H.M
φ = 90° = π/2
x = R.
res
R/2
R
30
90+60° = 150°
φ = 135° = 3π/4
360° → T
1° → T/360°
θ → (T/360 × θ)
φ = 0 (Initial Phase)
x = 0
M.P
V
at t = 0
π/6 = φ
30
x = R sin30°
= R/2
at t = 0
φ = π/4 = 45
45
R sin45 = R/√2
at t = 0
60°
x = R sin60° = √3R/2



t=0
π/2 = 90°
M.P
V
+A/2
ϕ=0
30° π/6
60°
π/3 = T/6
t₁ = T/12
+A
+E.P
V=0
ϕ = 90° (π/2)
ϕ_tl = 210°
30° (π/6)
60° (π/3)
-E.P
-A
π/2
V
30° (π/6)
60° π/3
ϕ = 150°
= 5π/6 (total)
ϕ_tal = π
30°
π/6
π/3 (60°)
ϕ_tl = 270°
= 3(π/2)
ϕ = 3π/2 + π/3 =
= 11π/6
ϕ = 11π/6 + π/6 = 12π/6
= 2π (T)
t_θ = (T/360) × θ
t_θ = T/2π × θ_rad
π → T/2
45°
π/4
A/√2
A
ϕ = 60°
3√A/2
ϕ = π/3
30°
π/6
ϕ = 90°

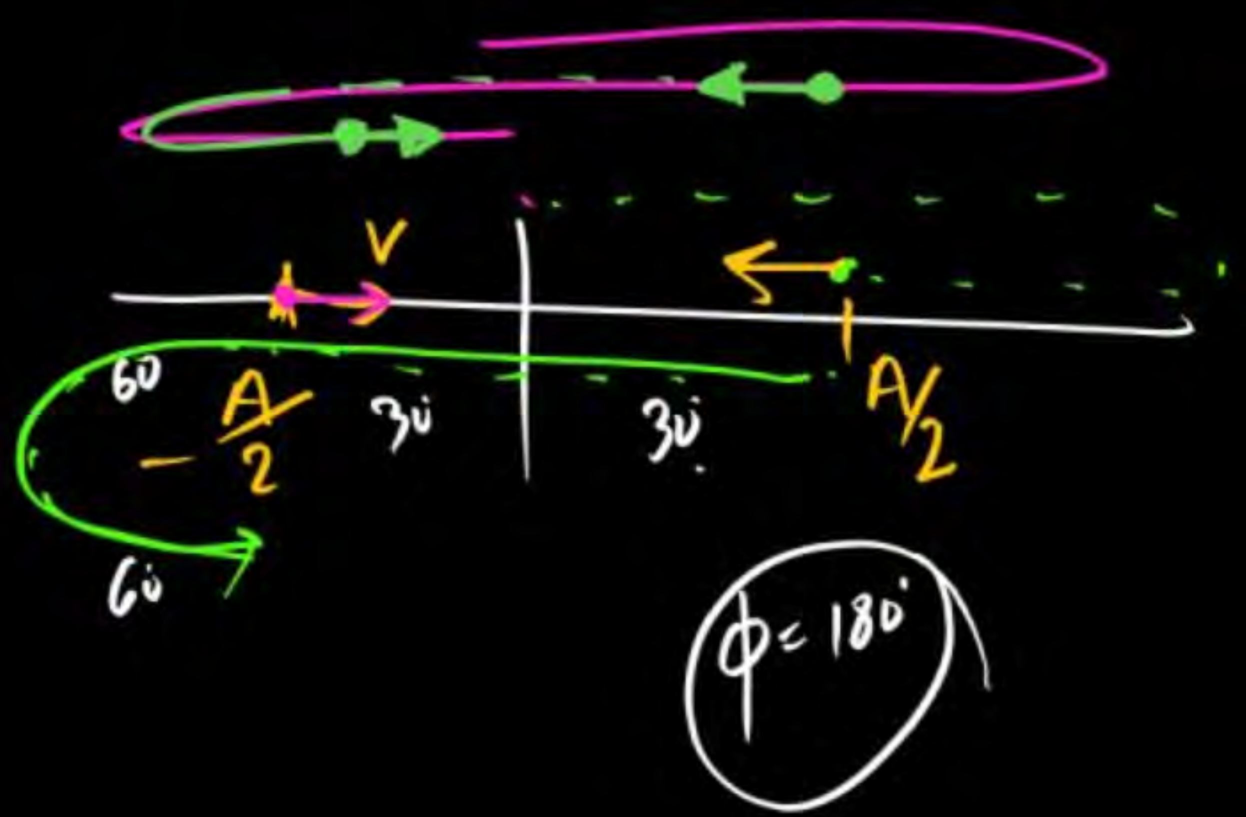
Two Particle at half of the extreme one is moving towards extreme & other is moving towards mean then φ (phase diff).



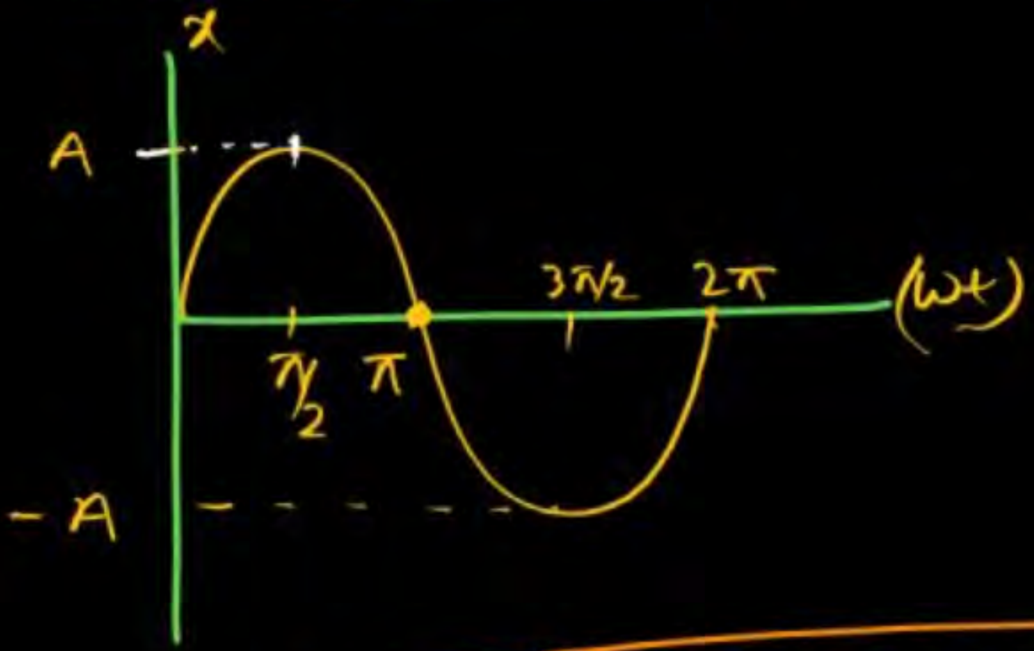
$$\phi = \frac{\pi}{6} - \frac{5\pi}{6}$$

$$= \frac{-4\pi}{6}$$

$$\boxed{\phi = \frac{2\pi}{3}} \rightarrow \text{mp}$$



$$x = A\sin(\omega t)$$



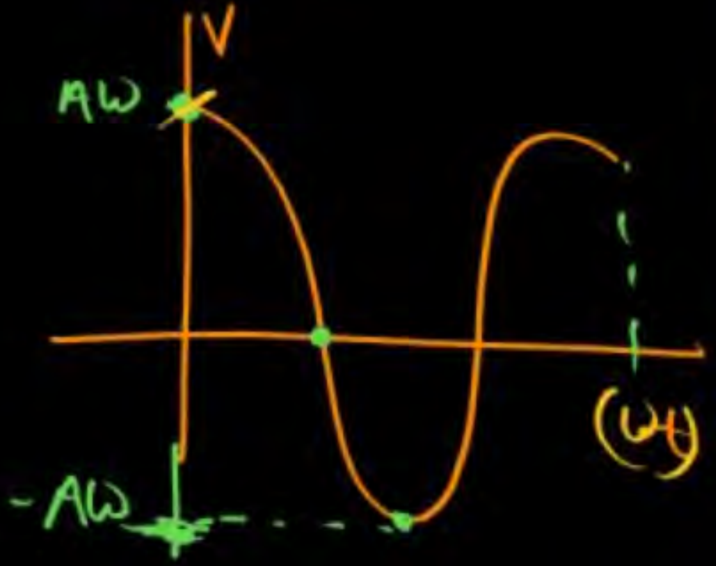
$$v = A\omega\cos(\omega t)$$

$$v = \omega A\sqrt{1-\sin^2(\omega t)}$$

$$v = \omega\sqrt{A^2 - A^2\sin^2\omega t}$$

$$v = \omega\sqrt{A^2 - x^2}$$

$$\frac{v^2}{\omega^2} = A^2 - x^2$$

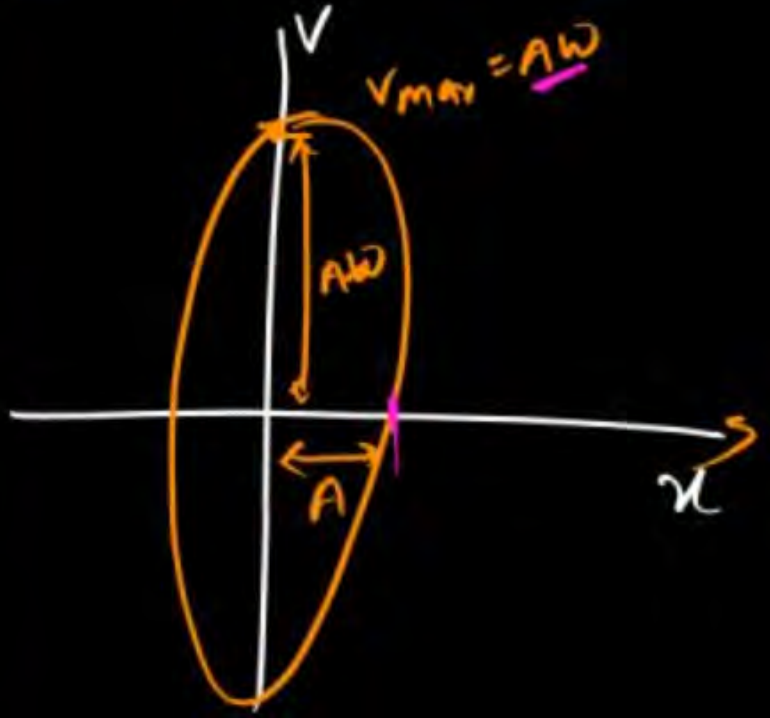


$$\frac{v^2}{\omega^2} + x^2 = A^2$$

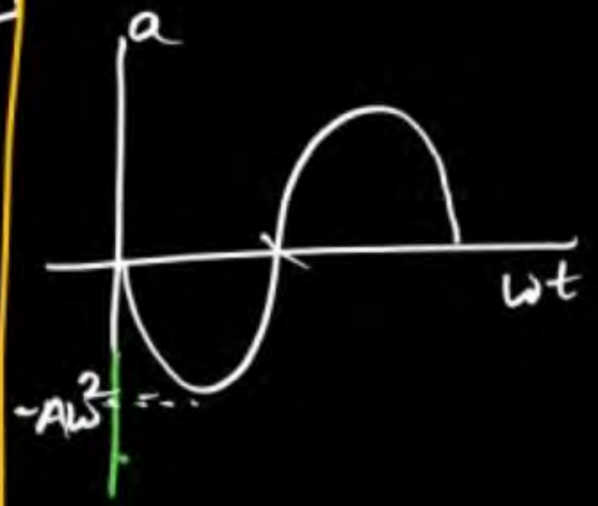
$$\frac{v^2}{A^2\omega^2} + \frac{x^2}{A^2} = 1$$

$$\frac{y^2}{a^2} + \frac{x^2}{b^2} = 1$$

ellipse.

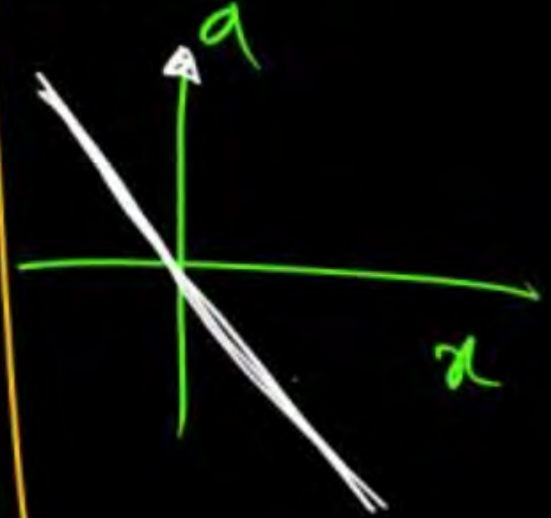


$$a = -\omega^2 A\sin(\omega t)$$



$y = mx + c$

$$a = -\omega^2 x$$



graph b/w velocity & acc^n for S.H.M.

$$\frac{V^2}{A^2\omega^2} + \frac{a^2}{A^2\omega^4} = 1$$

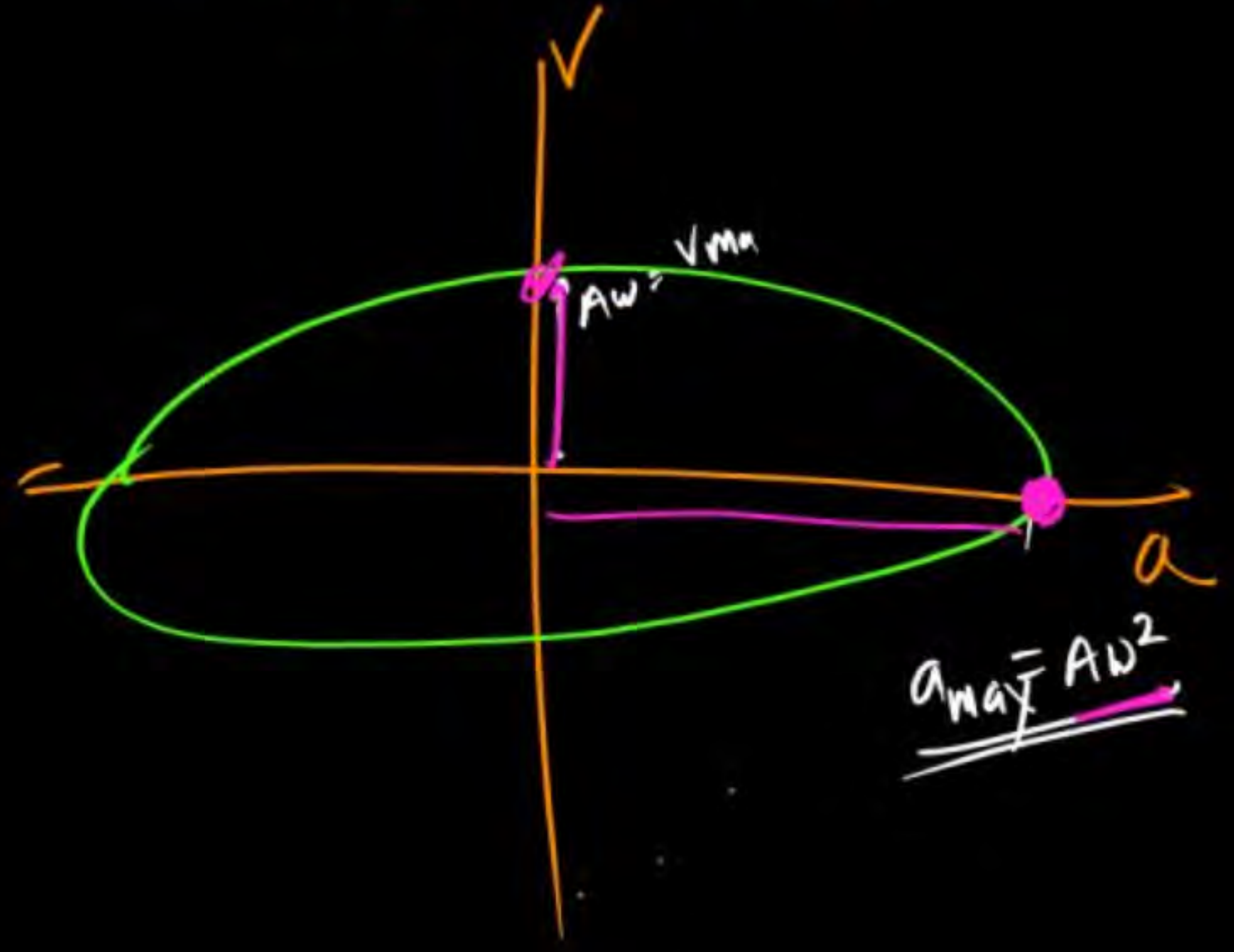
dim^n $a_{max} = A\omega^2$

(a) straight line

(b) ellipse ✓

(c) circle

(d) Parabola.



we know this.

$$\frac{V^2}{A^2\omega^2} + \frac{x^2}{A^2} = 1$$

$a = -\omega^2 x$

$x = \frac{-a}{\omega^2}$ (square)

$$x^2 = \frac{a^2}{\omega^4}$$



dim^n correct

K.B.D.

QUESTION

A particle executing SHM along y-axis, which is described by $y = 10 \sin \frac{\pi t}{4}$, phase of particle at t = 2s is

1. $\frac{\pi}{4}$
2. $\frac{\pi}{2}$
3. $\frac{\pi}{8}$
4. π

QUESTION

A particle is performing SHM with A, ω s.t at $t = 0$ particle is at $x = \frac{A\sqrt{3}}{2}$ moving away from m.p. Find equal of SHM.

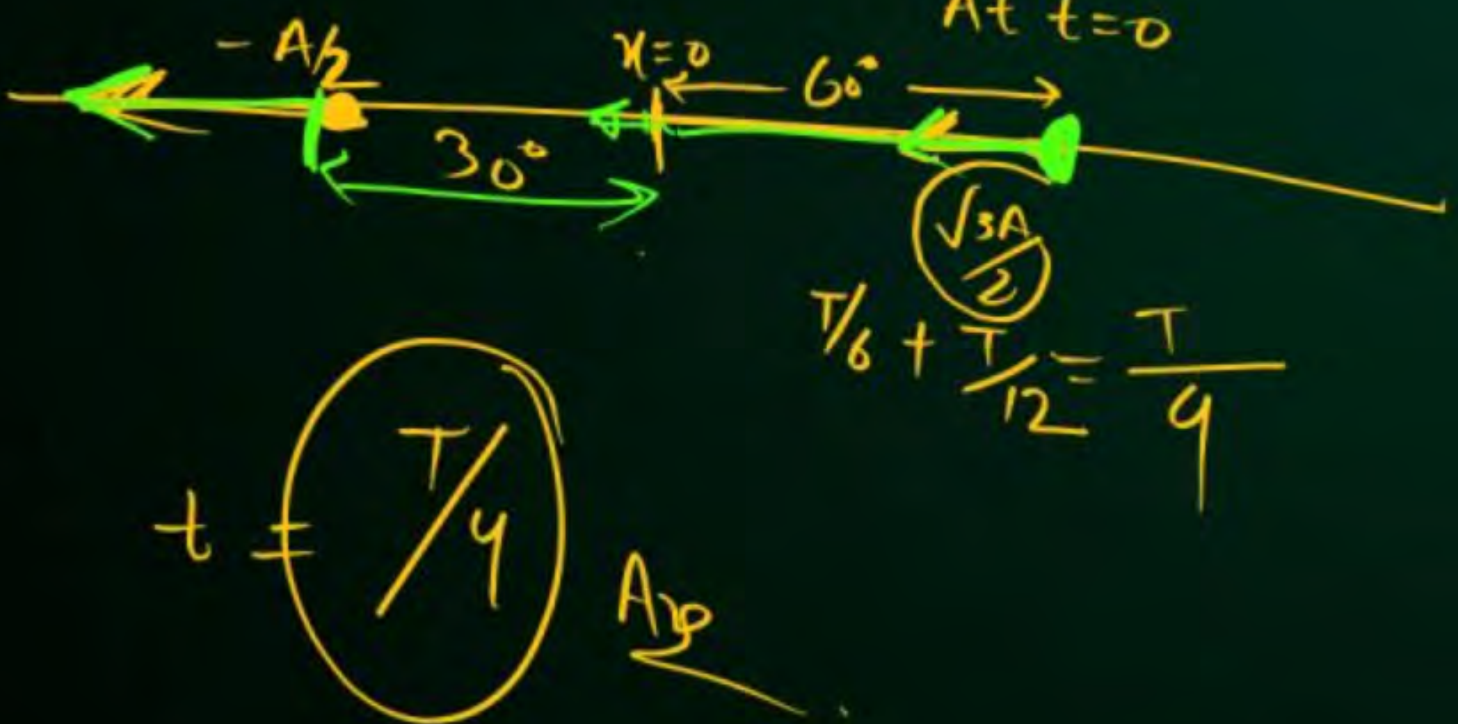
straight line

$$x = A\sin\left(\omega t + \pi/3\right)$$



QUESTION

In SHM if at $t = 0$, $x = \frac{A\sqrt{3}}{2}$ moving towards M.P. Find when it will reach $x = -A/2$ moving away from MP.



QUESTION

A particle is performing SHM with A, ω s.t at $t = 0$ particle is at $x = -A/\sqrt{2}$ moving away from m.p. Find equal of SHM.

$$\pi + \frac{\pi}{4} = \frac{5\pi}{4}$$

$$x = A\sin\left(\omega t + \frac{5\pi}{4}\right)$$

QUESTION

A particle is performing SHM having amplitude A, angular frequency ω s.t. at $t = 0$ particle is at $x = +A/2$ moving towards from m.p. Find equation of SHM.

QUESTION

Two simple harmonic motions of angular frequency 100 and 1000 rad S^{-1} have the same displacement amplitude. The ratio of their maximum accelerations is:

$$\frac{a_{max_1}}{a_{M_2}} = \frac{\omega_1^2 A}{\omega_2^2 A} = \left(\frac{100}{1000}\right)^2$$

1. $1 : 10^3$
2. $1 : 10^4$
3. $1 : 110$
4. $1 : 10^2$ ✓

QUESTION

A particle is in linear simple harmonic motion between two points A and B, 10 cm apart. Take the direction from A to B as the positive direction and given the signs of velocity, acceleration and force on the particle when it is. origin is at mean pos.

(a) At the end A. ($v = 0$, $a_{max} = +\omega^2 A$, $F = +ve$, $x = -A$)

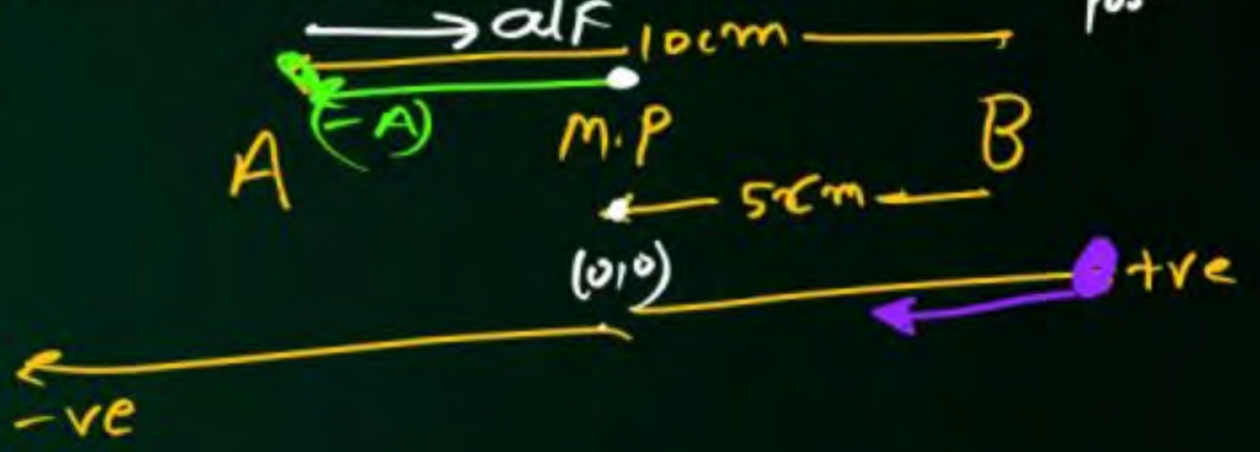
(b) At the end B. ($v = 0$, $a_{max} = -\omega^2 A$, $F = -ve$, $x = +A$)

(c) At the mid-point of AB going towards A.

(d) At 2 cm away from B going towards A.

(e) At 3 cm away from A going towards B.

(f) At 4 cm away from A going towards A.



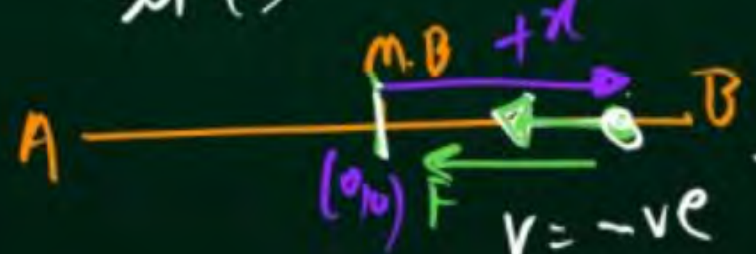
Sol^n (c)



$v_{max} = -ve\ (\omega A)$

$a = 0 \quad F = 0 \quad x = 0$

Sol^n (d)



$v = -ve$

$a = -ve$

$x = +ve$

Sol^n (e)



$x = -ve$

$v = +ve \quad a = +ve$

(f)



$v = -ve$

$a = +ve$

$x = -ve$

$F = +ve$

QUESTION

A particle execute simple harmonic motion according to equation $4\frac{d^2x}{dt^2} + 320\,x = 0$. Its time period of oscillation is

1. $\frac{2\pi}{5\sqrt{3}}$ s
2. $\frac{\pi}{3\sqrt{2}}$ s
3. $\frac{\pi}{2\sqrt{5}}$ s
4. $\frac{2\pi}{\sqrt{3}}$ s

Ans

$4\frac{d^2x}{dt^2} + 320x = 0$

$4a = -320x$

$a = -80x \quad (a = -\omega^2 x)$

$\omega^2 = 80$

$\omega = \frac{2\pi}{T} = \sqrt{80}$

$T = \frac{2\pi}{\sqrt{16\times5}} = \frac{2\pi}{2\times2\sqrt{5}}$

QUESTION

If a simple harmonic oscillator has got a displacement of 0.02 m and acceleration equal to $2.0\ ms^{-2}$ at any time, the angular frequency of the oscillator is equal to

1. $10\ rad\ s^{-1}$
2. $0.1\ rad\ s^{-1}$
3. $100\ rad\ s^{-1}$
4. $1\ rad\ s^{-1}$

QUESTION

A particle is executing a simple harmonic motion. Its maximum acceleration is α and maximum velocity is β. Then, its time period of vibration will be

[Re-AIPMT-2015]

1. $\frac{2\pi\beta}{\alpha}$
2. $\frac{\beta^2}{\alpha^2}$
3. $\frac{\alpha}{\beta}$
4. $\frac{\beta^2}{\alpha}$

$T = \frac{v}{a}$

$a = \frac{\Delta v}{T}$

$T = \frac{v}{a}$

$\alpha = A\omega^2$

$\beta = A\omega$

$\frac{\alpha}{\beta} = \omega = \frac{2\pi}{T}$

$T = \frac{2\pi\beta}{\alpha}$

QUESTION

The distance covered by a particle undergoing SHM in one time period is (amplitude = A),

1. 4A
2. Zero
3. A
4. 2A

QUESTION

$v = A\omega\cos(\omega t)$

$v = \omega\sqrt{A^2 - x^2}$

A particle is executing S.H.M. with amplitude A and has maximum velocity v_0. Its speed at displacement $\frac{3A}{4}$ will be $v = ??$

$x = \frac{3A}{4}$

1. $\frac{\sqrt{7}}{4} v_0$ Ans

2. $\frac{v_0}{\sqrt{2}}$

3. v_0

4. $\frac{\sqrt{3}}{2} v_0$

$v = \omega\sqrt{A^2 - \frac{9A^2}{16}}$

$= \omega A\sqrt{1 - \frac{9}{16}}$

$= V_0\sqrt{\frac{16-9}{16}}$

$= \frac{v_0\sqrt{7}}{4}$

QUESTION

Which one of the following statements is true for the velocity v and the acceleration a of a particle executing simple harmonic motion?

1. When v is maximum, a is zero. (at mean)
2. When v is zero, a is zero.
3. When v is maximum, a is maximum.
4. Value of a is zero, whatever may be the value of v.

QUESTION

For a particle executing simple harmonic motion, the amplitude is A and time period is T. The maximum speed will be

1. $4AT$

2. $\frac{2A}{T}$

3. 2π

4. $\frac{2\pi A}{T}$

$V_{max} = A\omega$

$= \frac{A 2\pi}{T}$

QUESTION

A body is executing SHM when its displacement from the mean position is 4 cm and 5 cm the corresponding velocity of the body is 10 cm/sec and 8 cm/sec. Then the time period of the body is

1. 2π sec
2. $\pi/2$ sec
3. π sec
4. $3\pi/2$ sec

$V_1 = \omega\sqrt{A^2 - x_1^2}$

$V_2 = \omega\sqrt{A^2 - x_2^2}$

H/W

QUESTION

H/W → hint

A particle is executing SHM along a straight line. Its velocities at distance x_1 and x_2 from the mean position are V_1 and V_2 respectively. Its time period is

[AIPMT-2015]

(1) $2\pi\sqrt{\frac{V_1^2 - V_2^2}{x_1^2 - x_2^2}}$

(2) $2\pi\sqrt{\frac{x_1^2 + x_2^2}{V_1^2 + V_2^2}}$

(3) $2\pi\sqrt{\frac{x_1^2 - x_2^2}{V_1^2 - V_2^2}}$

(4) $2\pi\sqrt{\frac{V_1^2 + V_2^2}{x_1^2 + x_2^2}}$

$x_1 \rightarrow v_1$

$x_2 \rightarrow v_2$

$v_1 = \omega\sqrt{A^2 - x_1^2}$

$\left(\frac{v_1}{\omega}\right)^2 = A^2 - x^2$

$\left(\frac{v_1}{\omega}\right)^2 + x_1^2 = A^2 = \left(\frac{v_2}{\omega}\right)^2 + x_2^2$

H/W

$\frac{v_1^2}{\omega^2} - \frac{v_2^2}{\omega^2} = x_2^2 - x_1^2$

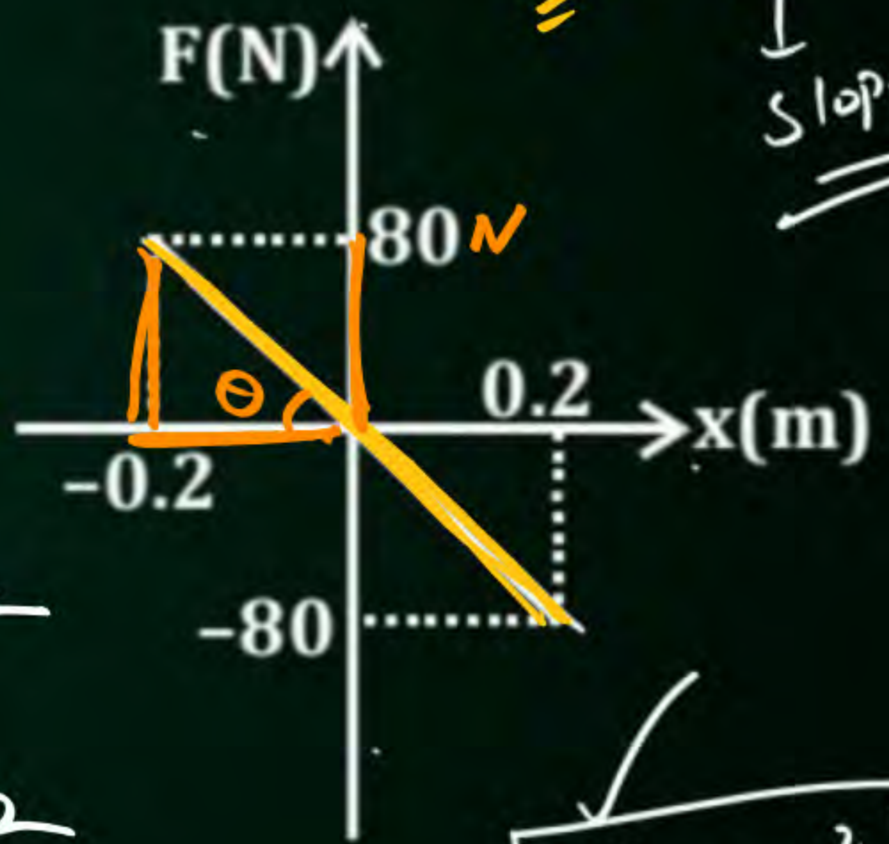
$\frac{v_1^2 - v_2^2}{x_2^2 - x_1^2} = \omega^2 = \left(\frac{2\pi}{T}\right)^2$

$T = 2\pi\sqrt{\frac{x_2^2 - x_1^2}{v_1^2 - v_2^2}}$

QUESTION

A body of mass 0.01 kg executes simple harmonic motion about $x = 0$ under the influence of a force as shown in figure, The time period of SHM is

1. 1.05 s
2. 0.52 s
3. 0.25 s
4. 0.03 s



QUESTION

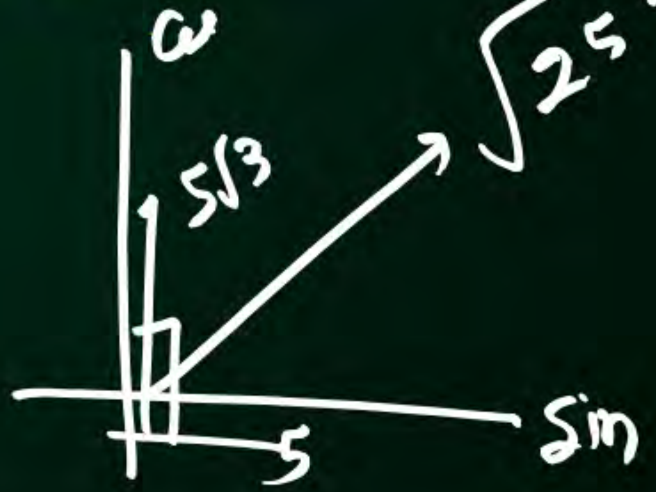
A particle is executing SHM about y = 0 along y-axis. Its position at an instant is given by $y(m) = 5(\sin 3\pi t + \sqrt{3}\cos 3\pi t)$. The amplitude of oscillation is

1. 10 m ✓
2. 5 m
3. $5(1 + \sqrt{3})$ m
4. $5\sqrt{3}$ m

$y = 5[\sin 3\pi t + \sqrt{3}\cos 3\pi t]$

$= 5\sin(3\pi t) + 5\sqrt{3}\cos(3\pi t)$

$\sqrt{25 + 25\times 3} = \sqrt{25+75} = \sqrt{100} = 10$

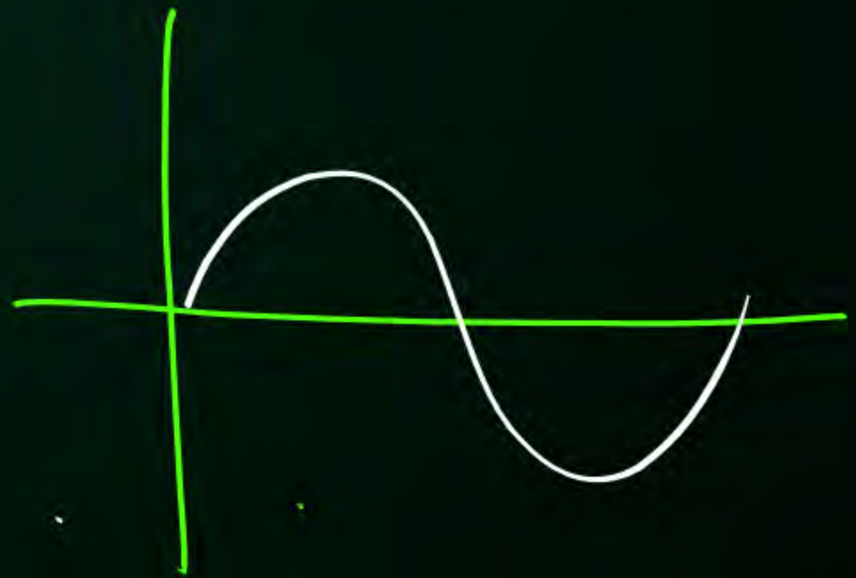


QUESTION



Particle executing SHM along y-axis has its motion described by the equation $y = 2 + 10 \sin 5\pi t$. Amplitude of SHM is

1. 2
2. 12
3. 10
4. $\sqrt{104}$



QUESTION

A simple pendulum performs simple harmonic motion about $x = 0$ with an amplitude a and time period t. The speed of the pendulum at $x = \frac{a}{2}$ will be

[AIPMT-2009]

1. $\frac{\pi a}{T}$
2. $\frac{3\pi^2 a}{T}$
3. $\frac{\pi a\sqrt{3}}{T}$
4. $\frac{\pi a\sqrt{3}}{2T}$

$$V = \omega\sqrt{A^2 - x^2}$$

$$V = \omega\sqrt{a^2 - \frac{a^2}{4}}$$

$$= \frac{2\pi}{T}\sqrt{\frac{3a^2}{4}} = \frac{2\sqrt{3}\pi a}{2T}$$

QUESTION

A particle executes linear simple harmonic motion with an amplitude of 3 cm. When the particle is at 2 cm from the mean position, the magnitude of its velocity is equal to that of its acceleration. Then its time period in seconds is

[NEET - 2017]

1. $\frac{\sqrt{5}}{\pi}$
2. $\frac{\sqrt{5}}{2\pi}$
3. $\frac{4\pi}{\sqrt{5}}$
4. $\frac{2\pi}{\sqrt{3}}$

QUESTION

The displacements of two particles executing SHM on the same line are given as $y_1 = a\sin\left(\frac{\pi}{2}t + \theta\right)$ and $y_2 = b\sin\left(\frac{2\pi}{3}t + \theta\right)$. The phase difference between them at t = 1s is

1. π
2. $\frac{\pi}{2}$
3. $\frac{\pi}{4}$
4. $\frac{\pi}{6}$ ✓

$\phi_1 = \frac{\pi}{2} + \theta$

$\phi_2 = \frac{2\pi}{3} + \theta$

$\Delta\phi = \frac{2\pi}{3} + \theta - \frac{\pi}{2} - \theta$

$= \frac{2\pi}{3} - \frac{\pi}{2}$

$= \frac{4\pi - 3\pi}{6} = \pi/6$

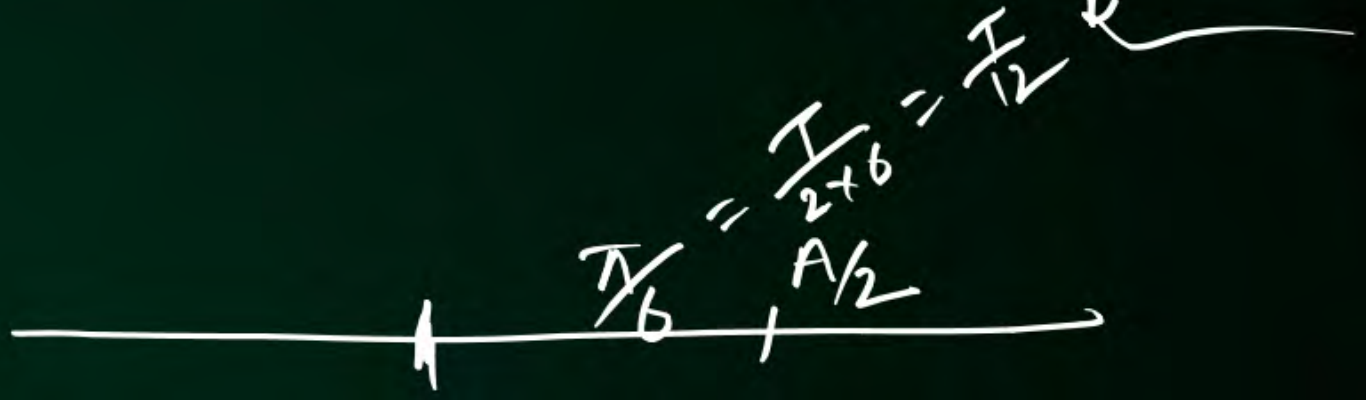
QUESTION

The shape of graph plotted between velocity and position of a particle executing simple harmonic motion is

1. A straight line
2. An ellipse
3. A parabola
4. A hyperbola

QUESTION

Motion starts from mean position then find time taken from $x = 0$ to $x = \frac{A}{2}$.



QUESTION

Displacement of a particle executing SHM is represented by $Y = 0.08 \sin(3\pi t + \pi/4)$ metre. Then calculate:

(a) Time period $\frac{2}{3}$

(b) Initial phase $\pi/4$

(c) Displacement from mean position at $t =$ [redacted] sec.

$\omega = 3\pi = \frac{2\pi}{T}$

$T = \frac{2}{3}$ sec

$$Y = 0.08 \sin\left(3\pi t + \frac{\pi}{4}\right)$$

$$= 0.08 \sin\left(3\pi \frac{1}{4} + \frac{\pi}{4}\right)$$

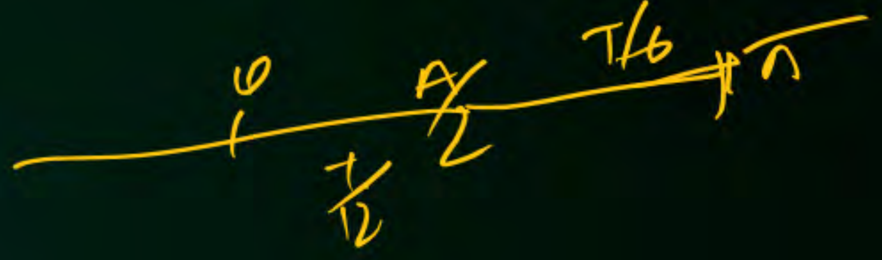
$$= 0.08 \sin\left(\frac{4\pi}{4}\right)$$

$$Y = 0$$

QUESTION

Motion starts from mean position then find time taken from $x = \frac{A}{2}$ to $x = A$.

T/6



QUESTION

Object moves from mean to half of the extreme ($x = A/2$) then phase of that time 't'. $\pi/6$

$t = \frac{T}{360^\circ} \times \theta$

QUESTION

Find time taken from mean to $x = \frac{A}{\sqrt{2}}$ $\left(T/8\right)$

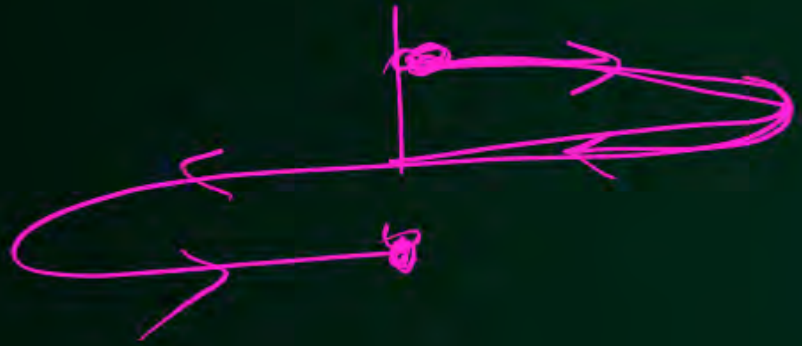
QUESTION

A particle is executing S.H.M. between $x = \pm A$. The time taken to go from 0 to $\frac{A}{2}$ is T_1 and to go from $\frac{A}{2}$ to A is T_2; then

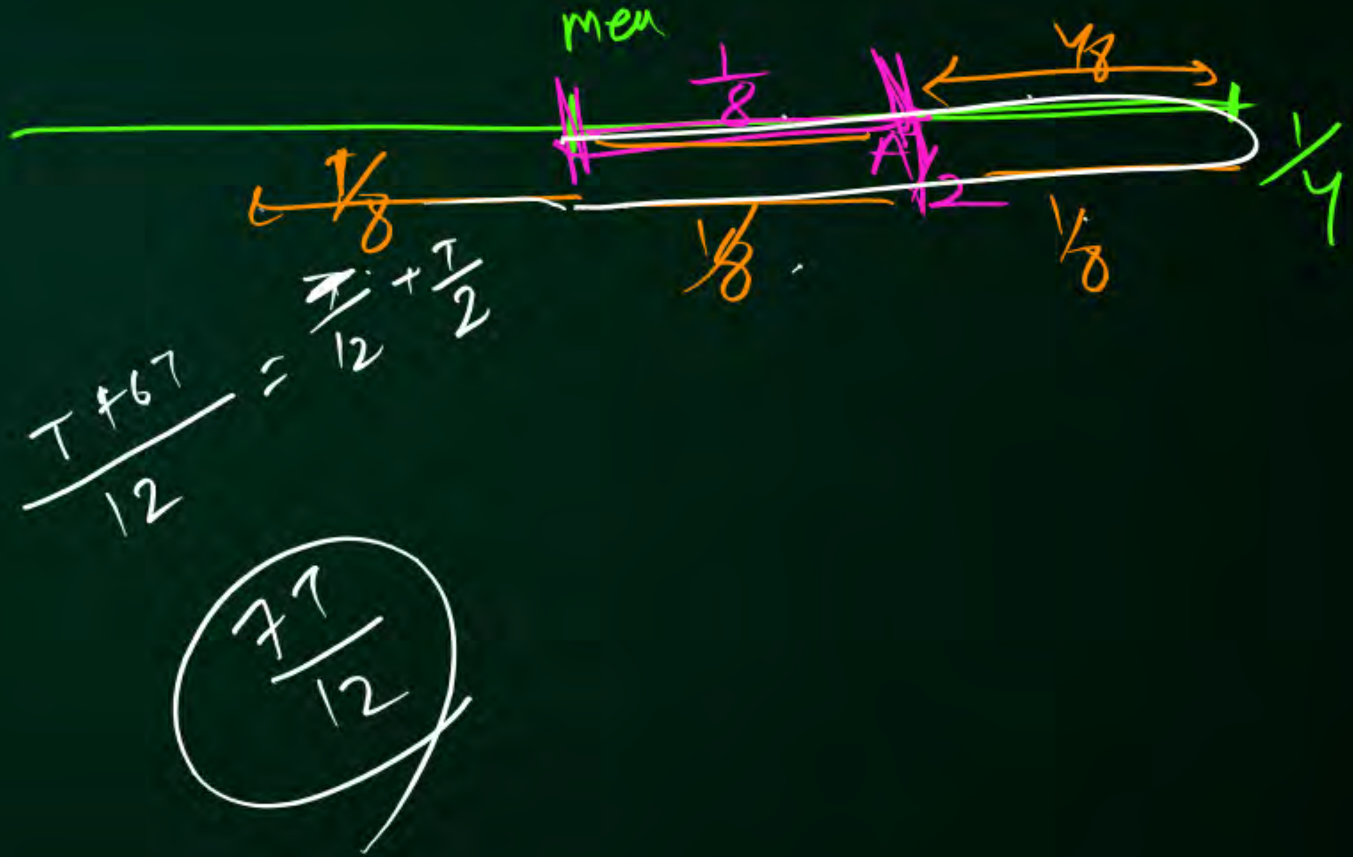
1. $T_1 < T_2$
2. $T_1 > T_2$
3. $T_1 = T_2$
4. $T_1 = 2T_2$

QUESTION

A particle is executing SHM with time period T. Starting from mean position, time taken by it to complete $\frac{5}{8}$ oscillations, is



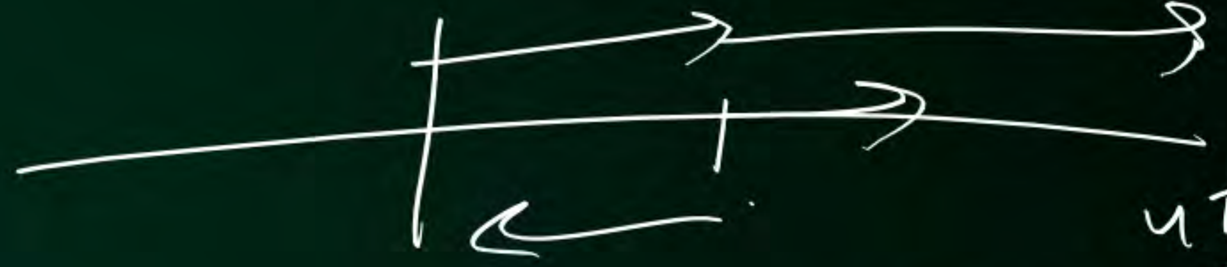
1. $\frac{T}{12}$
2. $\frac{T}{6}$
3. $\frac{5T}{12}$
4. $\frac{7T}{12}$



QUESTION

Two particles executing SHM of same frequency, meet at $x = +A/2$, while moving in opposite directions. Phase difference between the particles is

1. $\frac{\pi}{6}$
2. $\frac{\pi}{3}$
3. $\frac{5\pi}{6}$
4. $\frac{2\pi}{3}$



$$\frac{5\pi}{6} - \frac{\pi}{6} = \frac{4\pi}{6} = \frac{2\pi}{3}$$

QUESTION

The potential energy of a particle of mass 100 g moving along x-axis is given by U = $5x(x-4)$, where x is in metre. The period of oscillation is

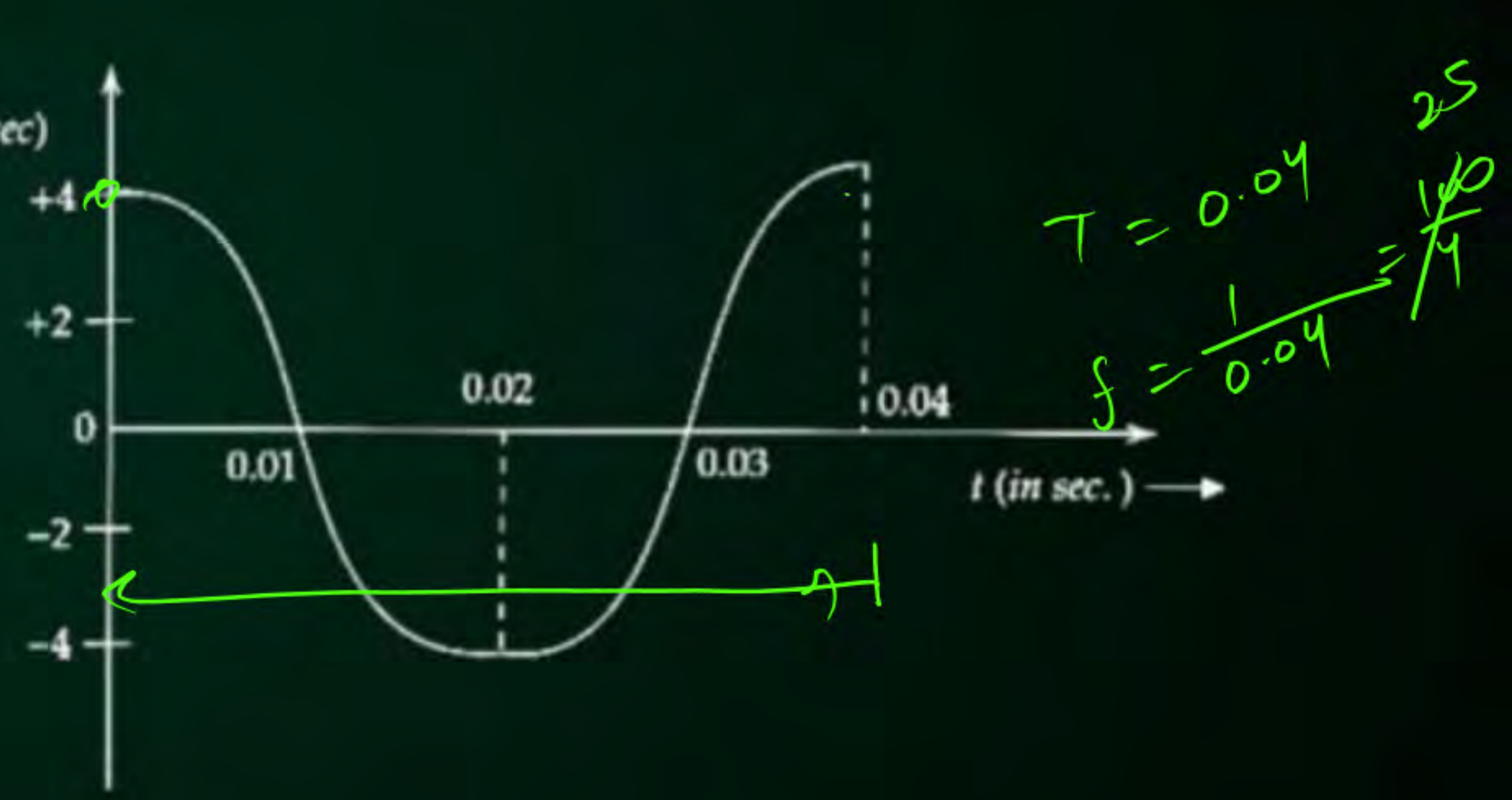
1. 0.2π s
2. 0.1π s
3. π s
4. $\frac{1}{\pi}$ s

We will do it in next class

QUESTION

The velocity-time diagram of a harmonic oscillator is shown in the adjoining figure. The frequency of oscillation is:

1. 25 Hz
2. 50 Hz
3. 12.25 Hz
4. 33.3 Hz



QUESTION

The displacement of a particle in SHM is indicated by equation $y = 10 \sin(20t + \pi/3)$ where y is in metres. The value of time period of vibration will be (in seconds):

1. $10/\pi$
2. $\pi/10$ ✓
3. $2\pi/10$
4. $10/2\pi$

$\frac{2\pi}{T} = 20$

$T = \frac{\pi}{10}$

QUESTION

A particle oscillates along the x-axis according to equation $x = 0.05 \sin(5t - \pi/6)$ where x is in metre and t is in second. Find its velocity at $t = 0$ second.

$$V = 0.05 \cos(5t - \pi/6) \times 5$$

$$V = \frac{5}{100} \times 5 \cos(-\pi/6)$$

$$= \frac{1}{4} \frac{\sqrt{3}}{2}$$

$$\cos(-\theta) = \cos\theta$$

$$V = \frac{\sqrt{3}}{8} \text{ m/s}$$

H/W

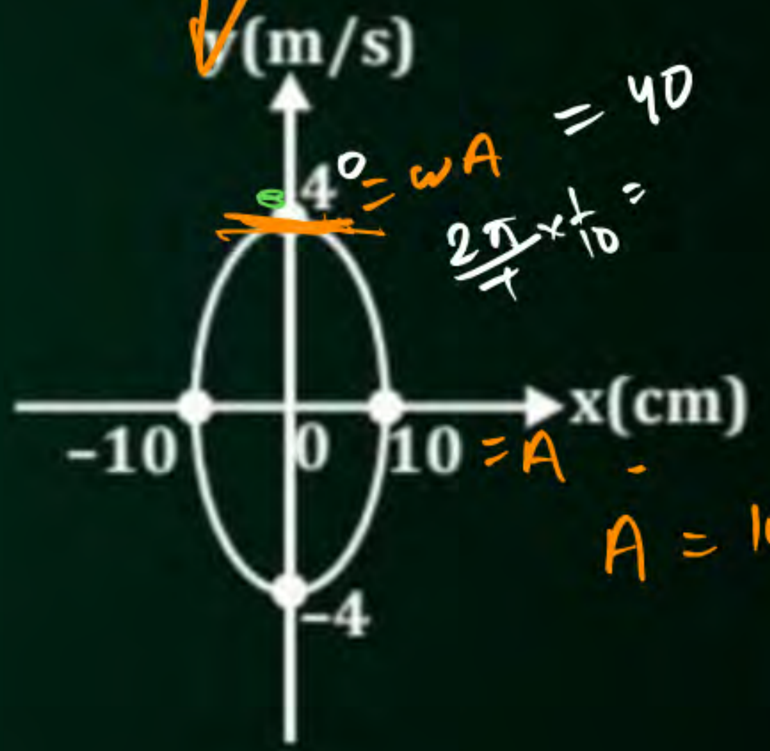
Soln

DPP

QUESTION

The plot of velocity (v) versus displacement (x) of a particle executing simple harmonic motion is shown in figure. The time period of oscillation of particle is

1. $\frac{\pi}{2}$ s
2. π s
3. 2π s
4. 3π s




THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 04 | Physics

Simple Harmonic Motion



By- Dr. Manish Raj (MR SIR)

Topics to be covered

1. # K.E / P.E / Total
2. #
3. #



$\sin\theta \pm \sin(\omega t)$

\# $\sin^2\theta + \cos^2\theta = 1$

\# $\sin^2\theta = 1 - \cos^2\theta$

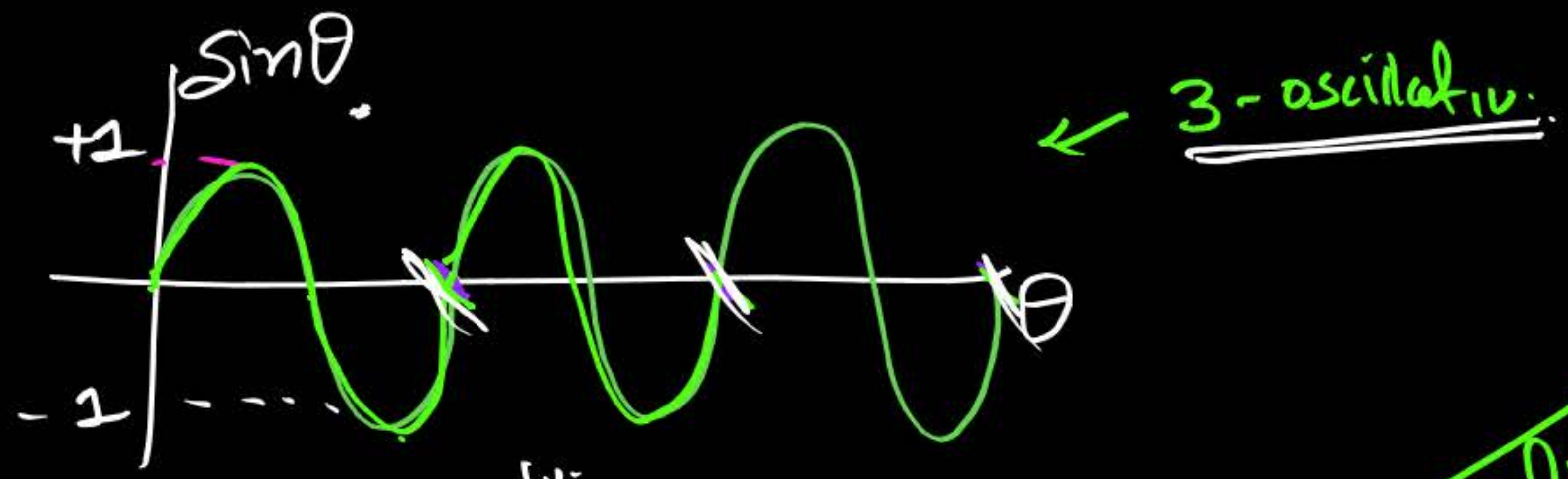
\# $\sin(2\theta) = 2\sin\theta \cdot \cos\theta$

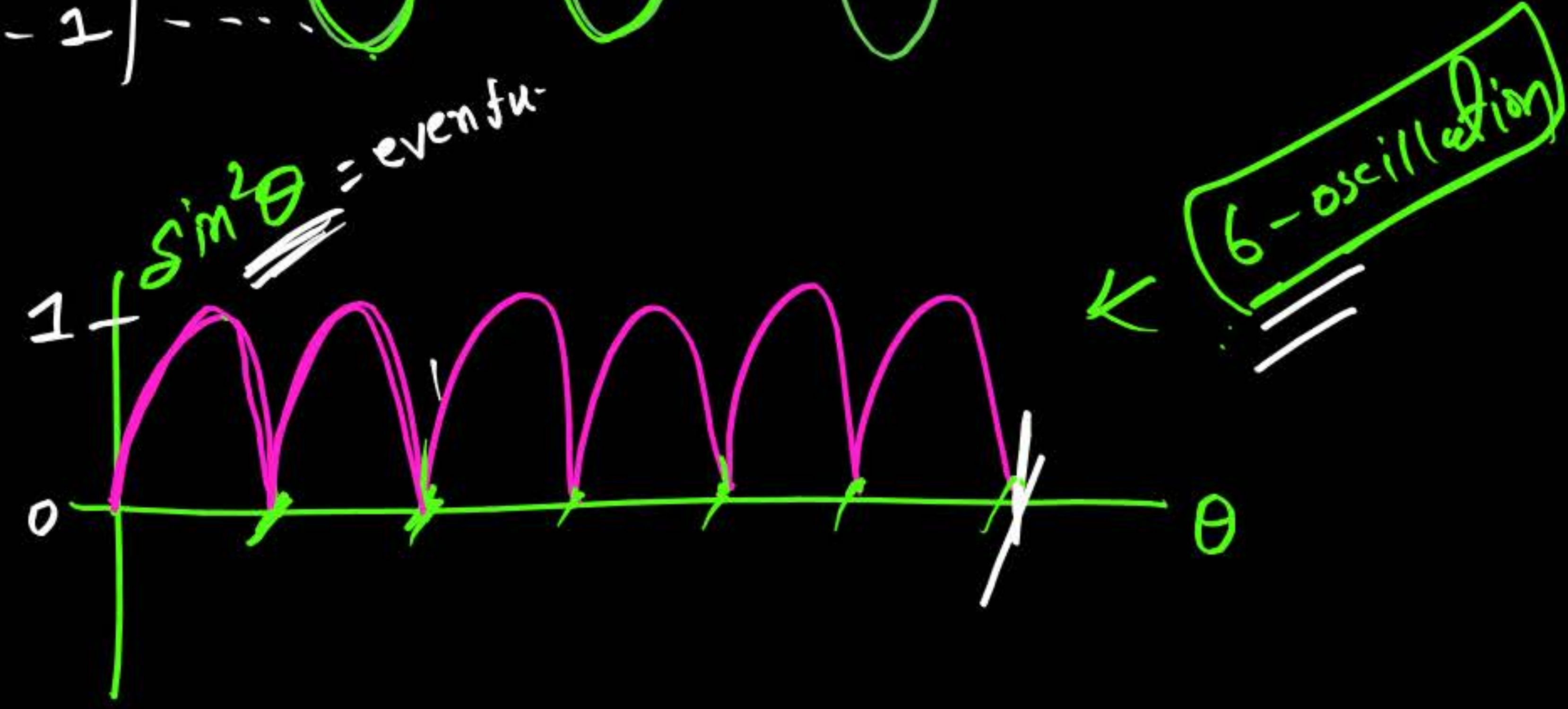
\# $\cos(2\theta) = \cos^2\theta - \sin^2\theta$

$\cos(2\theta) = 2\cos^2\theta - 1$

* $$\frac{1+\cos(2\theta)}{2} = \cos^2\theta$$

$$\frac{1-\cos(2\theta)}{2} = \sin^2\theta$$





$$y = A\sin^2(\omega t)$$

→ this function is Periodic but not oscillating

→ If asking (about function)

$$y = A\sin^2(\omega t) = A\left[\frac{1-\cos(2\omega t)}{2}\right]$$

Position of Particle

$$y = \frac{A}{2} - \frac{A\cos(2\omega t)}{2}$$

→ Particle S.H.M kar raha hai with Angular frequency $= 2\omega$

NEET

$y = A + B\sin(\omega t)$ → S.H.M with amplitude (B).

$y = A\sin(\omega t) + B\cos(\omega t)$ → S.H.M with amplitude $\sqrt{A^2+B^2}$

$y = A\sin(\omega t) + B\sin(\omega t)$ → S.H.M with amplitude $(A+B)$

$y = A\sin^2(\omega t)$ → S.H.M with with frequency $(2f)$ Amplitude $\left(\frac{A}{2}\right)$

$y = A\sin(2\omega t) + B\cos(\omega t)$ → Not a S.H.M

$y = A\tan\theta$ → No S.H.M

$y = A\sin^3\omega t$ → Not a S.H.M

$y = A\sin(2\omega t)$ — Yes S.H.M

$y = A\sin(3\omega t) + A\sin(2\omega t)$ — NO S.H.M

KINETIC ENERGY of S.H.M

$V = A\omega \cos(\omega t)$ — (I)

$V = \omega\sqrt{A^2 - x^2}$ — (II)

$K = m\omega^2$

$K.E = \frac{1}{2} m (v)^2$

$K.E = \frac{1}{2} m (A\omega \cos \omega t)^2$

$K.E = \frac{1}{2} m A^2 \omega^2 \cos^2(\omega t)$

$K.E = \frac{1}{2} K A^2 \cos^2(\omega t)$

$t = 0$
at mean Positio

$K.E = \frac{1}{2} K A^2$
mean
Maximu

$t = T/4$

$K.E = \frac{1}{2} K A^2 \cos\left(\frac{2\pi}{T} \cdot \frac{T}{4}\right)$

$K.E_{min} = 0$
extrem

$K.E = \frac{1}{2} m v^2$

$= \frac{1}{2} m \omega^2 (A^2 - x^2)$

$K.E = \frac{1}{2} K (A^2 - x^2)$

$x = 0$

$K.E_{mean} = \frac{1}{2} K A^2$
Maximum

$x = A$
extrem Posi

$K.E = \frac{1}{2} K (A^2 - A^2)$

$K.E = 0$
minimu.

K.E can't be -ve
→ Scalar

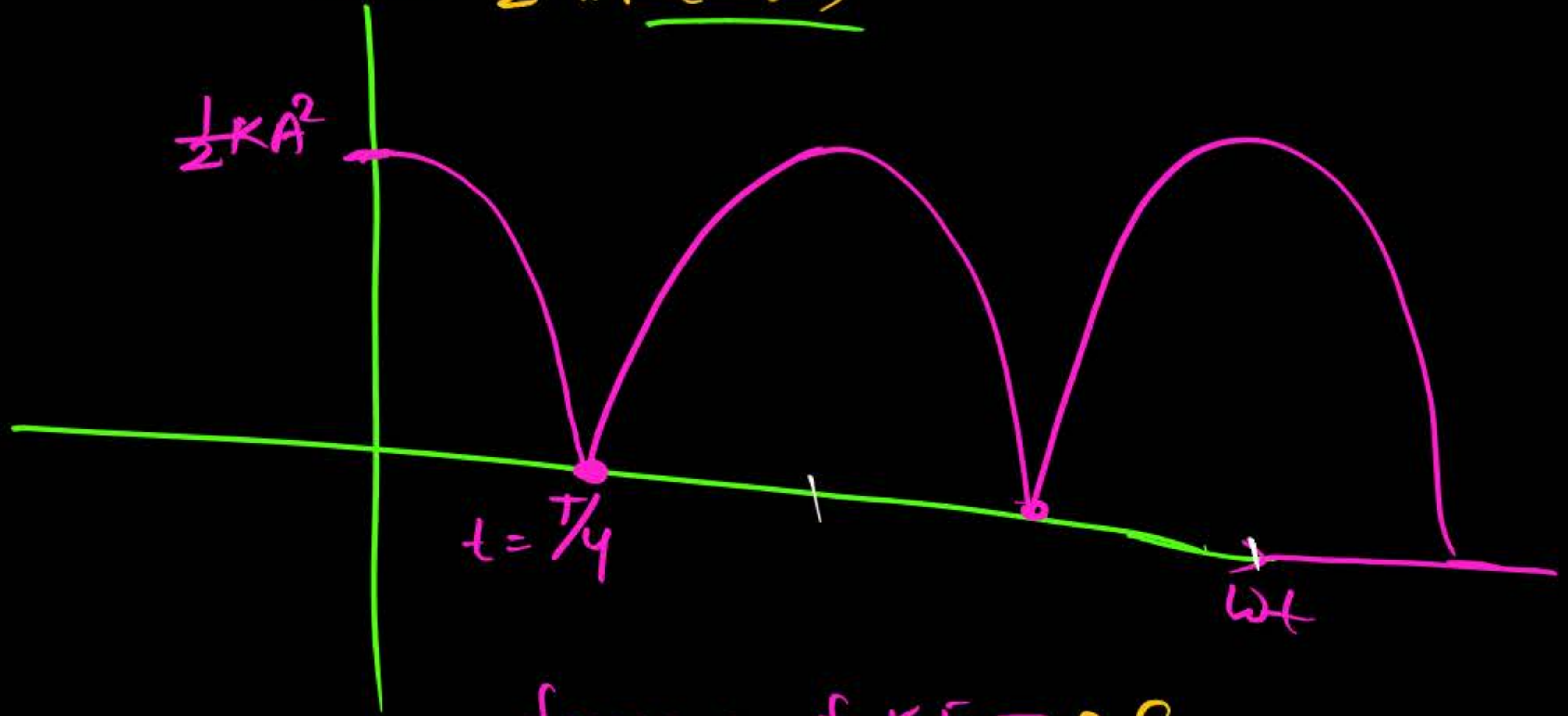
$K.E_{minimum} = 0$

$K.E_{max} = \frac{1}{2} K A^2$

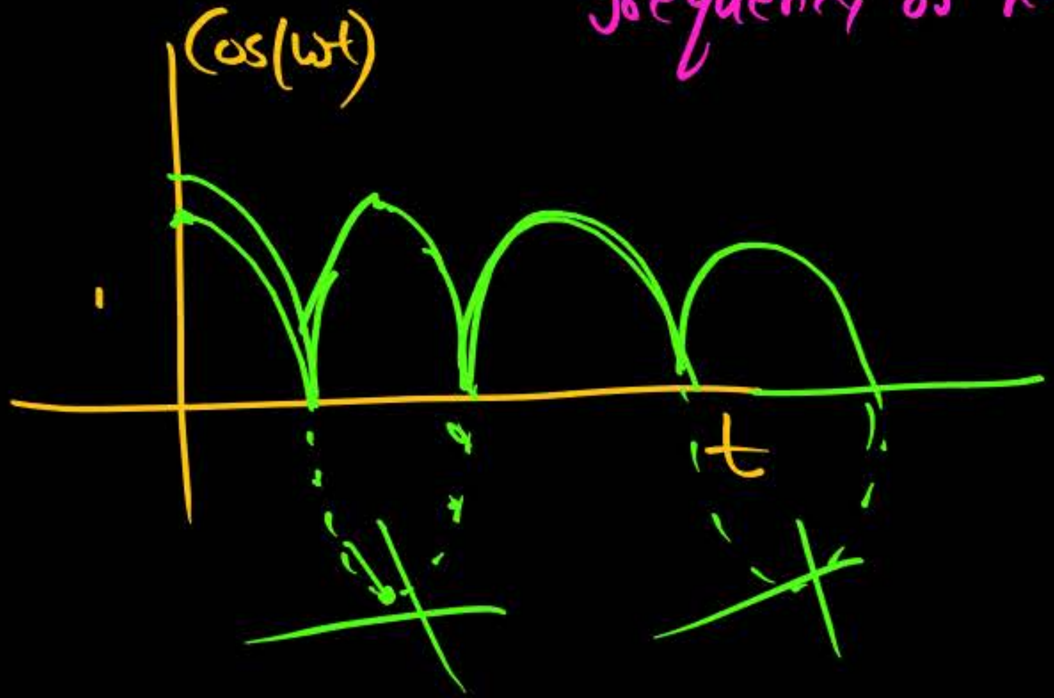
$$K.E = \frac{1}{2} K A^2 \cos^2(\omega t)$$

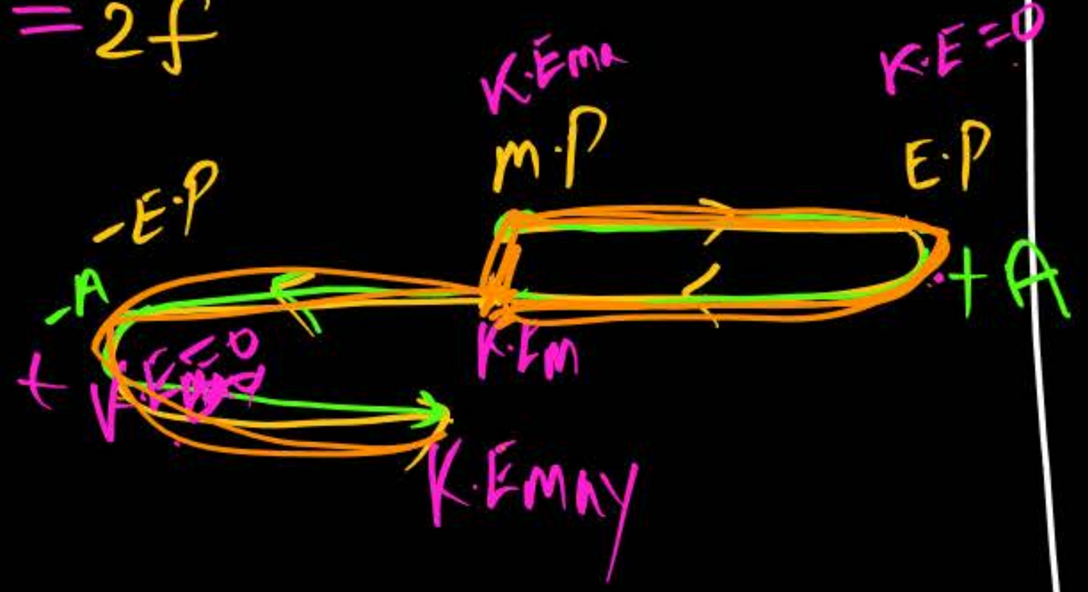
$$K.E = \frac{1}{2} K A^2 \cos^2(\omega t)$$

NEET-21



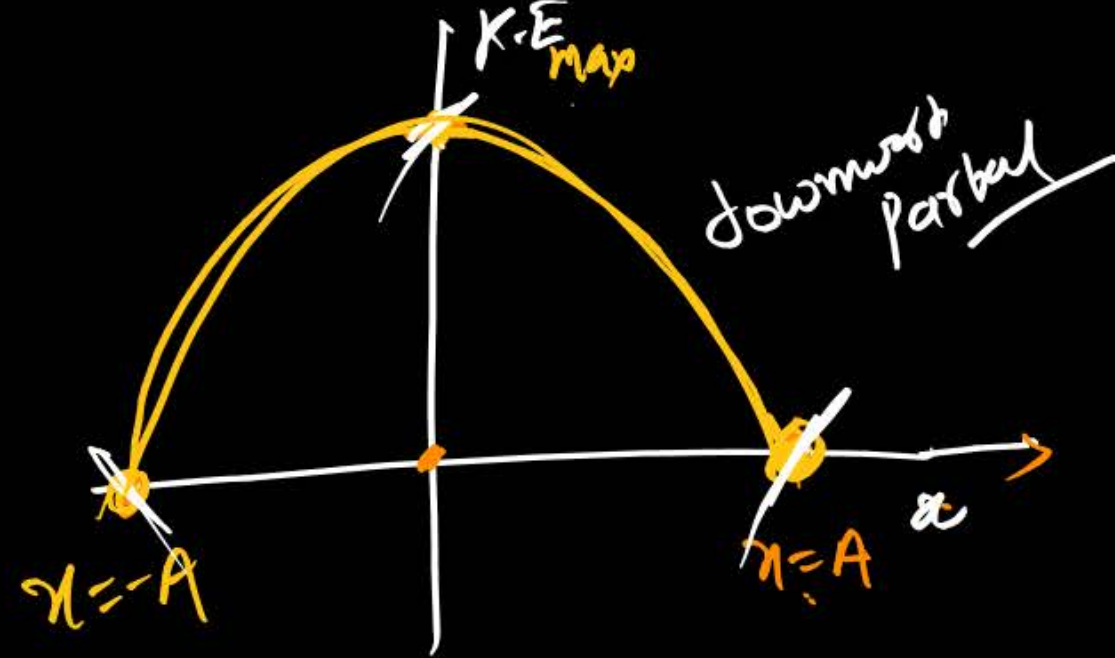
frequency of $K.E = 2f$





$$K.E = \frac{1}{2} K(A^2 - x^2)$$

$$K.E \propto -x^2$$



Potential energy

$U = \frac{1}{2} K x^2$ (ref^n of P.E at mean)

$U = \frac{1}{2} K (A \sin(\omega t))^2$

$U = \frac{1}{2} K A^2 \sin^2(\omega t)$

$K.E = \frac{1}{2} K A^2 \cos^2(\omega t)$

$M.E (T.E) = K.E + P.E$

$= \frac{1}{2} K A^2 \left[\cos^2(\omega t) + \sin^2(\omega t)\right]$

$K.E + U =$ $M.E = \frac{1}{2} K \cdot A^2$ = Conserved

S.H.M

$F = -Kx$

$+\frac{dU}{dx} = +Kx$

$\int_{U=0}^{U} dU = \int_{x=0}^{x} Kx \, dx$

$U = \frac{1}{2} K x^2$

$K.E = \frac{1}{2} K (A^2 - x^2)$

$P.E = \frac{1}{2} K x^2$

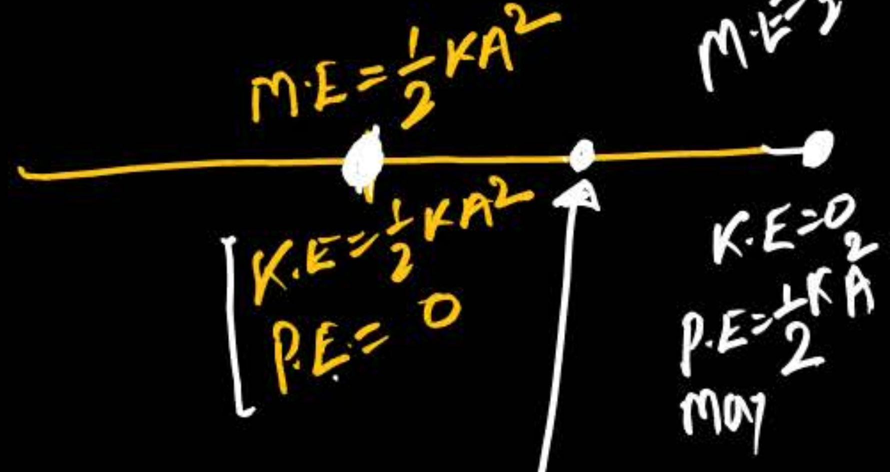
$M.E = \frac{1}{2} K (A^2 - x^2) + \frac{1}{2} K x^2$

$M.E = \frac{1}{2} K A^2 - \frac{1}{2} K x^2 + \frac{1}{2} K x^2$

$M.E = \frac{1}{2} K A^2$

K.E & P.E depends on time & Position but M.E remains cost^n

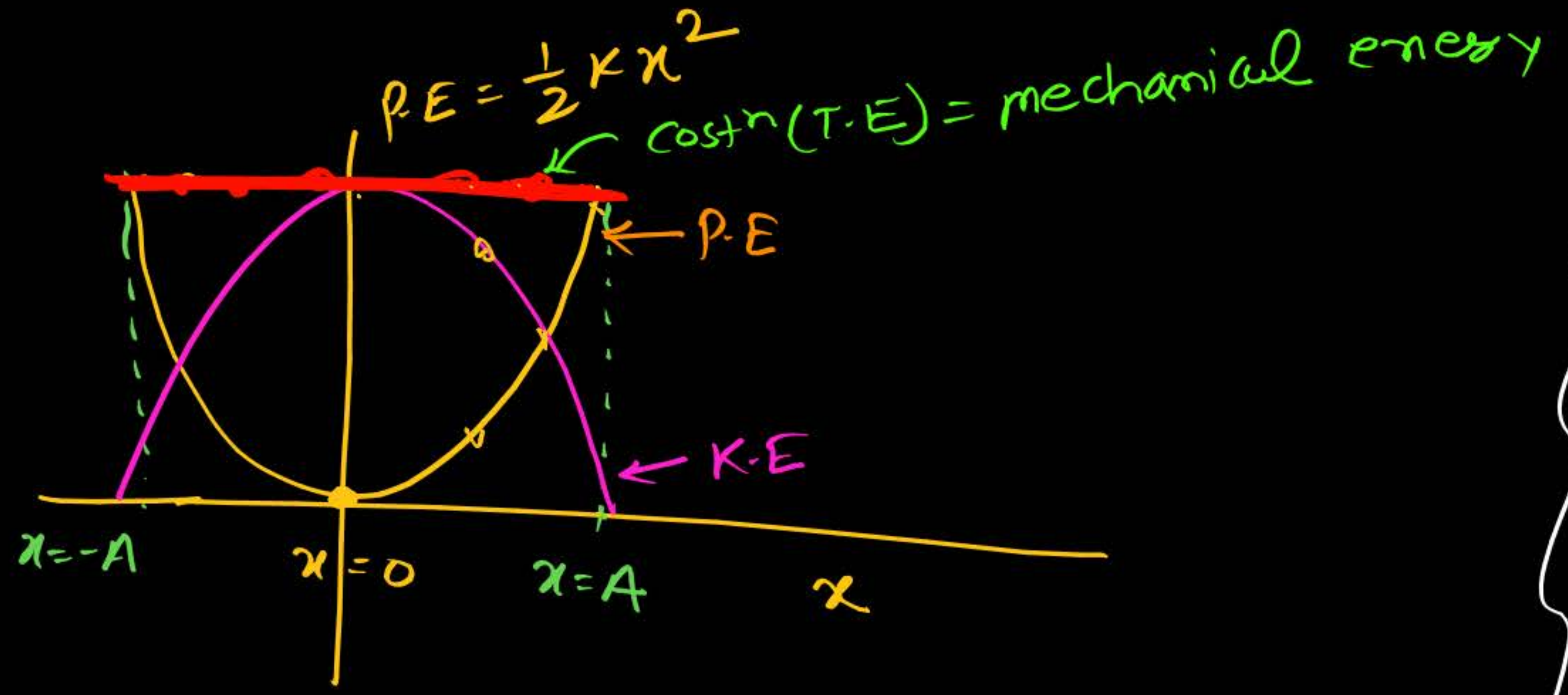
M.E. is Not a function of time & position



B/w extreme & mean

$K.E + P.E = M.E$

$K.E \uparrow + P.E \downarrow = \frac{1}{2} K A^2$



frequency of oscillation = f

frequecy of P.E = 2f

frequecy of m.E = 0

Level up

If ref^n Potential energy at mean position is U_0

$$(P.E) = U_0 + \frac{1}{2}Kx^2$$

$U_{min} = U_0$ (mean)

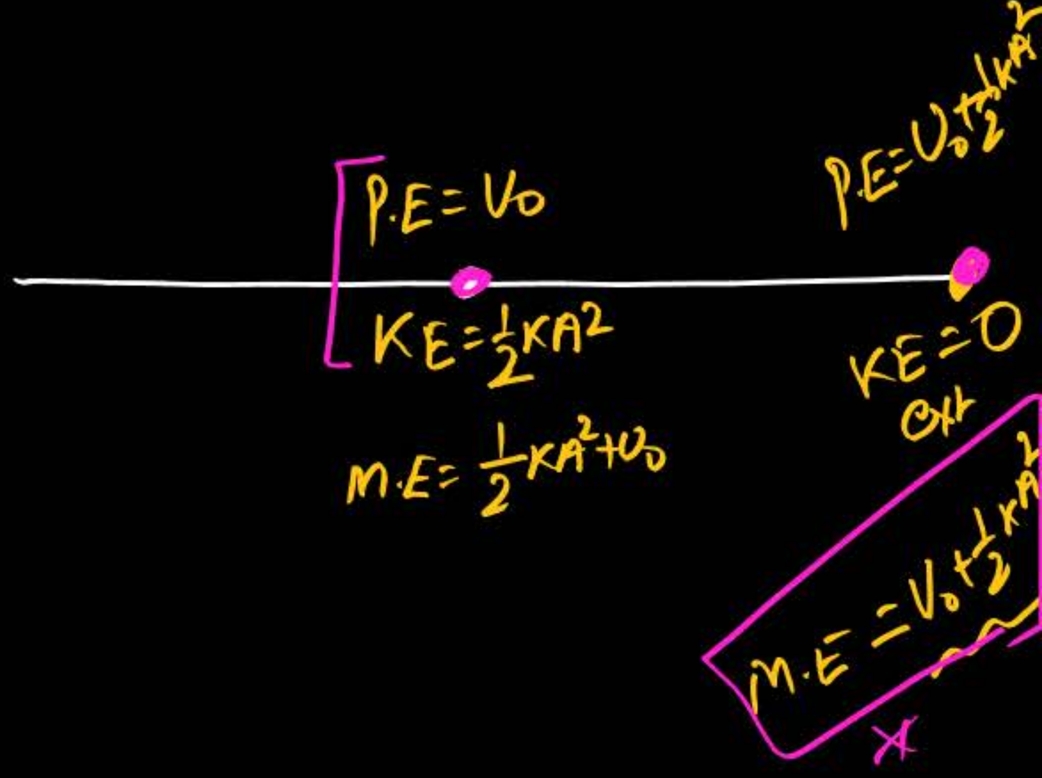
$U_{max} = U_0 + \frac{1}{2}KA^2$ (extn)

$$K.E = \frac{1}{2}K(A^2 - x^2)$$

$$M.E = P.E + K.E$$

$$= \frac{1}{2}K(A^2 - x^2) + U_0 + \frac{1}{2}Kx^2$$

$$M.E = \frac{1}{2}KA^2 + U_0 = C_{ot}^n$$



QUESTION

The kinetic energy and potential energy of a particle executing S.H.M. are equal, when displacement in terms of amplitude 'A' is

1. $\frac{A}{2}$
2. $\frac{A}{\sqrt{2}}$ ✓
3. $\frac{A\sqrt{2}}{3}$
4. $A\sqrt{2}$

$K.E = P.E$ (equal)

$\frac{1}{2}K(A^2 - x^2) = \frac{1}{2}Kx^2$

$A^2 - x^2 = x^2$

$A^2 = 2x^2$

$x = \sqrt{\frac{A^2}{2}} = \frac{A}{\sqrt{2}}$ (Ans)

$K.E + P.E = \frac{1}{2}KA^2$ (M.E)

Given in ques (K.E = P.E)

$2\,P.E = \frac{1}{2}KA^2$

$2 \cdot \frac{1}{2}Kx^2 = \frac{1}{2}KA^2$

$x = \sqrt{\frac{A^2}{2}} = \frac{A}{\sqrt{2}}$

Ans

QUESTION

A body is executing SHM with amplitude a and time period T. The ratio of kinetic and potential energy when displacement from the equilibrium position is half the amplitude

1. 1 : 1
2. 2 : 1
3. 1 : 3
4. 3 : 1

Ans

$x = A/2$

$K.E + P.E = \frac{1}{2}kA^2$

divided by P.E both side

$\left(\frac{K.E}{P.E}\right) + 1 = \frac{\frac{1}{2}kA^2}{\frac{1}{2}kx^2}$

$\frac{K.E}{P.E} = \frac{A^2}{\left(\frac{A}{2}\right)^2} - 1$

$= \frac{A^2}{\frac{A^2}{4}} - 1$

$= 4 - 1 = 3$

$\frac{K.E}{P.E} = \frac{\frac{1}{2}k\left(A^2 - \frac{A^2}{4}\right)}{\frac{1}{2}k\left(\frac{A^2}{4}\right)} = \frac{\frac{3A^2}{4}}{\frac{A^2}{4}} = \frac{3}{1}$

QUESTION

At what displacement the kinetic energy is half of the potential energy?

$$K.E = \frac{P.E}{2}$$

$$\frac{1}{2}K(A^2 - x^2) = \frac{1}{2}\left(\frac{1}{2}Kx^2\right)$$

$$A^2 - x^2 = \frac{x^2}{2}$$

$$A^2 = \frac{x^2}{2} + x^2$$

$$A^2 = \frac{3}{2}x^2$$

$$x = \sqrt{\frac{2}{3}}A$$

$$x = \sqrt{\frac{3}{2}}A$$

wrong

$$K.E + P.E = \frac{1}{2}Kx^2$$

$$\frac{P.E}{2} + P.E = \frac{1}{2}KA^2$$

$$\frac{3}{2}P.E = \frac{3}{2}\cdot\frac{1}{2}Kx^2 = \frac{1}{2}KA^2$$

$$x = \sqrt{\frac{2}{3}}A$$

find position where K.E is half of total enegy ??

$$K.E = \frac{1}{2} T.E$$

$$\frac{1}{2}K(A^2 - x^2) = \frac{1}{2}\left(\frac{1}{2}KA^2\right)$$

$$A^2 - x^2 = \frac{A^2}{2}$$

$$A^2 - \frac{A^2}{2} = x^2$$

$$\boxed{x = \frac{A}{\sqrt{2}}}$$

QUESTION

A linear harmonic oscillator of force constant 6×10^5 N/m and amplitude 4 cm, has a total energy 600 J. Select the correct statement.

1. Maximum potential energy is 600 J
2. Maximum kinetic energy is 480 J
3. Minimum potential energy is 120 J
4. All of these

at extm: $K.E + P.E_{max} = \frac{1}{2}KA^2 + 0 = M.E$

at extrem: $U_{max} = U_0 + \frac{1}{2}KA^2 = M.E$, $K.E = 0$

$K = 6 \times 10^5$ N/m

$K.E_{max} = \frac{1}{2}KA^2 = \frac{1}{2} 6 \times 10^5 (4 \times 10^{-2})^2 = 3 \times 10^5 \times 16 \times 10^{-4} = 480$ J

U_0 (let)

at mean point

$K.E_{max} = 480$ J at mean

$K.E_{max} + U_{min} = T.E (ME)$

$480 + U_{min} = 600$

$U_{min} = 600 - 480 = 120$ J at n

$K.E_{max} = \frac{1}{2}KA^2$

$P.E(U)_{max} = \frac{1}{2}KA^2 + U_0$

QUESTION

At the time $t = 0$, the particle is at its mean position, then at what times, the particle will have potential energy 50% of its total energy within $t = 0$ to $t = T$?

$\frac{1}{2} k x^2 = \frac{1}{2} k \frac{A^2}{2}$

$x = \frac{A}{\sqrt{2}}$

परम happiness

$t = \frac{T}{8}$

Ay

QUESTION

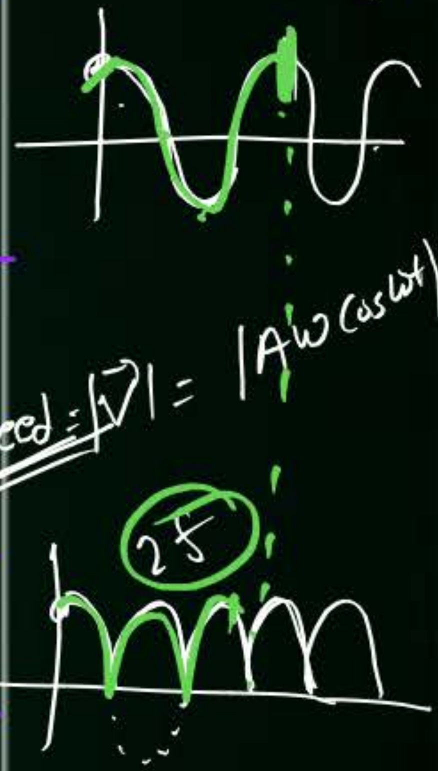
At the time $t = 0$, the particle is at its mean position, then at what times, the particle will have potential energy 50% of its total energy within $t = 0$ to $t = T$?

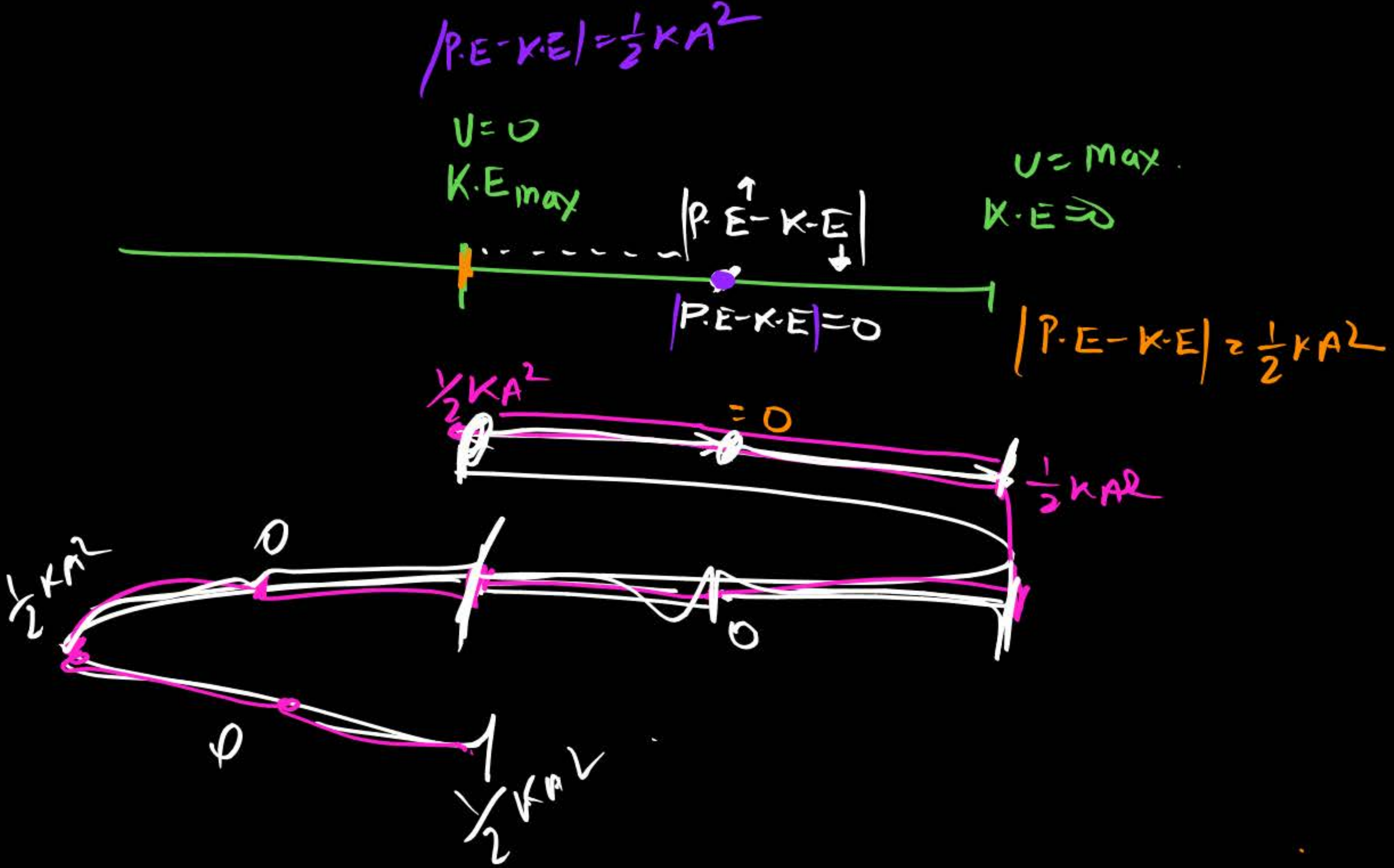
Physical Quantity	Time Period	Frequency
# Position / $disp^m = x_f - x_i$	T	f
~~Distance~~		
Velocity →	T	→ f
Speed	T/2	2f
Acceleration	T	f
K.E.	T/2	2f
P.E.	T/2	2f
⇒ K.E. – P.E.	T/2	2f
# |K.E. – P.E.|	T/4	4f
M.E. = K.E + P.E	(infinite)	0

$T = \frac{1}{f}$

$V = A\omega\cos(\omega t)$

Speed $= |\vec{V}| = |A\omega\cos(\omega t)|$




|P.E - K.E| = ½ KA²
V = 0
K.E max
V = max.
K.E = 0
|P.E - K.E|
|P.E - K.E| = 0
|P.E - K.E| = ½ KA²
½ KA²
= 0
½ KA²
½ KA²
0
0
0
½ KA²

QUESTION

A loaded vertical spring executes S.H.M. with a time period of 4 s. The difference between the kinetic energy and potential energy of this system varies with a period of

1. 2 s
2. 1 s
3. 8 s
4. 4 s

T/2

TIME PERIOD OF S.H.M.

Force Method : [displace the Particle from mean Position and write down restoring force]

(net restoring force) $F_{net} = -kx$

divide by mass m both side

$\left(\frac{F}{m}\right) = -\frac{k}{m}x$

$\vec{a} = -\frac{k}{m}\vec{x}$

$\frac{k}{m} = \omega^2$

$\omega = \sqrt{\frac{k}{m}} = \frac{2\pi}{T}$

$T = 2\pi\sqrt{\frac{m}{k}}$

Energy Method :

$$F = -\frac{dU}{dx}$$ ✓

Step-1 write down P.E.

Step-2 Calculate force using formula $F = -\frac{dU}{dx}$

$F_{net} = ma$

$a = -\omega^2 x$

QUESTION

The potential energy of a particle of mass 100 g moving along x-axis is given by U = $5x(x - 4)$, where x is in metre. The period of oscillation is

1. 0.2π s
2. 0.1π s
3. π s
4. $\frac{1}{\pi}$ s

$M = 100$ grm

$U = 5x(x-4) = 5x^2 - 20x$

$F = -\frac{dU}{dx} = -\frac{d(5x^2 - 20x)}{dx}$

$F = -[5(2x) - 20]$

$F = -10x + 20$

$K = 10$

$m\omega^2 = 10$

$\frac{1}{10}\omega^2 = 10$

$\omega = \sqrt{100} = 10$

$\frac{2\pi}{T} = 10$ 5

$T = \frac{\pi}{5}$

QUESTION

Potential energy of oscillating object is $U = U_0\,(1 - \alpha\cos(\alpha x)]$ then find time period of oscillation.

$$U = U_0 - \alpha U_0 \cos(\alpha x)$$

$$\vec{F} = -\frac{dU}{dx} = -\left(0 + \alpha U_0 \sin(\alpha x)\right)$$

$$F = -\alpha U_0 \sin(\alpha x) \times \alpha$$

No feel of S.H.M

S.H.M (Amplitude must be small)

$x \to$ small

$$F = -\alpha^2 U_0\,(\alpha x)$$

$$F = -\alpha^3 U_0\, x$$

S.H.M

$$K = \alpha^3 U_0$$

$$m\omega^2 = \alpha^3 U_0$$

$$\omega = \sqrt{\frac{\alpha^3 U_0}{m}} = \frac{2\pi}{T}$$

$$T = 2\pi\sqrt{\frac{m}{\alpha^3 U_0}}$$


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 05 | Physics

Oscillations

By- Dr. Manish Raj (MR SIR)



Topics to be covered

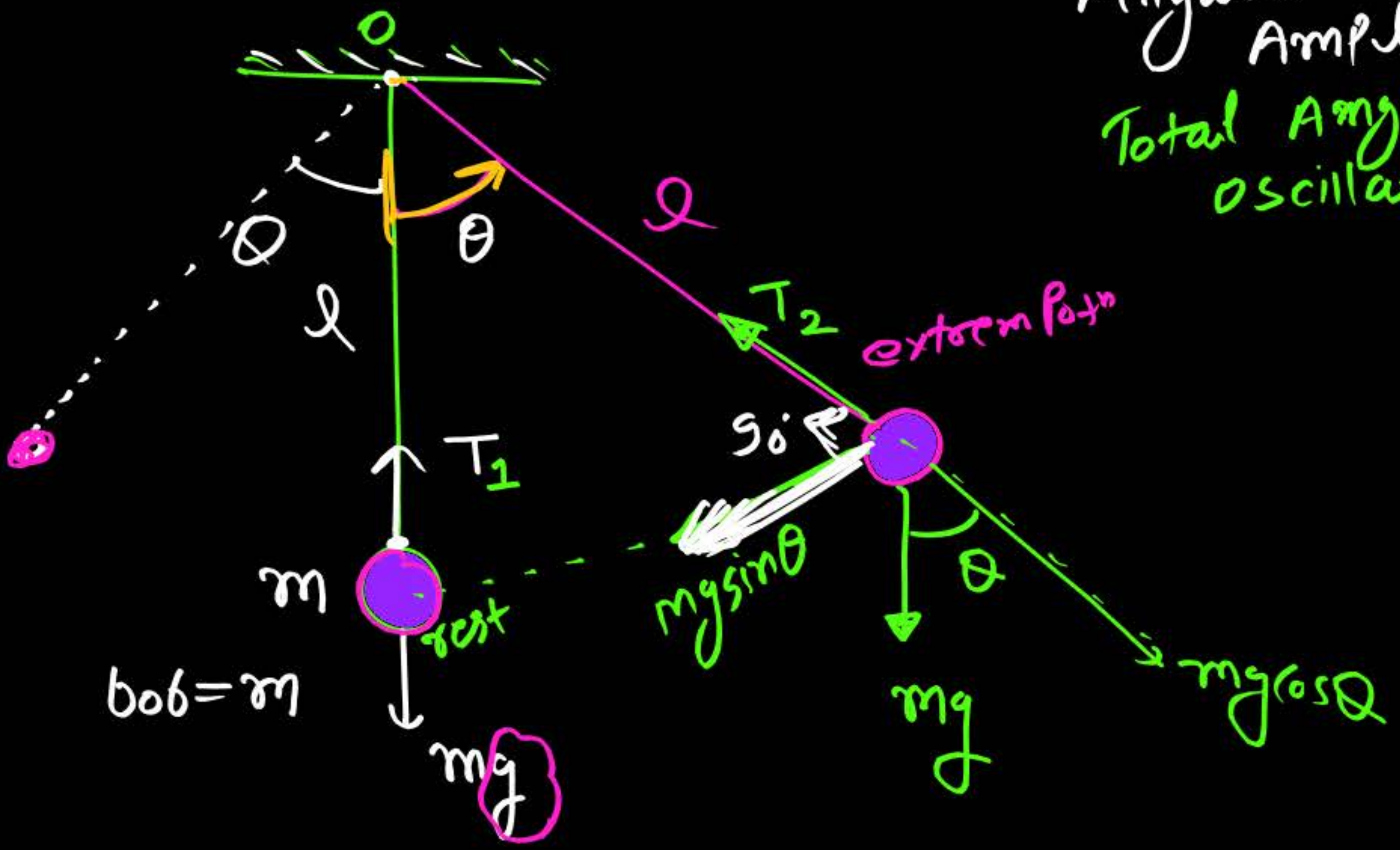
1 # Happy Diwali

2 #

3 #



Simple pendulum



Angular S.H.M
Amplitud = θ

Total Angle in one oscillation = 4θ

$[T_2 = mg\cos\theta]$

$\vec{\tau} = \vec{r} \times \vec{F}$

$\tau_0 = mg\sin\theta \times l$

$I\alpha = mg\sin\theta\, l$

~~$ml^2\alpha = mg\sin\theta\, l$~~

$\alpha = \frac{g}{l}\sin\theta$

scalar

at mean Position $(a = 0)$
$(F = 0)$

$F = -Kx = 0$

$a = -\omega^2 x$

vector form

$\alpha = -\frac{g}{l}\sin\theta$

Condⁿ of S.H.M

$\theta \to$ small.

$\sin\theta \approx \theta$

$\vec{\alpha} = -\left(\frac{g}{l}\right)\vec{\theta}$

Angular acⁿ = $-\frac{g}{l}$ Angular dispᵐ

$\omega^2 = \frac{g}{l}$

$\omega = \sqrt{g/l}$

$\frac{2\pi}{T} = \sqrt{g/l}$

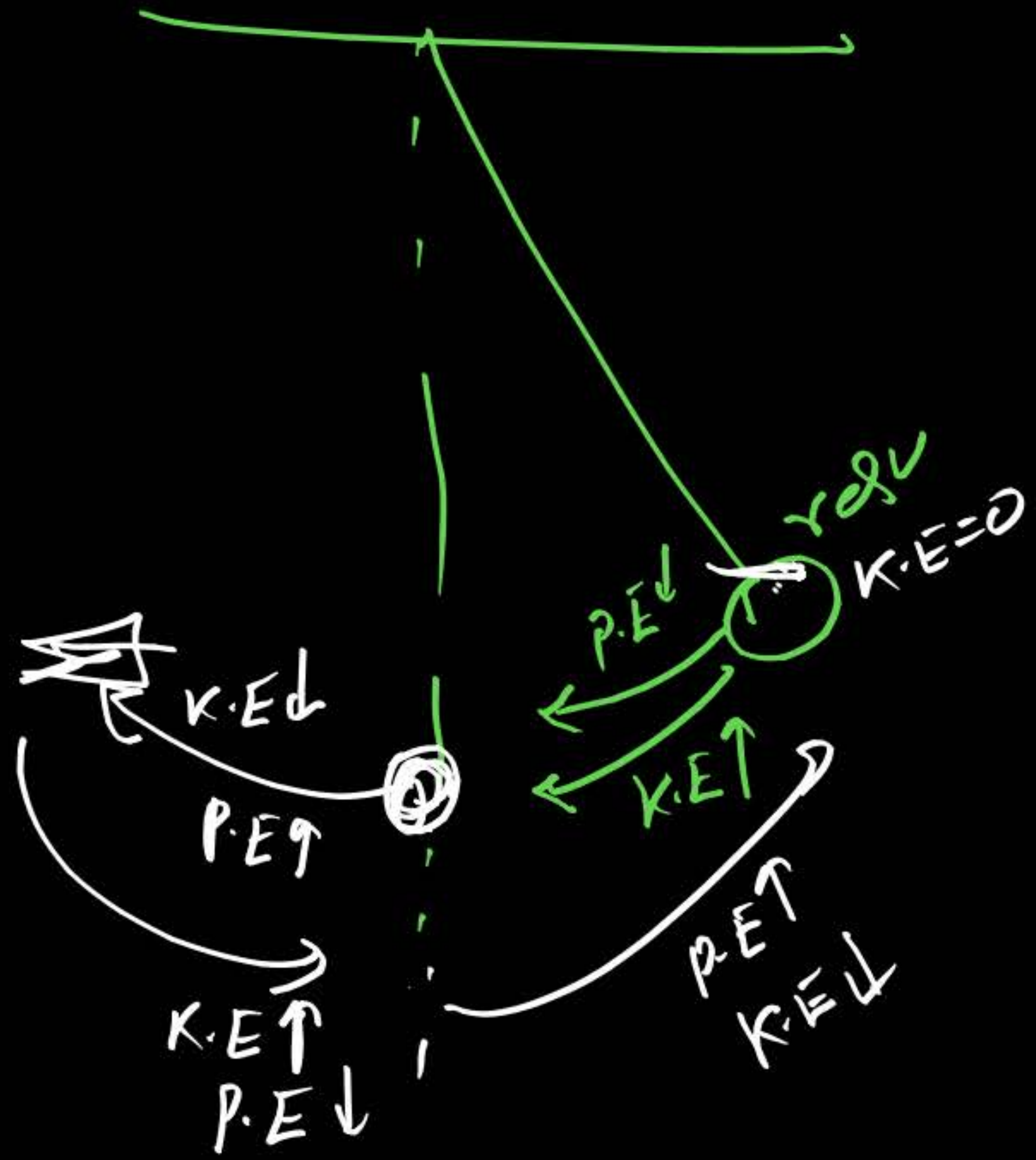
$T = 2\pi\sqrt{\frac{l}{g}}$

$$T = 2\pi\sqrt{\frac{l}{g}}$$

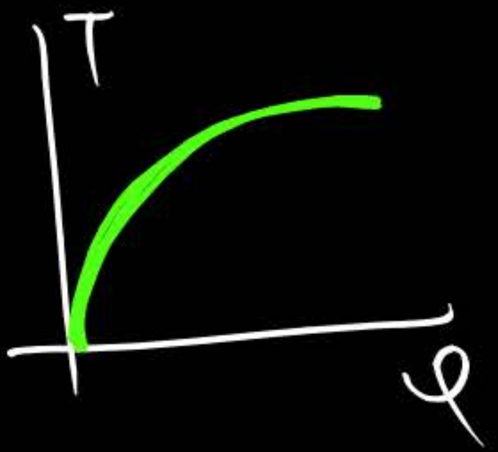
T = does not depends on mass of bob of simple pendulum.

T = does not depends on Amplitude of oscillation

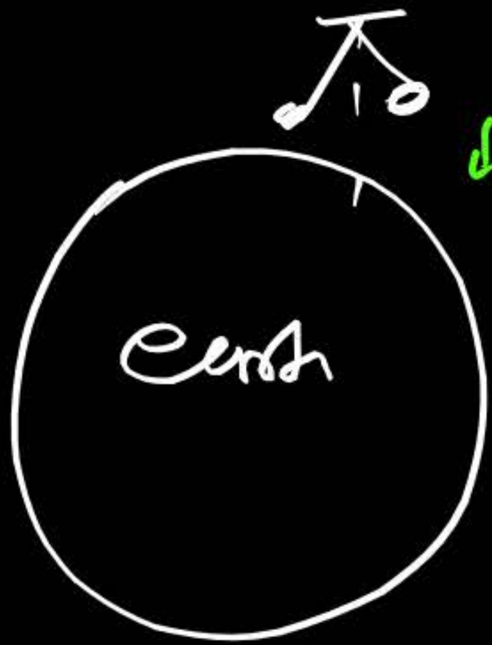
T = depends on length of pendulum



$$T \propto \sqrt{l}$$



$$T \propto \frac{1}{\sqrt{g}}$$



$$T_1 = 2\pi\sqrt{\frac{l}{g_e}}$$

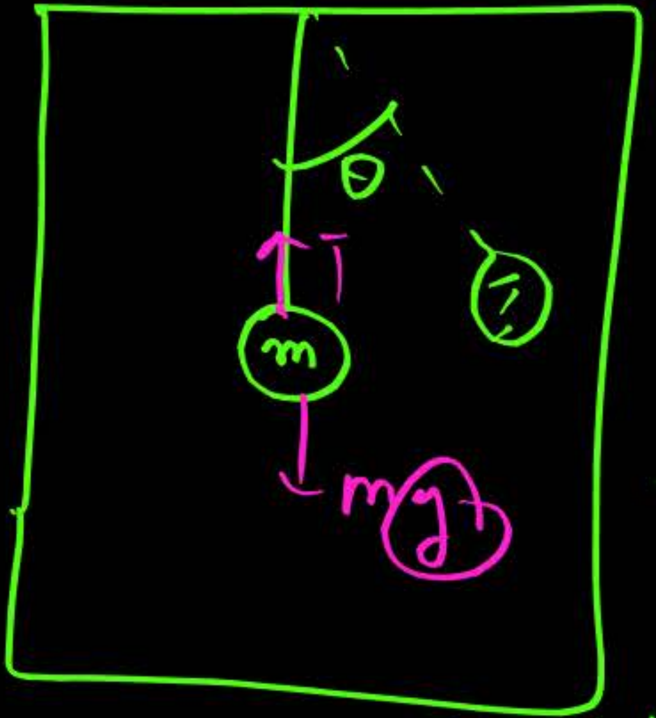


$$T_2 = 2\pi\sqrt{\frac{l}{g_m}}$$

$$T_1 < T_2$$

moon

परम happin



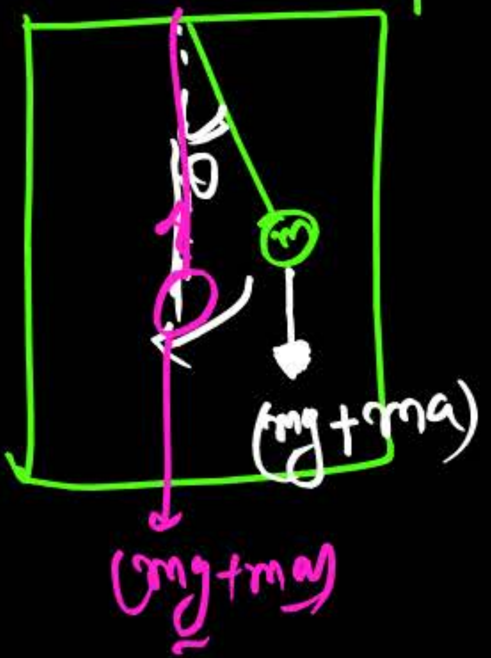
lift rest

$T = 2\pi\sqrt{\frac{l}{g}}$

$\downarrow V = \text{cost}^n$ $\quad T = 2\pi\sqrt{\frac{l}{g}}$

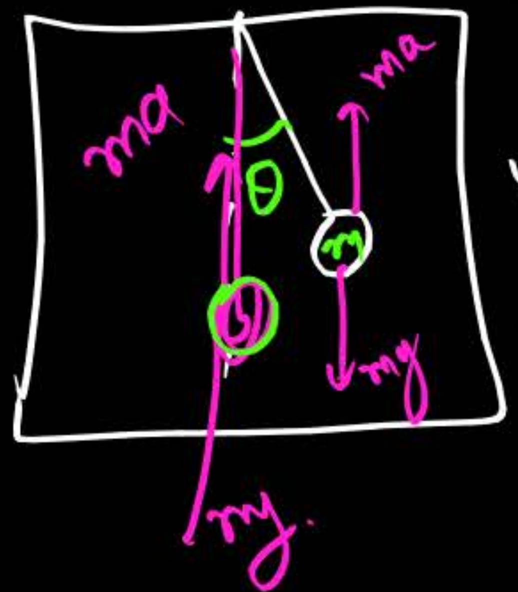
$$T = 2\pi\sqrt{\frac{l}{g_{eff}}}$$

$\uparrow a_{lift} = a_0$



$g' = g + a_0$

$T = 2\pi\sqrt{\frac{l}{(g+a_0)}}$



$\downarrow a_{lift}\ a_0$

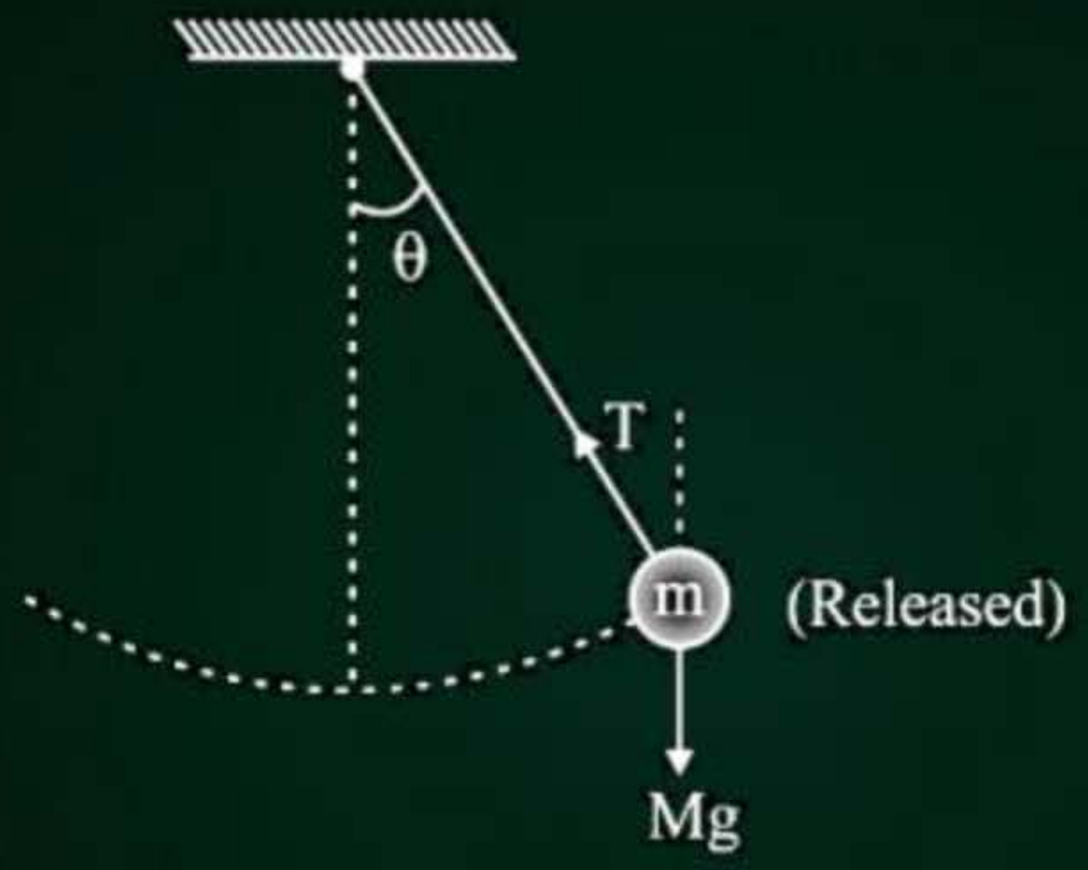
$\uparrow T = 2\pi\sqrt{\frac{l}{(g-a_0)}}\downarrow$

QUESTION

If particle is executing simple harmonic motion with time period T, then the time period of its total mechanical energy is

1. Zero
2. $T/2$
3. $2T$
4. Infinite

Time Period of Simple Pendulum :-



Accelerated Pendulum :-

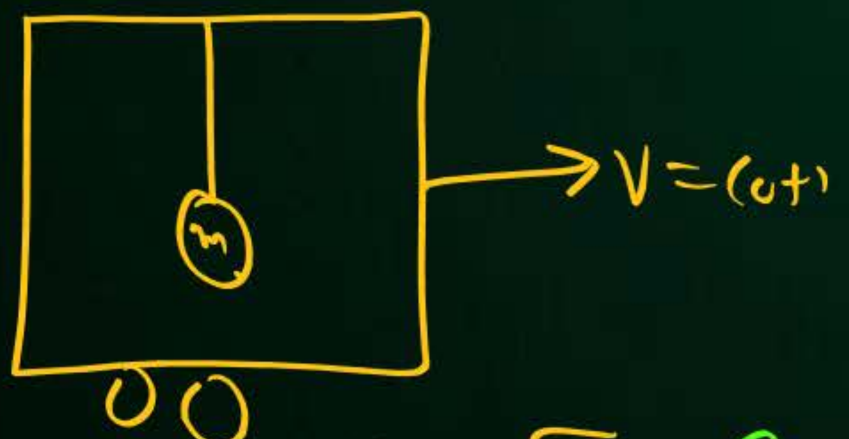
MR*

(i) $T = 2\pi\sqrt{\dfrac{L}{(g+a)}}$ (upward acceleration) ✓

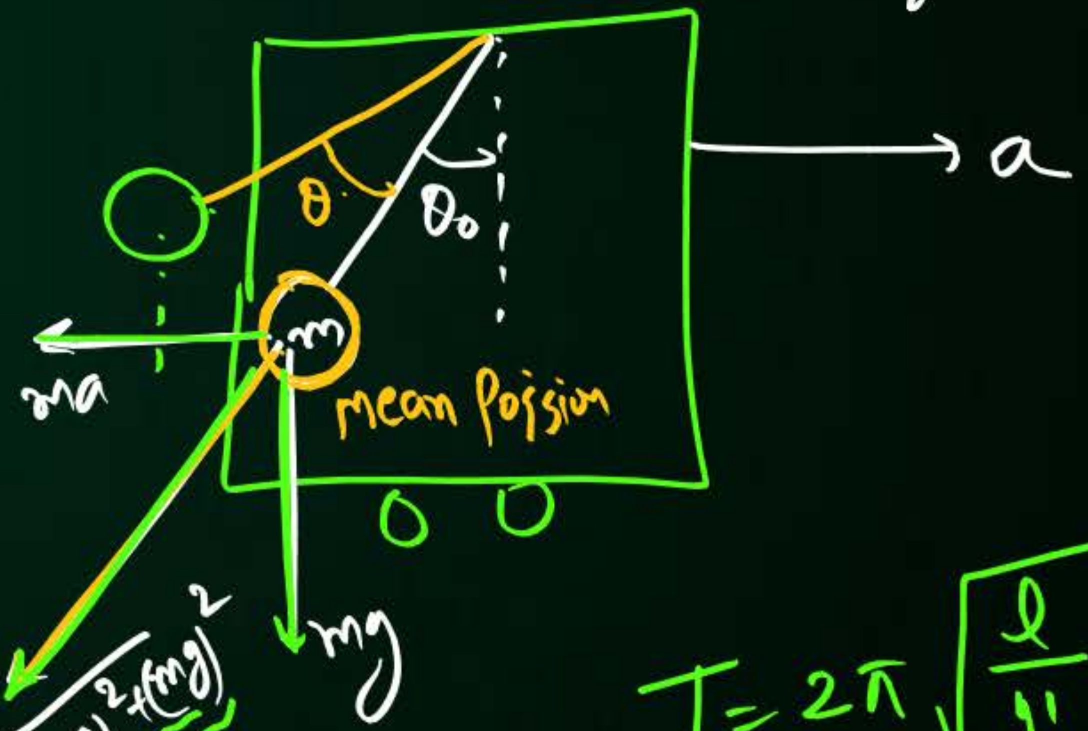
(ii) $T = 2\pi\sqrt{\dfrac{L}{(g-a)}}$ (downward acceleration)

$\theta_0 = \tan^{-1}(a/g)$ ↳ equilibrium

(iii) (Horizontal acceleration left)



$T = 2\pi\sqrt{l/g}$ same.



$F_{net} = \sqrt{(ma)^2 + (mg)^2}$

$g_{eff} = \sqrt{a^2+g^2}$

$T = 2\pi\sqrt{\dfrac{l}{g'}}$

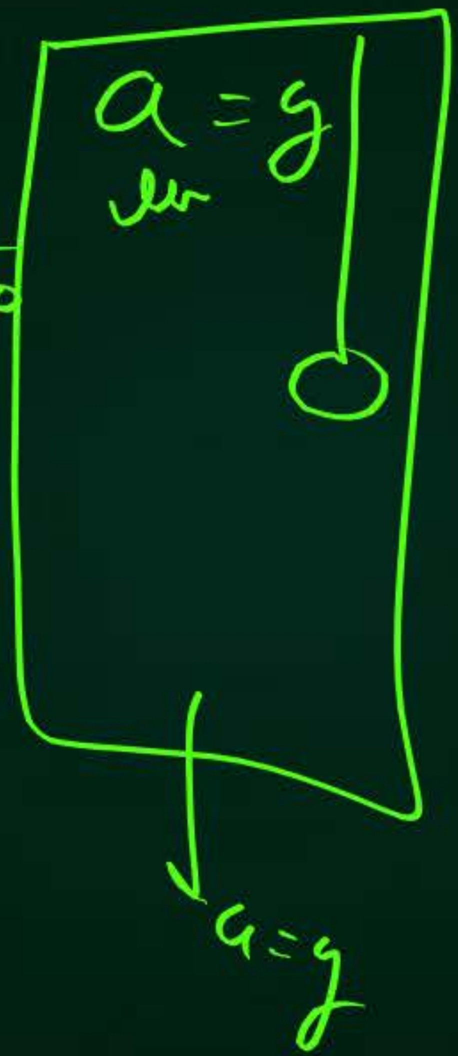
$T = 2\pi\sqrt{\dfrac{l}{\sqrt{a^2+g^2}}}$

QUESTION

Time period of a simple pendulum in a free.ly falling lift will be

1. Finite
2. Infinite
3. Zero
4. All of these

$$T = 2\pi\sqrt{\frac{l}{g-g}} = 0$$



(iii) $T = 2\pi\sqrt{\frac{L}{\sqrt{g^2+a^2}}}$

Horizontal accⁿ lift

QUESTION

A simple pendulum suspended from the ceiling of a stationary lift has period T_0. When the lift descends at steady speed, the period is T_1 and when it descends with constant downward acceleration, the period is T_2. Which one of the following is true?

1. $T_0 = T_1 = T_2$
2. $T_0 = T_1 < T_2$
3. $T_0 = T_1 > T_2$
4. $T_0 < T_1 < T_2$

$T_0 = 2\pi\sqrt{\frac{l}{g}}$

T_1



$T_2 = 2\pi\sqrt{\frac{l}{g-a}}$

QUESTION

A simple pendulum is oscillating in a trolley moving on a horizontal straight road with constant acceleration a. If direction of motion of trolley is taken as positive x direction and vertical upward direction as positive y direction then the mean position of pendulum makes an angle

1. $\tan^{-1}\left(\frac{g}{a}\right)$ with y axis in $+x$ direction
2. $\tan^{-1}\left(\frac{a}{g}\right)$ with y axis in $-x$ direction
3. $\tan^{-1}\left(\frac{a}{g}\right)$ with y axis in $+x$ direction
4. $\tan^{-1}\left(\frac{g}{a}\right)$ with y axis in $-x$ direction

QUESTION

A simple pendulum is suspended from the roof of a trolley which moves in a horizontal direction with an acceleration a, then the time period is given by $T = 2\pi\sqrt{(l/a')}$, where a' is equal to [1991]

1. g
2. $g - a$
3. $g + a$
4. $\sqrt{(a^2 + b^2)}$ ✓

H/W

THANK YOU



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FOR NEET 2025

Lecture- 6 | **Physics**

Oscillations



By- Dr. Manish Raj (MR SIR)

Topics to be covered

Questions on simple Pendulum ✓

Second Pendulum ✓

large Pendulum ✓

1. #
2. #
3. #



$$T = 2\pi\sqrt{\frac{l}{g}}$$

QUESTION

If the length of a simple pendulum is increased by 2%, then the time period [1997]

1. increases by 1%
2. decreases by 1%
3. increases by 2%
4. decreases by 2%

$T = 2\pi\sqrt{\frac{l}{g}}$

small change

$100 \times \frac{\Delta T}{T} = \frac{1}{2}\left[\frac{\Delta l}{l} \times 100\right]$

$= \frac{1}{2} \times 2\% = 1\%$

Time Period of simple Pendulum is T and length of Pendulum is l. find new Time period if, $T = 2\pi\sqrt{\frac{l}{g}}$ — (1)

(i) If length becomes 4-times and acc^n due to gravity half

(ii) If length becomes half and gravity becomes double

(iii) If length increased to 200%, then % change in Time Period

(iv) If length increases by 200%

Sol^n $T' = 2\pi\sqrt{\frac{l'}{g'}}$

$T' = 2\pi\sqrt{\frac{4l \times 2}{g}} = 2\pi\sqrt{\frac{l}{g}}\sqrt{8}$

$T' = T2\sqrt{2}$

(ii) $T' = 2\pi\sqrt{\frac{(l)}{2g \times 2}} = \frac{2\pi\sqrt{\frac{l}{g}}}{2} = \frac{T}{2}$

(iii) $l' = 200\% \, l_i = 2l$

$T' = 2\pi\sqrt{\frac{2l}{g}} = \sqrt{2}T$

% Change in Time $= \left(\frac{\sqrt{2}T - T}{T}\right) \times 100 = \frac{0.41 T}{T} \times 100 = 41\%$

Increase to 141% / Increase by 41%

(iv) $l_f = l_i + 200\% l_i$

$= l + \frac{200}{100} l$

$= 3l$

$T' = \sqrt{3}T = 1.71$

% change in time = Incr by 71%

QUESTION

If the length of a clock pendulum increases by 0.2% due to atmospheric temperature rise, then the loss in time of clock per day is

1. 86.4 s
2. 43.2 s
3. 72.5 s
4. 32.5 s

$\frac{\Delta l}{l \Delta \theta} = \alpha$

done in thermal exp^n

$T = 2\pi\sqrt{\frac{l}{g}}$

$100 \times \frac{\Delta T}{T} = \frac{1}{2}\left[\frac{\Delta l}{l} \times 100\right]$

$100 \times \frac{\Delta T}{T} = \frac{1}{2} \times 0.2$

$\Delta T = \frac{1}{2} \times \frac{2 \times T}{10 \times 100}$

$= \frac{86400}{1000} = 86.4$

QUESTION

Two masses M_A and M_B are hung from two strings of length l_A and l_B respectively. They are executing SHM with frequency relation $f_A = 2f_B$, then relation **[2000]**

1. $l_A = \frac{l_B}{4}$, does not depend on mass
2. $l_A = 4\,l_B$, does not depend on mass
3. $l_A = 2l_B$ and $M_A = 2M_B$
4. $l_A = \frac{l_B}{2}$ and $M_A = \frac{M_B}{2}$

QUESTION

The time period of oscillations of a simple pendulum is 1 minute. If its length is increased by 44%. then its new time period of oscillation will be

= 60 sec

1. 96 s
2. 58 s
3. 82 s
4. 72 s

$l_f = 144\% \, l_i$

$l_f = l_i + 44\% \, l_i$

$l_f = \frac{144}{100} l_i$

$T_i = 2\pi\sqrt{\frac{l_i}{g}} = 60 sec$

$T_f = 2\pi\sqrt{\frac{\frac{144}{100} l_i}{g}}$

$= \frac{12}{10} 2\pi\sqrt{\frac{l}{g}}$

$= \frac{12}{10} \times 60 = 72$

QUESTION

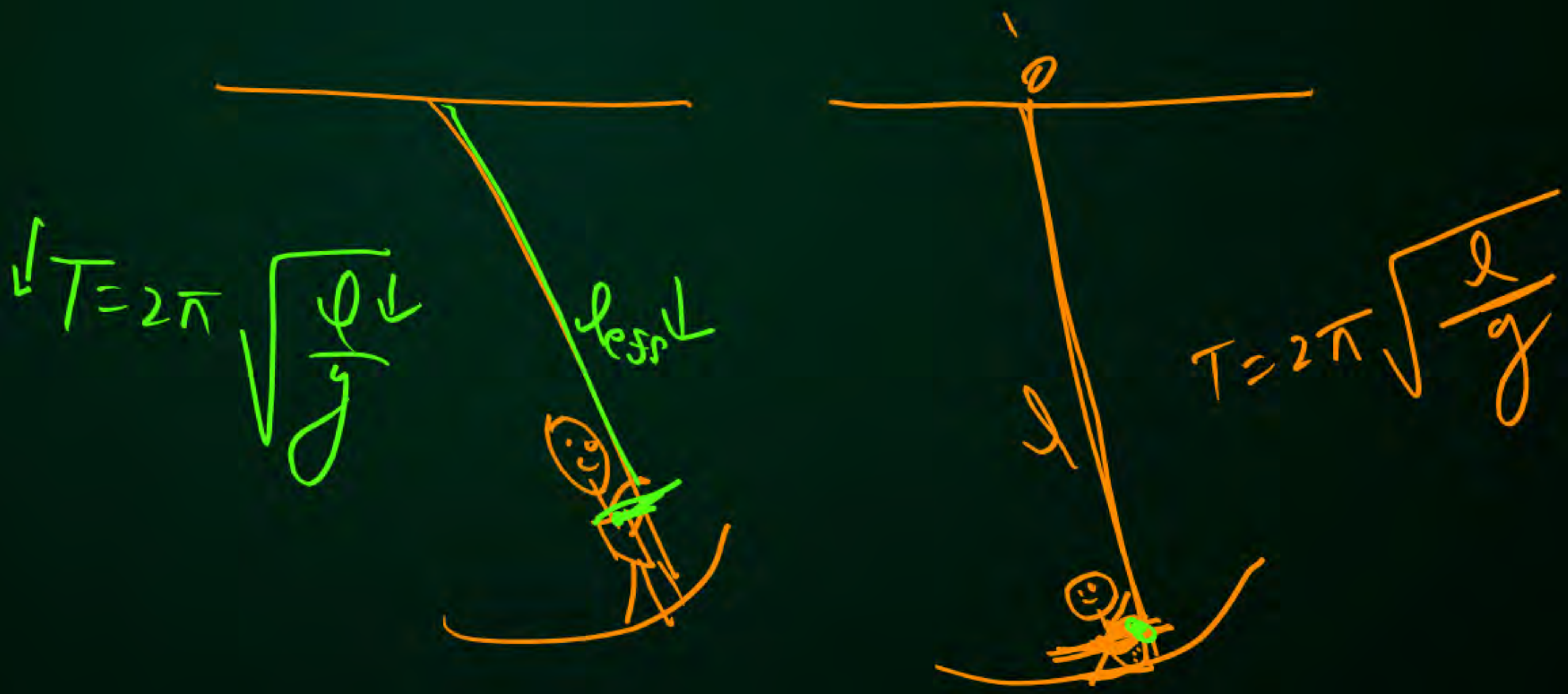
Time period of a simple pendulum is 2 sec. If its length is increased by 4 times, then its time period becomes [1999]

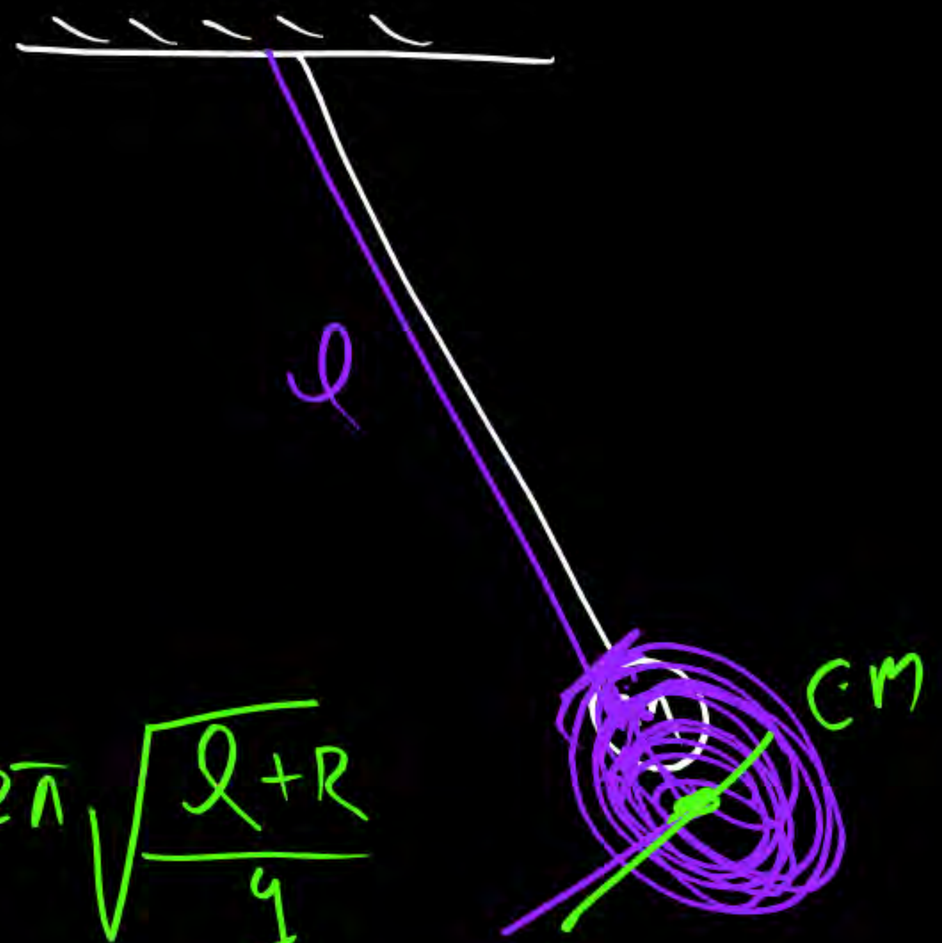
1. 8 sec
2. 12 sec
3. 16 sec
4. 4 sec

QUESTION

A boy is swinging in a swing. If he stands, the time period will ??

1. First decrease, then increase
2. Decrease
3. Increase
4. Remain same





$$T = 2\pi\sqrt{\frac{l+R}{g}}$$

QUESTION

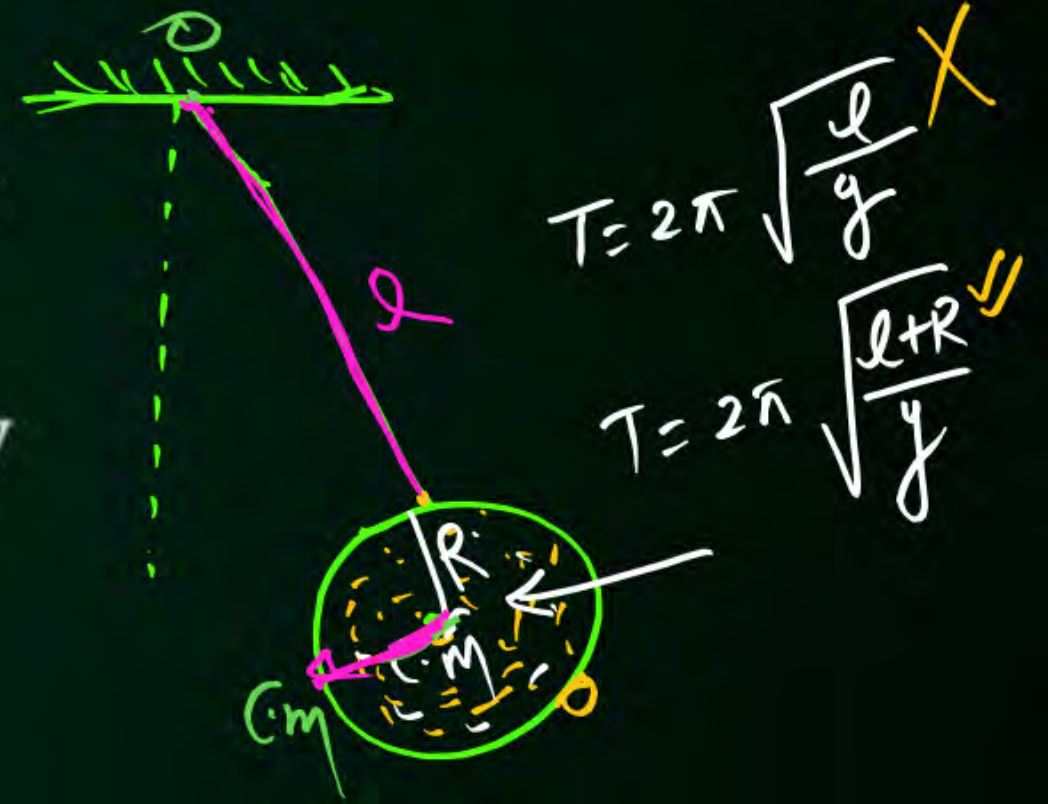
A hollow metal sphere is filled with water through a small hole in it. It is hung by a long thread and is made to oscillate. Water slowly flows out of the hole at the bottom. Select the correct variation of its time period

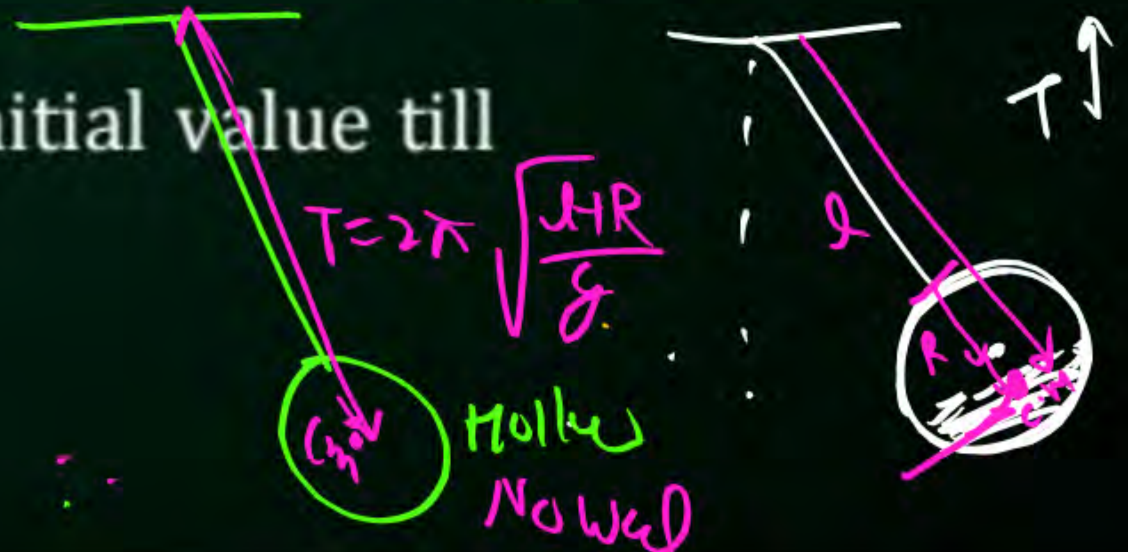
1. The period will go on increasing till the sphere is empty

2. The period will go on decreasing till the sphere is empty

3. The period will not be affected at all

4. The period will increase first, then decrease to initial value till the sphere is empty





Second Pendulum (T = 2 sec)

Simple Pendulum whose length is 1 m and Time period is 2 sec.

$\sqrt{10} = \pi$

$$T = 2\pi\sqrt{\frac{l}{g}}$$

If $l = 1\,m$

$$T = 2\pi\sqrt{\frac{1}{10}} = \frac{2\pi}{\sqrt{10}} = 2\,sec$$

QUESTION

If a Second's pendulum is moved to a planet where acceleration due to gravity is 4 times, the length of the second's pendulum on the planet should be made .

$g_p = 4g_e$

$T = 2\pi\sqrt{\frac{4\ell}{4g}}$

1. 2 times
2. 4 times ✓
3. 8 times
4. 15 times

QUESTION

The time period of oscillations of a second's pendulum on the surface of a planet having mass and radius double those of earth is

1. 4 s
2. 1 s
3. $\sqrt{2}$ s
4. $2\sqrt{2}$ s ✓

$M_p = 2M_e$
$R_p = 2R_e$

$g_{P\,surface} = \frac{GM}{R^2} = \frac{2}{4}\frac{GM_e}{R_e^2}$

$g_p = \frac{g_e}{2}$

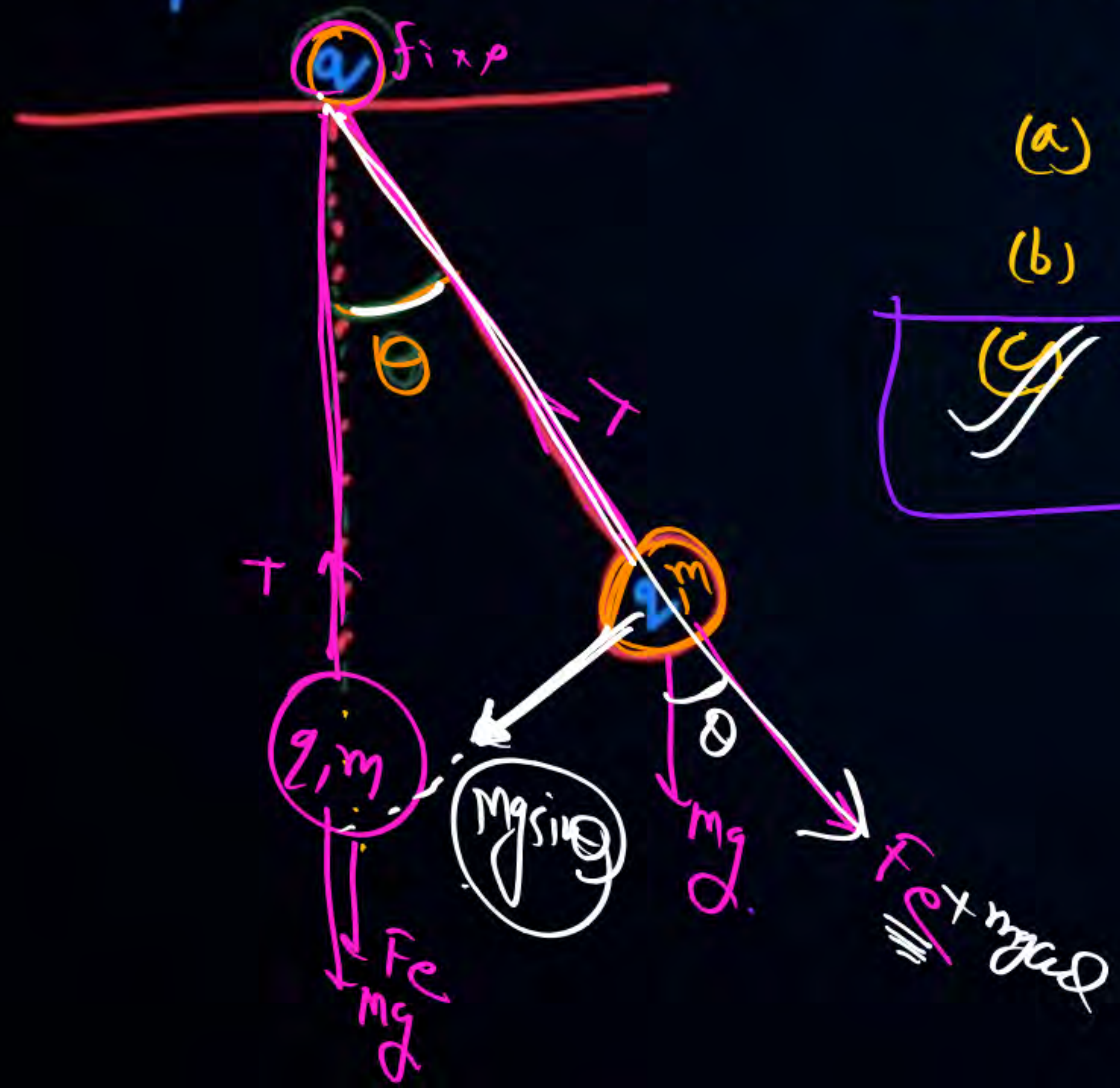
$l = 1\,m$

$T = 2\pi\sqrt{\frac{l}{g}}$

$= 2\pi\sqrt{\frac{1m \cdot 2}{g}}$

$= 2\sqrt{2}$

Time Period of simple Pendulum is T, Now two Identical point charge q given to bob and point of suspension then Time period of simple Pendulum will be ??



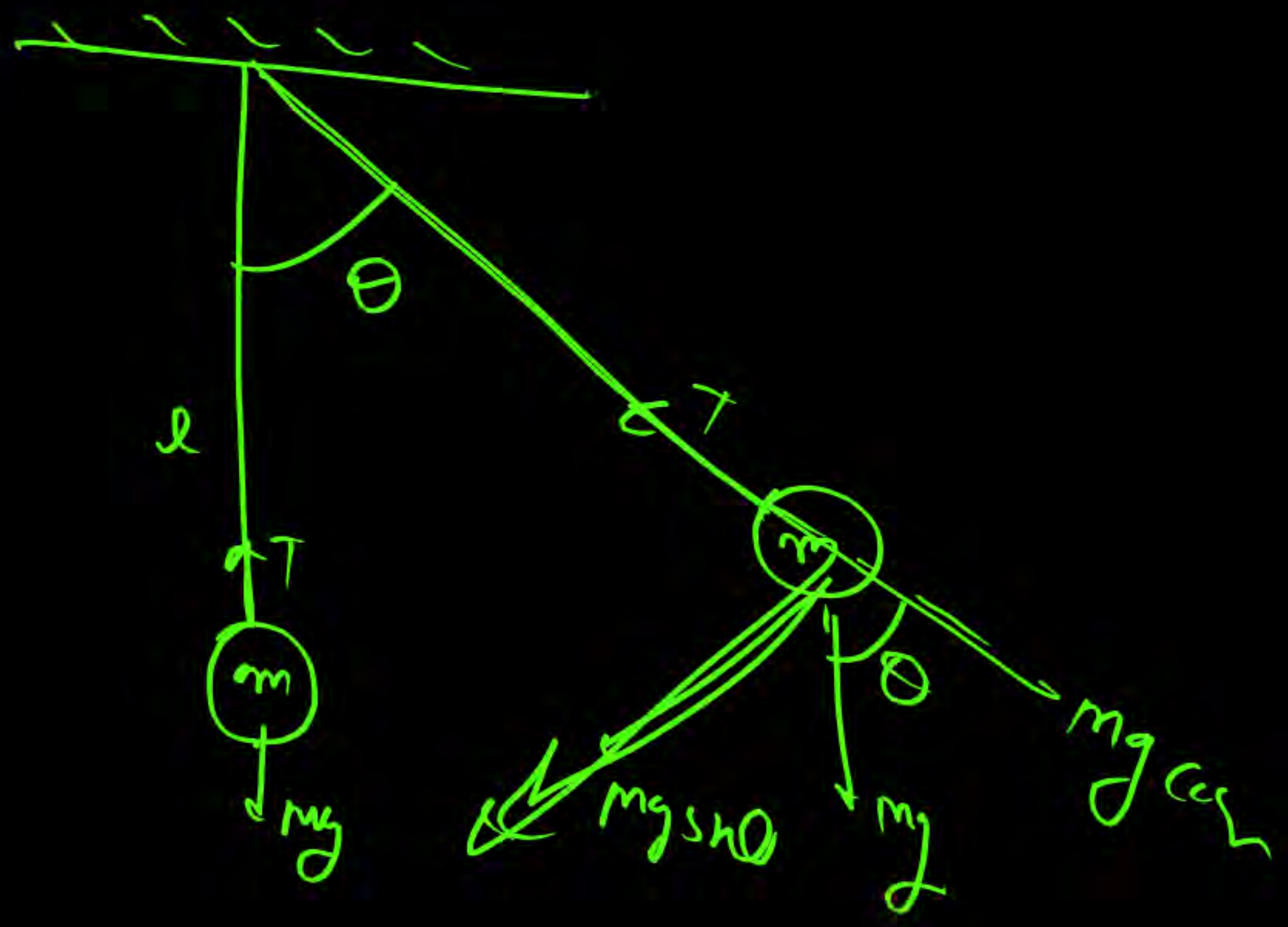
(a) T incres

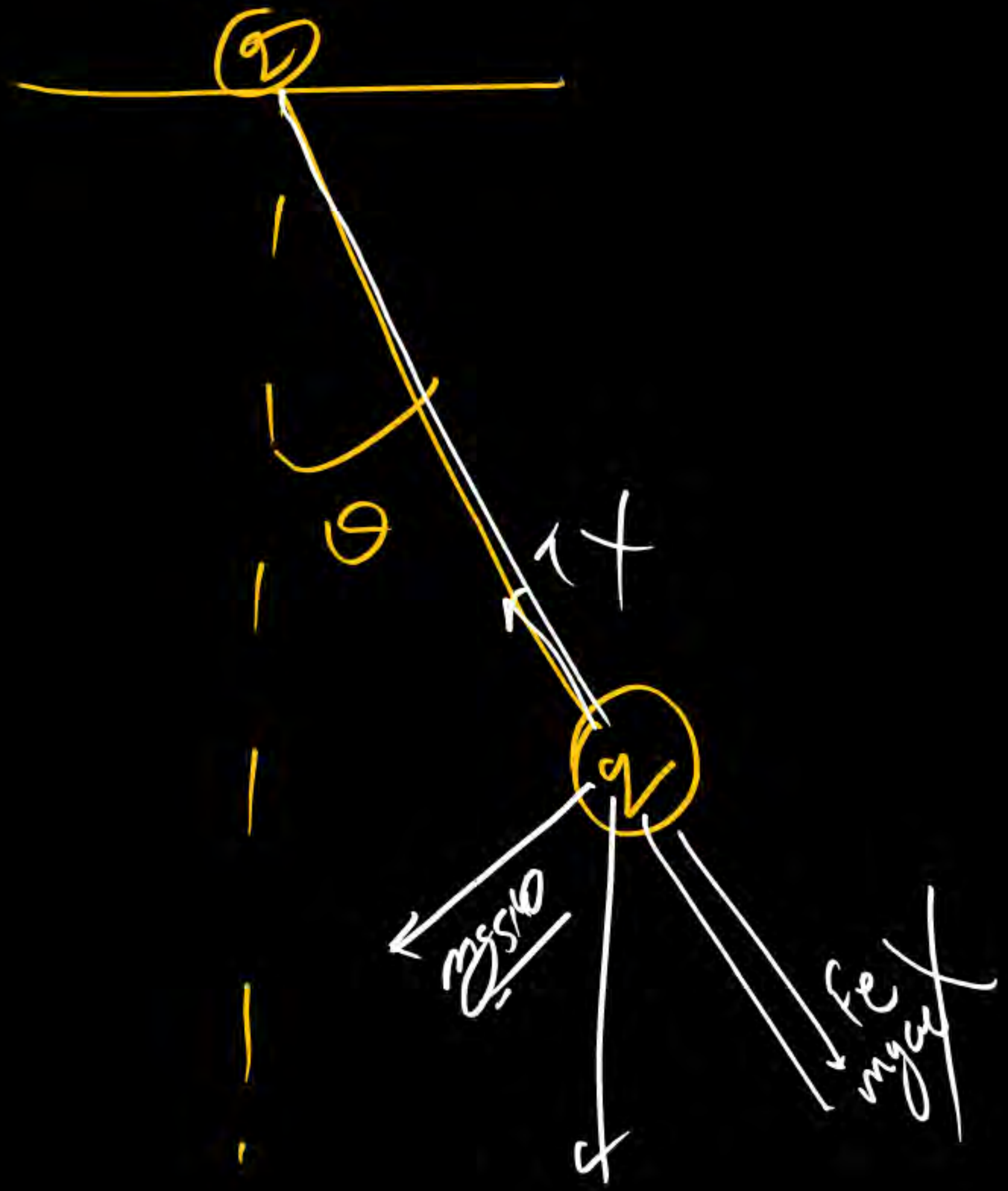
(b) T dec

(c) T Unchage.

$T = 2\pi\sqrt{\frac{l}{g}}$

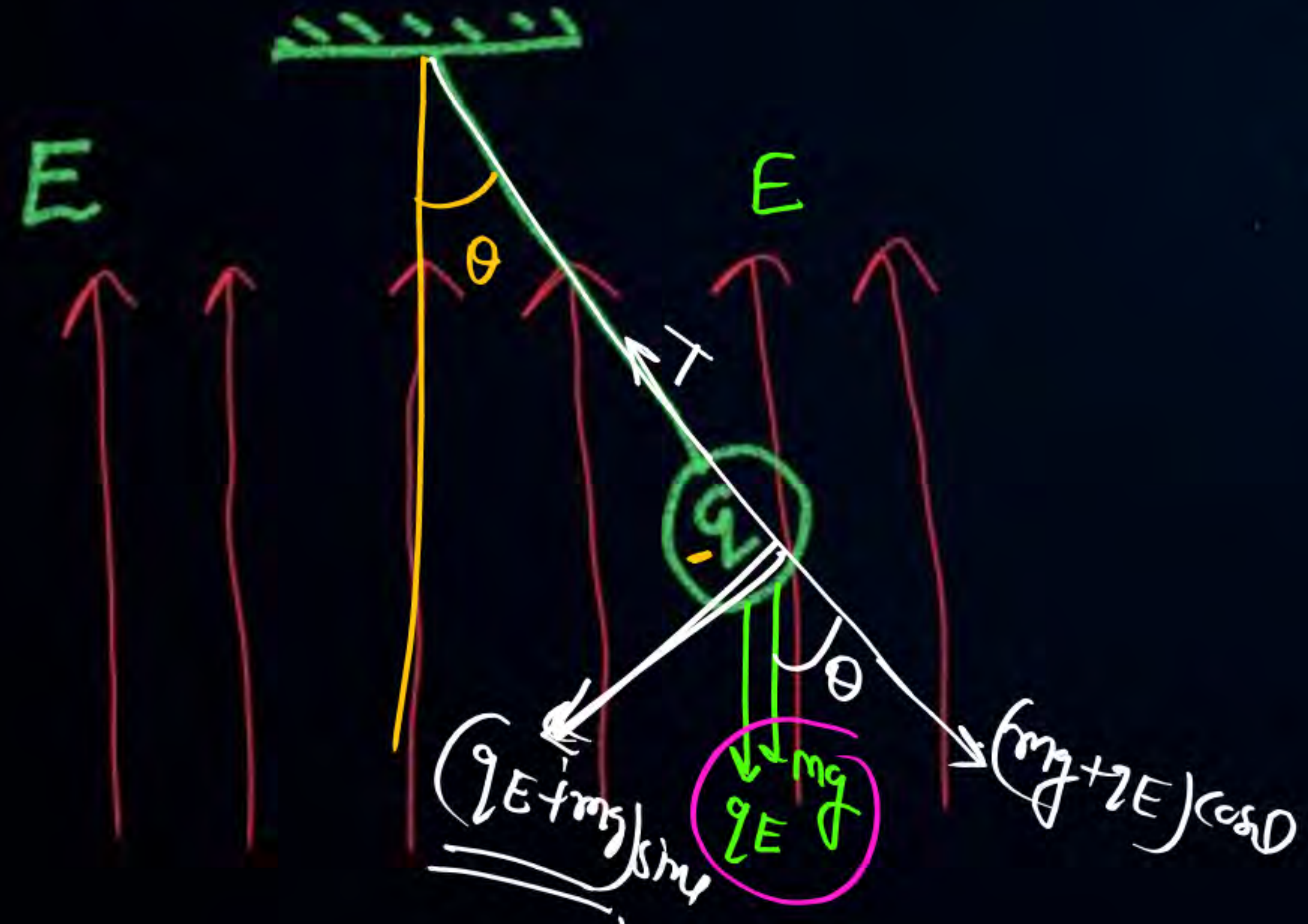



θ
l
T
T
m
m
mg
mg sinθ
mg
θ


q
θ
T
q
Fe

When electric field is zero then time period is T. find Time Period when electric field is switch on as shown in fig.

Ans (decre)





$T = 2\pi\sqrt{l/g}$

$$\tau = (mg+qE)\sin\theta\, l$$

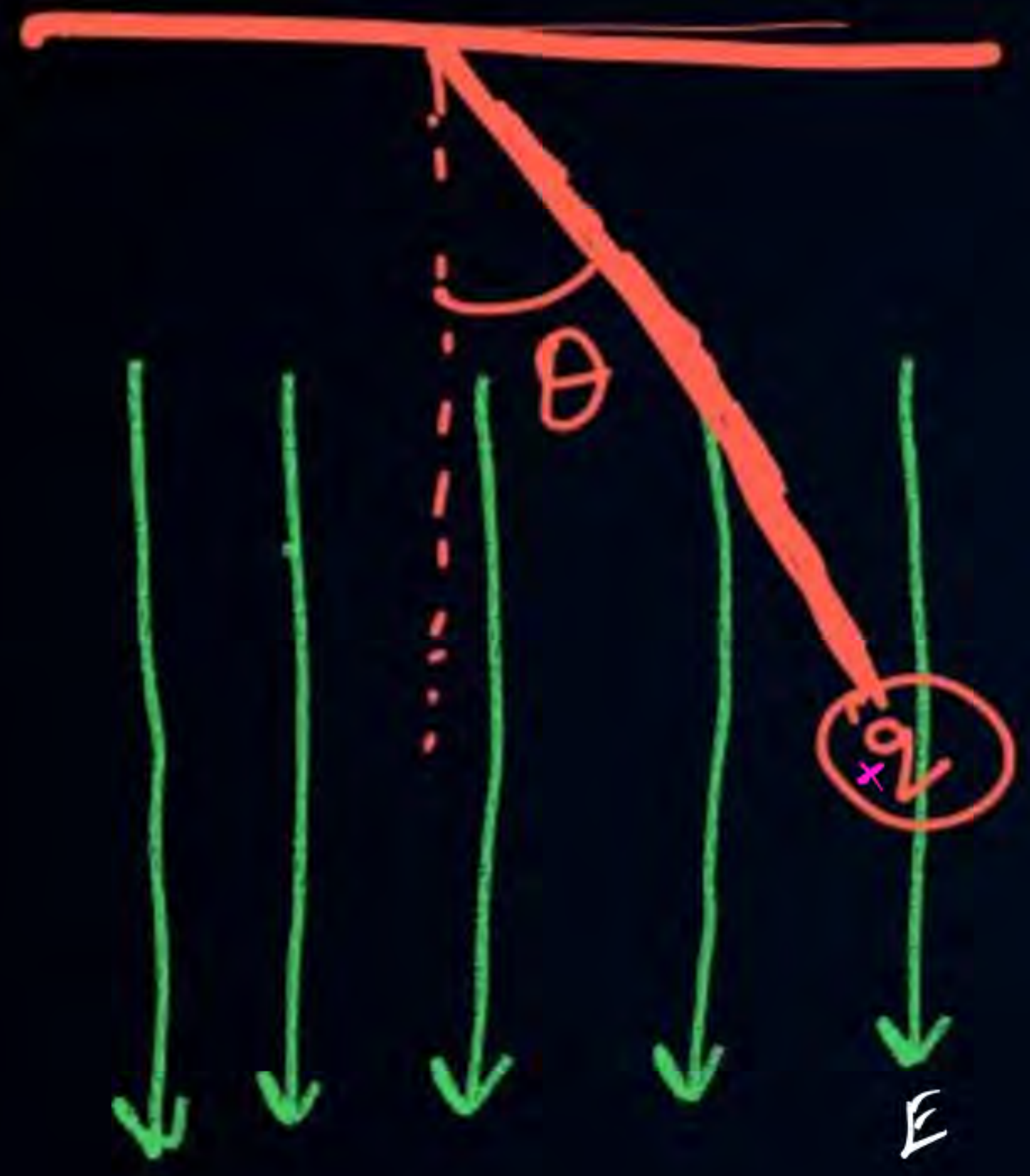
$$I\alpha = (mg+qE)l\,\theta$$

$$ml^2\alpha = (mg+qE)l\,\theta$$

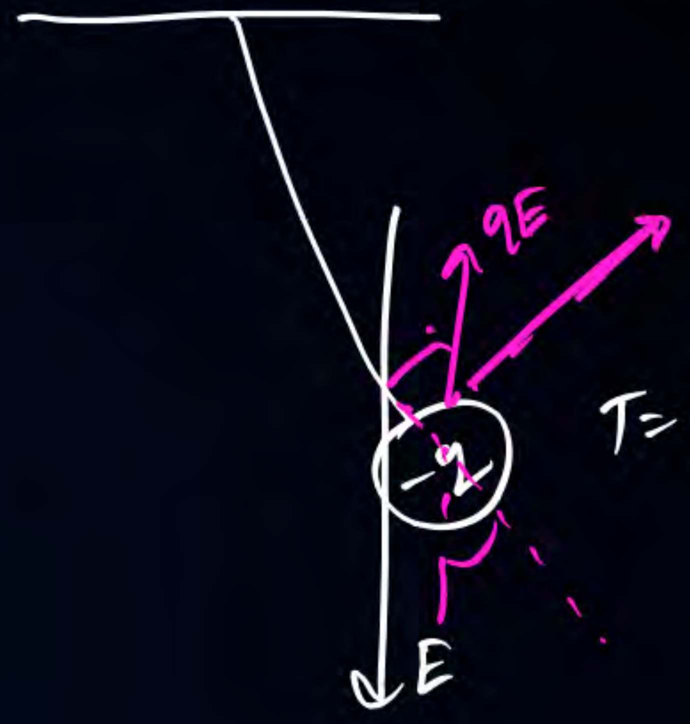
$$\alpha = \frac{(mg+qE)}{ml}\theta$$

$$\frac{2\pi}{T} = \omega = \sqrt{\frac{mg+qE}{ml}} = \sqrt{\frac{(g+qE/m)}{l}}$$

$$\Rightarrow T = 2\pi\sqrt{\frac{l}{(g+\frac{qE}{m})}}$$



$$T = 2\pi\sqrt{\frac{l}{g+\frac{qE}{m}}}$$

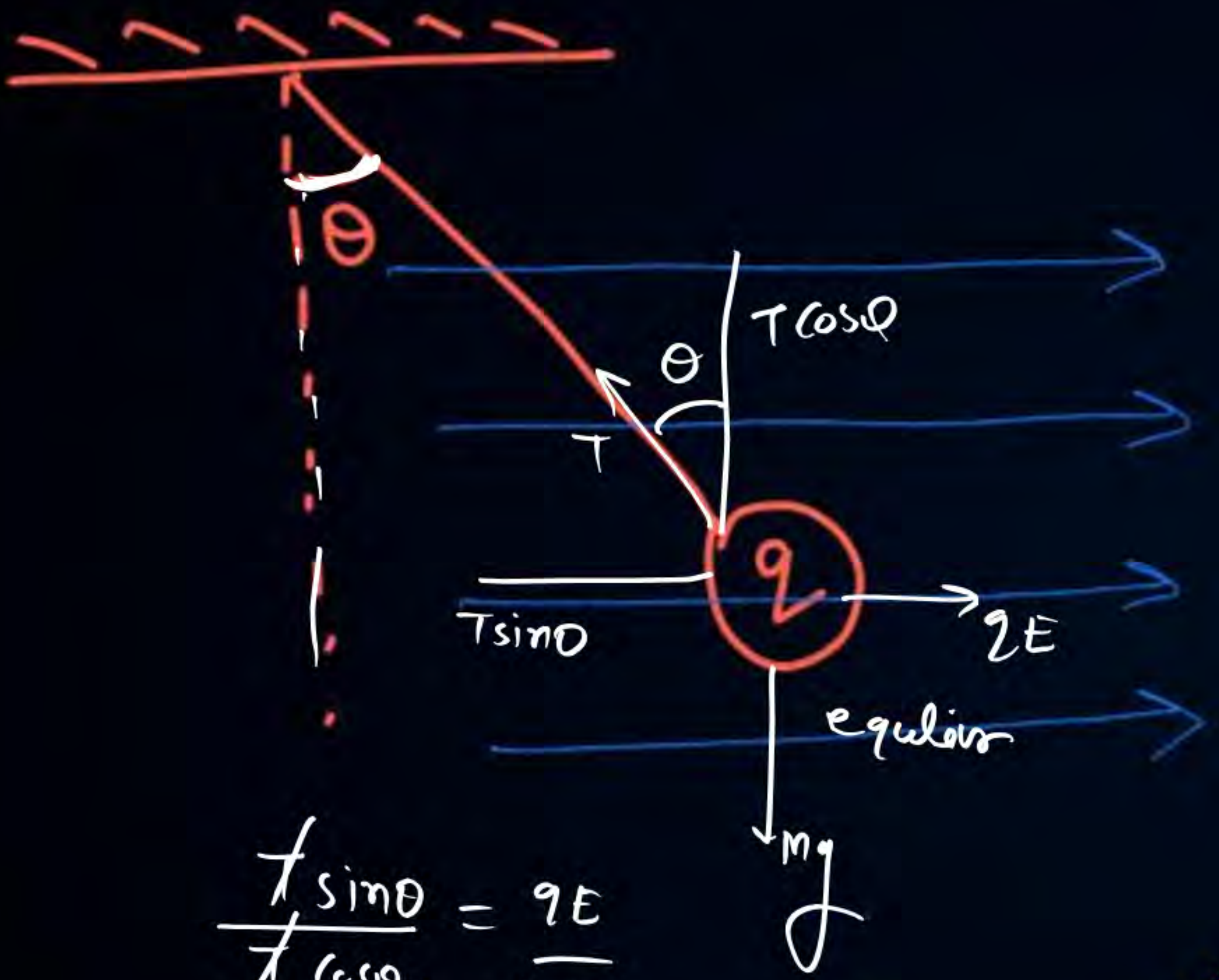


$$T = 2\pi\sqrt{\frac{l}{g-\frac{qE}{m}}}$$



$$T = 2\pi\sqrt{\frac{l}{g-\frac{qE}{m}}}$$

Find Time Period of oscillation.



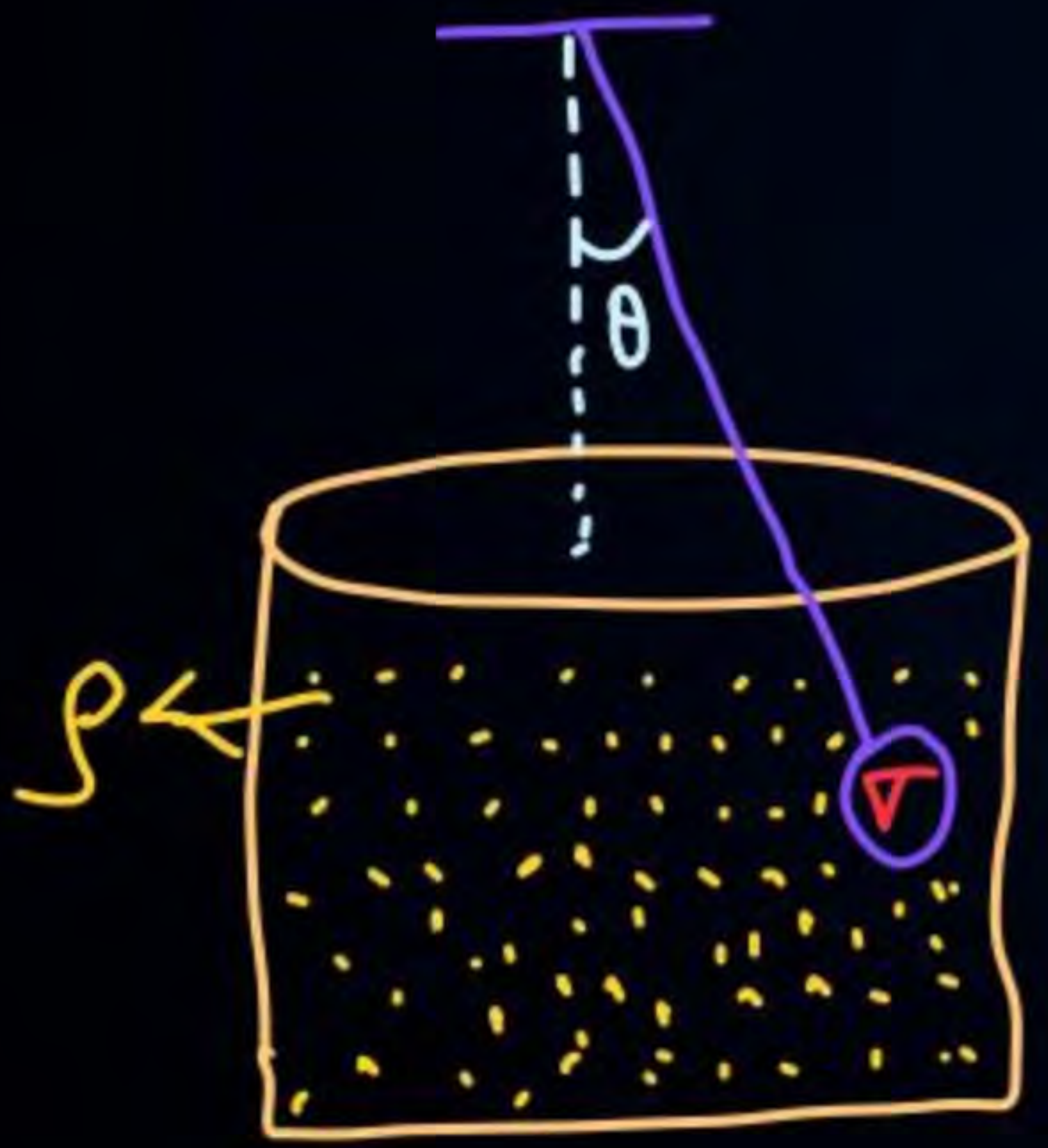
17/10

$$\frac{T\sin\theta}{T\cos\theta} = \frac{qE}{mg}$$

$\tan\theta = \frac{qE}{mg}$ at eqlbm

$$T = 2\pi\sqrt{\frac{l}{\sqrt{g^2+\left(\frac{qE}{m}\right)^2}}}$$

oscillation of simple pendulum in fluid, density of fluid ρ and density of object is σ. ($\rho < \sigma$), hint → Buyant force $F_B = \rho V g$.





QUESTION

A simple pendulum with a metallic bob has a time period T. The bob is now immersed in a non-viscous liquid and oscillated. If the density of the liquid is 1/4 that of metal, the time period of the same pendulum will be

1. $\frac{T}{\sqrt{3}}$
2. $\frac{2T}{\sqrt{3}}$
3. $\frac{4}{3}T$
4. $\frac{2}{3}T$

If length of Simple Pendulum is very large. compaired to Radius of earth.

MR Ratta

$$T = 2\pi\sqrt{\frac{1}{g\left(\frac{1}{R}+\frac{1}{l}\right)}}$$

→ dim^n समान

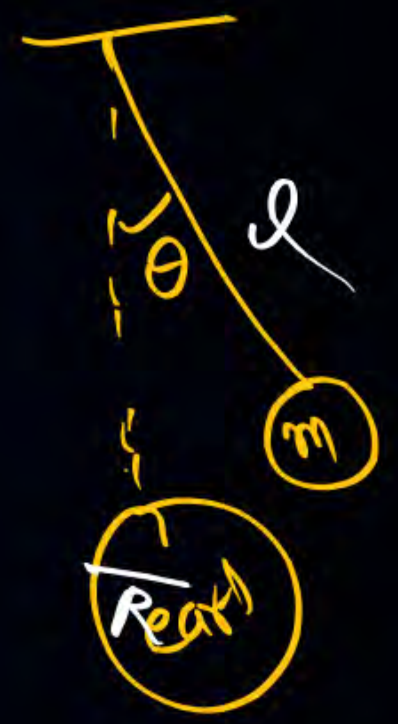
R = Radius of earth

l = length of Pendulum

case-2
If ($l <<<< R$)
Small simple pendulum

$$T = 2\pi\sqrt{\frac{1}{g\left(\frac{1}{R}^{0}+\frac{1}{l}\right)}}$$

$$T = 2\pi\sqrt{\frac{1}{g\left(\frac{1}{l}\right)}} = 2\pi\sqrt{\frac{l}{g}}$$



case-3
(If $l = R$)

$$T = 2\pi\sqrt{\frac{R}{2g}}$$

case-2
If $R <<<< l$ (length of simple pendulum is infinity)

$$T = 2\pi\sqrt{\frac{1}{g\left(\frac{1}{R}+\frac{1}{l}\right)^{0}}} = 2\pi\sqrt{\frac{R}{g}} = 84.4 \text{ min}$$

1.1 hr

QUESTION

If effective length of a simple pendulum is equal to radius of earth (R), time period will be

1. $T = \pi\sqrt{\frac{R}{g}}$

2. $T = 2\pi\sqrt{\frac{2R}{g}}$

3. $T = 2\pi\sqrt{\frac{R}{g}}$

4. $T = 2\pi\sqrt{\frac{R}{2g}}$

Two Pendulum of length 1m and 1.21m starts oscillating at same time after how many oscillation of longer Pendulum they again comes to in same Phase

H/D

QUESTION

Two simple pendulums of length 5 m and 20 m respectively are given small linear displacement in one direction at the same time. They will again be in the phase when the pendulum of shorter length has completed ______ oscillations. [1998]

1. 2
2. 1
3. 5
4. 3


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture-7 | Physics

Oscillations

By- Dr. Manish Raj (MR SIR)



Topics to be covered

1. # (Simple pendulum in fluid)
   H/W
2. # (Spring mass oscillation)
3. #



QUESTION

A simple pendulum suspended from the ceiling of a stationary lift has period T_0. When the lift descends at steady speed, the period is T_1 and when it descends with constant downward acceleration, the period is T_2. Which one of the following is true?

1. $T_0 = T_1 = T_2$
2. $T_0 = T_1 < T_2$
3. $T_0 = T_1 > T_2$
4. $T_0 < T_1 < T_2$

$T_0 = T_1$

$T_2 = 2\pi\sqrt{\frac{l}{g'}}$

$T_0 = T_1 < T_2$

QUESTION

A pendulum suspended from the roof of an elevator at rest has a time period T_1; when the elevator moves up with an acceleration a its time period becomes T_2; when the elevator moves down with an acceleration a, its time period becomes T_3, then:

1. $T_1 = \sqrt{(T_3 T_2)}$
2. $T_1 = \sqrt{T_1^2 + T_2^2}$
3. $T_1 = \dfrac{T_2 T_3 \sqrt{2}}{\sqrt{T_2^2 + T_3^3}}$
4. $T_1 = \dfrac{T_2^2}{T_3}$



$$\frac{2}{T_1^2} = \frac{1}{T_2^2} + \frac{1}{T_3^2}$$

$$\frac{2}{T_1^2} = \frac{T_3^2 + T_2^2}{T_2^2 T_3^2}$$

$$T_1 = \sqrt{\frac{2 T_2^2 T_3^2}{T_2^2 + T_3^2}}$$

$$T_1 = \frac{T_2 T_3 \sqrt{2}}{\sqrt{T_2^2 + T_3^2}}$$ Ans

QUESTION

Two simple pendulums of length 5 m and 20 m respectively are given small linear displacement in one direction at the same time. They will again be in the phase when the pendulum of shorter length has completed ___(2)___ oscillations. [1998]

(1) 2

(2) 1

(3) 5

(4) 3

$T_1 = 2\pi\sqrt{\frac{5m}{g}}$ — (1) $T_2 = 2\pi\sqrt{\frac{20m}{g}}$ — (11)

Small time Period (fast) (large time period) (slow)

$T_1 = T_0$ (1st) $T_2 = 2T_0$

1-oscill (T_0) ($2T_0$) 1-osci.

2nd method

at same phase

→ large pendulum complete n-oscill

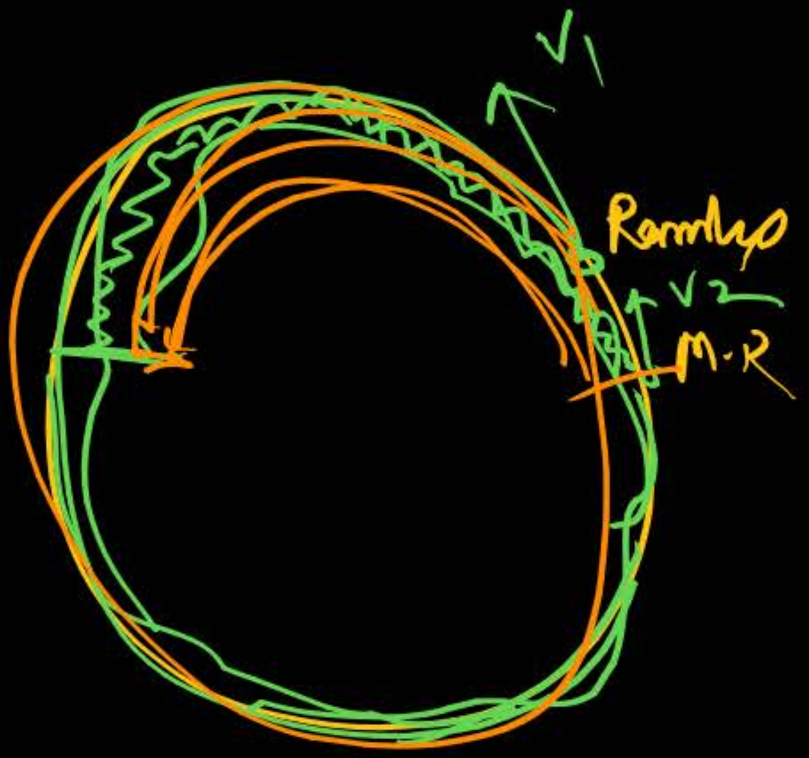
Small pendulum (n+1) oscill

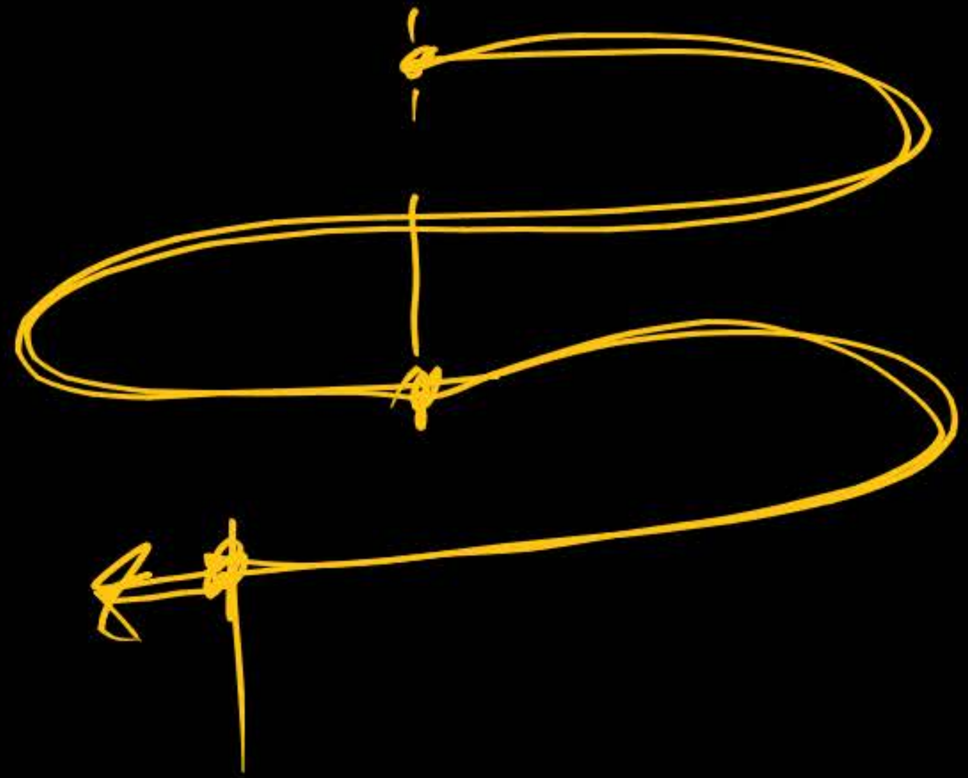
$2\pi(n+1)\sqrt{\frac{5m}{g}} = n\,2\pi\sqrt{\frac{20m}{g}}$

$(n+1)\sqrt{5} = 2n\sqrt{5}$

$n+1 = 2n$

$1 = 2n - n = (n=1)$


V1
V2
M·R



Two Pendulum of length 1m and 1.21m starts oscillating at same time after how many oscillation of longes pendulum they again comes to in same phase

$n = 10$ oscillat

$T_1 = 2\pi\sqrt{\frac{1}{g}}$ $T_2 = 2\pi\sqrt{\frac{1.21}{g}}$

fast — slow

$(n+1)$ — $n \rightarrow$ oscill (l.d)

$(n+1)2\pi\sqrt{\frac{1}{g}} = 2\pi\sqrt{\frac{1.21}{g}}\,n$

$n+1 = n\sqrt{\frac{121}{100}}$

$(n+1) = n\frac{11}{10}$

$10n + 10 = 11n$

$11n - 10n = 10$

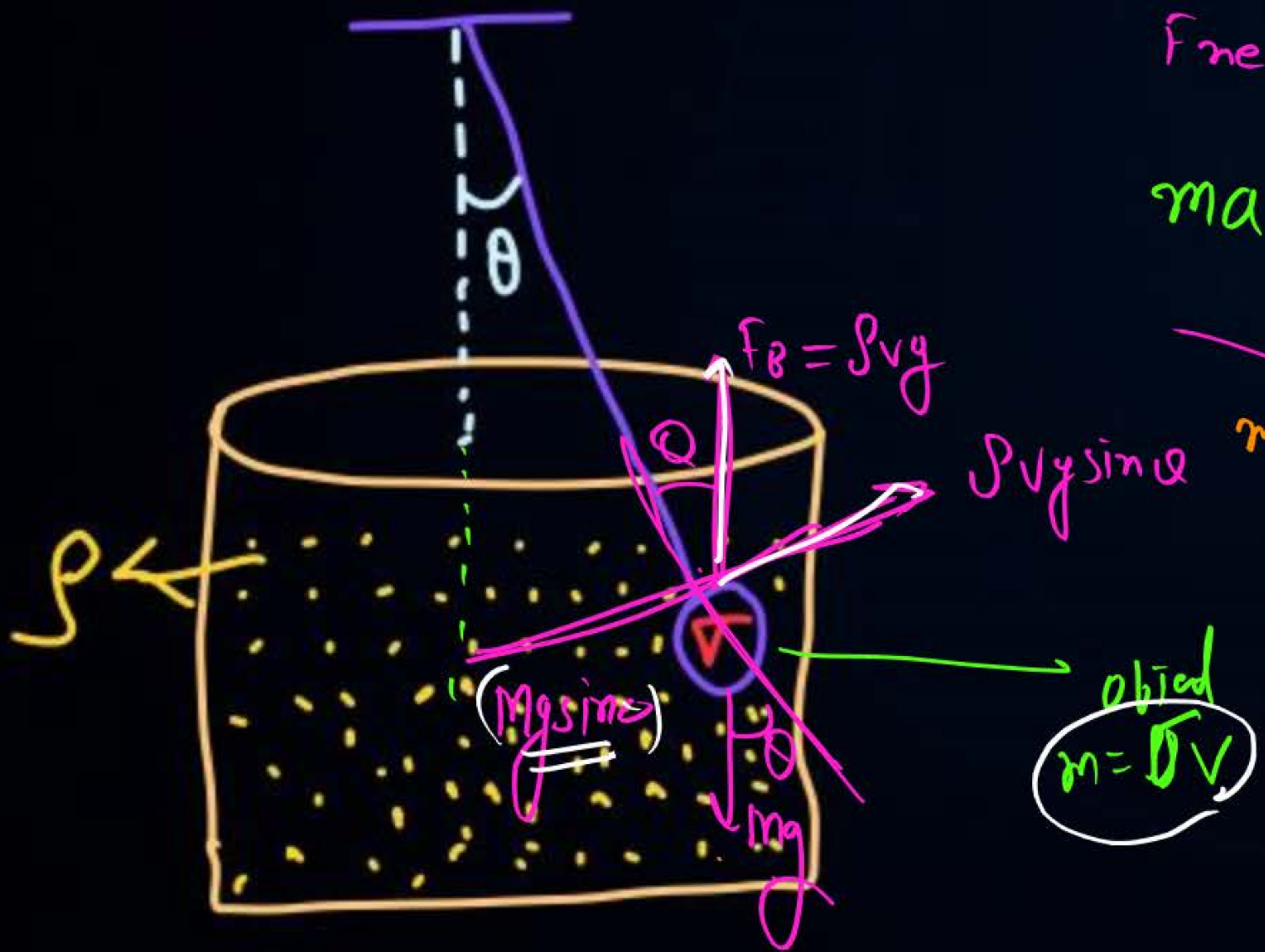
$n = 10$ oscill

Smaller → 11 oscil

Two Pendulum of length 1m and 1.21m starts oscillating at same time after how many oscillation of longes Pendulum they again comes to in same Phase

Oscillation of simple pendulum in fluid, density of fluid ρ and density of object is σ. $(\rho < \sigma)$, hint → Buyant force $F_B = \rho V g$.

(ρ liquid, σ object)



$F_{ne} = mg\sin\theta - \rho v g \sin\theta$

$ma = (\sigma v g - \rho v g)\sin\theta$

$ma = \sigma v g \left(1 - \frac{\rho}{\sigma}\right)\sin\theta$

$ma = mg\left(1 - \frac{\rho}{\sigma}\right)\theta$

$a = g\left(1 - \frac{\rho}{\sigma}\right)\theta$

→ g_{eff}

$T = 2\pi\sqrt{\frac{l}{g\left(1 - \frac{\rho}{\sigma}\right)}}$

Ramlal





$$\frac{F}{m} = \frac{mg - qE}{m}$$

$$T = 2\pi\sqrt{\frac{l}{g - \left(\frac{qE}{m}\right)}}$$

$$T = 2\pi\sqrt{\frac{l}{g - \frac{\rho V g}{m}}}$$



$$T = 2\pi\sqrt{\frac{l}{g\left[1 - \frac{\rho V}{\sigma V}\right]}}$$

$$T = 2\pi\sqrt{\frac{l}{g\left(1 - \frac{\rho}{\sigma}\right)}}$$

QUESTION

A simple pendulum with a metallic bob has a time period T. The bob is now immersed in a non-viscous liquid and oscillated. If the density of the liquid is 1/4 that of metal, the time period of the same pendulum will be

1. $\frac{T}{\sqrt{3}}$
2. $\frac{2T}{\sqrt{3}}$ Ans
3. $\frac{4}{3}T$
4. $\frac{2}{3}T$

$T = 2\pi\sqrt{\frac{l}{g}}$

$\rho = \frac{\sigma}{4}$

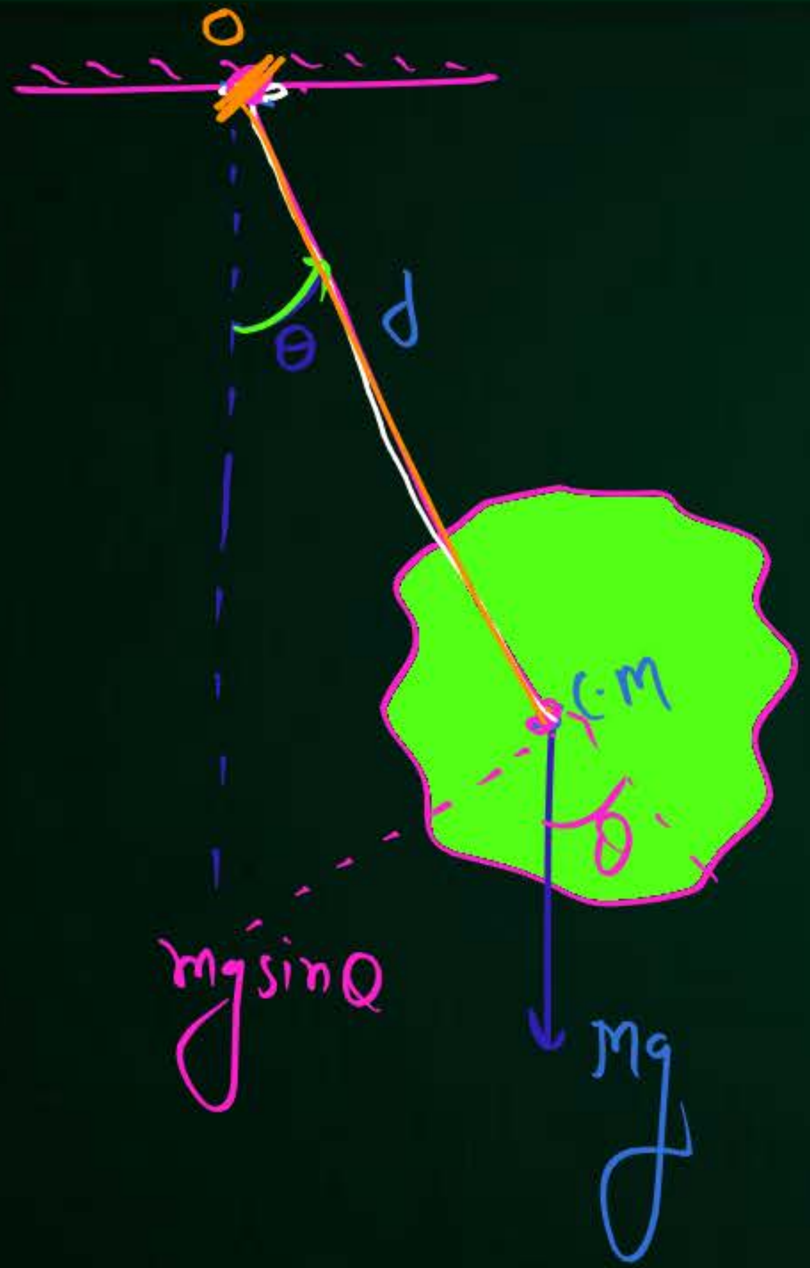
$T' = 2\pi\sqrt{\frac{l}{g\left(1-\frac{\sigma}{4\sigma}\right)}}$

$T' = 2\pi\sqrt{\frac{l}{g\left(\frac{3}{4}\right)}} = 2\pi\sqrt{\frac{l}{g}\frac{4}{3}}$

$= 2\pi\sqrt{\frac{l}{g}}\frac{2}{\sqrt{3}}$

$T' = \frac{T2}{\sqrt{3}}$

Compound Pendulum



$\tau_0 = mg\sin\theta \times d$ → from SHM θ → small

$I_0 \alpha = mgd\,\theta$

$\vec{\alpha} = -\frac{mgd}{I_0}\vec{\theta}$

$$T = 2\pi\sqrt{\frac{I_0}{mgd}}$$

$\omega^2 = \frac{mgd}{I_0}$

$\omega = \sqrt{\frac{mgd}{I_0}}$

$\frac{2\pi}{T} = \sqrt{\frac{mgd}{I_0}}$

I_0 = M.O.I about point of suspension

d = dist^n B/w centre of mass & point of suspension.

m = mass of object

$T = 2\pi\sqrt{\frac{I_0}{mgd}}$

Simple pendulum

$T = 2\pi\sqrt{\frac{md^2}{mgd}} = 2\pi\sqrt{\frac{d}{g}}$

Time Period of Physical Pendulum :-



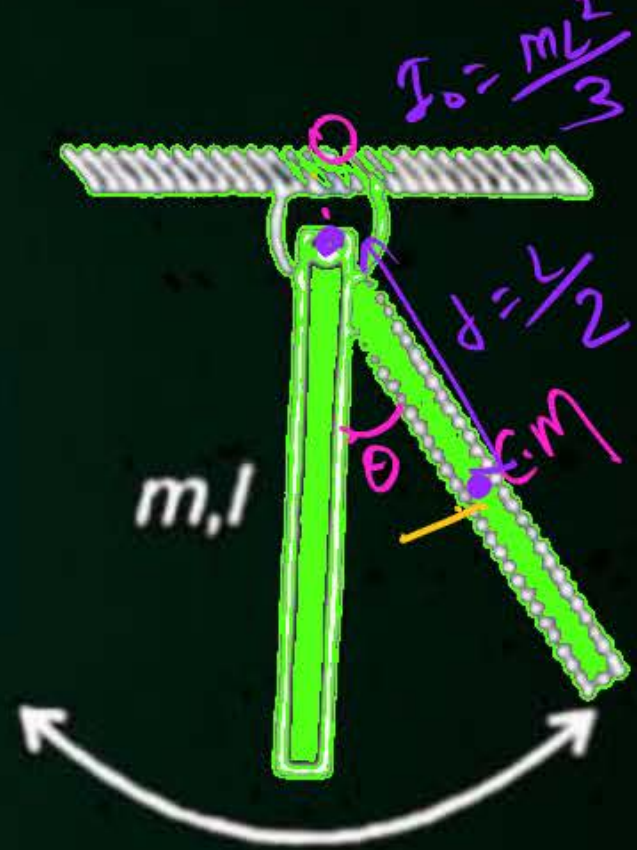
QUESTION

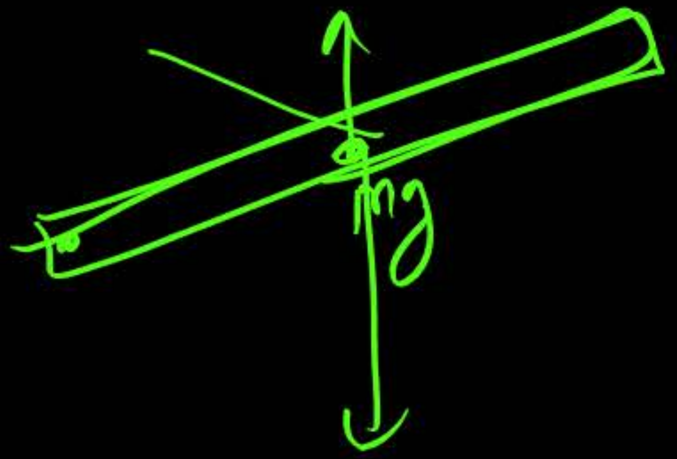
A uniform rod of mass m and length l is suspended about its end. Time period of small angular oscillations is

1. $2\pi\sqrt{\frac{l}{g}}$
2. $2\pi\sqrt{\frac{2l}{g}}$
3. $2\pi\sqrt{\frac{2l}{3g}}$
4. $2\pi\sqrt{\frac{l}{3g}}$

$$T = 2\pi\sqrt{\frac{mL^2 \cdot 2}{3mgL}}$$

$$T = 2\pi\sqrt{\frac{2L}{3g}}$$







$$I = \frac{ml^2}{12}$$

$$d = 0$$

$$T = 2\pi\sqrt{\frac{I}{mg \cdot 0}} = \infty$$

$$f = \frac{1}{T} = \frac{1}{\infty} = 0$$



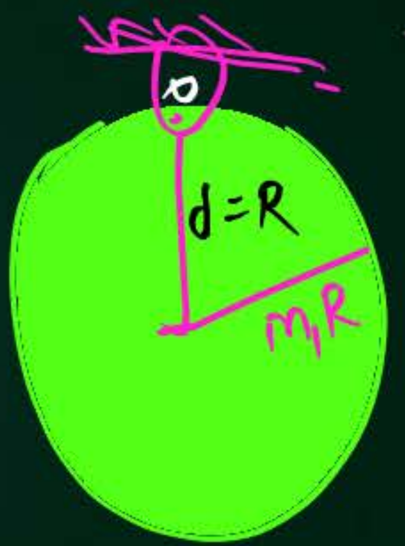
QUESTION

A uniform disc of mass M and radius R is suspended in vertical plane from a point on its periphery. Its time period of oscillation is

1. $2\pi\sqrt{\frac{3R}{g}}$
2. $2\pi\sqrt{\frac{R}{3g}}$
3. $2\pi\sqrt{\frac{2R}{3g}}$
4. $2\pi\sqrt{\frac{3R}{2g}}$

Ans

Disc (m, R)



$I_0 = \frac{mR^2}{2} + mR^2 = \frac{3mR^2}{2}$

$d = R$

$T = 2\pi\sqrt{\frac{3mR^2}{2mgR}}$

$T = 2\pi\sqrt{\frac{3R}{2g}}$

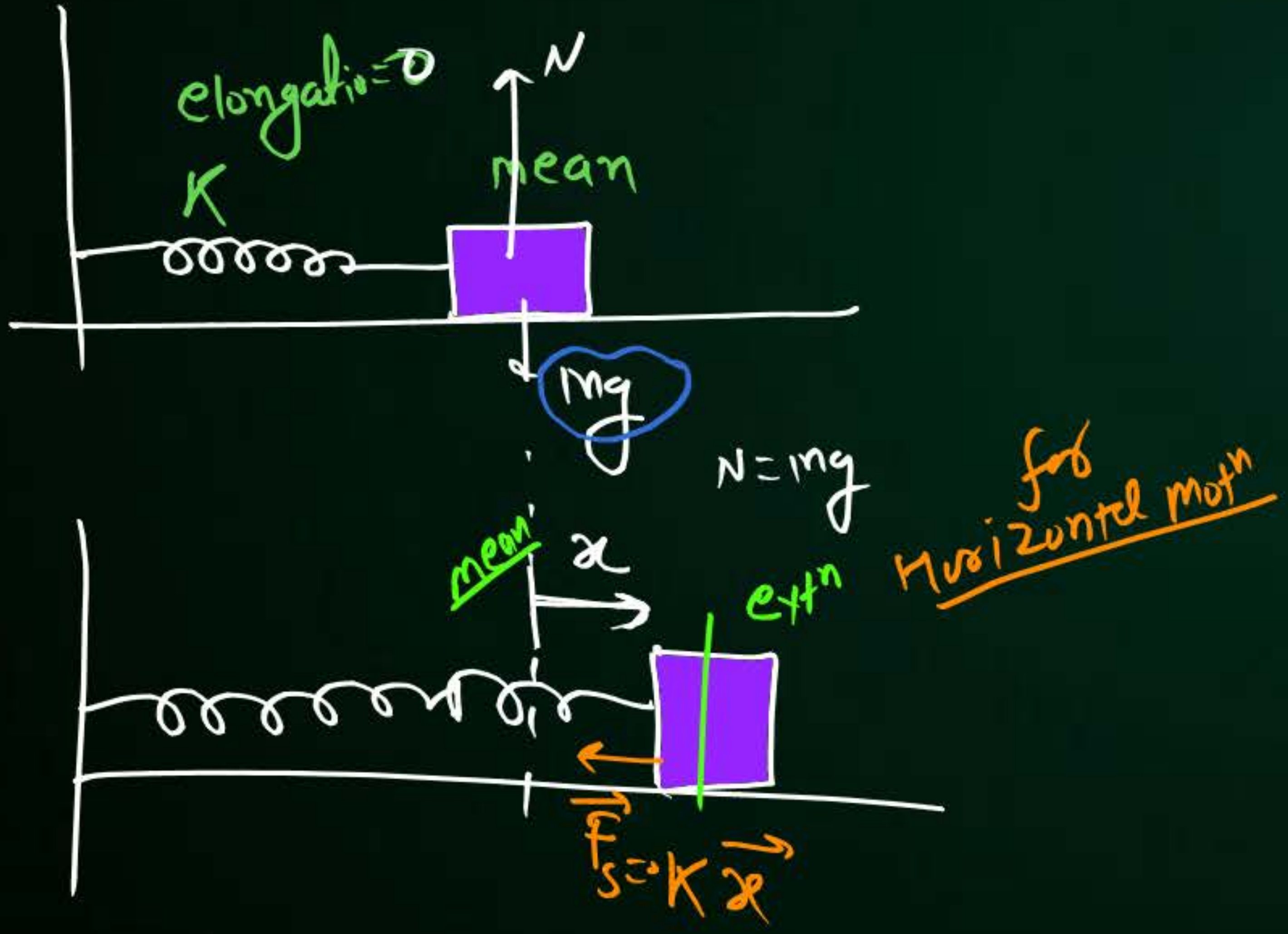
Spring-Mass Oscillation

Constant force kabhi S.H.M नहीं कराता

$f \propto -x$

$F = -Kx$

$\tau \propto -\theta$



$\vec{F}_s = -K\vec{x}$

$ma = -Kx$

$a = -\frac{K}{m}x$

$\omega^2 = \frac{K}{m}$

$\omega = \sqrt{\frac{K}{m}}$

$2\pi f = \sqrt{\frac{K}{m}}$

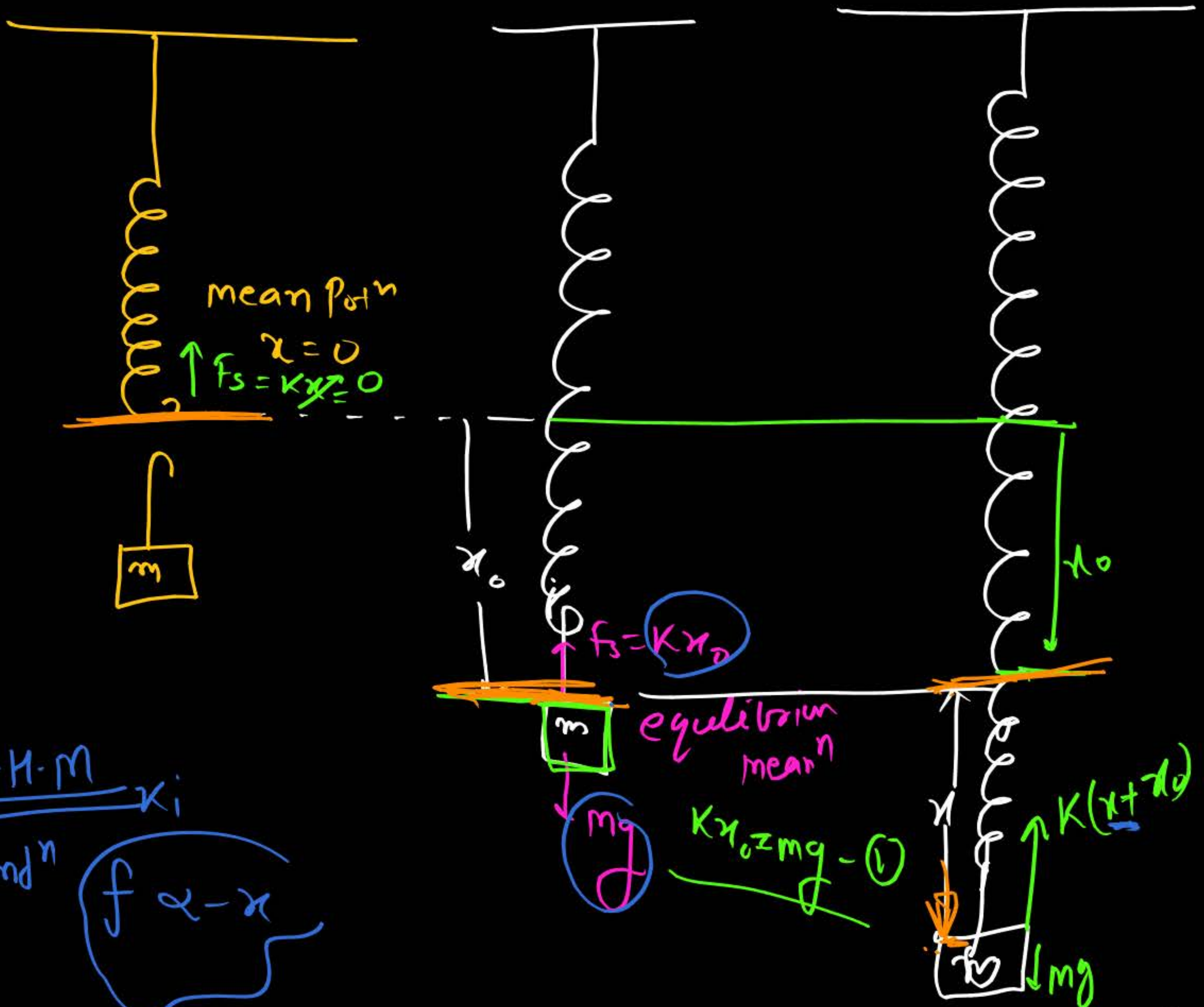
$$f = \frac{1}{2\pi}\sqrt{\frac{K}{m}}$$

$$T = 2\pi\sqrt{\frac{m}{K}}$$

does not depend on Amplitude

$T \propto \sqrt{Mass}$

$T \propto \frac{1}{\sqrt{K}}$



S.H.M condⁿ

$f \propto -x$

$F_{net} = K(x+x_0) - mg$

$m\,a_{net} = Kx + Kx_0 - mg$

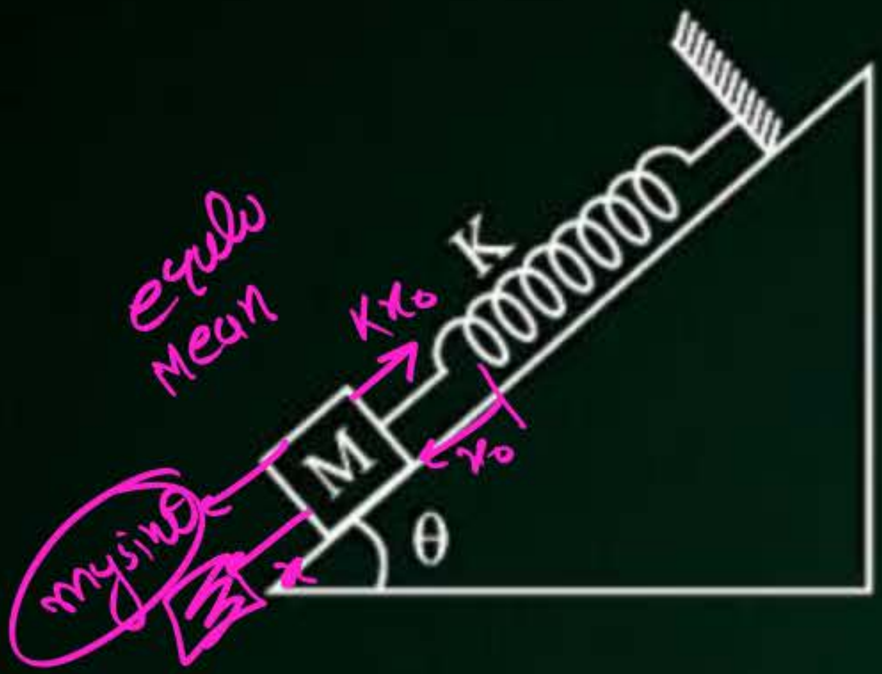
$ma = Kx + mg - mg$

$a = \frac{Kx}{m}$ ← scalar form

$a = -\left(\frac{K}{m}\right)x$ → ω^2

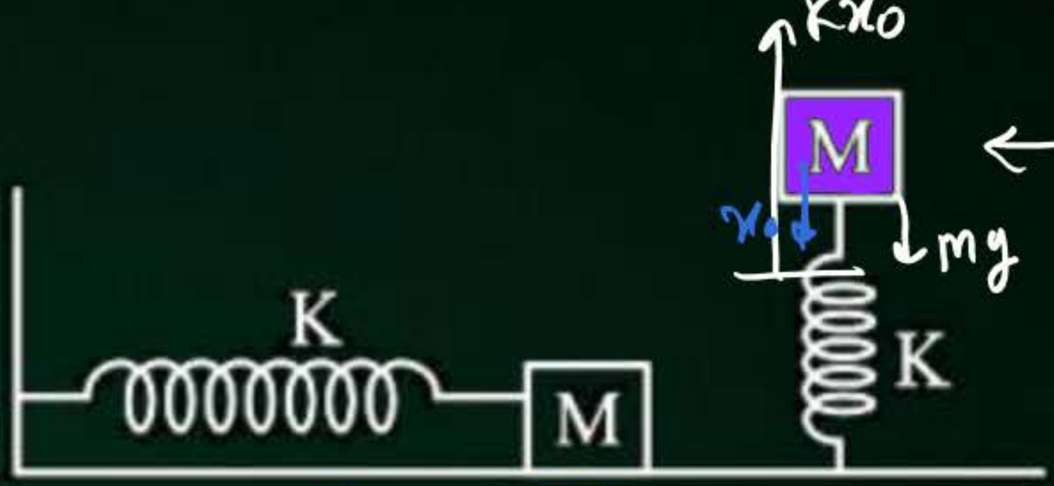
$\omega = \sqrt{\frac{K}{m}} = \frac{2\pi}{T}$

$$T = 2\pi\sqrt{\frac{m}{K}}$$



$Kx = F_{net} = ma$

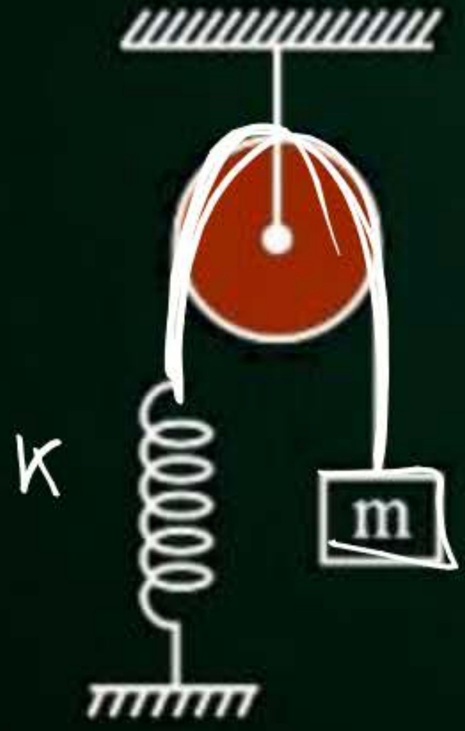
$T = 2\pi\sqrt{\frac{m}{K}}$



← at equilibrium

$Kx_0 = mg$ —(1)

$T = 2\pi\sqrt{\frac{m}{K}}$

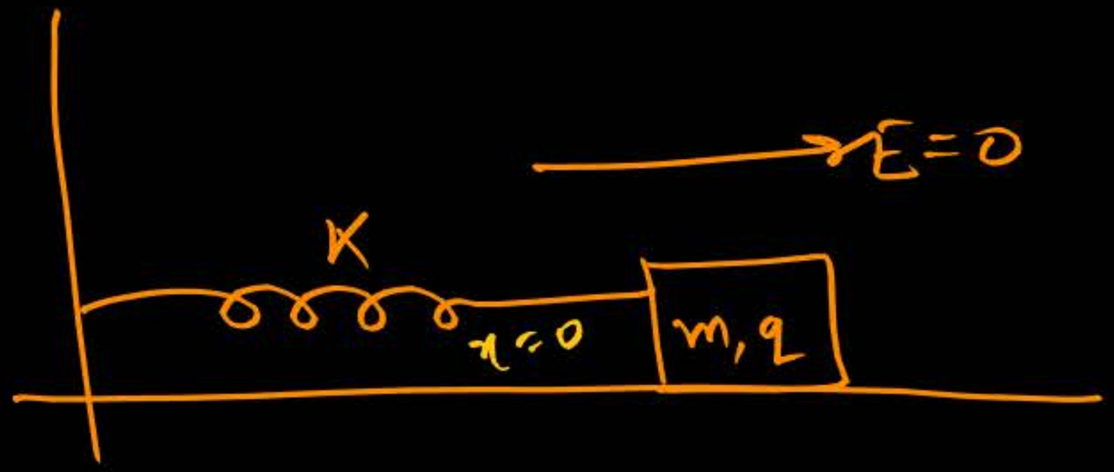


$T = 2\pi\sqrt{\frac{m}{K}}$ ✓

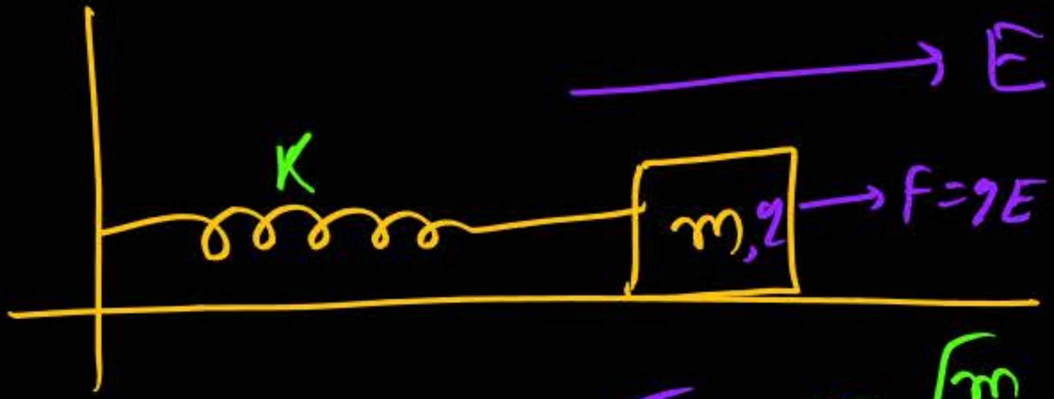
$T = T_0$ ✓

$T > T_0$

$T < T_0$

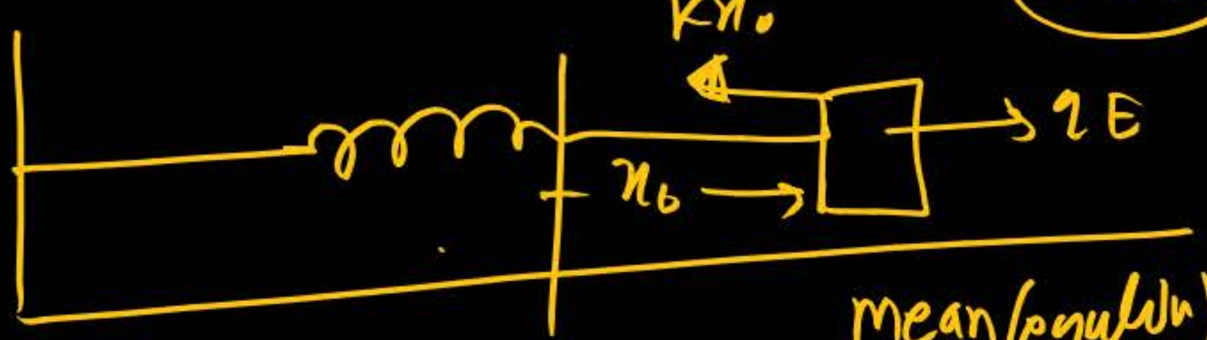


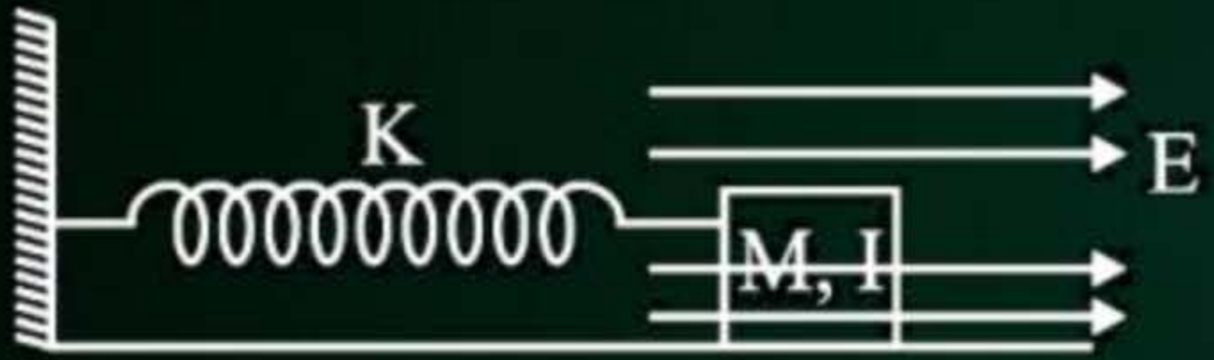
$T_0 = 2\pi\sqrt{\frac{m}{K}}$



$T = 2\pi\sqrt{\frac{m}{K}}$

$Kx_0 = qE$





$$T = 2\pi\sqrt{m/k}$$

QUESTION

A mass m is vertically suspended from a spring of negligible mass; the system oscillates with a frequency n. What will be the frequency of the system, if a mass 4m is suspended from the same spring? [1998]

1. $\frac{n}{2}$ ✓
2. $4n$
3. $\frac{n}{4}$
4. $2n$

$$T = 2\pi\sqrt{\frac{m}{k}}$$

$$f \propto \frac{1}{\sqrt{m}}$$

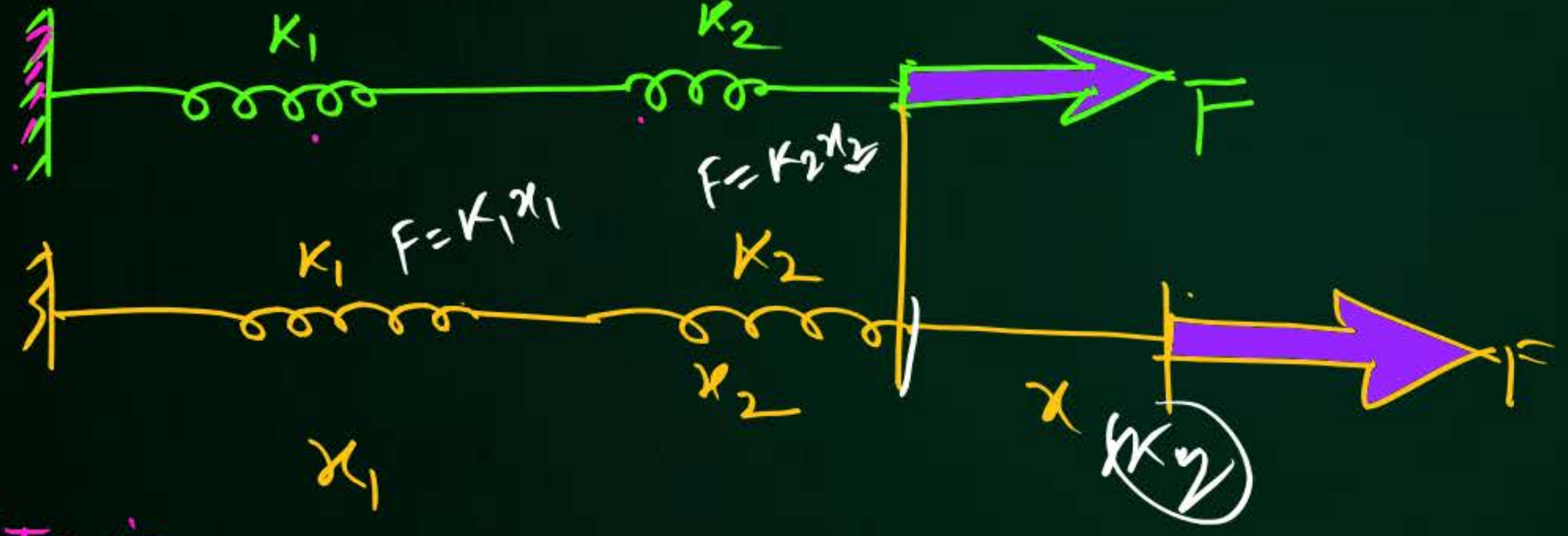
$$\frac{n}{n'} \propto \frac{\sqrt{4m}}{\sqrt{m}} = 2$$

$$\frac{n}{n'} = 2$$

$$n' = \frac{n}{2}$$

Combination of Spring

1. Series Combination: (Ideal spring)



(Tension or spring force) Same at all Point

$x_1 + x_2 = x$

$x_1 + x_2 = x$

$\frac{F}{K_1} + \frac{F}{K_2} = \frac{F}{K_{eq}}$

$$\frac{1}{K_{eq}} = \frac{1}{K_1} + \frac{1}{K_2}$$

$$K_{eq} = \frac{K_1 K_2}{K_1 + K_2}$$

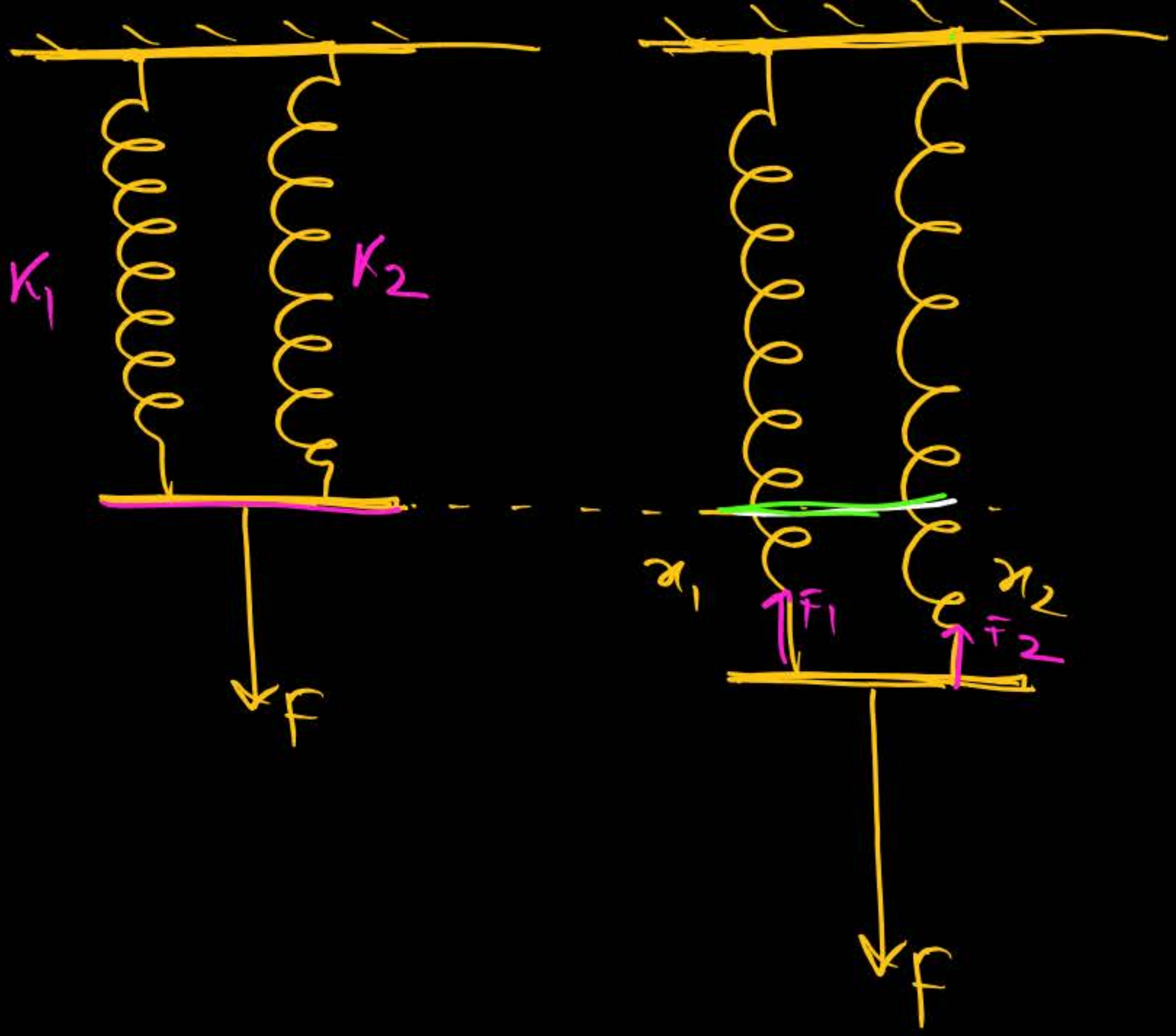
If $K_1 = K_2 = K$

$$K_{eq} = \frac{K}{2}$$

If there is n-Identical spring in series.

$$K_{eq} = \frac{K}{n}$$

Parall Comb^n of spring



$x_1 = x_2 = x$ = elongatn same in Parallel

$F = F_1 + F_2$

$K_{eq} x = K_1 x_1 + K_2 x_2$

$K_{eq} x = K_1 x + K_2 x$

$$K_{eq} = K_1 + K_2$$

If $K_1 = K_2$

$K_{eq} = 2K$.

If there is n-Indentic spring in Parall of spring const 'K' then $K_{eq} = nK$

QUESTION

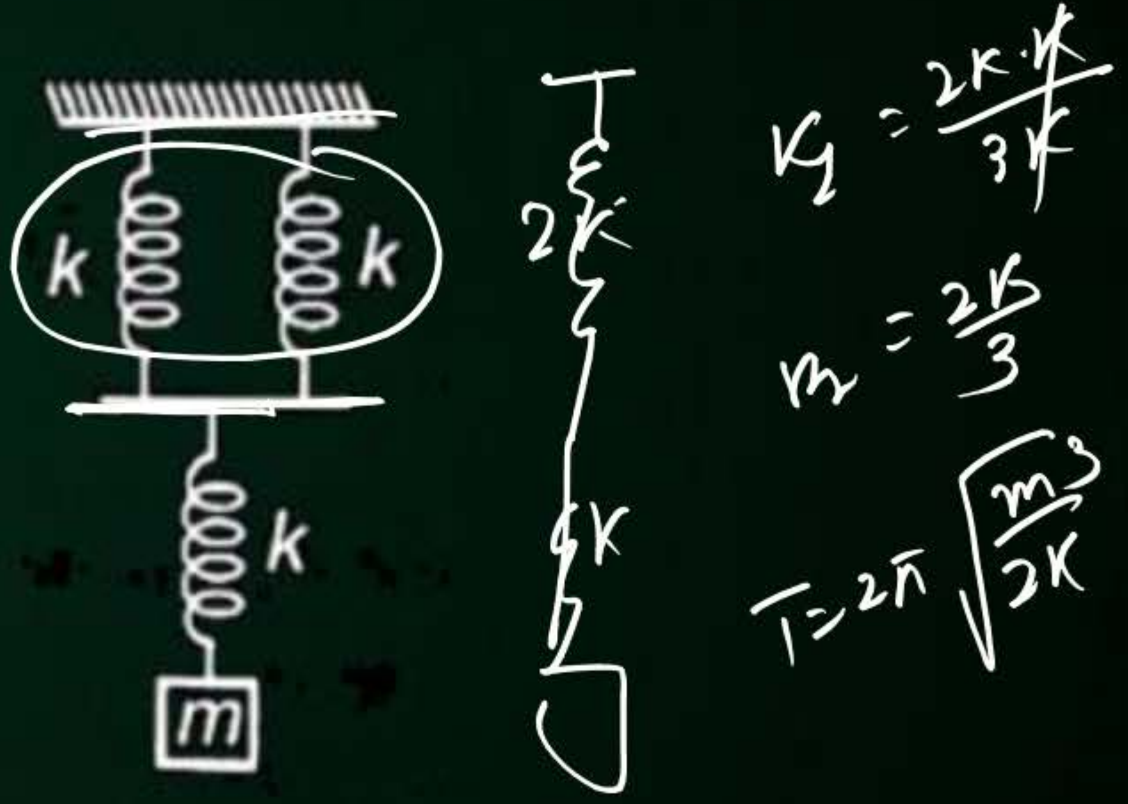
A block of mass m hangs from three springs having same spring constant k. If the mass is slightly displaced downwards, the time period of oscillation will be

(1) $2\pi\sqrt{\frac{m}{3k}}$

(2) $2\pi\sqrt{\frac{3m}{2k}}$

(3) $2\pi\sqrt{\frac{2m}{3k}}$

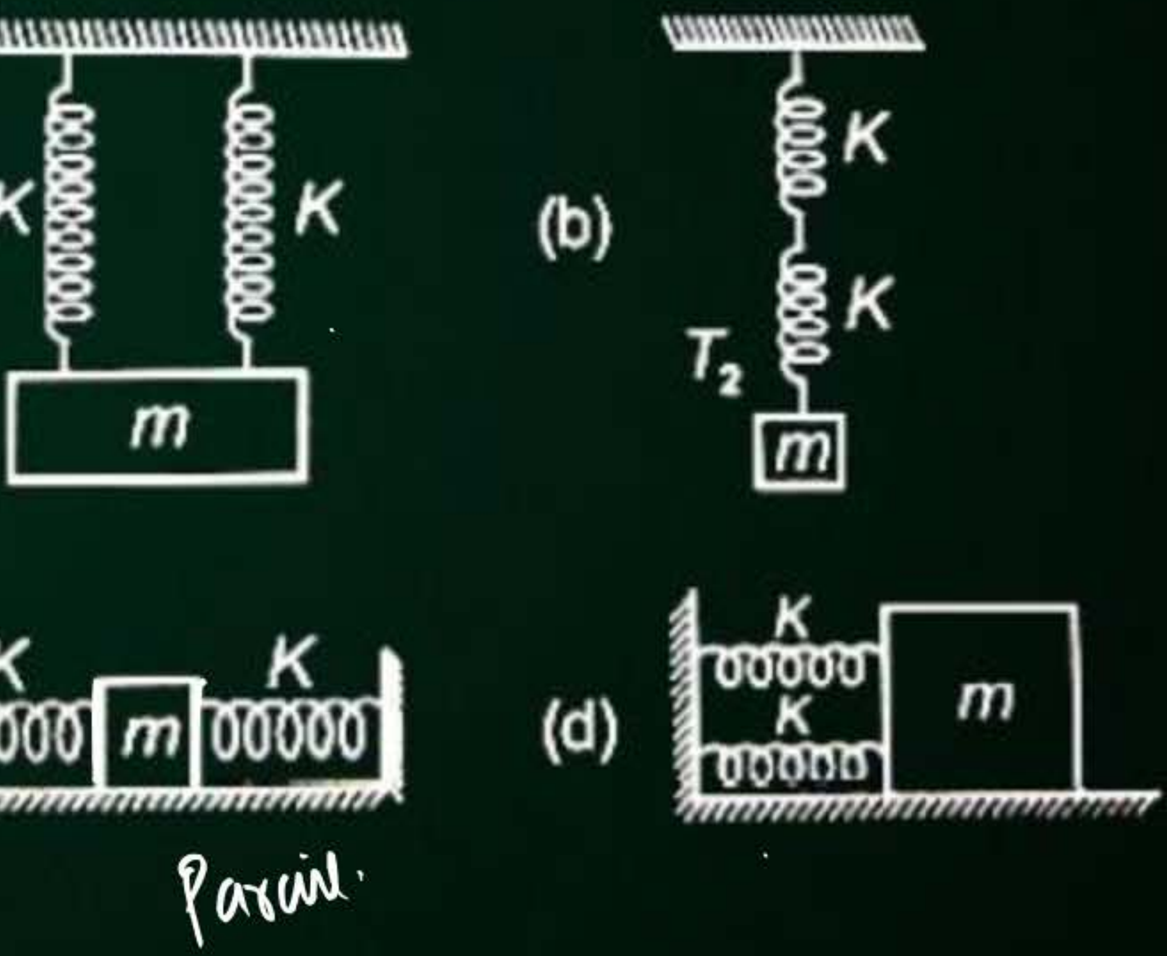
(4) $2\pi\sqrt{\frac{3k}{m}}$



QUESTION

A mass m is attached to two springs of same force constant K, as shown in following four arrangements. It T_1, T_2, T_3 and T_4 respectively be the time periods of oscillation in the following arrangements, in which case time period is maximum ?

1. (a)
2. (b)
3. (c)
4. (d)



QUESTION

A body of mass m is attached to the lower end of a spring whose upper end is fixed. The spring has negligible mass. When the mass m is slightly pulled down and released, it oscillates with a time period of 3 s. When the mass m is increased by 1 kg, the time period of oscillations becomes 5 s. The value of m in kg is

[NEET(Phase-2)-2016]

1. 3/4
2. 4/3
3. 16/9
4. 9/16

QUESTION

A spring block system in horizontal oscillation has a time-period T. Now the spring is cut into four equal parts and the block is re-connected with one of the parts. The new time period of vertical oscillation will be

1. $\frac{T}{\sqrt{2}}$

2. $2T$

3. $\frac{T}{2}$

4. $\frac{T}{2\sqrt{2}}$

QUESTION

A block of mass m is suspended separately by two different springs have time period t_1 and t_2. If same mass is connected to parallel combination of both springs, then its time period is given by

1. $\frac{t_1 t_2}{t_1 + t_2}$
2. $\frac{t_1 t_2}{\sqrt{t_1^2 + t_2^2}}$
3. $\sqrt{\frac{t_1 t_2}{t_1 + t_2}}$
4. $t_1 + t_2$

QUESTION

Two identical springs have the same force constant $73.5\ Nm^{-1}$. The elongation produced in each spring in three cases shown in figure-1, figure-2 and figure-3 are $(g = 9.8\ ms^{-2})$

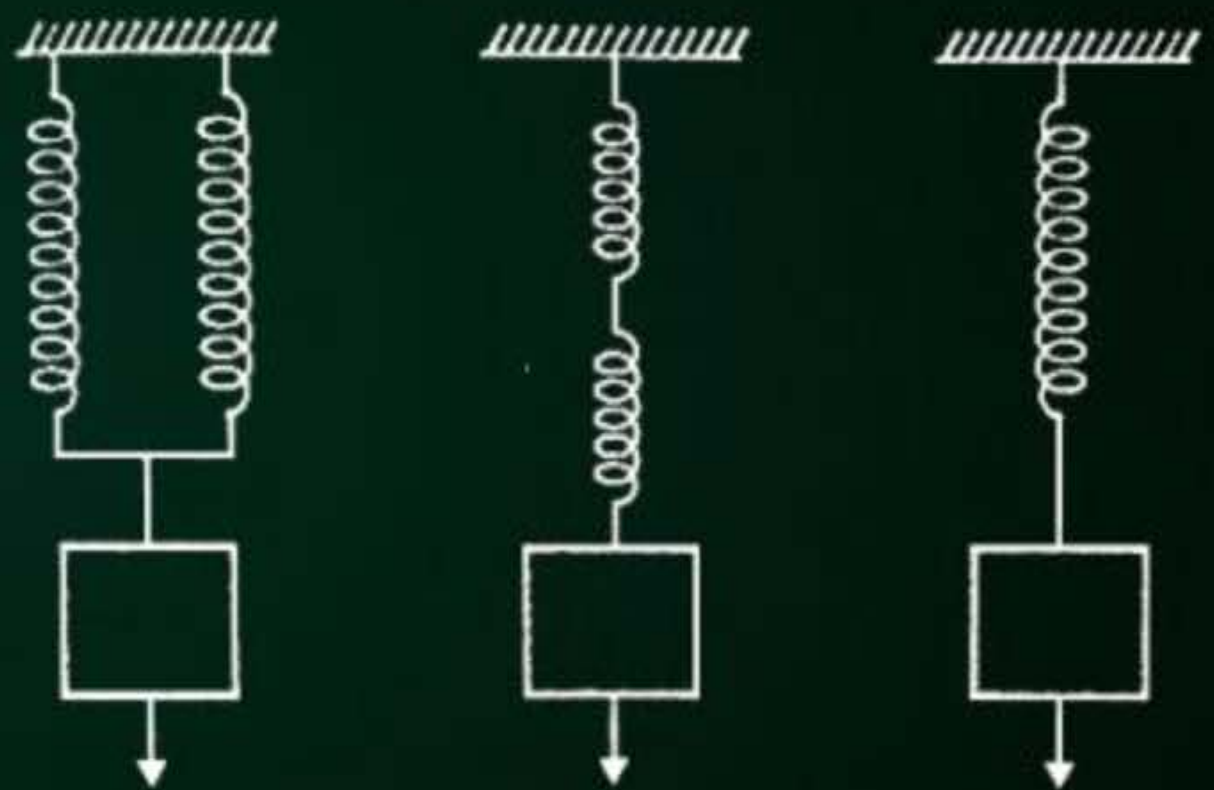


Figure 1 Figure 2 Figure 3

1. $\frac{1}{6}$ m, $\frac{2}{3}$ m, $\frac{1}{3}$ m
2. $\frac{1}{3}$ m, $\frac{1}{3}$ m, $\frac{1}{3}$ m
3. $\frac{2}{3}$ m, $\frac{1}{3}$ m, $\frac{1}{6}$ m
4. $\frac{1}{3}$ m, $\frac{4}{3}$ m, $\frac{2}{3}$ m

H/W


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture-8 | Physics

Oscillations

By- Dr. Manish Raj (MR SIR)



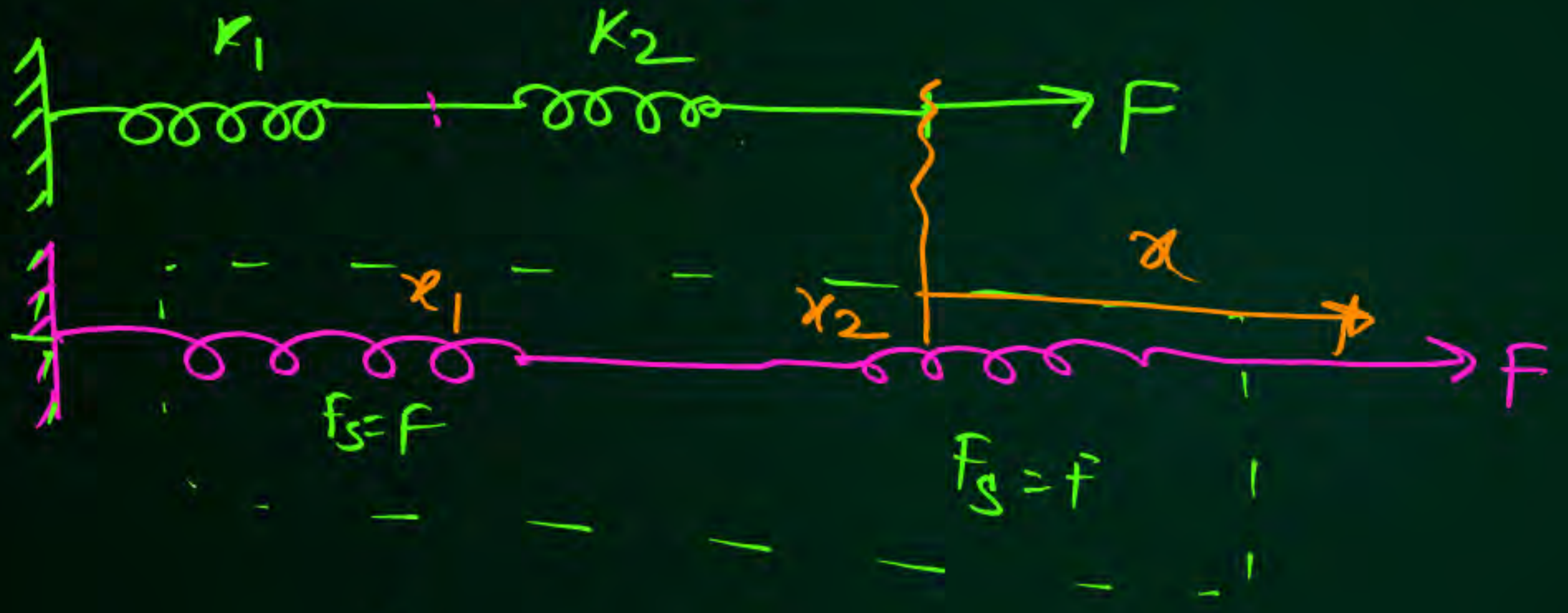
Topics to be covered

1. # Cutting of spring
2. # Question on spring
3. #



Combination of Spring

1. **Series Combination:** {end to end connection}



$$x = x_1 + x_2$$

$$K_{eq} = \frac{K_1 K_2}{K_1 + K_2}$$

$$\left(\frac{1}{K_{eq}} = \frac{1}{K_1} + \frac{1}{K_2}\right)$$

||r comb^n

$K_{eq} = K_1 + K_2$

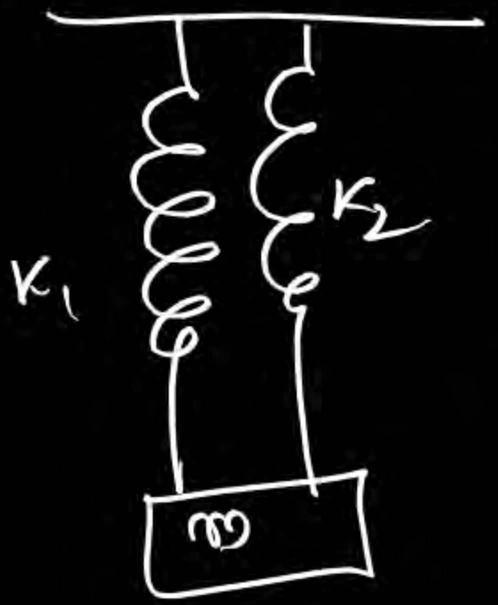
x = same, force diff.





$$k_{eq} = \frac{k_1 k_2}{k_1 + k_2}$$

$$T = 2\pi\sqrt{\frac{m(k_1+k_2)}{k_1 k_2}}$$



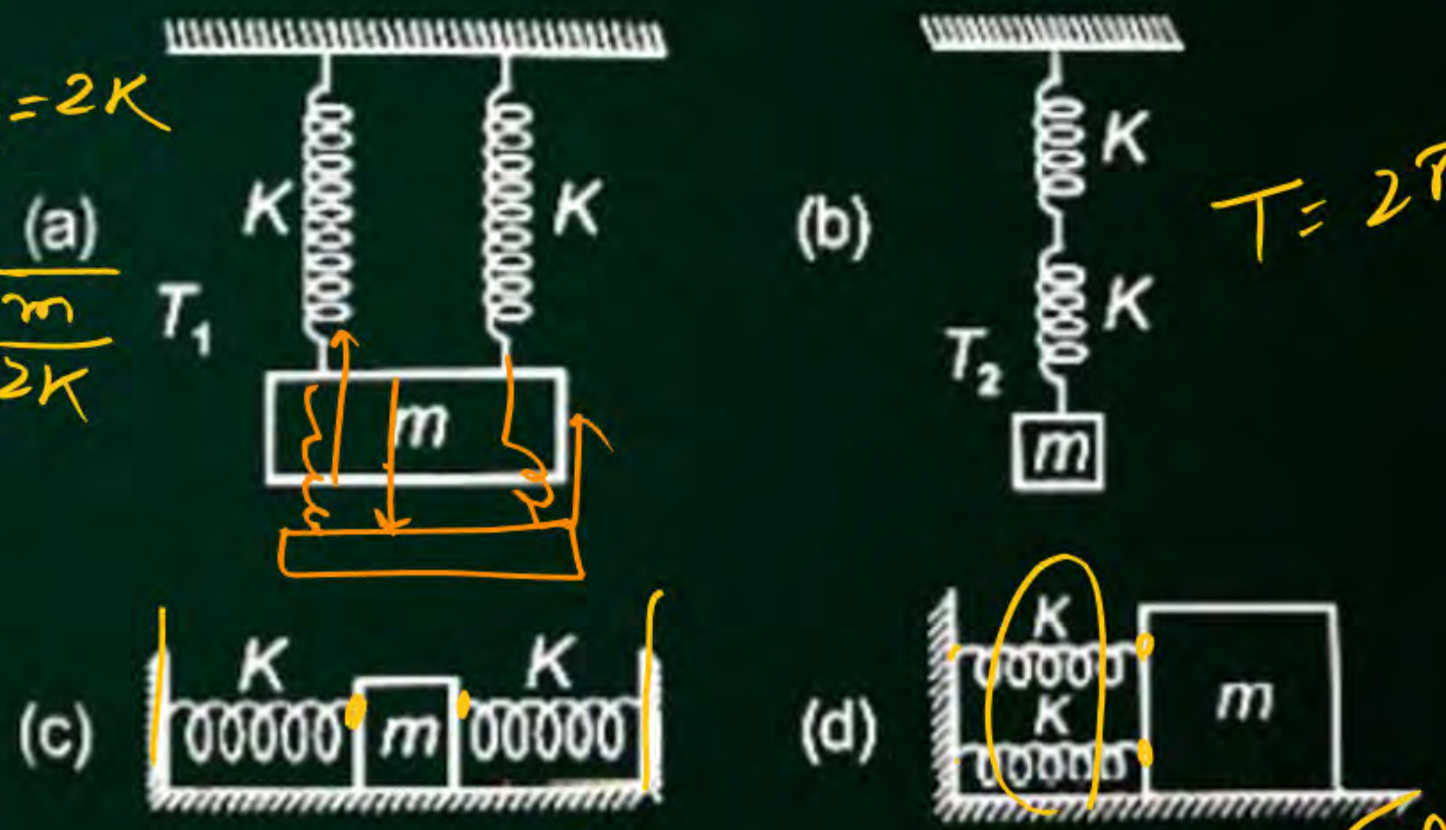
$$k_{eq} = k_1 + k_2$$

$$T = 2\pi\sqrt{\frac{m}{k_1+k_2}}$$ #

QUESTION

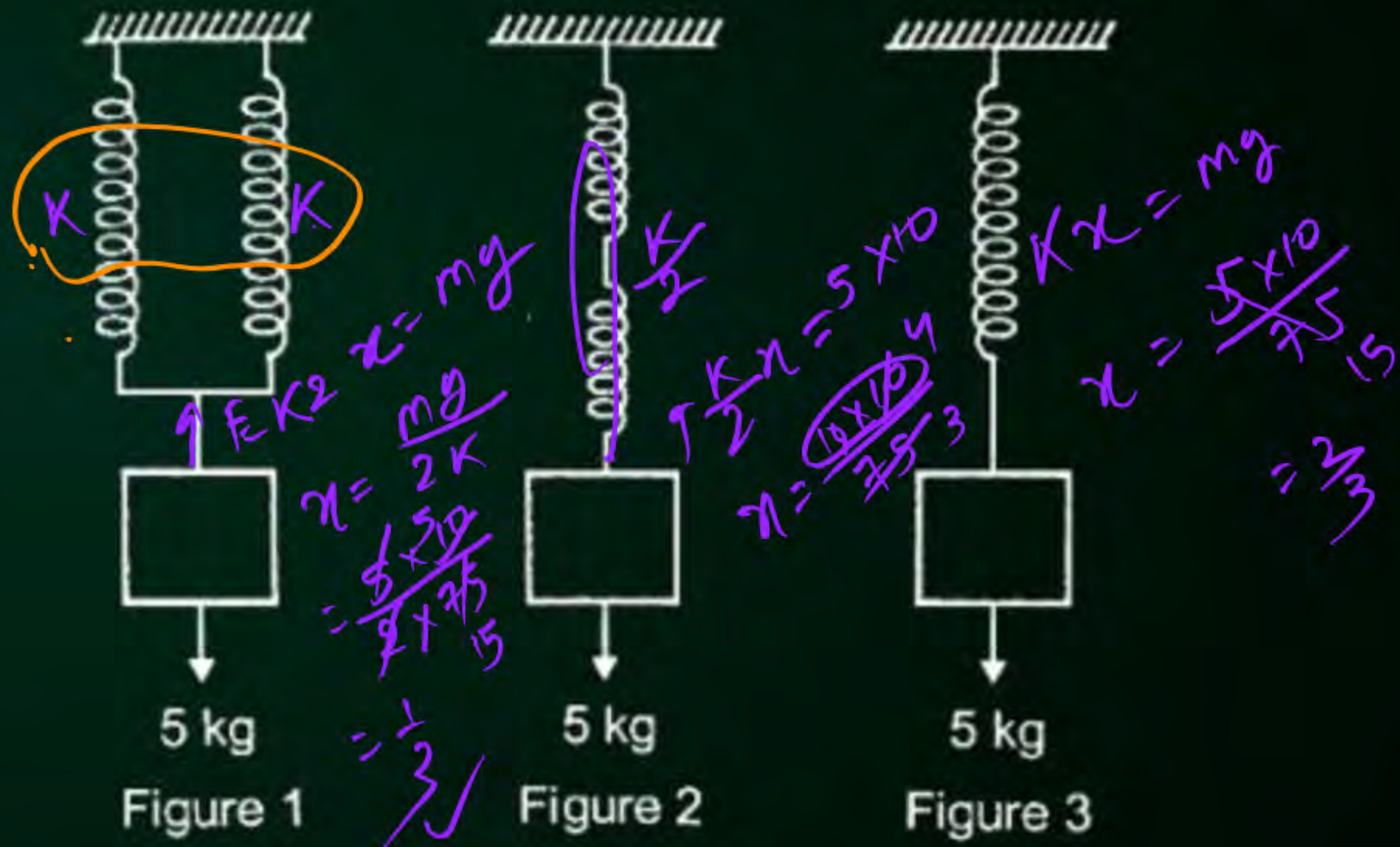
A mass m is attached to two springs of same force constant K, as shown in following four arrangements. It T_1, T_2, T_3 and T_4 respectively be the time periods of oscillation in the following arrangements, in which case time period is maximum ?

1. (a)
2. (b)
3. (c)
4. (d)



QUESTION

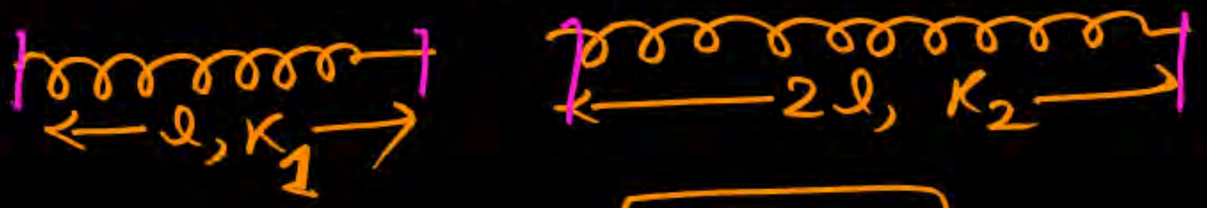
Two identical springs have the same force constant 73.5 Nm^{-1}. The elongation produced in each spring in three cases shown in figure-1, figure-2 and figure-3 are ($g = 9.8\ ms^{-2}$)



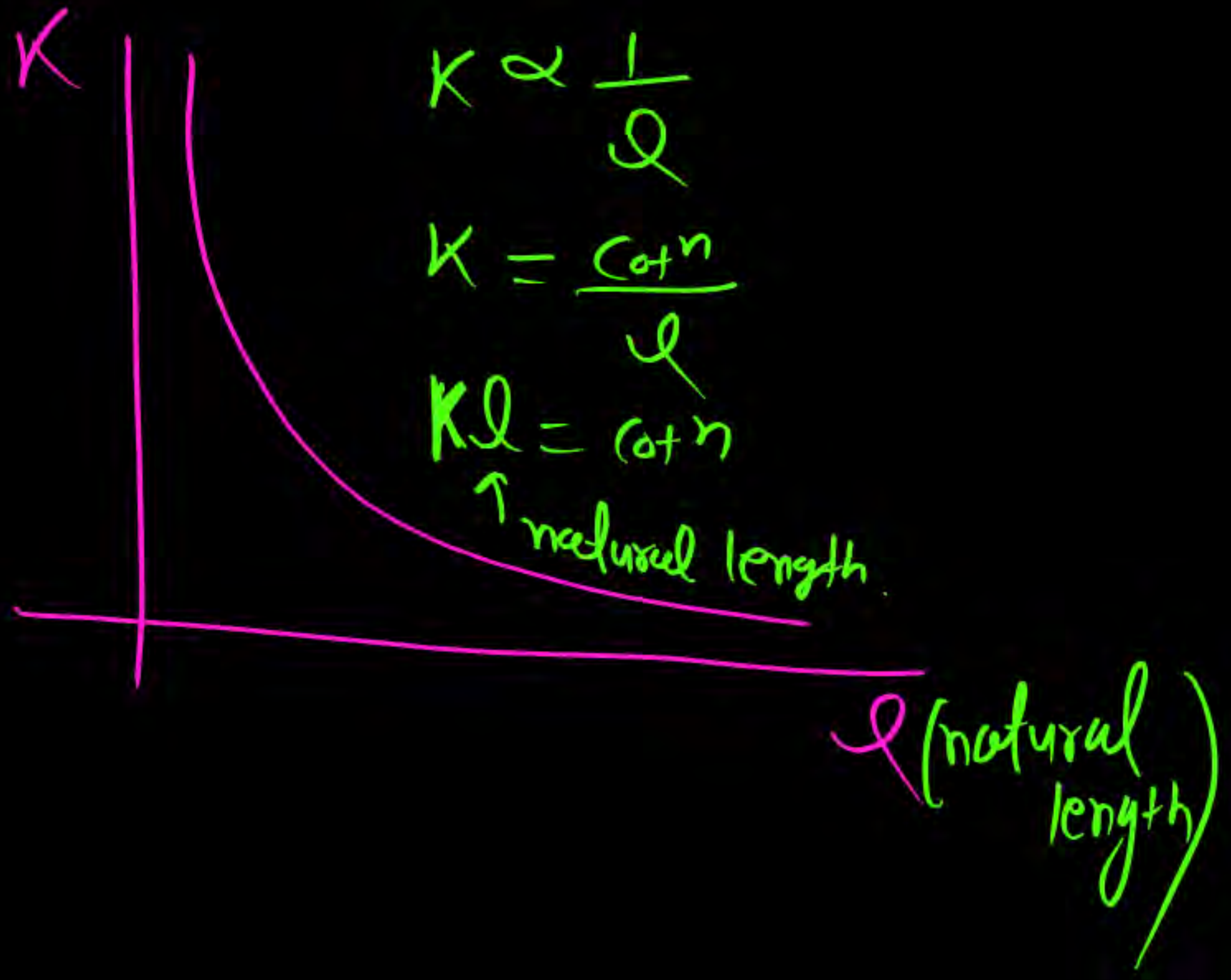
1. $\frac{1}{6}$ m, $\frac{2}{3}$ m, $\frac{1}{3}$ m
2. $\frac{1}{3}$ m, $\frac{1}{3}$ m, $\frac{1}{3}$ m
3. $\frac{2}{3}$ m, $\frac{1}{3}$ m, $\frac{1}{6}$ m
4. $\frac{1}{3}$ m, $\frac{4}{3}$ m, $\frac{2}{3}$ m

cutting of spring

same material only natural length is diff^n



$K_1 > K_2$

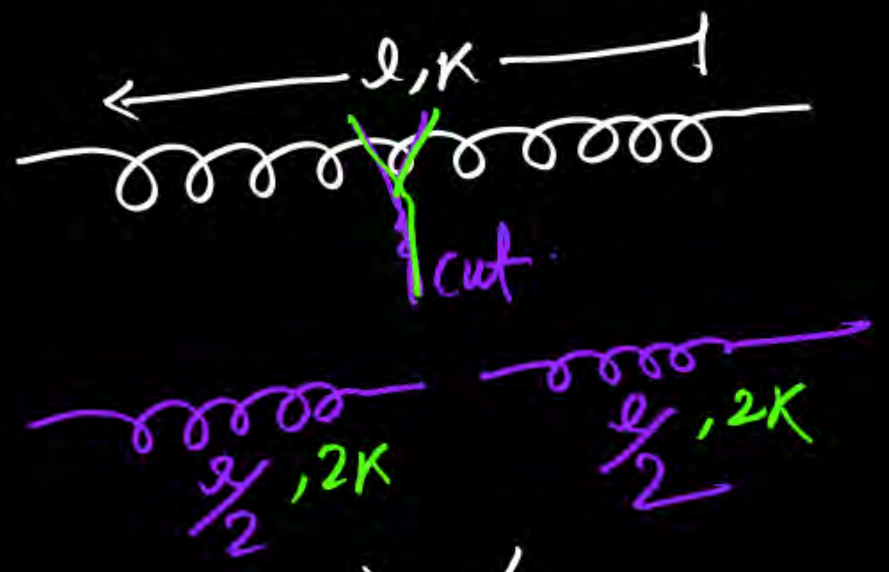


$K \propto \frac{1}{l}$

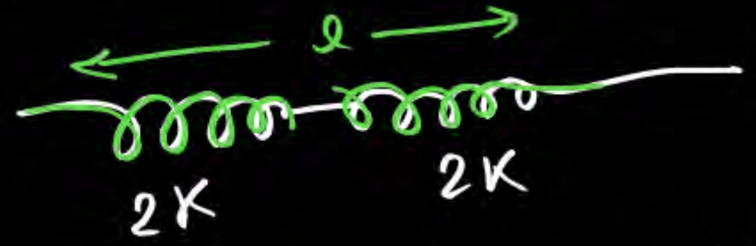
$K = \frac{\text{const}^n}{l}$

$Kl = \text{const}^n$

↑ natural length



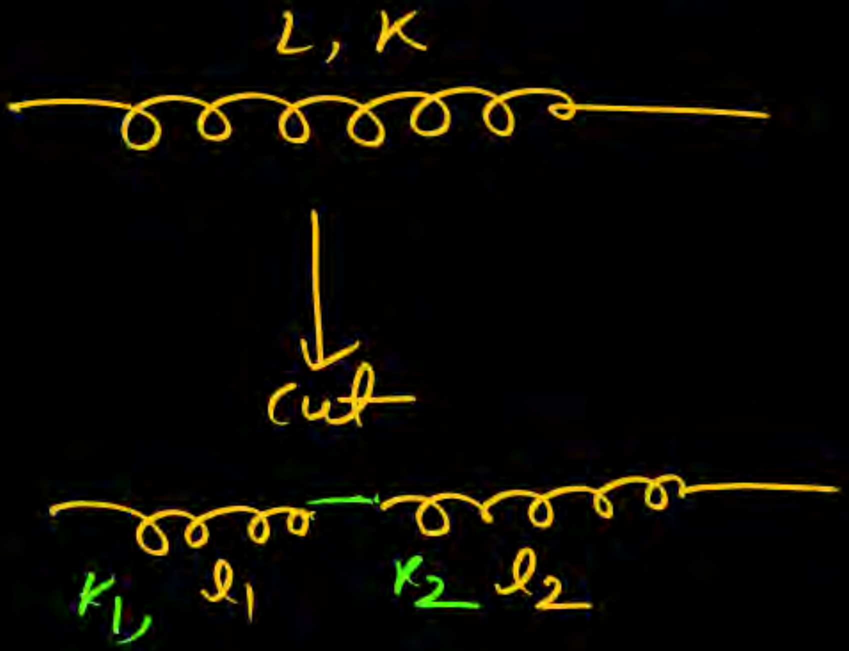
again connect in series



$K_{eq} = \frac{2K \times 2K}{4K} = \frac{4K^2}{4K} = K$



Spring constant K and Length 'L' cut into two part of length ratio 2 : 3 then find spring constant of bigger part.



$$\frac{l_1}{l_2} = \frac{2}{3}$$

$$l_1 : l_2 = \frac{2}{3} = \frac{4}{6} = \frac{16}{24}$$

$$l_1 : l_2 = 2x : 3x$$

$$2x + 3x = L$$

$$5x = L$$

$$x = \frac{L}{5}$$

$$2x = \frac{2L}{5}$$

$$3x = \frac{3L}{5}$$

$$KL = \text{Const}^n$$

$$K\cancel{L} = \frac{2\cancel{L}}{5} K_1$$

$$\boxed{K_1 = \frac{5K}{2}} \leftarrow$$

$$K\cancel{L} = \frac{3\cancel{L}}{5} K_2$$

$$\boxed{K_2 = \frac{5K}{3}} \leftarrow$$

$$\frac{1}{K_{eq}} = \frac{2}{5K} + \frac{3}{5K} = \frac{5}{5K}$$

$K_{eq} = K$

Spring of length L and spring constant K cut into three part of length ratio 1 : 2 : 3 then find timeperiod if mass m is connected to the smaller spring



$$x_1 : x_2 : x_3 = 1 : 2 : 3$$

$$= x : 2x : 3x$$

assume length of smaller part

$$x + 2x + 3x = L$$

$$6x = L$$

$$x = \frac{L}{6}$$

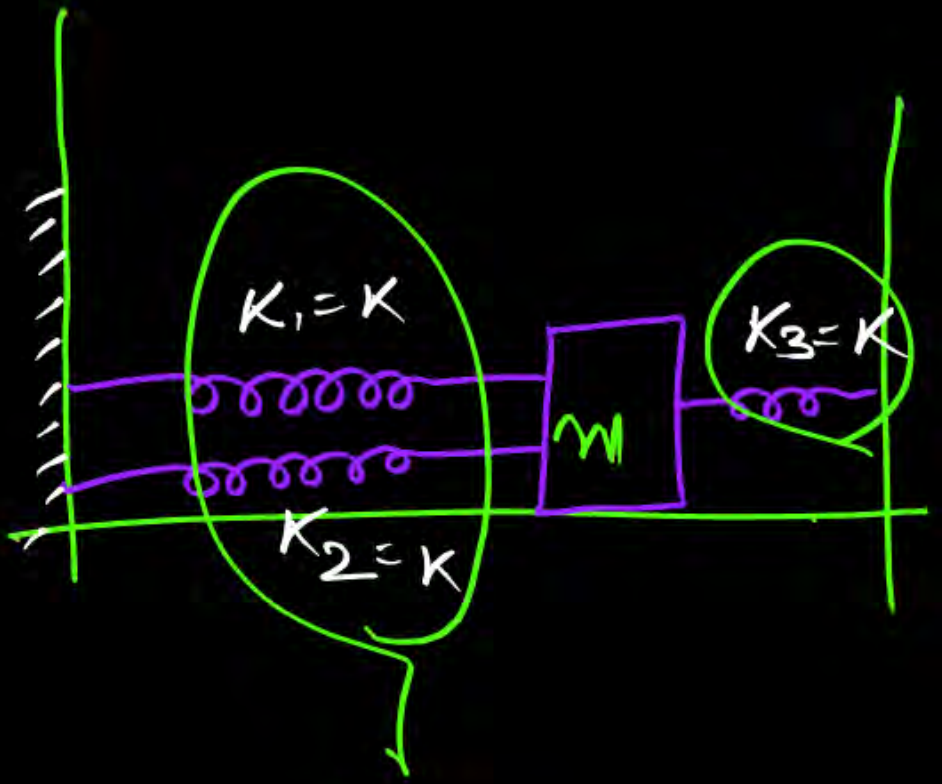
$$xK_1 = L \times K$$

$$\frac{L}{6} K_1 = L K$$

$$K_1 = 6K$$



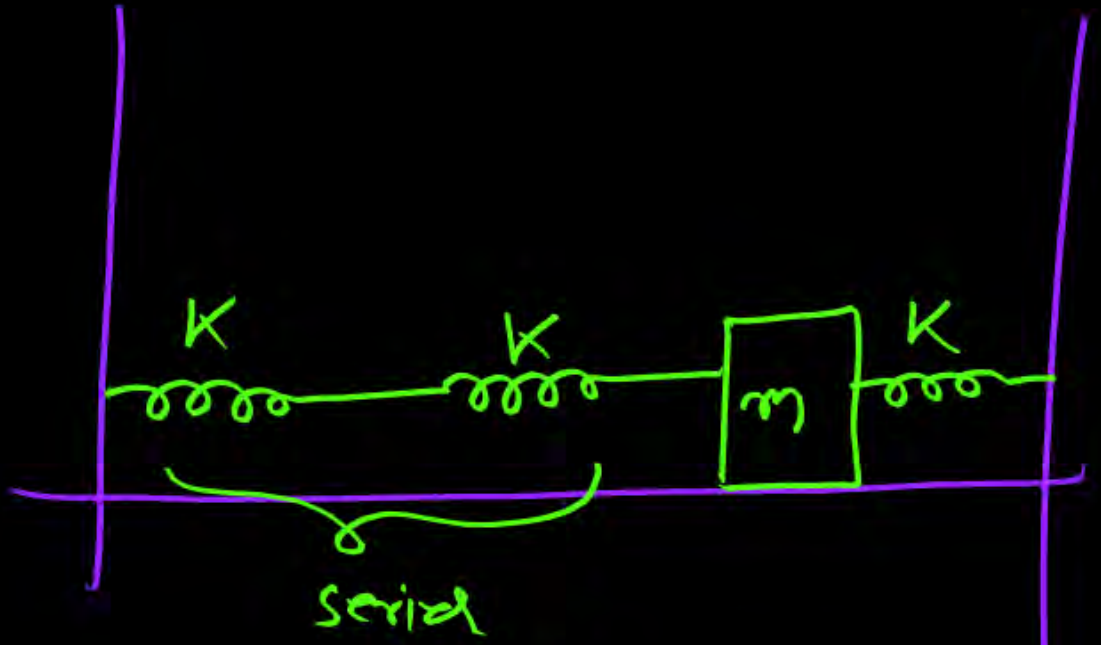
$$T = 2\pi \sqrt{\frac{m}{6K}}$$



$$K_{eq} = 2K$$

$$K_{e} = 3K$$

$$T = 2\pi\sqrt{\frac{m}{3K}}$$



$$K_{eq} = \frac{K}{2}$$

$$K_{eq} = \frac{K}{2} + K = \frac{3K}{2}$$

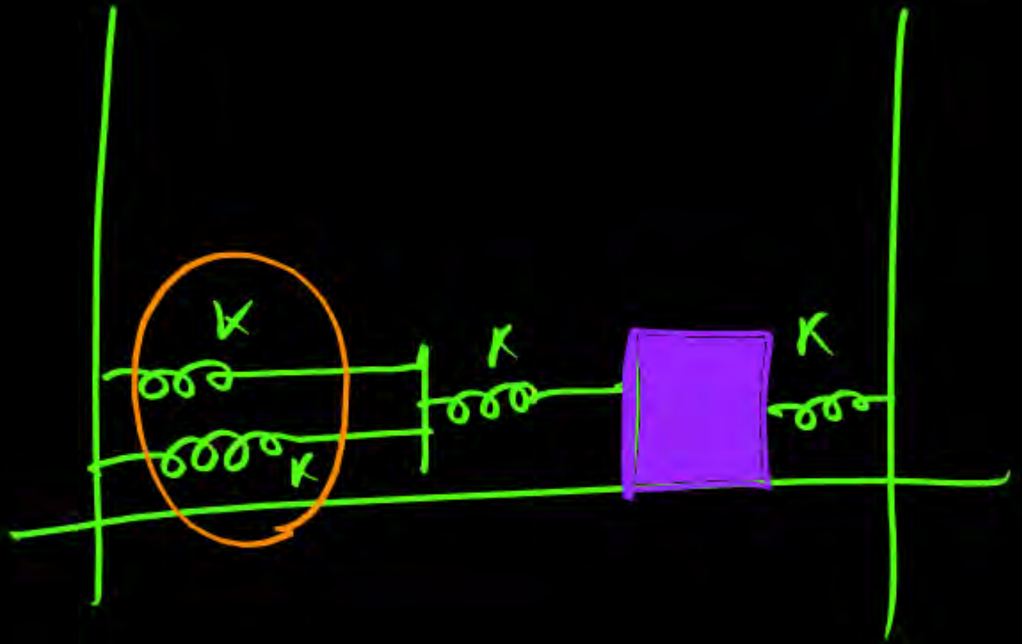


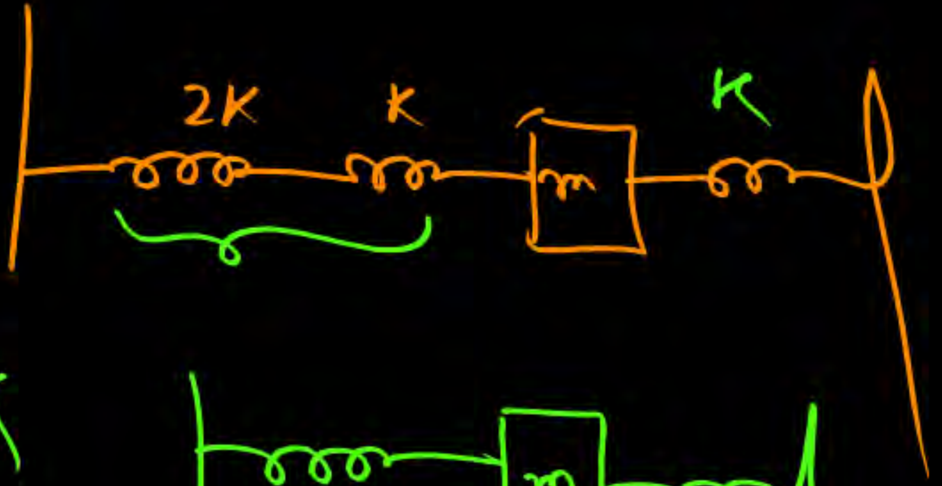
$$T = 2\pi\sqrt{\frac{m2}{3K}}$$

$$T = 2\pi\sqrt{\frac{2m}{3k}}$$

Ans

find time period of oscillation



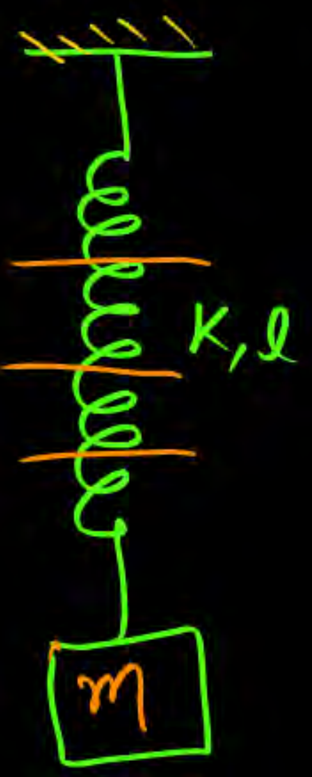


$$\frac{2K \cdot K}{2K + K} = \frac{2}{3}K$$



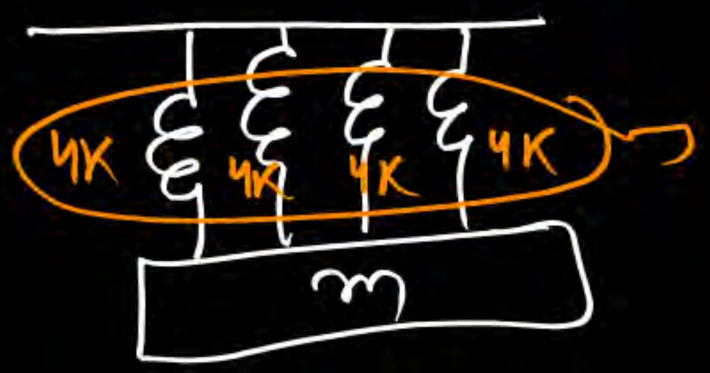
$$K_{eq} = \frac{2K}{3} + K = \frac{2K + 3K}{3} = \frac{5K}{3}$$

$$T = 2\pi \sqrt{\frac{m3}{5K}}$$



This spring Now cut in 4-equal Part and all are connected Parallel then find Time period of oscillatn

$$T = 2\pi\sqrt{\frac{m}{K}}$$



$$K_{eq} = 16K$$

$$T' = 2\pi\sqrt{\frac{m}{16K}}$$

$$T' = \frac{2\pi}{4}\sqrt{\frac{m}{K}}$$

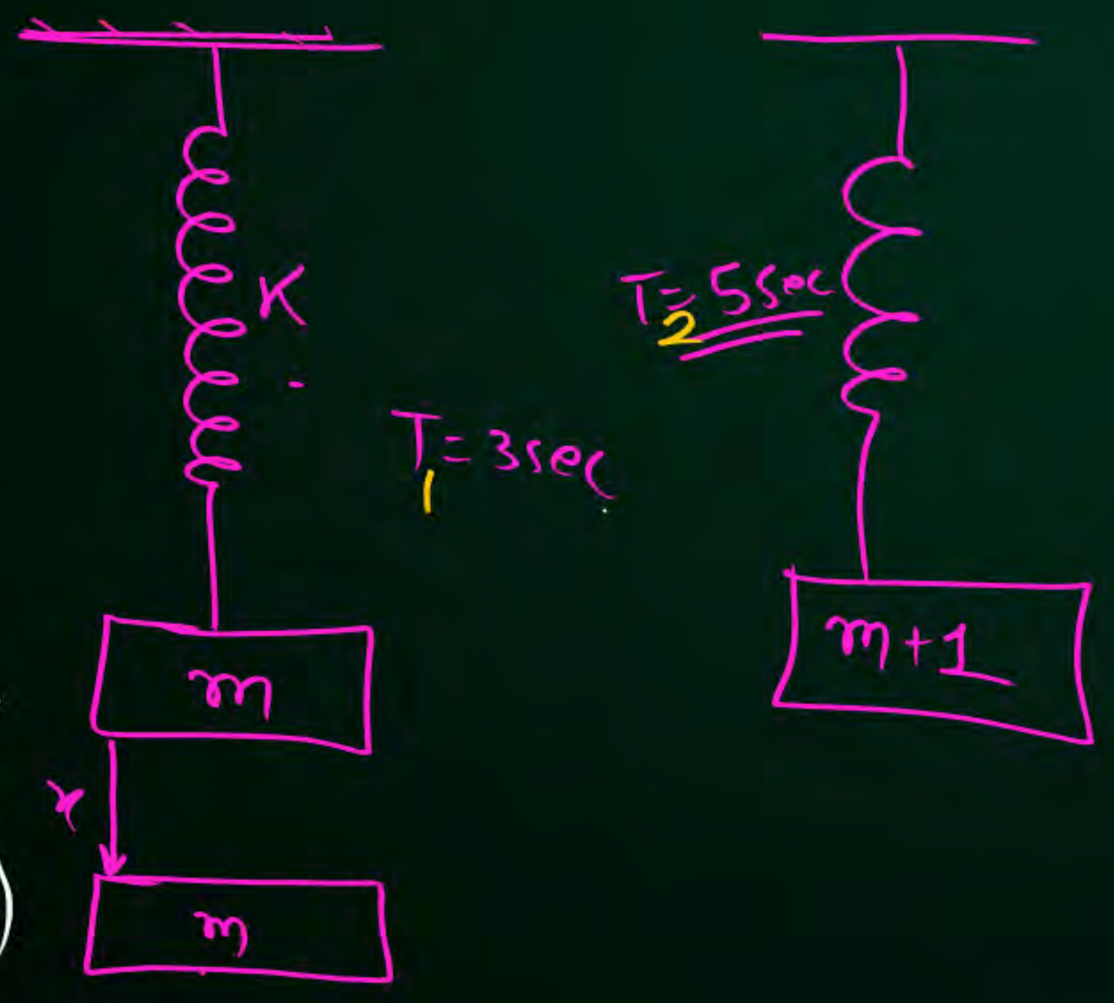
$$T' = \frac{T}{4}$$ Ans

QUESTION

A body of mass m is attached to the lower end of a spring whose upper end is fixed. The spring has negligible mass. When the mass m is slightly pulled down and released, it oscillates with a time period of 3 s. When the mass m is increased by 1 kg, the time period of oscillations becomes 5 s. The value of m in kg is

[NEET(Phase-2)-2016]

1. 3/4
2. 4/3
3. 16/9
4. 9/16 (Ans)



$$\frac{T_1 = 2\pi\sqrt{\frac{m}{k}}}{T_2 = 2\pi\sqrt{\frac{m+1}{k}}}$$

$$\frac{T_1}{T_2} = \sqrt{\frac{m}{m+1}}$$

$$\left(\frac{3}{5}\right)^2 = \frac{m}{m+1}$$

$$\frac{9}{25} = \frac{m}{m+1}$$

$$9m + 9 = 25m$$

$$9 = 25m - 9m$$

$$16m = 9$$

$$m = \frac{9}{16}$$

QUESTION

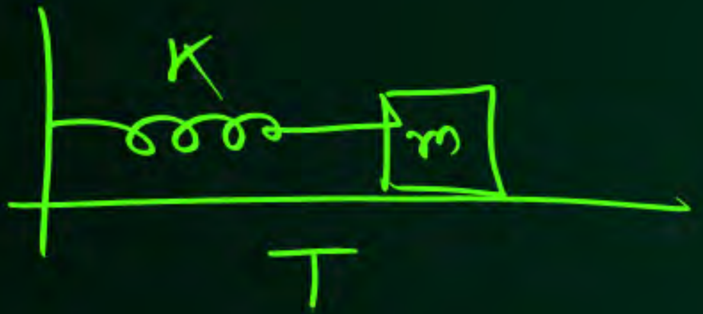
A spring block system in horizontal oscillation has a time-period T. Now the spring is cut into four equal parts and the block is re-connected with one of the parts. The new time period of vertical oscillation will be ??

1. $\frac{T}{\sqrt{2}}$

2. $2T$

3. $\frac{T}{2}$ ✓

4. $\frac{T}{2\sqrt{2}}$



$4K$

$T' = 2\pi\sqrt{\frac{m}{4K}}$

$T' = \frac{T}{2}$

QUESTION

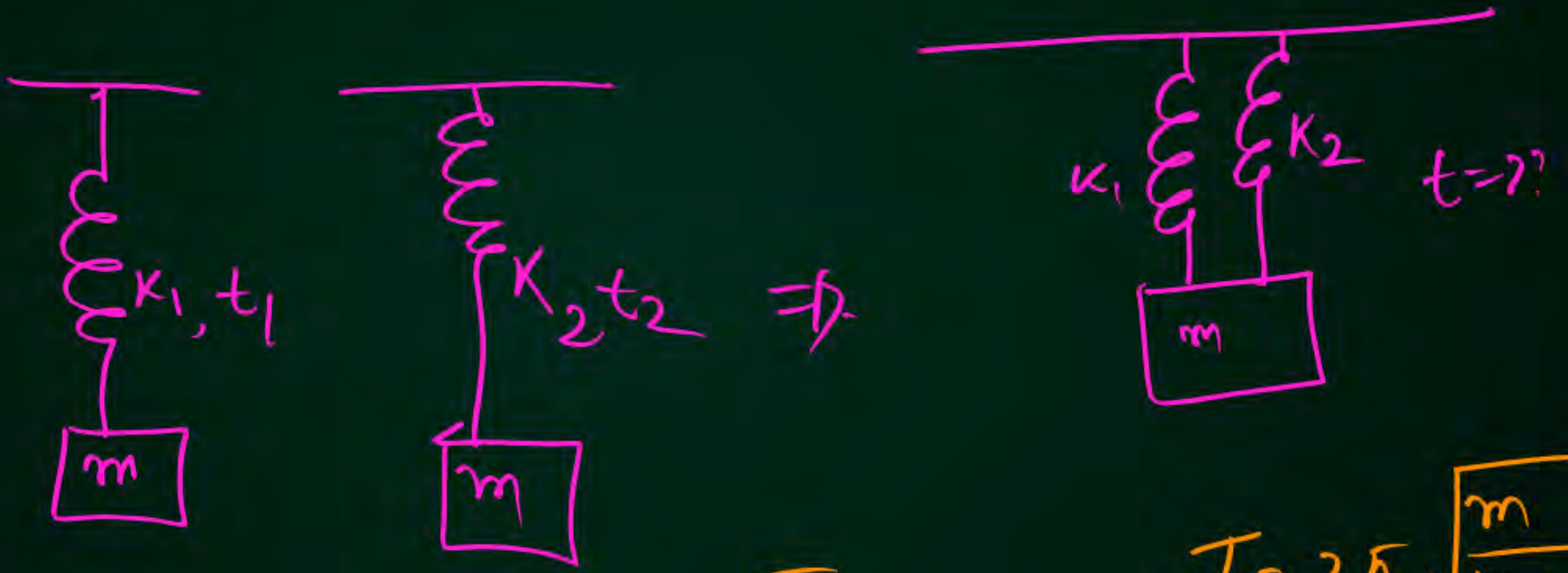
A block of mass m is suspended separately by two different springs have time period t_1 and t_2. If same mass is connected to parallel combination of both springs, then its time period is given by

(1) $\dfrac{t_1 t_2}{t_1 + t_2}$

(2) $\dfrac{t_1 t_2}{\sqrt{t_1^2 + t_2^2}}$ ✓

(3) $\sqrt{\dfrac{t_1 t_2}{t_1 + t_2}}$

(4) $t_1 + t_2$



$t_1 = 2\pi\sqrt{\dfrac{m}{K_1}}$ $\qquad$ $t_2 = 2\pi\sqrt{\dfrac{m}{K_2}}$

$K_2 \propto \dfrac{1}{t_2^2}$ Squr Both side

$K_1 \propto \dfrac{1}{t_1^2}$ $\quad t_1^2 = (2\pi)^2 \dfrac{m}{K_1}$ $\quad t_1^2 \propto \dfrac{1}{K_1}$

$T = 2\pi\sqrt{\dfrac{m}{K_1 + K_2}}$

$T^2 = \dfrac{1}{K_1 + K_2}$

$K_1 + K_2 = \dfrac{1}{T^2}$

$\dfrac{1}{t_1^2} + \dfrac{1}{t_2^2} = \dfrac{1}{T^2}$

$\dfrac{t_1^2 + t_2^2}{t_1^2 t_2^2} = \dfrac{1}{T^2}$

$T = \sqrt{\dfrac{t_1^2 t_2^2}{t_1^2 + t_2^2}}$

$T = \dfrac{t_1 t_2}{\sqrt{t_1^2 + t_2^2}}$ Ans

QUESTION

The frequency of oscillation of a mass m suspended by a spring is v_1. If length of spring is cut to one third then the same mass oscillates with frequency v_2, then

1. $v_2 = 3v_1$
2. $3v_2 = v_1$
3. $v_2 = \sqrt{3}\, v_1$ ✓ Ans
4. $\sqrt{3}\, v_2 = v_1$

$f = \frac{1}{2\pi}\sqrt{\frac{K}{m}}$

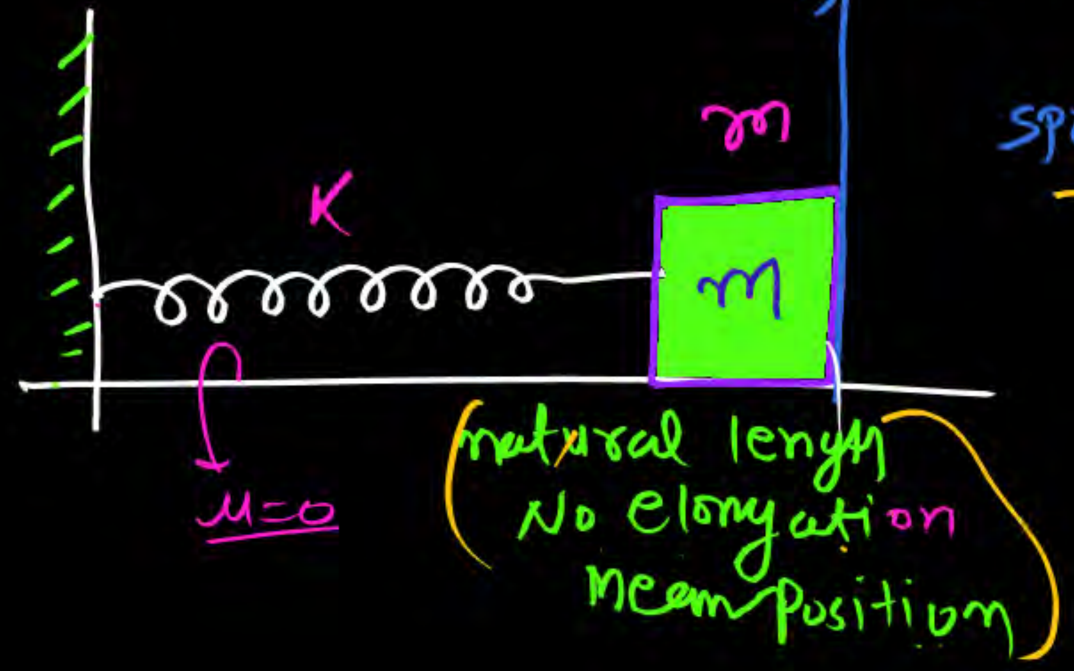
$f' = \frac{1}{2\pi}\sqrt{\frac{3K}{m}} = \sqrt{3}\, f_1$

$v_2 = \sqrt{3}\, v_1$

Level up

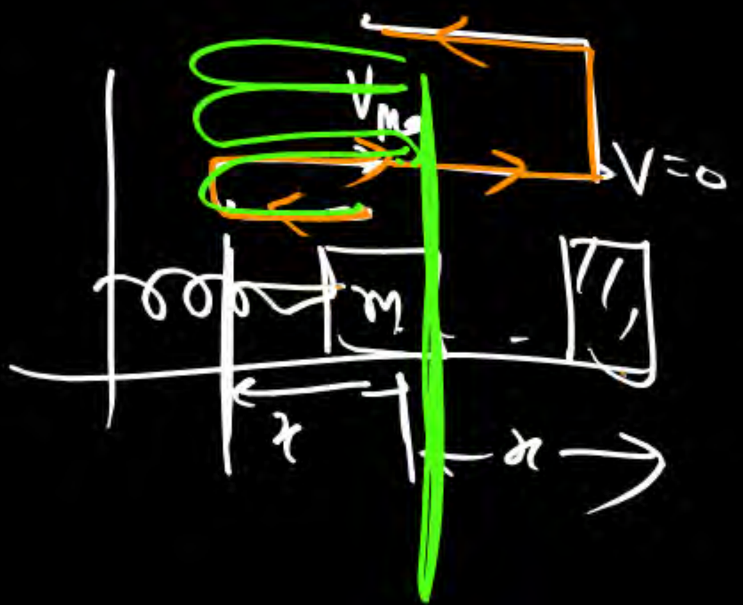
elastic collision

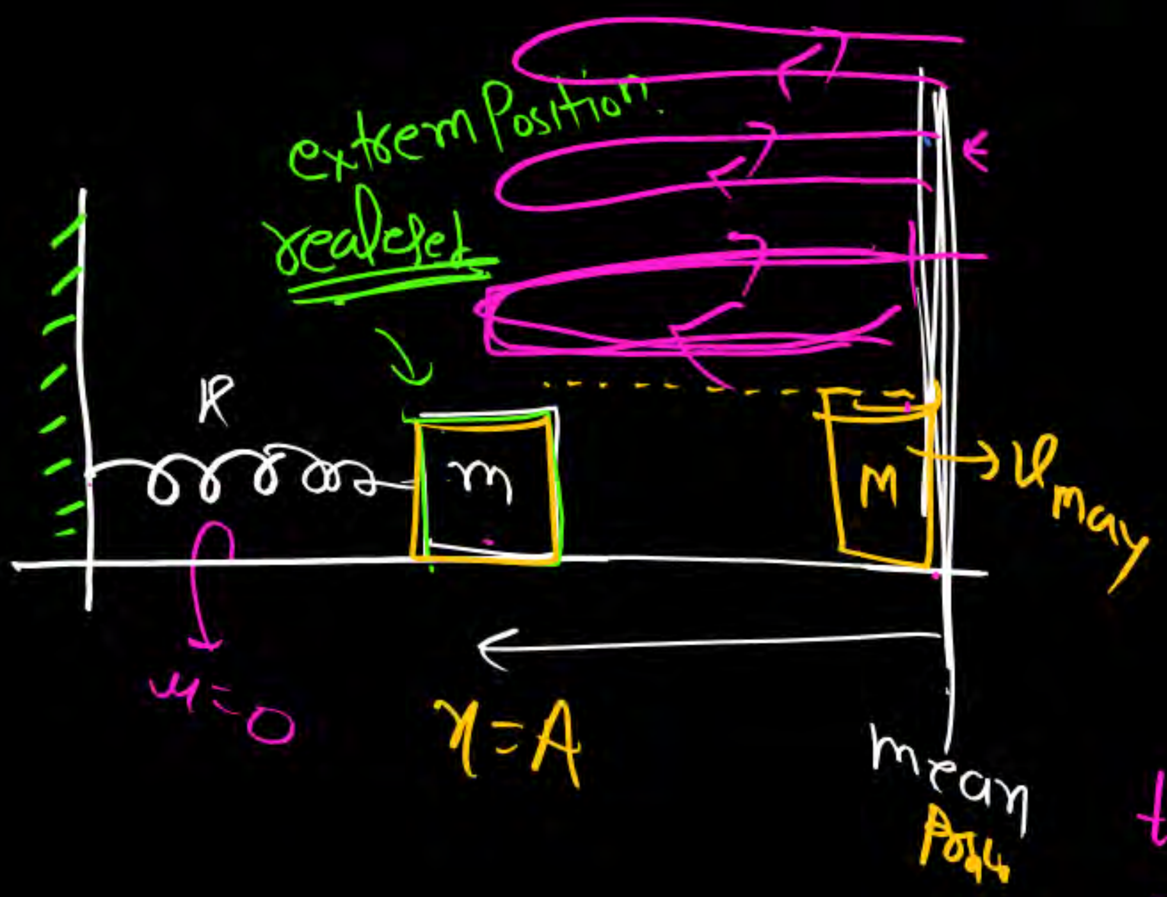
spring is at natural length as shown in fig. then find Time period of ~~oscillation~~ periodic motion if object compress length x in left and released.



$f = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$

$T = 2\pi\sqrt{\frac{m}{k}}$





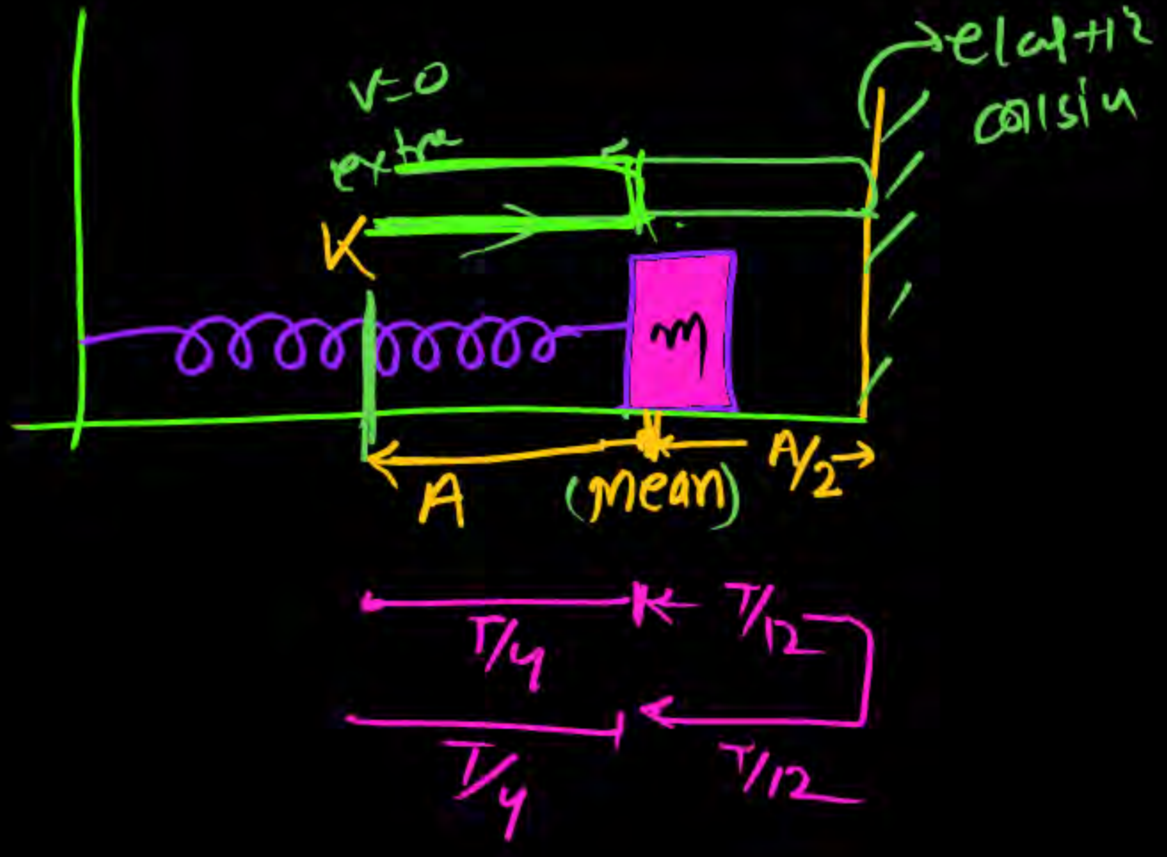
This is Not a oscillation but this motion is periodic.

What is period of oscillation

$t = \frac{T}{2} = \frac{2\pi\sqrt{\frac{m}{K}}}{2}$

$t = \pi\sqrt{\frac{m}{K}}$ ← time period of periodic motion.

Level up Ka स्टडी

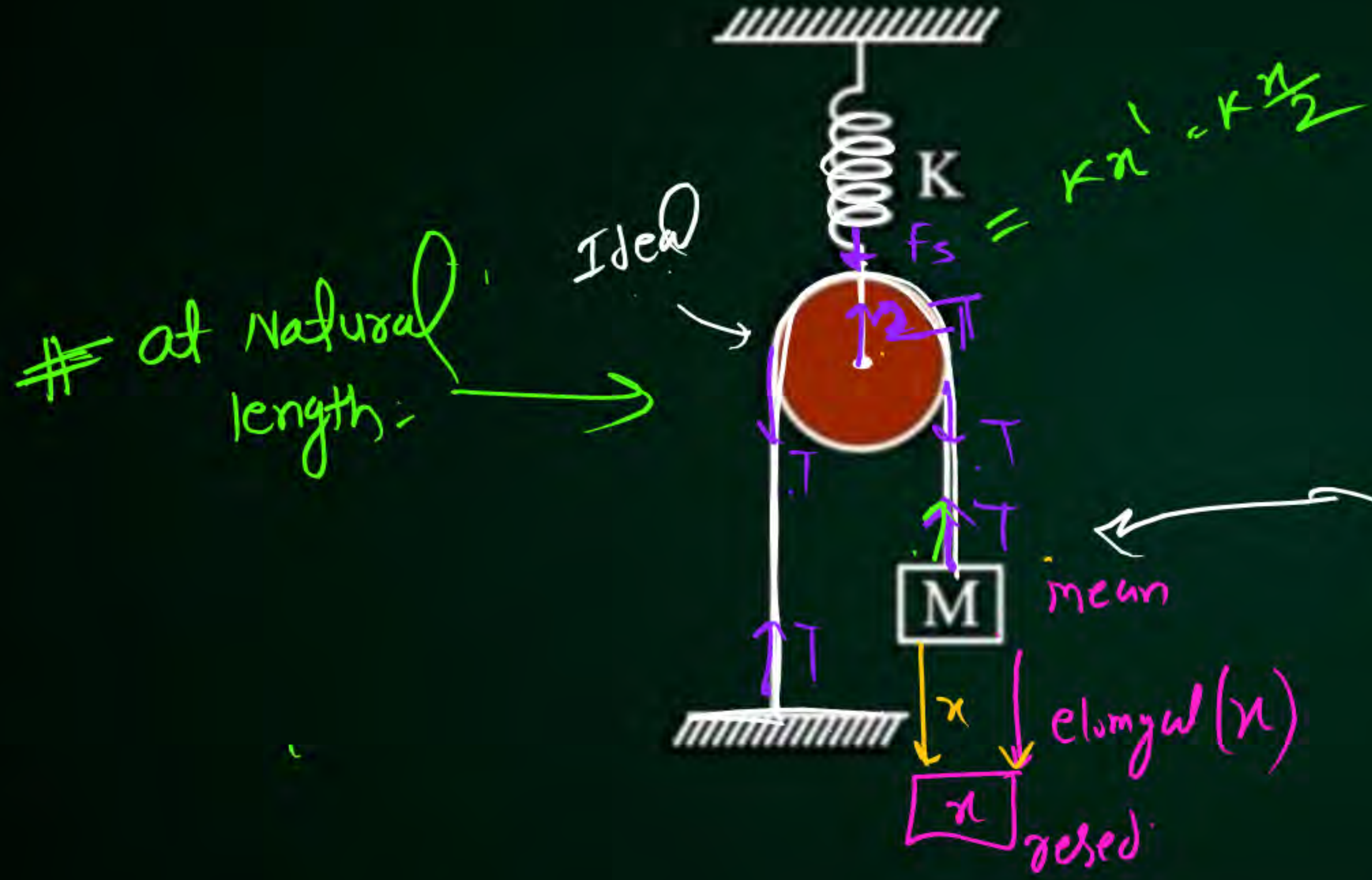


Initially spring is at natural length, Now compressed length A left and Released then find time period of motion.

$$t = \frac{T}{4} + \frac{T}{4} + \frac{T}{12} + \frac{T}{12}$$

$$= \frac{3T + 3T + T + T}{12} = \frac{8T}{12} = \frac{2T}{3} = \frac{2}{3} 2\pi \sqrt{\frac{m}{K}}$$

$$t = \frac{4\pi}{3} \sqrt{m/K}$$



Time period of oscillation ??

$T = 2\pi\sqrt{\frac{m}{k}}$ ✗

Constrain motion $T_1x_1 = T_2x_2$

$2T = f_s$ —— (1)

$Tx = 2Tx'$

elongation in spring → $x' = \frac{x}{2}$

FBD on block

$f_{ext} = ma$

(eqn) $T = ma$

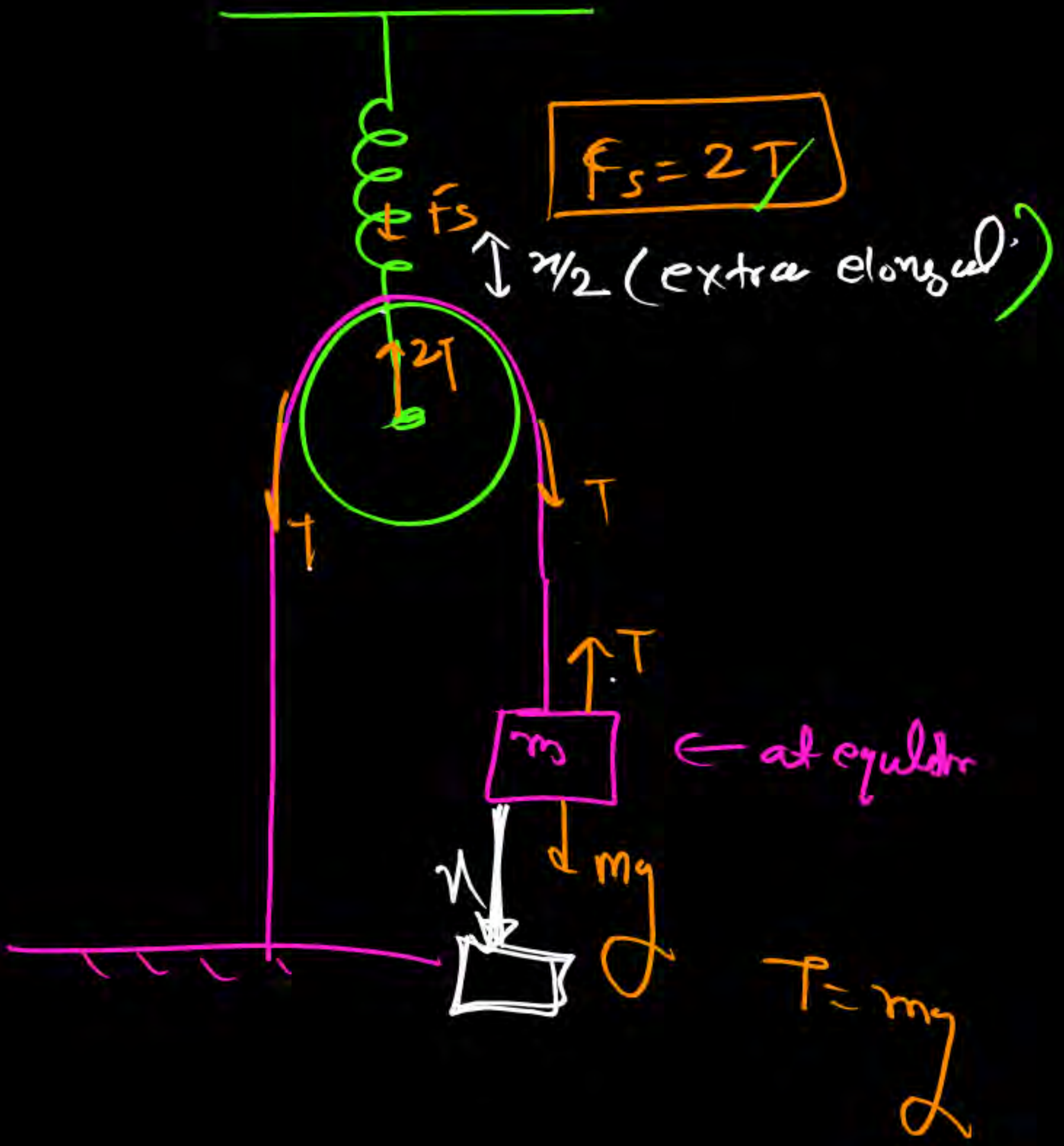
$\frac{f_s}{2} = ma$

$\frac{kx}{2\times 2} = ma$

$a = \left(\frac{K}{4m}\right)x$

$\omega = \sqrt{\frac{K}{4m}}$

$T = 2\pi\sqrt{\frac{4m}{K}}$

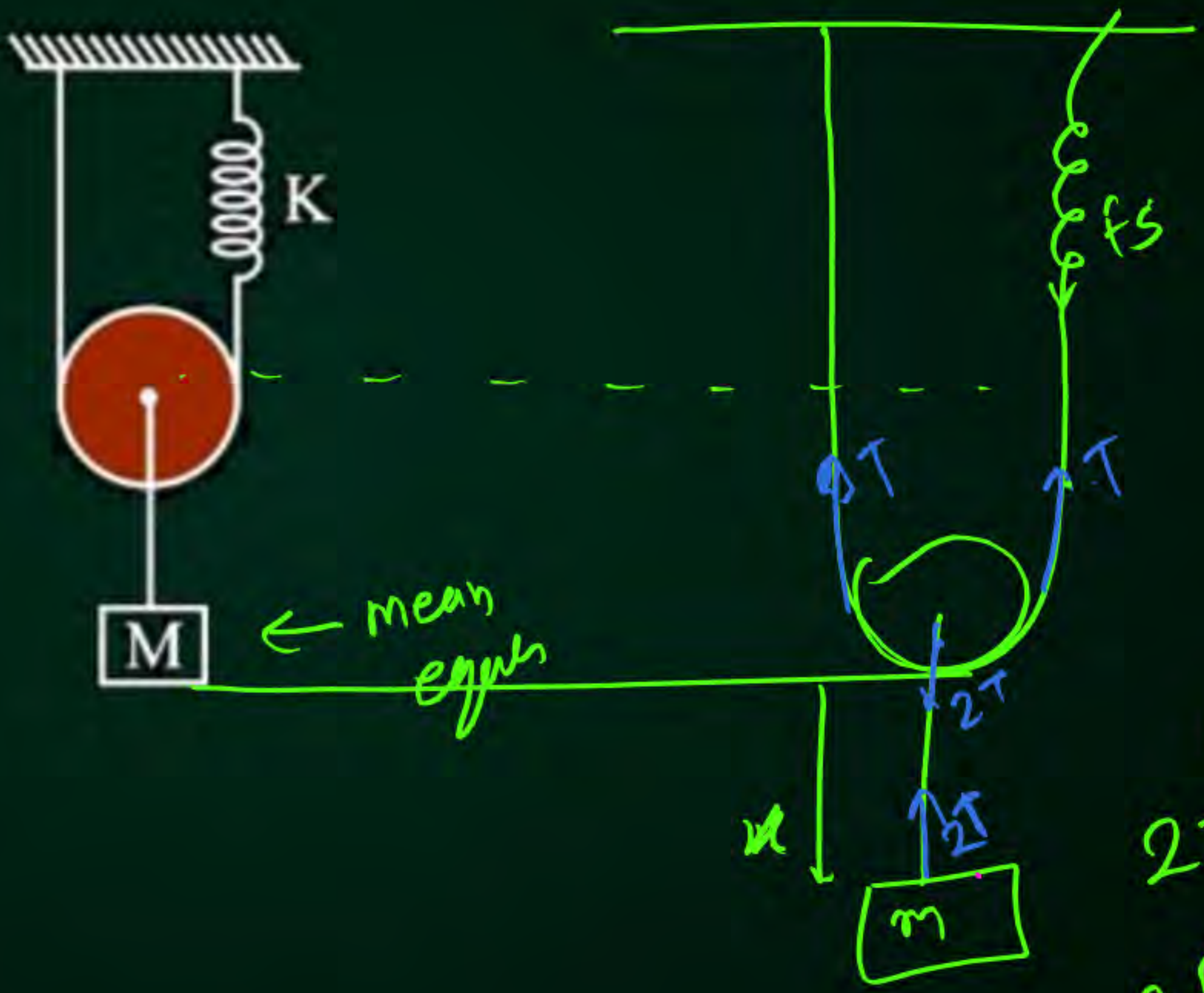


$$T(\text{extra}) = ma$$

$$\frac{f_s}{2} = ma$$

$$\frac{Kx}{2 \times 2} = ma$$

$$T = 2\pi\sqrt{\frac{4m}{K}}$$



Contra...

$2Tx = Tx'$

$x' = 2x$

$$T = 2\pi\sqrt{\frac{m}{4K}}$$

← Answer

on block

$2T = ma$ — (1)

$2F_s = ma$

$\therefore 2Kx' = ma$

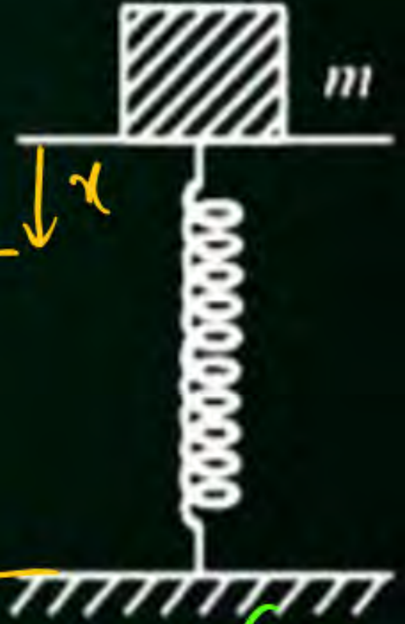
$2K2x = ma$

$ma = 4Kx$

QUESTION

A mass of 2.0 kg is put on a flat pan attached to a vertical spring fixed on the ground as shown in the figure. The mass of the spring and the pan is negligible. When pressed slightly and released by mass executes a simple harmonic motion. The spring constant is 200 N/m. What should be the minimum amplitude of the motion so that the mass gets detached from the pan ? [Take $g = 10\ m/s^2$]

[AIPMT (Prelims)-2007]



1. 10.0 cm
2. Any value less than 12.0 cm
3. 4.0 cm
4. 8.0 cm

$F = kx$, $a = \left(\frac{k}{m}\right)x$

Time period does not depend on amplitude but v_{max} or a_{max} depend on amplitude

$a_{max} < g$ at eq: object will not detach

$a_{max} \geq g$: object will lose contact (detached)

$\omega^2 A = g$

$\frac{k}{m} A = g$

$A = \frac{gm}{k} = \frac{10 \times 2}{200} = \frac{1}{10}\ m = 10\ cm$

QUESTION

Two masses m_1 and m_2 are suspended together by a massless spring of force constant k, as shown in figure. When the masses are in equilibrium, mass, m_1 is removed without disturbing the system. The angular frequency of oscillation of mass m_2 is



1. $\sqrt{\frac{k}{m_2}}$
2. $\sqrt{\frac{k}{m_1}}$
3. $\sqrt{\frac{k m_1}{m_2^2}}$
4. $\sqrt{\frac{k m_2}{m_1^2}}$

QUESTION

A particle executes SHM and its position varies with time as $x = A \sin \omega t$. Its average speed during its motion from mean position to mid-point of mean and extreme position is

1. Zero
2. $\frac{3A\omega}{\pi}$ Ans
3. $\frac{A\omega}{2\pi}$
4. $\frac{2A\omega}{\pi}$



$x = A\sin(\omega t)$ → motion starts from mean.

$\omega = \frac{2\pi}{T}$

$T = \frac{2\pi}{\omega}$

Avg speed $= \frac{\text{total dist}^n}{\text{time}}$

$= \frac{A}{2 \times \frac{T}{12}} = \frac{6A}{T} = \frac{6A\omega}{2\pi} = \frac{3A\omega}{\pi}$

QUESTION

A particle is executing SHM and its velocity v is related to its position (x) as $v^2 + ax^2 = b$, where a and b are positive constants. The frequency of oscillation of particle is

1. $\frac{1}{2\pi}\sqrt{\frac{b}{a}}$
2. $\frac{\sqrt{a}}{2\pi}$
3. $\frac{\sqrt{b}}{2\pi}$
4. $\frac{1}{2\pi}\sqrt{\frac{a}{b}}$

$$\frac{v^2}{A^2\omega^2} + \frac{x^2}{A^2} = 1$$

$$A^2 = \frac{b}{a}$$

$$A^2\omega^2 = b$$

$$\frac{b}{a}\omega^2 = b$$

$$\omega^2 = a \qquad \omega = \sqrt{a}$$

$$f = \frac{\sqrt{a}}{2\pi}$$

$$v^2 + ax^2 = b$$

$$\frac{v^2}{b} + \frac{ax^2}{b} = 1$$

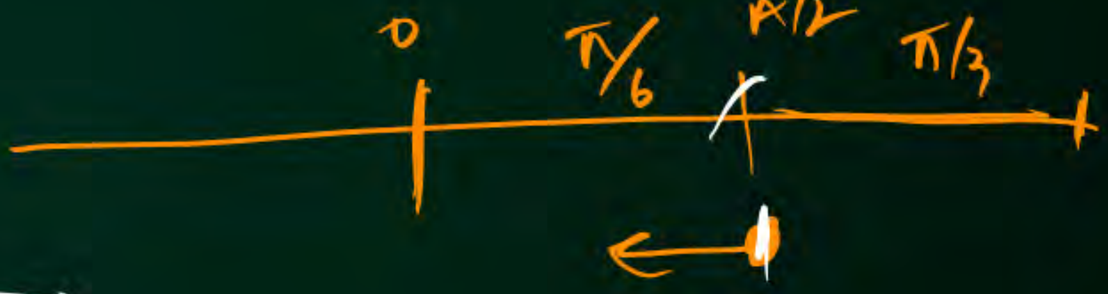
$$\frac{v^2}{b} + \frac{x^2}{(b/a)} = 1$$

QUESTION

$E = \frac{1}{2}KA^2$

A simple pendulum of mass m executes SHM with total energy E. If at an instant it is at one of extreme positions, then its linear momentum after a phase shift of $\frac{\pi}{3}$ rad will be

1. $\sqrt{2mE}$
2. $\sqrt{\frac{3mE}{2}}$
3. $2\sqrt{mE}$
4. $\sqrt{\frac{2mE}{3}}$



$$P = \sqrt{2m\,K.E} = \sqrt{2m\frac{3E}{4}} = \sqrt{\frac{3mE}{2}}$$

$$K.E = \frac{1}{2}K(A^2 - x^2) = \frac{1}{2}K\left(A^2 - \frac{A^2}{4}\right)$$

$$K.E = \frac{1}{2}K\left(\frac{3A^2}{4}\right) = \frac{3E}{4}$$


THANK YOU


25th Nov.
YAKEEN 2.0
FOR NEET 2025
Lecture- 9
Physics
Oscillations
By- Dr. Manish Raj (MR SIR)

Todays Goal

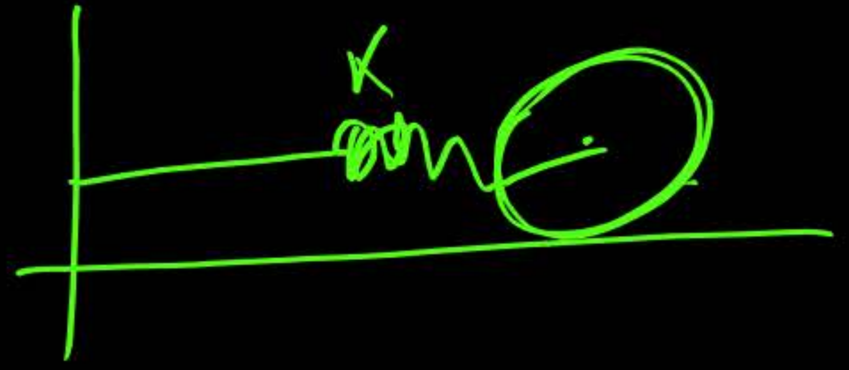
→ Revision

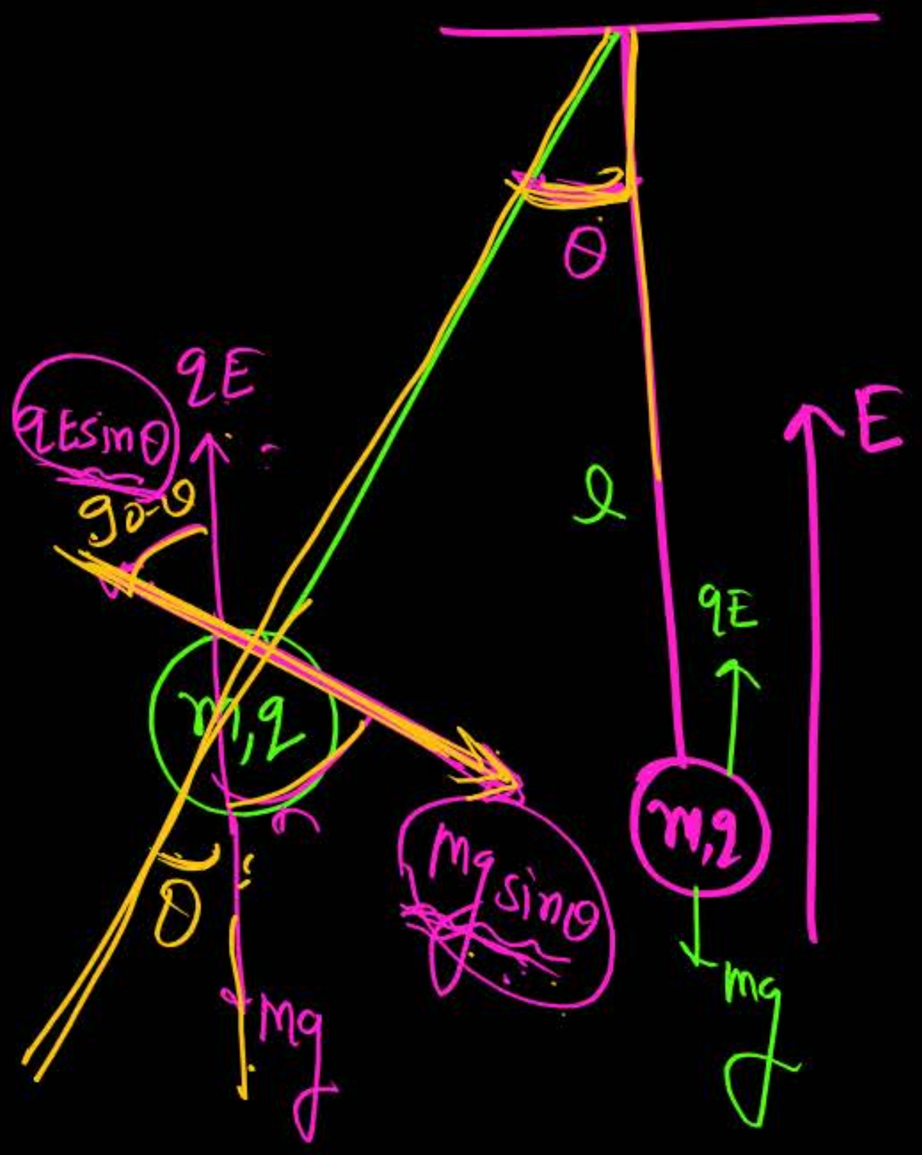
→ special S.H.M

→ superposition of S.H.M

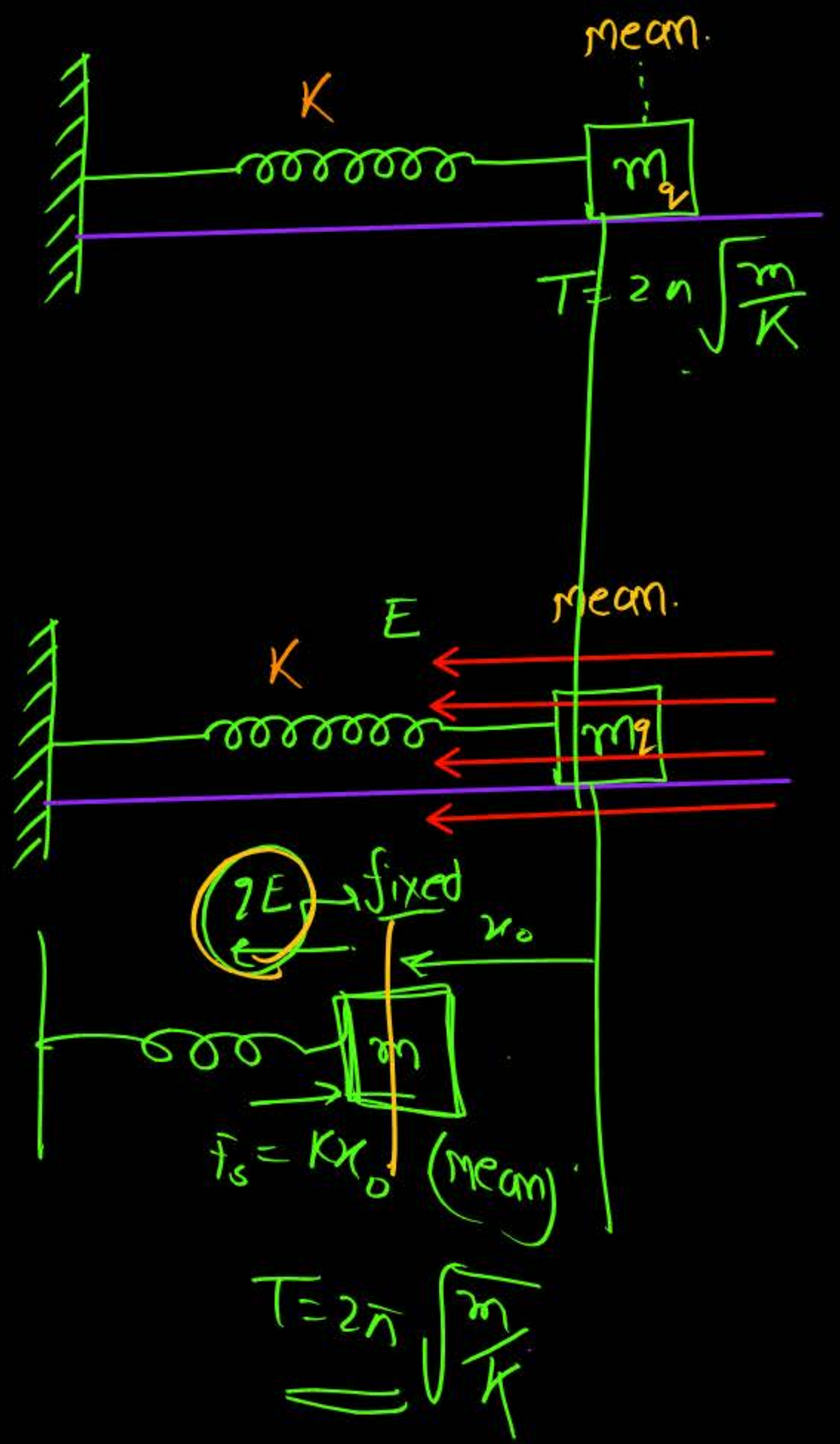




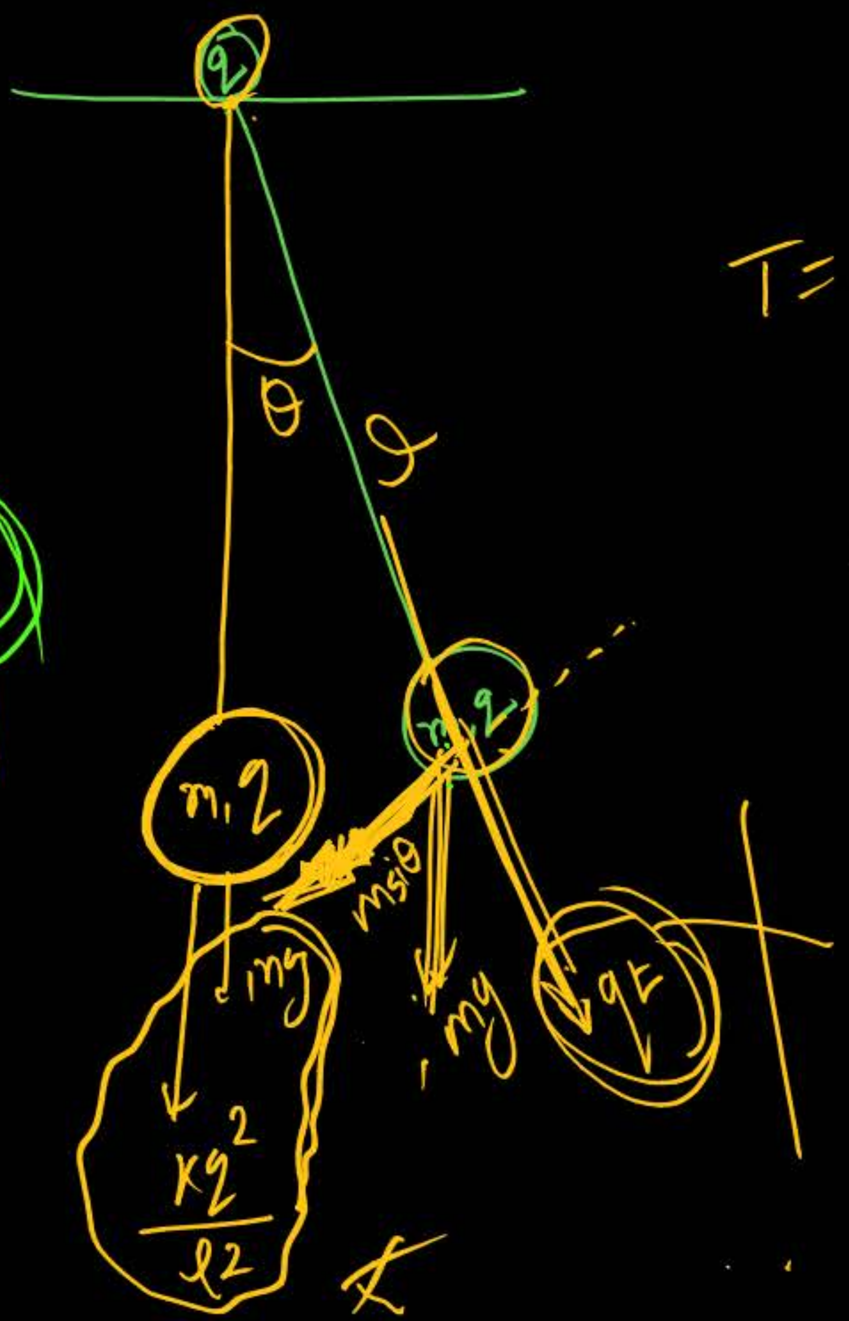




$$T = 2\pi\sqrt{\frac{l}{g - \frac{qE}{m}}}$$



$$F \propto -x$$



$$T = 2\pi\sqrt{\frac{l}{g}}$$

$$F = \frac{K q \times q}{l^2}$$



spring-mass system on earth (T)

on Moon (T_m)

(a) less → 12%

(b) more → 42%

(c) same (43%)

→ ज्यादा ।

$$T = 2\pi\sqrt{\frac{m}{K}}$$

does not depend on acc^n due to gravity.

$$T = 2\pi\sqrt{\frac{l}{g}}$$

→ Time Period of simple Pendulum

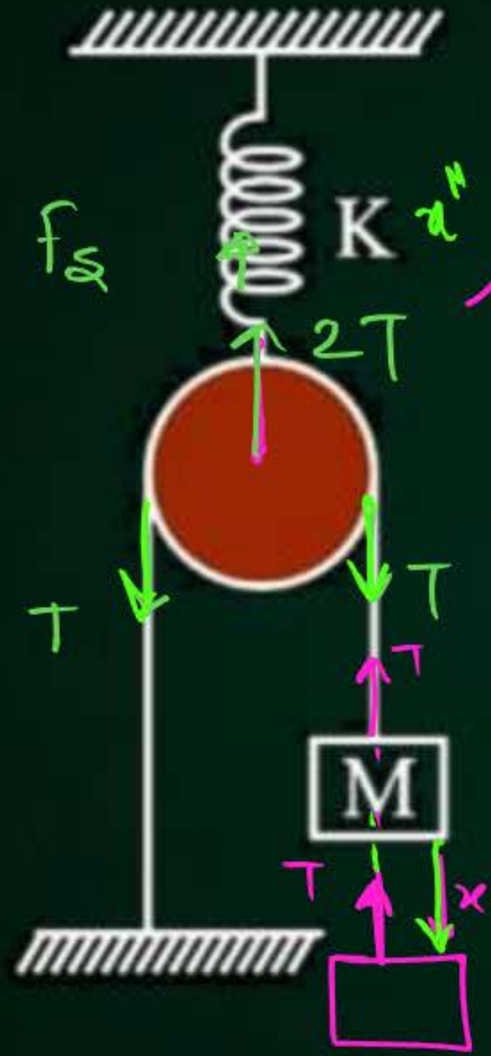


← equalium

$mg = kx_0$

$F_{net} = kx + kx_0 - mg$

$F_{ne} = kx$ (extree.)



← assume

$kx = 2kx'$

$x' = \frac{x}{2}$

$F_s = 2T$ (after elongu extra Tension)

$kx' = 2T$ — (1)

$k\frac{x}{2} = 2T$

on object

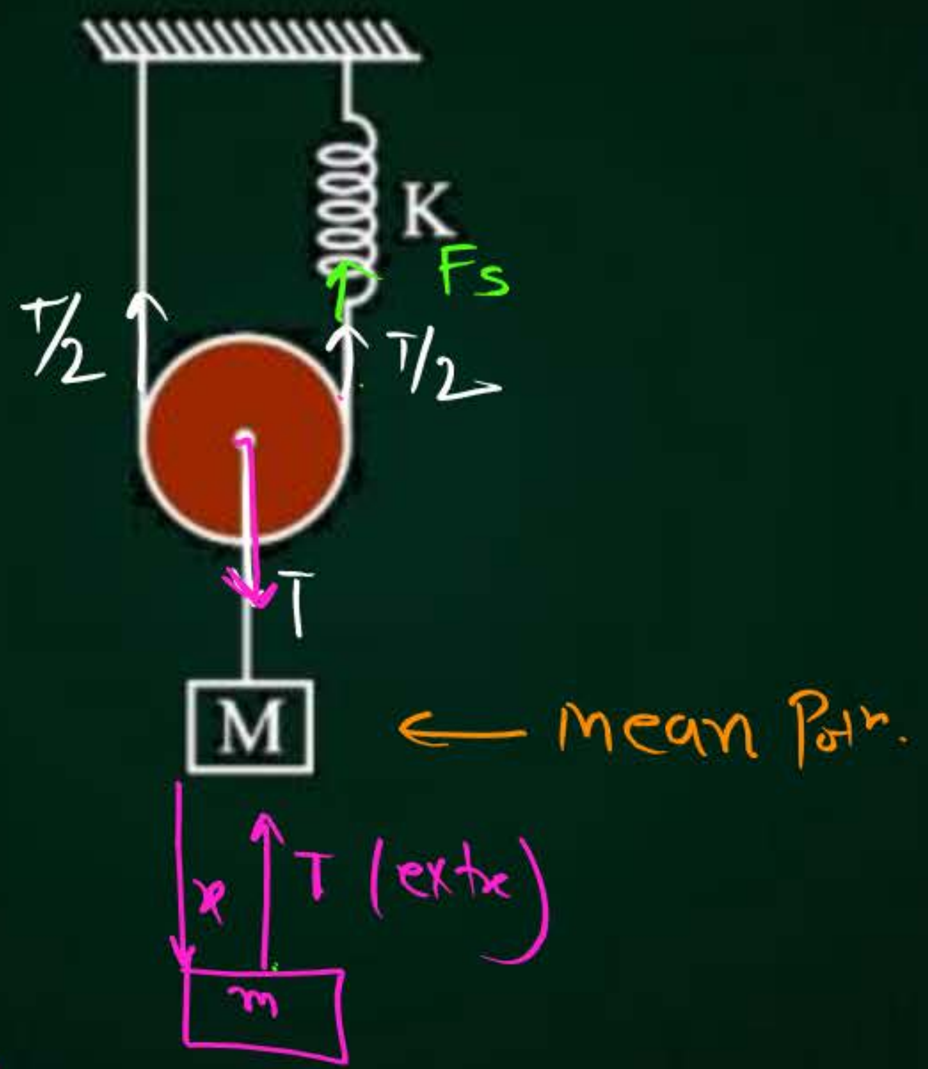
$\frac{kx}{4} = T = ma$

$a = \frac{kx}{4m}$

$\omega^2 = \frac{k}{4m}$

$\omega = \sqrt{\frac{k}{4m}}$

$T = 2\pi\sqrt{\frac{4m}{k}}$



$F_s = T/2$

$Kx' = \frac{T}{2}$

$K2x = T/2$

$4Kx = T$

on object

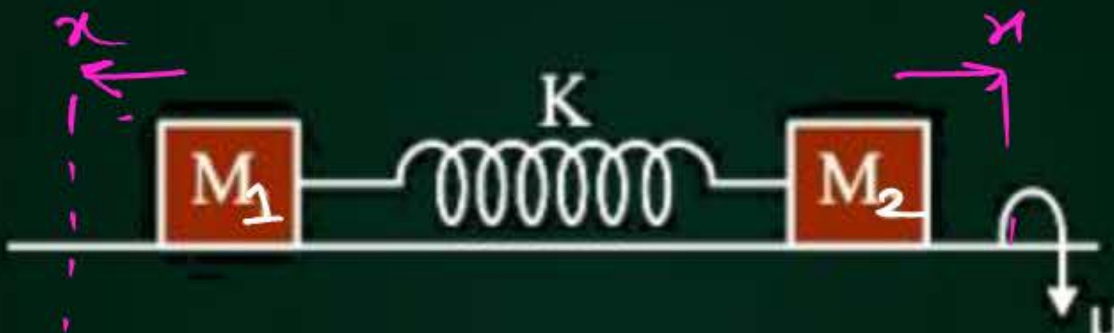
$4Kx = ma$

$a = \frac{4K}{m} x$

$T = 2\pi\sqrt{\frac{m}{4K}}$

$Tx = \frac{T}{2} \times x'$

$x' = 2x$



Spring to ek hi hai

Mass ka Parallel comb^n

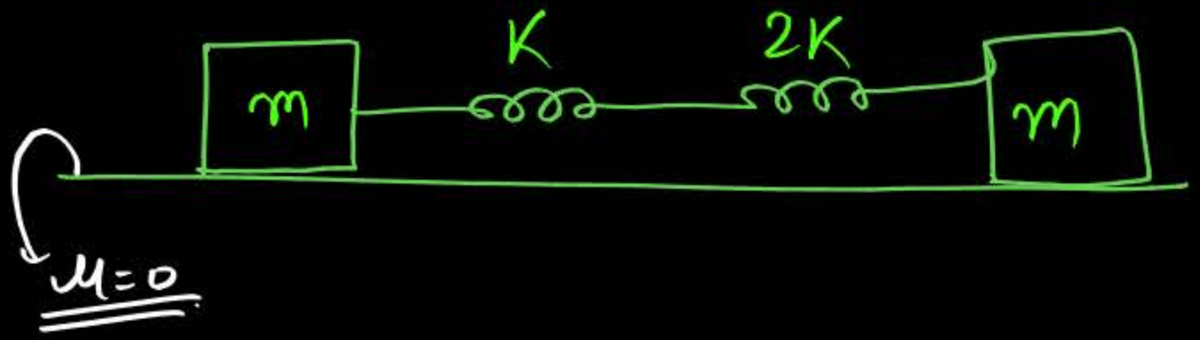
$$M_{eff} = \frac{m_1 m_2}{m_1 + m_2}$$

$$T = 2\pi \sqrt{\frac{m_1 m_2}{(m_1 + m_2) K}}$$

If $m_1 = m_2 = m$

$$T = 2\pi \sqrt{\frac{m^2}{2mK}} = 2\pi \sqrt{\frac{m}{2K}} \text{ Ans}$$

IIT-2023



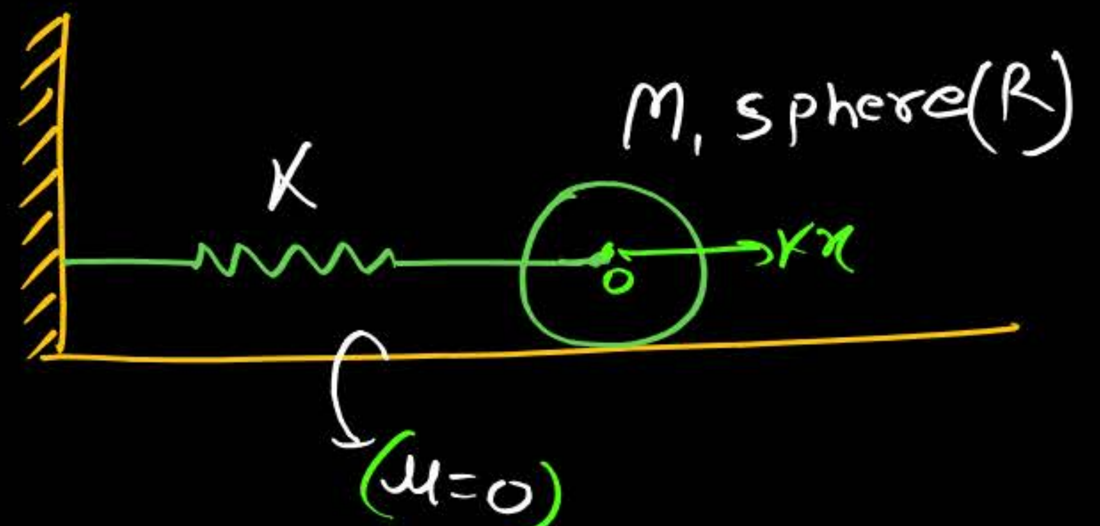
$$m_{eff} = \frac{m}{2}$$

$$K_{eq} = \frac{K \times 2K}{K + 2K} = \frac{2K}{3}$$

$$T = 2\pi\sqrt{\frac{m_{eff}}{K_{eff}}}$$

$$= 2\pi\sqrt{\frac{m\,3}{2 \times 2K}}$$

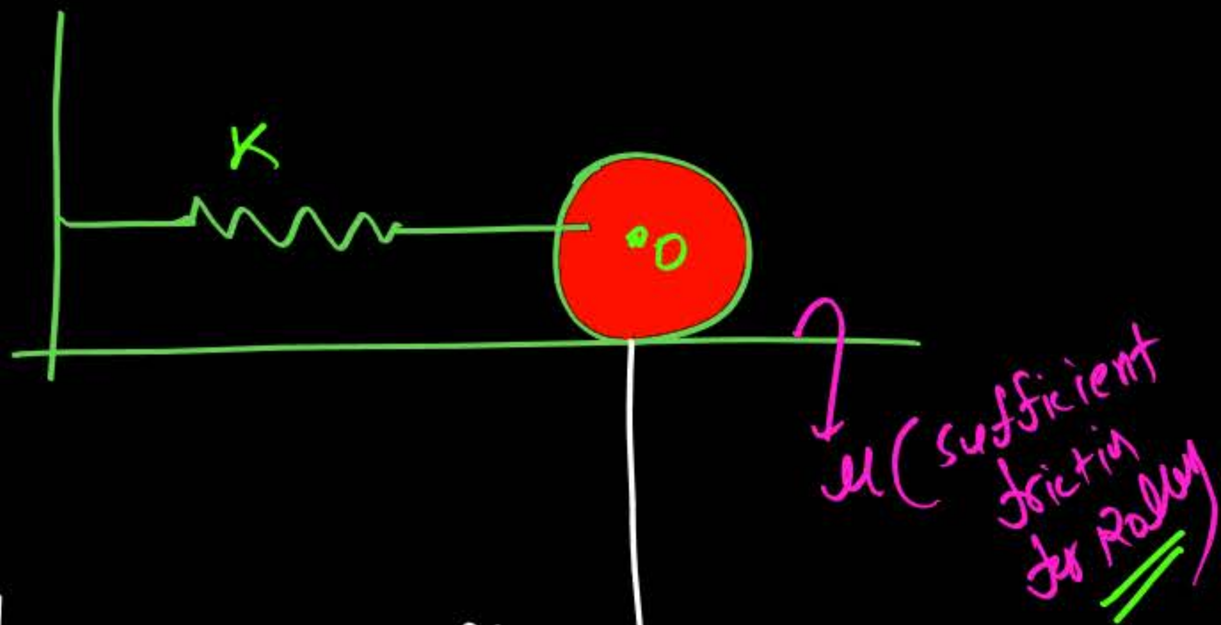
$$T = 2\pi\sqrt{\frac{3m}{4K}}$$ Ans

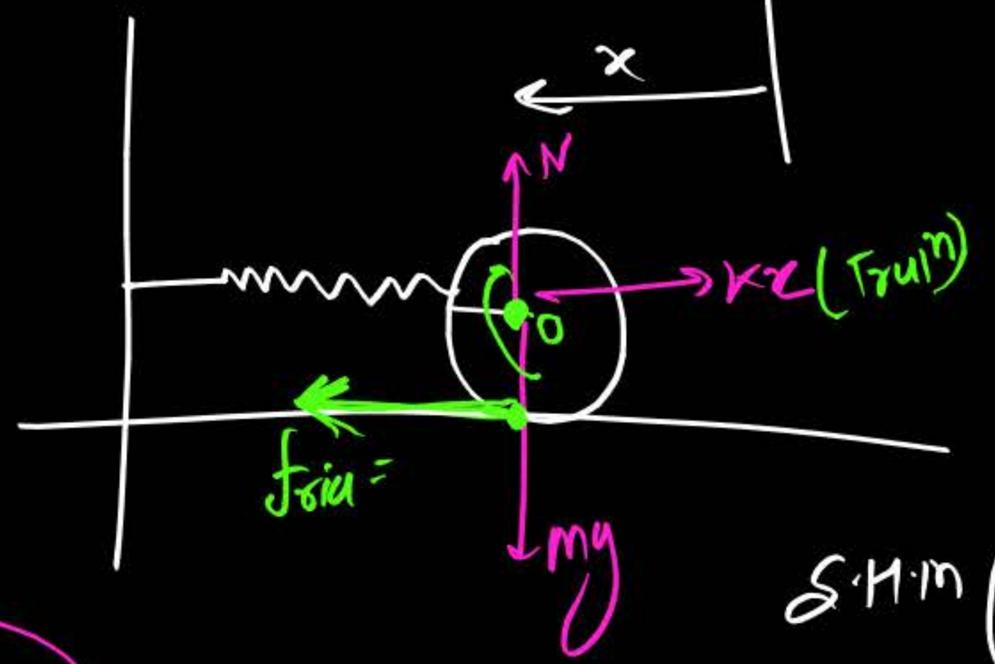


$$T = 2\pi\sqrt{\frac{m}{K}}$$

Time Period does not depend on Shap of object.

only (Transl^n S.H.M)



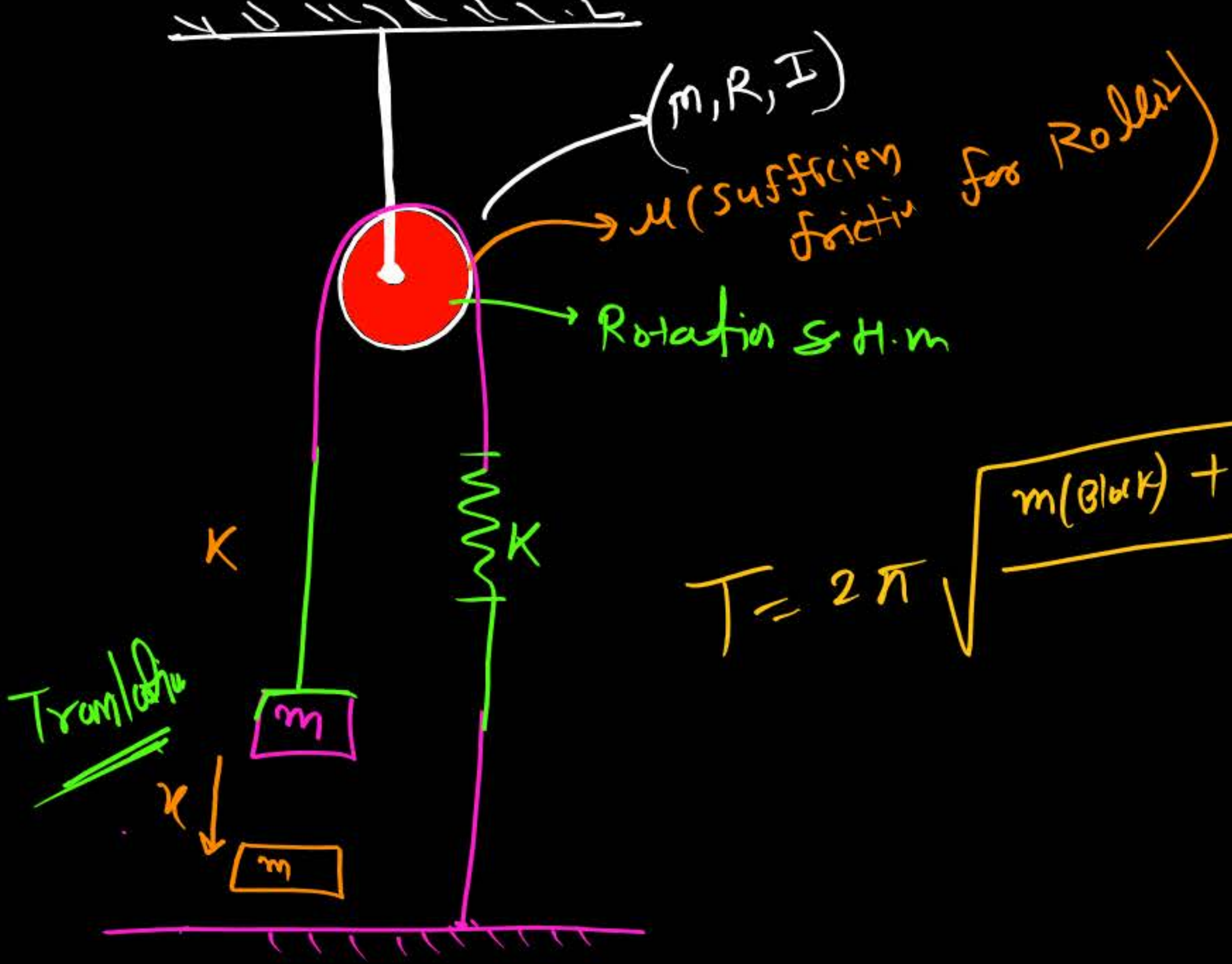


S.H.M (Translation + Rotational S.H.M)

AIIMS - 2017

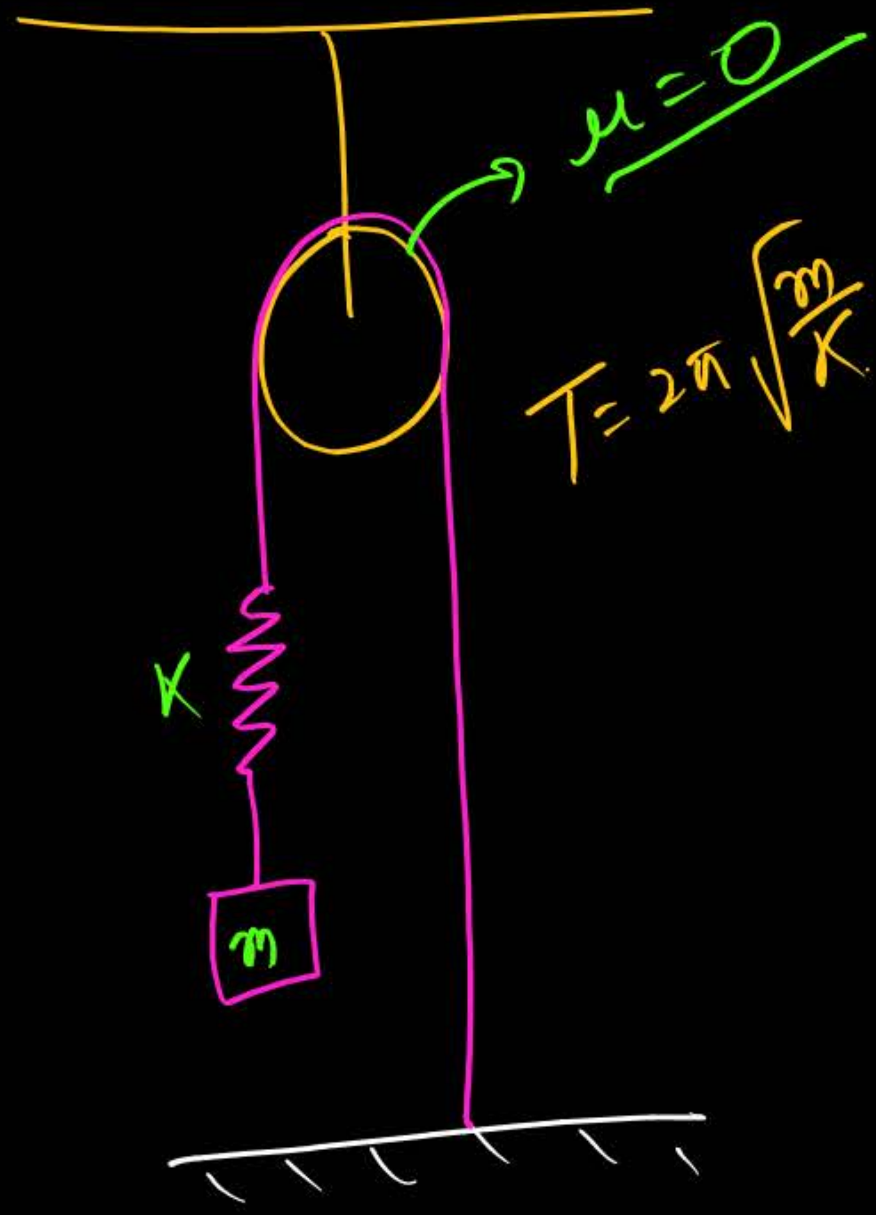
$$T = 2\pi\sqrt{\frac{(m + I/R^2)}{K}}$$

thats it



$$T = 2\pi\sqrt{\frac{m(\text{Block}) + \left(I/R^2\right)_{\text{pulley}}}{K}}$$

Ans



$$T = 2\pi\sqrt{\frac{m}{K}}$$

QUESTION

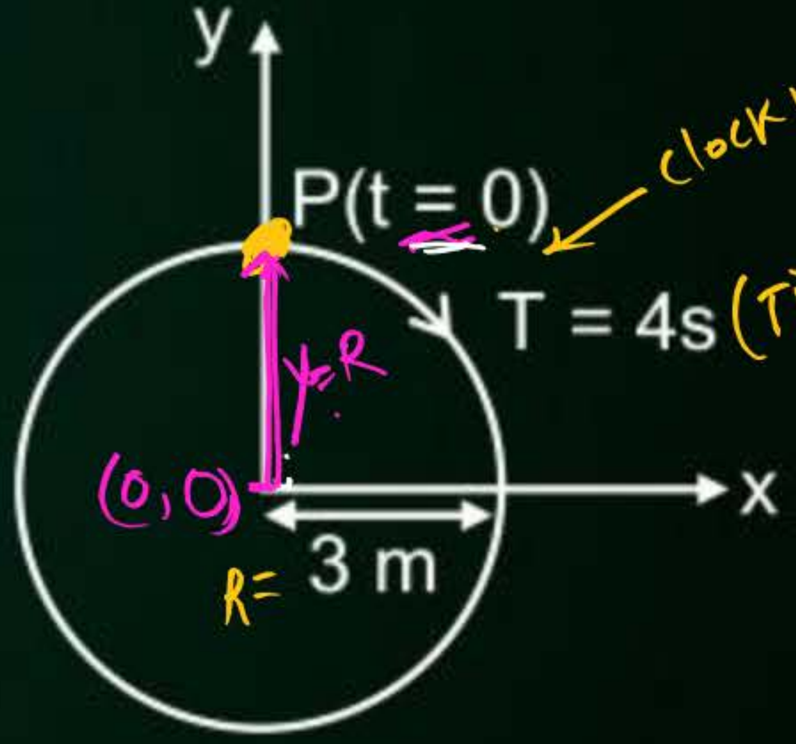
The radius of circle, the period of revolution, initial position and sense of revolution are indicated in the y-projection of the radius vector of rotating particle P is: **[2019]**

1. $y(t) = -3\cos 2\pi t$, where y in m

2. $y(t) = 4\sin\left(\frac{\pi t}{2}\right)$, where y in m

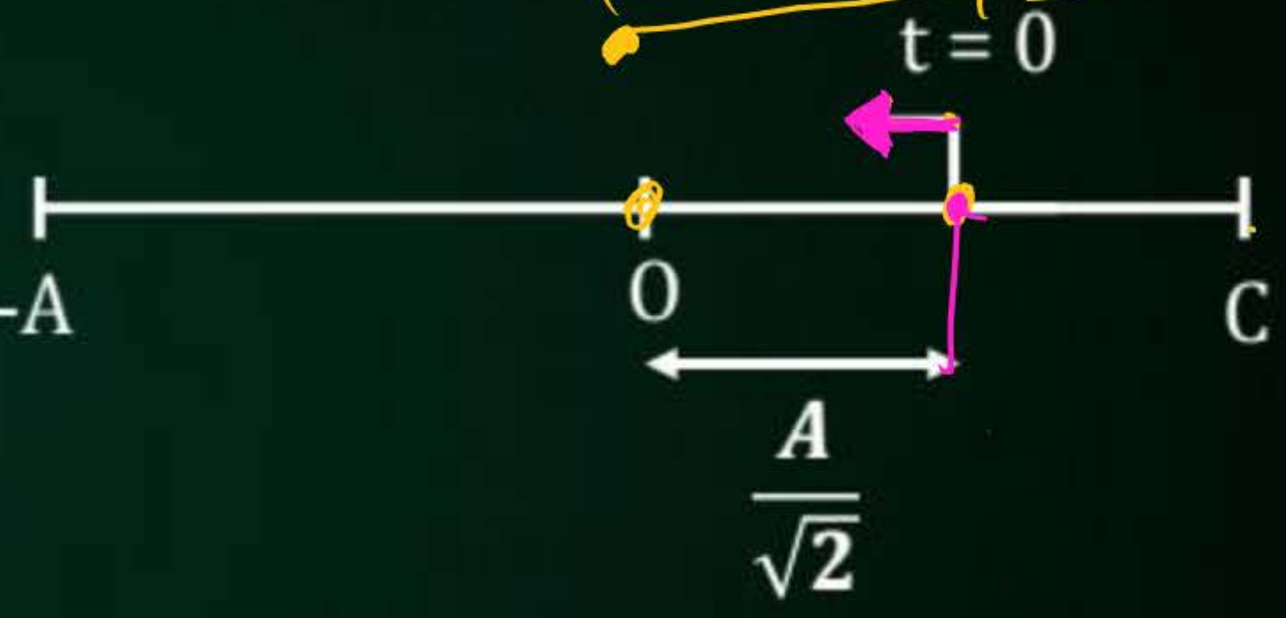
3. $y(t) = 3\cos\left(\frac{3\pi t}{2}\right)$, where y in m

4. $y(t) = 3\cos\left(\frac{\pi t}{2}\right)$, where y in m



QUESTION

For the given situation, which of the following options correctly represents the equation of the SHM?

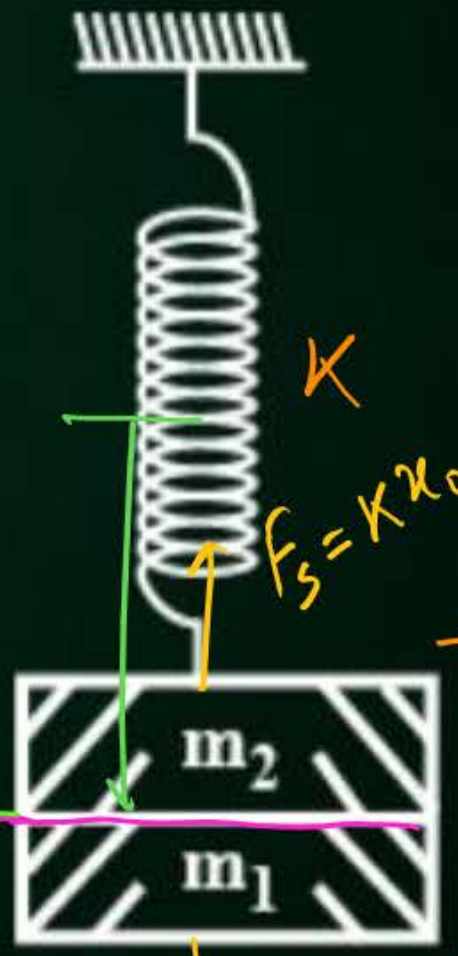


1. $x = \left(\omega t + \frac{\pi}{2}\right)$
2. $x = A\sin\left(\omega t + \frac{3\pi}{4}\right)$
3. $x = A\sin\left(\omega t + \frac{\pi}{4}\right)$
4. $x = a\sin\left(\omega t - \frac{3\pi}{4}\right)$

QUESTION

Two masses m_1 and m_2 are suspended together by a massless spring of force constant k, as shown in figure. When the masses are in equilibrium, mass, m_1 is removed without disturbing the system. The angular frequency of oscillation of mass m_2 is

1. $\sqrt{\frac{k}{m_2}}$
2. $\sqrt{\frac{k}{m_1}}$
3. $\sqrt{\frac{k m_1}{m_2^2}}$
4. $\sqrt{\frac{k\, m_2}{m_1^2}}$



QUESTION

Two masses m_1 and m_2 are suspended together by a massless spring of force constant k, as shown in figure. When the masses are in equilibrium, mass, m_1 is removed without disturbing the system. then find Amplitude of oscillation.

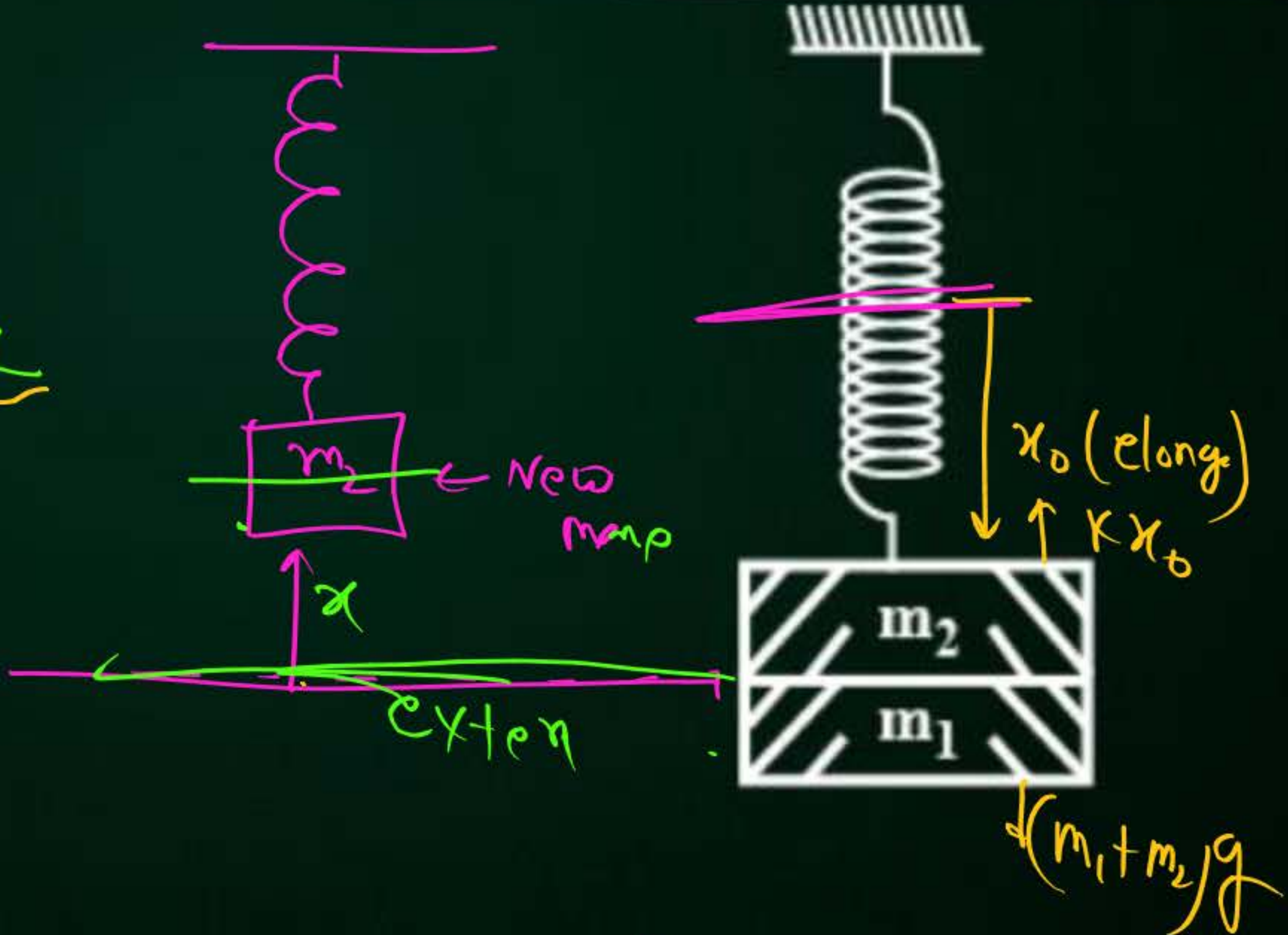
$$T = 2\pi\sqrt{\frac{m_2}{K}}$$

Time period

$$M_1 g = Kx$$

$$A = x = \frac{m_1 g}{K}$$

Amplit of oscillatio

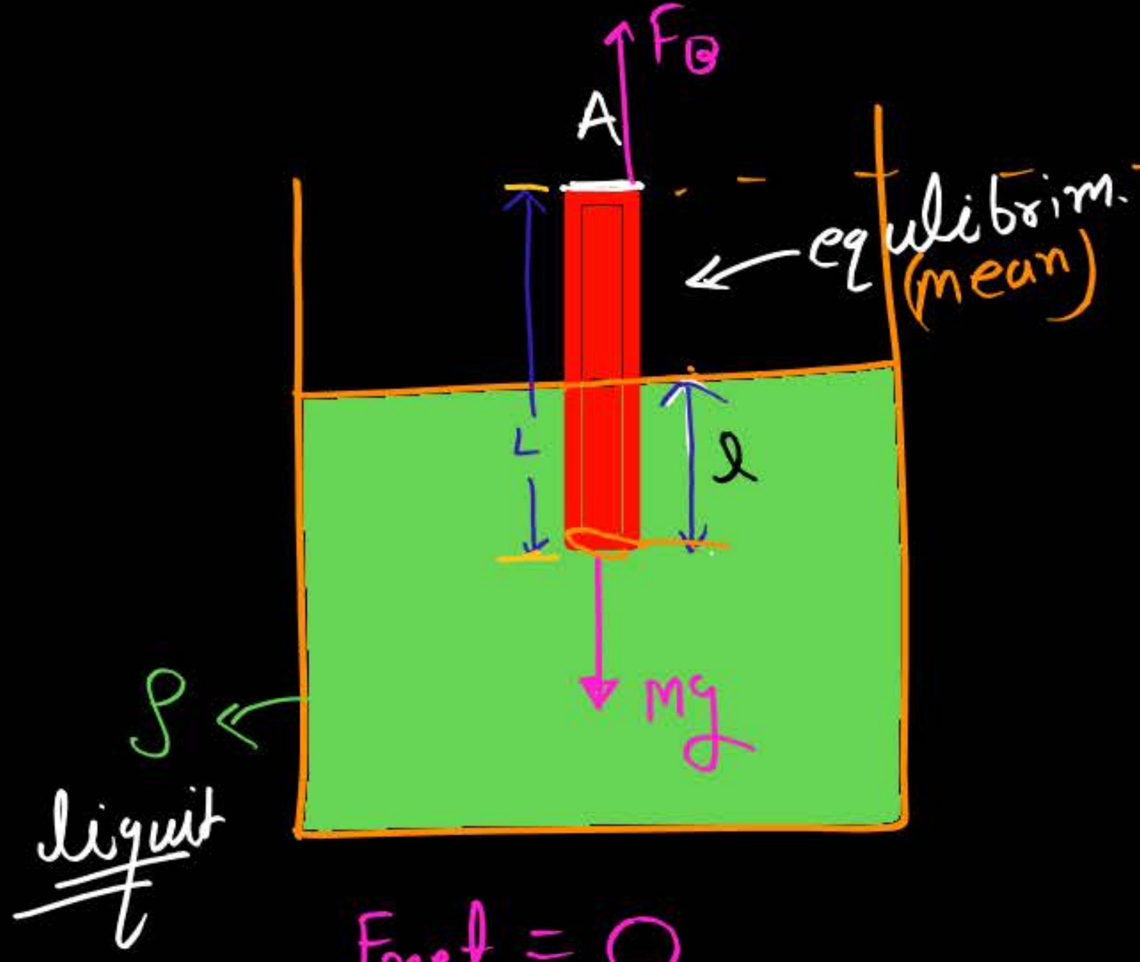


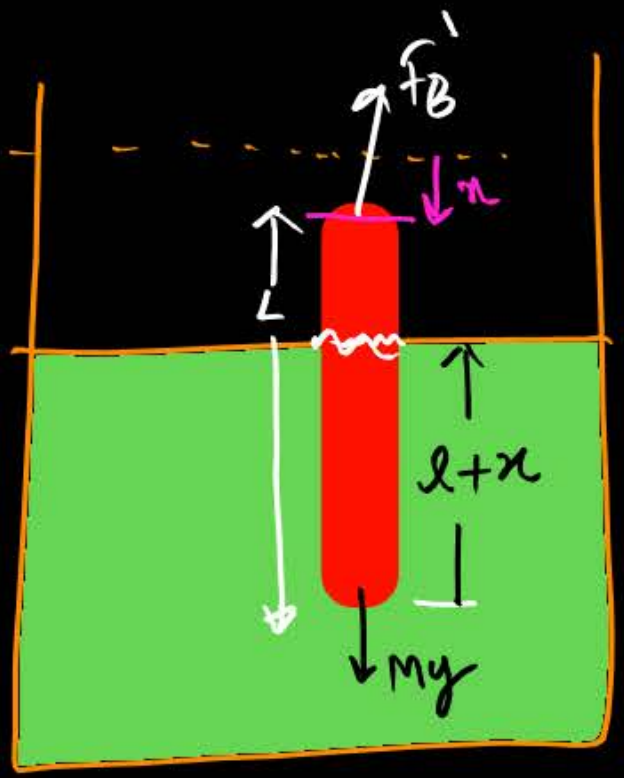
Oscillation of solid object [cylinder] Inside liquid

↳ (σ, M, H, A)

$(\rho > \sigma)$

$F_B = \rho V_{in} g$ — Buyancy Not in Syllabus





$F_{net} = 0$

$Mg = \rho (V_{Insid}) g$

$$mg = \rho A l g \quad \text{— (1) at equlin Mean (Posion)}$$

$F_{net} = F_B' - mg$

$= \rho A (l+x) g - mg$

$F_{net} = \rho A l g + \rho A x g - mg$ — (1)

using eqn (1) $(\rho A l g = mg)$

$F_{nl} = \rho A g x$

$ma = \rho A g x$

$a = \left(\frac{\rho A g}{m}\right) x$ → $\omega = \sqrt{\frac{\rho A g}{m}}$

$$T = 2\pi \sqrt{\frac{m}{\rho A g}}$$

direct MRX

$F_{extr\ buyan} = ma$

$\rho x A g = ma$

$a = \left(\frac{\rho A g}{m}\right) x$

$$T = 2\pi\sqrt{\frac{m}{\rho A g}}$$

mass of object $m = \sigma V$

$$m = \sigma A L$$

$$T = 2\pi\sqrt{\frac{\sigma A L}{\rho A g}}$$

$$T = 2\pi\sqrt{\frac{\sigma L}{\rho g}}$$

dim^n (correct) ✓

QUESTION

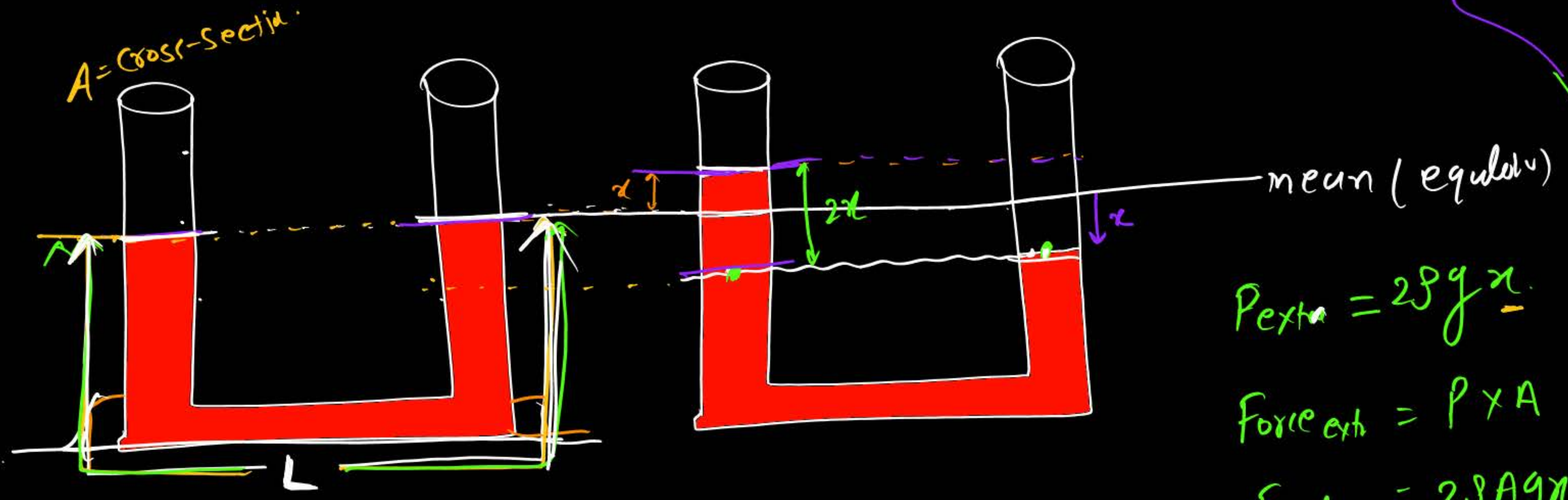
A rectangular block of mass m and area of cross-section A floats in a liquid of density n. If it is given a small vertical displacement from equilibrium it undergoes oscillation with a time period T. Then **[AIPMT (Prelims)-2006]**

1. $T \propto \sqrt{\rho}$
2. $T \propto \frac{1}{\sqrt{A}}$
3. $T \propto \frac{1}{\rho}$
4. $T \propto \frac{1}{\sqrt{m}}$



$$T = 2\pi\sqrt{\frac{m}{\rho A g}}$$

oscillation of liquid coloum



total length of liquid coloum = L

ρ = density of liquid.

m (mass of liq) $= \rho V$

$= \rho A L$

$P_{extra} = 2\rho g x$

$Force_{extr} = P \times A$

$F_{net\,for} = 2\rho A g x$

$ma = 2\rho A g x$

$\rho A L a = 2 \rho A g . x$

$a = \frac{2g}{L} x$

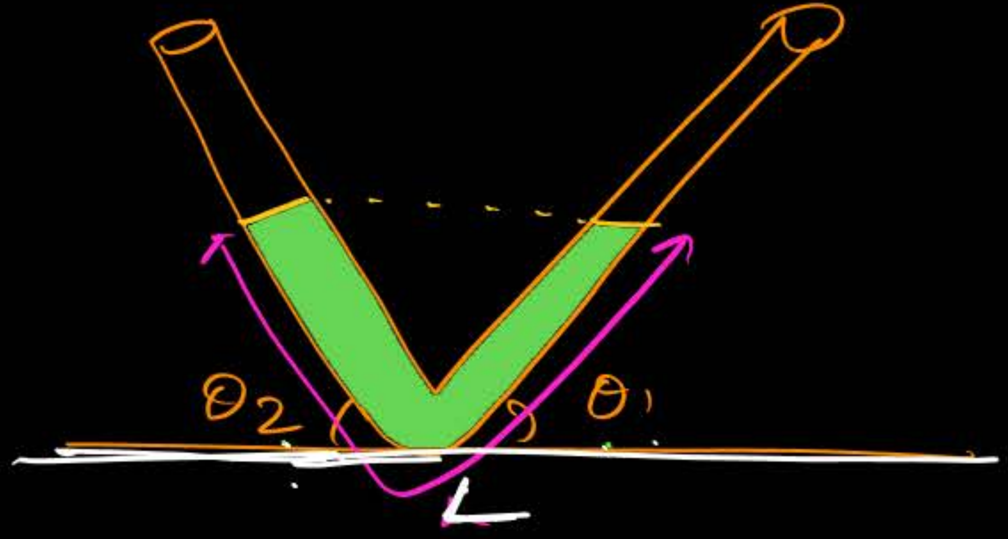
$\omega = \sqrt{\frac{2g}{L}}$

$T = 2\pi\sqrt{\frac{L}{2g}}$

L = total length both side

Jak ek side ka length = L

$T = 2\pi\sqrt{\frac{L}{g}}$



$$T = 2\pi\sqrt{\frac{L}{g(\sin\theta_1 + \sin\theta_2)}}$$

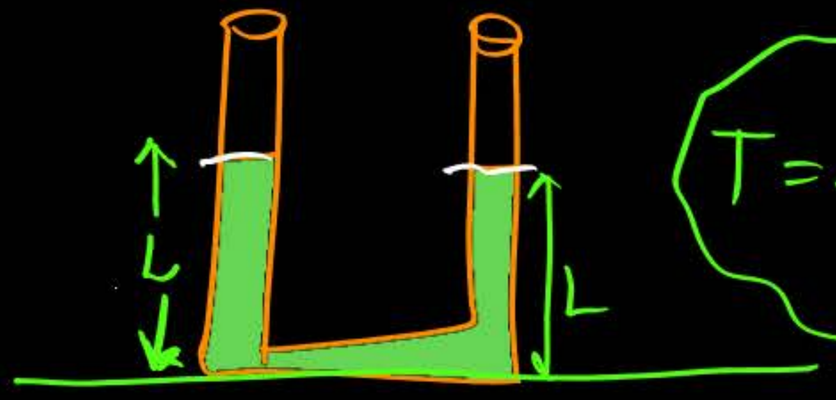
Not for NEET

If $\theta_1 = \theta_2 = 90^\circ$

(Like Privous Case)

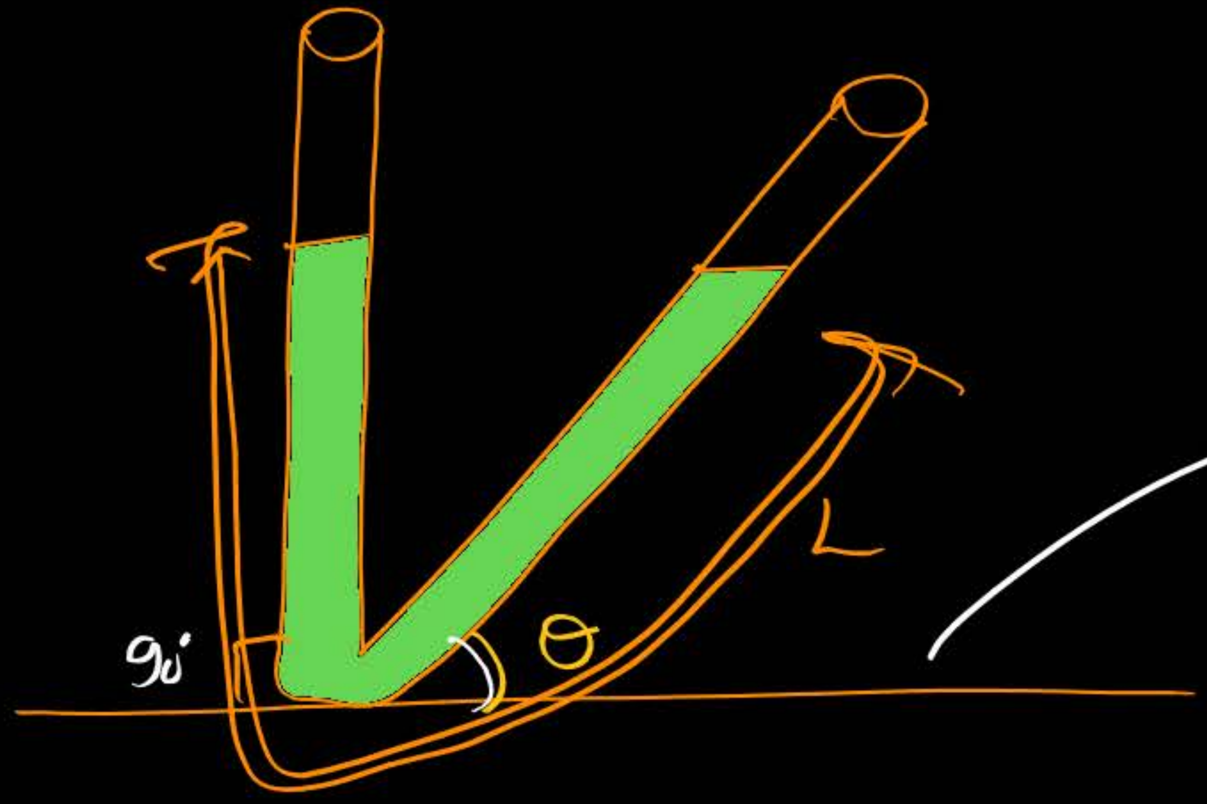
$$T = 2\pi\sqrt{\frac{L}{g(\sin 90^\circ + \sin 90^\circ)}}$$

$$T = 2\pi\sqrt{\frac{L}{2g}}$$ ✓



$L_{Tul} = 2L$

$$T = 2\pi\sqrt{\frac{2L}{2g}} = 2\pi\sqrt{\frac{L}{g}}$$



L = total length

$$T = 2\pi\sqrt{\frac{L}{2g}}$$

simple both arms vertical

L = total length

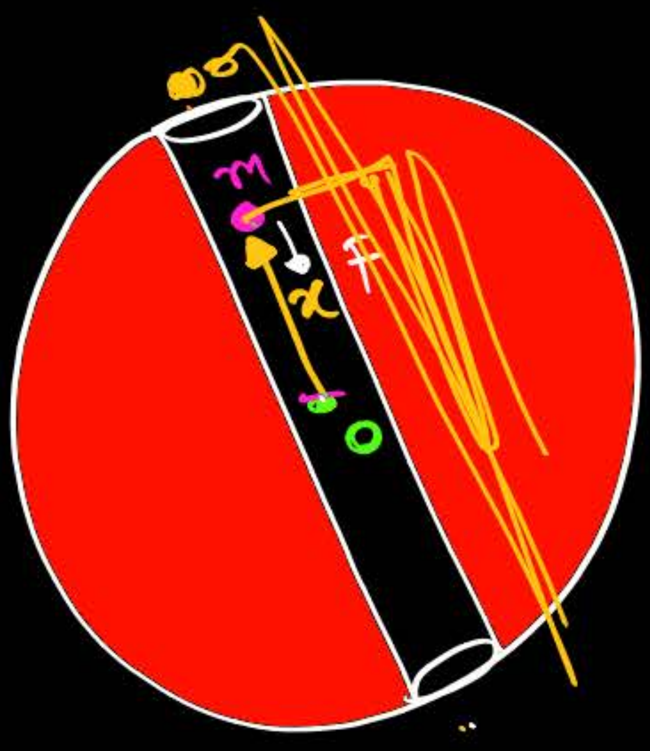
$$T = 2\pi\sqrt{\frac{L}{g(\sin\theta_1 + \sin\theta_2)}}$$

L = total length

$$T = 2\pi\sqrt{\frac{L}{g(\sin 90 + \sin\theta)}} = 2\pi\sqrt{\frac{L}{g(1+\sin\theta)}}$$

Ans

Oscillation of object in tunnel of earth.



$F_{net} = m g_x$

$$F_{net} = m g_x$$

$$\downarrow$$

$$m a = m \frac{g_0 x}{R}$$

$$\vec{a} = -\frac{g_0}{R}\vec{x}$$

$$\omega^2 = \frac{g}{R}$$

$$\omega = \sqrt{g/R}$$

$$T = 2\pi\sqrt{R/g}$$

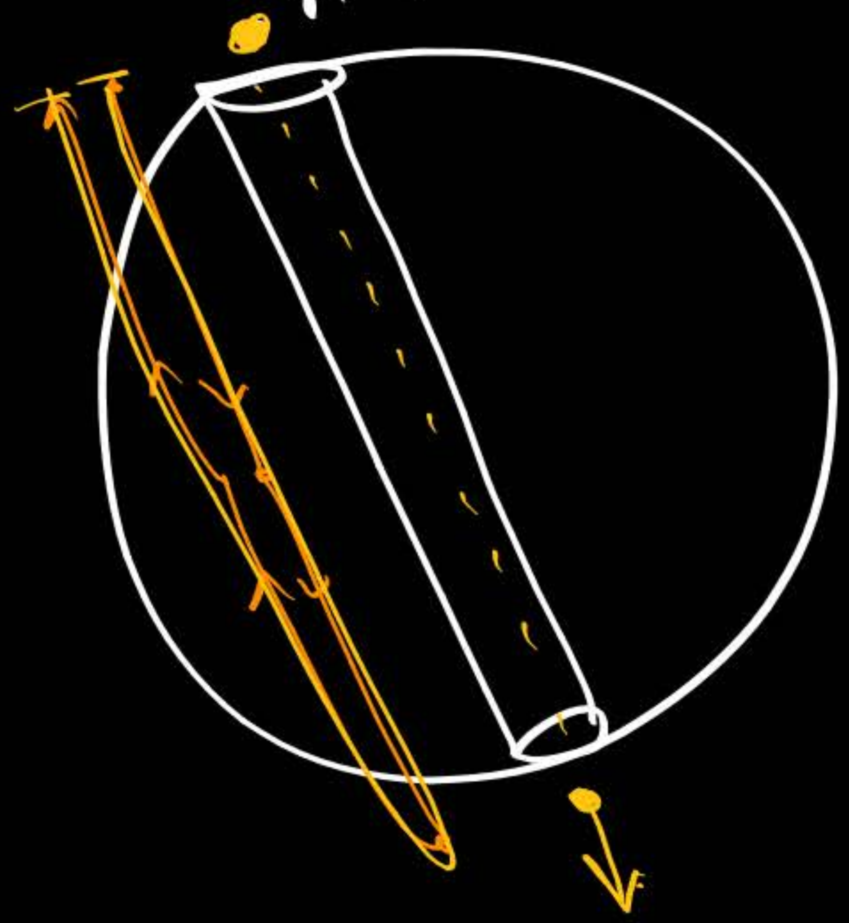
$$g_x = \frac{GM}{R^3}x$$

$$g_x = \frac{g_0 x}{R}$$

$$T = 2\pi\sqrt{\frac{R}{g}} \rightarrow 84.4 \text{ min}$$

Time period does not depend on amplitude.

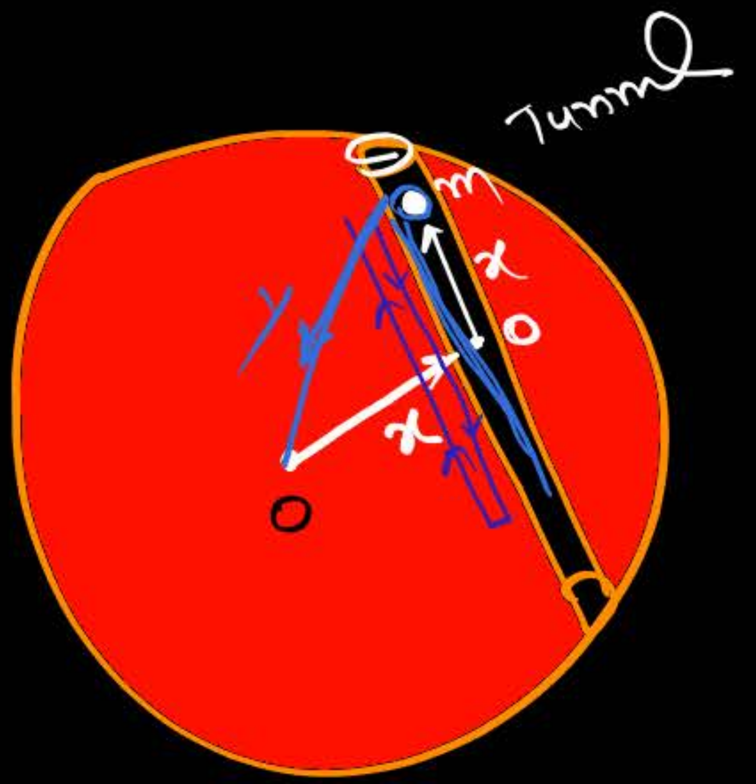
relese. m / find time to cross the earth. (A IIMS)



$$T = \frac{2\pi\sqrt{\frac{R}{g}}}{2} = \pi\sqrt{\frac{R}{g}}$$

$$T = \frac{84.4 \text{ min}}{2} = 42.2 \text{ min}$$

$= 42.3$ min



$$T = 2\pi\sqrt{\frac{R}{g}}$$

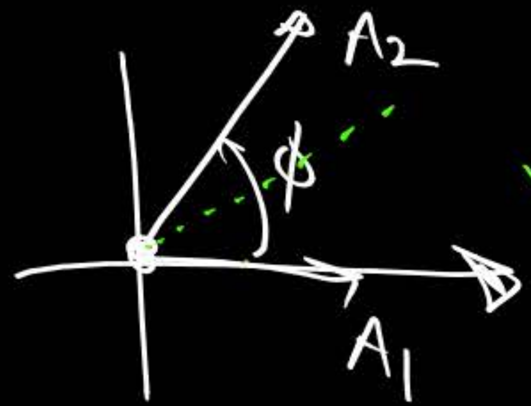
same

Superposition of S·H·M

Superposition of Two Particle oscillating in same direction

$x_1 = A_1 \sin(\omega t)$

$x_2 = A_2 \sin(\omega t + \phi)$



$$A_{net} = \sqrt{A_1^2 + A_2^2 + 2A_1A_2\cos\phi}$$

Two Particle oscillating in ⊥r direction.

$x = A_1 \sin(\omega t)$

$y = A_2 \sin(\omega t + \phi)$

$x^2 + y^2 = (A_1 \sin(\omega t))^2 + (A_2 \sin(\omega t + \phi))^2$

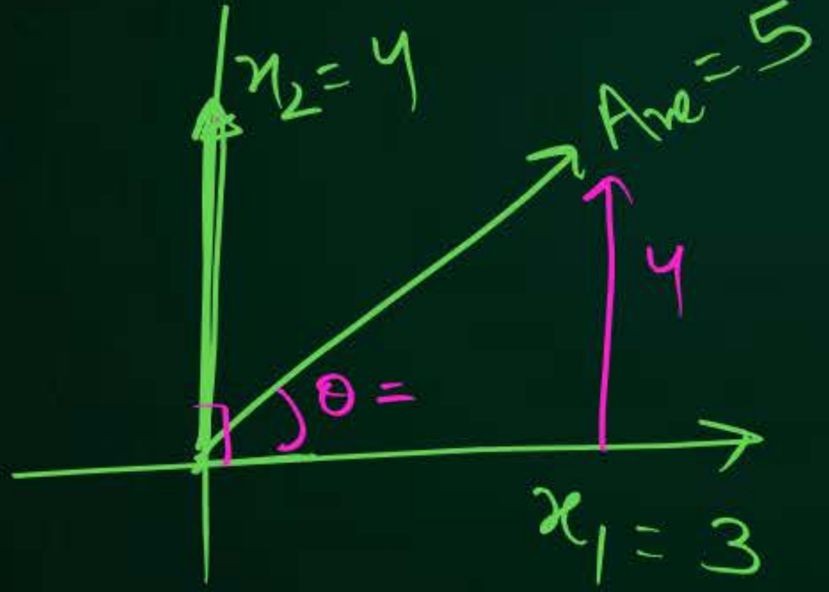
QUESTION

Equation of two oscillating particle $x_1 = A_1 \sin(\omega t)$, $x_2 = A_2 \sin(\omega t + \phi)$ then equation of superimposes SHM.

QUESTION

Equation of two oscillating particle $x_1 = 3\sin(\omega t)$, $x_2 = 4\cos(\omega t) = 4\sin(\omega t + \pi/2)$ then equation of superimposes SHM.

same dirn



$\tan\theta = \frac{4}{3}$

$\theta = 53°$

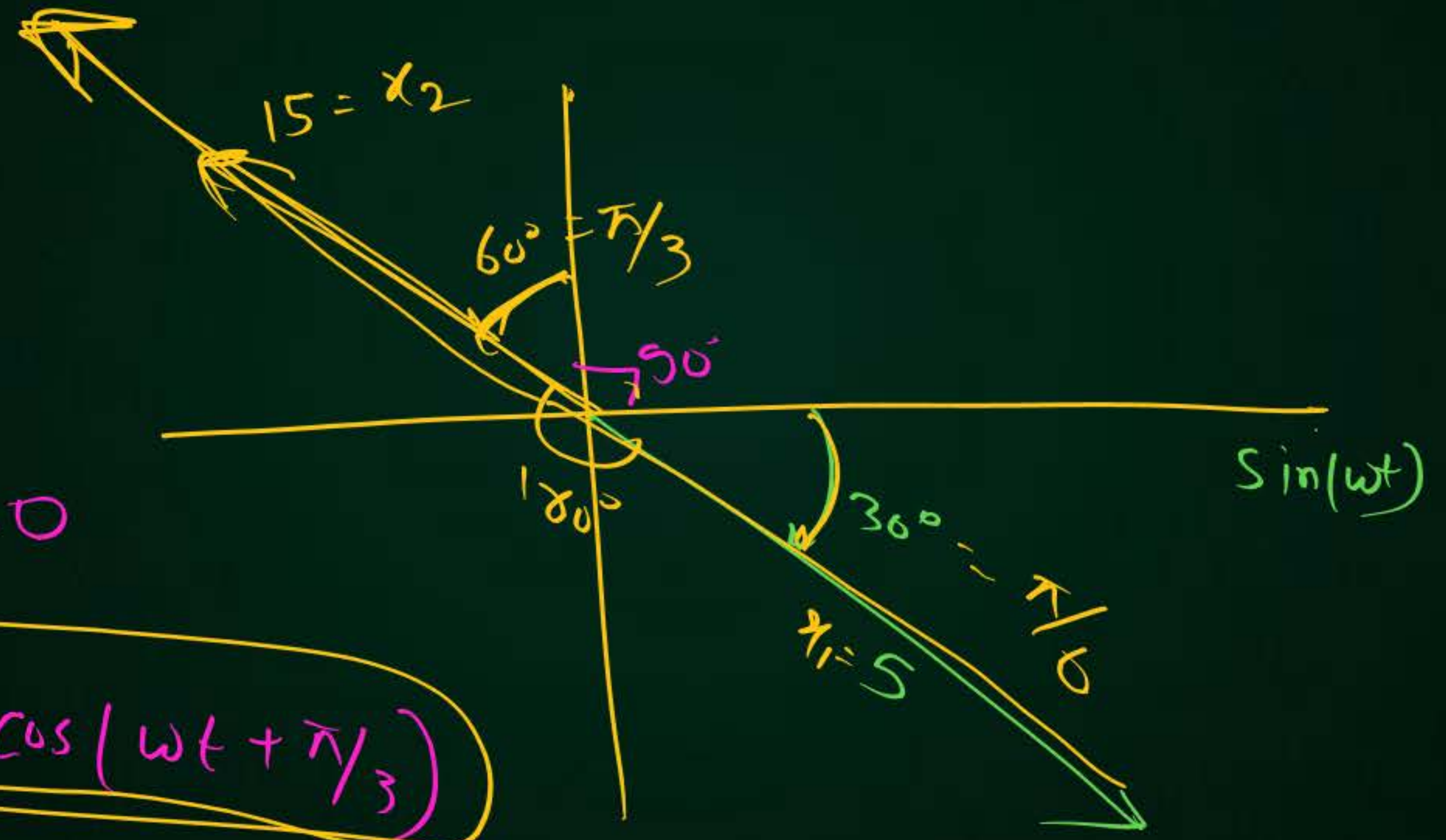
$x = 5\sin(\omega t + 53°)$

$x = 5\cos(\omega t - 37°)$

same

QUESTION

Equation of two oscillating particle $x_1 = 5\sin(\omega t - \pi/6)$, $x_2 = 15\cos(\omega t + \pi/3)$ then equation of superimposes SHM.



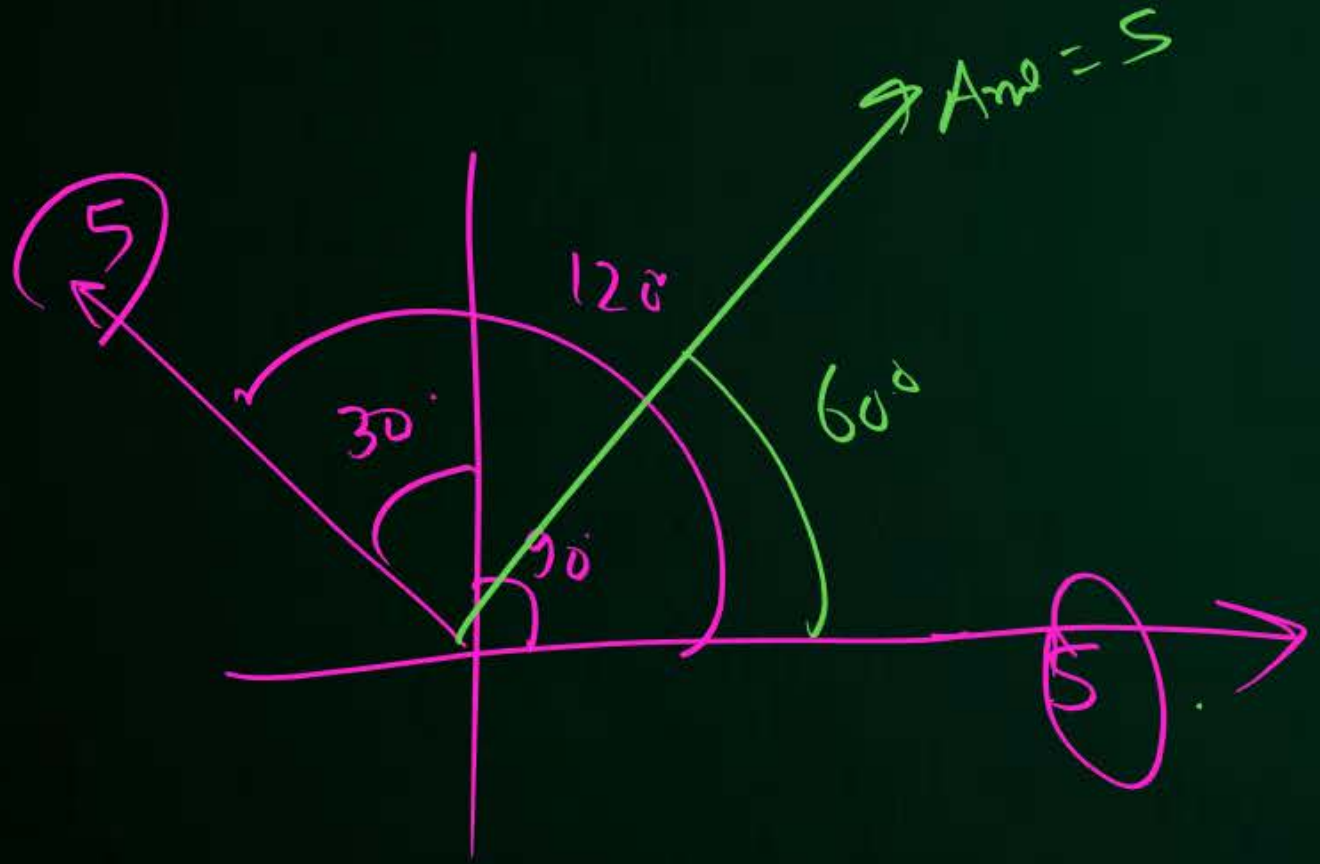
Amp = 10

$x = 10\cos(\omega t + \pi/3)$

$x = 10\sin(\omega t + 150°)$

QUESTION

Equation of two oscillating particle $x_1 = 5\sin(\omega t)$, $x_2 = 5\cos(\omega t + \pi/6)$ then equation of superimposes SHM.



$$x = 5\sin(\omega t + 60°)$$

Ans

QUESTION

Equation of two oscillating particle $x = A\sin(\omega t)$ and $y = A\cos(\omega t)$

oscillating in ⊥r dir^n.

$$x^2+y^2 = A^2\sin^2\omega t + A^2\cos^2(\omega t)$$

$$x^2+y^2 = A^2[\sin^2(\omega t)+\cos^2(\omega t)]$$

$$x^2+y^2 = 1$$

Net Path is circular.

Ans

QUESTION

Equation of two oscillation particle is $x_1 = 4\sin(\omega t)$ and $x_2 = 3\cos(\omega t)$ then find equation of superimposed oscillation of these two.

H/W

QUESTION

If $x_1 = 3\sin\left(\omega t + \frac{\pi}{3}\right)$, $x_2 = 3\sin\left(\omega t - \frac{\pi}{3}\right)$ then, find $x = x_1 + x_2$.

H/W

QUESTION

If $x_1 = 3\sin\left(\omega t - \frac{\pi}{2}\right)$ and $x_2 = 4\cos(\omega t)$, then, find $x_1 + x_2$.

QUESTION

If two mutually perpendicular simple harmonic motion of same amplitude, frequency and having zero phase difference superimpose on a particle, then its resultant path will be

1. A straight line
2. A circle
3. An ellipse
4. A hyperbola

QUESTION

The SHM of particle is given by the equation $x = 2\sin\omega t + 4\cos\omega t$. Its amplitude of oscillation is

1. 4 units
2. 2 units
3. 6 units
4. $2\sqrt{5}$ units

QUESTION

The displacement of a particle executing simple harmonic motion is given by $y = A_0 + A\sin\omega t + B\cos\omega t$. Then the amplitude of its oscillation is given by

[NEET-2019]

1. $A + B$
2. $A_0 + \sqrt{A^2 + B^2}$
3. $\sqrt{A^2 + B^2}$
4. $\sqrt{A_0^2 + (A + B)^2}$

QUESTION

Out of the following function representing motion of a particle, which represents SHM? [2011]

1. $y = \sin \omega t - \cos \omega t$
2. $y = \sin^3 \omega t$
3. $y = 5 \cos\left(\frac{3\pi}{4} - 3\omega t\right)$
4. $y = 1 + \omega t + \omega^2 t^2$

1. only (1)
2. only (4) does not represent SHM
3. only (1) and (3)
4. only (1) and (2)

QUESTION

If two mutually perpendicular simple harmonic motion of same amplitude, frequency and having $\pi/2$ phase difference superimpose on a particle, then its resultant path will be

1. A straight line
2. A circle
3. An ellipse
4. A hyperbola

QUESTION

When two displacements represented by $y_1 = a \sin(\omega t)$ and $y_2 = b \cos(\omega t)$ are superimposed the motion is [AIPMT-2015]

1. Simple harmonic with amplitude $\frac{(a+b)}{2}$
2. Not a simple harmonic
3. Simple harmonic with amplitude a/b
4. Simple harmonic with amplitude $\sqrt{a^2 + b^2}$

THANK YOU

damped
osscillat Not in syllabus



YAKEEN 2.0

FOR NEET 2025

Lecture- 01 | Physics

Wave [redacted]

A/C
EM wave
wave optics

By- Dr. Manish Raj (MR SIR)



Topics to be covered

1. # Types & eq^n of wave
2. #
3. #



S.H.M → wave motn.

Manish Ro

Yakeen 2.0

2-3% → 8th, 9th.
3-4% → 10th cu.
10% → 11th u
5-7% → 12 Cl.
75-80% → dropr

H/W

Superposit of S.H.M

- Same
  - add amplitude w/ phase
- Perpendicu
  - eq^n of trajectory ka concept
    - with phase diff^n

QUESTION

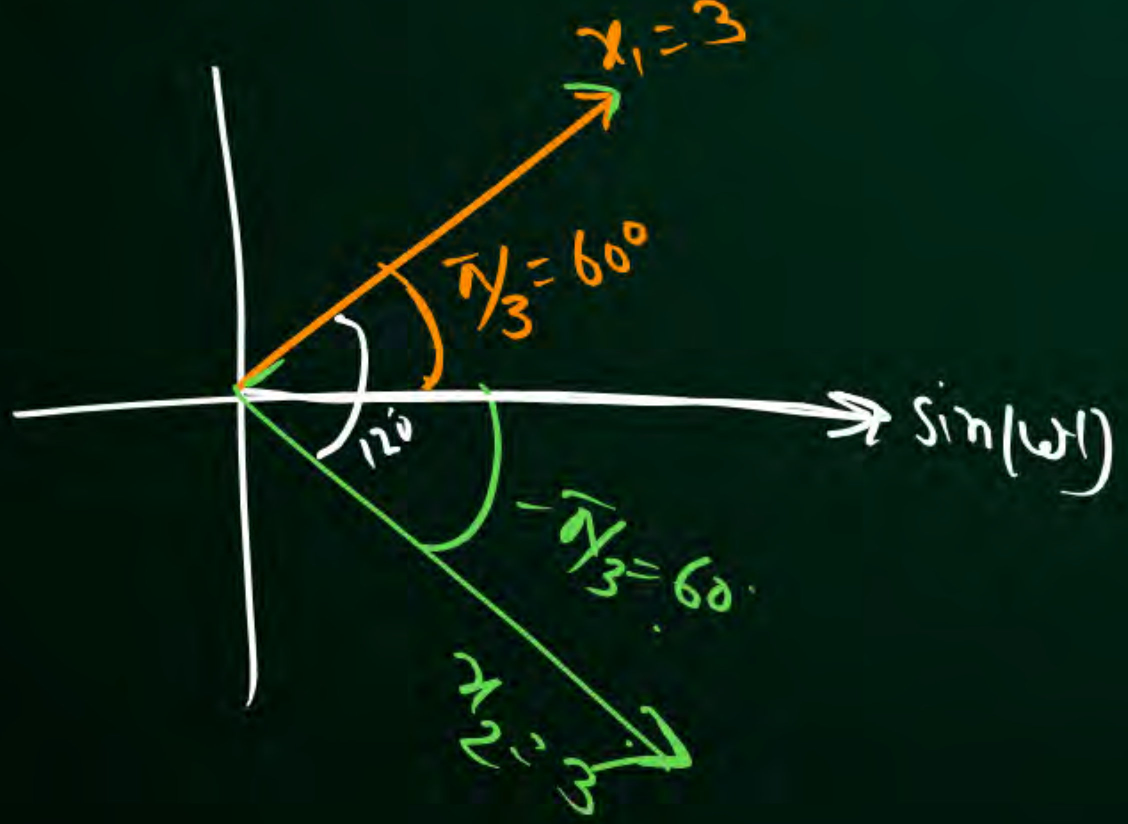
If $x_1 = 3\sin\left(\omega t + \frac{\pi}{3}\right)$, $x_2 = 3\sin\left(\omega t - \frac{\pi}{3}\right)$ then, find $x = x_1 + x_2$.

Same ampl.

$A_{net} = 2A\cos(\theta/2)$

Same dirn ka S.H.M

$x_1 = 3\sin(\omega t + \pi/3)$



$A_{net} = 3$

$x = x_1 + x_2 = 3\cos(\omega t - \pi/2)$

$= 3\sin(\omega t)$

QUESTION

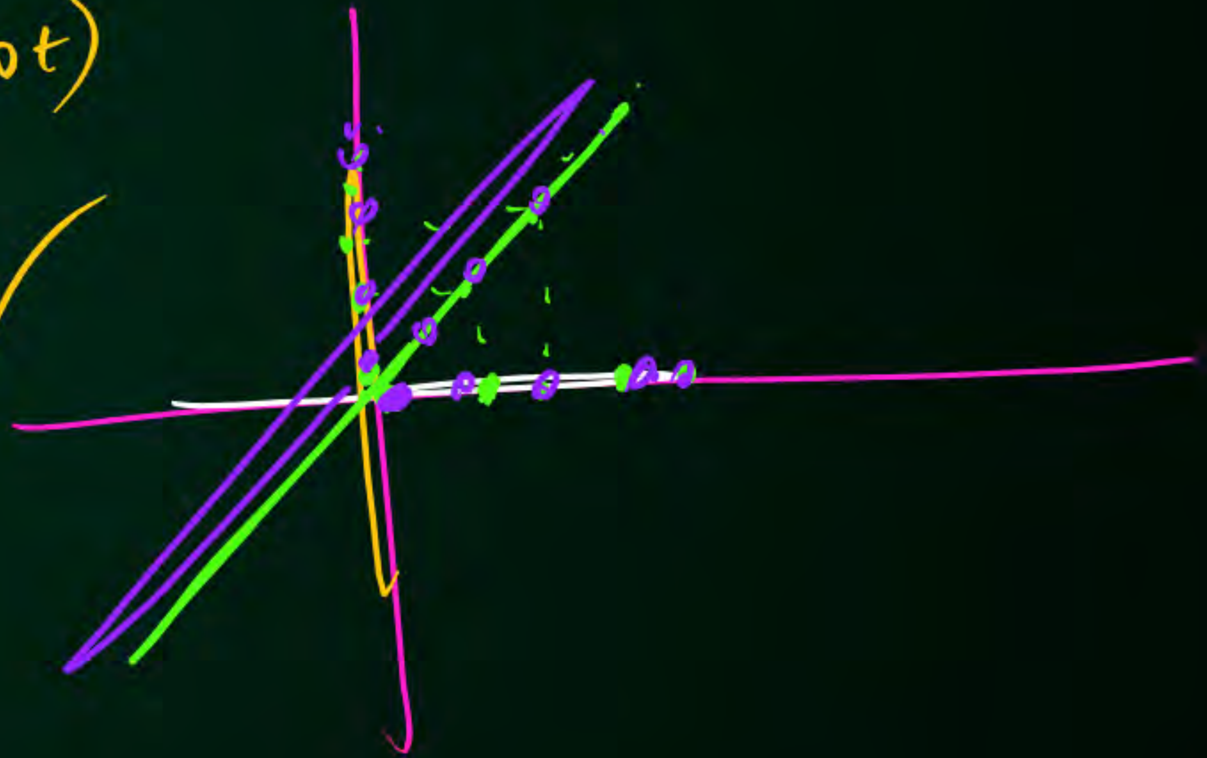
If two mutually perpendicular simple harmonic motion of same amplitude, frequency and having zero phase difference superimpose on a particle, then its resultant path will be

1. A straight line
2. A circle
3. An ellipse
4. A hyperbola

$x = A\sin(\omega t)$

$y = A\sin(\omega t)$

$x = y$



QUESTION

If two mutually perpendicular simple harmonic motion of different amplitude, frequency and having zero phase difference superimpose on a particle, then its resultant path will be

1. A straight line (only 23%)
2. A circle (38%)
3. An ellipse (32%)
4. A hyperbola (6%)

$x = A_1 \sin(\omega t)$

$y = A_2 \sin(\omega t)$

$\frac{x}{y} = \frac{A_1}{A_2}$

$x = \frac{A_1}{A_2} y$ ← straight line

QUESTION

If two mutually perpendicular simple harmonic motion of same amplitude, frequency and having $\pi/2$ phase difference superimpose on a particle, then its resultant path will be

1. A straight line
2. A circle
3. An ellipse
4. A hyperbola

$x = A\sin(\omega t)$

$y = A\sin(\omega t + \pi/2)$

$y = A\cos(\omega t)$

$x^2 + y^2 = A^2$ circle

QUESTION

If two mutually perpendicular simple harmonic motion of same amplitude, frequency and having $\pi/2$ phase difference superimpose on a particle, then its resultant path will be

1. A straight line
2. A circle
3. An ellipse
4. A hyperbola

$x = A_1 \sin(\omega t)$

$y = A_2 \cos(\omega t)$

$$\frac{x^2}{A_1^2} + \frac{y^2}{A_2^2} = 1$$

QUESTION

The SHM of particle is given by the equation $x = 2 \sin \omega t + 4 \cos \omega t$. Its amplitude of oscillation is

Same dir^n ($\phi = \pi/2$)

1. 4 units
2. 2 units
3. 6 units
4. $2\sqrt{5}$ units

$A_{net} = \sqrt{2^2 + 4^2}$
$= \sqrt{4+16} = \sqrt{20}$
$= \sqrt{5 \times 4}$
$= 2\sqrt{5}$

QUESTION

The displacement of a particle executing simple harmonic motion is given by $y = A_0 + A \sin \omega t + B \cos \omega t$. Then the amplitude of its oscillation is given by

[NEET-2019]

1. $A + B$ ✗
2. $A_0 + \sqrt{A^2 + B^2}$ ✗
3. $\sqrt{A^2 + B^2}$ ✓
4. $\sqrt{A_0^2 + (A + B)^2}$ ✗

$y = \underbrace{A_0}_{\text{Mean.}} + A \sin(\omega t) + B \cos(\omega t)$

$= \sqrt{A^2 + B^2}$

QUESTION

Out of the following function representing motion of a particle, which represents SHM? [2011]

1. $y = \sin \omega t - \cos \omega t$
2. $y = \sin^3 \omega t$
3. $y = 5 \cos\left(\frac{3\pi}{4} - 3\omega t\right)$
4. $y = 1 + \omega t + \omega^2 t^2$

(1) only (1)

(2) only (4) does not represent SHM

(3) only (1) and (3)

(4) only (1) and (2)

QUESTION

Which of the following represents a SHM?

1. $\sin \omega t - \cos \omega t$ ✓
2. $\sin \omega t + \cos \omega t$ ✓
3. $\sin \omega t + 2 \cos \omega t$ ✓
4. All of these   Ans

$\sin(\omega t) + \sin(\omega^2 t)$ ✗

$\sin(\omega t) + \cos(2\omega t)$ ✗

QUESTION

Same

When two displacements represented by $y_1 = a \sin(\omega t)$ and $y_2 = b \cos(\omega t)$ are superimposed the motion is

[AIPMT-2015]

1. Simple harmonic with amplitude $\frac{(a+b)}{2}$
2. Not a simple harmonic
3. Simple harmonic with amplitude a/b
4. Simple harmonic with amplitude $\sqrt{a^2 + b^2}$

Vector / Trigonometric (1)

Phasor diagram

motn in plane ka 1st leefr

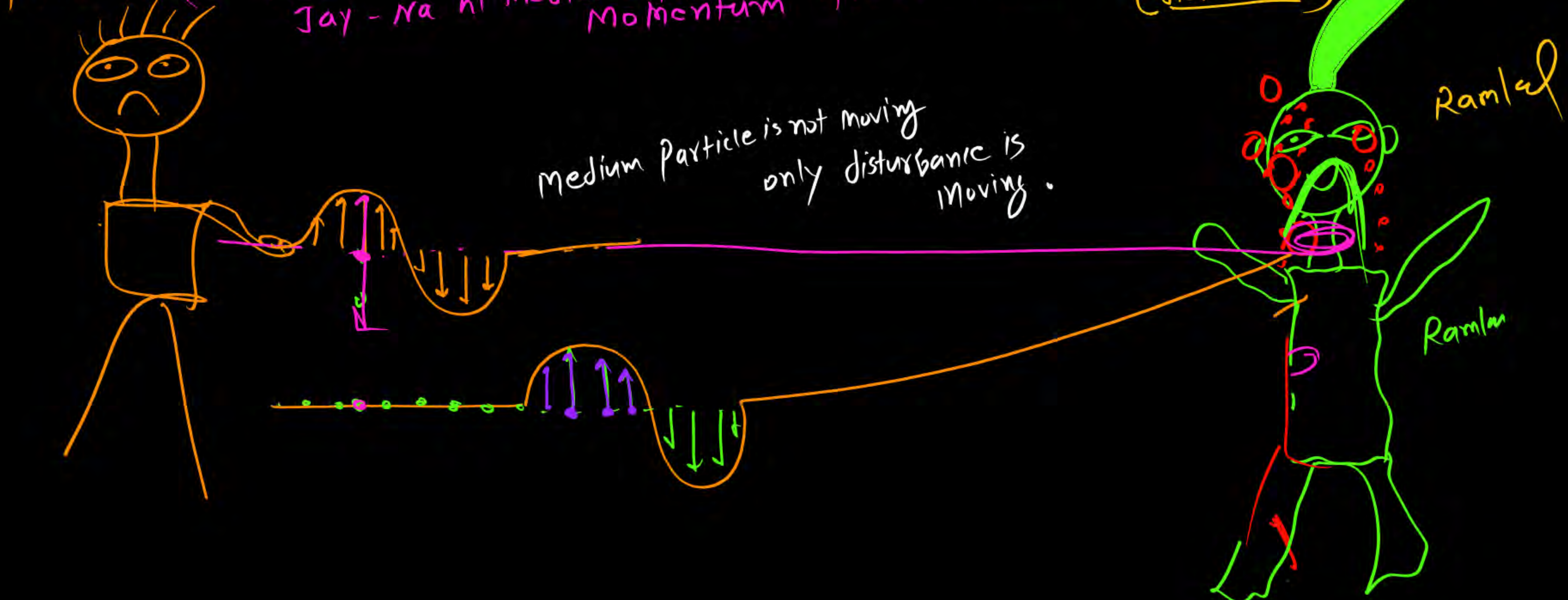
eqn of trajectory

- Super position of SHM (2)
- Super position of Wave (Interference) (3)
- Super position of A/C (4)
- Super position of wave optics (5)
- Super position of EM Wave (6)

(1) Source → move kiya.

(2) Source move Nahi kiya, but medium particln energy/momentum le ke move kiya

(3) Na hi source Jay - Na hi medium particle move kare but energy & Momentum Transfer ho Jay → wave (disturbance)



Particle Motion

Energy and **momentum** transfer from one point to other by a particle motion.

Wave-motion → energy & momentum transfer without transfering any medium particle

- S.H.M → To & fro motion of a particle about mean.
- Wave → (To & fro) motion of Lakho particle



Medium

Need medium particle

Mechanical Wave: A wave which required medium is called mechanic wave ✓

Ex - sound wave

Non-mechanical Wave: A wave which does not required medium. Ex - light EM, wave

On Moon there is no invirment hence No sound wave travells but light can travells

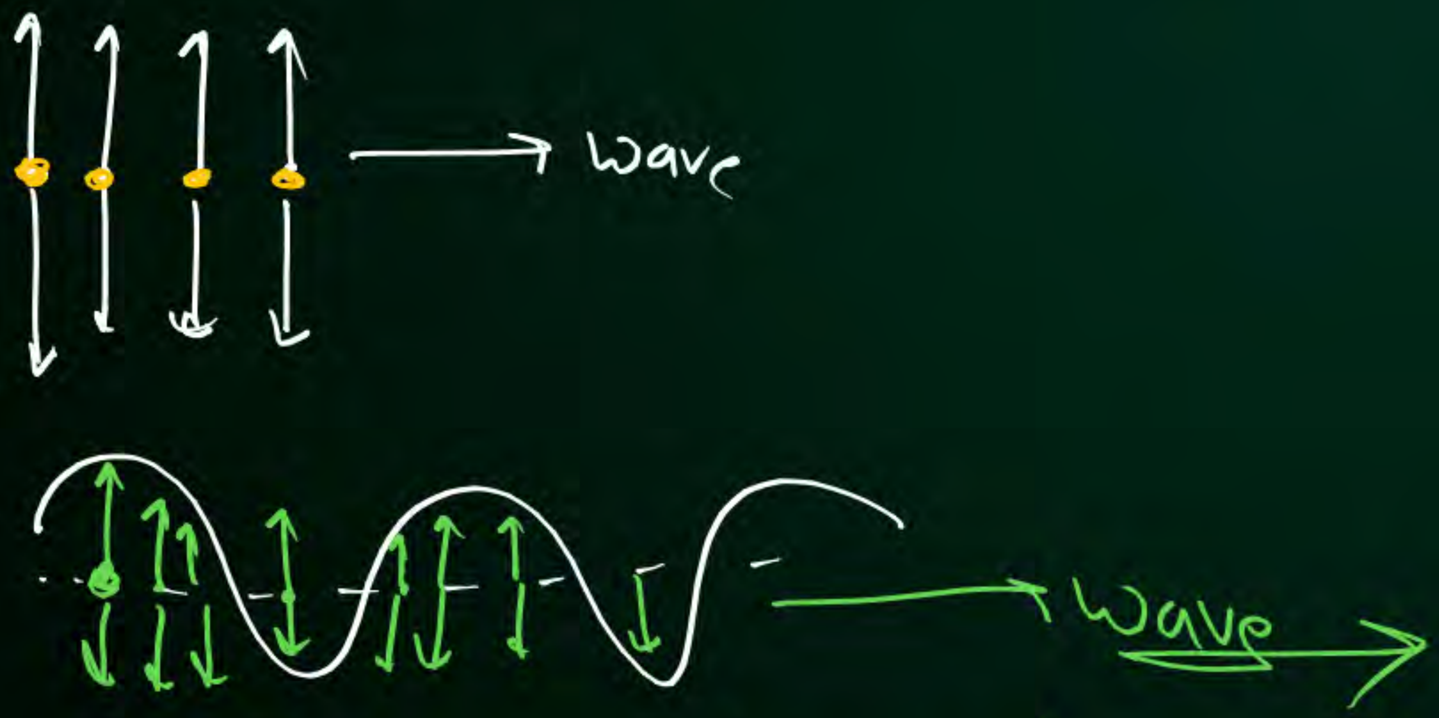
I am on moon, Let me come on earth

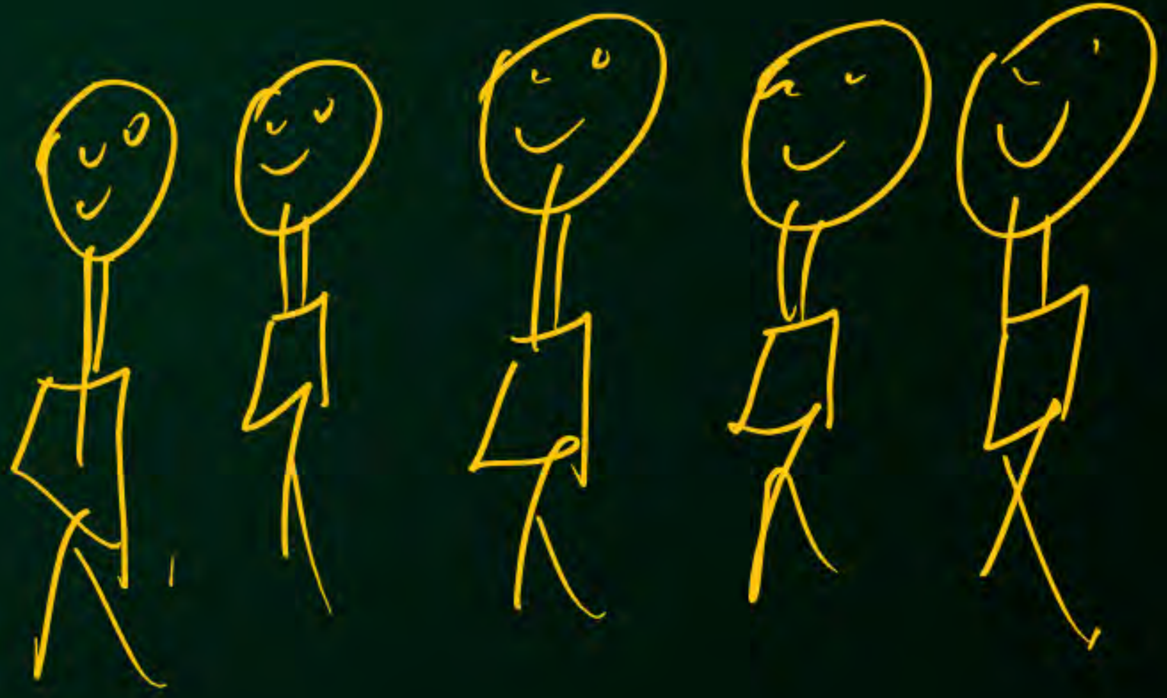
➢ On the basis of Propagation:

1. **Longitudinal Wave:** Particle oscillate in the direction of motion of wave.



2. **Transverse Wave:** Particle oscillate in the perpendicular direction of motion of wave.

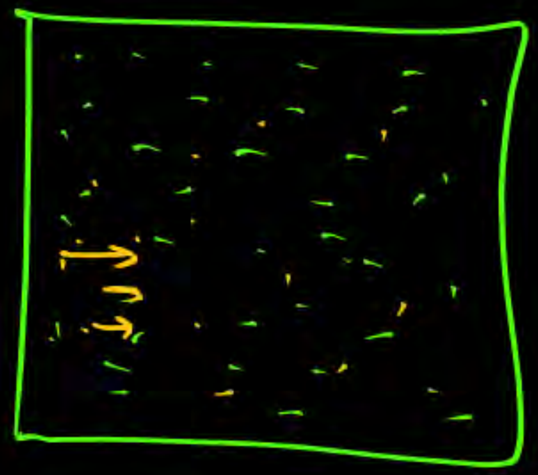




Transvers wave (light wave)
String wave

Transverse wave can exist on the surface of water.
but Transverse wave can't exist inside liquid & gas.

longitudinal wave can exist in solid, liquid & gas.
Ex - sound wave.





On the Surface of water

Both transverse and longitudinal can exist.

Inside water
only longitudinal can exist

QUESTION

A transverse wave travels along *x*-axis. The particles of medium move

1. Along x-axis
2. Along y-axis
3. Either along y-axis or z-axis
4. Either along y-axis or z-axis

➢ Equation of SHM of a Particle which is at $(x = 0)$

{To - & - fro motion about mean Position}

mean Position is at $(x=0)$

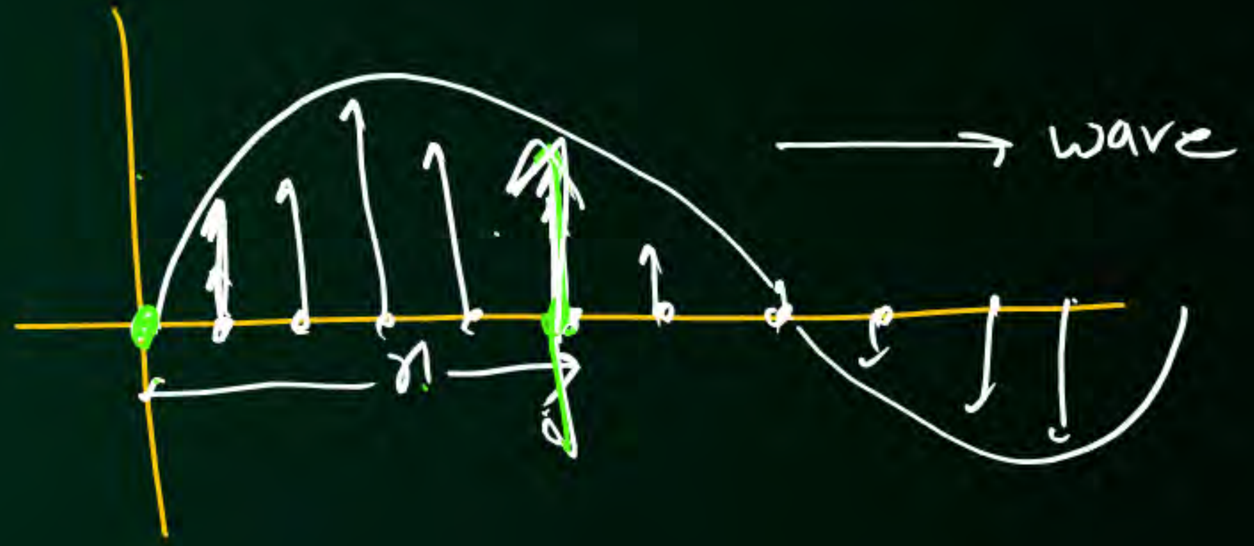
$$y = A\sin(\omega t)$$

← If $x=0$, $\phi=0$

Equation of S.H.M of a Particle which is at x

$$y = A\sin(\omega t - kx + \phi)$$

→ Eqn of harmonic wave



Transverse wave

$$y = A\sin(\omega t - Kx + \phi)$$

Position of Particle at 't' which is at x

ϕ = initial Phase

ω = Angular freq^n of Particle

K = Angular wave no

A = Amplitude of Particle

$\omega = 2\pi f = \frac{2\pi}{T}$

$K = \frac{2\pi}{\lambda}$ = Angular wave no.

$\frac{1}{\lambda}$ = Wave no = no. of wave in a unit length

longitudinal wave

$y_L = A\sin(\omega t - Ky + \phi)$

$x_L = A\sin(\omega t - Kx + \phi)$

(a) Yes class hona chahiye

(b) Nahi hona chahiye

$y = A\sin(+\omega t - Kx)$

$y = A\sin(+Kx - \omega t)$

→ wave +ve x में जायेगा

$y = A\sin(Kx + \omega t)$

$y = A\sin(-Kx - \omega t)$

→ wave −ve x में जायेगा

QUESTION

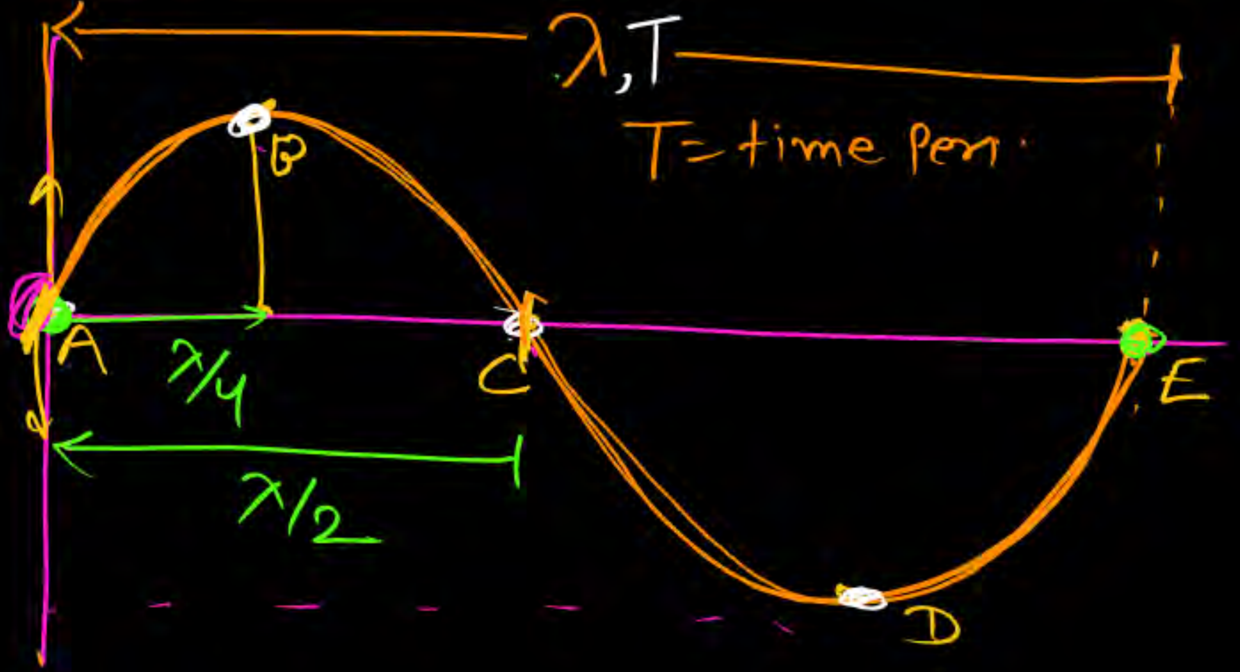
Which of the following equations represents a transverse wave travelling along – y axis? (–ve y axis)

1. $x = A \sin(\omega t - ky)$
2. $x = A \sin(\omega t + ky)$
3. $y_0 = A \sin(\omega t - ky)$
4. $y_0 = A \sin(\omega t + ky)$

QUESTION

A plane progressive wave propagating along positive x-axis is

1. $x = A \sin(\omega t + kx)$
2. $x = A \sin(\omega t - kx)$ (83%)
3. $y_0 = A \sin \omega t \cdot \sin kx$
4. $y = A [\sin \omega t] kx$



(Q) Which Pair are in same Phase ??

1. AB ✗
2. AC ✗
3. AD ✗
4. CE ✗
5. BD ✗
6. ✓ A E (only Pair)

V speed of wave $= \frac{\lambda}{T}$

$V_{wave} = \lambda f$

$= \frac{\lambda f \, 2\pi}{2\pi}$

✡ $$V_{wave} = \frac{\omega}{K} = \lambda f = \frac{\lambda}{T}$$

Phase diffⁿ at λ Path diffⁿ is 2π

" " at unit Pathdiffⁿ $= \frac{2\pi}{\lambda}$

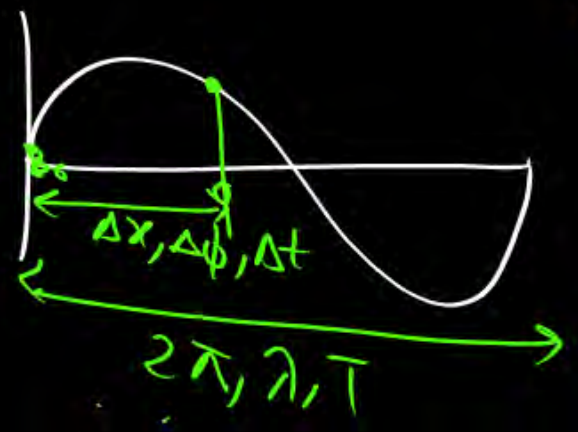
Phase diffⁿ at Δx Pathdiffⁿ $= \frac{2\pi}{\lambda}\Delta x$

IMP*

$$\frac{\Delta\phi}{2\pi} = \frac{\Delta x}{\lambda} = \frac{\Delta t}{T}$$

✓ $$\Delta\phi = \frac{2\pi}{\lambda}\Delta x$$

($\Delta\phi$: Phase diffⁿ; Δx: Path diff)



$$y = A\sin(\omega t - kx)$$

diffⁿ w.r.t. time

$$\frac{dy}{dt} = A\cos(\omega t - kx) \times \frac{d(\omega t - kx)}{dt}$$

$$= A\cos(\omega t - kx)(\omega \; 1)$$

S.H.M ka feel

$$V_{Particle} = A\omega\cos(\omega t - kx)$$

$$(V_{particle})_{max^m} = A\omega$$

$$V_{particle\ max} = A\frac{\omega}{k} \times k$$

$$V_{max\ of\ part.} = V_{wave} \times Ak.$$

$$y = A\sin(\omega t - kx)$$

dimension → $V_{wave} = \frac{\omega}{k}$

diff^n w.r.t time

$$\frac{dy}{dt} = A\omega\cos(\omega t - kx) \quad \text{— (i)}$$

$$\frac{d^2y}{dt^2} = -A\omega^2\sin(\omega t - kx) \quad \text{— (ii)}$$

$$\frac{dy}{dx} = A\cos(\omega t - kx)(-k)$$

$$\frac{dy}{dx} = -kA\cos(\omega t - kx) \quad \text{— (iii)}$$

diff^n w.r.t x

$$\frac{d^2y}{dx^2} = -k^2A\sin(\omega t - kx) \quad \text{— (iv)}$$

(ii)/(iv)

$$\frac{\frac{d^2y}{dt^2}}{\frac{d^2y}{dx^2}} = \frac{-A\omega^2\sin(\omega t - kx)}{-k^2A\sin(\omega t - kx)}$$

$$\Rightarrow \frac{d^2y}{dt^2} = \frac{\omega^2}{k^2}\frac{d^2y}{dx^2}$$

$$\frac{d^2y}{dt^2} = V_w^2\frac{d^2y}{dx^2}$$

eqn of wave

cond^n of wave

$x = A\sin(\omega t)$

$F = -kx$

$a = -\omega^2 x$

cond^n of S.H.M

$$\frac{d^2y}{dt^2} = V_w^2 \frac{d^2y}{dx^2}$$ ✓

$$\frac{d^2y}{dx^2} = \frac{1}{V_w^2} \frac{d^2y}{dt^2}$$ ✓

$$\frac{d^2y}{dt^2} = \frac{1}{V_w^2} \frac{d^2y}{dx^2}$$ ✗

Possible wave eqn →

$$y = (ax + bx) \text{ or } (ax+bx)^2$$

$$y = A \sin(\omega x^2 + kt)$$ ✗

$$y = A \sin(\omega x^2 + kt^2)$$ ✗

$$y = A \sin(\omega t + kx)^2$$ ✓

$$y = A\sin(\omega t - kx)$$

$$y = A\sin\left(\frac{2\pi}{T}t - \frac{2\pi}{\lambda}x\right) \checkmark$$

$$\boxed{y = A\sin 2\pi\left(\frac{t}{T} - \frac{x}{\lambda}\right)} \checkmark$$

QUESTION

The equation of the progressive wave, where t is the time in second, x is the distance in metre is $y = A\cos 24\left(t - \frac{x}{12}\right)$, then speed of wave.

$$y = A\cos(\omega t - kx)$$

$$y = A\cos\left(24t - \frac{24x}{12}\right)$$

$$\omega = 24$$

$$k = 2$$

$$V = \frac{\omega}{k} = \frac{24}{2} = 12\,m$$

QUESTION

A wave is represented by the equation $y = A\sin(10\pi x + 15\pi t + \frac{\pi}{6})$ Where x is in mere and t in second. The expression represents

1. A wave travelling in negative X-direction with a velocity of 1.5 m/s
2. A wave travelling in positive X-direction with a velocity of 1.5m/s
3. A wave traveling in positive X-direction with wavelength 0.2 m
4. A wave traveling in negative X-direction with a velocity of 150 m/s

QUESTION

A wave travelling in the positive x-direction having displacement along y-direction as 1 m, wavelength $2\pi m$ and frequency of $\frac{1}{\pi}$ Hz is represented by:

[NEET-2013]

1. $y = \sin(2\pi x - 2\pi t)$
2. $y = \sin(10\pi x - 20\pi t)$
3. $y = \sin(2\pi x + 2\pi t)$
4. $y = \sin(x - 2t)$

$A = 1$

$\lambda = 2\pi m \Rightarrow K = \frac{2\pi}{\lambda} = \frac{2\pi}{2\pi} = 1$

$f = \frac{1}{\pi} Hz \quad \omega = 2\pi f = 2\pi \frac{1}{\pi} = 2$

QUESTION

The equation of the progressive wave, where t is the time in second, x is the distance in metre is $y = A \cos 240\left(t - \frac{x}{12}\right)$. The phase difference (in SI units) between two positions 0.5 m apart is

(1) 40

(2) 20

(3) 10

(4) 5

$\Delta x = 0.5\,m$

$\Delta\phi = ??$

$K = \frac{240}{12}$

$\Delta\phi = \frac{2\pi}{\lambda}\Delta x$

$= \frac{240}{12} \times \frac{0.5}{10}$

$= 10$

Rel^n B/w Particle velocity & wave velocity for Transverse wa.

$$y = A\sin(\omega t - kx)$$

$$\frac{dy}{dx} = -Ak\cos(\omega t - kx)$$

$$\frac{dy}{dt} = A\omega\cos(\omega t - kx)$$

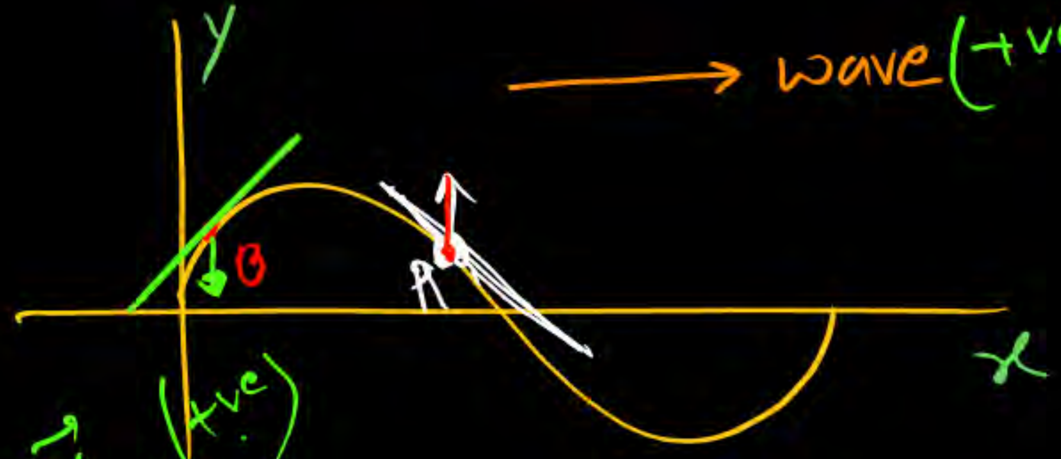
$$\frac{\frac{dy}{dx}}{\left(\frac{dy}{dt}\right)} = -\frac{k}{\omega}$$

$$\frac{dy}{dt} = -\frac{\omega}{k}\frac{dy}{dx}$$

MR Rath

$$\vec{V}_{particle} = -\vec{V}_{wave}\left(\frac{dy}{dx}\right)$$

$$\vec{V}_{partical} = -\vec{V}_{wave} \times (\text{slope of wave form})$$

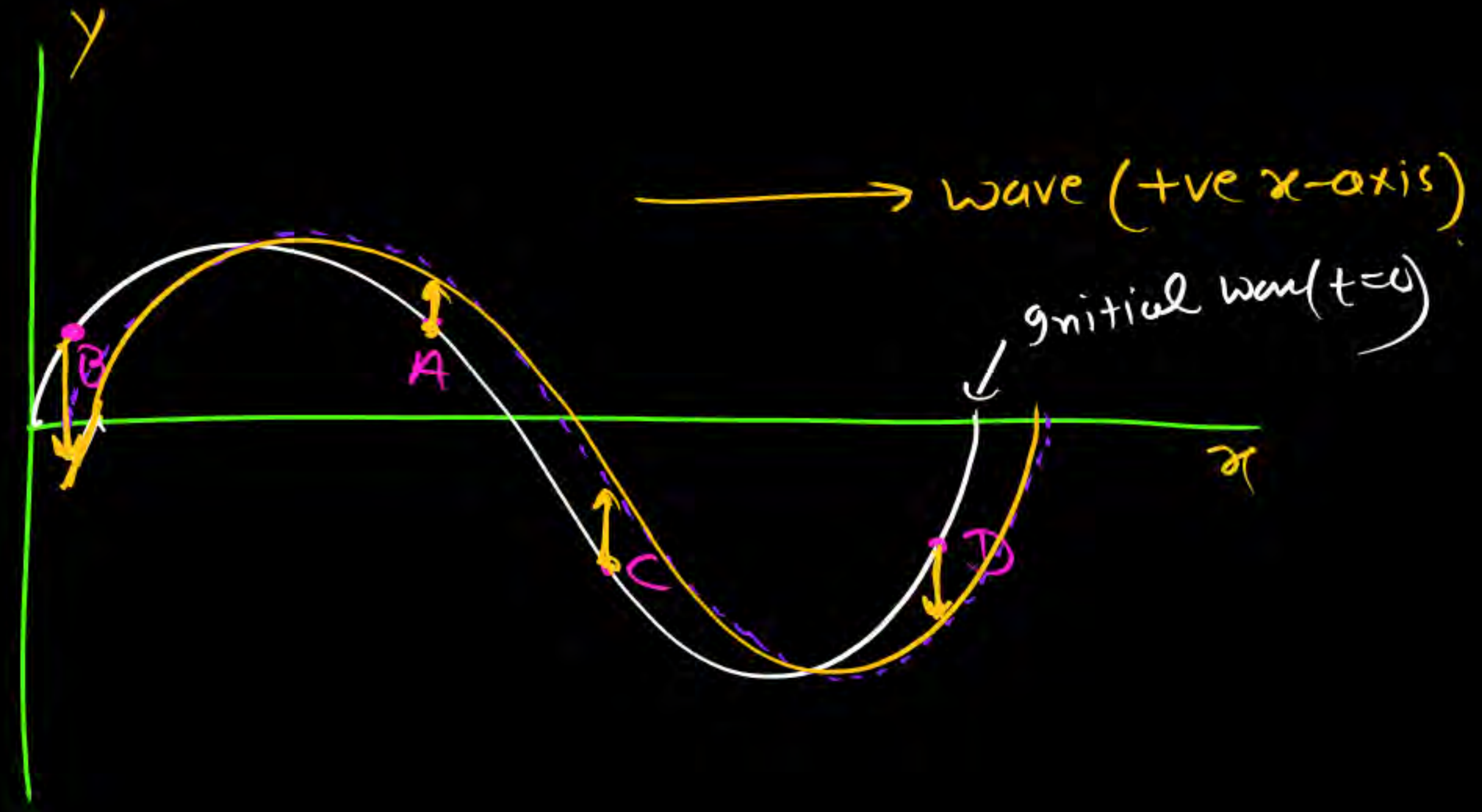


$\vec{V}_{parti}$ at O $= -\vec{V}_{wave}(+ve) = -ve$ (dow

$$\vec{V}_{parti} = -\left(\vec{V}_{wave}\right)(-ve)$$

$$= +ve\ \vec{V}_{wave}$$

$$\vec{V}_{partic} = -\vec{V}_{wave} \left(\text{slope of wave form}\right)$$

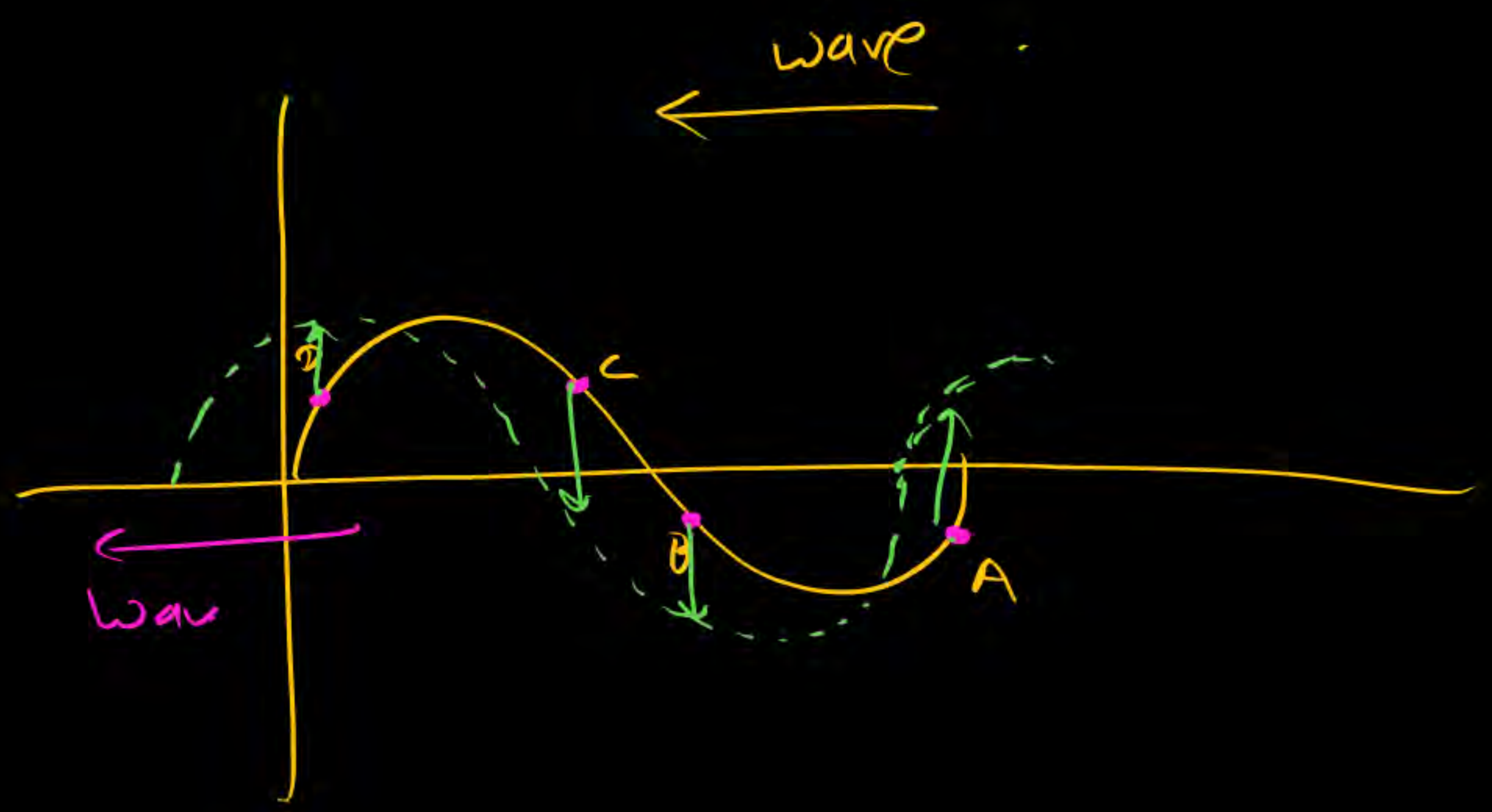


A → up

B → down

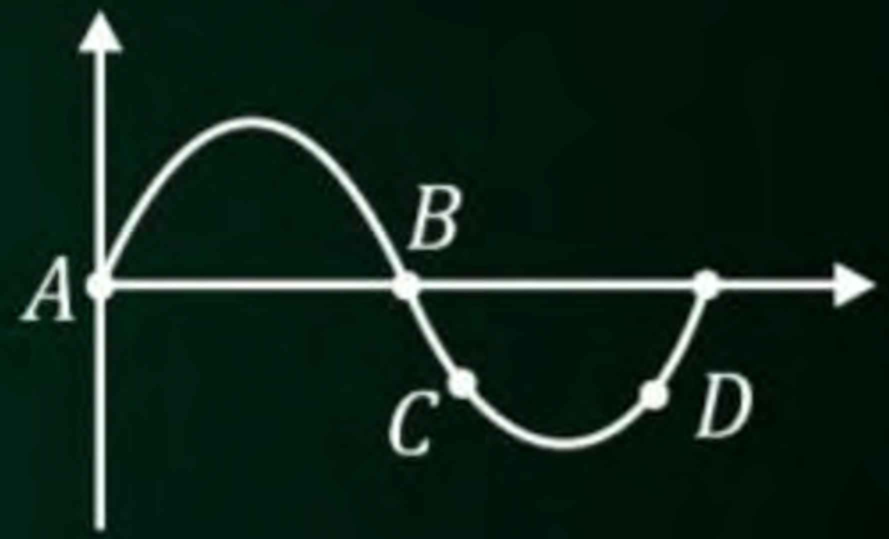
C → up

D → down


wave
D
C
B
A
wav

QUESTION

A transverse pulse is shown in the figure, on which 4 points are shown at any instant. Which of the following points are in a state to move upwards in following points are in a state to move upwards in subsequent time?



1. A, B
2. A, D
3. B, C
4. B, D

QUESTION

The wave function of a pulse is given by $y = \frac{5}{(4x+6t)^2}$, where x and y are in metre and t is in second. The velocity of pulse is in second. The velocity of pulse is

1. 2 m/s
2. 6 m/s
3. 1.5 m/s
4. 3 m/s

QUESTION

A wave is represented by $x = 4\cos\left(8t - \frac{y}{2}\right)$, where x and y are in metre and t in second. The frequency of the wave (in s^{-1})

1. $\frac{4}{\pi}$
2. $\frac{8}{\pi}$
3. $\frac{2}{\pi}$
4. $\frac{\pi}{4}$

QUESTION

A travelling wave in a string is represented by $y = 3\sin\left(\frac{\pi}{2}t - \frac{\pi}{4}x\right)$. The phase difference between two particles separated by a distance 4 cm is (Take x and y in cm and t in seconds)

1. $\frac{\pi}{2}$ rad
2. $\frac{\pi}{4}$ rad
3. π rad
4. 0

QUESTION

In sine wave, minimum distance between 2 particles which always have same speed is

(1) $\frac{\lambda}{2}$

(2) $\frac{\lambda}{4}$

(3) $\frac{\lambda}{3}$

(4) λ

QUESTION

The equation of a simple harmonic progressive wave is given by $y = A\sin(100\pi t - 3x)$. Find the distance between 2 particles having a phase difference of $\frac{\pi}{3}$.

1. $\frac{\pi}{9}$
2. $\frac{\pi}{18}$
3. $\frac{\pi}{6}$
4. $\frac{\pi}{3}$

QUESTION

A wave is represented by $y = 3\sin 2\pi\left(\frac{t}{0.04} - \frac{X}{0.01}\right)$ cm. The frequency of the wave and the maximum acceleration under this frequency are

1. $25\ \text{Hz}, 7.5 \times 10^4\ \text{cm/s}^2$
2. $100\ \text{Hz}, 4.5 \times 10^3\ \text{cm/s}^2$
3. $50\ \text{Hz}, 7.5 \times 10^3\ \text{cm/s}^2$
4. $25\ \text{Hz}, 4.5 \times 10^4\ \text{cm/s}^2$

QUESTION

A travelling wave is described by the equation $y = A \sin 2\pi (nt - x/\lambda_0)$. The maximum particle velocity is equal to 3 times the wave velocity if

1. $\lambda_0 = \frac{\pi A}{3}$
2. $\lambda_0 = \frac{2\pi A}{3}$
3. $\lambda_0 = \pi A$
4. $\lambda_0 = 3\pi A$

QUESTION

If $\vec{u}$ is instantaneous velocity of particle and $\vec{v}$ is, velocity of wave, then

(1) $\vec{u}$ is perpendicular to $\vec{v}$

(2) $\vec{u}$ is parallel to $\vec{v}$

(3) $|\vec{u}|$ is equal to $|\vec{v}|$

(4) $|\vec{u}|$ = (slope of wave form) $|\vec{v}|$

QUESTION

Which one of the following represents a wave?

(1) $y = A \sin(\omega t - kx)$

(2) $y = A \cos^2(at - bx + c) + A \sin^2(at - bx + c)$

(3) $y = A \sin kx$

(4) $y = A \sin \omega t$

QUESTION

Which of the following functions for y can never represent a travelling wave ?

(a) $(x^2 - vt)^2$

(b) $\log\left[\frac{(x+vt)}{x_0}\right]$

(c) $e^{\left\{-\frac{(x+vt)}{x_0}\right\}^2}$

(d) $\frac{1}{x+vt}$

(1) Only (a)

(2) (b) & (c)

(3) (c) and (d)

(4) Only (c)

QUESTION

A sinusoidal wave of frequency 500 Hz has a speed of 350 m/s. The phase difference between two displacements at a certain point at times 1 ms apart is

(1) $\frac{\pi}{4}$

(2) $\frac{\pi}{2}$

(3) π

(4) $\frac{3\pi}{2}$

QUESTION

The equation of travelling wave is $y = a \sin 2\pi \left(pt - \frac{x}{5}\right)$. Then the ratio of maximum particle velocity to wave velocity is

(1) $\frac{\pi a}{5}$

(2) $2\sqrt{5\pi a}$

(3) $\frac{2\pi a}{5}$

(4) $\frac{2\pi a}{\sqrt{5}}$

QUESTION

A travelling wave pulse is given by $y = \frac{4}{3x^2 + 48t^2 + 24xt + 2}$ where x and y are in metre and t is in second. The velocity of wave is

(1) 4 m/s
(2) 2 m/s
(3) 8 m/s
(4) 12 m/s

QUESTION

The ratio of maximum particle velocity to wave velocity is [where symbols have their usual meanings]

(1) kA

(2) $A\omega$

(3) $k\omega$

(4) ω/k

QUESTION

A transverse wave propagating along x-axis is represented by: $y(x, t) = 8 \sin (0.5\pi x - 4\pi t - \frac{\pi}{2})$ where x is in metres and t is in seconds. The speed of the wave is

[AIPMT (Prelims)-2006]

(1) 4π m/s

(2) 0.5π m/s

(3) $\frac{\pi}{4}$ m/s

(4) 8 m/s

QUESTION

Which one of the following statements is true? [AIPMT (Prelims)-2006]

(1) Both light and sound waves in air are transverse

(2) The sound waves in air are longitudinal while the light waves are transverse

(3) Both light and sound waves in air are longitudinal

(4) Both light and sound waves can travel in vacuum

QUESTION

A wave in a string has an amplitude of 2 cm The wave travels in the positive direction of x-axis with a speed of 128 m/s and it is noted that 5 complete waves fit in 4 m length of the string. The equation describing the wave is

[AIPMT (Prelims)-2009]

(1) $y = (0.02)\ \text{m} \sin(15.7x - 2010t)$

(2) $y = (0.02)\ \text{m} \sin(15.7x - 2010t)$

(3) $y = (0.02)\ \text{m} \sin(7.85x - 1005t)$

(4) $y = (0.02)\ \text{m} \sin(7.85x - 1005t)$

QUESTION

A transverse wave is represented by $y = A \sin(\omega t - kx)$. For what value of the wavelength is the wave velocity equal to the maximum particle velocity ?

[AIPMT (Prelims)-2010]

(1) $\frac{\pi A}{2}$

(2) πA

(3) $2\pi A$

(4) A

QUESTION

The equation of a simple harmonic wave is given by $y = 3 \sin \frac{\pi}{2}(50t - x)$, where x and y are in metres and t is in seconds. The ratio of maximum particle velocity is

[AIPMT (Mains)-2012]

(1) 2π

(2) $\frac{3}{2}\pi$

(3) 3π

(4) $\frac{2}{3}\pi$

THANK YOU



YAKEEN 2.0

FOR NEET 2025

HOME WORK Solution

Lec-01(Part-B) | **Physics**

Wave [redacted]

A/C
EM wave
wave optics

Homework Solution of Lec-01

By- Dr. Manish Raj (MR SIR)



QUESTION

A transverse pulse is shown in the figure, on which 4 points are shown at any instant. Which of the following points are in a state to move upwards in following points are in a state to move upwards in subsequent time?

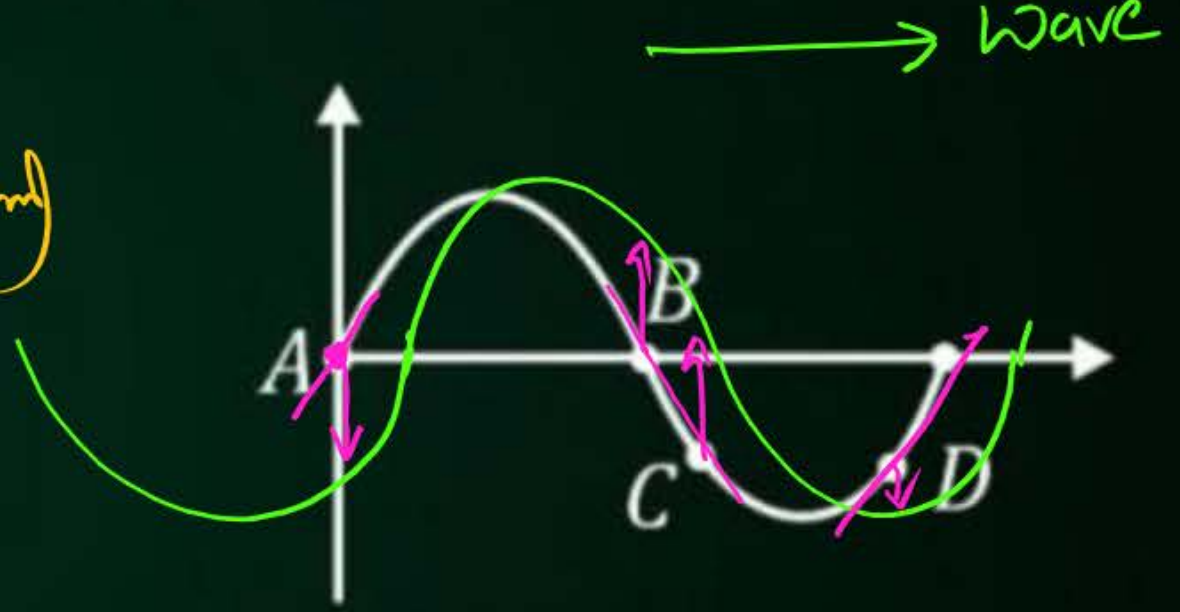
(1) A, B

(2) A, D

(3) B, C

(4) B, D

$\vec{v}_p = -\vec{V}_{wave}$ (slope of wave form)



QUESTION

The wave function of a pulse is given by $y = \frac{5}{(4x + 6t)^2}$, where x and y are in metre and t is in second. The velocity of pulse is in second. The velocity of pulse is

1. 2 m/s
2. 6 m/s
3. 1.5 m/s
4. 3 m/s

$y = (ax + bt)^n$

$y = 5(4x + 6t)^{-2}$

$V_{wave} = \frac{\omega}{k} = \frac{6}{4} = \frac{3}{2} = 1.5$

QUESTION

A wave is represented by $x = 4 \cos \left(8t - \frac{y}{2}\right)$, where x and y are in metre and t in second. The frequency of the wave (in s^{-1})

1. $\frac{4}{\pi}$ ✓
2. $\frac{8}{\pi}$
3. $\frac{2}{\pi}$
4. $\frac{\pi}{4}$

$x = 4 \cos \left(8t - \frac{y}{2}\right)$

Partic

ω $\quad K = \frac{1}{2}$

$\omega = 2\pi f = 8$

$f = \frac{4}{\pi}$

QUESTION

A travelling wave in a string is represented by $y = 3\sin\left(\frac{\pi}{2}t - \frac{\pi}{4}x\right)$. The phase difference between two particles separated by a distance 4 cm is (Take x and y in cm and t in seconds)

1. $\frac{\pi}{2}$ rad
2. $\frac{\pi}{4}$ rad
3. π rad
4. 0

$\omega = \frac{\pi}{2}$

$k = \frac{\pi}{4}$

$\Delta x = 4\,cm$

$\Delta\phi = k\,\Delta x$

$\Delta\phi = \frac{\pi}{4} \times 4 = \pi$

QUESTION

In sine wave, minimum distance between 2 particles which always have same speed is

(1) $\frac{\lambda}{2}$ ✓

(2) $\frac{\lambda}{4}$

(3) $\frac{\lambda}{3}$

(4) λ



$$v_p = A\omega\cos(\omega t - kx)$$

QUESTION

The equation of a simple harmonic progressive wave is given by $y = A\sin(100\pi t - 3x)$. Find the distance between 2 particles having a phase difference of $\frac{\pi}{3}$.

1. $\frac{\pi}{9}$
2. $\frac{\pi}{18}$
3. $\frac{\pi}{6}$ Ans
4. $\frac{\pi}{3}$

$y = A\sin(100\pi t - 3x)$

$\omega = 100\pi$, $k = 3$

$\Delta\phi = k\,\Delta x$

$\frac{\pi}{3} = 3\,\Delta x$

$\Delta x = \frac{\pi}{6}\,m$

QUESTION

$V_{wave} = \frac{\omega}{K} = \text{Coff}^n$

A wave is represented by $y = 3 \sin 2\pi \left(\frac{t}{0.04} - \frac{X}{0.01}\right)$ cm. The frequency of the wave and the maximum acceleration under this frequency are

1. 25 Hz, $7.5 \times 10^4\ cm/s^2$ Ans
2. 100 Hz, $4.5 \times 10^3\ cm/s^2$
3. 50 Hz, $7.5 \times 10^3\ cm/s^2$
4. 25 Hz, $4.5 \times 10^4\ cm/s^2$

$= 3 \sin\left[\frac{2\pi}{0.04} t - \frac{2\pi}{0.01} x\right]$

$\omega = 2\pi f = \frac{2\pi}{0.04}$

$f = \frac{100}{4} = 25\ Hz$

$a_{max} = A\omega^2$

$= 3 \times \frac{4\pi^2}{\left(\frac{4}{100}\right)^2} = \frac{3 \times 4 \times 10}{\frac{4 \times 4}{10^4}}$

$= \frac{3}{4} \times 10^5$

QUESTION

A travelling wave is described by the equation $y = A \sin 2\pi (nt - x/\lambda_0)$. The maximum particle velocity is equal to 3 times the wave velocity if

1. $\lambda_0 = \frac{\pi A}{3}$
2. $\lambda_0 = \frac{2\pi A}{3}$ Ans
3. $\lambda_0 = \pi A$
4. $\lambda_0 = 3\pi A$

question ki cond^n

$3V_{wave} = V_{max\ part}$

$3\frac{\omega}{K} = A\omega$

$3 = AK$

$3 = A\frac{2\pi}{\lambda_0}$

$\lambda_0 = \frac{2\pi A}{3}$

QUESTION

If $\vec{u}$ is instantaneous velocity of particle and $\vec{v}$ is, velocity of wave, then

(1) $\vec{u}$ is perpendicular to $\vec{v}$

(2) $\vec{u}$ is parallel to $\vec{v}$

(3) $|\vec{u}|$ is equal to $|\vec{v}|$

(4) $|\vec{u}| =$ (slope of wave form) $|\vec{v}|$

$\vec{u}_{partn} = -\vec{V}_{wav}$ (slope of wav)

$y = A\sin(\omega t - kx)$

$\frac{dy}{dt} = A\omega\cos(\omega t - kx)$

$\frac{dy}{dx} = -kA\cos(\omega t - kx)$

QUESTION

Which one of the following represents a wave?

(1) $y = A \sin(\omega t - kx)$

(2) $y = A \cos^2(at - bx + c) + A \sin^2(at - bx + c)$

(3) $y = A \sin kx$

(4) $y = A \sin \omega t$

QUESTION

H|w we will discuss

Which of the following functions for y can never represent a travelling wave ?

(a) $(x^2 - vt)^2$

(b) $\log\left[\frac{(x+vt)}{x_0}\right]$

(c) $e^{\left\{-\frac{(x+vt)}{x_0}\right\}^2}$

(d) $\frac{1}{x+vt}$

(1) Only (a)

(2) (b) & (c)

(3) (c) and (d)

(4) Only (c)

QUESTION

A sinusoidal wave of frequency 500 Hz has a speed of 350 m/s. The phase difference between two displacements at a certain point at times 1 ms apart is

(1) $\frac{\pi}{4}$

(2) $\frac{\pi}{2}$

(3) π ✓

(4) $\frac{3\pi}{2}$

$f = 500\,H$

$v = 350$

$\Delta t = 1\,m/s$

$\frac{\Delta\phi}{2\pi} = \frac{\Delta t}{T}$

$\Delta\phi = 2\pi f\,\Delta t$

$= \frac{2\pi \times 500 \times 1 \times 10^{-3}}{2}$

$= \pi$

QUESTION

The equation of travelling wave is $y = a \sin 2\pi\left(pt - \frac{x}{5}\right)$. Then the ratio of maximum particle velocity to wave velocity is

(1) $\frac{\pi a}{5}$

(2) $2\sqrt{5\pi a}$

(3) $\frac{2\pi a}{5}$

(4) $\frac{2\pi a}{\sqrt{5}}$

$\frac{v_{max\,pa}}{V_{wav}} = AK = \frac{A\omega}{\omega/K} = AK$

$= \frac{a\,2\pi}{5}$

$= \frac{2a\pi}{5}$

QUESTION

A travelling wave pulse is given by $y = \frac{4}{3x^2 + 48t^2 + 24xt + 2}$ where x and y are in metre and t is in second. The velocity of wave is

(1) 4 m/s ✓

(2) 2 m/s

(3) 8 m/s

(4) 12 m/s

$$y = \frac{4}{3(x^2 + 16t^2 + 8xt) + 2} = \frac{4}{3[(x+4t)^2] + 2}$$

$$(x+4t)^2 = x^2 + 16t^2 + 2x4t = x^2 + 16t^2 + 8xt$$

$k = 1$

$\omega = 4$

$$v = \frac{\omega}{k} = \frac{4}{1} = 4\ \text{m/s}$$

QUESTION

The ratio of maximum particle velocity to wave velocity is [where symbols have their usual meanings]

(1) kA

(2) $A\omega$

(3) $k\omega$

(4) ω/k

QUESTION

A transverse wave propagating along x-axis is represented by: $y(x, t) = 8 \sin\left(0.5\pi x - 4\pi t - \frac{\pi}{2}\right)$ where x is in metres and t is in seconds. The speed of the wave is

[AIPMT (Prelims)-2006]

(1) 4π m/s

(2) 0.5π m/s

(3) $\frac{\pi}{4}$ m/s

(4) 8 m/s

$y = 8 \sin\left(0.5\pi x - 4\pi t - \frac{\pi}{2}\right)$

$\frac{4\pi}{\frac{\pi}{2}} = 8$

QUESTION

Which one of the following statements is true? [AIPMT (Prelims)-2006]

(1) Both light and sound waves in air are transverse

(2) The sound waves in air are longitudinal while the light waves are transverse

(3) Both light and sound waves in air are longitudinal

(4) Both light and sound waves can travel in vacuum

QUESTION

A wave in a string has an amplitude of 2 cm The wave travels in the positive direction of x-axis with a speed of 128 m/s and it is noted that 5 complete waves fit in 4 m length of the string. The equation describing the wave is

[AIPMT (Prelims)-2009]

(1) $y = (0.02)\text{ m} \sin(15.7x - 2010t)$

(2) $y = (0.02)\text{ m} \sin(15.7x - 2010t)$

(3) $y = (0.02)\text{ m} \sin(7.85x - 1005t)$

(4) $y = (0.02)\text{ m} \sin(7.85x - 1005t)$



QUESTION

A transverse wave is represented by $y = A \sin(\omega t - kx)$. For what value of the wavelength is the wave velocity equal to the maximum particle velocity ?

[AIPMT (Prelims)-2010]

(1) $\frac{\pi A}{2}$

(2) πA

(3) $2\pi A$

(4) A

$V_{wave} = V_{max\ Part.}$

$\frac{\omega}{k} = \omega A$

$A = \frac{1}{k}$

$A = \frac{\lambda}{2\pi}$

$\lambda = 2\pi A$

QUESTION

The equation of a simple harmonic wave is given by $y = 3\sin\frac{\pi}{2}(50t - x)$, where x and y are in metres and t is in seconds. The ratio of maximum particle velocity is

[AIPMT (Mains)-2012]

(1) 2π

(2) $\frac{3}{2}\pi$

(3) 3π

(4) $\frac{2}{3}\pi$


THANK YOU

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FOR NEET 2025

Lecture- 02 | Physics

Wave [redacted]



By- Dr. Manish Raj (MR SIR)

Topics to be covered

1 # Transverse wave in string

2 # Sound wave

3 #



QUESTION

When a wave propagating through a medium encounters a change in medium, then which of the following property remains same?

(a) Speed → change

(b) Amplitude → chang

(c) Frequency → does not change

(d) Wavelength → change



QUESTION

The frequency of a mechanical wave is 256 Hz. Calculate its wavelength when its speed is 512 m/s.

$v_{wave} = \lambda f = \frac{\lambda}{T} = \frac{\omega}{k}$

$\lambda = \frac{v}{f} = \frac{512}{256} = 2\,m$

Velocity of Transverse Wave in a String

μ = mass per unit length $= \frac{M}{L}$

ρ = mass per unit volume $= \frac{M}{\text{Volume}} = \frac{M}{AL}$

$\rho = \frac{M}{AL} = \frac{\mu}{A}$

$$\boxed{\mu = \rho A}$$

$V \propto \sqrt{\text{Tension}}$

$V \propto \frac{1}{\sqrt{\mu}}$

velocity of wave

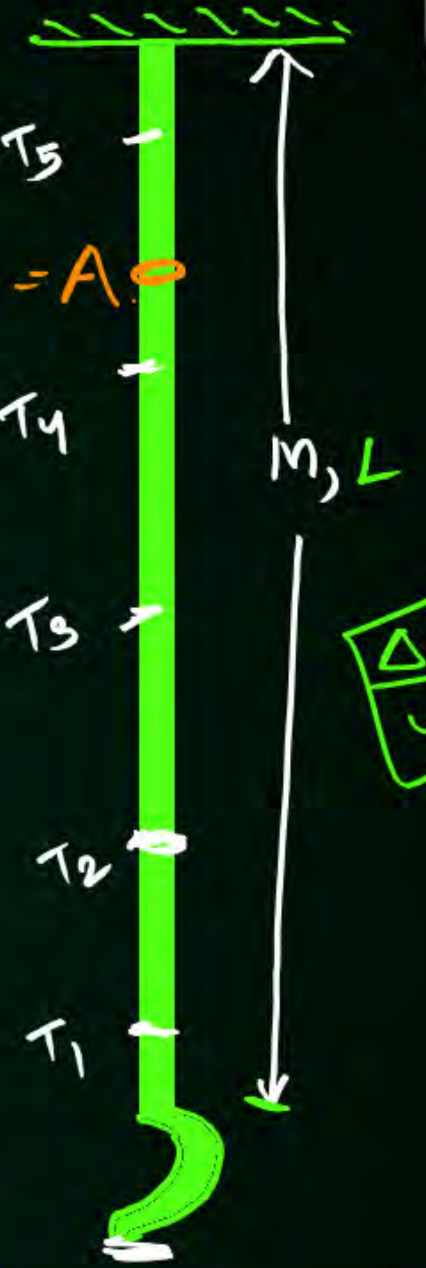
MR Rafta $\rightarrow$ $V = \sqrt{\frac{T}{\mu}}$

$T_5 > T_4 > T_3 > T_2 > T_1$

$$V = \sqrt{\frac{T}{\mu}} = \sqrt{\frac{T}{\rho A}} = \sqrt{\frac{\text{Stress}}{\rho}} = \sqrt{\frac{Y \times \text{strain}}{\rho}}$$

$$V = \sqrt{\frac{T}{\mu}} = \sqrt{\frac{T}{\rho A}} = \sqrt{\frac{\text{stress}}{\rho}} = \sqrt{\frac{Y\,\text{strain}}{\rho}} = \sqrt{\frac{Y}{\rho}\left(\frac{\Delta l}{l}\right)}$$

$$= \sqrt{\frac{Y \alpha \Delta\theta}{\rho}}$$



$$\boxed{\frac{\Delta l}{l} = \alpha \Delta\theta}$$

$\Delta\theta$ = change in temp

α = coefficient of linear thermal expansion

ρ = density

Y = Young modulus

velocity of wave at distⁿ x from bottom

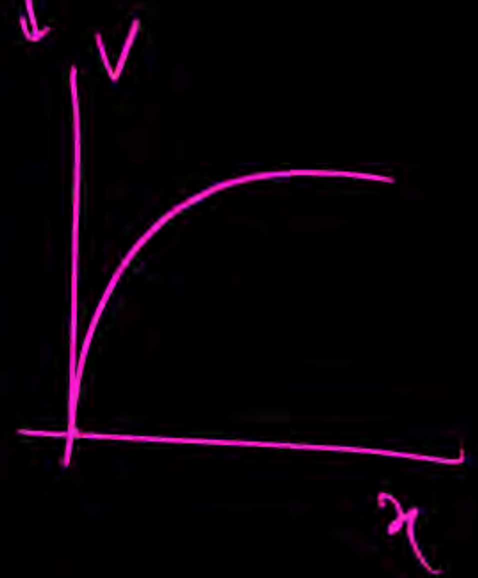
$$T = \frac{Mgx}{L}$$

$$V_x = \sqrt{\frac{T_x}{\mu}} = \sqrt{\frac{\frac{Mgx}{L}}{\left(\frac{M}{L}\right)}} = \sqrt{gx}$$

$$\boxed{V = \sqrt{gx}}$$

$V \propto \sqrt{x}$

acc^n const^n



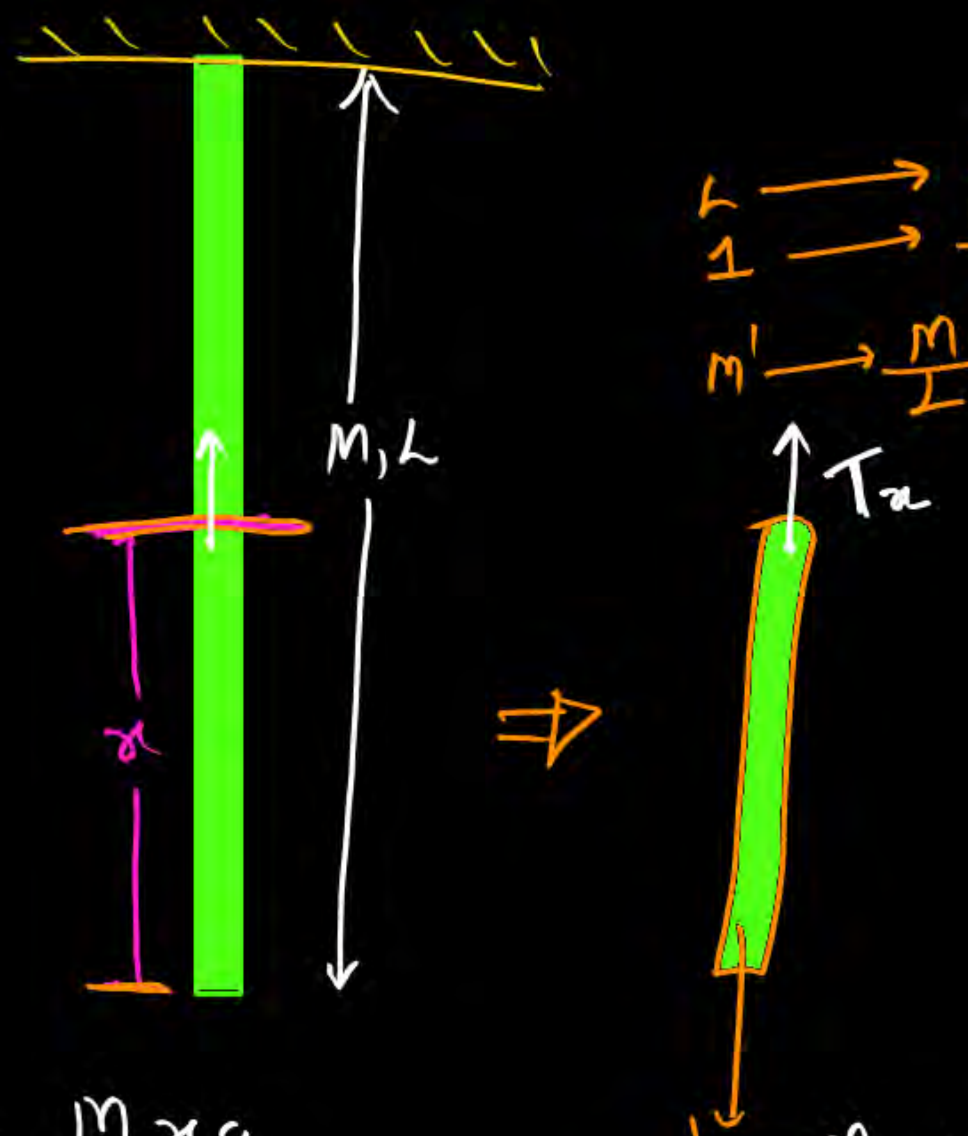
3rd eqn of motⁿ compair

$$v^2 - u^2 = 2ax$$

$$v^2 = gx$$

$$2a = g$$

acc^n of wave $\boxed{a = \frac{g}{2}}$ = const^n



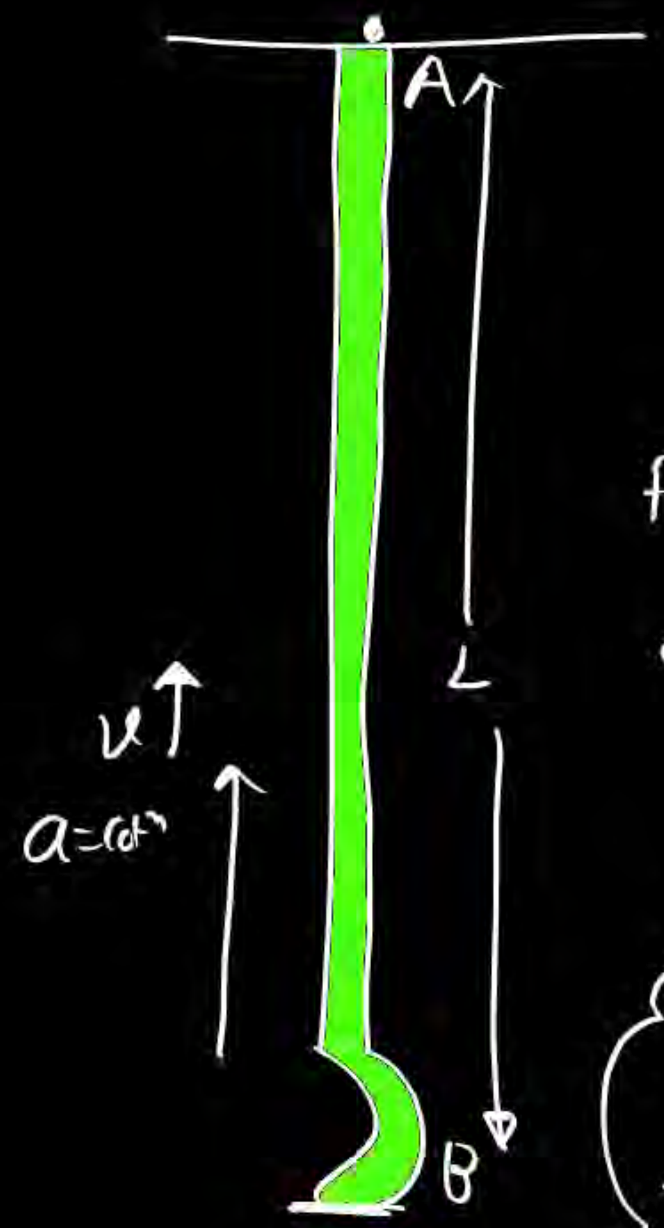
$L \rightarrow M$

$1 \rightarrow \frac{M}{L}$

$m' \rightarrow \frac{M}{L}x$

$$T_x = \frac{M}{L}xg$$

$$m'g = \frac{M}{L}xg$$



find time to reach the wave from point B to A

$$s = \overset{0}{\cancel{u}t} + \frac{1}{2}at^2$$

$$L = \frac{1}{2}\left(\frac{g}{2}\right)t^2$$

$$\sqrt{\frac{4L}{g}} = t$$

QUESTION

A metallic wire of 1 m length has a mass of 10×10^{-3} kg If a tension of 100 N is applied to a wire, what is the speed of transverse wave?

(1) 100 m/s
(2) 10 m/s
(3) 200 m/s
(4) 0.1 m/s

QUESTION

Calculate the velocity of the transverse wave in a string which is stretched by a load of 15 kg. The mass of the string is 3×10^{-2} kg and its length is 2 m.



$m = 3\times10^{-2}\ kg$

$\mu = \frac{m}{L} = \frac{3\times10^{-2}}{2}$

$v = \sqrt{\frac{15\times10}{\frac{3\times10^{-2}}{2}}} = \sqrt{\frac{10\times10}{10^{-2}}} = 10^{2}\ m/s$

QUESTION

A steel wire 100 cm long has a mass of 10gm. If the wire is under a tension of 400 N, what is the speed of transverse waves in the wire?

Hint : $v = \sqrt{\frac{T}{\mu}}$ where $\mu = \frac{M}{L}$

QUESTION

A pulse is generated at lower end of a hanging rope of uniform density and length L. The speed of the pulse when it reaches the mid point of rope is

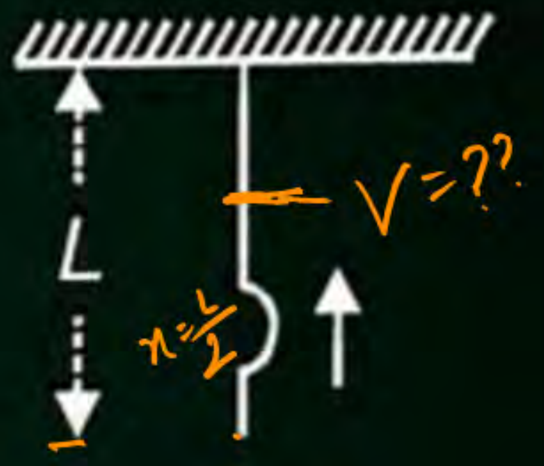
(1) $\sqrt{2gL}$

(2) $\sqrt{gL}$

(3) $\sqrt{\frac{gL}{2}}$

77%

(4) $\frac{\sqrt{gL}}{2}$



$v_x = \sqrt{gx}$

$v_x = \sqrt{gx}$

$= \sqrt{g\frac{L}{2}}$

$= \sqrt{\frac{gL}{2}}$

QUESTION

A uniform rope of length L and mass m_1 hangs vertically from a rigid support. A block of mass m_2 is attached to the free end of the rope. A transverse pulse of wavelength λ_1 is produced at the lower end of the rope. The wavelength of the pulse when it reaches the top of the rope is λ_2. The ratio λ_2/λ_1 is

(1) $\sqrt{\frac{m_1+m_2}{m_1}}$

(2) $\sqrt{\frac{m_1}{m_2}}$

(3) $\sqrt{\frac{m_1+m_2}{m_2}}$

(4) $\sqrt{\frac{m_2}{m_1}}$



QUESTION

A uniform rope having some mass hangs vertically from a rigid support. A transverse wave pulse is produced at the lower end. The speed (u) of the wave pulse varies with height (h) from the lower end as

(a)



(b)





(c)



(d)



QUESTION

A rope of length L and mass M hangs freely from the ceiling. If the time taken by a transverse wave to travel from the bottom to the top of the rope is T, then time to cover first half length is

(1) T

(2) $T\left(\frac{\sqrt{2}-1}{\sqrt{2}}\right)$

(3) $\frac{T}{\sqrt{2}}$

(4) $\frac{T}{2}$



$T = \sqrt{\frac{4L}{g}}$

$t_1 = \sqrt{\frac{4L}{g\,2}} = \frac{1}{\sqrt{2}}\sqrt{\frac{4L}{g}} = \frac{T}{\sqrt{2}}$

$$\frac{L = \frac{1}{2}\left(\frac{g}{2}\right)T^2}{\frac{L}{2} = \frac{1}{2}\frac{g}{2}t_1^2}$$

$2 = \frac{T^2}{t_1^2}$

$t_1^2 = \frac{T^2}{2}$

$t_1 = \frac{T}{\sqrt{2}}$ Ans

QUESTION

A transverse pulse generated at the bottom of a uniform rope of length L, travels in upward direction. The time taken by it to travel the full length of rope will be

(a) $\sqrt{\frac{L}{2g}}$

(b) $\sqrt{\frac{2L}{g}}$

(c) $\sqrt{\frac{L}{g}}$

(d) $\sqrt{\frac{4L}{g}}$

already done

QUESTION

Two strings of same material are stretched to the same tension. If their radii are in the ratio 1: 2, then respective wave velocities in them will be in ratio

(a) 4: 1

(b) 2: 1

(c) 1: 2

(d) 1: 4

$$v = \sqrt{\frac{T}{\rho A}}$$

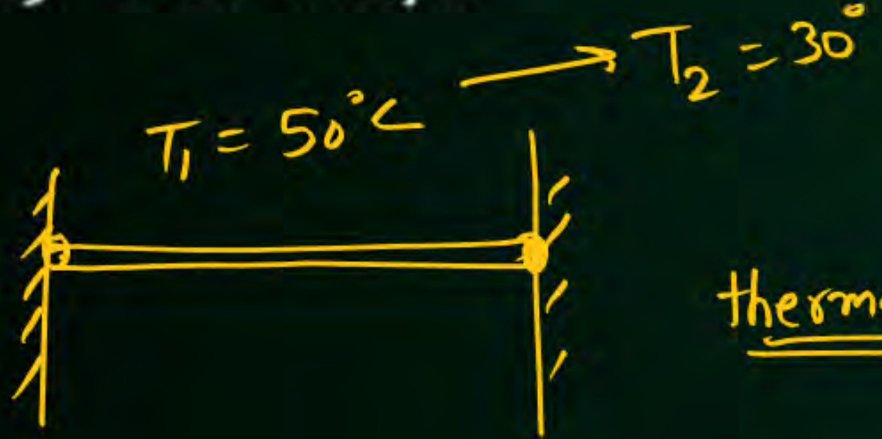
$$v \propto \frac{1}{\sqrt{\pi r^2}} \propto \frac{1}{r}$$

$$\frac{v_1}{v_2} = \frac{r_2}{r_1} = \frac{2}{1}$$

QUESTION

A copper wire is held at the two ends by rigid supports. At 50°C the wire is just taut, with negligible tension. If $Y = 1.2 \times 10^{11}\ \text{N/m}^2$, $\alpha = 1.6 \times 10^{-5}/{}^\circ\text{C}$ and $\rho = 9.2 \times 10^3\ \text{kg/m}^3$, then the speed of transverse waves in this wire at 30°C is

(a) 64.6 m/s ✓
(b) 16.2 m/s
(c) 23.2 m/s
(d) 32.2 m/s

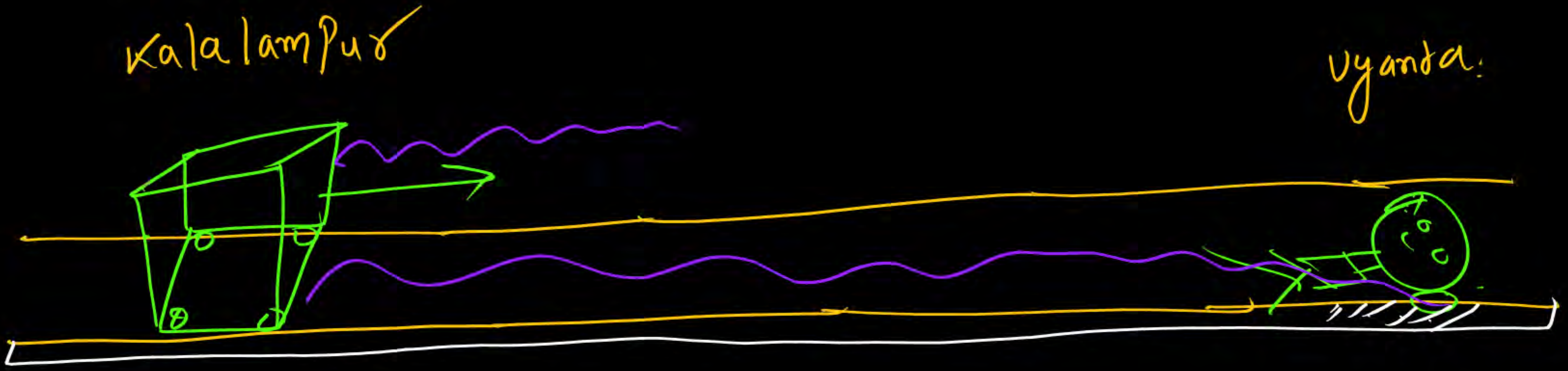


thermal stress

$$V = \sqrt{\frac{T}{\mu}} = \sqrt{\frac{T}{\rho A}} = \sqrt{\frac{\text{stress}}{\rho}} = \sqrt{\frac{Y}{\rho}\left(\frac{\Delta l}{l}\right)} = \sqrt{\frac{Y\alpha\Delta\theta}{\rho}}$$

$$V = \sqrt{\frac{Y\alpha\Delta\theta}{\rho}} = \sqrt{\frac{1.2\times10^{11}\times1.6\times10^{-5}\times20}{9.2\times10^{3}}}$$

$$= 100\sqrt{\frac{3.2\times1.2}{9.2}} = \sqrt{\frac{12}{28}}\times100 = \sqrt{0.42}\times100 = \sqrt{\frac{42}{100}}\times100$$


Kalalampur
Uganda

SOUND WAVE

$V_{solid} > V_{liquid} > V_{air}$

V_{sound} = 5100 m/s   1700 m/s   330 m/s

Speed of sound

* infrasonic < 20 Hz

✓ audiable sound 20 Hz to 20 KHz

* ultrasonic > 20 KHz

Speed of light wave

$V_{solid} < V_{liquid} < V_{gas} < V_{vaccum}$

Speed of sound wave In solid

→ $v \propto \sqrt{\text{elastic Property}}$

→ $v \propto \dfrac{1}{\sqrt{\text{Inertial Property}}}$

$$v = \sqrt{\frac{Y}{\rho}}$$ (speed of sound in solid)

Y → Young modulus of solid

ρ = density of solid

$$V_{\text{transverse wave}} = \sqrt{\frac{T}{\mu}} = \sqrt{\frac{T}{\rho A}}$$

speed of sound in a liquid & gas:

$$V = \sqrt{\frac{\beta}{\rho}}$$

β = Bulk modulus

ρ = density

Newtons Law of speed of sound in a gas

Propagation of sound in a gas is isothermal Process. Tempr = $const^n$

$$V_{\text{Sound}} = \sqrt{\frac{\beta}{\rho}} = \sqrt{\frac{P}{\rho}}$$

$PV = const^n$

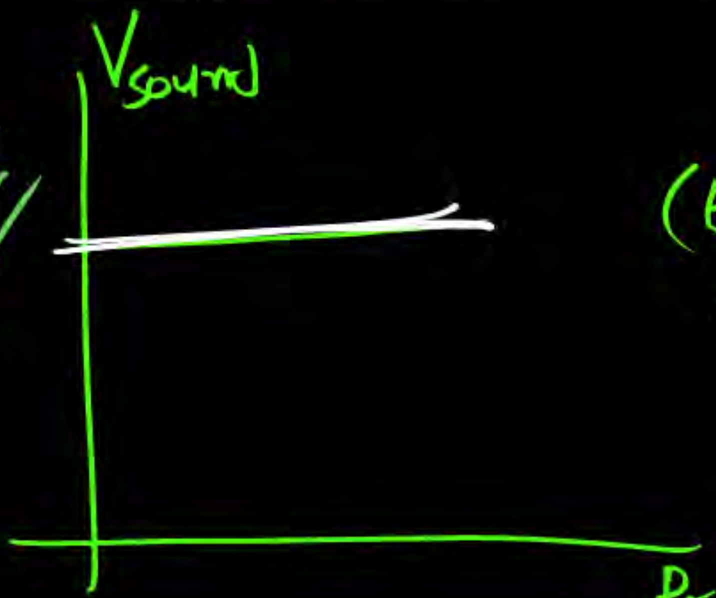
$$\frac{\Delta P}{P} = -\frac{\Delta V}{V}$$

$$-\frac{\Delta P}{\frac{\Delta V}{V}} = P$$

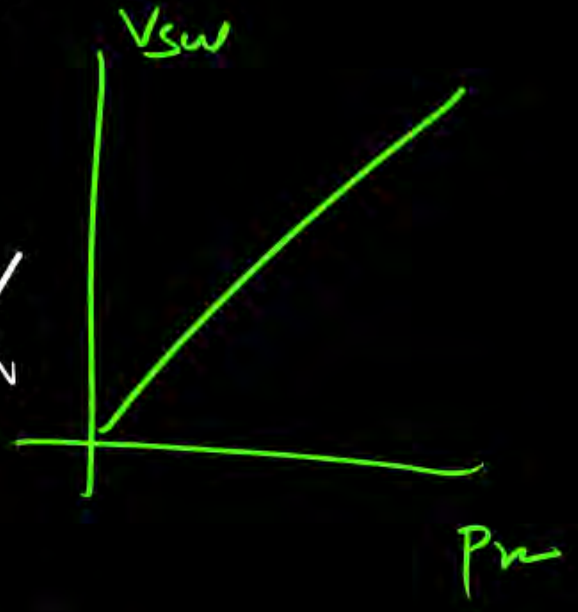
$$\beta = P \quad \text{— (i)}$$

$$V_{sound\ in\ gas} = \sqrt{\frac{P}{\rho}}$$

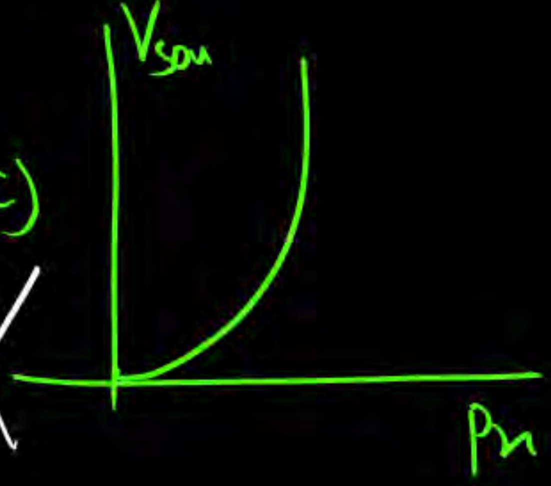
(a)



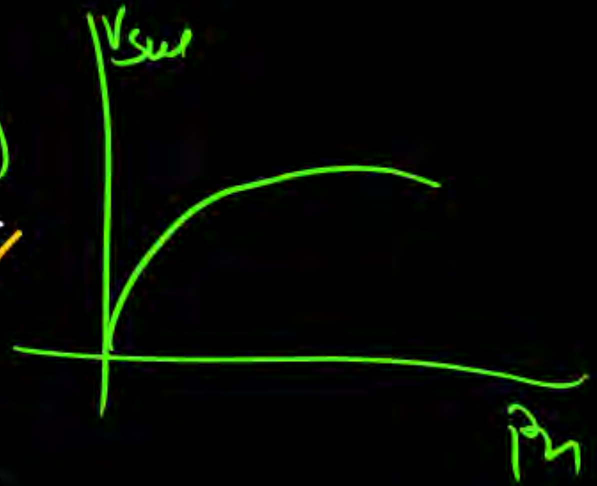
(b)



(c)



(d)



$$V_{sound} = \sqrt{\frac{P}{\rho}} = \sqrt{\frac{RT}{M}}$$

we know this

$$\rho = \frac{PM}{RT}$$

$$\frac{RT}{M} = \frac{P}{\rho} \quad \text{--- (*)}$$

$$V_{sound} = \sqrt{\frac{RT}{M}} \propto \frac{1}{\sqrt{M}}$$



$$V_{H\text{-}gas} > V_{oxygen}$$

NEWTONS FORMULA FOR SPEED OF SOUND

$$V = \sqrt{\frac{RT}{M}} = \sqrt{\frac{P}{\rho}}$$

at $1\,atm = 1.01 \times 10^5\ N/m^2$

$\rho = 1.2\ kg/m^3$

* $V \simeq 280\ m/s$ formula.

but Practical
$V_{sound} = 330\ m/s$

It seems Newtons formula for velocity of sound is not correct

LAPLACE CORRECTION OF VELOCITY OF SOUND

→ Propagation of sound wave in a medium is not a gsothermal Process it is adibatic Process.

$$PV^{\gamma} = \text{const}^n.$$

$$\frac{\Delta P}{P} + \gamma \frac{\Delta V}{V} = 0$$

$$-\frac{\Delta P}{P} = \frac{\Delta V}{V}\gamma$$

$$\left(\frac{-\Delta P}{\Delta V/V}\right) = \gamma P$$

$$\beta = \gamma P$$

$$V_{sound} = \sqrt{\frac{\gamma P}{\rho}} = \sqrt{\frac{\gamma RT}{m}}$$

↳ correct formula

QUESTION

Calculate the speed of longitudinal wave in steel. Young's modulus for steel is $3 \times 10^{10}\ \mathrm{N/m^2}$ and its density is $1.2 \times 10^3\ \mathrm{kg/m^3}$.

Sound

$$V = \sqrt{\frac{Y}{\rho}}$$

$$= \sqrt{\frac{3 \times 10^{10}}{1.2 \times 10^3}} = \sqrt{\frac{3 \times 10}{12} 10^7}$$

$$= \sqrt{\frac{100}{4} \times 10^6} = \frac{10}{2} \times 10^3$$

$$= 5 \times 10^3 = 5000\ \mathrm{m/s}$$

QUESTION

If the speed of longitudinal mechanical waves in water is 1400 m/s then calculate the Bulk modulus of elasticity of water. (given density of water is 1 g/cm^3).

$$V = \sqrt{\frac{\beta}{\rho}}$$

$$v^2 = \frac{\beta}{\rho}$$

$$\beta = v^2 \times \rho$$

QUESTION

The wavelength of sound waves in hydrogen gas corresponding to the lower limit of audibility is (speed of sound in hydrogen gas is about 1350 m/s)

(a) 60 m

90% (b) 67.5 m

(c) 100 m

(d) 500 m

$f = 20 Hz$

$v = 1350$

$v = \lambda f$

$1350 = \lambda 20$

$\lambda = \frac{135}{2}$

QUESTION

The speed of longitudinal mechanical wave in a material is $4200\ \mathrm{m/s}$. Young's modulus of the material is $15 \times 10^{9}\ \mathrm{N/m^2}$. What is the density of the material?

easy

QUESTION

Speed of sound wave in a gas is v_1 and rms speed of molecules of the gas at the same temperature is v_2. Then

(a) $v_1 = v_2$

(b) $v_1 < v_2$ (66%)

(c) $v_1 > v_2$

(d) $v_1 \leq v_2$

$$V_{Rms} = \sqrt{\frac{3RT}{M}} = V_2$$

$$V_{Sou} = \sqrt{\frac{\gamma RT}{M}} = V_1$$

QUESTION

The speed of sound in air at NTP is 332 m/s. Calculate the percentage error in speed of sound as calculated from Newton's formula. Given that the density of air is $1.293\ \mathrm{kg/m^3}$.

$$V'_{sound} = \sqrt{\frac{1.01 \times 10^5}{1.293}}$$

$$\%\ \text{error} = \frac{V' - V}{V} \times 100 = 15.67\%$$

QUESTION

The speed of sound in hydrogen at NTP, is 1270 m/s. Then the speed in a mixture of hydrogen and oxygen in the ratio 4: 1 by volume, (in m/s) will be

(a) 635

(b) 318

(c) 158

(d) 1270

H/w

QUESTION

The speed of sound waves in air at 300 K is 332 m/s. At what temperature will the speed be 574 m/s?

$v \propto \sqrt{\text{tempr}}$

$\rightarrow \frac{v_1}{v_2} = \frac{\sqrt{300K}}{\sqrt{T_2}}$

H/W

QUESTION

The velocity of sound in air at 20°C is 340 m s^{-1}. Keeping the temperature constant, what will be the velocity of sound in air when the pressure of the gas is doubled?

→ remains same

QUESTION

Calculate the speed of sound in hydrogen at N.T.P., if density of hydrogen at N.T.P. is $1/16^{th}$ of air. Given that the speed of sound in air is 332 m/s.

H/W

QUESTION

If speed of sound wave is v_0 at 0°C then find speed at t°C.

QUESTION

If temperature increases by 3°C then speed of sound increased by?

QUESTION

Sound wave travel due to density and pressure variation.


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 03 | Physics

Wave [redacted]

By- Dr. Manish Raj (MR SIR)



Topics to be covered

H/W ✓

Intesisity, Loudness, Interferce

1. #
2. #
3. #



QUESTION

The speed of sound in hydrogen at NTP, is 1270 m/s. Then the speed in a mixture of hydrogen and oxygen in the ratio 4: 1 by volume, (in m/s) will be

(a) 635

(b) 318

(c) 158

(d) 1270

$$v_{s\ in\ H} = \sqrt{\frac{\gamma P}{\rho_H}} = 1270\ m/s$$

$$\rho = \frac{m}{V}$$

$$\frac{V_H}{V_O} = \frac{4}{1}$$

$V_O = 1$, $V_H = 4$

$$v_{s\ in\ mix} = \sqrt{\frac{\gamma P}{\rho_{mix}}}$$

$$\rho_{mix} = \frac{\text{Total mass}}{\text{Total volume}} = \frac{\rho_H V_H + \rho_O V_O}{V_H + V_O}$$

$$\rho_m = \frac{\rho_H 4 + 16\rho_H 1}{4+1} = \frac{20\rho_H}{5} = 4\rho_H$$

$$= \sqrt{\frac{\gamma P}{4\rho_H}} = \frac{1270}{2} = 635$$

QUESTION

The speed of sound waves in air at 300 K is 332 m/s. At what temperature will the speed be 574 m/s?

$v \propto \sqrt{\text{Tempr}}$

$$\frac{v_1}{v_2} = \frac{\sqrt{T_1}}{\sqrt{T_2}}$$ ✓

QUESTION

Oxygen is 16 times heavier than hydrogen. Equal volume of hydrogen and oxygen are mixed. The ratio of speed of sound in the mixture to that in hydrogen is

(1) $\sqrt{8}$

(2) $\sqrt{\frac{2}{17}}$ ✓

(3) $\sqrt{\frac{1}{8}}$

(4) $\sqrt{\frac{32}{17}}$

$V_H = V_O = V$

$v_H = \sqrt{\frac{\gamma P}{\rho_H}}$

$v_{mix} = \sqrt{\frac{\gamma P}{\rho_{mix}}}$

$\rho_{mix} = \frac{\rho_H V_H + \rho_O V_O}{V_H + V_O} = \frac{\rho_H V + 16\rho_H V}{2V} = \frac{17\rho_H}{2}$

$= \sqrt{\frac{\gamma P}{\frac{17\rho_H}{2}}} = v_H\sqrt{\frac{2}{17}}$

QUESTION

Calculate the speed of sound in hydrogen at N.T.P., if density of hydrogen at N.T.P. is $1/16^{th}$ of air. Given that the speed of sound in air is 332 m/s.

H/W

QUESTION

If speed of sound wave is v_0 at 0°C then find speed at t°C.

0°C → 273 K

t°C → (t + 273)

$v_{sound} = \sqrt{\frac{\gamma RT}{M}}$

at 0°C $v_{sou} = 0$ ✗

at 0 K $V_{sound} = 0$ ✓

$v_0 \propto \sqrt{273}$ — (I)

$v_t \propto \sqrt{t+273}$ — (II)

(II)/(I)

$$\frac{v_t}{v_0} = \frac{\sqrt{t+273}}{\sqrt{273}}$$

$$v_t = v_0\left(\frac{t+273}{273}\right)^{1/2}$$

$$V_t = v_0 \left(1 + \frac{t}{273}\right)^{1/2}$$

$$V_t = V_0 \left(1 + \frac{t}{2 \times 273}\right)$$

$$V_t = v_0 + \frac{V_0 t}{2 \times 273} \quad (1)$$

$$(V_t - v_0) = \frac{V_0 t}{546}$$

$$(v_t - v_0) = 0.61\, t = 0.61 \text{ m/s}$$

change in velocity in $t°c$ change in Tempr

change in velocity per unit raise in Tempr = 0.61 m/s

QUESTION

If temperature increases by 3°C then speed of sound increased by?

$$\Delta v = 0.61 \times 3$$
$$= 1.83 \text{ m/s}$$

QUESTION

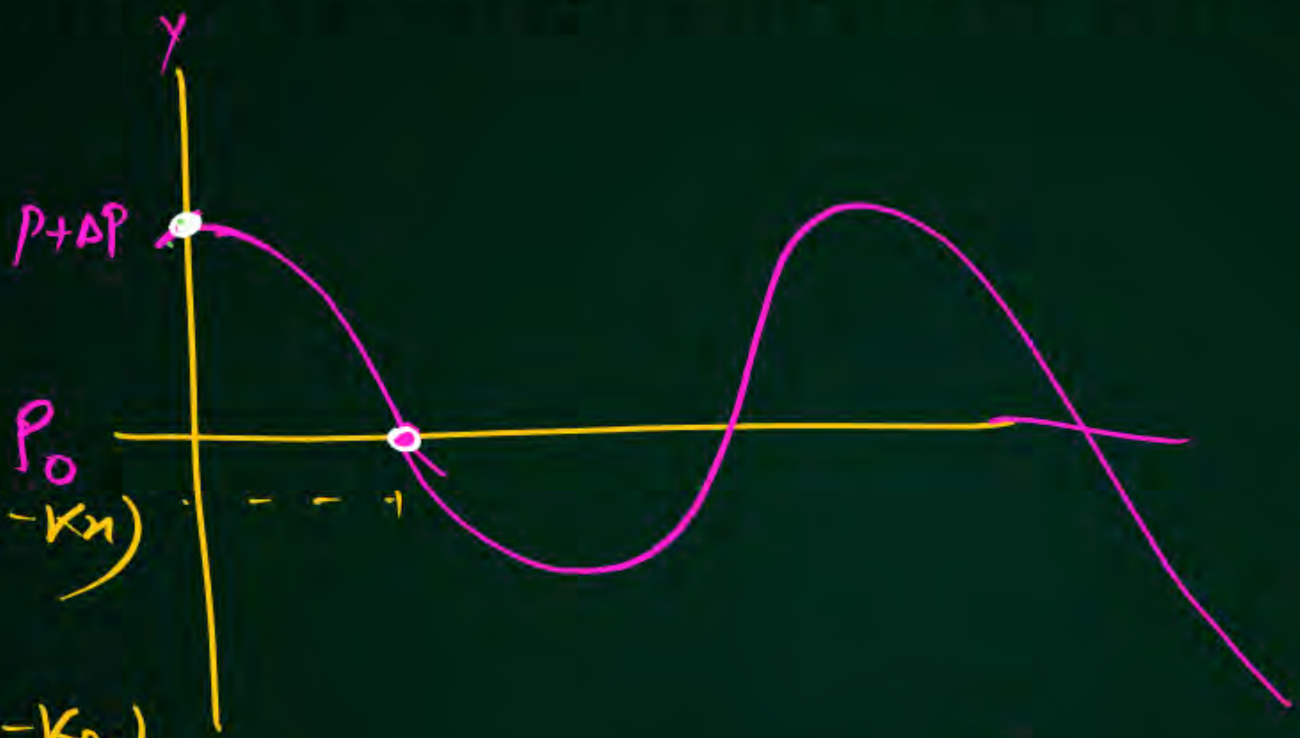
[not in NEET]

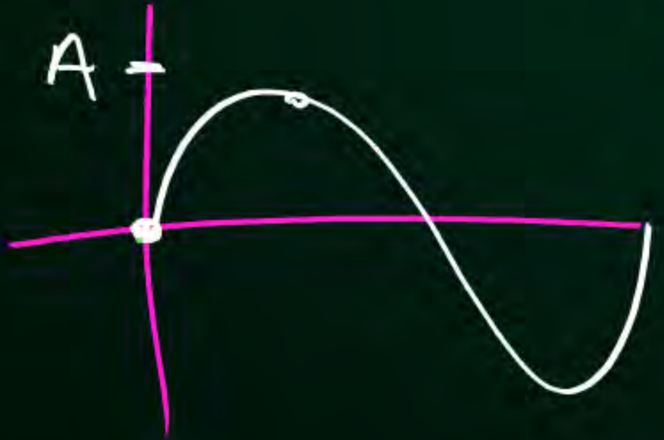
Sound wave travel due to density and pressure variation.

→ longitudinal wave

$P_x = \Delta P \cos(\omega t - kx)$

$x = A \sin(\omega t - kx)$





A

Compre rarefn

$P_{max} = P_0 + \Delta P$

$\Delta P = A \beta K$

Pressure amp dispn Amplitude Bulk mod

Pressure density } maximum at that point Amplitude minimum.

Pressure density } minimum at that point Amplitude maximum

QUESTION

What is the phase difference between the displacement wave and pressure wave in sound wave?

(a) Zero

(b) $\pi/2$

(c) π

(d) $\pi/4$

Intensity of Wave

Intensity = energy per unit Area per-sec is called Intensity,

$$I = \frac{E}{At}$$

$$I = \frac{1}{2}\rho A v^2 \omega^2$$

ρ = density of medium

A = Amplitude of wave

v = velocity of wave

ω = Angular freqn.

$$I = \frac{1}{2}\rho A v^2 (2\pi f)^2$$

$$I = 2\pi^2 \rho A v^2 f^2$$

$I \propto v$

$I \propto \rho$

$I \propto \omega^2$

$\Rightarrow I \propto A^2$

QUESTION

If amplitude becomes half and frequency becomes one fourth then intensity of wave becomes.

$$I = \frac{1}{2} v \rho A^2 \omega^2$$

$$I \propto A^2 f^2$$

$$= \frac{A^2}{4} \times \left(\frac{f}{4}\right)^2$$

$$I' = I/64$$

Intensity is I, If Amplitude becomes half & frequency becomes double then new Intensity will be.

Sol^n

$$I = \frac{1}{2} \rho v A^2 \omega^2$$

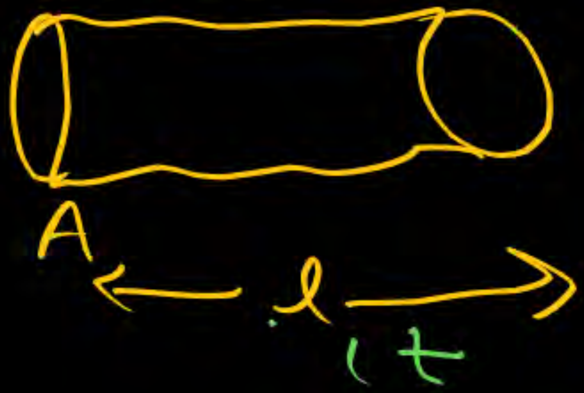
Unchanged

Energy density

$U =$ energy per unit volume

$$U = \frac{E}{\text{volume}} = \frac{E}{A\ell}$$

$$U = \frac{E}{A\ell} \cdot \frac{t}{t}$$



$$U = I\left(\frac{t}{\ell}\right)$$

$$\boxed{U = \frac{I}{v}}$$ ← speed of wave

$$\text{Intensity} = \frac{E}{At} = I$$

EM wave

$$U = \frac{I}{c}$$ ← speed of light

Loudness of Sound Wave

= measure of Intensity of sound wave

✓ $L = \log_{10}\left(\frac{I}{I_0}\right)$ Bel

(*) $I_0 = 10^{-12}$ watt/m^2 $= 10^{-12} \frac{J}{m^2\text{-sec}}$

ref^n Intens..

✓ $L = 10 \log_{10}\left(\frac{I}{I_0}\right)$ dB

↑ Loudness

1 Bel = 10 dB

QUESTION

What is the intensity of sound of 70 decibel? (Given the reference intensity $I_0 = 10^{-12}$ watt/m^2)

$L = 70\ dB$

$L = 10 \log_{10}\left(\frac{I}{I_0}\right) dB$

$70\ dB = 10 \log_{10}\left(\frac{I}{I_0}\right) dB$

$7 = \log_{10}\left(\frac{I}{I_0}\right)$

Antinlge

$10^7 = \frac{I}{I_0}$

$I = I_0 \times 10^7$

$= 10^{-12} \times 10^7$

$I = 10^{-5}$

$y = e^x$

log

$\log_e y = x$ power

QUESTION

If the intensity of sound is increased by a factor of 30, by how many decibels is the sound level increased?

(a) 12 dB (b) 14.77 dB

(c) 10 dB (d) 13 dB

$I_2 = 30 I_1$

$\log_e a - \log_e b = \log_e (a/b)$

$L_1 = 10 \log_{10}\left(\frac{I_1}{I_0}\right) dB$ — (i)

$L_2 = 10 \log_{10}\left(\frac{I_2}{I_0}\right) dB$ — (ii)

$L_2 - L_1 = 10\left[\log_{10}\left(\frac{I_2}{I_0}\right) - \log_{10}\left(\frac{I_1}{I_0}\right)\right]$

$= 10\left[\log_{10}\left(\frac{I_2}{I_0} \times \frac{I_0}{I_1}\right)\right]$

$L_2 - L_1 = 10 \log_{10} 30$

$L_2 - L_1 = 10\left[\log_{10} 10 + \log_{10} 3\right]$

$= 10\left[1 + 0.47\right]$

QUESTION

The sound intensity level at a point 4 m from the point source is 10 dB, then the sound level at a distance 2 m from the same source will be

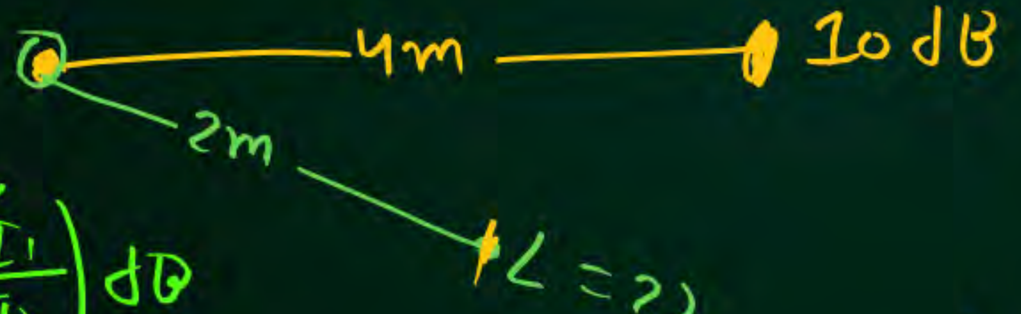
(a) 26 dB (b) 16 dB ✓

(c) 23 dB (d) 32 dB

$I \propto \frac{1}{r^2}$ (Point Sou)

Let Intensity at 4m is I

" " " 2m → $4I$



$L_1 = 10 \log_{10}\left(\frac{I_1}{I_0}\right)$ dB

$L_2 = 10 \log_{10}\left(\frac{4I}{I_0}\right)$ dB

$L_2 - L_1 = 10\left[\log_{10}\left(\frac{4I_1}{I_0} \times \frac{I_0}{I_1}\right)\right]$ dB

$L_2 - L_1 = 10 \times \log_{10} 4$

$\log_{10} 2 = 0.301$

$L_2 = 10 + 10 \times 2 \log_{10} 2$

$= 10 + 10 \times 0.6 = 10 + 6 = 16$ dB

QUESTION

The ratio of intensities between two coherent sound source is 4 : 1. The difference of loudness in decibels (dB) between maximum and minimum intensities, when they interfere in space is -

(a) 10 log 2

(b) 20 log 3

(c) 10 log 3

(d) 20 log 2

$L_1 - L_2 =$

QUESTION

Temperature at which the speed of sound in air becomes doubled its value at 0°C is:

1. 1092°C
2. 819°C
3. 819K
4. 546°C

$\sqrt{273} \rightarrow K \rightarrow v$

$T = 273 \times 4\ K$

Intensity

Energy Density

LOUDNESS IS MEASURE OF INTENSITY

- The sound intensity level at a point 14 m from the point Source is 10 dB, then the sound level at a distance 7 m from the same _____ will be

16 dB

$I \propto \frac{1}{(\text{dist}^n)^2}$

QUESTION

If at STP, velocity of sound in a gas $(\gamma = 1.5)$ is $600\ \text{m/s}$, the r.m.s. velocity of the gas molecules at STP will be

(a) $400\ \text{m/s}$

(b) $600\ \text{m/s}$

(c) $600\sqrt{2}\ \text{m/s}$

(d) $300\sqrt{2}\ \text{m/s}$

$$\frac{V_{sound} = \sqrt{\frac{\gamma RT}{M}}}{V_{rms} = \sqrt{\frac{3RT}{M}}} \Rightarrow \frac{V_{sound}}{V_{rms}} = \sqrt{\frac{\gamma}{3}}$$

$$600\sqrt{\frac{3}{3/2}} = V_{rms}$$

$$600\sqrt{2} = V_{rms}$$

QUESTION

Stationary point source emits sound uniformly in all directions in non-absorbing medium two points P and Q are at a distance of 4 m and 9 m respectively from the source. The ratio of amplitudes of the waves at P and Q is

1. 3/2
2. 4/9
3. 2/3
4. 9/4

$$\frac{A_P}{A_Q} = \frac{9}{4}$$

$$I \propto A^2 \propto \frac{1}{r^2}$$

$$A^2 \propto \frac{1}{r^2}$$

$$A \propto \frac{1}{r}$$

Ans

THE PRINCIPLE OF SUPERPOSITION OF WAVES

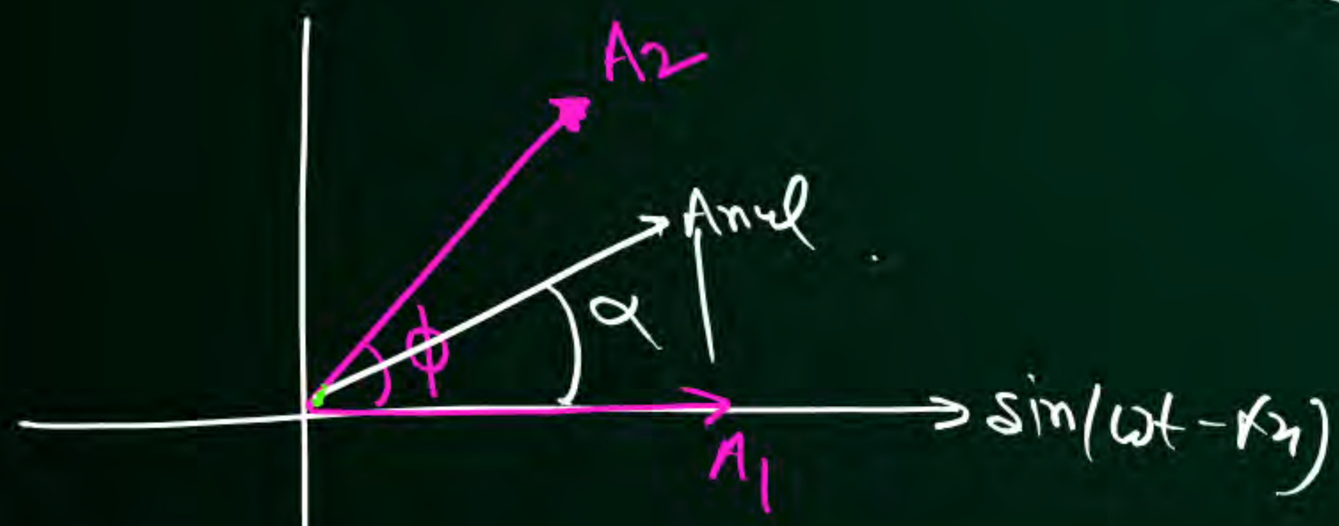
$y_1 = A_1 \sin(\omega t - kx)$

$y_2 = A_2 \sin(\omega t - kx + \phi)$

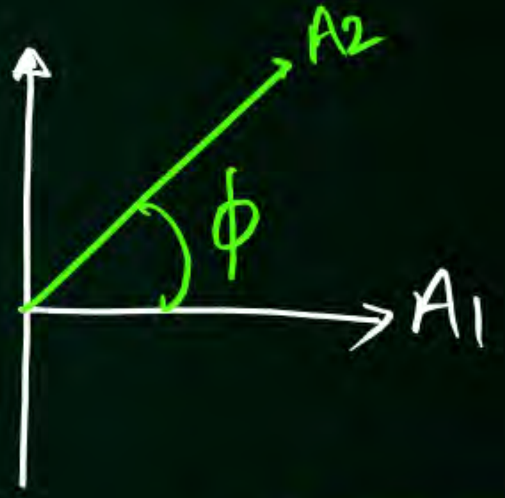
$\tan\alpha = \dfrac{A_2 \sin\phi}{A_1 + A_2\cos\phi}$

$y_1 = A_1 \sin(\omega t)$

$y_2 = A_2 \sin(\omega t + \phi)$







$A_{net} = \sqrt{A_1^2 + A_2^2 + 2A_1A_2\cos\phi}$

Amplitude of superimposed wave

$A_{net} = \sqrt{A_1^2 + A_2^2 + 2A_1A_2\cos\phi}$

$y_n = A_{net} \sin(\omega t - kx + \alpha)$

$$A_{net} = \sqrt{A_1^2 + A_2^2 + 2A_1A_2\cos\phi}$$

$\phi = 0$

$A_{net} = A_1 + A_2$

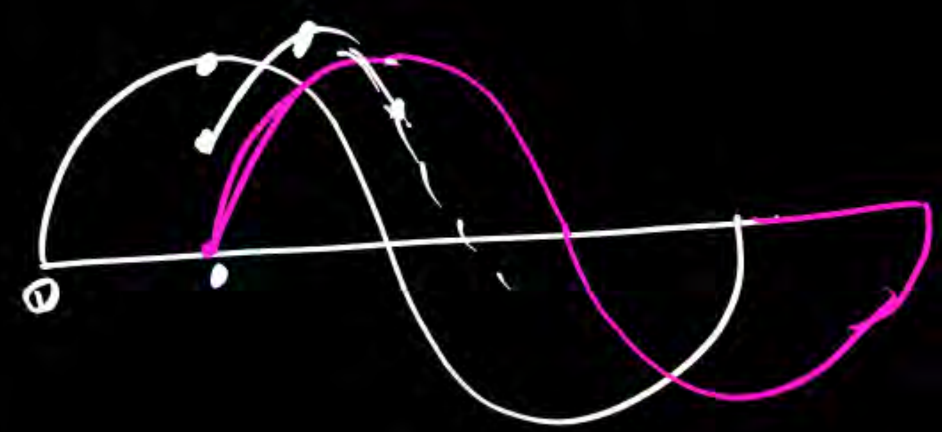
$\phi = 180^\circ$

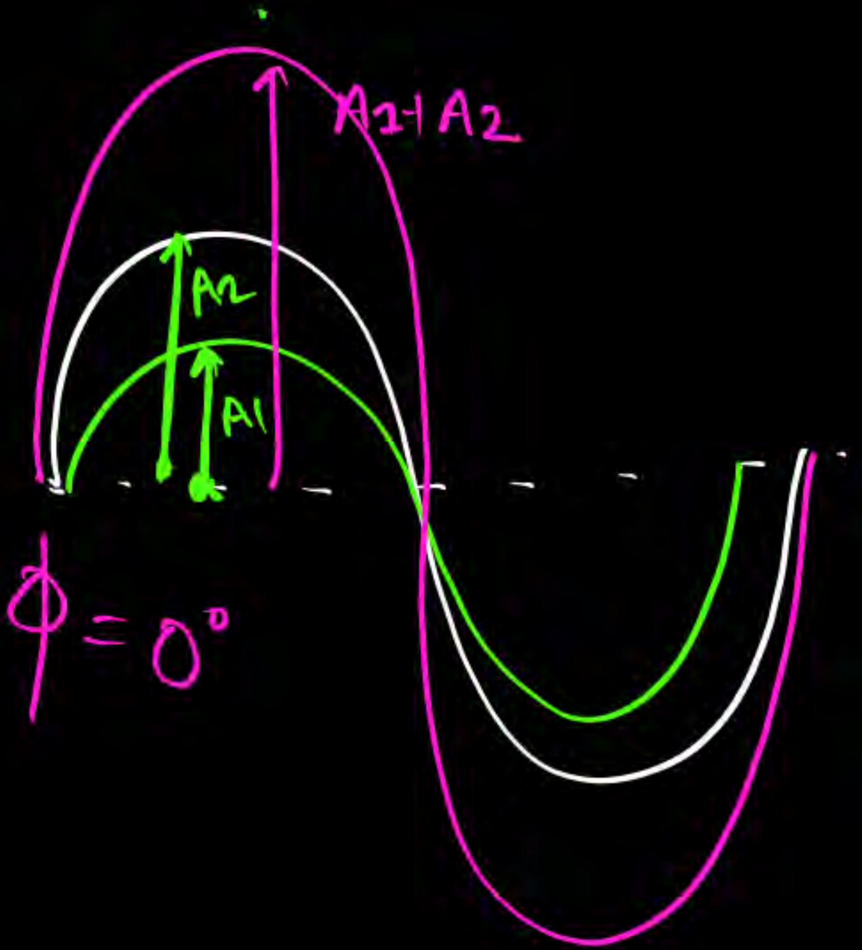
$A_{net} = (A_2 - A_1)$

$\phi = 90^\circ$

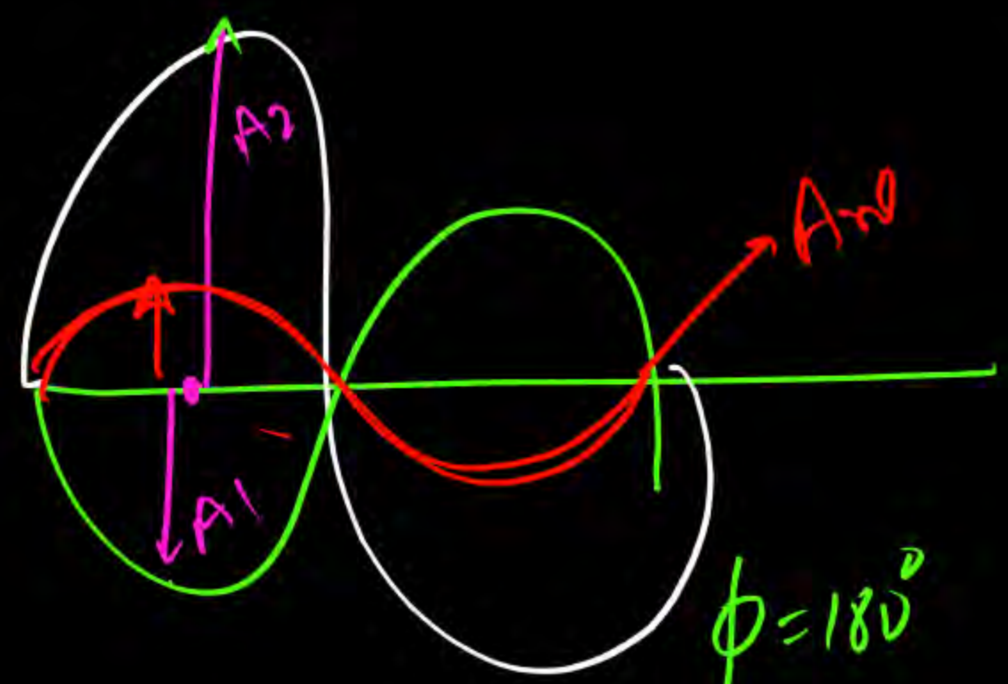
$A_{net} = \sqrt{A_1^2 + A_2^2}$

$\phi = \pi/2$





$\phi = 0^\circ$



$\phi = 180^\circ$

$$A_{net} = \sqrt{A_1^2 + A_2^2 + 2A_1A_2\cos\phi}$$

$$\rightarrow A_{net}^2 = A_1^2 + A_2^2 + 2A_1A_2\cos\phi$$

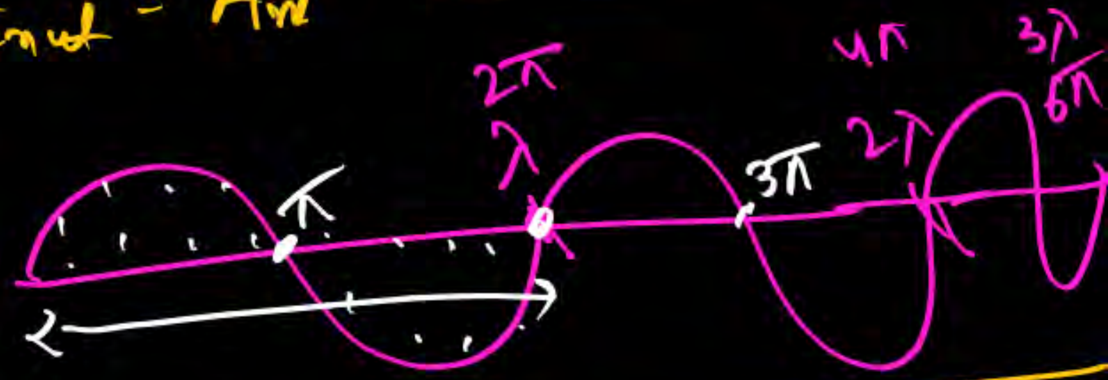
$$\rightarrow I_{net} = I_1 + I_2 + 2\sqrt{I_1}\sqrt{I_2}\cos\phi$$

$I_1 = kA_1^2$

$I_2 = kA_2^2$

$I_{net} = A_{net}^2$

$$I \propto A^2$$
$$I = kA^2$$



$\phi = 0°$

[Constructive Interference]

$A_{net}^2 = (A_1 + A_2)^2 \rightarrow A_{max} = A_1 + A_2$

$I_{max} = (A_1 + A_2)^2 = (\sqrt{I_1} + \sqrt{I_2})^2$

$\phi = 0, 2\pi, 4\pi, 6\pi, 8\pi$

$\phi = n(2\pi)$ $n = 0, 1, 2, 3, 4, 5, 6$

$\Delta x = \frac{\lambda}{2\pi}\Delta\phi = \frac{\lambda}{2\pi} n(2\pi)$

$\Delta x = n\lambda$, $0, \lambda, 2\lambda, 3\lambda, 4\lambda$

Path diff $\rightarrow n = 0, 1, 2, 3, 4, 5$

distructive Interfer (D.I)

$\phi = \pi, 3\pi, 5\pi, 7\pi, 9\pi$

$\phi = (2n-1)\pi$

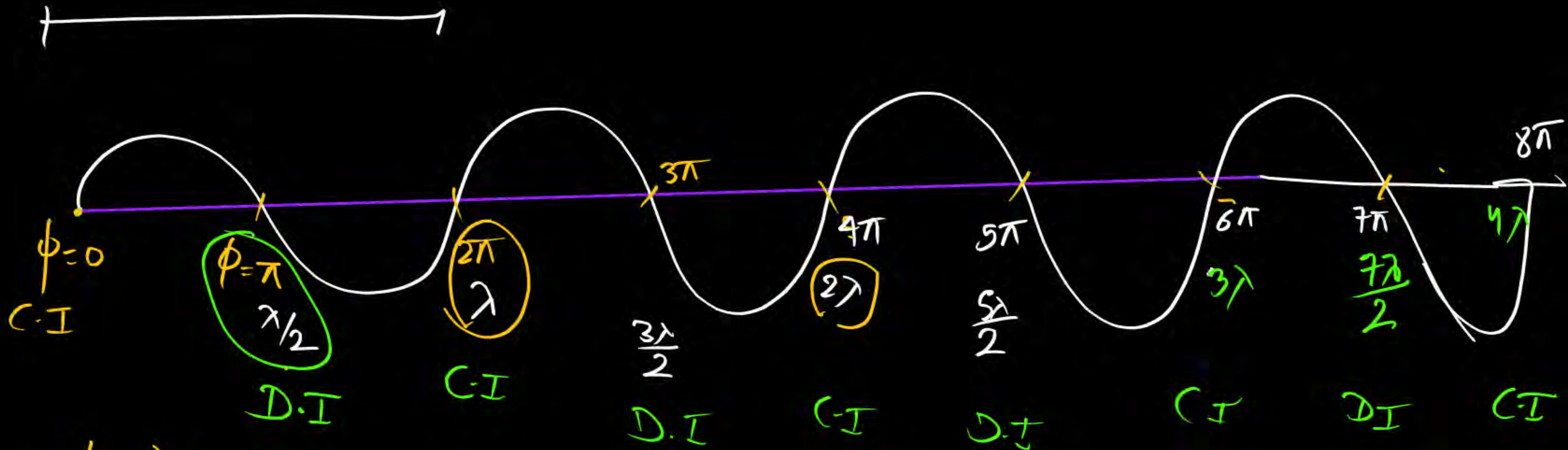
$n = 1, 2, 3, 4, 5$

$\Delta x = \frac{\lambda}{2\pi}\pi(2n-1)$

$$\Delta x = (2n-1)\frac{\lambda}{2}$$

$A_{min} = (A_1 - A_2) = (\sqrt{I_1} - \sqrt{I_2})^2$

$I_{min} = (A_1 - A_2)^2$



$$\phi = n(2\pi) = 0, 2\pi, 4\pi, 6\pi, 8\pi.$$

$$\Delta x = n\lambda = 0, \lambda, 2\lambda, 3\lambda$$

{ If $I_1 = I_2 = I_0$
$A_1 = A_2 = A_0$ }

$$A_{net} = 2A_0 \cos(\phi/2)$$

square both side.

$$A_{net}^2 = 4A_0^2 \cos^2(\phi/2)$$

$$I_{net} = 4 I_0 \cos^2(\phi/2)$$

QUESTION

Two waves represented by $y = a \sin(\omega t - kx)$ and $y = a \sin\left(\omega t - kx + \frac{2\pi}{3}\right)$ are superposed. What will be the amplitude of the resultant wave ? = a (Ans)



QUESTION

Two waves represented by $y_1 = 3\sin(200x - 150t)$ and $y_2 = 3\cos(200x - 150t)$ are superposed where x and y are in metre and t is in second. Calculate the amplitude of resultant wave.

QUESTION

On the superposition of the two waves given as $y_1 = A_0 \sin(\omega t - kx)$ and $y_2 = A_0 \cos\left(\omega t + kx + \frac{\pi}{6}\right)$, the resultant amplitude of oscillations will be

1. $\sqrt{3}A_0$
2. $A_0/2$
3. A_0
4. $\frac{3}{2}A_0$

QUESTION

Two waves of amplitudes A_0 and xA_0 pass through a region. If $x > 1$, the difference in the maximum and minimum resultant amplitude possible is

1. $(x + 1) > A_0$
2. $(x - 1) A_0$
3. $2x A_0$
4. $2A_0$

QUESTION

Two periodic waves of intensities I_1 and I_2 pass through a region at the same time in the same direction. The sum of the maximum and minimum intensities is

1. $2(I_1 + I_2)$
2. $I_1 + I_2$
3. $(\sqrt{I_1} + \sqrt{I_2})^2$
4. $(\sqrt{I_1} - \sqrt{I_2})^2$

QUESTION

Two waves have equations $x_1 = a \sin(\omega t + \phi_1)$ $x_2 = a \sin(\omega t + \phi_2)$. If in the resultant wave the frequency and amplitude remain equal to amplitude of superimposing waves, the phase difference between them is [2001]

1. $\pi/6$
2. $2\pi/3$
3. $\pi/4$
4. $\pi/3$

QUESTION

Two sound waves, each of amplitude A and frequency ω superpose at a point with phase difference of $\pi/2$. The amplitude and frequency of the resultant wave are respectively

1. $\frac{A}{\sqrt{2}}, \frac{\omega}{2}$
2. $\frac{A}{\sqrt{2}}, \omega$
3. $\sqrt{2A}, \frac{\omega}{2}$
4. $\sqrt{2A}, \omega$

QUESTION

The ratio of intensities between two coherent sound source is $4:1$. The difference of loudness in decibels (dB) between maximum and minimum intensities, when they interfere in space is -

(a) $10 \log 2$
(b) $20 \log 3$
(c) $10\, log\, 3$
(d) $20 \log 2$

QUESTION

If $\frac{I_1}{I_2} = \frac{9}{4}$ then find $\frac{I_{\max}}{I_{\min}} = ?$

QUESTION

$\frac{I_{\max}}{I_{\min}} = \frac{25}{16}$ then find $\frac{I_1}{I_2} = ?$

$$\frac{I_{max} = \sqrt{I_1} + \sqrt{I_2}}{I_{min} = \sqrt{I_1} - \sqrt{I_2}}$$


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 4 | Physics

Wave Motion

By- Dr. Manish Raj (MR SIR)



Topics to be covered

Revision of 3rd lecture

{ P.h.D on Interference }

Reflection of wave

1 #

2 #

3 #



QUESTION

The speed of sound in hydrogen at NTP, is 1270 m/s. Then the speed in a mixture of hydrogen and oxygen in the ratio 4: 1 by volume, (in m/s) will be

(a) 635

(b) 318

(c) 158

(d) 1270

$$v_{s \text{ in } H} = \sqrt{\frac{\gamma P}{\rho_H}} = 1270 \text{ m/s}$$

$$\rho = \frac{m}{V}$$

$$\frac{V_H}{V_O} = \frac{4}{1}$$

$$V_O = 1, \quad V_H = 4$$

$$v_{s \text{ in mix}} = \sqrt{\frac{\gamma P}{\rho_{mix}}}$$

$$= \sqrt{\frac{\gamma P}{4\rho_H}} = \frac{1270}{2} = 635$$

$$\rho_{mix} = \frac{\text{Total mass}}{\text{Total volume}} = \frac{\rho_H V_H + \rho_O V_O}{V_H + V_O}$$

$$\rho_m = \frac{\rho_H 4 + 16\rho_H 1}{4 + 1} = \frac{20\rho_H}{5} = 4\rho_H$$

QUESTION

The speed of sound waves in air at 300 K is 332 m/s. At what temperature will the speed be 574 m/s?

$$v \propto \sqrt{\text{Tempr}}$$

$$\frac{v_1}{v_2} = \frac{\sqrt{T_1}}{\sqrt{T_2}} \checkmark$$

QUESTION

$\rho = \frac{m}{V}$

Oxygen is 16 times heavier than hydrogen. Equal volume of hydrogen and oxygen are mixed. The ratio of speed of sound in the mixture to that in hydrogen is

1. $\sqrt{8}$
2. $\sqrt{\frac{2}{17}}$
3. $\sqrt{\frac{1}{8}}$
4. $\sqrt{\frac{32}{17}}$

$v_H = \sqrt{\frac{\gamma P}{\rho_H}}$ $\quad V_H = V_O = V$

$v_{mix} = \sqrt{\frac{\gamma P}{\rho_{mix}}}$ $\quad \rho_{mix} = \frac{\rho_H V_H + \rho_O V_O}{V_H + V_O}$

$= \sqrt{\frac{\gamma P}{\frac{17\rho_H}{2}}} = v_H\sqrt{\frac{2}{17}}$ $\quad = \frac{\rho_H V + 16\rho_H V}{2V}$

$= \frac{17\rho_H}{2}$

QUESTION

Calculate the speed of sound in hydrogen at N.T.P., if density of hydrogen at N.T.P. is $1/16^{th}$ of air. Given that the speed of sound in air is 332 m/s.

H/w

QUESTION

If speed of sound wave is v_0 at 0°C then find speed at t°C.

0°C → 273 K

t°C → (t + 273)

$$v_{sound} = \sqrt{\frac{\gamma R T}{M}}$$

at 0°C $v_{sou} = 0$ ✗

at 0 K $V_{sound} = 0$ ✓

Tempr → K ✓
ΔTempr → K / °C ✓

$$v_0 \propto \sqrt{273} \quad \text{— (I)}$$

$$v_t \propto \sqrt{(t+273)} \quad \text{— (II)}$$

(II)/(I)

$$\frac{v_t}{v_0} = \frac{\sqrt{t+273}}{\sqrt{273}}$$

$$v_t = v_0\left(\frac{t+273}{273}\right)^{1/2}$$



$$V_t = v_0 \left(1 + \frac{t}{273}\right)^{1/2}$$ → Binomial

$$V_t = v_0 \left(1 + \frac{t}{2 \times 273}\right)$$

$$V_t = v_0 + \frac{v_0 t}{2 \times 273}$$ — (1)

$$(V_t - v_0) = \frac{v_0 t}{546}$$

$$(v_t - v_0) = 0.61\, t = 0.61 \text{ m/s}$$

Change in velocity in 1°C change in Tempr

MR Rafter

change in velocity per unit raise in Tempr = 0.61 m/s

QUESTION

If temperature increases by 3°C then speed of sound increased by?

$$\Delta v = 0.61 \times 3$$
$$= 1.83 \text{ m/s}$$

QUESTION

[Not in NEET]

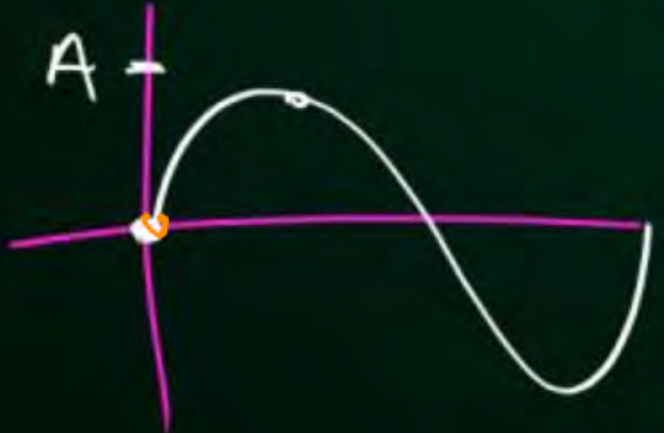
Sound wave travel due to density and pressure variation.

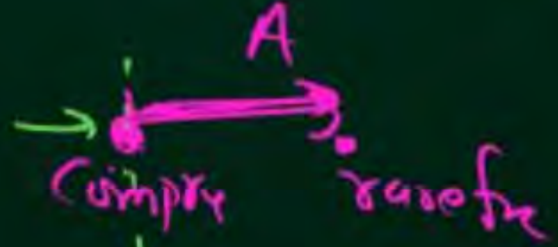
→ longitudinal wave

$P_x = \Delta P \cos(\omega t - kx)$

$x = A \sin(\omega t - kx)$







$P_{max} = P_0 + \Delta P$

$\Delta P = A \beta K$

Pressure amp, dispm Amplitu, Bulk mod

Pressure, density — maximum at that point, Amplitu minim.

Pressure, density — minimum at that point, Amplitu maximum

QUESTION

What is the phase difference between the displacement wave and pressure wave in sound wave?

(a) Zero

(b) $\pi/2$

(c) π

(d) $\pi/4$

Intensity of Wave

Intensity = energy per unit Area per-sec is called Intensity.

$$I = \frac{E}{At}$$

$I \propto v$

$I \propto \rho$

$I \propto \omega^2$

$\Rightarrow$ $I \propto A^2$

$$I = \frac{1}{2}\rho A^2 v \omega^2$$

ρ = density of medium

A = Amplitude of wave

v = velocity of wave

ω = Angular freq.

$$I = \frac{1}{2}\rho A v^2 (2\pi f)^2$$

$$I = \frac{1}{2}\rho v A^2 \omega^2$$

$$I = 2\pi^2 \rho A v^2 f^2$$

QUESTION

If amplitude becomes half and frequency becomes one fourth then intensity of wave becomes.

$$I = \frac{1}{2} v \rho A^2 \omega^2$$

$$I \propto A^2 f^2$$

$$= \frac{A^2}{4} \times \left(\frac{f}{4}\right)^2$$

$$I' = I/64$$

Intensity is I , If Amplitude becomes half & frequency becomes double then new Intensity will be.

Sol^n

$$I = \frac{1}{2} \rho v A^2 \omega^2$$

Unchanged ✓

Energy density

$U =$ energy per unit volume

$$U = \frac{E}{\text{volume}} = \frac{E}{A\ell}$$

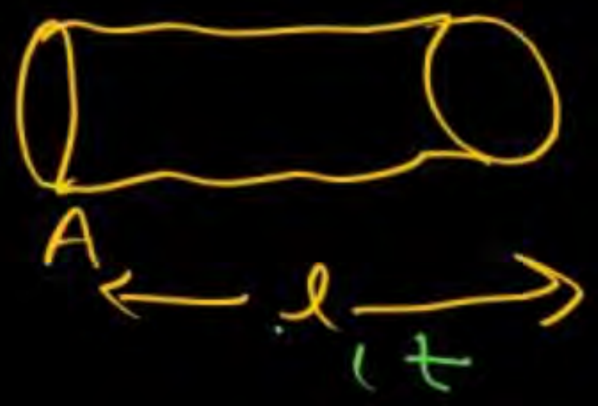
$$U = \frac{E\,t}{A\,\ell\,t}$$

$$U = I\left(\frac{t}{\ell}\right)$$

$$U = \frac{I}{v}$$

energy density

v ← speed of wave



Intensity $= \dfrac{E}{At} = I$

$$I = \frac{E}{At}$$

EM wave

$$U = \frac{I}{c}$$

c ← speed of light

QUESTION

A sound wave $y = A \sin(\omega t - kx)$ is propagating through a medium of density ρ. What is the sound energy per unit volume ?

1. $\frac{1}{2}\rho A^2\omega^2$ (88%)
2. $\rho A^2\omega^2$
3. $2\rho A^2\omega^2$
4. $4\rho A^2\omega^2$

$\frac{E}{\text{volume}} = \frac{E/t}{A \times l / t} = \frac{I}{(l/t)} = \frac{I}{v}$

$= \frac{\frac{1}{2}\rho v A^2\omega^2}{v}$

$= \frac{1}{2}\rho A^2\omega^2$

Loudness of Sound Wave = Measure of Intensity of sound wave

$L = \log_{10}\left(\frac{I}{I_0}\right)$ Bel

$$L = 10 \log_{10}\left(\frac{I}{I_0}\right) \text{ dB}$$

↑ Loudness

(*) $I_0 = 10^{-12}$ watt/m² $= 10^{-12} \frac{J}{m^2\text{-sec}}$

ref^n Intens.

1 Bel = 10 dB

$$\frac{\pi}{3} = \Delta\phi \times 3$$

$$\frac{\pi}{9} = \Delta\phi$$

QUESTION

What is the intensity of sound of 70 decibel? (Given the reference intensity $I_0 = 10^{-12}$ watt/m^2)

(refn intensity)

$1 \text{ Bel} = 10 \text{ dB}$

$L = \log_{10}\left(\frac{I}{I_0}\right) \text{ Bel}$

$L = 10\log_{10}\left(\frac{I}{I_0}\right) \text{ dB}$

$L = 70 \text{ dB}$

$Y = e^x$

log

$\log_e Y = x$ (power)

$L = 10\log_{10}\left(\frac{I}{I_0}\right) \text{ dB}$

$70 \text{ dB} = 10\log_{10}\left(\frac{I}{I_0}\right) \text{ dB}$

$7 = \log_{10}\left(\frac{I}{I_0}\right)$

Antinlge

$10^7 = \frac{I}{I_0}$

$I = I_0 \times 10^7$

$= 10^{-12} \times 10^7$

$I = 10^{-5}$

QUESTION

If the intensity of sound is increased by a factor of 30, by how many decibels is the sound level increased?

(a) 12 dB

(b) 14.77 dB

(c) 10 dB

(d) 13 dB

$I_2 = 30 I_1$

$\log_e a - \log_e b = \log_e (a/b)$

$L_1 = 10 \log_{10}\left(\frac{I_1}{I_0}\right)$ dB — (i)

$L_2 = 10 \log_{10}\left(\frac{I_2}{I_0}\right)$ dB — (ii)

$L_2 - L_1 = 10\left[\log_{10}\left(\frac{I_2}{I_0}\right) - \log_{10}\left(\frac{I_1}{I_0}\right)\right]$

$= 10\left[\log_{10}\left(\frac{I_2}{I_0} \times \frac{I_0}{I_1}\right)\right]$

$L_2 - L_1 = 10 \log_{10} 30$

$\log_{10} 30 = \log_{10} (10 \times 3)$

$= \log_{10} 10 + \log_{10} 3$

$= (1 + 0.47)$

$L_2 - L_1 = 10\left[\log_{10} 10 + \log_{10} 3\right]$

$= 10\left[1 + 0.47\right]$

QUESTION

The sound intensity level at a point 4 m from the point source is 10 dB, then the sound level at a distance 2 m from the same source will be

(a) 26 dB (b) 16 dB

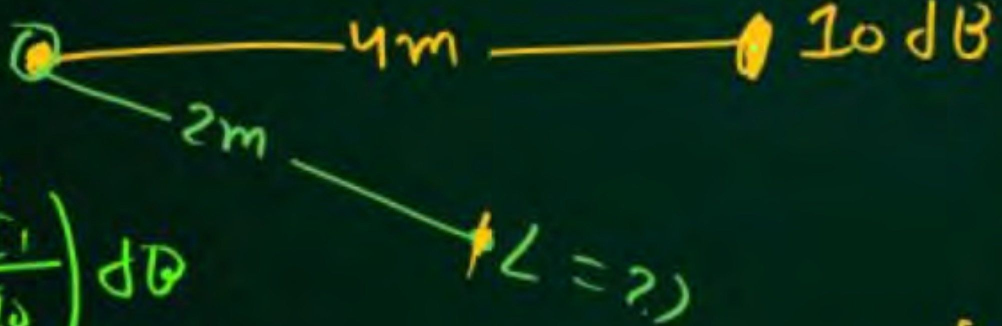
(c) 23 dB (d) 32 dB



$I \propto \frac{1}{r^2}$ Point Sou

Let Intem at 4m is I

" " " 2m → 4I



$L_1 = 10 \log_{10}\left(\frac{I_1}{I_0}\right)$ dB

$L_2 = 10 \log_{10}\left(\frac{4I}{I_0}\right)$ dB

$L_2 - L_1 = 10\left[\log_{10}\left(\frac{4I_1}{I_0} \times \frac{I_0}{I_1}\right)\right]$ dB

$\log_{10} 2 = 0.301$

$L_2 - L_1 = 10 \times \log_{10} 4$

$L_2 = 10 + 10 \times 2 \log_{10} 2$

$= 10 + 10 \times 0.6 = 10 + 6 = 16$ dB

QUESTION

Temperature at which the speed of sound in air becomes doubled its value at 0°C is:

1. 1092°C
2. 819°C
3. 819K $v \propto \sqrt{T}$ ✓
4. 546°C

$\sqrt{273}$ K → v

$T = 273 \times 4$ K

Intensity

$$I = \frac{1}{2} \rho v A^2 \omega^2$$

$$U = \frac{I}{v}$$

LOUDNESS IS MEASURE OF INTENSITY

- The sound intensity level at a point 14 m from the point Source is 10 dB, then the sound level at a distance 7 m from the same ____ will be

Loudness at 14m is $L_1 = 10\,dB \longrightarrow I_1$ (Let)

" " 7m $L_2 = ?? \longrightarrow I_2$

$I \propto \frac{1}{r^2}$

$\frac{I_1}{I_2} \propto \frac{(7)^2}{(14)^2} = \left(\frac{7}{14}\right)^2 = \frac{1}{4}$

$4I_1 = I_2$

$L_1 = 10 \log_{10}\left(\frac{I_1}{I_0}\right) dB$

$L_2 = 10 \log_{10}\left(\frac{I_2}{I_0}\right) dB$

$L_1 - L_2 = 10\left[\log_{10}\left(\frac{I_1}{I_0}\right) dB - \log_{10}\left(\frac{I_2}{I_0}\right) dB\right]$

$L_1 - L_2 = 10 \log\left(\frac{I_1}{I_0} \frac{I_0}{4I_1}\right) = 10 \log_{10}\left(\frac{1}{4}\right)$

$$L_1 - L_2 = 10\log_{10}(4^{-1})\ dB$$

$$L_1 - L_2 = -10\log_{10} 4\ dB$$

$$10 - L_2 = -10\log_{10} 4\ dB$$

$$\frac{1}{4} = 4^{-1}$$

$$10 + 10 \times 0.6 = L_2$$

$$10 + 6 = L_2$$

$$L_2 = 16\ dB$$

QUESTION

If at STP, velocity of sound in a gas ($\gamma = 1.5$) is $600\ m/s$, the r.m.s. velocity of the gas molecules at STP will be

(a) $400\ m/s$

(b) $600\ m/s$

(c) $600\sqrt{2}\ m/s$

(d) $300\sqrt{2}\ m/s$

$$\frac{V_{sound} = \sqrt{\frac{\gamma RT}{M}}}{V_{rms} = \sqrt{\frac{3RT}{M}}} \Rightarrow \frac{V_{sound}}{V_{rms}} = \sqrt{\frac{\gamma}{3}}$$

$$\frac{V_s}{V_r} = \sqrt{\frac{\gamma}{3}}$$

$$600\sqrt{\frac{3}{3/2}} = V_{rms}$$

$$600\sqrt{2} = V_{rms}$$

$$\frac{V_{\text{sound in gas}} = \sqrt{\frac{\gamma RT}{M}}}{V_{rms} = \sqrt{\frac{3RT}{M}}}$$

QUESTION

Stationary point source emits sound uniformly in all directions in non-absorbing medium two points P and Q are at a distance of 4 m and 9 m respectively from the source. The ratio of amplitudes of the waves at P and Q is

1. 3/2
2. 4/9
3. 2/3
4. 9/4

$$\frac{A_P}{A_Q} = \frac{9}{4}$$

$$I \propto A^2 \propto \frac{1}{r^2}$$

$$A^2 \propto \frac{1}{r^2}$$

$$A \propto \frac{1}{r}$$

Ans

Interference → superposition of Two wave having same frequency, wave no, but diff^n or may same Amplitued & phase.

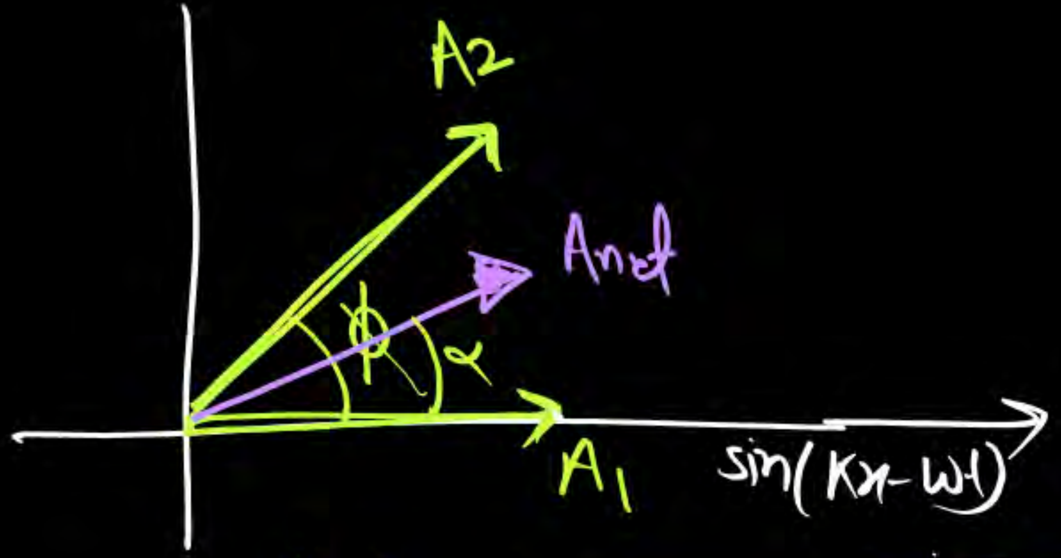
ω, k = same

$y_1 = A_1 \sin(kx - \omega t)$

$y_2 = A_2 \sin(kx - \omega t + \phi)$

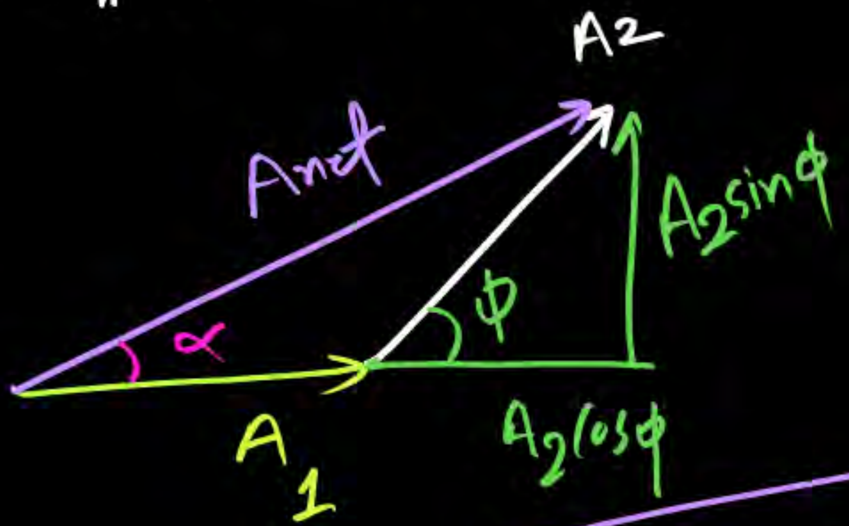
ϕ may be 0°, 90°, 180°, 120°, 60°

$$A_{net} = \sqrt{A_1^2 + A_2^2 + 2A_1A_2\cos\phi}$$



$$A_{net} = \sqrt{A_1^2 + A_2^2 + 2A_1A_2\cos\phi}$$

⇒



$$\tan\alpha = \frac{A_2\sin\phi}{A_1 + A_2\cos\phi}$$

QUESTION

If $y_1 = 4 \sin(\omega t + kx)$

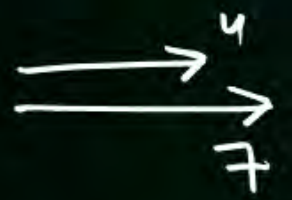
$y_2 = 7 \sin(\omega t + kx + \phi)$

Find Amplitude of superimposed wave if

(i) $\phi = 0$ (ii) $\phi = 90°$ (iii) $\phi = 120°$ (iv) $\phi = 180°$

mean

(i)



$A_{net} = 11$

$y = 11 \sin(\omega t + kx)$

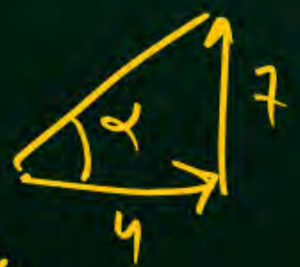
(ii)

$A_{net} = \sqrt{A_1^2 + A_2^2 + 2A_1A_2\cos 90°}$

$= \sqrt{A_1^2 + A_2^2}$

$= \sqrt{16 + 49} = \sqrt{65}$

$A_{net} = \sqrt{65}$



$\tan\alpha = 7/4$

(iii)

$A_{net} = \sqrt{4^2 + 7^2 + 2 \times 4 \times 7 \cos 120°}$

$= \sqrt{16 + 49 - 2 \times 4 \times 7 \times \frac{1}{2}}$

$= \sqrt{65 - 28}$

$= \sqrt{37}$

(iv)

$A_{net} = 7 - 4$

$A_{net} = 3$

$$A_{net} = \sqrt{A_1^2 + A_2^2 + 2A_1A_2\cos\phi}$$

$A_{net}^2 = A_1^2 + A_2^2 + 2A_1A_2\cos\phi$

$I_{net} = I_1 + I_2 + 2\sqrt{I_1}\sqrt{I_2}\cos\phi$

$\phi = 0^\circ, 2\pi, 4\pi, 6\pi, 8\pi, 10\pi, 12\pi$

$\phi = n(2\pi)$

$\phi = 0^\circ \rightarrow$ C.I.

$$A_{net}^2 = A_1^2 + A_2^2 + 2A_1A_2 = (A_1 + A_2)^2$$

$$I_{net\,max} = I_1 + I_2 + 2\sqrt{I_1}\sqrt{I_2} = (\sqrt{I_1} + \sqrt{I_2})^2$$

$A_{net\ maximum} = A_1 + A_2$

$I_{max} = (\sqrt{I_1} + \sqrt{I_2})^2 = (A_1 + A_2)^2$

If $\phi = \pi/2$

$$A_{net}^2 = A_1^2 + A_2^2 + 2A_1A_2\cos 90^\circ \quad (\cos 90^\circ \rightarrow 0)$$

$$A_{net}^2 = A_1^2 + A_2^2 \rightarrow A_{net} = \sqrt{A_1^2 + A_2^2}$$

$$I_{net} = I_1 + I_2$$

If $\phi = 60^\circ$

$$A_{net}^2 = A_1^2 + A_2^2 + A_1A_2$$

$$I_{net} = I_1 + I_2 + \sqrt{I_1}\sqrt{I_2}$$

If $\phi = \pi, 3\pi, 5\pi, 7\pi, \ldots$; $(2n-1)\pi = \phi$, $n = 1, 2, 3, 4, 5, 6,$

$$A_{net}^2 = A_1^2 + A_2^2 - 2A_1A_2 = (A_1 - A_2)^2$$

$A_{min} = A_1 - A_2$

$$I_{net} = (A_1 - A_2)^2$$

$$I_{min} = (A_1 - A_2)^2 = (\sqrt{I_1} - \sqrt{I_2})^2$$

distructiv Interfer

THE PRINCIPLE OF SUPERPOSITION OF WAVES

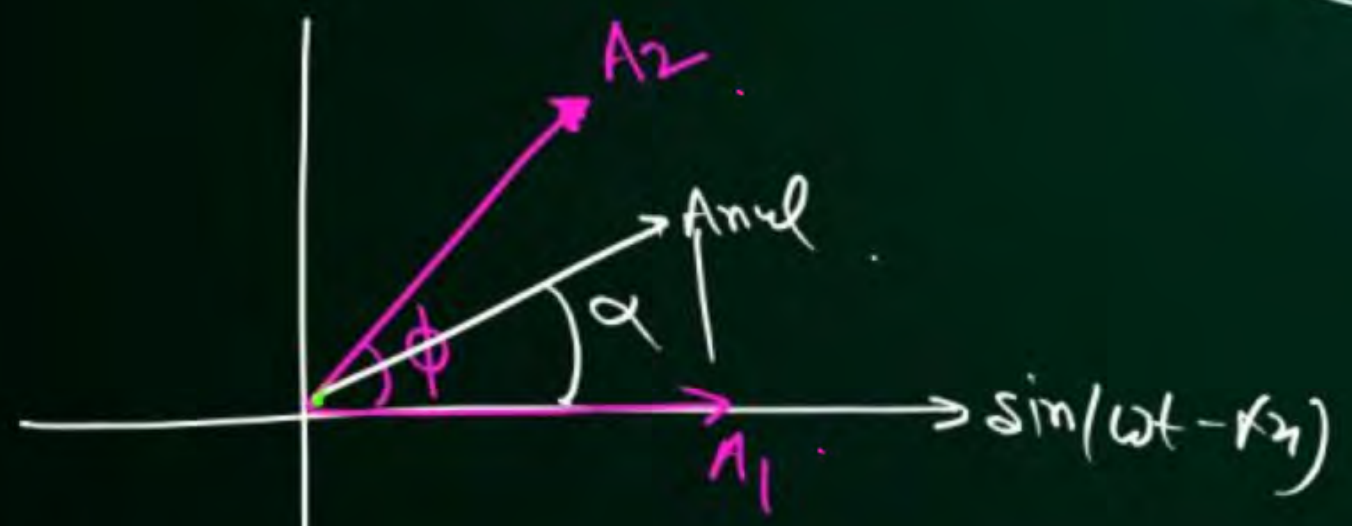
$y_1 = A_1 \sin(\omega t - kx)$

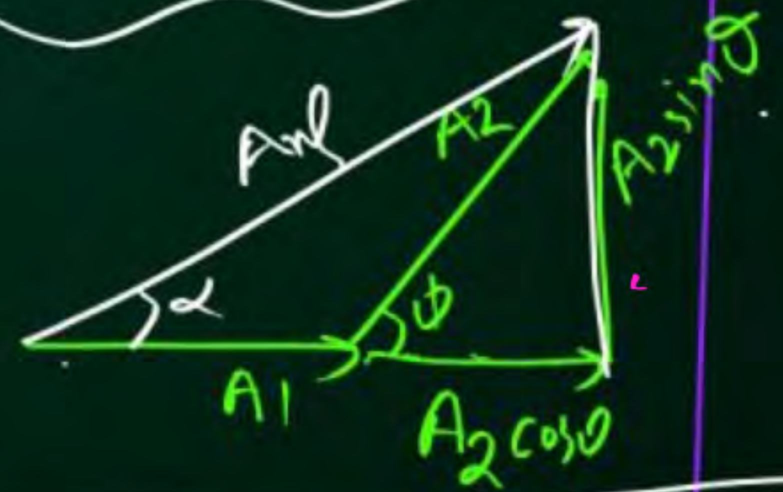
$y_2 = A_2 \sin(\omega t - kx + \phi)$

$\tan\alpha = \dfrac{A_2 \sin\phi}{A_1 + A_2\cos\phi}$

$y_1 = A_1 \sin(\omega t)$

$y_2 = A_2 \sin(\omega t + \phi)$







$A_{net} = \sqrt{A_1^2 + A_2^2 + 2A_1A_2\cos\phi}$

Amplitude of superimposed wave

$A_{net} = \sqrt{A_1^2 + A_2^2 + 2A_1A_2\cos\phi}$

$y_{net} = A_{net} \sin(\omega t - kx + \alpha)$

$$A_{net} = \sqrt{A_1^2 + A_2^2 + 2A_1A_2\cos\phi}$$

$\phi = 0$

$A_{net} = A_1 + A_2$

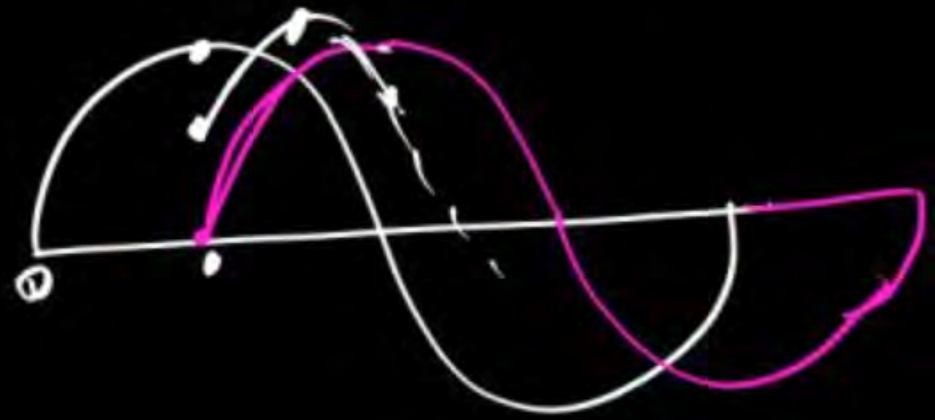
$\phi = 180^\circ$

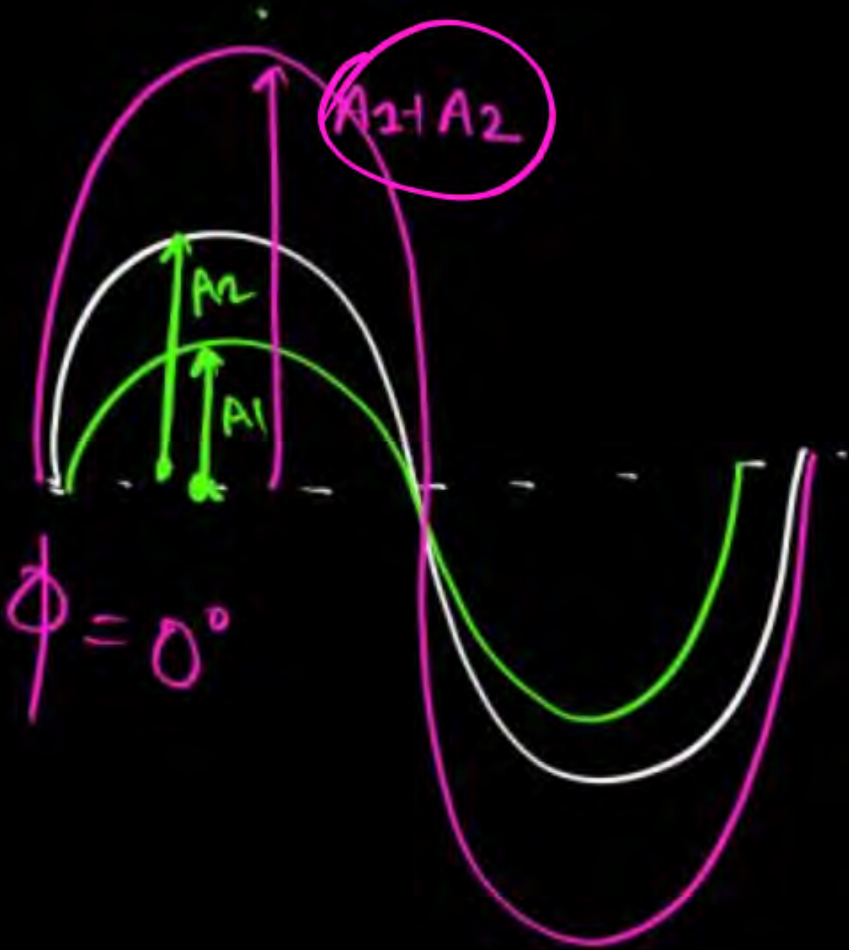
$A_{net} = (A_2 - A_1)$

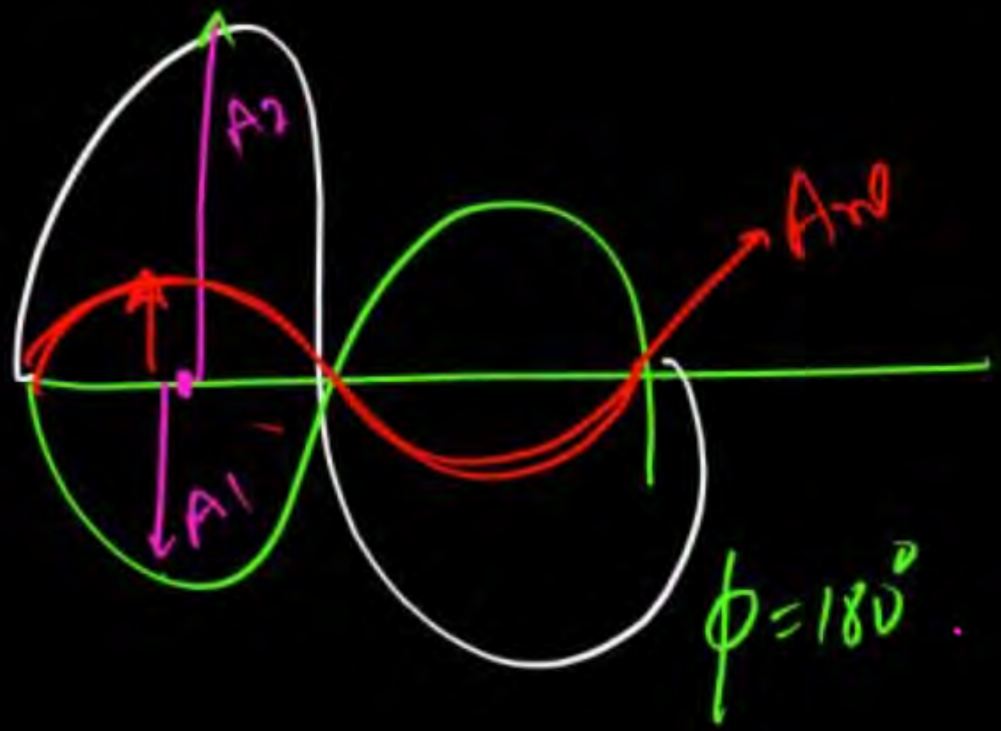
$\phi = 90^\circ$

$A_{net} = \sqrt{A_1^2 + A_2^2}$

$\phi = \pi/2$







$$A_{net} = \sqrt{A_1^2 + A_2^2 + 2A_1A_2\cos\phi}$$

→ $$A_{net}^2 = A_1^2 + A_2^2 + 2A_1A_2\cos\phi$$

→ $$I_{net} = I_1 + I_2 + 2\sqrt{I_1}\sqrt{I_2}\cos\phi$$

$I_1 = KA_1^2$

$I_2 = KA_2^2$

$I_{net} = A_{net}^2$

$I \propto A^2$

$I = K A^2$



$\phi = 0^\circ$

[Constructive Interference]

$A_{net}^2 = (A_1 + A_2)^2$ → $A_{max} = A_1 + A_2$

$I_{max} = (A_1 + A_2)^2 = (\sqrt{I_1} + \sqrt{I_2})^2$

$\phi = 0, 2\pi, 4\pi, 6\pi, 8\pi$

$\phi = n(2\pi)$, $n = 0, 1, 2, 3, 4, 5, 6$

$\Delta x = \frac{\lambda}{2\pi}\Delta\phi = \frac{\lambda}{2\pi} n(2\pi)$

$\Delta x = n\lambda$, $0, \lambda, 2\lambda, 3\lambda, 4\lambda$

Path diff → $n = 0, 1, 2, 3, 4, 5$

distructive Interfer (D.I)

$\phi = \pi, 3\pi, 5\pi, 7\pi, 9\pi$

$\phi = (2n-1)\pi$

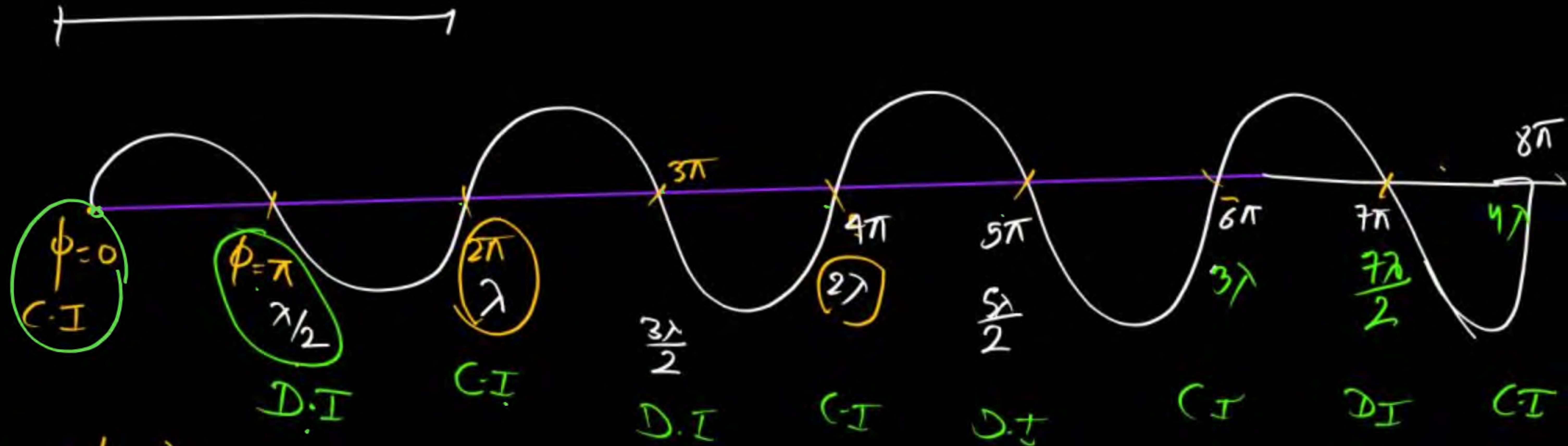
$n = 1, 2, 3, 4, 5$

$\Delta x = \frac{\lambda}{2\pi}\pi(2n-1)$

$\Delta x = (2n-1)\frac{\lambda}{2}$

$A_{min} = (A_1 - A_2)$

$I_{min} = (A_1 - A_2)^2 = (\sqrt{I_1} - \sqrt{I_2})^2$



$$\phi = n(2\pi) = 0, 2\pi, 4\pi, 6\pi, 8\pi.$$

$$\Delta x = n\lambda = 0, \lambda, 2\lambda, 3\lambda$$

{ If $I_1 = I_2 = I_0$
$A_1 = A_2 = A_0$ }

$$A_{net} = 2A_0 \cos(\phi/2)$$

square both side

$$A_{net}^2 = 4A_0^2 \cos^2(\phi/2)$$

$$I_{net} = 4 I_0 \cos^2(\phi/2)$$

$\Delta\phi = 0^\circ, 2\pi \text{ rad}, 4\pi, 6\pi, 8\pi$

$\Delta\phi = n(2\pi)$

$\Delta x = \frac{\lambda}{2\pi} \times \Delta\phi = \frac{\lambda}{2\pi} n(2\pi)$

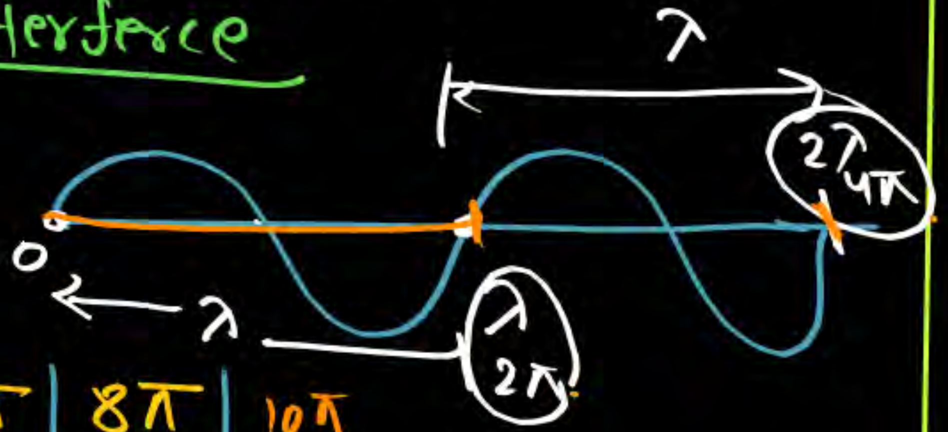
$$\boxed{\Delta x = n\lambda}$$

$\Delta\phi = n(2\pi)$

Constructive Interference

$\Delta\phi = n(2\pi)$

$\Delta x = n(\lambda)$



$\Delta\phi$ = 0°	2π	4π	6π	8π	10π
Δx = 0 m	λ	2λ	3λ	4λ	5λ

$$\boxed{A_{max} = A_1 + A_2}$$

$I_{max} = (A_1 + A_2)^2 = (\sqrt{I_1} + \sqrt{I_2})^2$

$I_1 = I_2$

$I_{max} = 4I$

$\Delta\phi = \pi, 3\pi, 5\pi, 7\pi, 9\pi, 11\pi,$

$\Delta\phi = (2n-1)\pi \quad , n = 1, 2, 3, 4$

$\Delta x = \frac{\lambda}{2\pi}(2n-1)\pi = (2n-1)\frac{\lambda}{2}$

distructin Interferce

$n = 1, 2, 3, 4, 5, 6$

$\Delta\phi = (2n-1)\pi$

$\Delta x = (2n-1)\frac{\lambda}{2}$



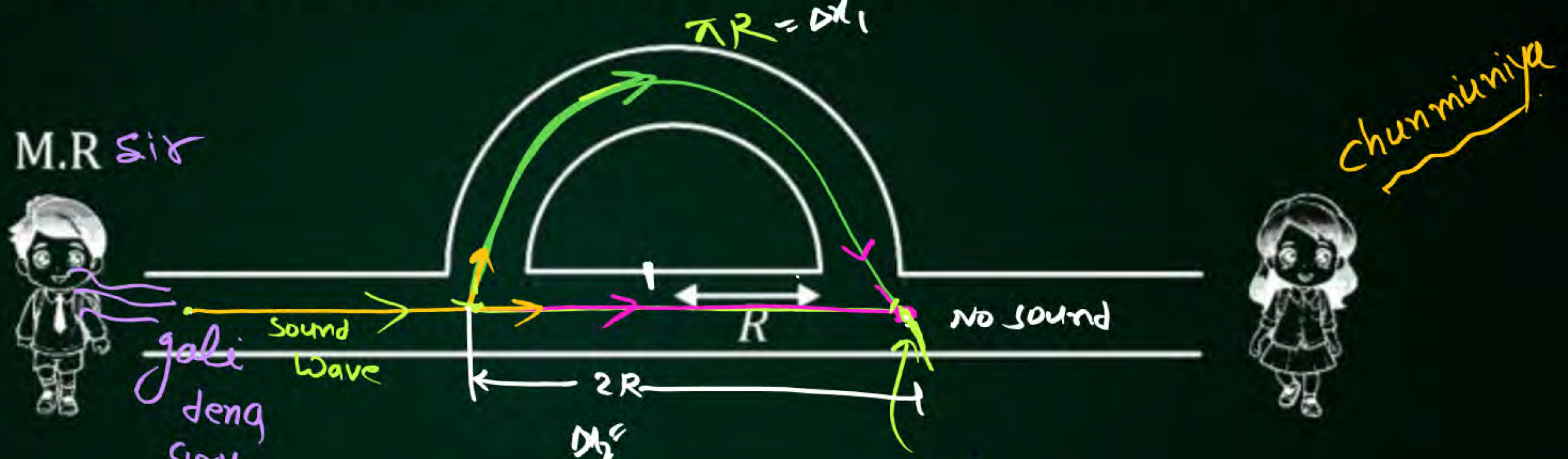
$A_{net} = A_1 - A_2$

$I_{net} = (A_1 - A_2)^2 = (\sqrt{I_1} - \sqrt{I_2})^2$

$$\boxed{I_1 = I_2 \rightarrow I_{min} = 0}$$

QUESTION

Find relation between R and wavelength of sound if pinky is unable to hear.



Cond of 1st distructive Intf

$\phi = \pi$

$\Delta x = \lambda/2, \frac{3\lambda}{2}, \frac{5\lambda}{2}$

Δx in both case $= \pi R - 2R = \lambda/2$

$R(\pi - 2) = \frac{\lambda}{2}$

$R = \frac{\lambda}{2(\pi-2)}$ Ans

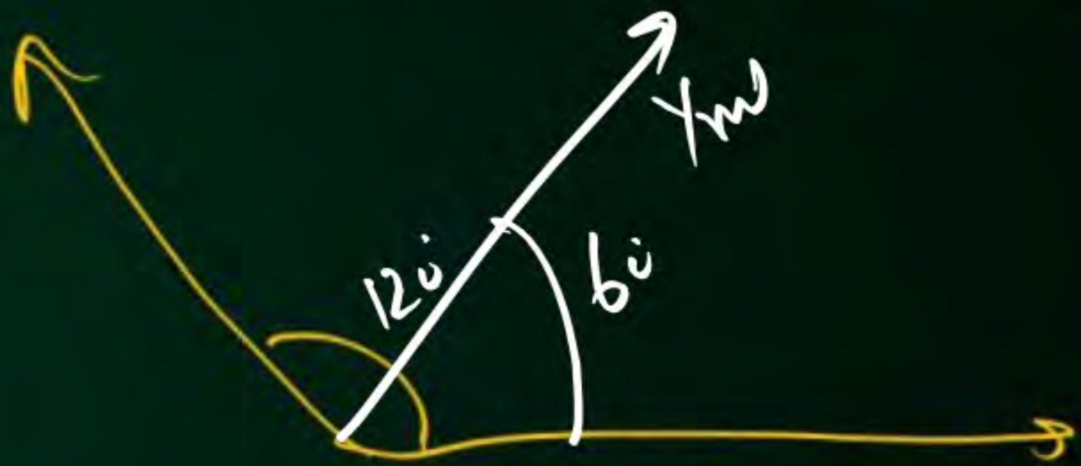
Interferce → distructive Interferce of two sound wave of same amplitues

QUESTION

Two waves represented by $y = a \sin(\omega t - kx)$ and $y = a \sin\left(\omega t - kx + \frac{2\pi}{3}\right)$ are superposed. What will be the amplitude of the resultant wave ? = a (Ans)

Soln

$\Delta\phi = \frac{2\pi}{3} = 120°$



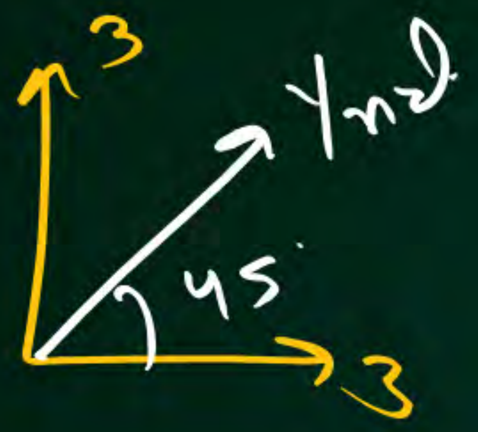
$A_{net} = a$

$y = y_1 + y_2 = a \sin(\omega t - kx + 60°)$

QUESTION

Two waves represented by $y_1 = 3 \sin (200x - 150t)$ and $y_2 = 3 \cos (200x - 150t)$ are superposed where x and y are in metre and t is in second. Calculate the amplitude of resultant wave.

$$A_{net} = 3\sqrt{2}$$



$$\phi = \pi/2$$

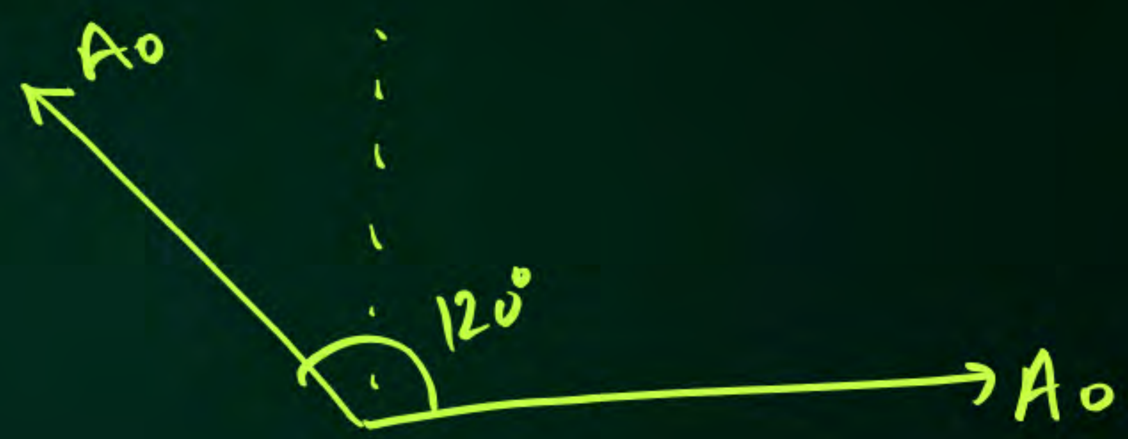
$$y = y_1 + y_2 = 3\sqrt{2} \sin\left(200x - 150t + \pi/4\right)$$

Ans

QUESTION

On the superposition of the two waves given as $y_1 = A_0 \sin(\omega t - kx)$ and $y_2 = A_0 \cos\left(\omega t + kx + \frac{\pi}{6}\right)$, the resultant amplitude of oscillations will be

$\pi/6 \rightarrow \frac{180}{6} = 30°$



1. $\sqrt{3}A_0$
2. $A_0/2$
3. A_0 ✓
4. $\frac{3}{2}A_0$

QUESTION

Two waves of amplitudes A_0 and xA_0 pass through a region. If $x > 1$, the difference in the maximum and minimum resultant amplitude possible is

C.I. D.I

1. $(x + 1) > A_0$
2. $(x - 1) A_0$
3. $2x A_0$
4. $2A_0$ ✓

Ans

$A_{max} = xA_0 + A_0$

$A_{min} = xA_0 - A_0$

$A_{max} - A_{min} = xA_0 + A_0 - xA_0 + A_0$

$= 2A_0$

QUESTION

Two periodic waves of intensities I_1 and I_2 pass through a region at the same time in the same direction. The sum of the maximum and minimum intensities is

1. $2(I_1 + I_2)$
2. $I_1 + I_2$
3. $(\sqrt{I_1} + \sqrt{I_2})^2$
4. $(\sqrt{I_1} - \sqrt{I_2})^2$

$I_{max} = (\sqrt{I_1} + \sqrt{I_2})^2$

$I_{max} = I_1 + I_2 + 2\sqrt{I_1}\sqrt{I_2}$

$I_{min} = I_1 + I_2 - 2\sqrt{I_1}\sqrt{I_2}$

QUESTION

Two waves have equations $x_1 = a \sin(\omega t + \phi_1)$ $x_2 = a \sin(\omega t + \phi_2)$. If in the resultant wave the frequency and amplitude remain equal to amplitude of superimposing waves, the phase difference between them is [2001]

1. $\pi/6$
2. $2\pi/3$
3. $\pi/4$
4. $\pi/3$

QUESTION

Two sound waves, each of amplitude A and frequency ω superpose at a point with phase difference of $\pi/2$. The amplitude and frequency of the resultant wave are respectively

(1) $\frac{A}{\sqrt{2}}, \frac{\omega}{2}$

(2) $\frac{A}{\sqrt{2}}, \omega$

(3) $\sqrt{2}A, \frac{\omega}{2}$

(4) $\sqrt{2}A, \omega$

$\sqrt{2}A, \omega$



QUESTION

The ratio of intensities between two coherent sound source is 4 : 1. The difference of loudness in decibels (dB) between maximum and minimum intensities, when they interfere in space is -

(a) 10 log 2

(b) 20 log 3

(c) 10 log 3

(d) 20 log 2

$L_1 - L_2 =$

Interference

The ratio of intensities between two coherent sound source is 4 : 1. The difference of loudness in decibels (dB) between maximum and minimum intensities, when they interfere in space is -

(a) 10 log 2

(b) 20 log 3 ✓

(c) 10 *log* 3

(d) 20 log 2

$I_{max} = (\sqrt{I_1} + \sqrt{I_2})^2 = (\sqrt{4} + \sqrt{1})^2 = (2+1)^2 = 9$

$I_{min} = (\sqrt{4} - \sqrt{1})^2 = 1$

$\left[\frac{I_1}{I_2} = \frac{4}{1}\right]$

$L_{max} = 10 \log_{10}\left(\frac{I_{max}}{I_0}\right)$ dB

$L_{min} = 10 \log_{10}\left(\frac{I_{min}}{I_0}\right)$ dB

$L_{max} - L_{min} = 10\left[\log_{10}\frac{9}{I_0} - \log_{10}\frac{1}{I_0}\right] = 10\left[\log_{10}\left(\frac{9}{I_0} \times \frac{I_0}{1}\right)\right] = 10 \log_{10} 9 = 10 \times 2 \log_{10} 3 = 20 \log 3$

QUESTION

NEET-16
JEE, 22, 23, 24

The interference pattern is obtained with two coherent light sources of intensity ratio n. In the interference pattern, the ratio $\frac{I_{max}-I_{min}}{I_{max}+I_{min}}$ will be

1. $\frac{\sqrt{n}}{n+1}$ $= \frac{1}{2}$ ✗
2. $\frac{2\sqrt{n}}{n+1}$ ✓
3. $\frac{\sqrt{n}}{(n+1)^2}$ $= \frac{1}{4}$ ✗
4. $\frac{2\sqrt{n}}{(n+1)^2}$ ✗

$\frac{I_1}{I_2} = n$

If $n = 1$

$\frac{I_1}{I_2} = 1$

$I_{min} = 0$

$\frac{I_{max} - I_{min}}{I_{max} + I_{min}} = ?$ (1) Ans

$\left\{\frac{I_{max} - I_{min}}{I_{max} + I_{min}}\right\} < 1$

n = Kuch bhi hai to bhi < 1

QUESTION

NEET-16
JEE, 22, 23, 24

The interference pattern is obtained with two coherent light sources of intensity ratio n. In the interference pattern, the ratio $\frac{I_{max}-I_{min}}{I_{max}+I_{min}}$ will be

1. $\frac{\sqrt{n}}{n+1} = \frac{1}{2}$ ✗
2. $\frac{2\sqrt{n}}{n+1}$ ✓
3. $\frac{\sqrt{n}}{(n+1)^2} = \frac{1}{4}$ ✗
4. $\frac{2\sqrt{n}}{(n+1)^2}$ ✗

$\frac{I_1}{I_2} = n$

$I_1 = n I_2$ — (1)

$\Rightarrow \frac{(\sqrt{I_1}+\sqrt{I_2})^2 - (\sqrt{I_1}-\sqrt{I_2})^2}{(\sqrt{I_1}+\sqrt{I_2})^2 + (\sqrt{I_1}-\sqrt{I_2})^2}$

QUESTION

If $\frac{I_1}{I_2} = \frac{9}{4}$ then find $\frac{I_{max}}{I_{min}} = ?$

$$\frac{I_1}{I_2} = \frac{9}{4}$$

$$\frac{(\sqrt{I_1}+\sqrt{I_2})^2}{(\sqrt{I_1}-\sqrt{I_2})^2} = \left(\frac{\sqrt{9}+\sqrt{4}}{\sqrt{9}-\sqrt{4}}\right)^2 = \left(\frac{3+2}{3-2}\right)^2 = \frac{25}{1} \text{ Ans.}$$

QUESTION

$\frac{I_{max}}{I_{min}} = \frac{25}{16}$ then find $\frac{I_1}{I_2} = ?$

$$\frac{I_{max}}{I_{min}} = \frac{\sqrt{I_1}+\sqrt{I_2}}{\sqrt{I_1}-\sqrt{I_2}}$$

$$\frac{I_{max}}{I_{min}} = \frac{25}{16} = \left(\frac{\sqrt{I_1}+\sqrt{I_2}}{\sqrt{I_1}-\sqrt{I_2}}\right)^2$$

Sol^n

$$\frac{5}{4} = \frac{\sqrt{I_1}+\sqrt{I_2}}{\sqrt{I_1}-\sqrt{I_2}}$$

$$5\sqrt{I_1} - 5\sqrt{I_2} = 4\sqrt{I_1} + 4\sqrt{I_2}$$

$$5\sqrt{I_1} - 4\sqrt{I_1} = 5\sqrt{I_2} + 4\sqrt{I_2}$$

$$\sqrt{I_1} = 9\sqrt{I_2}$$

$$\frac{\sqrt{I_1}}{\sqrt{I_2}} = \frac{9}{1}$$

$$\frac{I_1}{I_2} = 81/1$$

QUESTION

In the figure the intensity of waves arriving at D from two coherent sources S_1 and S_2 is I_0. The wavelength of the wave is $\lambda = 4m$. Resultant intensity at D will be:

1. $4I_0$
2. I_0
3. $2I_0$ (62%)
4. zero



$\Delta x = 5m - 4m$

$\Delta x = 1m = \frac{\lambda}{4}$

$\Delta\phi = \frac{2\pi}{\lambda}\Delta x$

$= \frac{2\pi}{\lambda}\frac{\lambda}{4}$

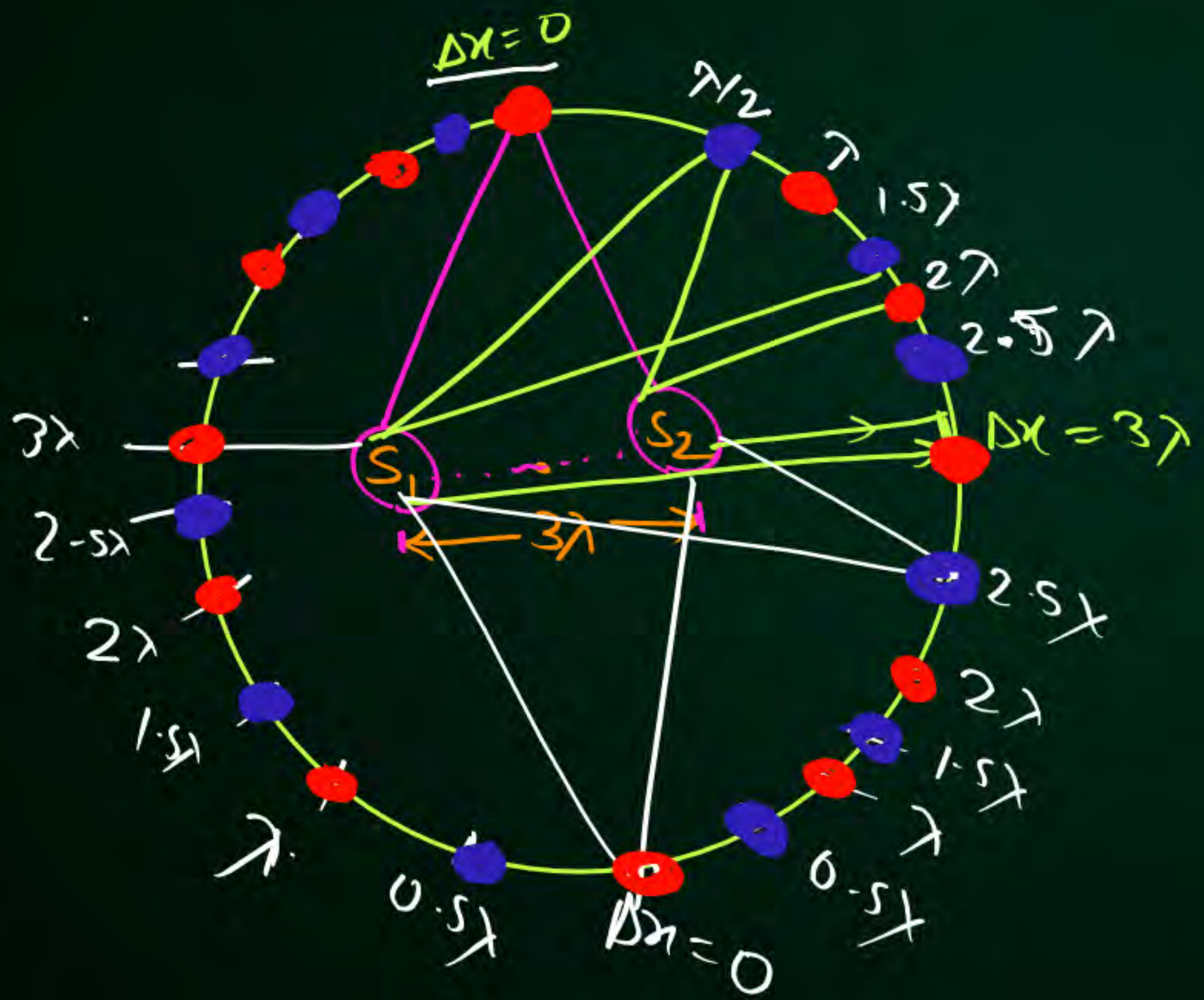
$\Delta\phi = \pi/2$

$I_{net} = I_1 + I_2 + 2\sqrt{I_1}\sqrt{I_2}\cos 90^\circ$ (→ 0)

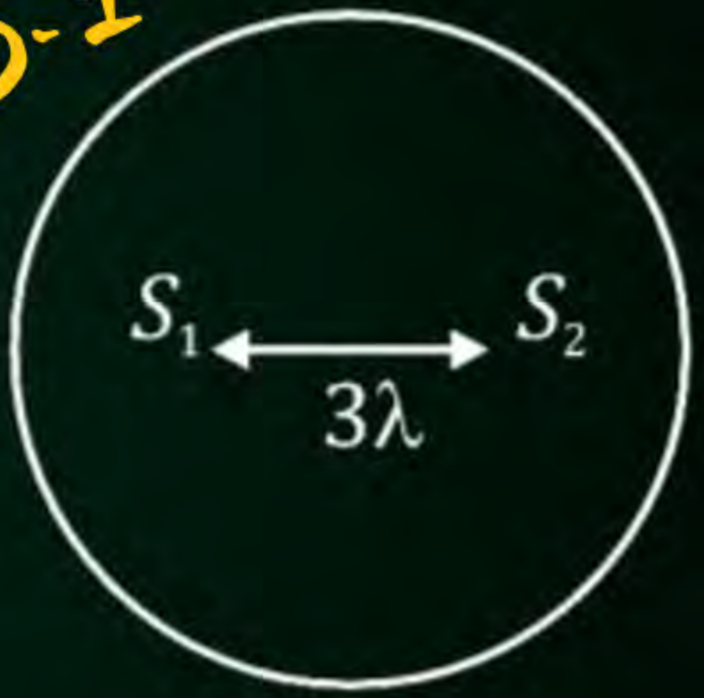
QUESTION

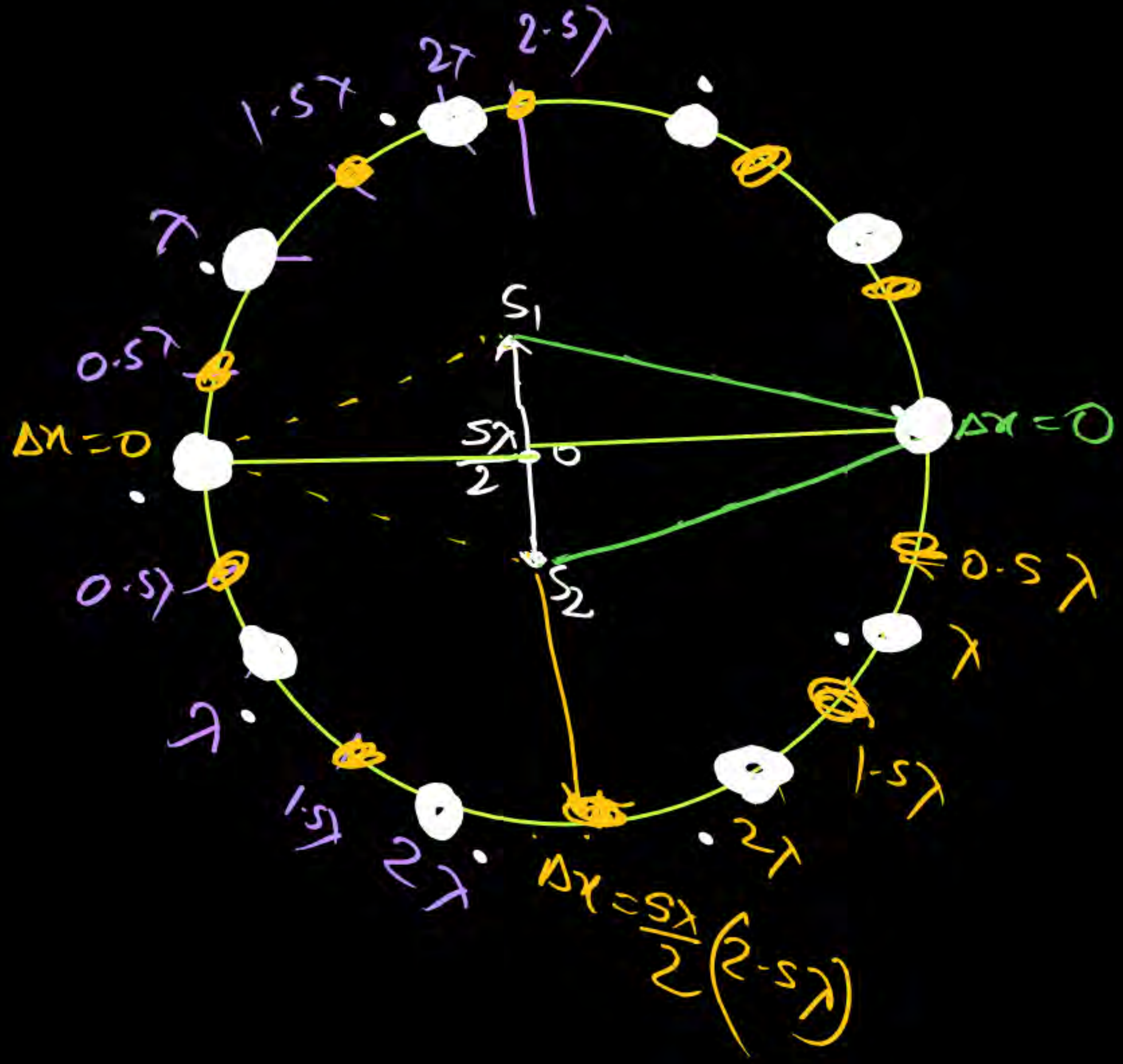
$\Delta\phi = 0, 2\pi, 4\pi, 6\pi, 8\pi \rightarrow$ C-I
$= 0, \lambda, 2\lambda, 3\lambda, 4\lambda \rightarrow$

Two source of same frequency wavelength and amplitude then find total no of maximum and minimum on circular ring.



12 → C-I
12 → D-I





C.I = 10

D.I = 10

QUESTION

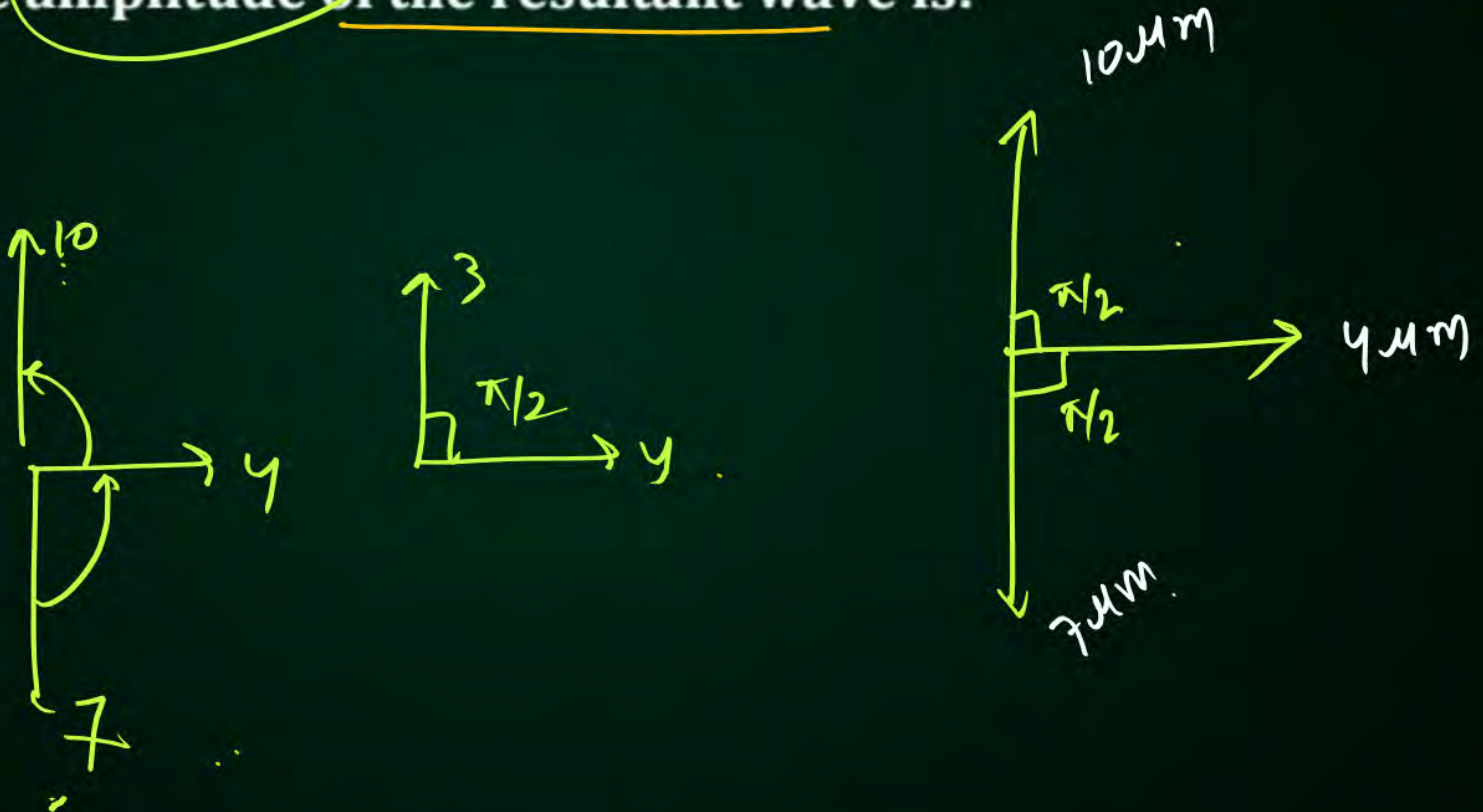
Two coherent sources of different intensities send waves which interfere. The ratio of the maximum intensity to the minimum intensity is 25. The intensities are in the ratio:

1. 25 : 1
2. 5 : 1
3. 9 : 4
4. 625 : 1

QUESTION

Three waves producing displacement in the same direction of same frequency and of amplitudes 10 μm, 4 μm and 7 μm arrive at a point with successive phase difference of $\pi/2$. The amplitude of the resultant wave is:

1. 2 μm
2. 7 μm
3. 5 μm
4. 1



Reflection & refraction of string wave / sound wave

frequency → always same in reflection/refraction.

speed of wave string wave → $v\downarrow \propto \frac{1}{(\text{density})\uparrow}$

$V_{str} = \sqrt{\frac{T}{\mu}}$

Wavelength $V = \lambda f$ → same

$\lambda \propto v \propto \frac{1}{\text{density}}$

phase change → ($\phi = 0$ in refraction)

$\phi = 0$ in reflector from rarary medium or Non-rigid boundry

$\phi = \pi$ → only when wave is reflectin from denser mediu or rigid boundary

wave is moving from denser medium to rarer



Properties	Reflected wave	Refracted Transmitted wave
~~Velocity~~ speed	same	↑
Frequency	same	Same
Wavelength	same	$\lambda \uparrow$
Phase difference	No phase change	No phase change

Properties	Reflected wave	Refracted Transmitted wave
Velocity		
Frequency		
Wavelength		
Phase difference		

Stationary Wave

- Superposition of two wave having same velocity. Amplitude, frequency, wavelength but moving in same direction.

Important point for stationary wave:

- Formed by identical wave moving in opposite direction.
- All the particles are in same phase between two node. But π is a phase different between particle which is in adjacent node
- All the particle is oscillating with same frequency.
- All the particle have different amplitude
- Particle which have zero amplitude is called node.

- **Particle which have maximum amplitude is called anti-node.**
- **Distance between node and antinode is $\lambda/4$.**
- **Distance between two node is $\lambda/2$.**
- **All particle will cross the mean position at same time but different speed.**

MOVING WAVE / STATIONARY WAVE

Moving wave	Stationary wave
1. Wave equation $Y = A \sin(kx - \omega t)$	1. $Y = 2A \sin(kx) \cdot \cos(\omega t)$
2. Energy transmitted in medium	2. There is no transmission of energy
3. No particles permanently at rest	3. Particle at node always at rest
4. all are in different phase at a time	4. All are in same phase between two node
5. Amplitude same for all	5. Amplitude different for all.

QUESTION

A stationary wave is represented by $y = A\sin(100t)\cos(0.01x)$, where y and A are in millimetres, t is in second and x is in metre. The velocity of the constant wave is

1. 10^4 m/s
2. Not derivable
3. 1 m/s
4. 10^2 m/s

QUESTION

The equation given below represents a stationary wave set-up in a medium $y = 12 \sin(4\pi X) \sin(40\pi t)$, where y and x are in cm and t is in second. Calculate the amplitude, wavelength and velocity of the component waves.

QUESTION

MR* sawal
H/w

Two particles of medium disturbed by the wave propagation are at $x_1 = 0$ and $x_2 = 1$ cm. The respective displacements (in cm) of the particles can be given by the equations:

$y_1 = 2 \sin 3\pi t$ $y_2 = 2 \sin (3\pi t - \pi/8)$

The wave velocity is:

1. 16 cm/sec
2. 24 cm/sec
3. 12 cm/sec
4. 8 cm/sec


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 05 | **Physics**

Wave Motion

By- Dr. Manish Raj (MR SIR)



Topics to be covered

1. # Reflection & transmission of wave
2. # stationary wave
3. #



Reflection of wave & refraction

frequency → Never change in reflection / refn.

speed → $v \propto \frac{1}{\text{density}}$

wavelength $v = \lambda f \propto \frac{1}{\text{density}}$ (f — same)

✗ phase only change in reflection from denser or rigid / fixed boundary.

QUESTION

Two particles of medium disturbed by the wave propagation are at $x_1 = 0$ and $x_2 = 1$ cm. The respective displacements (in cm) of the particles can be given by the equations:

$y_1 = 2 \sin 3\pi t$ ← $x = 0$

$y_2 = 2 \sin (3\pi t - \pi/8)$ ← $x = 1$

The wave velocity is:

1. 16 cm/sec
2. 24 cm/sec ✓
3. 12 cm/sec
4. 8 cm/sec

$y = 2 \sin(3\pi t - kx)$

$k = \pi/8$

$\omega = 3\pi$

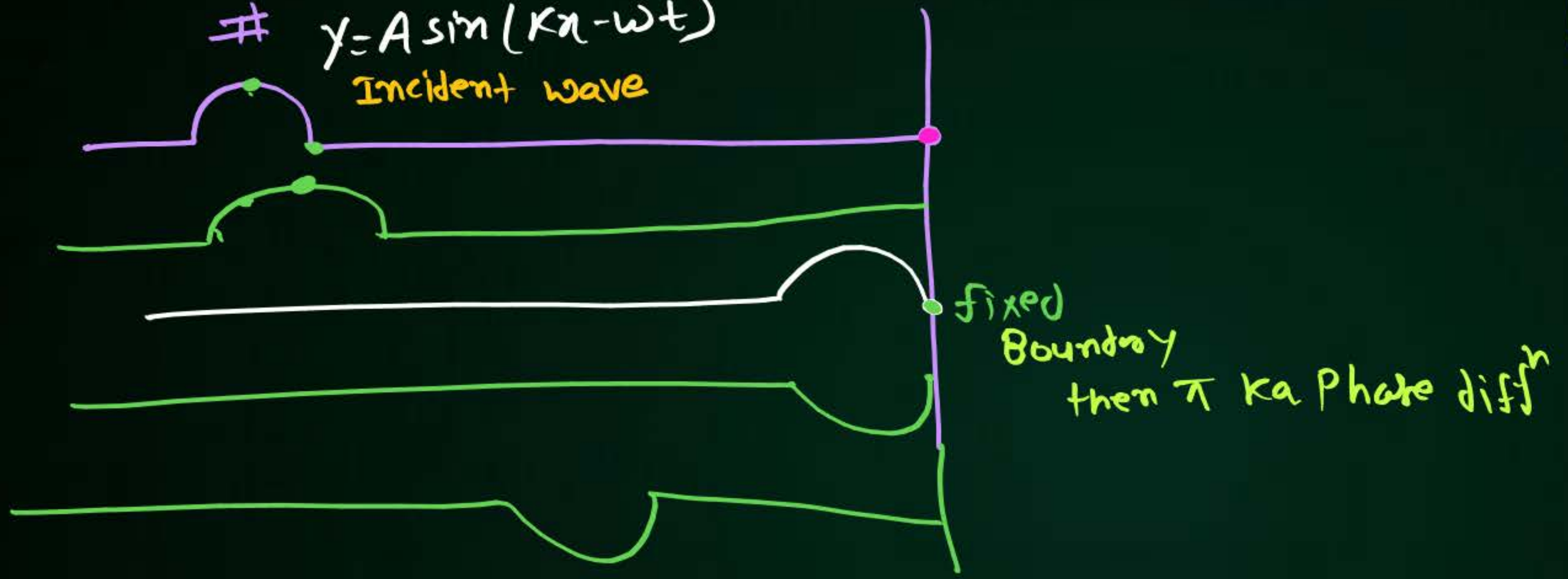
$v = \frac{\omega}{k} = \frac{3\pi}{\pi/8}$

$= 24$ m/s

⇒ Reflection of Transverse wave in a String from rigid boundary

$\sin(\theta + \pi) = -\sin\theta$ *

$y = A\sin(kx - \omega t)$



Equation of reflected wave

$$y_{reflected} = A\sin(kx + \omega t + \pi)$$
$$= -A\sin(kx + \omega t)$$

⇒ Reflection of Transverse wave in a String from free boundary

$$y_{in} = A\sin(kx - \omega t)$$

$$y_{reflect} = A\sin(kx + \omega t)$$

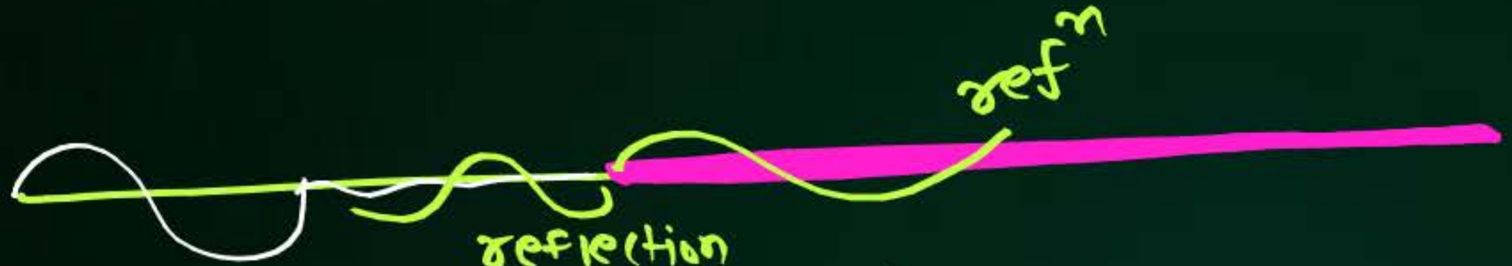
only dirⁿ of motion change

Transmission of Wave

Refraction

$\uparrow k = \frac{2\pi}{\lambda \downarrow}$

$\downarrow \lambda \propto \frac{1}{\text{density} \uparrow}$



$y = A\sin(kx - \omega t)$

$y_{reflection} = A_{refl} \sin(kx + \omega t + \pi)$ opposite dir me reflection in same medium. reflection from denser

$y_{refraction} = A_{refracti.} \sin(k'x - \omega t)$ sam dirn (frequecy - same, wavelength → change)

reflection | refraction

1 leg stand



$y = A \sin(kx - \omega t)$

Incident

$y_{reflection} = A_{reflect} \sin(kx + \omega t)$

$y_{refracti} = A_{refrac} \sin(k'x - \omega t)$

Stationary Wave

$\cos(-\theta) = \cos\theta$

$\sin C + \sin D = 2\sin\left(\frac{C+D}{2}\right)\cdot\cos\left(\frac{C-D}{2}\right)$

Superposition of two wave having same Amplitude, same frequency same wave no, in same phase, dirn of motion is opposite.

$Y_1 = A\sin(kx - \omega t)$

$Y_2 = A\sin(kx + \omega t)$

$$Y = Y_1 + Y_2 = A\left[\sin(\underbrace{kx-\omega t}_{C}) + \sin(\underbrace{kx+\omega t}_{D})\right]$$

$$Y = A\,2\sin\left(\frac{2kx}{2}\right)\cdot\cos\left(\frac{-2\omega t}{2}\right)$$

$$Y = 2A\sin(kx)\cdot\cos(\omega t)$$

eqn of stationary wave

$$Y = 2A\cos(kx)\cdot\sin(\omega t)$$

$$Y = 2A\cos(kx)\cos(\omega t)$$

$$Y = 2A\sin(kx)\sin(\omega t)$$

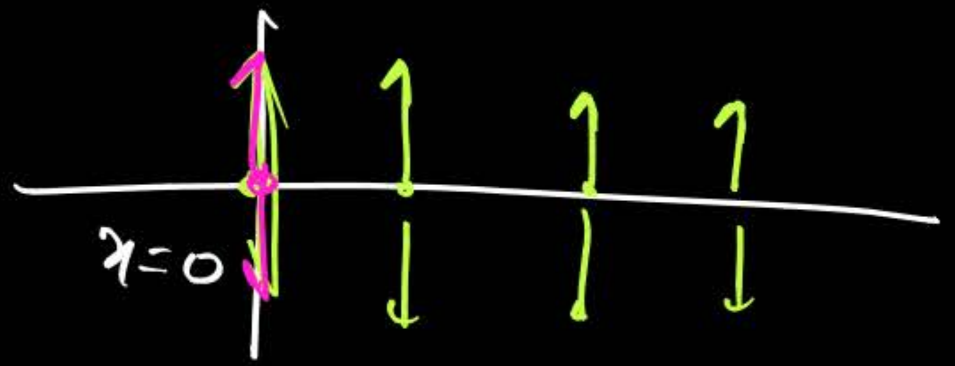
Travelling wave

$$y = A\sin(kx - \omega t)$$

Let we consider an medium particle at $[x = 0]$

$\Longrightarrow$ $y = A\sin(-\omega t) = -A\sin(\omega t)$

Position depends on time



Stationary wave

$$y = 2A\,\sin(kx)\cdot\cos(\omega t)$$

If we consider an medium particle at $x=0$

$y = 2A\sin(0)\cdot\cos(\omega t)$

$y = 0$

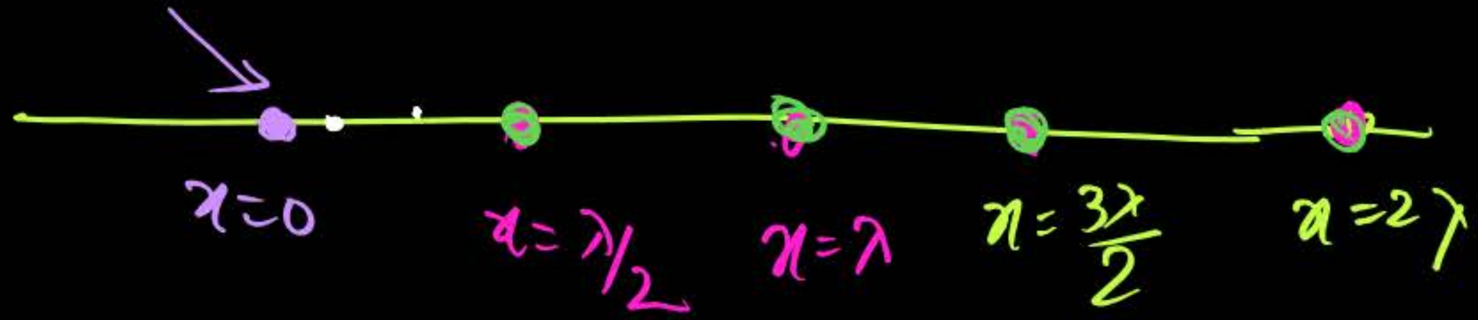
→ Position of that particle does not depends on time.

at $x = \lambda/2$

$y = 2A\sin\left(\frac{2\pi}{\lambda}\times\frac{\lambda}{2}\right)\cdot\cos(\omega t)$

$y = 2A\sin(\pi)\cdot\cos(\omega t)$

$y = 0$

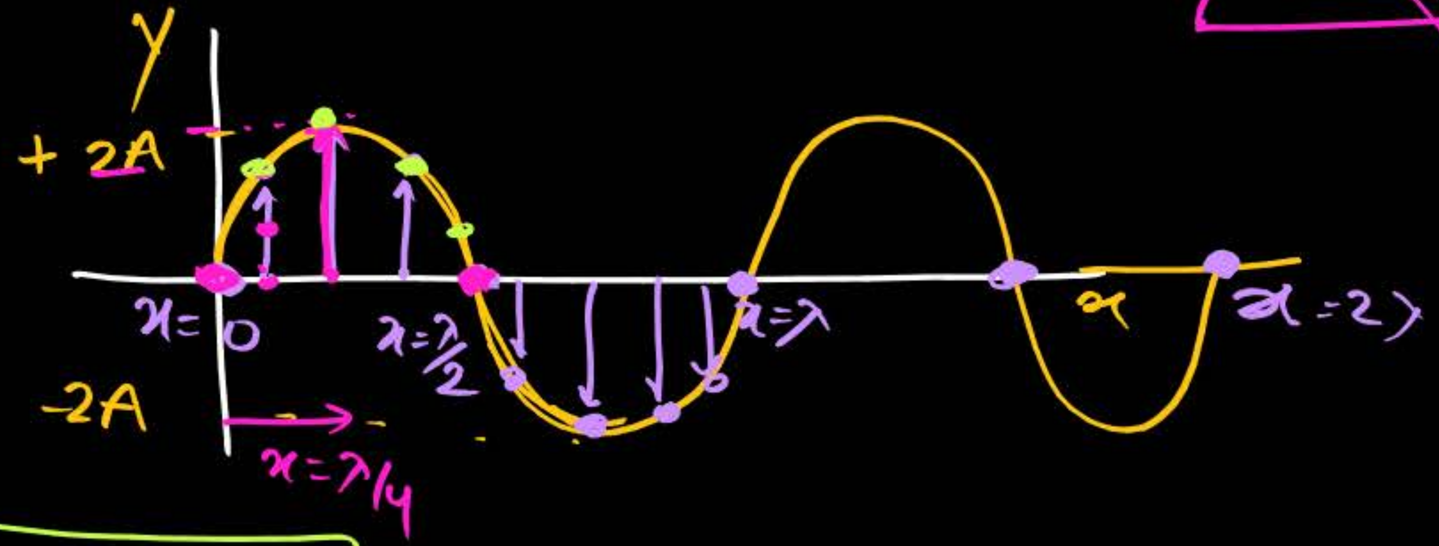


(Corresponding Node)

$$y = 2A\sin(kx)\cdot\cos(\omega t)$$

If $t = 0$

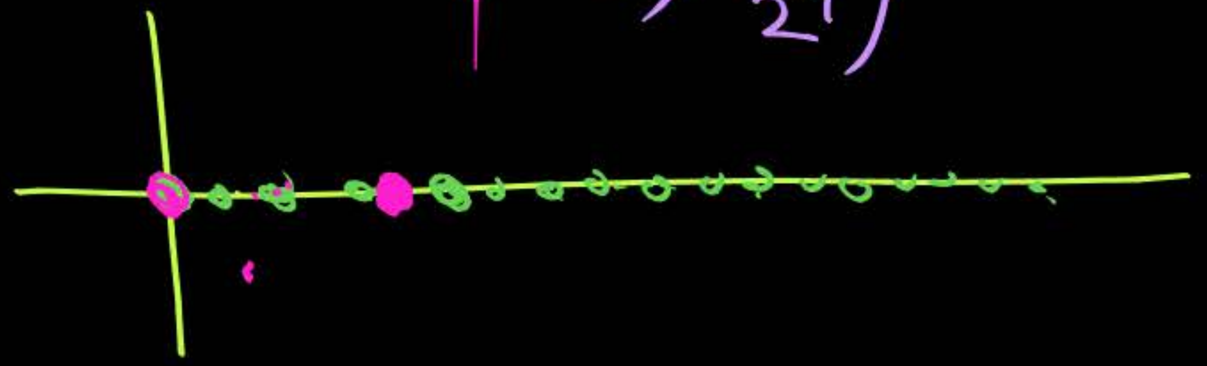
$$y = 2A\sin(kx) \times 1$$





If $t = T/4$

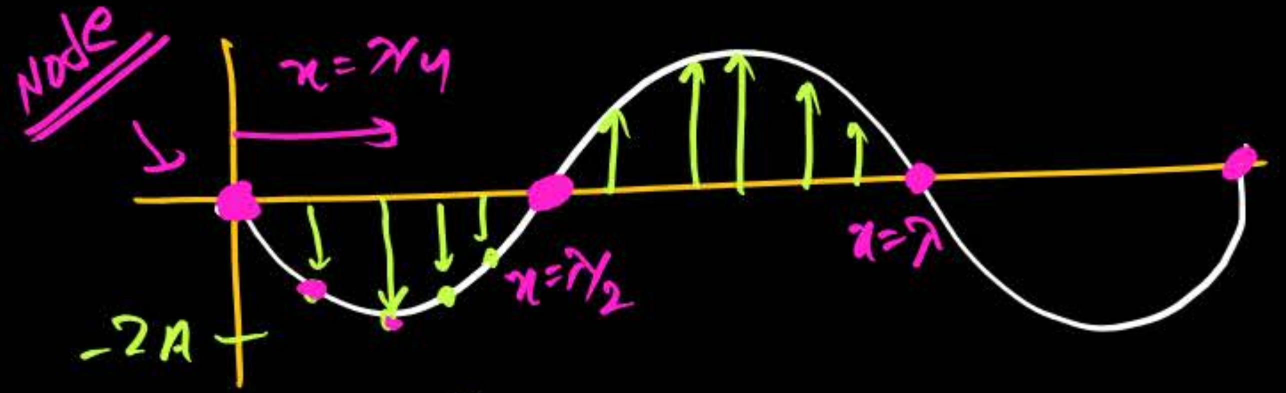
$$y = 2A\sin(kx)\cos\left(\frac{2\pi}{T}\times\frac{T}{4}\right) = 2A\sin(kx)\cos(\pi/2) = 0$$



If $t = T/2$

$$y = 2A\sin(kx)\cos\left(\frac{2\pi}{T}\times\frac{T}{2}\right)$$

$$y = -2A\sin(kx)$$



at $t = 3T/4$

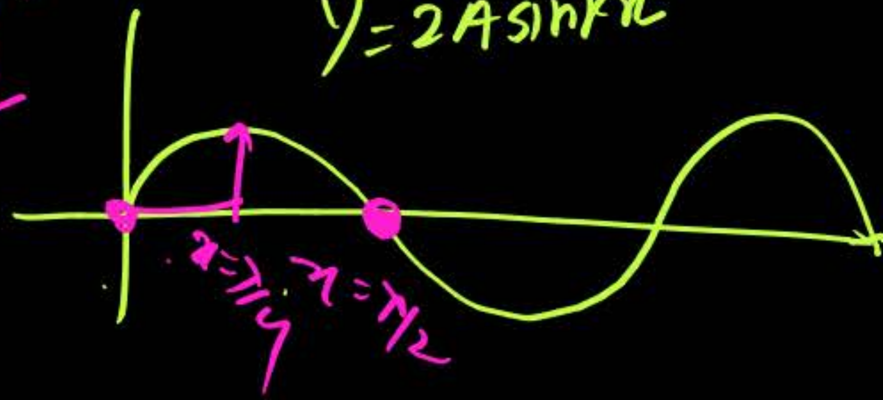
$$y = 2A\sin(kx)\cos\left(\frac{3\pi}{2}\right)$$

$$y = 0$$



at $t = T$

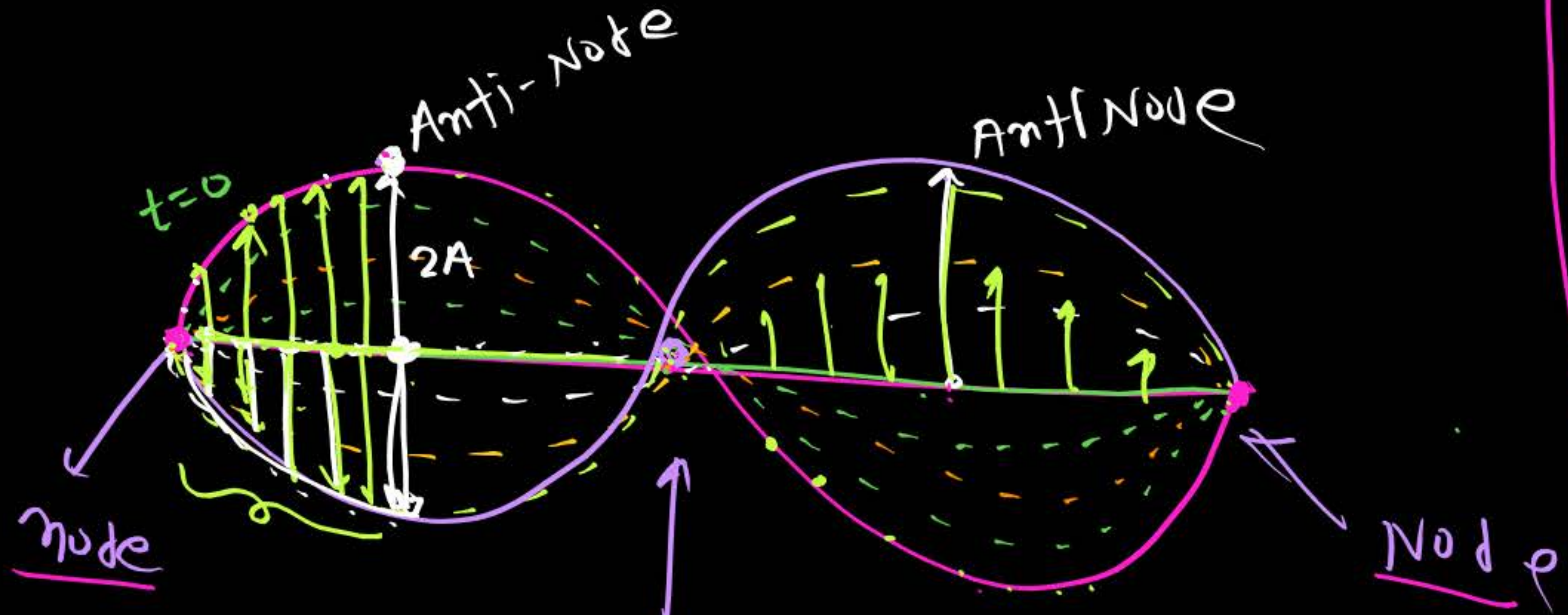
$$y = 2A\sin kx$$



$y = 2A\sin(kx) \cdot \cos(\omega t)$

$2A\sin(kx)$ → Amplitude; $\cos(\omega t)$ → S.H.M

$y = A' \cos(\omega t)$



$x = 0, \frac{\lambda}{2}, \lambda, \frac{3\lambda}{2}, 2\lambda, \frac{5\lambda}{2}$ → Position of Node

$x = \frac{\lambda}{4}, \frac{3\lambda}{4}, \frac{5\lambda}{4}$ → Anti-node

Amplitude of oscillation of Node is = zero

Amplitude of oscillation of Anti-Node is = 2A

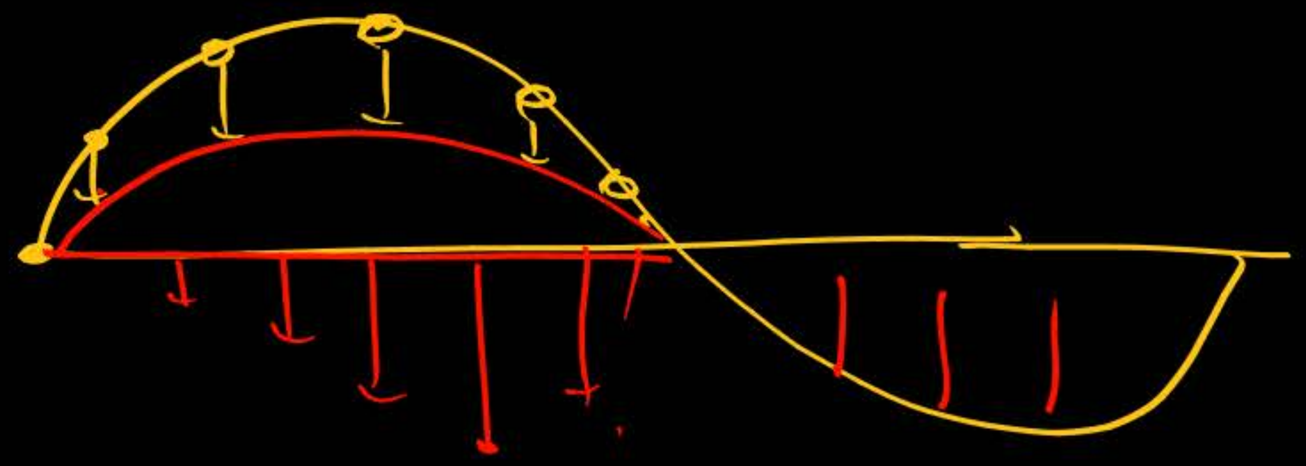
All the Particle oscillate in diffⁿ Amplitude

All crosses mean position at same time but diffⁿ speed $V_{max} = \omega A_{diff^n}$

all the Particle b/w two node are in same phase.
Two Particle b/w two adjacent node have phase diffⁿ of π.

No energy Transfer in a stationary wave

speed of stationary wave $V = \omega / K$ ✓



Stationary Wave

- Superposition of two wave having same velocity. Amplitude, frequency, wavelength but moving in same direction.

Important point for stationary wave:

1. ➢ Formed by identical wave moving in opposite direction.

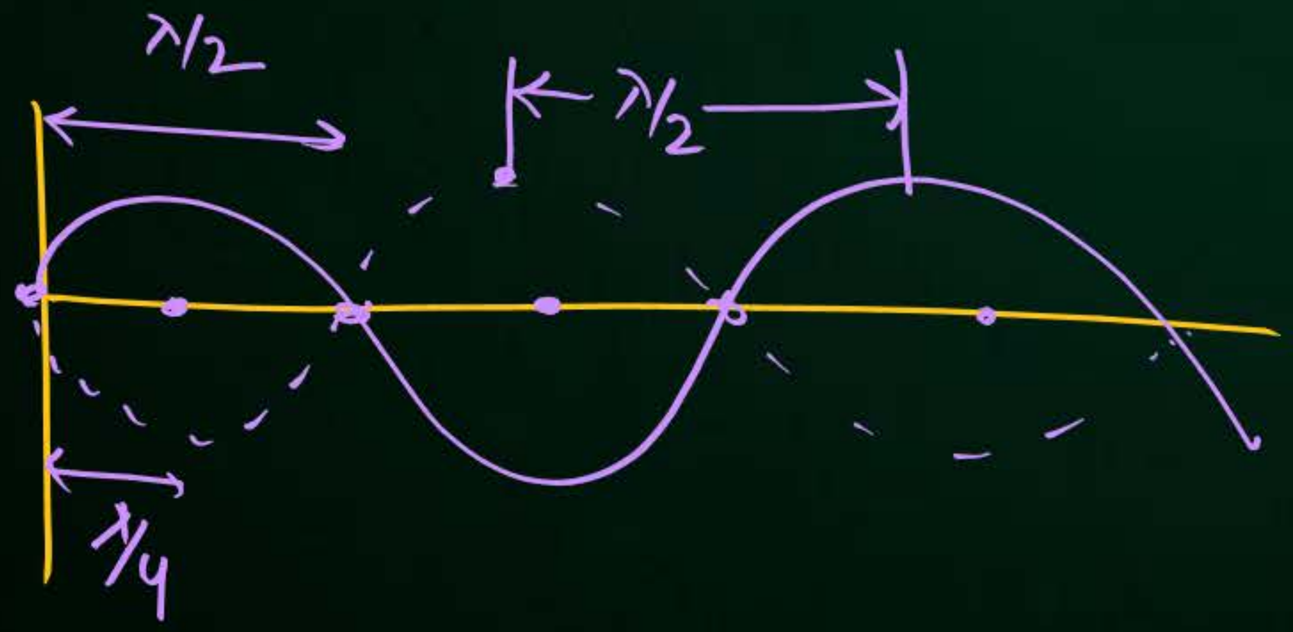
2. ➢ All the particles are in same phase between two node. But π is a phase different between particle which is in adjacent node

3. ➢ All the particle is oscillating with same frequency.

4. ➢ All the particle have different amplitude

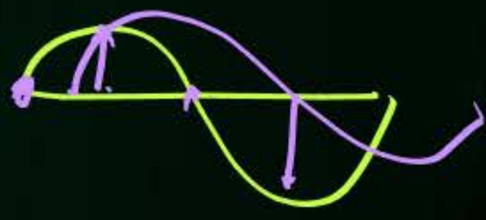
5. ➢ Particle which have zero amplitude is called node.

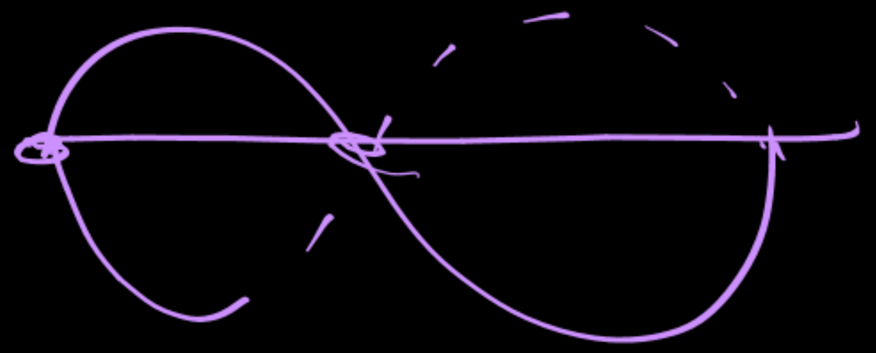
- Particle which have maximum amplitude is called anti-node.
- Distance between node and antinode is $\lambda/4$.
- Distance between two node is $\lambda/2$.
- All particle will cross the mean position at same time but different speed.



MOVING WAVE / STATIONARY WAVE

Moving wave	Stationary wave
1. Wave equation $Y = A \sin(kx - \omega t)$	1. $Y = 2A \sin(kx) \cdot \cos(\omega t)$
2. Energy transmitted in medium	2. There is no transmission of energy
3. No particles permanently at rest	3. Particle at node always at rest
4. all are in different phase at a time	4. All are in same phase between two node
5. Amplitude same for all	5. Amplitude different for all.





QUESTION

A stationary wave is represented by $y = A\sin(100t)\cos(0.01x)$, where y and A are in millimetres, t is in second and x is in metre. The velocity of the constant wave is

1. 10^4 m/s
2. Not derivable
3. 1 m/s
4. 10^2 m/s

QUESTION

The equation given below represents a stationary wave set-up in a medium $y = 12 \sin(4\pi X) \sin(40\pi t)$, where y and x are in cm and t is in second. Calculate the amplitude, wavelength and velocity of the component waves.

$$y = 12 \sin(4\pi x) \cdot \sin(40\pi t)$$

$$y = 2A \sin(Kx) \sin(\omega t)$$

$$A = 6$$

$$K = 4\pi$$

$$\omega = 40\pi$$

QUESTION

The constituent waves of a stationary wave have amplitude, frequency and velocity as 8 cm, 25 Hz and 150 cm s^{-1} respectively. What is the amplitude of the stationary wave at $x = 2$ cm

$\sin(120^\circ) = \frac{\sqrt{3}}{2}$

$A = 8\,cm$

$f = 25\,Hz$

$v = 150\,cm/s$

$v = \lambda f$

$150 = \lambda \times 25$

$\lambda = 6\,cm$

$y = 2A\sin(kx)\cos(\omega t)$, where $A' = 2A\sin(kx)$

$A' = 2A\sin(kx)$

$= 2 \times 8 \sin\left(\frac{2\pi}{6} \times 2\right)$

$= 16 \sin\left(\frac{2\pi}{3}\right)$

$= 16 \times \frac{\sqrt{3}}{2} = 8\sqrt{3}$

if equation of stationary wave is $y = 2A\sin(kx)\cos(\omega t)$ find Amplitude of Particle which is at $x = \lambda/8$.

$$y = \underline{2A\sin(kx)}\cos(\omega t)$$

$$A' = 2A\sin\left(\frac{2\pi}{\lambda} \times \frac{\lambda}{8}\right)$$

$$A' = 2A\sin\left(\frac{\pi}{4}\right)$$

$$= 2A \times \frac{1}{\sqrt{2}} = \sqrt{2}A$$

Ans

QUESTION

In stationary wave find amplitude of oscillation of a particle which is between node and anti-node, frequency of oscillation of that particle?

FORMATION OF STATIONARY WAVE IN STRING

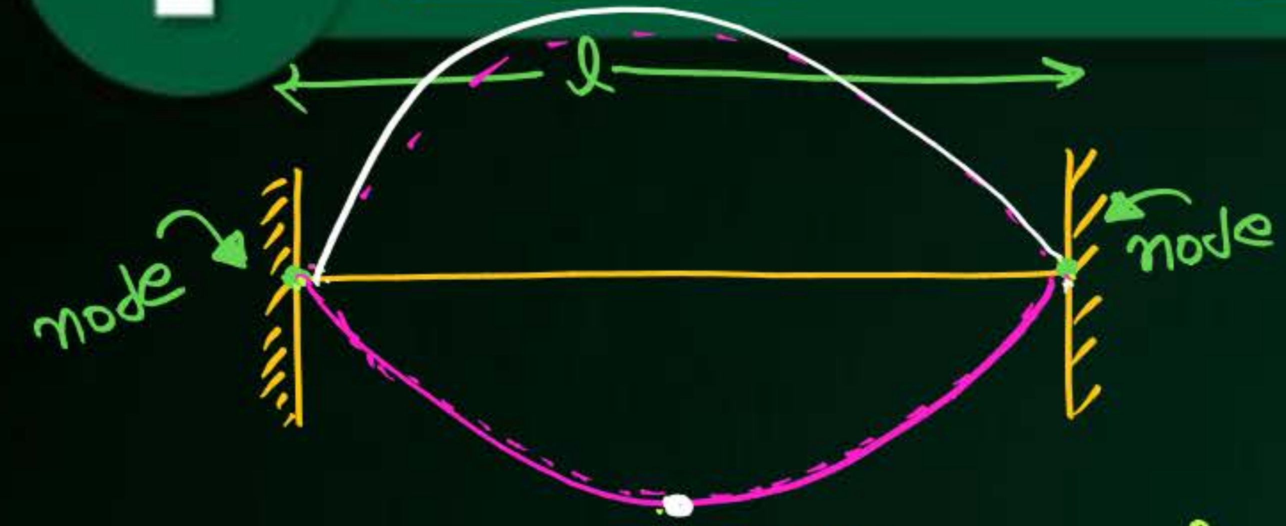
QUESTION

A wave $y = a \sin(\omega t - kx)$ on a string meets with another wave producing a node at $x = 0$. Then the equation of the unknown wave is

1. $y = a \sin(\omega t - kx)$
2. $y = -a \sin(\omega t - kx)$
3. $y = a \cos(\omega t - kx)$
4. $y = -a \cos(\omega t - kx)$

Formation of Stationary Wave String

→ Transverse wave in a string



$l = \lambda/2$

$\boxed{\lambda = 2l}$ — (1)

⊕ fundamental frequency (minimum wave form)

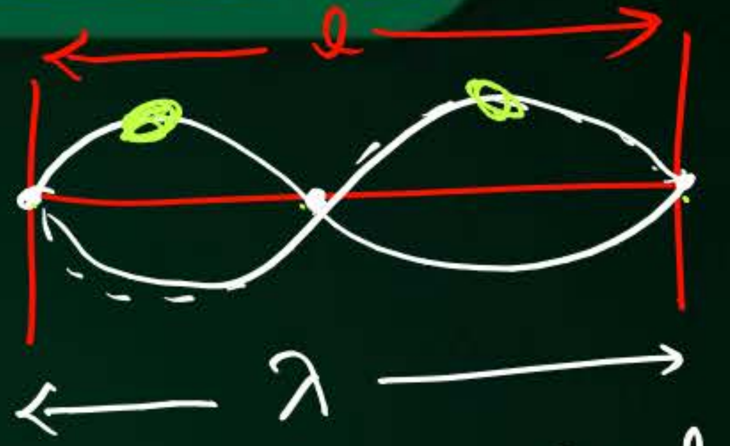
$v = \lambda f$

$f = \frac{v}{\lambda}$

$f = \frac{v}{2l}$ — (1)

$$\boxed{f = \frac{1}{2l}\sqrt{\frac{T}{\mu}}}$$

⊕ 1st harmonic



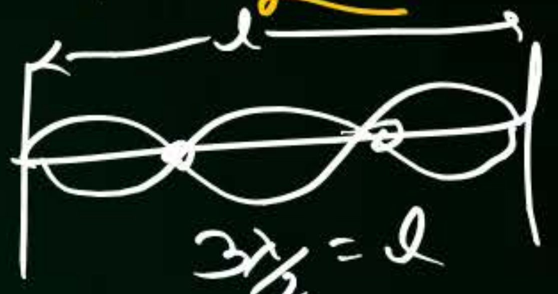
$\lambda = l$

$f = \frac{v}{\lambda} = \frac{v}{l}$

$f = 2\left(\frac{v}{2l}\right)$

2nd harmonic

[1st overtone]



$\frac{3\lambda}{2} = l$

3rd harmonic

$f = \frac{v}{\lambda} = \frac{3v}{2l}$

$f = 3\left(\frac{v}{2l}\right)$

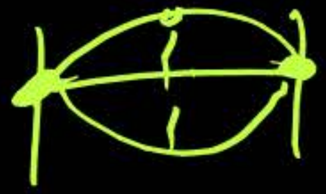
2nd overtone

3rd harmonic

* $(n-1)^{th}$ overtone

n^{th} harmonics

$$\boxed{f = \frac{nv}{2l}}$$



1st harmonic
fundamental freqn.

$f = \frac{V}{2l}$

2 node
1 Anti-node



2nd harmon.
1st overtone

$f = 2\left[\frac{V}{2l}\right]$

3 node
2 Anti

3rd harmonic
2nd overto.

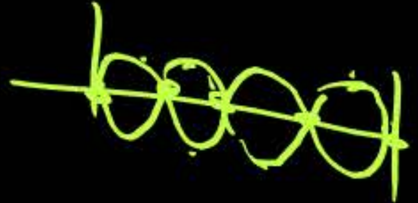
$f = 3\left[\frac{V}{2l}\right]$

4 node
3 Antin.



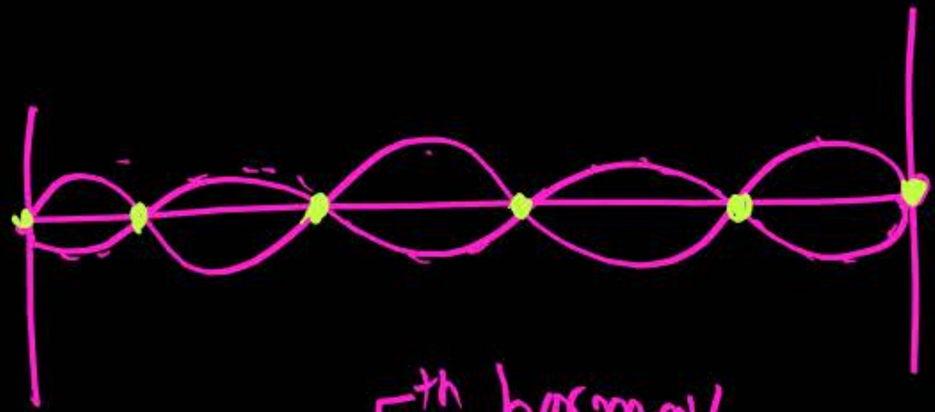
4th harmon.
3rd overto

$f = 4\left[\frac{V}{2l}\right]$



n^{th} harmonic
$(n-1)^{th}$ overtone $= \frac{nV}{2l}$ [n-Antin (n+1) node]

$f_{fundamental\ freq} = f_{n^{th}} - f_{(n-1)^{th}} = \frac{V}{2l}$

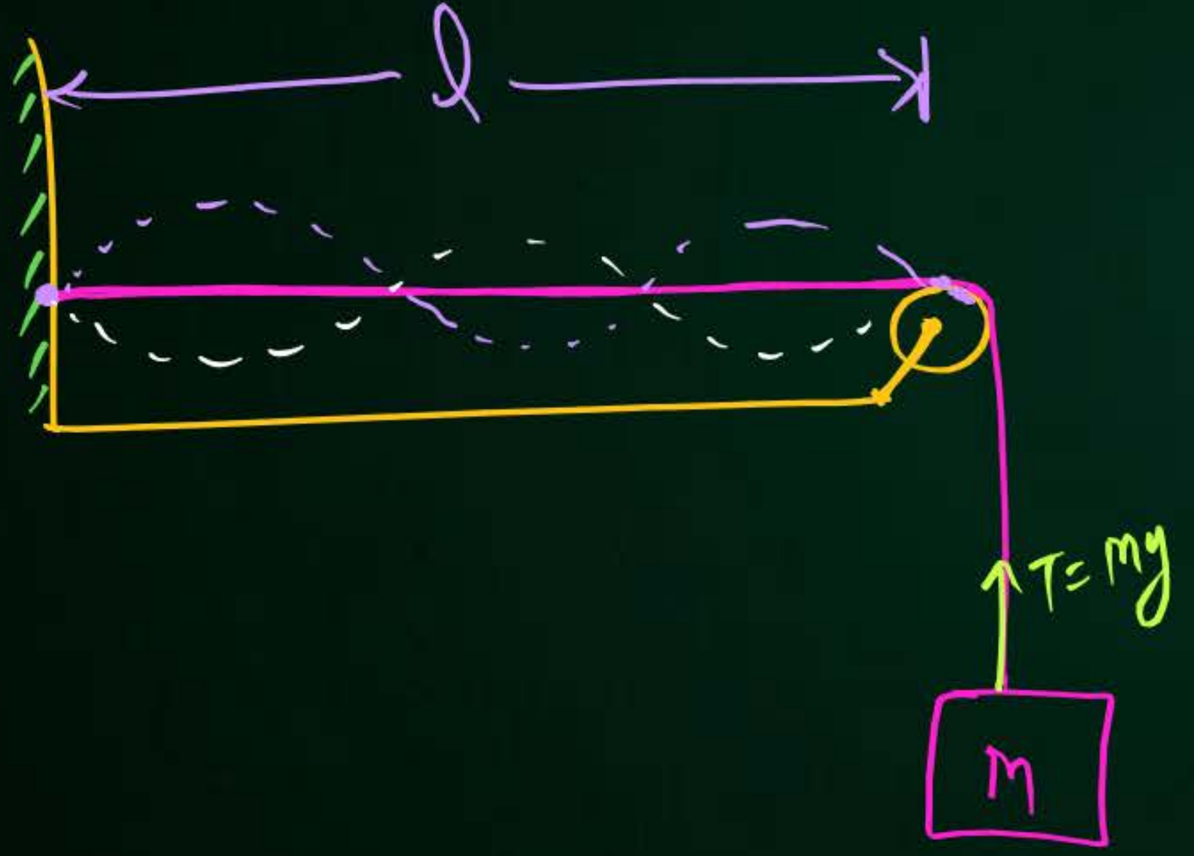


5th harmonic

5 Antinode
(5+1) = 6 node

Sonometre Wire

→ formation of stationary wave in a string is called Sonometre wire.



$$f = \frac{nV}{2l} = \frac{n}{2l}\sqrt{\frac{T}{\mu}}$$

$$f_{n^{th}} = \frac{n}{2l}\sqrt{\frac{mg}{\mu}}$$

μ = mass per unit length of wire

QUESTION

A string 50 cm long is under a tension of 20 N force. Calculate the frequency of fundamental mode given that mass of the string is 1 g.

$$\mu = \frac{M}{L} = \frac{1g}{50cm} = \frac{1}{50} g/cm$$

$$\mu = \frac{1}{50} \frac{\times 10^{-3}}{10^{-2}}$$

$$= \frac{1}{500} kg/m$$

$$\mu = \frac{1}{50} \times \frac{10^{-3}}{10^{-2}} = \frac{1}{50 \times 10} = \frac{1}{500}$$

$$f = \frac{v}{2l} = \frac{1}{2l}\sqrt{\frac{T}{\mu}}$$

$$= \frac{1}{2 \times \frac{1}{2}} \sqrt{20 \times 500}$$

$$= \sqrt{10 \times 10^3} = 100 \text{ Hz}$$

Ans

QUESTION

A sonometer wire is under a tension of 10 N and the length between the bridges is 2 m. A metre long wire of sonometer has mass of 1.0 gm. Deduce the speed of transverse wave and the frequency of 1st harmonic.

$$v = \sqrt{\frac{T}{\mu}}$$

$$f = \frac{1}{2l}\sqrt{\frac{T}{\mu}}$$



$L = 1m$

$\mu = 1gm$

QUESTION

The tension in a wire is decreased by 19%. The percentage decrease in frequency will be

1. 0.19%
2. 10%
3. 19%
4. 0.9%

$f = \frac{v}{2l} = \frac{1}{2l}\sqrt{\frac{T}{\mu}}$

$f \propto \sqrt{T}$

MR ✗

$T \rightarrow 100\%$

$T' = 81\% \cdot T = \frac{81}{100}T$

$f = \sqrt{T}$

$f' = \sqrt{\frac{81}{100}T}$

$= \frac{9}{10}T = \frac{9}{10}T \times 100 = 90\%$

QUESTION

The length of a sonometer wire is 0.75 m and density 9×10^3 Kg/m^3. It can bear a stress of 8.1×10^8 N/m^2 without exceeding the elastic limit. The fundamental frequency that can be produced in the wire, is

1. 200 Hz
2. 150 Hz
3. 600 Hz
4. 450 Hz

$$f = \frac{v}{2l} = \frac{1}{2l}\sqrt{\frac{T}{\mu}} = \frac{1}{2l}\sqrt{\frac{T}{\rho A}}$$

$$= \frac{1}{2l}\sqrt{\frac{\text{stress}}{\rho}}$$

$$= \frac{1}{2 \times \frac{75}{100}}\sqrt{\frac{8.1 \times 10^8}{9 \times 10^3}}$$

$$= \frac{50}{75}\sqrt{\frac{81 \times 10^4}{9}}$$

$$= \frac{50}{75} \times 3 \times 10^2$$

$$= 200\ \text{Hz}$$

QUESTION

The string of a violin has a frequency of 440 cps. If the violin string is shortened by one fifth, its frequency will be changed to

(1) 440 cps

(2) 880 cps

(3) 550 cps

(4) 2200 cps

440 Hz

$f = \frac{v}{2l}$

$f \propto \frac{1}{l}$ —— (1)

$l' = l - \frac{l}{5} = \frac{4l}{5}$

$f' = \frac{5l}{4l}$

$f' = \frac{5}{4} f$

$= \frac{5}{4} \times 440$

QUESTION

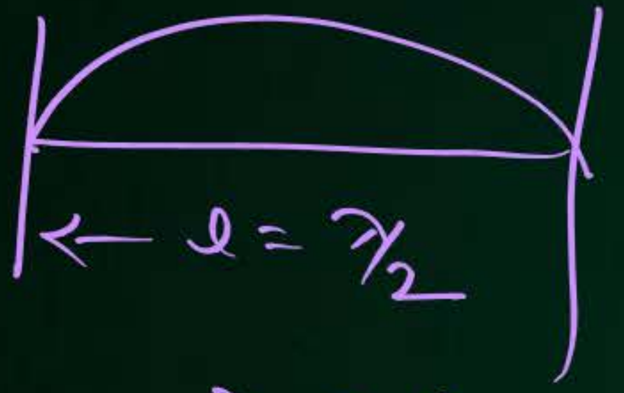
The string of a violin has a frequency of 440 cps. If the violin string is shortened to one fifth, its frequency will be changed to

1. 440 cps
2. 880 cps
3. 550 cps
4. 2200 cps

QUESTION

A 12 m long vibrating string has the speed of wave 48 m/s. To what frequency it will resonate?

1. 2 cps
2. 4 cps
3. 6 cps
4. All of these



$\lambda = 2l$

$\lambda = 2 \times 12$

$\lambda = 24$

$v = f\lambda$

$48 = f \times 24$

$f = 2\,Hz$

$f = \frac{v}{2l} = \frac{48}{2 \times 12} = 2\,Hz$

$= 4\,Hz$

$= 6\,Hz$

QUESTION

A certain string will resonante to several frequencies, the lowest of which is 200 cps. What are the next three higher frequencies to which it resonantes?

1. 400, 600, 800
2. 300, 400, 500
3. 100, 150, 200
4. 200, 250, 300

QUESTION

A wire of length one metre under a certain initial tension emits a sound of fundamental frequency 256 Hz. When the tension is increased by 1 kg wt, the frequency of the fundamental node increases to 320 Hz. The initial tension is

1. 3/4 kg wt
2. 4/3 kg wt
3. 16/9 kg wt
4. 20/9 kg wt

10N

$f \propto \sqrt{T}$

$256 \propto \sqrt{T}$

$320 \propto \sqrt{T+10}$

QUESTION

A string is stretched between fixed points separated by 75.0 cm. It is observed to have resonant frequencies of 420 Hz and 315 Hz. There are no other resonant frequencies between these two. The lowest resonant frequency for this string is

(2015)

1. 10.5 Hz
2. 105 Hz
3. 155 Hz
4. 205 Hz

QUESTION

If the tension and diameter of a sonometer wire of fundamental frequency n is doubled and density is halved then its fundamental frequency will become (2001)

1. $\frac{n}{2}$

2. $\sqrt{2}\,n$

3. n

4. $\frac{n}{\sqrt{2}}$

QUESTION

The length of a sonometer wire AB is 110 cm. Where should the two bridges be placed from A to divide the wire in 3 segments whose fundamental frequencies are in the ratio of 1 : 2 : 3? (1995)

1. 60 cm and 90 cm
2. 30 cm and 60 cm
3. 30 cm and 90 cm
4. 40 cm and 80 cm

QUESTION

A standing wave having 3 nodes and 2 antinodes is formed between two atoms having a distance 1.21 Å between them. The wavelength of the standing wave is

(1998)

1. 6.05 Å
2. 242 Å
3. 1.21 Å
4. 3.63 Å

QUESTION

Standing waves are produced in 10 m long stretched string. If the string vibrates in 5 segments and wave velocity is 20 m/s, the frequency is (1997)

1. 5 Hz
2. 10 Hz
3. 2 Hz
4. 4 Hz

QUESTION

A string is cut into three parts, having fundamental frequencies n_1, n_2, n_3 respectively. Then original fundamental frequency n related by the expression as

(2000)

1. $\frac{1}{n} = \frac{1}{n_1} + \frac{1}{n_2} + \frac{1}{n_3}$
2. $n = n_1 \times n_2 \times n_3$
3. $n = n_1 + n_2 + n_3$
4. $n = \frac{n_1 + n_2 + n_3}{3}$

QUESTION

A stretched string resonates with tuning fork frequency 512 Hz when length of the string is 0.5 m. The length of the string required to vibrate resonantly with a tuning fork of frequency 256 Hz would be (1993)

1. 0.25 m
2. 0.5 m
3. 1 m
4. 2 m

QUESTION

The length of the wire between two ends of a sonometer is 100 cm. What should be the positions of two bridges below the wire so that the three segments of the wire have their fundamental frequencies in the ratio 1 : 3 : 5.

(Karanataka NEET 2013)

(1) $\frac{1500}{23}$ cm, $\frac{500}{23}$ cm

(2) $\frac{1500}{23}$ cm, $\frac{300}{23}$ cm

(3) $\frac{300}{23}$ cm, $\frac{1500}{23}$ cm

(4) $\frac{1500}{23}$ cm, $\frac{200}{23}$ cm


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 06 | Physics

Wave Motion

By- Dr. Manish Raj (MR SIR)



Topics to be covered

1 # Questions on statinary wave

2 # organ pipe → open organ pipe
→ close organ pipe

3 #



QUESTION

A wire of length one metre under a certain initial tension emits a sound of fundamental frequency 256 Hz. When the tension is increased by 1 kg wt, the frequency of the fundamental node increases to 320 Hz. The initial tension is

1. 3/4 kg wt
2. 4/3 kg wt
3. 16/9 kg wt
4. 20/9 kg wt

T (1st) = ??

1 kg wt → 10 N

$f = \frac{v}{2l} = \frac{1}{2l}\sqrt{\frac{T}{\mu}}$

$f \propto \sqrt{T}$

$\frac{256\,Hz \propto \sqrt{T}}{320\,Hz \propto \sqrt{T+10}}$

$\frac{256}{320} = \sqrt{\frac{T}{T+10}}$

$\frac{4}{5} = \sqrt{\frac{T}{T+10}}$

$\frac{16}{25} = \frac{T}{T+10}$

$16T + 160 = 25T$

$160 = 25T - 16T$

$160 = 9T$

$T = \frac{160}{9}\,N = \frac{16}{9}\,kg\,wt$

QUESTION

A string is stretched between fixed points separated by 75.0 cm. It is observed to have resonant frequencies of 420 Hz and 315 Hz. There are no other resonant frequencies between these two. The lowest resonant frequency for this string is

(2015)

1. 10.5 Hz
2. 105 Hz
3. 155 Hz
4. 205 Hz

420
- 315
105 Hz fundt

QUESTION

If the tension and diameter of a sonometer wire of fundamental frequency n is doubled and density is halved then its fundamental frequency will become (2001)

1. $\frac{n}{2}$
2. $\sqrt{2}\,n$
3. n
4. $\frac{n}{\sqrt{2}}$

76%

$T' = 2T$

$r' = 2r$

$\rho' = \rho/2$

$f = \frac{nv}{2l} = \frac{1}{2l}\sqrt{\frac{T}{\rho A}} = \sqrt{\frac{2T}{\frac{\rho}{2} \times 4\pi r}}$

$D = 2r$ — (i)

$D' = 2r'$ — (ii)

$\frac{D}{2D} = \frac{D}{D'} = \frac{r}{r'}$

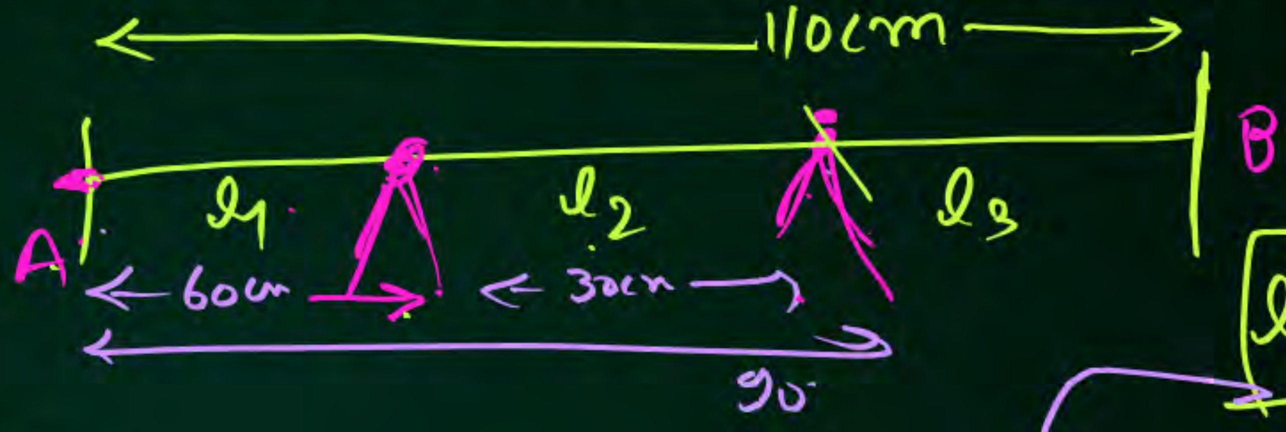
$r' = 2r$ $\frac{1}{2} = \frac{r}{r'}$

$D = 2r$

QUESTION

The length of a sonometer wire *AB* is 110 cm. Where should the two bridges be placed from A to divide the wire in 3 segments whose fundamental frequencies are in the ratio of 1 : 2 : 3? (1995)

1. 60 cm and 90 cm
2. 30 cm and 60 cm
3. 30 cm and 90 cm
4. 40 cm and 80 cm



$x + \frac{x}{2} + \frac{x}{3} = 110$ cm

$f_1 : f_2 : f_3 = 1 : 2 : 3$

$f = \frac{nV}{2l}$

$f \propto \frac{1}{l}$ — (1)

$l \propto \frac{1}{f}$

$l_1 : l_2 : l_3 = \frac{1}{f_1} : \frac{1}{f_2} : \frac{1}{f_3}$

$l_1 : l_2 : l_3 = \frac{x}{1} : \frac{x}{2} : \frac{x}{3}$

$l_1 + l_2 + l_3 = 110$ cm

$x + \frac{x}{2} + \frac{x}{3} = 110$ cm

$\frac{6x + 3x + 2x}{6} = 110$ cm

$11x = 110 \times 6$

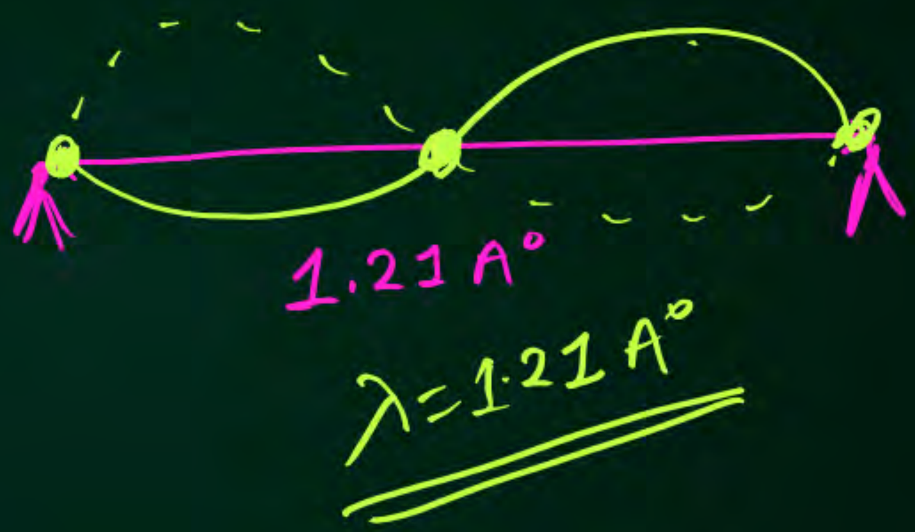
$x = 60$ cm Ans

QUESTION

A standing wave having 3 nodes and 2 antinodes is formed between two atoms having a distance 1.21 Å between them. The wavelength of the standing wave is

(1998)

1. 6.05 Å
2. 242 Å
3. 1.21 Å
4. 3.63 Å

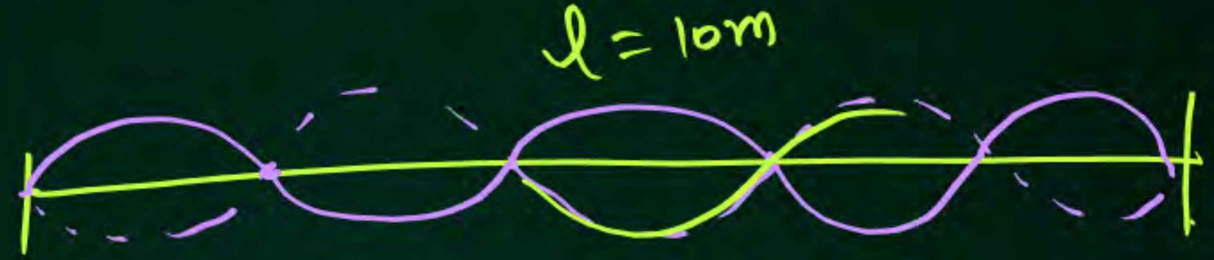


QUESTION

Standing waves are produced in 10 m long stretched string. If the string vibrates in 5 segments and wave velocity is 20 m/s, the frequency is (1997)

1. 5 Hz
2. 10 Hz
3. 2 Hz
4. 4 Hz

5 loop



$\frac{5\lambda}{2} = 10$

$\lambda = 4$

$v = \lambda f$

$20 = 4 f$

$f = 5 Hz$

QUESTION

A string is cut into three parts, having fundamental frequencies n_1, n_2, n_3 respectively. Then original fundamental frequency n related by the expression as (2000)

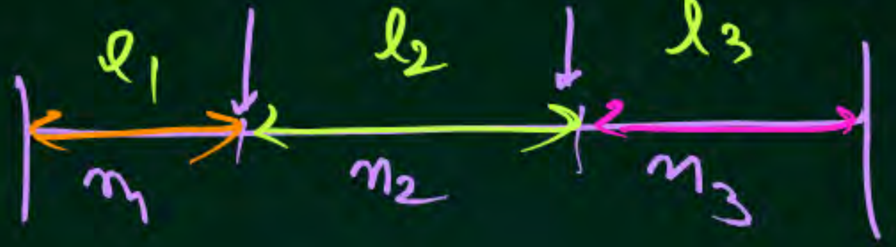
only 60%

1. $\dfrac{1}{n} = \dfrac{1}{n_1} + \dfrac{1}{n_2} + \dfrac{1}{n_3}$ ✓

2. $n = n_1 \times n_2 \times n_3$

3. $n = n_1 + n_2 + n_3$

4. $n = \dfrac{n_1 + n_2 + n_3}{3}$ ✗



$n_1 = \dfrac{v}{2l_1}$ — (i)

$n_2 = \dfrac{v}{2l_2}$ — (ii)

$n_3 = \dfrac{v}{2l_3}$

$n = \dfrac{v}{2l}$ — (iv)

$l_1 + l_2 + l_3 = l$

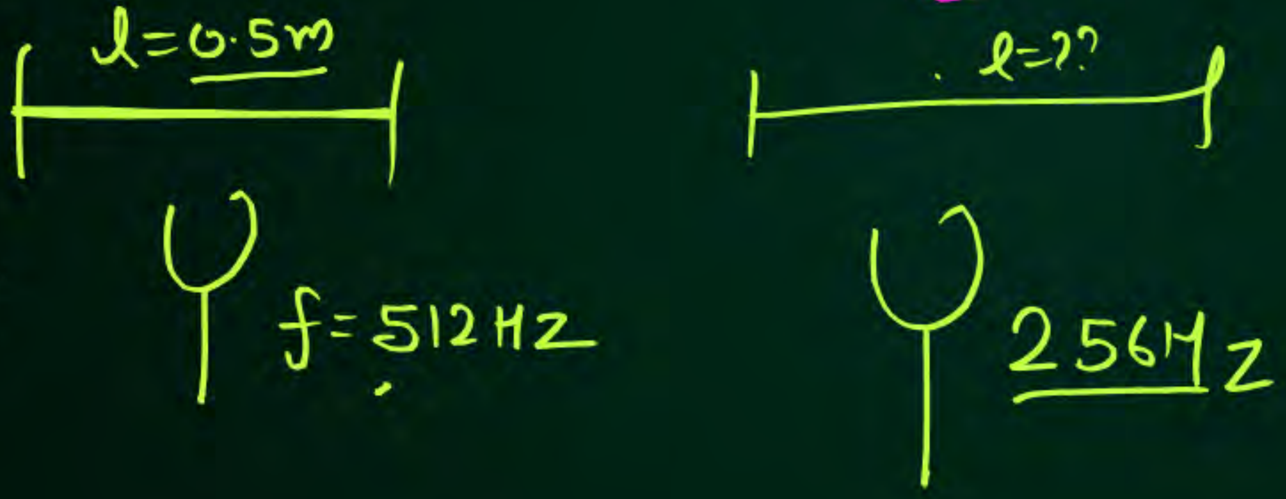
$\dfrac{v}{2n_1} + \dfrac{v}{2n_2} + \dfrac{v}{2n_3} = \dfrac{v}{2n}$

$\dfrac{1}{n_1} + \dfrac{1}{n_2} + \dfrac{1}{n_3} = \dfrac{1}{n}$

QUESTION

A stretched string resonates with tuning fork frequency 512 Hz when length of the string is 0.5 m. The length of the string required to vibrate resonantly with a tuning fork of frequency 256 Hz would be (1993)

1. 0.25 m
2. 0.5 m
3. 1 m
4. 2 m

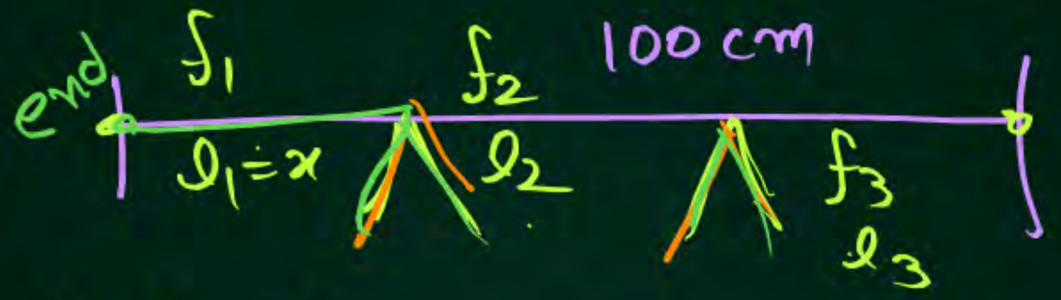


QUESTION

The length of the wire between two ends of a sonometer is 100 cm. What should be the positions of two bridges below the wire so that the three segments of the wire have their fundamental frequencies in the ratio 1 : 3 : 5.

(Karanataka NEET 2013)

1. $\frac{1500}{23}$ cm, $\frac{500}{23}$ cm (for length of wire) — correct
2. $\frac{1500}{23}$ cm, $\frac{300}{23}$ cm
3. $\frac{300}{23}$ cm, $\frac{1500}{23}$ cm
4. $\frac{1500}{23}$ cm, $\frac{200}{23}$ cm



$f_1 : f_2 : f_3 = 1 : 3 : 5$

$x + \frac{x}{3} + \frac{x}{5} = 100$

$\frac{15x + 5x + 3x}{15} = 100$

$23x = 1500$

$x = \frac{1500}{23}$

$l_2 = \frac{x}{3} = \frac{1500}{23 \times 3}$

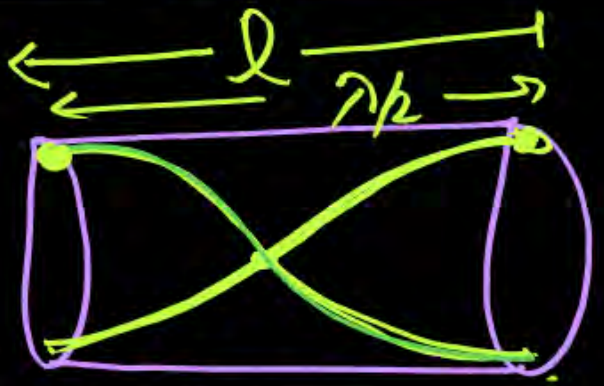
$l_2 = \frac{500}{23}$

from one end position of brige $= x + \frac{x}{3}$

$= \frac{1500}{23} + \frac{500}{23}$

$= \left(\frac{2000}{23}\right)$ cm

Stationary wave in open organ pipe [Sound wave] longitudinal wave



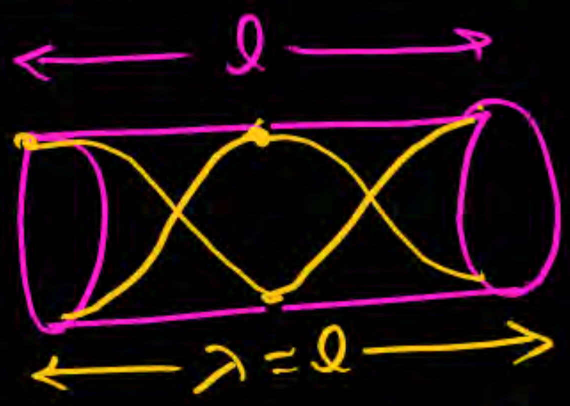
open end pe min
Hamesa Antinode Banta hai displacement Ka.

$l = \lambda/2$ — (1)

$$f = \frac{v}{\lambda} = \left[\frac{v}{2l}\right]$$

↳ fundamental frequency & 1st harmonic.

☆ 2 Anti-node
one - node



$$f = \frac{v}{\lambda} = \frac{v}{l}$$

$$f = 2\left[\frac{v}{2l}\right]$$

2nd harmonic.
1st overtone.
3- Antinode
2 node.

$$V = \sqrt{\frac{\gamma P}{\rho}} = \sqrt{\frac{\gamma RT}{M}}$$

Sound wave

due to Pressure diffn of medium sound reflected from boundary (end). due to this incident & reflected wave there is a formation of stationary wave.



$\lambda = \frac{2l}{3}$

$$f = \frac{v}{\lambda}$$

$$f = 3\left[\frac{v}{2l}\right]$$

3rd harmonic
2nd overtone.

nth harmonic
$(n-1)$ overtone

$$f = n\left[\frac{v}{2l}\right]$$

$n \to$ node $(n+1)$ Antinode

$$f = f_{n^{th}} - f_{(n-1)^{th}}$$

fundamental

QUESTION

If 7th overtone is 120 Hz then find fundamental frequency. in open organ pipe.

Sol^n

→ 8th harmo

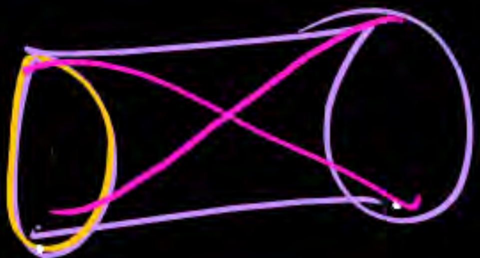
$f_{8^{th}} = 8 f_{fun}$.

$120 = 8 f_{fundam}$

$f_{funda} = \frac{120}{8} = 15 \text{ Hz}$ Ans



open organ pipe (Both end open)



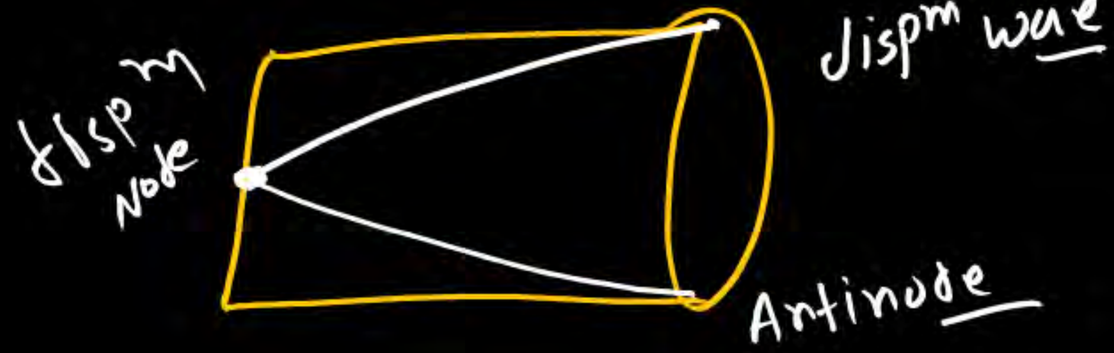
disp^m wave Ka Anti-node at open end

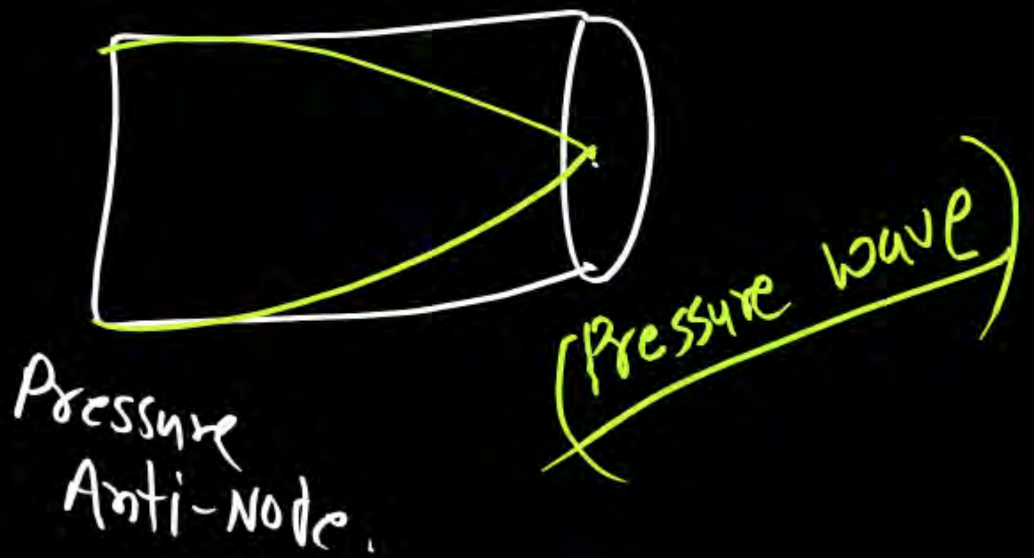
Pressure wave Ka node Banega at open end.



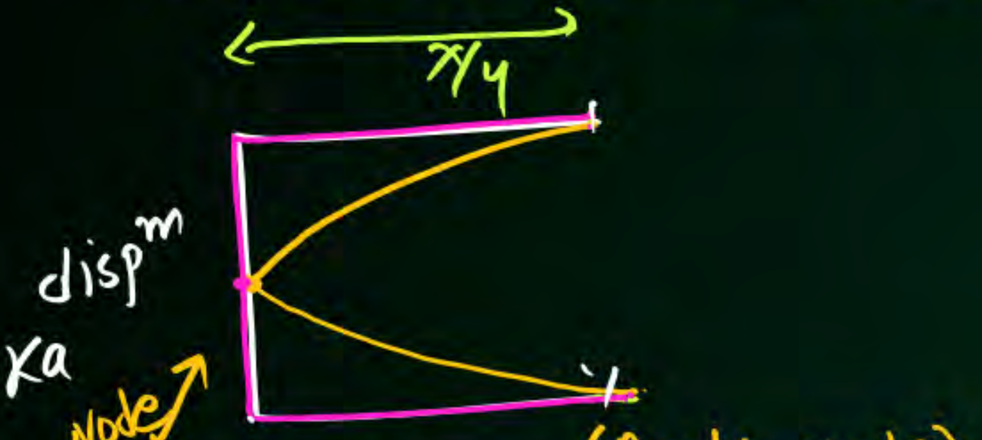
Close organ pipe ~~(Both are close)~~

one end open / one end close





➢ Normal Modes of Oscillation of an Air Column with One End Closed and Other Open (Closed Organ Pipe):



$\frac{\lambda}{4} = l$

$\lambda = 4l$ — (1)

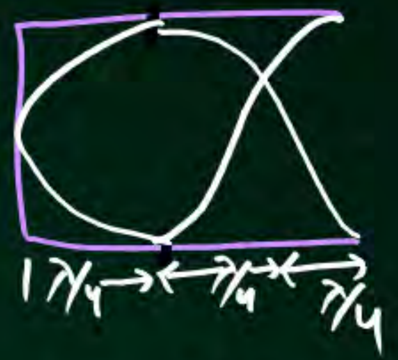
$f = \frac{V}{\lambda}$

$$f = \frac{V}{4l}$$

→ fundamental frequency

1st harmonic





$l = \frac{3\lambda}{4}$

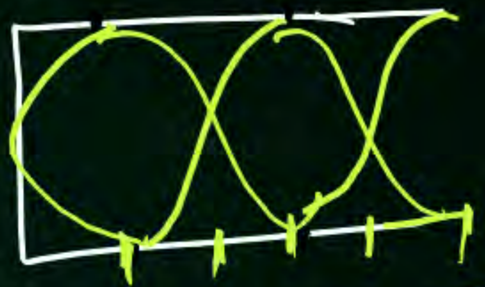
$\lambda = \frac{4l}{3}$

$f = \frac{V}{\lambda}$

$$f = \frac{3V}{4l}$$

3rd harmonics

1st overtone



$\frac{5\lambda}{4} = l$ — (1)

$\lambda = \frac{4l}{5}$

$f = 5\left(\frac{V}{4l}\right)$

5th harmonic

2nd overtone

$f_1 : f_{3rd} : f_{5th} : f_{7th} = 1 : 3 : 5 : 7 : 9$

$$f = \frac{(2n+1)\,v}{4l}$$

हमारा यही है

→ n^{th} overtone
$(2n+1)^{th}$ harmon.

Biyoyoyoyoum

n = 0
- fundamental
- 1^{st} harm

n = 1
$\frac{3v}{4l}$
3^{rd} harmonic
1^{st} overtone

n = 2
$\frac{5v}{4l}$
5^{th} harmo
2^{nd} overtone

n = 3
$\frac{7v}{4l}$
7^{th} harmone
3^{rd} overtone

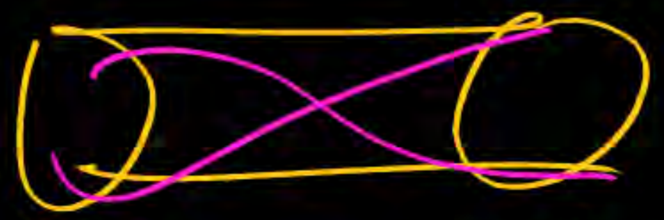
$$f = (2n-1)\frac{v}{4l}$$

$(2n-1)^{th}$ harmo.
$(n-1)$ overtone

n = 1	n = 2	n = 3	n = 4	n = 5
fundamental, 1^{st} harmo	3^{rd} harm.	5^{th} harmo.	7^{th} harm	9^{th} harm
	$\frac{3v}{4l}$	$\frac{5v}{4l}$	$\frac{7v}{4l}$	$\frac{9v}{4l}$
	1^{st} overt	2^{nd} overtone	3^{rd} overtone	4^{th} overtone

frequ ka ratio = 1 : 3 : 5 : 7 : 9

open organ pipe



$$f = \frac{nv}{2l}$$

→ n^{th} harmonics

$(n-1)$ overtone.

$f = \frac{v}{2l}$	$\frac{2v}{2l}$	$\frac{3v}{2l}$	$\frac{4v}{2l}$	$\frac{5v}{2l}$	$\frac{6v}{2l}$	$\frac{7v}{2l}$
1st har fundan	2nd har 1st ov	3rd har 2nd overt	4th h 3rd ov	5th har 4th ov	6th har 5th ov	7th 6th ov



$$f = \frac{(2n+1)v}{4l}$$

$n=0$	$n=1$	$n=2$	$n=3$
fundan 1st har $\frac{v}{4l}$	1st ovr 3rd ha $\frac{3v}{4l}$	2nd ov $\frac{5v}{4l}$	3rd ov $\frac{7v}{4l}$

QUESTION

Find number of anti-node in 3rd overtone in open organ pipe.

4th harmonic



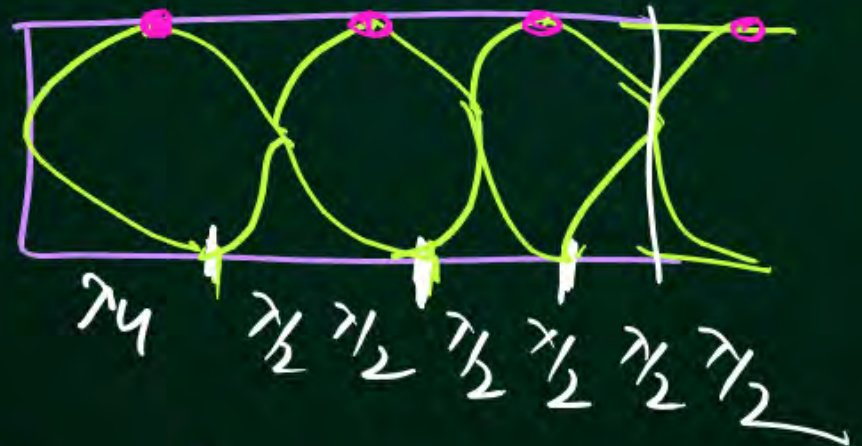
5 Anti-node

QUESTION

Find number of anti-node in 3rd overtone in close organ pipe.

n=3

7th harmony = 7-times of fundame



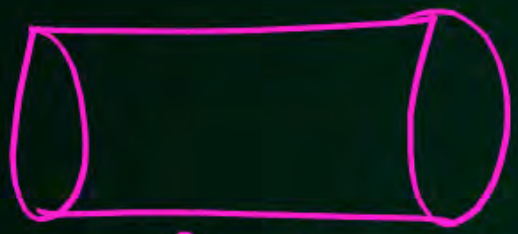
$f = \frac{7v}{4l}$ ✓

4- Anti-node

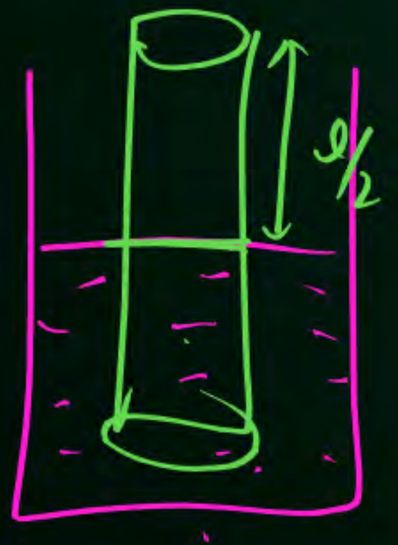
QUESTION

A cylindrical tube, open at both ends, has a fundamental frequency f in air. The tube is dipped vertically in water so that half of it is in water. The fundamental frequency of the air column is now

1. $\frac{f}{2}$
2. $\frac{3f}{4}$
3. f
4. $2f$



$f = \frac{v}{2l}$ — (1)



$f' = \frac{v}{4 \frac{l}{2}} = \frac{v}{2l}$

QUESTION

In case of closed pipe which harmonic the p^{th} overtone will be

1. $2p + 1$
2. $2p - 1$
3. $p + 1$
4. $p - 1$

QUESTION

A closed pipe of length 10 cm has its fundamental frequency half that of the second overtone of an open pipe. The length of the open pipe

1. 10 cm
2. 20 cm
3. 30 cm
4. 40 cm

$\frac{v}{4 \times l_c} = \frac{3v}{2l_0} \times \frac{1}{2}$

$l_0 = 3 l_c$

$= 3 \times 10 = 30\,cm$

QUESTION

The pitch of an organ pipe is highest when the pipe is filled with

frequency

1. Air
2. Hydrogen
3. Oxygen
4. Carbon dioxide

$$f = \frac{v}{2l} = \frac{1}{2l}\sqrt{\frac{\gamma RT}{M}}$$

QUESTION

The vibrations of four air columns under identical conditions are represented in the figure below. The ratio of frequencies $n_p : n_q : n_r : n_s$ will be

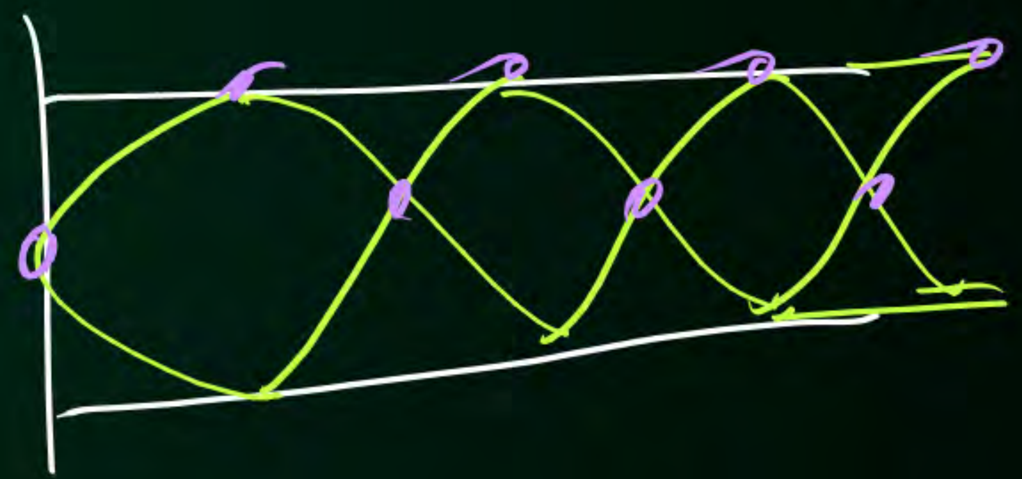
1. 12 : 6 : 3 : 4
2. 1 : 2 : 4 : 3
3. 4 : 2 : 3 : 1
4. 6 : 2 : 3 : 4



QUESTION

A closed organ pipe (closed at one end) is excited to support the third overtone. It is found that air in the pipe has (1991)

1. three nodes and three antinodes
2. three nodes and four antinodes
3. four nodes and three antinodes
4. four nodes and four antinodes.



close $\frac{9}{H}$

n^{th} overtone

$(2n+1)$ harmon.

open $\frac{9}{H}$

n^{th} harmonics

$(n-1)$ overtone

$2\, f_{undamental} = f_{n^{th}} - f_{(n-2)^{th}}$

QUESTION

For a particular resonance tube, following are four of the six harmonics below 1000 Hz;

300, 600, 750 and 900 Hz

The two missing harmonics are

1. 75, 150
2. 150, 450
3. 400, 800
4. 250, 400

QUESTION

The fundamental frequency of a closed organ pipe of length 20 cm is equal to the second overtone of an organ pipe open at both the ends. The length of organ pipe open at both the ends is [AIPMT-2015]

1. 140 cm
2. 80 cm
3. 100 cm
4. 120 cm

QUESTION

For a certain organ pipe, three successive resonance frequencies are observed at 425, 595, and 765, Hz respectively, Taking the speed of sound in air to be 340 m/s the fundamental frequency of the pipe (in Hz) is

1. 425
2. 170
3. 85
4. 245

QUESTION

In a closed organ pipe of length 105 cm, standing waves are set up corresponding to third overtone. What distance from the closed end, a pressure node is formed?

1. 5 cm
2. 15 cm
3. 25 cm
4. 30 cm

QUESTION

A tuning fork and an air column whose temperature is 51°C produce 4 beats in one second, when sounded together. When the temperature of air column decreases the number of beats per second decreases. When the temperature remains 16°C only one beat per second is produced. The frequency of the tuning fork is

1. 100 Hz
2. 75 Hz
3. 150 Hz
4. 50 Hz

QUESTION

A second harmonic has to be generated in a string of length l stretched between two rigid supports. The points where the string has to be plucked and touched are respectively

1. $\frac{l}{4}, \frac{l}{2}$

2. $\frac{l}{4}, \frac{3l}{4}$

3. $\frac{l}{2}, \frac{l}{2}$

4. $\frac{l}{2}, \frac{3l}{4}$

QUESTION

In a standing wave, all particles of the medium cross the mean position with

1. Different speeds at different instants
2. Different speeds at same instant
3. Same speed at different instants
4. Same speed at same instant

QUESTION

A uniform string resonates with a tuning fork, at a maximum tension of 32 N. If it is divided into two segments by placing a wedge at a distance one-fourth of length from one end, then to resonance with same frequency the maximum value of tension for string will be

1. 2 N
2. 4 N
3. 8 N
4. 16 N

QUESTION

The two nearest harmonics of a tube closed at one end and open at other end are 220 Hz and 260 Hz. What is the fundamental frequency of the system?

[NEET-2017]

1. 10 Hz
2. 20 Hz
3. 30 Hz
4. 40 Hz

QUESTION

The number of possible natural oscillations of air column in a pipe closed at one end of length 85 cm whose frequencies lie below 1250 Hz are (velocity of sound $= 340\ ms^{-1}$)

[AIPMT-2014]

1. 4
2. 5
3. 7
4. 6

QUESTION

The second overtone of an open organ pipe has the same frequency as the first overtone of a closed pipe L metre long. The length of the open pipe will be

[NEET (Phase-2)-2016]

1. L
2. $2L$
3. $L/2$
4. $4L$

QUESTION

An air column, closed at one end and open at the other, resonates with a tuning fork when the smallest length of the column is 50 cm. The next larger length of the column resonating with the same tuning fork is [NEET-2016]

1. 200 cm
2. 66.7 cm
3. 100 cm
4. 150 cm


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 07 | **Physics**

Wave [redacted]



By- Dr. Manish Raj (MR SIR)

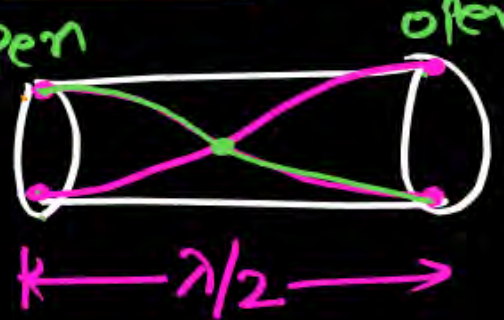
Topic to be Covered :

- Revion of organ pipe
  - H/W
  - Resonance Tube
    end correction
  - (Beat frequency)

Doppler effect
Not in syllabus

Open organ pipe

Pressure wave ka Node at open end.
→ dispm wave ka anti-node at open end.

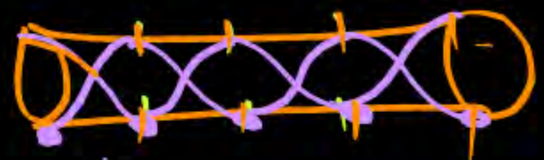






Pressure wave

$$f = n\left[\frac{v}{2l}\right]$$



4th harmon.

$n \to n^{th}$ harmonic.

$(n-1)^{th}$ overtone.

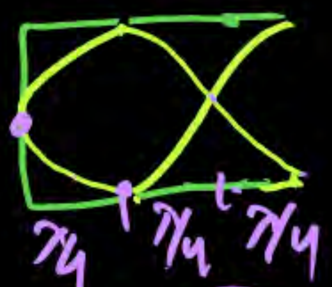
Close organ pipe

dispm wave ka minima at closed end
dispm wave ka maxima at open end



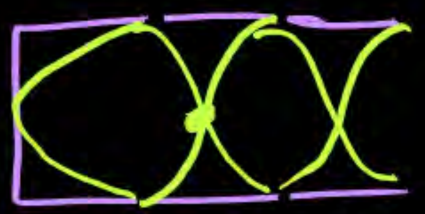
$f = \frac{v}{4l}$

1st haromic
fundamental



$f = \frac{3v}{4l}$

3rd harmoic.
1st overtone.



$\frac{5\lambda}{4} = l$

$f = \frac{5v}{4l}$

5th harmonic
2nd overtone

$$f = \frac{(2n+1)v}{4l}$$

$(2n+1) \to$ harmonic
$n^{th} \to$ overtone
$n = 1, 2, 3, 4$
→ overtone

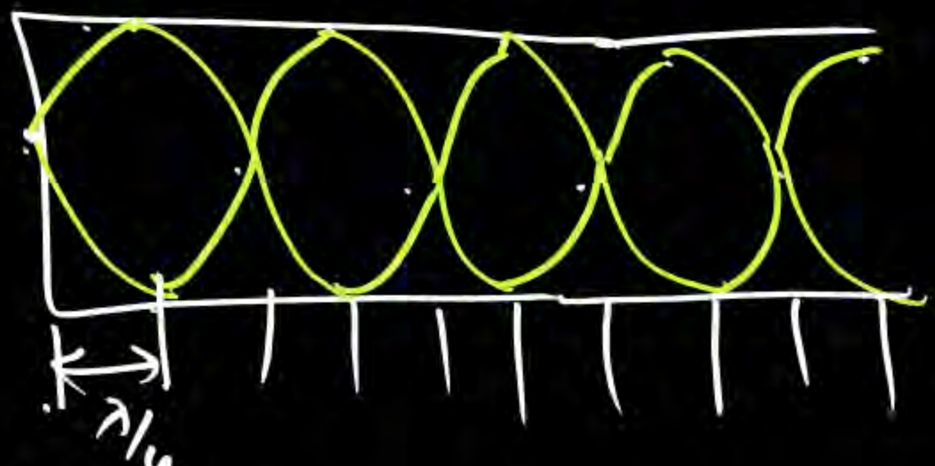
$n = 0$
fundamental

4th overtone in close organ pipe

→ $n = 4$

$$f = \frac{(2n+1)v}{4l}$$

9th harmonic



S- node
N- antinode

7th harmonic in close organ pipe then find overtone

$(2n+1) = 7$

$2n+1 = 7$

$2n = (7-1)$

$n = \frac{6}{2} = 3$rd overtone

$$\boxed{\frac{nv}{2l} = f}$$

Open org

$n \rightarrow$ harmic

$(n-1)$ over tone

$$\frac{(2n+1)v}{4l} = f$$

$(2n+1) \rightarrow$ harmc

$n \rightarrow$ overtone

$$\frac{nv}{2l} = f$$

$n \to$ harmonic

$n-1$ overtone

$$\frac{(2n+1)v}{4l} = f$$

$(2n+1) =$ harm

$n \to$ overtone

QUESTION

The fundamental frequency of a closed organ pipe of length 20 cm is equal to the second overtone of an organ pipe open at both the ends. The length of organ pipe open at both the ends is [AIPMT-2015]

1. 140 cm
2. 80 cm
3. 100 cm
4. 120 cm

$$\frac{v}{4l_c} = \frac{3v}{2l_0}$$

$$\frac{1}{4 \times 20} = \frac{3}{2 l_0}$$

$$l_0 = 120\,cm$$

QUESTION

For a certain organ pipe, three successive resonance frequencies are observed at 425, 595, and 765, Hz respectively, Taking the speed of sound in air to be 340 m/s the fundamental frequency of the pipe (in Hz) is

1. 425
2. 170 — 71%
3. 85 — 22%
4. 245

425, 592, 765,

595
425
+170 fundame open org

for close pipe

$2f = 170$

$f_{fund} = \frac{170}{2} = 85$

85, 85×3, 85×5, 85×7

170, 340, 510,

Open organ pipe. Not Possible

QUESTION

In a closed organ pipe of length 105 cm, standing waves are set up corresponding to third overtone. What distance from the closed end, a pressure node is formed?

1. 5 cm
2. 15 cm
3. 25 cm
4. 30 cm

disp^m wave



$\frac{7\lambda}{4} = 105$

harmonic $= (2n+1) = 2\times3+1 = 7^{th}$ harm

$\frac{\lambda}{4} = \frac{105}{7} = 15\,cm$

disp^n b/w node & anti-node

QUESTION

A tuning fork and an air column whose temperature is 51°C produce 4 beats in one second, when sounded together. When the temperature of air column decreases the number of beats per second decreases. When the temperature remains 16°C only one beat per second is produced. The frequency of the tuning fork is

1. 100 Hz
2. 75 Hz
3. 150 Hz
4. 50 Hz

$f_{op} = \sqrt{Temp} \propto \sqrt{273+51}$

$T_f = 16°C$

$f_{op_1} - f_{TF} = 4$ — (i)

$f_{op_2} - f_{TF} = 1$ — (ii)

$f_{op_1} = 4 + f_{TF}$ — (i)

$f_{op_2} = 1 + f_{TF}$ — (ii)

$\frac{\sqrt{273+51}}{\sqrt{273+16}} = \frac{4+f_{TF}}{1+f_{TF}}$

$\frac{18}{17} = \sqrt{\frac{324}{289}} = \frac{4+f_{TF}}{1+f_{TF}}$

$18 + 18 f_{TF} = 68 + 17 f_{TF}$

$f_{TF} = 68 - 18 = 50$

QUESTION

A tuning fork and an air column whose temperature is 51°C produce 4 beats in one second, when sounded together. When the temperature of air column decreases the number of beats per second decreases. When the temperature remains 16°C only one beat per second is produced. The frequency of the tuning fork is

1. 100 Hz
2. 75 Hz
3. 150 Hz
4. 50 Hz

$f_{op} - f_{TF} = 4$.

$\downarrow$ (Tempr $\downarrow$)

$f_{TF} - f_{op\downarrow} = \text{diff}^n \uparrow$

(Temp) $\downarrow$

QUESTION

A second harmonic has to be generated in a string of length l stretched between two rigid supports. The points where the string has to be plucked and touched are respectively



1. $\frac{l}{4}, \frac{l}{2}$
2. $\frac{l}{4}, \frac{3l}{4}$
3. $\frac{l}{2}, \frac{l}{2}$
4. $\frac{l}{2}, \frac{3l}{4}$

QUESTION

In a standing wave, all particles of the medium cross the mean position with

1. Different speeds at different instants
2. Different speeds at same instant
3. Same speed at different instants
4. Same speed at same instant

QUESTION

A uniform string resonates with a tuning fork, at a maximum tension of 32 N. If it is divided into two segments by placing a wedge at a distance one-fourth of length from one end, then to resonance with same frequency the maximum value of tension for string will be

1. 2 N
2. 4 N
3. 8 N
4. 16 N

$l, T_1 = 32\,N$

$f_{TF} = f_{string}$

$l/4$

Tension = ??

$f_{1\,string} = f_{2\,string} = \frac{1}{2l}\sqrt{\frac{T}{\mu}} \propto \frac{\sqrt{T}}{l}$

$\frac{\sqrt{T_1}}{l} = \frac{\sqrt{T_2}}{l_2}$

$\frac{\sqrt{32}}{l} = \frac{\sqrt{T_2}}{l/4}$

$\frac{1}{4}\sqrt{32} = \sqrt{T_2}$

$\frac{4}{4}\sqrt{2} = \sqrt{T_2}$

$T_2 = 2\,N$

QUESTION

close organ pipe

The two nearest harmonics of a tube closed at one end and open at other end are 220 Hz and 260 Hz. What is the fundamental frequency of the system?

[NEET-2017]

1. 10 Hz
2. 20 Hz ✓ 66%
3. 30 Hz
4. 40 Hz ✗ 23%

260 Hz
220 Hz

40 Hz = 2 f_{funda}

f_{funda} = 20 Hz

QUESTION

The number of possible natural oscillations of air column in a pipe closed at one end of length 85 cm whose frequencies lie below 1250 Hz are (velocity of sound $= 340\ ms^{-1}$) [AIPMT-2014]

1. 4
2. 5
3. 7
4. 6

Close



funda $= \frac{v}{4l}$

funda $= \frac{340}{4 \times \frac{85}{100}} = 100\ Hz$

100 Hz, 300 Hz, 500 Hz, 700 Hz, 900 Hz, 1100 Hz, 1300 Hz

44%

QUESTION

The second overtone of an open organ pipe has the same frequency as the first overtone of a closed pipe L metre long. The length of the open pipe will be

[NEET (Phase-2)-2016]

1. L
2. $2L$ ✓ 78%
3. $L/2$
4. $4L$



$$\frac{3v}{2l_0} = \frac{3v}{4L}$$

$$l_0 = 2L$$

END CORRECTION

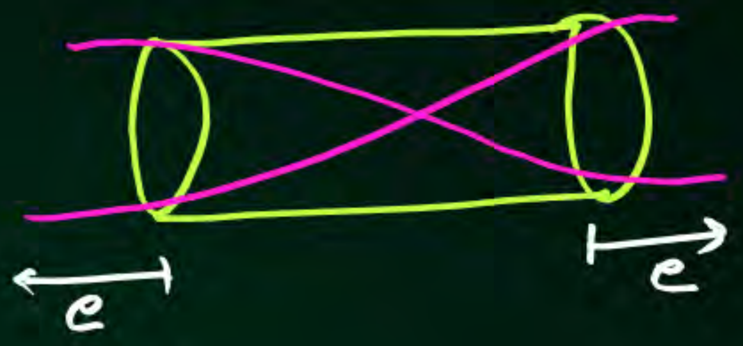


Close organ pipe

$$e = 0.6r \quad \text{--- (1)}$$

$$f = \frac{(2n+1)v}{4(l+0.6r)}$$

$$f_{fundamental} = \frac{v}{4(l+0.6r)}$$



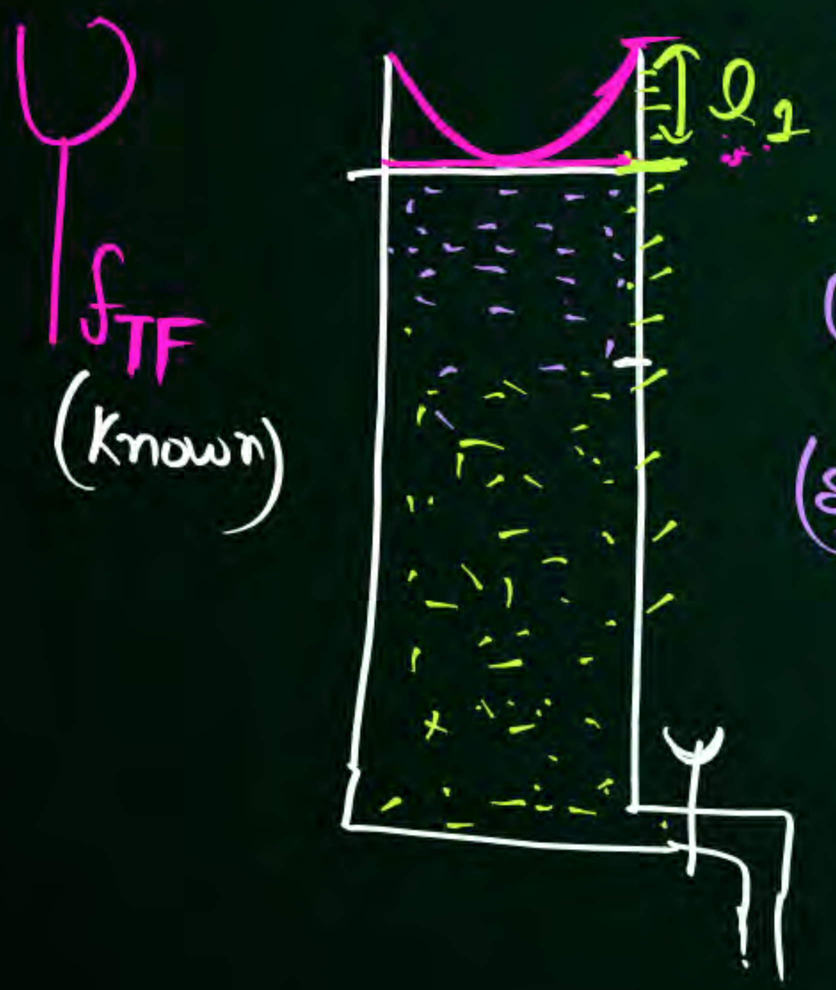
$$f_{fundal.} = \frac{v}{2(l+2e)} = \frac{v}{2(l+1.2r)}$$

r = radius of organ pipe

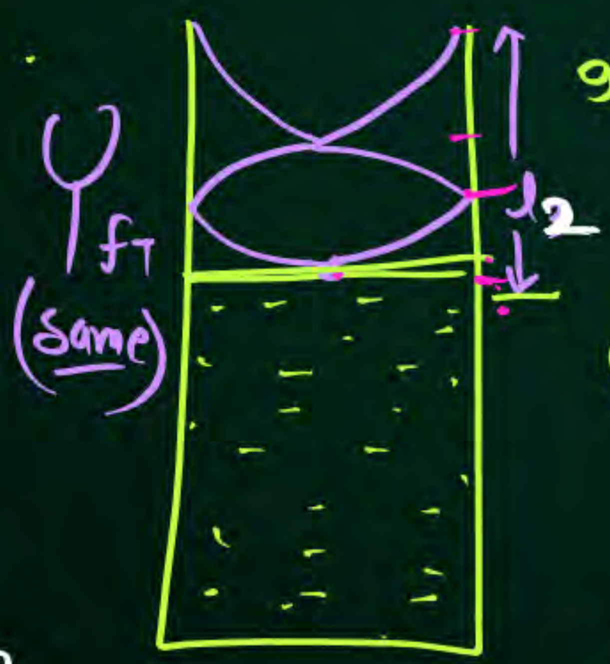
RESONANCE TUBE

→ [Close organ pipe of variable length.]

→ Instrument to find speed of sound experientaly, and also use to find end correct.



$f_{organ\ pipe} = \frac{v}{4l}$



If resonance cond^n is achived on 3rd harmonics.

$f_{TF} = 3\left[\frac{v}{4l_2}\right]$ — (II)

$\frac{3v}{4l_2} = \frac{v}{4l}$

$3l_1 = l_2$

at resonance on 1st harmonic

(Known) $f_{TF} = f_{organ\ pipe}$ (experimental)

$f_{TF} = \frac{v}{4l_1}$ — (I)

V (speed of sound) $= 4 f_{TF} l_1$

Ans

QUESTION

An air column, closed at one end and open at the other, resonates with a tuning fork when the smallest length of the column is 50 cm. The next larger length of the column resonating with the same tuning fork is [NEET-2016]

1. 200 cm
2. 66.7 cm
3. 100 cm
4. 150 cm

80%

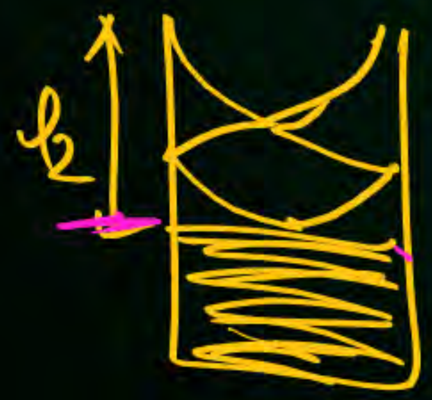
➢ Find of end correction using resonance tube

Resonce at 1^{st} harmonic





$$f_{TF} = \frac{v}{4(l_1+e)} \quad \text{— (I)}$$ ✓



3rd harmonic (Resonce)

$$f_{TF} = \frac{3v}{4(l_2+e)} \quad \text{— (II)}$$

(I) = (II)

$$\frac{v}{4(l_1+e)} = \frac{3v}{4(l_2+e)}$$

$$l_2 + e = 3(l_1+e)$$

$$l_2 + e = 3l_1 + 3e$$

$$l_2 - 3l_1 = 3e - e$$

$$2e = l_2 - 3l_1$$

MR Ratta

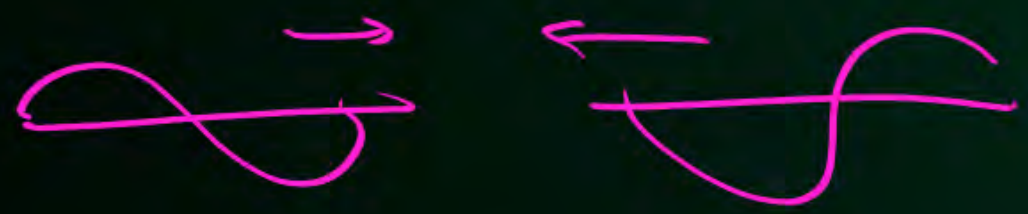
$$\boxed{e = \frac{l_2 - 3l_1}{2}}$$

Interference

Superposition of two wave having difference amplitude but same frequency, wave no ……

Stationary Wave

Superposition of wave having same amplitude, same frequency, same wave no moving in opposite direction.



Beat frequequcy

Superposition of two wave having same amplitude but different frequency, different wave no.

$$f_1 - f_2 = \beta$$

⇑ Beat frequency

Tuning force



$frequency \propto \frac{1}{waxing}$



frequey ⟶ depend on sharpness

$frequency \propto sharpness$



$organ\ pipe \propto \sqrt{Tempo}$



$f_{string.} \propto \sqrt{Tension}$

Beats

When two harmonic sound waves of equal amplitude but slightly different frequencies superpose, the resultant wave looks like a single sinusoidal wave with a varying amplitude that goes from maximum to zero and back. The amplitude variation causes the variation of intensity called beats. The frequency with which the amplitude rises and falls is called the beat frequency and is equal to the difference in frequencies of the two waves.

QUESTION

Two vibrating tuning forks produce progressive waves given by $y_1 = 4\sin 500\pi\ t$ and $y_2 = 2\sin 506\pi t$. Number of beats produced per minute is

(1) 360

(2) 180 40%

(3) 3

(4) 60

$y_1 = 4\sin(500\pi t)$

$y_2 = 2\sin(506\pi t)$

$\omega_1 = 500\pi$

$\omega_2 = 506\pi$

$2\pi f_1 = 500\pi$

$f_1 = 250$

$2\pi f_2 = 506\pi$

$f_2 = 253\,\text{Hz}$

$f_2 - f_1 = 253 - 250$

$f_2 - f_1 = 3$

QUESTION

Two source of sound placed close to each other, are emitting progressive waves given by $y_1 = 4 \sin 600\pi t$ and $y_2 = 5 \sin 608\pi t$. An observer located near these two source of sound will hear

1. 8 beats per second with intensity ratio 81 : 1 between waxing and waning
2. 4 beats per second with intensity ratio 81 : 1 between waxing and waning
3. 4 beats per second with intensity ratio 25 : 16 between waxing and waning
4. 8 beats per second with intensity ratio 25 : 16 between waxing and waning

$\omega = 2\pi f = 600\pi$

$f_1 = 300$

$f_2 = 304$

$I_{max} = (5+4)^2 = 81$

$I_{min} = (5-4)^2 = 1$

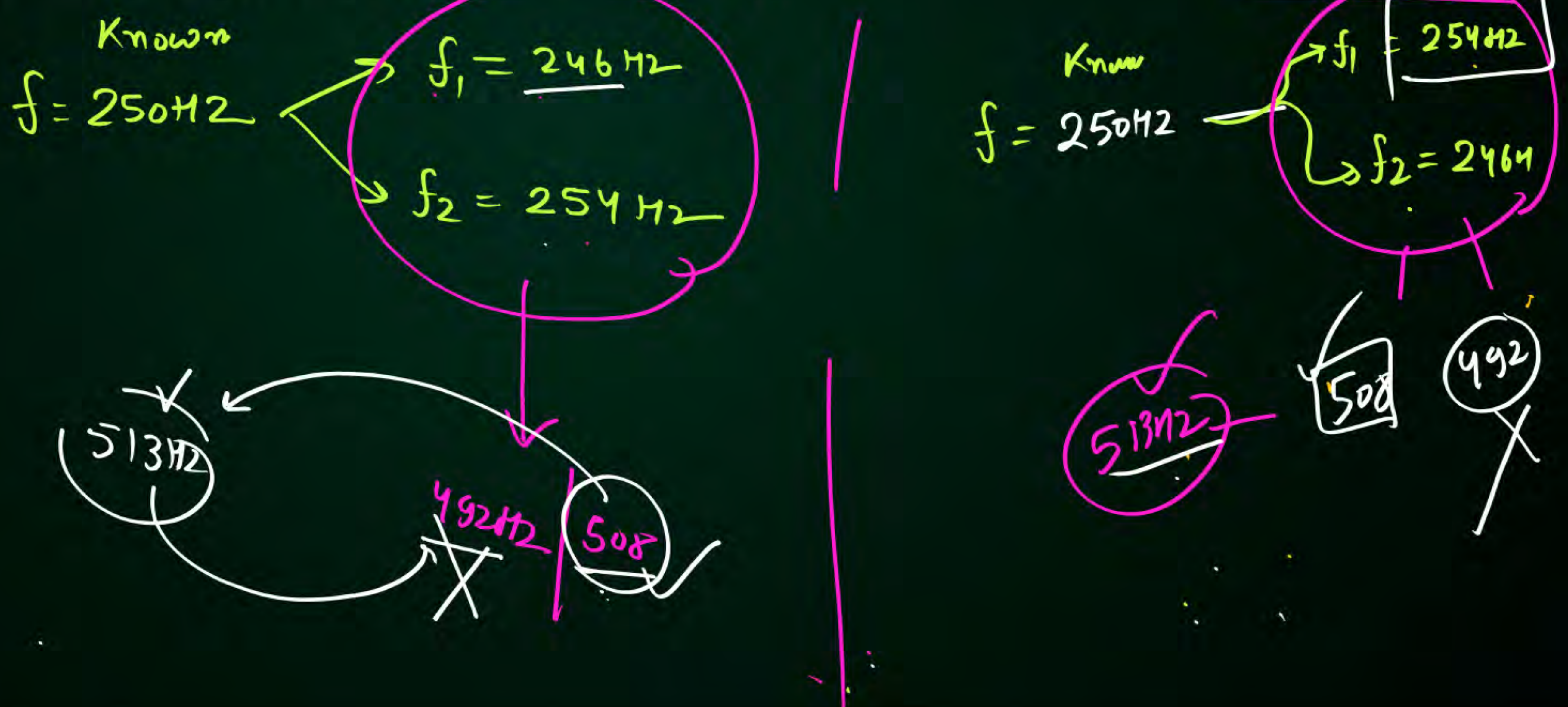
Ans

Maxima Minima

QUESTION

A source of unknown frequency gives 4 beats/s, when sounded with a source of known frequency 250 Hz. The second harmonic of the source of unknown frequency gives five beats per second, when sounded with a source of frequency 513 Hz. The unknown frequency is [NEET-2013]

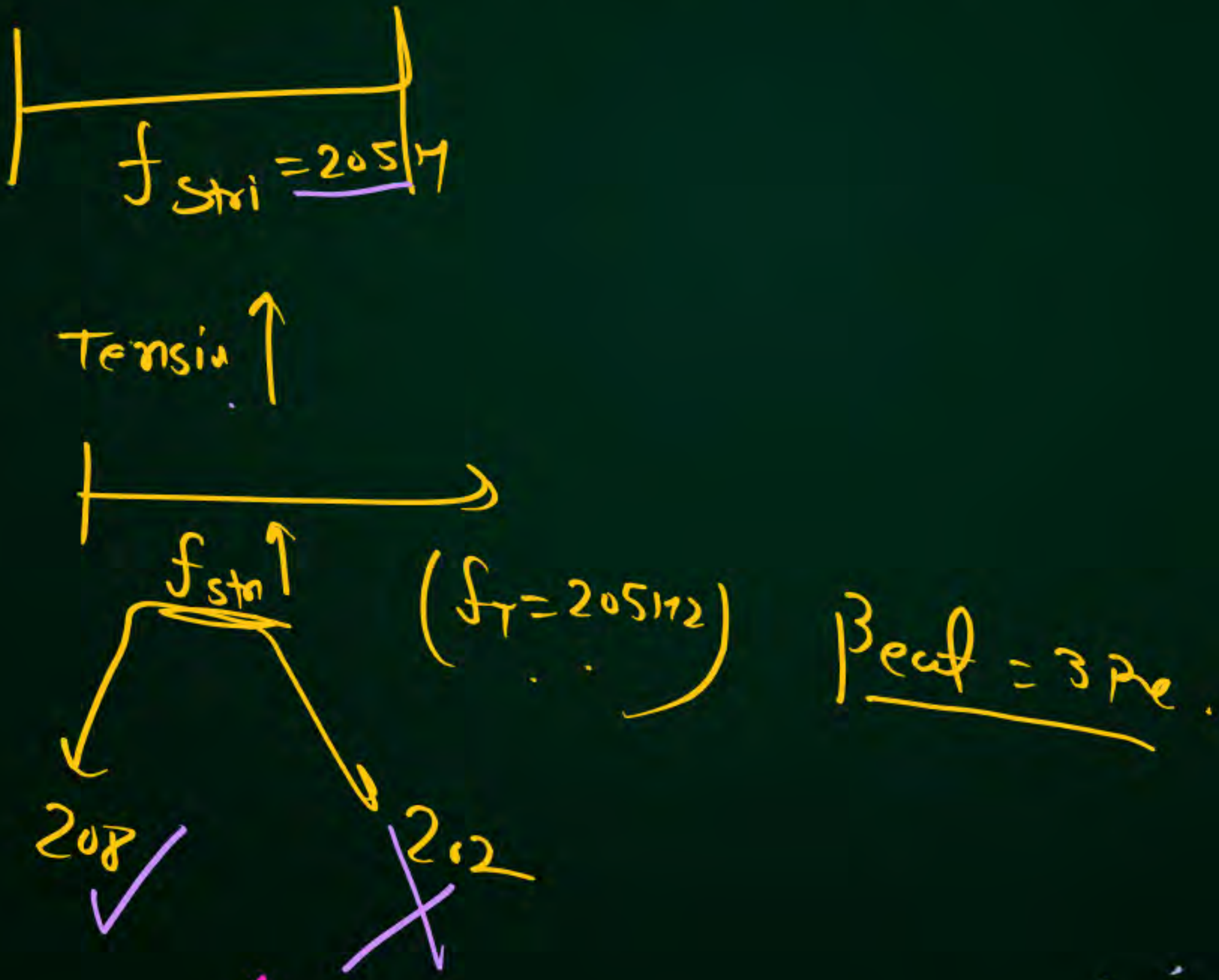
1. 246 H
2. 240 Hz
3. 260 Hz
4. 254 Hz



QUESTION

The string of a violin emits a note of 205 Hz at its correct tension. The string is tightened slightly and then it produces six beats in two second with a tuning fork of frequency 205 Hz. The frequency of the note emitted by the taut string is

1. 211 Hz
2. 199 Hz
3. 208 Hz
4. 202 Hz



QUESTION

A source of frequency v gives 5 beats/second when sounded with a source of frequency 200 Hz. The second harmonic of frequency 2v of source gives 10 beats/second when sounded with a source of frequency 420 Hz. The value of v is

1. 205 Hz
2. 195 Hz
3. 200 Hz
4. 210 Hz

QUESTION

When two tuning forks (fork 1 and fork 2) are sounded together, 4 beats per second are heard. Now some tape is attached on the prong of the fork 2. When the tuning forks are sounded again, 6 beats per second are heard. If the frequency of fork 1 is 200 Hz, then what was the original frequency of fork 2?

1. 204 Hz
2. 196 Hz
3. 202 Hz
4. 200 Hz

QUESTION

A tuning fork of unknown frequency produces 4 beats per second when sounded with another tuning fork of frequency 254 Hz. It gives the same number of beats per second when unknown tuning fork loaded with wax. The unknown frequency before loading with wax is

1. 258
2. 254
3. 250
4. Can't be determined

QUESTION

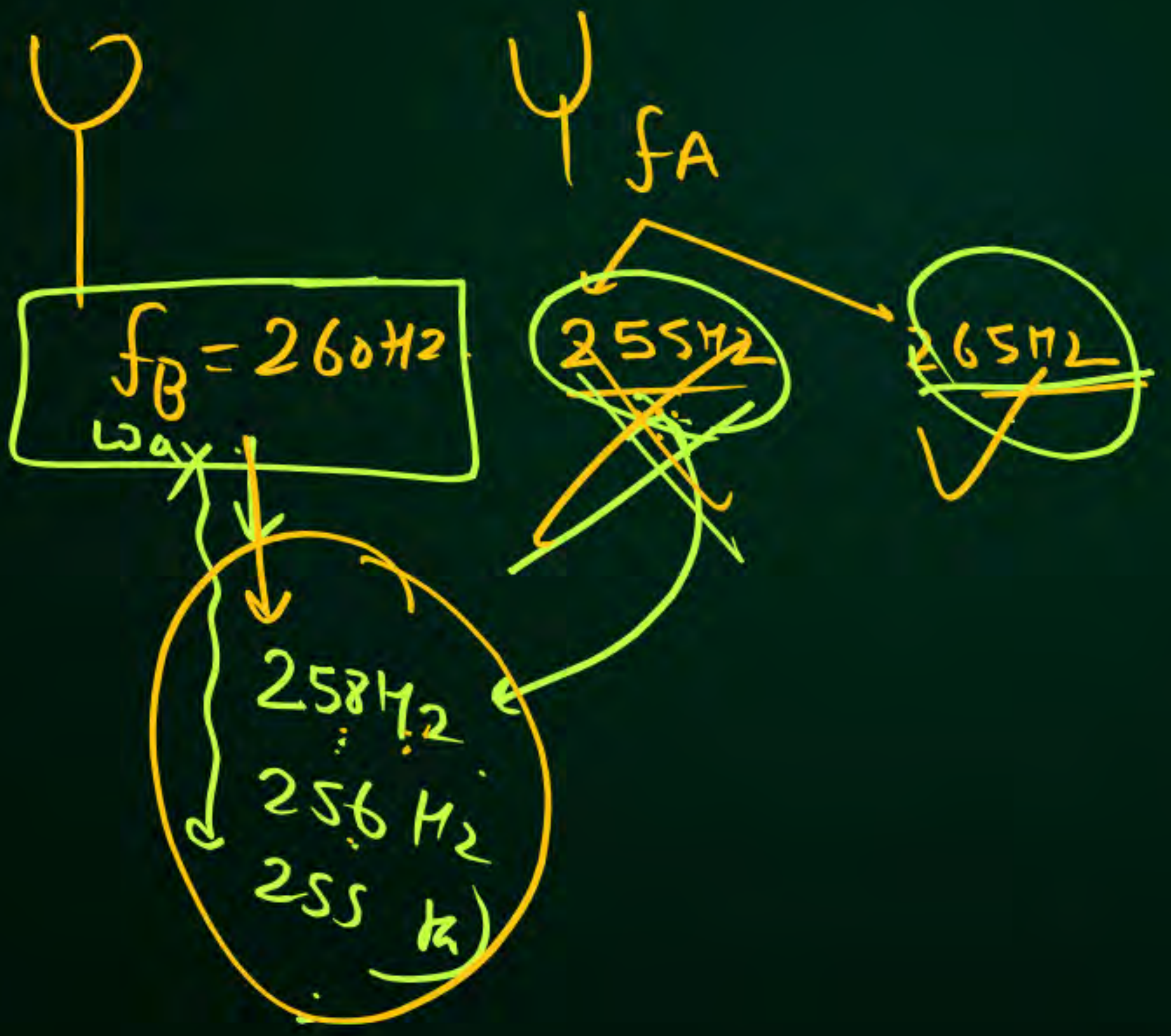
Ten tuning forks are arranged in increased order of frequency in such a way that any two consecutive tuning forks produce 4 beats per second. The highest frequency is twice that of the lowest. Possible highest and lowest frequencies (in Hz) are

1. 80 and 40
2. 100 and 50 Basic math
3. 44 and 22
4. 72 and 36

QUESTION

Two tuning fork A and B are sounded together gives 5 beats per second. If frequency of B is 260 Hz and after loading B with wax the beat frequency increase the frequency of A is

1. 265 Hz
2. 255 Hz
3. 260 Hz
4. 250 Hz




THANK YOU
1:30 12th class

YAKEEN 2.0

FOR NEET 2025

Lecture- 01 | **Physics**

Electric Charges and Fields

15th NOV

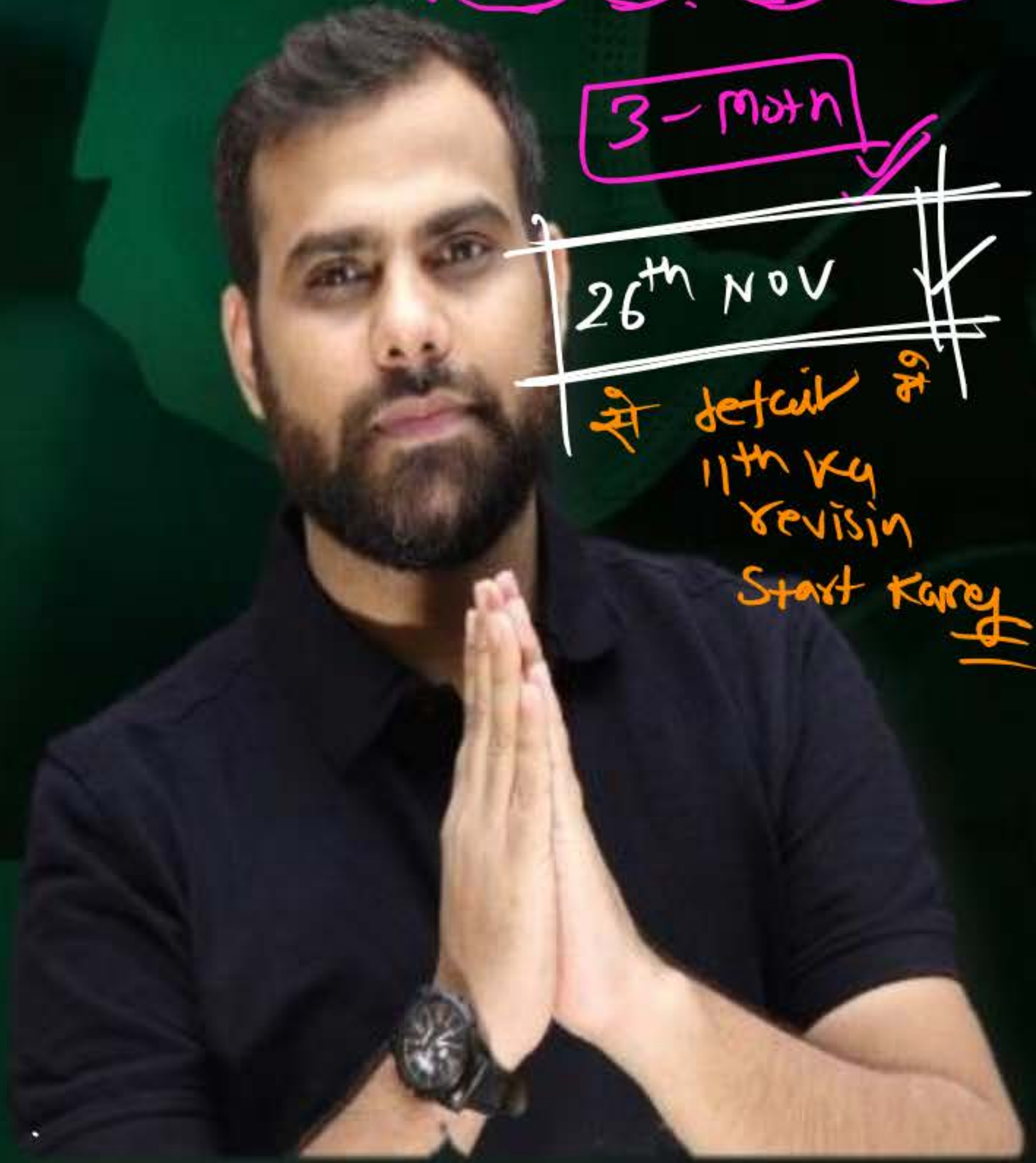
12th start kar rahe hai

half NOV, DEC, JAN, feb

3-Moth

26th NOV

से detail में 11th ka revisin start karey



By- Dr. Manish Raj (MR SIR)

Topics to be covered

1. # feel of electric charge
2. #
3. #



Electromagnetism.

Electric charge & field → electric Potential & Capacitor → Electric current → M.E.C → magnetism → E.M.I → A/c → EM wave

optics
- Ray optics
- wave optics

Modern Physics
- P.E.E
- dual nature
- atom, nuclear physics

Semiconductor

NEET → 60% - 55% 12th

40% - 45% 11th

Charge → Not visible
→ property of matter by virtue of which, matter apply or experience (Electro-magnetic force).

fundamental force

1, gravitational force
(2) Electro-magnetic force
3, strong nuclear force
4, weak Nuclear force

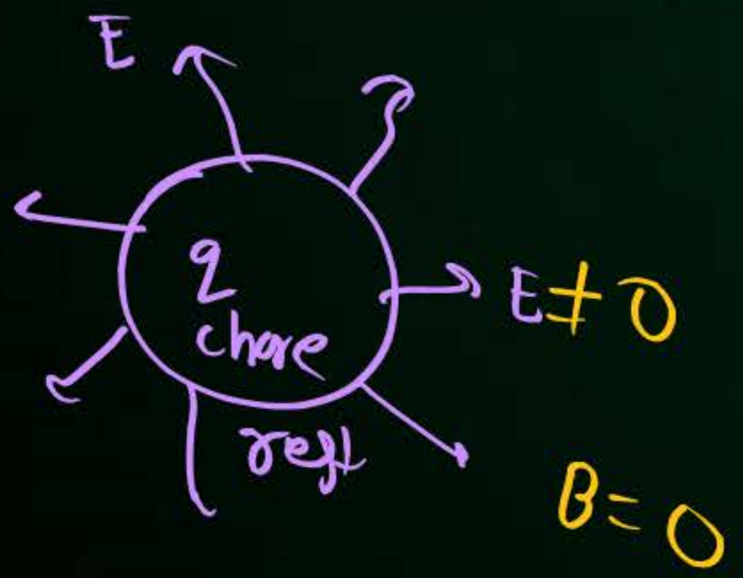
MASS

↳ cause of gravitational force $F = \frac{G m_1 m_2}{r^2}$

- Quantity of matter contained in a body — 8th/9th class
- Properties of object due to which it apply or experience gravitational force always attractive
- Mass is nothing but form of energy
  ↳ gr (modern physics)

ELECTRIC FIELD AND CHARGES

State of Charge	Electric field	Magnetic field	EM wave
1. Rest	✓	✗	✗
2. Constant velocity	✓	✓	✗
3. accelerated	✓	✓	✓



q → $\vec{v}$ = const

$\vec{E} \neq 0$

$\vec{B} \neq 0$

E.M. wave = 0

q → acceleration

E ✓

B ✓

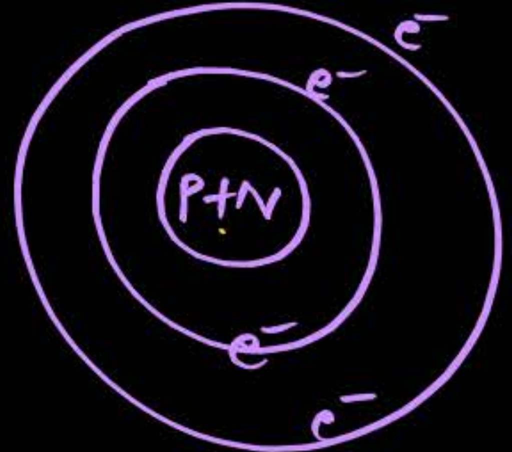
EM wave ✓

charge → पूरा e^- ka Jhol है।

Body have -ve charge does not have any electron → Not Possible
Body have +ve charge does not have any electron → yes. $_2He^{4++}$
Body have some charge, but Mass of body is zero → Not possible.
Body is neutral (No charge) but have some mass → yes.



← Some extra e^-s given to this neutral atom



Some e^-s are removed →



6 electron
4-Proton, 4 Neutron
(excessness of electron)
$Q = -ve$
M_1 (Increase)

4 Proton + 4 Neutron + 4 electron
$Q_{atom} = 0$ {neutral}
no. of Proton = no of e^-
M_0 (let)

4 Proton, 4 -Neutron
2 e^-
(deficiency of e^-)
$Q = +ve$
M_2 (↓)
(decrease).

HOW DOES A BODY ATTAIN ANY CHARGE ??



Neutral

No. of P = No. of e-

$Q_{net} = 0$

CHARGE

\# Property of object by virtue of which it apply or experience electromagnetic force

\# ➤ Scalar

$I = \frac{q}{t}$

$q = It$ = Amper-sec = coulomb

➤ S.I. unit : (C) columb

➤ C.G.S. unit : e.s.u (electrostatic unit)

\# 1 C = 3×10^9 e.s.u

➤ Practical unit : e.m.u (Electromagnetic unit)

$1C = \frac{1}{10}$ emu

➤ Smallest unit : (e.s.u) / frankline

➤ Largest unit : 1 faraday = 96500C

TYPES OF CHARGE

(1) **Positive charge :** deficiency of electrons

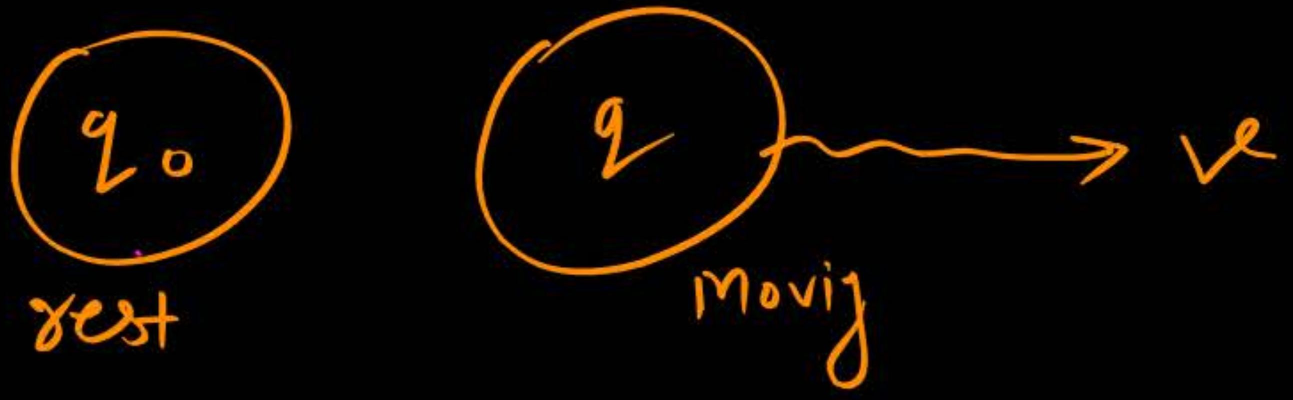
(2) **Negative charge :** excessness of electrons

Neutral body is not a type of charge, it mince uncharged body,

no. of electrons = no. of proton

Ex - Neutron

Charge is Invariant



$$q = q_0$$

Value of charge on a body does not depends on speed.

Mass, length, time

→ variant (depends on speed)

$$m = \frac{m_0}{\sqrt{1 - v^2/c^2}}$$

m → moving mass of object

If $v = c$, $m = \frac{m_0}{\sqrt{1 - c^2/c^2}} = \frac{m_0}{0} = \infty$

$$l = l_0 \sqrt{1 - v^2/c^2}$$

as speed ↑ length ↓

Specific charge

$$S = \frac{\text{charge}}{\text{mass of a body}}$$

for e^-

$$S = \frac{e}{m_e}$$

↑ Specific charge of e^-

for proton

$$S_p = \frac{e}{m_p}$$

$$S_{e^-} > S_p$$

for deutron ($1P + 1N$)

$$S_D = \frac{e}{2m_p}$$

for α-parti ($2P+2N$)

$$S_\alpha = \frac{2e}{4m_p}$$

$$S_\alpha = \frac{e}{2m_p}$$

If charge is moving with increasing speed then its charge & specific charge will be ??

Sol^n

charge → Same

$S = \frac{q \leftarrow \text{same}}{m\uparrow} = $ (decrease)

Quantization of charge

→ half e^- or fraction of e^- is not possible.

$Q = e = 1.6 \times 10^{-19} C$ (minimum)

$Q_{\text{next possible charge}} = 2e = 2(1.6 \times 10^{-19} C) = 3.2 \times 10^{-19} C$ ✓

Charge is possible in fraction ✓

no. of e^- can't be in fraction ✓

$Q = ne$

n = fraction ✗
$n = 1.5$ ✗

$n = +1, +2, +3, +4, +5, +6 \ldots$ (deficiency of e^-)

$n = -1, -2, -3, -4, -5,$ excess of e^-

length mass are not quantized

Charge is possible in fraction → NO (a) ✗ 54% → Yes (b) ✓

$Q = ne$

$n = \frac{Q}{e}$ → must be whole no.

QUANTIZATION OF CHARGE

Value of charge on the body must be an integral multiple of the fundamental charge that is charge of electron

$$Q = \pm ne$$

$n \rightarrow$ excess of electron

$n \rightarrow$ deficiency of electron

QUESTION

Which of the following is not the unit of charge?

1. farad
2. coulomb
3. stat coulomb
4. faraday


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 02 | **Physics**

Electric Charges and Fields



By- Dr. Manish Raj (MR SIR)

Todays Goal

→ Properties of charge

& Method of charging

Charge → Property of a body, by which it experience and apply electro-magnetic force,

→ charge does not have direction (Scalar)

→ S.I Unit (1A-sec) = coulomb. (1 esu = franklin = smallest unit of charge)

→ C.G.S 1C = 3×10^9 esu

→ Practical unit 1C = $\frac{1}{10}$ emu.

→ 1 faraday = 96500 C ⇒ faraday is largest Unit of charge.

→ charge is Invariant → does not depends on speed.

→ Two type of charge. -ve charge → excessency of electron.

+ve charge → deficiencey of electron,

during -ve charging mass ↑ / during +ve charge mass ↓

⊕ R ⊕

⊖ R ⊖

⊕ A ⊖

[opposite nature of charge → must attract ; same nature of charge → repel.]

* one charge & other neutral → / same nature of charge → [May Electrostatic Attract. (Induction)]

sure check of charge is Repulsion.

Carge can't exist without mass, but mass can exist without charge.

$Q = ne$

n = −1, −2, −3, −4. → excess of e⁻

n = +1, +2, +3, +4 deficient of e⁻

Charge is Quantize → Integral multiple of e⁻

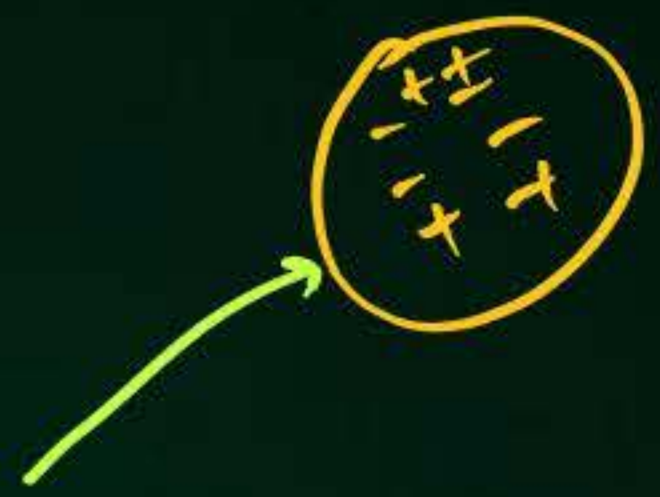
charge charge follow scalar addition, charge is trasferable.

Charge is conserved,

excess charge on the body always on the surface, & charge density high on sharp edge.

QUESTION (1.)

Neutral body can be negatively charged by



1. giving some excess proton ✗
2. giving some extra neutron ✗
3. giving some extra electron ✓
4. removing some proton ✗
5. removing some electron ✗

QUESTION

A positively charged body can be make neutral by

1. giving some electron
2. giving some proton
3. removing some proton.
4. None of these

QUESTION

During charging of body mass of the body increases then body becomes

1. Positively charge
2. remains neutral
3. Negatively charge
4. None of these

QUESTION

Smallest unit of charge is

1. frankline ✓ (e.s.u)
2. Faraday
3. coulomb
4. e.m.u.

QUESTION

If a body has positive charge on it, then it means it has

1. Gained some protons
2. Lost some protons
3. Gained some electrons
4. Lost some electrons ✓

QUESTION

Sure check for presence of electric charge is

1. Process of induction
2. Repulsion between bodies
3. Attraction between bodies
4. Frictional force between bodies

QUESTION

Which of the following is not true about electric charge?

1. Charge on a body is always integral multiple of certain charge known as charge of electron
2. Charge is a scalar quantity
3. Net charge on an isolated system is always conserved
4. Charge can be converted into energy and energy can be converted into charge

QUESTION

Select the correct statement about electric charge

1. Charge can be converted into energy and energy can be converted into charge
2. Charge of a particle increases with increase in its velocity
3. Charge on a body Is always integral multiple of a certain charge called charge of electron
4. Charge on a body is always positive or zero

QUESTION

Which of the following charge is not possible ?

(A) 1.6×10^{-18} C ✓

(B) 1.6×10^{-19} C ✓

(C) 1.6×10^{-20} C ✓✓
70%

(D) None of these ✗

$Q = ne$

$1.6 \times 10^{-18} = n \, 1.6 \times 10^{-19}$

$n = 10$

$1.6 \times 10^{-20} = n \, 1.6 \times 10^{-19}$

$n = \frac{10^{-20}}{10^{-19}} = 10^{-1} = 0.1$ ✗

$Q = 0.34C$

→ Possible (a) 71%

Not Possible (b) 27%

$Q = ne$

$0.34C = n \, 1.6 \times 10^{-19} C$

$n = \frac{0.34}{1.6 \times 10^{-19}}$

$= \frac{34}{160} \times 10^{+19}$

$n = \frac{34}{16} \times 10^{18} = 2.1 \times 10^{18}$ ✓ $= 21 \times 10^{17}$

$Q = \frac{1}{10} C$ ✓

$Q = \frac{1}{200} C$ ✓

$Q = 1.1C$ ✓

$Q = 1.3789C$ ✓

$Q = 3600C$ ✓

$Q = 3.1 \times 10^{-11} C$ ✓

MR*

$Q = 4.8 \times 10^{-20} C$ ✗

→ Not Possible

$$Q = 32 \times 10^{-20}\ C$$

(a) Not Possi (50%)

(b) Possible. (48%)

$$Q_{min} = 1.6 \times 10^{-19}\ C$$

** $\Rightarrow$ $Q = ne$

$$32 \times 10^{-20} = n \times 1.6 \times 10^{-19}$$

10^{-1}

IMP* $Q = ne$

$$\frac{32}{10} = n\ 1.6$$

$$3.2 = n\ 1.6$$

2

$n = 2$

$$Q = 1.1\,C$$

$$Q = ne$$

$$1.1\,C = n\,1.6 \times 10^{-19}\,C$$

$$n = \frac{1.1}{1.6} \times 10^{+19}$$

→ Posbile

$$Q = 1.1\,e$$

(a) Possible 34%

(b) Not Possille (65%)

$$Q = ne$$

$$1.1\,e = ne$$

$$n = 1.1$$ ✗

QUESTION

Which of the following charge is possible.

(A) $1C/100 = 0.01C$ ✓ → 77%

(B) $1e/50$ ✗

(C) 4.8×10^{-23} C ✗

(D) 1.56×10^{-18} C ✗

$1.56 \times 10^{-18} = n\, 1.6 \times 10^{-19}$

$\frac{15.6}{1.6} = n$

QUESTION

Which of the following charge exist ?

(a) 1.6×10^{-20} C

(b) 3.2×10^{-17} C

(c) 3.24×10^{-16} C

(d) 4.67 C

(e) 3.41 e

(f) 4.50×10^{-14} C

(g) 7.29×10^{-10} C

(h) 4.5×10^{-17} C

(i) $\frac{1}{100}$ C

(j) $\frac{1}{100}$ e

Sol^n

(c) $Q = ne$

$3.24 \times 10^{-16} = 1.6 \times 10^{-19} n$

$3.24 \times 10^{3} = 1.6\, n$

$\frac{324}{100} \times 10^{3} = \frac{16}{10} n$

$n = \frac{324}{16} \times 10^{2}$

$= 20.25 \times 10^{2}$

$= 2025$

QUESTION

Charge developed on the body if 10 e^- is removed from that body.

deficiency ($n = +10$)

$$Q = ne$$

$$= +10 \times 1.6 \times 10^{-19}\ C$$

$$= 1.6 \times 10^{-18}\ C$$

QUESTION

Which of the following is not true about electric charge?

1. Charge is a scalar quantity
2. Charge on an isolated system is always conserved
3. A particle having nonzero rest mass can have zero charge
4. A particle having zero rest mass can have non zero charge

QUESTION

Which of the following is not the unit of charge?

1. farad. Ans (1)
2. coulomb
3. stat coulomb (e.s.u)
4. faraday

QUESTION

A glass rod is rubbed with a silk cloth. The glass rod acquires a charge of 19.2×10^{-19} C. Find the number of electrons lost by glass rod.

$Q = ne$

$19.2 \times 10^{-19} = n \, 1.6 \times 10^{-19}$ C

$n = \frac{19.2}{1.6}$

$n = \frac{192}{16} = 12$

QUESTION

Find no of e^- transferred to create 1C charge.

$1C \rightarrow$ Bhot large amount of charge

$Q = ne$

$1C = n \; 1.6 \times 10^{-19}$

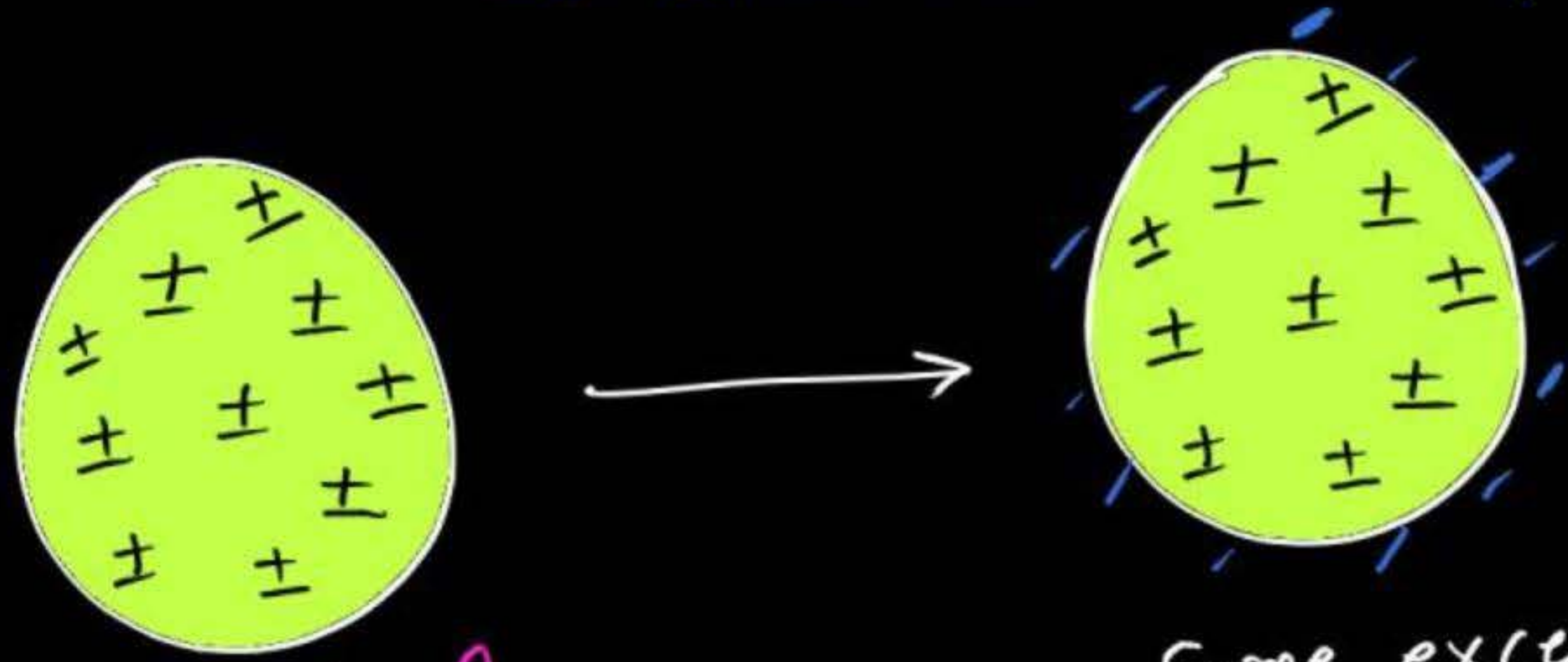
$n = \frac{1}{1.6 \times 10^{-19}}$

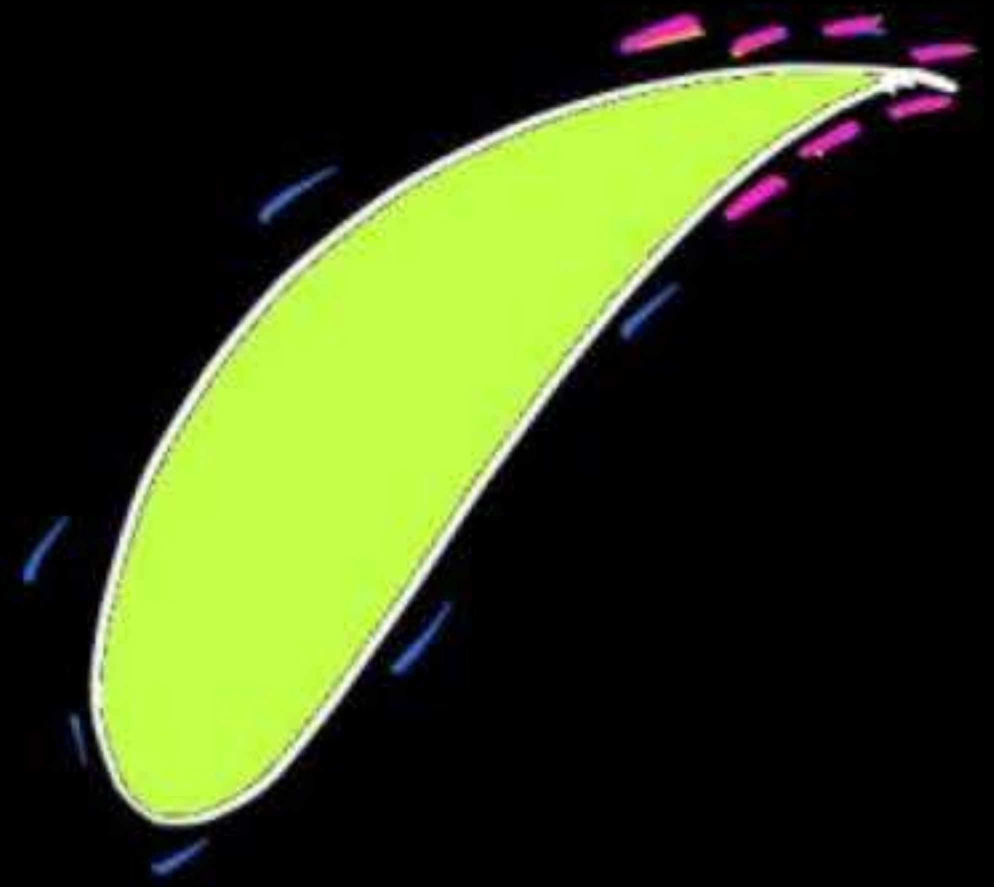
$= \frac{10^{19}}{1.6}$

* $n = \frac{10 \times 10^{18}}{1.6} = 6.25 \times 10^{18}$

Conductor ⟶ Having large no. of free e^-

⟶ which allow electricity





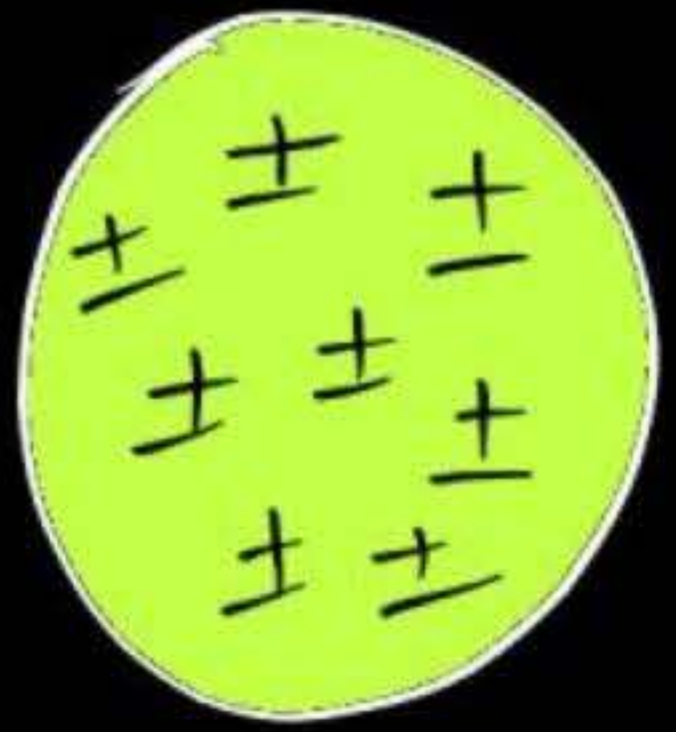
Q = neutral = 0

no. of e^- = no. of Proton

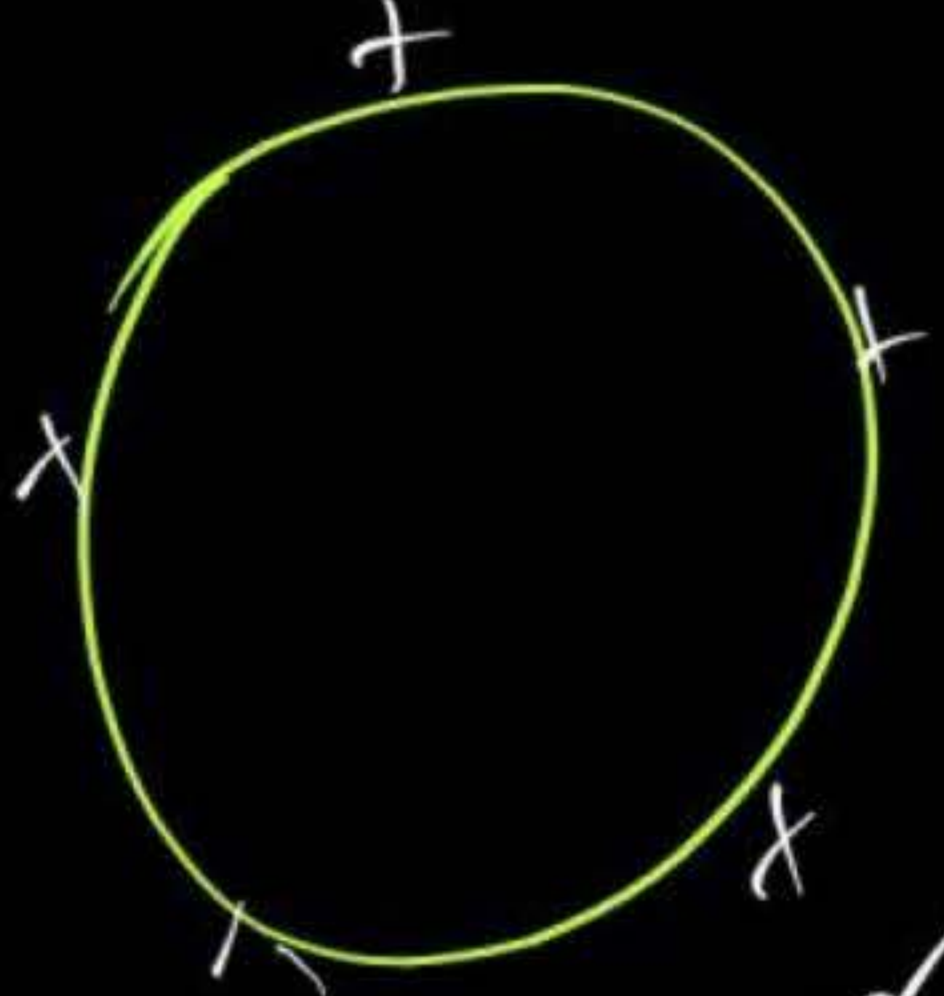
free e^-s are allow to Move inside volume of Conductor.

Some excess charge given to conductor resides on the surface of conductor.

Insulator


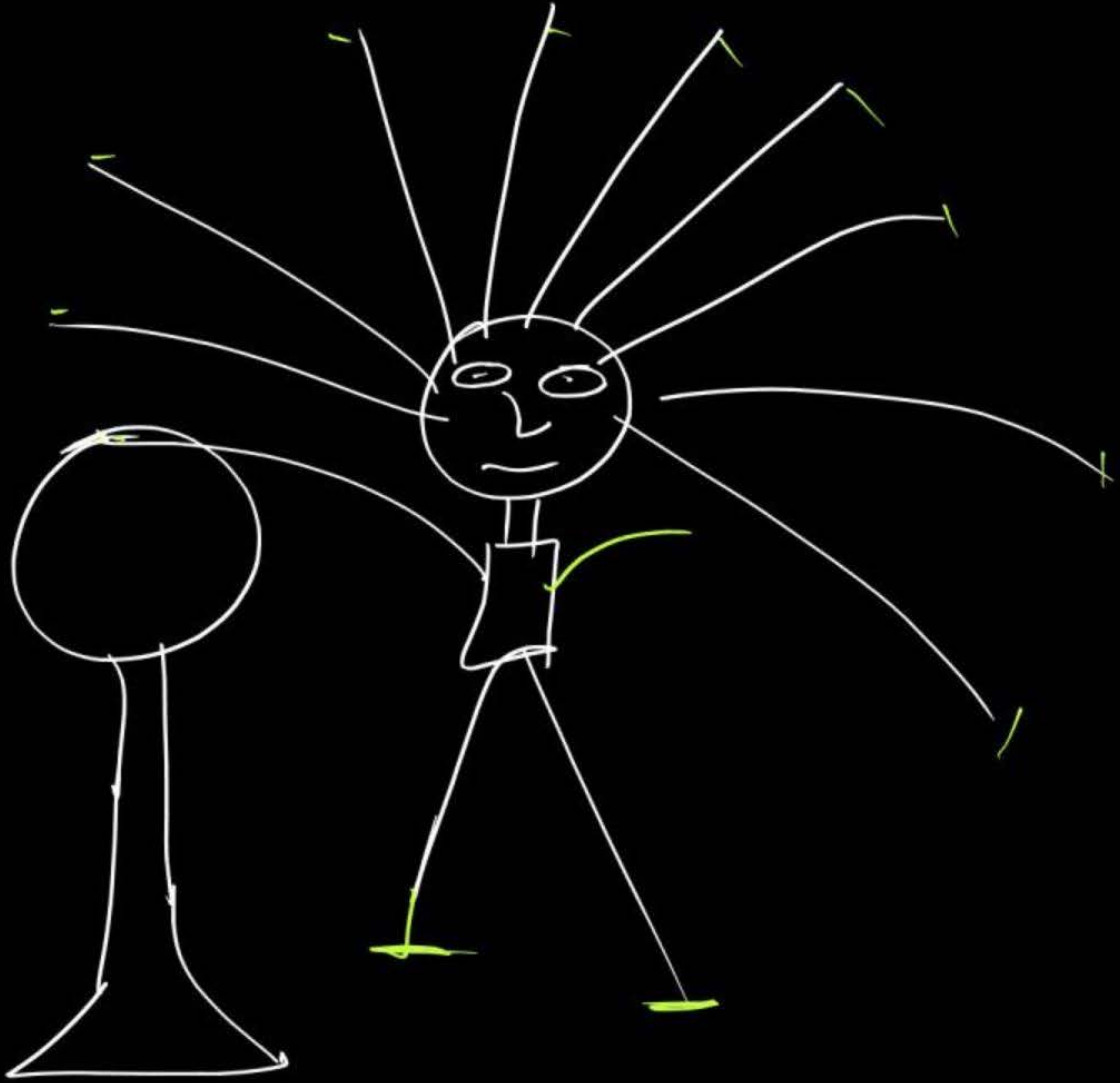
bonded e^-



conductor

Some excess charge given to Insulator, remains there where it is placed.


+Q
Q = 0
neutral conductor
Q = 0
neutral conductor (only sepration of charge)
Induction → sepration of charge
→ Not in Insulator
only In conductor or di-electric.
Q = 0
neutree insulator.
Q = 0
neutree insulator.



CONDUCTORS AND INSULATORS

- **In conductors, the valence electrons of the atoms can be easily removed from the atoms and moved about in conductor.**
- **In insulators, even the loosest bound electrons are too tightly bond to be easily removed from their atoms.**

QUESTION

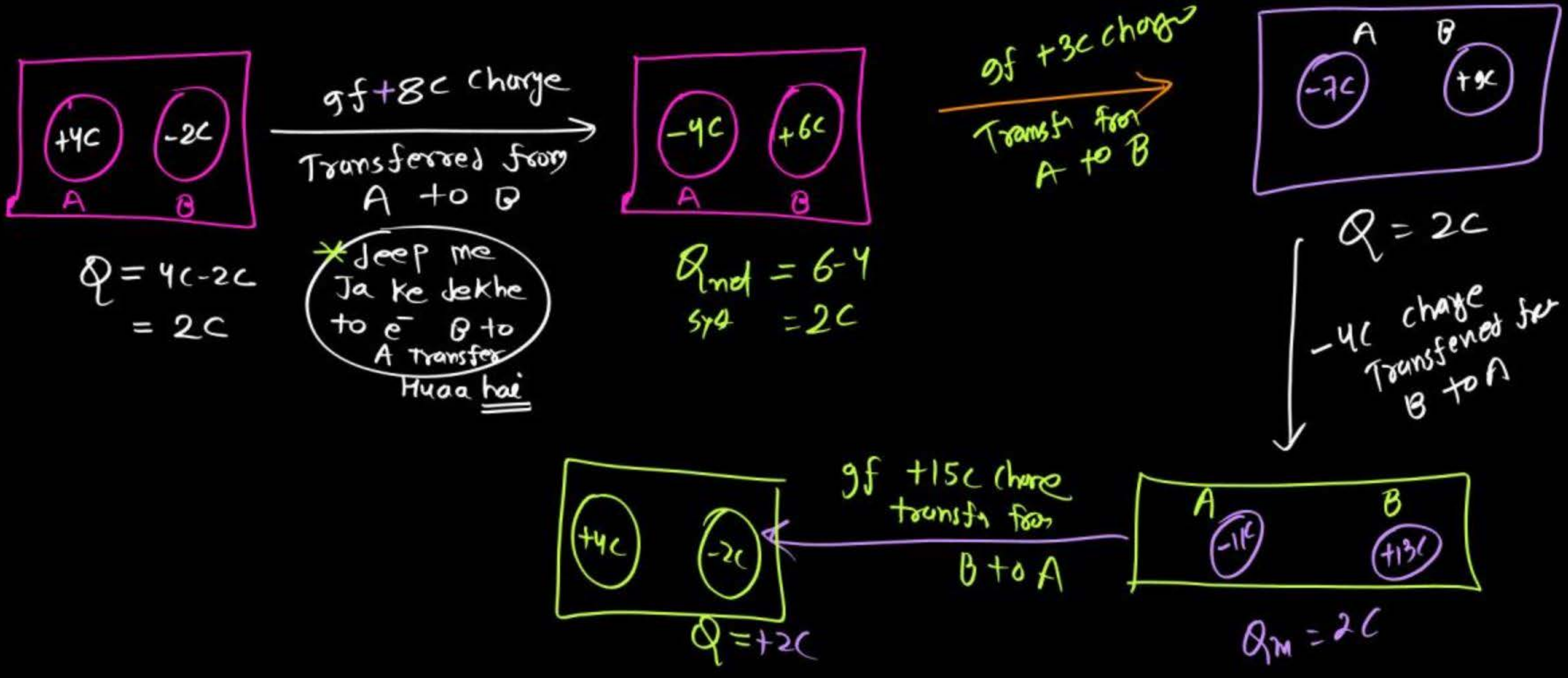
If a solid and a hollow conducting sphere have same radius then, some excess charge is given.

1. Hollow sphere will hold more maximum charge
2. Solid sphere will hold more maximum charge
3. ✓ Both the spheres will hold same maximum charge
4. Both the sphere can't hold charge



Conservation of charge

↳ No new Charge can be created or destroyed only charge can transfer from one body to other body.



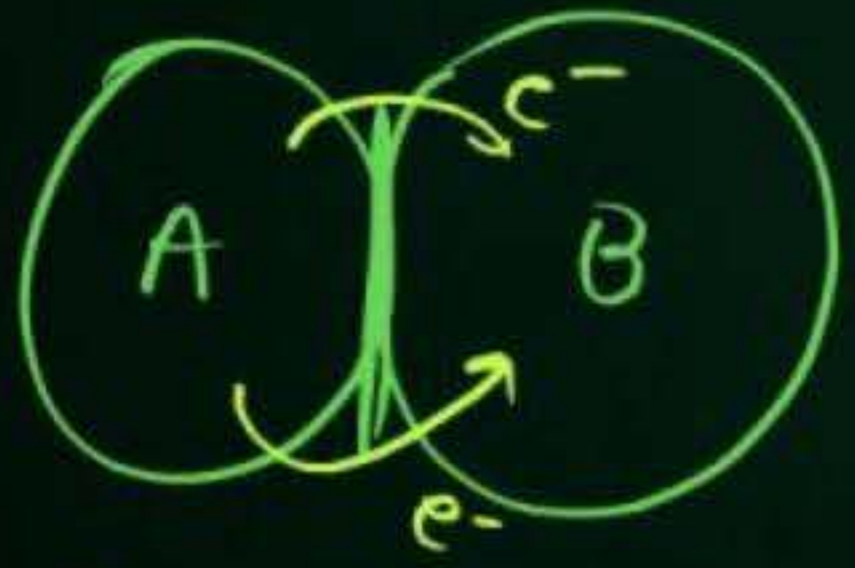
CHARGING OF A BODY

only for Insulator Not for Conductor

* **Charging by Friction:**

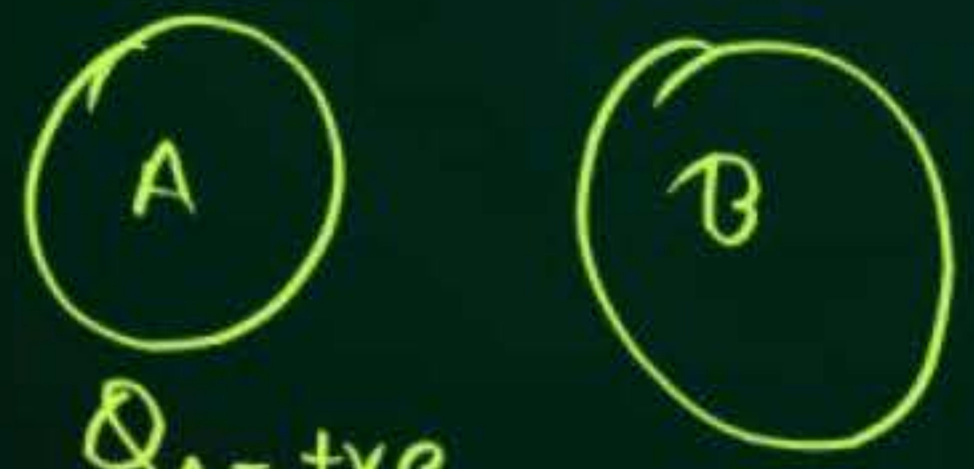
When two bodies are rubbed together, electrons are transferred from one body to the other making one body positively charged and the other negatively charged.

always equal & opposite nature of charge created on the body.



$Q_A = 0$ $Q_B = 0$

Both are neutral



$Q_A = +ve$

* deficiency of e^-

* $Q_B = -ve$

excess of e^-

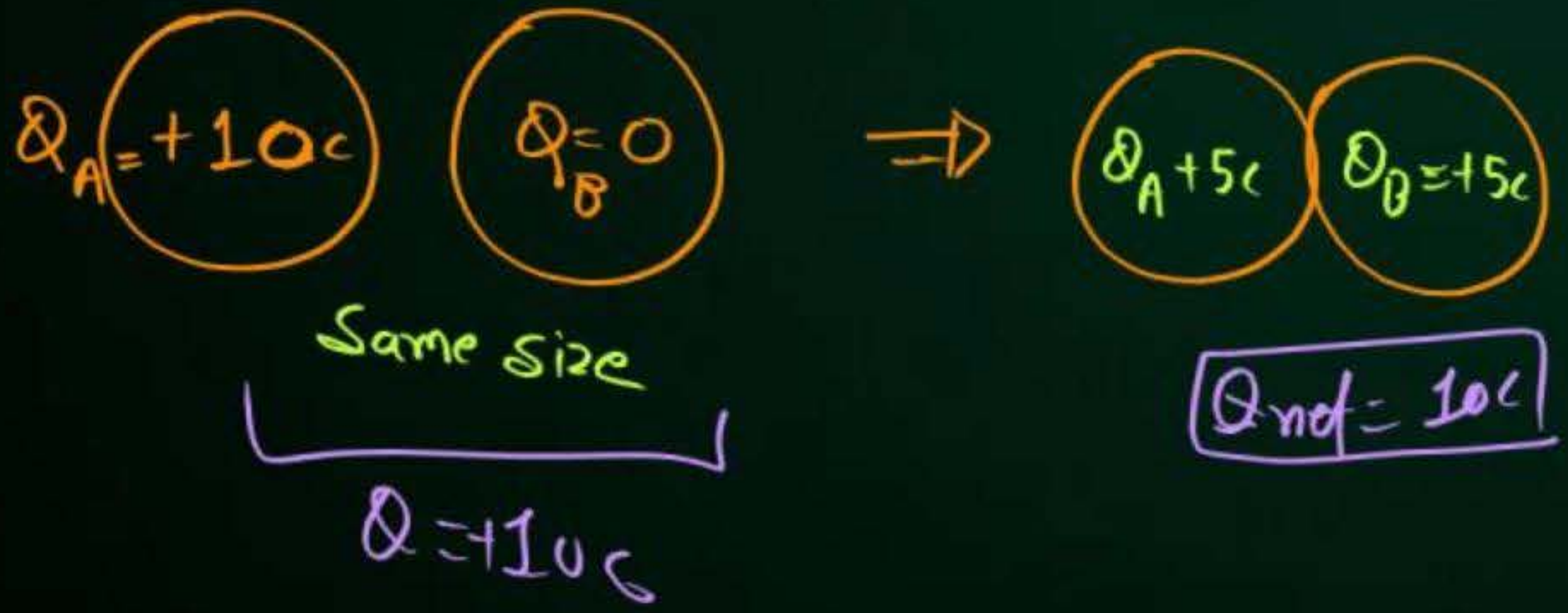
CHARGING OF A BODY

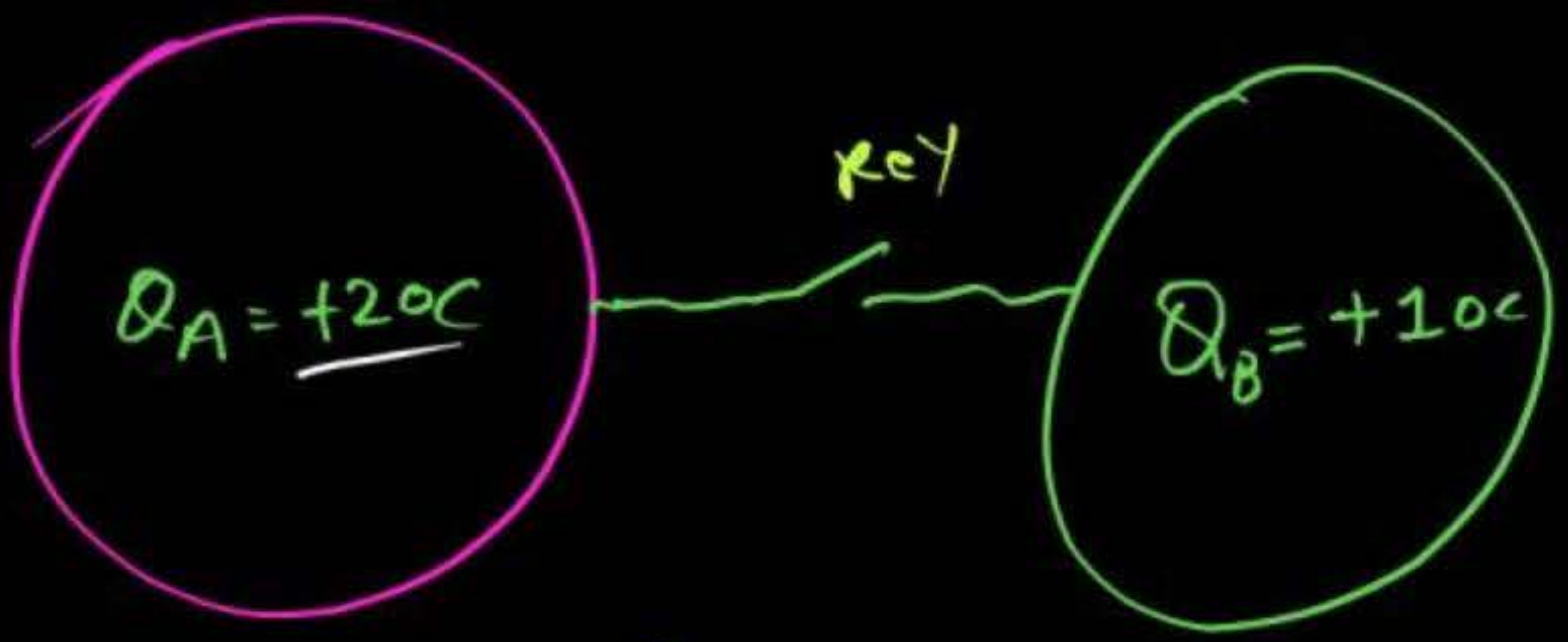
only for conductor

Not for Insulator & di-electric

Charging by Conduction:

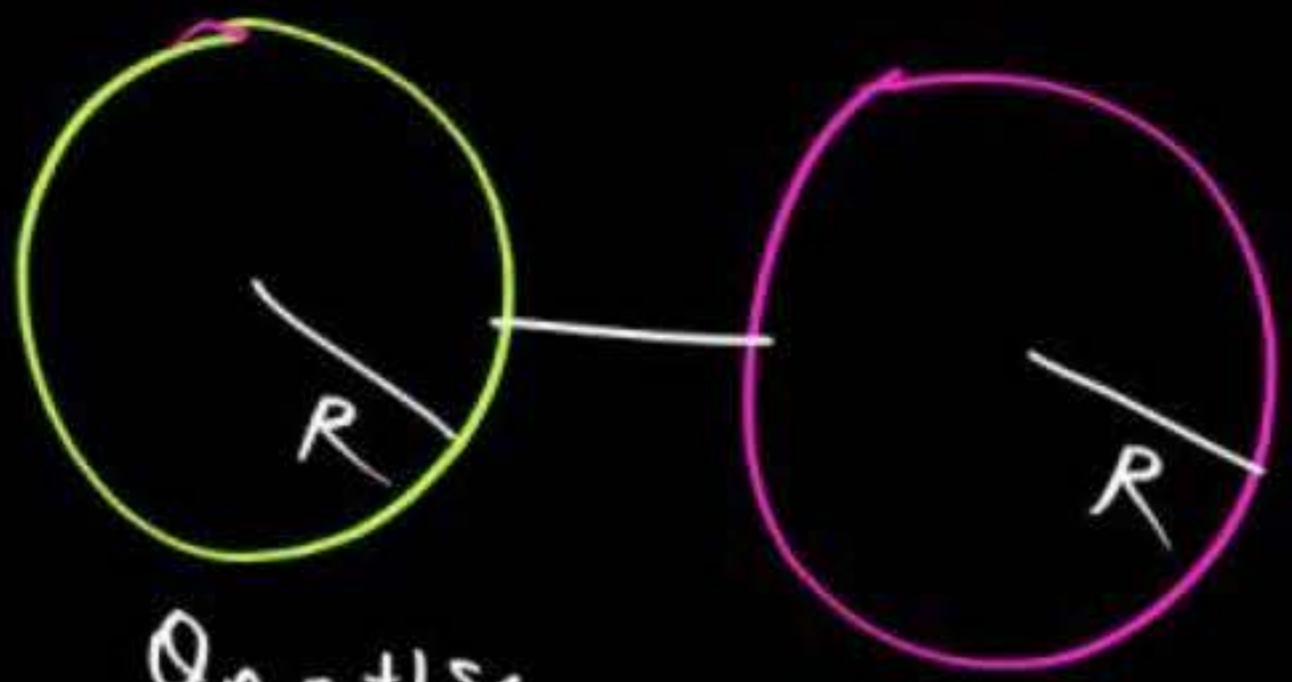
Conduction from a charged body involves transfer of Like Charges. A positively charged body can cause more bodies to get positively charged. But the sum of the total charge on all positively charged bodies will be the same as charge on initially considered charged body.





Same size

find final charge when key is closed

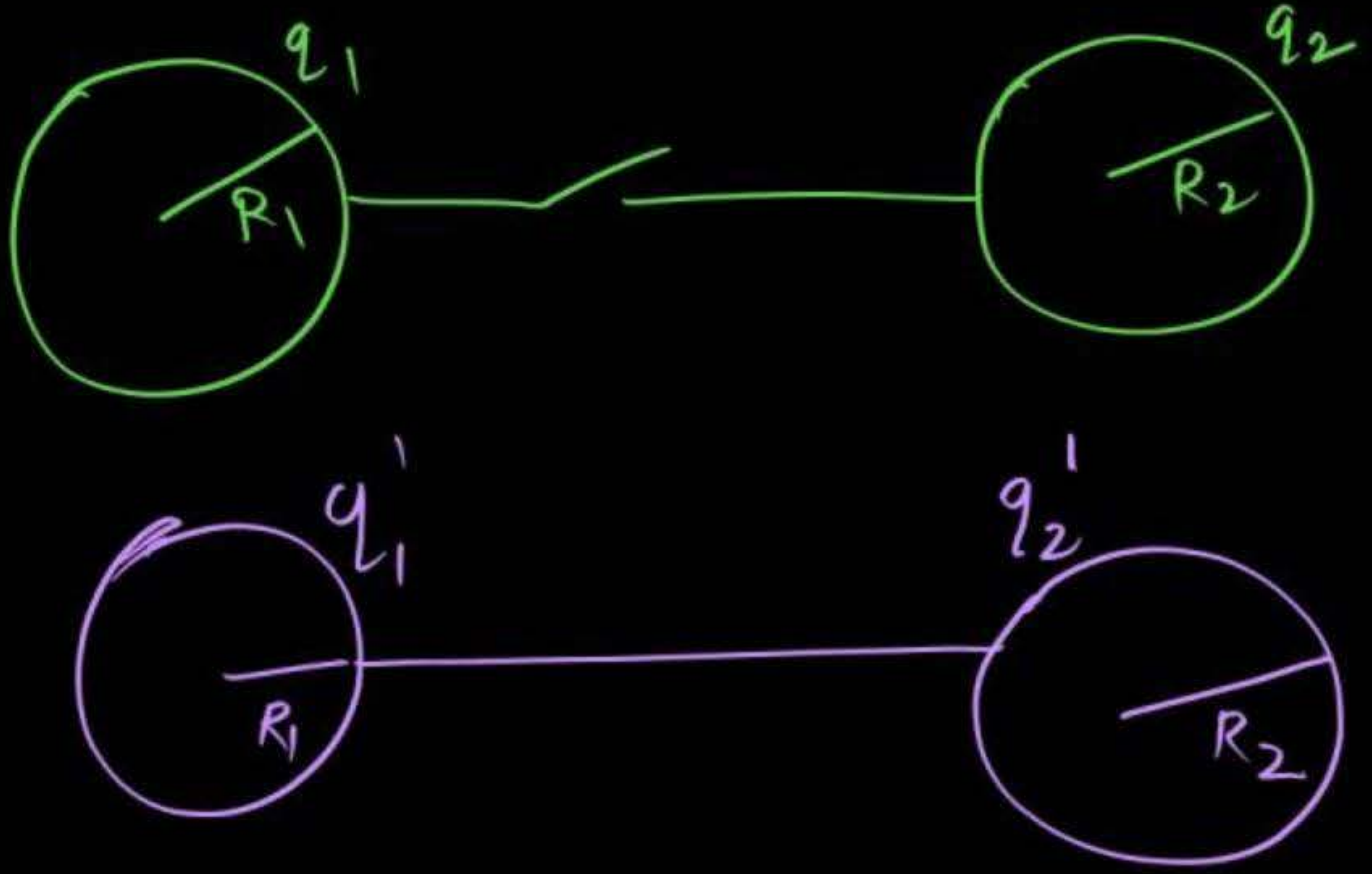


$Q_A = +15C$

$Q_B = +15C$

$Q_{net} = 30C$

Transfer of charge from one to other of diff^n radius



$$q_1' = (q_1 + q_2)\left[\frac{R_1}{R_1 + R_2}\right]$$

final charge on 1st sphere

$$q_2' = (q_1 + q_2)\frac{R_2}{R_1 + R_2}$$

$$q \left(\begin{matrix}\text{max}^n \text{ charge} \\ \text{holding cap}\end{matrix}\right) \propto R$$

QUESTION

When 10^{14} electrons are removed from a neutral metal sphere, then the charge on the sphere becomes

(1) $16\ \mu C$

(2) $-16\ \mu C$

(3) $32\ \mu C$

(4) $32\ \mu C$

QUESTION

A conductor has 14.4×10^{-19} C positive charge. The conductor has (charge on electron = 1.6×10^{-19} C)

1. 9 electrons in excess
2. 27 electrons in short
3. 27 electrons in excess
4. 9 electrons in short

QUESTION

Charge on α-particle is

1. 4.8×10^{-19} C
2. 1.6×10^{-19} C
3. 3.2×10^{-19} C
4. 6.4×10^{-19} C

QUESTION

A body has –80 micro column of charge. Number of additional electrons in it will be

1. 8×10^{-5}
2. 80×10^{-17}
3. 5×10^{14}
4. 1.28×10^{-17}

QUESTION

When a glass rod is rubber with silk, it

1. Gains electrons from silk
2. Gives electrons to silk
3. Gains protons from silk
4. Gives protons to silk

QUESTION

When a soap bubble is charged then its size

1. Increases
2. decreases
3. remains same
4. May increase or decrease depends on nature of charge

QUESTION

If point charge is placed vary near to the uncharged conducting sphere then net charge induced on sphere is

1. Zero
2. +ve
3. –ve
4. can't say

QUESTION

Two sphere of Radius R and 4R having charge 15C and –5C respectively, if they are placed in contact then find final charge on each sphere.

QUESTION

In induction the charge induced in the near surface of conductor is

1. Equal and similar
2. Unequal and similar
3. equal and dissimilar
4. zero

QUESTION

Electric charge X and Y repel each other and X and Z attract each other then nature of force between Y and Z

1. Attract
2. repel
3. zero
4. information not sufficient

QUESTION

When three identical sphere X, Y and Z having charge Q, $-2Q$ and $3Q$ respectively. At first X and Y are in contact then Y and Z are in contact then final charge on X, Y and Z will be

1. $\frac{Q}{2}, \frac{3Q}{2}, \frac{Q}{2}$
2. $\frac{-Q}{2}, \frac{5Q}{4}, \frac{+5Q}{4}$
3. Q, Q, Q
4. $\frac{Q}{2}, \frac{3Q}{2}, \frac{-Q}{2}$


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 03 | Physics

Electric Charges and Fields

By- Dr. Manish Raj (MR SIR)



Topics to be covered

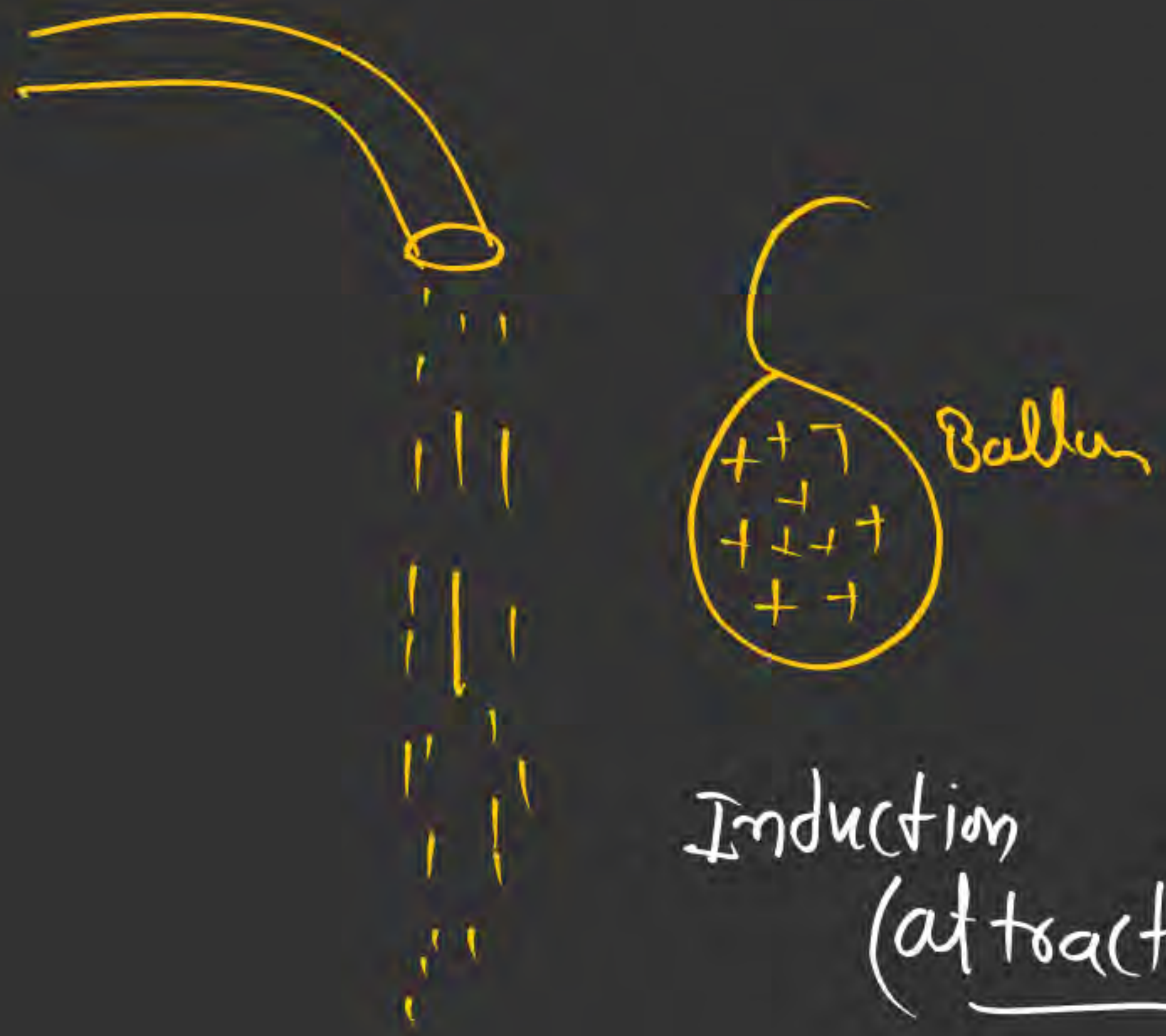
1. #
2. #
3. #

Todays Goal

method of charging

Coulombs law





Induction
(attraction)

METHOD OF CHARGING

(1) **Friction (Rubbing)** - for insulator only ; nor for conductor.

— When two bodies are rubbed together electron transfer from one body to other making 1st body positive (who lose e^-s)other body –ve (who gain e^-s)

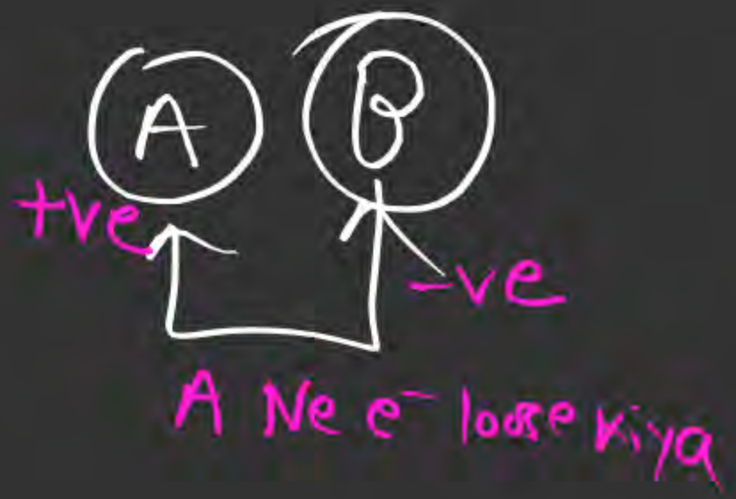
Equal and opposite chare appears on both the body

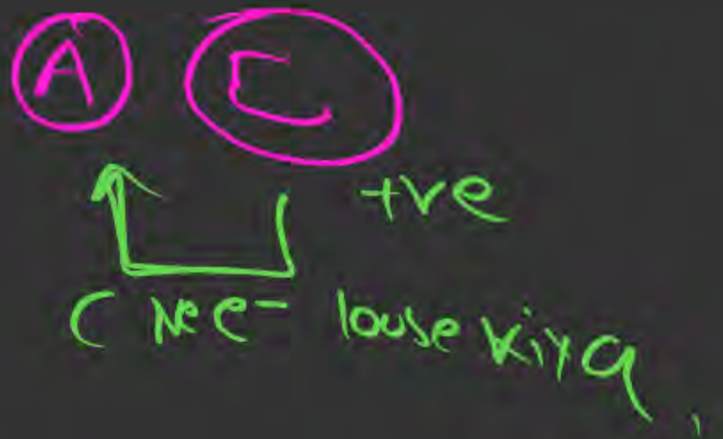
Ex. Clouds gets charge due to friction.

QUESTION

If an object made of substance A rubs an object made of substance B, then A becomes positively charged and B becomes negatively charged. If. however, an object made of substance A is rubbed against an object made of substance C. then A becomes negatively charged. What will happen if an object made of substance B is rubbed against an object made of substance C?

1. B becomes positively charged and C becomes positively charged.
2. B becomes positively charged and C becomes negatively charged.
3. B becomes negatively charged and C becomes positively charged.
4. B becomes negatively charged and C becomes negatively charged.

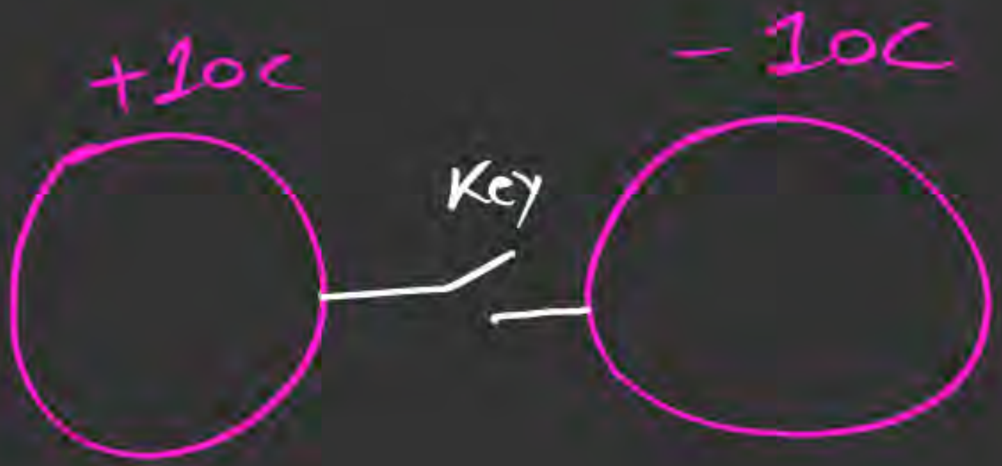

A
B
+ve
-ve
A Ne e⁻ loose kiya


A
C
+ve
C Ne e⁻ louse kiya

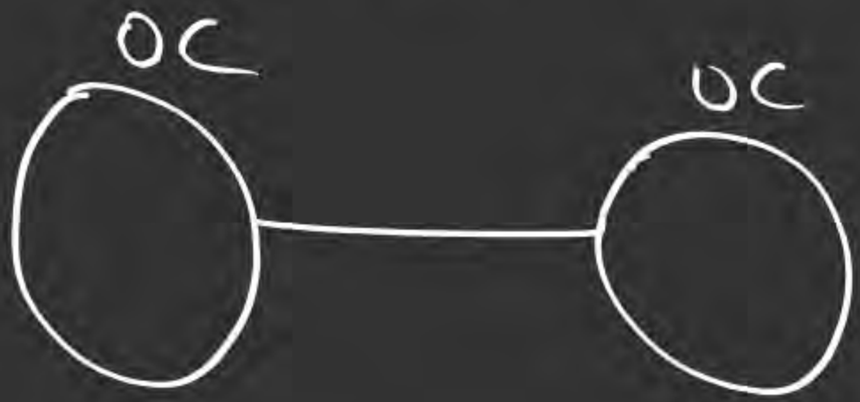

B > A > C
Strok
Weak

CHARGING ON CONDUCTION

- ✓ For conductor only *i* Not for insulator.
- ✓ In charging by conduction one body must be initially charged.
- ✓ When one charged body placed in contact with other neutral body then some charge flows to other body.
- ✓ Hence A positively charged body can cause more bodies to get positively charge.
- ✓ Also one negative charge body can cause more bodies to get negatively charge.



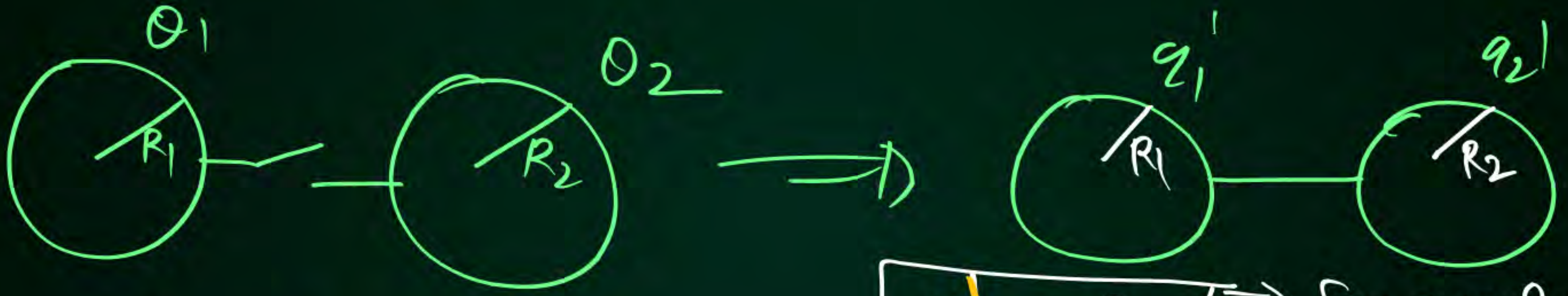
find final charge on each
when key is closed.



* Charge flows to make equal potential

QUESTION

Initially charge on spheres Q_1, and Q_2 having radius R_1 and R_2 respectively then find final charge on each when placed in contact or placed in touch with each other.



$$Q_1 + Q_2 = q_1' + q_2'$$

$$\frac{q_1'}{q_2'} \propto \frac{R_1}{R_2}$$ → for equal potential

$$Q_1 + Q_2 = q_1' + q_1' \frac{R_2}{R_1}$$

$$q_2' = \frac{R_2}{R_1} q_1'$$

$$Q_1 + Q_2 = q_1' \left(1 + \frac{R_2}{R_1}\right)$$

$$q_1'\left(\frac{R_1+R_2}{R_1}\right) = Q_1+Q_2$$

$$q_1' = \left(\frac{R_1}{R_1+R_2}\right)(Q_1+Q_2)$$

→ dim^m

→ $q_1' \propto R_1$

MP*

If $R_1 = R_2$

$$q_1' = \frac{Q_1+Q_2}{2}$$

MP*

$R_2 = 0$

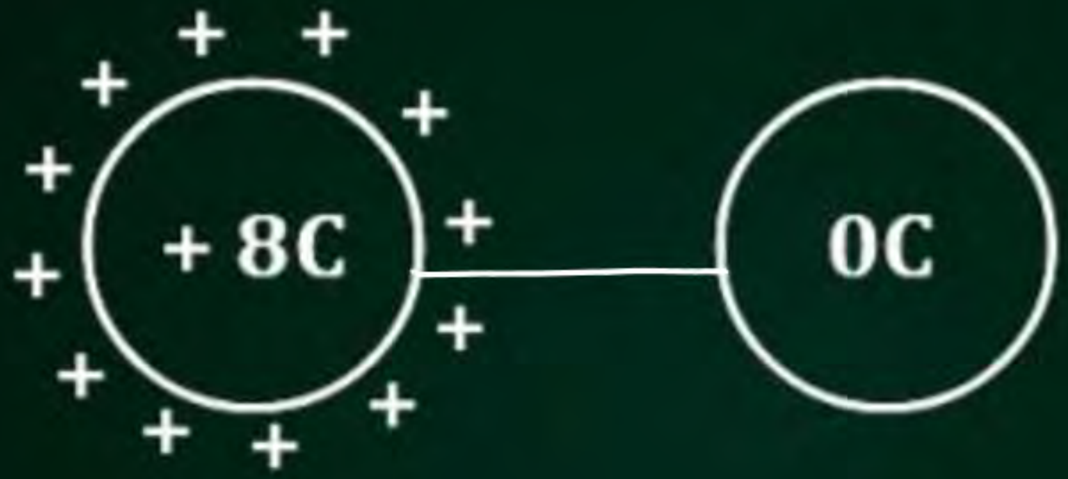
$q_2 = 0$

$q_1 = Q_1+Q_2$

$$q_1' = Q_1+Q_2$$ *

QUESTION

Find charge on each when they placed in contact.



Final chage.

$$q_1 = \frac{8+0}{2} = 4C = q_2.$$

QUESTION

Two sphere of Radius R and 4R having charge 15C and –5C respectively, if they are placed in contact then find final charge on each sphere.

$$q_1 = \frac{R}{R+4R}(15C - 5C)$$

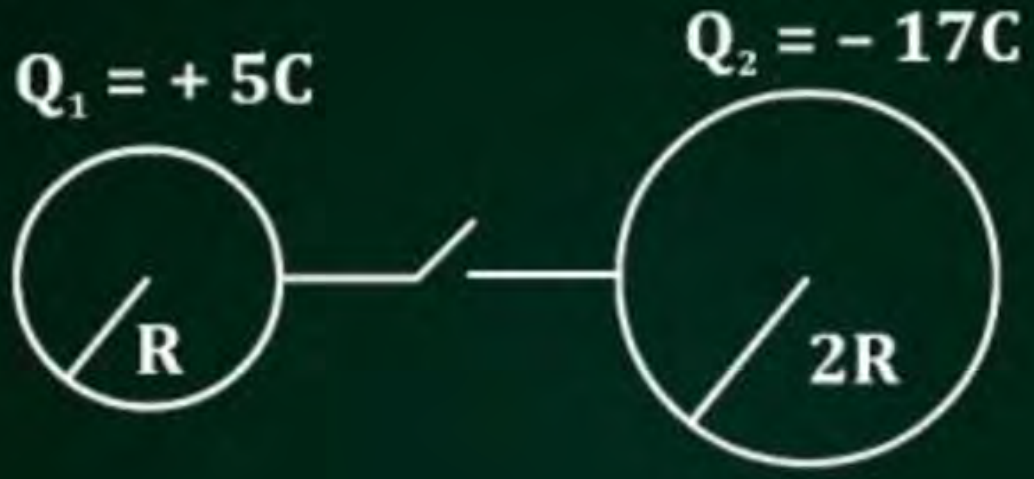
$$= \frac{R}{5R}(10C)$$

$$= 2C$$

$$q_2 = 8C$$

QUESTION

Find charge on each sphere when key is close.

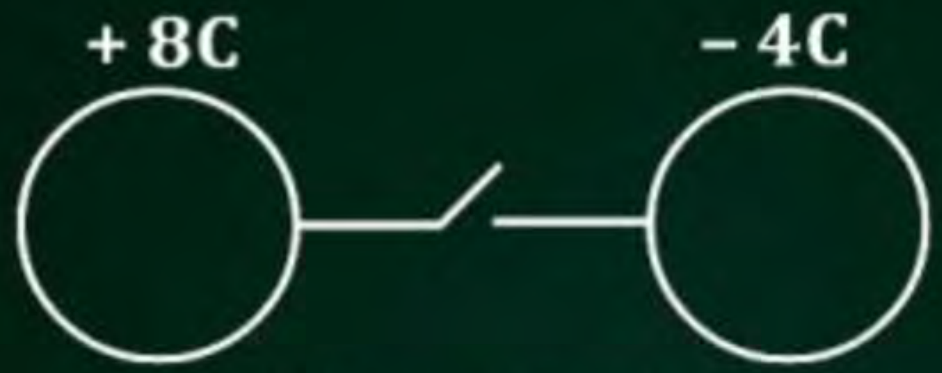


$$q_1' = \frac{R}{3R}(-12) = -4C$$

$$q_2' = -8C$$

QUESTION

Find charge on each when key is close.



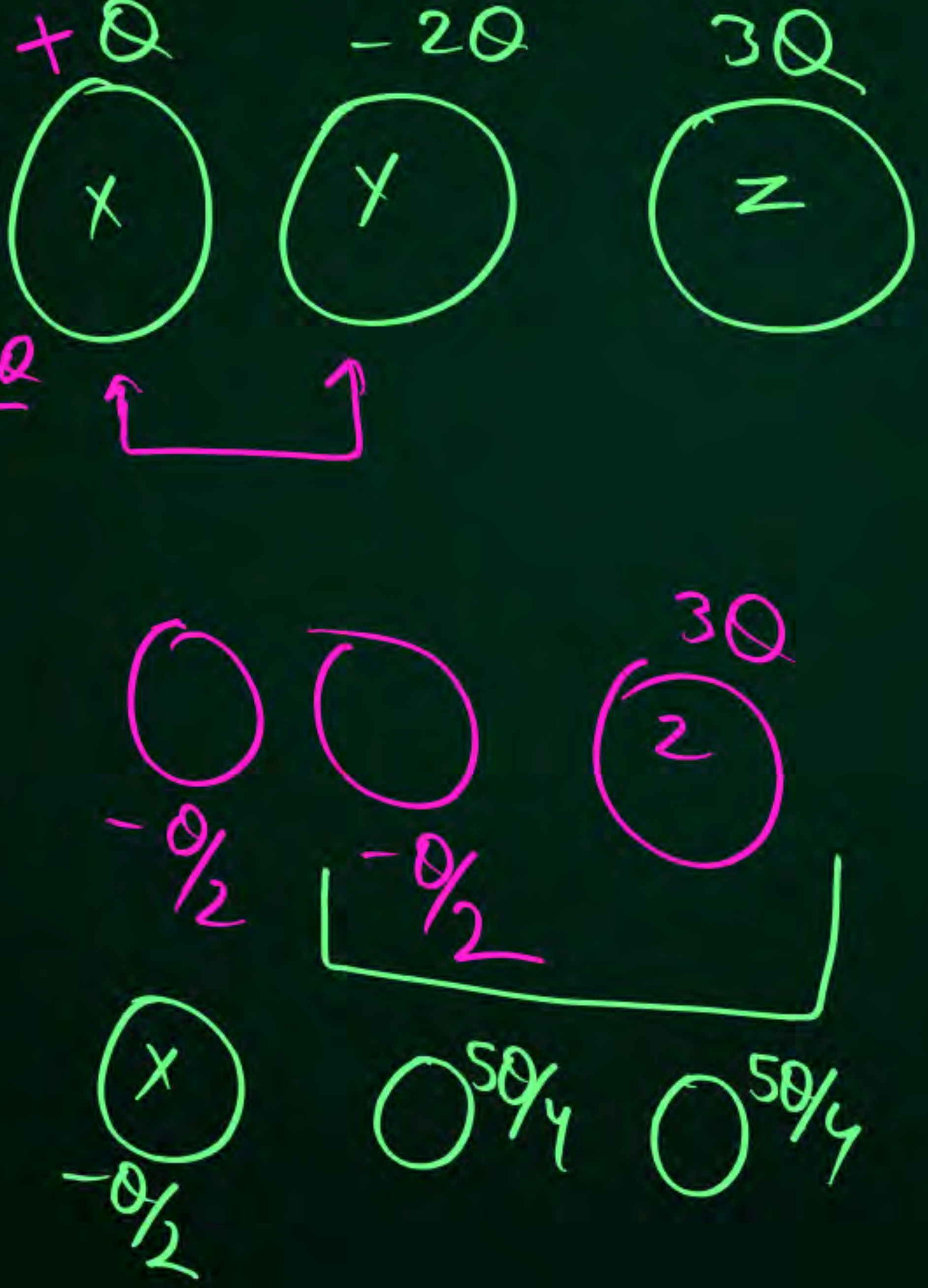
(Same size)

$q_1' = 2c = q_2'$

QUESTION

When three identical sphere X, Y and Z having charge Q, $-2Q$ and $3Q$ respectively. At first X and Y are in contact then Y and Z are in contact then final charge on X, Y and Z will be

1. $\frac{Q}{2}, \frac{3Q}{2}, \frac{Q}{2}$
2. $\frac{-Q}{2}, \frac{5Q}{4}, \frac{+5Q}{4}$
3. Q, Q, Q
4. $\frac{Q}{2}, \frac{3Q}{2}, \frac{-Q}{2}$



QUESTION

When 10^{14} electrons are removed from a neutral metal sphere, then the charge on the sphere becomes

1. $16\ \mu C$
2. $-16\ \mu C$
3. $32\ \mu C$
4. $32\ \mu C$

$Q = ne$

$= 10^{14} \times 1.6 \times 10^{-19}\ C$

QUESTION

A conductor has 14.4×10^{-19} C positive charge. The conductor has (charge on electron = 1.6×10^{-19} C)

1. 9 electrons in excess
2. 27 electrons in short
3. 27 electrons in excess
4. 9 electrons in short

$Q = ne$



If +4C charge given to both the sphere, then find final charge on each sphere.

Ans



QUESTION

Find total charge on 81.9 kg electron.



mass of one e^- = 9.1×10^{-31} kg

mass on $n\,e^-$ = $n \times 9.1 \times 10^{-31}$ kg

$81.9 = n\; 9.1 \times 10^{-31}$ kg

find n

$Q = ne$ ✓

QUESTION

Charge on α-particle is

$_2He^{4++}$

$Q = 2e$

1. 4.8×10^{-19} C
2. 1.6×10^{-19} C
3. 3.2×10^{-19} C ✓
4. 6.4×10^{-19} C

QUESTION

A body has –80 micro column of charge. Number of additional electrons in it will be

1. 8×10^{-5}
2. 80×10^{-17}
3. 5×10^{14}
4. 1.28×10^{-17}

$Q = -80 \times 10^{-6} C$

QUESTION

If 3.2×10^8 electron are acquired by a body per sec. then find time in which body will get total charge 2C.

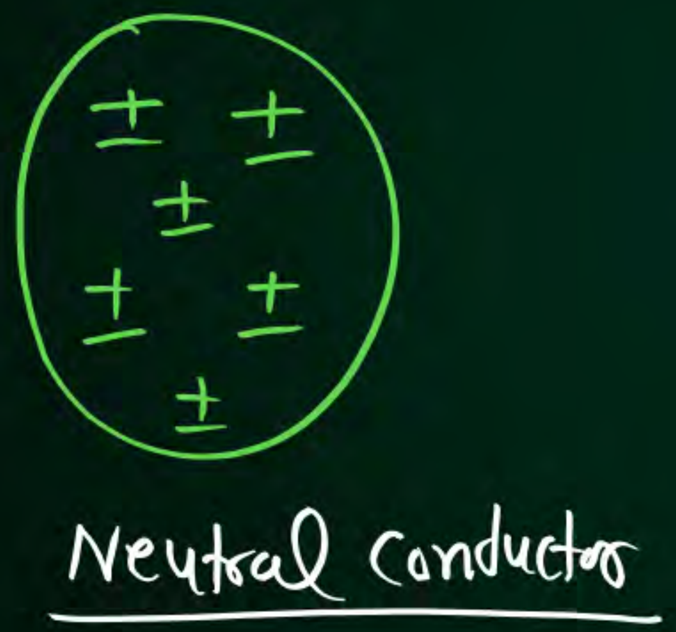
no. of $\bar{e}$ acquired in t sec $= 3.2 \times 10^8 t$

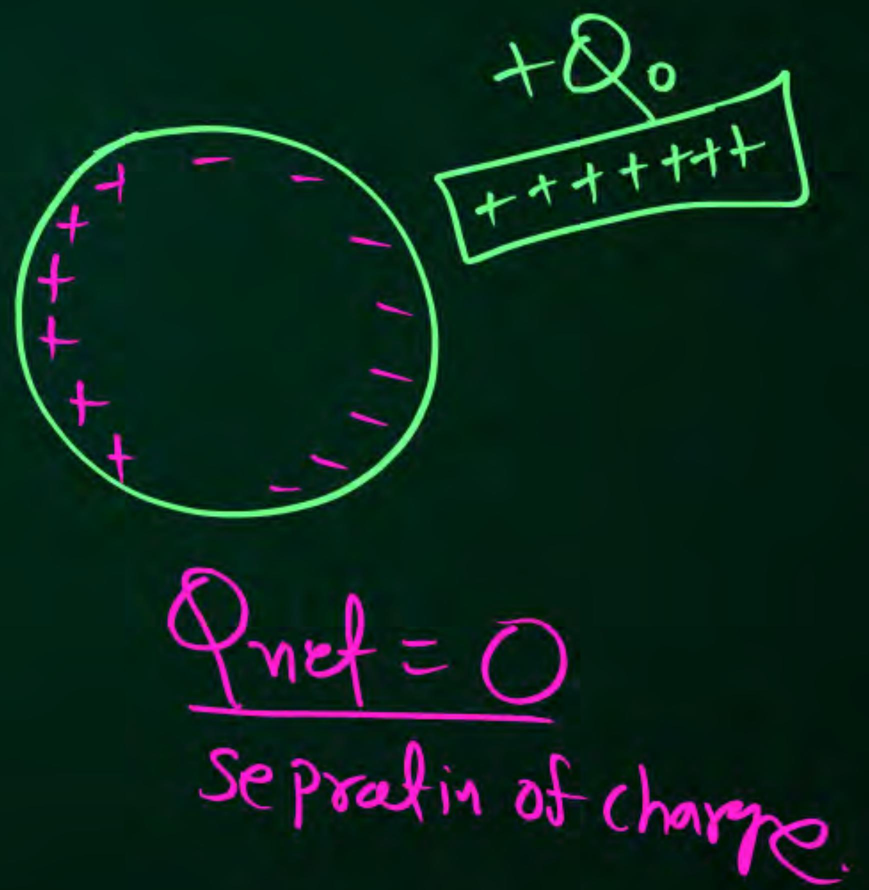
$$q = 3.2 \times 10^8 e t$$

$$2C = 3.2 \times 10^8 \times 1.6 \times 10^{-19} t$$

Charging by Induction:

Induction is a process by which a charged body can be used to create other charged bodies without touching them or losing its own charge.





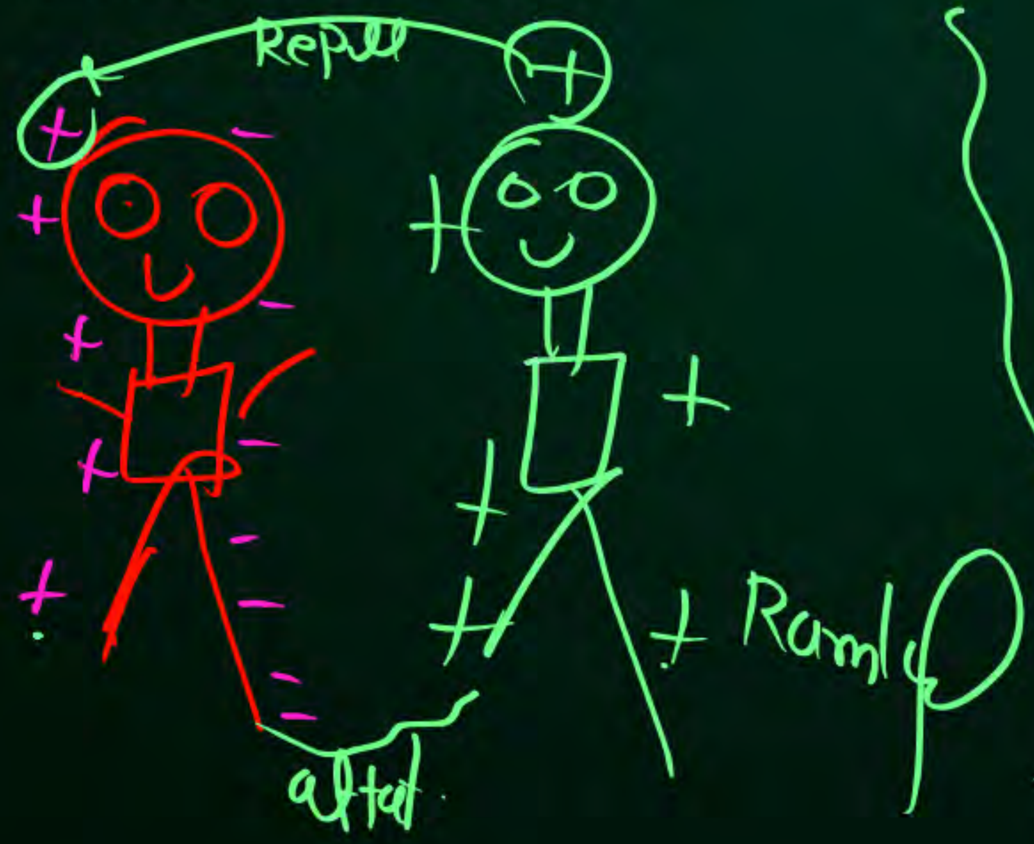
Charging By induction

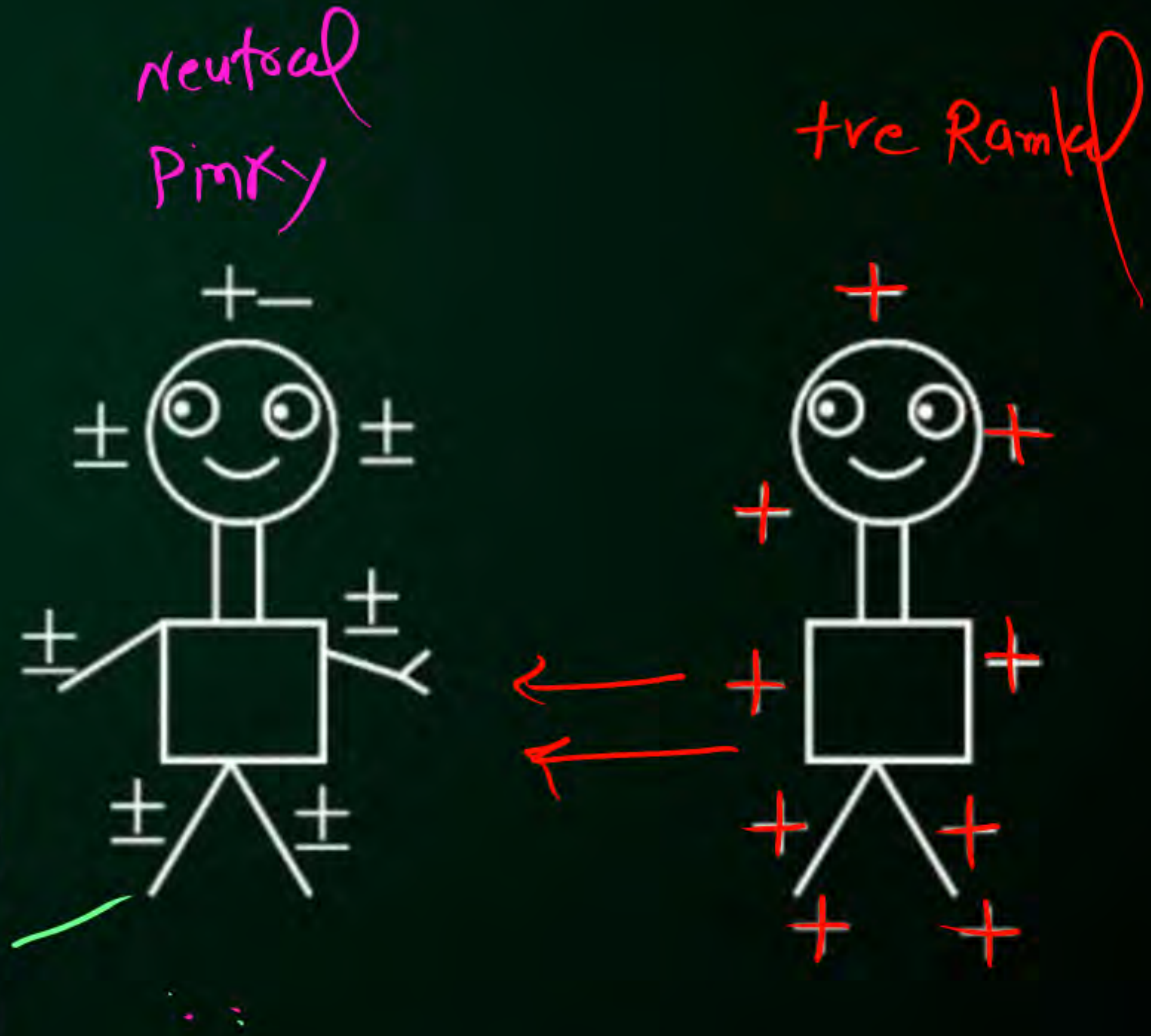
→ Separation of charge ✓

→ Contact is not required

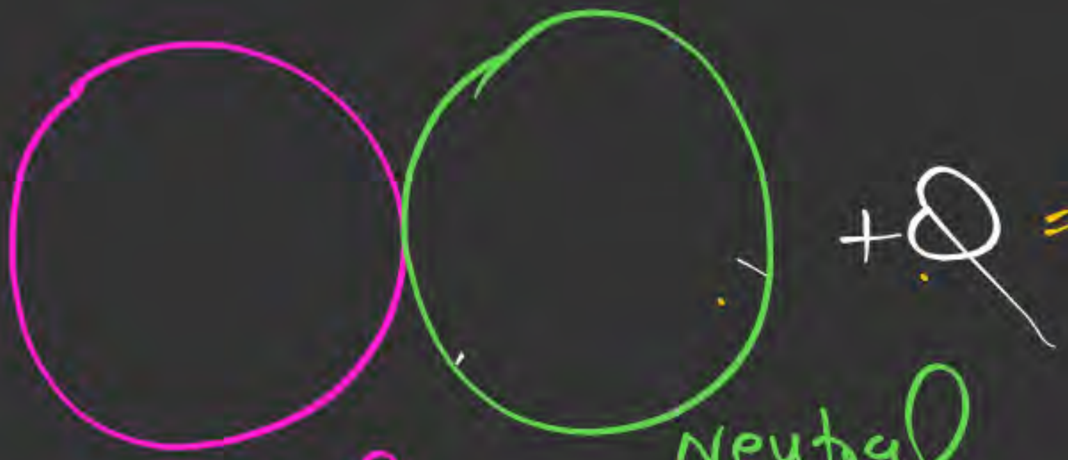
→ For conductor and dielectric

→ Not in insulator





Process of Induction



Now Place a +ve Point charge near a sphr 'B'



$Q_A = +ve$ $Q_B = -ve$

Now seprate Spr A & B, remove +ve charge



$Q_A = +ve$ $Q_B = -ve$

$q = -Q_{Inducing}$

Induced on nearest

QUESTION

MCQ

Consider a neutral conducting sphere. A positive point charge is placed outside the sphere. The net charge on the sphere is then

1. Negative and distributed uniformly over the surface of the sphere.
2. Negative and appears only at the point on the sphere closest to the point charge
3. Negative and distributed non-uniformly over the entire surface of the sphere
4. Zero (56%)



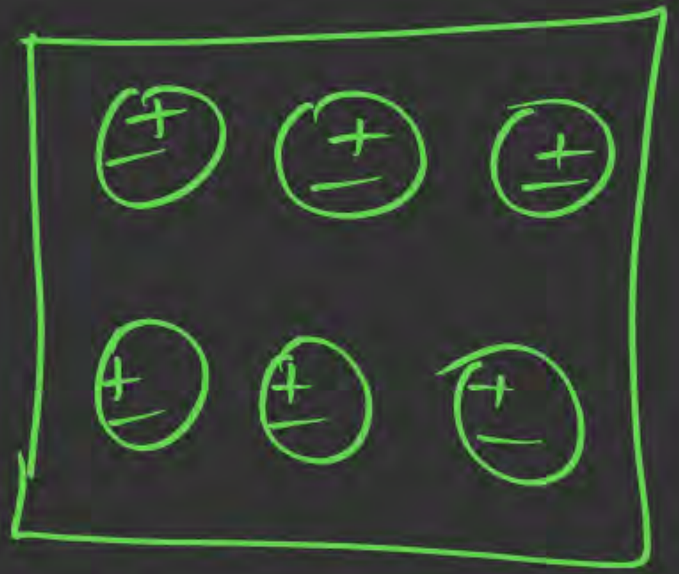
+ve

QUESTION

Electric charges A and B are attracted to each other. Electric charges B and C are also attracted to each other. If A and C are held close together they will

1. attract
2. repel
3. not affect each other
4. More information is needed to answer.

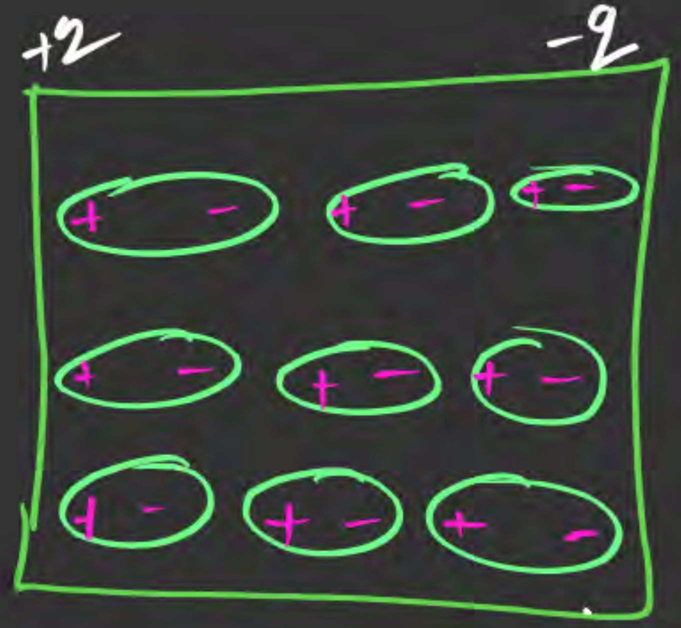
Induction in dielectric



di-electric

No free e^-

→ bonded e^- can be Break at high e^- field



+ve

+Q

Slightly separation of charge.

$q_{\text{Induced charge}} < Q_{\text{inducing}}$

QUESTION

When a soap bubble is charged then its size

1. Increases
2. decreases
3. remains same
4. May increase or decrease depends on nature of charge



QUESTION

Two uncharged metal sphere placed in contact as shown in figure and A positive charged rod placed in contact with A, then charge on A and B will be

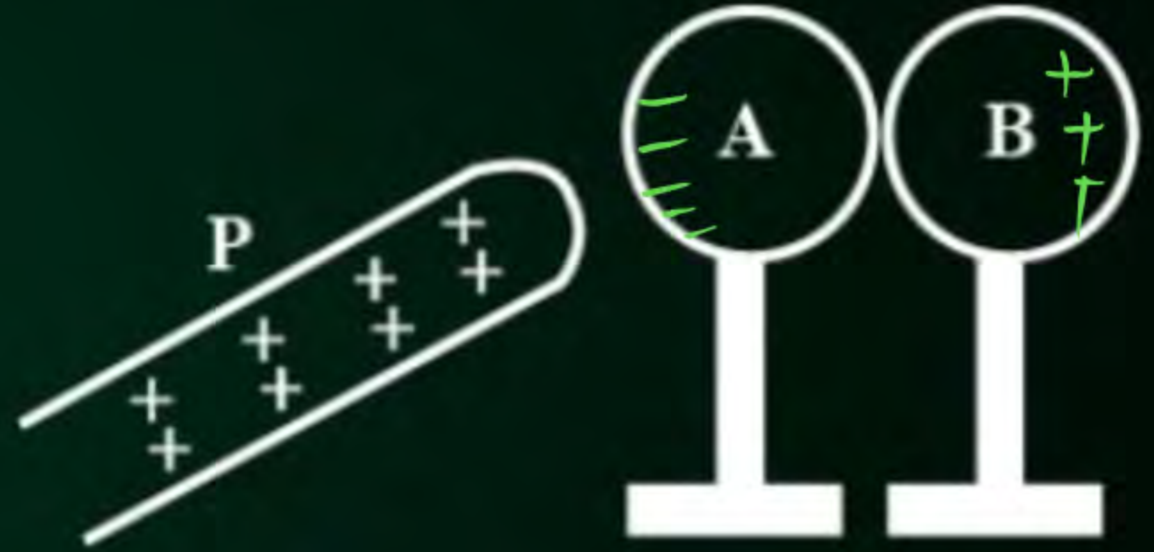


1. Both becomes +ve (26%)
2. Both become –ve
3. A –ve abut B become +ve (57%)
4. A become +Ve and B –ve

QUESTION

Two uncharged metal sphere placed in contact as shown in figure and A positive charged rod placed near to the A, then charge on A and B will be

1. Both becomes +ve
2. Both become –ve
3. A –ve abut B become +ve
4. A become +Ve and B –ve



QUESTION

In induction the charge induced in the near surface of conductor is

1. Equal and similar
2. Unequal and similar
3. equal and dissimilar
4. zero

H/W

Newtons Law of gravition → only valid for Point mass & spherical symmetric mass

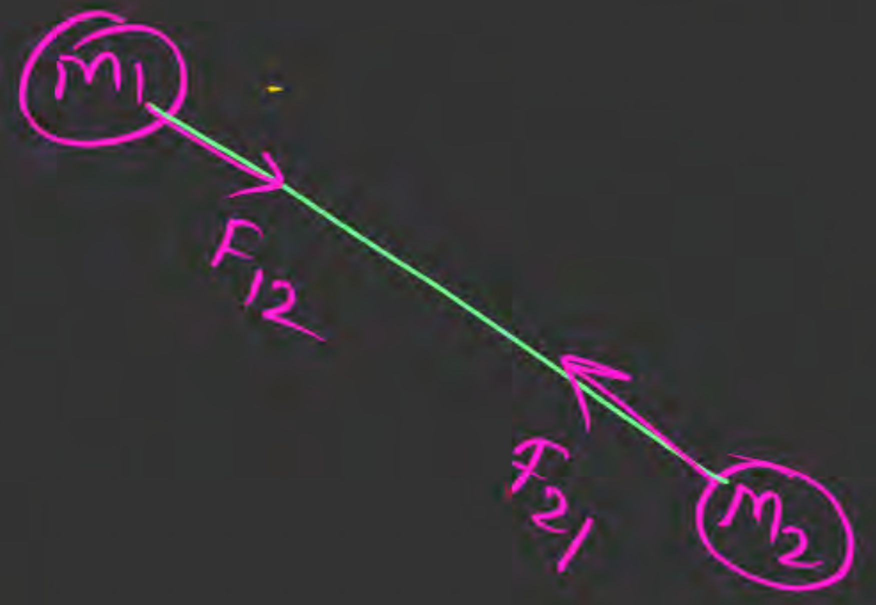
$$F = G\frac{m_1 m_2}{r^2}$$

- equal & opposition on m_1 & m_2
- Action-reaction Pair
- central force
- long-range
- conservative
- Inverse square law
- doesnot depend on medium
- always attractive

mediated by gravity

weakest force in nature

Can't be Proved only can verify



Coulombs Law is like newtons law of gravition.

- → form action-reacti Pair
- → follow Inverse square law
- → central
- → long range
- → conservative
- → May be attracti / Repuli
- → electrostatic force depends on medium.
- → mediated by Photon.
- → Valid for Point charge & spherical chag

q_1 ——— r ——— q_2

F_{12} = force on q_1 due to q_2

F_{21} = force on q_2 due to q_1

which is correct

(a) $\vec{F_{12}} = \vec{F_{21}}$ 37(1.)

(b) $\vec{F_{12}} \neq \vec{F_{21}}$ ✓

$\vec{F_{12}} = -\vec{F_{21}}$ ✓

$F_{12} = F_{21}$ ✓

$|\vec{F_{12}}| = |\vec{F_{21}}|$ correct ✓

force → { किसने force लगाया
किसपे लगा
कितना लगा
magnitude
किधर लगा (dirn) }

$$|\vec{F}_{12}| = |\vec{F}_{21}| \propto q_1 q_2$$
$$\propto \frac{1}{r^2}$$

$$F_{12} = \frac{K q_1 q_2}{r^2}$$

Value of $K = 1$ in C.G.S unit

(a) correct (18%) ✓

(b) wrong ✗

Value of K is one when q is in e.s.u & r = cm.

$1 C = 3 \times 10^9$ e.s.u

1 e.s.u $= \frac{1 C}{3 \times 10^9}$ e.s.u

$10^{-5} N = 1$ dyn.

If $q_1 = 3$ e.s.u, $q_2 = 2$ esu at distn 1 cm then find force on each other

Soln

C.G.S

$$F = \frac{K q_1 q_2}{r^2}$$

$$= \frac{1 \times 3\,\text{e.s.u} \times 2\,\text{e.s.u}}{(1\,\text{cm})^2}$$

$$= 6 \text{ dyne}$$

S.I Unit

$$F = \frac{9 \times 10^9 \times 3 \times \frac{1}{3 \times 10^9} \times 2 \times \frac{1}{3 \times 10^9}}{(10^{-2})^2}$$

$$= \frac{6 \times 10^{-9}}{10^{-4}} = 6 \times 10^{-5} \text{ New}$$

$= 6$ dyne ✓

* $$F = \frac{K q_1 q_2}{r^2}$$

$$F = \frac{G m_1 m_2}{r^2}$$ → does not depend on medium

$$K = 9 \times 10^9 \ Nm^2/c^2$$

Proportional constⁿ in air

$$K = \frac{1}{4\pi\varepsilon_0} = 9 \times 10^9 \text{ in air}$$

$$K_m = \frac{1}{4\pi\varepsilon_m} \text{ in medium}$$

[ε_0 = Permitivity of air
ε_m = Permitivity of Medium]

(dielectric constⁿ. k)

$(k)\ \varepsilon_r$ = relative Permitivity $= \frac{\varepsilon_m}{\varepsilon_0}$

↳ unitless

$$\varepsilon_m = \varepsilon_r \varepsilon_0$$ *

Value of permitivity ε_0 for air

$$\frac{1}{4\pi\varepsilon_0} = 9\times10^{9}$$

$$\varepsilon_0 = \frac{1}{4\pi\times9\times10^{9}}$$

$$= 8.85\times10^{-12}\ C^2/Nm^2$$

QUESTION

Two Statement:

A: Electrostatic force depends on medium.

B: Electrostatic force on one charge due to other does not depends on medium.

1. Both are true (48%)
2. Both are false
3. A – True, B – False (40%)
4. A – False, B - True

Superposition Theorem

QUESTION

Two positive ions, each carrying a charge q, are separated by a distance d. If F is the force of repulsion between the ions, the number of electrons missing from each ion will be (e being the charge on an electron) (2010)

1. $\dfrac{4\pi\varepsilon_0 F d^2}{e^2}$
2. $\sqrt{\dfrac{4\pi\varepsilon_0 F e^2}{d^2}}$
3. $\sqrt{\dfrac{4\pi\varepsilon_0 F d^2}{e^2}}$
4. $\dfrac{4\pi\varepsilon_0 F d^2}{q^2}$

QUESTION

Two point charges A and B, having charges $+Q$ and $-Q$ respectively, are placed at certain distance apart and force acting between them is F. If 25% charge of A is transferred to B, then force between the charges becomes [NEET 2019]

1. $\frac{4F}{3}$
2. F
3. $\frac{9F}{16}$
4. $\frac{16F}{9}$

QUESTION

Two point charges repel each other with a force of 100 N. One of the charges is increased by 10% and other is reduced by 10%. Then new force of repulsion at the same distance would be:

1. 99 N
2. 121 N
3. 100 N
4. 110 N

QUESTION

Charges Q, q and $4Q$ placed along y-axis at position $y = 0$; $y = \frac{l}{2}$ and $y = l$ respectively. Find the value of q so that force on charge Q is zero.

1. Q
2. $Q/2$
3. $-Q/2$
4. $-Q$

QUESTION

A charge q is placed at the center of the line joining two equal charges of magnitude equal charges Q. Three charges are in equilibrium then what will be the value of 'q'?

1. $\frac{Q}{4}$
2. $\frac{-Q}{4}$
3. Q
4. $\frac{-Q}{8}$

QUESTION

Five point charges, each of value $+q$, are placed on five vertices of a regular hexagon of side L. The magnitude of the force on a point charge of value $-q$ coulomb placed at the centre of the hexagon is:

1. $\frac{1}{\pi\varepsilon_0}\left(\frac{q}{L}\right)^2$
2. $\frac{2}{\pi\varepsilon_0}\left(\frac{q}{L}\right)^2$
3. $\frac{1}{2\pi\varepsilon_0}\left(\frac{q}{L}\right)^2$
4. $\frac{1}{4\pi\varepsilon_0}\left(\frac{q}{L}\right)^2$

QUESTION

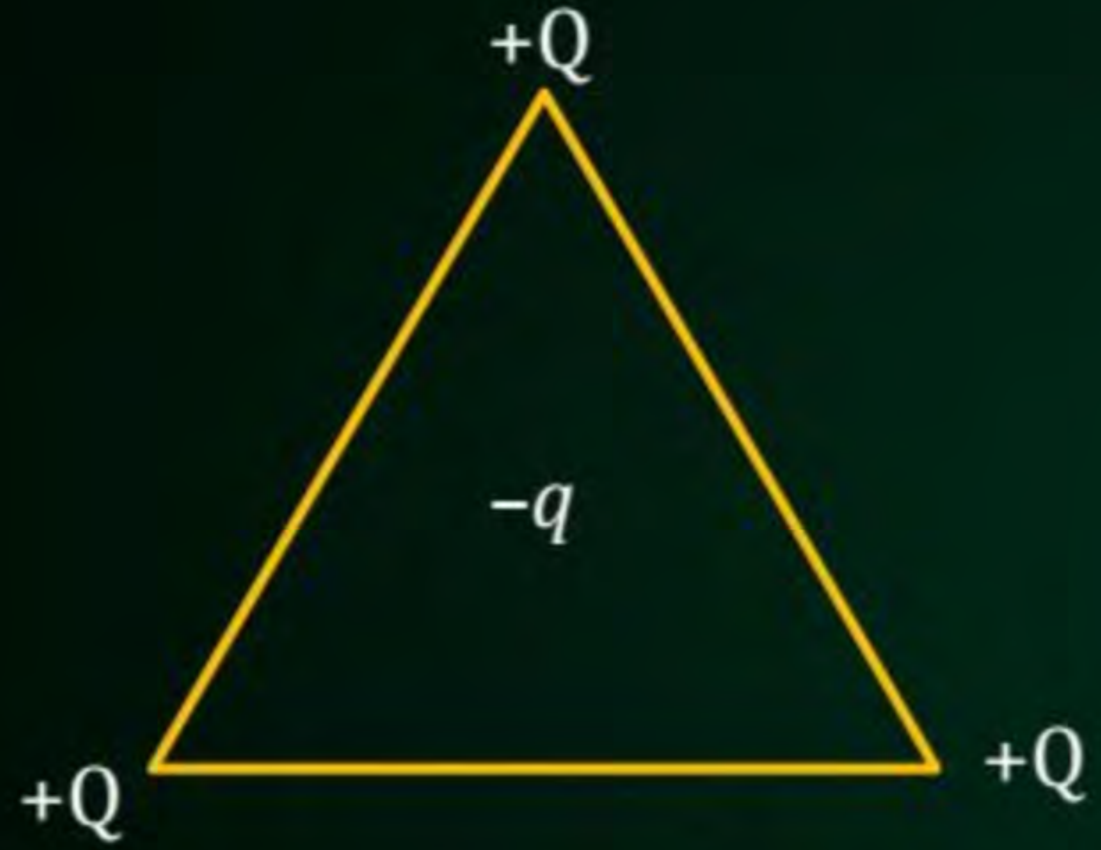
Three charges $+4q, Q$ and q are placed in a straight line of length l at points $0, \frac{\ell}{2}$ and ℓ distance away from one end respectively. What should be Q in order to make the net force on q to be zero?

1. $-q$
2. $4q$
3. $-q/2$
4. $-2q$

QUESTION

Find value of *q* so that system is in equilibrium.




+Q
−q
+Q
+Q


+Q
+Q
−q
+Q
+Q


THANK YOU

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FOR NEET 2025

Lecture- 4 | **Physics**

Electric Charges and Fields



By- Dr. Manish Raj (MR SIR)

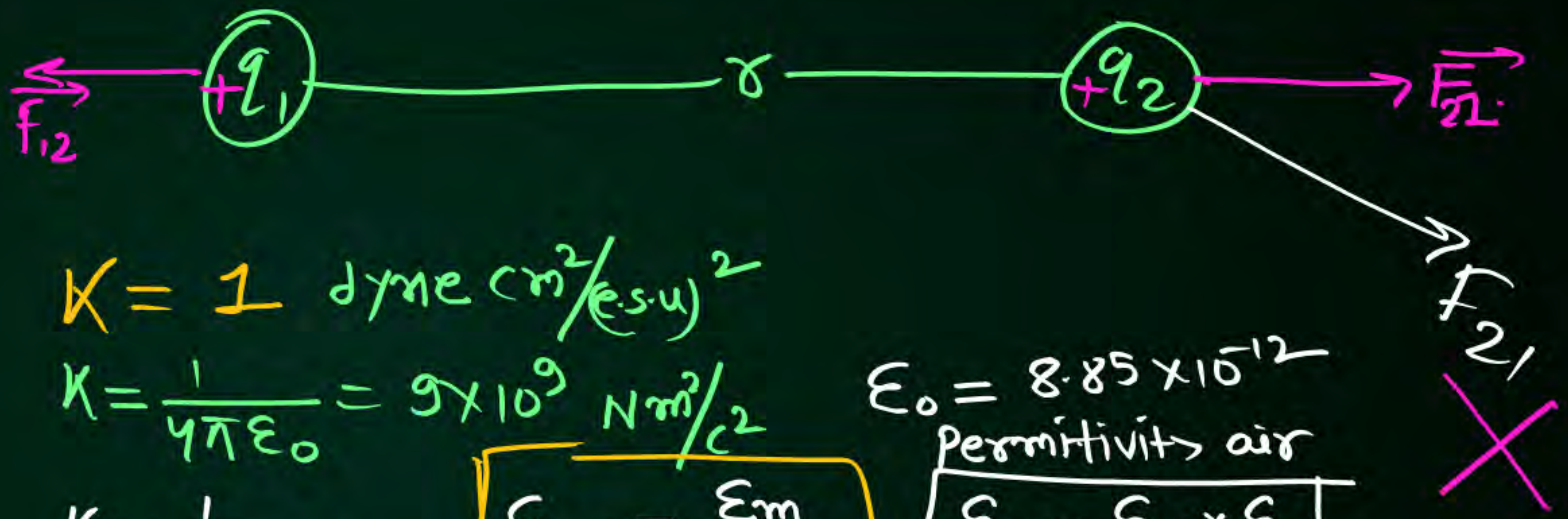
Todays Goal

PhD. on Coulombs Law

Coulombs Law

Same charge → repel
Opposite charge → attraction

→ $\vec{F}_{12} = \vec{F}_{21}$ ✗



$$F_{12} = \frac{K q_1 q_2}{r^2}$$

(Value of force)

$K = 1$ dyne $cm^2/(e.s.u)^2$

$K = \frac{1}{4\pi\varepsilon_0} = 9\times10^9\ Nm^2/C^2$

$\varepsilon_0 = 8.85\times10^{-12}$
permittivity air

$K = \frac{1}{4\pi\varepsilon_m}$

$$\varepsilon_r = \frac{\varepsilon_m}{\varepsilon_0}$$

$$\varepsilon_m = \varepsilon_r \times \varepsilon_0$$

$$F_{2nd\ med} = \frac{1}{4\pi\varepsilon_m}\frac{q_1 q_2}{r^2}$$

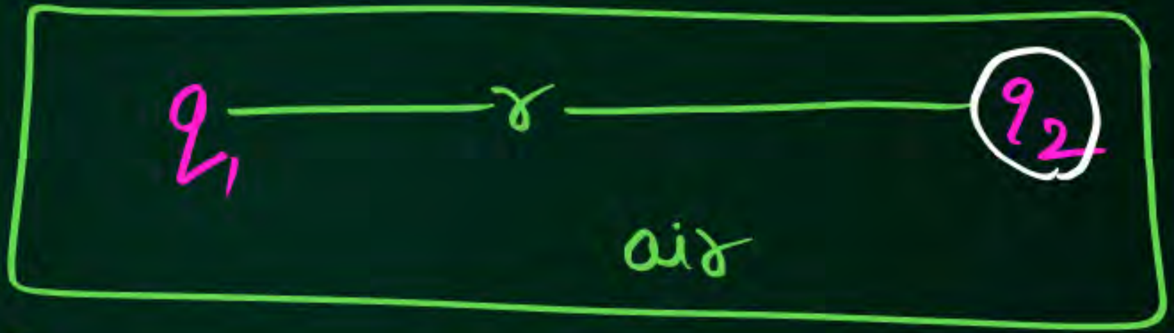
QUESTION

Two Statement:

A: Electrostatic force depends on medium.

B: Electrostatic force on one charge due to other does not depends on medium.

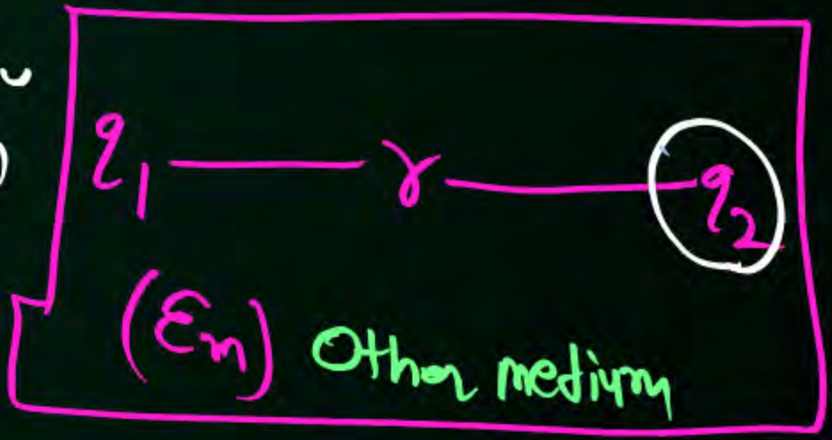
1. Both are true
2. Both are false
3. A – True, B – False
4. A – False, B - True



$$\vec{F}_{21\,air} = \frac{q_1 q_2}{4\pi\varepsilon_0 r^2}$$ = Fnet force on q_2 in air

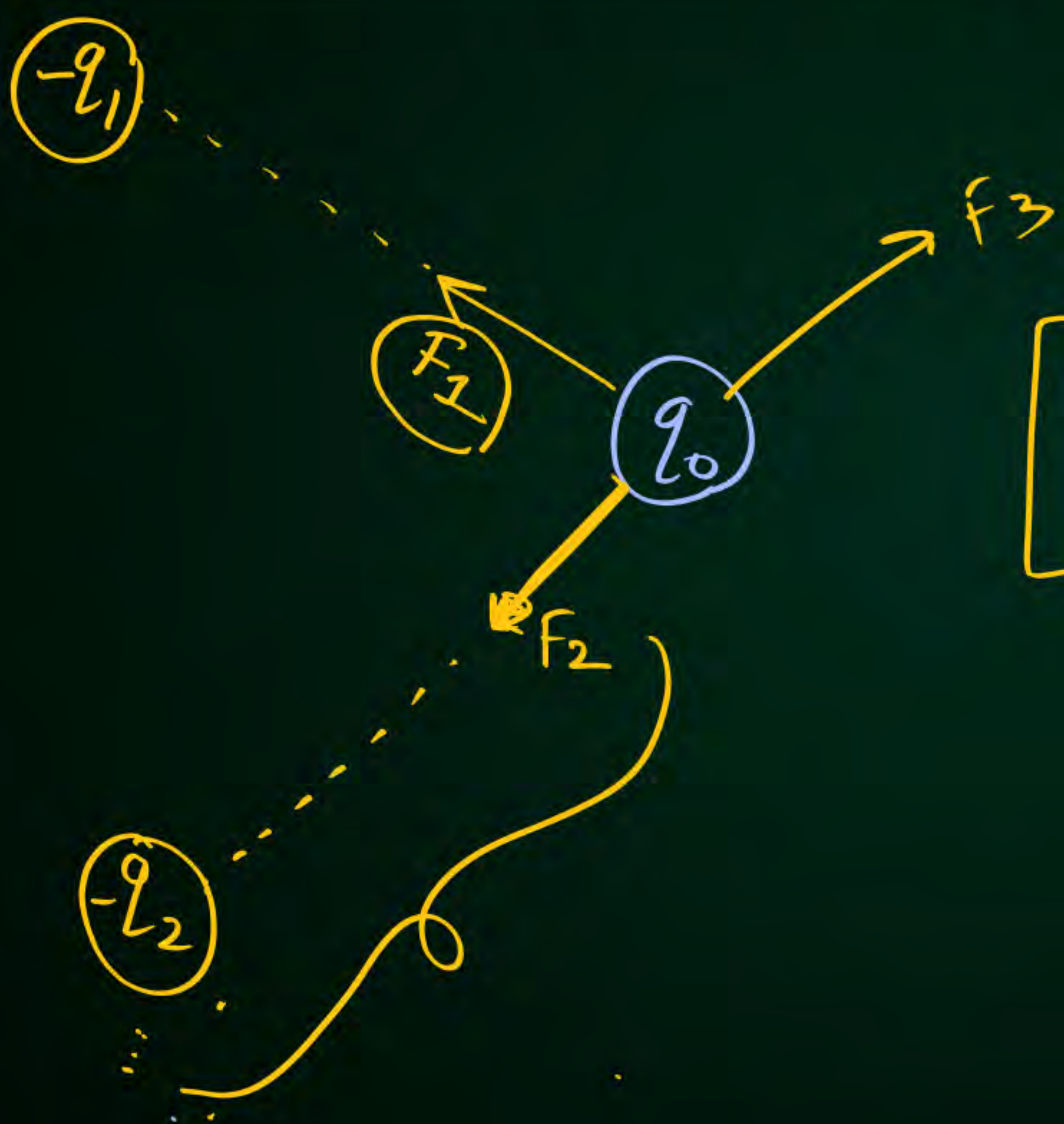
$$\vec{F}_{21\,medium} = \frac{q_1 q_2}{4\pi\varepsilon_0 r^2}$$

force on 2nd charge due to 1st



Fnet force on q_2 in medium $= \frac{q_1 q_2}{4\pi\varepsilon_m r^2}$

Superposition Theorem



$$F_{net}\ \text{force on } q_0 = \vec{F_1} + \vec{F_2} + \vec{F_3}$$

$$\vec{F}_{air\ net} = \frac{q_1 q_2}{4\pi\varepsilon_0 r^2}$$

$$K = \frac{1}{4\pi\varepsilon_0}$$

$$\vec{F}_{net\ in\ mediu} = \frac{q_1 q_2}{4\pi\varepsilon_m r^2}$$

$$= \frac{q_1 q_2}{4\pi\varepsilon_r\varepsilon_0 r^2}$$

$$F_{net\ in\ Medium} = \frac{F_{air}}{\varepsilon_r} = \frac{F_{air}}{K}$$ *

Two Point charge q_1 and q_2 placed at distⁿ r and value of force acting on each other is F, now find change in force & % change in force.

(i) If distⁿ B/w them becomes half.

Ans $F' = 4F$ $= 3F + F$ → 300%

$$F' = \frac{K q_1 q_2}{(r/2)^2}$$

% change in force $= \frac{F' - F}{F} \times 100 = \frac{4F - F}{F} \times 100 = 300\%$ Increases

(ii) If distⁿ Becomes double.

$$F' = \frac{K q_1 q_2}{(2r)^2} = \frac{F}{4}$$

$$F' = F - \frac{3F}{4} =$$

$\frac{3}{4} \times 100 = 75\%$ decrease

q_1 —— r —— q_2

$$F = \frac{K q_1 q_2}{r^2}$$

(iii) If both the charges & distance becomes double.

Solⁿ same

(Q) If both charges becomes double & distance becomes half

Solⁿ $F' = 16F$

→ force Increases to 1600%.

→ force Increases by 1500%

QUESTION

Two positive ions, each carrying a charge q, are separated by a distance d. If F is the force of repulsion between the ions, the number of electrons missing from each ion will be (e being the charge on an electron) (2010)

1. $\dfrac{4\pi\varepsilon_0 F d^2}{e^2}$
2. $\sqrt{\dfrac{4\pi\varepsilon_0 F e^2}{d^2}}$
3. ✓ $\sqrt{\dfrac{4\pi\varepsilon_0 F d^2}{e^2}}$
4. $\dfrac{4\pi\varepsilon_0 F d^2}{q^2}$

$q_2 = ne$ $q_1 = ne$

d

$$F = \frac{n^2 e^2}{4\pi\varepsilon_0 d^2}$$

$$\sqrt{\frac{F\, 4\pi\varepsilon_0 d^2}{e^2}} = n$$

QUESTION

Two point charges A and B, having charges $+Q$ and $-Q$ respectively, are placed at certain distance apart and force acting between them is F. If 25% charge of A is transferred to B, then force between the charges becomes [NEET 2019]

1. $\frac{4F}{3}$
2. F
3. $\frac{9F}{16}$
4. $\frac{16F}{9}$

$+Q \longleftarrow r \longrightarrow -Q$

$F = \frac{KQ^2}{r^2}$

(Transfer) $Q' = Q \times 25\% = \frac{Q}{4}$

$-Q + \frac{Q}{4} = \frac{-3Q}{4}$

$Q_{remain} = Q - \frac{Q}{4} = \frac{3Q}{4}$

$\longleftarrow r \longrightarrow$

Force becomes 56.25%

Force change by 43.75%

$F' = \frac{9F}{16}$

% change in force

$\Rightarrow \frac{\frac{9F}{16} - F}{F} \times 100$

$\Rightarrow \frac{-\frac{7F}{16}}{F} \times 100 = \frac{-700}{16}$

$\Rightarrow 43.75$

QUESTION

Two point charges repel each other with a force of 100 N. One of the charges is increased by 10% and other is reduced by 10%. Then new force of repulsion at the same distance would be:

1. 99 N
2. 121 N
3. 100 N (35%)
4. 110 N

$$F = \frac{K q_1 q_2}{r^2} = 100\,N \quad -(1)$$

q_1 —— r —— q_2

$$q_1' = 110\% \cdot q_1 = \frac{110 q_1}{100}$$

$$q_2' = q_2 - 10\% \cdot q_2 = q_2 - \frac{10}{100} q_2 = \frac{90 q_2}{100}$$

$$F' = \frac{K\, 110 q_1}{100} \times \frac{90 q_2}{100\, r^2}$$

$$F' = \frac{99}{100} \left(\frac{K q_1 q_2}{r^2}\right) = \frac{99}{100} \times 100$$

QUESTION

Two charge of 1 nC are at distance 3 cm apart in vacuum, then the force between them is ....

$$q_1 = q_2 = 1 \times 10^{-9} C$$
$$r = 3 cm = 3 \times 10^{-2} m$$

$$F = \frac{K q_1 q_2}{r^2}$$

QUESTION

Two charge q_1 and q_2 apply force on each other F_0 when in air. Find force applied on each other when placed in a medium of dielectric constant 81. Also find net force on charges in medium.

$\Rightarrow F_{12_{air}} = F_{12 \cdot medium} = F_0$

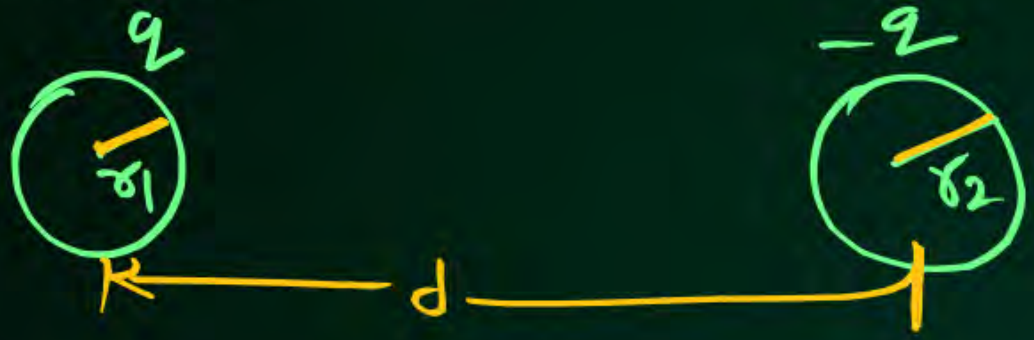
$F_{net\ force} = \dfrac{F_0}{81}$

QUESTION

Two sphere of radius in the radio 1 : 2 having equal and opposite charges exert a force F, now they placed in contact and again placed at previous position then new force acting on them will be?

1. F
2. F/2
3. 2F
4. Zero ✓

62%



$$F = \frac{Kq(q)}{d^2} \quad -(1)$$

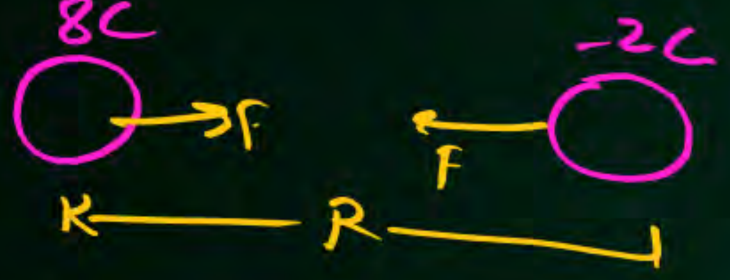
$$\Rightarrow \frac{2F - F}{F} = \frac{F}{F} = 0$$

$$q_1' = \frac{r_1(0-0)}{r_1 + r_2} = 0$$

$$F' = \frac{K\,0 \times 0}{d^2} = 0$$

QUESTION

Two small conducting sphere having charge 8C and –2C respectively and placed at distance R, then force between them is F, if they are brought in contact and separated to the same distance then force F_2 then ratio of $F_1 : F_2$ is



$F = \frac{K\, 8C \times 2C}{R^2}$

$F_1 = 16\frac{K}{R^2}$

$\frac{K}{R^2} = \frac{F}{16}$

$q_1' = \frac{(8C - 2C)}{2} = 3C$

$q_1' = \frac{R}{R+R}(Q_1 + Q_2)$

$q_2' = 3C$

$F' = \frac{K(3C \times 3C)}{R^2}$

$F_2' = 9\frac{K}{R^2} = \frac{9F}{16}$

Putting value of (K/R^2)

Ans $\frac{F_1}{F_2} = \frac{16}{9}$

QUESTION

Two point charge separated by a distance r repel each other with a force of 64 N, if distance between them becomes 4-times and each charges becomes double then new force between them will be.

Sol^n

q_1 —— r —— q_2

$$F = \frac{K q_1 q_2}{r^2} = 64\ N$$

$r' = 4r$

$q_1' = 2q_1$

$q_2' = 2q_2$

$$F' = \frac{K\, 2q_1 \times 2q_2}{16 r^2} = \frac{F}{4} = \frac{64}{4} = 16\ N$$

QUESTION

F_g and F_e represents gravitational and electrostatic force respectively between electrons situated at a distance 10 cm. The ratio of F_g/F_e is of the order of

1. 10^{-42} ✓
2. 10 ✗
3. 1 ✗
4. 10^{-4} ✗

$$\frac{F_g}{F_e} = \frac{\text{small}}{\text{large}} = \frac{1}{10^{36}} = 10^{-36} \text{ (for two proton)}$$

$$\frac{F_g = \frac{m_e \times m_e \times G}{r^2}}{F_e = \frac{k e \times e}{r^2}} = \frac{6.67 \times 10^{-11} \times (10 \times 10^{-31})^2}{9 \times 10^{9} \times (1.6 \times 10^{-19})^2} = \frac{10^{-60} \times 10^{-11} \times 6.6}{(9 \times 2.5)\, 10^{-29}} = 10^{-42}$$

$-38+9 = -29$

e ← r → e

10^{-31}

QUESTION

Two charge +6C and +4C are placed at some distance then force between them is 10 N now, –4C charge given to each sphere then force between them becomes.

Sol.

2C

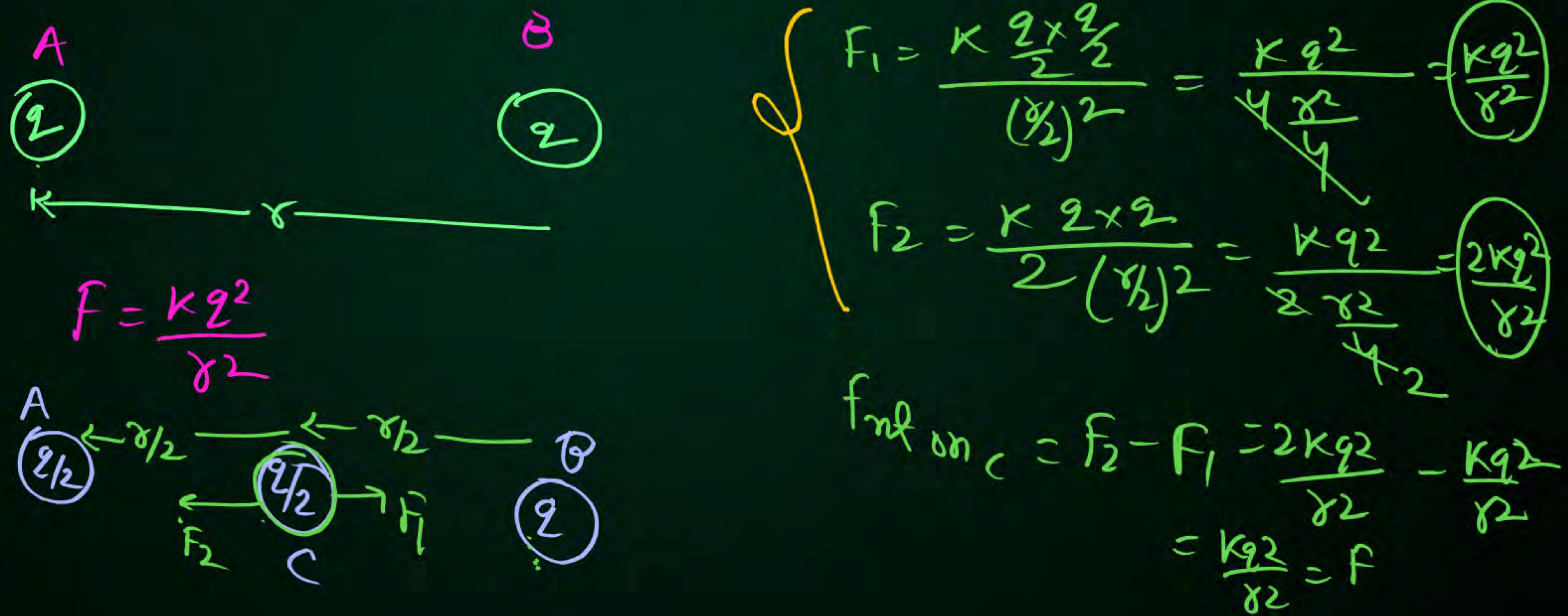
+4C − 4C = 0

F = 0 (fina

QUESTION

Two equally charged, identical metal spheres A and B repel each other with a force 'F'. The spheres are kept fixed with a distance 'r' between them. A third identical, but uncharged sphere C is brought in contact with A and then placed at the mid-point of the line joining A and B. The magnitude of the net electric force on C is

1. F
2. 3F/4
3. F/2
4. F/4



QUESTION

The charge on two sphere is 8C and –4C respectively they experience a force F, if each charge is given –4C on each sphere then new force between them is

1. F ✓ Ans
2. F/2
3. F/4
4. 2F

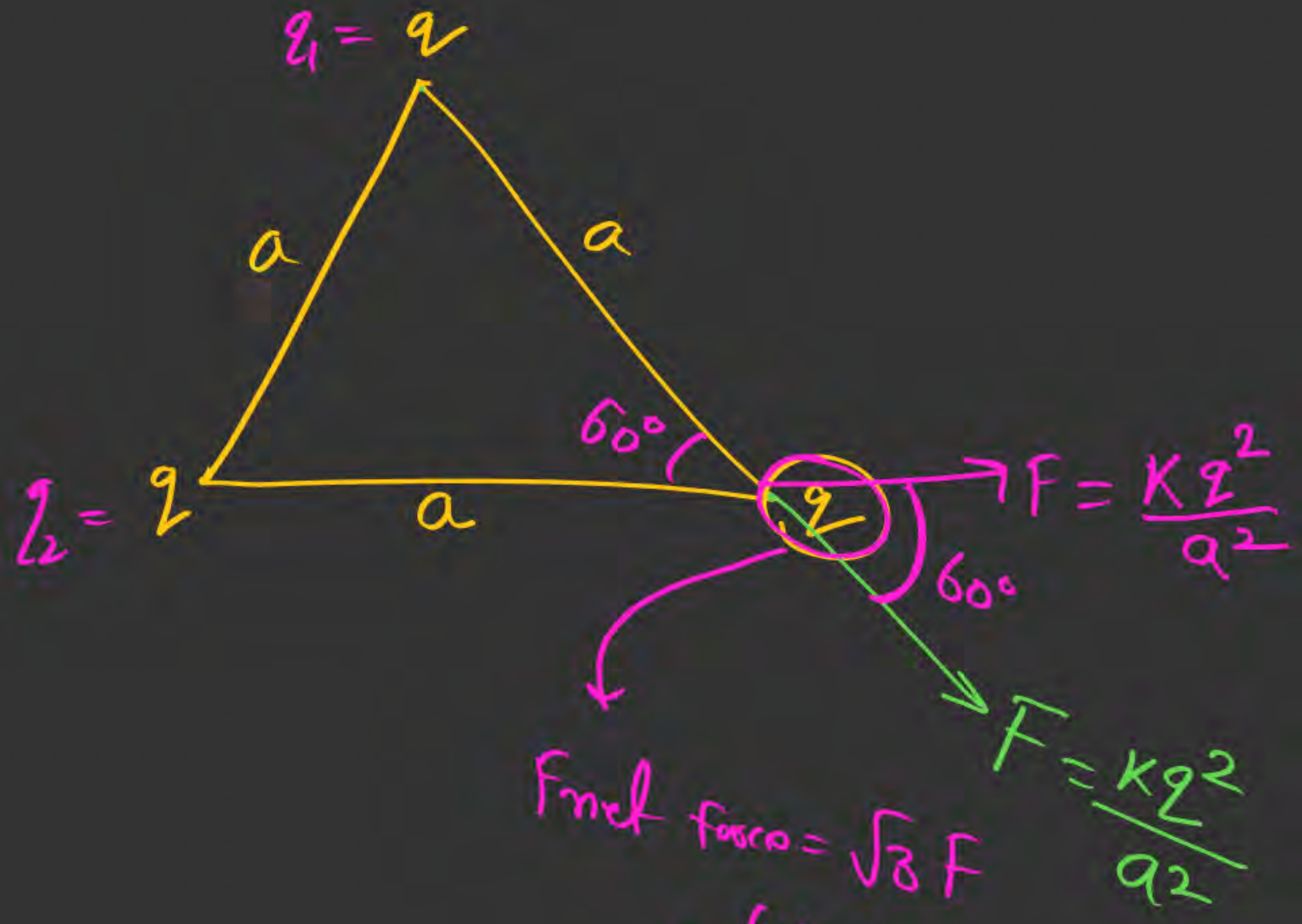


$$F = \frac{K\, 8 \times 4}{r^2}$$

$8C - 4C = 4C \qquad -4C - 4C = -8C$

$$F' = \frac{K\, 4C \times -8C}{r^2}$$

Find net force on one charge due to other 2-Charges

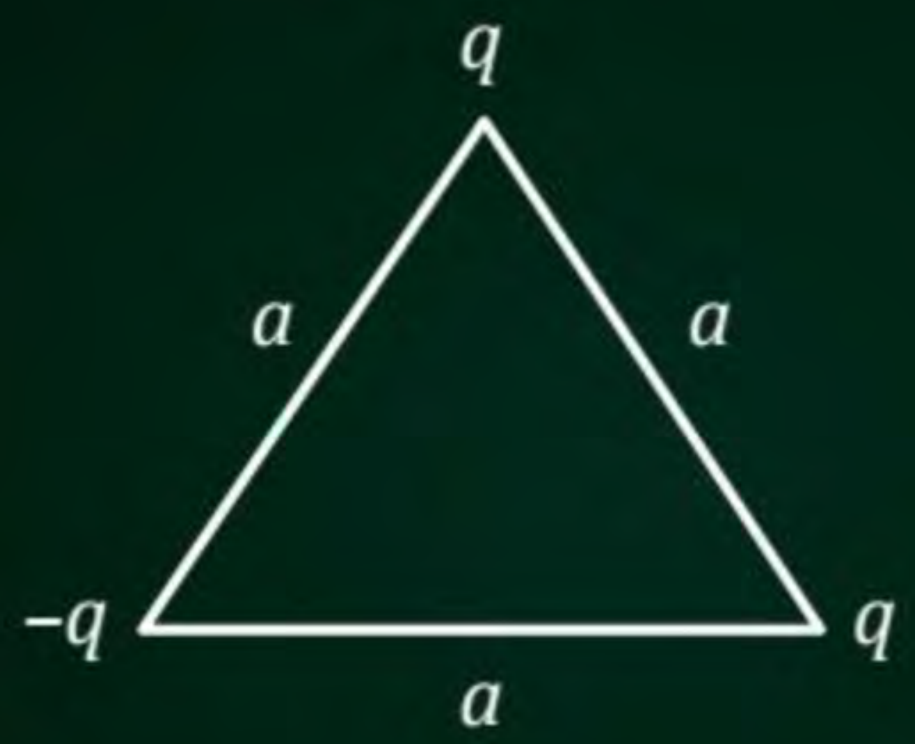


F_{net} force $= \sqrt{3}F$

$= \frac{\sqrt{3}Kq^2}{a^2}$

QUESTION

Find force on $+q$ charge due to other two charge.



QUESTION

A charge q is placed at the center of the line joining two equal charges of magnitude equal charges Q. Three charges are in equilibrium then what will be the value of 'q'?

1. $\frac{Q}{4}$

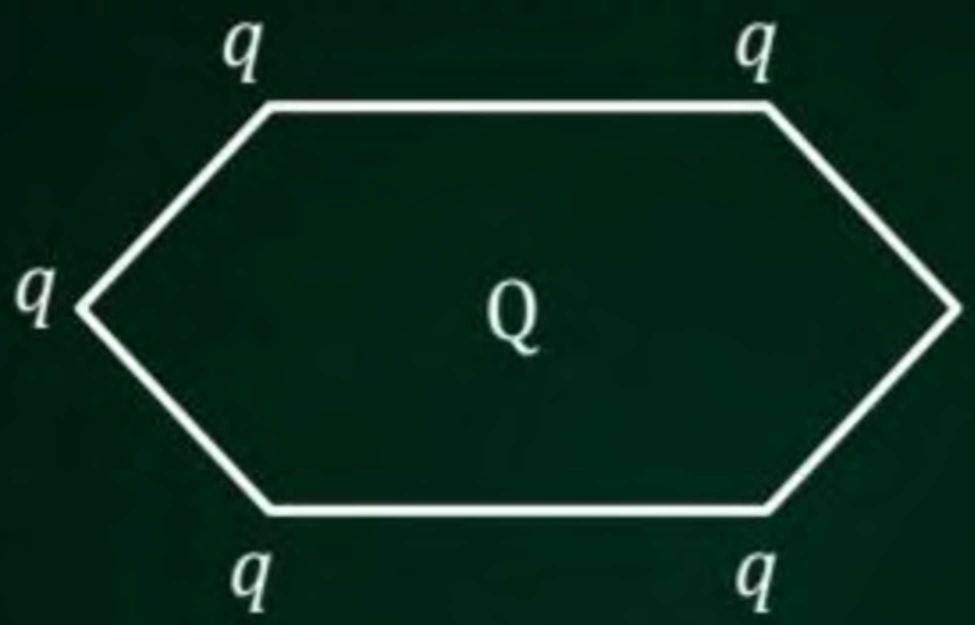
2. $\frac{-Q}{4}$

3. Q

4. $\frac{-Q}{8}$

QUESTION

Find net force on charge Q which is at centre.



ELECTROSTATICS EQUILIBRIUM

- Two point charges placed as shown in figure then find position of 3rd charge so that that 3rd remains in equilibrium.

QUESTION

Find position of 3rd charge q in a given system so that net force exercised by q is zero.

$$+Q \longleftarrow r \longrightarrow -nQ$$

QUESTION

Find position of 3rd charge q so that force on q will be zero.

(a) $Q \longleftarrow 10\text{m} \longrightarrow +16Q$

(b) $3Q \longleftarrow 30\text{m} \longrightarrow 27Q$

(c) $25Q \longleftarrow 20\text{m} \longrightarrow 16Q$

QUESTION

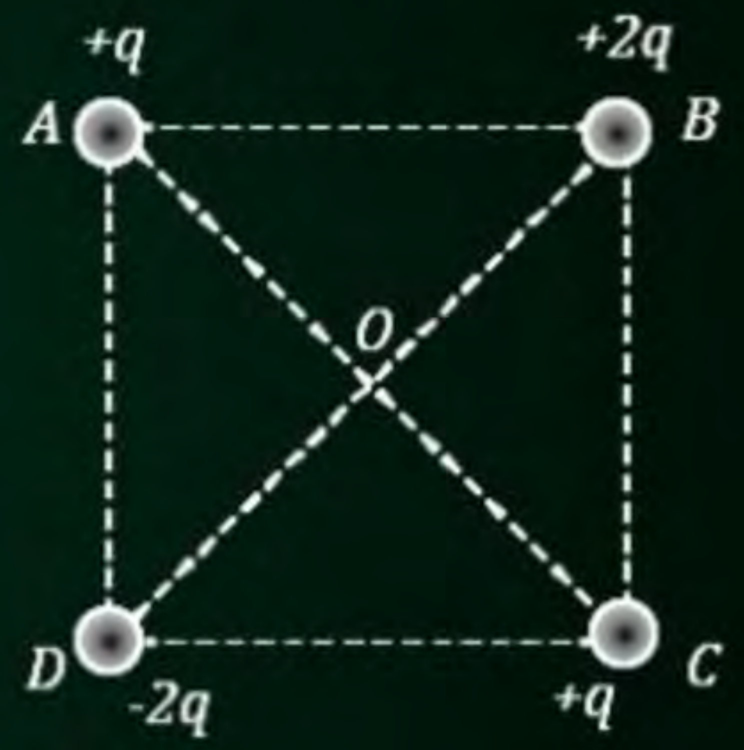
Find ..



QUESTION

Four charges are arranged at the corners of a square ABCD, as shown in the adjoining figure. The force on the charge kept at the centre O is:

1. Zero
2. Along the diagonal AC
3. Along the diagonal BD
4. Perpendicular to side AB



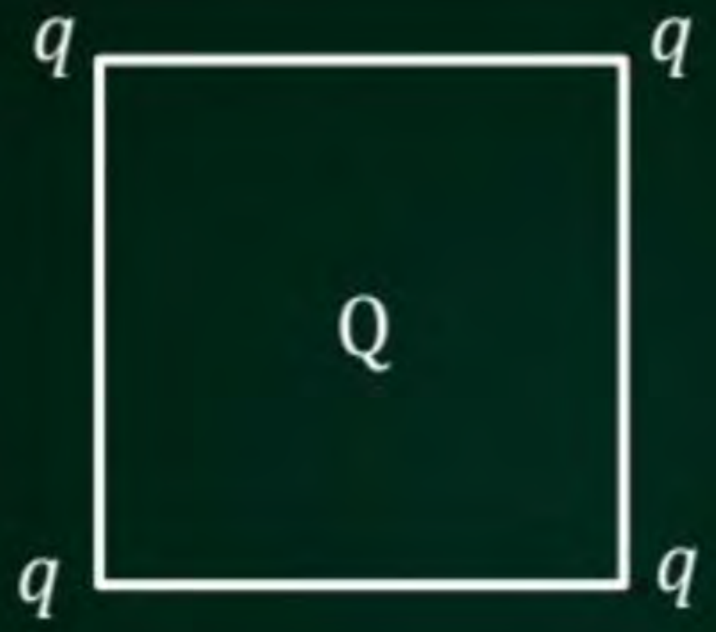
QUESTION

Find relation between q and Q so that force on Q is zero.



QUESTION

Find value of Q so that force on charge q is zero which is at corner of square of figure.




THANK YOU

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FOR NEET 2025

Lecture- 5 | **Physics**

Electric Charges and Fields

By- Dr. Manish Raj (MR SIR)



Topics to be covered

1. # Questions on Coulombs
2. #
3. #

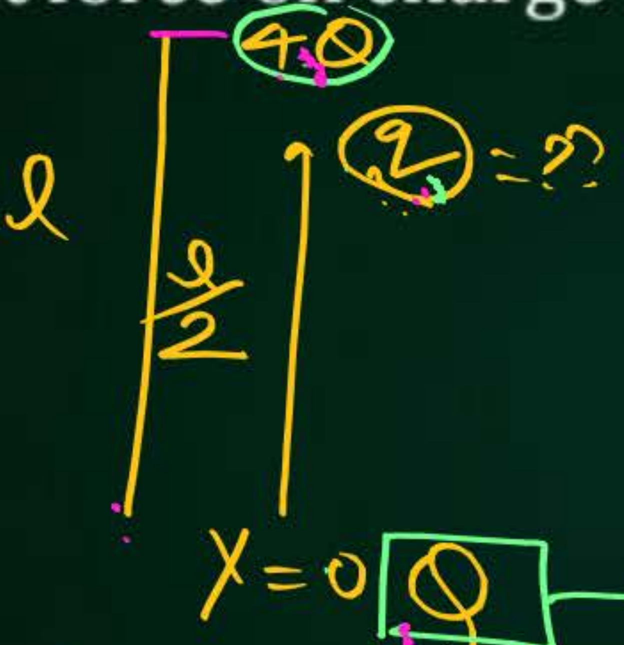
$x = \frac{r}{\sqrt{n}+1}$



QUESTION

Charges Q, q and $4Q$ placed along y-axis at position $y = 0$; $y = \frac{l}{2}$ and $y = l$ respectively. Find the value of q so that force on charge Q is zero.

1. Q
2. $Q/2$
3. $-Q/2$
4. $-Q$



$F_{net} = 0$

$|F_1| = |F_2|$

$F_2 = \frac{K4QQ}{l^2}$ (Repulsive)

$F_1 = \frac{KqQ}{(l/2)^2}$ → Attract.

$\frac{KqQ}{\frac{l^2}{4}} = \frac{4KQ^2}{l^2}$

$4q = 4Q$ (Nature of charge)

2nd method

$F_1 + F_2 = 0$

$\frac{4KQ^2}{l^2} + \frac{KqQ}{\frac{l^2}{4}} = 0$

$\frac{4KqQ}{l^2} = \frac{-4KQ^2}{l^2}$

$q = -Q$

QUESTION

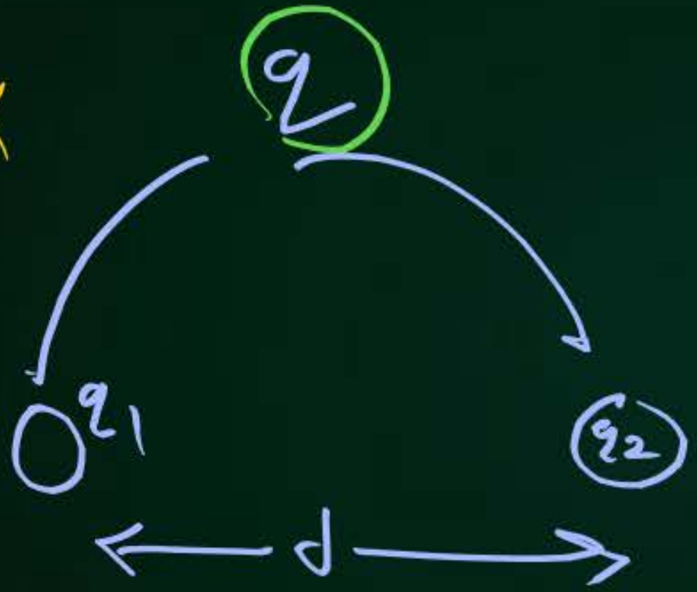
A charge q is placed at the center of the line joining two equal charges of magnitude equal charges Q. Three charges are in equilibrium then what will be the value of 'q'?

1. $\frac{Q}{4}$
2. $\frac{-Q}{4}$
3. Q
4. $\frac{-Q}{8}$

QUESTION

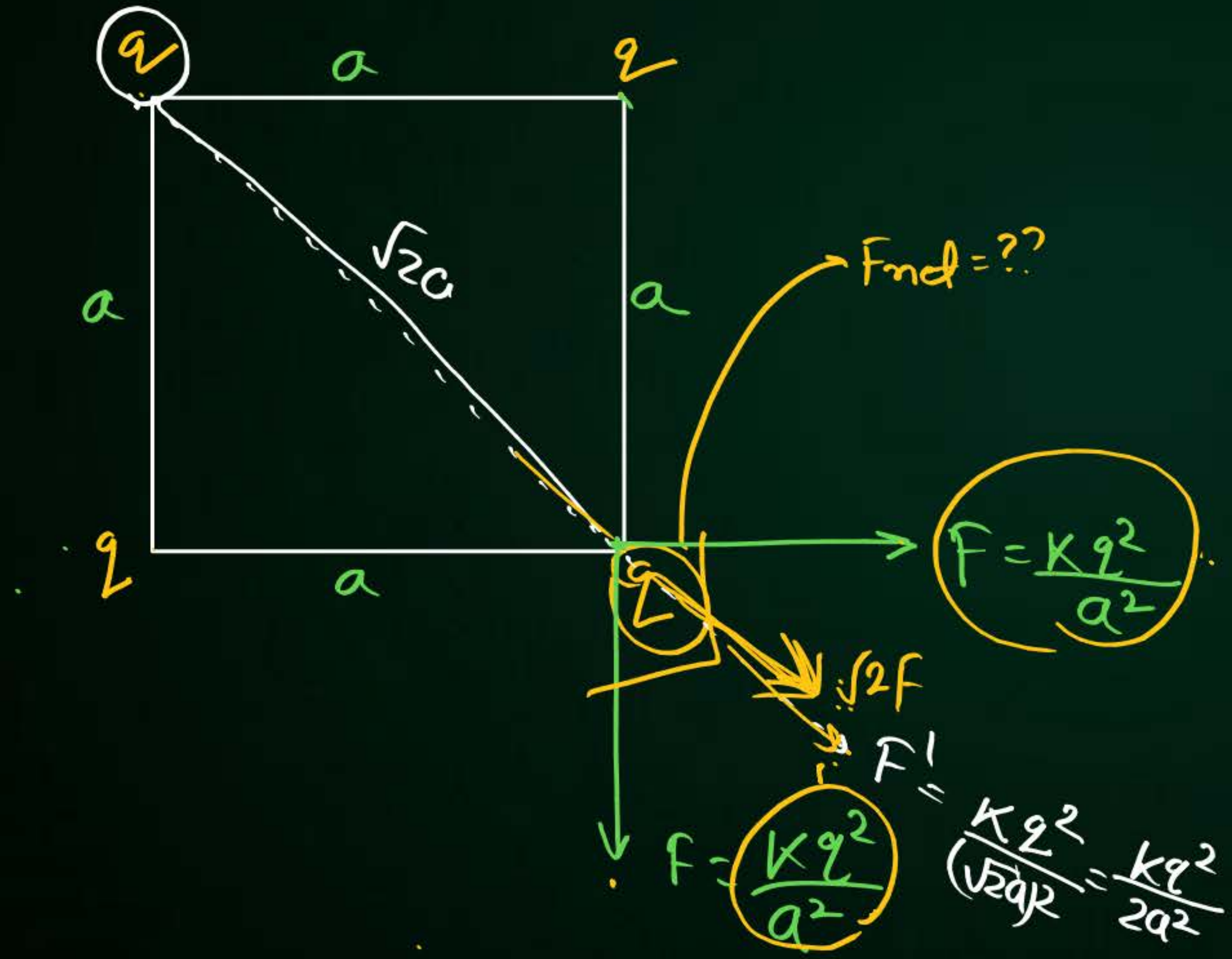
A charge q is to be divided on two small conducting spheres. What should be the value of charges on the spheres so that when placed at a certain distance apart, the repulsive force between them is maximum?

1. $\frac{q}{4}$ and $\frac{3q}{4}$
2. $\frac{q}{2}$ and $\frac{q}{2}$
3. $\frac{q}{3}$ and $\frac{q}{3}$
4. $\frac{q}{4}$ and $\frac{q}{4}$



QUESTION

Find net force on one charge due to other charges ??



$$F_{net} = \sqrt{2}F + \frac{Kq^2}{2a^2}$$

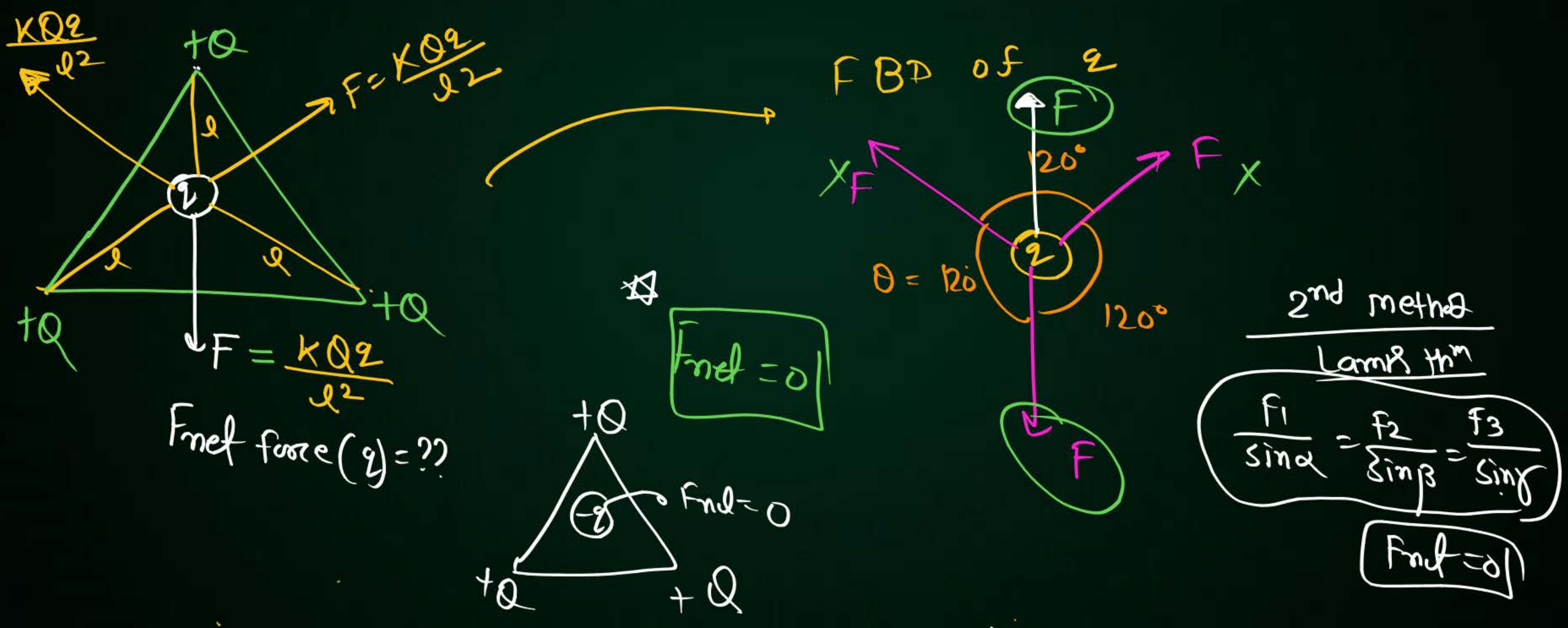
$$= \frac{\sqrt{2}Kq^2}{a^2} + \frac{Kq^2}{2a^2}$$

$$= \frac{Kq^2}{a^2}\left[\sqrt{2} + \frac{1}{2}\right]$$

Ans

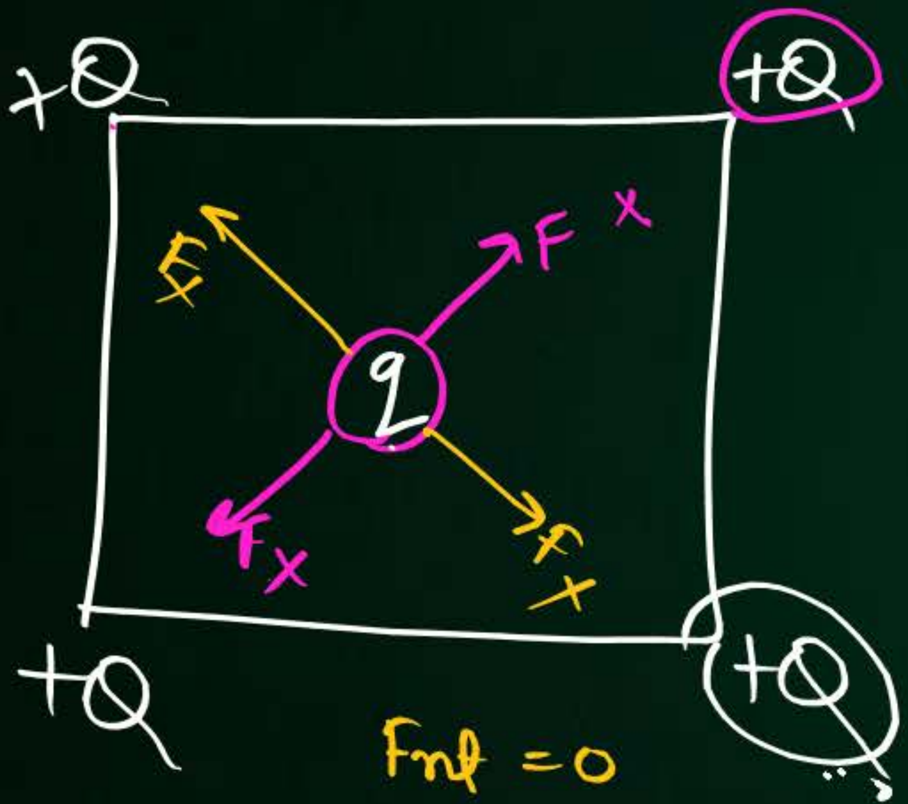
QUESTION

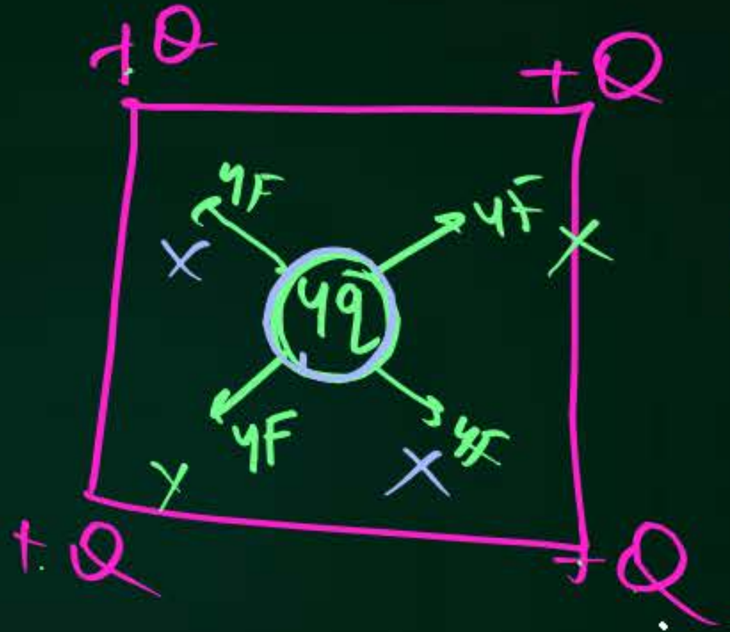
Find net force on one q charge due to other charges.



QUESTION

Find net force on one charge due to other charges.





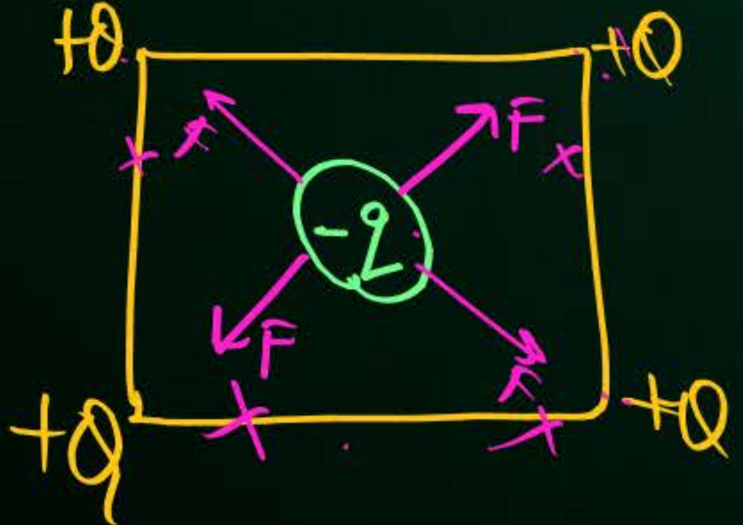
Fnet force on (4q) = ??

= zero

Fnet on (−q) = ??

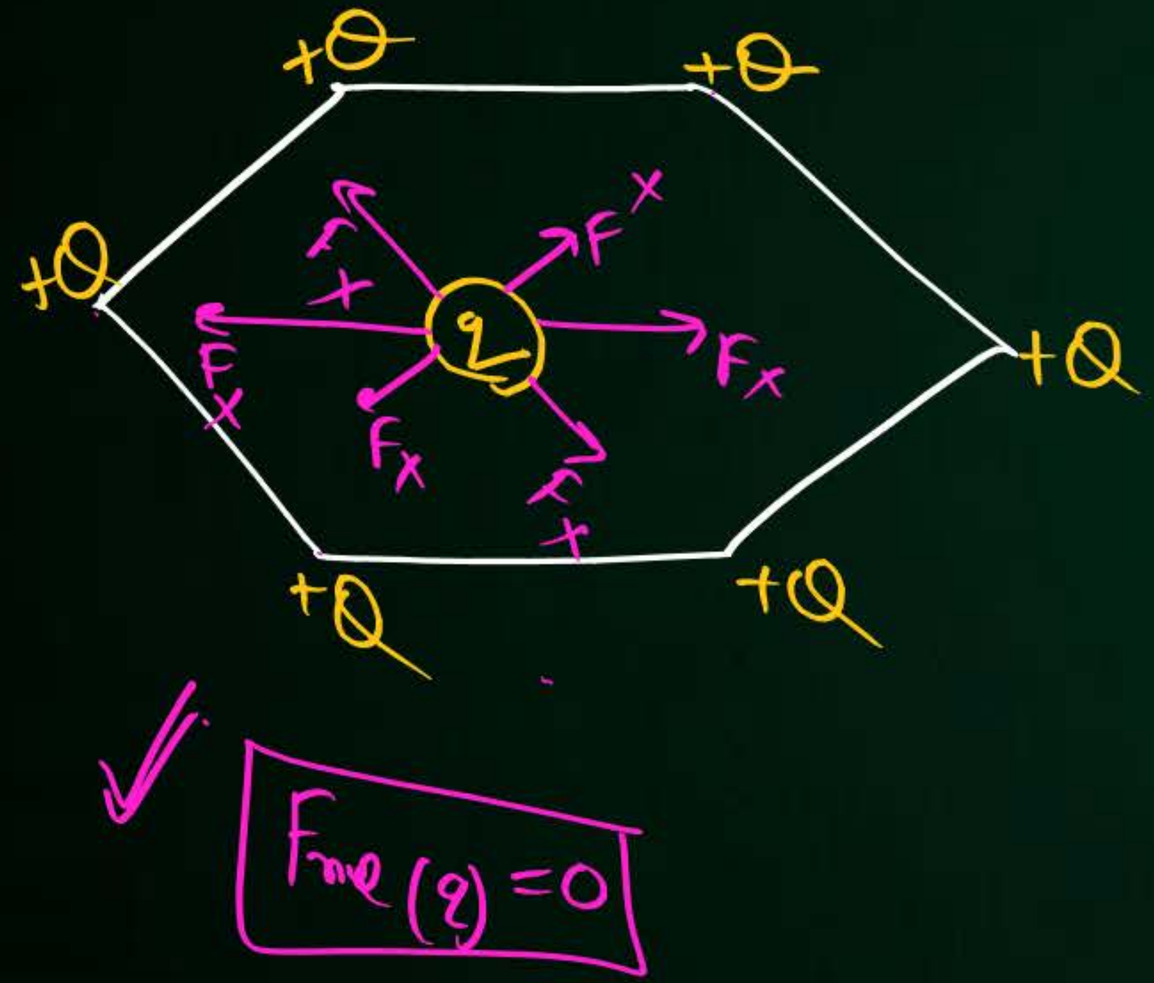
= zero

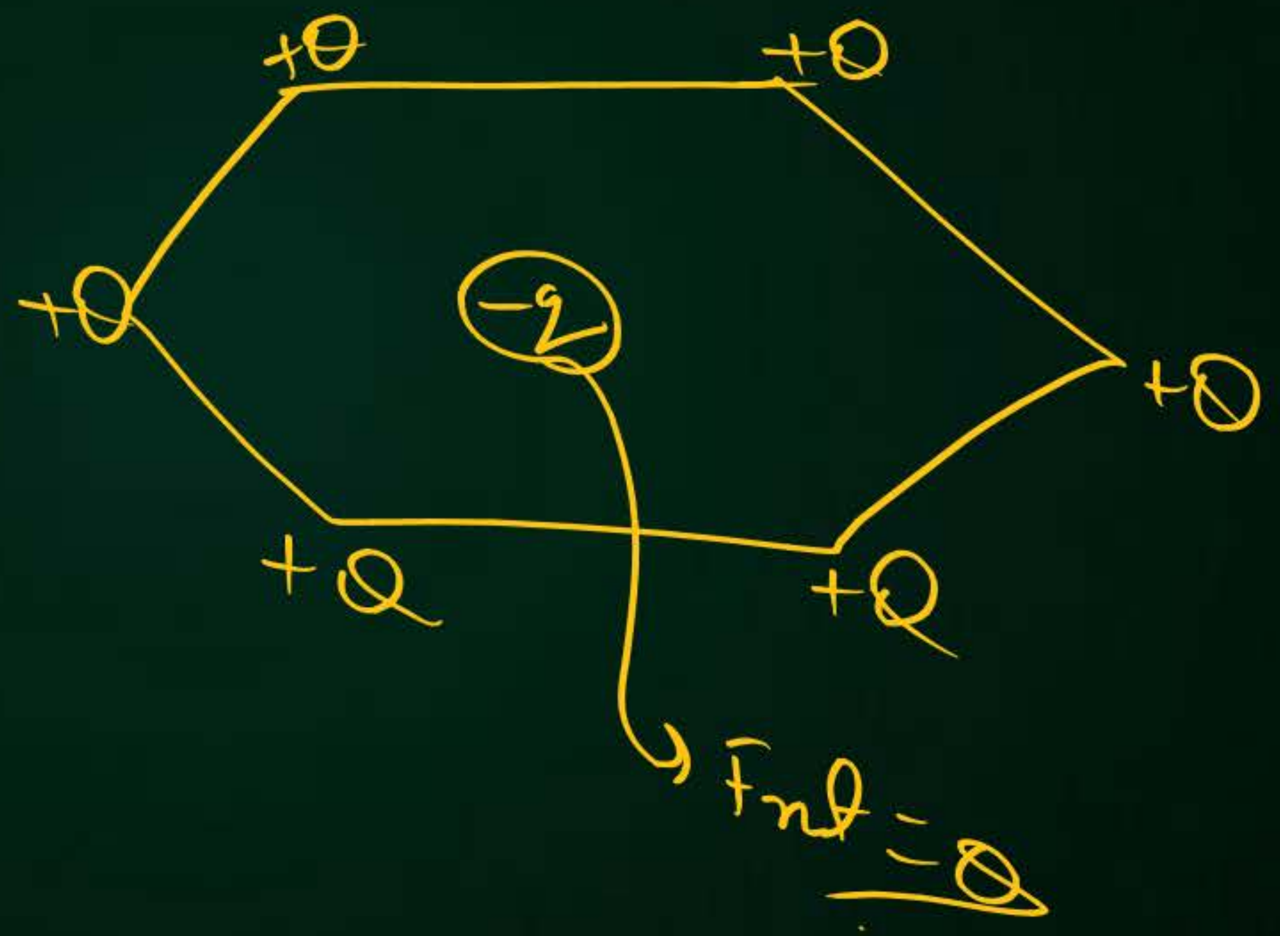
Ans



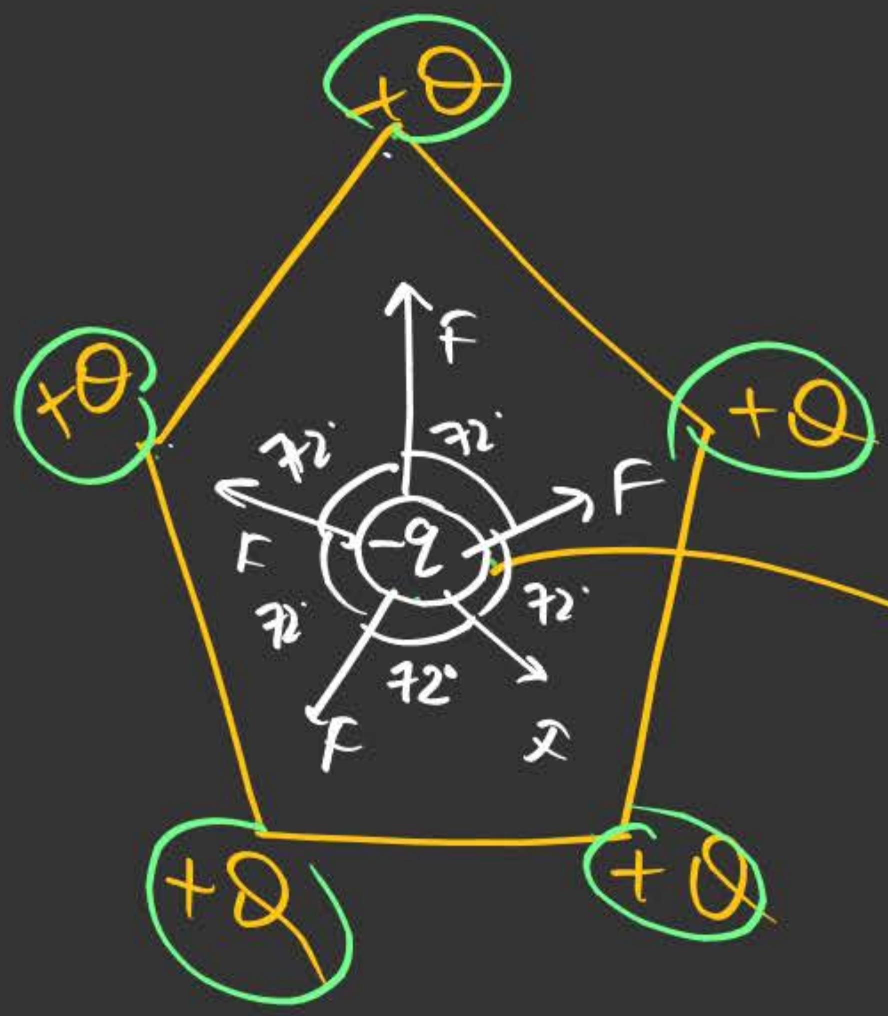
QUESTION

Find net force on small q charge placed at the centre.





Symmetric Pentagon



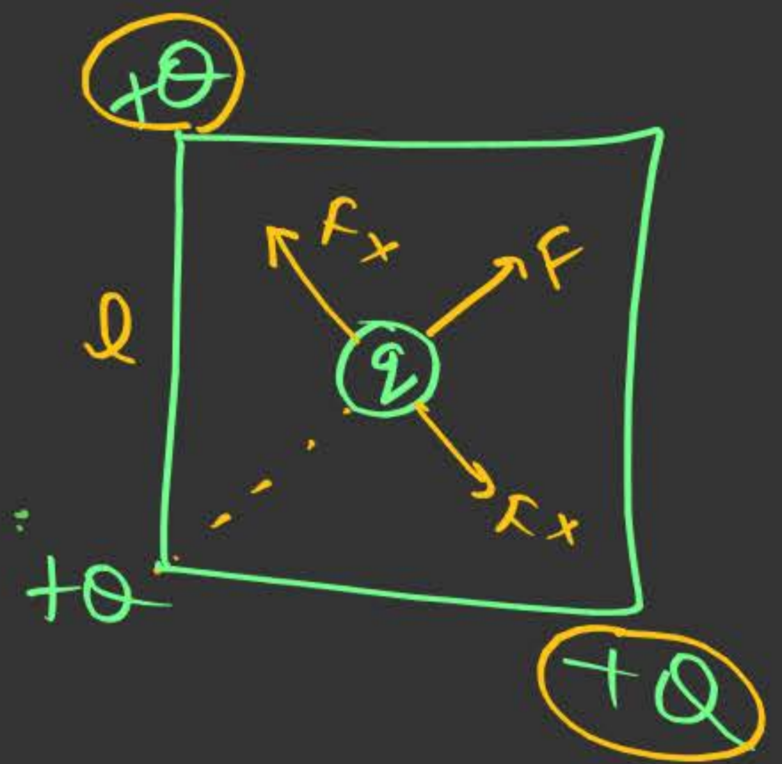
F_{net} on (q) = ??

$$F_{net} = 0$$

✓ (a) $F_{net} = 0$

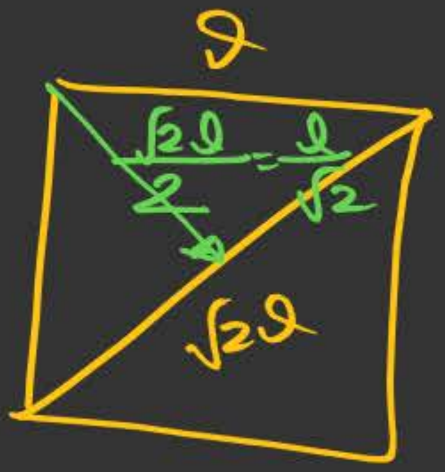
~~(b) $F_{net} \neq 0$~~

Find net force on (q)

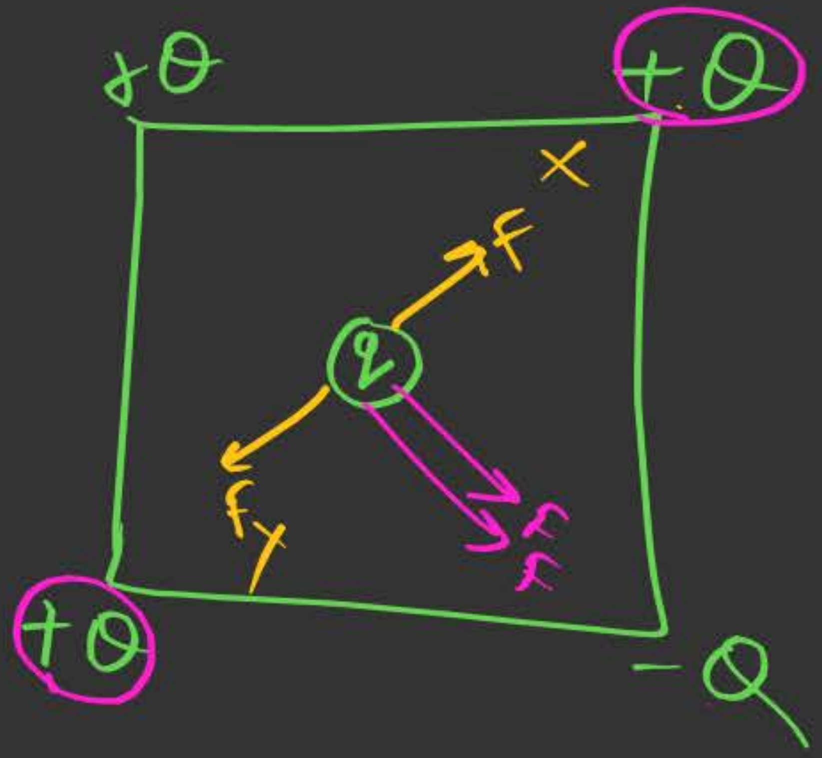


$$F_{net}(q) = \frac{KQq}{\left(\frac{l}{\sqrt{2}}\right)^2}$$

$$= \frac{2KQq}{l^2} \text{ Ans}$$



find force on (q)

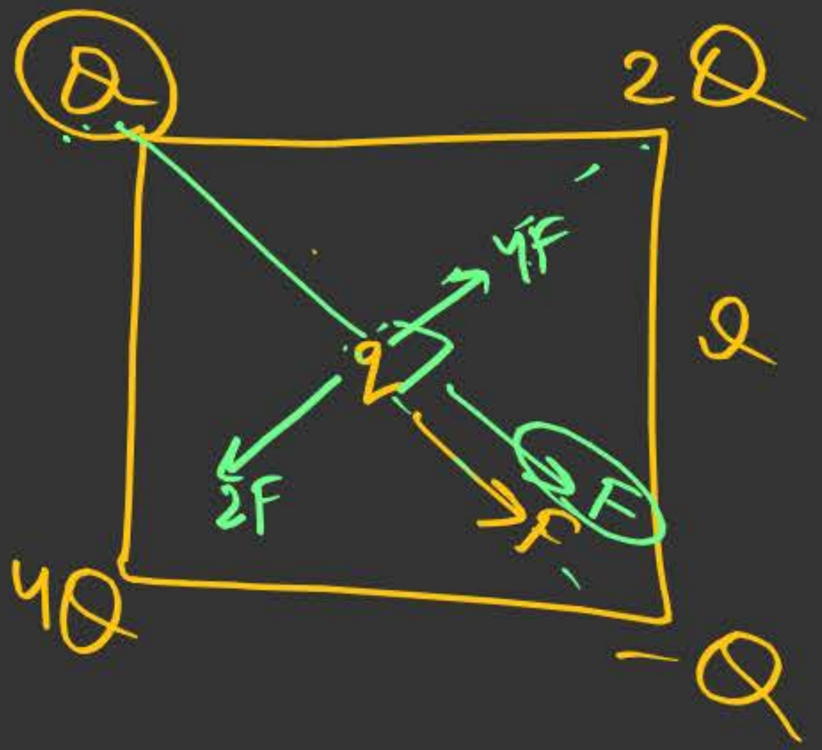


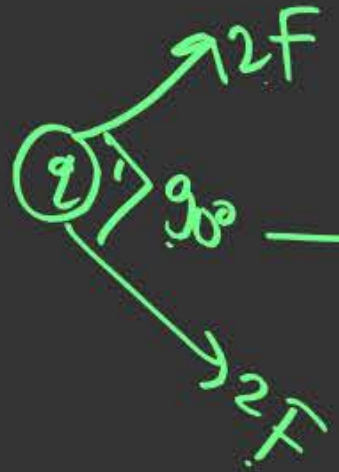
$$F_{net} = 2F$$

$$= 2\left(\frac{KQq}{\left(\frac{l}{\sqrt{2}}\right)^2}\right)$$

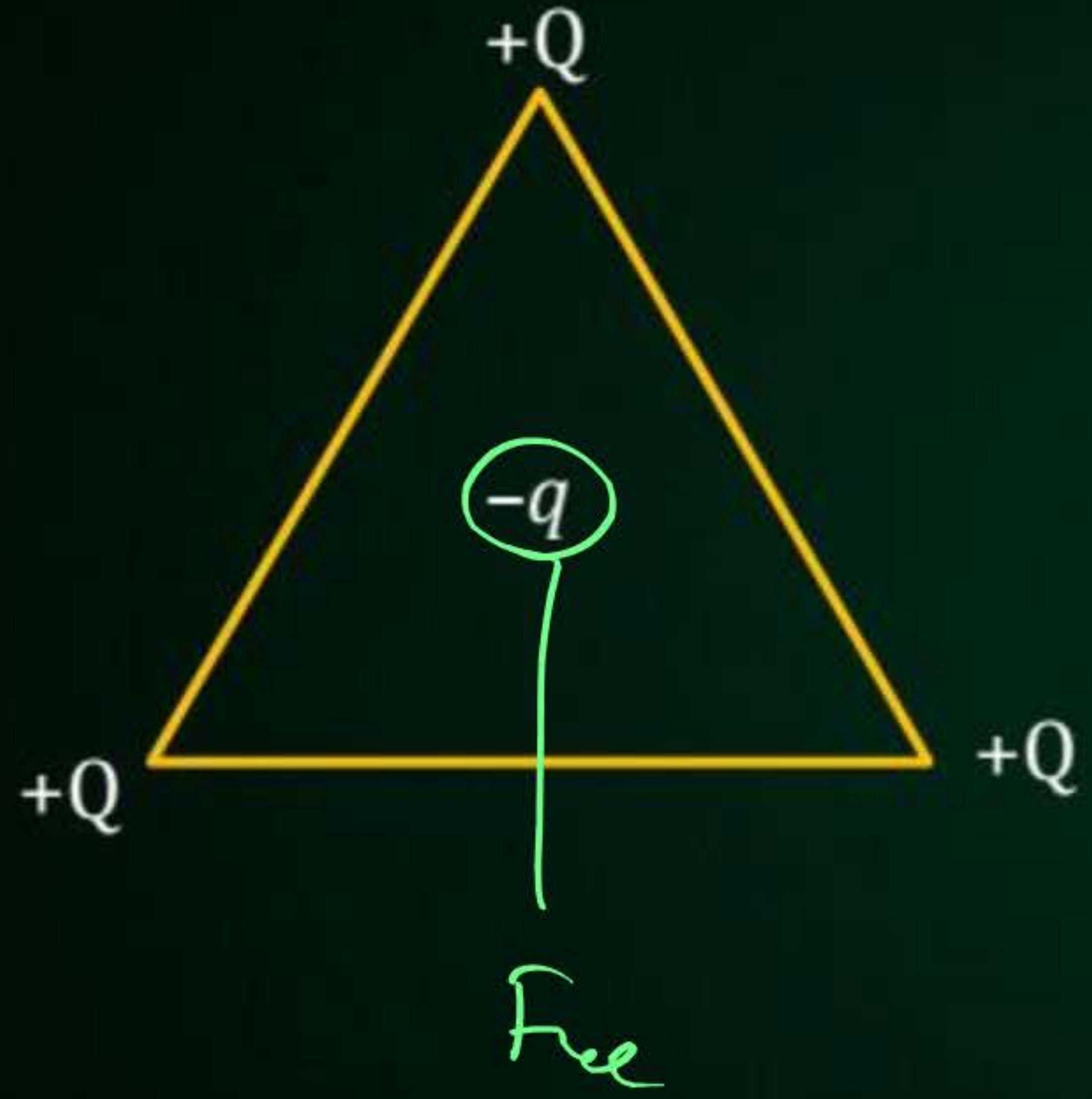
$$= \frac{4KQq}{l^2}$$

#



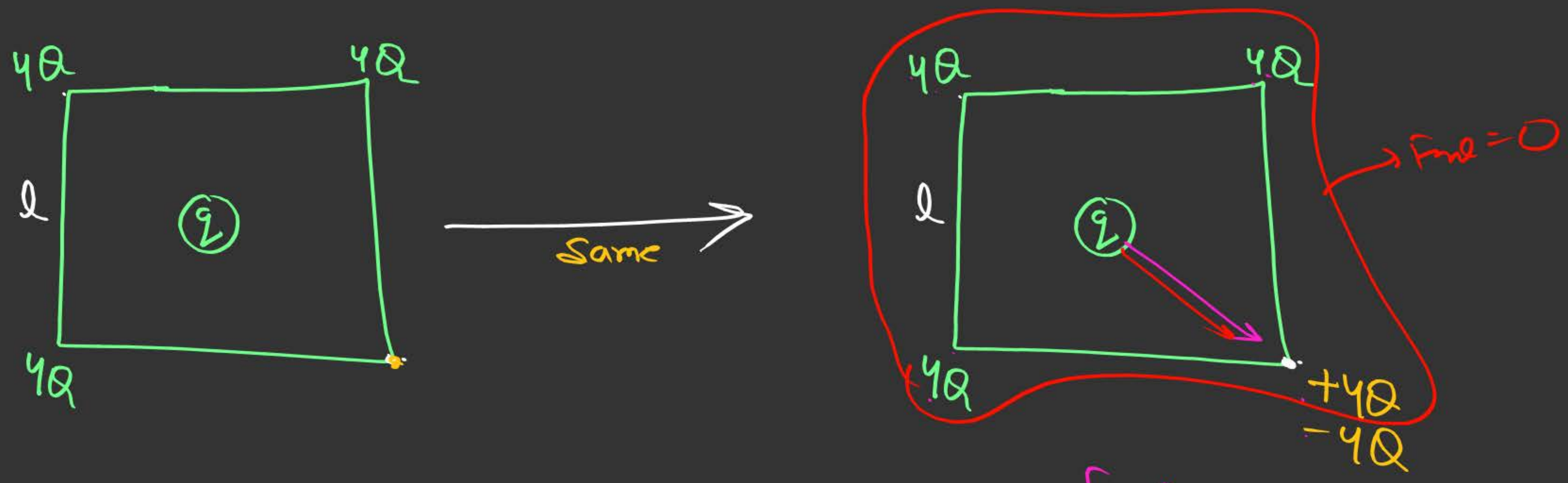


$$\sqrt{2}(2F) = 2\sqrt{2}\,\frac{KqQ}{\left(\frac{l}{\sqrt{2}}\right)^2} = \frac{4\sqrt{2}\,KqQ}{l^2}$$ Ans


+Q
−q
+Q
+Q
Free

+Q
+Q
−q
+Q
+Q

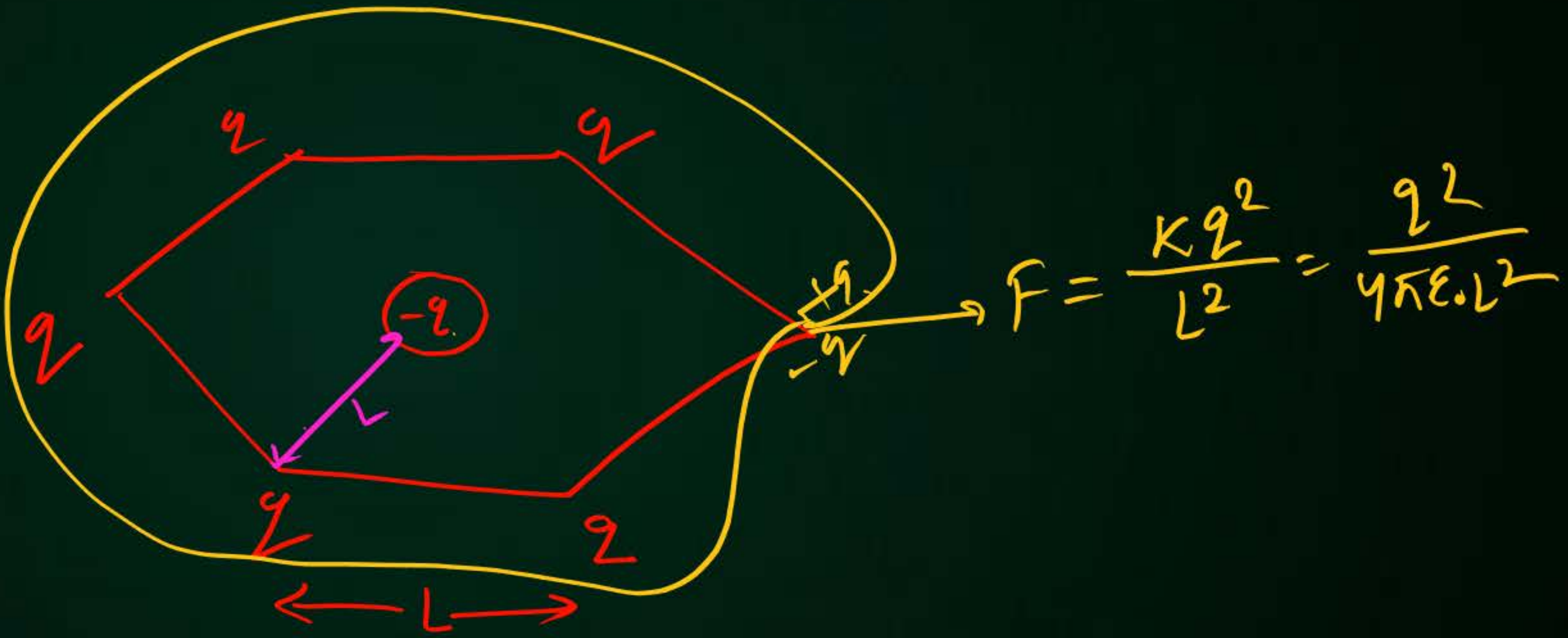
Find force on (q) charge?



$$F_{net} = \frac{Kq(4Q)}{\left(\frac{l}{\sqrt{2}}\right)^2}$$

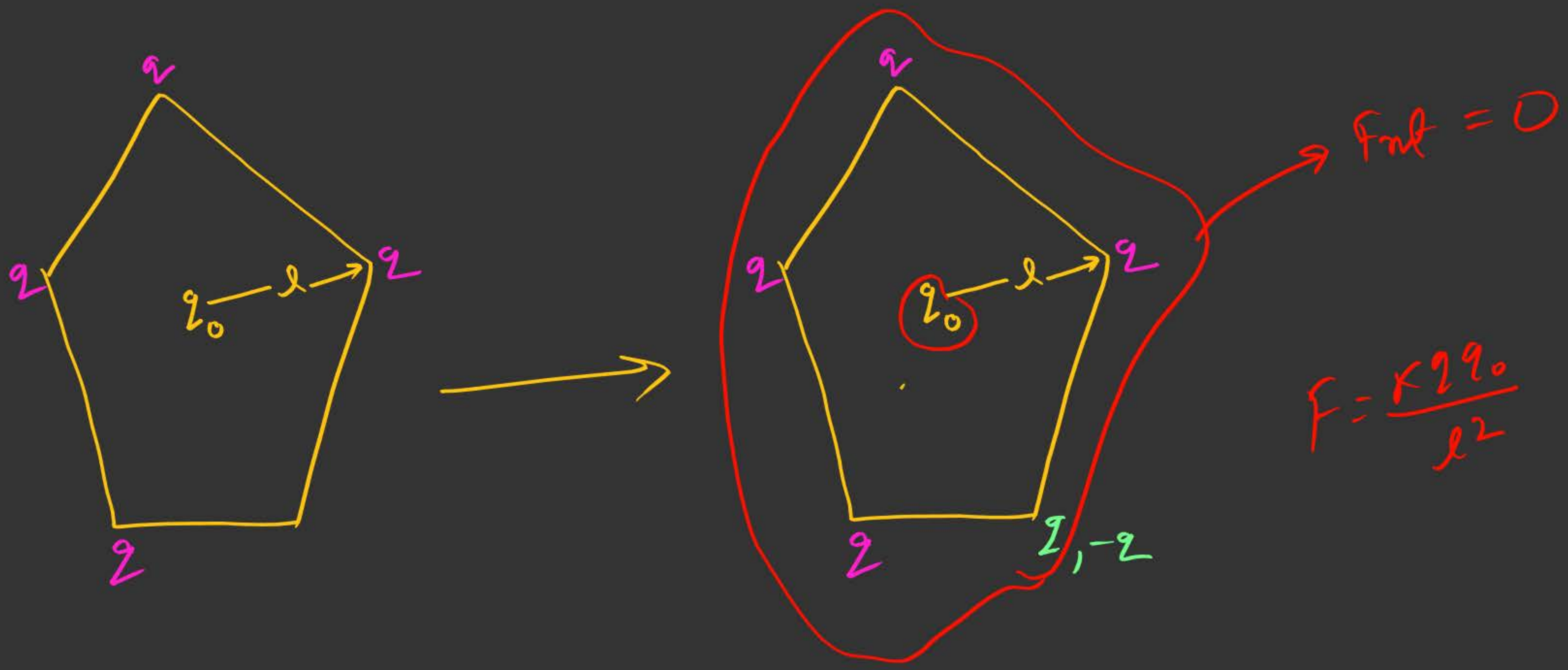
QUESTION

Five point charges, each of value $+q$, are placed on five vertices of a regular hexagon of side L. The magnitude of the force on a point charge of value $-q$ coulomb placed at the centre of the hexagon is:



1. $\frac{1}{\pi\varepsilon_0}\left(\frac{q}{L}\right)^2$
2. $\frac{2}{\pi\varepsilon_0}\left(\frac{q}{L}\right)^2$
3. $\frac{1}{2\pi\varepsilon_0}\left(\frac{q}{L}\right)^2$
4. $\frac{1}{4\pi\varepsilon_0}\left(\frac{q}{L}\right)^2$

symmetric Pentagon then find net force on q_0 charge ??



QUESTION

Find net force on charge Q which is at centre.



QUESTION

A rod of length L and linear charge density λ is placed along x-axis and a point charge q is placed and distance ‘a’ from one end then find force on rod due to this point charge.

$$\lambda = \frac{dq}{dL}$$



* Coulomb law is not valid for liner charge.

Coulomb law only valid for Point charge spherical symmetric

total charge on rod $= \lambda L$

$dq = \lambda\, dx$ — (1)

$$dF = \frac{Kq\,dq}{x^2}$$

$$\int dF = \int \frac{Kq\lambda\, dx}{x^2}$$

$$F = Kq\lambda \int_a^{a+L} \frac{1}{x^2}\, dx$$

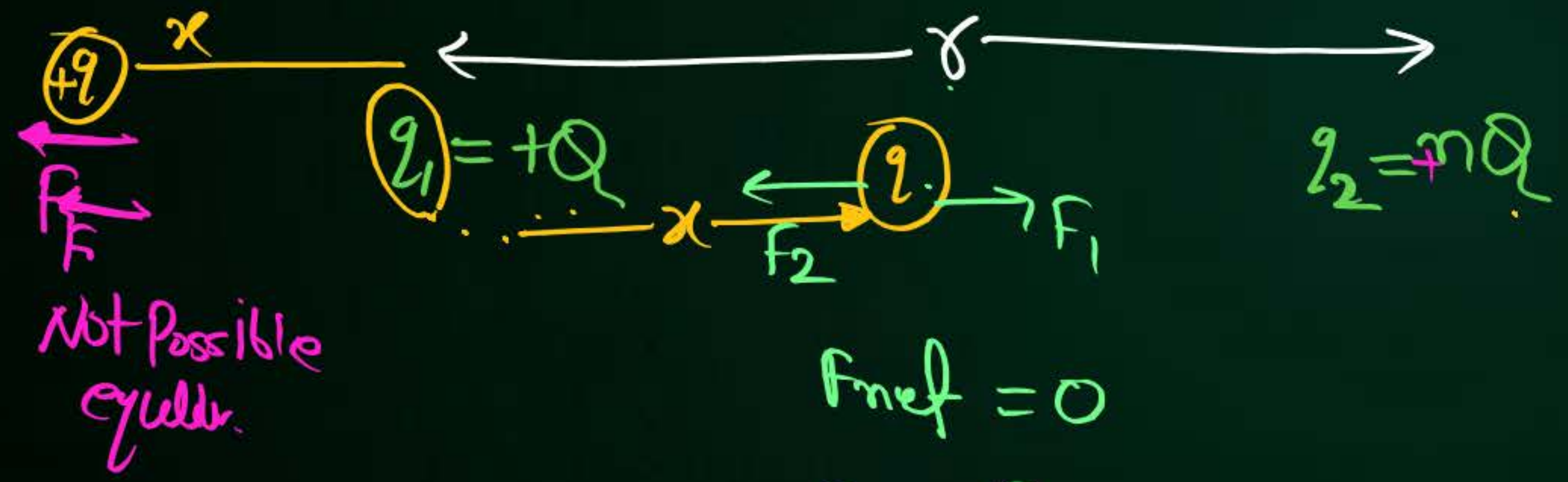
$$Kq\lambda \left(-\frac{1}{x}\right)_a^{a+L}$$

$$= \frac{Kq\lambda L}{a(a+L)} \quad \text{Ans}$$

ELECTROSTATICS EQUILIBRIUM

$$\frac{q_2}{q_1} = \frac{nQ}{Q} = n$$

- Two point charges placed as shown in figure then find position of 3rd charge so that that 3rd remains in equilibrium.



$$F_{net} = 0$$

$$F_1 = F_2$$

$$\frac{KQq}{x^2} = \frac{Kq\,nQ}{(r-x)^2}$$

$$\left(\frac{r-x}{x}\right)^2 = n$$

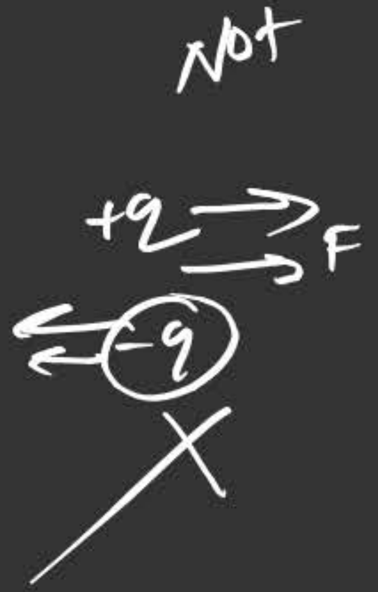
$$\frac{r-x}{x} = \sqrt{n}$$

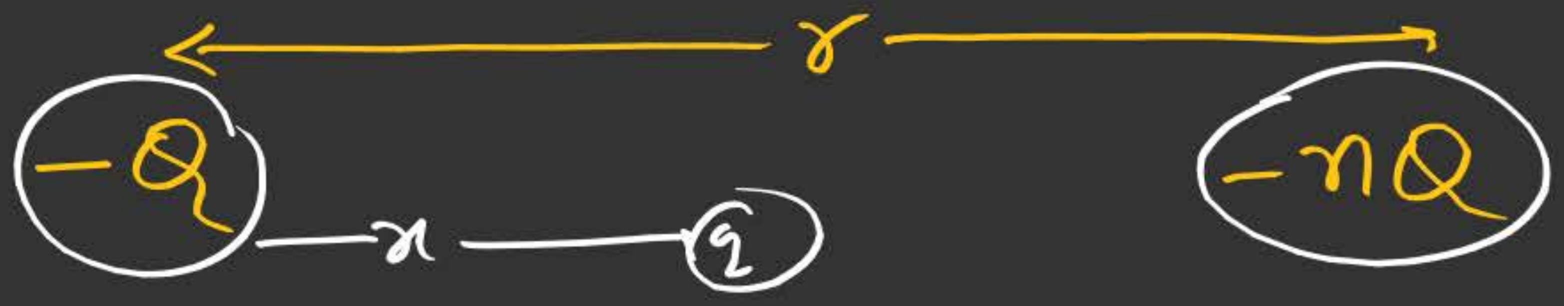
$$r = \sqrt{n}x + x$$

$$x = \frac{r}{\sqrt{n}+1}$$

If $n=1$

$$x = \frac{r}{1+1} = \frac{r}{2}$$



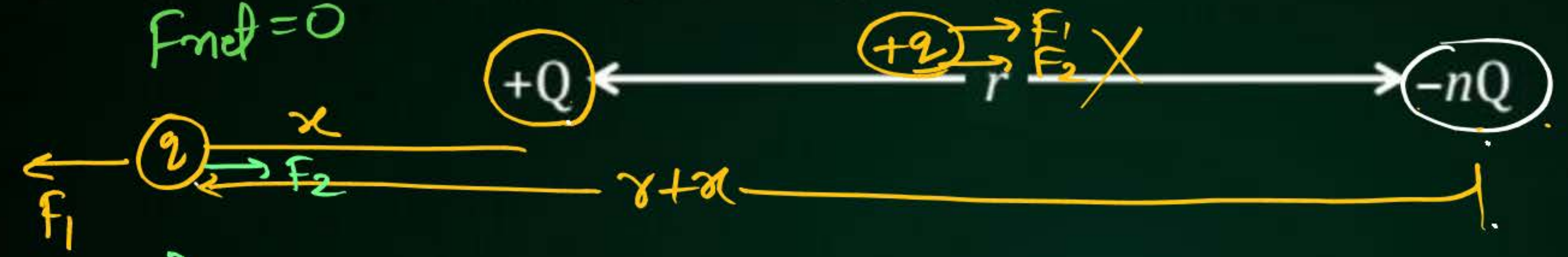


$$x = \frac{r}{\sqrt{n}+1}$$

→ same nature of charge

QUESTION

Find position of 3rd charge q in a given system so that net force exercised by q is zero.



$$F_{net} = 0$$

$$F_1 = F_2$$

$$\frac{kqQ}{x^2} = \frac{kq\,nQ}{(r+x)^2}$$

$$\frac{(r+x)^2}{x^2} = n$$

$$\frac{r+x}{x} = \sqrt{n}$$

$$r = \sqrt{n}\,x - x$$

$$x(\sqrt{n}-1) = r$$

$$x = \left[\frac{r}{\sqrt{n}-1}\right]$$



find Position of 3rd
Charge so that force
on that charge is zero

$$x = \frac{r}{\sqrt{n} - 1}$$

for small chg $= \frac{r}{1-1} = \frac{r}{0} = \infty$

QUESTION

Find position of 3rd charge q so that force on q will be zero.

(a) Q ←— 10m —→ +16Q

(b) 3Q ←— 30m —→ 27Q

(c) 25Q ←— 20m —→ 16Q

Sol^n

(a) $x = \frac{10m}{\sqrt{16}+1} = \frac{10m}{4+1} = 2m$ from $+Q$

$= 8m$ from $16Q$

(b) $x = \frac{30}{\sqrt{9}+1} = \frac{30}{4} = 7.5m$ from $3Q$

$n = \frac{27Q}{3Q} = 9$

(c) $x = \frac{20}{\sqrt{\frac{25}{16}}+1}$

$= \frac{20}{\frac{5}{4}+1}$

$= \frac{20\times 4}{9}$

$= 80/9\ m$

from $16Q$

QUESTION

Find position of 3rd charge so that force on that will be zero.

$$+Q \longleftarrow r \longrightarrow -Q$$

$\sqrt{-4}$ ✗

QUESTION

Find position of 3rd charge so that force on 3rd charge will be zero.

$9m + 6m = 15m$

(A) +25Q ←—— 6m ——→ –9Q —— x ——→ q

(B) –Q ←—— 10m ——→ –4Q

(C) –2Q ←—— 20m ——→ 8Q

(q placed at distance x to the left of –2Q)

Soln (a) $x = \frac{6}{\sqrt{\frac{25}{9}} - 1} = \frac{6}{\frac{5}{3} - 1} = \frac{6 \cdot 3}{2}$ $= 9m$ for (–9Q)

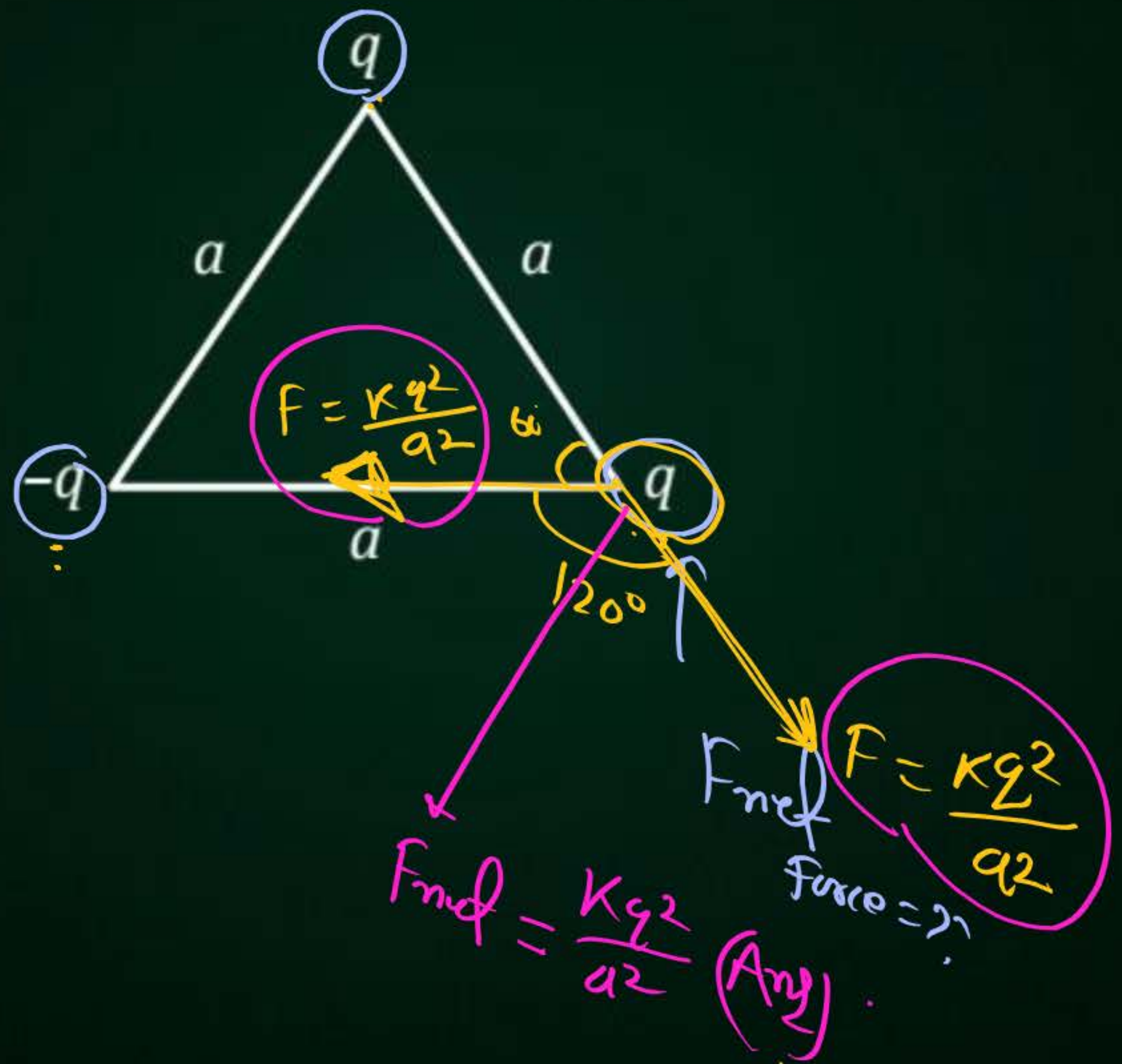
(b) $x = \frac{r}{\sqrt{n}+1} = \frac{10}{\sqrt{4}+1} = \frac{10}{3} m$ from (–Q)

(c) $x = \frac{20}{\sqrt{4} - 1} = \frac{20}{2-1} = 20m$ from (–2Q)

from 8Q = 40m

QUESTION

Find force on $+q$ charge due to other two charge.



$F_{net} = \frac{\sqrt{3}Kq^2}{a^2}$ (wrong)

(a) Yes

(b) NO

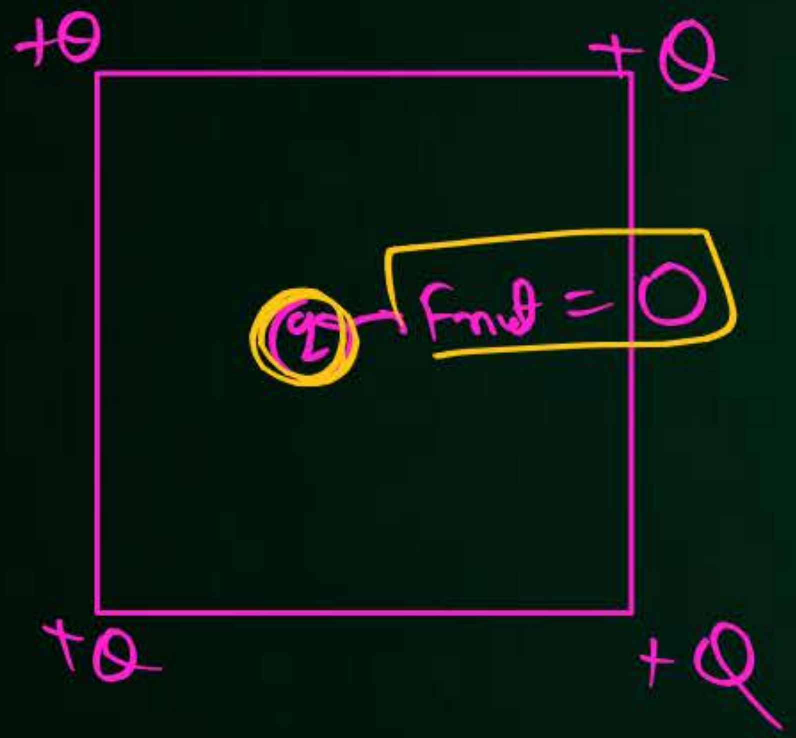
QUESTION

Find ..



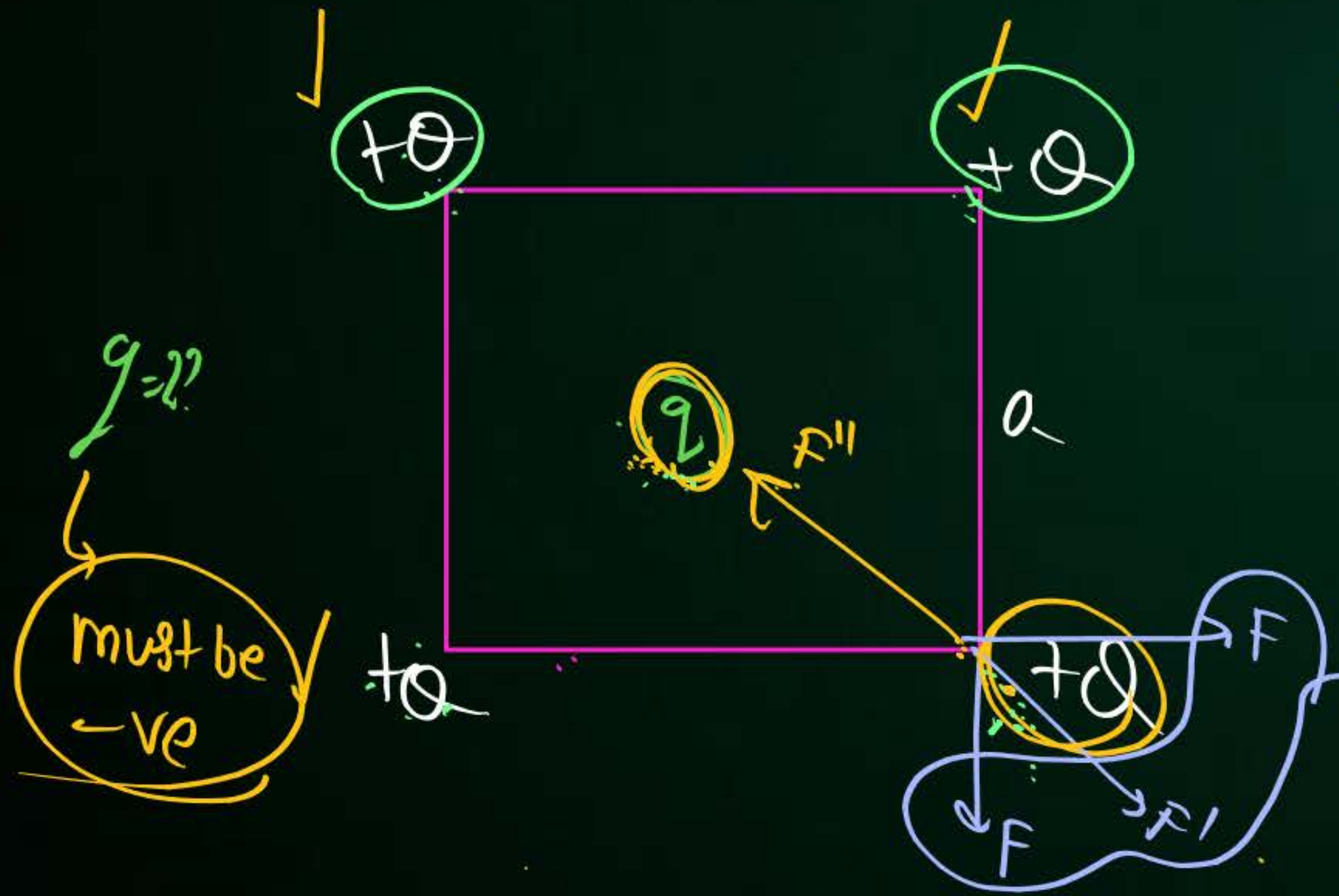
QUESTION

Four identical charge Q placed at the corner of square then find force on 5th charge which is at centre.



QUESTION

Four identical charge Q placed at the corner of square then find, value of 5^{th} charge which is at the centre of square so that net force on the system is zero [force on every charge is zero]



$$F'' = \frac{KQq}{\left(\frac{a}{\sqrt{2}}\right)^2} = \frac{KQ^2}{a^2}\left(\sqrt{2}+\frac{1}{2}\right)$$

$$\Rightarrow 2q = Q\left(\sqrt{2}+\frac{1}{2}\right)$$

$$F_{net} = \frac{KQ^2}{a^2}\left(\sqrt{2}+\frac{1}{2}\right)$$

$$q = -\frac{Q}{2}\left(\sqrt{2}+\frac{1}{2}\right)$$

Ans

Not for us



Find Position & value of 3rd charge (q) so that system is in equilibrium, (Net force on every charge is zero)

$$F_2 = \frac{KQq}{(r-x)^2}$$

$$F_1 = \frac{KQnQ}{r^2}$$



$F_{net} = 0$ (on +Q)

$F_{net} = 0$ (on q)

$$x = \frac{r}{\sqrt{n}+1} \quad (1)$$

$$F_1 = F_2$$

$$\frac{KQnQ}{r^2} = \frac{KQq}{(x^2)}$$

$$\frac{nQ}{r^2} = \frac{q}{x^2}$$

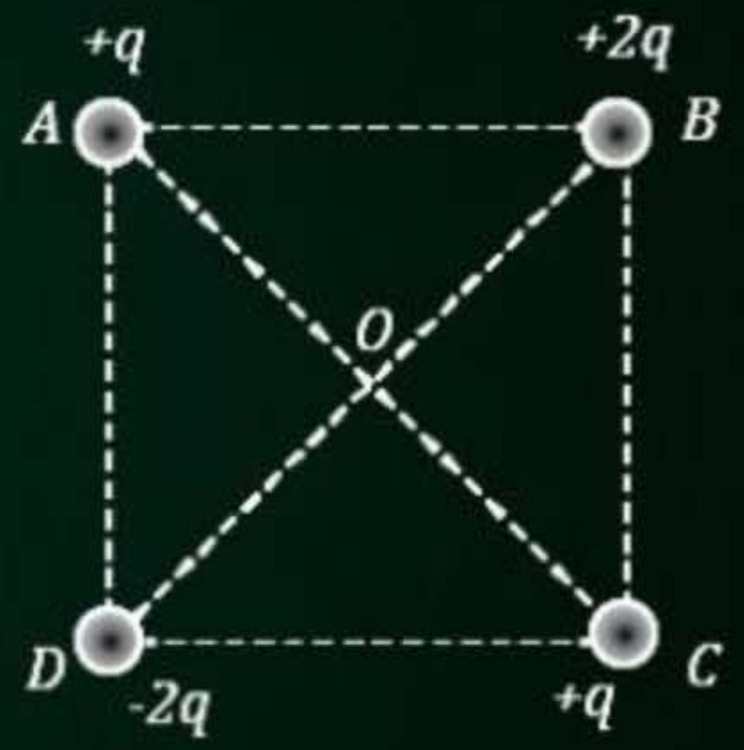
$$\frac{nQ}{r^2} = \frac{q}{\frac{r^2}{(\sqrt{n}+1)^2}}$$

$$q = \frac{nQ}{(\sqrt{n}+1)^2}$$

QUESTION

Four charges are arranged at the corners of a square ABCD, as shown in the adjoining figure. The force on the charge kept at the centre O is:

1. Zero
2. Along the diagonal AC
3. Along the diagonal BD
4. Perpendicular to side AB



QUESTION

Two charge θ_1 and θ_2 shows repulsion then which of the following option is correct for this:-

1. $\theta_1 \times \theta_2 = 0$
2. $\theta_1 \times \theta_2 > 0$
3. $\theta_1 \theta_2 < 0$
4. all of these

HW

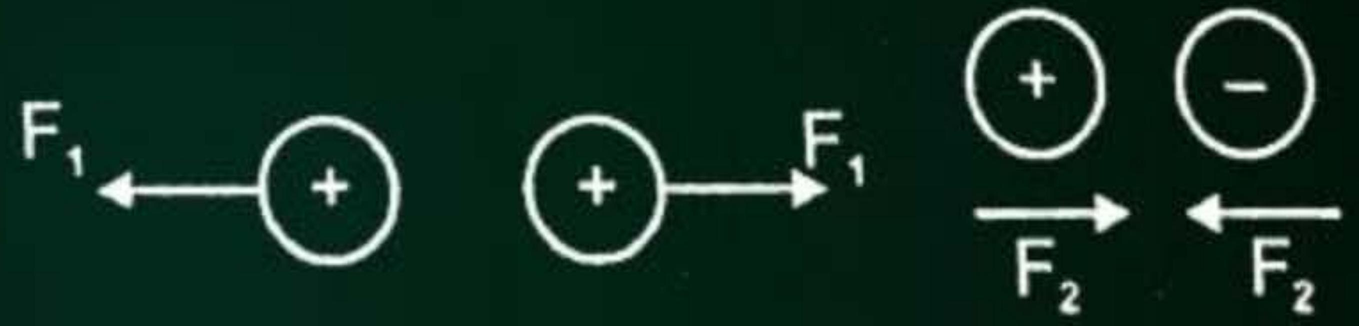
QUESTION

Electrostatic attraction between two point charge is F_0 when they are placed at r. If they are given to the conducting sphere of radius R. Then electrostatic attraction will be, if distance between centre of sphere is r ($r > R$).

1. $F > F_0$
2. $F < F_0$
3. $F = F_0$
4. zero

QUESTION

Two identical spheres are given equal charges in one case & opposite charge in another case having force F_1 & F_2 respectively. Distance between spheres is not large as compare to diameter then compare F_1 & F_2.



1. $F_1 > F_2$
2. $F_1 = F_2$
3. $F_1 < F_2$
4. Information is not sufficient to draw the conclusion

QUESTION

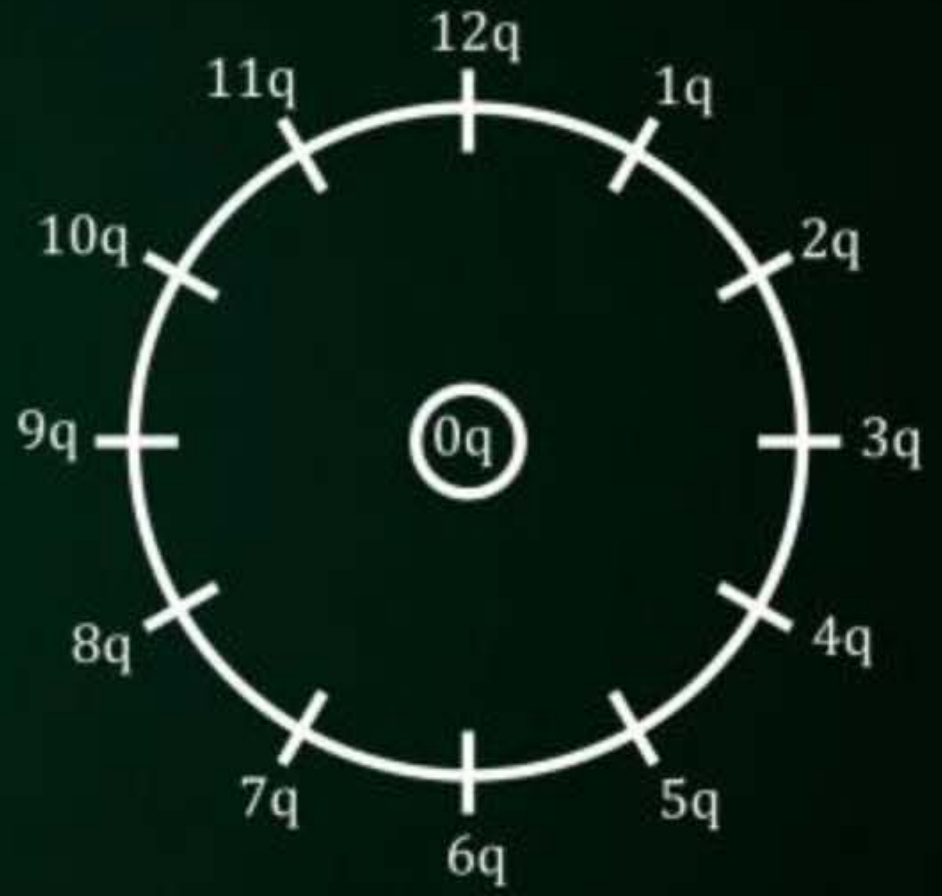
Suppose the charge of a proton and an electron differ slightly. One of them is $-e$, the other is $(e + \Delta e)$. If the net of electrostatic force and gravitational force between two hydrogen atoms placed at a distance d (much greater than atomic size) apart is zero, then Δc is of the order of [Given mass of hydrogen $m_h = 1.67 \times 10^{-27}$ kg]

[NEET (UG) 2017]

1. $10^{-23} \times C$
2. $10^{-37} \times C$
3. $10^{-47} \times C$
4. $10^{-20} \times C$

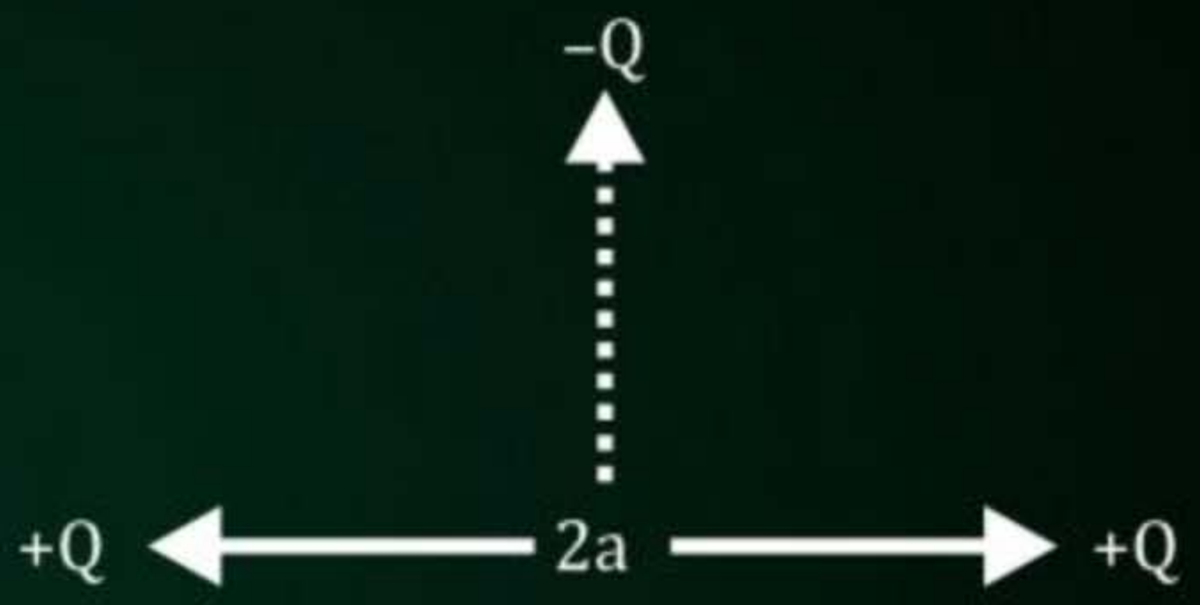
QUESTION

Find force on $-q_0$ which is cot centre in x and y-axis.



QUESTION

Find force on + ‘Q’



H/W

THANK YOU



YAKEEN 2.0

FOR NEET 2025

Lecture- 6 | **Physics**

Electric Charges and Fields



By- Dr. Manish Raj (MR SIR)

Topics to be covered

⇒ S.H.M in electroste

1 # ⇒ Pendulum Prbm

2 # ⇒ electric field

3 #



QUESTION

Find position and value of 3[rd] charge so that complete system will be in equilibrium.

Force on each charge will be zero

$+Q \longleftarrow r \longrightarrow +nQ$

x — q equli^m

$$x = \frac{r}{\sqrt{n}+1}$$

for same natur of chag

$x << r$

$$x = \frac{r}{\sqrt{n}-1}$$

Opposite nate of chag.

Fnet force $+Q = 0$

$$q = \frac{-nQ}{(\sqrt{n}+1)^2}$$

$-q$ — $+Q$ — r — $-nQ$

$$x = \frac{r}{\sqrt{n}-1}$$

$F_{net} = 0$

$$|q| = \frac{-nQ}{(\sqrt{n}-1)^2}$$

QUESTION

Two charge θ_1 and θ_2 shows repulsion then which of the following option is correct for this:-

1. $\theta_1 \times \theta_2 = 0$
2. $\theta_1 \times \theta_2 > 0$ ✓
3. $\theta_1 \times \theta_2 < 0$
4. all of these

θ_1 θ_2

+ve +ve → Repu greater than 0

+ve −ve → attra ⊖ −ve

+ve zero = zero (attraction)

QUESTION

Find distance from $9Q$ where 3rd charge is placed to experience zero force.

$-Q$ ———— 18m ———— $9Q$

(2) ← x (measured from $-Q$)

$x = \frac{18}{\sqrt{9}-1} = \frac{18}{2} = 9m$

$(9m + 18m) = 27m$

$x = \frac{r}{\sqrt{n}-1}$

$x = \frac{18}{\sqrt{9}-1} = \frac{18}{3-1} = \frac{18}{2} = 9m$ (wrong)

Find value of q so that system is in equilibrium.

$\Rightarrow q = \frac{nQ}{(\sqrt{n}-1)^2} = \frac{9Q}{(\sqrt{9}-1)^2} = \frac{9Q}{4}$ Ans.

QUESTION

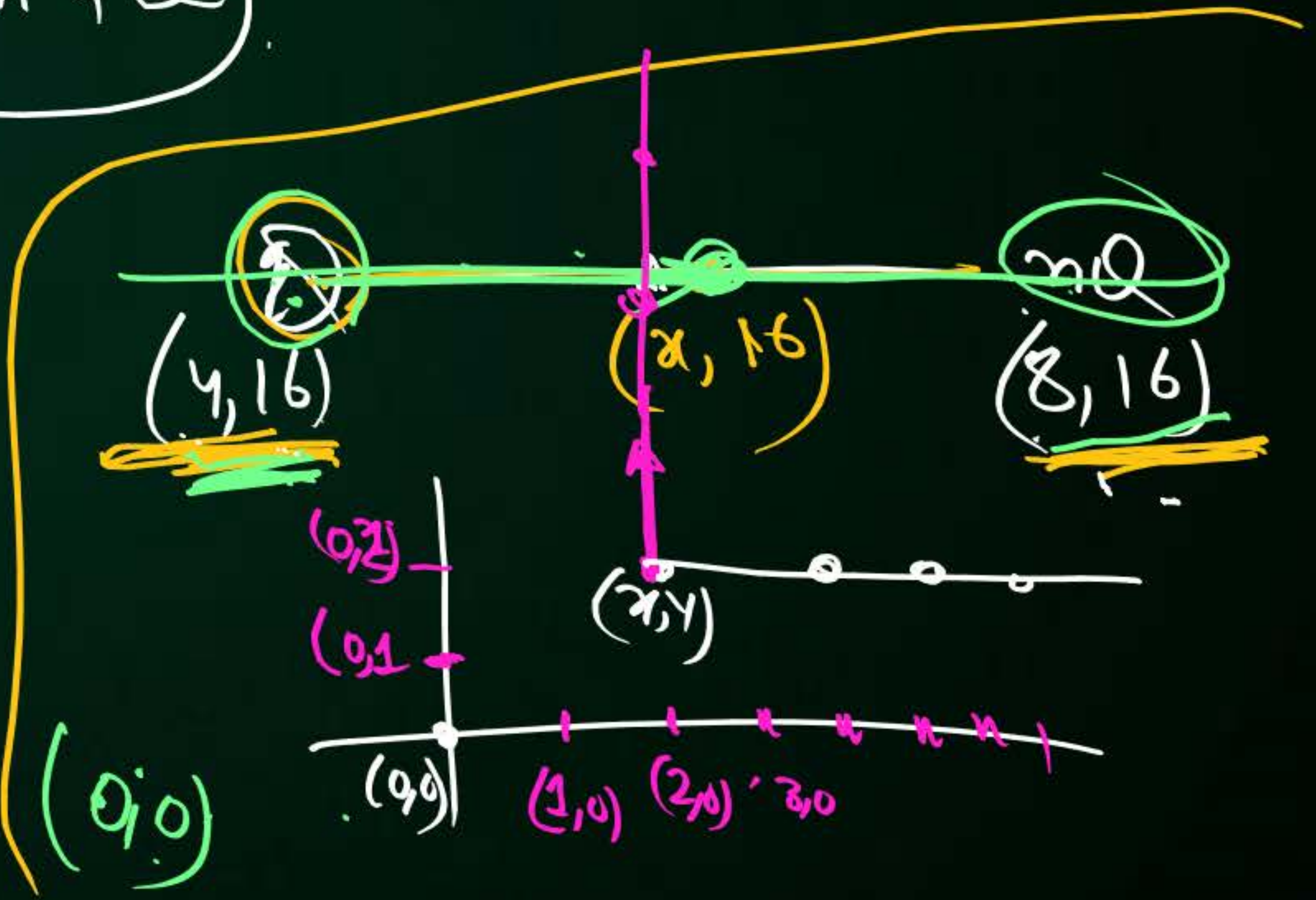
Find the value and position of q so that system will be in equilibrium.



$$r = \frac{10}{\sqrt{16}+1} = \frac{10}{5}\,m = 2\,m \text{ from } +Q$$

$$q = \frac{16Q}{25} \text{ Ans}$$

$$q = \frac{nQ}{(\sqrt{n}+1)^2} \text{ Ans}$$



QUESTION

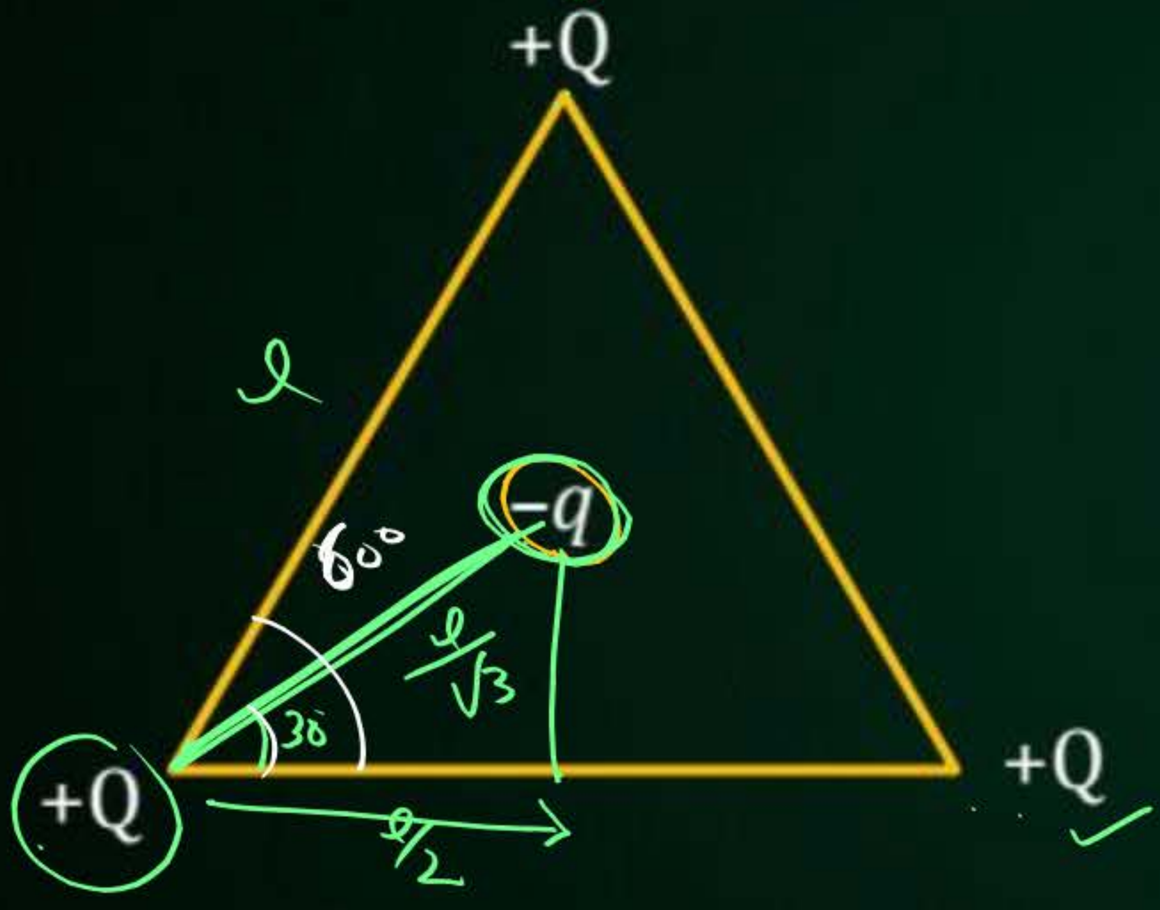
If net force on q_3 is zero then find relation between q_1 and q_2

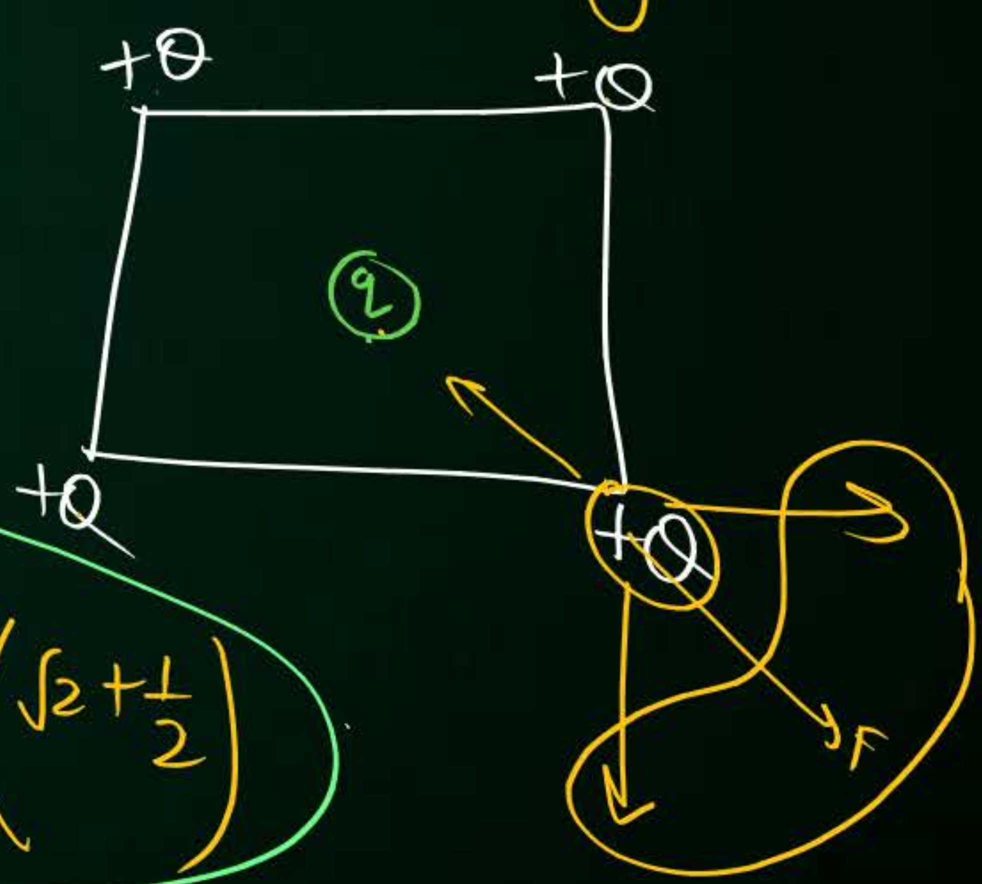


QUESTION

Find value of q placed at centre of (equilateral) triangle so that system is in equilibrium.

Force on every charge is zero.





$$F = \frac{\sqrt{3}KQ^2}{l^2} = \frac{Kq Q}{\left(\frac{l}{\sqrt{3}}\right)^2}$$

$$\frac{\sqrt{3}}{3}Q = q \quad \frac{Q}{\sqrt{3}} = q \text{ Ans.}$$

$$\frac{KqQ}{\left(\frac{l}{\sqrt{2}}\right)^2} = \frac{KQ^2}{l^2}\left(\sqrt{2}+\frac{1}{2}\right)$$

QUESTION

A particle of mass m and carrying charge $-q_1$ is moving around a charge $+q_2$ along a circular path of radius r. Find period of revolution of the charge $-q_1$

1. $\sqrt{\dfrac{16\pi^3\varepsilon_0 m r^3}{q_1 q_2}}$
2. $\sqrt{\dfrac{8\pi^3\varepsilon_0 m r^3}{q_1 q_2}}$
3. $-\sqrt{\dfrac{q_1 q_2}{16\pi^3\varepsilon_0 m r^3}}$
4. Zero

$\dfrac{mv^2}{r}$ $\quad T = \dfrac{2\pi r}{v}$

$m, -q_1$ —— r —— $+q_2$ fixed cen

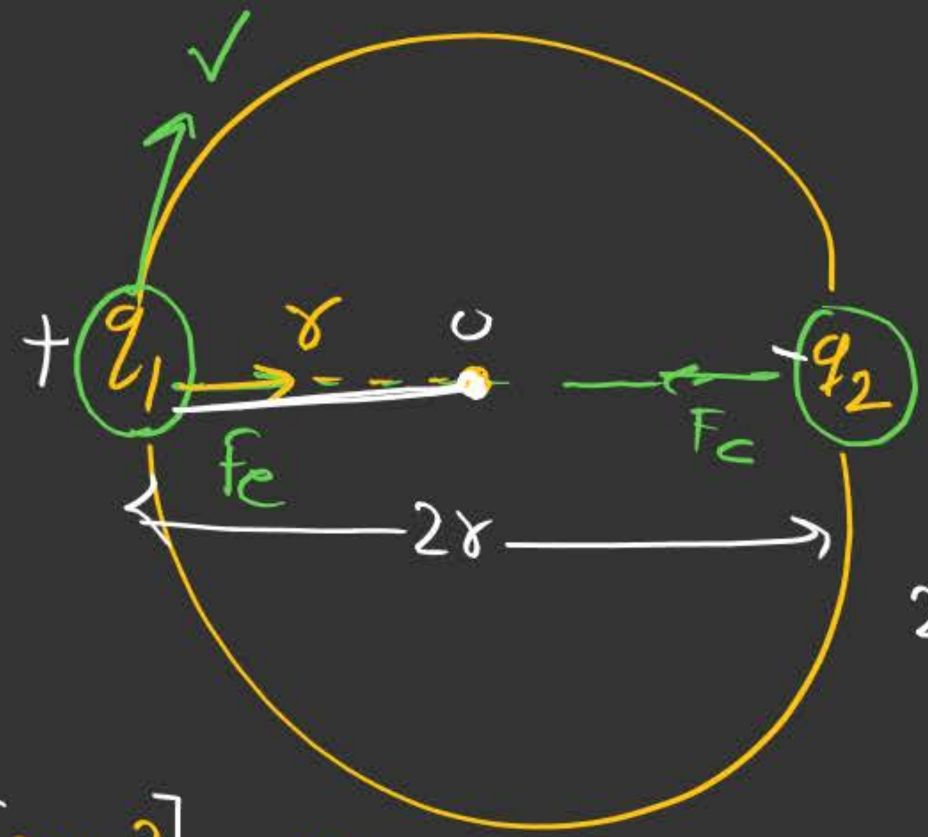
(centri) $m\omega^2 r = \dfrac{q_1 q_2}{4\pi\varepsilon_0 r^2}$ (electosu)

$\left(\dfrac{2\pi}{T}\right)^2 = \dfrac{q_1 q_2}{4\pi\varepsilon_0 m r^3}$

$\dfrac{2\pi}{T} = \left(\sqrt{\dfrac{q_1 q_2}{4\pi\varepsilon_0 m r^3}}\right)$

$T = 2\pi\sqrt{\dfrac{4\pi\varepsilon_0 m r^3}{q_1 q_2}}$

(Q) Two charge q_1 & $-q_2$ moving on the circular path due to their mutual electrostatic force then find its speed and time period.



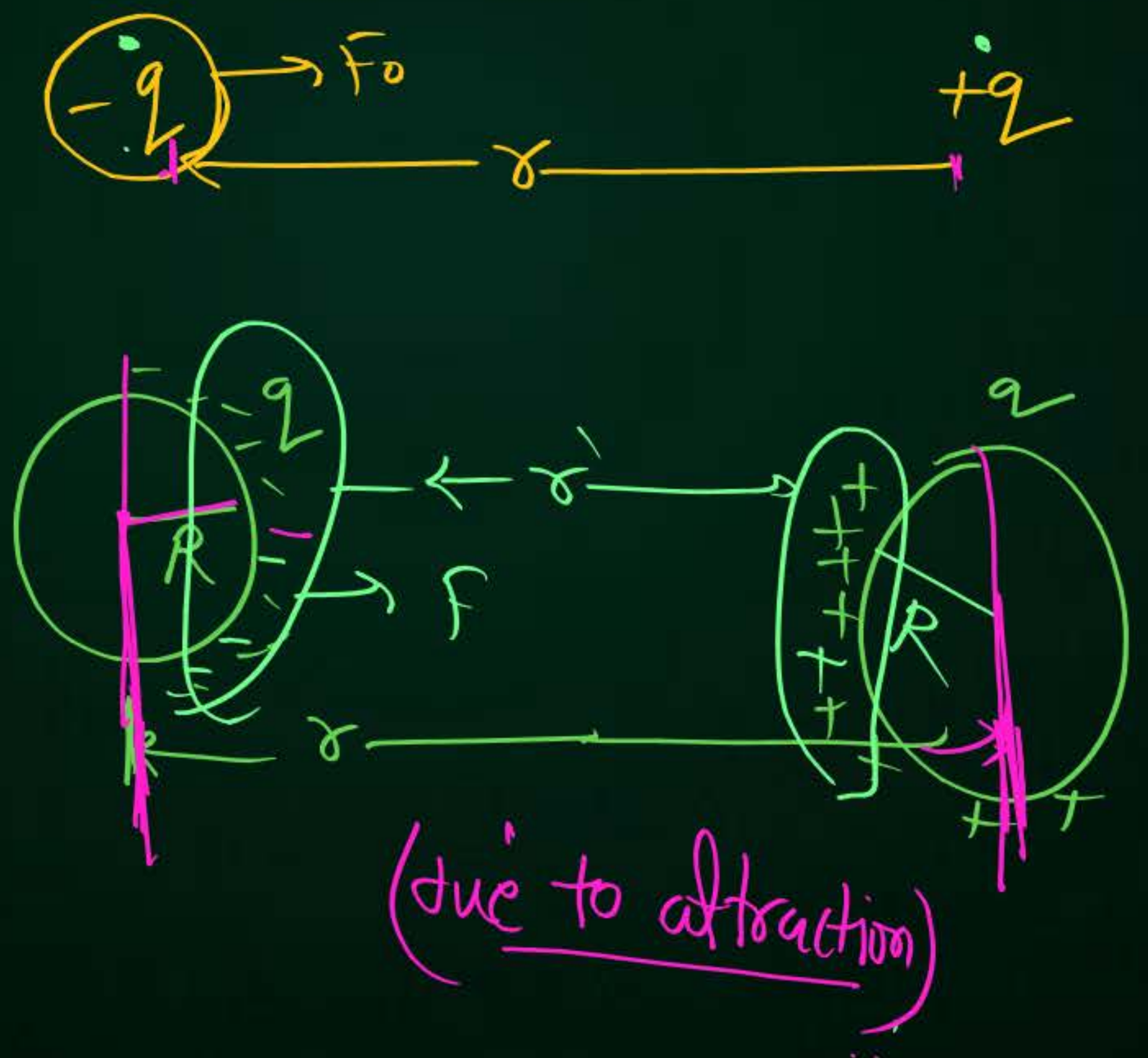
$2r$ = distⁿ b/w charge

$$\Rightarrow \left[\frac{mv^2}{r}\right] = \frac{Kq_1q_2}{(2r)^2}$$

QUESTION

Electrostatic attraction between two point charge is F_0 when they are placed at r. If they are given to the conducting sphere of radius R. Then electrostatic attraction will be, if distance between centre of sphere is r $(r > R)$.

1. $F > F_0$
2. $F < F_0$
3. $F = F_0$
4. zero



QUESTION

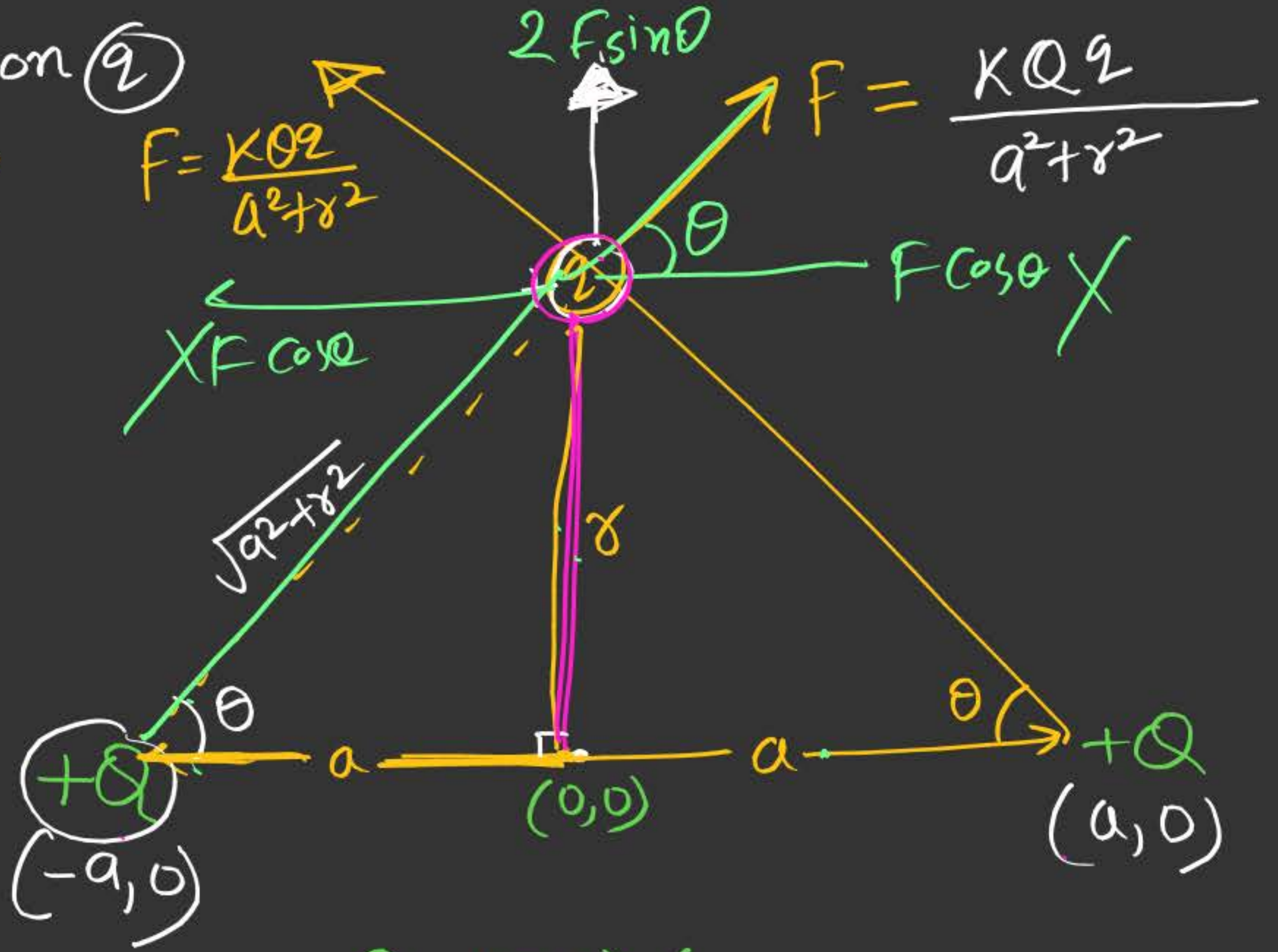
Two identical spheres are given equal charges in one case & opposite charge in another case having force F_1 & F_2 respectively. Distance between spheres is not large as compare to diameter then compare F_1 & F_2.



1. $F_1 > F_2$
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3. $F_1 < F_2$
4. Information is not sufficient to draw the conclusion

Find force on (q)

Not for NEET



$$F_{net} = 2F\sin\theta$$

$$= 2 \times \frac{KQq}{(a^2+r^2)} \times \sin\theta$$

$$= \frac{2KQq}{(a^2+r^2)^1} \times \frac{r}{\sqrt{a^2+r^2}}$$

$$F_{net} = \frac{\sqrt{2}\,KQq}{a^2+r^2}$$

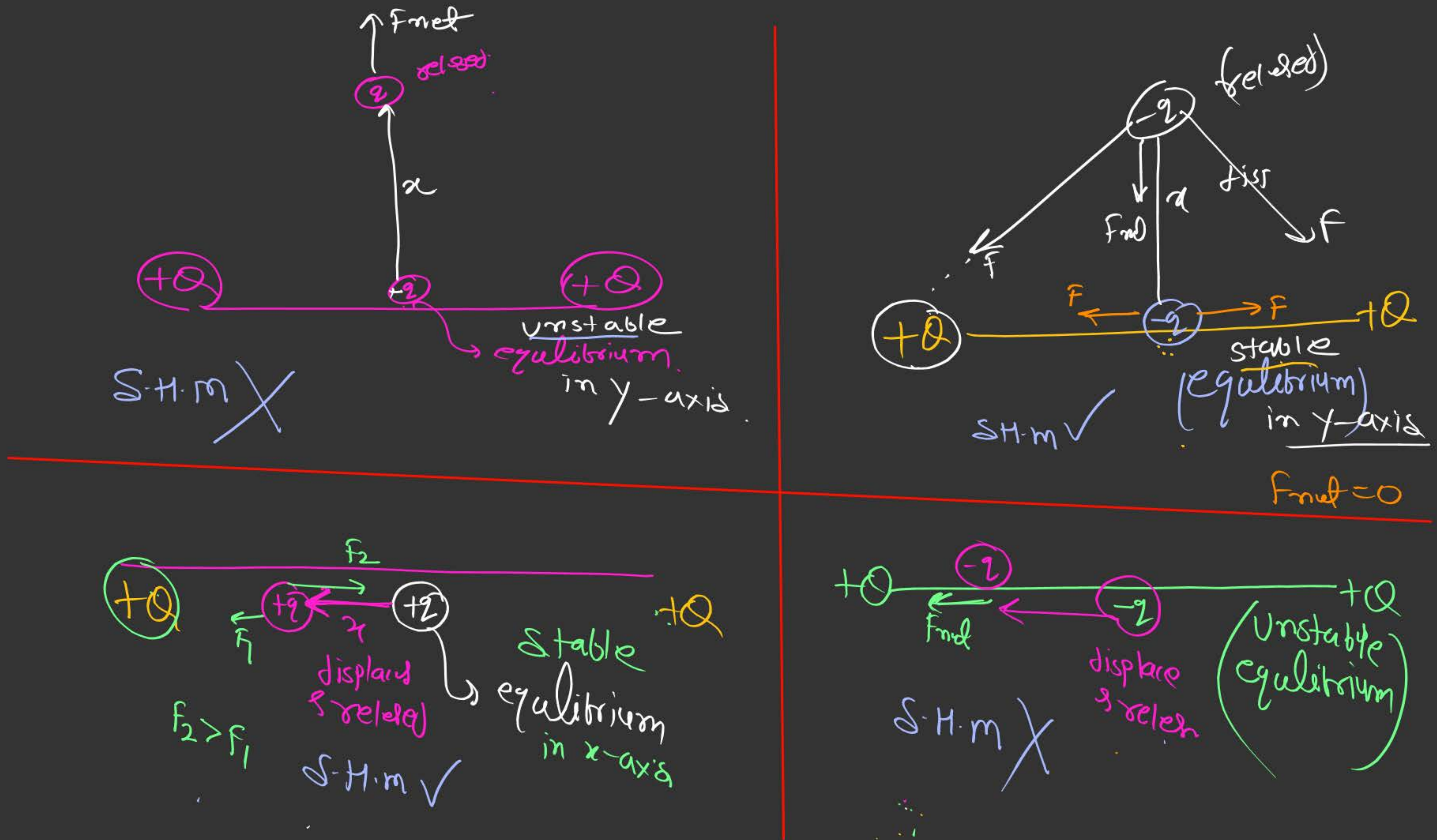
Wrong

$\theta = 45°$ ✗

$\theta = 60$ ✗

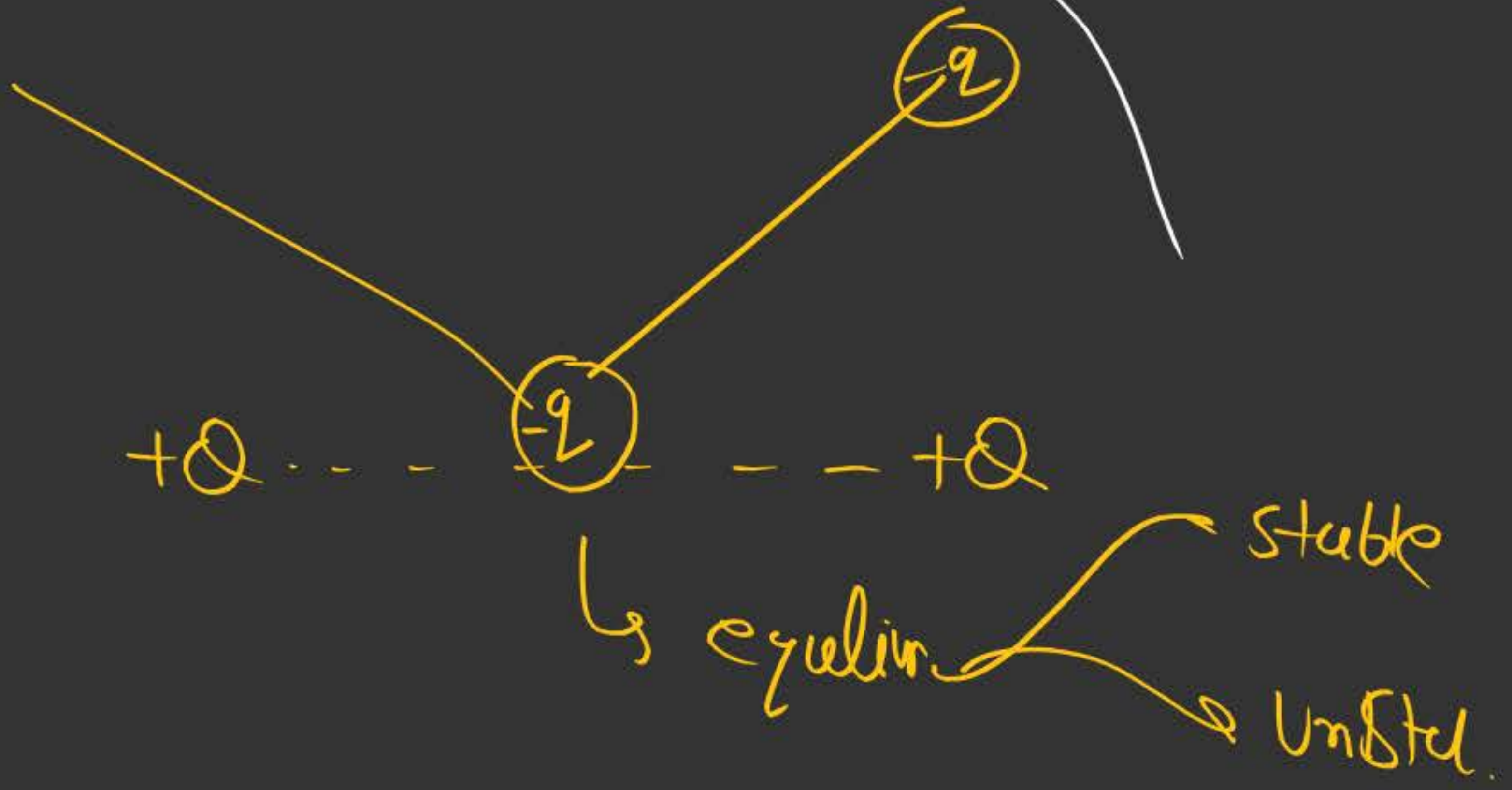
$$\cos\theta = \frac{a}{\sqrt{a^2+r^2}} \qquad \sin\theta = \frac{r}{\sqrt{a^2+r^2}}$$

$$F = \frac{2KQqr}{(a^2+r^2)^{3/2}}$$



Fnet
released
q
x
+Q
+q
+Q
unstable equilibrium in y-axis
S.H.M ✗
(released)
-q
F
Fnet
x
F
+Q
-q
F
F
+Q
stable (equilibrium) in y-axis
SHM ✓
Fnet = 0
F2
+Q
+q
+q
+Q
F1
x
displaced & released
Stable equilibrium in x-axis
F2 > F1
S.H.M ✓
+Q
-q
-q
+Q
Fnet
displace & release
Unstable equilibrium
S.H.M ✗

In electrostatic stable electrostatic equilibrium is never possible



(correct)

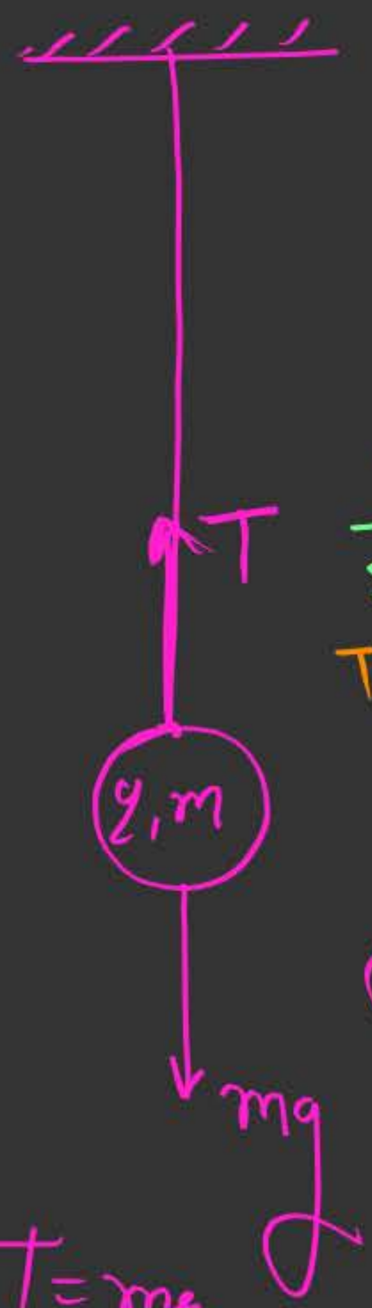
QUESTION H/W

Suppose the charge of a proton and an electron differ slightly. One of them is $-e$, the other is $(e + \Delta e)$. If the net of electrostatic force and gravitational force between two hydrogen atoms placed at a distance d (much greater than atomic size) apart is zero, then Δc is of the order of [Given mass of hydrogen $m_h = 1.67 \times 10^{-27}$ kg]

[NEET (UG) 2017]

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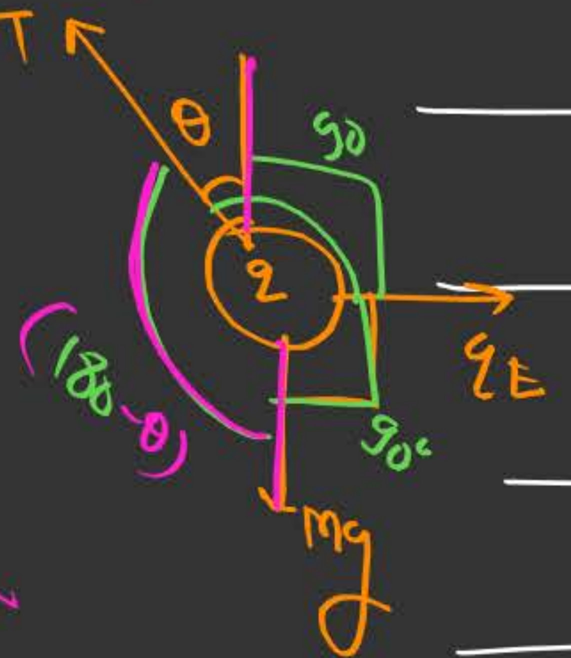
Pendulum Prob^n

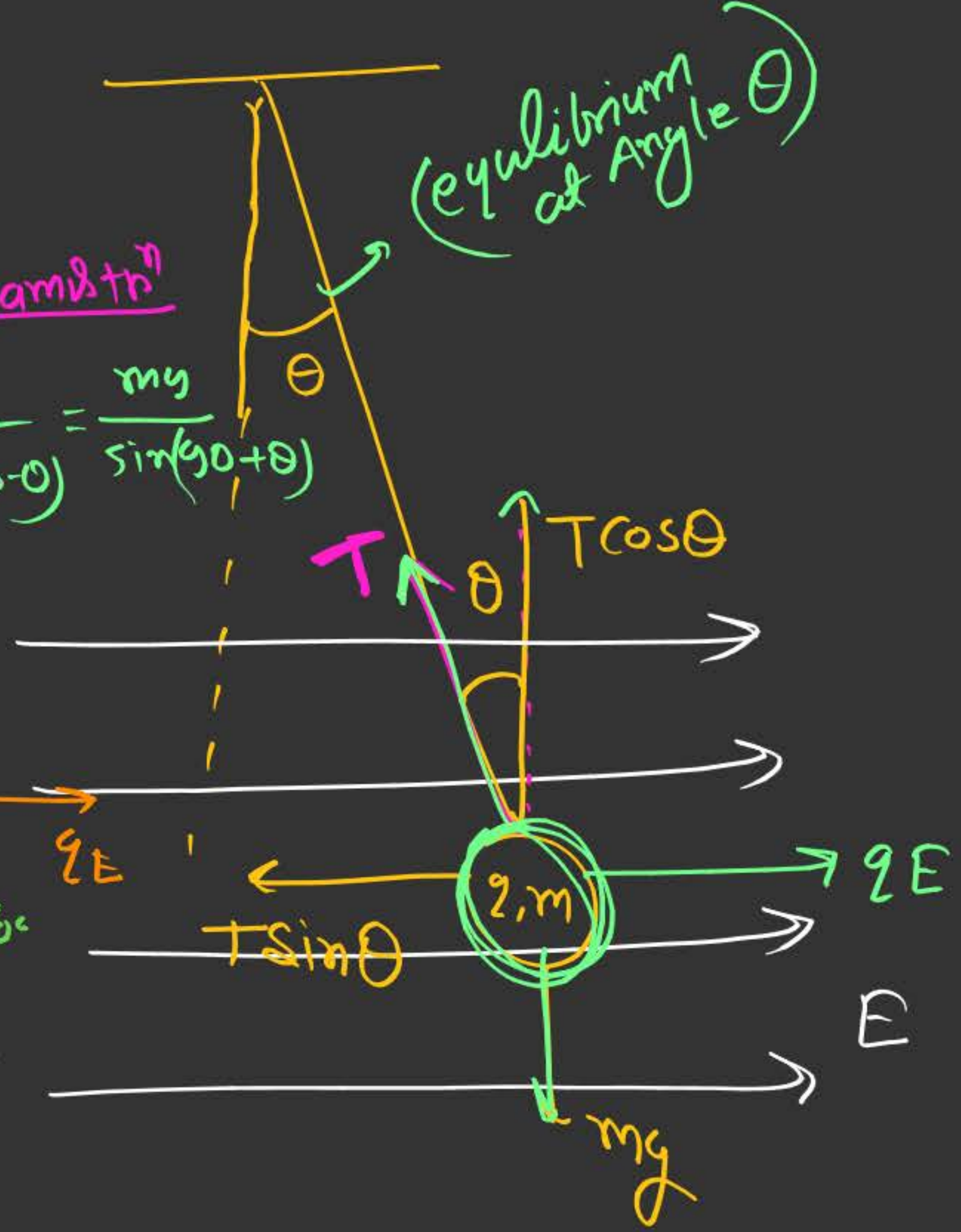


$T = mg \quad (E = 0)$

Apply lami's th^n

$$\frac{T}{\sin 90} = \frac{qE}{\sin(180-\theta)} = \frac{mg}{\sin(90+\theta)}$$





$\Sigma F_y = 0$

$T\cos\theta = mg \quad \text{— (I)}$

$T\sin\theta = qE \quad \text{— (II)}$

dividing (I)/(II)

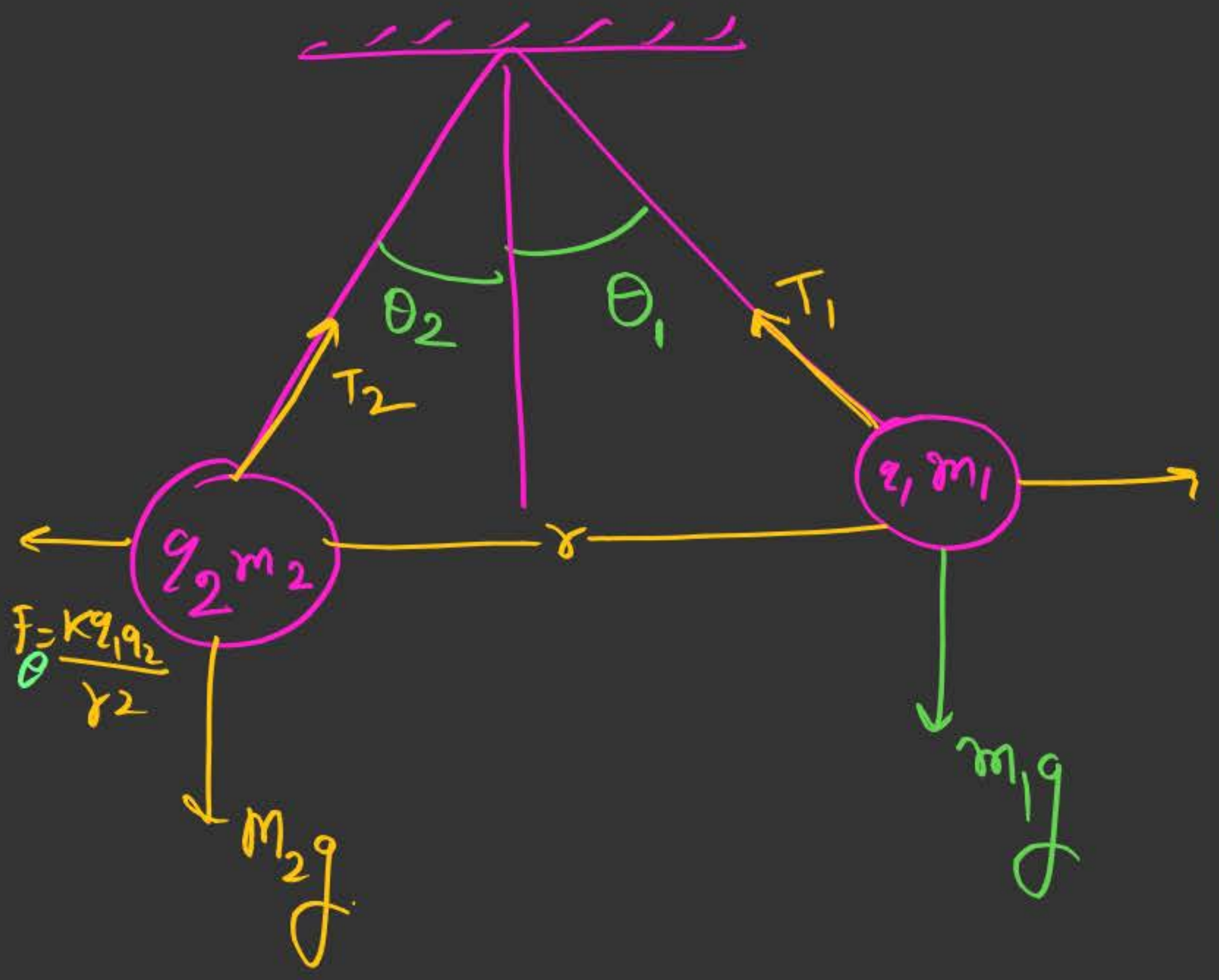
$$\cot\theta = \frac{mg}{qE}$$

$$\tan\theta = \frac{qE}{mg}$$

$$\theta = \tan^{-1}\left(\frac{qE}{mg}\right)$$

$(I)^2 + (II)^2$

$$T = \sqrt{(mg)^2 + (qE)^2} \quad (*)$$



$F_e = \frac{Kq_1q_2}{r^2}$

(as in last question)

$$\tan\theta_1 = \frac{F_e}{m_1 g} = \frac{Kq_1q_2}{r^2 m_1 g} \quad \text{— (I)}$$

$$\tan\theta_2 = \frac{F_e}{m_2 g} = \frac{Kq_1q_2}{r^2 m_2 g} \quad \text{— (II)}$$

$$\frac{(I)}{(II)}$$

$$\frac{\tan\theta_1}{\tan\theta_2} = \frac{m_2}{m_1}$$

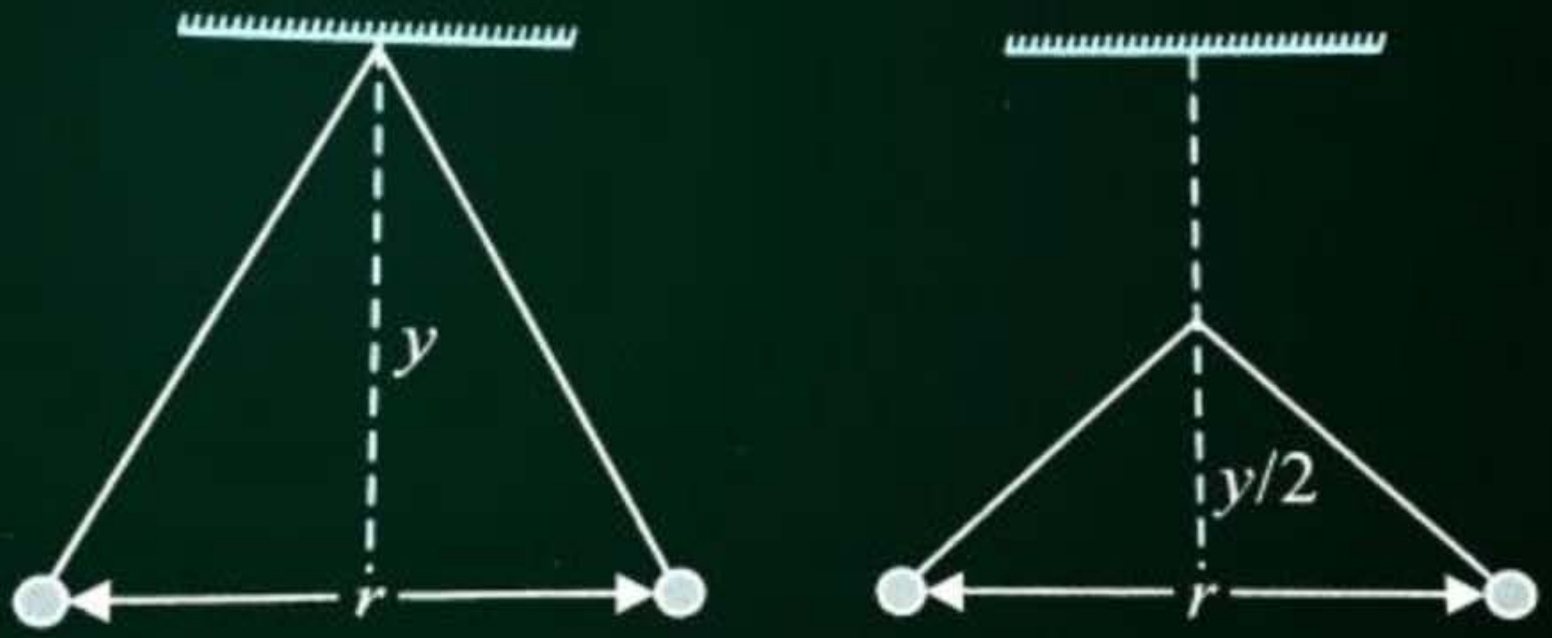
θ_1 & θ_2 depends on charge but $\frac{\tan\theta_1}{\tan\theta_2}$ ratio does not depe on cha

QUESTION

Two pith balls carrying equal charges are suspended from a common point by strings of equal length, the equilibrium separation between them is r. Now the strings are rigidly clamped at half the height. The equilibrium separation between the balls now become:

[NEET-UG 2013]

1. $\left(\frac{2r}{3}\right)$
2. $\left(\frac{1}{\sqrt{2}}\right)^2$
3. $\left(\frac{r}{\sqrt[3]{2}}\right)$
4. $\left(\frac{2r}{\sqrt{3}}\right)$



QUESTION

Two small spheres each having the charge +Q are suspended by insulating threads of length L from a hook. If this arrangement is taken in space where there is no gravitational effect, then the angle between the two suspensions and the tension in each will be:

(1) $180°, \frac{1}{4\pi\varepsilon_0}\frac{Q^2}{(2L)^2}$

(2) $90°, \frac{1}{4\pi\varepsilon_0}\frac{Q^2}{L^2}$

(3) $180°, \frac{1}{4\pi\varepsilon_0}\frac{Q^2}{2L^2}$

(4) $180°, \frac{1}{4\pi\varepsilon_0}\frac{Q^2}{L^2}$

Pendulum Problem

QUESTION

Two small spheres each having the charge +Q are suspended by insulating threads of length L from a hook. If this arrangement is taken in space where there is no gravitational effect, then the angle between the two suspensions and the tension in each will be:

(1) $180°, \frac{1}{4\pi\varepsilon_0}\frac{Q^2}{(2L)^2}$

(2) $90°, \frac{1}{4\pi\varepsilon_0}\frac{Q^2}{L^2}$

(3) $180°, \frac{1}{4\pi\varepsilon_0}\frac{Q^2}{2L^2}$

(4) $180°, \frac{1}{4\pi\varepsilon_0}\frac{Q^2}{L^2}$

QUESTION

If $q_1 < q_2$ but $M_1 < M_2$ then correct

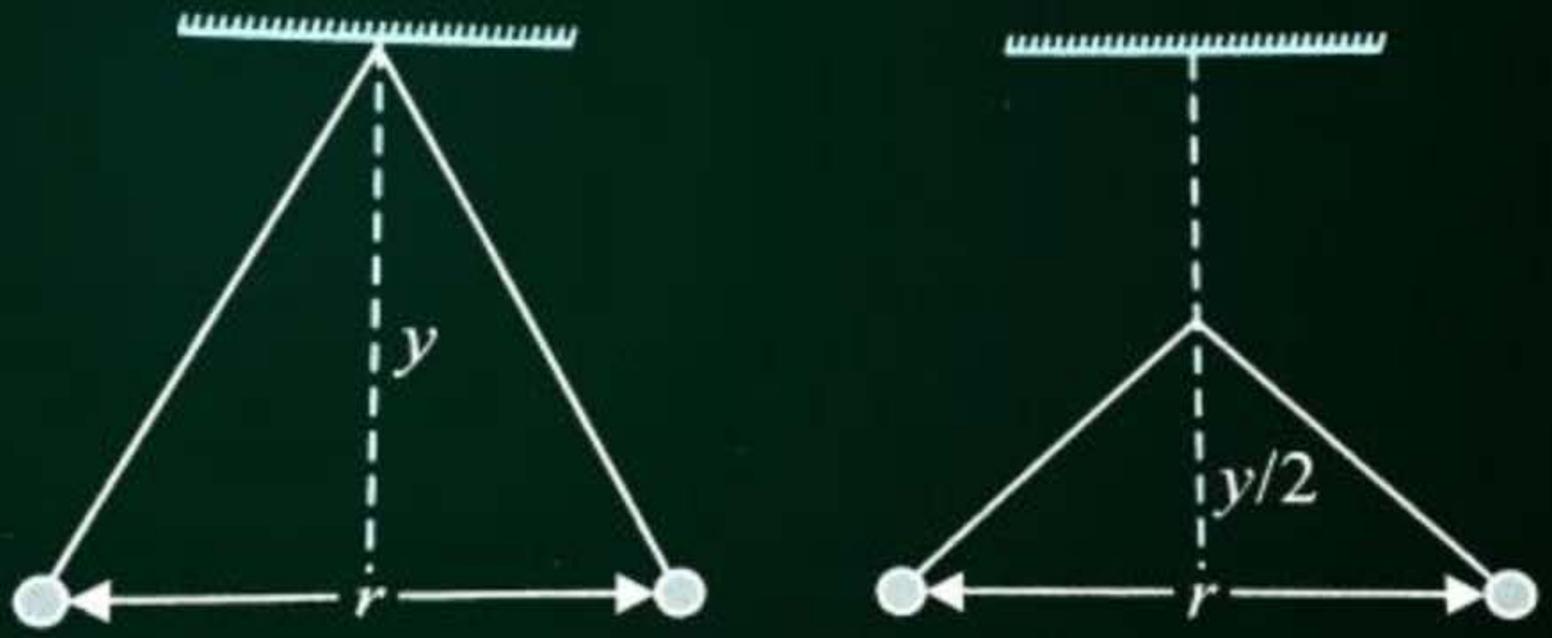
1. $\theta_1 = \theta_2$
2. $\theta_1 > \theta_2$
3. $\theta_1 < \theta_2$

QUESTION

Two pith balls carrying equal charges are suspended from a common point by strings of equal length, the equilibrium separation between them is r. Now the strings are rigidly clamped at half the height. The equilibrium separation between the balls now become:

[NEET-UG 2013]

1. $\left(\frac{2r}{3}\right)$
2. $\left(\frac{1}{\sqrt{2}}\right)^2$
3. $\left(\frac{r}{\sqrt[3]{2}}\right)$
4. $\left(\frac{2r}{\sqrt{3}}\right)$



QUESTION

An electron is moving round the nucleus of a hydrogen atom in a circular orbit of radius r. The Coulomb force $\vec{F}$ on the electron is: [AIPMT-2003]

1. $K\frac{e^2}{r^2}\hat{r}$
2. $-K\frac{e^2}{r^3}\hat{r}$
3. $K\frac{e^2}{r^3}\hat{r}$
4. $-K\frac{e^2}{r^3}\hat{r}$

QUESTION

Find force applied by 2C charge which is at (2, 3, 4) on 5C charge which is at (5, 7, 9)

QUESTION

Find force on $-3C$ charge at $(2, 0, 4)$ due to $4C$ charge which is at $(5, 4, 4)$.

Electric field

QUESTION

Find position where electric field will be zero?

QUESTION

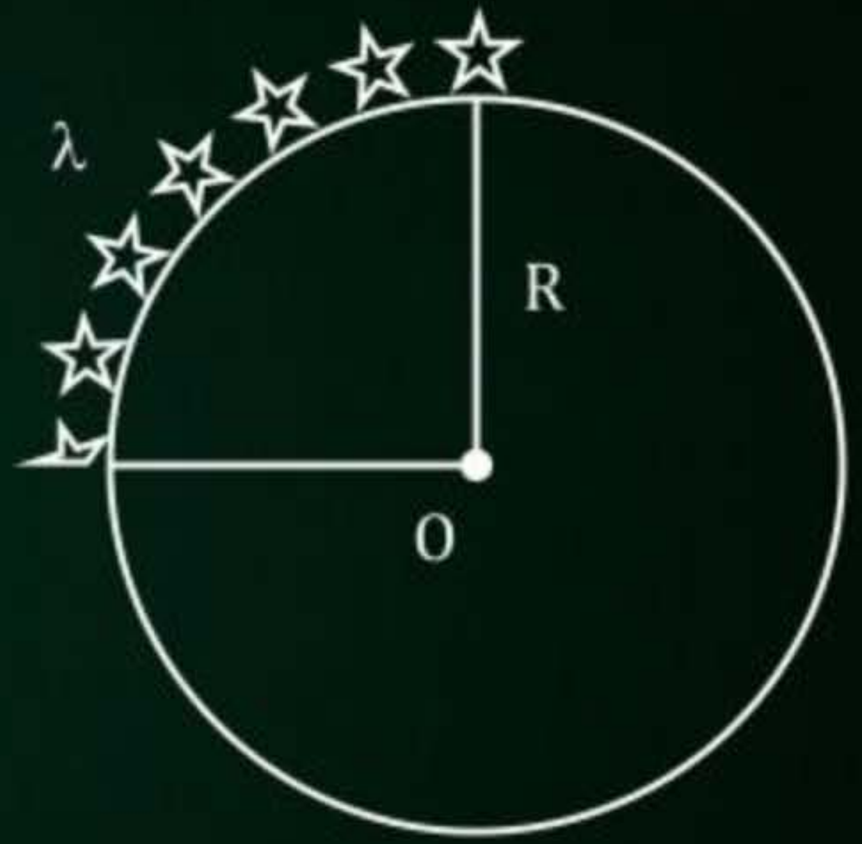
Find total net force on q_0 charge due to all the remaining charge. Find electric field at origin.

QUESTION

Find electric field at origin.

QUESTION

Find electric field at centre?



QUESTION

Net electric field along the direction.

Electric field due to ring

Gravitational field on the axis ring

Electric field due to circular arc



Electric field due to half ring



QUESTION

The magnitude of force exerted by a uniform electric field on an electron having mass m_e and proton of mass m_p are represented as F_e and F_p respectively are related as

(1) $F_p = F_e$

(2) $\frac{F_e}{F_p} = \frac{m_e}{m_p}$

(3) $\frac{F_e}{F_p} = \frac{m_p}{m_e}$

(4) $\frac{F_e}{F_p} = \frac{m_p}{m_e}$


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 07 | Physics

Electric Charges and Fields

By- Dr. Manish Raj (MR SIR)



Topics to be covered

1. # Questions on pendulum
   Coulombs Law in vector form
2. ## Electric field
3. #



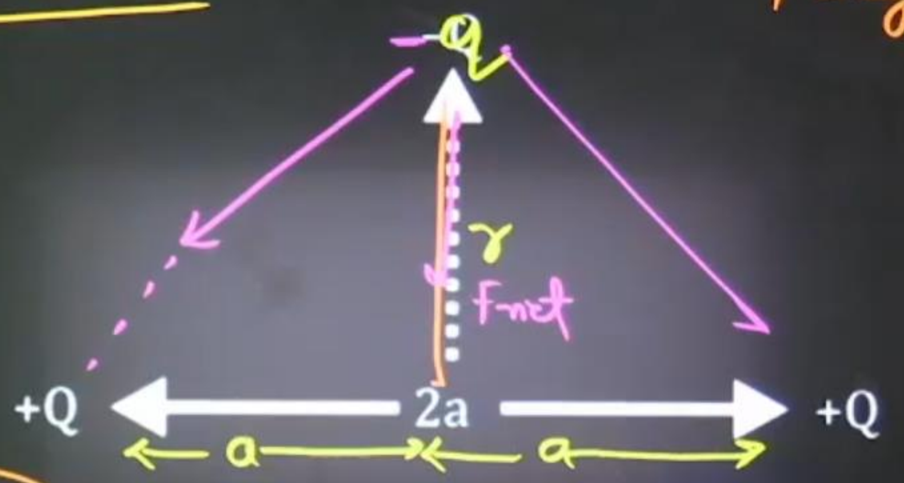
QUESTION (IIT) multiple (M.C.V)

Find force on $-q$ charge & its time period of oscillation.

$$F = \frac{KQq}{a^2}$$

In last question

$$F_{net} = \frac{2KQqr}{(a^2+r^2)^{3/2}}$$



$$ma = \frac{2KQq}{(a^2+r^2)^{3/2}}r$$

Cond^n of S.H.M ($r \lll a$)

$$a = \frac{2KQq\,r}{m(a^2)^{3/2}}$$

$$a = \frac{2KQq}{ma^3}r \quad \frac{2KQq}{ma^3} \to \omega^2$$

$$\frac{2\pi}{T} = \omega = \sqrt{\frac{2KQq}{a^3m}}$$

Pattern

$$T = 2\pi\sqrt{\frac{ma^3}{2KQq}}$$

dim^n

$$T = \sqrt{\frac{ma \text{ dis}^n}{F \text{ acc}^n (LT^{-2})}}$$

QUESTION

Suppose the charge of a proton and an electron differ slightly. One of them is $-e$, the other is $(e + \Delta e)$. If the net of electrostatic force and gravitational force between two hydrogen atoms placed at a distance d (much greater than atomic size) apart is zero, then Δe is of the order of [Given mass of hydrogen $m_h = 1.67 \times 10^{-27}$ kg]

[NEET (UG) 2017]

1. $10^{-23} \times C$
2. $10^{-37} \times C$ ✓
3. $10^{-47} \times C$
4. $10^{-20} \times C$

charge of $e^- = -e$
charge of proton $= e + \Delta e$

(H-atom) $= \Delta e$ ← d → (H-atom)

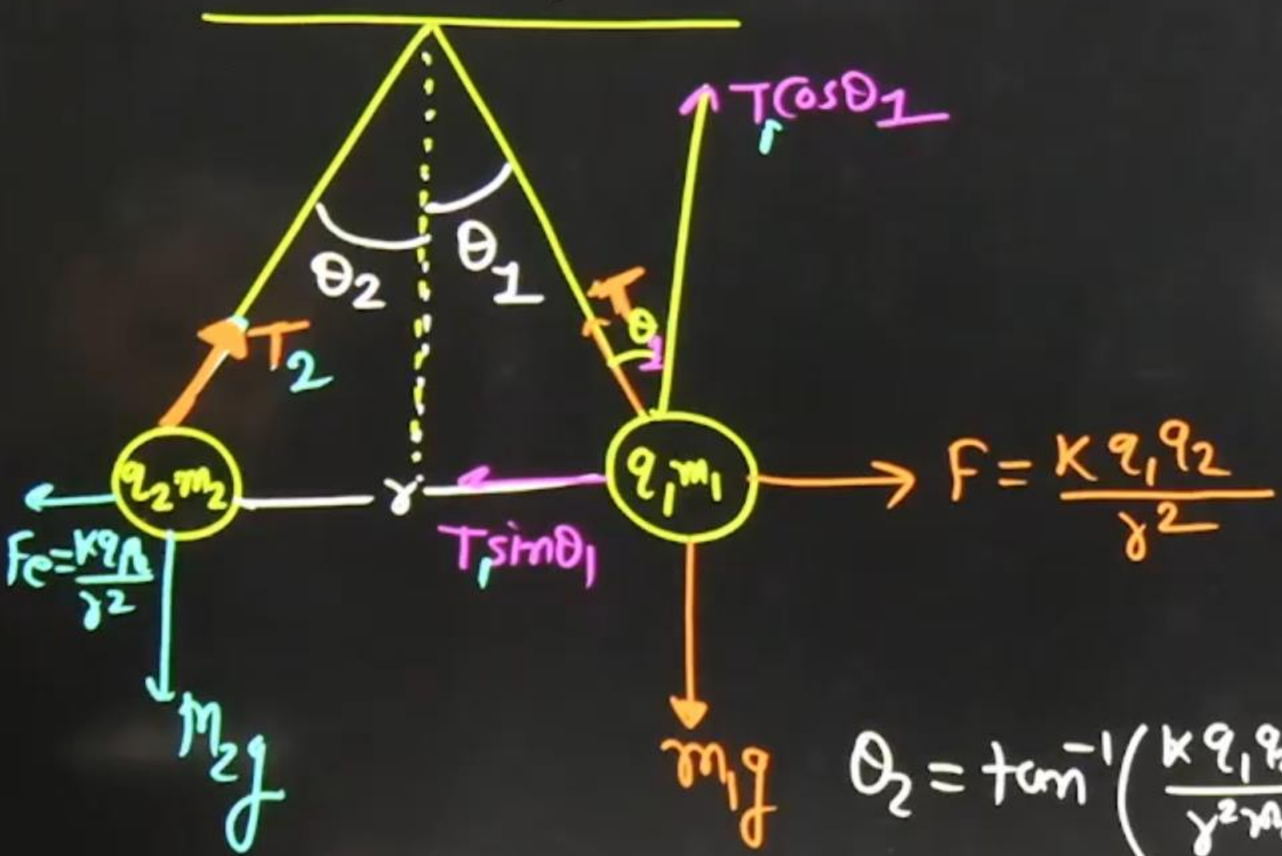
$F_g = F_{electrostatic}$

$$\frac{G (m_{proton})^2}{d^2} = \frac{K (\Delta e)^2}{d^2}$$

$$\Delta e = \sqrt{\frac{G m_p^2}{K}} = m_p \sqrt{\frac{G}{K}}$$

$$\Delta e = 1.67 \times 10^{-27} \sqrt{\frac{6.67 \times 10^{-11}}{9 \times 10^{9}}} = 10^{-37}\ C$$

Pendulum Probm



$$\theta_2 = \tan^{-1}\left(\frac{Kq_1q_2}{r^2 m_2 g}\right)$$

If m_1 & m_2 are at equlibrium

$$T_1 \sin\theta_1 = \frac{Kq_1q_2}{r^2} \quad \text{— (i)}$$

$$T_1 \cos\theta_1 = m_1 g \quad \text{— (ii)}$$

$(i)^2 + (ii)^2$

$$T_1^2 = (m_1 g)^2 + \left(\frac{Kq_1q_2}{r^2}\right)^2$$

$$T_1 = \sqrt{(m_1 g)^2 + \left(\frac{Kq_1q_2}{r^2}\right)^2}$$

$(i)/(ii)$

$$\tan\theta_1 = \frac{Kq_1q_2}{r^2 m_1 g}$$

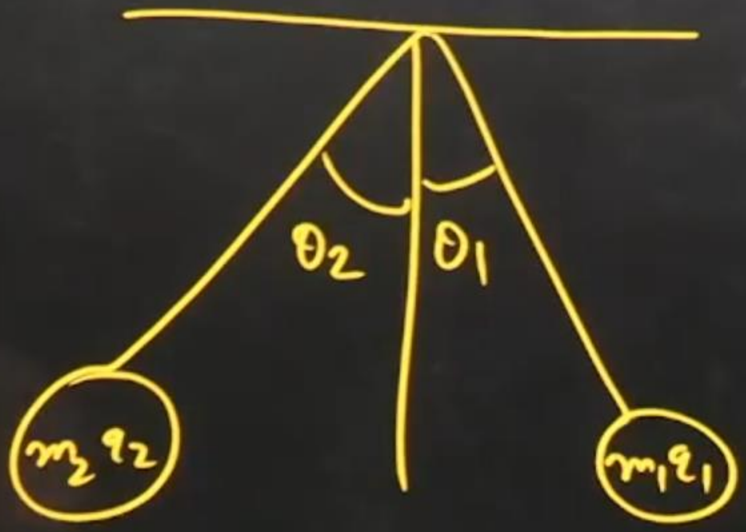
$$\theta = \tan^{-1}\left(\frac{Kq_1q_2}{r^2 m_1 g}\right) \quad \text{Ans}$$

15:35

θ_1 and θ_2 depends on q_1 & q_2 —— ✓

but $\frac{\tan\theta_1}{\tan\theta_2}$ does not depends on q_1 & q_2 – ✓

$$\boxed{\frac{\tan\theta_1}{\tan\theta_2} = \frac{m_2}{m_1}}$$



If $m_1 = m_2$ but $q_1 > q_2$ then correct

(a) ✓ $\theta_1 = \theta_2$

(b) $\theta_1 > \theta_2$

(c) $\theta_1 < \theta_2$

$$\frac{\tan\theta_1}{\tan\theta_2} = \frac{m_2}{m_1} = 1$$

QUESTION

Two small spheres each having the charge +Q are suspended by insulating threads of length L from a hook. If this arrangement is taken in space where there is no gravitational effect, then the angle between the two suspensions and the tension in each will be:

(1) $180^\circ, \frac{1}{4\pi\varepsilon_0}\frac{Q^2}{(2L)^2}$

(2) $90^\circ, \frac{1}{4\pi\varepsilon_0}\frac{Q^2}{L^2}$

(3) $180^\circ, \frac{1}{4\pi\varepsilon_0}\frac{Q^2}{2L^2}$

(4) $180^\circ, \frac{1}{4\pi\varepsilon_0}\frac{Q^2}{L^2}$

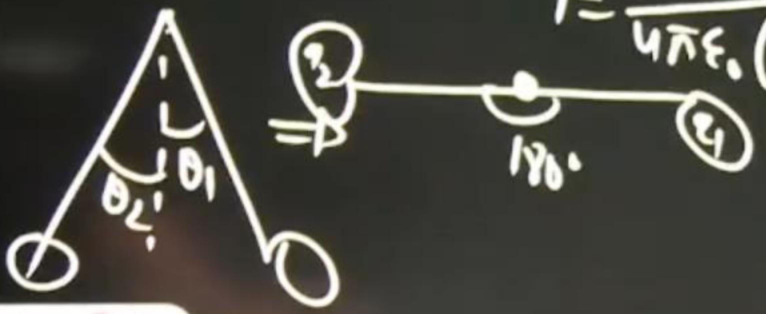
gravitational free space

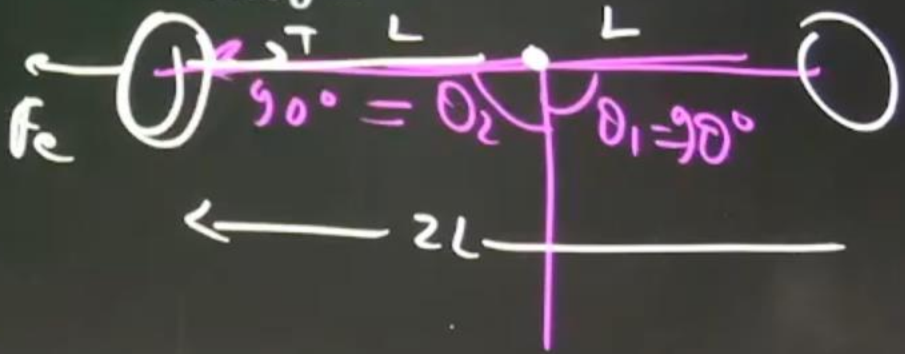
$F_g = mg \rightarrow 0$

$\tan\theta = \frac{F_e}{mg \rightarrow 0} = \infty$

$\theta = 90^\circ$

$T = \frac{Q^2}{4\pi\varepsilon_0 (2L)^2}$





QUESTION

Two pith balls carrying equal charges are suspended from a common point by strings of equal length, the equilibrium separation between them is r. Now the strings are rigidly clamped at half the height. The equilibrium separation between the balls now become:

[NEET-UG 2013]

1. $\left(\frac{2r}{3}\right)$
2. $\left(\frac{1}{\sqrt{2}}\right)^2$
3. $\left(\frac{r}{\sqrt[3]{2}}\right)$
4. $\left(\frac{2r}{\sqrt{3}}\right)$

MR* Ratta

$$\tan\theta_1 = \frac{F_e}{mg}$$

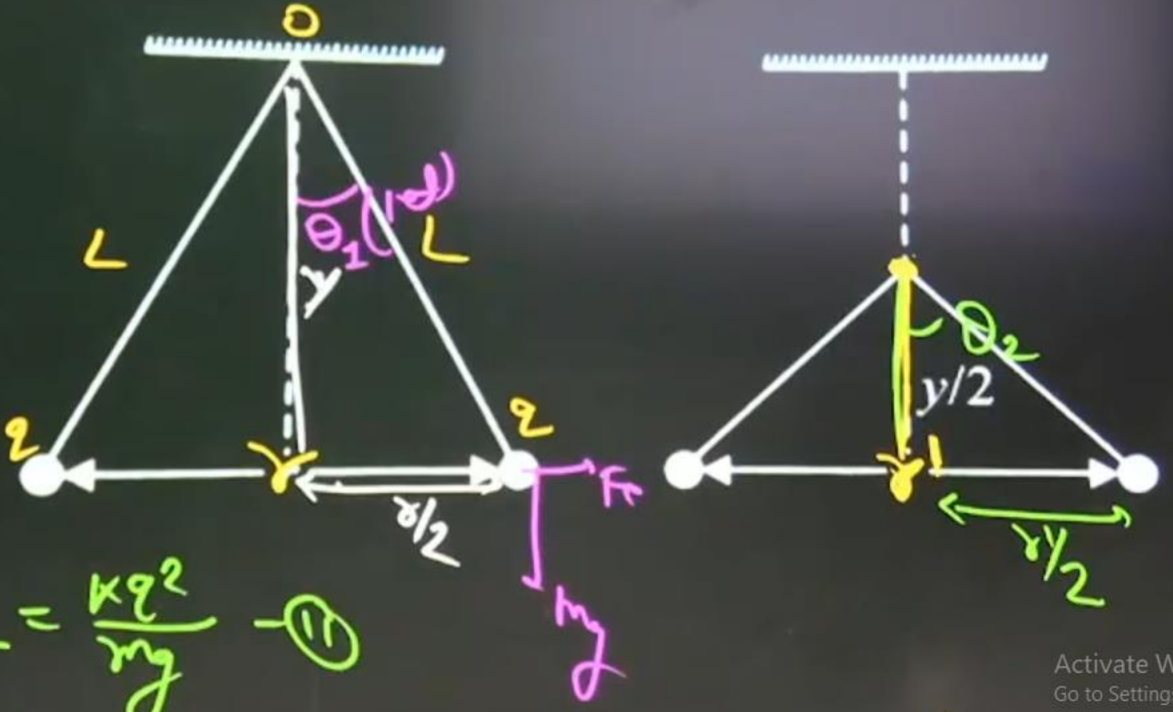
$$\frac{r}{2y} = \frac{kq^2}{r^2 mg}$$

$$\frac{r^3}{2y} = \frac{kq^2}{mg} \quad \text{— (i)}$$

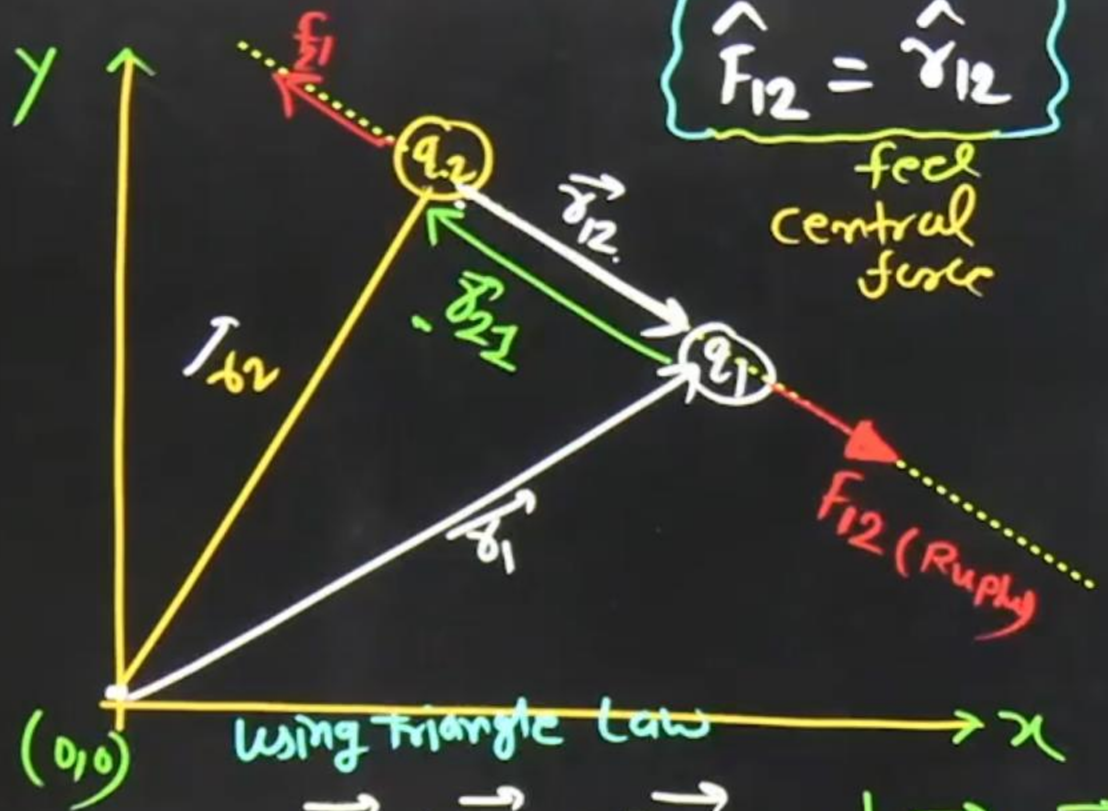
$$\tan\theta_2 = \frac{F_e}{mg}$$

$$\frac{r'}{2\frac{y}{2}} = \frac{kq^2}{r'^2 mg}$$

$$\frac{r'^3}{y} = \frac{kq^2}{mg} \quad \text{— (ii)}$$



Coulombs Law in vector form



$$\hat{F}_{12} = \hat{r}_{12}$$

feel central force

$$\hat{r}_{12} = \frac{\vec{r}_{12}}{r_{12}}$$

$$\vec{r}_{12} = \vec{r}_1 - \vec{r}_2$$

Position of 1st w.r.t 2nd.

feel

$$\vec{F}_{12} = \frac{K q_1 q_2}{|\vec{r}_{12}|^2}\hat{r}_{12}$$

Put q_1 & q_2 with sign

$$\vec{F}_{12} = \frac{K q_1 q_2}{|\vec{r}_{12}|^2} \times \frac{\vec{r}_{12}}{|\vec{r}_{12}|}$$

$$= \frac{K q_1 q_2 \vec{r}_{12}}{|\vec{r}_{12}|^3}$$

Using triangle Law

$$\vec{r}_2 + \vec{r}_{12} = \vec{r}_1$$

$$\vec{r}_{12} = \vec{r}_1 - \vec{r}_2$$

$$\vec{r}_1 + \vec{r}_{21} = \vec{r}_2$$

$$\vec{r}_{21} = \vec{r}_2 - \vec{r}_1$$

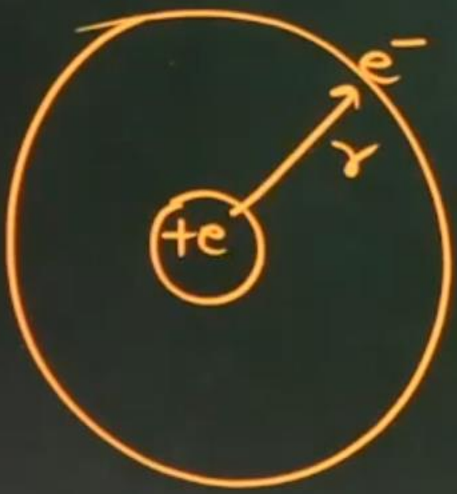
$$\vec{F}_{21} = \frac{K q_1 q_2}{|\vec{r}_{21}|^2}\hat{r}_{21}$$

15:54

QUESTION

An electron is moving round the nucleus of a hydrogen atom in a circular orbit of radius r. The Coulomb force $\vec{F}$ on the electron is: [AIPMT-2003]

1. $K\frac{e^2}{r^2}\hat{r}$
2. $-K\frac{e^2}{r^3}\vec{r}$ Ans
3. $K\frac{e^2}{r^3}\hat{r}$
4. $-K\frac{e^2}{r^3}\hat{r}$



Thank You

YAKEEN 2.0

FOR NEET 2025

Lecture- 08 | Physics

Electric Charges and Fields

By- Dr. Manish Raj (MR SIR)



Today's Goal

Coulomb law in vector form.

→ feel of electric field.

field due to point charge & ring

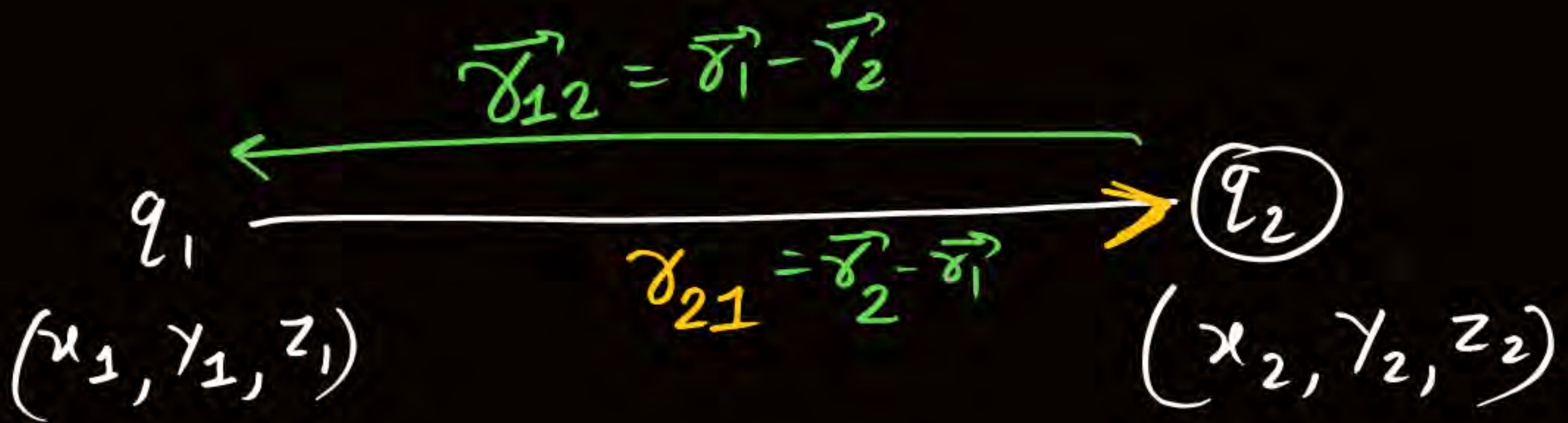
find force on these charges due to +Q charge.

+Q ———————— 2c

+Q ———————— 4c

+Q ———————— 6c

+Q ———————— 7c



$$\vec{F}_{12} = \frac{k q_1 q_2}{|\vec{r}_{12}|^2} \hat{r}_{12}$$

✡ force on 1 due to 2nd charge

$$\hat{r} = \frac{\vec{r}}{|\vec{r}|}$$

q_1 & q_2 ko sign ke sath Put kare.

feel

$$\vec{F}_{12} = \frac{k q_1 q_2}{|\vec{r}_{12}|^3} \vec{r}_{12}$$

$$\vec{F}_{21} = \frac{k q_1 q_2 \, \vec{r}_{21}}{|\vec{r}_{21}|^3}$$

find force on $-3C$ (q_1) charge at (2,0,4) due to $+4C$ charge which is at (5,4,4).

$q_2 =$

Not for NEET

$$\vec{F}_{12} = \frac{K q_1 q_2}{|\vec{r}_{12}|^3} \vec{r}_{12}$$

$$\vec{r}_{12} = \vec{r}_1 - \vec{r}_2$$

$$= (2\hat{i} + 4\hat{k}) - (5\hat{i} + 4\hat{j} + 4\hat{k})$$

$$\vec{r}_{12} = -3\hat{i} - 4\hat{j}$$

$$|\vec{r}_{12}| = \sqrt{(-3)^2 + (-4)^2}$$

$$= \sqrt{9+4} = \sqrt{25} = 5$$

$$\vec{F}_{12} = \frac{3\times10^9 \times -3\times4 \,(-3\hat{i} - 4\hat{j})}{(5)^3}$$

$$= \frac{36\times10^9 (3\hat{i} + 4\hat{j})}{125}$$ Ans

force on these charge due to +Q charge.



$$F_0 = \frac{KQ \times 2c}{r^2}$$

$$F = \frac{KQ\,5c}{r^2}$$

$$F = \frac{KQ \times q}{r^2}$$

Electric fi

$$F = \frac{KQ \times 1c}{r^2} = \frac{KQ}{r^2}$$

$$F = \frac{KQ \times 10}{r^2}$$

if force on 2c is F_0 then find force on 5c due to Q

$$\frac{F}{F_0} = \frac{\cancel{KQ}5c}{\cancel{r^2}} \Big/ \frac{\cancel{KQ}2c}{\cancel{r^2}}$$

$$F = \frac{5}{2} F_0$$

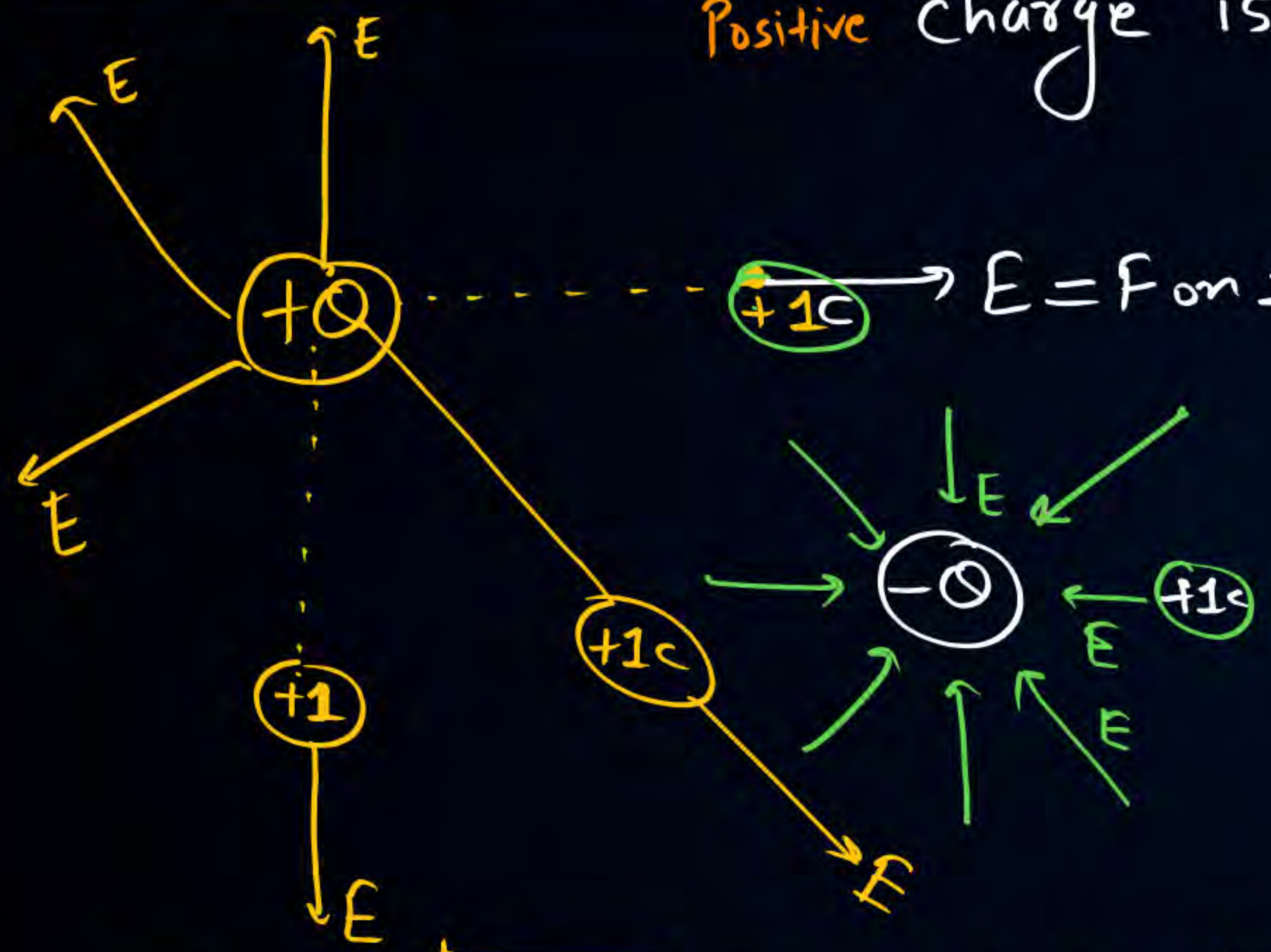
Atro chir feel hai

Electric field

→ Electrostatic force experience per unit Positive charge is called electric field.

Force on +1C is called electric field.

dir^n of electric field along the dir^n of force on +1C.





$$F_{q_0} = \frac{KQq_0}{r^2}$$

$$E = \frac{F_{q_0}}{q_0} = \frac{KQ\cancel{q_0}}{r^2\cancel{q_0}}$$

$$\boxed{\vec{E} = \frac{KQ}{r^2}}\hat{r}$$

* due to +ve Q charge electric field is radially away.
* due to -ve Q charge electric field is radially Inward.



$\hat{E} = \hat{r}$ (due to Positive Chare)

$\hat{E} = -\hat{r}$ (due to -ve charge)

vector form of Electric field

$\vec{E} = \frac{kQ}{r^2}\hat{r}$ (Q is with sign)

→ vector

→ Unit N/C

Scala form

$E = \frac{kQ}{r^2}$ (magnitu



$E = \frac{kQ}{r^2}$

Force on charge in electric field



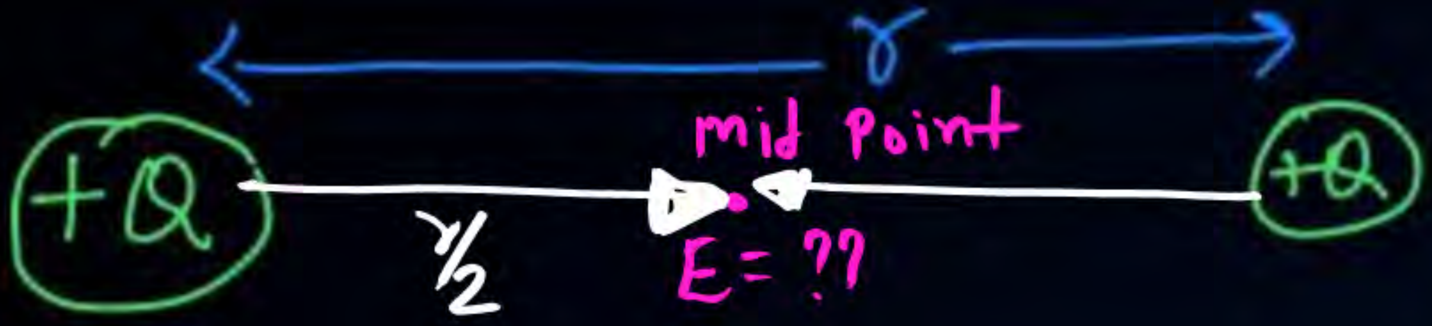
$$\vec{F} = q\vec{E}$$

$F = qE$

↳ value of Force

on Positive charge force along electric field

on -ve charge force opposite to the electric field.

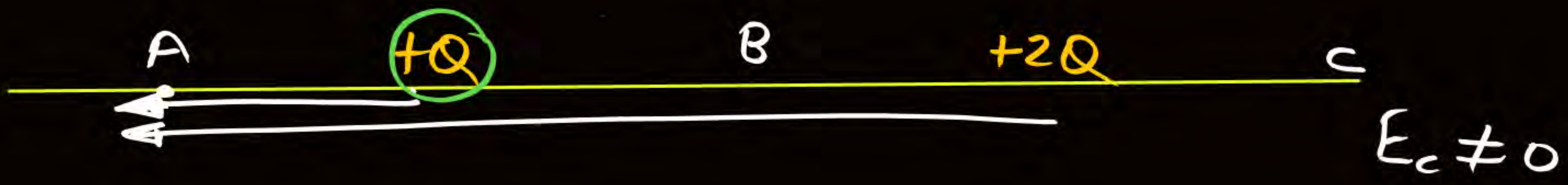


$E = 0$



$F = 0$

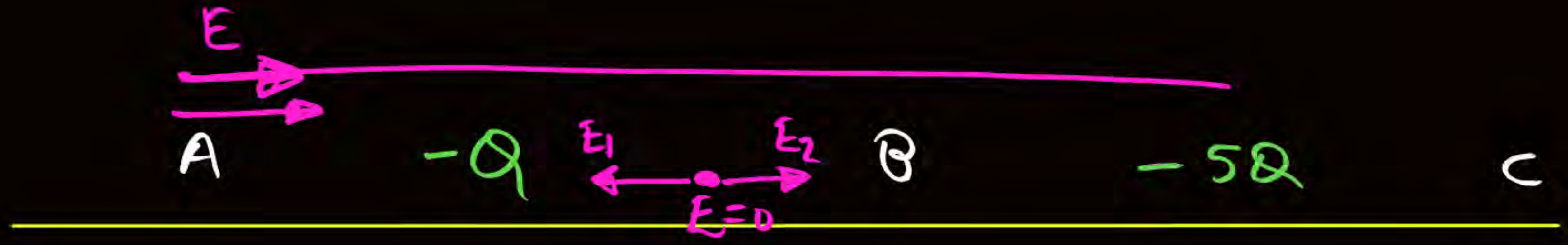
$E = 0$



$E_A \neq 0$

B/w the charges in region B

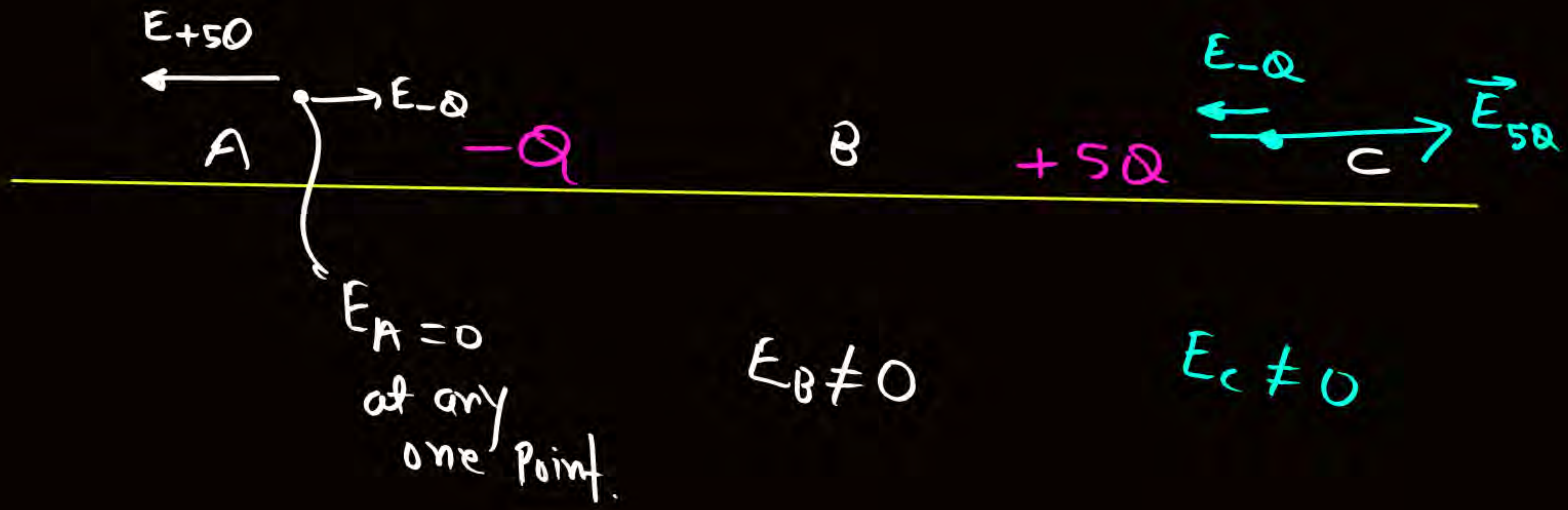
Electric field can be zero near to +Q



$E_A \neq 0$

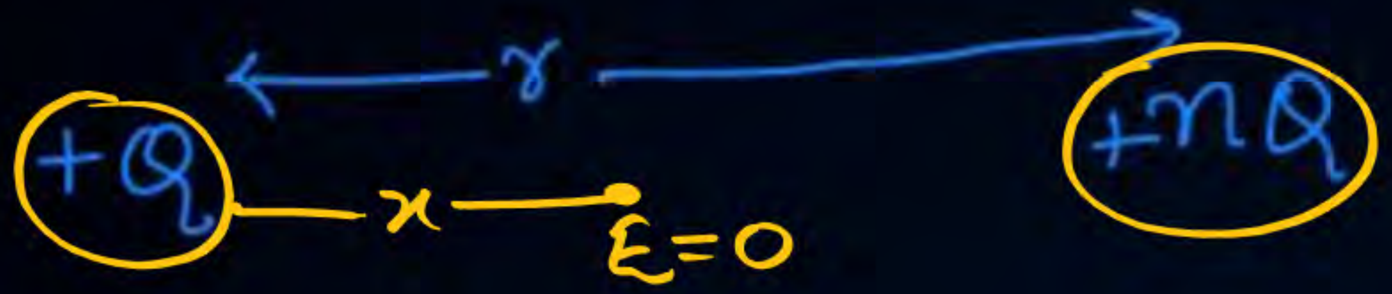
$E_B = 0$ (at a Point

$E_C \neq 0$



E+5Q
E-Q
A
-Q
B
+5Q
E-Q
E5Q
C
EA = 0
at any one Point.
EB ≠ 0
Ec ≠ 0

Find neutral point due to these two charges
(neutral point – point where electric field is zero



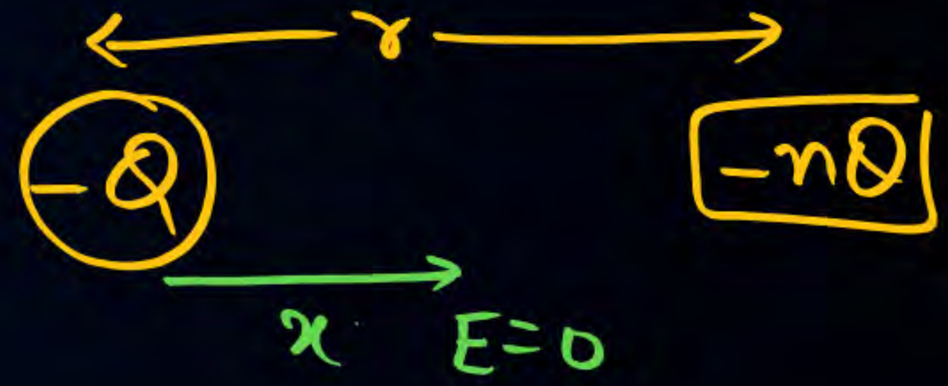
$$x = \frac{r}{\sqrt{n}+1}$$

mR*

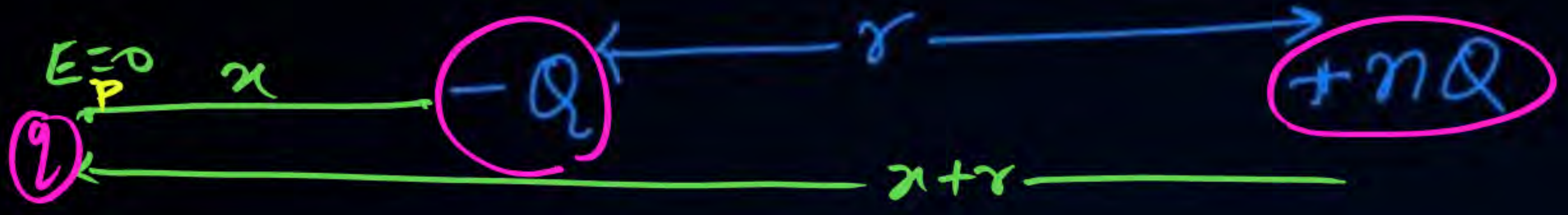
$n=1$

$$x = \frac{r}{2}$$

- Same nature of charge



$$x = \frac{r}{\sqrt{n}+1}$$



for $E_{net} = 0$ at P

$$\frac{KnQ}{(r+x)^2} = \frac{KQ}{x^2}$$

$$n = \left(\frac{r+x}{x}\right)^2$$

$$x\sqrt{n} = r + x$$

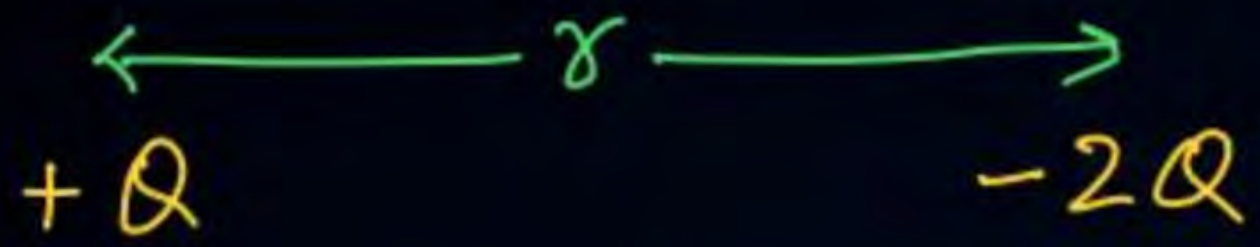
$$x\sqrt{n} - x = r$$

$$x(\sqrt{n}-1) = r$$

$$x = \frac{r}{\sqrt{n}-1}$$

If $(n>1)$

$$x = \frac{r}{\sqrt{n}-1}$$


r
+Q
-2Q

Find Point where field is zero.

2 μC ←—— 12 cm ——→ 8 μC

—— x —— E = 0

find x = ??

Soln

$$x = \frac{12}{\sqrt{4}+1} = \frac{12}{2+1} = \frac{12}{3} = 4\ \text{cm from } 2\,\mu C$$

←— x —— E = 0 +5 μC ←—— 10 m ——→ −20 μC

Soln

$$x = \frac{10}{\sqrt{4}-1} = \frac{10}{2-1} = 10\ \text{m from } 5\,\mu C$$

20 m from −20 μC.

$+16\,\mu C$ ———— 8 cm ———— $-9\,\mu C$ —— $x = ??$ —— $E = 0$

Find point where electric field is zero.

Sol^n:

$$x = \frac{8\,cm}{\sqrt{\frac{16}{9}} - 1}$$

$$= \frac{8}{\frac{4}{3} - 1} = \frac{8}{\frac{4-3}{3}} = \frac{8\times 3}{1} = 24\,cm$$ from $-9\,\mu C$

from $16\,\mu C$ it will be 32 cm ✓

(Q) Find electric field at origin, due to all these charges.

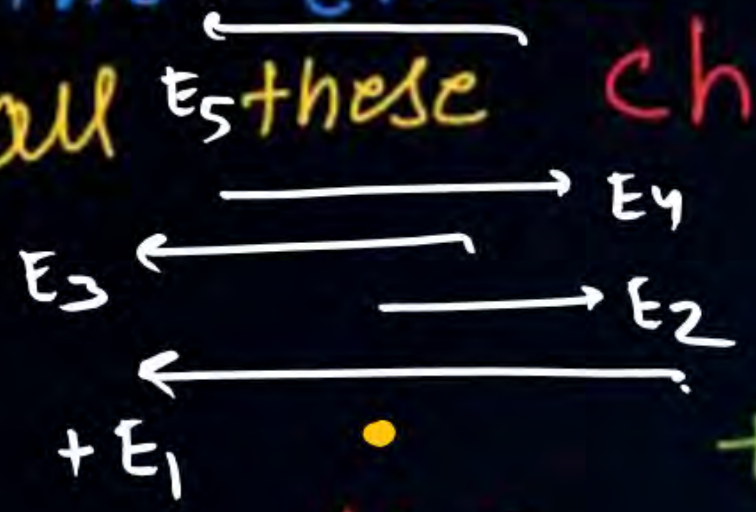


$$E = \frac{kq}{1^2} + \frac{kq}{2^2} + \frac{kq}{4^2} + \frac{kq}{8^2} + \frac{kq}{16^2} - - -$$

$$\vec{E} = kq\left[1 + \frac{1}{4} + \frac{1}{16} + \frac{1}{64} + \cdots\right]$$ GP series.

$$= kq\left[\frac{1}{1 - \frac{1}{4}}\right] = kq\left[\frac{1}{3/4}\right] = +\frac{4kq}{3}$$ Ans

(Q) Find electric field at origin, due to all these charges.



(0,0)	+q (1,0)	−q (2,0)	+q (4,0)	−q (8,0)	+q (16,0)	−q (- - -

$$E_{net} = \frac{kq}{1} - \frac{kq}{4} + \frac{kq}{16} - \frac{kq}{64} + \frac{kq}{256}$$

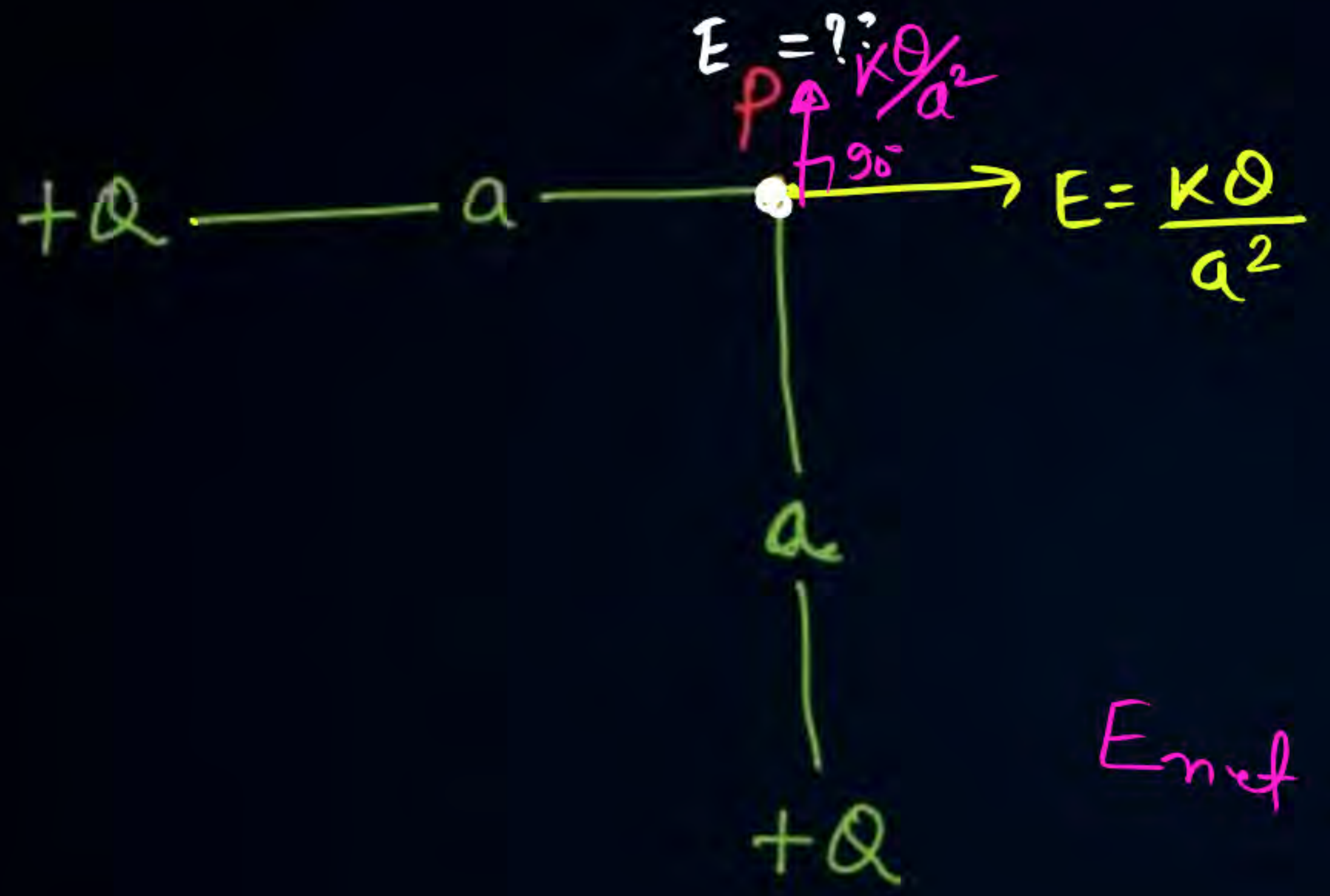
$$= kq\left(1 - \frac{1}{4} + \frac{1}{16} - \frac{1}{64} + \frac{1}{256} + \cdots\right]$$

G.P. series

$$C.r = \frac{1}{16\left(-\frac{1}{4}\right)} = -\frac{1}{4}$$

$$= kq\left[\frac{1}{1-\left(-\frac{1}{4}\right)}\right] = kq\left[\frac{1}{1+\frac{1}{4}}\right] = kq\left[\frac{4}{5}\right)$$

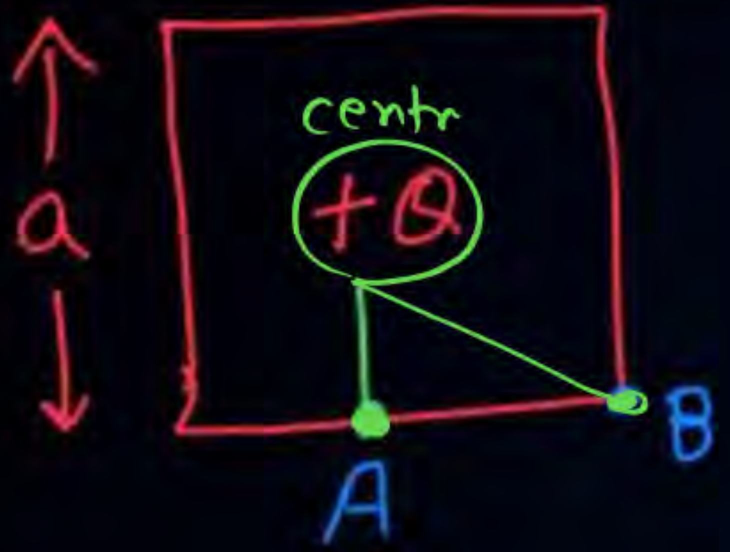
mP*

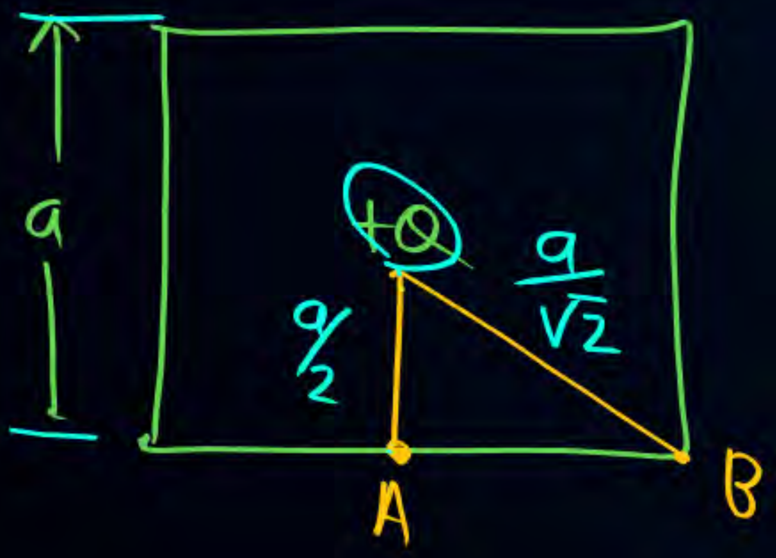


$$E_{net} = \sqrt{2}\,\frac{KQ}{a^2}$$

Square of side 'a'

Find $E_A/E_B = ??$

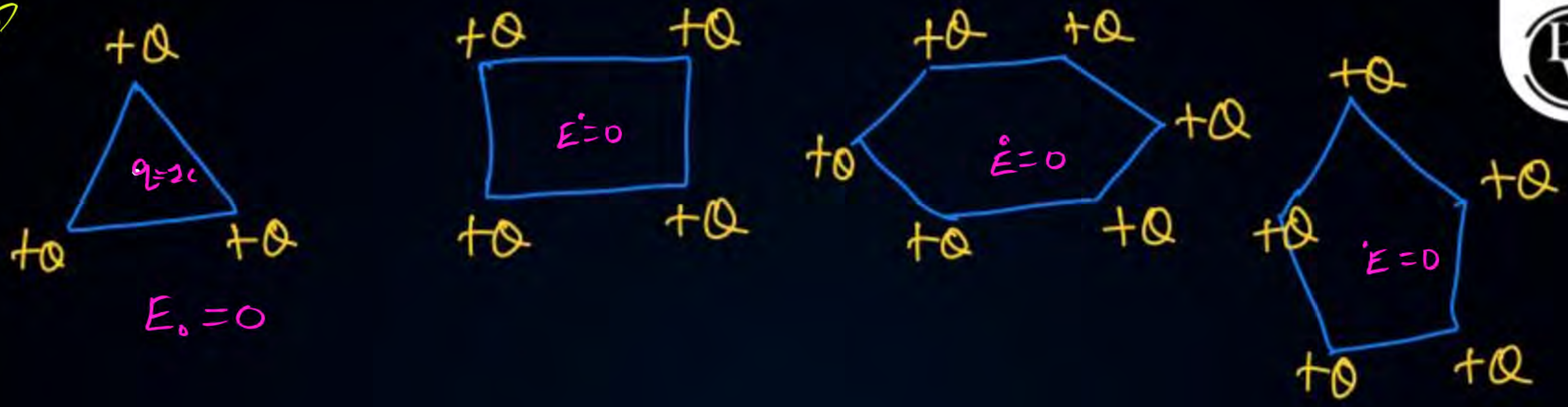




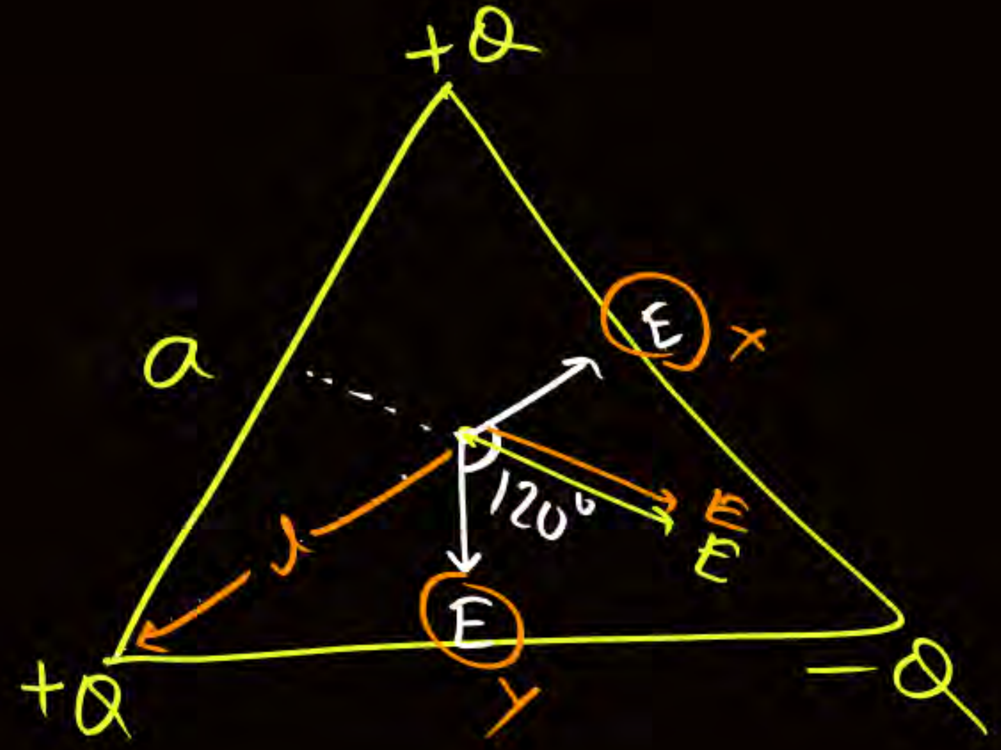
$$E_A = \frac{kQ}{(a/2)^2} = \frac{4kQ}{a^2}$$

$$E_B = \frac{kQ}{(a/\sqrt{2})^2} = \frac{2kQ}{a^2}$$

$$\frac{E_A}{E_B} = \frac{4}{2} = 2:1$$

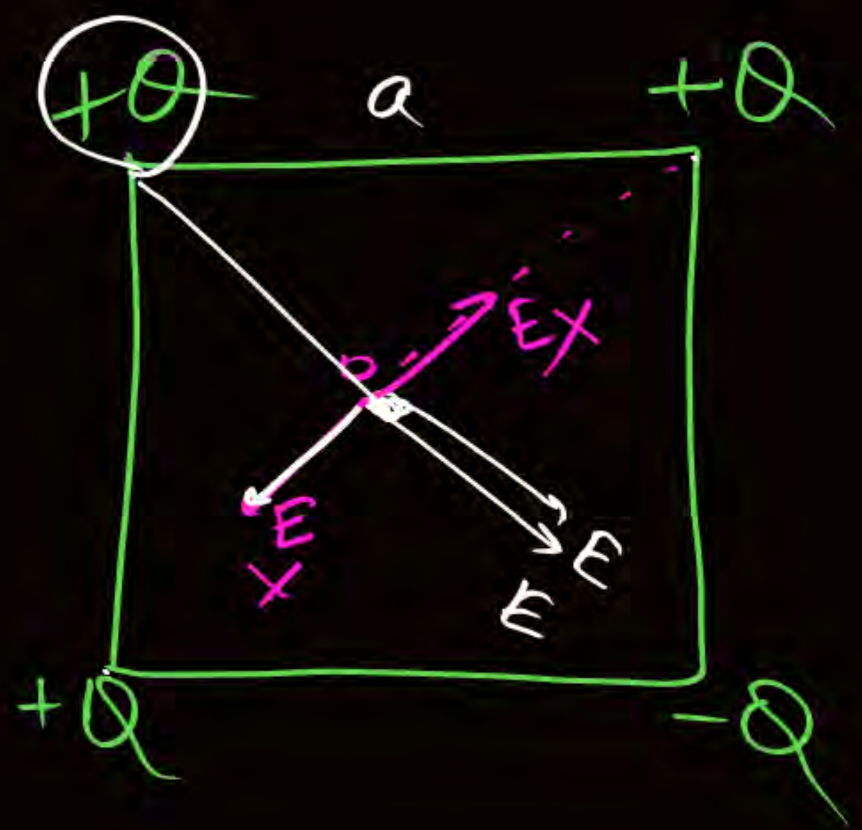


Find electric field at the centre of polygon



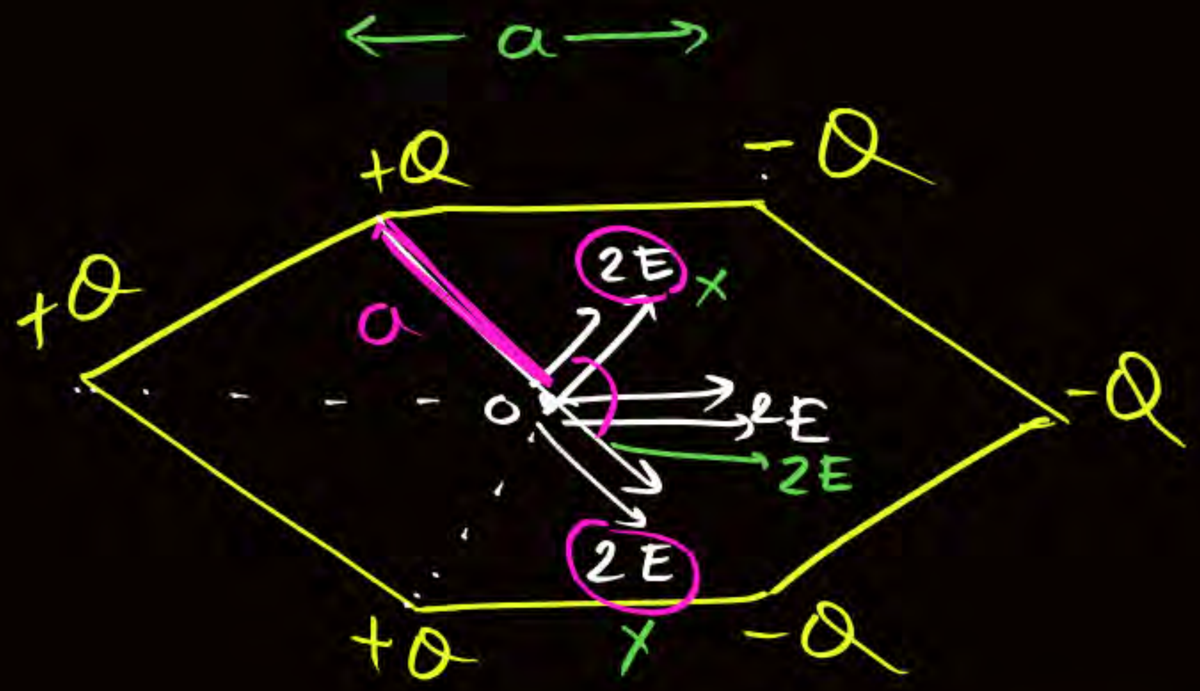
$$E_{net} = 2E$$

$$= 2\frac{kQ}{r^2}$$



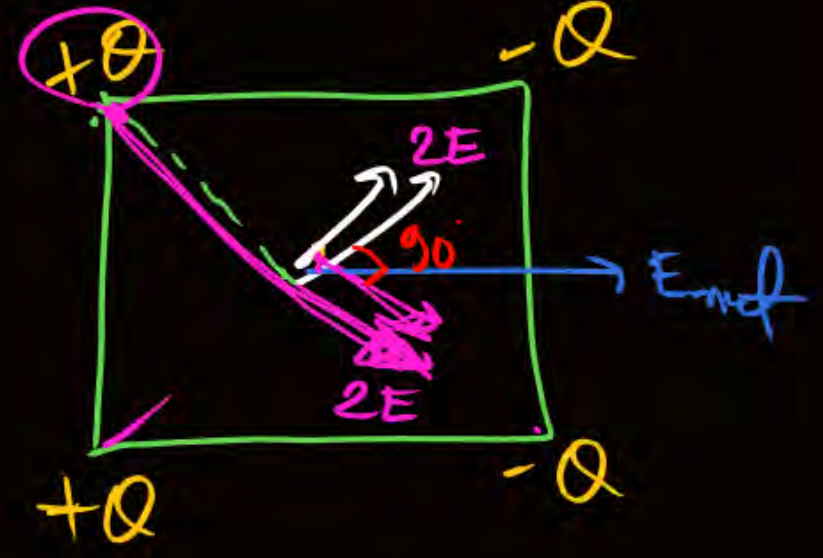
$E_0 = 2E$

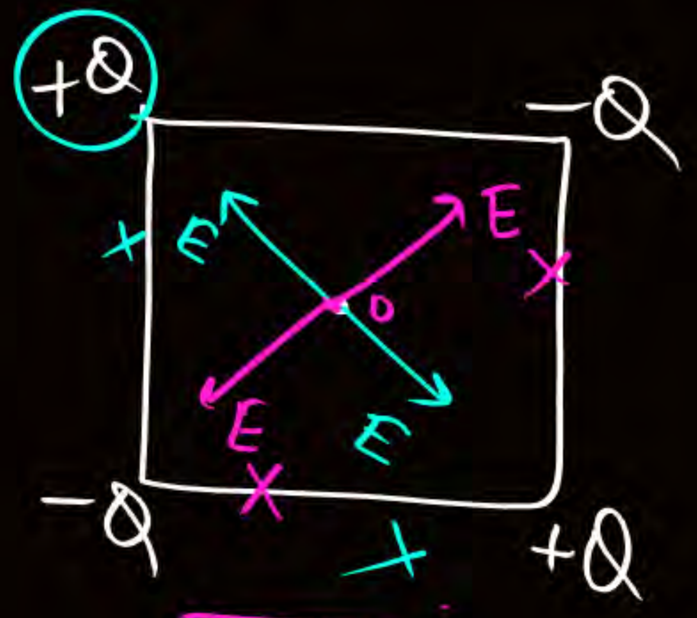
$$= 2\frac{kQ}{\left(\frac{a}{\sqrt{2}}\right)^2} = \frac{4kQ}{a^2} \quad \text{Ans}$$





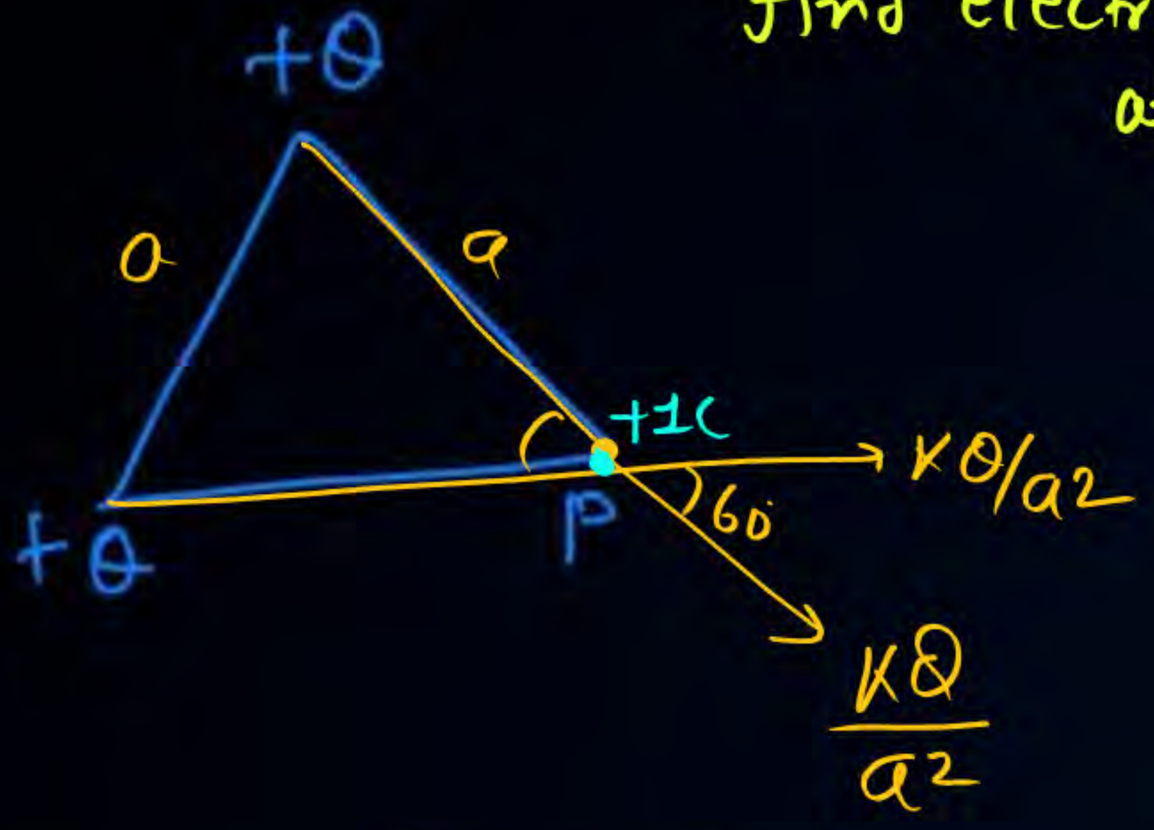
$$E_{net} = 4E$$
$$= 4\frac{kQ}{a^2}$$



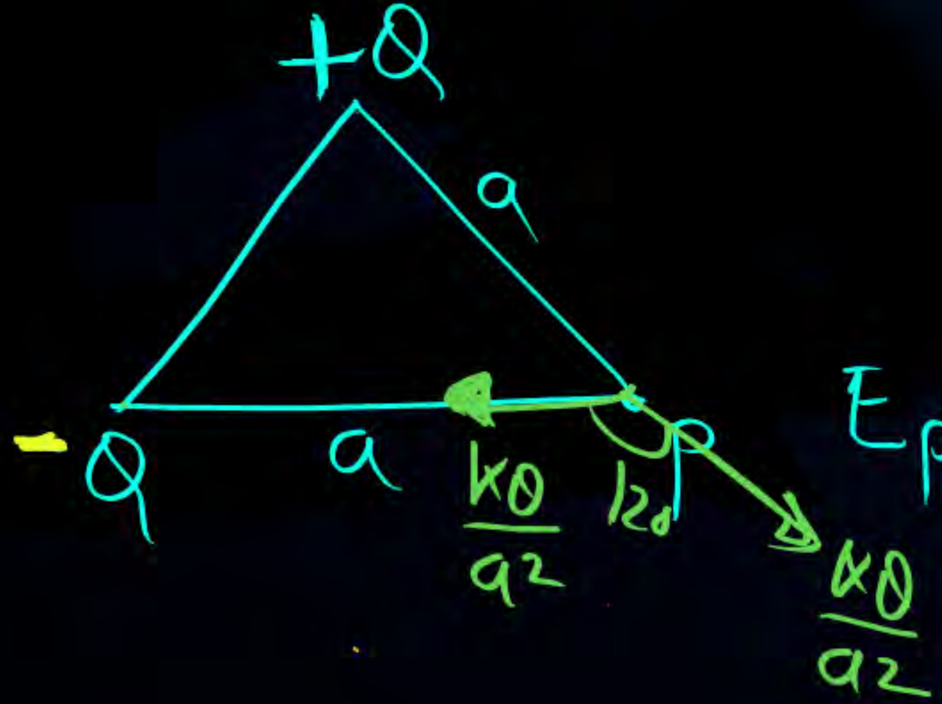


$\therefore$ $E_0 = 0$ at centre

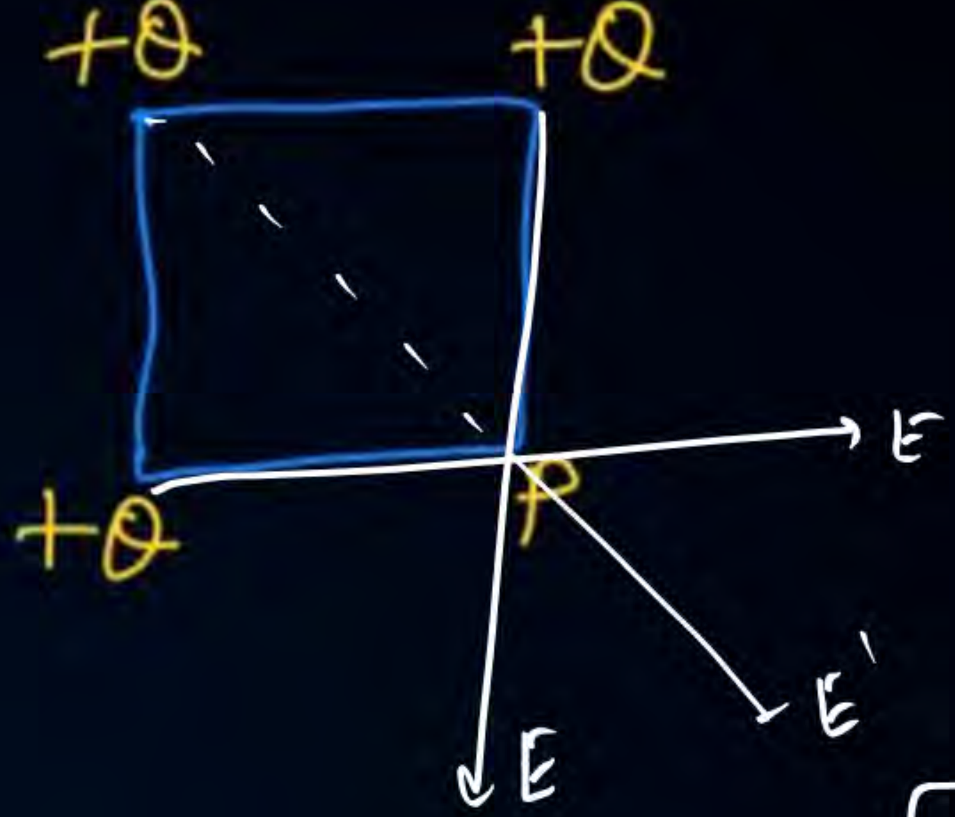
find electric field at P.



$$E_p = \sqrt{3}\frac{KQ}{a^2}$$

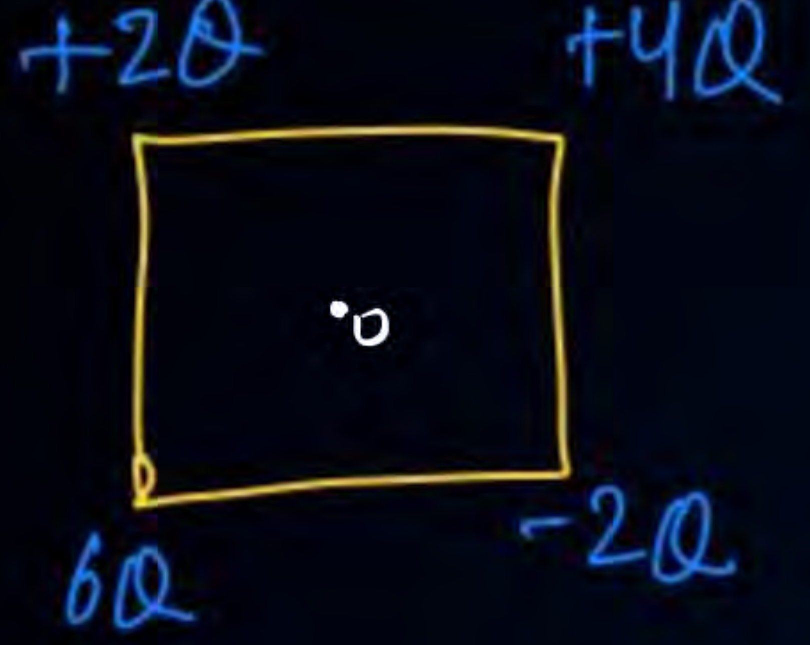


$$E_p = \frac{KQ}{a^2}$$ Ans



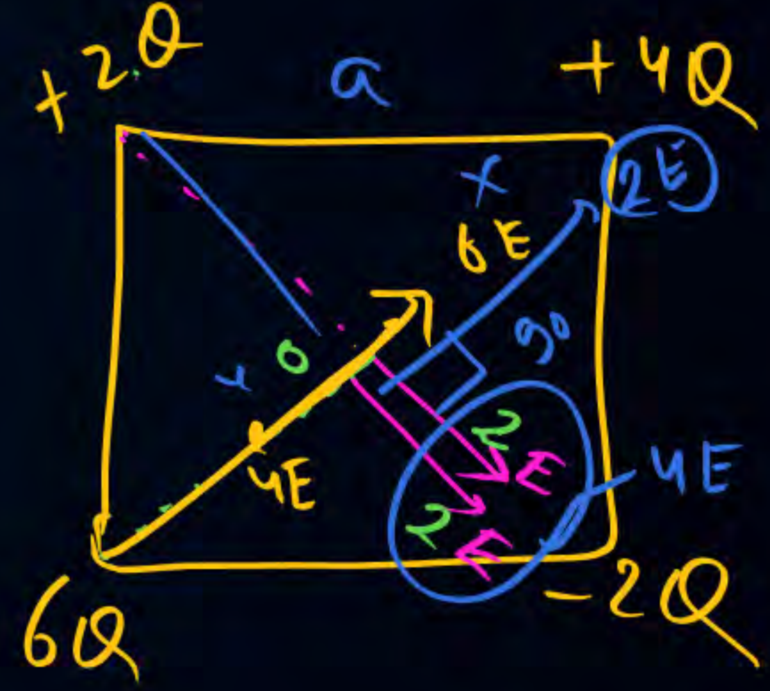
$$E_{net} = E' + \sqrt{2}E$$

Ans



find field at centre

Sol^n



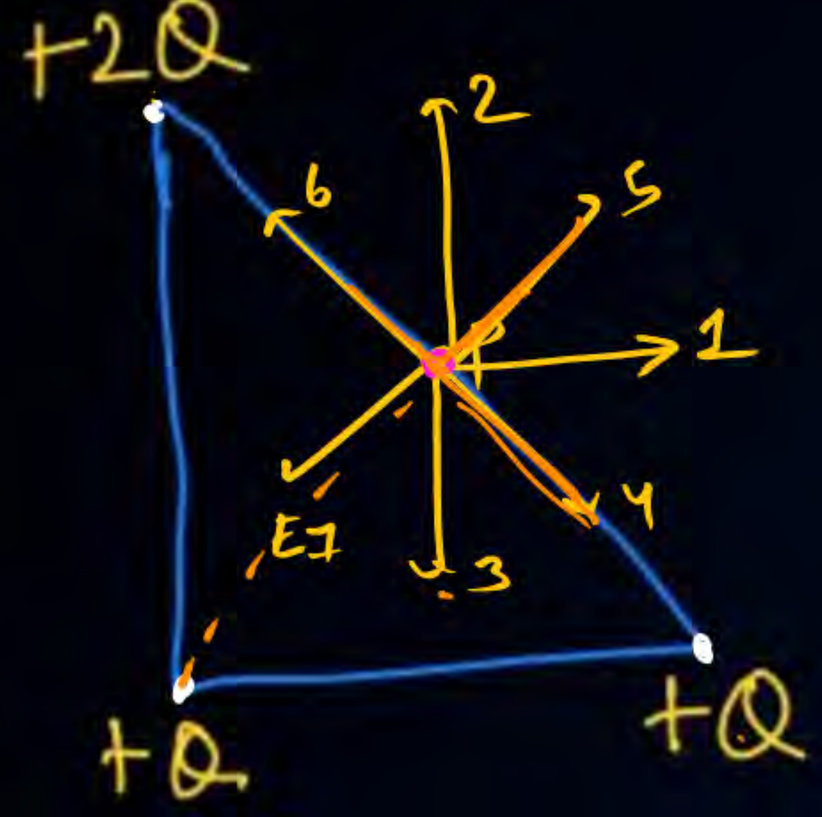
$$E_{net} = \sqrt{(4E)^2 + (2E)^2}$$

$$= \sqrt{20E^2}$$

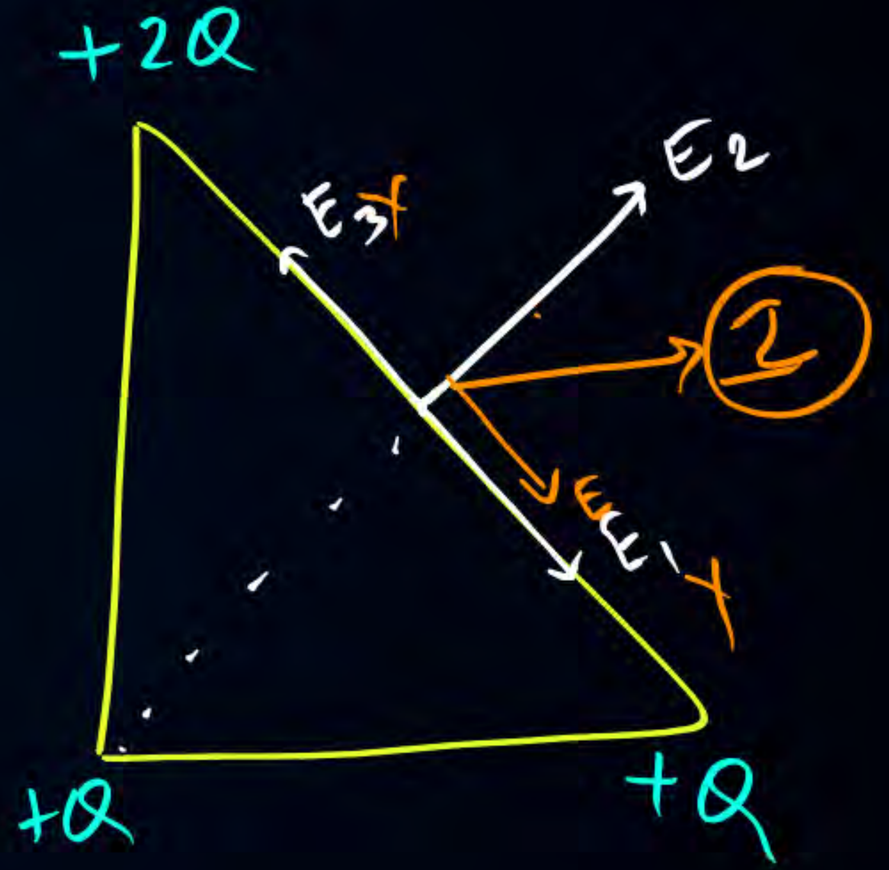
$$= 4\sqrt{5}E$$

$$= 4\sqrt{5}\frac{KQ}{(a/\sqrt{2})^2}$$

⇒ Let E is field at O due to Q at corner



zoom

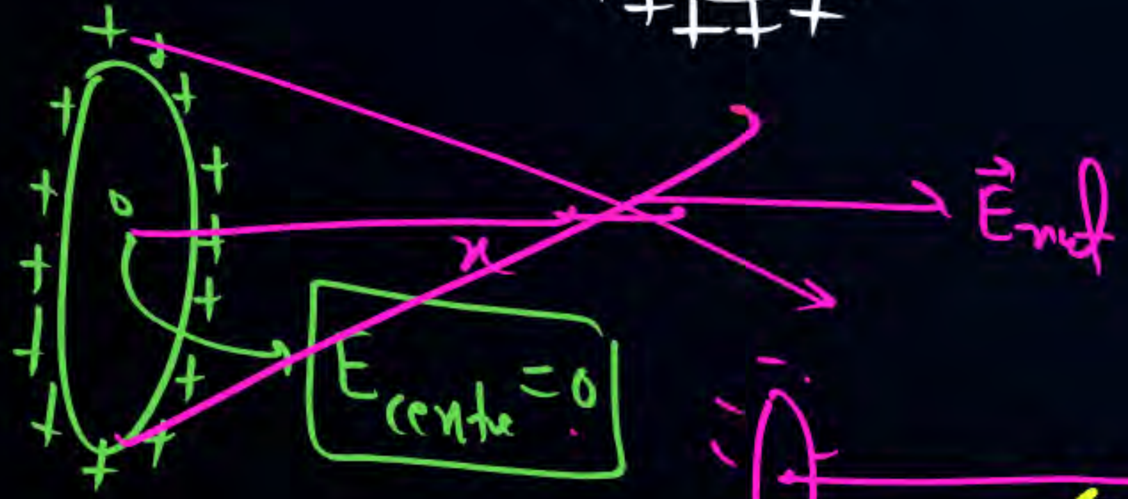


E net field
along line
1

Electric field due to ring at axis of Ring :-









$$E = \frac{KQx}{(R^2+x^2)^{3/2}}$$

✓ dimension correct.



MR ✗

If $x = 0$

$E = 0$

Centre

If $x <<< R$

$$E = \frac{KQx}{(R^2)^{3/2}}$$

$$E = \frac{KQx}{R^3}$$

☆ $E \propto x$

If $x >>> R$

$$E = \frac{KQx}{(x^2)^{3/2}}$$

$$E = \frac{KQx}{x^3}$$

$$E = \frac{KQ}{x^2}$$

✗ lik.

Electric field due to the circular Ring :-




λ
O
R





Thank You

Thank You ki dash

निकल यहाँ से

YAKEEN 2.0

FOR NEET 2025

Lecture- 09 | **Physics**

Electric Charges and Fields



By- Dr. Manish Raj (MR SIR)

Topic To be Covered

1 # Electric field due to Ring.
& half Ring.

2 # electric field lines

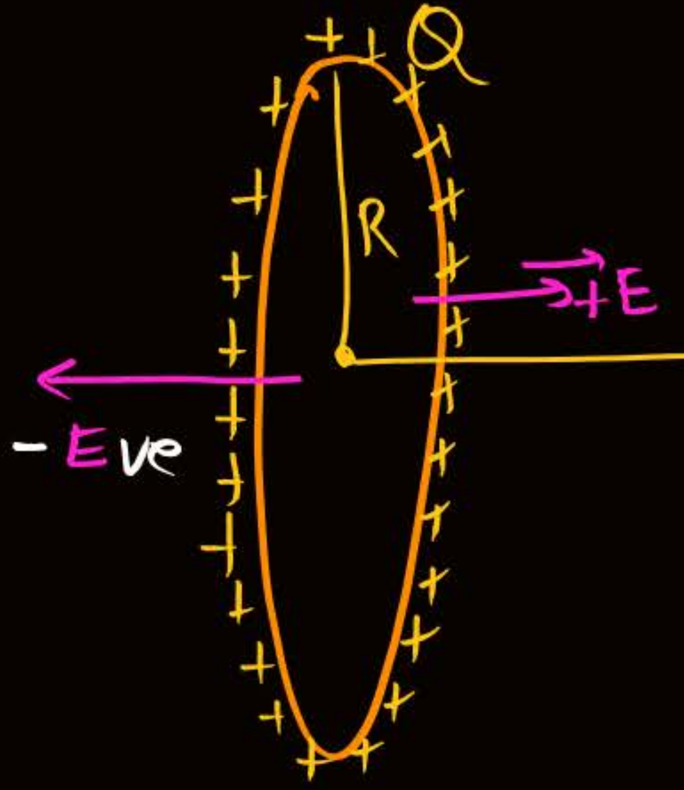
Motion of charge in electric field

3 #

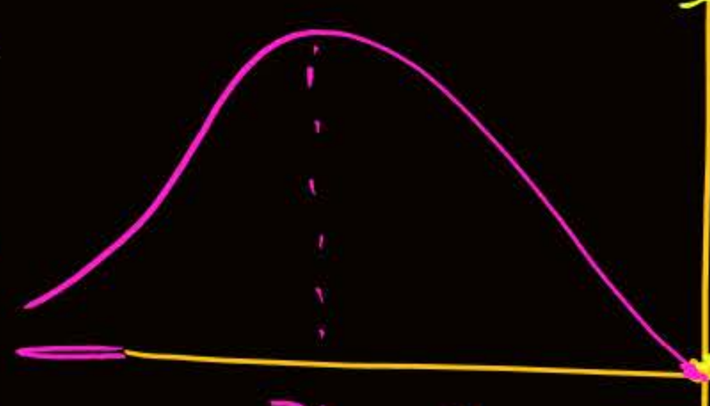
4 #

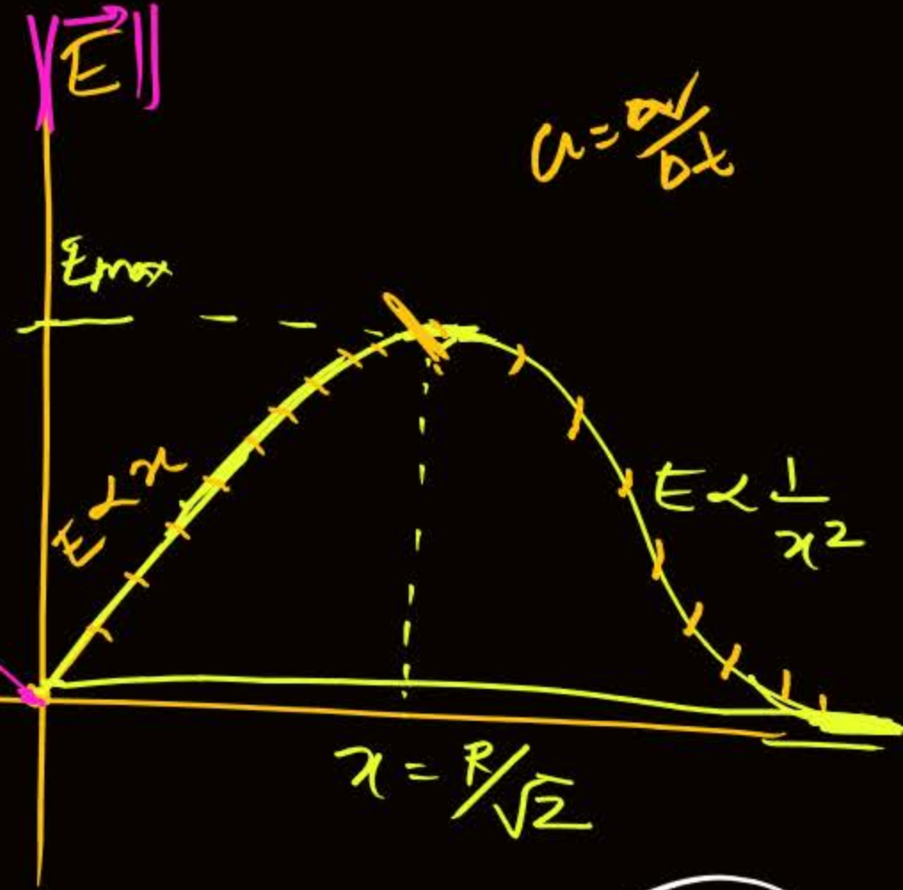


Ring find maximum electric field at dist^n $x = \frac{R}{\sqrt{2}}$



$$E = \frac{KQx}{(R^2+x^2)^{3/2}}$$



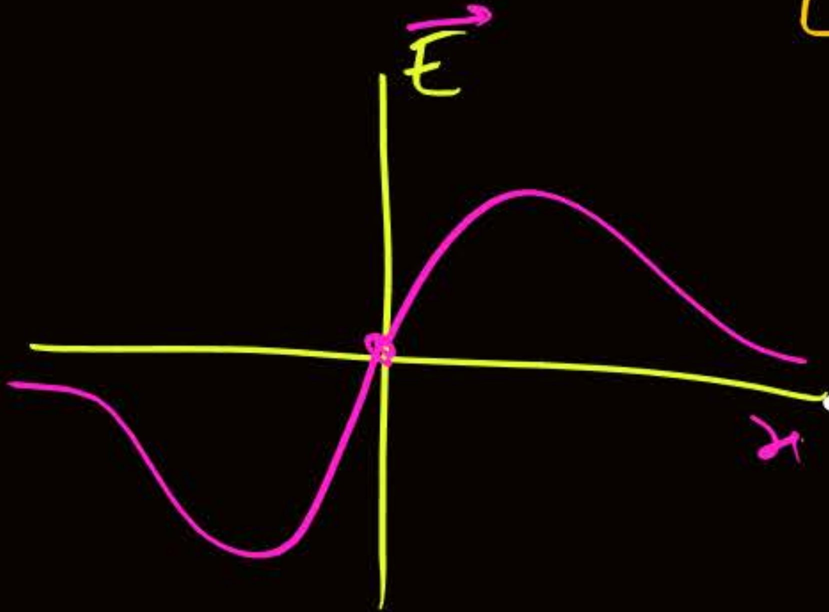


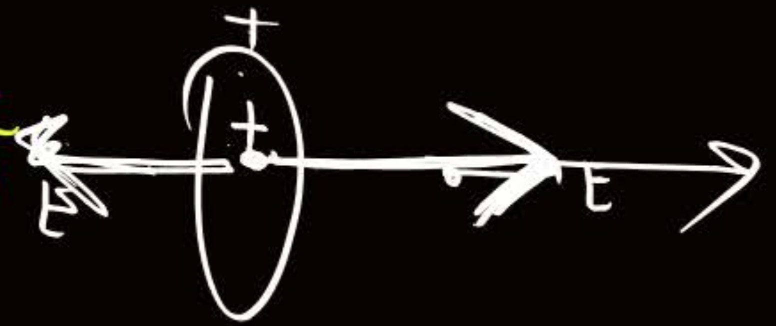
$a = \frac{dv}{dt}$

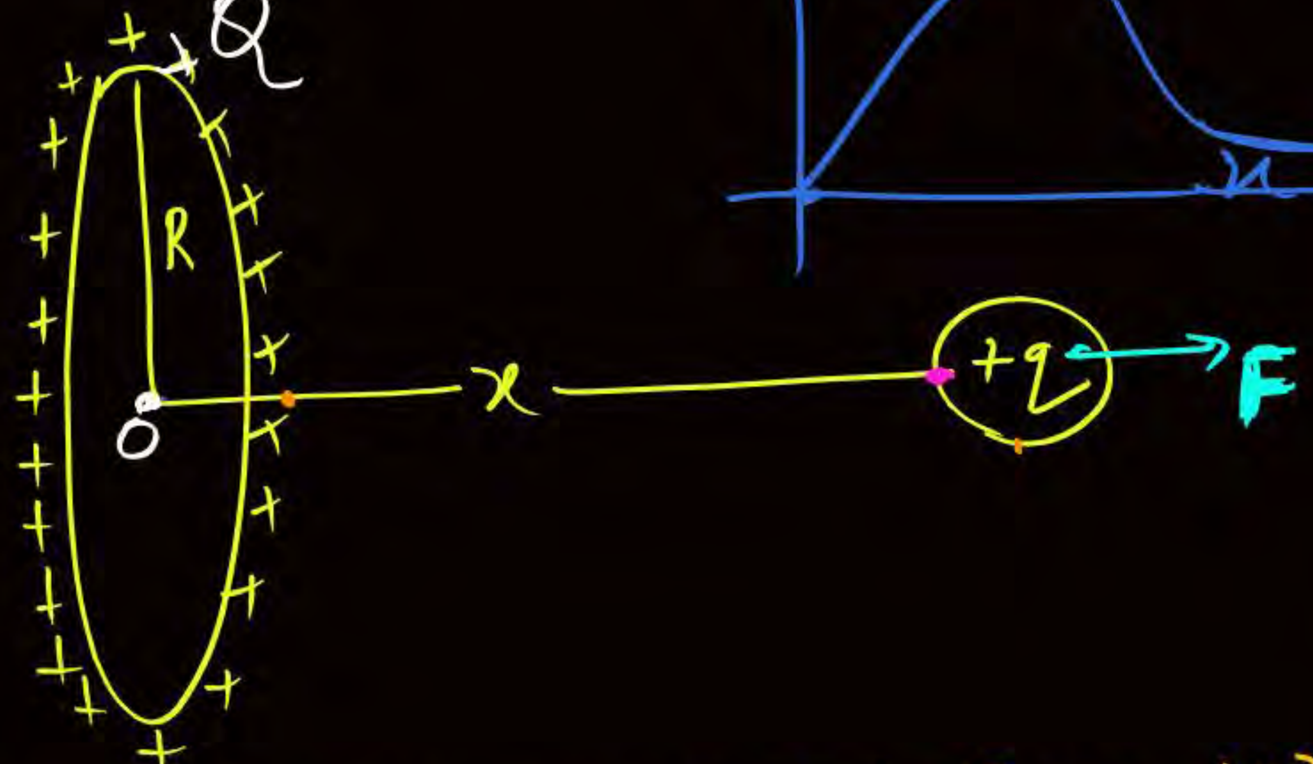
* at $x = \frac{R}{\sqrt{2}}$ electric field will be maximum.

$$E_{max}\Big|_{x=R/\sqrt{2}} = \frac{KQR}{\sqrt{2}\left[R^2+\frac{R^2}{2}\right]^{3/2}} = \frac{KQR}{\sqrt{2}\left[\frac{3R^2}{2}\right]^{3/2}} = \frac{KQR}{\sqrt{2}\left[\frac{3\sqrt{3}R^3}{2\sqrt{2}}\right]} = \frac{2KQ}{3\sqrt{3}R^2}$$

Ans









force on charge q due to Ring.

Force = qE

$$F = \frac{KQqx}{(R^2+x^2)^{3/2}} = qE \text{ force}$$

→ force Increases with distance then decreas with distance.

(Q) charge is reased from dist^n x as shown in above figure then its speed ?? ($x << R$)

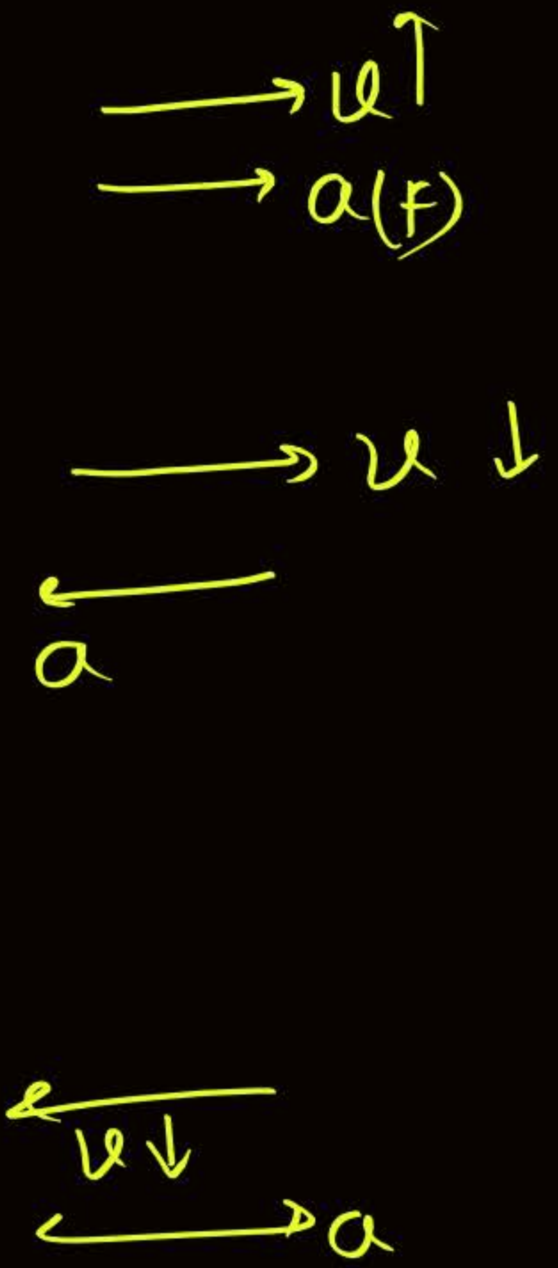
⟹ (a) always Increasing → 28% → Ans

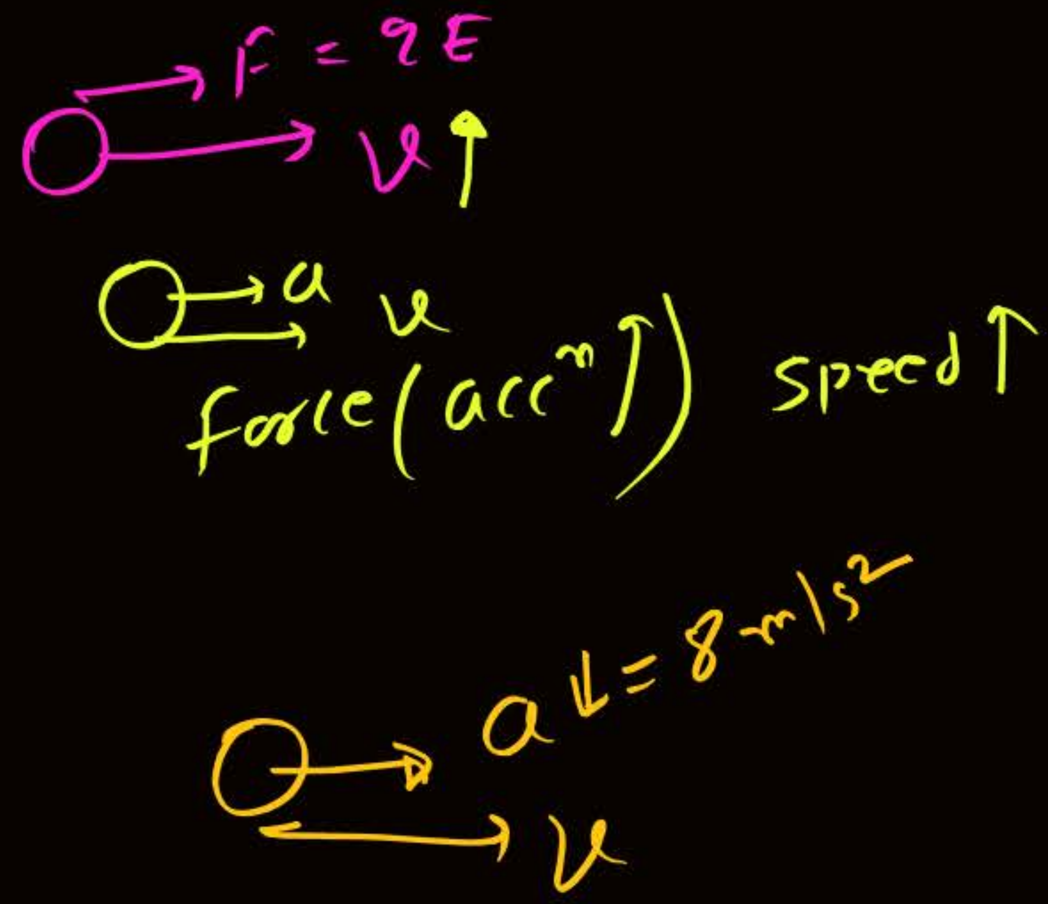
(b) 1st Inc. then dec 75.%

(c) always decrease

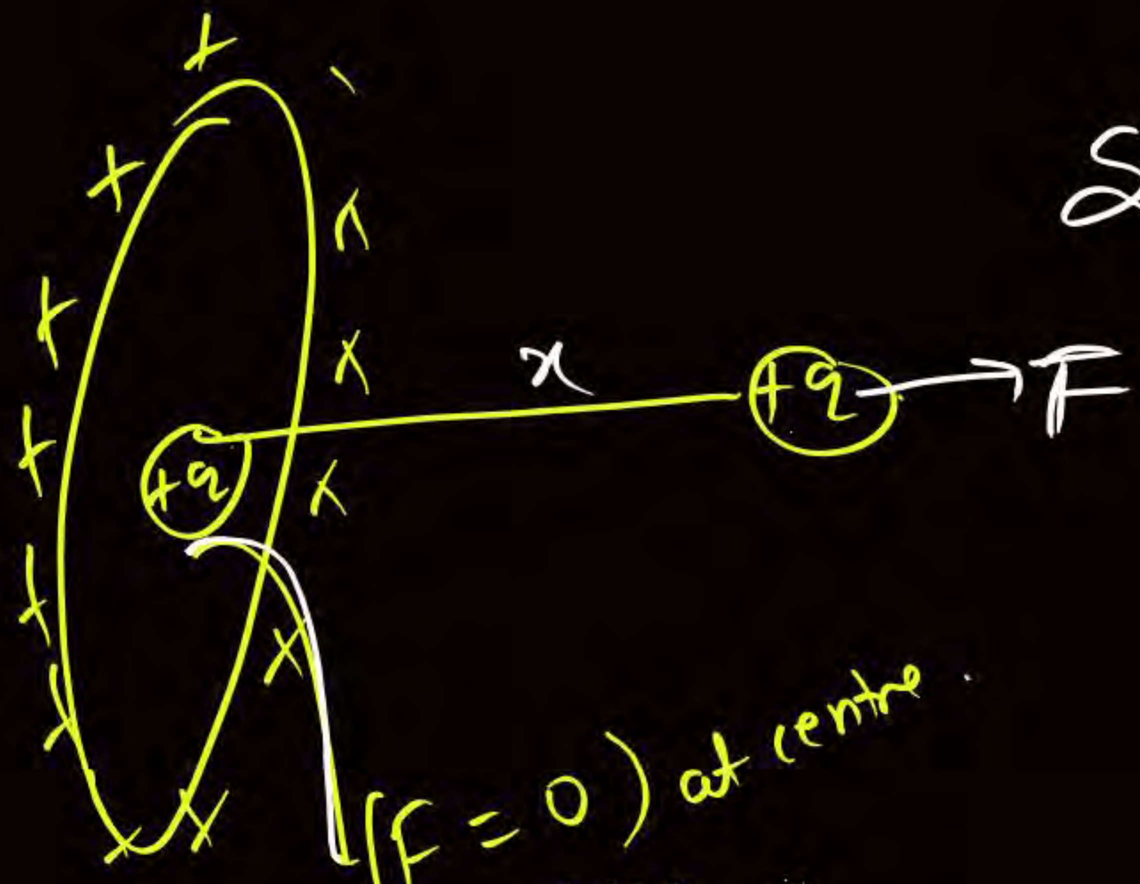
(d) 1st decreasing then ↑

14%


v ↑
a(F)
v ↓
a
v ↓
a

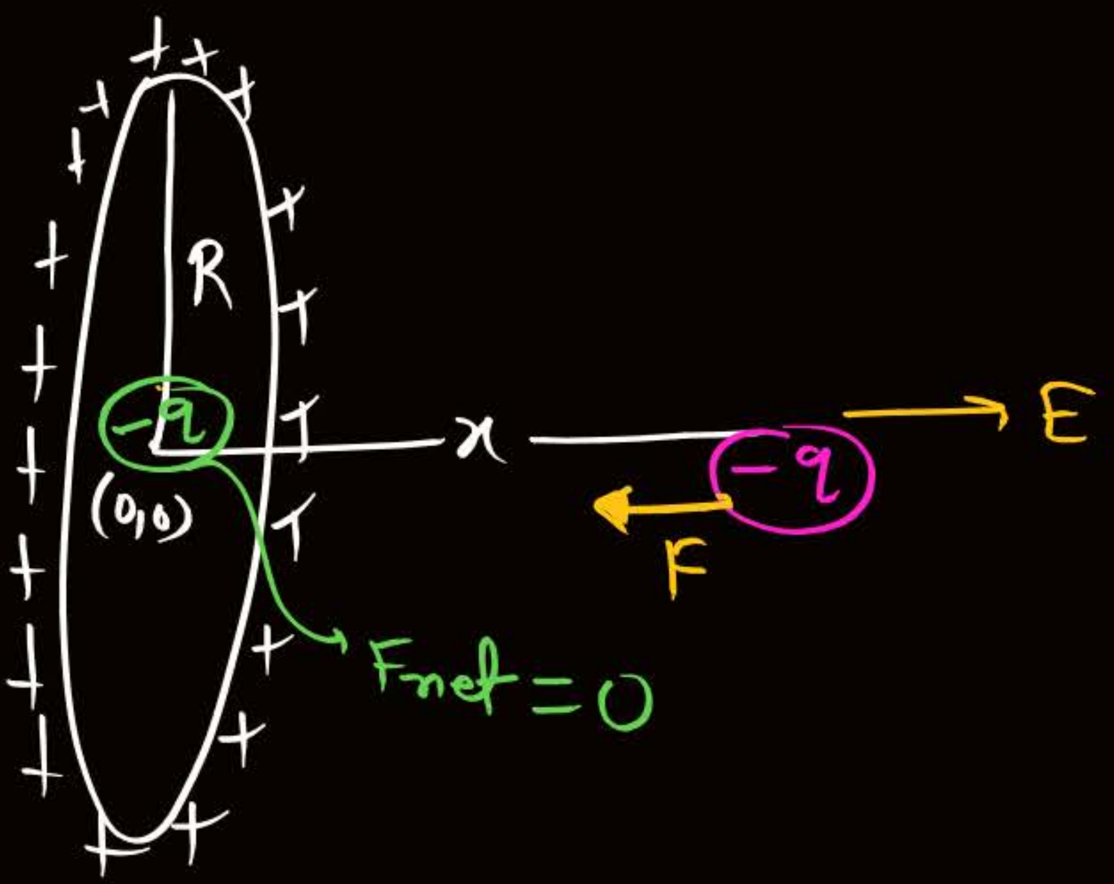

F = qE
v ↑
a
v
force (accⁿ ↑) speed ↑
a ↓ = 8 m/s²
v

S.H.M ??



(F = 0) at centre.

Unstable equilibrium



−q chare will oscillate about centre of Ring, then find its time period ??

$$\vec{F} = -\frac{KQq\vec{x}}{(R^2+x^2)^{3/2}}$$

Condⁿ of S.H.M. $(x <<< R)$

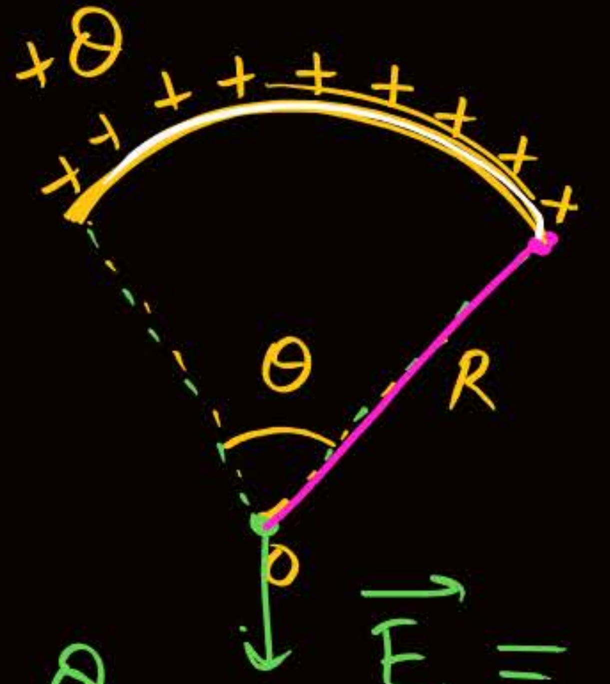
$$ma = -\frac{KQq\,x}{R^3}$$

$$a = -\frac{KQq}{mR^3}\,x \rightarrow \omega^2$$

$$\omega = \sqrt{\frac{KQq}{mR^3}}$$

$$T = 2\pi\sqrt{\frac{mR^3}{KQq}} \quad \text{(Ans)}$$

Electric field due to circular Arc



$$\vec{E} =$$

$$\lambda = \frac{Q}{R\theta}$$

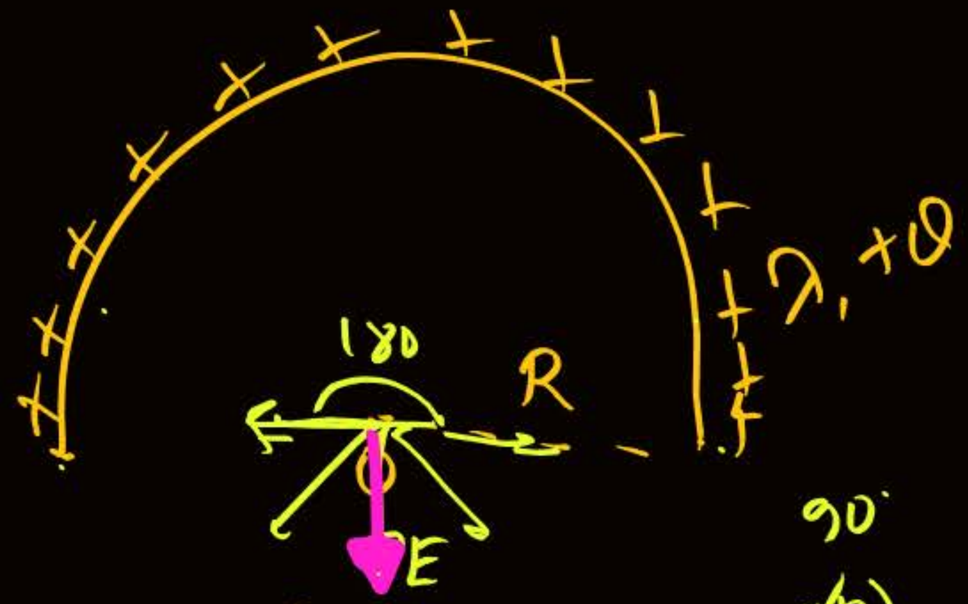
$$Q = \lambda R \theta$$

charge

$$E = \frac{kQ}{R^2} \frac{\sin(\theta/2)}{[\theta/2]}$$

$$E = \frac{k\lambda R\theta}{R\,R^2} \times \frac{\sin(\theta/2)}{\frac{\theta}{2}}$$

$$E = \frac{2k\lambda}{R} \times \sin(\theta/2)$$



$$E = \frac{2k\lambda}{R} \sin\left(\frac{180}{2}\right)$$

$$E = \frac{2k\lambda}{R}$$

QUESTION (NEET)

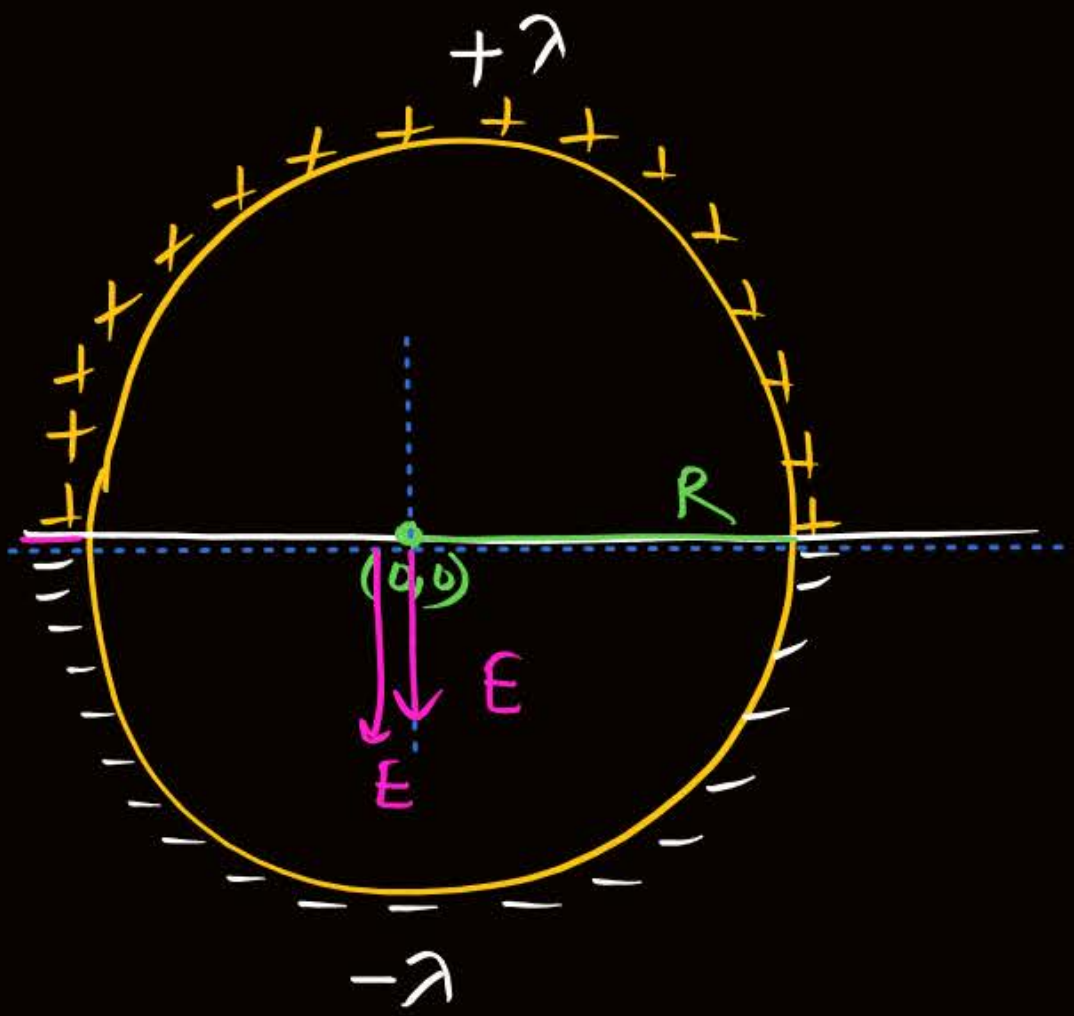
Electric field at centre O of semicircle of radius a having linear charge density λ a is given as

1. $\frac{2\lambda}{\varepsilon_0 a}$
2. $\frac{\lambda\pi}{\varepsilon_0 a}$ ✗✗
3. $\frac{\lambda}{2\pi\varepsilon_0 a}$ ✓
4. $\frac{\lambda}{\pi\varepsilon_0 a}$

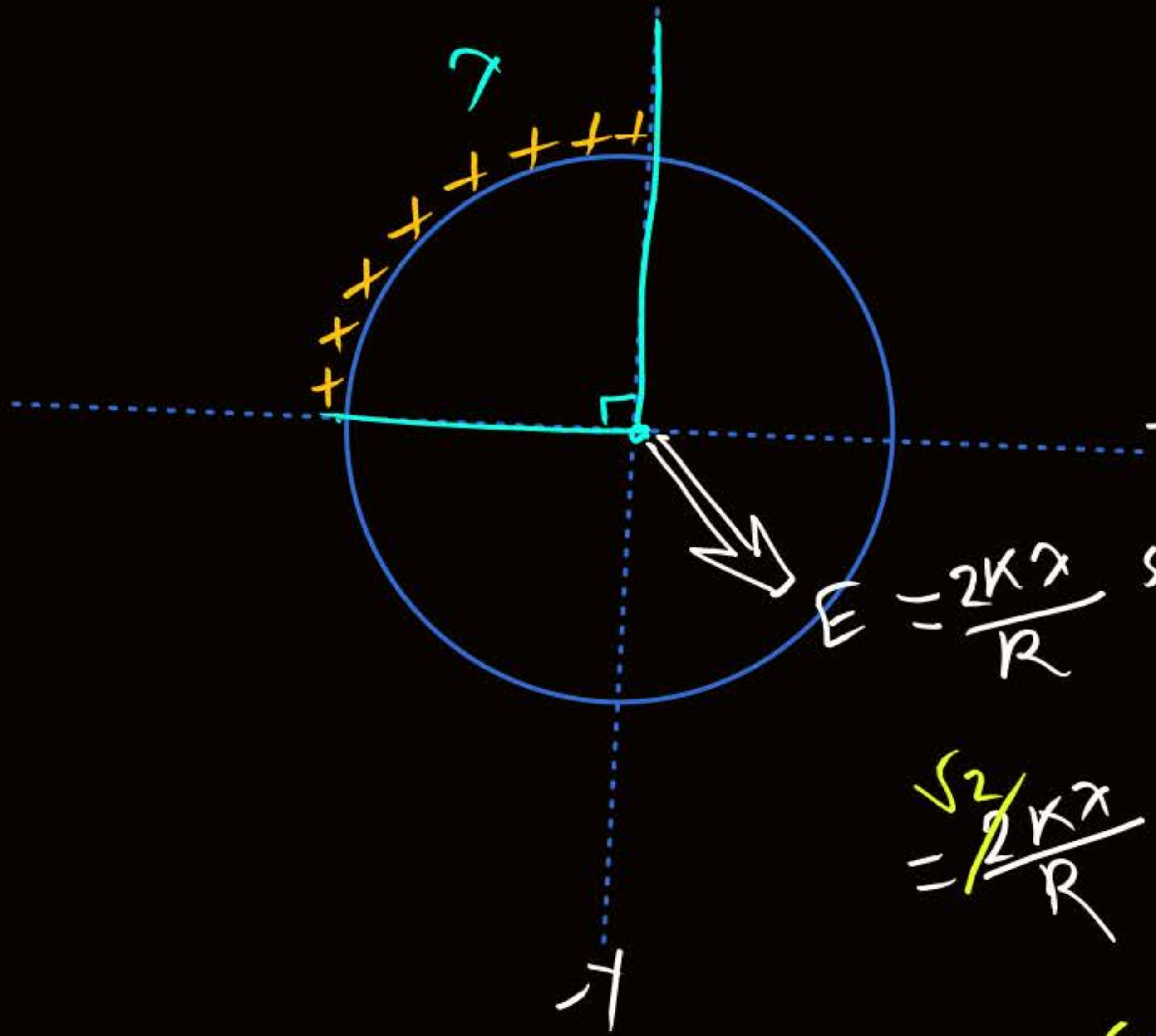
$$E = \frac{2k\lambda}{R}\sin\left(\frac{180}{2}\right)$$

$$E = \frac{2k\lambda}{a} = \frac{2\lambda}{4\pi\varepsilon_0 a} = \frac{\lambda}{2\pi\varepsilon_0 a}$$





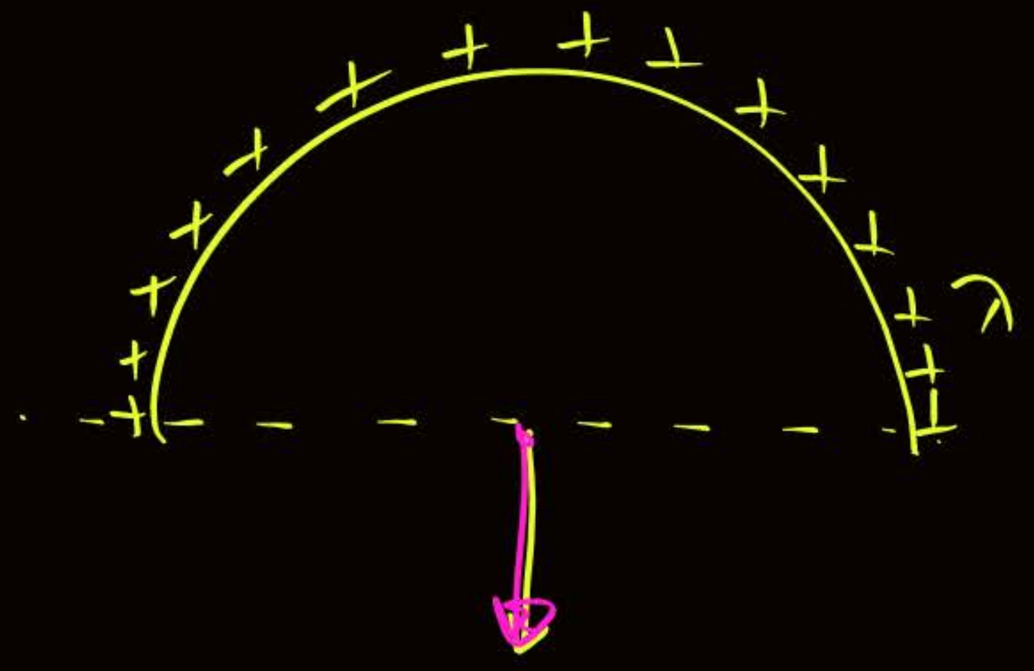
$$E_{net} = 2E_{Half\ ring} = \boxed{\frac{4k\lambda}{R}}$$



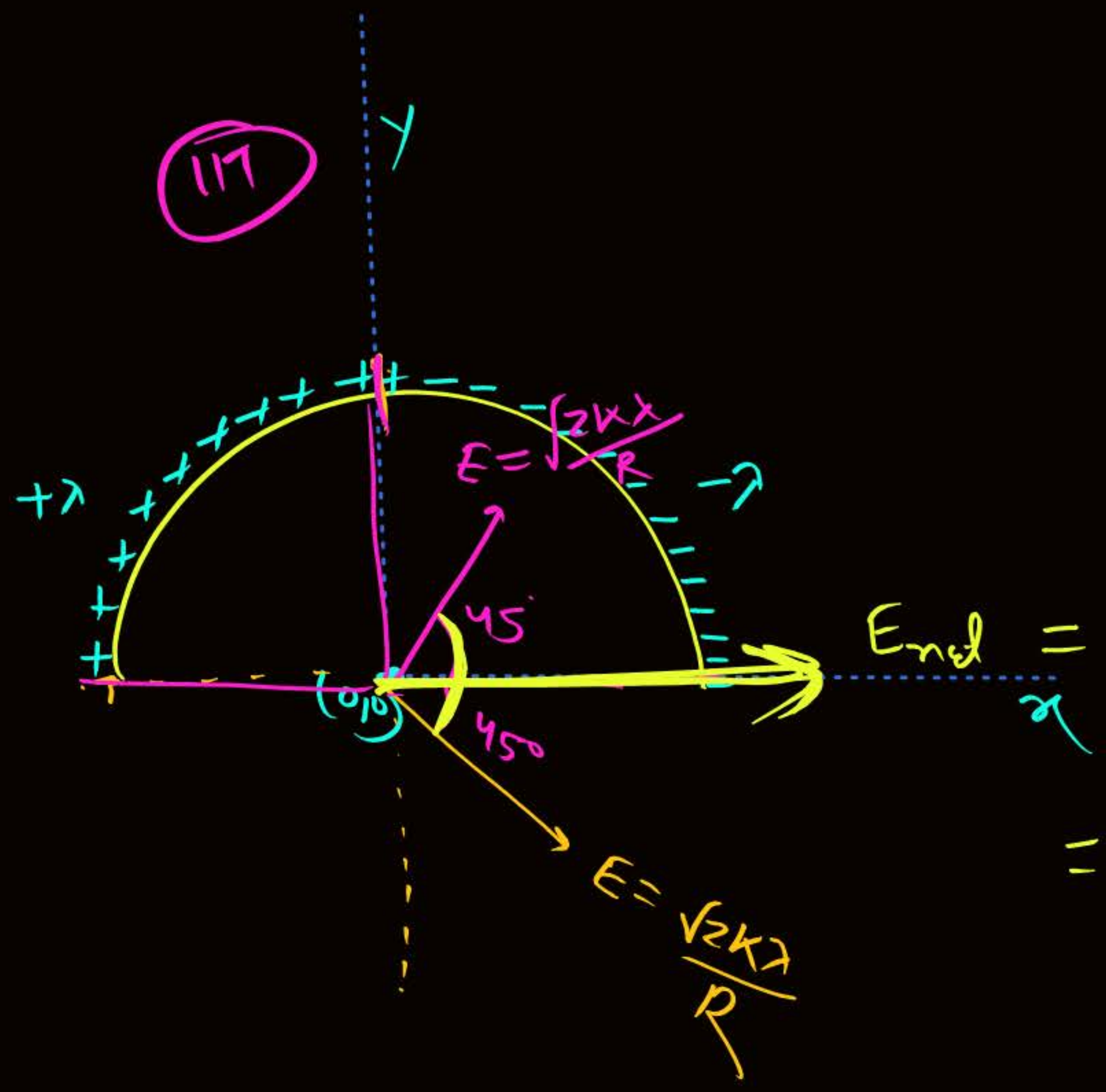
$$E = \frac{2k\lambda}{R}\sin\left(\frac{90}{2}\right)$$

$$= \frac{\sqrt{2}\,\cancel{2}k\lambda}{R}\frac{1}{\cancel{\sqrt{2}}}$$

$$= \frac{\sqrt{2}k\lambda}{R}$$ AS



$$E = \frac{2k\lambda}{R}$$



$$E = \frac{\sqrt{2}k\lambda}{R}$$

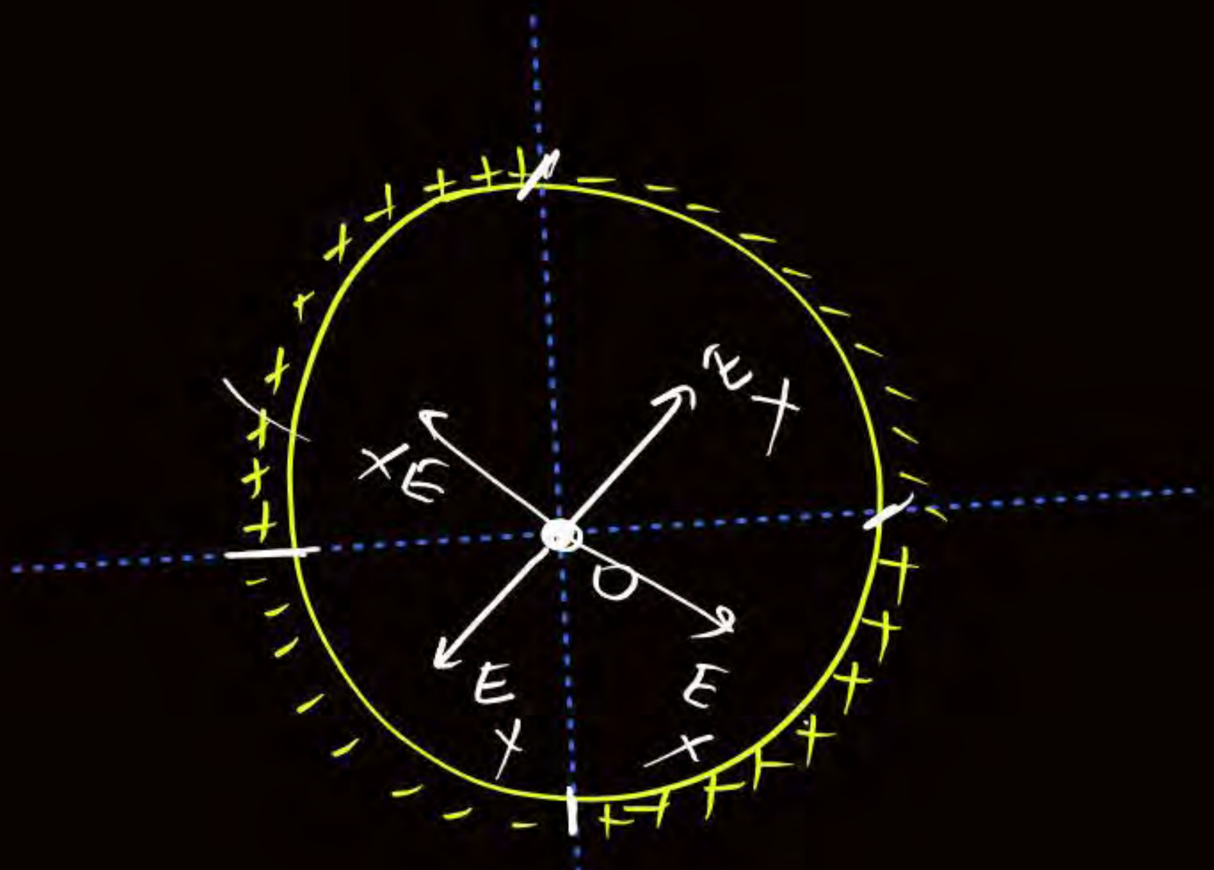
$$E = \frac{\sqrt{2}k\lambda}{R}$$

$$E_{net} = \sqrt{2}[E]$$

$$= \sqrt{2}\,\frac{\sqrt{2}k\lambda}{R}$$

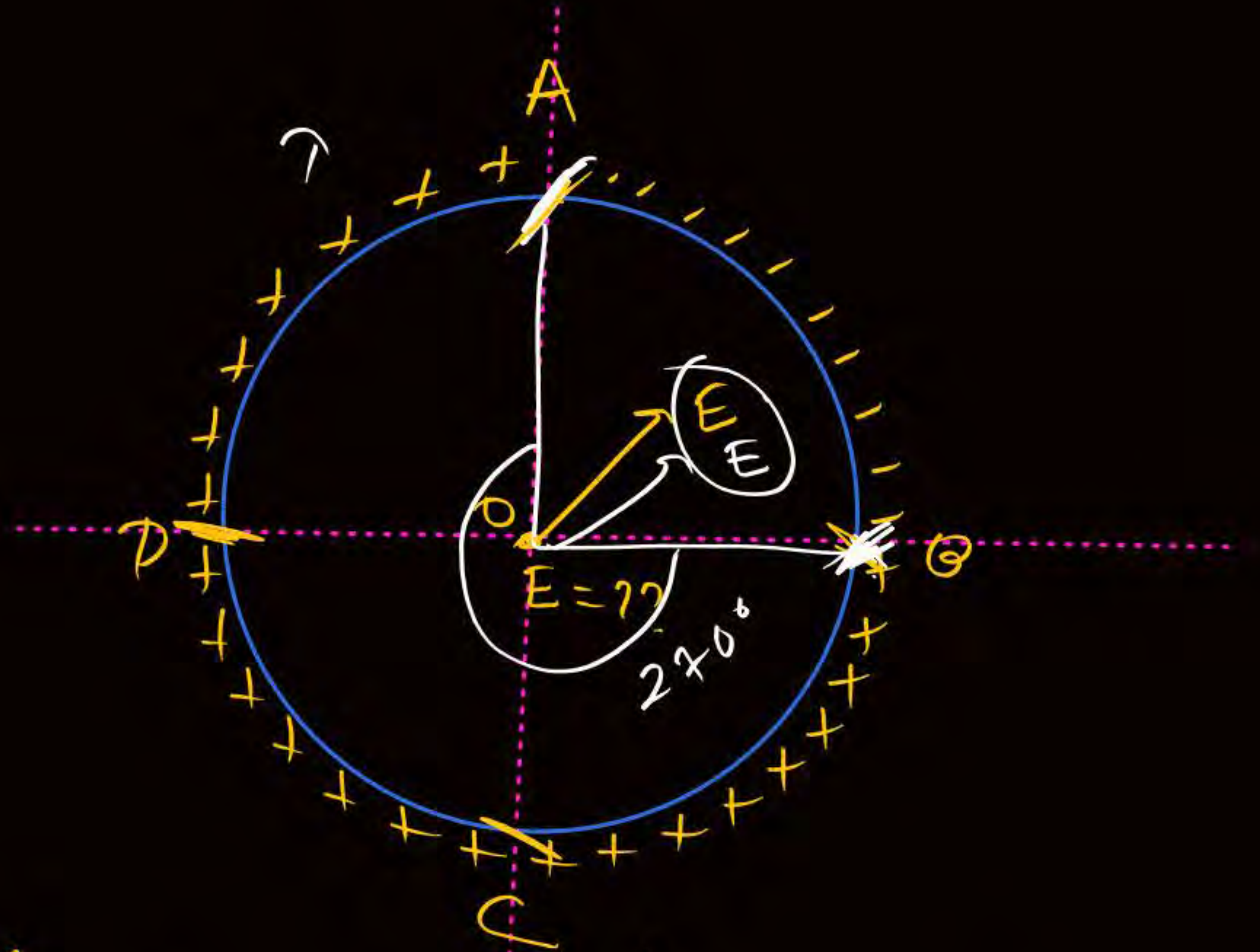
$$= \frac{2k\lambda}{R}$$

Ans



$E_O = 0$

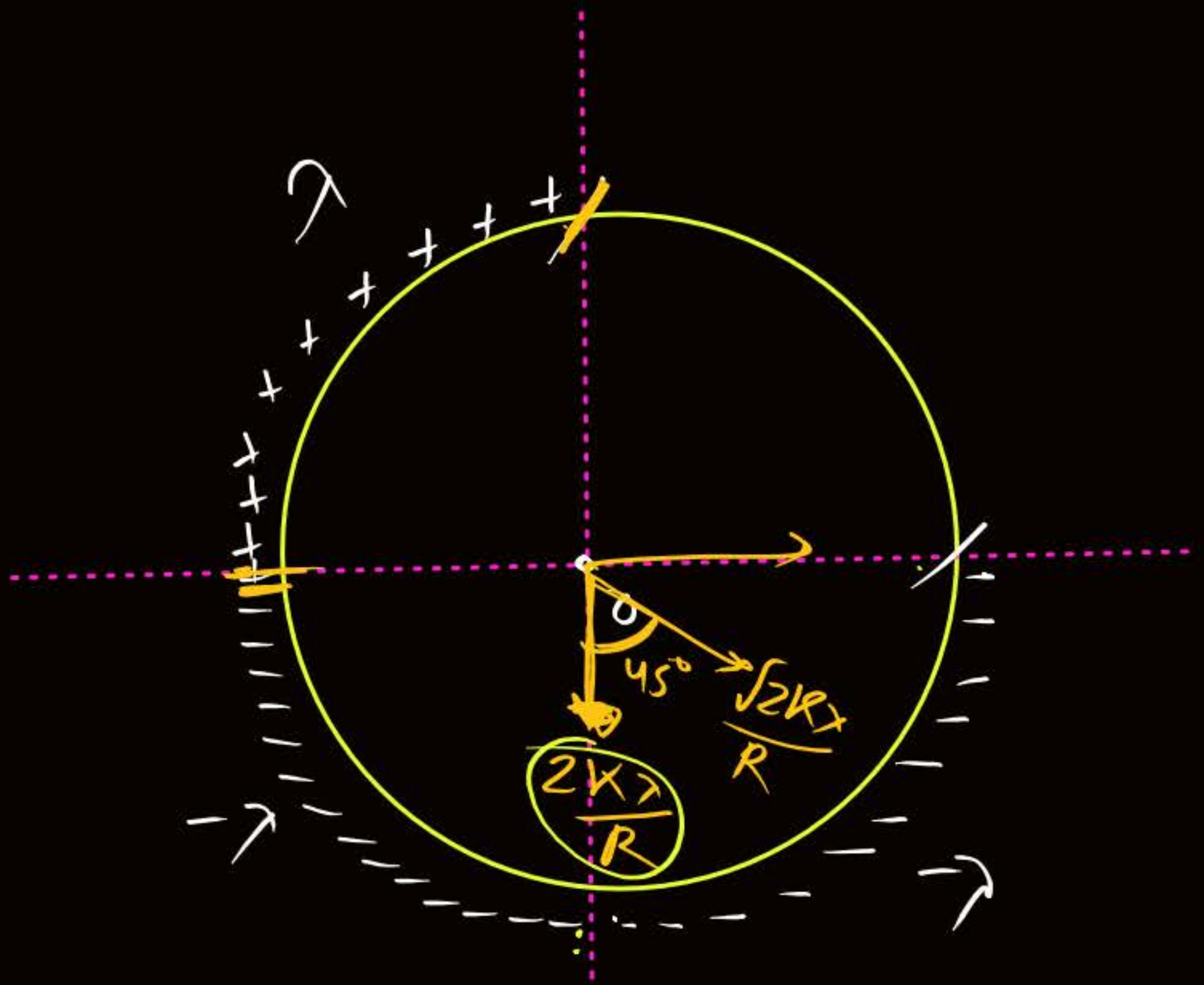
Centre



$(E_{net})_O = 2E = 2\left(\frac{\sqrt{2}K\lambda}{R}\right)$

$E_{ADCB} = ?? = \frac{2K\lambda}{R} \sin\left(\frac{270^\circ}{2}\right) = \frac{2K\lambda}{R}\frac{1}{\sqrt{2}}$ (135°)

$= \frac{\sqrt{2}K\lambda}{R}$ Ans



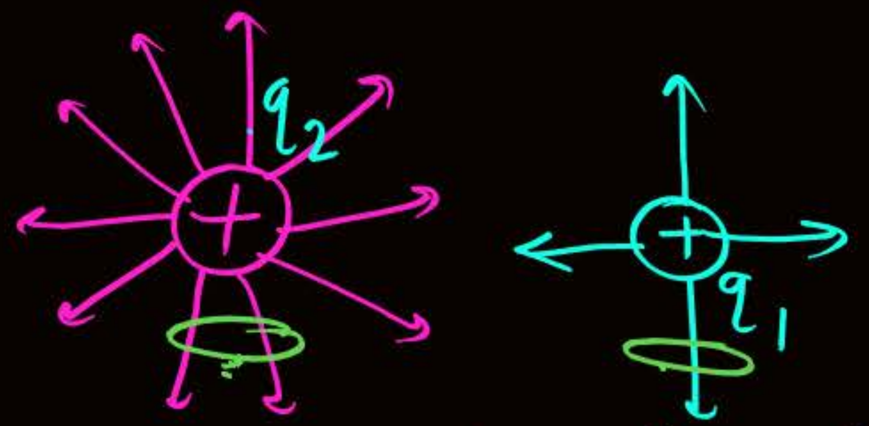
$$E_{net} = -\frac{2k\lambda}{R}\hat{j} - \frac{k\lambda}{R}\hat{j} + \frac{k\lambda}{R}\hat{i} = \frac{k\lambda}{R}\hat{i} - \frac{3k\lambda}{R}\hat{j}$$

at centre

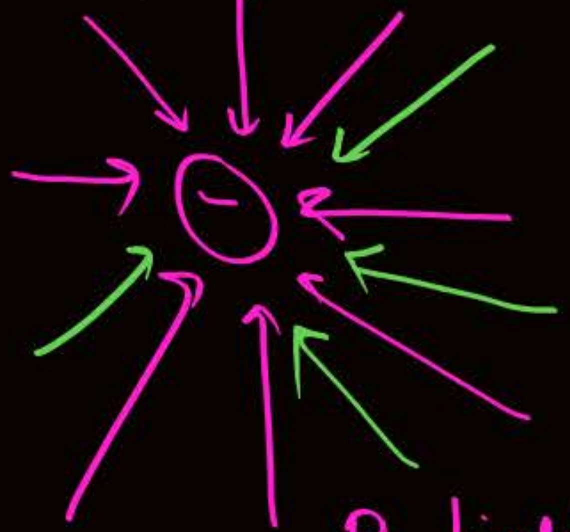
$$|E| = \frac{\sqrt{10}\,k\lambda}{R}$$

Electric field lines

→ Imaginary lines, tangent on which gives direction of electric field, & no. of field lines passing through area give the value of electric field.



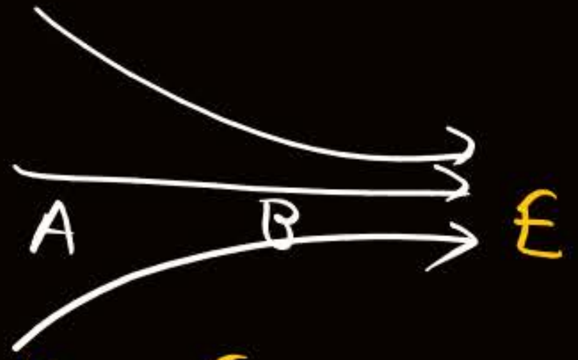
Radially outword $(q_2 > q_1)$



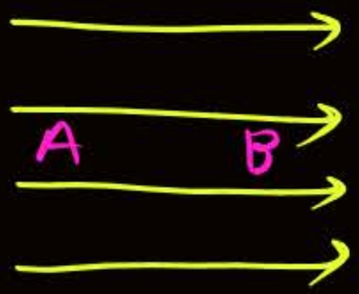
Radially Inward.



$E_A > E_B$



$E_A < E_B$



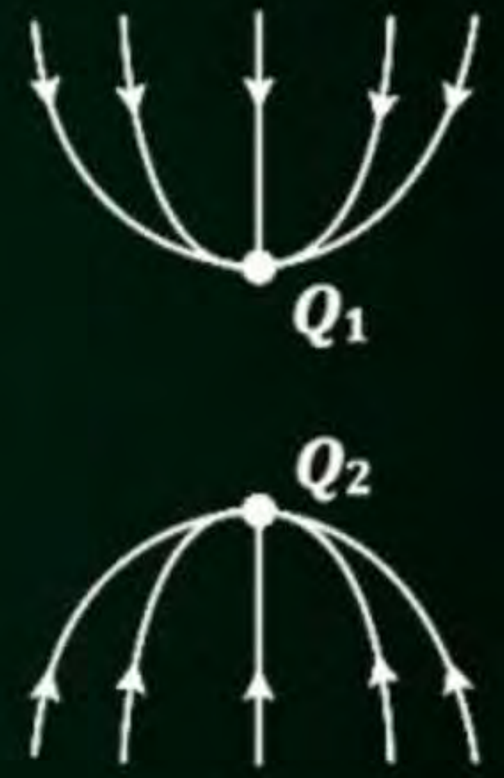
$E_A = E_B$

Uniform field

* Electric field lines also called electric force line.
* Two line never Intersect each other
* Conservatr line
* Never form close loop.
* Inside conductor there is no electric field.
* at surface of conductor $\vec{E}$ must be ⊥r.

QUESTION

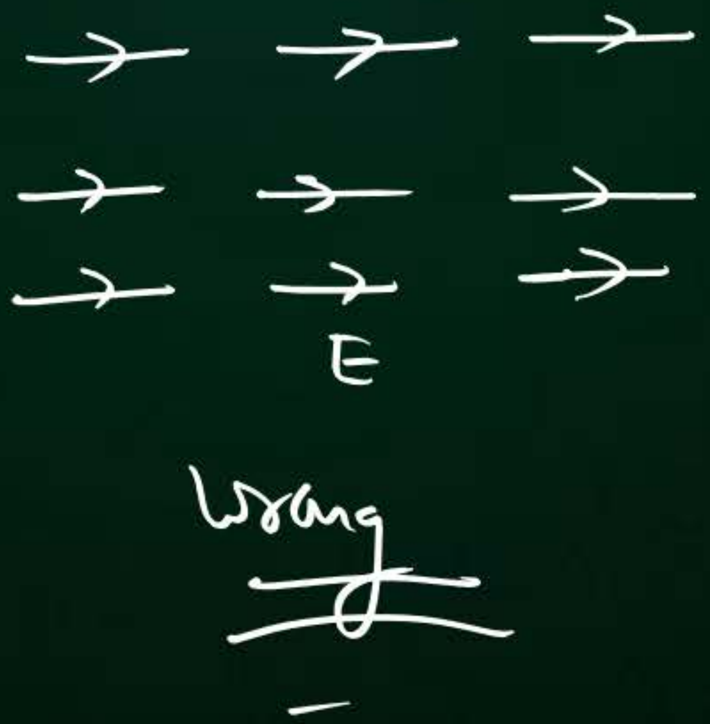
The figure shown is a plot of electric field lines due to two charges Q_1 and Q_2. The sign of charges is

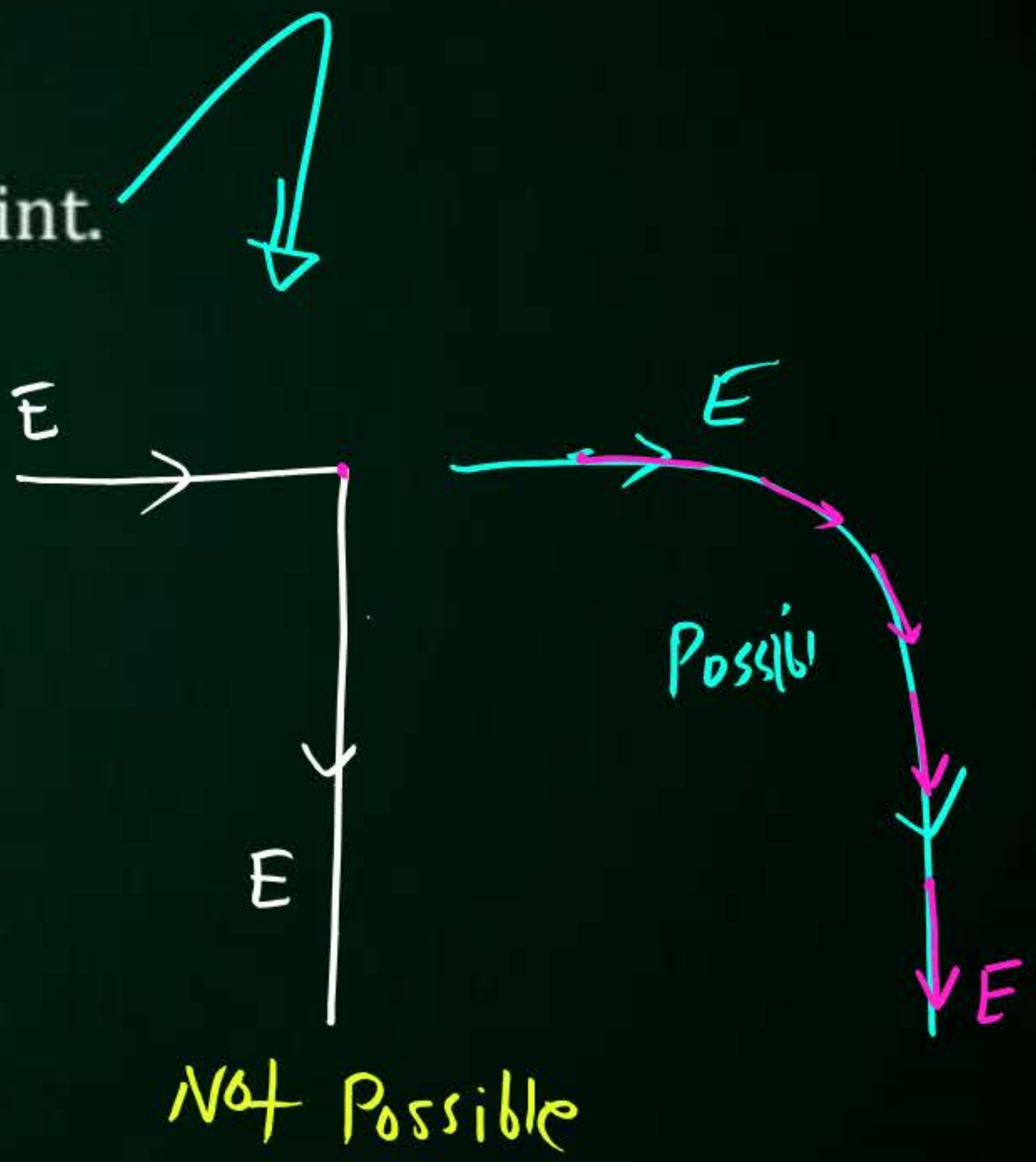


1. Both negative
2. Q_1 positive and Q_2 negative
3. Both position
4. Q_1 negative and Q_2 positive

- Magnitude of electric field is directly proportional to electric field density.
- Always perpendicular to the surface of conductor
- Inside isolated conductor electric field lines is zero.
- Sharp turn is not possible; always continuous at all point.
- Never forms close loop.
- It is conservative field.

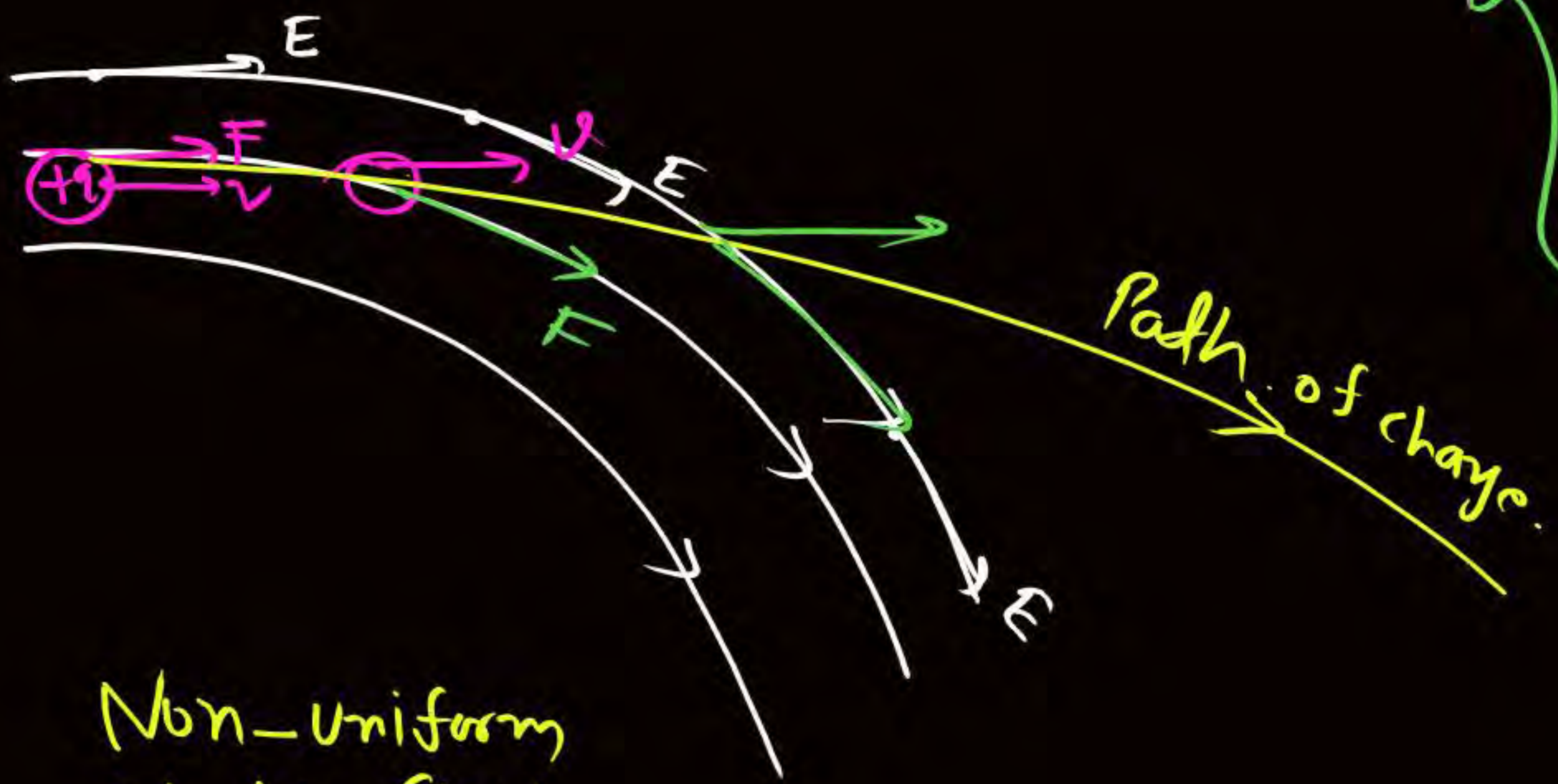






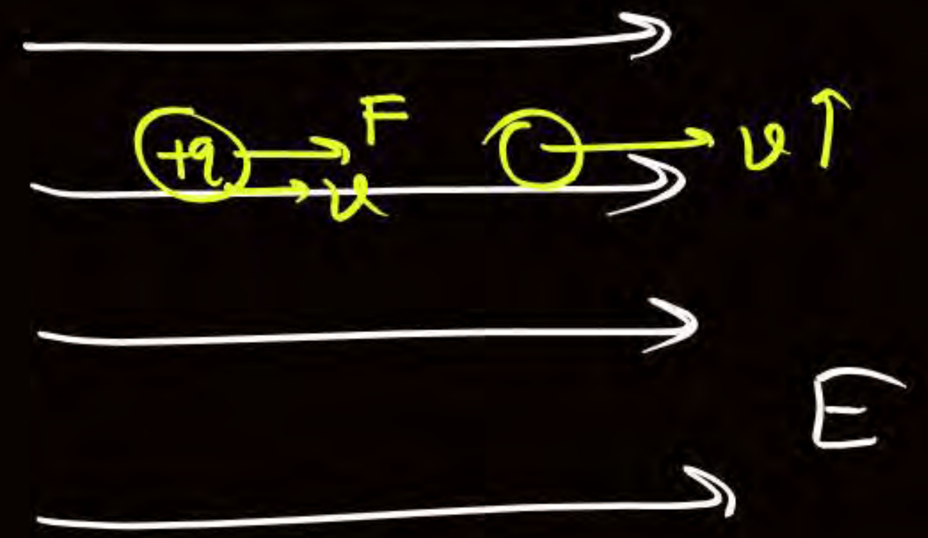
Electric Field lines:

- Imaginary line along the force on a unit positive charge also called force line.
- Electric field lines not along the path followed by unit +ve charge.
- Starts from +ve charge, end at –ve charge
- The tangent at any point on the electric field lines gives the direction of field.
- Radially outward from positive charge and radially inward for negative charge
- Do not Intersect two lines.
- Magnitude of charge $\propto$ no. of field lines starting from that charge.



Non-uniform Electric field due to variable dirn.

If Positive charge, placed in a electric field, then its Path along the electric field → Not always



1)

2)

3)

4)

5)

6)

7)

8)

9)

10)

QUESTION

Which of the electrostatic lines of forces are correctly drawn?

(1) 

(2) 

(3) 

(4) All of these

QUESTION

Looking at the various electric lines of forces between charges Q_1 and Q_2, find the value of Q_1/Q_2.

$$\frac{|Q_1|}{|Q_2|} = \frac{10}{4} = \frac{5}{2}$$



$$\frac{Q_1}{Q_2} = -5/2$$

Ans

QUESTION

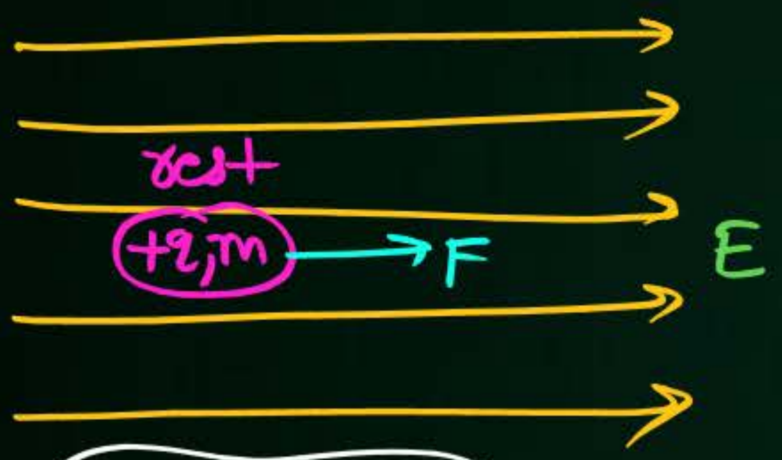
The figure shows electric field lines. If E_A and E_B are electric field at A and B and distance AB is r, then



1. $E_A > E_B$
2. $E_A = E_B/r$
3. $E_A < E_B$
4. $E_A = E_B/r^2$

Motion of Charge Particle in Uniform Electric Field

Case-1: Charge is released at rest.



$\vec{F} = q\vec{E}$

along electric field

$\left\{ a = \frac{F}{m} = \frac{qE}{m} \right\}$

→ constant in Magnitude & dirn

velocity after 't'

$v = u + at$

$v = \frac{qE}{m} t$

$s = ut + \frac{1}{2} at^2$

$s = \frac{1}{2} \frac{qE}{m} t^2$

K.E at time.

$K.E = \frac{1}{2} m v^2 = \frac{1}{2} m \left[\frac{qE}{m} t \right]^2$

$K.E = \frac{1}{2} \frac{(qEt)^2}{m}$

$p = m\vec{v}$

$p = m \frac{qEt}{m} = qEt$

$p = F \cdot \Delta t$

$p = qEt$

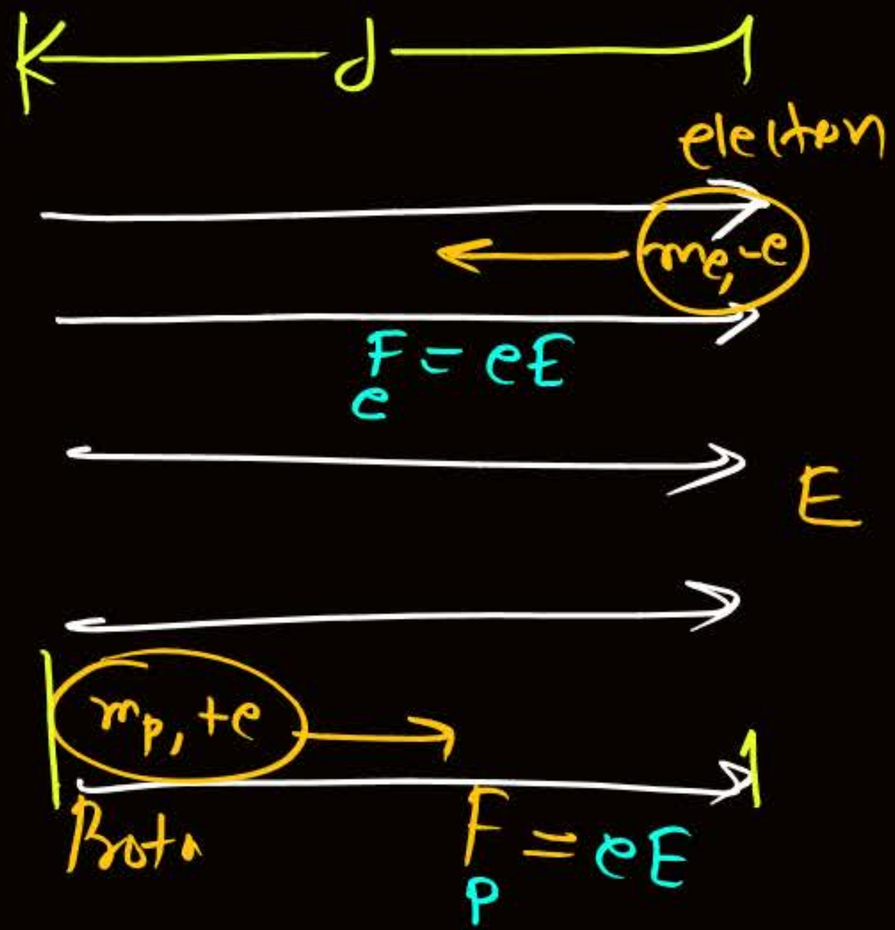
QUESTION

The magnitude of force exerted by a uniform electric field on an electron having mass m_e and proton of mass m_p are represented as F_e and F_p respectively are related as

1. $F_p = F_e$ (57%)
2. $\frac{F_e}{F_p} = \frac{m_e}{m_p}$
3. $\frac{F_e}{F_p} = \frac{m_p}{m_e}$
4. $\frac{F_e}{F_p} = \frac{m_p}{m_e}$

$F = qE$

$\frac{F_e = qE}{F_p = qE}$



$\# \quad |\vec{F_e}| = |\vec{F_p}|$

$$a_{electron} = \frac{eE}{m_e}$$

$$a_{proton} = \frac{eE}{m_p}$$

acc^n of e^- >> acc^n of Proton

$t_{e^-} < t_{proton}$

$$S = \frac{1}{2}at^2$$

$$t = \sqrt{\frac{2s}{a}}$$

QUESTION

A proton of mass '*m*' charge '*e*' is released from rest in a uniform electric field of strength 'E'. The time taken by it to travel a distance '*d*' in the field is

1. $\sqrt{\dfrac{2de}{mE}}$
2. $\sqrt{\dfrac{2dm}{Ee}}$
3. $\sqrt{\dfrac{2dE}{me}}$
4. $\sqrt{\dfrac{2Ee}{dm}}$

$$s = ut + \frac{1}{2}\frac{qE}{m}t^2$$

$$t = \sqrt{\frac{2md}{qE}}$$

QUESTION

A mass m carrying a charge q is suspended from a string and placed in a uniform horizontal electric field of intensity E. The angle made by the string with the vertical in the equilibrium position is

1. $\theta = \tan^{-1}\frac{mg}{Eq}$

2. $\theta = \tan^{-1}\frac{m}{Eq}$

3. $\theta = \tan^{-1}\frac{Eq}{m}$

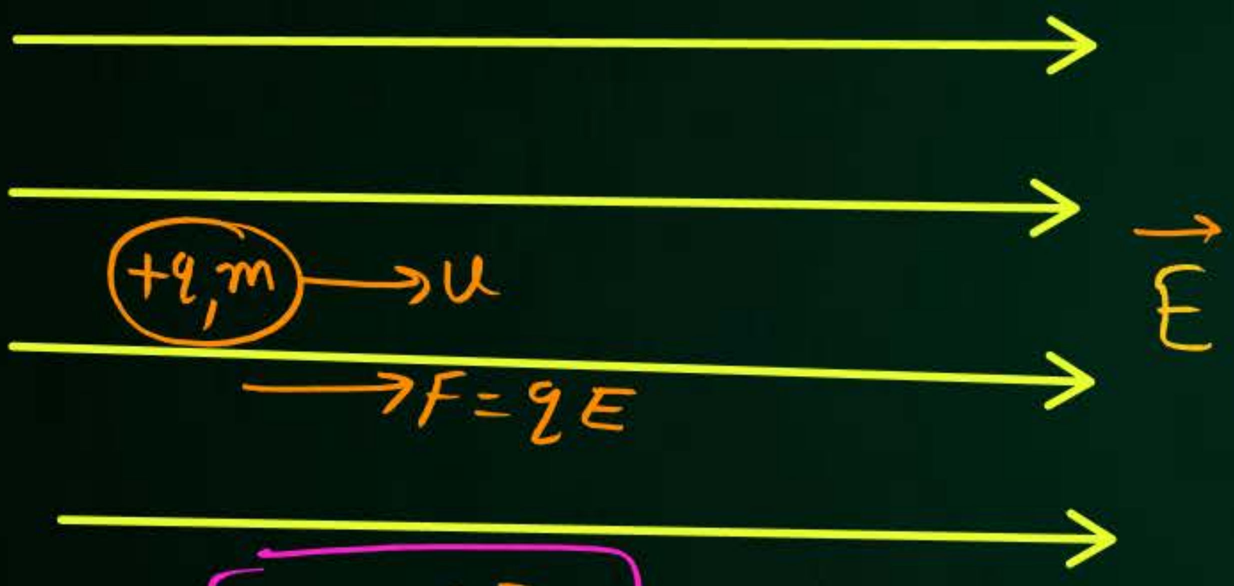
4. $\theta = \tan^{-1}\frac{Eq}{mg}$

$\tan\theta = \frac{qE}{mg}$

Case-2: Charge is projected parallel to electric field 'E'.

+ve charge projected along $\vec{E}$

$$S = ut + \frac{1}{2} a t^2$$



$a = \frac{qE}{m}$

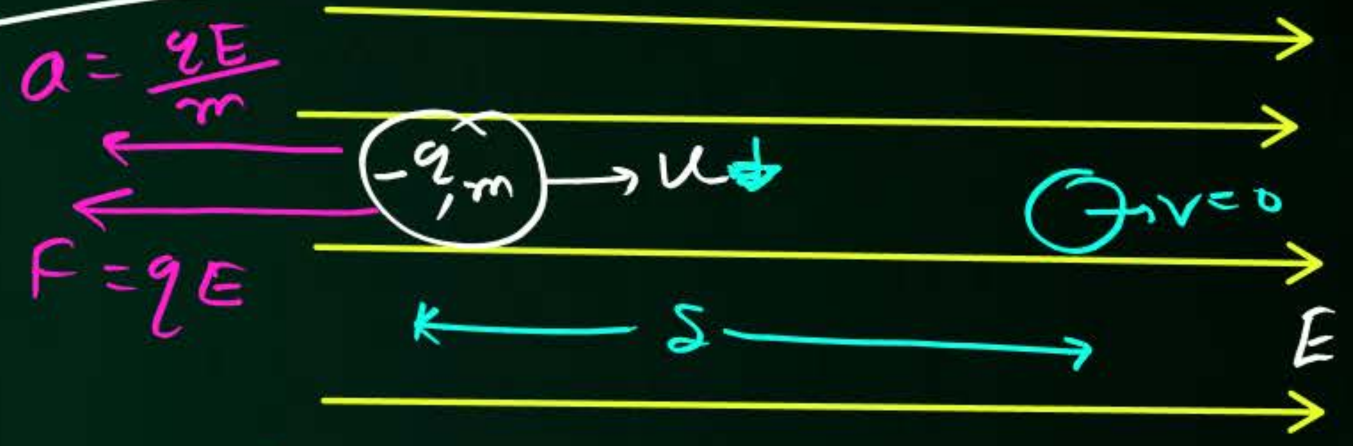
$$S = ut + \frac{1}{2} a t^2$$

$$S = ut + \frac{1}{2} \frac{qE}{m} t^2$$

$$v = u + at$$

$$v = u + \frac{qE}{m} t$$

-ve charge is projecting



3rd eqn of motn

$$v^2 - u^2 = 2aS$$

$$0 + u^2 = 2 \frac{qE}{m} \times S$$

$$S = \frac{u^2}{2(qE/m)}$$

Path straight line

Case-3: Charge is projected perpendicular to electric field. 'E'.

$\vec{E}$ (uniform)

mot^n in x only

$d = ut$

$t = \frac{d}{u}$

uniform mot^n in x-axis

Y-axis

$u_y = 0$

$a = \frac{qE}{m}$

$V_t = u_y + a_y t$

$V_t = \frac{qE}{m} t$

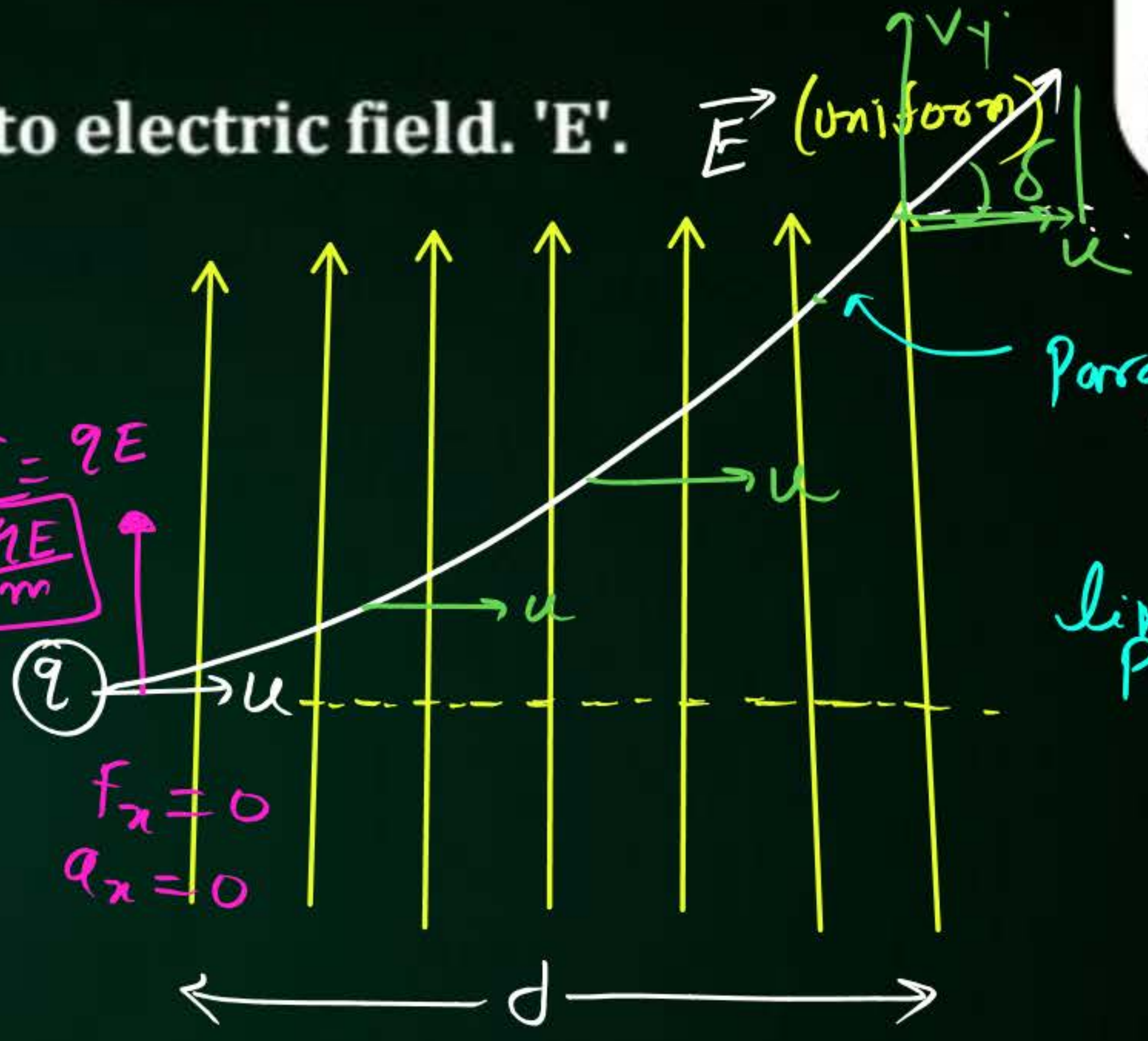
$V_t = \frac{qEd}{mu}$

$F = qE$

$cot^n = \; a = \frac{qE}{m}$

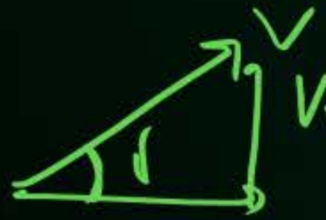
$F_x = 0$

$a_x = 0$



Parabolic path.

like Projectile motion



$V_y = \frac{qEd}{mu}$

$\tan\delta = \frac{V_y}{V_x} = \frac{qEd}{mu \times u} = \frac{qEd}{mu^2}$

deviation

$$\tan\delta = \frac{qEd}{mu^2}$$

$$\tan\delta = \frac{qEdm}{p^2}$$

$$\tan\delta = \frac{(dqE)}{mu^2}$$

dim^n less

MPX ka feel

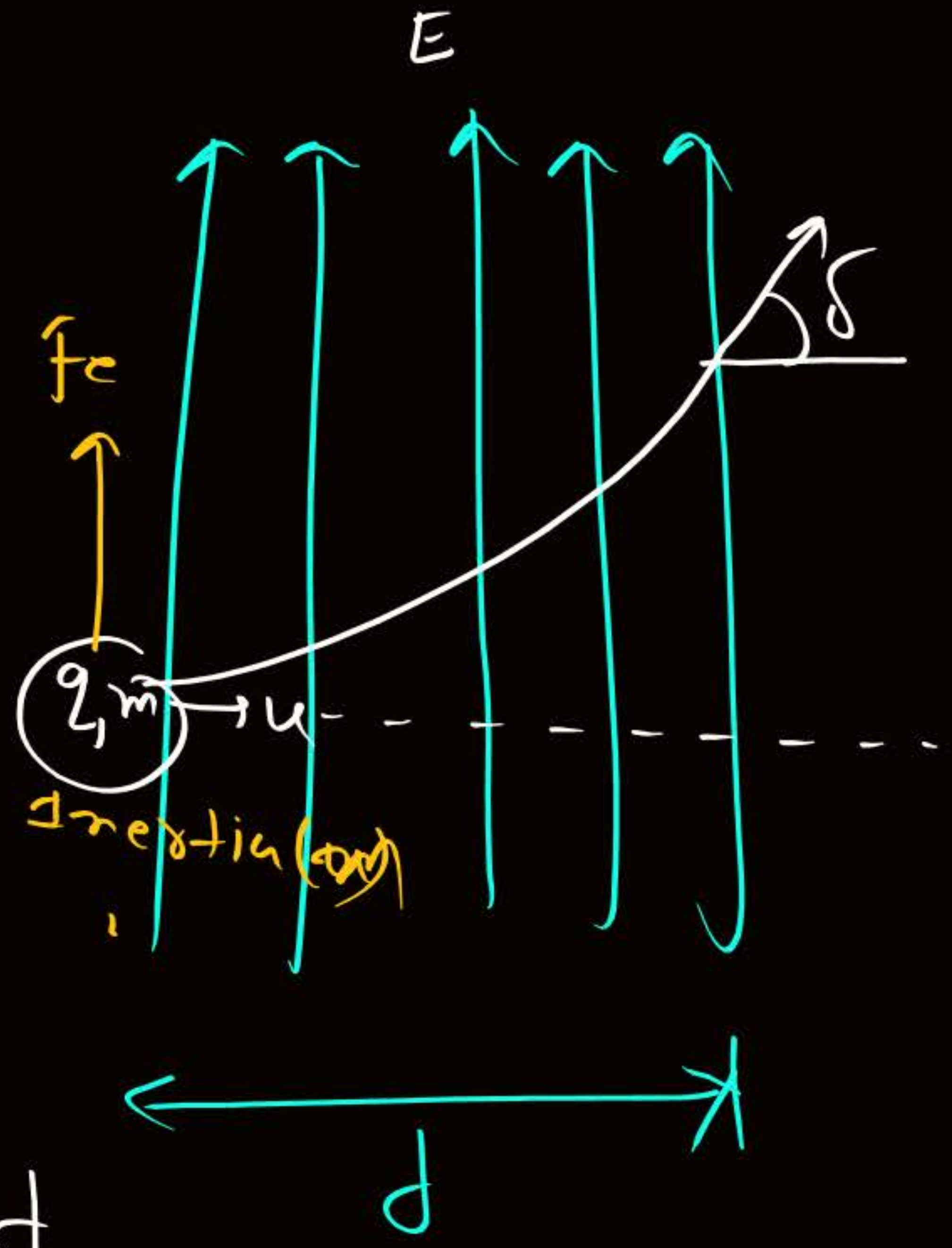
$\tan\delta \propto d$

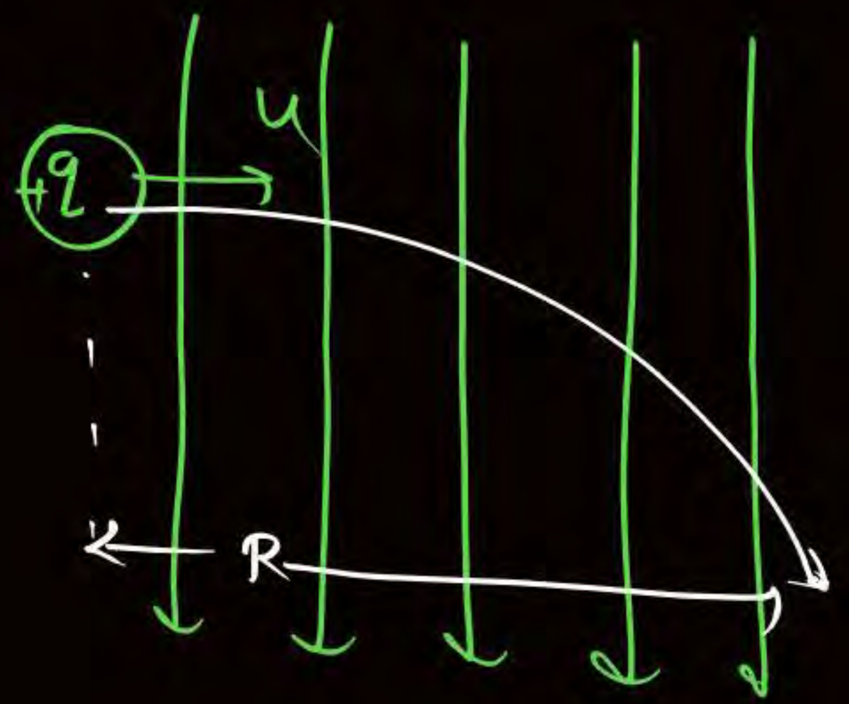
$\tan\delta \propto q$

$\tan\delta \propto E$

$\tan\delta \propto \frac{1}{u}$

$\tan\delta \propto \frac{1}{m}$





+q
u
R

QUESTION

In a uniform electric field if a charge is fired in a direction different from the line of electric field then the trajectory of the charge will be a

1. Straight line
2. Circle
3. Parabola
4. Ellipse

QUESTION

A positively charged pendulum is oscillating in a uniform electric field pointing upwards. Its time period as compared to that when it oscillates without electric field

1. Is less
2. Is more
3. Remains unchanged
4. Starts fluctuating

QUESTION

Two equal positive charges Q are fixed at points $(a, 0)$ and $(-a, 0)$ on the x-axis. An opposite charge -9 at rest is released from point $(0, a)$ on the y-axis. The charge -9 will

1. Move to infinity
2. Move to origin and rest there
3. Undergo SHM about the origin
4. Execute oscillatory periodic motion but not SHM

QUESTION

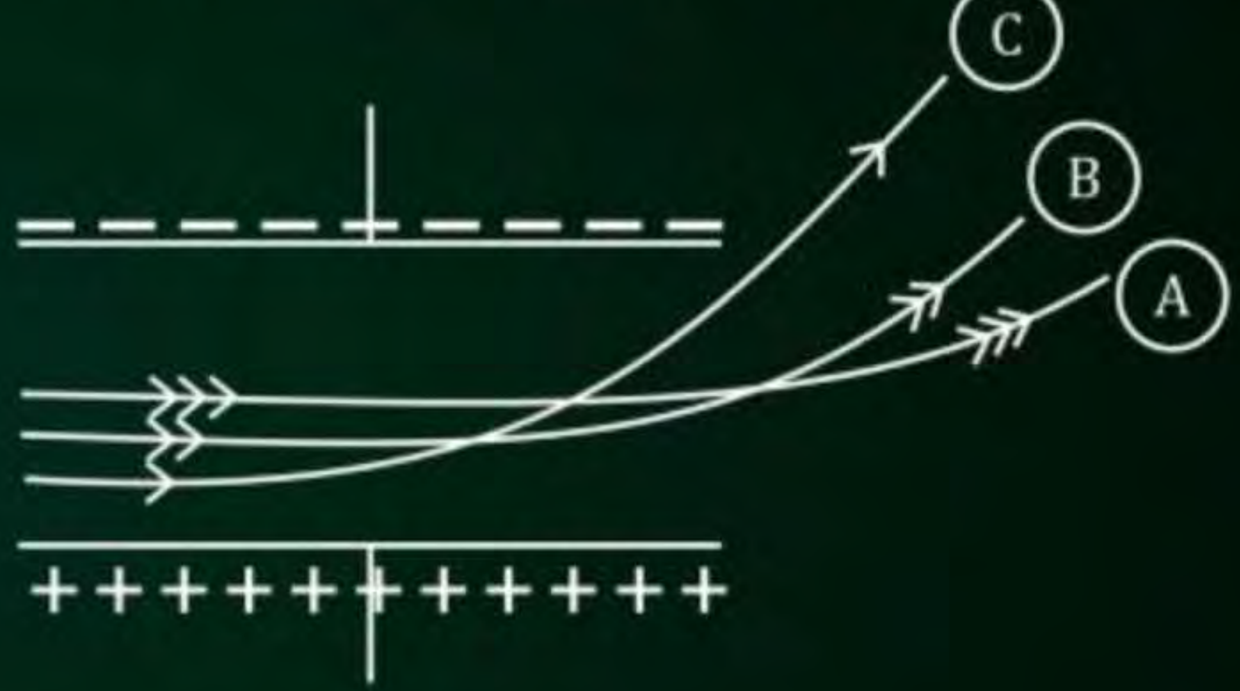
A proton and an α particle having equal kinetic energy are projected in a uniform transverse electric field as shown in figure



1. Proton trajectory is more curved
2. α particle trajectory is more curved
3. Both trajectories are equally curved but in opposite direction
4. Both trajectories are equally curved and in same direction

QUESTION

Three particles are projected in a uniform electric field with same velocity perpendicular to the field as shown. Which particle has highest charge to mass ratio?



1. A
2. B
3. C
4. All have same charge to mass ratio

QUESTION

A particle of mass m and charge q is thrown at a speed u against a uniform electric field E. How much distance will it travel before coming to rest?

1. $mu^2/2q\mathrm{E}$
2. $2mu^2/q\mathrm{E}$
3. $mq\mathrm{E}/2u^2$
4. $mu/q\mathrm{E}$

QUESTION

If electron and proton released in electric field find ratio of momentum after time 't'.

QUESTION

If electron and proton are released in electric field then find ratio of K.E. after distance x

QUESTION

A toy car with charge q moves on a frictionless horizontal plane surface under the influence of a uniform electric field $\vec{E}$. Due to the force $q\vec{E}$, its velocity increases from 0 to 6 m/s in one second duration. At that instant the direction of the field is reversed. The car continues to move for two more seconds under the influence of this field. The average velocity and the average speed of the toy car between 0 to 3 seconds are respectively [NEET-2018]

1. 2 m/s, 4 m/s
2. 1 m/s, 3 m/s
3. 1.5 m/s, 3 m/s
4. 1 m/s, 3.5 m/s

QUESTION

An electron falls from rest through a vertical distance h in a uniform and vertically upward directed electric field E. The direction of electric field is now reversed, keeping its magnitude the same. A proton is allowed to fall from rest in it through the same vertical distance h. The time of fall of the electron, in comparison to the time of fall of the proton is [NEET-2018]

1. Smaller
2. 5 times greater
3. Equal
4. 10 times greater

QUESTION

A particle of mass m and charge q is placed at rest in a uniform electric field E and then released. The kinetic energy attained by the particle after moving a distance y is

1. qEy
2. qE^2y
3. qEy^2
4. q^2Ey


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Syllabus Overview

Physics	Chemistry	Botany	Zoology
Basic Maths & Calculus (Mathematical Tools) Vectors Units and Measurements Motion in a straight line Motion in a plane Circular motion Laws of motion Circular Motion Work, energy and power Centre of mass and System of Particles Rotational Motion Gravitation Mechanical Properties of Solids	Some Basic Concept of Chemistry Redox Reaction Solutions Thermodynamics Equilibrium Electrochemistry Chemical Kinetics Structure of Atom Classification of Elements and Periodicity in Properties Chemical Bonding and Molecular Structure	Cell - The Unit of Life Cell Cycle and Cell Division The Living World Biological Classification Plant Kingdom Morphology of Flowering Plants Anatomy of Flowering Plants Respiration in Plants	Structural Organization in Animals Breathing and Exchange of Gases Body Fluids and Circulation Excretory Products & their Elimination Locomotion & Movement Neural Control & Coordination

REAL TEST

Glimpses of Previous Real Test




THANK YOU

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FOR NEET 2025

Lecture- 10 | Physics

Electric Charges and Fields

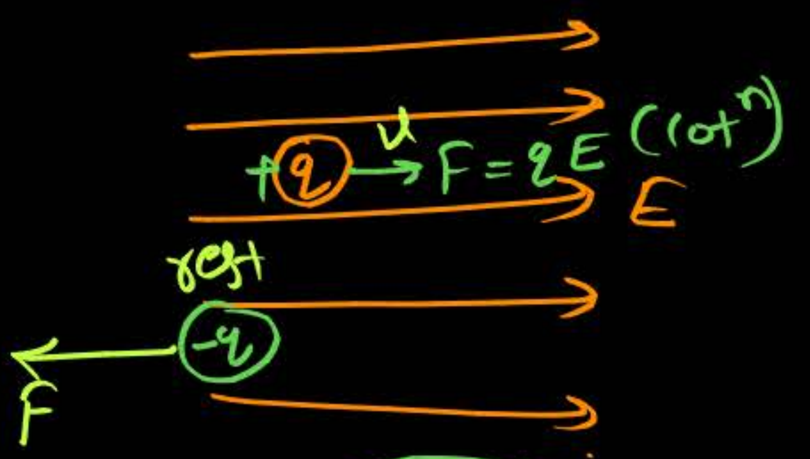
By- Dr. Manish Raj (MR SIR)



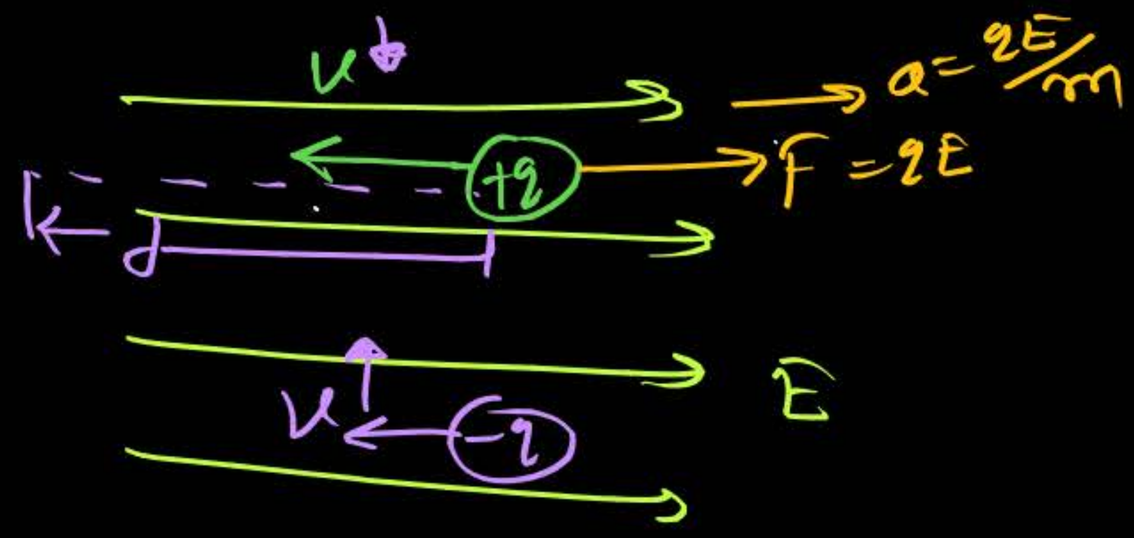
Topics to be covered

1. # Electric dipole
   Field due to electric dipole
2. #
3. #





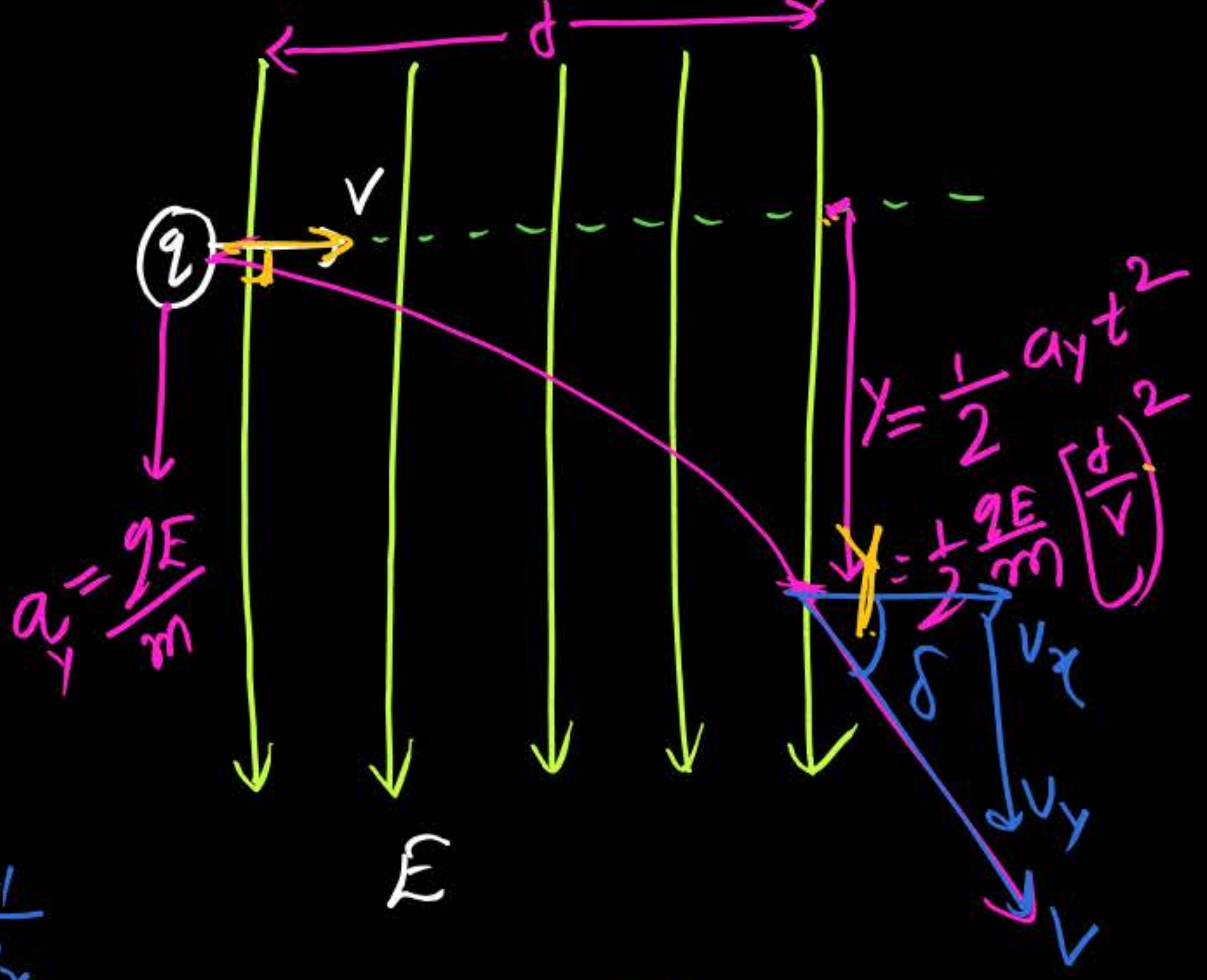
$$a = \frac{qE}{m}$$ (Col^n)



$$d = \frac{u^2}{2a} = \frac{u^2}{2\left(\frac{qE}{m}\right)}$$

$d = vt$ — (1)

$a_x = 0$
$v_x = v$



$$y = \frac{1}{2} a_y t^2$$

$$y = \frac{1}{2} \frac{qE}{m} \left(\frac{d}{v}\right)^2$$

$$a_y = \frac{qE}{m}$$

–ve charge

$F = qE$

$$a = \frac{qE}{m}$$

$$\tan\delta = \frac{v_y}{v_x} = \frac{a_y t}{v_x} = \frac{qEt}{mv} = \frac{qEd}{mv^2}$$ fool

QUESTION

In a uniform electric field if a charge is fired in a direction different from the line of electric field then the trajectory of the charge will be a

1. Straight line
2. Circle
3. Parabola
4. Ellipse

QUESTION

A positively charged pendulum is oscillating in a uniform electric field pointing upwards. Its time period as compared to that when it oscillates without electric field

1. Is less
2. Is more ✓ 58%
3. Remains unchanged
4. Starts fluctuating



$T = 2\pi\sqrt{\frac{l}{g}}$ ✓

$T = 2\pi\sqrt{\frac{l}{\left(g - \frac{qE}{m}\right)}}$

QUESTION

Proton, deuteron and α-particle projected in electric field. Perpendicular to it, then find ratio of deviation if:

(a) Velocity of projection is same

(b) K.E. of projection same

(c) Projected with same momentum

(a) $\delta_p : \delta_D : \delta_\alpha = \frac{e}{m_p} : \frac{e}{2m_p} : \frac{2e}{4m_p}$

$= 1 : \frac{1}{2} : \frac{1}{2}$

$= 2 : 1 : 1$ (Ans)

$\tan\delta = \frac{qEd}{mu^2}$ → same

$\tan\delta \propto \delta \propto \frac{q}{m}$

(b) $\tan\delta = \frac{qEd}{2 \times \frac{1}{2} mu^2}$

$\delta \propto q$ (charge)

$\delta_p : \delta_D : \delta_\alpha = e : e : 2e$

$= 1 : 1 : 2$

(c) $\tan\delta = \left[\frac{qEd}{mu^2}\right] \times \frac{m}{m}$

$= \frac{qEdm}{p^2}$ (same)

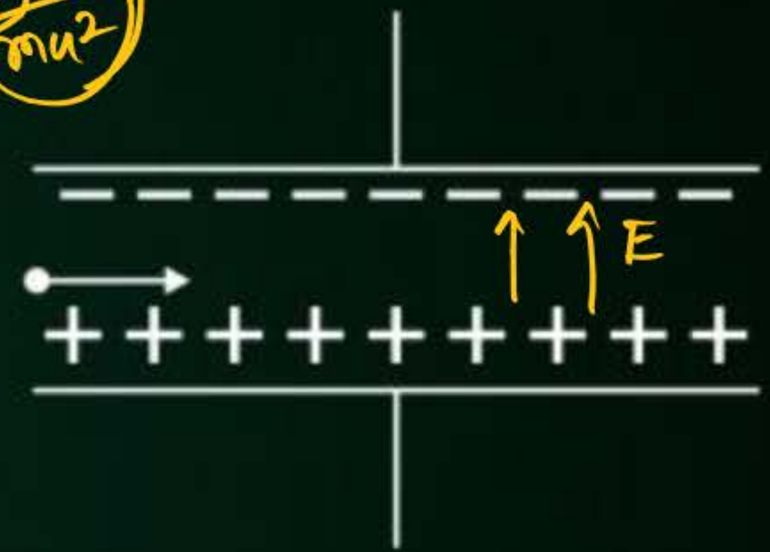
$\delta \propto qm$

$\delta_p : \delta_D : \delta_\alpha = em : 2em : 8me$

$= 1 : 2 : 8$

QUESTION

A proton and an α particle having equal kinetic energy are projected in a uniform transverse electric field as shown in figure



1. Proton trajectory is more curved
2. α particle trajectory is more curved
3. Both trajectories are equally curved but in opposite direction
4. Both trajectories are equally curved and in same direction

QUESTION

Three particles are projected in a uniform electric field with same velocity perpendicular to the field as shown. Which particle has highest charge to mass ratio?



1. A
2. B
3. C
4. All have same charge to mass ratio

QUESTION

A particle of mass m and charge q is thrown at a speed u against a uniform electric field E. How much distance will it travel before coming to rest?

1. $mu^2/2qE$ 83%
2. $2mu^2/qE$
3. $mqE/2u^2$
4. mu/qE

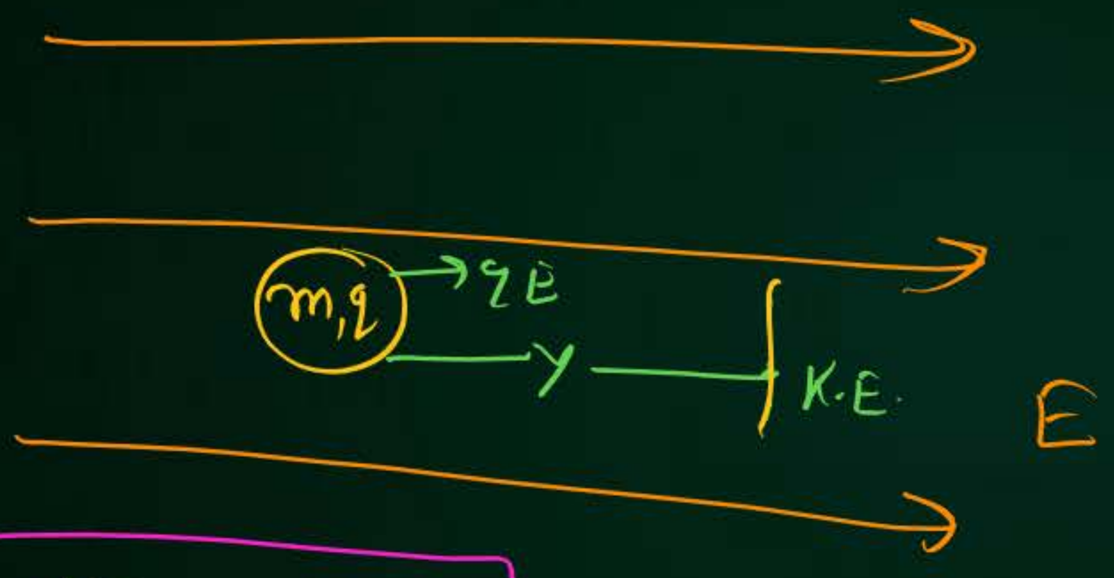


$$S = \frac{u^2}{2\left(\frac{qE}{m}\right)} = \frac{mu^2}{2qE}$$

QUESTION

A particle of mass m and charge q is placed at rest in a uniform electric field E and then released. The kinetic energy attained by the particle after moving a distance y is

1. qEy Ans
2. qE^2y
3. qEy^2
4. q^2Ey



$\Delta K.E = Work$

$K.E_f = qEy$

$F = qE$

$a = \frac{qE}{m}$

$v_f^2 - v_i^2 = 2as$

$v_f^2 = 2ay$

$K.E = \frac{1}{2}mv^2$

$= \frac{1}{2}m\,2ay$

$= may$

$= m\frac{qE}{m}y = qEy$

QUESTION

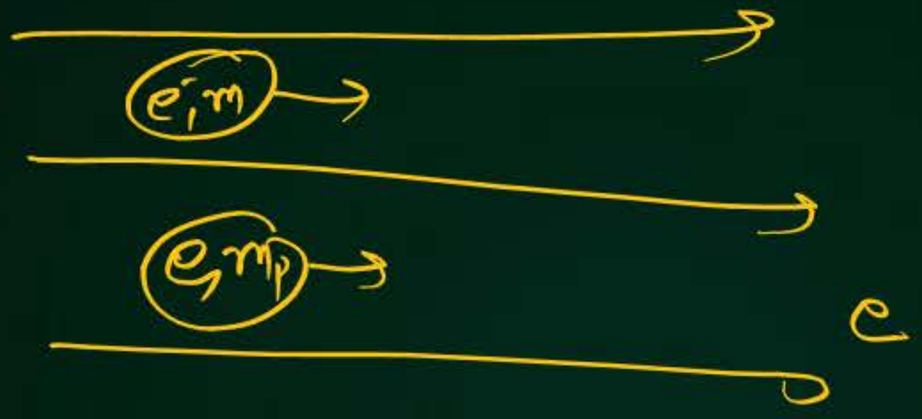
If electron and proton released in electric field find ratio of momentum after time 't'.

(a) 1 : 1 (67%)

(b) $m_p : m_e$

(c) $m_e : m_p$

(d) $\sqrt{m_e} : \sqrt{m_p}$



$\Delta p = F \cdot \Delta t$

$p_f - p_i = F t$ ($p_i = 0$)

$p_f = eEt$

QUESTION

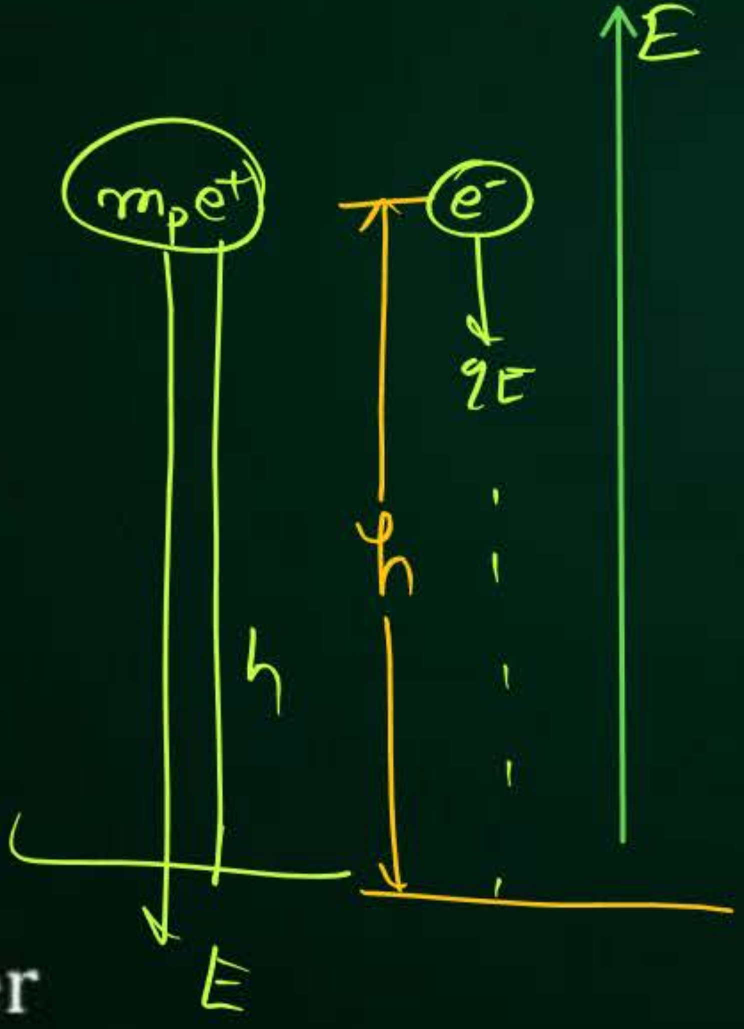
If electron and proton are released in electric field then find ratio of K.E. after distance x

1 : 1 Ans.

QUESTION

An electron falls from rest through a vertical distance h in a uniform and vertically upward directed electric field E. The direction of electric field is now reversed, keeping its magnitude the same. A proton is allowed to fall from rest in it through the same vertical distance h. The time of fall of the electron, in comparison to the time of fall of the proton is

[NEET-2018]



1. Smaller
2. 5 times greater
3. Equal
4. 10 times greater

QUESTION

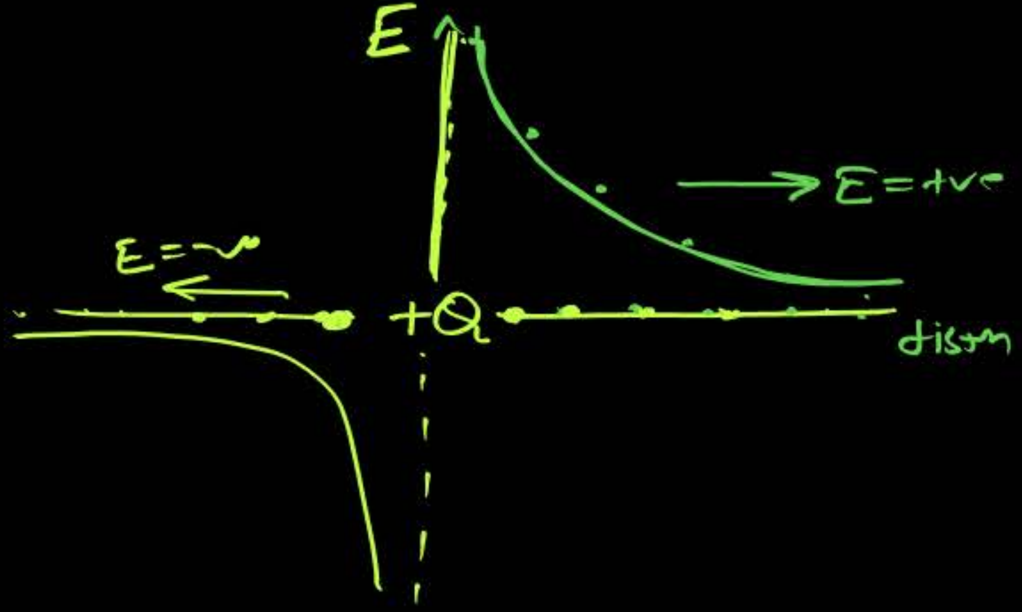
17/w
Kinematics

A toy car with charge q moves on a frictionless horizontal plane surface under the influence of a uniform electric field $\vec{E}$. Due to the force $q\vec{E}$, its velocity increases from 0 to 6 m/s in one second duration. At that instant the direction of the field is reversed. The car continues to move for two more seconds under the influence of this field. The average velocity and the average speed of the toy car between 0 to 3 seconds are respectively [NEET-2018]

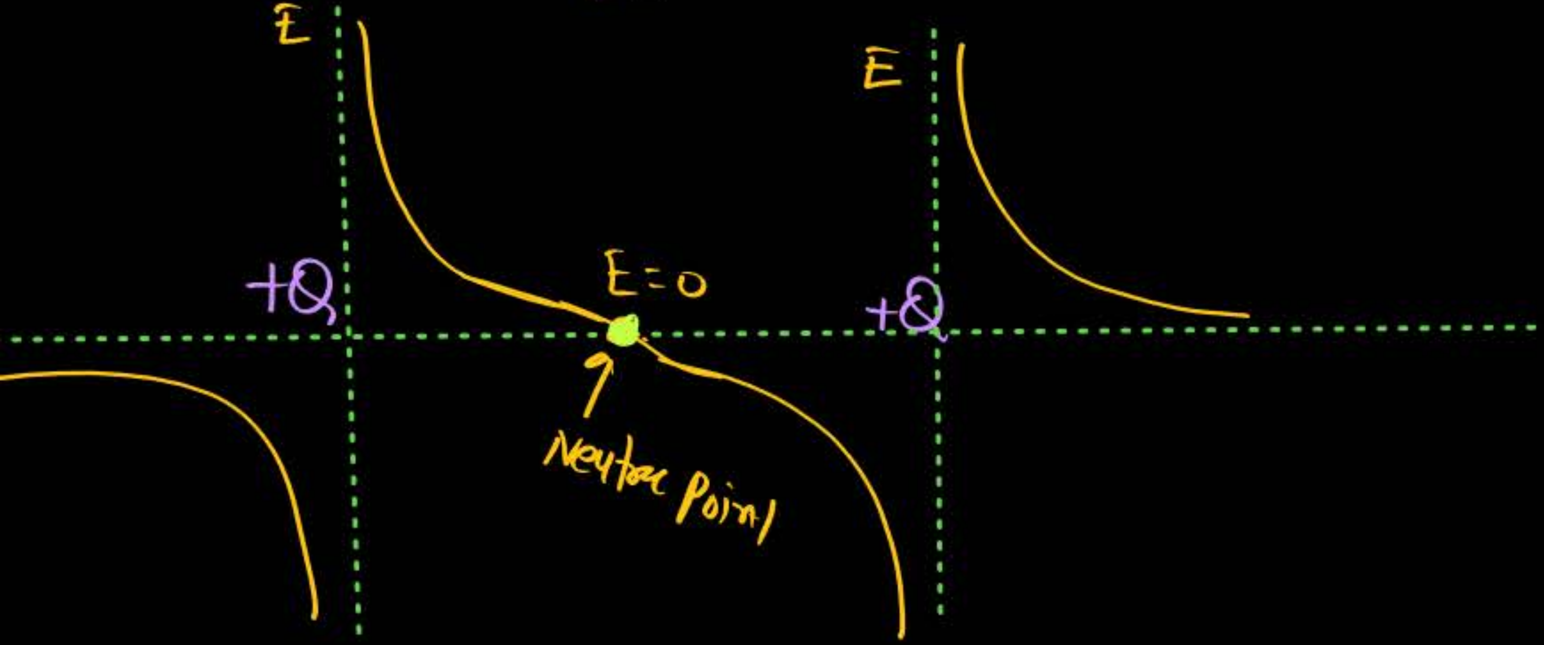
1. 2 m/s, 4 m/s
2. 1 m/s, 3 m/s
3. 1.5 m/s, 3 m/s
4. 1 m/s, 3.5 m/s

QUESTION

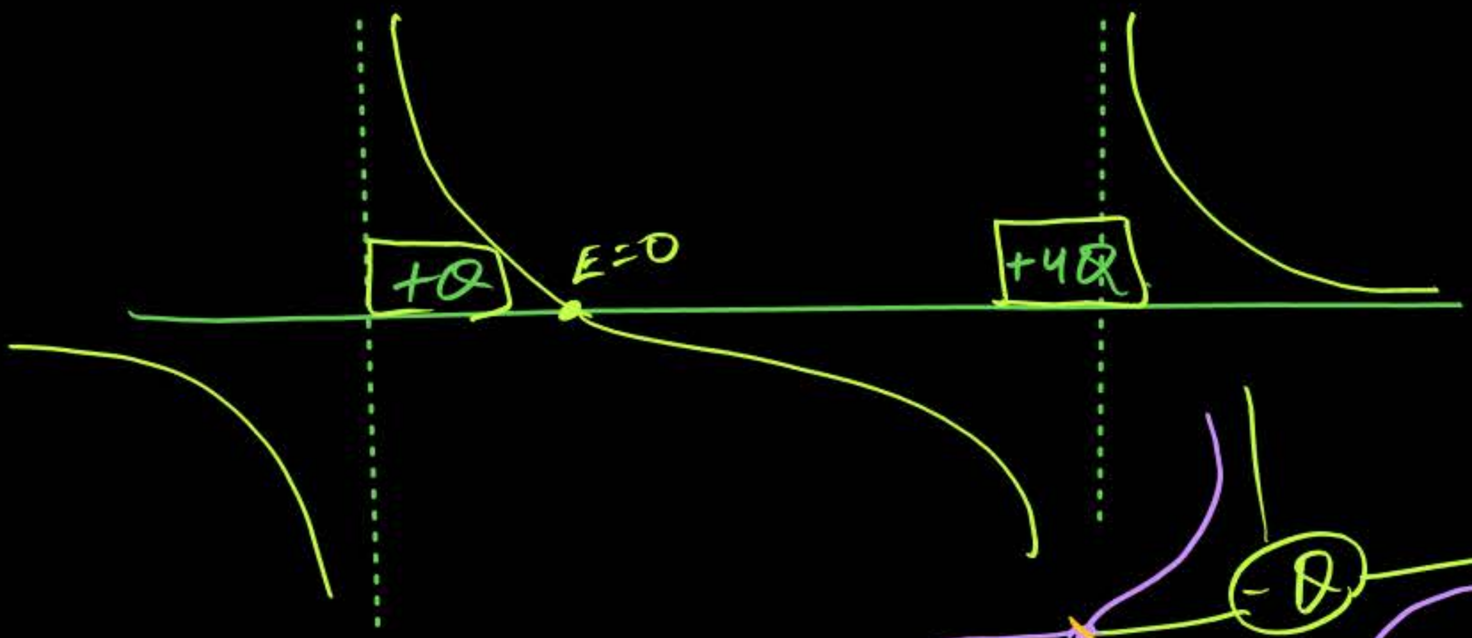
If electron and proton are released in electric field then find ratio of K.E. after distance x

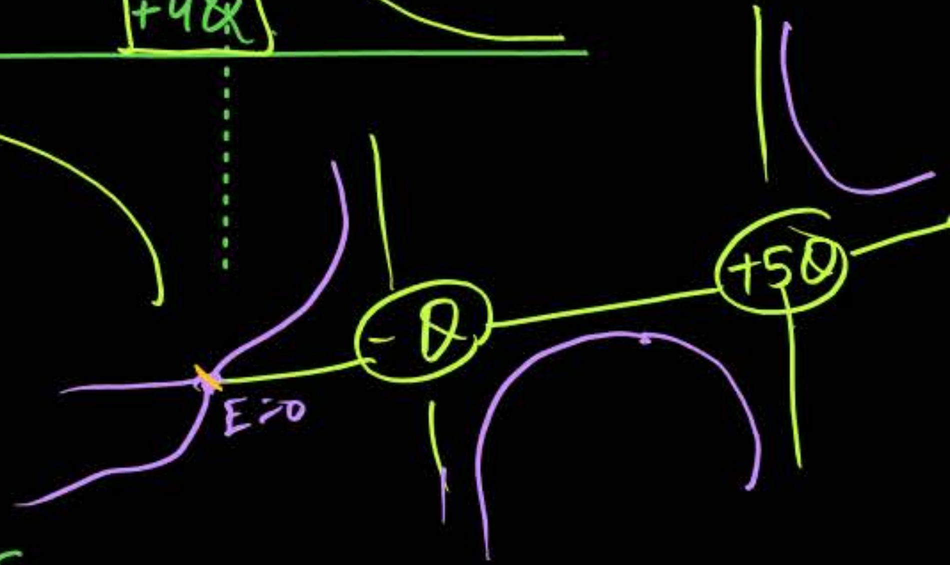


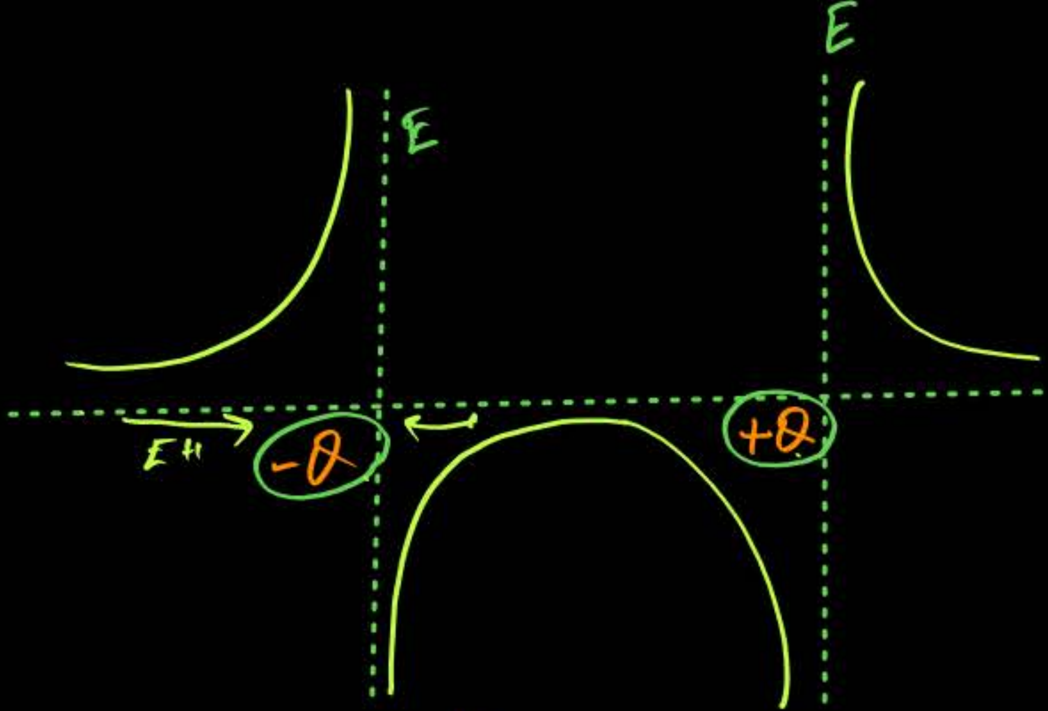
variation of electric field in x-axis.



☆ Not for NEET







[electric dipole]

ELECTRIC DIPOLE

\# Pair of equal and opposite charge q and $-q$ separated by a small distance 'r' then electric dipole moment is ql directed along $-q$ to $+q$.

$\vec{P} = q l$

dir^n ⇒ $-q$ to $+q$

$-q$ ←— r —→ $+q$

—————→ P

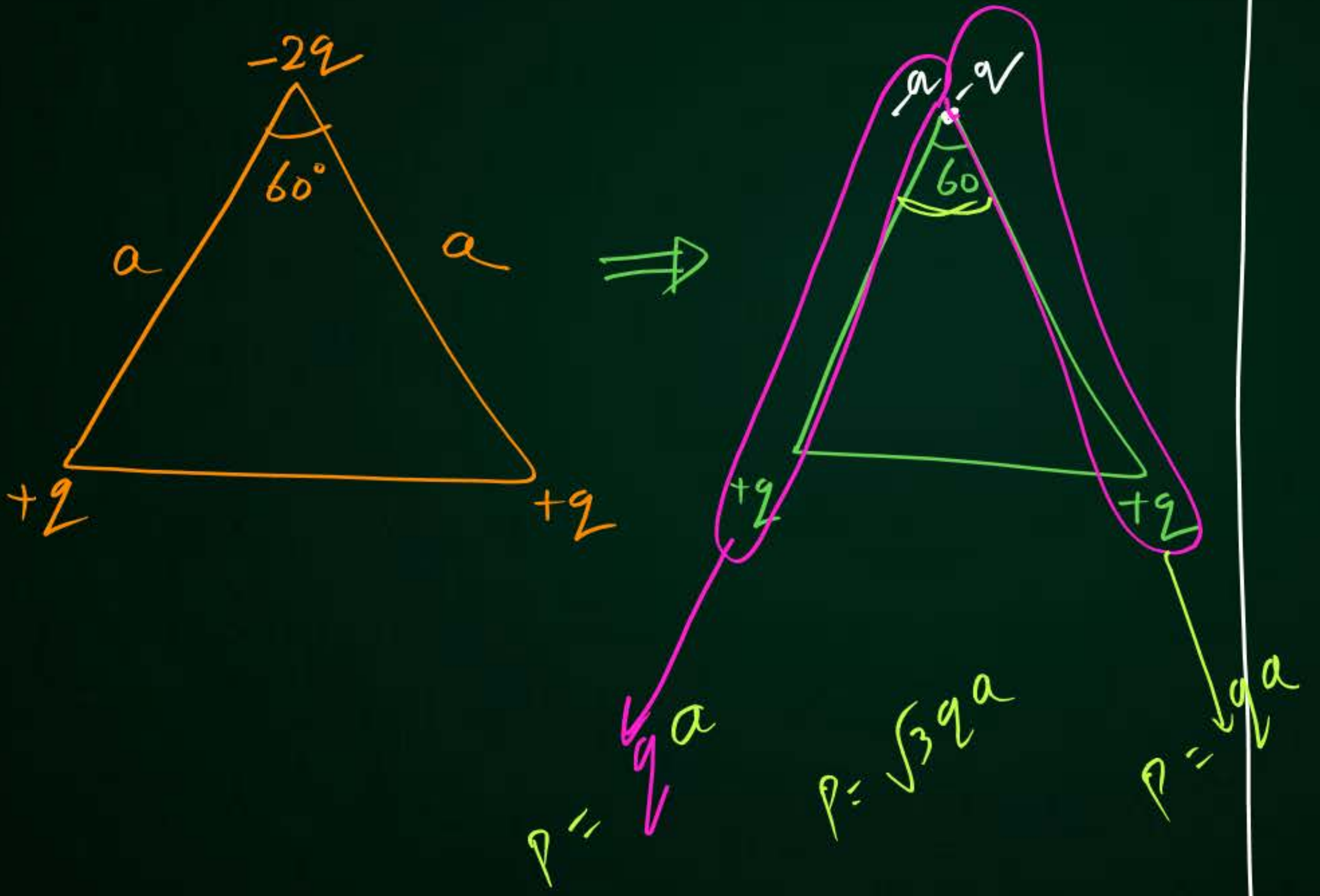
* Vector
* Unit (Coloumb-metre = C·m)
* Ideal dipole (≈ very-very small)

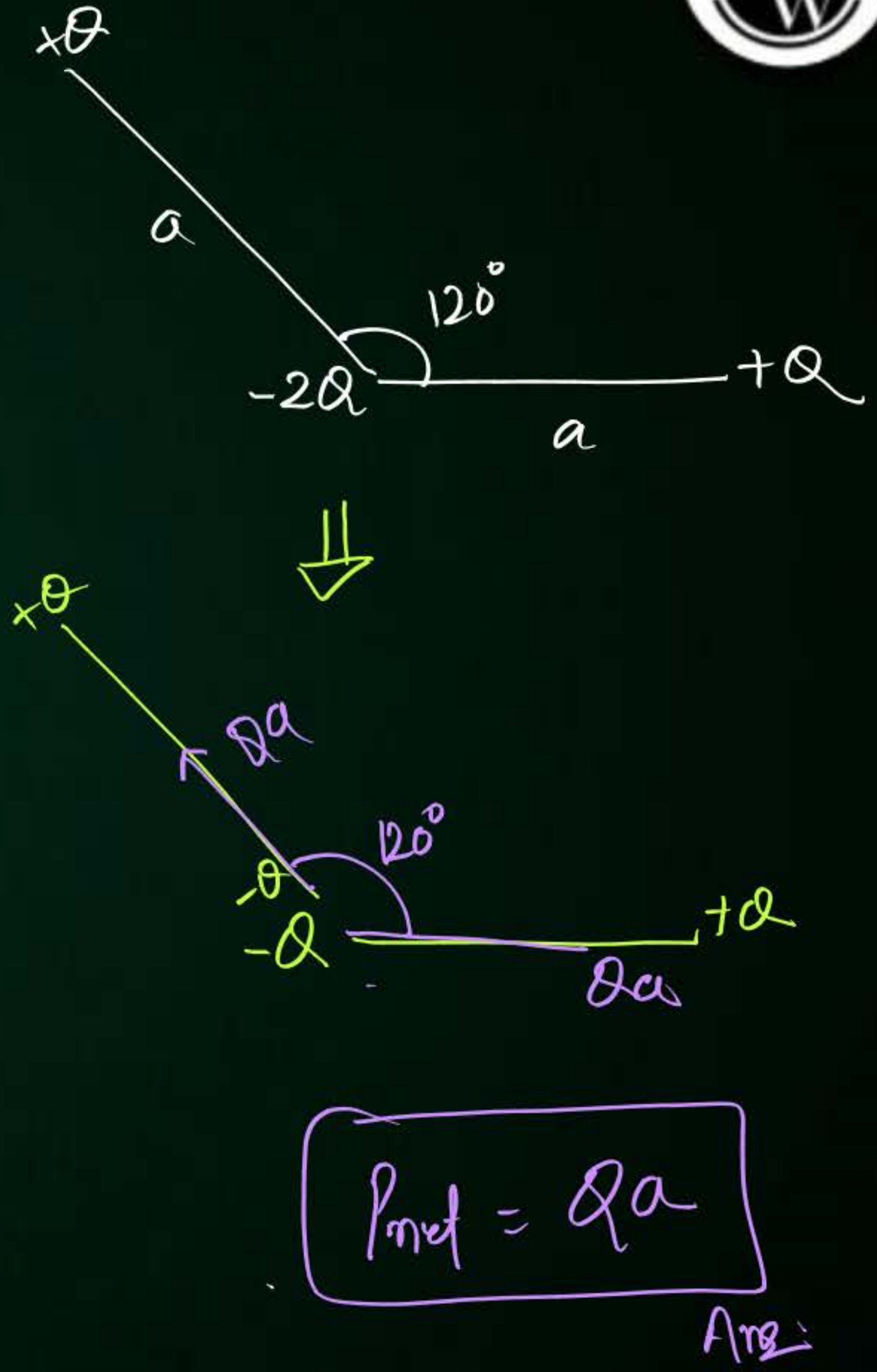
$-q$ ←— a —→ $+q$ $\quad$ $P = qa$

$-q$ ←— $2a$ —→ $+q$ $\quad$ $P = 2qa$

$\vec{P}$ = (magnitude of charge) × dist^n b/w the charge

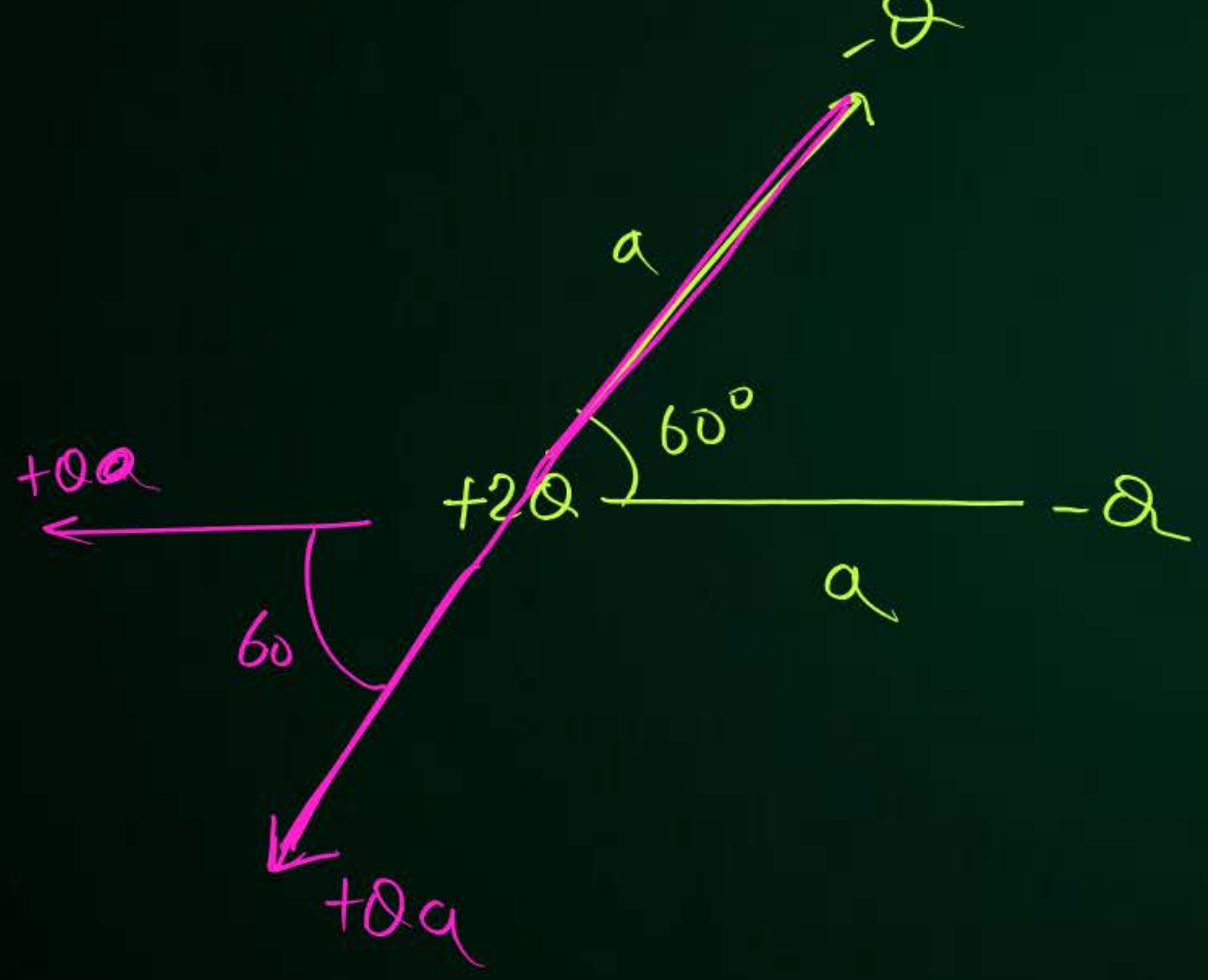
NET ELECTRIC DIPOLE MOMENT





QUESTION

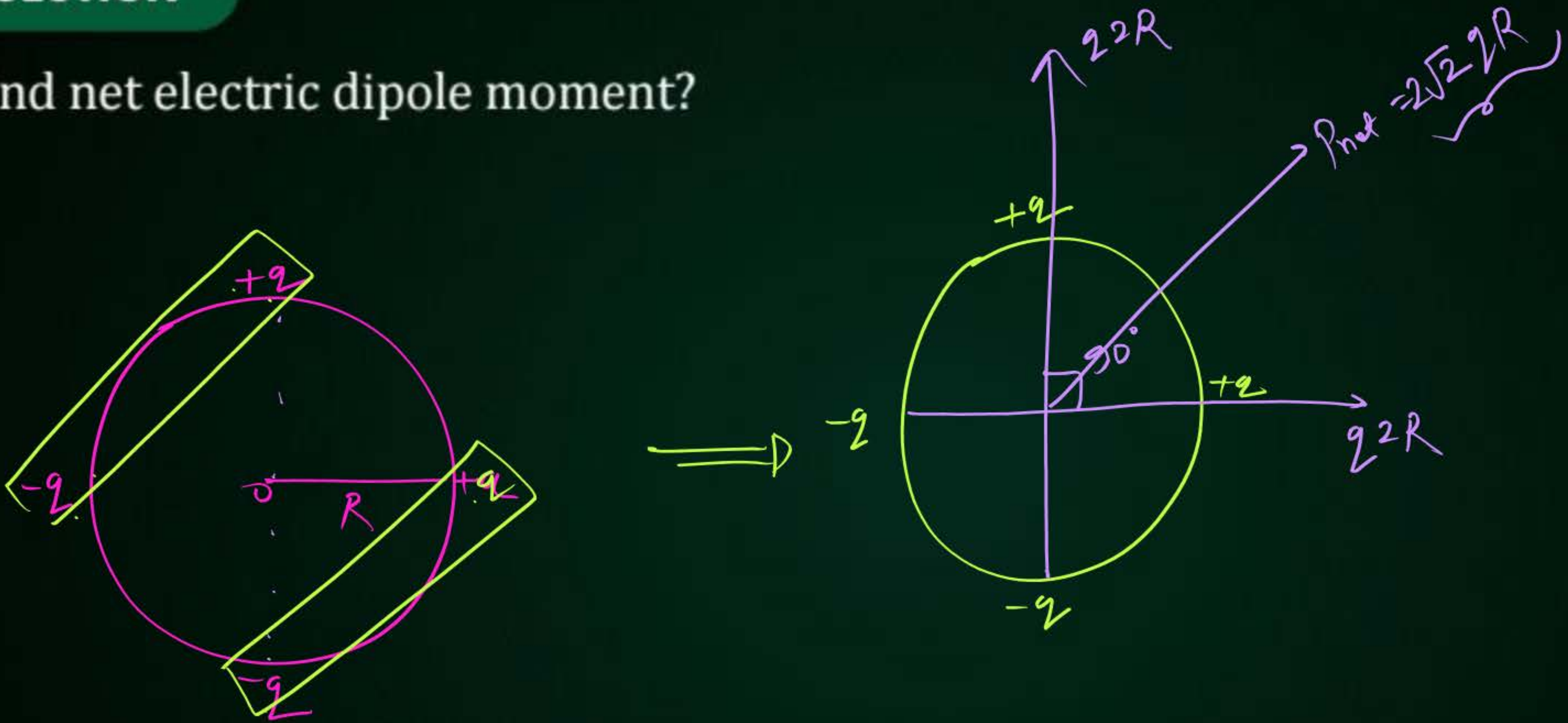
Find net electric dipole moment?



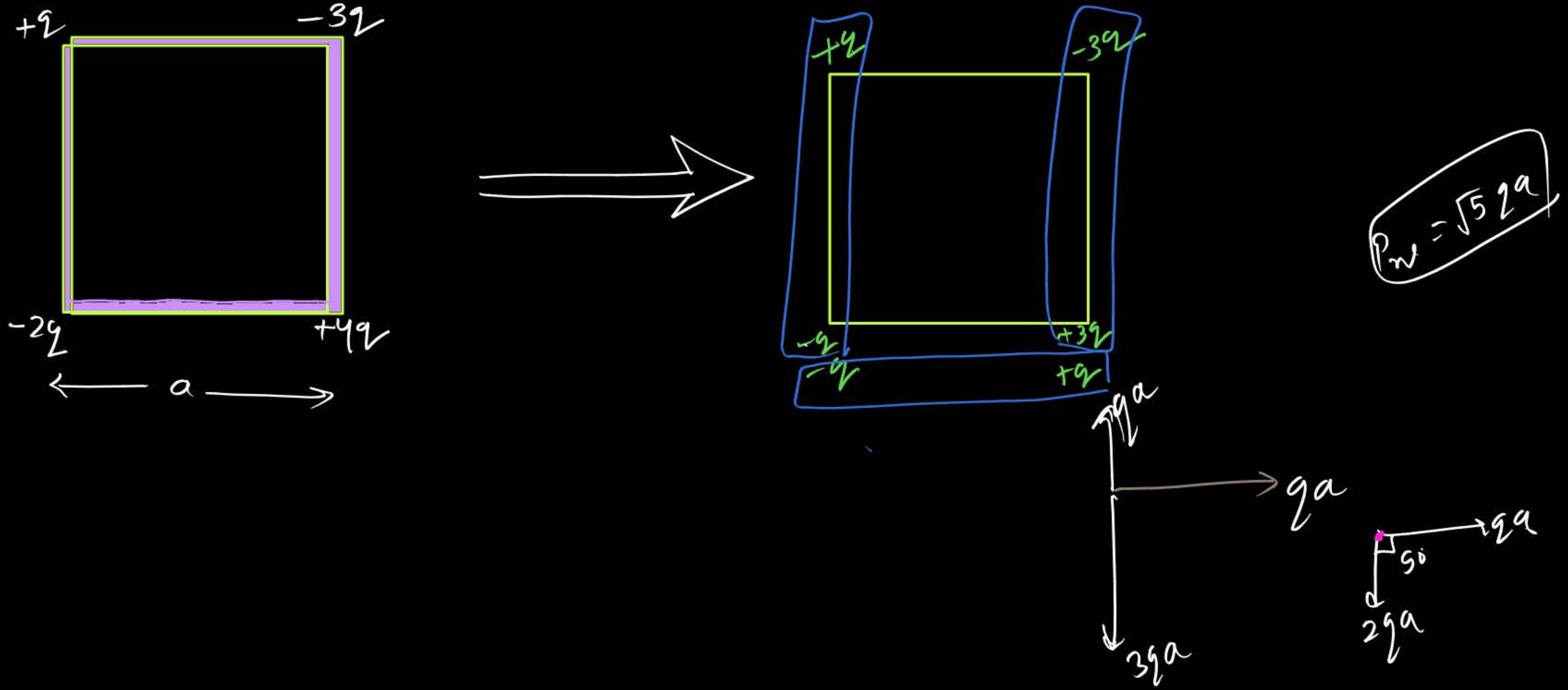
$p = \sqrt{3}Qa$

QUESTION

Find net electric dipole moment?



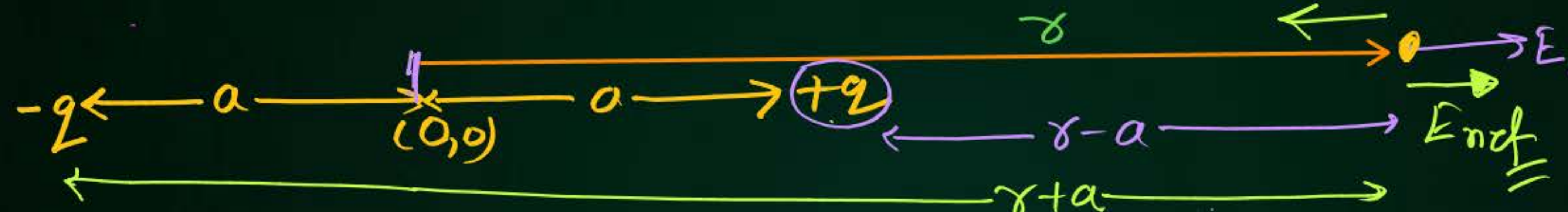
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ELECTRIC FIELD DUE TO DIPOLE on the axis of dipole

$P = q\,2a$ — (1)

$E_2 = \frac{Kq}{(r+a)^2}$



$\vec{E}_{net} = \vec{E}_1 + \vec{E}_2$

$= \frac{Kq}{(r-a)^2} - \frac{Kq}{(r+a)^2}$

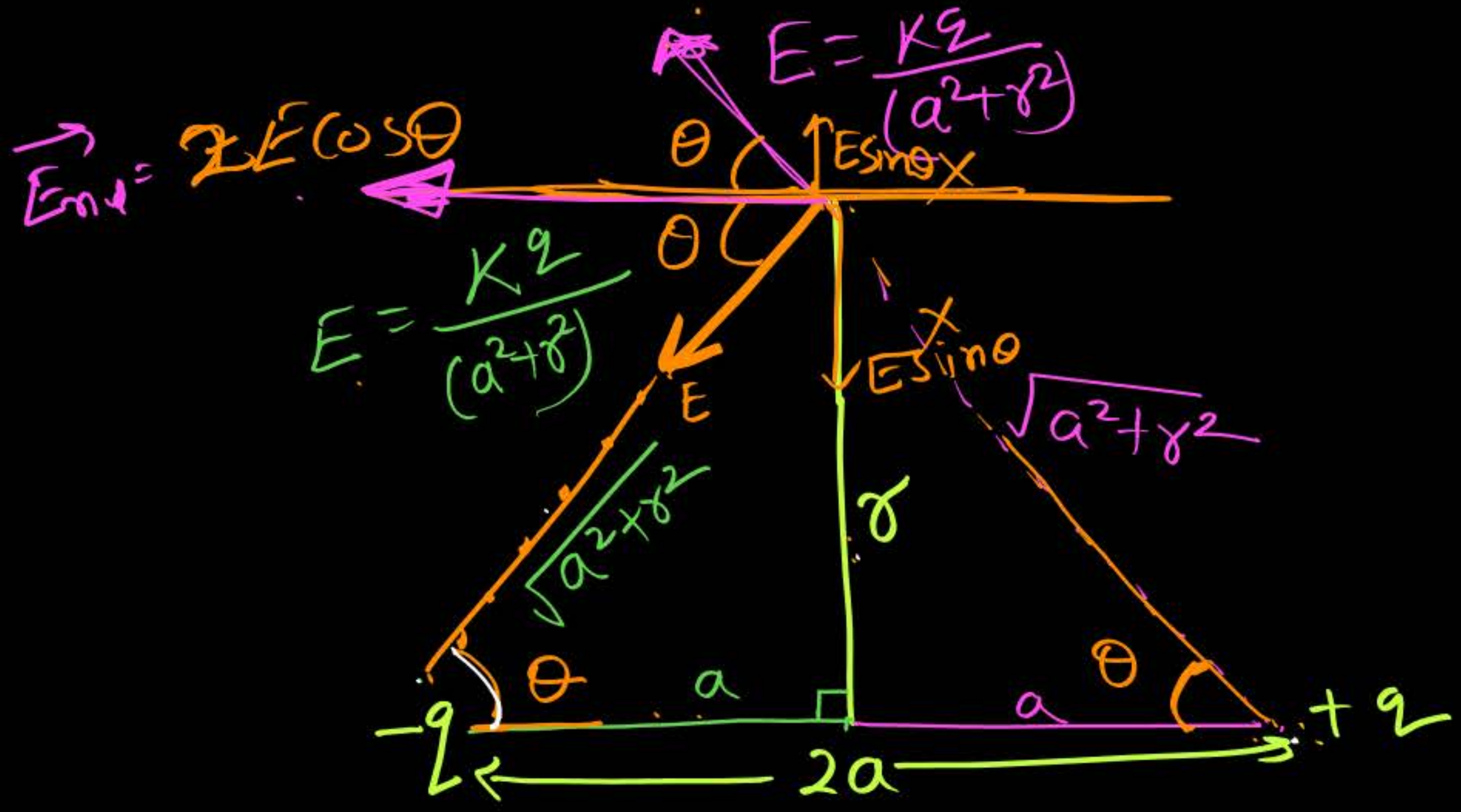
$= Kq\left[\frac{1}{(r-a)^2} - \frac{1}{(r+a)^2}\right] = Kq\left[\frac{(r+a)^2 - (r-a)^2}{(r^2-a^2)^2}\right] = Kq\left[\frac{r^2 + a^2 + 2ra - r^2 - a^2 + 2ra}{(r^2-a^2)^2}\right] = \frac{Kq(4ra)}{(r^2-a^2)^2}$

$E = \frac{KP2r}{(r^2-a^2)^2}$

Ideal dipole (small) $a <<< r$

$E = \frac{2KPr}{r^4} = \frac{2KP}{r^3}$

Electric field on the equitorial line of dipole



$$\cos\theta = \frac{a}{(a^2+r^2)^{1/2}}$$

$$p = q(2a)$$

$$E_{net} = 2E\cos\theta$$

$$= 2\frac{Kq}{(a^2+r^2)} \times \frac{a}{(a^2+r^2)^{1/2}}$$

$$E_{net} = \frac{2Kqa}{(a^2+r^2)^{3/2}}$$

$$E = \frac{Kp}{(a^2+r^2)^{3/2}}$$

Small dipole $(a << r)$

$$E = \frac{Kp}{r^3}$$

dirn.

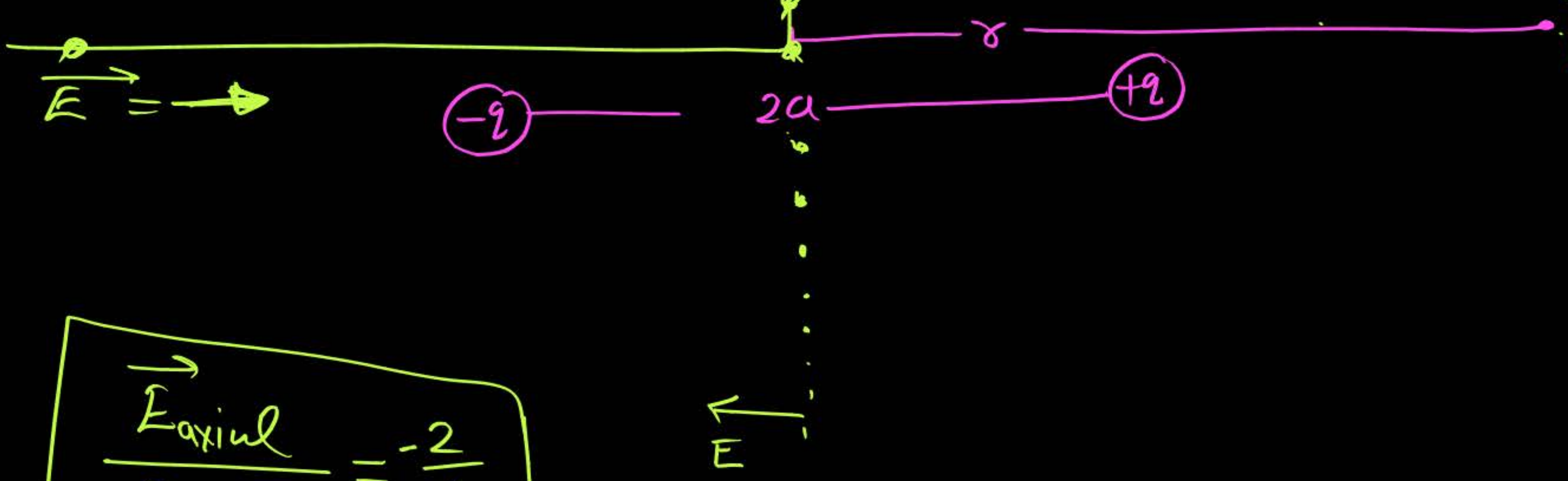
dirn of electric fied Anti parallel to the dipole moment

$$\vec{E} = \frac{-K\vec{p}}{r^3}$$

$$\vec{E}_{equatorial} = \frac{2kqa}{(a^2+r^2)^{3/2}}$$

$$= \frac{kp}{(a^2+r^2)^{3/2}}$$

$$\vec{E} = \frac{kp}{r^3}$$



$$\vec{E}_{axial} = \frac{4kqar}{(r^2-a^2)^2}$$

$$E = \frac{2kpr}{(r^2-a^2)^2}$$

$$\vec{E}_{axial} = \frac{2k\vec{p}}{r^3}$$

$$\frac{\vec{E}_{axial}}{\vec{E}_{equitr}} = \frac{-2}{1}$$

Ap

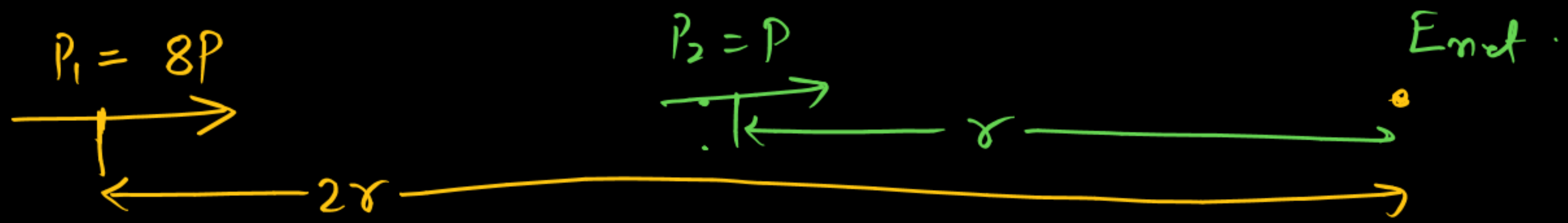


$$E_1 = \frac{2Kp}{r^3}$$

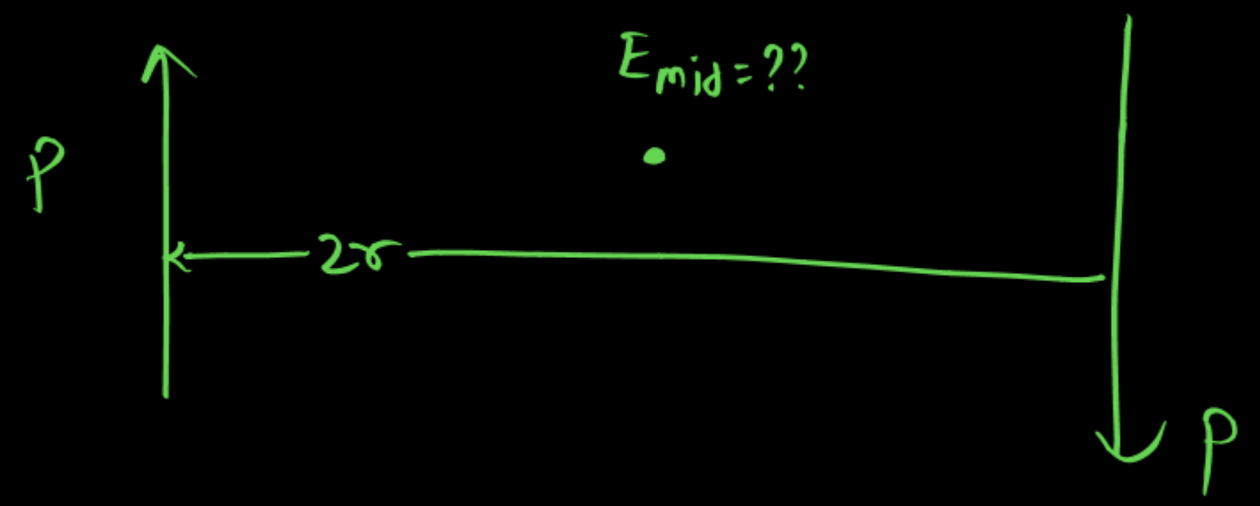
$$E_2 = \frac{Kp}{r^3}$$

$$E_{net} = \sqrt{E_1^2 + E_2^2}$$

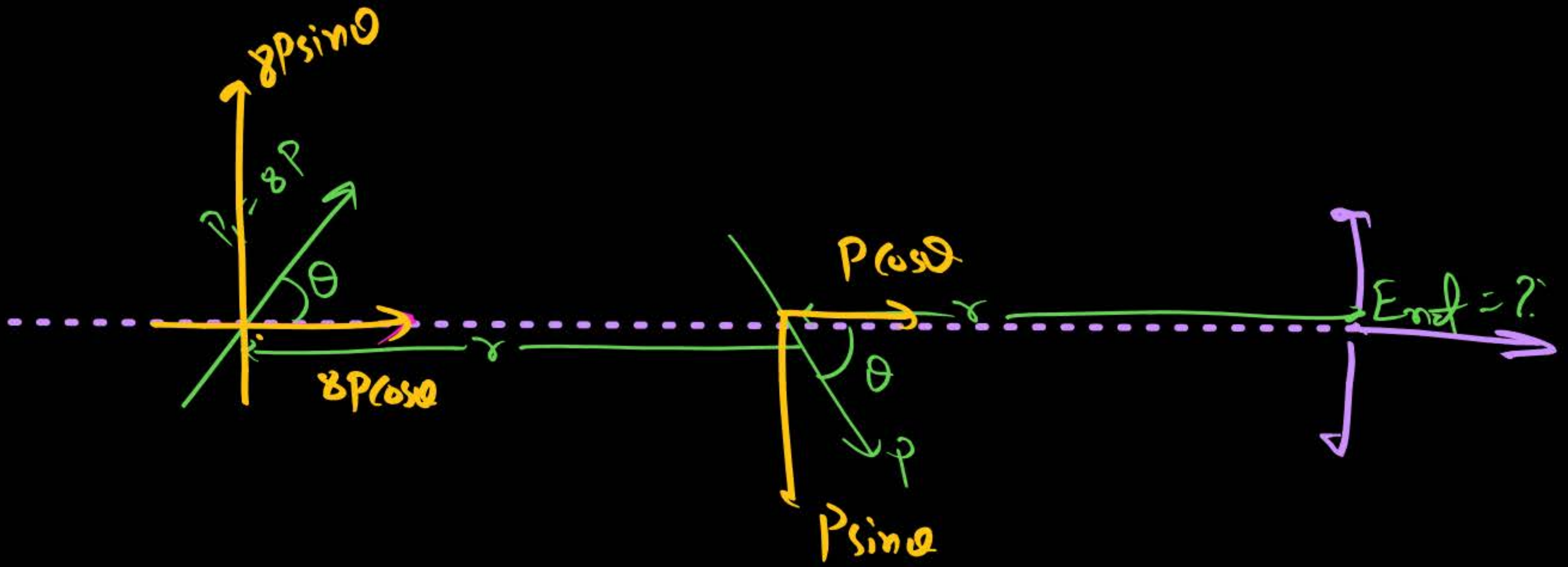
$$= \sqrt{5}\,\frac{K\vec{p}}{r^3}$$



$P_1 = 8P$
$P_2 = P$
E_{net}
r
$2r$



$E_{mid} = ??$
p
2r
p


8Psinθ
P = 8P
θ
8Pcosθ
r
Pcosθ
r
θ
P
Psinθ
Enet = ?

ELECTRIC FIELD DUE TO DIPOLE AT GENERAL POINT


THANK YOU

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FOR NEET 2025

Lecture- 11 | **Physics**

Electric Charges and Fields



By- Dr. Manish Raj (MR SIR)

Topics to be covered

1. # Questions on electric field due to dipole
2. #
3. #



Ideal dipole = Small dipole = a is not given *



$E_1 = \frac{2Kp}{r^3}$

$E_2 = \frac{Kp}{r^3}$

$E_{net} = \sqrt{E_1^2 + E_2^2}$

$= \sqrt{5}\,\frac{K\vec{p}}{r^3}$



$$\vec{E}_{net} = \frac{2KP}{r^3} + \frac{2K(8P)}{(2r)^3}$$

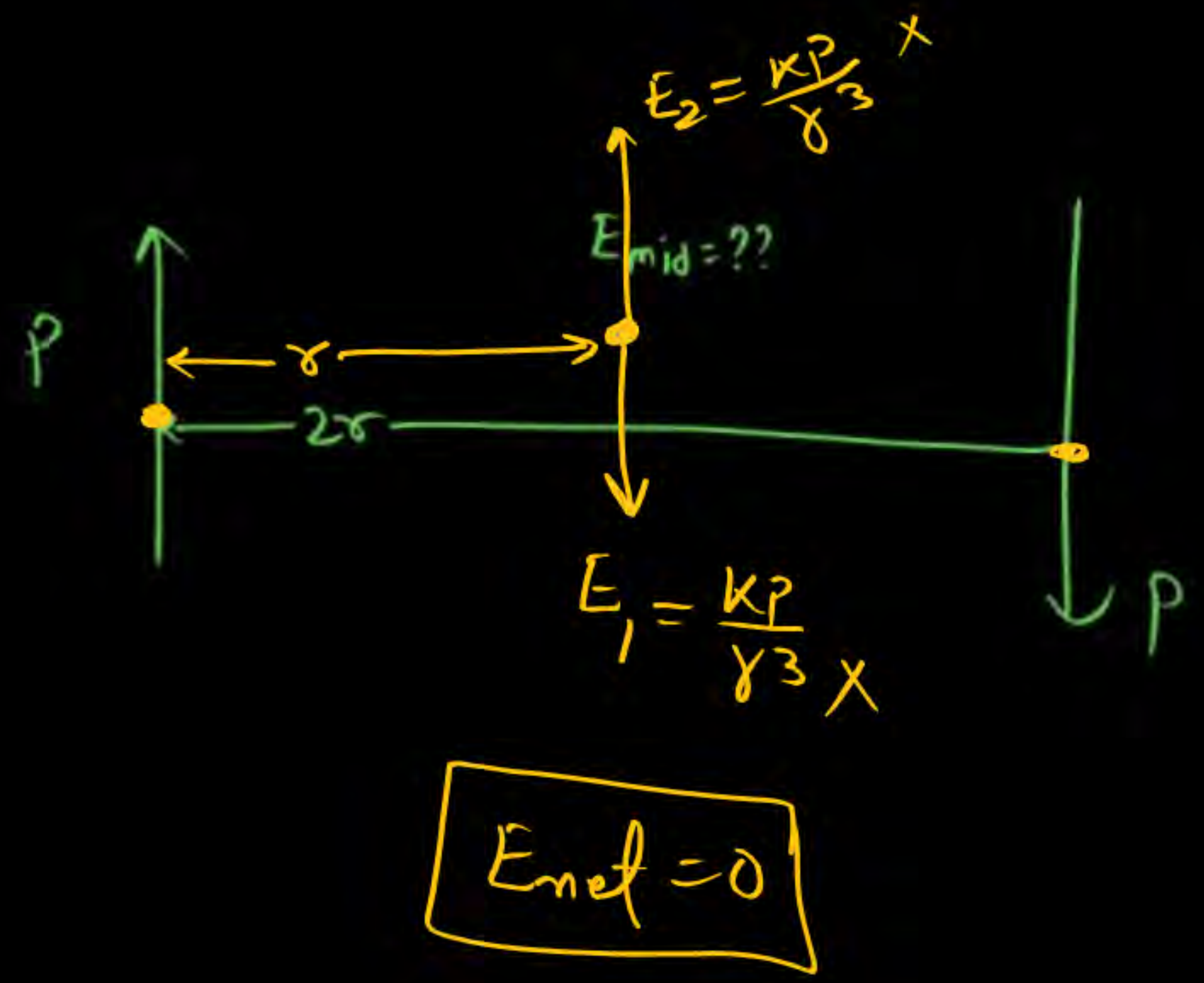
$$= \frac{2KP}{r^3} + \frac{2K8P}{8r^3}$$

$$= \frac{4KP}{r^3} \quad \text{Ans}$$

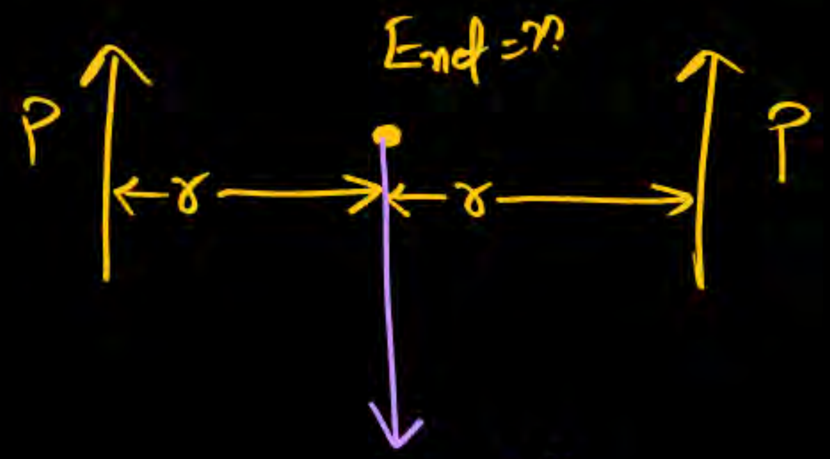


$$E_1 = \frac{2K8P}{(2r)^3} \qquad E_2 = \frac{2KP}{r^3}$$

$$\boxed{E_{net} = 0}$$



$E_2 = \frac{kp}{r^3}$ ✗
$E_{mid} = ??$
p
r
2r
p
$E_1 = \frac{kp}{r^3}$ ✗
$E_{net} = 0$



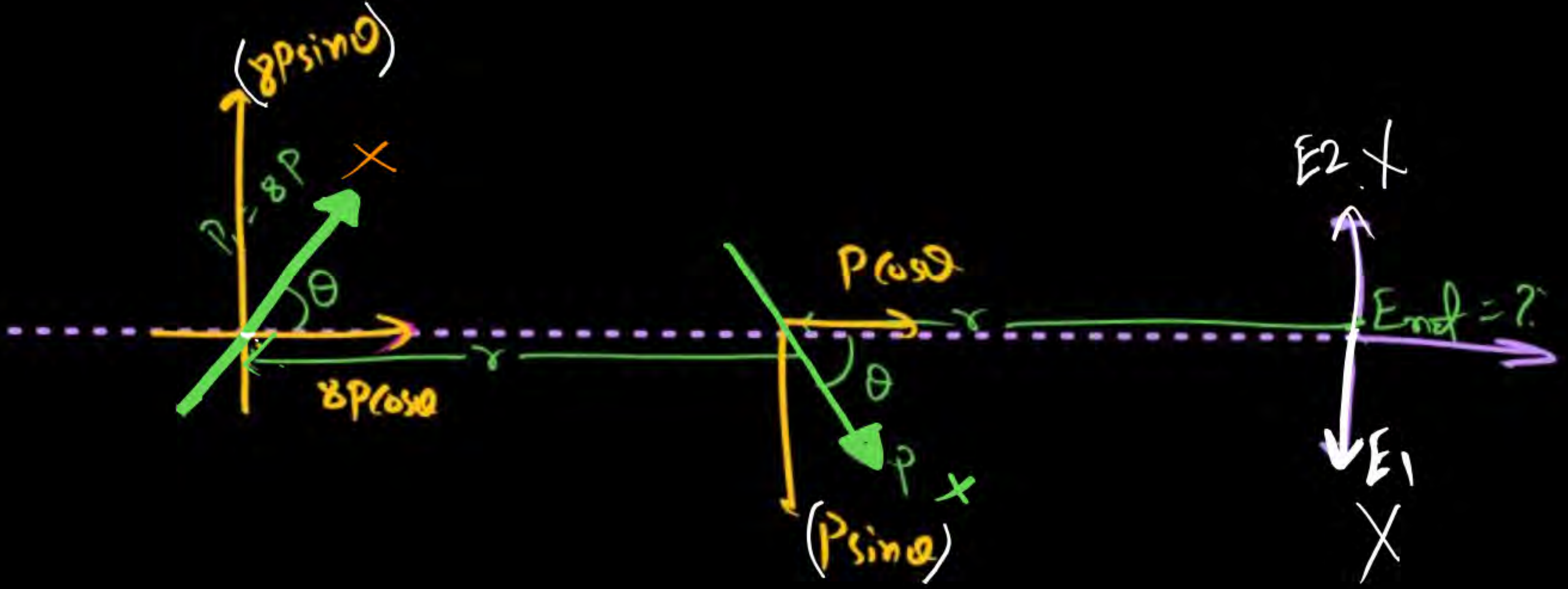
$$E_1 = \frac{kp}{r^3}$$

$$E_2 = \frac{kp}{r^3}$$

$$\vec{E}_{net} = -\frac{2kp}{r^3}\hat{j}$$

IIT-Adv



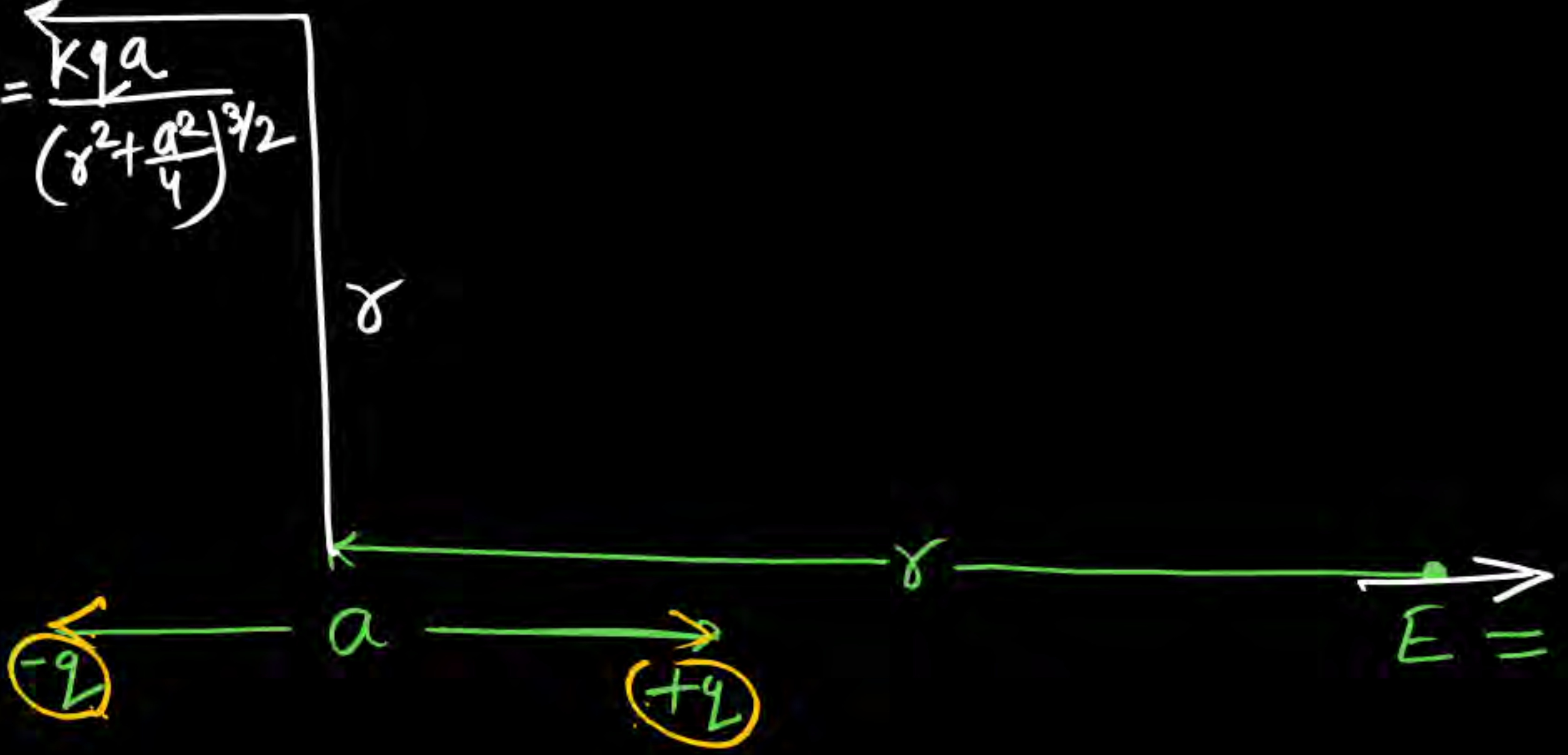


$$E_{net} = \frac{2KP\cos\theta}{r^3} + \frac{2K8P\cos\theta}{(2r)^3}$$

$$= \left[\frac{4KP\cos\theta}{r^3}\right]$$

Ans

$$E = \frac{kqa}{\left(r^2 + \frac{a^2}{4}\right)^{3/2}}$$



$$E = \frac{2kqar}{\left(r^2 - \frac{a^2}{4}\right)^2} \text{ Ans}$$

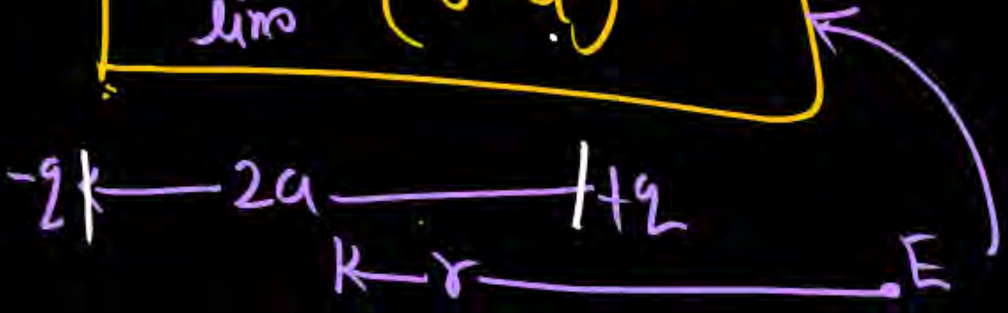
$$E = \frac{2kpr}{\left(r^2 - \frac{a^2}{4}\right)^2}$$

Small dipole $(r >>> a)$

$$E = \frac{2kp}{r^3}$$

$$E = \frac{4kqar}{(r^2 - a^2)^2}$$

axial line

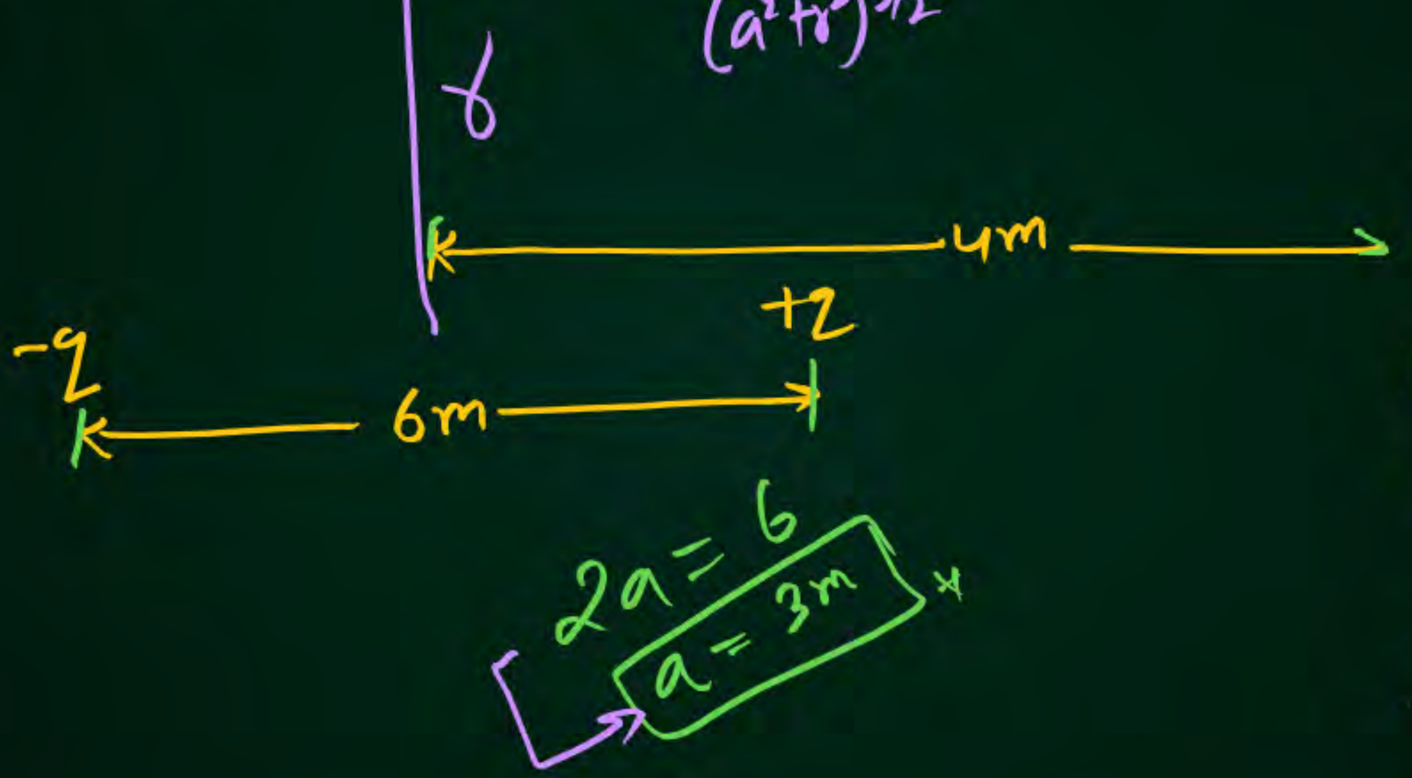


QUESTION

Two charges of $+25 \times 10^{-9}$ coulomb and -25×10^{-9} coulomb are placed 6m apart. Find the electric field intensity ratio at points 4m from the centre of the electric dipole (i) on axial line (ii) on equatorial line

1. $\frac{1000}{49}$
2. $\frac{49}{1000}$
3. $\frac{500}{49}$
4. $\frac{49}{500}$

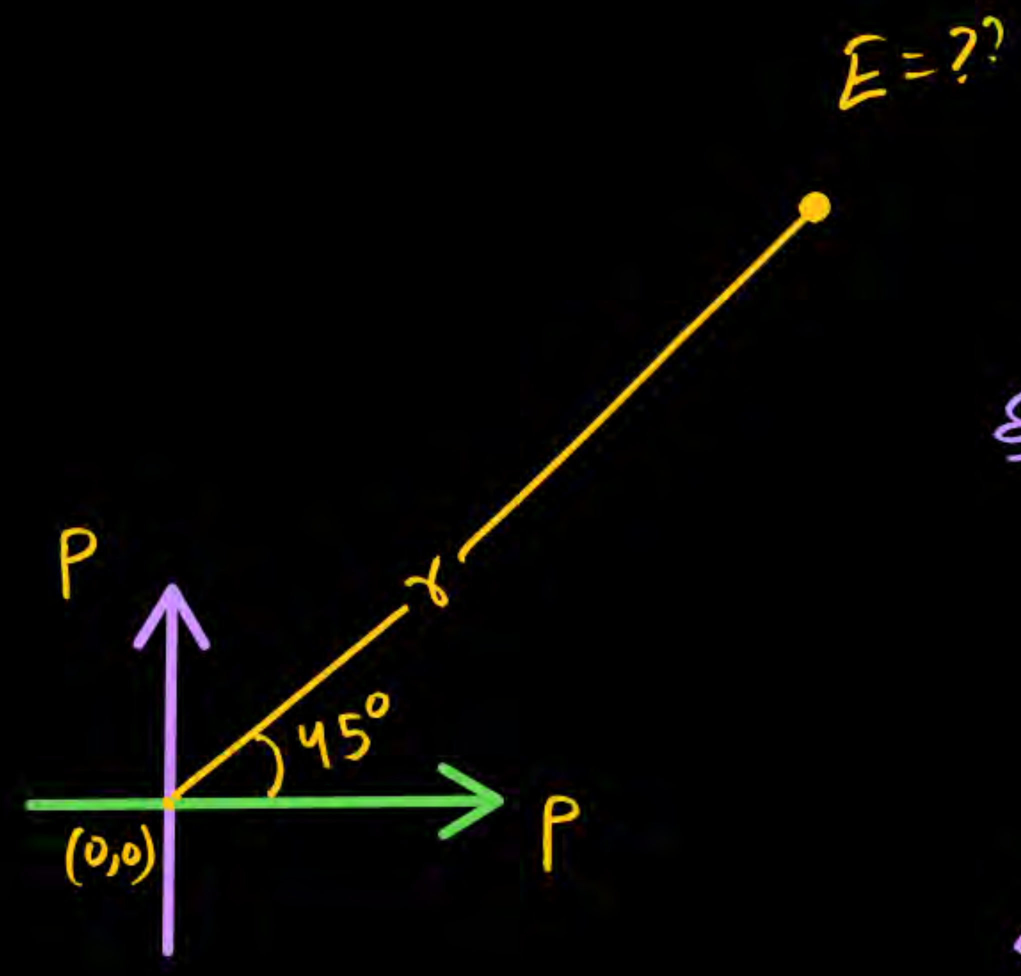
$E_2 = \frac{2kqa}{(a^2+r^2)^{3/2}}$



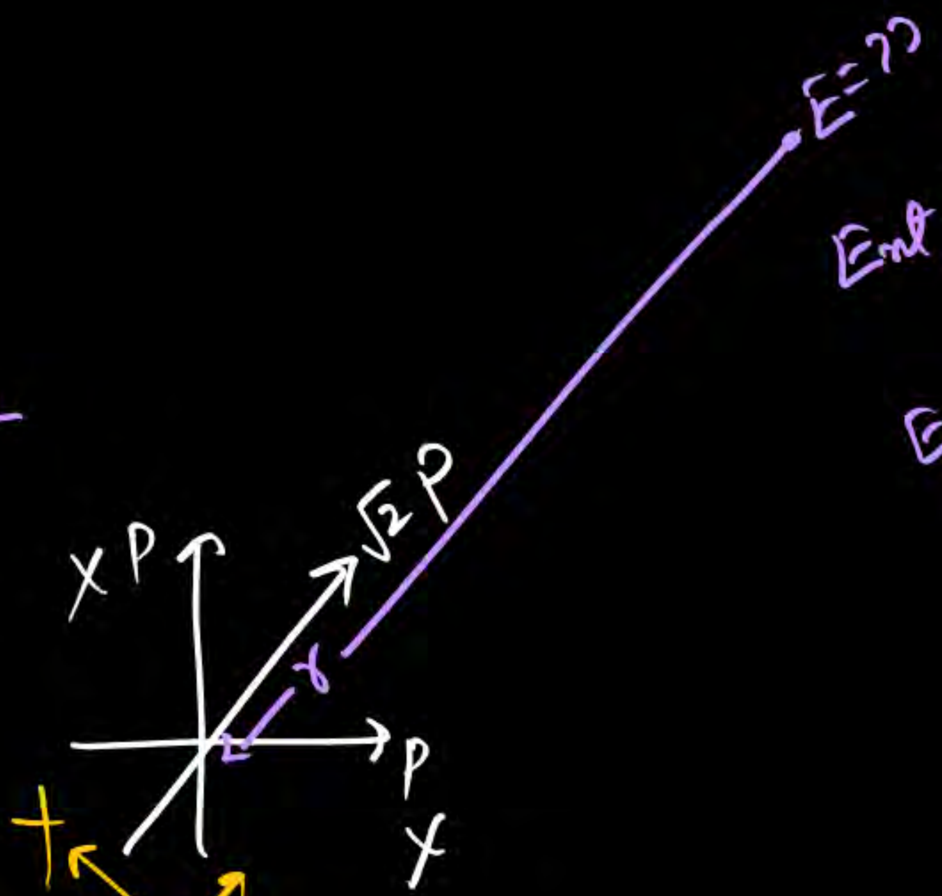
$\vec{E}_{axial} = \frac{4kqar}{(a^2-r^2)^2}$ large dipole.

$\frac{E_{axial}}{E_{eq}} = \frac{4kqar}{(a^2-r^2)^2} \times \frac{(r^2+a^2)^{3/2}}{2kqa}$

$= \frac{2\times4\,(16+9)^{3/2}}{(9-16)^2} = \frac{2\times4\times125}{49}$



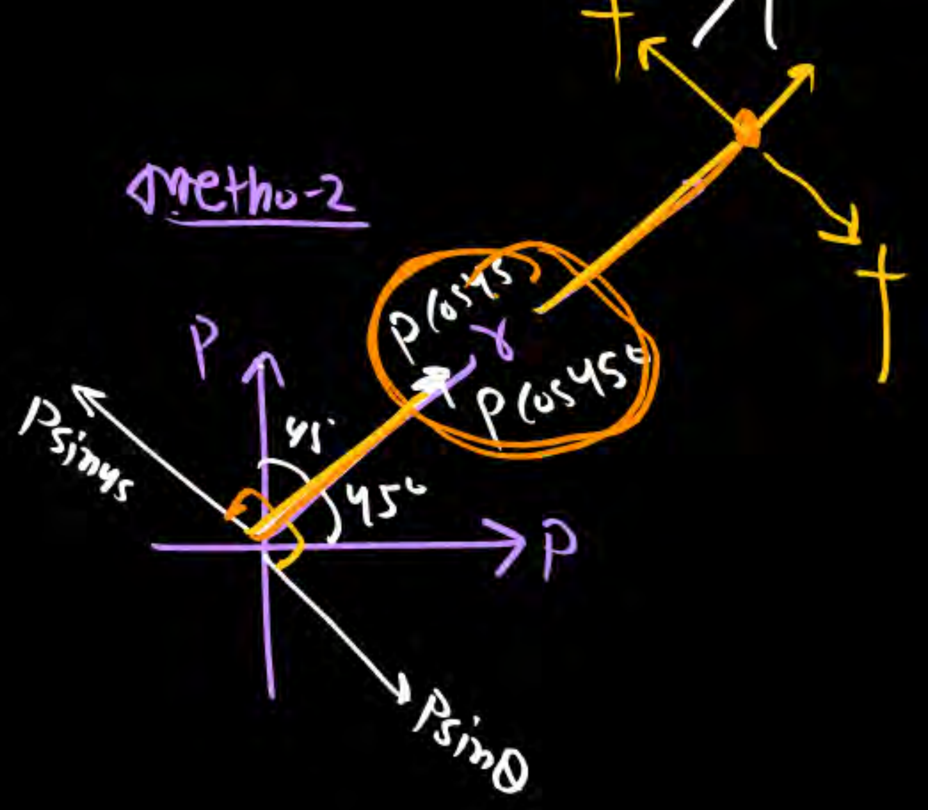
Sol^n method-1



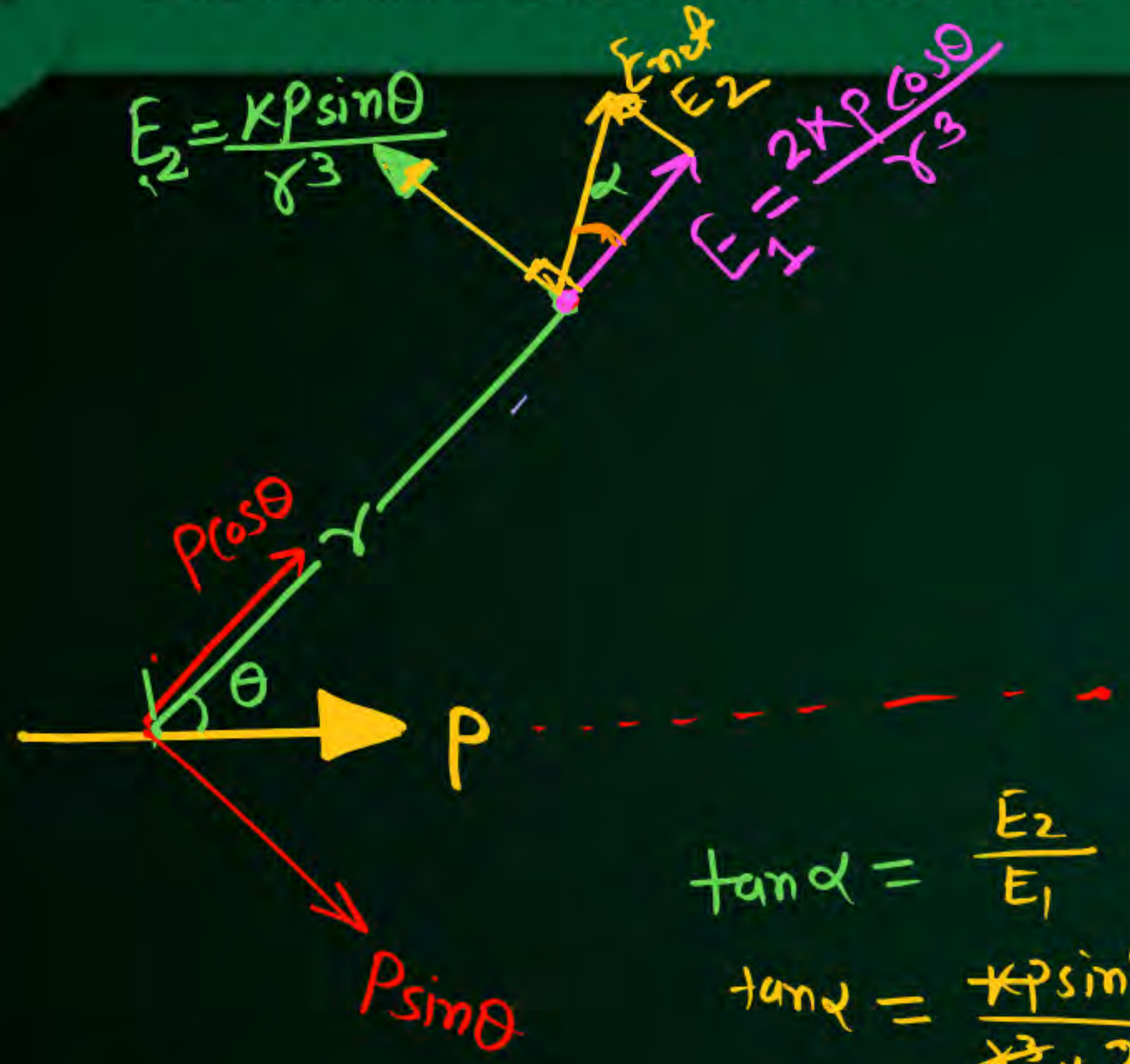
$$E_{net} = \frac{2K(\sqrt{2}P)}{r^3}$$

$$E_{net} = \frac{2\sqrt{2}KP}{r^3} \quad \text{Ans}$$

Metho-2



Find Electric Field at 'P'



$E_{net} = \sqrt{E_1^2 + E_2^2}$

$= \sqrt{\left(\frac{KP}{r^3}\right)^2 \left[4\cos^2\theta + \sin^2\theta\right]}$

$= \frac{KP}{r^3}\sqrt{4\cos^2\theta + \sin\theta}$

$= \frac{KP}{r^3}\sqrt{3\cos^2\theta + \cos^2\theta + \sin^2\theta}$

$E_{net} = \frac{KP}{r^3}\sqrt{3\cos^2\theta + 1}$

If $\theta = 0$

$E_{axial} = \frac{2KP}{r^3}$ — MR*

If $\theta = 90°$

$E_{eq} = \frac{KP}{r^3}$

$\tan\alpha = \frac{E_2}{E_1}$

$\tan\alpha = \frac{KP\sin\theta}{r^3} \times \frac{r^3}{2KP\cos\theta}$

$= \frac{\tan\theta}{2}$

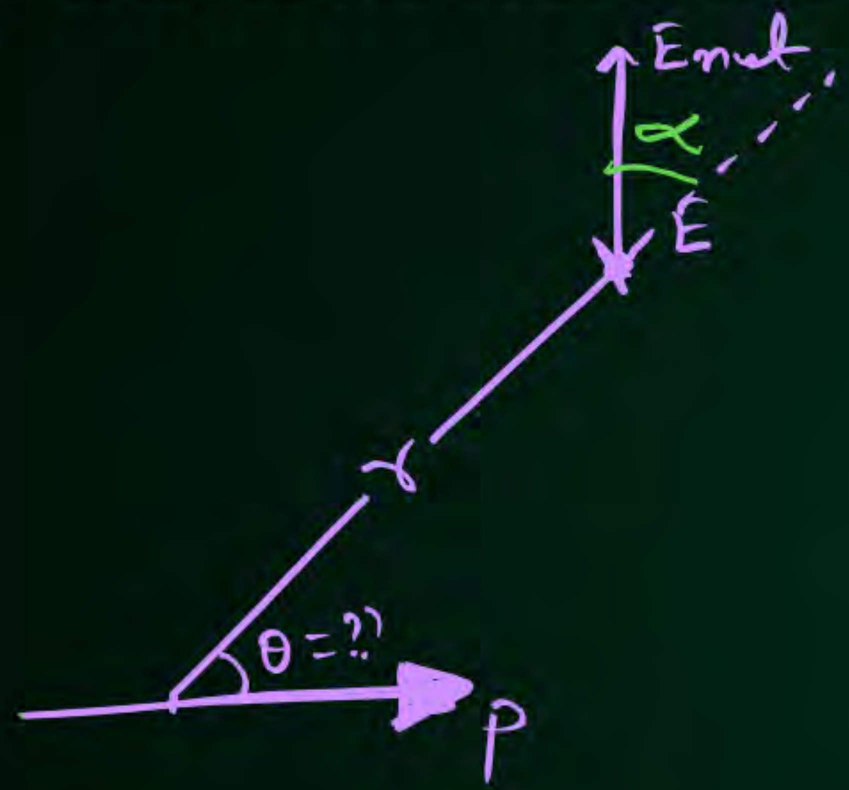
$\tan\alpha = \tan\theta / 2$

$\alpha = \tan^{-1}\left(\frac{\tan\theta}{2}\right)$ *

Angle B/w dipole moment & electric field = $= (\alpha + \theta)$

QUESTION

Find θ so that electric field exactly perpendicular to the dipole moment vector?



$$\vec{E} \perp_r \vec{P}$$

$$\theta + \alpha = 90^\circ$$

Angle θ b/w $\vec{p}$ & $\vec{E}$

we know this

$$\tan\alpha = \frac{\tan\theta}{2}$$

$$\tan(90-\theta) = \frac{\tan\theta}{2}$$

$$\cot\theta = \frac{\tan\theta}{2}$$

$$2 = \frac{\tan\theta}{\cot\theta}$$

$$\frac{1}{\cot\theta} = \tan\theta$$

$$2 = \tan^2\theta$$

$$\sqrt{2} = \tan\theta$$

$$\theta = \tan^{-1}\sqrt{2}$$

QUESTION

A point Q lies on the perpendicular bisector of an electrical dipole of dipole moment p. If the distance of Q from the dipole is r (much larger than the size of the dipole), then the electric field at Q is proportional to

1. p^2 and r^{-3}
2. p and r^{-3}
3. p^{-1} and r^2
4. p^{-1} and r^{-3}

QUESTION

Electric force between dipole and charge is F, now distance between them becomes double the force will becomes

1. Same
2. One fourth
3. 4 times
4. 1/8 times

(2) → $F = qE_{dipole}$

(66%)

→ Force between two point charge

$$F \propto \frac{1}{r^2}$$

Coulomb's law

→ Force between dipole and point charge

$$F \propto \frac{1}{r^3}$$

$E_{dipole} = \frac{2kp}{r^3}$

$F = qE$

→ Force between two dipole

$$F \propto \frac{1}{r^4}$$

$F \propto \frac{1}{r^4}$

If distance becomes double then force b/w two dipole will be $\left(\frac{1}{16}\right)^{th}$ times less.

"The rate of change in speed is not constant (→ varible) but Rate of change in velocity is constant."

✓ (a) True 68%

(b) false 30%

where it is true

(a) circular ✗

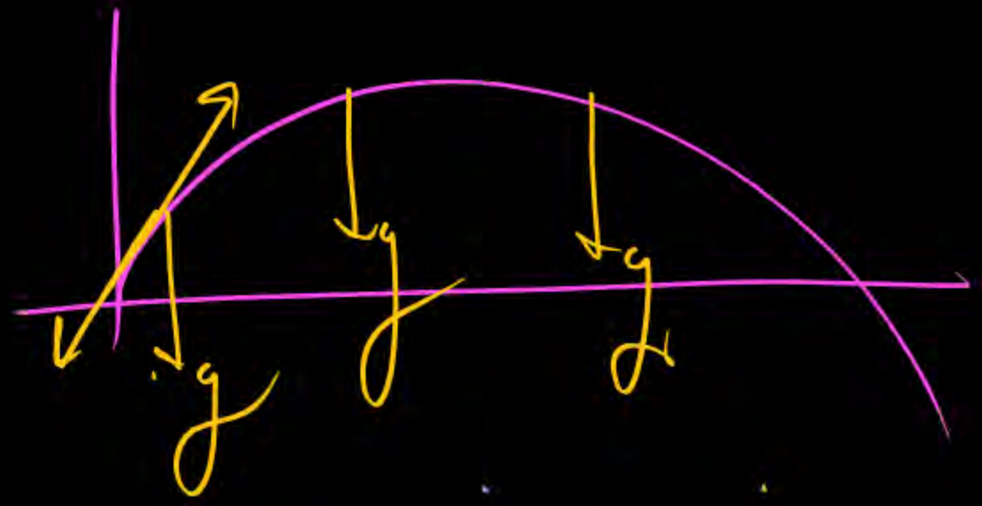
✓ (b) Projectile (70%)

(c) ellipse ✗

(d) Straight line

The Rate of change in speed → varible
↳ tangential accn. = varible

The Rate of change in velocity → cotn
↳ accn. = cotn



S-1 , Electric field on the equitorial line always anti-Parallel to the dipole moment. (correct)

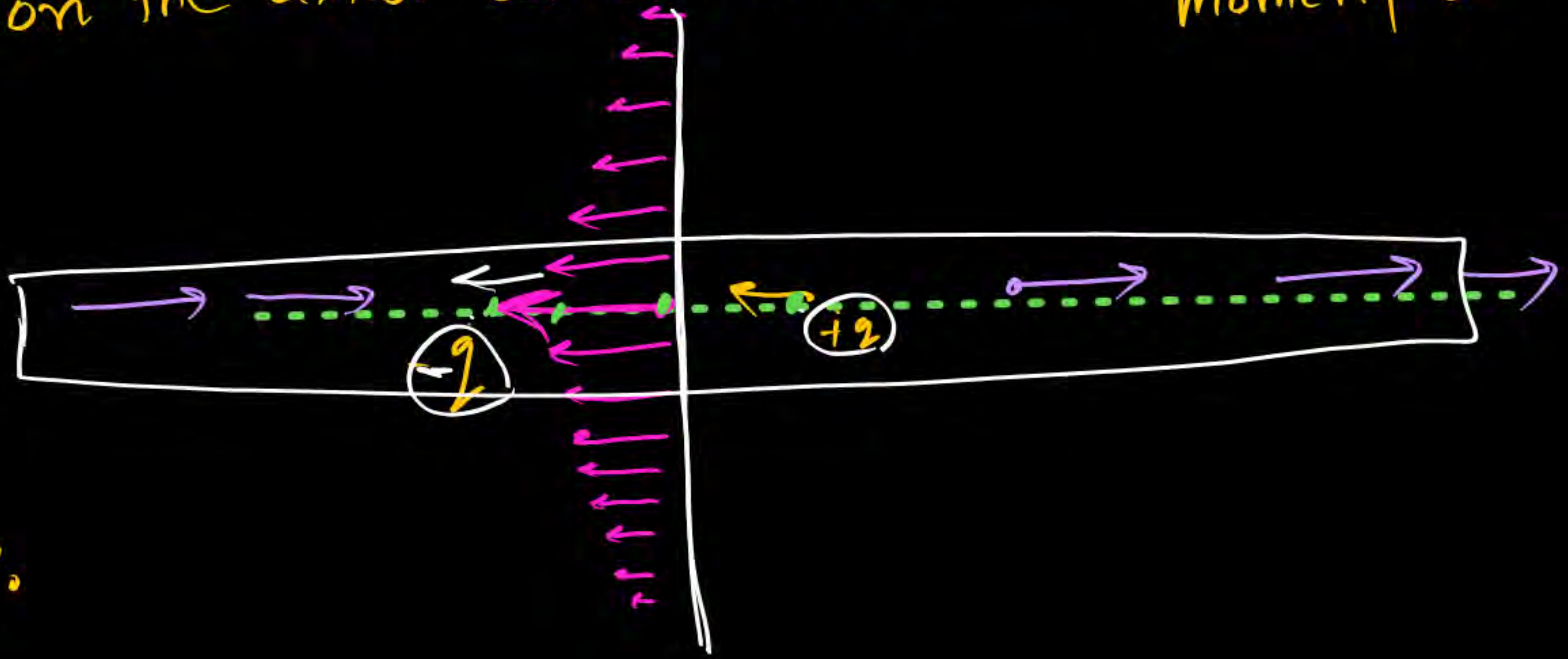
S-2 Electric field on the axial line Parallel to the dipole moment.

(a) both are correct 32%

(b) both are wrong (10%)

(c) 1st wrong 2nd correct 26%

(d) 1st correct 2nd wrong. (33%)

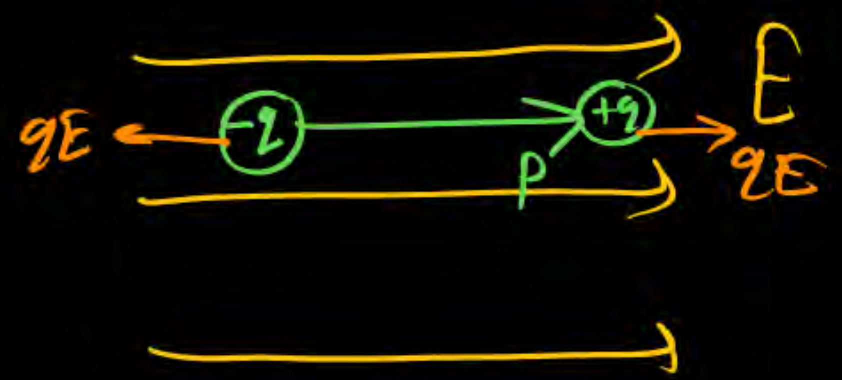


QUESTION

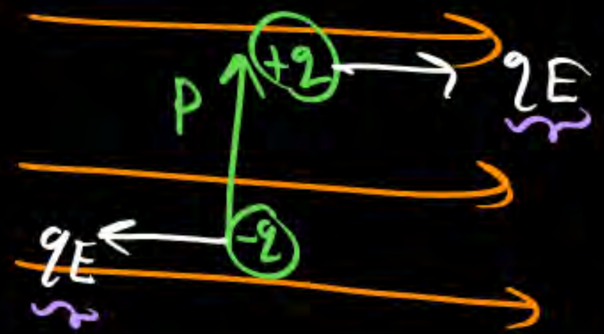
Electric force between two dipole is F, now distance between them becomes double the force will becomes

1. Same
2. One fourth
3. 1/16 times
4. 1/8 times

dipole in uniform electric field



$F_{net} = 0$



$F_{net} = 0$

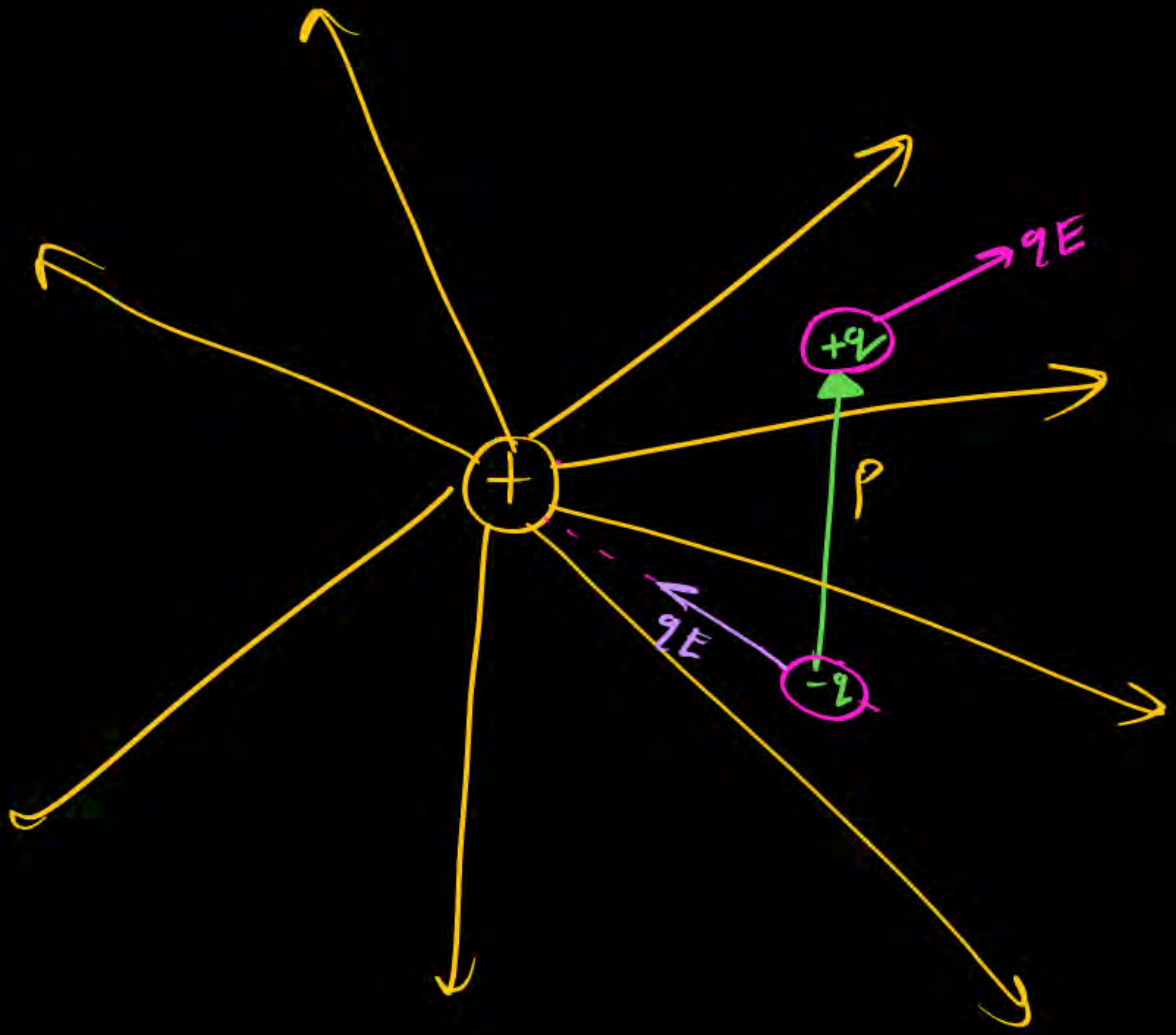
\# Net force on dipole is zero in electric field

(a) True (30%)

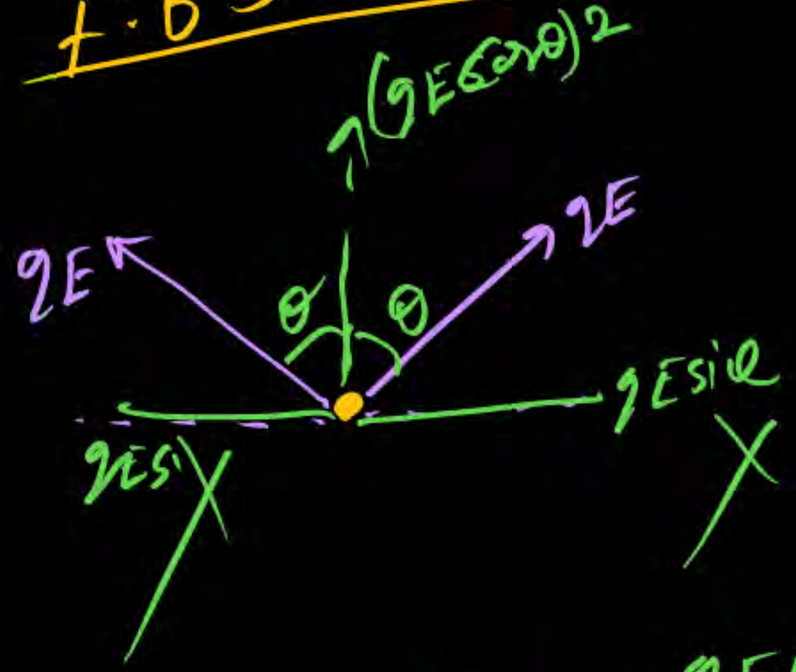
(b) false (67%)

\# force on dipole is always zero in uniform electric field → True

force acting on dipole in non-uniform electric field.

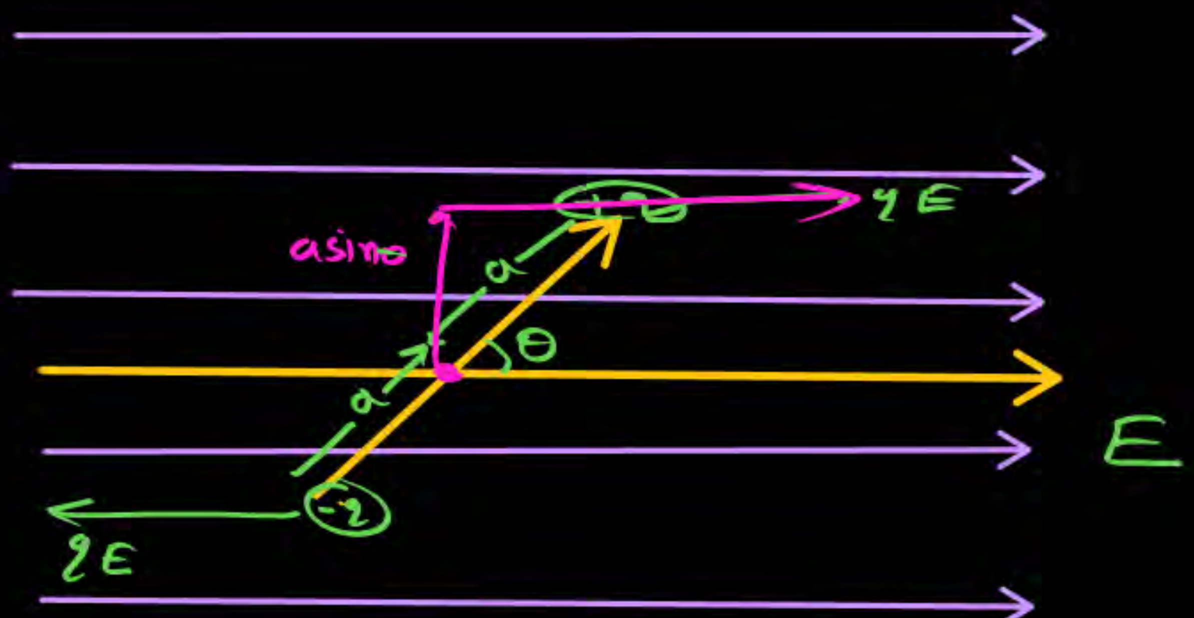


F.B.D of dipole



$F_{net} = 2qE\cos\theta$ ✓

dipole is placed in electric field



$P = q\,2a$

$F_{net} = 0$

$\tau = r_{\perp} \times F_{\perp}$

$\tau_1 = qE\,a\sin\theta$ ⊗

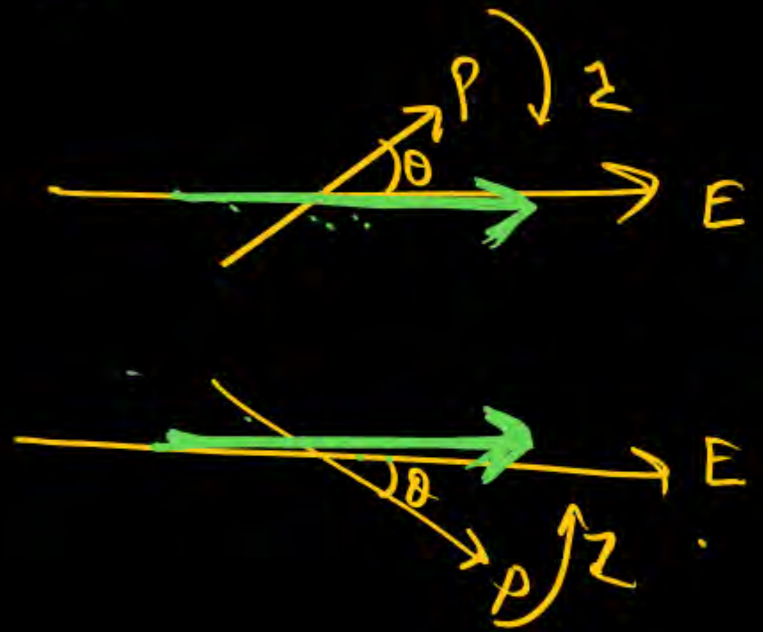
$\tau_2 = qE\,a\sin\theta$ ⊗

$\tau_{net} = 2qEa\sin\theta$

$\tau = PE\sin\theta$

$$\vec{\tau} = \vec{P} \times \vec{E}$$ *

(#)



$\tau = PE\sin\theta$

$\theta = 0°$	$\theta = 90°$	$\theta = 180$
$\tau = 0$	$\tau_{max} = PE$	$\tau = 0$
$F = 0$	$F = 0$ *	$F = 0$

$\theta = 0°$: Translaⁿ & Rotⁿ equilibrium

⊙ Stable equilibrium

$\theta = 180$: Translational & Rotational equilibrium

Unstable equilibrium

Aa Raha hai

⇒ M.R. physics

afosa tham ke baithe

ELECTRIC FLUX

→ counting of no of electric field lines passing through given cross-section area is called flux.

ELECTRIC FLUX

→ It gives the idea of electrostatic energy passing through given area.

→ Counting of electric field lines passing through given cross section area.

→ Scalar unit → Nm^2/C

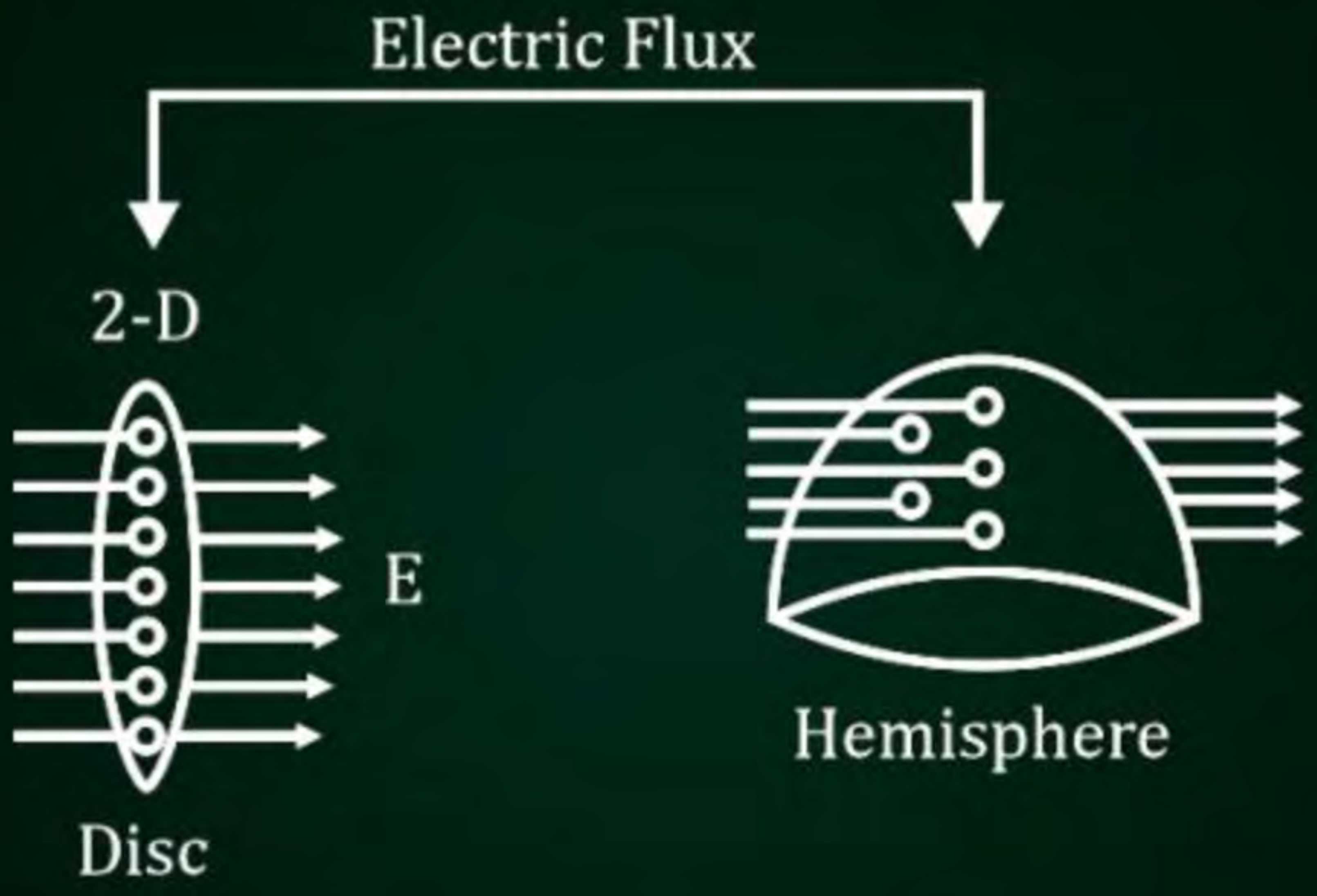
QUESTION

Electric field $\vec{E} = 2\hat{\imath} + 3\hat{\jmath} + 4\hat{k}$ then find flux through an rod of length 5m placed along 'y' axis.

1. 10
2. 15
3. 40
4. Not possible



E1
E2
E3


Electric Flux
2-D
E
Disc
Hemisphere

QUESTION

A square surface of side L metre is in the plane of the paper. A uniform electric field $\vec{E}$ (volt/m), also in the plane of the paper, is limited only to the lower half of the square surface (see figure). The electric flux in SI units associated with the surface is

[AIPMT (Prelims)-2006]

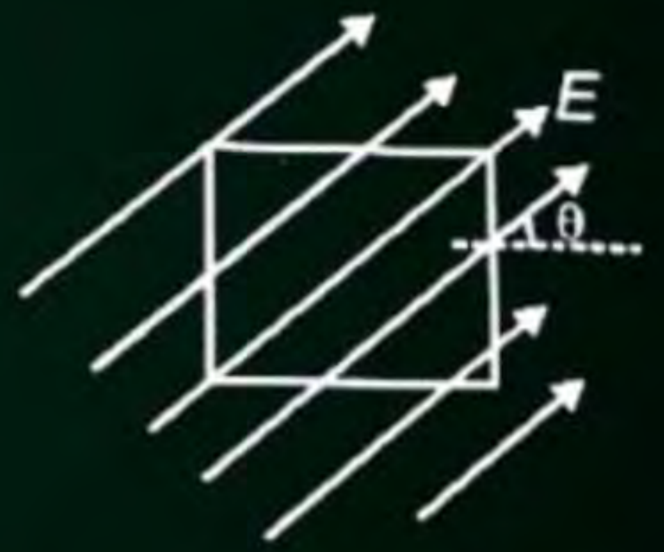


QUESTION

Electric field E = 50 N/C and area is $20m^2$ and angle between electric field and surface is 30° then find flux?

QUESTION

A square surface of side L meter in the plane of the paper is placed in a uniform electric field E (volt/m) acting along the same plane at an angle θ with the horizontal side of the square as shown in figure. The electric flux linked to the surface, in units of volt-m, is



1. Zero
2. EL^2
3. $EL^2 \cos\theta$
4. $EL^2 \sin\theta$

QUESTION

If an electric field is given by $10\hat{\imath} + 3\hat{\jmath} + 4\hat{k}$, calculate the electric flux through a surface of area 10 units lying in yz-plane

1. 100 units
2. 10 units
3. 30 units
4. 40 units

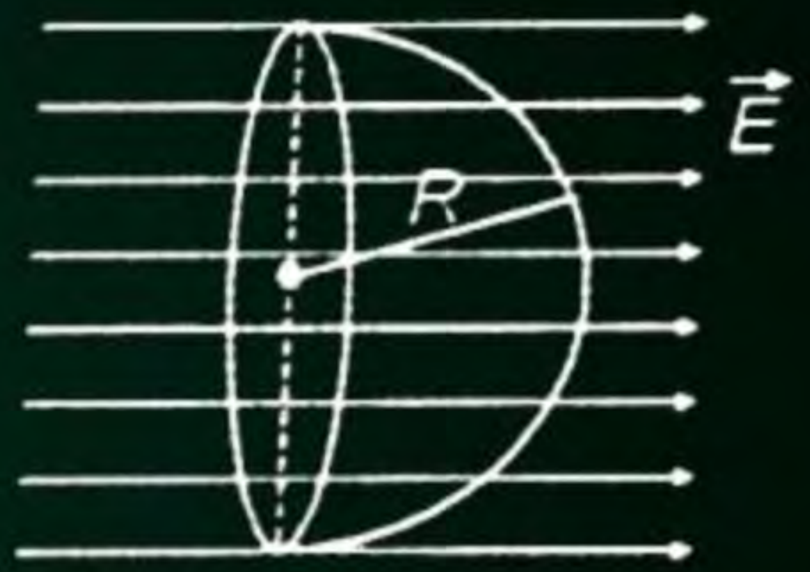
QUESTION

Find incoming and outgoing flux through cylinder.



QUESTION

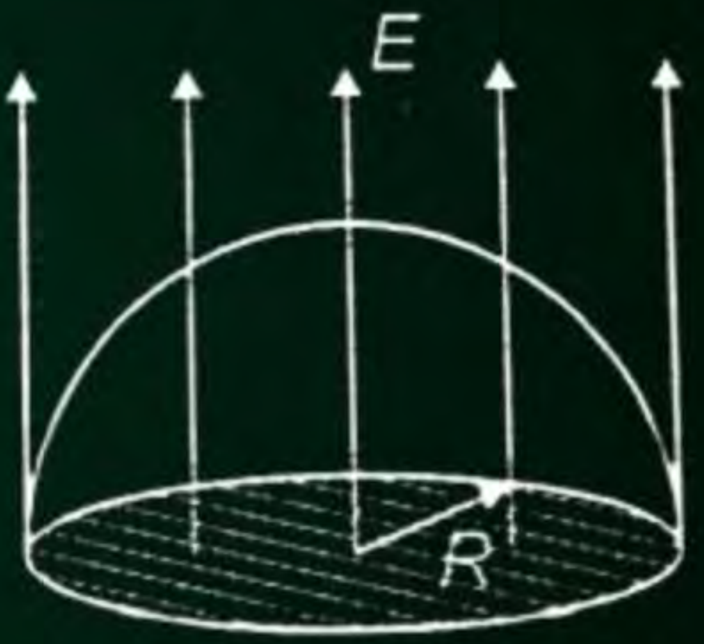
The flux through the hemispherical surface in the figure shown below is



1. $\pi R^2 E$
2. $2\pi R^2 E$
3. $\pi R E$
4. Zero

QUESTION

A hemispherical surface of radius R is kept in a uniform electric field E as shown in figure. The flux through the curved surface is



1. $E2\pi R^2$
2. $E\pi R^2$
3. $E4\pi R^2$
4. Zero

QUESTION

A cylinder of radius R and length L is placed in a uniform electric field E parallel to the cylinder axis. The outward flux over the surface of the cylinder is given by

1. $2\pi R^2 E$
2. $\frac{\pi R^2 E}{2}$
3. $2\pi RLE$
4. $\pi R^2 E$

QUESTION

If an electric field is given by $10\hat{\imath} + 3\hat{\jmath} + 4\hat{k}$, calculate the electric flux through a surface of area 10 units lying in yz-plane

1. 100 units
2. 10 units
3. 30 units
4. 40 units


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture-12 | **Physics**

Electric Charges and Fields

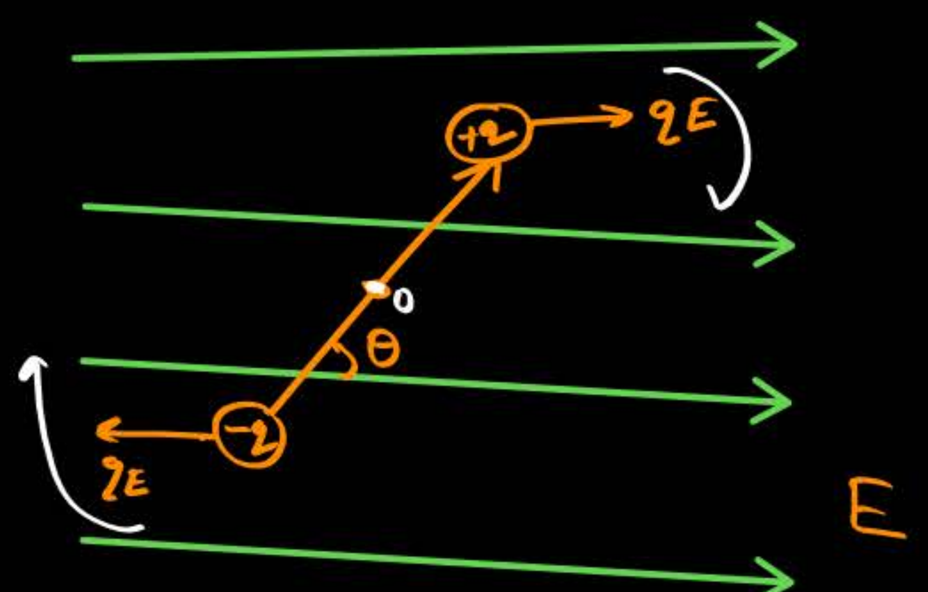


By- Dr. Manish Raj (MR SIR)

Topics to be covered

1. # Torque & Potential energy of dipole in uniform electric field
2. # flux
3. # Gauss Law





In Uniform electric field force on dipole is always zero.

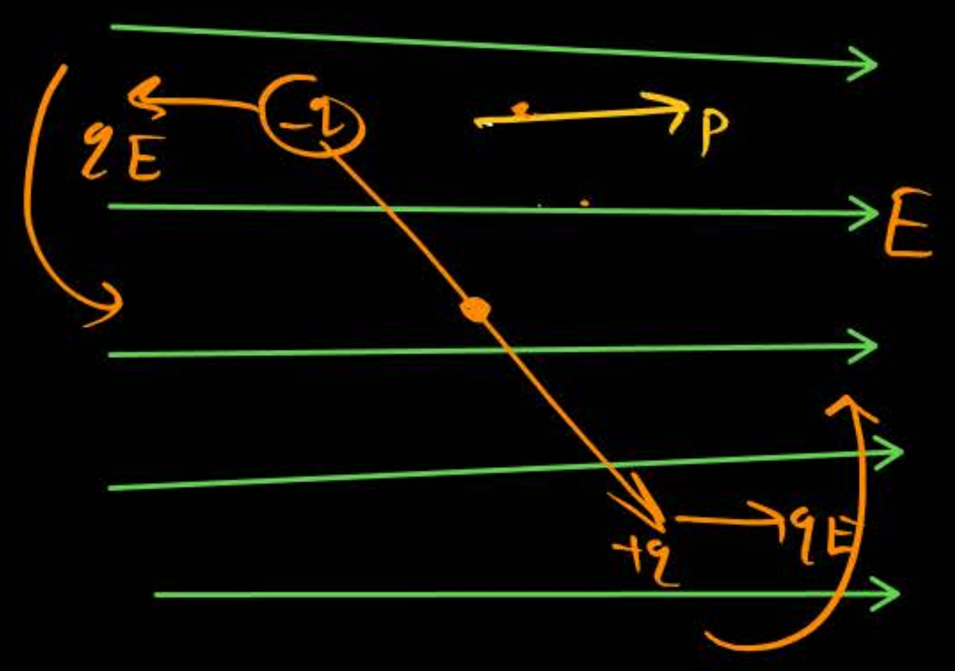
$\vec{F}_{net} = 0$

No transl^n Mot^n

$\vec{\tau} = \vec{P} \times \vec{E}$

$\tau = PE\sin\theta$

- vector
- unit [$\not{c}$-m × N/$\not{c}$] = Newton-metre
- unit & dim^n same as work or energy



ext^n work done

$dW = \tau \, d\theta$

$$\int_{U_i=0}^{U_f} dU = \int_{90°}^{\theta} PE\sin\theta \, d\theta$$

$$U - 0 = -\left[PE\cos\theta\right]_{90}^{\theta}$$

$$U = -PE\left[\cos\theta - \cos 90°\right]$$

(with $\cos 90° = 0$)

$$U = -PE\cos\theta$$

$U = -\vec{P} \cdot \vec{E}$ ✓

Torque	Potential eneyy
Vector	Scalar
Unit → Newton×metre	unit → Newton-metre.
(vector Product) PE	(scalar Product) PE
$\vec{\tau} = \vec{P} \times \vec{E}$	$U = -\vec{P} \cdot \vec{E}$
$\tau = PE\sin\theta$	$U = -PE\cos\theta$

3-chapter में Same theory

- 1 → electric charge & field
- 2) moving charge & magnet
- 3) Bar magnet

Stable equilibrium

Potential energy minimum

$\theta = 0°$, $F = 0$, $\tau = 0$, $U = -PE$ minimum

{S.H.M will occur at 0°C}

$\theta = 90°$, $F = 0$, $\tau_{max} = PE$, $U = 0$

$\theta = 180°$, $F = 0$, $\tau = 0$, $U = -PE\cos 180°$, $U = PE$ maximum

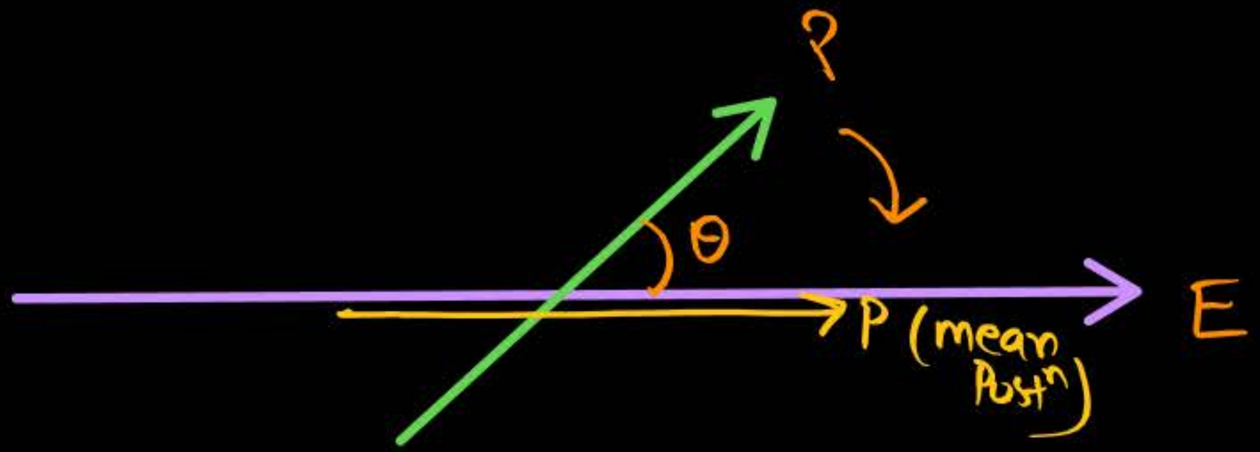
Unstable equilibrium

no S.H.M Possible

S.H.M of electric dipole in uniform electric field

(a) $T = 2\pi\sqrt{\frac{PE}{I}}$ ✗

(b) $T = 2\pi\sqrt{\frac{IP}{E}}$ ✗



$\tau = PE\sin\theta$

$I\alpha = PE\theta$

$\vec{\alpha} = \left(\frac{PE}{I}\right)\vec{\theta}$ → ω^2

Conᵈ of S.H.M
θ → small

$\omega^2 = \frac{PE}{I}$

$\omega = \sqrt{\frac{PE}{I}}$

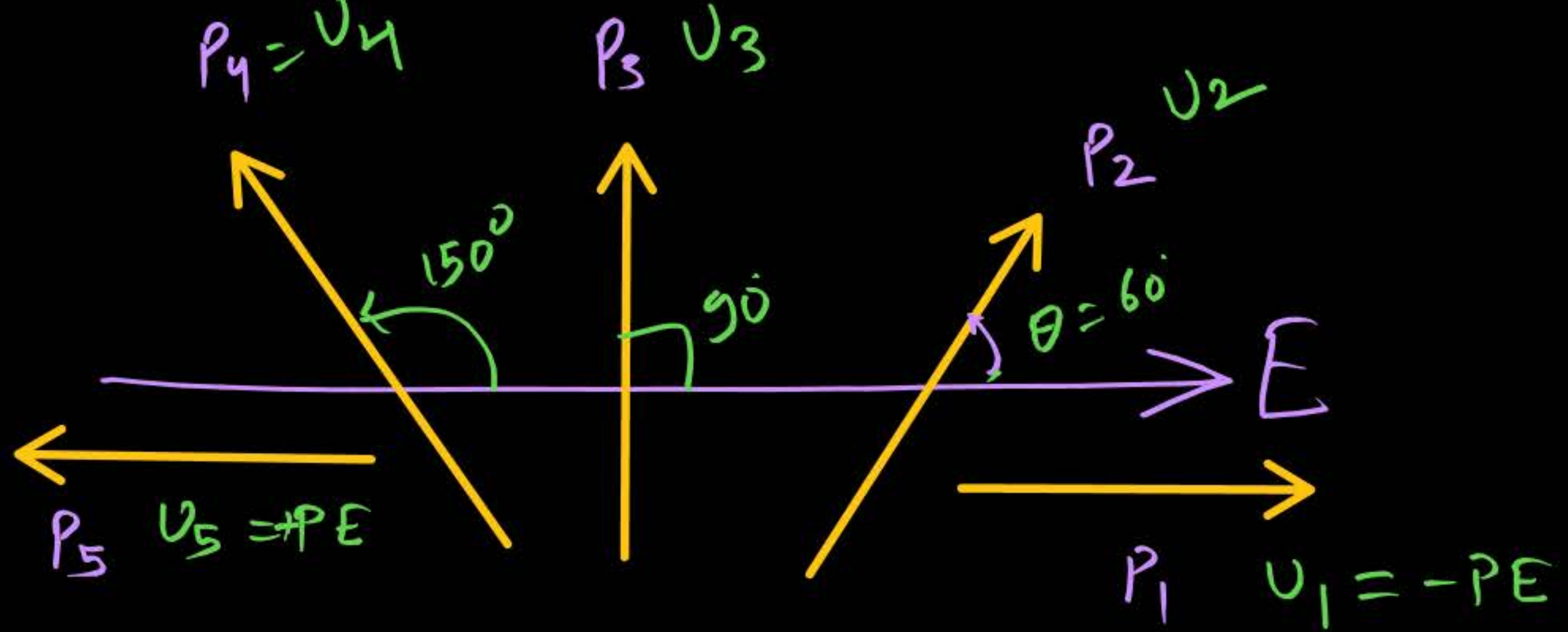
$\frac{2\pi}{T} = \sqrt{\frac{PE}{I}}$

$$T = 2\pi\sqrt{\frac{I}{PE}}$$

→ dimension

$T = 2\pi\sqrt{\frac{ML^2}{ML^2T^{-2}}} = \sqrt{T^2}$ = Time

I = moment of Inertia of dipole
E = electric field P = dipole moment



Arrange Potentential enegy in given dipole ??

$$U_1 < U_2 < U_3 < U_4 < U_5$$

$$U = -PE\cos\theta$$ *

$$U_{0^\circ} = -PE\cos 0^\circ = -PE$$

$$U_{60^\circ} = -PE\cos 60^\circ = -PE/2$$

$$U_{90} = -PE\cos 90^\circ = 0$$

$$U_{150^\circ} = -PE\cos 150^\circ = +PE\left(+\frac{\sqrt{3}}{2}\right)$$

$$= \frac{PE\sqrt{3}}{2}$$

$$V_{180^\circ} = -PE\cos 180^\circ = +PE$$

Work done to rotate the dipole

By ext^n agent

$$W_{ext\,F} = \Delta U$$

$$W_{ext\,F} = U_f - U_i$$

Work done by electric field

$$W_{c.f} = -\Delta U$$

$$W_{\text{electric field}} = -[U_f - U_i]$$

$$W = -U_f + U_i$$

$$U = -PE\cos\theta$$

Find work done to Rotate the dipole from stable equlibrium to unstable equlibrium by electric field.

Sol^n

$\theta_i = 0°$

$U_i = -PE$

$\theta_f = 180°$

$U_f = PE$

$$W = -\Delta U$$

$$= -[U_f - U_i]$$

$$= -[PE - (-PE)]$$

$$W = -2PE$$

Ans

find work done to Rotate the dipole from stable equlibrium to unstable equlibrium.

Soln

$$\text{Work} = \Delta U$$

$$= U_f - U_i$$

$$\left\{ \begin{array}{l} \theta_i = 0^\circ \\ U_i = -PE \end{array} \right.$$

$$= PE - (-PE)$$

$$= 2PE$$

Ans

$$\left\{ \begin{array}{l} \theta_f = 180 \\ U_f = -PE\cos 180^\circ \\ \quad = +PE \end{array} \right.$$

(Q) Find work done to rotate the dipole from $0°$ to $90°$.

Sol^n

$U_i = -PE$

$U_f = 0$

$$W_{ext} = \Delta U$$
$$= U_f - U_i$$
$$= 0 - (-PE)$$
$$= +PE$$

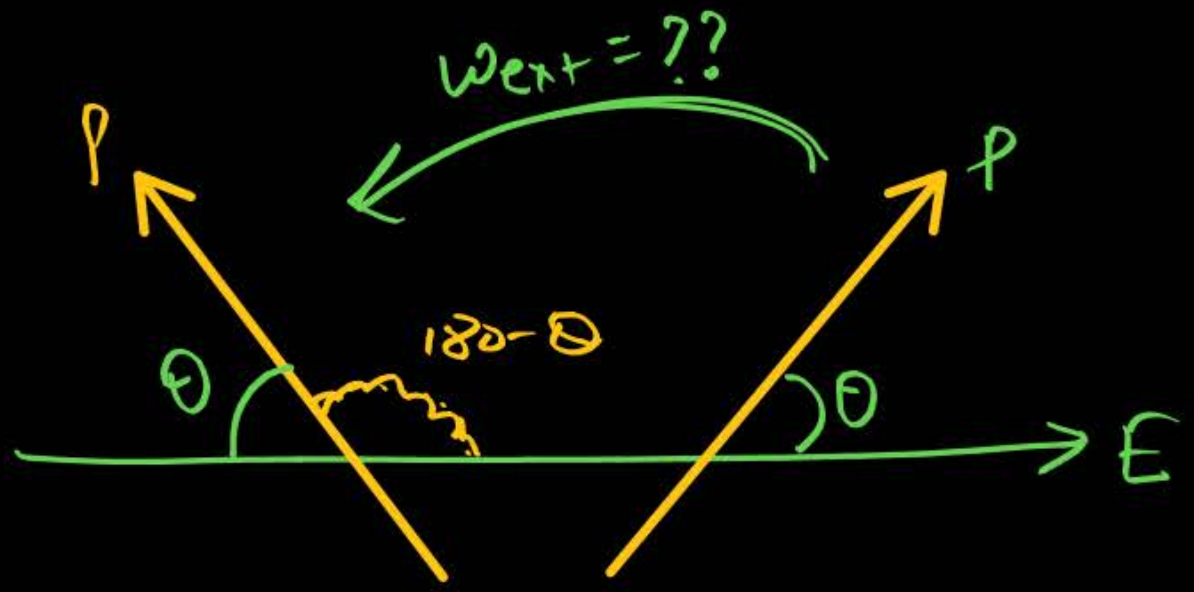
(Q) find work done to rotate the dipole from $90°$ to $270°$ by electric field.

Sol^n

$U_i = 0$

$U_f = 0$

$$\text{work} = -\Delta U$$
$$= 0$$



(a) zero (24%)

(b) $-2PE\cos\theta$

(c) $+2PE\cos\theta$ (55%)

(d) $PE\cos\theta$

$\theta_i = \theta$

$U_i = -PE\cos\theta$

$\theta_f = (180-\theta)$

$U_f = -PE\cos(180-\theta)$

$= -PE(-\cos\theta)$

$U_f = PE\cos\theta$ *

$W_{ex} = U_f - U_i$

$= PE\cos\theta - (-PE\cos\theta)$

$= 2PE\cos\theta$

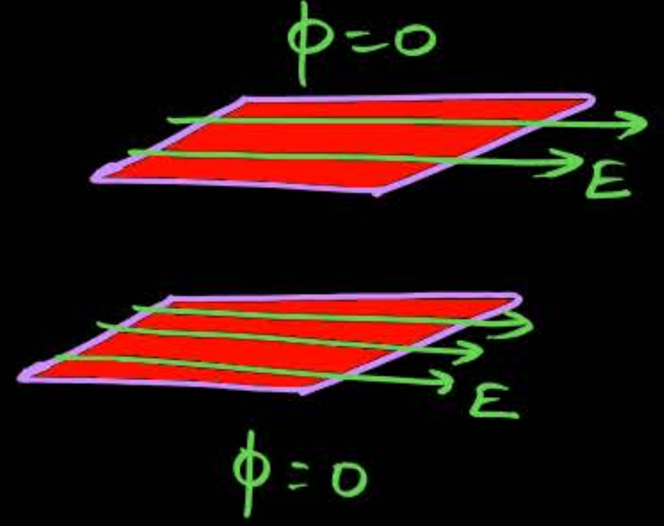
Electric flux

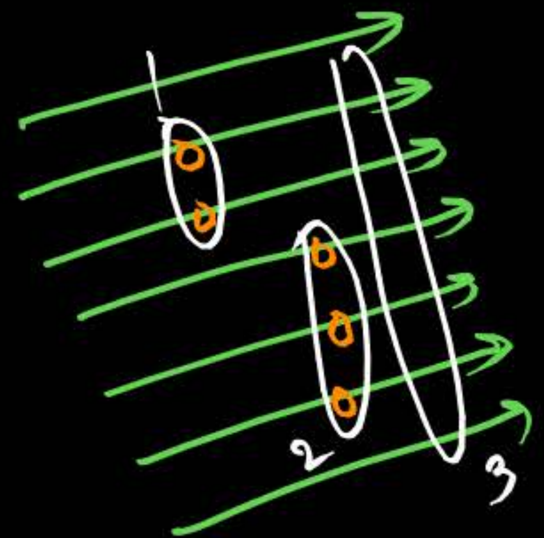
Area Always ⊥r to the plane.

$E = \text{volt}/\text{metre}$

Counting of electric field lines Passing through given Cross-section Area.

gives the Idea of electrostatic energy





$\phi \propto$ Area

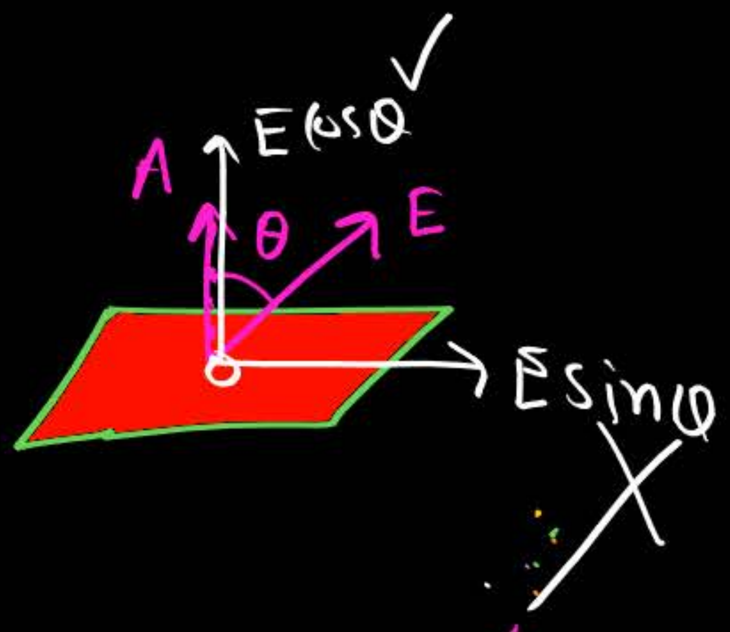
$\phi \propto$ electric field

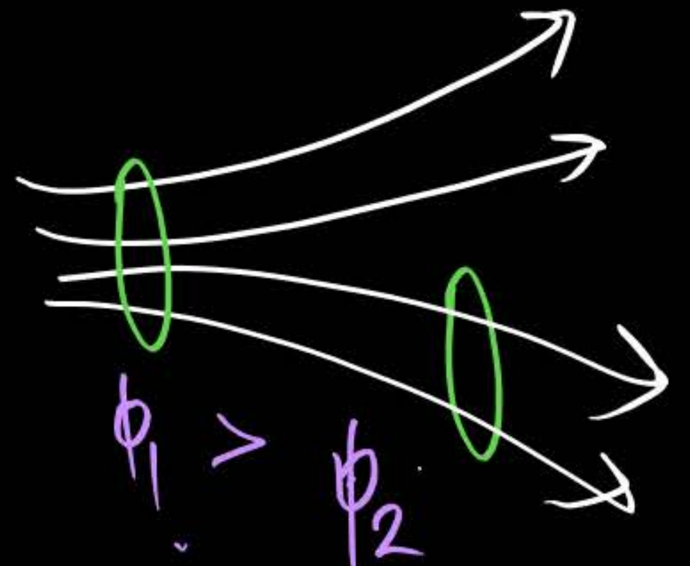
$\phi \propto \cos\theta$ ← Angle b/w Area & electric field.

$\phi = EA\cos\theta$

$\phi = \vec{E} \cdot \vec{A}$

↳ scalar $\left(\frac{Nm^2}{C}\right) \rightarrow$ (volt-metre)





$$\phi = \vec{E} \cdot \vec{A}$$

$$= EA\cos\theta$$ → Angle b/w electric field & Area vector.

$$\phi = \vec{E} \cdot \vec{A}$$

$$= (E_x\hat{i} + E_y\hat{j} + E_z\hat{k}) \cdot (A_x\hat{i} + A_y\hat{j} + A_z\hat{k})$$

$$= (E_x A_x + E_y A_y + E_z A_z)$$

A_z

QUESTION

Electric field $\vec{E} = 2\hat{\imath} + 3\hat{\jmath} + 4\hat{k}$ then find flux through an rod of length 5m placed along 'y' axis.

1. 10
2. 15 (80%)
3. 40
4. Not possible

[8%] correct

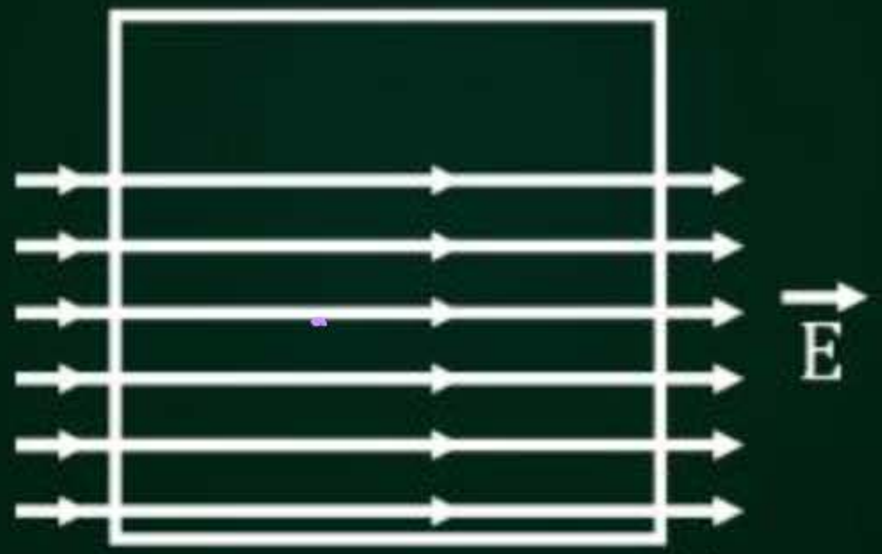
$\vec{E} \cdot \vec{A}$

$\phi = \vec{E} \cdot \vec{A}$ ↑ area

QUESTION

A square surface of side L metre is in the plane of the paper. A uniform electric field $\vec{E}$ (volt/m), also in the plane of the paper, is limited only to the lower half of the square surface (see figure). The electric flux in SI units associated with the surface is

[AIPMT (Prelims)-2006]



ϕ = zero

Angle b/w electric field & plane = 0°

Angle b/w electric field & Area = 90°

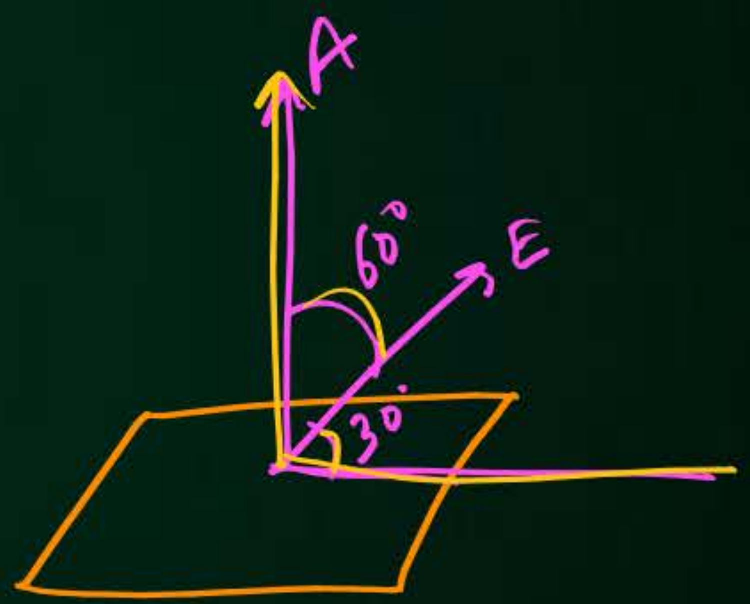
QUESTION

Electric field E = 50 N/C and area is $20 m^2$ and angle between electric field and surface is 30° then find flux?

$\phi = EA\cos\theta$

$= 50 \times 20 \times \cos 60°$

$= 50 \times 20 \times \frac{1}{2}$



wrong (a) $\frac{\sqrt{3}}{2} 50 \times 20$ (30%)

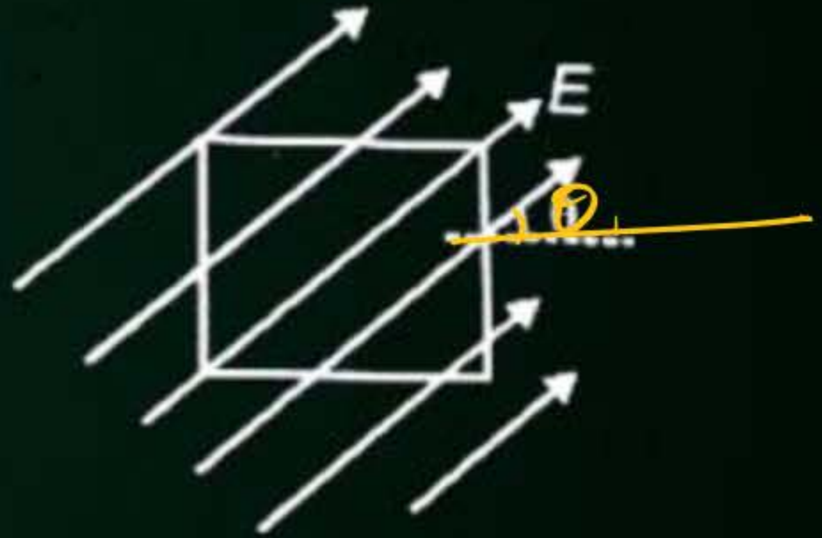
✓ (b) $\frac{1}{2} \times 50 \times 20$ (57%)

(c) zero ✗

(d) 50×20

QUESTION

A square surface of side L meter in the plane of the paper is placed in a uniform electric field E (volt/m) acting along the same plane at an angle θ with the horizontal side of the square as shown in figure. The electric flux linked to the surface, in units of volt-m, is



(1) Zero 68%

(2) EL^2

(3) $EL^2 \cos\theta$

(4) $EL^2 \sin\theta$

QUESTION

If an electric field is given by $10\hat{\imath} + 3\hat{\jmath} + 4\hat{k}$, calculate the electric flux through a surface of area 10 units lying in yz-plane

1. 100 units
   84%
2. 10 units
3. 30 units
4. 40 units

$\vec{E} = 10\hat{i} + 3\hat{j} + 4\hat{k}$

$A = 10\hat{i}$

$\phi = \vec{E} \cdot \vec{A}$

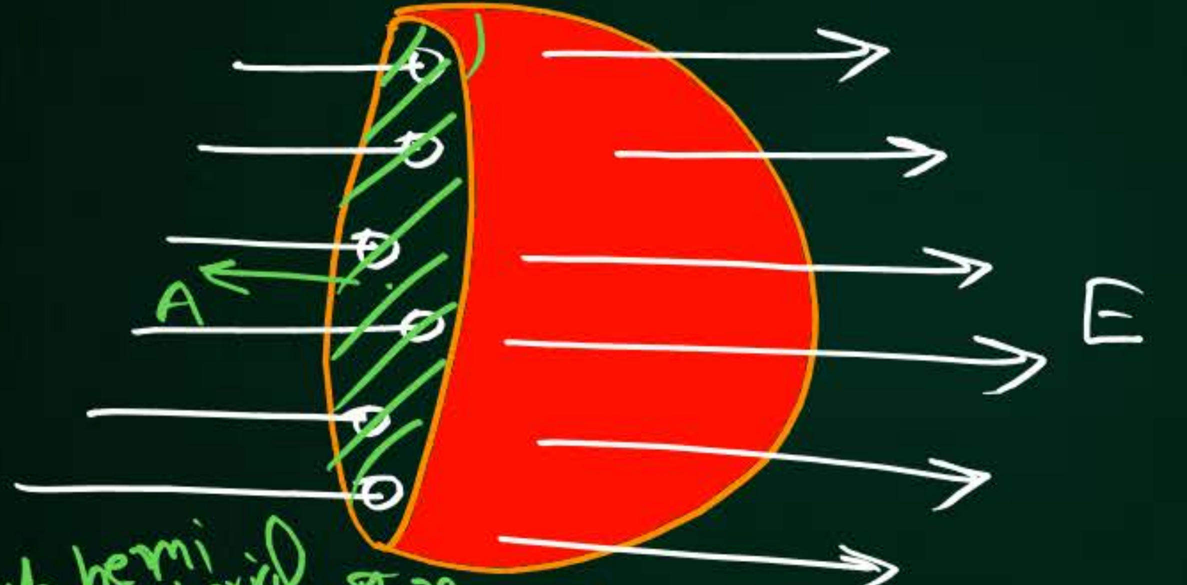
$= 100$

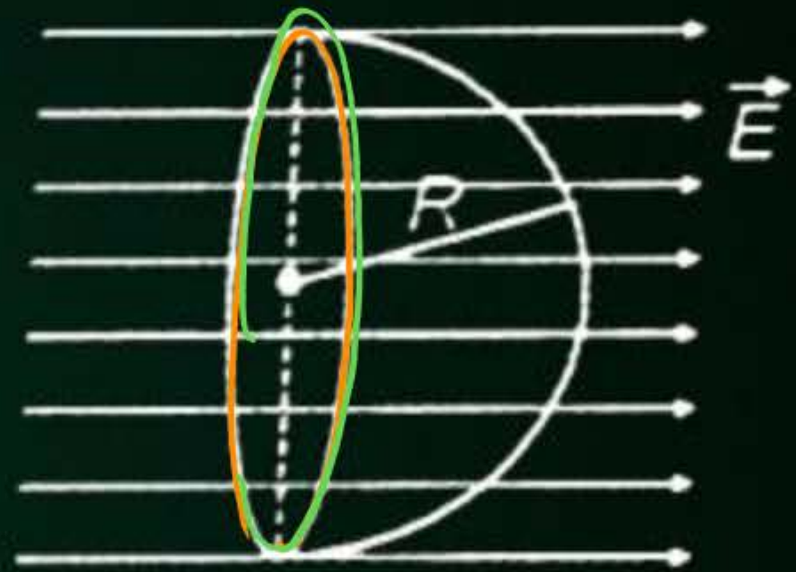
QUESTION

Area of sphere = $4\pi R^2$

The flux through the hemispherical surface in the figure shown below is

1. $\pi R^2 E$ ✓
2. $2\pi R^2 E$ (44%)
3. $\pi R E$
4. Zero





hemisphere

(*) through hemispherical surface

$\pi R^2 = \text{Area}$

$\phi = EA\cos\theta$

$= E(2\pi R^2)$ ✗

$\phi_{\text{total hemisph}} = 0$

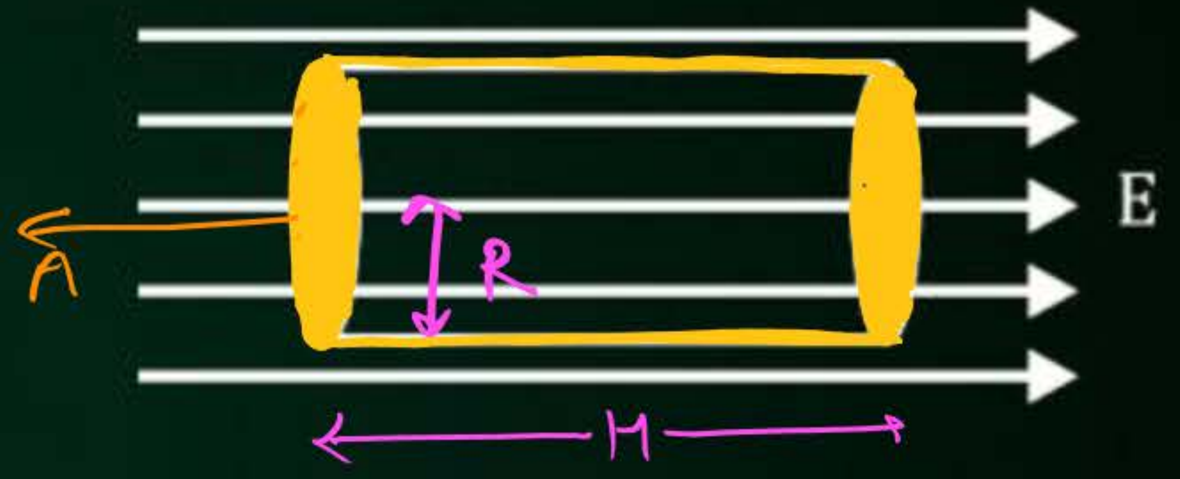
$\phi_{\text{incoming circle}} + \phi_{\text{out through hemispherical surface}} = 0$

$E\pi R^2 \cos 180° + \phi = 0$

$\phi = \pi R^2 E$

QUESTION

Find incoming and outgoing flux through cylinder.



$\phi_{total} = zero$

$\phi_{In} = EA\cos\theta$

$= E\pi R^2 \cos 180^\circ$

$= -E\pi R^2$

$\phi_{outgoing} = E\pi R^2$

$\phi_{total} = 0$

ϕ passing through curved surface of cylinder $= 0$

QUESTION

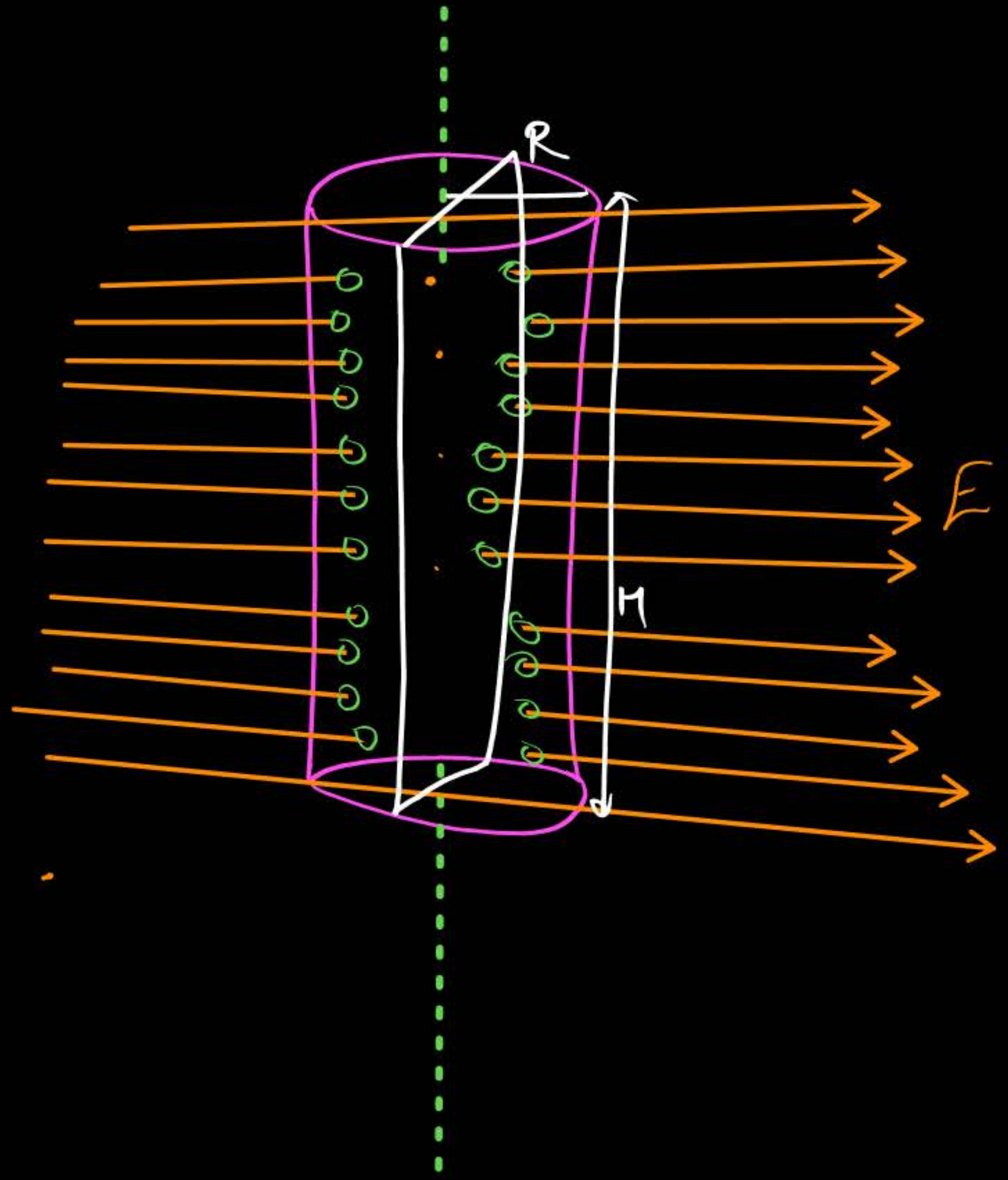
A cylinder of radius R and length L is placed in a uniform electric field E parallel to the cylinder axis. The outward flux over the surface of the cylinder is given by

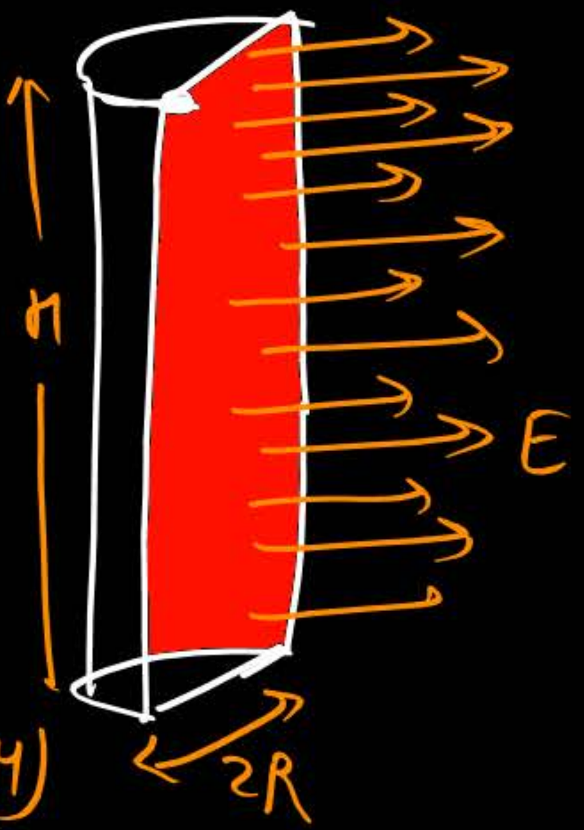
1. $2\pi R^2 E$
2. $\dfrac{\pi R^2 E}{2}$
3. $2\pi RLE$
4. $\pi R^2 E$



$\phi_{total\ cylin} = 0$

$\phi_{In} = ??$





$\phi = -E(2RH)$

$\phi_{out} = E(2RH)$

Electric flux

$$\phi = \vec{E} \cdot \vec{A}$$

$E = \text{const}^n$

$$\int d\phi = \int \vec{E} \cdot d\vec{A}$$

E = variable

$$\phi = \int \vec{E} \cdot d\vec{A}$$

★ which are close Surface

Rod →	✗
Ring	✗
disc	✗
Square plate	✗
Sphere	✓
Cube	✓
cylinder	✓

Gauss law

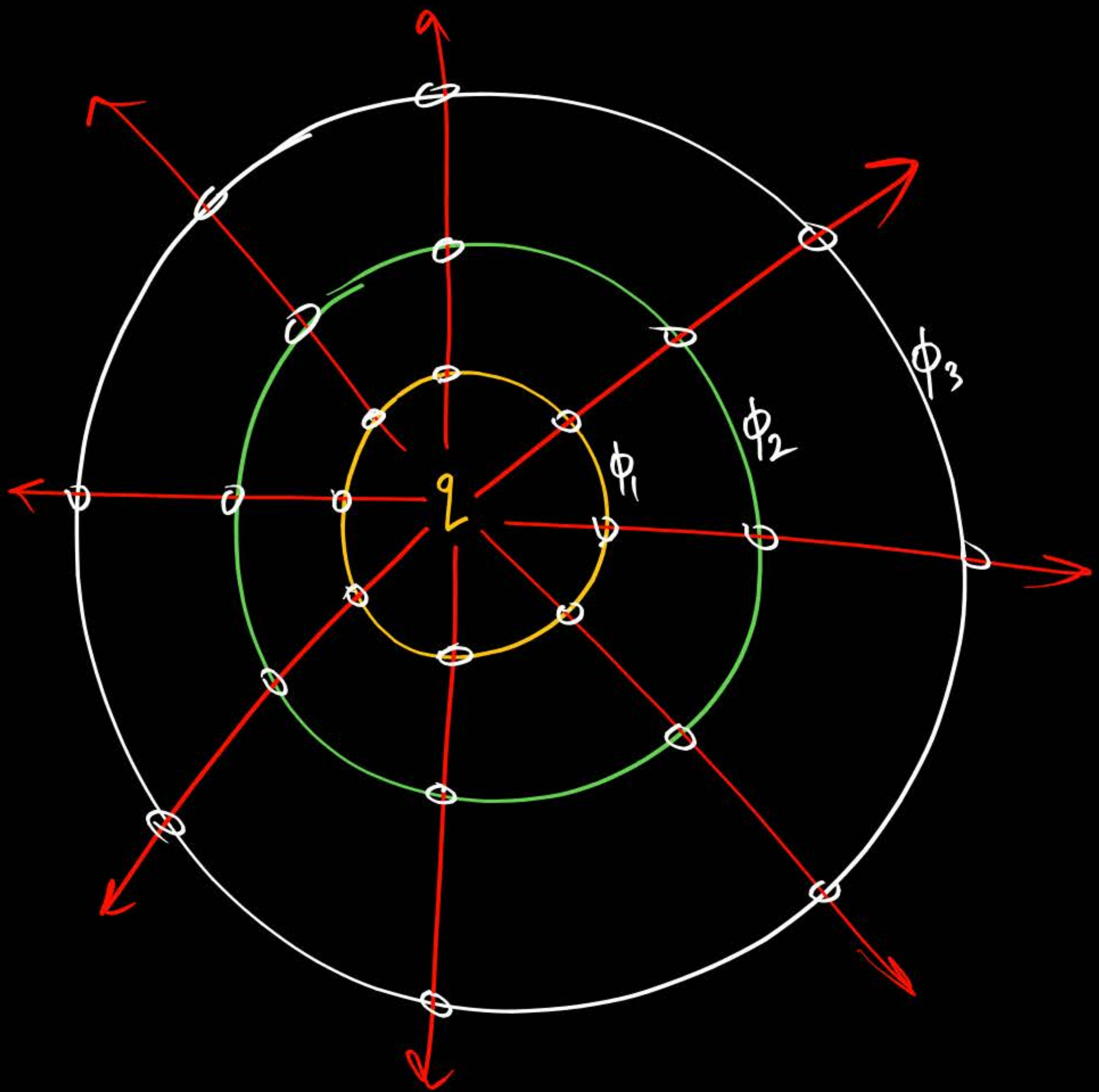
$$\phi = \oint \vec{E} \cdot d\vec{A} = \frac{q_{in}}{\varepsilon_0}$$

→ flux Passing through close surface $= \dfrac{q_{in}}{\varepsilon_0}$

$$\phi = \frac{q_{in}}{\varepsilon_0}$$

q_{in} = enclosed charge by the close surface

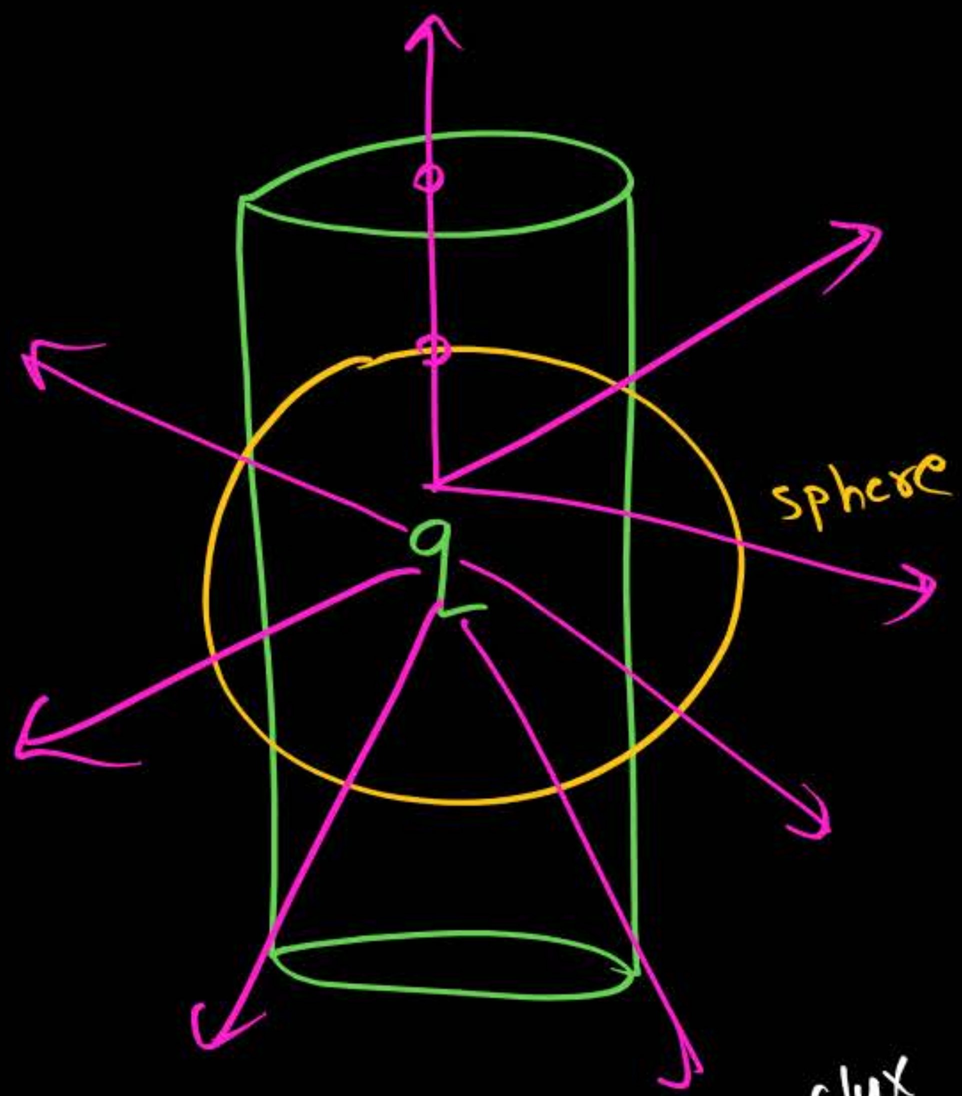
→ flux does not depends on Size of close surface, Shape of surface, Position of charge inside Close surface.



$$\phi_1 = \phi_2 = \phi_3$$

flux is counting of electric field lines Passing throug Area.

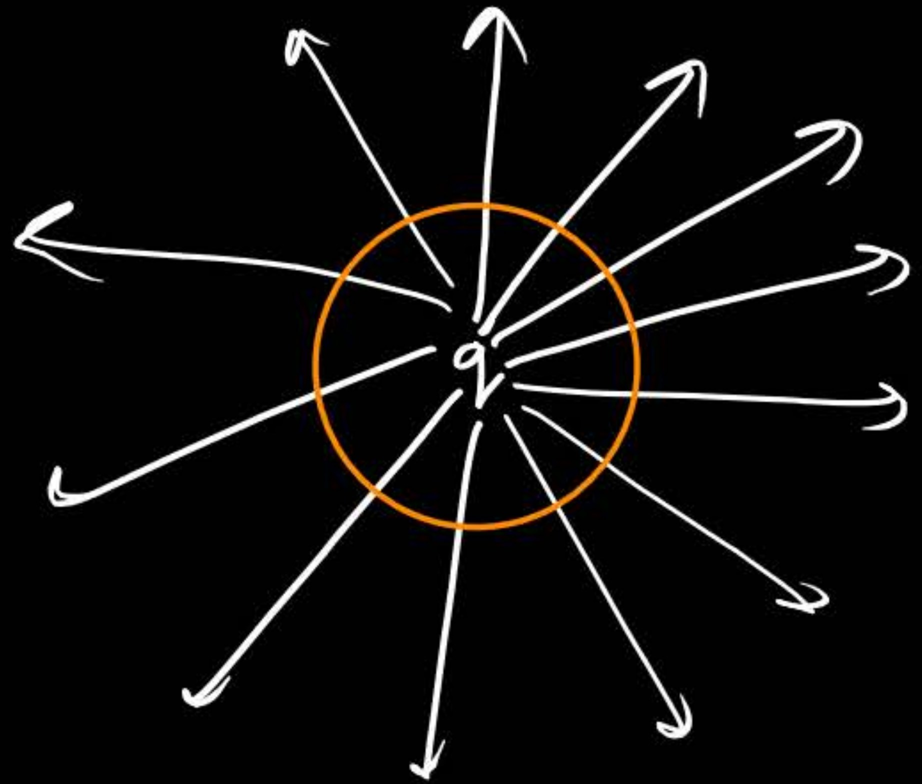
ϕ → does not depend on size of the surf.



$\phi_{cylinder} = ??$

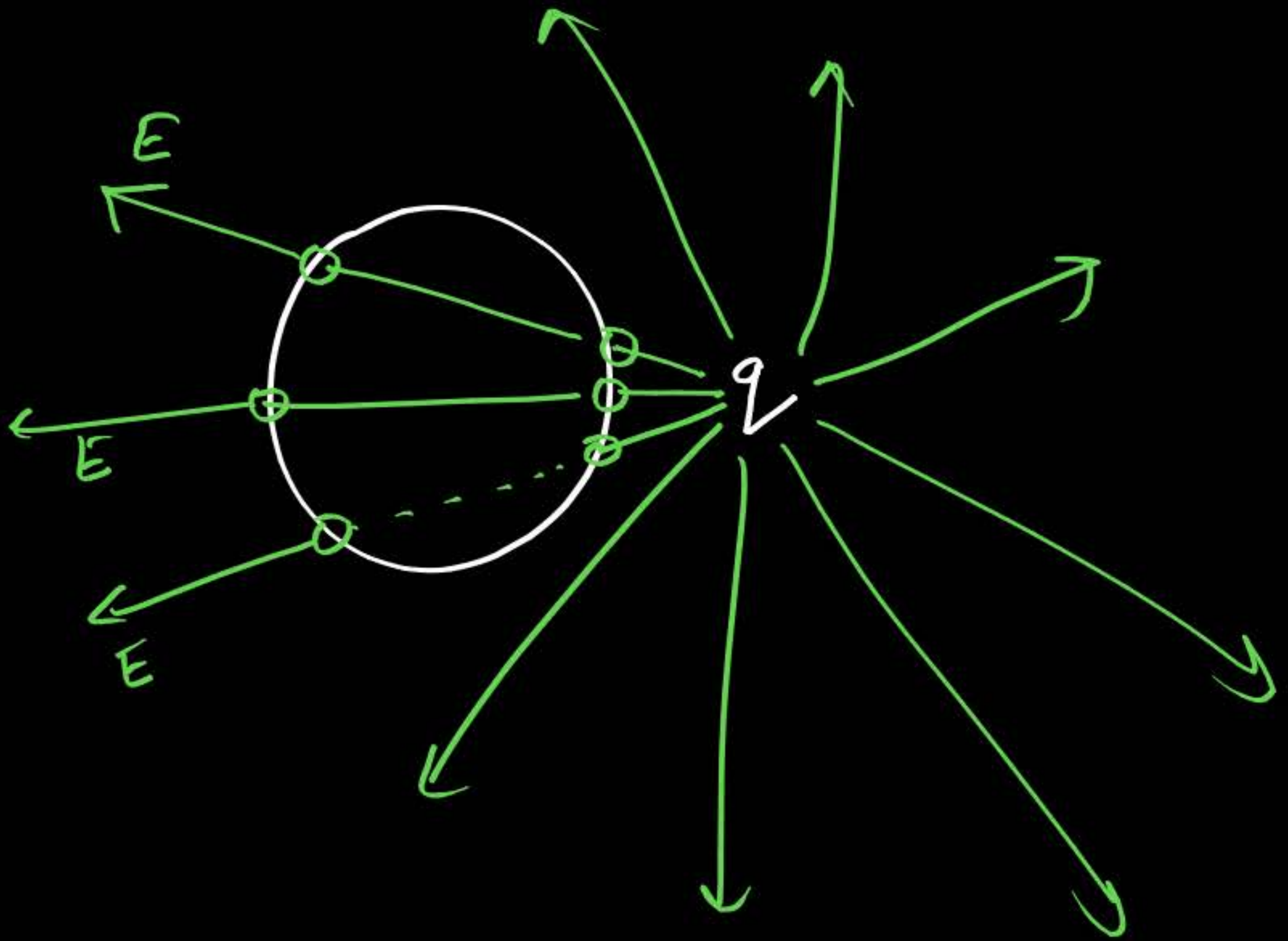
$\phi_{sphere} = ??$

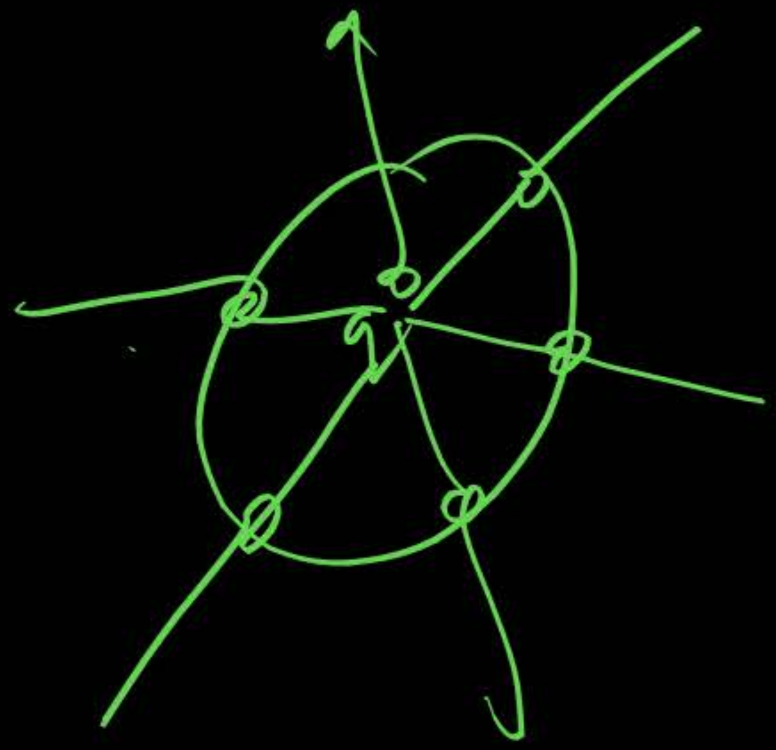
same flux





$\phi_{q_1} = \phi_{q_2} = \phi_{q_3}$



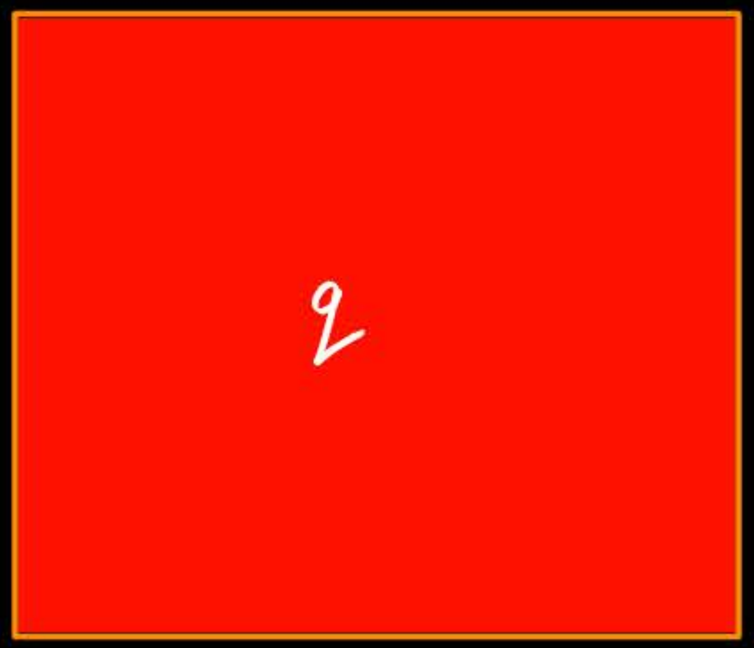


$\phi = 0$

zero

Yours & mine
dream going to
be true

M.R. Physics



Square plate

find flux Passing through this square plate = 0


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 13 | Physics

Electric Charges and Fields

By- Dr. Manish Raj (MR SIR)



Topics to be covered

Application of Gauss Law

(1) flux

(2) electric field.

1 #

2 #

3 #



$\phi = \int \vec{E} \cdot d\vec{A} = \frac{q_{in}}{\varepsilon_0}$ ⟶ No this is flux but not Gauss Law.

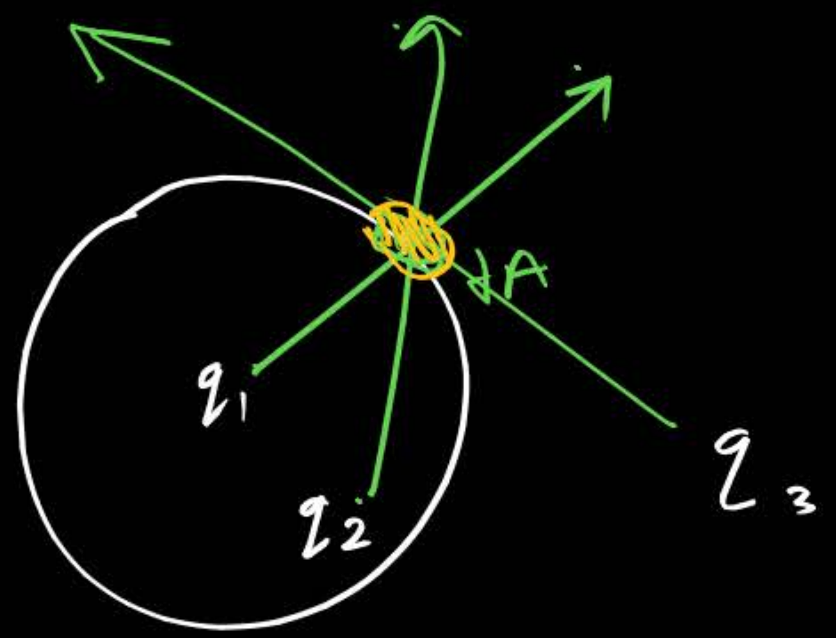
$\phi = \oint \vec{E} \cdot d\vec{A} = \frac{q_{in}}{\varepsilon_0}$ ⟶ flux through close surface, & Gauss Law

$$\phi = \oint \vec{E} \cdot d\vec{A} = \frac{q_{in}}{\varepsilon_0}$$



Gauss law valid for both surface. but to calculate electric field not always applicable.

Gauss Law is always valid, but not always applicable to calculate electric field.



$$\oint \vec{E} \cdot d\vec{A} = \frac{q_{in}}{\varepsilon_0}$$

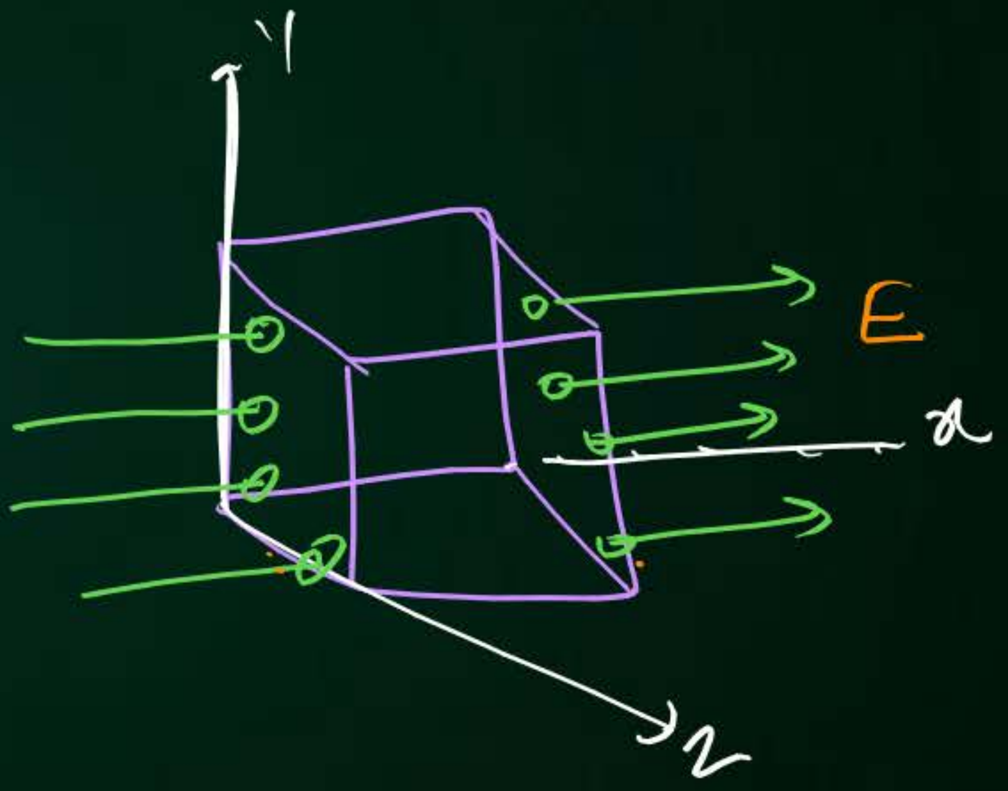
q_{in} = All enclosed charges $= q_1 + q_2$

$\vec{E}$ = due to all the charges present inside and outside

QUESTION

There is uniform electric field of $8 \times 10^3 \hat{\imath}$ N/C. What is the net flux (in SI units) of the uniform electric field through a cube of side 0.3 m oriented so that its faces are parallel to the coordinate plane?

1. $2 \times 8 \times 10^3$
2. $0.3 \times 8 \times 10^3$
3. Zero // Ans
4. $8 \times 10^6 \times 6$



GAUSS LAW

The total flux passing through any close surface is equal to $\frac{q}{\varepsilon_0}$

flux = no. of electric field lines = $\frac{q_{in}}{\varepsilon_0}$

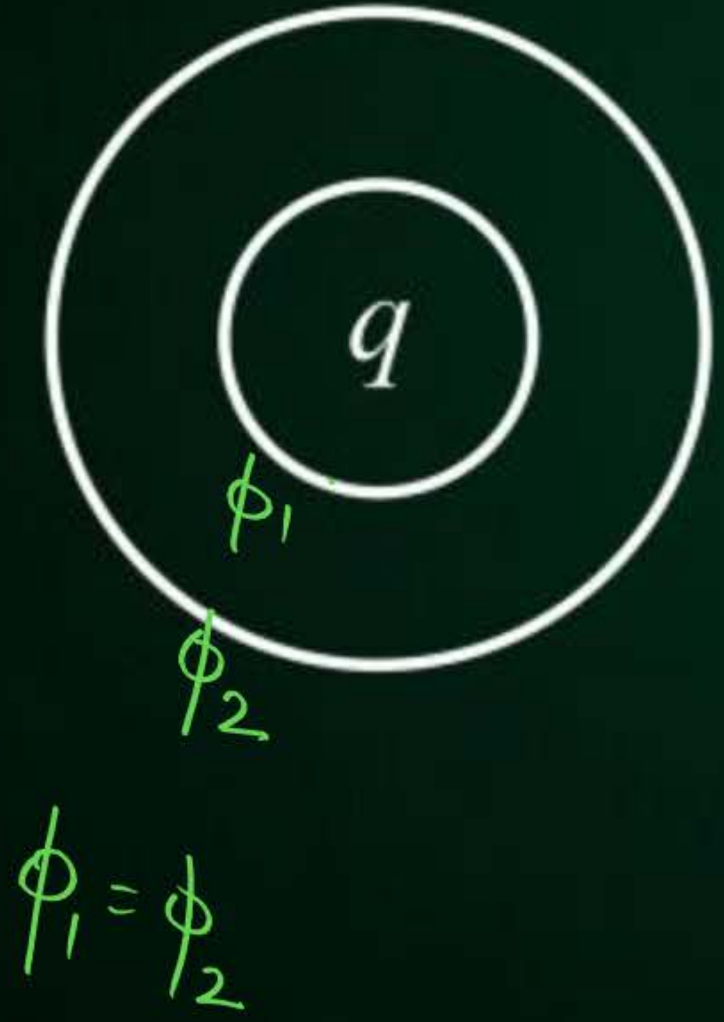
GAUSS LAW

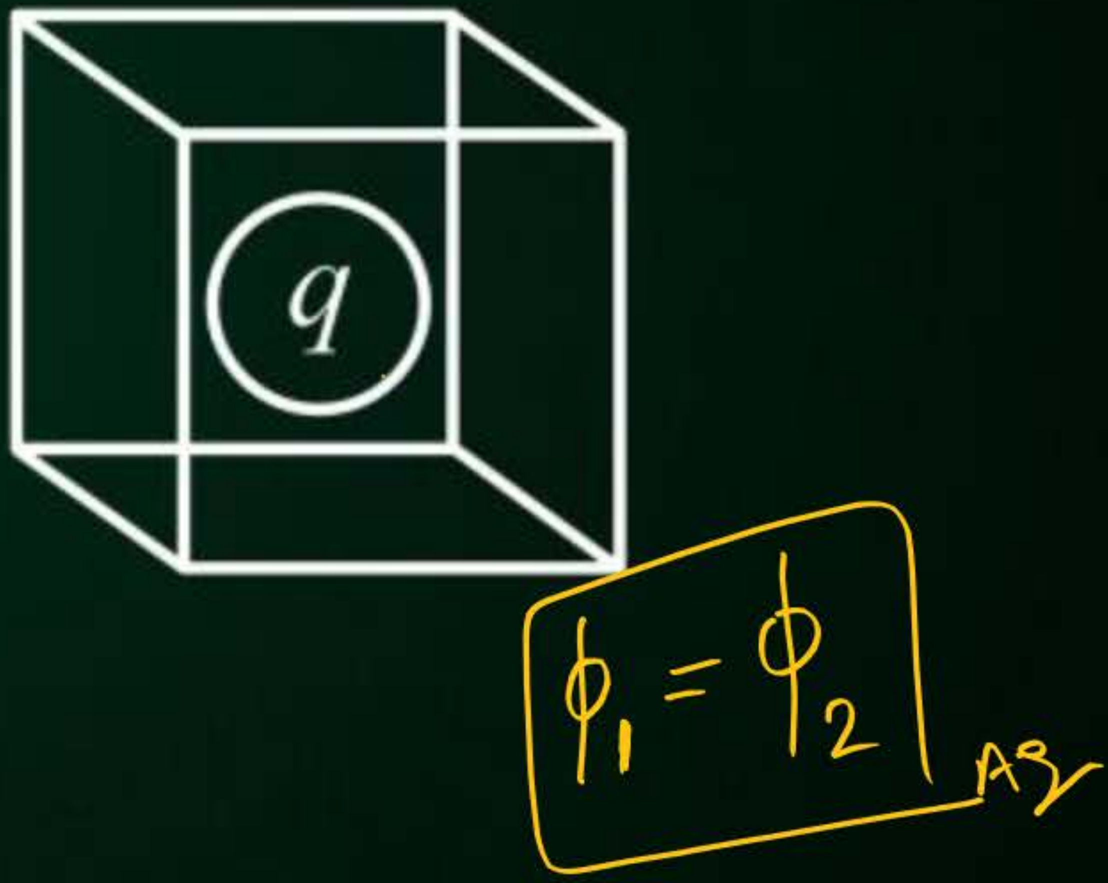
The electric Flux passing through a closed surface 'S' is equal to $\frac{q}{\varepsilon_0}$, where q is total charge enclosed by surface



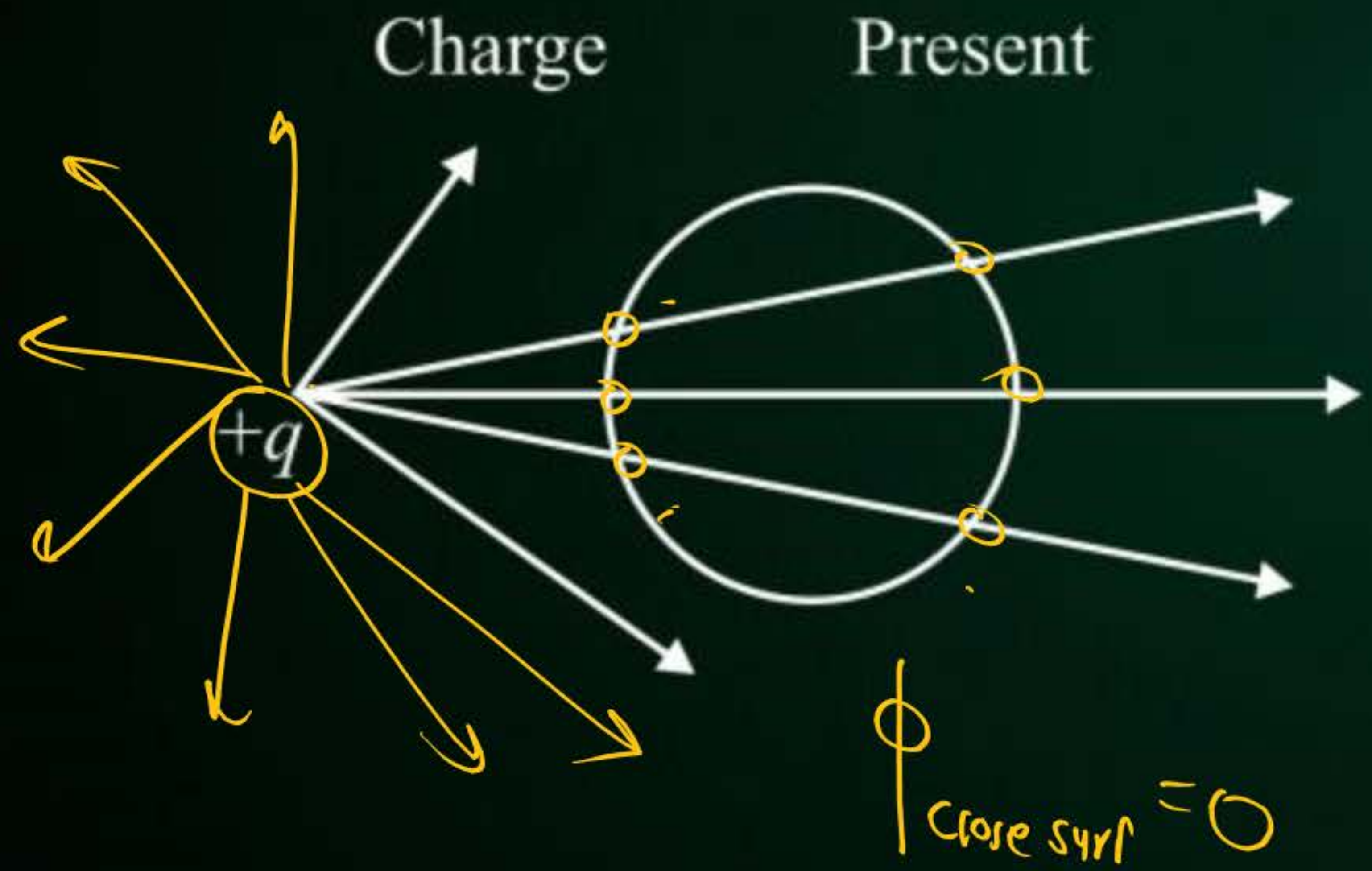
IMPORTANT POINT

1. Gauss Law is true for nay closed surface, no matter what its shape or size only depends on charge enclosed.

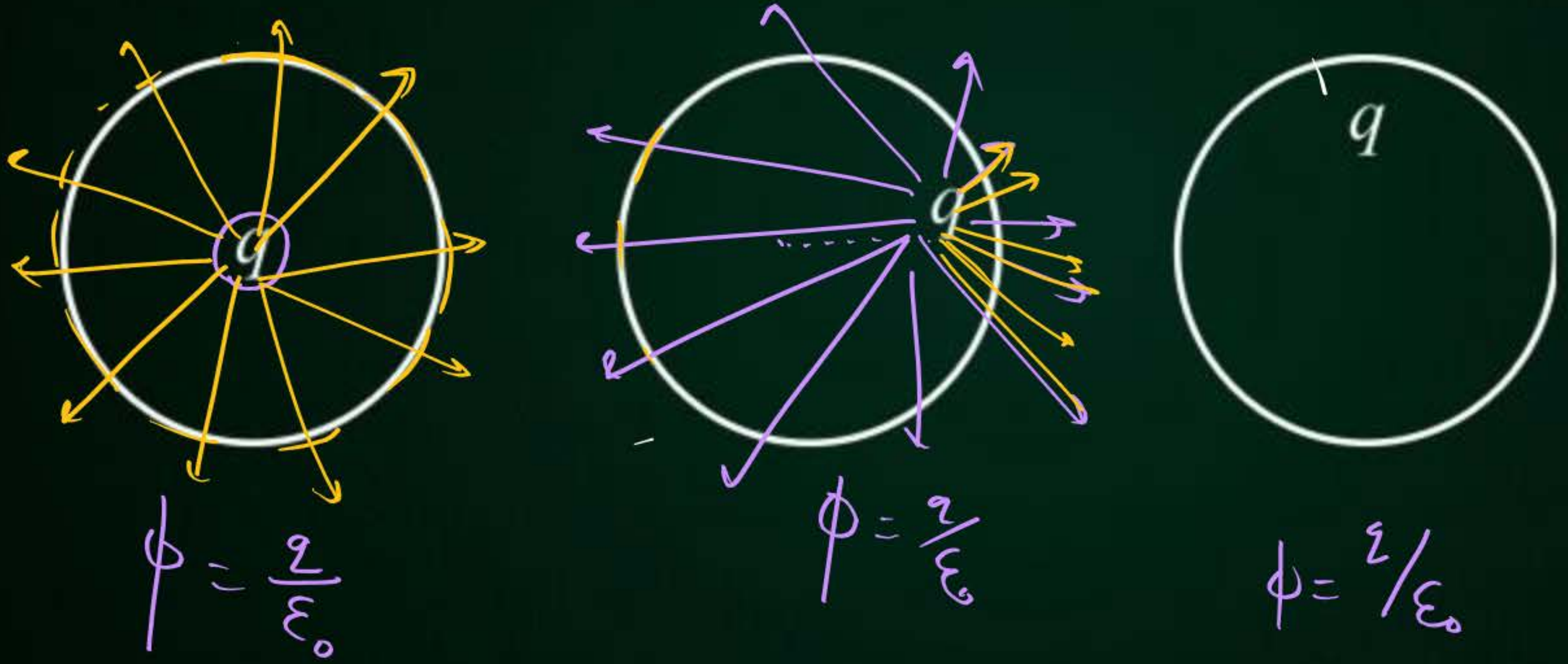




2. If no charge is enclosed then, total flux must be zero. it does not depends on charge present outside the surface.

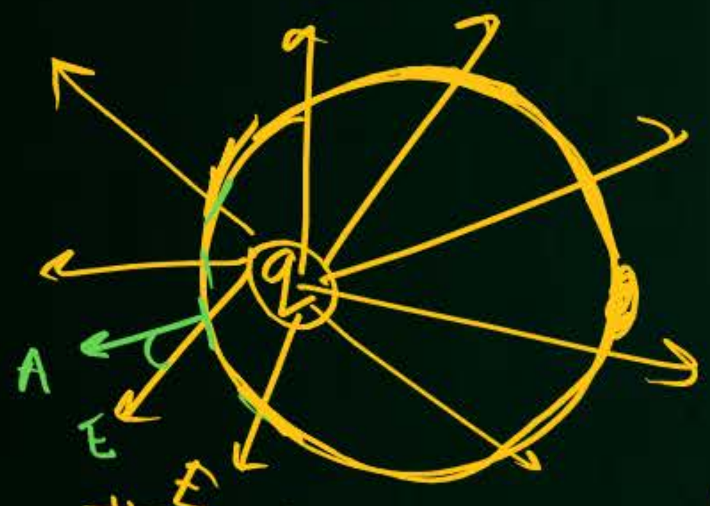


3. **Flux through close surface does not depend on location of enclosed charge.**

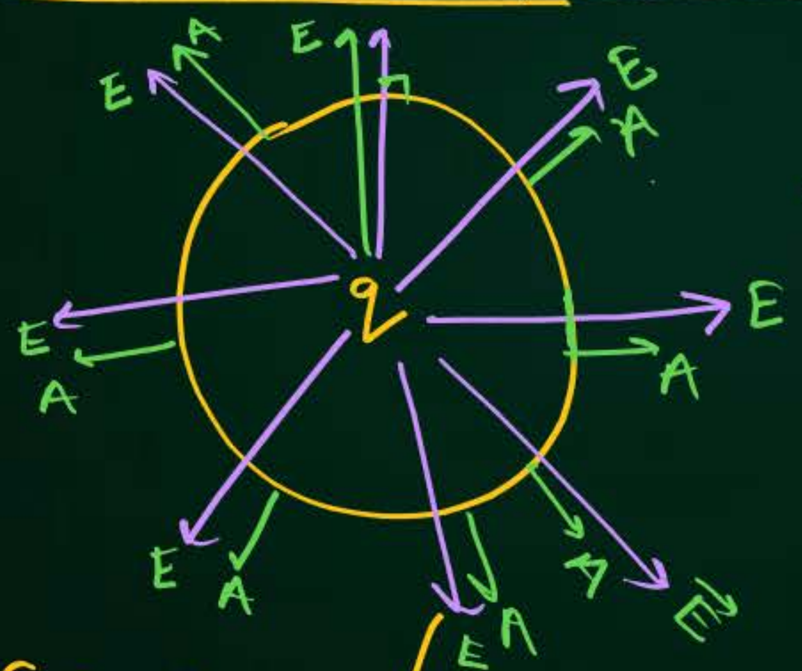


5. Gaussian surface:

Gauss Law useful and easy to calculate electric field when system have some symmetry; this is achieved by choice of a suitable Gaussian surface



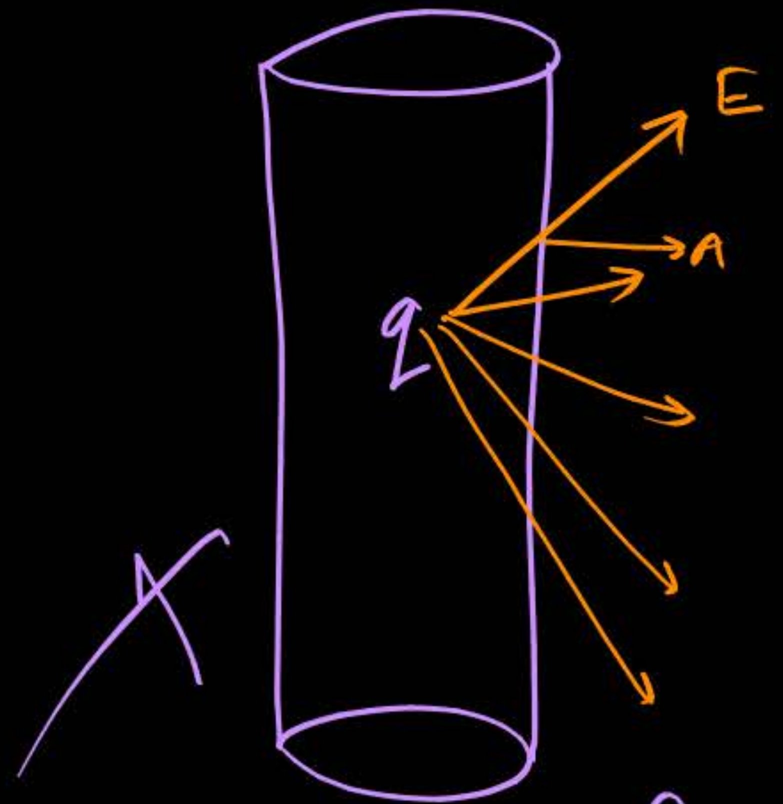
Gauss law is valid but to calculate electric field using Gauss law is not applicable here.



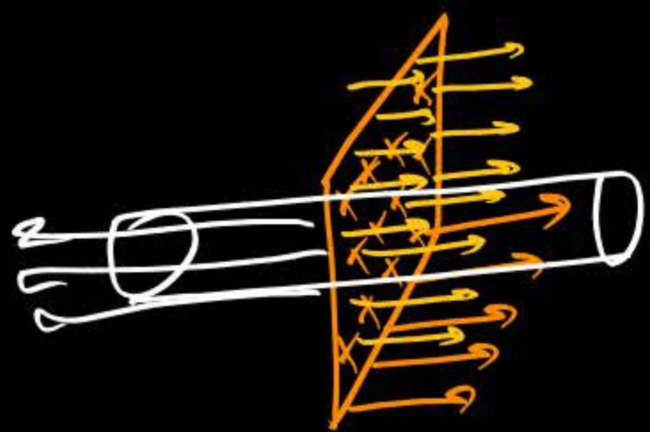
$\oint \vec{E} \cdot \vec{dA} = q/\epsilon_0$ ✓

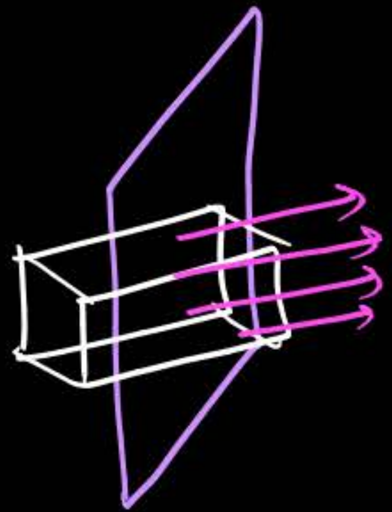
← Gauss Law valid & to calculate electric field it is applicable. ✓

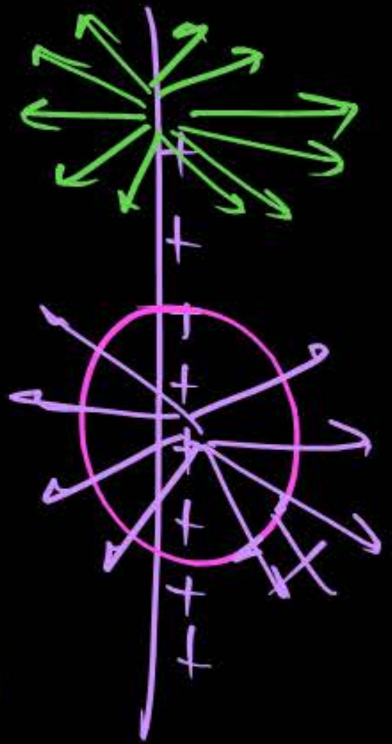
Point charge → spherical Gaussian surface.
spherical charge → " " Gaussian surface
line charge → cylindrical Gaussian sfare.
charge plate → " → cylindrical, cubical "

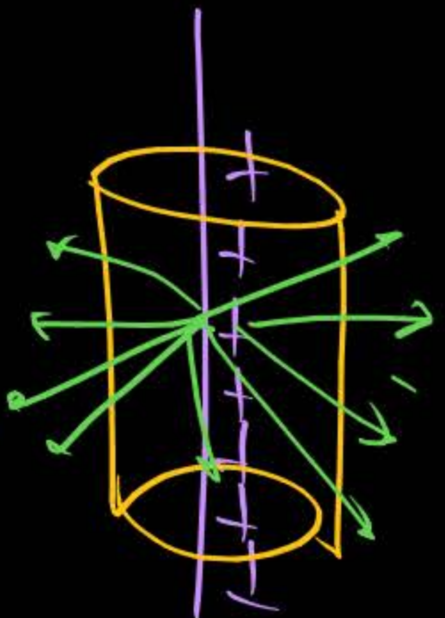


cylindrical Gaussian surface is not useful for Point charge



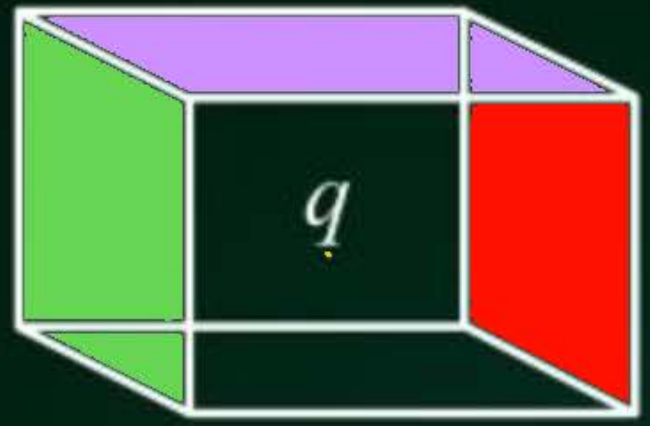






QUESTION

Find flux through cube in given situation, charge is placed at centre of cube.

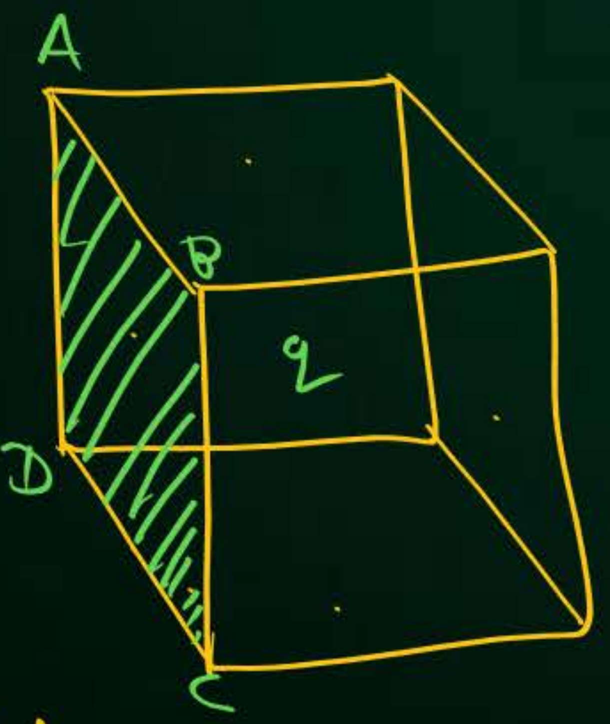


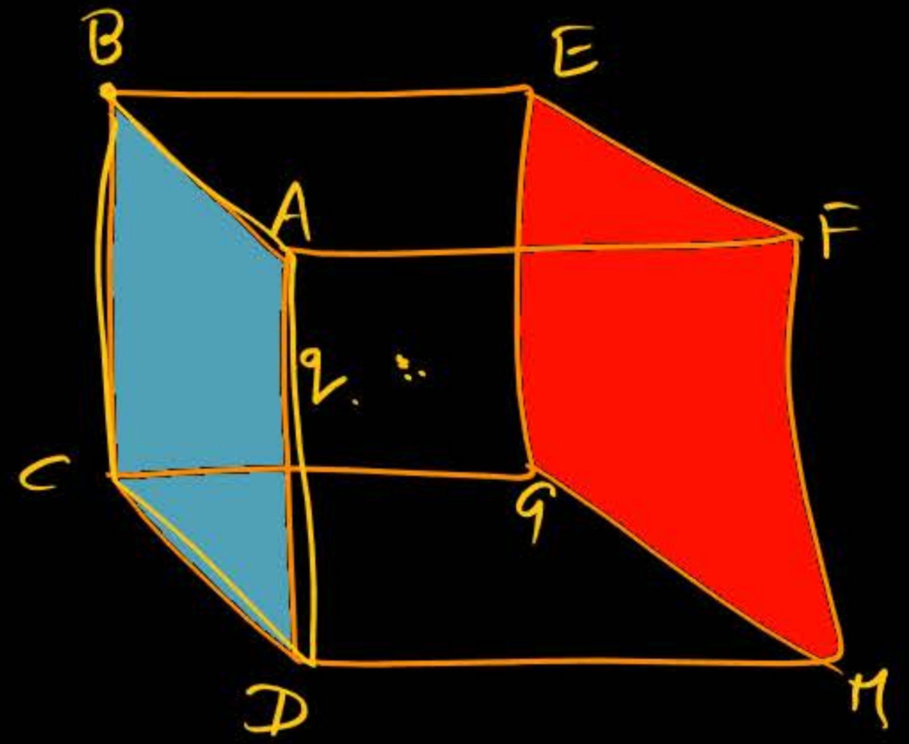
$$\phi_{cube} = \frac{q}{\varepsilon_0}$$

$$6\phi_{\text{each phase}} = \frac{q}{\varepsilon_0}$$

$$\phi_{\text{each phase}} = \frac{q}{6\varepsilon_0}$$

Ans.





$\phi_{cube} = \frac{q}{\varepsilon_0}$

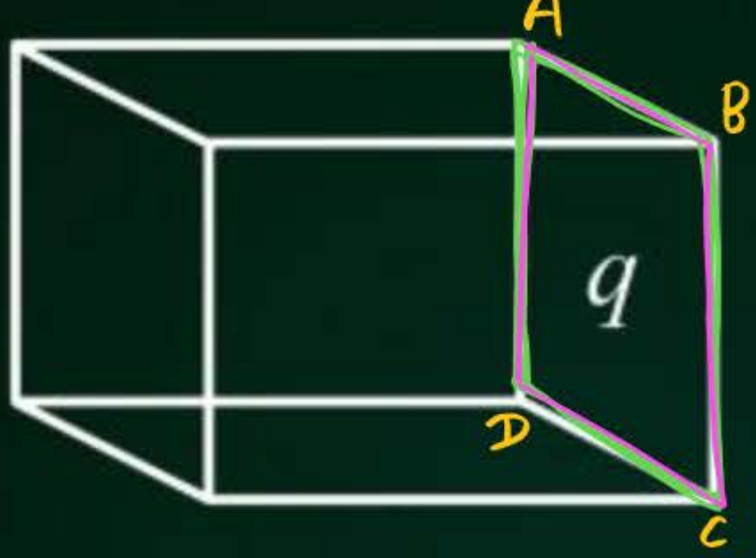
$$\left\{ \begin{array}{l} \phi_{ABCD} > \frac{q}{6\varepsilon_0} \\ \phi_{EFGH} < q/6\varepsilon_0 \end{array} \right\}$$

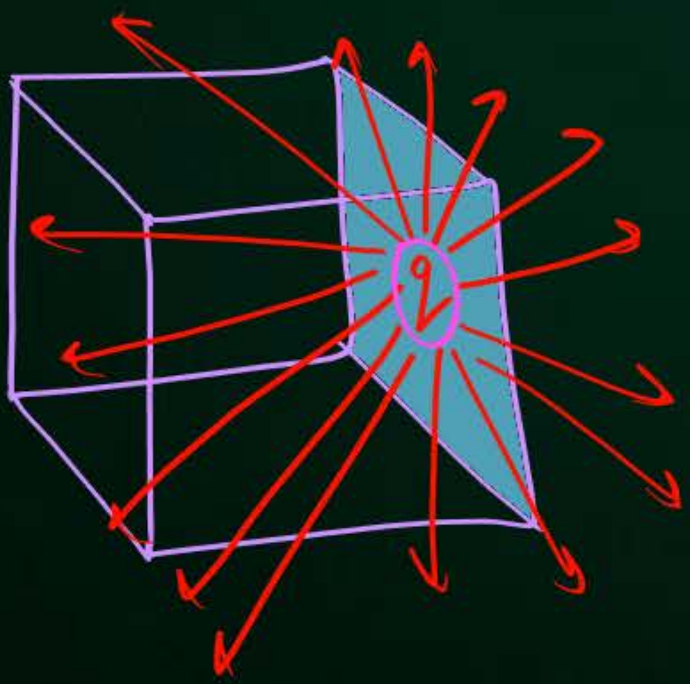
QUESTION

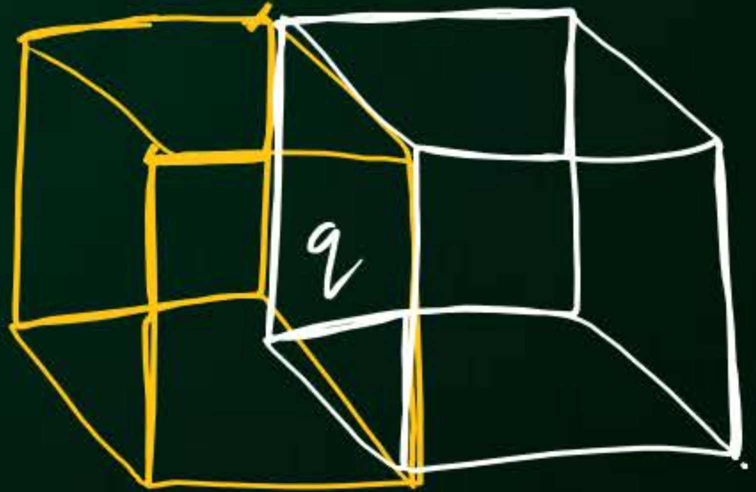
Charge is placed at centre of one phase then flux through cube?

$\phi_{ABCD} = ??$

$\phi_{ABCD} = 0$



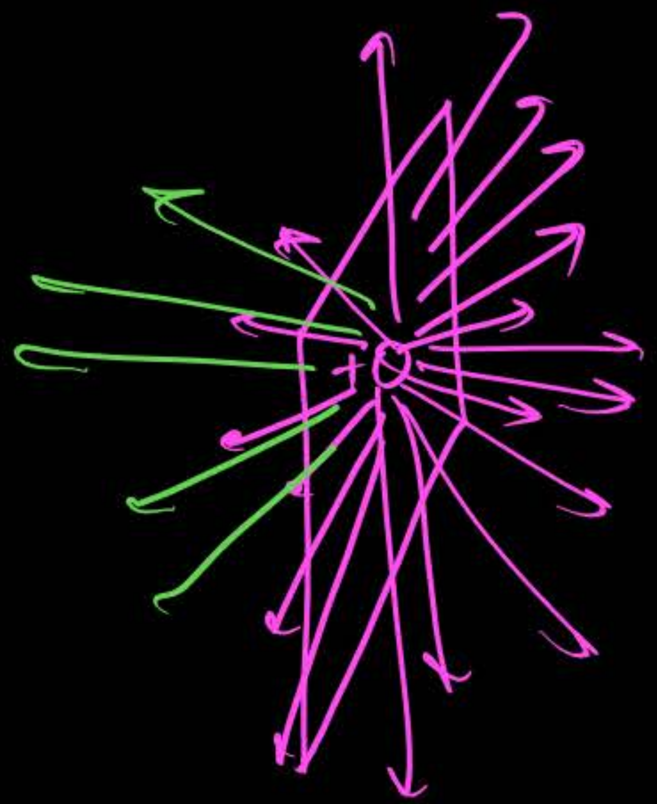


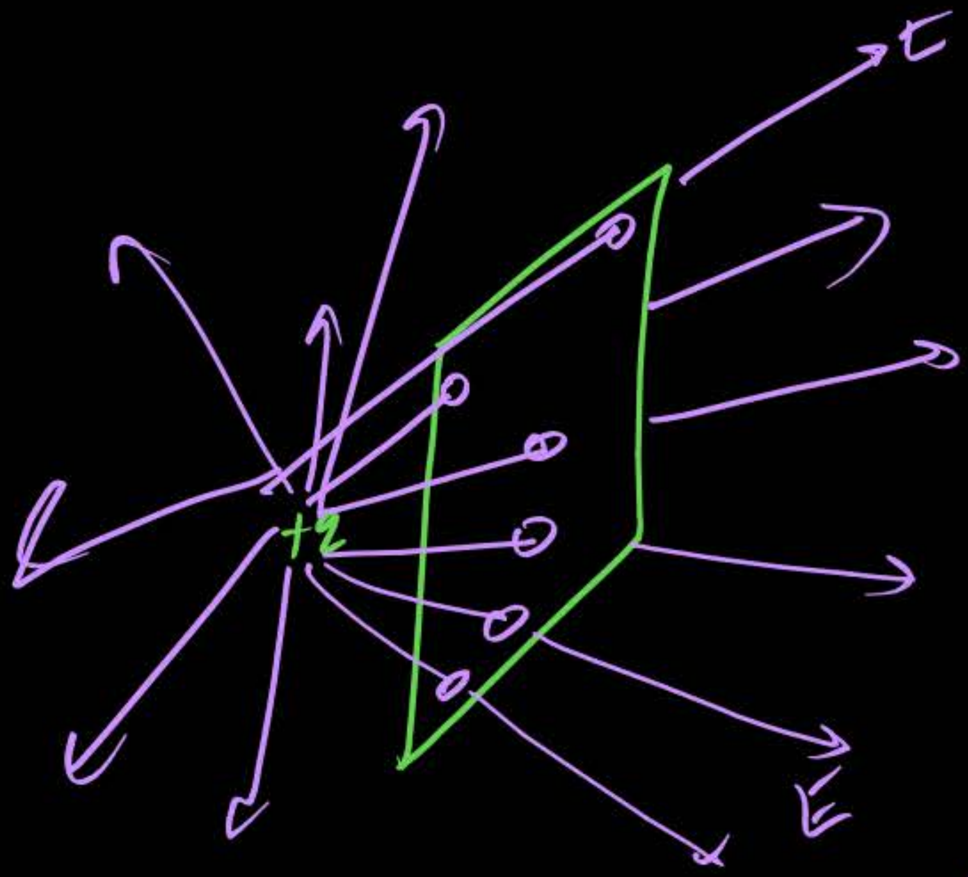


$\phi_{\text{close sur}} = \frac{q}{\varepsilon_0}$

$2\phi_{\text{cube}} = \frac{q}{\varepsilon_0}$

$\phi_{\text{cube}} = \frac{q}{2\varepsilon_0}$ Ans





$$\Phi_{plate} \neq 0$$

Revision ki planning ??

⟹ last one month se planning chal rahi thi ?

→ Monday se start karenge

☆ → Not for all. [Not mendatory for all]

→ Timing evening में होगी !!

⇒ Lakshya ke liye Mendate but for yakeen

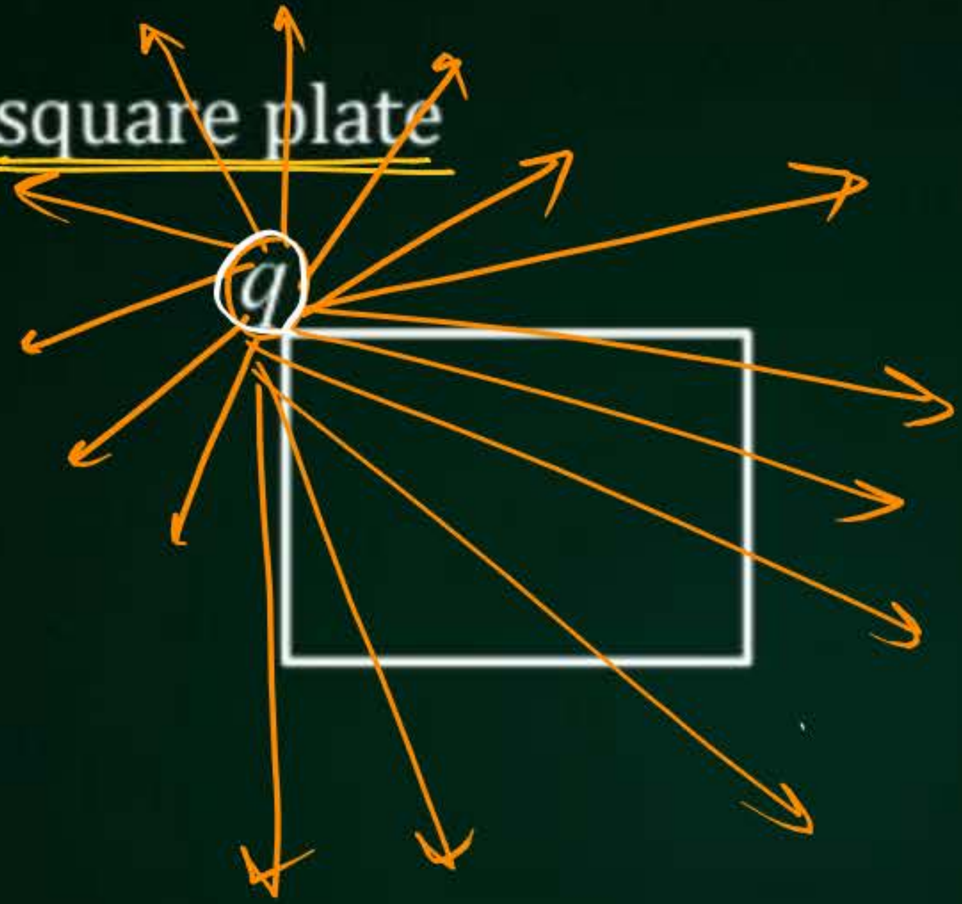
⇒ Basic se revision karenge

Live

⇒ Pdf → #MR. Physics ke sath

QUESTION

Charge is at corner of square plate

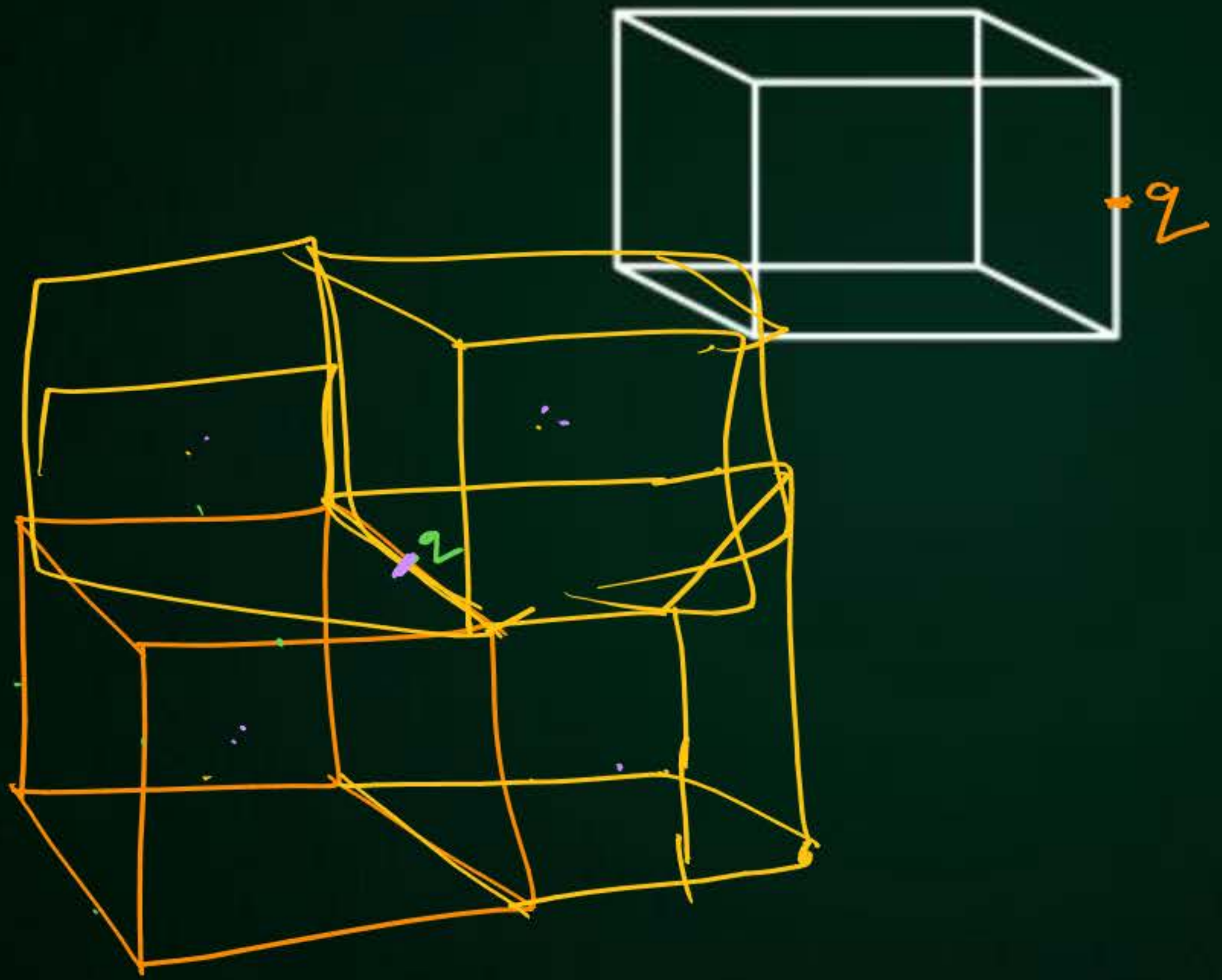


$$\phi_{plate} = 0$$

Ans.

QUESTION

Charge is at mid of side.



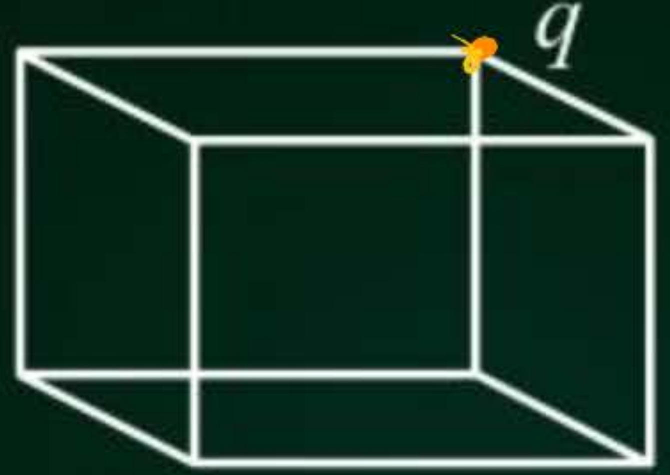
$$\phi_{\text{close surf}} = \frac{q}{\varepsilon_0}$$

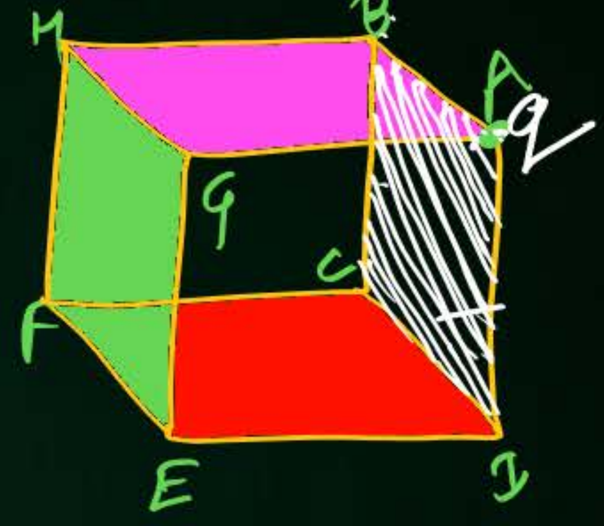
$$4\,\phi_{cube} = \frac{q}{\varepsilon_0}$$

$$\phi_{1\,cube} = \frac{q}{4\varepsilon_0}$$ Ans

QUESTION

Charge is at corner of cube:





$$\phi_{\text{Close surface}} = \frac{q}{\varepsilon_0}$$

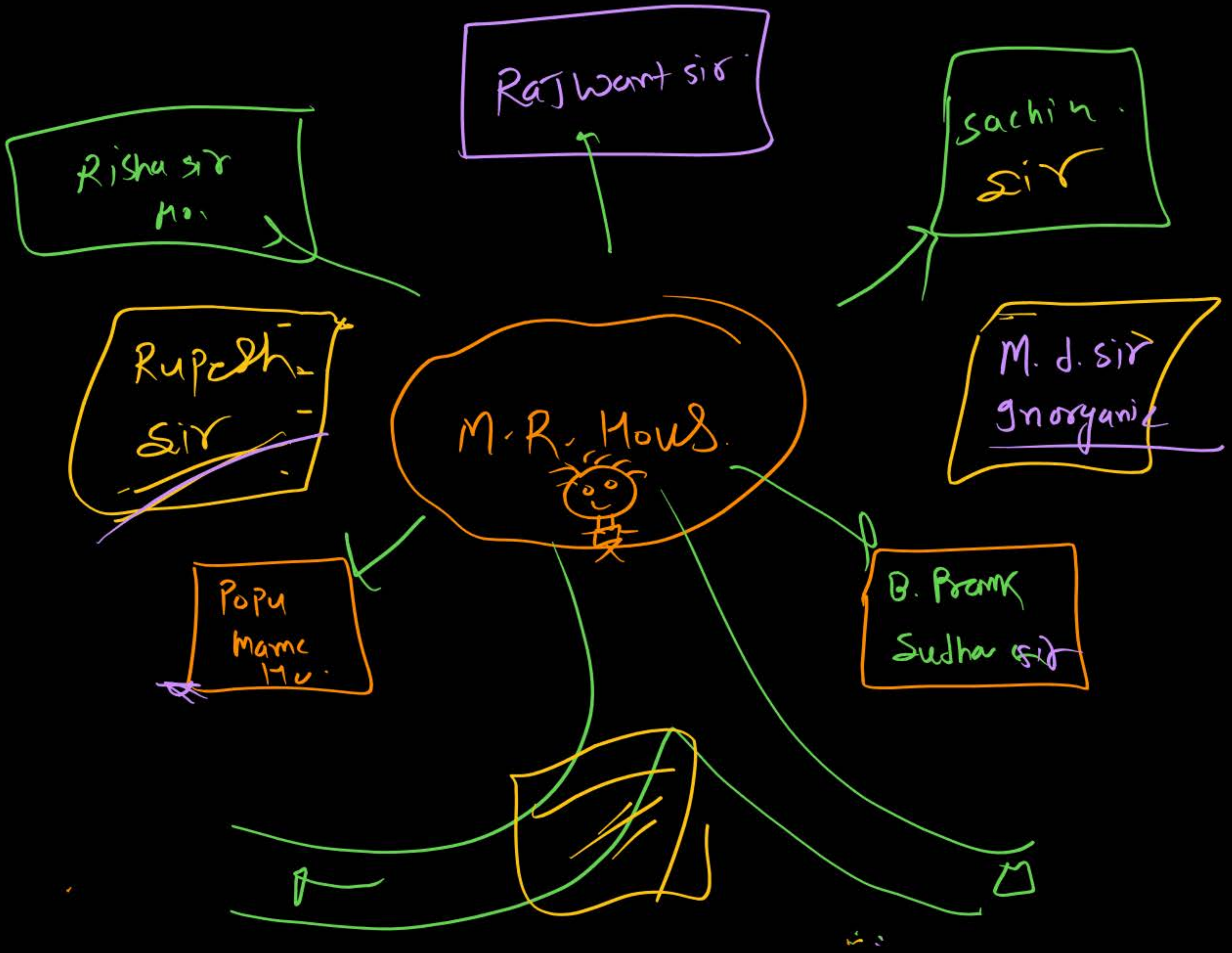
$$8\,\phi_{1\,\text{cube}} = \frac{q}{\varepsilon_0}$$

$$\phi_{1\,\text{cube}} = \frac{q}{8\varepsilon_0} \quad \text{Ans}$$

$$\phi_{ABCD} = 0$$
$$\phi_{ABGH} = 0$$
$$\phi_{AGED} = 0$$

$$3 \times \phi_{GHFE} = \phi_{1\,\text{cube}} = \frac{q}{8\varepsilon_0}$$

$$\phi_{GHFE} = \frac{q}{24\varepsilon_0} \quad \text{Ans}$$



RaJwant sir
Risha sir
Mo.
sachin
sir
Rupesh
sir
M. R. Mous.
M. d. sir
gnorganic
Popu
Mame
Mu.
B. Bank
Sudha sir

QUESTION

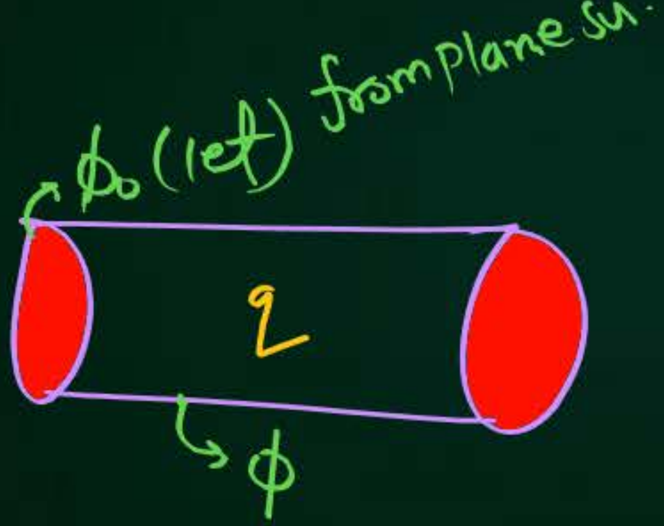
A hollow cylinder has a charge q coulomb within it. If ϕ is the electric flux in units of voltmetre associated with the curved surface B, the flux linked with the plane surface A in unit of voltmetre will be (charge is symmetrically placed within it)

(1) $\frac{q}{\varepsilon_0} - \phi$

(2) $\frac{1}{2}\left(\frac{q}{\varepsilon_0} - \phi\right)$ ✓

(3) $\frac{q}{2\varepsilon_0}$

(4) $\frac{\phi}{3}$





$\phi_{cylinder} = \frac{q}{\varepsilon_0}$

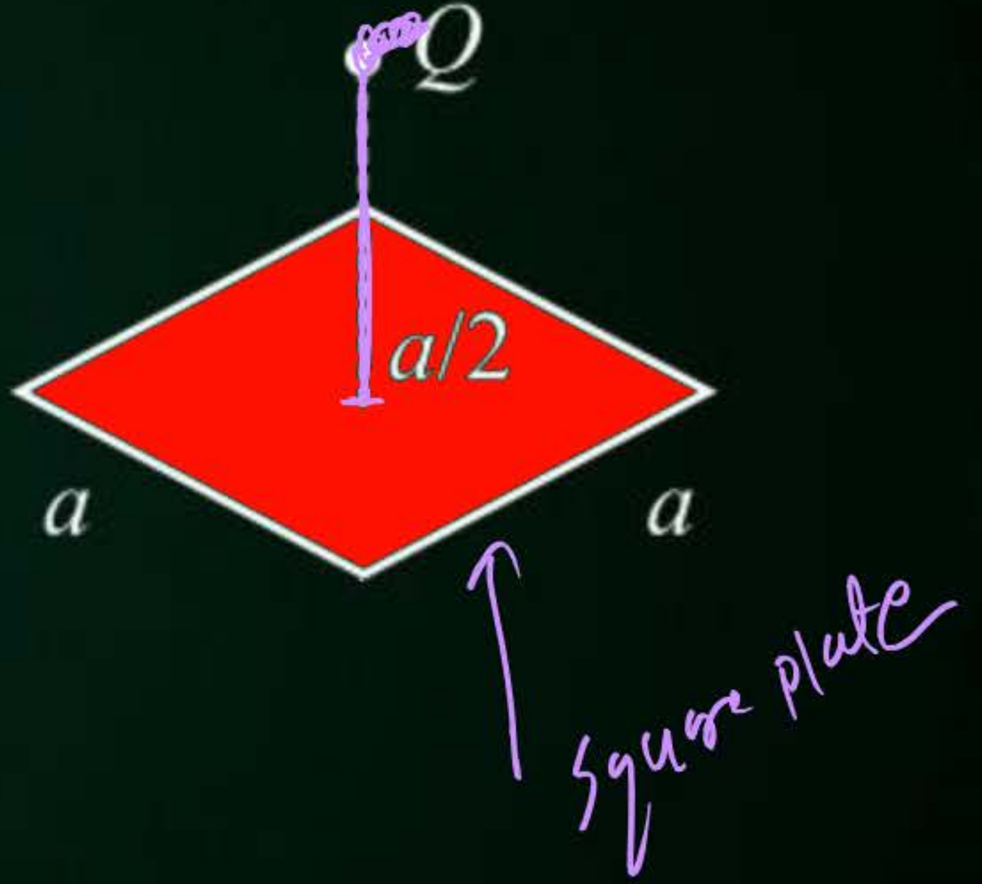
$\phi + 2\phi_0 = \frac{q}{\varepsilon_0}$

$2\phi_0 = \frac{q}{\varepsilon_0} - \phi$

$\phi_0 = \left(\frac{q}{\varepsilon_0} - \phi\right)\frac{1}{2}$

QUESTION

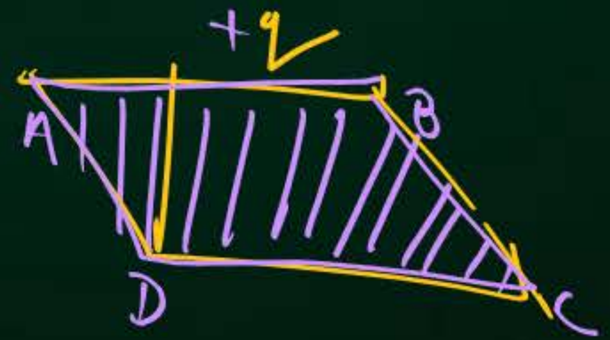
A charge Q is placed at a distance $a/2$ above the centre of a horizontal, square of edge 'a' as shown in figure. Fid the flux of the electric field through the square surface.



$\phi = \frac{q}{6\varepsilon_0}$

Think ??

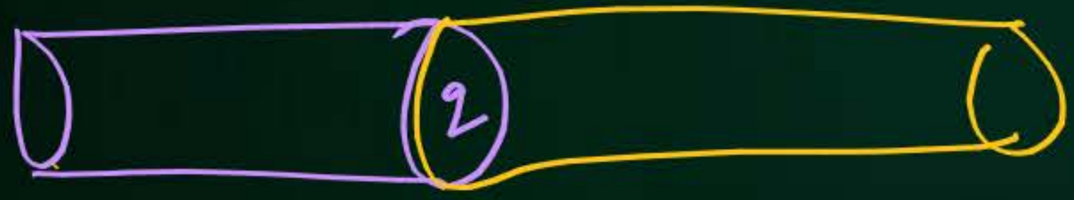
How



QUESTION

A charge q is placed at the centre of the open end of a cylindrical vessel. The flux of the electric field through the surface of the vessel is

1. Zero
2. $\dfrac{q}{\varepsilon_0}$
3. $\dfrac{q}{2\varepsilon_0}$
4. $\dfrac{2q}{\varepsilon_0}$



$\phi_{cylinder} = q/2\varepsilon_0$

QUESTION

A charge Q is kept at the corner of a cube. Electric flux passing through one of those faces not touching that charge is

1. $\frac{Q}{24\varepsilon_0}$
2. $\frac{Q}{3\varepsilon_0}$
3. $\frac{Q}{8\varepsilon_0}$
4. $\frac{Q}{6\varepsilon_0}$

QUESTION

A point charge is placed at the centre of spherical Gaussian surface. If electric flux ϕ_E changed if

(a) The sphere is replaced by a cube of same or different volume? → No change

(b) The charge is moved off-centre in the original sphere, still remaining inside? No change

(c) The charge is moved just outside the original sphere? → yes

(d) A second charge is placed near the outside of the original sphere? No change

(e) A second charge is placed inside the Gaussian surface? → Yes

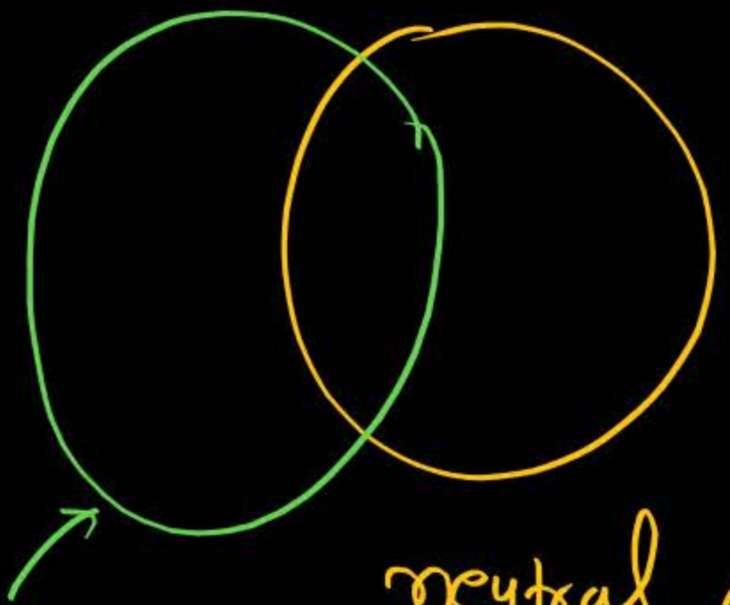


$\phi = q/\epsilon_0$



$\phi = 0$ Ans

dipole enclosed by spherical surface.



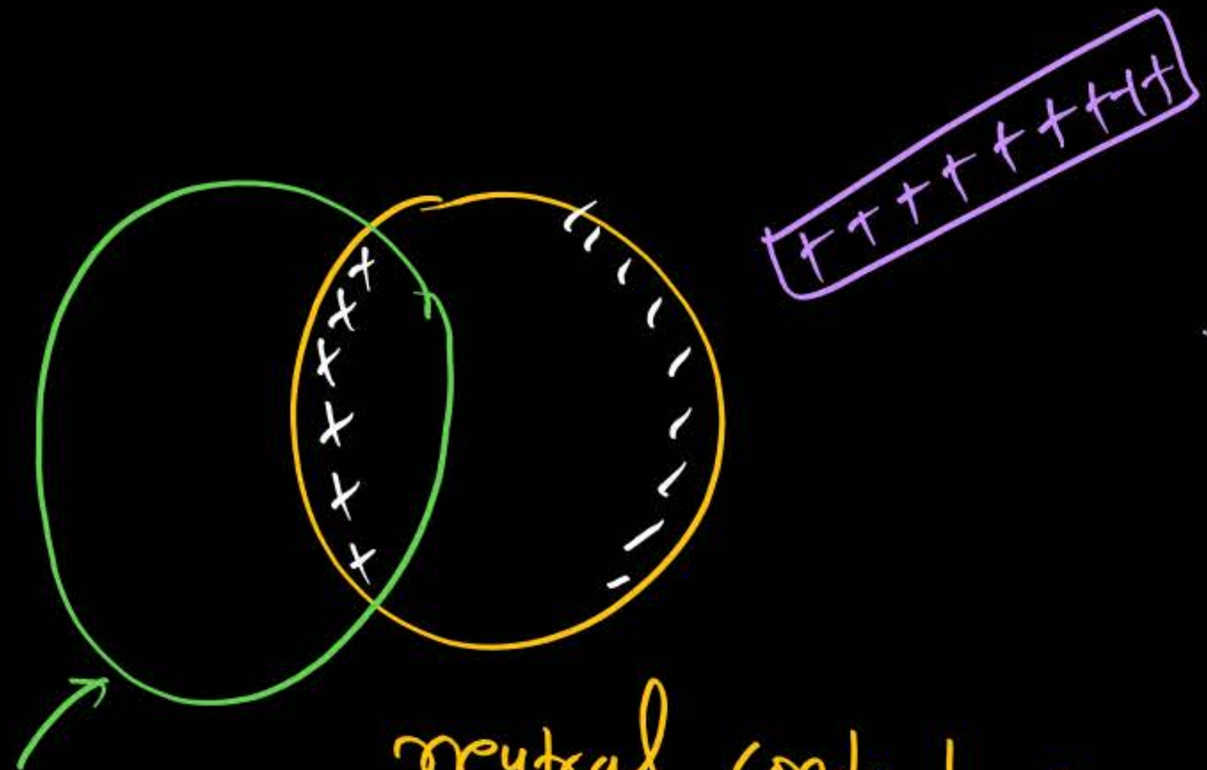
Gaussian Close Surface

$\phi = 0$

neutral conductor

$Q_{net} = 0$

+ve 9f charge Rod placed near to conductor, then flux passing through Gaussian surface.



Gaussian Close Surface

neutral conductor

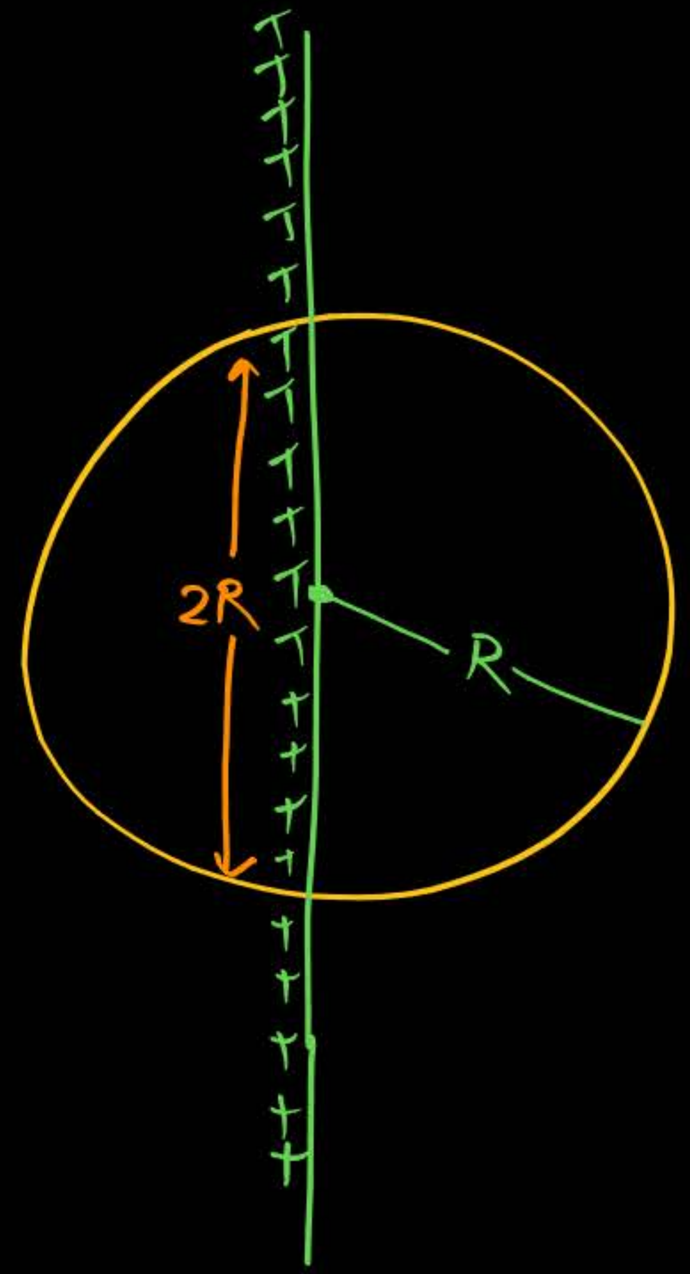
(a) $\phi = 0$ ✗

(b) $\phi = +ve$

(c) $\phi = -ve$

Ans

A Rod of linear charge density λ is placed inside sphere of Radius R as shown in figure. then find flux passing through sphere.

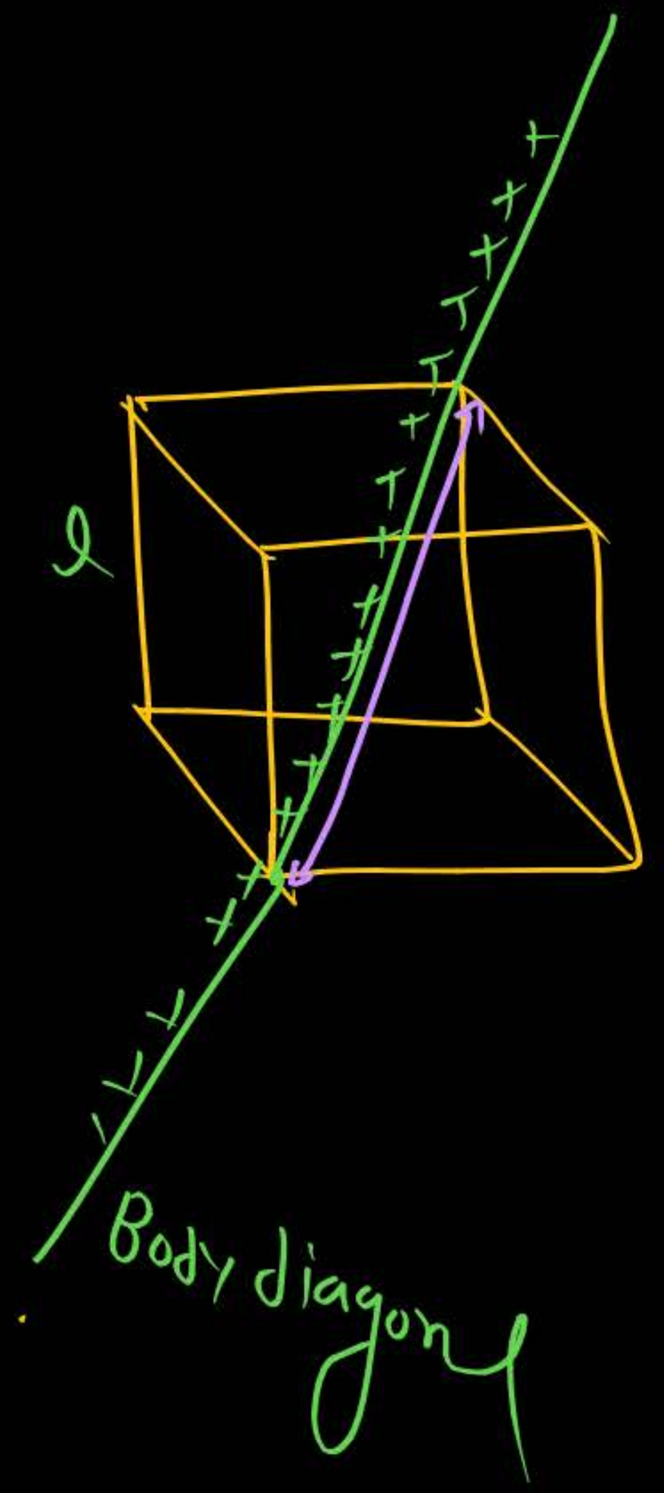


charge enclosed by sphere

$= \lambda 2R$ — (1)

$$\phi_{sphere} = \frac{\lambda 2R}{\varepsilon_0}$$

Ans



$$\phi = \frac{\sqrt{3}\, l \lambda}{\varepsilon_0}$$

Total flux passing through sphere ??

Sol^n

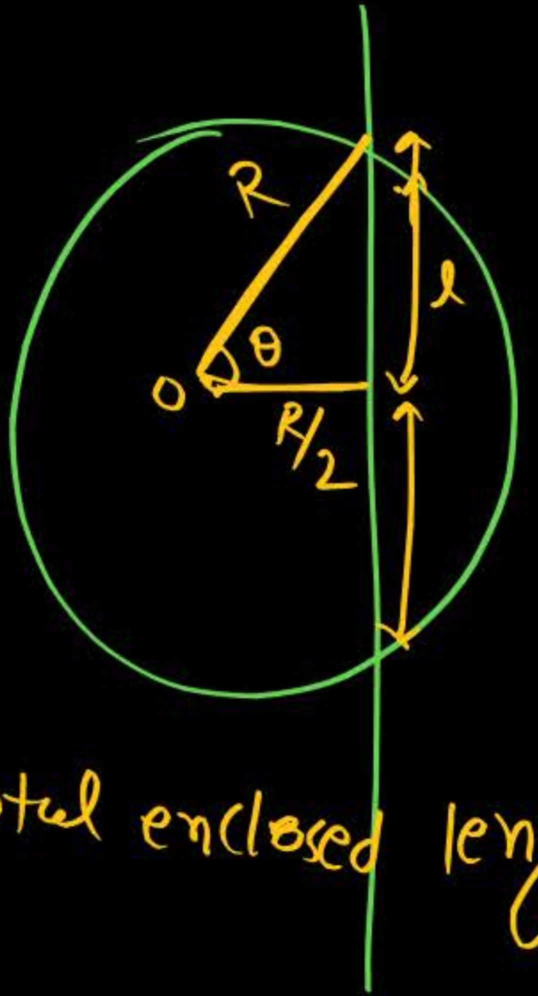
$\cos\theta = \frac{R}{2R}$

$\cos\theta = \frac{1}{2}$

$\theta = 60^\circ$

$\sin 60 = \frac{l}{R}$

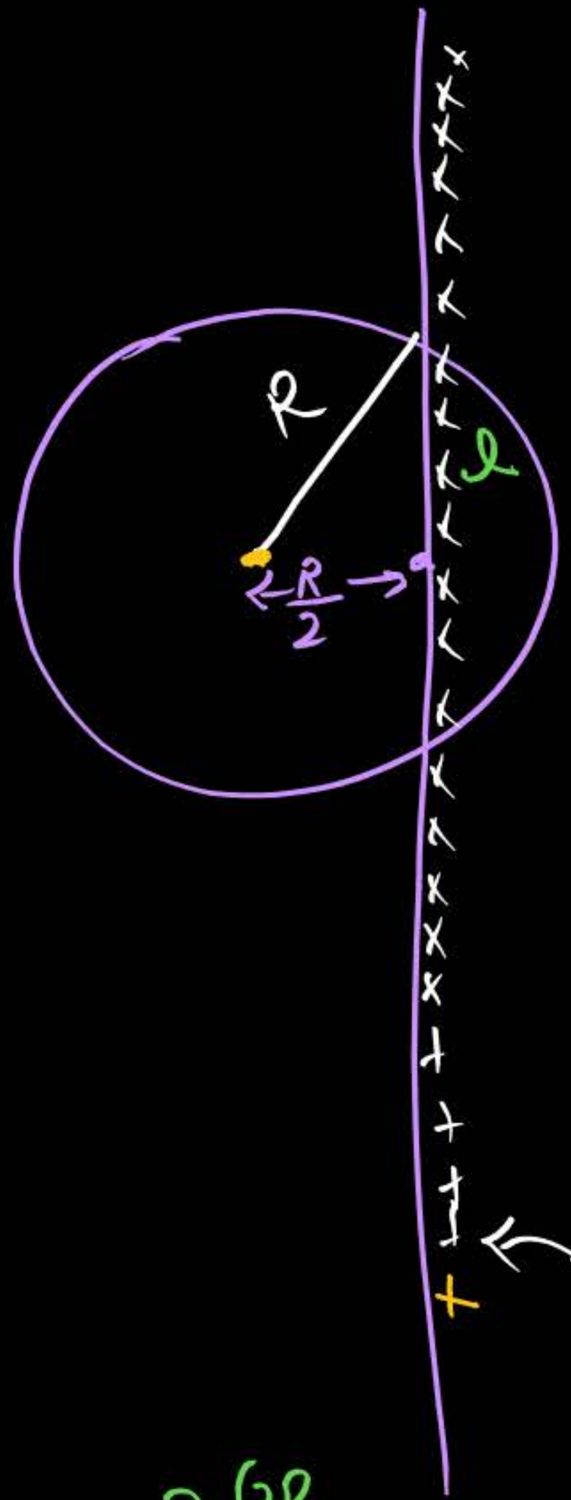
$\frac{\sqrt{3}}{2}R = l$



total enclosed length $= \sqrt{3}R$

$q_{enc} = \lambda\sqrt{3}R$

$\phi = \frac{\lambda\sqrt{3}R}{\varepsilon_0}$ A



$l^2 + \left(\frac{R}{2}\right)^2 = R^2$

$l = \sqrt{R^2 - \frac{R^2}{4}}$

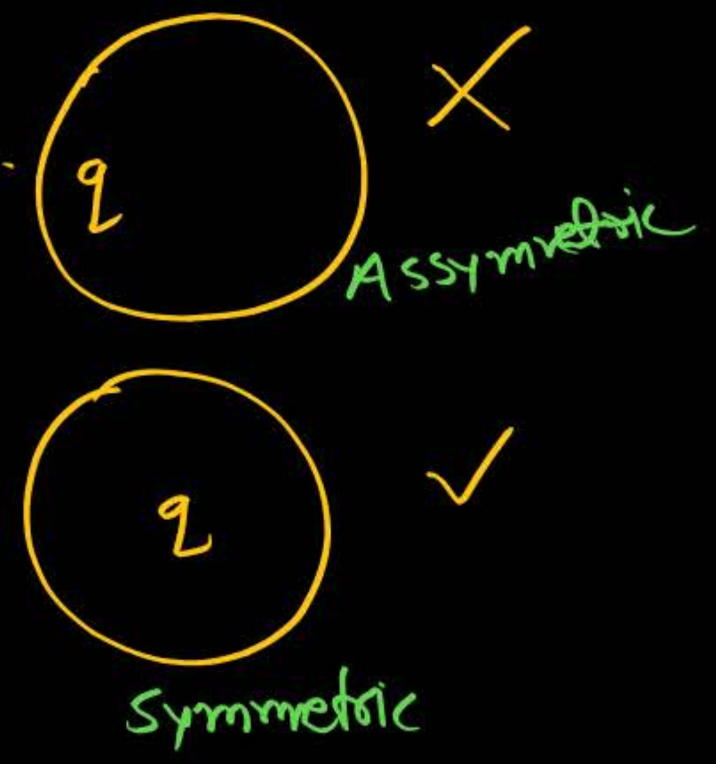
$l = \frac{\sqrt{3}R}{2}$

$\lambda \rightarrow$ charge per unit length

application of Gauss law to calculate electric field

steps to Apply Gauss law

1. take close and symmetric Gaussian surface.
2. that surface must be passing through point where electric field have to calculate.
3. Angle b/w $\vec{E}$ & Area must be 0° 90°, or 180° ✓



(*) 4. Gaussian surface may pass through continous charge distribut but must not passing throu discrate charge

5. Now apply $\oint \vec{E} \cdot d\vec{A} = \frac{q_{in}}{\varepsilon_0}$.

Step to Calculate Electric Field Using Gauss Law

1. Draw close-symmetric gaussian surface.

2. Gaussian surface must be passing through the point where electric field have to be calculate.

3. Gaussian surface must be symmetric to the change distribution.

4. Angle b/w Gaussian surface and electric field must be 0°, 90°, 180°.

Area

5. Apply $\oint \vec{E} \cdot d\vec{A} = \frac{q_{in}}{\varepsilon_0}$.

6. Gauss Law always valid for every type of charge distribution but only useful to calculate electric field when charge distribution is symmetric.

Step to Calculate Electric Field Using Gauss Law

1. Draw close-symmetric gaussian surface.

2. Gaussian surface must be passing through the point where electric field have to be calculate.

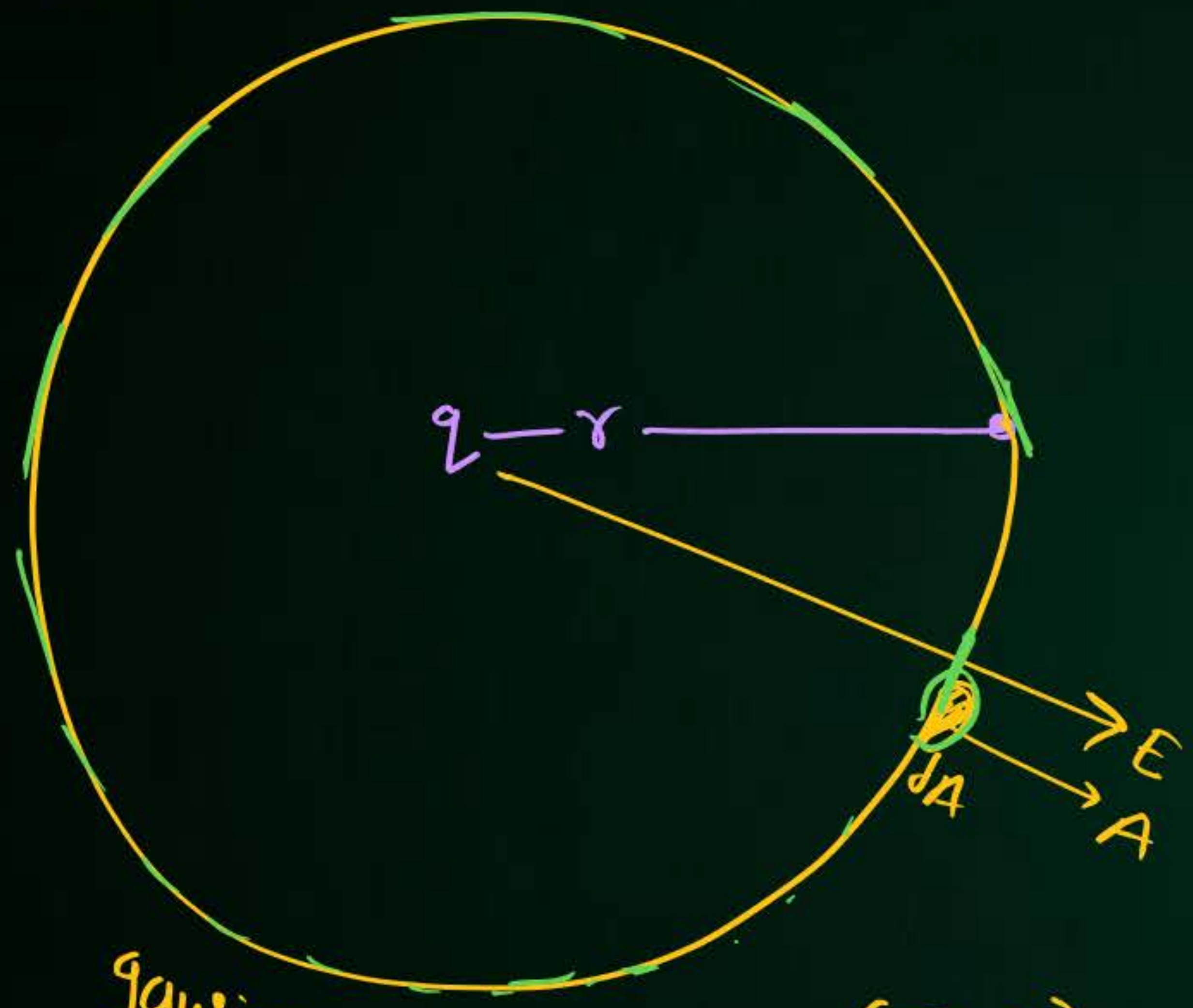
3. Gaussian surface must be symmetric to the change distribution.

4. Angle b/w Gaussian surface and electric field must be $0°$, $90°$, $180°$.

5. Apply $\oint \vec{E} \cdot d\vec{A} = \frac{q_{in}}{\varepsilon_0}$.

6. Gauss Law always valid for every type of charge distribution but only useful to calculate electric field when charge distribution is symmetric.

(i) Electric field due to Point charge using Gauss Law.



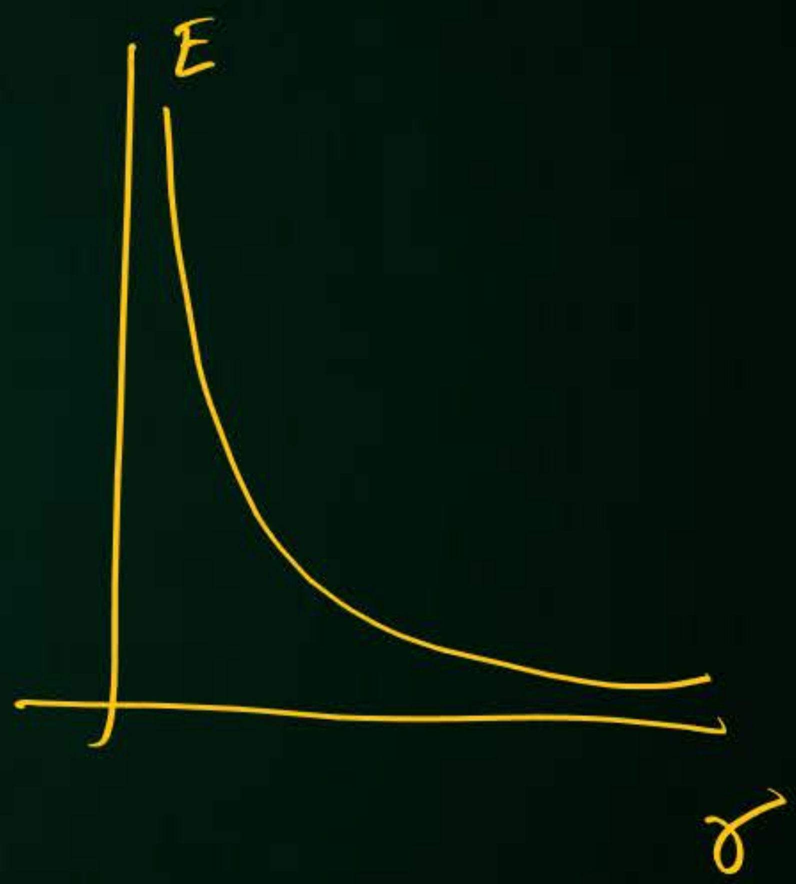
$$\oint \vec{E} \cdot \vec{dA} = \frac{q_{in}}{\varepsilon_0}$$

$$E \oint dA = \frac{q}{\varepsilon_0}$$

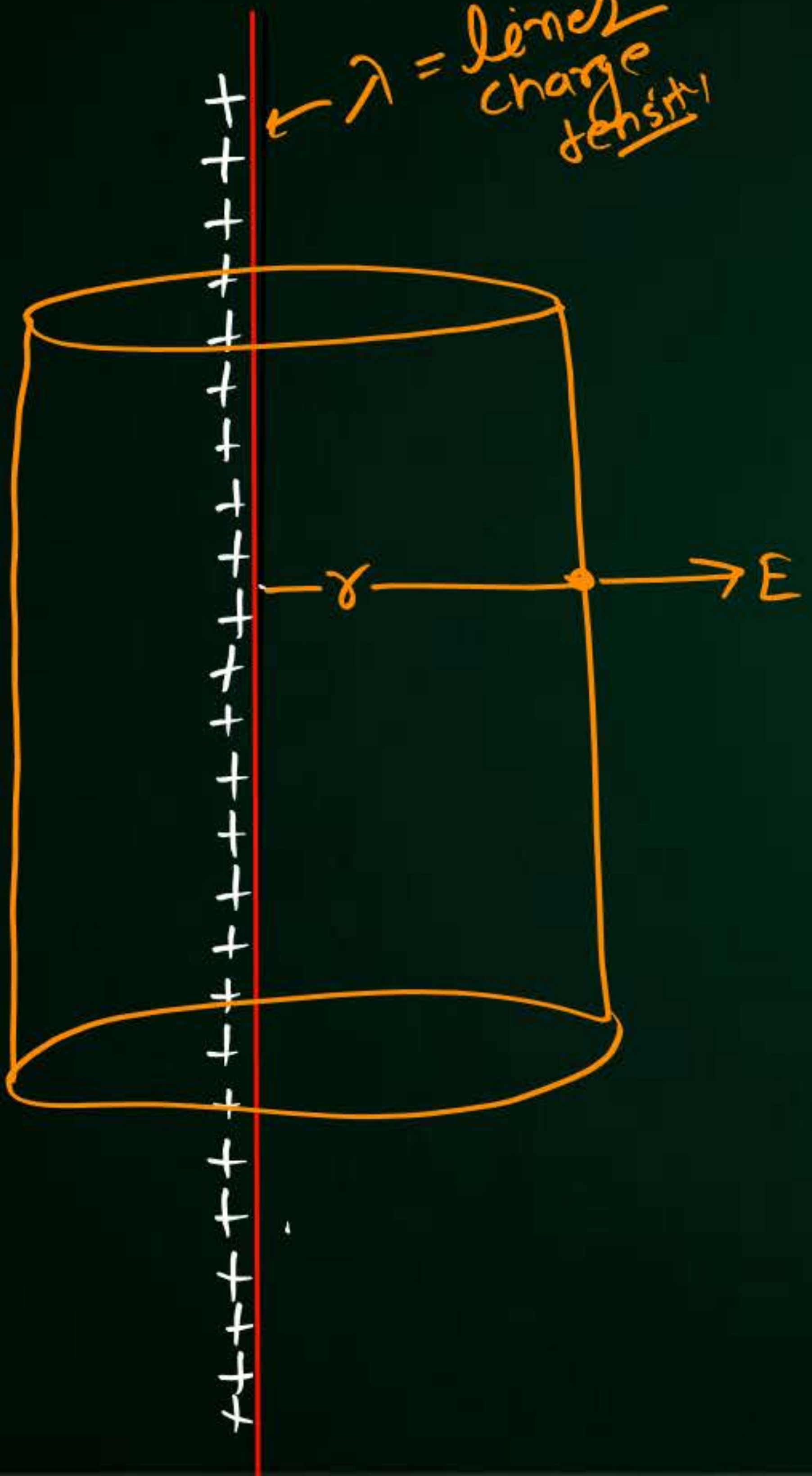
$$E\, 4\pi r^2 = \frac{q}{\varepsilon_0}$$

$$E = \frac{q}{4\pi\varepsilon_0 r^2}$$

$$E = \frac{Kq}{r^2}$$



(iv) Electric field due to Infinite line charge.

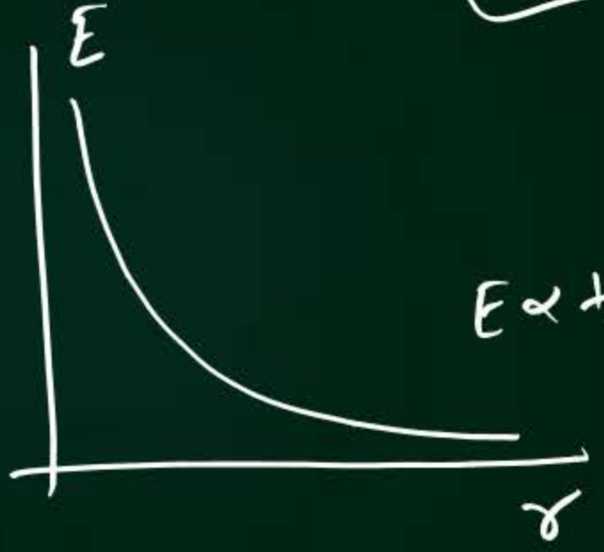


$$E = \frac{2k\lambda}{r}$$

at centre of half Ring

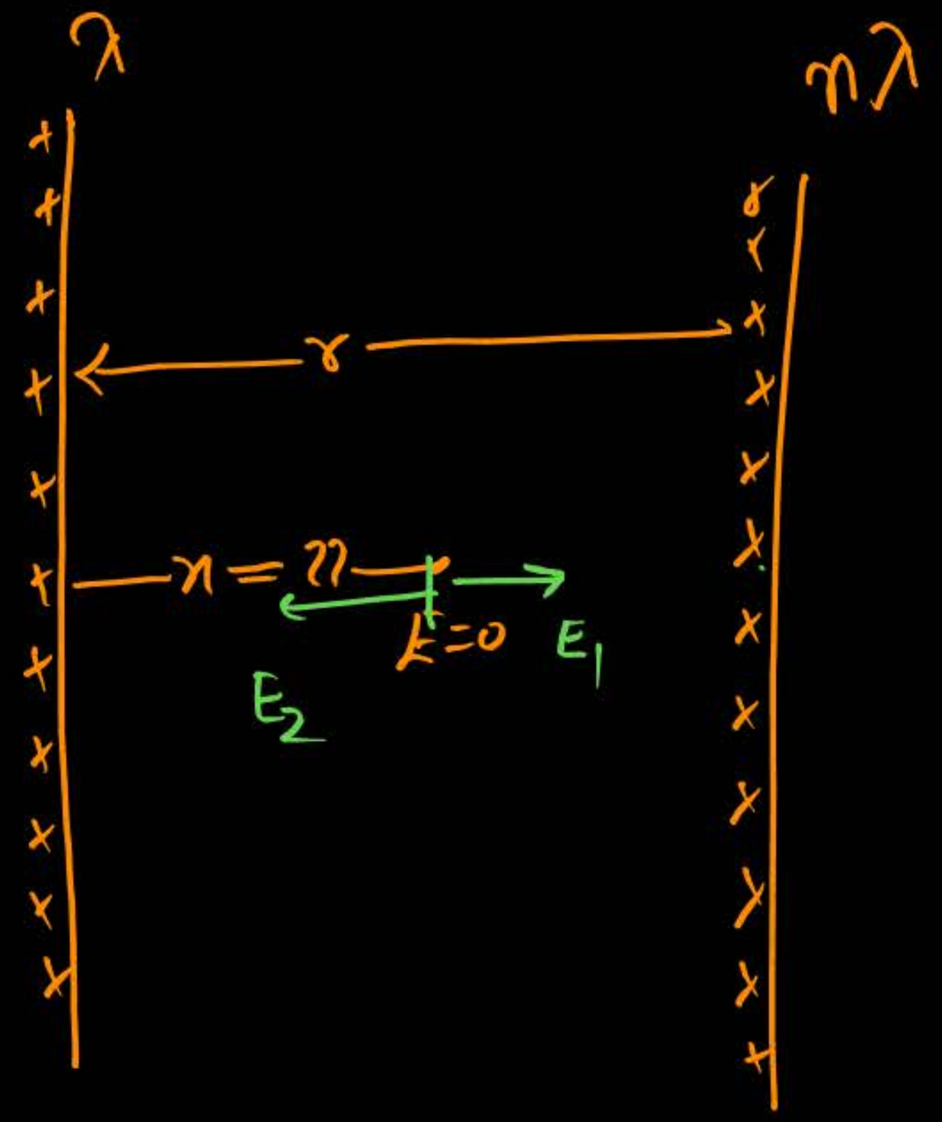
$$= \frac{2\lambda}{2\cdot 4\pi\varepsilon_0 r}$$

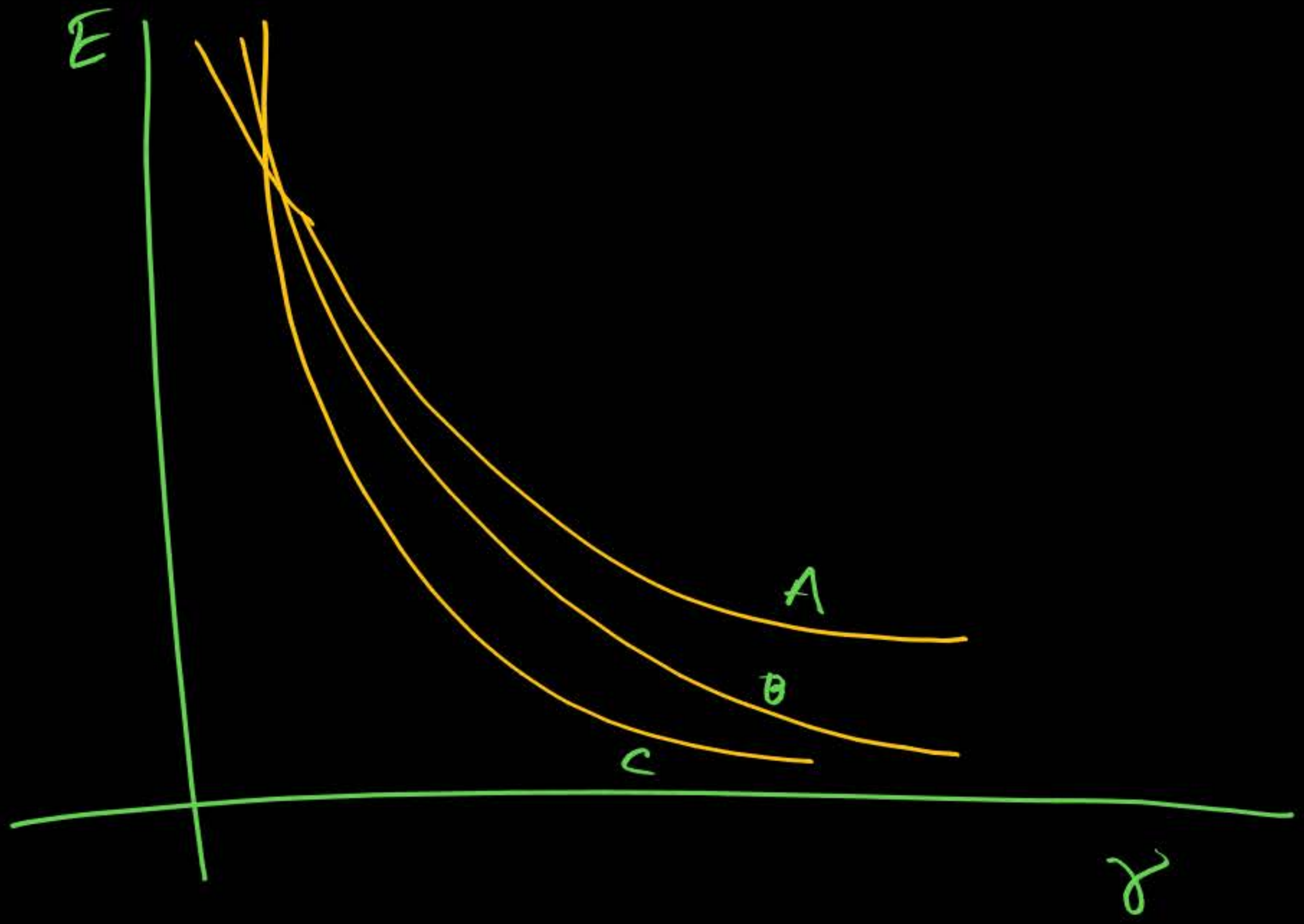
$$E = \frac{\lambda}{2\pi\varepsilon_0 r}$$



$$E \propto \frac{1}{r}$$

find x where electric field is zero





A → line charge $E = \frac{2K\lambda}{r}$

B → point chge $E = \frac{KQ}{r^2}$

C → dipole $E = \frac{2KP}{r^3}$

QUESTION

Two long thin charged rods with charge density λ each are placed parallel to each other at a distance d apart. The force per unit length exerted on one rod by the other will be (where $k = \frac{1}{4\pi\varepsilon_0}$)

1. $\frac{k2\lambda}{d}$
2. $\frac{k2\lambda^2}{d}$
3. $\frac{k2\lambda}{d^2}$
4. $\frac{k2\lambda^2}{d^2}$


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 14 | Physics

Electric Charges and Fields

By- Dr. Manish Raj (MR SIR)



Topics to be covered

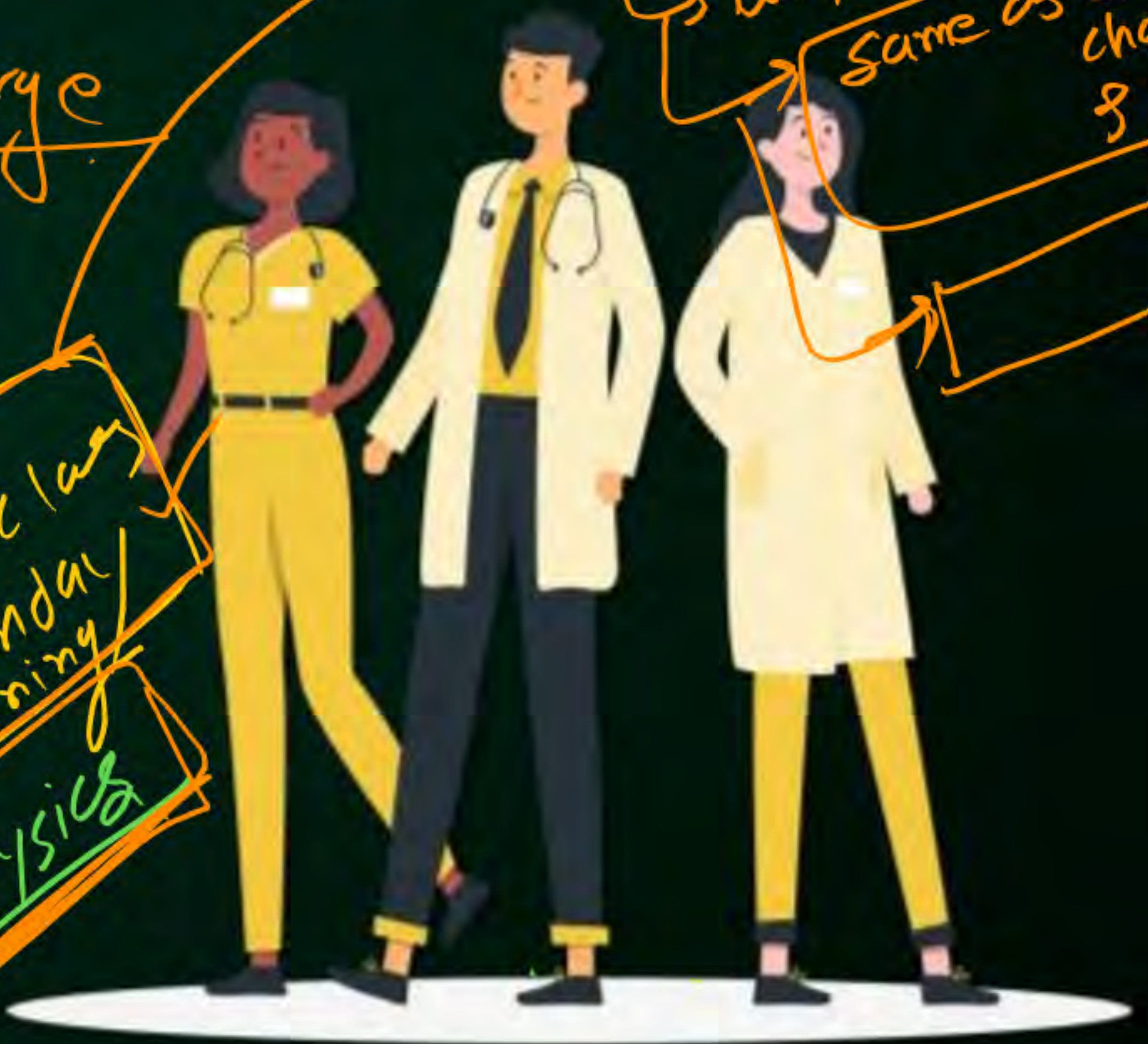
1. # electric field due to line charge
   → sheet
   → sphere
2. #
3. #

→ Kal evening yani Sunday
→ time → 6:15 pm (almost)
Topic → gravitation
→ Live → yakeen 2.0 batch

1st Revision class on sunday evening

MR. Physics

Gravitation
→ why reason
→ same as electric charge & field



QUESTION

If the number of electric lines of force emerging out of a closed surface is 1000, then the charge enclosed by the surface is

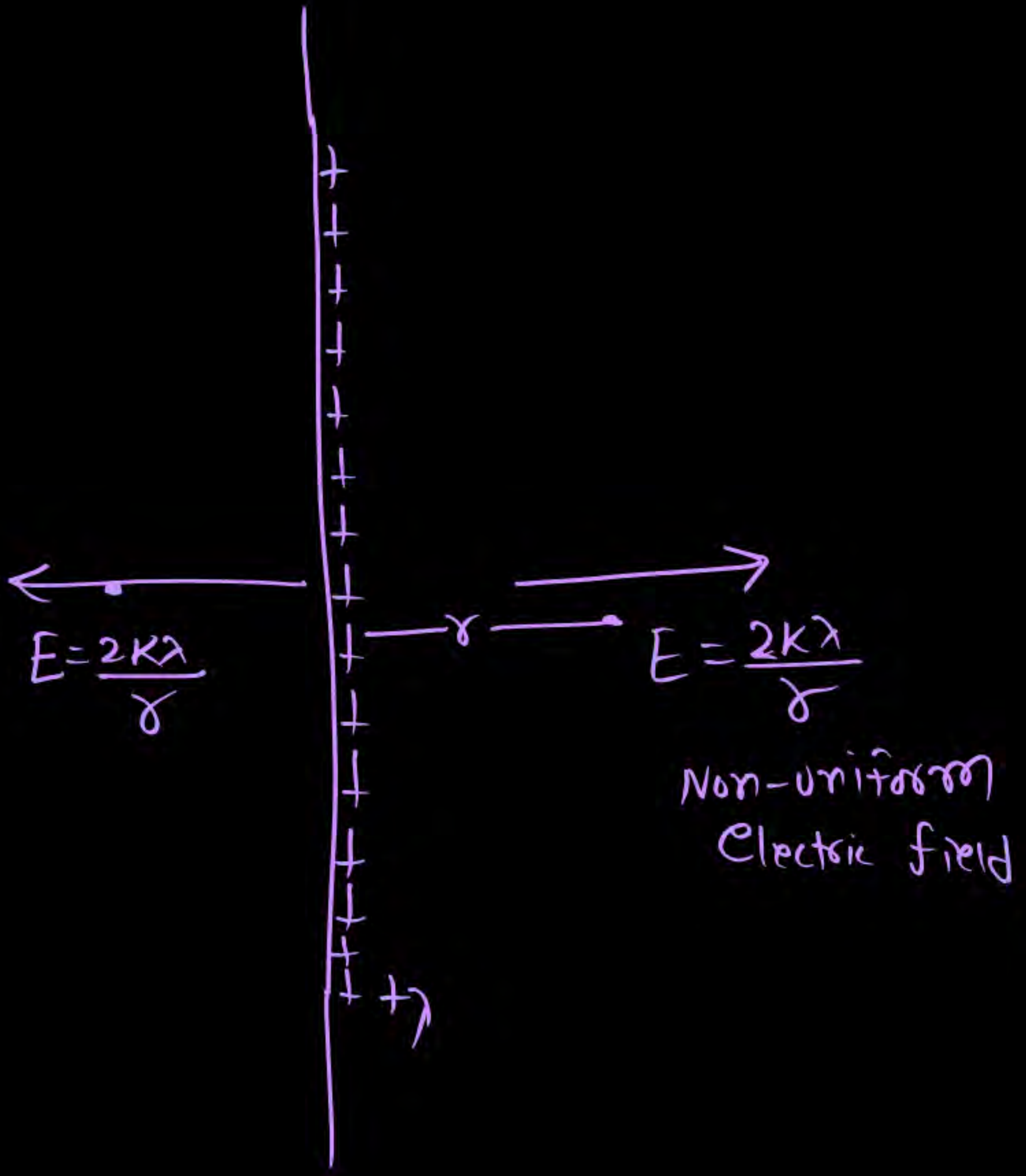
1. 8.854×10^{-9} C
2. 8.854×10^{-4} C
3. 8.854×10^{-1} C
4. 8.854 C



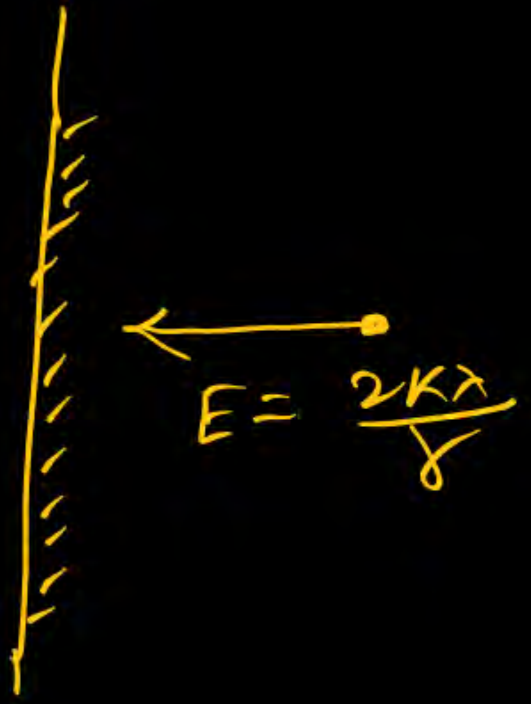
$$1000 = \frac{q}{\varepsilon_0}$$

$$q = 10^3 \times 8.85 \times 10^{-12}$$

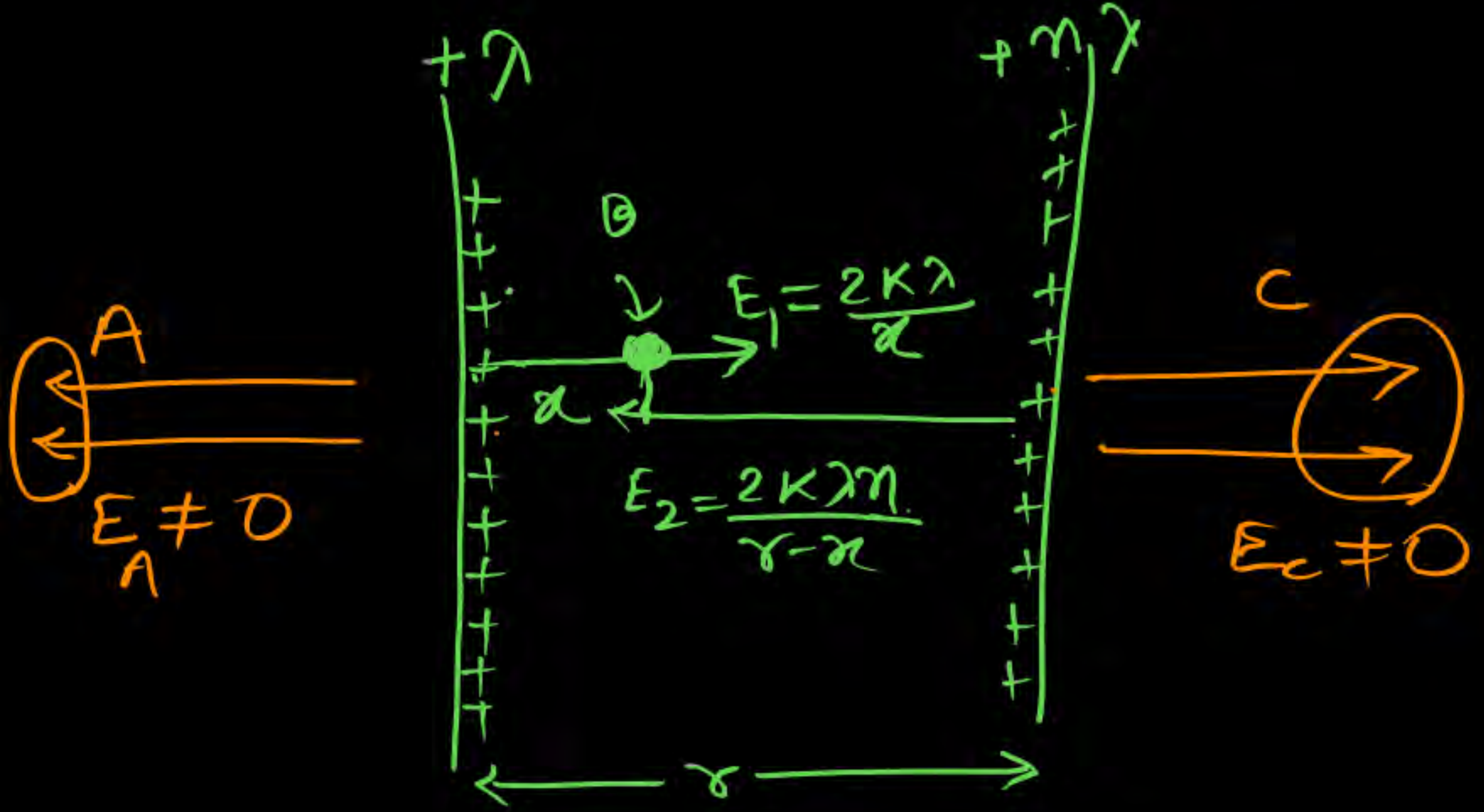
$$= 8.85 \times 10^{-9}\ C$$



E = 2Kλ/r
r
E = 2Kλ/r
+λ
Non-uniform
Electric field



E = 2Kλ/r



$$E_B = 0$$

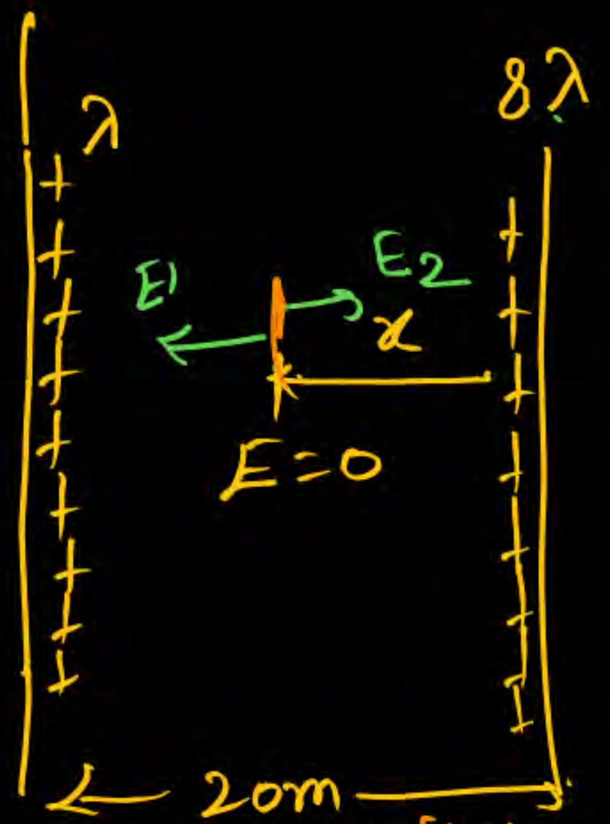
$$\frac{2K\lambda}{x} = \frac{2K\lambda n}{r-x}$$

$$r - x = nx$$

$$r = nx + x$$

$$r = x(n+1)$$

$$\boxed{x = \frac{r}{n+1}}$$



using formula of electric field

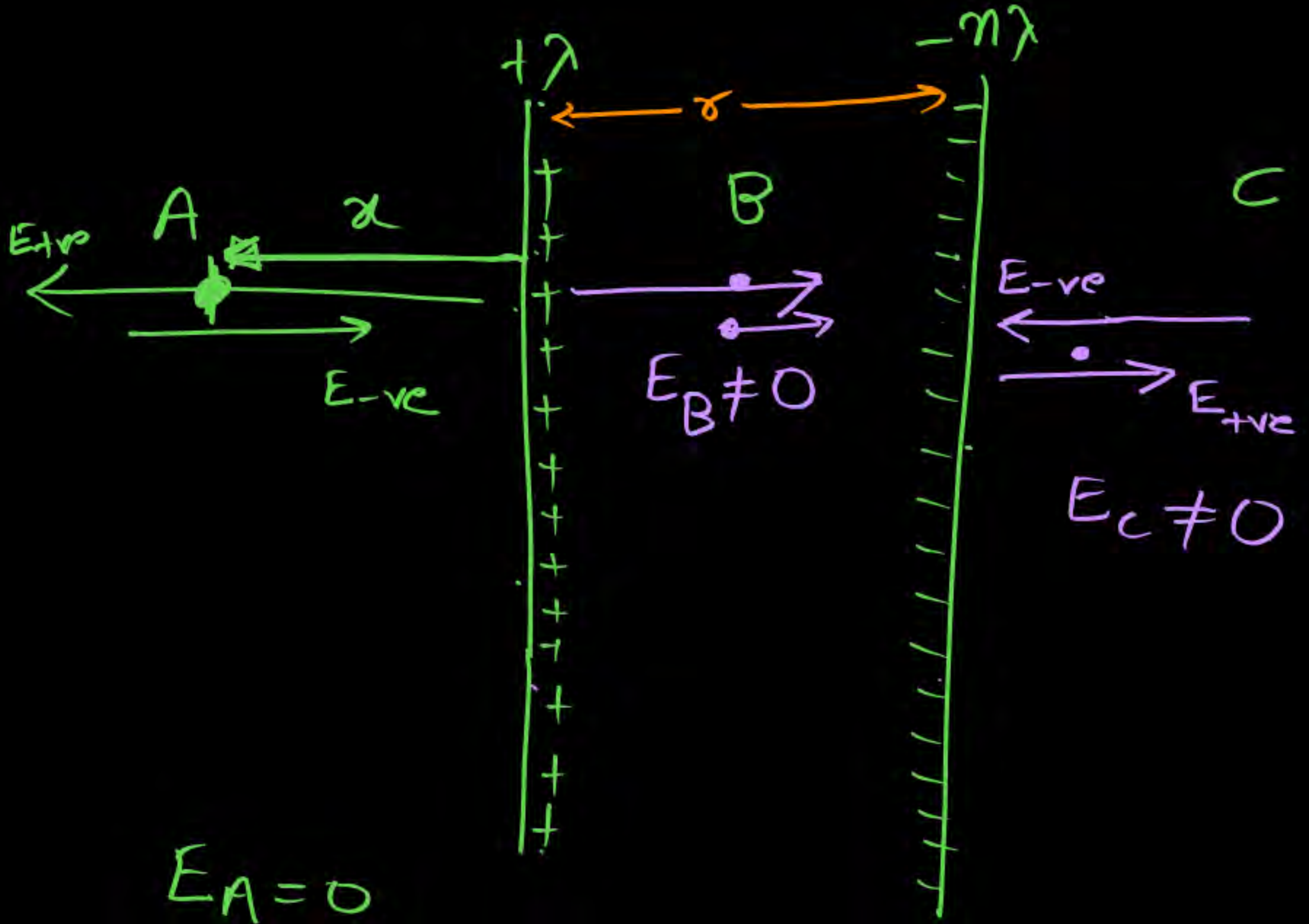
$$\frac{2K(8\lambda)}{x} = \frac{2K\lambda}{20-x}$$

$$160 - 8x = x$$

$$160 = 9x$$

$$\boxed{x = \frac{160}{9}\,m}$$

from wire of charge density 8λ)



$$E_A = 0$$

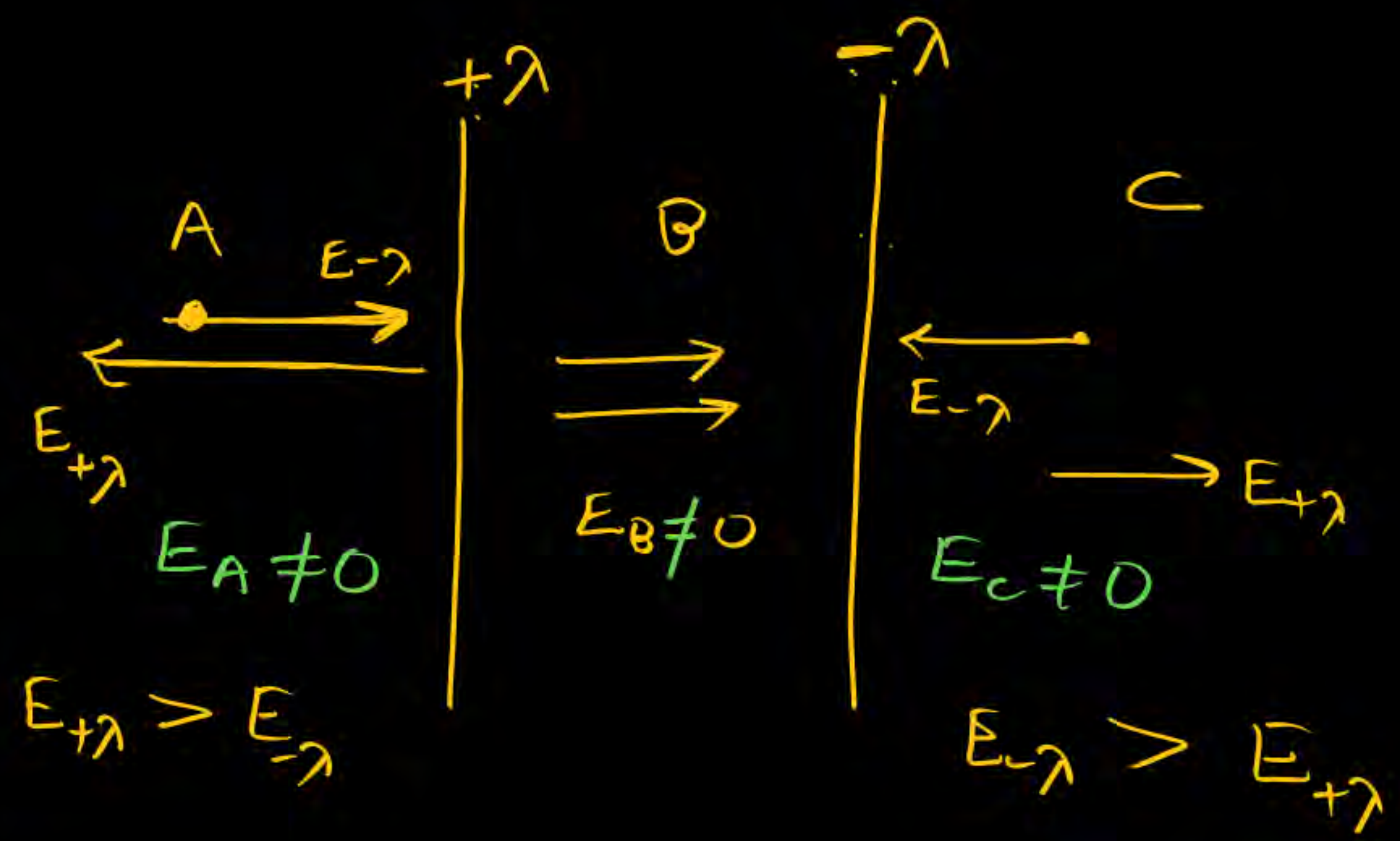
$$\frac{2K\lambda}{x} = \frac{2K\,n\lambda}{r+x}$$

$$nx = r + x$$

$$nx - x = r$$

$$x(n-1) = r$$

$$x = \left(\frac{r}{n-1}\right) \quad \text{Ans}$$



In which region electric field will be zero.

Ans

Electric field will not zero at any finite distance

QUESTION

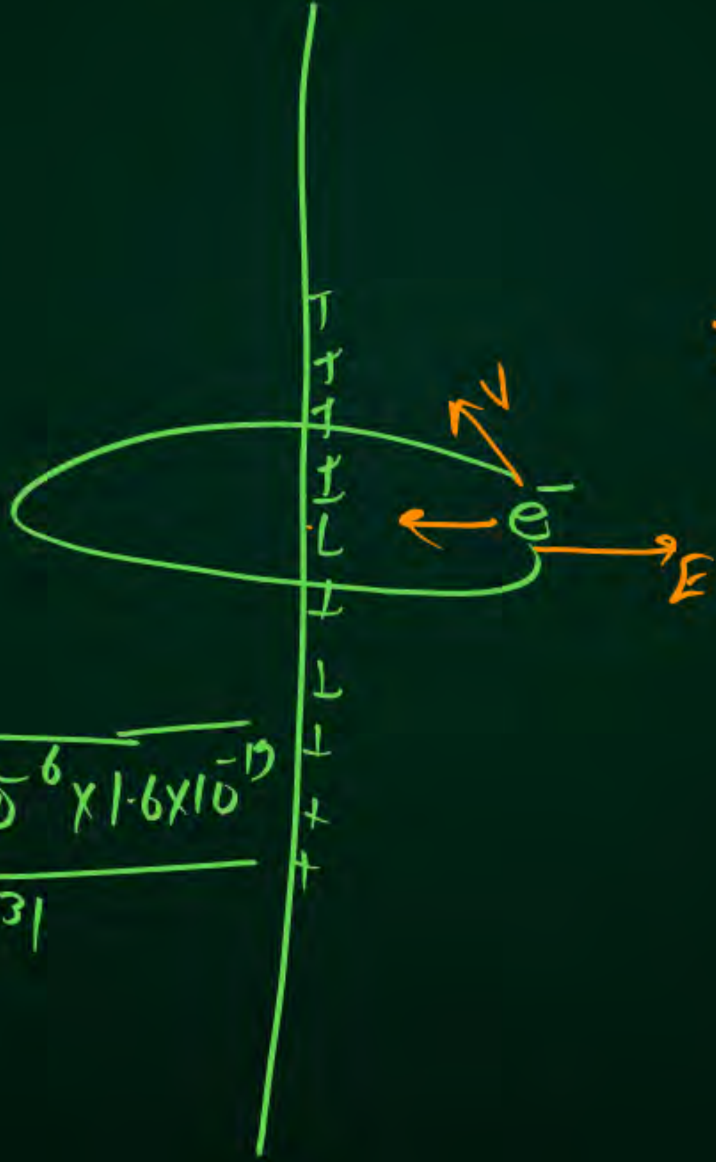
An electron is rotating around an infinite positive linear charge in a circle of radius 0.1 m, if the linear charge density is 1 μC/m, then the velocity of electron in m/s will be

(1) 0.562×10^{7}

(2) 5.62×10^{7}

(3) 562×10^{7}

(4) 0.0562×10^{7}



QUESTION

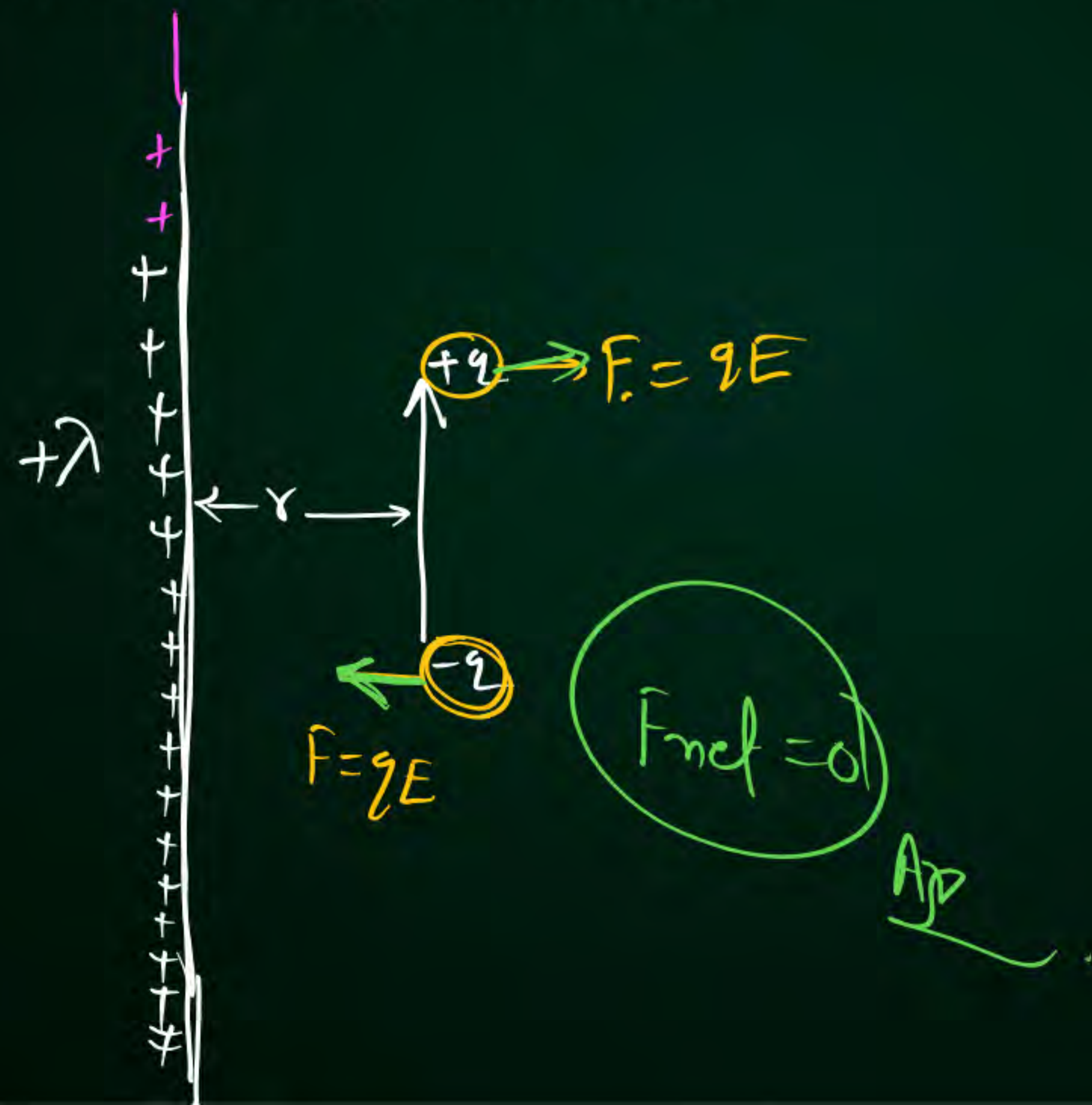
A dipole with an electric moment $\vec{p}$ is located at a distance r from a long thread charged uniformly with a linear charge density λ. Find the force F acting on the dipole if the vector $\vec{p}$ is oriented along the thread.

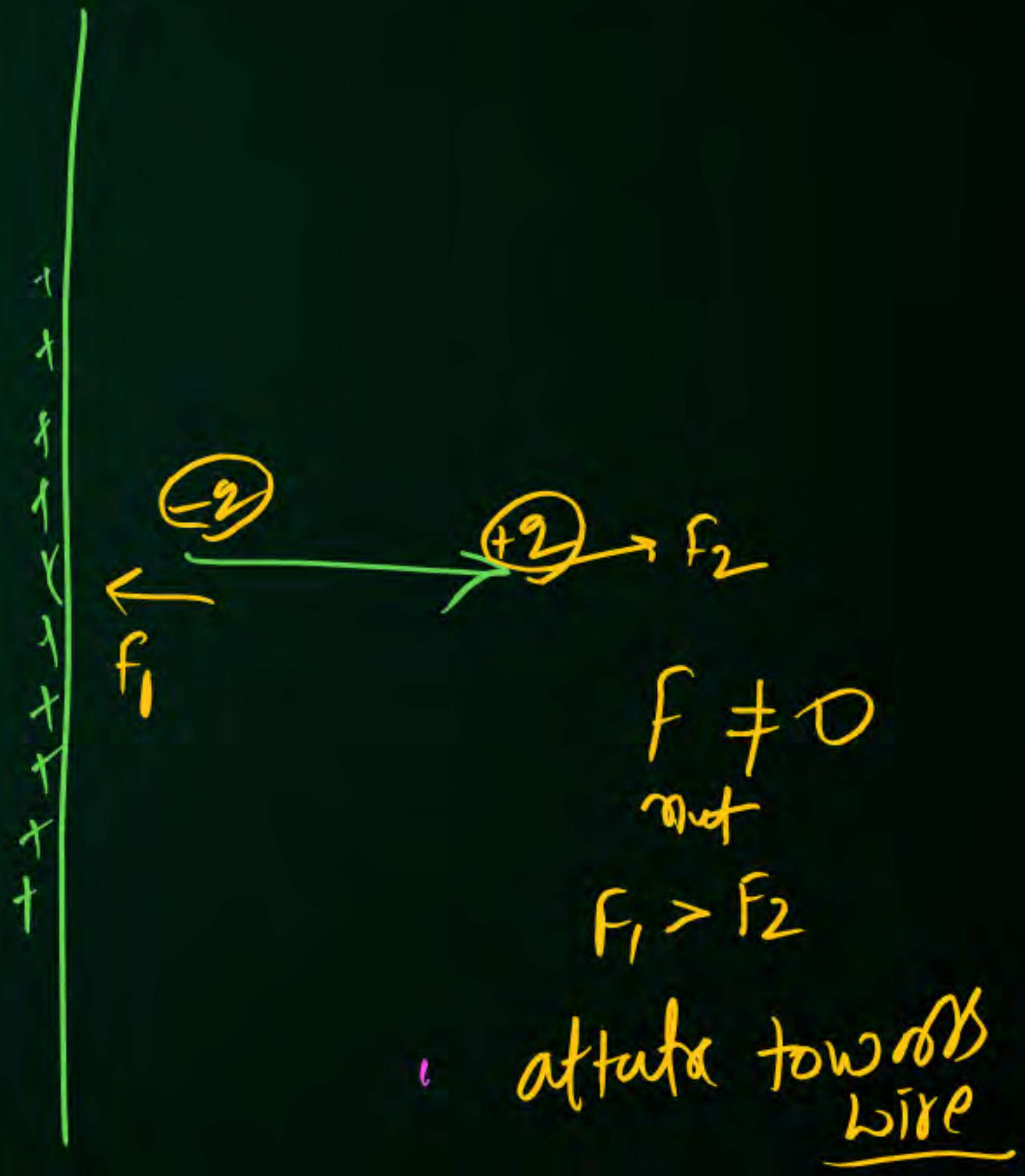
1. $\dfrac{p\lambda}{2\pi\varepsilon_0 r^2}$

2. $\dfrac{p\lambda}{2\pi\varepsilon_0 r}$

3. $\dfrac{p}{2\pi\varepsilon_0 r\lambda}$

4. Zero

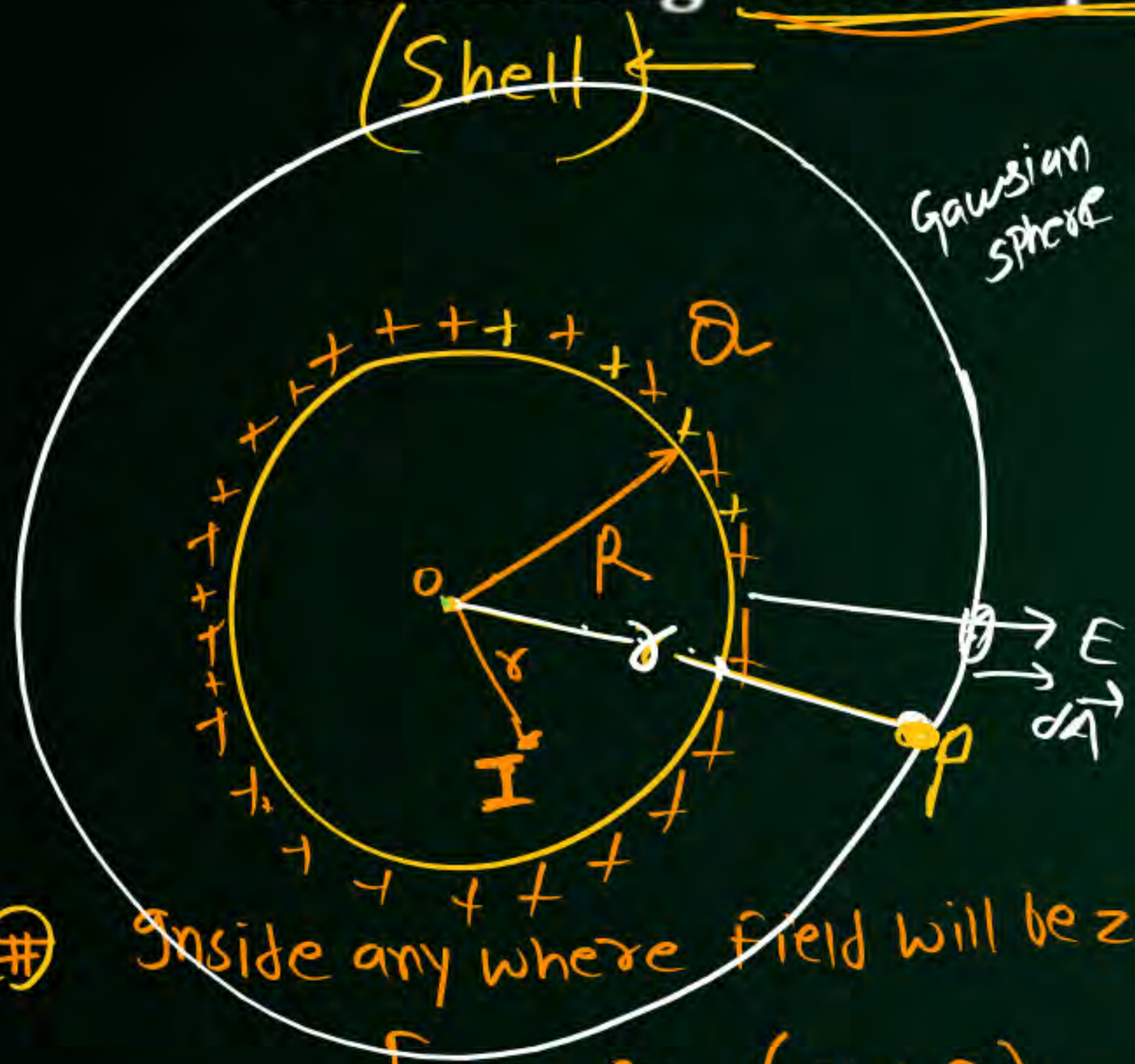




(iii) Electric field due to Hollow/Solid conducting sphere and Non conducting hollow sphere.

same

(Shell)



Inside any where field will be zero

$E_I = 0 \quad (r < R)$

(centre) $E_0 = 0$

$(r > R)$ outside

using Gauss Law

$$\oint \vec{E}_p \cdot d\vec{A} = \frac{q_{in}}{\varepsilon_0}$$

$$E_p \oint d\vec{A} = \frac{Q}{\varepsilon_0}$$

$$E_p \, 4\pi r^2 = \frac{Q}{\varepsilon_0}$$

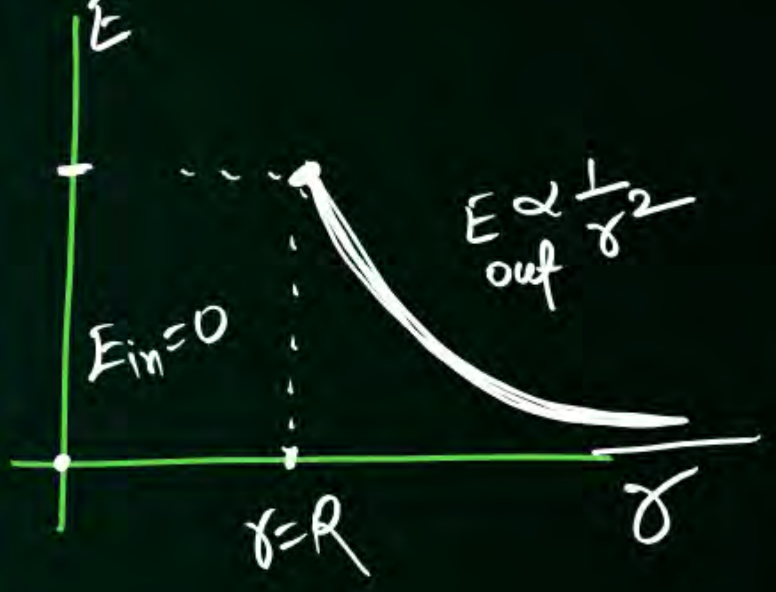
$$E_p = \frac{Q}{4\pi\varepsilon_0 r^2}$$

$$E_p = \frac{Q}{4\pi\varepsilon_0 r^2}$$

outside

$$E = \frac{kQ}{R^2} = \frac{Q}{4\pi\varepsilon_0 R^2}$$

at surface



electric field due to concentric sphere

field electric field at x, y & z



$$\vec{E_x} = 0$$

$$\vec{E_y} = \frac{Kq}{y^2} + 0$$

$$E_z = \frac{K(q+Q)}{z^2}$$

Electric field due to solid conducting spr ✓ → [Hollow spr / Shell]

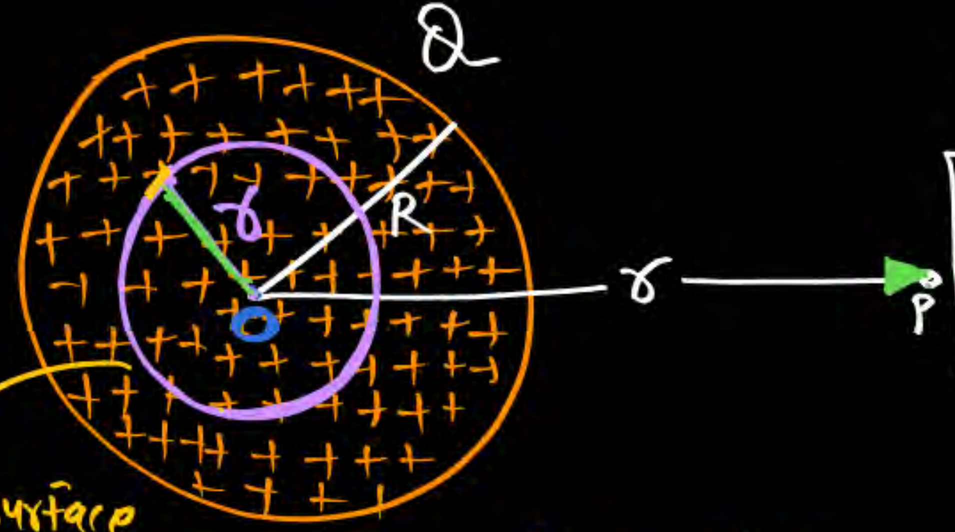
" " " " Non Conducting Hollow spr → [Hollow spr / Shell]

Electric field due to solid NON conducting sphere (Uniform charged sphere)

$\rho = \frac{Q}{\frac{4}{3}\pi R^3}$

$q' = \rho V_{inside}$

$= \frac{Q}{\frac{4}{3}\pi R^3} \times \frac{4}{3}\pi r^3$



$q'_{inside\ gausian\ sphere} = \frac{Q r^3}{R^3}$

outside (r>R)

$\vec{E}_P = \frac{KQ}{r^2}\hat{r}$

$E_P = \frac{KQ}{r^2}$

$E_{surface\ (r=R)} = \frac{KQ}{R^2}$

electric field Inside

$E \oint dA = \frac{q_{in}}{\varepsilon_0}$

$E\, 4\pi r^2 = \frac{Q r^3}{R^3 \varepsilon_0}$

$E = \frac{Q r}{4\pi\varepsilon_0 R^3} = \frac{KQr}{R^3}$

MR* Kisi bhi solid ke andar Koi sa bhi field hamesa directly proportional to distance.

$\frac{4}{3}\pi R^3 \rightarrow Q$

1 unit vol $\rightarrow \left(\frac{Q}{\frac{4}{3}\pi R^3}\right)$

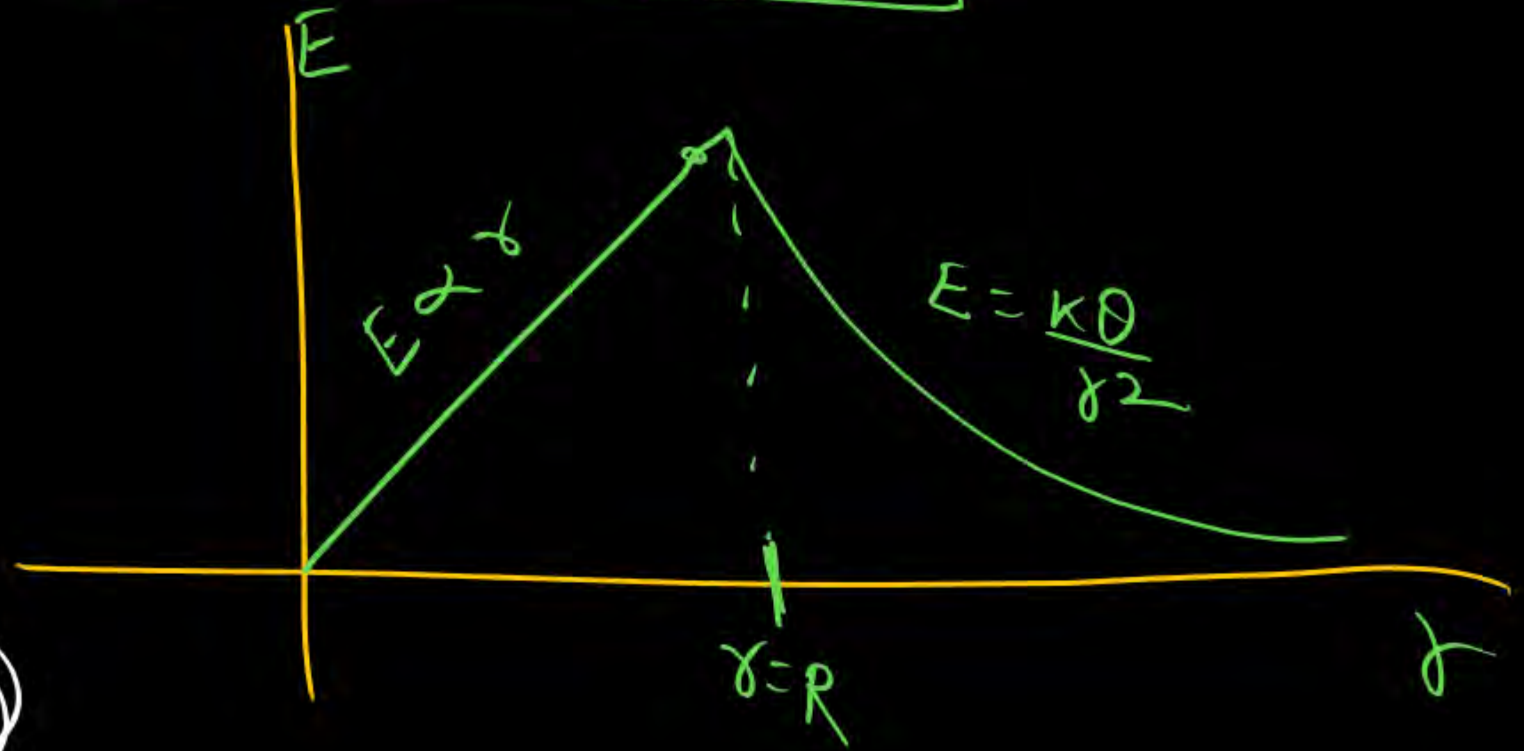
$\frac{4}{3}\pi r^3 \rightarrow \frac{Q}{\frac{4}{3}\pi R^3}\frac{4}{3}\pi r^3$

$q' = \frac{Q r^3}{R^3}$

$$E_{outside} = \frac{KQ}{r^2}$$ ($r \to$ distⁿ from centre)

$$E_{surface} = \frac{KQ}{R^2}$$

*# $$E_{Inside} = \frac{KQr}{R^3}$$



MR*

$$E = \frac{KQ}{r^2}$$

$$E_{Inside} = \frac{KQr}{R^3} = \frac{Qr}{4\pi\varepsilon_0 R^3}$$

$$\rho = \frac{Q}{\frac{4}{3}\pi R^3}$$

$$Q = \rho \frac{4}{3}\pi R^3$$

Puting value of Q

$$E = \frac{r\rho\frac{4}{3}\pi R^3}{4\pi\varepsilon_0 R^3}$$

$\rho = \frac{q}{volume}$

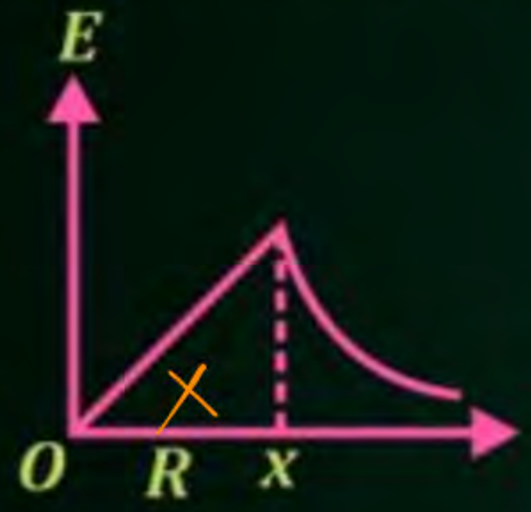
$$E = \frac{\rho r}{3\varepsilon_0}$$

Inside solid sphere

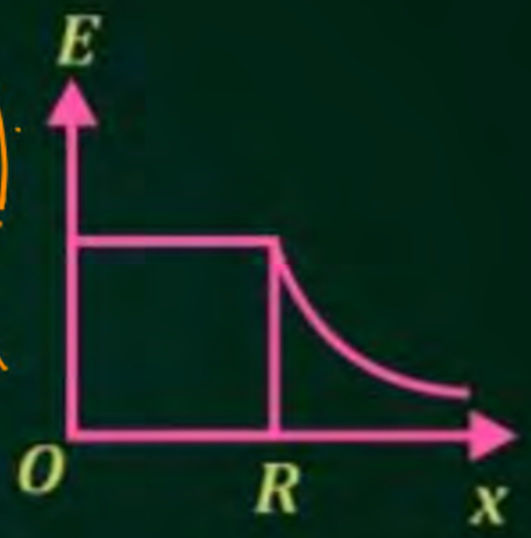
QUESTION

An isolated solid metal sphere of radius R is given an electric charge. Which of the graphs below best shows the way in which the electric field E varies with distance x from the centre of the sphere.

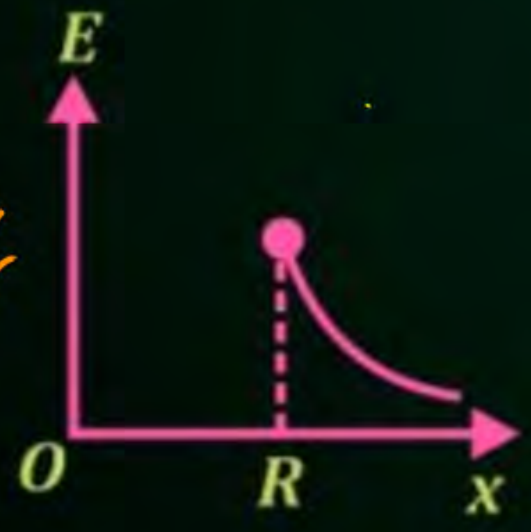
1



2



3



4



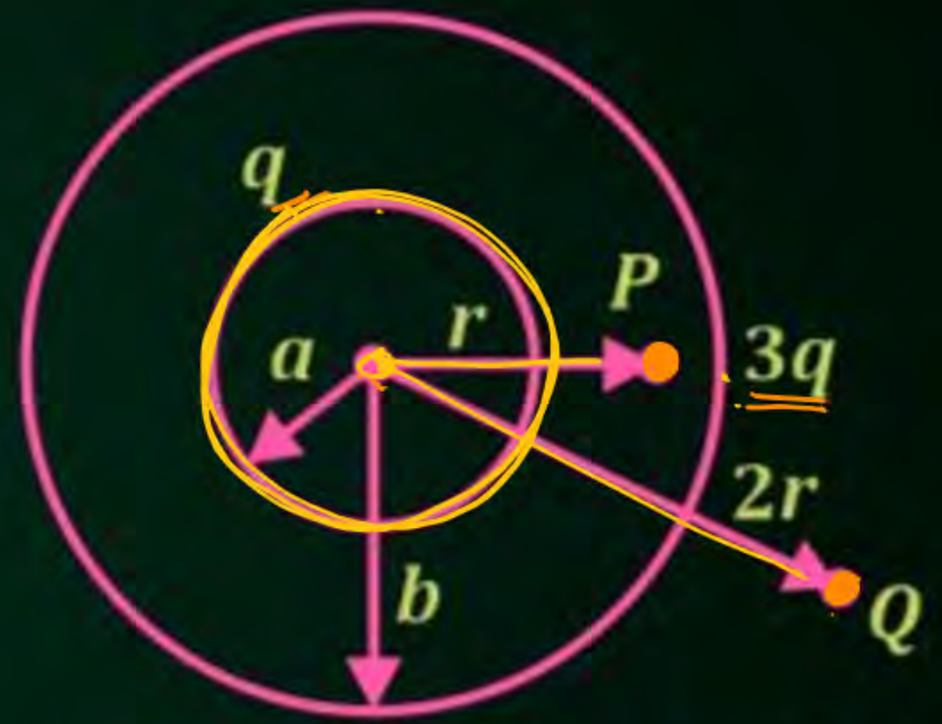
QUESTION

The electric field intensity at P and Q, in the shown arrangement, are in the ratio

1. 1 : 2
2. 2 : 1
3. 1 : 1
4. 4 : 3

$E_P = \frac{KQ}{r^2} + 0$

$E_Q = \frac{K4Q}{(2r)^2} = \frac{4KQ}{4r^2} = \frac{KQ}{r^2}$

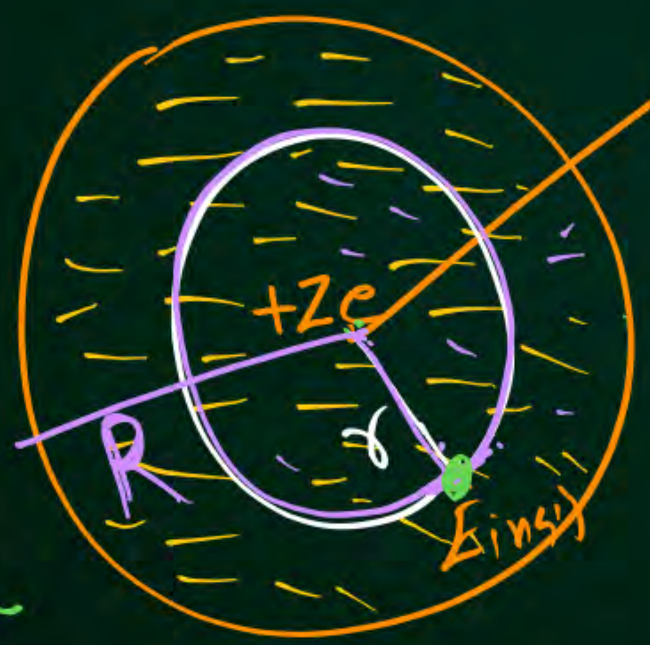


Hollow Concentric Shell

QUESTION

Consider an atom with atomic number Z as consisting of a positive point charge at the centre and surrounded by a distribution of negative electricity uniformly distributed within a sphere of radius R. The electric field at a point inside the atom at a distance r from the centre is

1. $\frac{Ze}{4\pi\varepsilon_0}\left[\frac{1}{r^2}-\frac{r}{R^3}\right]$
2. $\frac{Ze}{4\pi\varepsilon_0}\left[\frac{1}{r^2}+\frac{1}{R^3}\right]$
3. $\frac{2Ze}{4\pi\varepsilon_0 r^2}$
4. Zero

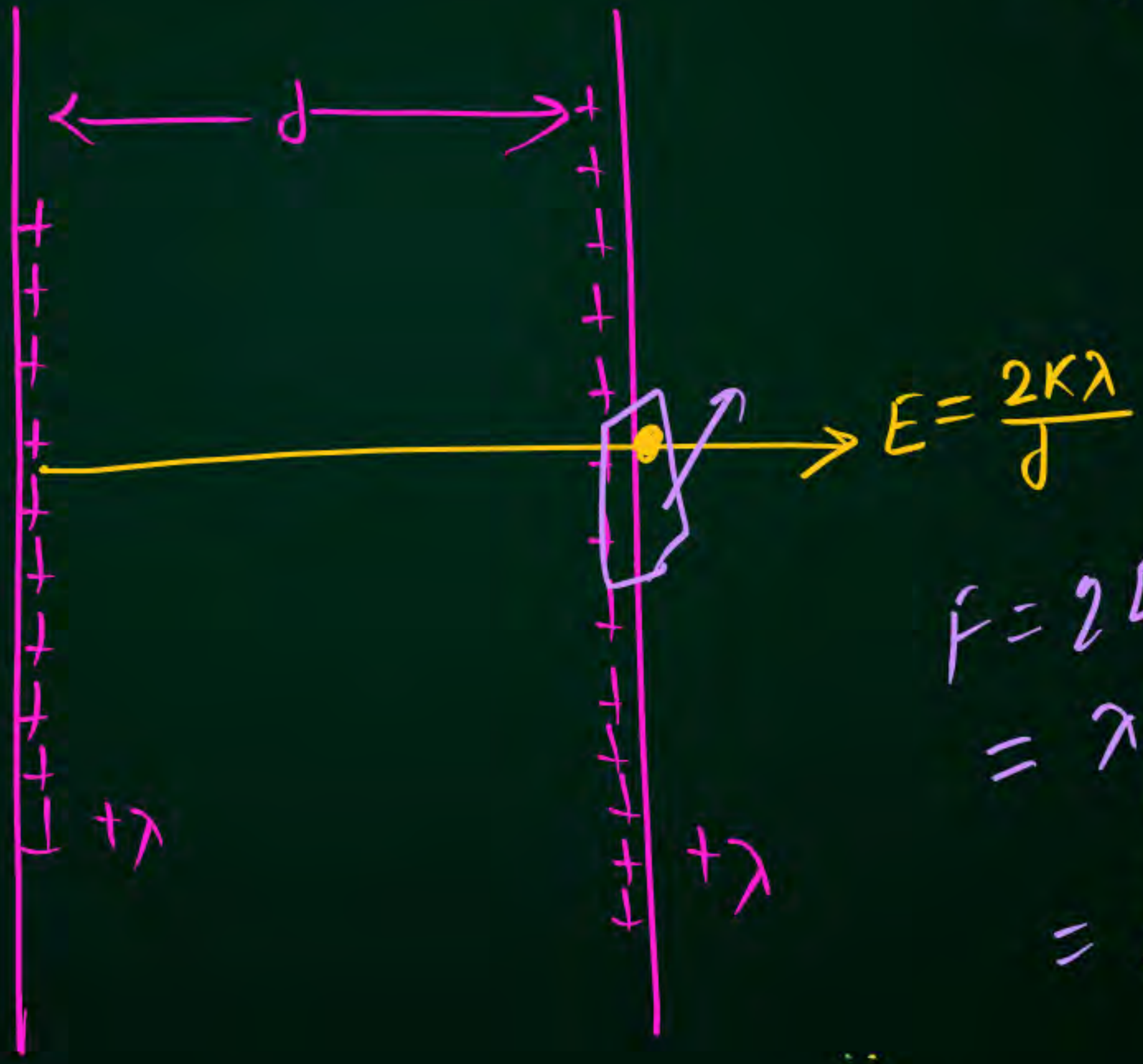


$$E = \frac{K(Ze)}{r^2} - \frac{KZer}{R^3}$$
$$= KZe\left[\frac{1}{r^2}-\frac{r}{R^3}\right]$$
$$= \frac{Ze}{4\pi\varepsilon_0}\left[\frac{1}{r^2}-\frac{r}{R^3}\right]$$

QUESTION

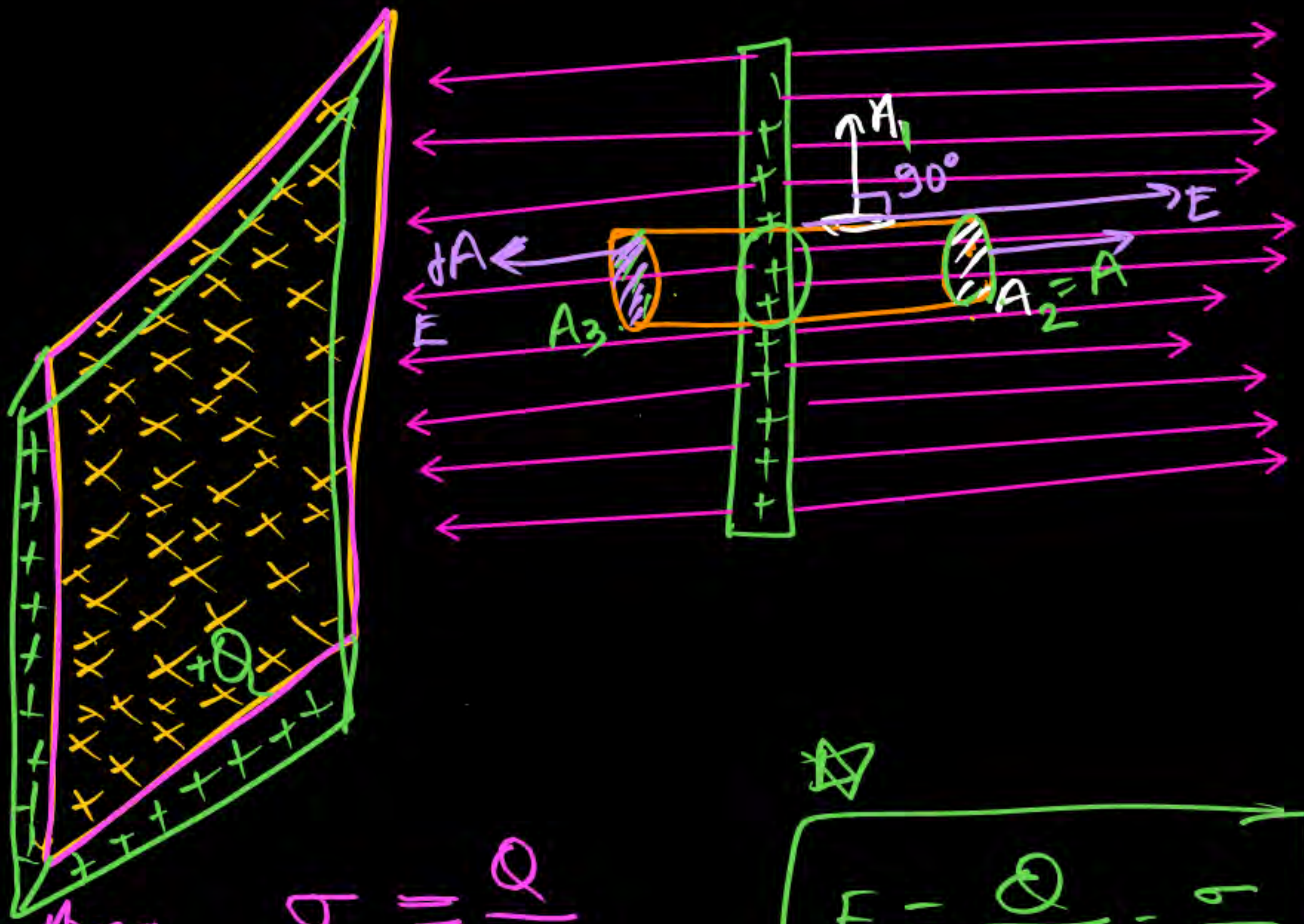
Two long thin charged rods with charge density λ each are placed parallel to each other at a distance d apart. The force per unit length exerted on one rod by the other will be (where $k = \frac{1}{4\pi\varepsilon_0}$)

1. $\frac{k2\lambda}{d}$
2. $\frac{k2\lambda^2}{d}$
3. $\frac{k2\lambda}{d^2}$
4. $\frac{k2\lambda^2}{d^2}$



(v) Electric field Inside non-conducting solid sphere.

Electric field due to charged sheet { Non conducting sheet }



Area

$$\sigma = \frac{Q}{A}$$

Surface charge density

$$\oint E \cdot dA = \frac{q_{in}}{\varepsilon_0}$$

$$\oint E \cdot dA_1 + \oint E \cdot dA_2 + \oint E \cdot dA_3 = \frac{\sigma A}{\varepsilon_0}$$

$$\oint E\, dA_1 \cos 90 + \oint E\, dA_2 \cos 0^\circ + \oint E \cdot dA_3 \cos 0^\circ = \frac{\sigma A}{\varepsilon_0}$$

(first term → 0)

$$EA + EA = \frac{\sigma A}{\varepsilon_0}$$

$$2EA = \frac{\sigma A}{\varepsilon_0}$$

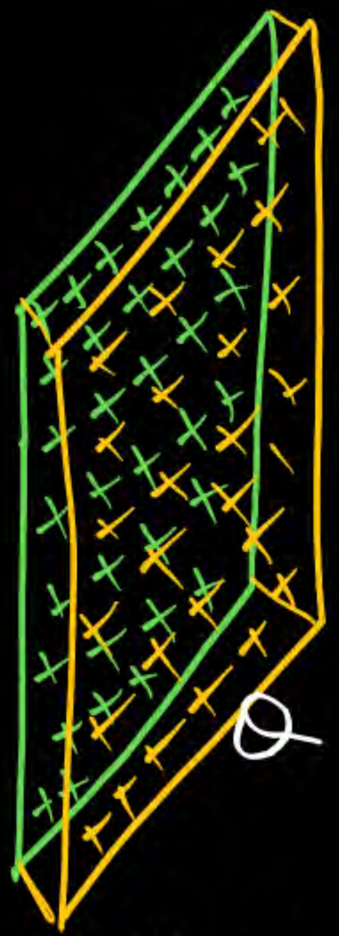
$$E = \frac{\sigma}{2\varepsilon_0}$$

$$E = \frac{Q}{2A\varepsilon_0} = \frac{\sigma}{2\varepsilon_0}$$

↳ uni from field

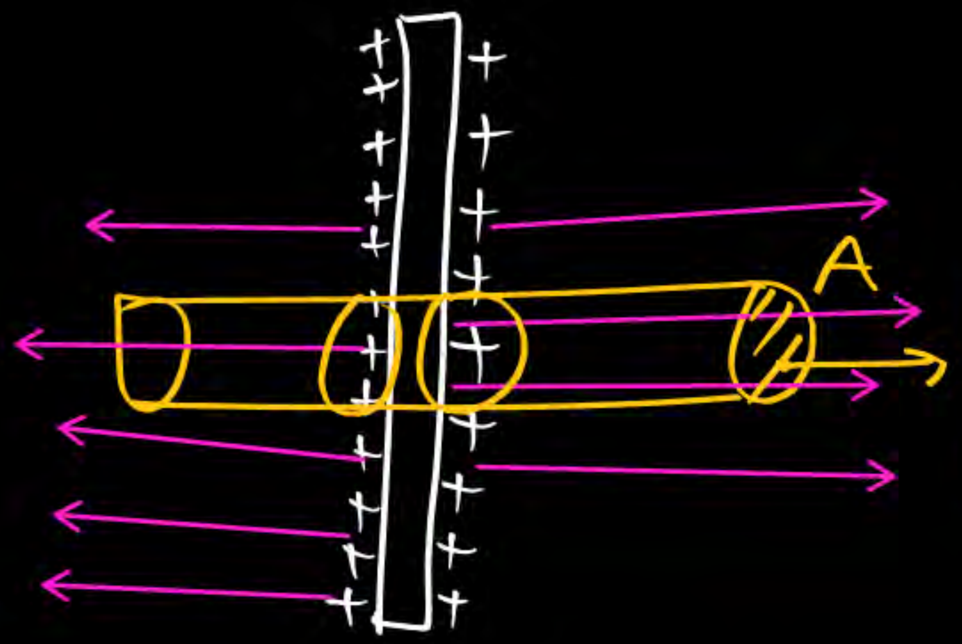
charged conducting sheet

excess charge always on the surface of conductor.



A = Area

$$\sigma = \frac{Q}{2A}$$



σ = surface charge density

$$E = \frac{\sigma}{\varepsilon_0}$$

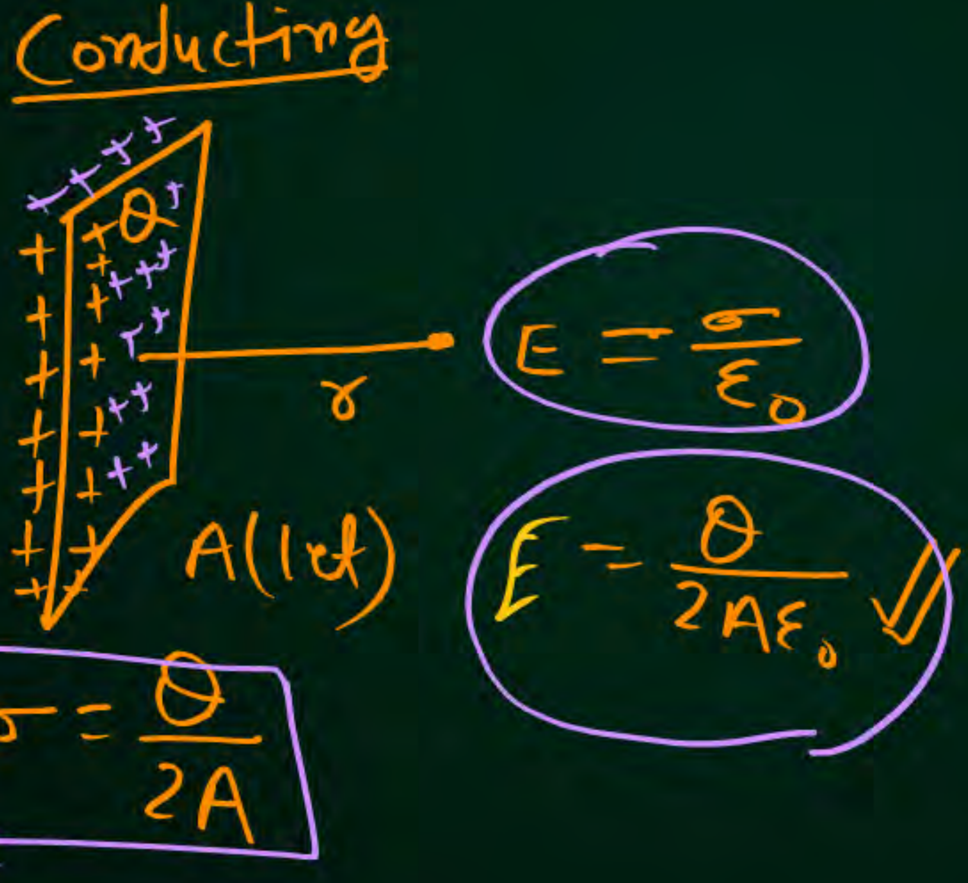
conducting sheet

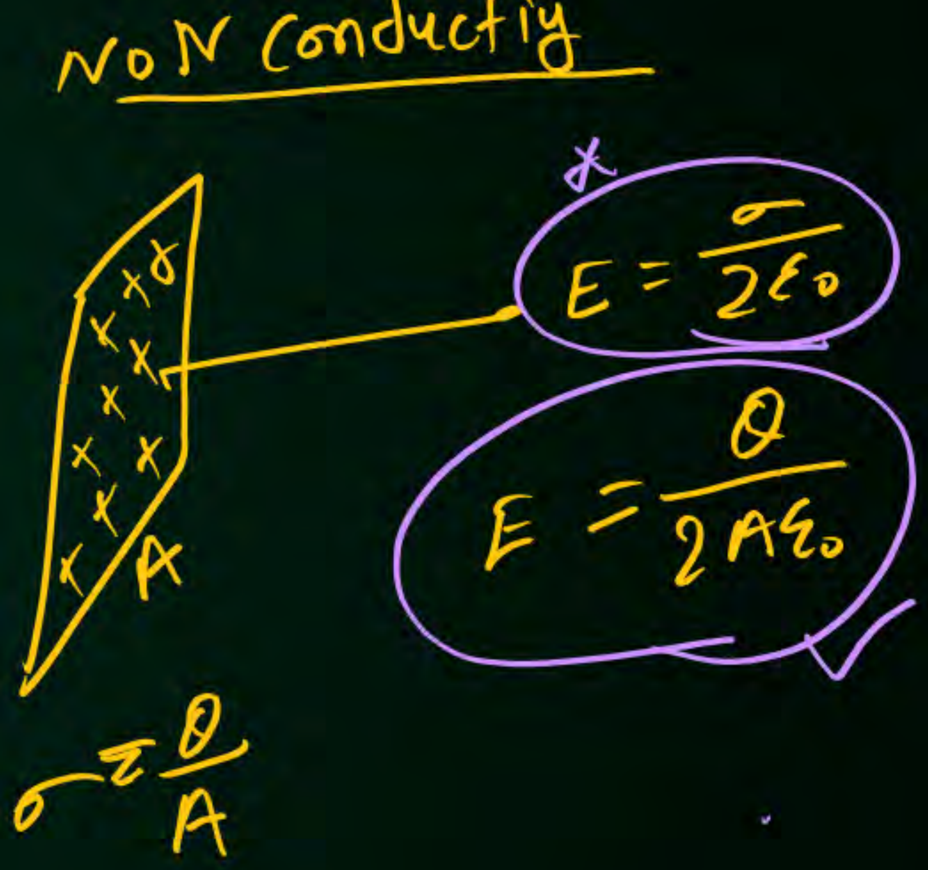


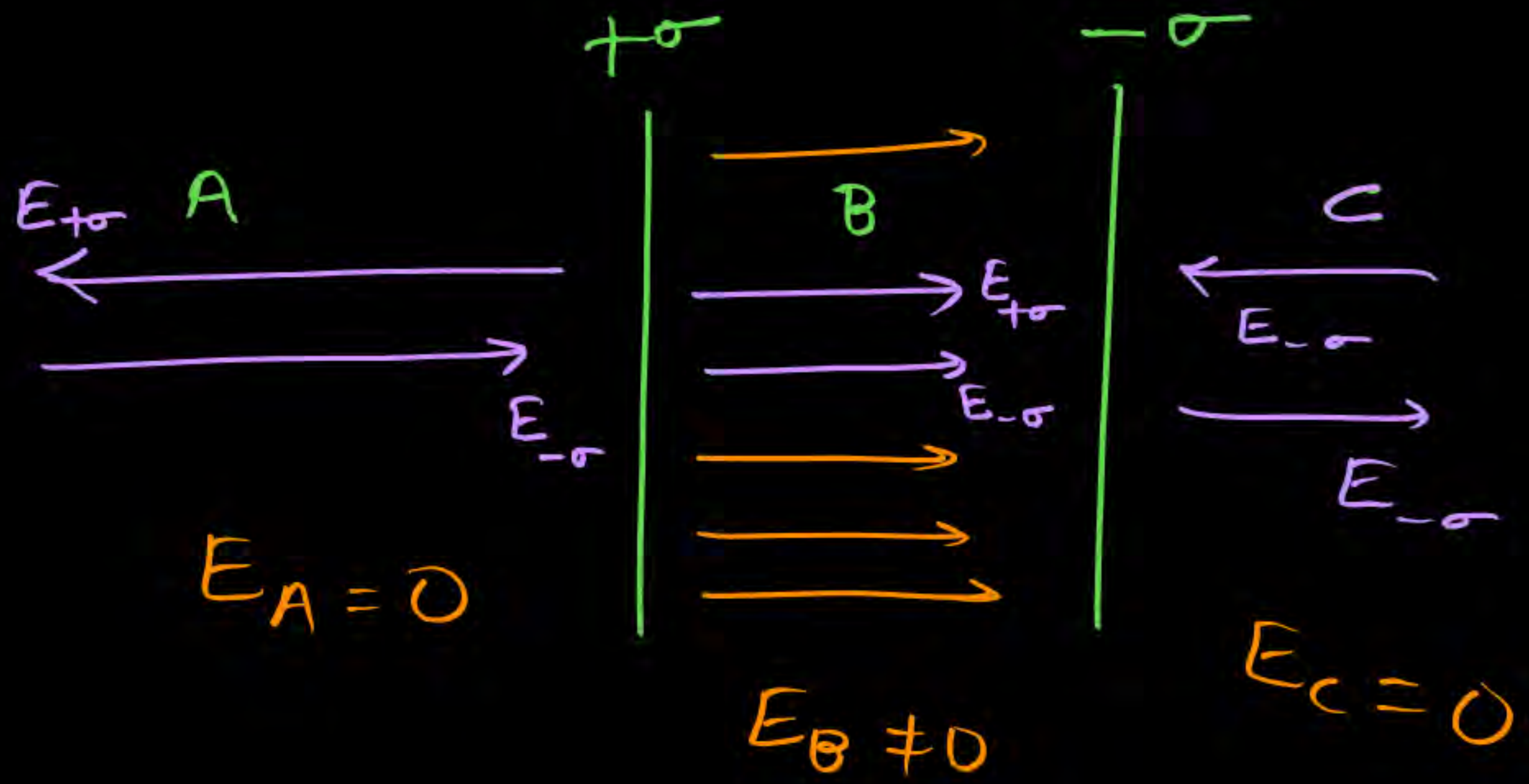
QUESTION

Charge Q is given to conducting and non conducting large sheet respectively then find ratio of electric field very near surface of plate.

1. 1 : 1
2. 1 : 2
3. 2 : 1
4. None of these







Two charged sheet

In which region field will be zero

(a) Not zero at finite dist (60%)

(b) A

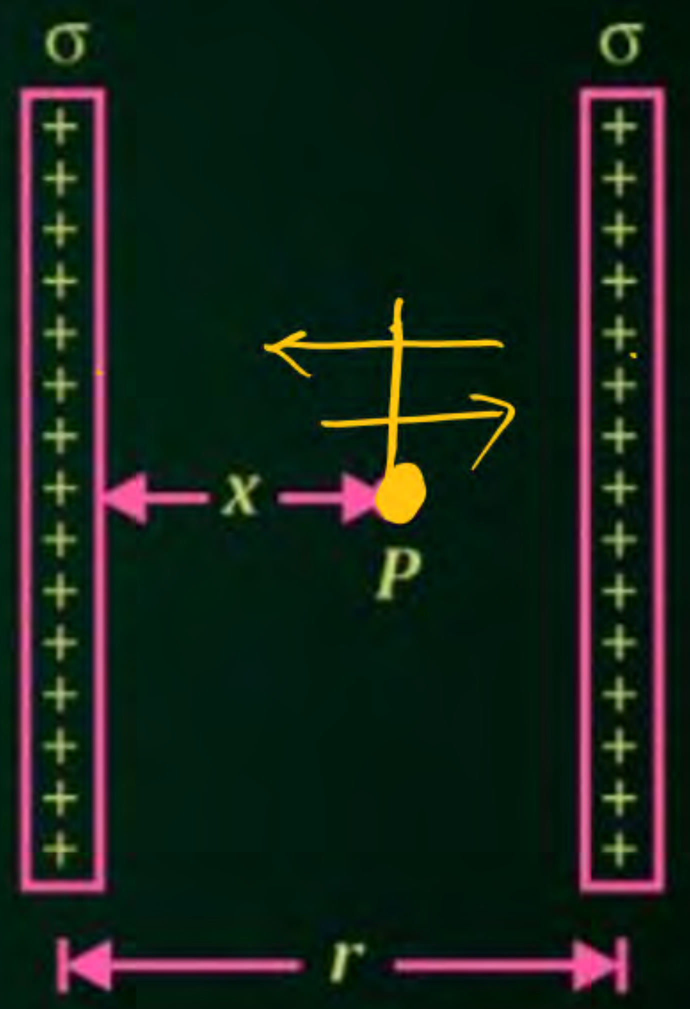
(c) C

(d) B

(e) A & C (22%)

QUESTION

For two infinitely long charged parallel sheets, the electric field at P will be



1. $\frac{\sigma}{2x} - \frac{\sigma}{2(r-x)}$

2. $\frac{\sigma}{2\varepsilon_0 x} + \frac{\sigma}{2\pi(r-x)\varepsilon_0}$

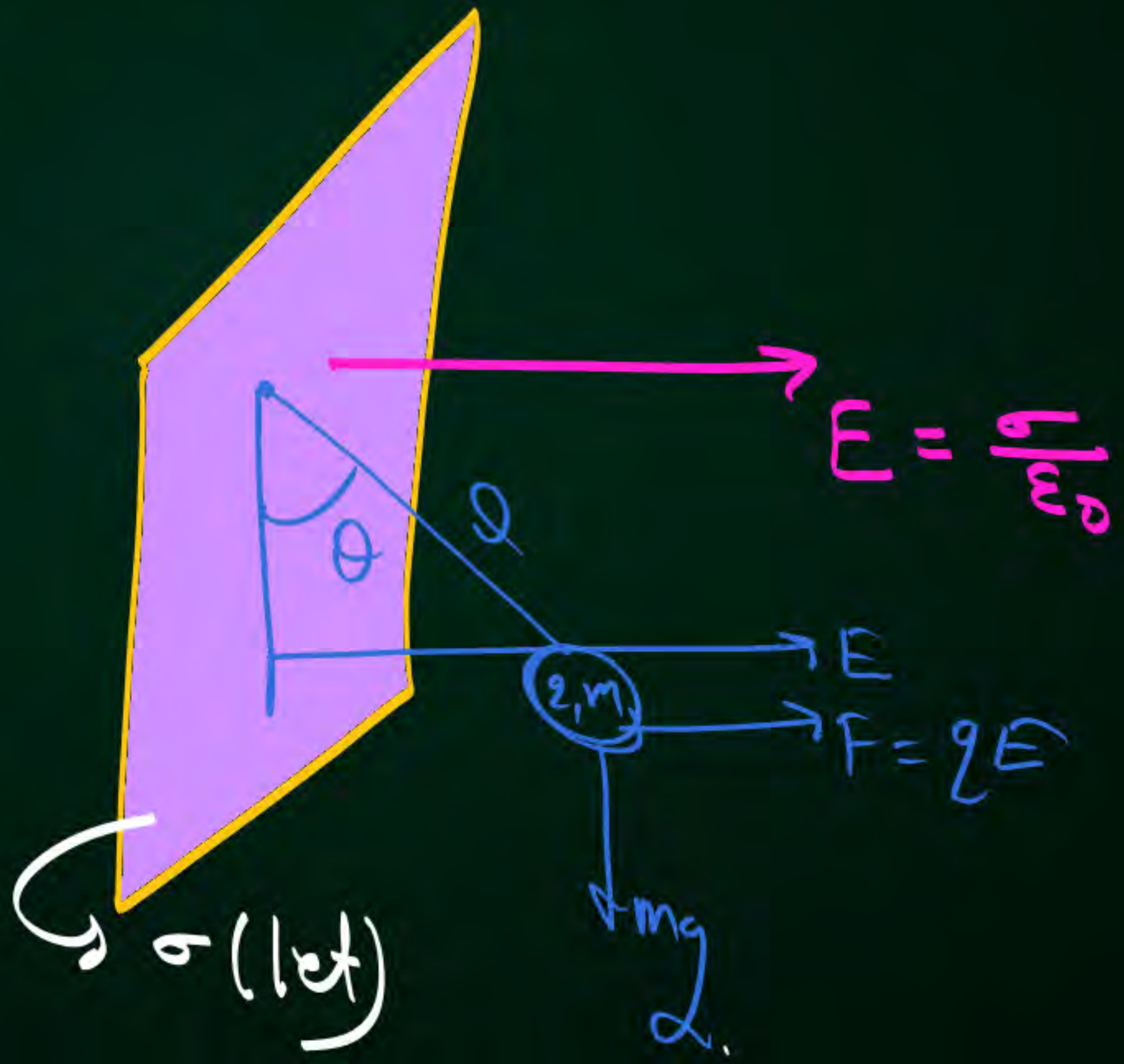
3. $\frac{\sigma}{\varepsilon_0}$

4. Zero

QUESTION

If a small sphere of mass m and charge q is hung from a silk thread at an angle θ with the surface of a vertical charged conducting plate, then for equilibrium of sphere, the surface charge density of the plate is

1. $\varepsilon_0 \left(\frac{mg}{q}\right) \tan\theta$
2. $\varepsilon_0 \left(\frac{2mg}{q}\right) \tan\theta$
3. $\varepsilon_0 (mgq) \tan\theta$
4. $\varepsilon_0 \left(\frac{mg}{3q}\right) \tan\theta$



$\tan\theta = \frac{qE}{mg}$

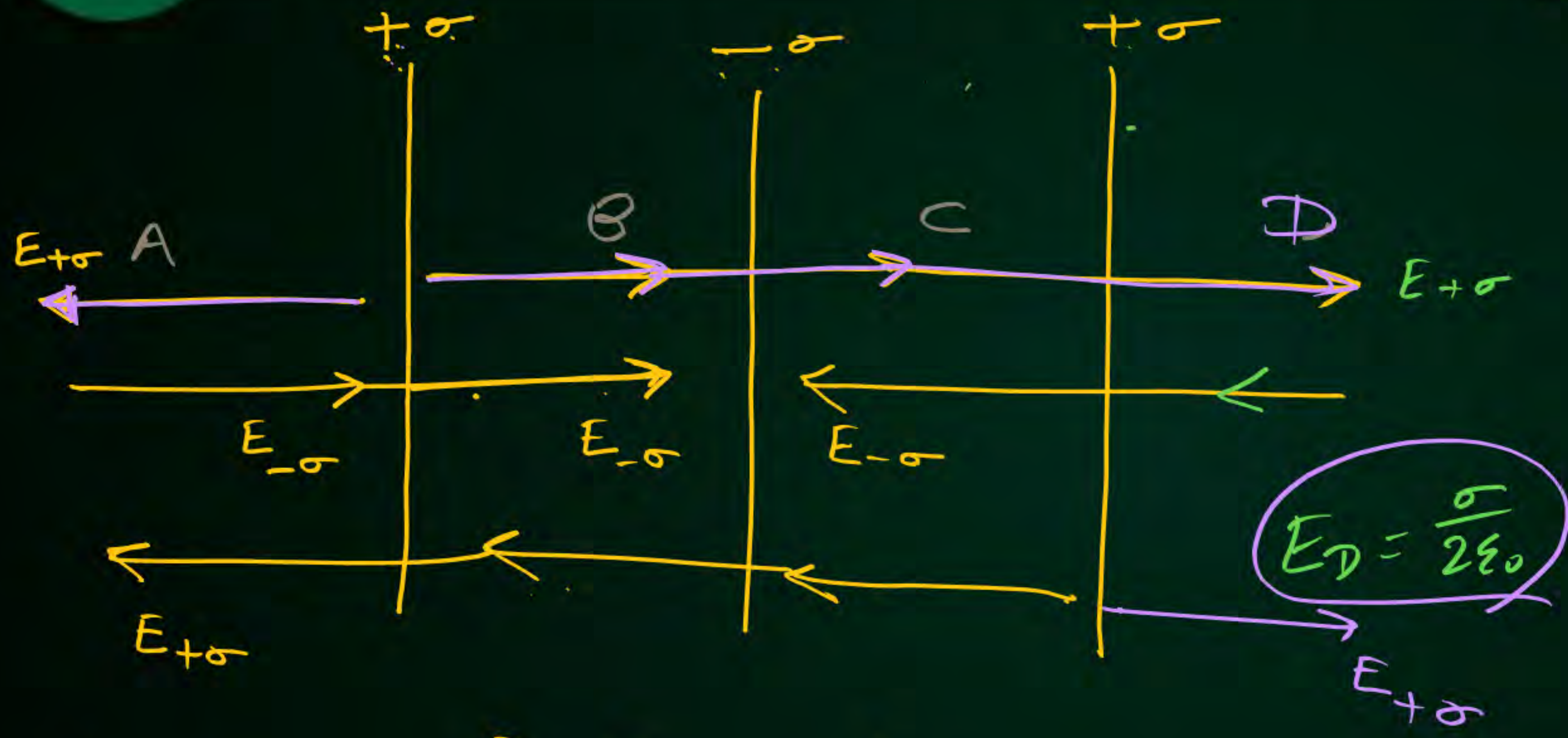
$\tan\theta = \frac{q\sigma}{\varepsilon_0 mg}$

$\sigma = \frac{\varepsilon_0 mg}{q} \tan\theta$

Electric field due to combination of sheet

Charge

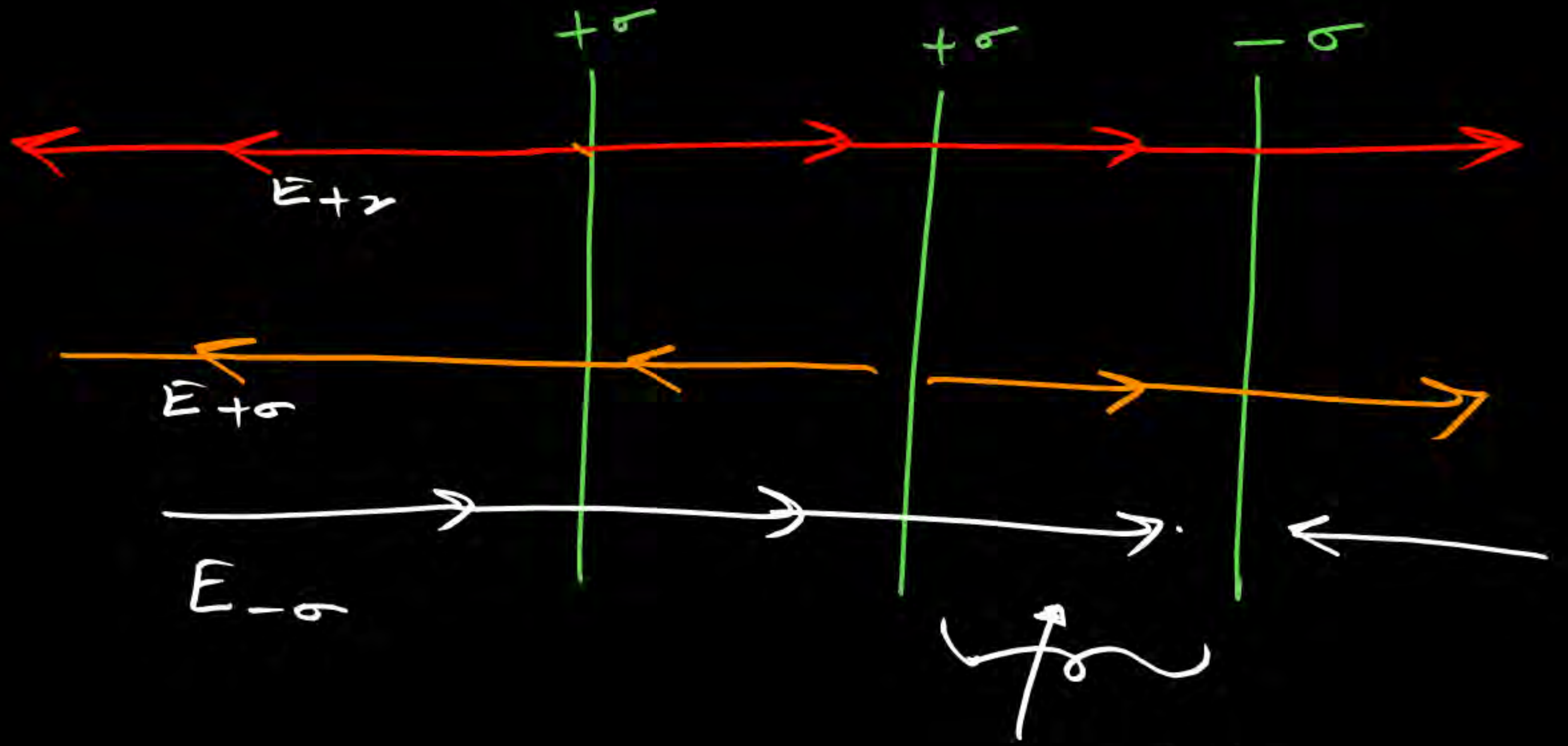
$E = \frac{\sigma}{2\varepsilon_0}$



$E_D = \frac{\sigma}{2\varepsilon_0}$

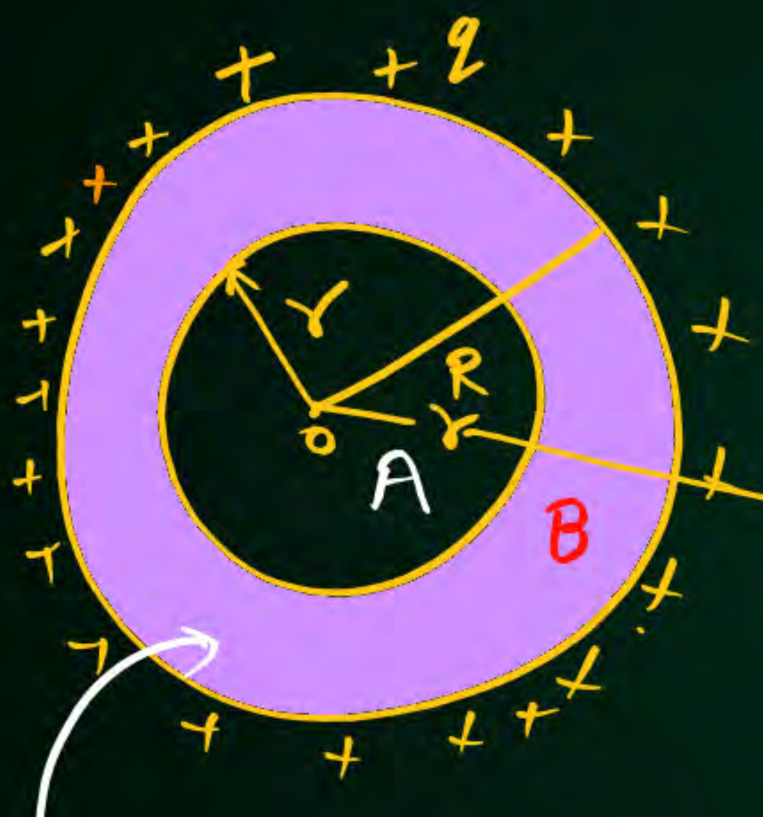
$E_A = \frac{\sigma}{2\varepsilon_0}$ $E_B = \frac{\sigma}{2\varepsilon_0}$ $E_C = \frac{\sigma}{2\varepsilon_0}$

Ans.



$$E = 3\left(\frac{\sigma}{2\varepsilon_0}\right)$$

Electric Field due to thick conducting sphere



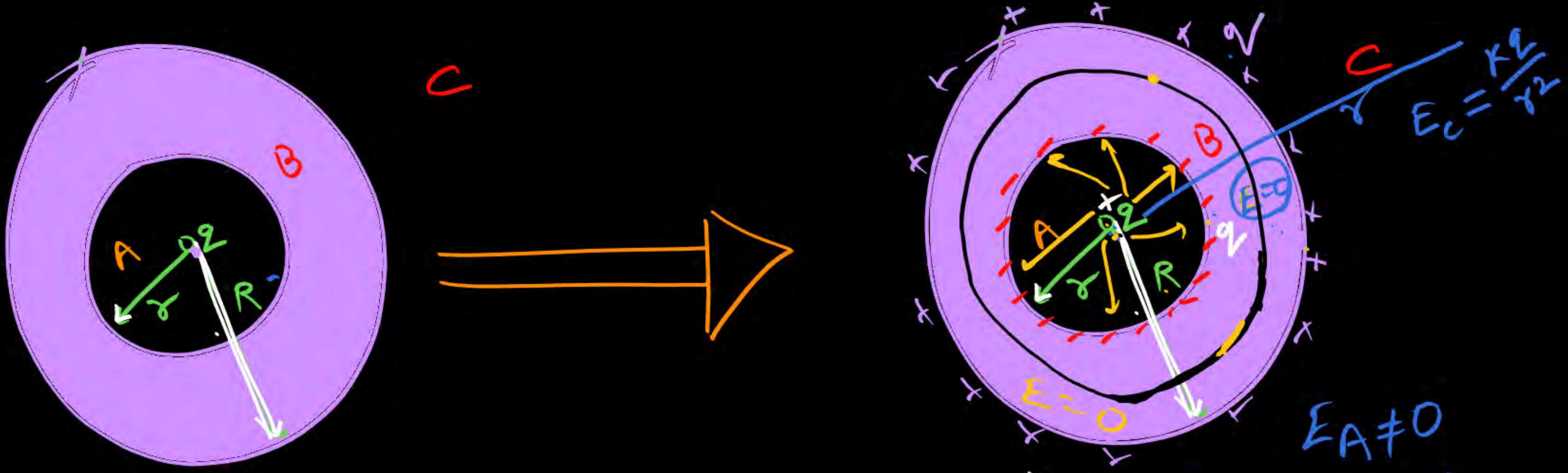
C $\left\{ E_C = \frac{Kq}{r^2} \right\}$

conducting material

$E_A = 0$ $E_B = 0$

$E_C \neq 0$

★ Electric field always zero inside isolated conductor where material is present.



thick conductor
Neutral

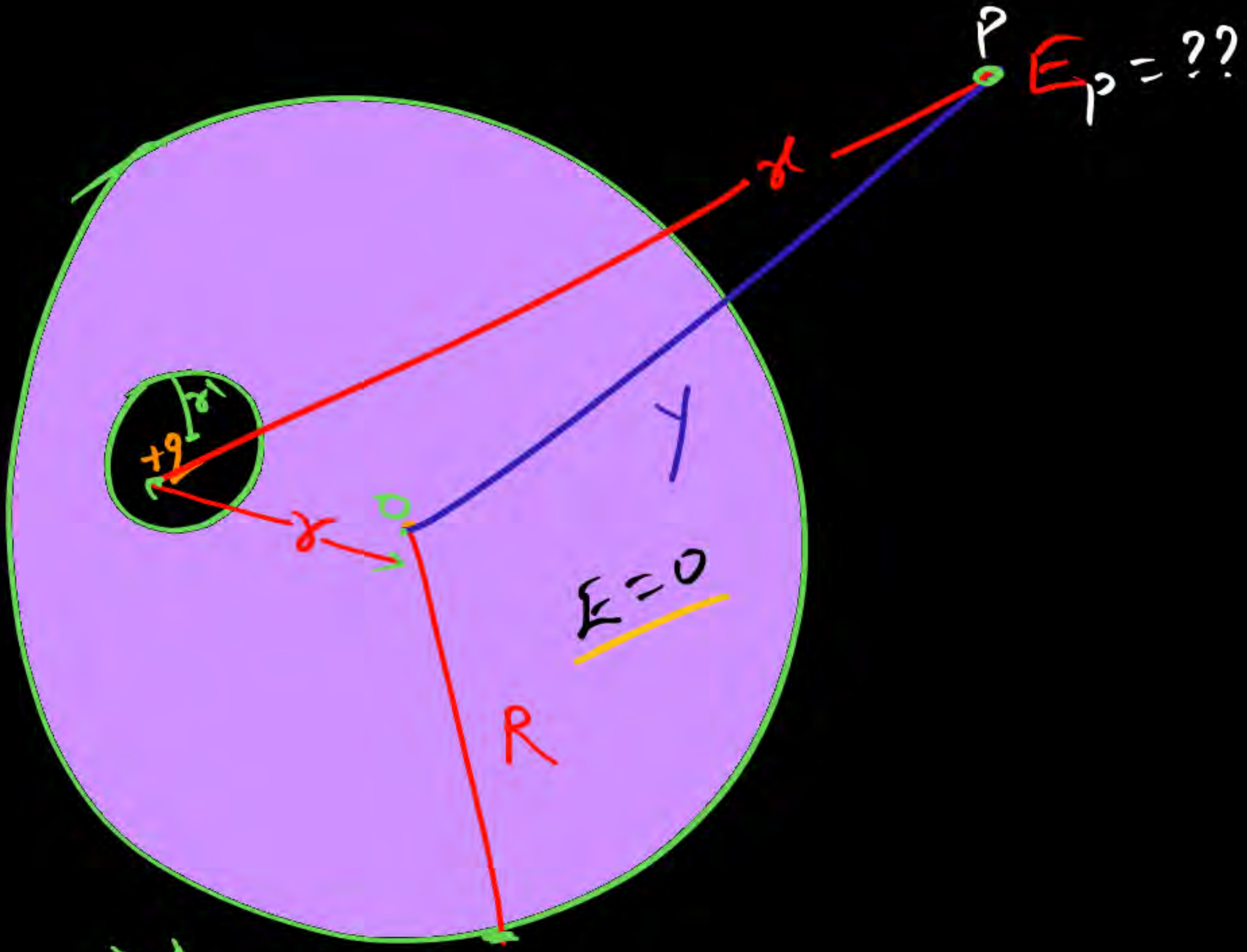
thick conductor
Neutral

$E_A \neq 0$

$E_B = 0$

$E_C \neq 0$

H/W *



⇒ Neutral Conductor.
Small charge q placed at centre of cavity.

QUESTION

Conducting neutral solid sphere having cavity and q is placed at centre of cavity. Find electric field at 'P'.

1. $E = \frac{kq}{r_1^2}$

2. $E = \frac{kq}{r_2^2}$

3. $E = \frac{kq}{(r_1 - r_0)^2}$

4. None of these

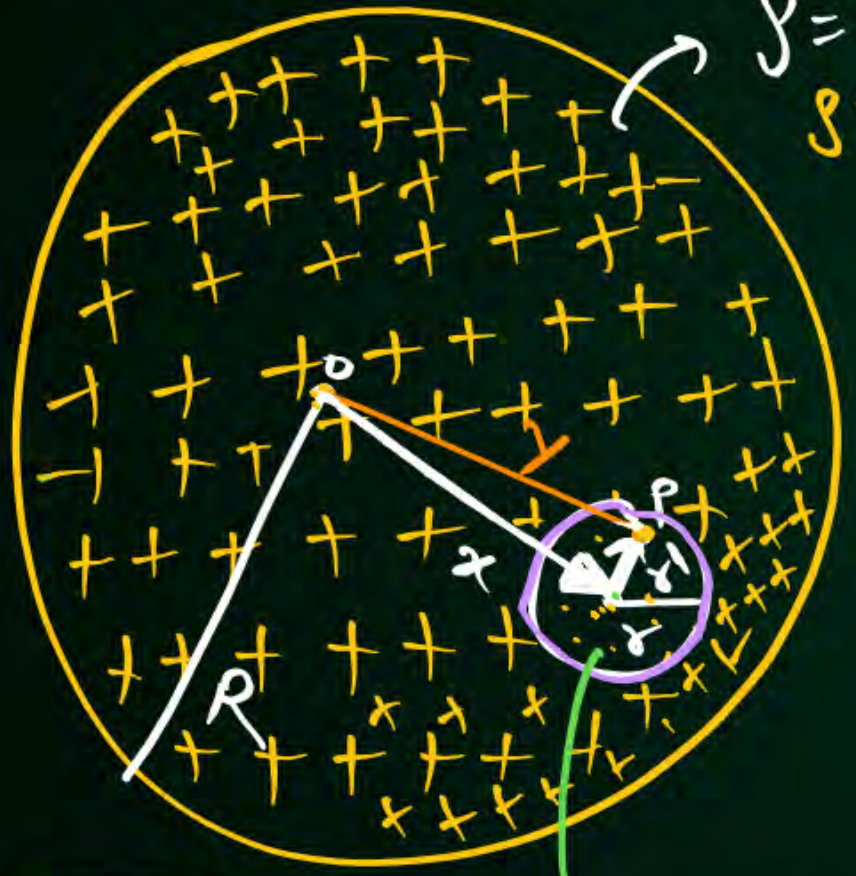
Electric field inside cavity of uniformly charge solid sphere

Not for NEET *

$E_P = ??$

ρ = volume charge density

$\rho = \frac{Q}{\text{Volume}}$



Cavity

$$\vec{x} + \vec{r'} = \vec{y}$$

$$\vec{x} = \vec{y} - \vec{r'}$$

$$\vec{E}_{\text{compt sphere}} = \frac{\rho \vec{y}}{3\varepsilon_0} \quad \text{— (1)}$$

$$\vec{E}_{\text{remaining Part}} = \left(\vec{E}_{\text{compt Part}}\right)_P - \left(\vec{E}_{\text{removed Part}}\right)_P$$

$$= \frac{\rho \vec{y}}{3\varepsilon_0} - \frac{\rho \vec{r'}}{3\varepsilon_0}$$

$$E_{\text{net}} = \frac{\rho}{3\varepsilon_0}\left[\vec{y} - \vec{r'}\right] = \frac{\rho \vec{x}}{3\varepsilon_0}$$

Inside cavity electric field is Uniform & equal to $\frac{\rho x}{3\varepsilon_0}$

Electric field at p inside cavity

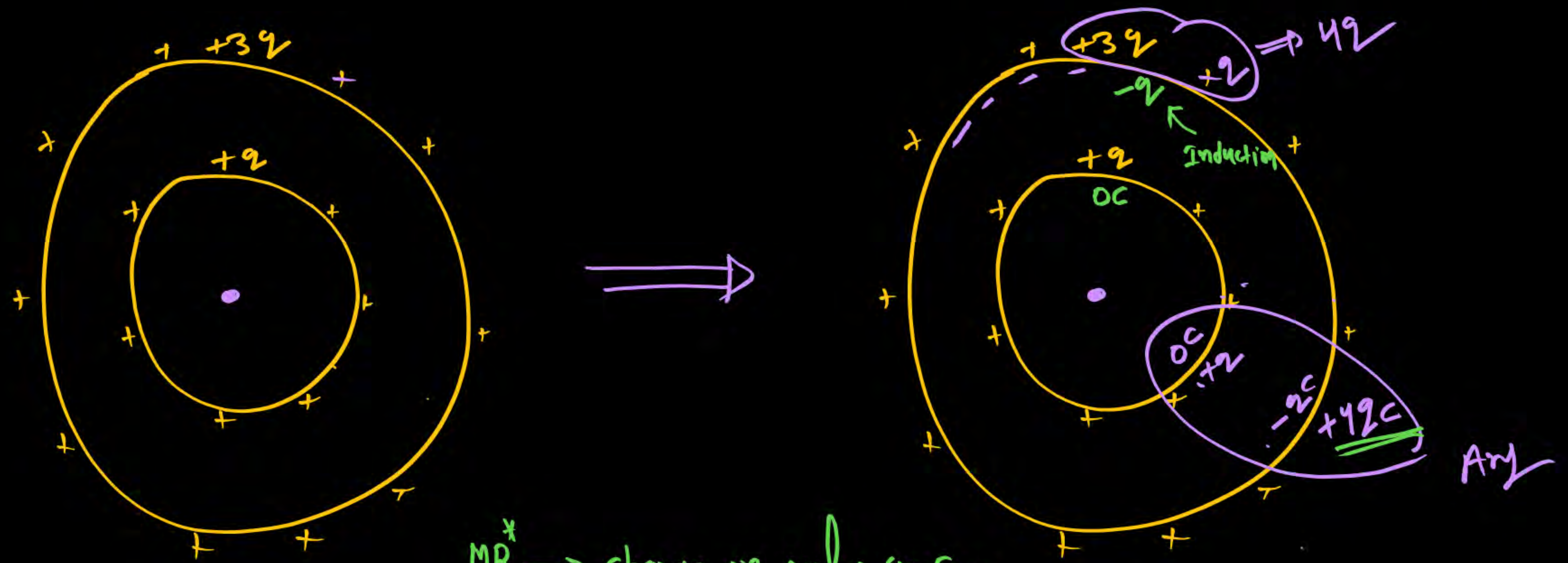
(a) zero

(b) Non uniform

(c) Uniform. ✓

Charge distribution due to induction

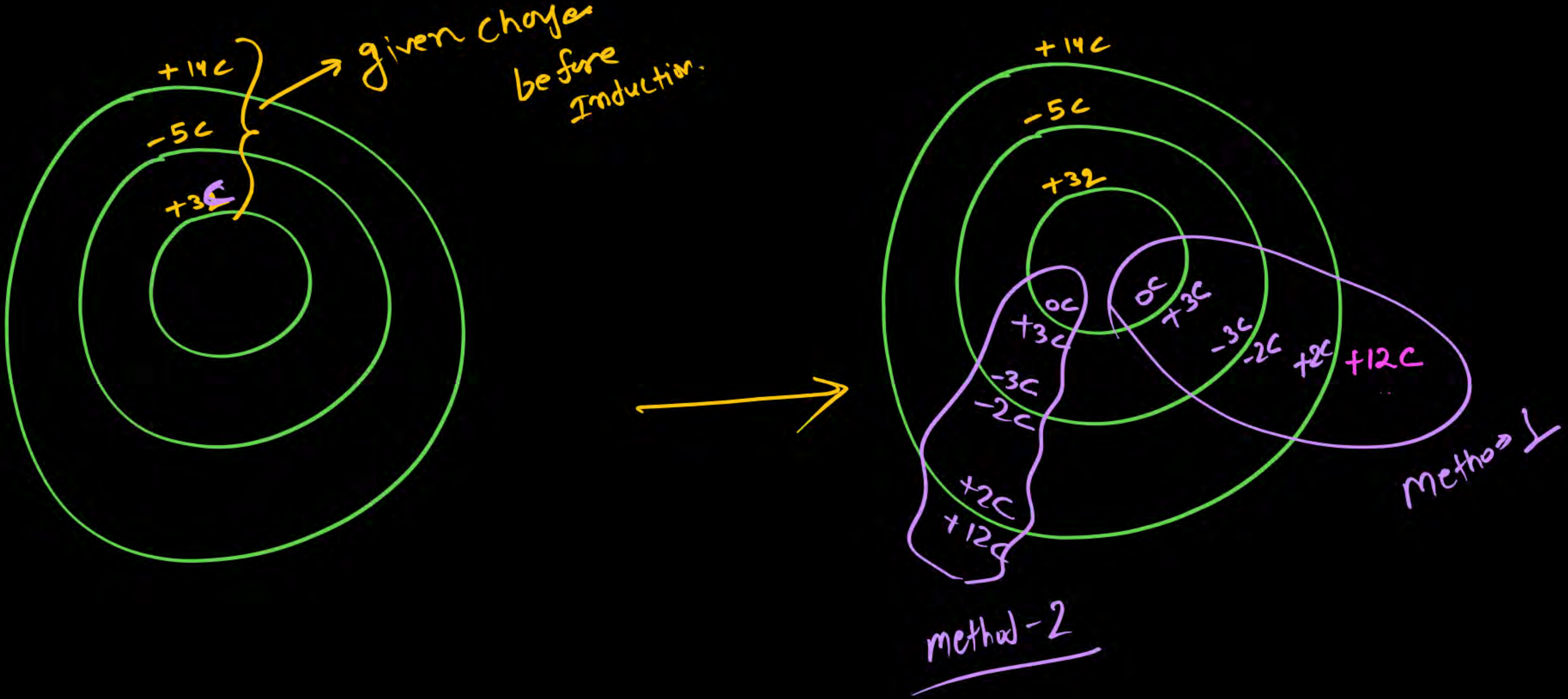
find charge on each surface of sphere after Induction.

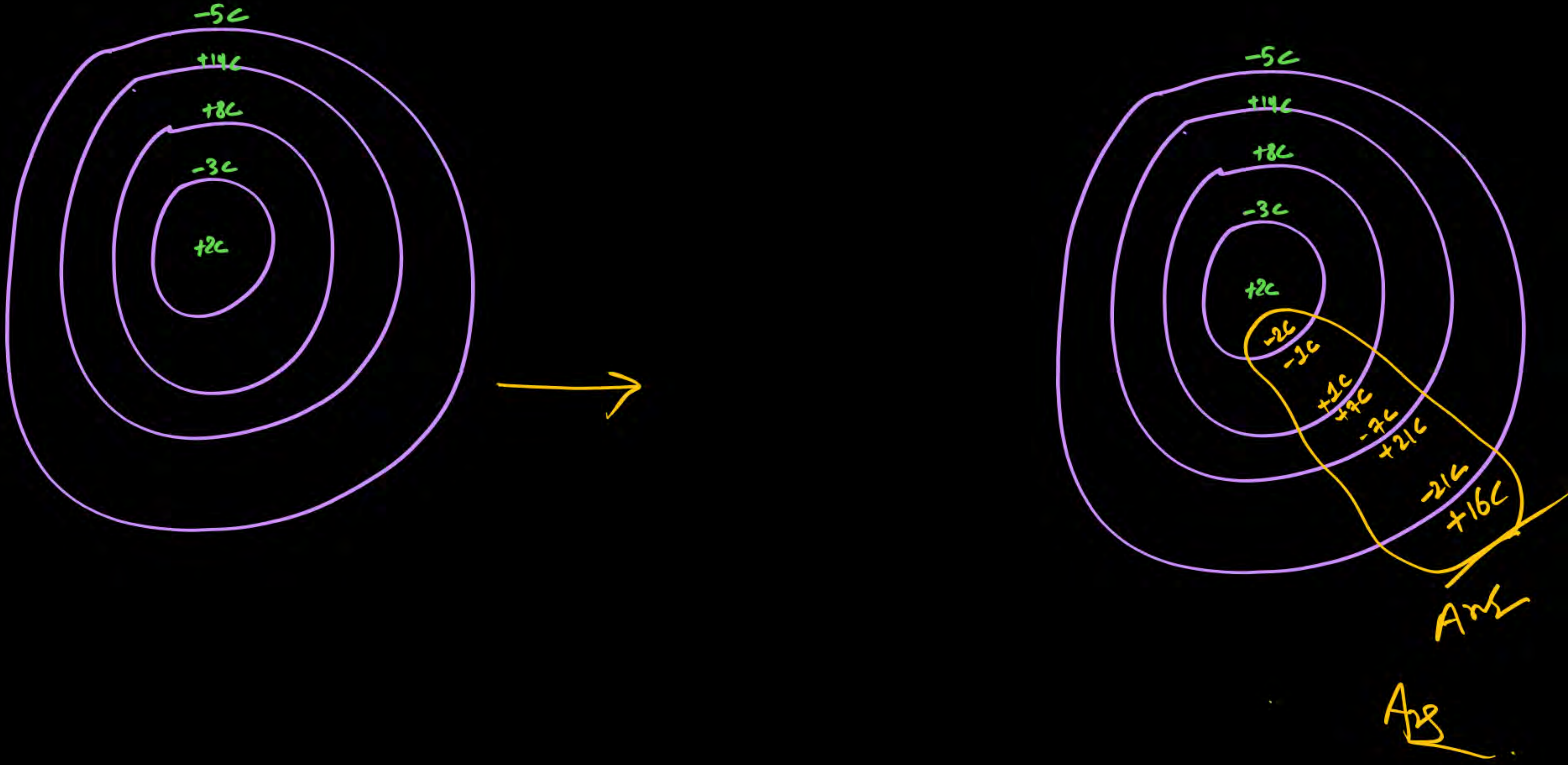


MR* → charge on outer surface of outer sphere = Sum of total charge on each Sphere.

→ always equal & opposite charge on facing surface

→ charge conserved on each sphere.


+14c
-5c
+3c
given charge before Induction
+14c
-5c
+32
0c
+3c
-3c
-2c
+2C
+12c
+3c
-3c
-2c
+2c
+12C
method 1
method-2



-5c
+14c
+8c
-3c
+2c
-5c
+14c
+8c
-3c
+2c
-2c
+7c
-7c
+21c
-21c
+16c
Ans


THANK YOU

SUMMARY LECTURE

- Subject - Physics
- Chapter – Electric Charges and Fields

One Shot



By- ER. MR SIR

ELECTRIC FIELD AND CHARGES

Charge	Electric field	Magnetic field	EM wave
Rest	✓	✗	✗
Constant velocity	✓	✓	✗
accelerated	✓	✓	✓

ELECTRIC CHARGE

→ Inharamet Property of body due to which it apply or experience Electro magnetic Intraction

Charge → Scalar, Conserved, Quantized, Invariant,

Unit → Coulomb, St. Coulomb (e.s.u.) = Frankline, e.m.u. Faraday

S.I unit (Coulomb); ↳ smallest unit of charge (St. Coulomb)

[mass ↑ ← Q = -ve (excess of e^-)
mass ↓ ← Q = +ve (deficiency of e^-)

↳ follows scalar addition

$1c + 6c = 7c$

$7c - 2c = 5c$

In an isolated system total charge (net charge) remains constant.
You can't create net new charge or destroyed
You can only transfer charge from one body to other body.

$Q_{min} = 1.6 \times 10^{-19} c$

$Q = n[e]$

$n = \pm 1, \pm 2, \pm 3, \pm 4,$

$Q = 3.2 \times 10^{-19} c$

$Q = ne$

Q given

$n = \frac{Q}{e} =$ integer

$$1C = 3 \times 10^9 \text{ e.s.u}$$

Smallest unit

$$1C = \frac{1}{10} \text{ e.m.u}$$

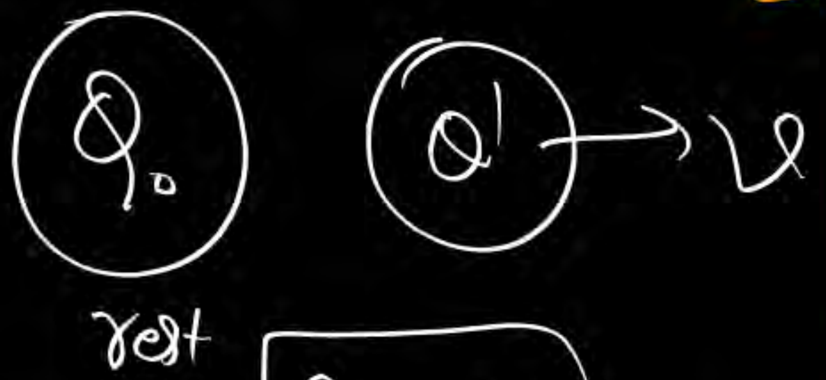
nu = const

$$n_1 u_2 = n_2 u_2$$

1 Far = 96500 C

Invariant

→ Value of charge on the body does not depends on speed of body.



$$Q_0 = Q'$$

$$\text{Specific charge} = \frac{Q}{m}$$ (#)

- Same charge repel each other → Same charge may attract ↳ due to Induction
- opposite charge must attract each other.
- charge always exist with mass → Mass can exist without charge
- charge cannot exists without mass
- charge is transferable



- **Positive charge** → deficiency of electron
- **Negative charge** → Excess of electron.
- **Superposition theorem** → force on one charge due to other charge does not depends on other charge and medium.

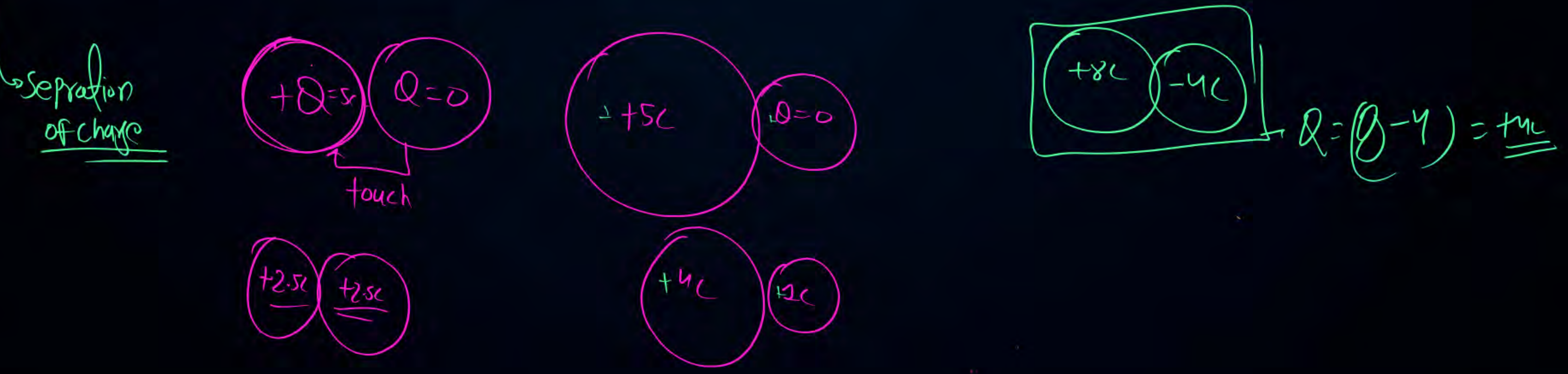
$$F_{net\ electrostatic} = \vec{F_1} + \vec{F_2} + \vec{F_3} + \vec{F_4} + \vec{F_5} + \ldots$$

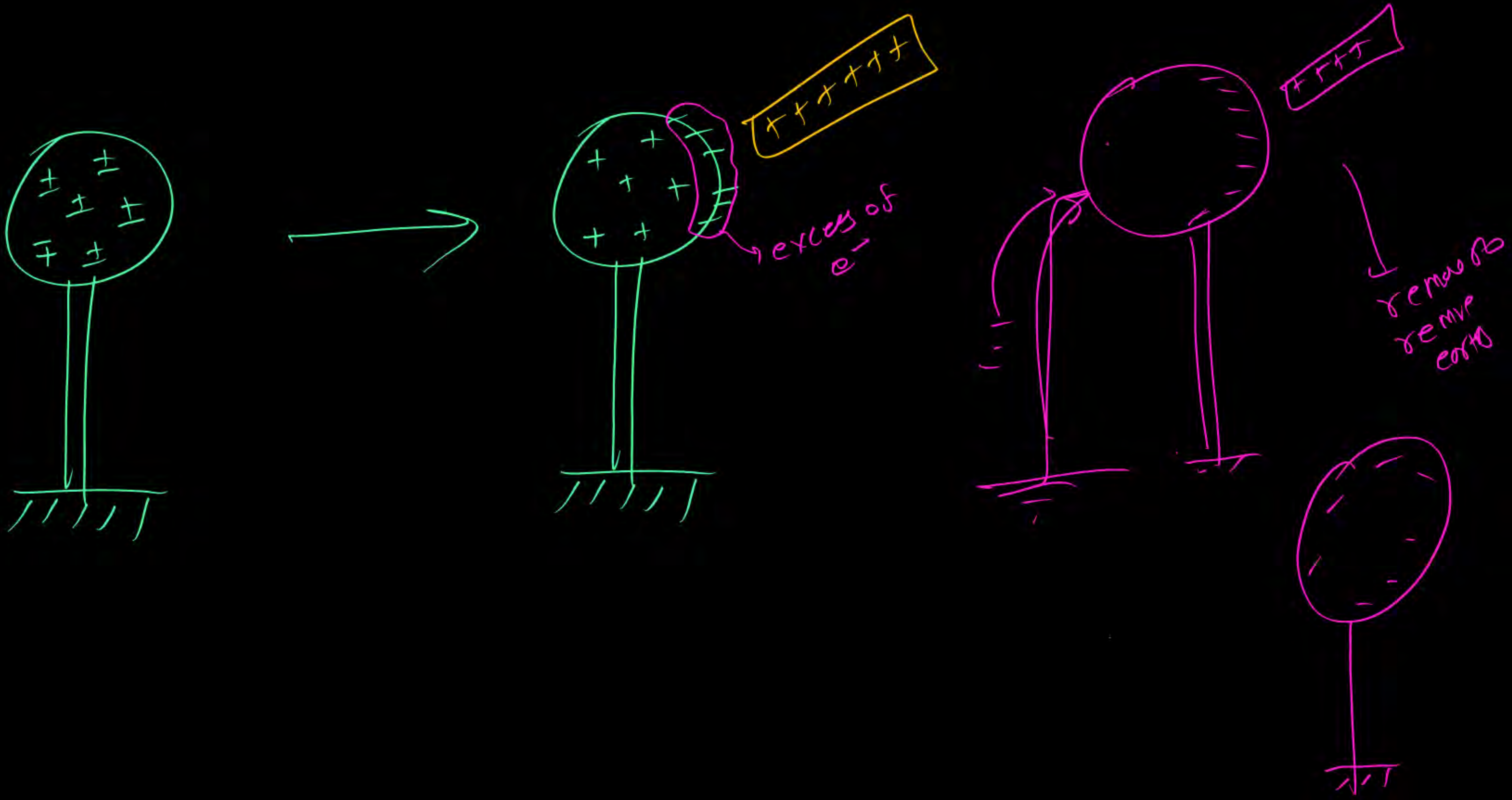
METHOD OF CHARGING

Friction → Insulator [Equal and opposite charge]

Induction → Conductor, dielectric [opposite and equal may lesser]

Conduction → For conductor [Similar nature may equal unequal]




excess of e^-
remove earth

QUESTION

Find charge when they are in contact



$q_1^1 = \frac{R_1}{R_1+R_2}(q_1+q_2)$

$q_2^1 = \frac{R_2}{R_1+R_2}(q_1+q_2)$

IMP Rate

Electrostatic force

air medium

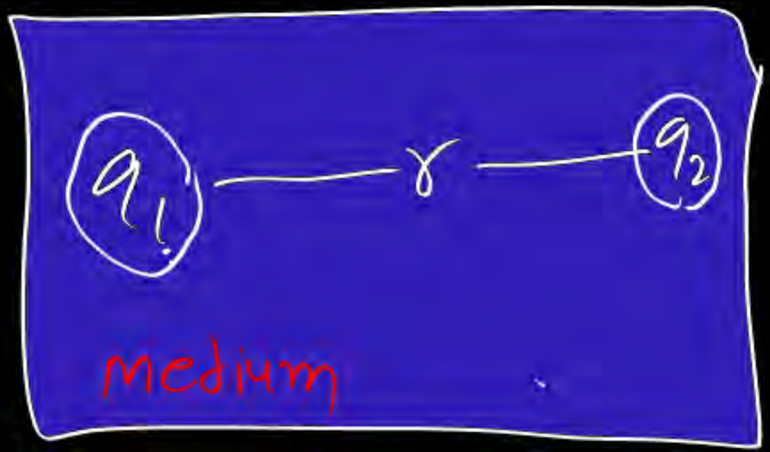
Central, Conservative, Inverse-square, long-range, medium, Photon,

$$|\vec{F}_{12}| = \frac{k q_1 q_2}{r^2} = \frac{q_1 q_2}{4\pi\varepsilon_0 r^2}$$



↳ Force on 1st charge due 2nd charge

F (net electrostatic force on 1st charge) $= \dfrac{q_1 q_2}{4\pi\varepsilon_0 r^2}$



* Force on q_1 due to q_2 $= \dfrac{q_1 q_2}{4\pi\varepsilon_0 r^2}$ ⟸

✓ Net electrostatic force on q_1 $= \dfrac{q_1 q_2}{4\pi\varepsilon_m r^2}$

ε_0 = Permitivity of free space

ε_m = " " "

$\varepsilon_r = \dfrac{\varepsilon_m}{\varepsilon_0} = k$

↳ unit less & dim^n less

$\varepsilon_m = k\varepsilon_0 = \varepsilon_r \varepsilon_0$

$F_{net\ medium} = \dfrac{F_0}{k(\varepsilon_r)}$ ← net force

PERMITIVITY

ε_0 = permitivity of free space = ✓

$= 8.85 \times 10^{-12}$ $\frac{C^2}{Nm^2}$

ε_m = permittivity of medium = $\varepsilon_r \varepsilon_0 = k\varepsilon_0$

$$\varepsilon_r = k = \frac{\varepsilon_m}{\varepsilon_0}$$

$$F = \frac{q_1 q_2}{4\pi \varepsilon_0 r^2}$$

$$\varepsilon_0 = \frac{q_1 q_2}{4\pi F r^2} = C^2/Nm^2$$

$$F = \frac{K q_1 q_2}{r^2}$$

q_1 — r — q_2 F

q_1 — $2r$ — q_2 $F/4$

q_1 — $(3r)$ — q_2 $F/9$

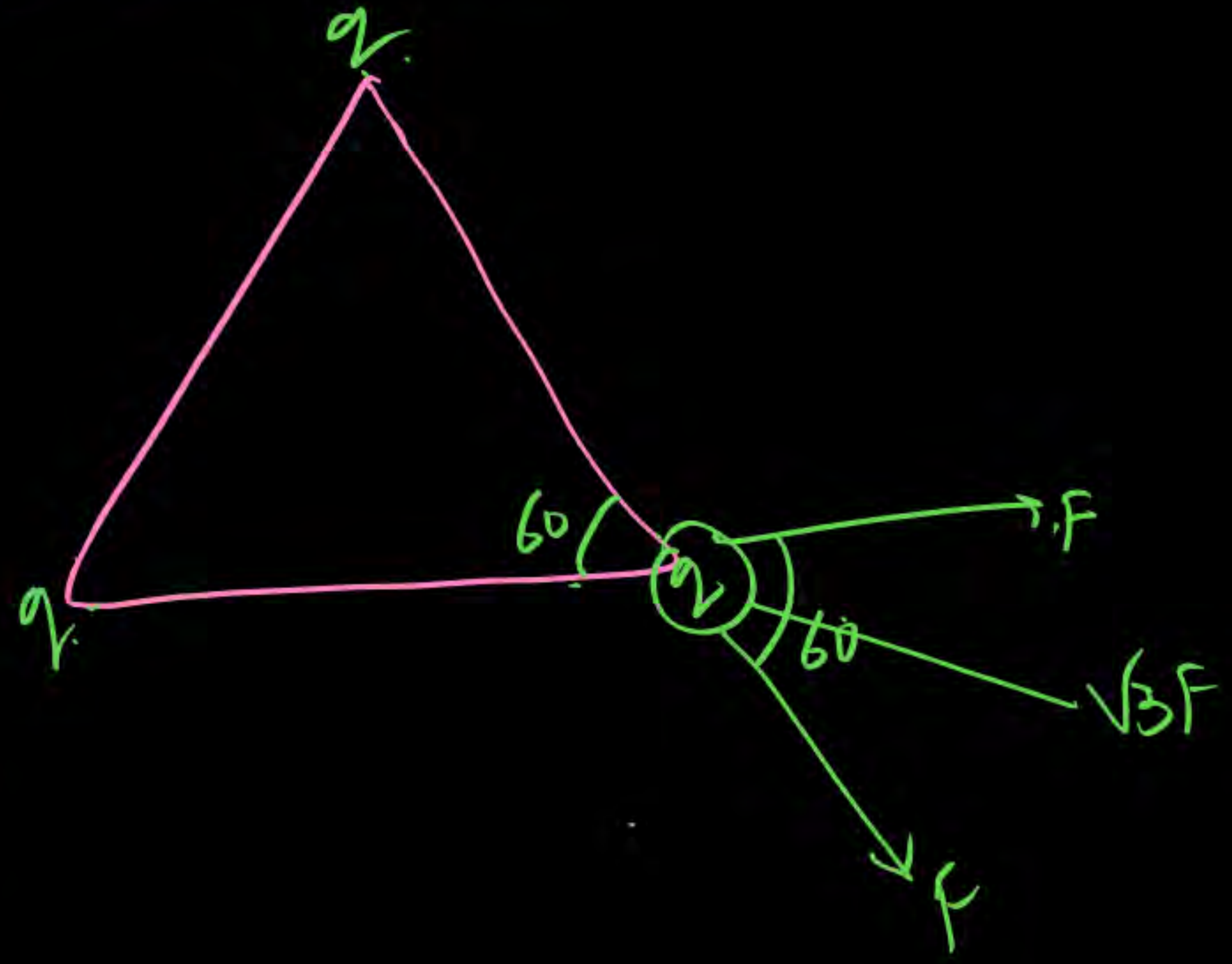
q_1 — $4r$ — q_2 $F/16$

q_1 — $\frac{r}{2}$ — q_2 $F' = 4F$



$$F_{max} = \frac{q_1 q_2}{4\pi\epsilon_0 r^2}$$

$q_1 = q_2$



$Q = ne$

$n = \left[\frac{Q}{e}\right]$

$n = 0.3$ ✗

$Q = 0.1e$ ✗

$Q = 0.1C$ ✓

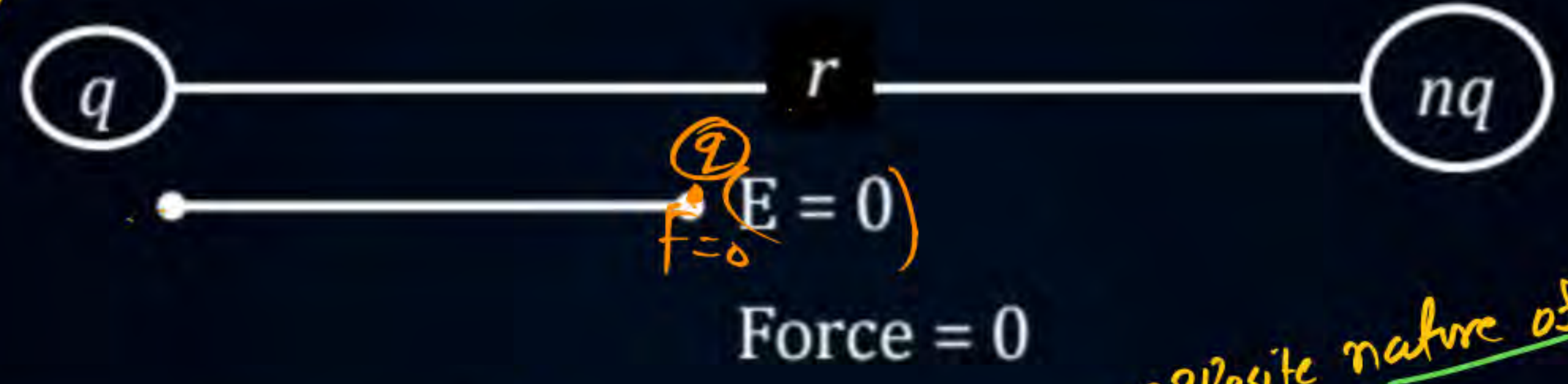


F force is acty then find no of e^- missn from each chare

$$F = \frac{Kq^2}{r^2}$$

$$\sqrt{\frac{Fr^2}{K}} = ne$$

$$n = \frac{1}{e}\sqrt{\frac{Fr^2}{K}}$$



Similar nature of chr

$$x = \frac{r}{\sqrt{n}+1}$$

opposite nature of chr

$$x = \frac{r}{\sqrt{n}-1}$$

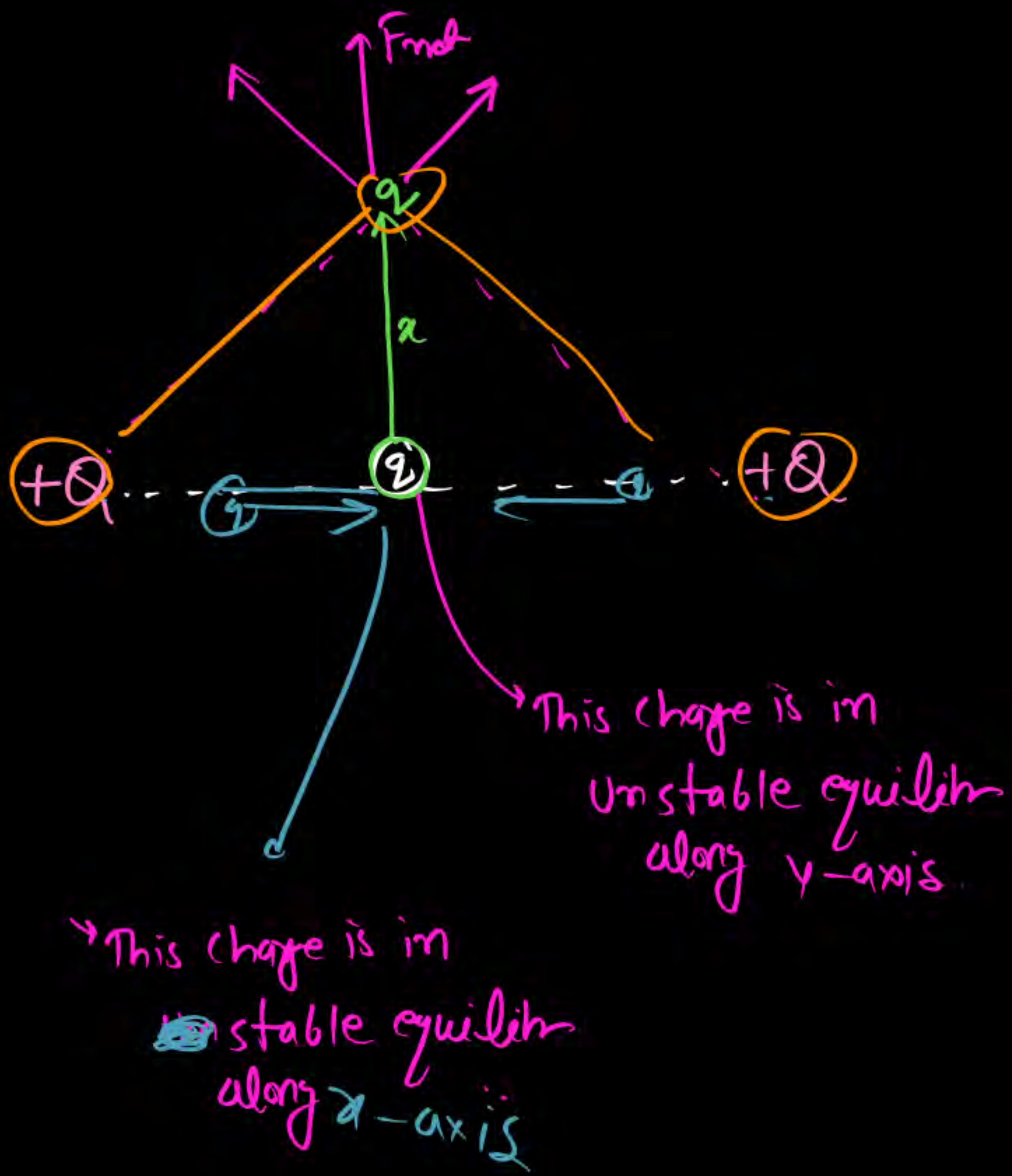
outside from small charge.

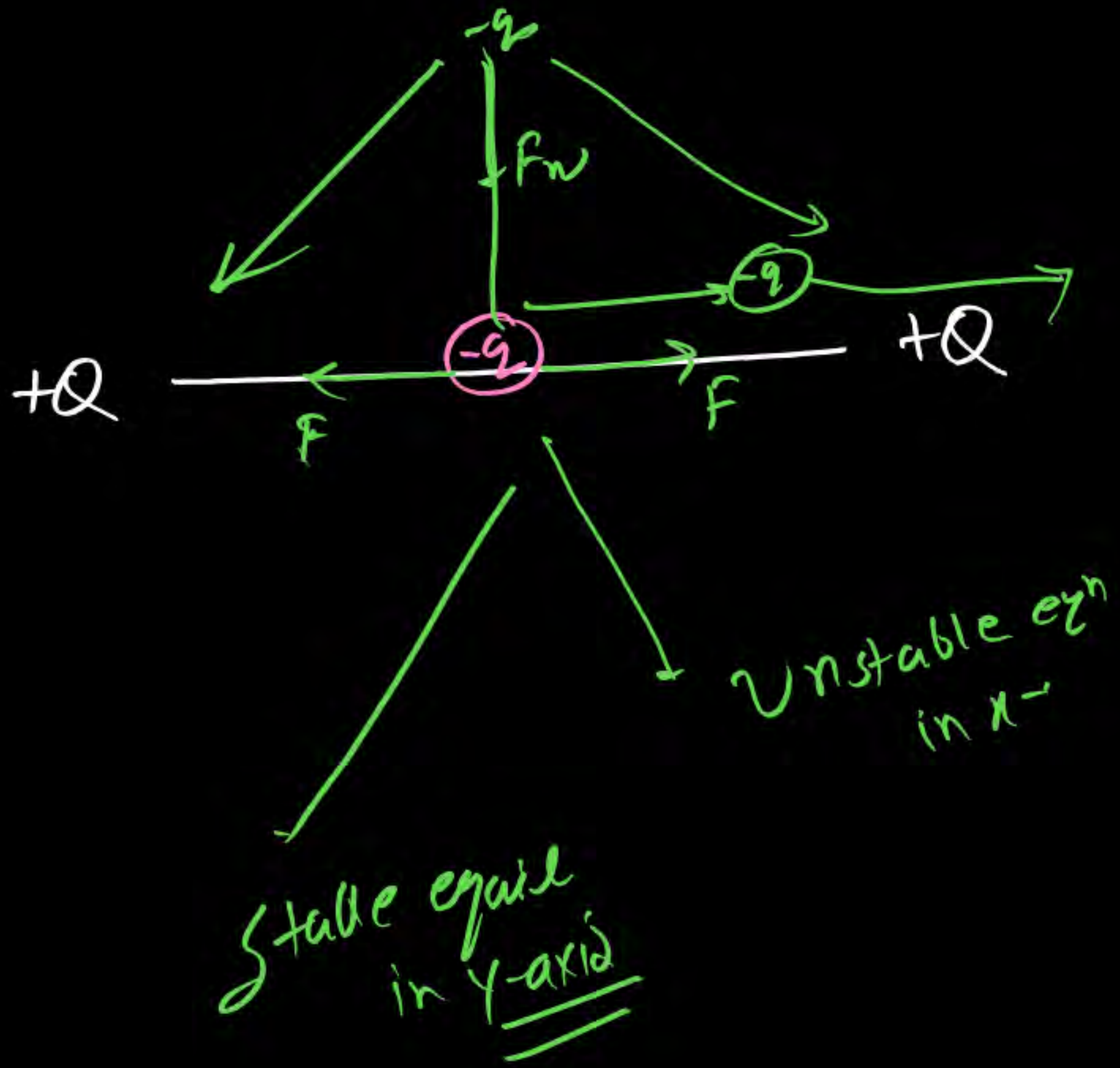
+Q ← 12 m → +4Q

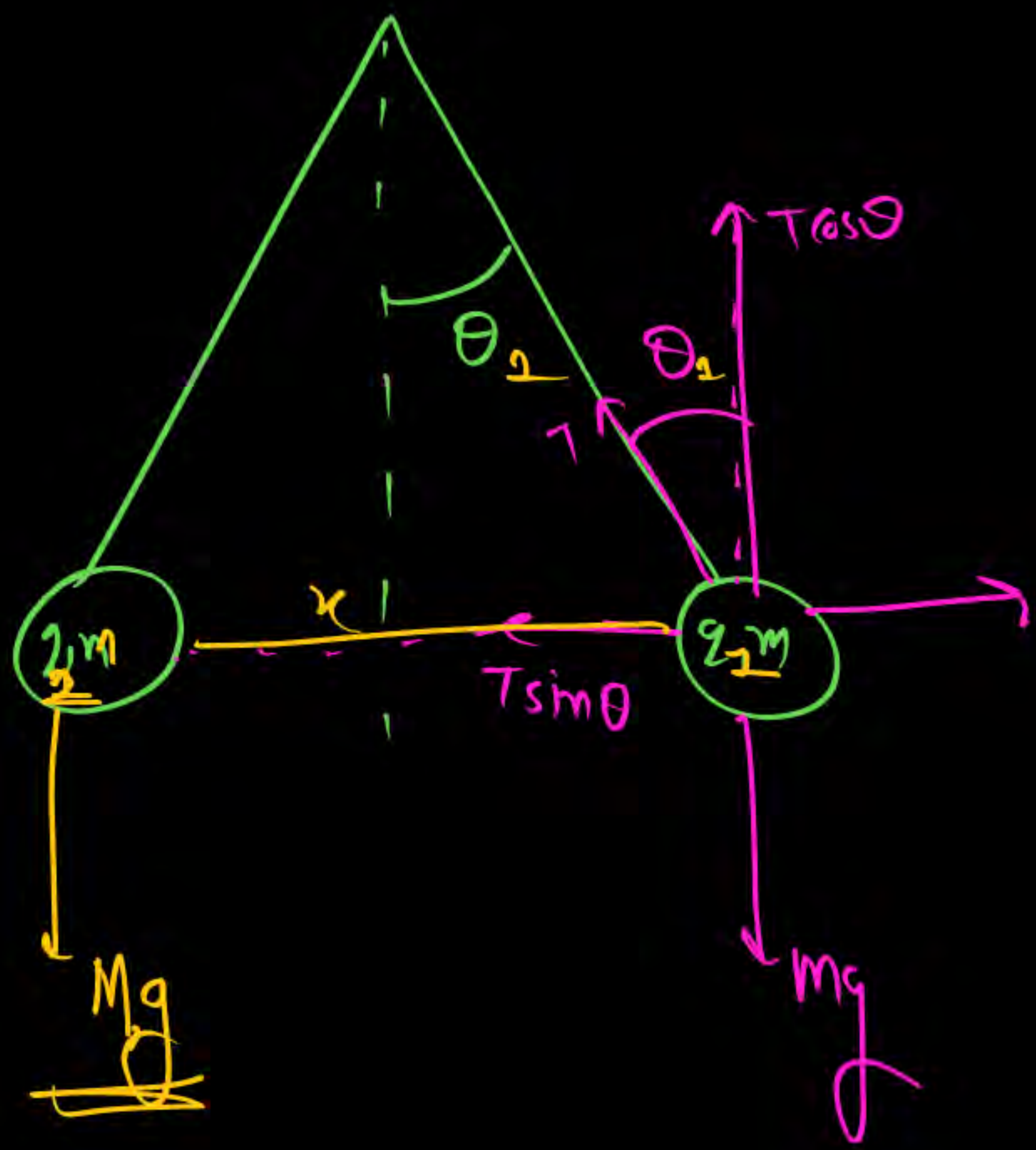
$x = \frac{12}{\sqrt{4}+1} = \frac{12}{3} = 4\text{ m}$

−q ← 12 → 9q

$x = \frac{12}{\sqrt{9}-1} = \frac{12}{3-1} = \frac{12}{2} = 6\text{ m}$ from (−q)


Fnet
q
x
+Q
q
+Q
This charge is in
Unstable equilibrium
along y-axis
This charge is in
stable equilibrium
along x-axis


-q
Fw
-q
+Q
-q
+Q
F
F
Unstable eqn
in x-
Stable equi
in y-axis



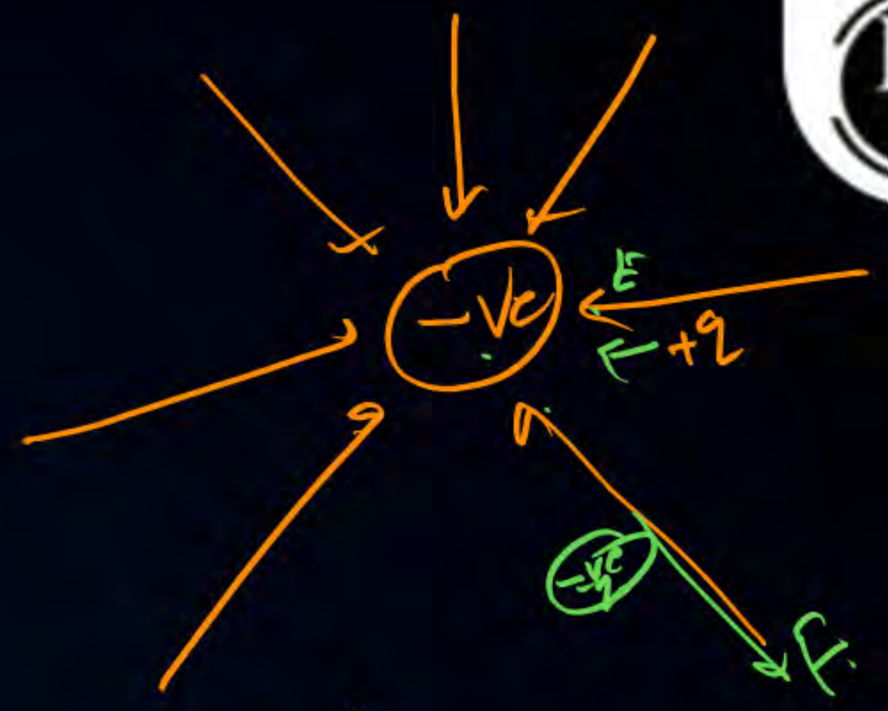
$$F_e = \frac{Kq^2}{x^2} = \frac{Kq_1q_2}{x^2}$$

$$\tan\theta_1 = \frac{Kq_1q_2}{x^2 m_1 g}$$

$$\tan\theta_2 = \frac{Kq_1q_2}{x^2 m_2 g}$$

$$\frac{\tan\theta_1}{\tan\theta_2} = \frac{m_2}{m_1}$$

ELECTRIC FIELD

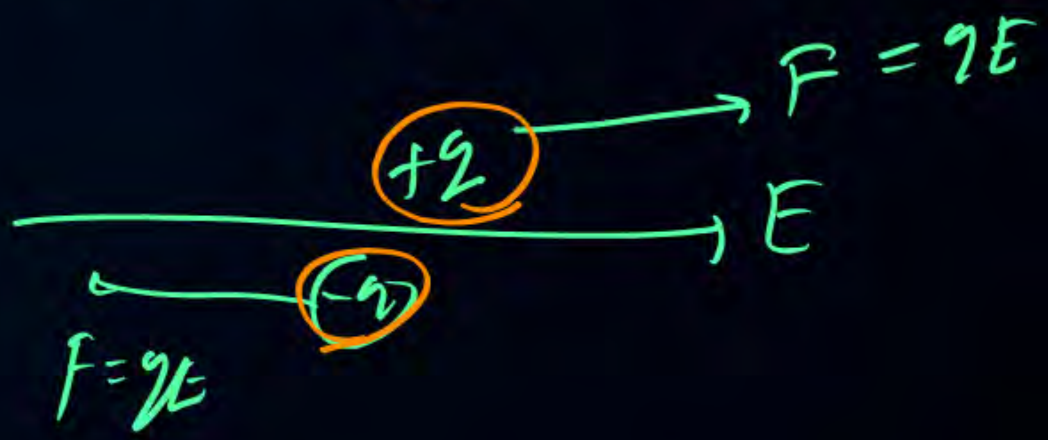


→ force experienced by unit positive charge.

→ vector

→ direction along the force of +ve charge

→ force on +ve charge in electric field along field, and force –ve charge along opposite direction of field.



$$\vec{E} = \frac{\vec{F}}{q}$$

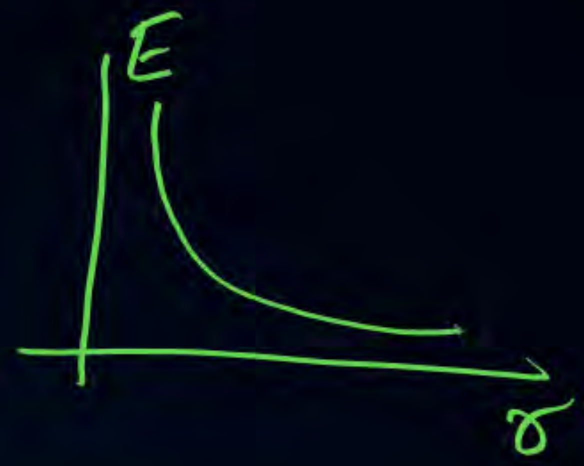




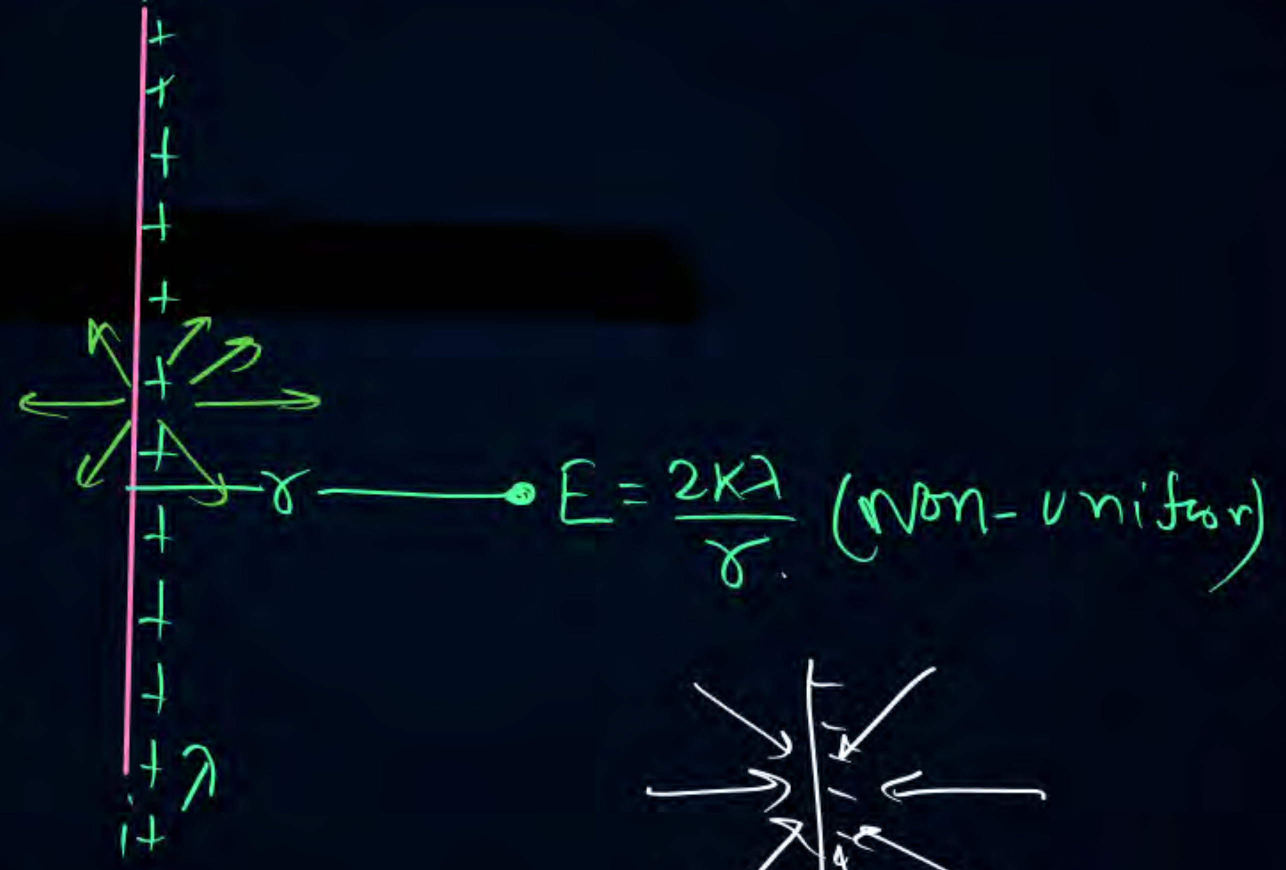
ELECTRIC FIELD

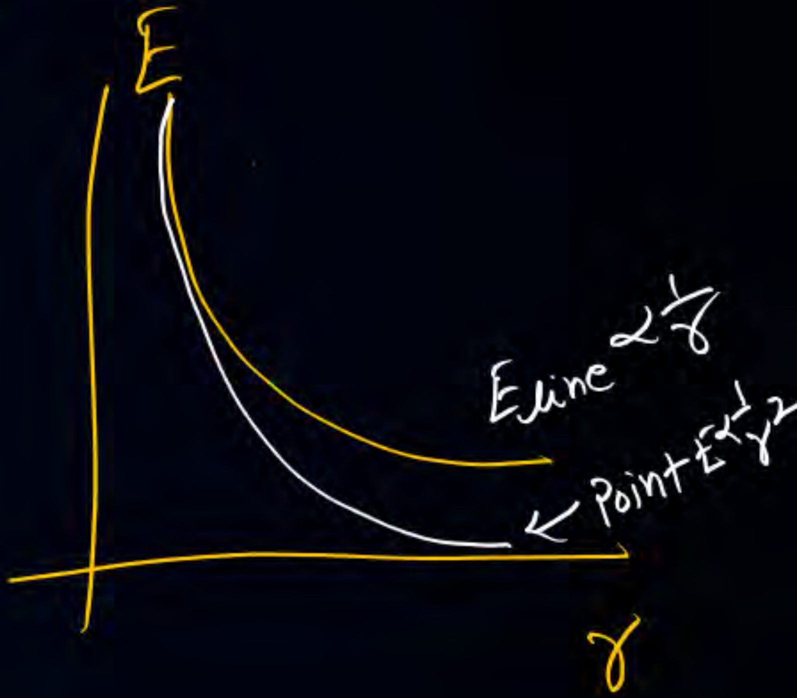
- Point charge





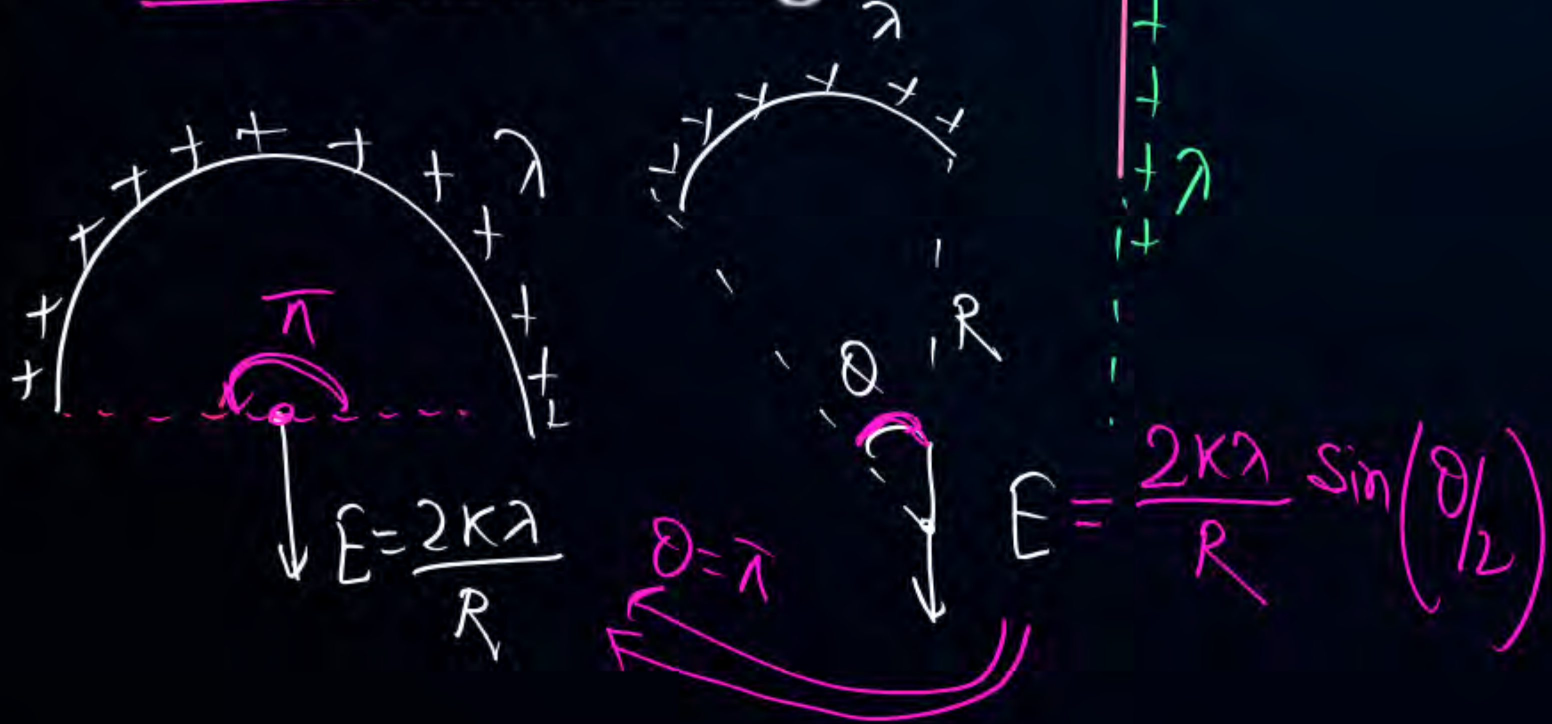
- Infinite line charge, [redacted]

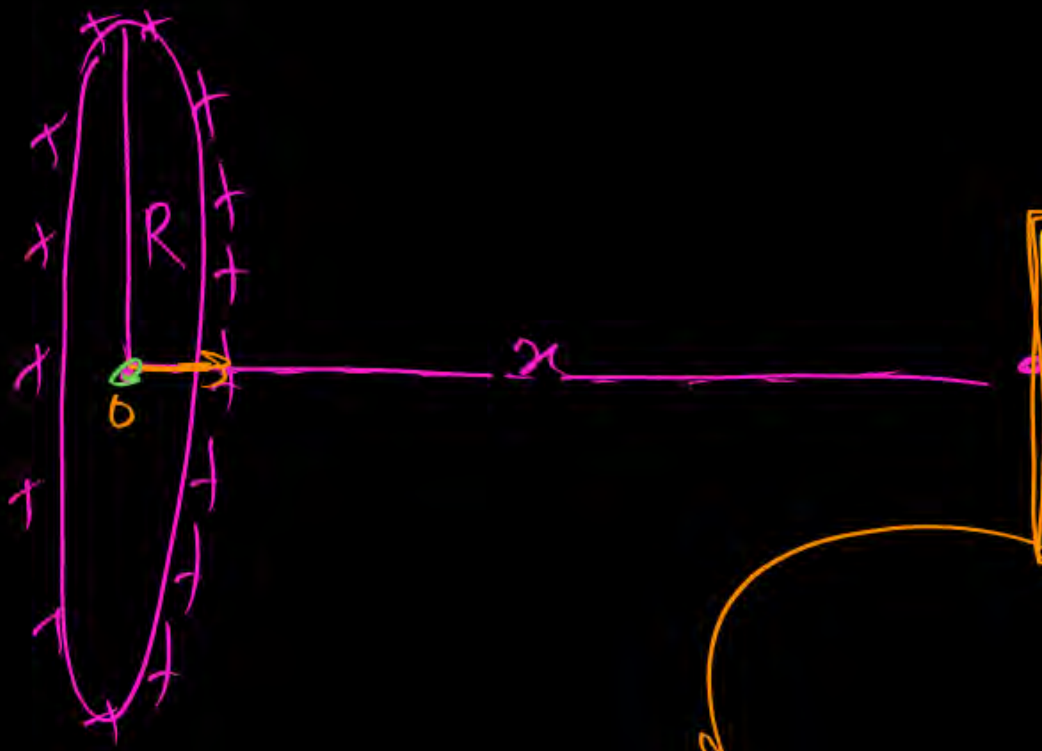






- On the axis of ring





$$E = \frac{KQx}{(R^2+x^2)^{3/2}}$$

$$E_{centre} = 0$$

$x <<< R$

$$E = \frac{KQx}{(R^2)^{3/2}}$$

$$E \propto x$$

$x >>> R$

$$E = \frac{KQ\cancel{x}}{\cancel{x^3}\,x^2}$$

$$E \propto \frac{1}{x^2}$$



$$x = \frac{R}{\sqrt{2}}$$

E will be max at $x = \frac{R}{\sqrt{2}}$

$$E = \sqrt{2}\left(\frac{\sqrt{2}K\lambda}{l}\right) = \frac{2K\lambda}{\ }$$



$$E = \frac{2K\lambda}{R}\sin\left(\frac{\pi}{2\times 2}\right)$$

$$E = \frac{\sqrt{2}K\lambda}{R}$$

DIPOLE MOMENT

Pair of two equal and opposite charge, placed at a small distance.

$\vec{P} = ql$

$-q \longleftarrow l \longrightarrow +q$

⇒ vector

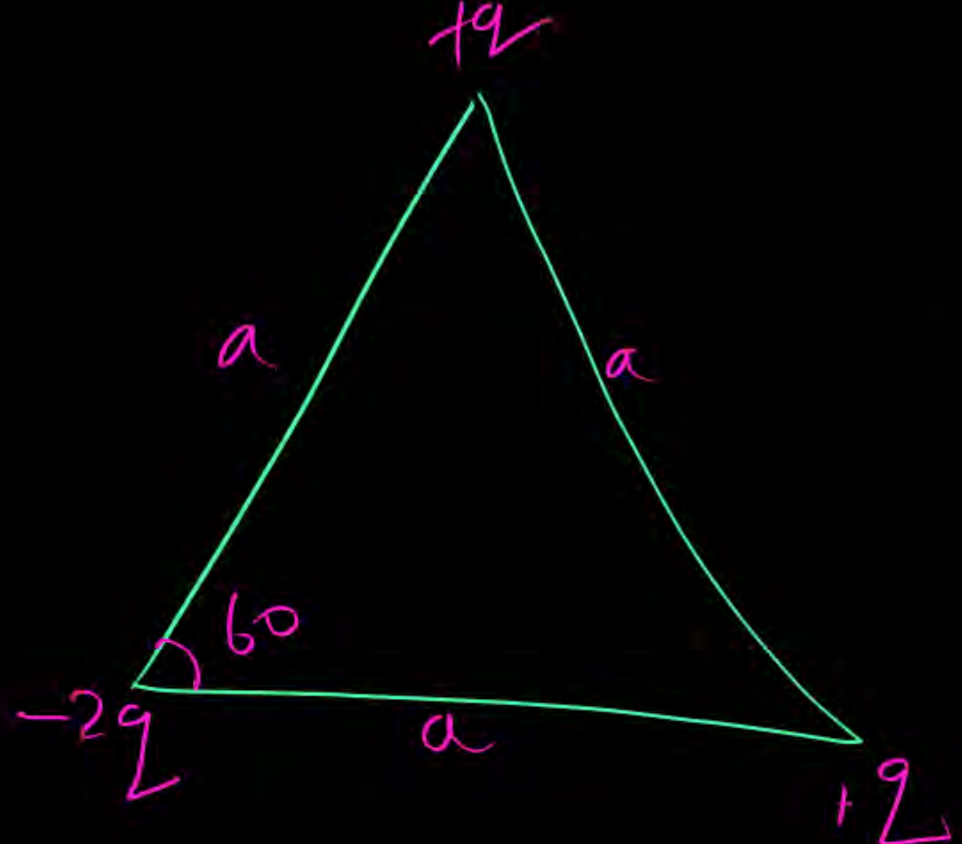
$-q \longleftarrow 2l \longrightarrow +q$ $\quad P = q(2l)$

⇒ unit c.m.

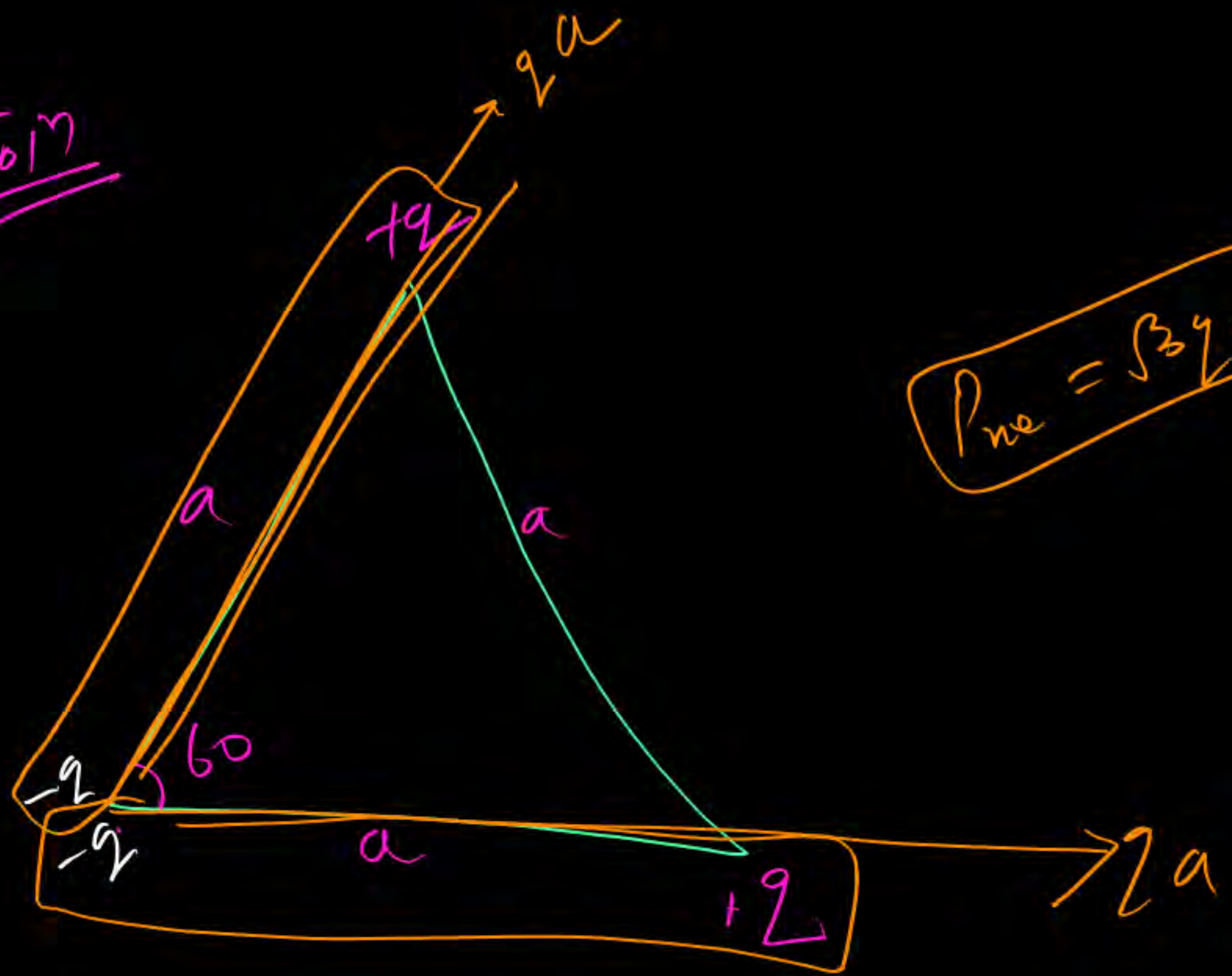
⇒ direction from –ve to +ve charge

$-q$ —— $2a$ —— $+q$

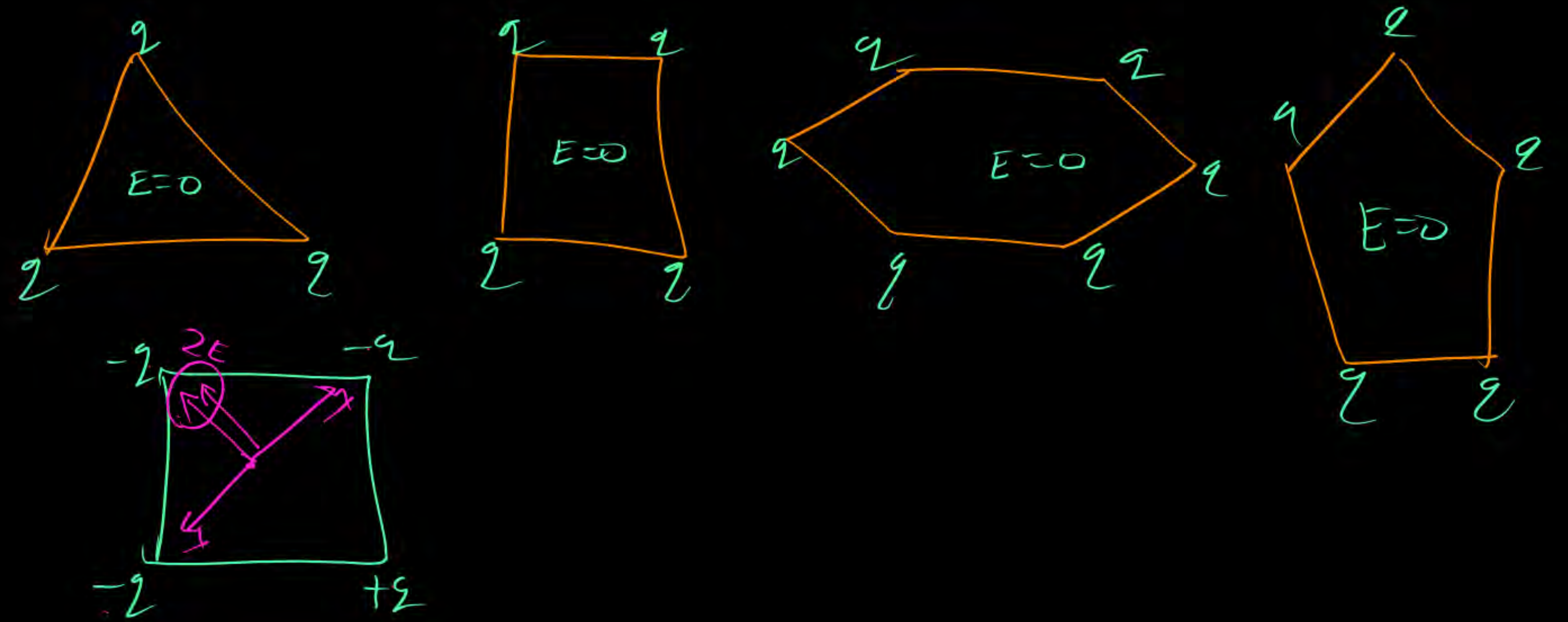
$P = q(2a)$



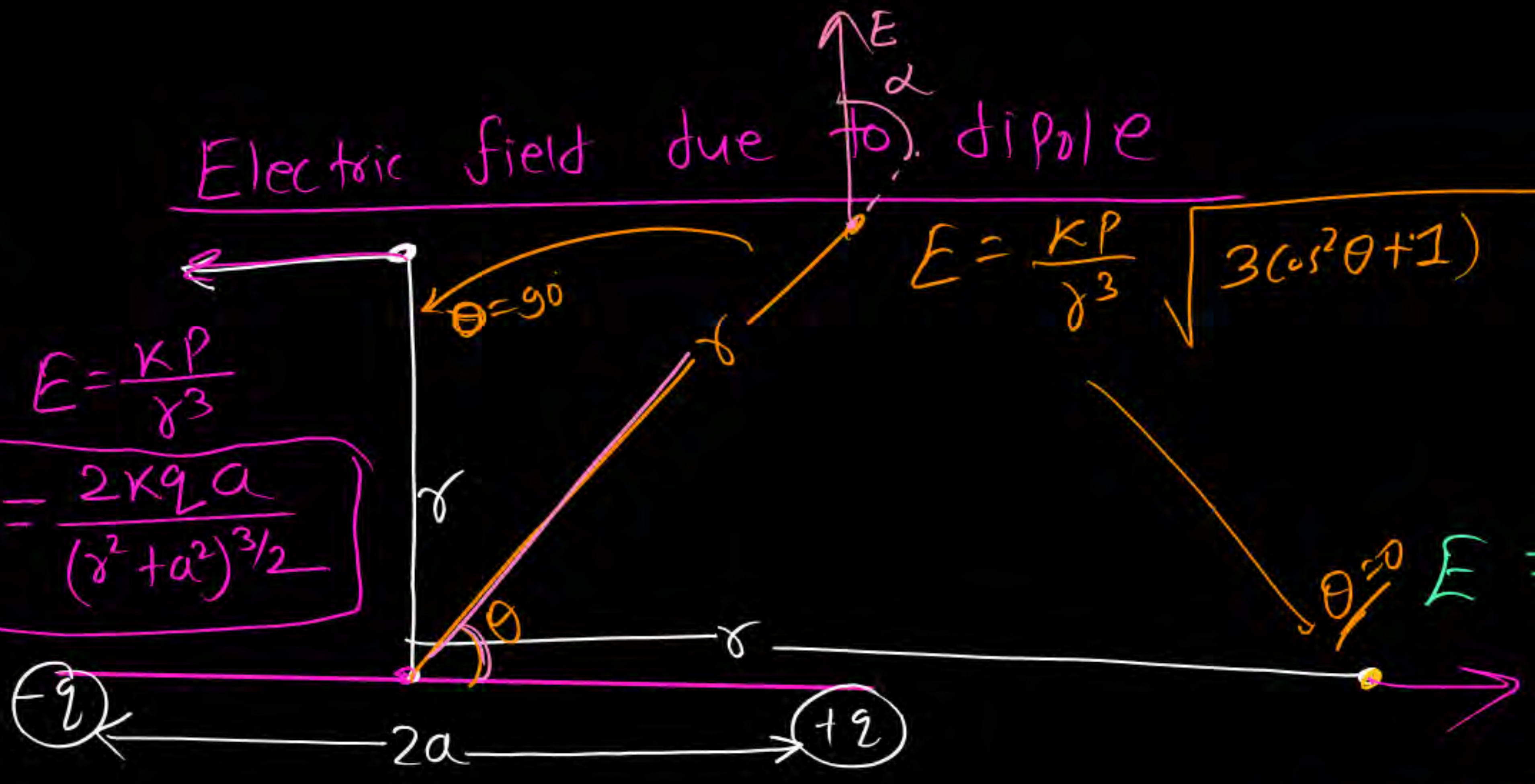
Soln



$P_{net} = \sqrt{3}qa$


q
E=0
E=0
E=0
E=0
-q
-q
2E
-q
+q

Electric field due to dipole



$P = q(2a)$

$E = \frac{KP}{r^3}$

$$E = \frac{2Kqa}{(r^2+a^2)^{3/2}}$$

$$E = \frac{2Kqa}{(r^2+a^2)^{3/2}}$$

$(a <<< r)$

$$E = \frac{KP}{r^3}$$

$$E = \frac{KP}{r^3}\sqrt{3\cos^2\theta + 1}$$

$\theta = 0$: $$E = \frac{4Kqra}{(r^2-a^2)^2} = \frac{2KPr}{(r^2-a^2)^2}$$

Small dipole $(r >>> a)$

$$E = \frac{2KP}{r^3}$$

$$\tan\alpha = \frac{\tan\theta}{2}$$

Angle (θ) at which 'E' & 'P' will be ⊥r

$$\theta = \tan^{-1}\sqrt{2}$$

- E_{axis} of dipole $= \dfrac{4kQar}{(r^2-a^2)^2} = \dfrac{2kP}{r^3}$

- $E_{\text{perpendicular}}$ of dipole $= \dfrac{2kQar}{(r^2+a^2)^{3/2}} = \dfrac{k\vec{P}}{r^3}$

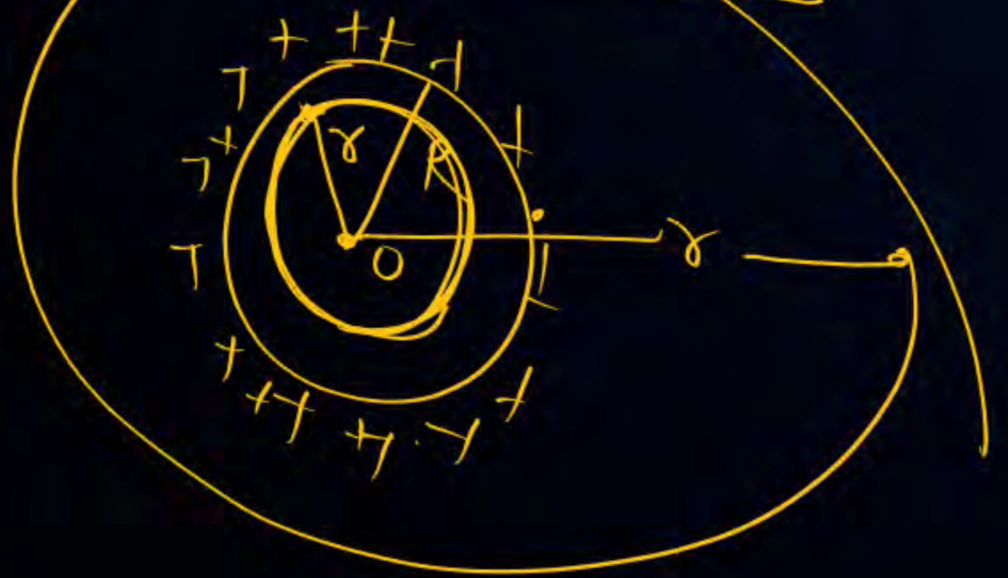
➢ **Hollow non-conducting sphere / Shell, Hollow, Solid conducting**

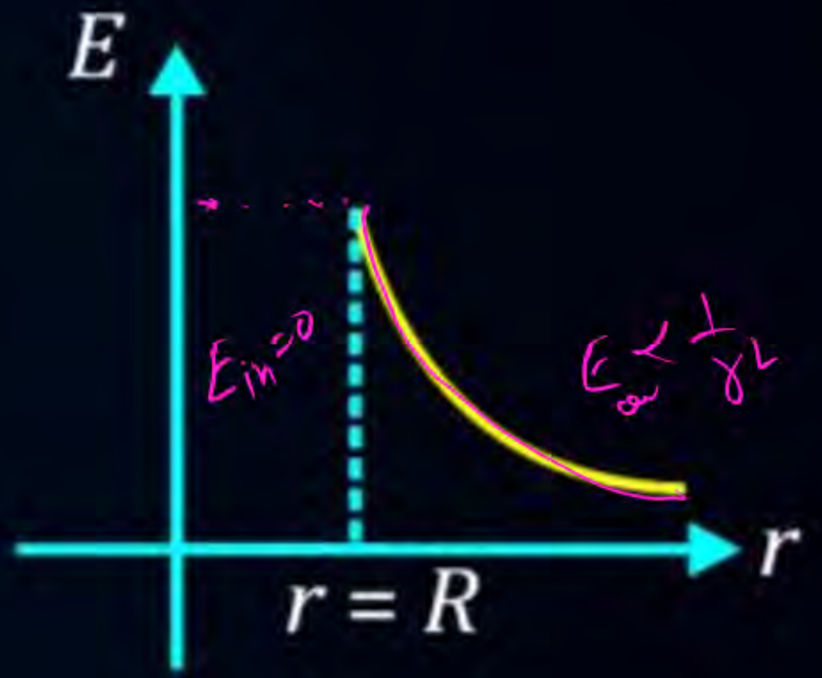
$E_{in} = 0$

$E_{centre} = 0$

$E_{surface} = \frac{KQ}{R^2}$

$E_{out} = \frac{kQ}{r^2}$





➤ Non-conducting Solid Sphere

$$E_{in} = \frac{\rho r}{3\varepsilon_0} = \frac{KQr}{R^3}$$

$$\rho = \frac{Q}{\frac{4}{3}\pi R^3}$$

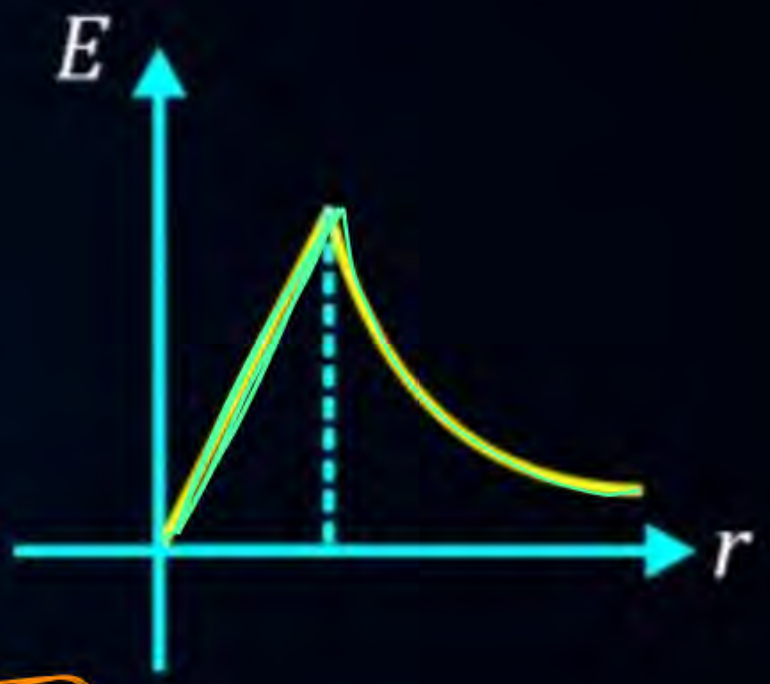
$$E_{surface} = \frac{KQ}{R^2}$$

$$E_{out} = \frac{KQ}{r^2}$$

$$E = \frac{KQr}{R^3}$$

$$= \frac{r}{4\pi\varepsilon_0 R^3} \cdot \frac{\rho \, 4\pi R^3}{3}$$

$$E = \frac{\rho r}{3\varepsilon_0}$$



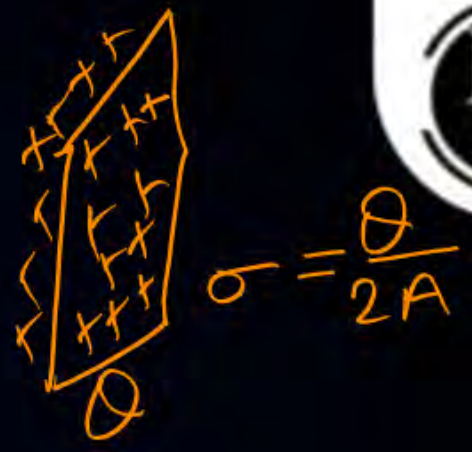


$$E_{in} = \frac{KQr}{R^3}$$

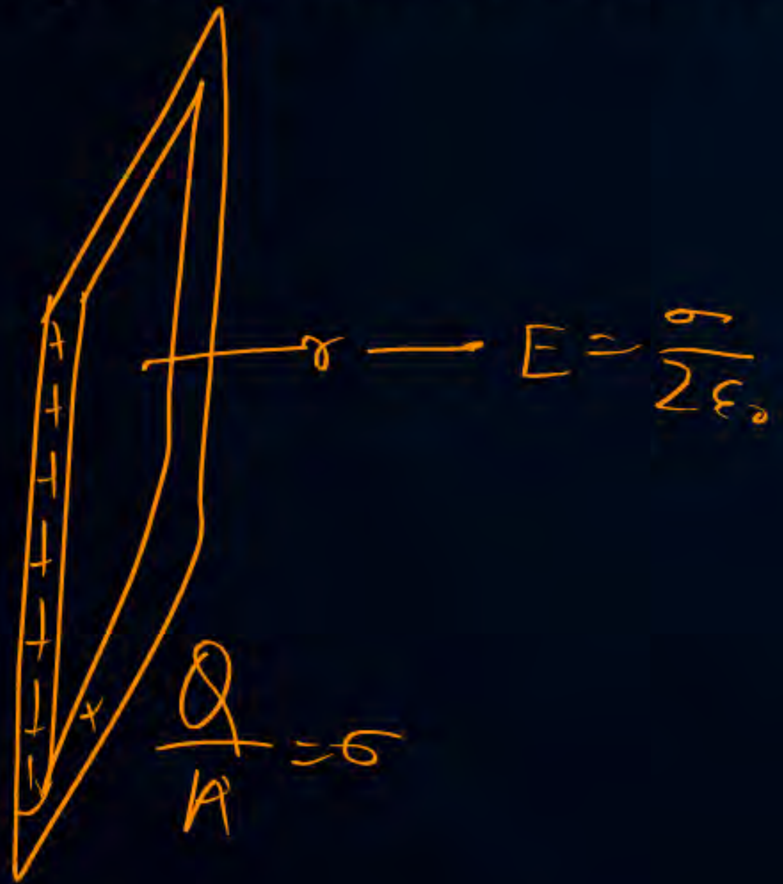
$$E_{out} = \frac{KQ}{r^2}$$

$$E = \frac{KQ}{r^2}$$

- ***Electric field due to plate conductiong*** $E = \dfrac{\sigma}{\varepsilon_0}$



- ***Electric field due to thin sheet / Non-conduct*** $E = \dfrac{\sigma}{2\varepsilon_0}$



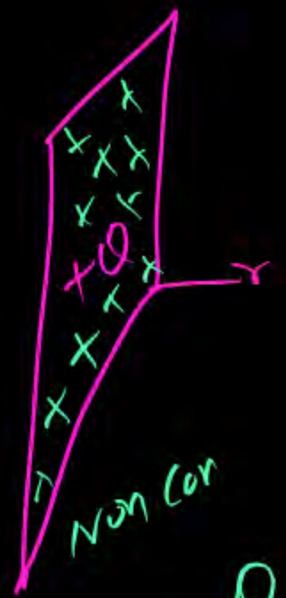
MR* Sarwal

A charge Q is given to large conducting and non-conducting sheet of area A then field electric dist^n at dist^n r from both the plate.



$$E = \frac{\sigma}{\varepsilon_0} = \frac{Q}{2A\varepsilon_0}$$

$$\sigma = \frac{Q}{2A}$$



$$E = \frac{\sigma}{2\varepsilon_0} = \frac{Q}{2A\varepsilon_0}$$

$$\sigma = \frac{Q}{A}$$

ELECTRIC FIELD LINE

- Imaginary lines tangent to which we get direction of electric field
- Continuous at all point
- Always from + to -



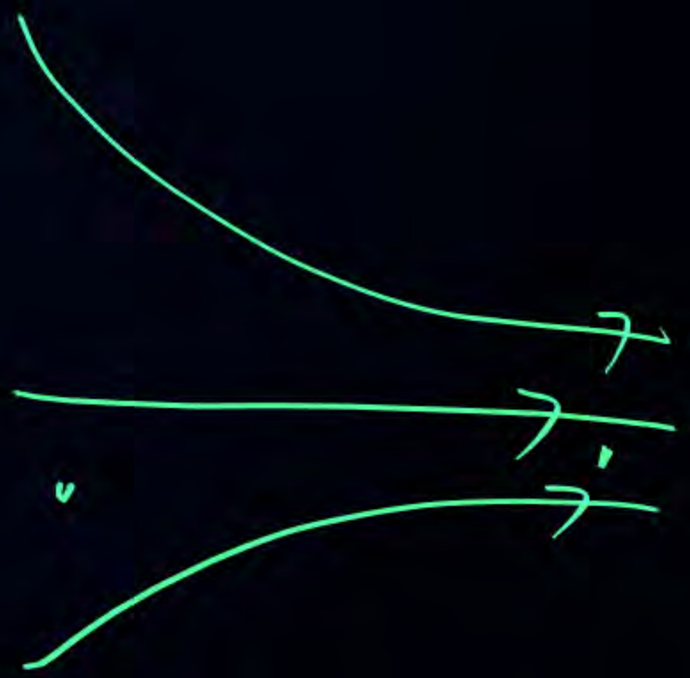
- Doesn't from close loop



- Can never intersect
- $q \propto$ no of field lines
- $E_{\text{inside cond}} = 0$



- EFL perpendicular to cond surface
- EF intensity $\propto = \dfrac{1}{\text{Spacing bet line}}$



Motion of charge in Electric field :

(i) Charge released → $\vec{F} = q\vec{E}$ (const)

$$a = \frac{qE}{m}$$

$$S = \frac{1}{2}at^2$$

$$u = \frac{qEt}{m}$$

$$\vec{P} = qEt = F \times t$$

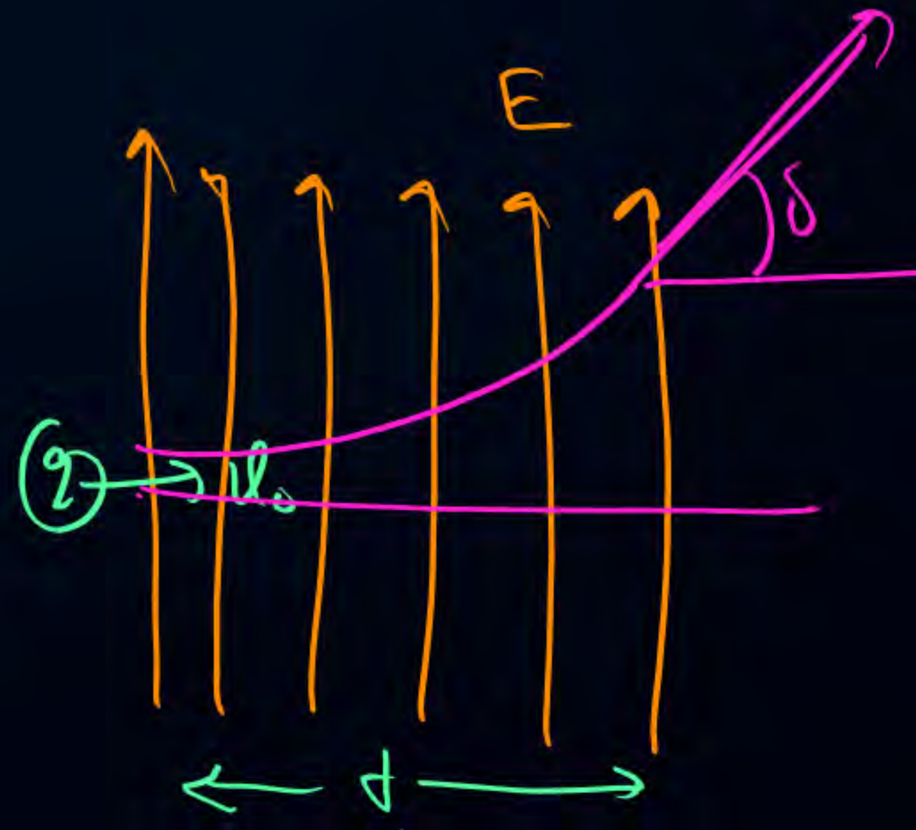
Straight line path

$$S = \frac{u^2}{2\left[\frac{qE}{m}\right]}$$

(ii) Projected perpendicular

$$\tan\delta = \frac{mu^2}{2qEd}$$

$$\delta_{devia} = \frac{qEd}{mu^2}$$



$$\tan\delta = \frac{qEd}{mu_0^2}$$

Gauss law

$\phi = \vec{E} \cdot \vec{A}$

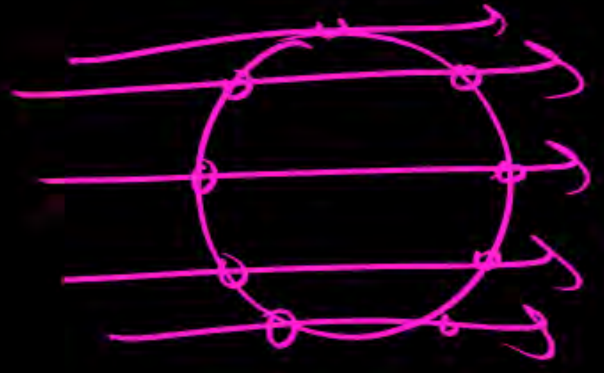
$\boxed{\phi = EA\cos\theta}$

$E = 3\hat{i} + 4\hat{j} + 6\hat{k}$

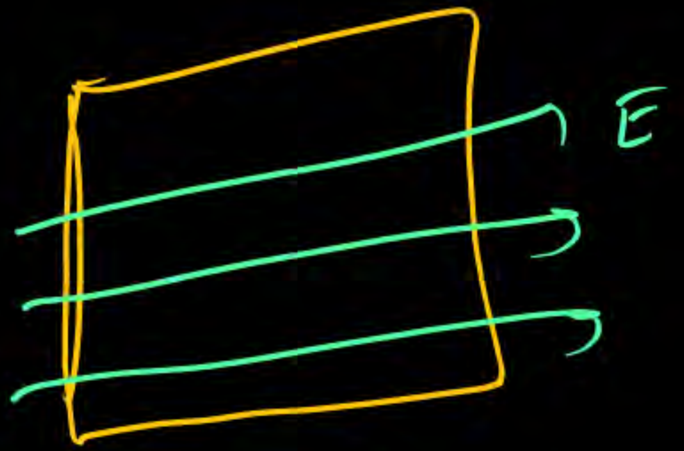
Area $= 20\,m^2$ in z-y plane

$\phi = (20\hat{i}) \cdot (3\hat{i} + 4\hat{j})$

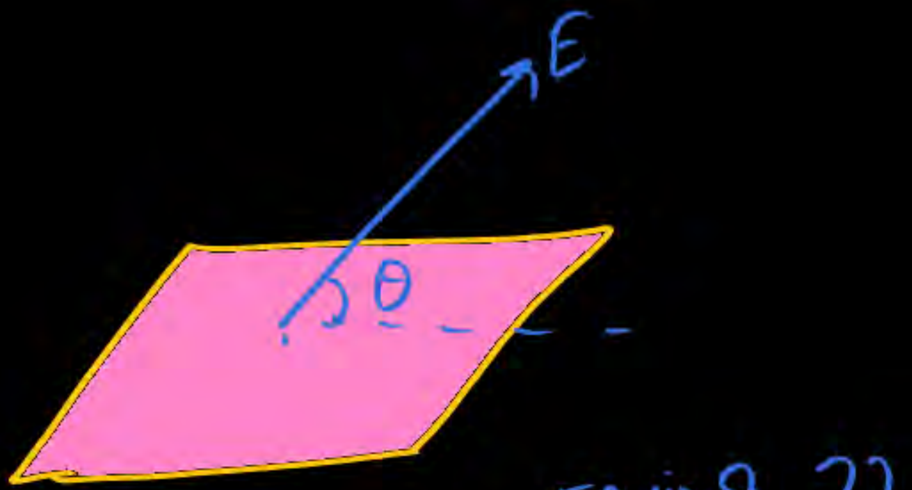
$\phi = 60$



$\phi_{net} = 0$



$\phi = 0$



$\phi = EA\sin\theta$??

Gauss Law

only Inclus charge

$$\phi = \oint \vec{E}\cdot d\vec{A} = \frac{q_{in}}{\varepsilon_0}$$

Clse Srfc

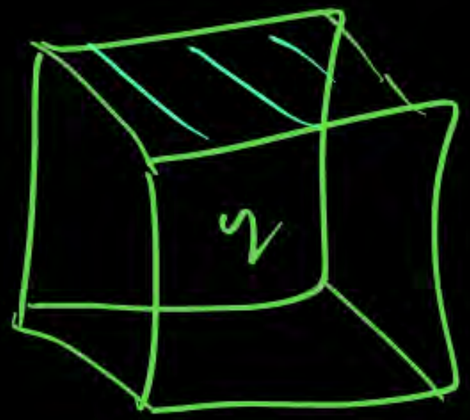
due to all the charge Insite or outer the s.

$\phi = 0$





ϕ = same

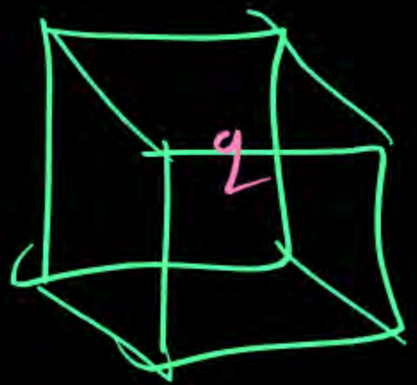


$\phi_{encl} = \frac{q}{\varepsilon_0}$

$\phi_{1\ plane} = \frac{q}{6\varepsilon_0}$



$\phi_{cube} = \frac{q}{2\varepsilon_0}$



$\phi_{cube} = \frac{q}{4\varepsilon}$



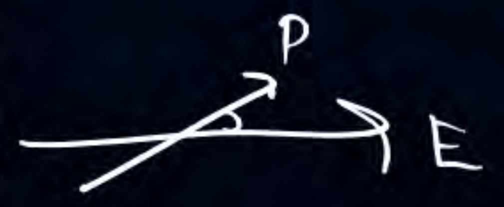
$\phi_{c} = \frac{q}{8\varepsilon_0}$

➢ Torque and Potential Energy on dipole :



Torque		Potential Energy	
Vector N m $\vec{\tau} = \vec{P} \times \vec{E}$ $\tau = PE \sin\theta$		Scalar N m = Joule $U = -\vec{P} \cdot \vec{E}$ $U = -PE\cos\theta$	
At 0°C $\tau = 0$ $F = 0$ $U = -PF$	At 90° $\tau = PE$ $F = 0$ $U = 0$	At 180° $\tau = 0$ $F = 0$ $U = +PE$	Stable equation at 0°C unstable equation at 180°

$$T = 2\pi\sqrt{\frac{I}{PE}}$$



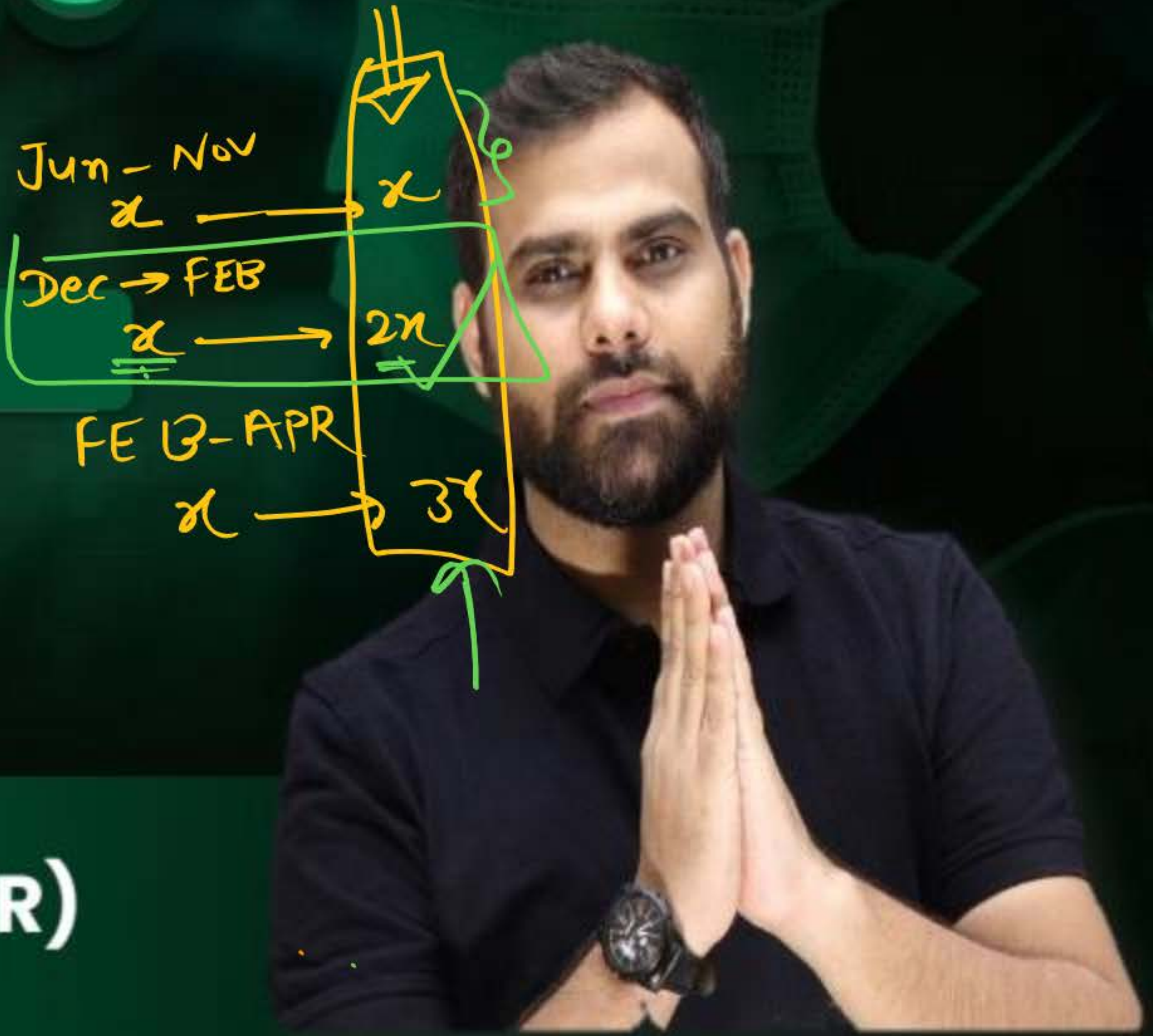
THANK YOU

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FOR NEET 2025

Lecture- 01 | Physics

Electrostatic Potential and Capacitance



By- Dr. Manish Raj (MR SIR)

Todays Goal

Gold leaf electroscope

electric Potential, electric Potential energy

Gold Leaf Electroscope

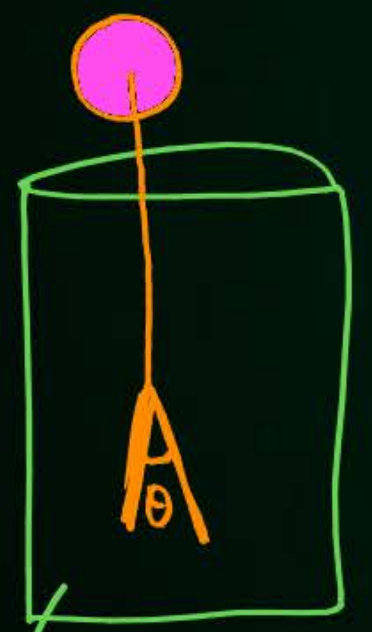
→ It is an instrument use to detect charged body. it can't measure of charge but can compair charge on the two body.

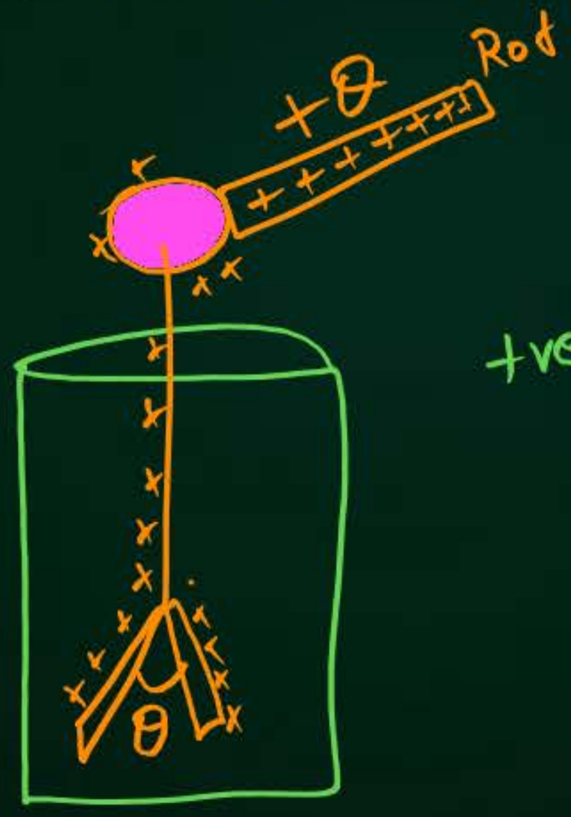
Base on electrostatic repulsion

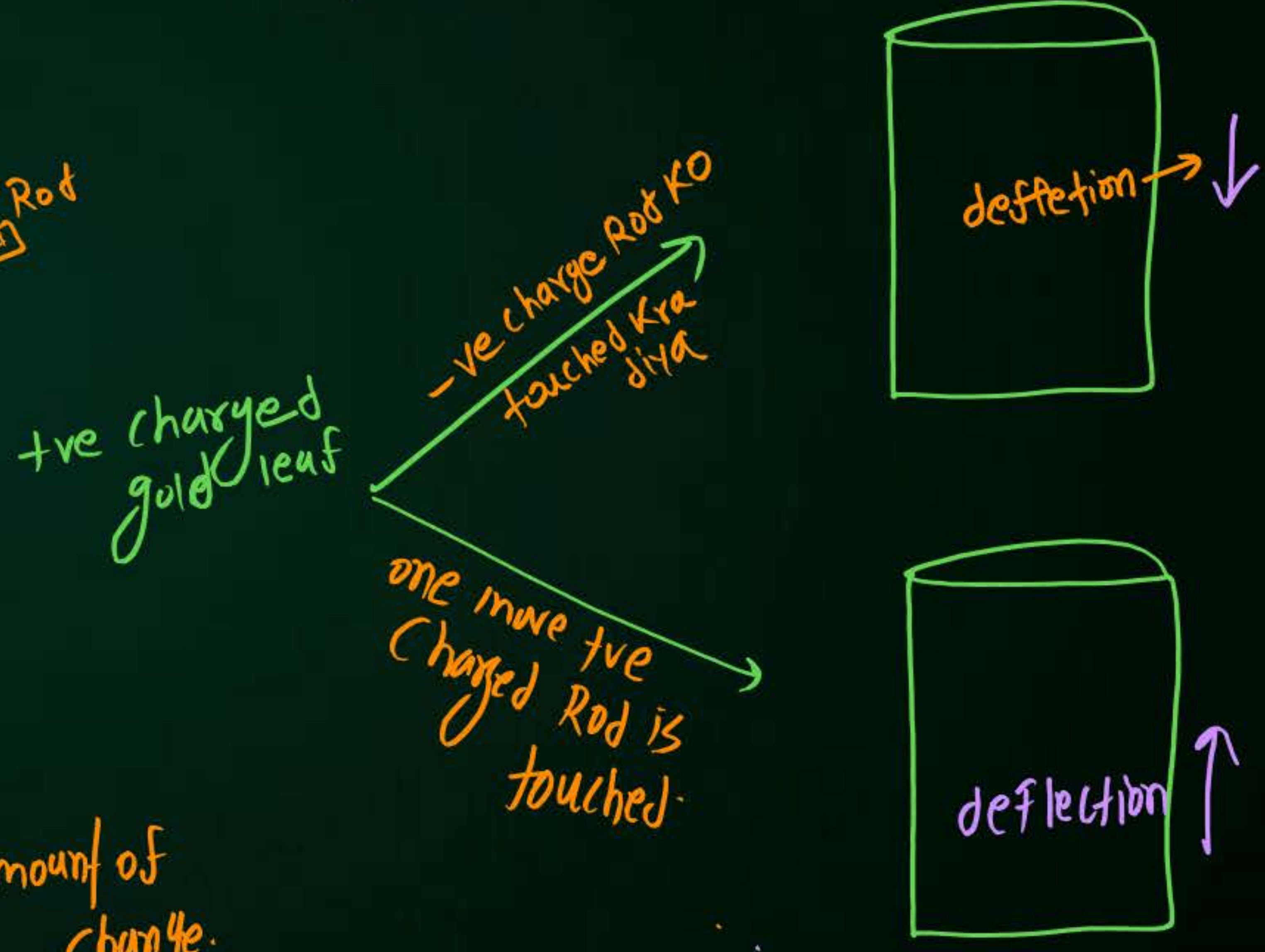
working method

(1) Charged body touched to Knob(disc) of electroscope

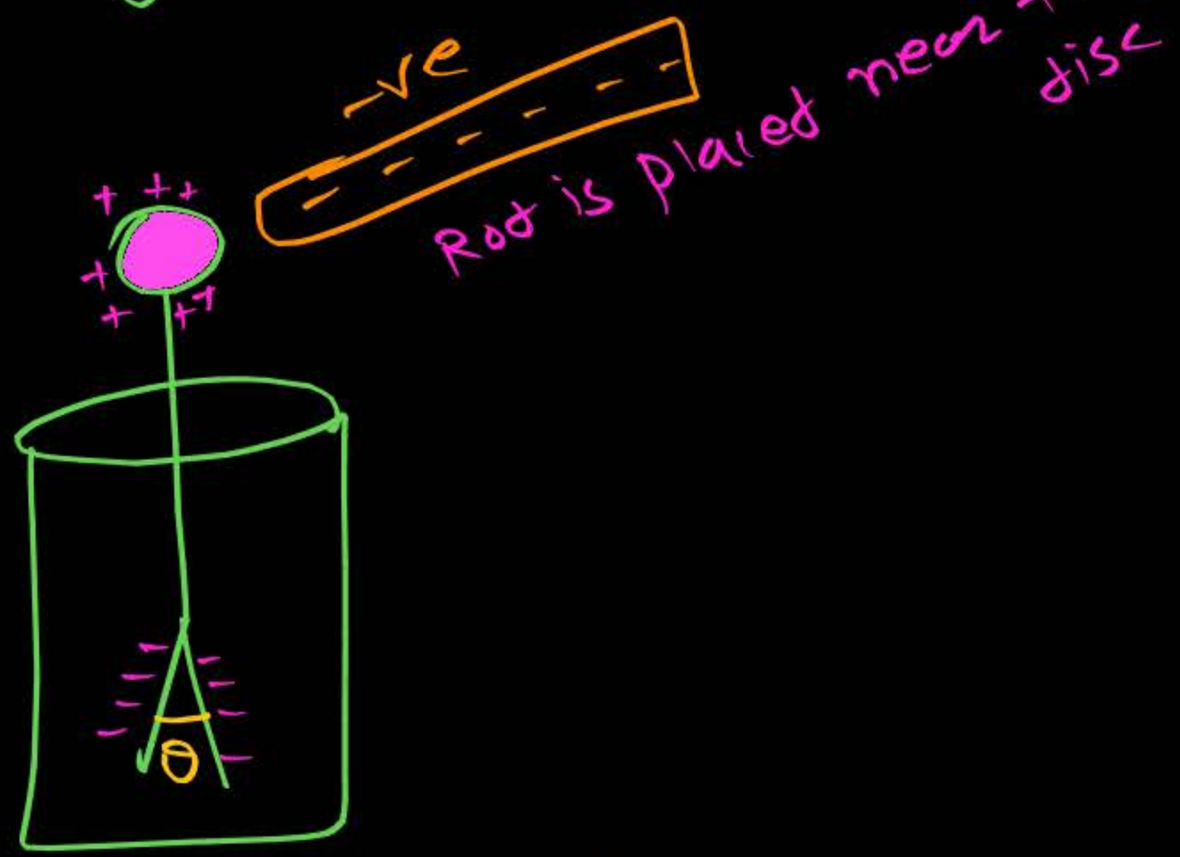
(2) charged body placed near to Knob(disc)







Working by Induction



$\theta \propto$ Amount of charge

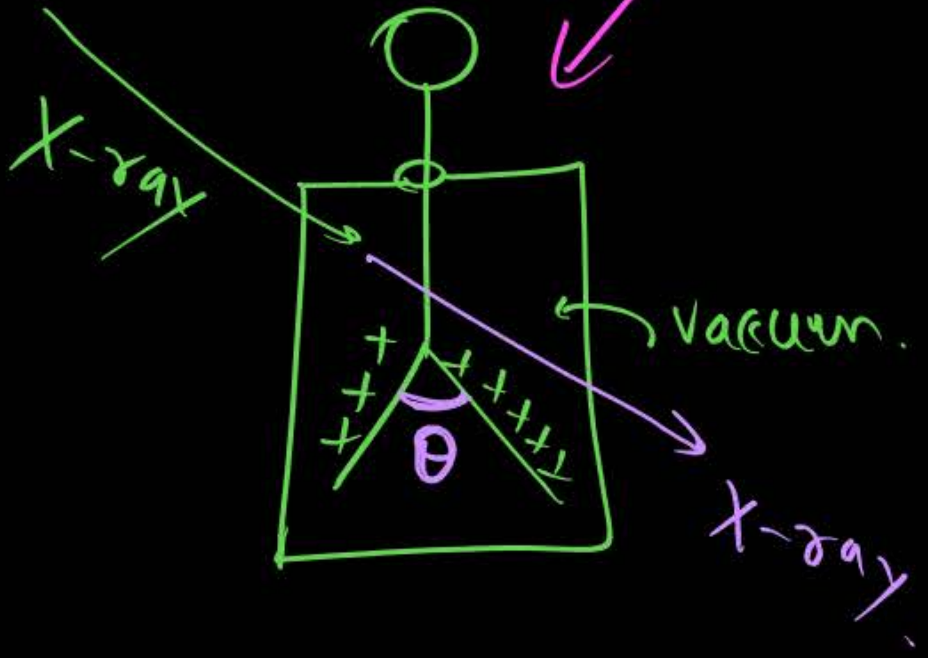
A leaf electroscope is a simple apparatus to detect any charge on a body. It consists of two metal leaves OA and OB, free to rotate about O. Initially both are vary slightly separated. When a charged object is touched to the metal knob at the top of the conducting rod, charge flows from knob to the leaves through the conducting rod. As the leaves are now charged similarly, they start repelling each other and get separated, (deflected by certain angle).

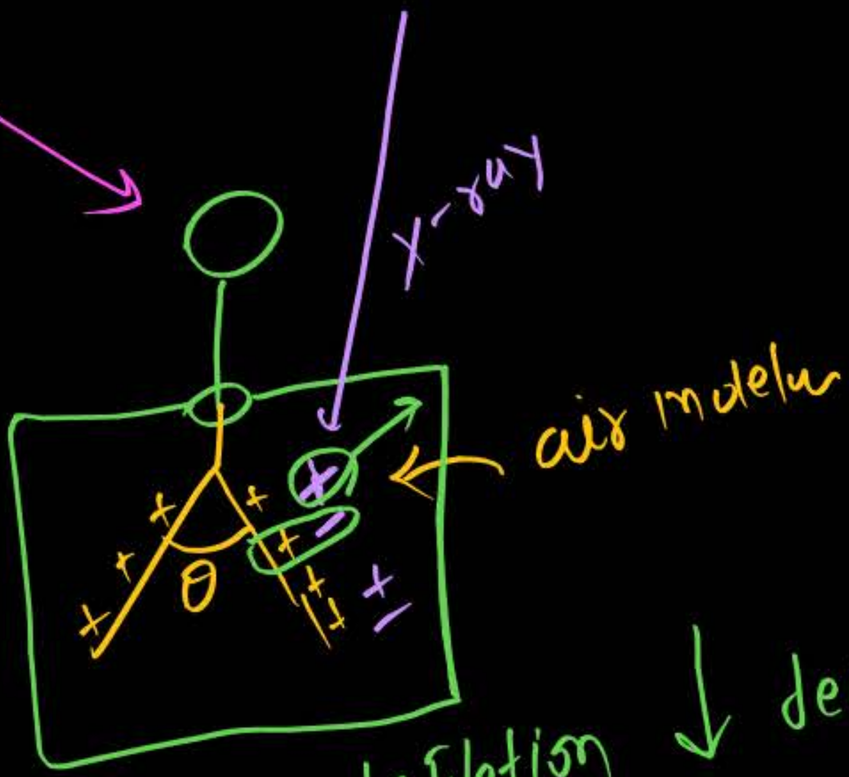
$\theta \propto$ Amout of charge

Angle of deflection

⊙ When X-ray fall of charged electroscope then deflection will ??

Ans → No defletion





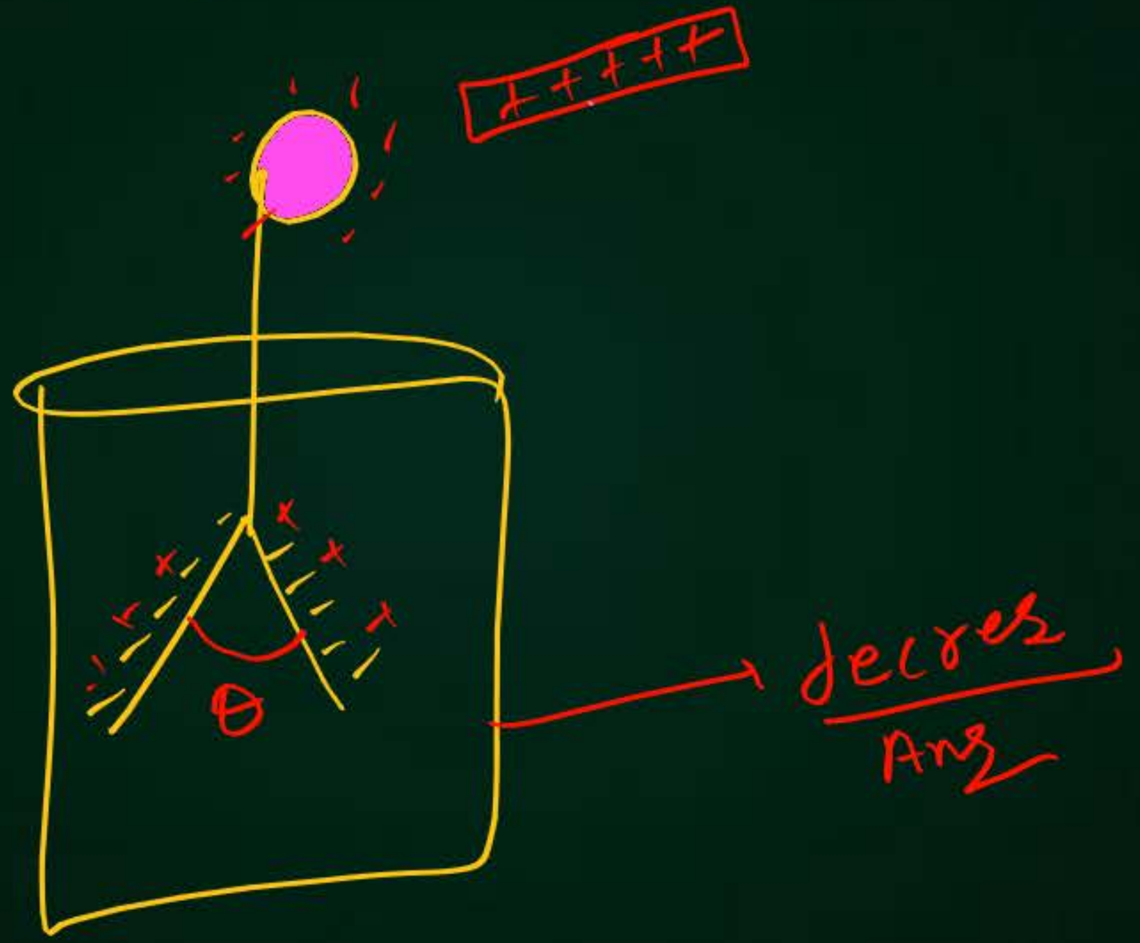
defletion ↓ dec. ✓

QUESTION

Positive charge rod placed near to knob of –ve charged electroscope.

then divergence will ??

Soln



QUESTION

When a + 20 C rod is touched to the knob, the deflection of leaves was 5° and when an identical rod of –40 C is touched, the deflection was found to be 9°. If an identical rod of +30 C is touched, then the deflection may be:

1. 0
2. 2°
3. 7°
4. 11°

QUESTION

A glass rod rubbed with silk is touched with the disc of negatively charged gold leaf electroscope that divergence.





If a perform these steps one by one.

(i) A positively charged rod is brought closer to initially uncharged knob

(a)



(ii) Then the positively charged rod is touched to the knob

(b)



(iii) Now the +vely charged rod is removed, and a negatively charged.

(c)



Rod of same magnitude is brought closer at same distance

In which case, the leaves will converge (come closer), as compared to the previous state ?

(a) (i)

(b) (i) and (iii)

(c) only (iii)

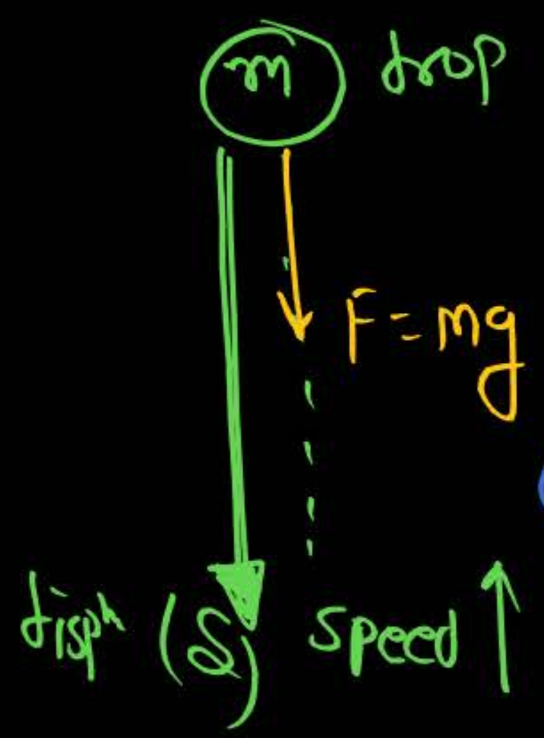
(d) In all cases, the leaves will diverge

QUESTION

A charged gold leaf electroscope, leaf's apart by some angle. X-ray fall on it then.

$\theta \rightarrow$ same

Electric Potential & Capacitor



W_{gr} = +ve

Work done by gravity Incr its speed

$W = \Delta K.E.$

Potential energy decrease, hence K.E ↑.

• When there is conservative force is involved then there is 2-method of explanation because Potential energy only defined for conservative force.

electrostatic force is conservative ⟶

(Jo bhi Natural event hota hai usme P.E Hamesha decrease hoti hai)

Proton & e^- moving towards each other



K.E ↑ P.E ↓

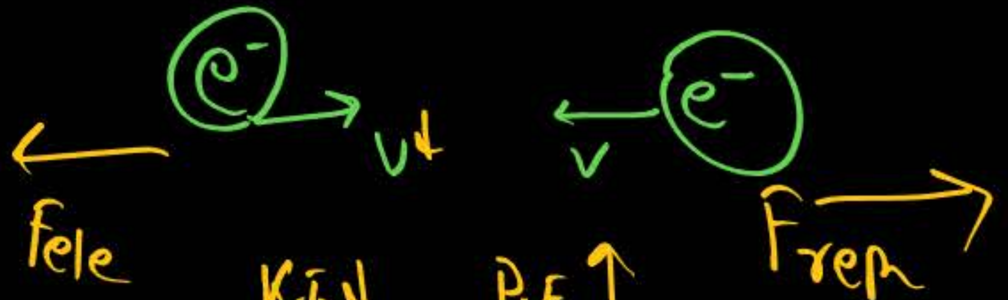


P.E ↓ K.E ↑



work done by electric force is +ve the P.E must decrease
work done by electri force is -ve then P.E ↑

K.E ↓ P.E ↑



K.E ↓ P.E ↑

Potential energy diffⁿ.

$$-W_{\text{electric force}} = \Delta U$$



$$-\underset{A \to B}{W_{\text{electric force}}} = U_B - U_A$$

If $U_A = 0$ (refⁿ point)

$$U_B = -\underset{A \to B}{W_{\text{electric force}}}$$

$$W_{\text{ext force}} = \Delta U = U_B - U_A$$

(slowly)

$$-W_{C.F} = \Delta U \quad (*)$$

Common refⁿ point → we assume at infinity

$A(\text{infinity}) = 0$

$$U_B - 0 = -\underset{\text{infinity} \to B}{W_{C.F}}$$

$$U_B = -W_{C.F} \text{ (from infinity to B)}$$

Negative work done by C.F. in taking q charge from infinity to that point is called potential energy at that point.

work done in bringing q charge from infinity to the point slowly is called Potential energy strored in q charge at that point.

—ve work done by C.F. in bringing q charge from infiniti to the point is called Potential energy strored in q charge at that point.

$$\Delta U = -W_{C.F}$$

$$\left\{ \Delta U = -W_{C.F} = -\int \vec{F}\cdot d\vec{r} \right\}$$

(divided by q both side)

[-ve work done by C.F per unit charge]

$$\frac{\Delta U}{q} = -\frac{W_{C.F}}{q}$$

$$\Delta V = -\frac{W_{C.F}}{q} = -\int \frac{\vec{F}\cdot d\vec{r}}{q}$$

$$\boxed{\Delta V = \frac{\Delta U}{q}}$$

Change in Potential = Change in Potential energy Per charge

$$\left[\vec{E} = \vec{F}/q\right]$$

$$\boxed{\Delta V = -\int \vec{E}\cdot d\vec{r}}$$

change in potential *

$$\boxed{-\frac{dV}{dr} = \vec{E}}$$ *

$$\boxed{\vec{F}_{C.F} = -\frac{dU}{dr}}$$ ✓

$$\vec{E} = -\frac{\partial V}{\partial r}\hat{r}$$

Potential gradiant (vector)

Potential is Scalar

Basic math
WEP
gravity
Electri Poteil

$$\vec{E} = -\frac{\partial V}{\partial r}\hat{r}$$

$$\vec{E} = -\left[\left(\frac{\partial V}{\partial x}\right)\hat{i} + \left(\frac{\partial V}{\partial y}\right)\hat{j} + \left(\frac{\partial V}{\partial z}\right)\hat{k}\right]$$

y, z const; x, z const.; y, x = const.

* In the direction of electric field Potential always decrease.

work done in bringing q charge from infinity to the point ~~slowly~~ is called Potential energy stored in q charge at that point.

work done in bringing 1C (unit charge) charge from infinity to the point slowly is called Potential ~~energy~~ stored in 1C charge at that point.

electric potential energy stored per unit charge is called electric potential.

−ve work done by C.F. in bringing q charge from infinity to the point is called Potential energy stored in q charge at that point.

$$\Delta U = -W_{C.F}$$

−ve work done by C.F. in bringing ~~q~~ 1C charge from infinity to the point is called Potential ~~energy~~ stored in ~~q~~ 1C charge at that point.

$$\Delta U = -W_{C.F}$$

Electric Potential → electric potential enegy per unit charge

1. $$V = \frac{U}{q}$$ $$\Delta V = \frac{\Delta U}{q}$$

2. $$\Delta V = -\int_{r_1}^{r_2} \vec{E}\cdot d\vec{r} = V_{r_2} - V_{r_1}$$

3. $$V = -\int_{\infty}^{r} E\cdot dr$$

$$E = -\frac{dV}{dr}$$ (const^n)

4. $$\vec{E} = -\frac{\partial V}{\partial r}\hat{r}$$

5. electric potential depends on refrece but change in Potential does not depends on ref^n.

6. Scalar.

7. volt $\left(\frac{Nm}{C}\right)$

8. In the dir^n of electric field potential always decrease.

9. In the opposite dir^n of electric field potential Increase

10. If Potential is constant in a region then Electric must be zero in that region.

11. Slope of Potential dis^n graph is -ve of $\vec{E}$.

12. Area of Electric field dis^n graph is -ve of change in Potential.

QUESTION

If work done to move +2C charge from infinity to the point is 30J then find potential energy stored in +2C charge at that point.

(a) 15 J (31%)

(b) −30 J

(c) +30 J only 23%

(d) −15 J

$\Delta U = W_{ext}$

$U_f - U_i = 30\text{ J}$ ($U_i = 0$)

$U_f = 30\text{ J}$

QUESTION

If work done to move +2C charge from infinity to the point is 30J then find potential energy stored in +6C charge at that point.

(a) 30 J

(b) 90 J

(c) −30 J

(d) +15 J

(e) −60 J

QUESTION

If work done to move +2c charge by electric field from infinity to the point is 120J then find potential at that point.

$$\Delta V = \frac{-W_{e.f}}{q}$$

$$V - V_\infty = \frac{-120}{2C}$$

$$\boxed{V = -60\ J/C}$$

QUESTION

If work done to move +4C charge from infinity to the point is 60 J by electric field then find potential energy stored by that charge at a point.

1. +60 J
2. +15 J
3. −60 J
4. −15 J

QUESTION

If work done to move +8C charge from infinity to the point is 40 J by electric field then find potential at that point.

1. +40 J
2. –5 J
3. –40 J
4. +5 J

$$V = -\frac{W_{E.F}}{q}$$

$$V = -\frac{40}{8} = -5$$

QUESTION

Work done in moving +8C by electric field from A to B is 48 J then find potential at B if at A is –30 J.

energy

$$\Delta U = -W_{C.F}$$

$$U_B - U_A = -W_{C.F}$$

$$U_B - (-30) = -48\ J$$

$$U_B = (-30 - 48)\ J$$

$$= -78\ J$$

QUESTION

Work done in moving –4C from B to A is +60 J, if potential at A is 20 J/C then potential at B.

final

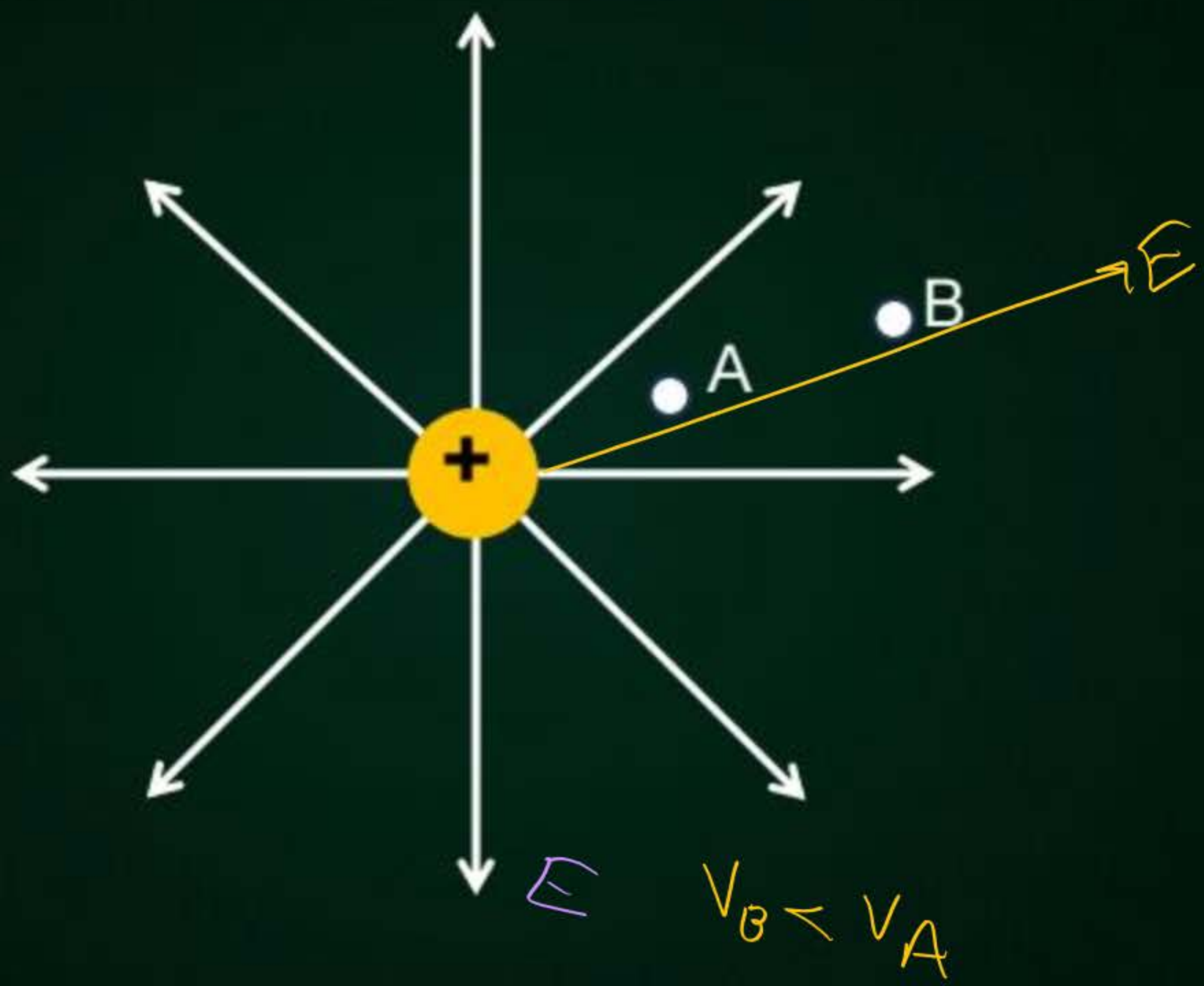
$$\Delta V = \frac{W_{ext}}{q}$$

$$V_A - V_B = \frac{60\,J}{-4C}$$

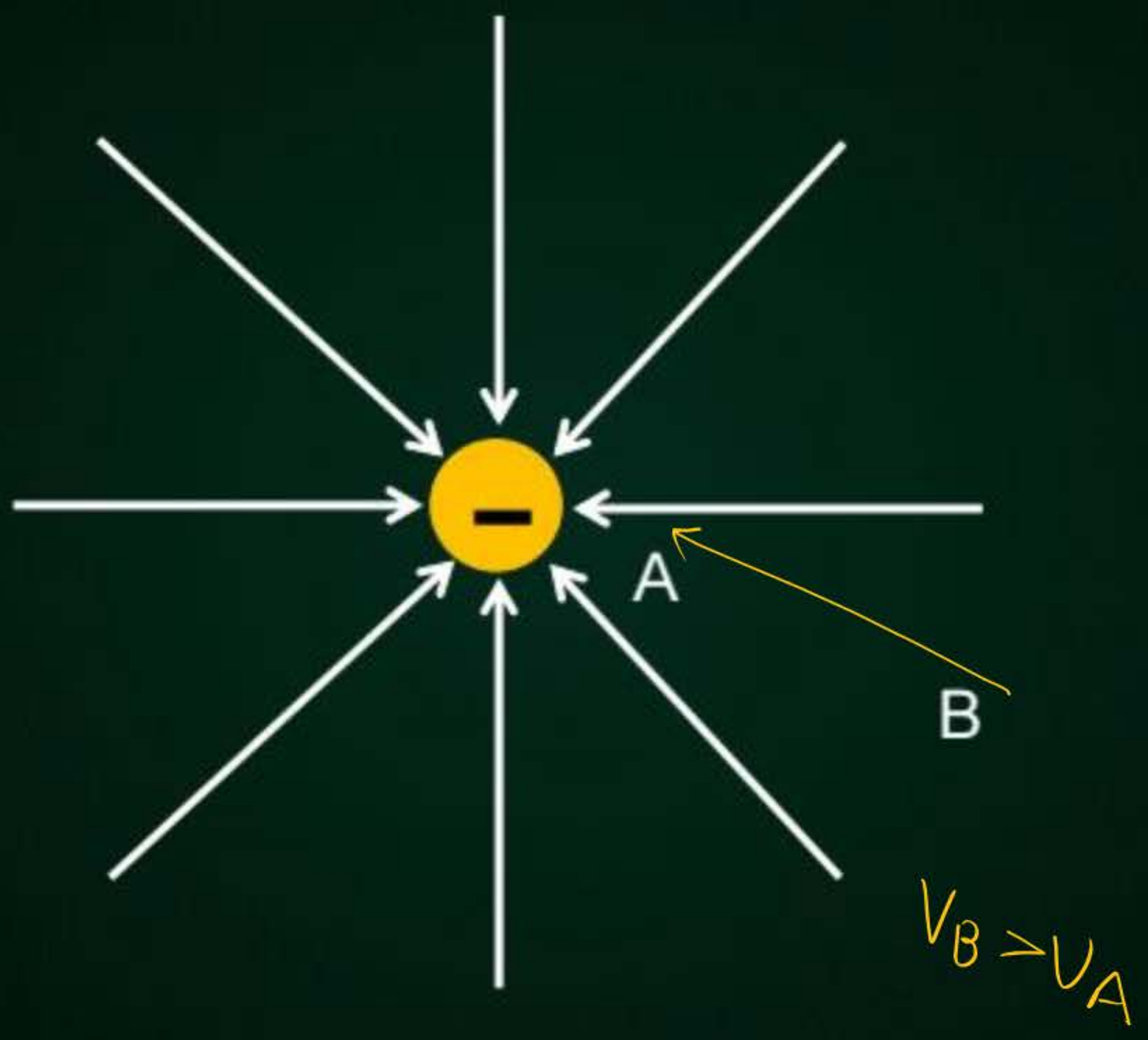
$$20 - V_B = -15$$

$$20 + 15 = V_B$$

$$V_B = 35\ J/C$$

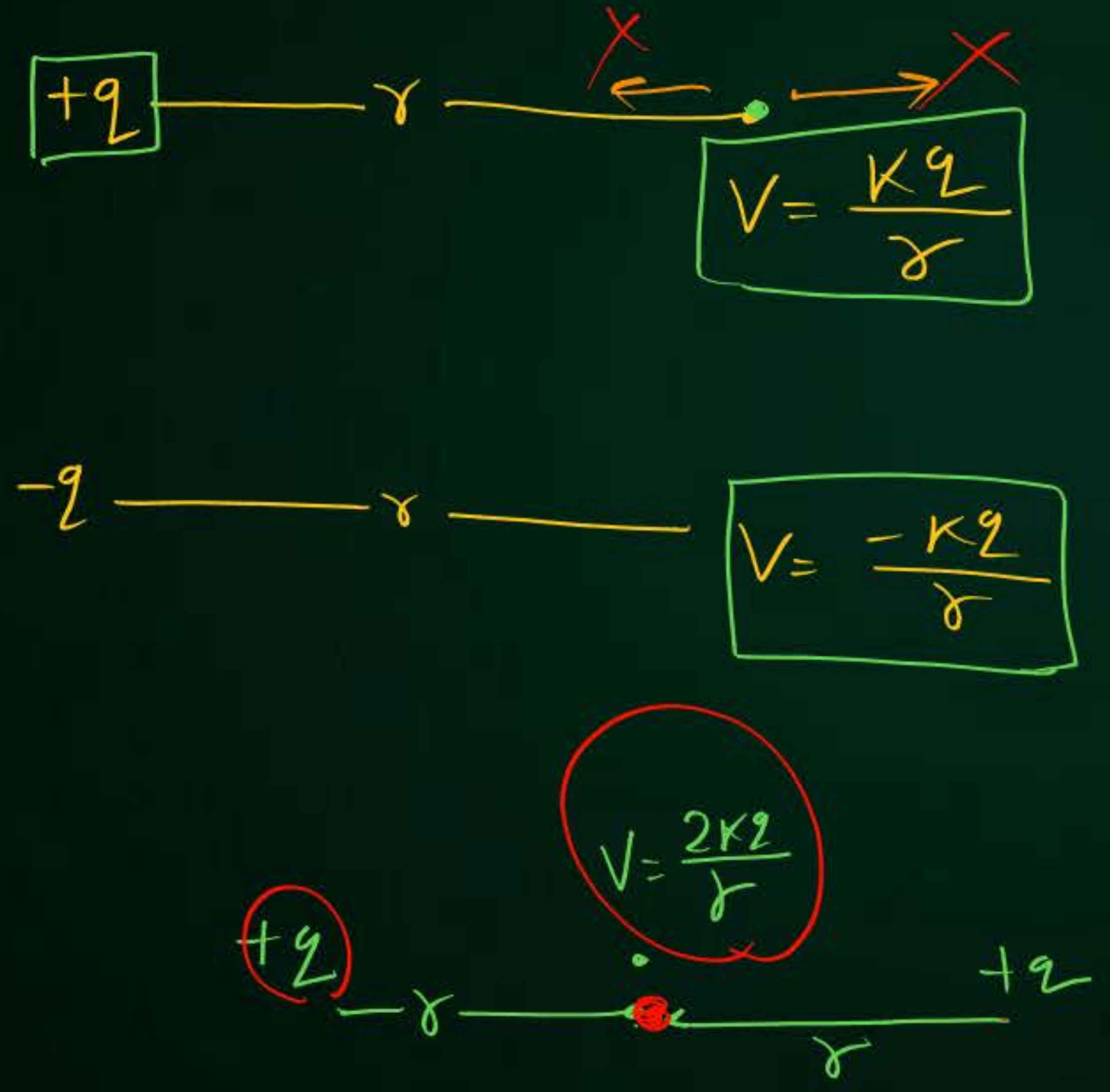


B
A
+
E
E
$V_B < V_A$



A
B
$V_B > V_A$

Electric Potential due to Point Charge



QUESTION

TRUE/FALSE

1. If electric field is zero at point then V must be zero at that point. ☐
2. If electric field constant then potential must be constant. ☐
3. If potential is constant then electric field must be zero. ☐
4. If potential is non-zero then electric field must be non-zero. ☐
5. Electric field is zero then potential may be non-zero. ☐

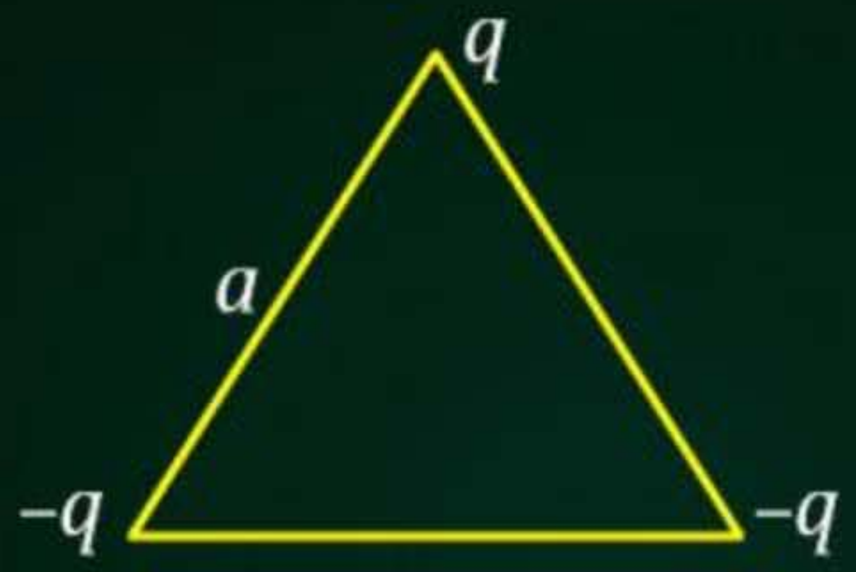
Electric Potential due to Combination of Charge

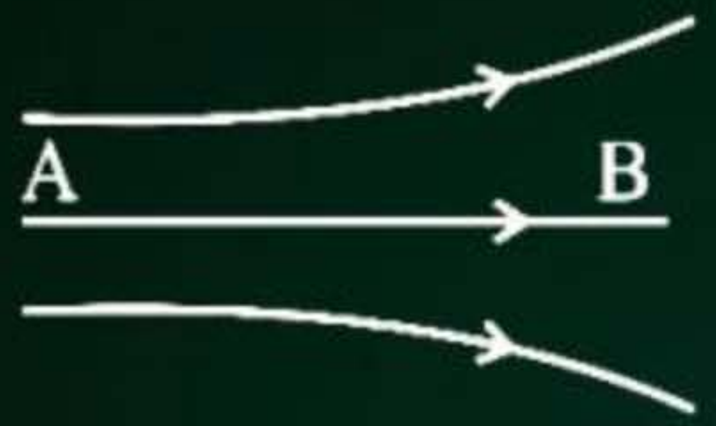
Electric Potential due to Ring

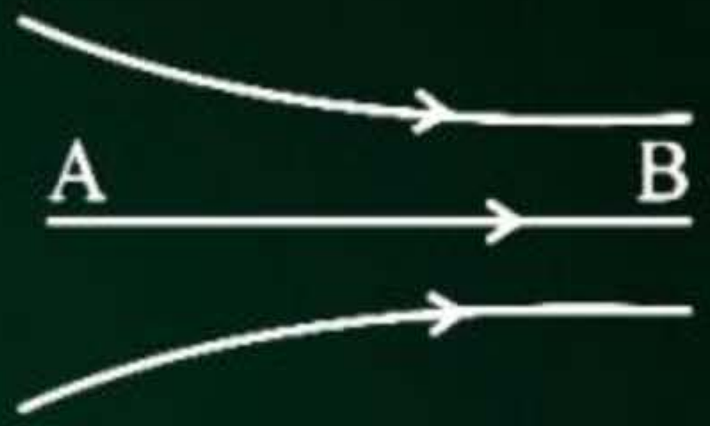
- **Electric potential at distance *r* from centre at an angle ‘θ’.**

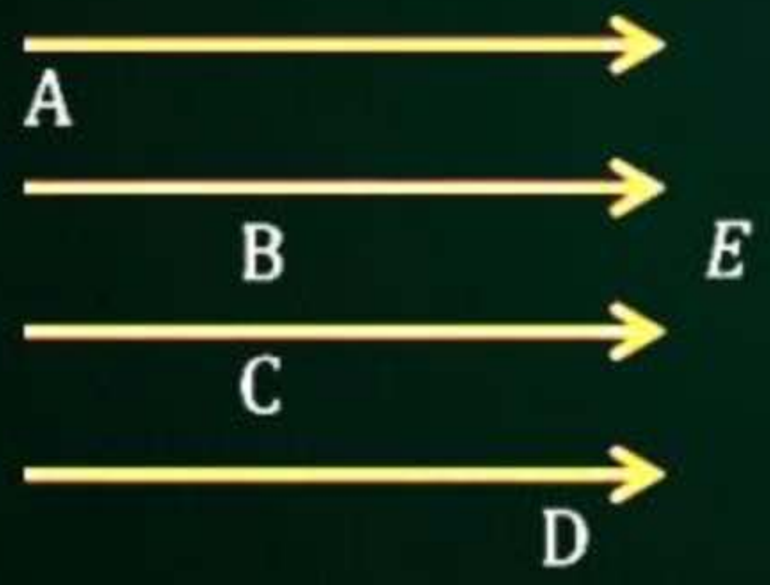
QUESTION

Find




A
B


A
B


A
B
E
C
D

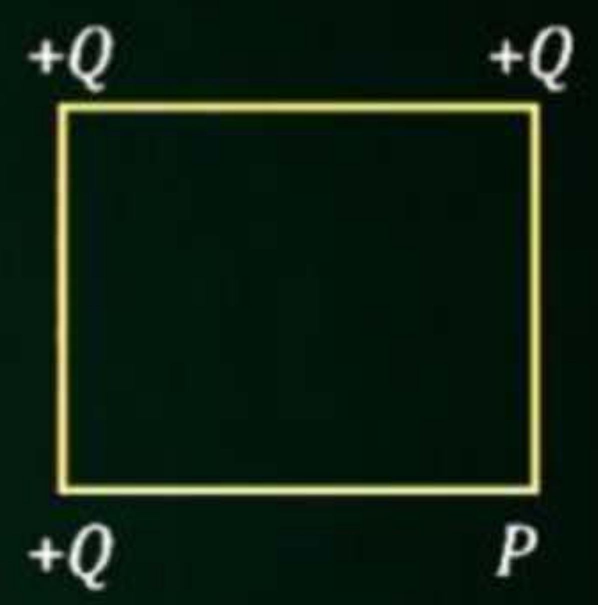
QUESTION

Electric potential due to point charge and combination of point charge.



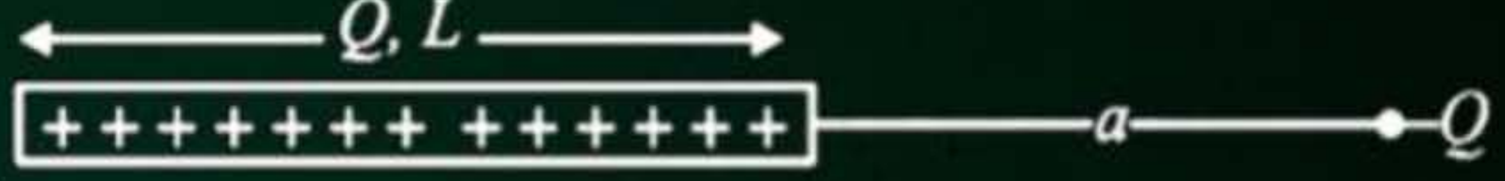
QUESTION

Find potential at 'P'.



QUESTION

Find electric field due to finite line charge along its length at distance '*a*' from one end as shown in figure.



QUESTION

Electric field due to finite line charge, charge density λ.



QUESTION

Electric field due to semi-infinite line charge.


-q
-q


$-q$
$+q$

QUESTION

Find electric dipole moment




THANK YOU

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FOR NEET 2025

Lecture-02 | Physics

Electrostatic Potential and Capacitance

Kitne logo ne revision kiya tha ??

(a) Yes → 72%

(b) No → 28%



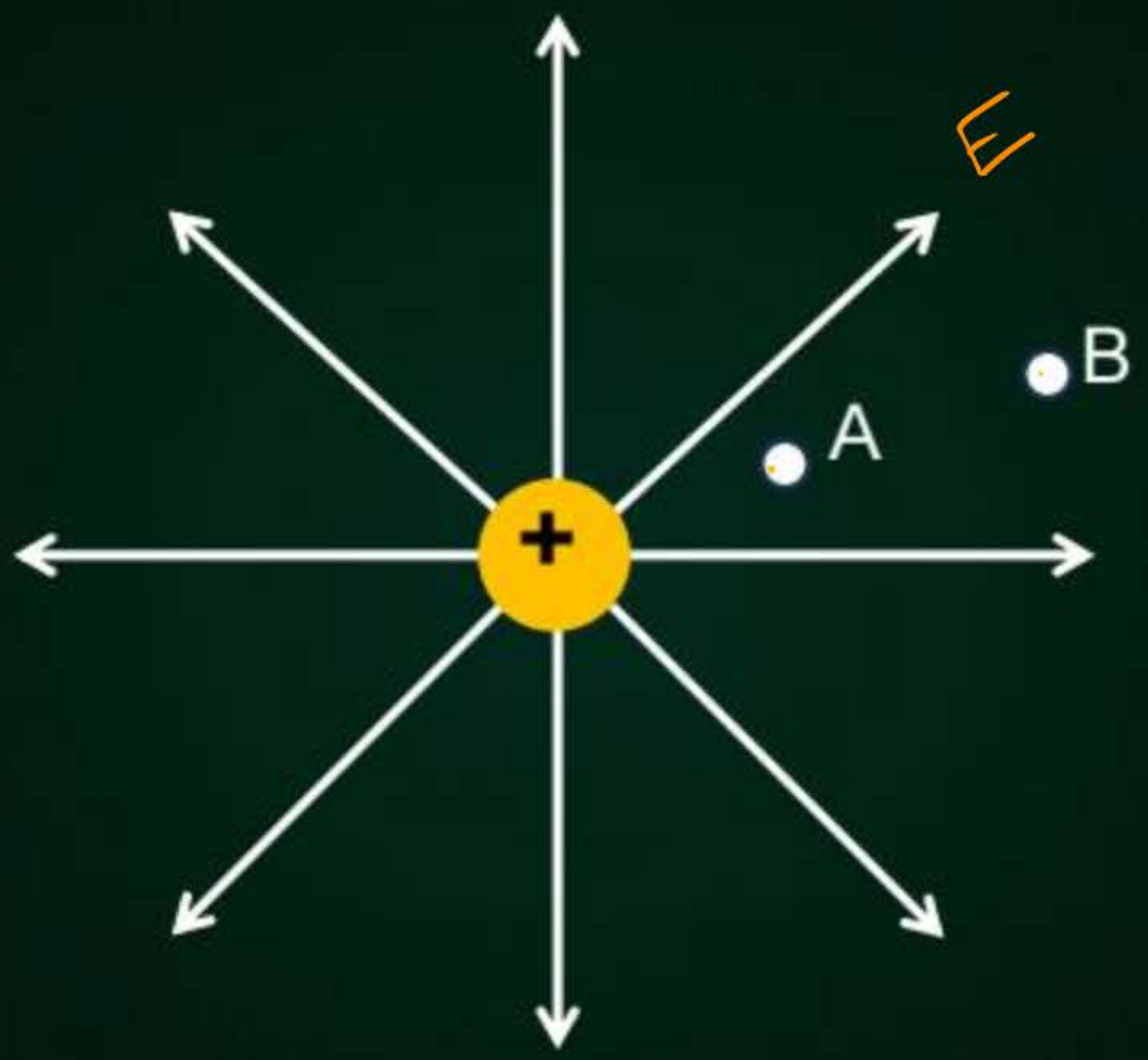
By- Dr. Manish Raj (MR SIR)

Topics to be covered

1. # electric Potential due to Point charge, sphere, Ring etc
2. #
3. #



* In the dirⁿ of field Potential dec.

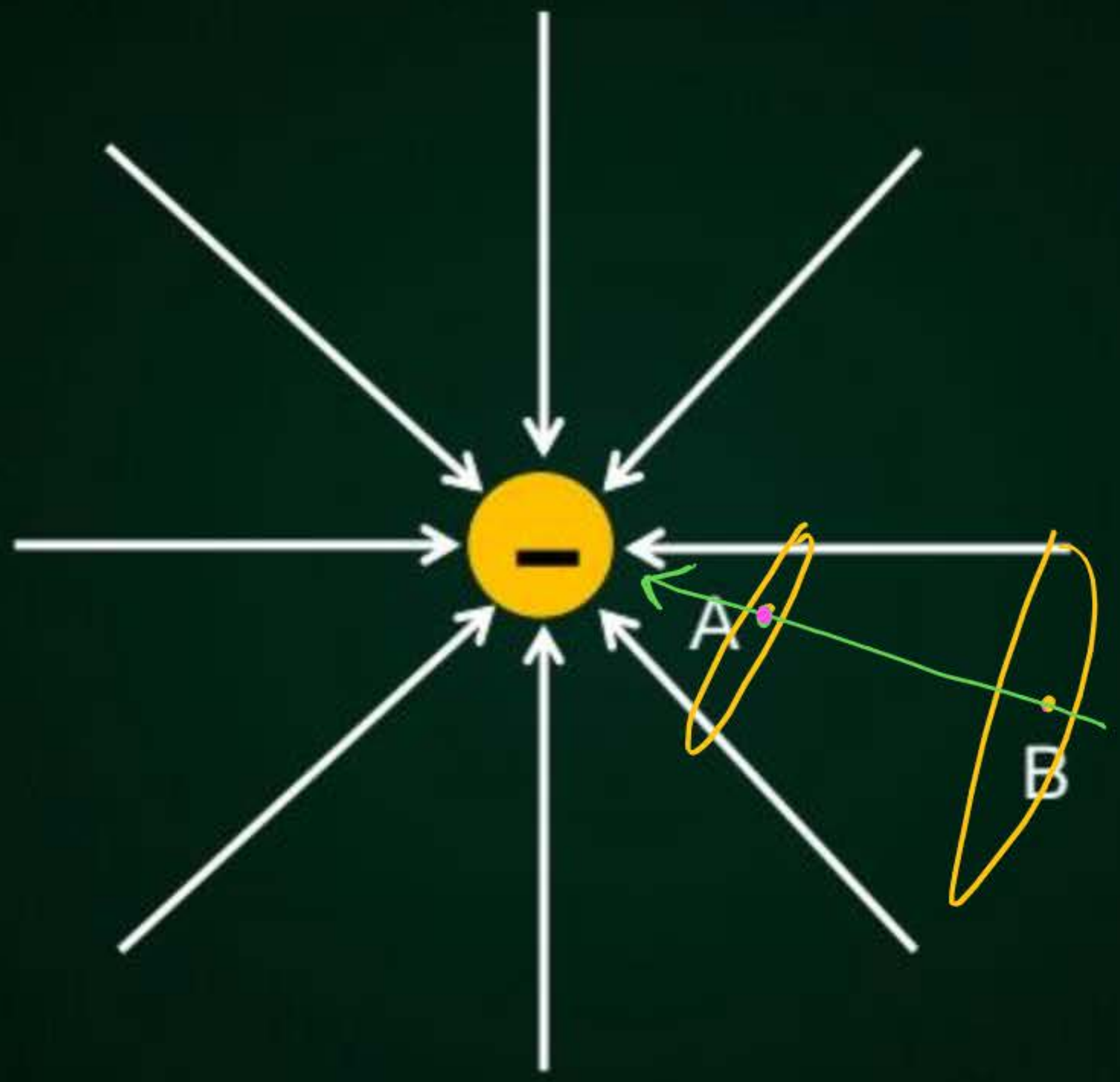


$V_A > V_B$

$E_A > E_B$

$E \propto V$

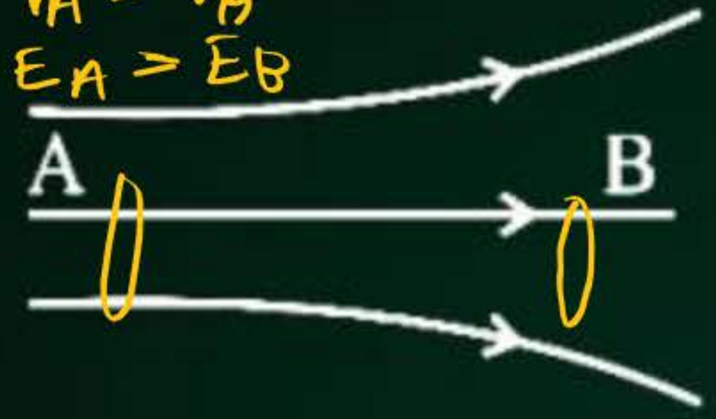
$r \propto E$



$$\begin{cases} V_B > V_A \\ E_B < E_A \end{cases}$$

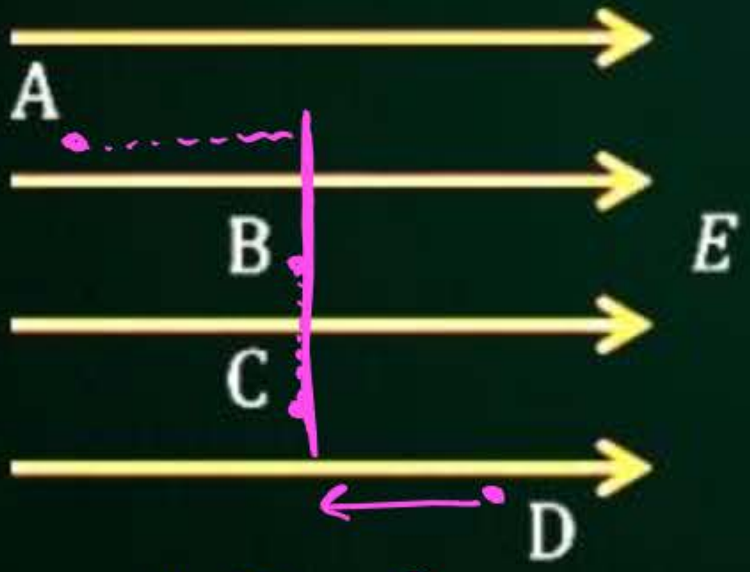
$$\vec{E} = -\left(\frac{dV}{dr}\right)$$

$V_A > V_B$
$E_A > E_B$



$V_A > V_B$
$E_A < E_B$





Uniform field

(#) $V_A > V_B = V_C > V_D$

(#) $E_A = E_B = E_C = E_D$

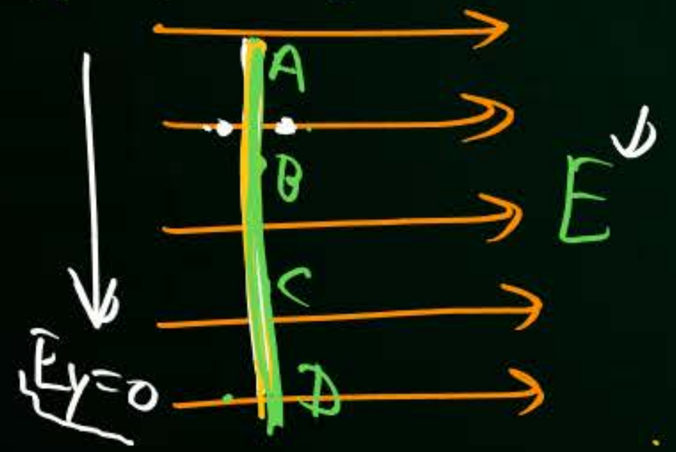
QUESTION

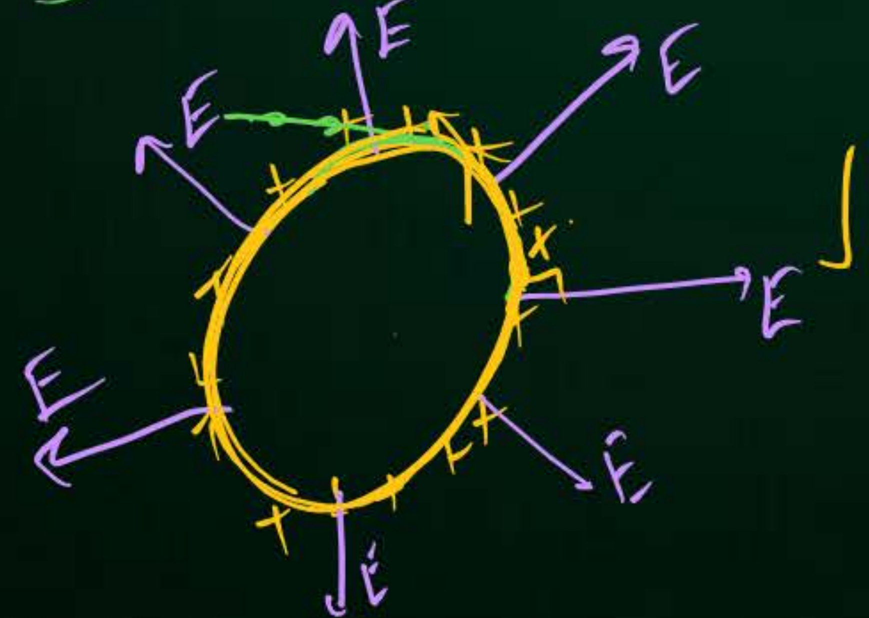
$\vec{E} = -\frac{dV}{dr}$

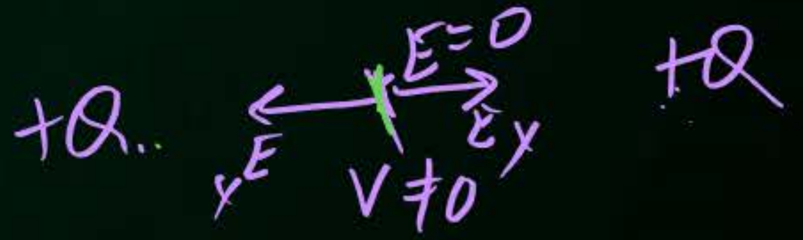
TRUE/FALSE

1. If electric field is zero at point then V must be zero at that point. — fasle
2. If electric field (is non zero) constant then potential must be constant. — false
3. If potential is constant then electric field must be zero. — True
   (a) True
   (b) fasle
4. If potential is non-zero then electric field must be non-zero. — false
5. Electric field is zero then potential may be non-zero. — True.

$V_A = V_B = V_C = V_D \rightarrow$ Potⁿ const along axis







Electric Potential due to Point Charge

Potential due to +ve Q charge at r dis^n must be $+\frac{KQ}{r}$ ⟶ **false**

+Q ——— r ——— •

scalar $V_4 = -4$ volt

$V_1 = \frac{KQ}{r}$

$V_2 = -\frac{KQ}{r}$

$V_3 = \text{zero}$

all can be correct depends on ref^n.

+Q ——— r ——— • $V = \frac{KQ}{r}$

−Q ——— r ——— • $V = \frac{-KQ}{r}$

ref^n is assumed at infinity ✓

* Potential does not have unique value at a point, it depends on reference.

$E = 0$

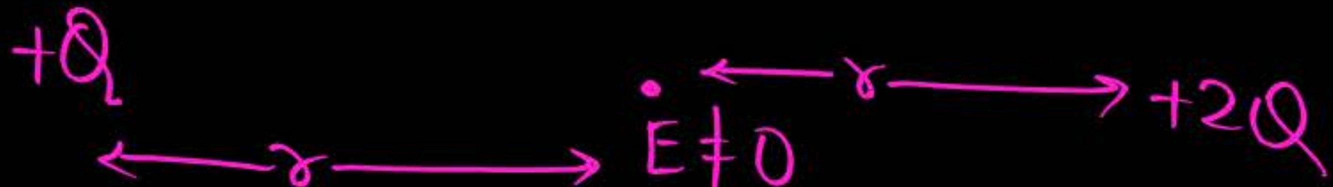
$V = \frac{2KQ}{r}$



$V = \frac{KQ}{r} - \frac{KQ}{r} = 0$

$E = \frac{2KQ}{r^2}$

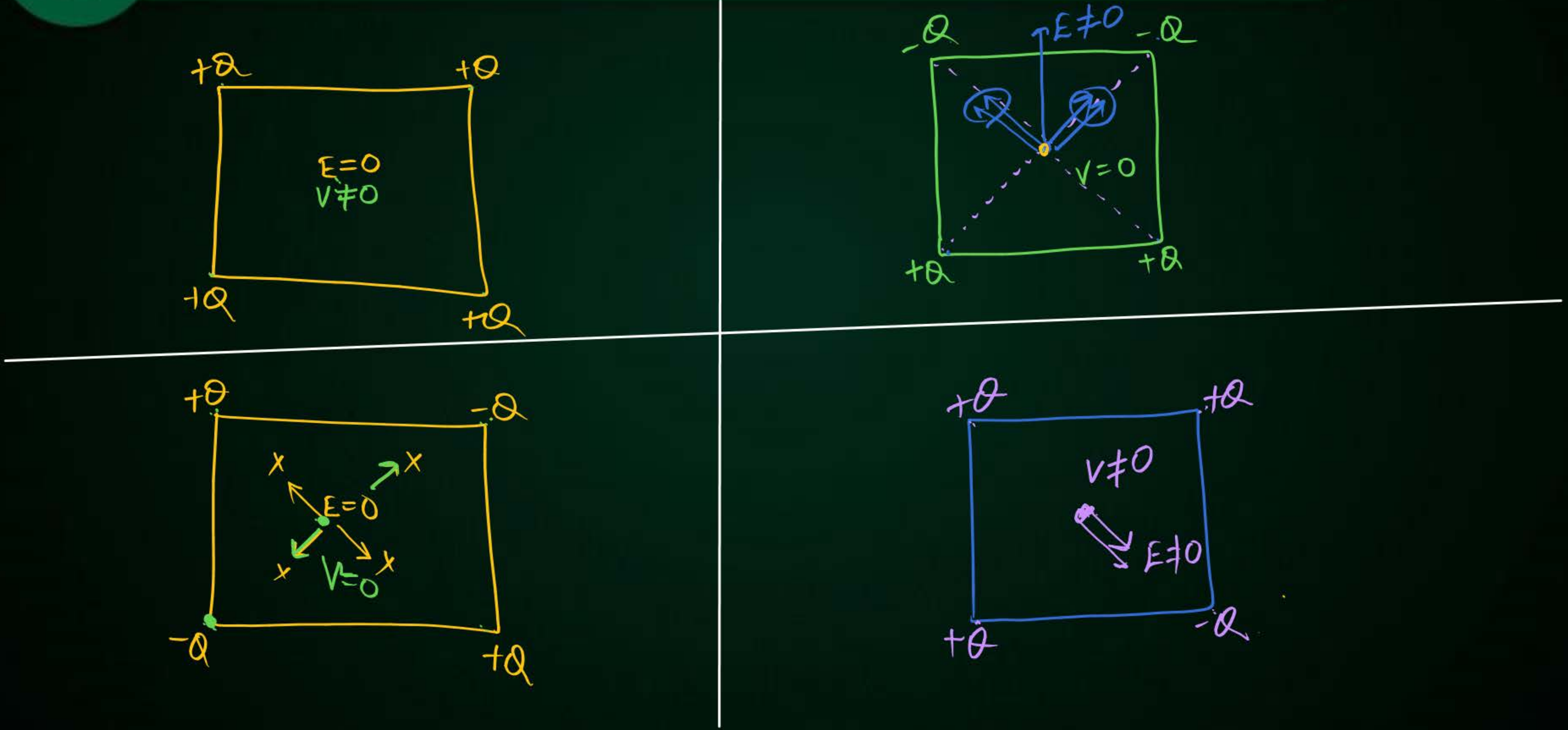




$E \neq 0$

$V \neq 0$

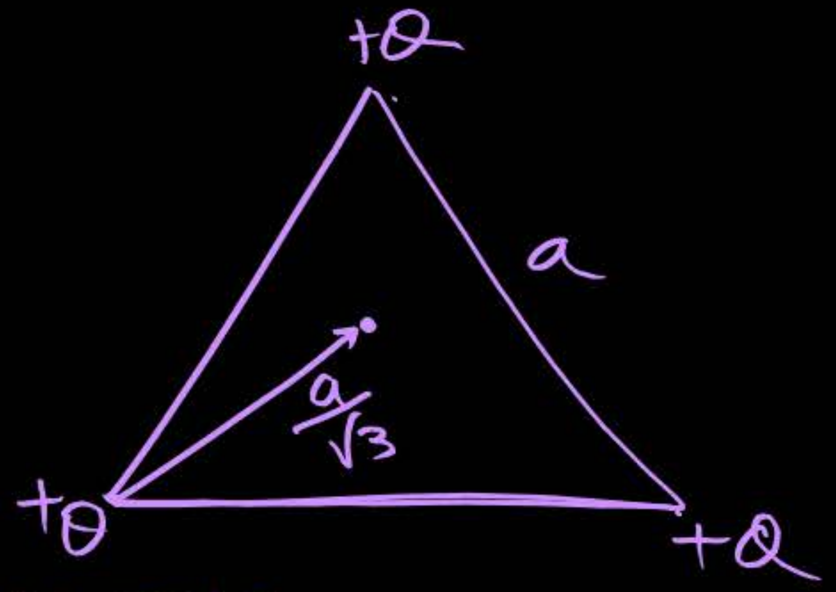
Electric Potential due to Combination of Charge



If net charge of the System is zero, then Potential must be zero.

(a) True (28%) ✗

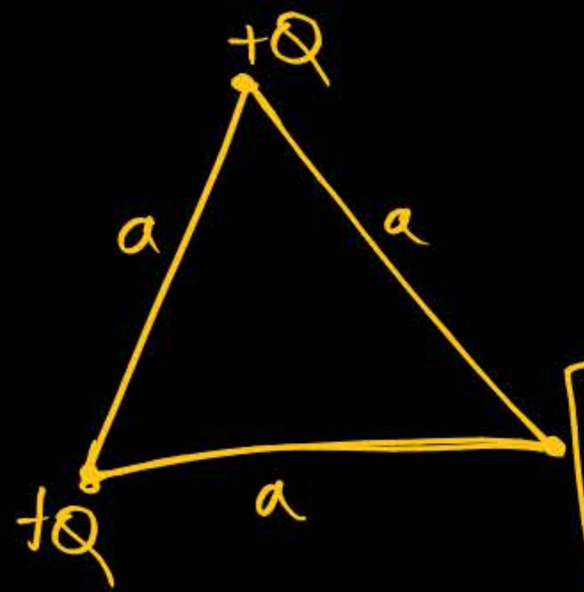
(b) false. (69%) ✓



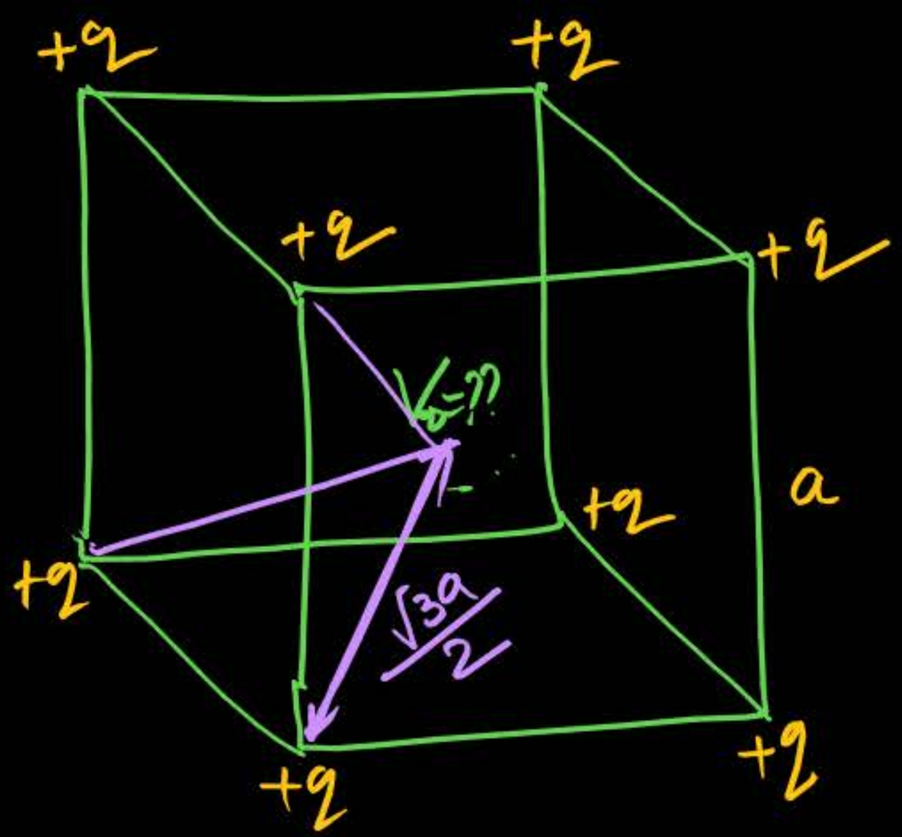
At centre

$E_0 = 0$

$V_0 = \frac{3KQ}{a/\sqrt{3}} = \frac{3\sqrt{3}KQ}{a}$



$V_p = \frac{2KQ}{a}$



find Potential at centre of cube ??

$V_0 = \left[\frac{Kq}{\frac{\sqrt{3}a}{2}}\right] \times 8$

$V_0 = \frac{16Kq}{\sqrt{3}a}$

+Q ←—— r ——→ +Q — Potential is not zero at any finite point.

−Q —— r —— −Q — Potential is not zero at any finite point.

−nQ —— r —— −Q

+Q —— r —— +nQ — Potential is not zero at any finite point.

V ← y — (+Q) —— V=0 —— r —— (−nQ)

← x → ← r−x →

at Two Point Potential is zero.

$$V = \frac{KQ}{y} - \frac{KnQ}{r+y} = 0$$

$$\frac{KQ}{y} = \frac{KnQ}{r+y}$$

$$r+y = ny$$

$$r = ny - y$$

$y = r/(n-1)$ ✱

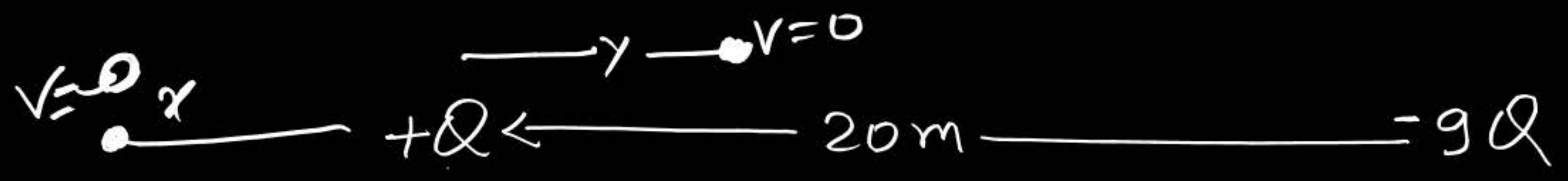
$$V = \frac{KQ}{x} - \frac{KnQ}{(r-x)} = 0$$

$$\frac{KQ}{x} = \frac{KnQ}{r-x}$$

$$nx = r - x$$

$$nx + x = r$$

$x = \frac{r}{n+1}$



Find distance from +Q charge where Potential is zero.

$x = \frac{20}{9-1} = \frac{20}{8} = 2.5\,m$

$y = \frac{20}{9+1} = \frac{20}{10} = 2\,m$

QUESTION

Find electric potential, where electric field is zero.

+Q ⟵ 12m ⟶ +9Q

x = 3m, E = 0, 9m

$$x = \frac{12}{\sqrt{n}+1} = \frac{12}{\sqrt{9}+1} = \frac{12}{4} = 3m$$

$$V = \frac{KQ}{3} + \frac{K9Q}{9}$$

$$= \frac{12KQ}{9} = \frac{4KQ}{3}$$

$$V = \frac{4KQ}{3}$$

QUESTION

Find electric potential, where electric field is zero.

$+Q \longleftarrow 10\text{m} \longrightarrow +16Q$

$x = \frac{10}{\sqrt{16}+1} = \frac{10}{5} = 2\text{m}$

$V = \frac{KQ}{2} + \frac{KQ \times 16}{8}$

$= \frac{5KQ}{2}$

find Potential at origin ??

(0,0) • ; +Q at (1,0); +Q at (2,0); +Q at (4,0); +Q at (8,0); +Q at (16,0) ......

$$V = \frac{KQ}{1} + \frac{KQ}{2} + \frac{KQ}{4} + \frac{KQ}{8} + \frac{KQ}{16} = KQ\left(1 + \frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \frac{1}{16} + \cdots\right)$$

G.P series.

$$= KQ\left[\frac{1}{1-\frac{1}{2}}\right] = 2KQ$$

(0,0) • ; +Q at (1,0); −Q at (2,0); +Q at (4,0); −Q at (8,0); +Q at (16,0) .... −Q

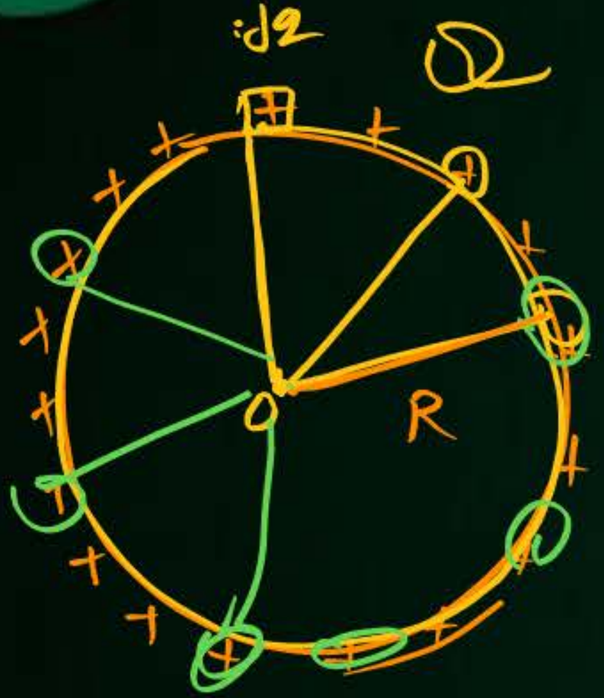
So on.

$$V = KQ - \frac{KQ}{2} + \frac{KQ}{4} - \frac{KQ}{8} + \frac{KQ}{16} = KQ\left(1 - \frac{1}{2} + \frac{1}{4} - \frac{1}{8} + \frac{1}{16} + \cdots\right)$$

$$= KQ\left[\frac{1}{1-\left(-\frac{1}{2}\right)}\right] = \frac{2KQ}{3}$$ Ans

Electric Potential due to Ring

Same as point charge



$$\int dV = \int \frac{K\,dq}{R}$$

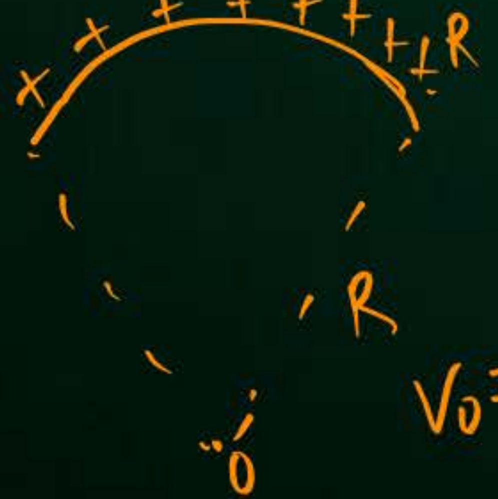
$$V = \frac{K}{R}\int dq$$

$$V = \frac{KQ}{R}$$

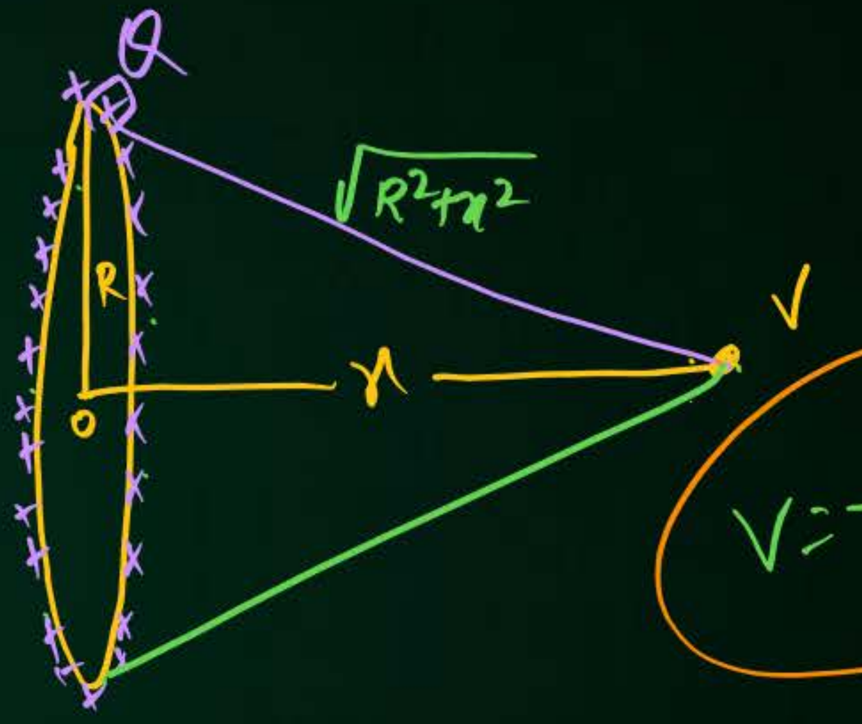
$$V_{\text{centre of Ring}} = \frac{KQ}{R}$$



$V_0 = KQ/R$ (Half Ring)



$$V_0 = \frac{KQ}{R}$$ (Circular Arc)



$$V = \frac{KQ}{\sqrt{R^2+x^2}}$$

$$V = \frac{KQ}{(R^2+x^2)^{1/2}}$$

MR*

$x = 0$

$$V_{\text{centre}} = \frac{KQ}{R}$$

$x >>> R$

$$V = \frac{KQ}{x}$$

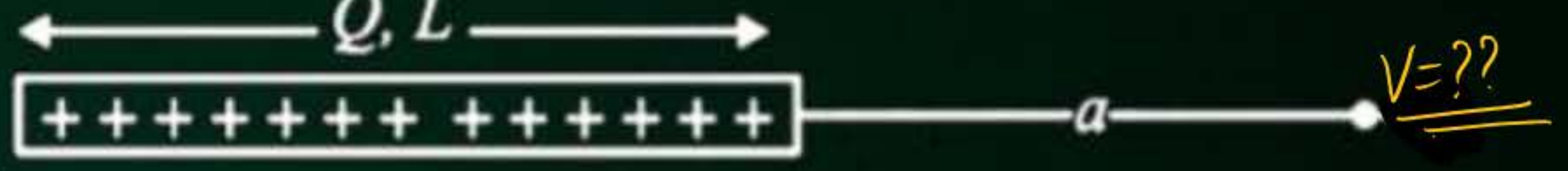


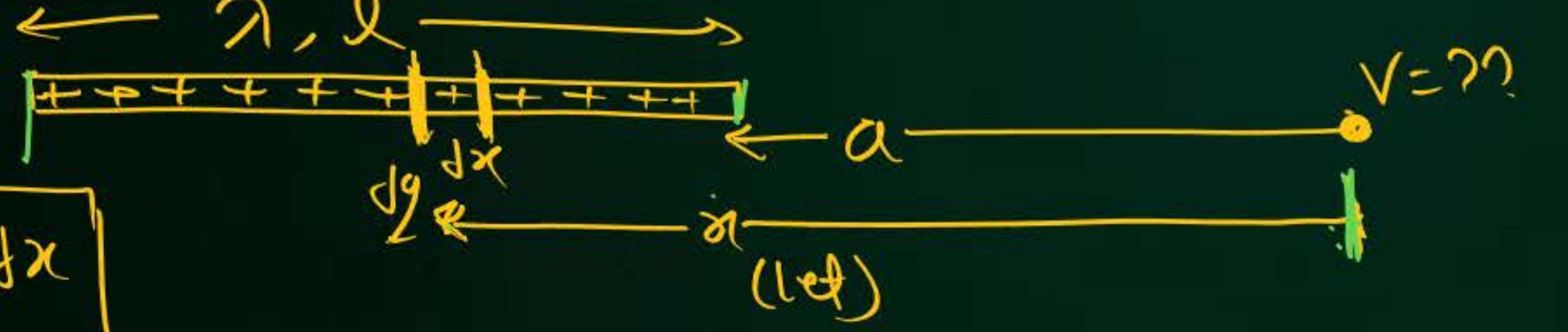
- **Electric potential at distance *r* from centre at an angle ‘θ’.**

QUESTION

Find electric Potential due to finite line charge along its length at distance 'a' from one end as shown in figure. $\lambda \rightarrow$ linear charge density.

$\lambda = Q/L$





$dq = \lambda dx$

$dV = \frac{K\,dq}{x}$

$dV = \frac{K\lambda\,dx}{x}$

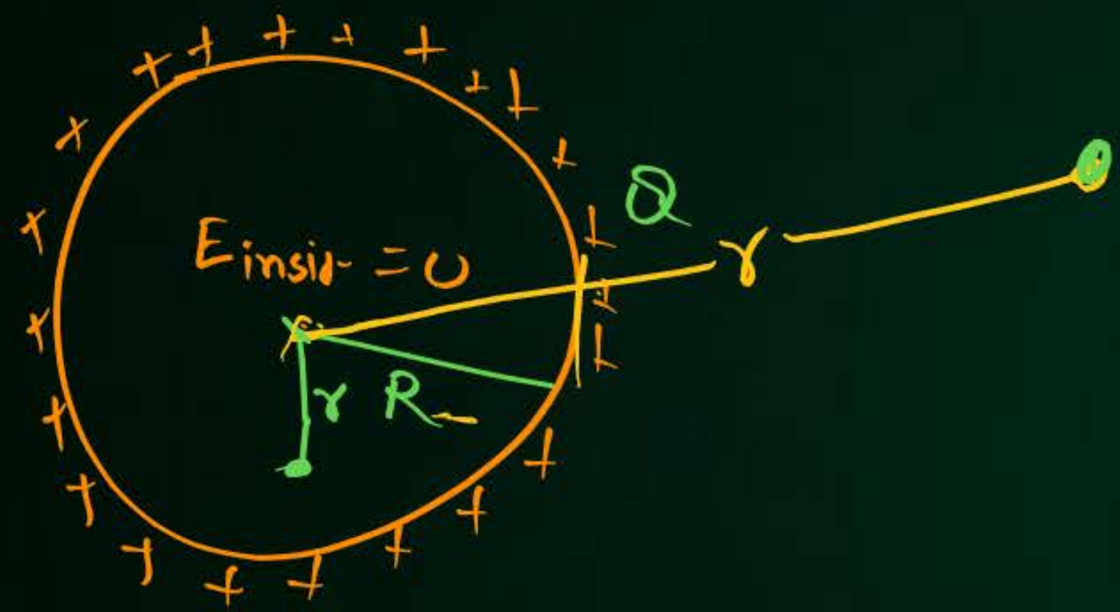
$\int dV = K\lambda \int_a^{a+l} \frac{dx}{x}$

$V = K\lambda \left(\log x\right)_a^{a+l} = K\lambda\left[\log(a+l) - \log a\right]$

$V = K\lambda \log\left(\frac{a+l}{a}\right)$

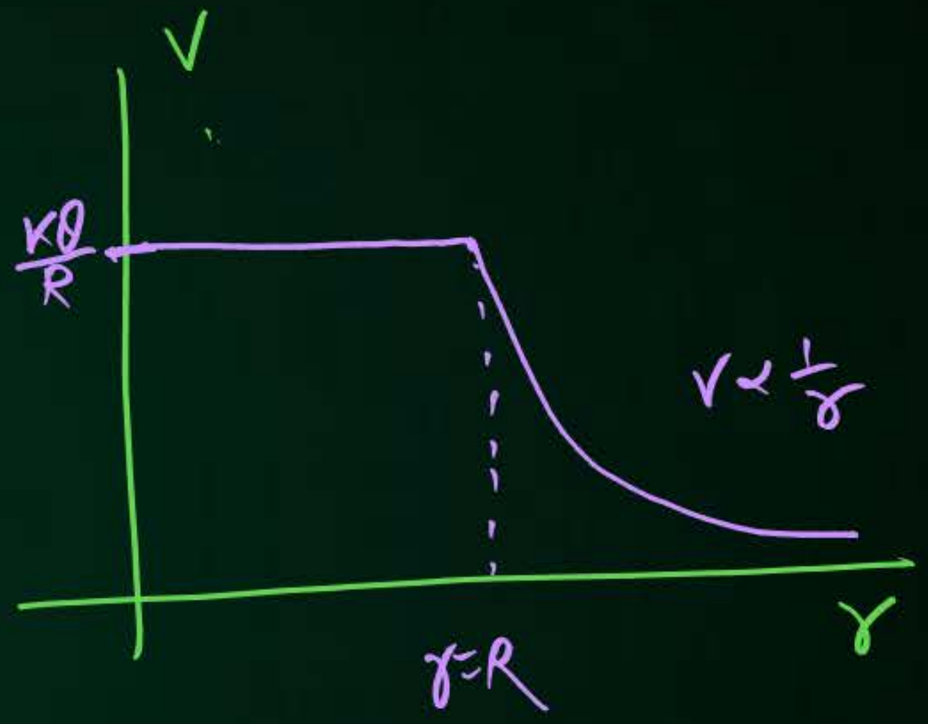
Electric Potential due to Conducting (Hollow/Solid) Sphere / (metal)

electric potential due spherical sell.



outside (r>R)

$$V_{out} = \frac{KQ}{r}$$



$$E = -\frac{dV}{dr}$$

Zero (V = const)

$$V_0 = \frac{KQ}{R}$$ centre

$$V_{in} = \frac{KQ}{R}$$

$$V_{sur} = \frac{KQ}{R}$$

equipotential region inside sphere

find electric Potential at centre of Hollow sphere if Potential at the surface of sphere assume to be zero.

Soln

V (Potential) = depend on refn

ΔV = does not depend on refrence ✓

for sphere

$\Delta V = 0$

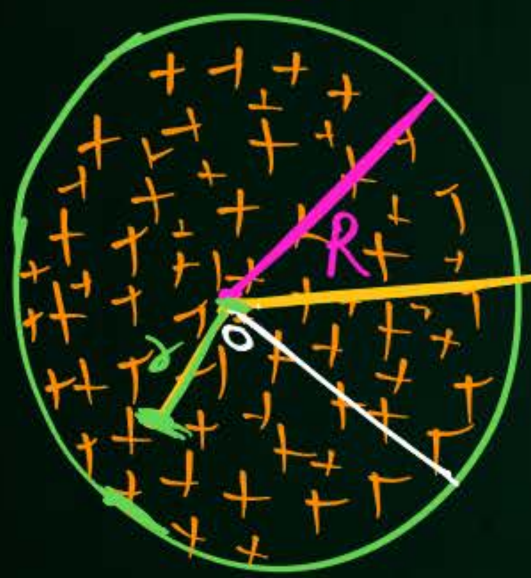
$V_0 - V_S = 0$

$V_0 = V_S$

V_0 = zero ✓

Electric Potential due to Non-Conducting Solid Sphere

Uniformally charge solid sphere → (nonconducting)



outside (r>R)

$$V_{out} = \frac{KQ}{r}$$

$$V_{surface} = \frac{KQ}{R}$$

$$V_0 = \frac{3}{2}\frac{KQ}{R} = \frac{3}{2}V_s$$

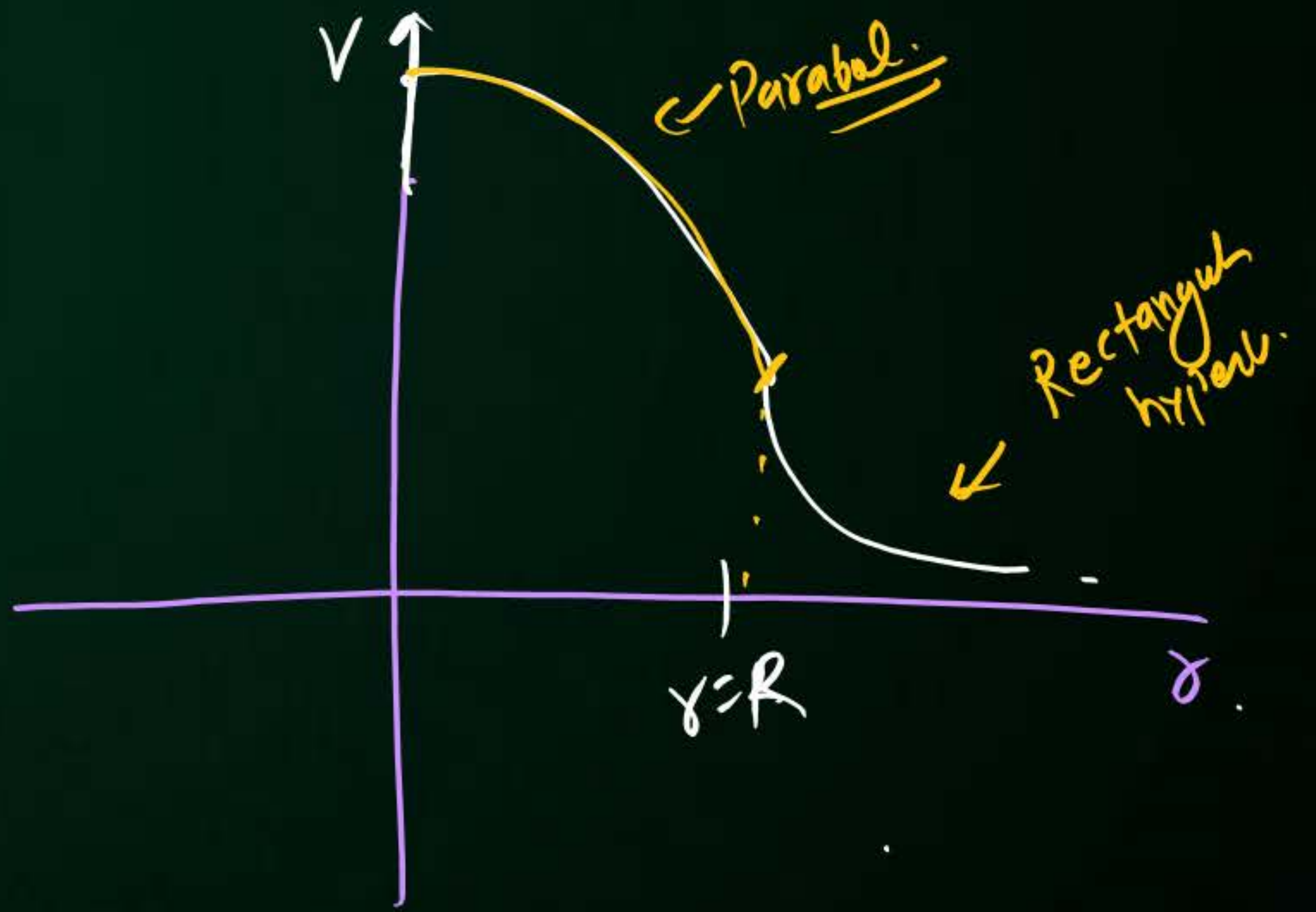
(r<R)

$$V_{Insin} = \frac{KQ[3R^2 - r^2]}{2R^3}$$

dim^n correct

$V \propto -r^2$

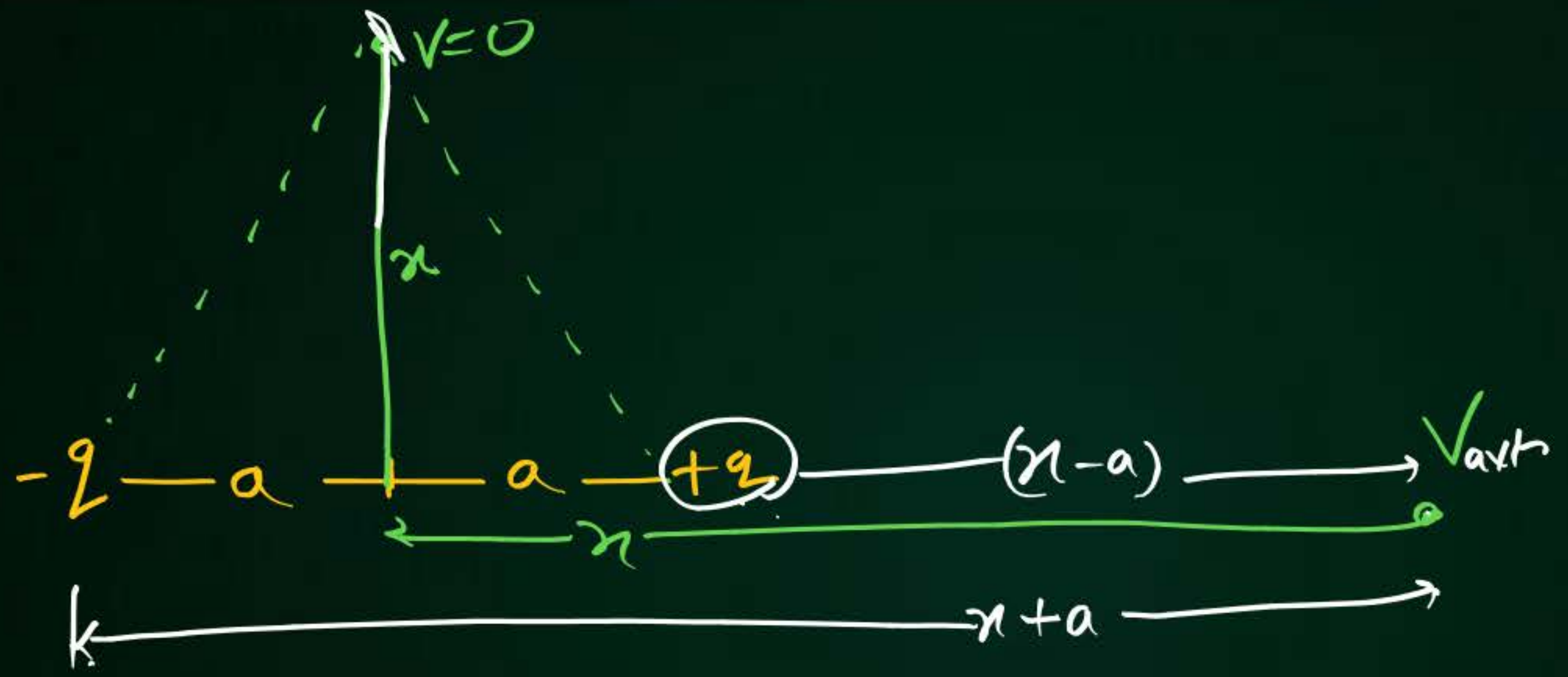
$$V_{in} = \frac{KQ[3R^2 - r^2]}{2R^3}$$



If Potential at surface is zero then find Potential at centre

$$\Delta V = \text{const}^n$$

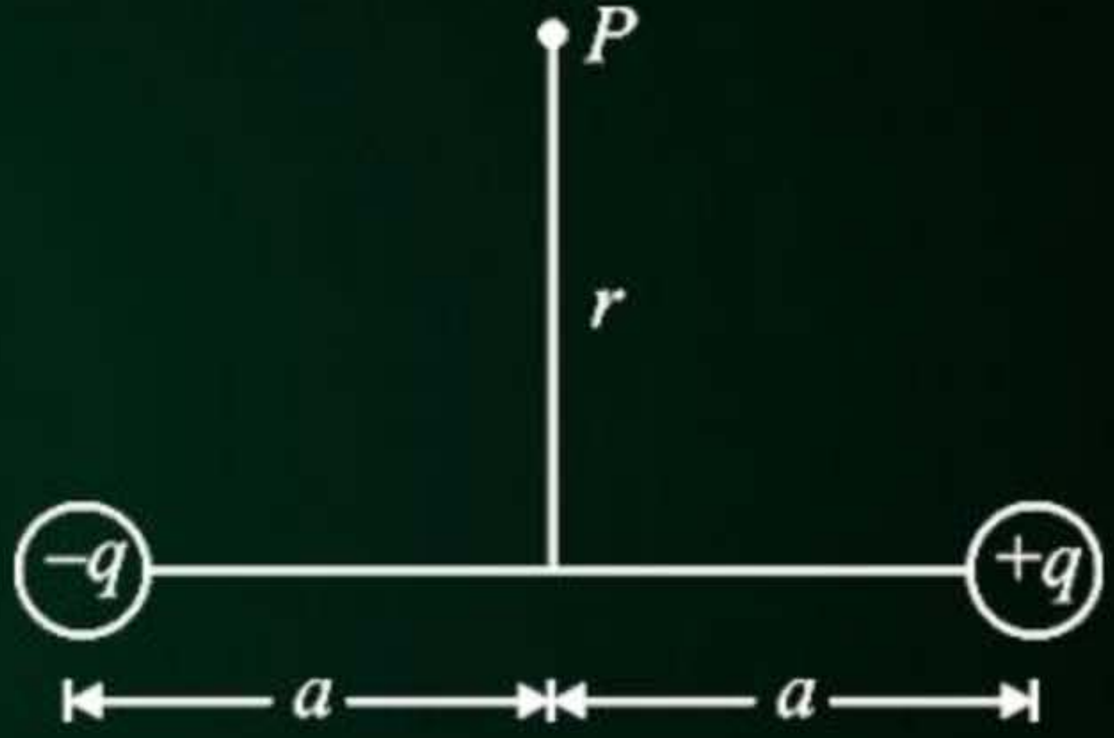
Electric Potential due to Dipole



Potential is zero at equitorial line of dipole.

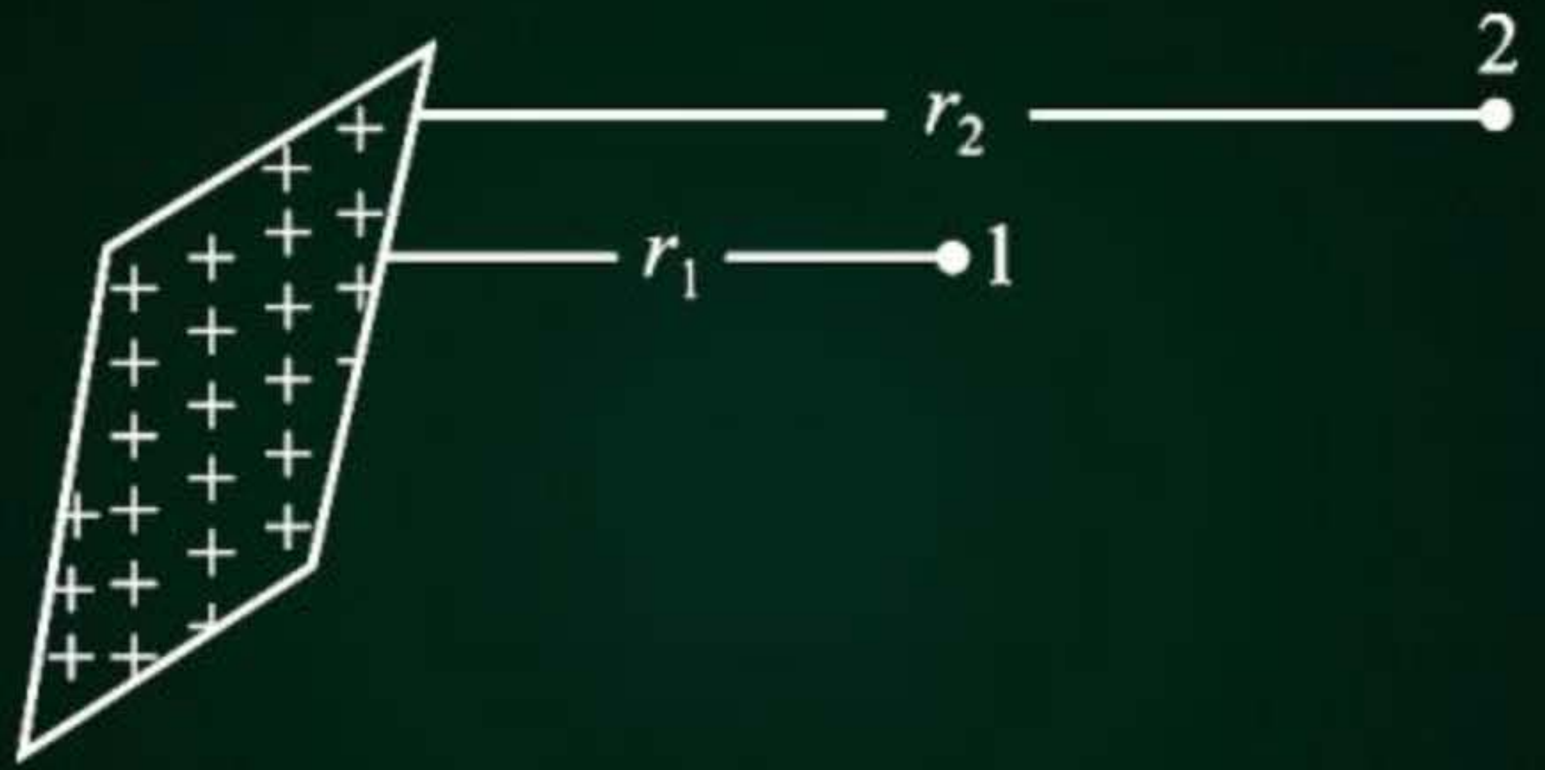
QUESTION

Electric potential due to dipole on equatorial line at distance *r* from centre of dipole.



Electric Potential due to Dipole at Angle θ from Dipole

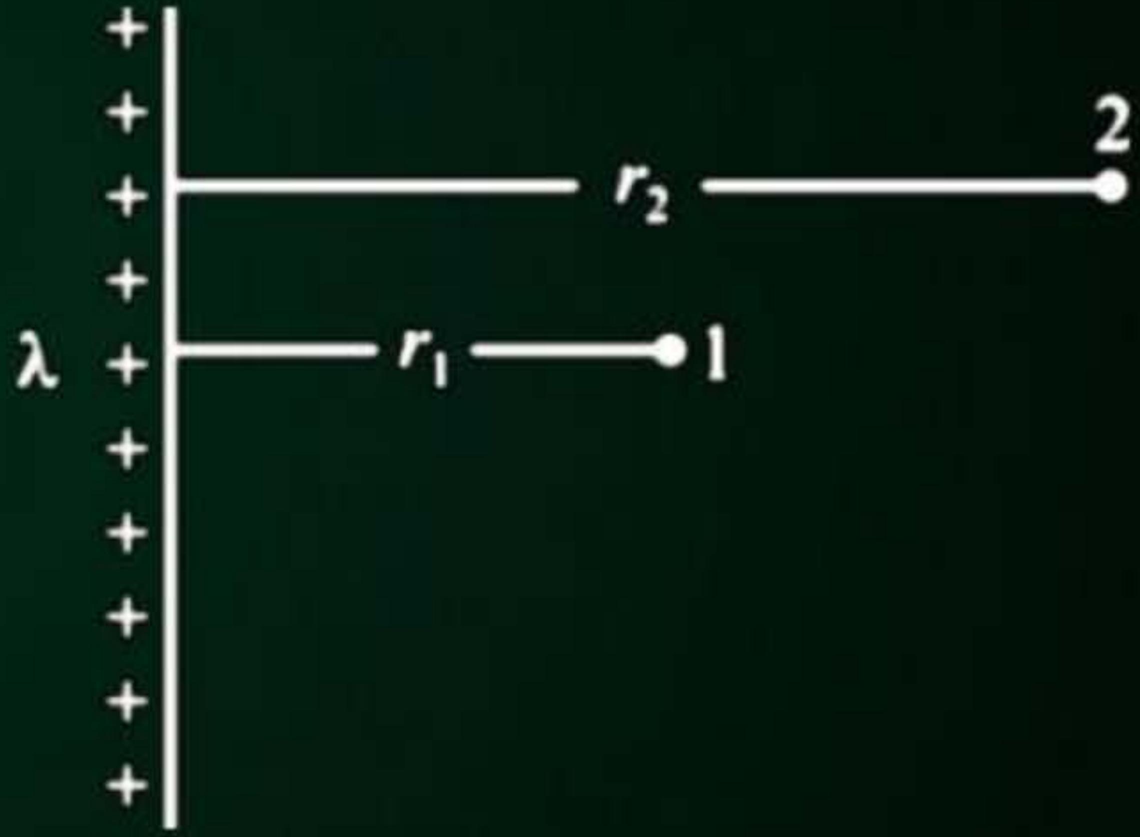
Electric potential difference between two point due to infinite thin charge sheet.



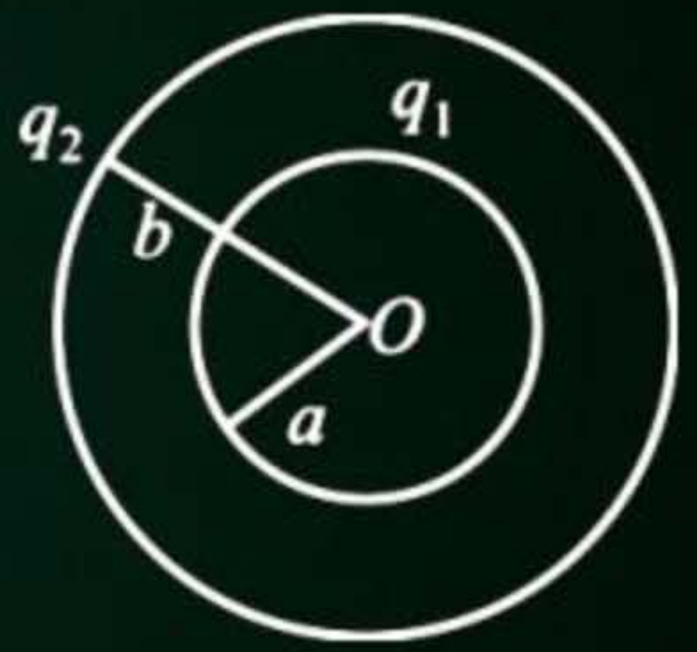
Potential Difference due to Variable Electric Field

Electric potential difference between two point charge due to infinite line charge density λ

$$\int_{V_1}^{V_2} dV = -\int_{r_1}^{r_2} \vec{E}.d\vec{r}$$



ELECTRIC POTENTIAL DUE TO GROUP OF CONCENTRIC SHELLS



- When two conductor is connected with a wire then their potential must be same

QUESTION

Two concentric conducting spheres of radii R and $2R$ are carrying charges Q and $-2Q$ respectively. If the charge on inner sphere is doubled, the potential difference between the two spheres will

1. Become two times
2. Become four times
3. Be halved
4. Remain same



QUESTION

Two concentric conducting spheres of radii R and $2R$ are carrying charges Q and $-2Q$ respectively. If the charge on outer sphere is doubled, the potential difference between the two spheres will

1. Become two times
2. Become four times
3. Be halved
4. Remain same



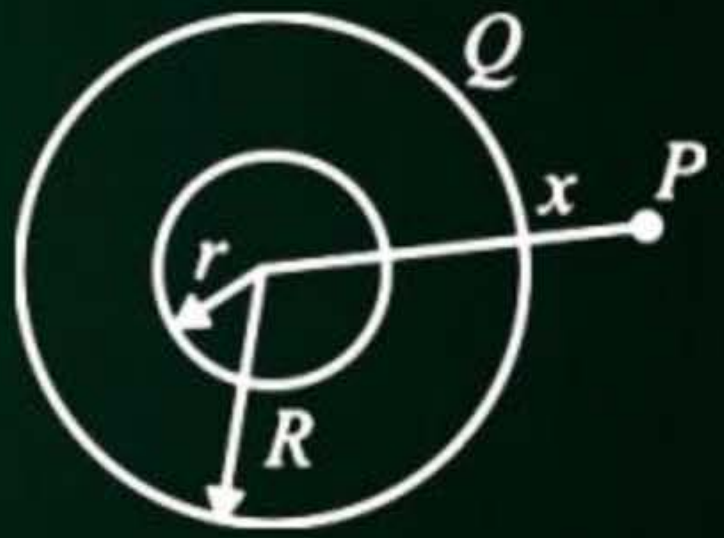
QUESTION

A hollow charged metal sphere has radius r. If the potential difference between its surface and a point at a distance $3r$ from the centre is V, then the electric field intensity at distance $3r$ from the centre is

1. $\frac{V}{3r}$
2. $\frac{V}{4r}$
3. $\frac{V}{6r}$
4. $\frac{V}{2r}$

QUESTION

Two concentric hollow conducting spheres of radius r and R are shown. The charge on outer shell is Q. What charge should be given to inner sphere so that the potential at any point P outside the outer sphere is zero?



1. $-\frac{Qr}{R}$
2. $-\frac{QR}{r}$
3. $-Q$
4. $-\frac{2QR}{r}$

QUESTION

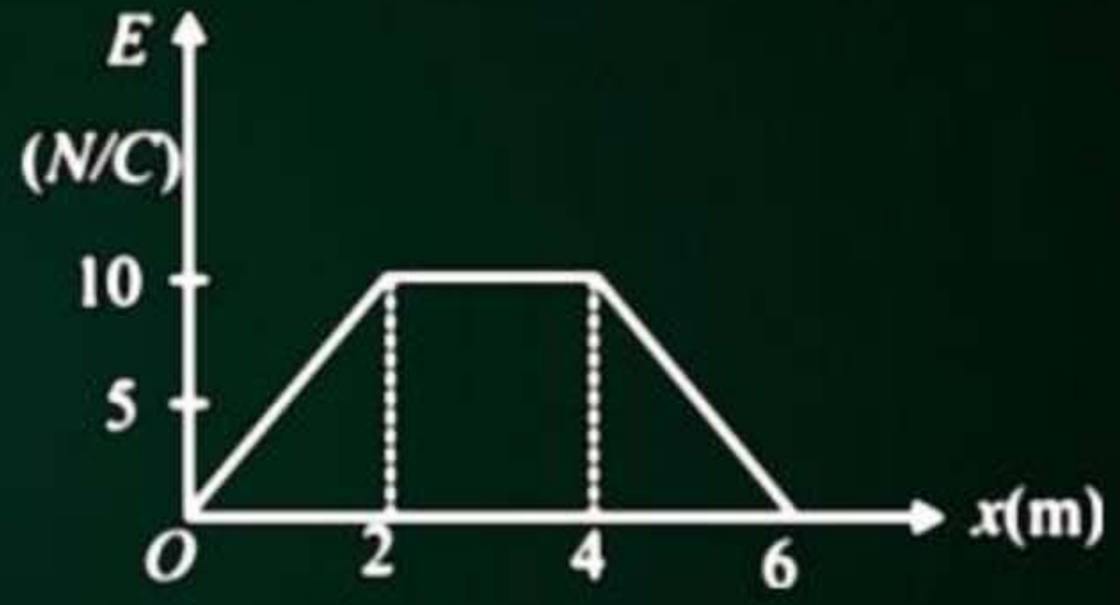
A spherical conductor having charge q and radius r is placed at the centre of a spherical shell of radius R and having charge Q ($R > r$). The potential difference between the two is

1. Proportional to Q
2. Proportional to q
3. Dependent on both Q and q
4. Independent of both Q and q

QUESTION

Figure shows the variation of electric field intensity E versus distance x. What is the potential difference between the points at $x = 2$ m and at $x = 6$ m from 0?

1. 30 V
2. 60 V
3. 40 V
4. 80 V



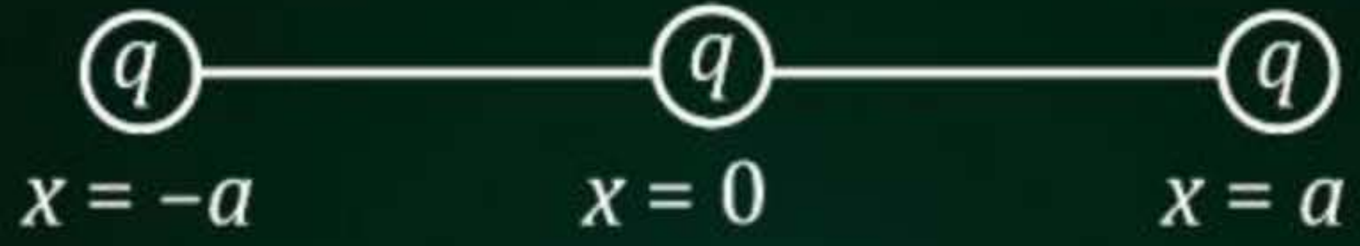
QUESTION

An infinite conducting sheet has surface charge density σ. The distance between two equipotential surfaces is *r*. The potential difference between these two surfaces is

1. $\frac{\sigma r}{2\varepsilon_0}$
2. $\frac{\sigma r}{\varepsilon_0}$
3. $\frac{\sigma}{\varepsilon_0 r}$
4. $\frac{\sigma}{2\varepsilon_0 r}$

QUESTION

Three charges are placed along x-axis at $x = -a$, $x = 0$ and $x = a$ as shown. Calculate the potential energy of the system.




THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 03 | Physics

Electrostatic Potential and Capacitance

By- Dr. Manish Raj (MR SIR)



Topics to be covered

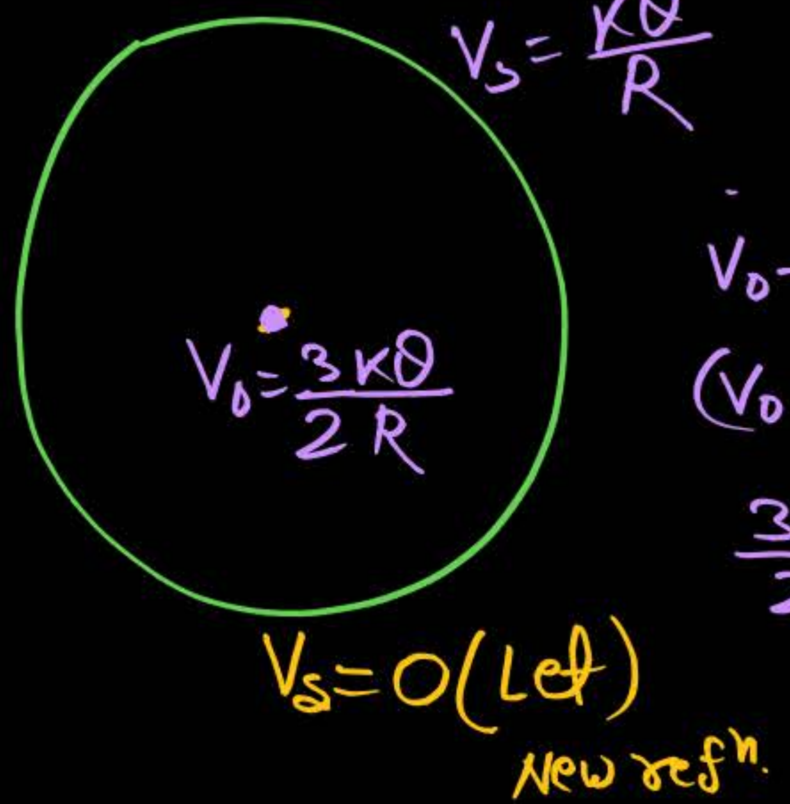
1. # Potential due to dipole, line charge
concentric sphere, sheet,
equipotential surface.

2. #

3. #



(Q) If Potential at surface of Non-conducting solid sph is zero then Potential at centre of solid sphere will be ??



$V_{\infty} = 0$ (ref^n)

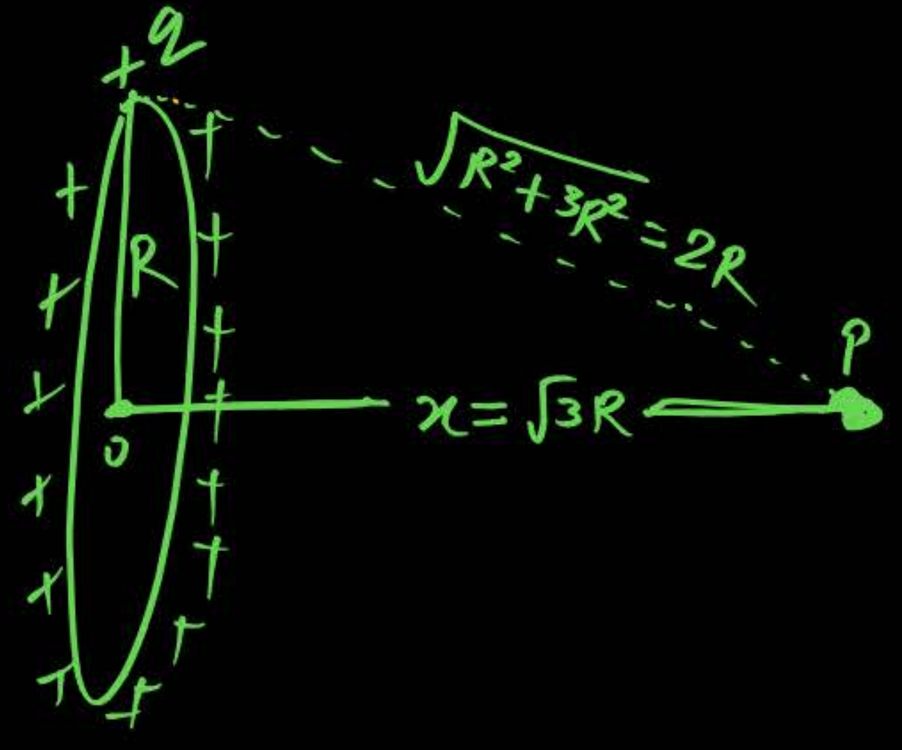
$V_0 - V_s = $ const^n

$(V_0 - V_s)_{init} = (V_0 - V_s)_{final}$

$\frac{3KQ}{2R} - \frac{KQ}{R} = V_0 - 0$

$$\boxed{\frac{KQ}{2R} = V_0}$$

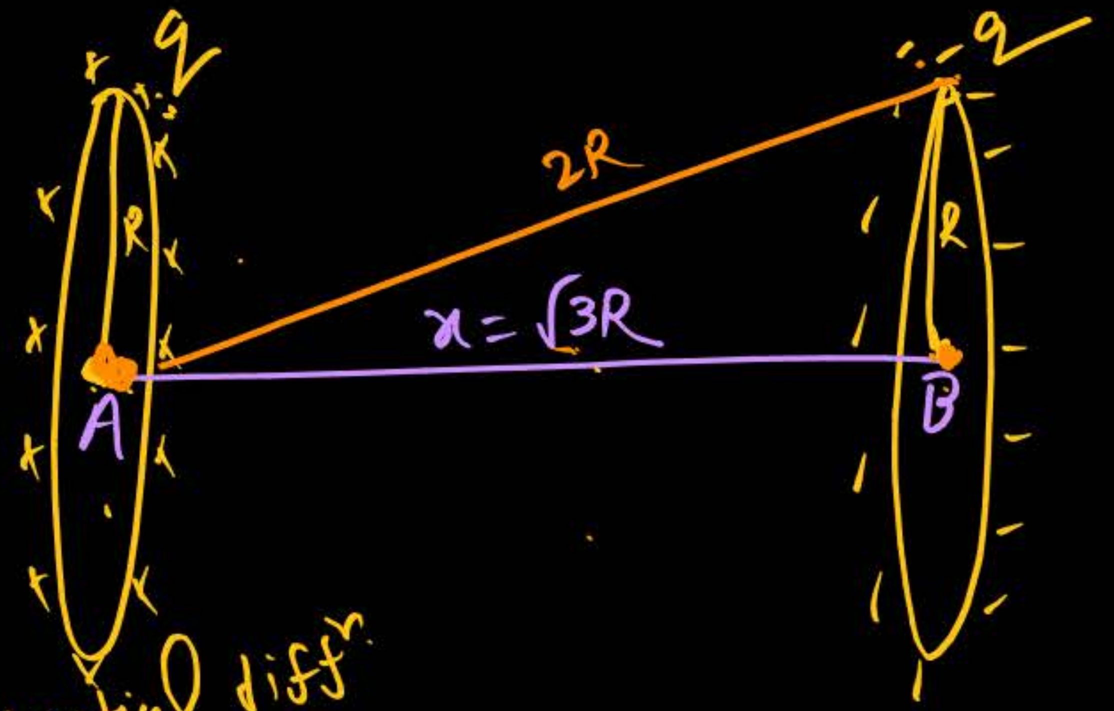
Ans



$V_O = \frac{Kq}{R}$

$V_P = \frac{Kq}{\sqrt{R^2+3R^2}} = \frac{Kq}{2R}$

Q



find Potential diffⁿ

$V_A - V_B = ??$

(a) $\frac{Kq}{2R}$

67% (b) zero

(c) $\frac{3Kq}{2R}$

(d) $\frac{Kq}{R}$ Ans.

$V_A = \frac{Kq}{R} - \frac{Kq}{2R} = \frac{Kq}{2R}$

$V_B = \frac{-Kq}{R} + \frac{Kq}{2R} = \frac{-Kq}{2R}$

$V_A - V_B = \frac{Kq}{2R} - \left(-\frac{Kq}{2R}\right)$

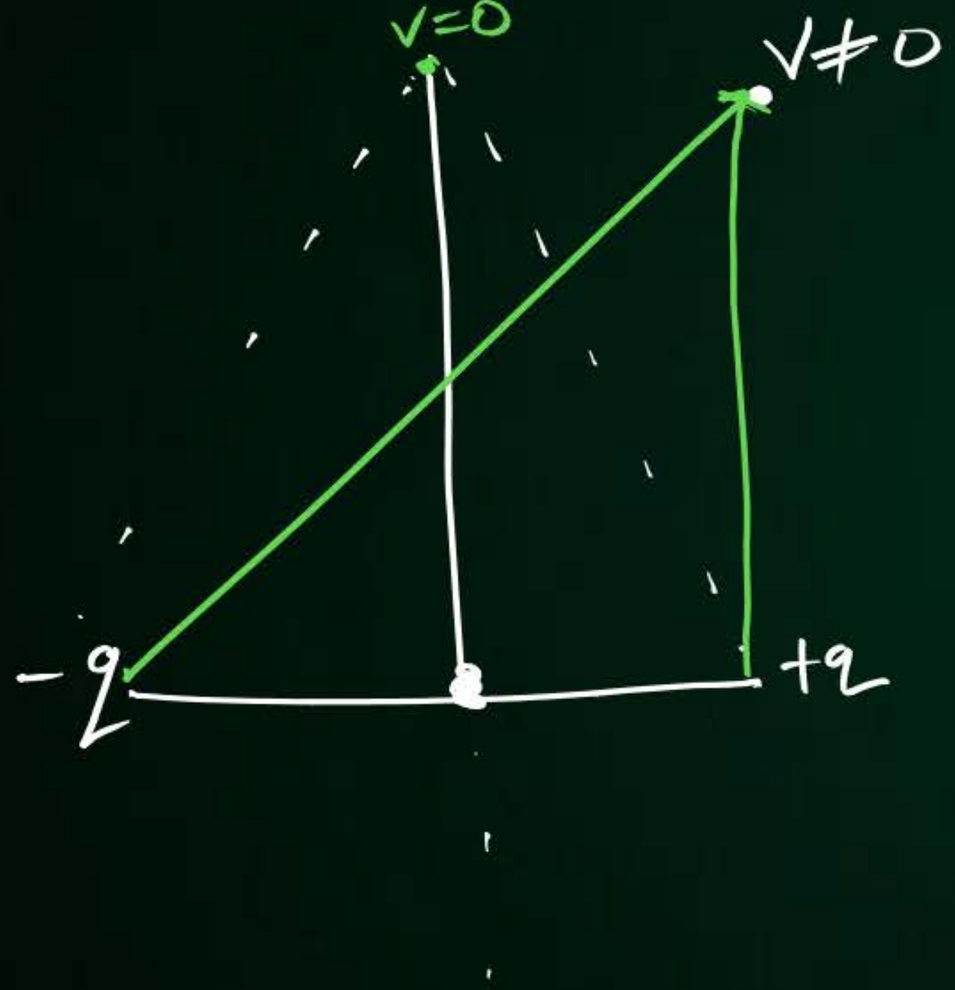
$= \frac{Kq}{R}$ Ans

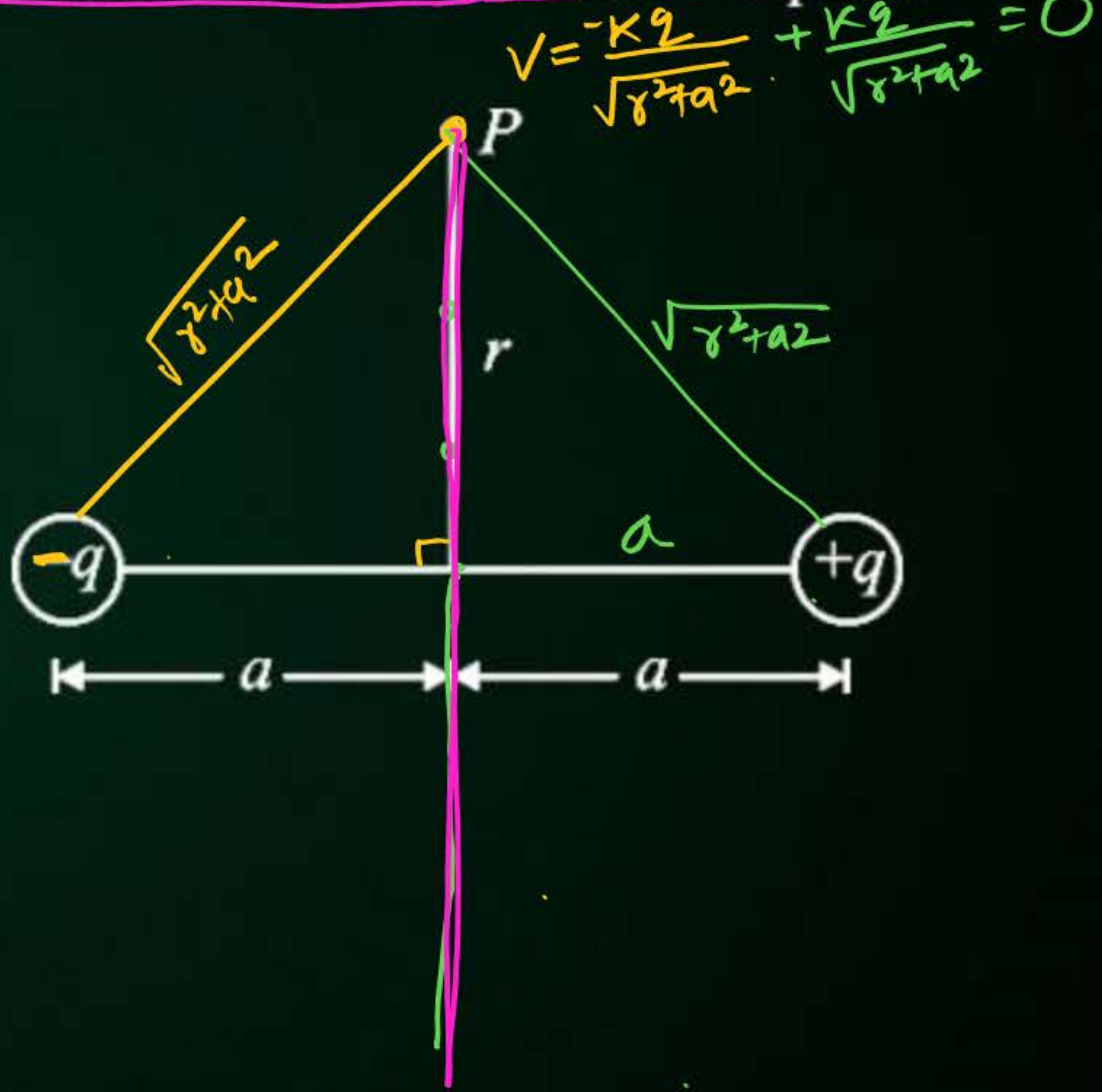
3

QUESTION

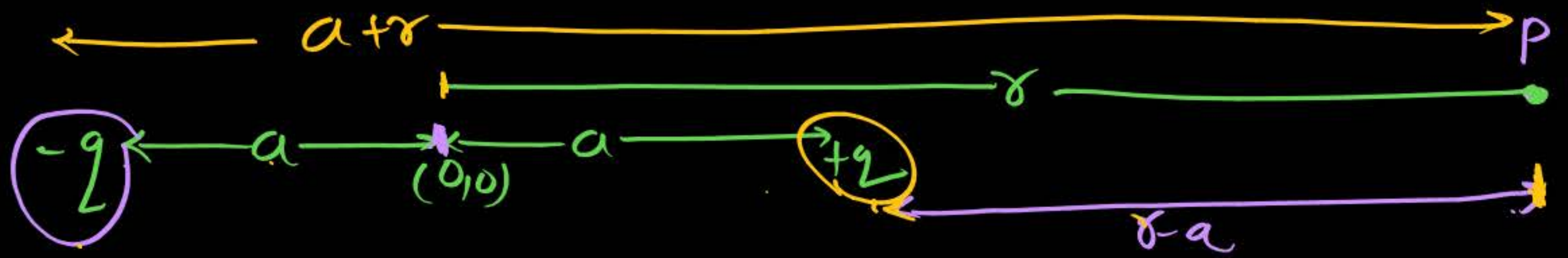
Electric potential due to dipole on equatorial line at distance *r* from centre of dipole.

is always zero.





Potential on axial line of dipole



$$V = \frac{Kq}{r-a} - \frac{Kq}{r+a}$$

$$V = Kq\left[\frac{1}{r-a} - \frac{1}{r+a}\right]$$

$$= Kq\left[\frac{\cancel{r}+a-\cancel{r}+a}{r^2-a^2}\right]$$

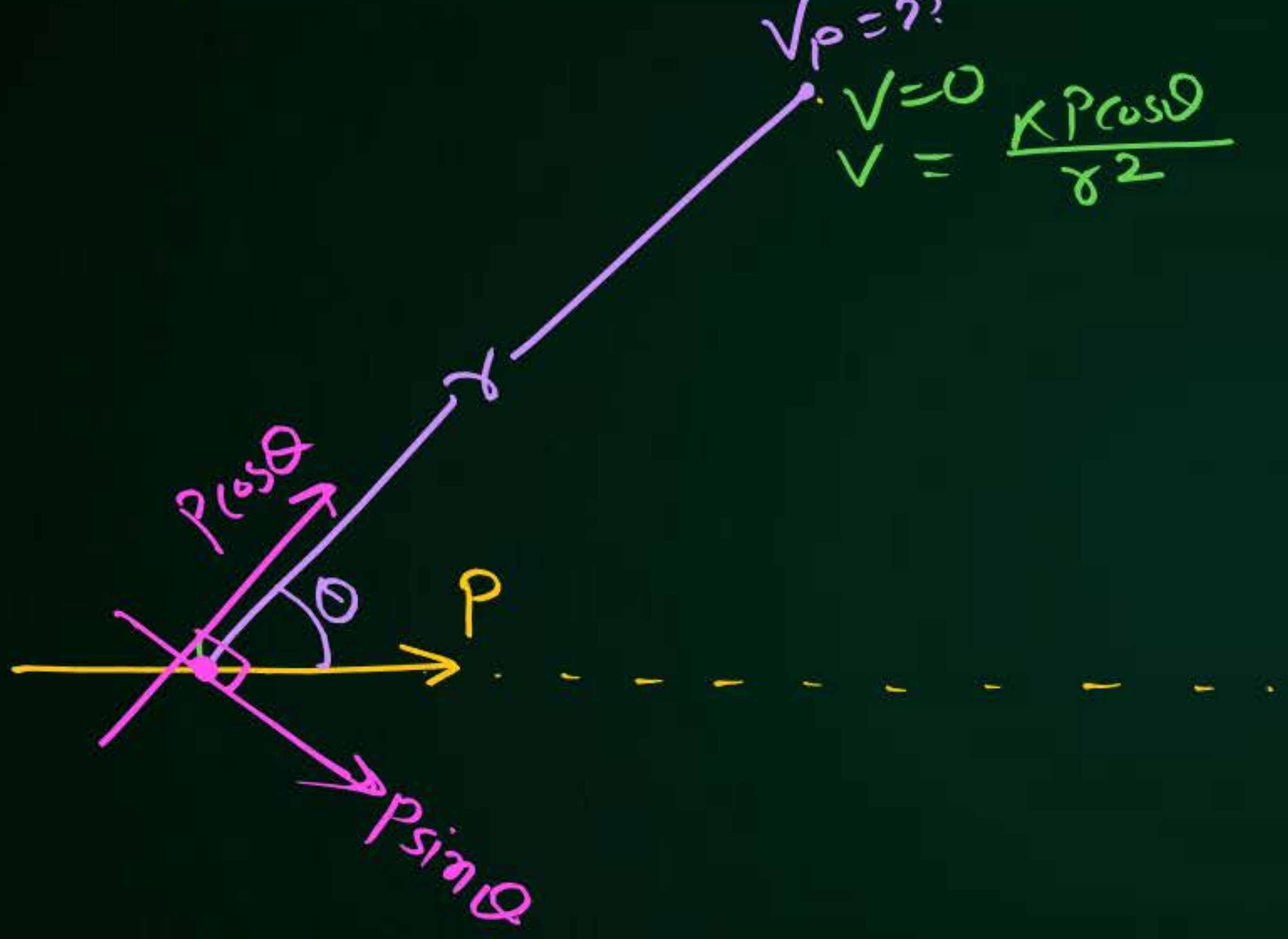
$$V = \frac{K(q\,2a)}{r^2-a^2} = \frac{KP}{r^2-a^2}$$

$$V = \frac{KP}{r^2-a^2}$$

Small dipole. $(r >>> a)$

☆ $$V = \frac{KP}{r^2}$$ axial line

Electric Potential due to Dipole at Angle θ from Dipole



$$V = \frac{Kp\cos\theta}{r^2}$$

θ → Angle b/w dipole moment & $\vec{r}$.

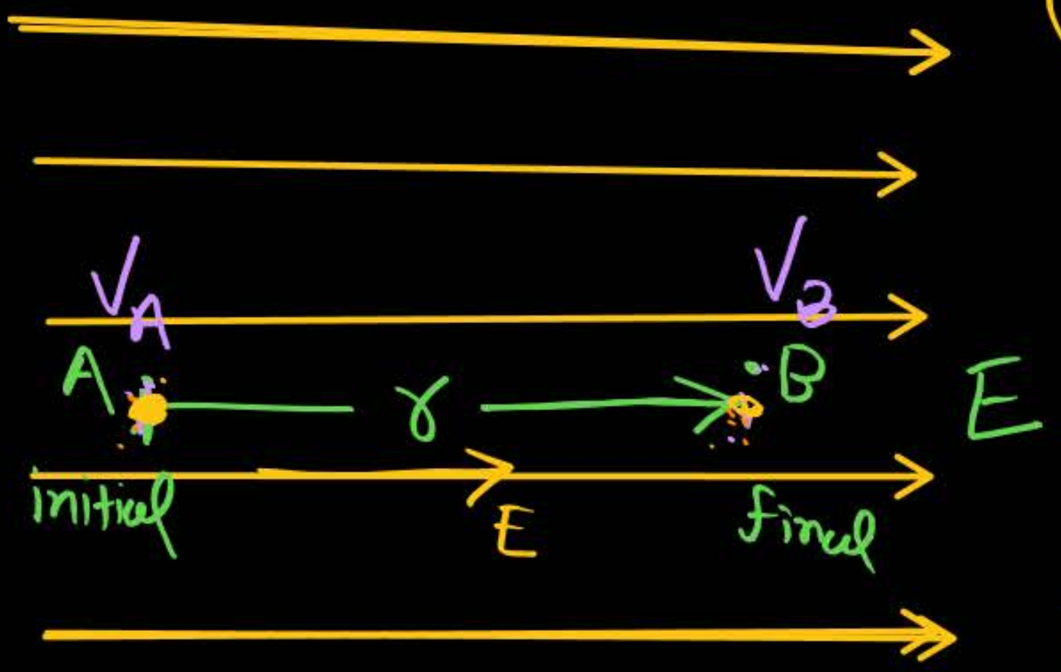
$\theta = 0$

$$V_{axial} = \frac{Kp}{r^2}$$

$\theta = 90°$

$$\boxed{V = 0}$$

Potential diffⁿ b/w Two point in uniform electric field :—



$V_A > V_B$

MR*

$dv = -E \cdot dr$

$|dv| = E \cdot \Delta r$

$V_A - V_B = E r$

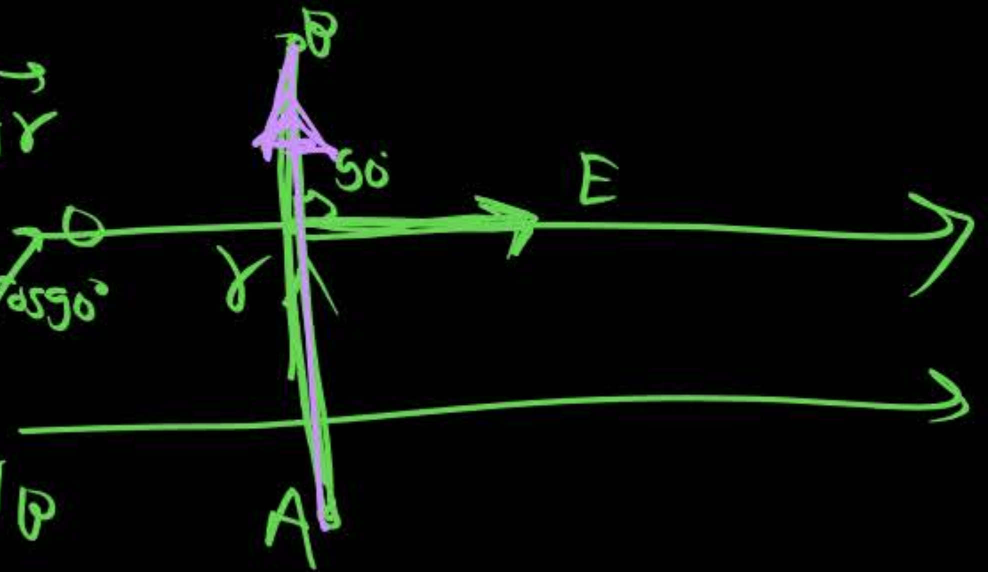
$V_B - V_A = -E r$ *

\# $dv = -\vec{E} \cdot \vec{dr}$

$= E\,dr \cos 90°$

$dv = 0$

* $V_A = V_B$



we know that

$\vec{E} = -\frac{dv}{dr}$

$dv = -\vec{E} \cdot \vec{dr}$

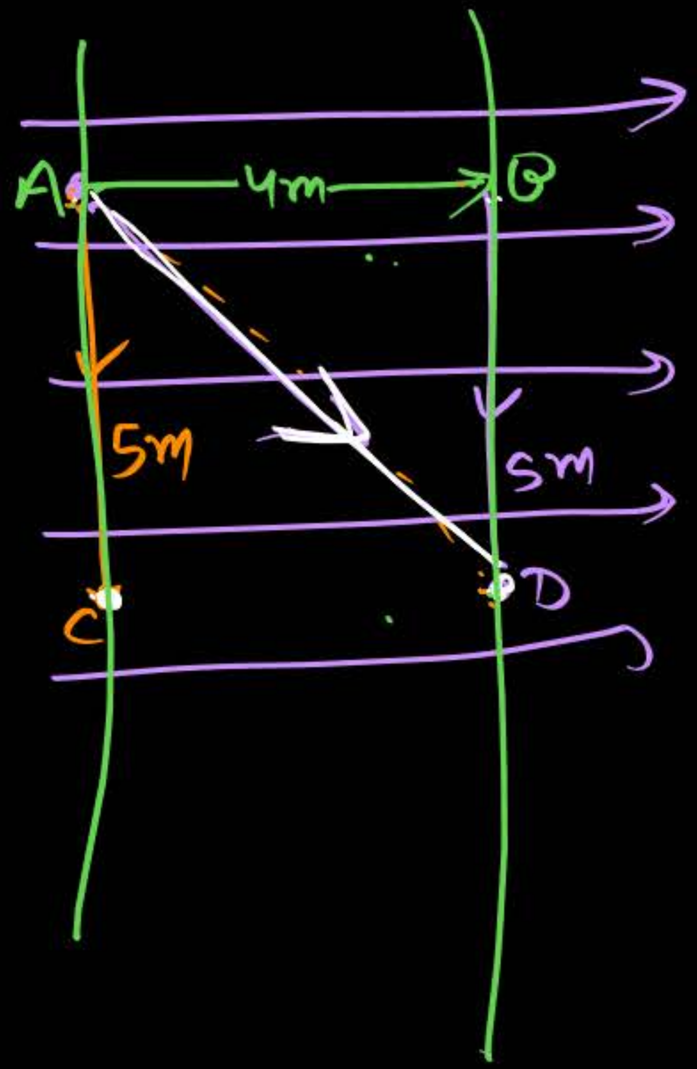
Angle b/w $\vec{E}$ & dr 0°

$\int_{V_A}^{V_B} dv = -\int_{r_A}^{r_B} E \cdot dr \cos 0°$

$[V]_{V_A}^{V_B} = -E \int_{r_A}^{r_B} dr$

$V_B - V_A = -E\,[\vec{r_B} - \vec{r_A}]$

$V_B - V_A = -E r$ Ans.



$E = 20\ N/C$

Soln

$|V_A - V_B| = |E \times r|$

$= 20 \times 4$

$V_A - V_B = 80$ volt.

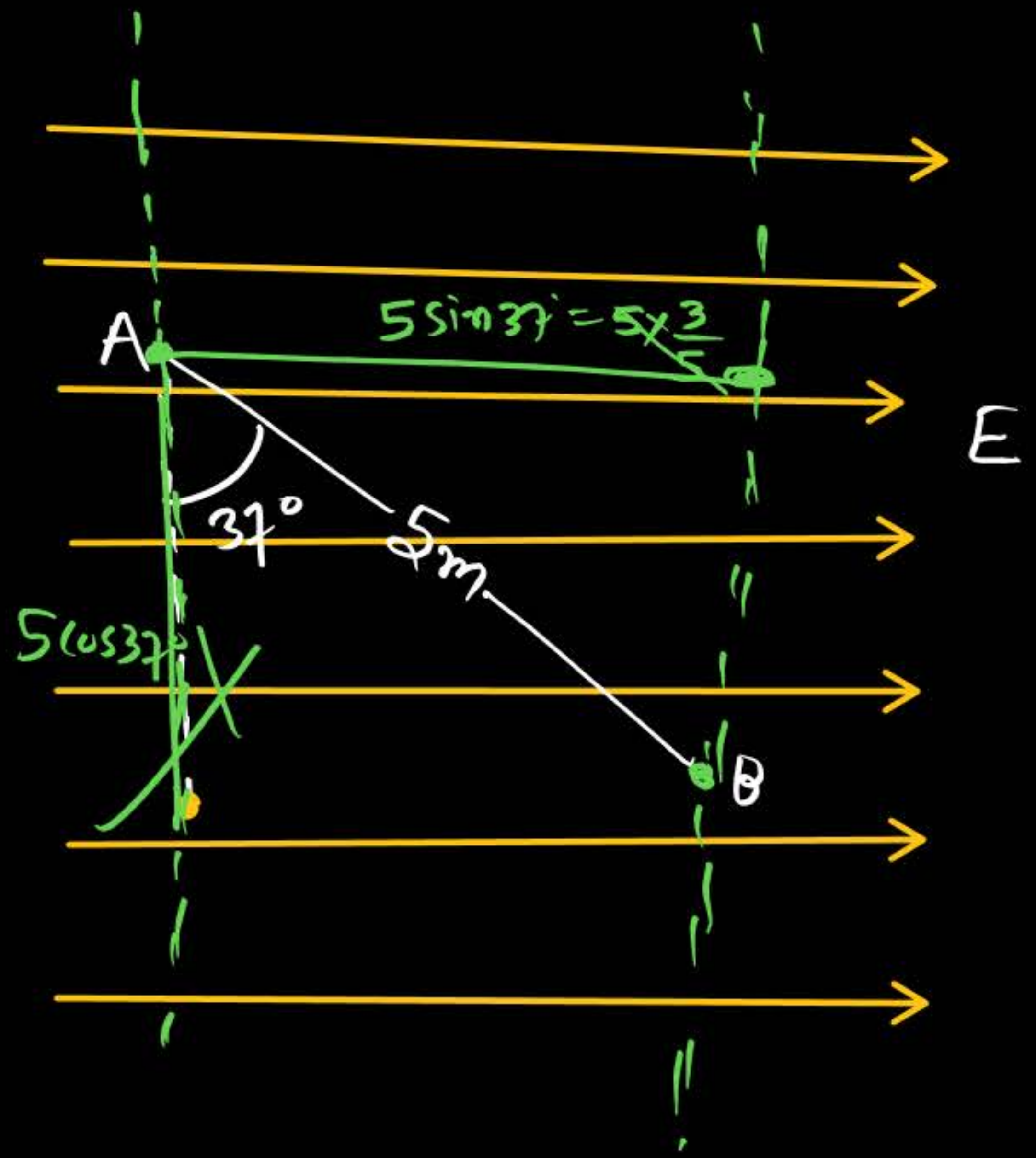
$\boxed{V_A - V_C = 0} \Rightarrow V_A = V_C$ ✓

$V_B - V_D = 0$ ∴ $\boxed{V_B = V_D}$ ✓

$V_A - V_D = ??$

$(V_B = V_D)$

$V_A - V_D = 80$ Volt



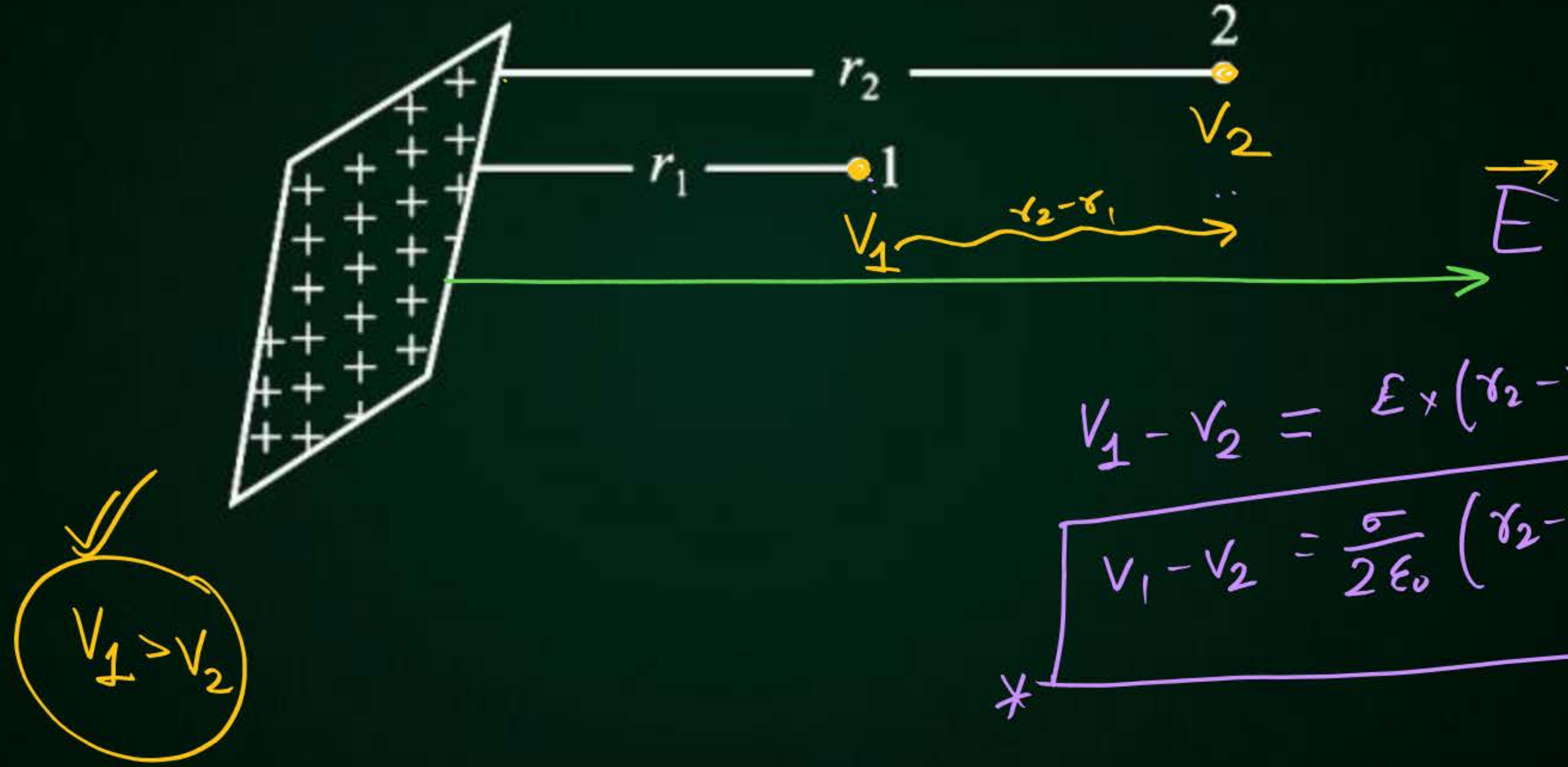
$V_A - V_B = ??$

$V_A - V_B = E \times 3$

Q

Electric potential difference between two point due to infinite thin charge sheet.

$E = \frac{\sigma}{2\varepsilon_0}$ (uniform)



$V_1 - V_2 = E \times (r_2 - r_1)$

$$V_1 - V_2 = \frac{\sigma}{2\varepsilon_0}(r_2 - r_1)$$

Potential Difference due to Variable Electric Field

$dV = -\vec{E} \cdot \vec{dr}$

$E = \text{Const}$

$\int dV = -E \int dr$

$\Delta V = -E \cdot \Delta r$

$E = \text{varible}$

$\int dV = -\int E \cdot dr$

Electric potential difference between two point [redacted] due to infinite line charge density λ

\# $$\int_{V_1}^{V_2} dV = -\int_{r_1}^{r_2} \vec{E}\cdot d\vec{r}$$

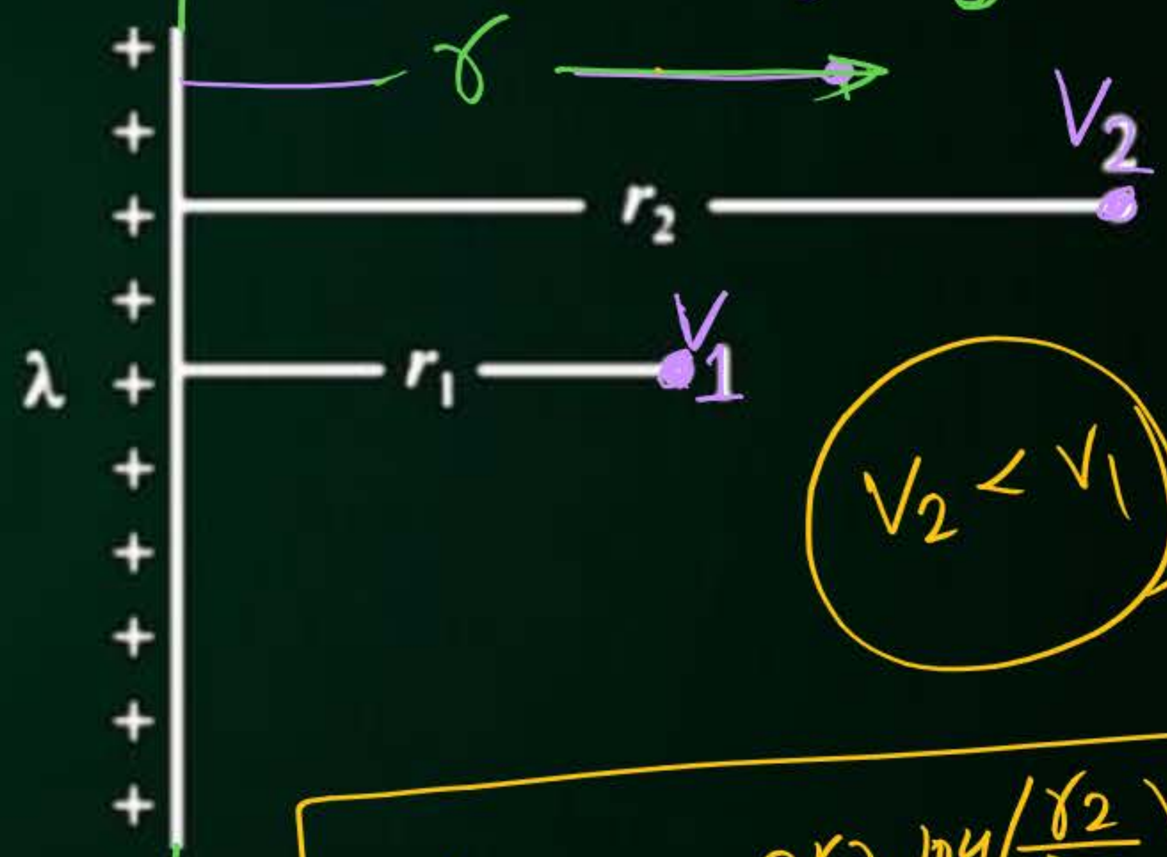
$$\left[V\right]_{V_1}^{V_2} = -\int_{r_1}^{r_2} \frac{2K\lambda}{r}\, dr$$

$$V_2 - V_1 = -2K\lambda \int \frac{1}{r}\, dr = -2K\lambda \left(\log r\right)_{r_1}^{r_2}$$

$$V_2 - V_1 = -2K\lambda\left(\log r_2 - \log r_1\right)$$

$$V_2 - V_1 = -2K\lambda \log\left(r_2/r_1\right)$$

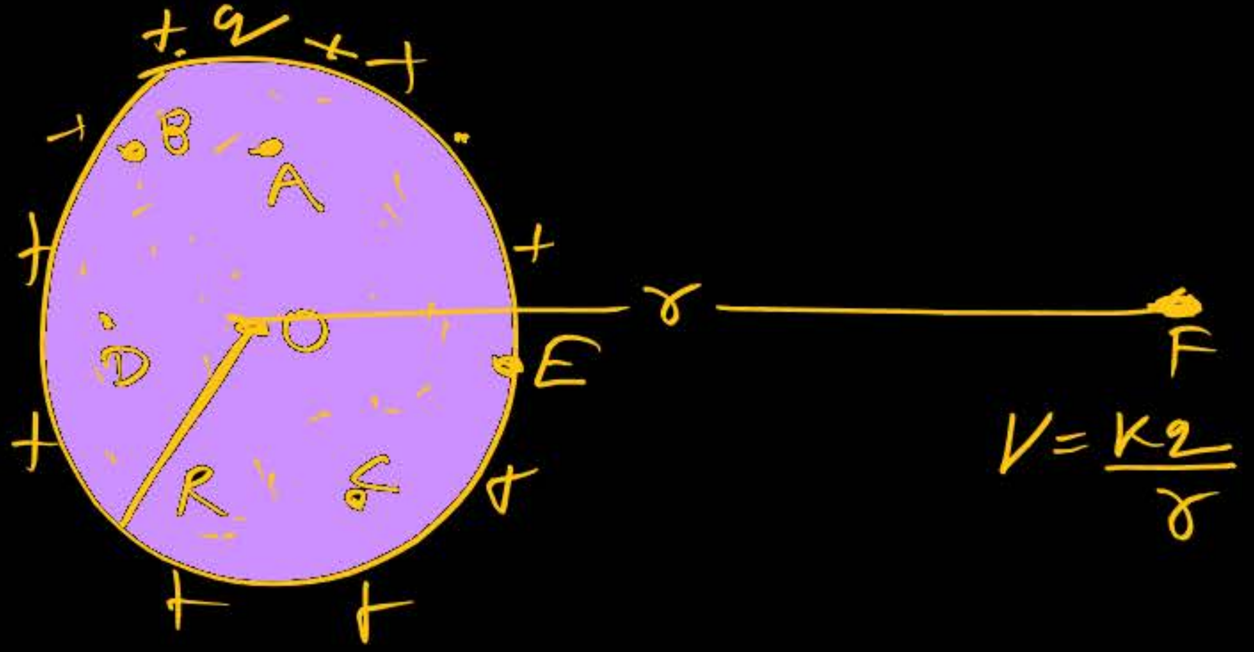
$E = \frac{2K\lambda}{r}$ (variable)



$V_2 < V_1$

$$V_2 - V_1 = -2K\lambda \log\left(\frac{r_2}{r_1}\right)$$

Potential due to Hollow sph



$V = \frac{Kq}{r}$

$$V_E = \frac{Kq}{R} = V_O = V_A = V_B = V_C = V_D$$

Electric Potential difference due to concentric cell.

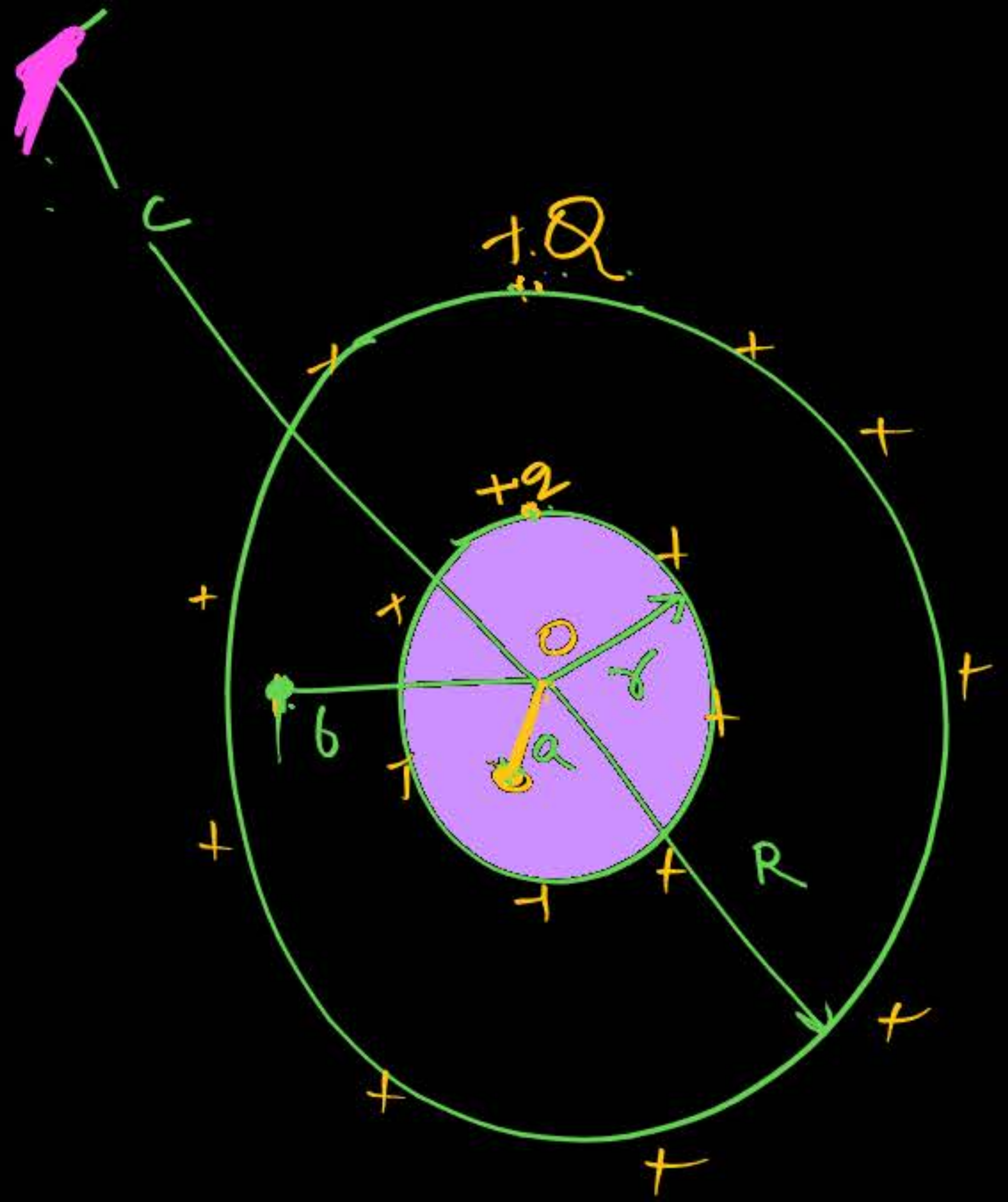
Inside = Surface

$$V_a = \frac{Kq}{r} + \frac{KQ}{R}$$

$$V_B = \frac{Kq}{b} + \frac{KQ}{R}$$

$$V_c = \frac{Kq}{c} + \frac{KQ}{c}$$

$$V_c = \frac{K}{c}(q+Q)$$



find Potential difference b/w surface of these two concentric sphere.

$$V_A = \frac{Kq}{r} + \frac{KQ}{R}$$

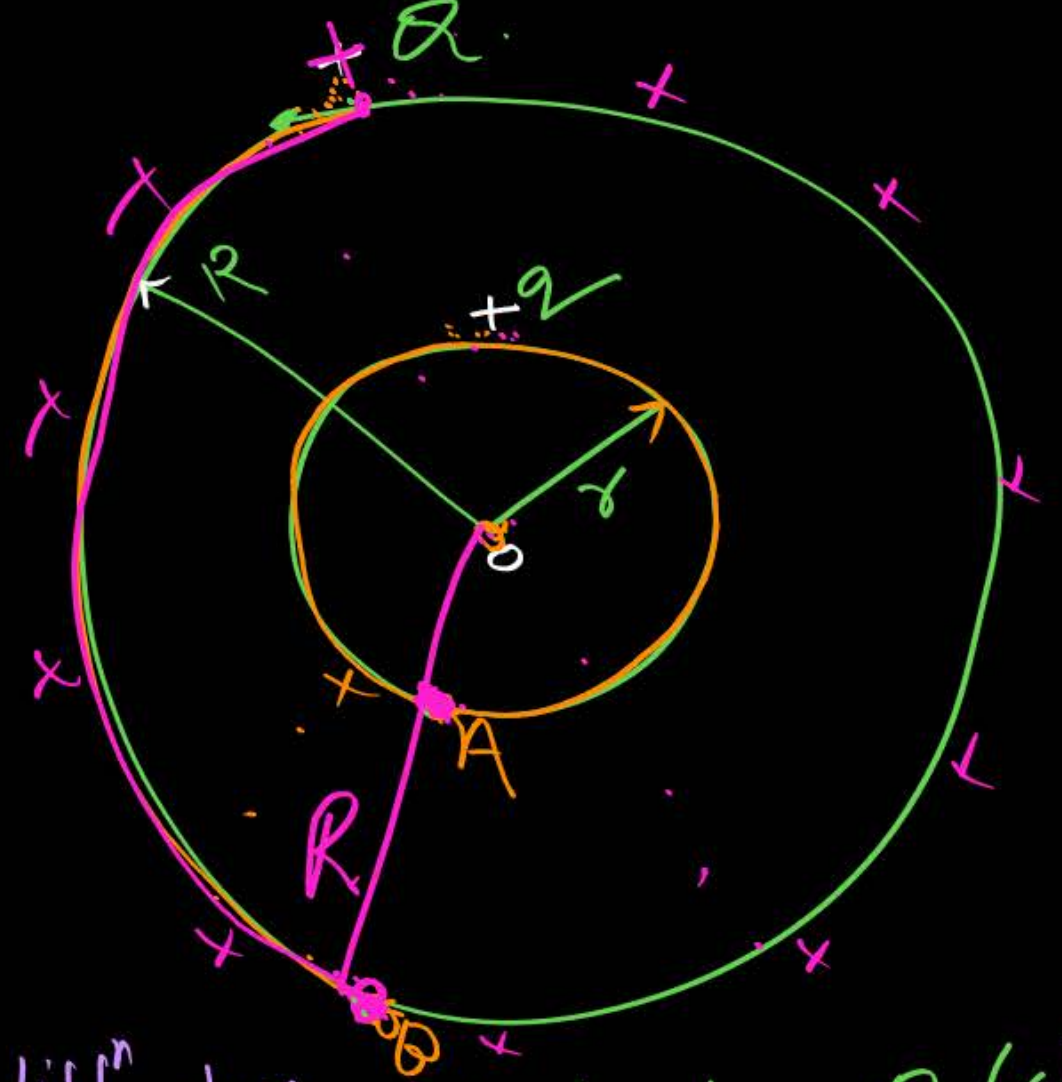
$$V_B = \frac{Kq}{R} + \frac{KQ}{R}$$

$$V_A - V_B = \frac{Kq}{r} + \frac{KQ}{R} - \frac{Kq}{R} - \frac{KQ}{R}$$

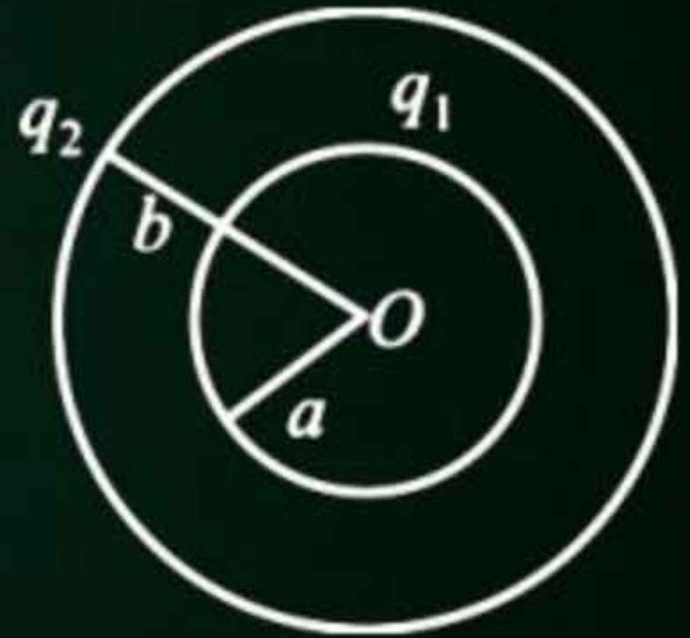
$$V_A - V_B = \frac{Kq}{r} - \frac{Kq}{R}$$

$$V_A - V_B = Kq\left[\frac{1}{r} - \frac{1}{R}\right]$$

Potential diffⁿ does not depends on Q (charge on outer sphere)



ELECTRIC POTENTIAL DUE TO GROUP OF CONCENTRIC SHELLS



- **When two conductor is connected with a wire then their potential must be same**

QUESTION

Two concentric conducting spheres of radii R and $2R$ are carrying charges Q and $-2Q$ respectively. If the charge on inner sphere is doubled, the potential difference between the two spheres will

1. Become two times
2. Become four times
3. Be halved
4. Remain same

$\Delta V \propto$ Charge of Inner sphere



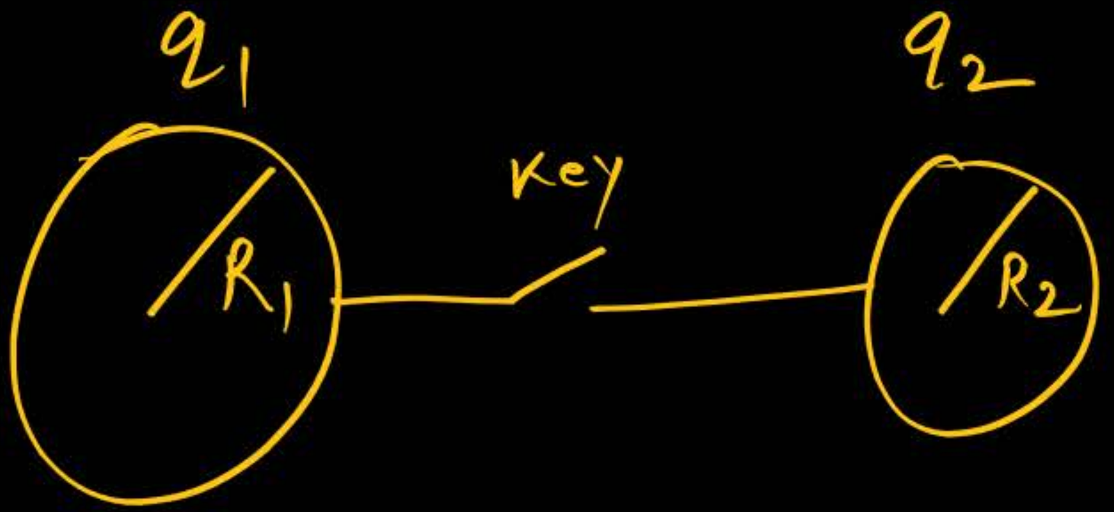
QUESTION

Two concentric conducting spheres of radii R and $2R$ are carrying charges Q and $-2Q$ respectively. If the charge on outer sphere is doubled, the potential difference between the two spheres will

1. Become two times
2. Become four times
3. Be halved
4. Remain same

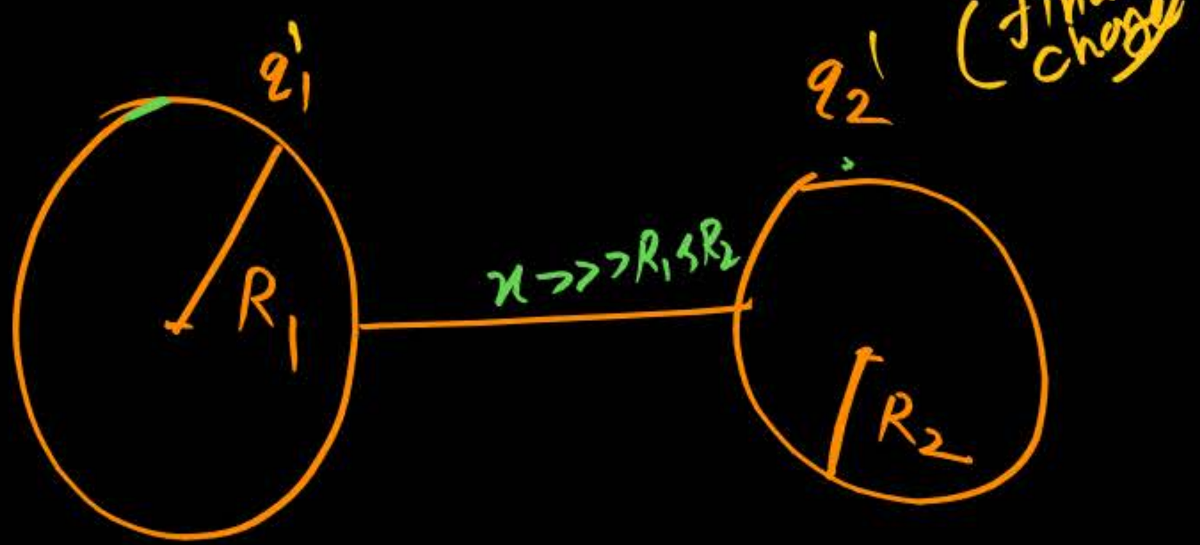


88%



* When we connect two sphere by wire then their potential becomes same.

When key is close



$$q_1 + q_2 = q_1' + q_2' \quad \text{(conservation of charge)} \quad -(1)$$

$$V_1 = \frac{kq_1'}{R_1} = \frac{kq_2'}{R_2} = \text{same.}$$

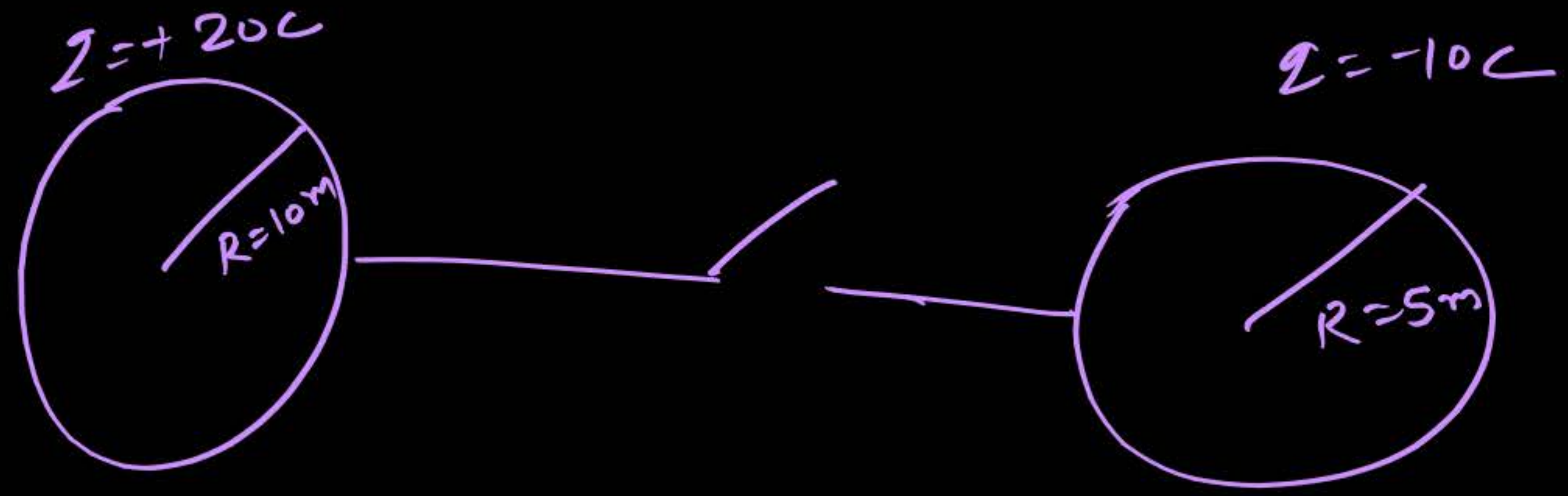
$$\frac{q_1'}{R_1} = \frac{q_2'}{R_2}$$

$$q_2' = \frac{q_1' R_2}{R_1}$$

Put the value of q_2' in eqn (1) & solve.

$$q_1' = \frac{R_1}{R_1 + R_2}(q_1 + q_2)$$

$$q_2' = \frac{R_2}{R_1 + R_2}(q_1 + q_2)$$

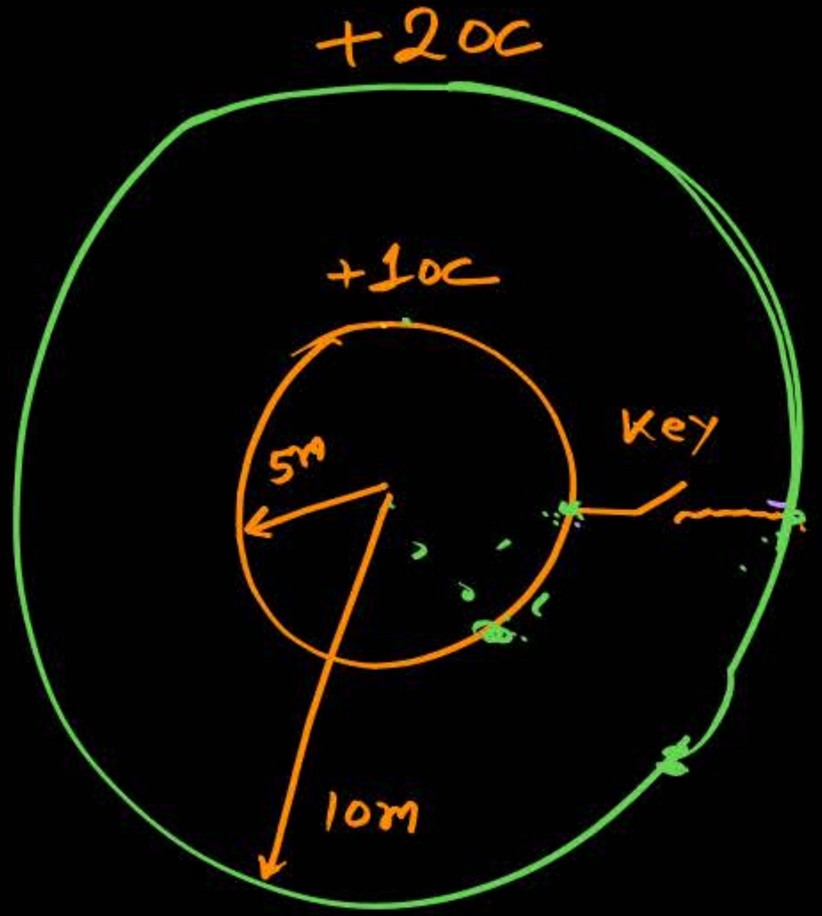


find final charge when key is closed.

final charge on 1st sphere →

$$q_1' = \frac{10}{10+5}(20-10) = \frac{2}{3} \times 10 = \frac{20}{3}$$

$$q_2' = \frac{10}{3}$$



Find final charge on Inner sphere when key is closed.

$\Delta V = 0 = Kq_{inn}\left(\frac{1}{r} - \frac{1}{R}\right)$

$\boxed{q_{inn} = 0}$

(a) $10/3$ c

(b) $\frac{20}{3}$

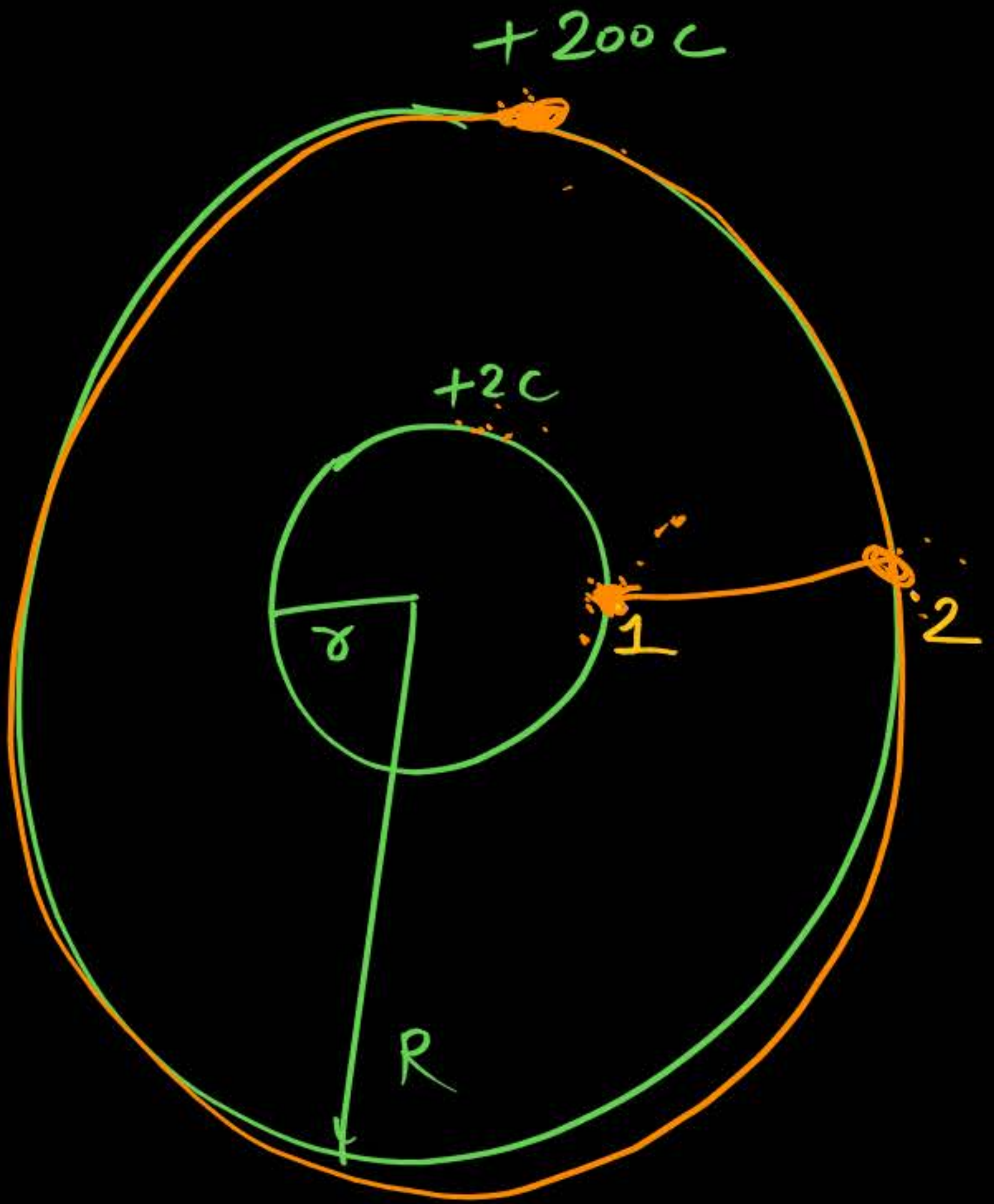
(c) 30

(d) zero (64%) ✓

all charge from Inner flow to outer sphere

$q_{final\ on\ Inner} = 0$

$q_{final\ on\ outer\ sph} = 30c$.



Which of followig is correct for given fig.

(a) $V_1 = V_2$ ✗

(b) $V_1 > V_2$ (53%) ✓

(c) $V_1 < V_2$ ✗

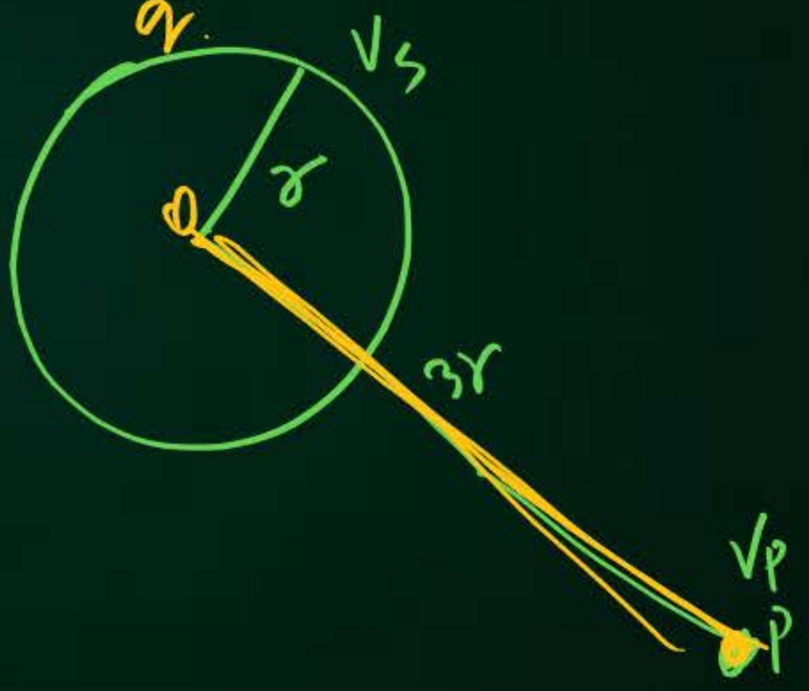
(d) none of these

$\Delta V \propto q_{inner}$

QUESTION

A hollow charged metal sphere has radius r. If the potential difference between its surface and a point at a distance $3r$ from the centre is V, then the electric field intensity at distance $3r$ from the centre is

1. $\frac{V}{3r}$
2. $\frac{V}{4r}$
3. $\frac{V}{6r}$ ✓ Ans
4. $\frac{V}{2r}$



$V_s - V_p = \frac{Kq}{r} - \frac{Kq}{3r} = V$

$\frac{3Kq - Kq}{3r} = V$

$\frac{2Kq}{3r} = V$

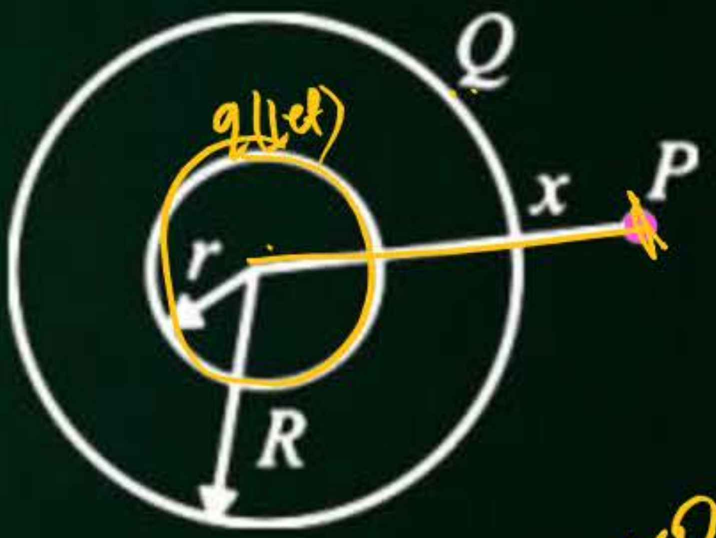
$E_p = \frac{Kq}{9r^2} = \frac{Kq}{3 \times 3r \times r}$

$= \frac{V}{2 \times 3r}$

QUESTION

Two concentric hollow conducting spheres of radius r and R are shown. The charge on outer shell is Q. What charge should be given to inner sphere so that the potential at any point P outside the outer sphere is zero?

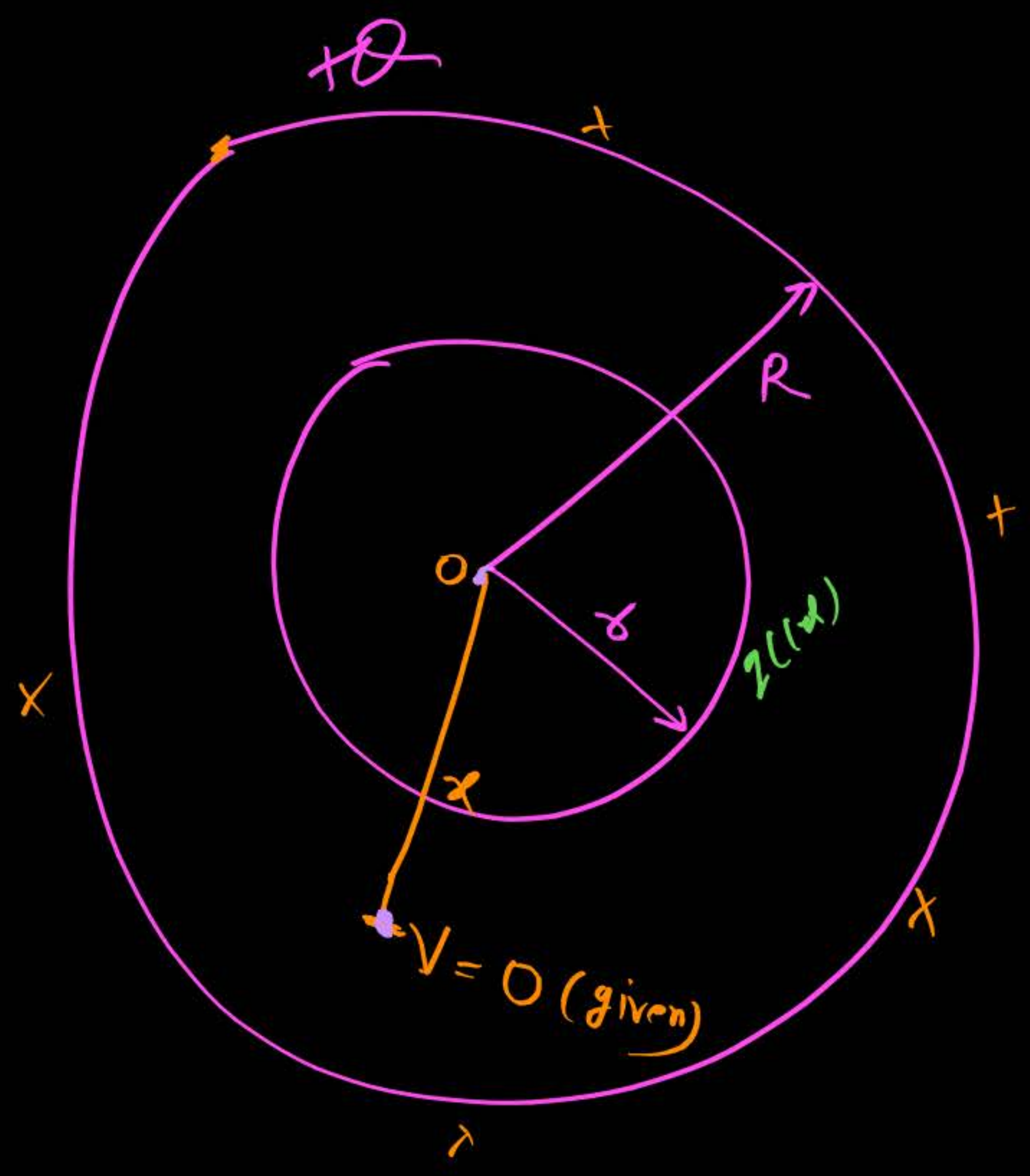
1. $-\frac{Qr}{R}$
2. $-\frac{QR}{r}$
3. $-Q$ ✓
4. $-\frac{2QR}{r}$



$V_P = \frac{KQ}{x} + \frac{Kq}{x} = 0$

$\frac{Kq}{x} = -\frac{KQ}{x}$

$q = -Q$



find charge on Inner sphere, if potential at x will be zero.

$$V_x = \frac{Kq}{x} + \frac{KQ}{R} = 0$$

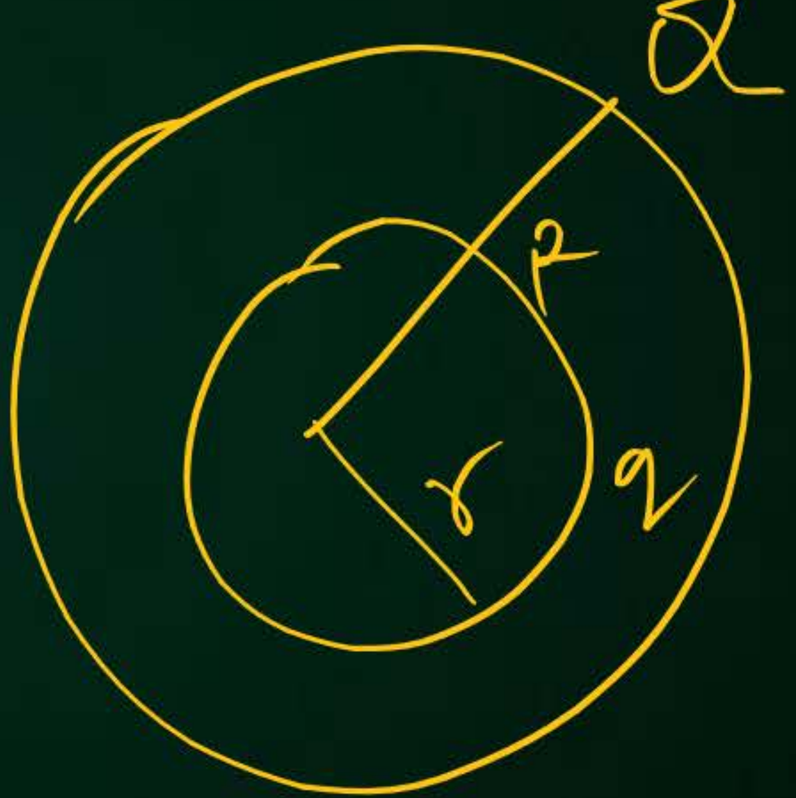
$$\frac{Kq}{x} = -\frac{KQ}{R}$$

$$\boxed{q = -\frac{Qx}{R}}$$

Ans

QUESTION

A spherical conductor having charge q and radius r is placed at the centre of a spherical shell of radius R and having charge Q ($R > r$). The potential difference between the two is



1. Proportional to Q
2. Proportional to q
3. Dependent on both Q and q
4. Independent of both Q and q

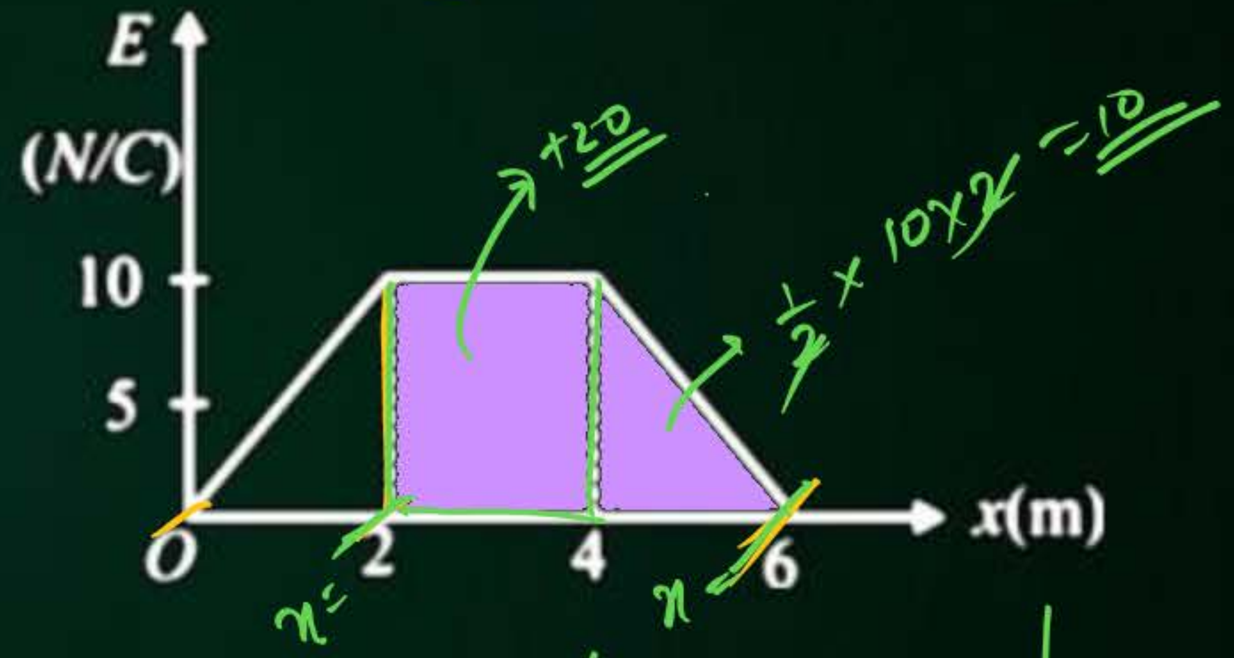
QUESTION

Figure shows the variation of electric field intensity E versus distance x. What is the potential difference between the points at $x = 2$ m and at $x = 6$ m from 0?

initial final

1. 30 V ✓
2. 60 V
3. 40 V
4. 80 V

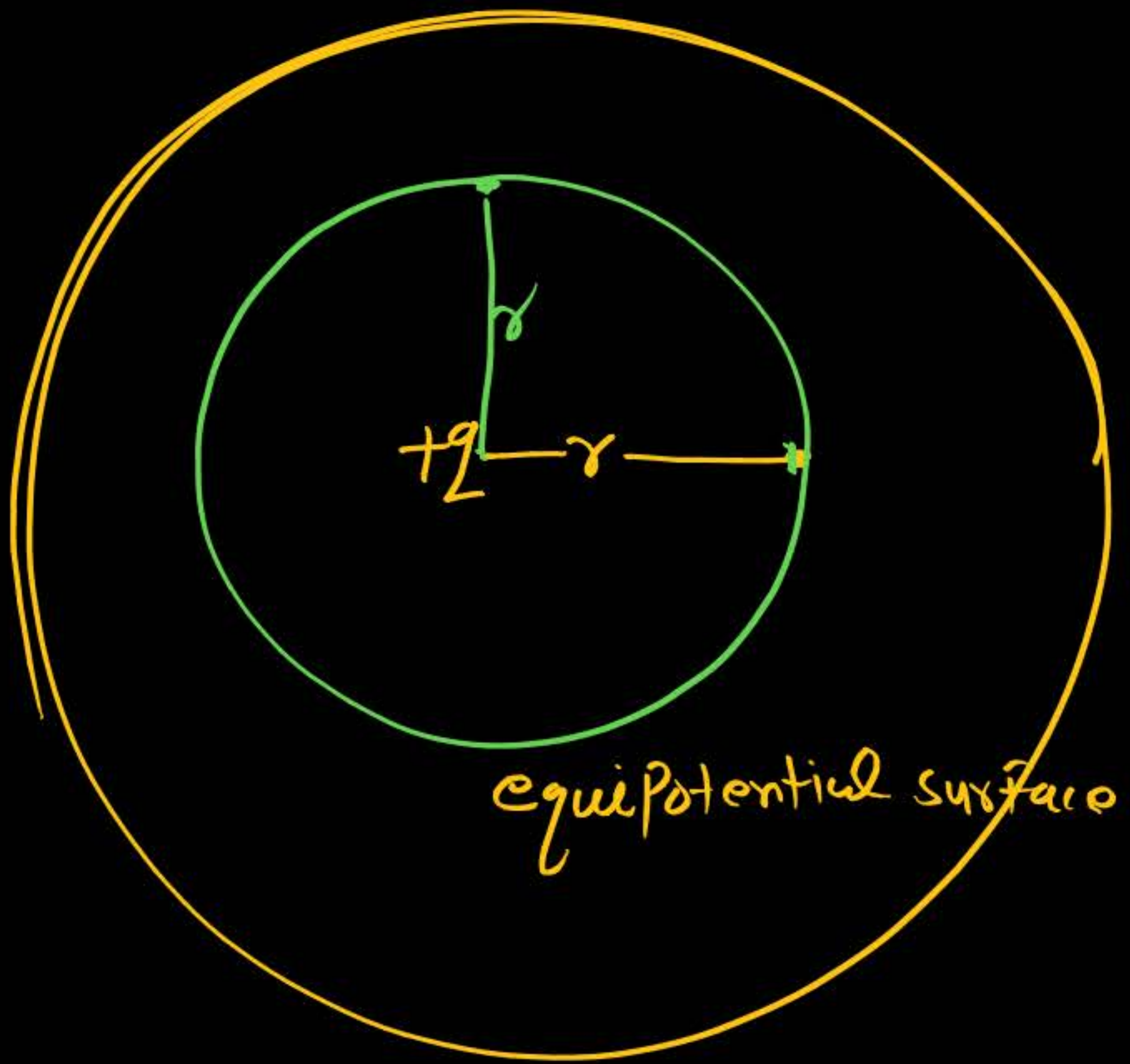
Area of E & x graph is $-\Delta V$

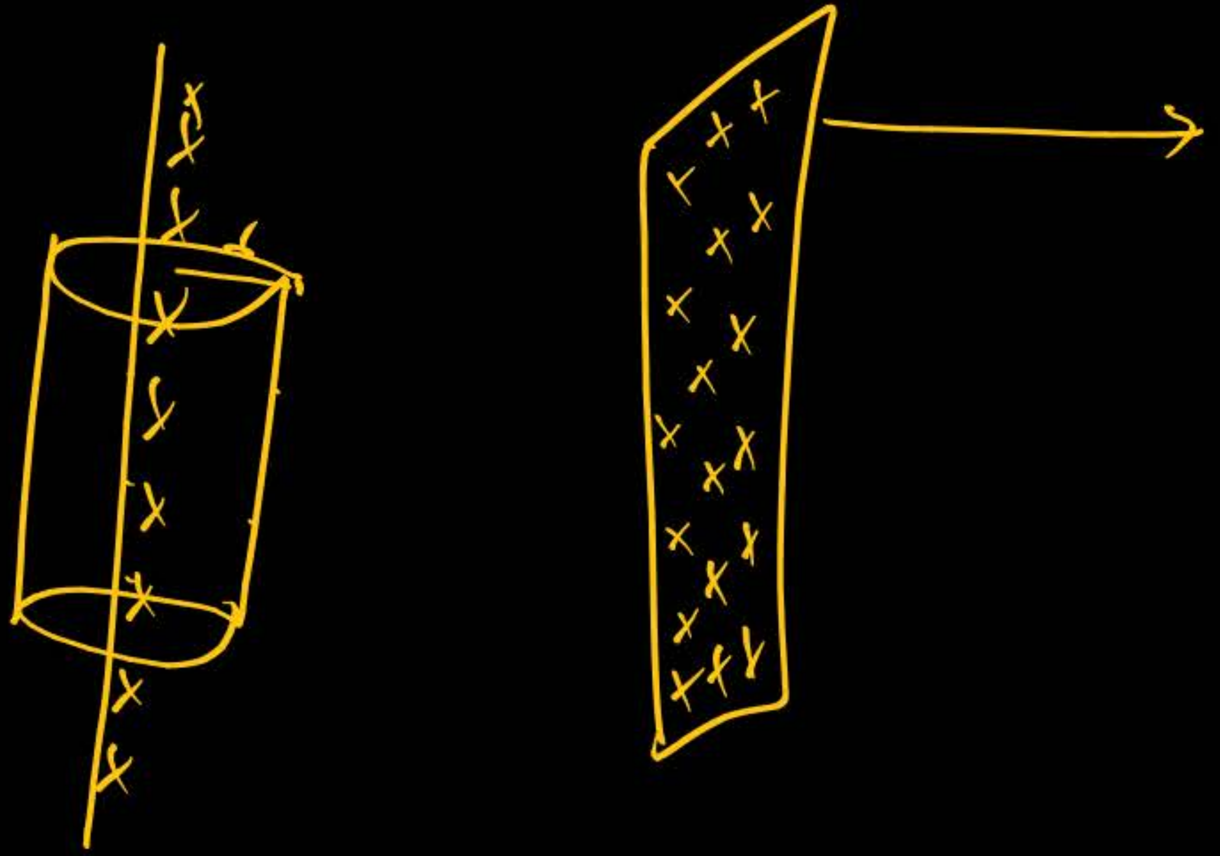


Area = 30

equipotential surface →

Space [surface] have same potential at all the point is called equipotential surface





QUESTION

An infinite conducting sheet has surface charge density σ. The distance between two equipotential surfaces is *r*. The potential difference between these two surfaces is

1. $\frac{\sigma r}{2\varepsilon_0}$
2. $\frac{\sigma r}{\varepsilon_0}$
3. $\frac{\sigma}{\varepsilon_0 r}$
4. $\frac{\sigma}{2\varepsilon_0 r}$


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 04 | **Physics**

Electrostatic Potential and Capacitance

By- Dr. Manish Raj (MR SIR)



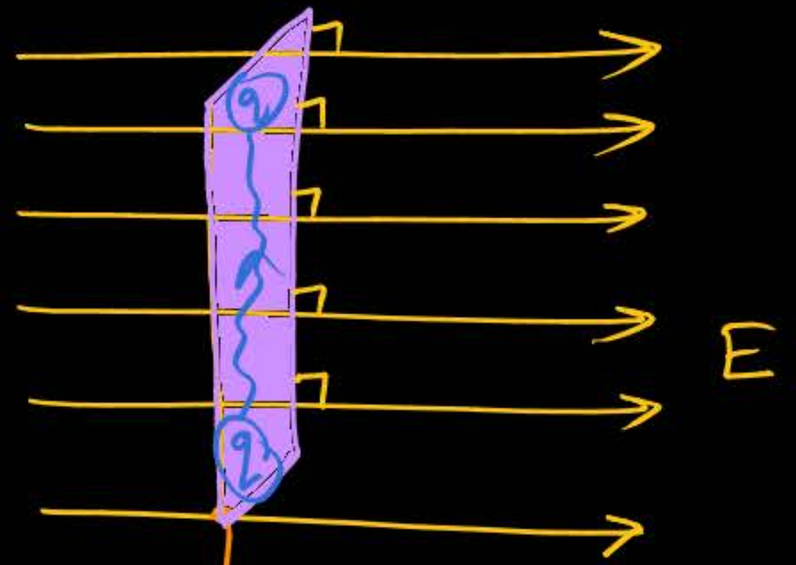
Topics to be covered

1 # # equipotential surface

2 # Potential enegy

3 # questions on work done in electrostatic



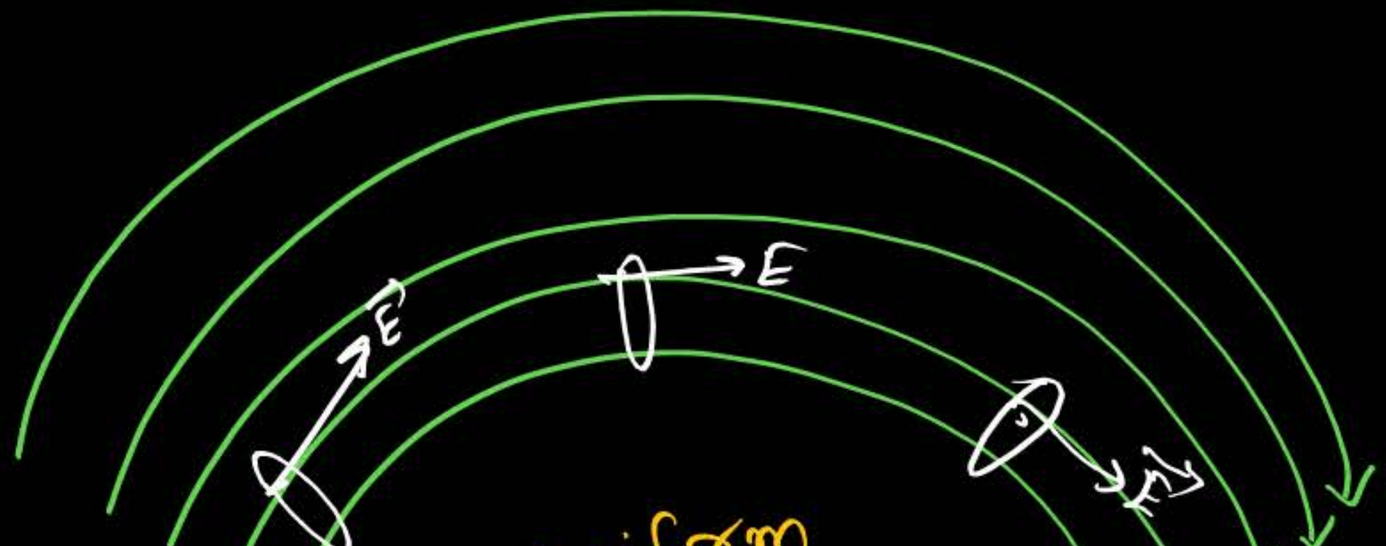


Uniform electric field.

→ equipotential surface (planer)

$\vec{E}_{along\ surface} = 0$

$\vec{E}_{\perp r\ surface} \neq 0$



Non-uniform electric field

Work done in moving charge on equipotential surface = 0

EQUIPOTENTIAL SURFACE

An equipotential surface is a surface with a constant potential at all points of surface.

Electric field is perpendicular to its surface.

Along equipotential surface electric field must be zero.

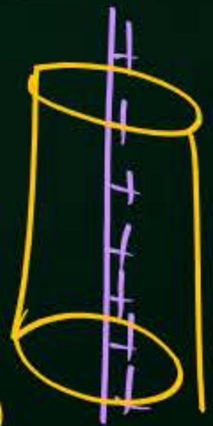
Work done in moving any charge on that surface is zero.

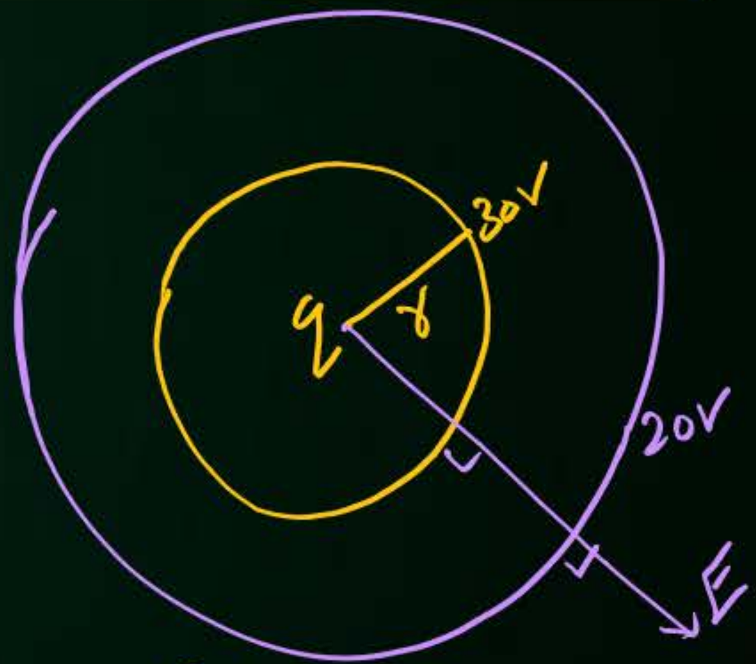
For point charge equipotential surface is spherical .

For line charge → cylindrical

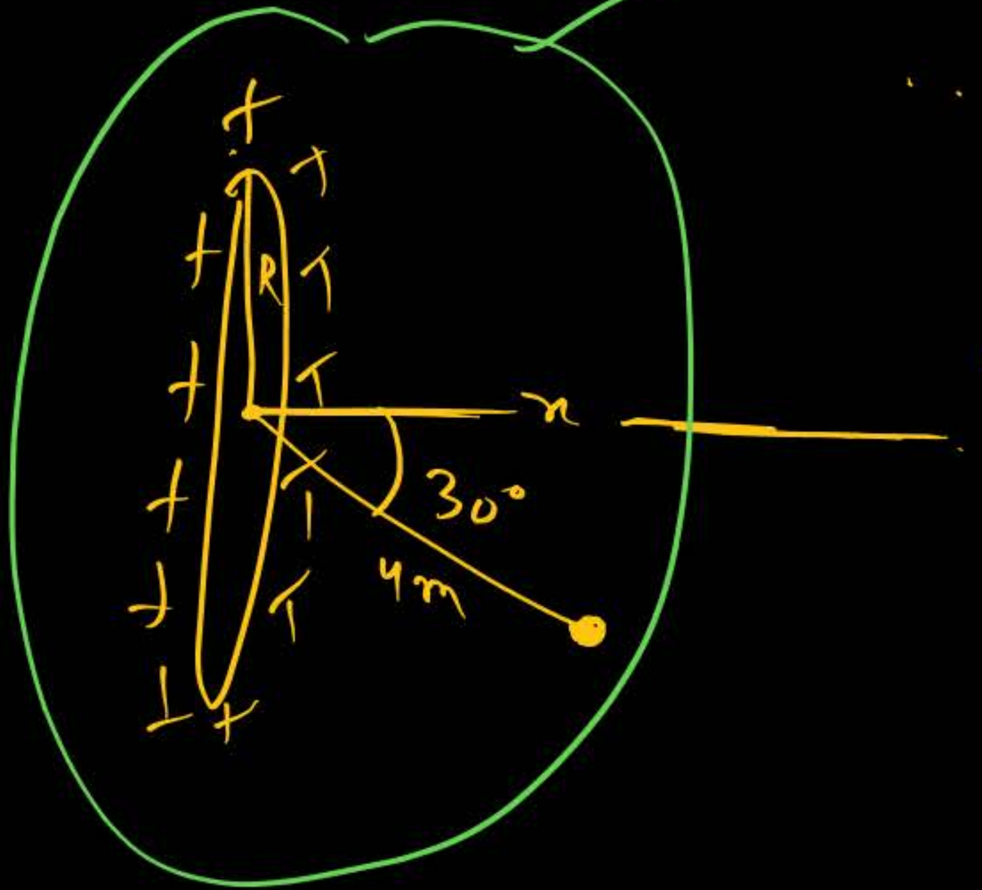
For charge sheet → sheet

Nature of equipotential surface at large dist^n from some collection of charge is sphere.



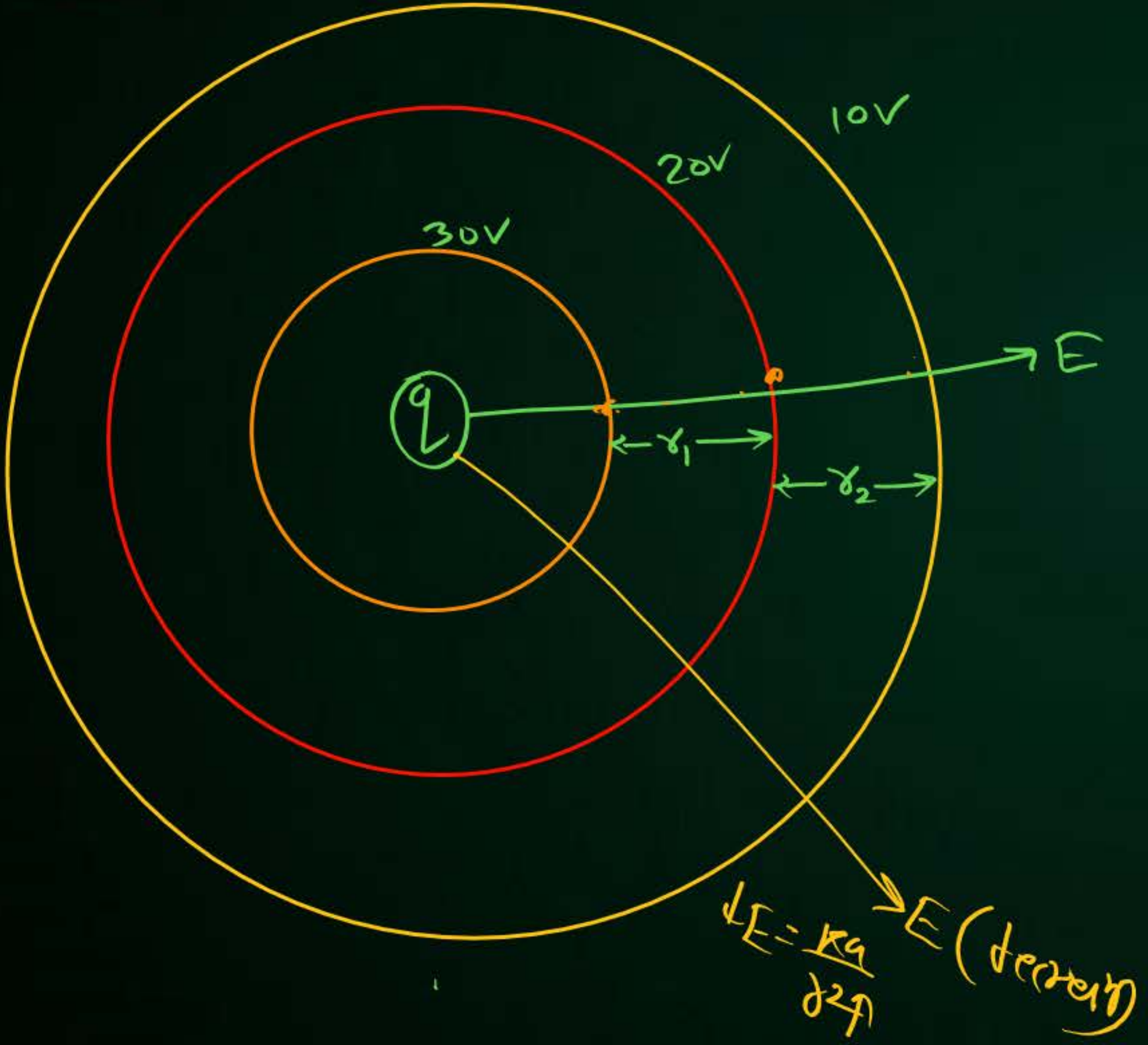


Spherical equipotential surface



Ring behave as Point charge at large distⁿ → equipotential surface is spherical

EQUIPOTENTIAL SURFACE



hint

$$\vec{E} = -\left[\frac{\Delta V}{\Delta r}\right]$$

$$|\vec{E}| = \frac{(\Delta V)}{(\Delta r)}$$

decreas ($|\vec{E}|$) ; ΔV → same ; Δr ↑ Increase

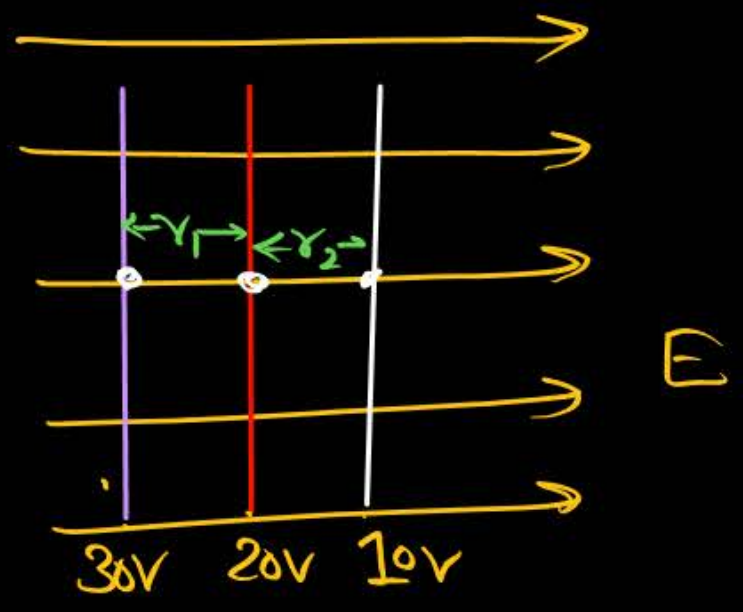
which of the following is correct.

(a) $r_1 = r_2$ 43% ←

(b) $r_1 > r_2$ 25% ←

✓(c) $r_1 < r_2$ (23%) only

(d) can't say.



$\Rightarrow r_1 = r_2$

Ans

$|\vec{E}| = \frac{(\Delta V)}{\Delta r}$

(ΔV) → Same (B/w two surfaces)

Uniform Same

Same hi ho Jayga

QUESTION

An infinite conducting sheet has surface charge density σ. The distance between two equipotential surfaces is r. The potential difference between these two surfaces is

1. $\frac{\sigma r}{2\varepsilon_0}$ ✗
2. $\frac{\sigma r}{\varepsilon_0}$ ✓
3. $\frac{\sigma}{\varepsilon_0 r}$
4. $\frac{\sigma}{2\varepsilon_0 r}$

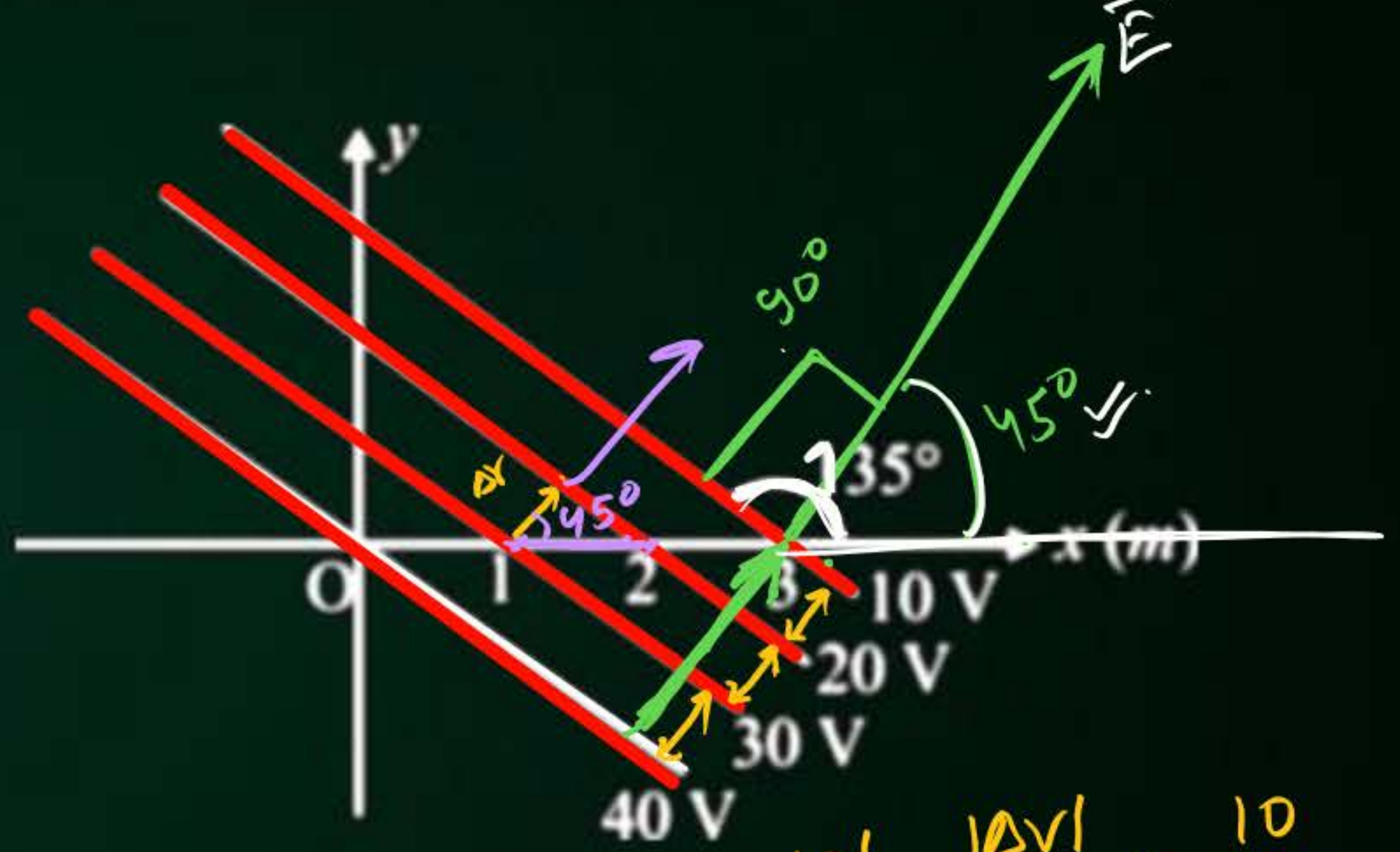
$$E = \frac{\Delta V}{\Delta r}$$

$$\frac{\sigma}{\varepsilon_0} = \frac{(\Delta V)}{r}$$

$$\Delta V = \frac{\sigma}{\varepsilon_0} r$$

QUESTION

Figure shows a set of equipotential surfaces. The magnitude and direction of electric field that exists in the region is



1. $10\sqrt{2}$ V/m at 45° with x-axis
2. $10\sqrt{2}$ V/m at −45° with x-axis
3. $10\sqrt{2}$ V/m at 45° with x-axis
4. $10\sqrt{2}$ V/m at −45° with x-axis



$W_{ext} = \Delta U$

$W_{ext} = q\,\Delta V = q[V_f - V_i]$

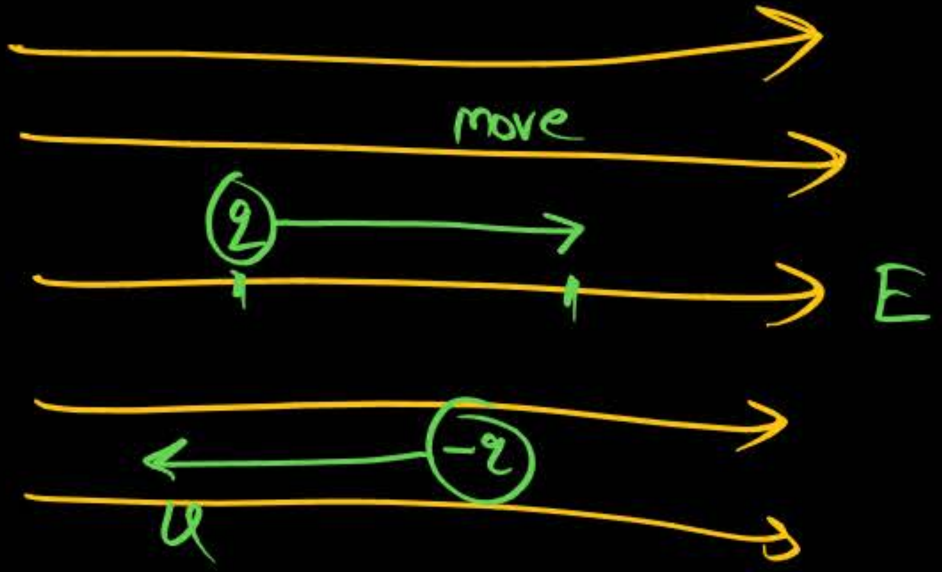
↑ ghuma rahe ho

$W_{elect\,fie} = -\Delta U$

$= -q[V_f - V_i]$

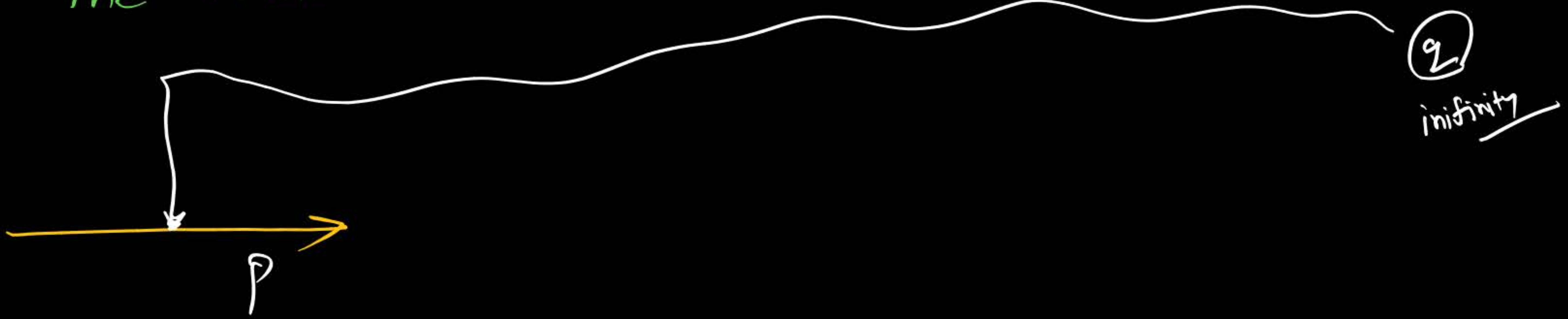
→ work done does not depends on path.

q is relsed in electric field.



$\Delta U_{loss} = \Delta K.E_{gain}$

Q find work done to move q charge from infinity to the centre of dipole.



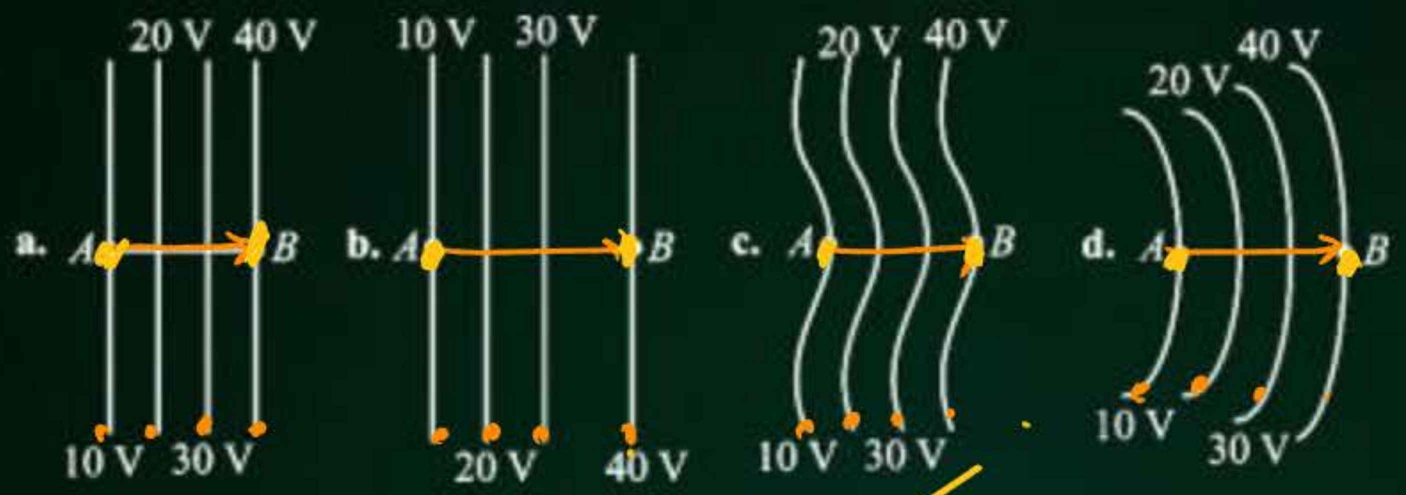
Work = 0 = $q\Delta V = \Delta U$

$= q[V_f - V_i]$

$= q[0-0] = q \times 0 = 0$

QUESTION

The diagrams below show regions of equipotential.



A positive charge is moved from A to B in each diagram.

[NEET-2017]

1. Maximum work is required to move q in figure (c).
2. In all the four cases the work done is the same.

$w = q\Delta V = \text{same}$ 84%

3. Minimum work is required to move q in figure (a).
4. Maximum work is required to move q in figure (b).

POTENTIAL ENERGY OF A SYSTEM OF CHARGES

Potential energy is defined for pairs of charges.

(i) Potential energy of two points charge.

$+Q$ ———— r ———— $+q$

$U = qV$

$= q\dfrac{KQ}{r}$

$$U = \frac{KQq}{r}$$

This energy is stored in the pair of charges $+Q$ & q.

$$U = \frac{K q_1 q_2}{r}$$

put q_1 & q_2 with proper sign



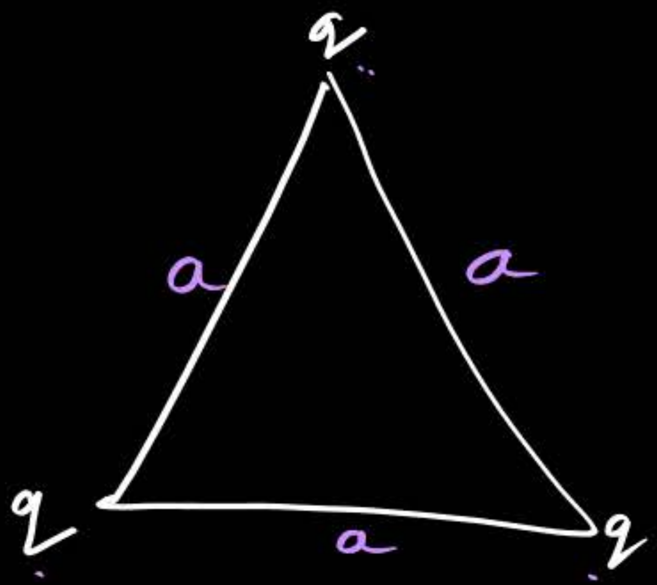
$$U = \frac{Kq^2}{a} + \frac{Kq^2}{a} + \frac{Kq^2}{2a}$$

$$U = \frac{5Kq^2}{2a}$$

total no. of terms of Potential energy

$$= \frac{N(N-1)}{2}$$

N = No of charge particle

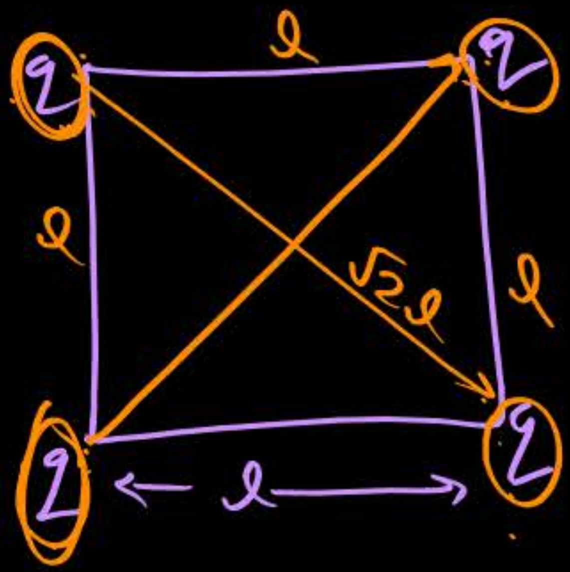


$U = \frac{3Kq^2}{a}$

#



$$U = -\frac{Kq^2}{a}$$



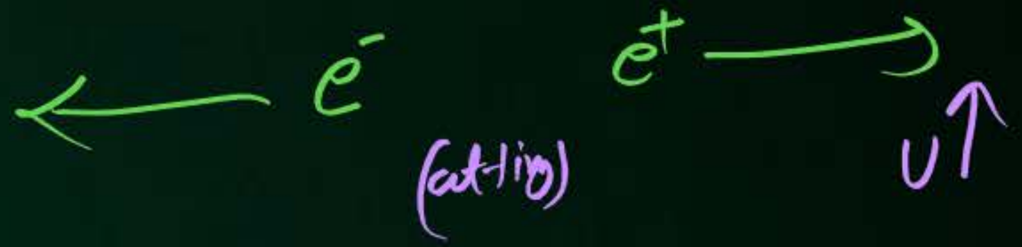
$$U = 4\frac{Kq^2}{l} + \frac{2Kq^2}{\sqrt{2}\,l}$$

Two proton is moving towards each other then potential energy of system

(Incresing)

One proton and e^- moving away then potential energy of system.

(Incresing)



QUESTION

Two electron is moving towards each other then potential energy of the system.

$e^- \rightarrow \leftarrow e^-$

Increase

Total number of terms of potential energy

For n-charge $= \dfrac{N\,(N-1)}{2}$

QUESTION

Three charges $-q$, Q and $-q$ are placed respectively at equal distances on a straight line. If the potential energy of the system of three charges is zero, then what is the ratio of $Q : q$?

1. $1 : 1$
2. $1 : 2$
3. $1 : 3$
4. $1 : 4$



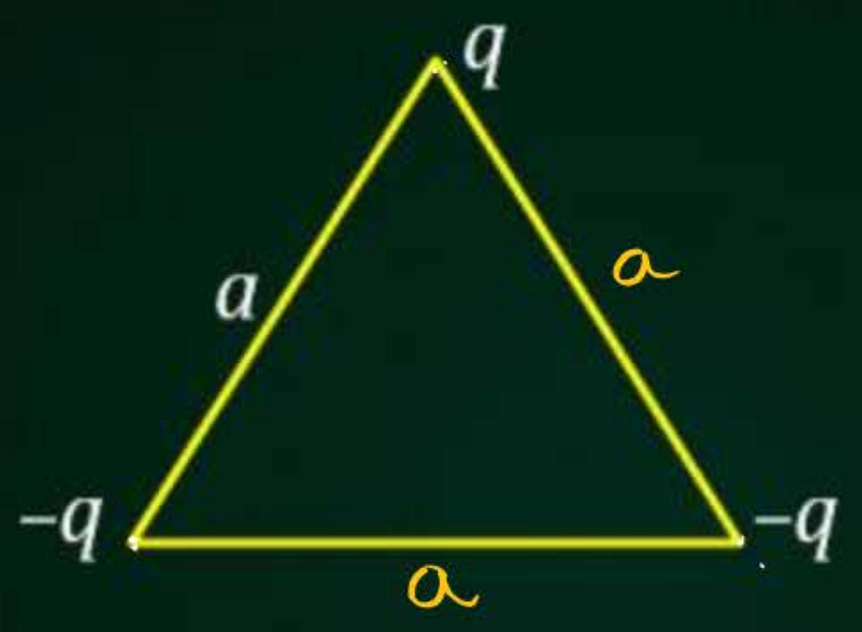
$$U = \frac{-KqQ}{a} + \frac{-KQq}{a} + \frac{Kq^2}{2a} = 0$$

$$\frac{Kq^2}{2a} = \frac{2KqQ}{a}$$

$$\frac{1}{4} = \frac{Q}{q}$$

QUESTION

Find

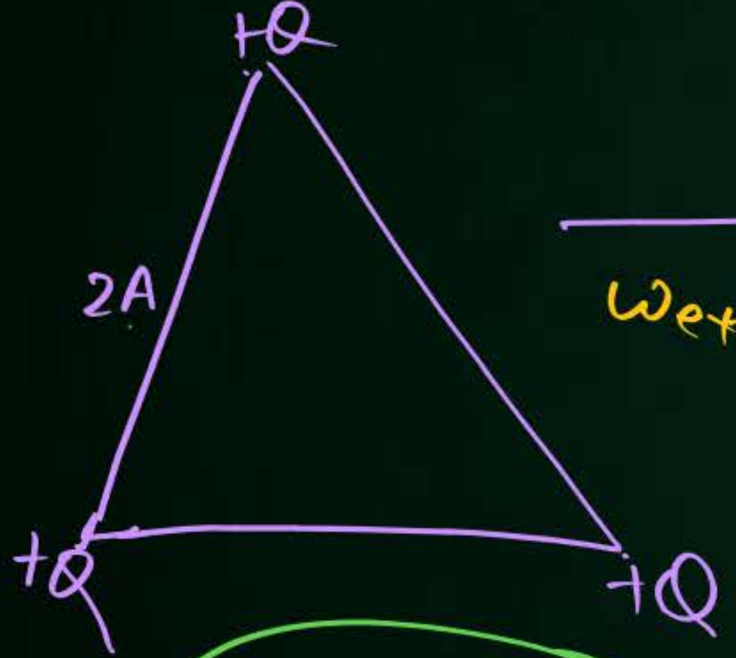


$$U = \frac{-Kq^2}{a} + \frac{Kq^2}{a} - \frac{Kq^2}{a}$$

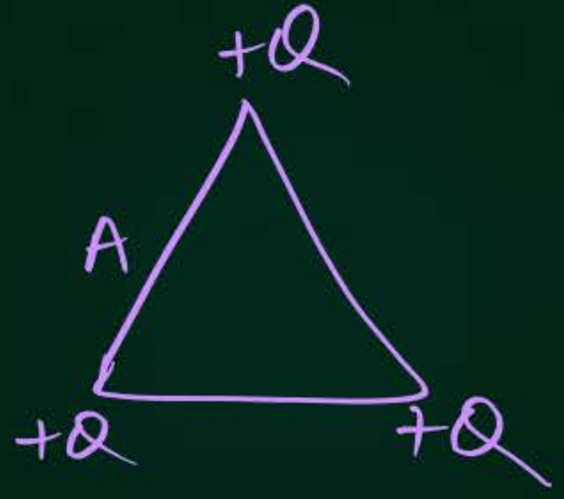
$$U = \frac{-Kq^2}{a}$$

QUESTION

Three equal charge Q are at the vertices of an equilateral triangle of side 2A, then how much work done is required in bringing them closer to an equilateral triangle of side 'A'.



$W_{ext} = U_f - U_i$



W_{ext}

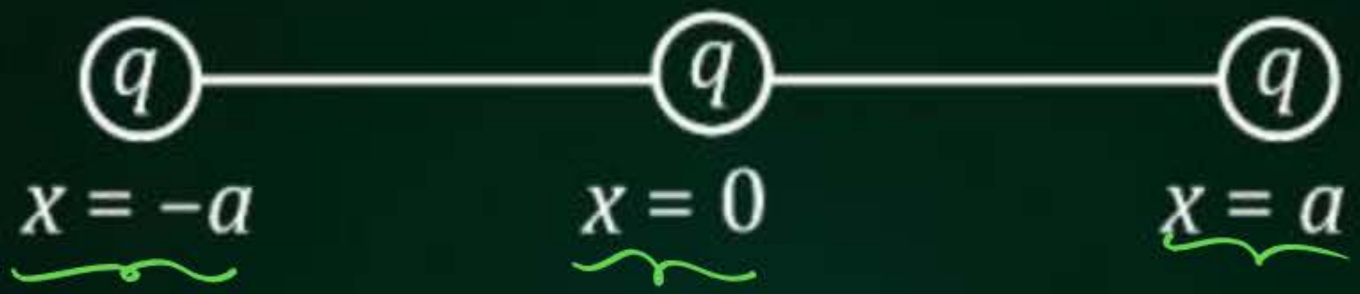
$U_i = \frac{3KQ^2}{2A}$

$U_f = \frac{3KQ^2}{A}$

$W = \frac{3KQ^2}{A} - \frac{3KQ^2}{2A} = \left[\frac{3KQ^2}{2A}\right]$ Ans

QUESTION

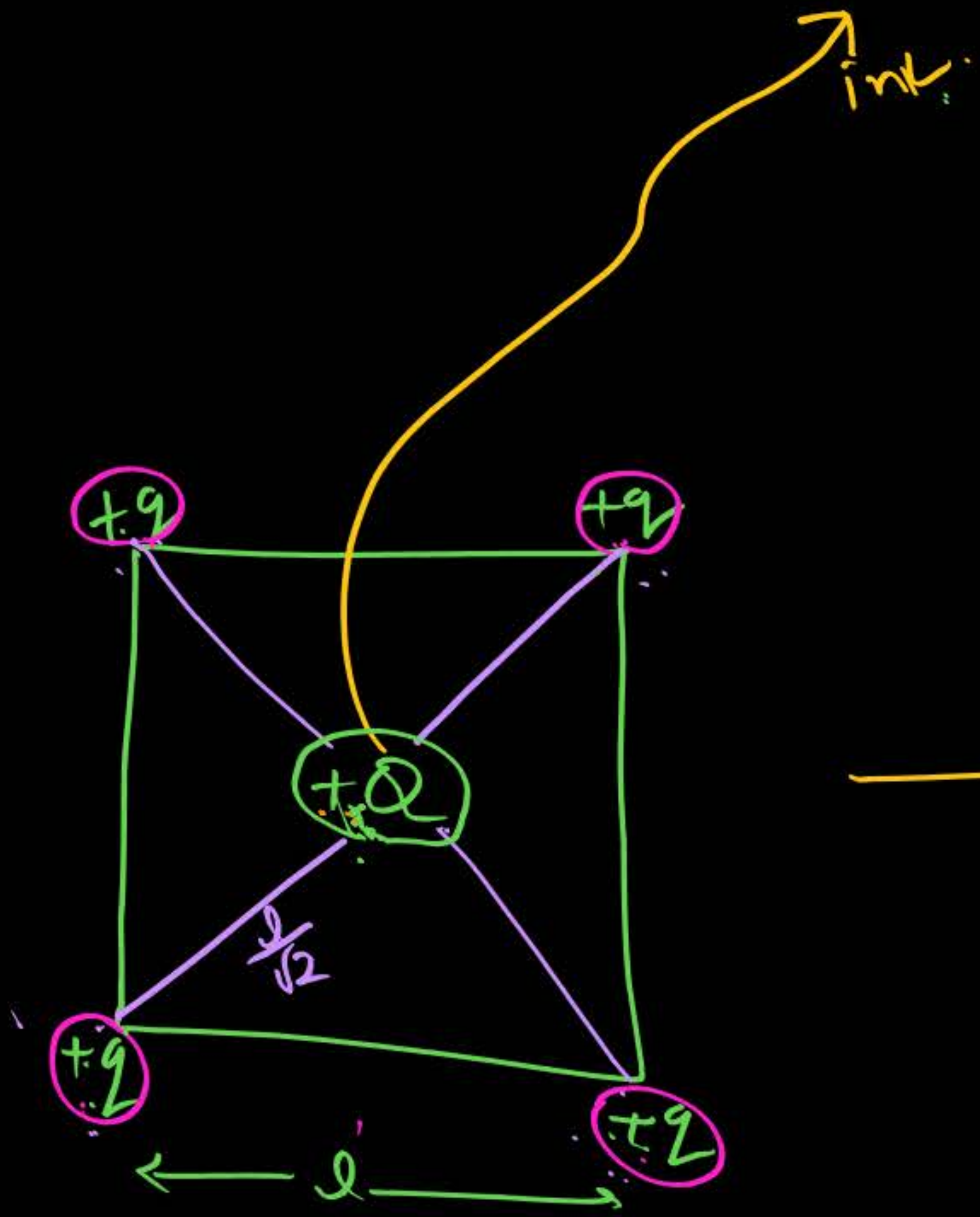
Three charges are placed along x-axis at $x = -a$, $x = 0$ and $x = a$ as shown. Calculate the potential energy of the system.



QUESTION

Calculate the work required to be done to make an arrangement of three particles each having a charge $+q$ such that the particles lie at the vertices of an equilateral triangle of side a. What work will be done by electric field when the particles are shifted away so that the side of triangle becomes $2a$?

done

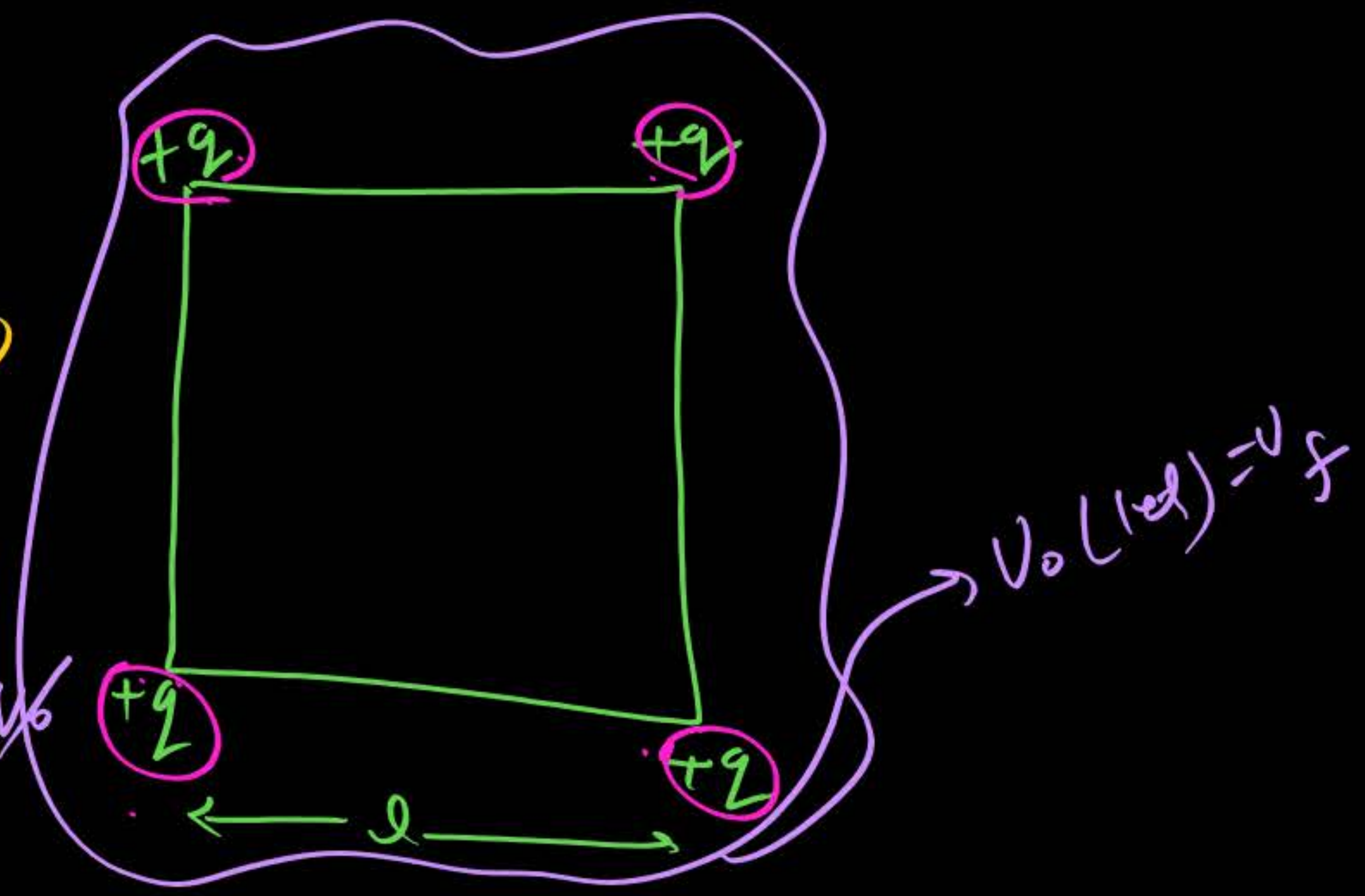


$(W_{ext})_{ele} = -\Delta U$

$= U_i - U_f$

$= U_0 + \frac{4kqQ}{l/\sqrt{2}} - U_0$

$= \frac{4kqQ\sqrt{2}}{l}$ Ans.



$U_i = U_0 + \frac{4kqQ}{l/\sqrt{2}}$

Find work done by electric field to shift charge +Q from centre of square to infinity.

2nd method.

$W_{ext} = -Q[\Delta V] = -Q[V_f - V_i] = Q[V_i - V_f^{\,0}] = QV_i$

QUESTION

A point charge q is surrounded by eight identical charges at distance r as shown in figure. How much work is done by the forces of electrostatic repulsion when the point charge at the centre is removed to infinity?

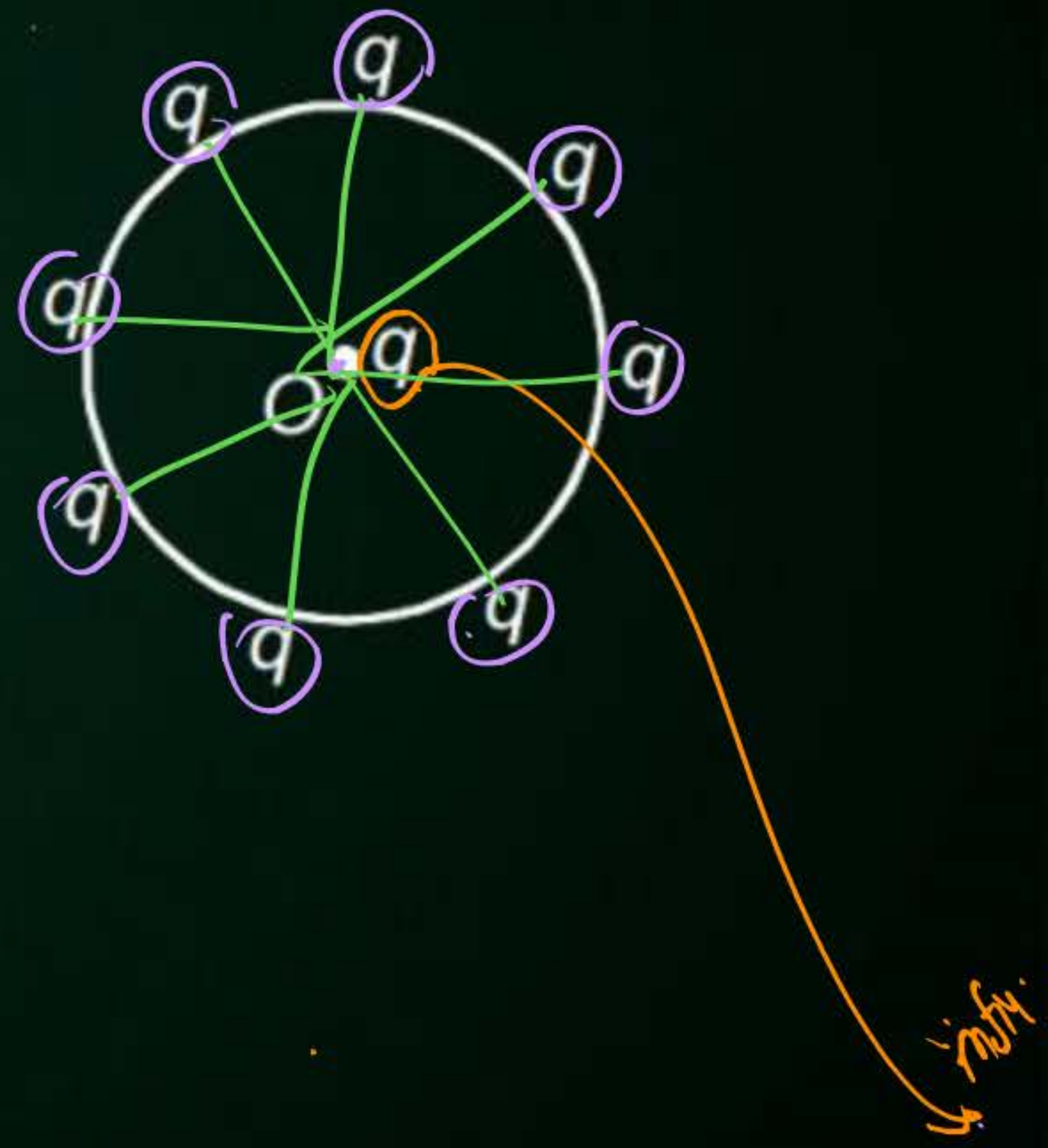
1. Zero
2. $\frac{8q^2}{4\pi\varepsilon_0 r}$ ✓
3. $\frac{8q}{4\pi\varepsilon_0 r}$
4. $\frac{64q^2}{4\pi\varepsilon_0 r}$

$$W_{\text{electric field}} = -q[\Delta V]$$

$$= q[V_i - V_f]$$

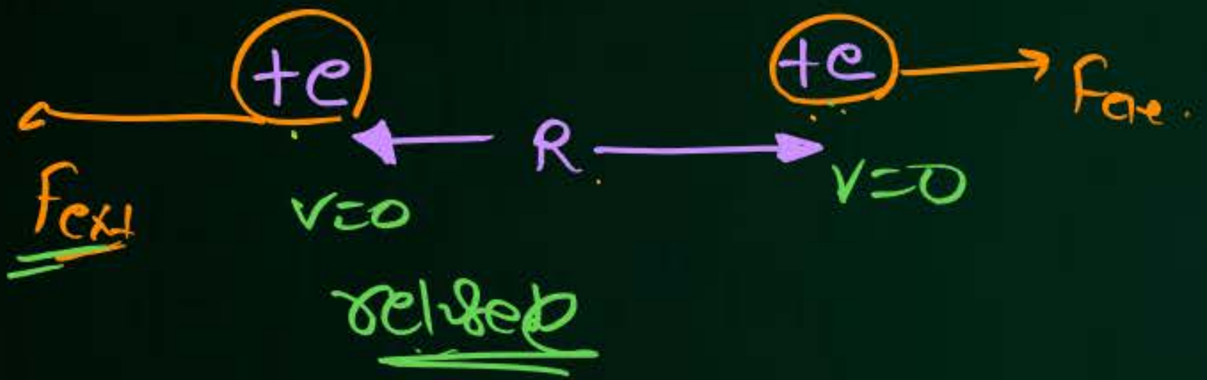
$$= q\left[\frac{8kq}{r} - 0\right]$$

$$= \frac{8kq^2}{r}$$



QUESTION

Two protons are separated by a distance R. What will be the speed of each proton when they reach! infinity under their mutual repulsion?



C.O.M.E = Conservation of mechanical energy

$$[K.E+U]_i = [K.E+U]_{final}$$

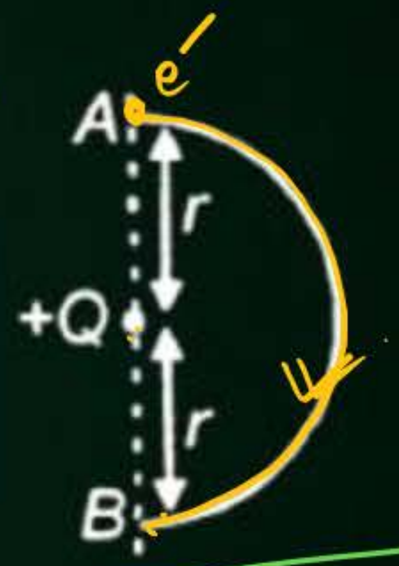
$$0 + \frac{K e \times e}{R} = \frac{1}{2} m v^2 \times 2 + 0$$

Potential energy at infinity

$$V = \sqrt{\frac{Ke^2}{mR}}$$

QUESTION

The work done in slowly moving an electron of charge e and mass m from A to B along a semicircular path (as shown in the figure) in vertical plane in the field of charge Q is



1. $-2\,mgr$
2. $-Qe/r$
3. $2\,mgr + \dfrac{2Qe}{r}$
4. zero

$W = q\,\Delta V$

$= -e\,[V_f - V_i]$

$W_{ext} = \Delta U = -2mgr$

Work energy th.

$W_g + W_{ele} + W_{ext} = \Delta KE = 0$

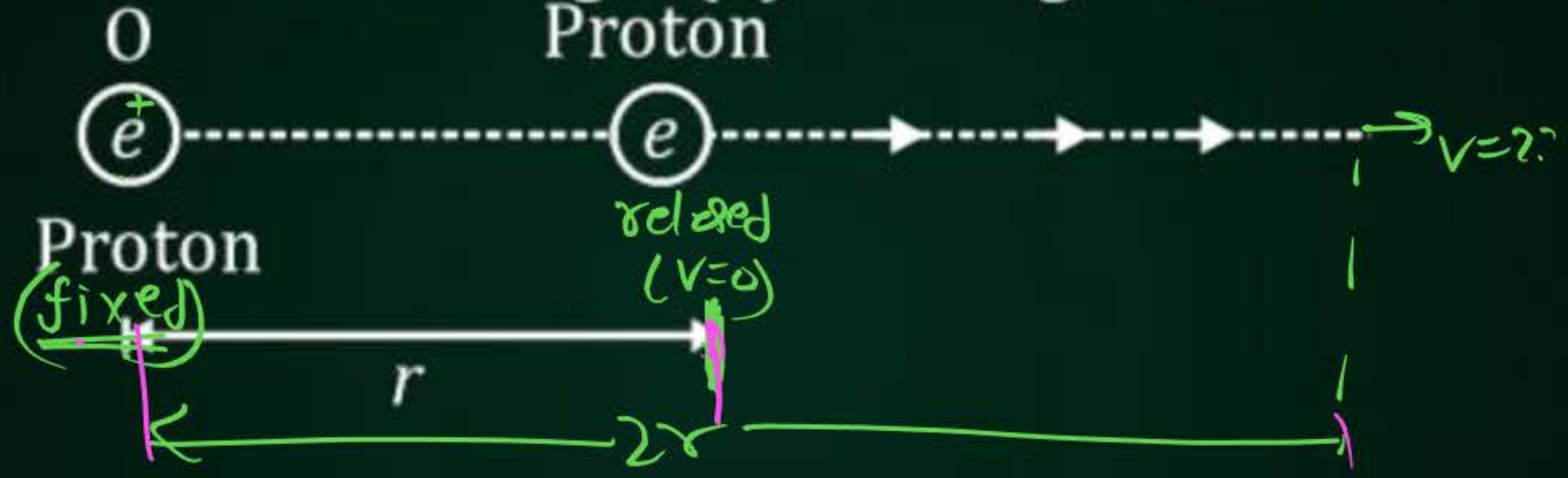
$2mgr + W_{ext} = 0$

$W_{ext} = -2mgr$

$W_{grav} = F \times disp^m = mg(2r) = 2mgr$

QUESTION

A proton is fixed at origin. Another proton is released from rest, from a point at a distance r from origin. Taking charge of proton as e and mass as m, find the speed of the proton (i) at a distance $2r$ from origin (ii) at a large distance from origin.



$r = \infty$

Sol^n (i)

COOMOEO

$$(K.E+U)_{infinit} = [K.E+U]_{final}$$

$$0 + \frac{Ke^2}{r} = \frac{1}{2}mv^2 + \frac{Ke^2}{2r}$$

$$\frac{Ke^2}{r} - \frac{Ke^2}{2r} = \frac{1}{2}mv^2$$

$$\frac{Ke^2}{2r} = \frac{1}{2}mv^2$$

$$v = \sqrt{\frac{Ke^2}{mr}}$$

(ii) COOMOEO

$(K.E+U)_{in} = (K+U)_f$

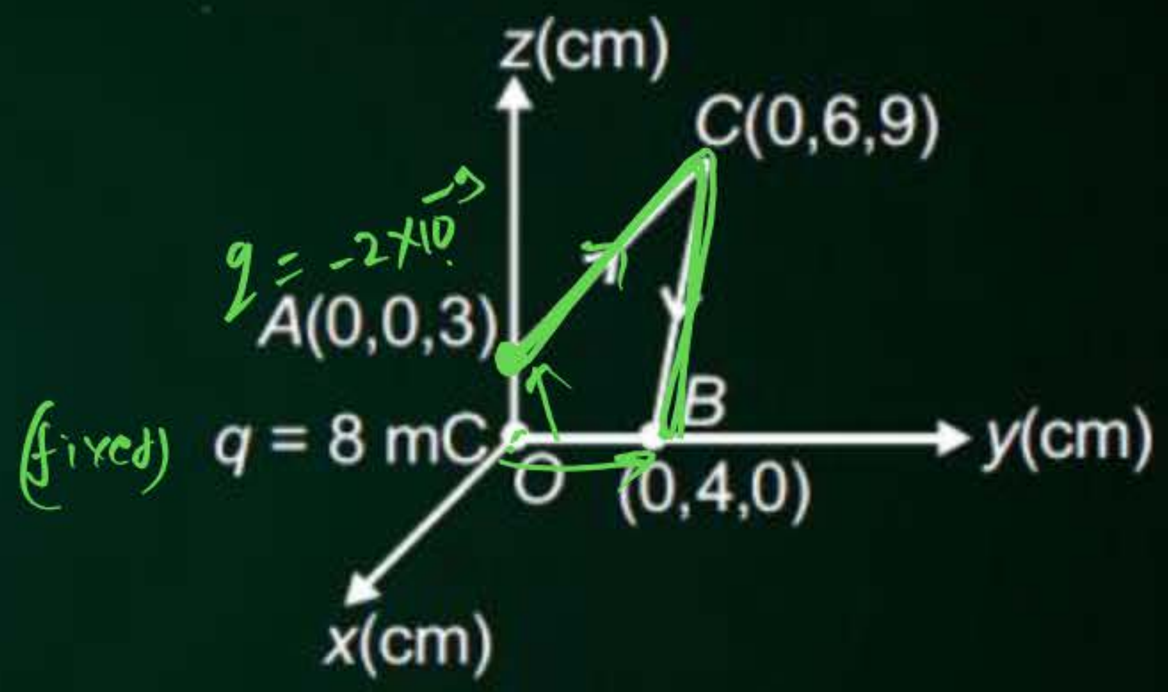
$$0 + \frac{Ke^2}{r} = \frac{1}{2}mv^2 + 0_{(infinity)}$$

$$v = \sqrt{\frac{2Ke^2}{mr}}$$

QUESTION

Calculate the work done in taking a charge -2×10^{-9} C from A to B via C (in diagram)

1. 0.2 joule
2. 1.2 joule
3. 2.2 joule
4. zero



$W_{ext} = q\Delta V$

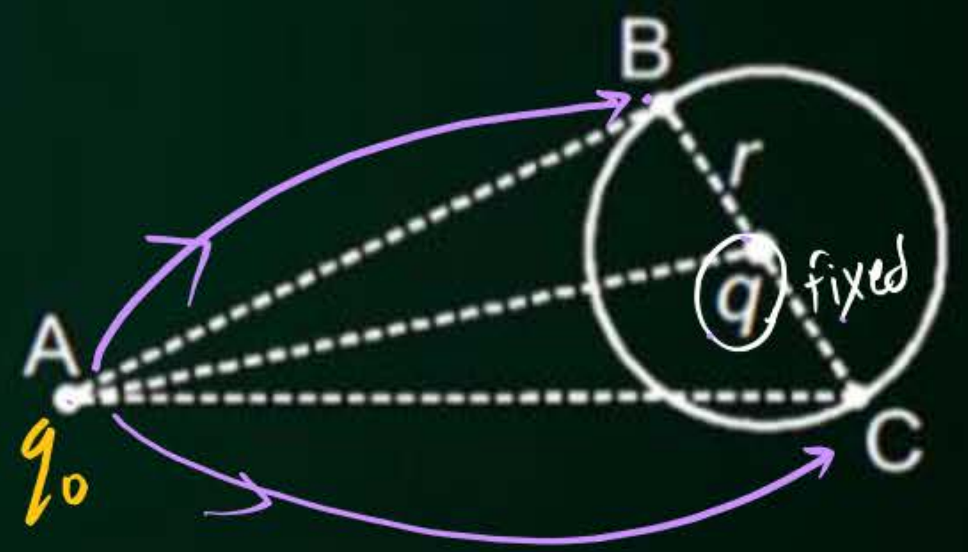
$= q[V_f - V_i]$

$= -2\times10^{-9}\left[\frac{K8\times10^{-3}}{3\times10^{-2}} - \frac{K8\times10^{-3}}{4\times10^{-2}}\right]$

QUESTION

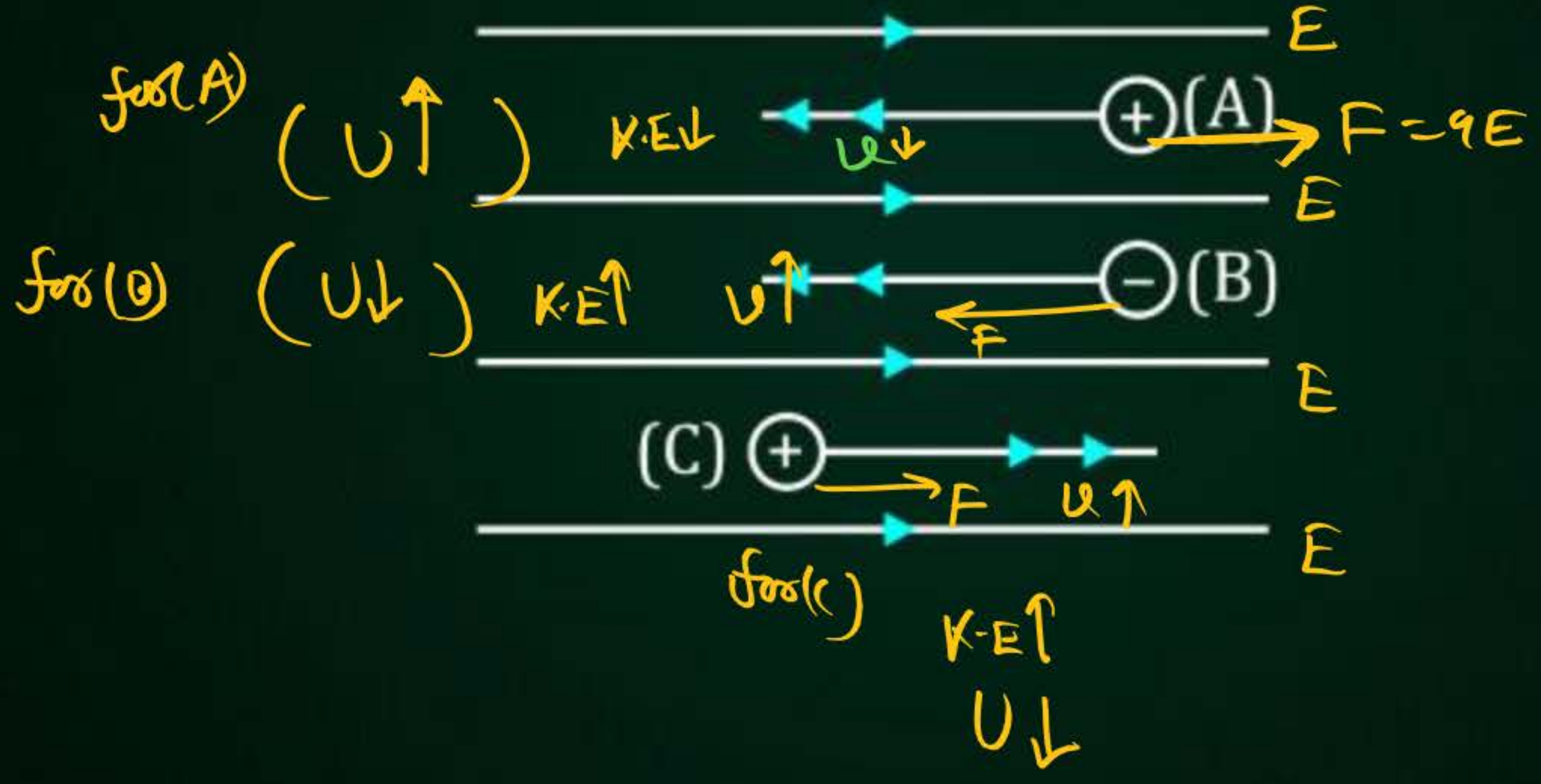
A point charge q is held at the centre of a circle of radius r. B, C are two points on the circumference of the circle and A is a point outside the circle. If W_{AB} represents work done by electric field in taking a charge q_0 from A to B and W_{AC} represents the workdone from A to C, then

1. $W_{AB} > W_{AC}$
2. $W_{AB} < W_{AC}$
3. $W_{AB} = W_{AC} = 0$
4. $W_{AB} = W_{AC} \neq 0$



QUESTION

Three charged particles (their sign are shown) move along the path in a uniform electric field as shown. In each of three cases, state whether the potential energy increases or decreases?



QUESTION

The charge q is fired towards another charged particle Q which is fixed, with a speed v. It approaches Q upto a closest distance r and then returns. If q were given a speed $2v$, the closest distance of approach would be

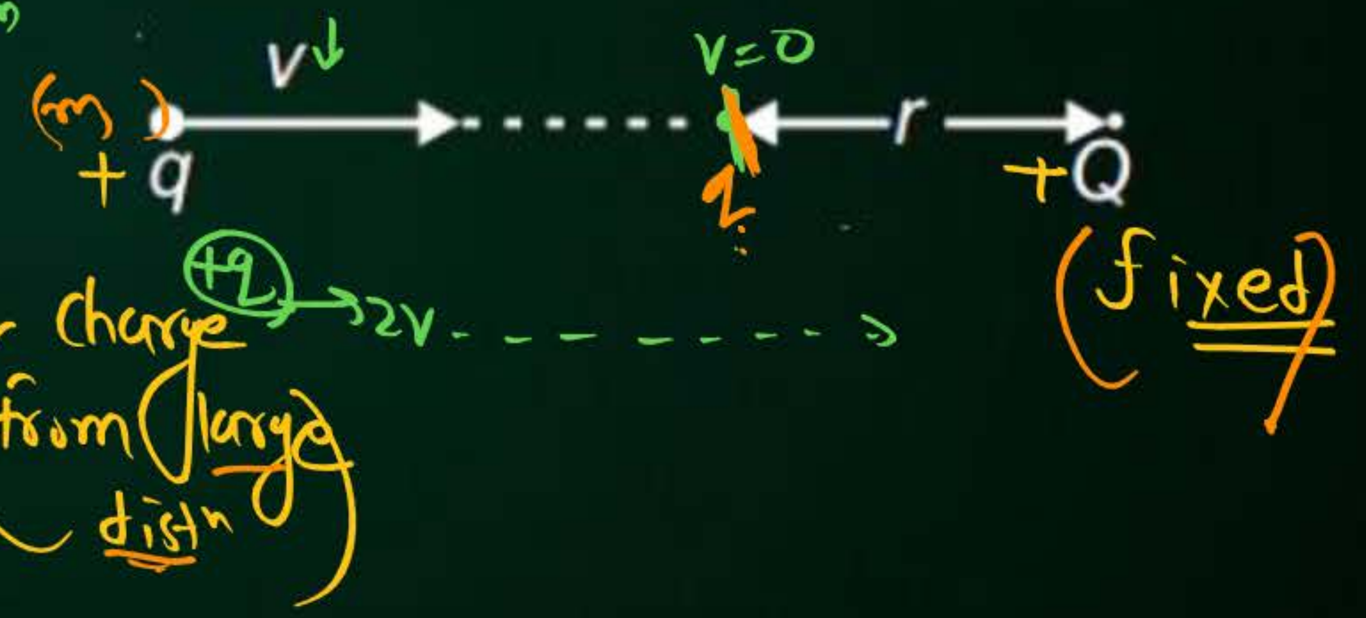
1. r
2. $2r$
3. $r/2$
4. $r/4$ ✓

Case-1 C.O.M.E

$[K.E+U]_{\text{system initial}} = [K.E+U]_{\text{system final}}$

$\frac{1}{2}mv^2 + 0 = 0 + \frac{KqQ}{r}$

$r = \frac{2KqQ}{mv^2}$ (dist^n of closest approach)



$r \propto \frac{1}{v^2}$

$r' \propto \frac{1}{(2v)^2} = \left(\frac{1}{4}\right)^{th}$

QUESTION

The work which is required to be done to make an arrangement of four particles each having a charge $+q$ such that the particle lie at the four corners of a square of side a is

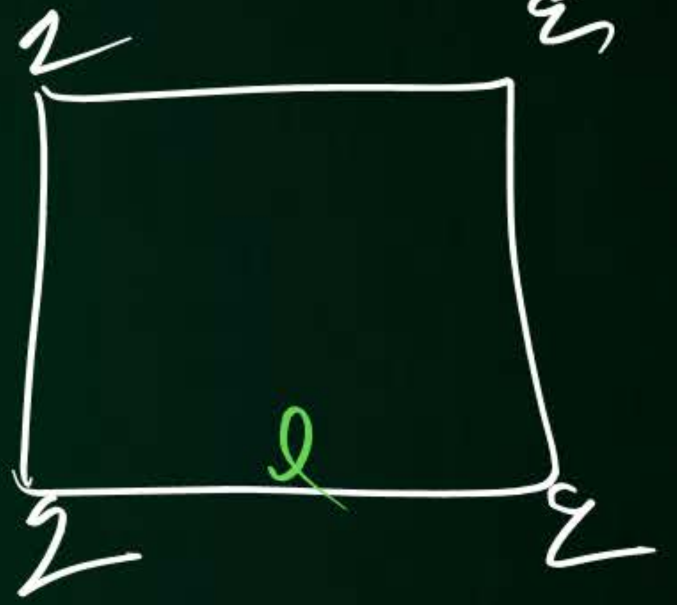
1. $(4+\sqrt{2})\dfrac{kq^2}{a}$ ✓
2. $4\dfrac{kq^2}{a}$
3. $(2+\sqrt{2})\dfrac{kq^2}{a}$
4. $2\dfrac{kq^2}{a}$

at infy

$U_i = 0$

at inifin

$W_{ext} = \Delta U = U_f - U_i$



$U = \dfrac{4kq^2}{l} + \dfrac{2kq^2}{\sqrt{2}\,l}$

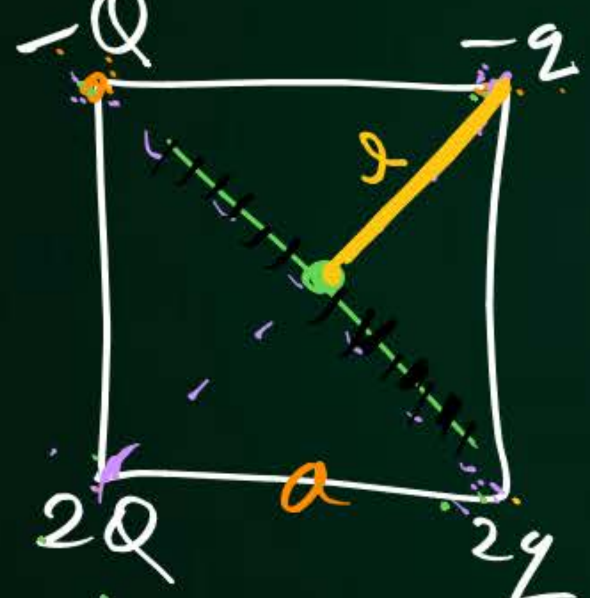
$= \dfrac{kq^2}{l}(4+\sqrt{2})$ Ans.

QUESTION

Four point charges $-Q, -q, 2q$ and $2Q$ are placed, one at each corner of the square. The relation between Q and q for which the potential at the centre of the square is zero is

[AIPMT (Prelims)-2012]

1. $Q = g$
2. $Q = 1/q$
3. $Q = -q$
4. $Q = -1/q$



$$V = \frac{-Kq}{l} + \frac{K2q}{l} - \frac{KQ}{l} + \frac{2KQ}{l} = 0$$

$$\frac{Kq}{l} + \frac{KQ}{l} = 0$$

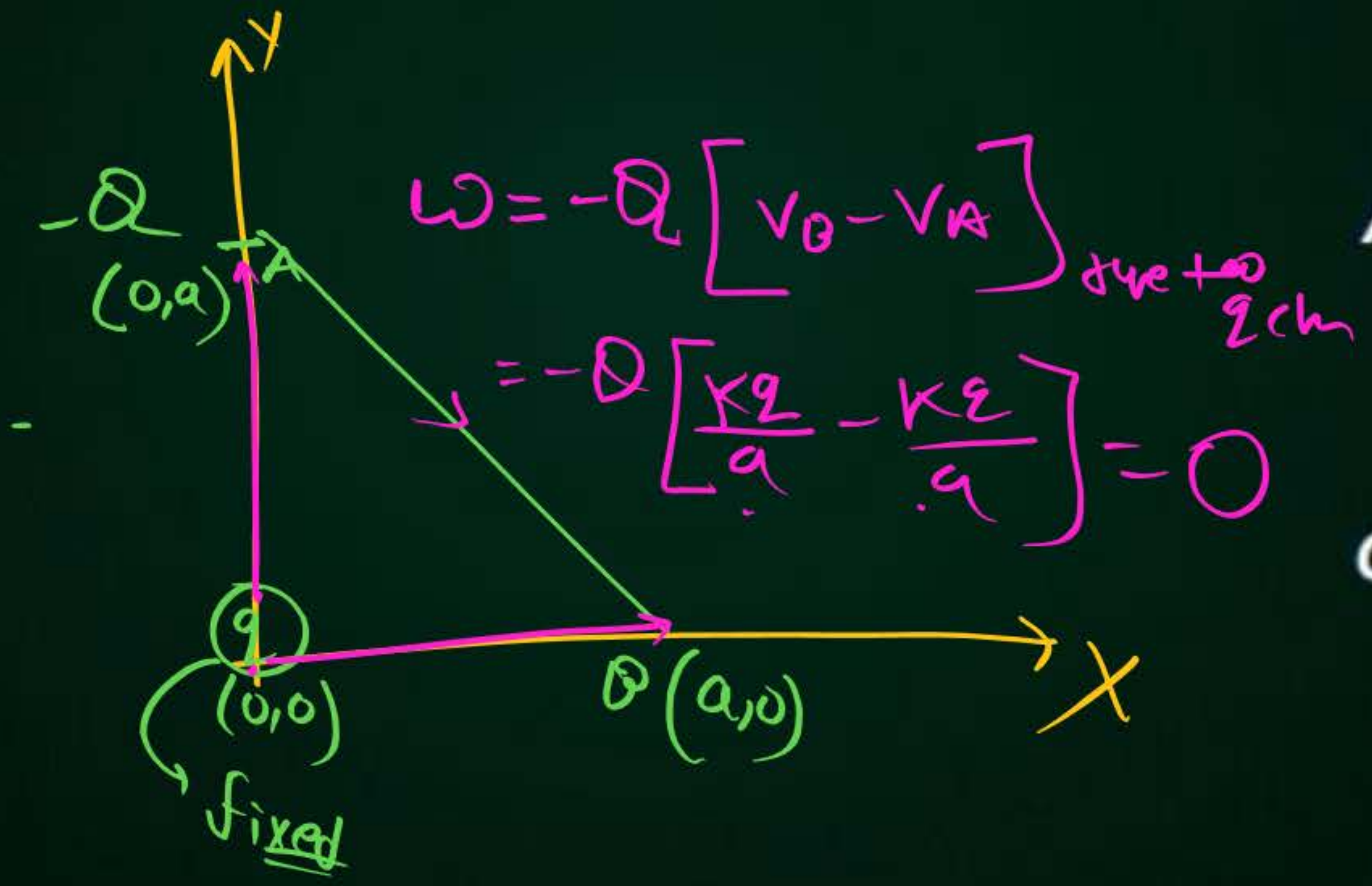
$$\frac{Kq}{l} = \frac{-KQ}{l}$$

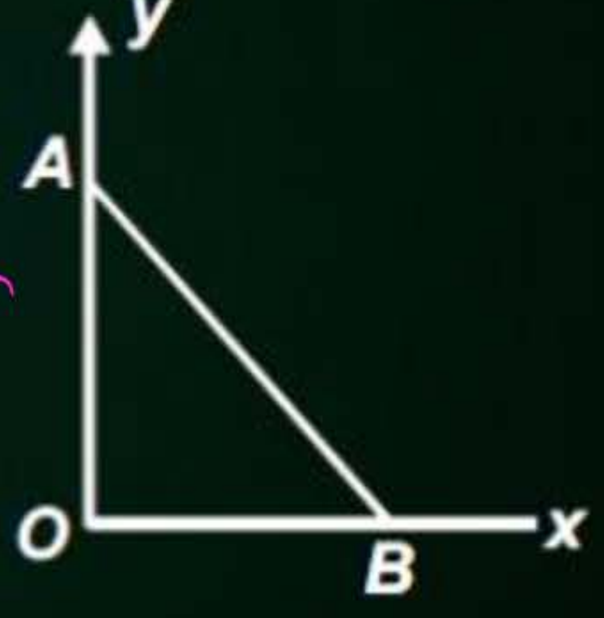
$$q = -Q$$

QUESTION

As per the diagram a point charge $+q$ is placed at the origin O. Work done in taking another point charge $-Q$ from the point A [coordinates $(0, a)$] to another point B [coordinates $(a, 0)$] along the straight path AB is **[AIPMT (Prelims)-2005]**

1. zero
2. $\left(\frac{-qQ}{4\pi\varepsilon_0}\frac{1}{a^2}\right)\sqrt{2}a$
3. $\left(\frac{qQ}{4\pi\varepsilon_0}\frac{1}{a^2}\right)\cdot\frac{a}{\sqrt{2}}$
4. $\left(\frac{qQ}{4\pi\varepsilon_0}\frac{1}{a^2}\right)\sqrt{2}a$

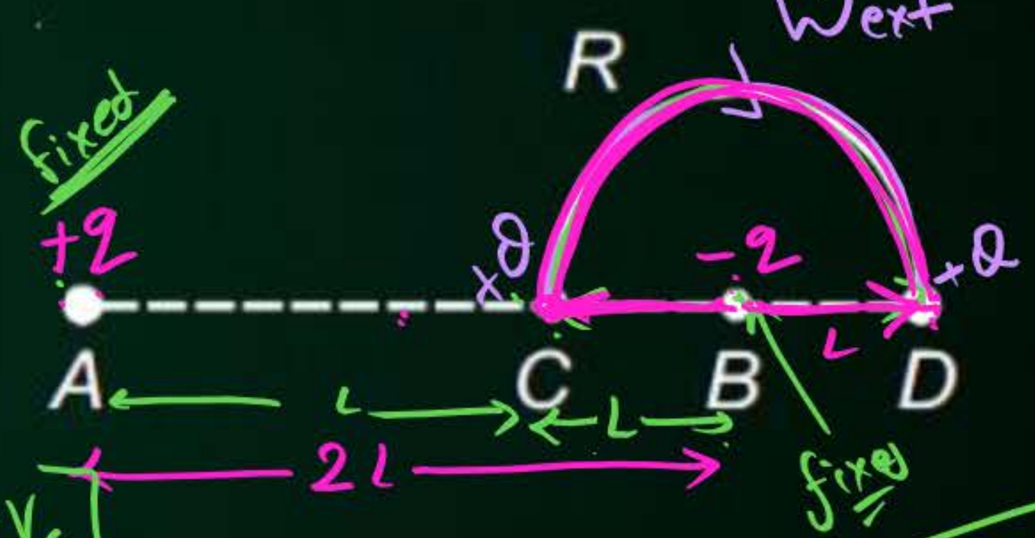




QUESTION

Charges $+q$ and $-q$ are placed at points A and B respectively which are a distance $2L$ apart, C is the midpoint between A and B. The work done in moving a charge $+Q$ along the semicircle CRD is





(1) $-\dfrac{qQ}{6\pi\varepsilon_0 L}$

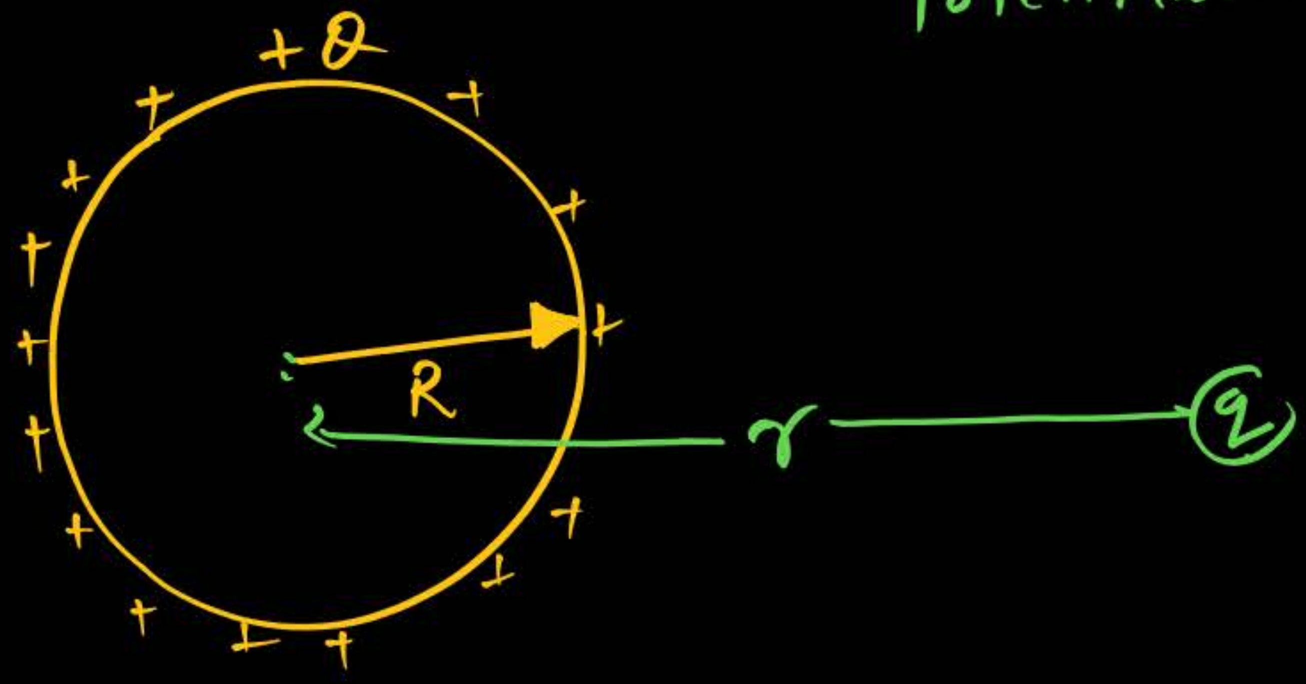
(2) $-\dfrac{qQ}{4\pi\varepsilon_0 L}$

(3) $\dfrac{qQ}{2\pi\varepsilon_0 L}$

(4) $-\dfrac{qQ}{2\pi\varepsilon_0 L}$

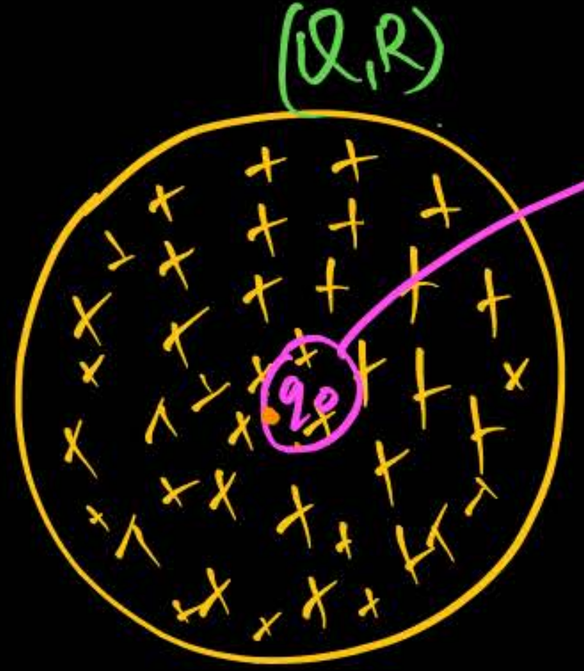
Potential energy of spherical charge & point charge

#



$$U = \frac{KQq}{r}$$

#

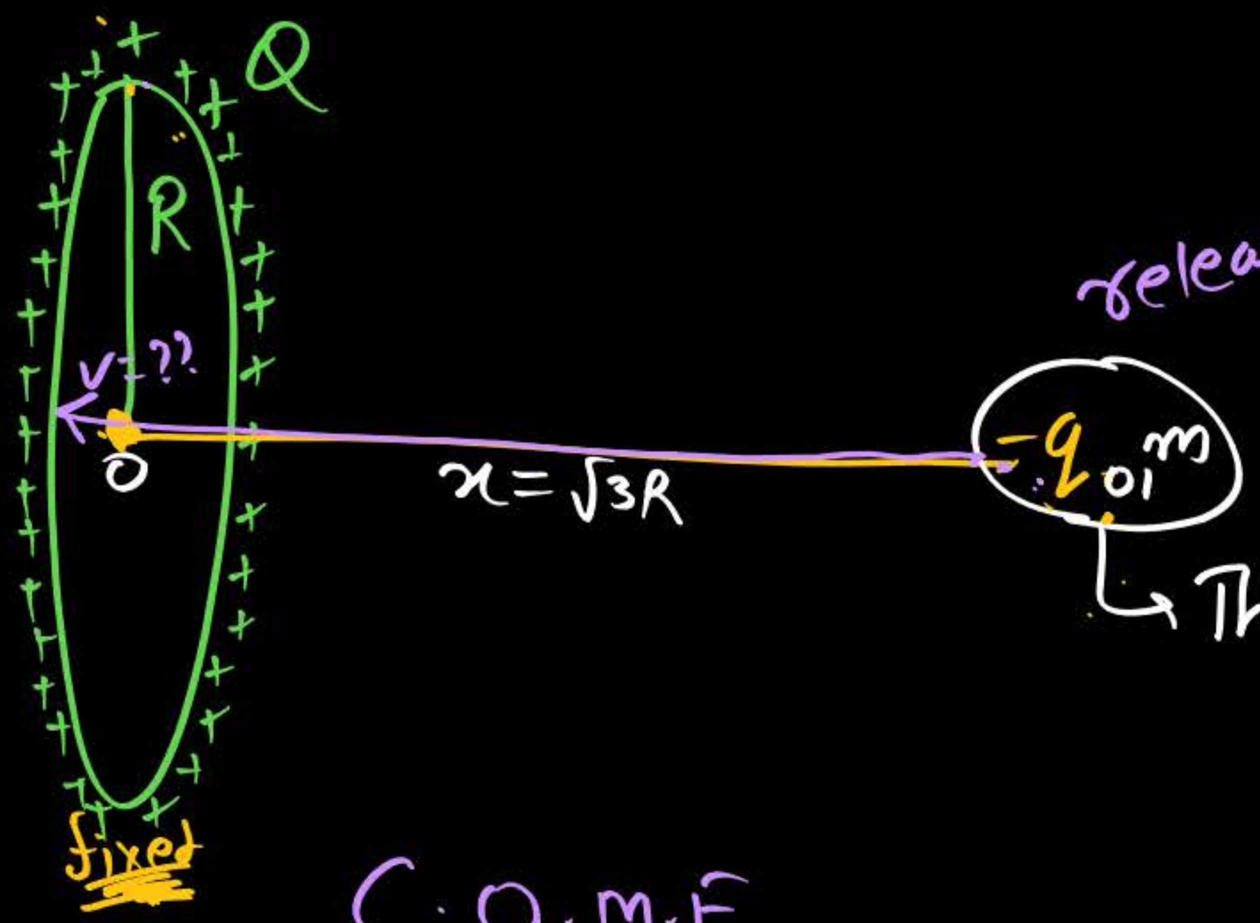


extra q_0 charge placed at centre then find Potential energy of system.

$U = Vq_0$

$$U = \frac{3KQq_0}{2R}$$

Answer



This charge is released from here then find its speed at centre of ring.

C.O.M.E

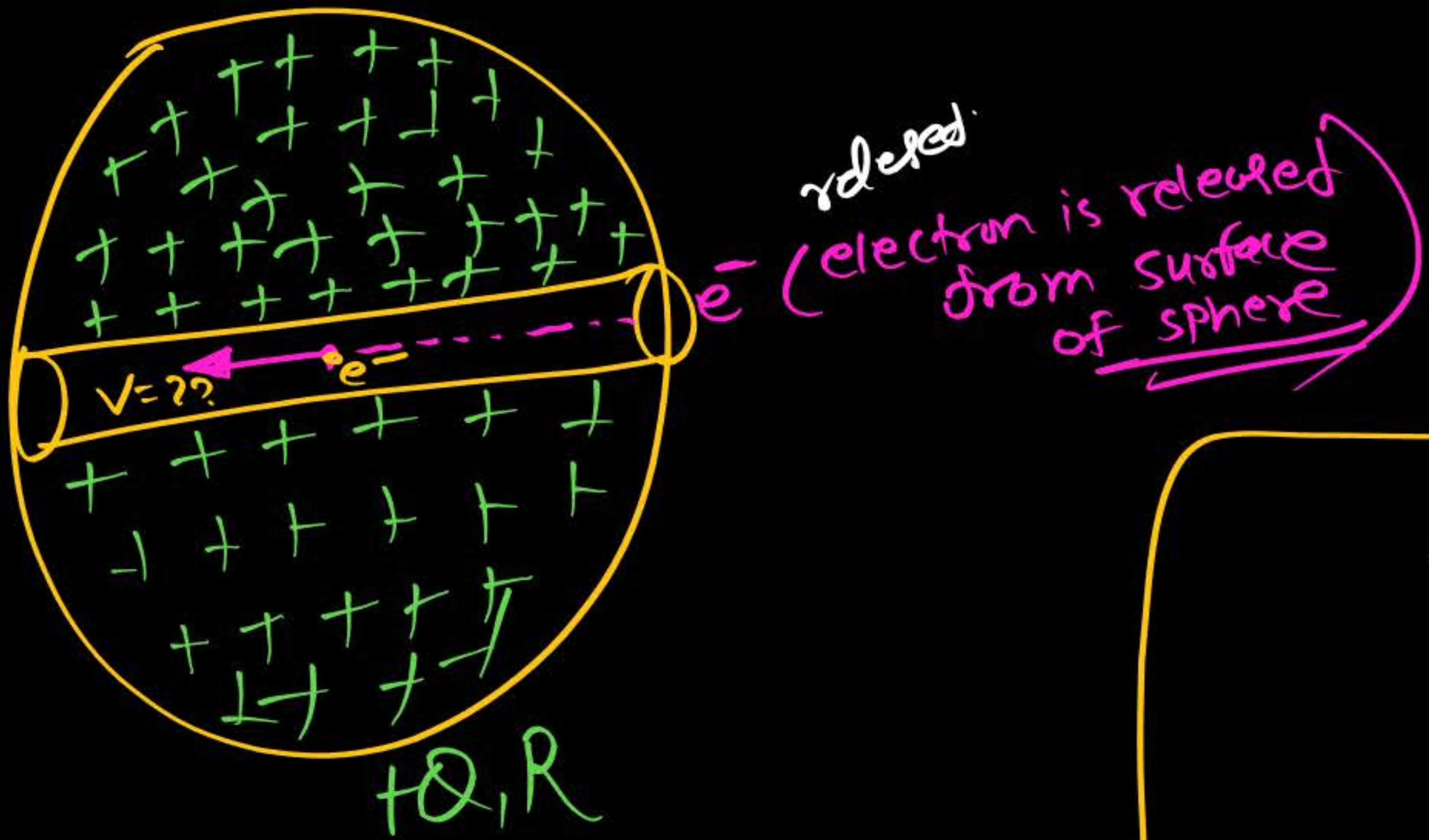
$$[K.E+U]_{initial} = [K.E+U]_f$$

$$0 - \frac{KQq_0}{\sqrt{R^2+(\sqrt{3}R)^2}} = \frac{1}{2}mv^2 - \frac{KQq_0}{R}$$

$$\frac{KQq_0}{R} - \frac{KQq_0}{2R} = \frac{1}{2}mv^2$$

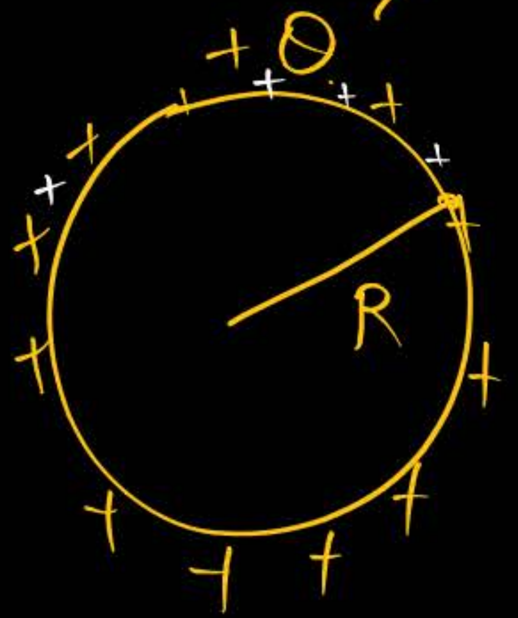
$$\frac{KQq_0}{2R} = \frac{1}{2}mv^2$$

$$v = \sqrt{\frac{KQq_0}{mR}} \quad \text{Ans}$$



C.O.M.E

$$[K.E+U]_{initial} = [K.E+U]_{final}$$



→ charge is at surface

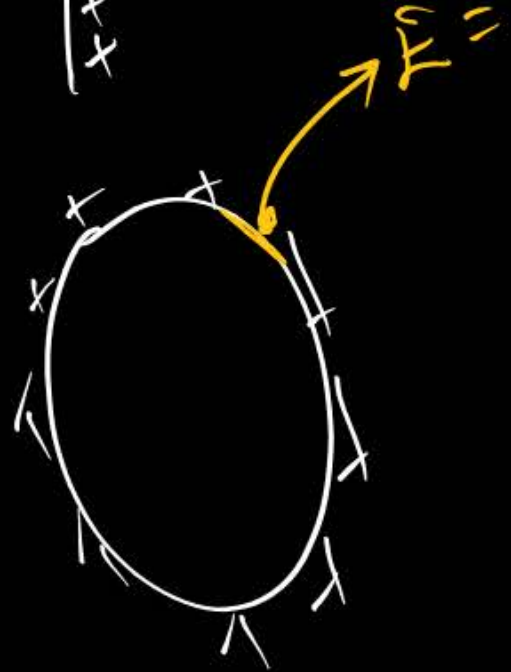
$$E_s = \frac{KQ}{R^2}$$

$$E = \frac{Q}{4\pi\varepsilon_0 R^2} = \frac{\sigma}{\varepsilon_0}$$

$\sigma = \frac{Q}{4\pi R^2}$

↳ surface charge densi..





QUESTION

Two charged metallic spheres of radii r_1 and r_2 are touched and separated. Calculate the ratio of their

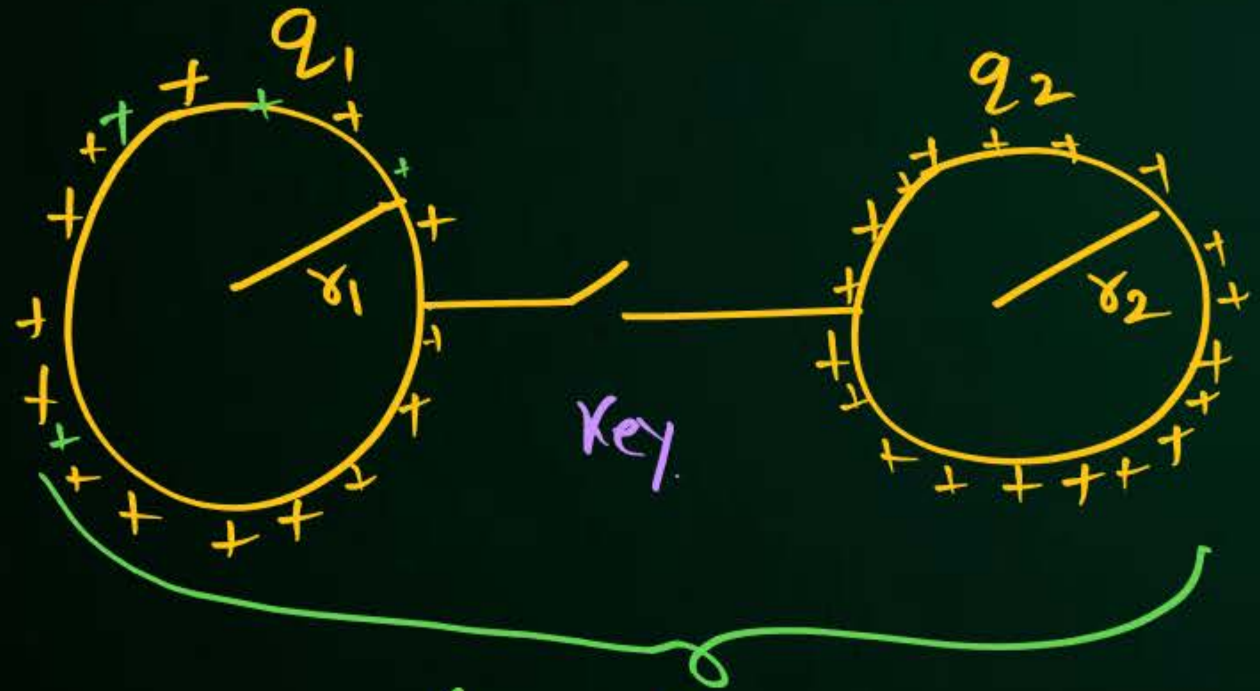
(i) Charges

(ii) Potential

[redacted]

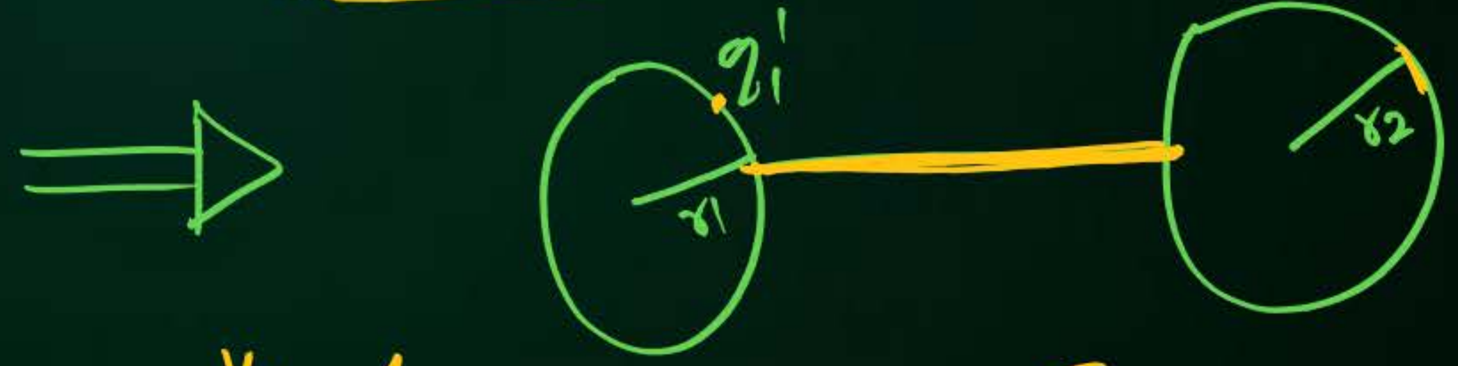
(iv) Electric field t the surface

(v) Surface charge density



(Initial condition)

after key is closed



(ii) $\frac{V_1}{V_2} = \frac{1}{1}$

(i) $\frac{q_1'}{q_2'} = \frac{r_1}{r_2}$

(iv) $E = \frac{\sigma}{\varepsilon_0}$

QUESTION

Two insulated charged conducting spheres of radii 20 cm and 15 cm respectively and having equal charge of 10 μC are connected by a copper wire and then they are separated. Hence

1. Both spheres will have equal charges
2. Surface charge density on the 20 cm sphere will be greater than that on the 15 cm sphere
3. Surface charge density on the 15 cm sphere will be greater than that on the 20 cm sphere
4. Surface charge density on the two spheres will be equal

QUESTION

Two spheres of radii R_1 and R_2 respectively are charged and joined by a wire. The ratio of electric field of spheres is

1. $\frac{R_2^2}{R_1^2}$
2. $\frac{R_1^2}{R_2^2}$
3. $\frac{R_2}{R_1}$
4. $\frac{R_1}{R_2}$

QUESTION

A conducting sphere of radius 10 cm is charged with 10 μC. Another uncharged sphere of radius 20 cm is allowed to touch it for some time. After that if the spheres are separated, then surface density of charge on the spheres will be in the ratio of

1. 1 : 1
2. 2 : 1
3. 1 : 3
4. 1 : 4

QUESTION

Charge Q is placed on surface of hollow conductor of radius R, then find potential energy of charge q placed at $r(r > R)$ from centre of sphere.

QUESTION

Find work done in bringing Q charge from infinity to the surface of hollow sphere of radius R'. (Self energy)


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 05 | **Physics**

Electrostatic Potential and Capacitance



By- Dr. Manish Raj (MR SIR)

Topics to be covered

1. # Elecstrostatic Nature of conductor
2. #
3. #



QUESTION

Two electrons are moving towards each other, each with a velocity of 10^6 m/s. What will be closest distance of approach between them?

1. 1.53×10^{-8} m
2. 2.53×10^{-10} m ✓
3. 2.53×10^{-6} m
4. Zero

r = lage dir^n

rest

$e^- \rightarrow$ $V = 10^6$ m/s r_0 $\leftarrow e^-$ $V = 10^6$ m/s

C.O.M.E

$(P.E. + K.E)_{initial} = (P.E + K.E)_{final}$

$0 + \frac{1}{2} m_e V_e^2 \times 2 = \frac{Ke^2}{r_0} + 0$

$$r_0 = \frac{Ke^2}{m_e V_e^2}$$

(Q) An e^- is moving from point A to B having potential at that point $V_A = 30V$ & $V_B = 50V$ then find speed of e^- at B if speed of e^- at A is zero.

$$\Delta U_{loss} = \Delta K.E_{gain}$$

$$q\Delta V = K.E_{f(B)} - K.E_{i(A)} \quad (K.E_{i} = 0)$$

$$-e[50-30] = \frac{1}{2}mv^2$$

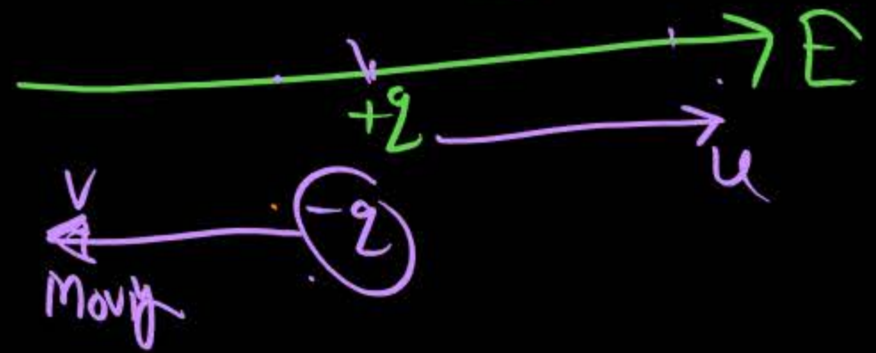
$$e \times 20 = \frac{1}{2}mv^2$$

$$V = \sqrt{\frac{40e}{m}} \quad \text{Ans}$$

\# By itself

+ve charge moves from Higher to Lower Potⁿ

\# but -ve charge moves from low to High Potential.



logic gate.

Photoelectric effect

de-broglie wavelength

Y.D.S.E *

optical instrument

Prism.

Properties of EM wave.

15-20 question

Alley NEET 2025 M.R.

Series L-C-R circuit.

Moment of Inertia.

Torque

Conservation of Angular Momentum.

Simple pendulum / spring time period

organ pipe.

dimen analysis.

instrument.

error.

Collision

Position of C.O.M

work → $\vec{F}\cdot\vec{S}$

Power

→ C.O.M.E

→ H-spectrum

→ Nuclei Ki Basic Property

→ Hook's law

→ energy density

→ orbital / escape

→ Satellite / Kepler Law

→ Electric field & electric force.

→ capacity

flux.

→ Surface / capillary rise.

→ thermodynamics process

→ expansion / thermometry

$$V = x^2y + y^2z + z^2x$$

↳ Find electric field → Sol^n already done 3-times

Basic math
WEP
gravitel

$$\vec{E} = -\left[\frac{\partial V}{\partial x}\hat{i} + \frac{\partial V}{\partial y}\hat{j} + \frac{\partial V}{\partial z}\hat{k}\right]$$

$$\vec{E} = -\left[(2xy + z^2)\hat{i} + (x^2 + 2yz)\hat{j} + (y^2 + 2zx)\hat{k}\right]$$

Ans

QUESTION

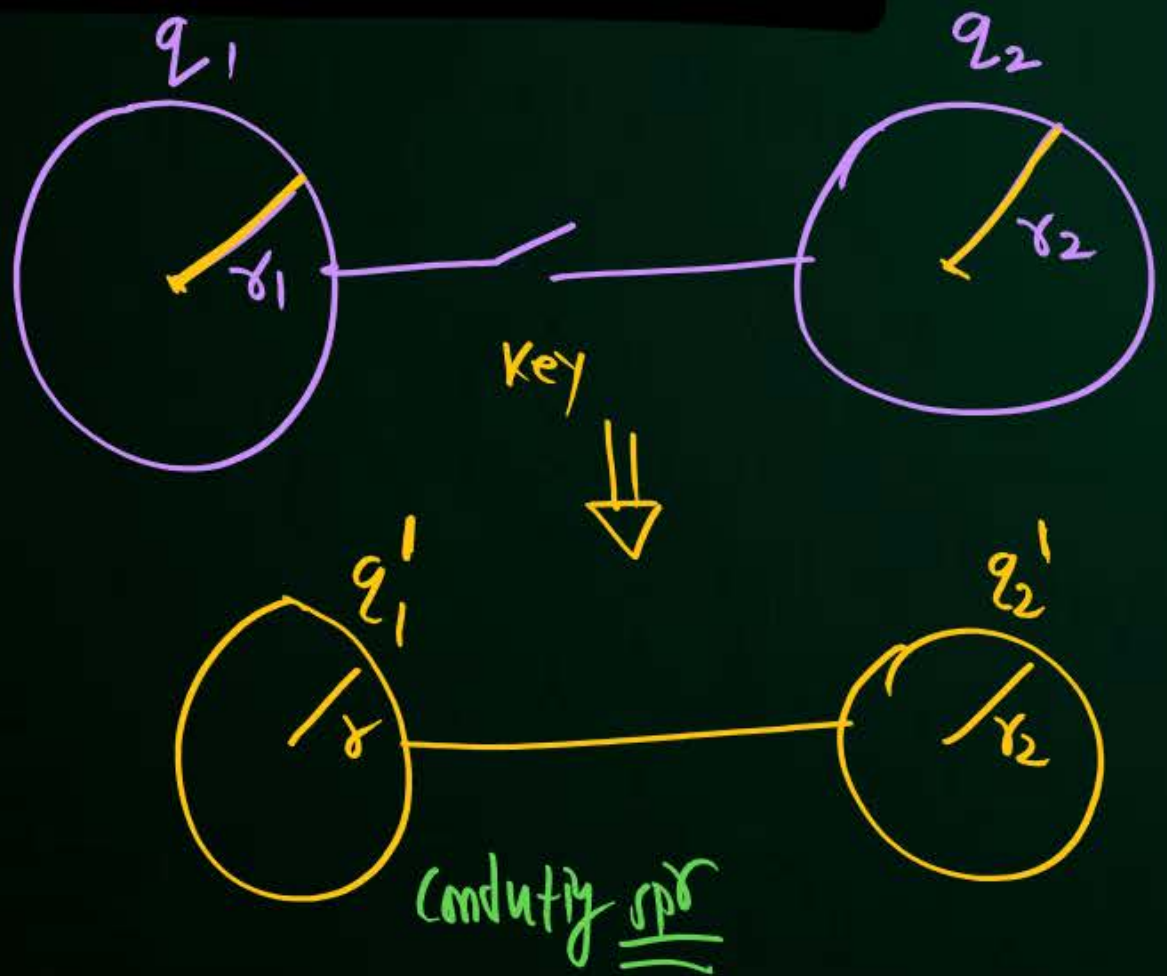
Two charged metallic spheres of radii r_1 and r_2 are touched and separated. Calculate the ratio of their

(i) Charges

(ii) Potential

(iii) Surface charge density

(iv) Electric field t the surface



(ii) $V_1 = V_2$

$$\frac{V_1}{V_2} = \frac{1}{1}$$ Ans

(i) $$\frac{q_1}{q_2} = \frac{r_1}{r_2}$$

(iii) surface charge density $= \frac{q}{\text{Area}}$

$$\propto \frac{R}{4\pi R^2} \propto \frac{1}{R}$$

$$\sigma \propto \frac{1}{R}$$

$$\frac{\sigma_1}{\sigma_2} = \frac{R_2}{R_1}$$ *

(iv) $$\frac{E_1}{E_2} = \frac{\sigma_1}{\sigma_2} = \frac{R_2}{R_1}$$

QUESTION

Two insulated charged conducting spheres of radii 20 cm and 15 cm respectively and having equal charge of 10 μC are connected by a copper wire and then they are separated. Hence

Potential equal
charge $\propto R$
$\sigma \propto \frac{1}{R}$

1. Both spheres will have equal charges
2. Surface charge density on the 20 cm sphere will be greater than that on the 15 cm sphere
3. Surface charge density on the 15 cm sphere will be greater than that on the 20 cm sphere (87%)
4. Surface charge density on the two spheres will be equal

QUESTION

Two spheres of radii R_1 and R_2 respectively are charged and joined by a wire. The ratio of electric field of spheres is

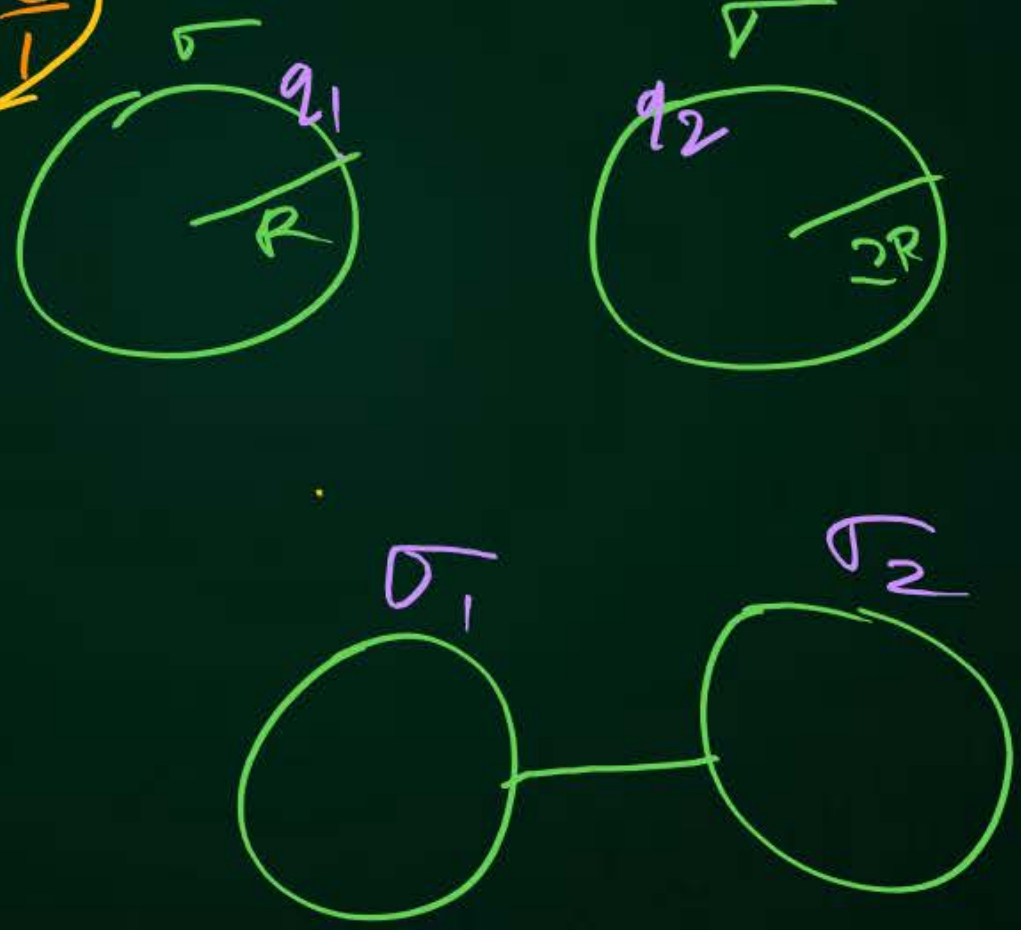


1. $\frac{R_2^2}{R_1^2}$
2. $\frac{R_1^2}{R_2^2}$
3. $\frac{R_2}{R_1}$
4. $\frac{R_1}{R_2}$

QUESTION

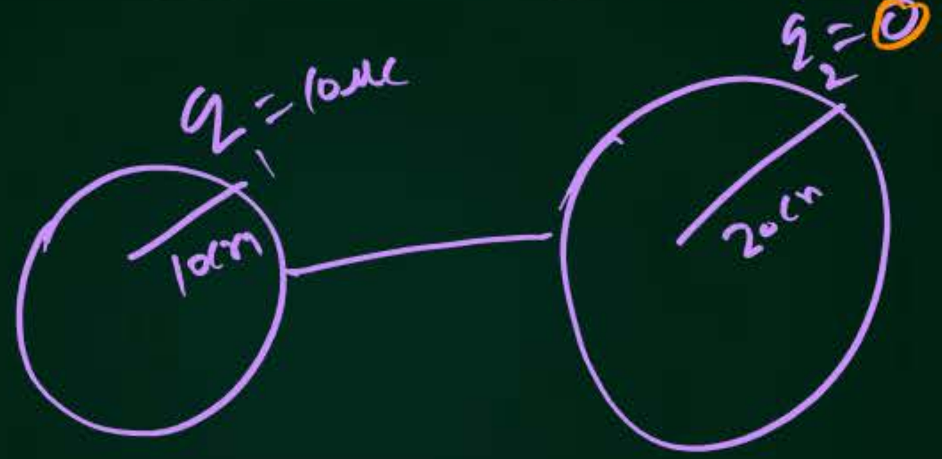
Two metal spheres, one of radius R and the other of radius 2R respectively have the same surface charge density σ. They are brought in contact and separated. What will be the new surface charge densities on them? **(Odisha NEET 2019)**

1. $\sigma_1 = \frac{5}{6}\sigma, \sigma_2 = \frac{5}{2}\sigma$
2. $\sigma_1 = \frac{5}{2}\sigma, \sigma_2 = \frac{5}{6}\sigma$
3. $\sigma_1 = \frac{5}{2}\sigma, \sigma_2 = \frac{5}{3}\sigma$
4. $\sigma_1 = \frac{5}{3}\sigma, \sigma_2 = \frac{5}{6}\sigma$



QUESTION

A conducting sphere of radius 10 cm is charged with 10 μC. Another uncharged sphere of radius 20 cm is allowed to touch it for some time. After that if the spheres are separated, then surface density of charge on the spheres will be in the ratio of



1. 1 : 1
2. 2 : 1
3. 1 : 3
4. 1 : 4

QUESTION

Two metallic spheres of radii 1 cm and 3 cm are given charges of -1×10^{-2} C and 5×10^{-2} C, respectively. If these are connected by a conducting wire, the final charge on the bigger sphere is (Mains 2012)

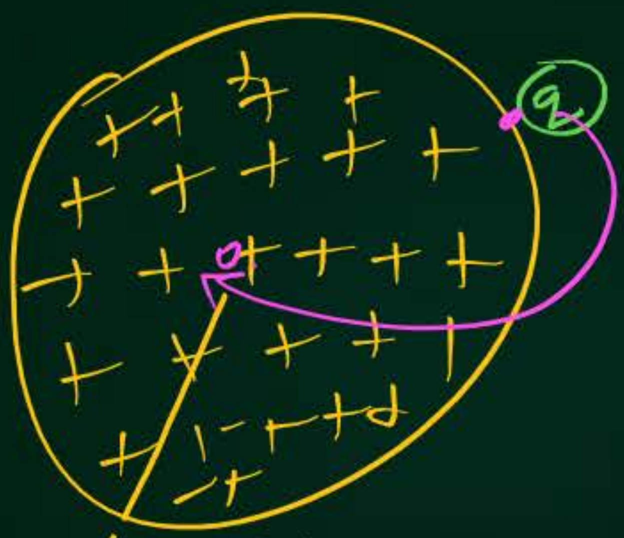
1. 2×10^{-2} C
2. 3×10^{-2} C
3. 4×10^{-2} C
4. 1×10^{-2} C

$q_2' = \frac{3}{1+3}(4 \times 10^{-2})$

$= 3 \times 10^{-2}$

QUESTION

Find work done to move q charge from surface of uniformly charge sphere of charge Q and radius R to centre of that sphere?



(R, Q)

$$W = q\Delta V$$
$$= q\left[\frac{3KQ}{2R} - \frac{KQ}{R}\right]$$
$$= q\left[\frac{KQ}{2R}\right]$$

(a) zero

(b) $\frac{3KQq}{2R}$

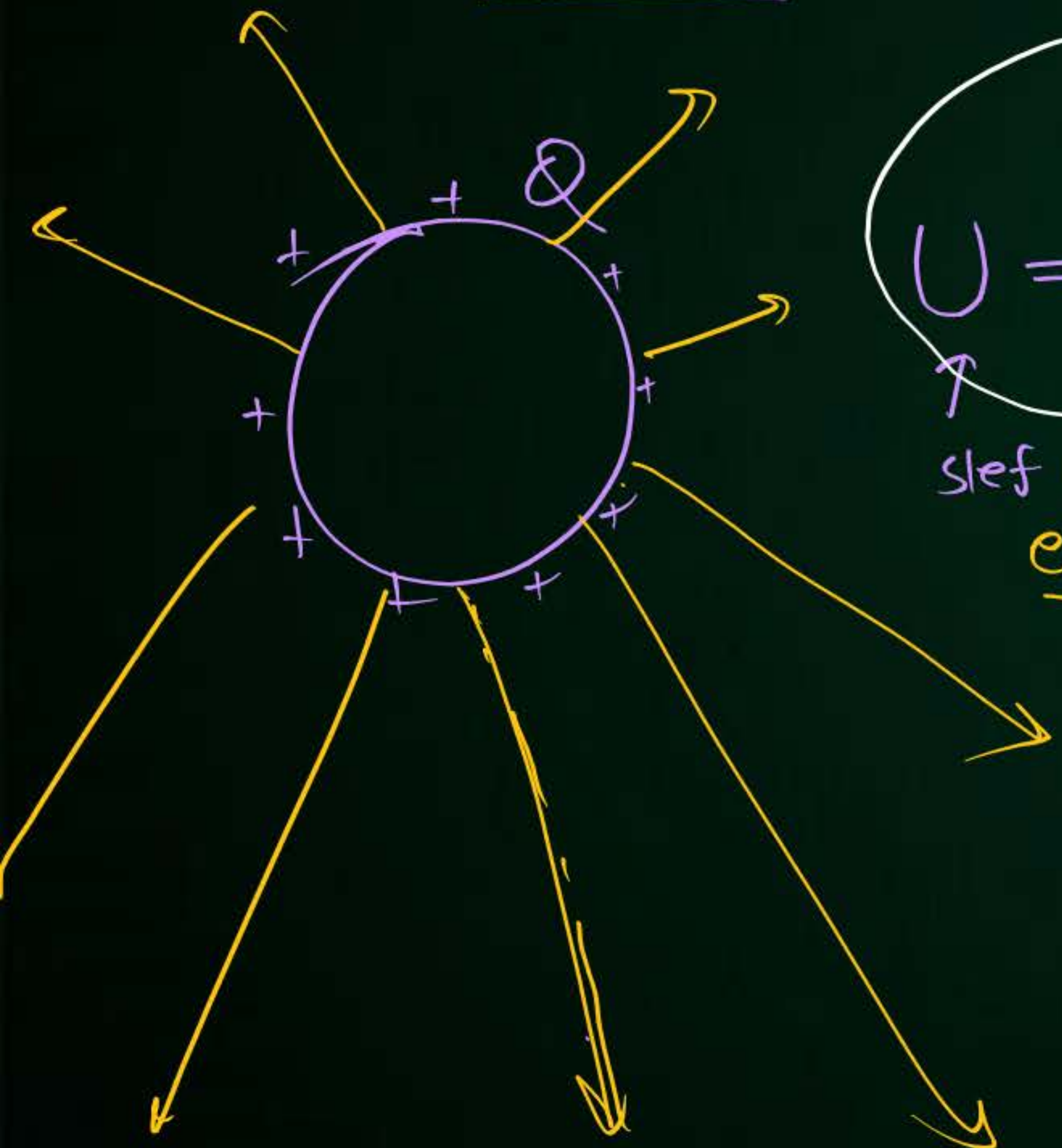
(c) $\frac{KQq}{2R}$ (74%) ✓

(d) $\frac{KQq}{R}$

QUESTION

NEET में नहीं आता

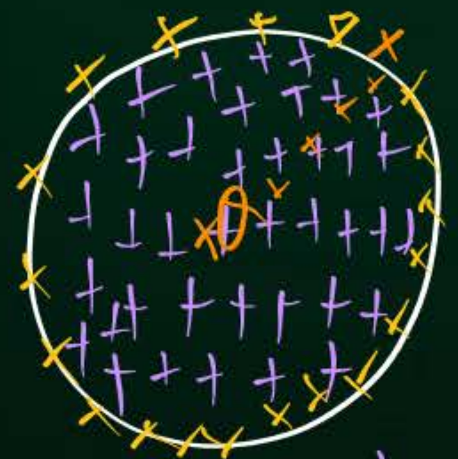
Find work done in bringing Q charge from infinity to the surface of hollow sphere of radius R'. (Self energy)



$$U = \frac{KQ^2}{2R} = 0.5\frac{KQ^2}{R}$$ } (dimension)

slef engy

electrostatic engy stored from surface to infinity



Nonducty sph.

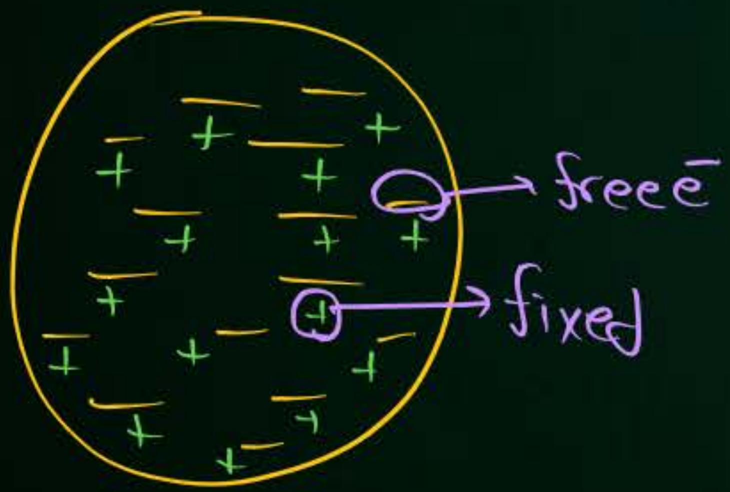
$$U = \frac{3KQ^2}{5R} = 0.6\frac{KQ^2}{R} = 0.1\frac{KQ^2}{R} + \frac{0.5KQ^2}{R}$$

inside – outsn

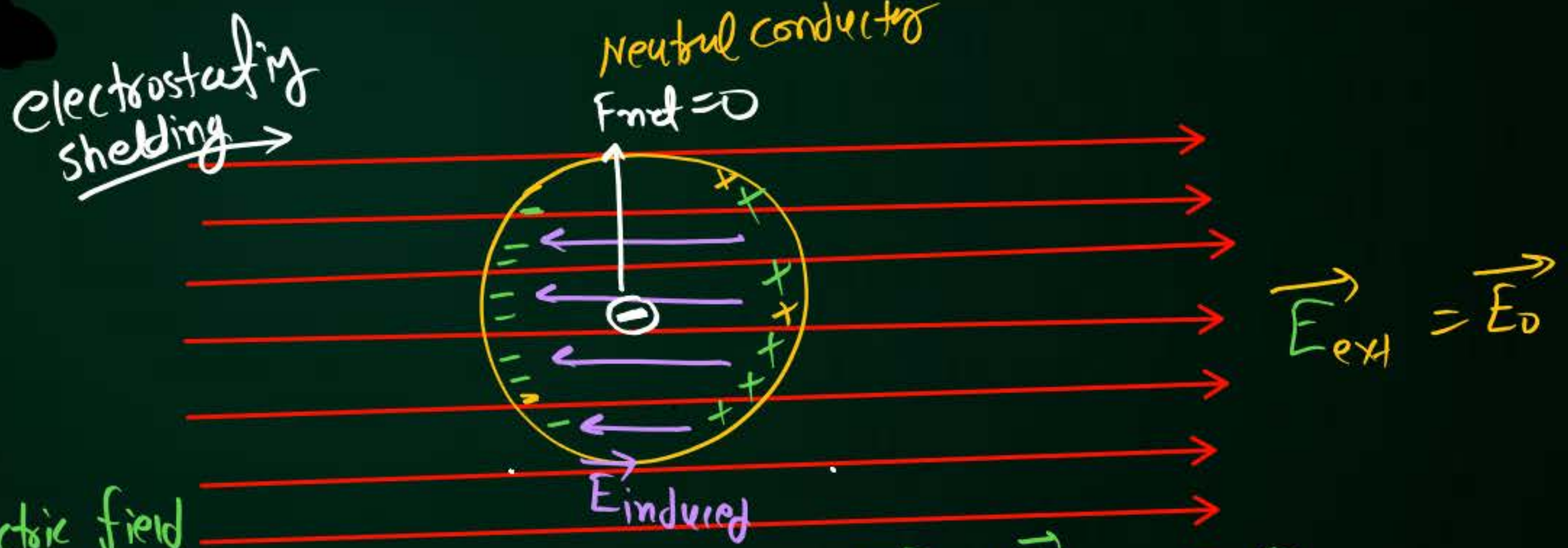
ELECTROSTATIC OF CONDUCTOR

- Conductors have large no. of free e^- distributed inside volume of conductor.
- The excess charge given to conductor resides on the surface of conductor.

[redacted]



neutral conductor $Q = 0$

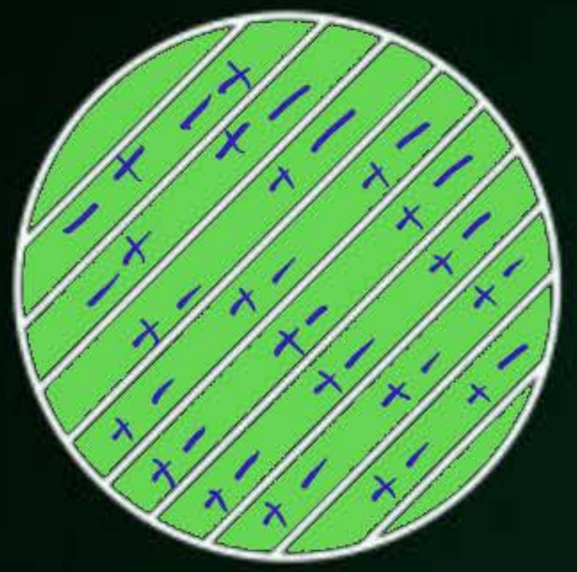


Net electric field inside isolated conductor is zero. where conductor material is present.

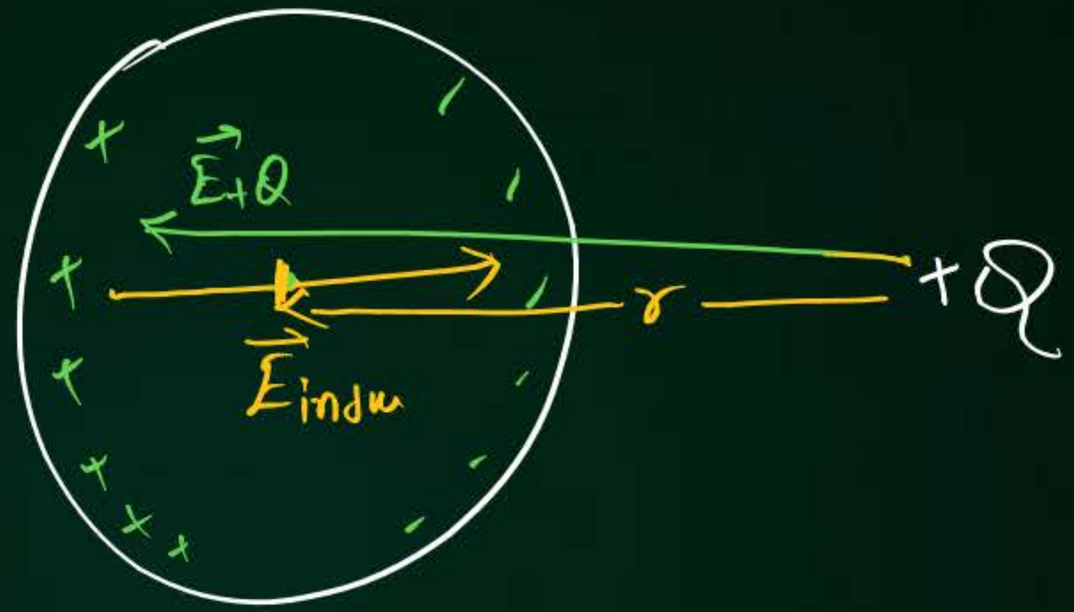
$\vec{E}_{net} = \vec{E}_0 + \vec{E}_{induced} = 0$

$$\vec{E}_{induced} = -\vec{E}_0$$

➢ When point charge placed near to conductor



$Q_{net} = 0$



$$\vec{E}_{net\ (inside)} = 0$$

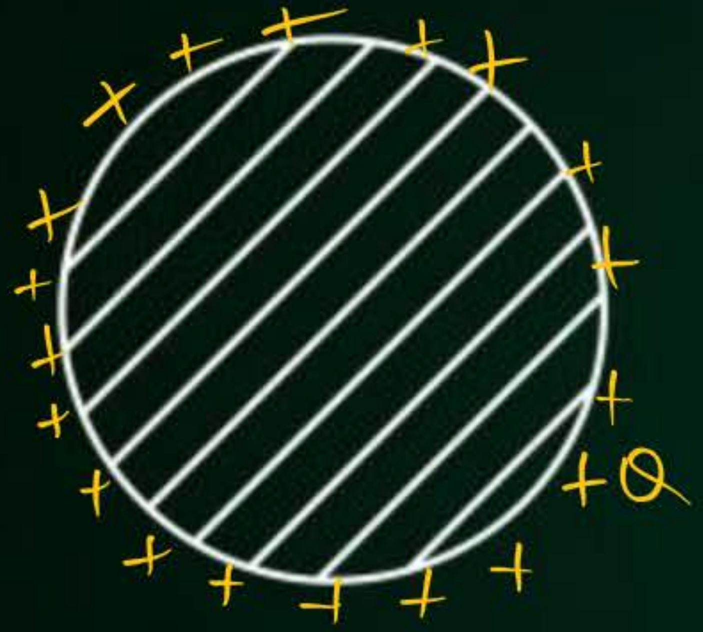
$$\vec{E}_{+Q\ at\ centre} = \frac{KQ}{r^2}$$

$$\vec{E}_{induced} = -\frac{KQ}{r^2}$$

$$\vec{E}_{net} = 0$$

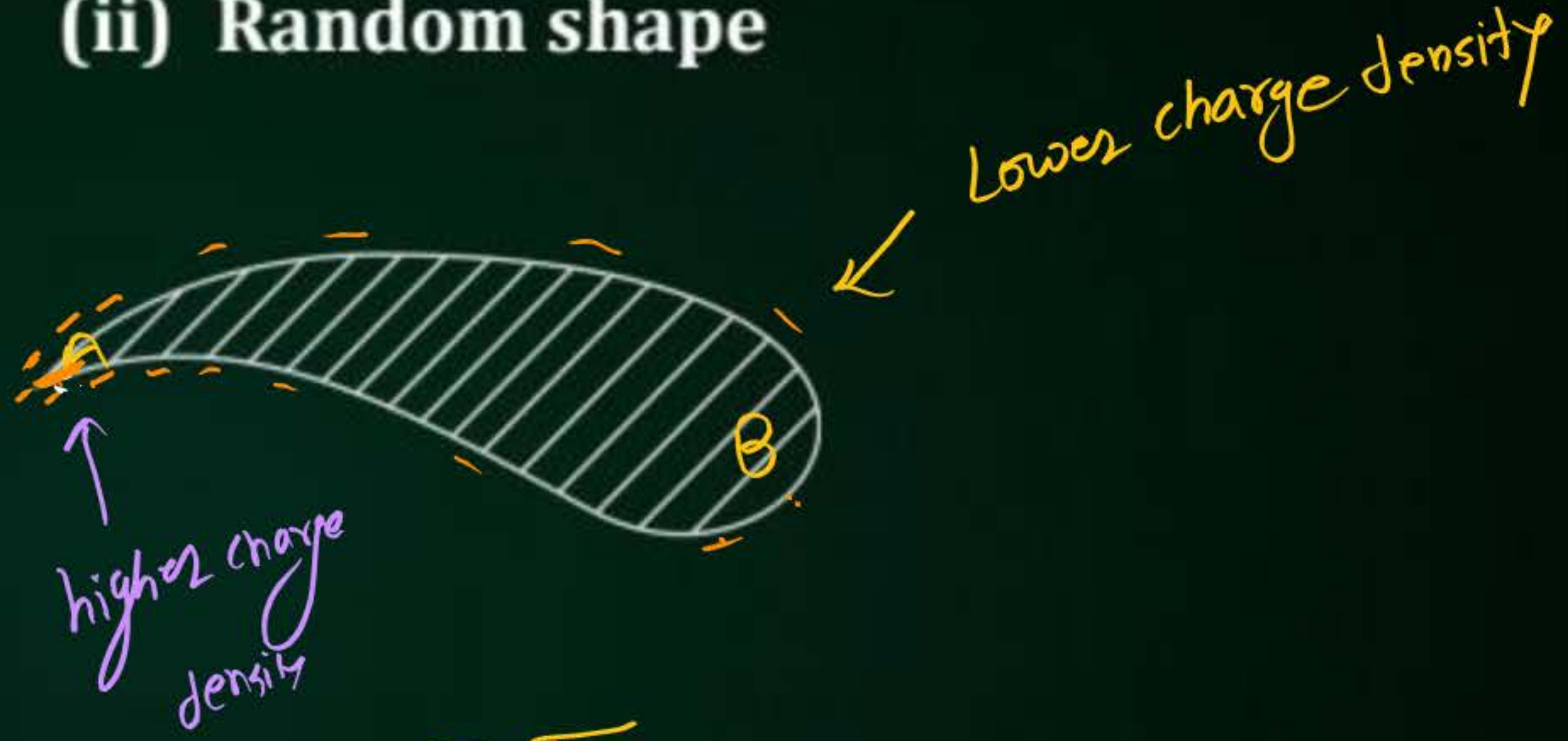
➢ Excess charge given to conductor

(i) Uniform shape



$Q_{net} = +Q$

(ii) Random shape



$\sigma_A > \sigma_B$

$E_A > E_B$

$V_A = V_B$ → conductor creates equipotential region

- Electric field perpendicular to the surface of conductor.
- Electric field Inside conductor where matter is present is always zero.
- Outside conducting surface electric field is $\frac{\sigma}{\varepsilon_0}$.
- When two conductor is connected then their potential becomes same
- Conductor creator equipotential region.
- charge is placed near to conductor then $\vec{E}_{net}$ inside condu = 0



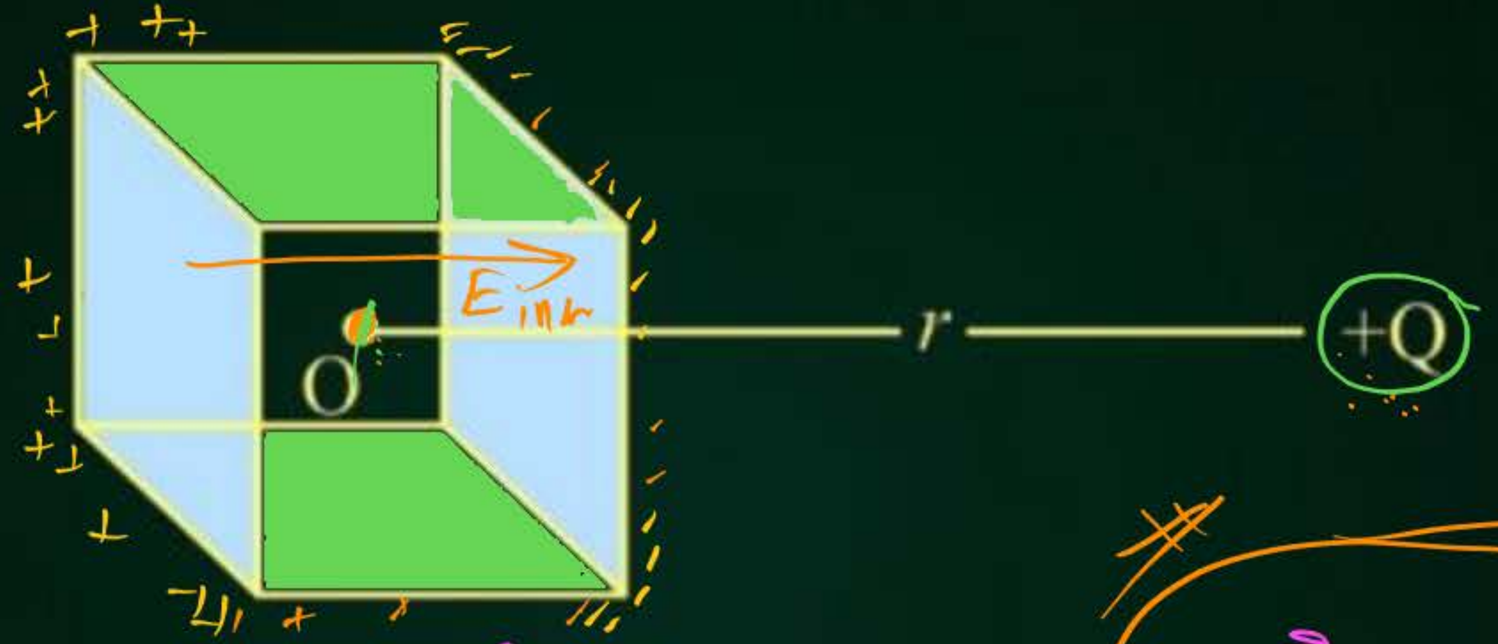
Neutral conductor

$(E_0)_{Net} = 0$

$(E_0)_{+Q} = \frac{KQ}{r^2}$

$(E_0)_{\text{due Induced charge}} = -\frac{KQ}{r^2}$

JEE



Neutral Conductor Cube.

(Q) find electric field due to Induced charge at centre of cube ??

(a) zero

(b) KQ/r^2

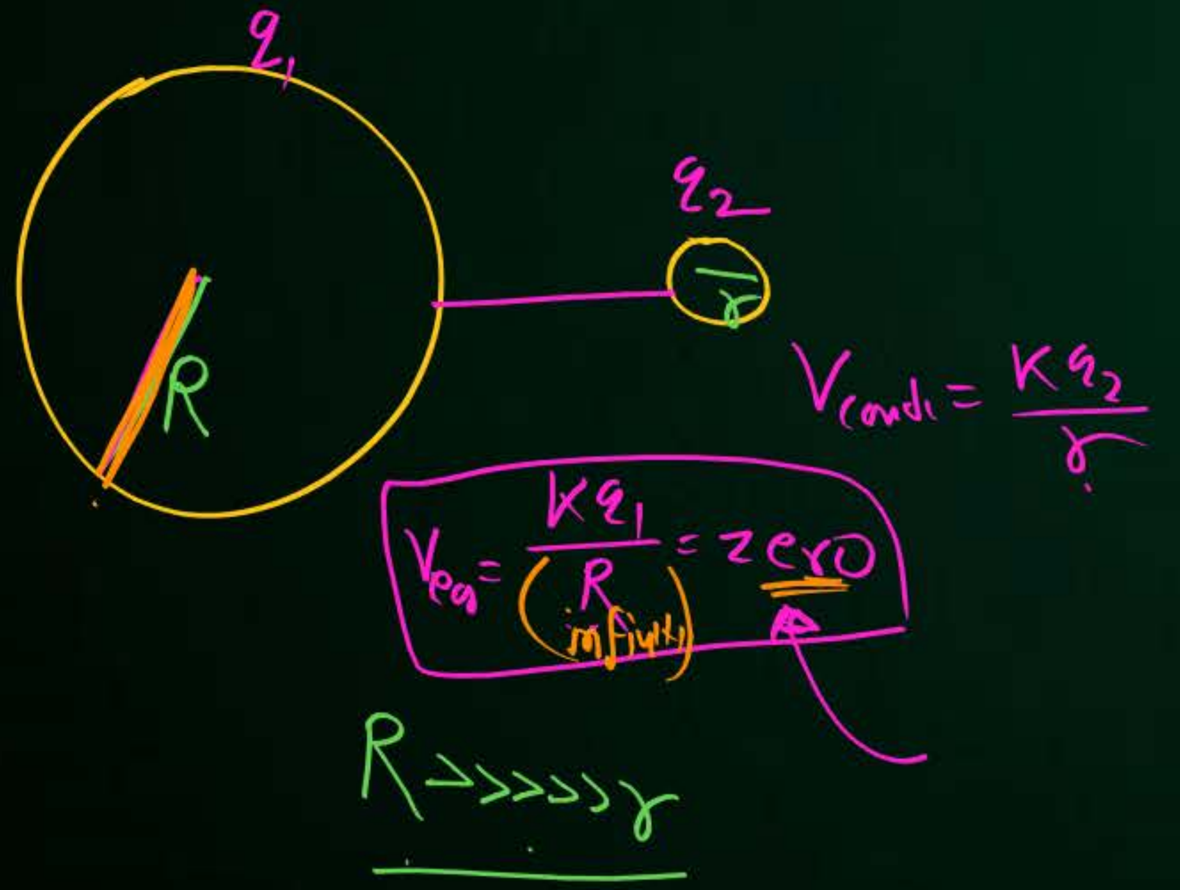
(c) $-KQ/r^2$

$$\vec{E}_{net} = 0 = \vec{E}_{+Q} + \vec{E}_{induce}$$

$$\vec{E}_{Induce} = -\vec{E}_{+Q} = -\frac{KQ}{r^2}$$

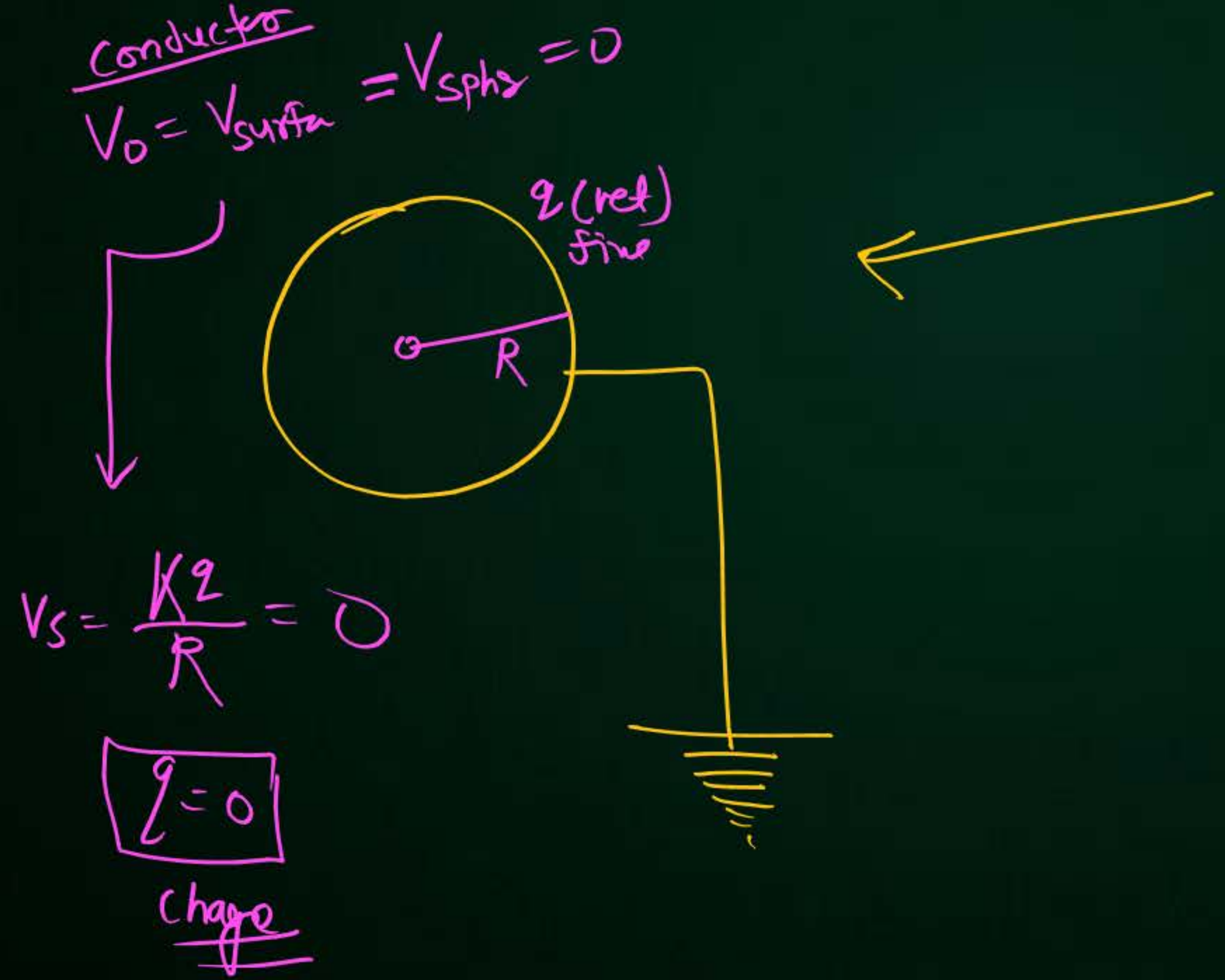
EARTHING OF CONDUCTOR

- Charge may or may not be zero on conductor but potential must becomes zero after connecting with earth.



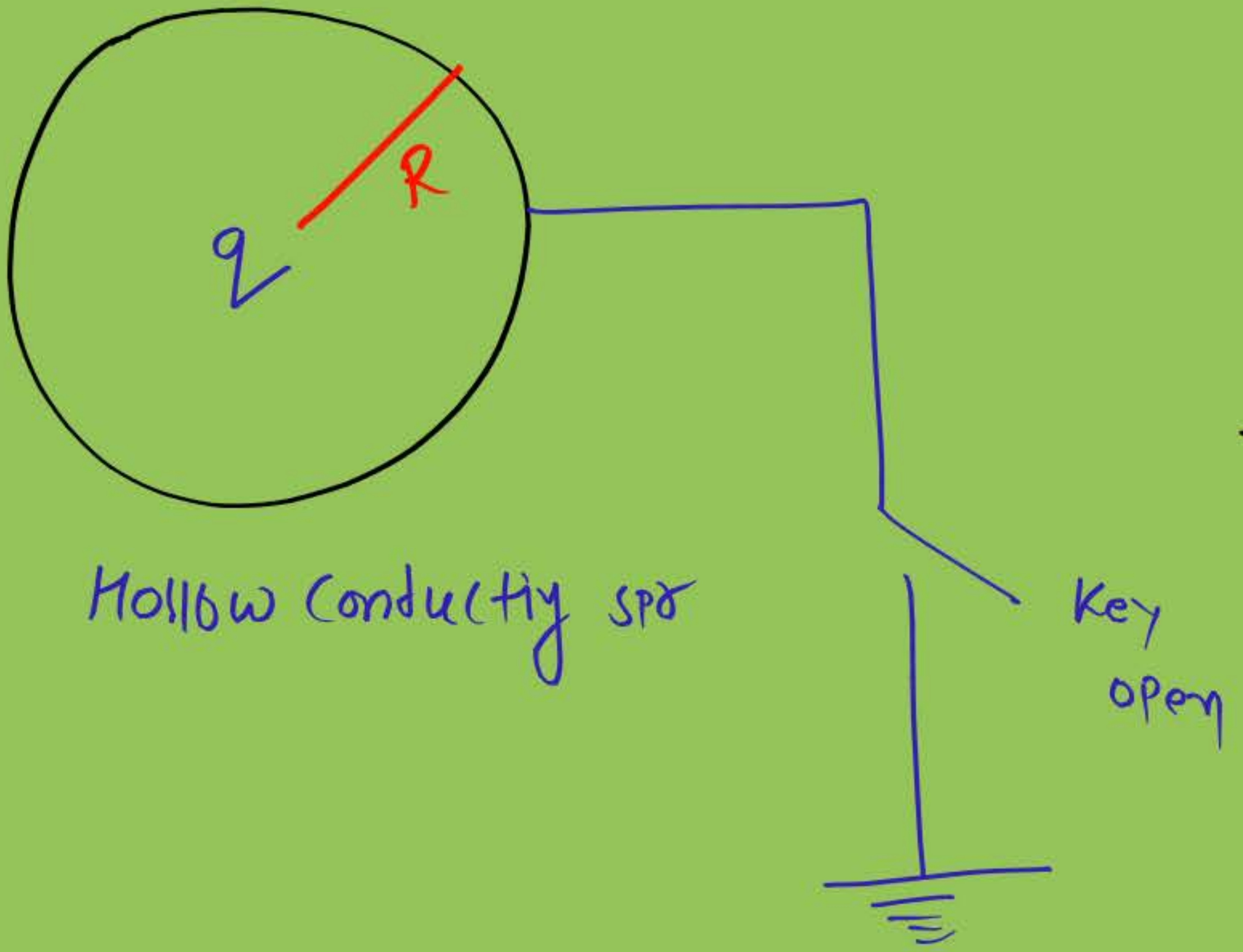
QUESTION

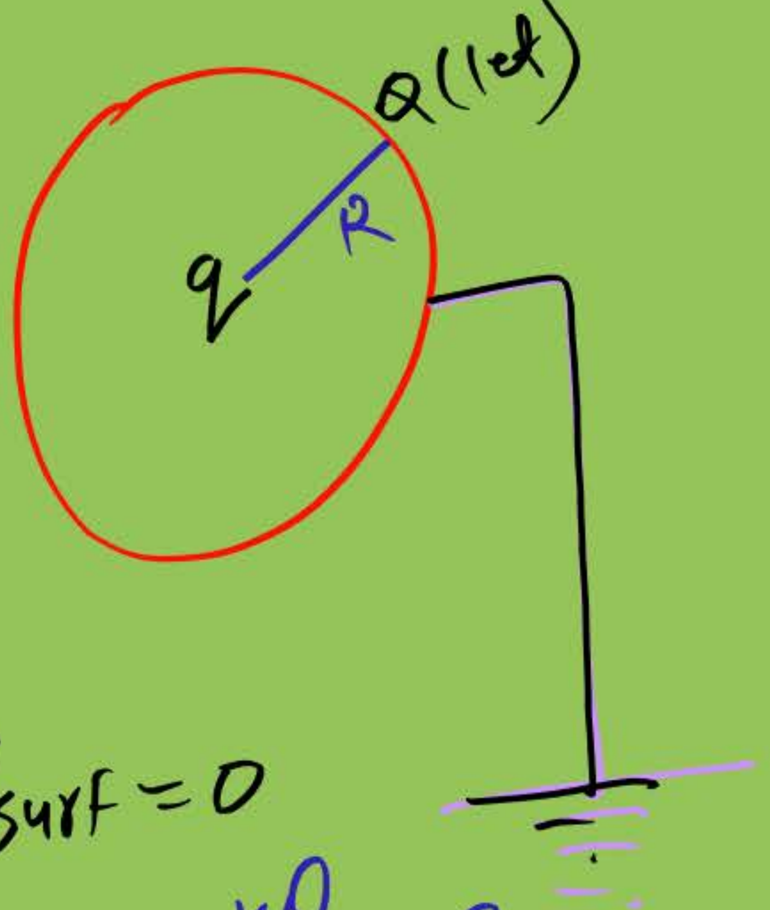
After connecting key final charge and potential of sphere.





find charge & Potential on surface of sphere when key is closed





$V_{surf} = 0$

$$\frac{Kq}{R} + \frac{KQ}{R} = 0$$

$$\frac{KQ}{R} = -\frac{Kq}{R}$$

$$Q = -q$$

QUESTION

Find : (q) let = ?



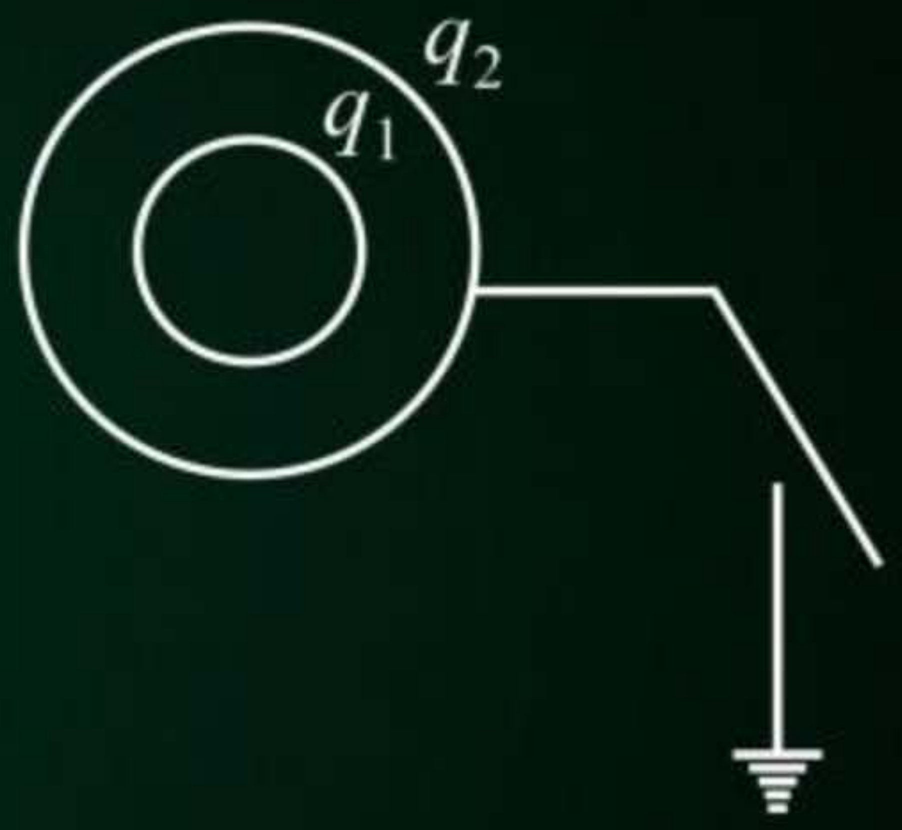
$$V_0 = 0$$

$$\frac{KQ}{r} + \frac{kq}{R} = 0$$

$$\boxed{q = -\frac{QR}{r}}$$

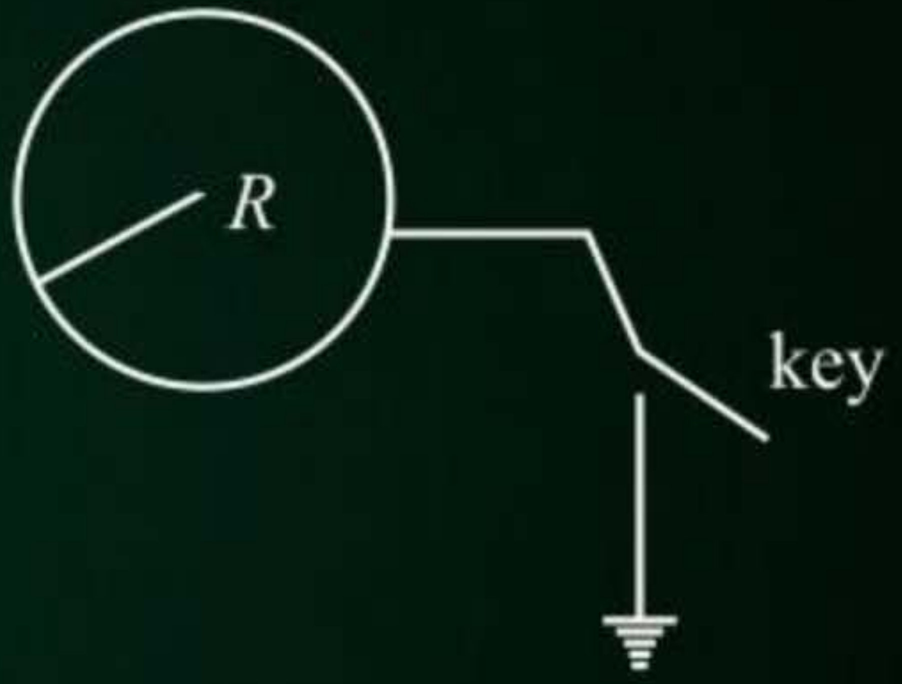
QUESTION

Find charge on each sphere when outer sphere is earthed.



QUESTION

Find charge flows from earth to conductor when switch is closed.



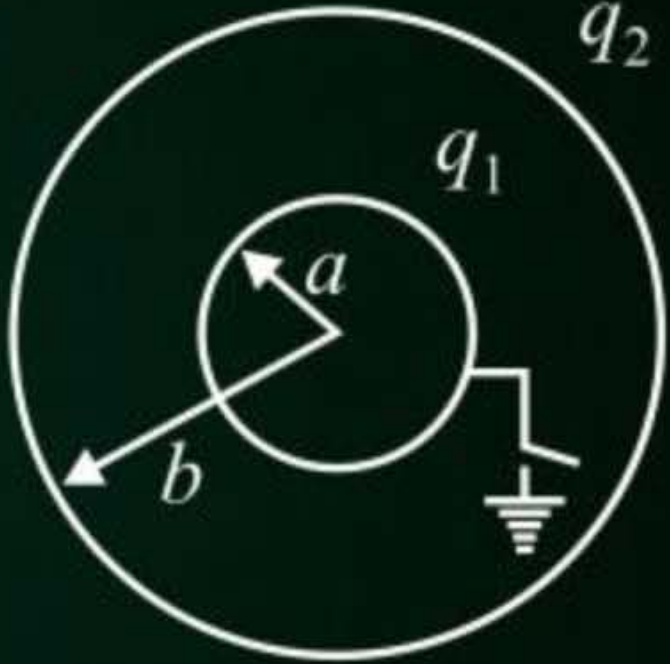
QUESTION

Two concentric hollow metal spheres have radii R_1 and R_2. The outer sphere is given a positive charge Q and the inner is earthed. What is the charge on the inner sphere? $(R_2 > R_1)$.



QUESTION

Find charge on each sphere when inner sphere is earthed.




THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 06 | Physics

Electrostatic Potential and Capacitance

By- Dr. Manish Raj (MR SIR)



Topics to be covered

4 March ko NEET ka paper

1 # Earthing

2 # Capacitor → Parallel plate, spherical

3 #



PRAMOD JADH...
pramod.jadhav18

10:50 PM

Namaskar sir, Mai Pramod Jadhav Karnataka seh, sir mai [redacted] mai padh raha hoon and physics mai yakeen 2.0 batch seh padh raha hoon and idhar mock test mai saare questions notes related content mai seh hee aa rahe hai and idhar saare bacche [redacted] mai aapse hee padh rahe hai , sab aapke deewane hai and almost saare bacche aapse padte hai and even mere ek coordinator hai unko maine kehte hue ye suna ek student ko! yeh Mr sir kon hai..? saare bacche unhi seh padh rahe hai. Yeh kehta hue suna maine. You are too good sir I love you sir . Love from Karnataka ❤️

❤️

QUESTION

In a certain region of space with volume $0.2\ m^3$, the electric potential is found to be 5 V throughout. The magnitude of electric field in this region is (NEET 2020)

1. zero
2. 0.5 N/C
3. 1 N/C
4. 5 N/C

8 min

$V = 0.2\ m^3 = \text{const}$

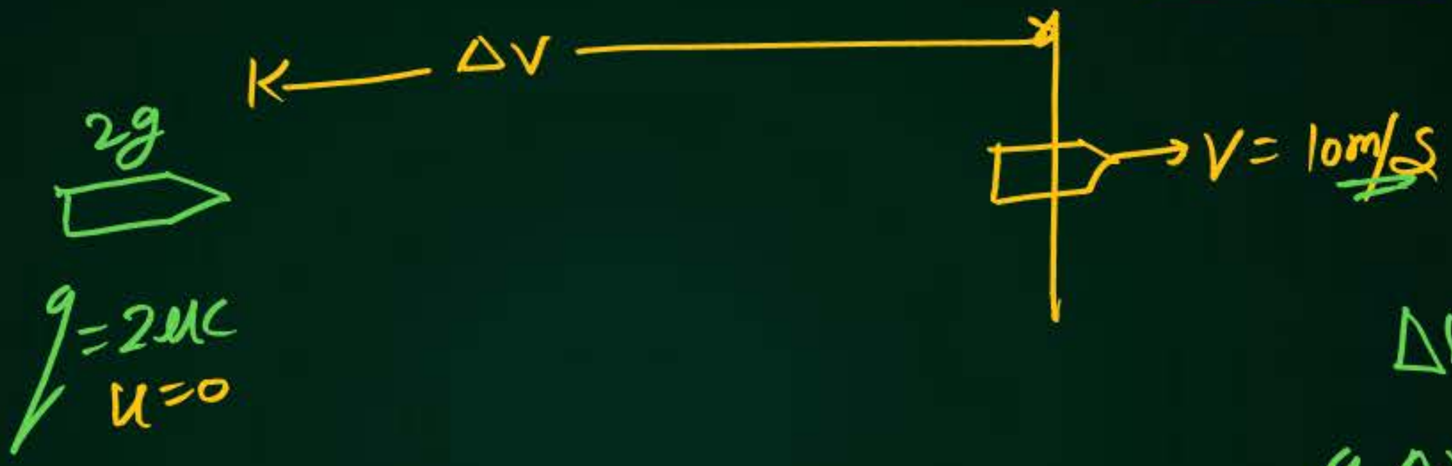
$E = 0$

$\vec{E} = \frac{dV}{dr} = 0$

QUESTION

A bullet of mass 2 g is having a charge of 2μC. Through what potential difference must it be accelerated, starting from rest, to acquire a speed of 10 m/s? **(NEET 2020)**

1. 5 kV
2. 50 kV
3. 5 V
4. 50 V



$\Delta W = \Delta K.E$

$q\Delta V = K.E_f - K.E_i$

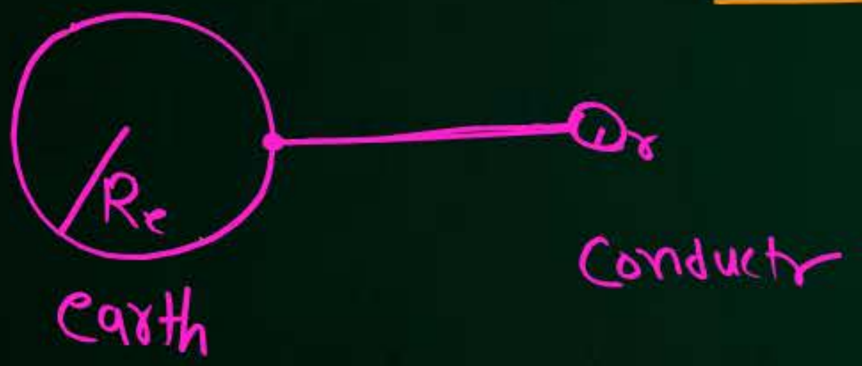
$2\times10^{-6}\,\Delta V = \frac{1}{2}\times 2\times10^{-3}\times(10)^2 - 0$

$\Delta V = \frac{100\times10^{3}}{2} = 50\,kV$

EARTHING OF CONDUCTOR

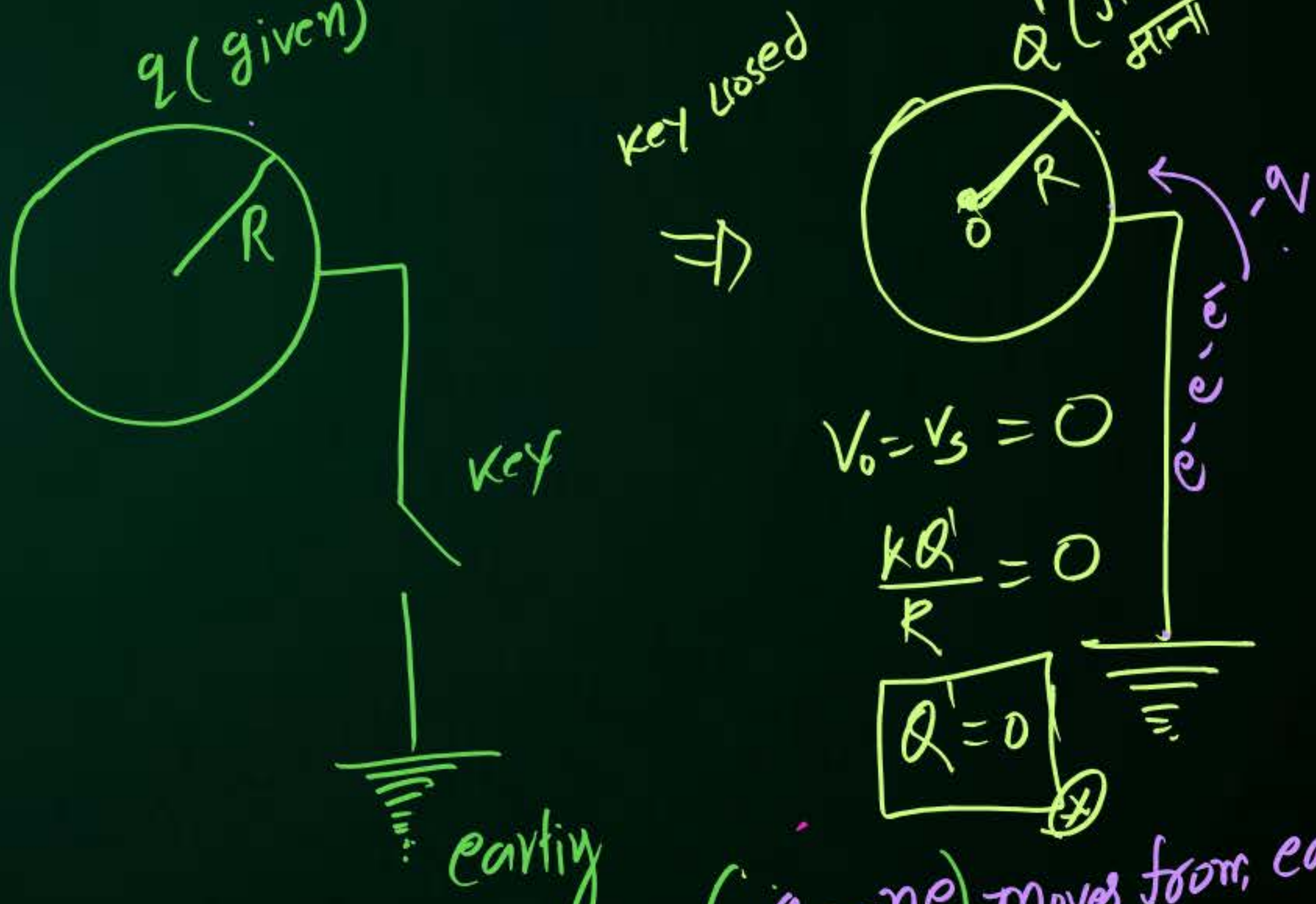
- Charge may or may not be zero on conductor but potential must becomes zero after connecting with earth.

earth is a infinite source of electron.



$R_e >>>>>>> r$

$V_{earth} = 0 = V_{conductor}$



$V_0 = V_s = 0$

$\frac{kQ'}{R} = 0$

$Q' = 0$ ✗

$(-q = -ne)$ moves from earth to sphere

QUESTION

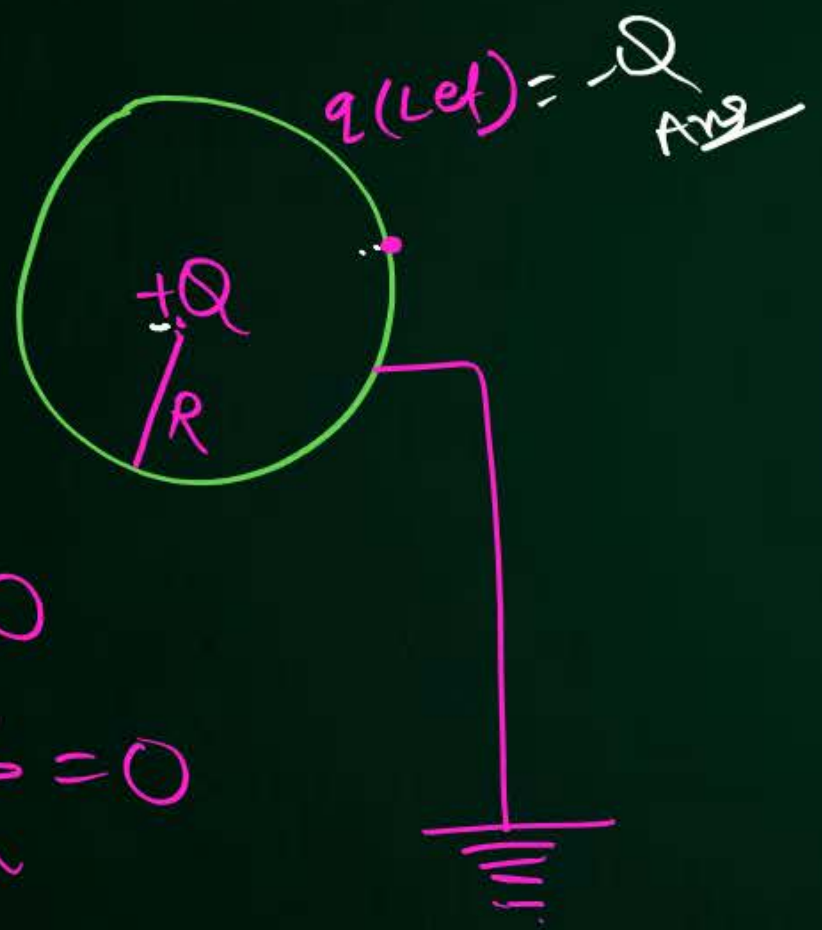
After connecting key final charge and potential of sphere.

$Q'_{final} = 0$
$V = 0$

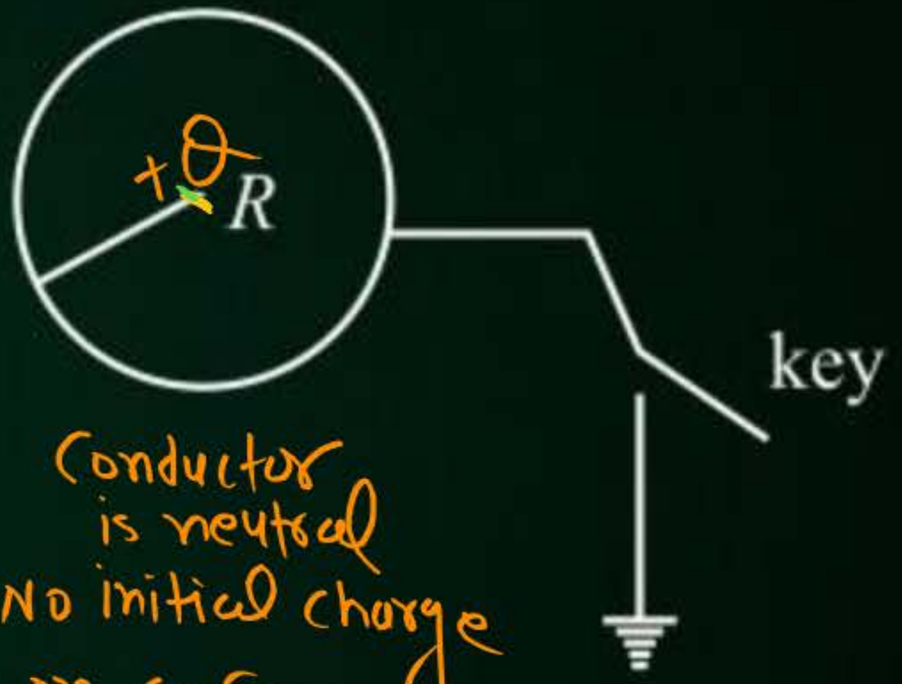


QUESTION

Find charge flows from earth to conductor when switch is closed.



Key is closed ←



Conductor is neutral
No initial charge on surface of sphere

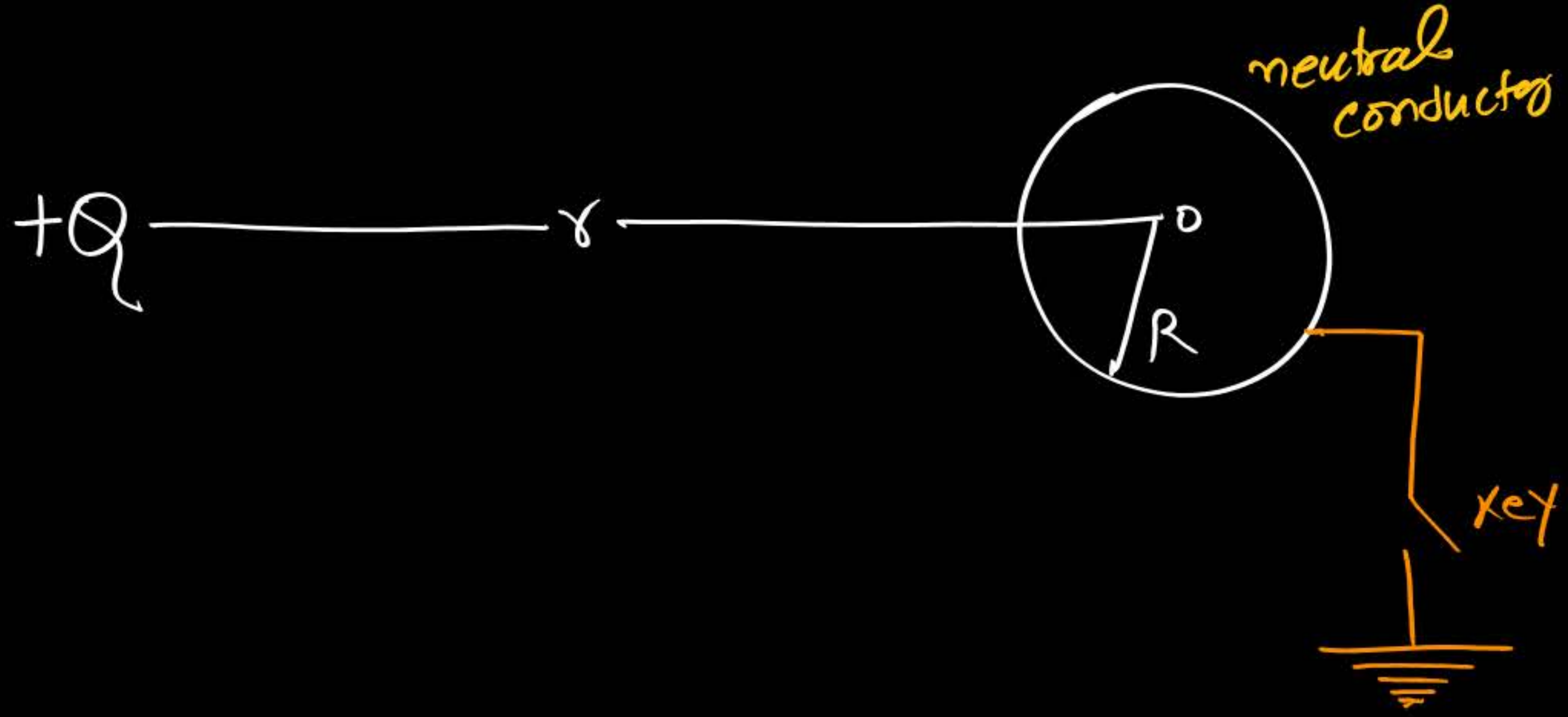
$V_s = 0$

$\frac{KQ}{R} + \frac{Kq}{R} = 0$

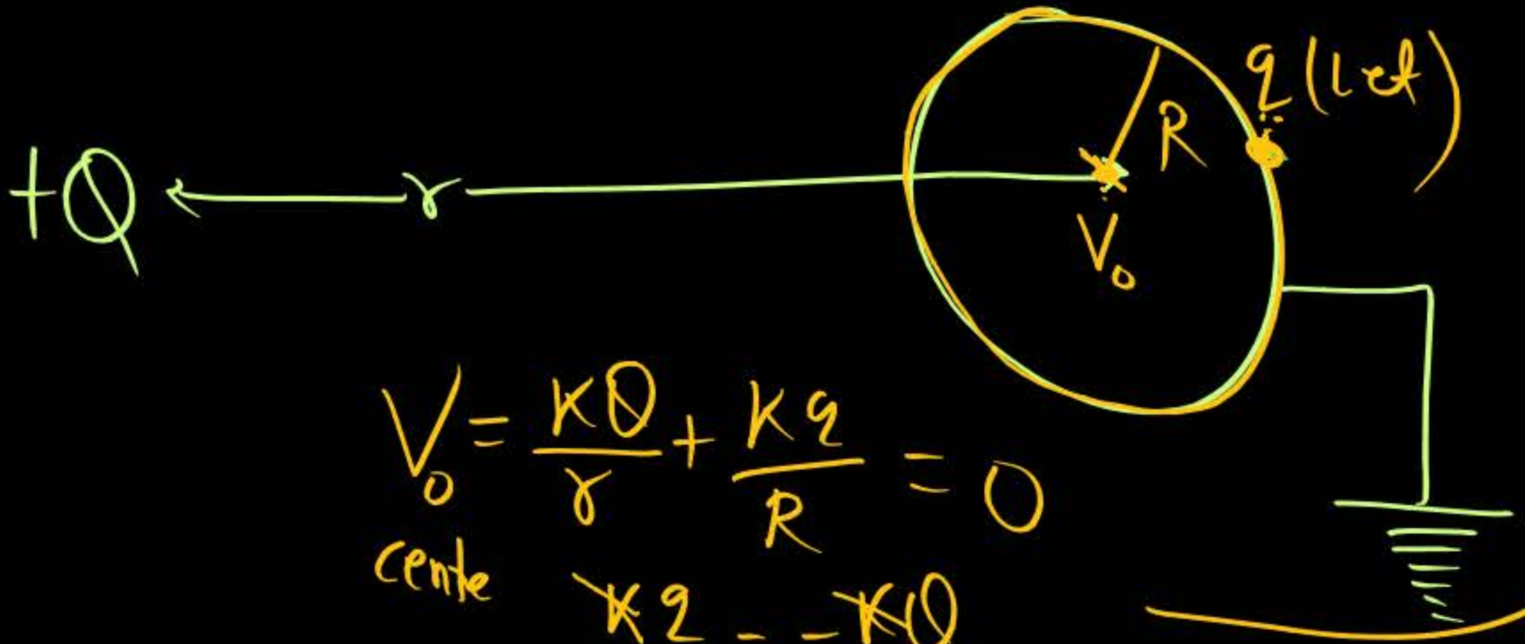
$\frac{Kq}{R} = -\frac{KQ}{R}$

$q = -Q$

→ charge on surface of sphere $= -Q$ — This amount of charge flows from earth to sphere.



Find charge on sphere when key is closed.



$$V_0 = \frac{KQ}{r} + \frac{Kq}{R} = 0$$

centre

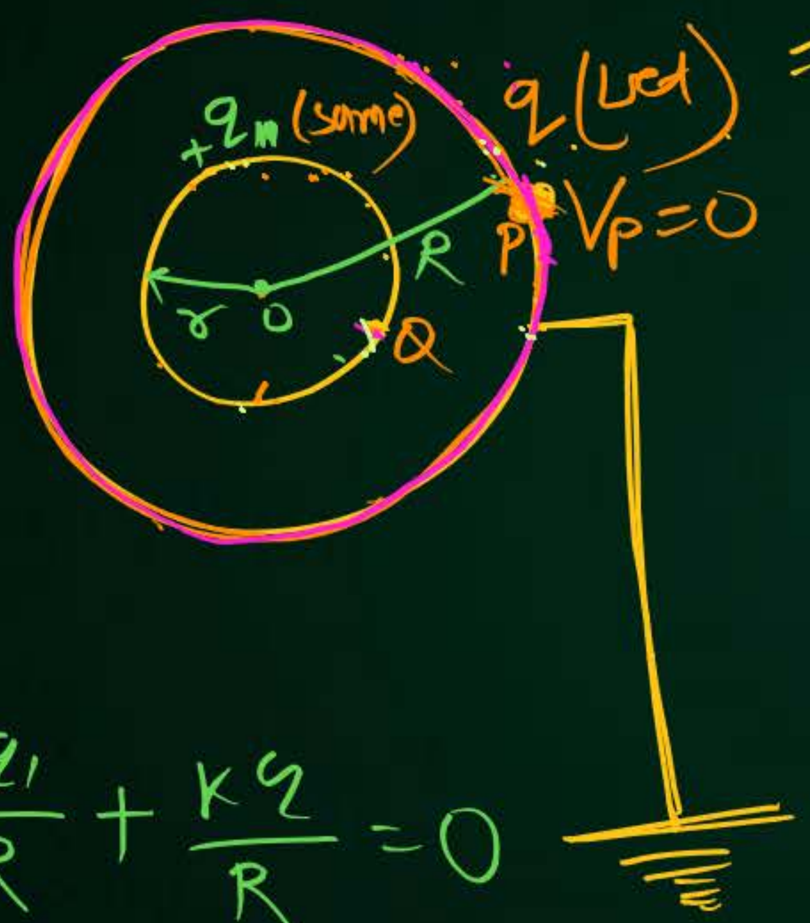
$$\frac{Kq}{R} = -\frac{KQ}{r}$$

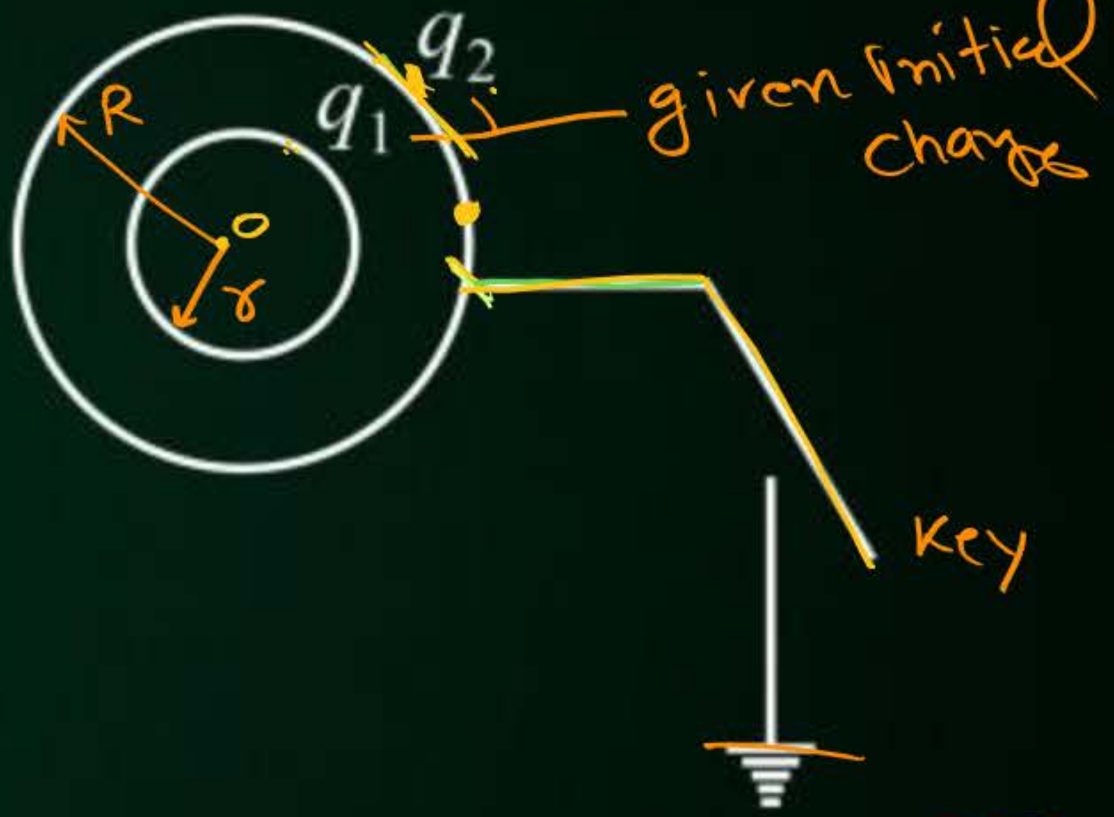
$$q = -\frac{RQ}{r}$$ Ans

$$V_{sph} = 0$$

QUESTION

Find charge on each sphere when outer sphere is earthed.





$V_P = \frac{Kq_1}{R} + \frac{Kq}{R} = 0$

$\frac{Kq}{R} = -\frac{Kq_1}{R}$

$q = -q_1$ Ans.

find Potential diff^n B/w two sphere after earthing.

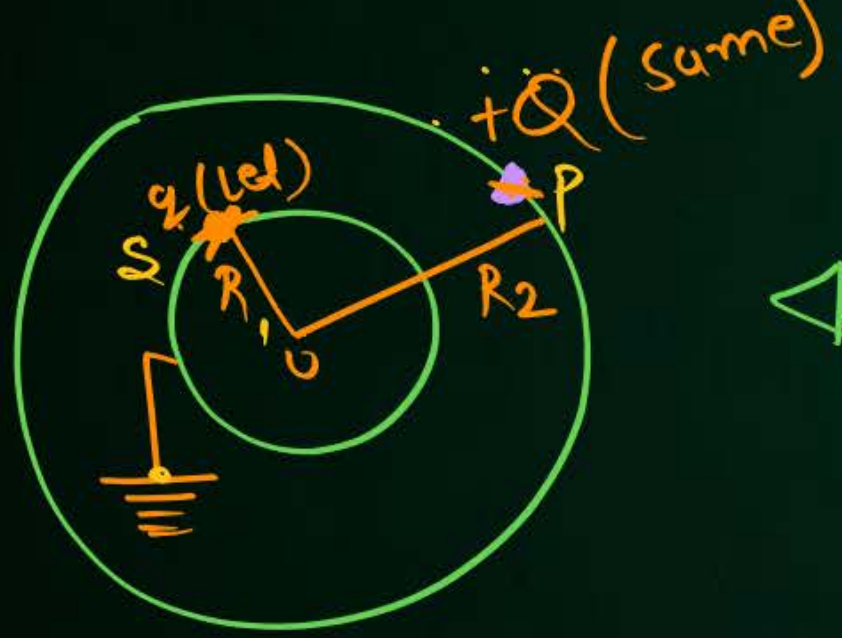
$\Delta V = V_Q - V_P = \frac{Kq_1}{r} - \frac{Kq_1}{R} = Kq_1\left(\frac{1}{r} - \frac{1}{R}\right)$ Ans

Charge on Inner sphere remains same

Level up

QUESTION

Two concentric hollow metal spheres have radii R_1 and R_2. The outer sphere is given a positive charge Q and the inner is earthed. What is the charge on the inner sphere? $(R_2 > R_1)$.





$V_{\text{surface of Inner}} = 0$

$V_S = \frac{Kq}{R_1} + \frac{KQ}{R_2} = 0$ $\quad \frac{Kq}{R_1} = -\frac{KQ}{R_2}$ $\quad q = -\frac{R_1 Q}{R_2}$

final charge on inner surface

$(\Delta V)_{B/w \text{ surface of sphere}} = V_P - V_S \; (\to 0)$

$= V_P$

$= \frac{KQ}{R_2} + \frac{Kq}{R_2}$

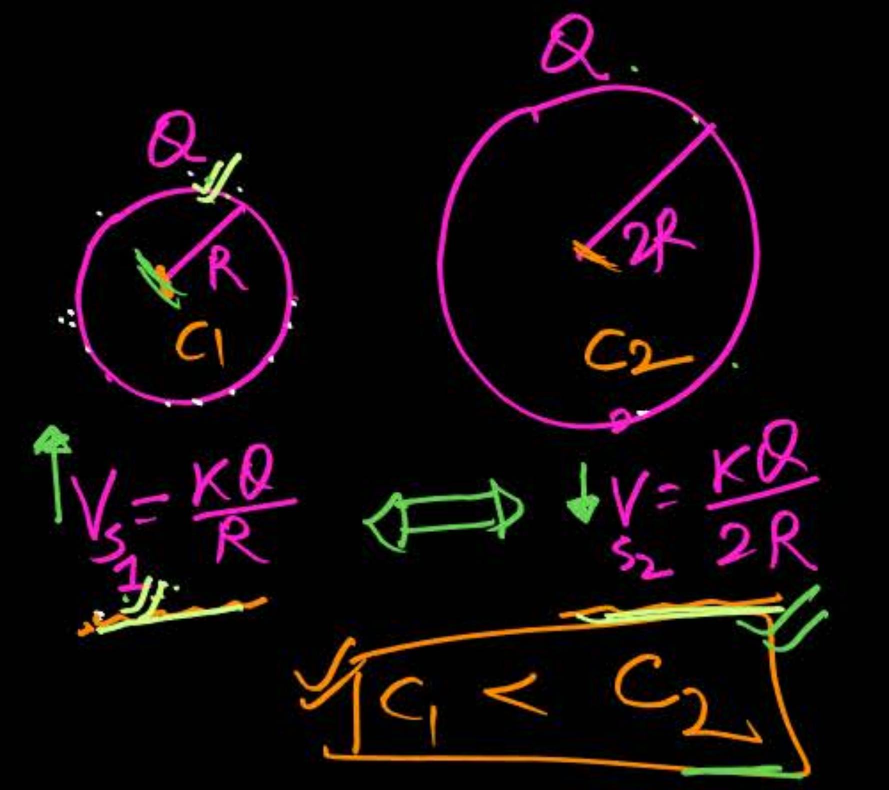
$= \frac{KQ}{R_2} - \frac{KR_1Q}{R_2^2}$

$= \frac{KQ}{R_2}\left[1 - \frac{R_1}{R_2}\right]$

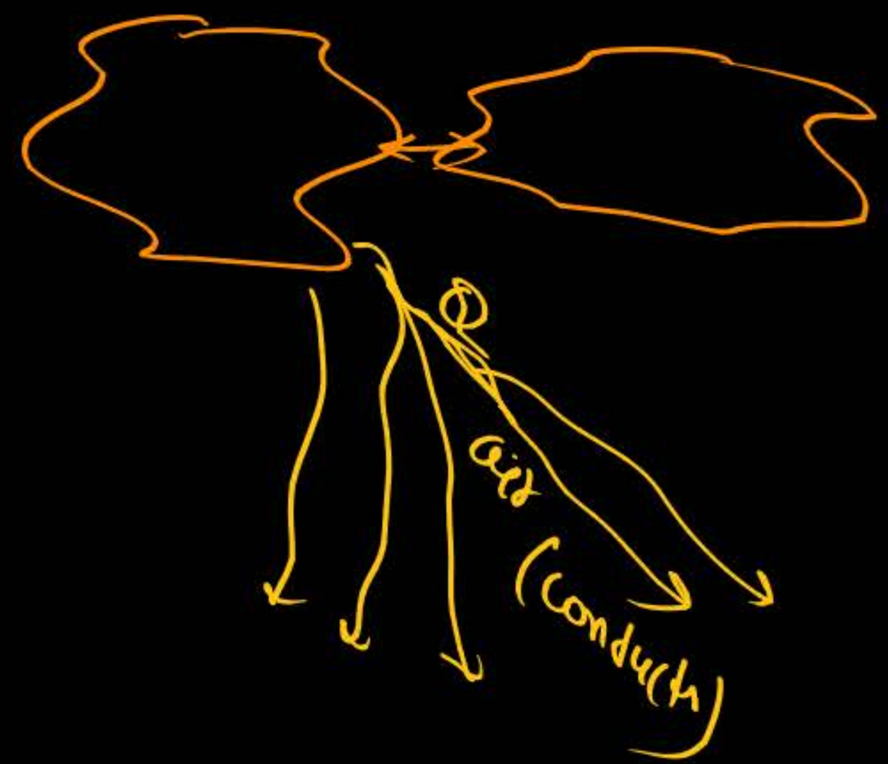
$= \frac{KQ}{R_2}\left(\frac{R_2 - R_1}{R_2}\right)$

air → Insulator

air → conductor



air is dielectric at low Potential (field) it behave as Insulator but at high Potential it behave as conductor.



Capacitor

Capacitance ($\propto Q$ (storing charge))

CAPACITOR

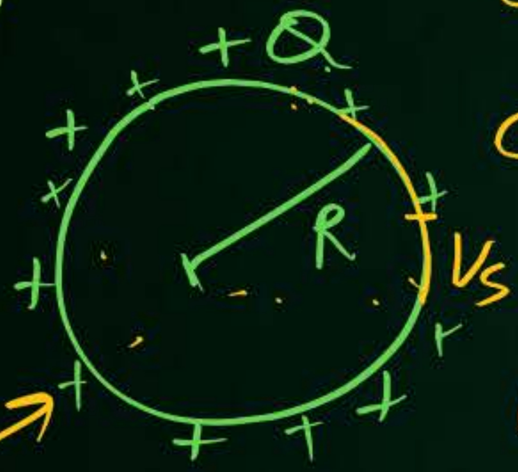
→ Capacitor is a device, which is use to store electrostatic enegy by storing charge.

$V = IR$

$R = \frac{V}{I}$ [redacted]

→ Resistance

$\rightarrow$ I R



संधारित्र → Capacitor

Hollow sphere.

$C \propto Q_{max}$ (charge)

$C \propto \frac{1}{V}$ (Potential)

$C = \left[\frac{Q}{V}\right]$

$\left[C = \frac{Q}{V}\right]$

→ capacitance

→ Scalar

→ C/volt = farad



$C = \frac{Q}{V}$

$= \frac{Q}{\frac{KQ}{R}} = \frac{R}{K}$

$C = 4\pi\varepsilon_0 R$

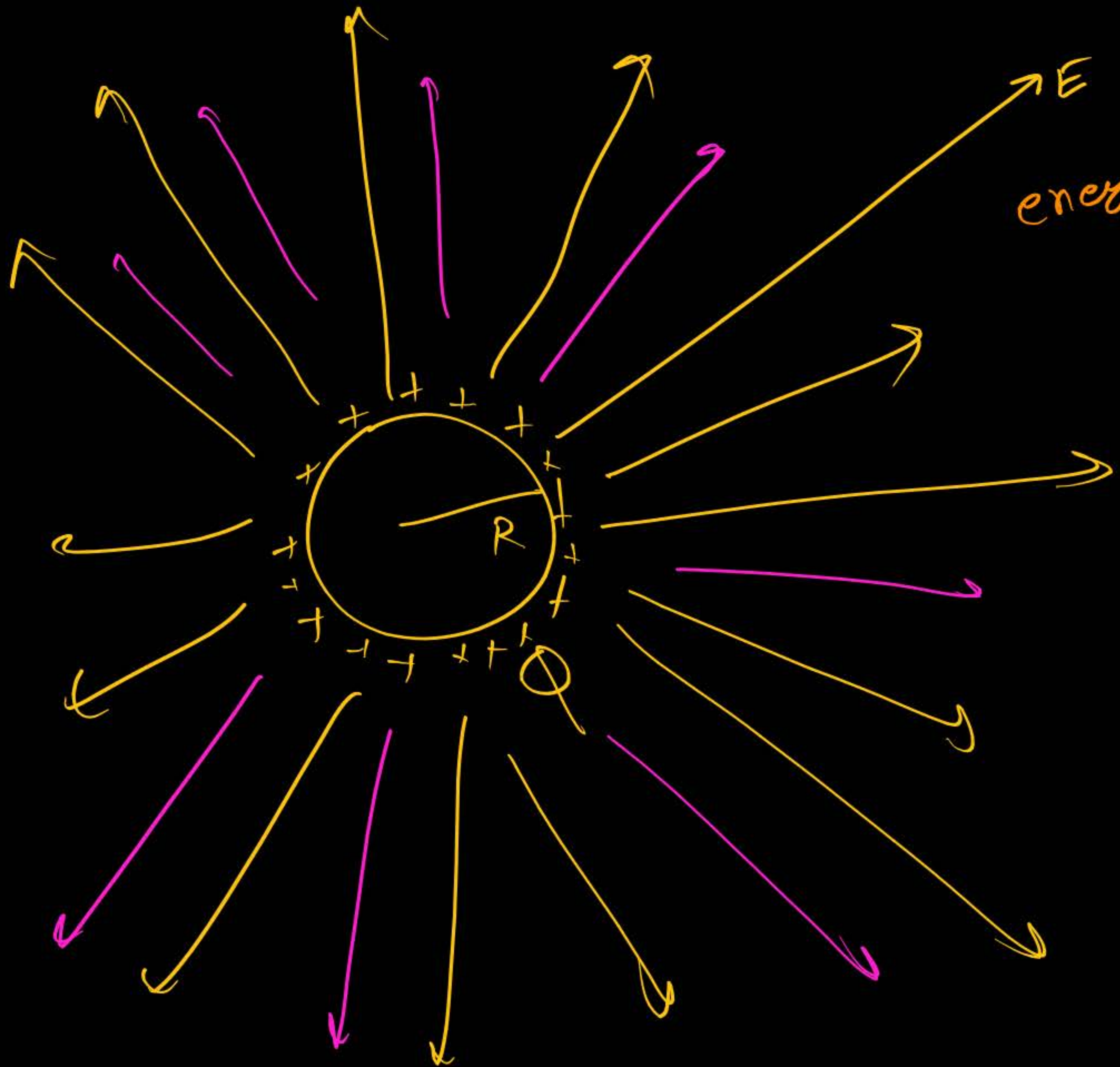
$C \propto$ Radius

$C \propto \varepsilon_0$ (medium)

does capacitance depends on charge → NO

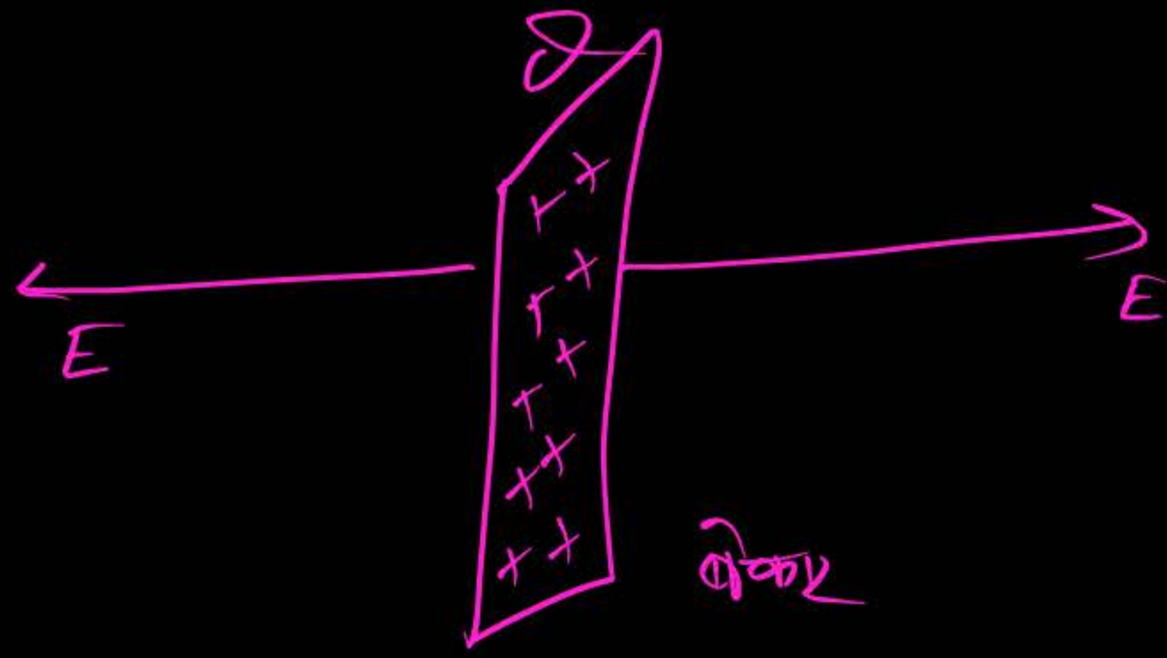
does capacitan depended on potentia → NO

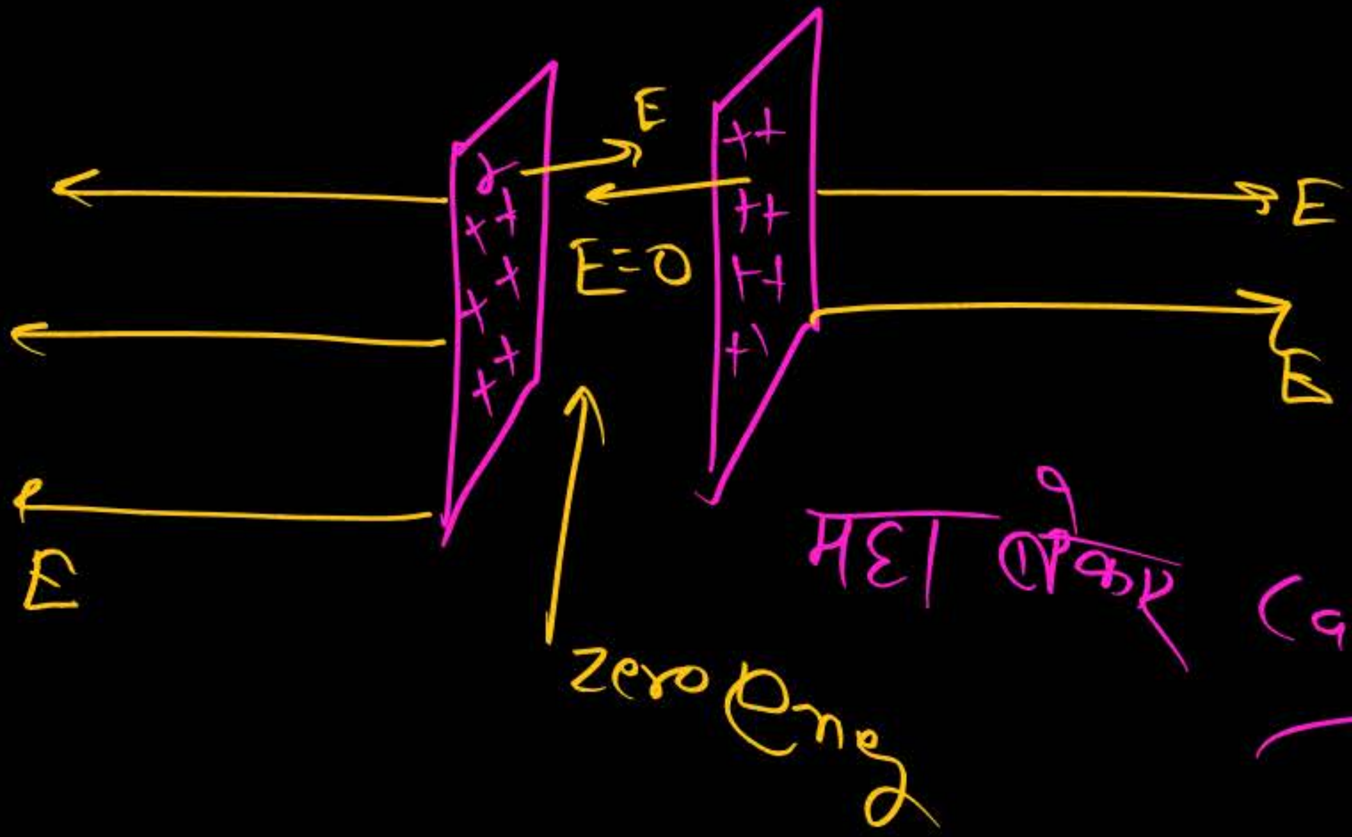
does capacitance dependence on ratio of Q & V = Q/V (Yes)



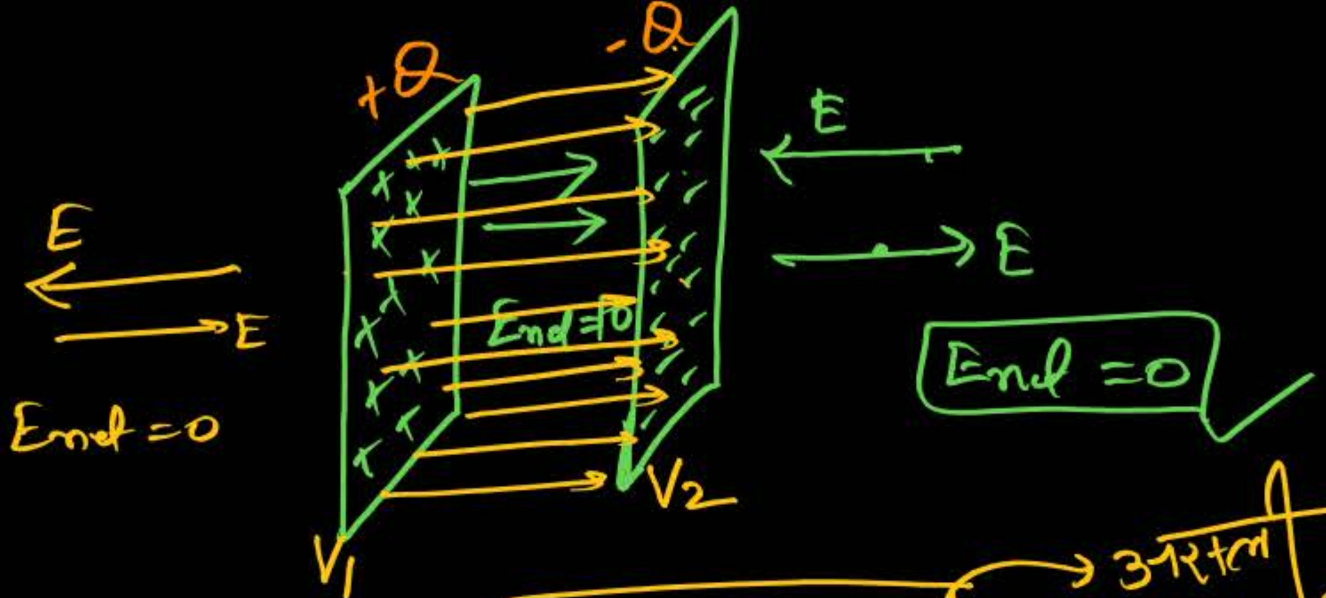
energy of this capacitor is distributed (stored) from surface to infinity.

बेकार capacitor





महा चालक Capacity



$$C = \frac{Q}{V_1 - V_2}$$

definition

CAPACITOR

Combination of two conductor used to store electrostatic energy, by storing charge.

- Any arrangement of two isolated conductors carrying equal and opposite charges can be called as capacitor.
- If $\Delta V = V_1 - V_2$ potential difference and charge Q and $-Q$ respectively then capacitance $C = \frac{Q}{\Delta V} = \frac{Q}{V_1 - V_2}$
- Scalar
- S.I. unit farad; 1 FARD = 1 C/V.



QUESTION

What is capacitance of earth.??

Solution:

Earth is sphere, hence its capacitance

$$C = 4\pi\varepsilon_0 R = \frac{R}{K}$$

$$= \frac{1}{9\times10^9} \times 6400 \times 10^3 = 711\ \mu F$$

1 farrad

$C = \frac{Q}{V} = \frac{1C}{1V}$ } = 1 farad

C = P farad = 10^{-12} f

C = μ farad = 10^{-6} f

C = m farad = 10^{-3} f

C = n farad = 10^{-9} f

➢ Air is insulator upto certain field, after that it behave as conductor, that limit is called dielectric strength of air $(3 \times 10^6\ N/C)$

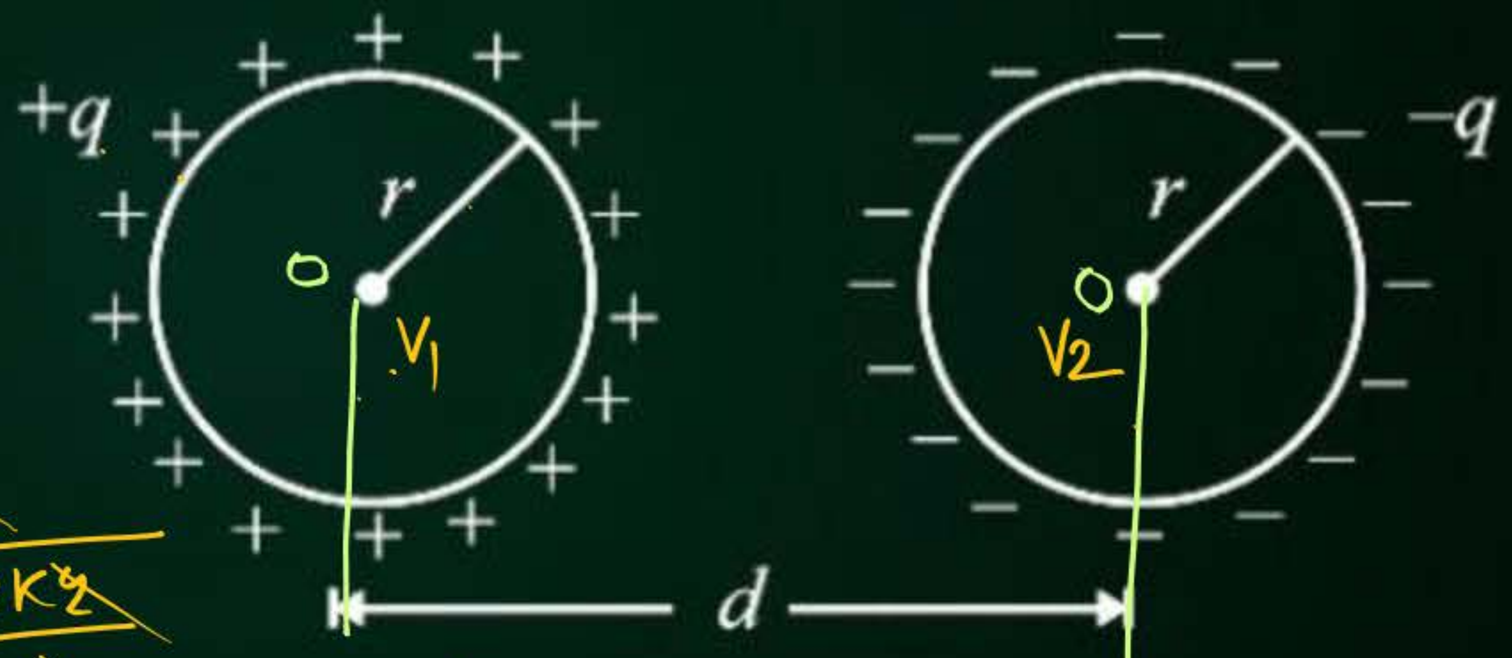
value of electric field at which medium change its Nature from insulator to conductor

QUESTION

Two similar conducting balls having charges $+q$ and $-q$ are placed at a separation d from each other in air. The radius of each ball is r and the separation between their centres is $d(d >> r)$. Calculate the capacitance of the two ball system

↳ sphere at large dist^n

1. $4\pi\varepsilon_0 r$
2. $2\pi\varepsilon_0 r$ ✓
3. $4\pi \log_e \frac{\varepsilon_0 r}{d}$
4. $4\pi \log_e \frac{r}{d}$



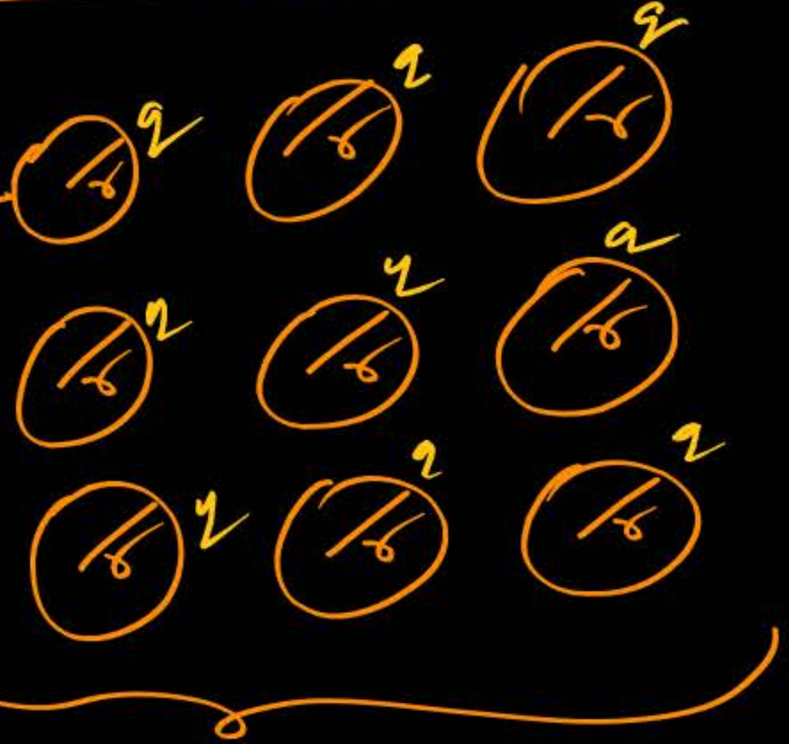
$V_1 = \frac{Kq}{r}$ $V_2 = \frac{-Kq}{r}$

$C = \frac{q}{V_1 - V_2}$

$= \frac{q}{\frac{Kq}{r} - \left(\frac{-Kq}{r}\right)} = \frac{q}{\frac{2Kq}{r}}$

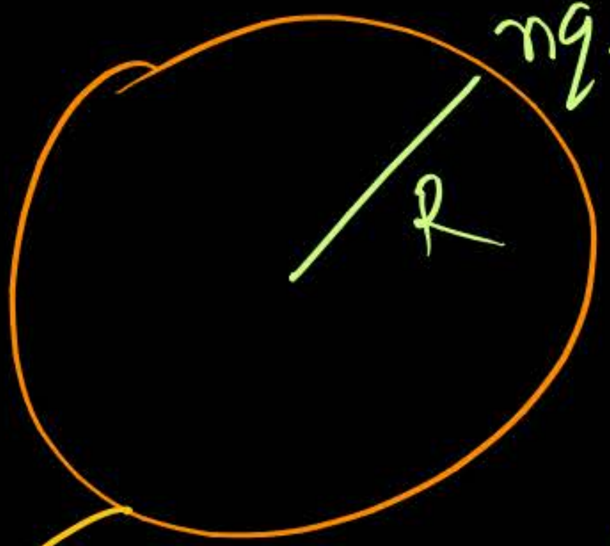
$C = \frac{4\pi\varepsilon_0 r}{2} = 2\pi\varepsilon_0 r$

Combination n - small spherical capacitor



n - no of small capa

coalesce



$nq = q_{total}$

volume constant

$R = n^{1/3} r$ — (1)

$C = 4\pi\varepsilon_0 r$

$V = \frac{Kq}{r}$

$U = \frac{Kq^2}{2r}$ (energy stored on one small capacitor)

#
$q' = nq$
$R = n^{1/3} r$
$C' = n^{1/3} C$
$V' = n^{2/3} V$
$U' = n^{5/3} U$

$V' = \frac{Knq}{R}$

$V' = \frac{Knq}{n^{1/3} r} = n^{1-1/3} V$

$V' = n^{2/3} V$

$C' = 4\pi\varepsilon_0 R$
$= 4\pi\varepsilon_0 n^{1/3} r$
$C' = 4\pi\varepsilon_0 n^{1/3} r$

$C' = n^{1/3} C$

$U' = n^{5/3} U = \frac{K(nq)^2}{2R}$

QUESTION

1000 small water drops each of capacitance C join together to form one large spherical drop. The capacitance of bigger sphere is

1. C
2. 10 C
3. 100 C
4. 1000 C

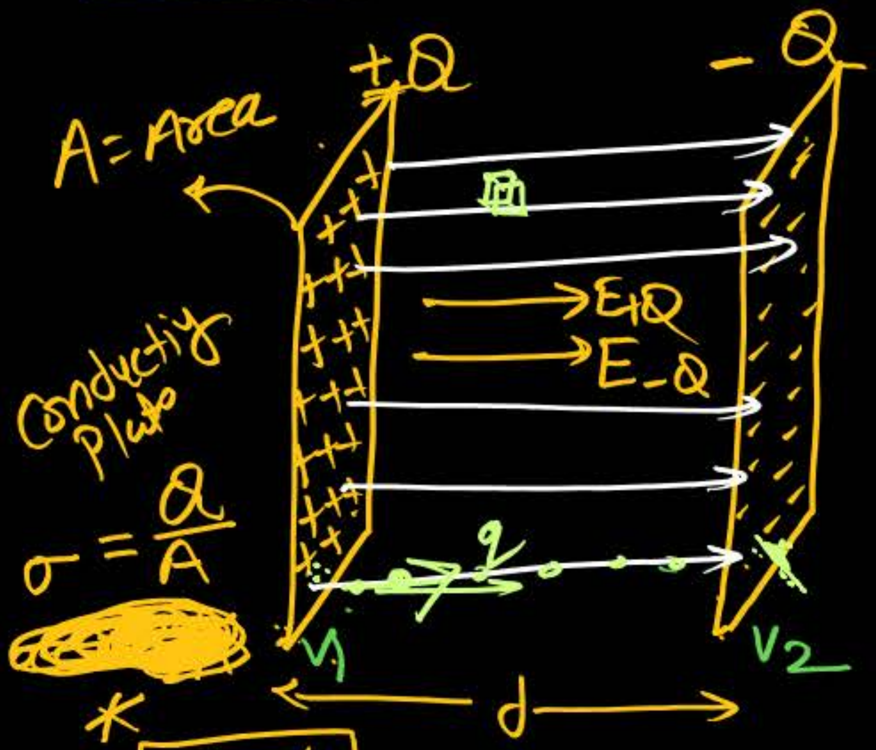
$n = 10^3$

$C' = n^{1/3} C$

$= 10^{3 \times \frac{1}{3}} C$

$= 10C$

Parallel plate capacitor



$\sigma = \frac{Q}{A}$

* $V_1 > V_2$



$E_{+Q} = \frac{Q}{2A\varepsilon_0}$ (due to one plate)

$E_{-Q} = \frac{Q}{2A\varepsilon_0}$

$E_{net} = \frac{Q}{2A\varepsilon_0} + \frac{Q}{2A\varepsilon_0} = \frac{Q}{A\varepsilon_0}$

$E_{net} = \frac{Q}{A\varepsilon_0}$ (uniform field b/w these two plate)

$|\Delta \vec{V}| = E \times dist^n$

$|V_1 - V_2| = \frac{Q}{A\varepsilon_0} \times d$

capacitance $C = \frac{Q}{\Delta V}$

$C = \frac{Q}{\frac{Qd}{A\varepsilon_0}}$

$$\boxed{C_0 = \frac{\varepsilon_0 A}{d}}$$

air medium is inside

$\boxed{\varepsilon_m = \varepsilon_r \varepsilon_0 = K\varepsilon_0}$

In a other medium

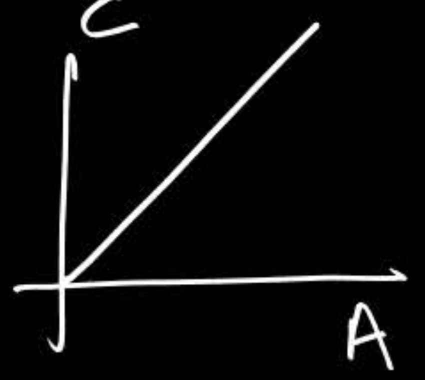
$$\boxed{C_m = \frac{\varepsilon_m A}{d}}$$

$C_m = \frac{K\varepsilon_0 A}{d}$

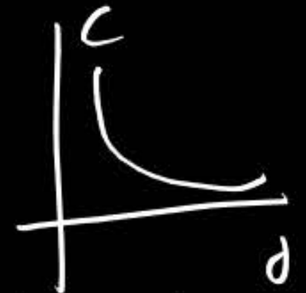
$$\boxed{C_m = K C_0}$$

C_m ← in medium; K ← dielectric const^n; C_0 ← in air

$C \propto Area$



$C \propto \frac{1}{d}$



$C \propto \varepsilon_m$

capacitance does not depend on charge & potential but depend on geometric size & medium.

$E_{net} = \frac{Q}{2A\varepsilon_0} + \frac{Q}{2A\varepsilon_0} = \frac{Q}{A\varepsilon_0}$

$\Delta V = E_{ne} \times dist$

$= \frac{Qd}{A\varepsilon_0}$

$$C = \frac{Q}{\Delta V}$$

$C = \frac{Q}{\frac{Qd}{A\varepsilon_0}}$

$$C = \frac{\varepsilon_0 A}{d}$$

$C \propto \varepsilon_0$

$C \propto A$

$C \propto \frac{1}{d}$

force on one plate due to others.

$F = Q(\vec{E})_{one\ plate}$

$= Q \times \frac{Q}{A\varepsilon_0}$] (a) ✗ 23%

$F = Q \times \frac{Q}{2A\varepsilon_0}$] (b) ✓ 72%

$$F = \frac{Q^2}{2A\varepsilon_0}$$ ← Force on one plate

$Pressure = \frac{F}{A} = \frac{Q^2}{2A^2\varepsilon_0}$

$P = \frac{Q^2}{2A^2\varepsilon_0}$ $\left(\sigma = \frac{Q}{A}\right)$

$$Pressure = \frac{\sigma^2}{2\varepsilon_0}$$

acting on plate

$$Pressure = \frac{\sigma^2}{2\varepsilon_0}$$

dimension $P = \frac{F}{A} = ML^{-1}T^{-2}$

energy density $U = \frac{E}{volume} = ML^{-1}T^{-2}$

dimension of Pressure & energy density is same

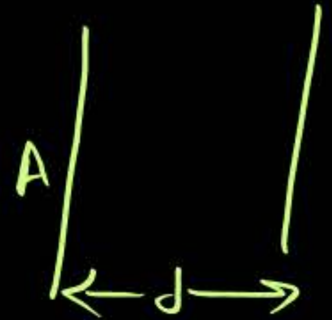
energy density = energy stored per unit volume

$$U = \frac{\sigma^2}{2\varepsilon_0}$$

Total stored energy

$$E = U \times \text{volume}$$

$$= \frac{\sigma^2}{2\varepsilon_0} \times A d$$



$$\text{Energy} = \frac{Q^2}{2A^2\varepsilon_0} A d$$

$$= \frac{Q^2}{2\left(\frac{A\varepsilon_0}{d}\right)}$$

$$\text{total Energy Stored} = \frac{Q^2}{2C}$$

$$U = \frac{\sigma^2}{2\varepsilon_0}$$ ← energy per unit volume.

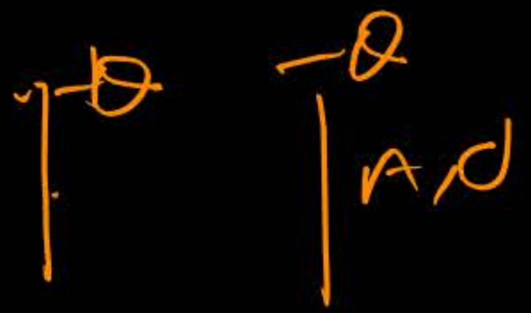
$$E = \frac{Q^2}{2C} \qquad C = \frac{Q}{V}$$

$$Q = CV$$

Putting value of 'Q'

$$\text{Energy} = \frac{C^2V^2}{2C}$$

$$\text{Energy} = \frac{1}{2}CV^2 = \frac{Q^2}{2C} = \frac{QV}{2}$$



$$E = \frac{Q}{2A\epsilon_0} + \frac{Q}{2A\epsilon_0} = \frac{Q}{A\epsilon}$$

$$\Delta V = \frac{Q}{A\epsilon_0} \times d$$

$$C = \frac{Q}{\Delta V}$$

$$C = \frac{Q}{\frac{Qd}{A\epsilon}}$$

$$C = \frac{\epsilon_0 A}{d}$$

$$F = QE$$

$$F = Q\left(\frac{Q}{2A\epsilon_0}\right)$$

$$C = \frac{\epsilon_0 A}{d}$$

$$F = \frac{Q^2}{2A\epsilon_0}$$

$$F_m = \frac{Q^2}{2A\epsilon_0}$$

$$C \propto A \quad = \frac{\sigma^2}{2\epsilon_0}$$

$$C \propto \frac{1}{d} \quad E = \frac{\sigma^2}{2\epsilon_0} \times Ad$$

$$= \frac{Q}{2}$$

DIMENSION OF CAPACITANCE

$$C = \frac{Q}{V} = \frac{C}{J/C} = \frac{C^2}{J} = \frac{I^2T^2}{ML^2T^{-2}} = M^{-1}L^{-2}T^4I^2$$

$$E = \frac{Q^2}{2C}$$

$$C = \frac{Q^2}{eny} = \frac{A^2T^2}{ML^2T^{-2}} = M^{-1}L^{-2}T^4A^2$$

PARALLEL PLATE CAPACITOR

(i) Electric field between the plate



QUESTION

A parallel plate condenser with oil between the plates (dielectric constant of oil K = 2) has a capacitance C. If the oil is removed, then capacitance of the capacitor becomes

(1999)

air

1. $C/\sqrt{2}$
2. $2C$
3. $\sqrt{2}C$
4. $C/2$

$C_m = K C_0$

$C = 2 C_0$

$C_0 = \frac{C}{2}$

QUESTION

The capacitance of a parallel plate capacitor with air as medium is 6μF. With the introduction of a dielectric medium, the capacitance becomes 30μF. The permittivity of the medium is ($\varepsilon_0 = 8.85 \times 10^{-12} C^2 N^{-1} m^{-2}$) **(NEET 2020)**

1. $0.44 \times 10^{-13} C^2 N^{-1} m^{-2}$
2. $1.77 \times 10^{-12} C^2 N^{-1} m^{-2}$
3. $0.44 \times 10^{-10} C^2 N^{-1} m^{-2}$
4. $5.00 C^2 N^{-1} m^{-2}$

QUESTION

The plates of an parallel-plate capacitor of capacitance 1.0 F are separated by a distance $d = 1$ cm. Find the plate area.

$$C = \frac{\varepsilon_0 A}{d}$$

$$1 = \frac{\varepsilon_0 A}{10^{-2}}$$

$$\text{Area} = \frac{10^{-2}}{\varepsilon_0}$$

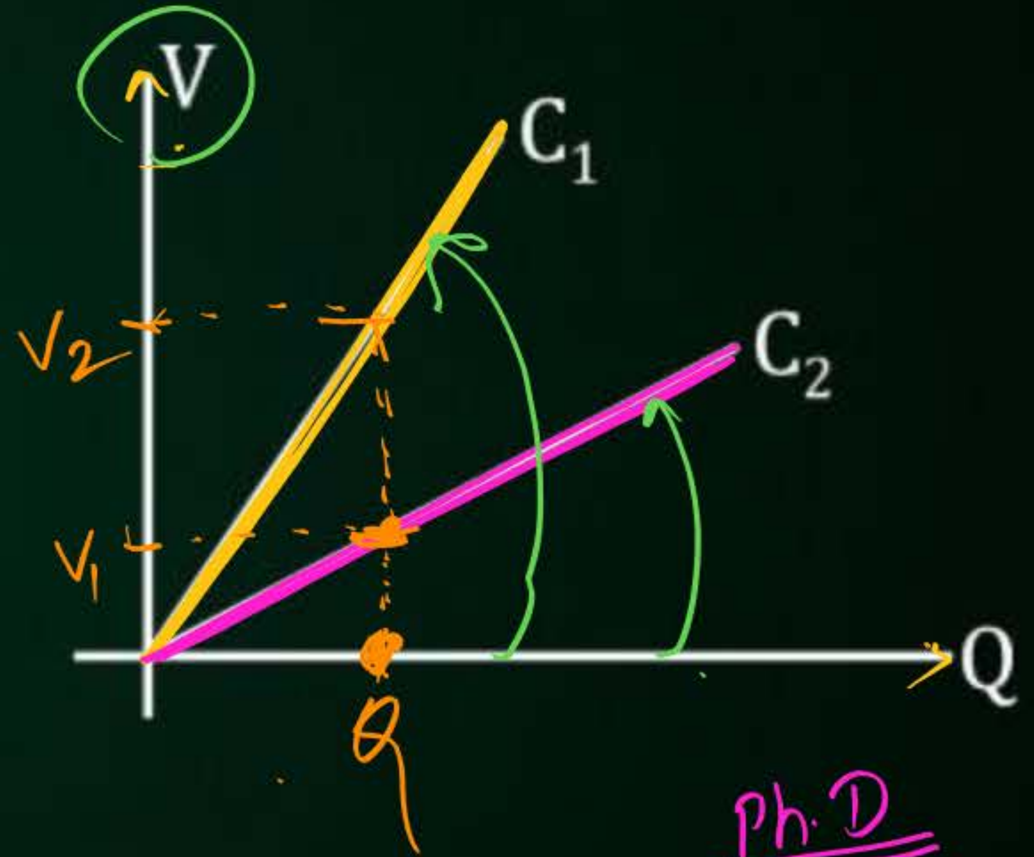
QUESTION

For two capacitor graph between potential and charge is given then which of the following option is correct ?

(a) $C_1 = C_2$

(b) $C_1 > C_2$

(c) $C_1 < C_2$



Sol^n

1st method

$C = \frac{Q}{V\downarrow}$ — same

2nd method

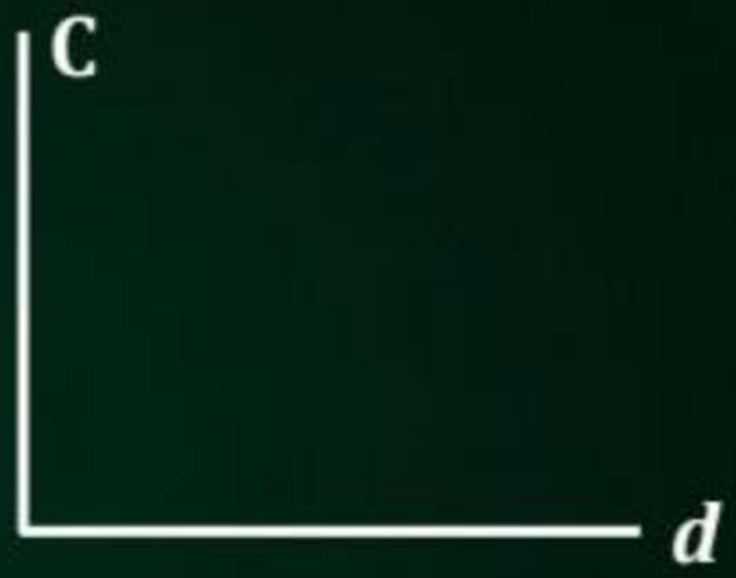
Slope $= \frac{V}{Q} = \frac{1}{C}$

Slope $\propto \frac{1}{\text{Capacit}}$

Ph.D capacitor

FOR PARALLEL PLATE CAPACITOR







CAPACITANCE OF PARALLEL PLATE CAPACITOR

$$C = \frac{Q}{\Delta V}$$

QUESTION

A parallel plate air capacitor has capacity C, distance of separation between plates is d and potential difference V is applied between the plates. Force of attraction between the plates of the parallel plate air capacitor is (2015)

1. $\frac{CV^2}{d}$

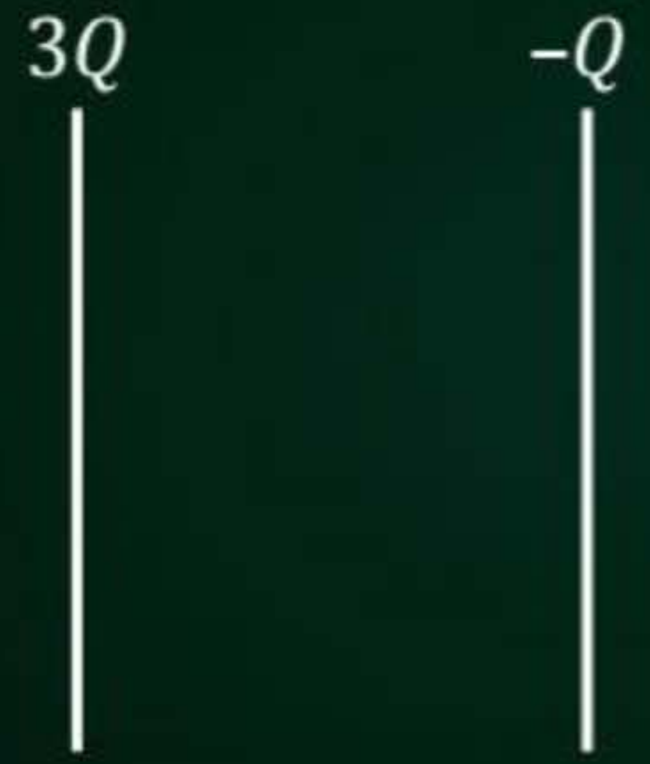
2. $\frac{C^2V^2}{2d^2}$

3. $\frac{C^2V^2}{2d}$

4. $\frac{CV^2}{2d}$

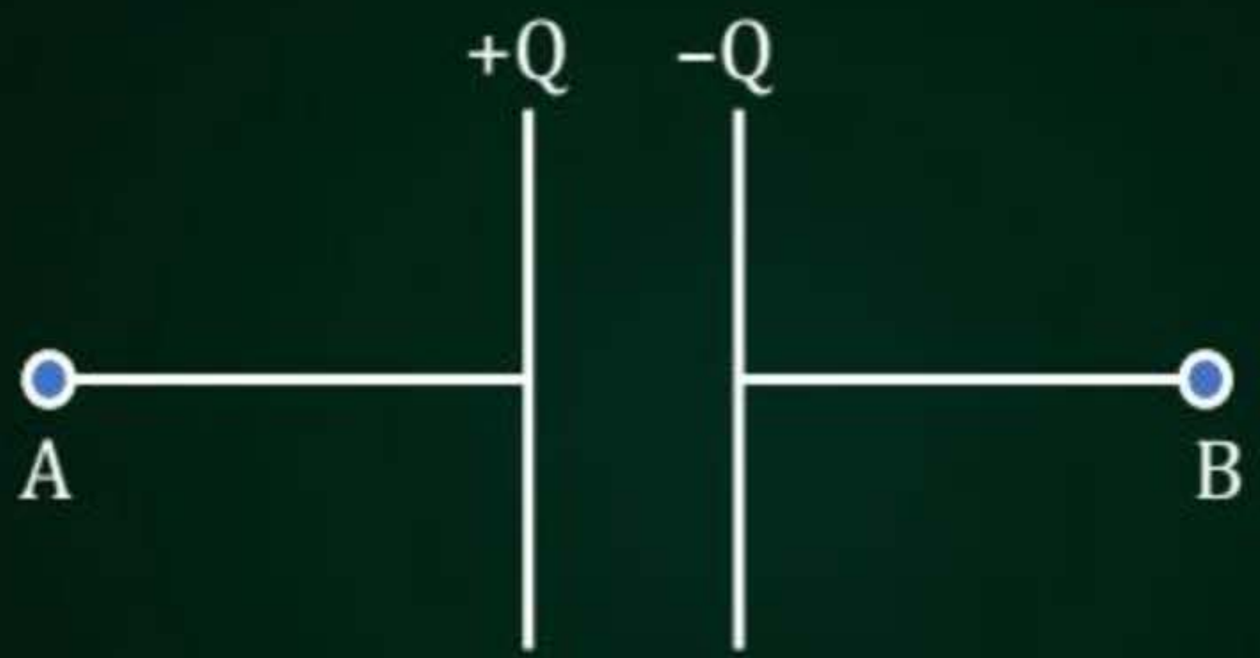
QUESTION

One plate given charge $3Q$ other is $-Q$ then find field and potential difference between them.

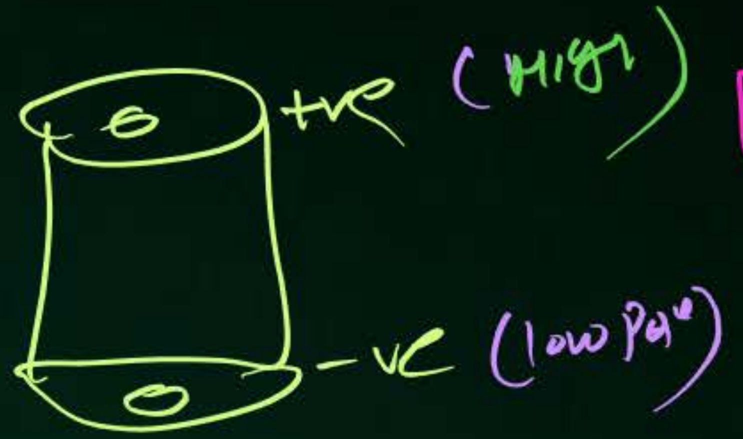


QUESTION

Find $V_A - V_B$



BATTERY



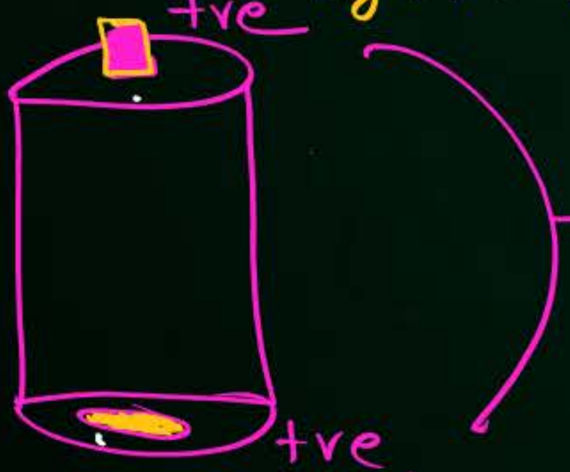
Battery is a

- ↳ Source of energy not a source of charge.
- It maintain potential difference between the points where it is connected.
- Work done by battery = $q\,\Delta V$. to move q charge through it



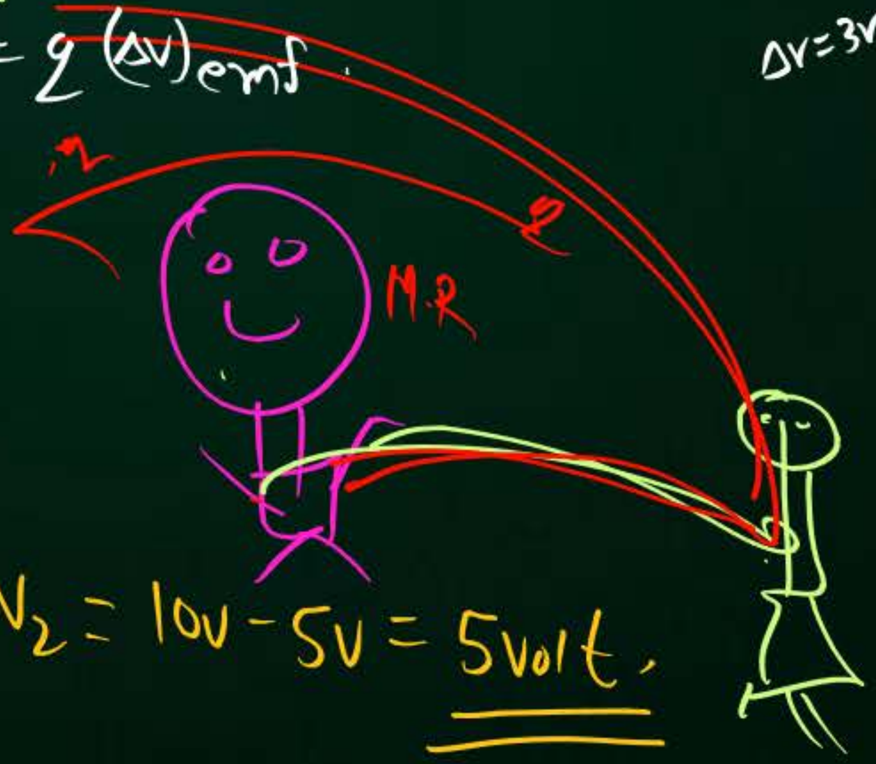
High: 7V, 0V, 20V, -6V | 3V

ΔV = 3V: 4V, -3V, 17V, -9V | 0

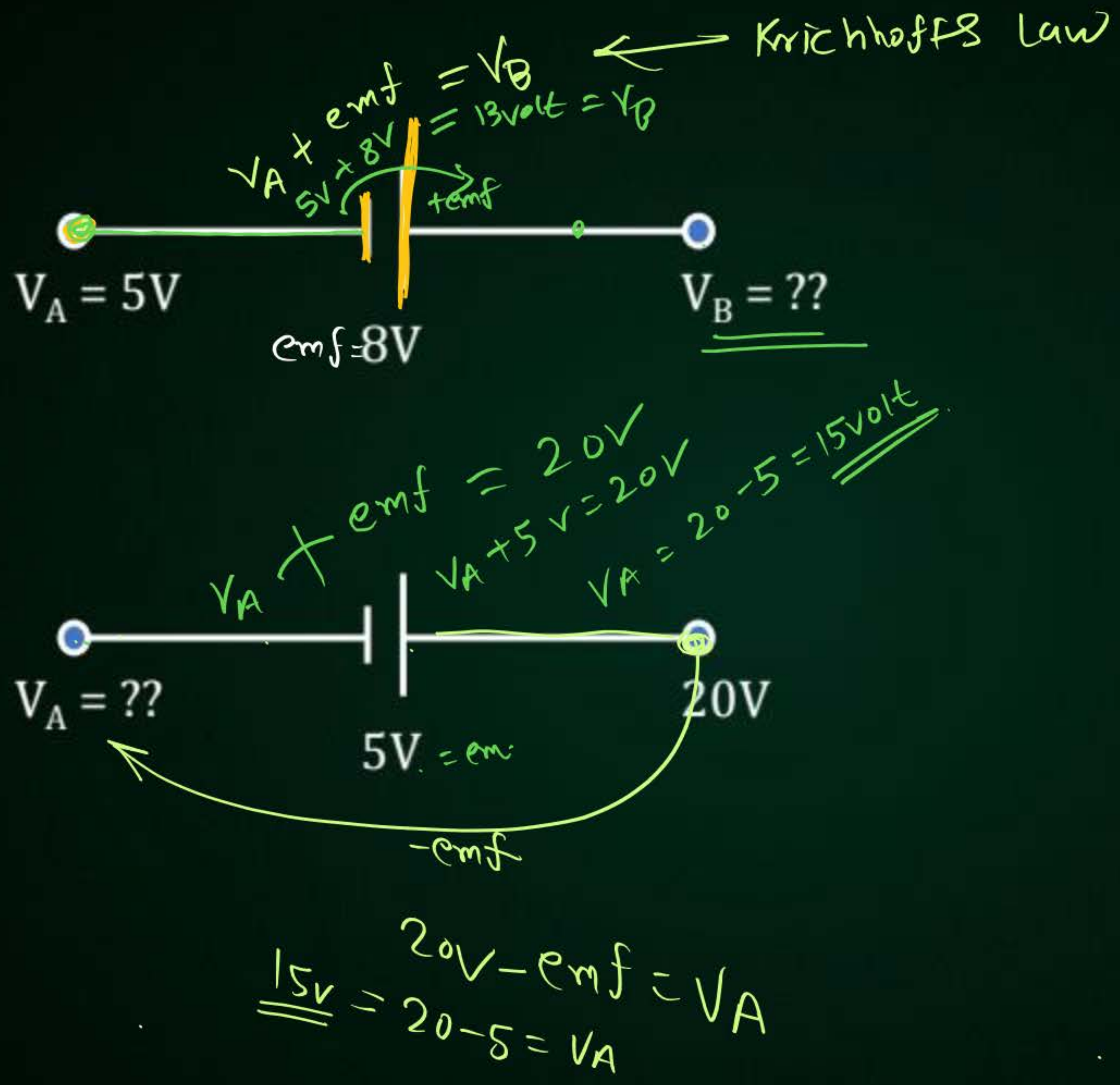


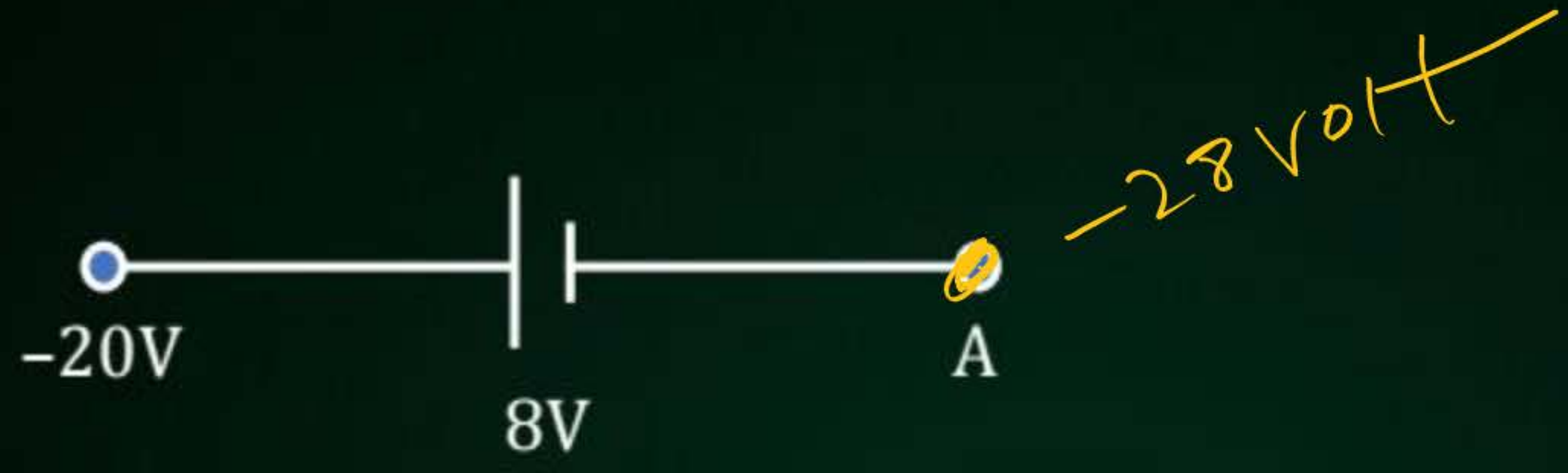
(a) NO (62%)

(b) yes (34%)



Batt = emf = $V_1 - V_2$ = 10V − 5V = 5 volt.


Krichhoffs law
VA + emf = VB
5V + 8V = 13volt = VB
+emf
VA = 5V
emf = 8V
VB = ??
VA + emf = 20V
VA + 5V = 20V
VA = 20 - 5 = 15volt
VA = ??
5V = em
20V
-emf
20V - emf = VA
15v = 20 - 5 = VA



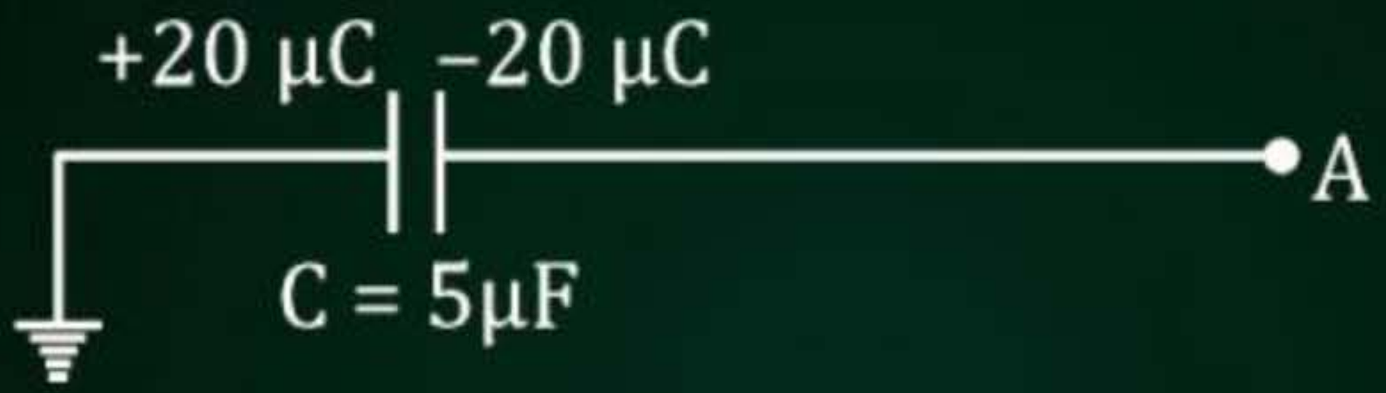
–28 volt
–20V
8V
A



40 μC
C = 2μF
8V
V = ??

QUESTION

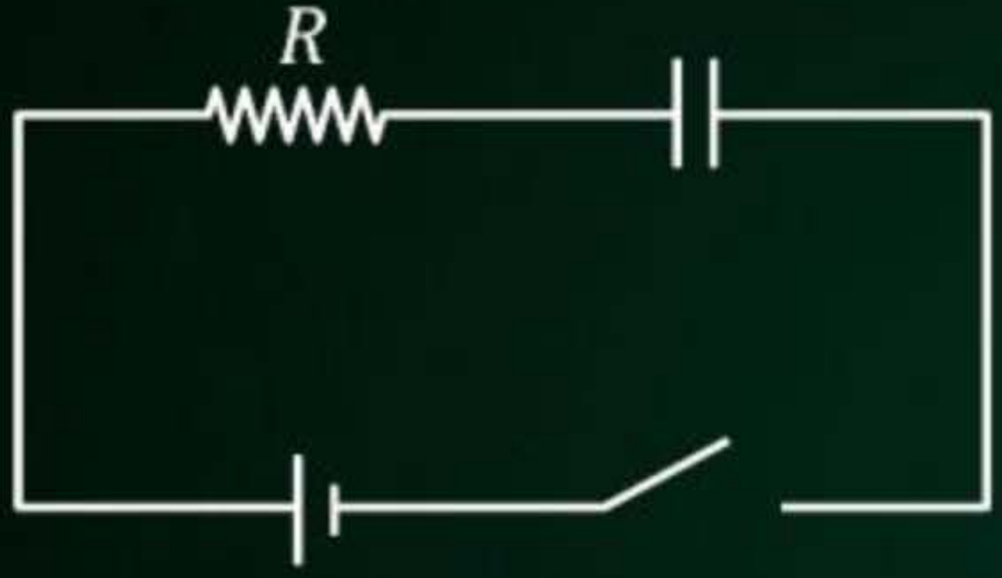
Find $V_A = ?$



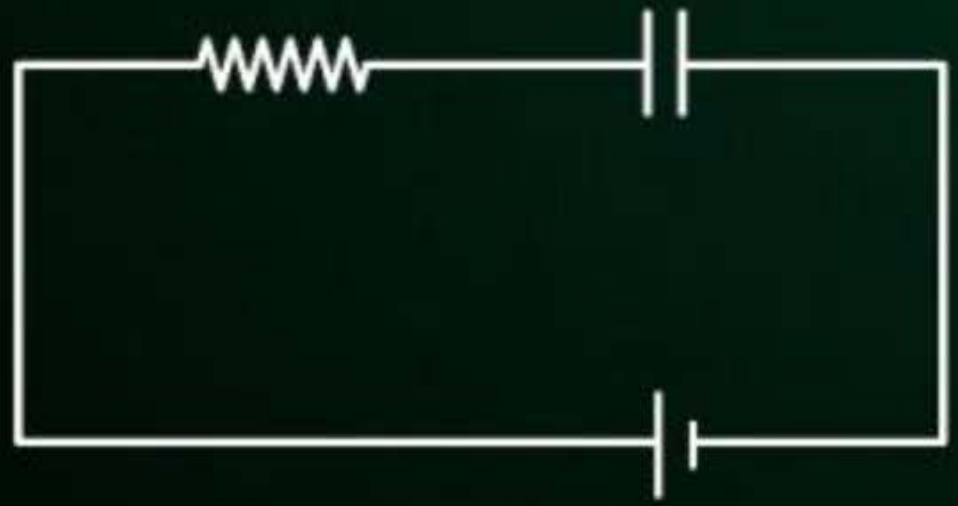
Find work done by Battery in Different Case

Charging of Capacitor by Battery

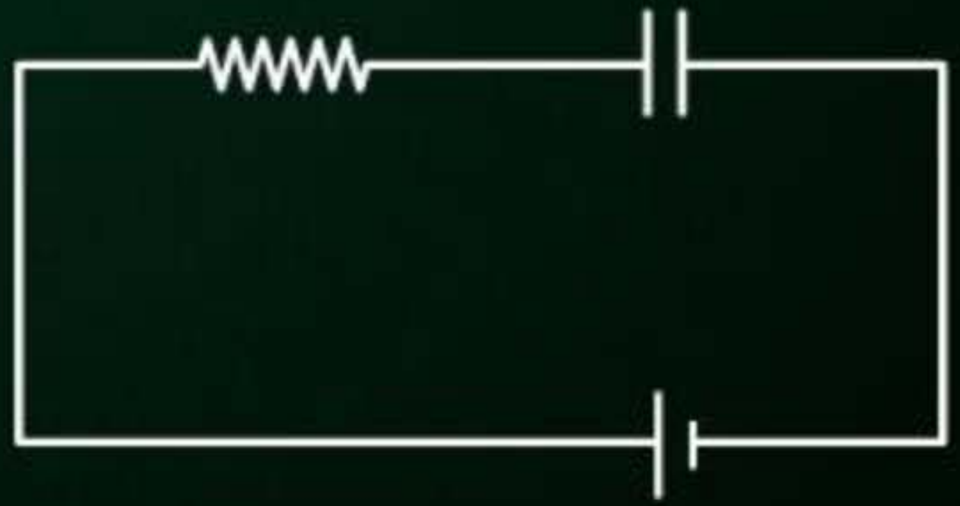
CHARGING OF CAPACITOR (D/C RC CIRCUIT)



(i) At $t = 0$ just after switch is close



(ii) at time 't'



(iii) At steady state


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 7 | Physics

Electrostatic Potential and Capacitance



By- Dr. Manish Raj (MR SIR)

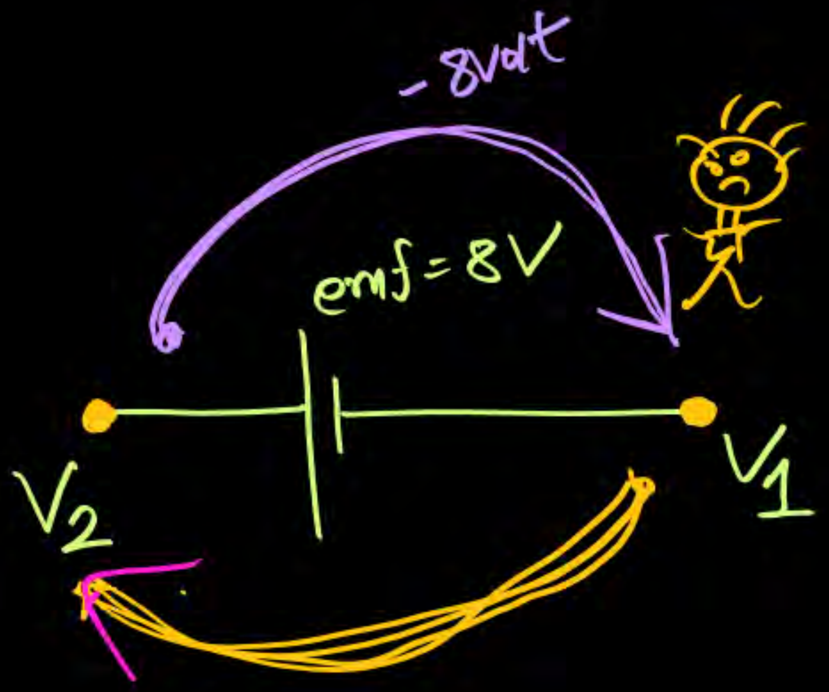
Topics to be covered

1. # Charging of Capacitor
2. #
3. #



$$V_2 - 8\text{volt} = V_1$$

$$-8\text{volt} = V_1 - V_2$$



$$V_1 + 8V = V_2$$

$$V_1 - V_2 = -8\text{volt}$$

$$V_2 - V_1 = 8\text{volt}$$

QUESTION

A parallel plate air capacitor has capacity C, distance of separation between plates is d and potential difference V is applied between the plates. Force of attraction between the plates of the parallel plate air capacitor is **(2015)** (H/W)

1. $\frac{CV^2}{d}$
2. $\frac{C^2V^2}{2d^2}$
3. $\frac{C^2V^2}{2d}$
4. $\frac{CV^2}{2d}$ Ans

$Q = CV$

$F = QE$

$F = Q\left[\frac{Q}{2A\varepsilon_0}\right] = \frac{Q^2}{2A\varepsilon_0}$

$= \frac{C^2V^2}{2\left(\frac{A\varepsilon_0}{d}\right)\times d}$

$v_{speed} = \sqrt{\frac{\gamma P}{\rho}}$

$C = \frac{Q}{V}$

$F = \frac{CV^2}{2d} = \frac{\varepsilon_0 A (E\times d)^2}{d(2d)}$

$\text{Force} = \frac{CV^2}{2d}$ Ans

QUESTION

The electrostatic force between the metal plates of an isolated parallel plate capacitor C having a charge Q and area A, is

(NEET 2018)

1. independent of the distance between the plates ✓
2. linearly proportional to the distance between the plates ✗
3. proportional to the square root of the distance between the plates. ✗
4. inversely proportional to the distance between the plates. ✗

$F = \frac{Q^2}{2A\varepsilon_0}$

Physics
- theory
- concept
- formula
- special case
  - multiple times

find work done by Battery in fig.



emf = V $Q = CV$

$W_{Battery} = Q\,emf$

$= CV[V] = +CV^2$



emf = V $Q = 2CV$

$W = 2CV \times V$

$= 2CV^2$

emf = 2V



$Q = \frac{CV}{2}$

$W = 2V \times \left[\frac{CV}{2}\right]$

$= CV^2$

emf = 4V

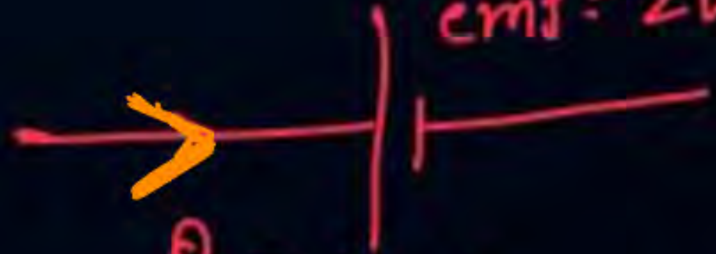


$Q = 3CV$

$W_B = Q\,emf = 3CV \times 4V$

$= 12CV^2$

emf = 2V



$Q = 2CV$

$W = -2V \times [2CV] = -4CV^2$

Kuddo Concept



capacitance $= C = \frac{Q}{\Delta V}$

$\boxed{\Delta V = \frac{Q}{C}}$ → Potential diffⁿ

\# $V_1 > V_2$

\# $\boxed{V_1 - \frac{Q}{C} = V_2}$

\# $\boxed{V_2 + Q/C = V_1}$



$5V - \frac{Q}{C} = V$

$5V - \frac{20\mu c}{4\mu f} = V$

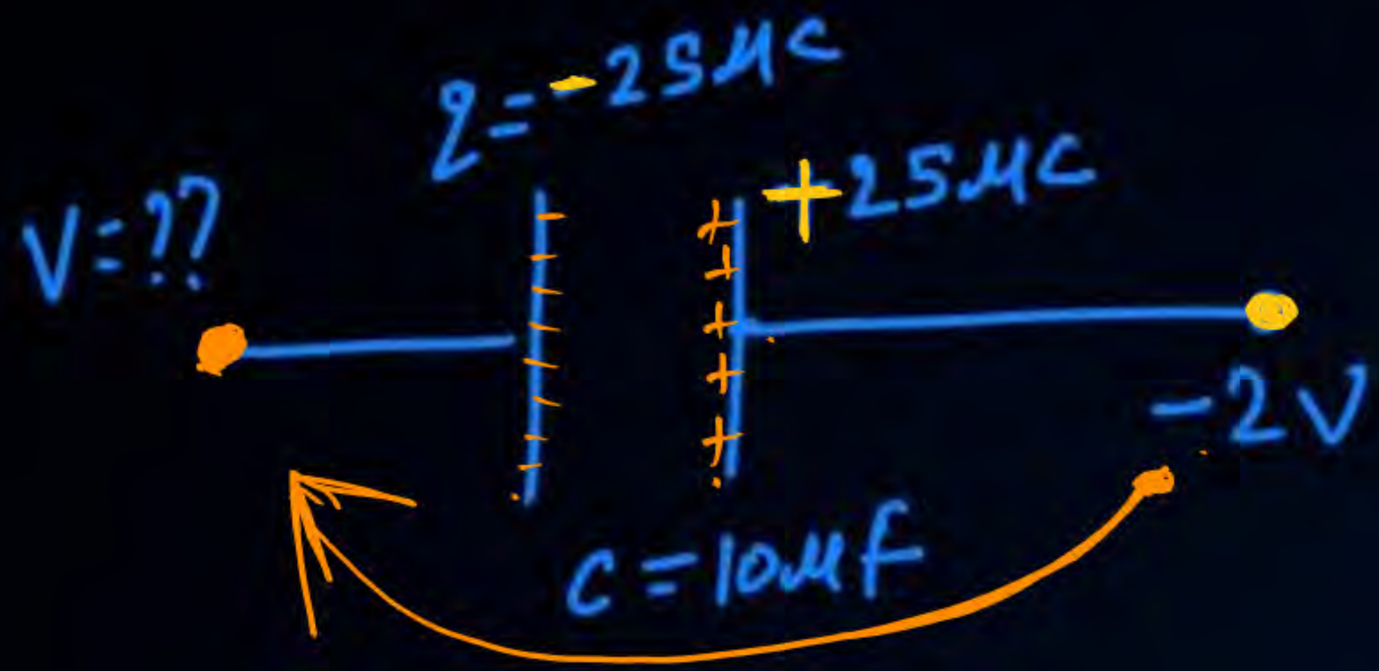
$\boxed{V = 0 \text{ (zero)}}$

find capacitance $= C$

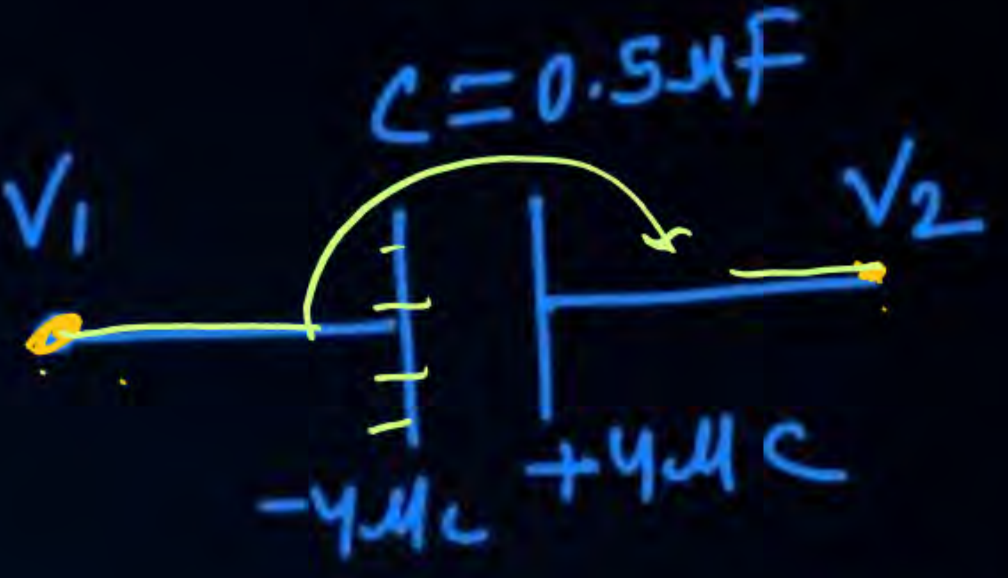


$0V + \frac{Q}{C} = 4$

$C = \frac{Q}{4} = \frac{4}{4} = 1\mu f$



Find V=??



find $V_1 - V_2 = ??$

$$-2V - \frac{Q}{C} = V$$

$$-2V - \frac{25}{10} = V$$

$$-2V - 2.5V = V$$

$$V = -4.5 \text{ volt}$$

If Charge on capacitor is zero then??

$$Q = C\Delta V$$

$$\frac{Q}{C} = \Delta V$$

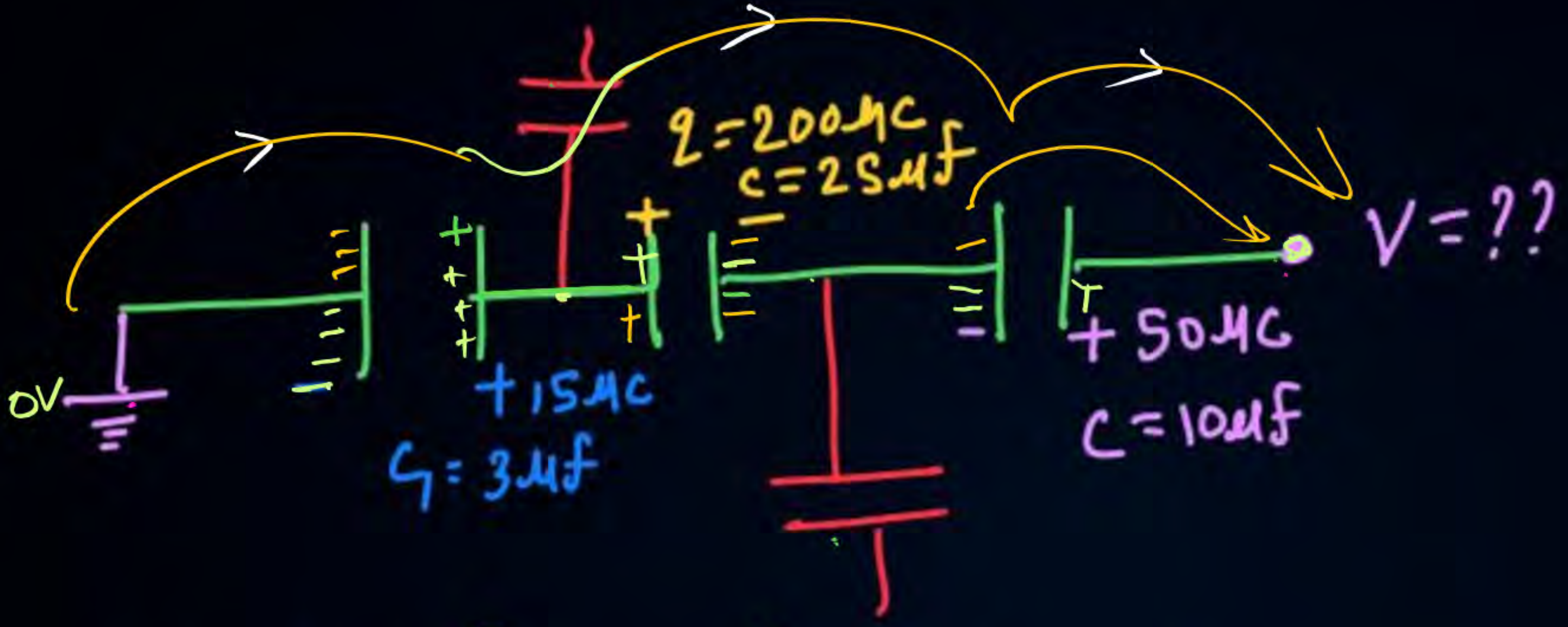
$$\Delta V = 0$$

$$V_1 - V_2 = 0$$

$$V_1 - V_2 = -\frac{Q}{C}$$

$$= -\frac{4}{0.5}$$

$$= -8 \text{ volt}$$



Ans
V=2volt

(#) $0V + \frac{15\mu C}{3\mu f} - \frac{200}{25} + \frac{50}{10} = V$

(cancelled to 5, 8, 5)

$10 - 8 = V$

$V = 2$ volt

Oiyoyoya*

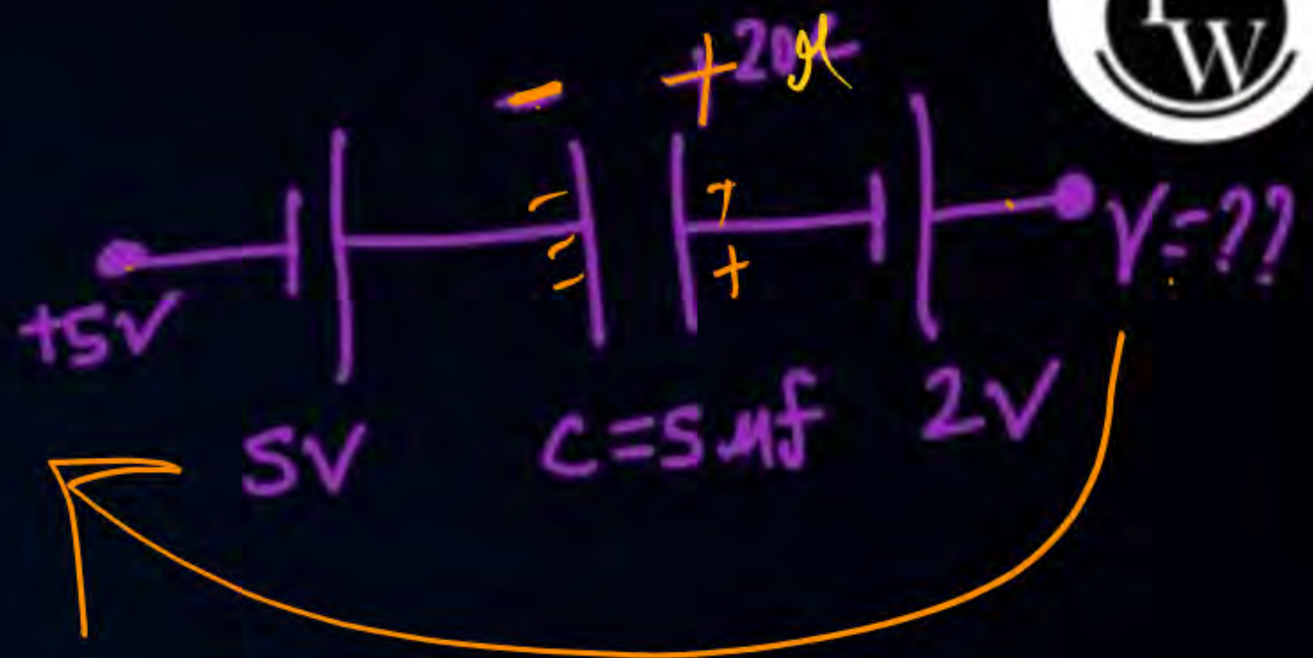


$$-4-5+\frac{Q}{C}=V$$

$$-4-5+\frac{40}{10}=V$$

$$V=-5\text{ volt}$$

Ans



$V-2-\frac{Q}{C}-5=+5V$

$$V-\frac{Q}{C}=7+5$$

$$V-\frac{20}{5}=12$$

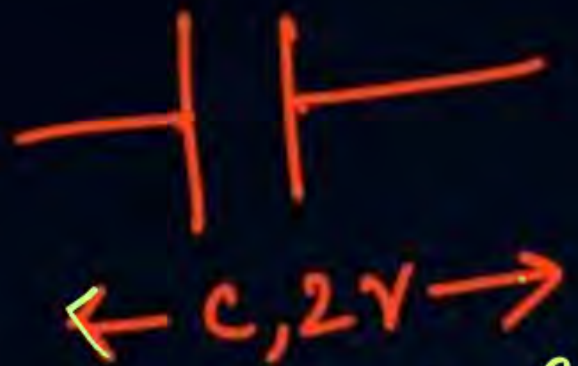
$$V=12+4=16\text{ volt}$$

Enegy stored on the Capacitor $U=\frac{1}{2}CV^2=\frac{Q^2}{2C}$ ✓



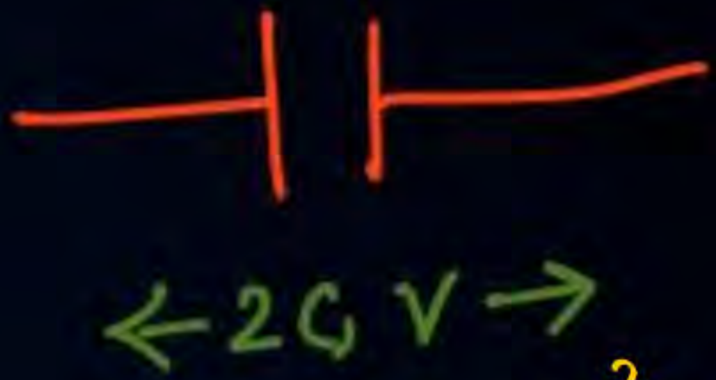
$U=\frac{1}{2}C(\Delta V)^2$

energy stored: $\boxed{U=\frac{1}{2}CV^2}$

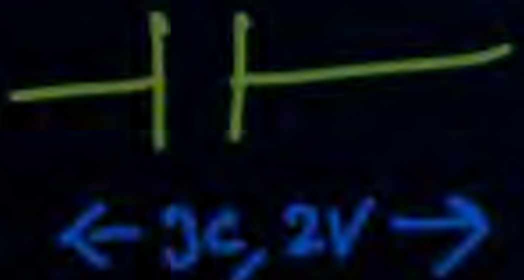


$U=\frac{1}{2}C(2V)^2$

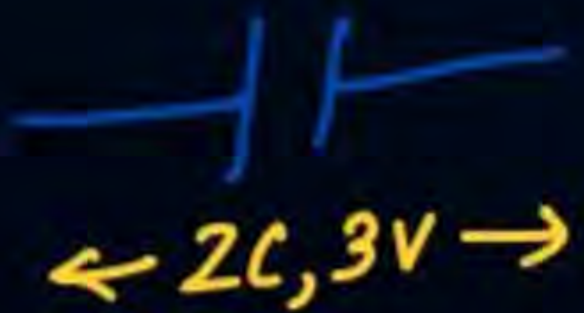
$=\frac{1}{2}C\,4V^2=2CV^2$



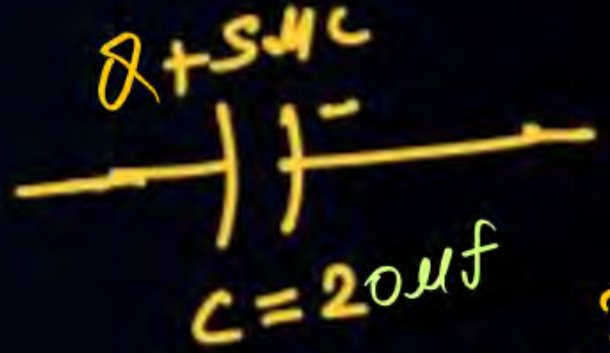
$U=\frac{1}{2}2C(V)^2=CV^2$



$U=\frac{1}{2}3C(2V)^2=6CV^2$

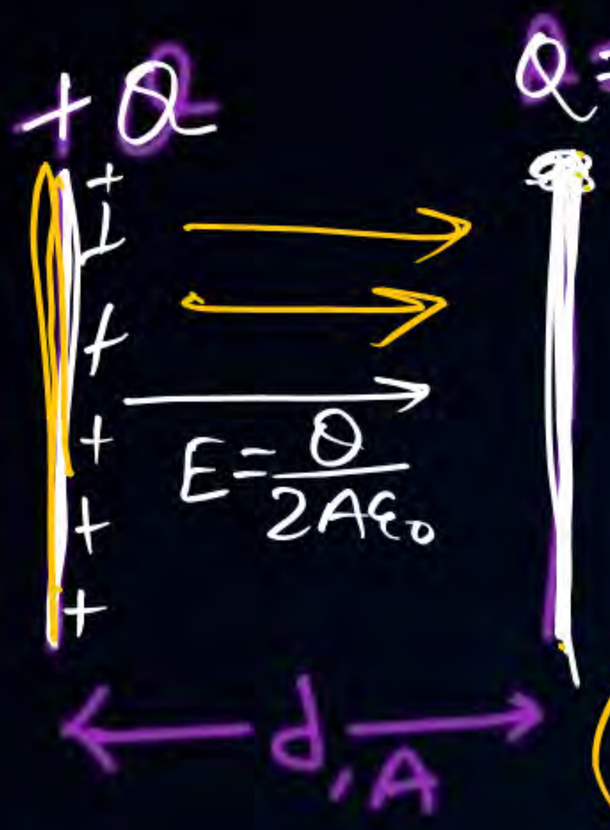


$U=\frac{1}{2}2C(3V)^2=9CV^2$



$U=\frac{Q^2}{2C}=\frac{(5\mu)^2}{2\times 20\mu f}$

$=\frac{25\times 10^{-12}}{40\times 10^{-6}}$ 10 J



Find Potential difference b/w plate.

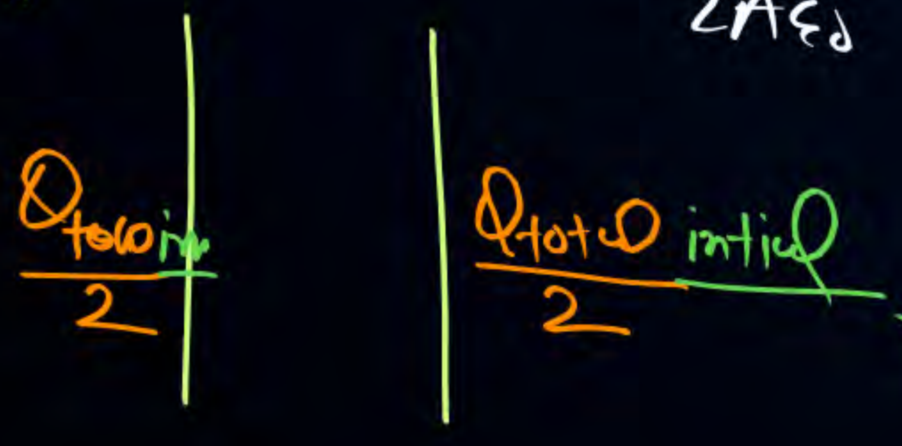
(a) $\frac{Qd}{A\varepsilon_0}$ (b) $\frac{Qd}{2A\varepsilon_0}$ (68%) (c) zero (d) $\frac{2Qd}{A\varepsilon_0}$

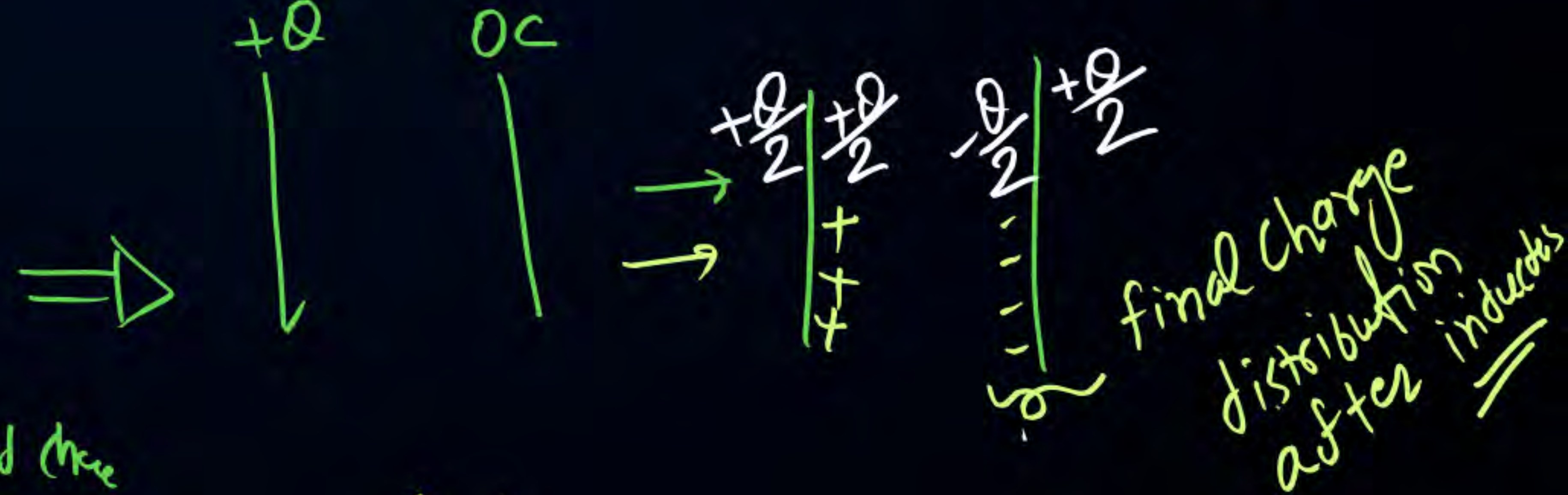
$C = \frac{\varepsilon_0 A}{d}$ Ans

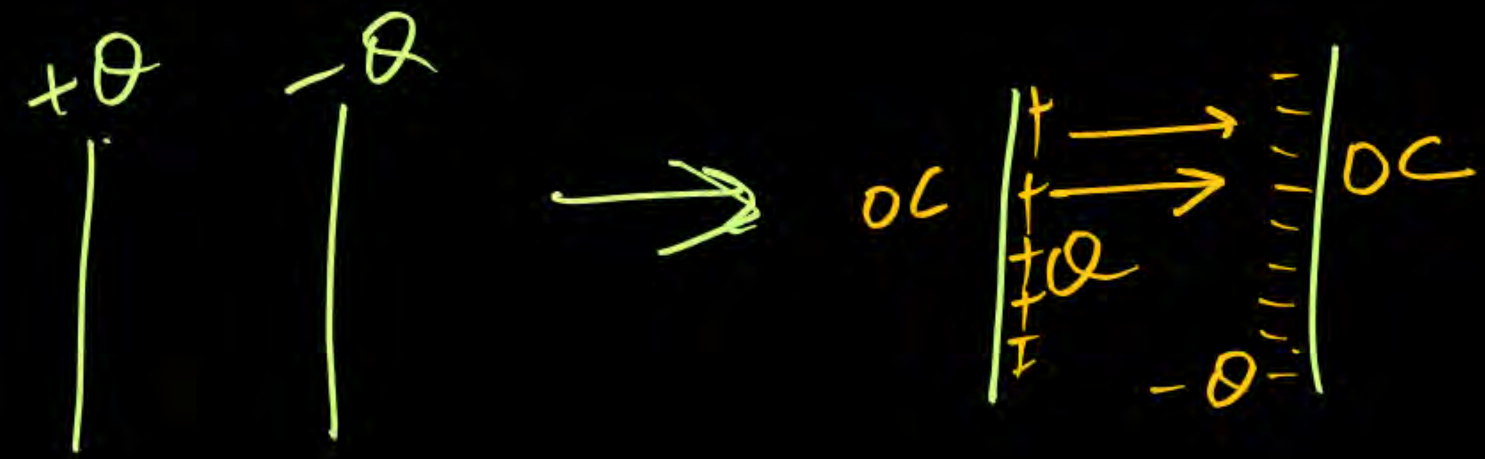
$\Delta V = E \times d$

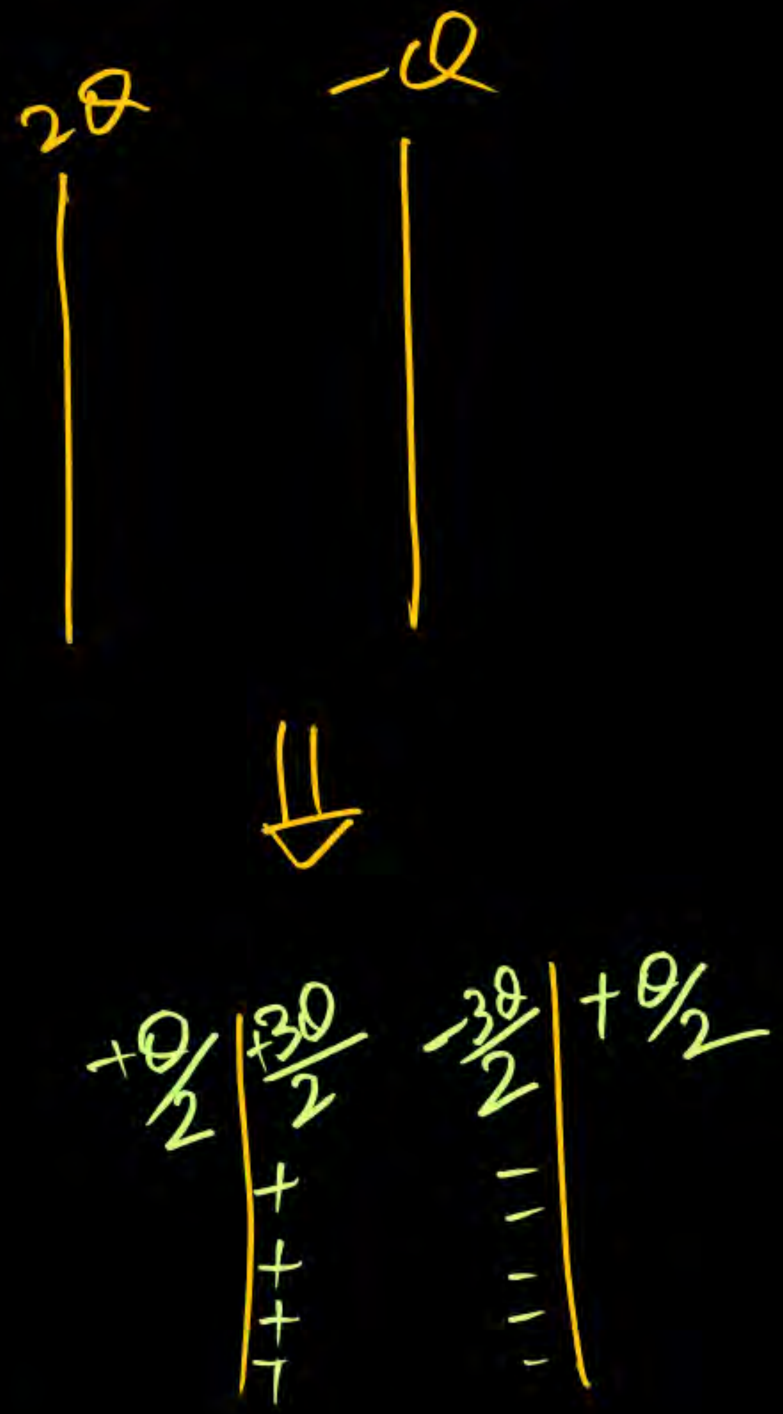
$= \frac{Q}{2A\varepsilon_0} d$ Ans

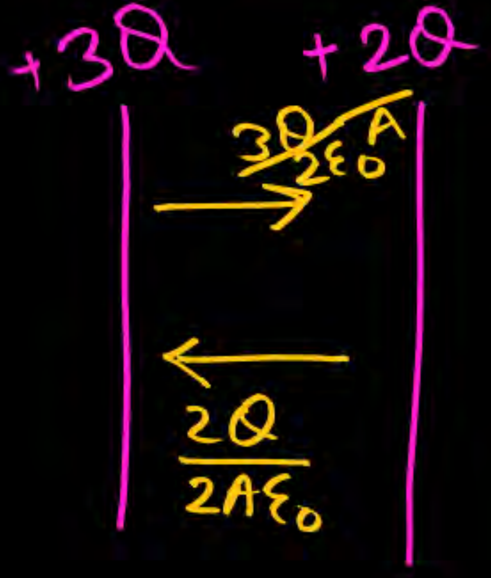
#

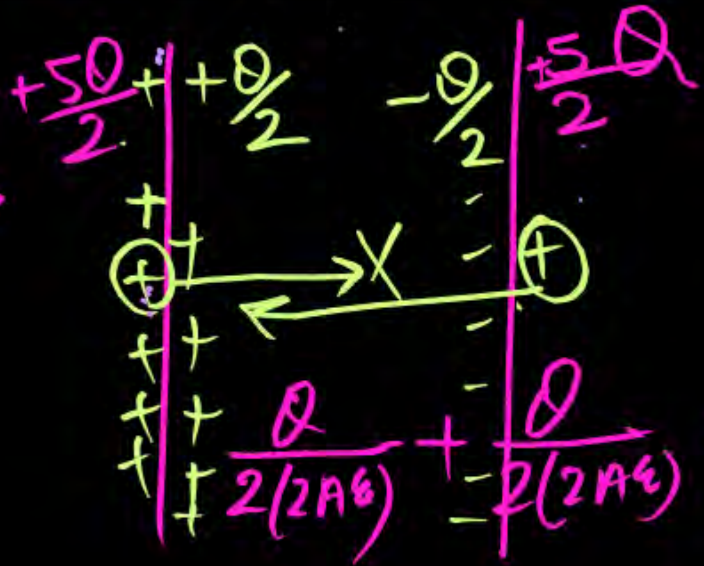








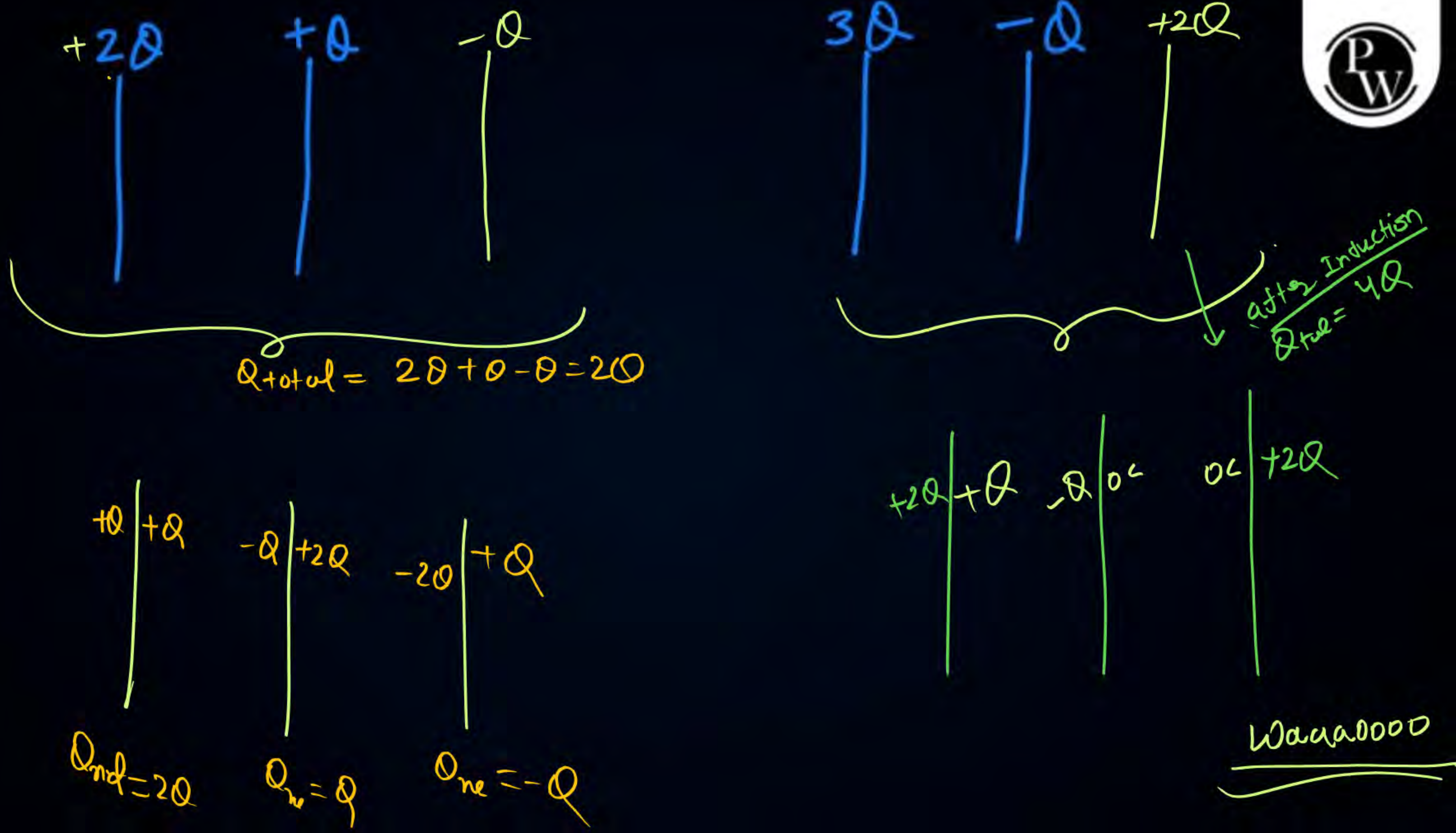




$$\frac{Q}{2(2A\varepsilon_0)} + \frac{Q}{2(2A\varepsilon_0)} = \frac{2Q}{2 \cdot 4A\varepsilon_0} = \frac{Q}{2A\varepsilon_0} \text{ Ans.}$$

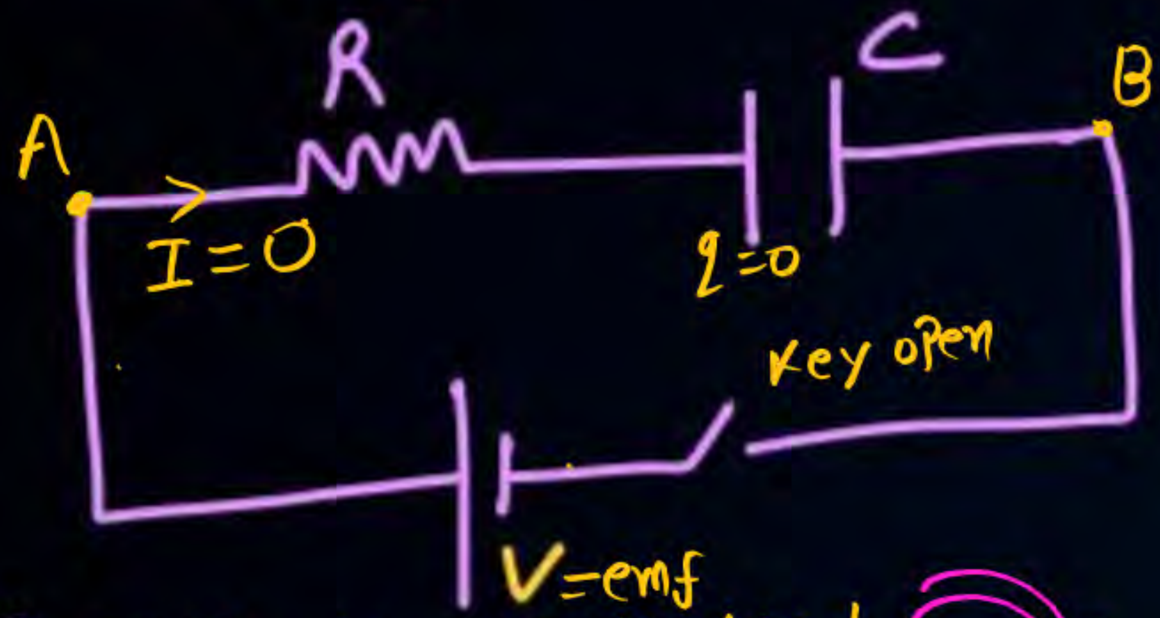
$$E_{net} = \frac{Q}{2A\varepsilon_0}$$

Net (without Induction)



+2Q +Q −Q
Qtotal = 2Q + Q − Q = 2Q
+Q | +Q −Q | +2Q −2Q | +Q
Qnet = 2Q Qnet = Q Qnet = −Q
3Q −Q +2Q
after Induction
Qtotal = 4Q
+2Q | +Q −Q | 0C 0C | +2Q
Waaaoooo

Charging of Capacitor by D/C Battery :-



Just after key is closed

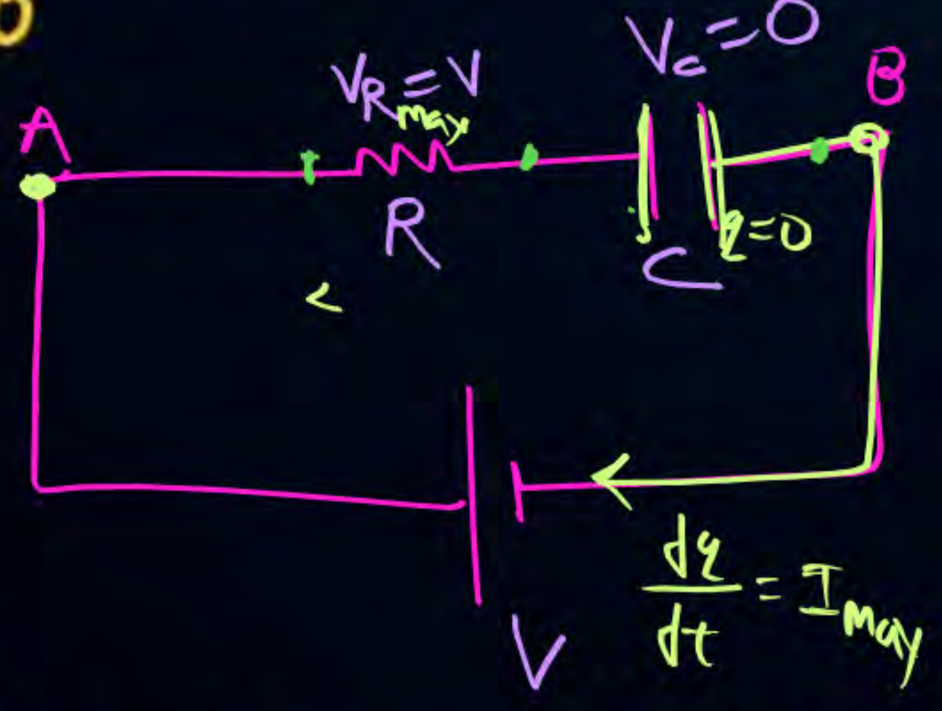
at $t=0$, $q=0$

$V_c = \frac{q}{c} = 0$

$V_R + V_c^{\,0} = V$

$\Rightarrow$ $V_{R_{max}} = V$

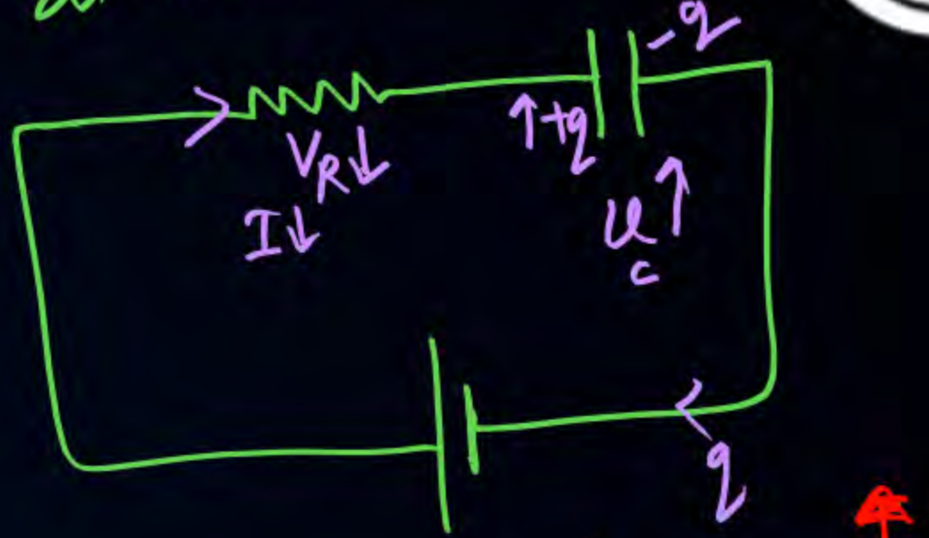
$I_{max} = \frac{V}{R}$ (at $t=0$)



$\frac{dq}{dt} = I_{max}$

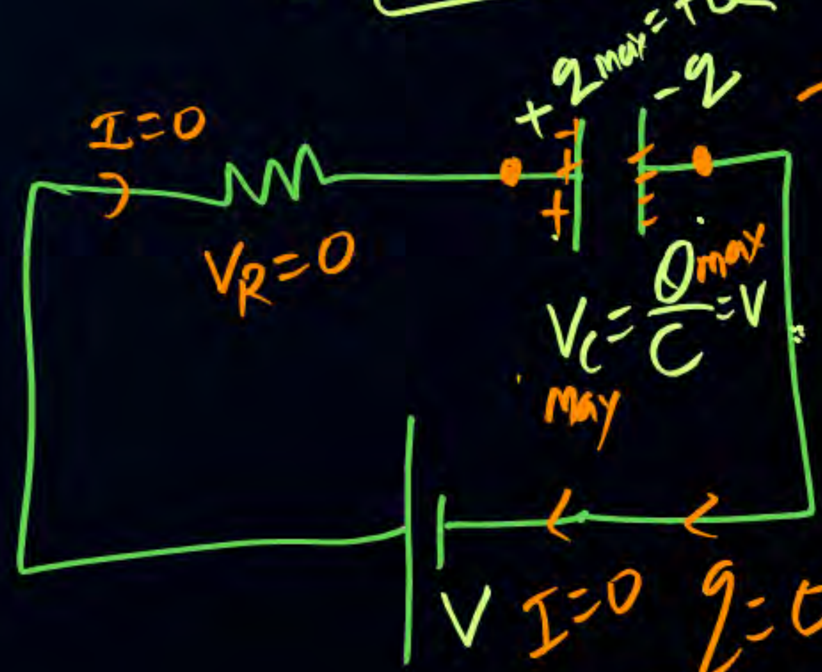
Capacitor will behave as simple wire.

at time 't'



$V = V_R + V_c$

after steady state



$I=0$ $q=0$ (flow of chg)

→ capacitor will behave as open wire

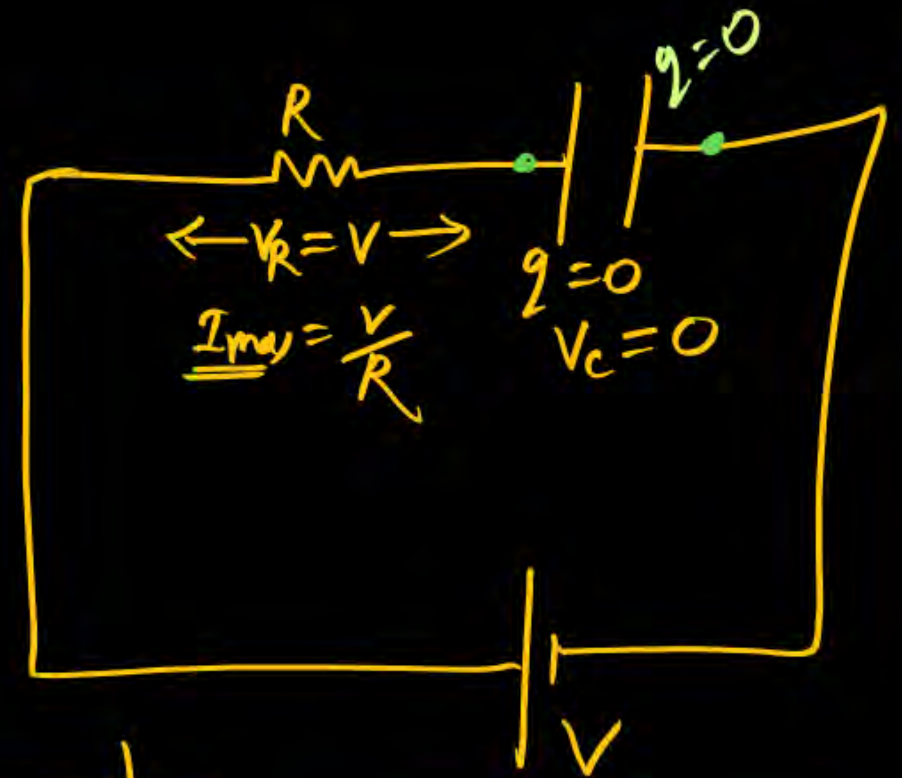
At $t=0$ capacitor behave as simple wire, allow current to flow in the circuit, $q_C = 0$ $U_{capacitor} = 0$ $I_c \neq 0$ (circuit)

$\Delta V_{across\ capaci} = 0$

---

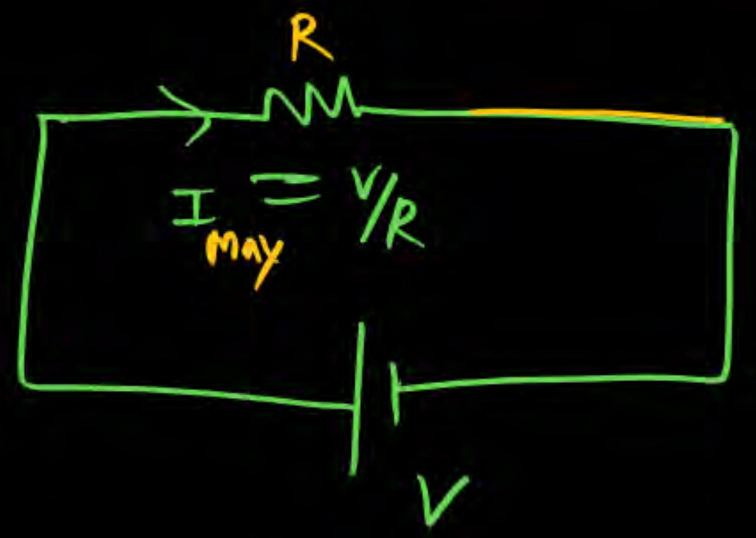
at $t = \tau$ steady state capacitor behave as open wire, does not allow current to flow through circuit, $I_c = 0$ (in w), but $q_c = Q_{max} = CV$ $U_{max} = \frac{1}{2}CV^2$

$(\Delta V)_{Potential\ across\ capaci} = V_{battery} = V$

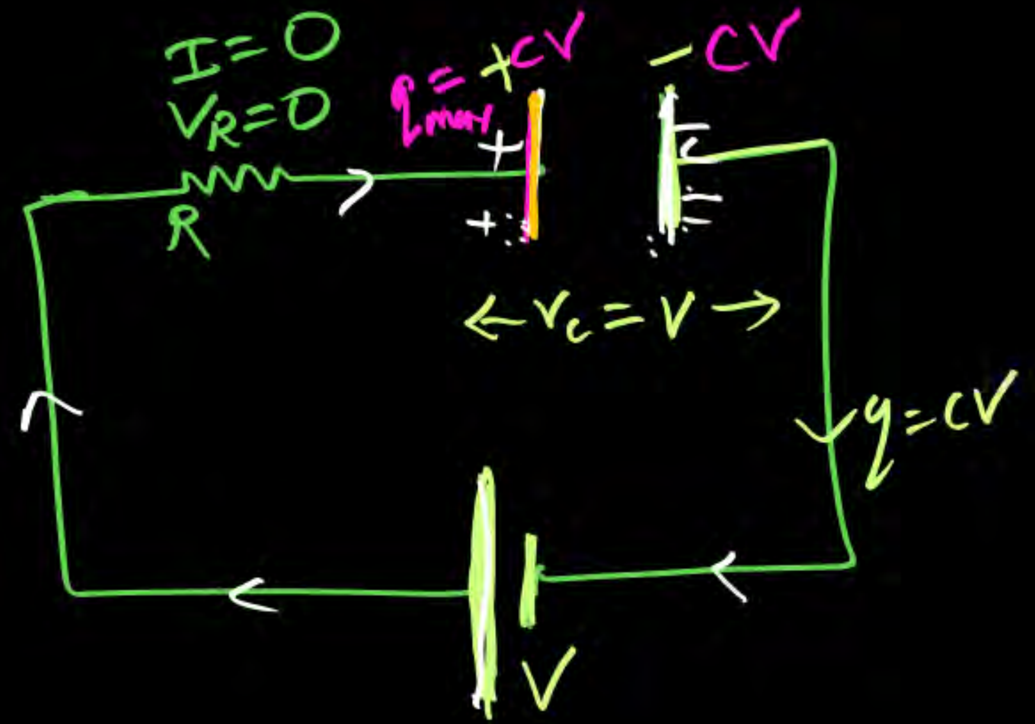


Just at t=0

$U_{intial} = 0$



at steady sate



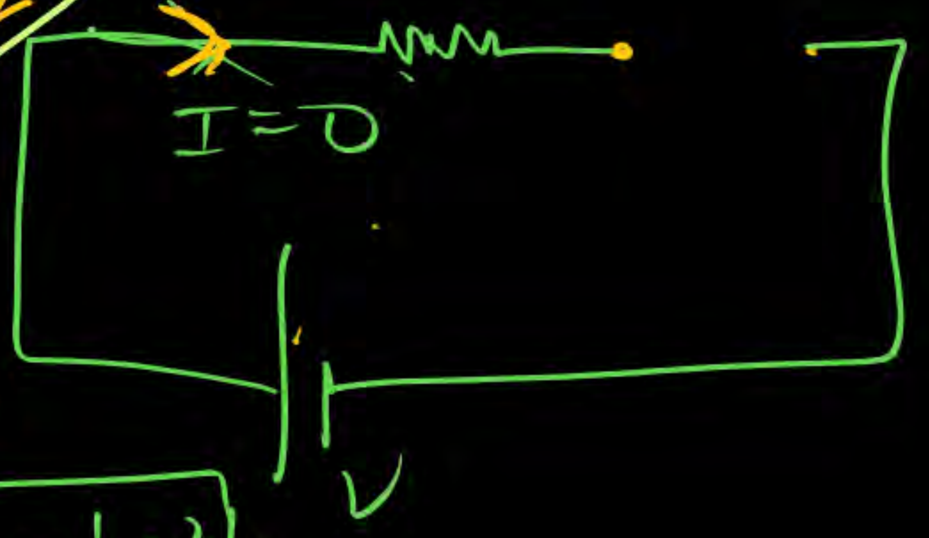
Work done by Battey

$= Q\, emf$

$= CV \times V$

$W_{Battey} = CV^2$

$U_{fin} = \frac{1}{2}CV^2$



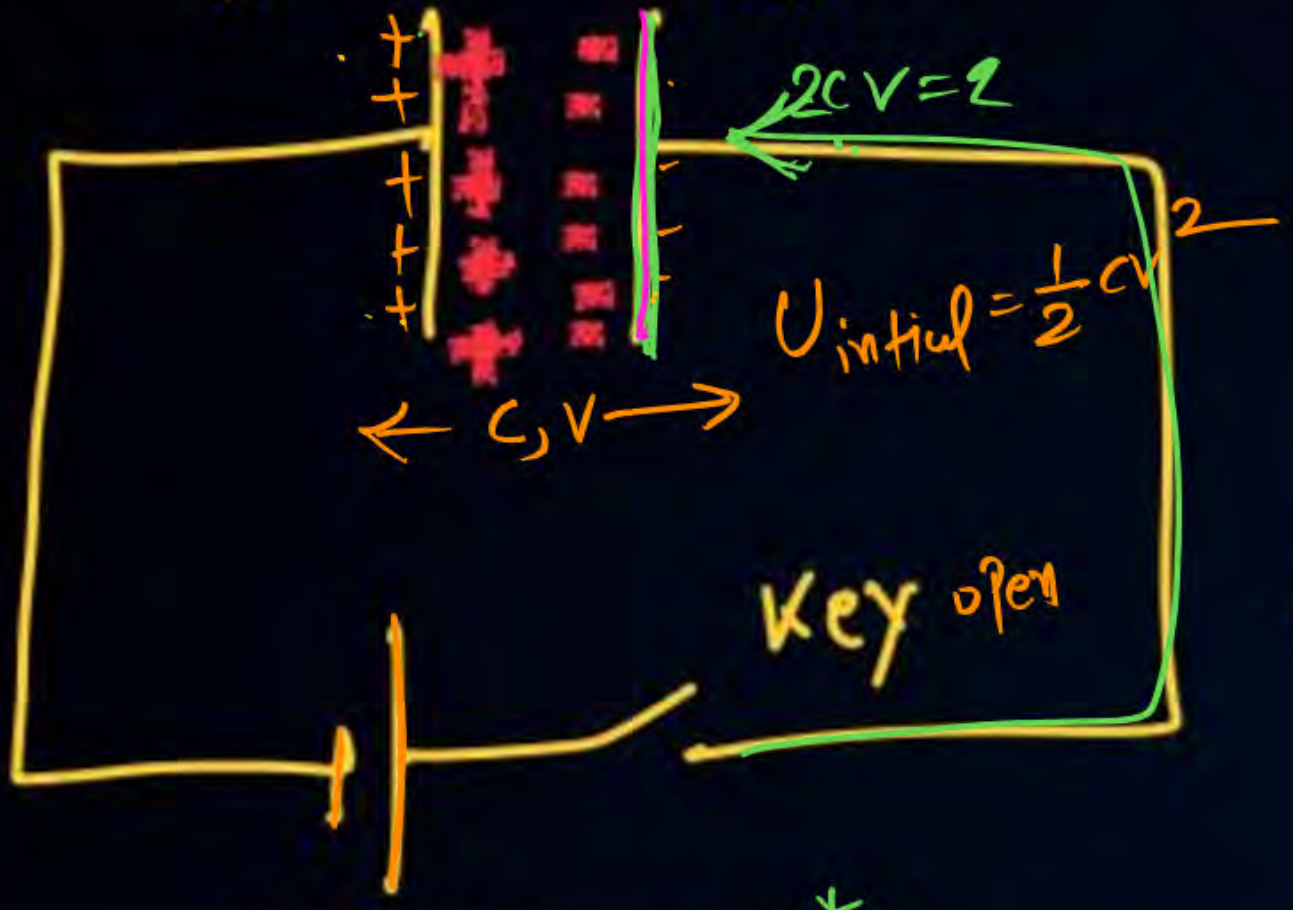
$$U_{intial} + W_{Battey} = U_f + U_{loss}$$

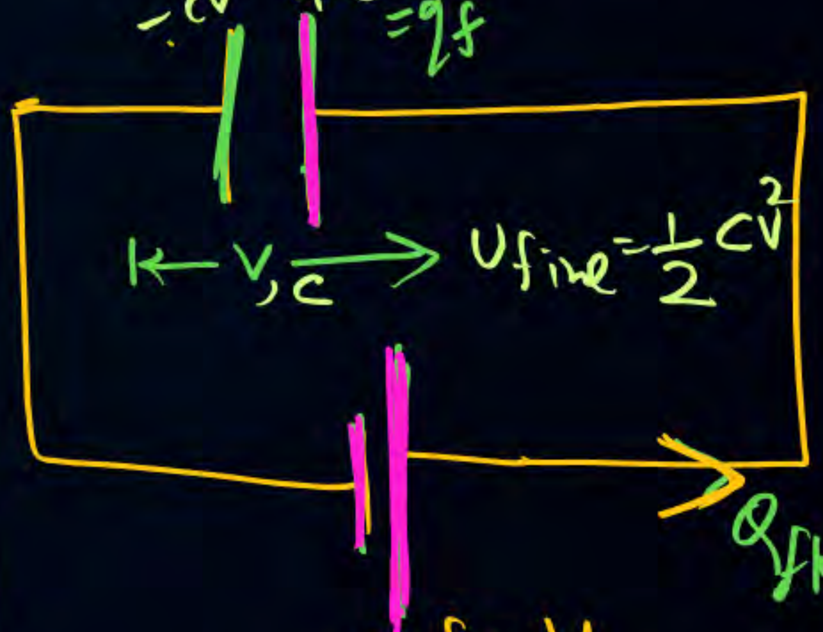
$$0 + CV^2 = \frac{1}{2}CV^2 + U_{loss}$$

$U_{loss} = \frac{1}{2}CV^2$ Ans

capacitor was initially charged

find total loss in energy when Key is closed. final energy on capacitor





$$U_{initial} + W_{Battery} = U_f + U_{loss}$$

$$\frac{1}{2}CV^2 + 2CV^2 = \frac{1}{2}CV^2 + U_{loss}$$

$$\boxed{U_{loss} = 2CV^2}$$ Ans

$W_{Battery} = q\ \text{emf}$

$= 2CV(V)$

$= 2CV^2$

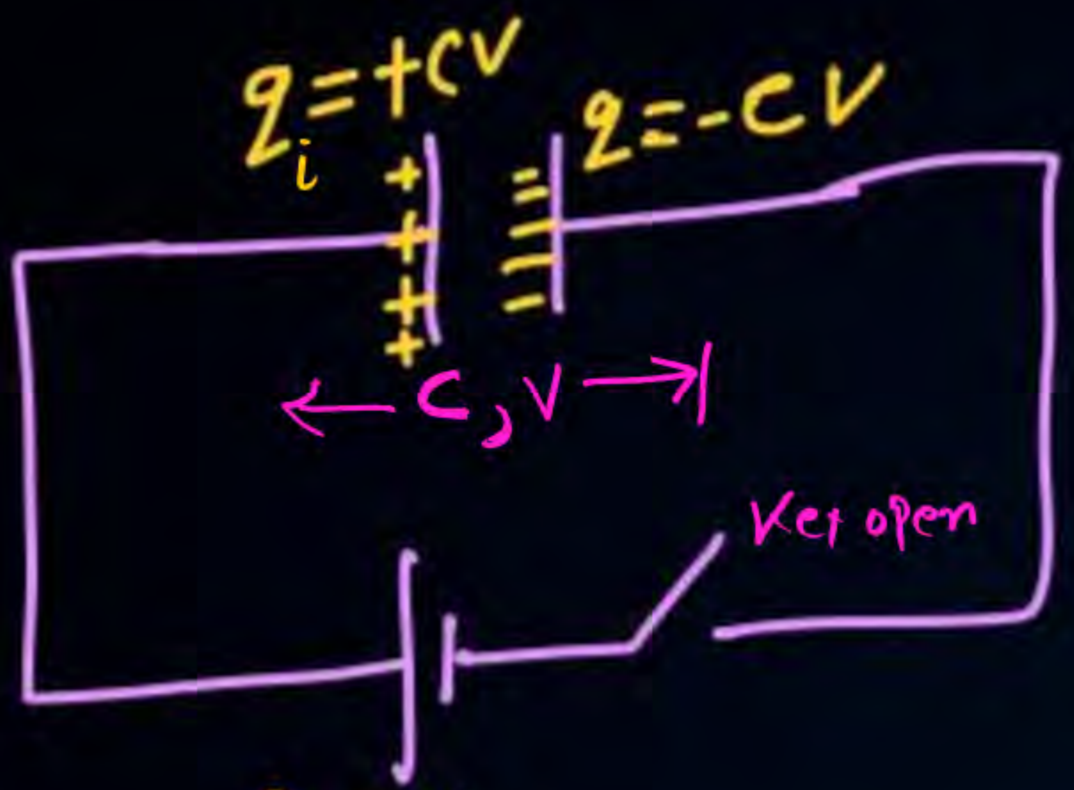
$Q_{flow} = \Delta Q$

$= q_f - q_i$

$= CV - (-CV)$

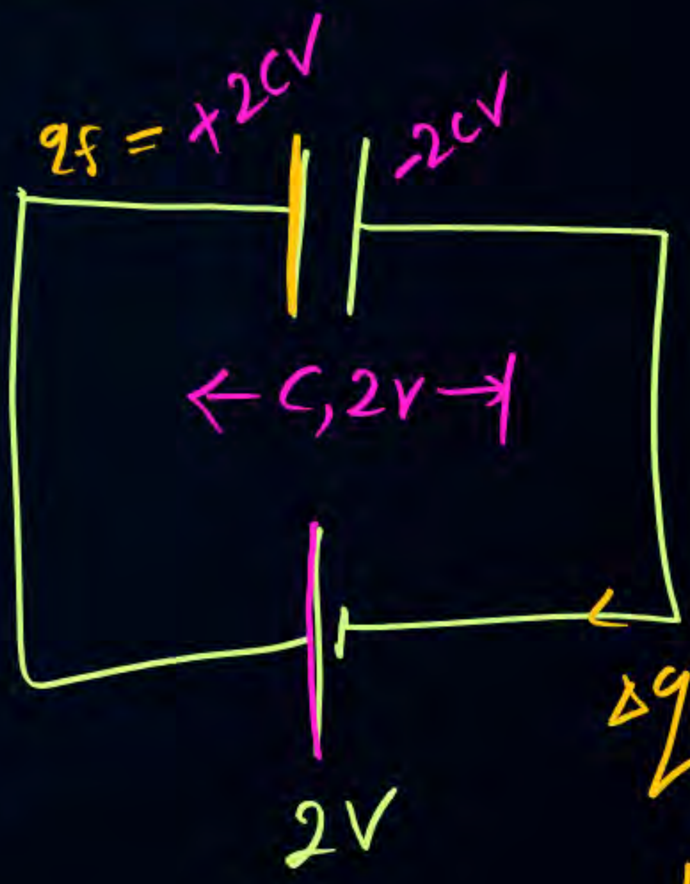
$= 2CV$ (Transfer flow)

find loss in energy when key is closed.



final $V_c = V_{Battery}$

Key is closed



$$U_i + W_{Batt} = U_f + U_{loss}$$

$$\frac{1}{2}CV^2 + 2CV^2 = \frac{1}{2}C(2V)^2 + U_{loss}$$

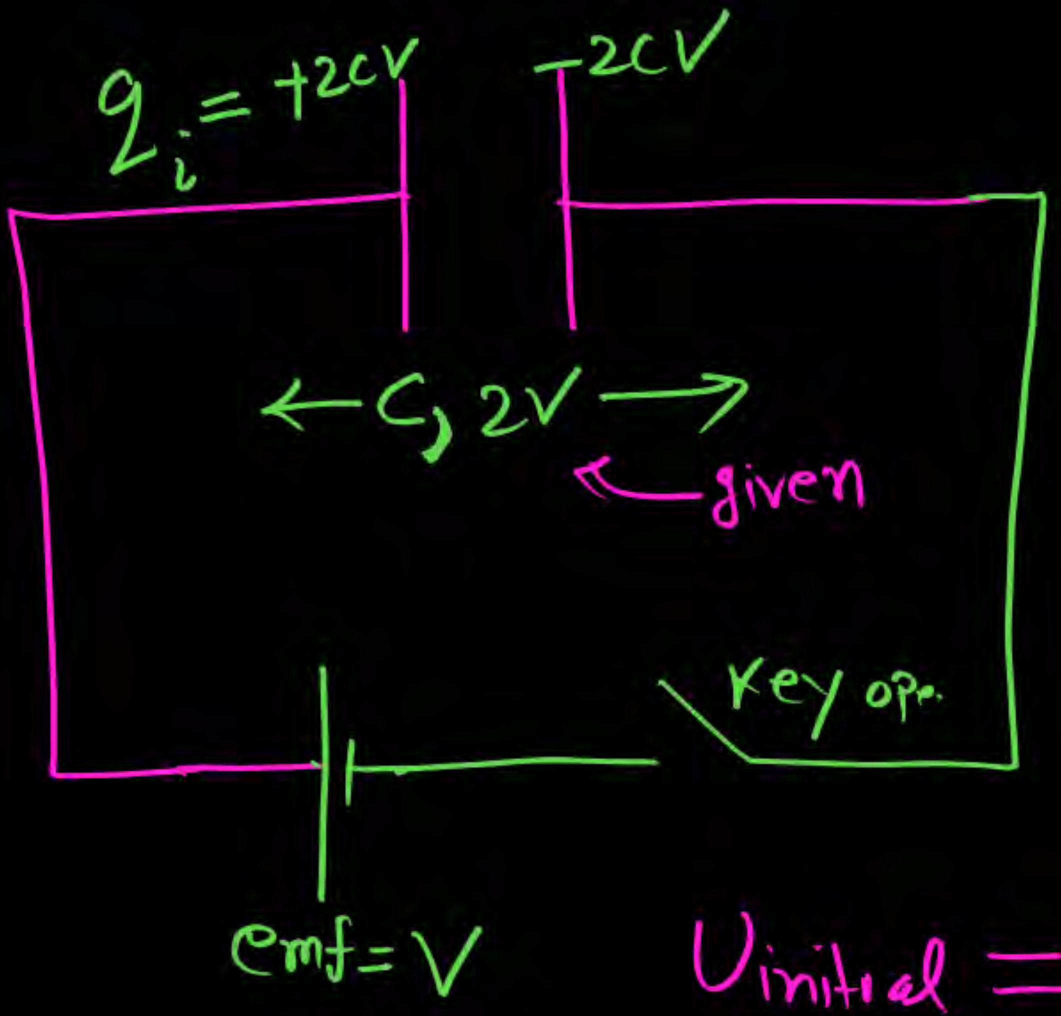
$$\frac{1}{2}CV^2 + 2CV^2 = 2CV^2 + U_{loss}$$

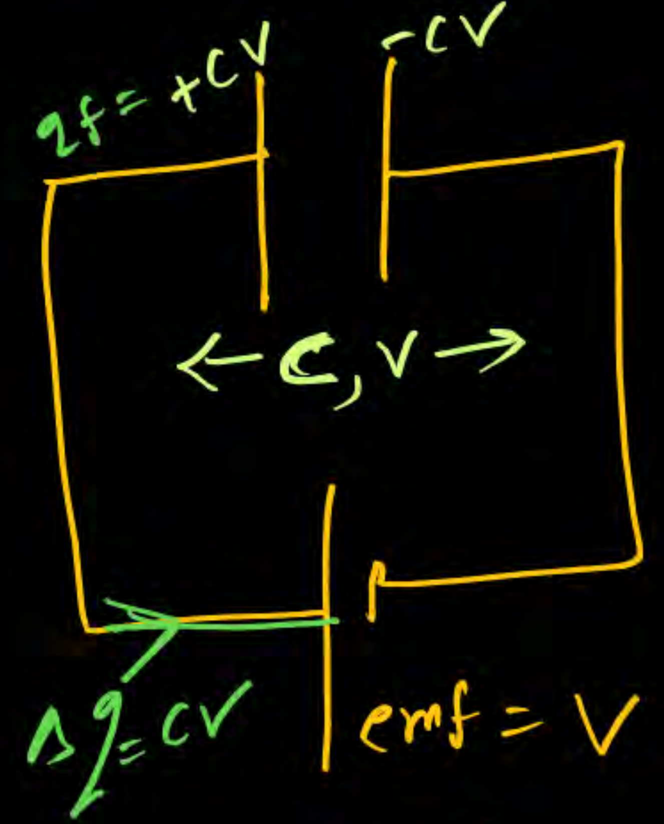
$$U_{loss} = \frac{1}{2}CV^2 \quad \text{Ans}$$

$$\Delta q = 2CV - CV = CV$$

$$W_{Batt} = \Delta q \times emf = CV[2V] = 2CV^2$$

When key is closed then find loss in energy





$$U_{initial} = \frac{1}{2} C (2V)^2 = \frac{1}{2} C \, 4V^2 = 2CV^2$$

$$U_{fin} = \frac{1}{2} CV^2$$

$$W_{Batty} = -CV(V) = -CV^2$$

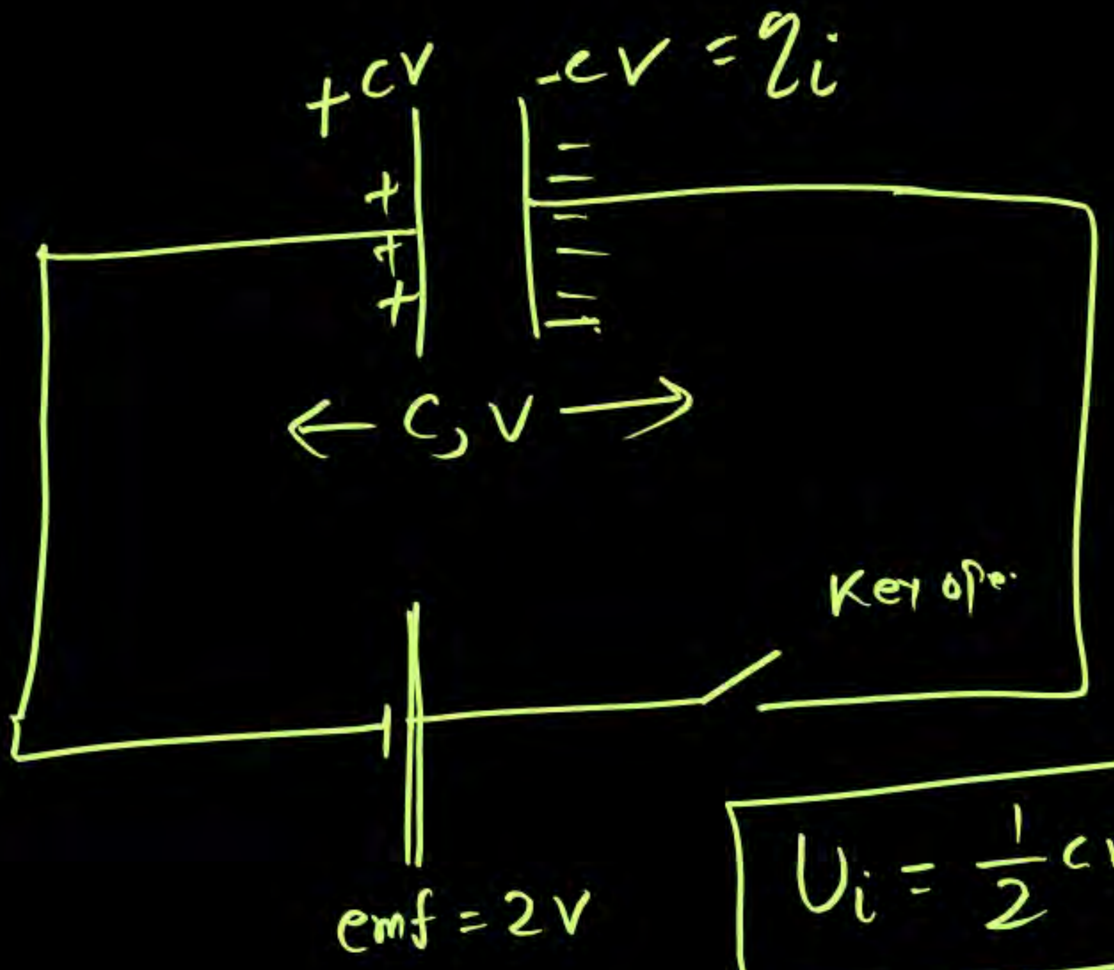
$$U_i + W_{Bat} = U_f + U_{loss}$$

$$2CV^2 - CV^2 = \frac{1}{2} CV^2 + U_{loss}$$

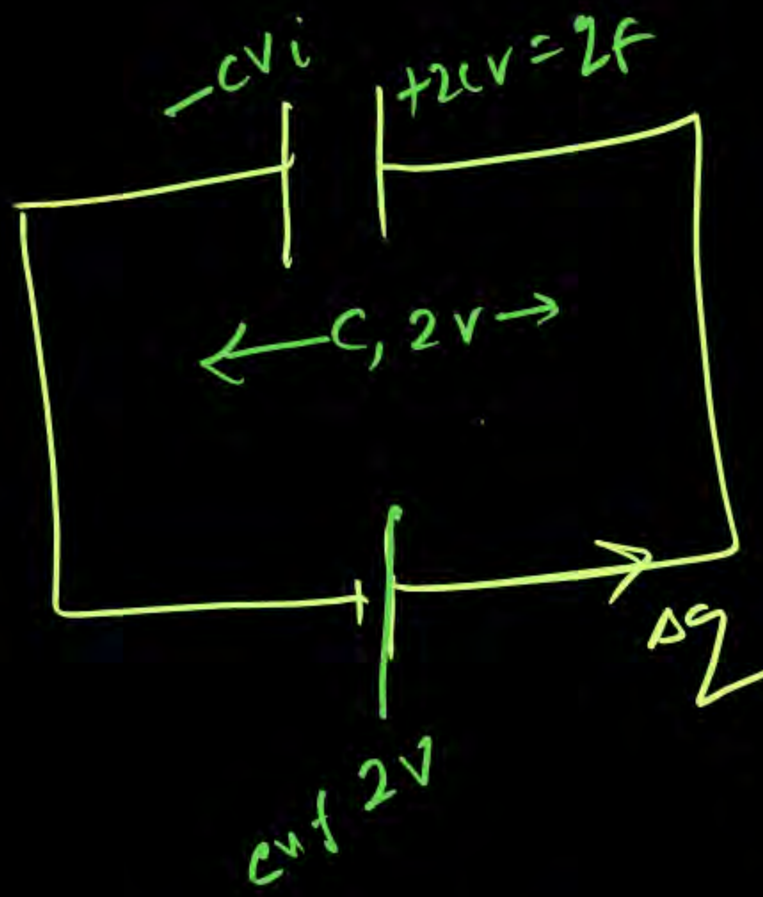
$$2CV^2 - \frac{3}{2} CV^2 = U_{loss}$$

* $\frac{1}{2} CV^2 = U_{loss}$

find loss in energy when key is closed



$$U_i = \frac{1}{2}cv^2$$



$$\Delta q = q_f - q_i$$
$$= 2cv - (-cv)$$
$$= 3cv$$

$$U_f = \frac{1}{2}c(2v)^2$$

$$U_f = 2cv^2$$

$$W_{bv} = 3cv(2v)$$
$$= 6cv^2$$

$$U_i + W_{batt} = U_f + U_{loss}$$

$$\frac{1}{2}cv^2 + 6v^2c = 2cv^2 + U_{loss}$$

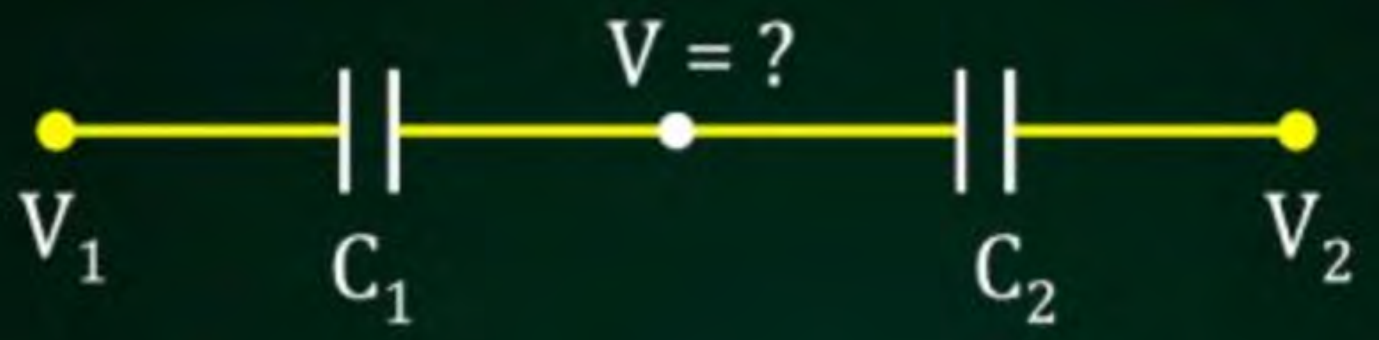
$$\frac{9}{2}cv^2 = U_{loss}$$

Opposite Polarity



QUESTION

Find




THANK YOU

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FOR NEET 2025

Lecture- 8 | **Physics**

Electrostatic Potential and Capacitance

By- Dr. Manish Raj (MR SIR)

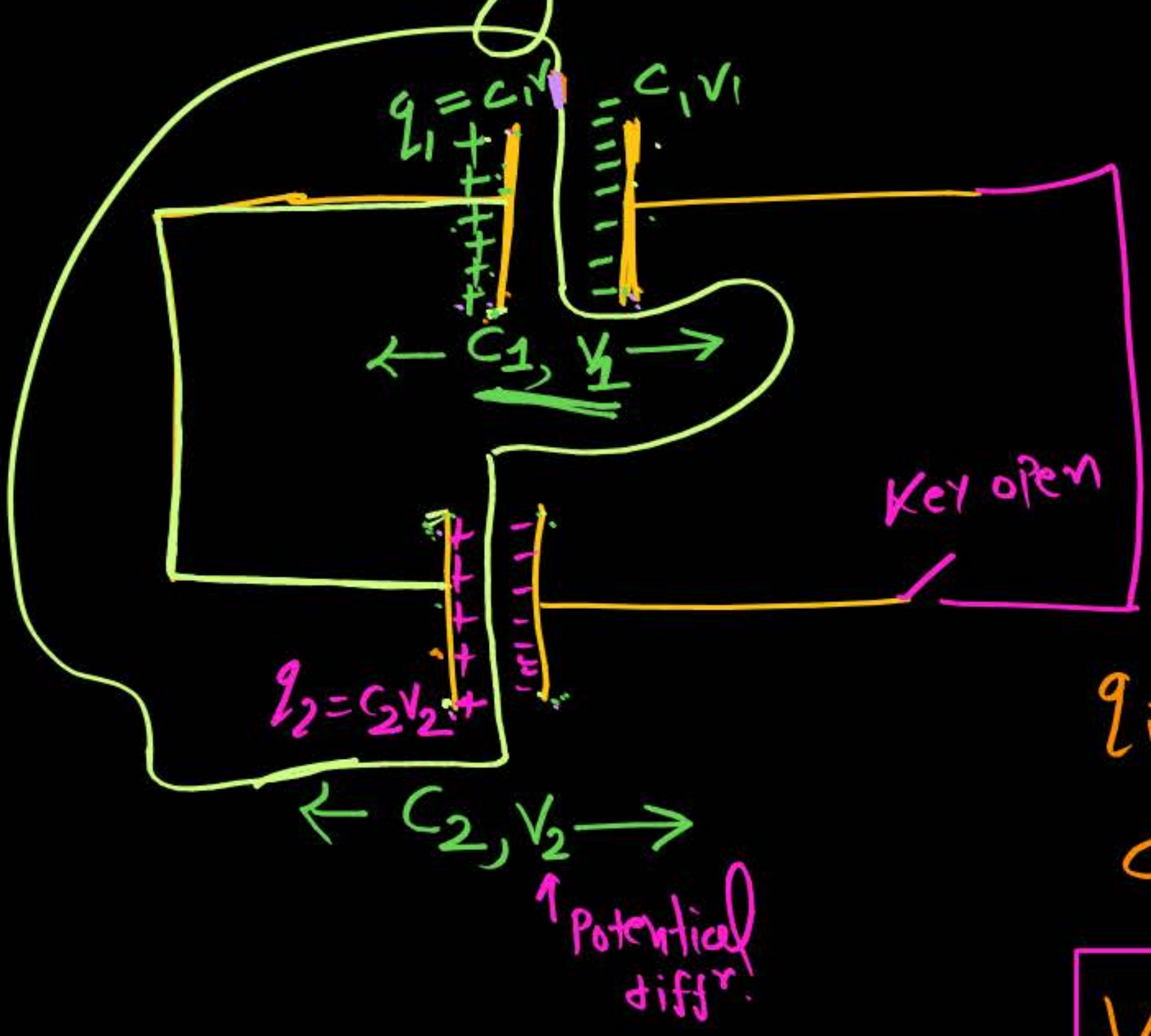


Topics to be covered

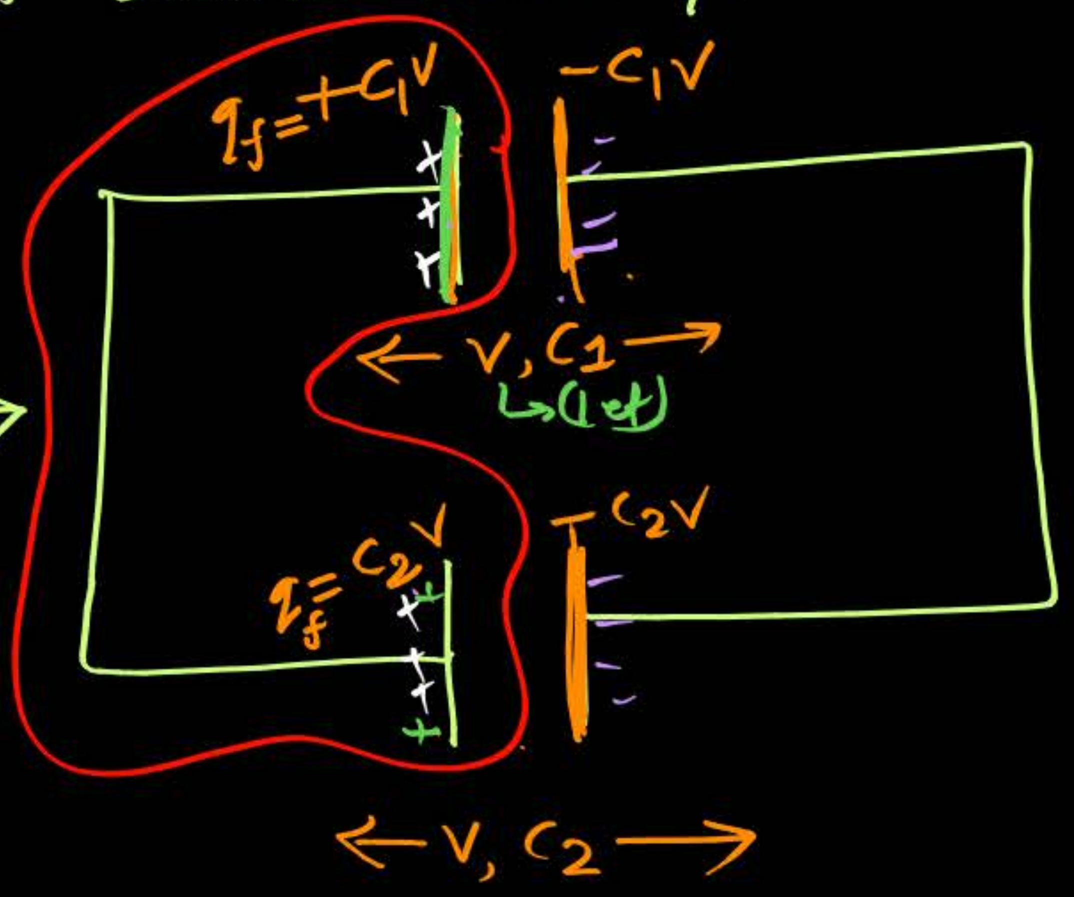
1. # ☆ Connecting two capacitor ← ★★.
2. # Series & paralle combinatio of capacitor
3. #



Connecting one capacitor with other of same polarity:-



Key is closed



$$q_{initial} = q_{final}$$

$$C_1V_1 + C_2V_2 = C_1V + C_2V$$

Common Potential

$$V = \frac{C_1V_1 + C_2V_2}{C_1 + C_2} = \frac{q_{i\,on\,1st} + q_{i\,on\,2nd}}{C_1 + C_2}$$

$\Delta q_{Trans\ on\ 1^{st}\ capacitor} = q_f - q_i = (C_1V - C_1V_1)$

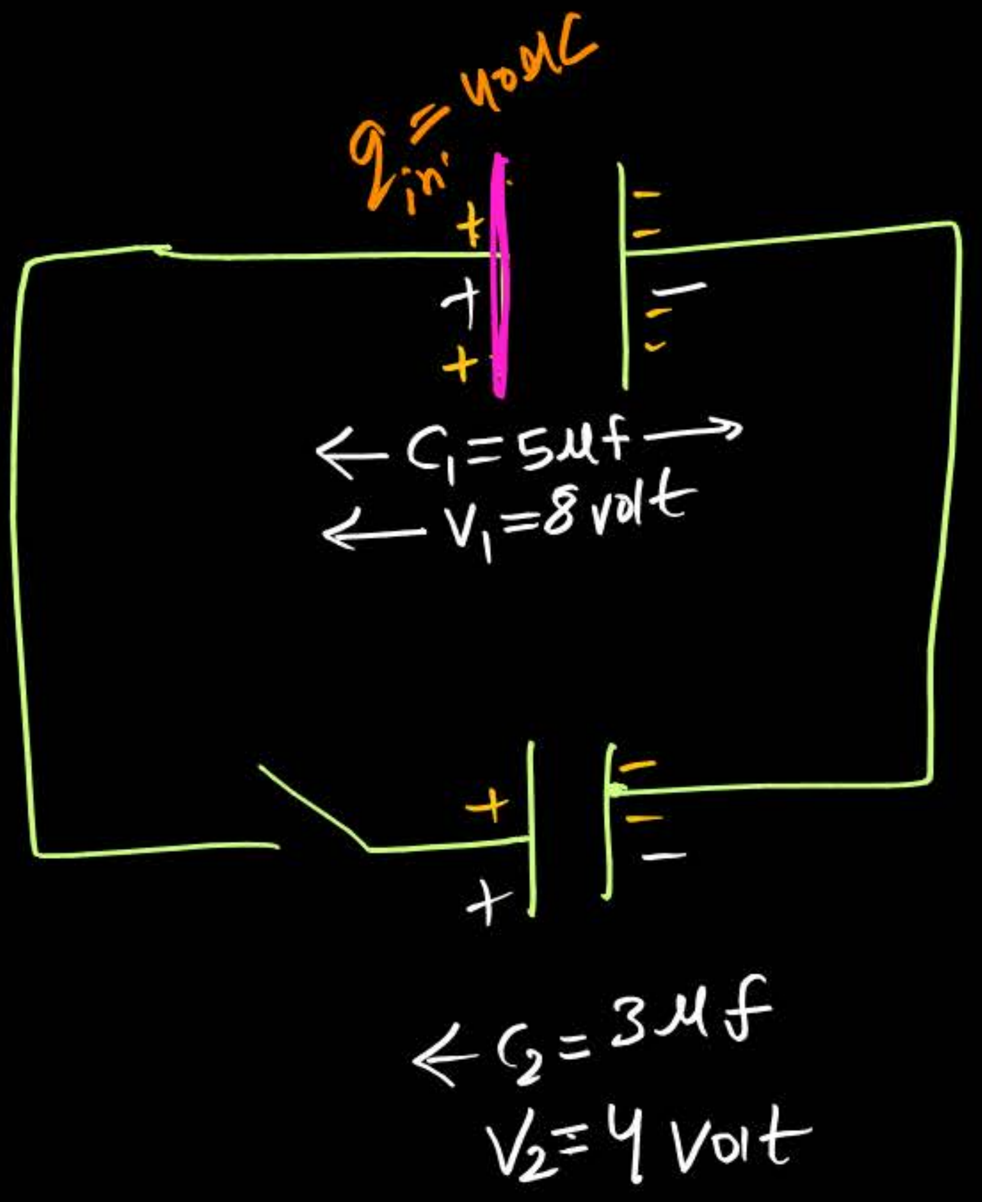
$$\Delta U_{loss} = U_{initial\ system} - U_{final\ syste}$$

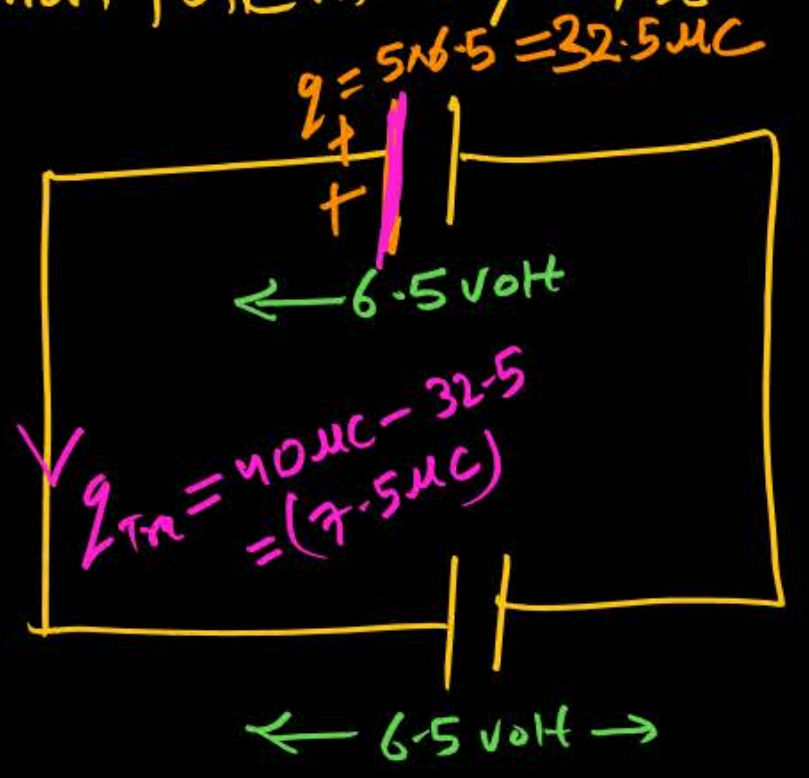
$$= \frac{1}{2}C_1V_1^2 + \frac{1}{2}C_2V_2^2 - \frac{1}{2}(C_1+C_2)V^2$$

putting value of 'V'

$$\Delta U = \frac{1}{2} \times \frac{C_1C_2}{C_1+C_2}(V_1 - V_2)^2$$

Find common Potential / V_{loss} when Key is closed.





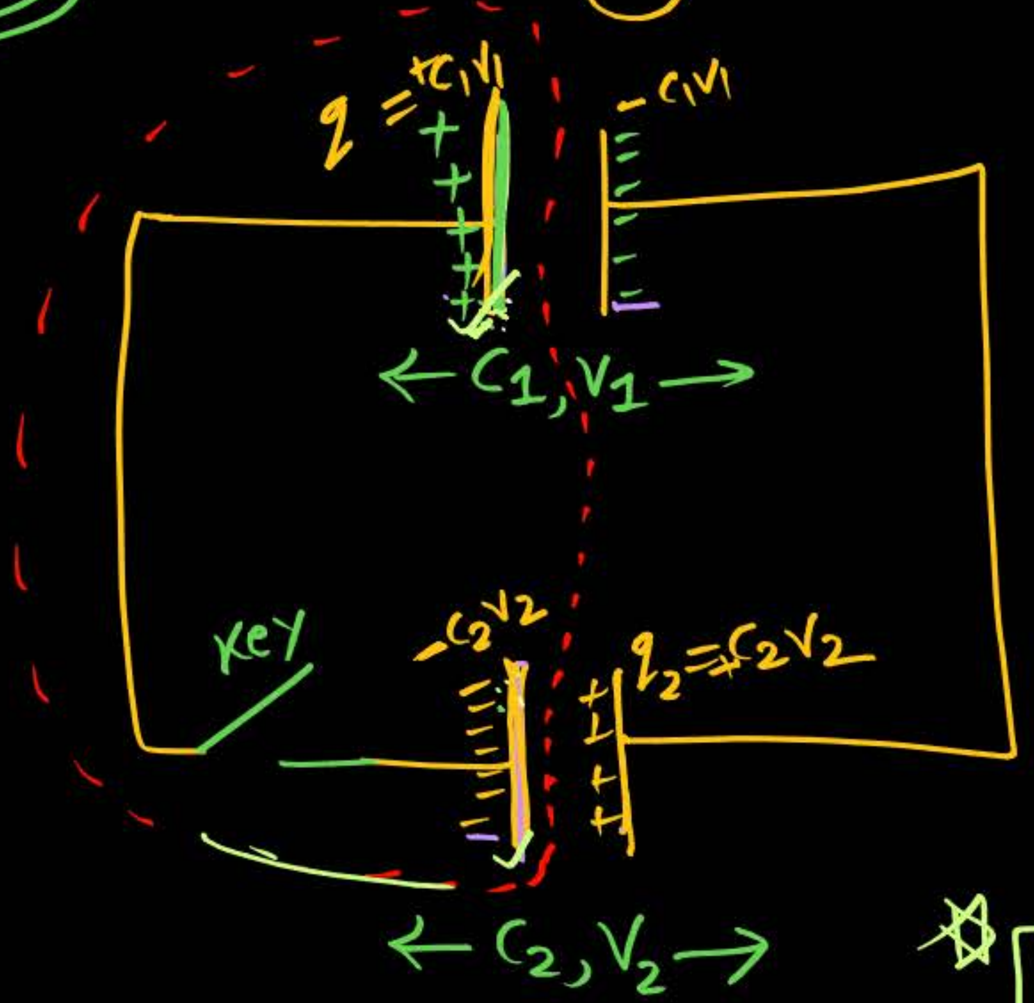
$$V_c = \frac{5\times8 + 3\times4}{5+3} = \frac{40+12}{8} = \frac{52}{8} = \frac{26}{4} = \frac{13}{2} = 6.5 \text{ volt}$$

$$\Delta U = \frac{1}{2}\frac{C_1C_2}{C_1+C_2}(V_1-V_2)^2 = \frac{1}{2}\frac{5\times3}{8}(8-4)^2 = \frac{15}{2\times8}\times16$$

$$= 15\,\mu \text{ Joule}$$

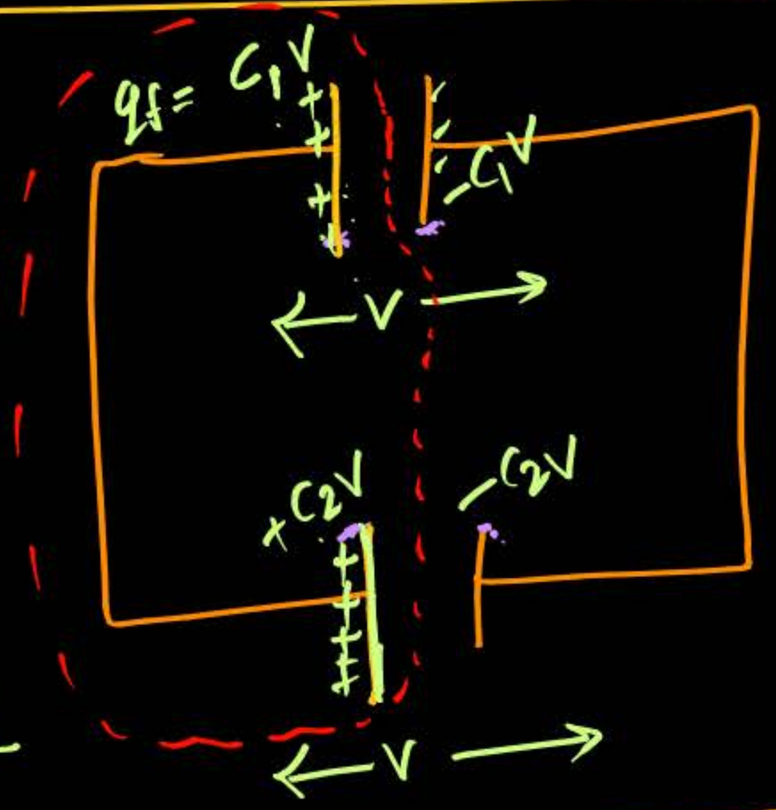
Level up

Connecting two capacitor with opposite Polarity



Key is closed →

let $(V_1 > V_2)$



Charge conserved

$$C_1V_1 - C_2V_2 = C_1V + C_2V$$

$$V = \frac{C_1V_1 - C_2V_2}{C_1 + C_2}$$

$$\Delta U = \frac{1}{2}\frac{C_1C_2}{C_1+C_2}(V_1+V_2)^2$$

opposite Polarity

$$q_{Transf} = [C_1V_1 - C_1V]$$

$$V = \frac{C_1V_1 + C_2V_2}{C_1+C_2}$$

Same Polarity

$$\Delta U = \frac{1}{2}\frac{C_1C_2}{C_1+C_2}(V_1-V_2)^2$$

Same Polarity

QUESTION

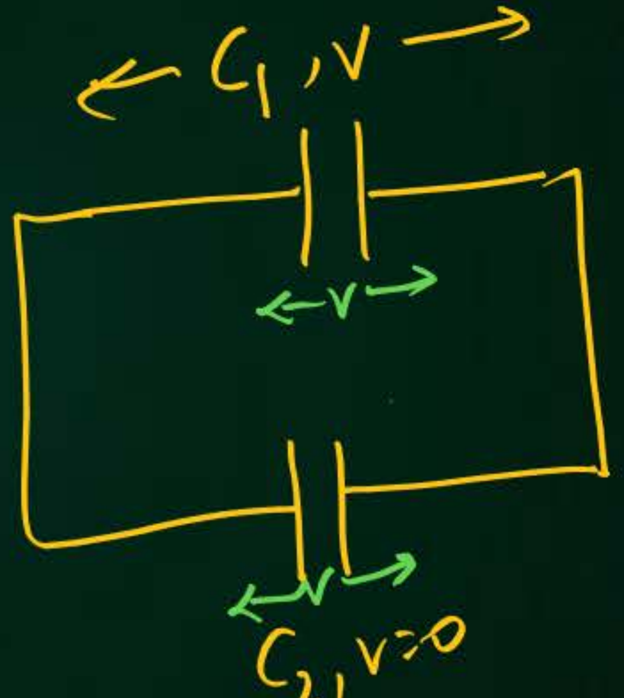
A capacitor of capacity C_1 is charged upto potential V volt and then connected in parallel to an uncharged capacitor of capacity C_2. The final potential difference across each capacitor will be:

1. $\dfrac{C_2V}{C_1 + V_2}$

2. $\dfrac{C_1V}{C_1 + V_2}$ ✓ Ans

3. $\left(1 + \dfrac{C_2}{C_1}\right)V$

4. $\left(1 - \dfrac{C_2}{C_1}\right)V$



$$V = \frac{C_1V + C_2 \times 0}{C_1 + C_2}$$

$$= \frac{C_1V}{C_1 + C_2}$$

QUESTION

A capacitor is charged by connecting a battery across its pates. It stores energy u. How the battery is disconnected and another identical capacitor is connected across it, then the energy by both the capacitors of the system will be:

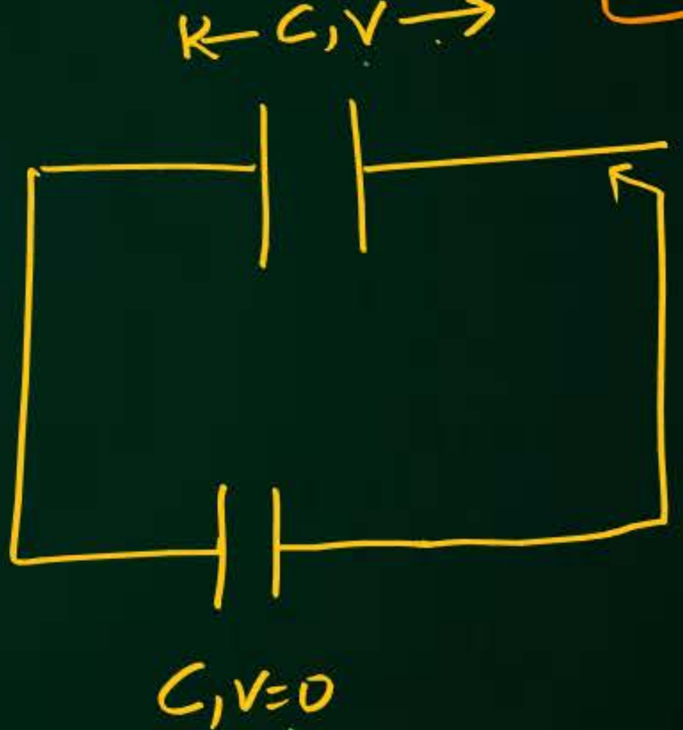
1. u
2. $\frac{u}{4}$
3. $2u$
4. $\frac{u}{2}$

Let $U = \frac{1}{2}CV^2$

$$V_c = \frac{CV + C\times 0}{C + C}$$

$$V_c = \frac{CV}{2C} = V/2$$

$$U_{final} = \frac{1}{2}C(V/2)^2 + \frac{1}{2}C(V/2)^2 = \frac{1}{2}\frac{CV^2}{4}\times 2 = \frac{CV^2}{4} = \frac{U}{2}$$



$$\Delta U_{loss} = \frac{1}{2}\frac{C\times C}{2C}(V-0)^2 = \frac{1}{4}CV^2 = \frac{U}{2}$$

QUESTION

Two identical capacitors have the same capacitance C. One of them is charged to potential V_1 and the other to V_2. The negative ends of the capacitors are connected together. When the positive ends are also connected, the decrease in energy of the combine system is

(1) $\frac{C}{4}(V_1^2 - V_2^2)$

(2) $\frac{C}{4}(V_1^2 + V_2^2)$

(3) $\frac{C}{4}(V_1 - V_2)^2$

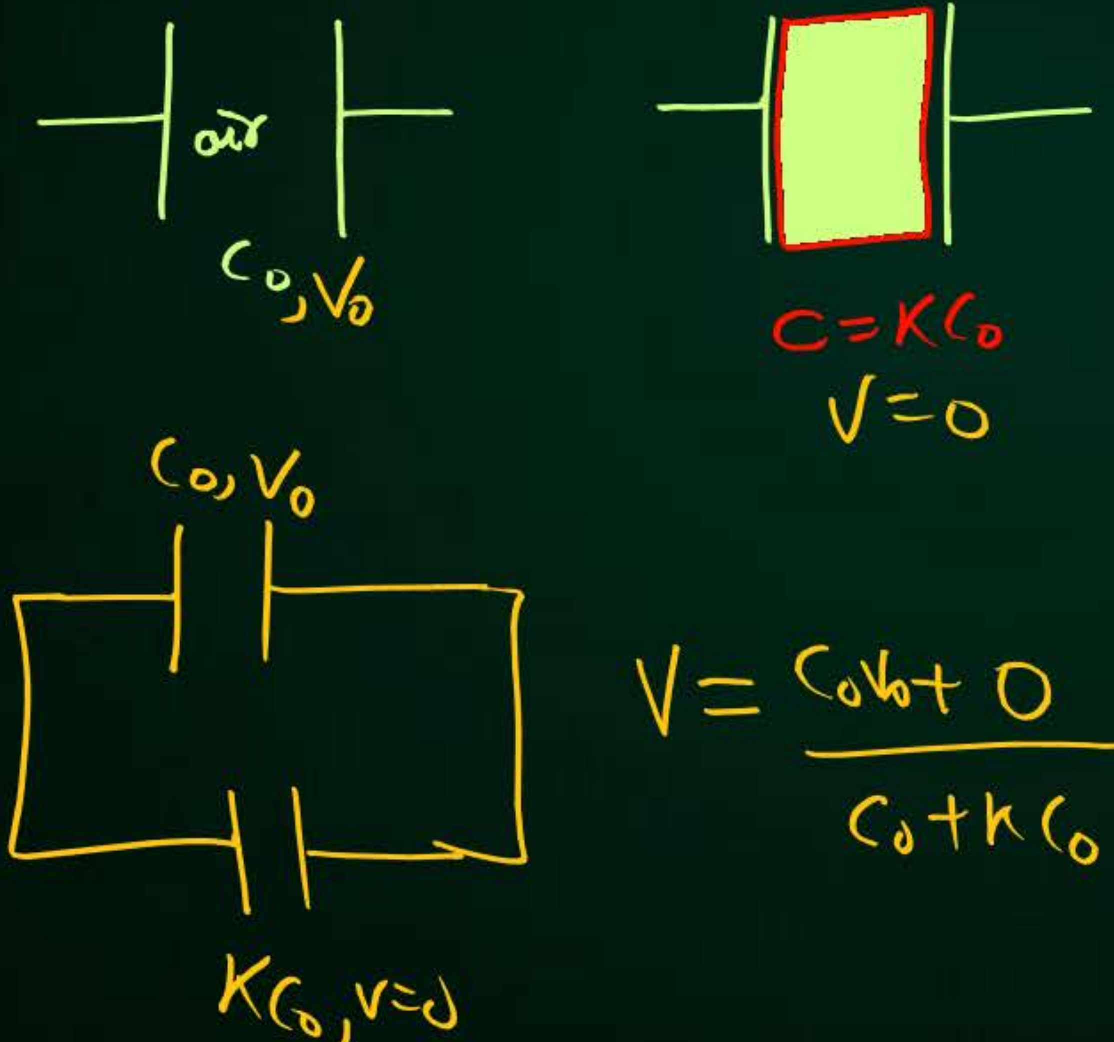
(4) $\frac{C}{4}(V_1 + V_2)^2$

$\Delta U = \frac{1}{2}\frac{C \times C}{2C}(V_1 - V_2)^2$

QUESTION

An uncharged capacitor with a solid dielectric is connected to a similar air capacitor charged to a potential of V_0. If the common potential after sharing of charges becomes V ,then the dielectric constant of the dielectric must be

1. $\frac{V_0}{V}$
2. $\frac{V}{V_0}$
3. $\frac{V_0 - V}{V}$
4. $\frac{V_0 - V}{V_0}$



$$V = \frac{C_0V_0 + 0}{C_0 + KC_0} = \frac{C_0V_0}{C_0(1+K)}$$

$$V = \frac{V_0}{1+K}$$

$$1 + K = \frac{V_0}{V}$$

$$K = \frac{V_0}{V} - 1$$

$$K = \frac{V_0 - V}{V}$$

QUESTION

done

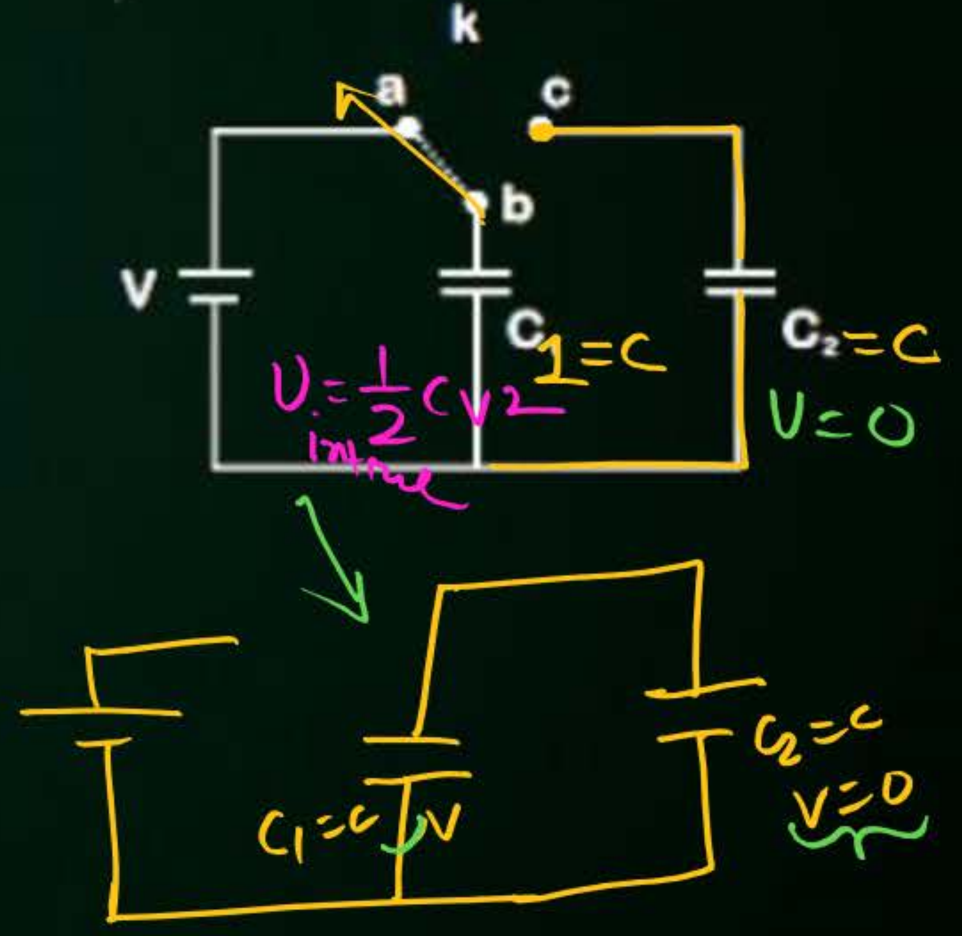
A capacitor is charged by a battery. The battery is removed and another identical uncharged capacitor is connected in parallel. The total electrostatic energy of resulting system:

1. Increase by a factor of 2
2. Increase by a factor of 4
3. Decrease by a factor of 2
4. Remains the same

QUESTION

Same question (JEE)

Two identical capacitors C_1 and C_2 of equal capacitance are connected as shown in the circuit. Terminals a and b of the key k are connected to charge capacitor C_1 using battery of emf V volt. Now disconnecting a and b the terminals **b** and **c** are connected. Due to this, what will be the percentage loss of energy?



1. 50%
2. 25%
3. 75%
4. 0%

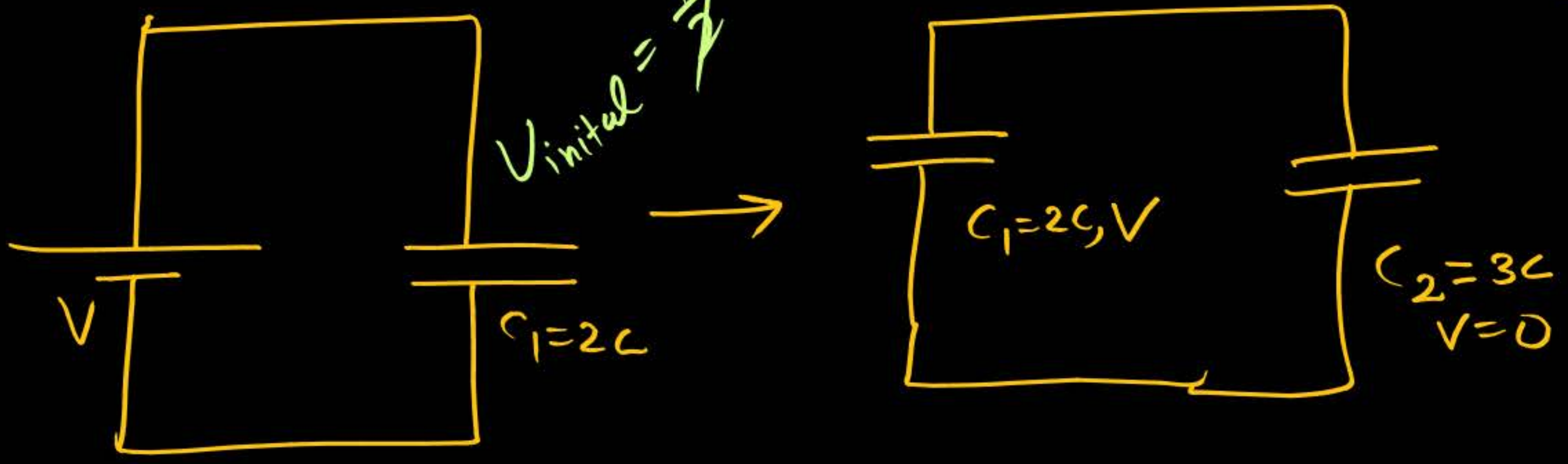
$$\Delta U = \frac{1}{2}\frac{C \times C}{C + C}(V^2)$$

$$= \frac{1}{2}\frac{C \times C}{2C}V^2$$

$$\Delta U = \frac{1}{4}CV^2$$

$$\Rightarrow \frac{\Delta U}{U_i} \times 100 = \frac{\frac{1}{4}CV^2}{\frac{1}{2}CV^2} = \frac{1}{2} \times 100 = 50\%$$

$V_{inital} = \frac{1}{2} 2cV^2 = cV^2$



C_1 is charged by removed & removed then connected to C_2 find loss in enegy.

$$\Delta U = \frac{1}{2} \frac{2c \times 3c}{5c} \times V^2$$

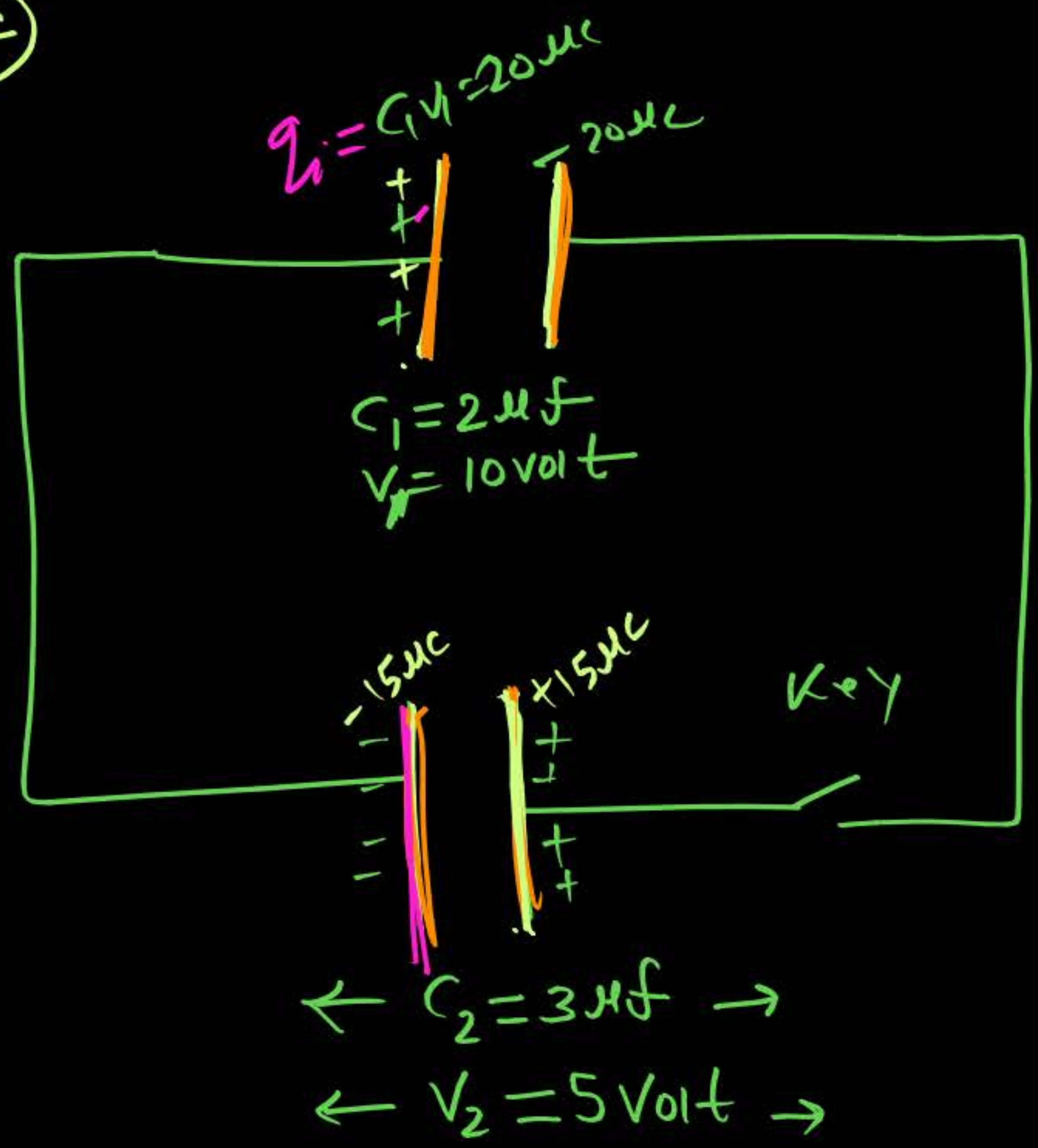
$$\Delta U = \frac{3}{5} cV^2$$

$$\% \text{ loss in enegy} = \frac{(V_f - V_i)}{V_i} \times 100$$

$$= \frac{\frac{3}{5} cV^2}{cV^2} \times 100$$

$$= 60\%$$

#

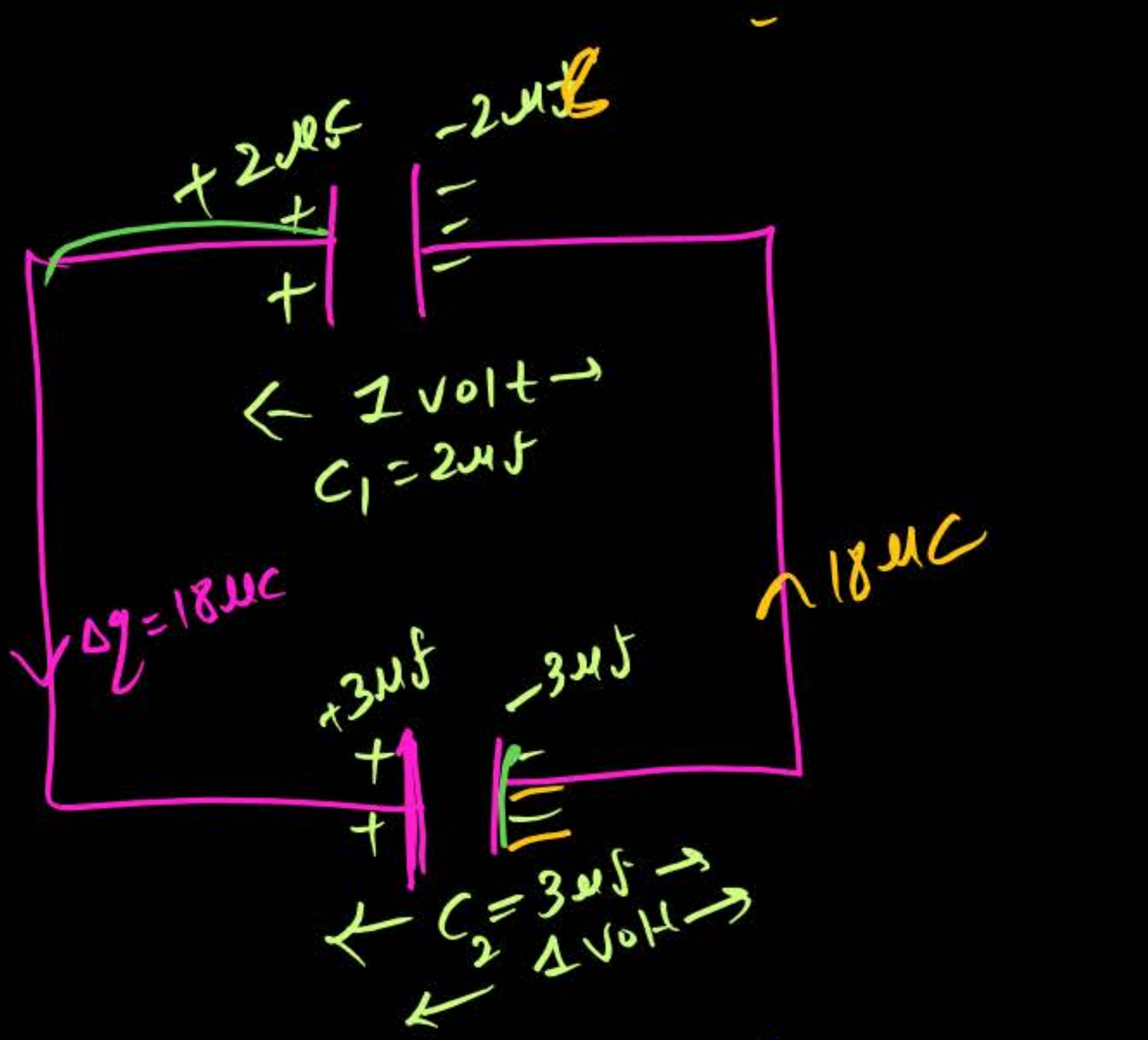


Key is close

(a) find common Potential

(b) loss in energy

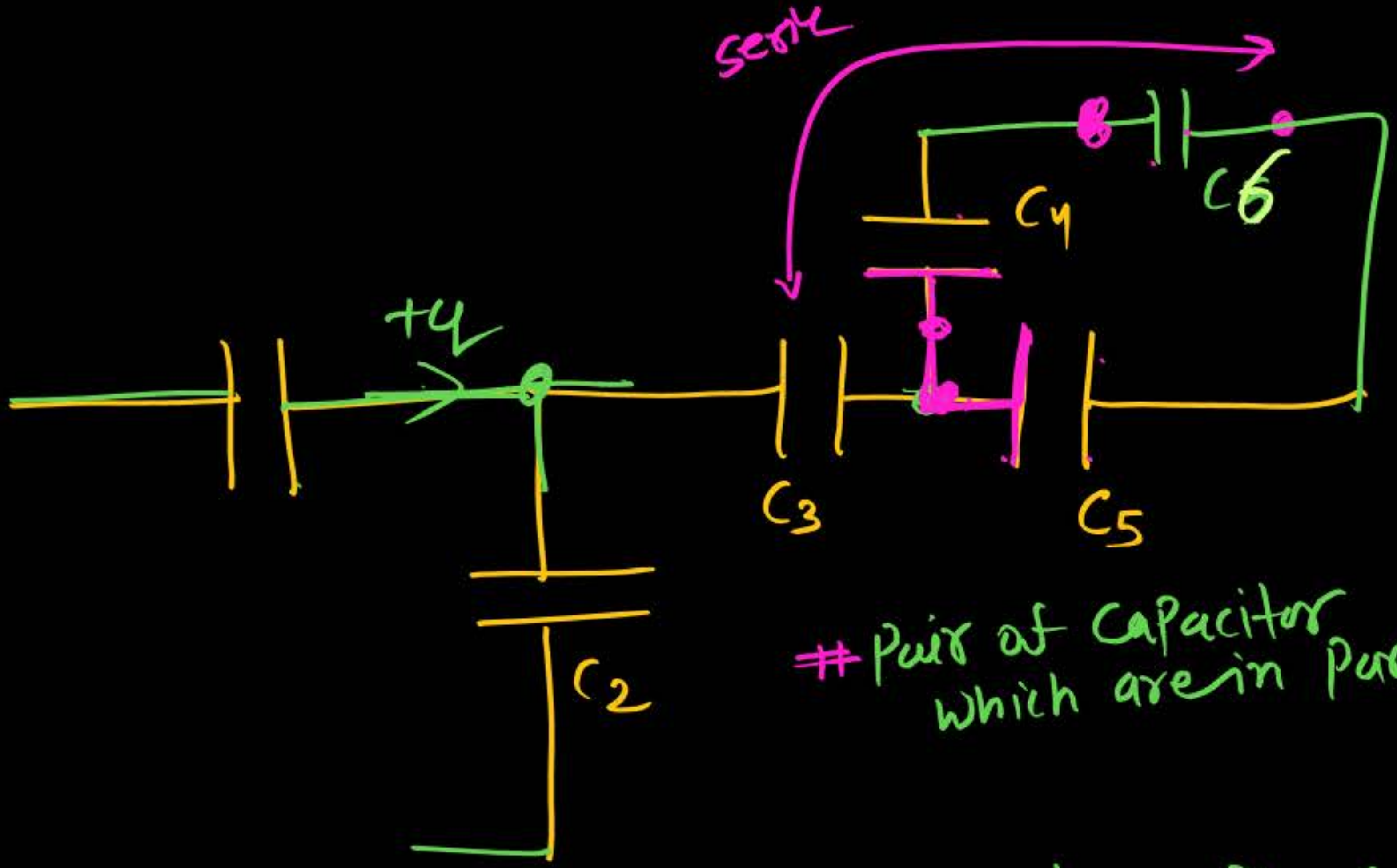
(c) Transferred charge



$$V_c = \frac{20-15}{5} = \frac{5}{5} = 1 \text{ volt}$$

$$\Delta U_{loss} = \frac{1}{2}\frac{C_1C_2}{C_1+C_2}(V_1+V_2)^2$$

$$= \frac{1}{2}\frac{3\times 2}{5}(15)^2 = \frac{3}{5}\times 15\times 15 = 135\mu J$$



which of following pair of Capacitors are in Series

1, (C1, C2)

(2) C2 C3

(3) C5, C4

(4) (C1 C2), (C2, C3)
(C1, C3) (C3 C4)

(8) C3, C5

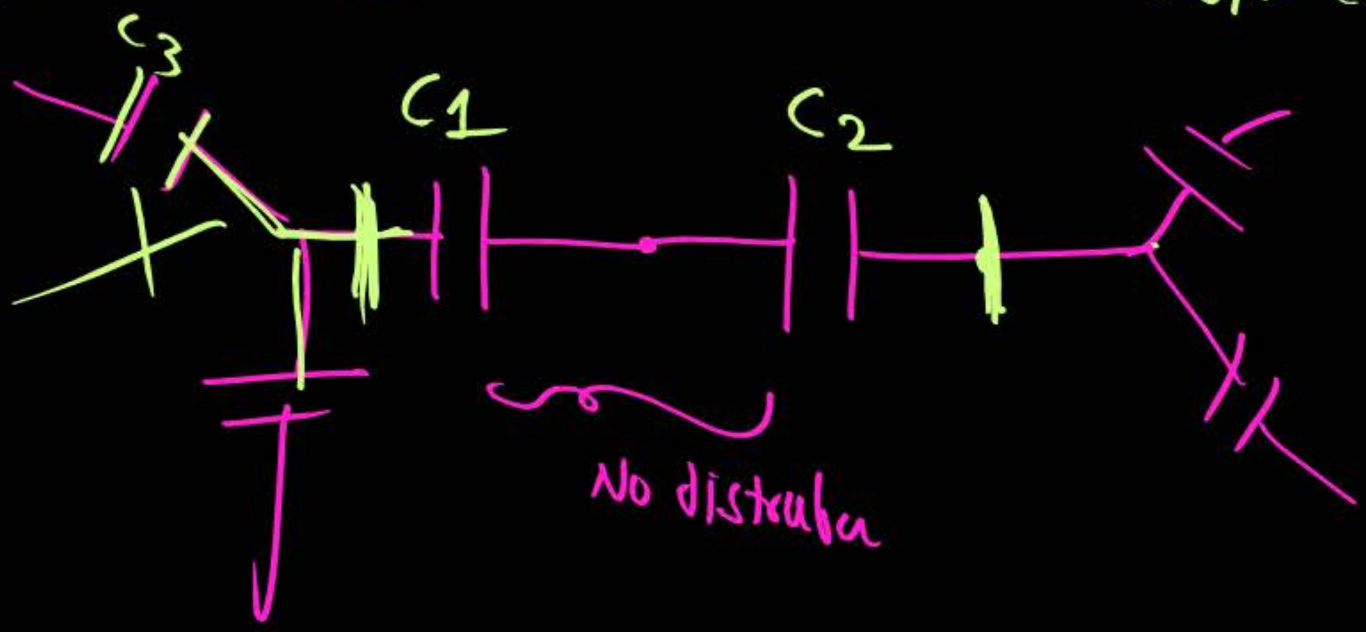
(5) (C4, C6)

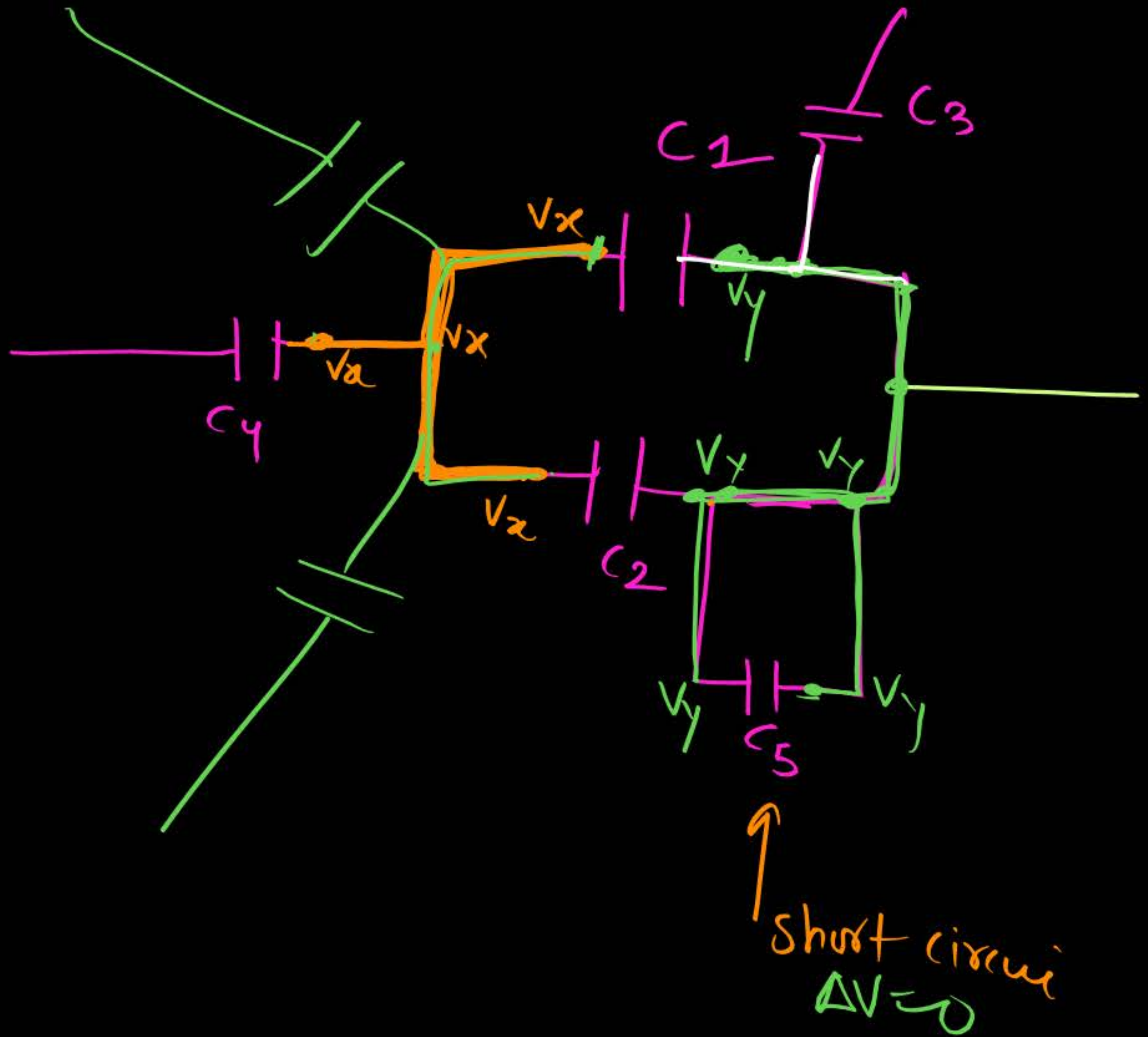
(6) C6, C5

(7) (C4 C5)
(C4 C6)
(C6 C5)

pair of capacitor which are in parallel → NO pair of capacitor

Series combination → same charge flows in series Comb
→ end to end connection (No distrubance B/w capacitor)





Pair of capacitor are in Parallel.

C1 & C2 are in Parallel

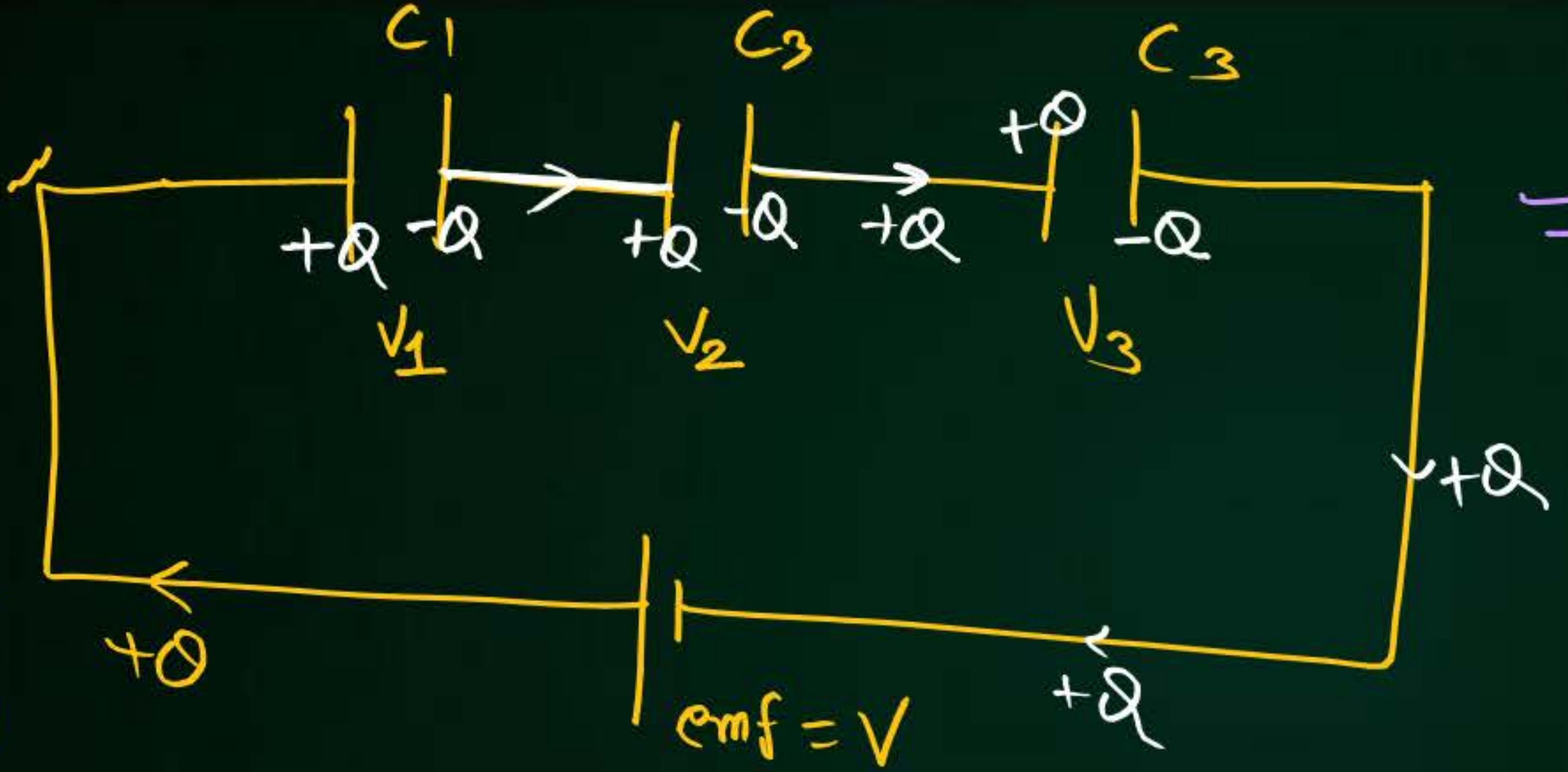
(*) Potential diff^n across them must be same.

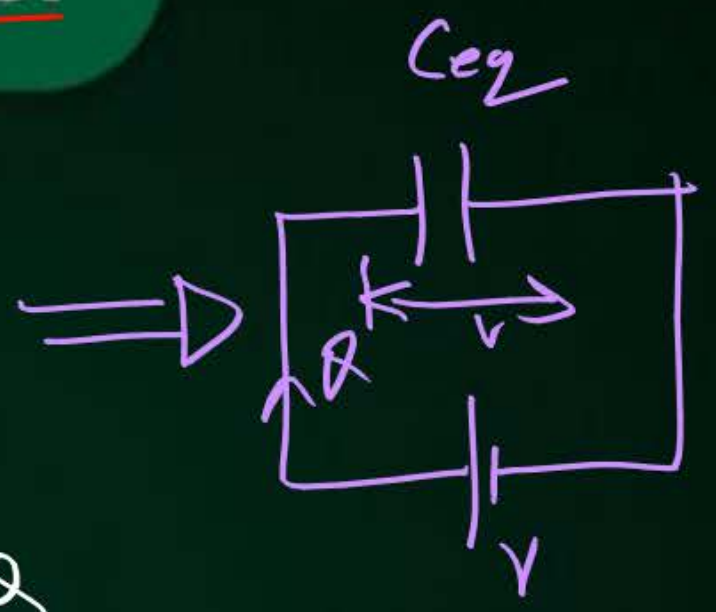
(*) KVL → सिधा Potential को के चलते रहो, जहा capacitor, Battery आये तो कुछ आये।

Series Combination of Capacitor

Same difⁿ

$Q = CV$





Ceq must be smaller than smallest capacitance

$V_1 + V_2 + V_3 = V$

$\frac{Q}{C_1} + \frac{Q}{C_2} + \frac{Q}{C_3} = \frac{Q}{C_{eq}}$

$\boxed{\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} = \frac{1}{C_{eq}}}$ → series combinat

↳ for two capacitor

$\boxed{C_{eq} = \frac{C_1 C_2}{C_1 + C_2}}$

End to end connection

Chage on each Capacitor is same.

Sum of Potential across each capacitor is equal emf Battey.

QUESTION

n capacitor of equal capacitance 'C' connected in series then find equivalent capacitance.

$$\frac{1}{C_{eq}} = \frac{1}{C} + \frac{1}{C} + \frac{1}{C} + \frac{1}{C} + \cdots \frac{1}{C}$$

$$\frac{1}{C_{eq}} = \frac{n}{C}$$

$$C_{eq} = \frac{C}{n}$$

MR* Law for Potential

In series combination.

$q = CV$

$V = \frac{q}{C}$ → q same

$V \propto \frac{1}{C}$ *.

$\frac{V_1}{V_2} = \frac{C_2}{C_1}$

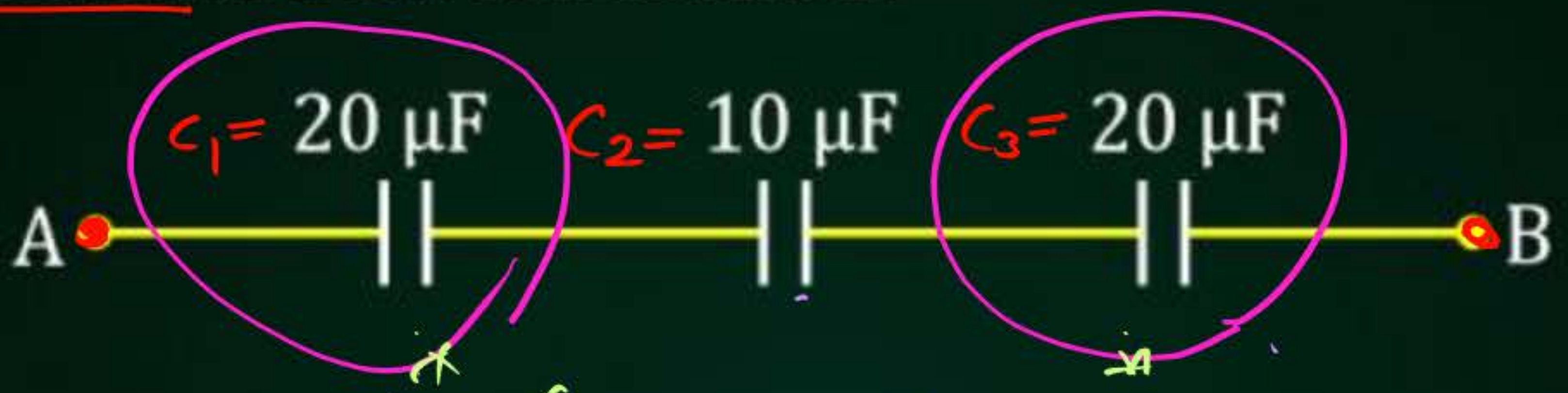
↓ $V \propto \frac{1}{C}$ ↑

↑ $V \propto \frac{1}{C}$ ↓

QUESTION

Find equivalent capacitance between A and B.

NEET



serie → (a) No
(b) Yes

$C_{eq} = 5\mu F$ → MR*

$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$$

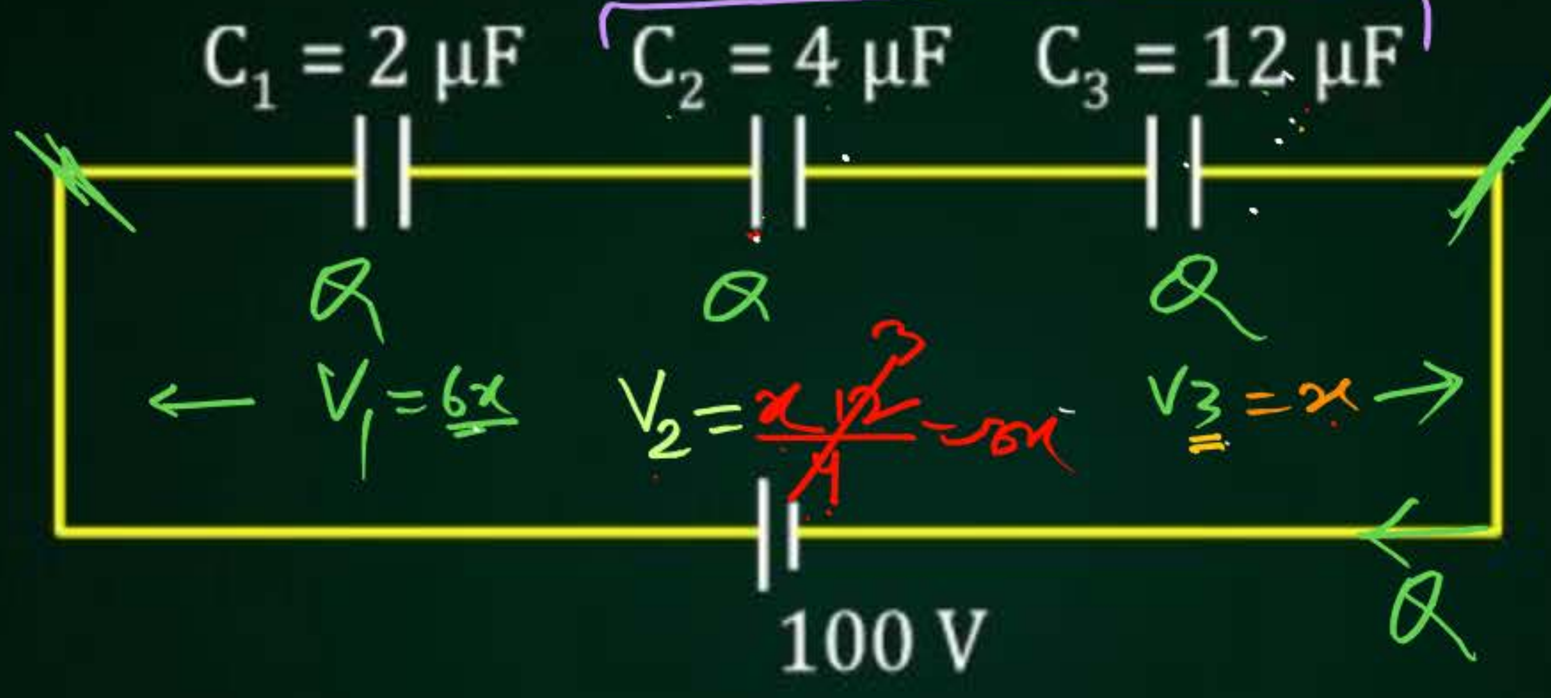
$$= \frac{1}{10} + \frac{1}{20} + \frac{1}{20}$$

$$\frac{1}{C_{eq}} = \frac{2+1+1}{20} = \frac{4}{20}$$

$$C_{eq} = 5\mu f$$

QUESTION

Find potential drop and charge on each capacitor.



\# Method-1

$C_{eq} = \frac{12\times 4}{12+4} = \frac{48}{16} = 3\ \mu F$

$(C_{eq})_{final} = \frac{3\times 2}{3+2}$

$C_{eq} = \frac{6}{5}\ \mu F$

$Q_{Batt} = C_{eq} V_{Batt} = \frac{6}{5}\times 100 = 120\ \mu C$

$Q_{Batt} = 120\ \mu C$

MR*

$V \propto \frac{1}{C}$ (series)

$\frac{V_1}{V_2} = \frac{C_2}{C_1}$

\# $6x + 3x + x = 100\ V$

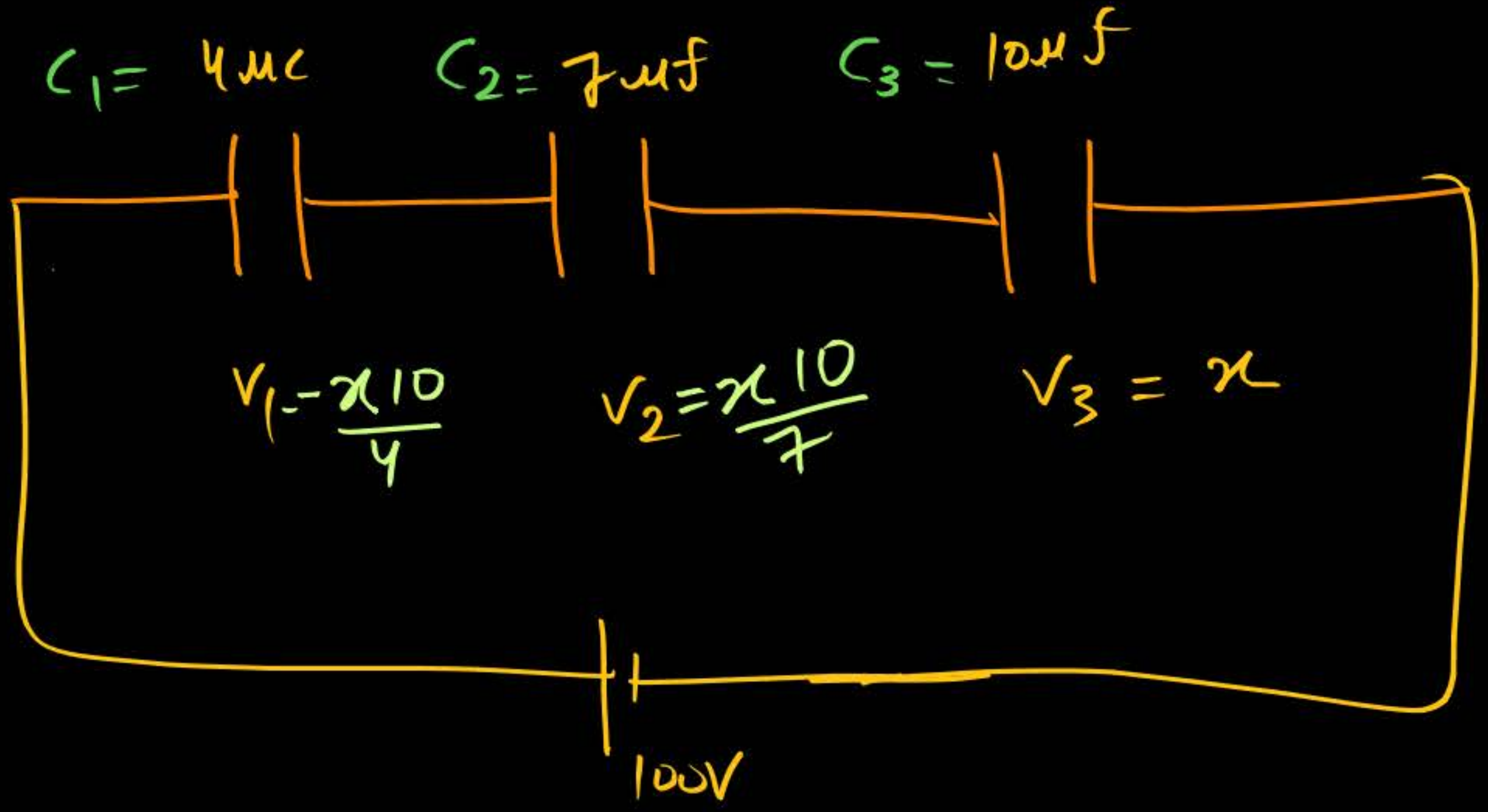
$x = \frac{100}{10} = 10$ volt — Ans

60V

$V_1 = \frac{Q}{C_1} = \frac{120\ \mu C}{2\ \mu F} = 60\ V$

$V_2 = \frac{120}{4} = 30\ V$

$V_3 = \frac{120}{12} = 10$ volt



$$\downarrow V \propto \frac{1}{C\uparrow}$$

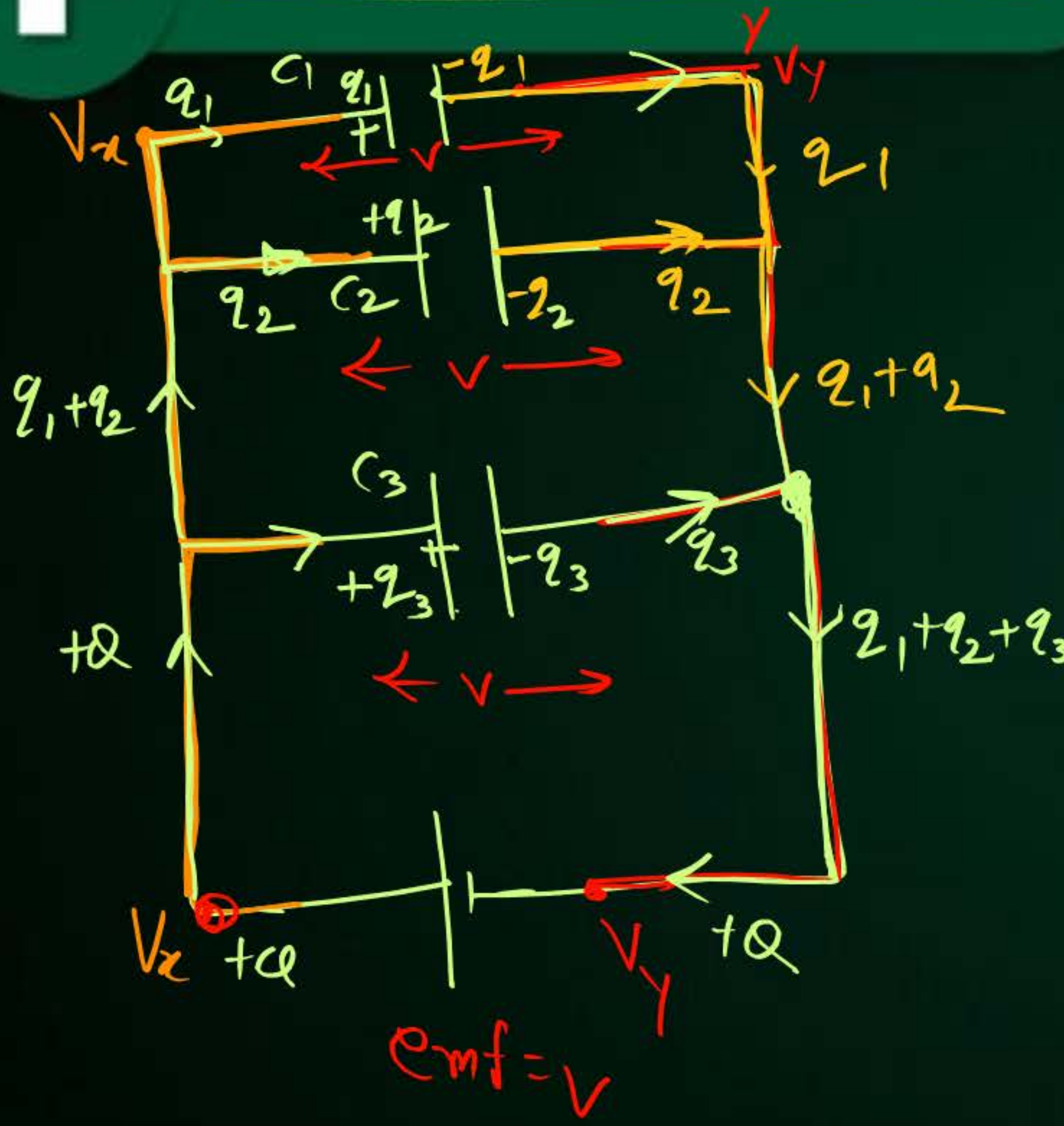
$$\frac{10x}{4} + \frac{10x}{7} + x = 100$$

$$\Rightarrow \frac{70x + 40x + 28x}{28} = 100$$

$$\Rightarrow 138x = 2800$$

$$x = 2800/138$$

Parallel Combination





Potential across each capacitor will be same.

$q = C V$ (V: same; q, C: diff)

$Q_{Battery} = q_1 + q_2 + q_3$

$C_{eq} V = C_1 V + C_2 V + C_3 V$

$C_{eq} = C_1 + C_2 + C_3$

C_{eq} must be larger than largest capacitor

If n-capacitor of equal capacitance 'C'

$C_{eq} = nC$

MR* Law for charge in parallel

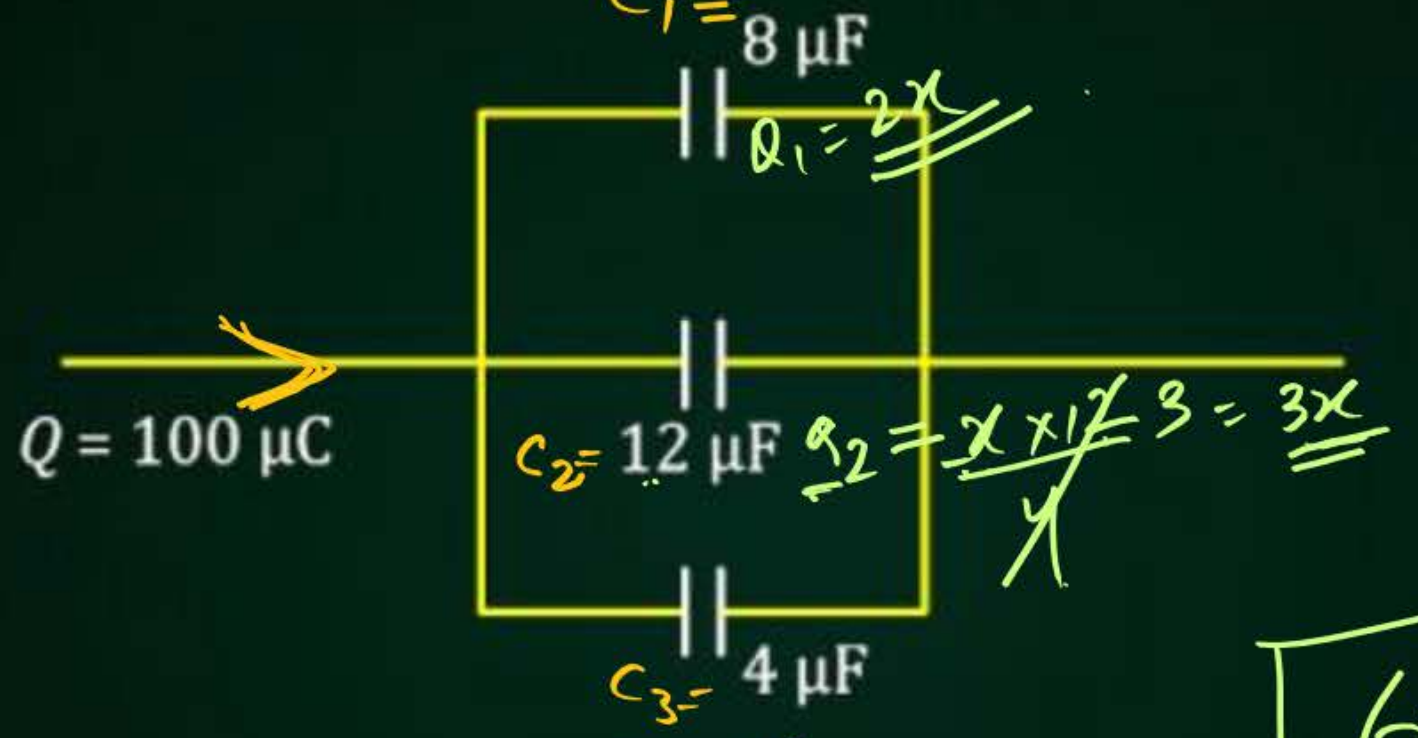
$$Q = C\boxed{V}$$ → same

$Q \propto C$ ✓

$$\boxed{\frac{Q_1}{Q_2} = \frac{C_1}{C_2}}$$

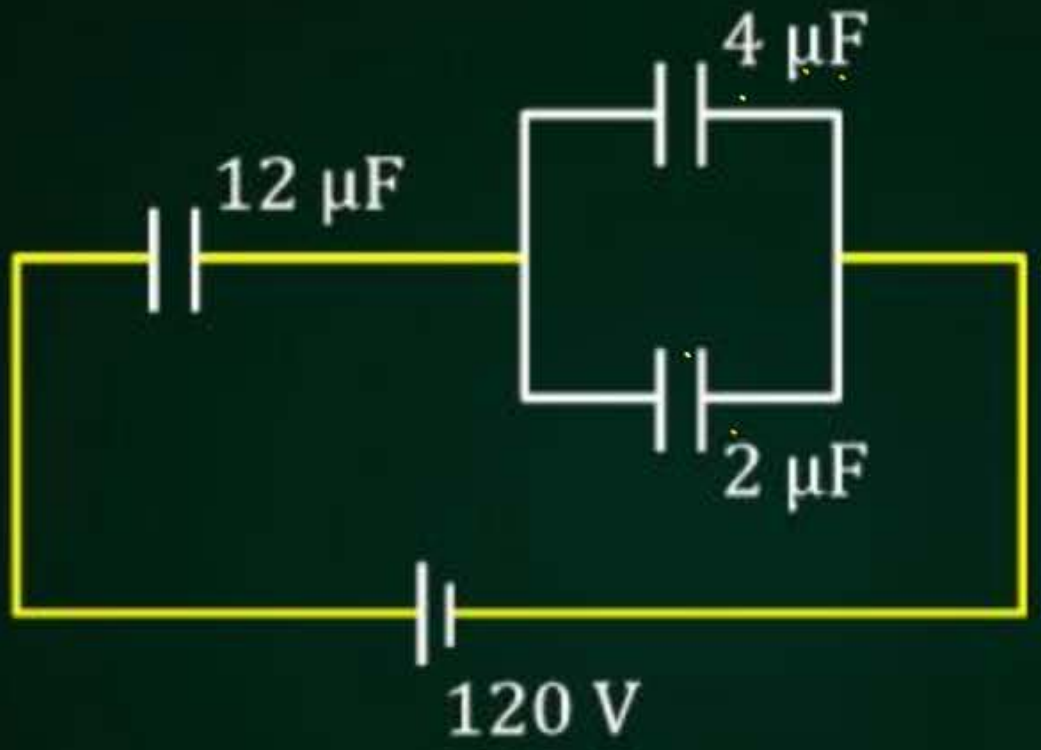
QUESTION

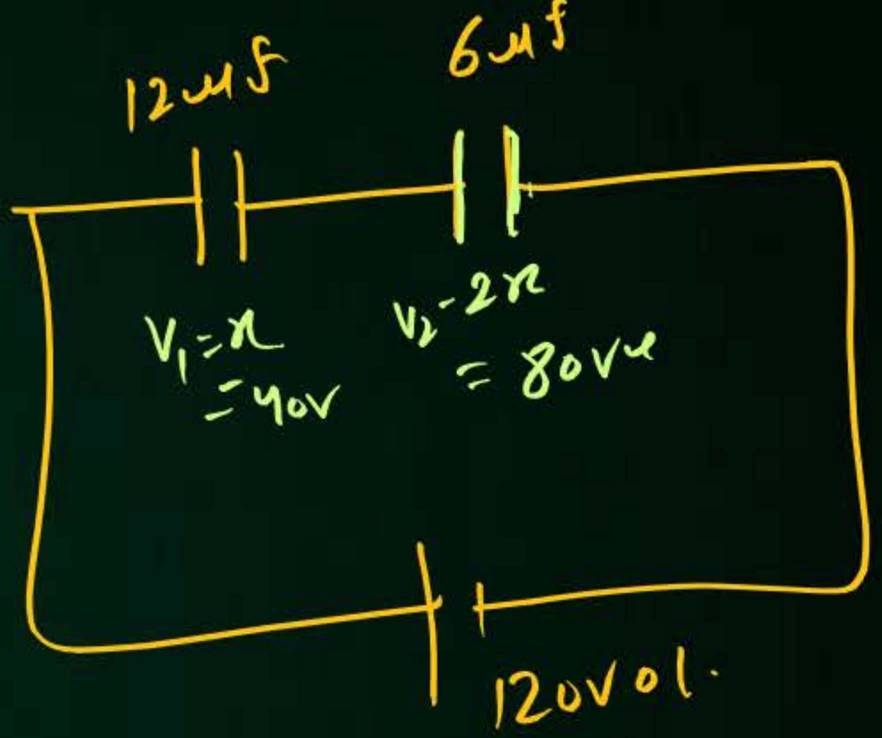
Find charge on each capacitor?



QUESTION

Find charge and potential across each capacitor.



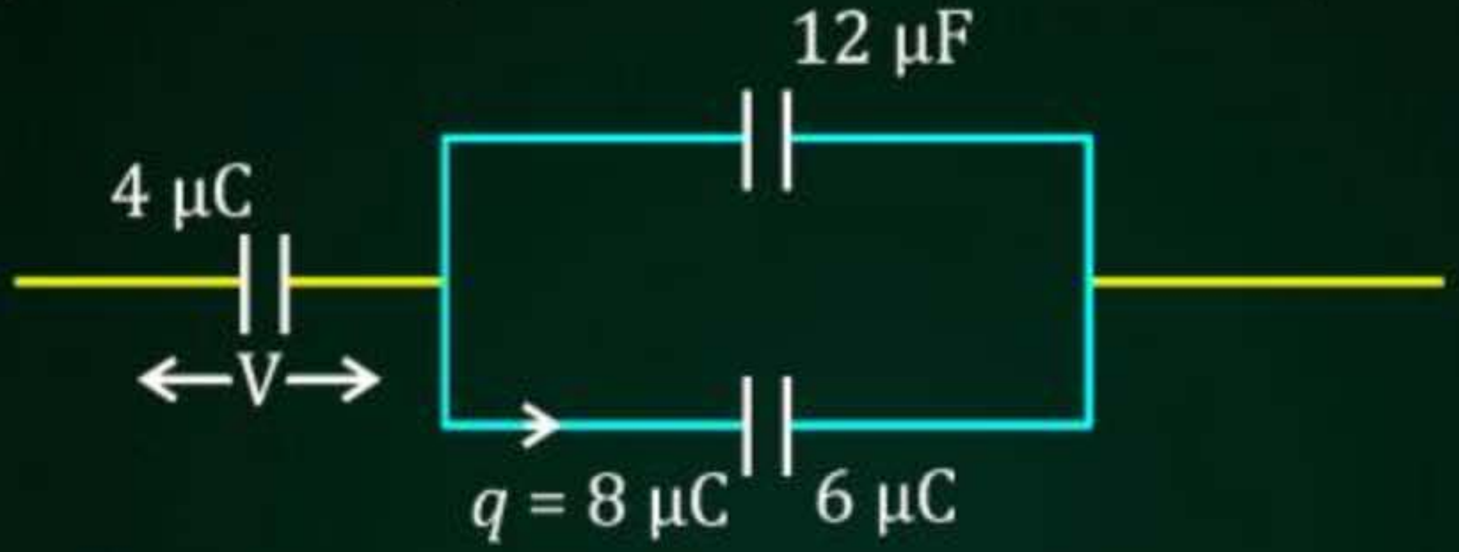


$3x = 120$

$x = 40V$

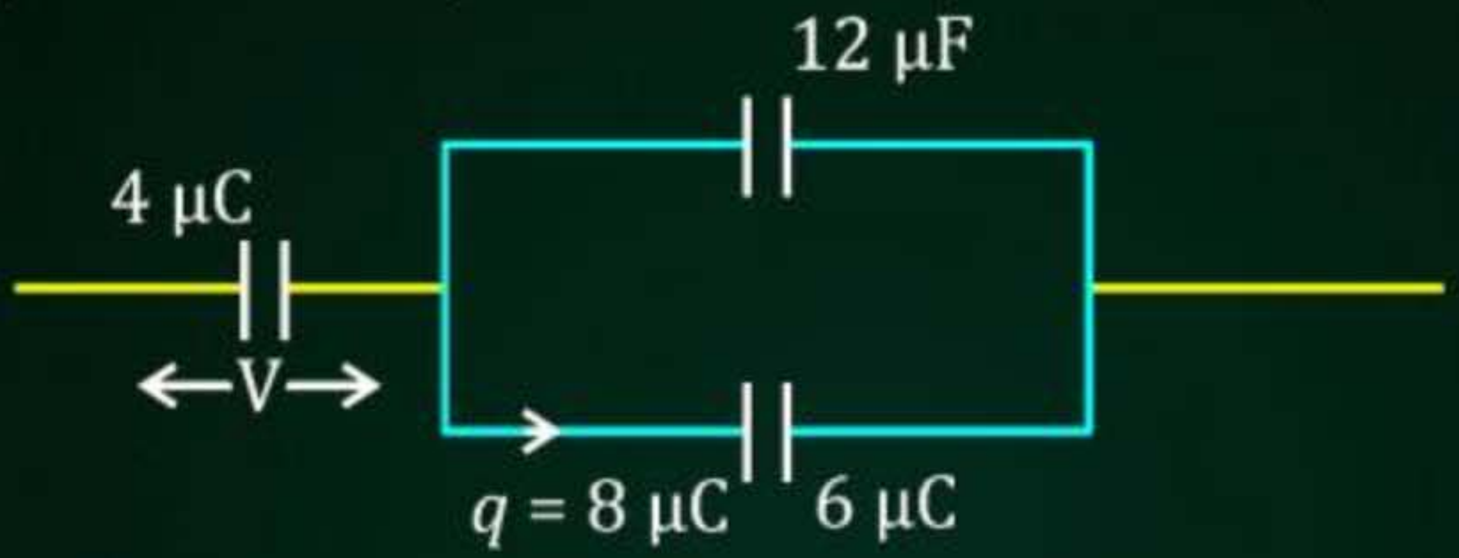
QUESTION

Charge on 6 μF is 8 μC then find potential drop across 4 μF.



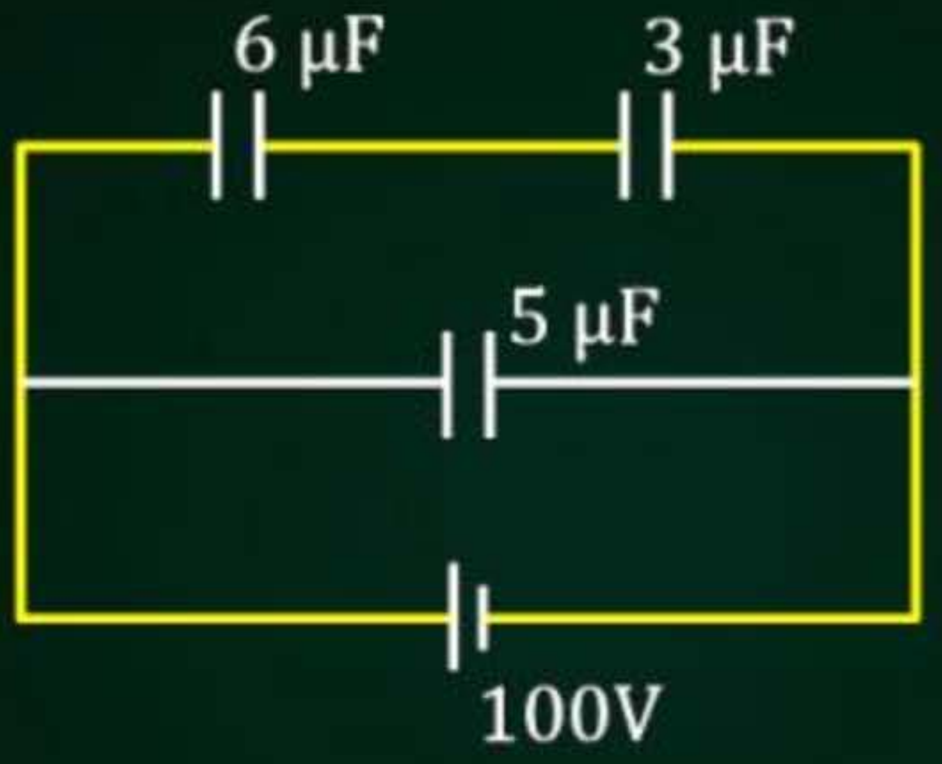
QUESTION

Charge on 6 μF is 8 μC then find potential drop across 4 μF.



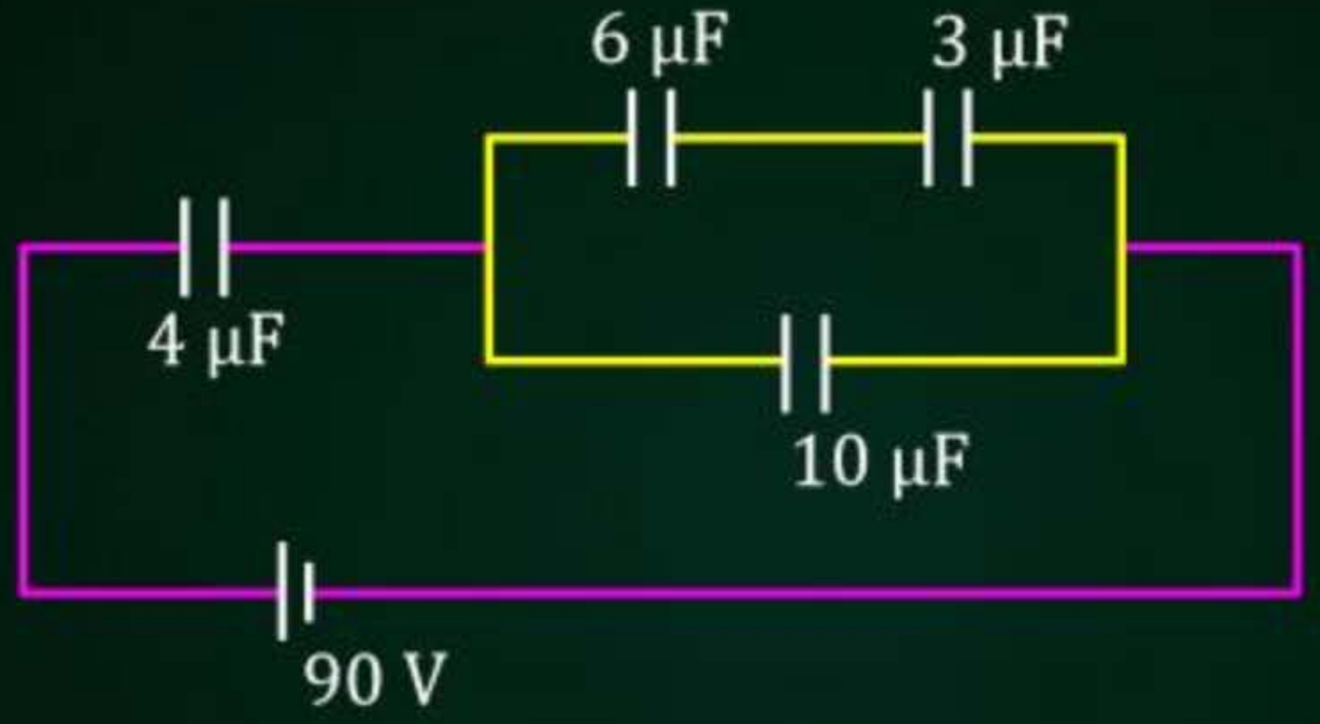
QUESTION

Find charge and potential across each capacitor.



QUESTION

Find charge and potential drop across each capacitor.



MR. Wala Sawal

Find total change in charge when key is closed.



KRICHOFF'S LAW

Conservation of charge:

- Point Rule → at any point total sum of charges is zero.

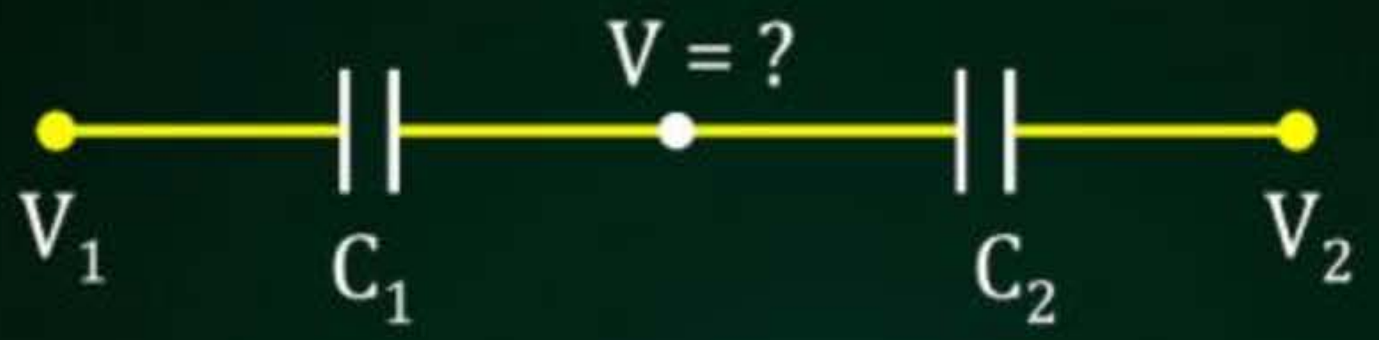
$$Q_{in} = Q_{out} \quad \text{or} \quad \Sigma Q_{net} = 0$$

- Loop Rule → Conservation of energy → sum of potential in close loop is always zero.

$$\Sigma Q_{\theta} + \Sigma \frac{\theta}{C} = 0$$

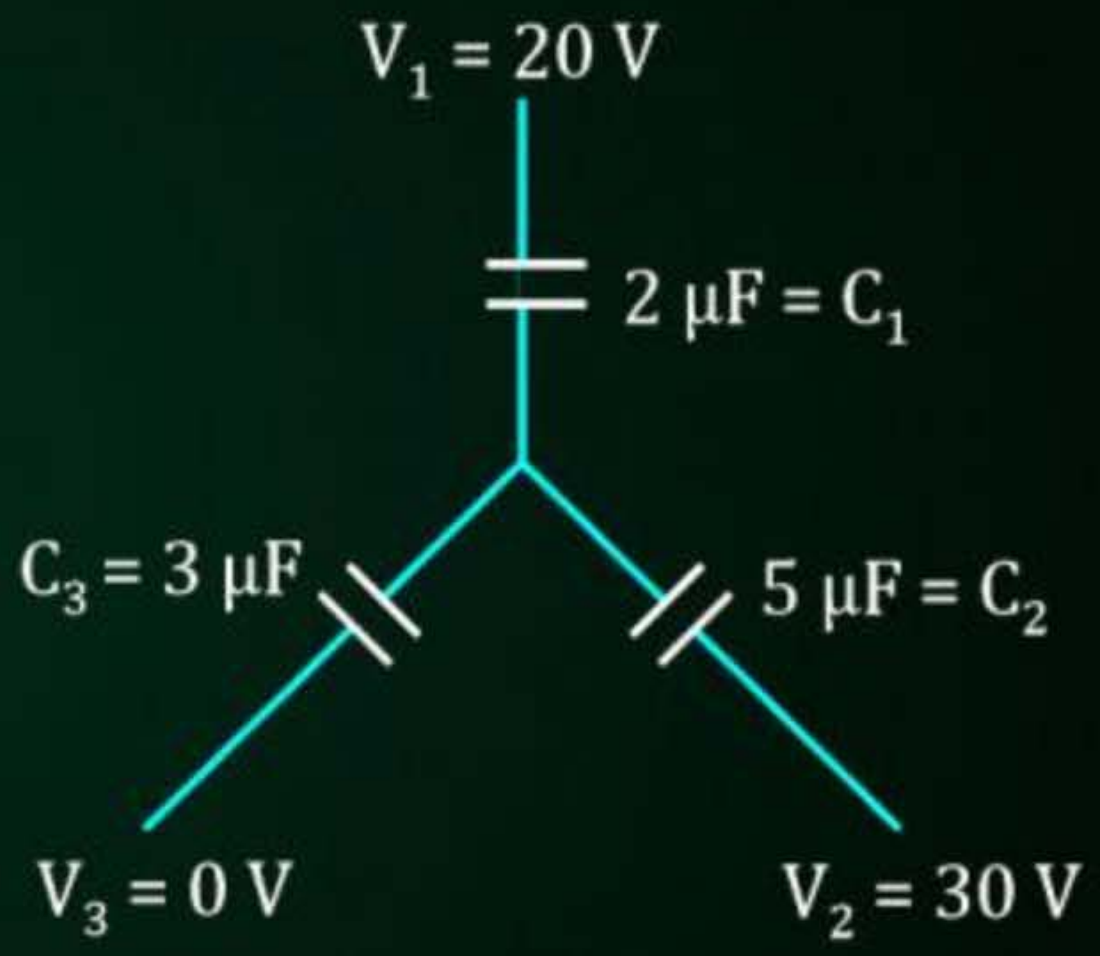
QUESTION

Find



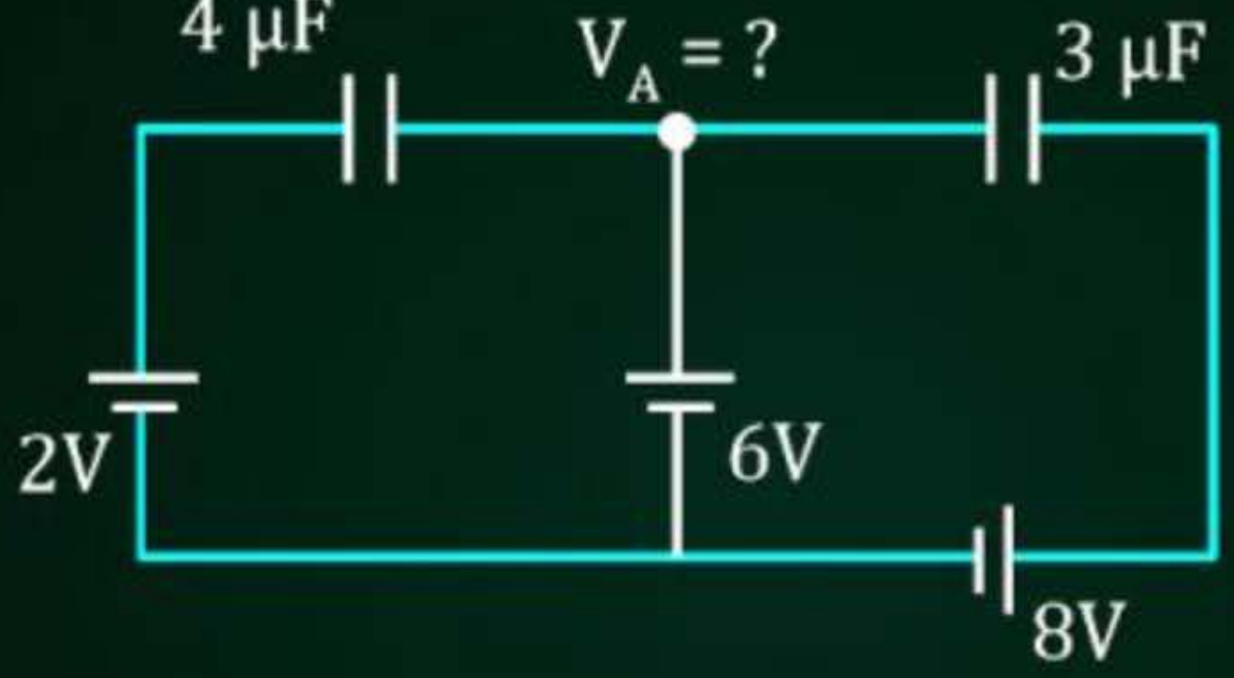
QUESTION

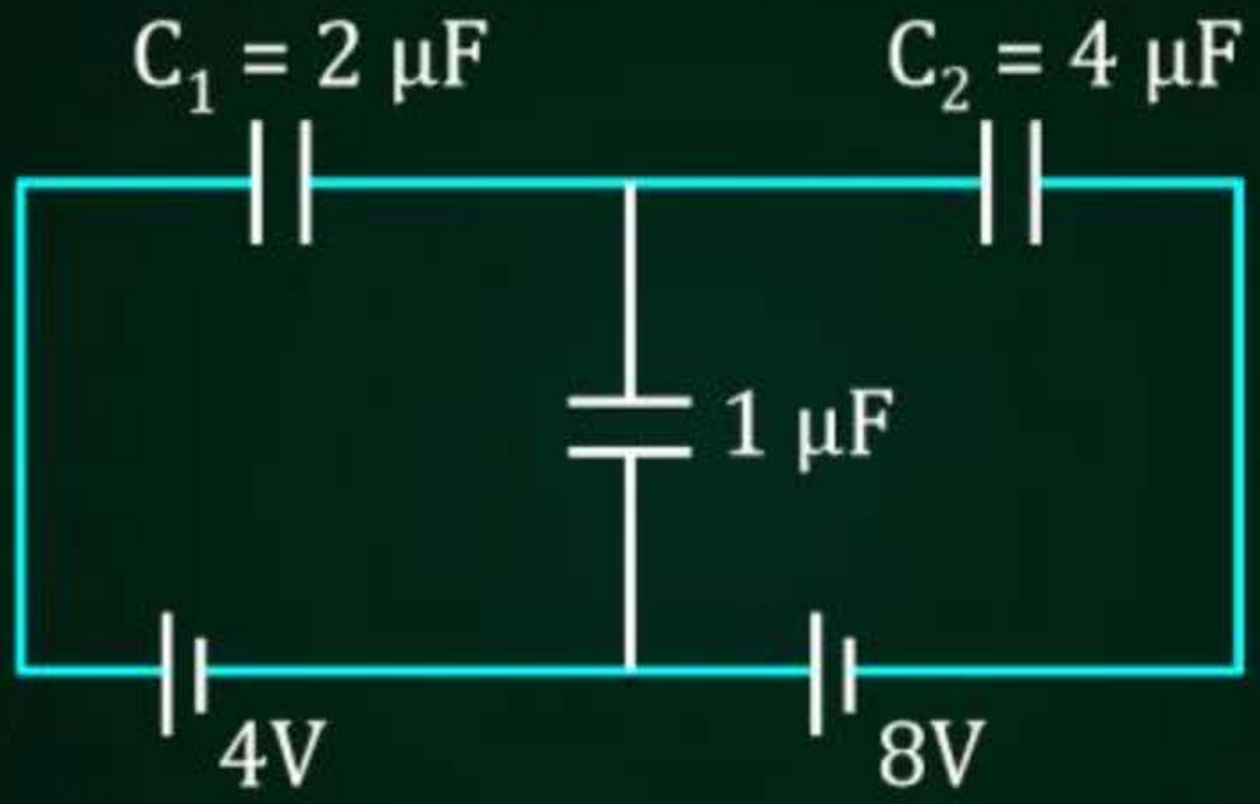
Find common potential and charge on each plate.



QUESTION

Find potential at 'A' and charge on each capacitor.





C1 = 2 μF
C2 = 4 μF
1 μF
4V
8V


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture-09 | **Physics**

Electrostatic Potential and Capacitance

By- Dr. Manish Raj (MR SIR)



Topics to be covered

1. # Questions on Series & Parallel Capacitor

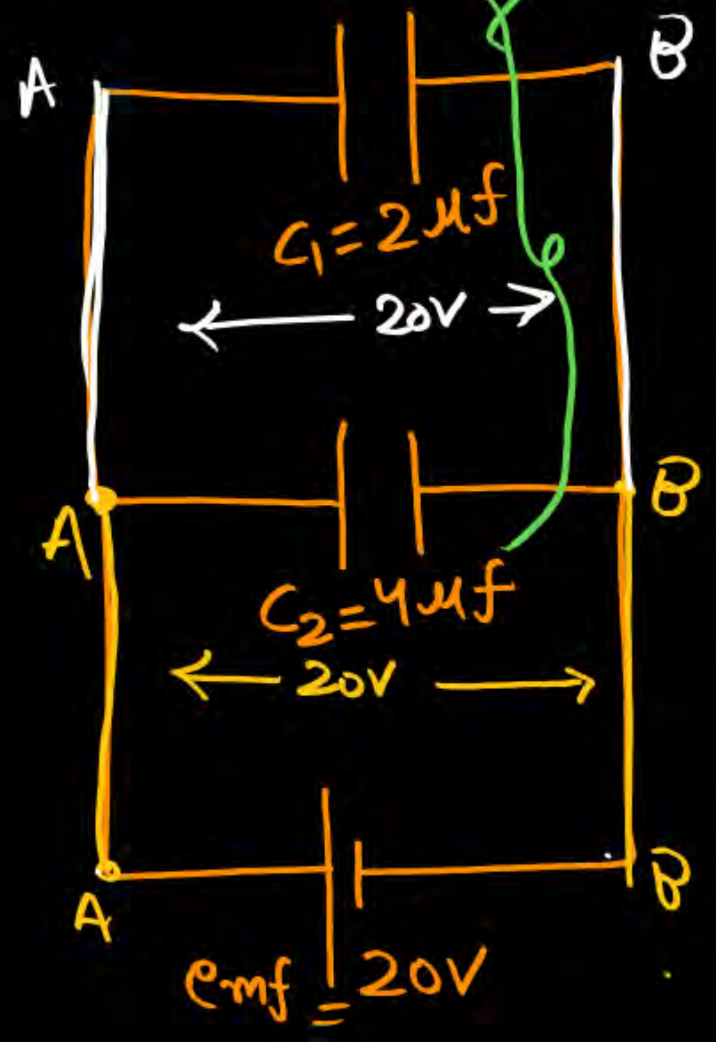
   Circuit analysis Based on Capacitor

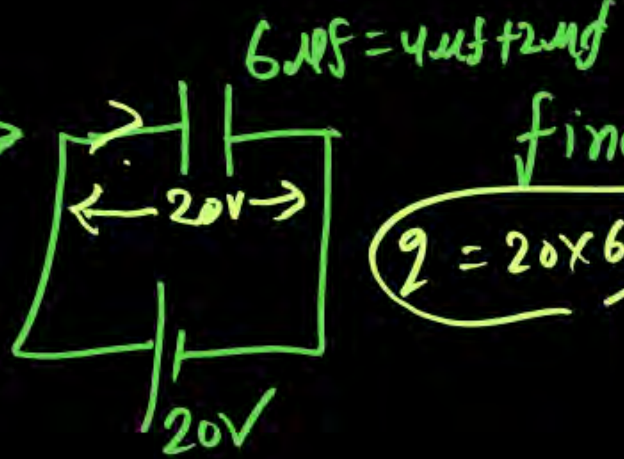
2. #

3. #



find Potential diff^n & charge on each capacitor.





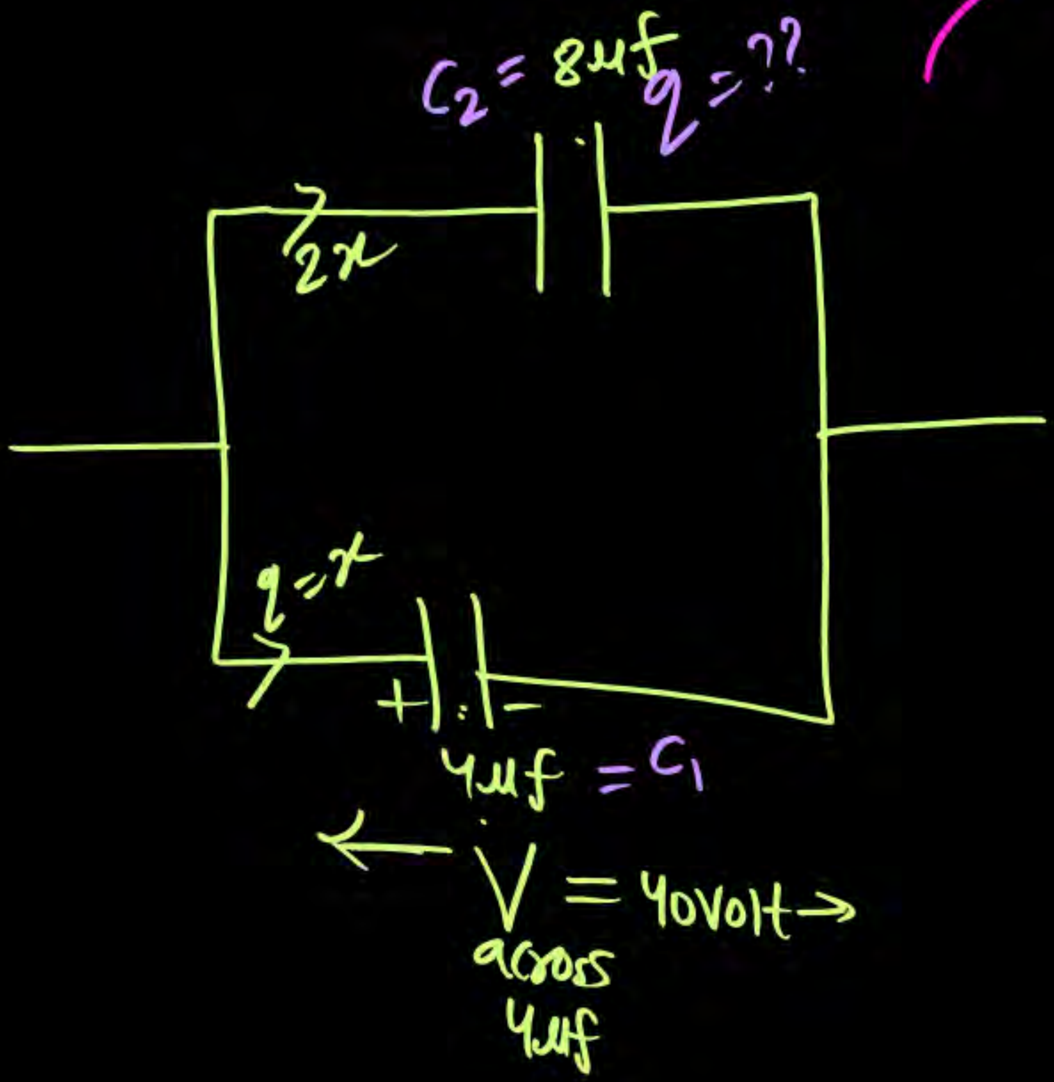
$q = 20 \times 6 = 120\mu C$

$\Rightarrow q_{on\ C_2} = 4\mu f \times 20 = 80\mu C$

$q_{on\ C_1} = 2\mu f \times 20V = 40\mu C$

$q_{parall} \propto$ capacitance

find charge on 8μf ??



(x) $q = CV$

$= 4 \times 40$

$= 160\mu C$

$2x = 160 \times 2$

$= 320\mu C$ Ans

(2x) 8μf

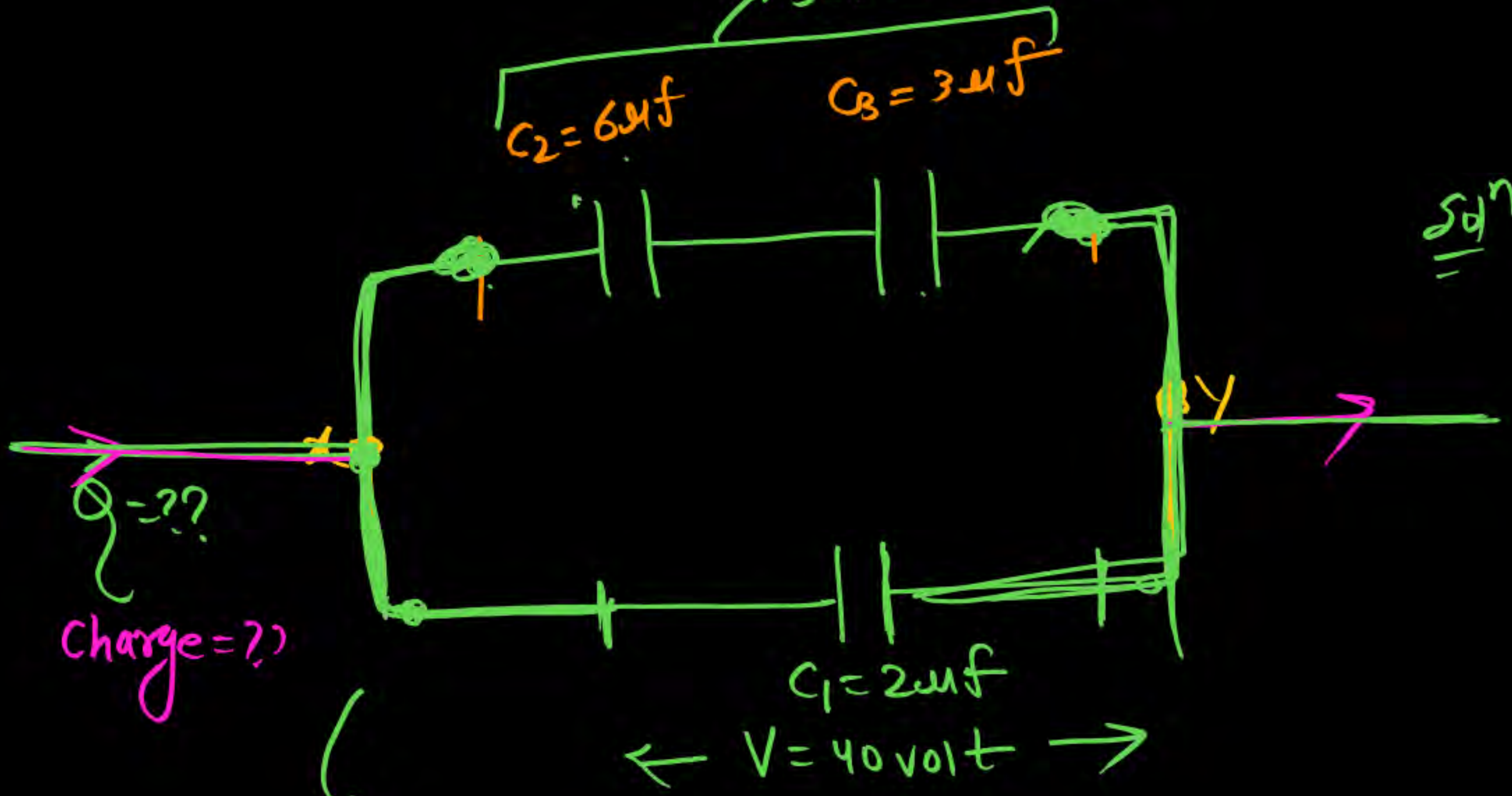
$q = CV$

$= 8\mu f \times 40$

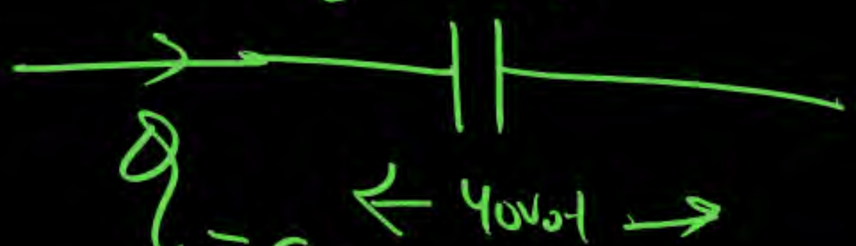
$= 320\mu C$

Ans

series $= \frac{6\times3}{6+3} = \frac{18}{9} = 2\mu f$



$C_q = 4\mu f$

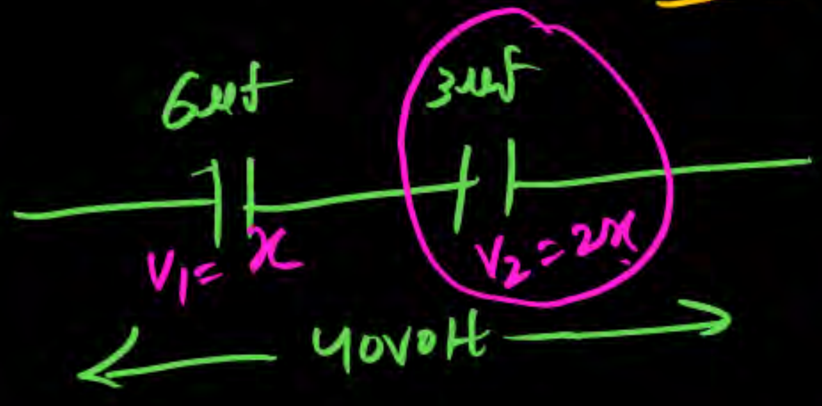


$Q = C_q V = 40 \times 4 = 160\mu C$

find charge on $3\mu f$ = ??

find total Incoming charge in circuit

Soln



$V \propto \frac{1}{C}$

$\Rightarrow 3x = 40$

$x = \frac{40}{3}$

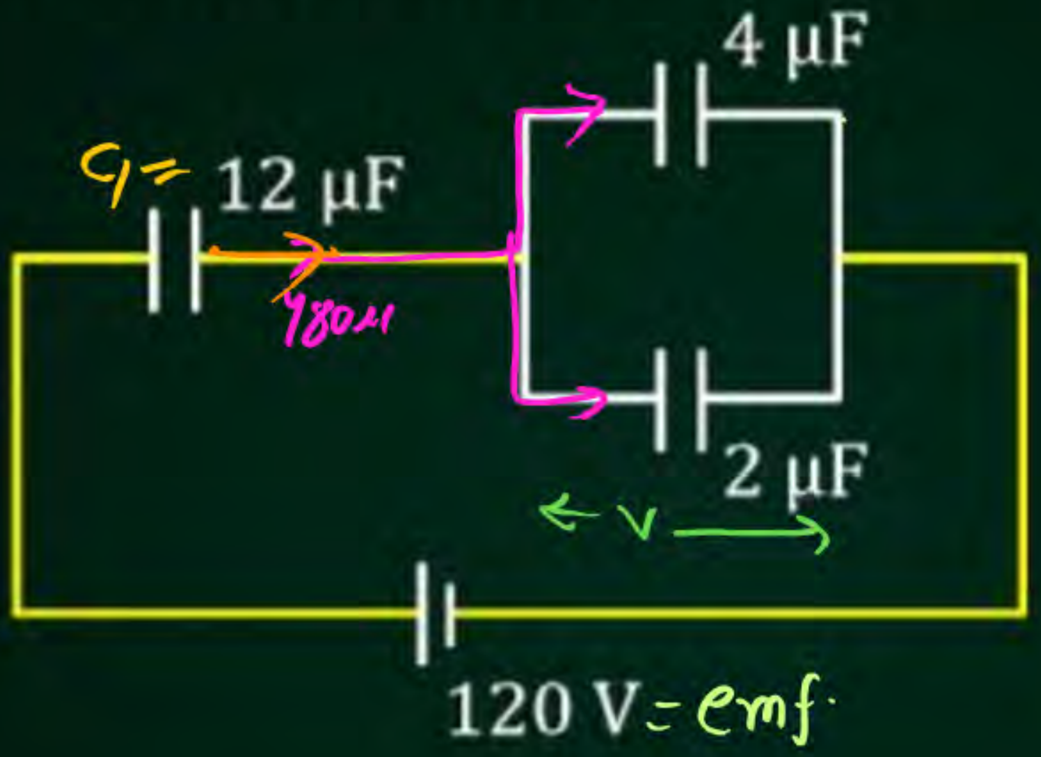
on $3\mu f$

$V_2 = \frac{80}{3}$ volt

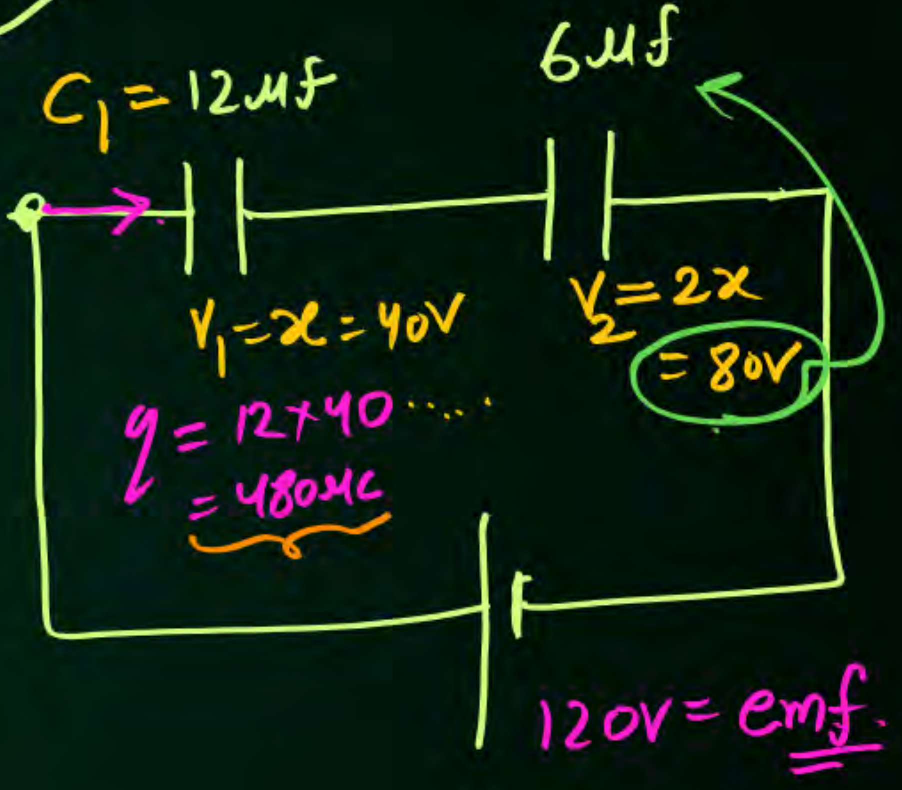
$q = 3 \times \frac{80}{3} = 80\mu C$

QUESTION

Find charge and potential across each capacitor.



$V \propto \frac{1}{C}$



$x + 2x = 120$

$3x = 120$

$x = 40$ volt

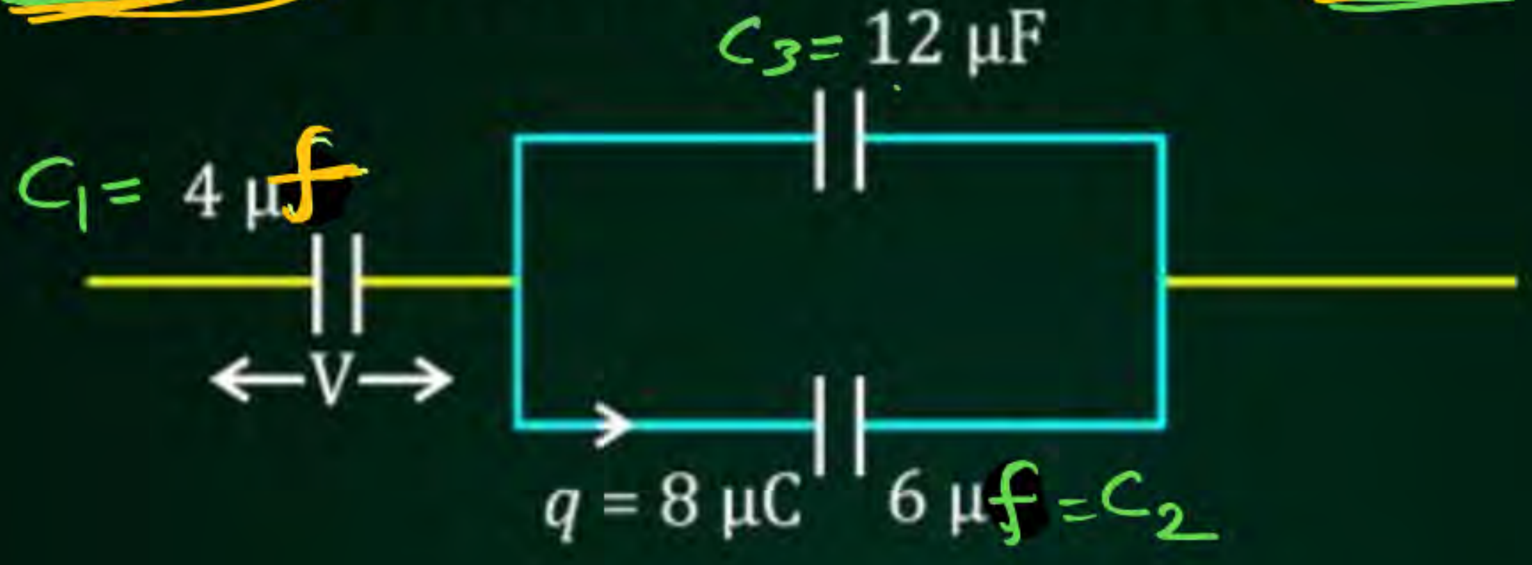
Potential drop across 4μf & 2μf = 80V.

$q_{4\mu C} = 80 \times 4 = 320\,\mu C$

$q_{2\mu f} = 80 \times 2 = 160\,\mu C$

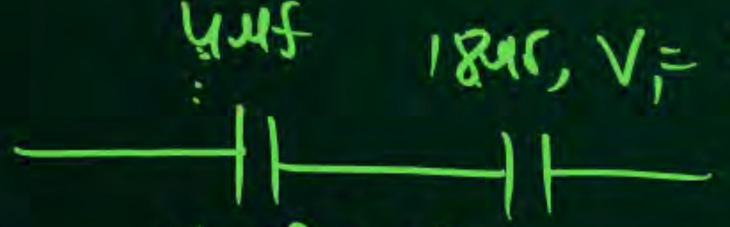
QUESTION

Charge on 6 μF is 8 μC then find potential drop across 4 μF.



Sol^n MR*

$\leftarrow V_1 = \frac{q}{C} = \frac{8}{6}$ volt →



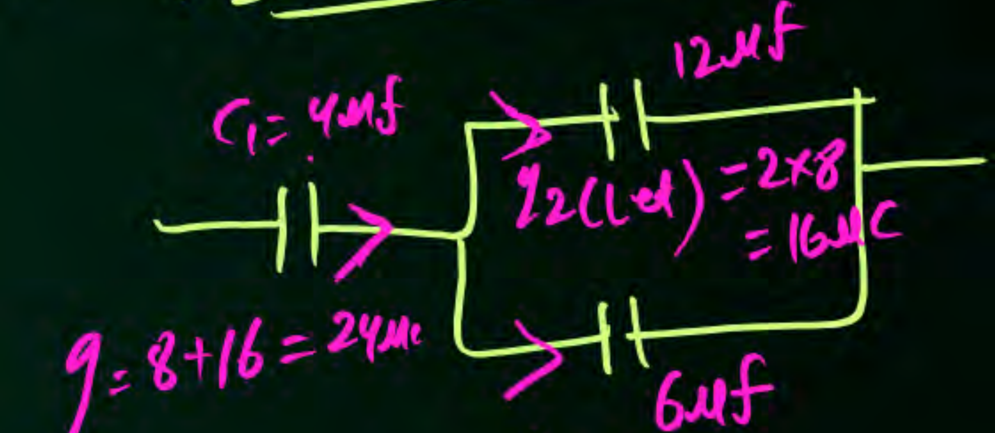
Same $q = CV$

$V = \frac{8^2}{6} \times \frac{18^3}{4}$ = 6 volt

$4 \times V = 18 \times \frac{8}{6}$

$V = 6V$

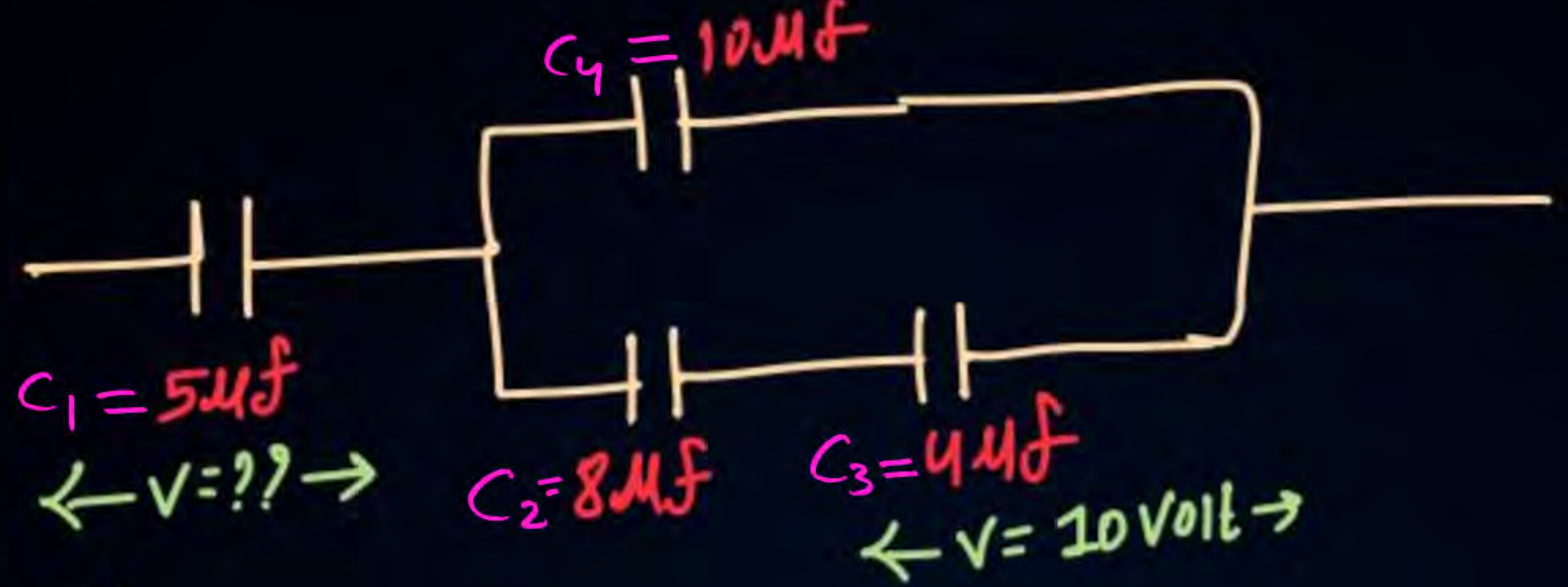
→ 2nd method



$q = 8 + 16 = 24\mu C$

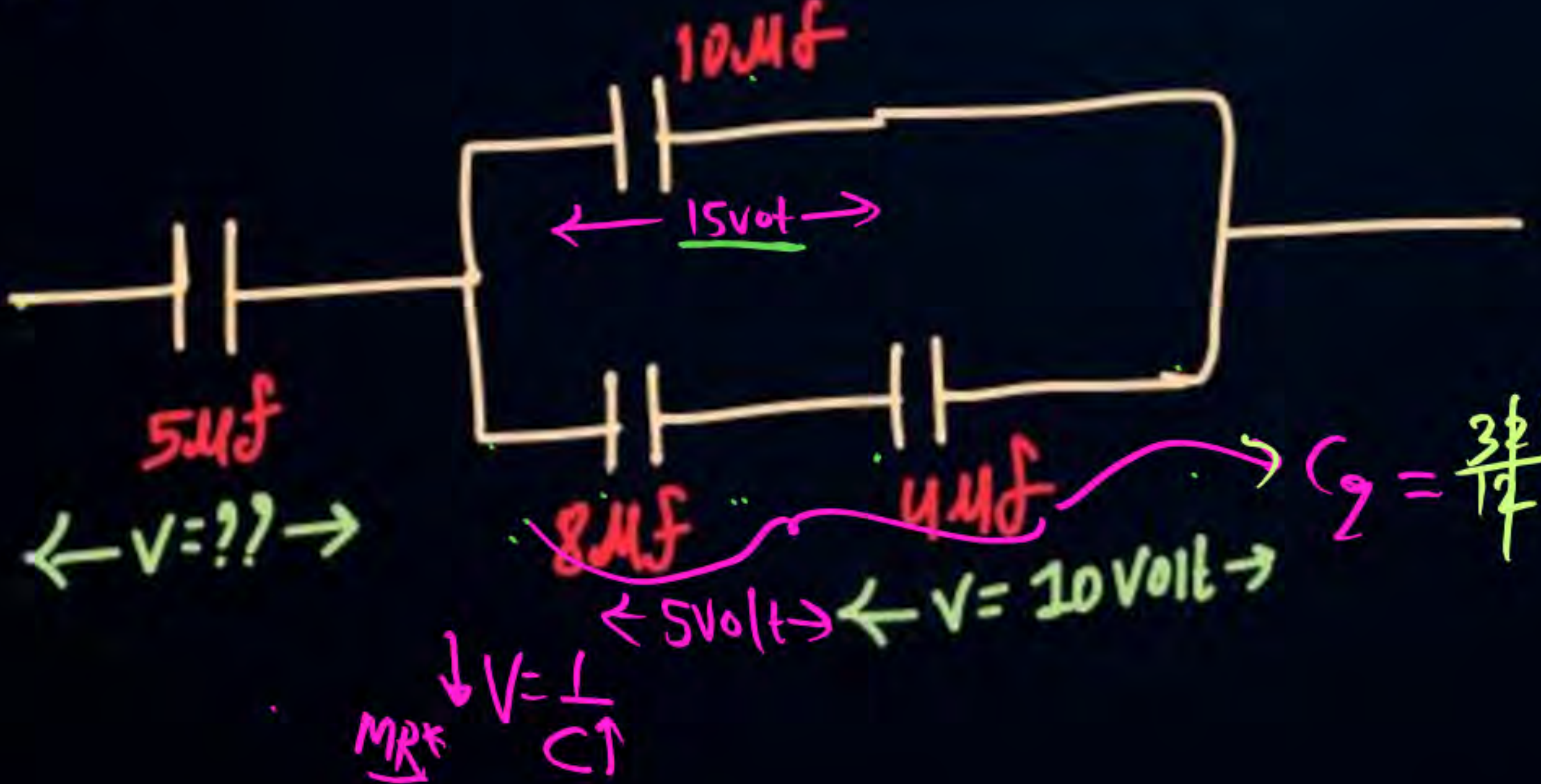
$q_1 = 8\mu C$

$V = \frac{q}{C} = \frac{24}{4} = 6$ volt



Potential drop on 4μf is given. then find Potential on 5μf.

Sol^n



MR* ↓V = 1/C↑

$C_{eq} = \frac{32}{12} = \frac{8}{3}\mu f$

Parallel में

$C_{eq} = \frac{8}{3} + 10 = \frac{38}{3}\mu f$

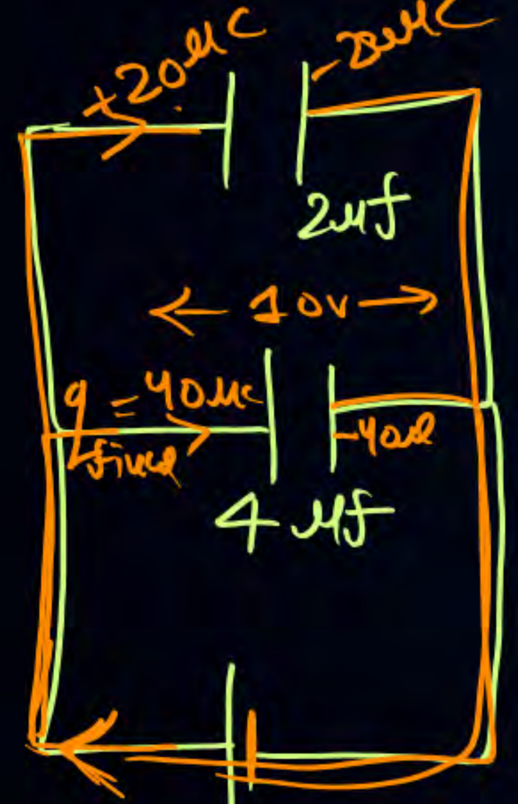
$V_{eq} = 15$ volt

q = same

$\frac{38}{3} \times 15 = 5 \times V$

$V = 38$ volt

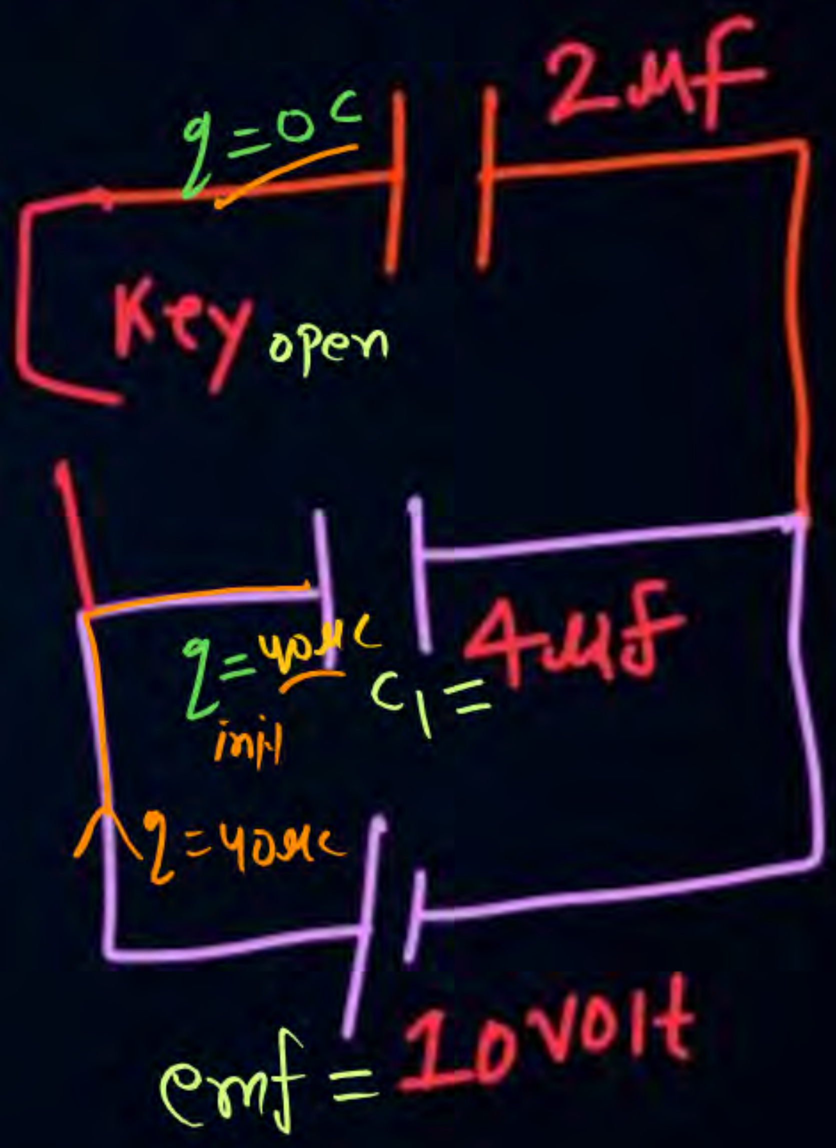
Find total change in charge on 4 μf capacitor when Key is closed in given circuit (mR)



$q_{Tot} = 60 \mu C$

on 4 μf charge remain same

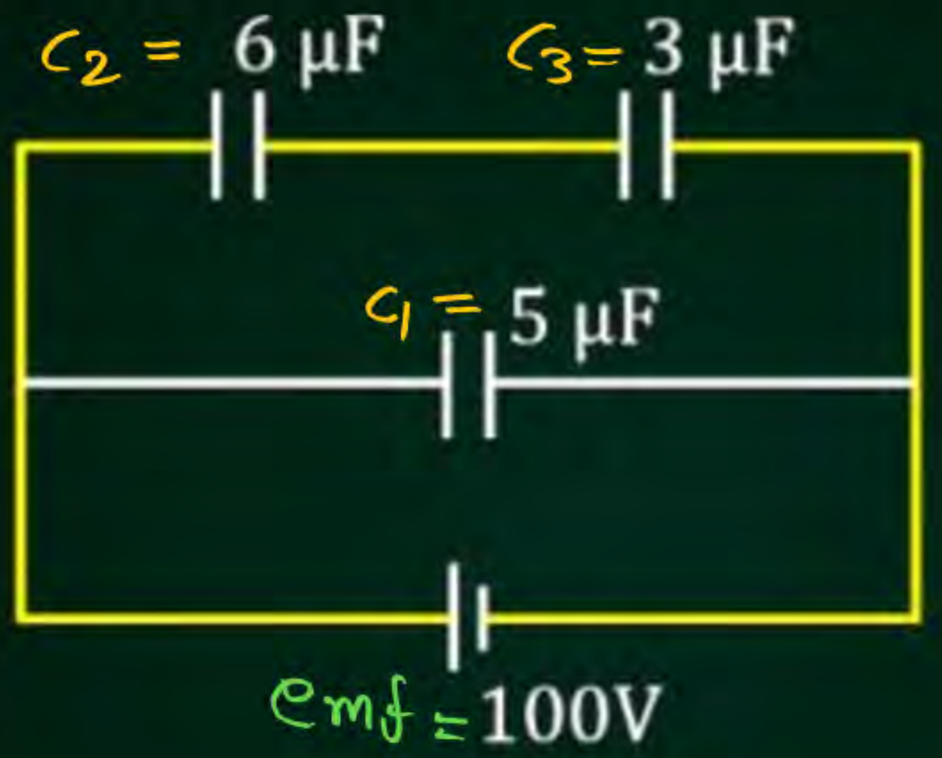
$\Delta q_{on\ 4\mu f} = 0$

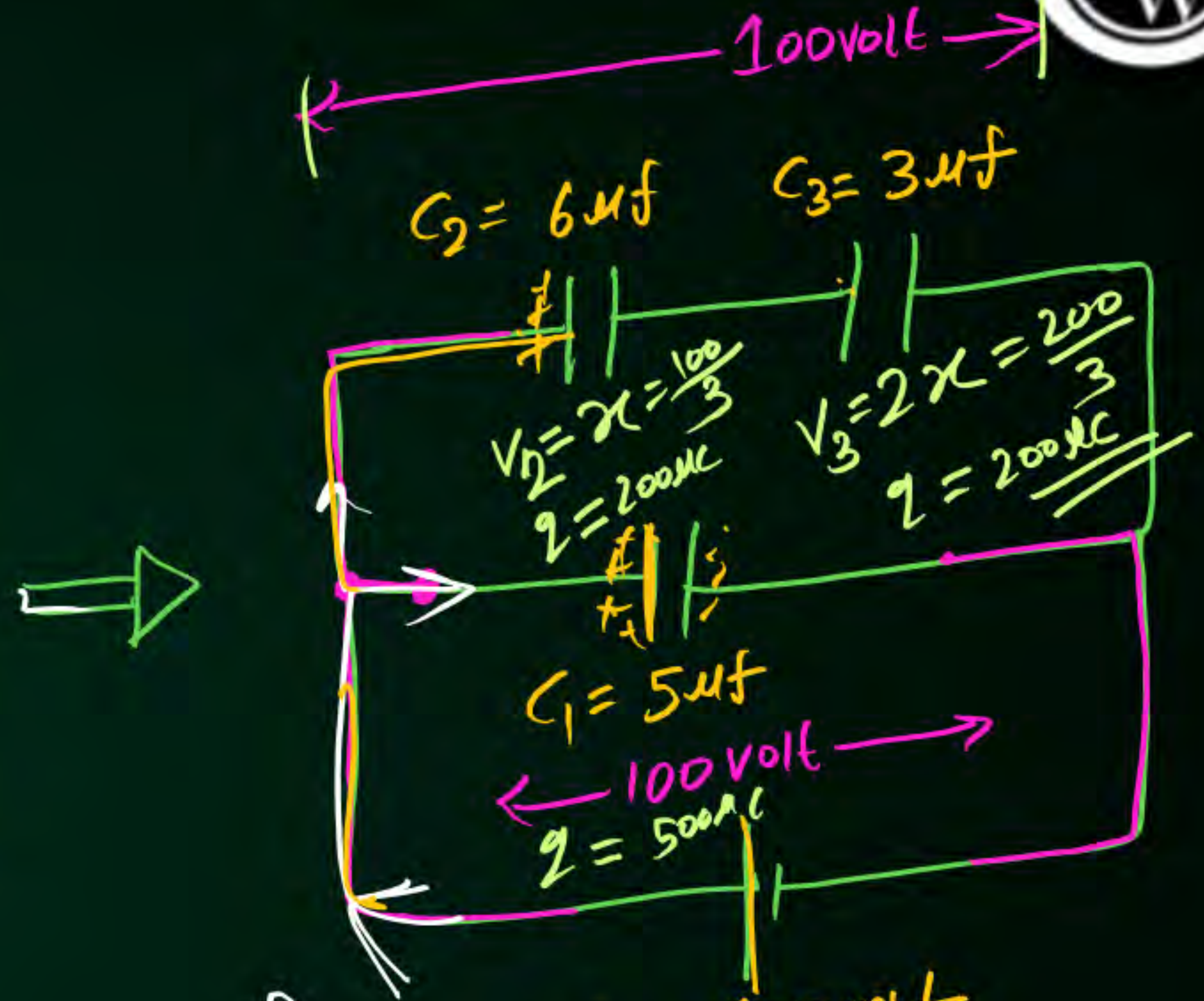


(a) 40 μC
(b) 20 μC
(c) 60 μC
(d) zero (62%)
(e) 10 μC

QUESTION

Find charge and potential across each capacitor.



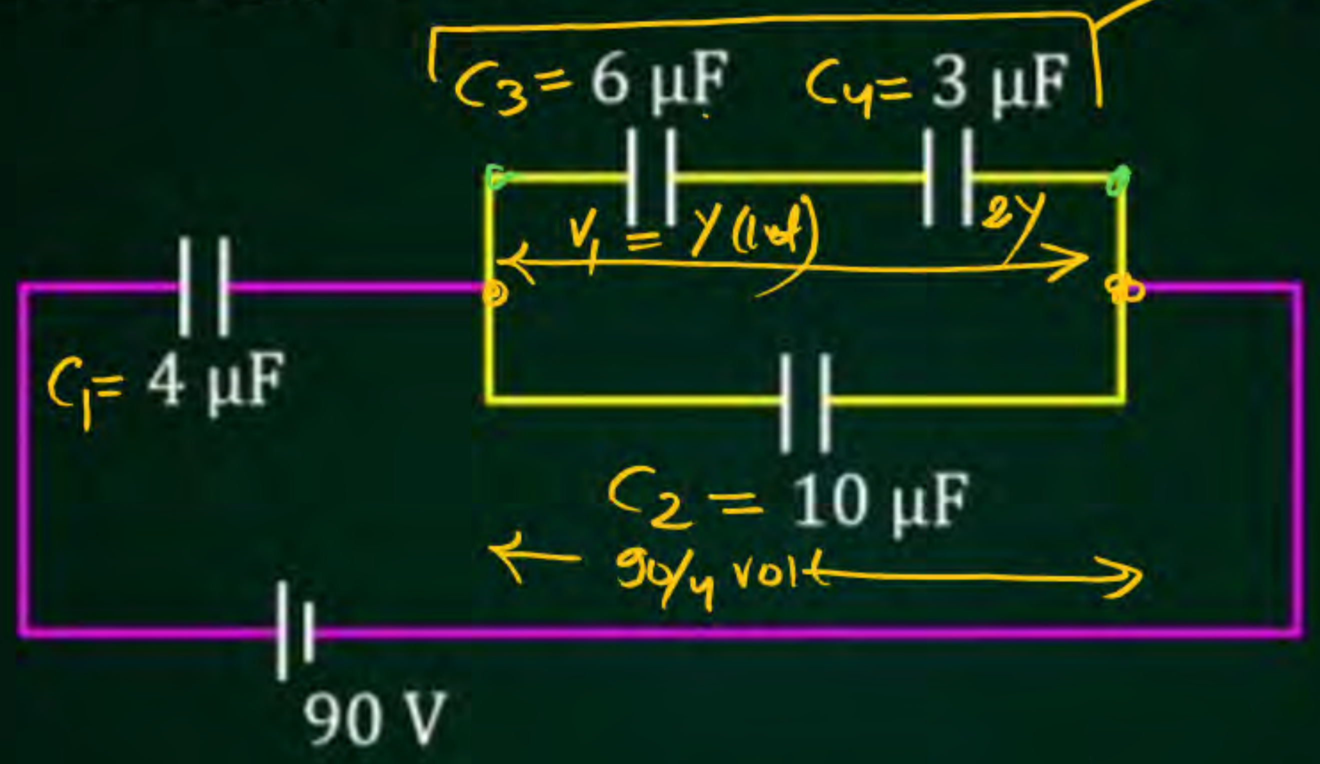


$Q_{total} = 700\mu C$

$(C_{eq})_{total\ circuit} = 7\mu f$

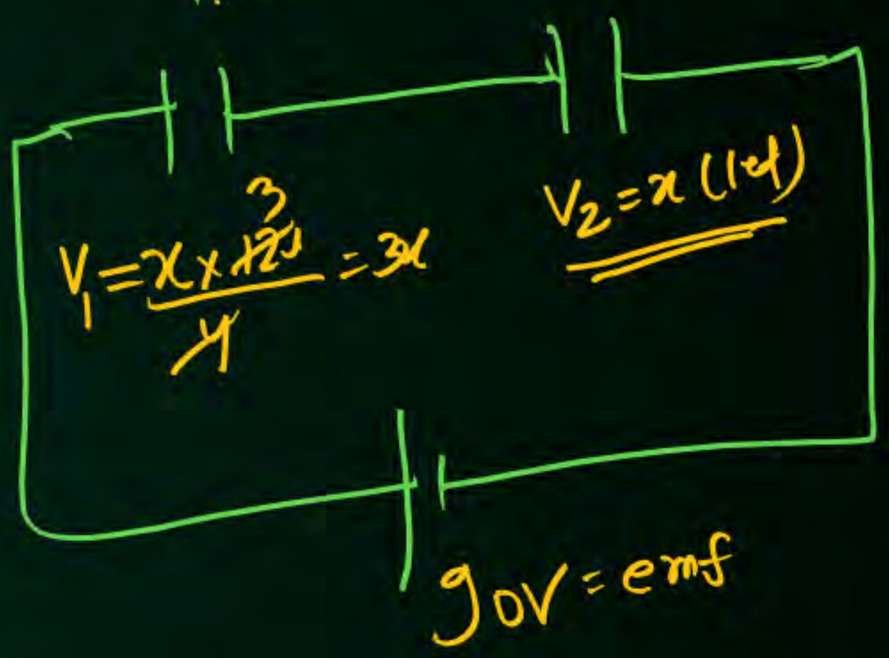
QUESTION

Find charge and potential drop across each capacitor.



series $C_y = \frac{6\times 3}{6+3} = \frac{18}{9} = 2\ \mu f$

$12\ \mu f = (10+2)$



on 3 μf

$V = 2y = 2\left(\frac{30}{4}\right) = 15$ volt

$q_{on\,3\mu} = CV = 3\times 15 = 45\ \mu c$

$y + 2y = \frac{90}{4}$

$3y = \frac{90}{4}$

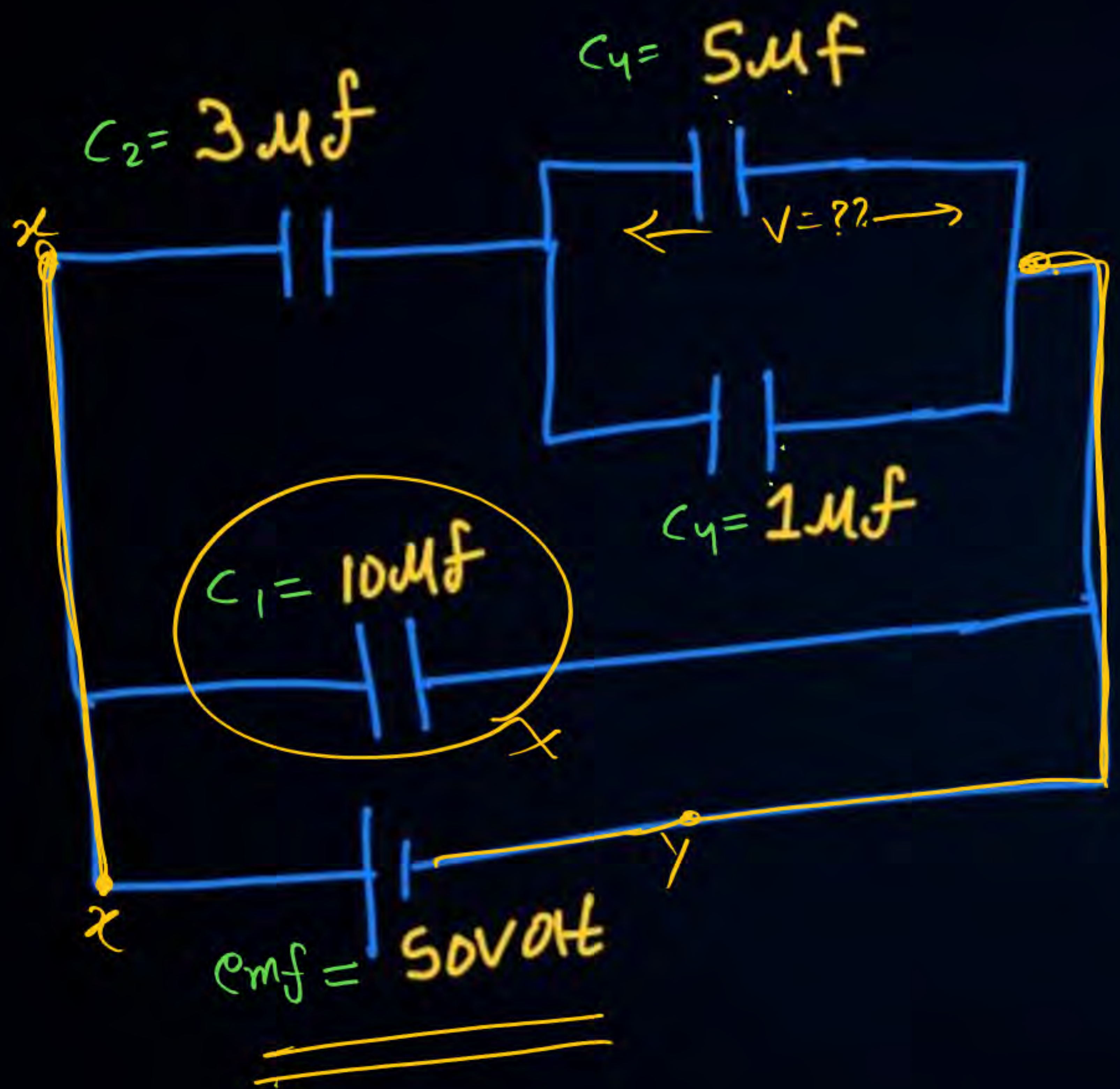
$y = \frac{30}{4}$

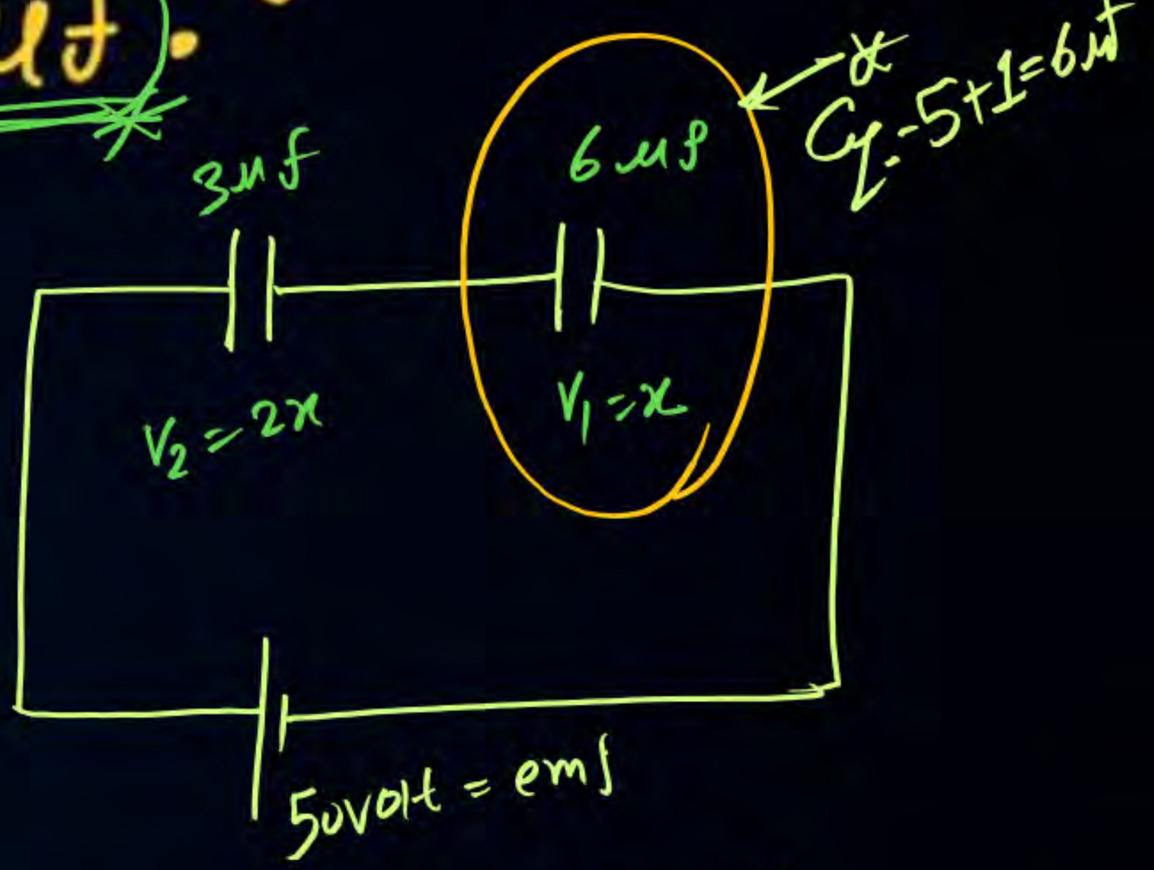
$V_1 + V_2 = x + 3x = 90$

$4x = 90$

$x = \frac{90}{4}$ V

find Potential and charge on 5μf.



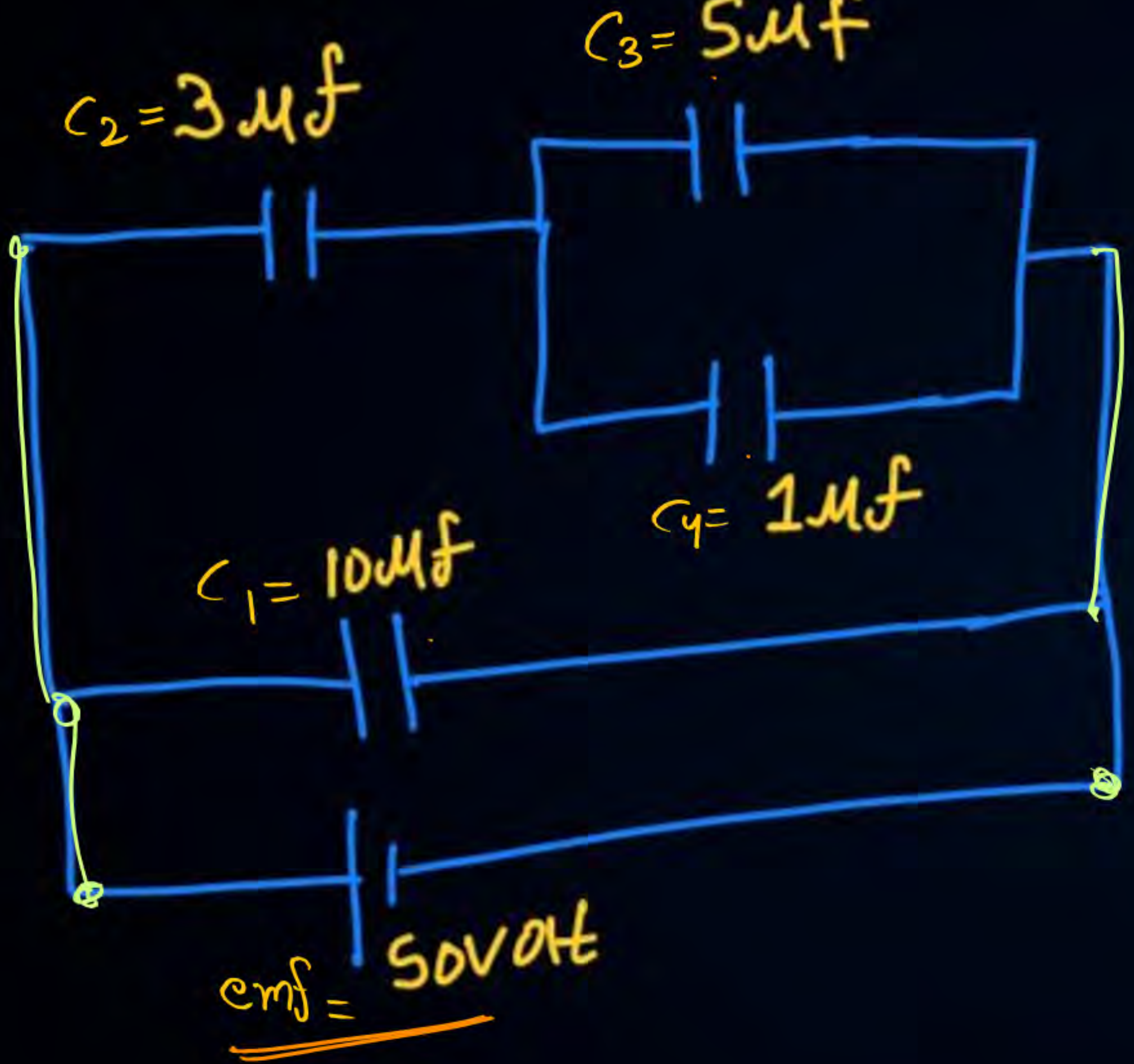


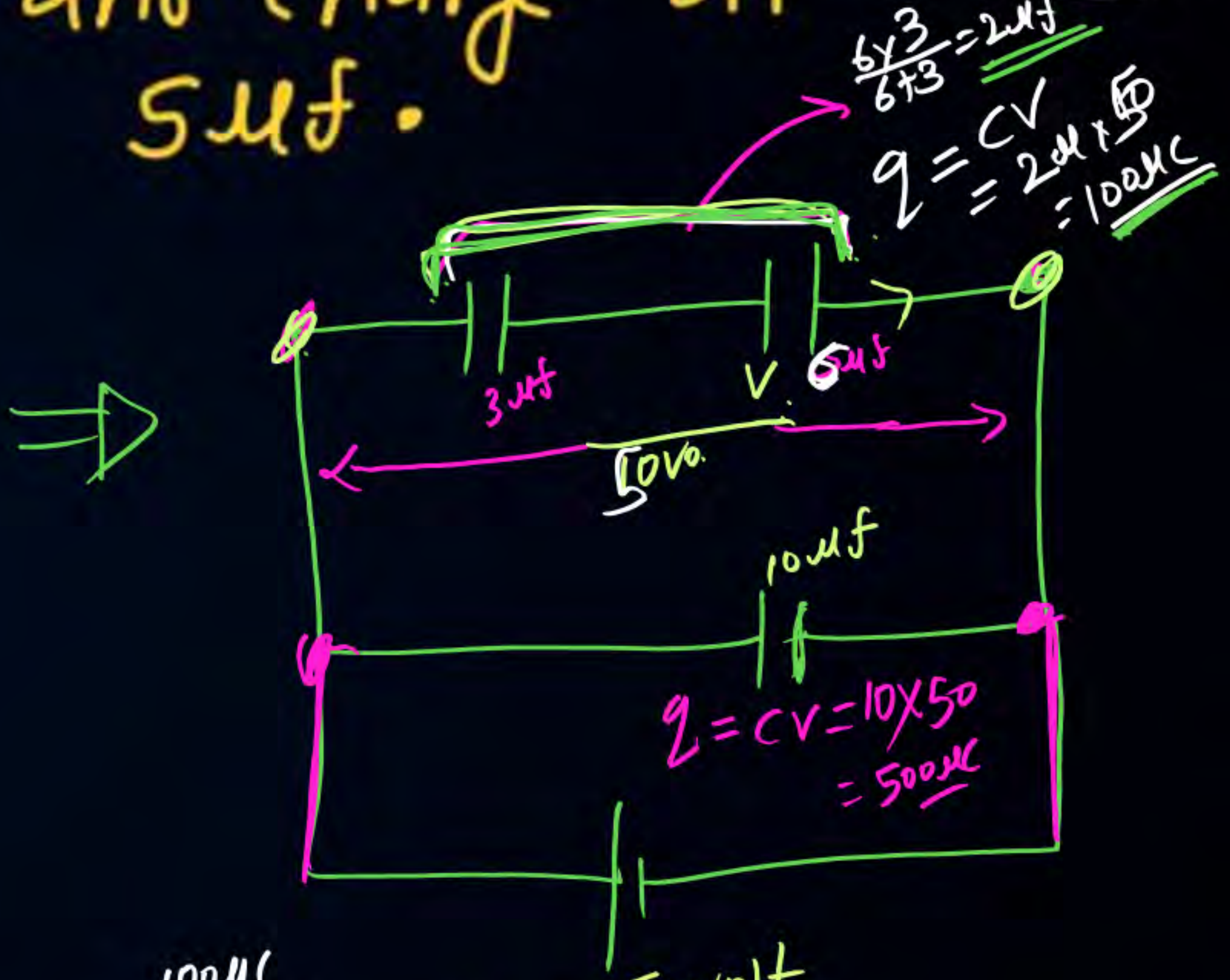
$2x + x = 50$

$x = \frac{50}{3}$

Poten on $5\mu f = \frac{50}{3} V$

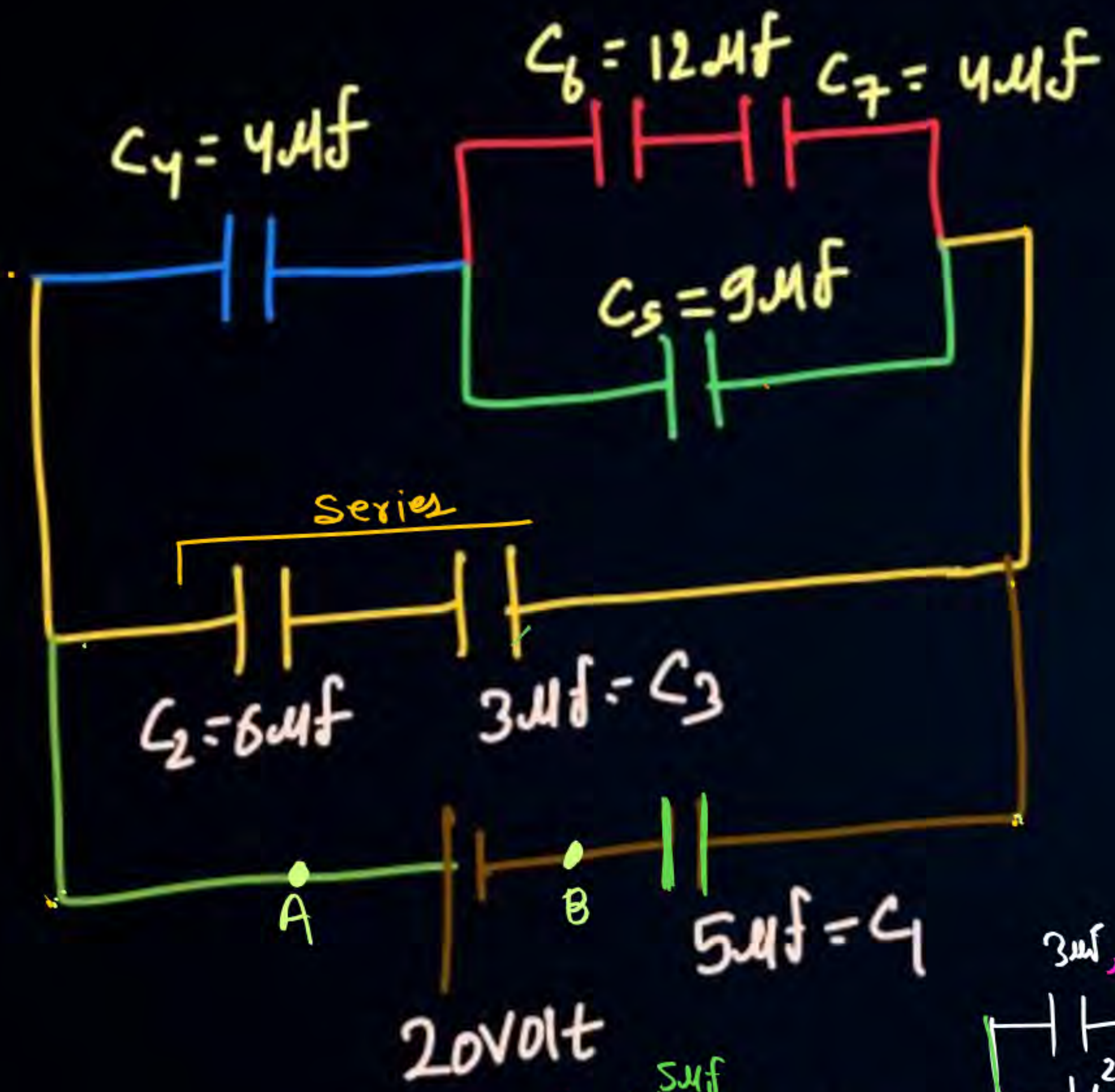
Find Potential and charge on 5μf.

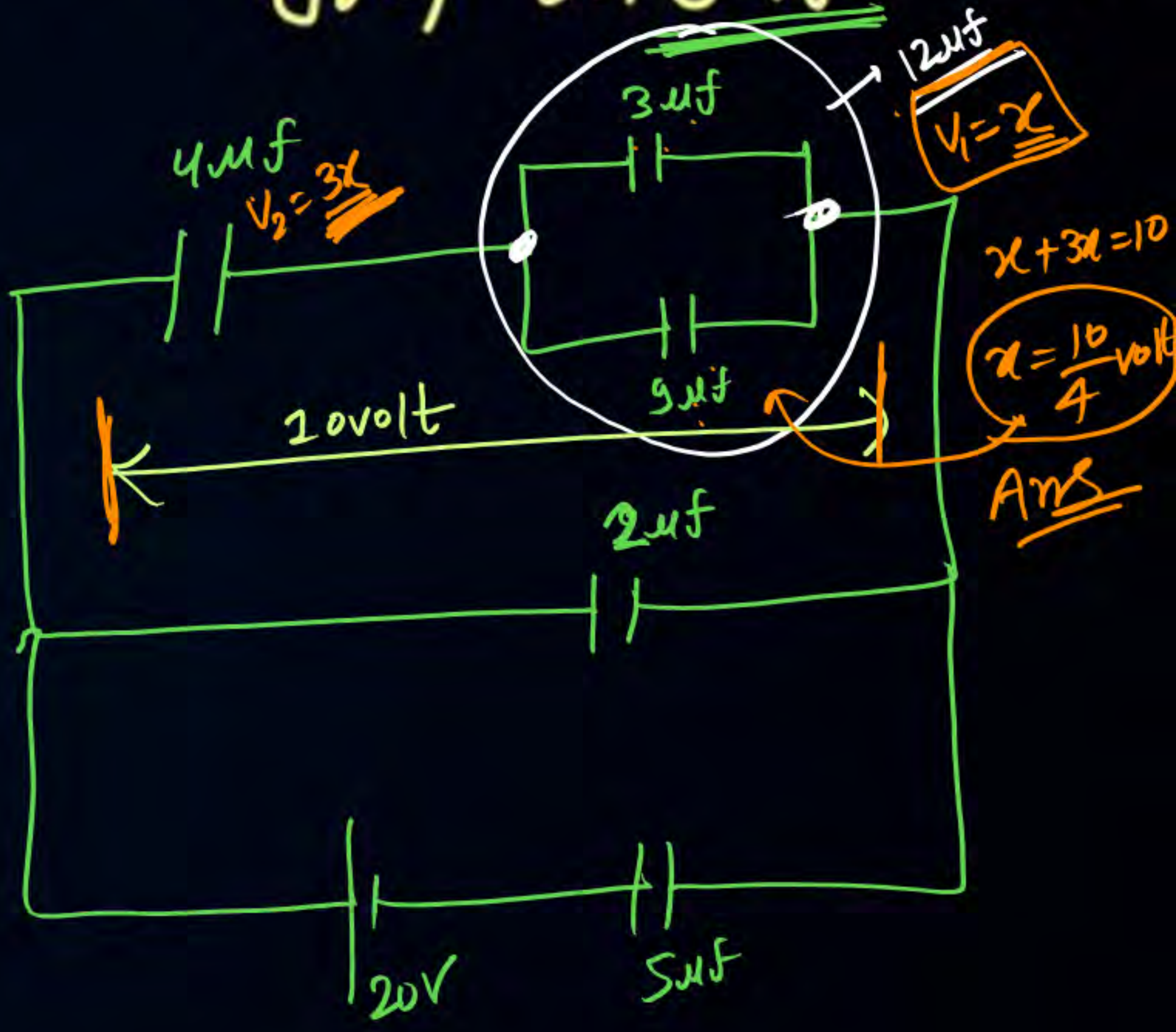




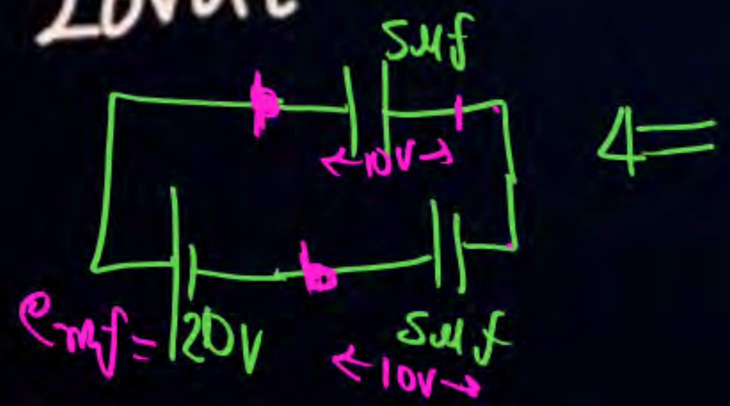
$V_{on\ 6\mu f} = \frac{100\mu C}{6} = \frac{50}{3}$ volt

find potential drop on 9μf.

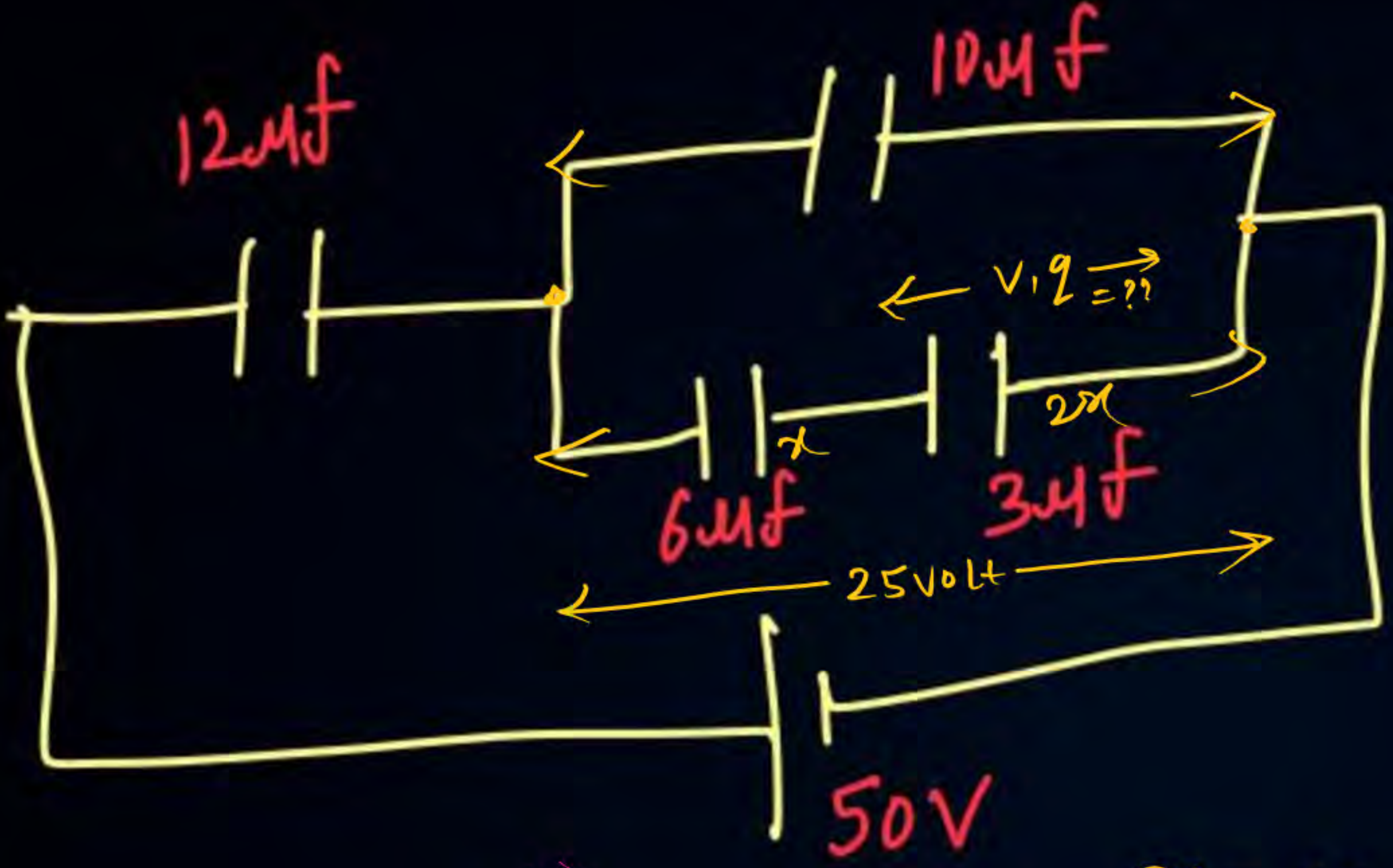


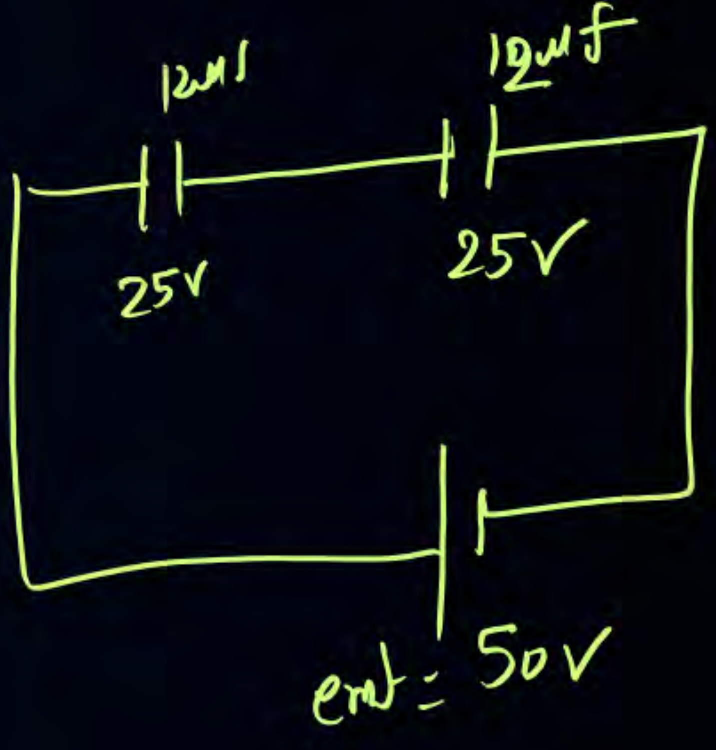






Potential & charge on 3μf.



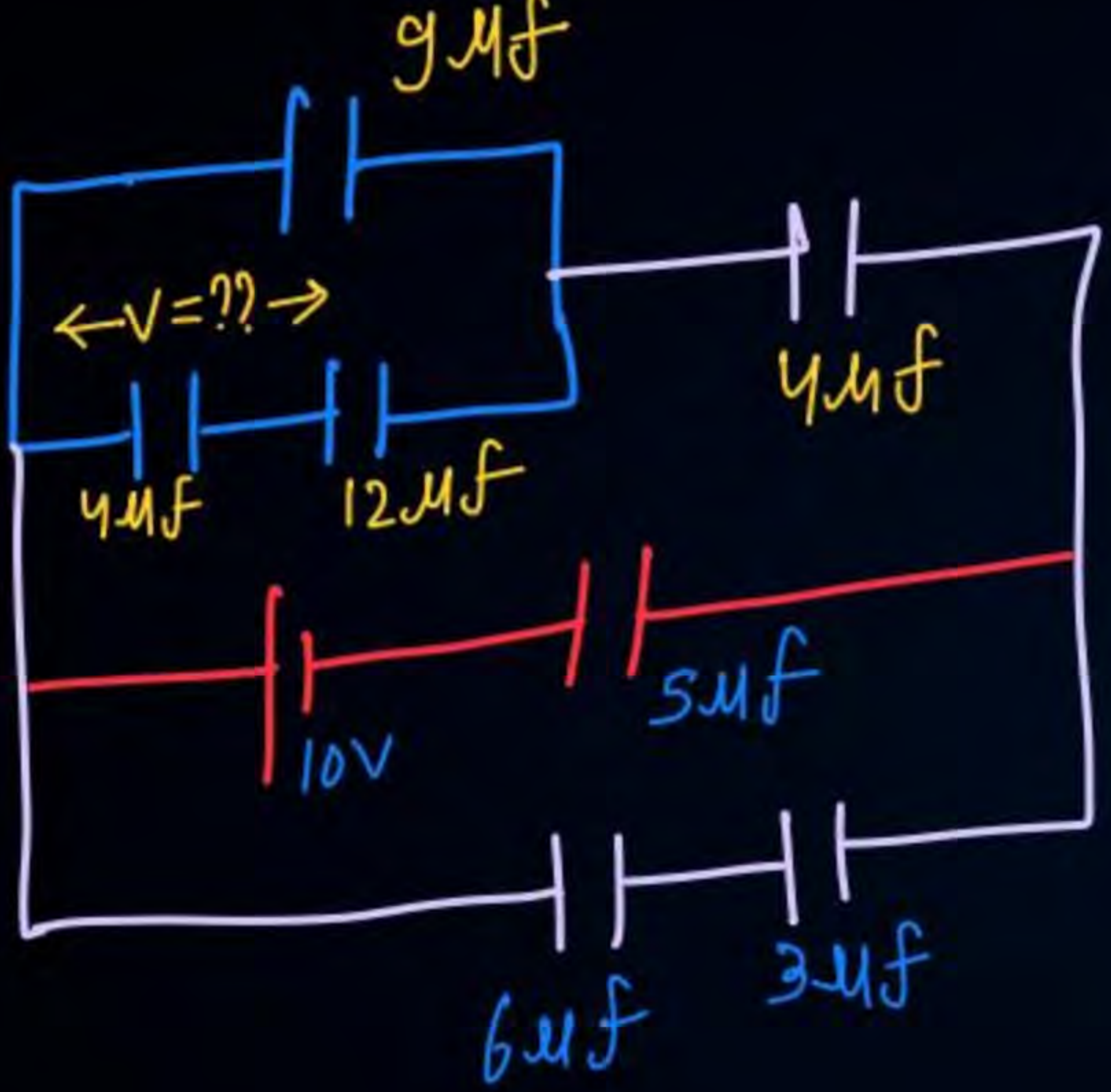


H/W

$3x = 25$

$x = \frac{25}{3}$

$V_{\text{on } 3\mu f} = 2x = \frac{50}{3}$ volt



find V across 4μf

charge on 6μf.

H/W

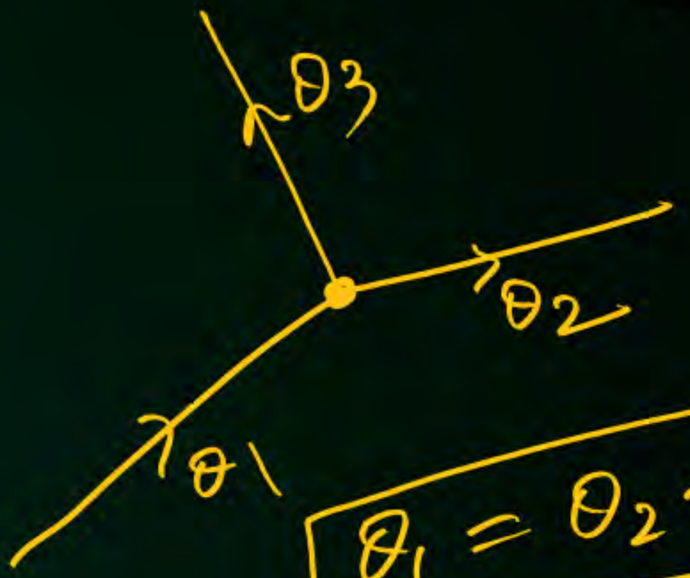
अभी पे करना है

KRICHOFF'S LAW

"Conservation of charge:"

➤ 1. Point Rule → at any point total sum of charges is zero.

$$Q_{in} = Q_{out} \quad \text{or} \quad \Sigma Q_{net} = 0$$

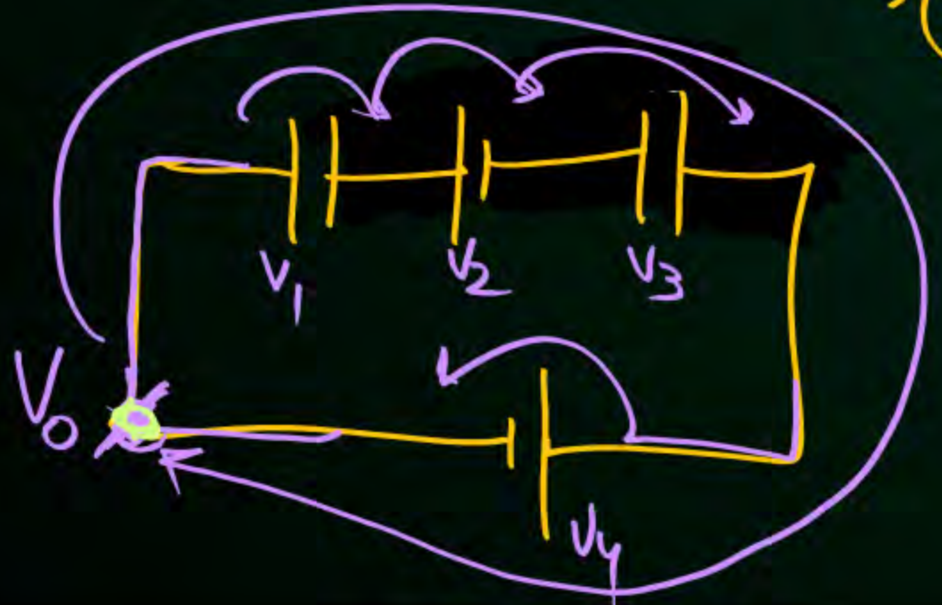


$\theta_1 = \theta_2 + \theta_3$

➤ Loop Rule → Conservation of energy → sum of potential in close loop is always zero.

(कुदा (Kudoo In loop))

$\Delta V_{\text{loop में कुदा}} = 0$

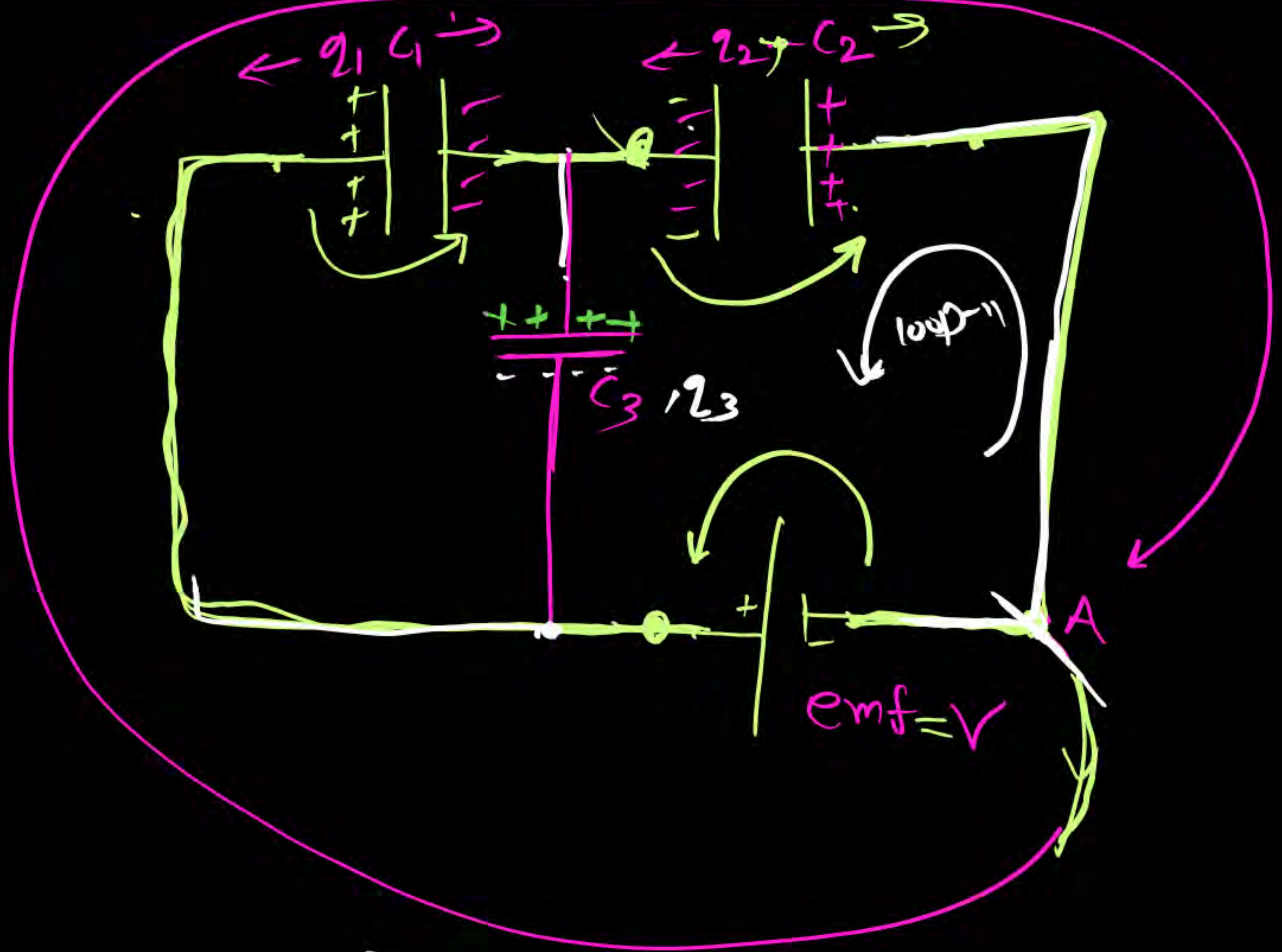


$V_0 + V_1 + V_2 + V_3 + V_4 = V_0$

$V_1 + V_2 + V_3 + V_4 = 0$

Put value with sign

Jitni Bar Kudda uska change in potent ko sum = 0



loop rule → based on energy
(Kudoo concept)

$$+V - \frac{q_1}{C_1} + \frac{q_2}{C_2} = 0$$

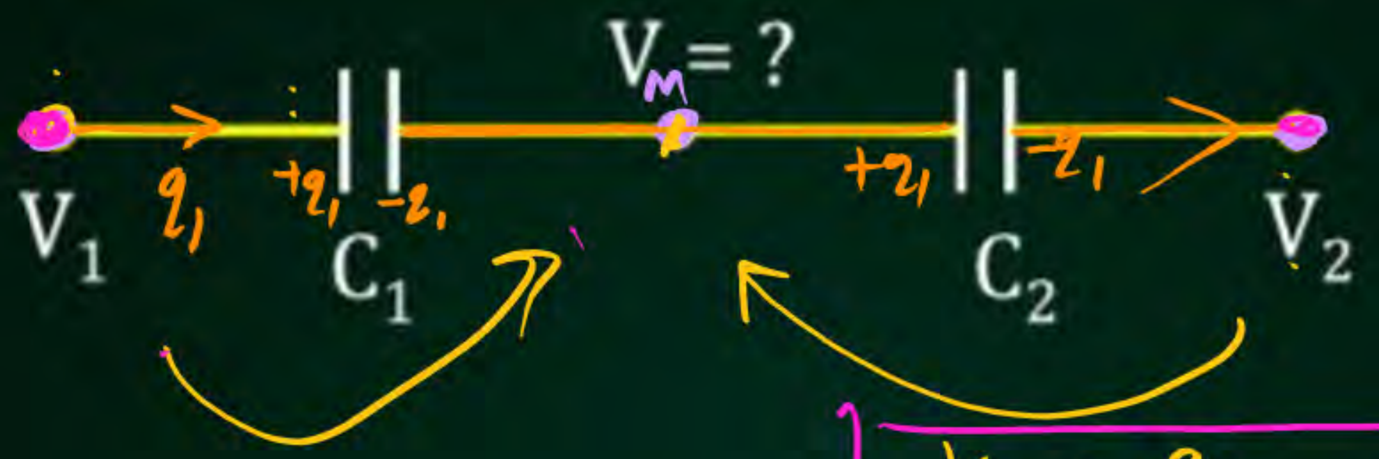


Kloop-2

$$-\frac{q_2}{C_2} - \frac{q_3}{C_3} - V = 0$$

QUESTION

Find



$$V_2 + \frac{q_1}{C_2} = V_m \quad \text{— (II)}$$

$$q_1 = (V_m - V_2)C_2 \quad \text{— (II)}$$

$$V_1 - \frac{q_1}{C_1} = V_m \quad \text{— (I)}$$

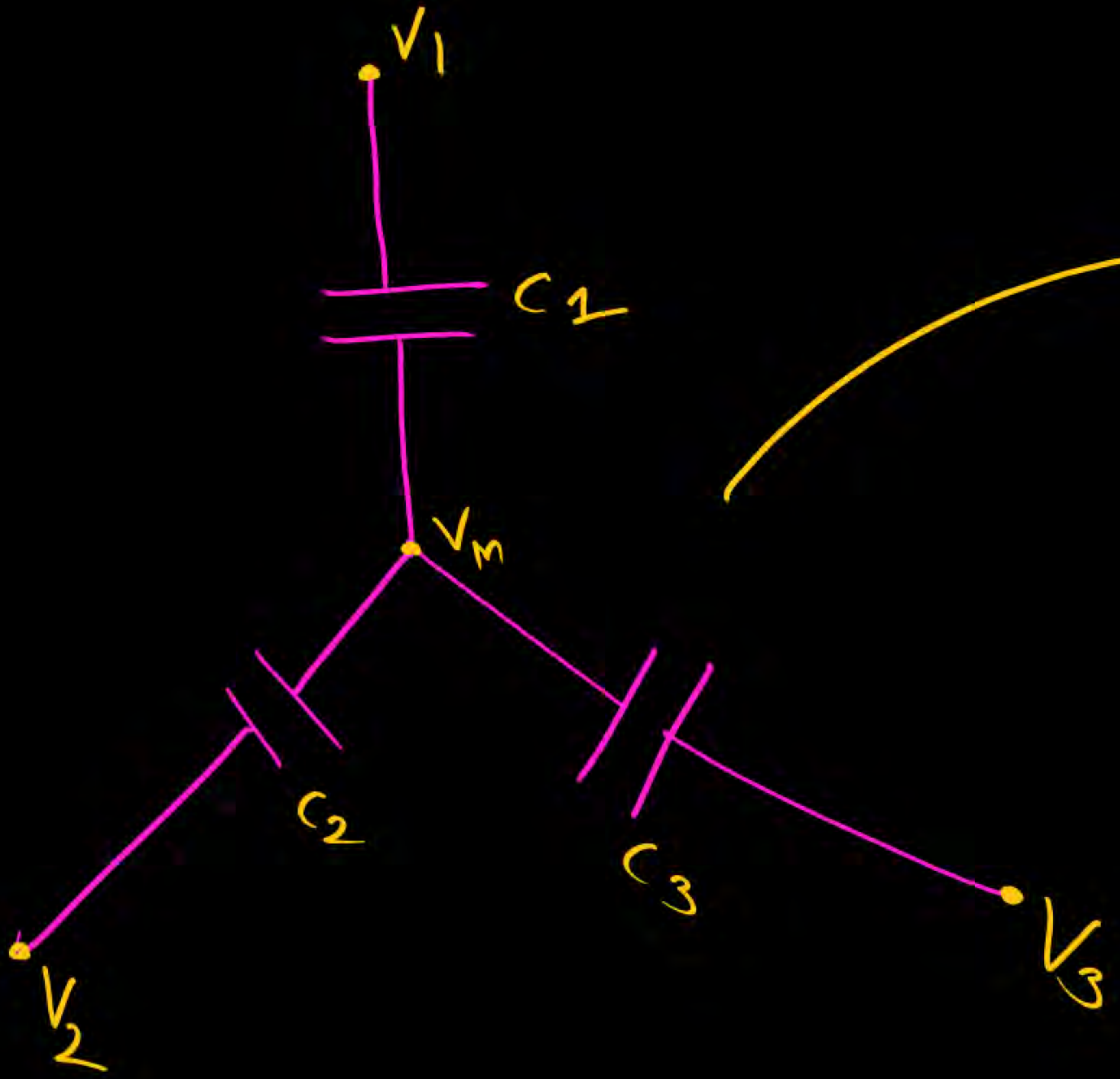
$$C_1(V_1 - V_m) = q_1 \quad \text{— (I)}$$

$$\text{(I)} = \text{(II)}$$

$$C_1V_1 - C_1V_m = V_mC_2 - C_2V_2$$

$$V_m(C_1 + C_2) = C_1V_1 + C_2V_2$$

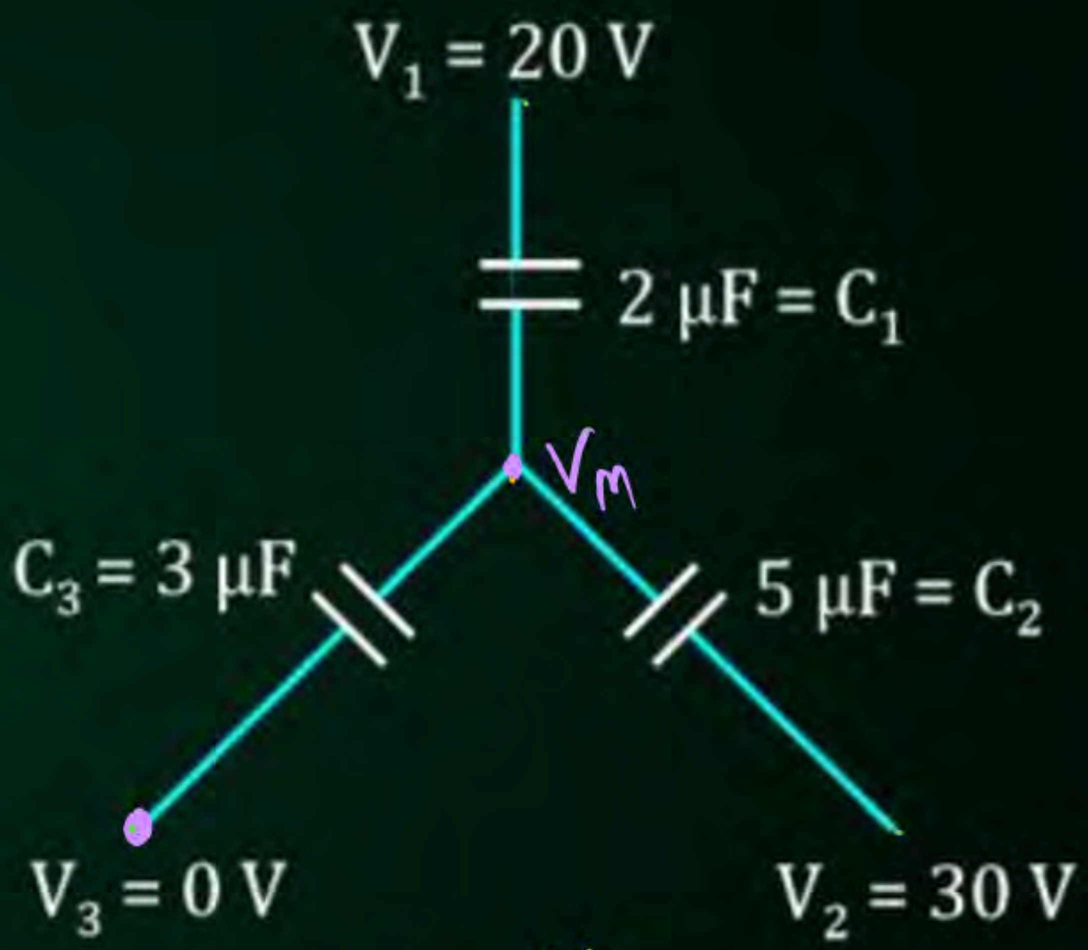
$$V_m = \frac{C_1V_1 + C_2V_2}{C_1 + C_2}$$



$$V_M = \frac{C_1 V_1 + C_2 V_2 + C_3 V_3}{C_1 + C_2 + C_3}$$

QUESTION

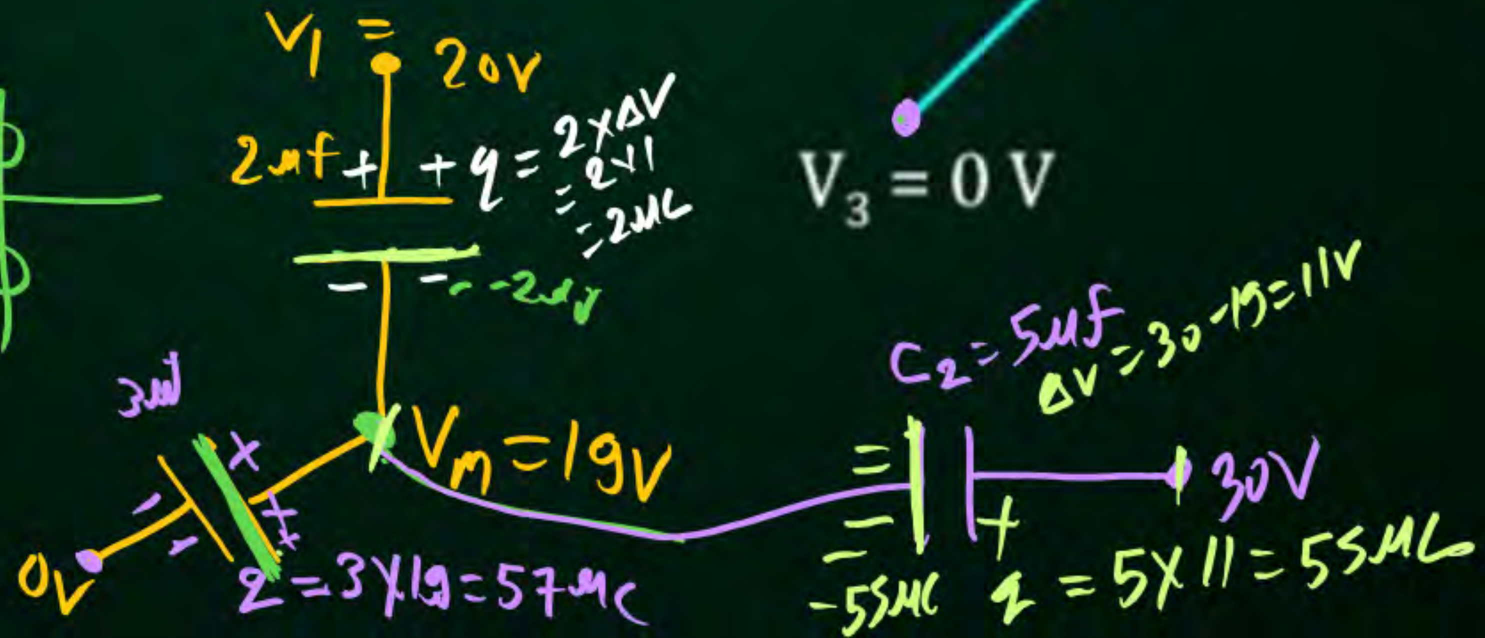
Find common potential and charge on each plate.

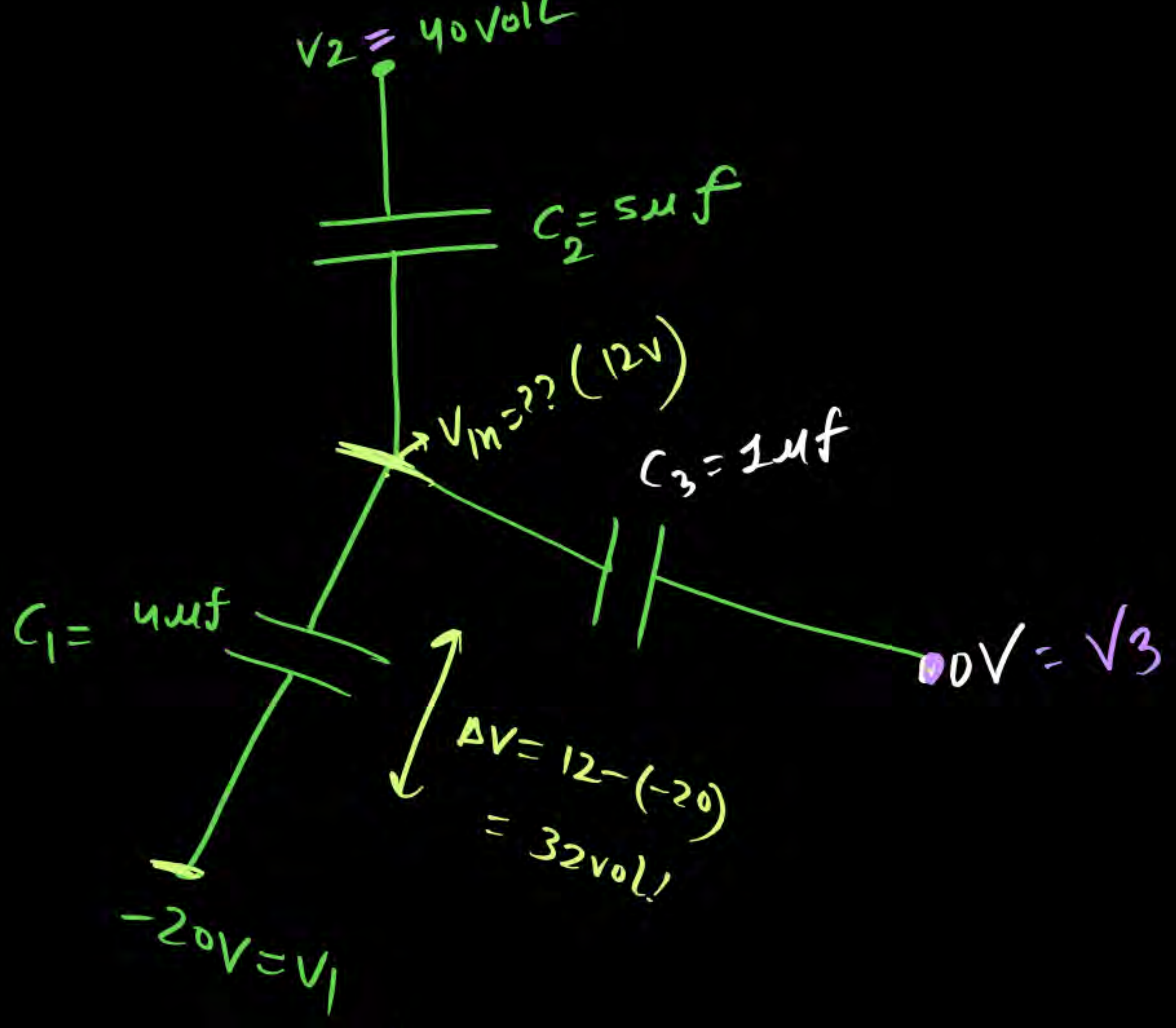


$$V_m = \frac{20\times 2 + 0\times 3 + 30\times 5}{2+3+5}$$

$$= \frac{190}{10}$$

$$\boxed{V_m = 19\,\text{volt}}$$

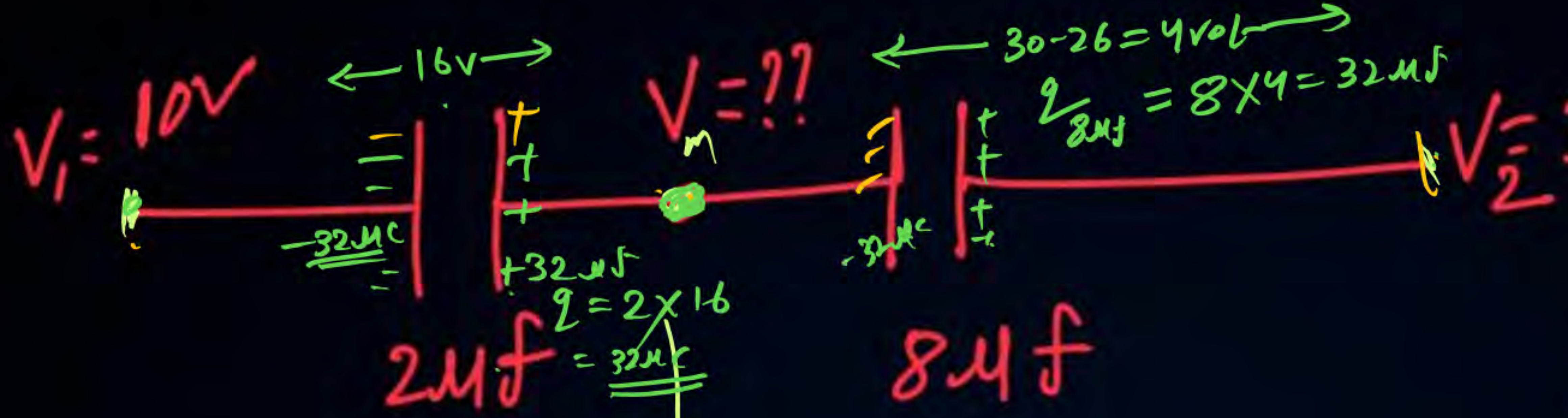




$$V_m = \frac{40\times 5 + 0\times 3 - 4\times 20}{5+4+1}$$

$$= \frac{120}{10}$$

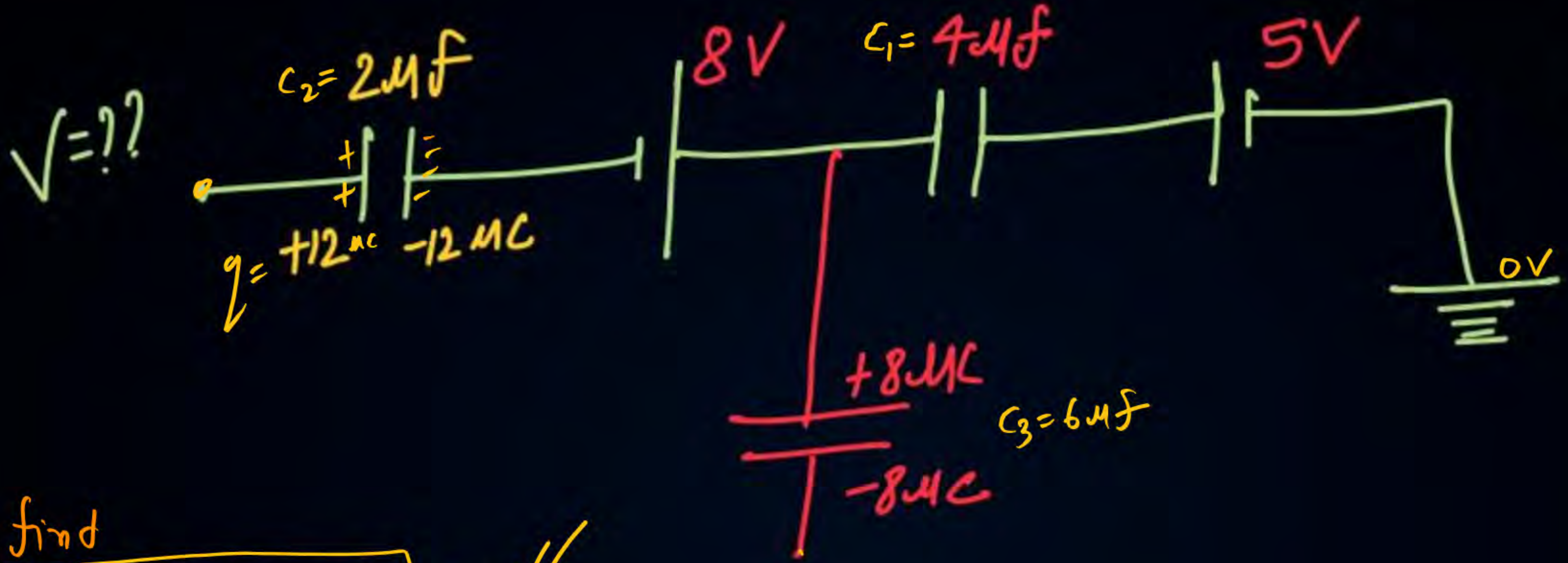
$$\boxed{V_m = 12\ \text{volt}}$$



find charge on each capacitor

$$V_m = \frac{10\times 2 + 30\times 8}{10}$$

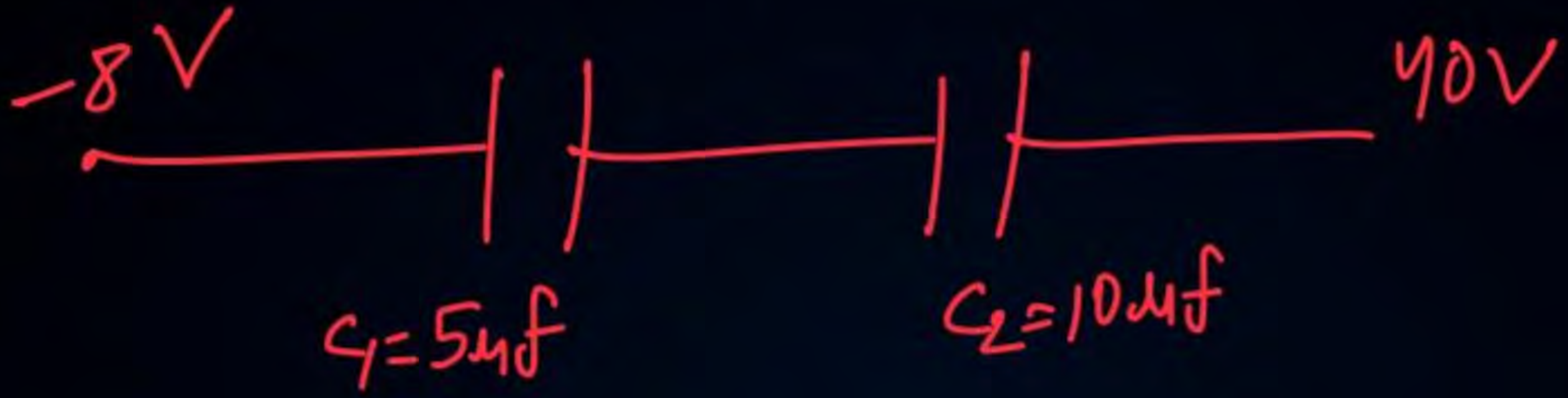
$$= \frac{260}{10} = 26\ \text{Volt}$$



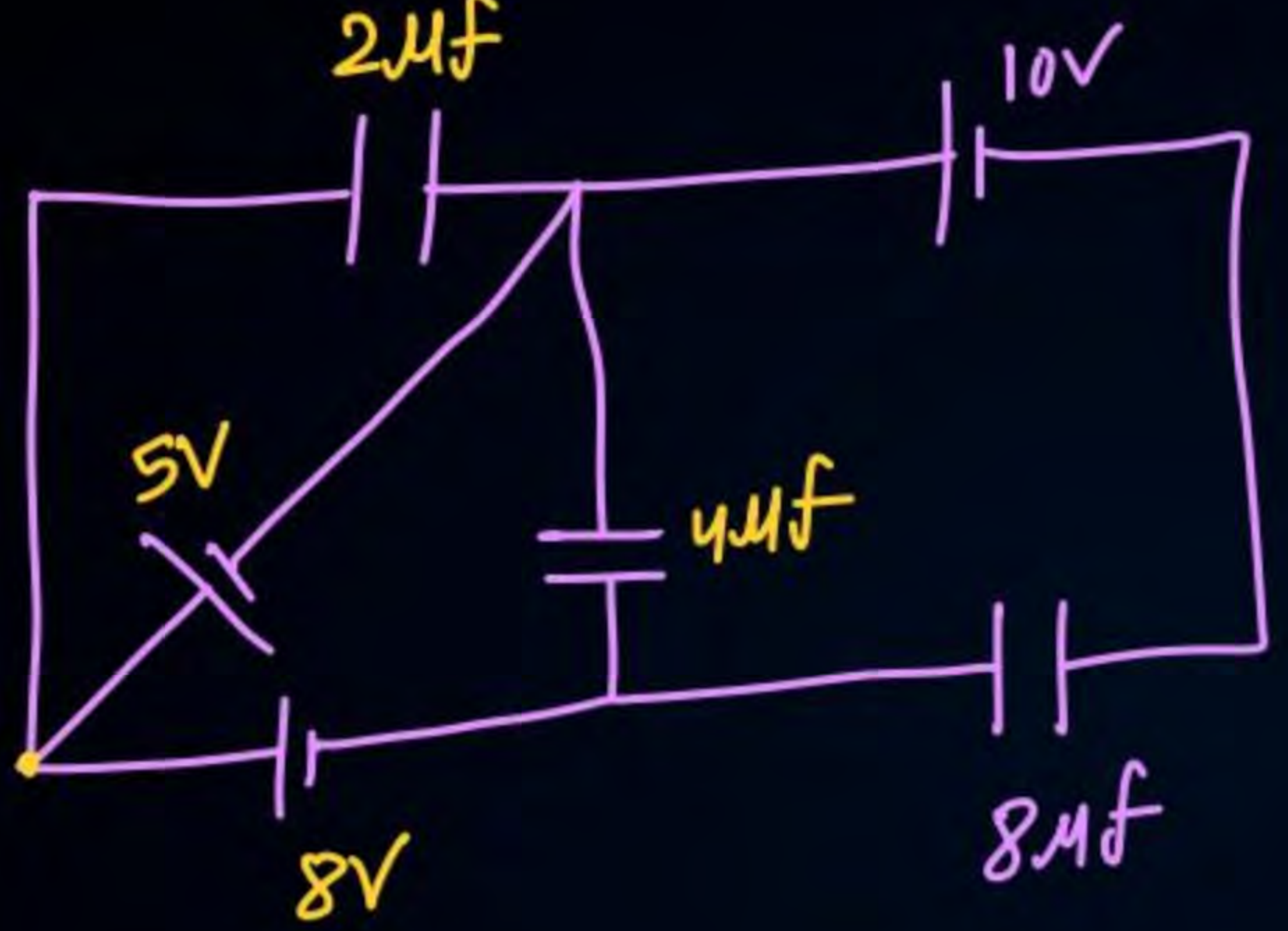
find

(a) V can't be calule — 52%

(b) V can be calculen — 41%



-8V
40V
C1=5μf
C2=10μf



2μf
10V
5V
4μf
8μf
8V


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 10 | Physics

Electrostatic Potential and Capacitance



By- Dr. Manish Raj (MR SIR)

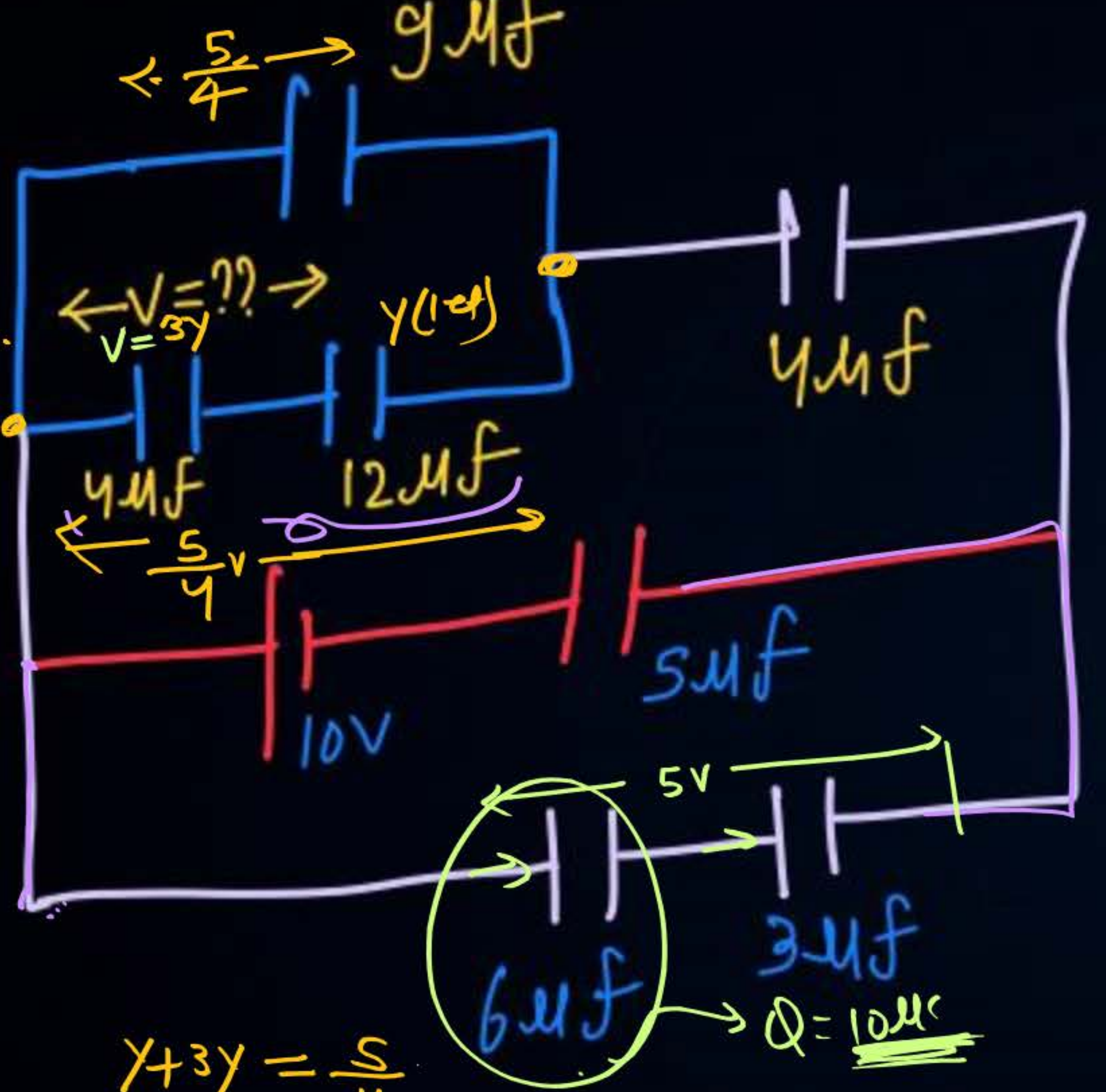
Todays Goal

→ Circuit analysis

→ dielectric b/w Capacity

find V across 4μf

charge on 6μf.

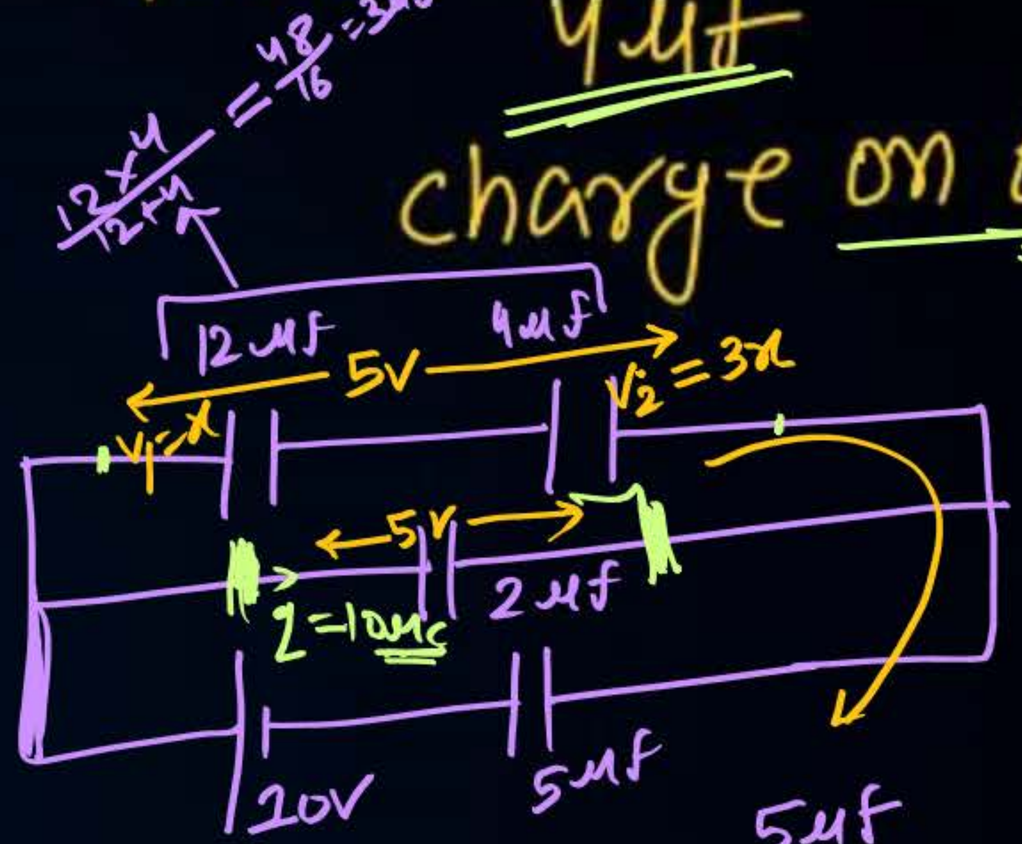


$y + 3y = \frac{5}{4}$

$4y = \frac{5}{4}$

$y = \frac{5}{16}$ volt → (Potential on 4μf.) $3y = \frac{15}{16}$ volt

⟹

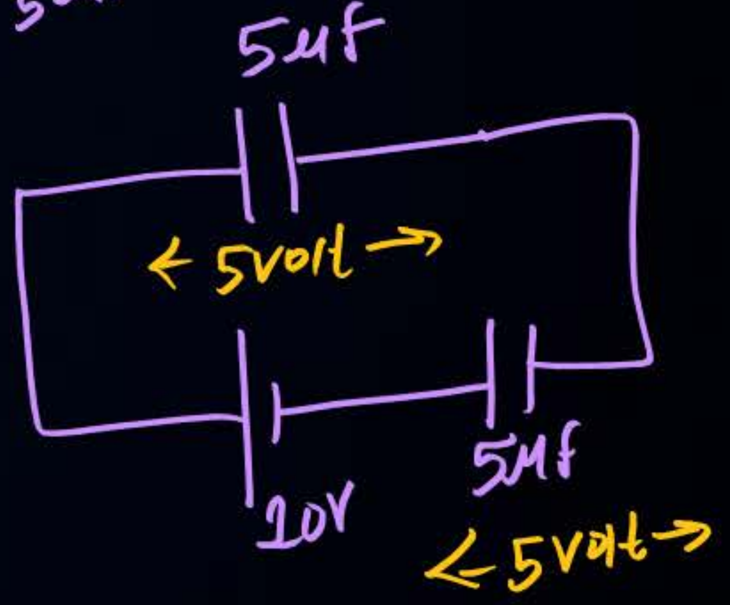


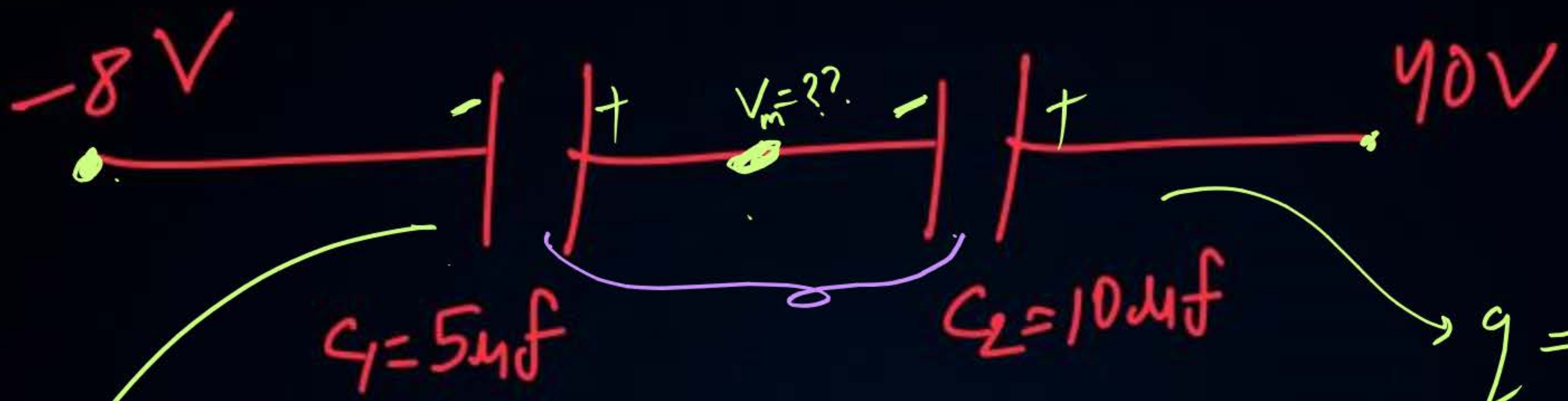
$x + 3x = 5$

$x = \frac{5}{4}$

$x = \frac{5}{4}$ volt

across 12μf



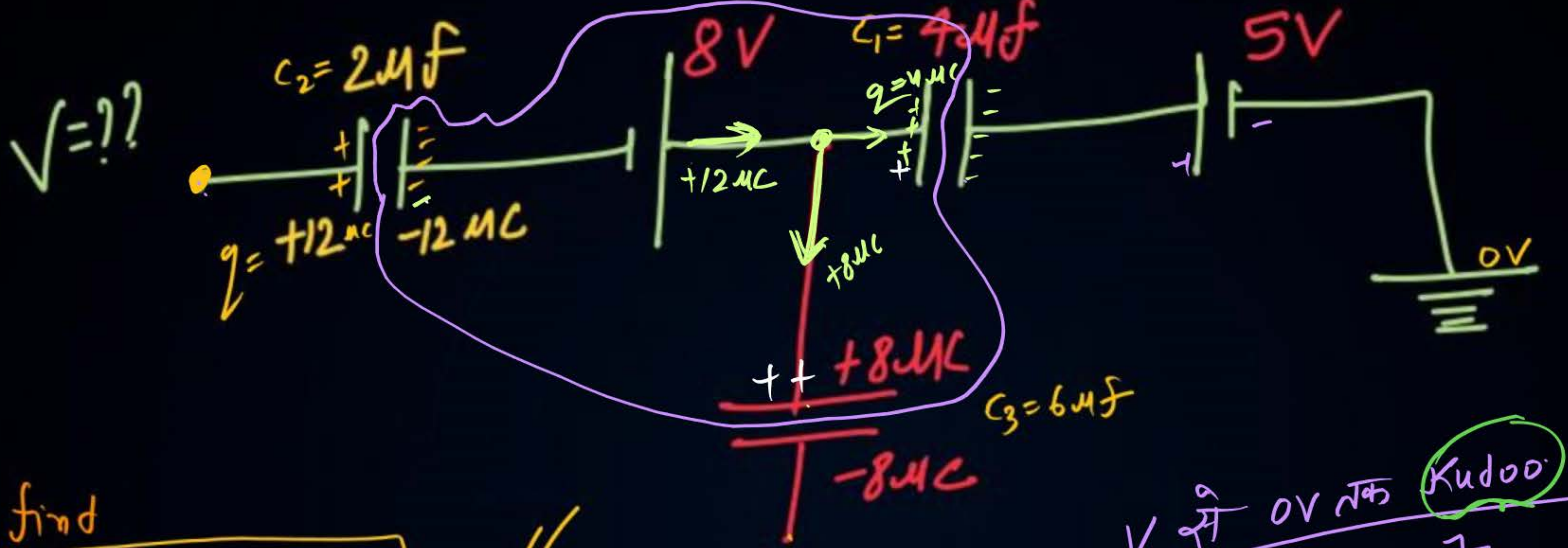


$$q = 10[40-24]$$
$$= 10 \times 16$$
$$= 160\mu C$$

$$V_m = \frac{-8\times5 + 40\times10}{15}$$

$$V_m = \frac{360}{15} = 24 \text{ volt}$$

$$q_1 = C\Delta V$$
$$= 5(24-(-8))$$
$$= 5\times32 = 160\mu C$$



find

(a) V can't be calulate 52%

(b) V can be calculate 41%

V से 0V तक Kudoo

$V - \frac{12}{2} + 8V - \frac{4}{4} - 5 = 0$

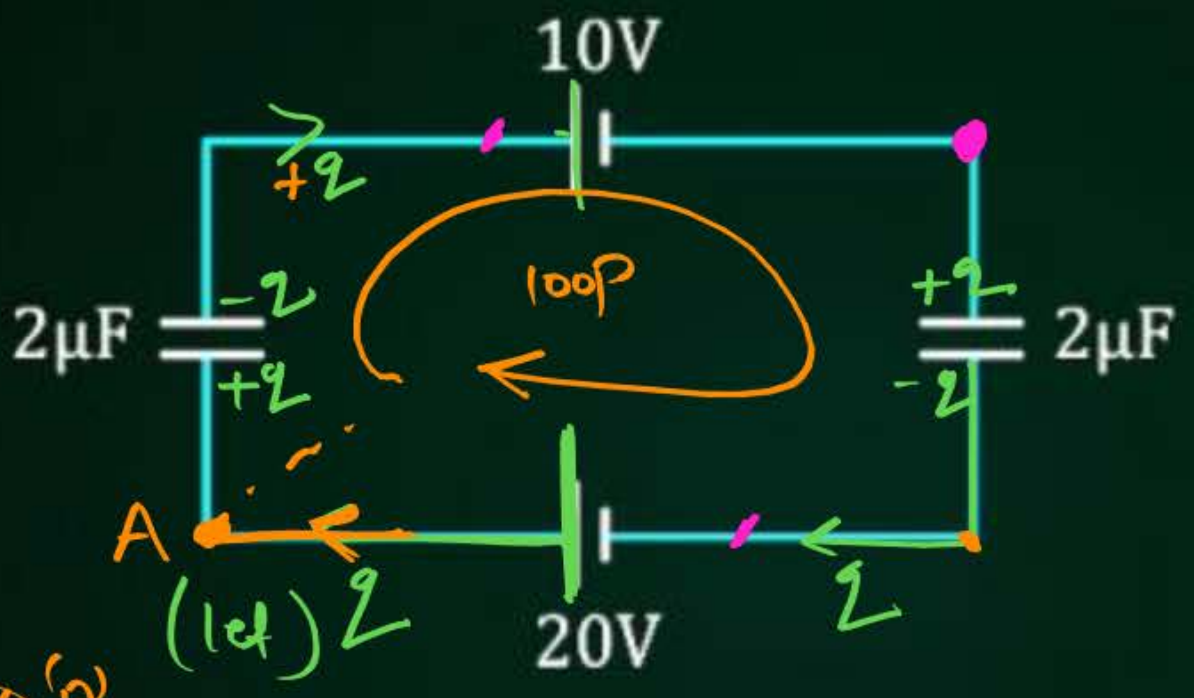
$V - 12 + 8 = 0$

$V - 4 = 0$

V = 4 volt

QUESTION

Find charge on 2 µF.

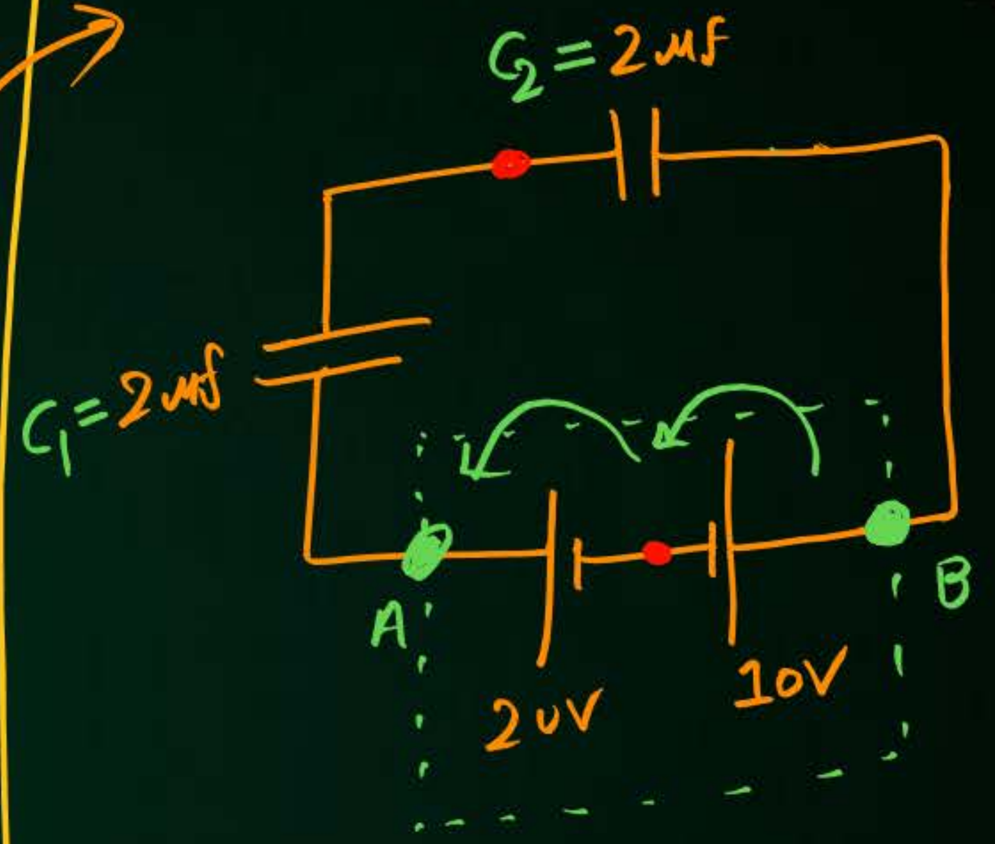


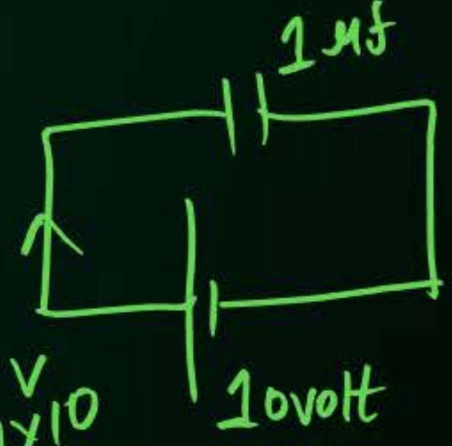
loop me kud DO 'A'

$$-\frac{q}{2} - 10V - \frac{q}{2} + 20V = 0$$

$$10 = q$$

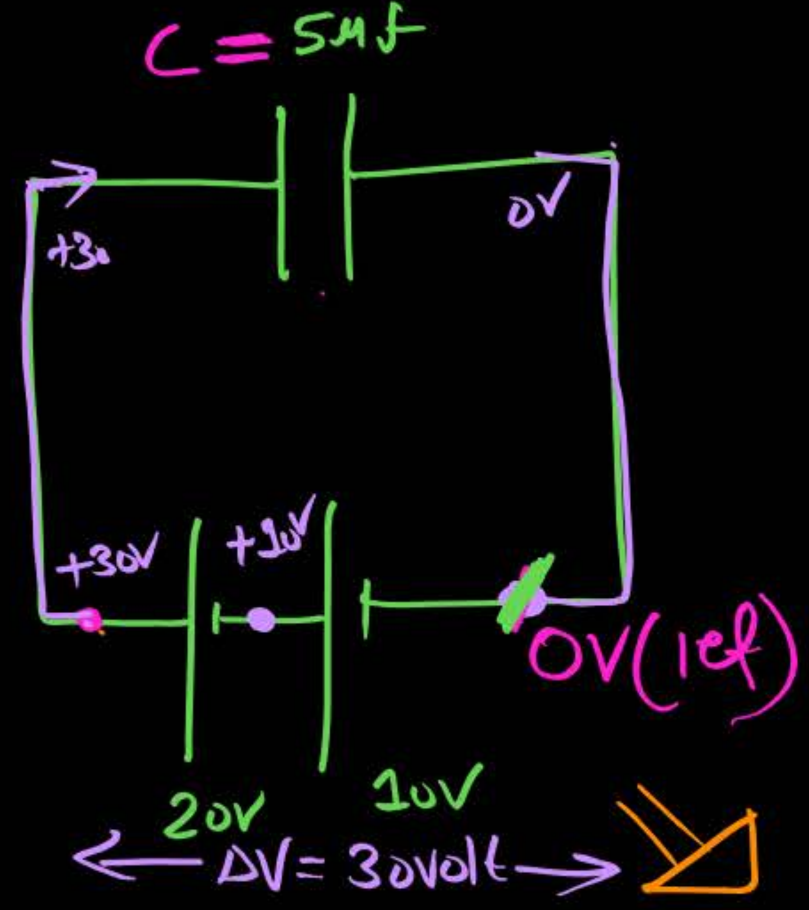
$$q = 10\mu C$$

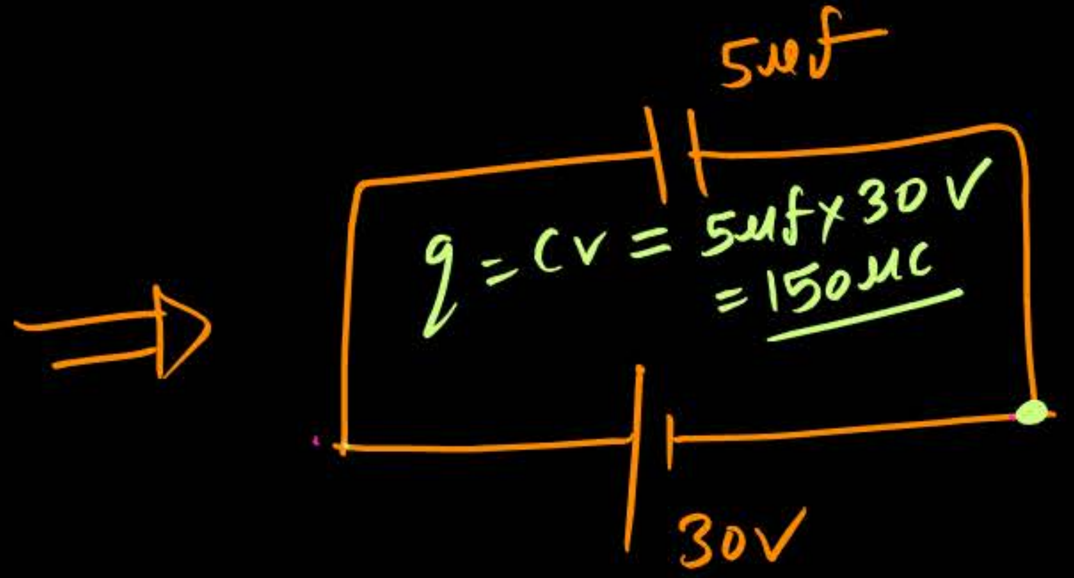


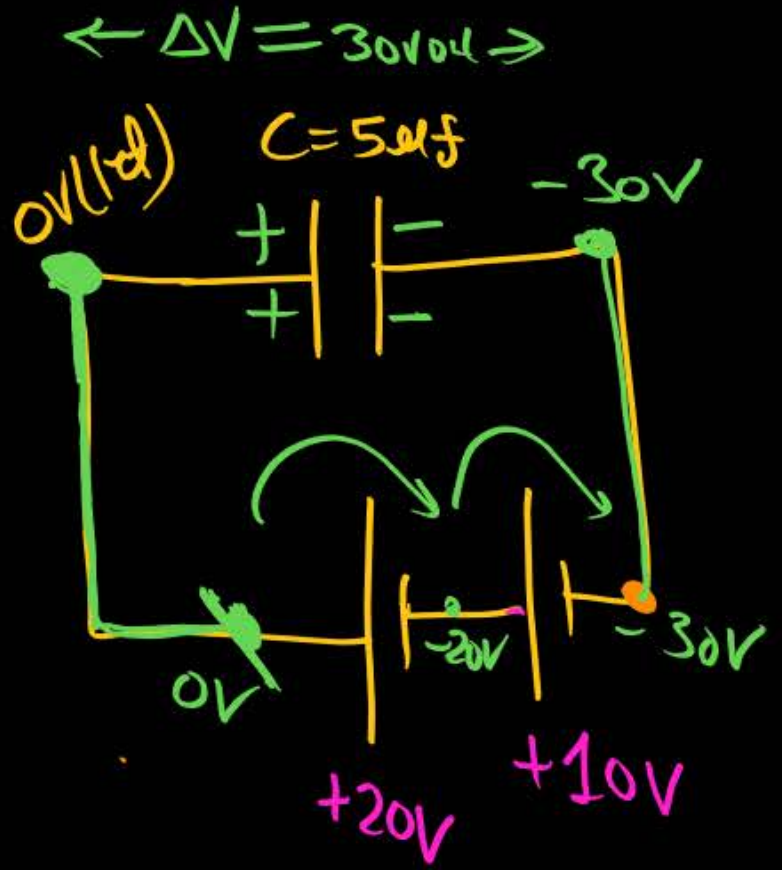


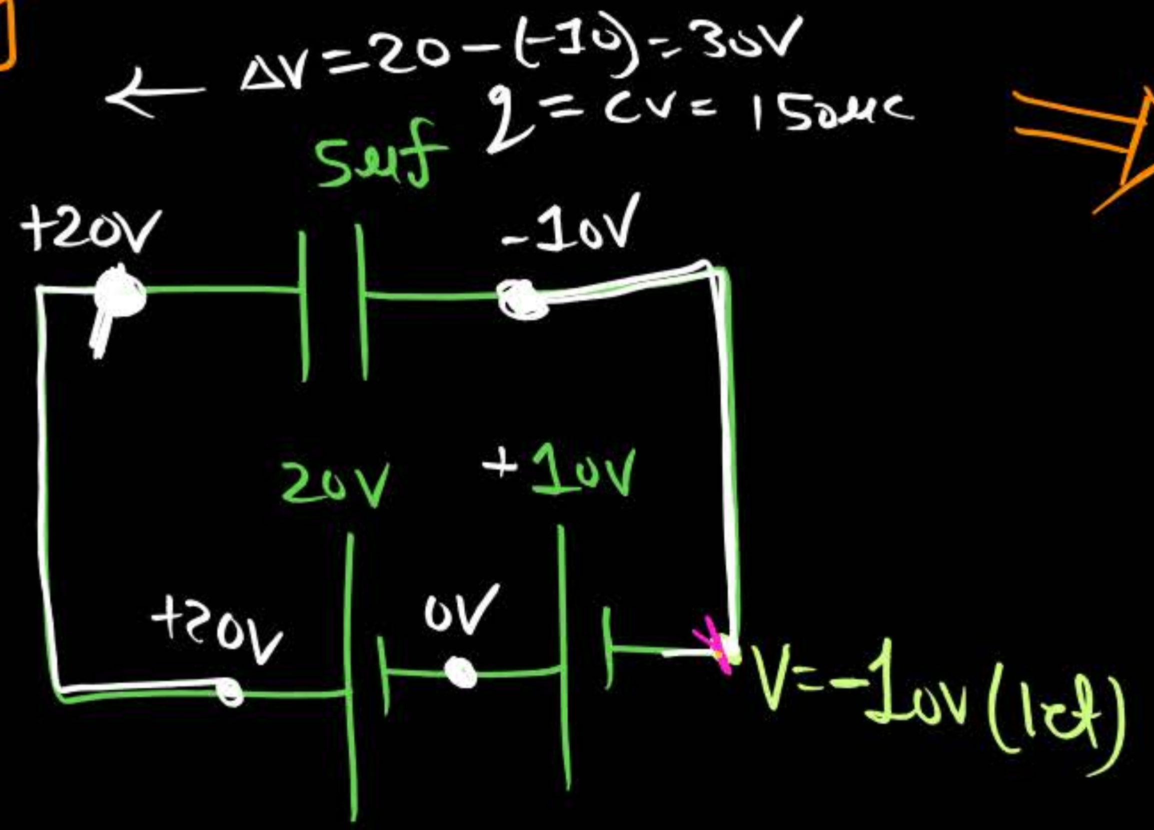
$$Q = CV = 1 \times 10 = 10\mu C$$

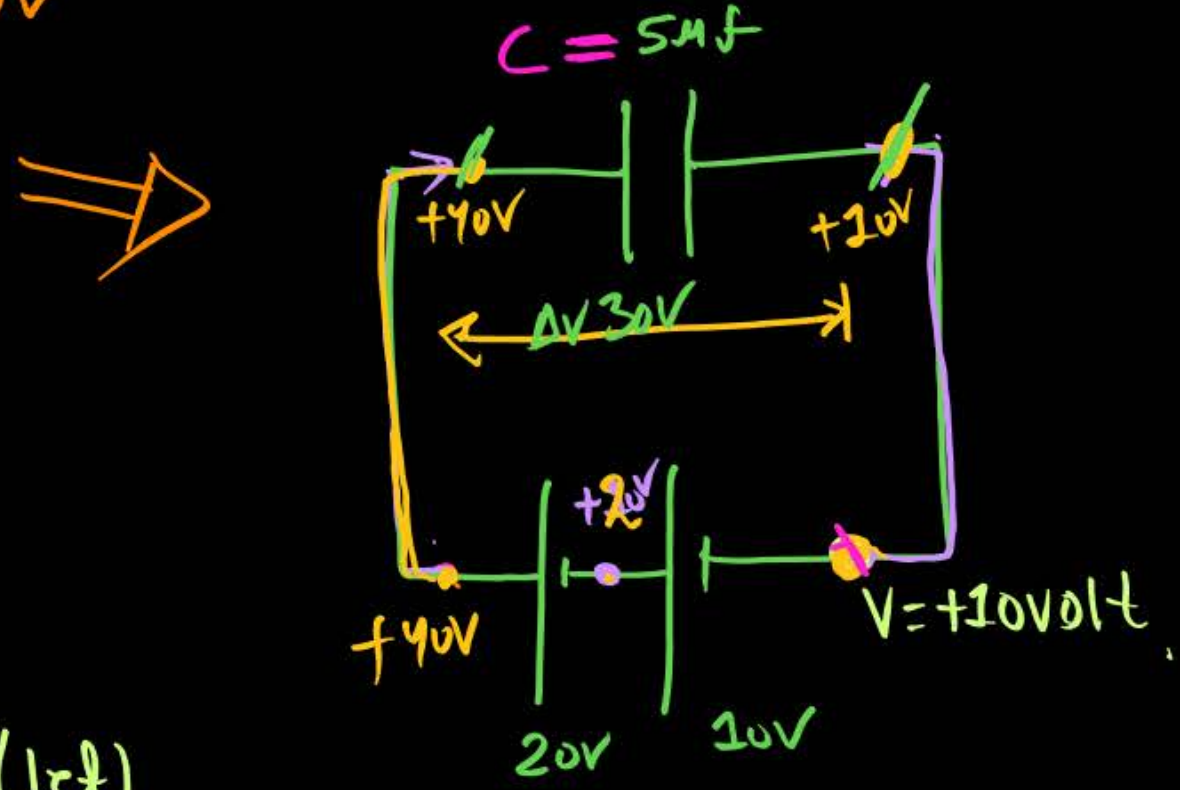
Point Potential method

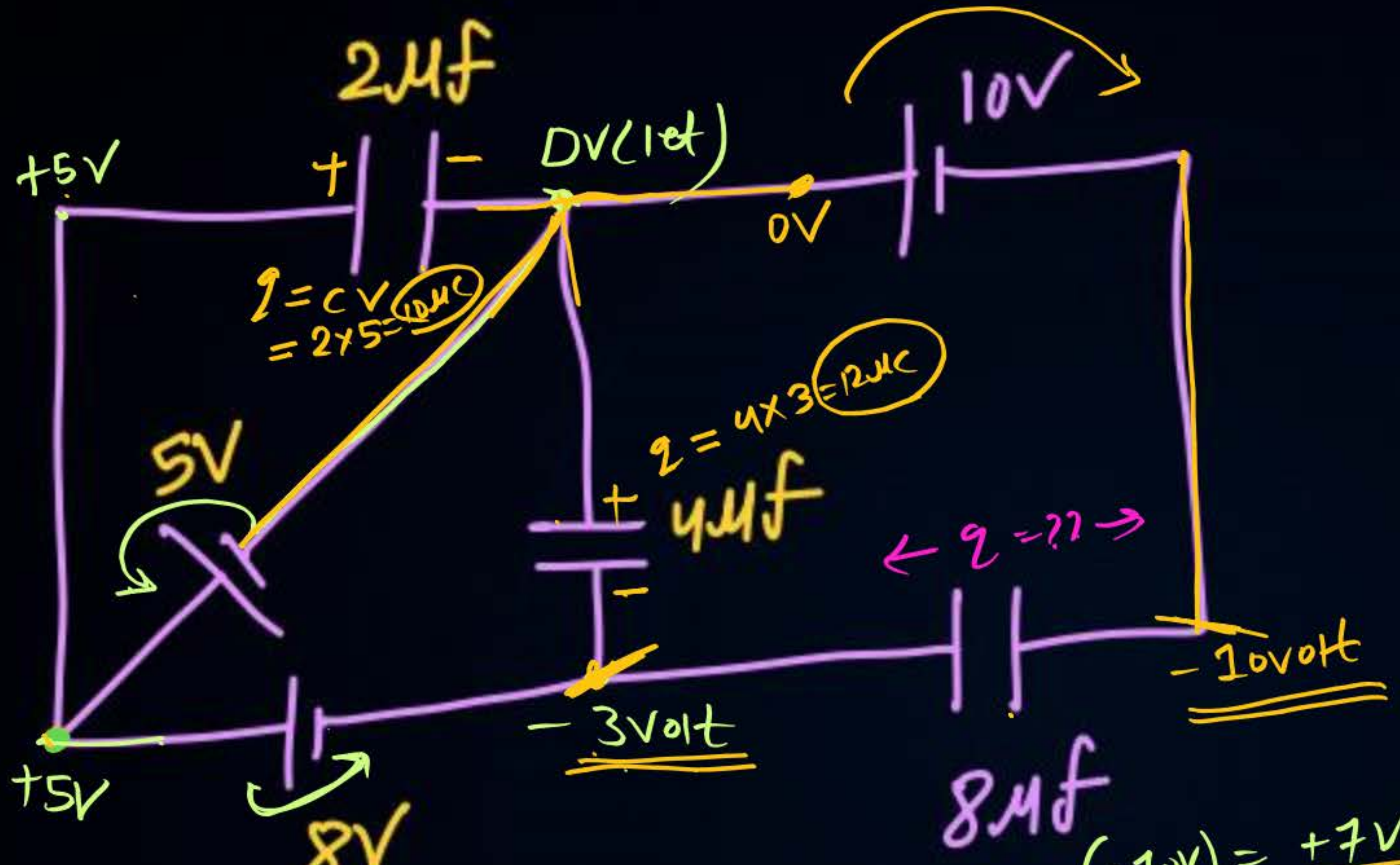








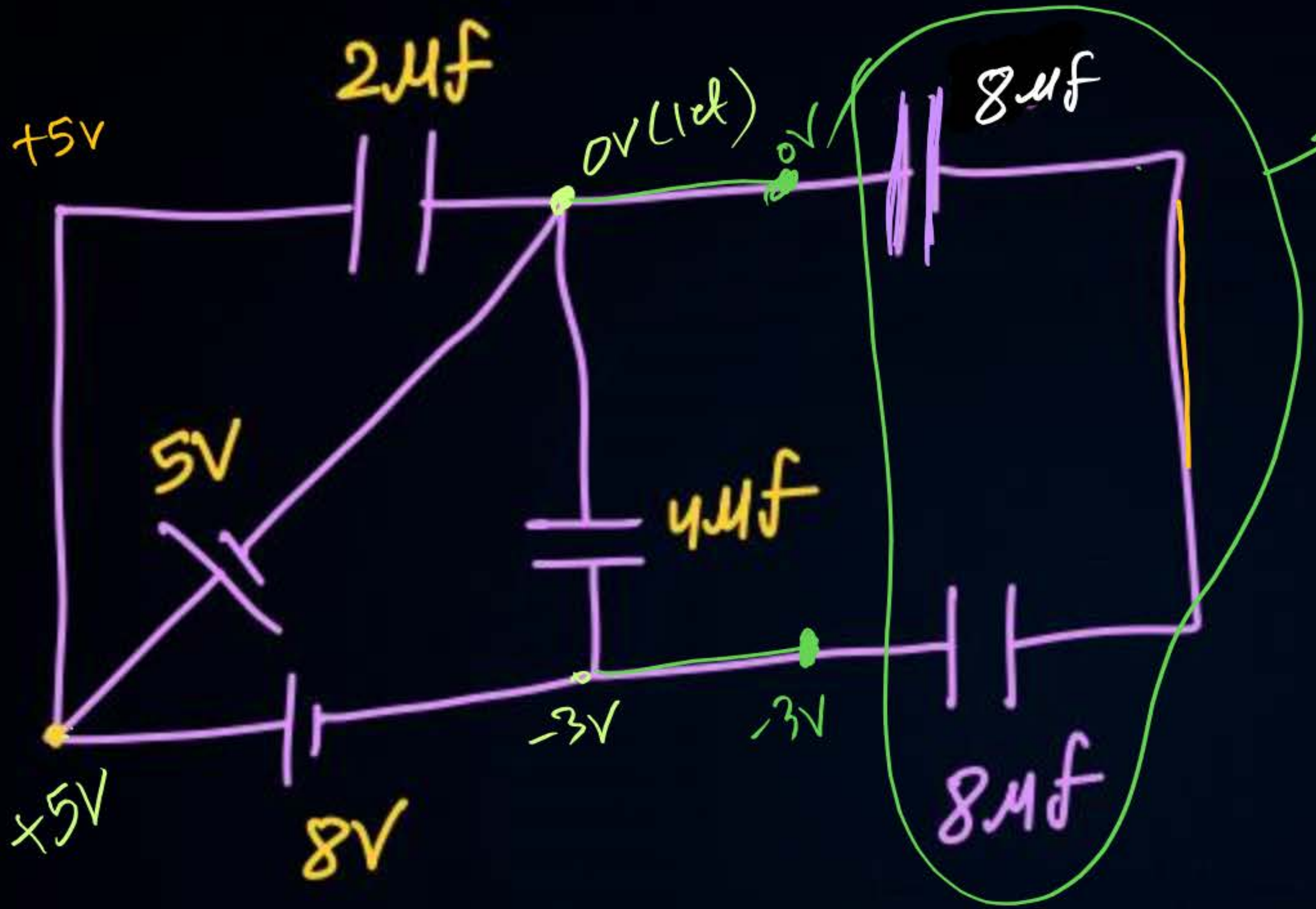




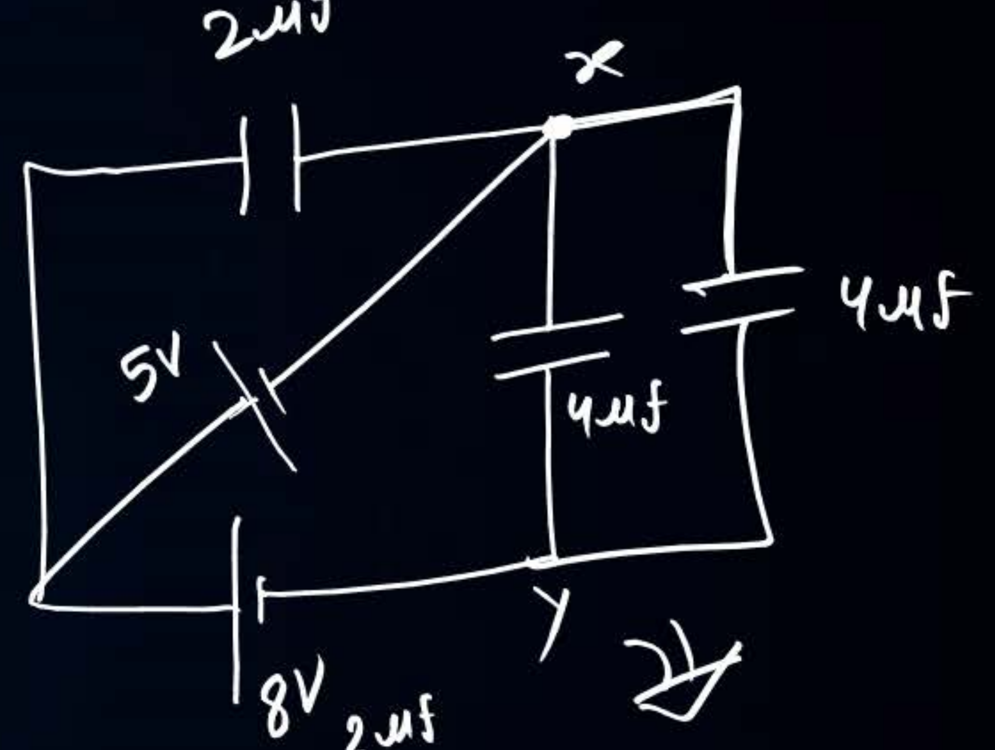
$\Delta V = -3 - (-10V) = +7\ \text{volt}$

$q = CV = 8\mu f \times 7$

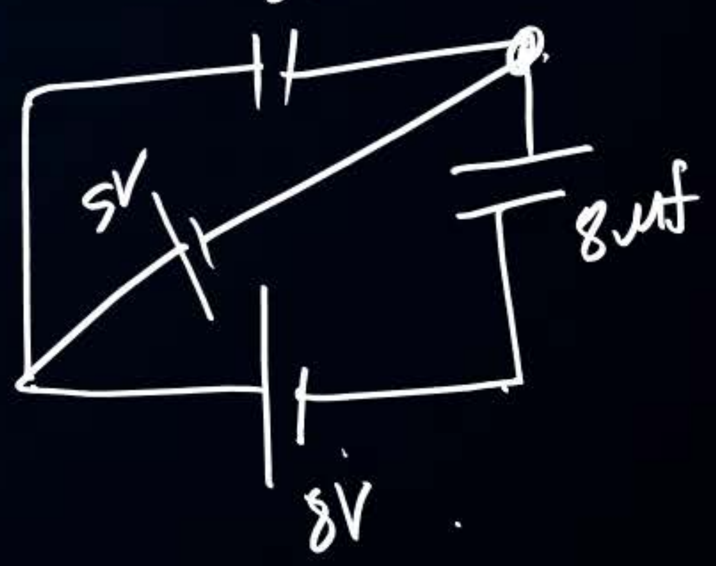
$= 56\mu C$



+5V
2μf
0V(let)
0V
8μf
5V
4μf
+5V
8V
-3V
-3V
8μf
series
$\left(\frac{8\times8}{8+8}=4\mu f\right)$



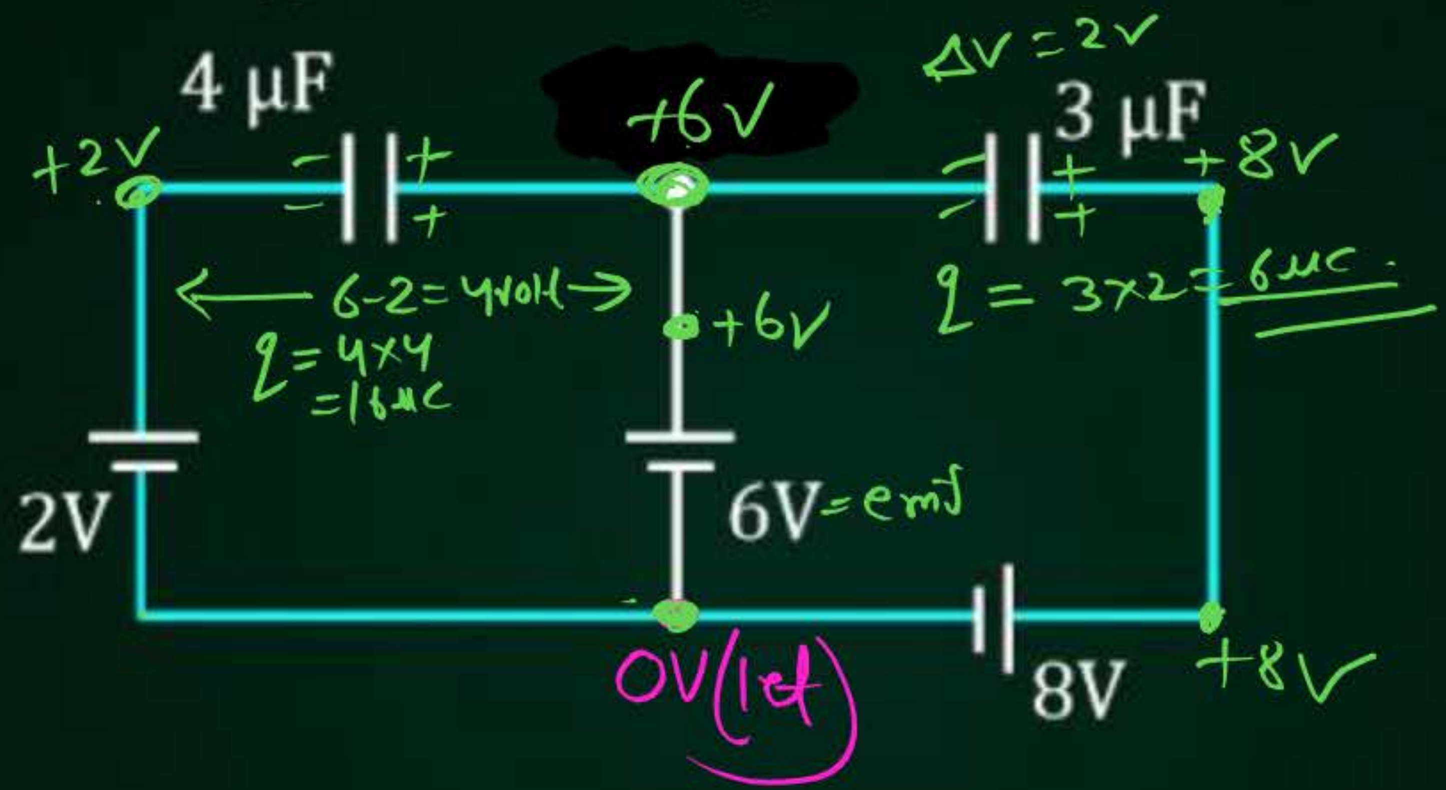
2μf
x
5V
4μf
4μf
8V
y



2μf
5V
8μf
8V

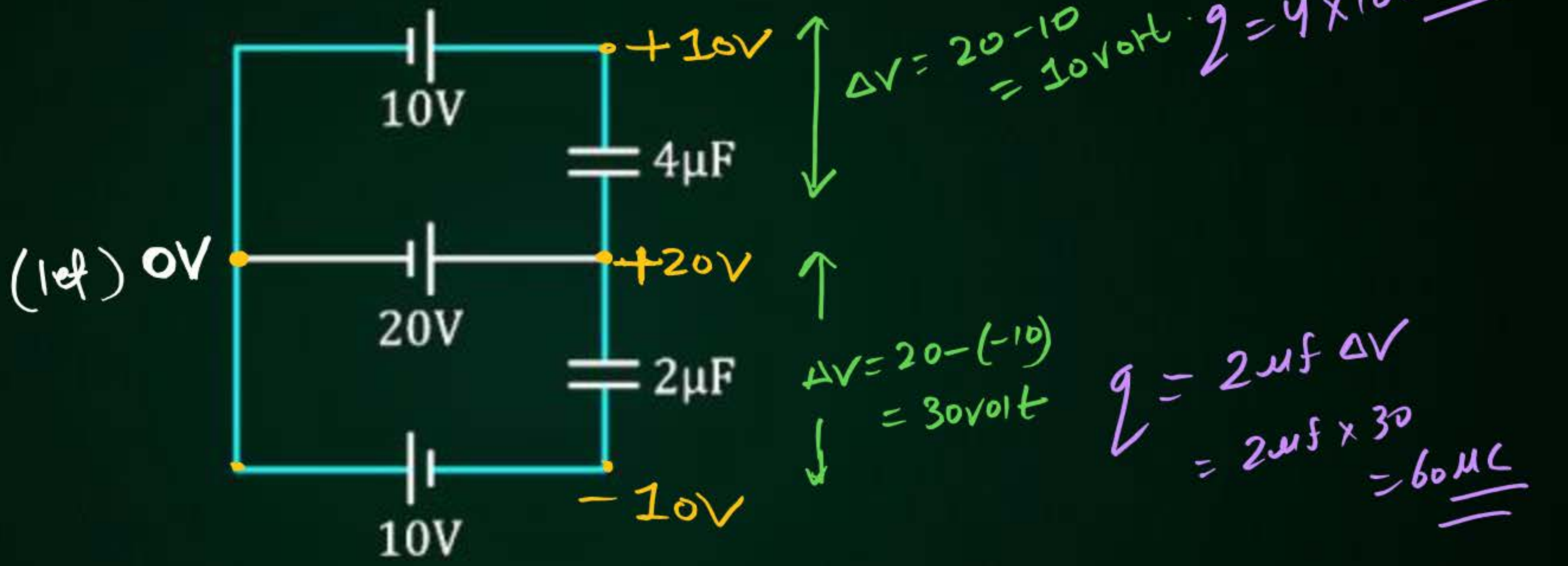
QUESTION

Find [redacted] charge on each capacitor.



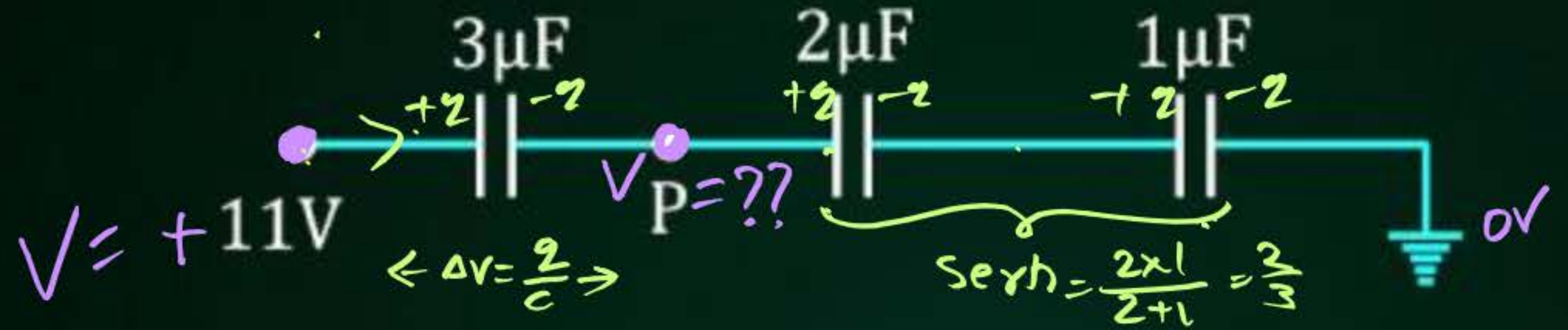
QUESTION

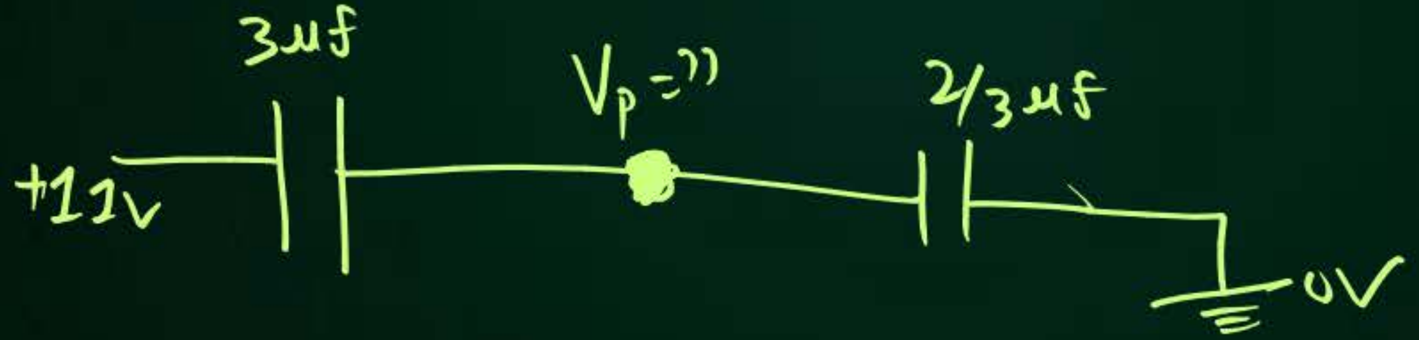
Find charge on 4 μF.



QUESTION

In the given circuit, the electric potential at P will be:





$$V_p = \frac{11\times 3 + \frac{2}{3}\times 0}{3+\frac{2}{3}} = \frac{33}{\frac{9+2}{3}} = \frac{33\times 3}{11} = 9 \text{ volt}$$

Basic concept

Kuddo concept

$$11 - \frac{q}{3} - \frac{q}{2} - \frac{q}{1} = 0$$

$$11 = \frac{q}{3} + \frac{q}{2} + \frac{q}{1}$$

$$11 = \frac{2q + 3q + 6q}{6}$$

$$11q = 11\times 6$$

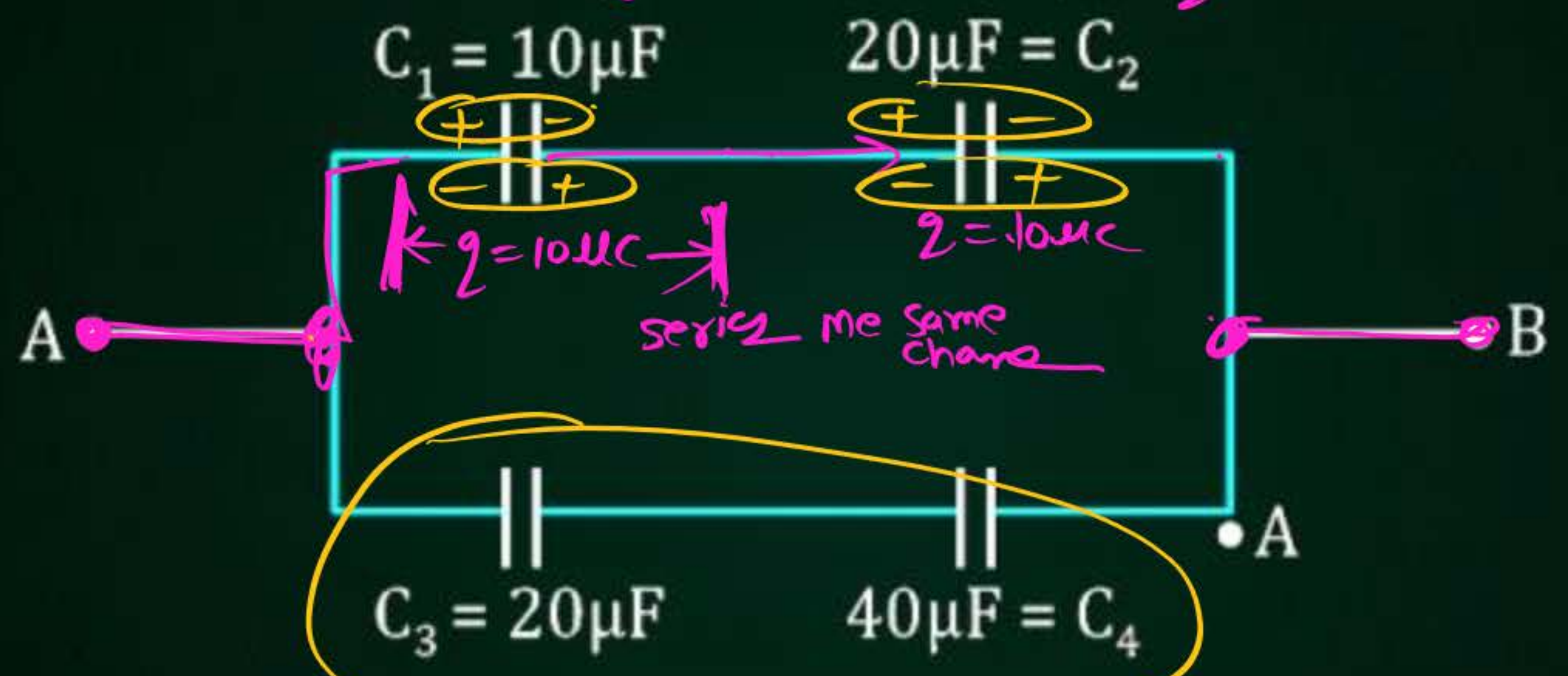
$$q = 6\ \mu C$$

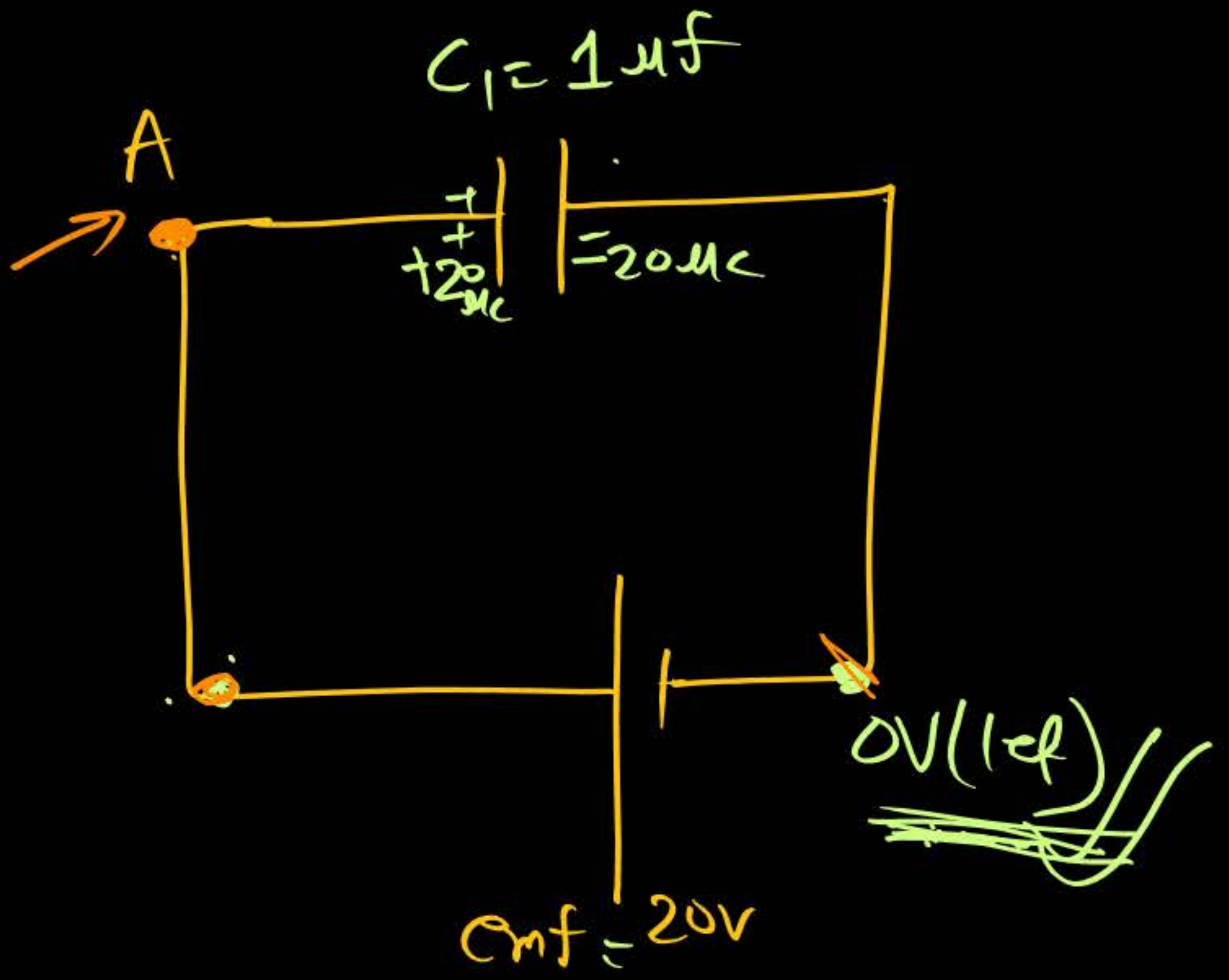
$$11 - \frac{6}{3} = V_p$$

$$9V = V_p$$

QUESTION

If charge on C_1 is 10 μC then find potential difference between A and B.





find Potential at A

(a) zero

(b) 20V → 22%

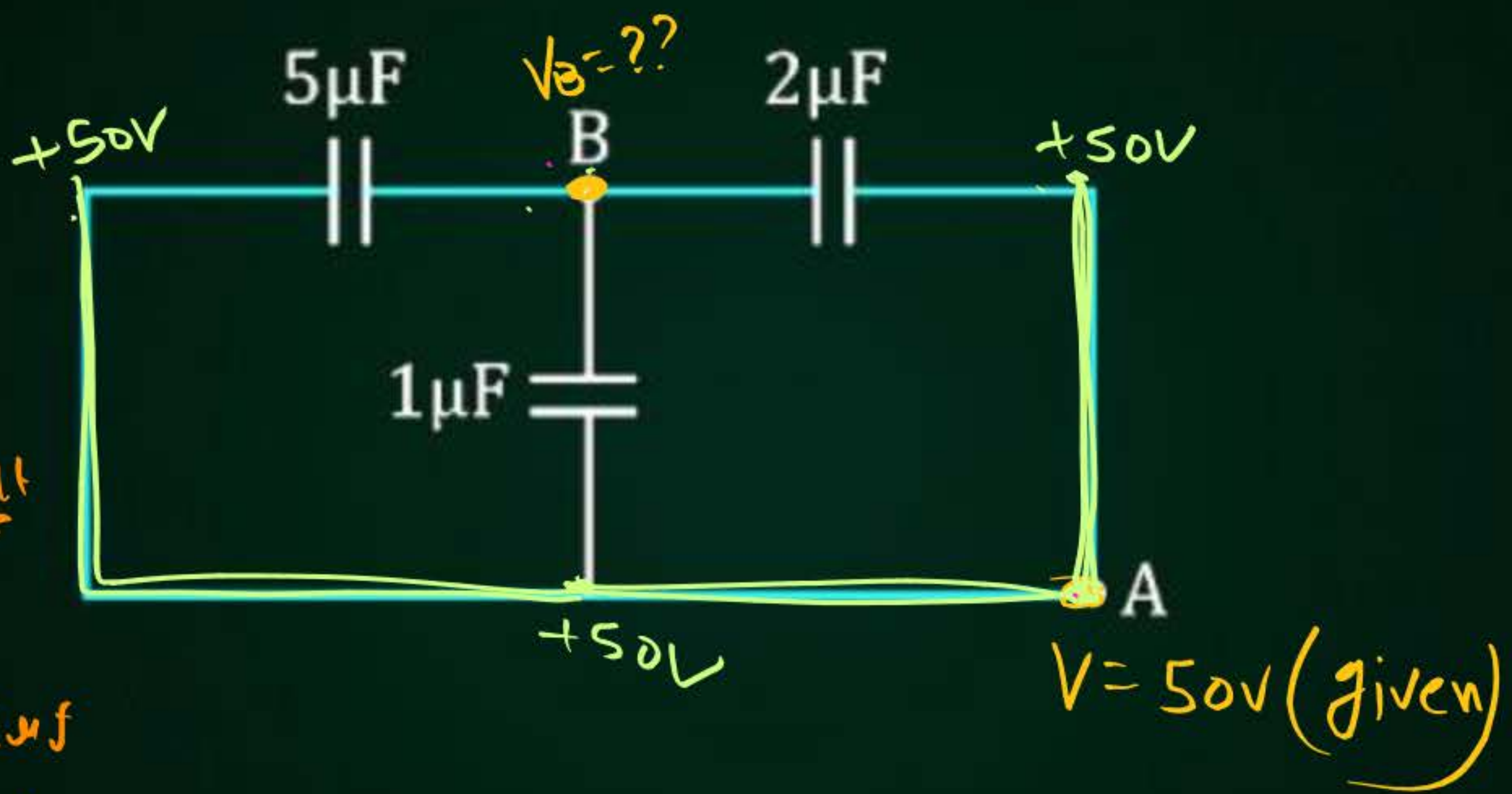
(c) -20V

(d) 100V

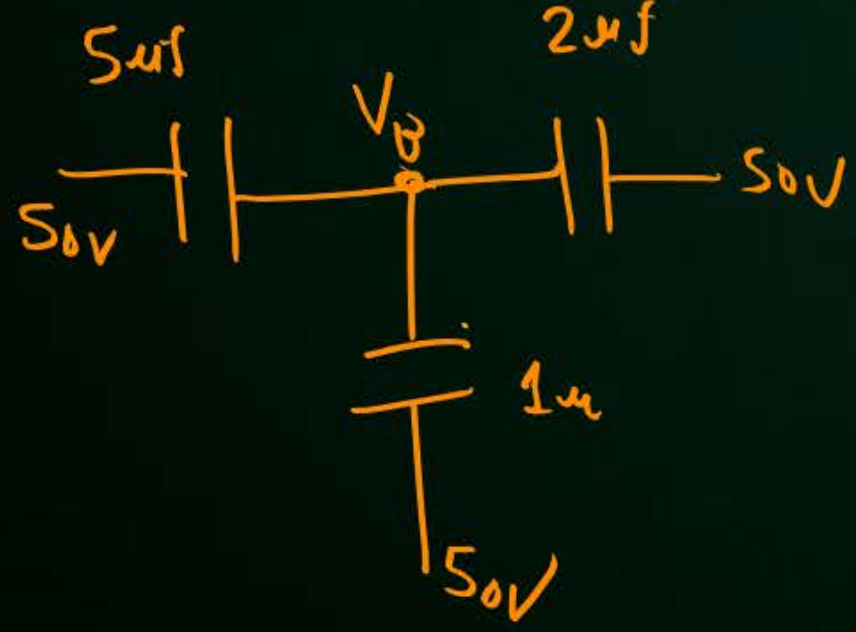
(e) can't find

QUESTION

If potential at A is 50 V then find potential at B.



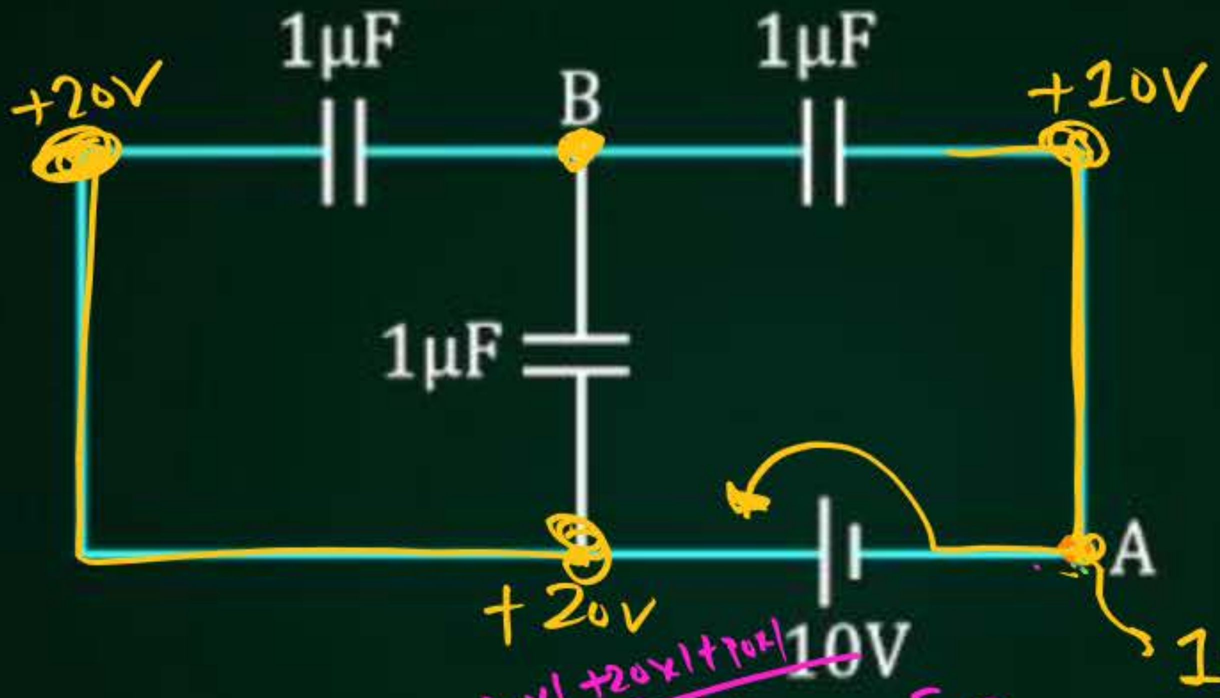
$V_B = \frac{C_1V_1 + C_2V_2 + C_3V_3}{C_1 + C_2 + C_3}$
$= 50$ volt



QUESTION

(JEE)

If potential at A is 10V then find potential at B.



17% wrong

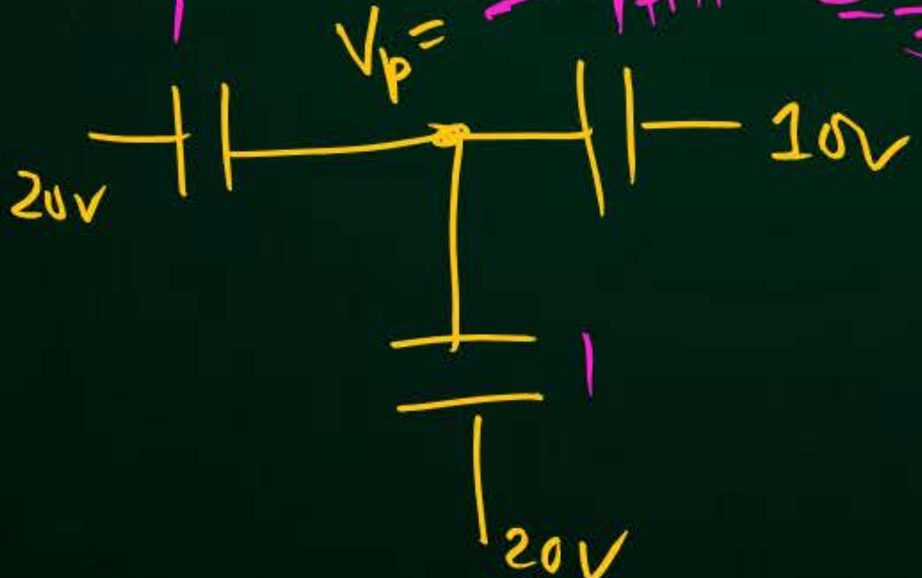
(a) 10V

(B) 20v

(c) 50/3

(d) Can't find

$V_p = \frac{20\times1 + 20\times1 + 10\times1}{1+1+1} = \frac{50}{3}$

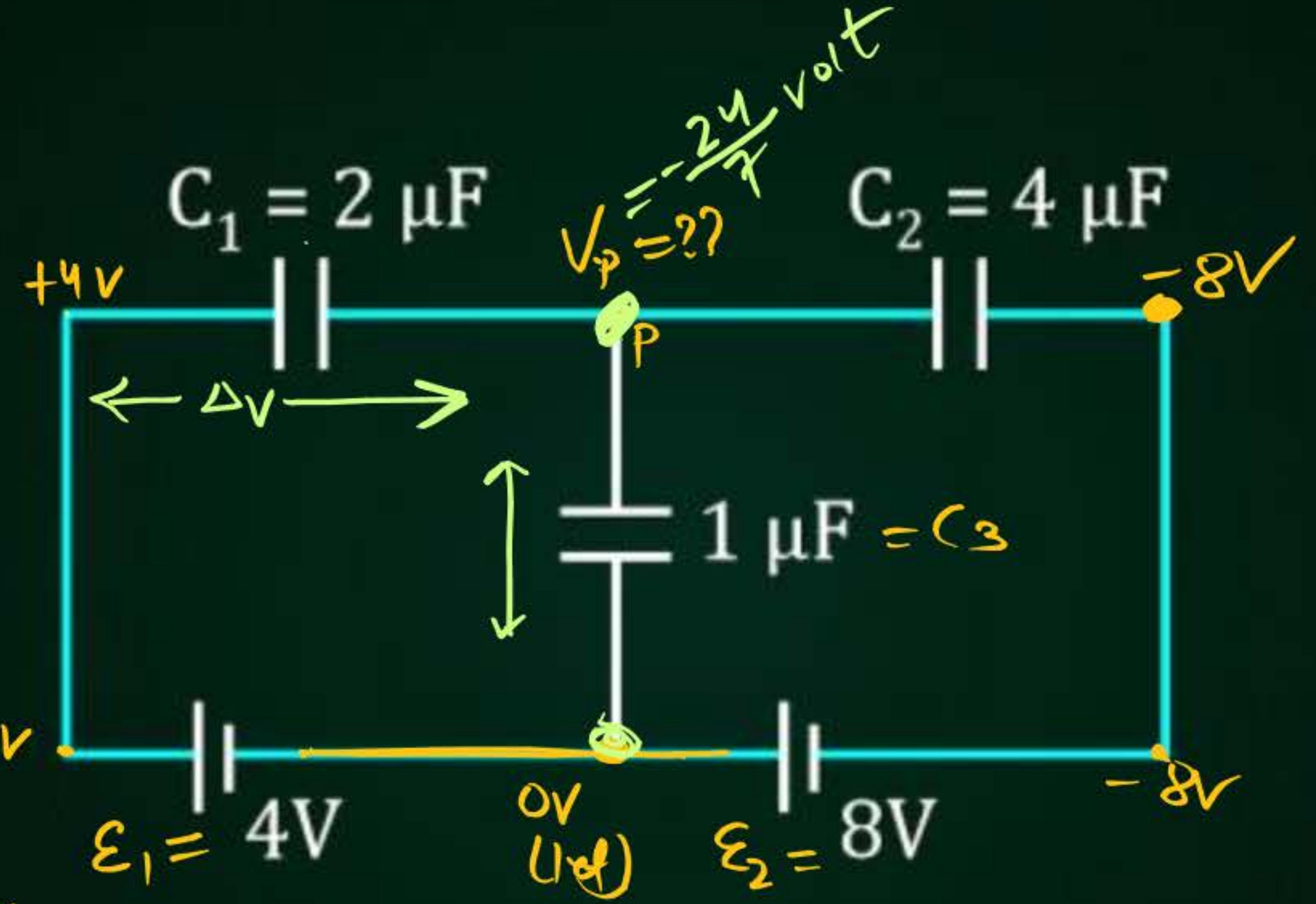


Type of circuit

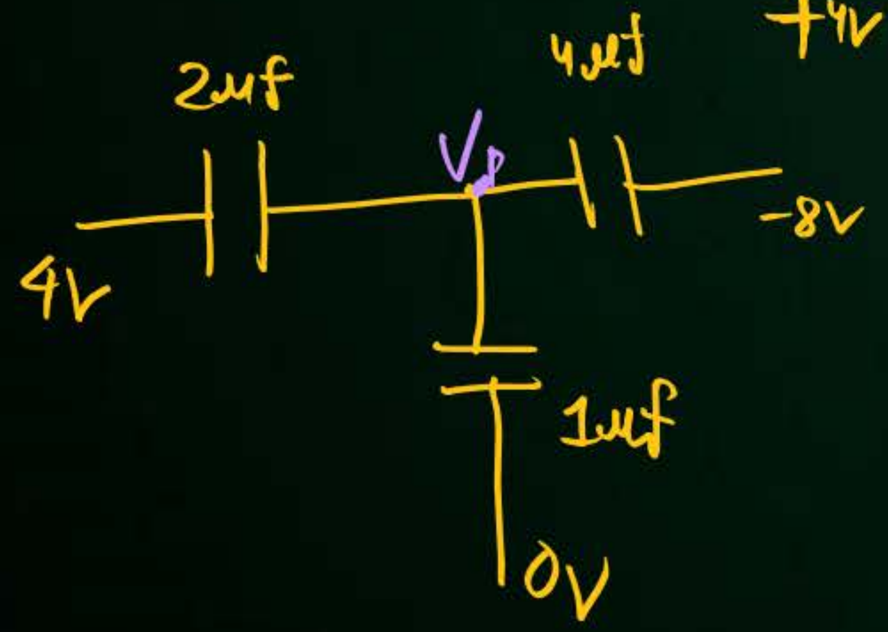
1. 1. Battery Bala circuit (Baki capacitor series parallel me)
   - → loop ke kisi ek wire me sirf Battery hai.

2. Many Battery Bala circui
   - → loop में mixed capacitor & Battery

find charge on each capacitor



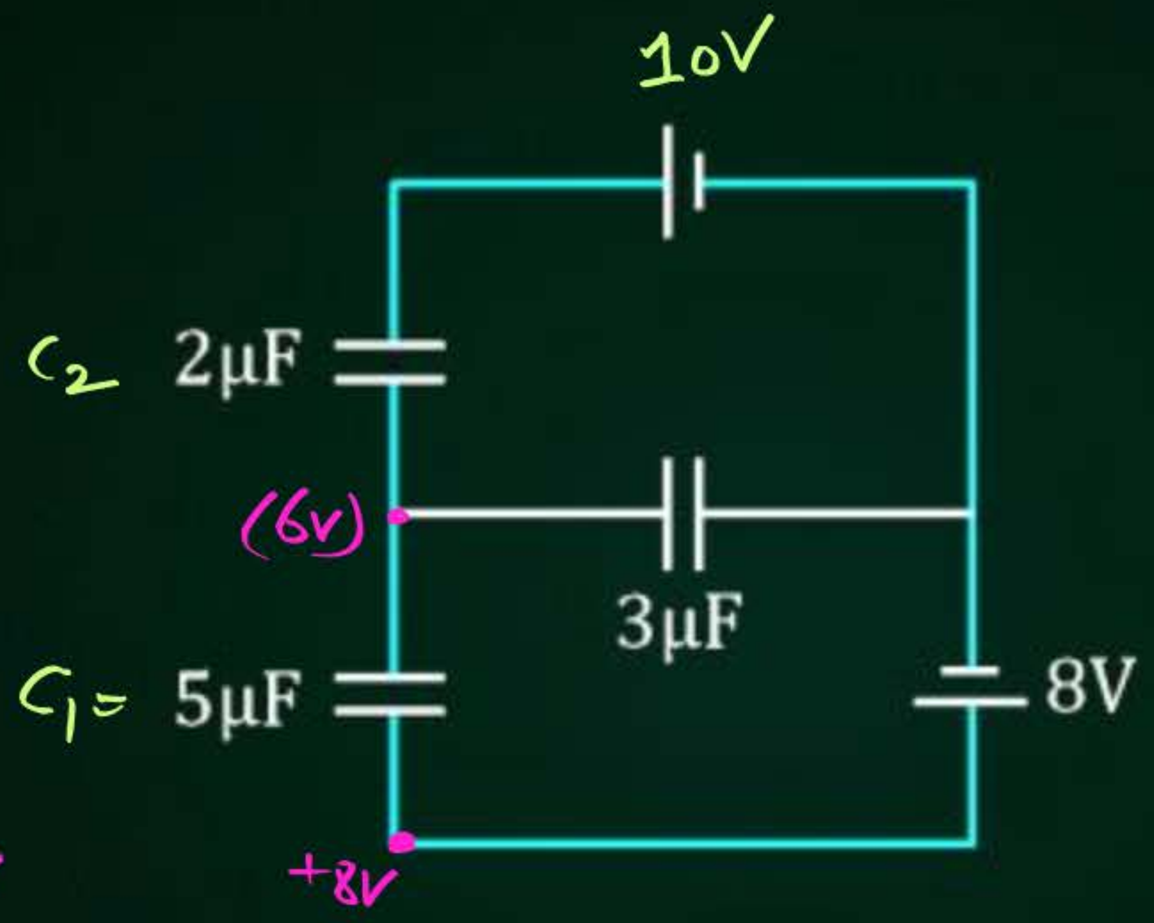
#



$$V_p = \frac{4\times2 + 0\times1 - 8\times4}{7} = \frac{8-32}{7} = -\frac{24}{7}\text{ volt}$$

QUESTION

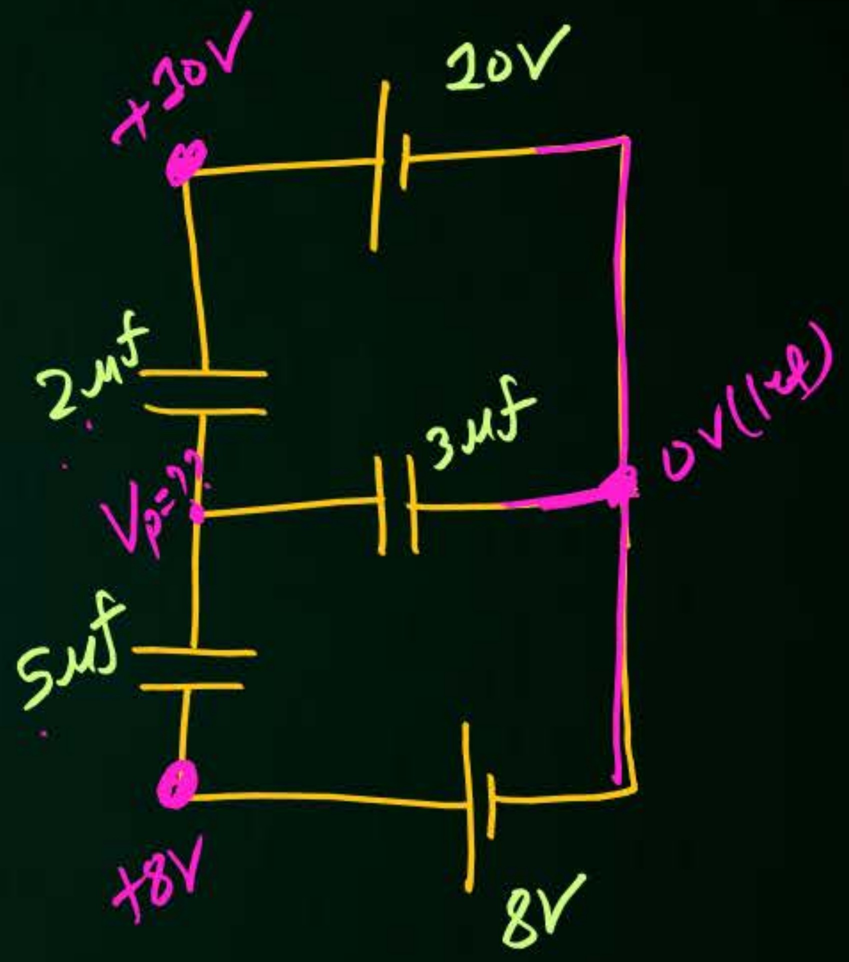
Find charge on 5 μF.



$\Delta V = 8 - 6$
$= 2V$

$q = \Delta V C_1$
$= 2 \times 5$
$= 10 \mu C$

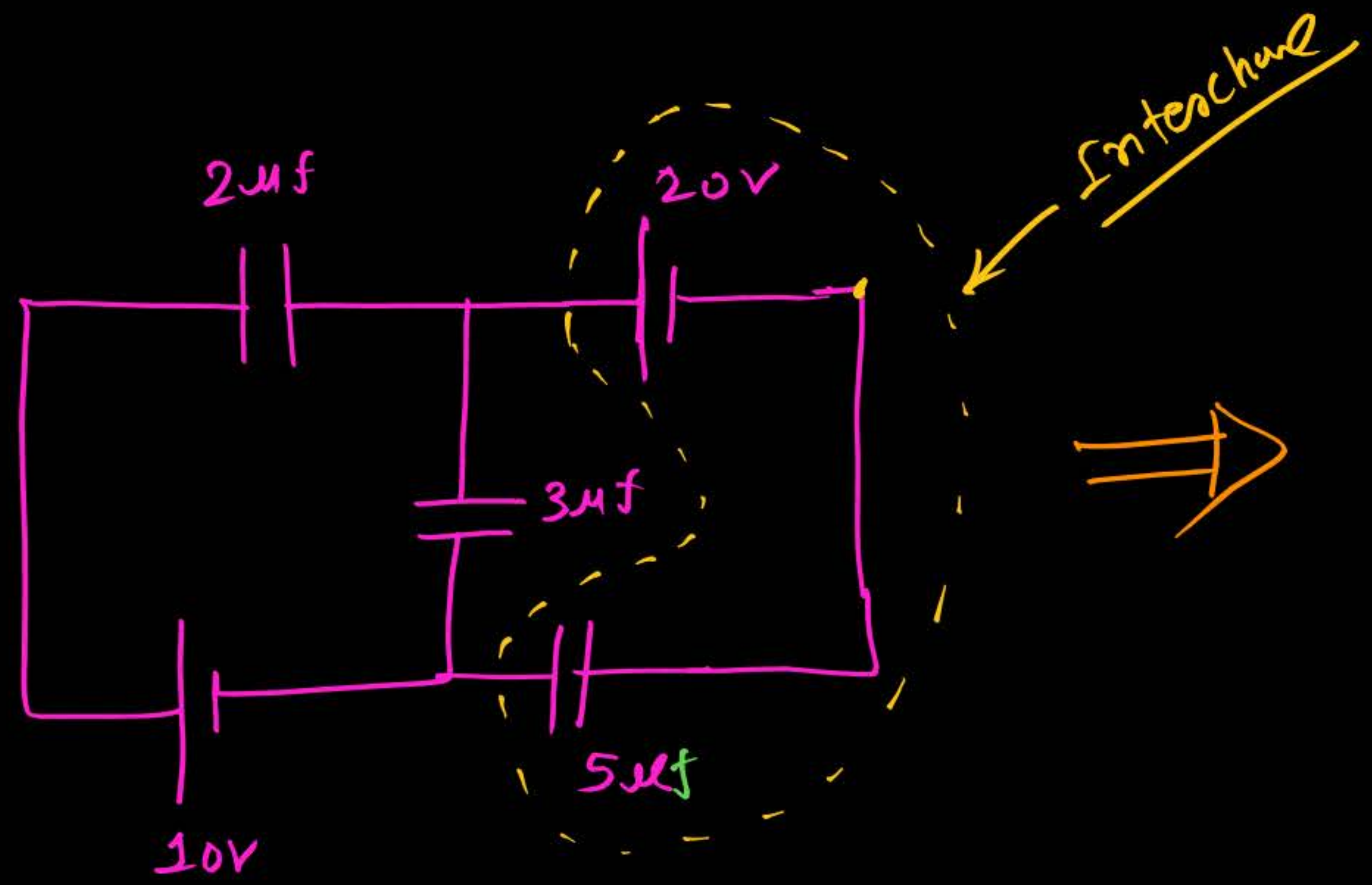
$\Rightarrow$



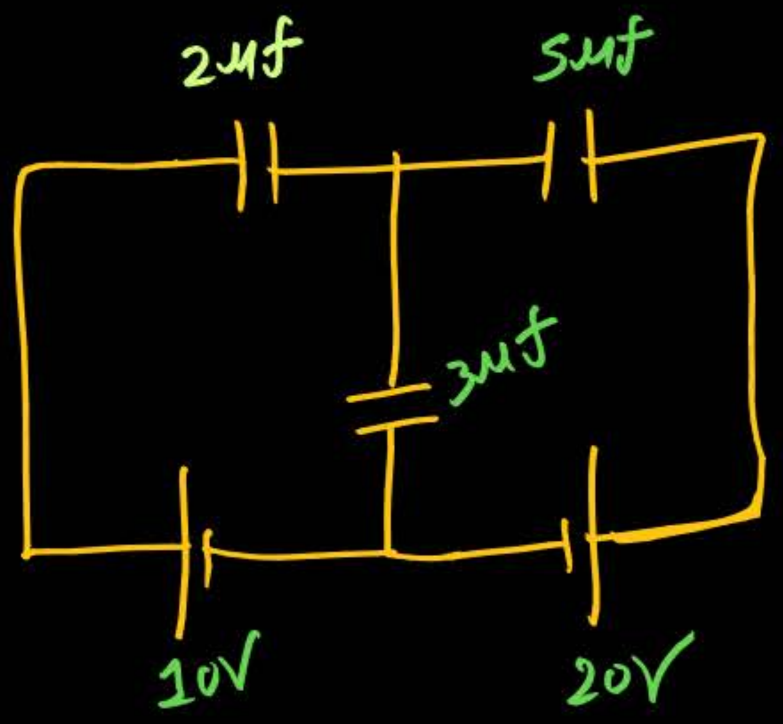
$$V_p = \frac{8 \times 5 + 3 \times 0 + 10 \times 2}{5 + 2 + 3}$$

$$= \frac{60}{10} = 6 \text{ volt}$$

Find charge on capacitor

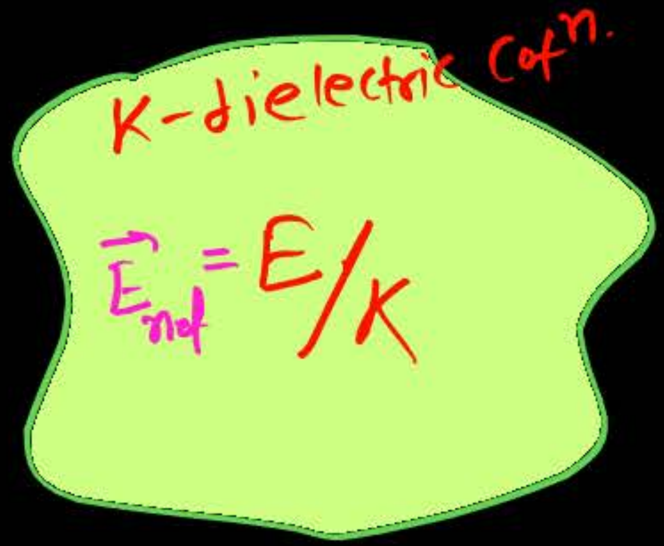


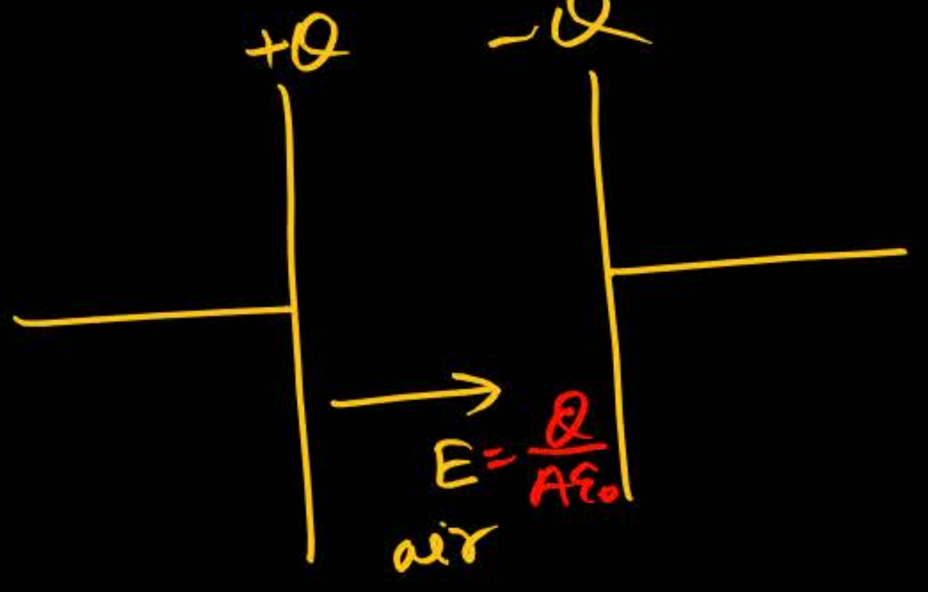
⇒

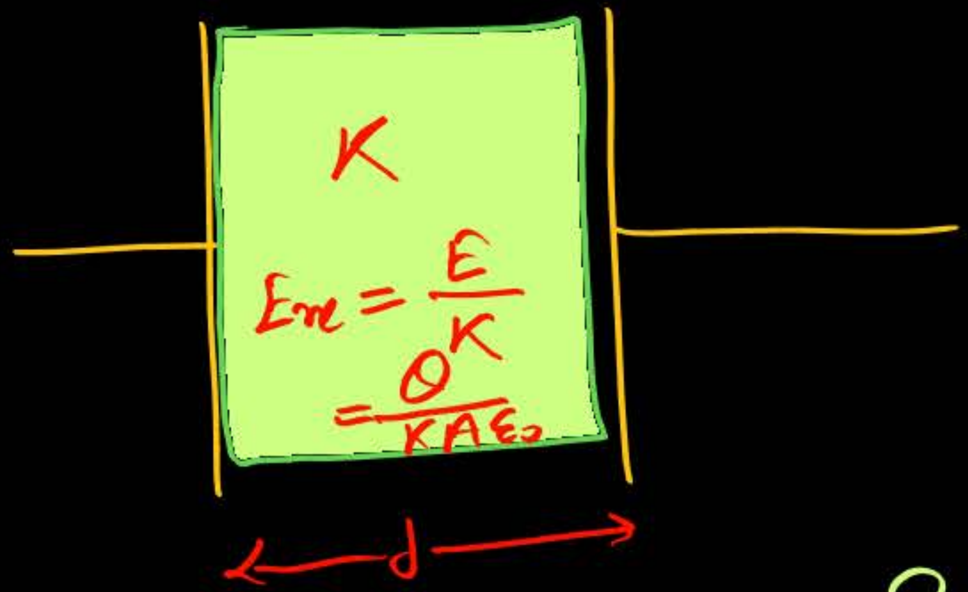


#Now easy


air medium
E


K-dielectric cofn.
E net = E/K





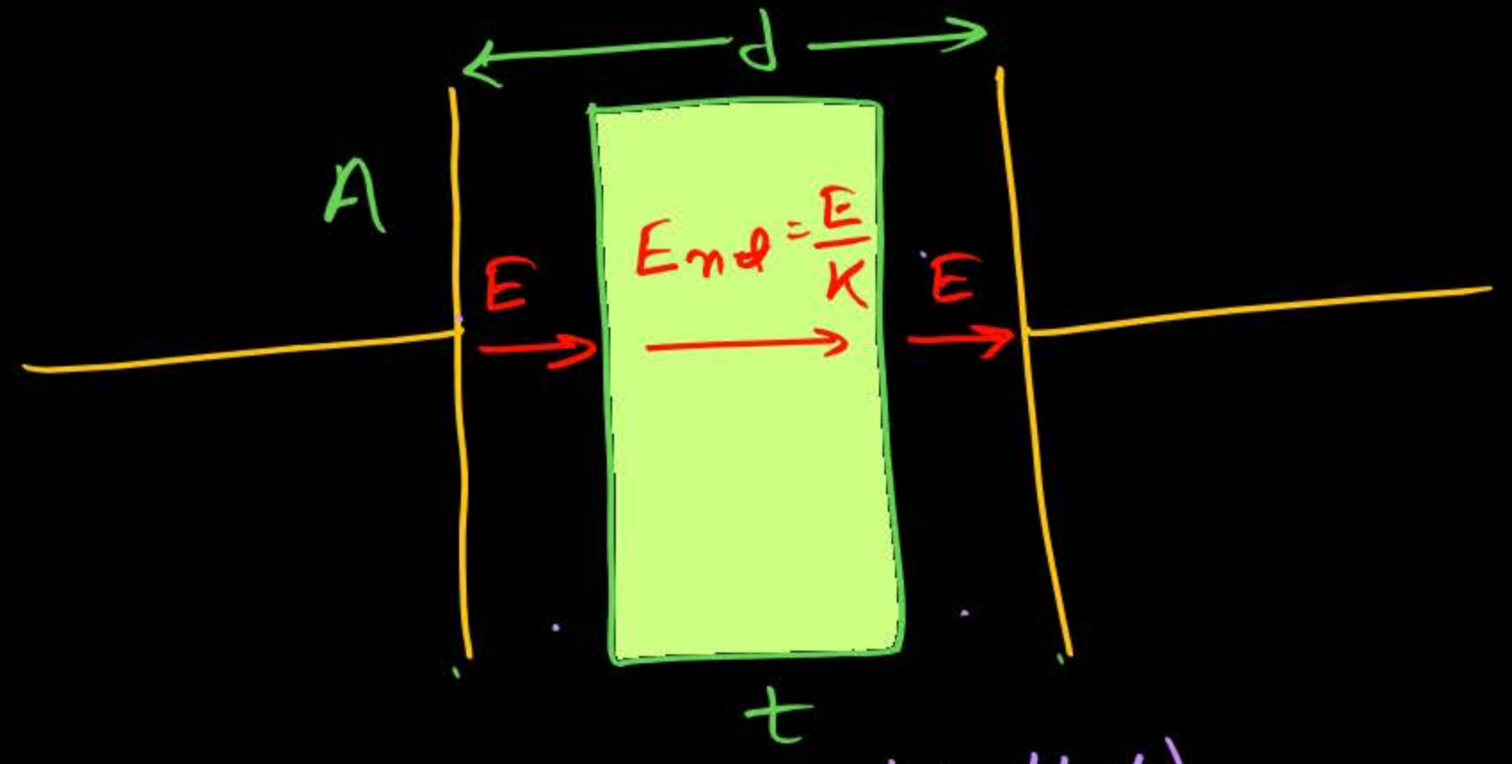
$$\Delta V = E \times d = \frac{Qd}{KA\varepsilon_0}$$

$$C = \frac{Q}{\Delta V} = \frac{Q}{\frac{Qd}{KA\varepsilon_0}}$$

$$C = \frac{K\varepsilon_0 A}{d} = K C_0$$

C_0 (air medium)

in medium =



$d_{air} = (d - t)$

$$\Delta V = E(d-t) + \frac{E}{K}t$$

$$\Delta V = E\left[d - t + \frac{t}{K}\right]$$

$$\Delta V = \frac{Q}{A\varepsilon_0}\left(d - t + \frac{t}{K}\right)$$

$$C = \frac{Q}{\Delta V}$$

$$= \frac{Q}{\frac{Q}{A\varepsilon_0}\left(d - t + \frac{t}{K}\right)}$$

$$C = \frac{\varepsilon_0 A}{(d-t) + \frac{t}{K}}$$

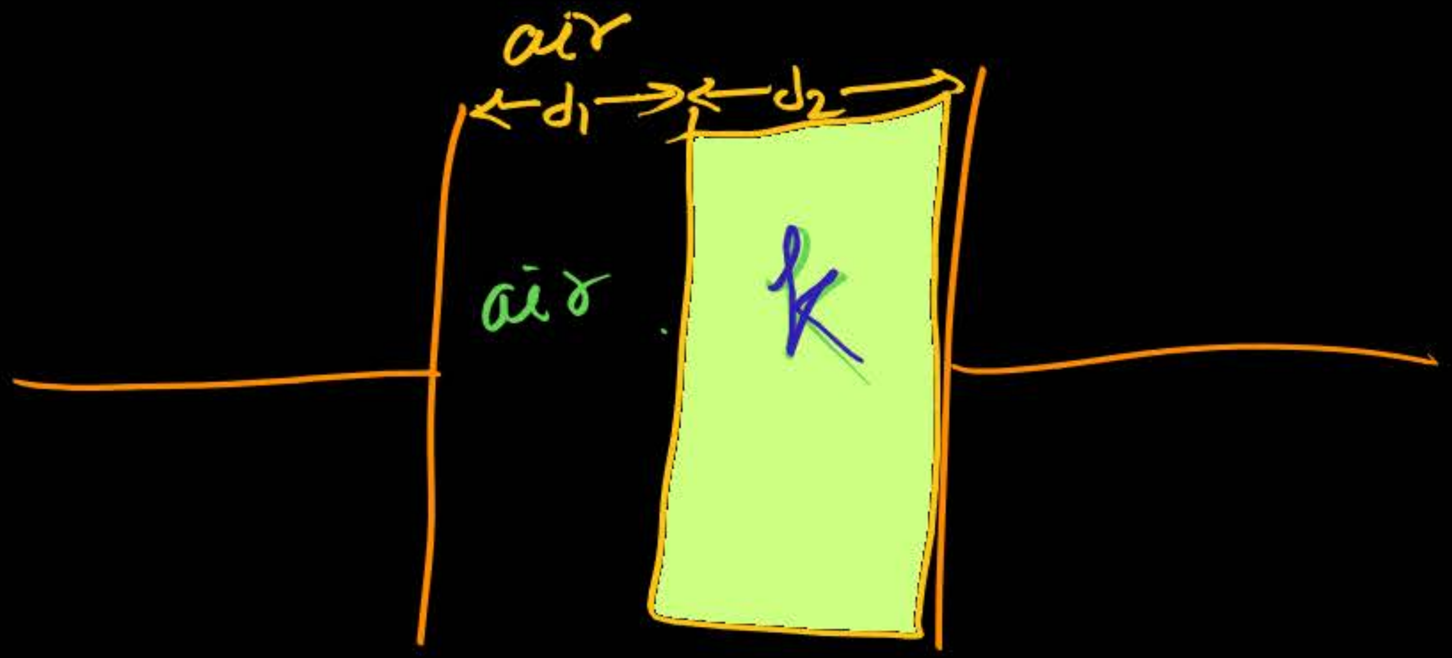
No need to remember

☆ If $t = 0$

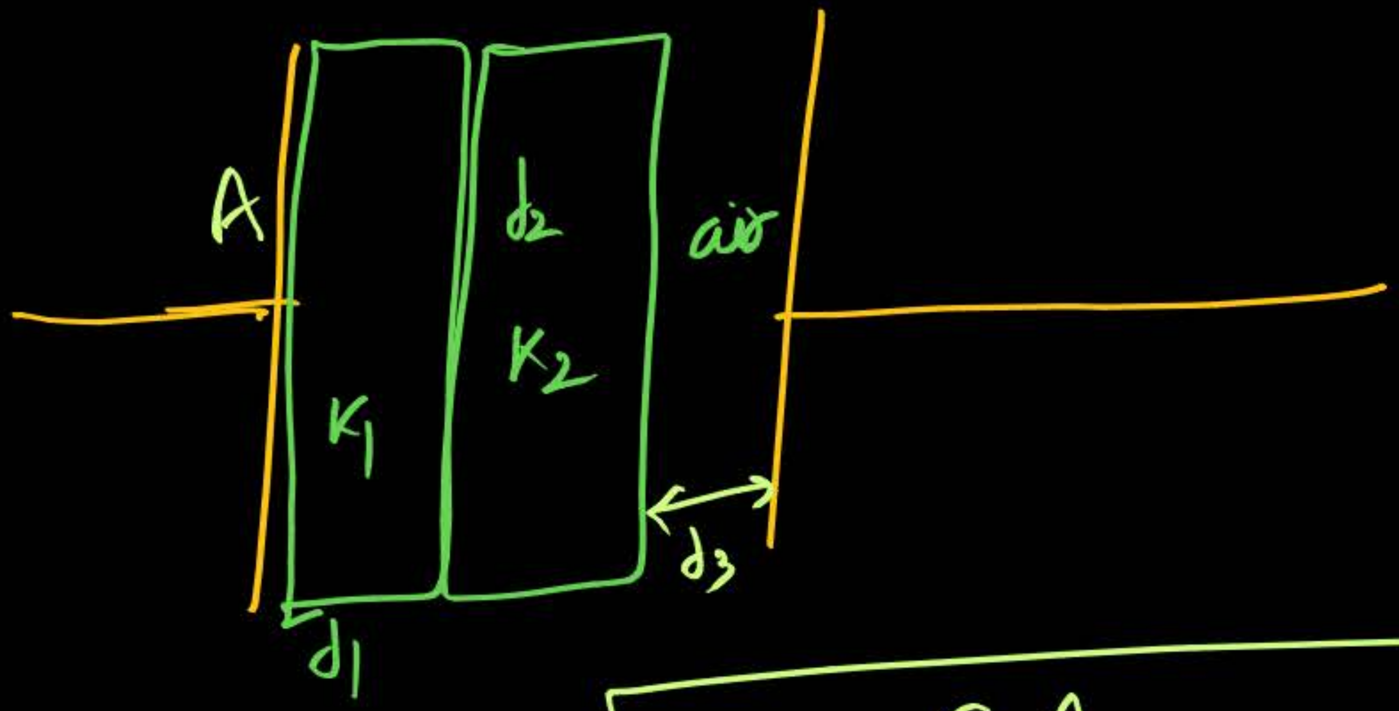
$$C = \frac{\varepsilon_0 A}{d}$$

If $t = d$

$$C = \frac{\varepsilon_0 A}{t/K} = \frac{K\varepsilon_0 A}{t}$$



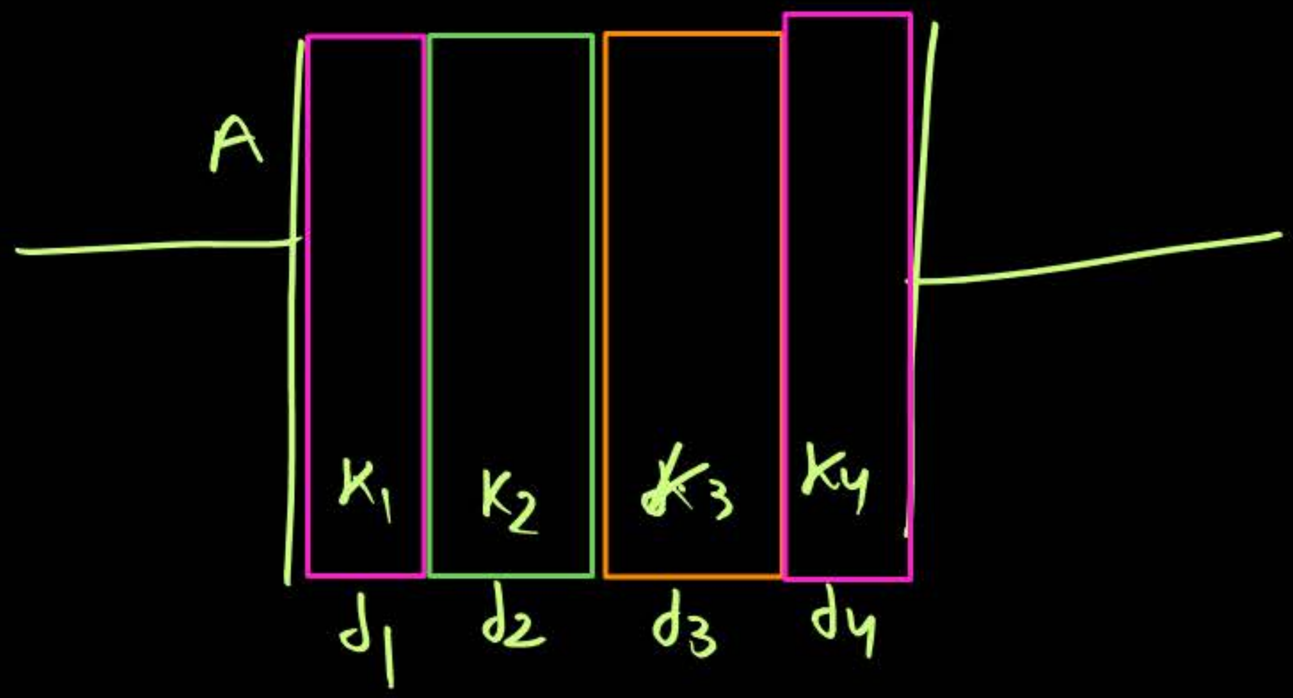
$$C = \frac{\varepsilon_0 A}{\frac{d_1}{1} + \frac{d_2}{K}}$$



$$C = \frac{\varepsilon_0 A}{\frac{d_1}{K_1} + \frac{d_2}{K_2} + \frac{d_3}{1}}$$

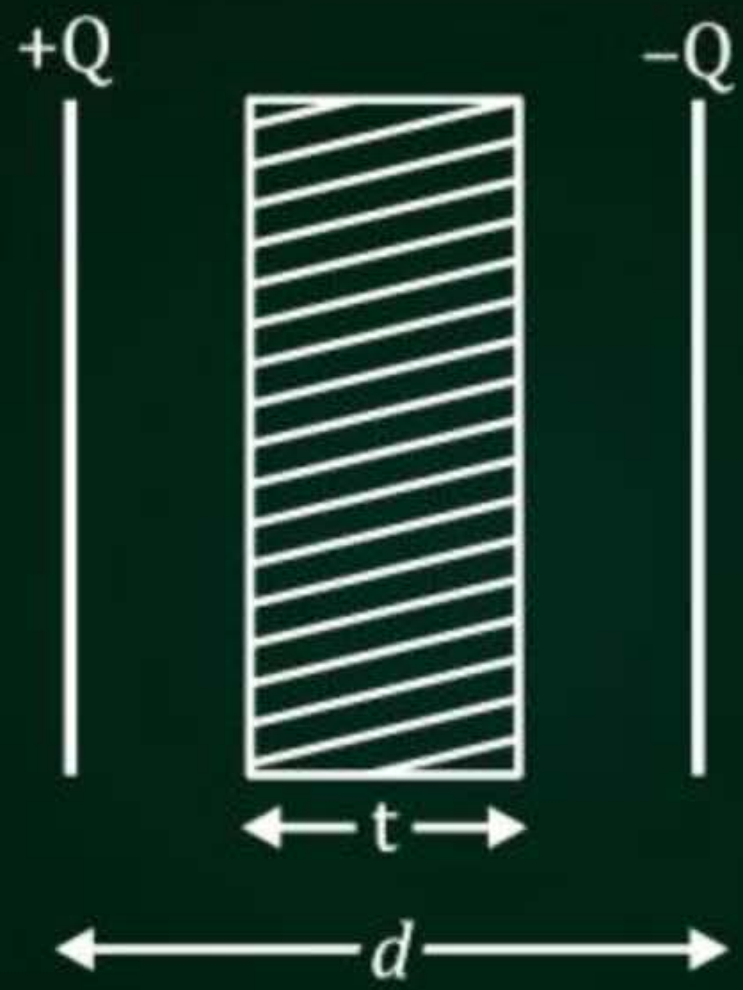
#

Series combination of di-electric



$$C = \frac{\varepsilon_0 A}{\frac{d_1}{K_1} + \frac{d_2}{K_2} + \frac{d_3}{K_3} + \frac{d_4}{K_4}}$$

- Effect of dielectric slab paced between parallel plate capacitor.



QUESTION

A parallel plate air capacitor has capacitance C. Half of space between the plates is filled with dielectric of dielectric constant K as shown in figure. The new capacitance is C′. Then



1. $C' = C\left[\frac{K}{K+1}\right]$
2. $C' = C\left[\frac{2K}{K+1}\right]$
3. $C' = \frac{2C}{K+1}$
4. $C' = C\left[1 + \frac{K}{2}\right]$

QUESTION

A capacitor with plate separation d is charged to V volts. The battery is disconnected and a dielectric slab of thickness $\frac{d}{2}$ and dielectric constant '2' is inserted between the plates. The potential difference across its terminals becomes

1. V
2. 2V
3. $\frac{4V}{3}$
4. $\frac{3V}{4}$


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 11 | Physics

Electrostatic Potential and Capacitance

By- Dr. Manish Raj (MR SIR)



Topics to be covered

Combination of di-electric

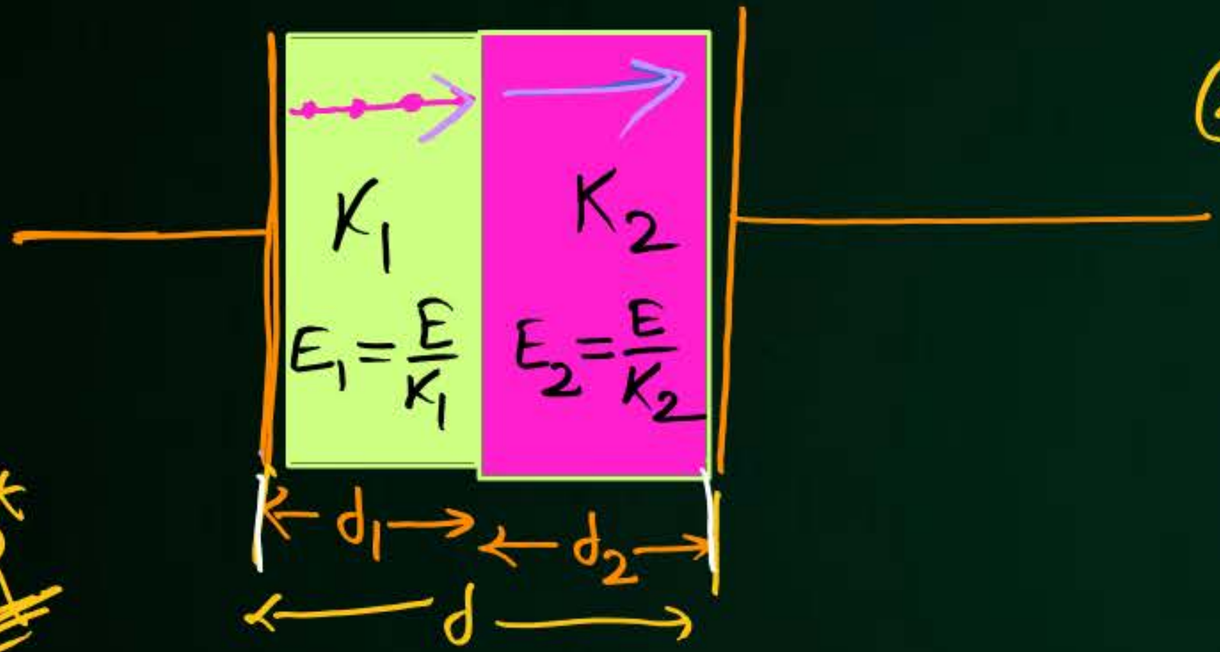
→ mixed combination of capacito

1. #
2. #
3. #



SERIES COMBINATION OF DIELECTRIC

→ A = Area, same for all



MR*

(1)

$$C_{eq} = \frac{\varepsilon_0 A}{\frac{d_1}{K_1} + \frac{d_2}{K_2}}$$

A = same

$$C = \frac{K\varepsilon_0 A}{d}$$

(2) find equivalent dielectric const^n

$$C = \frac{K_{eq}\varepsilon_0 A}{d} = \frac{\varepsilon_0 A}{\frac{d_1}{K_1} + \frac{d_2}{K_2}}$$

$$K_{eq} = \frac{d}{\frac{d_1}{K_1} + \frac{d_2}{K_2}}$$

If $d_1 = d_2 = d/2$

Series combination →

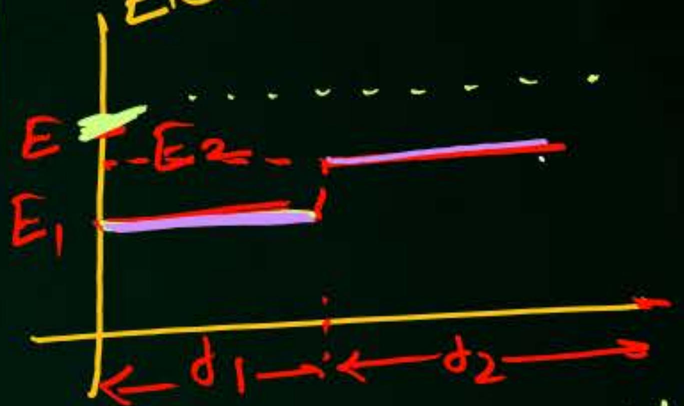
$$K_{eq} = \frac{d}{\frac{d}{2}\left[\frac{1}{K_1} + \frac{1}{K_2}\right]} = \frac{2K_1K_2}{K_1 + K_2}$$

If $K_1 = K_2 = K$

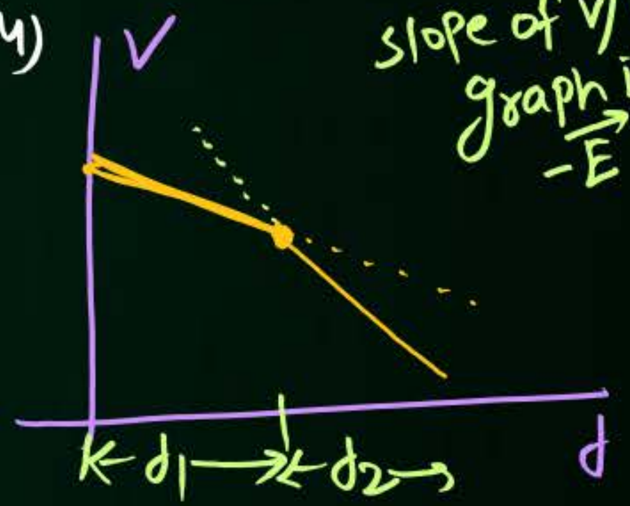
$$K_{eq} = \frac{2K^2}{2K}$$

$$K_{eq} = K$$

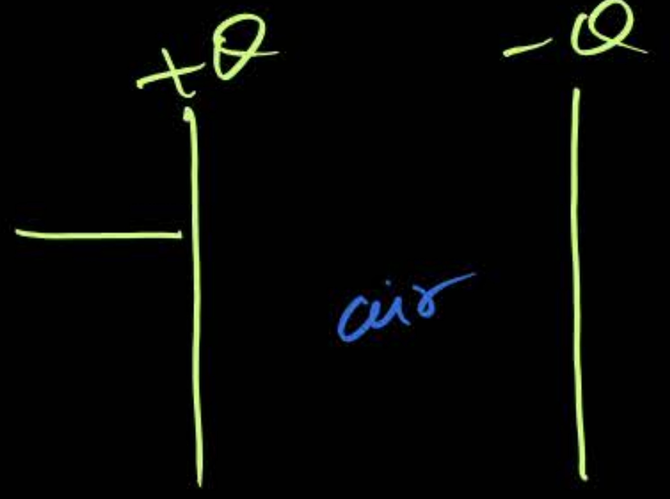
(3) If $K_1 > K_2$



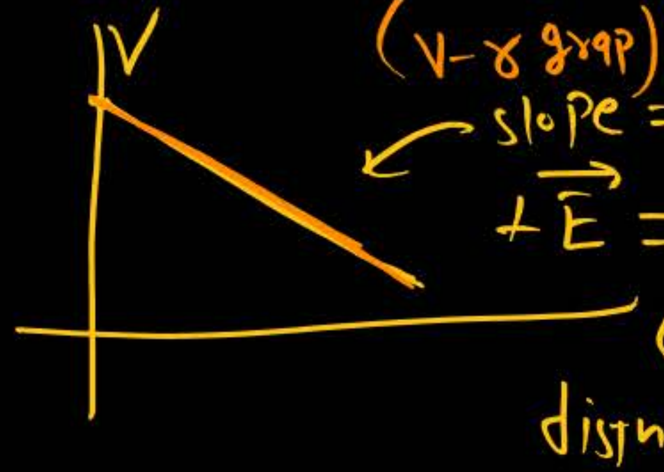
(4)



slope of V/d graph is $-\vec{E}$





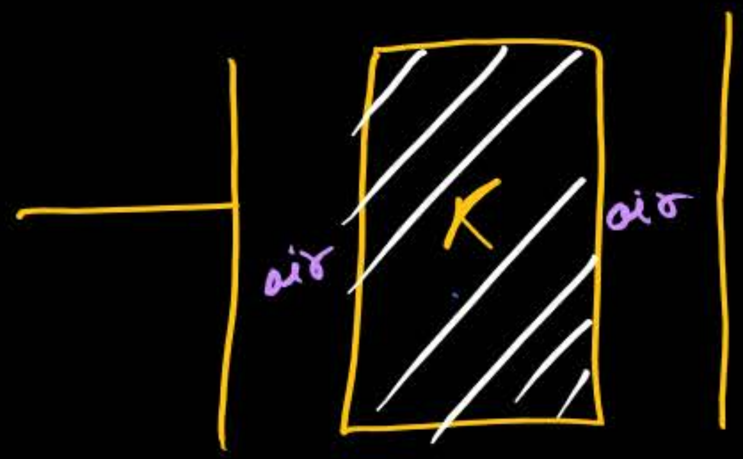


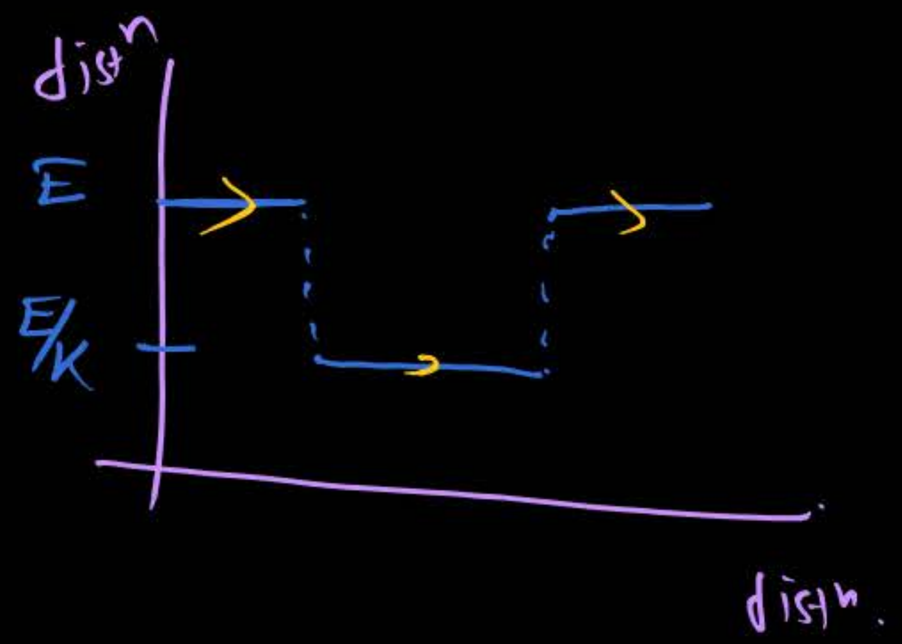
(V-r graph)

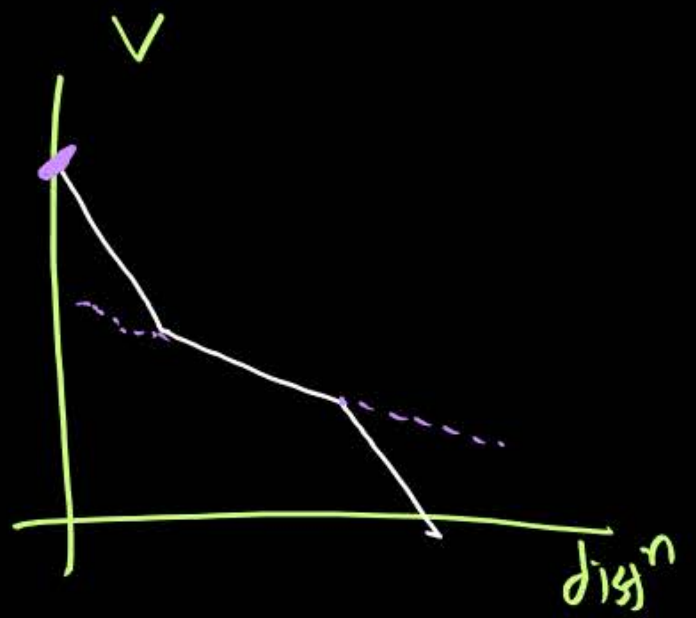
slope = -ve × cotn

$+\vec{E}$ = +ve cst

$\vec{E}$ = +ve cotn ✓



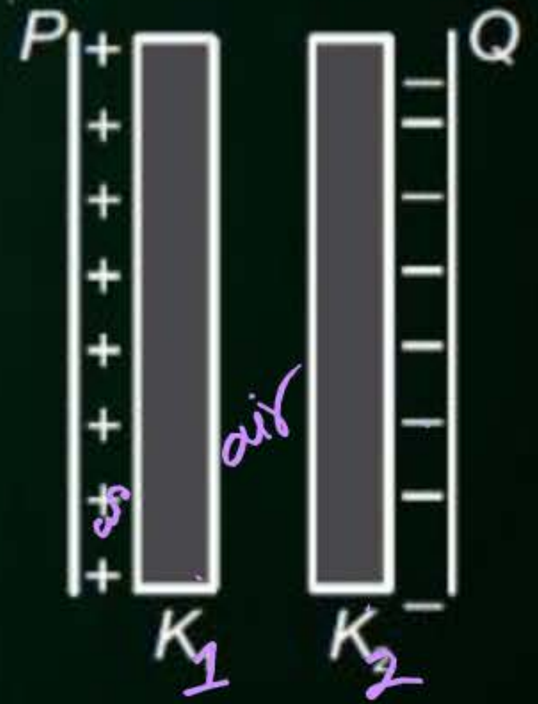


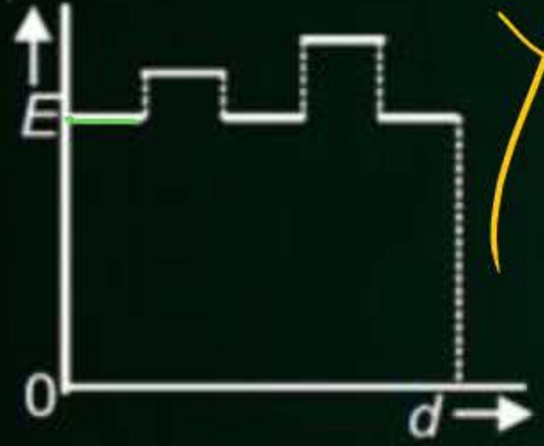


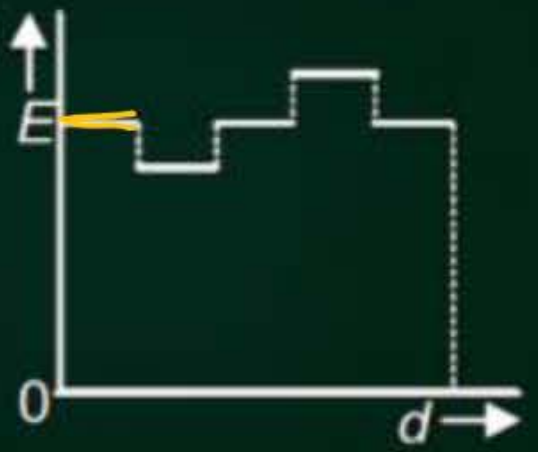
QUESTION

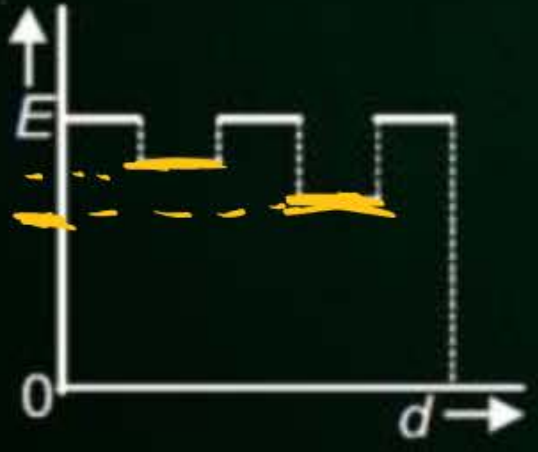
Two thin dielectric slabs of dielectric constants K_1 and K_2 $(K_1 < K_2)$ are inserted between plates of a parallel plate capacitor, as shown in the figure. The variation of electric field E between the plates with distance d as measured from plate P is correctly shown by

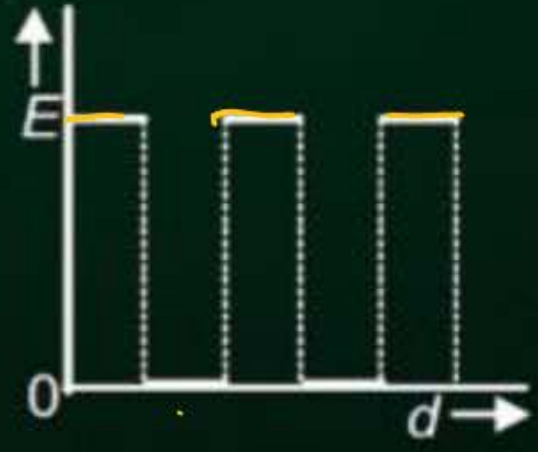
[AIPMT-2014]

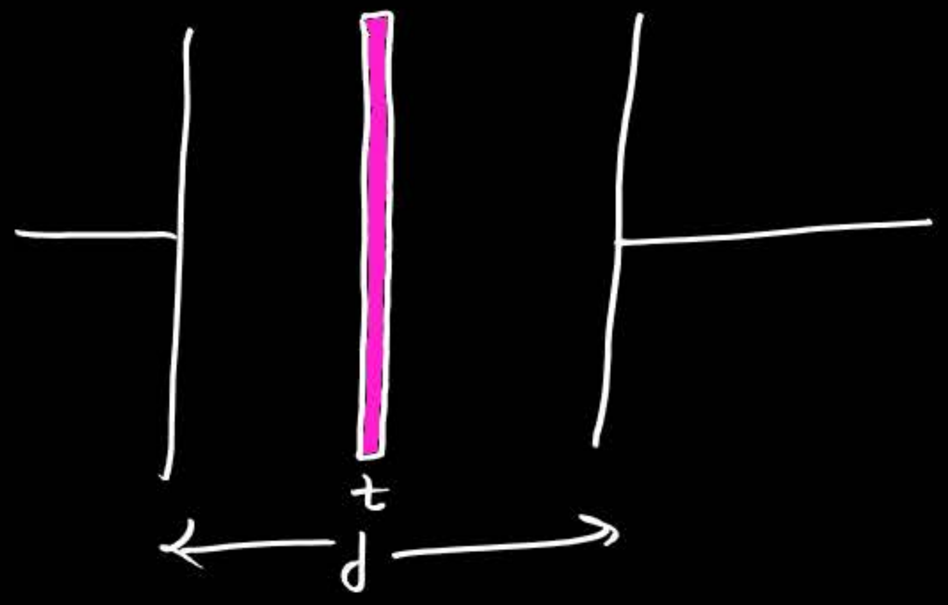


1. 

2. 

3. 

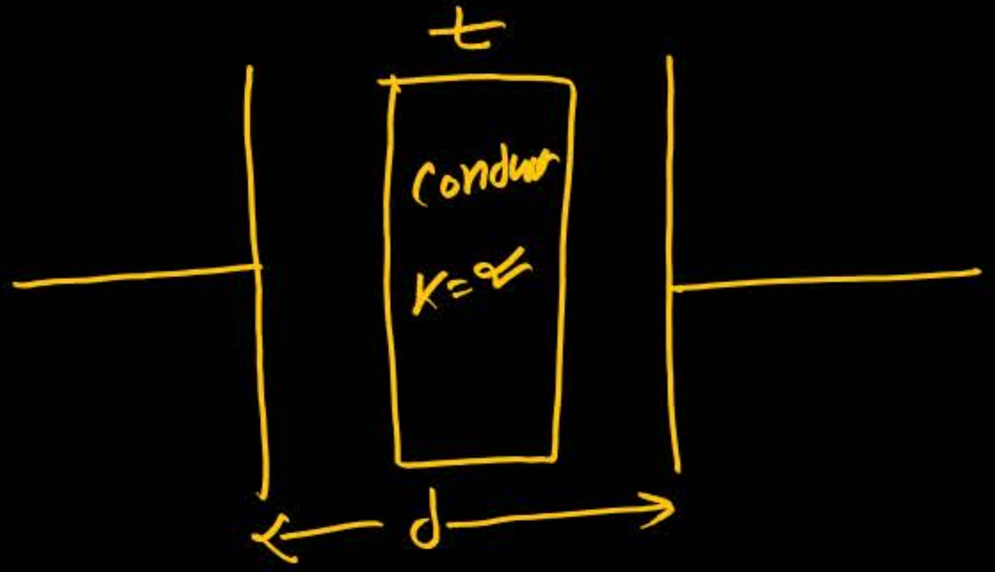
4. 



$t <<< d$ (thin conducting sheet is placed inside capacitor plate)

$$C' = \frac{\varepsilon_0 A}{\frac{(d-t)}{1} + \frac{t}{\infty}}$$

$$C' = \frac{\varepsilon_0 A}{d-t} = \frac{\varepsilon_0 A}{d} \text{ (remains const)}$$



Thick conductor placed inside capacitor

$$C_0(\text{air}) = \frac{\varepsilon_0 A}{d}$$

Complete air medium

$$C' = \frac{\varepsilon_0 A}{\frac{(d-t)}{1} + \frac{t}{\infty}}$$

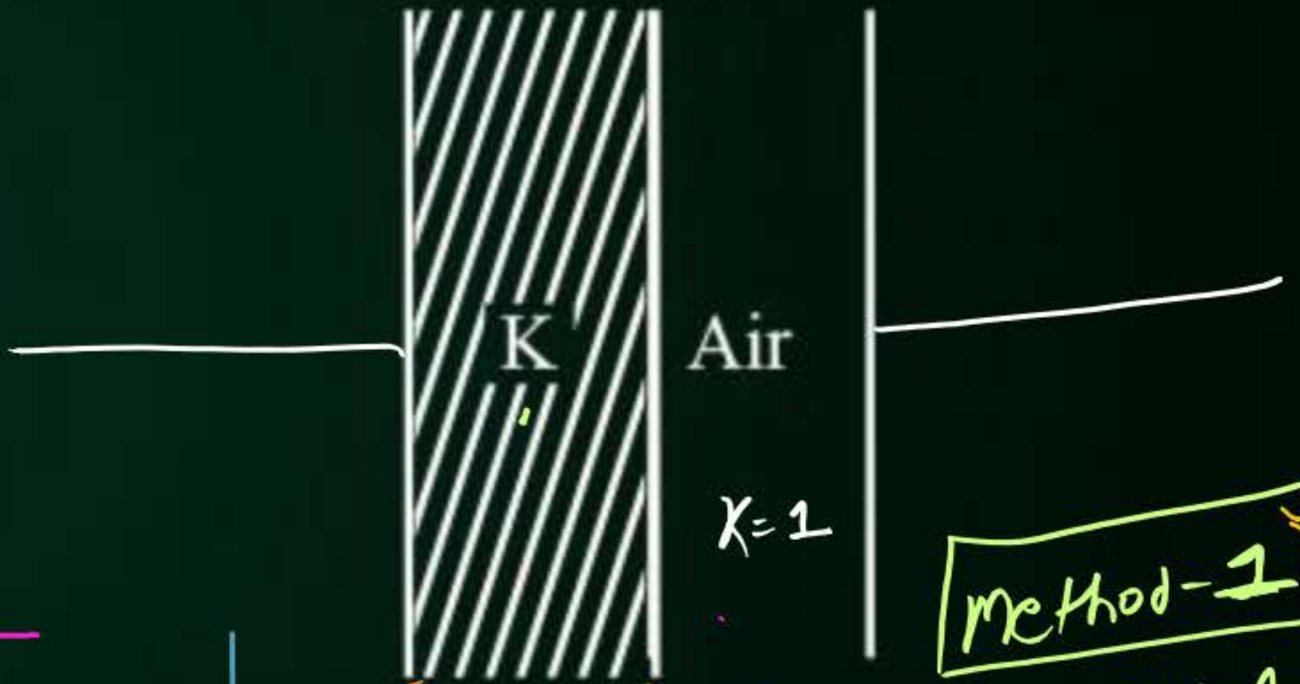
$$C' = \frac{\varepsilon_0 A}{(d-t)}$$

(decrease)

(capacitance will increase)

QUESTION

A parallel plate air capacitor has capacitance C. Half of space between the plates is filled with dielectric of dielectric constant K as shown in figure. The new capacitance is C′. Then



1. $C' = C\left[\frac{K}{K+1}\right]$
2. $C' = C\left[\frac{2K}{K+1}\right]$
3. $C' = \frac{2C}{K+1}$
4. $C' = C\left[1+\frac{K}{2}\right]$

QUESTION

An air filled parallel plate condenser has a capacity of 2 pF. The separation of the plates is doubled and the interspace between the plates is filled with wax. If the capacity is increased to 6 pF, the dielectric constant of wax is

1. 2
2. 3
3. 4
4. 6

Ans

$C = 2\,pF \rightarrow C' = 6\,\mu f$

$2\,pf = \frac{\varepsilon_0 A}{d}$

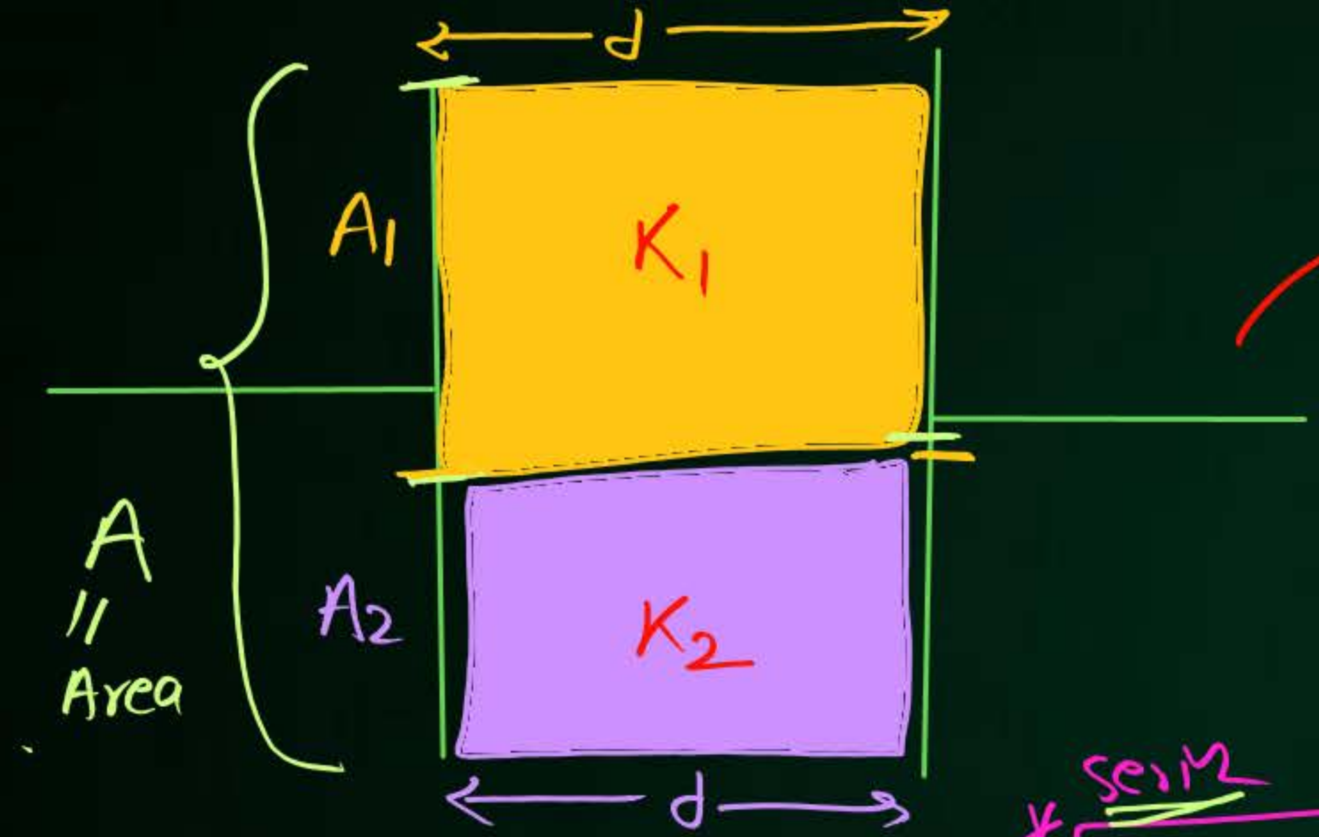


$C' = 6\,\mu f = \frac{K \varepsilon_0 A}{2d}$

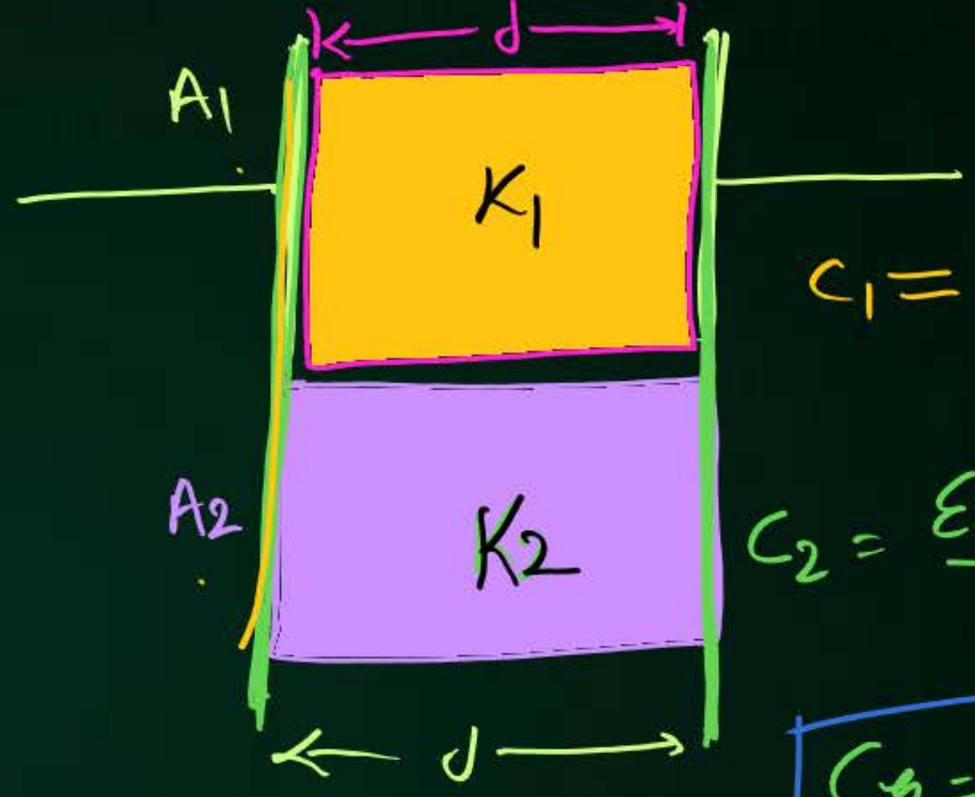
$6 = \frac{K}{2} \times 2$

Area = different / d = same

➤ Dielectrics slab placed between capacitor in parallel combination.



The mR*



$$C_1 = \frac{\varepsilon_0 A_1 K_1}{d}$$

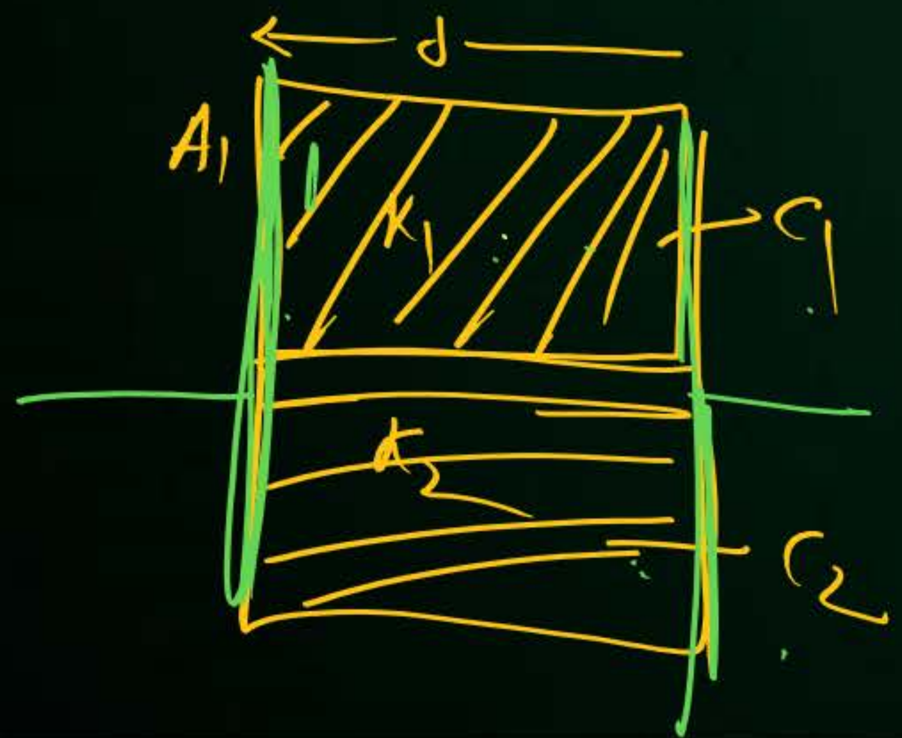
+

$$C_2 = \frac{\varepsilon_0 A_2 K_2}{d}$$

Parallel

$$C_{eq} = C_1 + C_2$$

$$= \frac{\varepsilon_0}{d}\left[A_1K_1 + A_2K_2\right]$$



Series

$$C = \frac{\varepsilon_0 A}{\frac{d_1}{K_1} + \frac{d_2}{K_2}}$$

Parallel

$$C = \frac{\varepsilon_0 (A_1K_1 + A_2K_2)}{d}$$

K_{eq} in Parallel combination

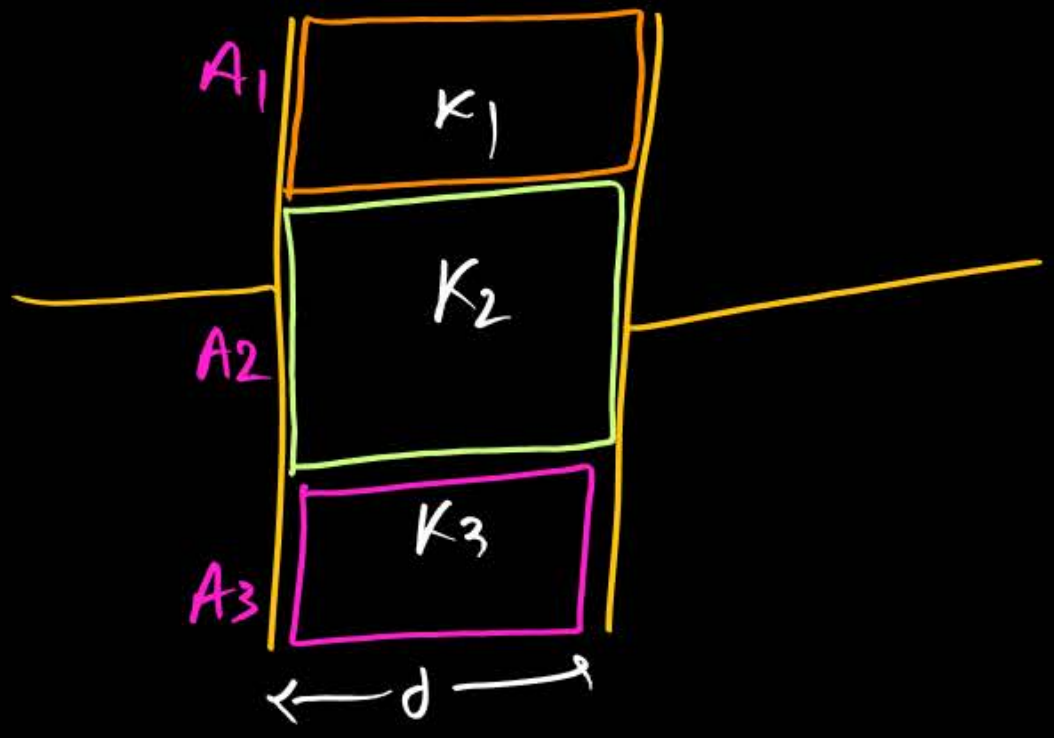
$$C = \frac{\varepsilon_0 (A_1 K_1 + A_2 K_2)}{d} = \frac{K_{eq}\,\varepsilon_0 A}{d}$$

$$K_{eq} = \frac{A_1 K_1 + A_2 K_2}{A}$$

If $A_1 = A_2 = A/2$

$$K_{eq} = \frac{\frac{A}{2}(K_1 + K_2)}{A}$$

$$K_{eq} = \frac{K_1 + K_2}{2}$$



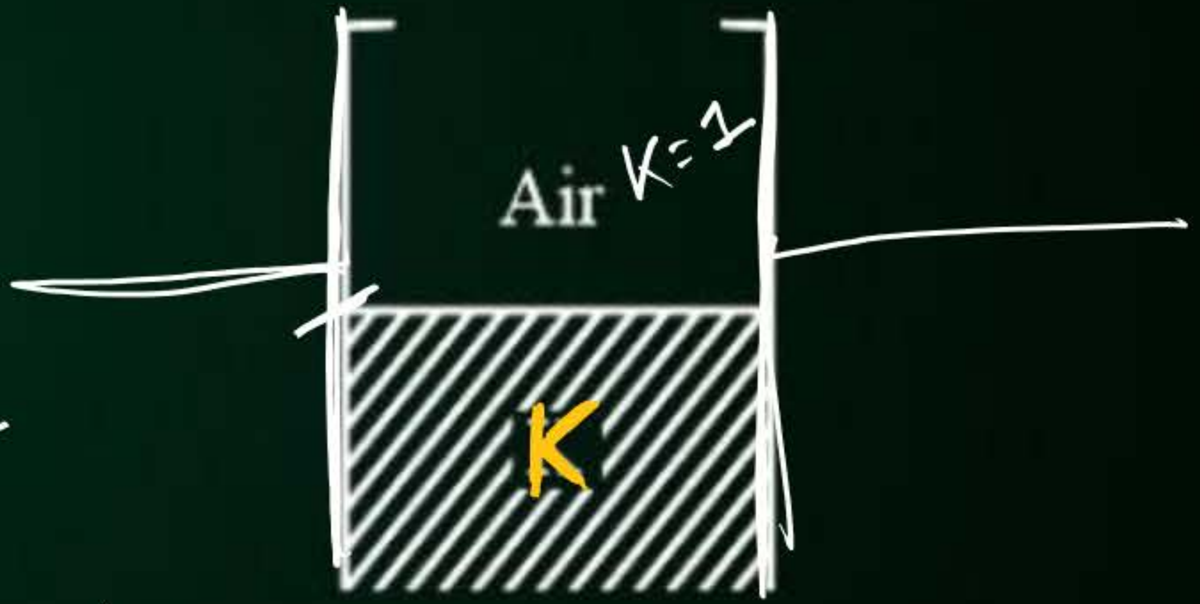
$$C_{eq} = \frac{\varepsilon_0}{d}(A_1 K_1 + A_2 K_2 + A_3 K_3)$$

$$K_{eq} = \frac{A_1 K_1 + A_2 K_2 + A_3 K_3}{A_1 + A_2 + A_3}$$

QUESTION

A parallel plate air capacitor has capacitance C. Now half of the space is filled with a dielectric material with dielectric Constant K as shown in figure. The new capacitance is C. Then

1. $C' = \frac{C}{2}[1 + K]$
2. $C' = C[1 + K]$
3. $C' = C\left[1 + \frac{K}{2}\right]$
4. $C' = C\left[\frac{1}{2} + K\right]$

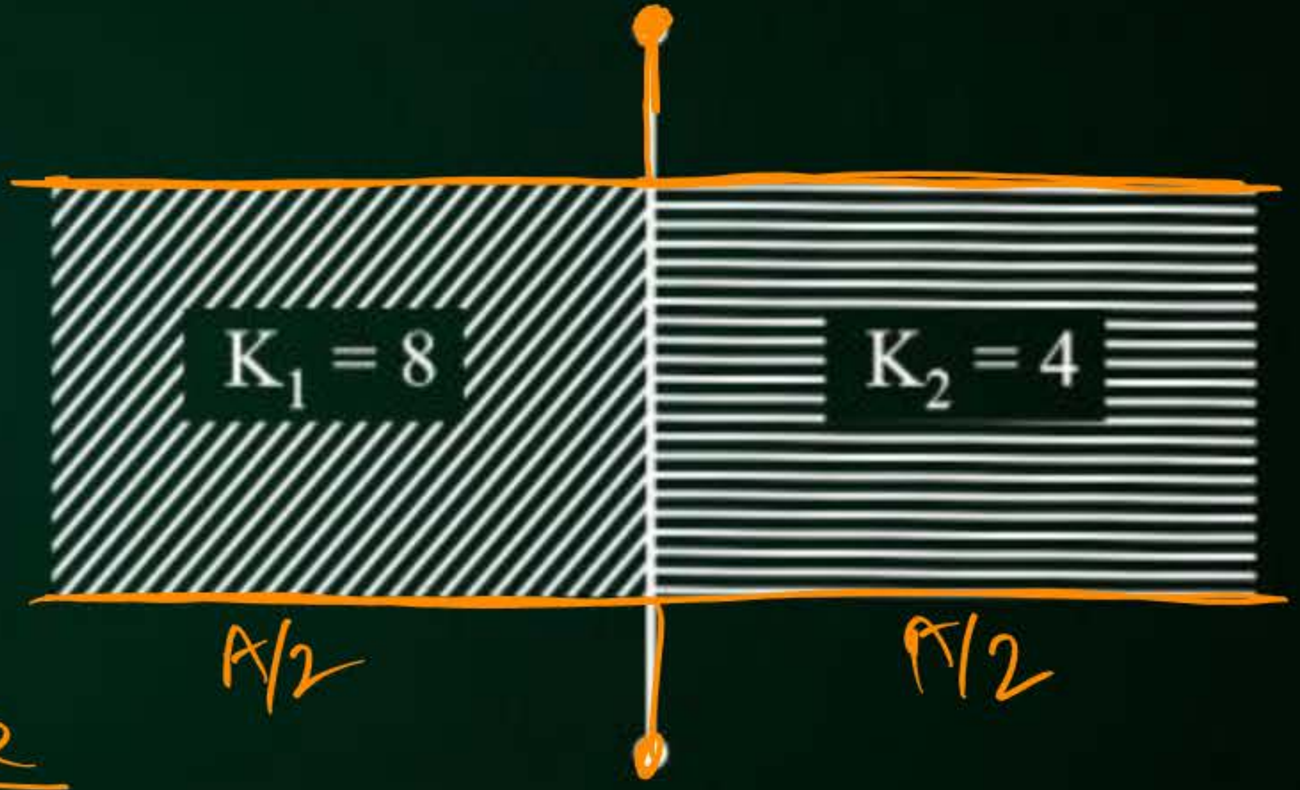


QUESTION

A capacitor having capacitance 1 μF with air, is filled half-half with two dielectrics as shown. How many times capacitance will become?

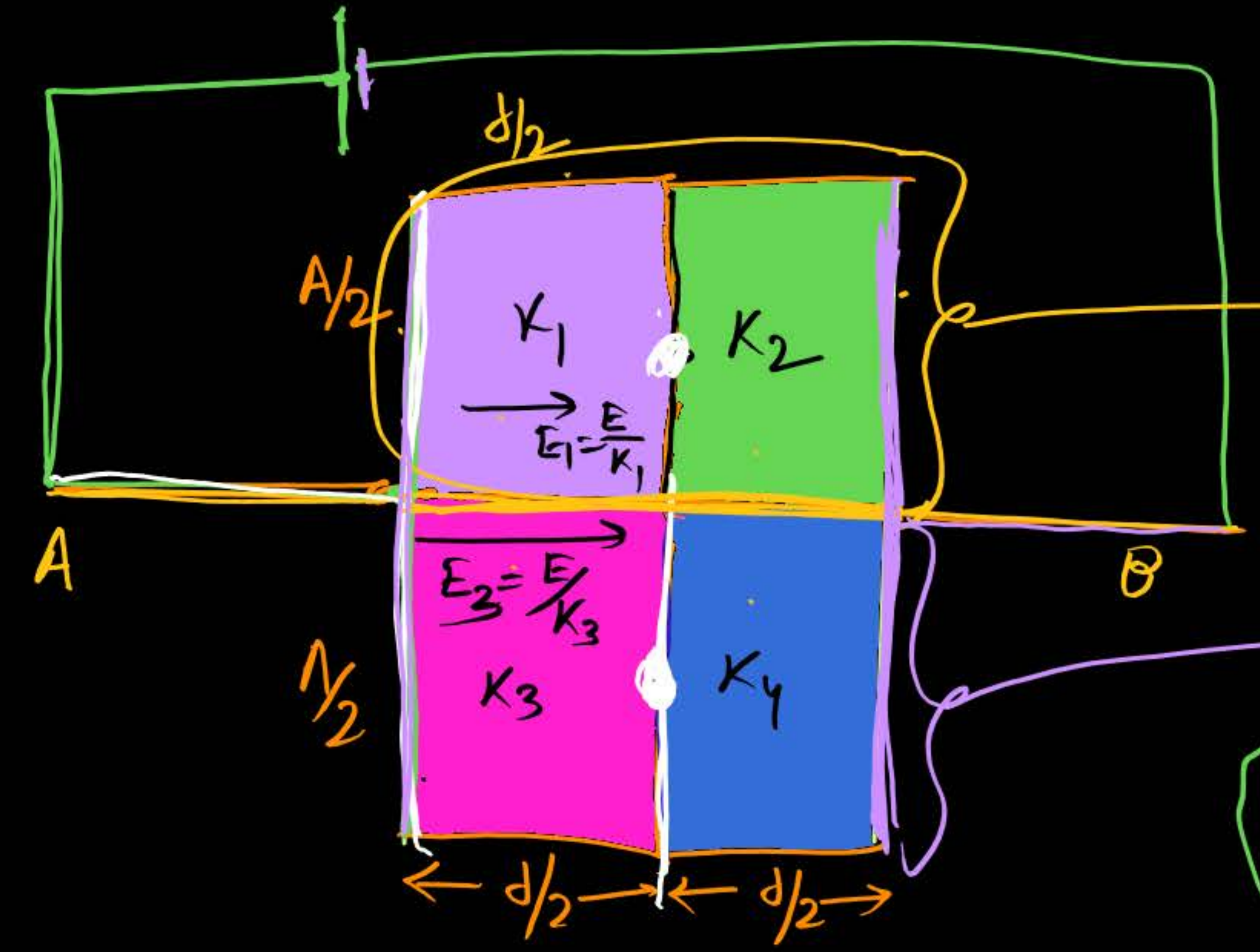
1. 12
2. 6
3. 8/3
4. 3

$C_m = K_{eq} C$



$K_{eq} = \frac{K_1 + K_2}{2}$

$= \frac{8+4}{2} = 6$



find C_{eq} = ??

$$C_1 = \frac{\varepsilon_0 A}{2\left[\frac{d}{2K_1} + \frac{d}{2K_2}\right]} = \frac{\varepsilon_0 A}{d/K_1 + d/K_2}$$

(K_1 & K_2 are in series)

$$C_2 = \frac{\varepsilon_0 A}{2\left(\frac{d}{2K_3} + \frac{d}{2K_4}\right)} = \frac{\varepsilon_0 A}{\frac{d}{K_3} + \frac{d}{K_4}}$$

If $K_1 = K_2 = K_3 = K_4 = 1$
$C = \frac{\varepsilon_0 A}{d}$

Now C_1 & C_2 are in Parallel

$$C = \frac{\varepsilon_0 A}{d\left(\frac{1}{K_1} + \frac{1}{K_2}\right)} + \frac{\varepsilon_0 A}{d\left(\frac{1}{K_3} + \frac{1}{K_4}\right)}$$

$$C = \frac{\varepsilon_0 A}{d}\left(\frac{K_1 K_2}{K_1 + K_2} + \frac{K_3 K_4}{K_3 + K_4}\right)$$

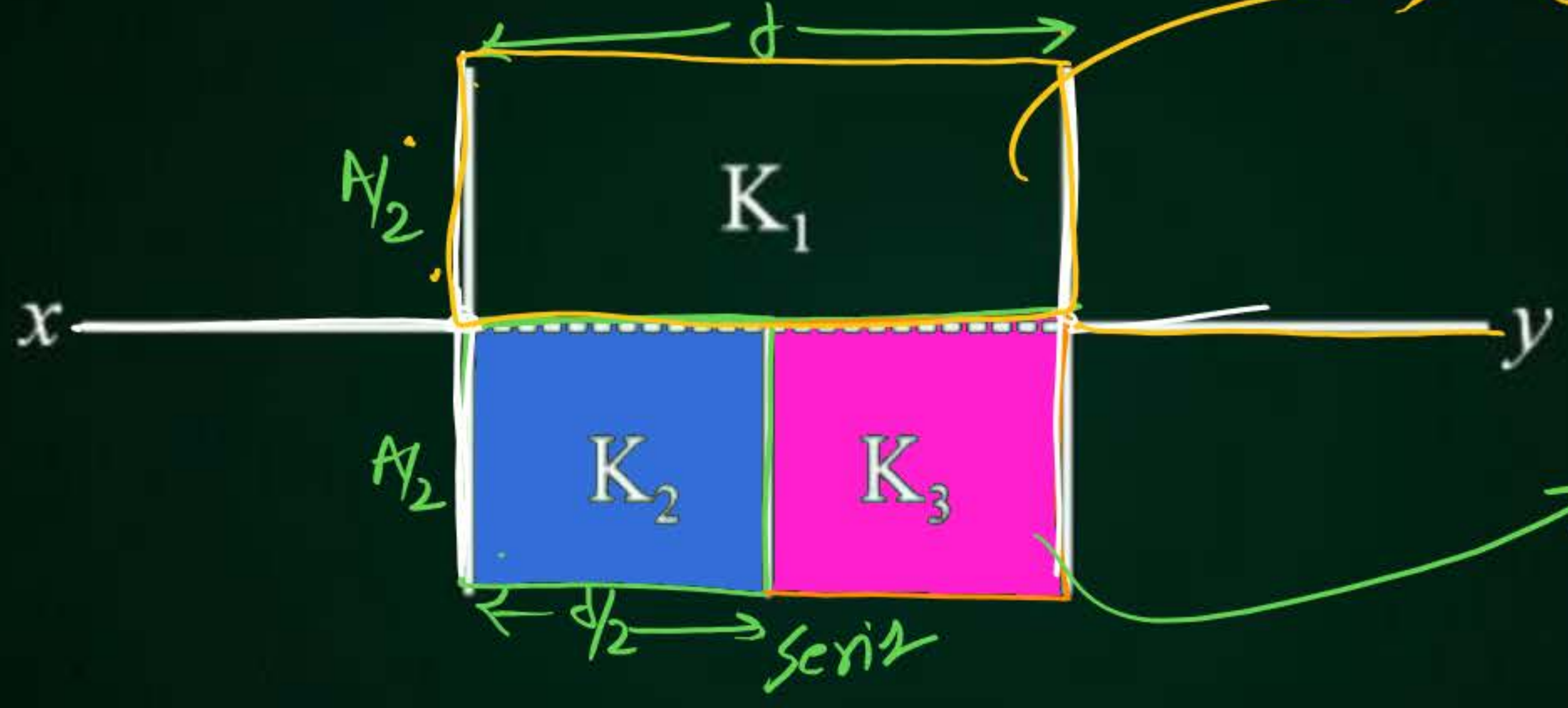
(Q) Is K_1 & K_3 are Parallel to each other.

→ (a) yes ✗

(b) No (27%)

$$K_{eq} = \frac{K_1 K_2}{K_1 + K_2} + \frac{K_3 K_4}{K_3 + K_4}$$

Calculate Capacitance Between x and y



$$C_1 = \frac{\varepsilon_0 A K_1}{2d}$$

$$C_2 = \frac{\varepsilon_0 A}{2\left[\frac{d}{2K_3} + \frac{d}{2K_2}\right]}$$

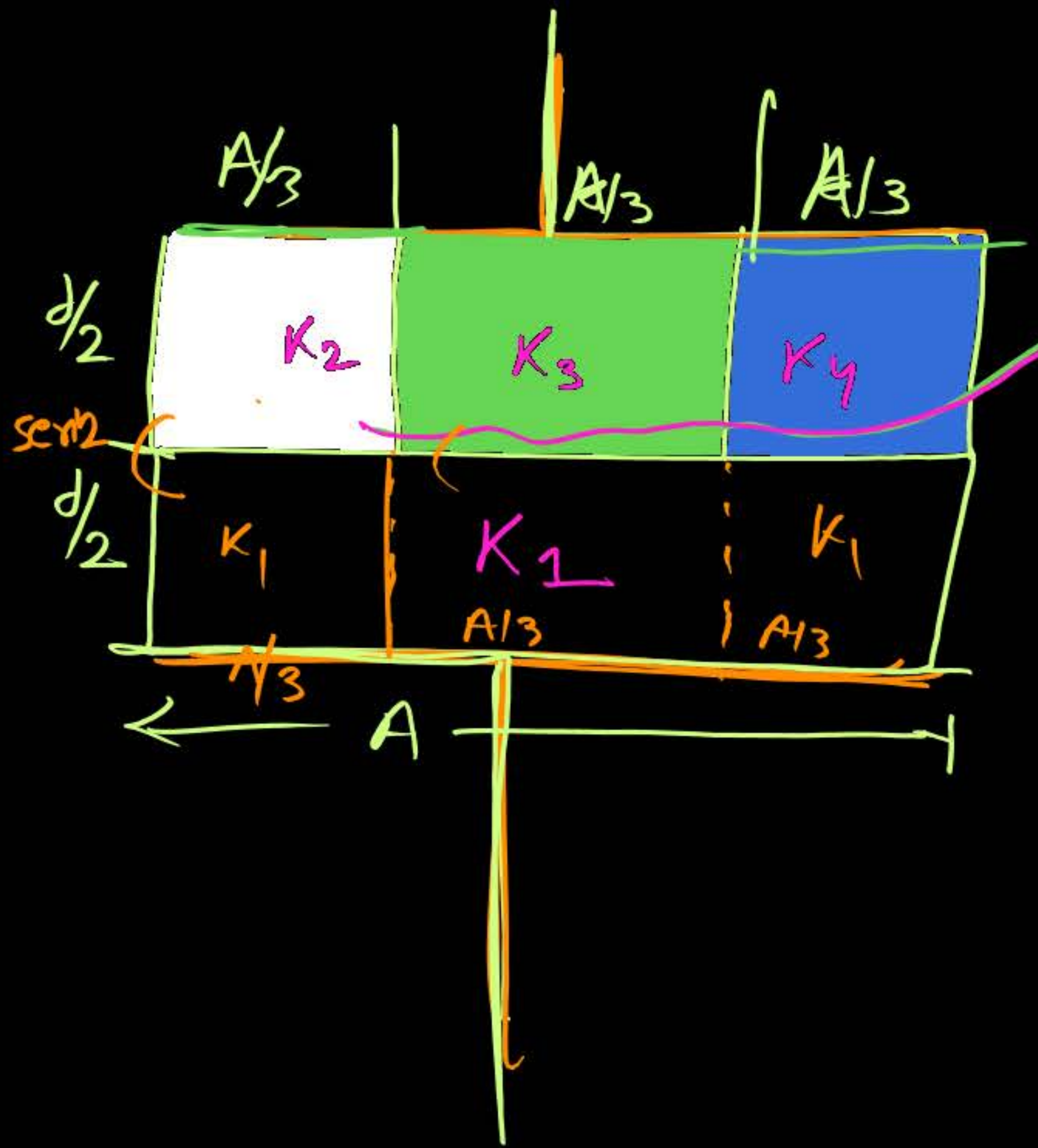
$$C_2 = \frac{\varepsilon_0 A}{d\left[\frac{1}{K_3} + \frac{1}{K_2}\right]}$$

C_1 & C_2 are in Parallel

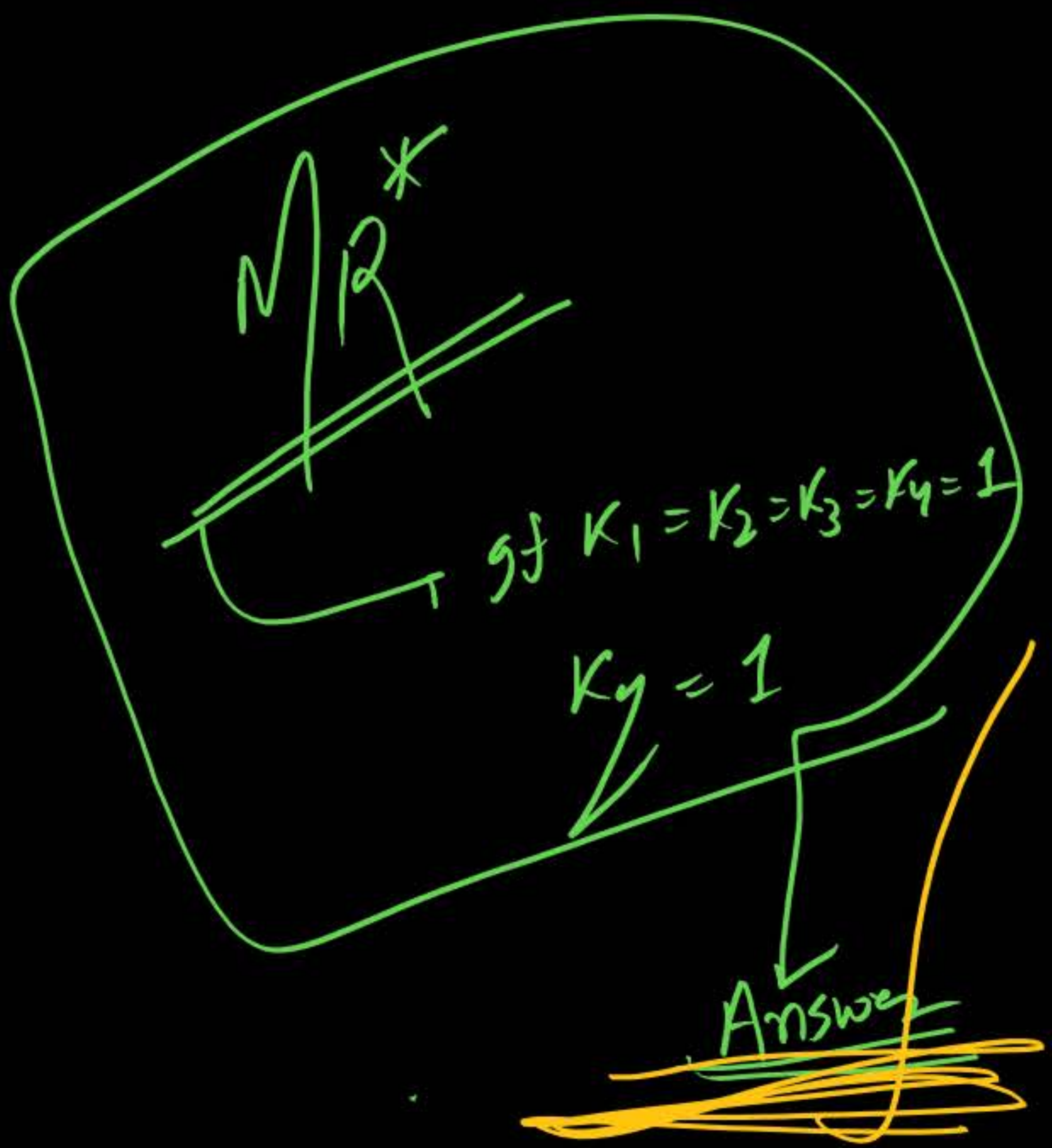
$$C_{eq} = \frac{\varepsilon_0 A K_1}{2d} + \frac{\varepsilon_0 A}{d\left[\frac{K_3 + K_2}{K_3 K_2}\right]} = \frac{\varepsilon_0 A}{d}\left[\frac{K_1}{2} + \frac{K_2 K_3}{K_2 + K_3}\right]$$

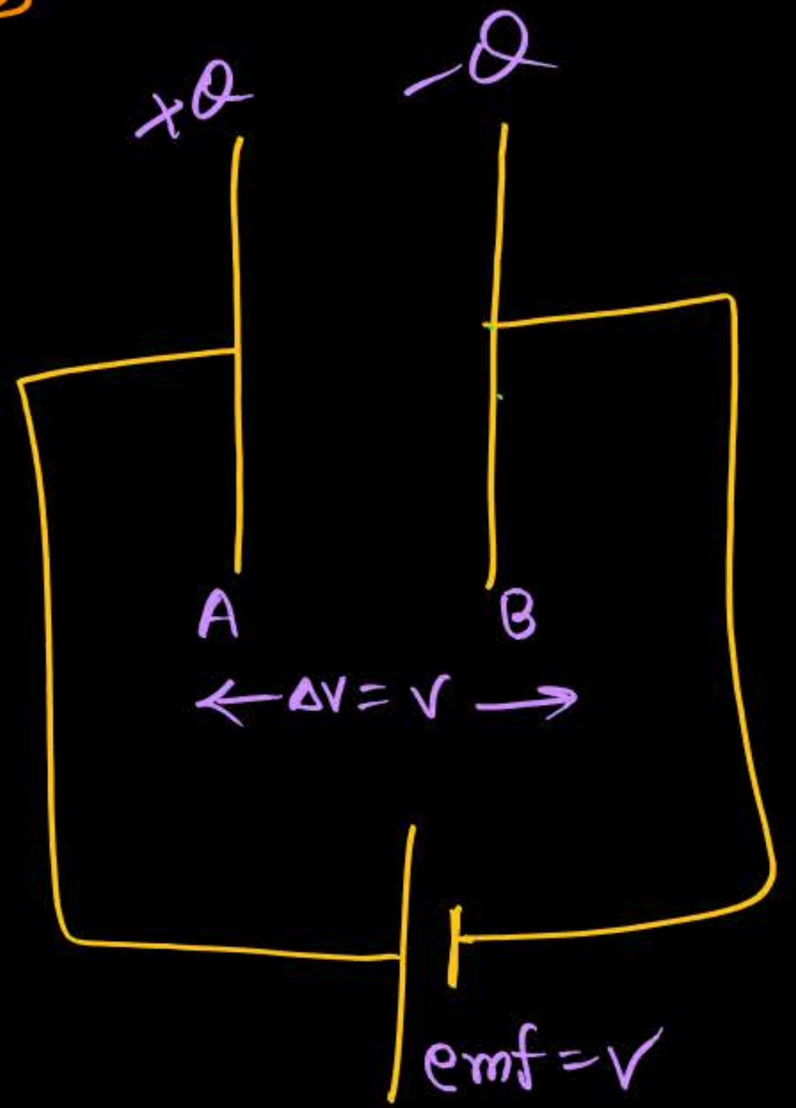
AIPMT-2015

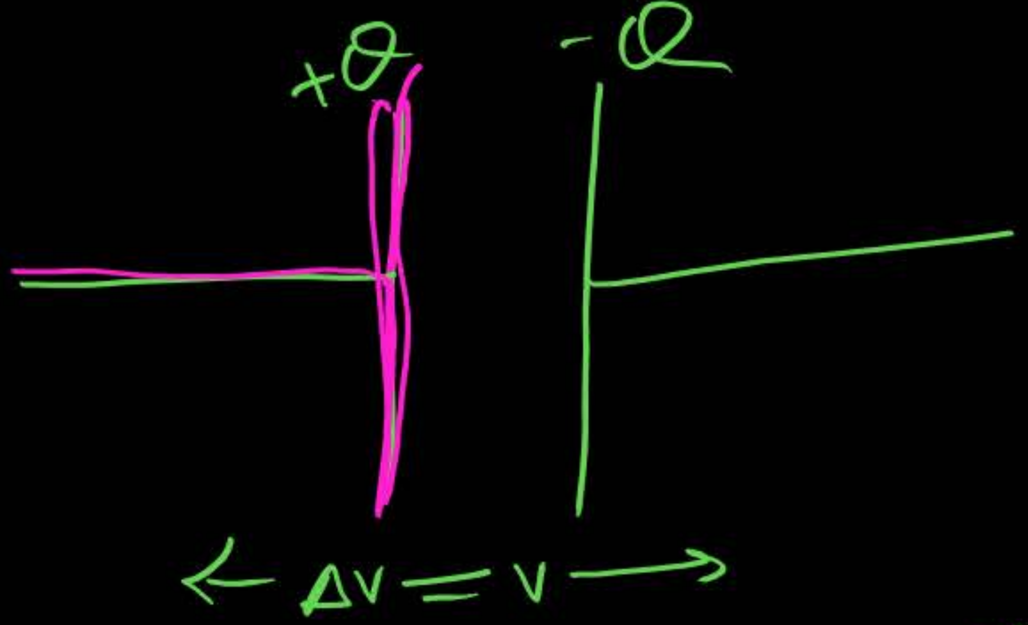
$K_{eq} = ??$



K_2, K_3 & K_4 → are not in parallel







* Battery removed & dielectric placed.

charge = same

Potential = change

Battery remains connected → Potential maintain (constant)

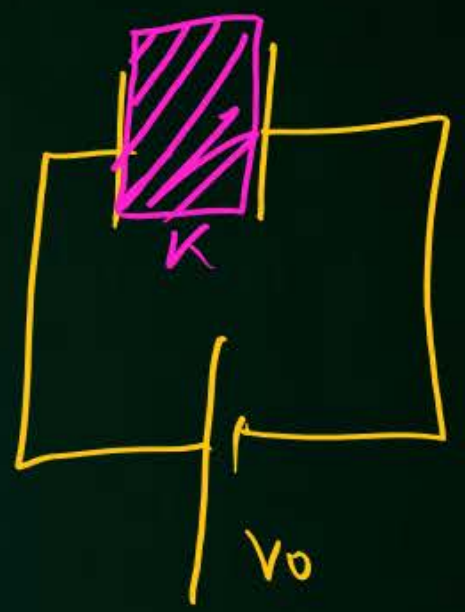
— Q → Battery can transfer charge

QUESTION

Capacitor of capacitance C_0 is charged by a battery of emf V_0, now battery remains connected and dielectric plate is placed inside it.

Physical quant	initial	final
charge	Q_0	$Q_{fin} = CV = KQ_0$
Potential	V_0	$V_f = V_0$
Capacitance	C_0	$C_f = KC_0$
energy	$U_0 = \frac{1}{2} C_0 V_0^2$ (same)	$U_f = KU_0$
Electric field	$E_0 = \left[\frac{\Delta V}{d}\right] = \frac{Q}{A\epsilon_0}$	$E_f = E_0 = \frac{Q_f}{A\epsilon_m}$ Same
force	$F_0 = QE$	$F_f = Q_f E_f = KF_0$



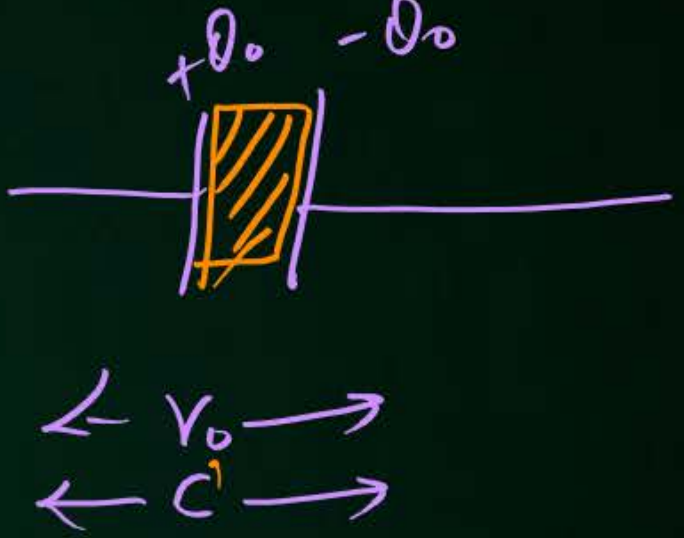


QUESTION

Capacitor of capacitance C_0 is charged by a battery of emf V_0, now battery ~~remains connected~~ (removed) and dielectric plate is placed inside it.

$Q = C\uparrow V\downarrow$

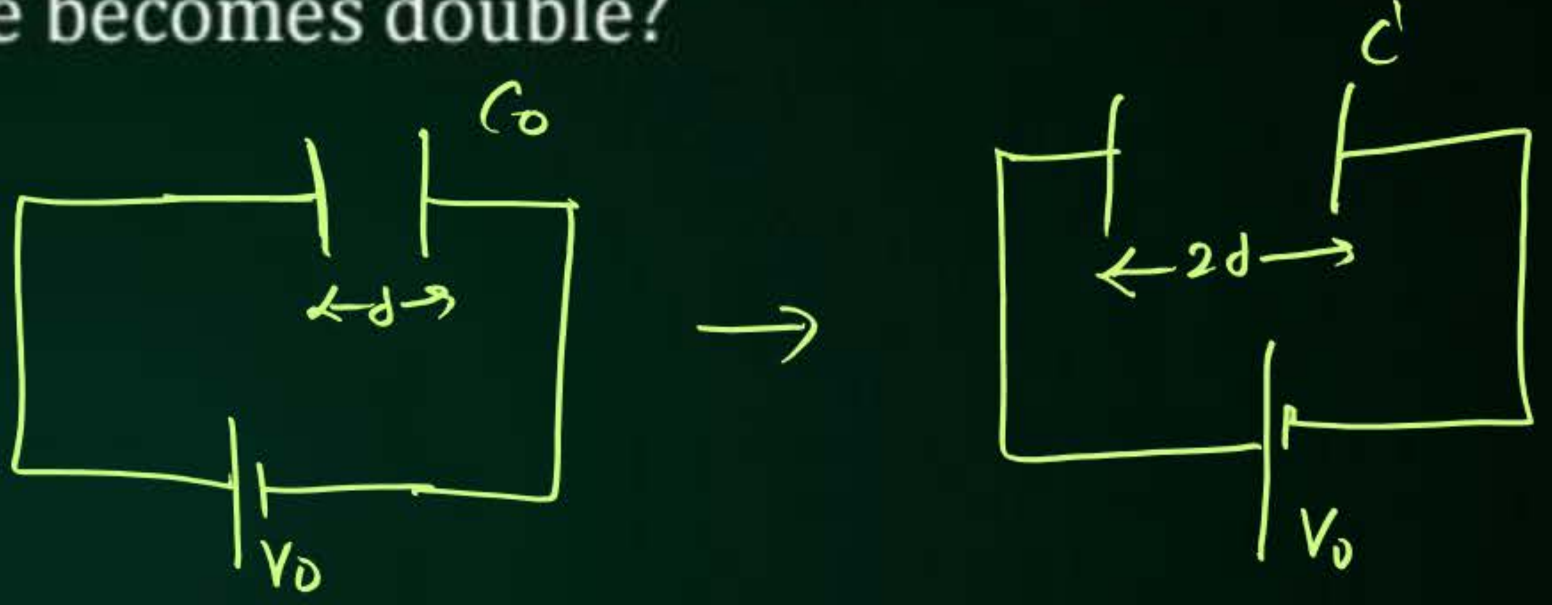
Charge	Q_0	$Q_f = Q_0$ (same)
Potential	V_0	$V_f = \frac{Q}{C} = \frac{V_0}{K}$
Capacitance	C_0	$C_f = KC_0$
energy	$U_0 = \frac{Q^2}{2C} = \frac{1}{2}CV^2$ (Q same)	$U_f = U_0/K$
Electric field	$E_0 = \frac{\Delta V}{d} = \frac{Q}{A\varepsilon_0}$	$E_f = E_0/K$
force	$F_0 = QE$	$F_f = F_0/K$



QUESTION

Capacitor of capacitance C_0 is charged by a battery of emf V_0, now battery remains connected and distance between the plate becomes double?

Charge	$Q_0 =$	$\rightarrow Q_f = C_f V_f = Q_0/2$
Potential	V_0	$\rightarrow V_f = V_0$
Capacitance	C_0	$\rightarrow C_f = C/2$
Force	$F_0 = QE$	$F_0 = \frac{F_0}{4}$
electric field	$E_0 = \frac{\Delta V}{\Delta d}$	$E_0 = E/2$
energy	$U_0 = \frac{1}{2}CV^2$	$U_0 = U_0/2$



QUESTION

Capacitor of capacitance C_0 is charged by a battery of emf V_0, now battery → removed → and distance between the plate becomes double.

Q Charge	Q_0	$Q_f = Q_0$
Potential →		
Capacitor	C_0	$C_f = C_0/2$

QUESTION

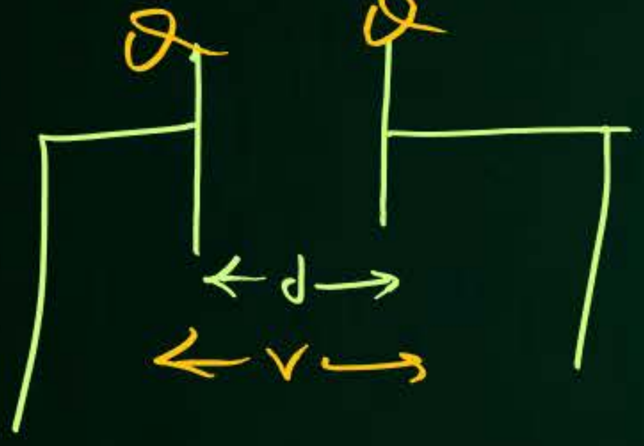
A parallel plate capacitor after charging is kept connected to a battery and the plates are pulled apart with the help of insulating handles. Now which of the following quantities will decrease?

1. Charge
2. Capacitance
3. Energy stored
4. All of these

QUESTION

A capacitor with plate separation d is charged to V volts. The battery is disconnected and a dielectric slab of thickness $\frac{d}{2}$ and dielectric constant '2' is inserted between the plates. The potential difference across its terminals becomes

1. V
2. 2V
3. $\frac{4V}{3}$
4. $\frac{3V}{4}$



$V = \frac{Q}{C}$ ← same

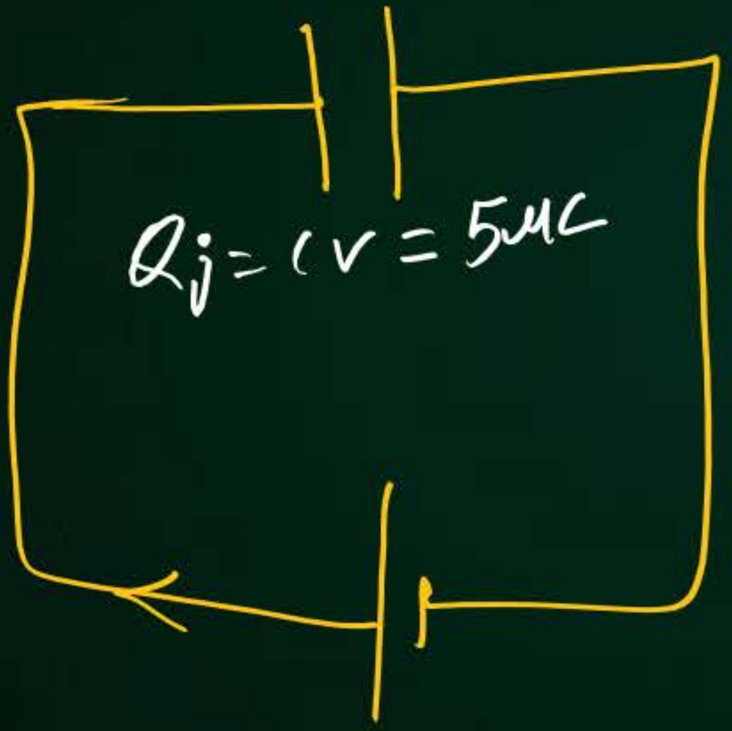
$C = \frac{\varepsilon_0 A}{\frac{d}{2\times 2} + \frac{d}{2\times 1}} = \frac{\varepsilon_0 A}{d\left[\frac{1}{4}+\frac{1}{2}\right]} = \frac{\varepsilon_0 A}{d\left[\frac{3}{4}\right]} = \frac{4C}{3}$

$V' = \frac{3Q}{4C} = \frac{3}{4}V$

QUESTION

A parallel plate capacitor of capacity 5 μF and plate separation 6 cm is connected to a 1V battery and is charged. A dielectric of constant 4 and thickness 4 cm is introduced into the capacitor. The additional charge that flows into the capacitor from the battery is

1. 2 μC
2. 3 μC
3. 5 μC
4. 10 μC



$$C' = \frac{\varepsilon_0 A}{\frac{4\,cm}{4} + \frac{2}{1}} = \frac{\varepsilon_0 A}{3}$$

$$C_0 = \frac{\varepsilon_0 A}{6}$$ initial

$C' = 2C_0$ (double)

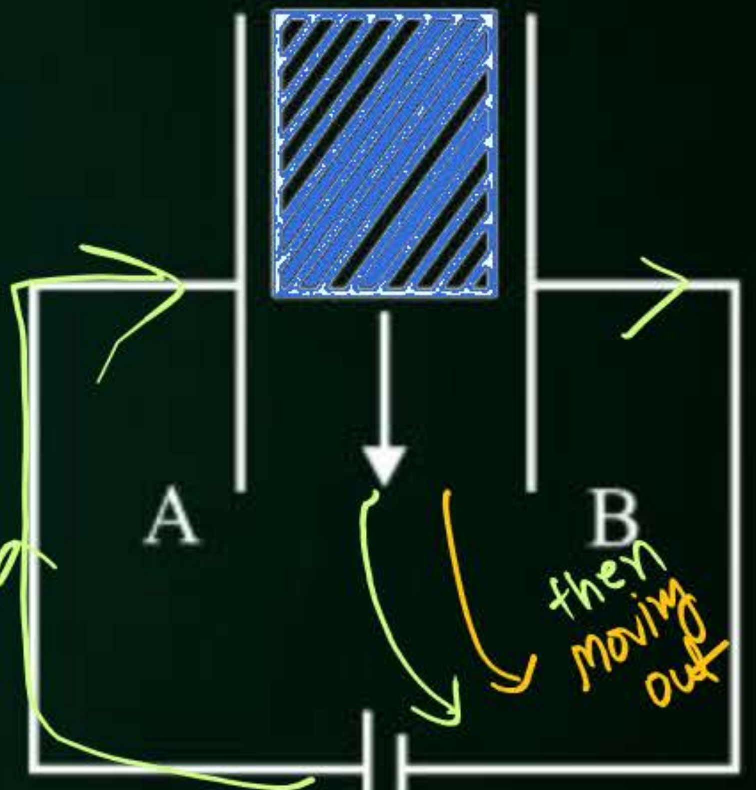
V = same

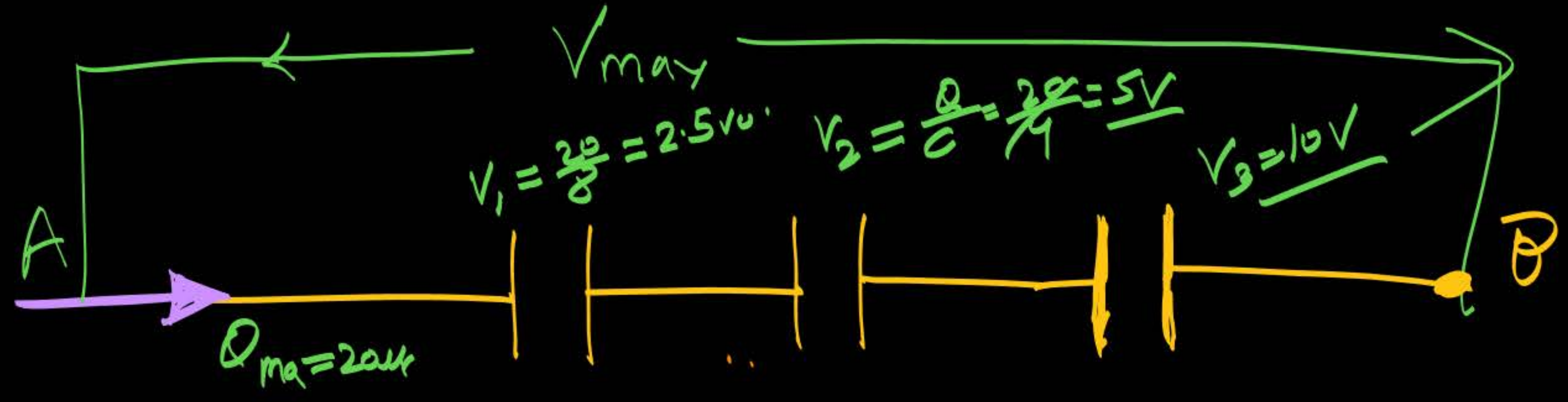
$Q_f = CV = 10\mu C$

QUESTION

An insulator plate is passed through the plates of a capacitor. Then current outside the capacitor.

1. First flows from A to B and then from B to A
2. First flows from B to A and then from A to B
3. Always flows from B to A
4. Always flows from A to B





$C_1 = 8\mu f$ | $C_2 = 4\mu f$ | $C_3 = 2\mu f$

$V_{max} = 10$ volt

$Q_{max} = 8 \times 10 = 80\mu c$

$V_{max} = 10V$

$Q_{max} = 40\mu c$ *

$V_{max} = 10V$

$Q_m = 20\mu c$

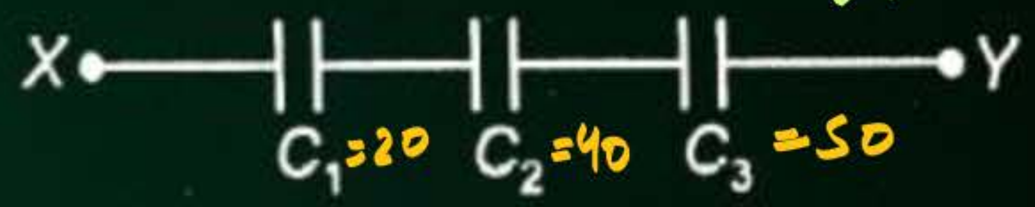
Max^m Potential can be apply across each capacitor is 10v/only

9 can suppy only 20μc Charge in this circuit

9 can supply $V_{AB} = 17.5$ volt

QUESTION

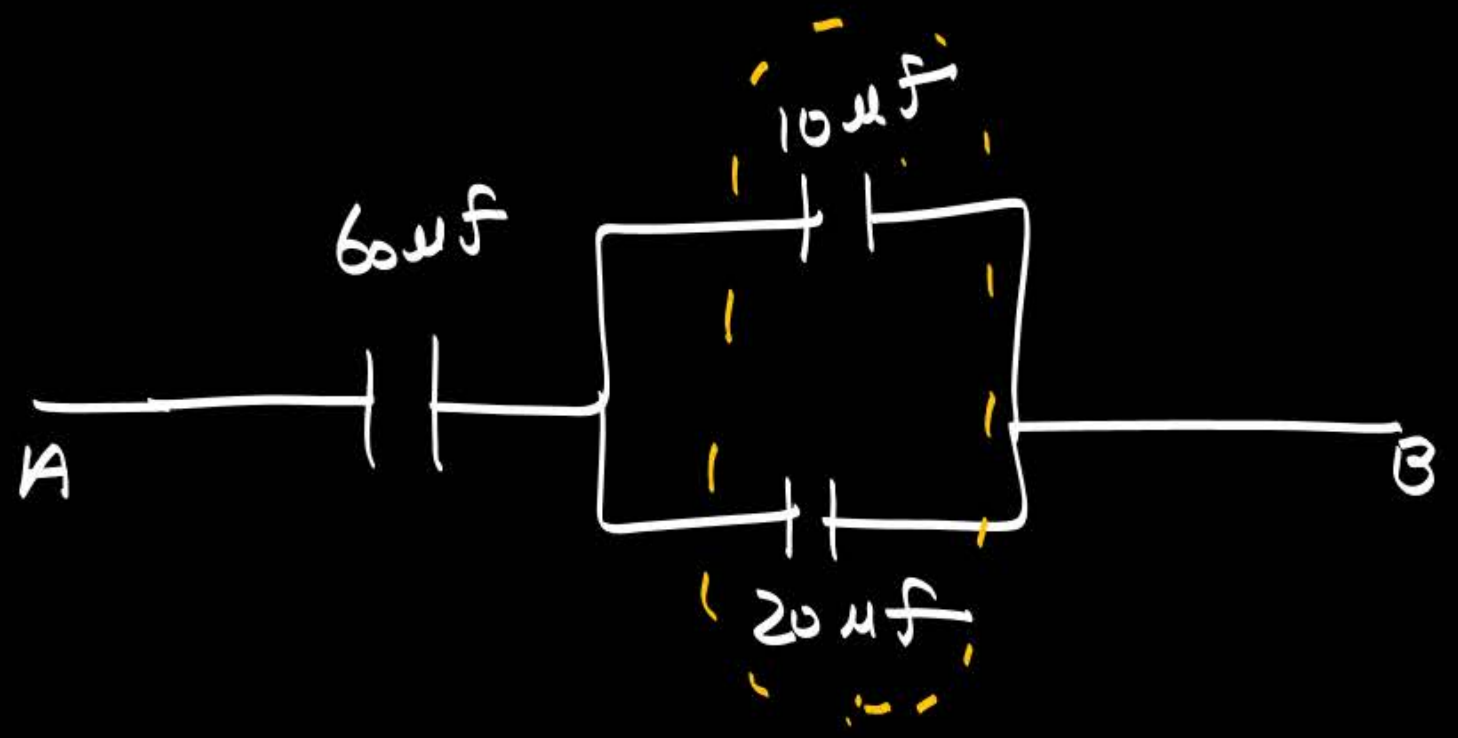
In the circuit below $C_1 = 20\ \mu F$, $C_2 = 40\ \mu F$ and $C_3 = 50\ \mu F$. If no capacitor can sustain more than 50V, then maximum potential difference between X and Y is



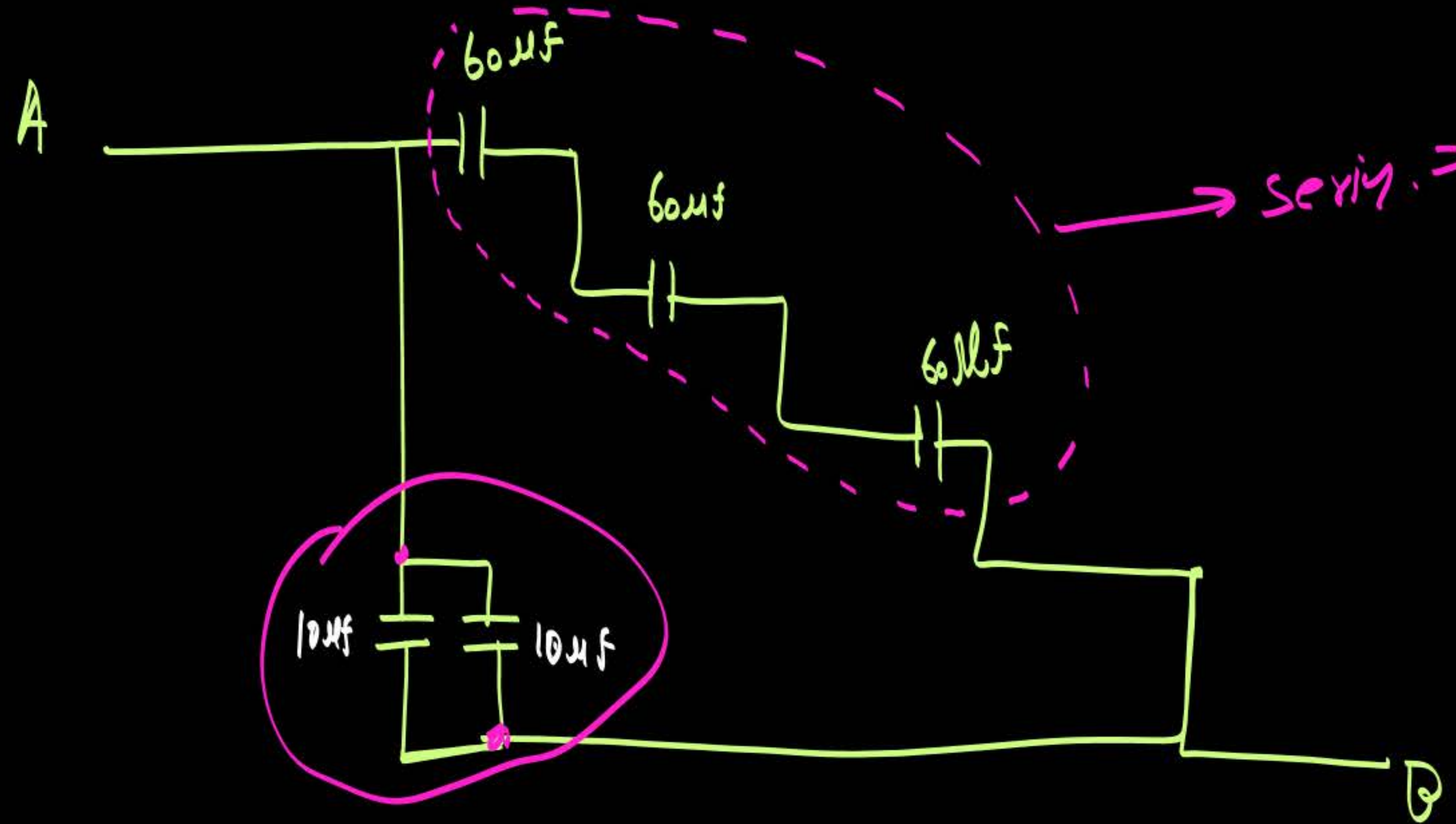
1. 95 V
2. 75 V
3. 150 V
4. 65 V

mixed combination of capacitor

NEET

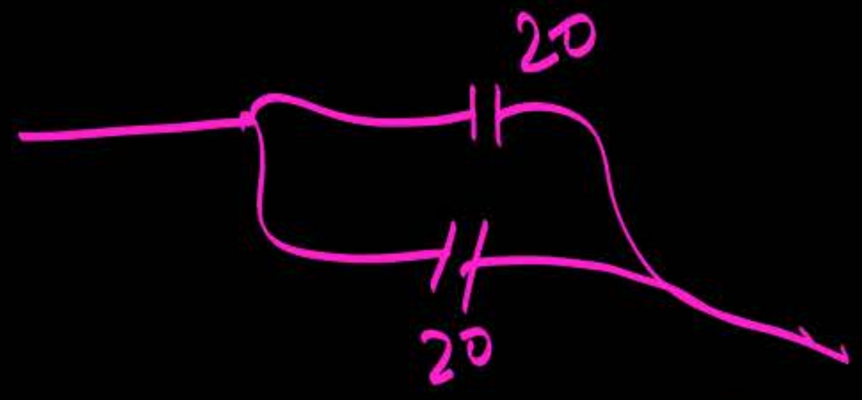


$$C_{AB} = \frac{30 \times 60}{30 + 60} = \frac{60 \times 30}{90} = 20 \mu F$$

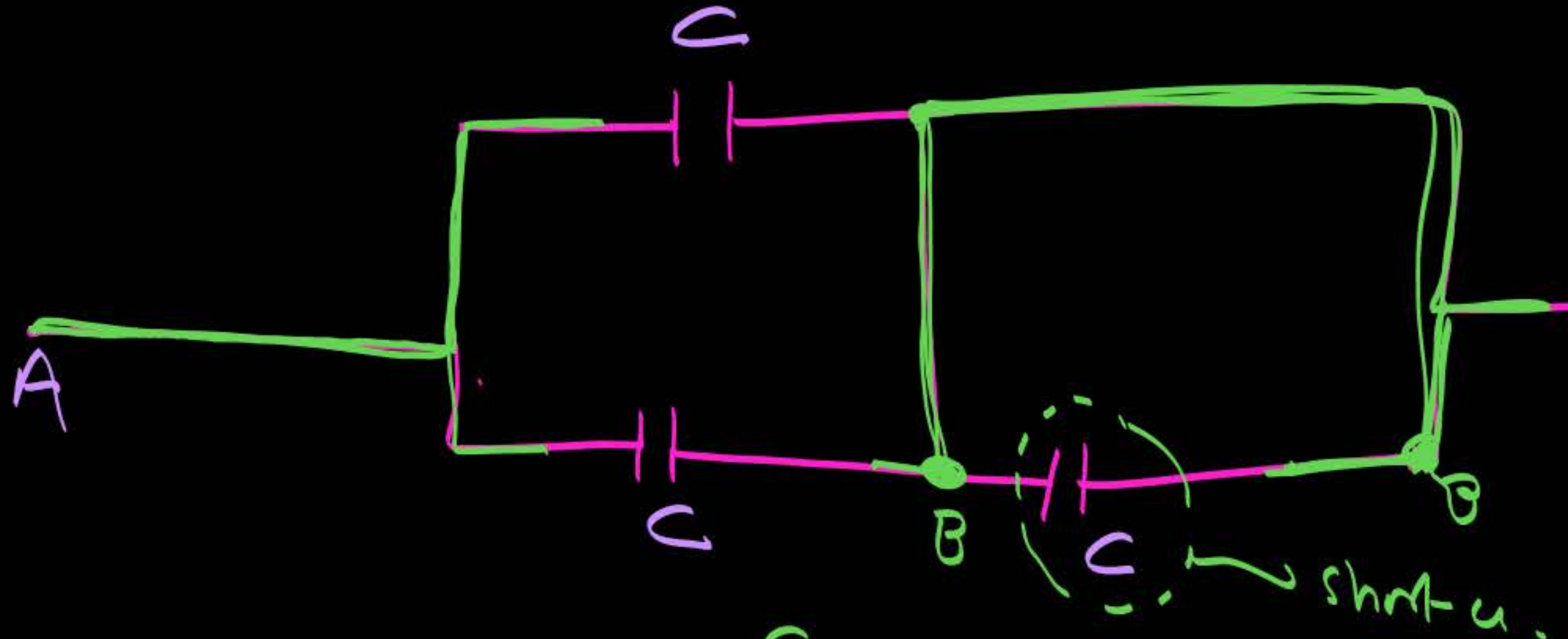


$series = \frac{60}{3} = 20\mu f$

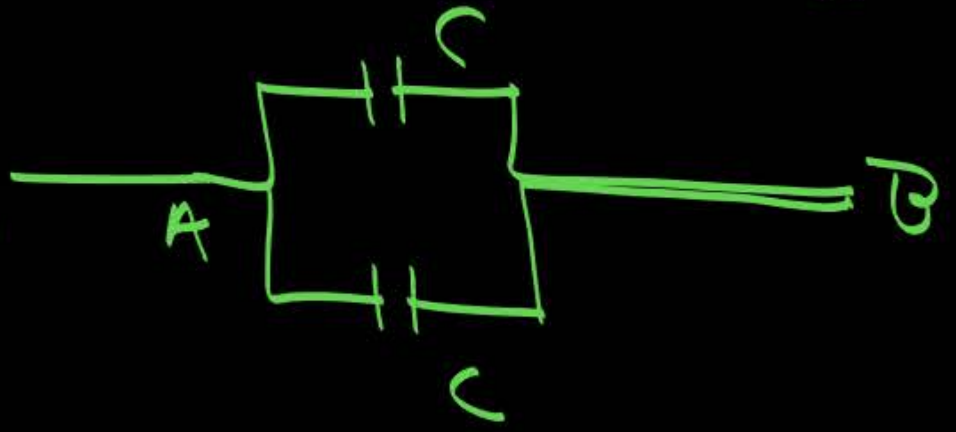
$C_{AB} = ??$

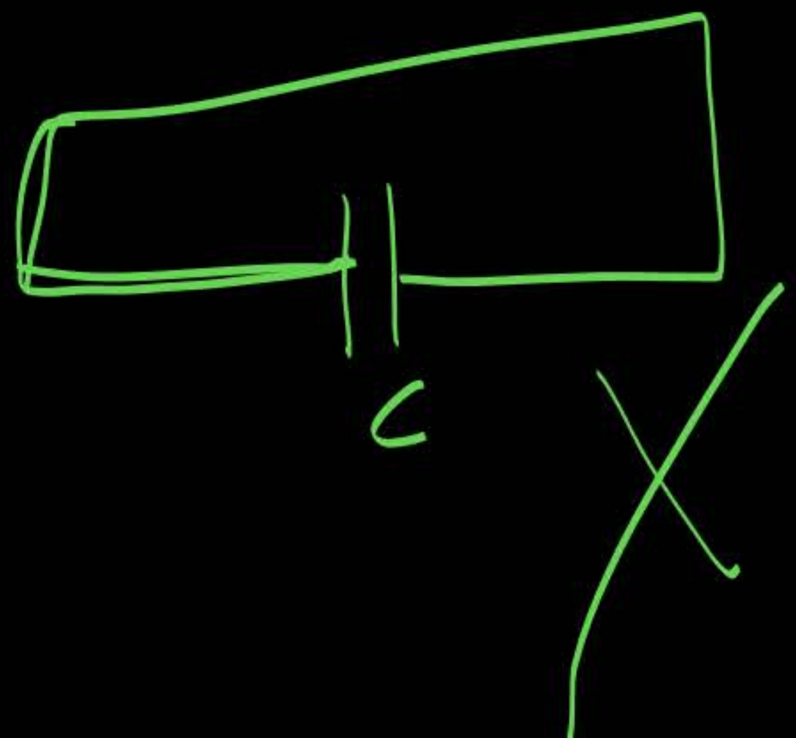


$C = 40\mu f$



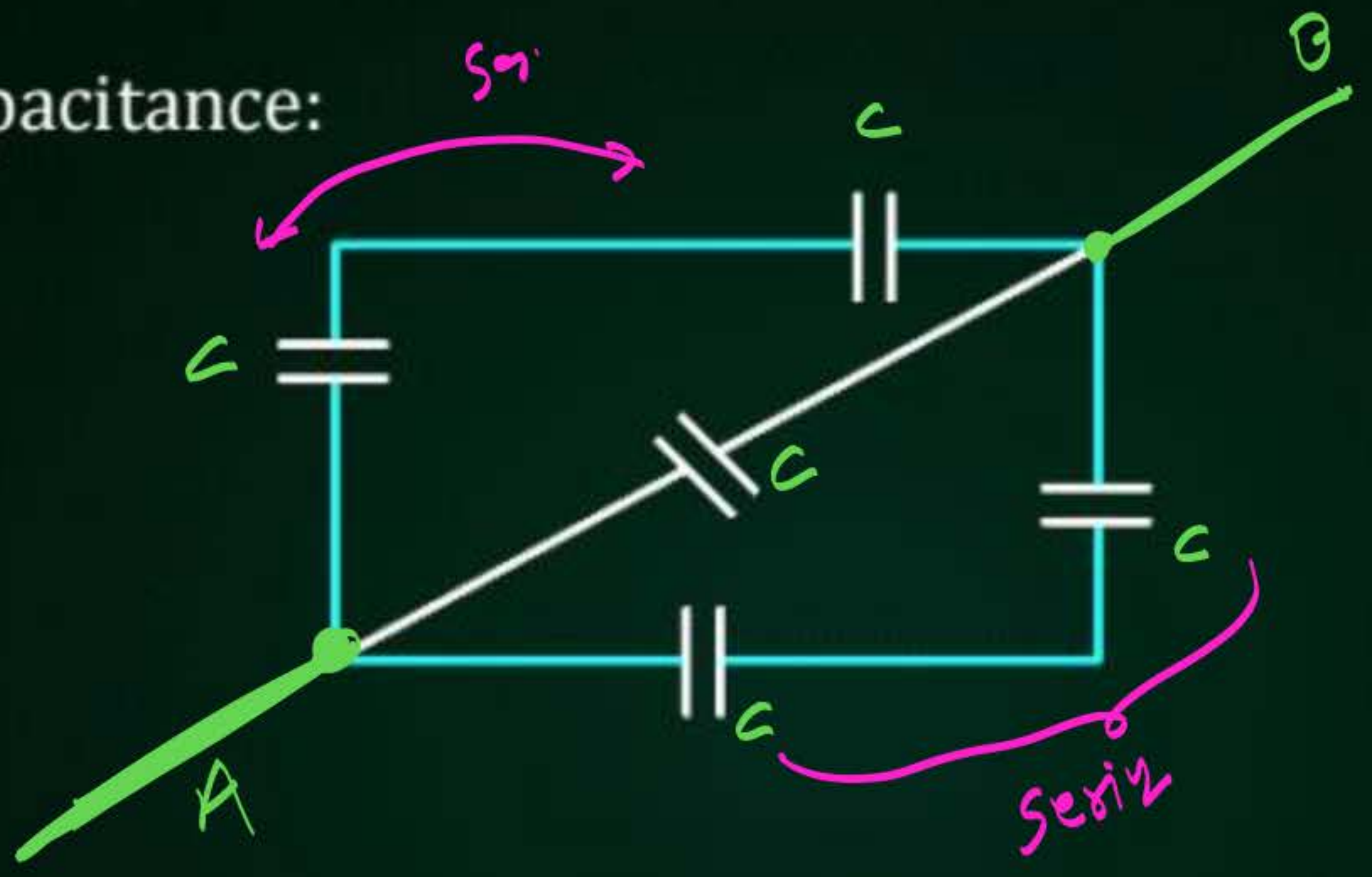
$C_{AB} = 2c$





QUESTION

Find equivalent capacitance:

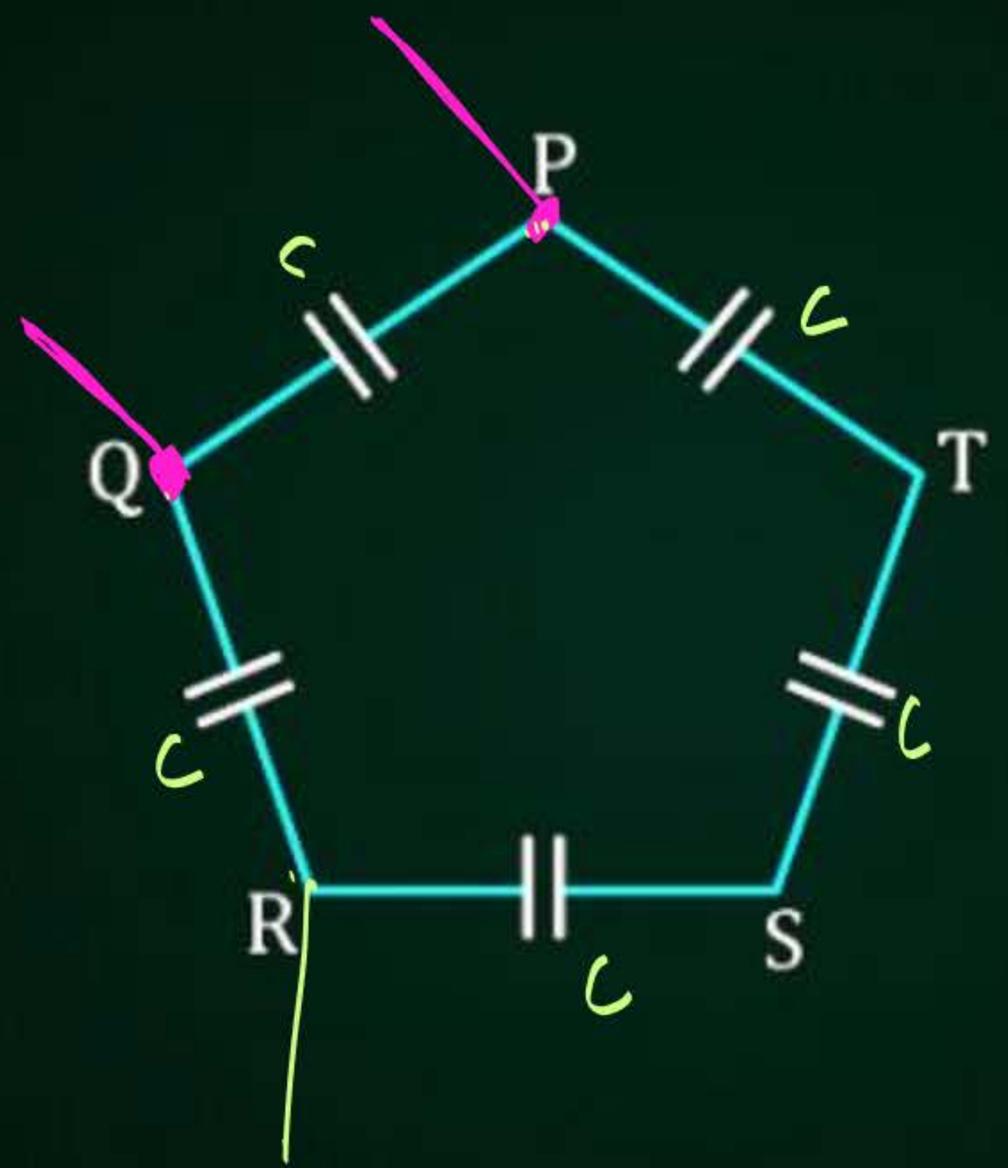


$C_{AB} = 2C$

Ans

QUESTION

Find C_{PQ}/C_{PR} = ??



H/W

$C_{PQ} = c + \frac{c}{4} = \frac{5c}{4}$

$C_{PR} = \frac{c}{3} + \frac{c}{2}$

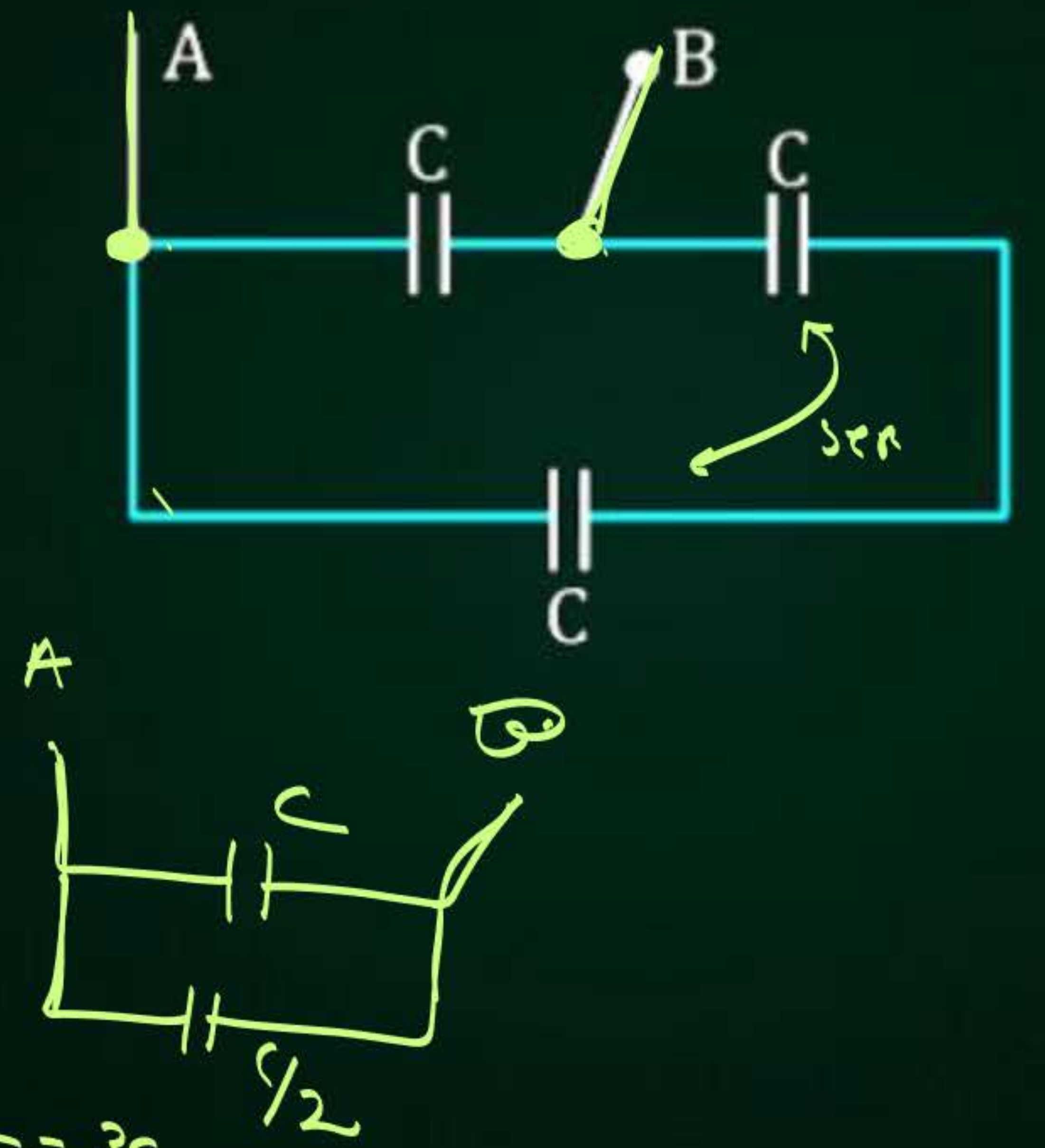
$= \frac{5c}{6}$

$\frac{C_{PQ}}{C_{PR}} = \frac{5c}{4} \times \frac{6}{5c}$

$= \frac{3}{2}$

QUESTION

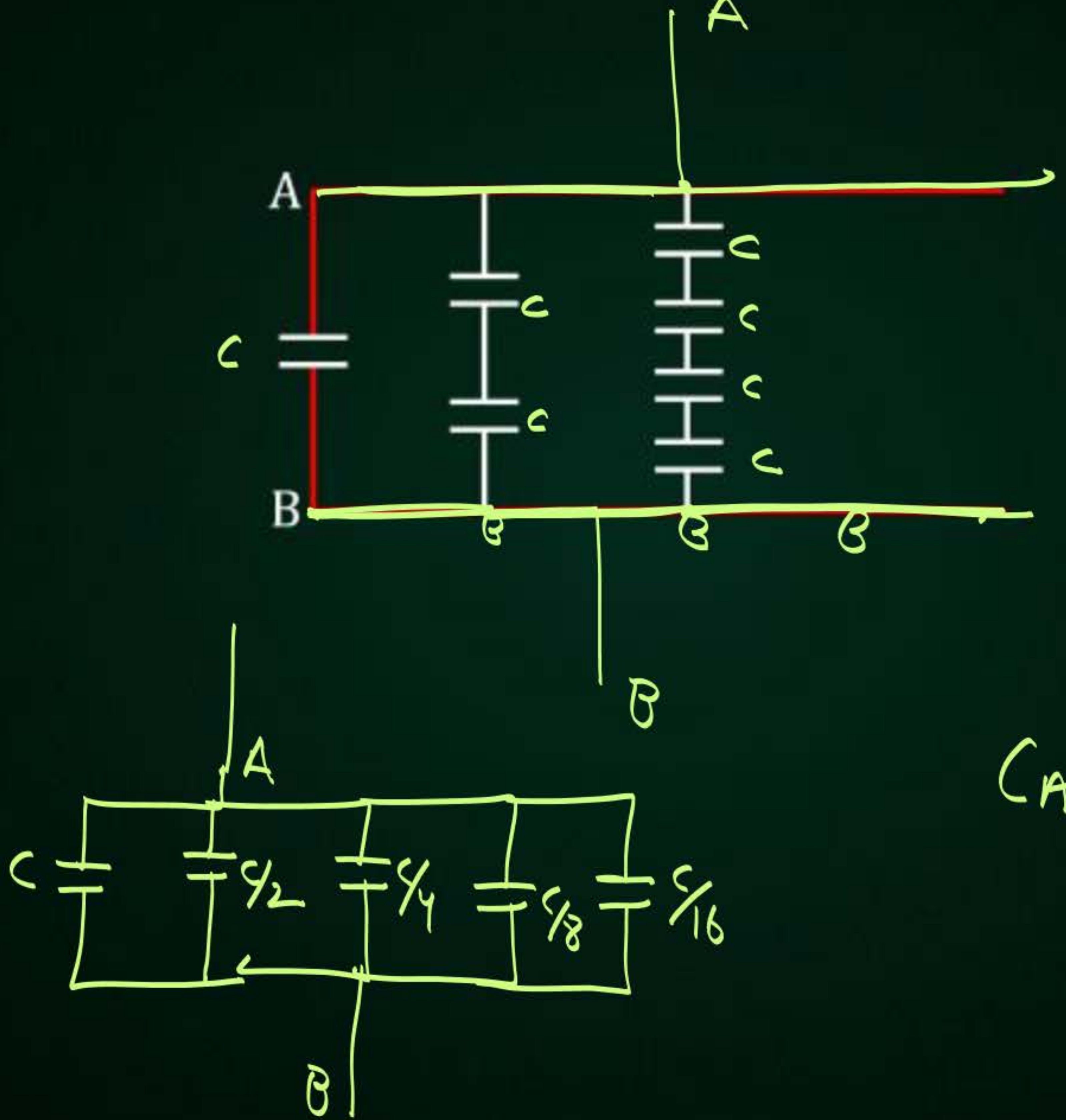
Find



$C_{AB} = C + \frac{C}{2} = \frac{3C}{2}$ Ans

QUESTION

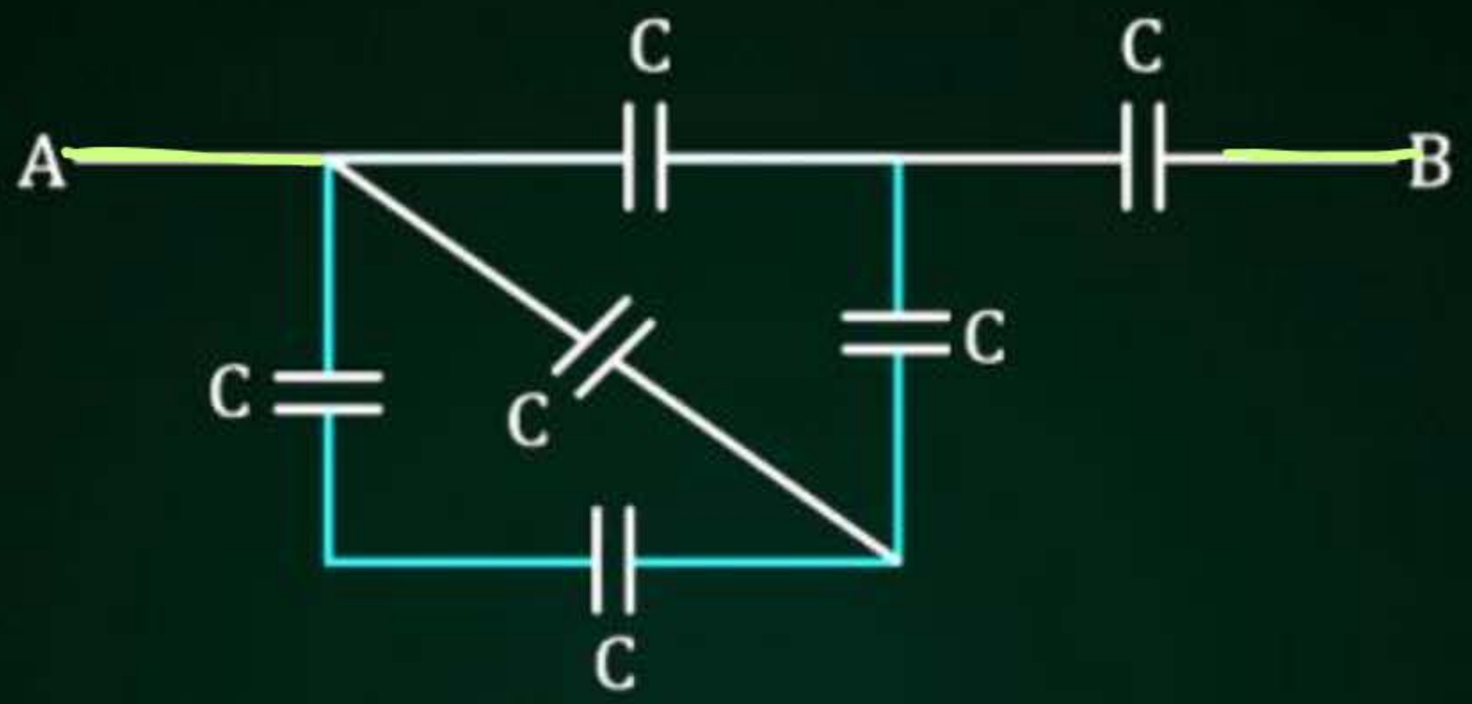
Find C_{AB} = ??



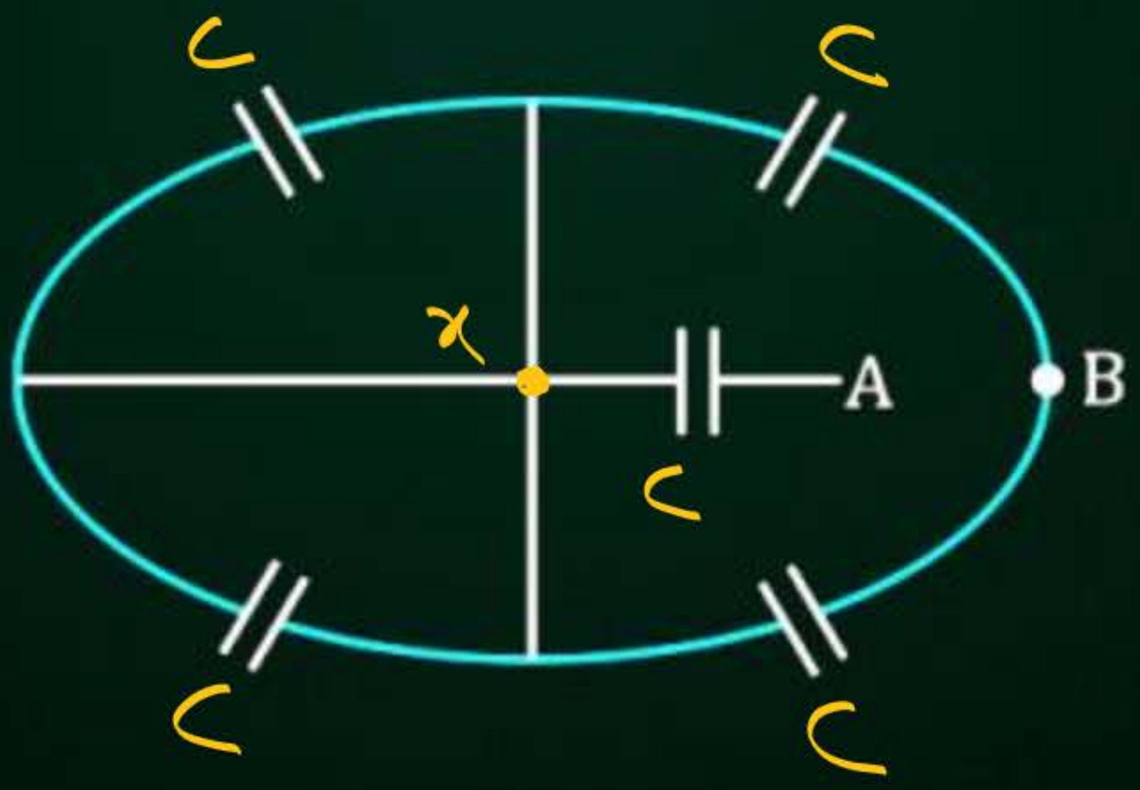
$$C_{AB} = C + \frac{C}{2} + \frac{C}{4} + \frac{C}{8} + \frac{C}{16}$$

$$= C\left[1 + \frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \frac{1}{16}\right]$$

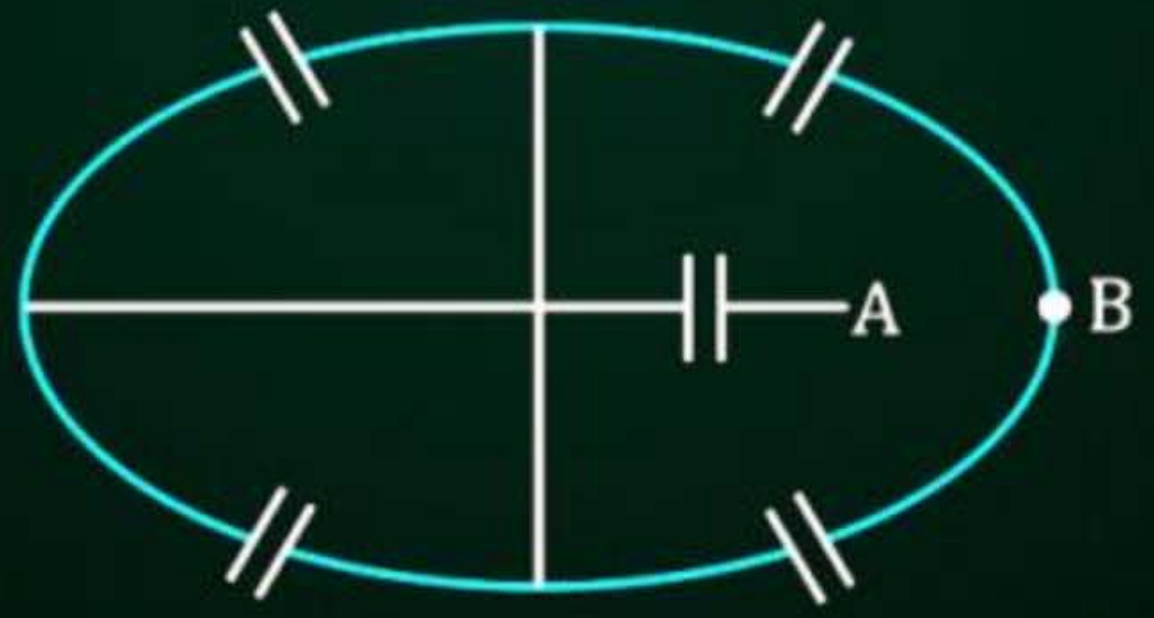
$$= C(2) = 2C$$



A
B
C
C
C
C
C
C



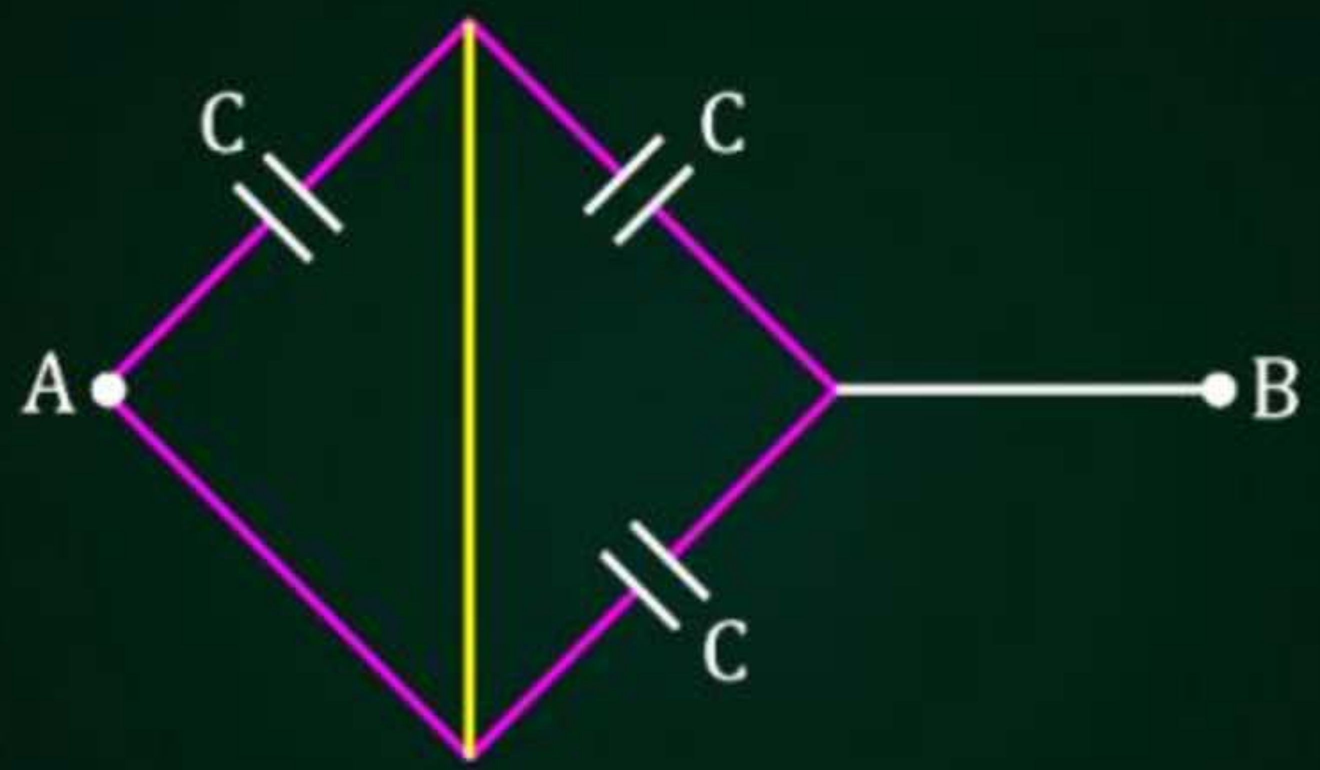
A
B



A
B

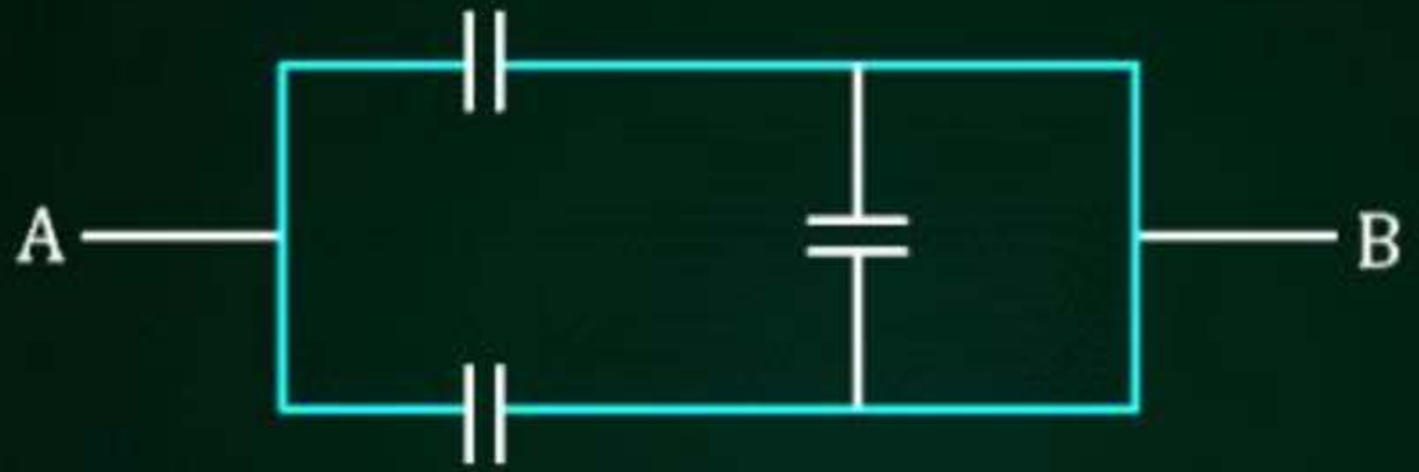
QUESTION

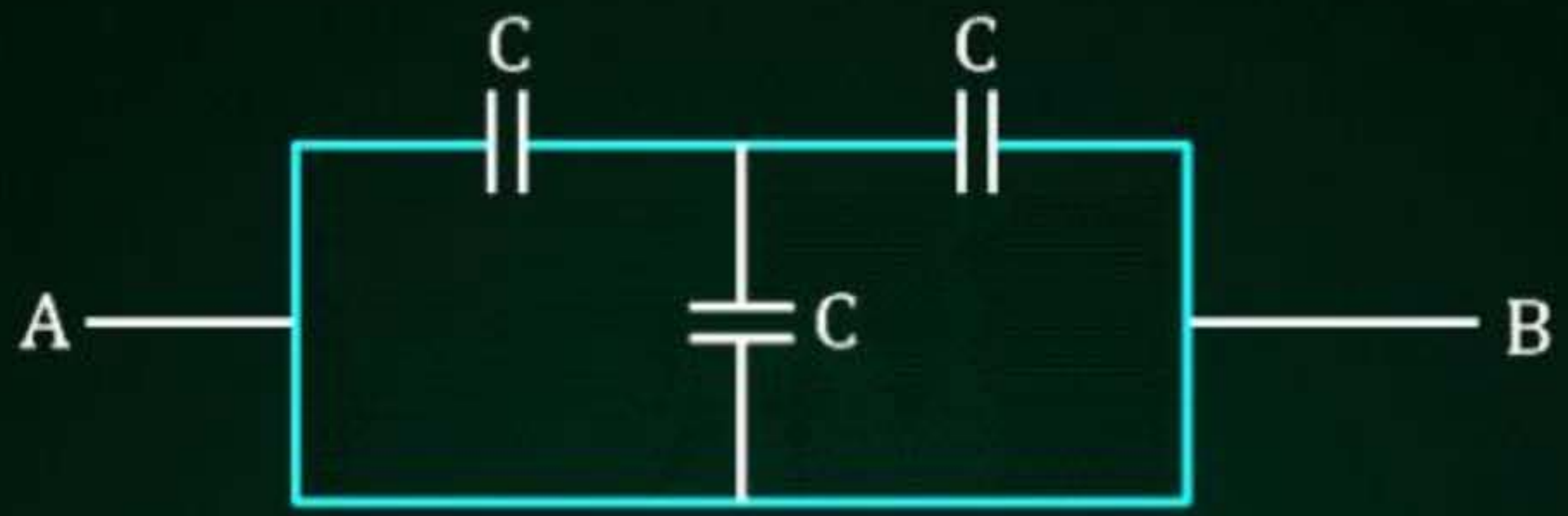
Find C_{AB}.

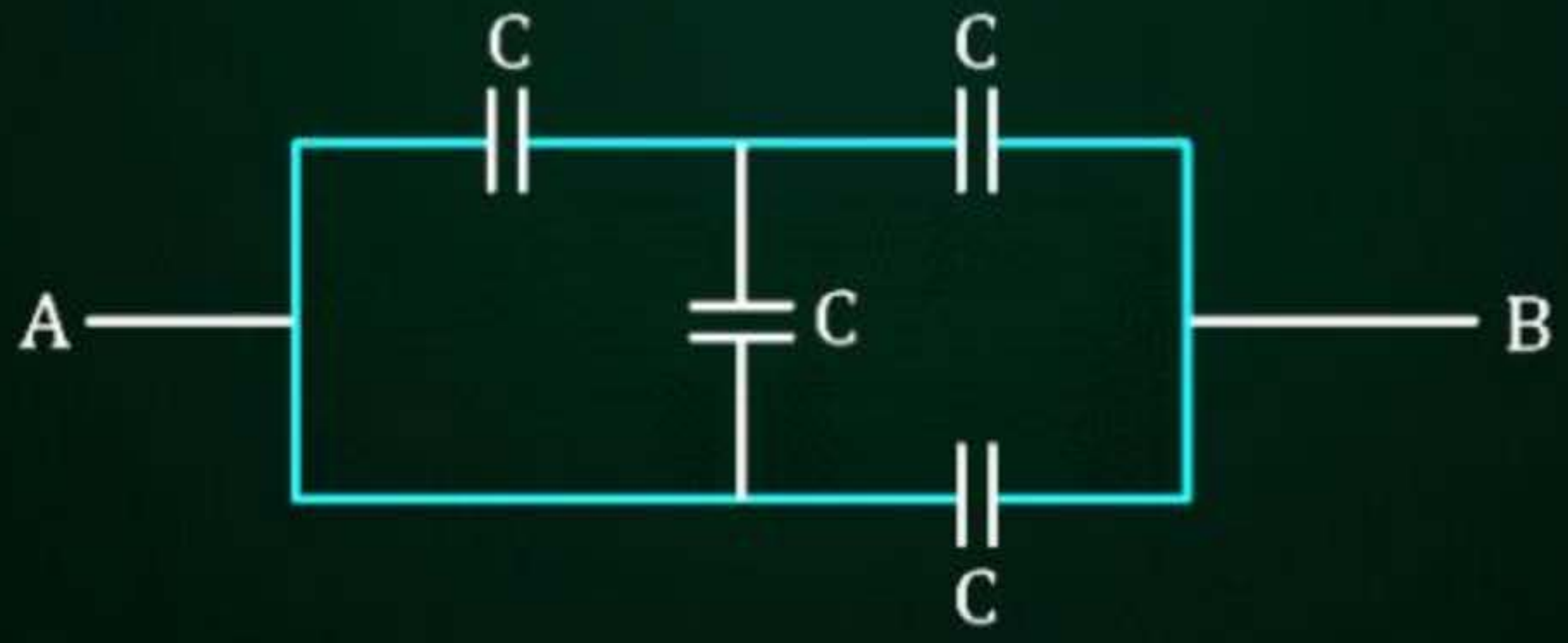


QUESTION

Find equivalent capacitance:




C
C
A
C
B


C
C
A
C
B
C

QUESTION

Find C_q between A and B.



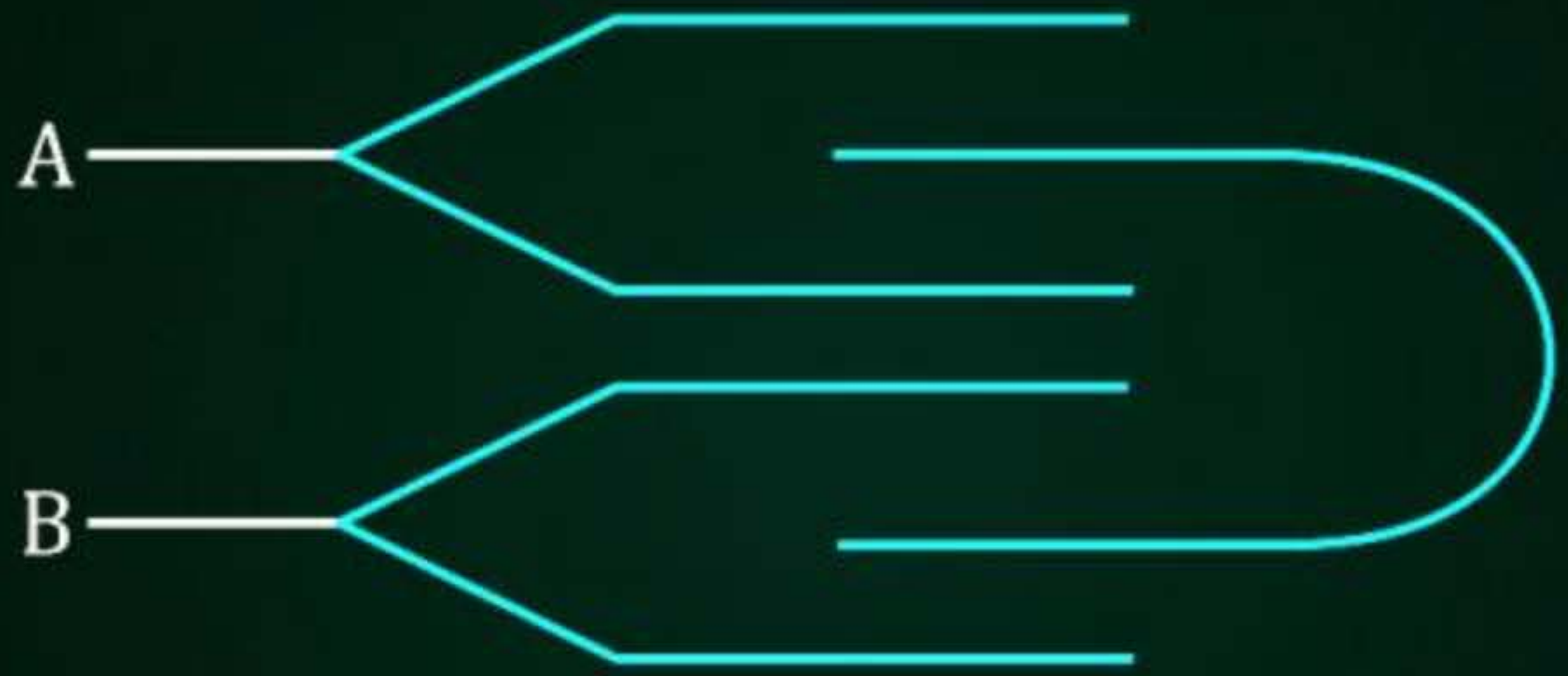
QUESTION

Find



QUESTION

Find



YAKEEN 2.0

FOR NEET 2025

Lecture- 12 | Physics

Electrostatic Potential and Capacitance

By- Dr. Manish Raj (MR SIR)



Todays Goal finding of

equivalent Capacitance

QUESTION

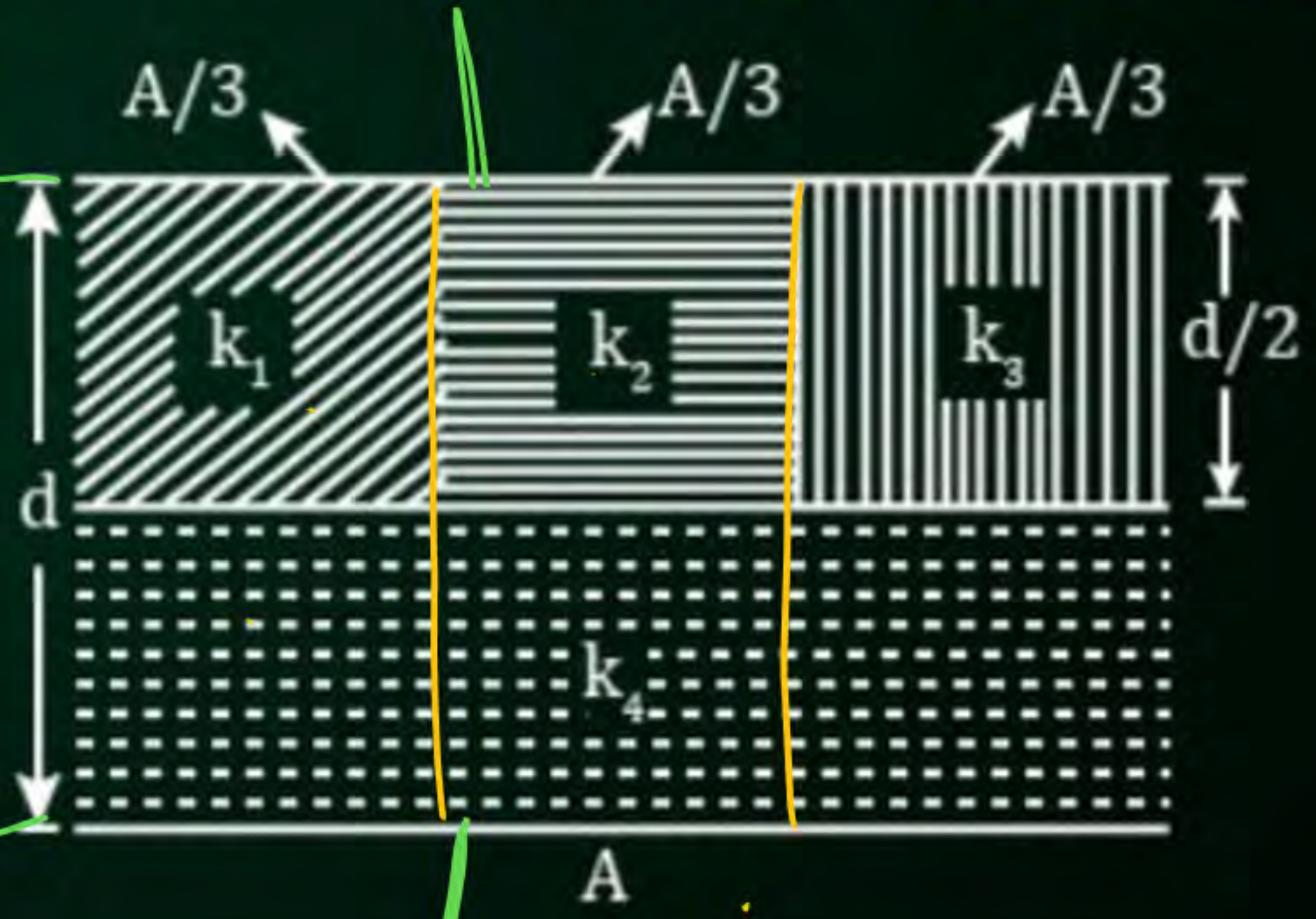
A parallel-plate capacitor of area A, plate separation d and capacitance C is filled with four dielectric materials having dielectric constants k_1, k_2, k_3 and k_4 as shown in the figure below. If a single dielectric material is to be used to have the same capacitance C in this capacitor, then its dielectric constant k is given by [NEET (Phase-2)-2016]

1. $k = k_1 + k_2 + k_3 + 3k_4$

2. $k = \frac{2}{3}(k_1 + k_2 + k_3) + 2k_4$

3. $\frac{2}{k} = \frac{3}{k_1 + k_2 + k_3} + \frac{1}{k_4}$

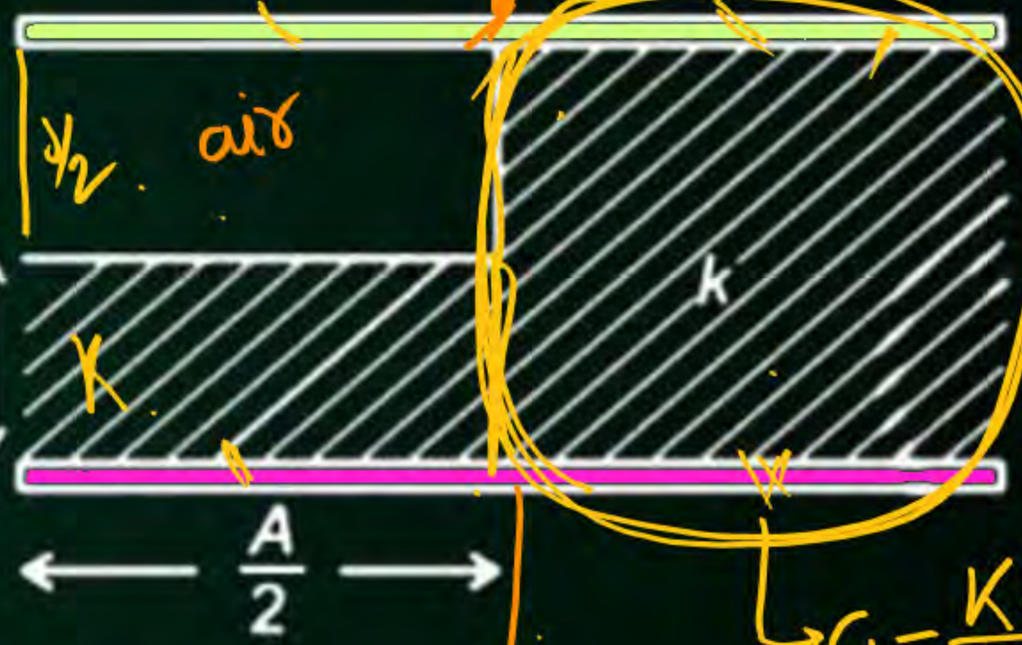
4. $\frac{1}{k} = \frac{1}{k_1} + \frac{1}{k_2} + \frac{1}{k_3} + \frac{3}{2k_4}$



QUESTION

A parallel plate capacitor with plate area A and plate separation d, is filled with a dielectric slab as shown. What is the capacitance of the arrangement?

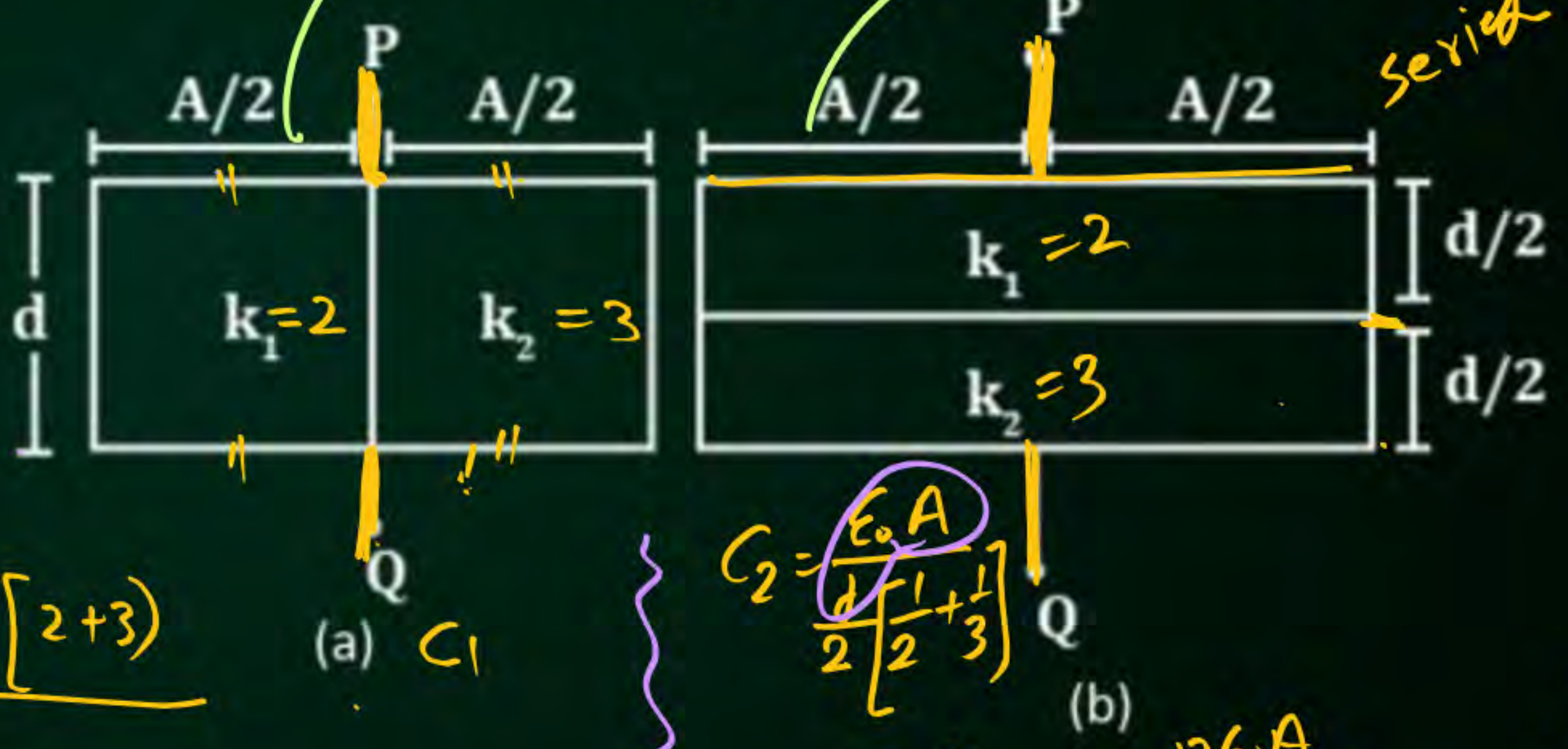
1. $\left(\frac{k+1}{2}\right)\frac{\varepsilon_0 A}{d}$
2. $\frac{3}{2}\frac{k\varepsilon_0 A}{2}$
3. $\frac{4}{3}\frac{k\varepsilon_0 A}{d}$
4. $\frac{k(k+3)}{2(k+1)}\frac{\varepsilon_0 A}{d}$



QUESTION

In the arrangement shown in figure, dielectric constant $K_1 = 2$ and $K_2 = 3$. If the capacitance across P and Q are C_1 and C_2 respectively, then C_1/C_2 will be (the gaps shown are negligible)

1. 1 : 1
2. 2 : 3
3. 9 : 5
4. 25 : 24

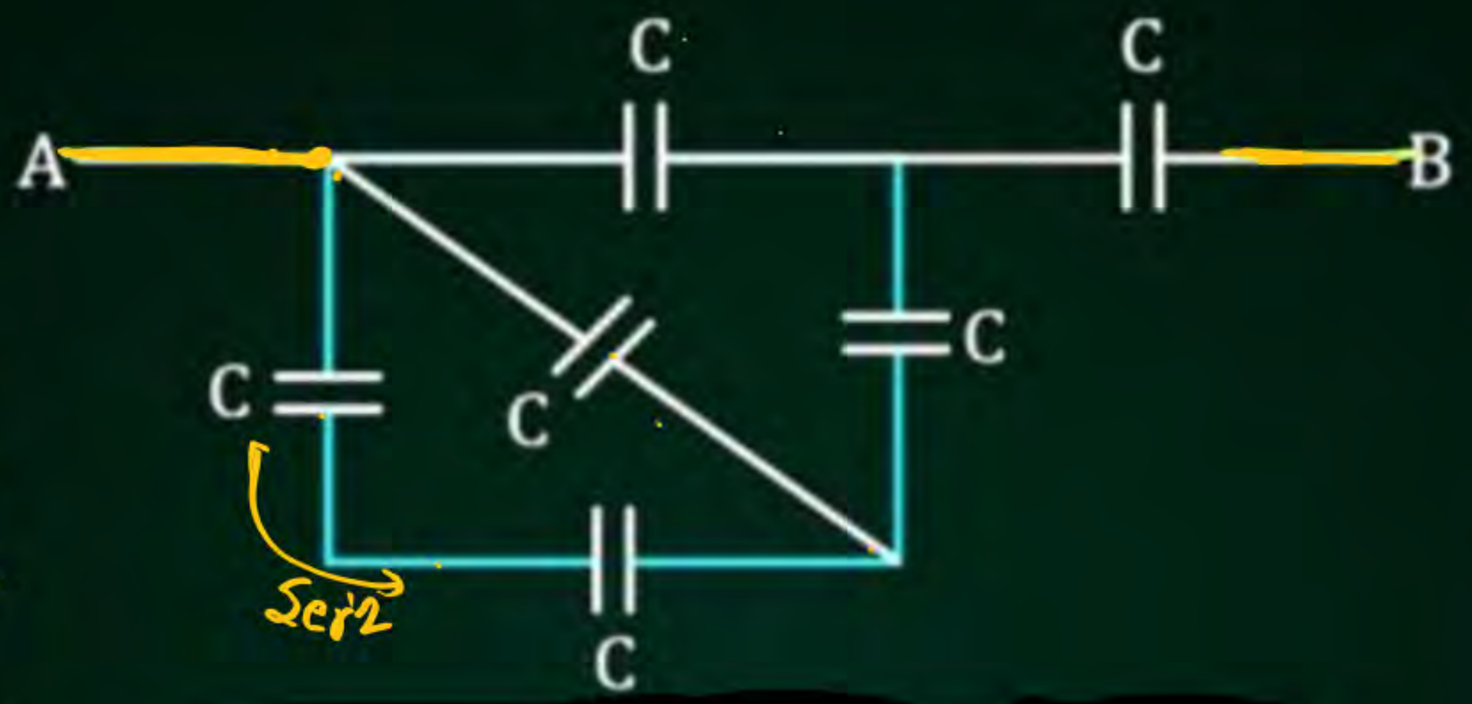


QUESTION

Three different dielectrics are filled in a parallel plate capacitor as shown. What should be the dielectric constant of a material, which when fully filled between the plates produces same capacitance?



1. 4
2. 6
3. 5
4. 9





$$\frac{1}{C_{eq}} = \frac{1}{C} + \frac{5}{8C}$$

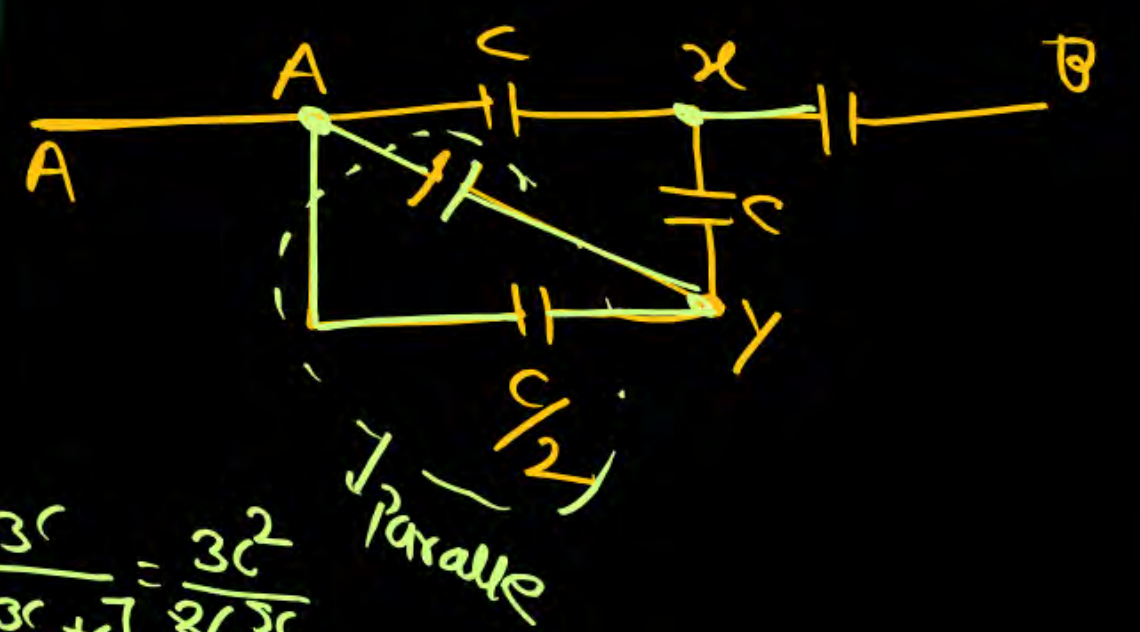
$$\frac{1}{C_{eq}} = \frac{8+5}{8C}$$

$$C_{eq} = \frac{8C}{13}$$

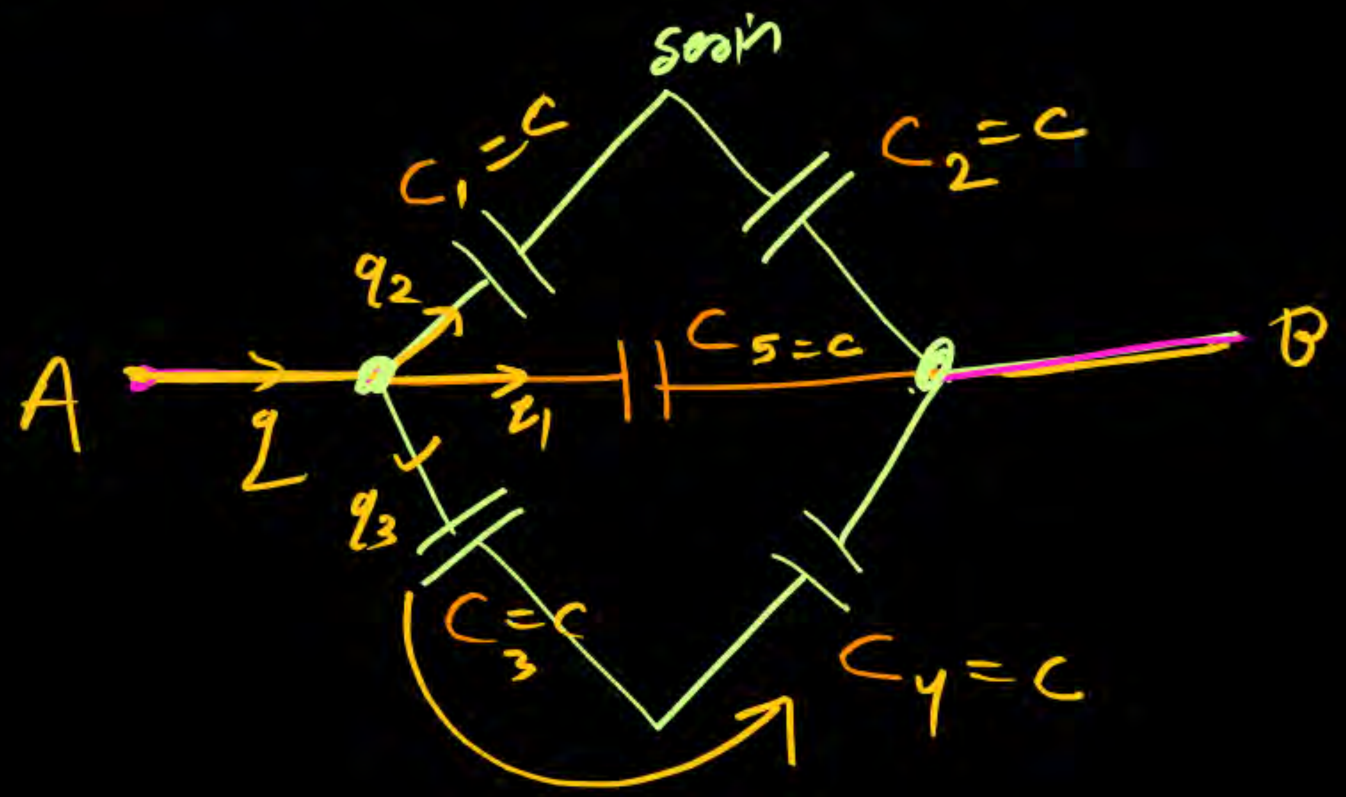


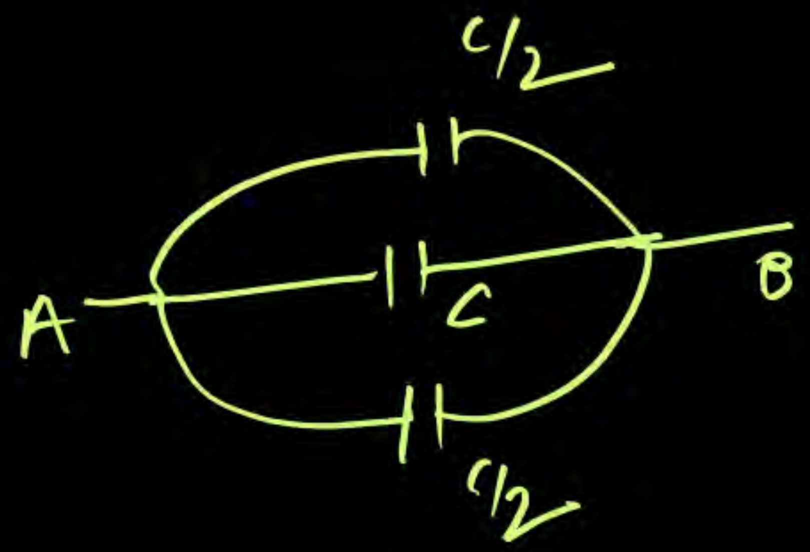
$$\frac{C \times 3C}{2\left[\frac{3C}{2} + C\right]} = \frac{3C^2}{2\left(\frac{5C}{2}\right)} = \frac{3C}{5}$$

$$\frac{3C}{5} + C = \frac{8C}{5}$$



Not. Wheatstone Bridge





$C_{AB} = 2C$

(Q) On which capacitor charge will be zero in Balance cond^n.

wrong

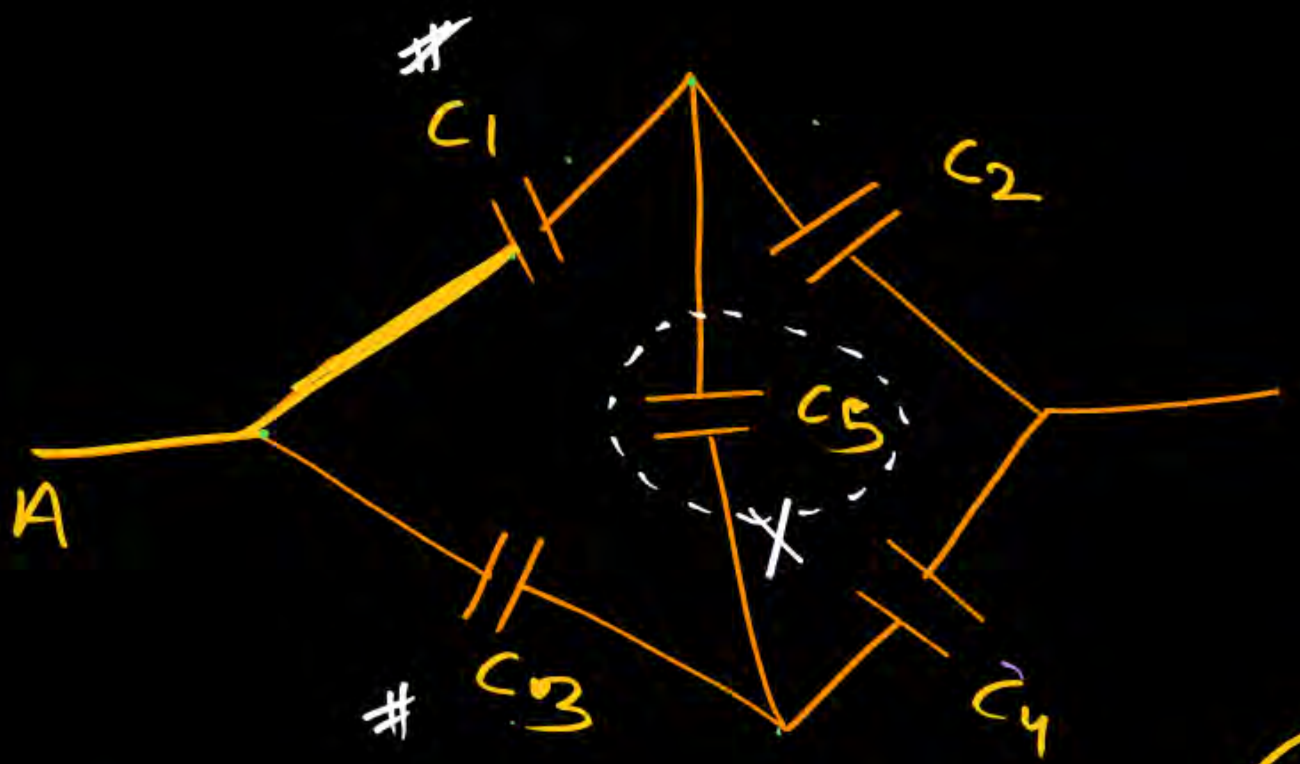
(a) on C_1, C_2

(b) on C_5 (66%)

(c) on all

(d) none of these (26%) correct

Wheat stone Brige



Balance condn

If $\frac{C_1}{C_2} = \frac{C_3}{C_4}$ → (a) No current
(b) current

$\frac{C_1}{C_3} = \frac{C_2}{C_4}$ then charge of C_5 will be zero because Potential across C_5 will be same

$\Delta V = 0$

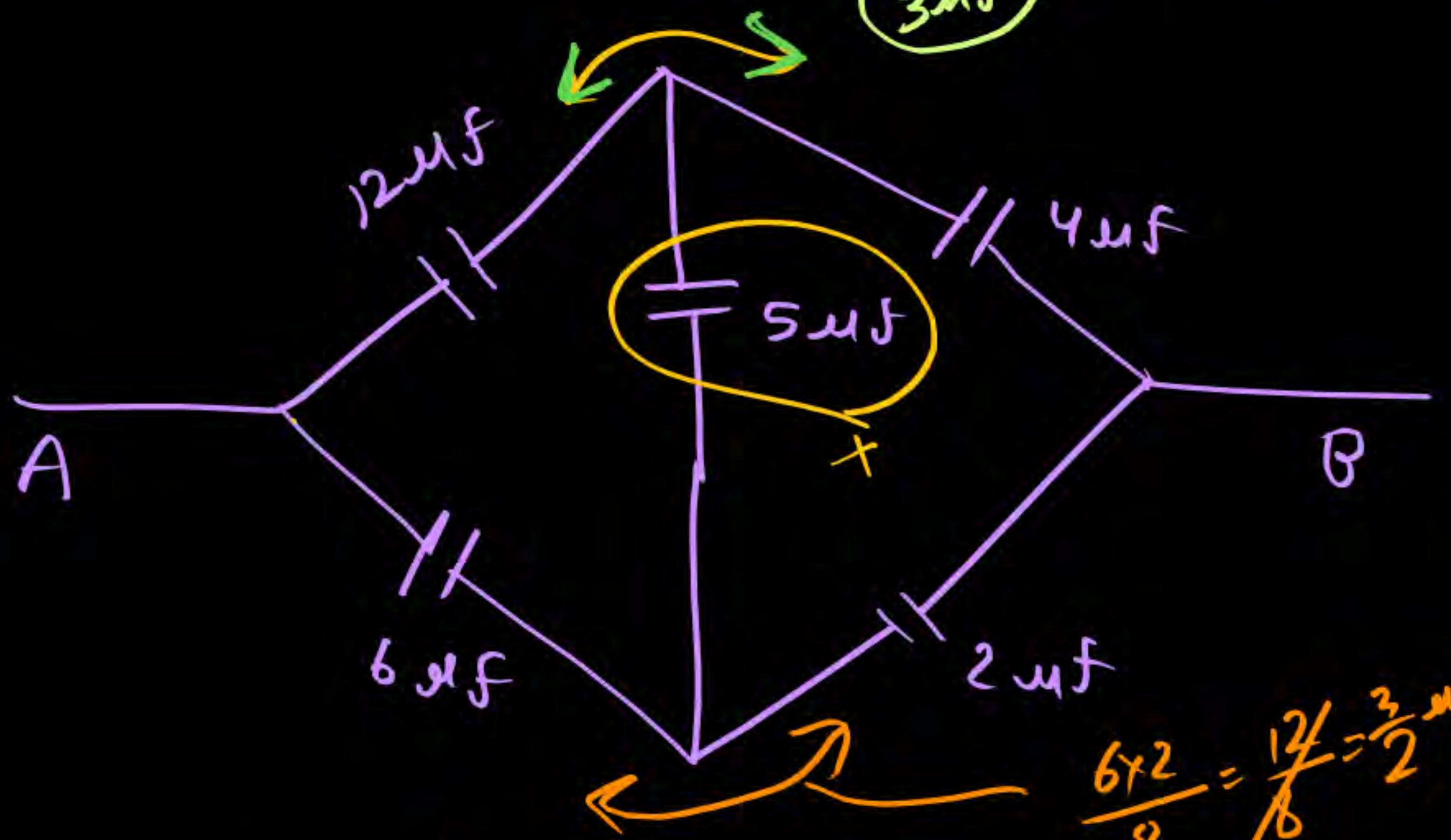
same

$$\frac{C_1}{C_2} = \frac{C_3}{C_4}$$

No two capacitor are in series or in Parallel

$3\mu f \rightarrow$ series of $12\mu f$ & $4\mu f$

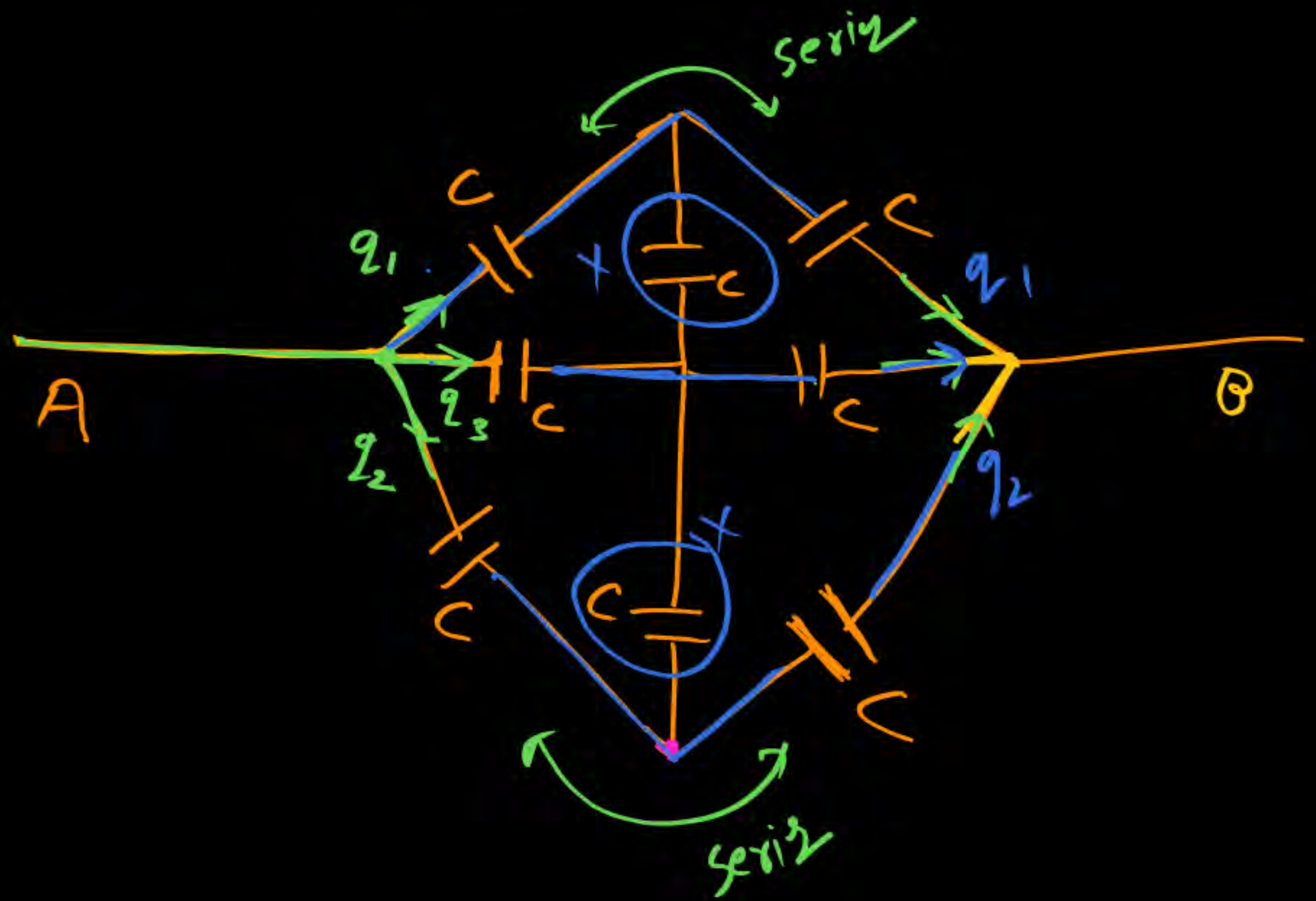
$$3 + \frac{3}{2} = \frac{9}{2}\,\mu f$$



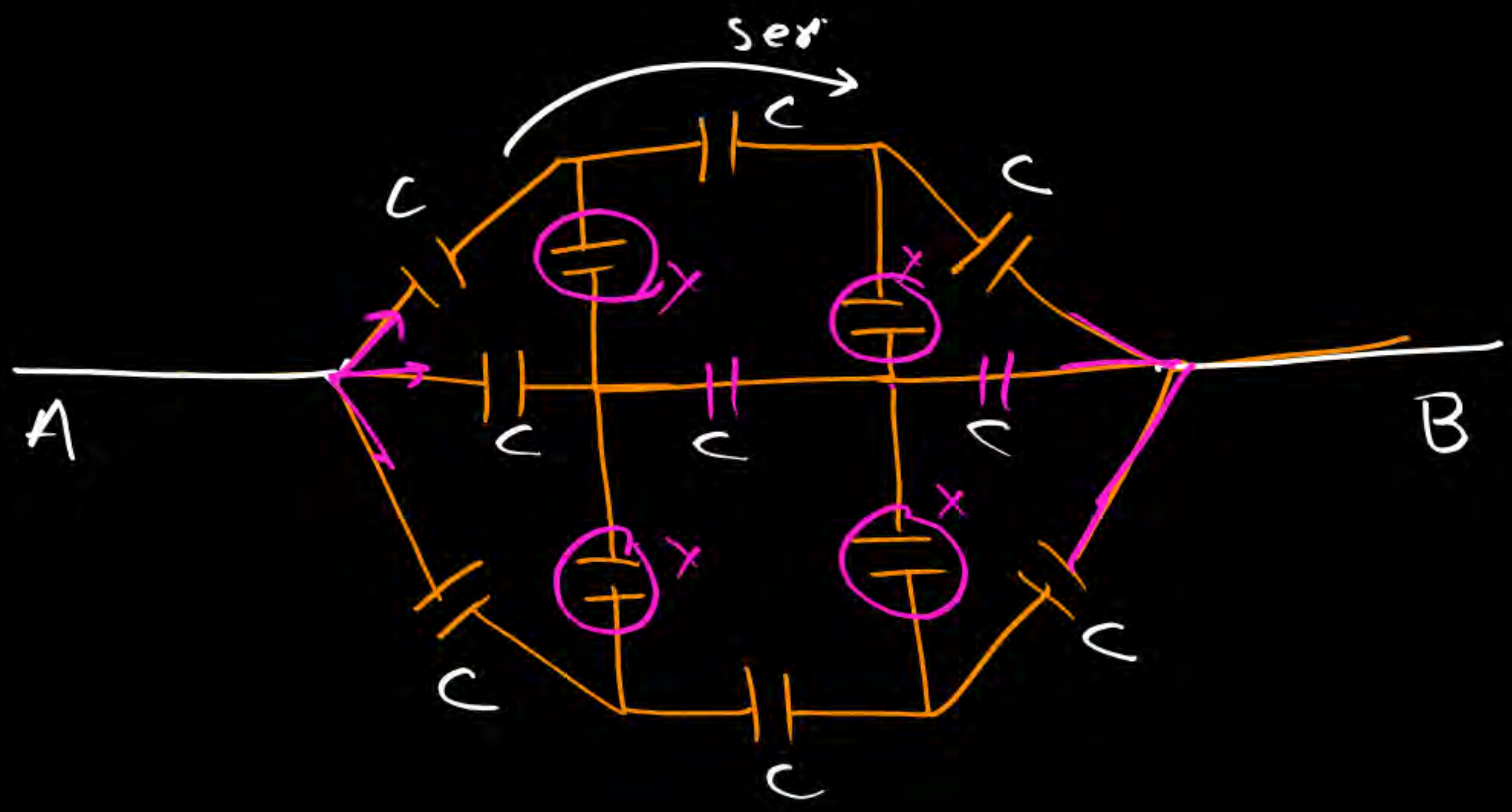
$$\frac{6\times 2}{8} = \frac{12}{8} = \frac{3}{2}\,\mu f$$

$\frac{12}{6} = \frac{4}{2}$

Symmetric circuit



$$C_{AB} = \frac{3C}{2}$$ Ans



$$C_{AB} = \frac{C}{3} \times 3$$

$$\boxed{C_{AB} = C}$$ Ans

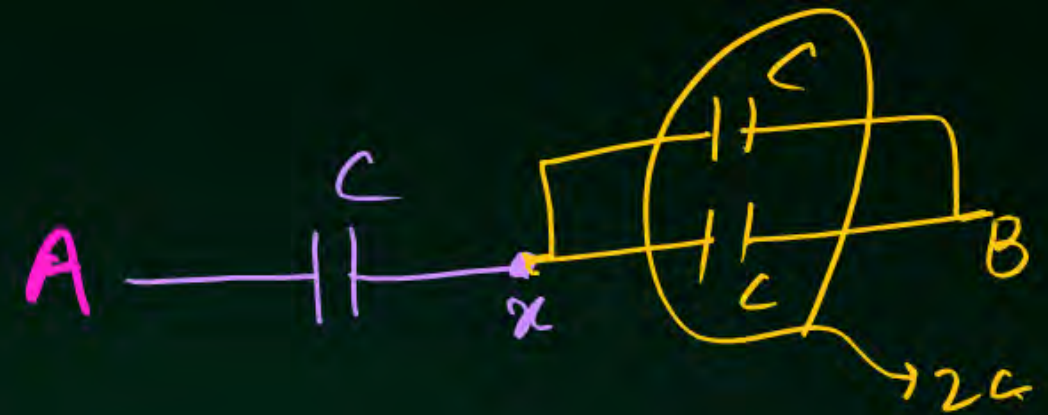
(a) C

(b) $\frac{5C}{4}$

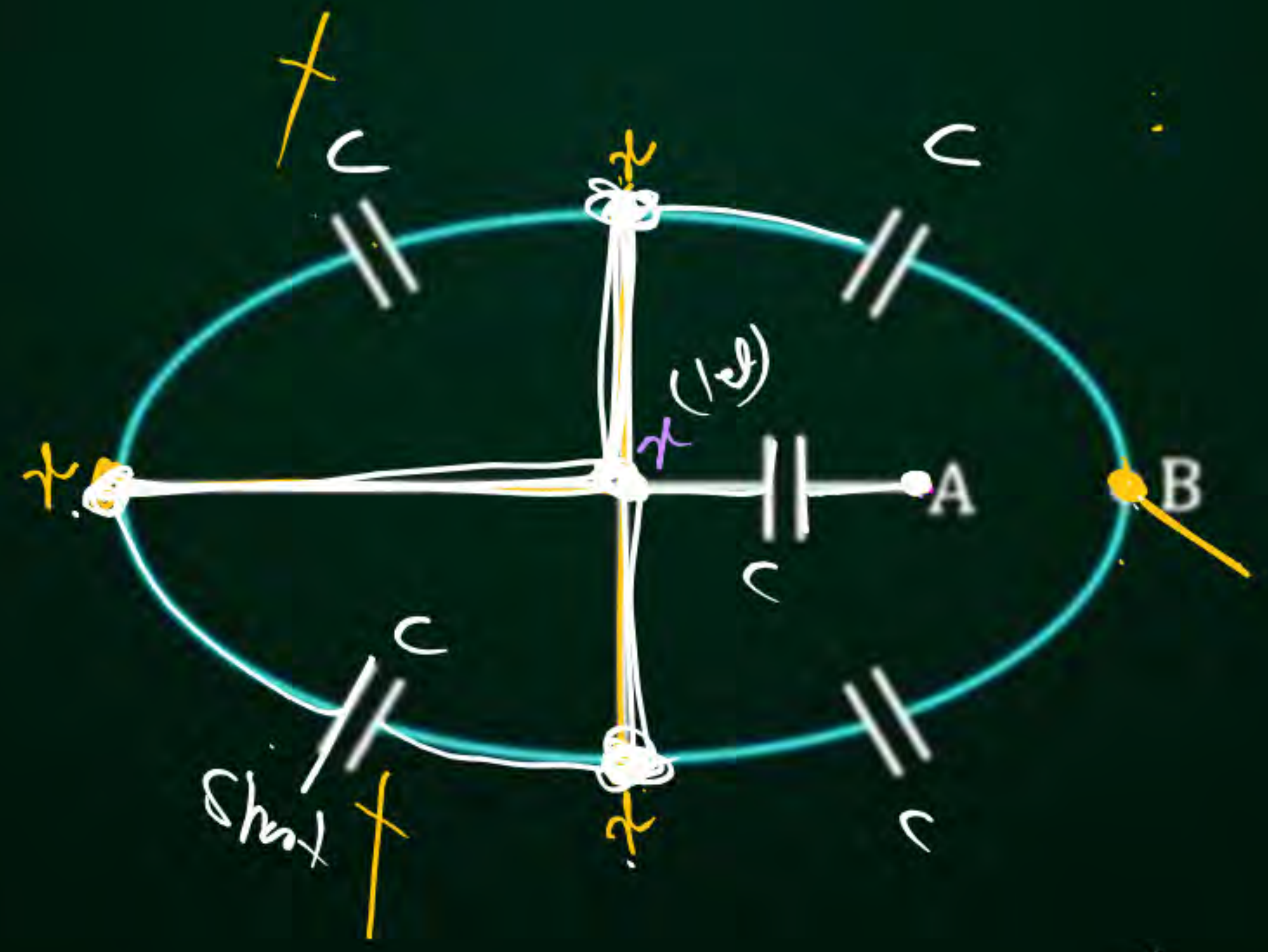
(c) $\frac{4C}{5}$

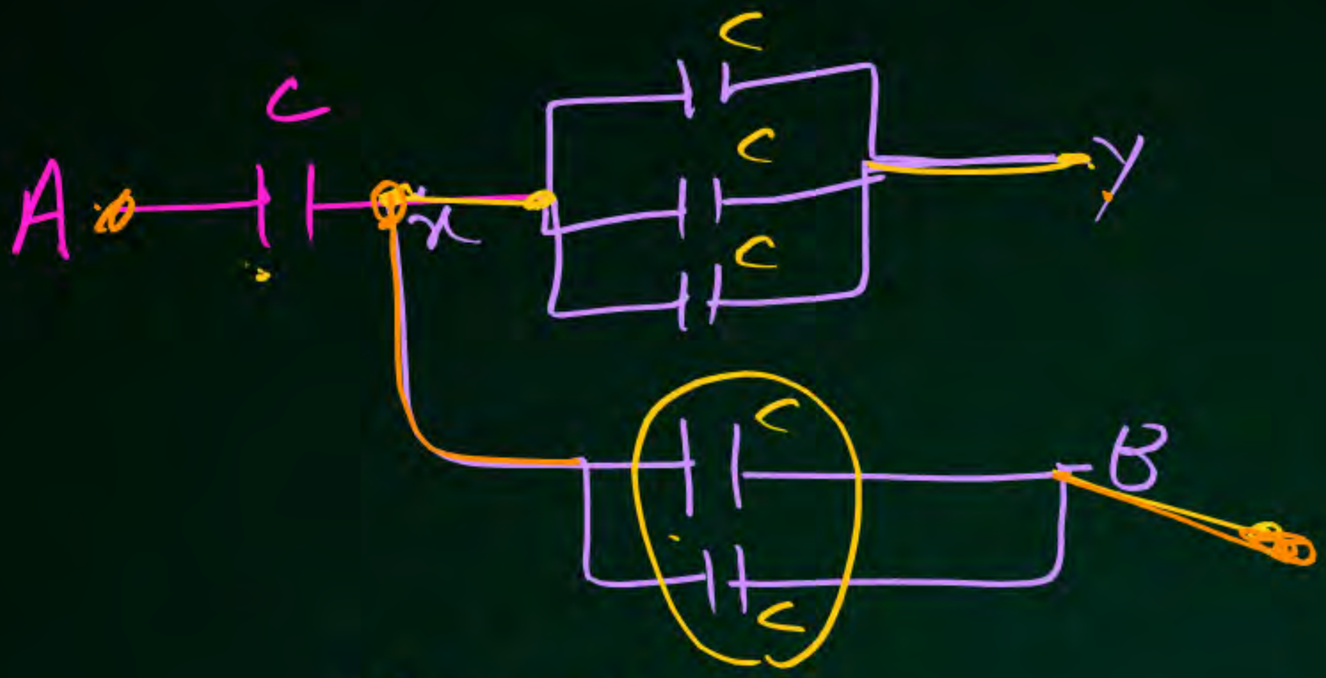
(d) $C/2$

(e) ✓ $\frac{2C}{3}$



$$C_{AB} = \frac{2C \times C}{2C + C} = \frac{2C^2}{3C} = \frac{2C}{3}$$



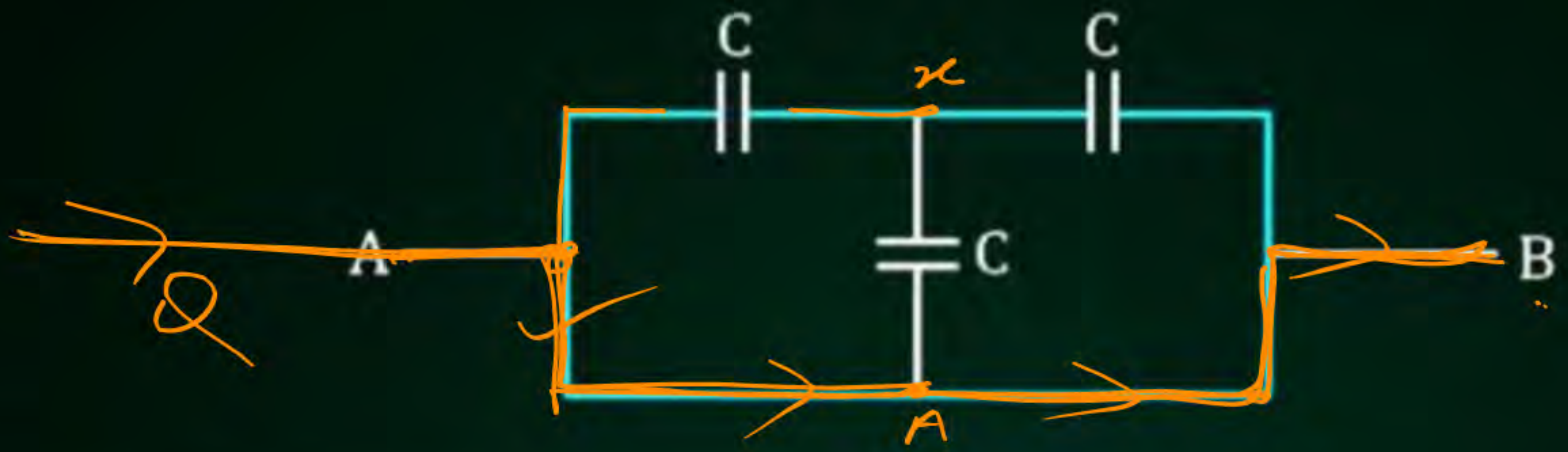


$C_{AB} = \frac{2C}{3}$

$\frac{6C}{11} = C_{eq}$

$C_{AB} = ??$



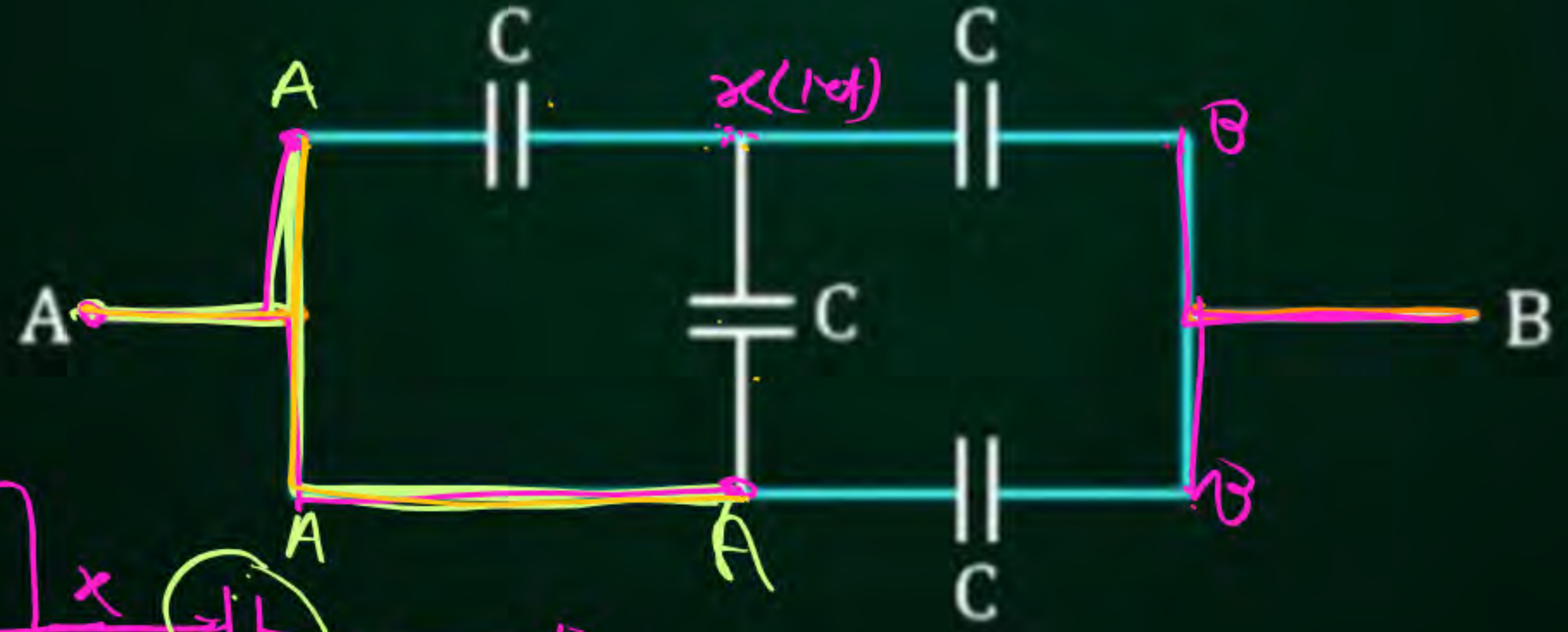


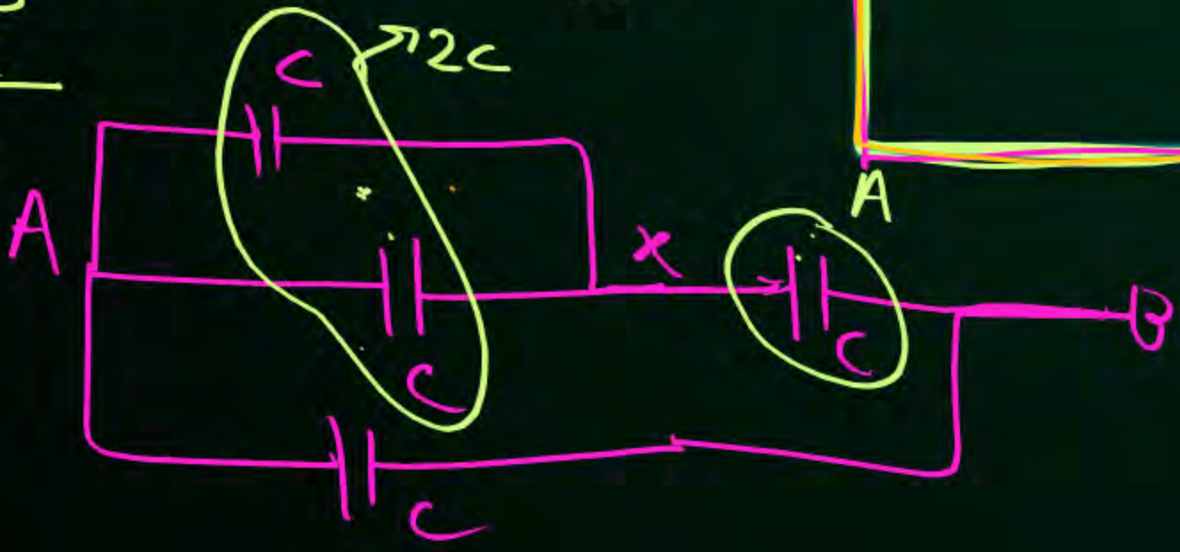
$C_{AB} = 0$ (zero)

$C_{eq} = \frac{2C \times k}{3k} = \frac{2C}{3}$

$C_{AB} = \frac{2C}{3} + C$

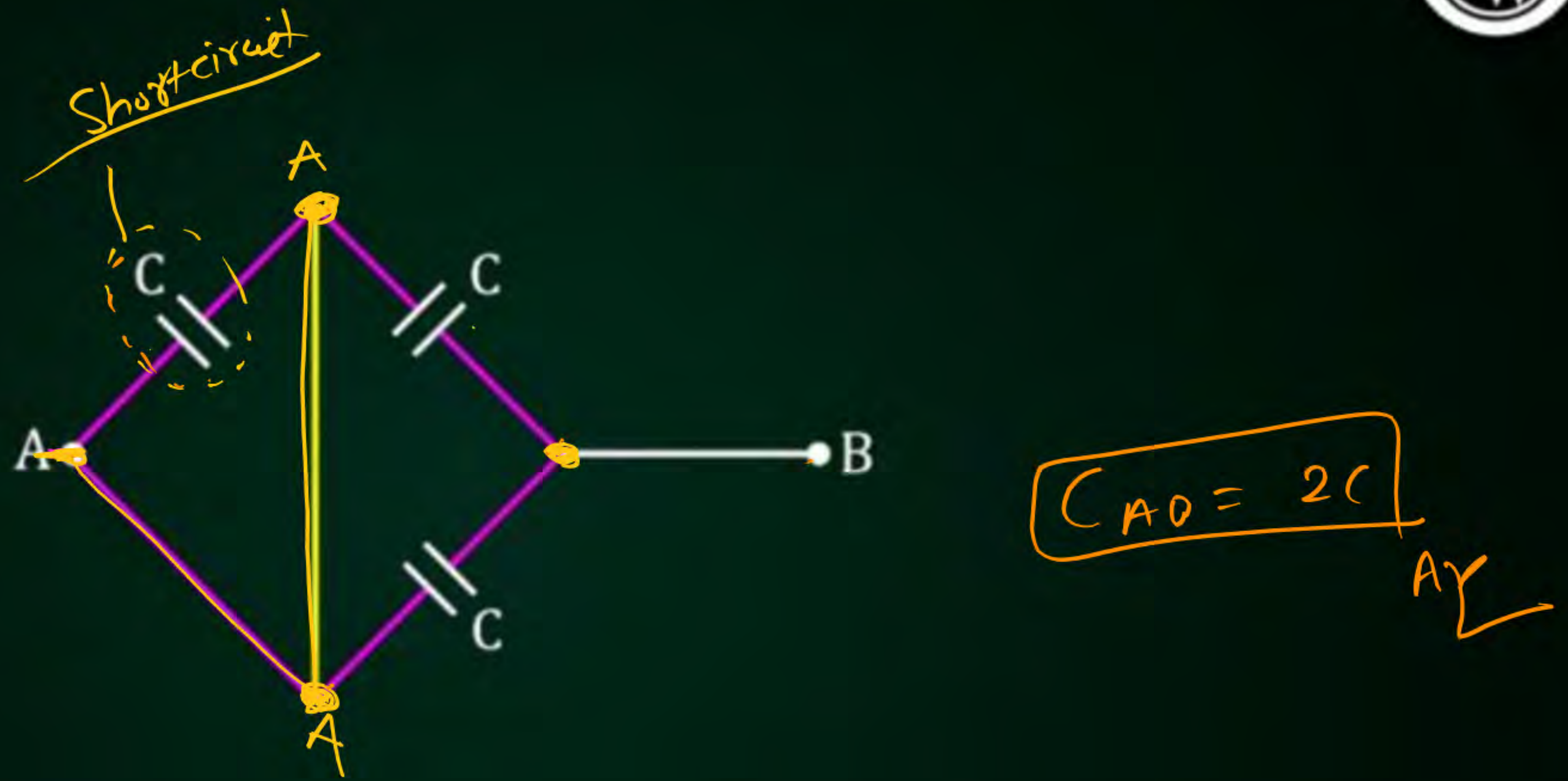
$= \frac{5C}{3}$ Ans





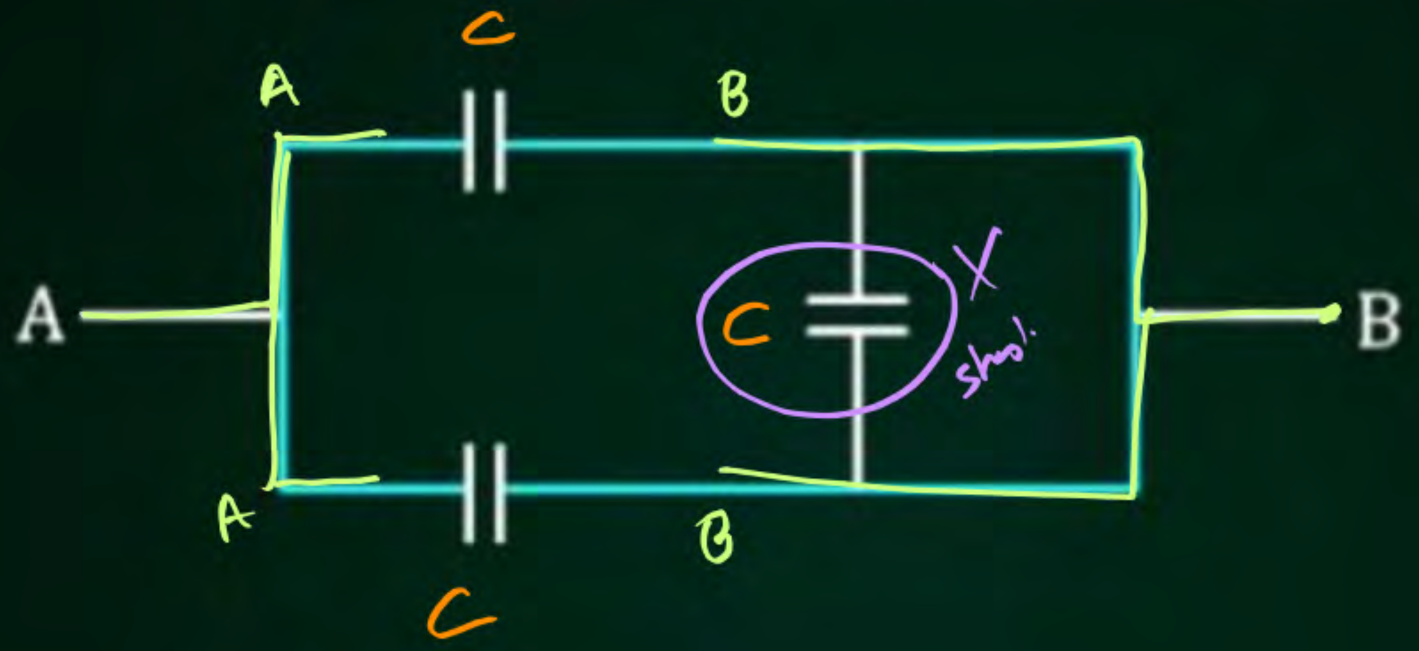
QUESTION

Find C_{AB}.



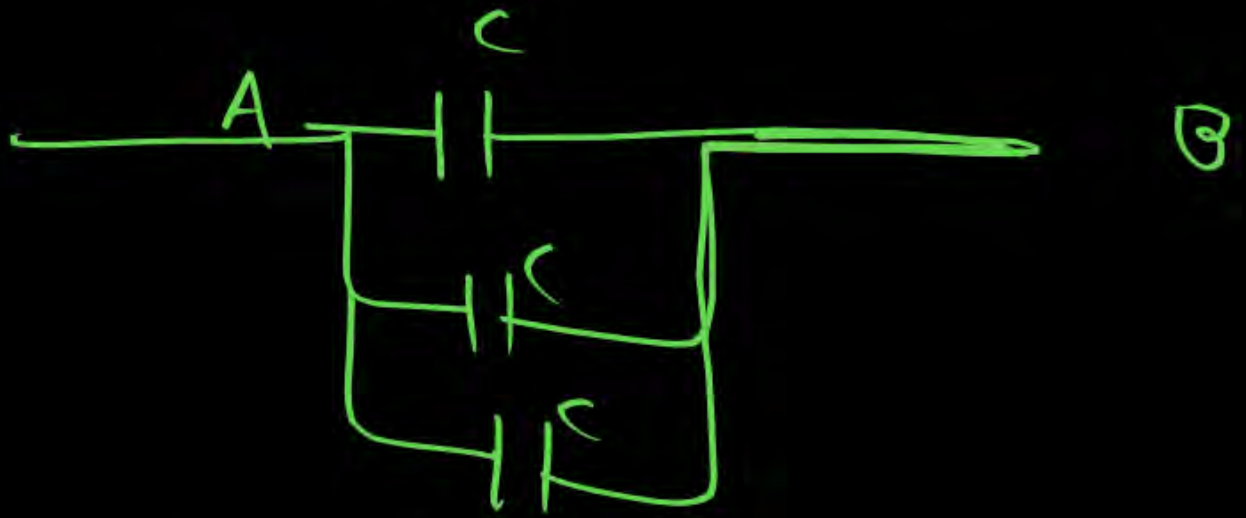
QUESTION

Find equivalent capacitance:





$C_{AB} = ??$



$C_{AB} = 3C$

Ap

78%

(a) 5c

(b) 4c

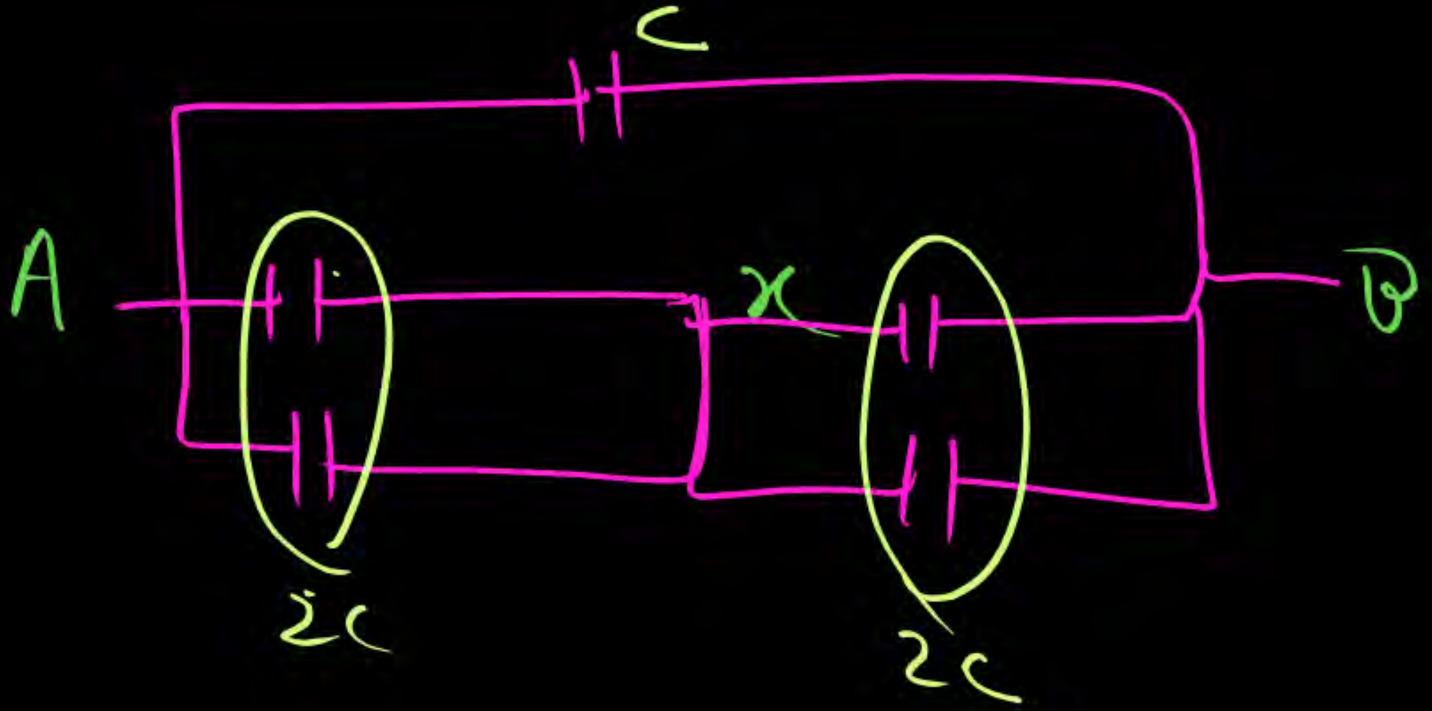
(c) 2C

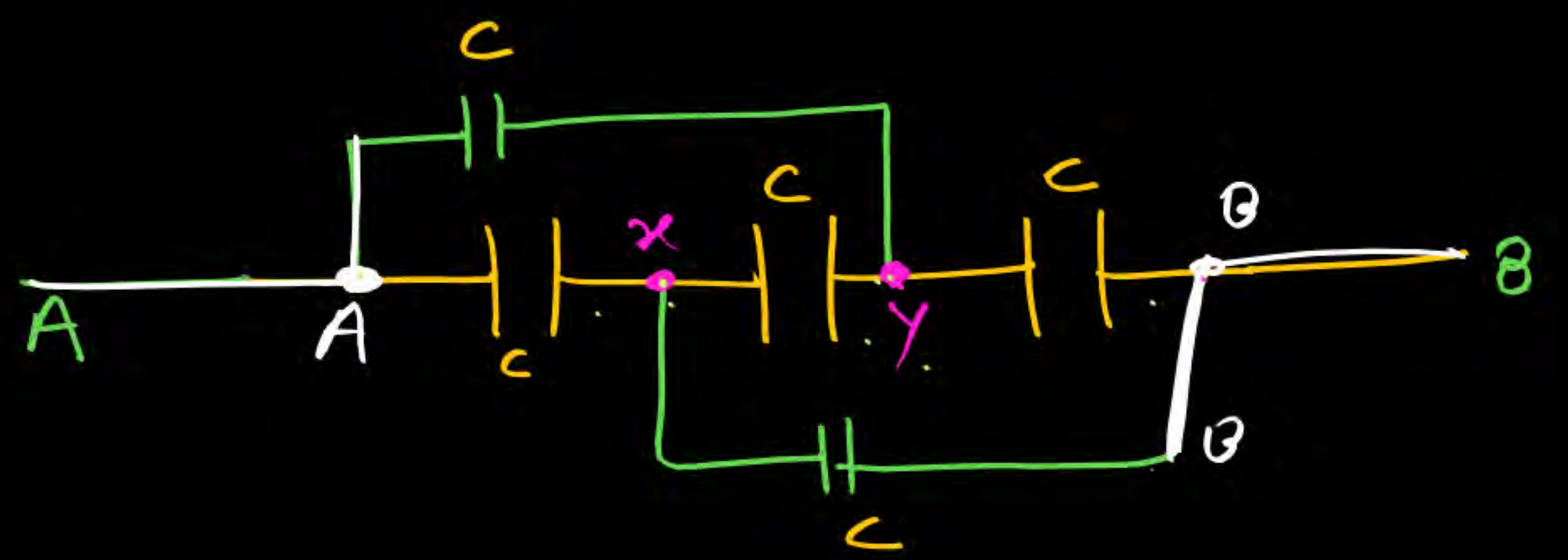
only 22%

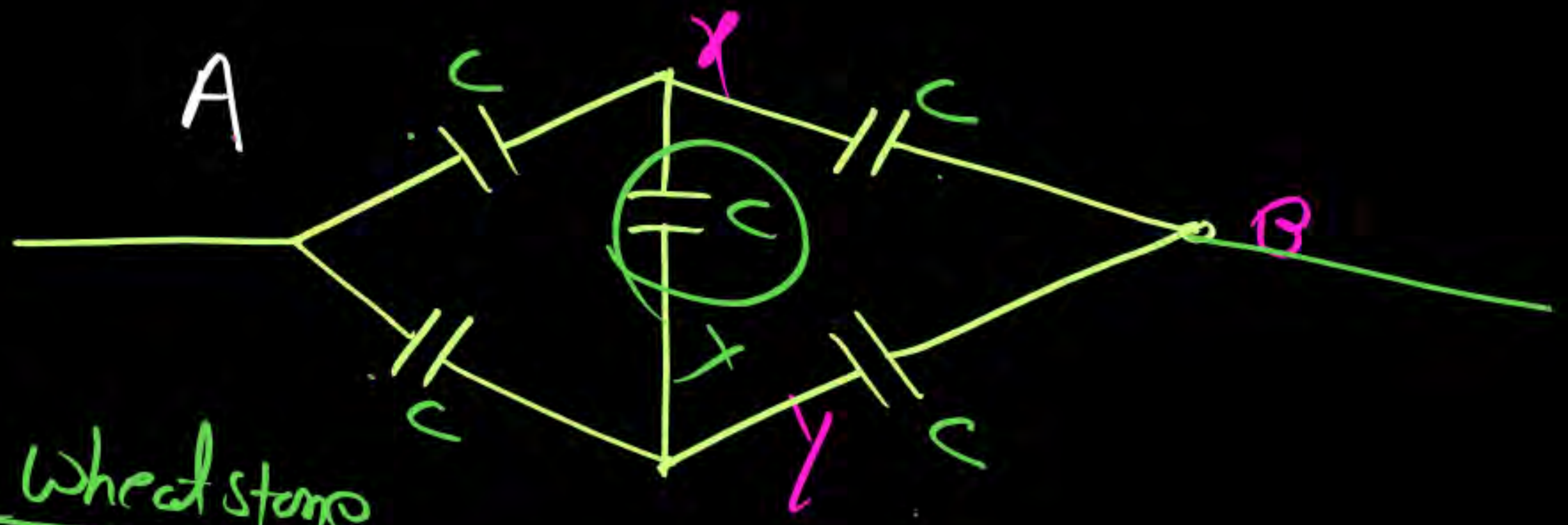
(d) C

(e) zero

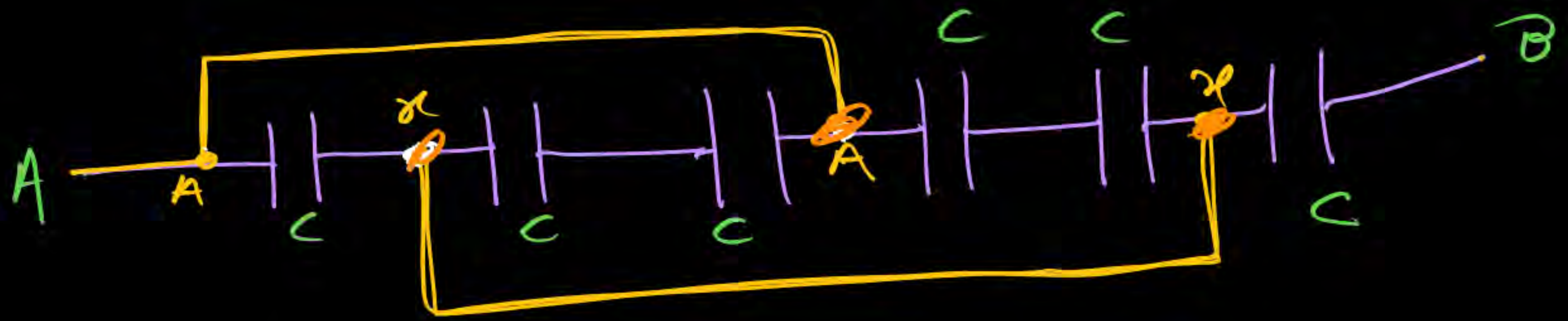


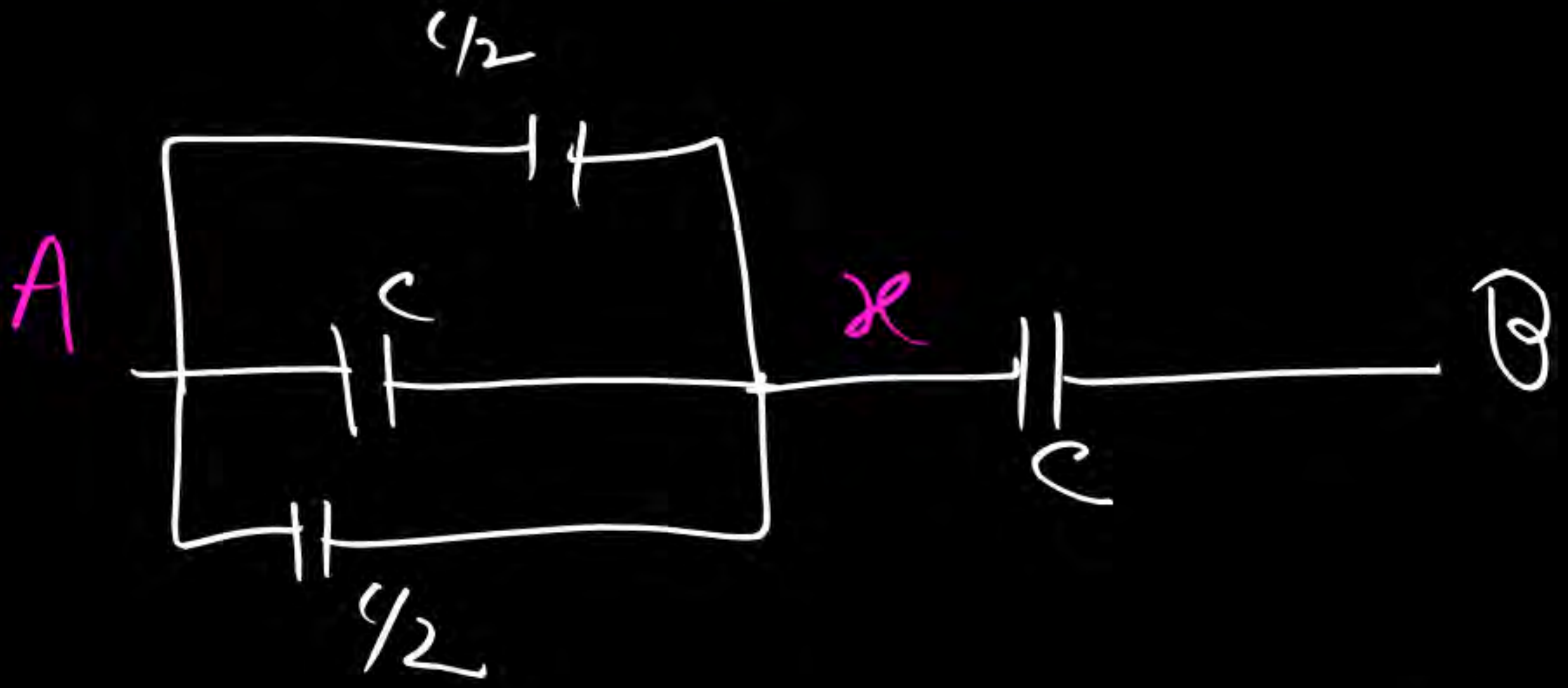




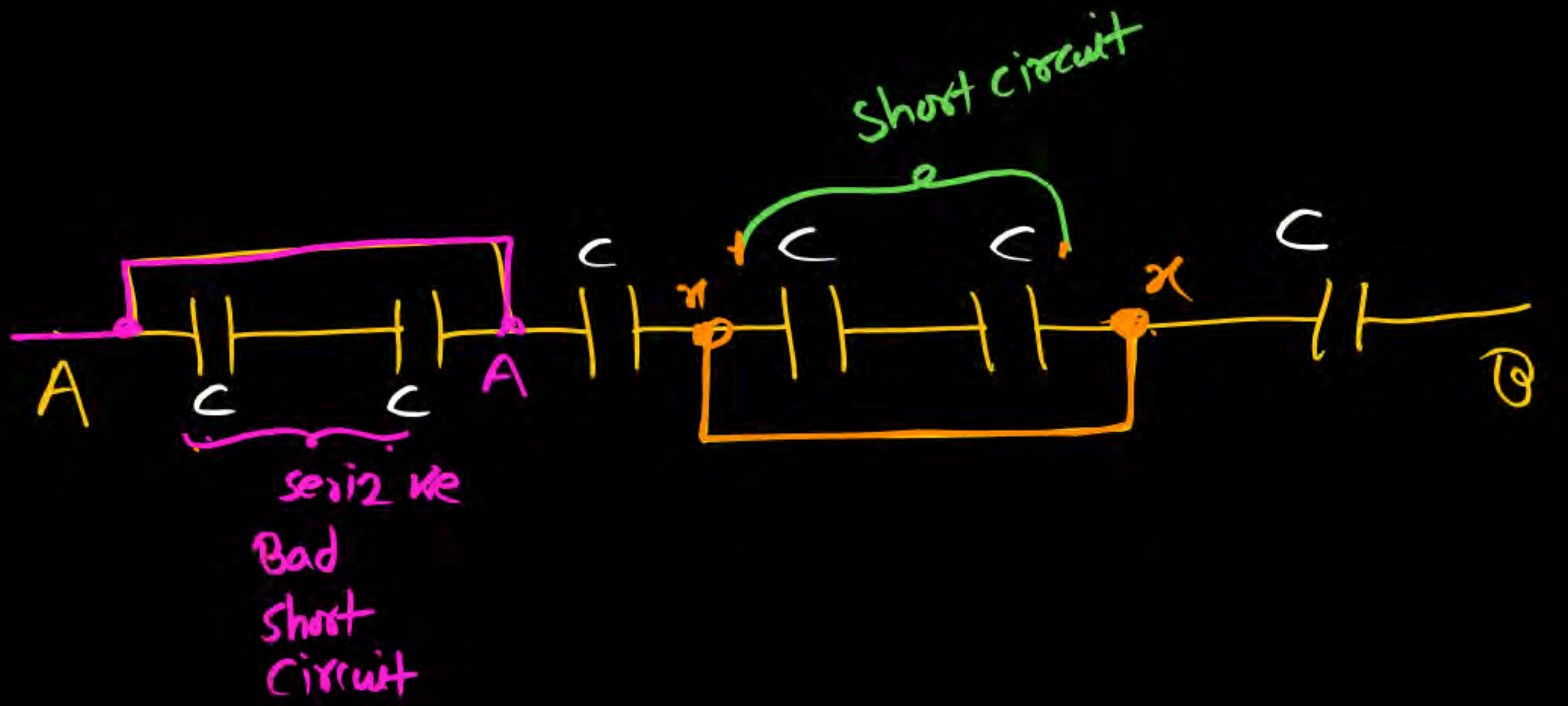


Wheatstone bridge $C_{AB} = C$ Ans





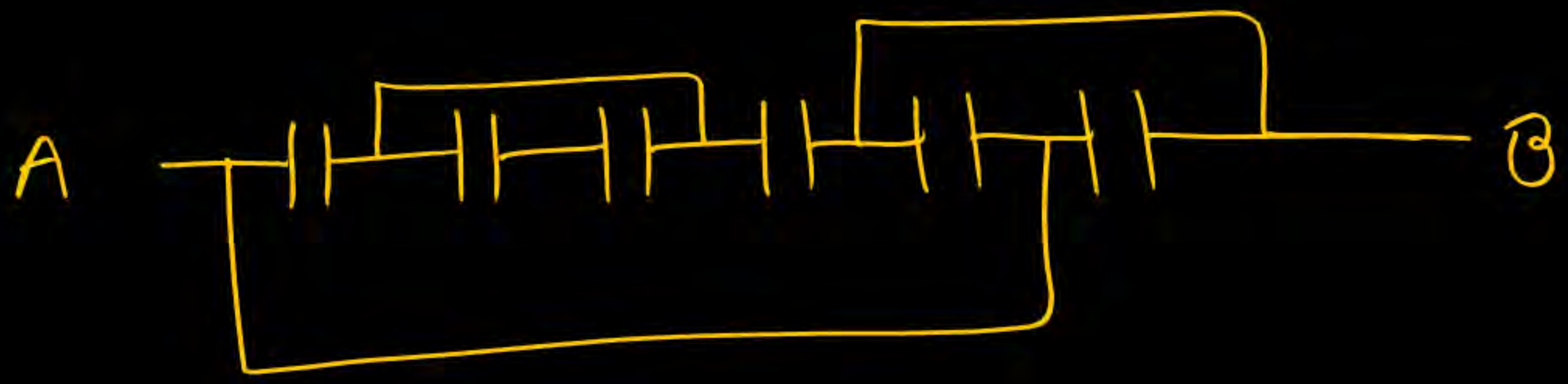
$$C_{AB} = \frac{2C}{3}$$


Short circuit
C
C
C
C
x
x
A
A
C
C
B
series me
Bad
short
circuit


A
x
B
C
C

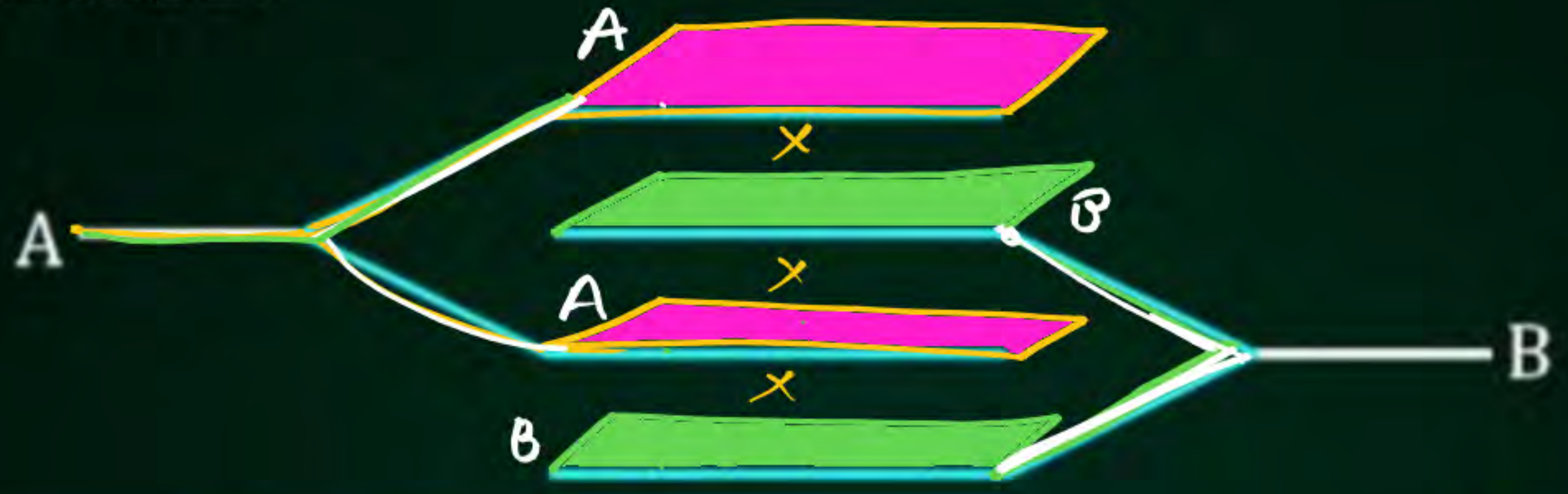
$$C_{AB} = \frac{C}{2}$$

H/W



QUESTION

Find C_q between A and B.



No of gaps = 3 - Capacitor



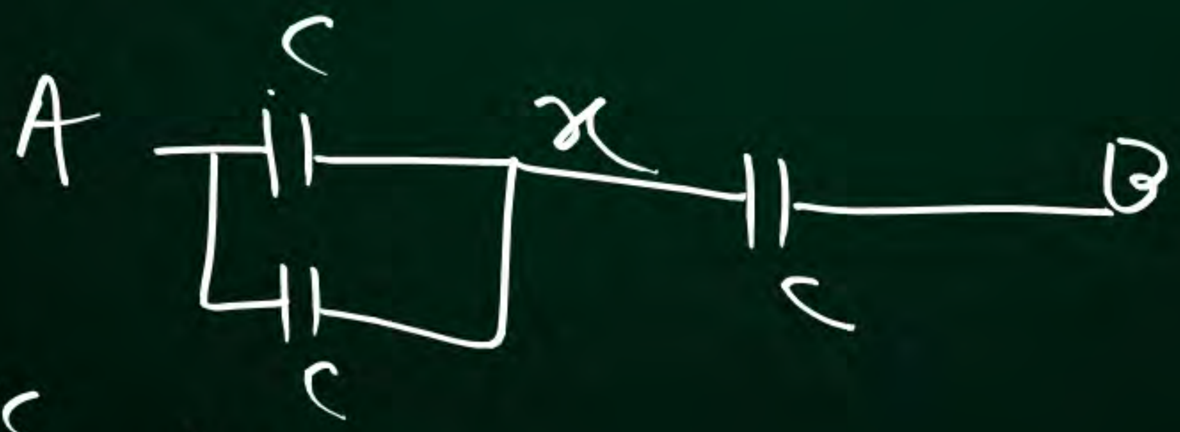
$C_{AB} = 3C$

QUESTION

Find



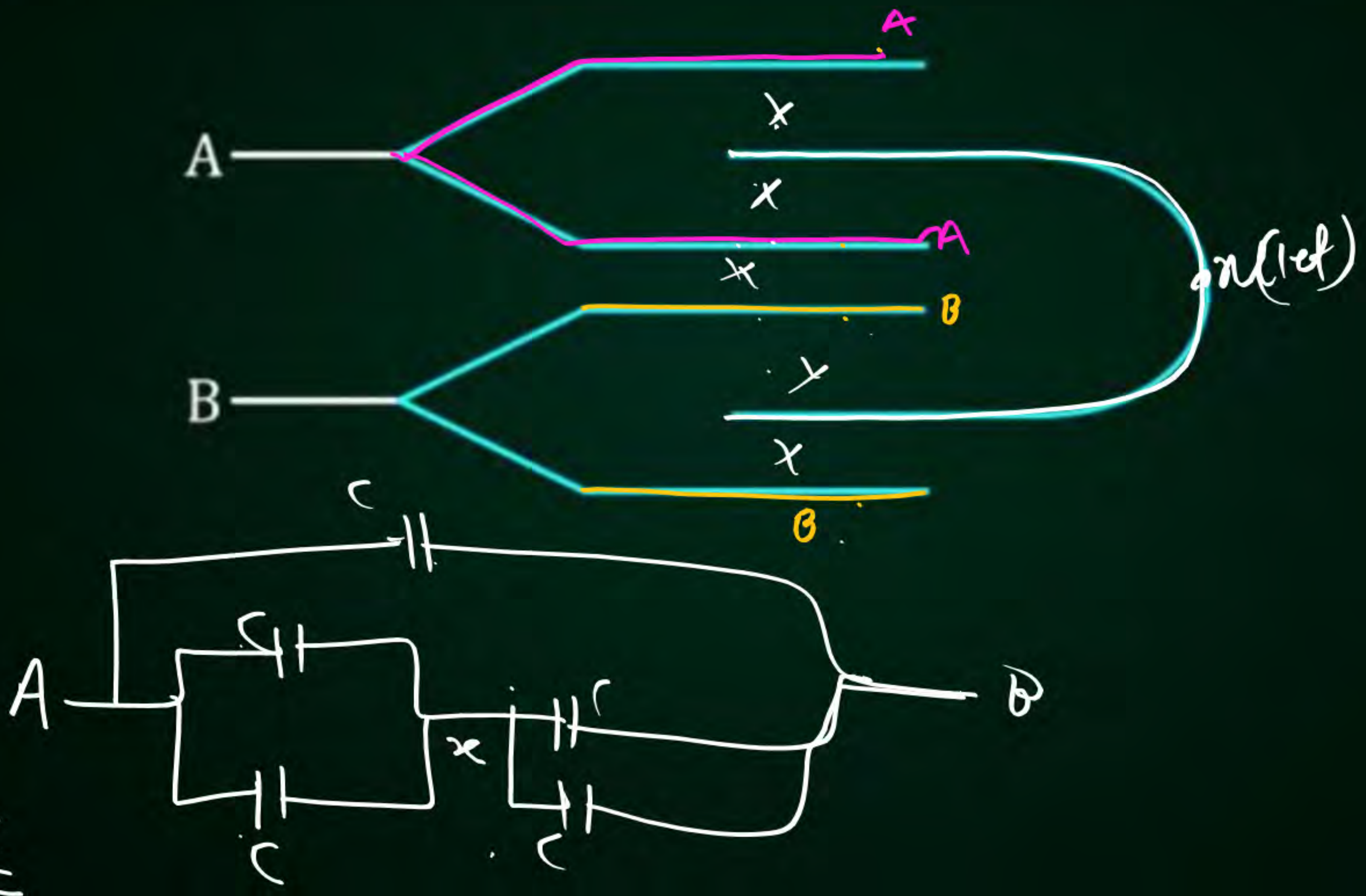
3- Capacitor



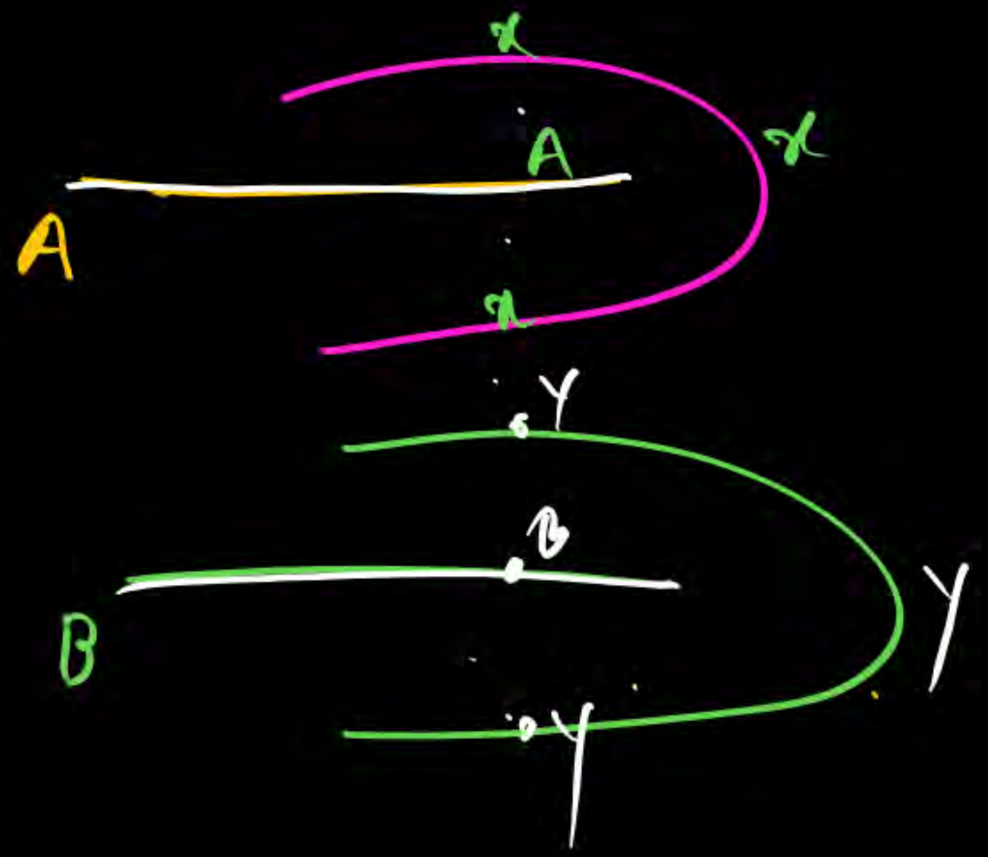
$$C_{AB} = \frac{2C \times C}{2C + C} = \frac{2C}{3}$$

QUESTION

Find $C_{AB} = ??$



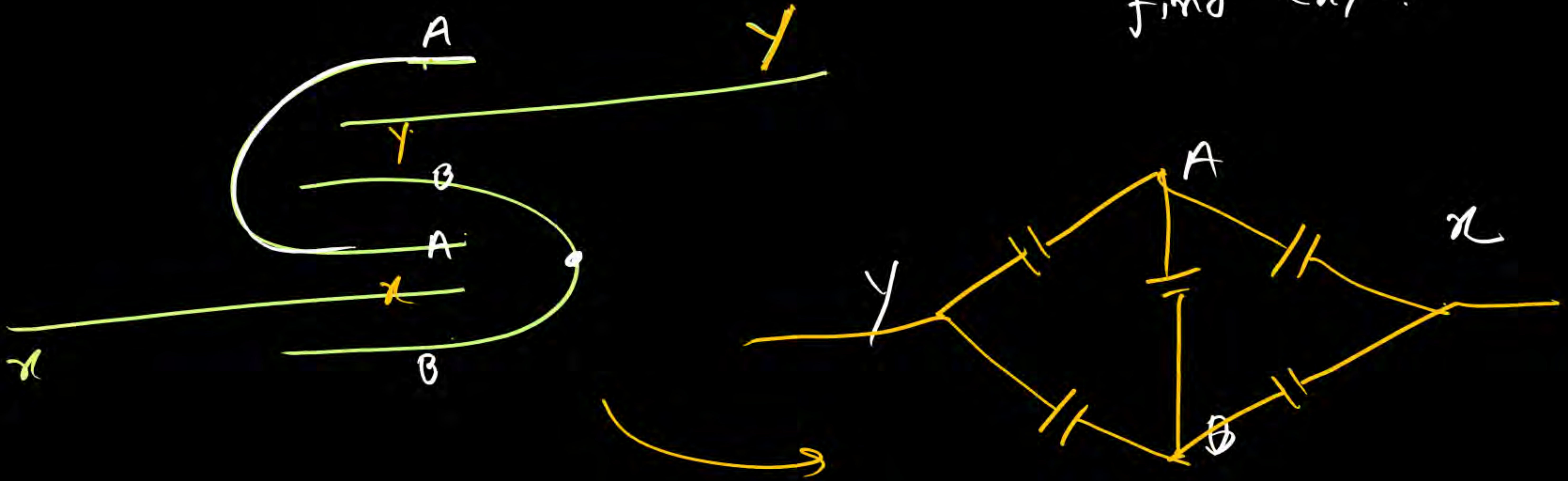
$C_{AB} = 2C$



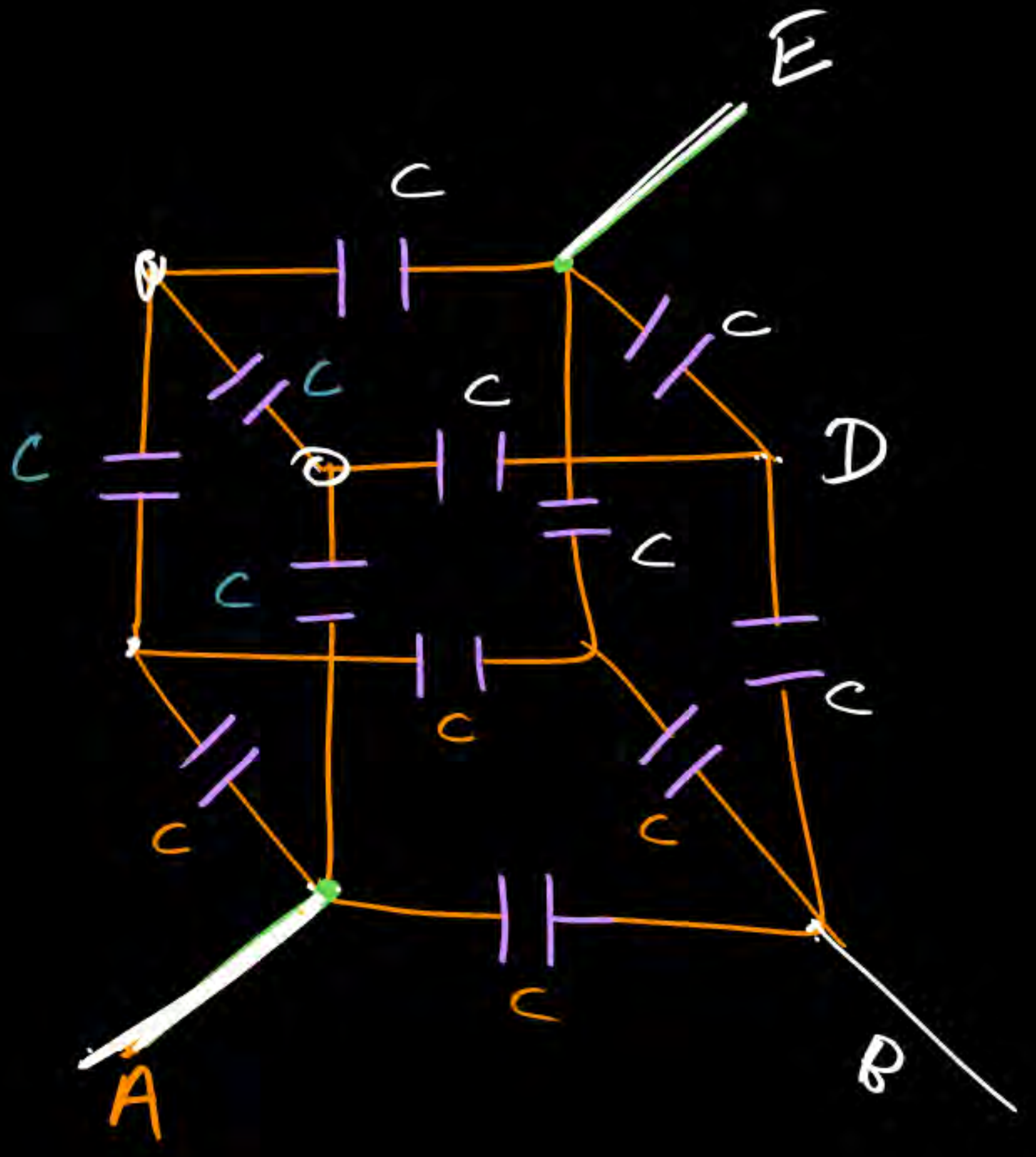


$$C_{AB} = \frac{C}{2}$$

find C_{xy} = ??



Wheat stone Brige



not for NEET ✗
Just for fun

$\Rightarrow$ $C_{AB} = \frac{12C}{7}$ $C_{AD} = \frac{4C}{3}$ $C_{AE} = \frac{6C}{5}$

$C_{AB} = \frac{12C}{7}$ $C_{AD} = \frac{4C}{3}$ $C_{AE} = \frac{6C}{5}$

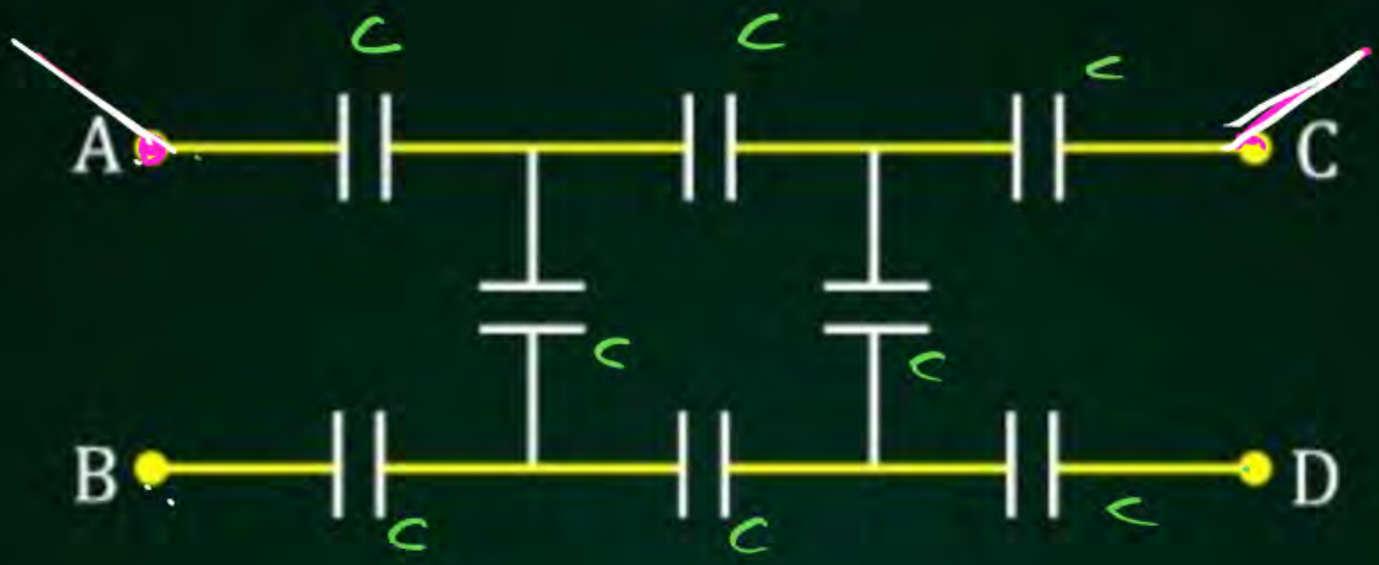
C_{AB} = (along side)

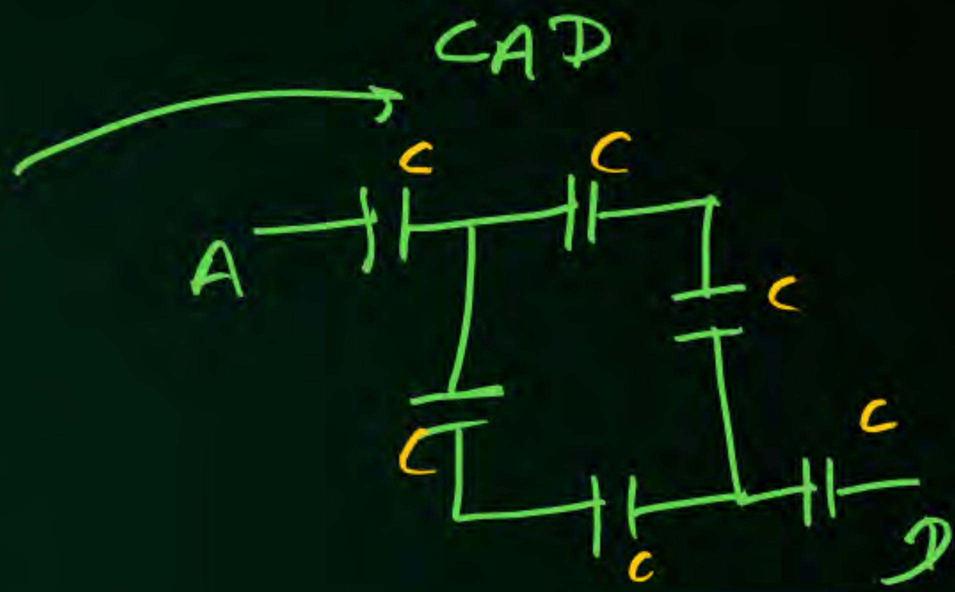
C_{AD} (Phase diagn)

C_{AE} (along body diagonal)

QUESTION

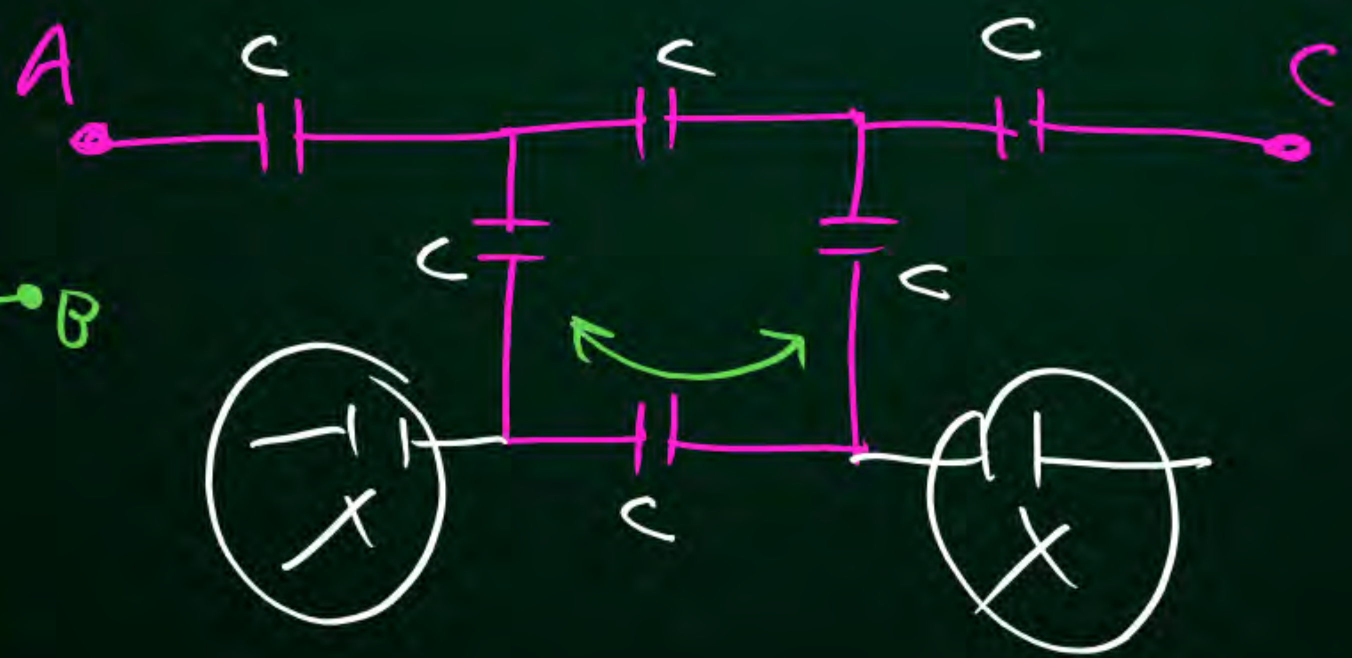
Find ...

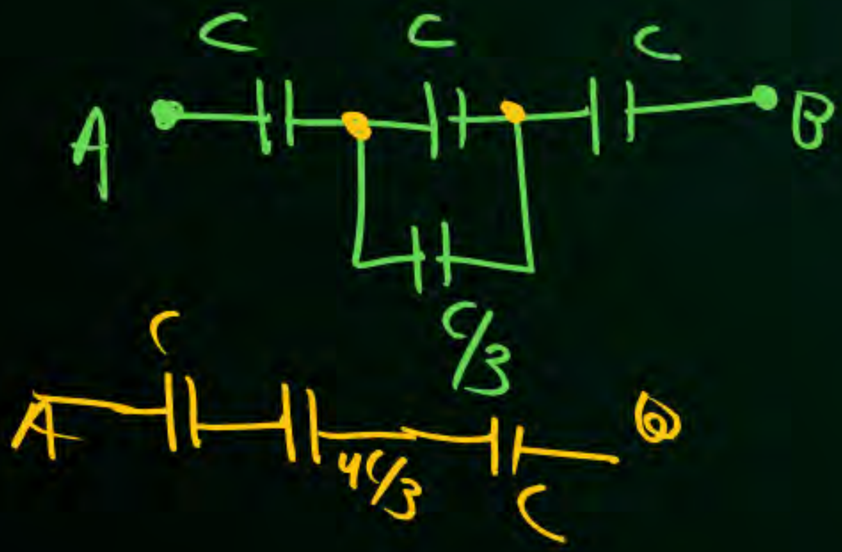




$C_{AD} = \frac{C}{3}$

$C_{AC} = ??$

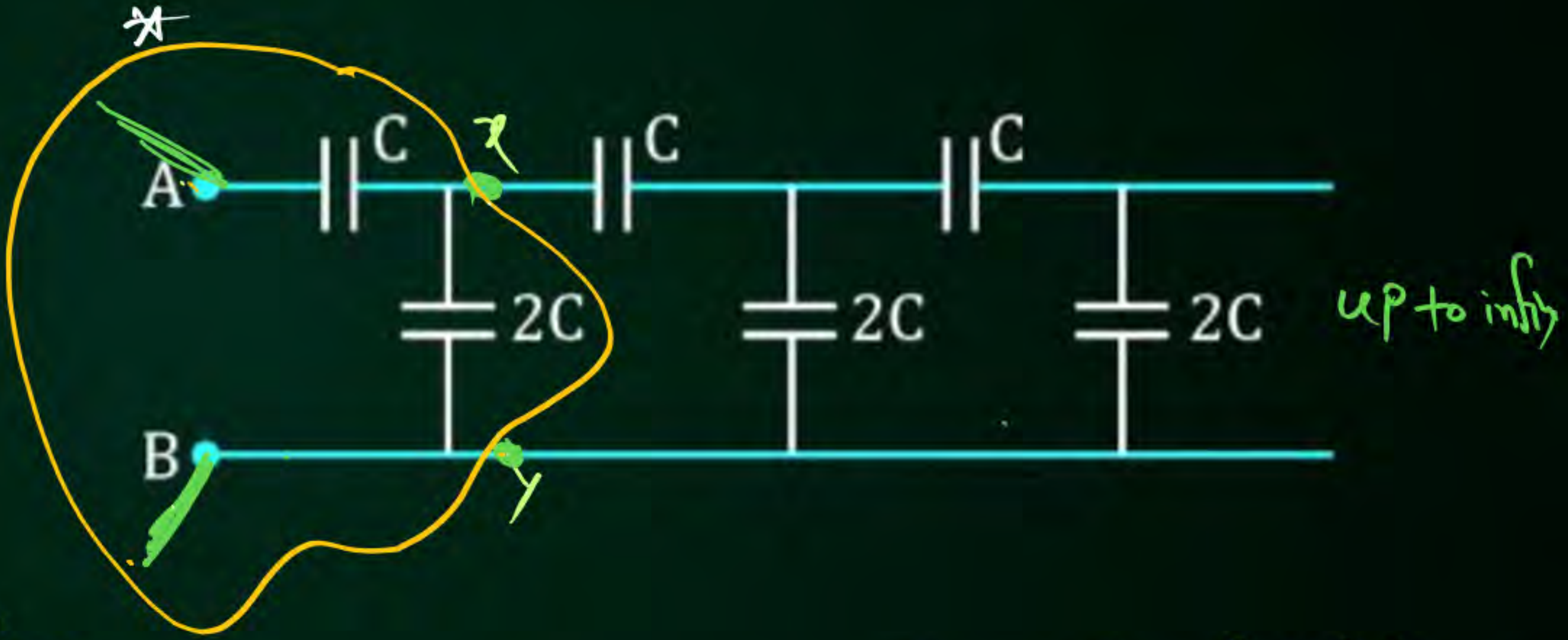




LADDER NETWORK

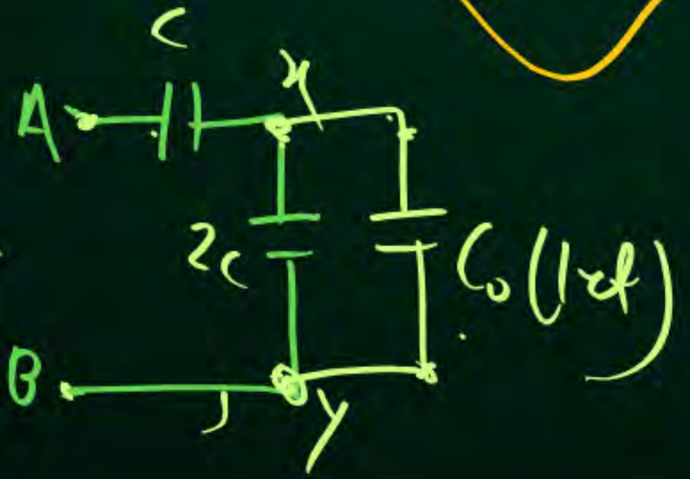
↳ aaj tak neet में nahi aaya

$\cancel{\text{imp}}$ $C_{AB} < C$



$C_{xy} = (C_0 + 2C)$

$$C_{AB} = \frac{(C_0 + 2C) \times C}{(C_0 + 2C) + C} = C_0$$



$C_0C + 2C^2 = (C_0 + 3C)C_0$

$CC_0 + 2C^2 = C_0^2 + 3CC_0$ H/W

$$C_0^2 + 2CC_0 - 2C^2 = 0$$


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 01 | **Physics**

Current Electricity



By- Dr. Manish Raj (MR SIR)

Topics to be covered

electric
feel of current

1. #
2. #
3. #



air/water/electric current ⟶ The rate of directional flow of air/water/charge is called air/water/electric current.

⟹ dirⁿ of current along the flow (motion) of +ve charge & opposite to the motion of negative charge ☆

I

in time 't' ⟶

$$I_{Avg} = \frac{\Delta Q}{\Delta t}$$

$$I_{Avg} = \frac{\int I\,dt}{\int dt}$$

at time 't' ⟶

$$I_{inst} = \frac{dq}{dt}$$

I_{inst} = slope of charge/time graph is electric current.

= scalar (does not follow Triangle law of vector addition)

⟹ Unit (Amp = 1 C/sec)

$$\Delta Q = \int I\,dt = \text{Area of current-time}$$

$$[\text{illegible}] = \int q\,dt$$

Area of charge-time graph

[illegible]

q

I

$$I = \frac{dq}{dt}$$

Slope of q/t graph = current

$$\frac{dI}{dt} = [\text{illegible}]$$

Slope of I/t graph = [illegible]

ELECTRIC CURRENT

- Scalar
- Moves in the direction of motion of +ve charge



QUESTION

A current of 0.6 A is drawn by an electric bulb for 10 minutes. Which one of the following is the amount of electric charge that flows through the circuit?

1. 6 C
2. 0.6 C
3. 360 C
4. 36 C

$\Delta Q = \int I\,dt$

$= 0.6\int_0^{600} dt$

$= \frac{6}{10} \times 600$

$= 360$



$I = 0.6\text{A}$ $t = 10\text{ min} = 10 \times 60\text{ sec.}$

$I = \frac{Q}{t}$

$Q = It$

QUESTION

If the amount of charge passing through the cell in 4 minutes is 480 C then calculate the current passing through the cell?

Sol^n

$$I = \frac{\Delta Q}{\Delta t}$$

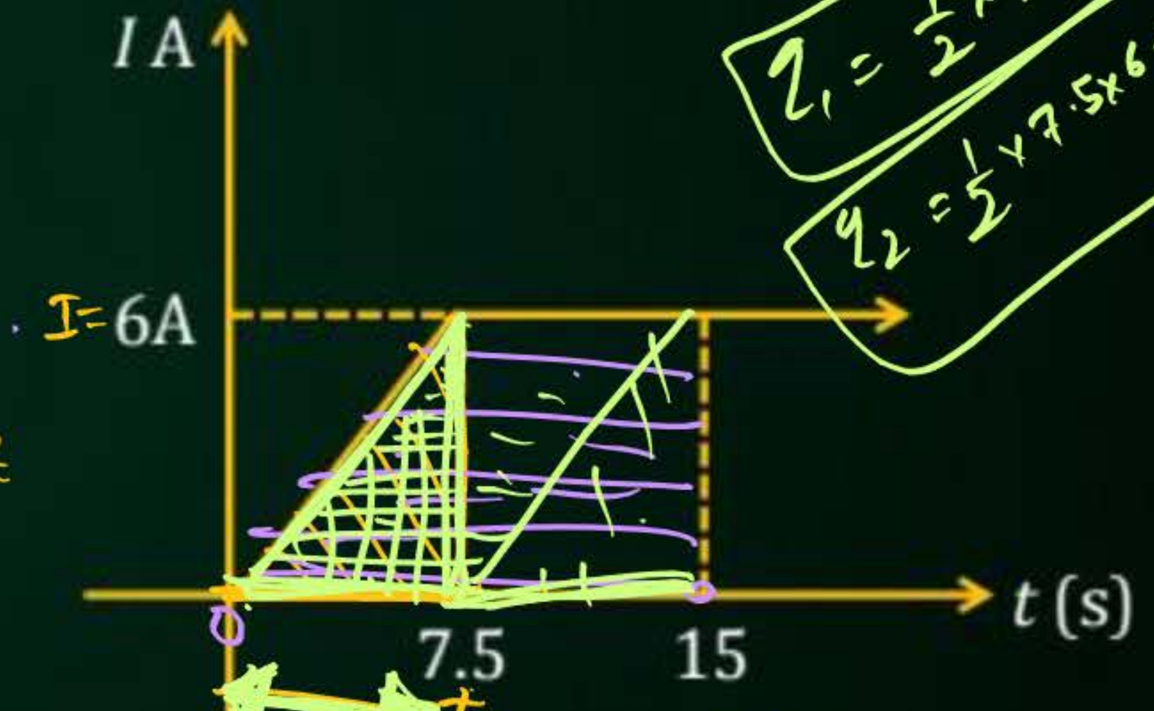
$$= \frac{480}{4 \times 60}$$

$$= 2 \text{ Amp}$$

QUESTION

The graph of current versus time in a wire is given by

If charge flows through the wire in 7.5s is q_1 and that flows through the wire in 15s is q_2, then ratio $q_1 : q_2$ is



1. 2 : 1
2. 1 : 2
3. 4 : 1
4. 1 : 4

QUESTION

The current in a wire varies with time according to the equation $I = 4 + 2t$, where I is in ampere and t is in sec. The quantity of charge which has passed through a cross-section of the wire during the time t = 2 sec tot = 6 sec will be:

1. 60 coulomb
2. 24 coulomb
3. 48 coulomb ✓
4. 30 coulomb

$I = 4 + 2t$

$$\Delta Q = \int_{t_1}^{t_2} I \, dt$$

$$= \int_2^6 (4+2t)\,dt = (4t)_2^6 + 2\left(\frac{t^2}{2}\right)_2^6 = 4[6-2] + (6^2 - 2^2)$$

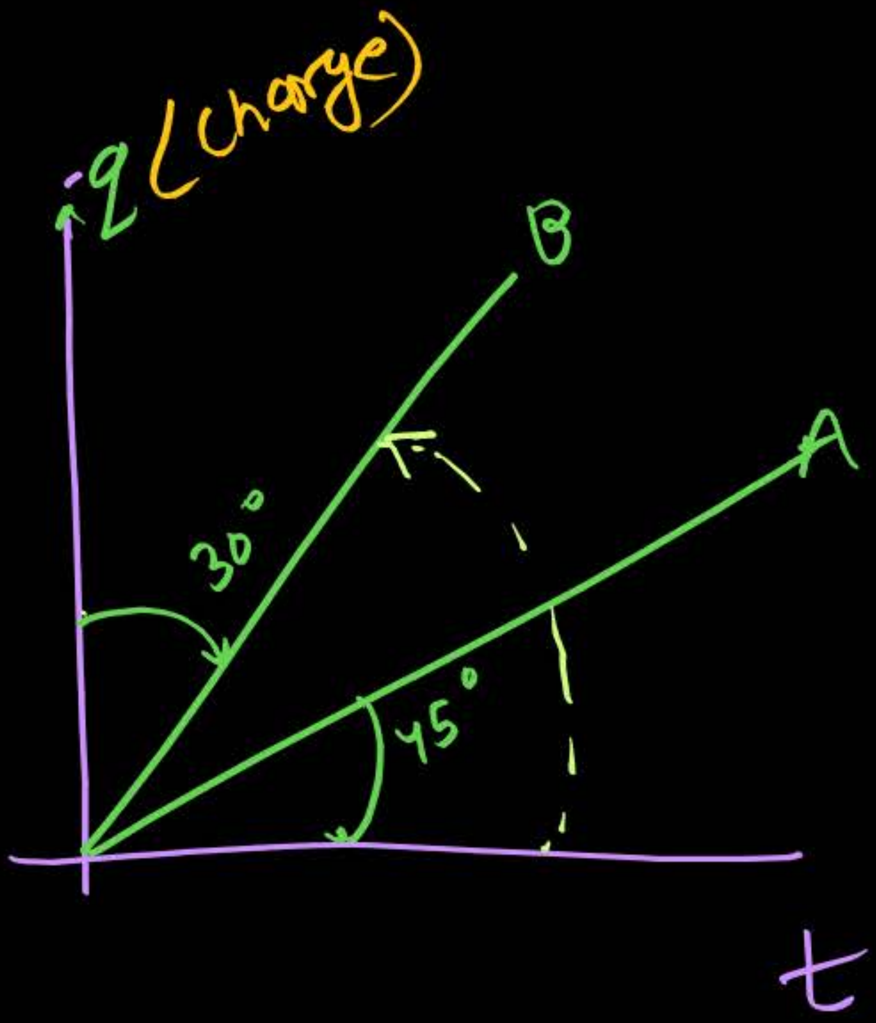
$$= 16 + (36-4) = 16 + 32 = 48\,C$$

\# $\frac{I_A}{I_B} = ??$

$$\Rightarrow \frac{I_A}{I_B} = \frac{\text{slope}_A}{\text{slope}_B} = \frac{\tan 45^\circ}{\tan 60^\circ}$$

$$= \frac{1}{\sqrt{3}}$$

$$= 1 : \sqrt{3}$$



QUESTION

If charge $Q = t^2 + 2t - 4$ is flowing through wire then find current at $t = 2$ sec and in 2 sec.

instantaneous   Avg

$$Q = t^2 + 2t - 4$$

$$I = \frac{dQ}{dt} = 2t + 2$$

$$I = 2t + 2$$

$$I_{at\, t=2} = 2 \times 2 + 2$$

$$I_{at\, 2sec} = 6\ \text{Amp}$$

$$\underset{\substack{\text{in 2 sec} \\ (0 \text{ to } 2\text{sec})}}{I_{Avg}} = \frac{Q_{2sec} - Q_{t=0}}{2}$$

$$= \frac{4 - (-4)}{2}$$

$$= \frac{8}{2} = 4\ \text{Amp}$$

QUESTION

Through a given cross section n_1 electrons per second are passing from left to right and n_2 protons per second are passing from right to left simultaneously. The electric current through that cross section is (e = electronic charge)

1. $(n_1 + n_2)\, e$ towards left
2. $(n_2 - n_1)\, e$ towards right
3. $(n_1^2 + n_2^2)\, e$ towards left
4. $(n_2^2 - n_1^2)\, e$ towards right

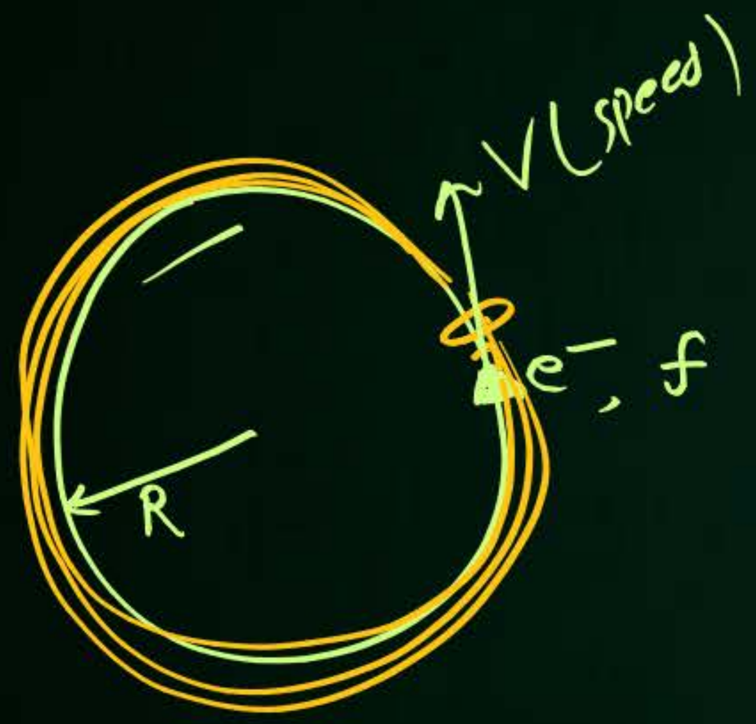
$I_{e^-} = n_1 e$

$I_{e^+} = \frac{n_2 e}{1\,s} = n_2 e$

$I = n_1 e + n_2 e = (n_1 + n_2)\, e$

QUESTION

If electron is moving on the circular path with frequency f then find current.

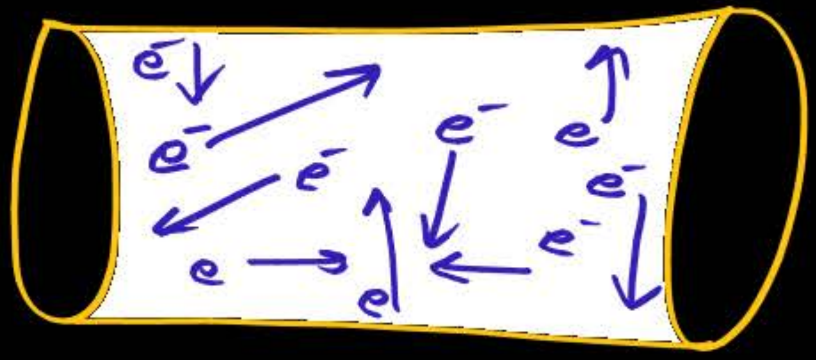


$$T = \frac{1}{f} \text{ (Time period)}$$

$$I_{Avg.} = \frac{q}{T} = \frac{e}{T} = ef \text{ Amp}$$

$$I_{Avg} = \frac{e}{\left(\frac{2\pi R}{V}\right)} = \frac{eV}{2\pi R} \text{ Amp}$$

Isolated conductor → Not Connected to any Battery.



$\uparrow$ speed $\propto \sqrt{\text{Temp}}\uparrow$

If we Increase ↑ then randomness will Increase

$E_{inside} = 0$ → force on $e^- = 0$

large no. of free e^-, moving inside Matter in random direction with high speed

speed $= 10^4$ m/s to 10^5 m/s.

but $\vec{\text{Velocity}} = 0$

due to random Moti

Path of e^- are straight line

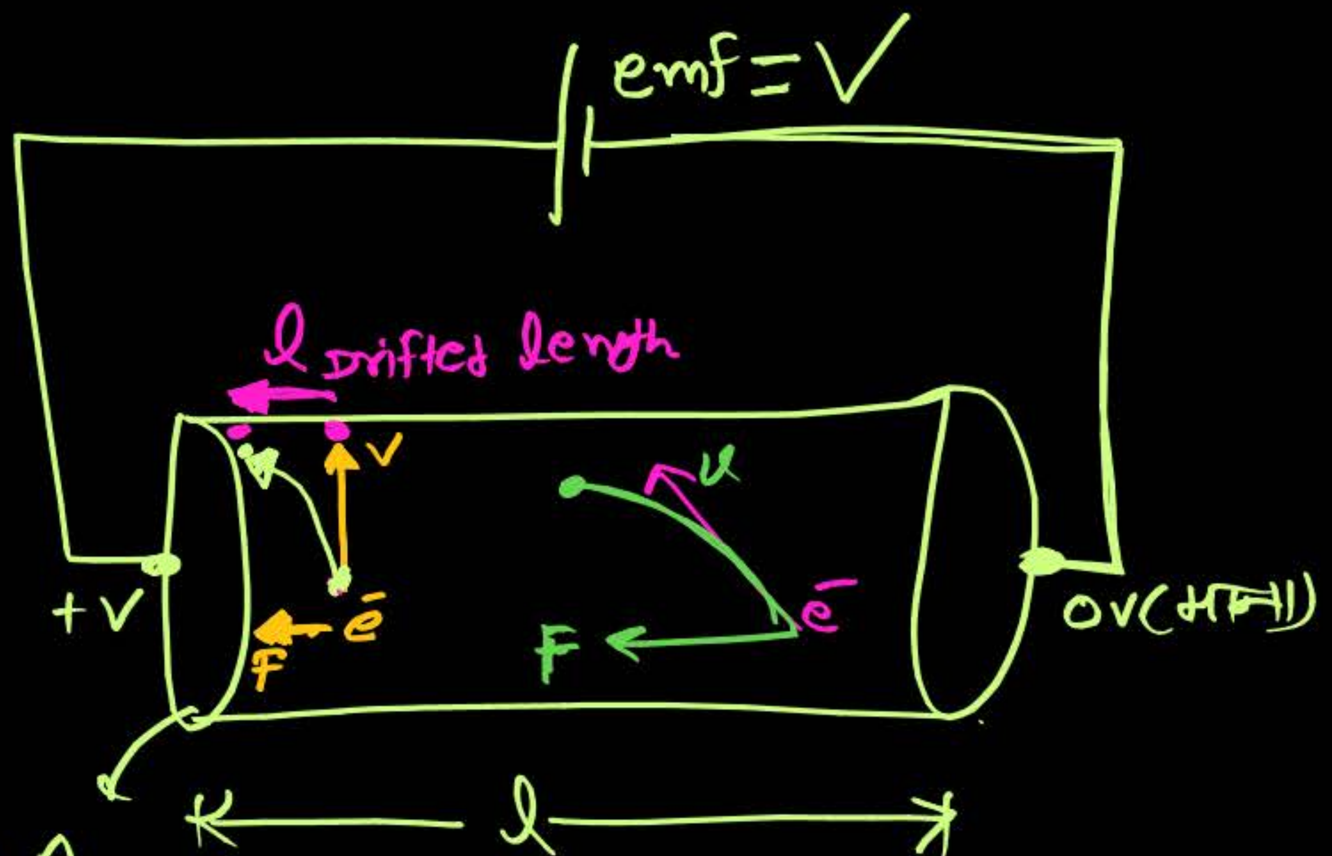
#

$F = eE$ ✓

$a = \frac{eE}{m}$ ✓

$v_y = \frac{eE}{m} \times t$ #

Think about it.



Cross-section Area = A

$E_{inside} = \frac{V}{l}$

Parabolic Path

$F = eE$

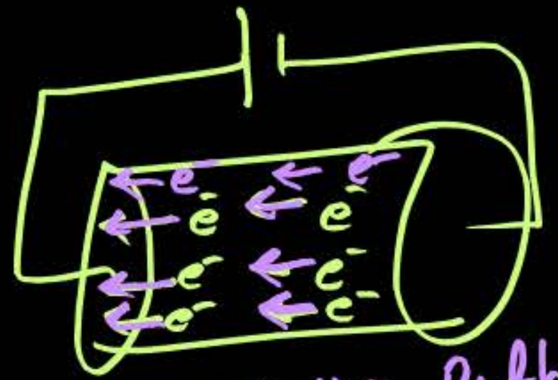
$a = \frac{eE}{m}$

drift velocity

$\vec{v}_d = \langle a \rangle \tau$ (relaxation time)

$\vec{v}_d = \frac{eE}{m}\tau$

$\vec{v}_d = \frac{eV\tau}{ml}$

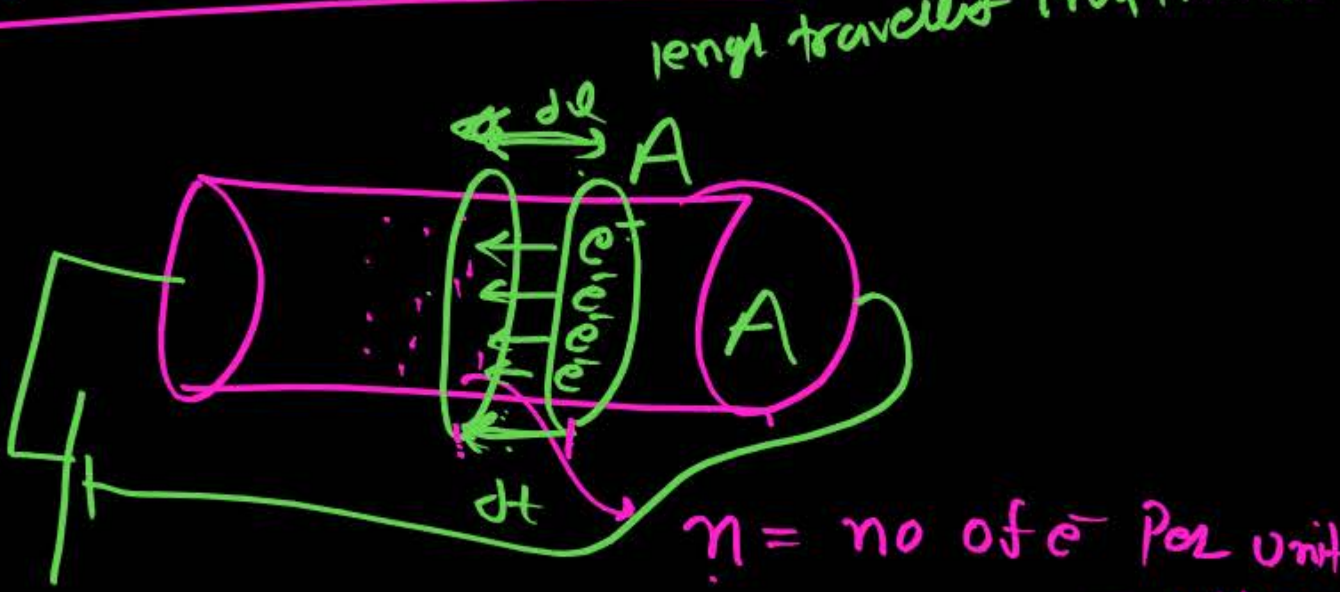


effective Path

τ (relaxation time)

τ = Avg time b/w two collision

Expression of Current



n = no of e^- per unit volume

$dq = [nA\,dl]e$

$$I = \frac{dq}{dt} = \frac{nA\,dl\,e}{dt}$$

$$I = neA\left(\frac{dl}{dt}\right)$$

#

$$\boxed{I = neAv_d}$$

v_d = drift velocity

A = Area

n = no. of e^- per unit volume

e = Charge of e^-

$$v_d = \frac{eE\tau}{m} \quad \text{—(I)}$$

$$v_d = \frac{I}{neA} \quad \text{—(II)}$$

(I) = (II)

$$\frac{eE\tau}{m} = \frac{I}{neA}$$

$$I = \frac{ne^2AE\tau}{m}$$

$E \to V$ (potential)

$$\boxed{I = \frac{ne^2\tau A\,V}{ml}}$$

$$\boxed{I = \frac{V}{R}}$$

$$\boxed{R = \frac{ml}{ne^2\tau A}}$$

Compare

Microscopic form of Ohms Law

$$R = \frac{\rho l}{A}$$

$$R = \frac{ml}{ne^2\tau A}$$

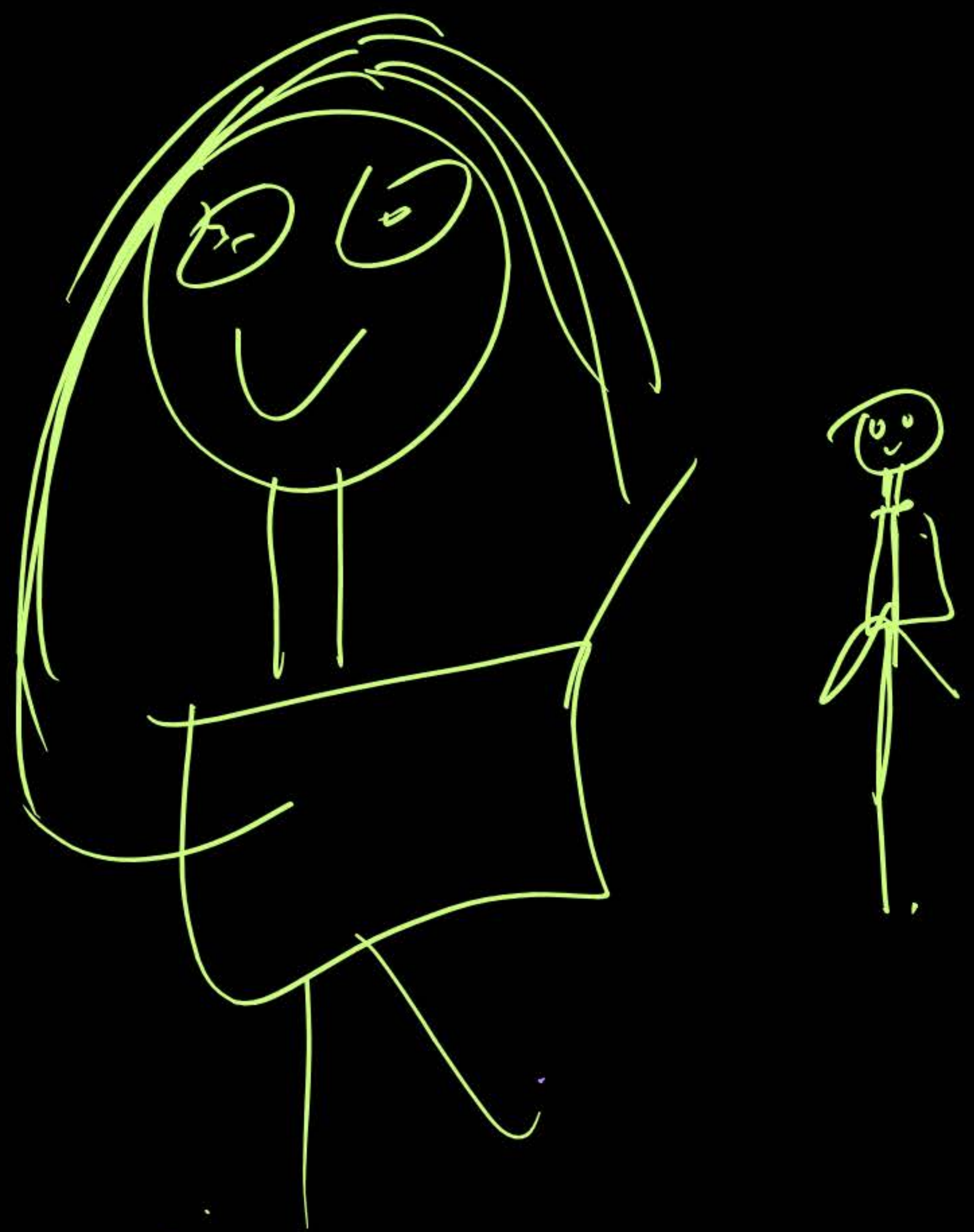
Compair

Resistivity

$$\rho = \frac{m}{ne^2\tau}$$

Conductivity $\sigma = \frac{1}{\rho}$

$$\sigma = \frac{ne^2\tau}{m}$$



Conductivity

(fead ka sath)

$$\sigma = \frac{ne^2\tau}{m}$$

MR Ratta

Resistivity

* $$\rho = \frac{1}{\sigma} = \frac{m}{ne^2\tau}$$

Resistance

$$R = \frac{\rho l}{A}$$

$$R = \frac{ml}{ne^2\tau A}$$

ohms Law

$$V = IR$$

$$V = \frac{Iml}{ne^2\tau A}$$ → microsopic of ohms Law

$$I = neAv_d$$ → *

$$v_d = \frac{eE}{m}\tau$$ → *

$$\sigma = \frac{ne^2\tau}{m}$$

$\rho = \frac{1}{\sigma}$

$\rho = \frac{m}{ne^2\tau}$

$$R = \frac{\rho l}{A}$$

$$R = \frac{ml}{ne^2\tau A}$$

$$V = IR$$

$$V = \frac{Iml}{ne^2\tau A}$$

$I = neAv_d$

$v_d = \frac{eE\tau}{m}$

$j = I/A$

MOBILITY = drift velocity per unit electric field.

$$\mu = \frac{v_d}{E}$$

- Property of charge particle.

$$\mu = \frac{e\tau}{m}$$

$$\mu = \frac{e\tau}{m}$$

$\mu_{e^-} = \frac{e\tau}{m_e}$

$\mu_p = \frac{e\tau}{m_p}$

$$\mu_e >> \mu_p$$

$$v_d = \frac{eE\tau}{m}$$

Putting value of v_d in mobility.

$$\mu = \frac{eE\tau}{mE} = \frac{e\tau}{m}$$

(Q) If v_d (drift velocity) becomes double then Mobility will??

Soln $\mu \rightarrow$ remains same

$\mu_{proton} =$

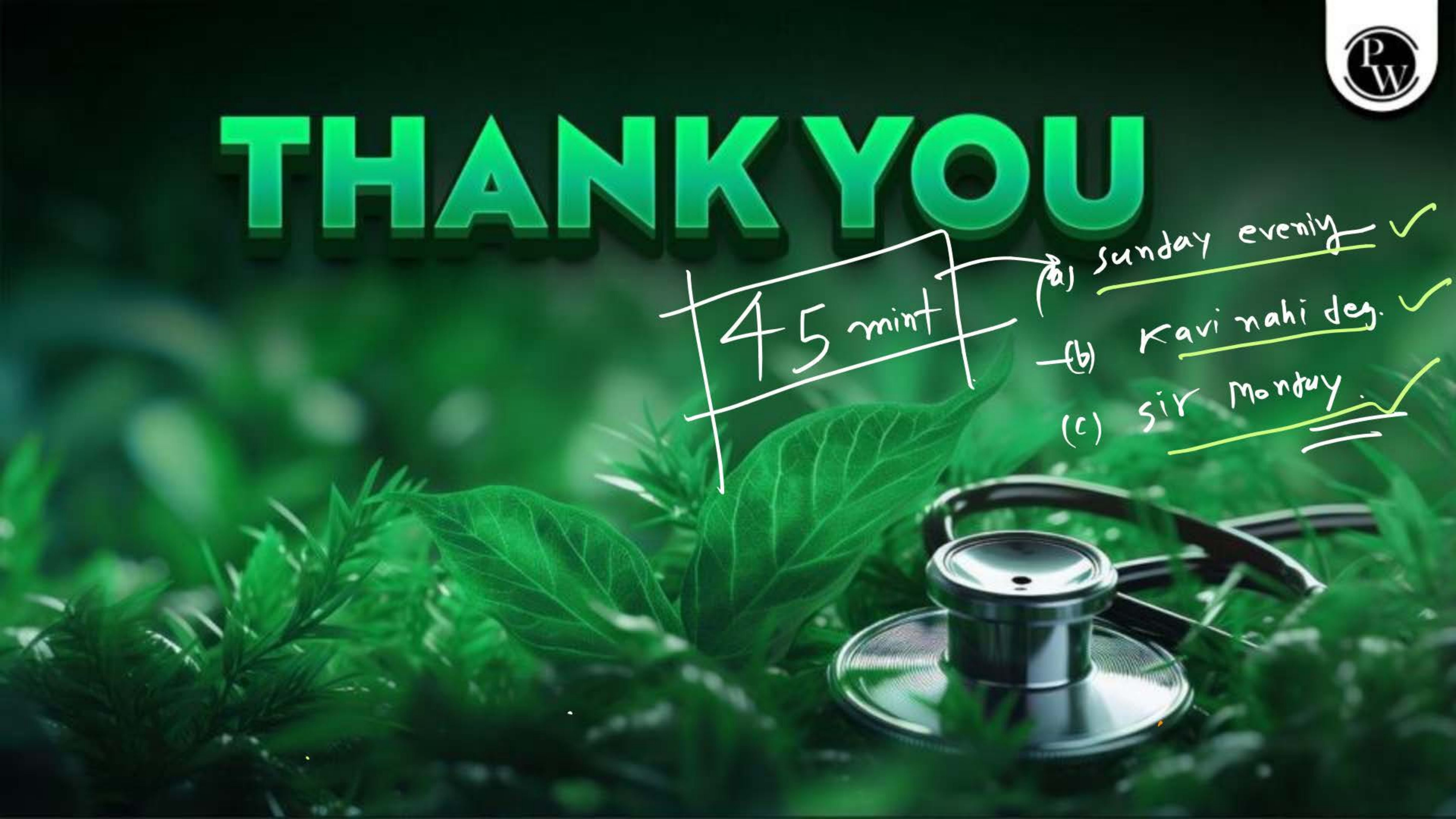
$(P) \rightarrow (m_p : e)$

$\mu_{Deutron} =$

$(P+N) \rightarrow (2m, +e)$

$\mu_{\alpha\text{-particle}} =$

$(2P+2N) \Rightarrow (2e, 4m)$


THANK YOU
45 mint
(a) sunday eveniy
(b) Kavi nahi deg.
(c) sir Monday

YAKEEN 2.0

FOR NEET 2025

Lecture- 02 | Physics

Current Electricity

By- Dr. Manish Raj (MR SIR)



Topics to be covered

1 # Variation of Resistance *

2 #

3 #



QUESTION

The total number of 2 μF, 300V capacitors needed to obtain a capacitance value of 4 μF rated for 1200 V is:

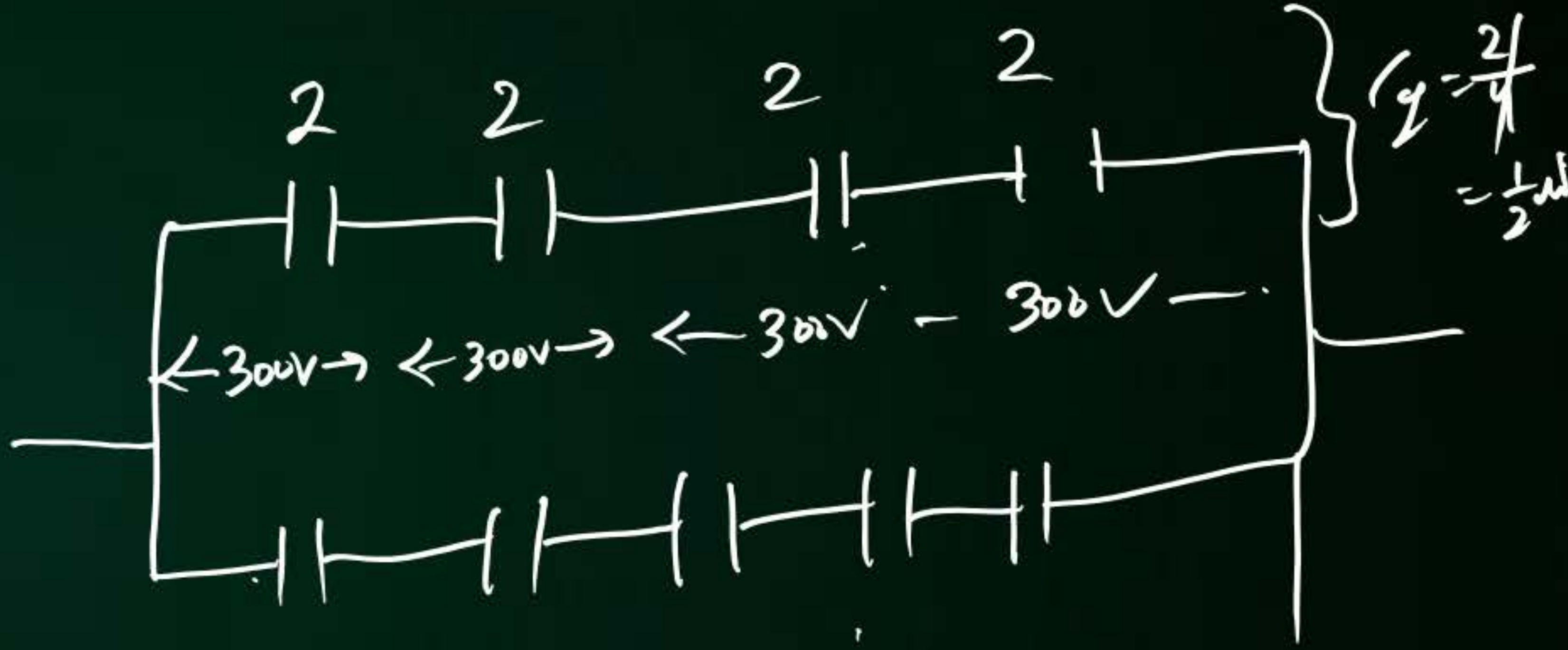
avilable

* $C = 2\mu f$
* $V = 300$ Volt

required

$C = 4\mu f$

$V = 1200$ volt



n- times

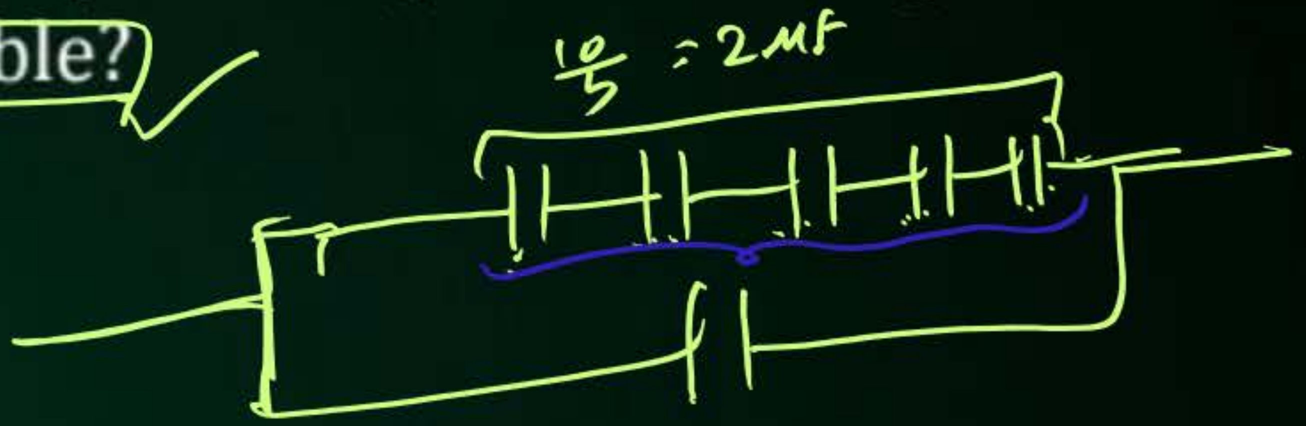
$n \frac{1}{2} = 4$

$n = 8$

no. required Capa = 32

QUESTION

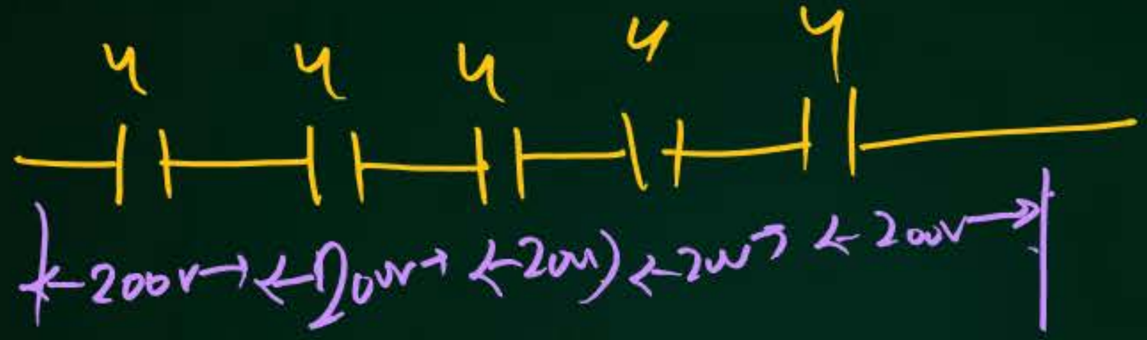
What would be the minimum number of capacitors required to produce an equivalent capacitance of 12 μF, only 10 μF capacitors are available?



1. 2
2. 6
3. 4
4. 12

QUESTION

Available capacitor is 4 μF, 200V no of required, this capacitor to obtain 8 μF net capacitance and required breakdown voltage 1000V.



$n\frac{4}{5} = 8$

$n = 10$

Total no of capacitor = 50

QUESTION

A capacitance of 2 μF is required in an electrical circuit across a potential difference of 1.0 kV. A large number of 1 μF capacitors are available which can withstand a potential difference of not more than 300V. The minimum number of capacitors required to achieve this is:

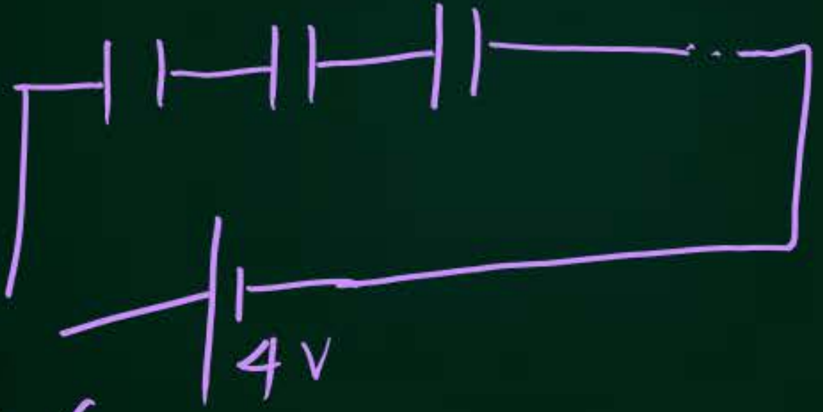
17/22

1. 32
2. 2
3. 16
4. 24

QUESTION

A series combination of n_1 capacitors, each of value C_1, is charged by a source of potential difference 4V. When another parallel combination of n_2 capacitors, each of value C_2, is charged by a source of potential difference V, it has the same (total) energy stored in it, as the first combination has. The value of C_2, in terms of C_1, is then

1. $\dfrac{2C_1}{n_1 n_2}$
2. $16\dfrac{n_2}{n_1}C_1$
3. $2\dfrac{n_2}{n_1}C_1$
4. $\dfrac{16C_1}{n_1 n_2}$ ✓



$C_{eq} = C_1/n_1$

emf = 4 V

$E = \frac{1}{2}\frac{C_1}{n_1}(4V)^2 = \frac{8C_1V^2}{n_1}$ — (1)



$\frac{8C_1V^2}{n_1} = \frac{1}{2}n_2C_2V^2$

$n_2 = \frac{16C_1}{n_1 n_2}$

DRIFT VELOCITY/OHM LAW

IMP* flow

$\sigma = \frac{ne^2 \tau}{m}$

- n = no. of e^- density = m^{-3}
- e = charge of e^-
- m = mass of e^-
- τ = relaxation time.

$\rho = \frac{1}{\sigma}$

$\rho = \frac{m}{ne^2 \tau}$

→ depends upon nature of conductor.

$$R = \frac{\rho l}{A}$$

$$R = \frac{m l}{ne^2 \tau A}$$

ohms Law

$$V = IR$$

$$V = \frac{I m l}{ne^2 \tau A}$$

microscopic ohms law.

$I = neAv_d$

$v_d = \frac{eE}{m}\tau$

$$\mu = \frac{v_d}{E} = \frac{e\tau}{m}$$

current density $J = I/A$

$I = \vec{J} \cdot \vec{A}$

$I = neAv_d \Rightarrow J = nev_d$

$$J = ne\mu E$$

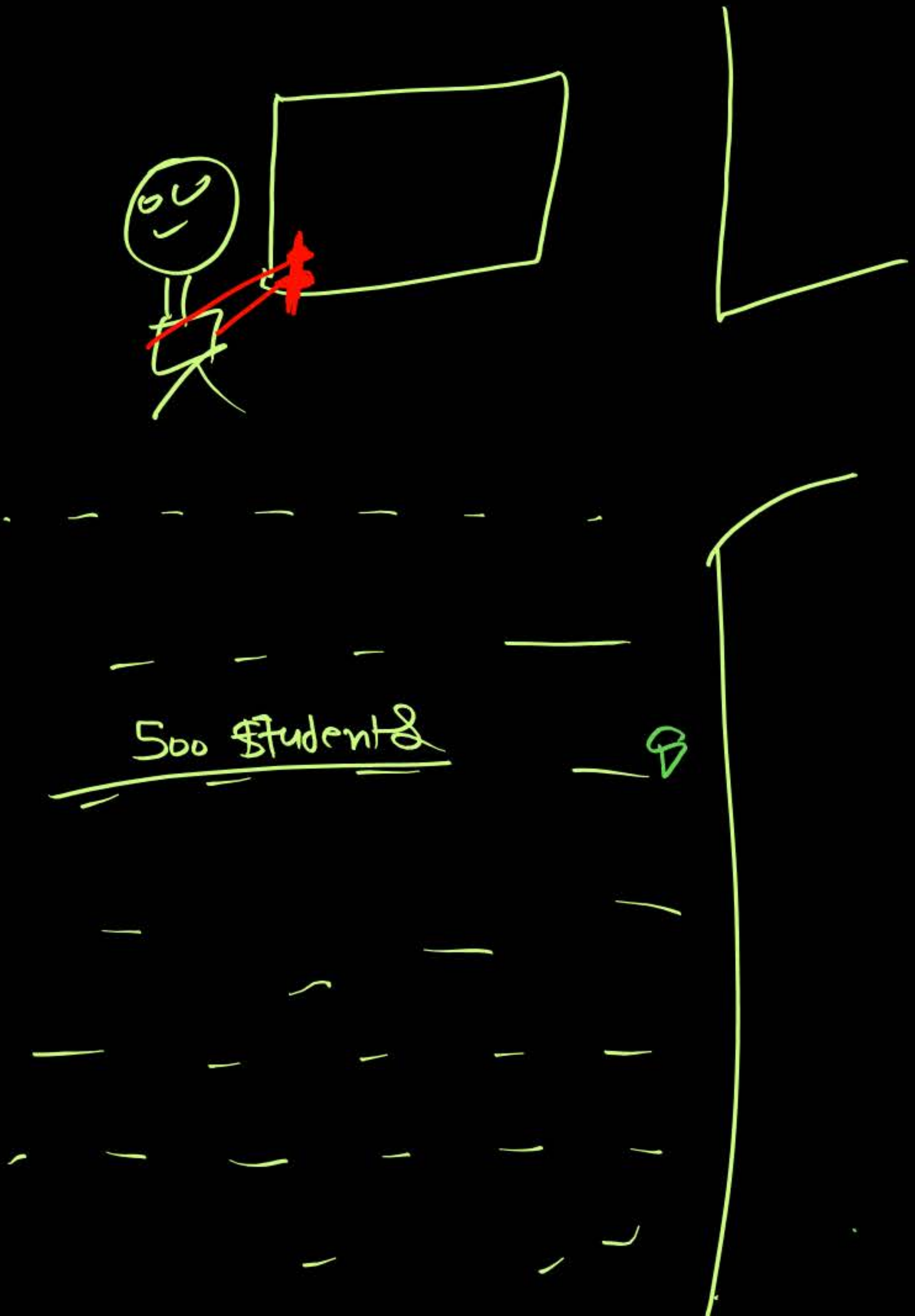
$I = neAv_d$ ← Putting the value of v_d

$I = neA\left[\frac{eE\tau}{m}\right]$

$\frac{I}{A} = \frac{ne^2\tau}{m} E$

$$\vec{J} = \sigma \vec{E}$$ ⇒ ohms Law in Vector form

$$\vec{E} = \rho \vec{J}$$



Conductor

→ Tempr ↑ (Increase).

✡ thermal energy of $\bar{e}$ will Increase

✡ → speed ↑ (Incre)

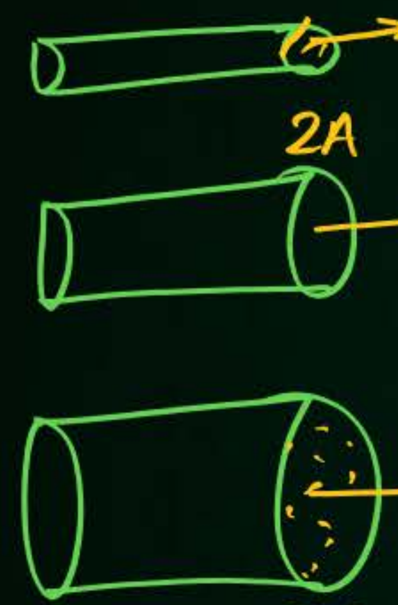
Randomness ↑

τ → decres ↓ → conductivity ↓

resistivity ↑

	Conductor	Insulator	Semi-conductor
# Temprature ↑	Randomness ↑ τ ↓ Conductivity ↓ Resistivity ↑	Same as semiconductor	e- hole pair ↑ Conductivity (Charge carriers) ↑ Resistivity ↓
# Temprature ↓	Randomness ↓ τ ↑ Conductivity ↑ $\left(\sigma = \frac{ne^2\tau}{m}\right)$ resistivity ↓		e- hole pair (anihilation) ↓ Conductivity ↓ resistivity ↑

CURRENT DENSITY



$J_1 = I/A$

$J_2 = \frac{I}{2A}$

$J_3 = \frac{I}{3A}$

$J_3 < J_2 < J_1$



$v_1 < v_2$

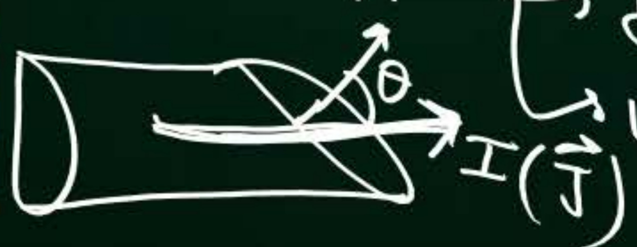
$J = ne\,v_d$ (ne → same)

$J \propto v_d \propto \frac{1}{\text{Area}}$

$J = \frac{I}{A}$ (I → scalar)

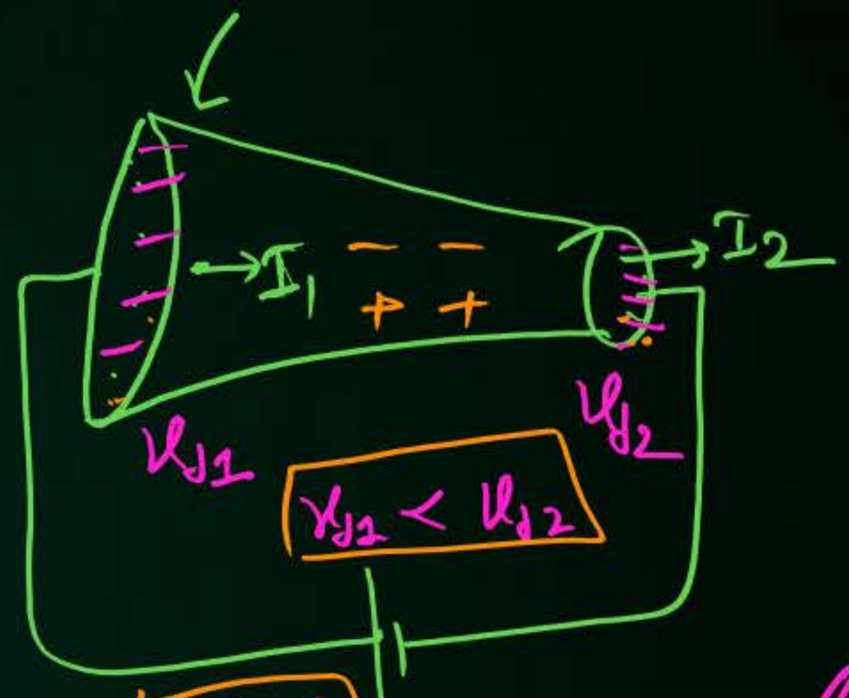
$I = \vec{J} \cdot \vec{A}$

* $I = \vec{J} \cdot \vec{A}$



- current density → vector
- dirn along flow of current.
- Unit Amp/m²

Charge of current carrying wire??
Ans → neutral



$v_{d1} < v_{d2}$

$J_1 < J_2$

$I_1 = I_2$

QUESTION

Current density $\vec{j}$ at an area is $\vec{A} = (2\hat{\imath} + 3\hat{\jmath})\ \text{mm}^2$ is $\vec{j} = (3\hat{\imath} + 4\hat{\jmath})\ \text{A/m}^2$. Current through the area is

1. 9 µA
2. Zero
3. 18 µA
4. 12 µA

$I = \vec{J} \cdot \vec{A}$

$= (3\hat{i} + 4\hat{j}) \cdot (2\hat{i} + 3\hat{j})$

$= 6 + 12$

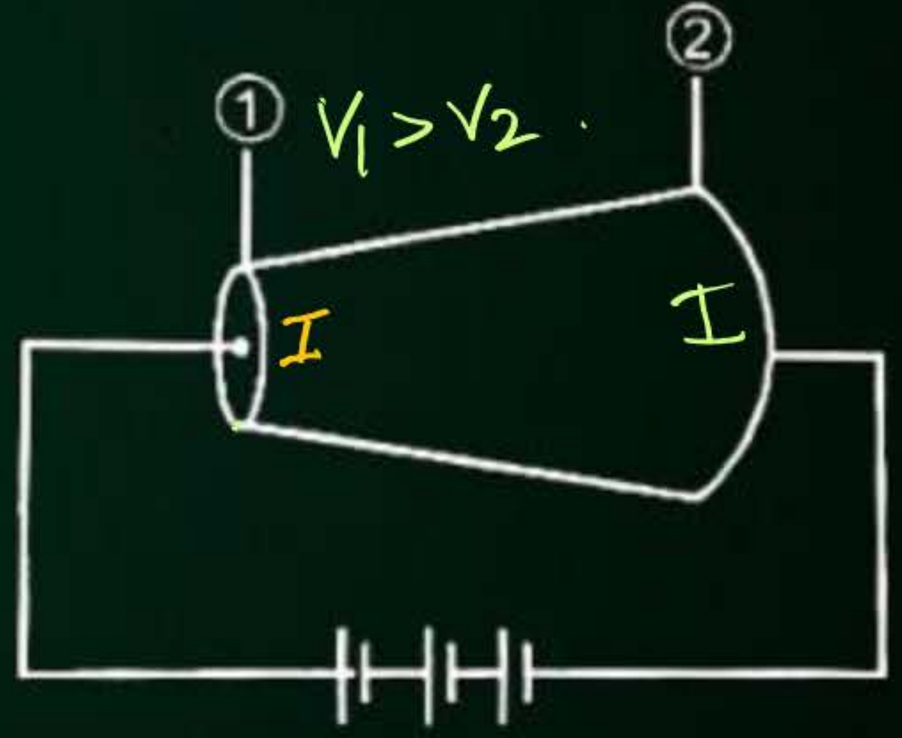
$= 18\ \mu\text{Amp}$

QUESTION

The value of drift speeds at cross section (1) and (2) are V_1 and V_2 respectively in the conductor shown below in the shape of a truncated cone.

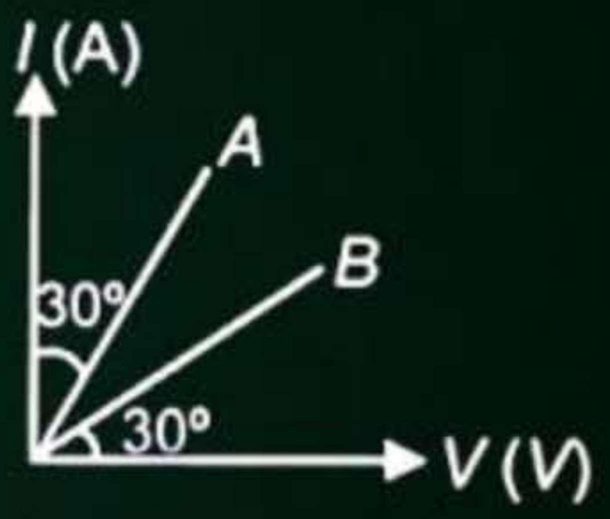
Which of the following is correct?

1. $V_1 > V_2$
2. $V_1 < V_2$
3. $V_1 = V_2$
4. Any of these



QUESTION

Figure shows graph between I and V for two conductor A and B. Their respective resistance are in the ratio.



(1) 1 : 1

(2) 1 : 3

(3) 3 : 1

(4) 1 : 2

RESISTANCE

$R \propto l$ ...(i)

$R \propto \frac{1}{A}$ ...(ii)

Resistance

$R \propto \frac{l}{A}$



$$R = \frac{\rho l}{A}$$

$R = \frac{\rho l}{A}$ → scalar, ohm.

$\Rightarrow \rho = \frac{RA}{l}$

ρ = ohm metre

- depends on nature of conductor
- does not depend on Area & length

Case-1

$A = cost^n$.

$R \propto l$

$$\frac{R_1}{R_2} = \frac{l_1}{l_2}$$

$$100 \times \frac{\Delta R}{R} = \left[\frac{\Delta l}{l} \times 100\right]$$

% change in resist = $\frac{\Delta l}{l} \times 100$

Case-2

- Volume = cost^n.

$$R = \frac{\rho l \times l}{A \times l}$$ ($A \times l$ → cost^n)

$R \propto l^2$

$$\frac{R_2}{R_1} = \frac{l_2^2}{l_1^2}$$

$$\frac{\Delta R}{R} \times 100 = \left[2\frac{\Delta l}{l}\right] \times 100$$

% change in resist = $\left[2\frac{\Delta l}{l}\right] \times 100$

Case-3

$l = cost^n$

$R = \frac{\rho l}{A}$ (ρl → const)

$R \propto \frac{1}{A} \propto \frac{1}{r^2}$

$$\frac{R_2}{R_1} = \frac{A_1}{A_2}$$

small change

$$\frac{\Delta R}{R} \times 100 = -\frac{\Delta A}{A} \times 100$$

$$\frac{\Delta R}{R} \times 100 = -\frac{2\Delta r}{r} \times 100$$

Case-3

Volume = cost^n.

$$R = \frac{\rho l \times A}{A \times A}$$ ($\rho l \times A$ → cost^n)

$R \propto \frac{1}{A^2} \propto \frac{1}{r^4}$

$$\frac{R_2}{R_1} = \frac{A_1^2}{A_2^2}$$

$$\frac{\Delta R}{R} \times 100 = -2\frac{\Delta A}{A} \times 100$$

$$\frac{\Delta R}{R} \times 100 = -4\frac{\Delta r}{r} \times 100$$

QUESTION

A certain piece of copper is to be shaped into a conductor of minimum resistance. Its length and diameter should respectively be

1. L, D
2. $2L, \frac{D}{2}$
3. $\frac{L}{2}, 2D$
4. $L, \frac{D}{2}$



$R_{min} \propto \frac{l}{A}$

QUESTION

A wire of resistance x ohm is drawn out, so that its length is increased to twice its original length, and its new resistance becomes 20 Ω, then x will be

1. 5 Ω
2. 10 Ω
3. 15 Ω
4. 20 Ω

Volume = const

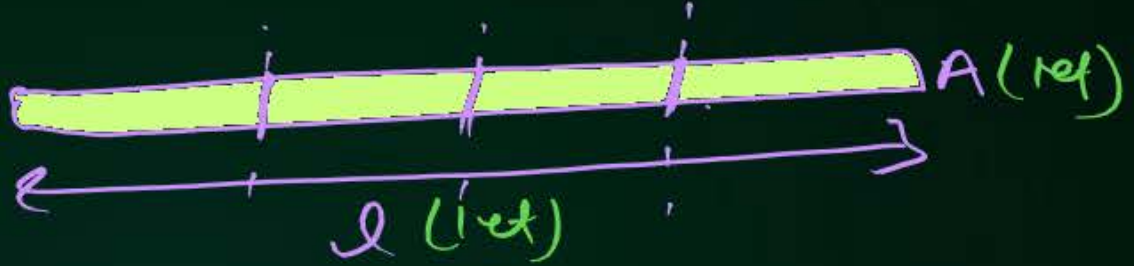
$R \propto l^2$

$\frac{x}{20} = \frac{l^2}{(2l)^2}$

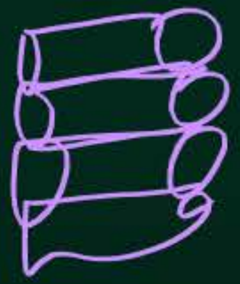
$x = \frac{20}{4} = 5\Omega$

QUESTION

A piece of wire is cut into four equal parts and the pieces are bundled together side by side to form a thicker wire. Compared with that of the original wire, the resistance of the bundle is



$R = \frac{\rho l}{A}$



$R' = \rho \frac{l}{4A \times 4} = \frac{\rho l}{16 A} = \frac{R}{16}$ ✓

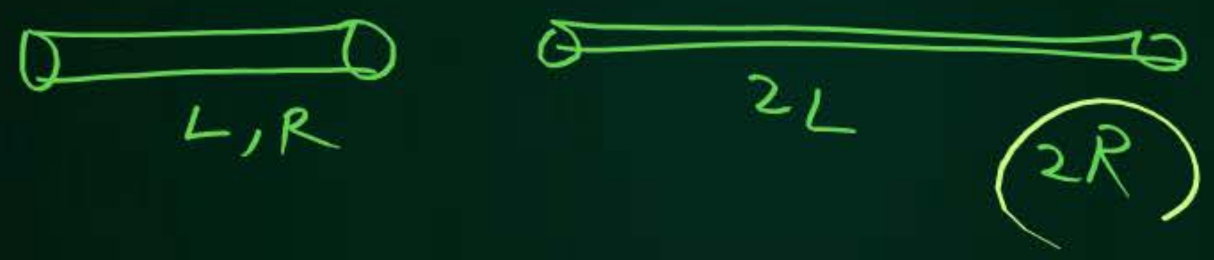
1. The same
2. $\frac{1}{16}$ as much ✓
3. $\frac{1}{8}$ as much
4. $\frac{1}{4}$ as much

QUESTION

Two copper wires of length L and $2L$ have radii R and $2R$ respectively. What is ratio of their specific resistances?

(Hint : Specific resistance or resistivity is material property, independent of geometry).

1. 1 : 2
2. 2 : 1
3. 1 : 1
4. 1 : 3



QUESTION

Two wires A and B of the same material, having radii in the ratio 1 : 2 carry currents in the ratio 4 : 1. The ratio of drift speed of electrons in A and B is

1. 16 : 1
2. 1 : 16
3. 1 : 4
4. 4 : 1

$A_1 : A_2 = 1 : 4$

$I = neAv_d$ (ne same)

$v_d = \frac{I}{A}$

$\frac{v_{d_1}}{v_{d_2}} = \frac{I_1}{A_1} \times \frac{A_2}{I_2} = \frac{4}{1} \times \frac{4}{1}$

$= 16 : 1$

QUESTION

If a copper wire is stretched to make its radius decrease by 0.1%, then the percentage increase in resistance is nearly

1. 0.1%
2. 0.8%
3. 0.4%
4. 0.2%

volume = const^n

$\frac{\Delta r}{r} \times 100 = -0.1\%$

$R \propto \frac{1}{A^2} \propto \frac{1}{r^4}$

QUESTION

A flow of 10^7 electrons per second in a conducting wire constitutes a current of **(1994)**

1. 1.6×10^{-12} A
2. 1.6×10^{26} A
3. 1.6×10^{-26} A
4. 1.6×10^{12} A

$$I = \frac{Q}{t}$$

$$= \frac{ne}{t}$$

$$I = \frac{10^7 \times 1.6 \times 10^{-19}}{1 sec}$$

$$= 1.6 \times 10^{-12}$$

QUESTION

Resistivity

Specific resistance of a conductor increases with (2002)

1. ✓ increase in temperature
2. ✗ increase in cross-section area
3. ✗ increase in cross-section and decrease in length
4. ✗ decrease in cross-section area.

QUESTION

A charged particle having drift velocity of $7.5 \times 10^{-4}\ \mathrm{m\,s^{-1}}$ in an electric field of $3 \times 10^{-10}\ \mathrm{V\,m^{-1}}$, has a mobility in $\mathrm{m^2\,V^{-1}\,s^{-1}}$ of [NEET-2020]

1. 2.25×10^{15}
2. 2.5×10^{6} (Ans)
3. 2.5×10^{-6}
4. 2.25×10^{-15}

$\mu = \frac{u_d}{E}$

$= \frac{7.5 \times 10^{-4}}{3 \times 10^{-10}}$

$= 2.5 \times 10^{6}$ Ans

QUESTION

The resistance of a wire is 'R' ohm. If it is melted and stretched to 'n' times its original length, its new resistance will be [NEET-2017]

1. R/n
2. n^2R
3. R/n^2
4. nR

volume const

$R \propto l^2$

$R' \propto (nl)^2$

$R' \propto n^2 l^2$

$R' \propto n^2 R$

$R \propto l^2 = n^2 l^2$

QUESTION

A wire of resistance 4Ω is stretched to twice its original length. The resistance of stretched wire would be **[NEET-2013]**

volum = C'

$R \propto l^2$

1. 8Ω
2. 16Ω Ans (84%)
3. 2Ω
4. 4Ω

QUESTION

The masses of the wires of copper is in the ratio of 1 : 3 : 5 and their lengths are in the ratio of 5 : 3 : 1. The ratio of their electrical resistance is **(1988)**

1. 1 : 3 : 5
2. 5 : 3 : 1
3. 1 : 25 : 125
4. 125 : 15 : 1 ✓

Ans

$\lambda = \frac{m}{\text{volume}}$ (density)

$R = \frac{\rho l \times l}{(A \times l)}$

$R = \frac{\rho l^2}{\text{volume}} = \frac{\rho l^2 \lambda}{m}$

$R \propto \frac{l^2}{m}$

$R_1 : R_2 : R_3 = \frac{(5)^2}{1} : \frac{3^2}{3} : \frac{1^2}{5}$

$= \left[25 : 3 : \frac{1}{5}\right]$

$= 125 : 15 : 1$

QUESTION

The electric resistance of a certain wire of iron is R. If its length and radius are both doubled, then **(2004)**

1. The resistance will be doubled and the specific resistance will be halved
2. The resistance will be halved and the specific resistance will remain unchanged
3. The resistance will be halved and the specific resistance will be doubled
4. The resistance and the specific resistance will both remain unchanged.

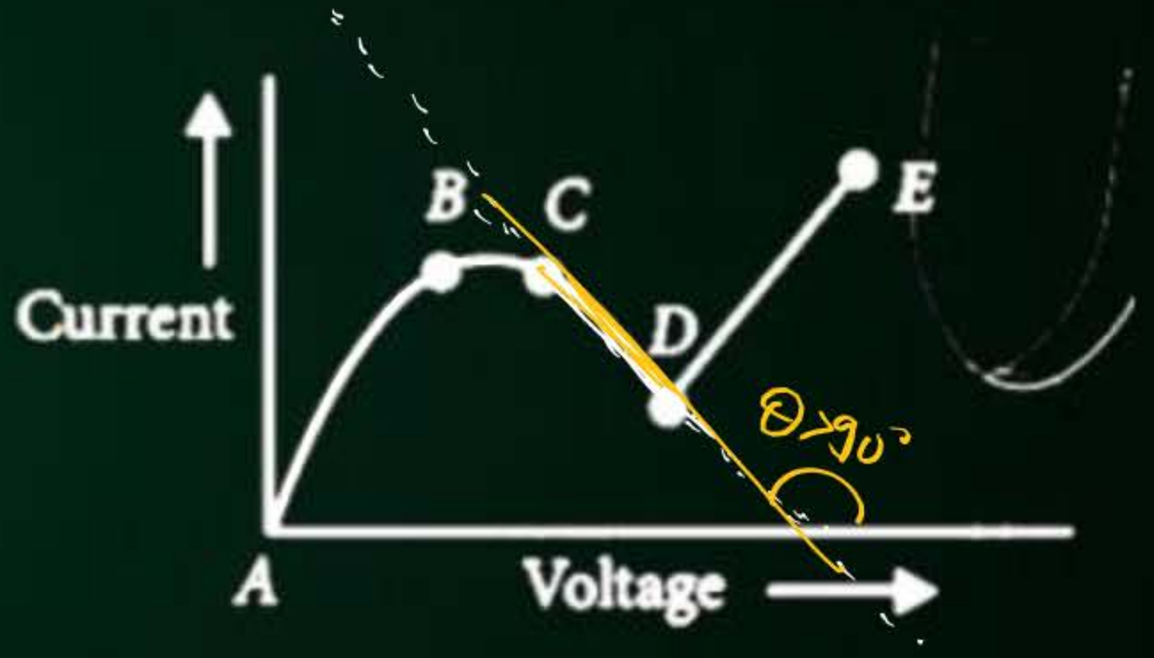
QUESTION

From the graph between current (I) and voltage (V) is shown. Identify the portion corresponding to negative resistance [1997]

1. CD ✓ Ans
2. DE
3. AB
4. BC

$V = IR$

$\frac{1}{R} = \frac{I}{V} = \text{slope}$



QUESTION

The solids which have the negative temperature coefficient of resistance are

[NEET 2020]

1. metals
2. insulators only
3. semiconductors only
4. insulators and semiconductors.

Same as coefficient of thermal exp^n

$\alpha_R = \frac{\Delta R}{R \Delta T}$

$\alpha_l = \frac{\Delta l}{l \Delta T}$

Temp^r ↑ → Resist^n ↑

α_R = +ve

Temp^r ↑ → Resist^n ↓

α_R = −ve

QUESTION

The mean free path of electrons in a metal is 4×10^{-8} m. The electric field which can give on an average 2 eV energy to an electron in the metal will be in units V/m [2009]

1. 5×10^{-11}
2. 8×10^{-11}
3. 5×10^{7} ✓ Ans
4. 8×10^{7}

$\Delta K.E = \text{Work done}$

$\Delta K.E = eE \times \{l_{\text{mean free}}\}$

$E = \frac{\Delta K.E}{el} = \frac{2\,eV}{e \times 4 \times 10^{-8}} = 0.5 \times 10^{8}$

$E = \frac{dV}{dx}$ → electric field

QUESTION

Which of the following acts as a circuit protection device? [NEET 2019]

1. fuse
2. conductor
3. inductor
4. switch

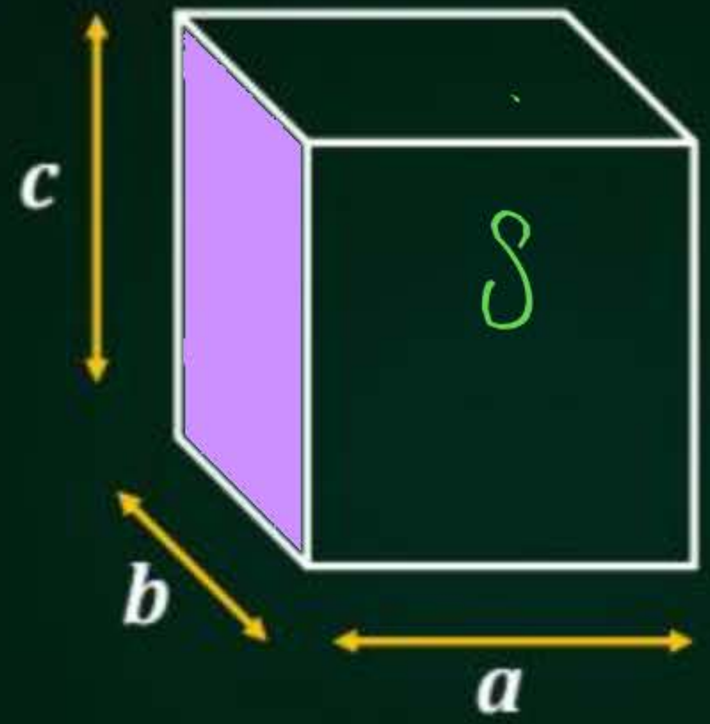
QUESTION

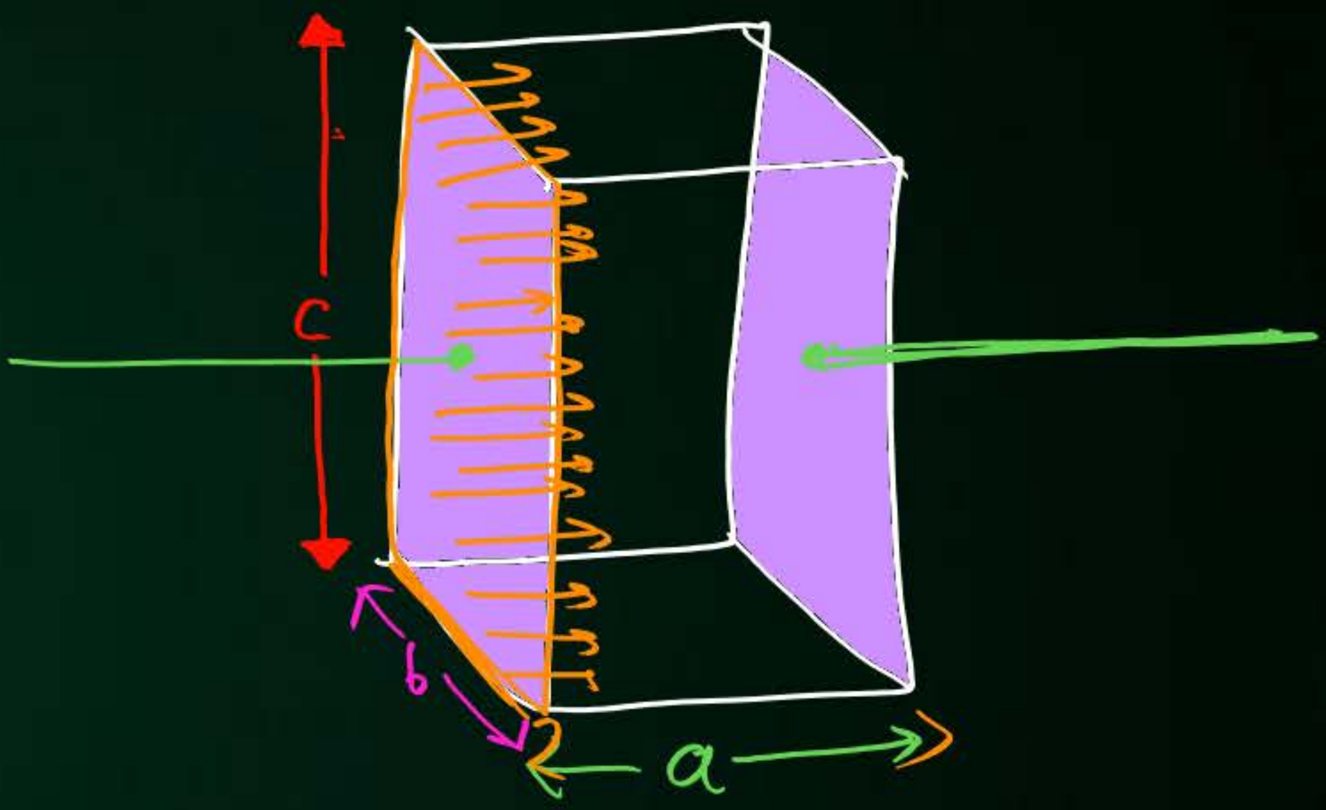
Three copper wires of lengths and cross-sectional areas are (l, A), $(2l, A/2)$ and $(l/2, 2A)$. Resistance is minimum in [1997]

1. wire of cross-sectional area 2A
2. wire of cross-sectional area A/2
3. wire of cross-sectional area A
4. same in all three cases.

QUESTION

A potential difference V is applied to a conducting wire of length l and diameter d. How are the electric field E, the drift speed v_d and the resistance R affected if (i) V is doubled (ii) is doubled (iii) d is doubled?

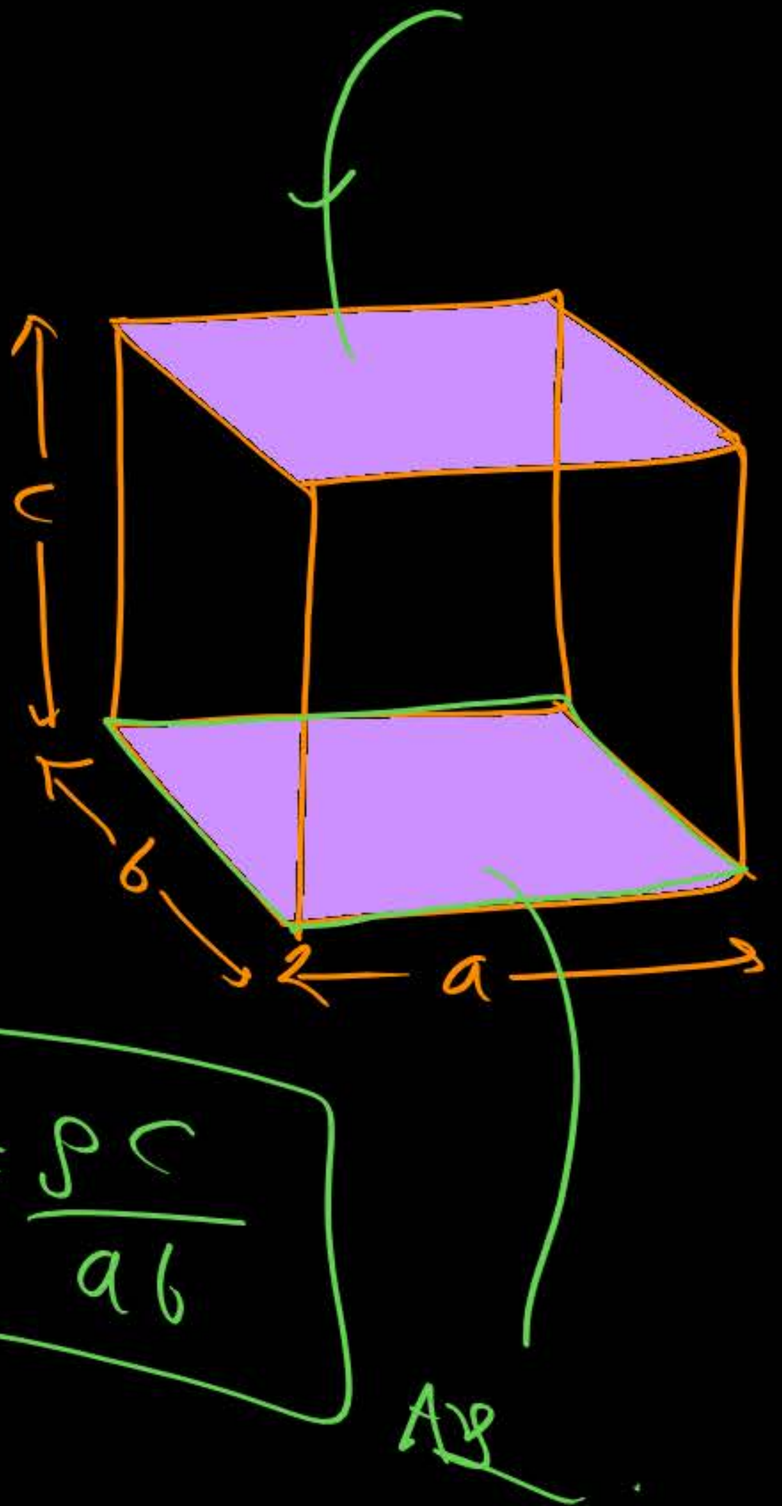




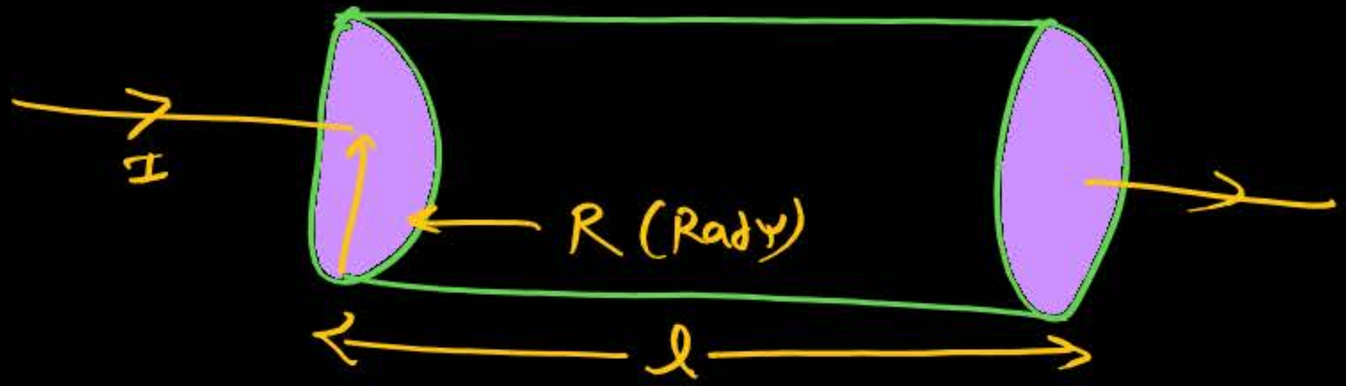
Area = bc

l = a

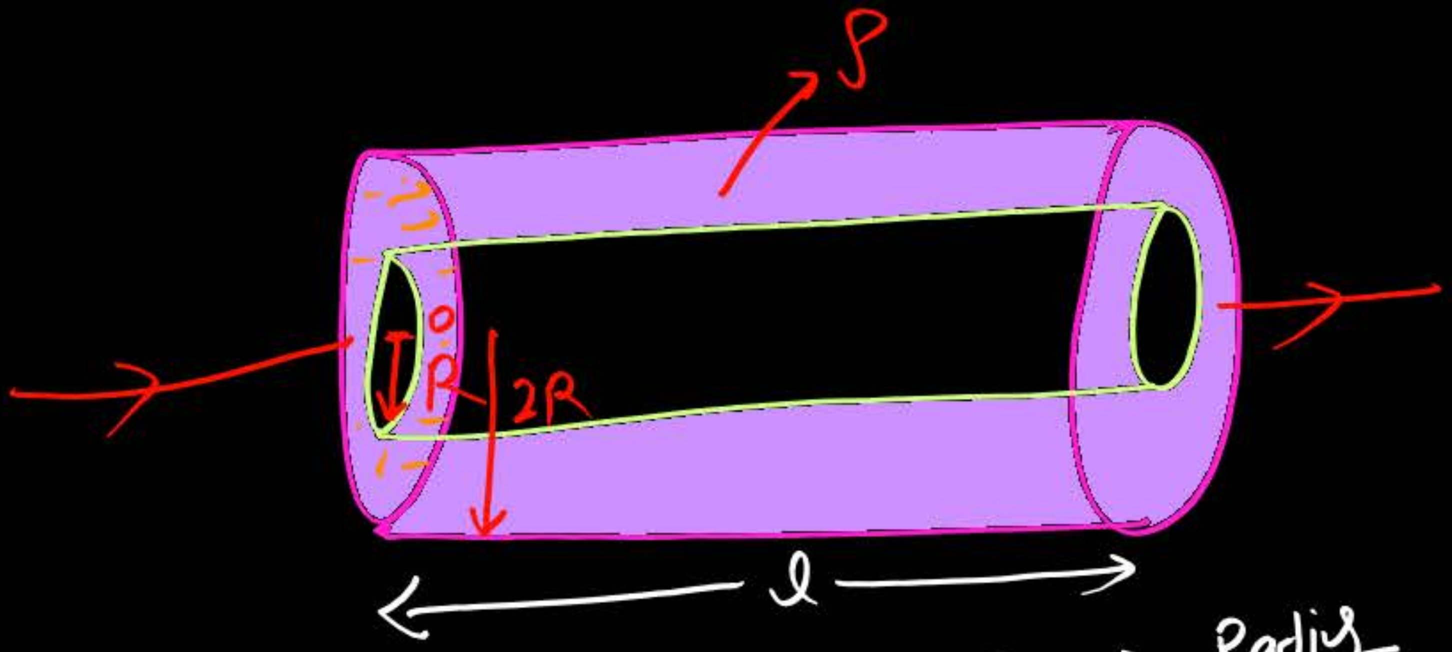
$$R = \frac{\rho a}{bc}$$ Ans



$$R = \frac{\rho c}{ab}$$



$$R = \frac{\rho l}{\pi R^2}$$



R = Inner Radius
2R = outer Radius

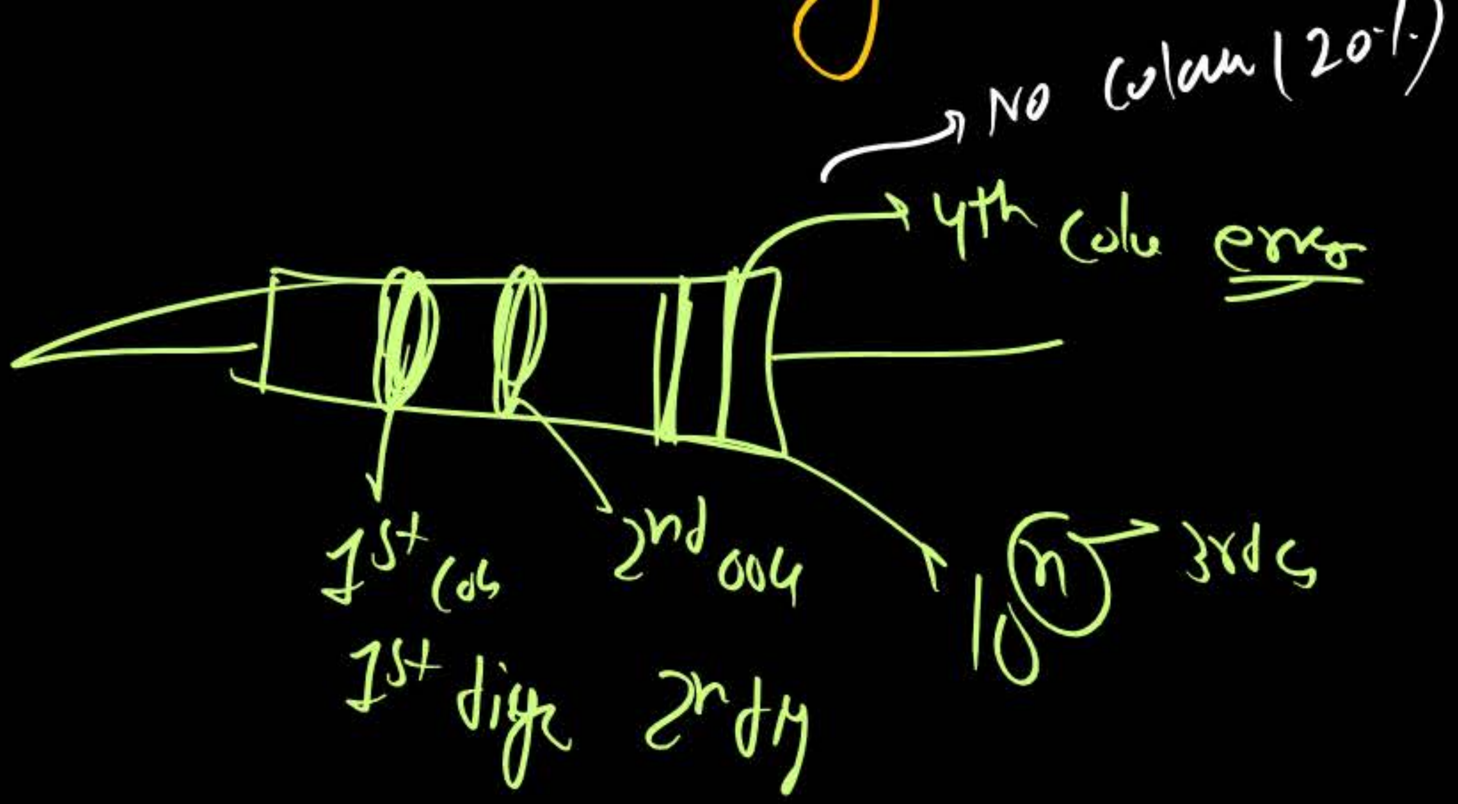
$$R = \frac{\rho l}{\pi (2R)^2 - \pi R^2} = \frac{\rho l}{3\pi R^2}$$

Ans

B. B. R. O. Y. G. B. V. G. W. G. S

Blac Brwe Red ory Yeh Gre Blu Vom Gra Whiz Golld silvr

5% 10%



RESISTOR COLOUR CODES

Colour	Number	Multiplier	Tolerance (%)
Black	0	1	
Brown	1	10^1	
Red	2	10^2	
Orange	3	10^3	
Yellow	4	10^4	
Green	5	10^5	
Blue	6	10^6	

Colour	Number	Multiplier	Tolerance (%)
Violet	7	10^7	
Gray	8	10^8	
White	9	10^9	
Gold		$10^{\&1}$	5
Silver		$10^{\&2}$	10
No colour			20

A carbon resistor has a set of coaxial coloured rings in them, whose significance are listed in above table.

First two bands formed : First two significant figures of the resistance in ohm.

Third band : Decimal multiplier as shown in table.

Last band : Tolerance or possible variation in percentage as per the indicated value. For Gold $\pm 5\%$, for silver $\pm 10\%$ and No colour $\pm 20\%$.

QUESTION

Find the resistance of following carbon resistor.



QUESTION

A carbon resistor of $(47 \pm 4.7)\ \mathrm{k\Omega}$ is to be marked with rings of different colours for its identification. The colour code sequence will be

1. Violet – Yellow – Orange – Silver
2. Yellow – Violet – Orange – Silver
3. Yellow – Green – Violet – Gold
4. Green – Orange – Violet – Gold

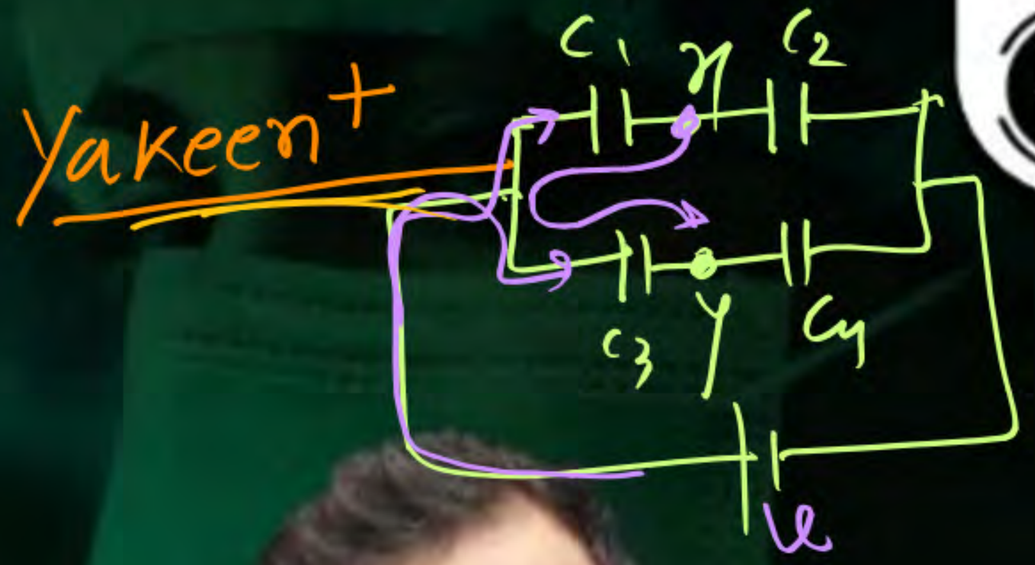
QUESTION

The color code of a resistance is given below Yellow Violet Brown Gold. The values of resistance and tolerance , respectively are [NEET 2020]



1. 470 kW, 5%
2. 47 kW, 10%
3. 4.7 kW, 5%
4. 470 Ω, 5%


THANK YOU



YAKEEN 2.0

FOR NEET 2025

Lecture- 03 | **Physics**

Current Electricity

By- Dr. Manish Raj (MR SIR)



Topics to be covered

1 #

MR चाचा ka Law

Kuddoo Concept

2 #

Seris and Parallel Combinata of Resistan.

3 #



QUESTION

JEE Main-2023

Column-I gives certain physical terms associated with flow of current through a metallic conductor.

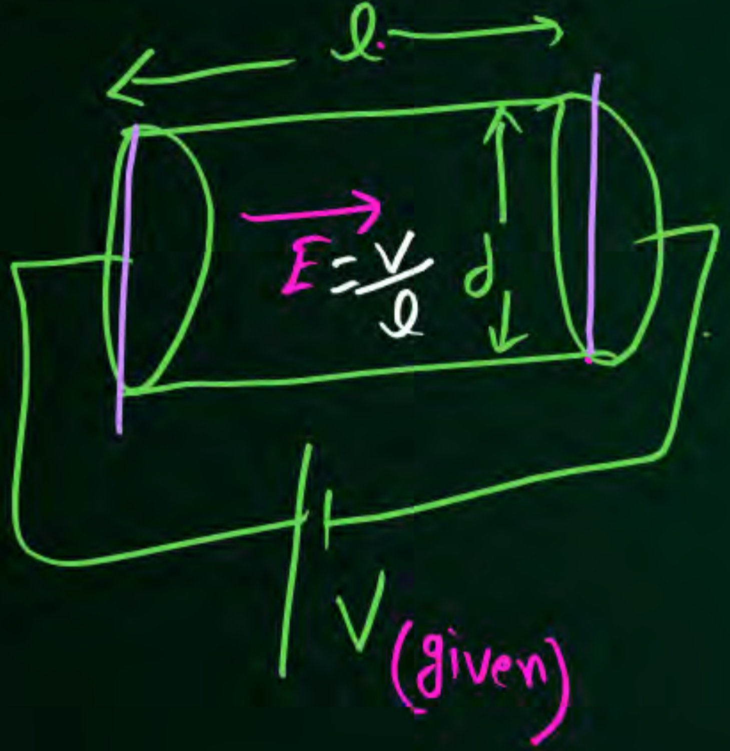
Column-II gives some mathematical relations involving electrical quantities. Match Column-I and Column-II with appropriate relations.

Column-I		Column-II	
(A)	Drift velocity	(P)	$\frac{m}{ne^2\rho}$
(B)	Electrical Resistivity	(Q)	$J = \frac{I}{A}$ (nev_d)
(C)	Relaxation period	(R)	$\frac{eE}{m}T$
(D)	Current density	(S)	$\frac{E}{J}$ $J = \sigma E$, $\rho = \frac{E}{J}$

1. (A)-(R); (B)-(Q); (C)-(S); (D)-(P)
2. (A)-(R); (B)-(S); (C)-(P); (D)-(Q)
3. (A)-(R); (B)-(S); (C)-(Q); (D)-(P)
4. (A)-(R); (B)-(P); (C)-(S); (D)-(Q)

QUESTION

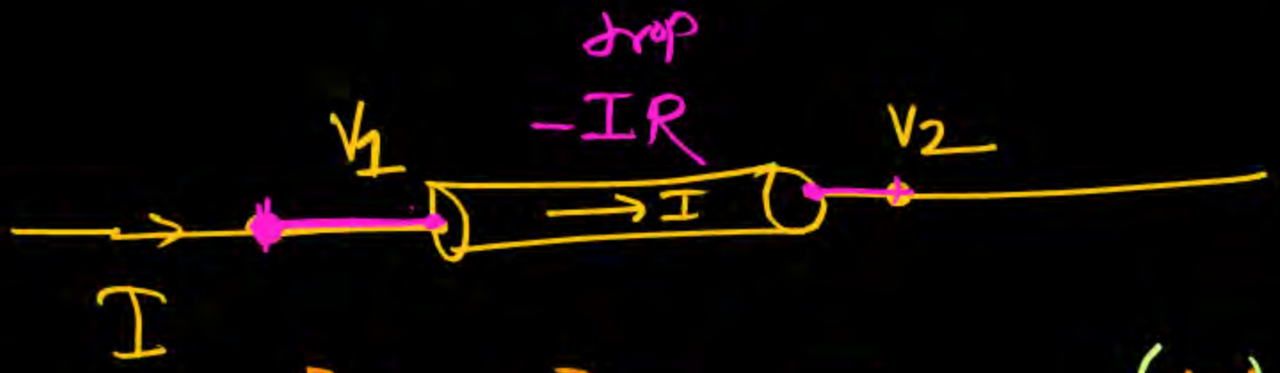
A potential difference V is applied to a conducting wire of length l and diameter d. How are the electric field E, the drift speed v_d and the resistance R affected if (i) V is doubled (ii) l is doubled (iii) d is doubled?



	(i) V = double	(ii) l = double	(iii) d = double
(a) Electric field	$E = \frac{V}{l}$ = double	$E = \frac{V}{2l}$ Half	Same
(b) drift speed	$v_d = \frac{eE\tau}{m}$ = double	$v_d = \frac{eE\tau}{m}$ Half	Same
(c) Resistance	Same	double $R = \frac{\rho l}{A}$	$\frac{1}{4}$ th

Ohms चाचा ka Law

Potential drop across any conductor at constant Temp^r & Pressure is directly Propotional to current flowing through it.



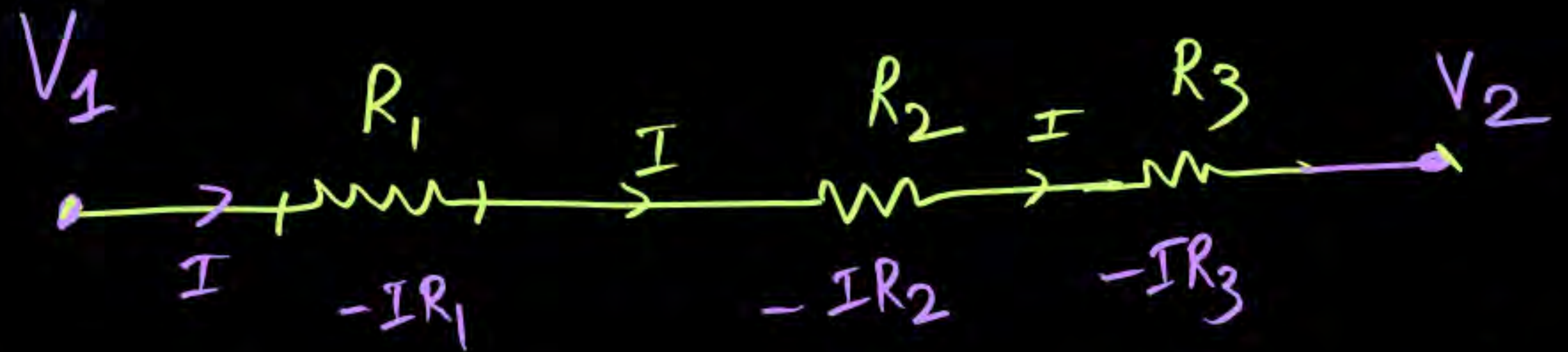
$$[V_1 - V_2] \propto I$$

$$V_1 - V_2 = R I$$

R → Propotional Con^st

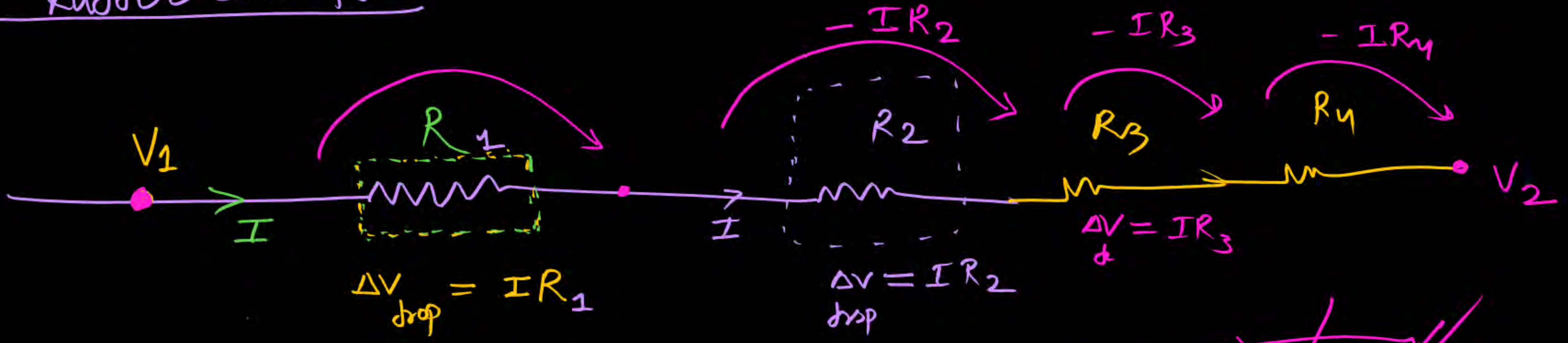
$$\boxed{V_1 - IR = V_2}$$





$$V_1 - IR_1 - IR_2 - IR_3 = V_2 \checkmark$$

Kuddoo concept



$$V_1 - IR_1 - IR_2 - IR_3 - IR_4 = V_2$$ *

~~ohms law~~

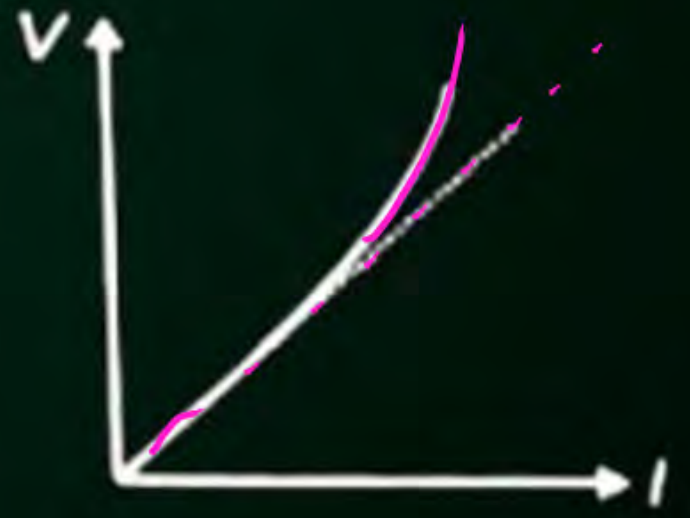
~~Kirchhoff law~~

Kuddoo concept

LIMITATIONS OF OHM'S LAW

The proportionality of V and I does not hold for certain materials and devices used in electric circuits.

1. V ceases to be proportional to I for a good conductor. at high Tempr



2. Value of current is different for same potential difference on reversing the direction of V.

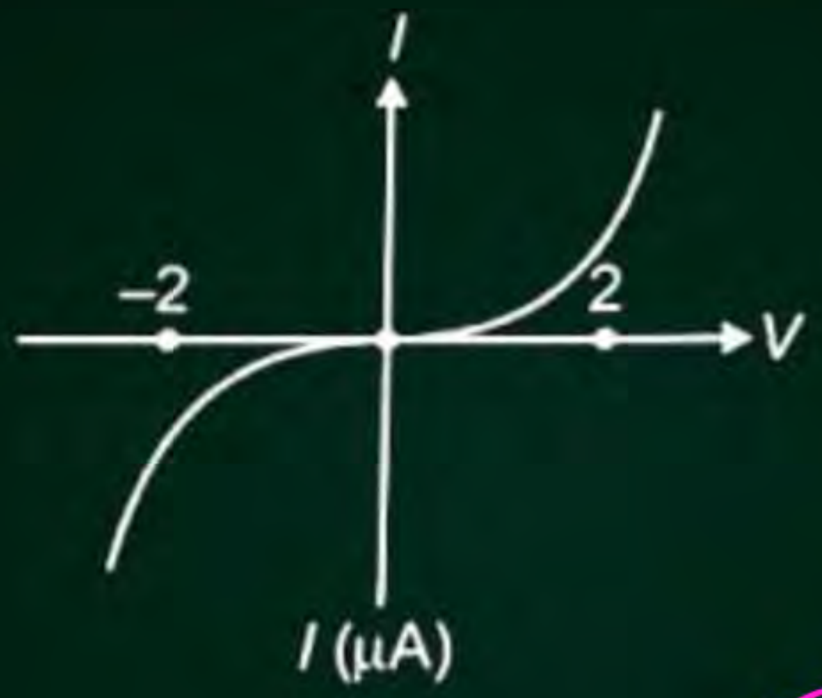


Fig.: Characteristic curve of diode

Semiconductor

Non-ohmic crystal

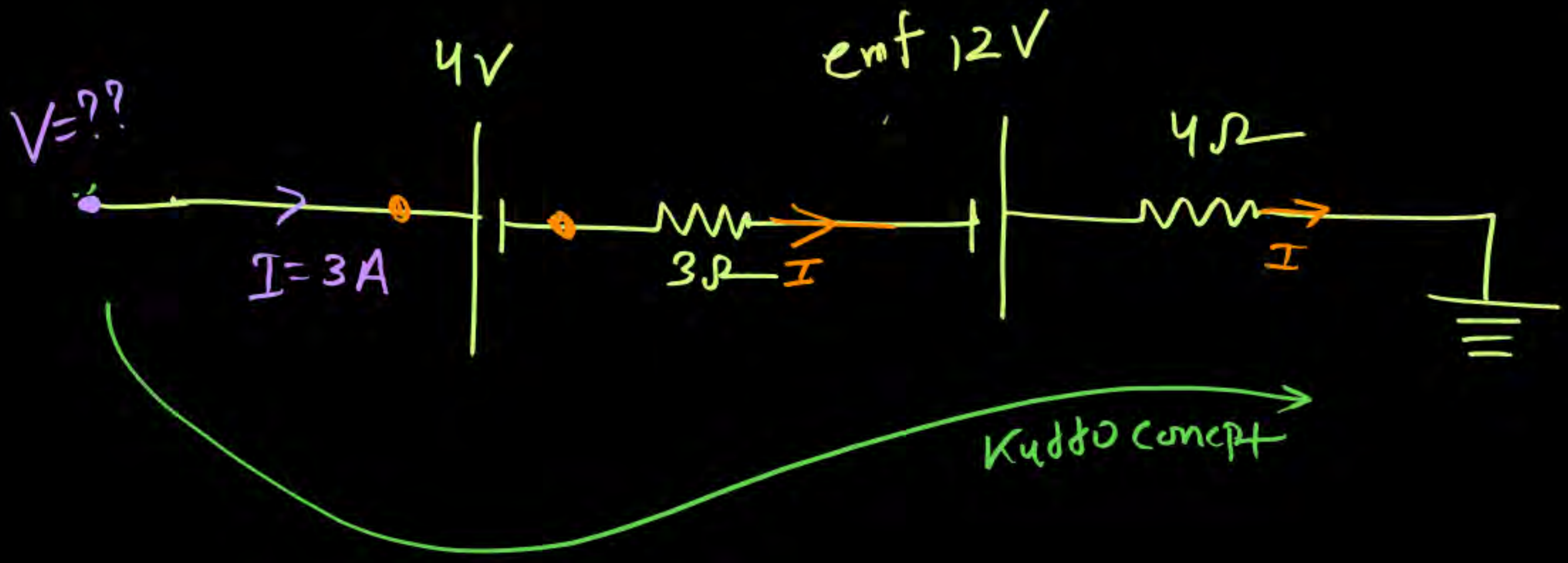
3. Value of potential is different for same current.

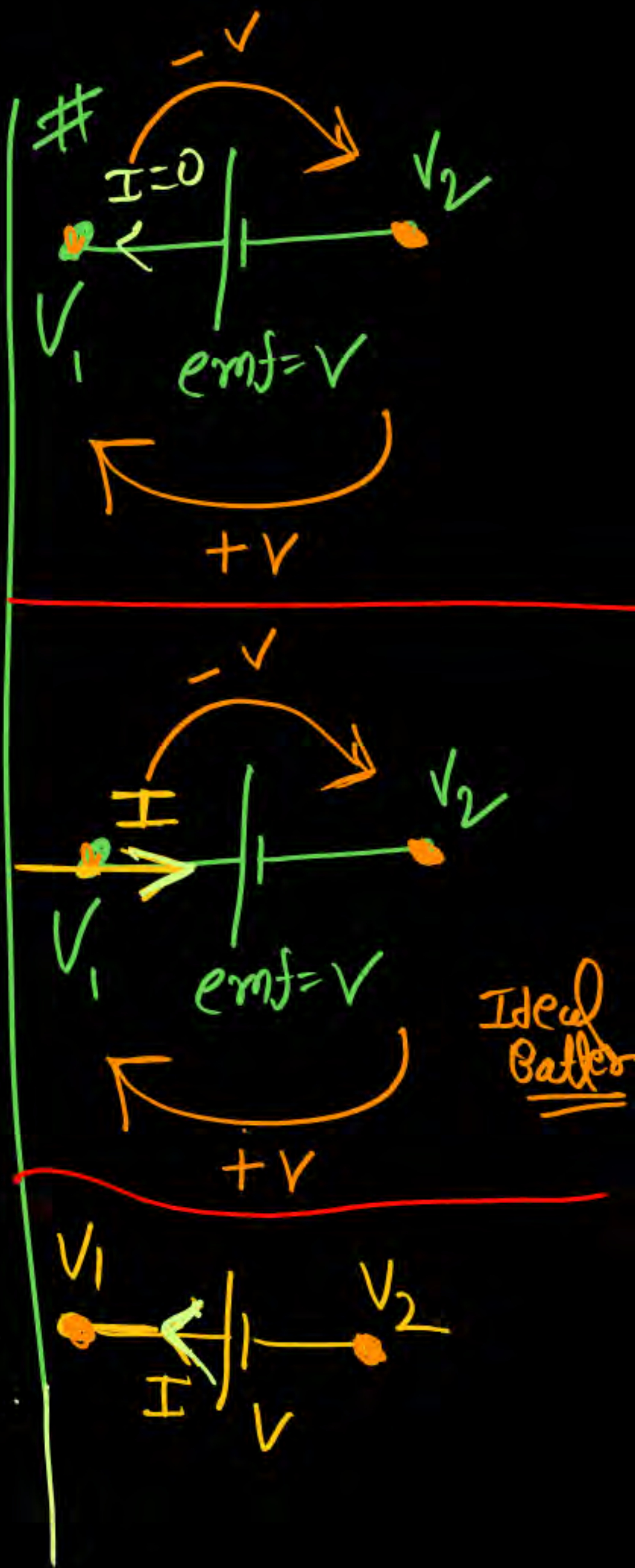


Fig.: Variation of current Vs voltage for GaAs

semiconductor

NEET-2016





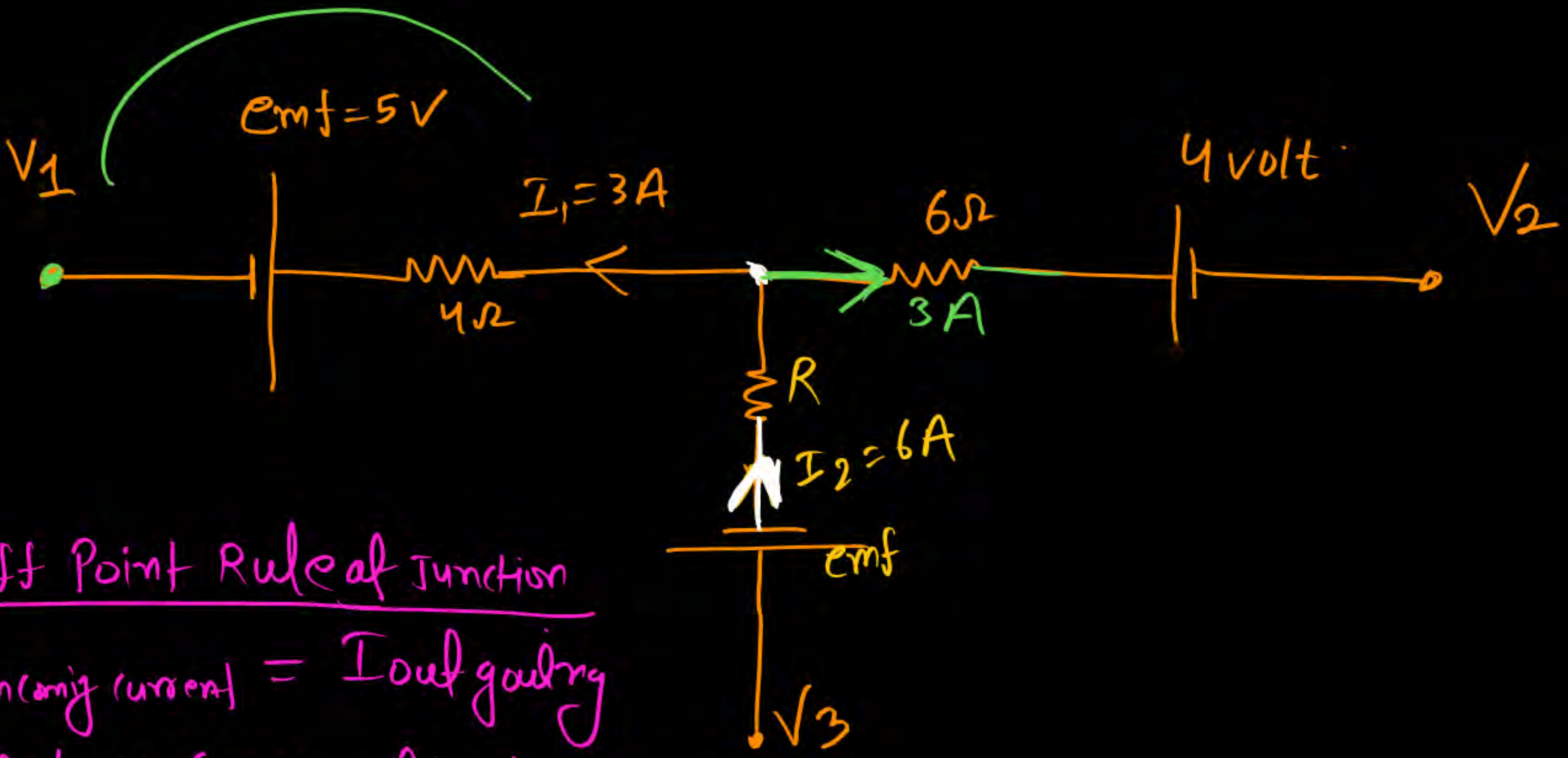
$$V - 4 - I \times 3 + 12 - I \times 4 = 0$$

$$V + 8 - 7 \times I = 0$$

$$V + 8 - 7 \times 3 = 0$$

$$V = 21 - 8 = \underline{13 \text{ volt}}$$

Ans



find $V_1 - V_2 = ??$

Krichhoff Point Rule of Junction

I incoming current = I out going

→ Based on Conservation charge

Kuddo concept V_1 to V_2.

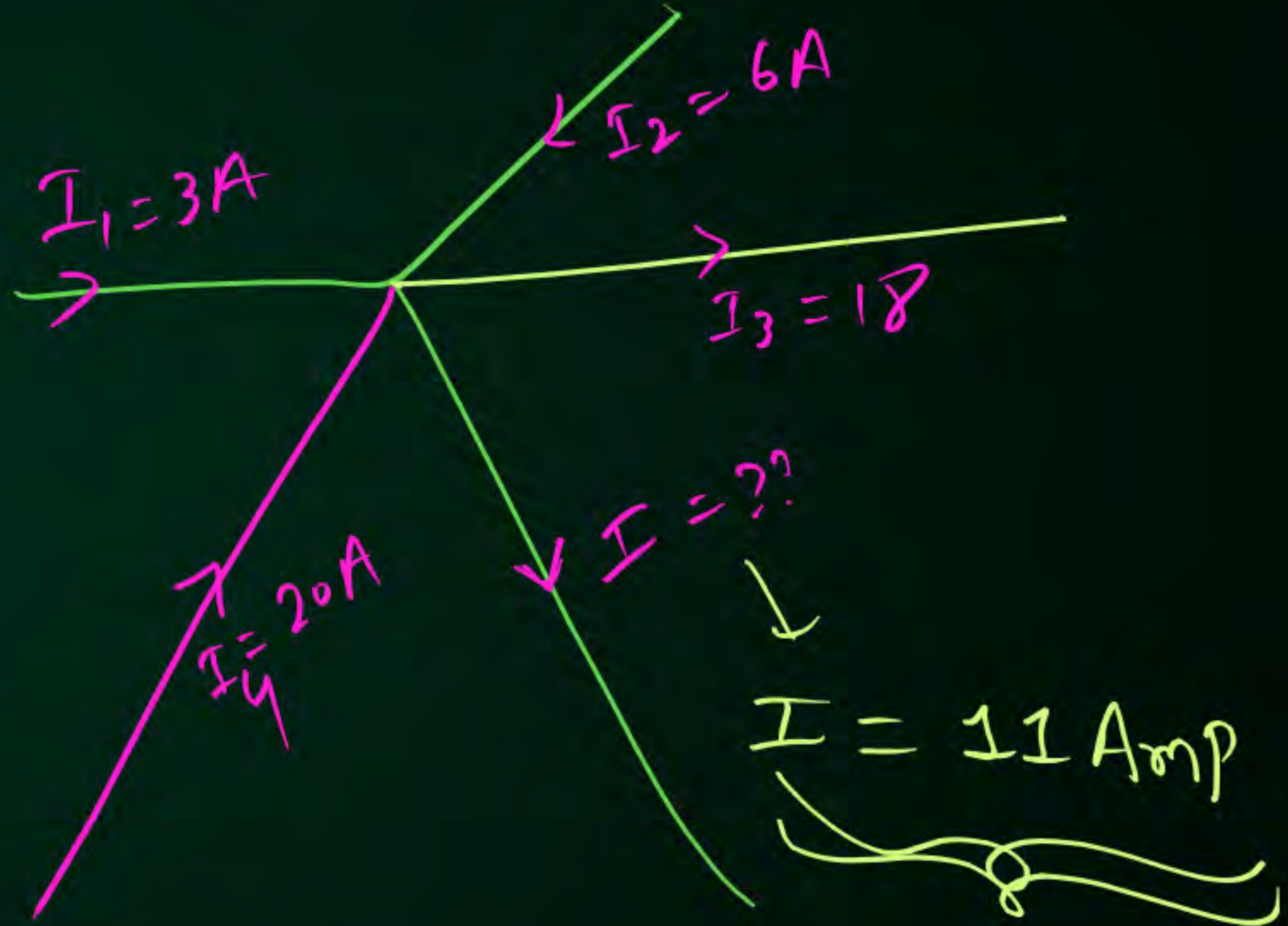
$$V_1 + 5 + 4 \times 3 - 6 \times 3 - 4 = V_2$$

$$V_1 + 17 - 22 = V_2$$

$V_1 - V_2 = +5$ Volt ✓

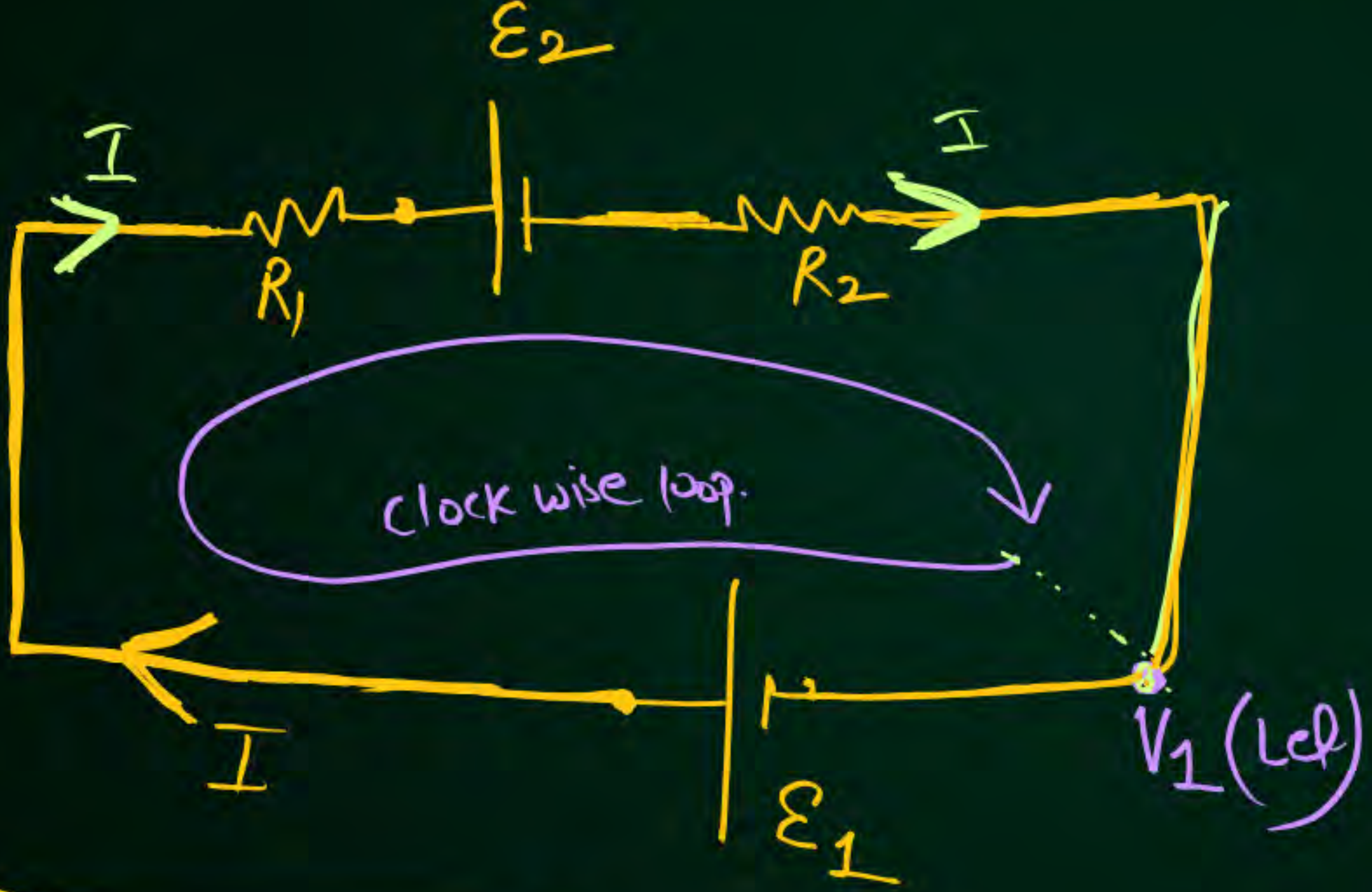
Kirchhoff Point Rule

→ Based on conservation of charge



Kirchhoff Loop Rule (Voltage Rule)

→ Based on energy



$$\cancel{V_1} + \varepsilon_1 - IR_1 - \varepsilon_2 - IR_2 = \cancel{V_1}$$

$$\boxed{\varepsilon_1 - IR_1 - \varepsilon_2 - IR_2 = 0}$$

$$\sum \Delta V_{\text{कुल}} = 0$$

close loop

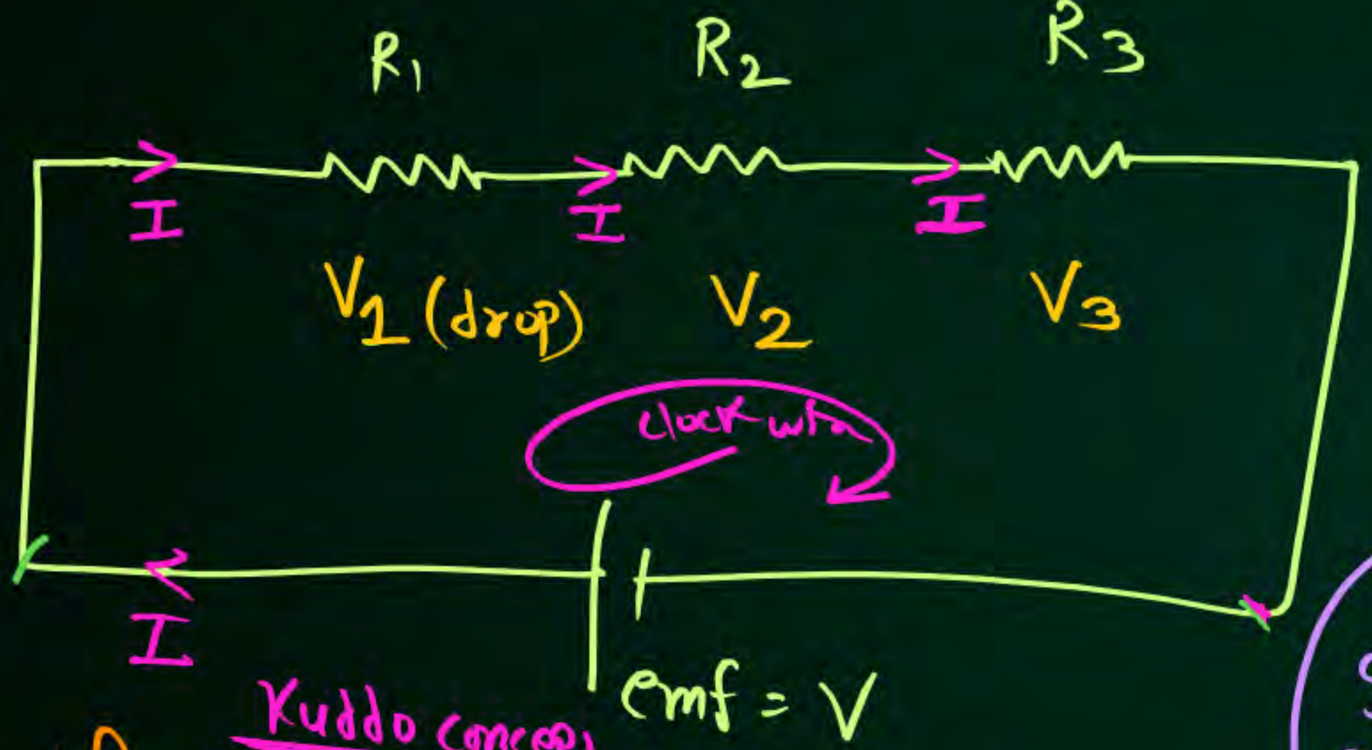
fed

V_1 - - - - - - - - = V_2

Series Combination of Resistance

→ end to end connection.

→ If two or more than two resistor share same current then they all are in series.



current through all resistor is same

Sum of Potential drop across each Resistance is equal to Potential of the Battery.

$V_1 + V_2 + V_3 = V$

$IR_1 + IR_2 + IR_3 = I R_{eq}$

$\cancel{I}(R_1 + R_2 + R_3) = \cancel{I} R_{eq}$

$R_{eq} = R_1 + R_2 + R_3$ ☆

If n-equal resistance connected in series then

$R_{eq} = nR$

* R_{eq} Must be greater than largest resistance.

Kuddo concept ☆

$V - V_1 - V_2 - V_3 = 0$

$V = V_1 + V_2 + V_3$

MR*

Law of Potential drop

$V = I R$ (I same)

$V \propto R$ (drop)

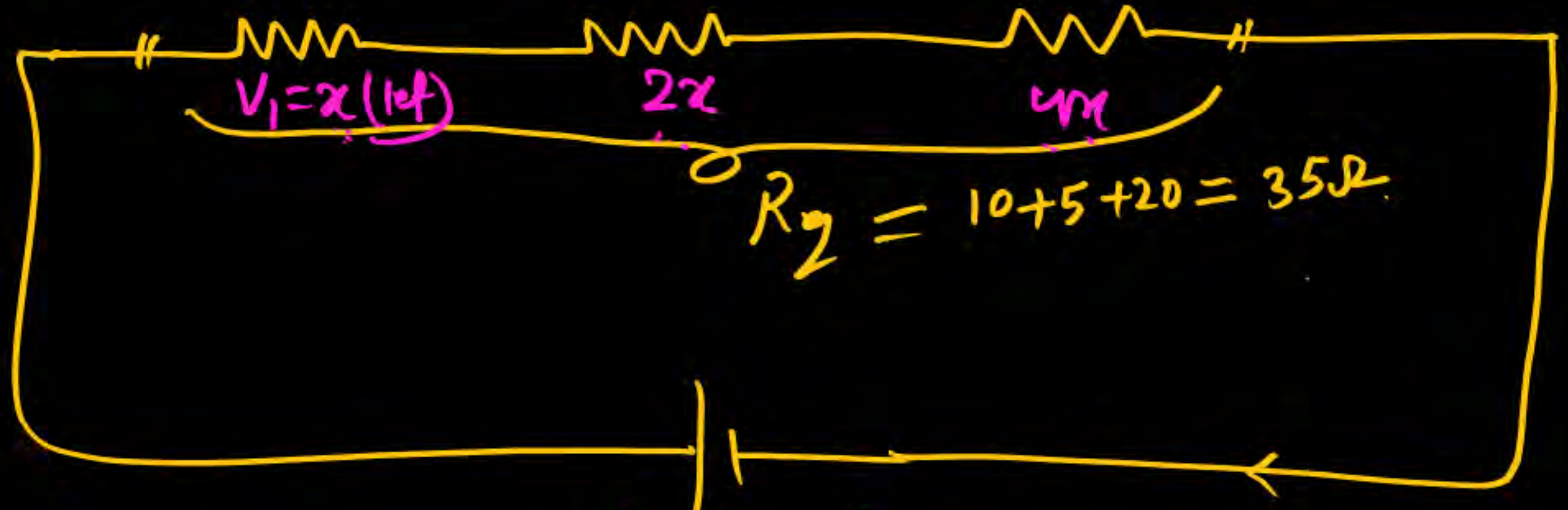
$\frac{V_1}{V_2} = \frac{R_1}{R_2}$

$V_1 = IR_1 = \frac{10}{35_7} \times 5 = \frac{10}{7}$ volt

$V_2 = \frac{100}{35}$ $\quad V_3 = 20\left(\frac{10}{35}\right)$

Potential drop across each resistance ??

$R_1 = 5\Omega \quad R_2 = 10\Omega \quad R_3 = 20\Omega$



$R_{eq} = 10 + 5 + 20 = 35\Omega$

emf = 10 volt

$I = \frac{10}{35}$ Amp

mR*

$V_{कम} \propto R_{कम}$

$x + 2x + 4x = 10$

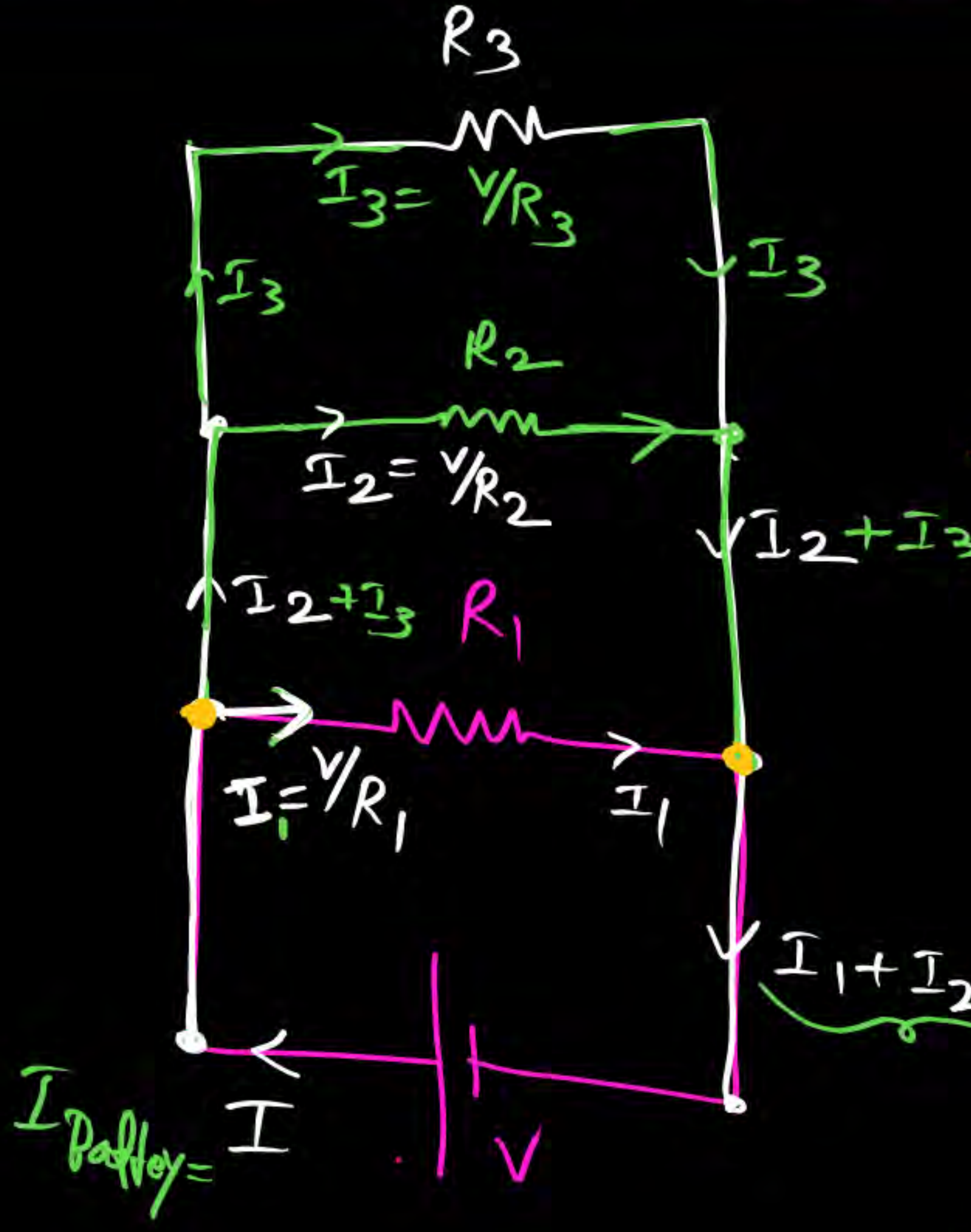
$7x = 10$

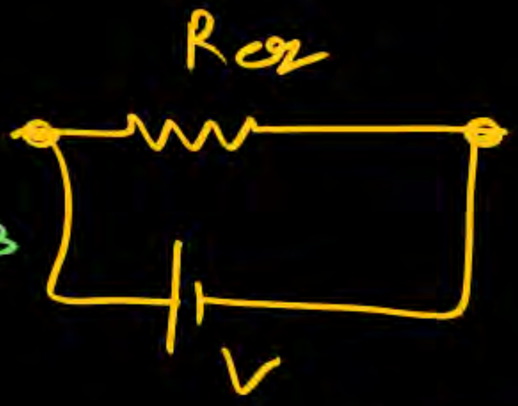
$x = \frac{10}{7}$ volt

Parallel combination

→ # Potential drop across each resistance will be same.

→ # Sum of current flowing through each resistance is equal to total current flowing through Battery.





$$I = I_1 + I_2 + I_3$$

$$\frac{V}{R_{eq}} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$$

$$\boxed{\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$$

→ If n equal resistors in parallel

$$\boxed{R_{eq} = \frac{R}{n}}$$

→ smaller than smallest resistance.

MR*

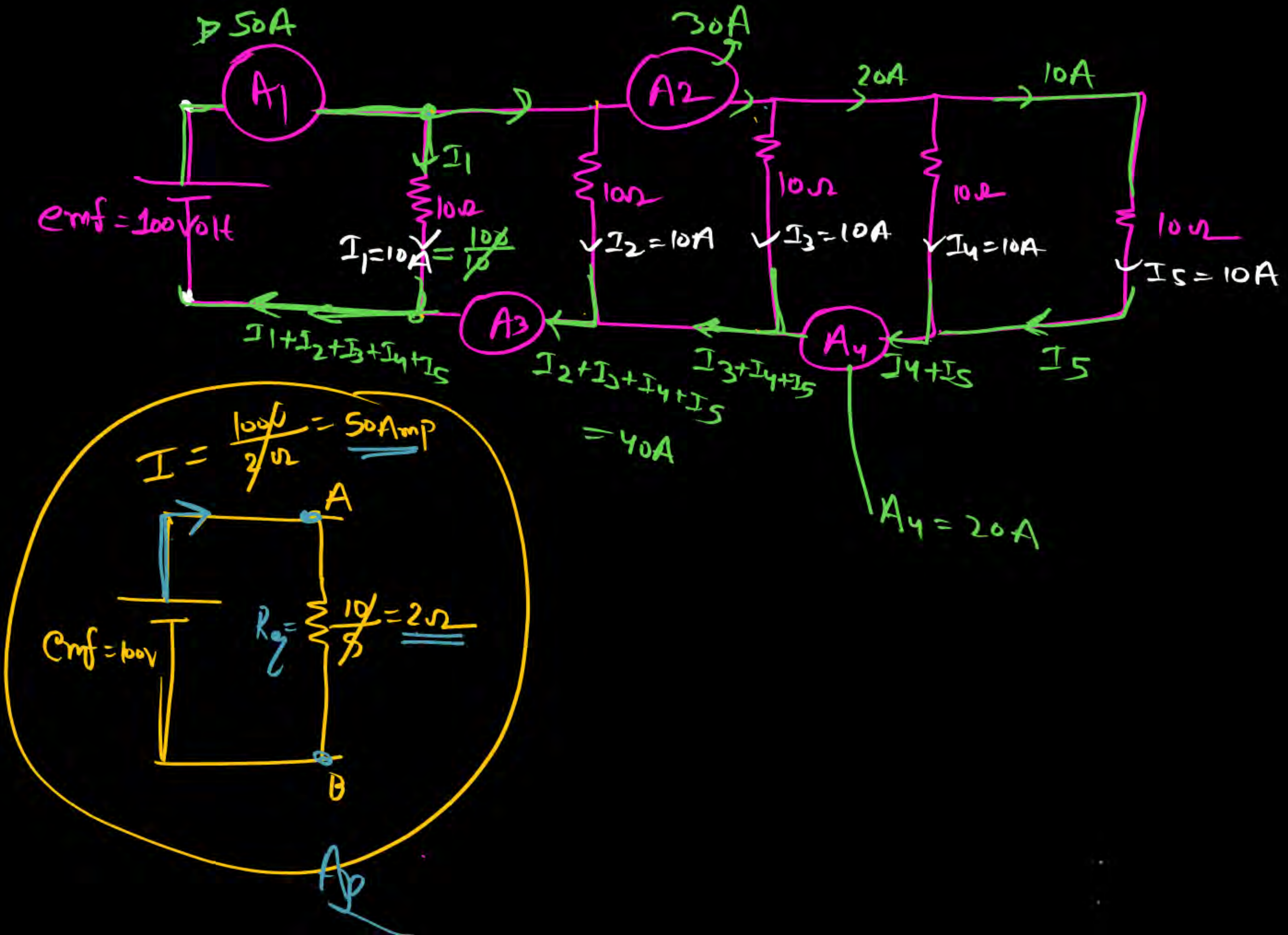
$I = \frac{V}{R}$ (V → same)

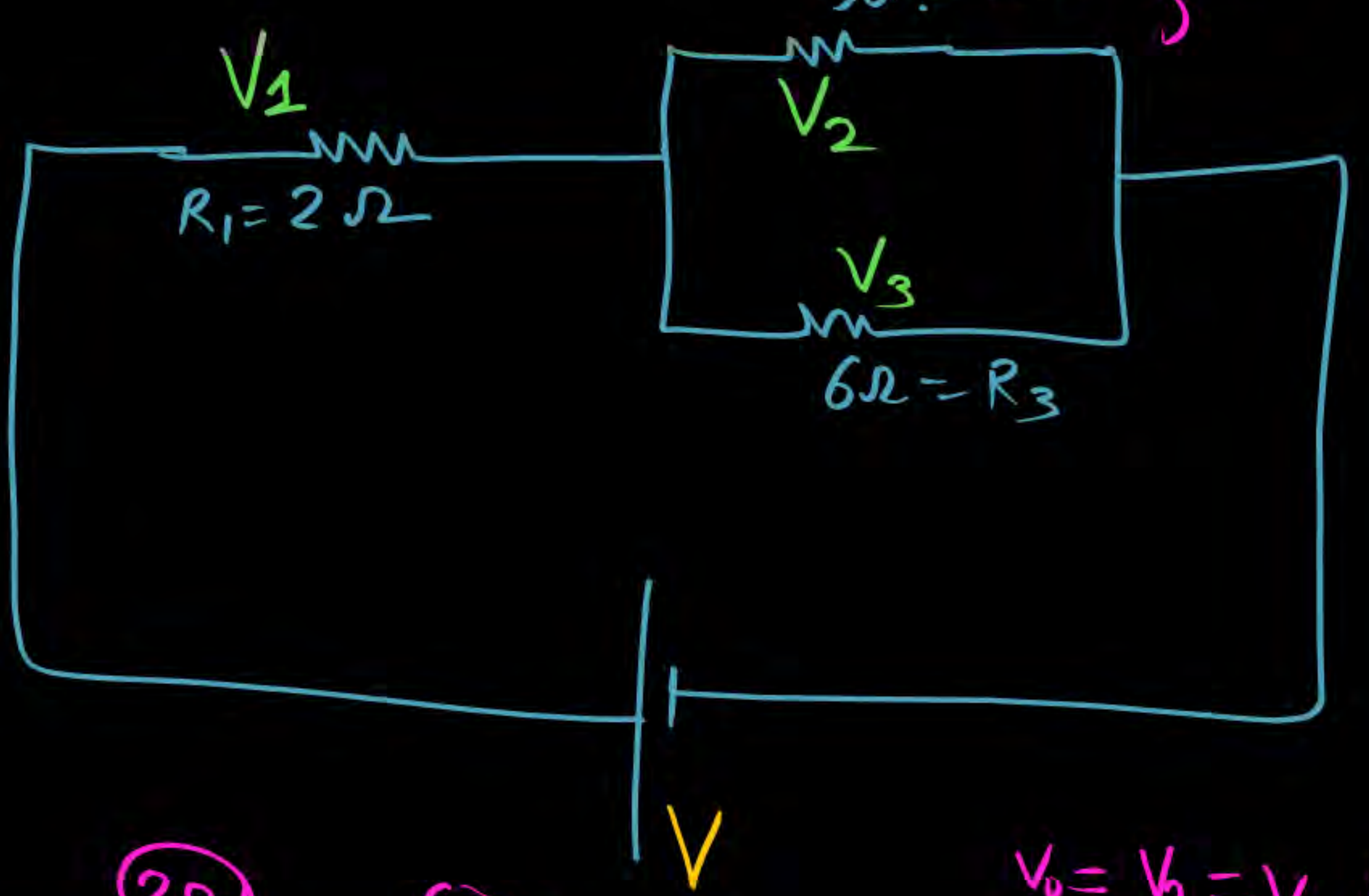
$IR = V = $ c

$I_1 R_1 = I_2 R_2$

$\frac{I_1}{I_2} = \frac{R_2}{R_1}$ #

find reading of $A_1 A_2 A_3$ & A_4





$\frac{6\times3}{6+3} = \frac{18}{9} = 2\Omega$

which is correct

(a) $V_1 \neq V_2 = V_3$ (50%)

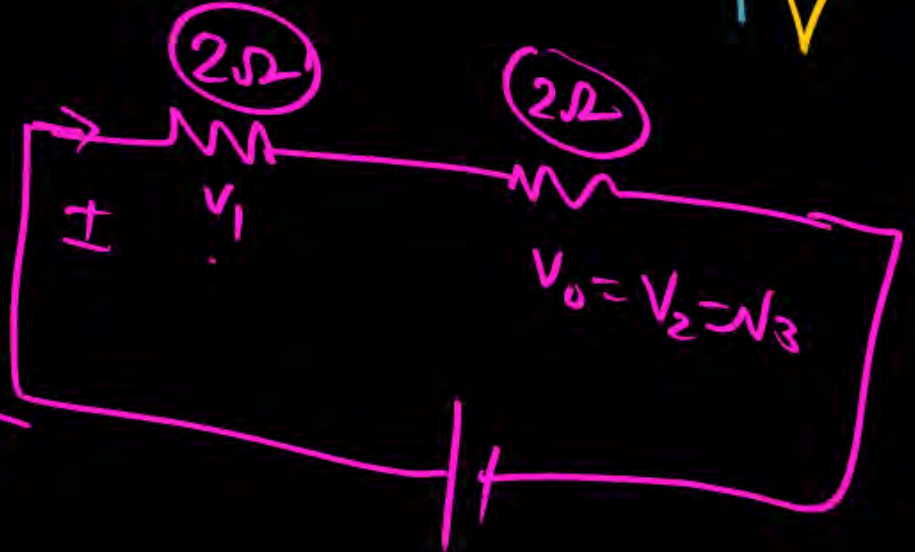
(b) $V_1 = V_2 \neq V_3$

(c) $V_1 = V_3 \neq V_2$

(d) $V_1 = V_2 = V_3$ (37%)

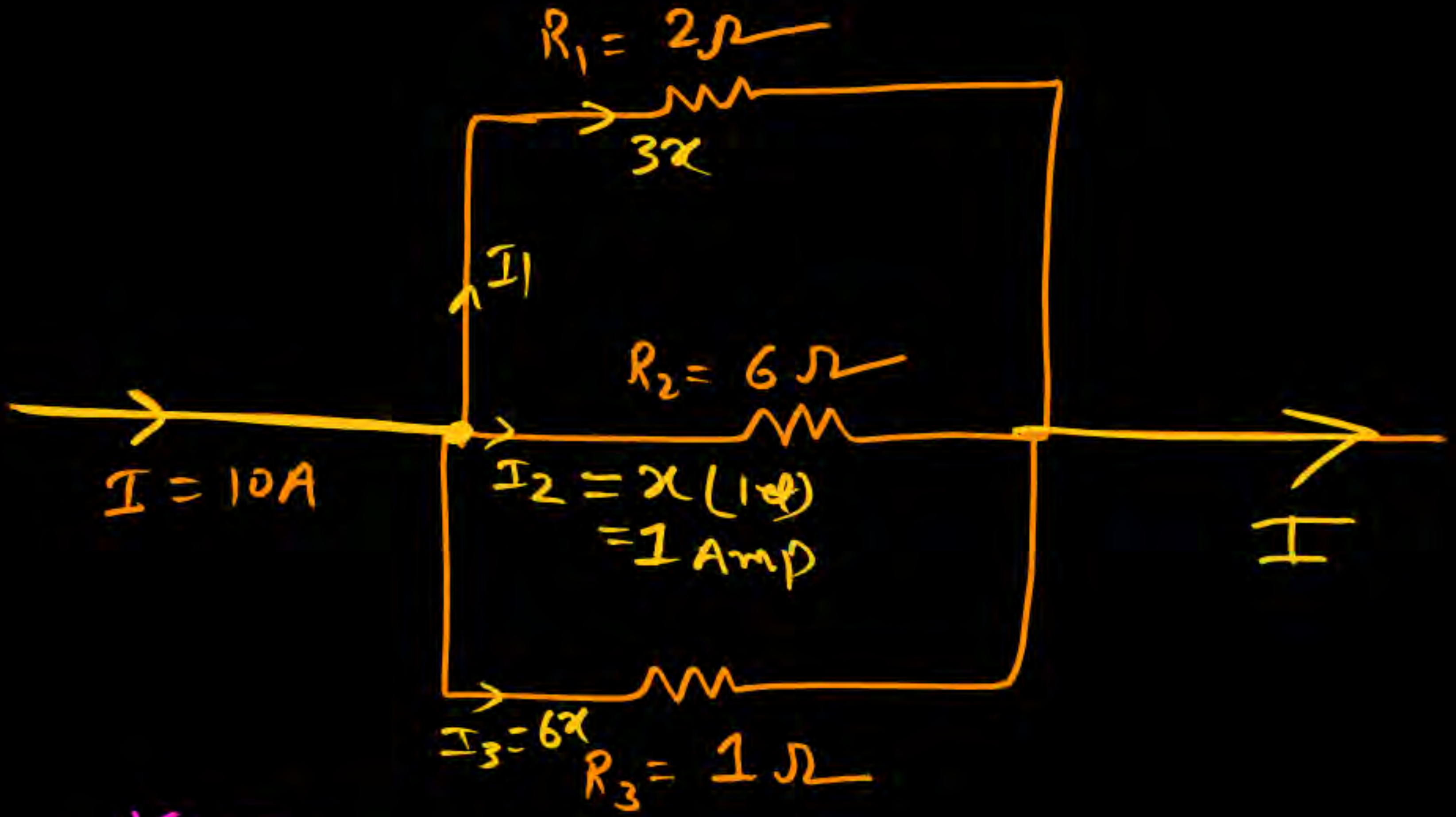
(e) $V_1 = V_2 + V_3$

$V_0 = V_2 = V_3$ (due to Parallel)



$V_1 = V_0 = V_2 = V_3$

$V_1 = V_2 = V_3 = V/2$



$I \propto \frac{1}{R}$

$3x + x + 6x = 10A$

$10x = 10$

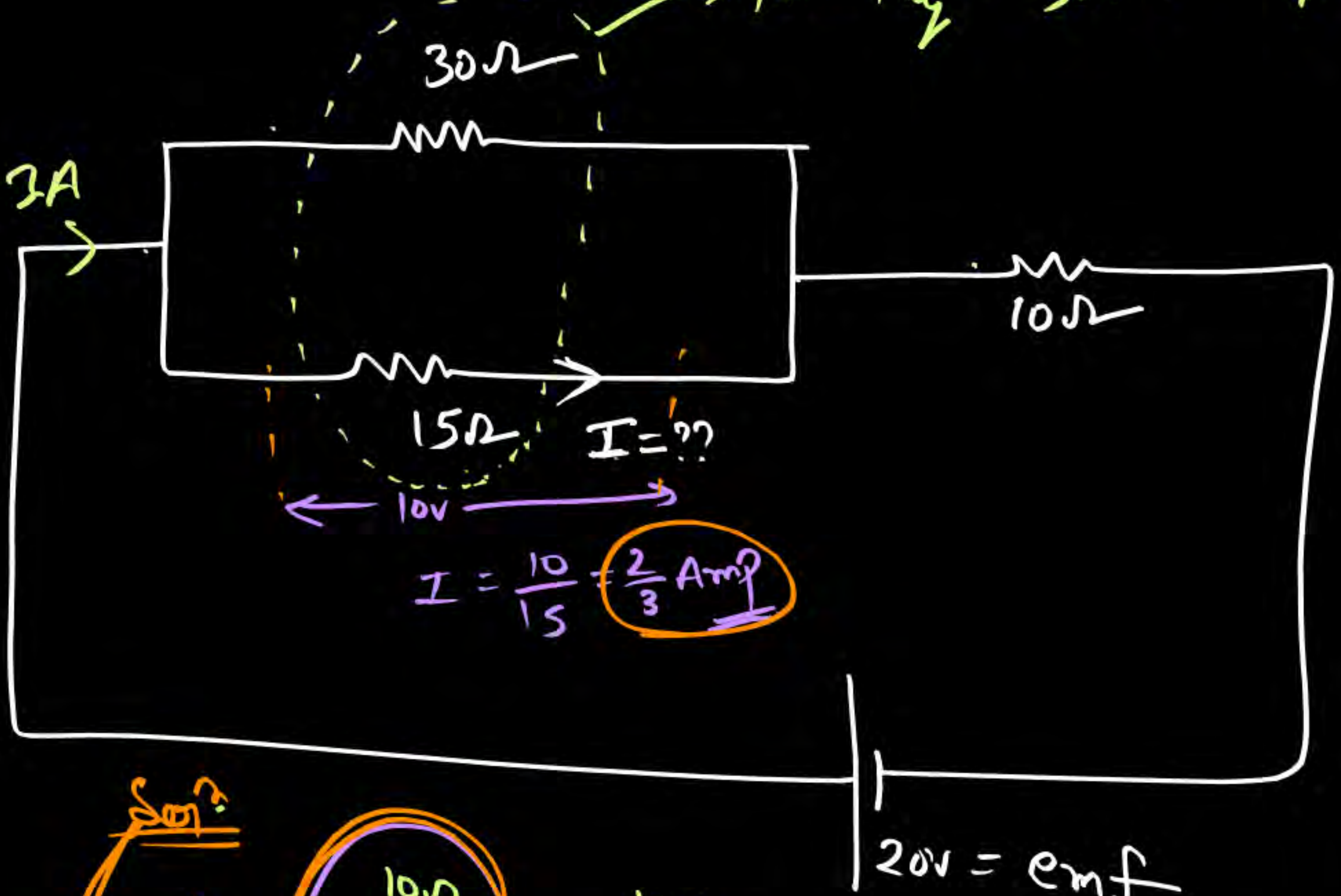
$x = 1A$

$I_1 = 3A$

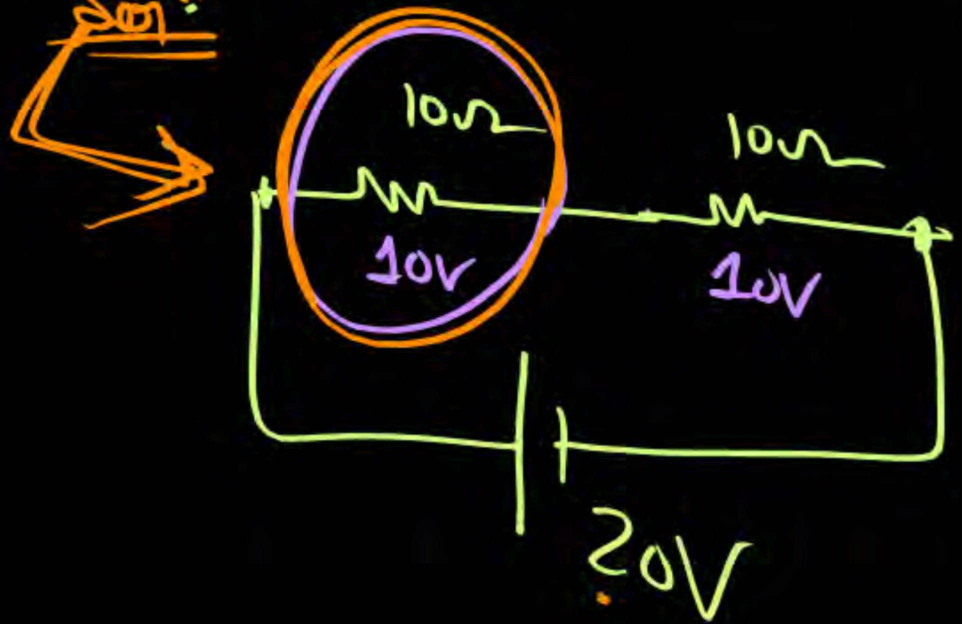
$I_2 = 1A$

$I_3 = 6A$

$$\text{Parall } R_{eq} = \frac{30 \times 15}{30 + 15} = \frac{30 \times 15}{45} = 10\Omega$$



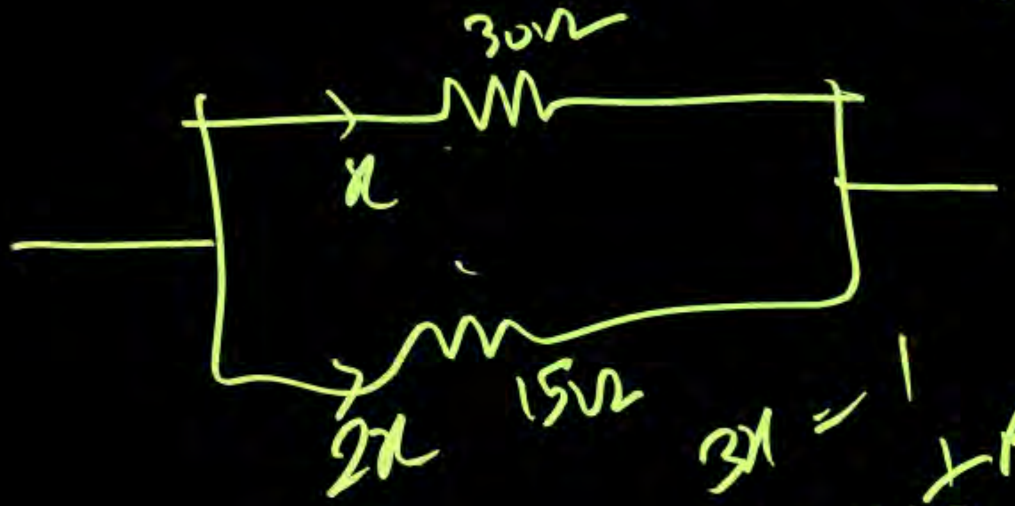
Sol?



→ मजबूरी *

$$R_{eq} = 10\Omega + 10\Omega = 20\Omega$$

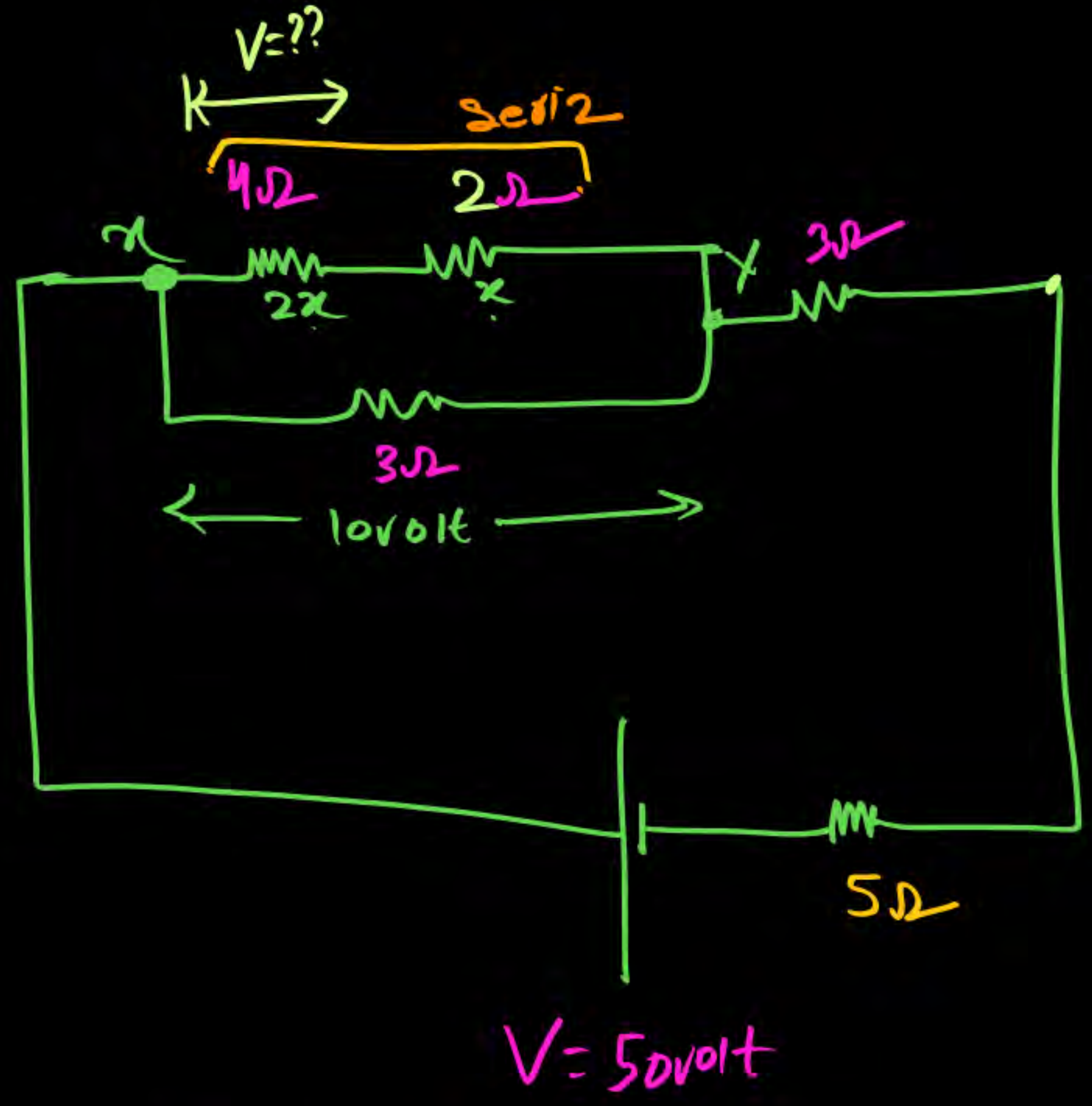
$$I_{battr} = \frac{20}{20} = 1A$$



$3x = 1$

$x = \frac{1}{3}$ Amp

$2x = \frac{2}{3}$ Amp Ans

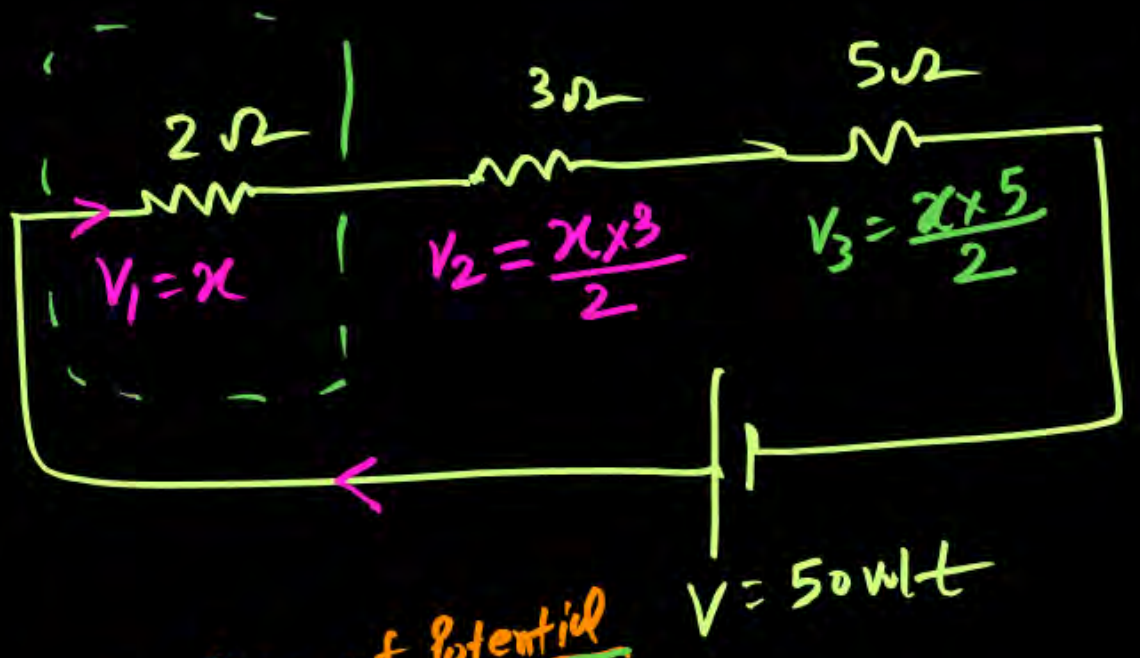


$$x + 2x = 10$$

$$x = \frac{10}{3}$$

$$V = 2x = \frac{20}{3} \text{ Volt}$$

3

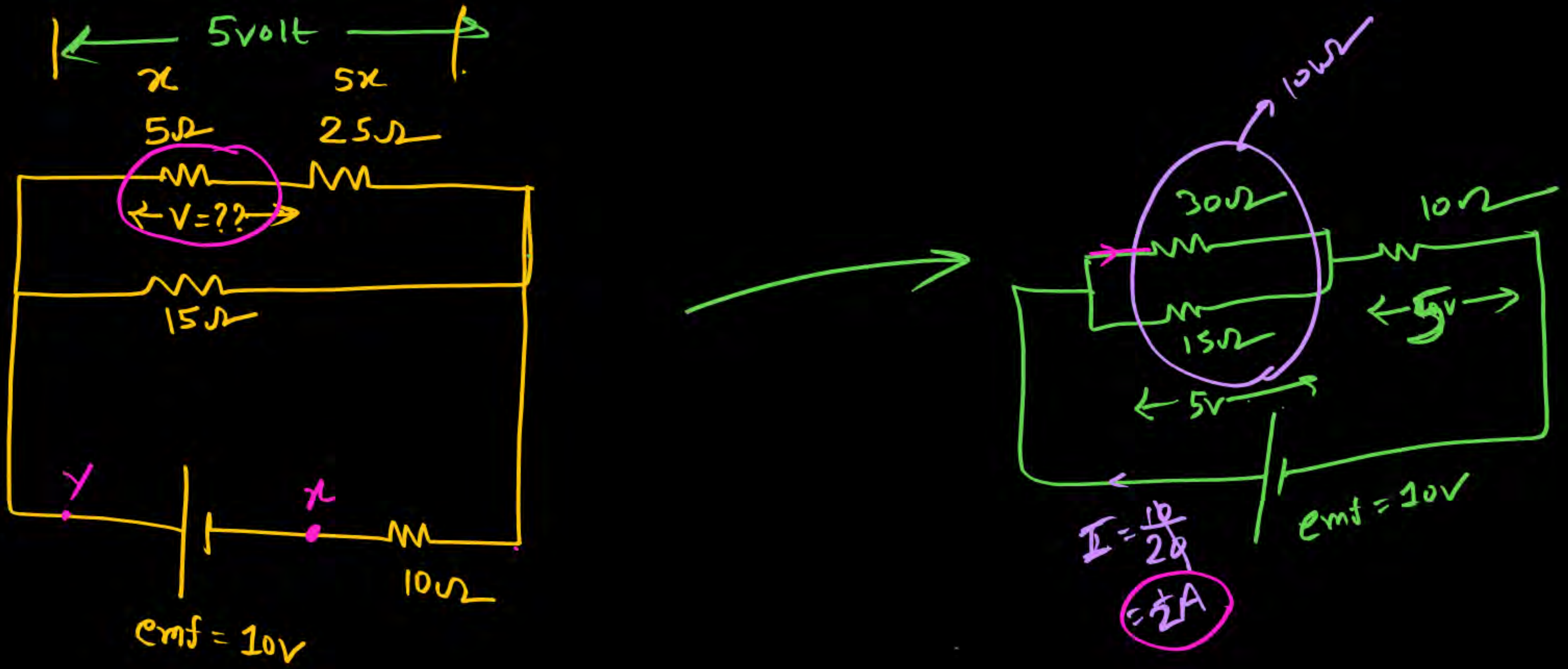


Sum of Potential

$$x + \frac{3x}{2} + \frac{5x}{2} = 50$$

$$\frac{10x}{2} = 50$$

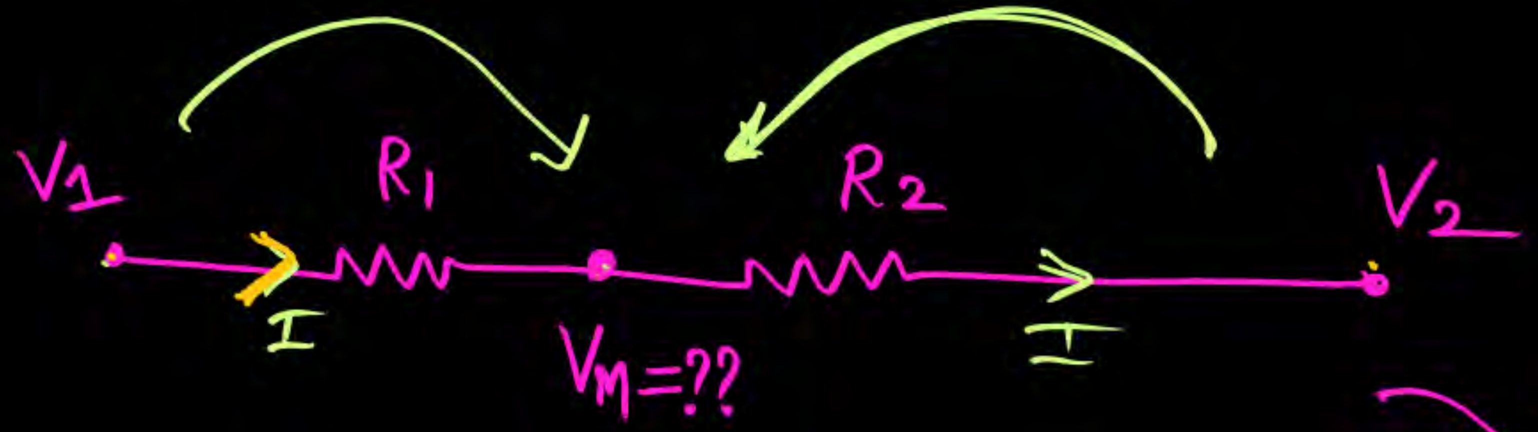
$$x = 10 \text{ volt}$$



$$x + 5x = 5$$

$$6x = 5$$

$$V_{(5\Omega)} = x = 5/6 \text{ volt}$$



sol^n

~~$V_m = \frac{V_1 R_1 + V_2 R_2}{V_1 + V_2}$~~ dim wrong

~~$V_m = \frac{V_1 R_1 + V_2 R_2}{R_1 + R_2}$~~ ← wrong

$I = \text{same} - V/R$

$V_1 - IR_1 = V_m$ *

$\frac{V_1 - V_m}{R_1} = I \quad - (1)$

$V_2 + IR_2 = V_m$

$IR_2 = V_m - V_2$

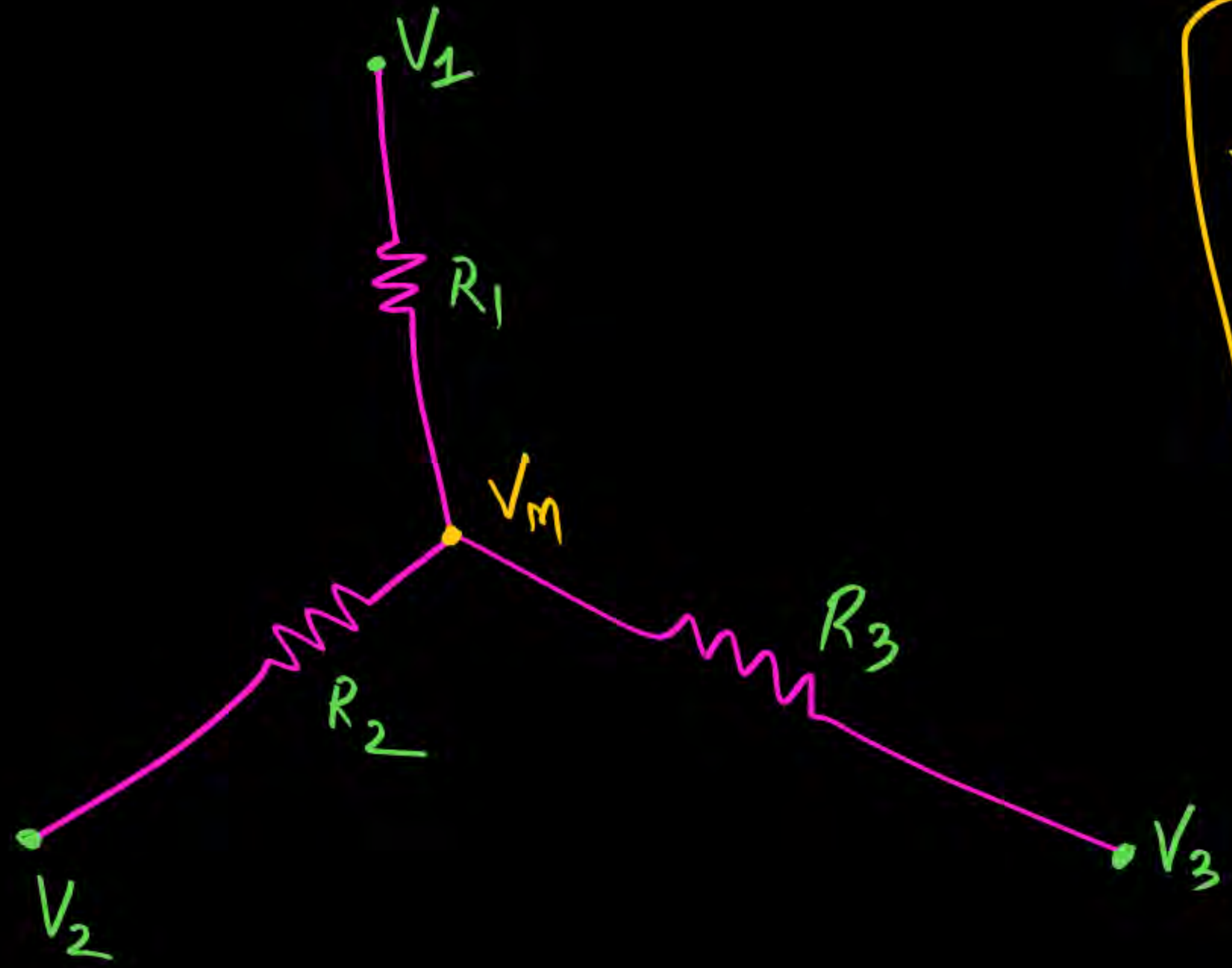
$I = \frac{V_m - V_2}{R_2} \quad - (11)$

$(1) = (11)$

By solving eq^n (1) & (11)

*

$$V_m = \frac{\frac{V_1}{R_1} + \frac{V_2}{R_2}}{\frac{1}{R_1} + \frac{1}{R_2}}$$ *



$$V_M = \frac{\frac{V_1}{R_1} + \frac{V_2}{R_2} + \frac{V_3}{R_3}}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$$


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 04 | **Physics**

Current Electricity

By- Dr. Manish Raj (MR SIR)

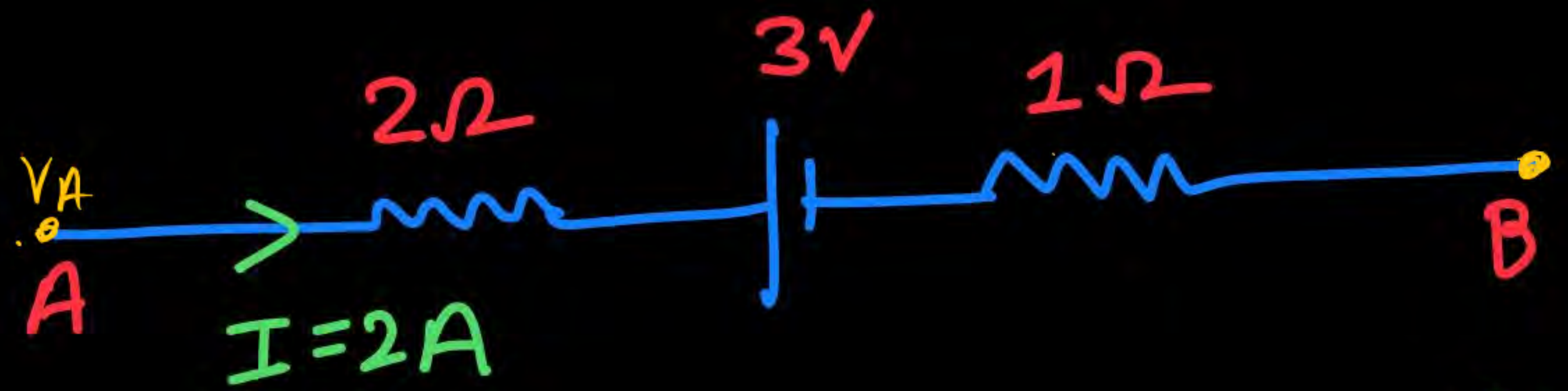


Todays Goal

Circuit analysis.

#

NEET-2016



Find $V_A - V_B = ??$

$$V_A - 2\times 2 - 3 - 1\times 2 = V_B$$

$$V_A - V_B = +9 \text{ volt}$$

Electric potential decreases uniformly from 120 V to 80 V, as one moves on the x-axis from x = −1 cm to x = +1 cm. The electric field at the origin

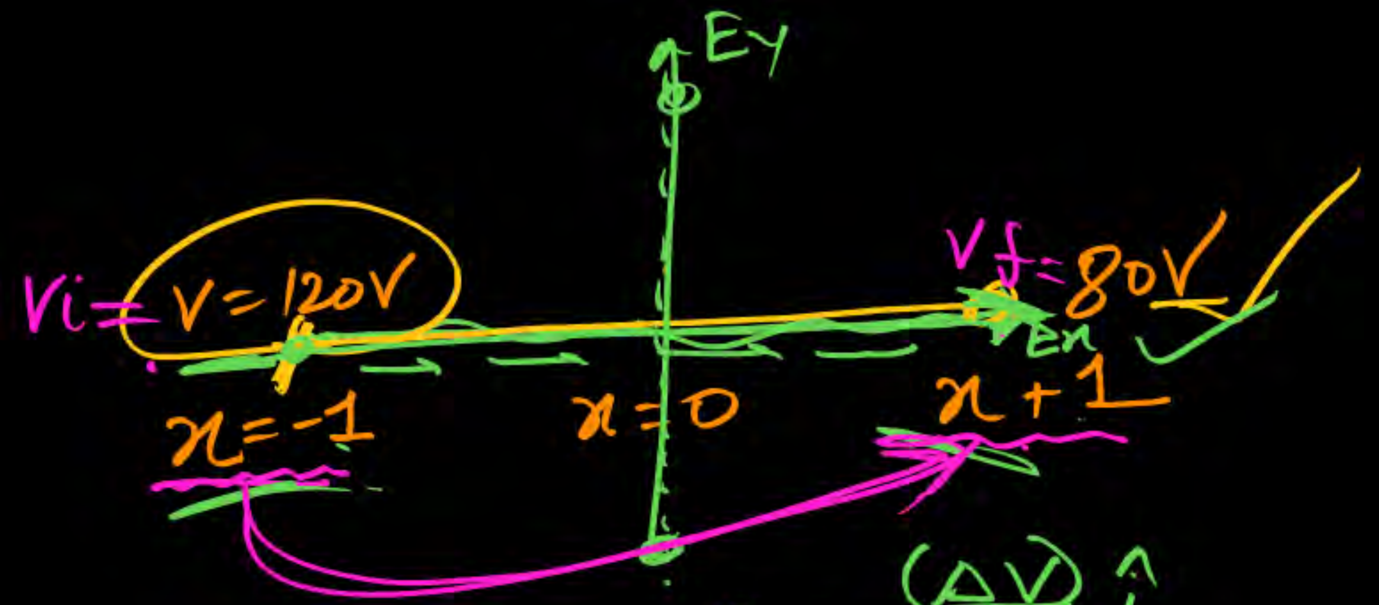
(a) must be equal to 20 Vcm^{-1}

(b) may be equal to 20 Vcm^{-1}

(c) may be greater than 20 Vcm^{-1}

(d) may be less than 20 Vcm^{-1}

→ Both are correction



$$E = -\frac{(\Delta V)}{\Delta x}\hat{i}$$

$$E = \frac{(\Delta V)}{\Delta r}$$

$$= -\left[\frac{80-120}{2}\right] i$$

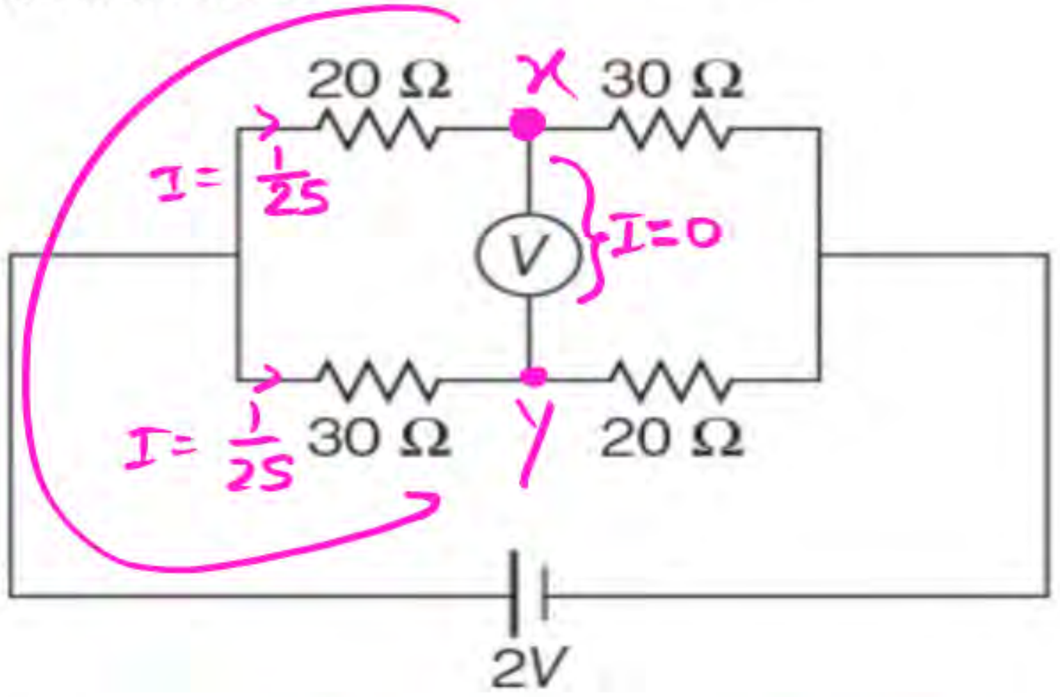
$$= -\left[\frac{-40}{2}\right]$$

$$= +20 i \quad (10\%)$$

$$\vec{E} = -\left[\frac{\Delta V}{\Delta x}\hat{i} + \frac{\Delta V}{\Delta y}\hat{j} + \frac{\Delta V}{\Delta z}\right]$$

this information is given.

Q4: The reading of an ideal voltmeter in the circuit shown is



(a) 0.6 V
(b) 0 V
(c) 0.5 V
(d) 0.4 V

NEET

Ans

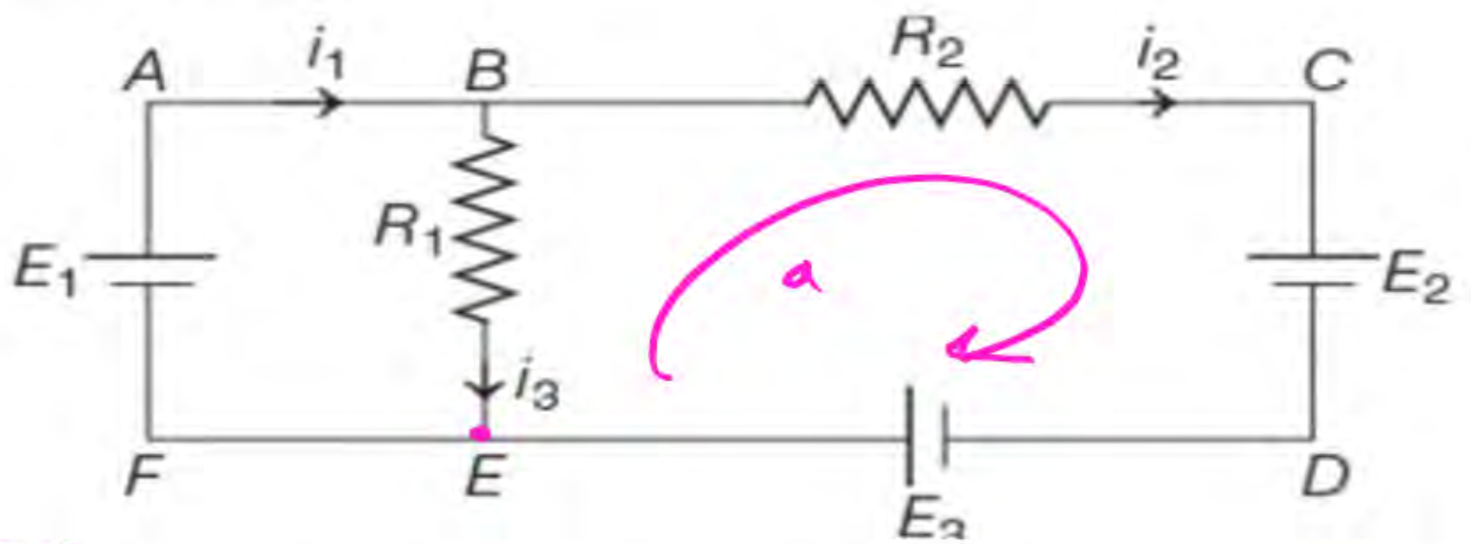
$V_x + 20 \times \frac{1}{25} - \frac{30}{25} = V_y$

$V_x - V_y = \frac{30}{25} - \frac{20}{25} = \frac{10}{25}$

$= \frac{2}{5}$

$= 0.4$

Q8: For the circuit given below, the Kirchhoff's loop rule for the loop BCDEB is given by the equation



(a) $-i_2R_2 + E_2 - E_3 + i_3R_1 = 0$

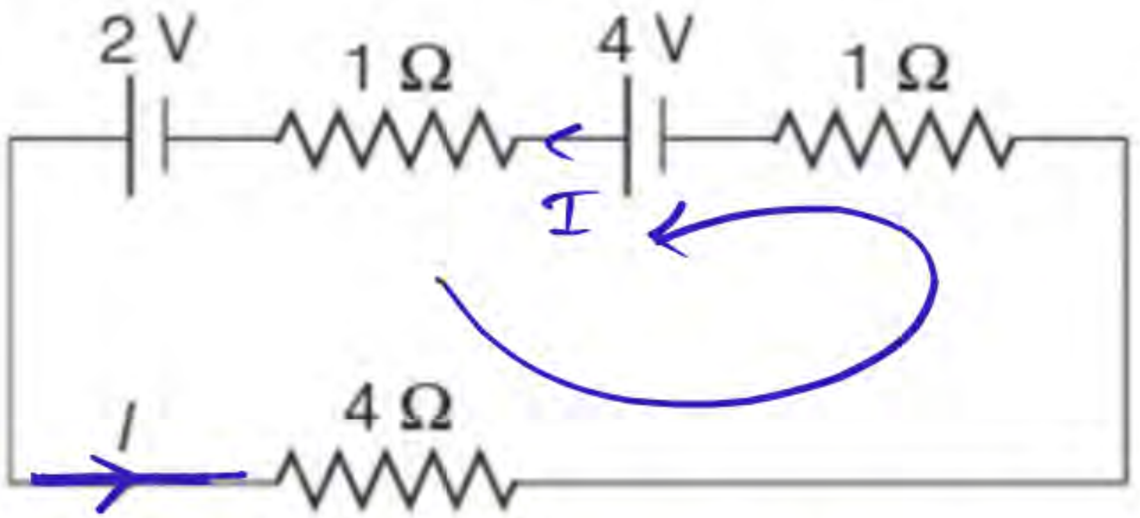
(b) $i_2R_2 + E_2 - E_3 - i_3R_1 = 0$ ← Ans

(c) $i_2R_2 + E_2 + E_3 + i_3R_1 = 0$

(d) $-i_2R_2 + E_2 + E_3 + i_3R_1 = 0$

$+R_1I_3 - I_2R_2 - E_2 + E_3 = 0$

Q7: For the circuit shown in the figure, the current I will be



(a) 0.75 A

✓(b) 1 A (Ans)

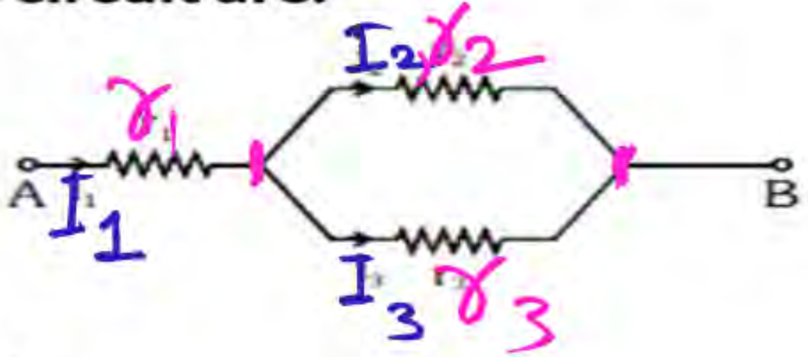
(c) 1.5 A

(d) 0.5 A

$-4I - 1I + 4 - 1I + 2 = 0$

$6 = 6I$

Q4: Three resistors having resistances r_1, r_2, and r_3 are connected as shown in the given circuit. The ratio i_3/i_1 of currents in terms of resistances used in the circuit are:



(a) $\frac{r_1}{r_1+r_2}$

(b) $\frac{r_2}{r_1+r_3}$

(c) $\frac{r_1}{r_2+r_3}$

(d) $\frac{r_2}{r_2+r_3}$

$$I_2 r_2 = I_3 r_3$$

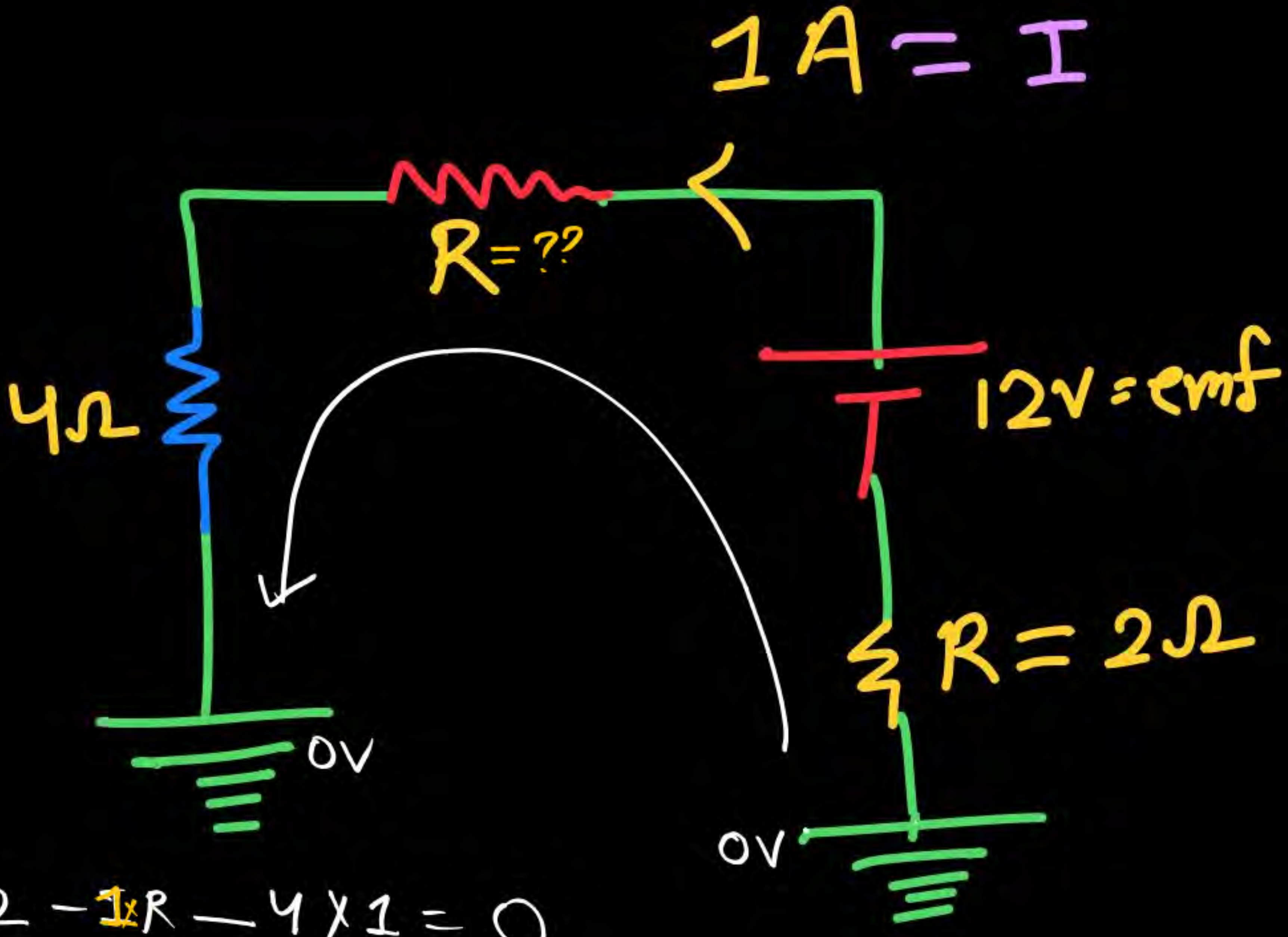
$$I_1 = I_2 + I_3$$

$$I_1 = \frac{I_3 r_3}{r_2} + I_3$$

$$I_1 = I_3\left(\frac{r_3+r_2}{r_2}\right)$$

$$\frac{I_3}{I_1} = \frac{r_2}{r_3+r_2}$$

find 'R'

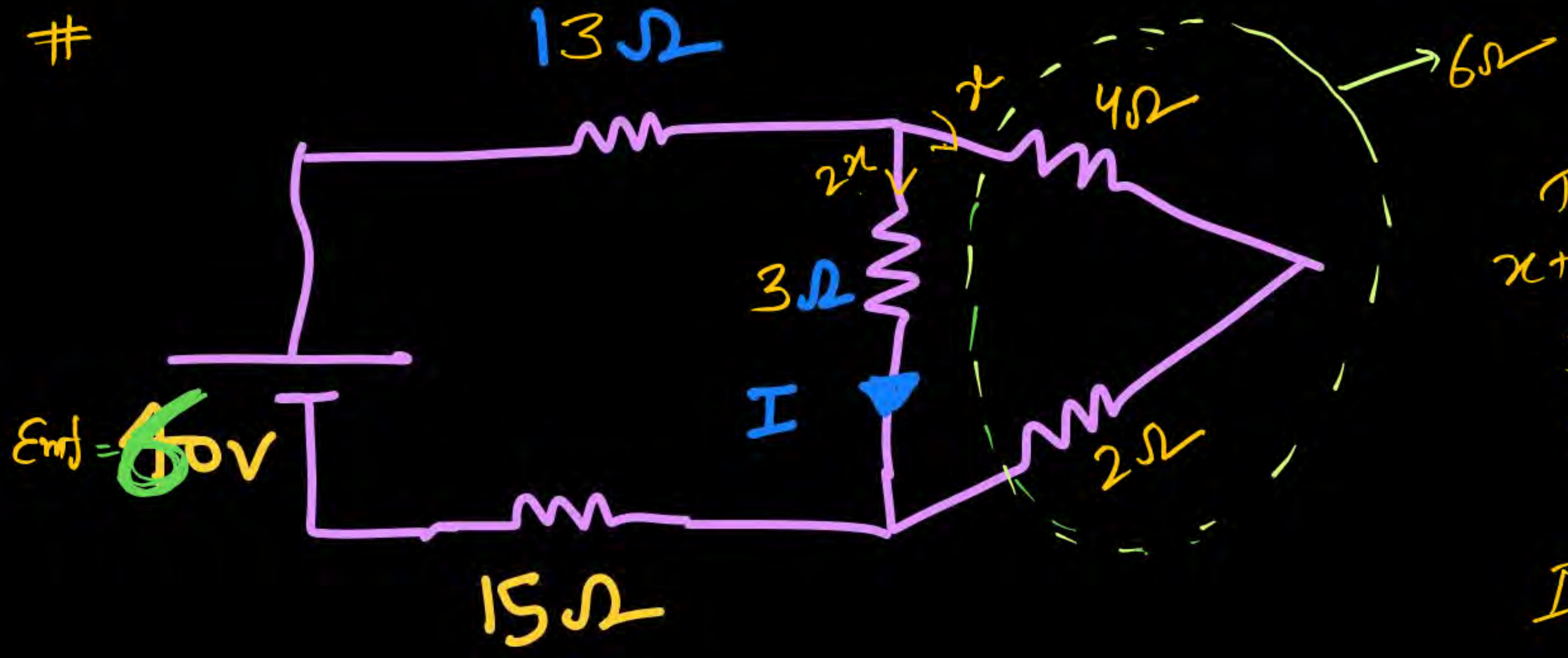


$$0 - 2 \times 1 + 12 - 1 \times R - 4 \times 1 = 0$$

$$-2 + 12 - 4 = R$$

$$\boxed{6 = R}$$ Ans

#



find = I

Total curnt

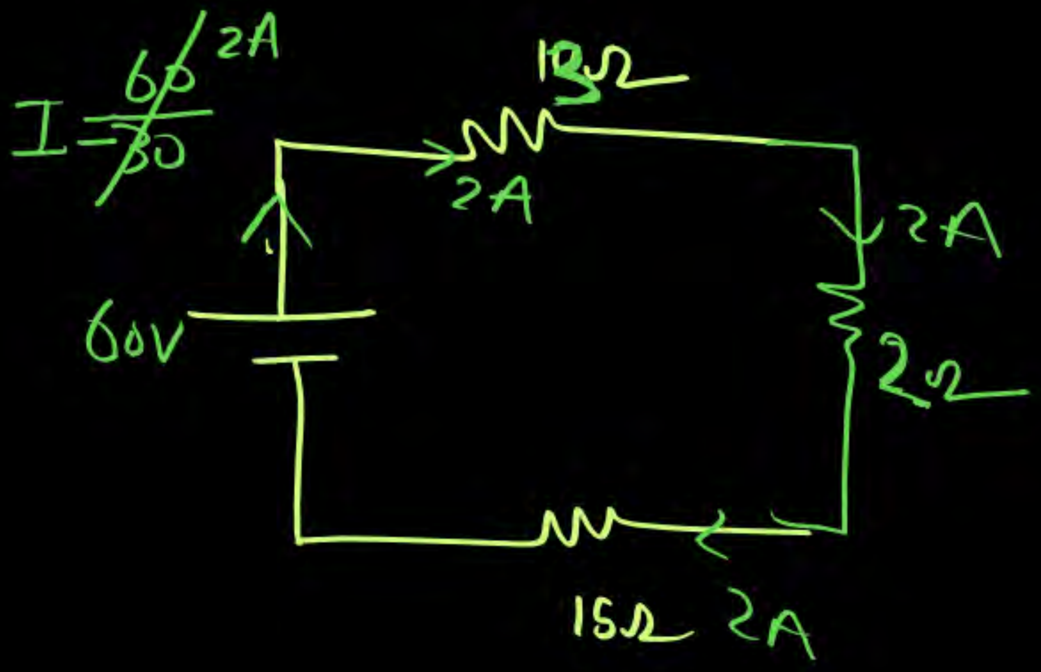
$x + 2x = 2$

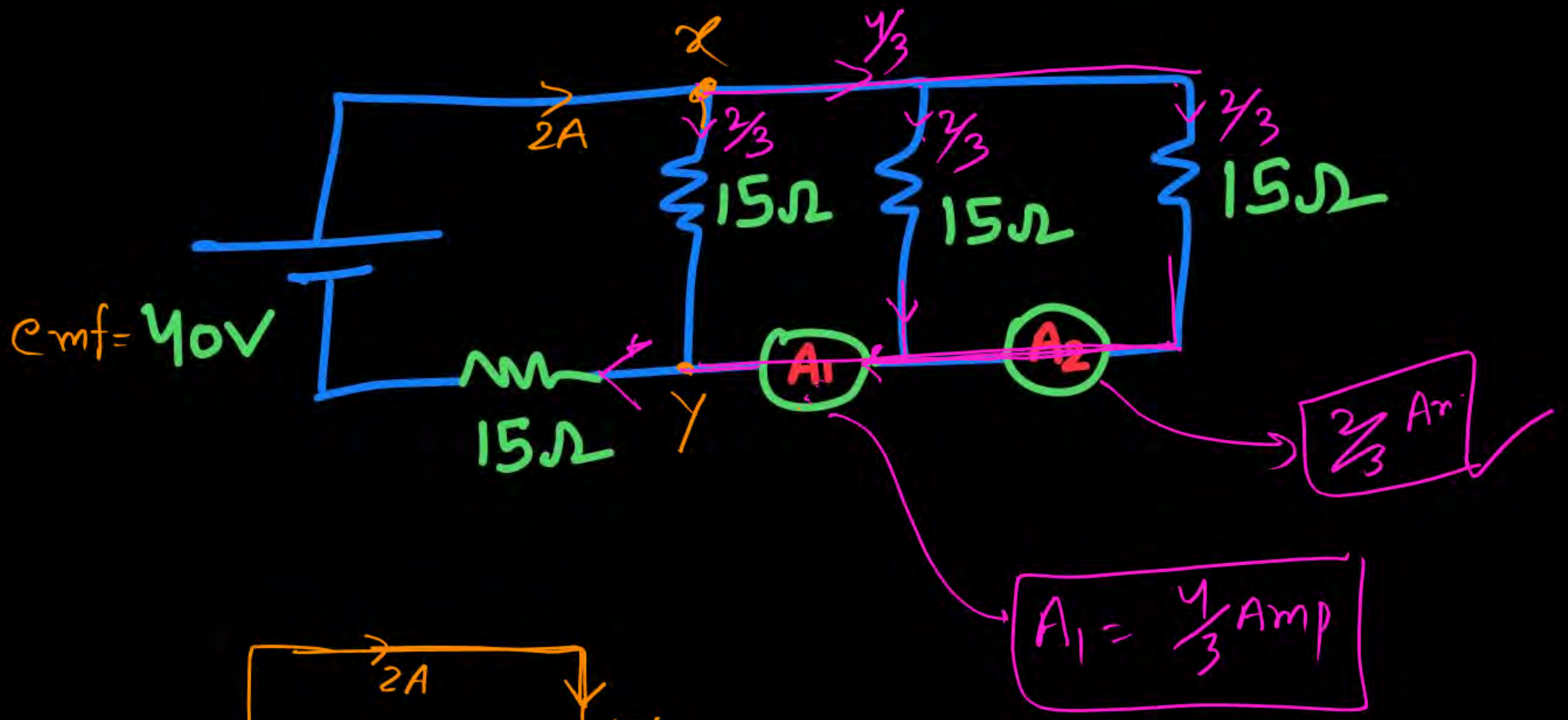
$3x = 2$

$x = \frac{2}{3}$

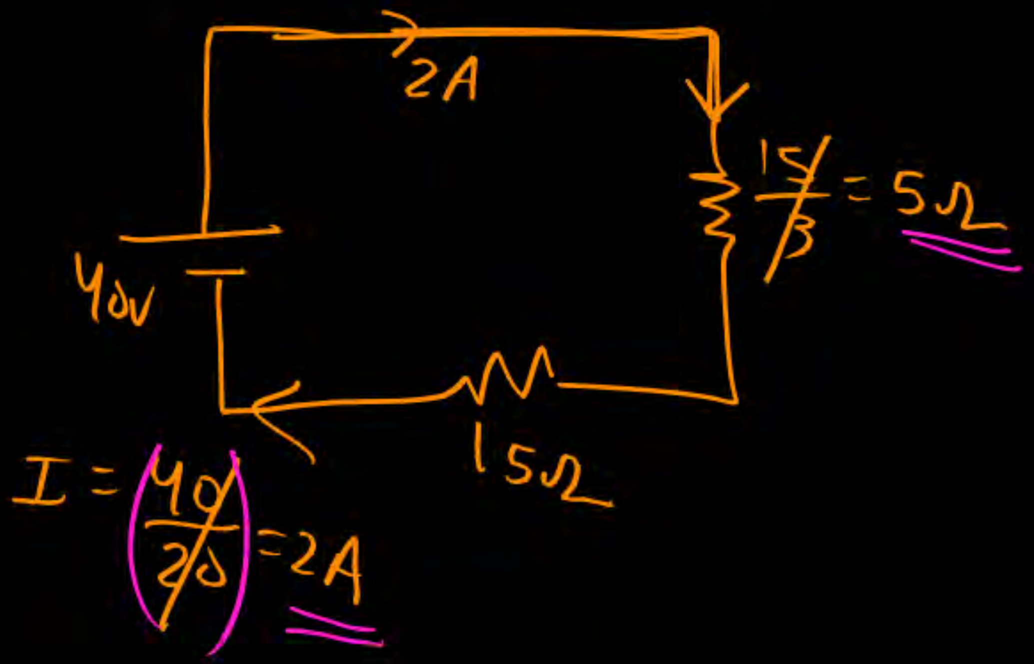
$I = 2x = 2 \times \frac{2}{3}$

$= \frac{4}{3}$ Amp



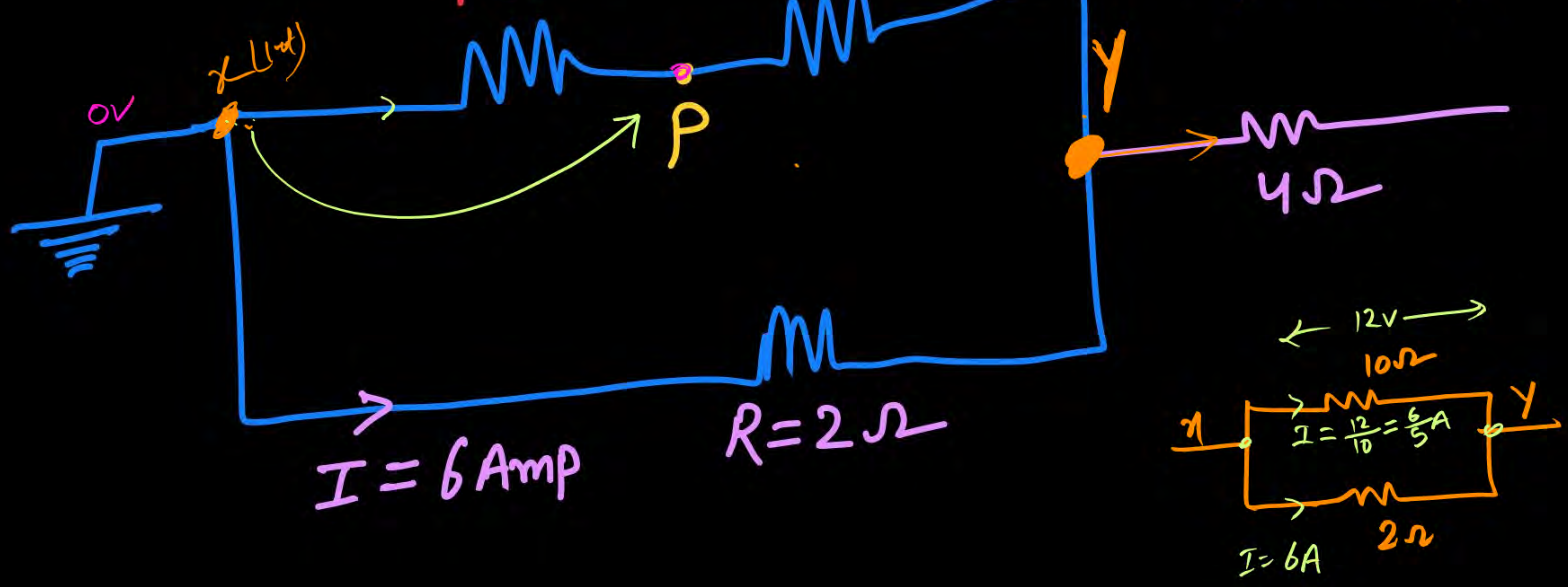


emf = 40V
2A
x
4/3
2/3
15Ω
15Ω
15Ω
15Ω
y
A1
A2
A1 = 4/3 Amp
2/3 Amp



2A
15/3 = 5Ω
40V
15Ω
I = 40/20 = 2A

Find V_p

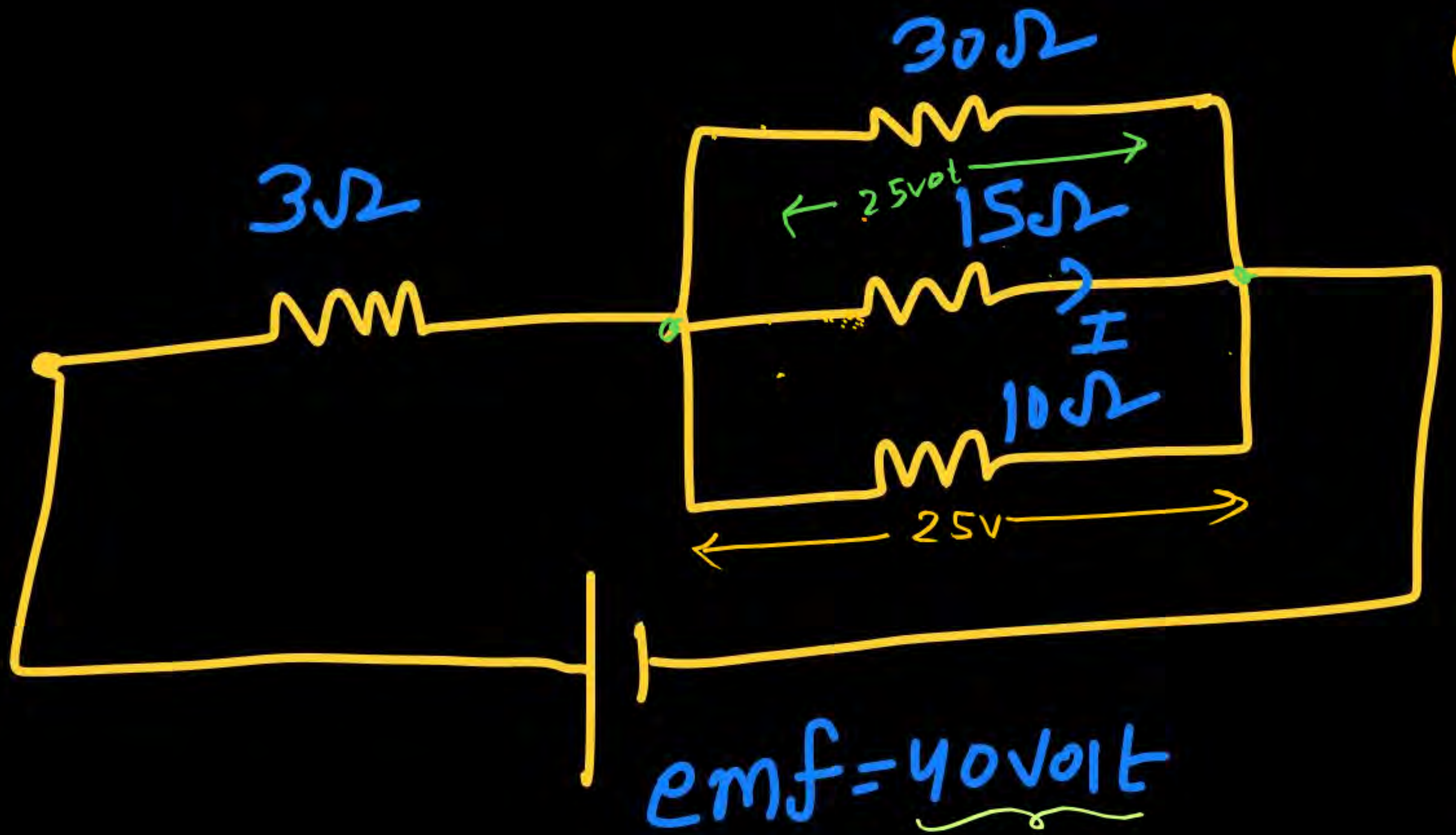


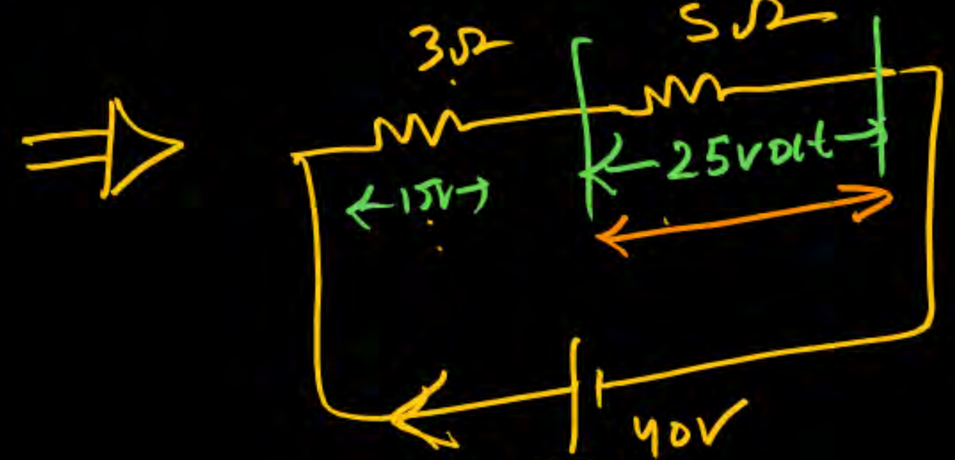
kudoo

$$0V - \frac{6}{5} \times 4 = V_p$$

$$V_p = -\frac{24}{5} \text{ volt}$$

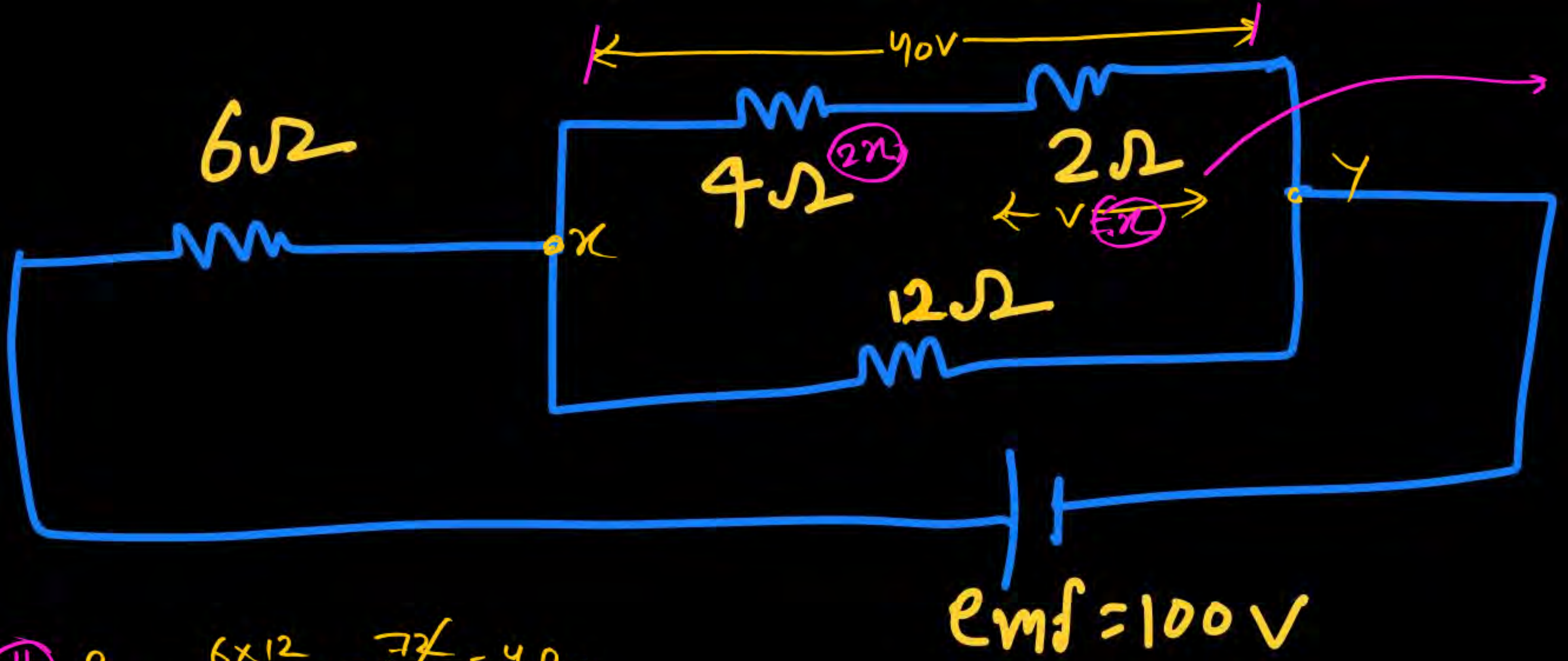
$$\frac{1}{R_{eq}} = \frac{1}{30} + \frac{1}{15} + \frac{1}{10} = \frac{1+2+3}{30} = \frac{6}{30} = \frac{1}{5}$$





$$I = \frac{40}{8} = 5\text{ Amp}$$

$$I = \frac{25}{15} = \frac{5}{3}\text{ Amp}$$

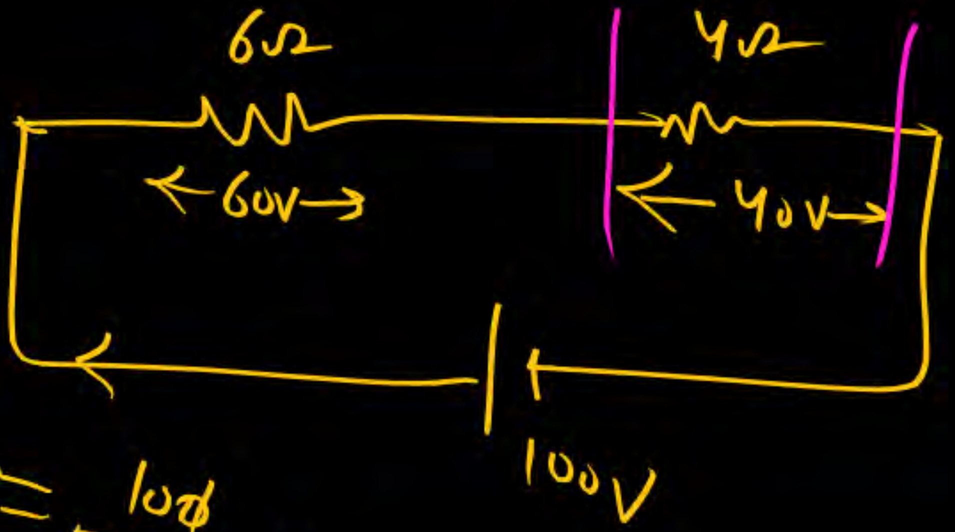


$3x = 40$

$x = \boxed{\frac{40}{3}}$ volt

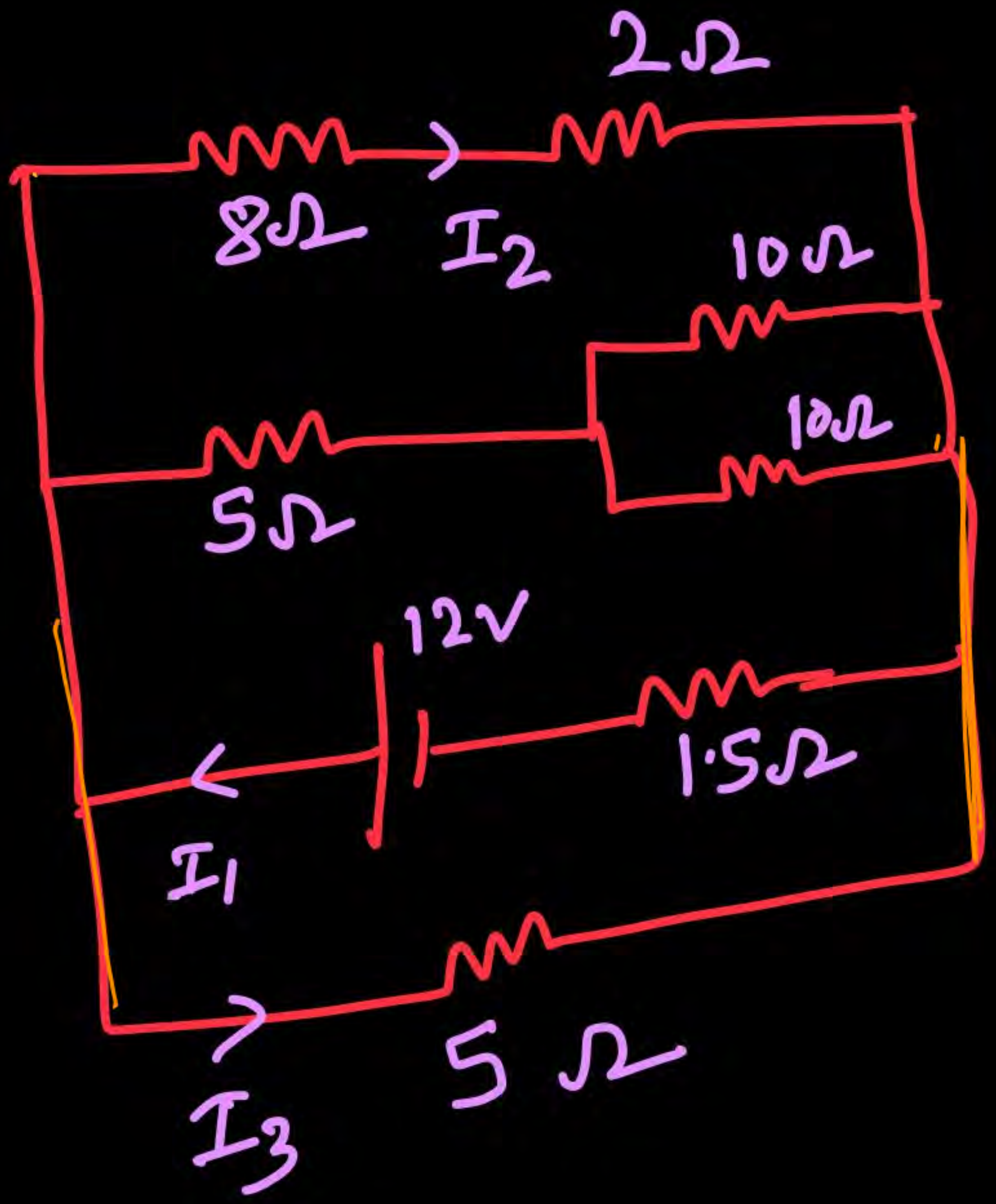
Ans

$R_{eq} = \frac{6\times 12}{6+12} = \frac{72}{18} = 4\Omega$

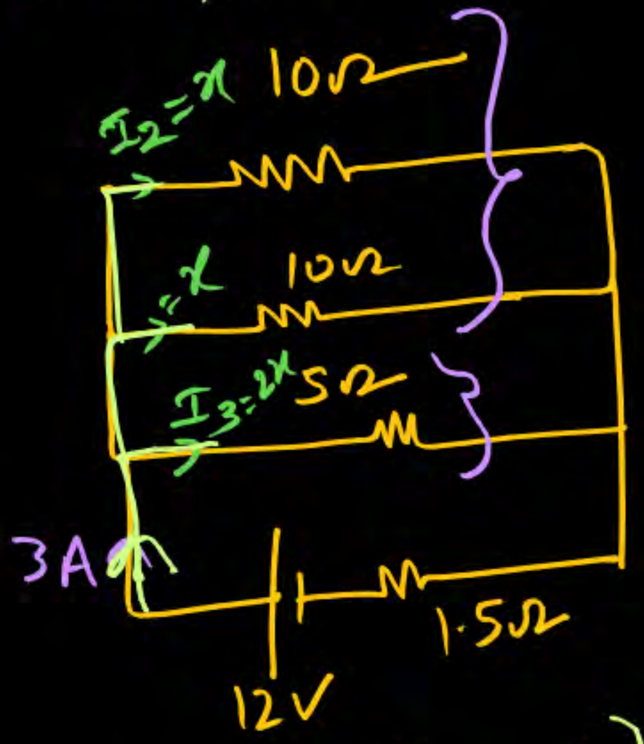


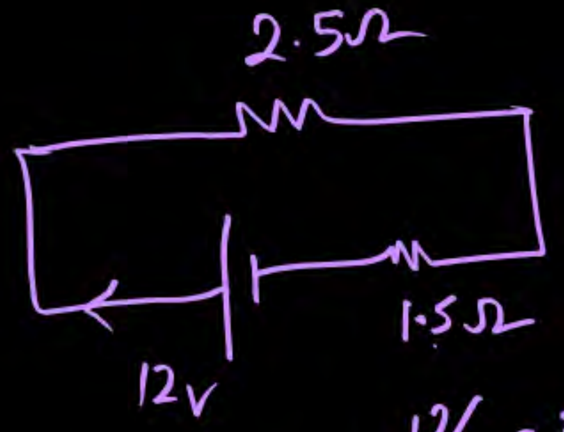
$I = \frac{100}{10} = 10A$

Find I_1, I_2, I_3



Sav
$V = IR$
$\downarrow I \propto \frac{1}{R} \uparrow$



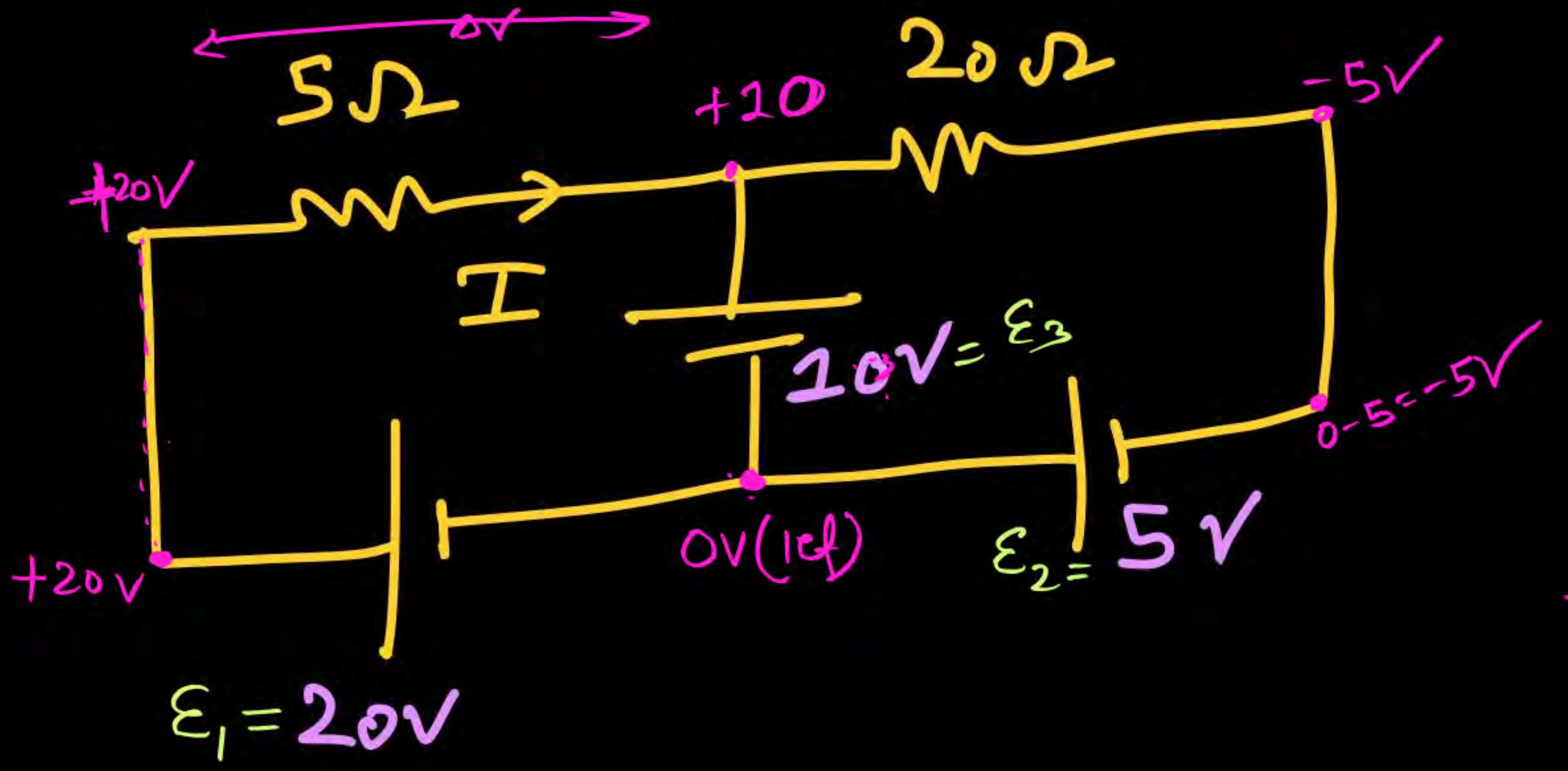


$I_1 = \frac{12}{4} = 3A$

$(4x = 3)$

$I_2 = x = \frac{3}{4} Amp$ ✓

$I_3 = 2x = \frac{6}{4} Amp$ ✓

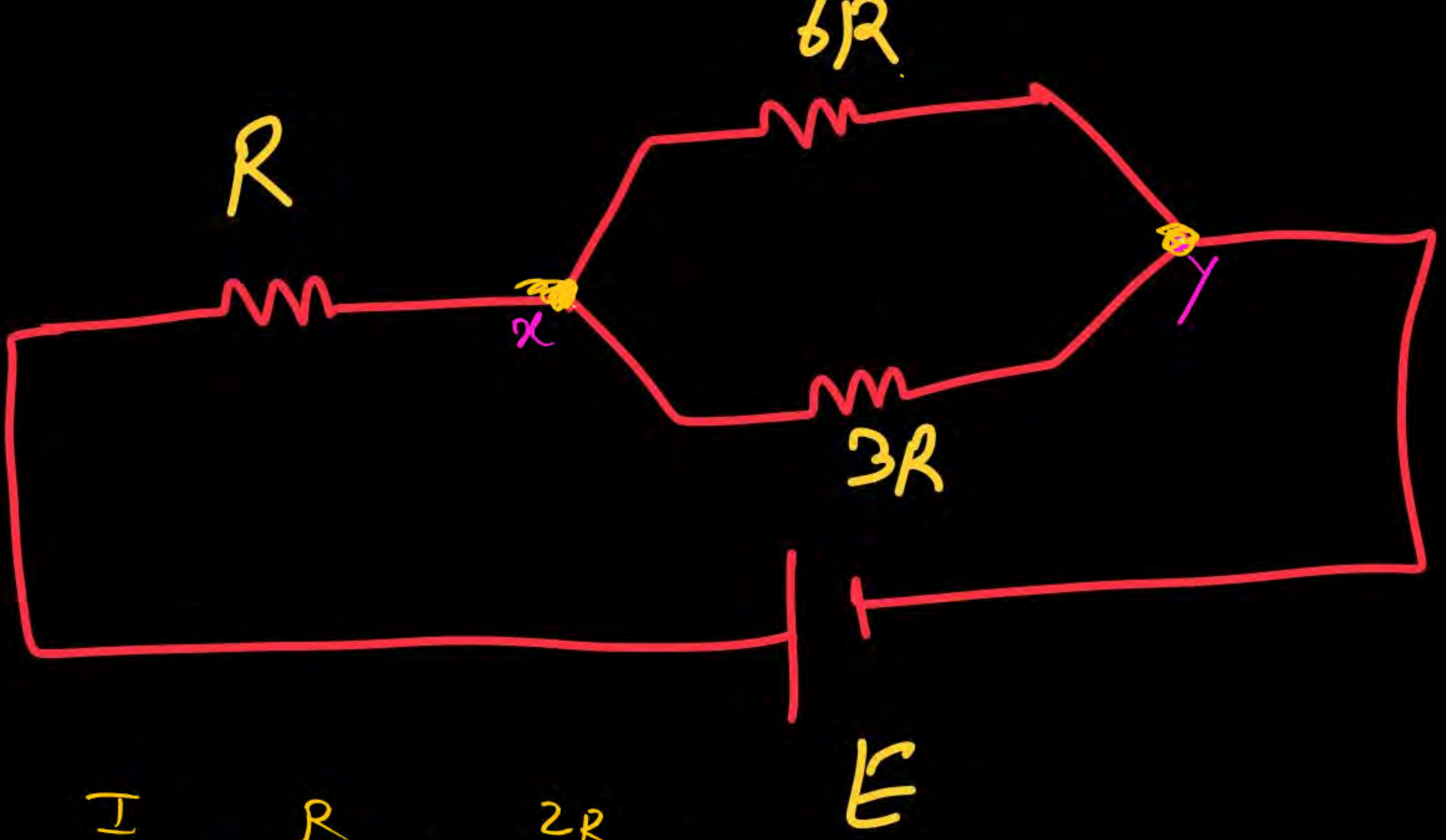


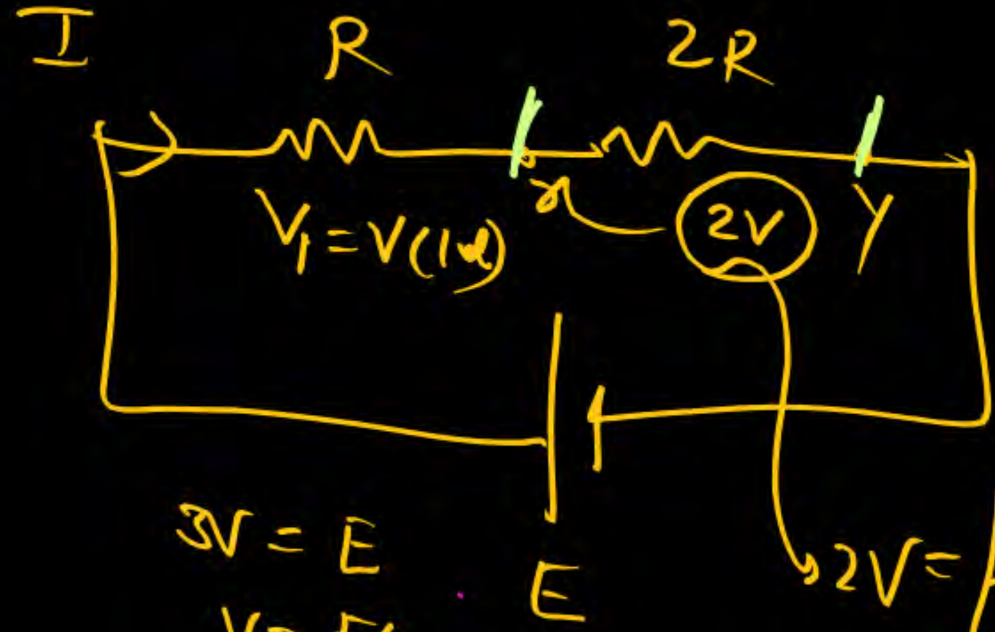
find I

$$I = \frac{20-10}{5}$$

$$= \frac{10}{5} = 2\ \text{Amp}$$

$V_{xy} = ??$



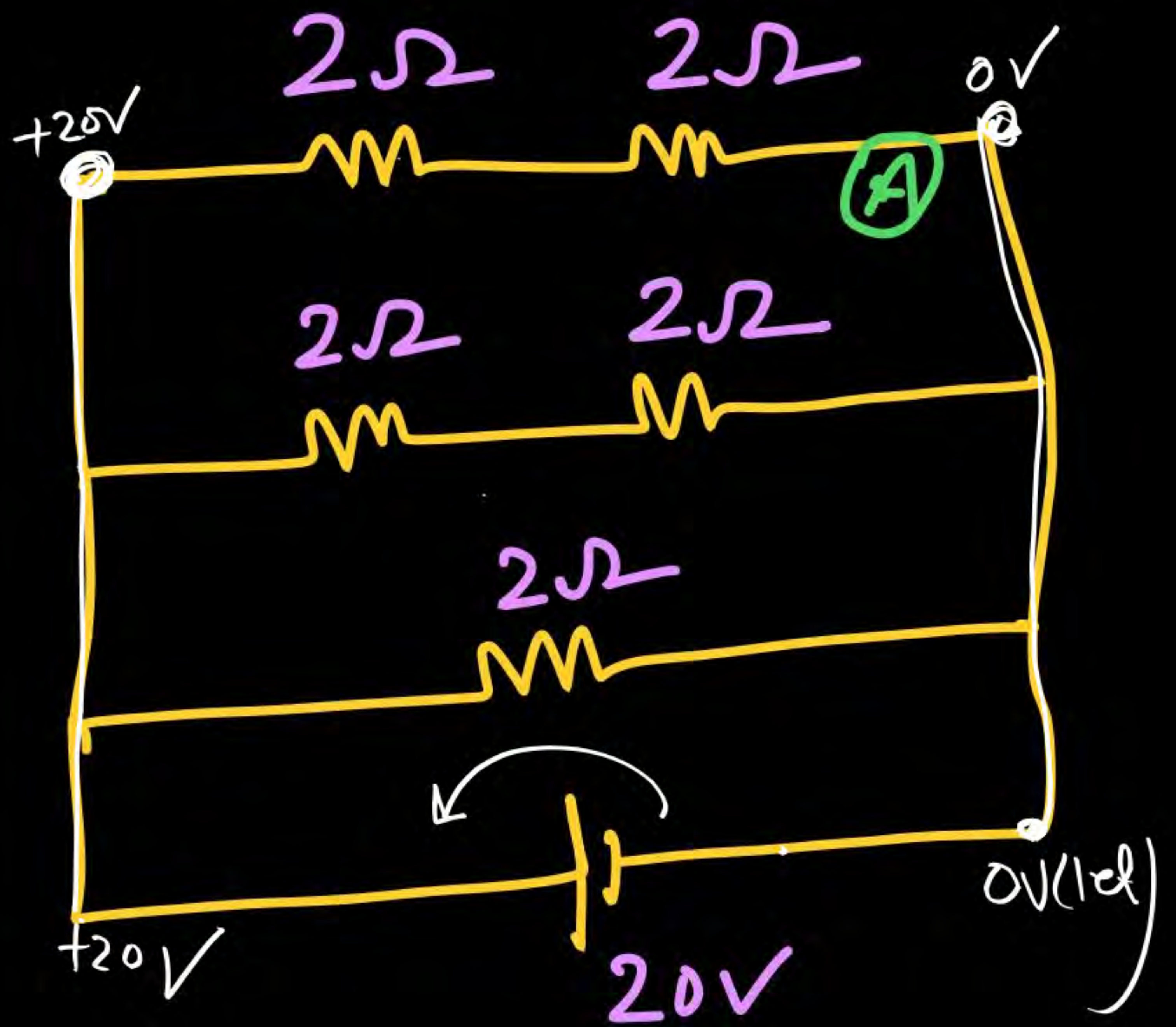


$3V = E$

$V = E/3$

$2V = \left[\frac{2E}{3}\right]$ Ans $= V_{xy}$

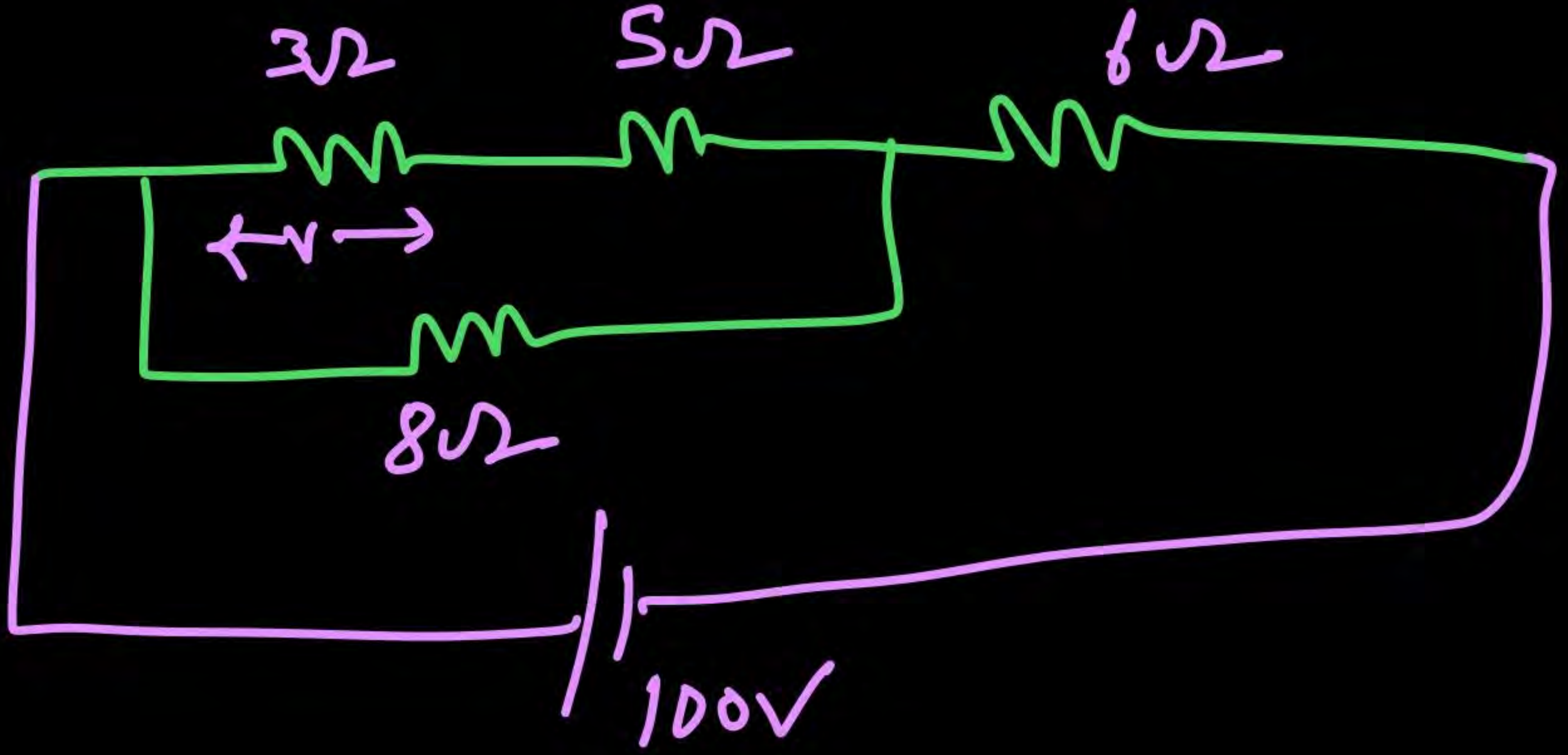
find reading (A)



$I = \frac{20}{4}$

$= 5$ Amp

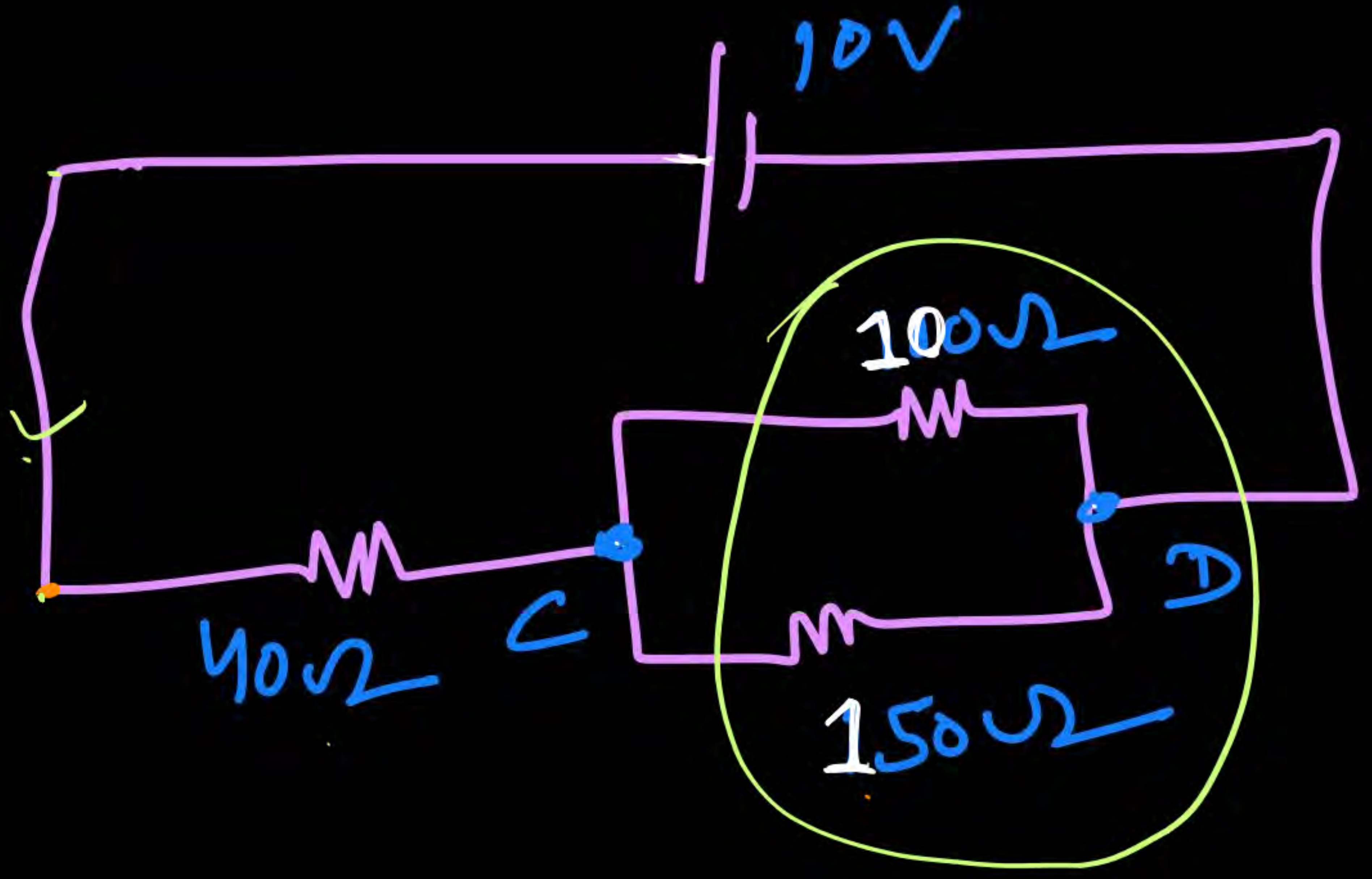
Ans



find V = ??
across
3Ω.

done many
times
H/W

$V_{CD} = ??$



$I = \frac{10}{100}$

$R_{eq} = \frac{150 \times 100}{250} = 60\Omega$

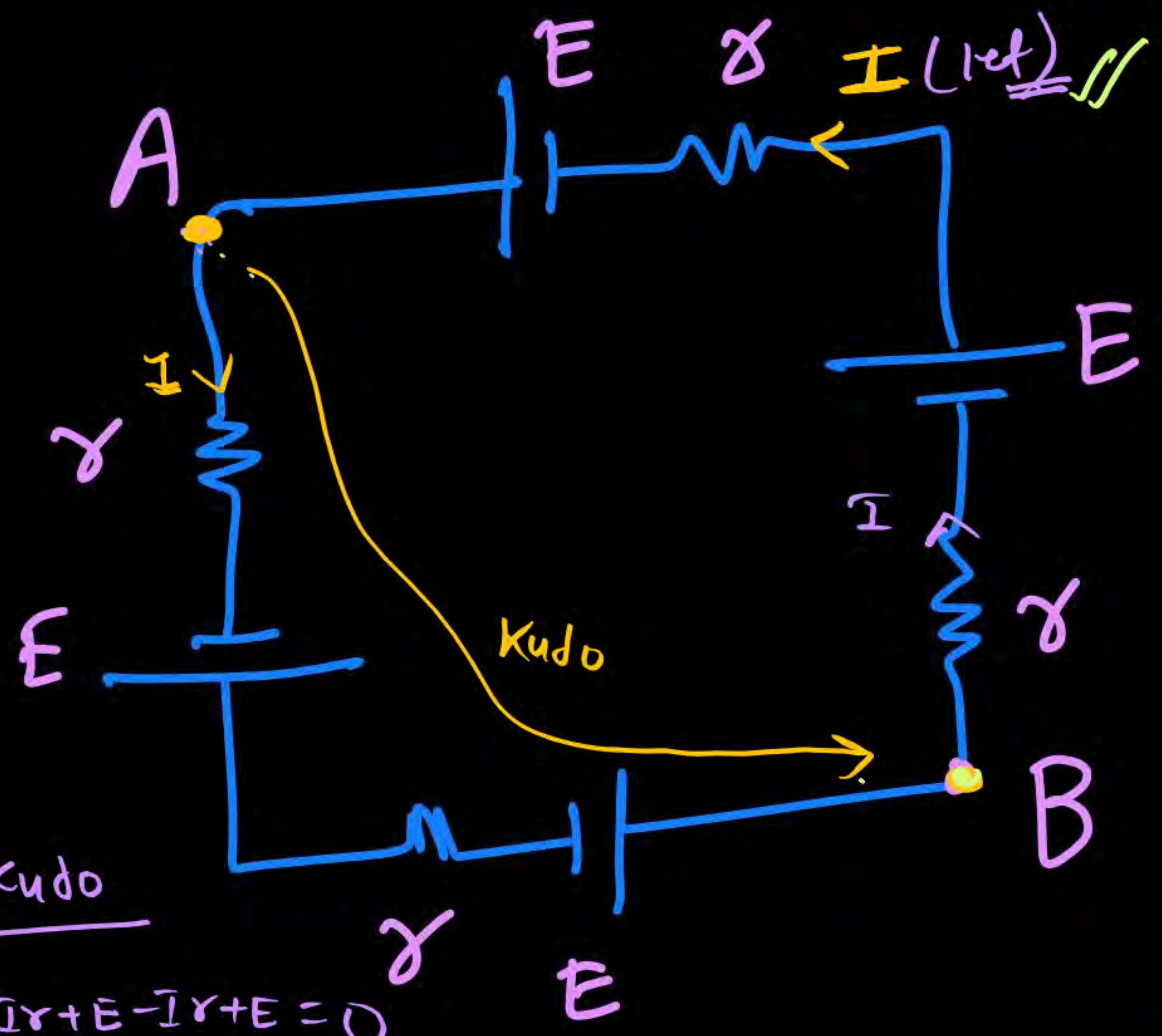
$V_{CD} = 6$ volt

$V_{AB} = ??$

$V_A - Ir + E - Ir + E = V_B$

✓ $V_A - V_B = 2Ir - 2E$

$= 2\frac{E}{r}r - 2E = \text{zero}$



Compt loop में Kudo

$-Ir + E - Ir + E - Ir + E - Ir + E = 0$

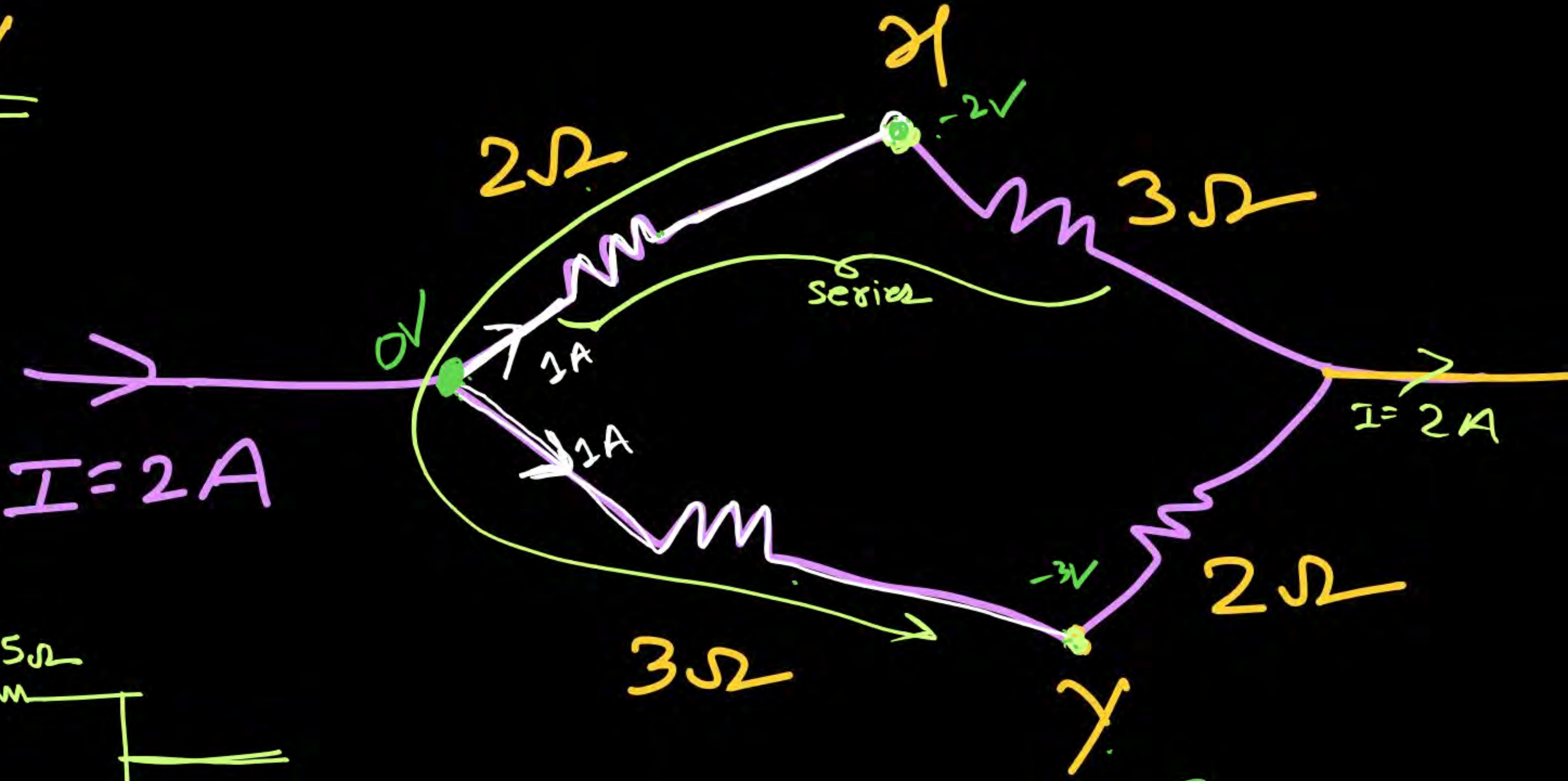
$-4Ir + 4E = 0$

$\frac{4E}{4r} = I$

Put the value of I

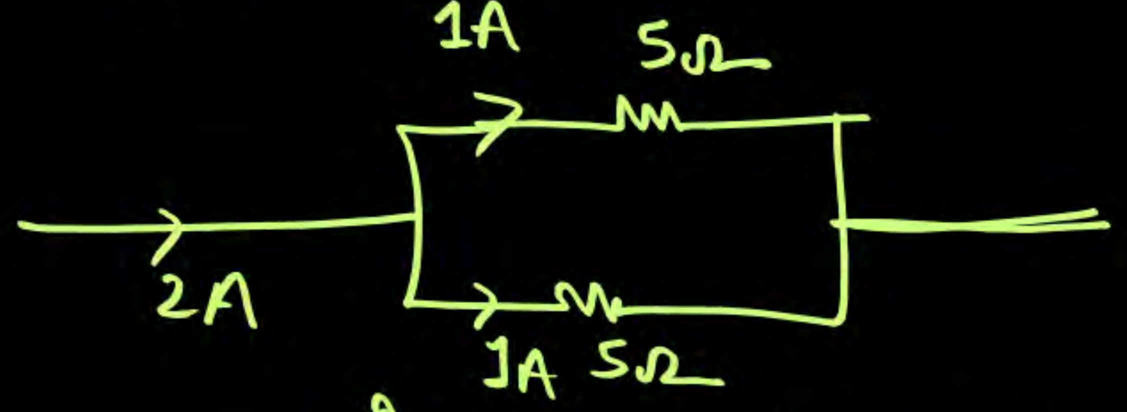
find $V_x - V_y$

(a) zero ✗
(b) +1 V ✓
(c) −1 V ✗
(d) 4 V ✗



$$V_x - V_y = +ve$$

Sol^n

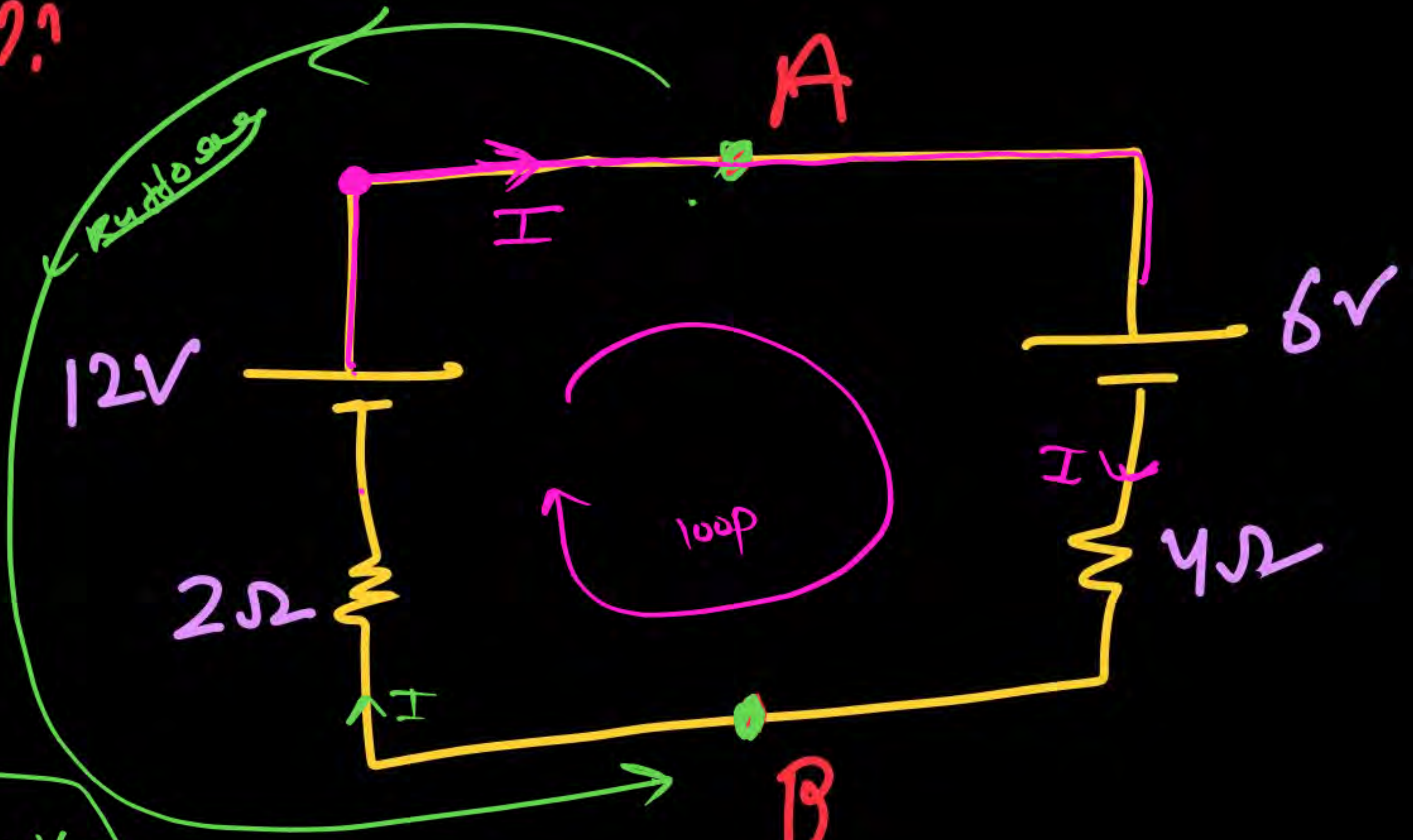


x से y pe kudoooooo

$$V_x + 1 \times 2 - 3 \times 1 = V_y$$

$$V_x - V_y = 3 - 2 = 1 \text{ volt}$$

find $V_{AB} = ??$



$V_A - 12 + 2 \times 1 = V_B$

$V_A - V_B = 12 - 2$

$= 10\,\text{volt}$

Ans

$-6V - 4I - 2I + 12 = 0$

$-6I + 6V = 0$

$I = \frac{6}{6} = 1\,\text{Amp}$

find I = ??

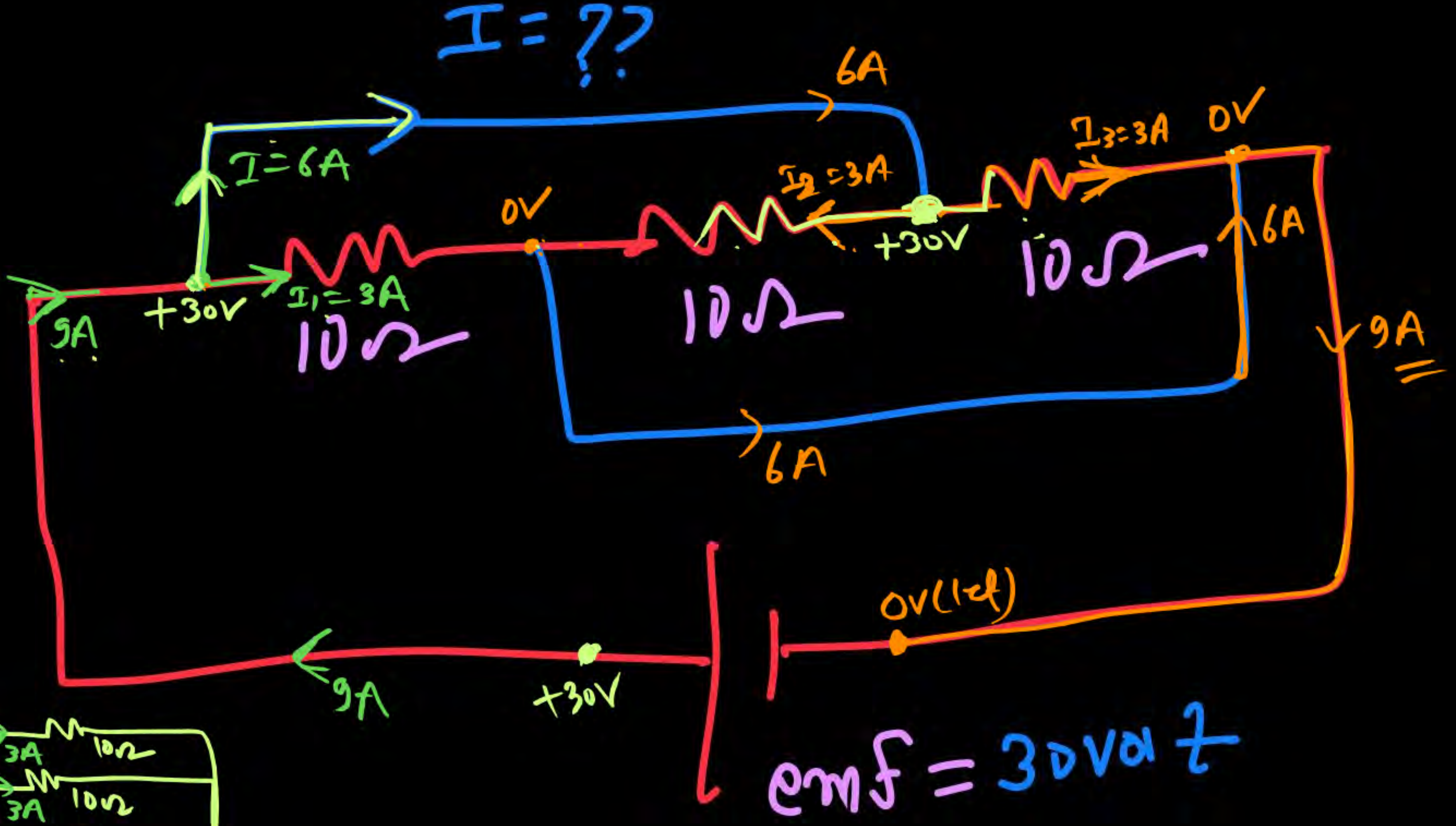
(a) I = 0 ✗

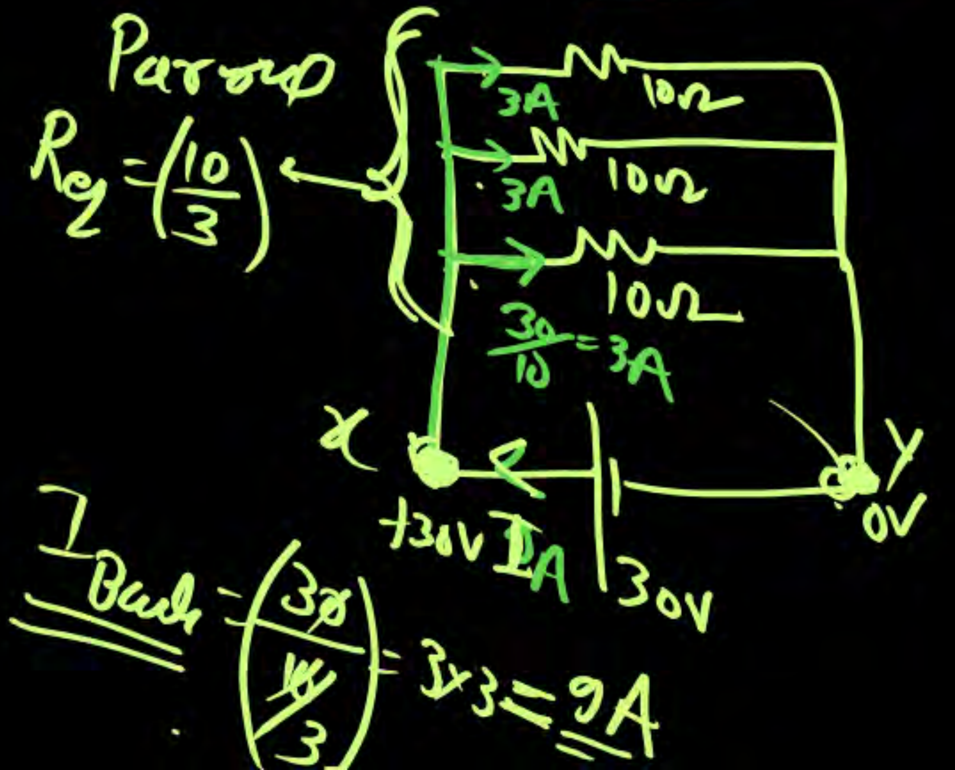
(b) I = 9A

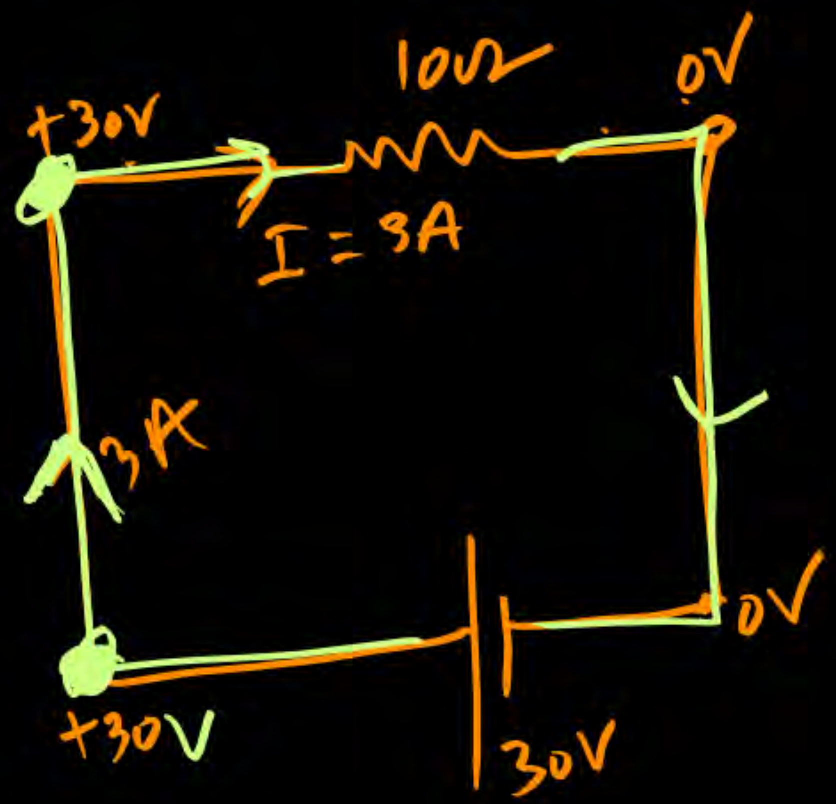
(c) infinite ✗

(d) I = 3A

(e) I = 6A ✓



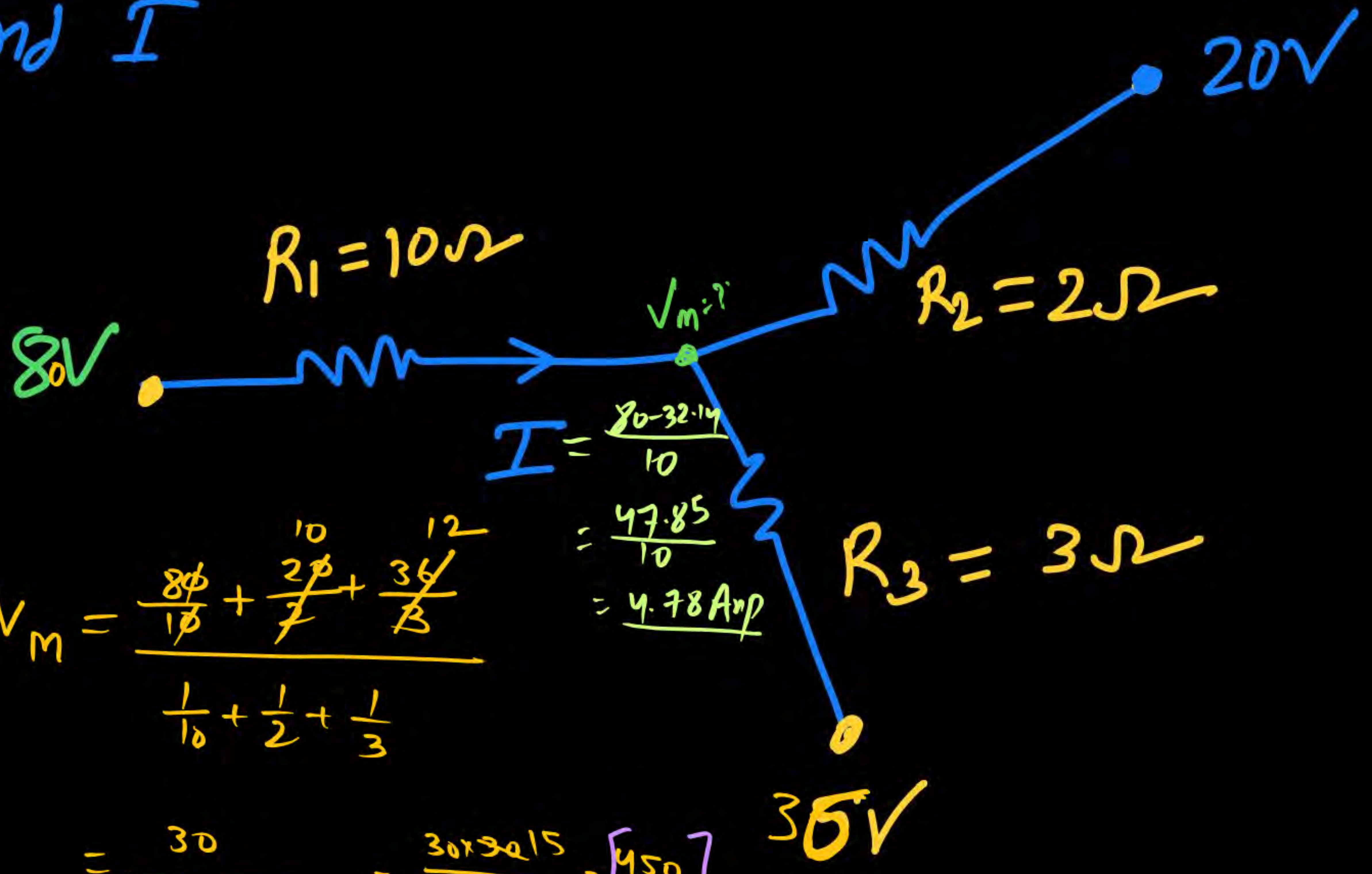




10Ω
+30V
0V
I = 3A
3A
0V
+30V
30V

find I

don't solve numerically

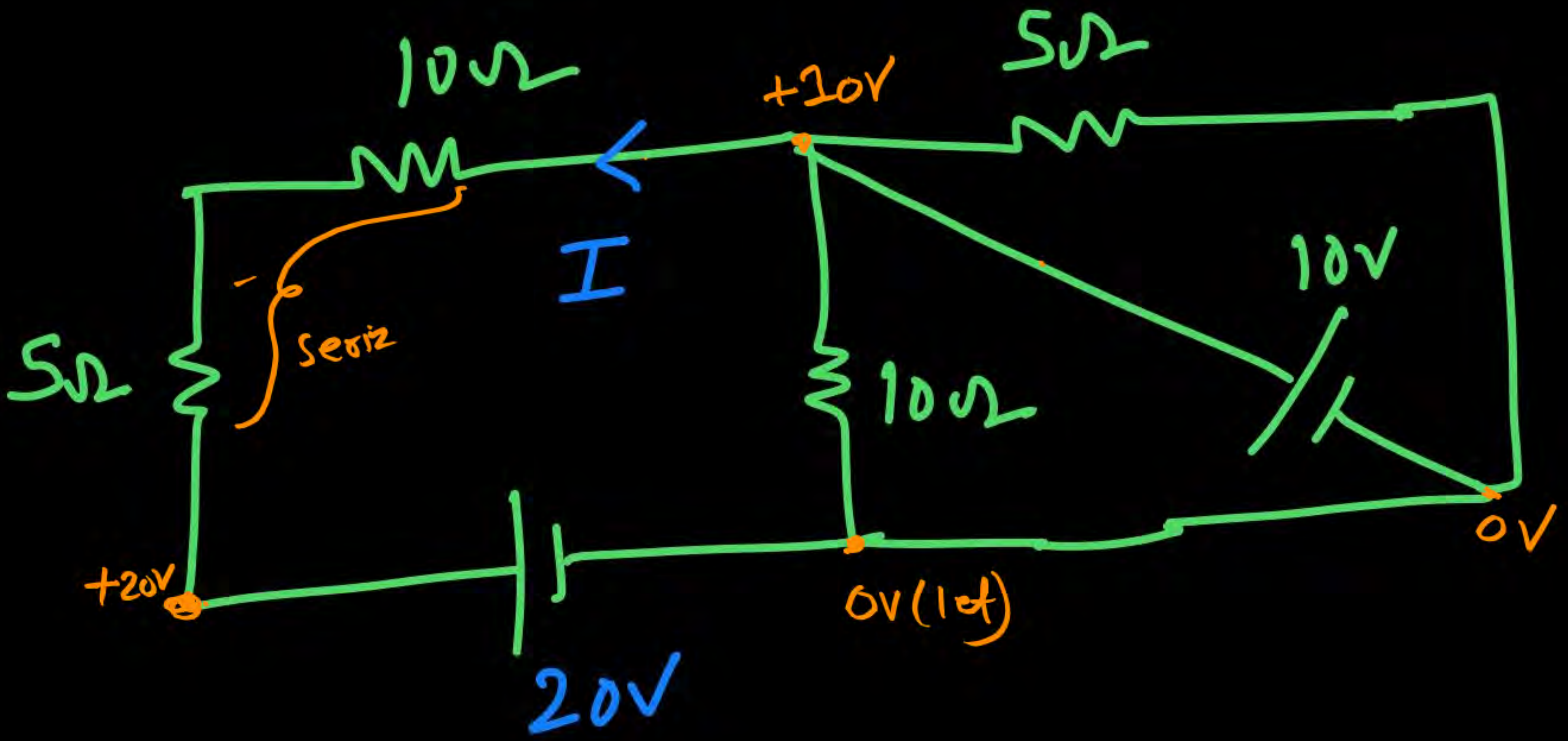


$$V_m = \frac{\frac{80}{10} + \frac{20}{2} + \frac{35}{3}}{\frac{1}{10} + \frac{1}{2} + \frac{1}{3}}$$

(8, 10, 12)

$$= \frac{30}{\frac{3+15+10}{30}} = \frac{30 \times 30}{28} = \frac{450}{14} = 32.14 \text{ volt.}$$

$$I = \frac{80 - 32.14}{10} = \frac{47.85}{10} = 4.78 \text{ Amp}$$

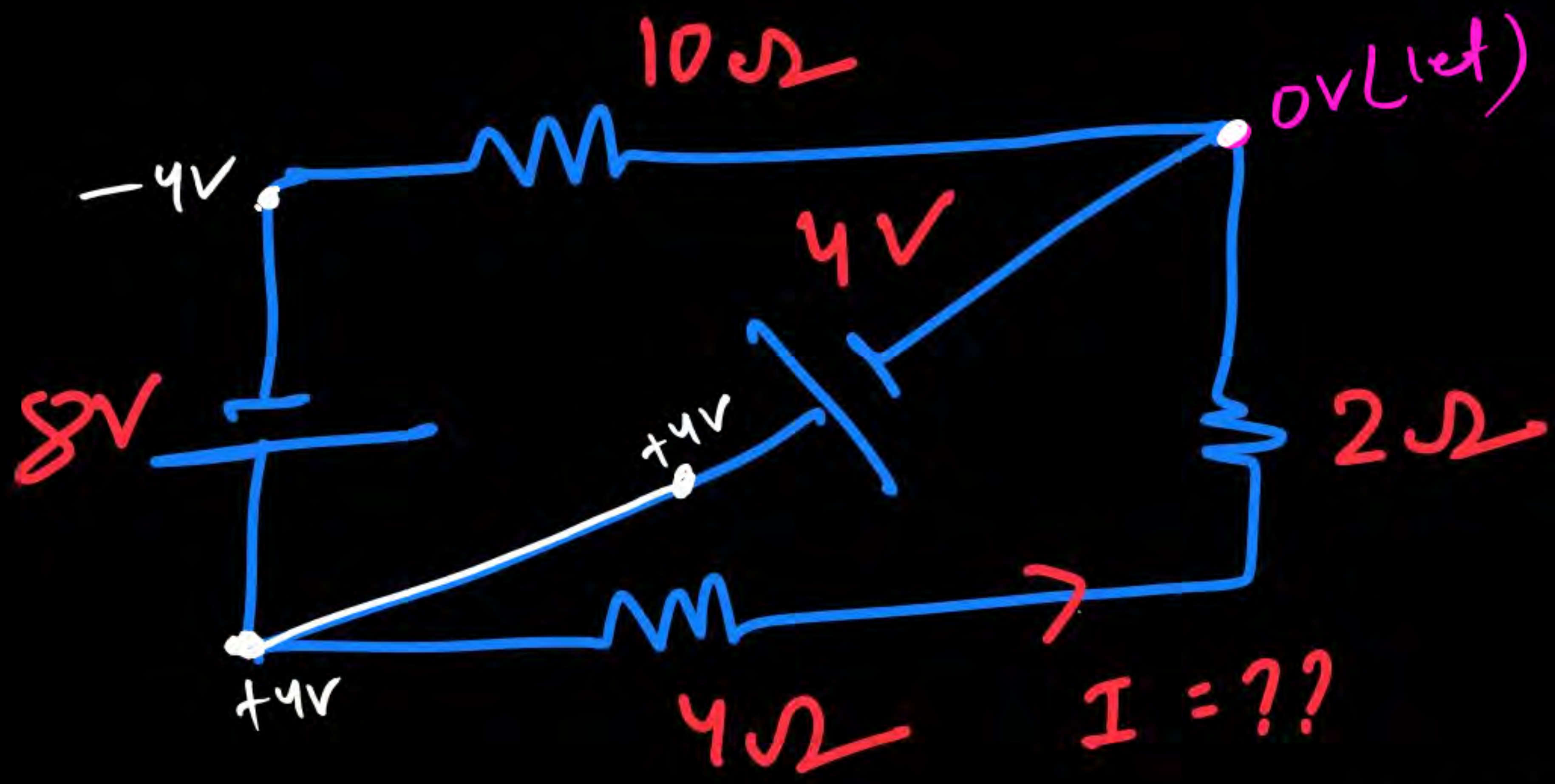


Circuit ka Type

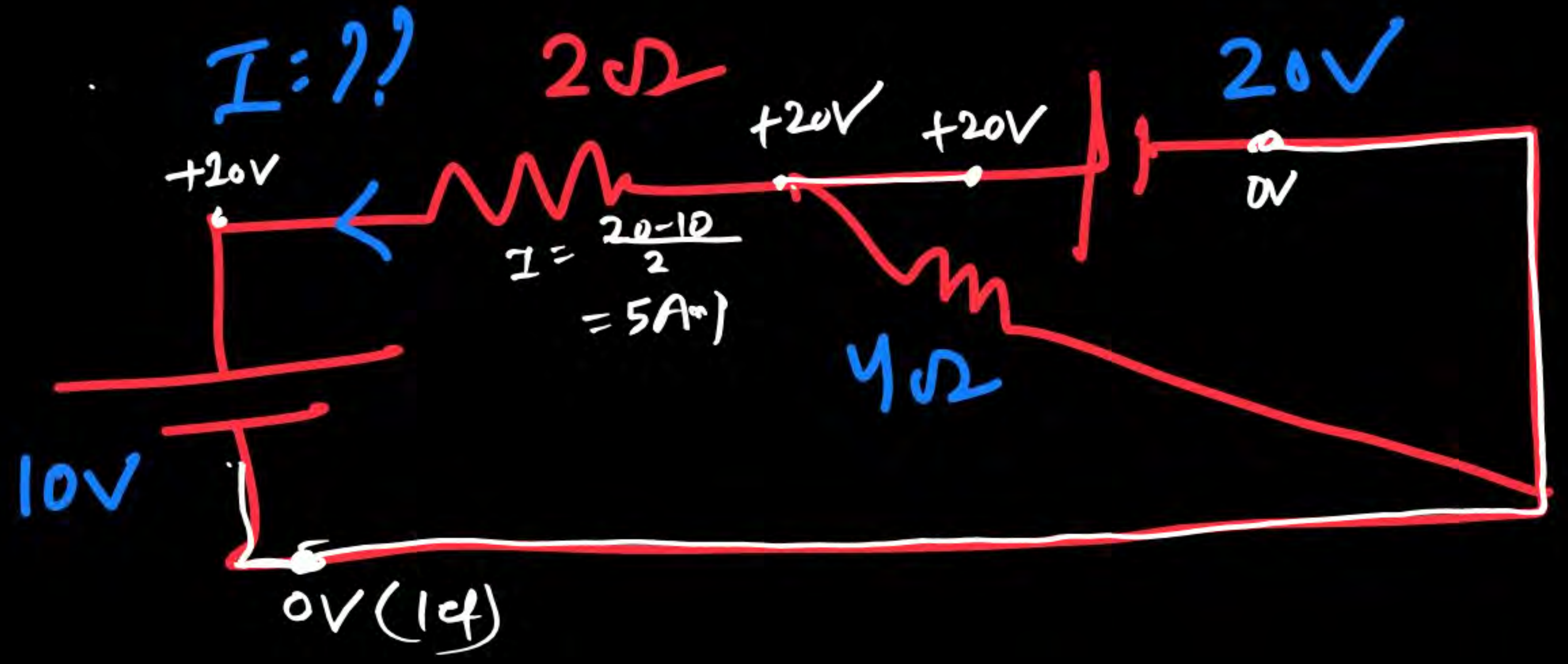
$$I = \frac{10 - 20}{15}$$

$$= -\frac{10}{15} = -\frac{2}{3} A$$

opposite dirn

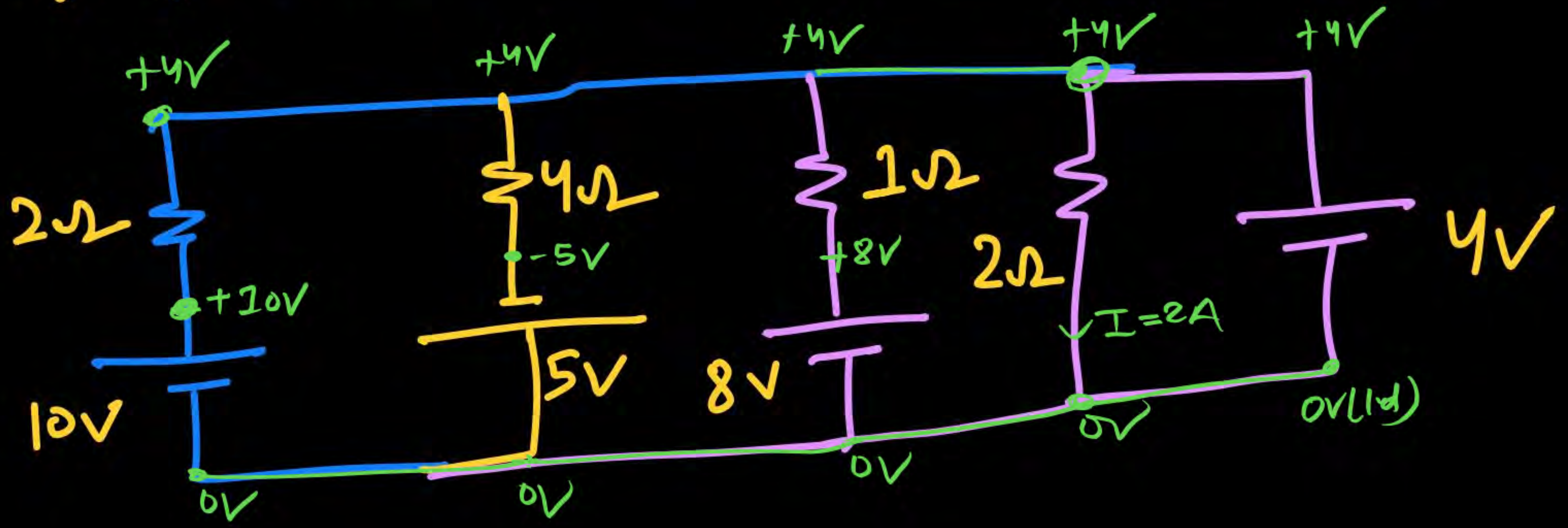


$$I = \frac{4-0}{6} = \frac{4}{6} = \frac{2}{3} \text{ Amp.}$$



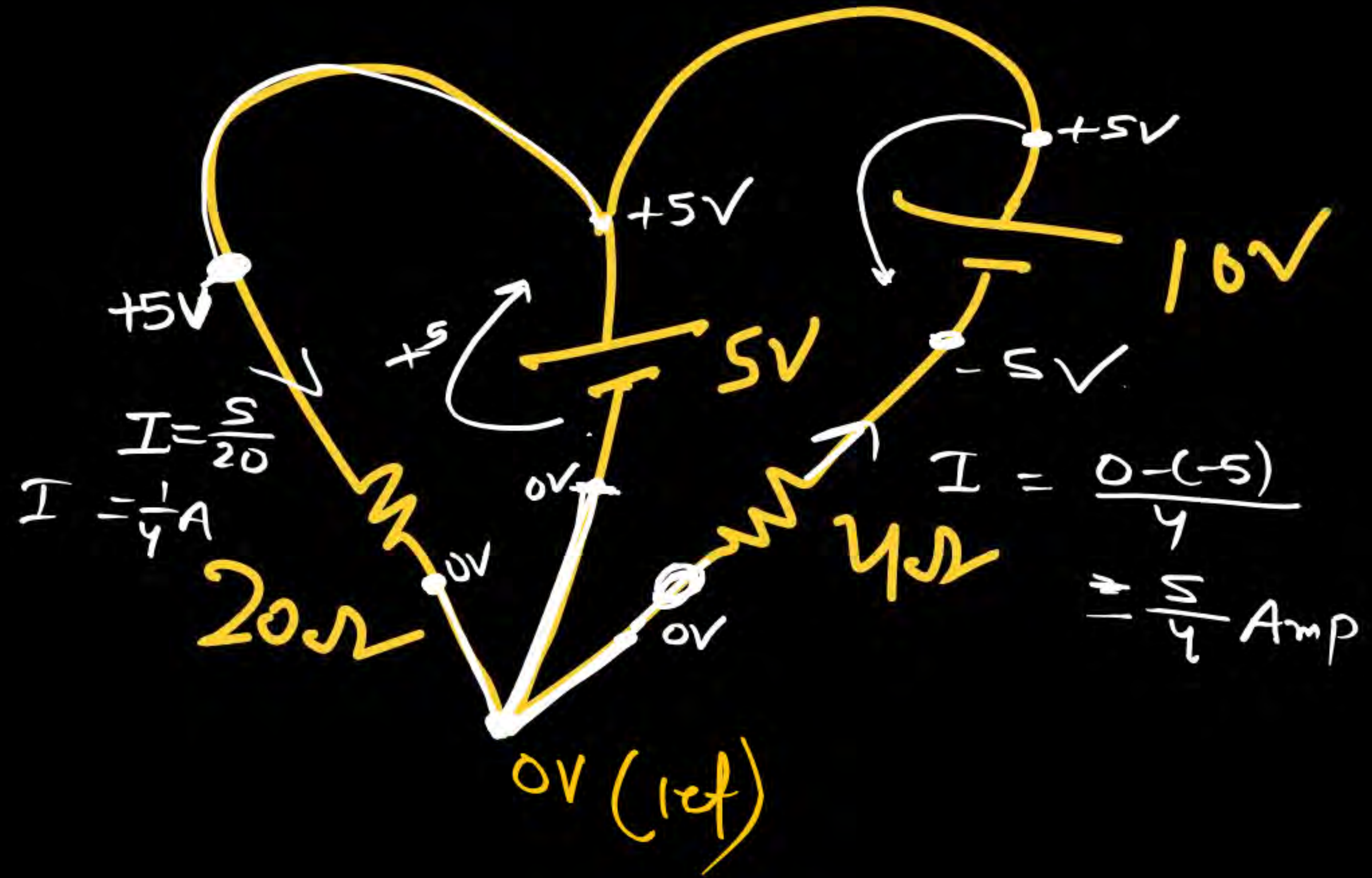
I: ??
2Ω
+20V
+20V
+20V
20V
0V
I = (20-10)/2
= 5A
4Ω
10V
0V (ref)

find current in each resistor.





find current in 20Ω 4Ω

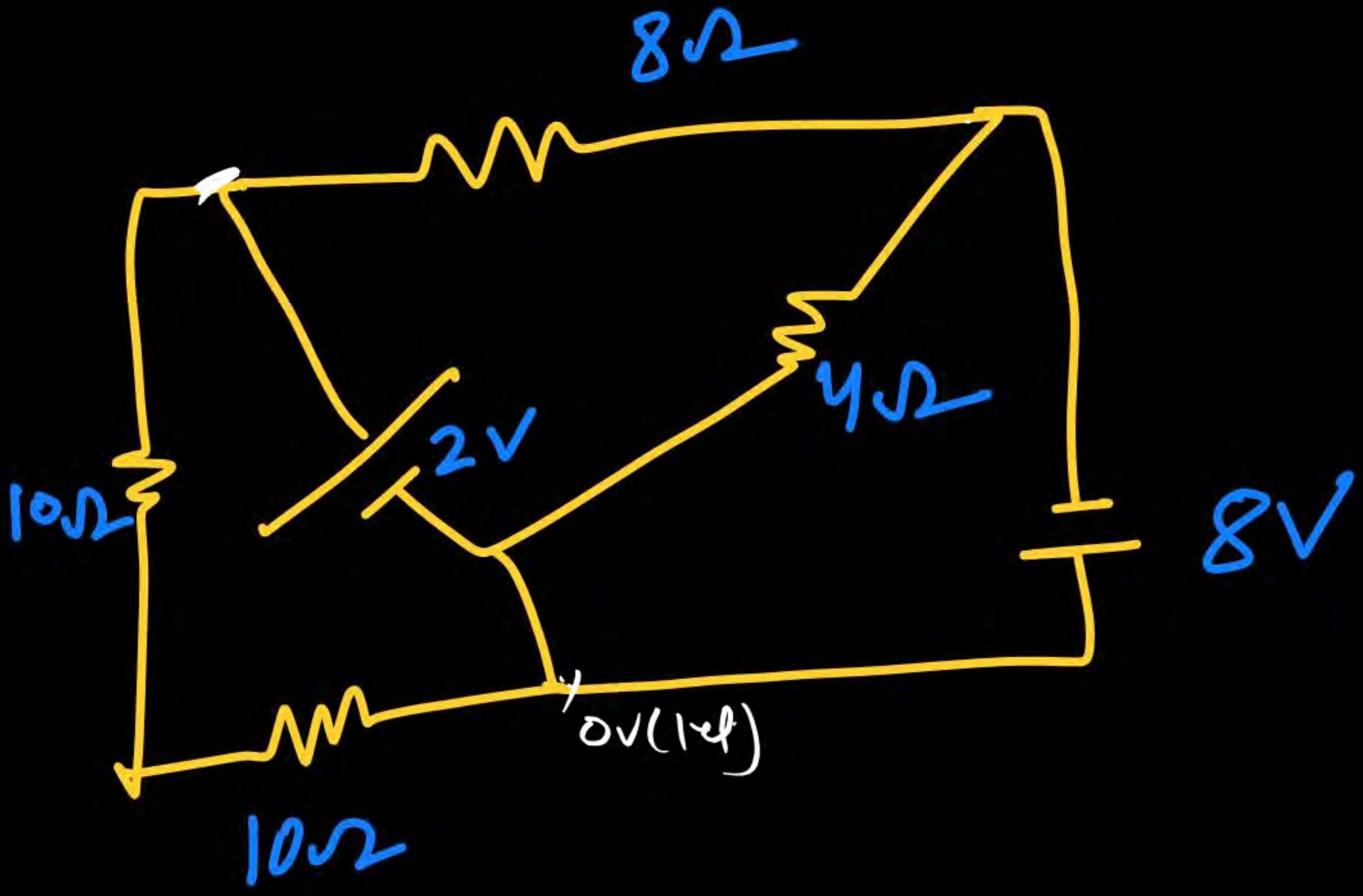


$I = \frac{5}{20}$

$I = \frac{1}{4} A$

$I = \frac{0-(-5)}{4}$

$= \frac{5}{4}$ Amp

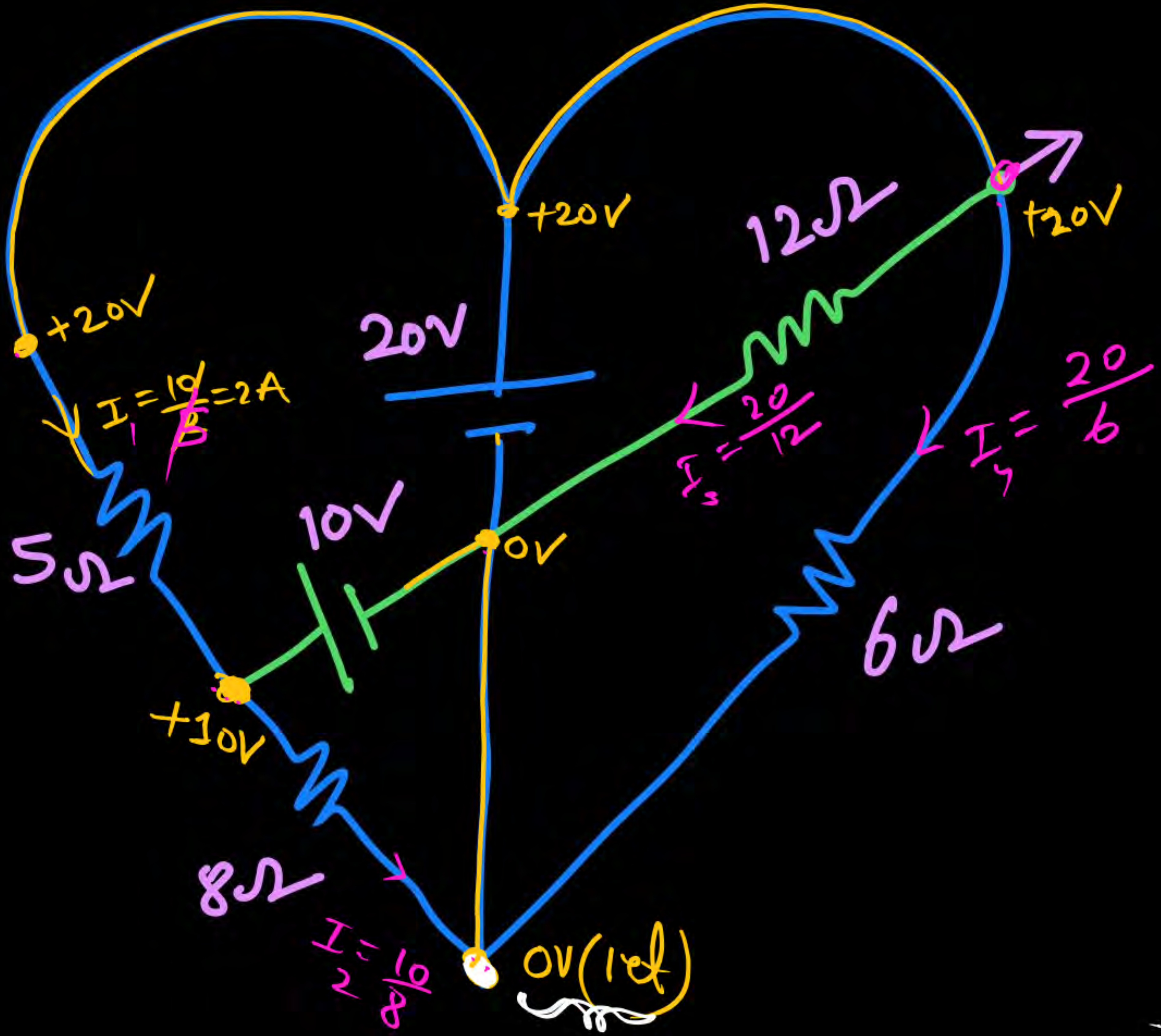


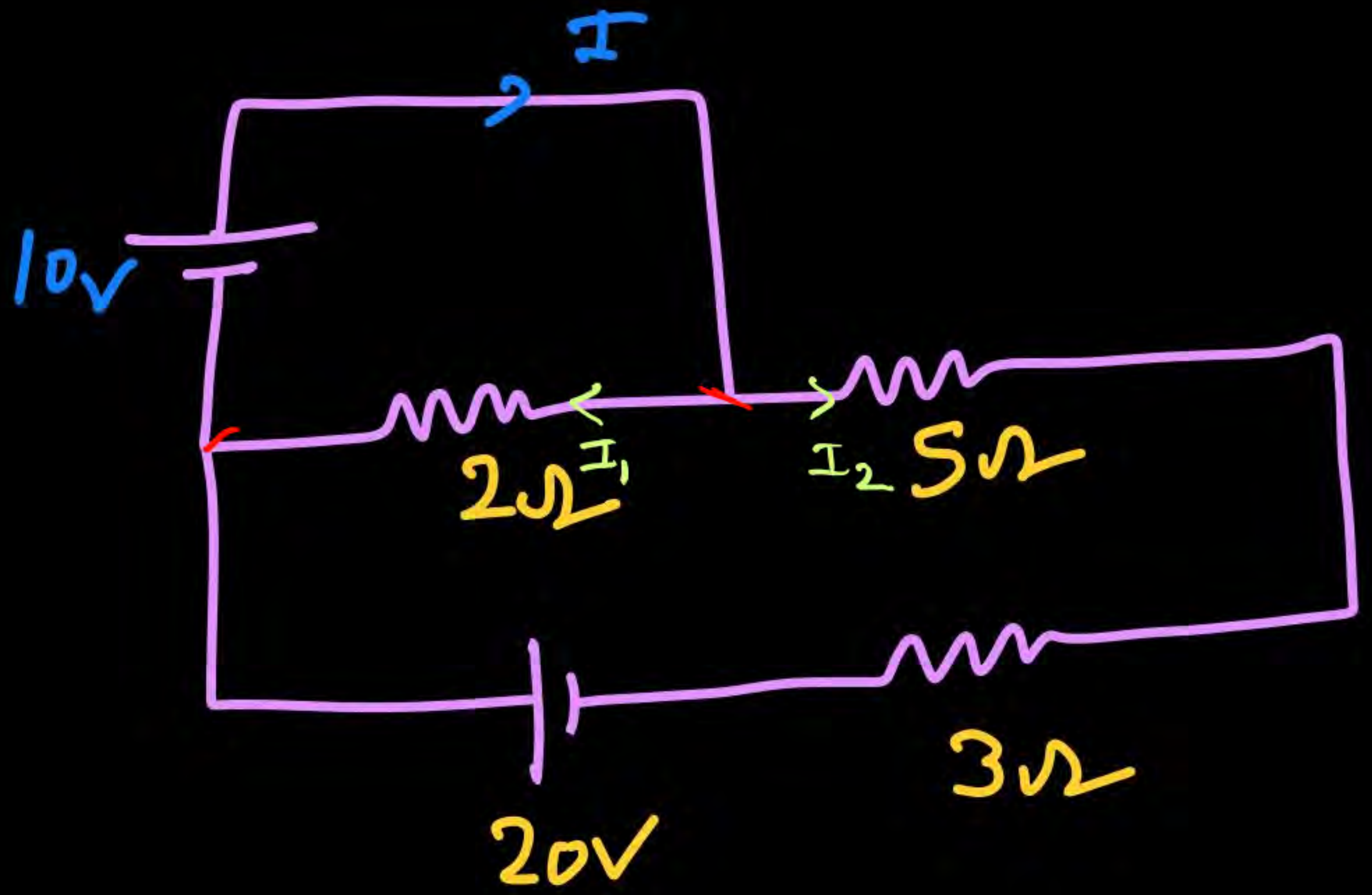
find current in 8Ω

H/W

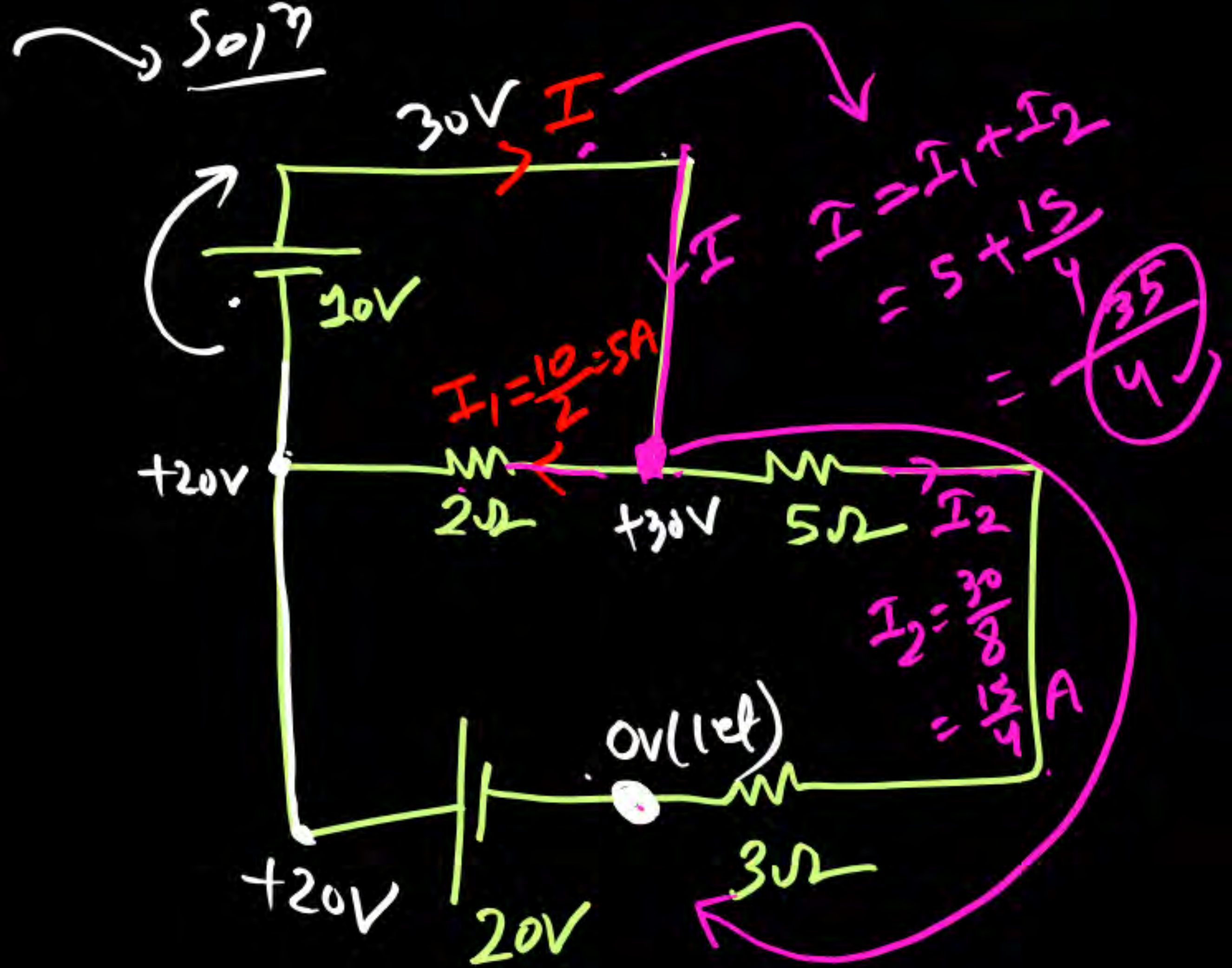
Jai Biya-yo Mata

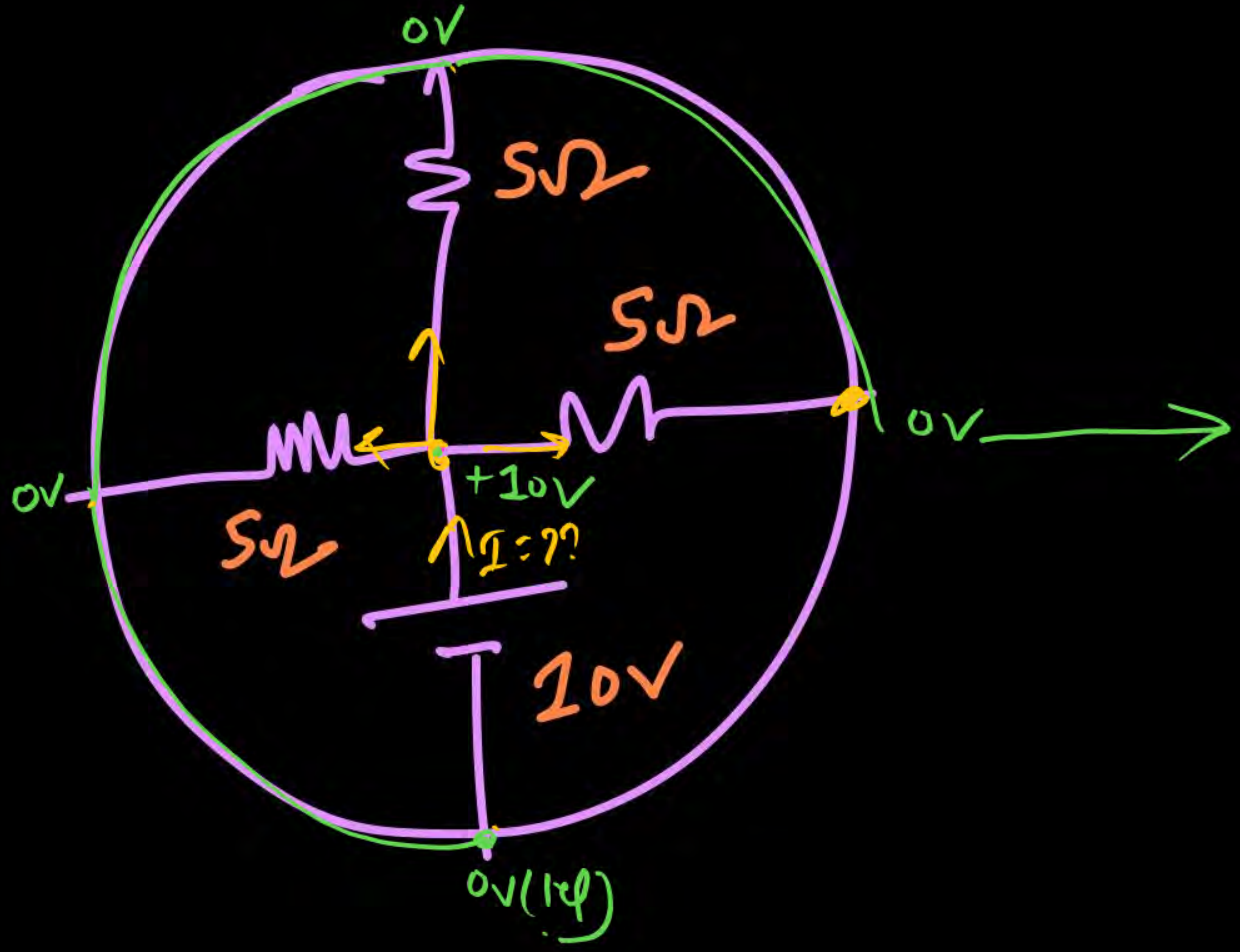
find current in 5Ω, 8Ω & 6Ω



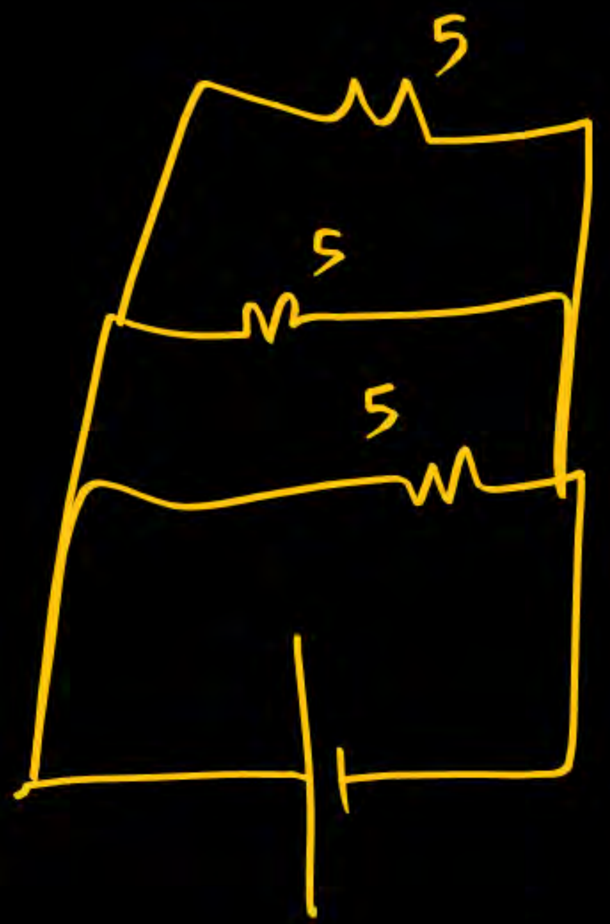

I
10V
2Ω
I_1
I_2
5Ω
3Ω
20V

find I = ??

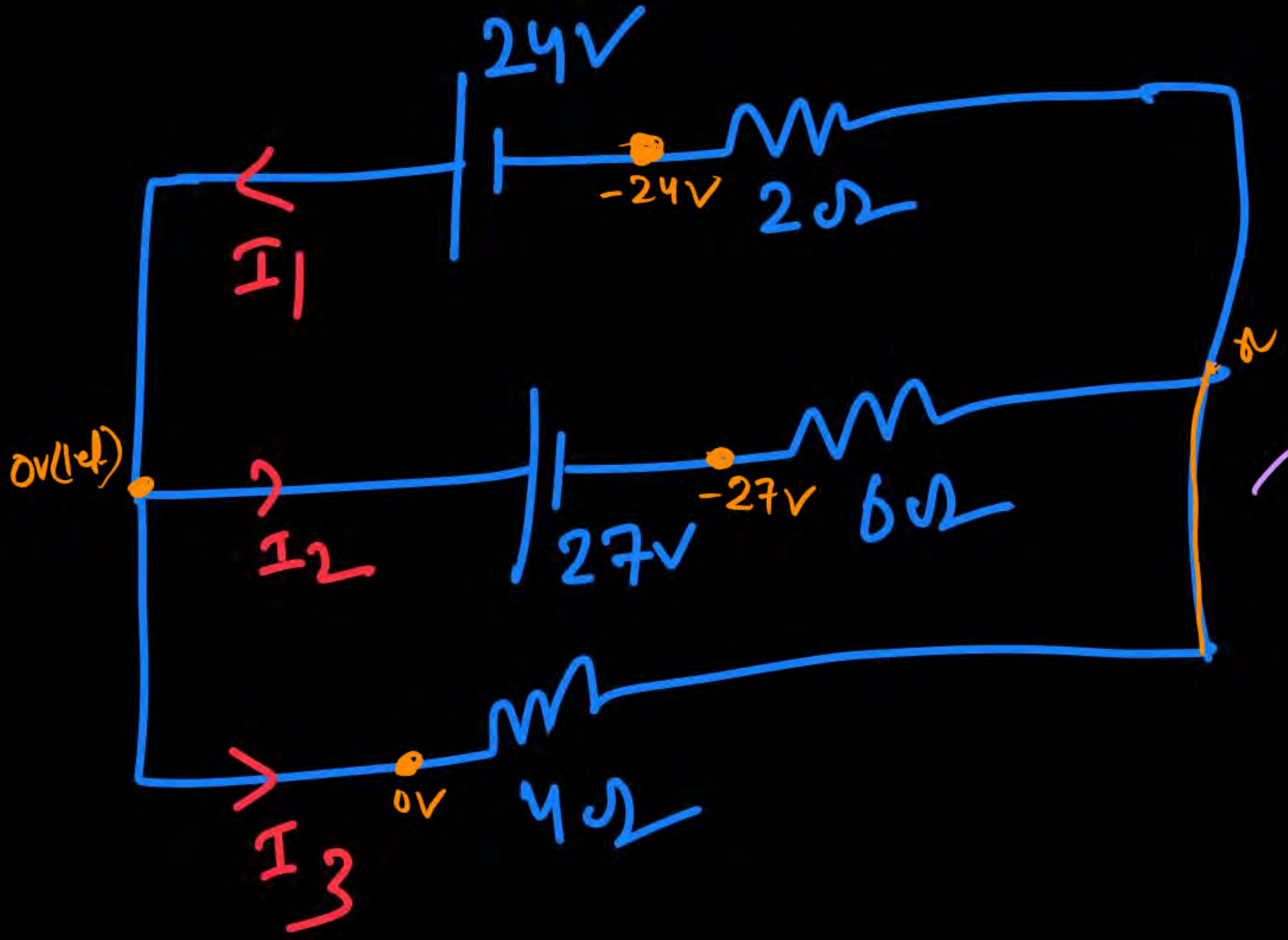

Sol^n
30V
I
10V
I
$I_1 = \frac{10}{2} = 5A$
+20V
2Ω
+30V
5Ω
I_2
$I_2 = \frac{30}{8} = \frac{15}{4}$ A
0V (ref)
3Ω
+20V
20V
$I = I_1 + I_2$
$= 5 + \frac{15}{4}$
$= \frac{35}{4}$

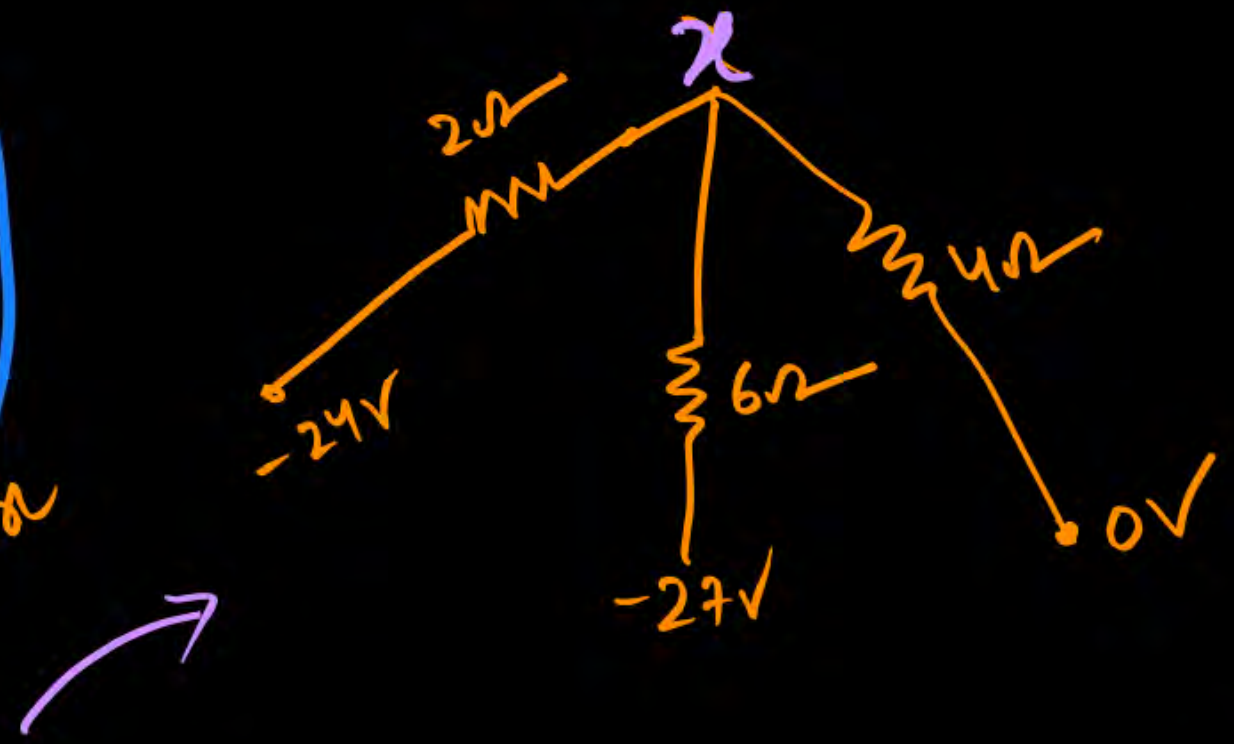


0V
5Ω
5Ω
0V
0V
+10V
5Ω
I = ??
10V
0V(1φ)



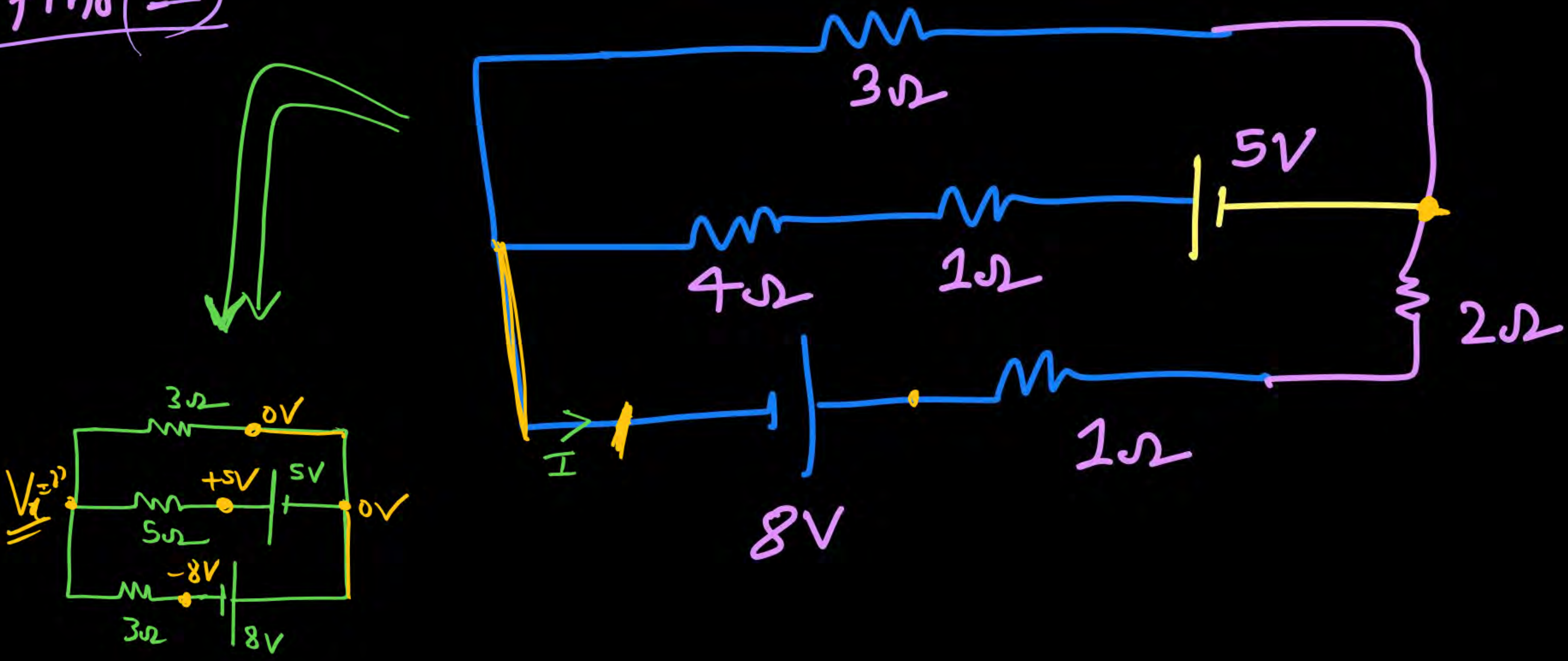
5
5
5





$$V_x = \frac{-\frac{24}{2} - \frac{27}{6} - \frac{0}{4}}{\frac{1}{2} + \frac{1}{6} + \frac{1}{4}}$$

Find (I)



Temperature Coefficient of Resistance

Cell (Battery)

QUESTION

The internal resistance of a 2.1 V cell which gives a current of 0.2 A through a resistance of 10 Ω is [NEET 2013]

1. 0.8 Ω
2. 1.0 Ω
3. 0.2 Ω
4. 0.5 Ω

QUESTION

A student measures the terminal potential difference (V) of a cell (of emf ε and internal resistance r) as a function of the current (I) flowing through it. The slope, and intercept, of the graph between V and I, then, respectively, equal [2009]

1. $-r$ and ε
2. r and $-ε$
3. $-ε$ and r
4. ε and $-r$

QUESTION

For a cell terminal potential difference is 2.2V when circuit is open and reduces to 1.8 V when cell is connected to a resistance of $R = 5\ \Omega$. Determine internal resistance of cell (r). [2002]

1. $10/9\ \Omega$
2. $9/10\ \Omega$
3. $11/9\ \Omega$
4. $5/9\ \Omega$

QUESTION

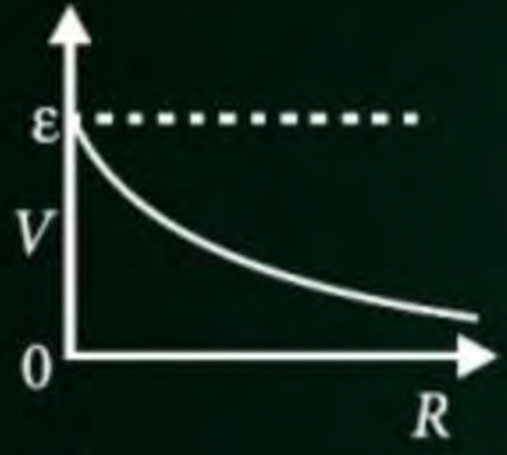
A car battery of emf 12 V and internal resistance $5 \times 10^{-2}\ \Omega$, receives a current of 60 amp from external source, then terminal potential difference of battery is [2000]

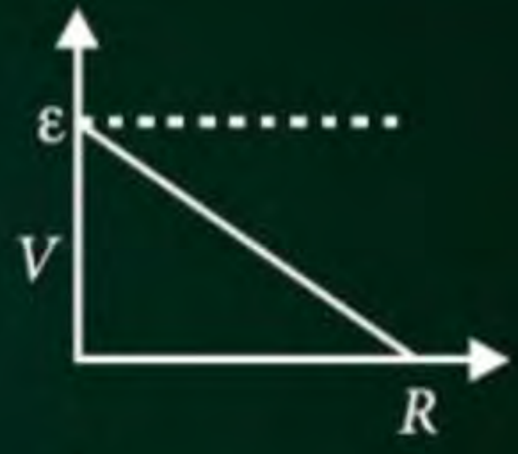
1. 12 V
2. 9 V
3. 15 V
4. 20 V

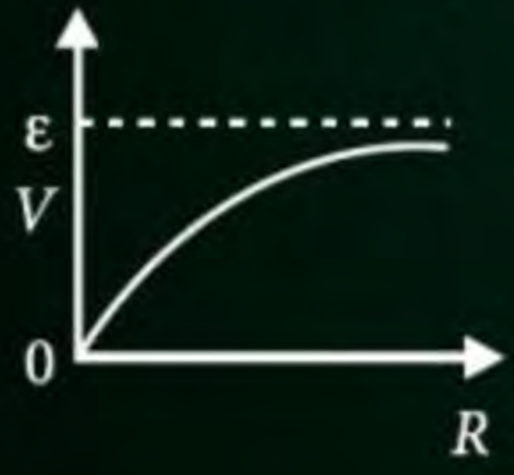
QUESTION

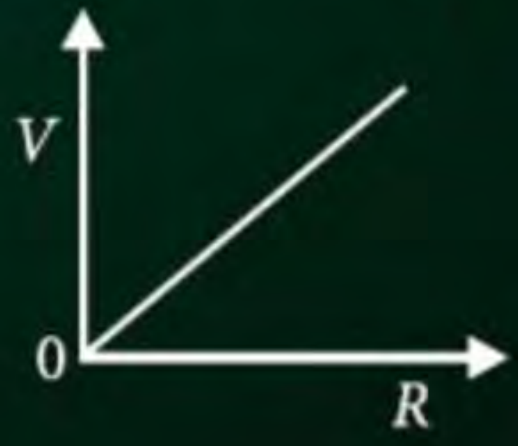
A cell having an emf ε and internal resistance r is connected across a variable external resistance R. As the resistance R is increased, the plot of potential difference V across R is given by

[Main 2012]

1 

2 

3 

4 

QUESTION

A current of 2 A flows through a 2 Ω resistor when connected across a battery. The same battery supplies a current of 0.5 A when connected across a 9 Ω resistor. The internal resistance of the battery is [2011]

1. 0.5 Ω
2. 1/3 Ω
3. 1/4 Ω
4. 1 Ω

QUESTION

The internal resistance of a cell of e.m.f. 2 V is 0.1 Ω. It is connected to a resistance of 3.9 Ω. The voltage across the cell will be [1999]

1. 1.95 V
2. 1.9 V
3. 0.5 V
4. 2 V

QUESTION

A battery of e.m.f 10 V and internal resistance 0.5 Ω is connected across a variable resistance R. The value of R for which the power delivered in it is maximum is given by

[1992]

1. 0.5 Ω
2. 1.0 Ω
3. 2.0 Ω
4. 0.25 Ω

QUESTION

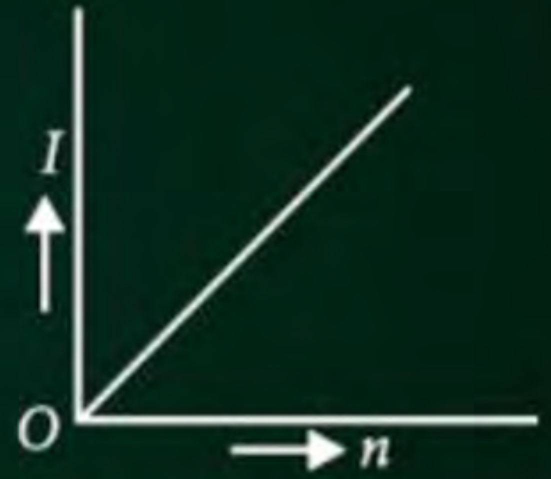
A battery consists of a variable number n of identical cells (having internal resistance r each) which are connected in series. The terminals of the battery are short-circuited and the current I is measured. Which of the graphs shows the correct relationship between I and n?

[2018]

(1)



(2)



(3)



(4)



QUESTION

Ten identical cells connected in series are needed to heat a wire of length one meter and radius 'r' by 10°C in time 't'. How many cells will be required to heat the wire of length two meter of the same radius by the same temperature in time 't'? [NEET 2013]

1. 20
2. 30
3. 40
4. 10

QUESTION

Two cells, having the same e.m.f. are connected in series through an external resistance R. Cells have internal resistances r_1 and r_2 ($r_1 > r_2$) respectively. When the circuit is closed, the potential difference across the first cell is zero. The value of R is [2006]

1. $r_1 + r_2$
2. $r_1 - r_2$
3. $\frac{r_1 + r_2}{2}$
4. $\frac{r_1 - r_2}{2}$


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 5 | Physics

Current Electricity



By- Dr. Manish Raj (MR SIR)

Topics to be covered

MR → This topic is more important.

1 # Tempr dependency of Resistance

2 # Non-Ideal cell (Battery)

3 #



QUESTION

Find equivalent resistance between x and y



1. $5R/3$
2. R
3. $3R/5$
4. $2R/5$

QUESTION

A wire of resistance 12 ohms per meter is bent to form a complete circle of radius 10 cm. The resistance between its two diametrically opposite points, A and B as shown in the figure is

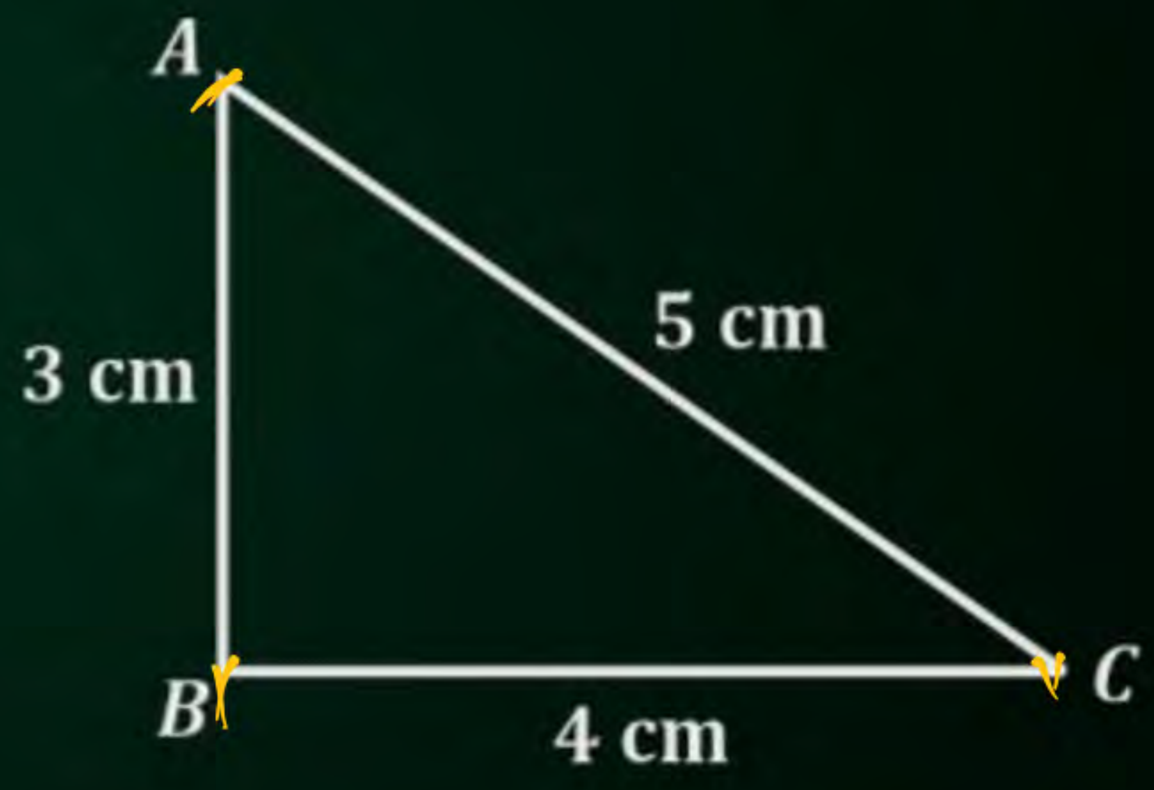


1. $3\,\Omega$
2. $6\pi\,\Omega$
3. $6\,\Omega$
4. $0.6\pi\,\Omega$

QUESTION

A 12 cm wire is given a shape of a right angled triangle *ABC* having sides 3 cm, 4 cm and 5 cm as shown in the figure. The resistance between two ends (*AB*, *BC*, *CA*) of the respective sides are measured one by one by a multimeter. The resistances will be in the ratio

1. 9 : 16 : 25
2. 27 : 32 : 35
3. 21 : 24 : 25
4. 3 : 4 : 5



QUESTION

A ring is made of a wire having a resistance $R_0 = 12\ \Omega$. Find the points A and B, as shown in the figure, at which a current carrying conductor should be connected so that the resistance R of the sub circuit between these points is equal to $8/3\ \Omega$



1. $\frac{l_1}{l_2} = \frac{5}{8}$
2. $\frac{l_1}{l_2} = \frac{1}{3}$
3. $\frac{l_1}{l_2} = \frac{3}{8}$
4. $\frac{l_1}{l_2} = \frac{1}{2}$

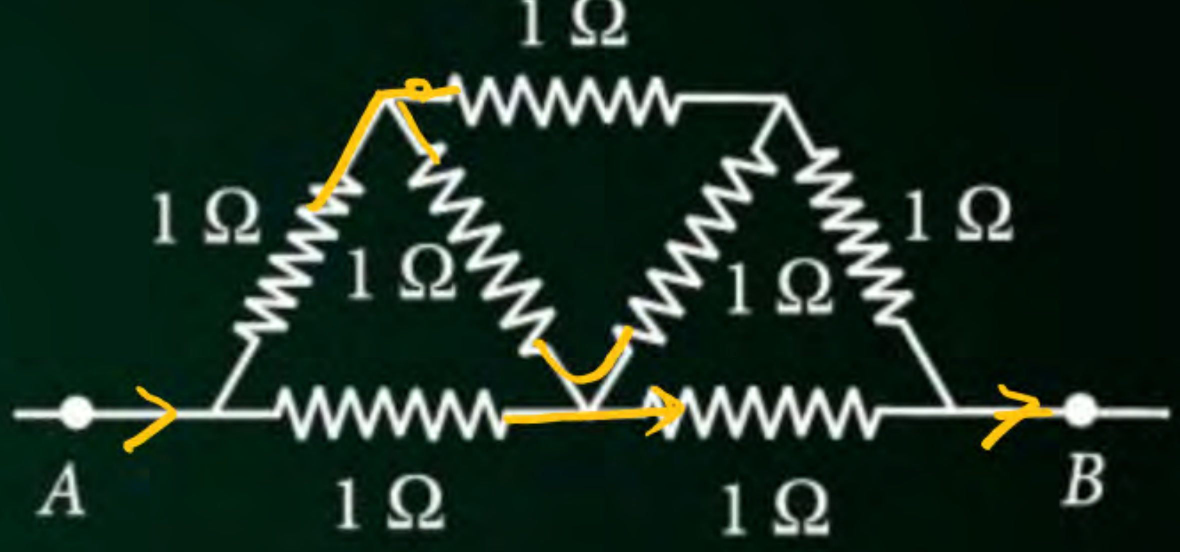
QUESTION

When a wire of uniform cross-section a, length l and resistance R is bent into a complete circle, resistance between any two of diametrically opposite points will be

1. $R/4$
2. $4R$
3. $R/8$
4. $R/2$

QUESTION

In the network shown in figure each resistance is 1 Ω. The effective resistance between A and B is



1. $\frac{4}{3}\,\Omega$
2. $\frac{3}{2}\,\Omega$
3. $7\,\Omega$
4. $\frac{8}{7}\,\Omega$

QUESTION

You are given several identical resistances each of value $R = 10\ \Omega$ and each capable of carrying a maximum current of one ampere. It is required to make a suitable combination of these resistances of $5\ \Omega$ which can carry a current of 4 ampere. The minimum number of resistances of the type R that will be required for this job is

1. 4
2. 10
3. 8
4. 20

QUESTION

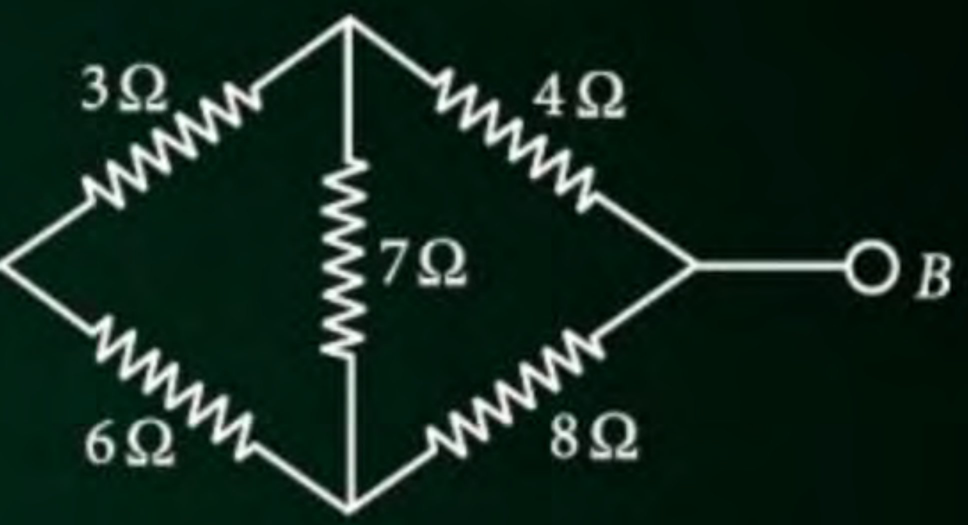
n equal resistors are first connected in series and then connected in parallel. What is the ratio of the maximum to the minimum resistance ?

1. n
2. $1/n^2$
3. n^2
4. $1/n$

QUESTION

The net resistance of the circuit between A and B is

1. $\frac{8}{3}\Omega$
2. $\frac{14}{3}\Omega$
3. $\frac{16}{3}\Omega$
4. $\frac{22}{3}\Omega$



QUESTION

In the network shown in the figure, each of the resistance is equal to 2 Ω. The resistance between the points A and B is

wheat stone Bridge



1. 3 Ω
2. 4 Ω
3. 1 Ω
4. 2 Ω

QUESTION

The resistance between the terminal points P and Q of the given infinitely long circuit will be

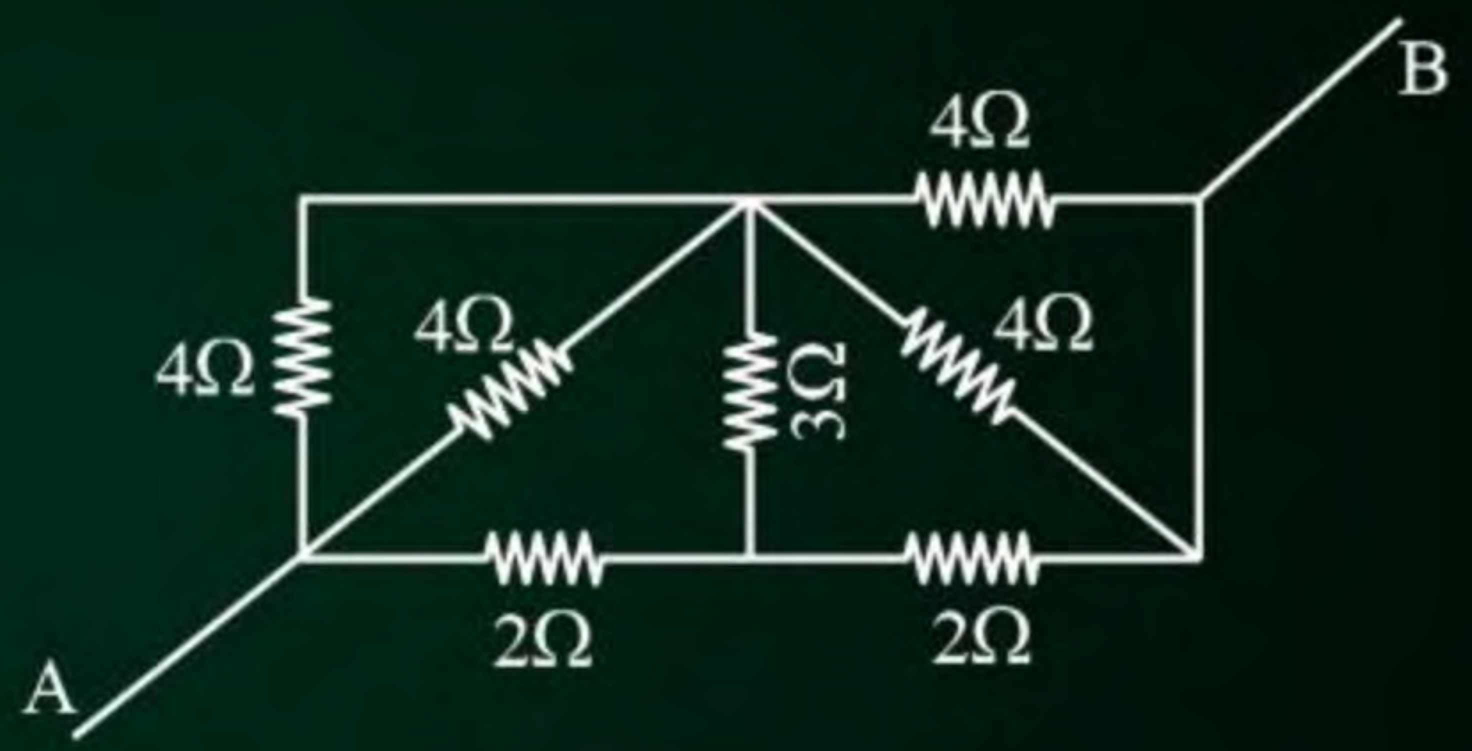


1. $2(\sqrt{3}-1)\,\Omega$
2. $2(\sqrt{3}+1)\,\Omega$
3. $(\sqrt{3}-1)\,\Omega$
4. $(\sqrt{3}+1)\,\Omega$

QUESTION

Resistance across AB as shown in figure is

1. $2\,\Omega$
2. $4\,\Omega$
3. $6\,\Omega$
4. $12\,\Omega$



QUESTION

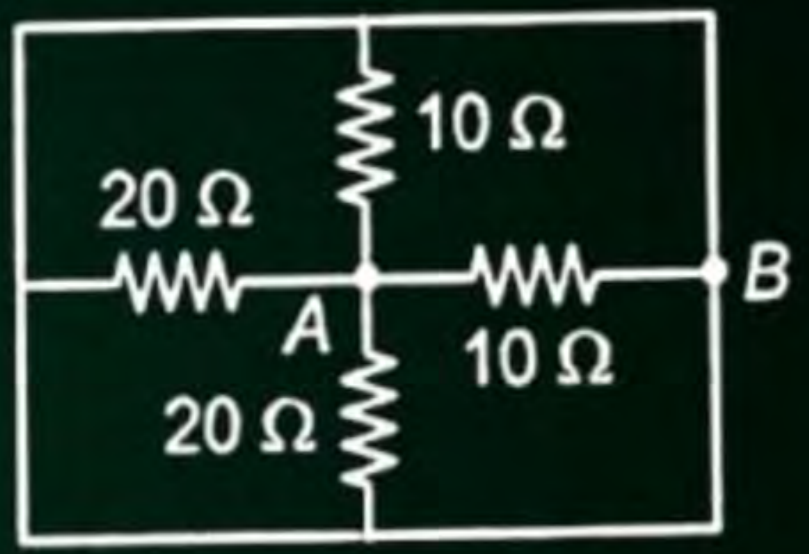
For the given figure equivalent resistance between point A and B is



1. 4 R
2. R/4
3. R/2
4. Zero

QUESTION

What is the equivalent resistance between points A and B in the network shown



(1) $\frac{20}{3}\,\Omega$

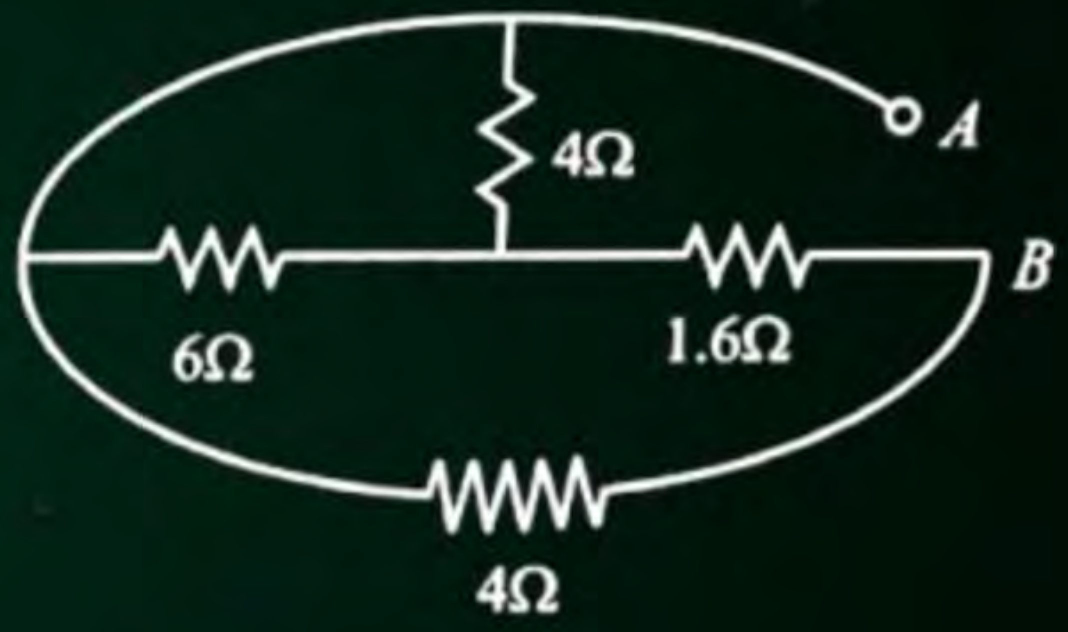
(2) $\frac{20}{6}\,\Omega$

(3) $20\,\Omega$

(4) $30\,\Omega$

QUESTION

If four resistance are connected as shown in the figure between A and B the effective resistance is

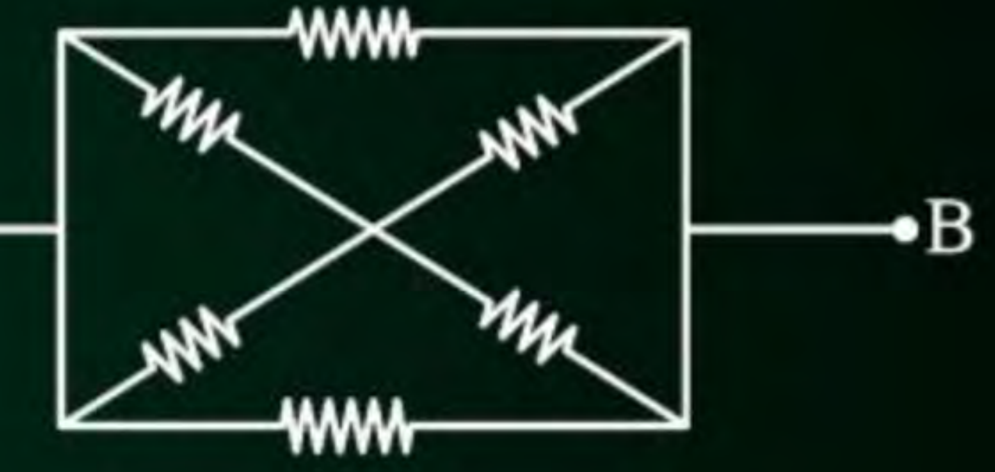


1. $4\,\Omega$
2. $8\,\Omega$
3. $2.4\,\Omega$
4. $2\,\Omega$

QUESTION

Six resistance of each 12 ohm are connected as shown in the figure. The effective resistance between the terminals A and B is

1. $8\,\Omega$
2. $6\,\Omega$
3. $4\,\Omega$
4. $12\,\Omega$



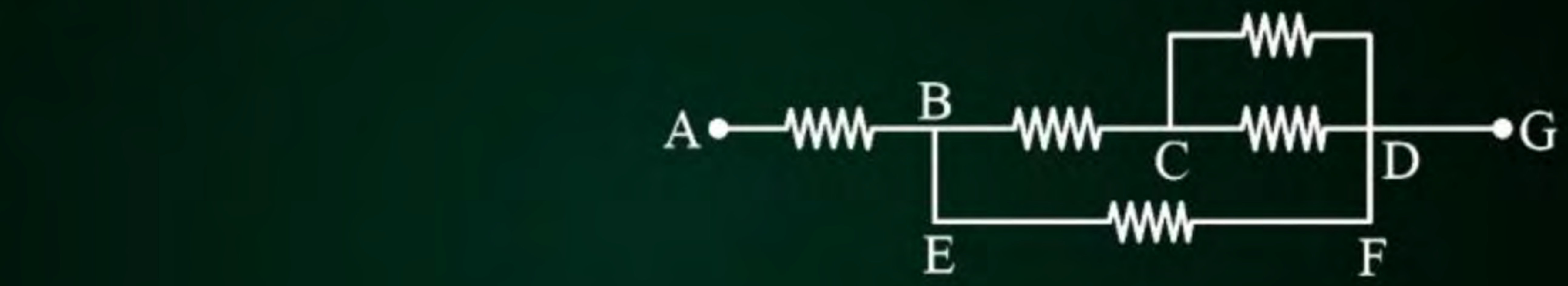
QUESTION

There are five equal resistors. The minimum resistance possible by their combination is 2 ohm. The maximum possible resistance we can make with them is

1. $25\,\Omega$
2. $50\,\Omega$
3. $100\,\Omega$
4. $150\,\Omega$

QUESTION

Resistance of each 10 Ω are connected as shown in the figure. The effective resistance between A and G is



1. 16
2. 20
3. 12
4. 8

QUESTION

Six resistors of each 2 ohm are connected as shown in the figure. The resultant resistance between A and B is



1. $4\,\Omega$
2. $2\,\Omega$
3. $1\,\Omega$
4. $10\,\Omega$

QUESTION

The resistance between A and B is

1. $8\,\Omega$
2. $4\,\Omega$
3. $3.75\,\Omega$
4. $2\,\Omega$

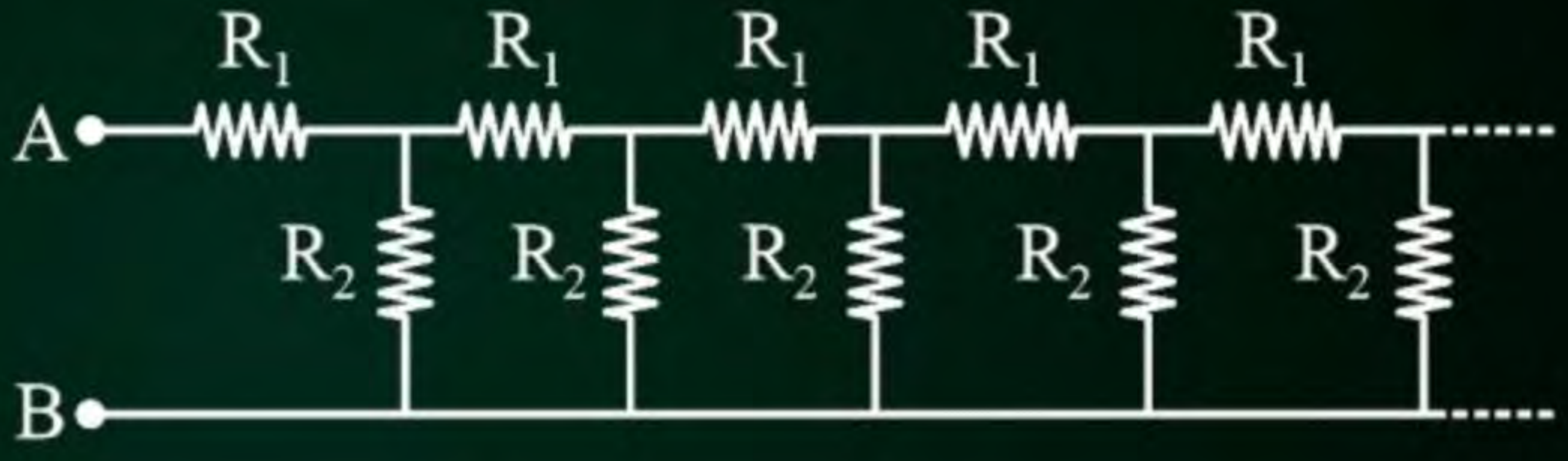
QUESTION

A metallic wire of resistance $12\ \Omega$ is bent to form a square. The resistance between two diagonal points would be

1. $12\ \Omega$
2. $24\ \Omega$
3. $6\ \Omega$
4. $3\ \Omega$

QUESTION

An infinite sequences of resistance is shown in the figure. The resultant resistance between A and B will be when $R_1 = 1\,\Omega$ and $R_2 = 2\Omega$



1. Infinity
2. $1\,\Omega$
3. $2\,\Omega$
4. $1.5\,\Omega$

QUESTION

The equivalent resistance between points a and b of a network shown in figure is

1. $\frac{3}{4}R$
2. $\frac{4}{3}R$
3. $\frac{5}{4}R$
4. $\frac{4}{5}R$



QUESTION

The effective resistance across the point A and B is

1. $2\,\Omega$
2. $1\,\Omega$
3. $0.5\,\Omega$
4. $5\,\Omega$



QUESTION

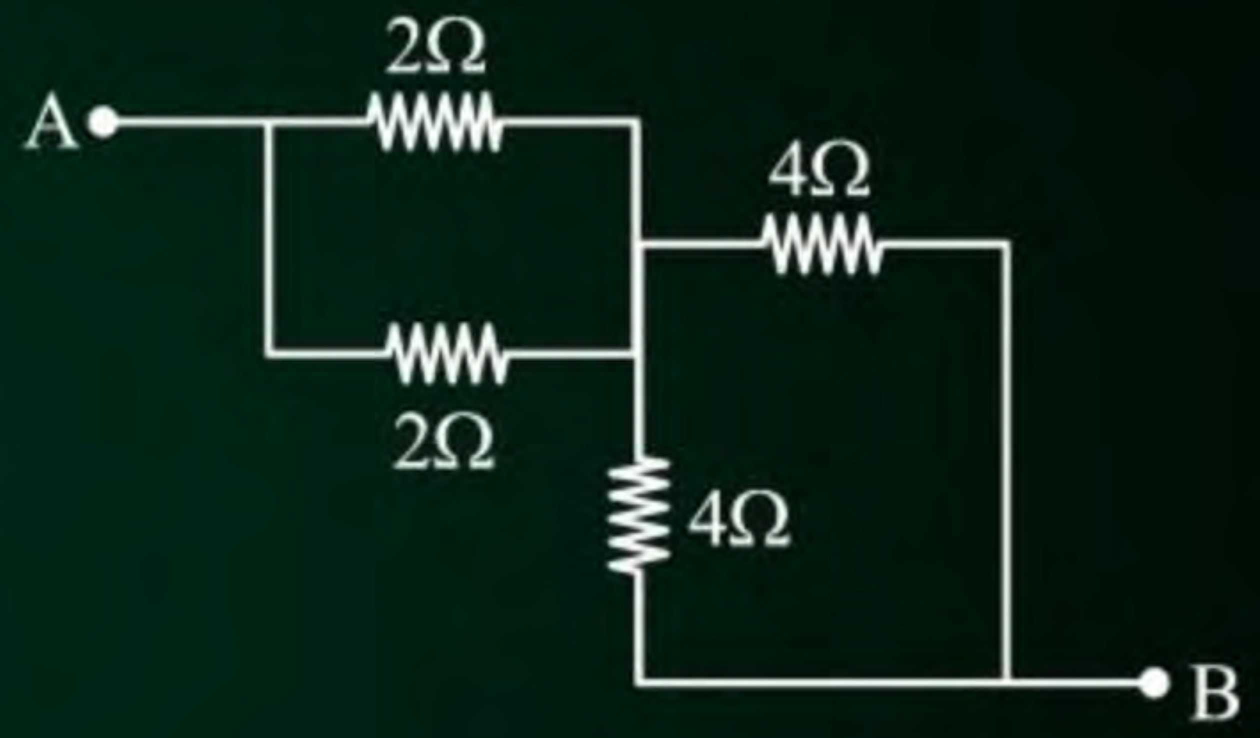
The equivalent resistance between A and B for the mesh shown in the figure is

1. $16\,\Omega$
2. $30\,\Omega$
3. $4.8\,\Omega$
4. $7.2\,\Omega$



QUESTION

Effective resistance across AB in the network shown in



1. 6 Ω
2. 3 Ω
3. 5 Ω
4. 8 Ω

Parallel Combination of Resistance

➢ Temperature dependence of Resistance and Resistivity

#

$\alpha_l = \frac{\Delta l}{l_0 \Delta T}$

$\alpha_l l_0 \Delta T = l_f - l_0$

$l_f = l_0 + \alpha_l l_0 \Delta T$

$\beta = \frac{\Delta A}{A_0 \Delta T}$

$A_f = A_0(1 + \beta \Delta T)$

$\Delta R \propto \Delta T$

$\Delta R \propto R_0$

$\Delta R = \alpha_R R_0 \Delta T$

→ Prop^n Const^n (depends on Nature of material)

$\alpha_R = \frac{\Delta R}{R_0 \Delta T}$

$R_f = R_0(1 + \alpha_R \Delta T)$

R_0 → Initial resistance at 0°C → R_0

α_R → at 0°C α_R is defined

$R_T = R_0[1 + \alpha_R(T - 0)]$

$\rho_T = \rho_0(1 + \alpha_\rho T)$

$R_T = R_0(1 + \alpha_R T)$

QUESTION

The resistance of platinum wire at 0°C is 2Ω and 6.8Ω at 80°C. The temperature coefficient of resistance of the wire is:

1. $3 \times 10^{-3}\ °C^{-1}$
2. $3 \times 10^{-2}\ °C^{-1}$
3. $3 \times 10^{-1}\ °C^{-1}$
4. $3 \times 10^{-4}\ °C^{-1}$

R_0

$$R_T = R_0(1 + \alpha \Delta T)$$

$$6.8\Omega = 2(1 + \alpha(80))$$

$$3.4 = 1 + 80\alpha$$

$$3.4 - 1 = 80\alpha$$

$$2.4 = 80\alpha$$

$$\alpha = \frac{2.4}{80} = \frac{24 \times 10^{-1}}{8 \times 10} = 3 \times 10^{-2}$$

QUESTION

If resistance R_1 at T_1 and resistance R_2 at T_2 then find relation between R_1 and R_2. If α_R is at 0°C.

Sol^n

$R_2 = R_1 (1 + \alpha (T_2 - T_1))$

$R_1 = R_0 [1 + \alpha_R (T_1)]$

$R_2 = R_0 [1 + \alpha_R T_2]$ Temp. Coefficient of Resistance

$$\frac{R_1}{R_2} = \left(\frac{1 + \alpha_R T_1}{1 + \alpha_R T_2}\right)$$

QUESTION NEET

The temperature coefficient of resistance of a wire is 0.00125 per °C. At 300K its resistance is 1 ohm. The resistance of the wire will be 2 ohms at

1. 1154 K
2. 1100 K
3. 1400 K
4. 1127 K

$R_{T_2} = R_{T_1}(1+\alpha(T_2 - T_1))$

$$\frac{R_{T_1} = R_0(1+\alpha T_1)}{R_{T_2} = R_0(1+\alpha T_2)}$$

$$\frac{1}{2} = \frac{1+\alpha 300}{1+\alpha T_2}$$

$1 + \alpha T_2 = 2 + 600\alpha$

$\alpha T_2 - 600\alpha = 2 - 1$

$\alpha(T_2 - 600) = 1$

$T_2 - 600 = \frac{1}{\alpha}$

$T_2 = \frac{1}{\alpha} + 600$

$= \frac{1}{0.00125} + 600$

$= \frac{10^5}{125} + 600$

$= \frac{1000 \times 10^2}{125} + 600$

$= 800 + 600$

$= 1400$

QUESTION

Find relation between coefficient of linear expansion α, temperature coefficient of resistance α_R and temperature coefficient of resistance α_ρ for a wire.

$\alpha, \alpha_R, \alpha_\rho$

$\beta = 2\alpha$ *

$$R = \frac{\rho l}{A}$$

$$\frac{\Delta R}{\Delta T\, R} = \frac{\Delta \rho}{\rho \Delta T} + \frac{\Delta l}{l \Delta T} - \frac{\Delta A}{A \Delta T}$$

$$\alpha_R = \alpha_\rho + \alpha - 2\alpha$$

$$\boxed{\alpha_R = \alpha_\rho - \alpha}$$

Ans

QUESTION

Resistance of a wire at temperature t°C is $R = R_0(1 + at + bt^2)$. Here, R_0 is the temperature at 0°C. The temperature coefficient of resistance at temperature t is:

1. $\frac{a + 2bt}{1 + at + bt^2}$

2. $(a + 2bt)$

3. $\frac{1 + at + bt^2}{a + 2bt}$

4. constant

QUESTION

Two resistances R_1 and R_2 are made of different materials. The temperature coefficient of the material of R_1 is α and that of material of R_2 is $-\beta$. The material of R_1 and R_2 will not change with temperature if $\frac{R_1}{R_2}$ equal to

hint :- (Thermal physics)

"$R_1\alpha = R_2\beta$"

$$\frac{R_1}{R_2} = \frac{\beta}{\alpha}$$

Ans

Temp ↑ R_1 ↑, α Temp ↑ R_2 ↓, $-\beta$

$\alpha = \frac{(\Delta R_1)}{R_1 \Delta T}$ # $\beta = -\frac{(\Delta R_2)}{R_2 \Delta T}$

If material made by α (R_1) & β (R_2) is mixed and does not change with tempr hence

$\Delta R_1 + \Delta R_2 = 0$

$\Delta R_1 = -\Delta R_2$

$\Delta R_1 = -\Delta R_2$

$\alpha R_1 \Delta T = \beta R_2 \Delta T$

$\frac{R_1}{R_2} = \beta/\alpha$

Ans

⇒ $R_{eq} = R_1 + R_2$

$R_{eq} = R_1 + R_2$

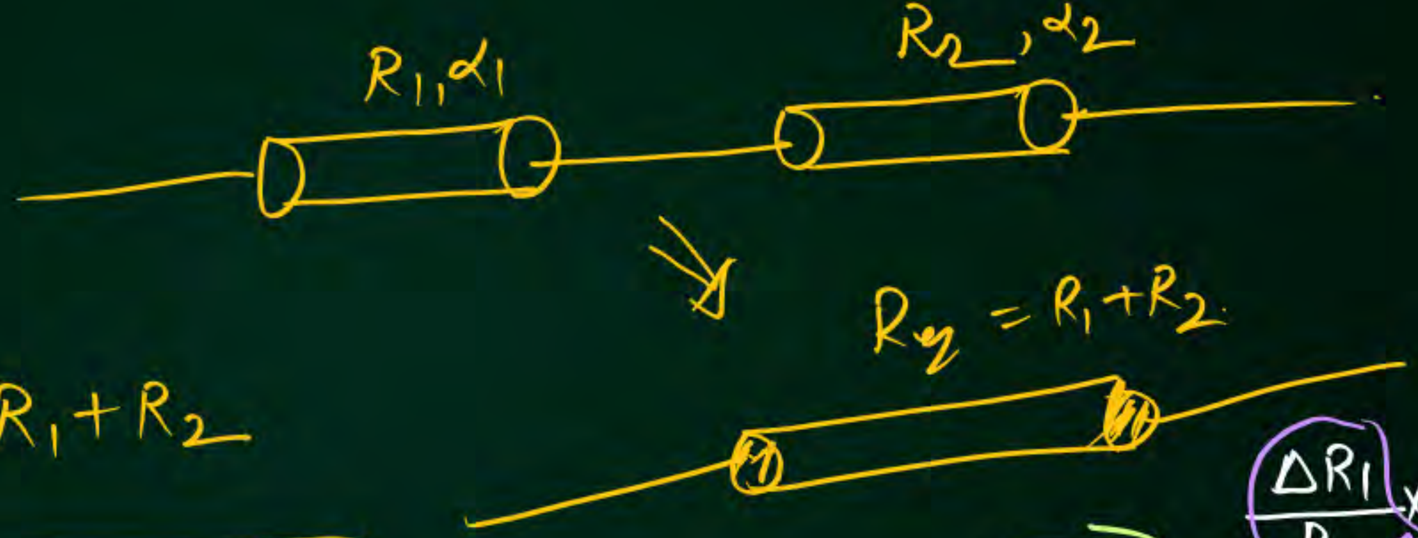
Con

$\frac{\Delta R_{eq}}{R_{eq}} = \frac{\Delta R_1}{R_1} + \frac{\Delta R_2}{R_2}$

QUESTION

Two wires of resistance R_1 and R_2 have temperature coefficient of resistance α_1 and α_2, respectively. These are joined in series. The effective temperature coefficient of resistance is

1. $\dfrac{\alpha_1 + \alpha_2}{2}$
2. $\sqrt{\alpha_1 \alpha_2}$
3. $\dfrac{\alpha_1 R_1 + \alpha_1 R_2}{R_1 + R_2}$ ✓
4. $\dfrac{\sqrt{R_1 R_2 \alpha_1 \alpha_2}}{\sqrt{R_1^2 + R_2^2}}$



$R_{eq} = R_1 + R_2$

$\dfrac{\Delta R_{eq}}{R_{eq}} = \dfrac{\Delta R_1}{R_1} + \dfrac{\Delta R_2}{R_2}$ → wrong

$\Delta R_{eq} = \Delta R_1 + \Delta R_2$ ✓

$\dfrac{\Delta R_{eq}}{R_{eq}} = \dfrac{\Delta R_1 + \Delta R_2}{R_1 + R_2}$

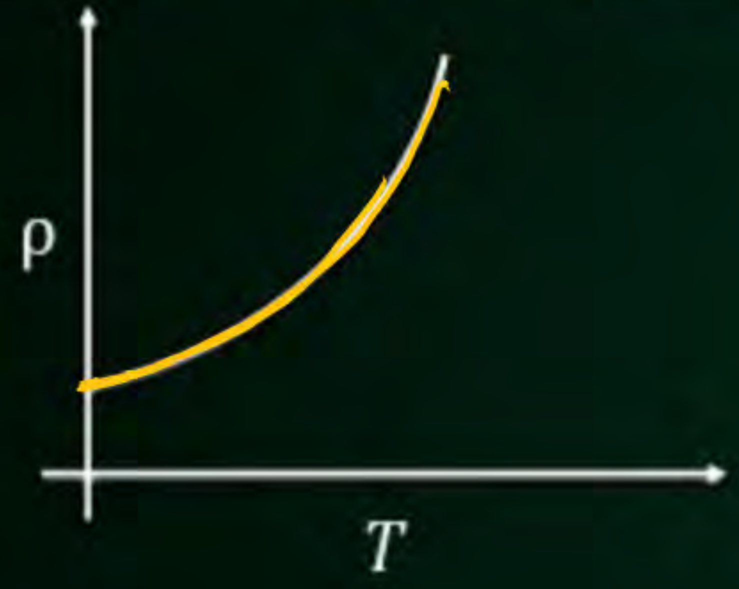
$\dfrac{\frac{\Delta R_1}{R_1 \Delta T} \times R_1 + \frac{\Delta R_2}{R_2 \Delta T} \times R_2}{R_1 + R_2} = \dfrac{\Delta R_{eq}}{R_{eq} \Delta T}$

$\dfrac{\alpha_1 R_1 + \alpha_2 R_2}{R_1 + R_2} = \alpha_{eq}$

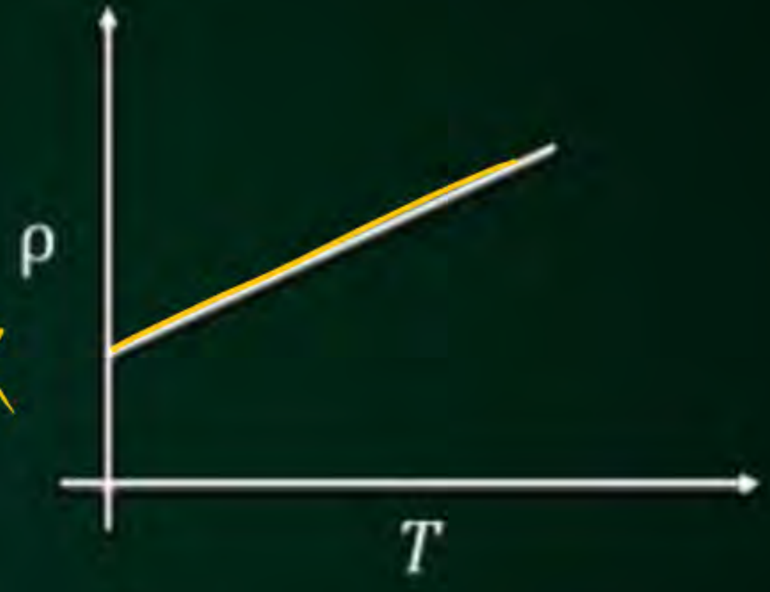
QUESTION

Which of the following graph represents the variation of resistivity (ρ) with temperature (T) for copper?

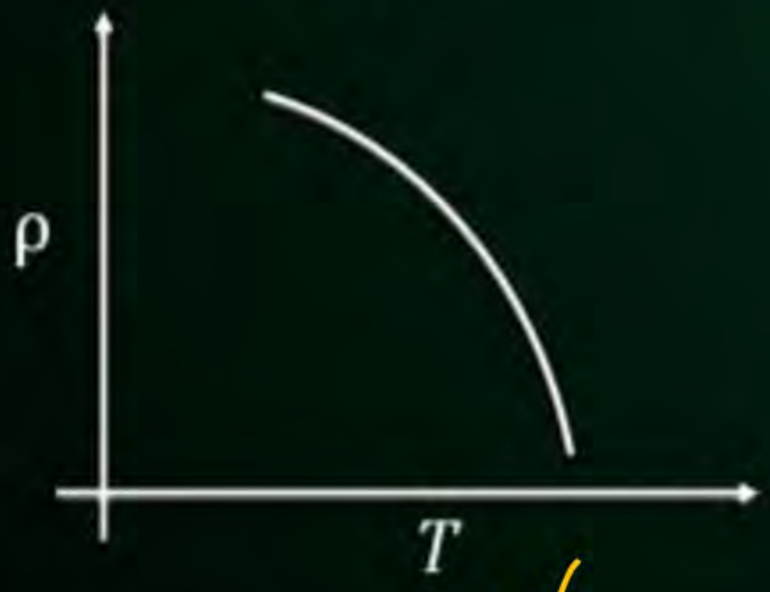
(1)



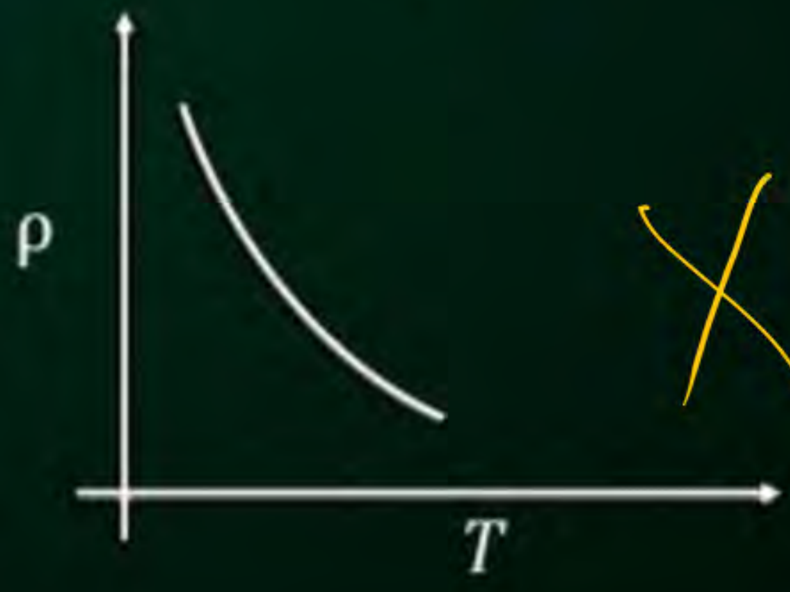
(2)



(3)



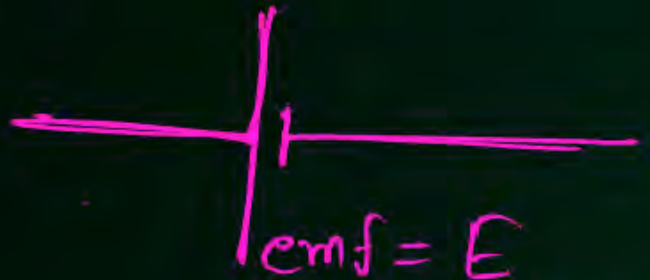
(4)



1st time dropper

$$\text{Selection} \propto \frac{1}{\text{Spam \& Chat}}$$

Cell (Battery)



{ Ideal Battery }

Practical Battery



or



Charging of Battery



$V_A - E - Ir = V_B$

$V_A - V_B = E + Ir = V_{TP}$

Discharging of Battery



$V_A - E + Ir = V_B$

$V_A - V_B = E - Ir$

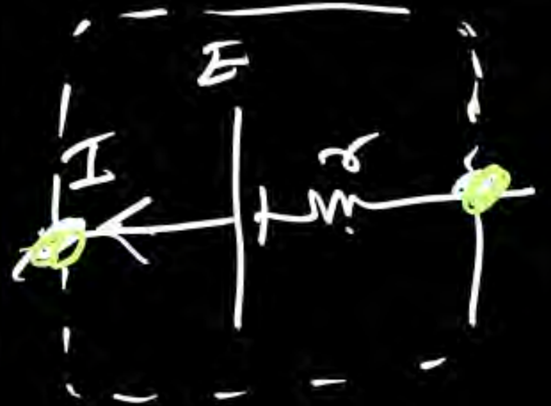
Ideal Battery ($r = 0$)

$V_{TP} = E$

Charging of Battery

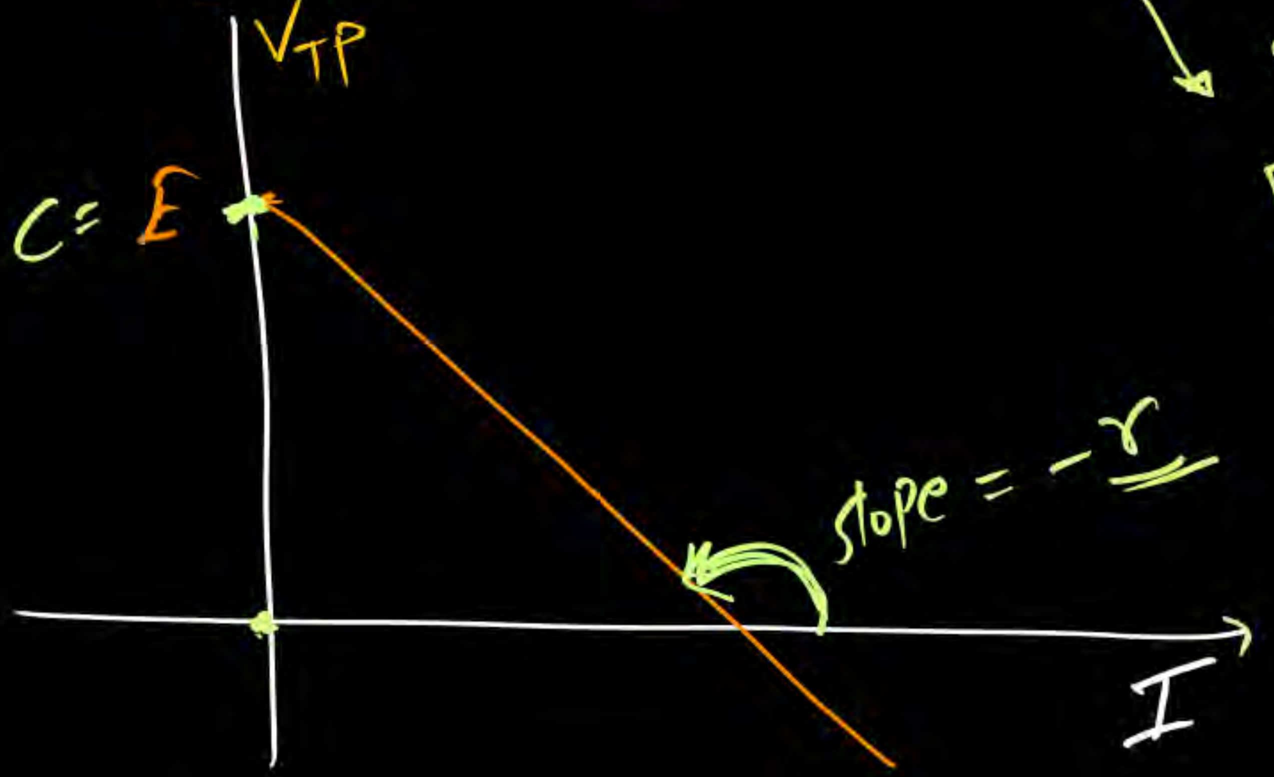
$$V_{TP} = E + Ir$$

discharge of Battery



$$V_{TP} = E - Ir$$

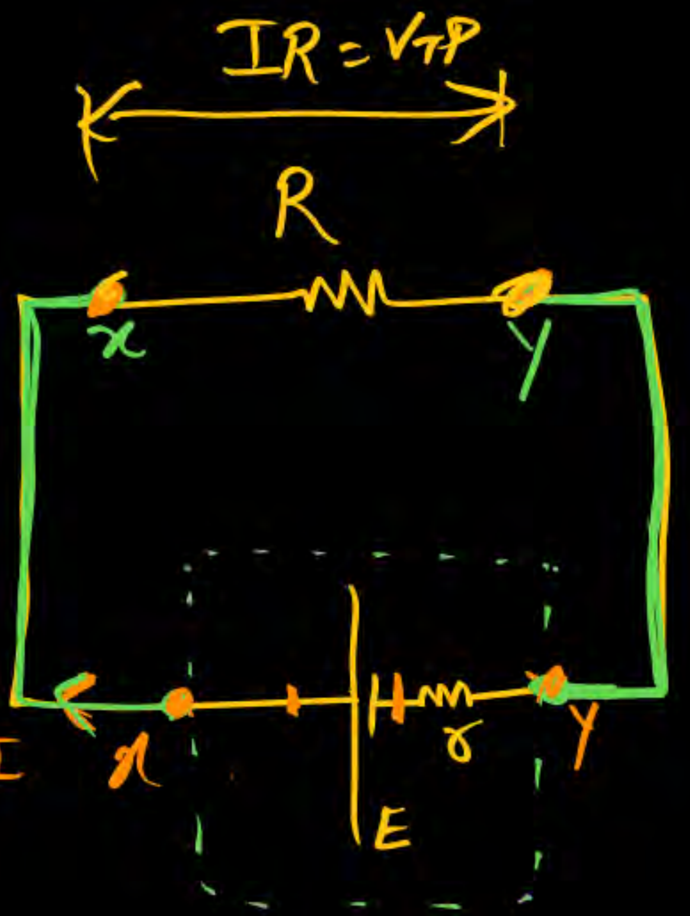
$$y = c + mx$$



$I = 0$ (current)

$$V_{TP} = E$$

Battery is connected to external load resistance 'R'



$$\frac{E}{R+r} = I$$

"$V_{TP} = V_{xy} = E - Ir = IR$"

#

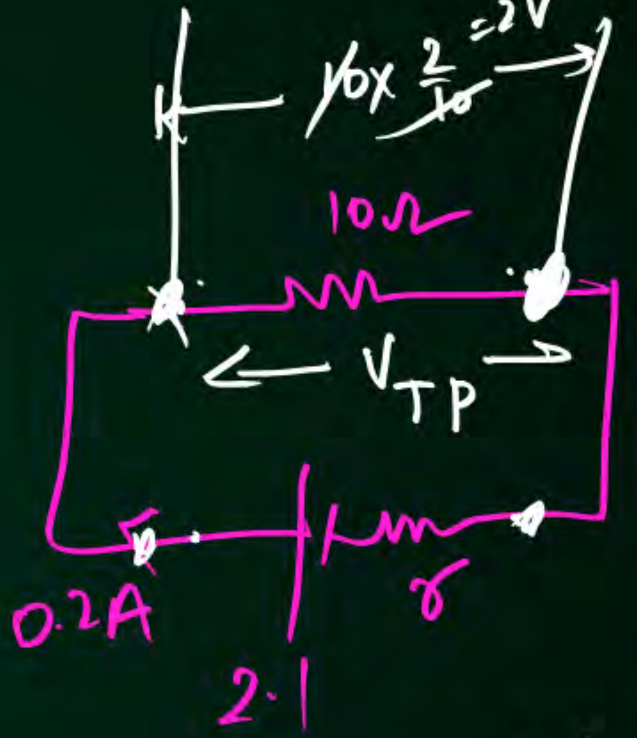
$$V_{TP} = \left(E - \frac{E}{R+r} r\right) = \left(\frac{E}{R+r}\right) R$$

L.C.M

QUESTION

The internal resistance of a 2.1 V cell which gives a current of 0.2 A through a resistance of 10 Ω is **[NEET 2013]**

1. 0.8 Ω
2. 1.0 Ω
3. 0.2 Ω
4. 0.5 Ω ✓



$$V_{TP} = emf - Ir$$
$$2 = 2.1 - 0.2r$$
$$0.2r = 2.1 - 2$$
$$0.2r = 0.1$$
$$r = \frac{1}{2} = 0.5\,\Omega$$

QUESTION

A student measures the terminal potential difference (V) of a cell (of emf ε and internal resistance r) as a function of the current (I) flowing through it. The slope, and intercept, of the graph between V and I, then, respectively, equal [2009]

1. $-r$ and ε
2. r and $-ε$
3. $-ε$ and r
4. ε and $-r$

QUESTION

For a cell terminal potential difference is 2.2V when circuit is open and reduces to 1.8 V when cell is connected to a resistance of R = 5 Ω. Determine internal resistance of cell (r). [2002]

1. 10/9 Ω
2. 9/10 Ω
3. 11/9 Ω
4. 5/9 Ω

emf = 2.2 V

$V_{TP} = 1.8\text{ V}$

$V_{TP} = E - Ir$

$1.8 = 2.2 - Ir$

$Ir = 2.2 - 1.8$

$I = \frac{1.8}{5}$

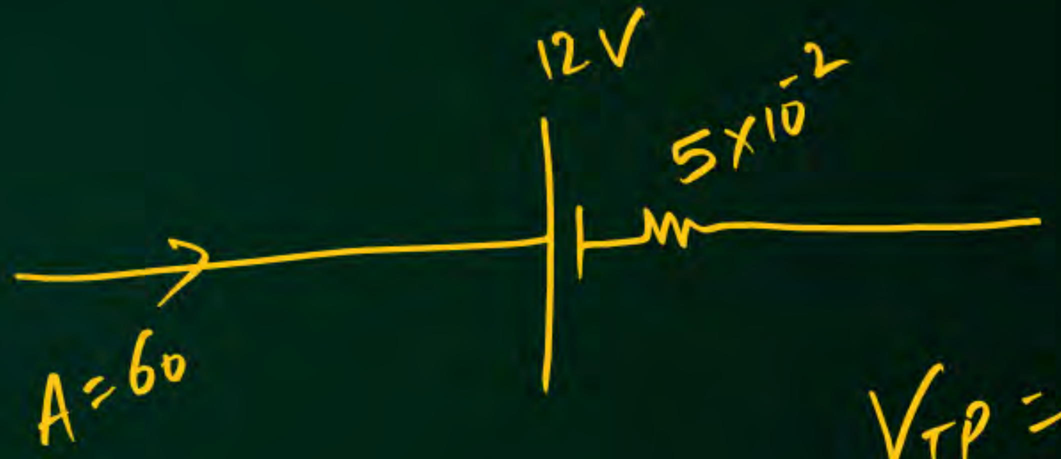
$\frac{1.8}{5} r = 0.4$

$r = 10/9\ \Omega$

QUESTION

A car battery of emf 12 V and internal resistance $5 \times 10^{-2}\ \Omega$, receives a current of 60 amp from external source, then terminal potential difference of battery is [2000]

1. 12 V
2. 9 V
3. 15 V
4. 20 V



$V_{TP} = E + Ir$

$= 12 + 60 \times 5 \times 10^{-2}$

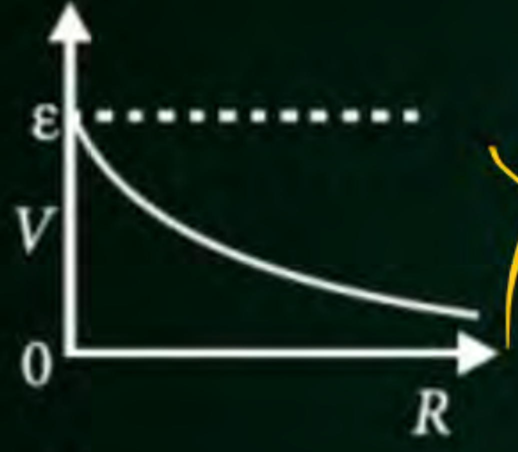
$= 15\ V$

QUESTION

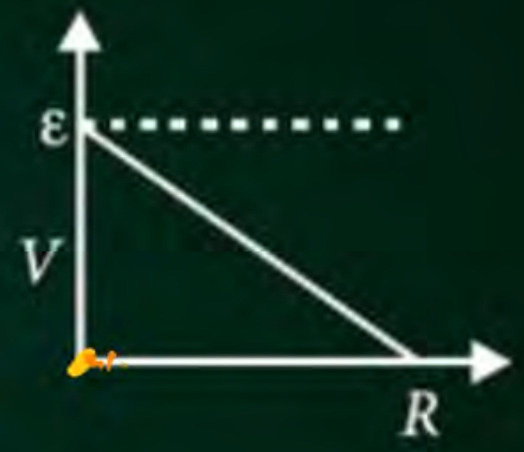
A cell having an emf ε and internal resistance r is connected across a variable external resistance R. As the resistance R is increased, the plot of potential difference V across R is given by

[Main 2012]

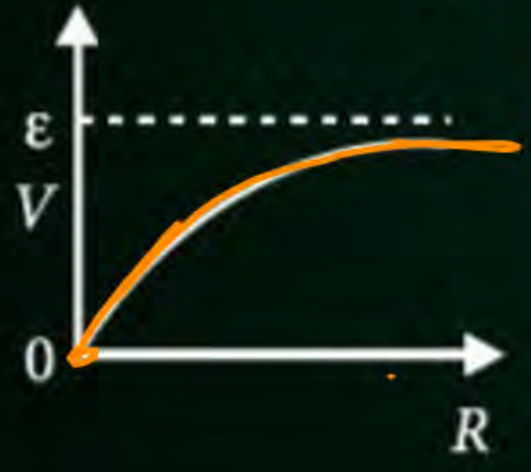
(1)



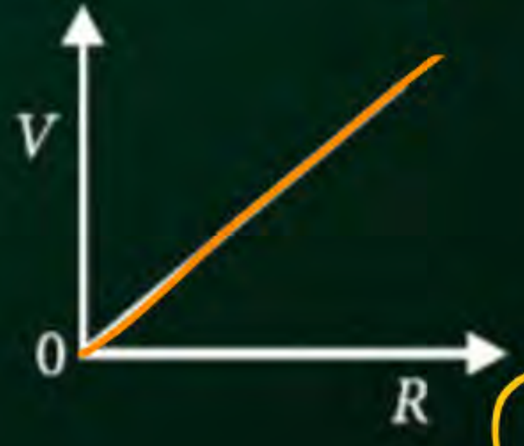
(2)



(3)



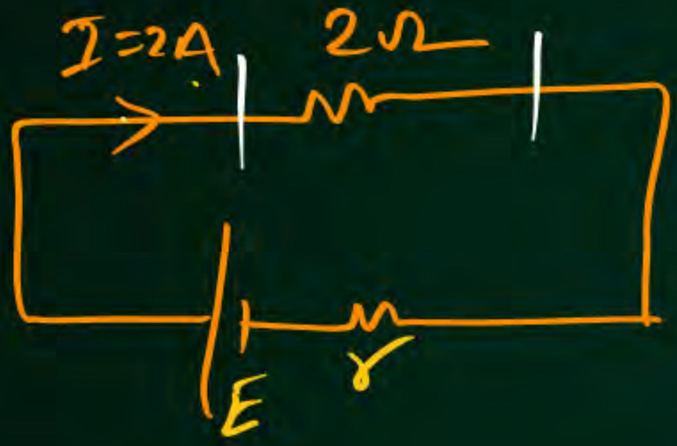
(4)



QUESTION

A current of 2 A flows through a 2 Ω resistor when connected across a battery. The same battery supplies a current of 0.5 A when connected across a 9 Ω resistor. The internal resistance of the battery is [2011]

1. 0.5 Ω
2. 1/3 Ω ✓
3. 1/4 Ω
4. 1 Ω





$V_{TP} = E - Ir$

$E = V_{TP_1} + I_1 r$ — (1)

$E = V_{TP_2} + I_2 r$ — (2)

(1) = (2)

$4 + 2r = \frac{9}{2} + \frac{1}{2}r$

$2r - \frac{r}{2} = \frac{9}{2} - 4 = \frac{1}{2}$

$\frac{3r}{2} = \frac{1}{2}$

$r = \frac{1}{3}\,\Omega$

QUESTION

The internal resistance of a cell of e.m.f. 2 V is 0.1 Ω. It is connected to a resistance of 3.9 Ω. The voltage across the cell will be [1999]

$V_{TP} = ??$

1. 1.95 V
2. 1.9 V
3. 0.5 V
4. 2 V

QUESTION

A battery of e.m.f 10 V and internal resistance 0.5 Ω is connected across a variable resistance R. The value of R for which the power delivered in it is maximum is given by

[1992]

Power will be max^m

$r = R$

$0.5 = R$

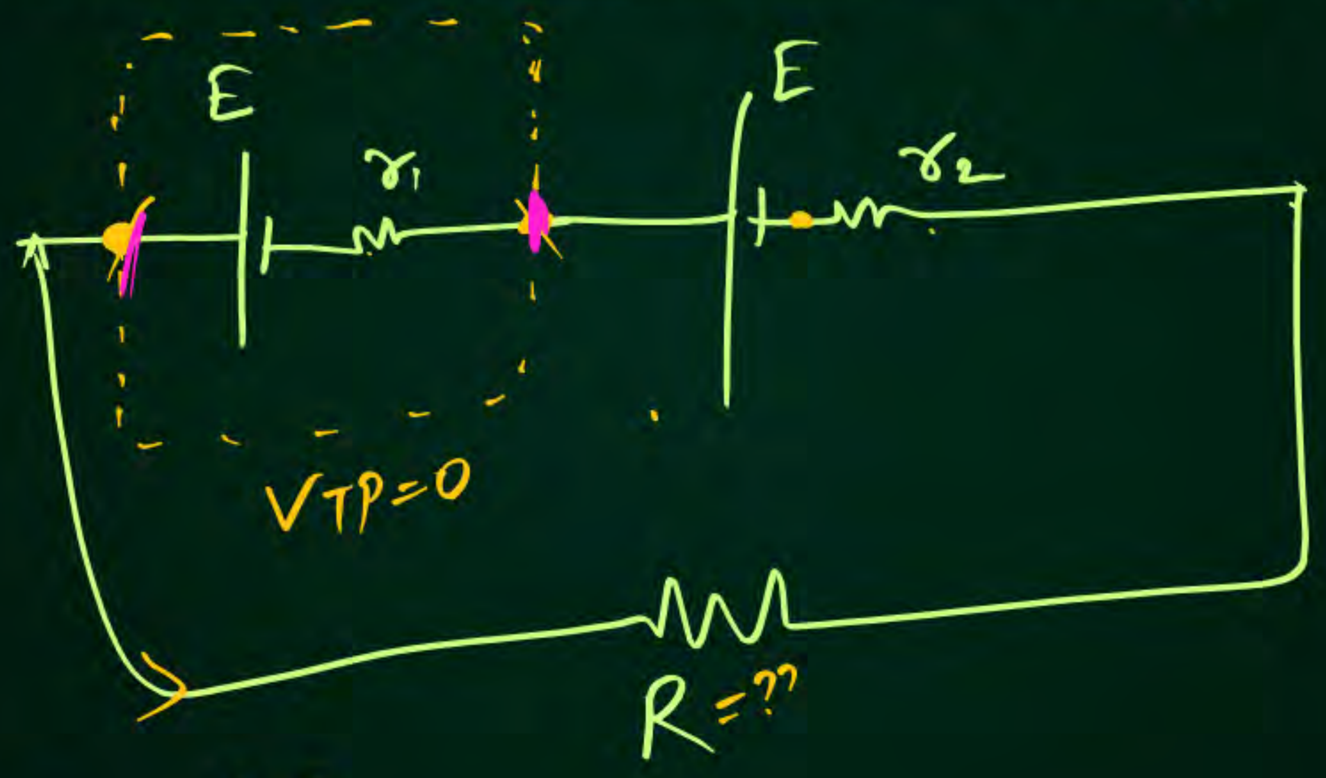
1. 0.5 Ω ✓
2. 1.0 Ω
3. 2.0 Ω
4. 0.25 Ω

QUESTION

Two cells, having the same e.m.f. are connected in series through an external resistance R. Cells have internal resistances r_1 and r_2 $(r_1 > r_2)$ respectively. When the circuit is closed, the potential difference across the first cell is zero. The value of R is [2006]

JEE

1. $r_1 + r_2$
2. $r_1 - r_2$
3. $\frac{r_1 + r_2}{2}$
4. $\frac{r_1 - r_2}{2}$



$$I = \frac{2E}{r_1 + r_2 + R} \quad \text{— (1)}$$

next (5 mint)
one leg stan

$V_{TP} = E - I r_1$

$0 = E - I r_1$

$E = \frac{2E}{R + r_1 + r_2} r_1$

$R + r_1 + r_2 = 2r_1$

$R = 2r_1 - r_1 - r_2$

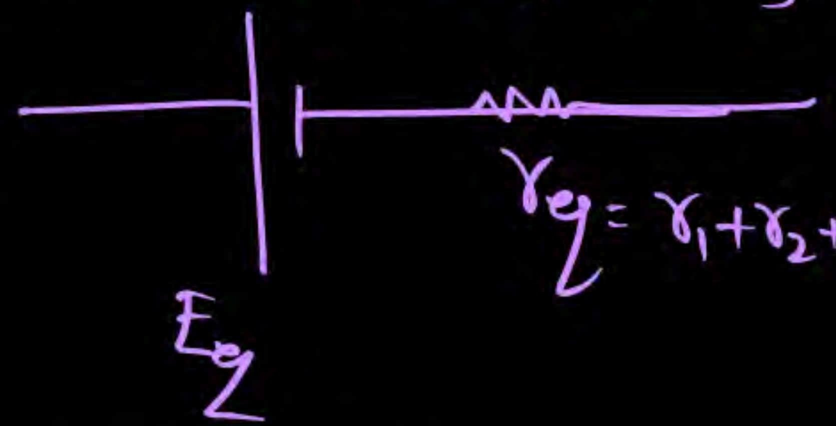
$= (r_1 - r_2)$

Series combination of Battery

(end to end connection)



$emf = E_1 + E_2 + E_3 + E_4 + E_5$



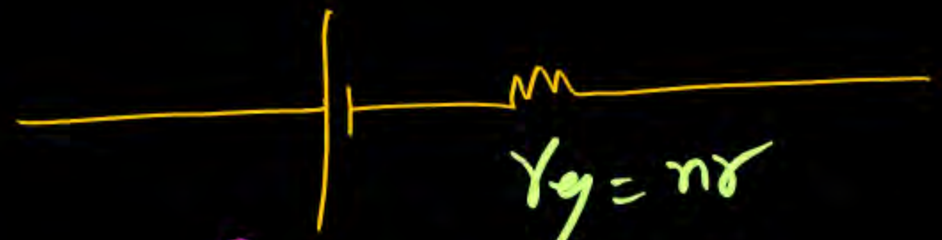
$r_{eq} = r_1 + r_2 + r_3 + r_4 + r_5$

If n-Battery Connected in serie (E, r)

$E_q = nE$ | $r_q = nr$

(E, r)

(Q) out of n-Identical Battery, if m-Battery are conneted in opposite Polarity, then E_q & r_q will



$r_q = nr$

$E_{nt} = nE - 2mE$

$E_{nt} = E(n - 2m)$



$$I = \frac{4E}{4r} = \frac{E}{r}$$

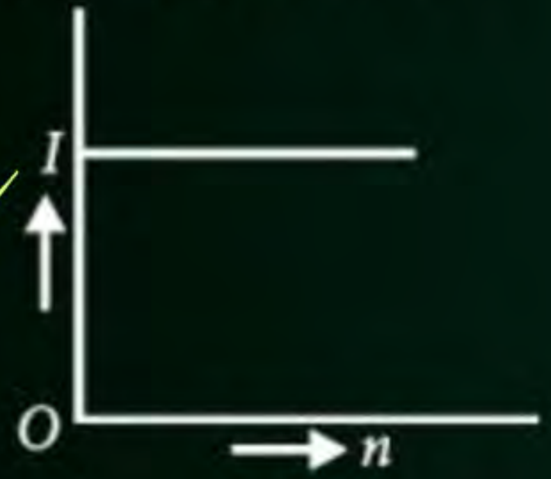
$$(V_{TP}) = E - Ir$$

$$(V_{TP})_{\text{after one Bu}} = E - \frac{E}{r}r = 0$$

QUESTION

A battery consists of a variable number n of identical cells (having internal resistance r each) which are connected in series. The terminals of the battery are short-circuited and the current I is measured. Which of the graphs shows the correct relationship between I and n?

[2018]

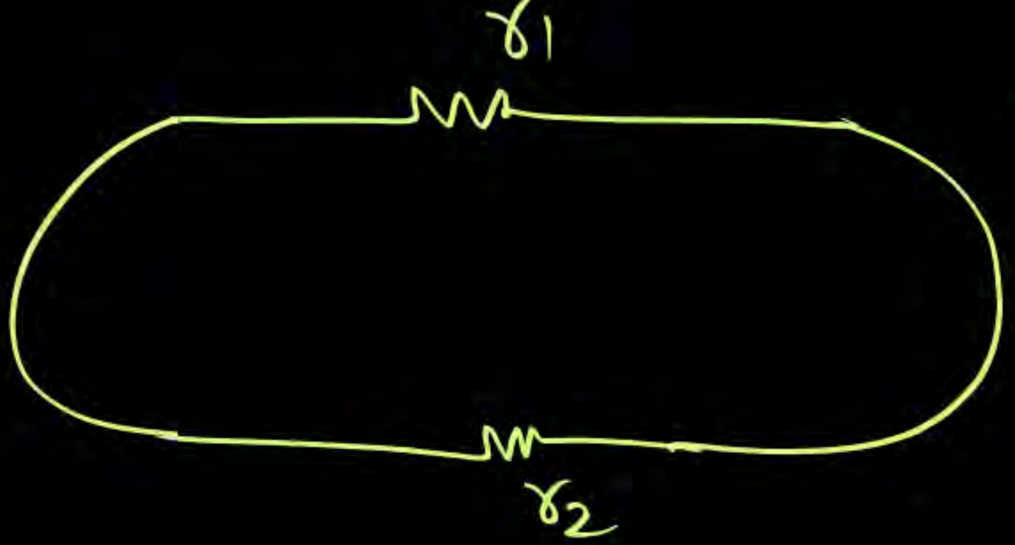
1


2


3


4

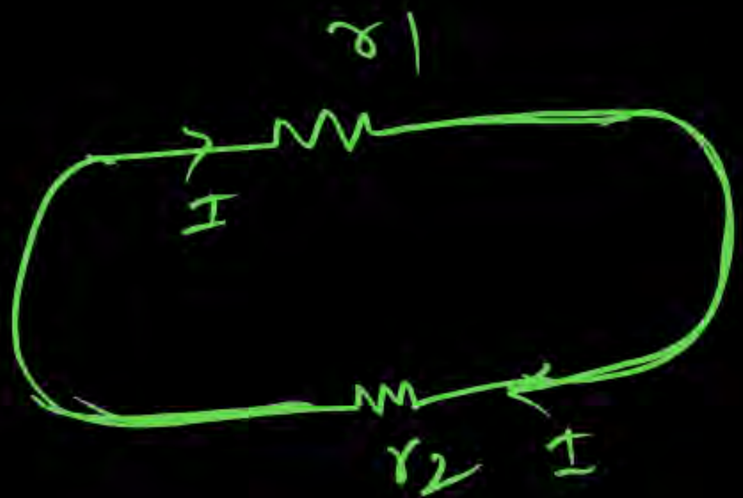


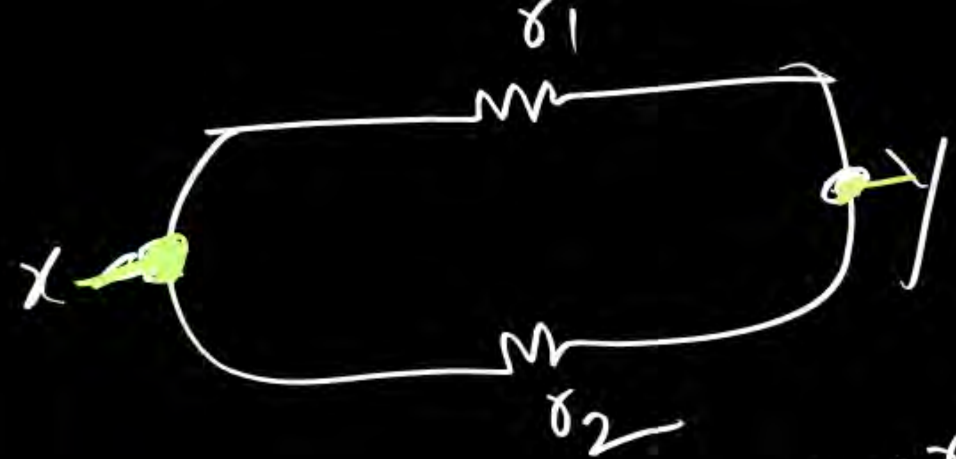
we can't say

r_1 & r_2 are in series

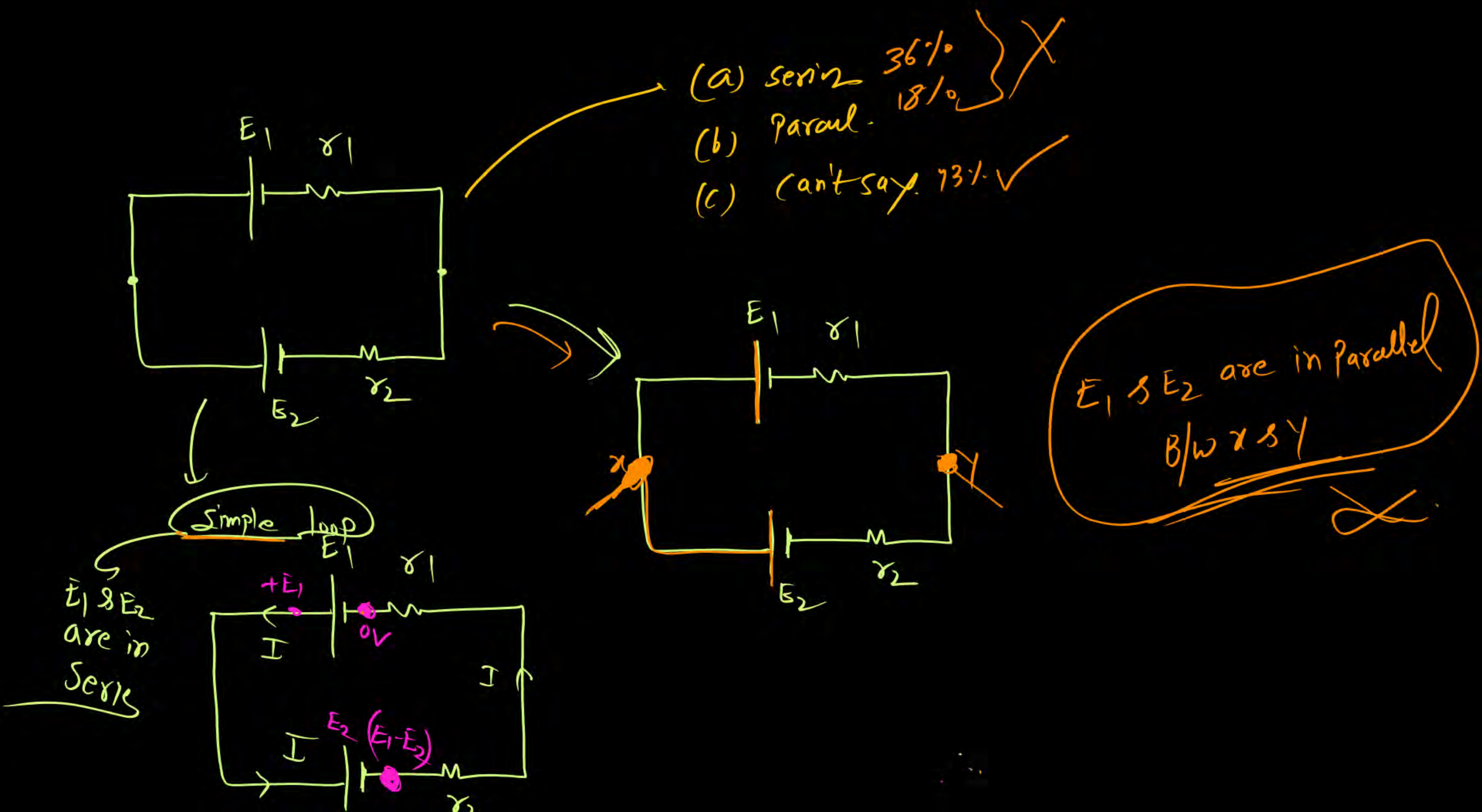
or Parallel.



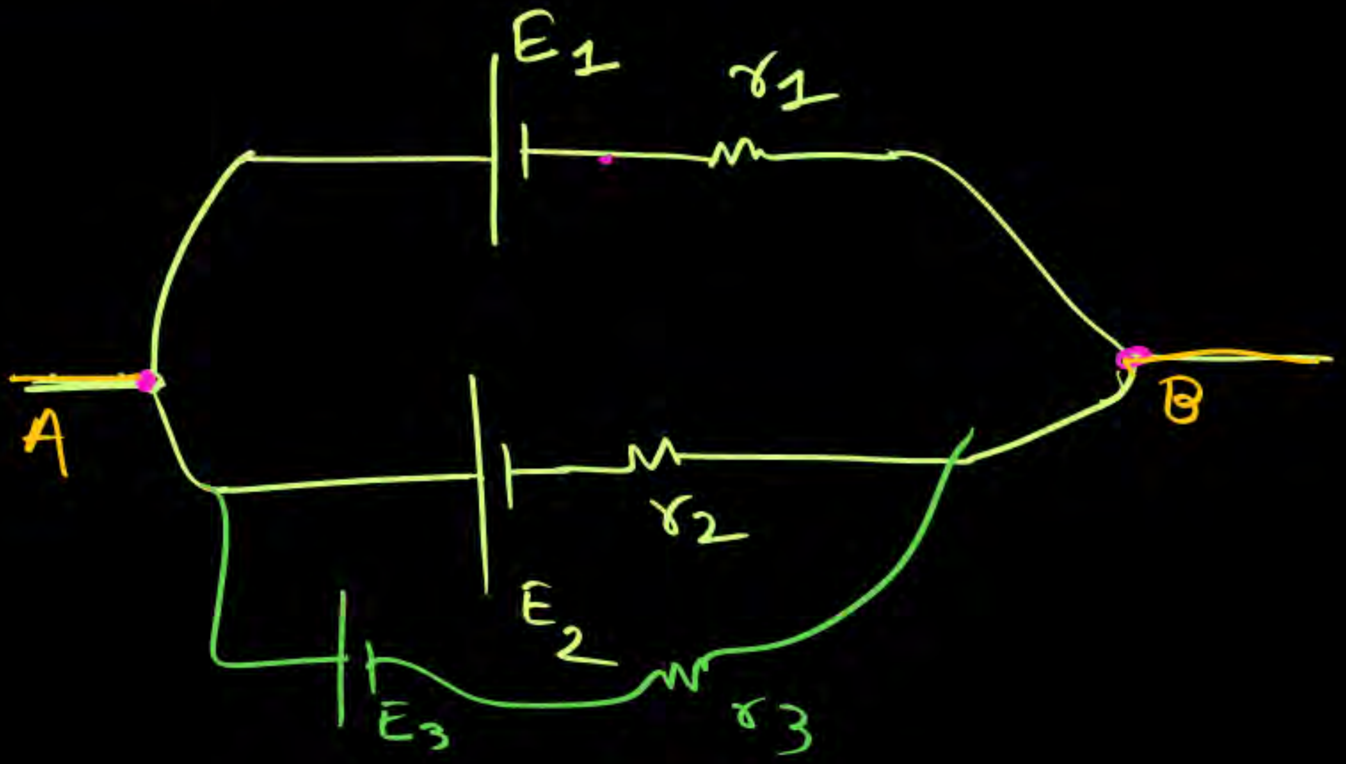
r_1 & r_2 are in series.



r_1 & r_2 are in Parallel b/w x & y

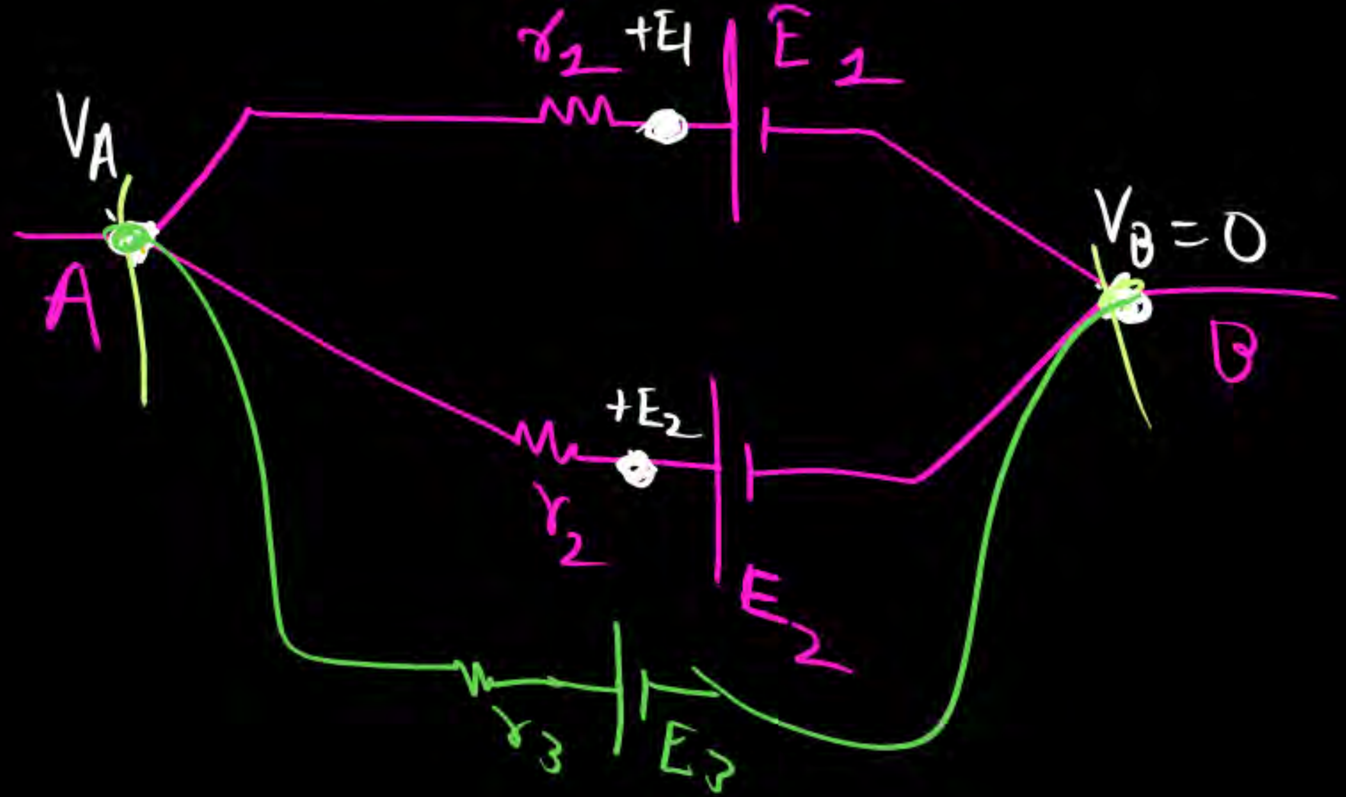

(a) series 36%
(b) Parallel. 18%
(c) can't say. 73%
E1
r1
r2
E2
Simple loop
E1 & E2 are in Series
+E1
0V
I
E2
(E1-E2)
E1 & E2 are in Parallel
B/w x & Y
x
Y

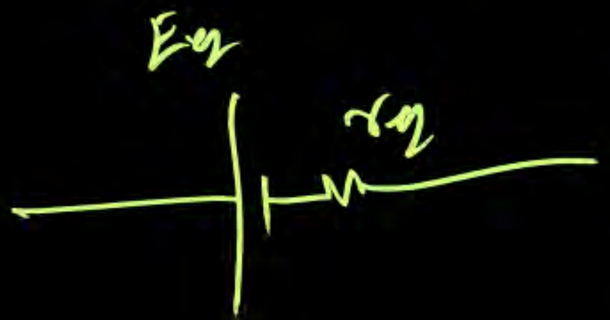
Parallel combination of cell.



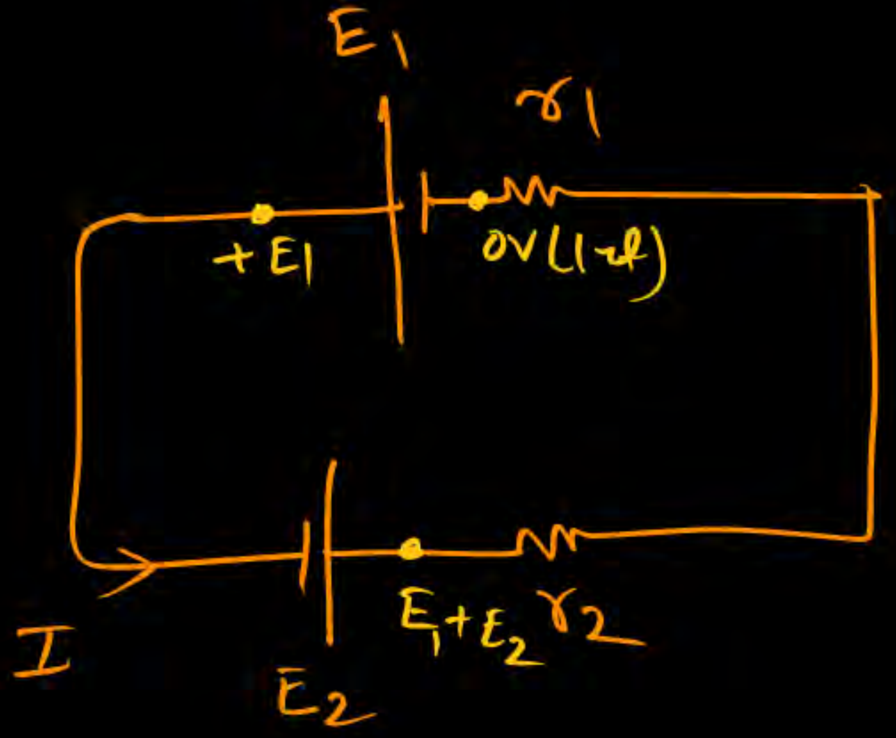
$$V_A = \frac{\frac{E_1}{r_1} + \frac{E_2}{r_2}}{\frac{1}{r_1} + \frac{1}{r_2}}$$

$$V_{AB} = V_A - V_B = \frac{\frac{E_1}{r_1} + \frac{E_2}{r_2} + \frac{E_3}{r_3}}{\frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3}} = E_{eq}$$

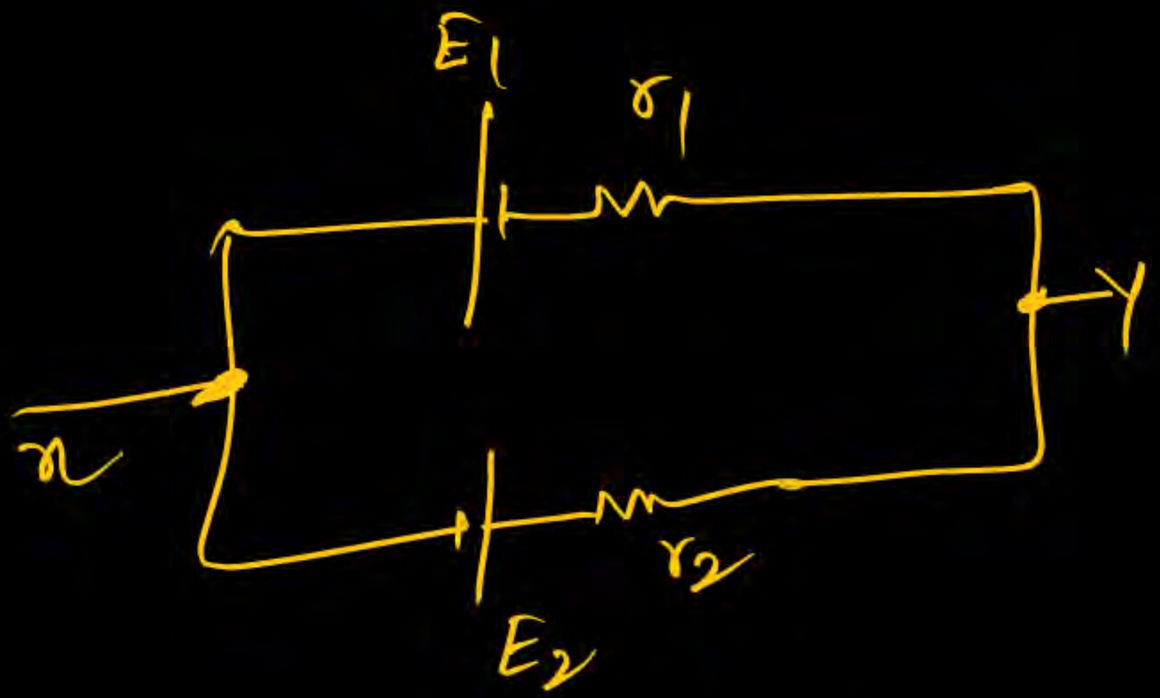




$$\frac{1}{r_{eq}} = \frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3}$$



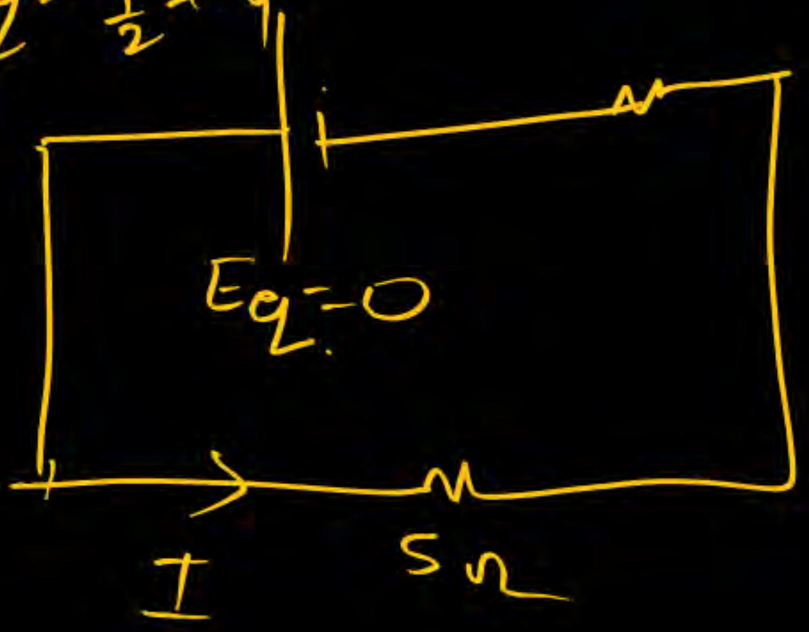
$$I = \frac{E_1 + E_2}{r_1 + r_2}$$

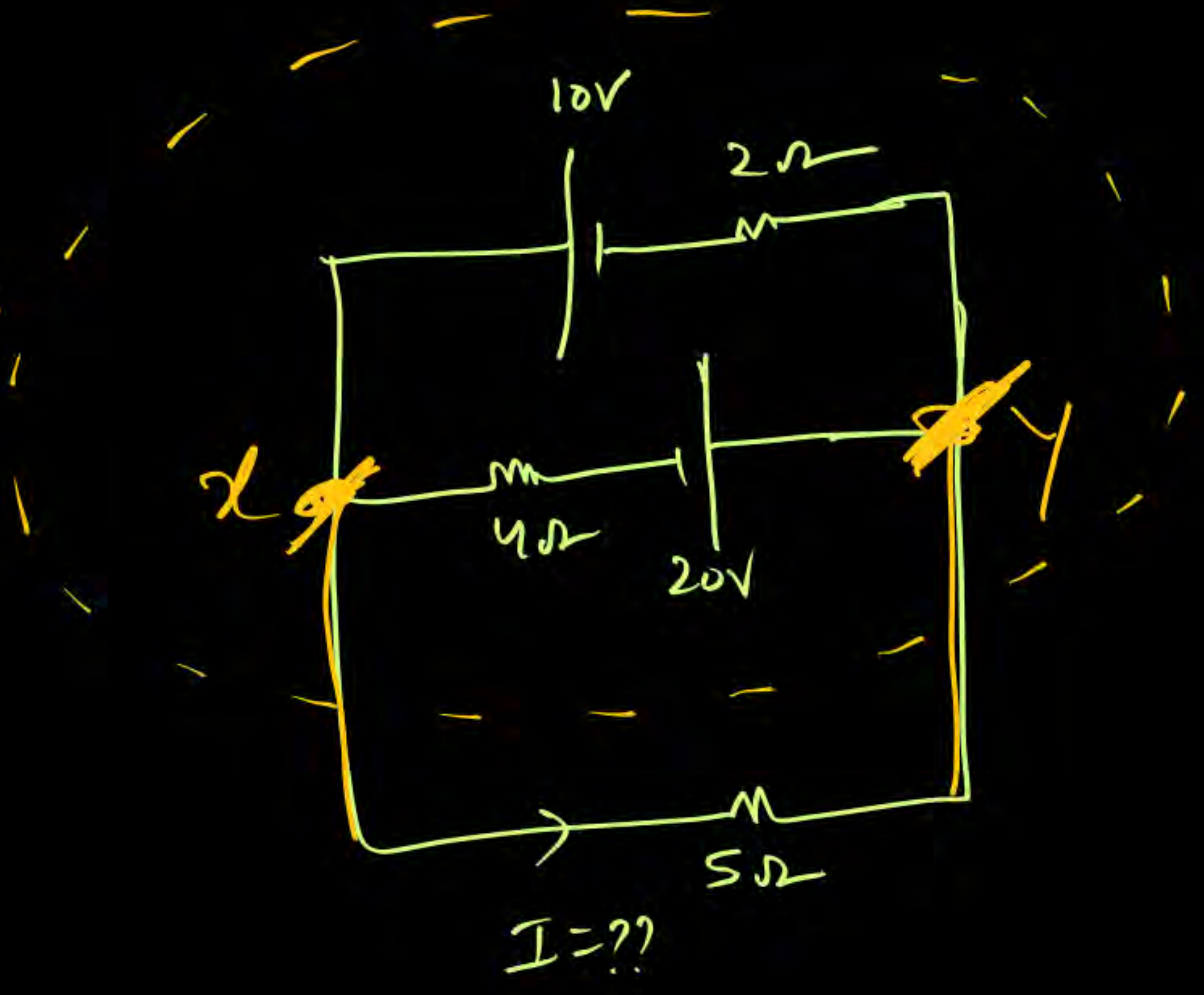


$$E_{eq(xy)} = \frac{\frac{E_1}{r_1} - \frac{E_2}{r_2}}{\frac{1}{r_1} + \frac{1}{r_2}}$$

$$\frac{1}{r_{eq}} = \frac{1}{r_1} + \frac{1}{r_2}$$

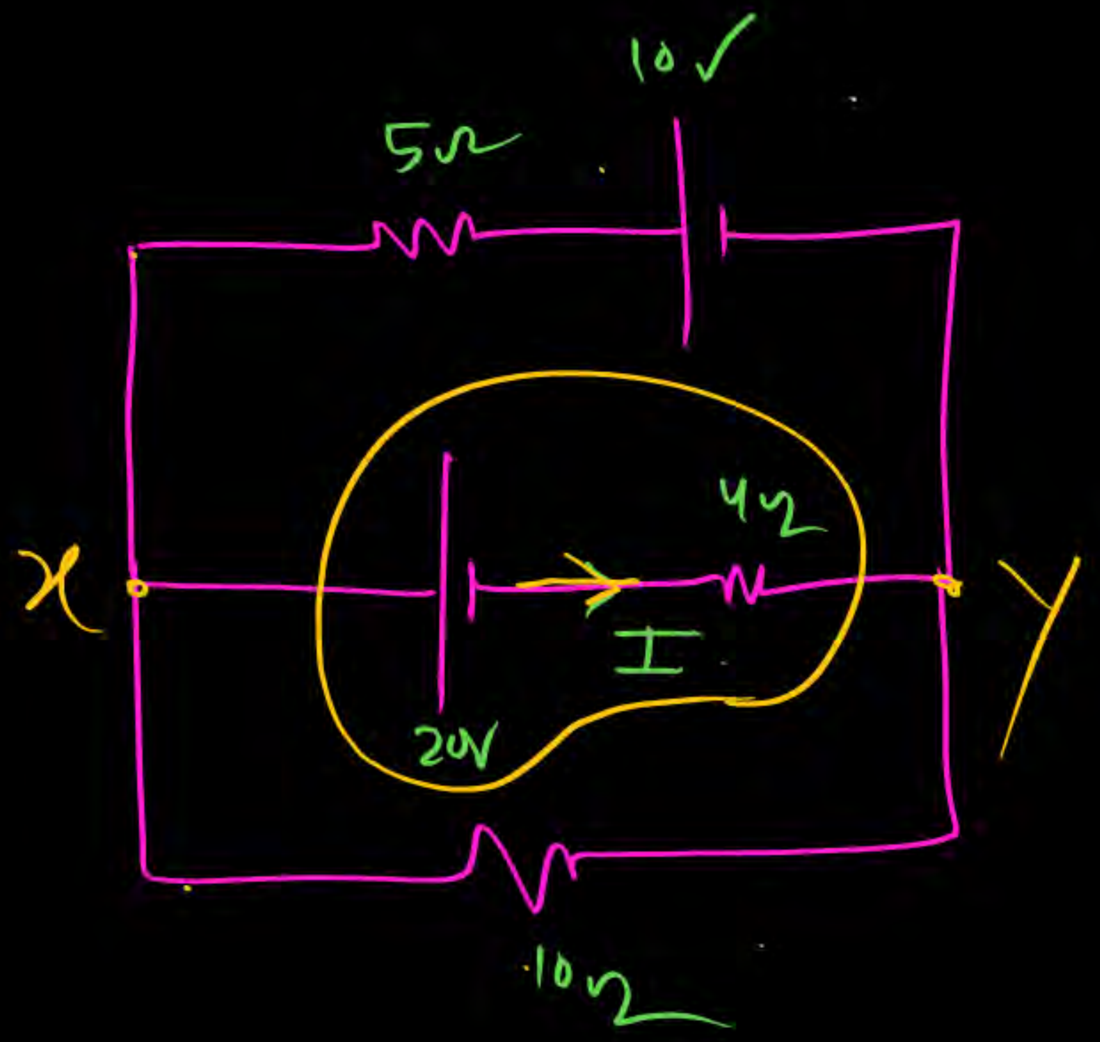
$$E_q = \frac{\frac{10}{2} - \frac{20}{4}}{\frac{1}{2} + \frac{1}{4}} = 0$$ Parallel comb^n of Bw.



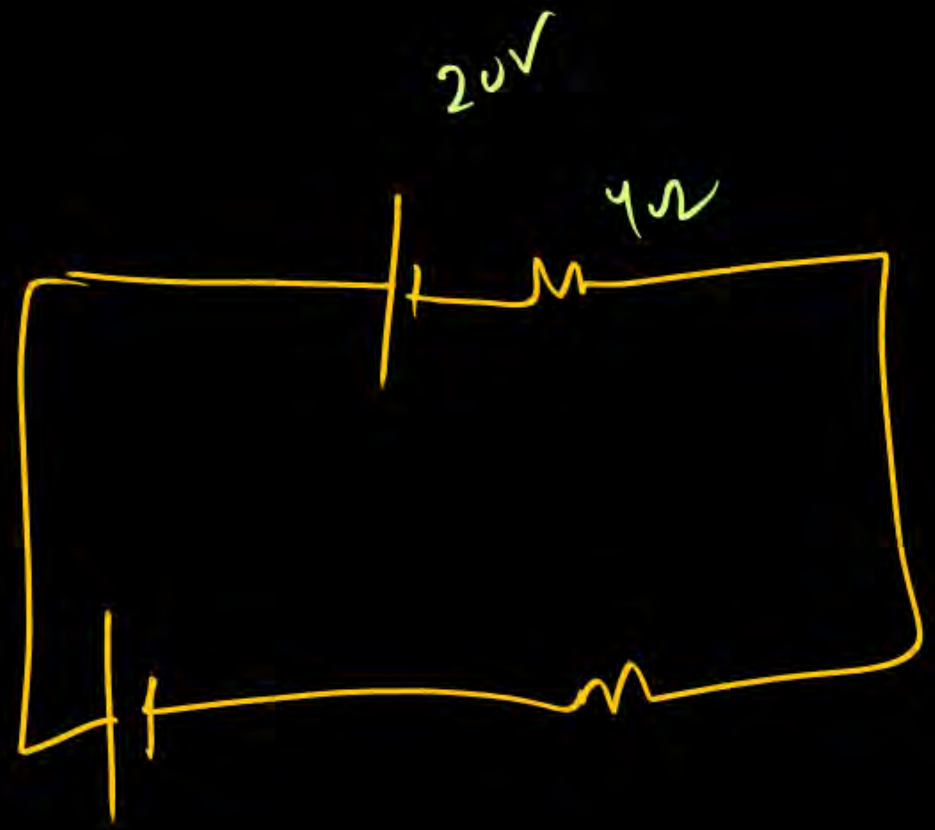


I = zero

Ay



10V
5Ω
4Ω
x
y
I
20V
10Ω



20V
4Ω

THANK YOU



YAKEEN 2.0

FOR NEET 2025

Lecture- 6 | Physics

Current Electricity



By- Dr. Manish Raj (MR SIR)

Todays Topic

PhD. Combination of cell.

$$\alpha = \left(\frac{\Delta R}{R\,\Delta T}\right)$$

$\alpha = 0.000125$ per °C

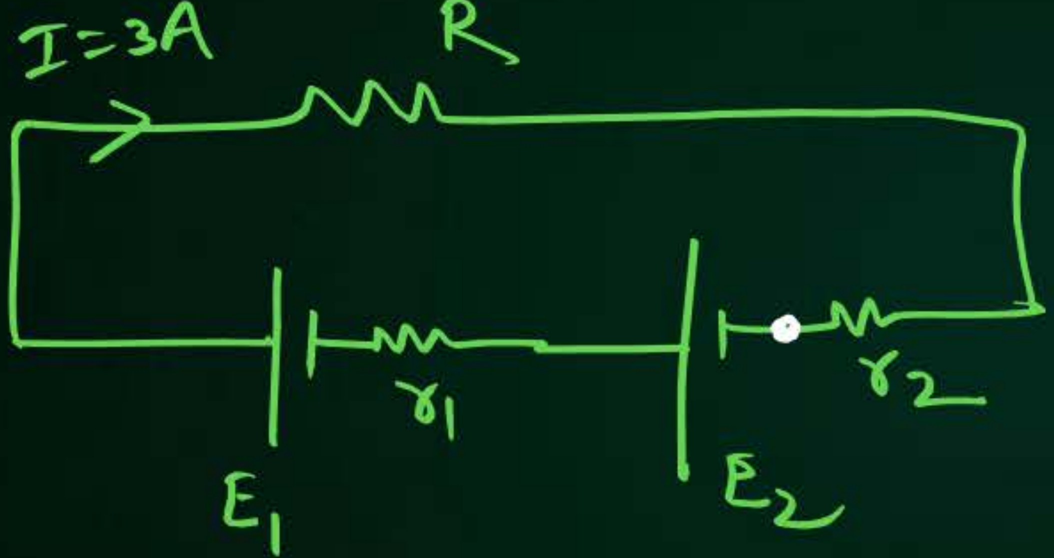
$T_1 = 300K \rightarrow 1\,\Omega$

$T_2 = ?$ $2\,\Omega$

QUESTION

Two batteries of different e.m.f.'s and internal resistance connected in series with each other and with an external load resistor. The current is 3.0 A. When the polarity of on battery is reversed, the current becomes 1.0. A. The ratio of the e.m.f.'s of the two batteries is

1. 2.5
2. 2
3. 1.5
4. 1



$$I = \frac{E_1 + E_2}{R + r_1 + r_2}$$

$$\frac{E_1 + E_2 = 3(R + r_1 + r_2)}{E_1 - E_2 = 1(R + r_1 + r_2)}$$



$$I_2 = \frac{E_1 - E_2}{R + r_1 + r_2}$$

$$\frac{E_1 + E_2}{E_1 - E_2} = \frac{3}{1}$$

$E_1 + E_2 = 3E_1 - 3E_2$

$3E_2 + E_2 = 3E_1 - E_1$

$4E_2 = 2E_1$

$\frac{E_1}{E_2} = \frac{4}{2} = 2/1$

$\frac{E_1}{E_2} = \frac{3+1}{3-1} = \frac{4}{2} = \frac{2}{1}$

QUESTION

Thousand cells of same emf E and same internal resistance r are connected in series in same order without as external resistance. The potential drop across 399 cells is found to be

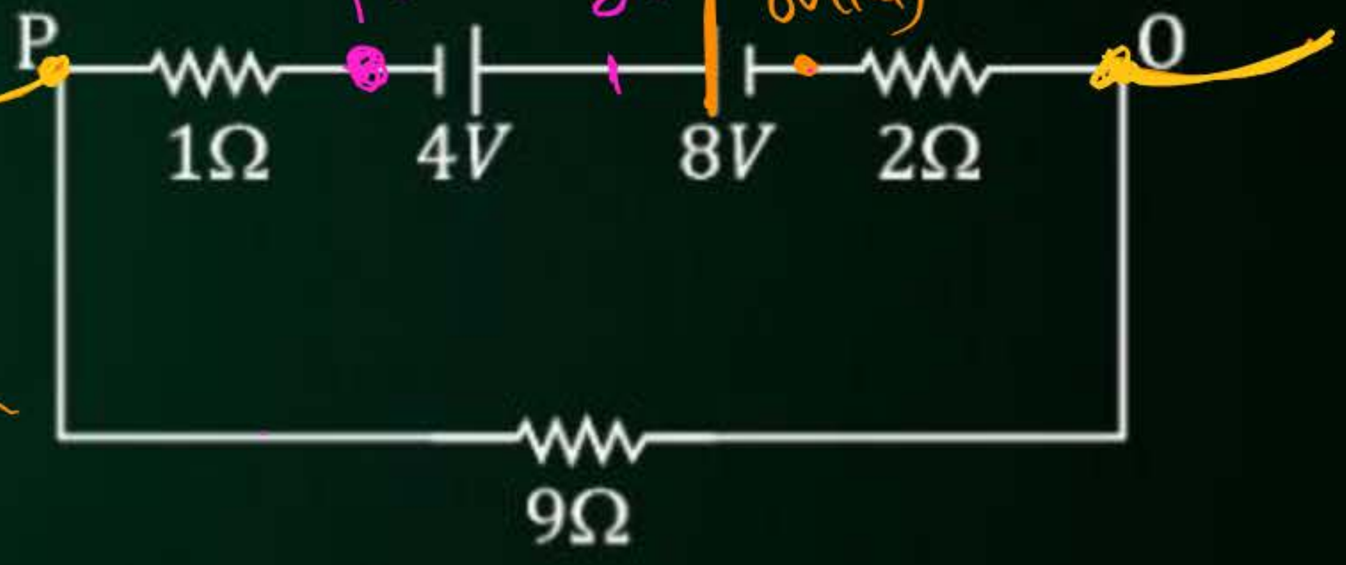
1. Zero
2. 399 E
3. 601 E
4. 1000 E

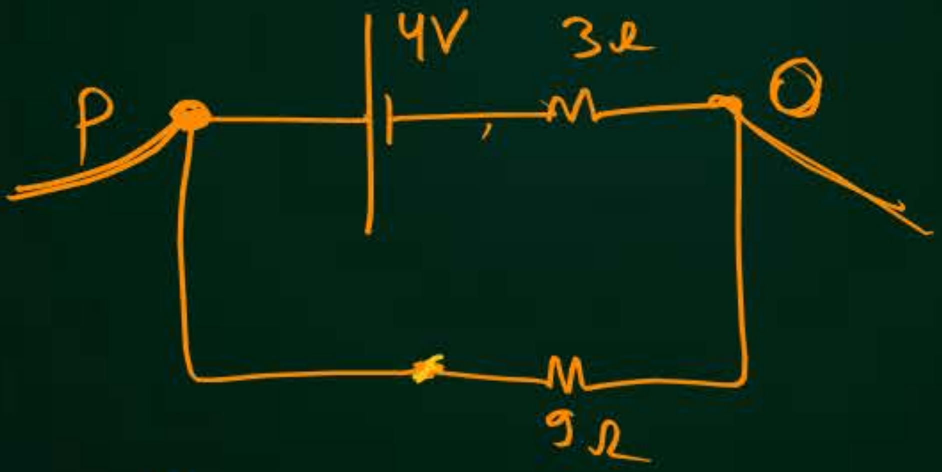


QUESTION

Two batteries of emf $4V$ and $8V$ having the internal resistance of 1Ω and $2\ \Omega$ respectively are connected in circuit with a resistance of $9\ \Omega$ as shown in figure. The current and potential difference between the points P and Q are

1. $\frac{1}{2}$ A and 12 V
2. $\frac{1}{9}$ A and 9 V
3. $\frac{1}{6}$ A and 4V
4. $\frac{1}{3}$ A and 3V





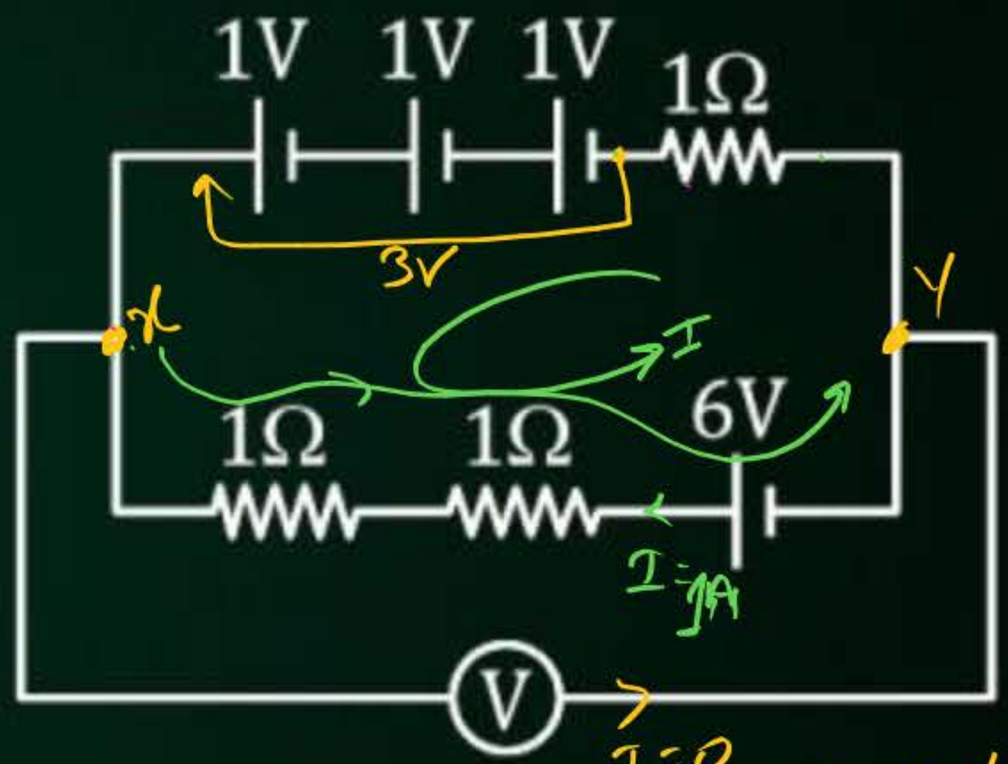
$$V_{PQ} = \frac{\frac{4}{3}+\frac{0}{9}}{\frac{1}{3}+\frac{1}{9}} = \frac{\frac{4}{3}}{\frac{3+1}{9}} = \frac{4}{3}\times\frac{9}{4} = 3 \text{ volt}$$

QUESTION

Reading of an ideal voltmeter in the circuit below is

1. zero
2. 2 V
3. 4 V
4. 6 V

$V_{xy} = \dfrac{\frac{3}{1} + \frac{6}{2}}{\frac{1}{1} + \frac{1}{2}} = \dfrac{6}{3/2} = 4\text{ volt}$



I = 0

Ideal voltmeter (R = infinite)

2nd method

$I = \dfrac{3V}{3} = 1A$

$V_x + 2\times1 - 6 = V_y$ $\quad V_x - V_y = 6 - 2 = +4\text{ volt}$

QUESTION

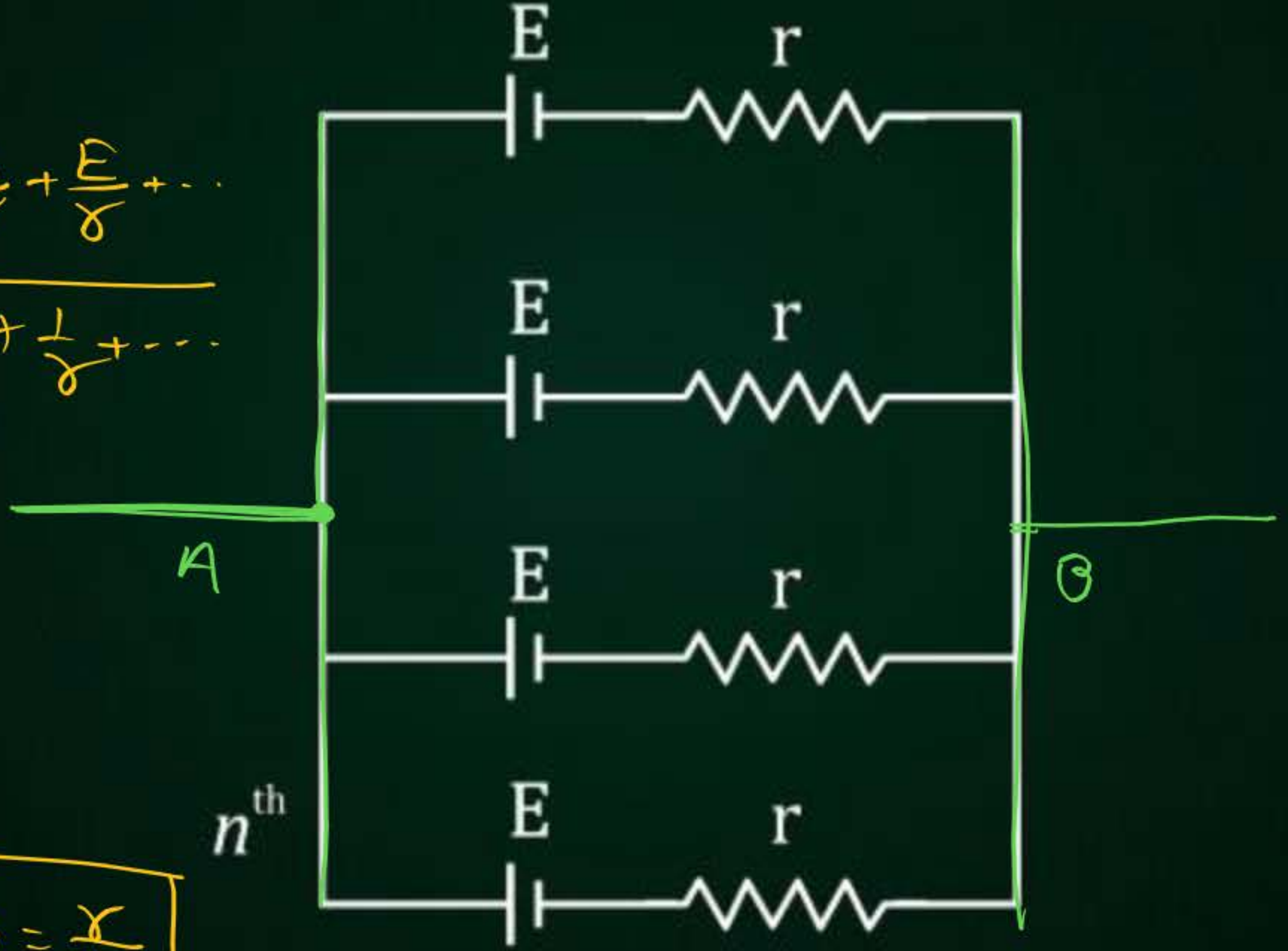
If n-identical battery (E, r) connected in a parallel, then find equivalent emf.

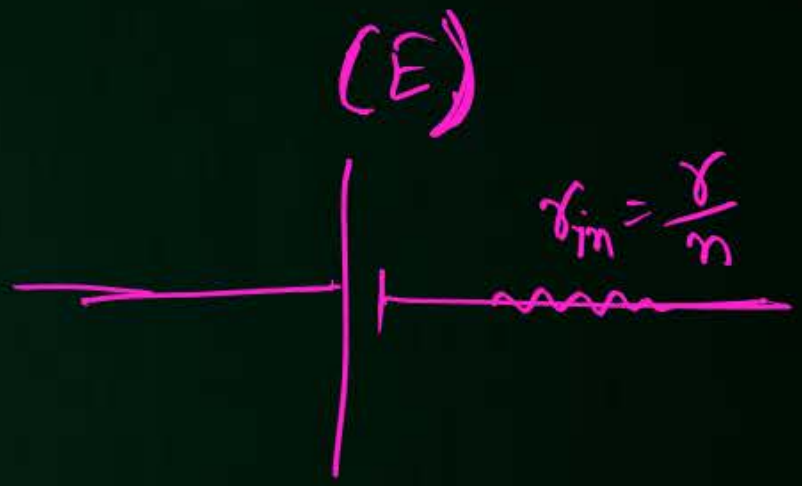
$$(emf)_{AB} = \frac{\frac{E}{r} + \frac{E}{r} + \frac{E}{r} + \frac{E}{r} + \cdots}{\frac{1}{r} + \frac{1}{r} + \frac{1}{r} + \frac{1}{r} + \cdots}$$

$$= \frac{\frac{nE}{r}}{\frac{n}{r}}$$

$$(emf)_{eq} = E$$

$$r_{eq} = \frac{r}{n}$$





QUESTION

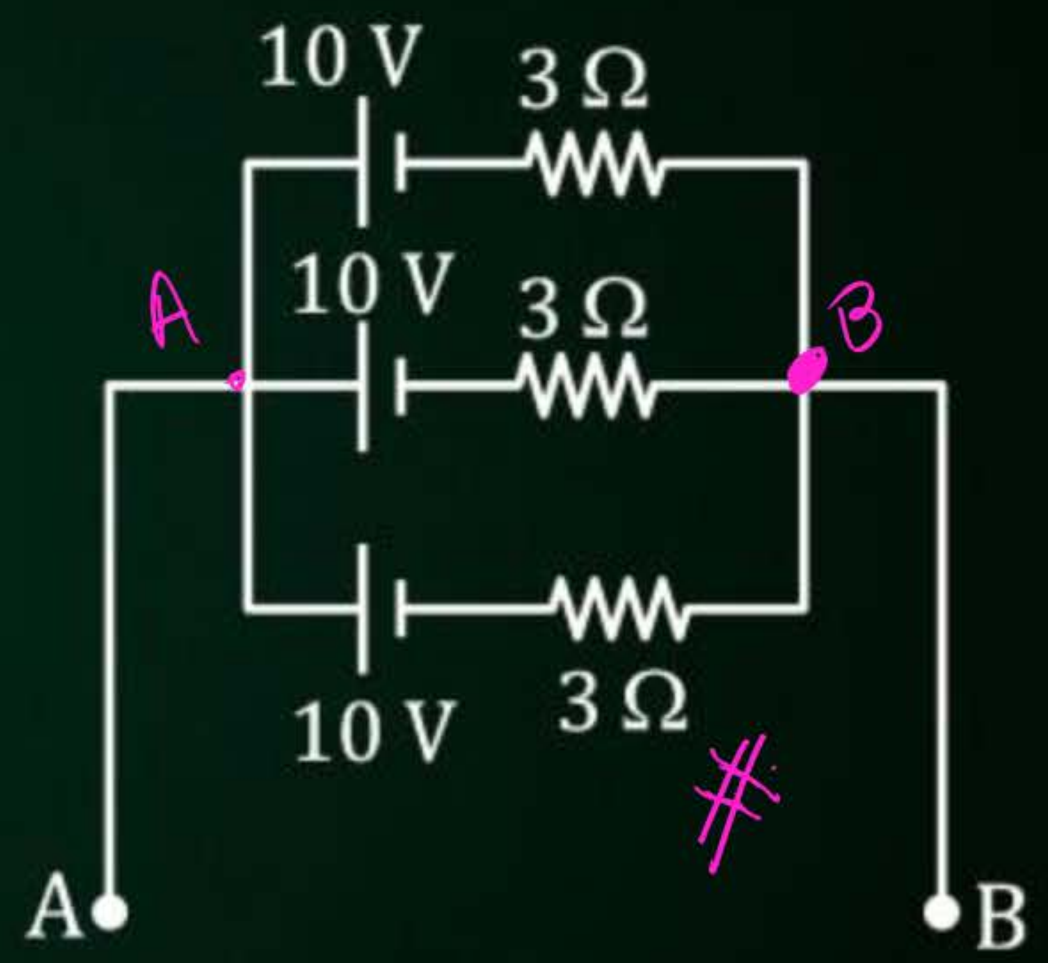
Three identical cells are connected in parallel across AB. Net emf across AB is

(1) 10 V // (Ans)

(2) 30 V

(3) 15 V

(4) 12 V



$$(emf)_{eq} = \frac{\frac{10}{3} + \frac{10}{3} + \frac{10}{3}}{\frac{1}{3} + \frac{1}{3} + \frac{1}{3}}$$

$$= \frac{10\left(\frac{1}{3} + \frac{1}{3} + \frac{1}{3}\right)}{\left(\frac{1}{3} + \frac{1}{3} + \frac{1}{3}\right)}$$

$$= 10 \text{ volt}$$

QUESTION

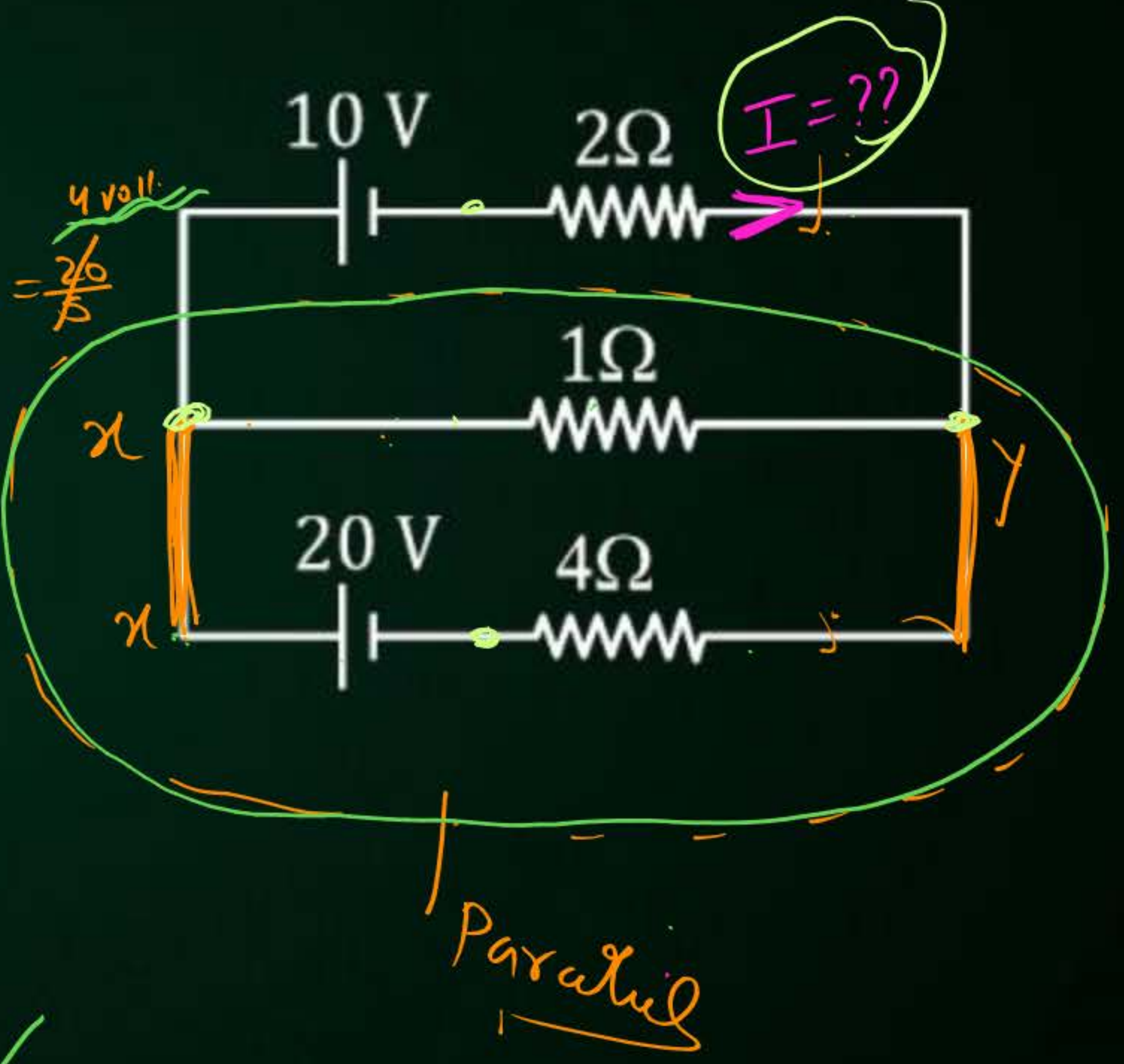
The value of current through 2 Ω resistor is

(1) 1.0 A

(2) 1.5 A

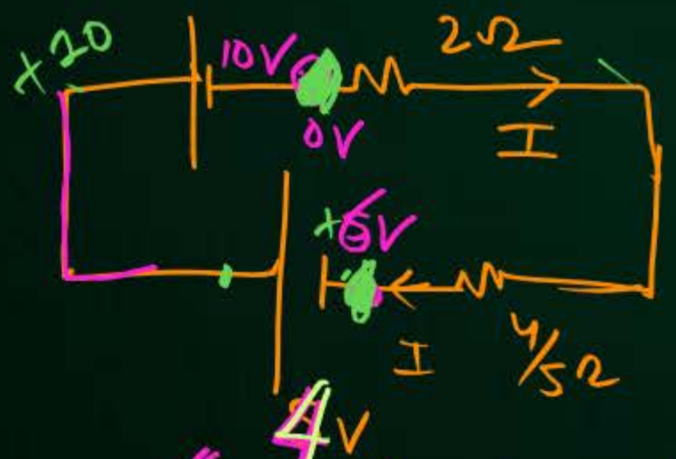
(3) 5.0 A

(4) 2.1 A



$$\text{emf}_{eq} = \frac{\frac{0}{1} + \frac{20}{4}}{\frac{1}{1} + \frac{1}{4}} = \frac{\frac{20}{4}}{\frac{5}{4}} = 4 \text{ volt}$$

$$r_{eq} = \frac{4}{5}\,\Omega$$



$$I = \frac{6}{2+\frac{4}{5}} = \frac{6}{\frac{14}{5}} = \frac{30}{14} = 2.1 \text{ Amp}$$

QUESTION

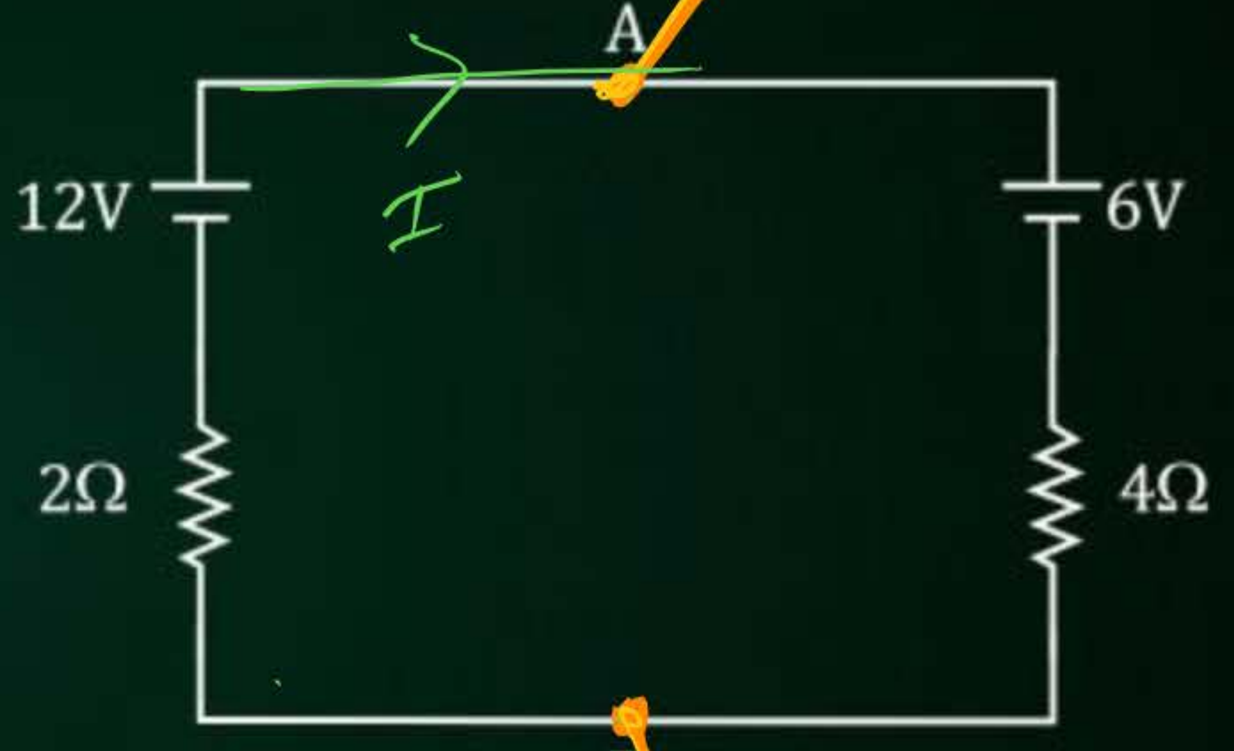
Potential difference across AB *i.e.*, $V_A - V_B$ is =??

(1) 10 V

(2) 8 V

(3) 6 V

(4) Zero

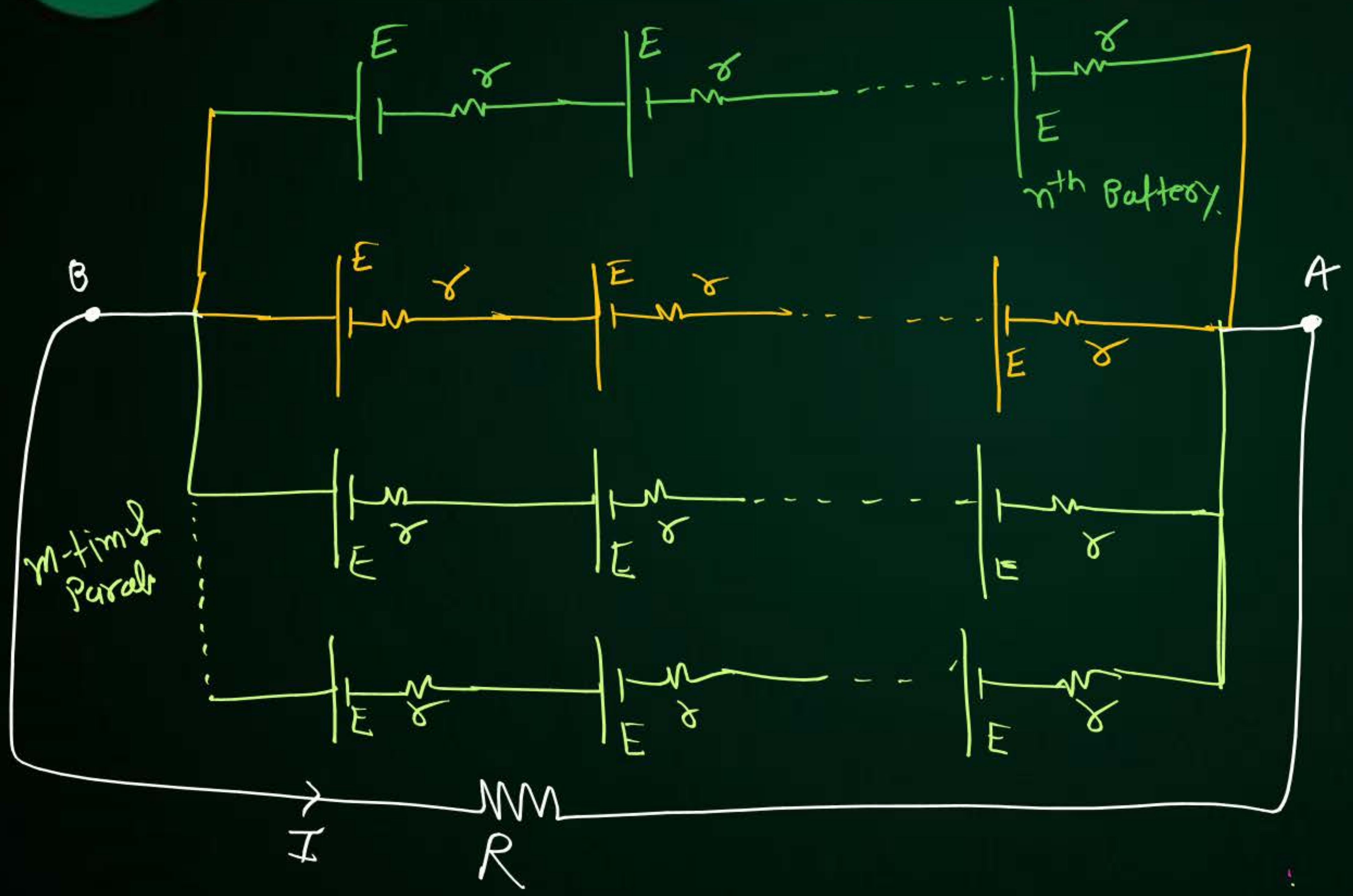


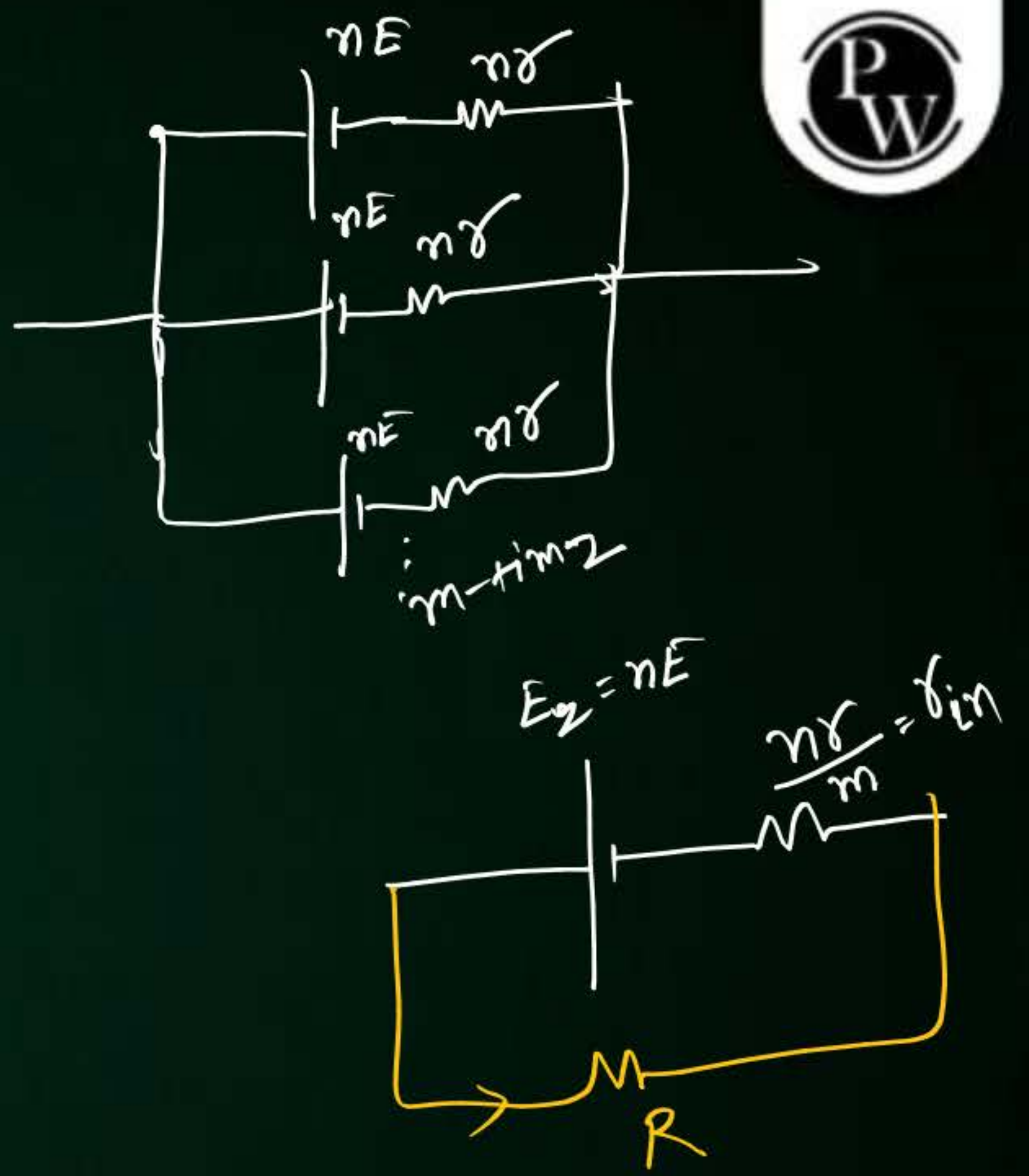
$$V_A - V_B = \frac{\frac{12V}{2} + \frac{6V}{4}}{\frac{1}{2} + \frac{1}{4}}$$

$$= \frac{\frac{24+6}{4}}{\frac{2+1}{4}}$$

$$= \frac{30}{3} = 10V$$

Mixed Combination of Cell





$$I = \frac{nE}{\frac{nr}{m} + R} = \frac{nmE}{nr + mR}$$

Ans

QUESTION

NEET

If the galvanometer G does not show any deflection in the circuit shown, the value of R is given by:

1. 400 Ω
2. 200 Ω
3. 50 Ω
4. 100 Ω

Ans

V_{xy} = same

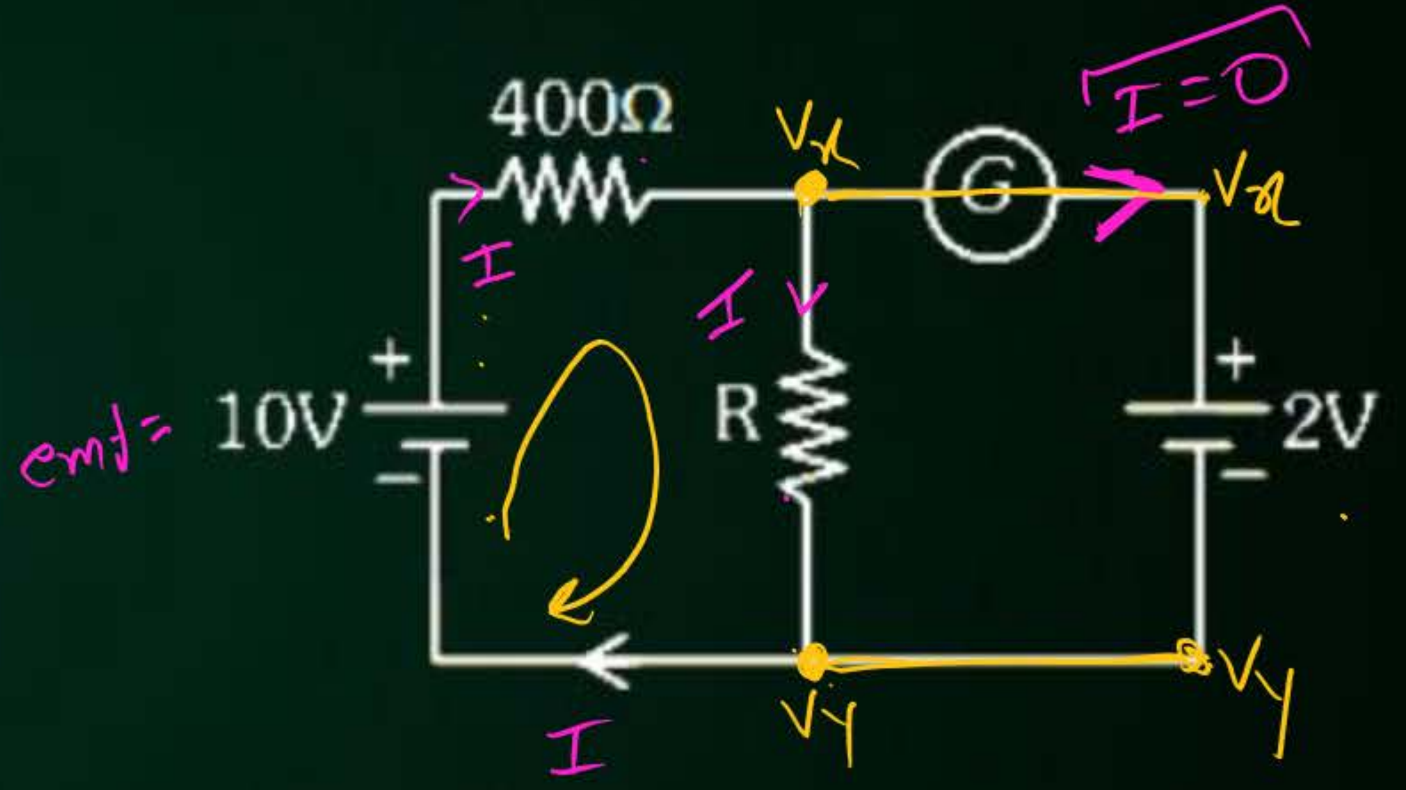
$2V = IR$

$2 = \frac{10}{400+R} R$

$400 + R = 5R$

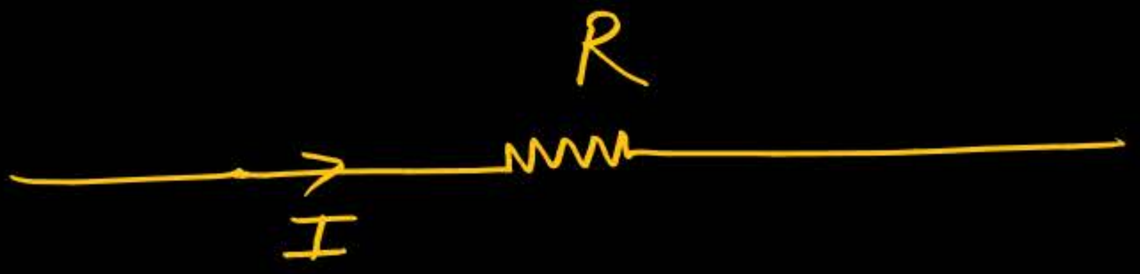
$400 = 5R - R = 4R$

$R = 100\Omega$ Ans



$I = \frac{10}{400+R}$ — (1)

Joules Law of Heating effect



$I = cost^n$

$H \propto I^2$

$H \propto R$

$H \propto t$

$H = I^2 R t$

→ Scalar
→ Joule

$I = \text{variable}$

$dH = I^2 R\, dt$

$\int dH = \int I^2 R\, dt$

$$H = R \int_0^t I^2\, dt$$

#

Heat loss Per-sec

$\text{Power} = \frac{H}{t}$ — ($I = cost$)

$P = \frac{I^2 R t}{t} = I^2 R$

$J/sec = \text{watt}$

→ Scalar

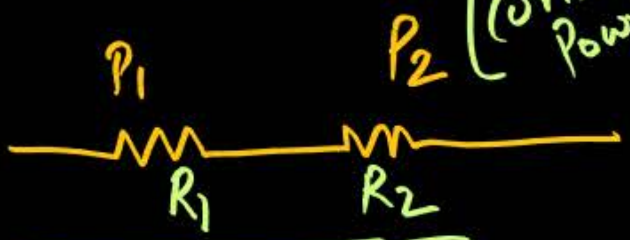
$I = \text{variable}$

$P = \frac{dH}{dt}$

$P = \frac{I^2 R\, dt}{dt}$

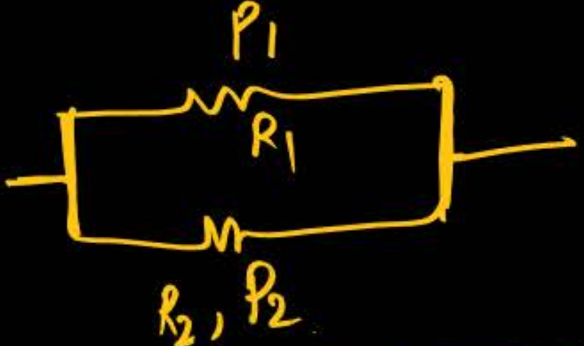
$P = I^2 R$

$\int dH = \int P\, dt$



$P_{total} = P_1 + P_2$

consume (add)



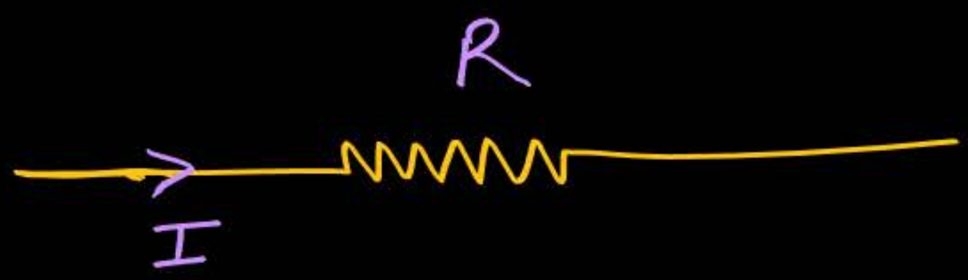
$P_{total} = P_1 + P_2$

→ Power consumed

electricity Bill में Kis Baat Ka Paisa dete hai??

(a) Power (b) Current
✓(c) Energy (d) voltage
(100%)

$|\leftarrow V = IR \rightarrow|$



$$P = I^2 R$$

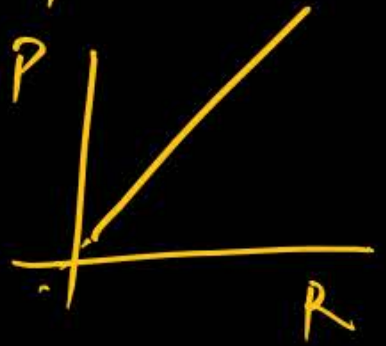
$$P = \frac{V^2}{R^2} R$$

$$P = \frac{V^2}{R}$$

$$P = I \frac{V}{R} \times R = IV$$

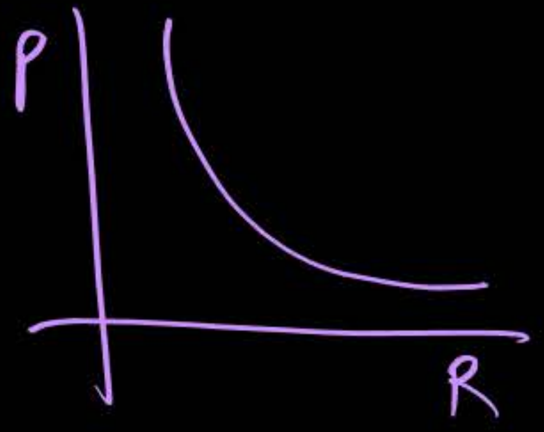
I = same → Series combination

$P \propto R$



V = same (Parallel combn)

$P \propto \frac{1}{R}$

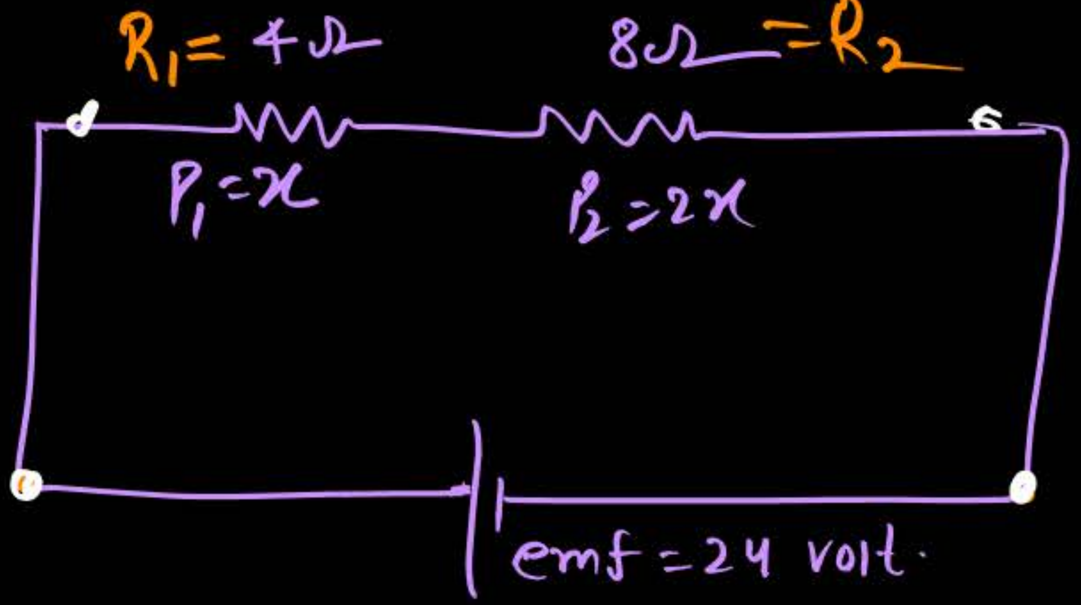


$H = P \times t$

$I = const^n$

I = varia.

$dH = P\,dt$



Sol^n

method - 1

$R_{eq} = 8 + 4$
$= 12\,\Omega$

$I = \frac{24}{12} = 2\text{ Amp}$

Power $= I^2 R_{eq} = (2)^2 \times 12 = 4 \times 12 = 48\,W$

$P_{R_1} = I^2 R_1 = (2)^2 \times 4 = 16\,W$

$P_{R_2} = I^2 R_2 = (2)^2 \times 8 = 32\,W$

method - 2

$R_{eq} = 12\,\Omega$
emf = 24 volt

$P = \frac{V^2}{R_{eq}}$

$P_{net} = \frac{(24)^2}{12} = \frac{24 \times 24}{12}$
$= 48\,W$

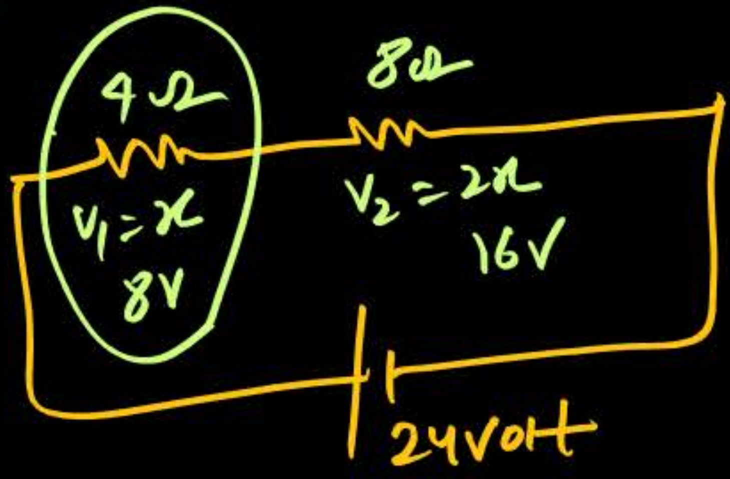
Power ka sum
$2x + x = 3x = 48$

$x = 16\,W$ → on 4Ω

$2x = 32\,W$

Power loss in each resistor & in total circuit

method - 3



$x + 2x = 24$ volt
$x = 8$ volt

$P_1 = \frac{(8V)^2}{4} = \frac{64}{4} = 16\,W$

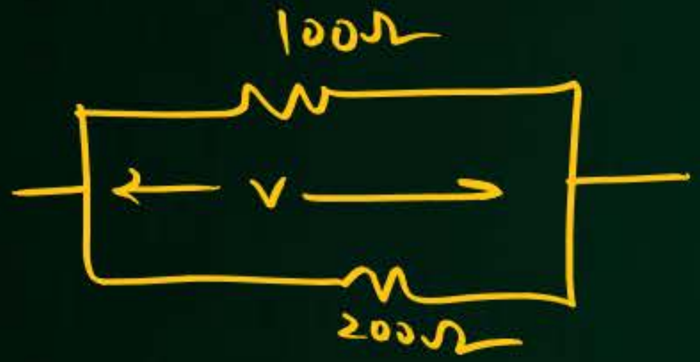
$P_2 = \frac{(16)^2}{8} = \frac{16 \times 16}{8} = 32\,W$

$P_{net} = P_1 + P_2 = 16 + 32$
$= 48\,W$

QUESTION

Two resistors of resistance, 100Ω and 200Ω are connected in parallel in an electrical circuit. The ratio of the thermal energy developed in 100Ω to that in 200Ω in a given time is

1. 1 : 2
2. 2 : 1 (Ans)
3. 1 : 4
4. 4 : 1



$$\frac{H_1 = \frac{V^2}{R_1} t}{H_2 = \frac{V^2}{R_2} t} = \frac{R_2}{R_1} = \frac{200}{100}$$

QUESTION

The charge flowing through a resistance R varies with time t as $Q = \text{at}\ bt^2$, where a and b are positive constants. The total heat produced in R is

1. $\frac{a^3R}{2b}$
2. $\frac{a^3R}{b}$
3. $\frac{a^3R}{6b}$
4. $\frac{a^3R}{3b}$

QUESTION

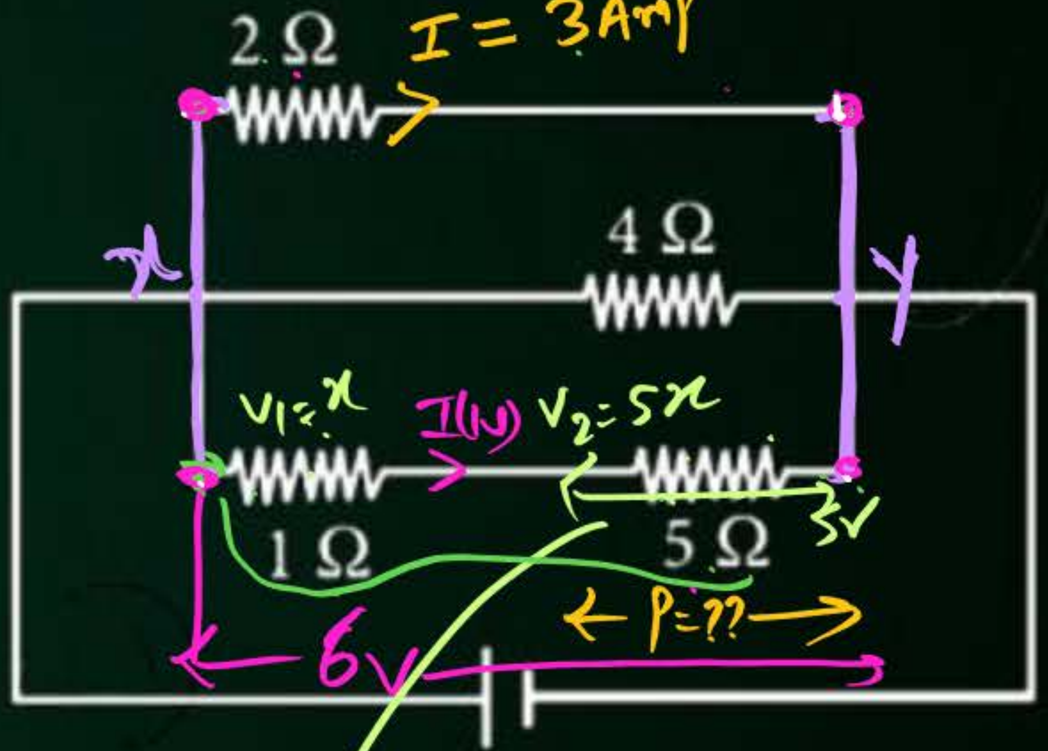
One kilowatt hour is equal to (1997)

1. 36×10^{-5} J
2. 36×10^{-4} J
3. 36×10^{5} J
4. 36×10^{3} J

QUESTION

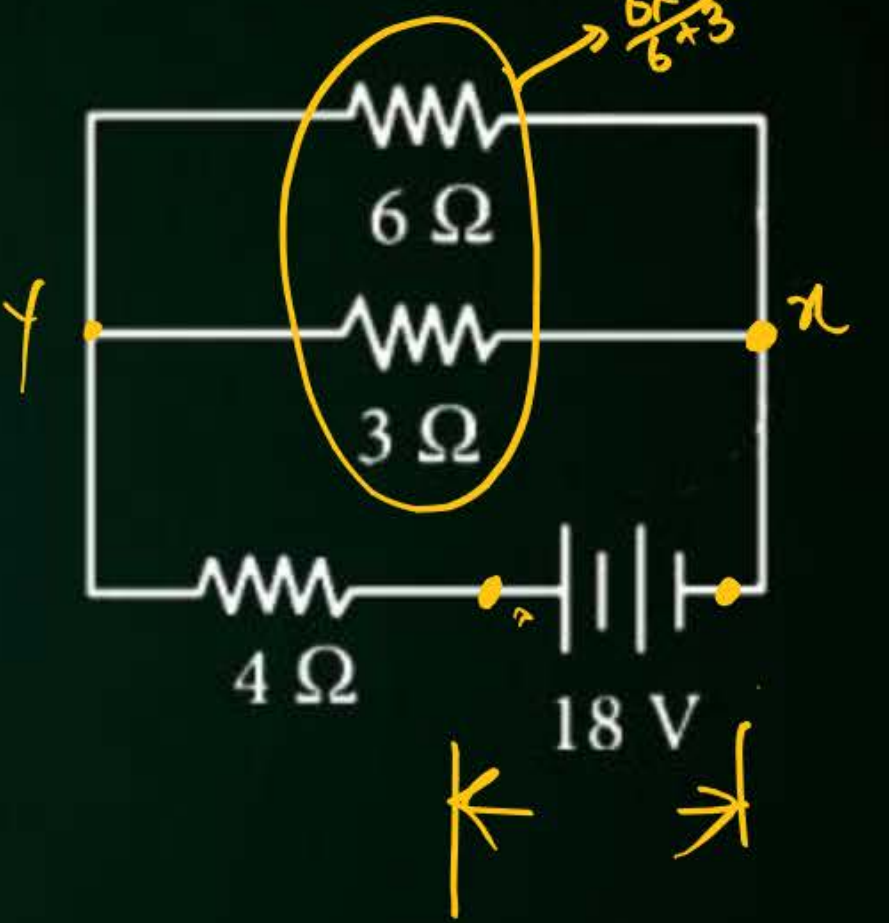
A current of 3 amp. flows through the 2Ω resistor shown in the circuit. The power dissipated in the 5Ω resistor is (2008)

1. 1 watt
2. 5 watt
3. 4 watt
4. 2 watt



QUESTION

The total power dissipated in watt in the circuit shown here is (2007)

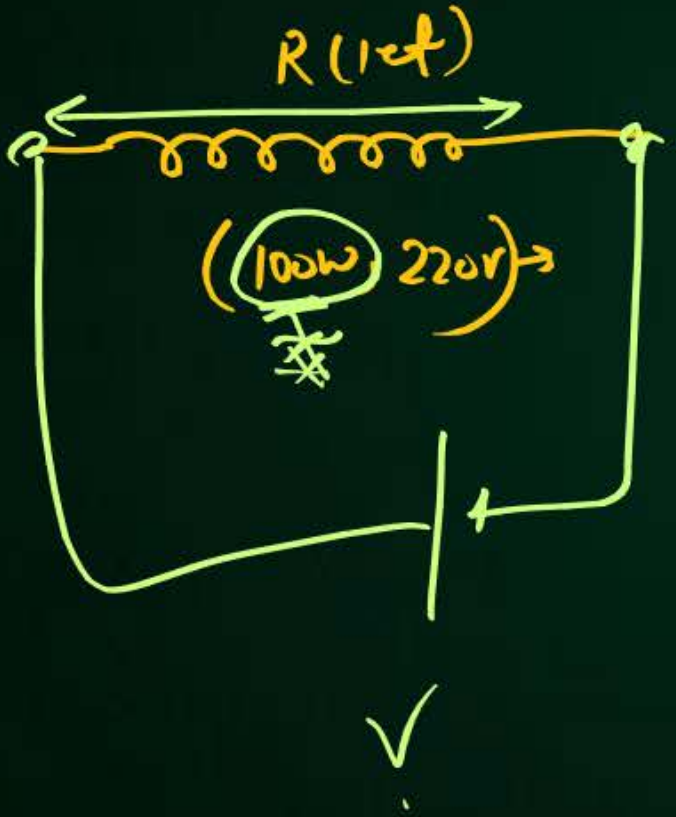


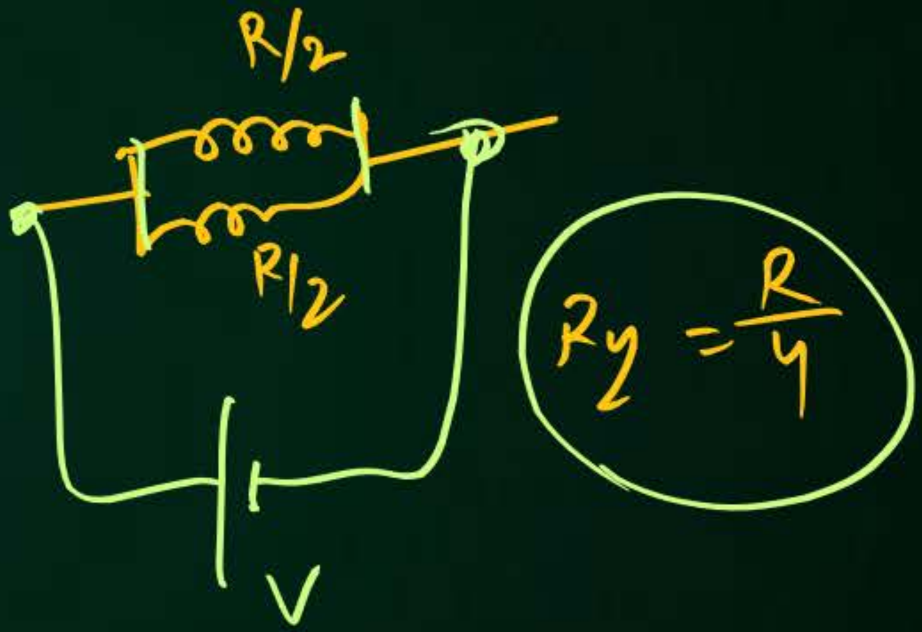
1. 40
2. 54
3. 4
4. 16

QUESTION

A heating coil is labelled 100 W, 220 V. The coil is cut in half and the two pieces are joined in parallel to the same source. The energy now liberated per second is **(1995)**

1. 200 W
2. 400 W
3. 25 W
4. 50 W





$P_0 = \frac{V^2}{R}$

BulB → Pure Resistance

Resistance of BulB

$$P_R = \frac{V_R^2}{R_{Bulb}}$$

$$R_{Bulb} = \left\{ \frac{V_R^2}{P_{Rated}} \right\}$$



BulB

(100W, 220V)

(P_{Rated}, V_{Rated})

Max^n Power Consumed.

Max^m Voltage than Can be Supply to Bulb.

U.S.A



BulB

($V_{supl} = 110V$, $P_{Con} = ??$)

(100W, 220V)

$$\# \; P_{Consumed} = \frac{V_{sup}^2}{R_{Bulb}}$$

$$P_{Consumed} = \frac{V_S^2}{V_R^2} \times P_{Rat.} = \frac{V_{supp}^2}{V_{Rate}^2} P_{Rate}$$

$$\# \; P_{Con} = \left(\frac{110}{220}\right)^2 \times 100W = 25 \text{ watt}$$

QUESTION

In India electricity is supplied for domestic use at 220 V. It is supplied at 110 V in USA. If the resistance of a 60 W bulb for use in India is R, the resistance of a 60W bulb for use in USA will be **(2004)**

1. R
2. 2R
3. R/4 ✓
4. R/2

$$R_{Bulb} = \frac{V_R^2}{P_{Rated}}$$

$$R = \frac{(220)^2}{60W} \quad \leftarrow \text{INDIA}$$

$$R' = \frac{(110V)^2}{60W} \quad \leftarrow \text{USA}$$

$$\frac{R}{R'} = (2)^2$$

$$R' = \frac{R}{4}$$

QUESTION

Two bulbs are of (40 W, 200 V), and (100 W, 200 V). Then correct relation for their resistances is (2000)

↓ $R_{bulb} \propto \frac{1}{Power}$ ↑

1. $R_{40} < R_{100}$
2. $R_{40} > R_{100}$
3. $R_{40} = R_{100}$
4. no relation can be predicted.

QUESTION

An electric bulb is rated 60 W, 220 V. The resistance of its filament is (1994)

1. 870Ω
2. 780Ω
3. 708Ω
4. 807Ω

$$R = \frac{V_R^2}{P_{Rated}}$$

QUESTION

A (100 W, 200 V) bulb is connected to a 160 volts supply. The power consumption would be (1997)

1. 100 W
2. 125 W
3. 64 W ✓
4. 80 W

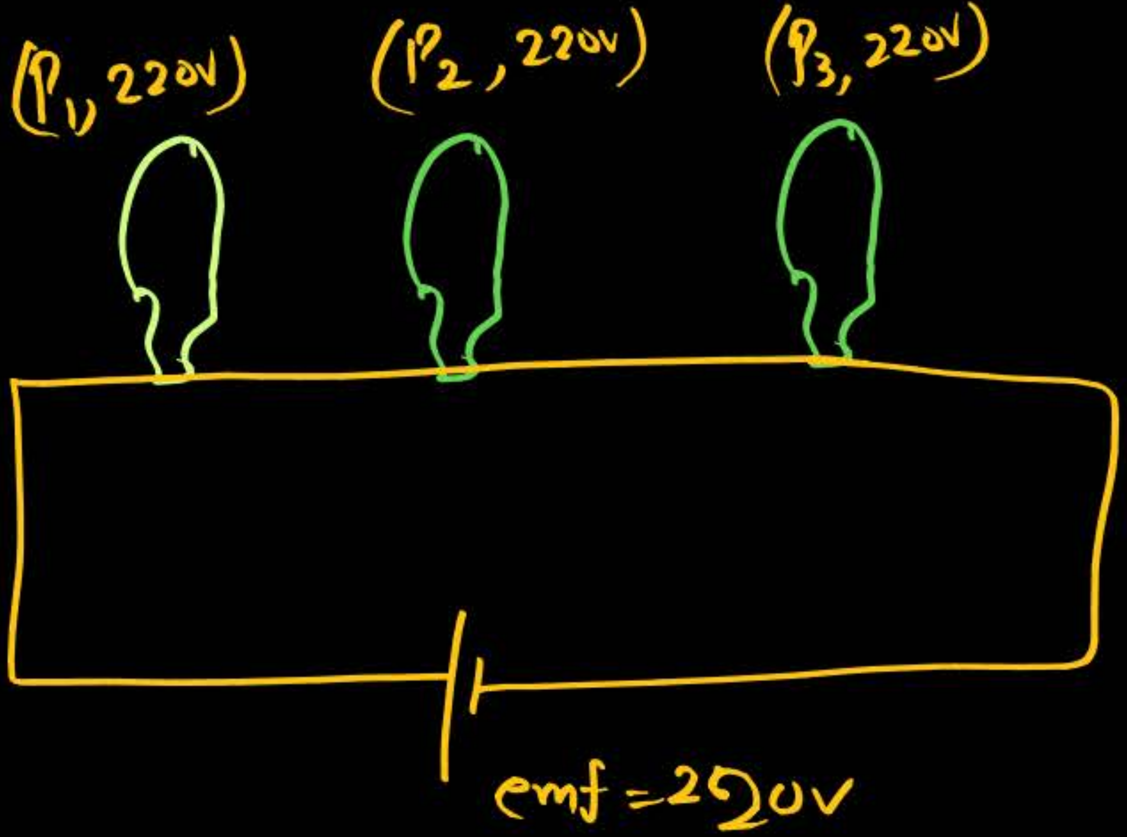
$$P_{Con} = \frac{V_S^2}{R_{Bulb}}$$

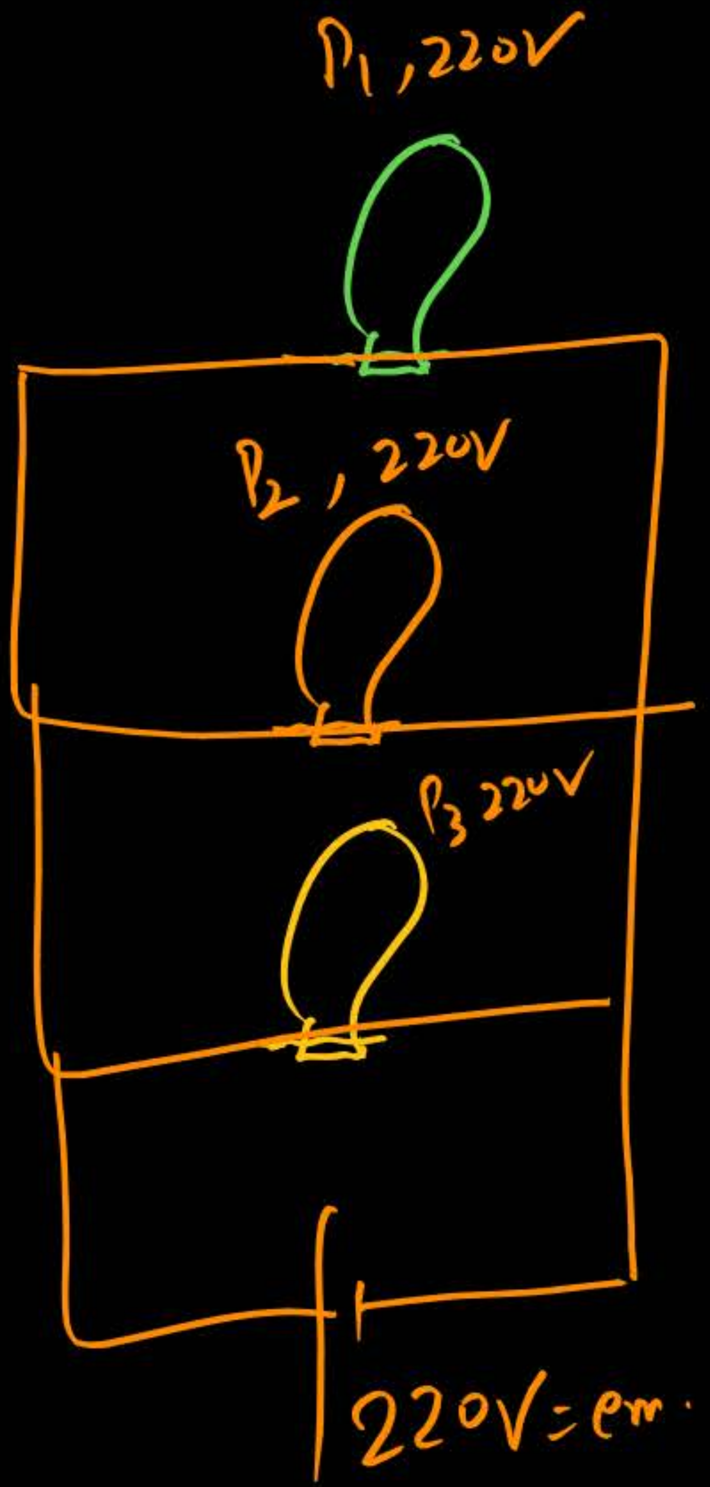
$$P_{consu} = \frac{V_S^2}{V_R^2} \times P_{Rate}$$

$$= \left(\frac{160}{200}\right)^2 \times 100\,W$$

$$= \left(\frac{4}{5}\right)^2 \times 100 = \frac{16 \times 100}{25} = 64\,W$$

Series comb^{n} of Bulb





QUESTION

If voltage across a bulb rated 220 volt- 100 watt drops by 2.5% of its rated value, the percentage of the rated value by which the power would decrease is (1995)

1. 20%
2. 2.5%
3. 5%
4. 10%

QUESTION

A 5 ampere fuse wire can withstand a maximum power of 1 watt in the circuit. The resistance of the fuse wire is (2005)

1. 0.04 ohm
2. 0.2 ohm
3. 5 ohm
4. 0.4 ohm

QUESTION

A 5° C rise in temperature is observed in a conductor by passing a current. When the current is doubled the rise in temperature will be approximately (1998)

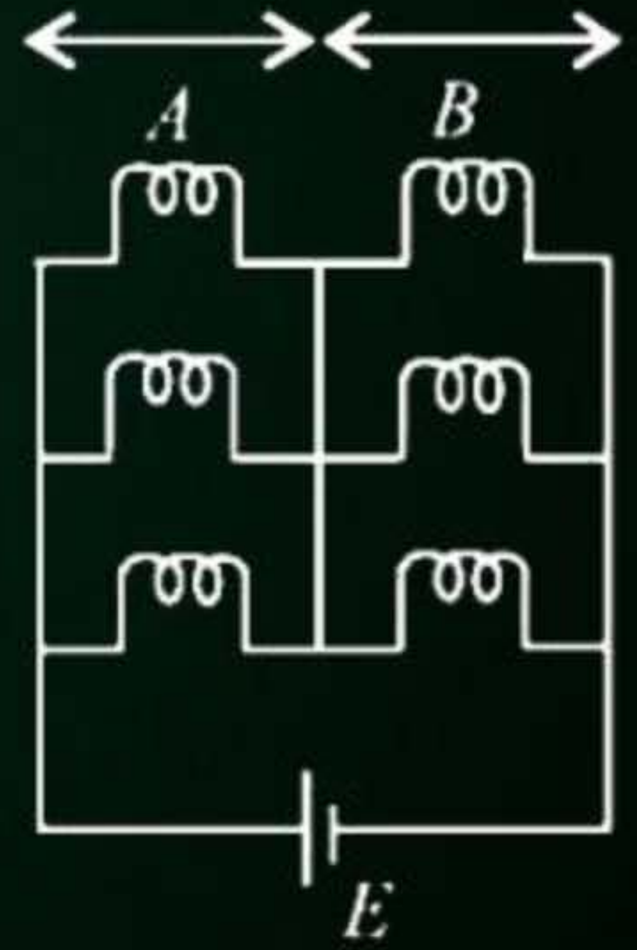
1. 20°C
2. 16°C
3. 10°C
4. 12°C

QUESTION

Six similar bulbs are connected as shown in the figure with a DC source of emf E, and zero internal resistance. The ratio of power consumption by the bulbs when (i) all are glowing and (ii) in the situation when two from section A and one from section B are glowing, will be

(NEET 2019)

1. 2 : 1
2. 4 : 9
3. 9 : 4
4. 1 : 2



QUESTION

A filament bulb (500 W, 100 V) is to be used in a 230 V main supply. When a resistance R is connected in series, it works perfectly and the bulb consumes 500 W. The value of R is

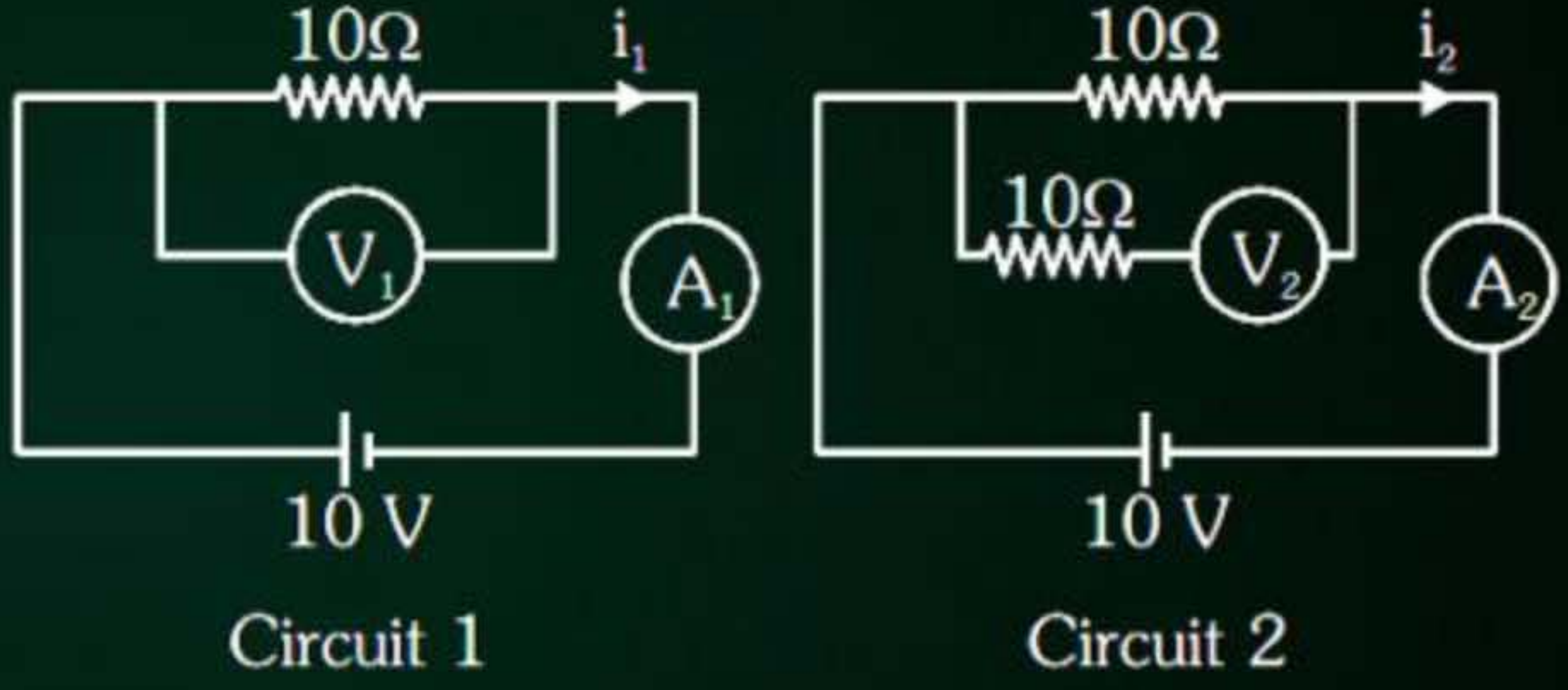
(NEET-II 2016)

1. 230Ω
2. 46Ω
3. 26Ω
4. 13Ω

QUESTION

In the circuits shown below, the readings of the voltmeters and the ammeters will be:

1. $V_2 > V_1$ and $i_1 = i_2$
2. $V_1 = V_2$ and $i_1 > i_2$
3. $V_1 = V_2$ and $i_1 = i_2$
4. $V_2 > V_1$ and $i_1 > i_2$




THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 7 | Physics

Current Electricity

By- Dr. Manish Raj (MR SIR)



Topics to be covered

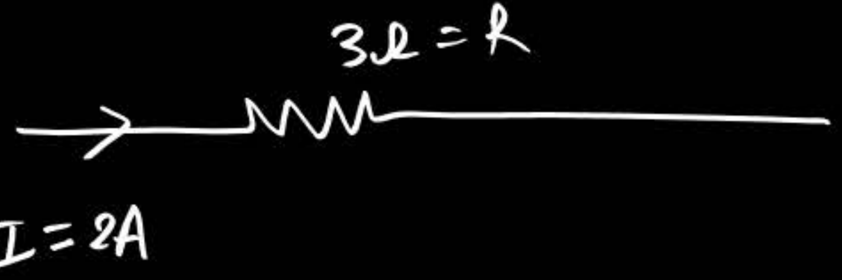


1. # → Max^m Power theorem
   → Combination of Bulb
2. # Questions on Power
3. # $P = IV = I^2R = V^2/R$

$H = Pt = IVt = I^2Rt = \frac{V^2}{R}t$.



find Heat loss in 2-sec in each resistance



$H = I^2 R t$

$= (2)^2 \times 3 \times 2$

$= 4 \times 3 \times 2$

$H = 24\,J$



$H = I^2 R t$ ✗

$\int dH = \int (2t)^2 R \, dt$

$H = \int 4t^2 \times 3 \, dt$

$= 12 \int_0^2 t^2 \, dt$

$= 12 \left[\frac{t^3}{3} \right]_0^2$ (12/3 cancelled to 4)

$= 4 \left[2^3 - 0^3 \right] = 32$ Joule

find heat loss in circuit when key is open and close in time 't'.

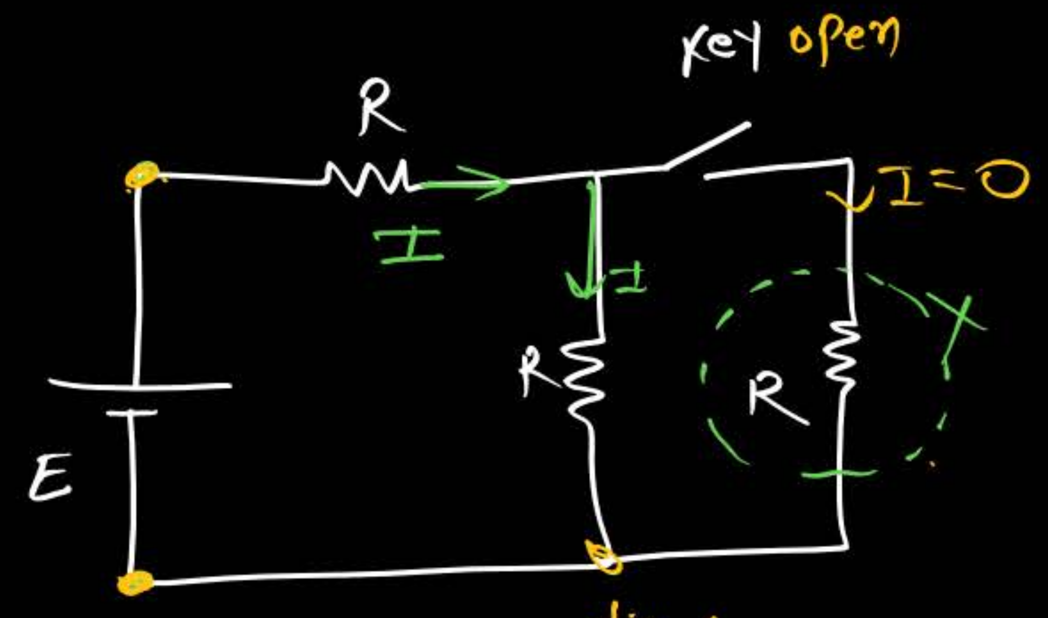


fig-1

$R_{eq} = 2R$ *

$I = \frac{E}{2R}$

$H_1 = I^2 R_{eq} t = \left(\frac{E}{2R}\right)^2 \times 2R\, t$

$= \frac{E^2}{4R^2} \times 2R\, t = \frac{E^2}{2R} t$

$H_1 = \frac{V^2}{(R_{eq})} t = \frac{E^2 t}{2R}$

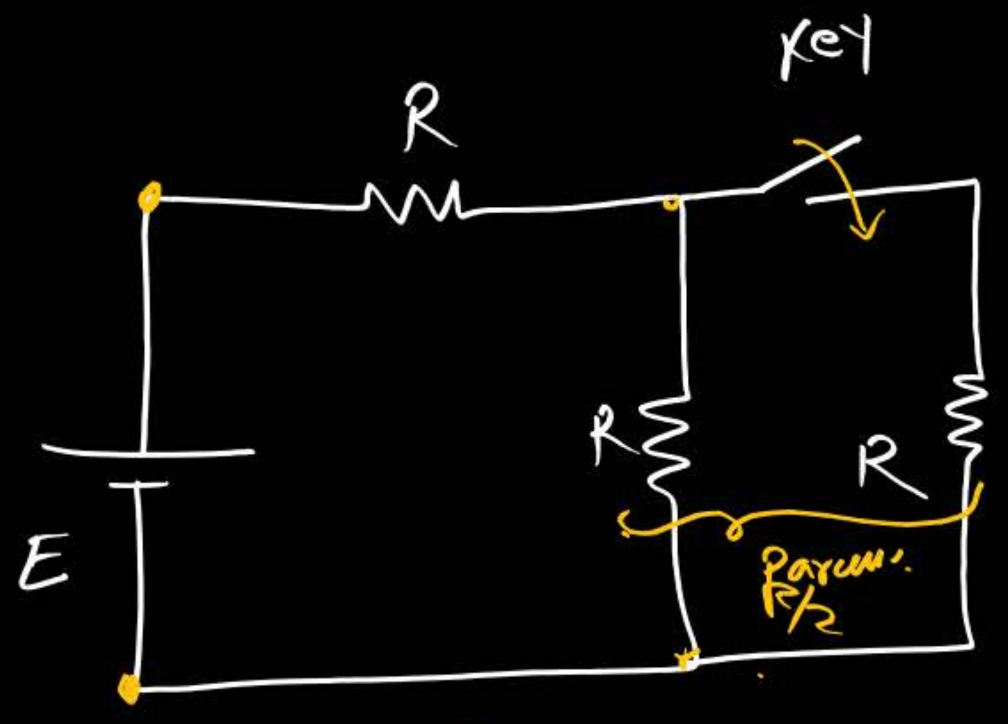


fig-2

$R_{eq} = R + \frac{R}{2} = \left(\frac{3R}{2}\right)$ *

$H_2 = \frac{E^2}{\left(\frac{3R}{2}\right)} t$

$H_1 < H_2$

IIT-2008 Adv

Total Power loss in circuit

fig-1

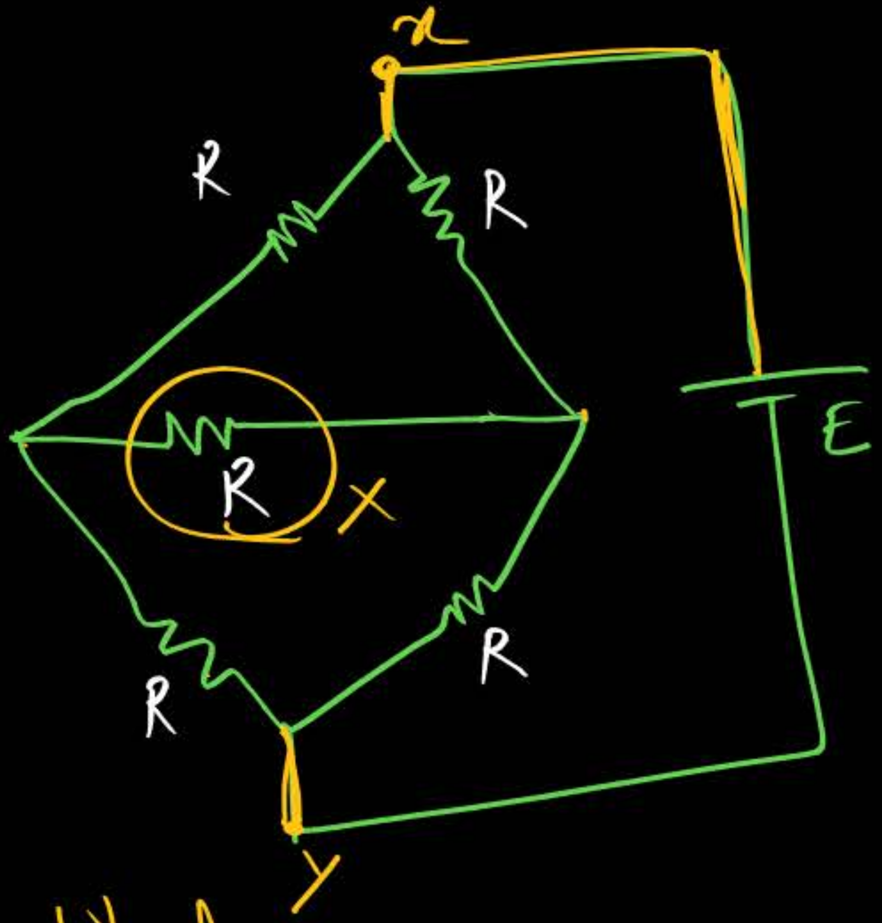


fig-2

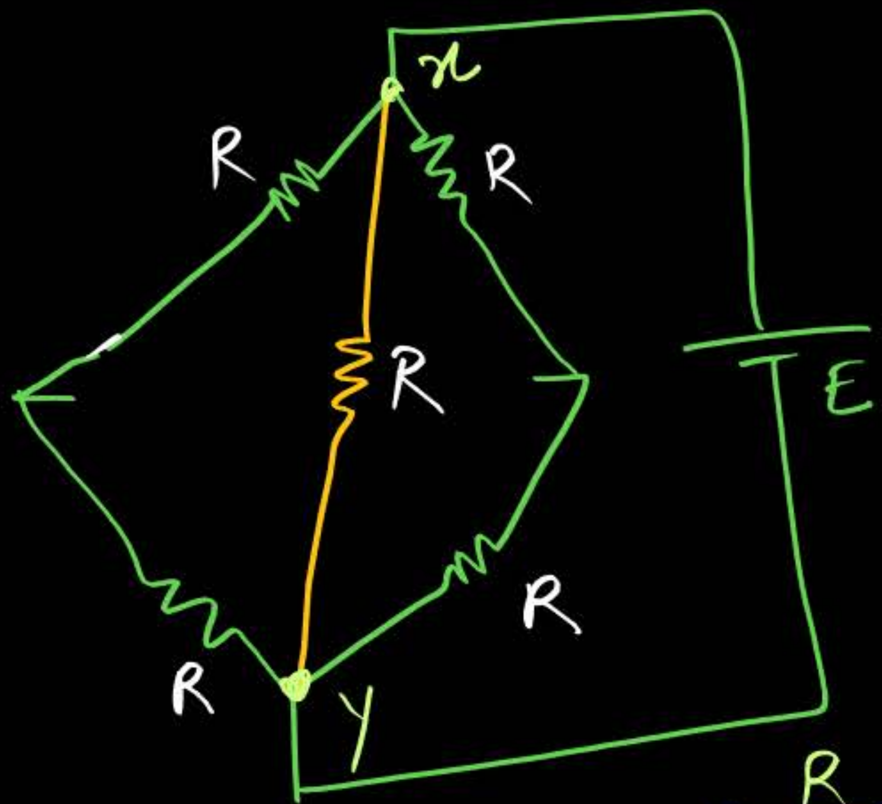
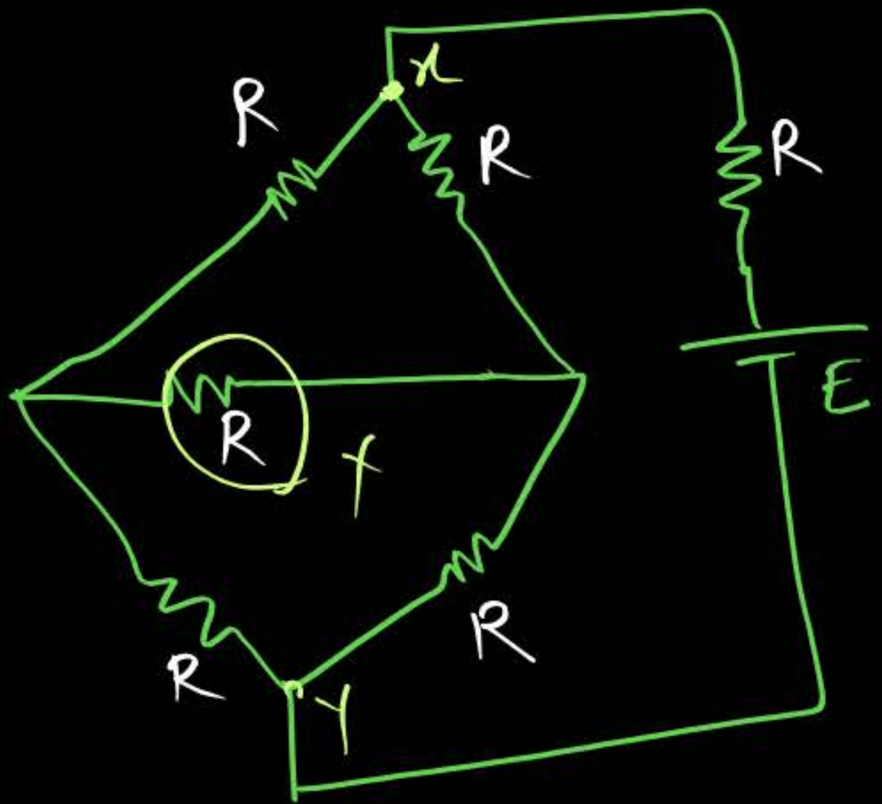


fig-3



☆ Wheat stone Brige

$R_{eq} = R$

$P_1 = \frac{E^2}{R}$

$R_{eq(xy)} = \frac{R}{2}$

$P_2 = \frac{E^2}{(R/2)} = \frac{2E^2}{R}$

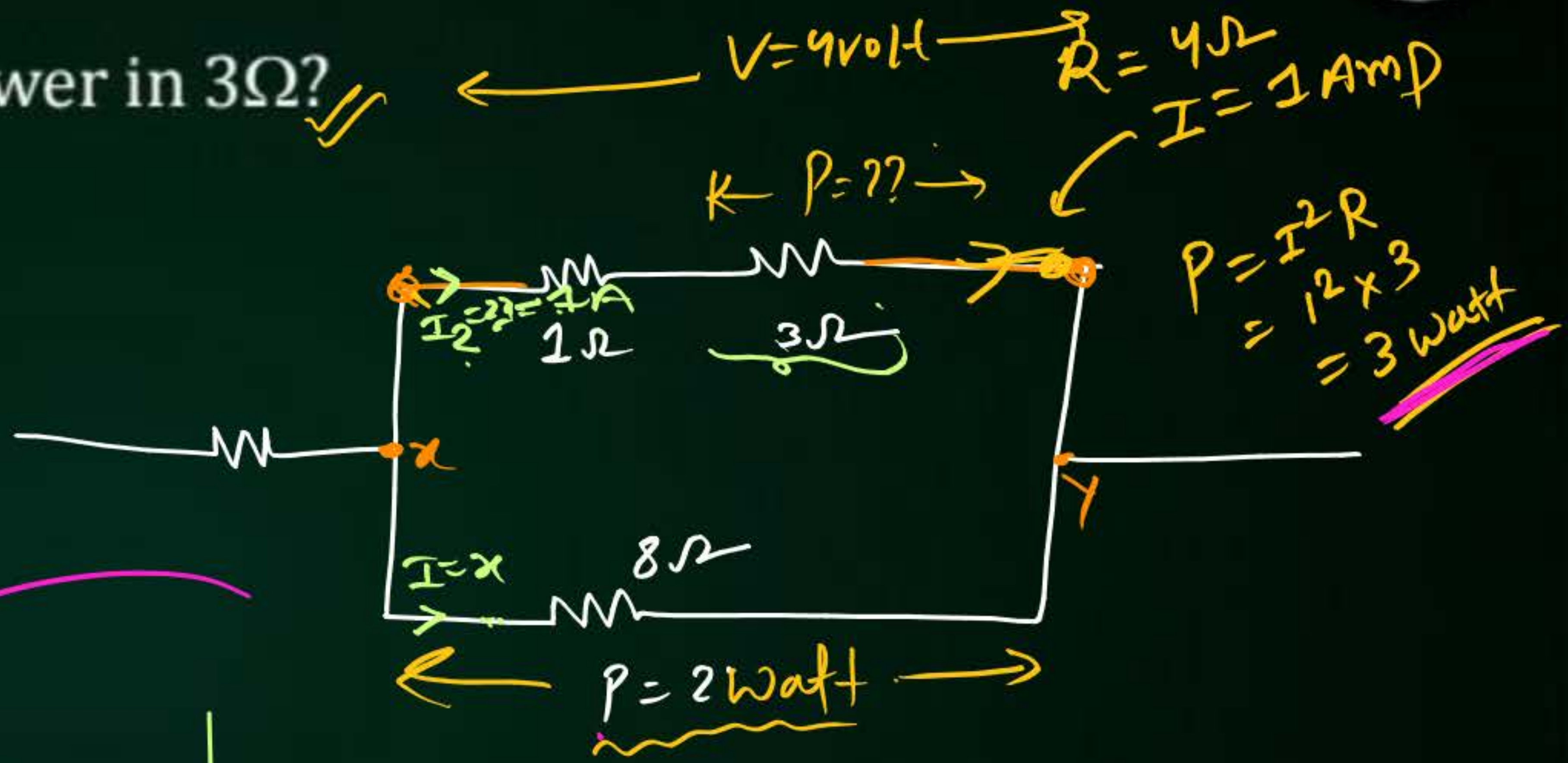
$R_{eq} = 2R$

$P_3 = \frac{E^2}{2R}$

$\boxed{P_2 > P_1 > P_3}$ Ans

QUESTION

Power decipated in 8Ω is 2 watt then power in 3Ω?



* 2nd method

$P = I^2 R$

$2 = I^2 \times 8$

$\frac{1}{4} = I^2$

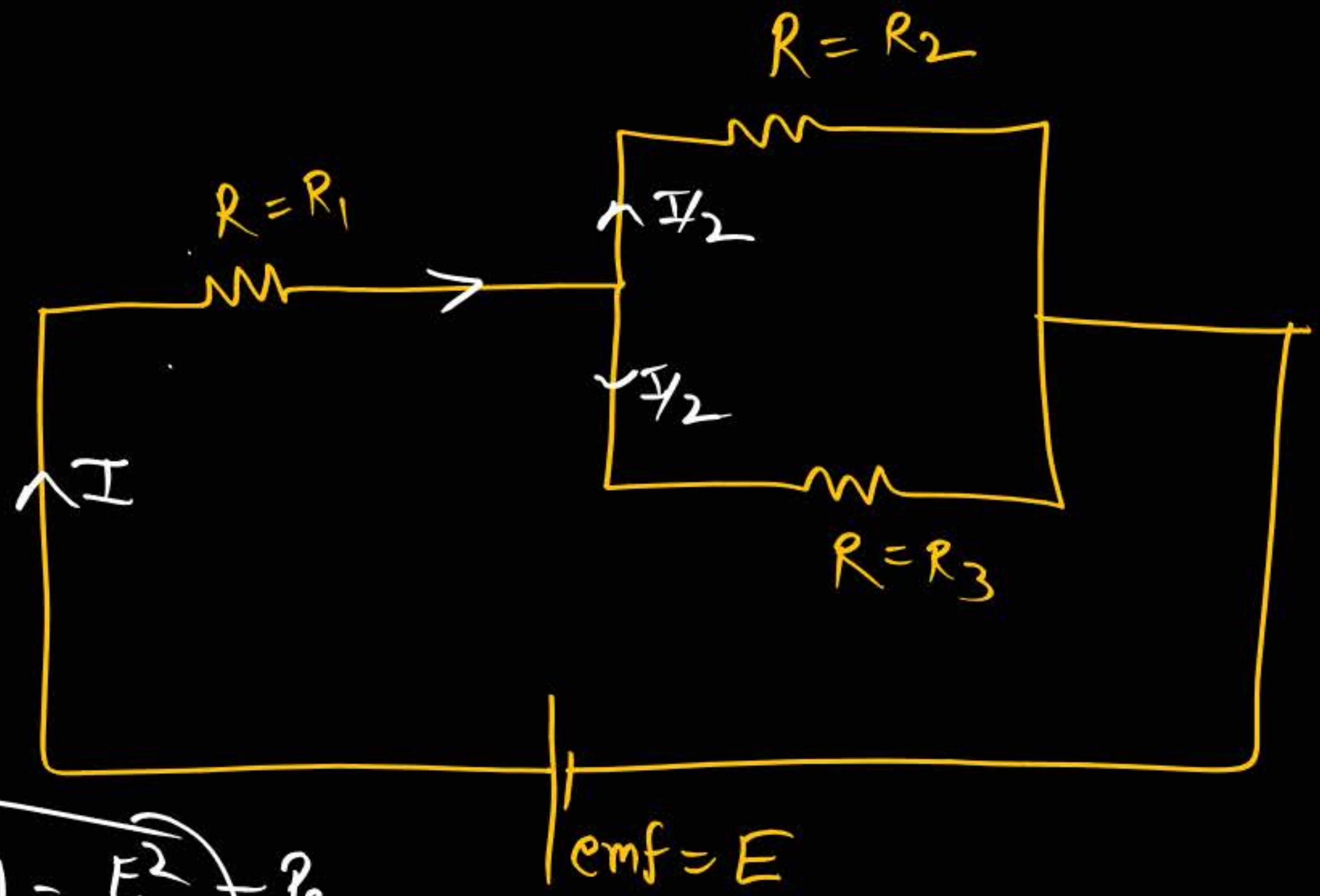
$I = \frac{1}{2}$ Amp

$P = \frac{V^2}{R}$

$V^2 = P \times R$

$V = \sqrt{8 \times 2} = \sqrt{16} = 4$ volt

maximum powr loss in.



$R_{eq} = \frac{3R}{2}$

$I = \frac{2E}{3R}$ — (1)

Max^m Powr loss in (R_1)

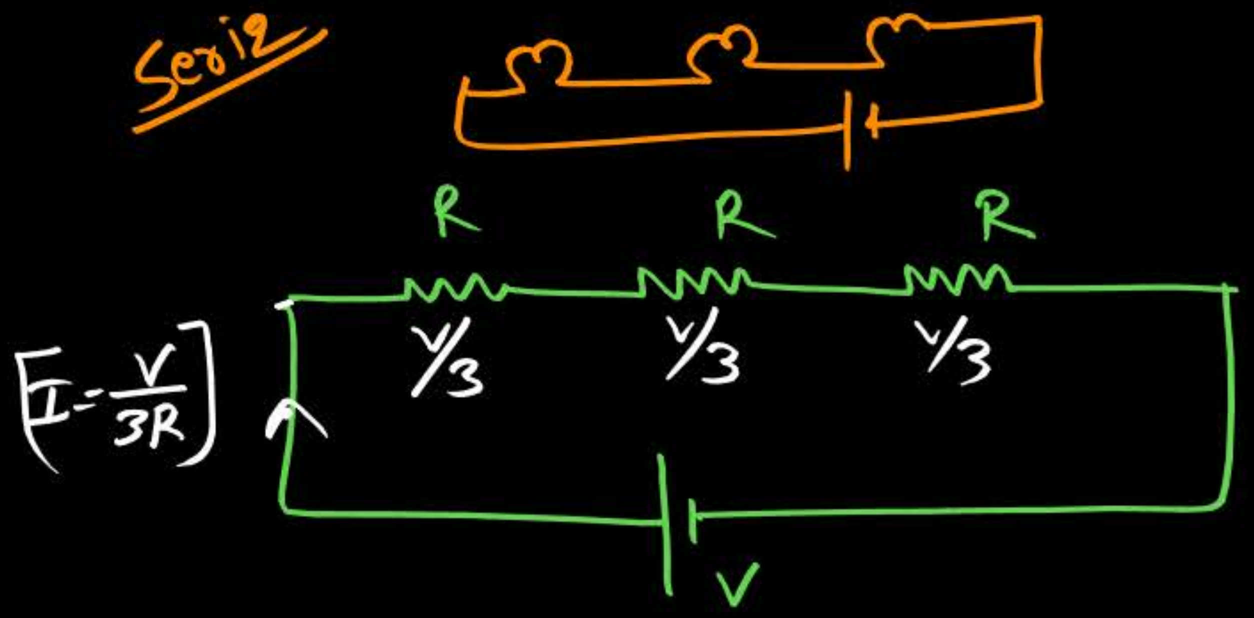
$P_1 = I^2 R_1 = \left(\frac{2E}{3R}\right)^2 \times R$

$= \frac{4E^2}{9R}$

$P_2 \text{ (in } R_2) = \frac{E^2}{9R} = P_3$

Bulb is Pure (R resistor)

Serie



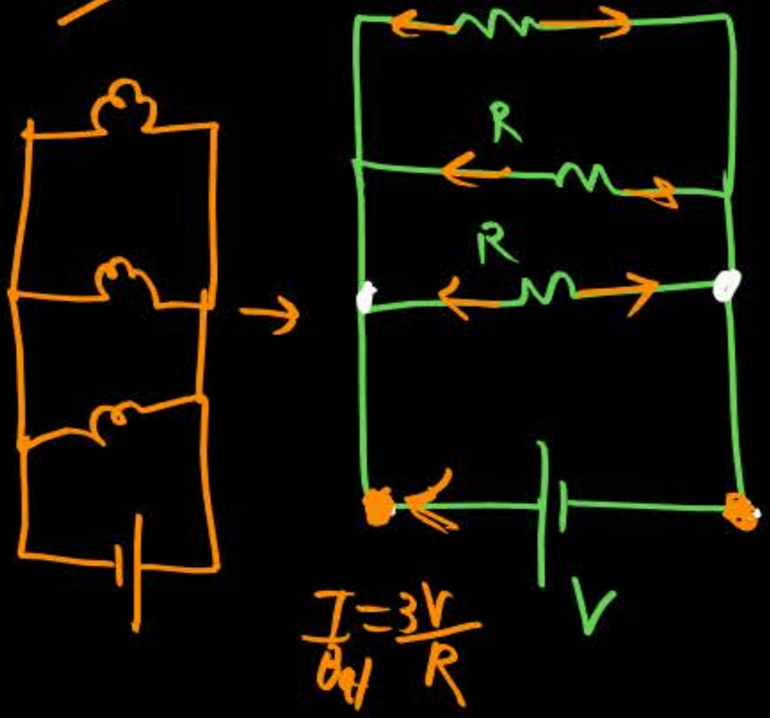
$\Rightarrow P_1 \text{ (total)} = \frac{V^2}{3R}$ (total) →

$P_{\text{in one R resis.}} = \frac{V^2}{3R} \times \frac{1}{3}$

$= \left(\frac{V^2}{9R}\right)$

why itna kam ?? Jyada

Parallel

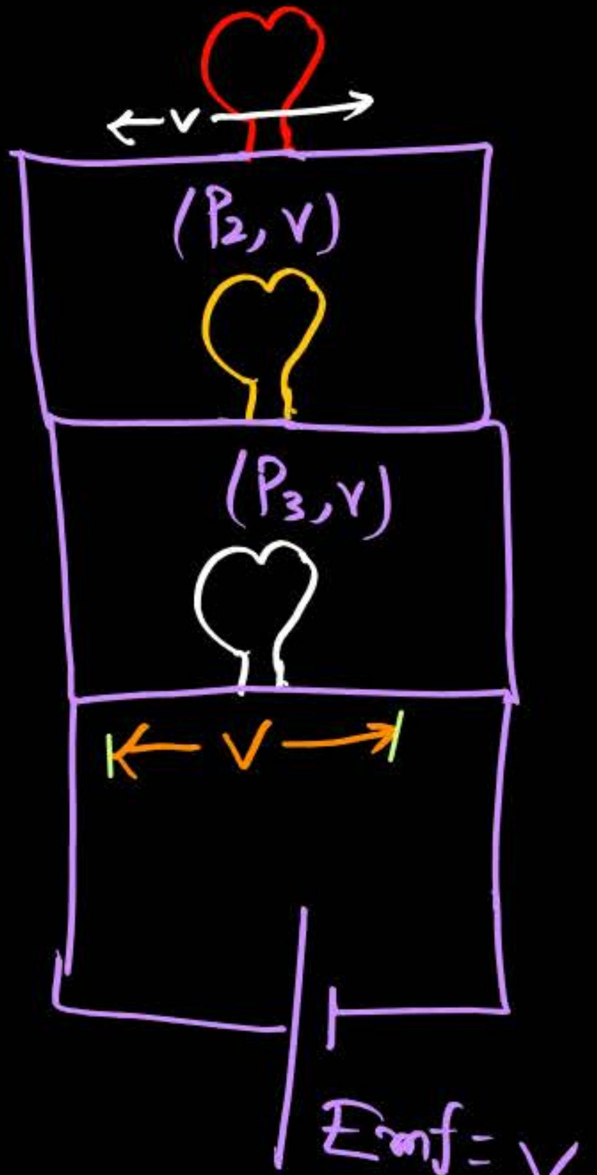


$\Rightarrow (P_2)_{\text{total in cir}} = \frac{3V^2}{R}$ →

$P_{\text{in one resist}} = \left(\frac{V^2}{R}\right)$

Parallel combination of Bulb

← Rated Power & Rated voltage



$R_1 = \frac{V^2}{P_1}$ P_1 ← consumed Power

$R_2 = \frac{V^2}{P_2}$ P_2 ← Consumed Pw.

$R_3 = \frac{V^3}{P_3}$ P_3 ← consu. Power



⊛ Power consumed in one Resistor (bulb) $= \frac{V_S^2}{R} \propto \frac{P_{Rated}}{V_R} \propto P_{Rated}$ (same)

MR* $P_{net} = P_1 + P_2 + P_3$

Brightness ∝ Power consumed

→ मजदूरी $\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$ — (1)

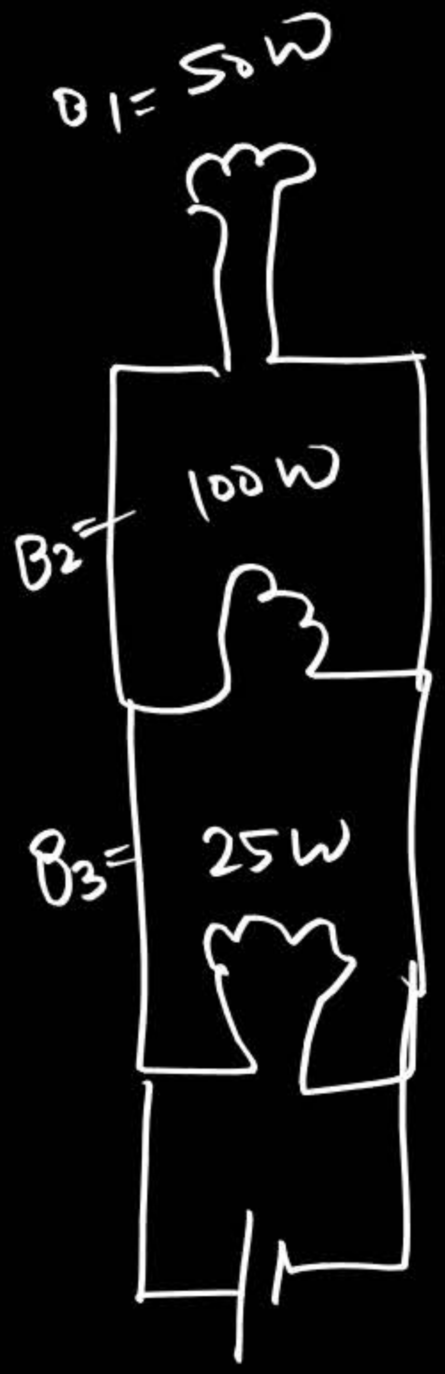
$P_{net} = \frac{V^2}{R_{eq}} = V^2\left(\frac{1}{R_{eq}}\right)$

$P_{net} = V^2\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)$

$= V^2\left[\frac{P_1}{V^2} + \frac{P_2}{V^2} + \frac{P_3}{V^2}\right]$

$P_{net} = \frac{V^2}{V^2}\left(P_1 + P_2 + P_3\right)$

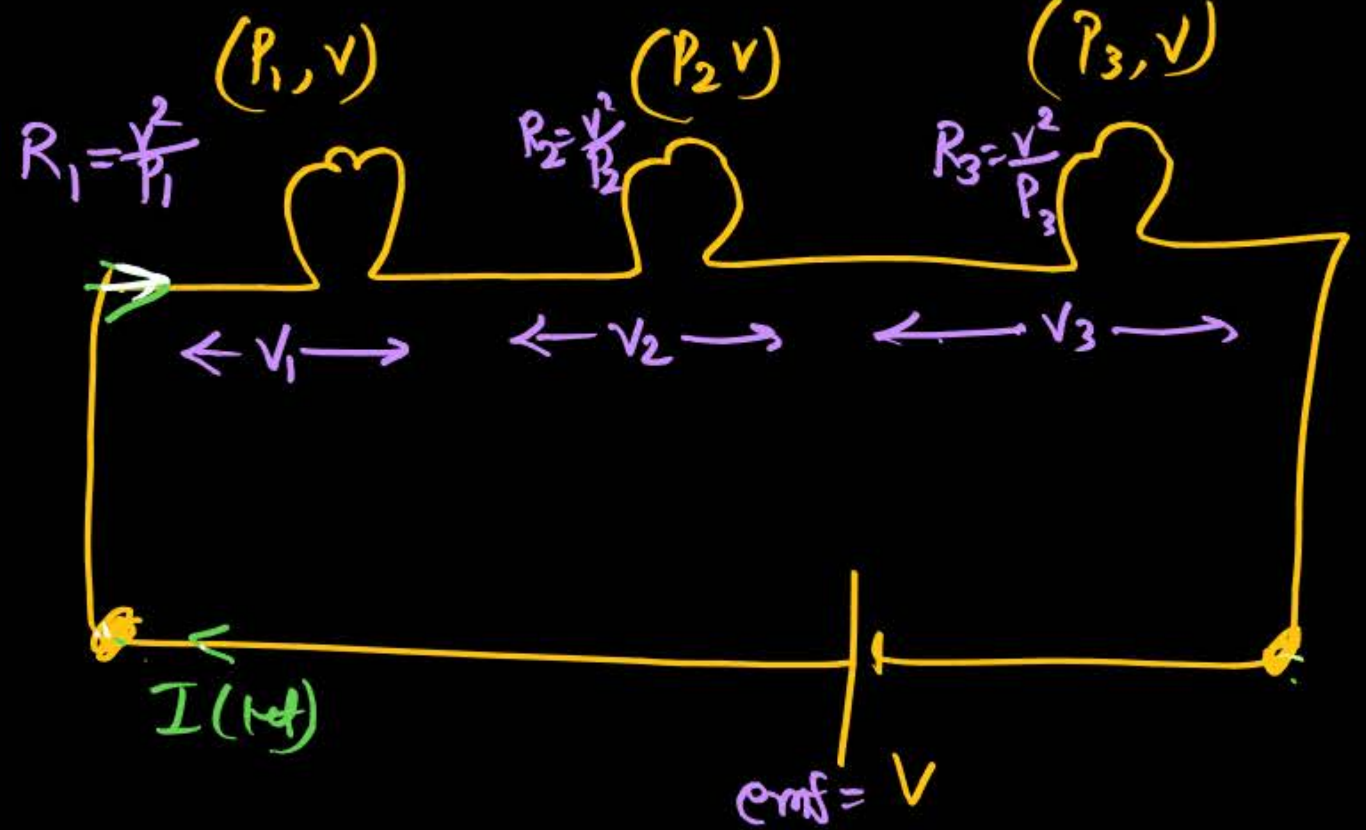
$P_{net} = (P_1 + P_2 + P_3)$ ← Rated



$B_2 > B_1 > B_3$

Brightness

Series combination of Bulb



$$R_{eq} = R_1 + R_2 + R_3$$

$$P_{eq} = \frac{V^2}{R_{eq}}$$

$$= \frac{V^2}{(R_1 + R_2 + R_3)}$$

$$P_{eq} = \frac{V^2}{\left(\frac{V^2}{P_1} + \frac{V^2}{P_2} + \frac{V^2}{P_3}\right)}$$

$$\frac{V^2}{P_1} + \frac{V^2}{P_2} + \frac{V^2}{P_3} = \frac{V^2}{P_{eq}}$$

$$\frac{1}{P_{eq}} = \frac{1}{P_1} + \frac{1}{P_2} + \frac{1}{P_3}$$

Rated Power

\# $P_{\text{in one Bulb}}$ = $I^2 R_{Bulb} \propto R_{Bulb} \propto \frac{V^2}{(P_{Rated})}$

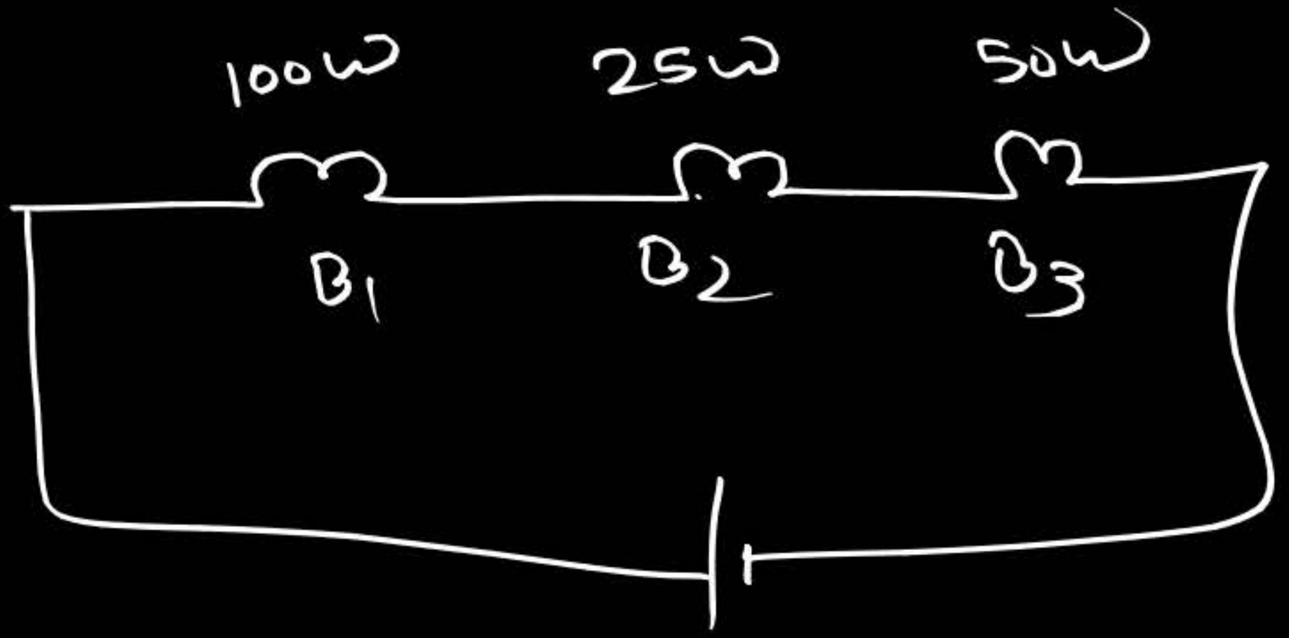
Bulb Consum

↑ Same

$$P_{\text{consumed loss}} \propto \frac{1}{P_{Rated}}$$

$P_{con} = I^2 R$

$P_{con} = \frac{V^2}{R}$



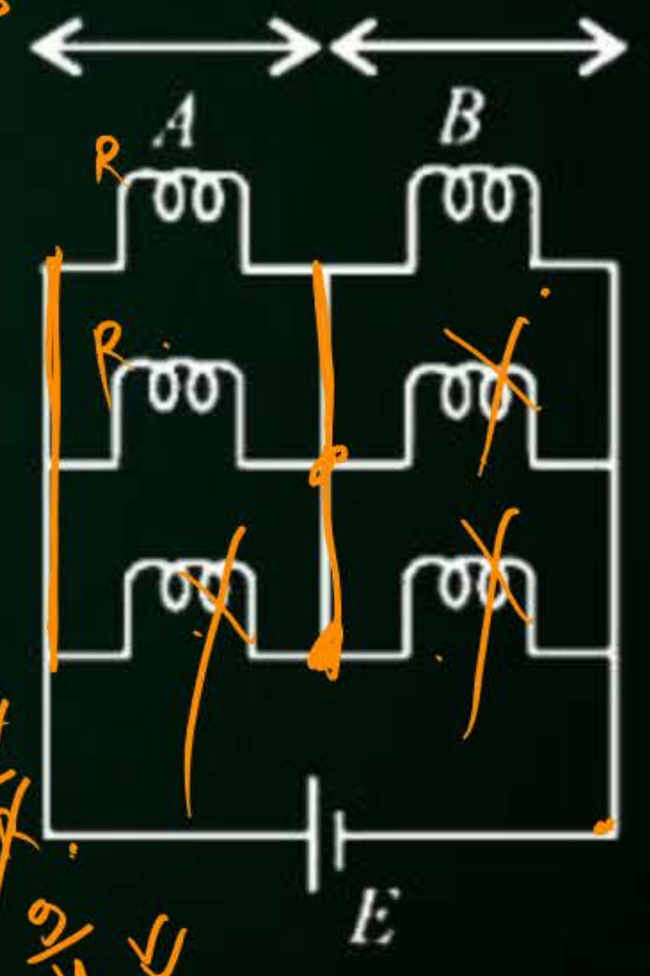
$B_2 > B_3 > B_1$

order of Brightness

QUESTION

Six similar bulbs are connected as shown in the figure with a DC source of emf E, and zero internal resistance. The ratio of power consumption by the bulbs when (i) all are glowing and (ii) in the situation when two from section A and one from section B are glowing, will be

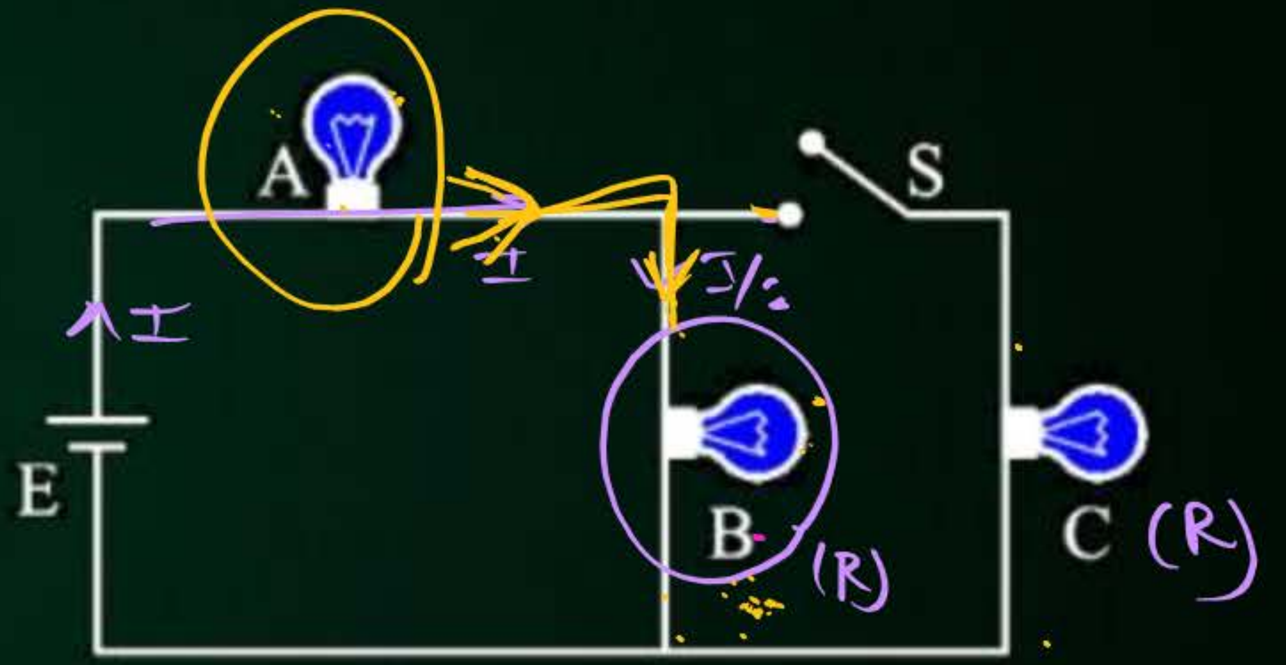
(NEET 2019)



1. 2 : 1
2. 4 : 9
3. 9 : 4
4. 1 : 2

QUESTION

Three identical bulbs are connected as shown in figure. When switch S is closed, the power consumed in bulb B is P. What will be the power consumed by the same bulb when switch S is opened?



1. $\frac{9P}{4}$
2. $\frac{16P}{9}$
3. $\frac{9P}{16}$
4. $\frac{4P}{9}$

(i) Key closed

$R_{eq} = \frac{3R}{2}$

$I_{circuit} = \frac{2E}{3R} = \frac{0.66E}{R}$

Current in Bulb (B)

$I' = \frac{I}{2} = \frac{2E}{3R} \times \frac{1}{2} = \frac{E}{3R}$

$P_B = I'^2 R = \frac{E^2}{9R^2} \times R = \frac{E^2}{9R} = P$

(ii) Key open

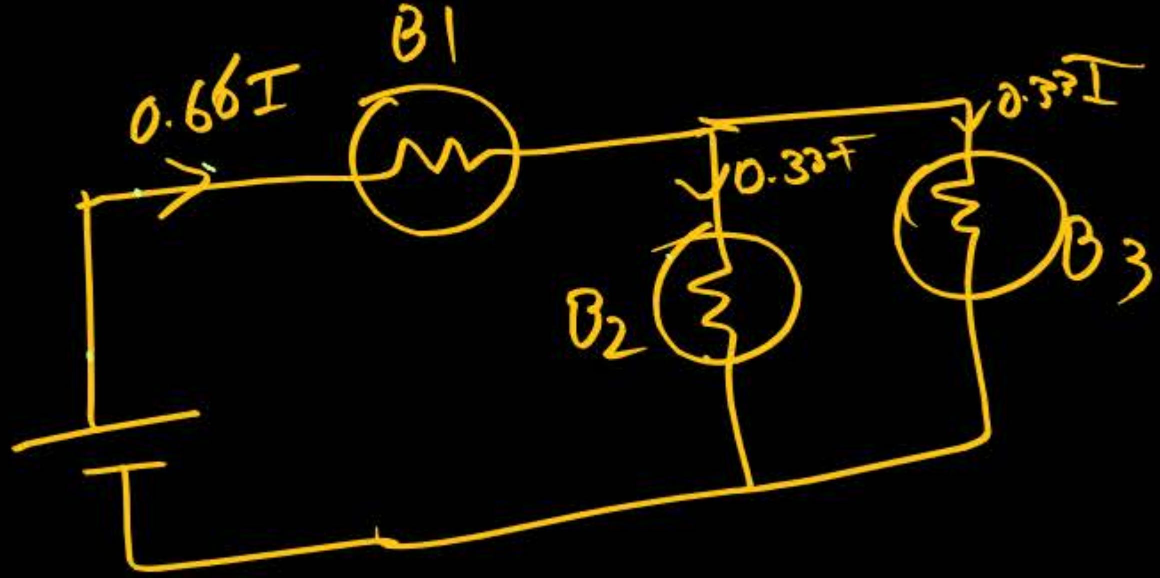
$R_{eq} = 2R$

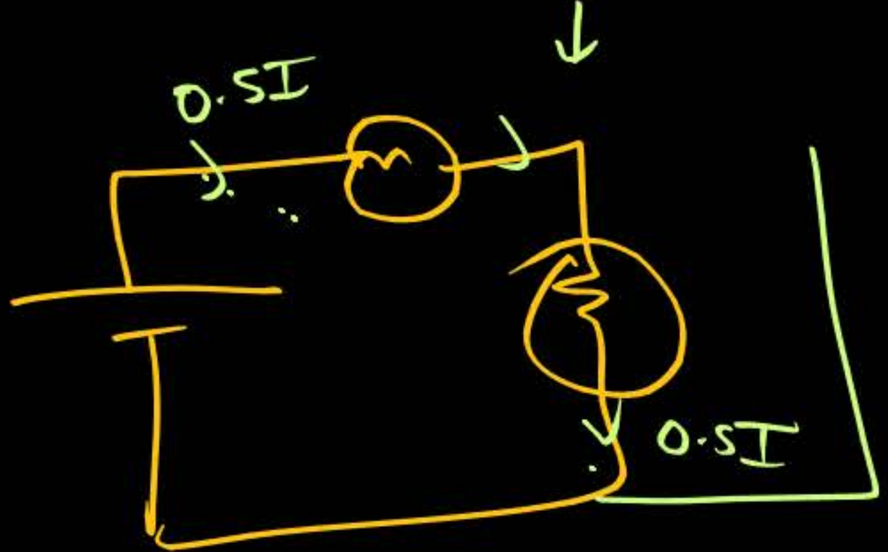
$I = \frac{E}{2R}$

$I = 0.5\frac{E}{R}$

$P_B = I^2 R = \frac{E^2}{4R^2} \times R = \frac{E^2}{4R}$

$= \frac{E^2}{4R} = \frac{9P}{4}$





If B_3 get fused

then brightness of

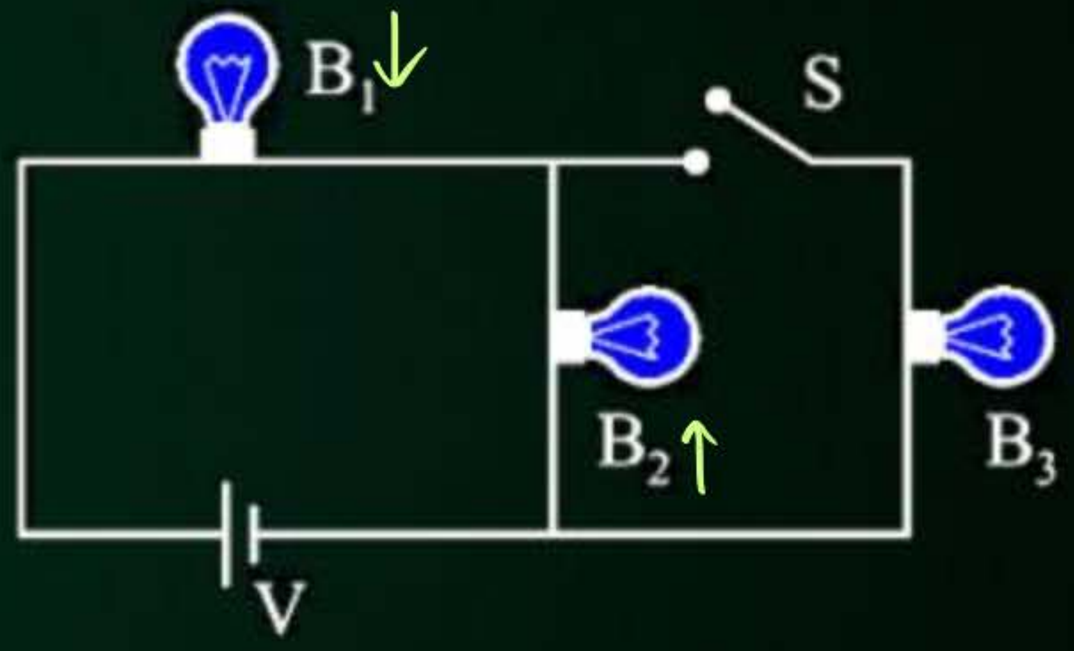
B_1 ↓ Brightness of B1 decr

B_2 ↑ ←

QUESTION

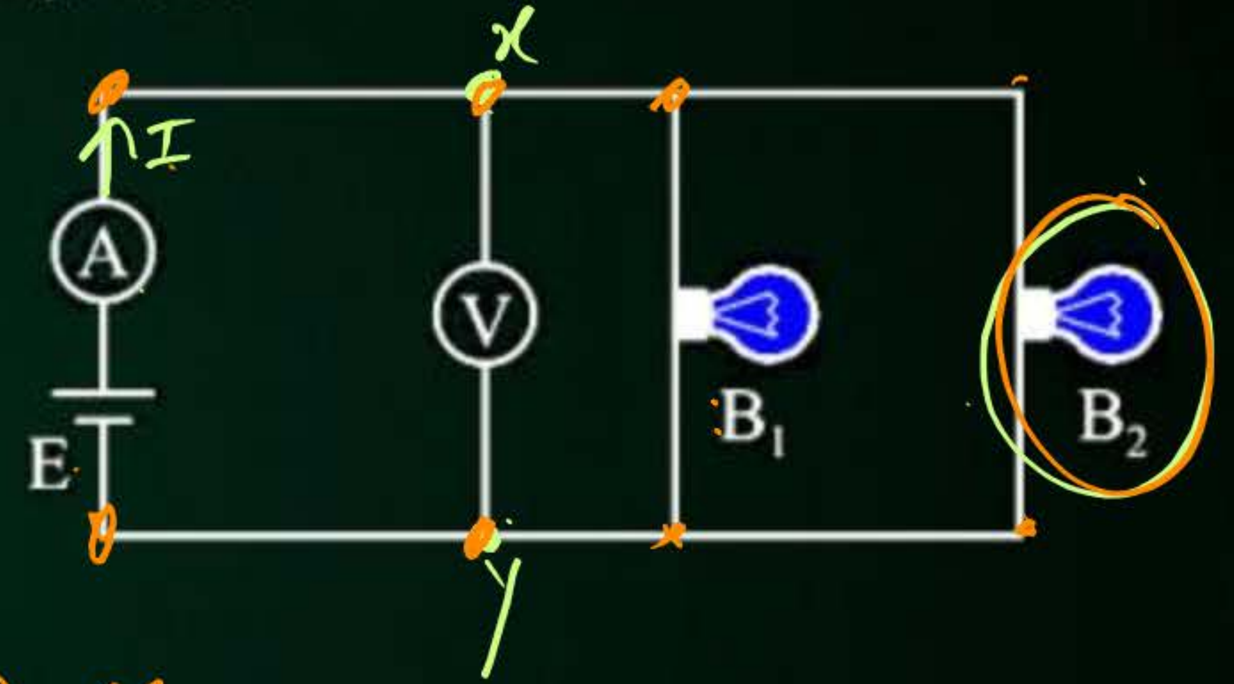
Three identical bulbs B_1, B_2 and B_3 are connected to the mains as shown in figure. If B_3 is disconnected from the circuit by opening switch S, then incandesces of bulb B_1 will

1. Increase
2. Decrease
3. Become zero
4. No change



QUESTION

Two identical bulbs are connected in parallel across an ideal source of emf E. The ammeter A and voltmeter V are ideal. If bulb B_2 gets fused, then



1. Reading of A will increase but that of V will remain same
2. Reading of A will decrease but that of V will increase
3. Reading of A will decrease but that of V will remain same
4. Reading of A will increase and reading of V will also increase

QUESTION

Three identical bulb (60 W, 200 V) rating connected in series with 200V, then total power drawn:

1. 60 W
2. 180 W
3. 20 W ✓
4. 120 W

$$\frac{1}{P_{eq}} = \frac{1}{60} + \frac{1}{60} + \frac{1}{60}$$

$$\frac{1}{P_{eq}} = \frac{3}{60}$$

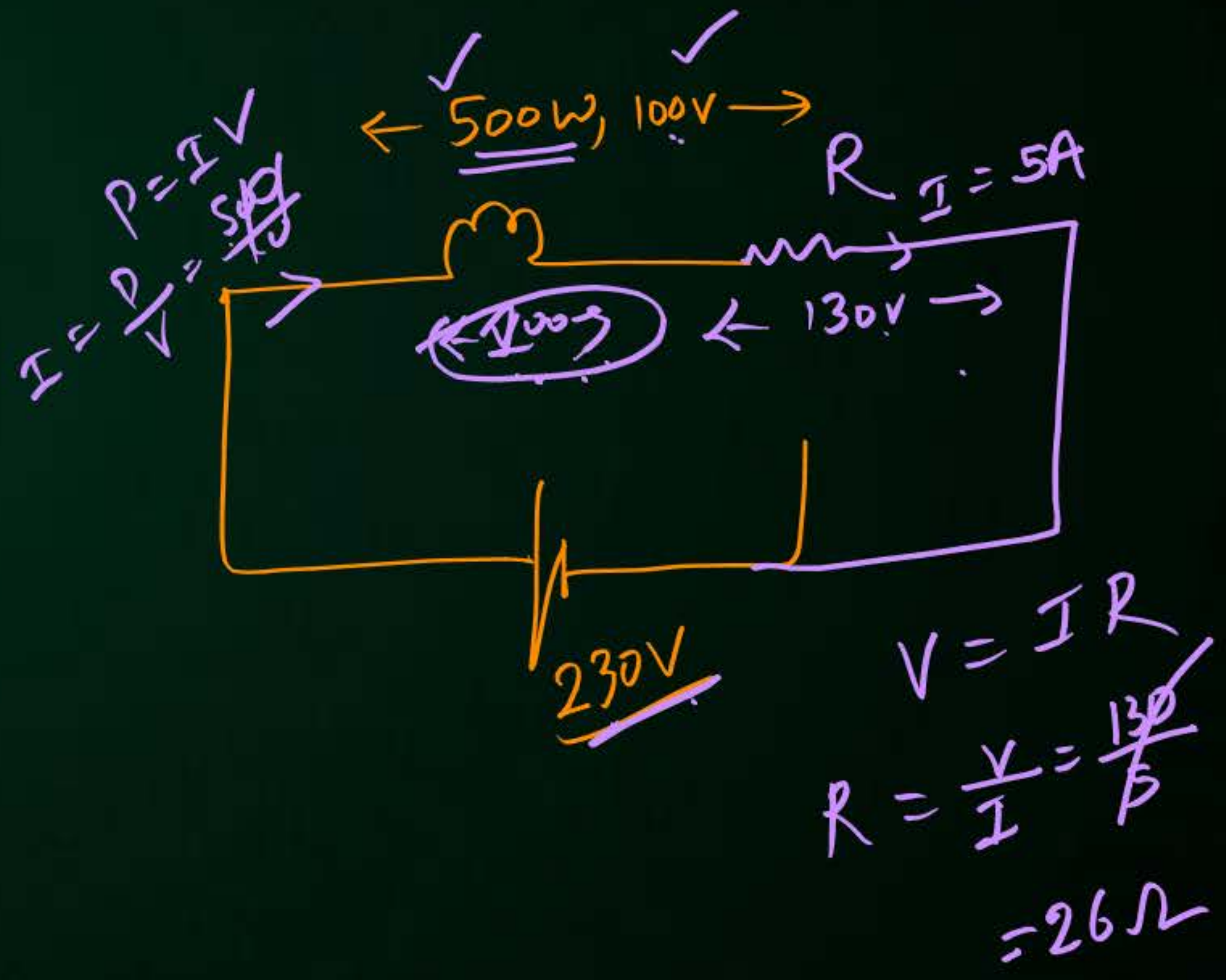
$$P_{com} = 20\,W$$

QUESTION

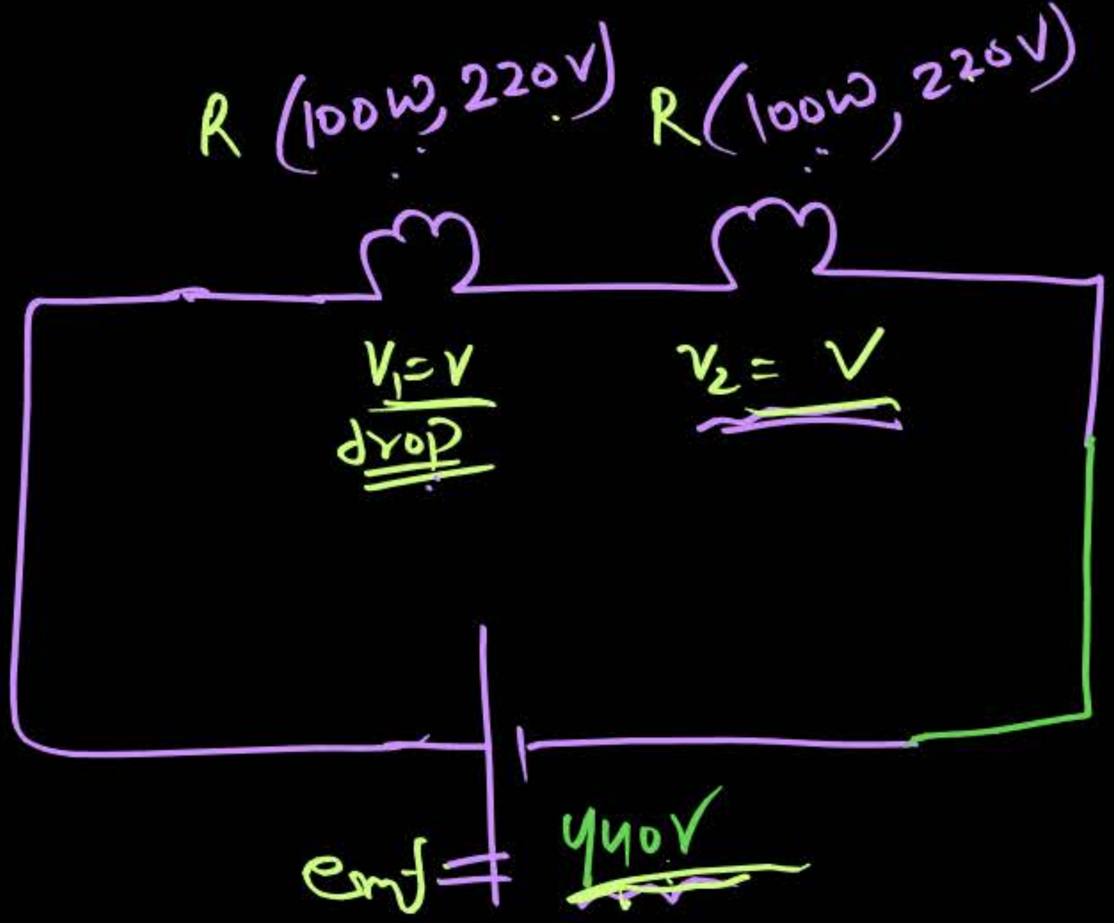
A filament bulb (500 W, 100 V) is to be used in a 230 V main supply. When a resistance R is connected in series, it works perfectly and the bulb consumes 500 W. The value of R is

(NEET-II 2016)

1. 230Ω
2. 46Ω
3. 26Ω
4. 13Ω



Level up



$2V = 440$

$V = 220$ volt

Total Power consumed in circuit.

(a) 100W → 11% ✗

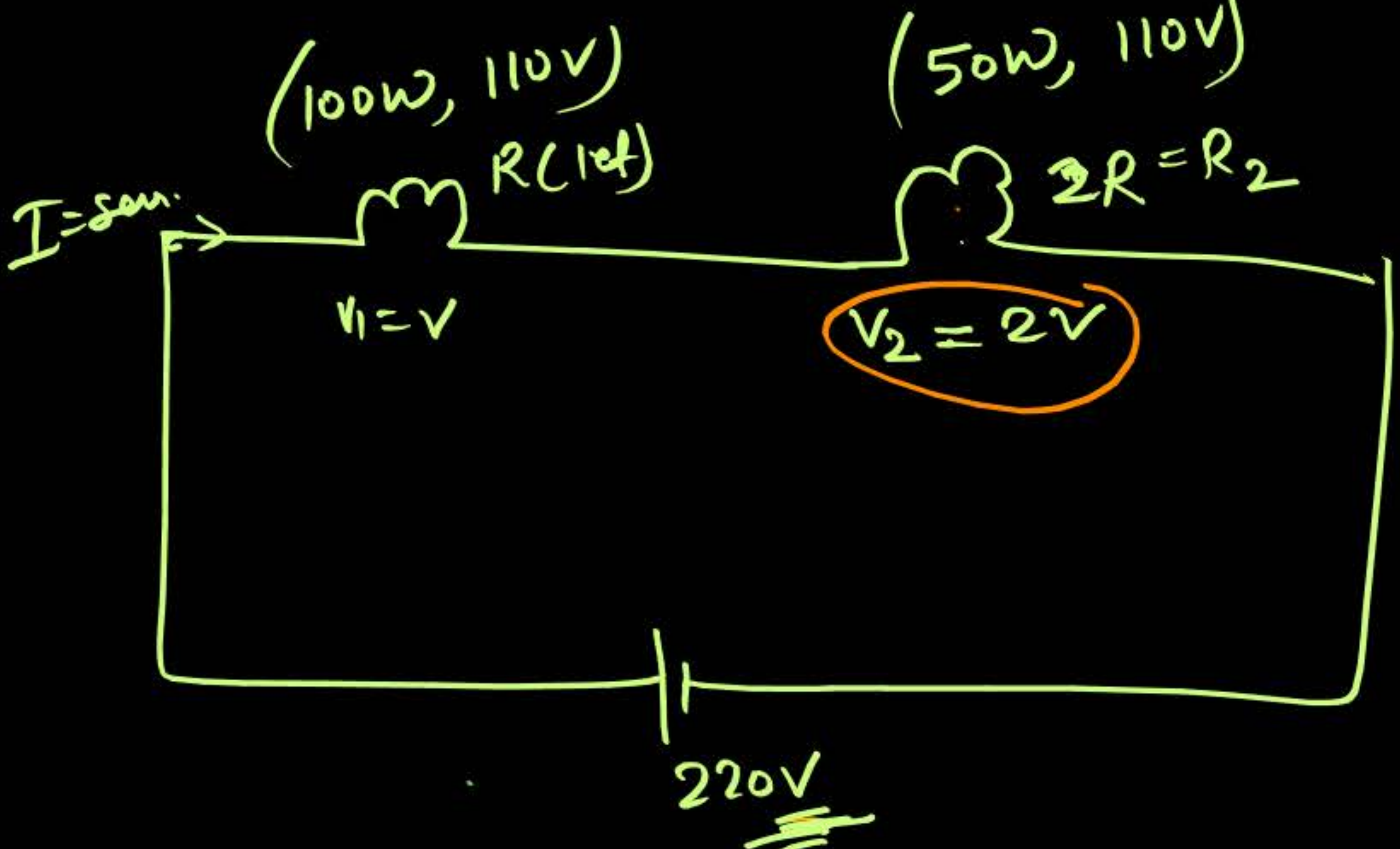
(b) 50W ✗ 54%

Ans (c) 200W ✓ 30%

(d) 25W 5% ✗

$$\frac{1}{P_{eq}} = \frac{1}{P_1} + \frac{1}{P_2}$$

Q. find total Power consumed



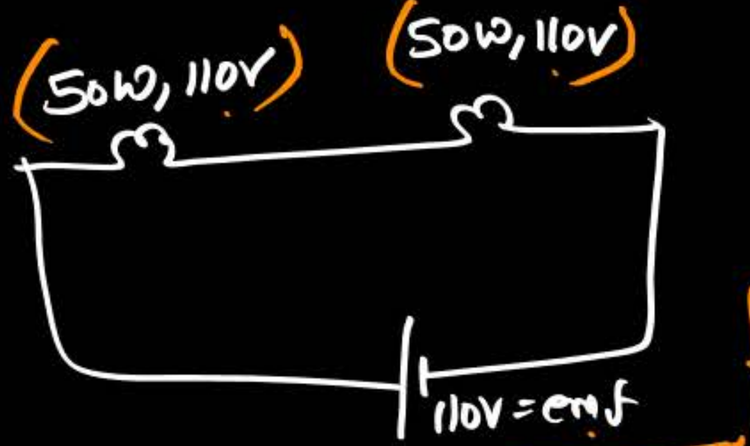
$V_1 + V_2 = 220V$

$V + 2V = 220V$

$V_1 = V = \frac{220}{3} = 73.33V$

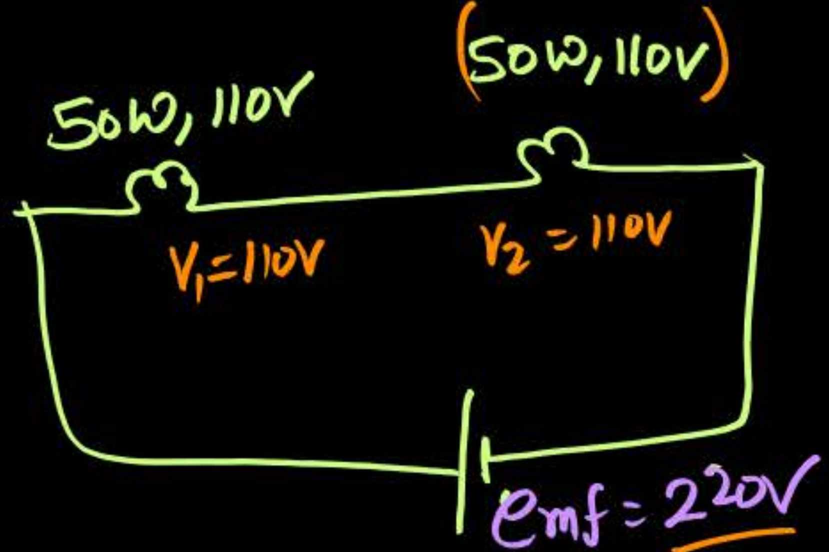
$V_2 = 2V = 2 \times 73.33 = 146.66$ Volt

50 watt bulb will fuse



$\frac{1}{P_{eq}} = \frac{1}{P_1} + \frac{1}{P_2}$

P_{cons} total $= 25W$



$P_{consum.} = 50 + 50 = 100W$


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture 08 | **Physics**

[redacted]

Current Electricity



By- Dr. Manish Raj (MR SIR)

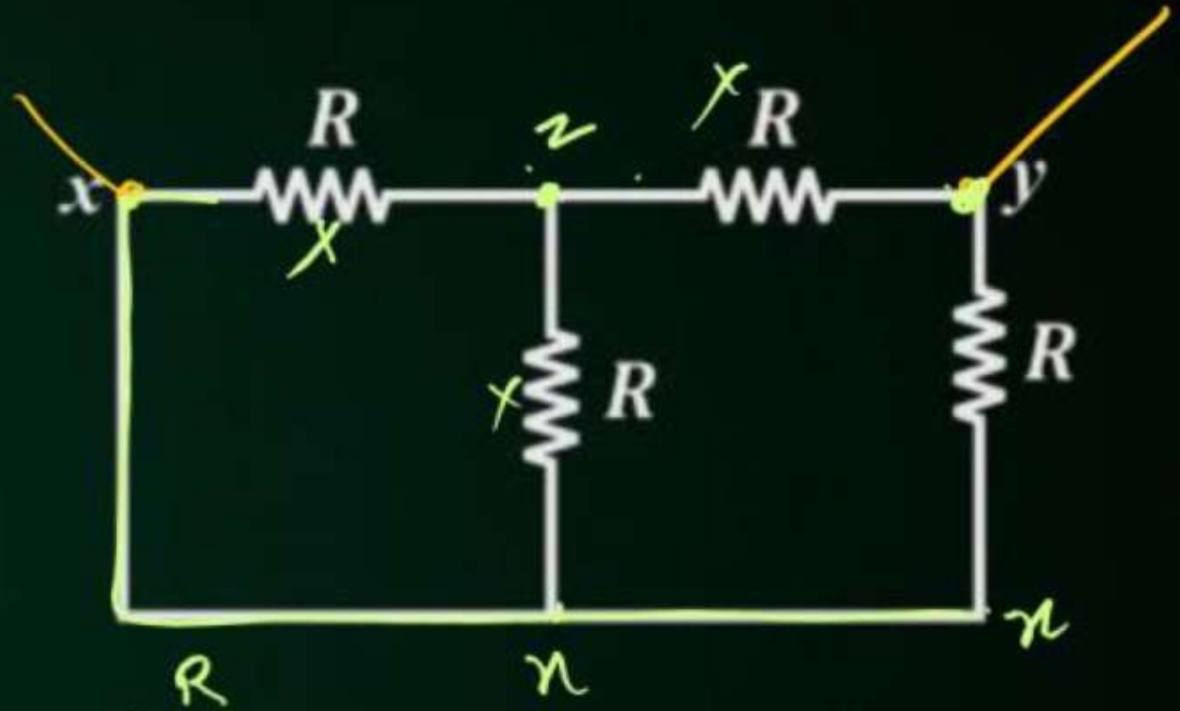
Topics *to be covered*

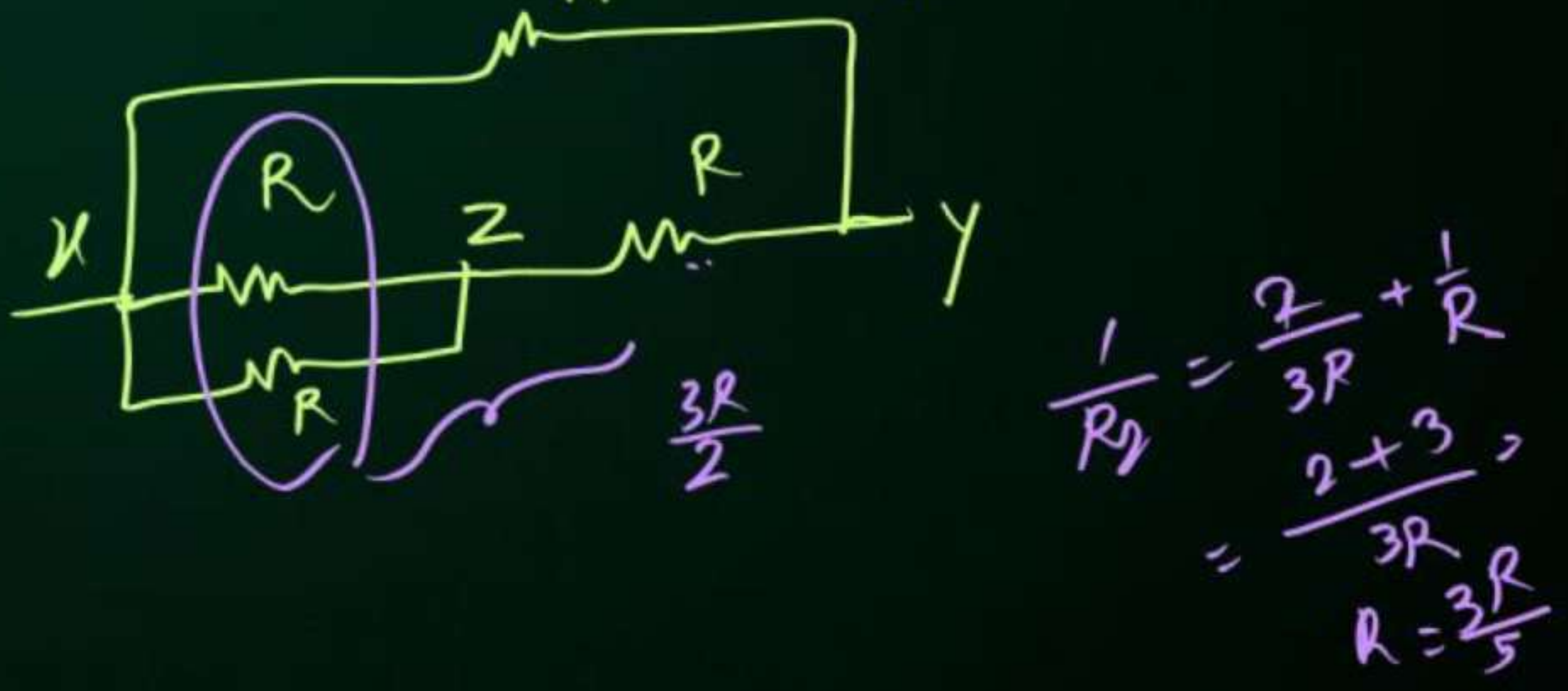
Assignment 01

QUESTION

Find equivalent resistance between x and y

1. $5R/3$
2. R
3. $3R/5$ ✓
4. $2R/5$





QUESTION

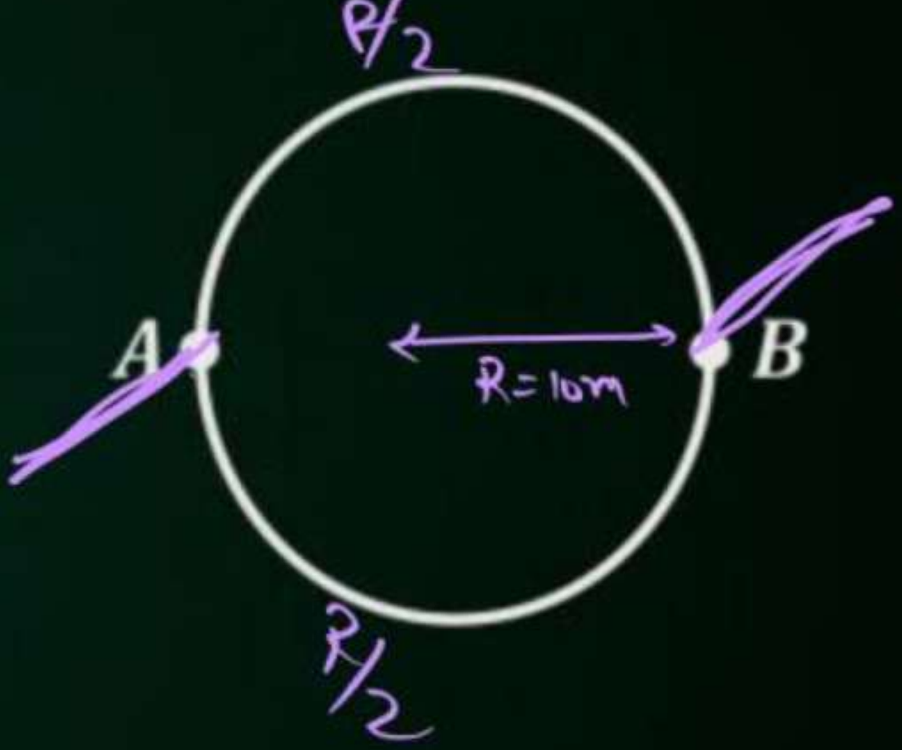
A wire of resistance 12 ohms per meter is bent to form a complete circle of radius 10 cm. The resistance between its two diametrically opposite points, A and B as shown in the figure is

$\lambda = 12\ \Omega/m$

$l = 2\pi R = 2\pi \frac{1}{10} m = \frac{\pi}{5} m$

$R = \lambda l = \left(12 \times \frac{\pi}{5}\right) \Omega$

$R_{eq} = \frac{R}{4} = \frac{12\pi}{5 \times 4} = 0.6\pi\ \Omega$

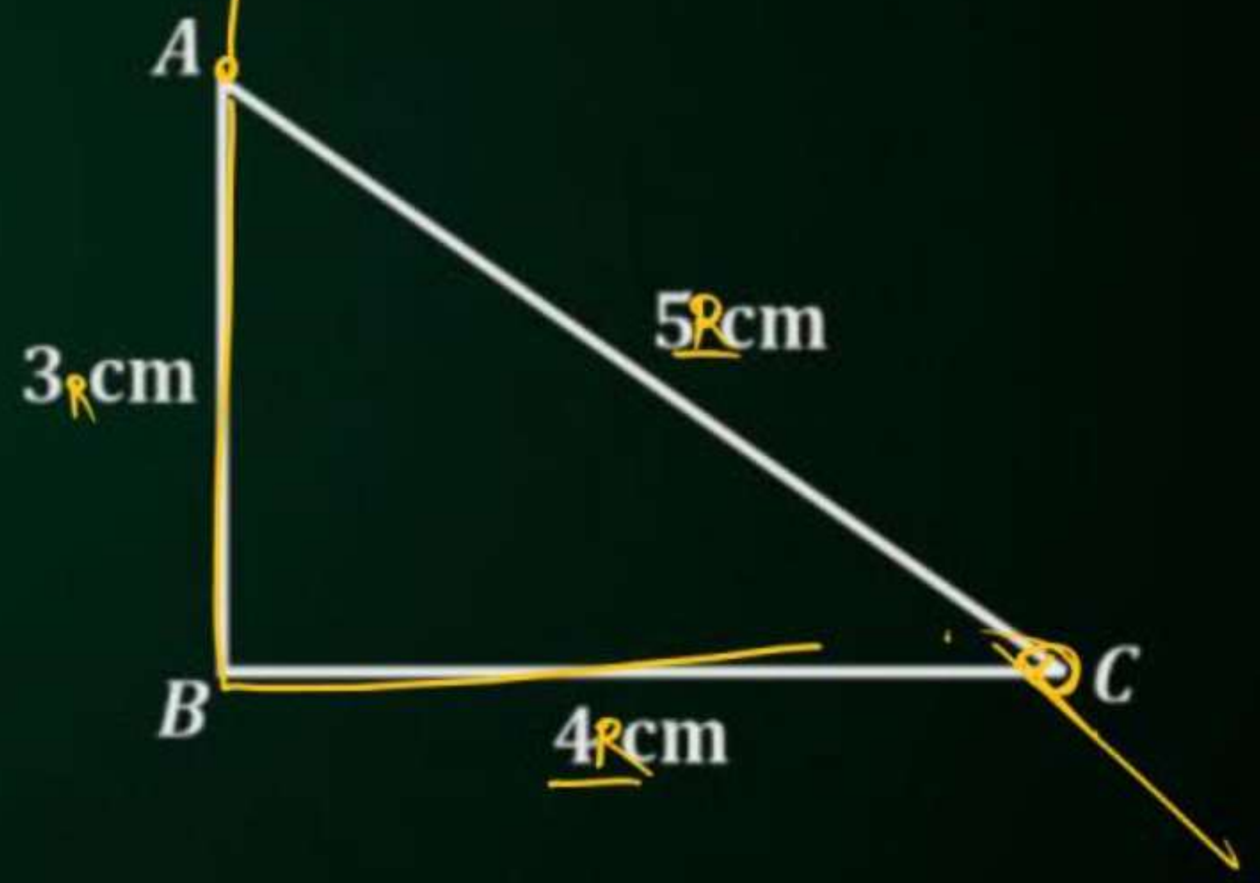


1. $3\,\Omega$
2. $6\pi\,\Omega$
3. $6\,\Omega$
4. $0.6\pi\,\Omega$

QUESTION

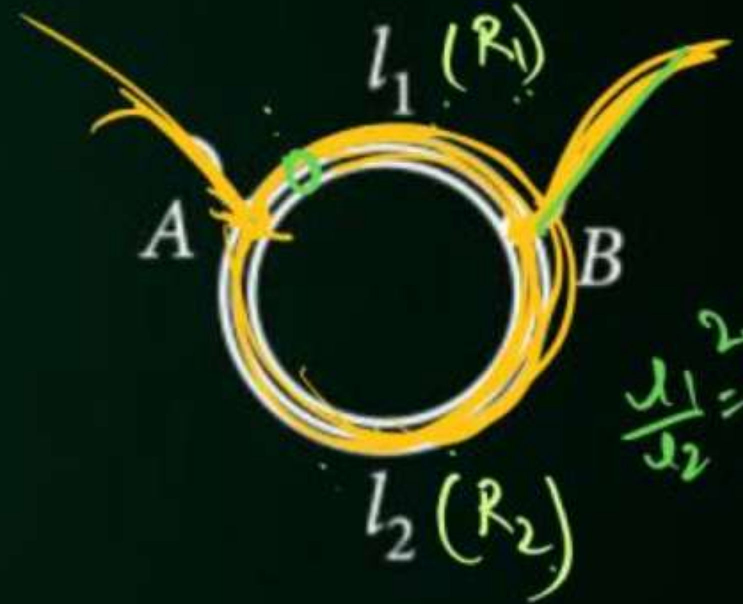
A 12 cm wire is given a shape of a right angled triangle ABC having sides 3 cm, 4 cm and 5 cm as shown in the figure. The resistance between two ends (AB, BC, CA) of the respective sides are measured one by one by a multimeter. The resistances will be in the ratio

1. $9:16:25$
2. $27:32:35$
3. $21:24:25$
4. $3:4:5$



QUESTION

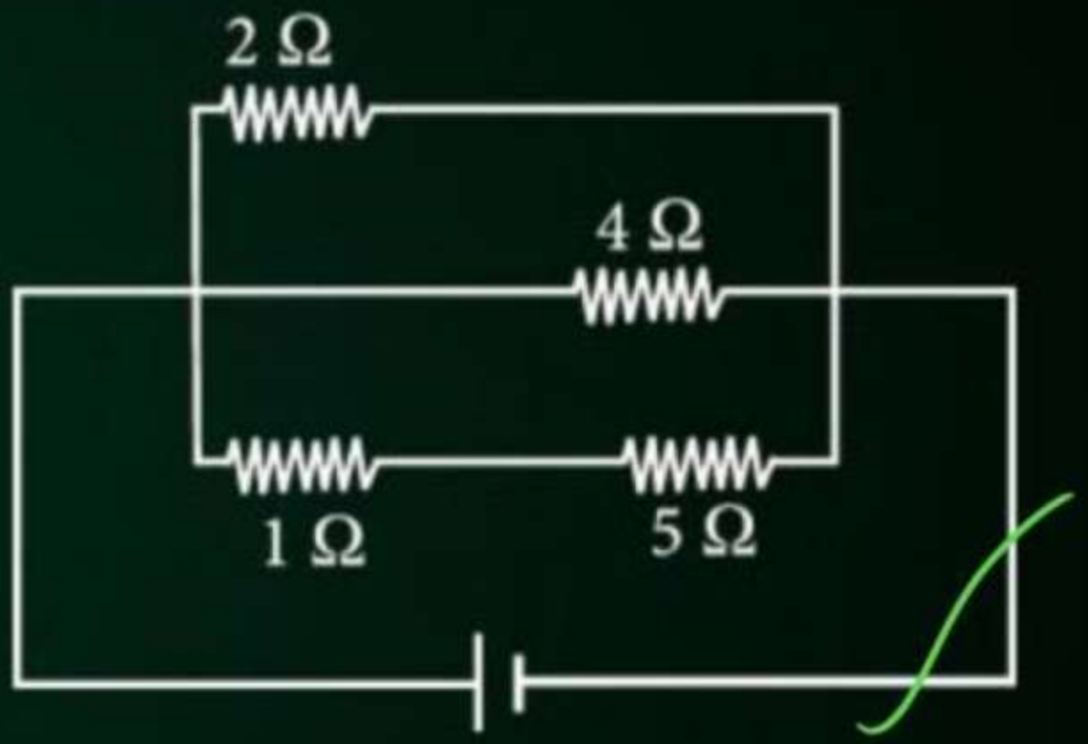
A ring is made of a wire having a resistance $R_0 = 12\ \Omega$. Find the points A and B, as shown in the figure, at which a current carrying conductor should be connected so that the resistance R of the sub circuit between these points is equal to $8/3\ \Omega$



1. $\frac{l_1}{l_2} = \frac{5}{8}$
2. $\frac{l_1}{l_2} = \frac{1}{3}$
3. $\frac{l_1}{l_2} = \frac{3}{8}$
4. $\frac{l_1}{l_2} = \frac{1}{2}$

QUESTION

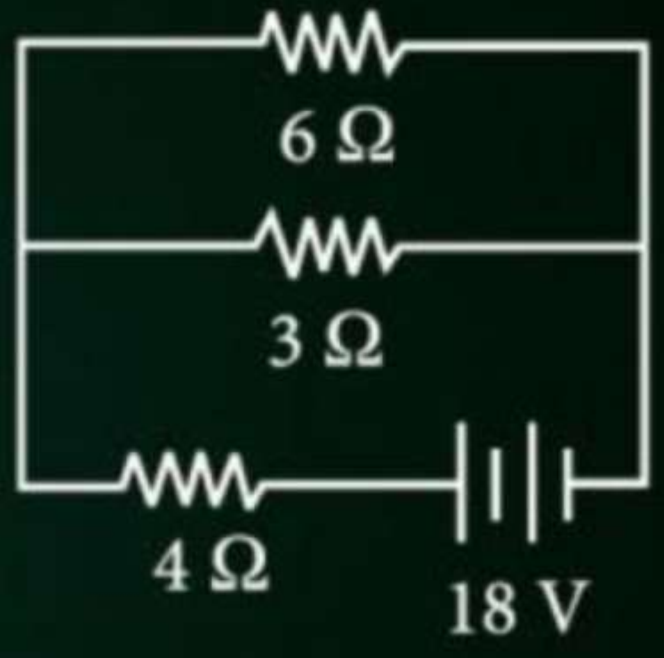
A current of 3 amp. flows through the 2 Ω resistor shown in the circuit. The power dissipated in the 5 Ω resistor is



1. 1 watt
2. 5 watt
3. 4 watt
4. 2 watt

QUESTION

The total power dissipated in watt in the circuit shown here is

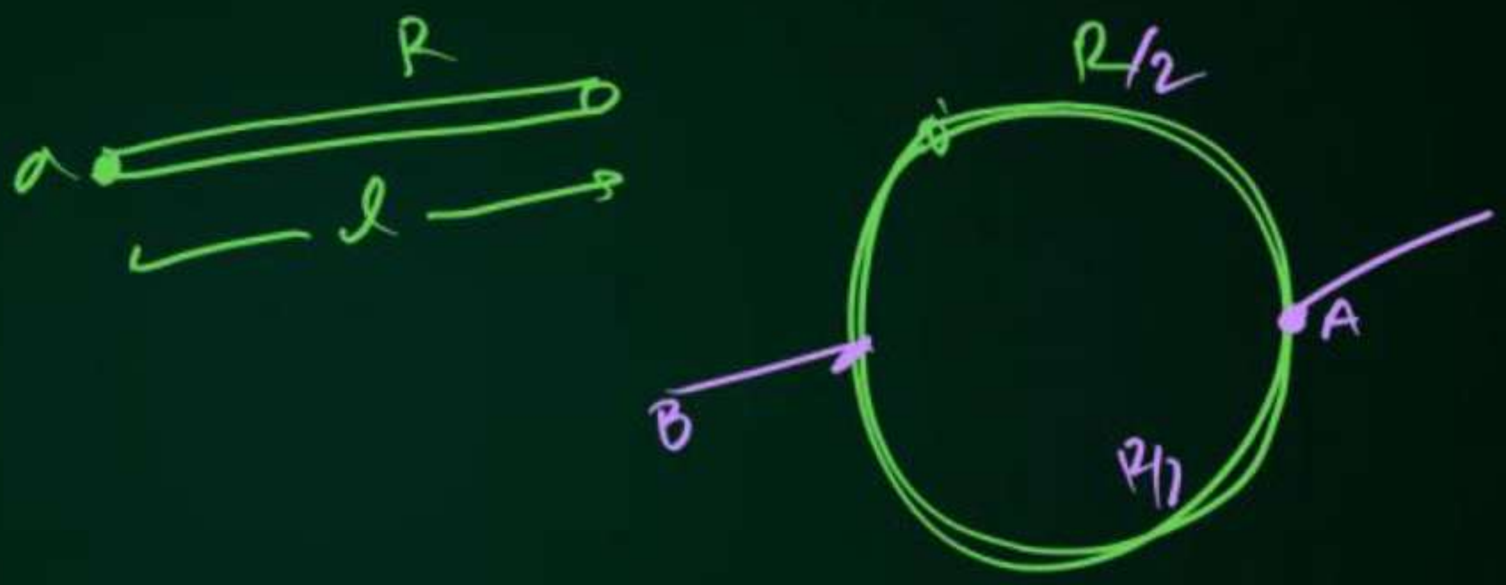


1. 40
2. 54
3. 4
4. 16

QUESTION

When a wire of uniform cross-section a, length l and resistance R is bent into a complete circle, resistance between any two of diametrically opposite points will be

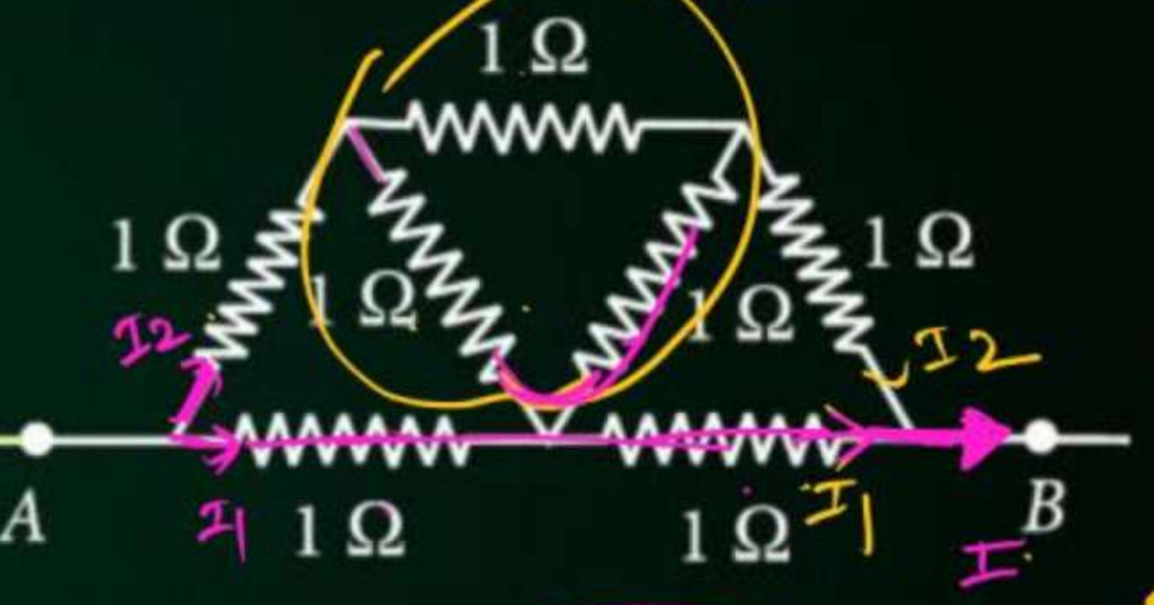
1. $R/4$
2. $4R$
3. $R/8$
4. $R/2$



Not for NEET

QUESTION

In the network shown in figure each resistance is 1 Ω. The effective resistance between A and B is



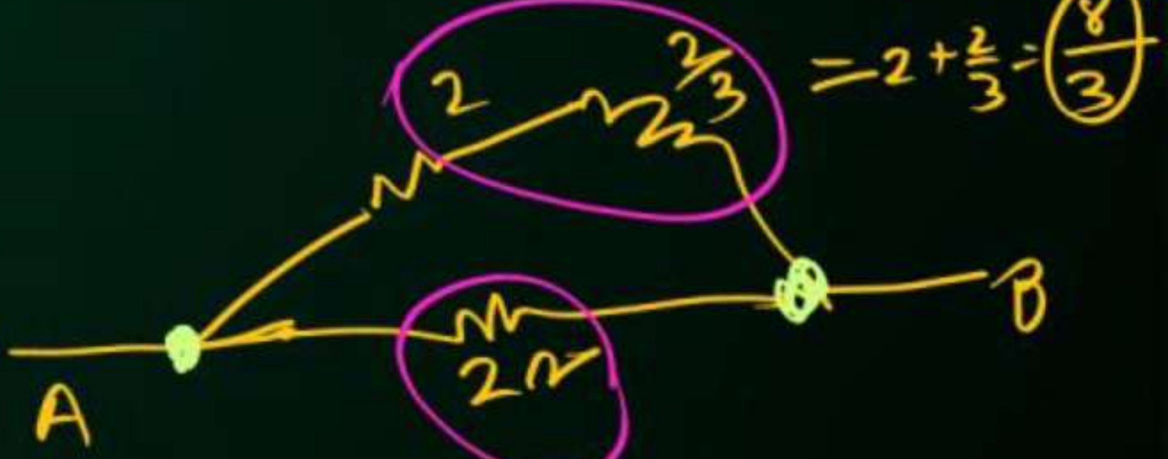
(1) $\frac{4}{3}\Omega$

(2) $\frac{3}{2}\Omega$

(3) $7\,\Omega$

(4) $\frac{8}{7}\Omega$

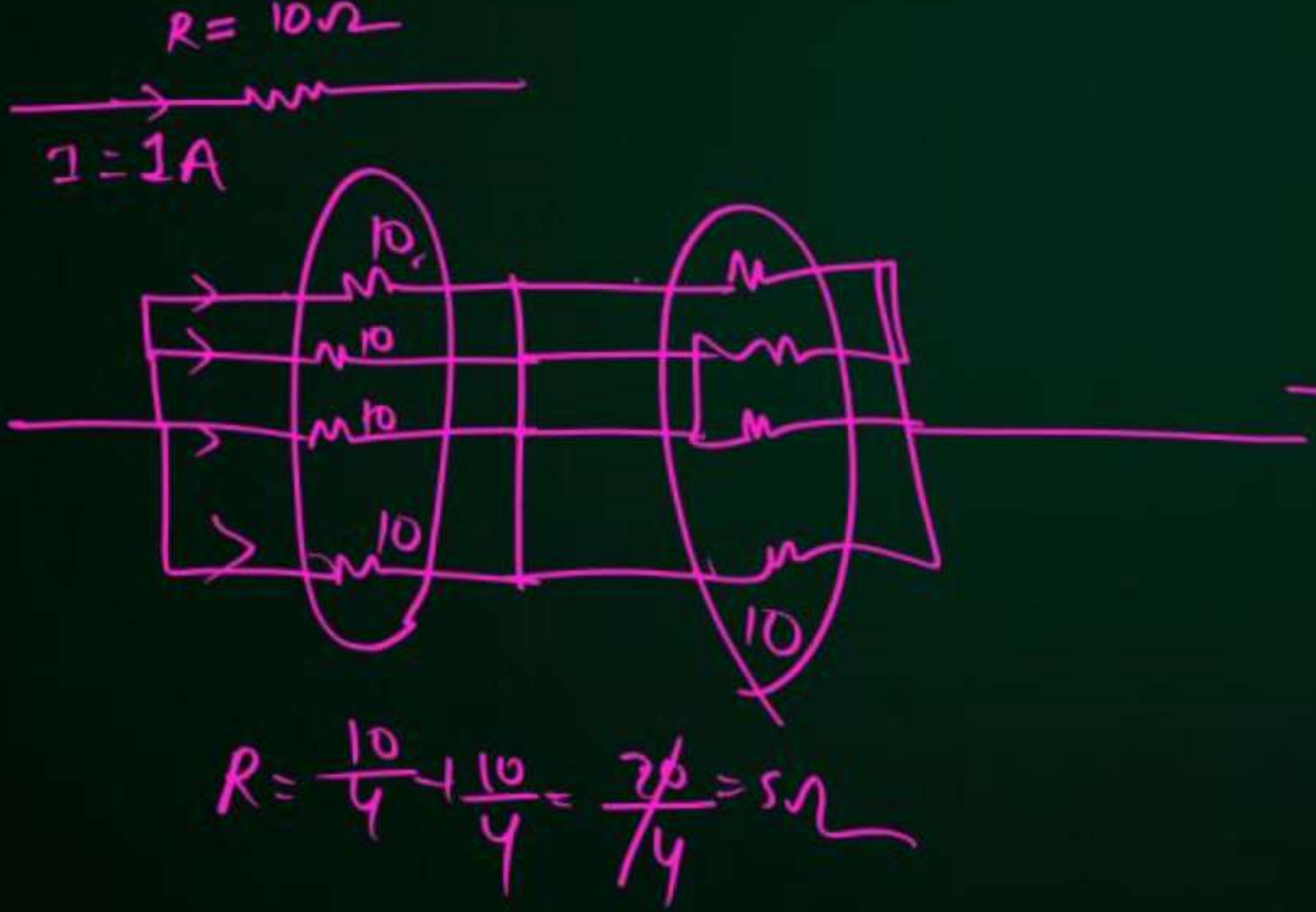
$R_{AB} = \frac{\frac{8}{3}\times 2}{\frac{8}{3}+2} = \frac{16/3}{14/3} = \frac{16}{14} = \frac{8}{7}$

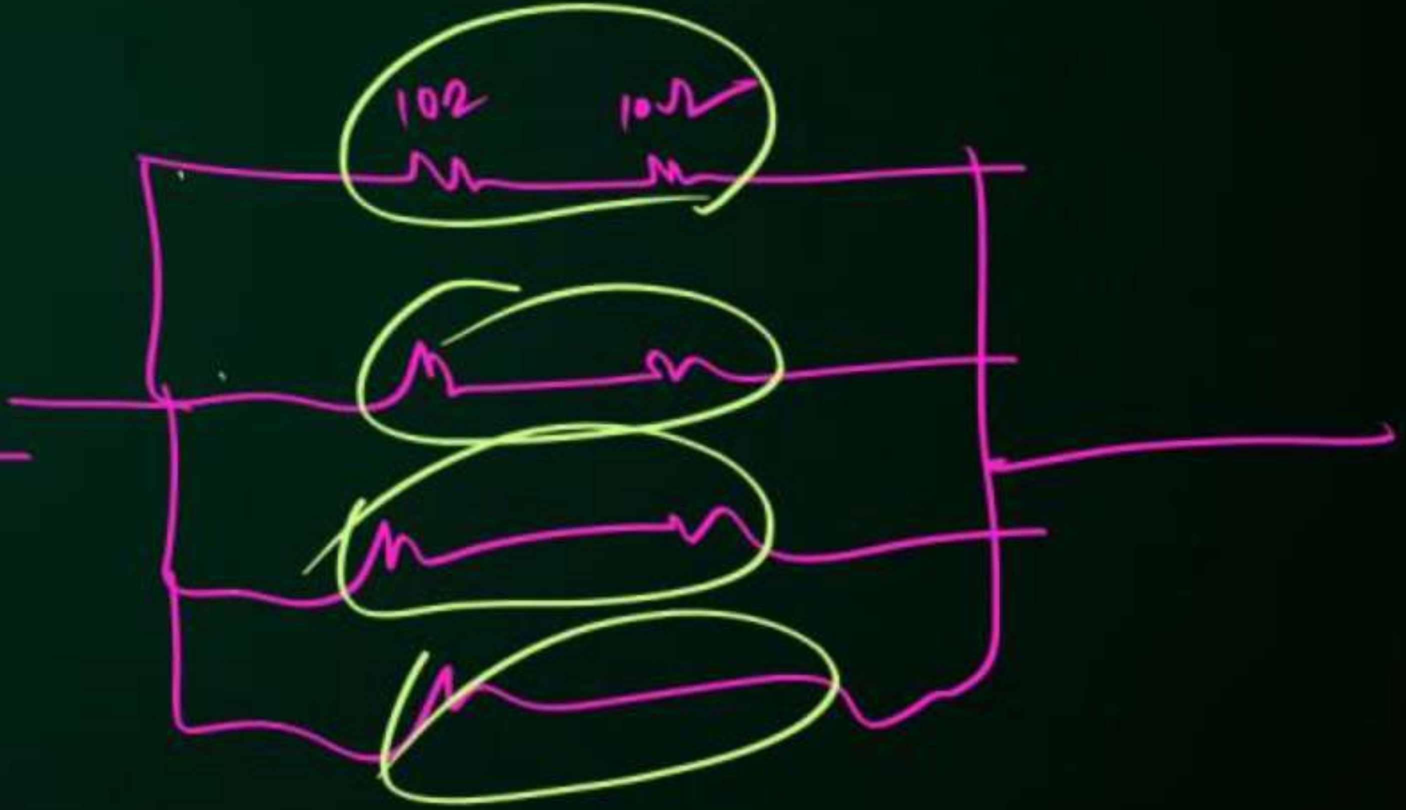


QUESTION

You are given several identical resistances each of value R = 10 Ω and each capable of carrying a maximum current of one ampere. It is required to make a suitable combination of these resistances of 5 Ω which can carry a current of 4 ampere. The minimum number of resistances of the type R that will be required for this job is

1. 4
2. 10
3. 8
4. 20





QUESTION

n equal resistors are first connected in series and then connected in parallel. What is the ratio of the maximum to the minimum resistance ?

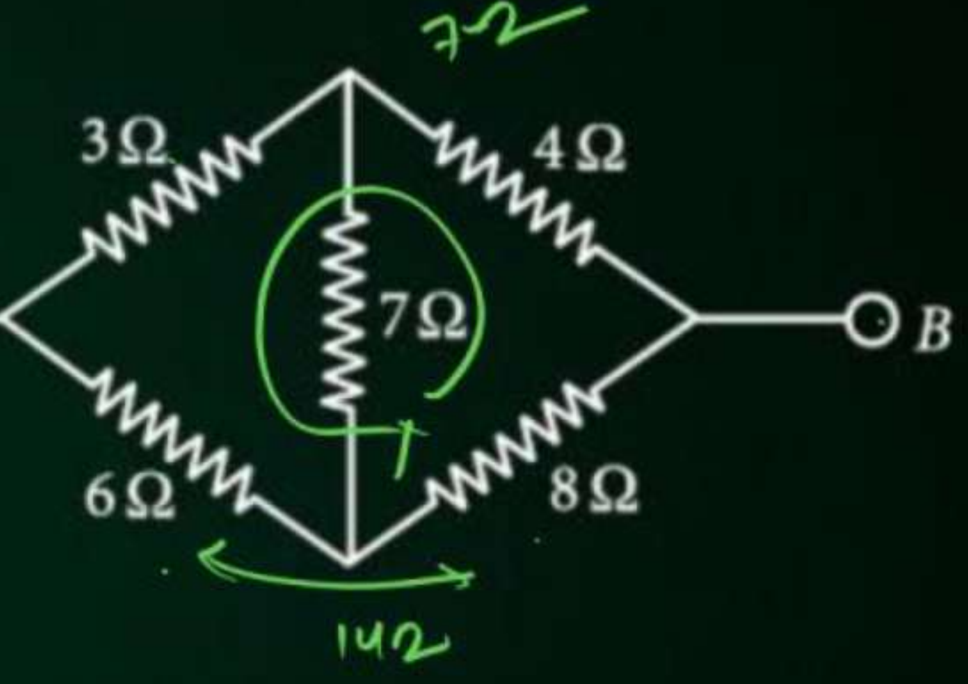
1. n
2. $1/n^2$
3. n^2 ✓
4. $1/n$

$$\frac{R_{\Sigma} = nR}{R_{\parallel} = \frac{R}{n}} = n^2 : 1$$

QUESTION

The net resistance of the circuit between A and B is

1. $\frac{8}{3}\Omega$
2. $\frac{14}{3}\Omega$
3. $\frac{16}{3}\Omega$
4. $\frac{22}{3}\Omega$

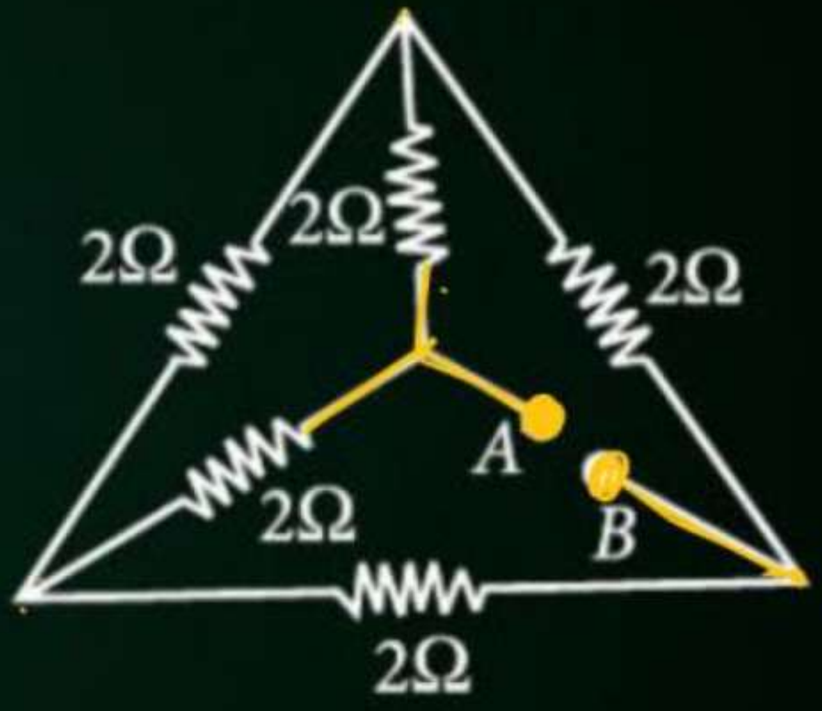


QUESTION

In the network shown in the figure, each of the resistance is equal to 2 Ω. The resistance between the points A and B is

1. 3 Ω
2. 4 Ω
3. 1 Ω
4. 2 Ω ✓





QUESTION

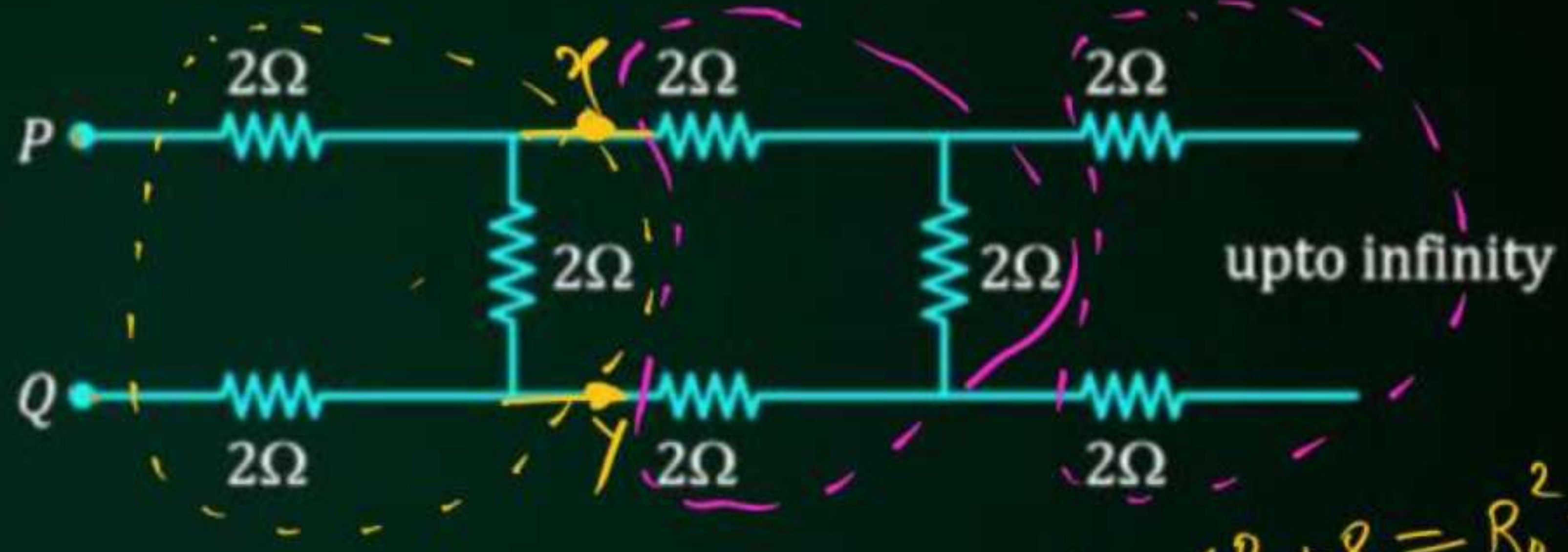
The resistance between the terminal points P and Q of the given infinitely long circuit will be

(1) $2(\sqrt{3}-1)\,\Omega$

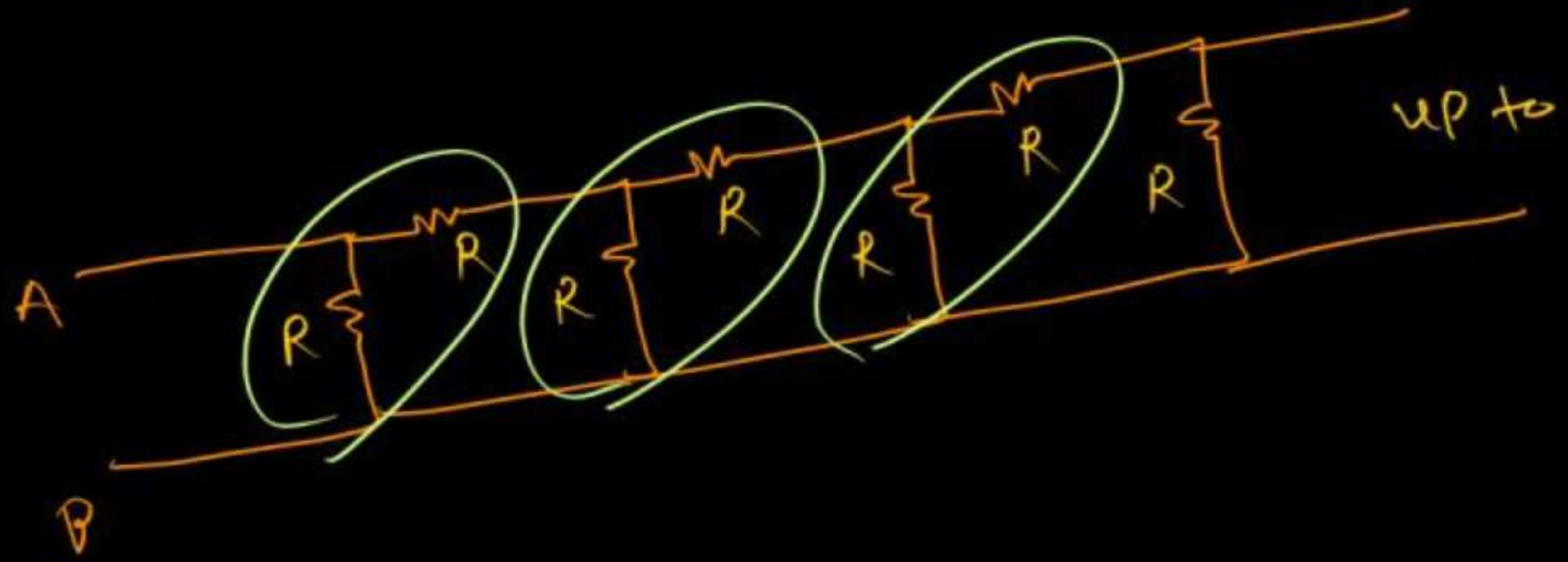
(2) $2(\sqrt{3}+1)\,\Omega$

(3) $(\sqrt{3}-1)\,\Omega$

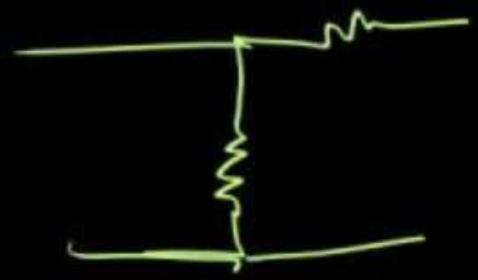
(4) $(\sqrt{3}+1)\,\Omega$

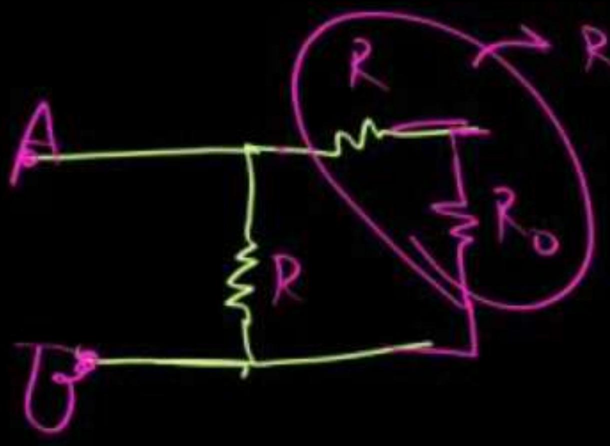


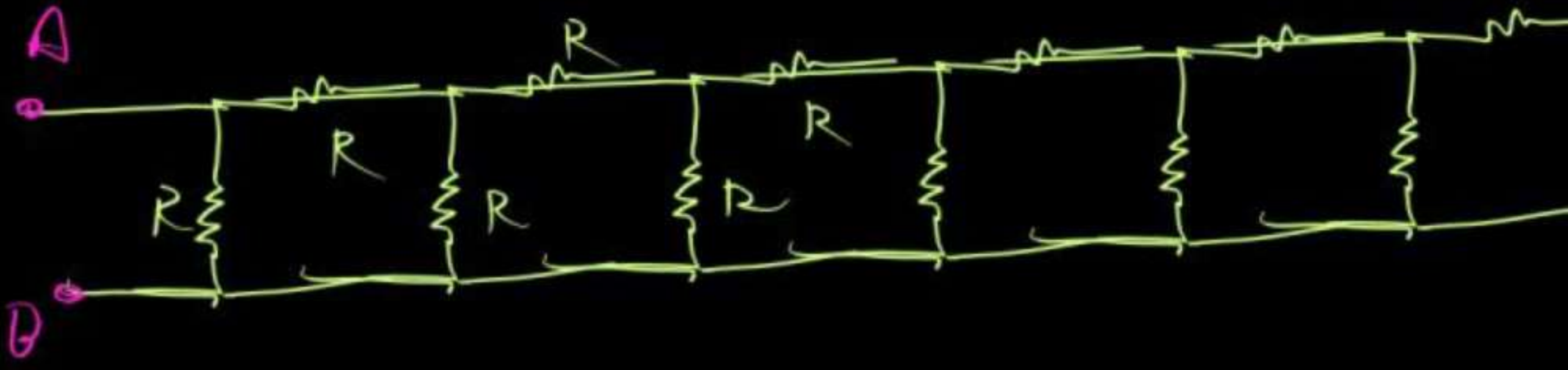
$m\overset{*}{R}$ $R_{AB} < R$



$R_{AB} = ??$







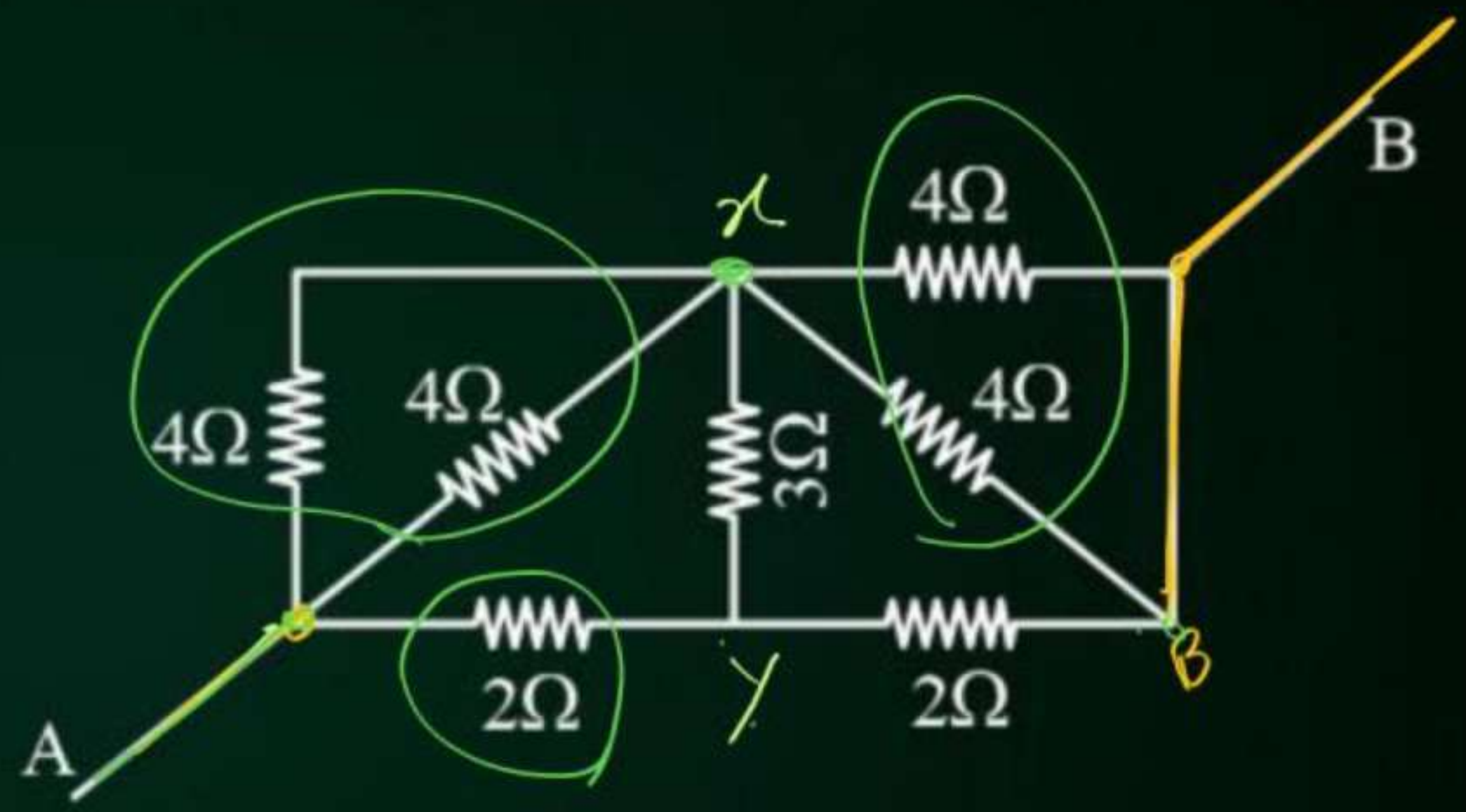
$$R_{AB} = \frac{(R_0+R)\times R}{R_0+R+R}$$

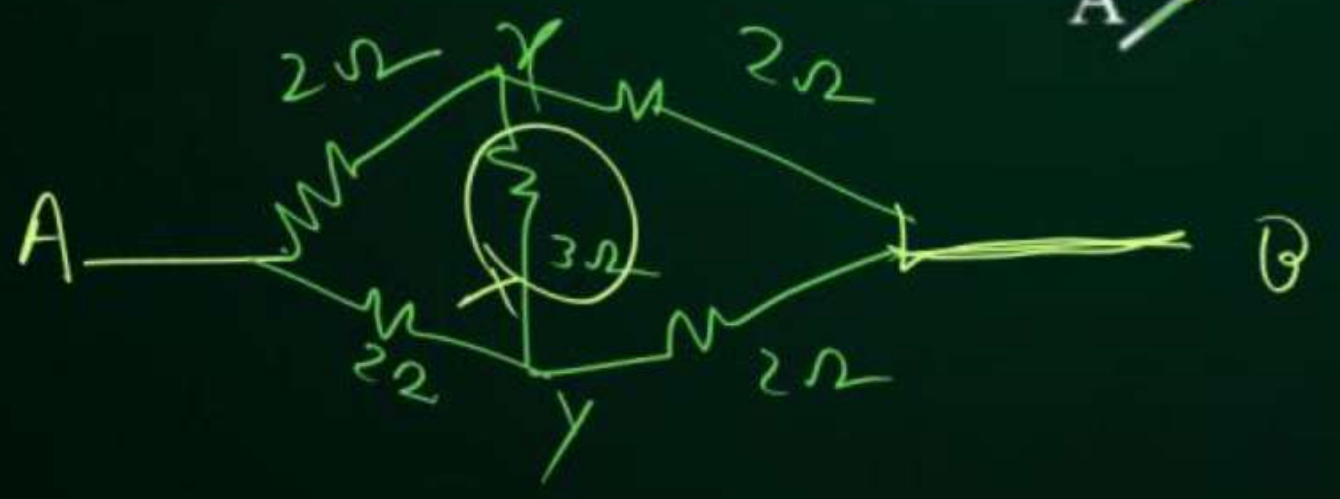
$R_0 (1\Omega)$

QUESTION

Resistance across AB as shown in figure is

1. 2 Ω
2. 4 Ω
3. 6 Ω
4. 12 Ω

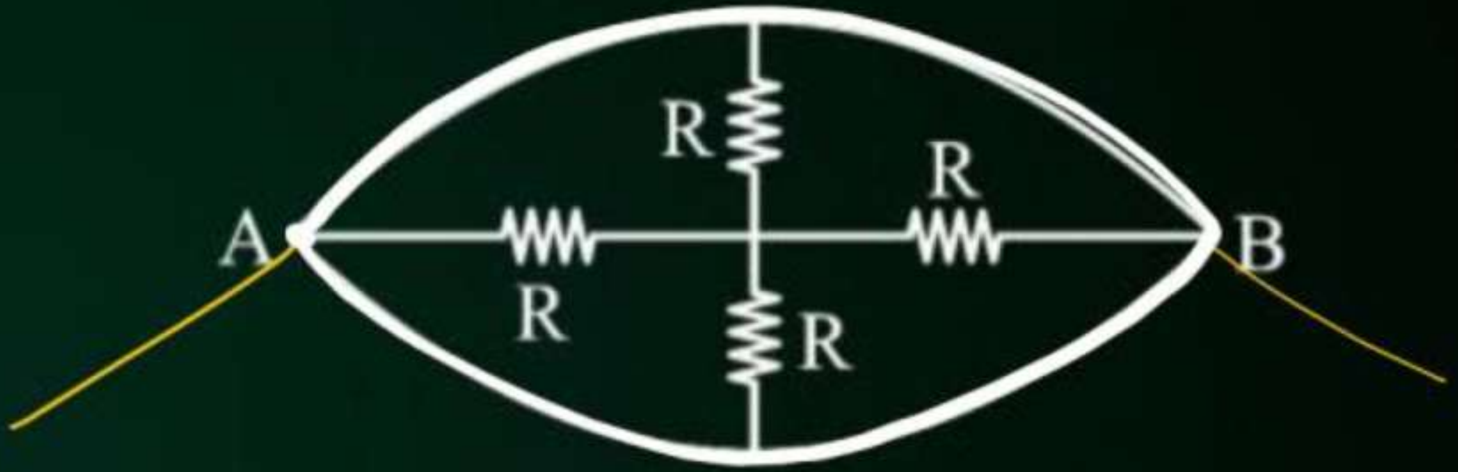




QUESTION

For the given figure equivalent resistance between point A and B is

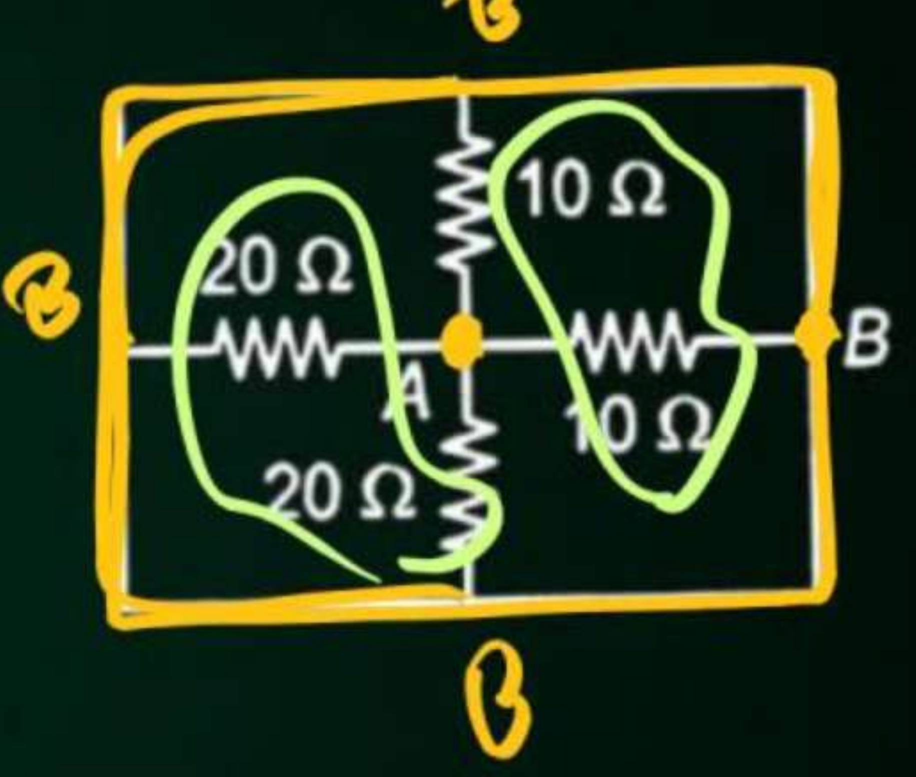
1. 4 R
2. R/4
3. R/2
4. Zero



QUESTION

What is the equivalent resistance between points A and B in the network shown

1. $\frac{20}{3}\,\Omega$
2. $\frac{20}{6}\,\Omega$ ✓
3. $20\,\Omega$
4. $30\,\Omega$

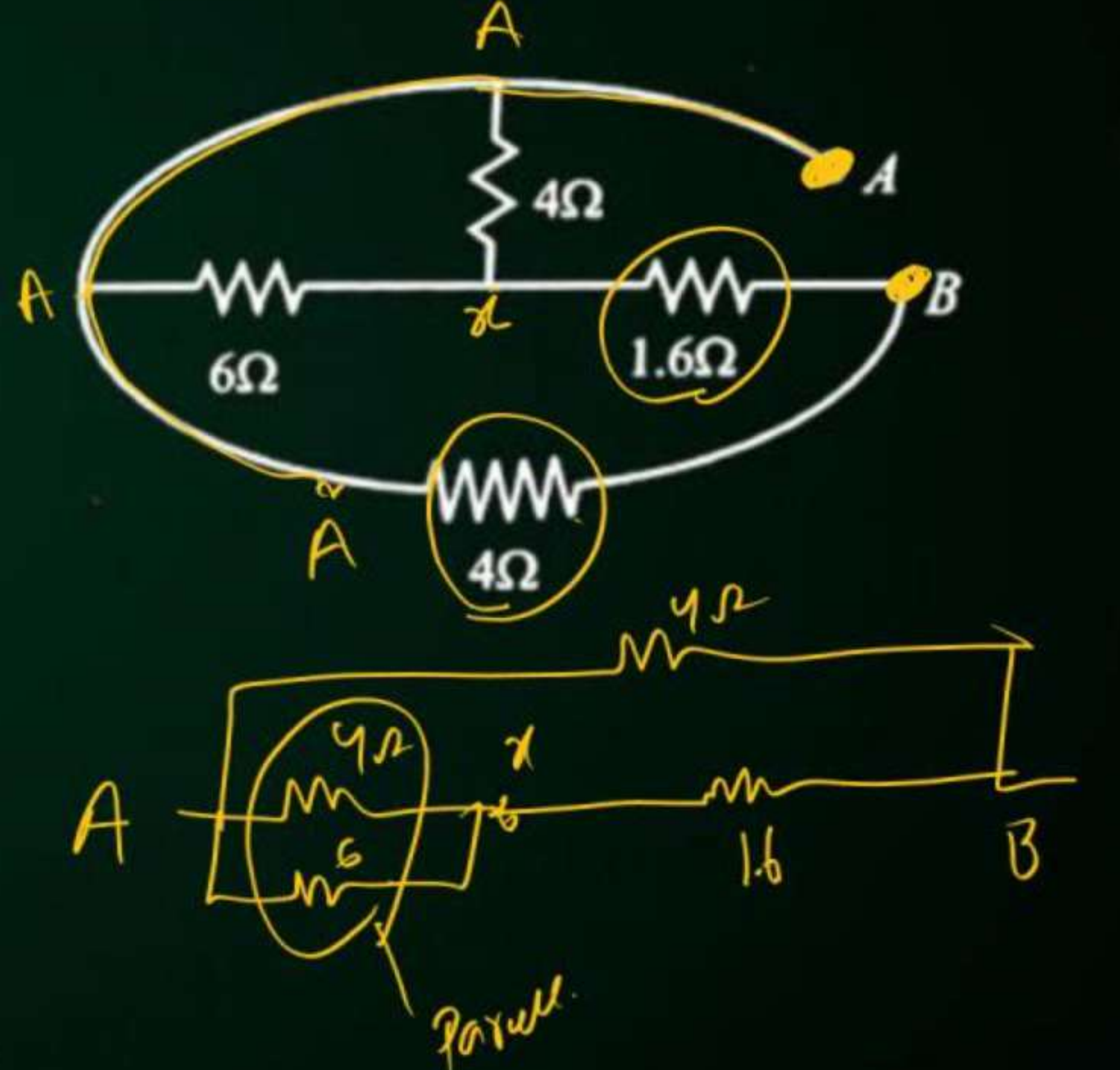


$\frac{5 \times 10}{15}$

QUESTION

If four resistance are connected as shown in the figure between A and B the effective resistance is

1. $4\,\Omega$
2. $8\,\Omega$
3. $2.4\,\Omega$
4. $2\,\Omega$



QUESTION

Six resistance of each 12 ohm are connected as shown in the figure. The effective resistance between the terminals A and B is

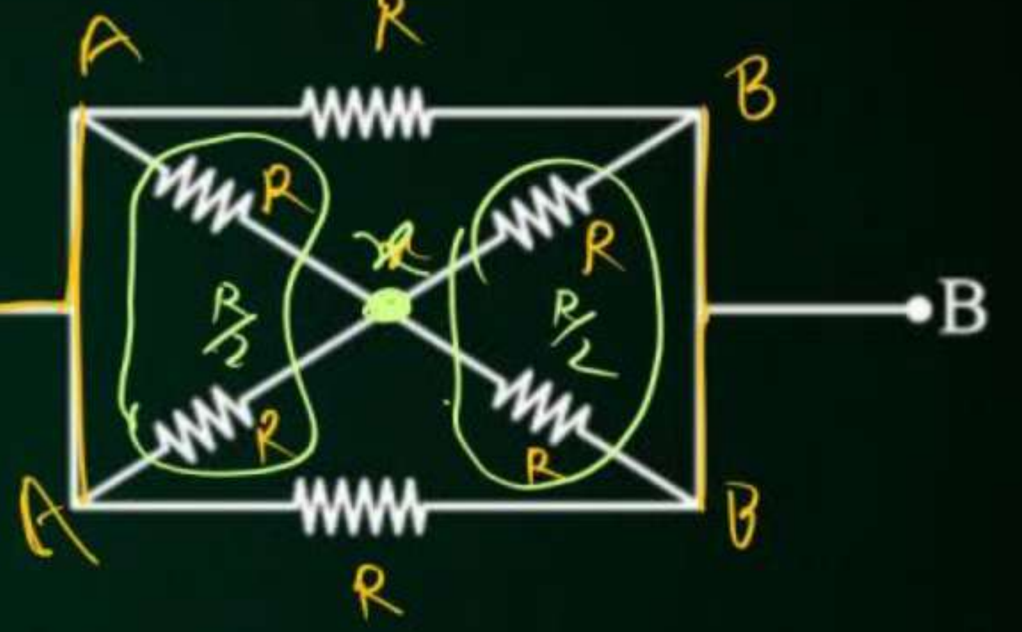
(1) $8\,\Omega$

$R_{\text{eq}} = \frac{R}{3} = \frac{12}{3} = 4\,\Omega$

(2) $6\,\Omega$

(3) $4\,\Omega$ ✓

(4) $12\,\Omega$



QUESTION

There are five equal resistors. The minimum resistance possible by their combination is 2 ohm. The maximum possible resistance we can make with them is

1. $25\,\Omega$
2. $50\,\Omega$
3. $100\,\Omega$
4. $150\,\Omega$

$\frac{R}{5} = 2$

$R = 10\Omega$

QUESTION

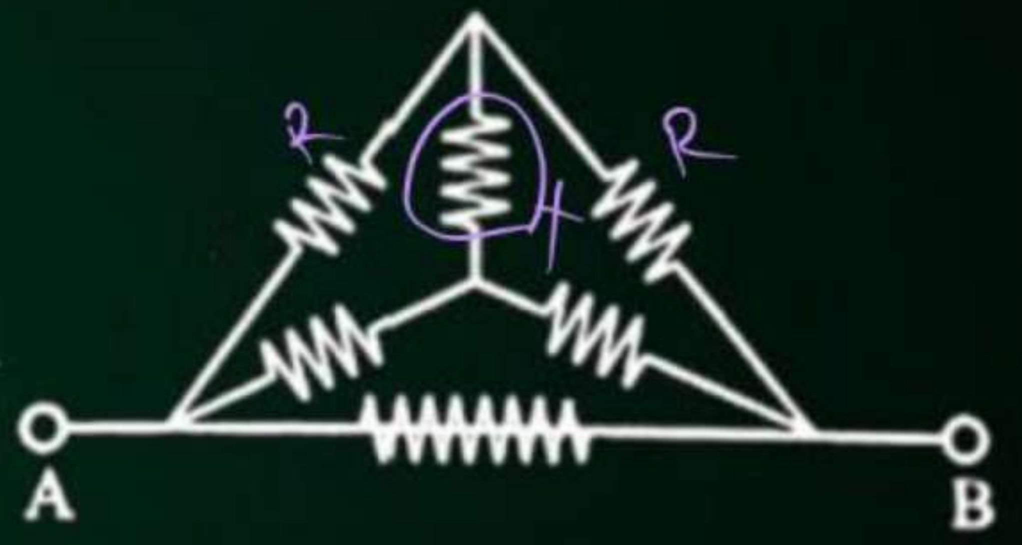
Resistance of each 10 Ω are connected as shown in the figure. The effective resistance between A and G is



1. 16
2. 20
3. 12
4. 8

QUESTION

Six resistors of each 2 ohm are connected as shown in the figure. The resultant resistance between A and B is



1. $4\,\Omega$
2. $2\,\Omega$
3. $1\,\Omega$
4. $10\,\Omega$

QUESTION

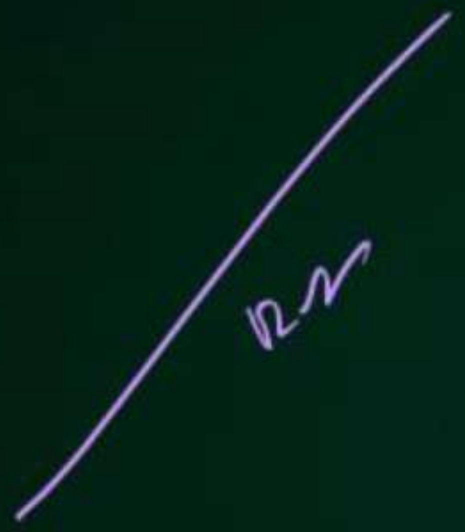
The resistance between A and B is

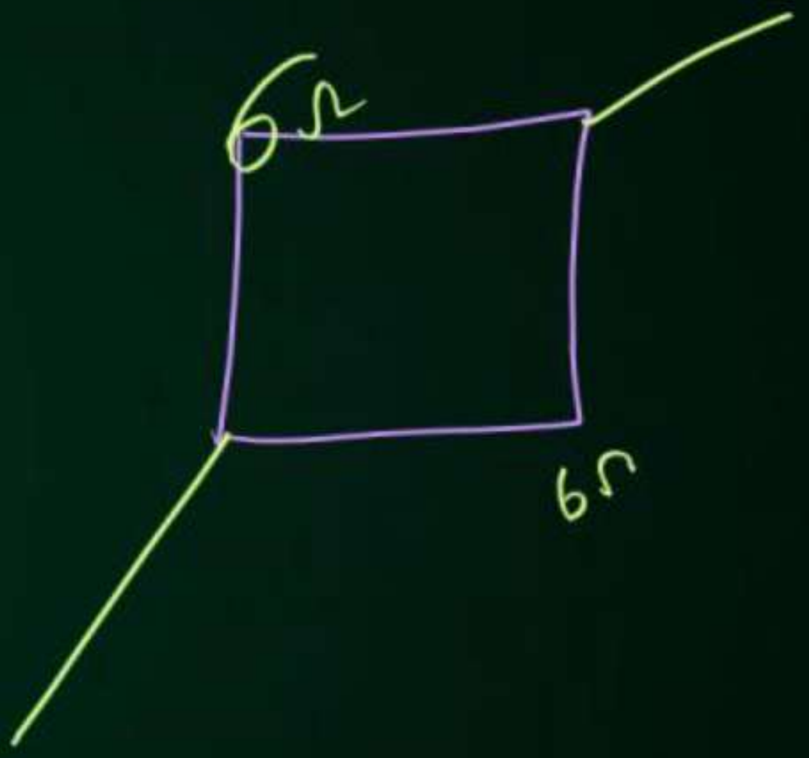
1. $8\,\Omega$
2. $4\,\Omega$
3. $3.75\,\Omega$
4. $2\,\Omega$

fig - miss

QUESTION

A metallic wire of resistance $12\,\Omega$ is bent to form a square. The resistance between two diagonal points would be

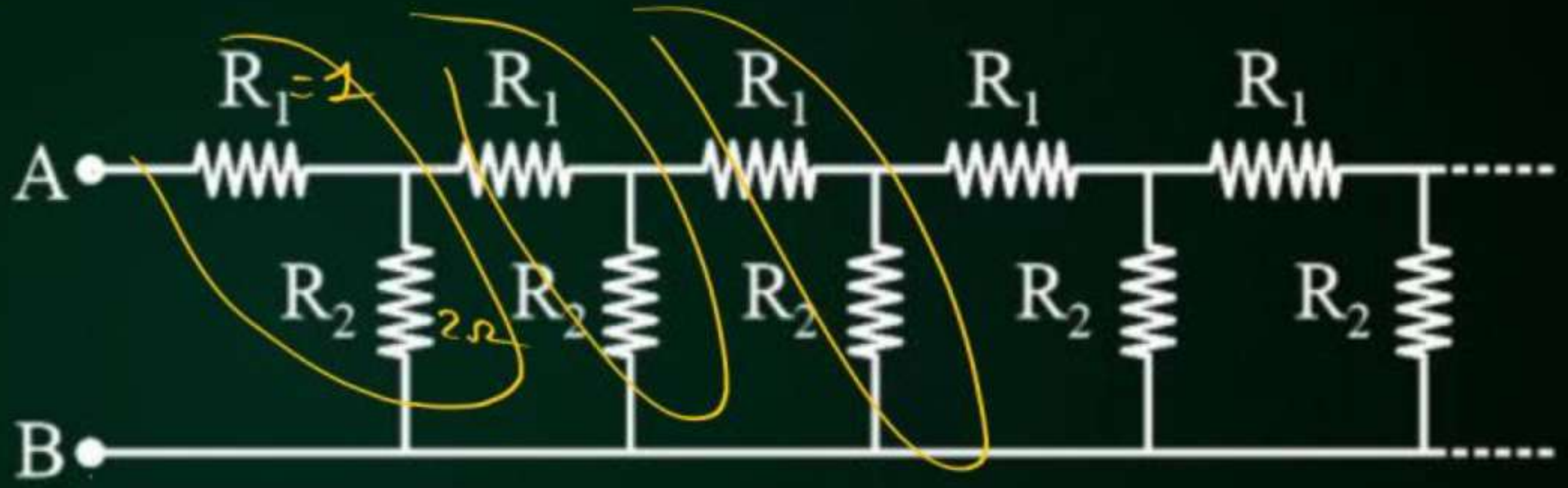




1. $12\,\Omega$
2. $24\,\Omega$
3. $6\,\Omega$
4. $3\,\Omega$

QUESTION

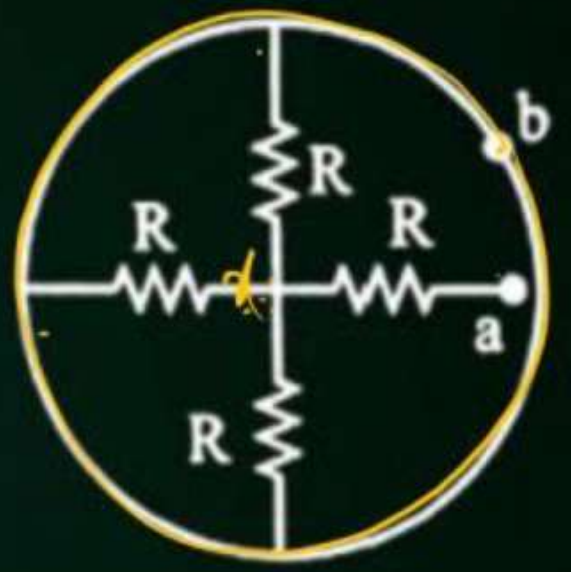
An infinite sequences of resistance is shown in the figure. The resultant resistance between A and B will be when $R_1 = 1\ \Omega$ and $R_2 = 2\Omega$



1. Infinity
2. $1\ \Omega$
3. $2\ \Omega$
4. $1.5\ \Omega$

QUESTION

The equivalent resistance between points a and b of a network shown in figure is

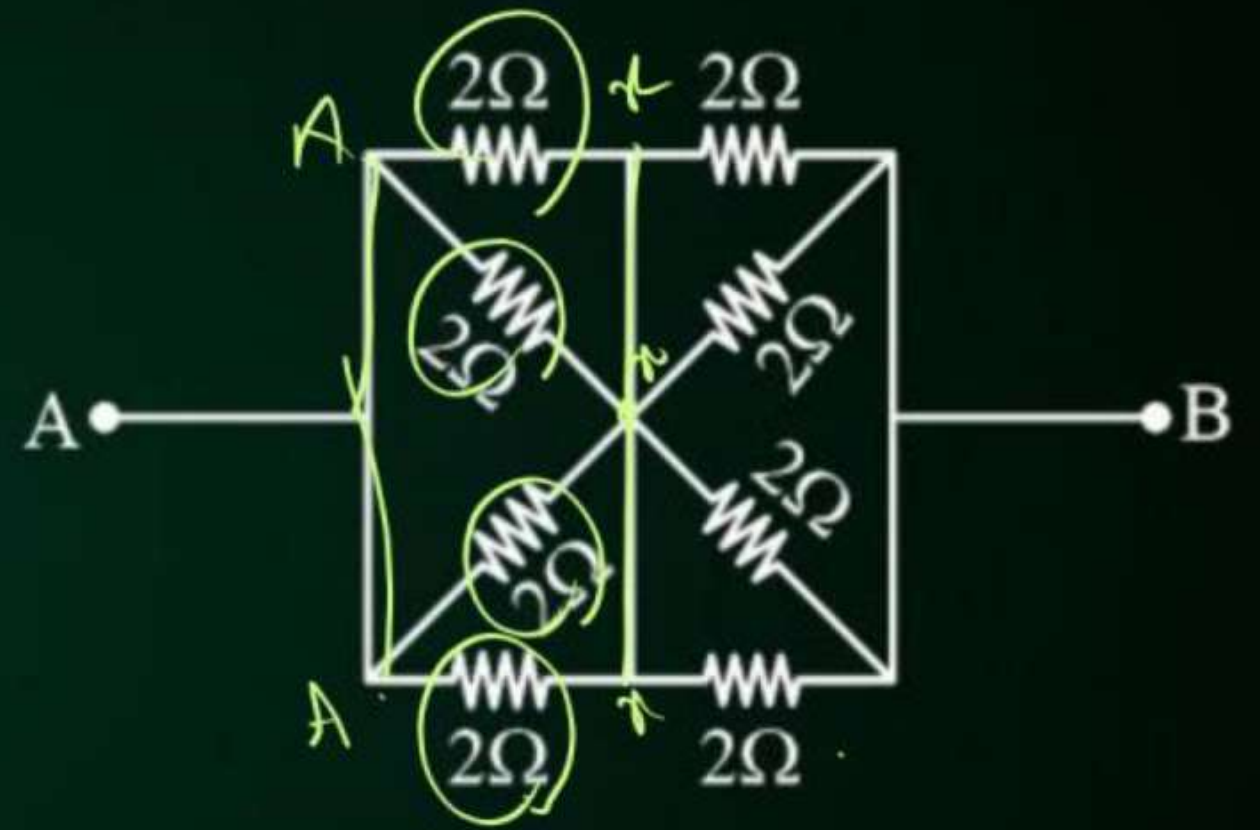


1. $\frac{3}{4}R$
2. $\frac{4}{3}R$
3. $\frac{5}{4}R$
4. $\frac{4}{5}R$

QUESTION

The effective resistance across the point A and B is

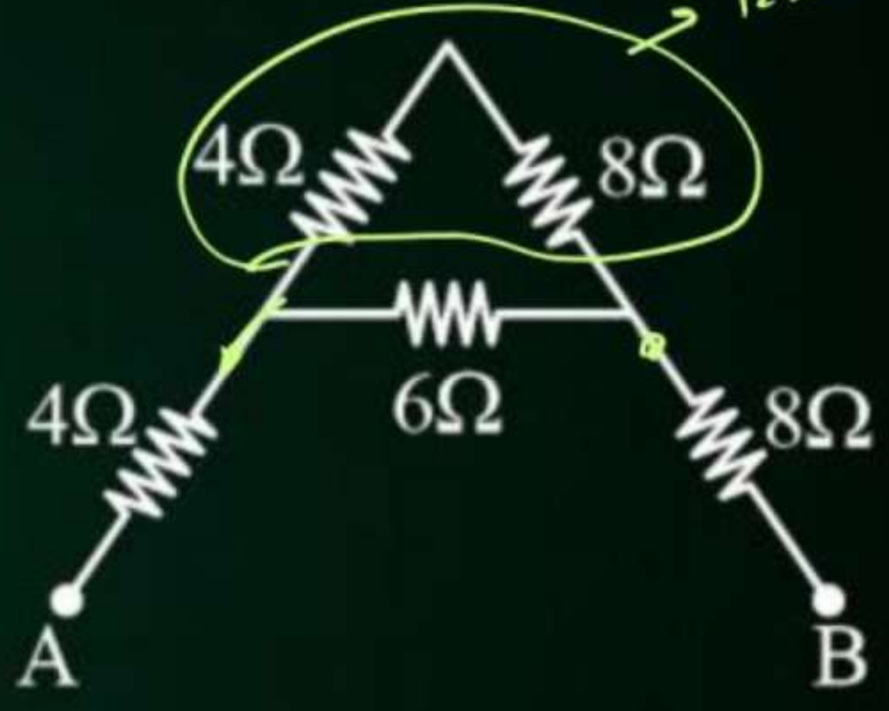
1. $2\,\Omega$
2. $1\,\Omega$ ✓
3. $0.5\,\Omega$
4. $5\,\Omega$



$= \frac{8}{4}\ \Omega = 2$

QUESTION

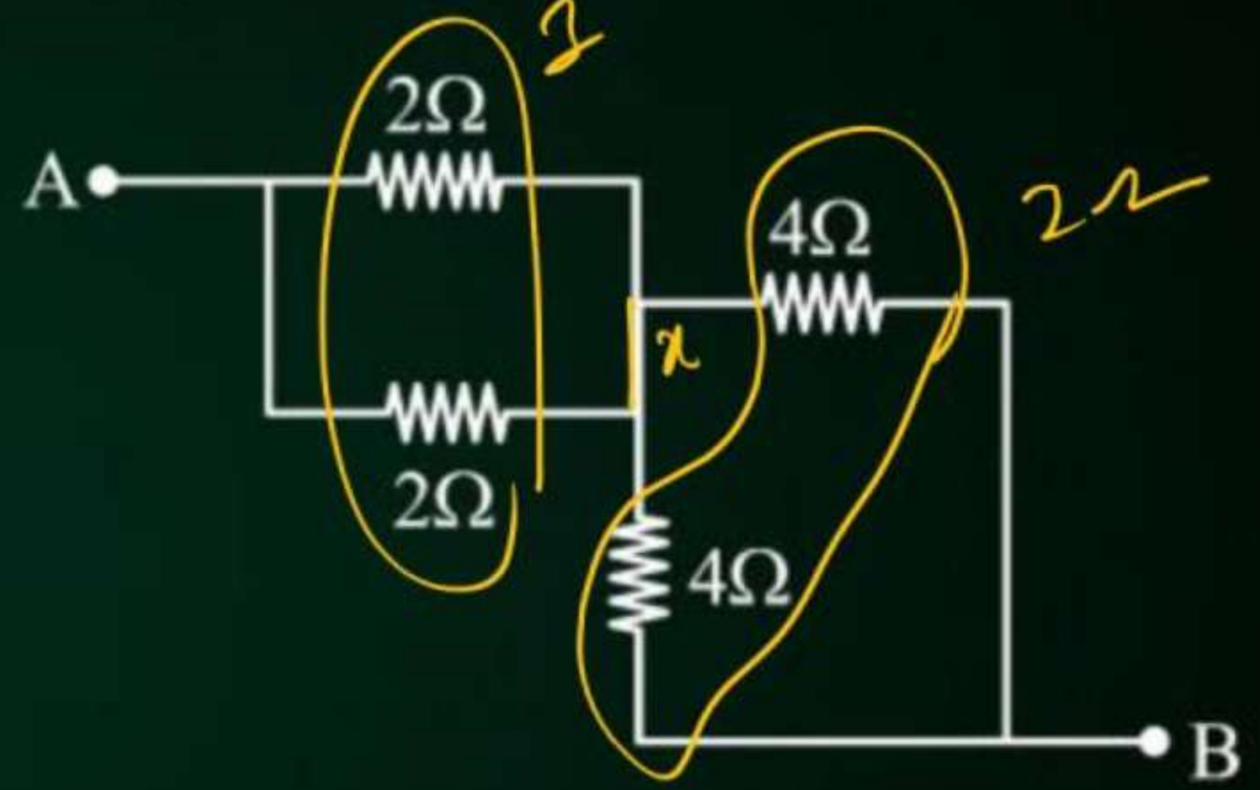
The equivalent resistance between A and B for the mesh shown in the figure is



1. $16\,\Omega$
2. $30\,\Omega$
3. $4.8\,\Omega$
4. $7.2\,\Omega$

QUESTION

Effective resistance across AB in the network shown in



1. 6 Ω
2. 3 Ω
3. 5 Ω
4. 8 Ω

MAXIMUM POWER THEOREM

A cell of e.m.f. E and internal resistance r is connected [redacted]

Power loss across load resistance

$P = I^2 R$

$P = \frac{E^2}{(R+r)^2} R$

P will be max^m when $\frac{dP}{dR} = 0$ at $(r = R)$

If $R = 0$

$P = 0$

If $R \lll r$

$P = \frac{E^2}{r^2} R$

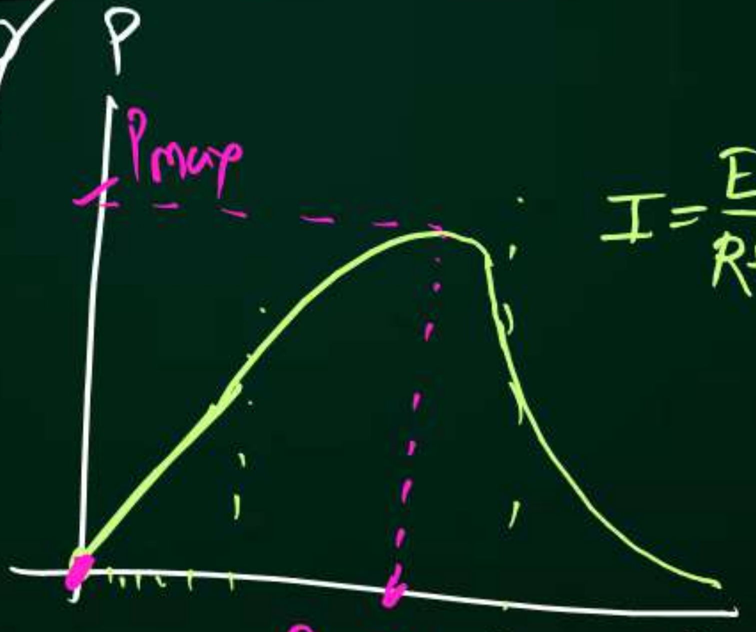
$P \propto R$

If $R \ggg r$

$P = \frac{E^2}{R^2} R$

$P = \frac{E^2}{R}$

$P \propto \frac{1}{R}$



$P_{max} = \frac{E^2}{(2R)^2} R$

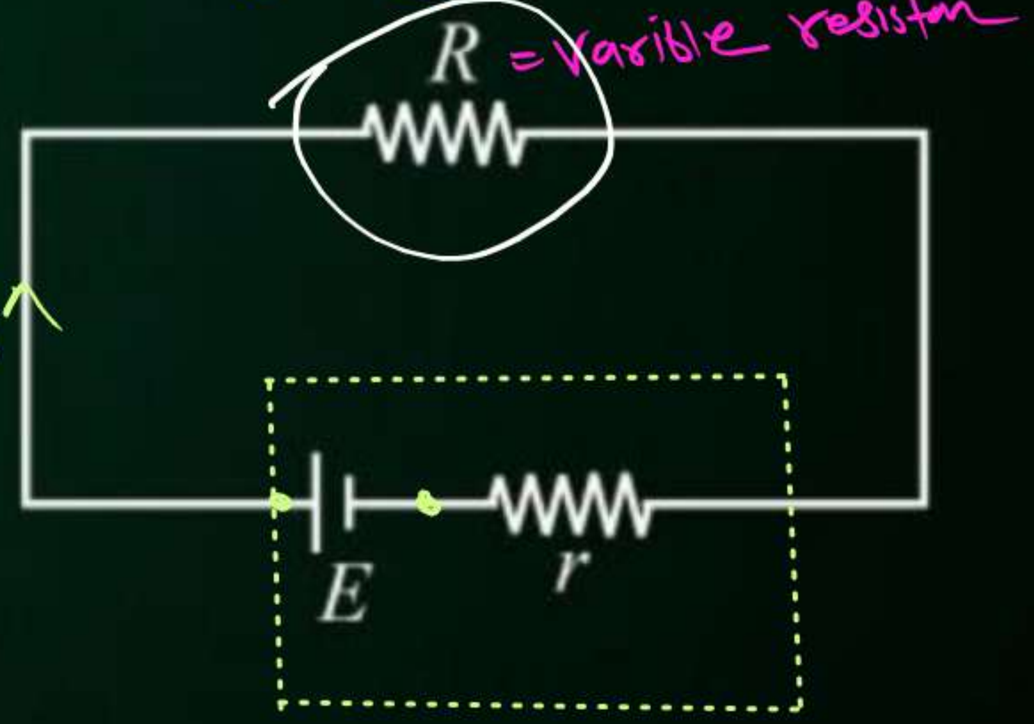
$R = r$

$P_{max} = \frac{E^2}{4R}$

$P = I^2 R$

drop

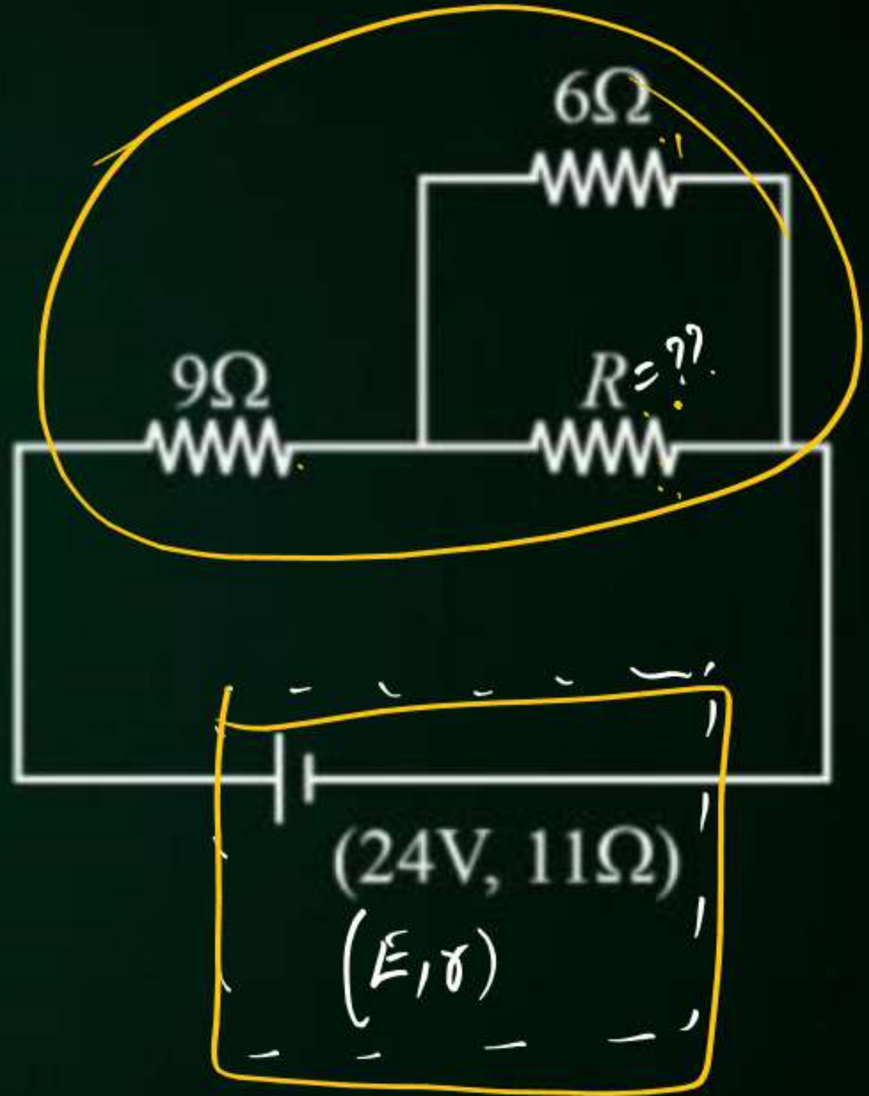
$I = \frac{E}{R+r}$



QUESTION

Find R so that power supplied by the battery is maximum

1. $R = 11\Omega$
2. $R = 9\Omega$
3. $R = 2\Omega$
4. $R = 3\Omega$ Ans



QUESTION

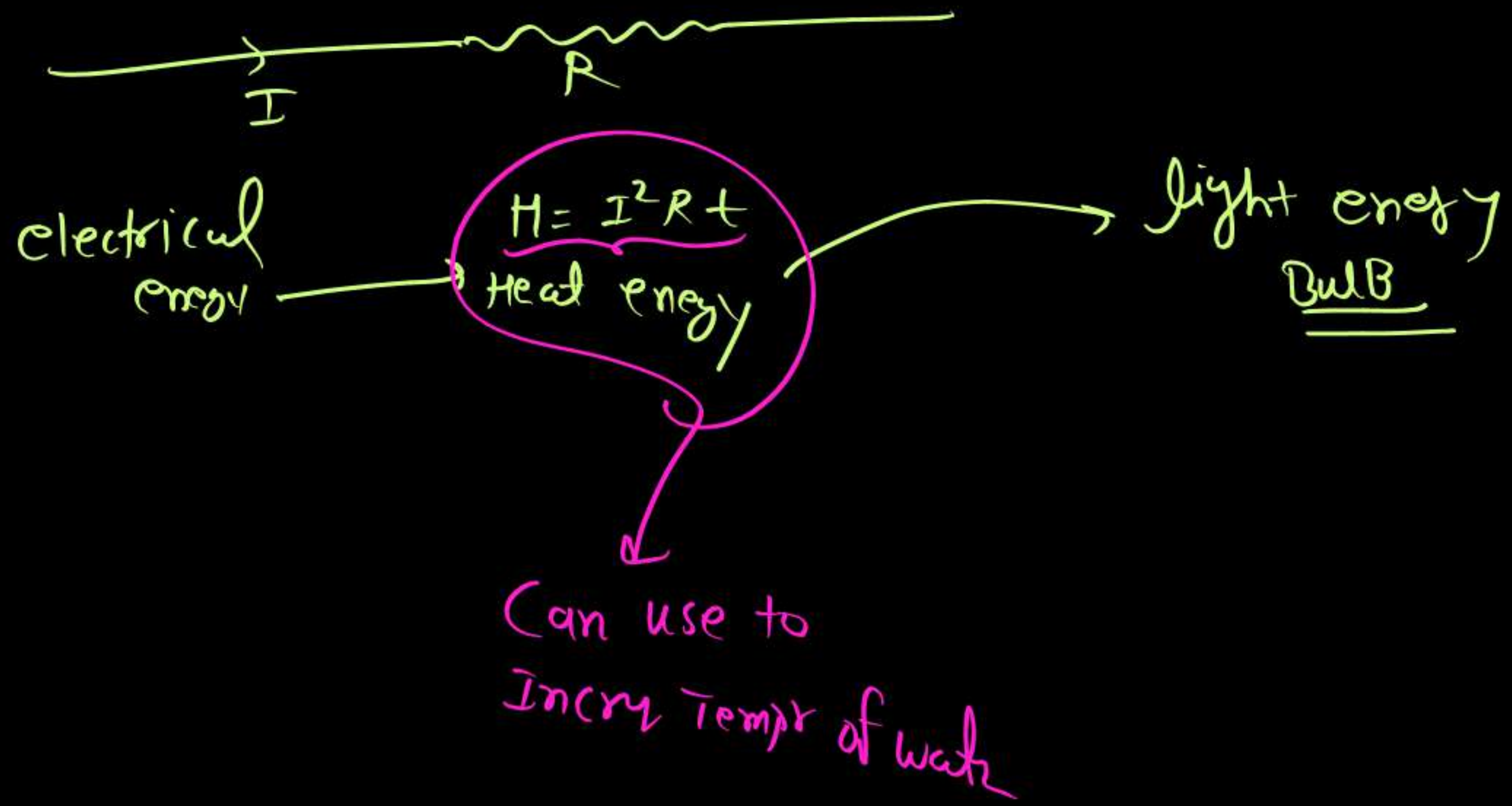
If voltage across a bulb rated 220 volt- 100 watt drops by 2.5% of its rated value, the percentage of the rated value by which the power would decrease is (1995)

1. 20%
2. 2.5%
3. 5% ✓
4. 10%

$$P_{consum} = \left(\frac{V_S}{V_R}\right)^2 P_{Rated}$$

$$P_C \propto V_S^2$$

$$\frac{\Delta P_C}{P_C} = 2\frac{\Delta V_S}{V_S} \times 100$$


I
R
electrical energy
H = I²R t
Heat energy
light energy
BulB
Can use to
Incr Tempr of water

QUESTION

A 5° C rise in temperature is observed in a conductor by passing a current. When the current is doubled the rise in temperature will be approximately (1998)

1. 20°C
2. 16°C
3. 10°C
4. 12°C

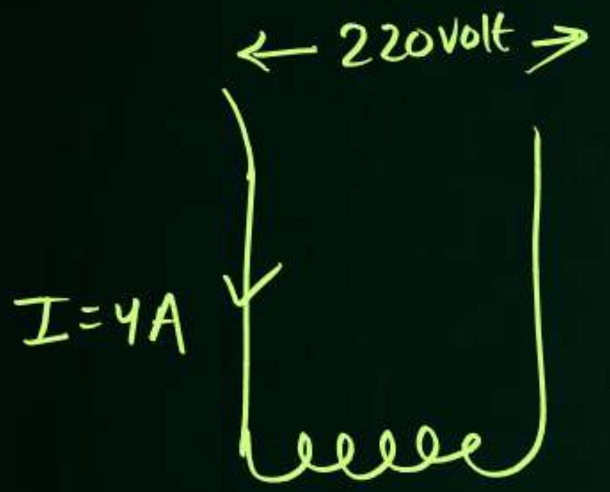
$H = I^2 R t$

$ms\Delta T = I^2 R t$

$\Delta T \propto I^2$

QUESTION

A electric kettle takes 4A current at 220V. How much time it will take to boil 1 kg water from 20°? (Temperature of boiling water is 100°C)



$s = \frac{1\,J}{gm\,°C} = \frac{4.2}{10^{-3}} = 4.2 \times 10^{3}$

$T_f = 100°C$

$T_i = 20°C$

$W = 1000\, gm.$

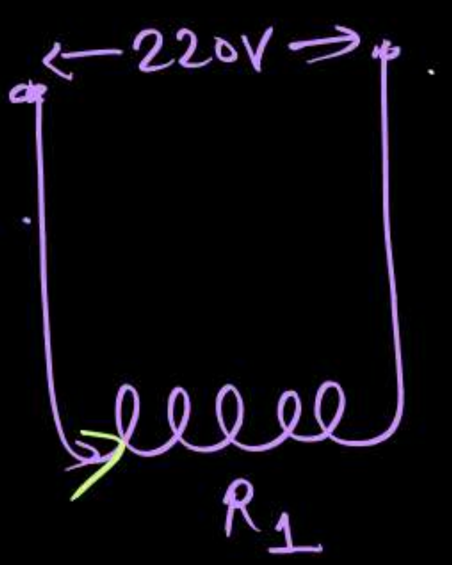
$H = IVt = ms\Delta T$

$4 \times 220\, t = 1 \times 4200 \times 80$

$t = \frac{4200 \times 80}{4 \times 220}$

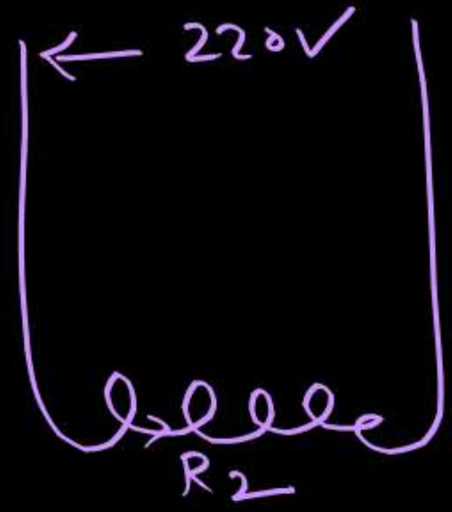
$= \frac{420 \times 20}{22}$ sec

Heater coil.



$$H = \frac{V^2}{R_1} t_1$$

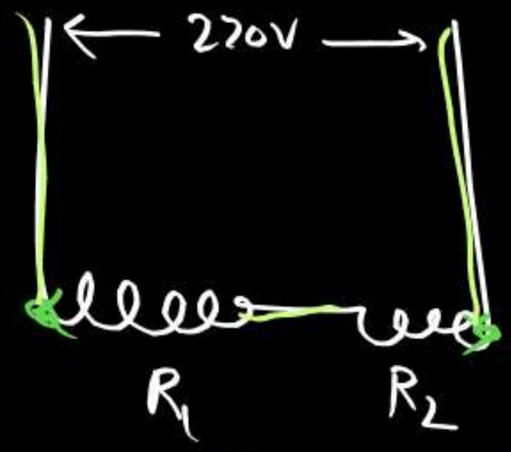
Heat 'H' supply by 1^{st} Heater coil in t_1



$$H = \frac{V^2}{R_2} t_2$$

Heat 'H' supply by 2^{nd} Heater coil in t_2

Series comb^n of Heater



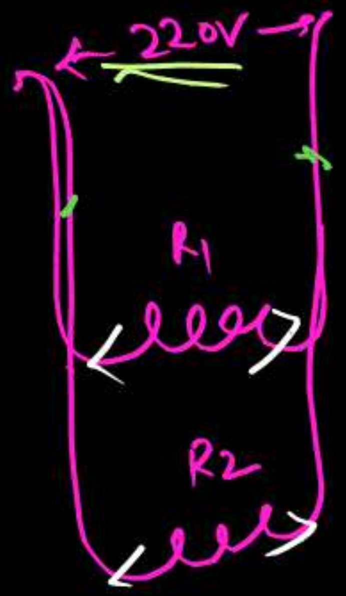
$$H = \frac{V^2}{R_{eq}} t = \frac{V^2}{(R_1+R_2)} t$$

$$H = \left(\frac{V^2}{\frac{V^2 t_1}{H} + \frac{V^2 t_2}{H}} \right) t$$

$$H = \frac{t}{\frac{1}{H}(t_1+t_2)}$$

☆ $t = t_1 + t_2$

Heater coil in Parallel.



$$H = \frac{V^2 t}{R_{eq}} = V^2\left(\frac{1}{R_1} + \frac{1}{R_2}\right) t$$

$$H = V^2\left[\frac{H}{V^2 t_1} + \frac{H}{V^2 t_2}\right] t$$

$$1 = \left(\frac{1}{t_1} + \frac{1}{t_2}\right) t$$

$$\frac{1}{t} = \frac{1}{t_1} + \frac{1}{t_2}$$

$$t = \frac{t_1 t_2}{t_1 + t_2}$$

QUESTION

Two heater coils separately take 10 minute and 5 minute to boil certain amount of water. If both the coils are connected in series the time taken will be:

1. 15 min
2. 7.5 min
3. 3.33 min
4. 2.5 min

QUESTION

A heater boil certain amount of water in 15 min another heater in 10 min, find time taken to boil same amount of water when they are connected in parallel?

$$t = \frac{15 \times 10}{25} = \frac{30}{5} = 6\ \text{min}$$


THANK YOU


YAKEEN 2.0
FOR NEET 2025
Lecture- [redacted] 9
Physics
Current Electricity
By- Dr. Manish Raj (MR SIR)
PW

Topics to be covered

(*) Heater coil / Max^m Power Theor^m

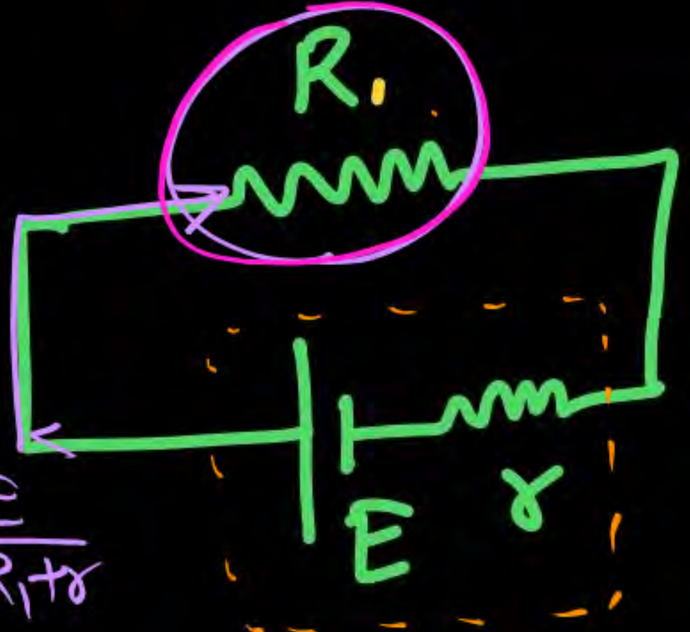
1. # — # Galvanometre → Ammetre, voltmere
2. # — → metre/Bridge
3. #

~~Potentiometre~~ → Not in syllabus

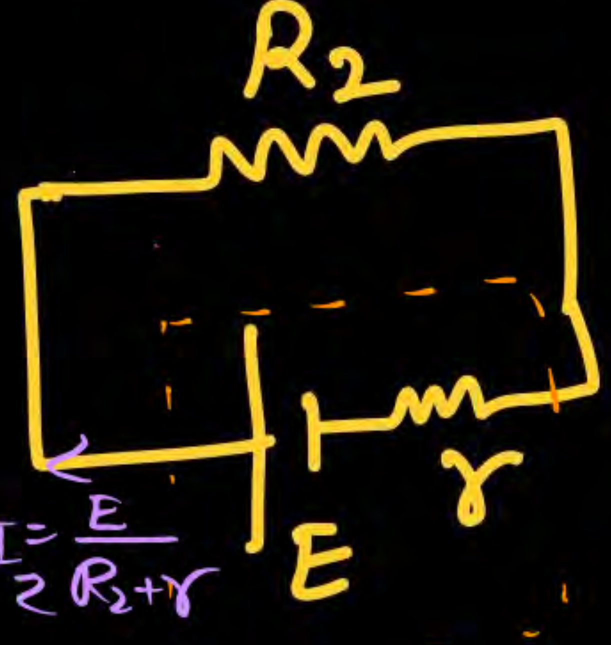


Q) IIT

Two Identical Battery connected with different external load R_1 and R_2 as shown in figure. then Find Relation B/w R_1, R_2 and r if Heat loss in R_1 and R_2 is same.



$I_1 = \frac{E}{R_1+r}$



$I_2 = \frac{E}{R_2+r}$

Sol^n

* $H_1 = I_1^2 R_1 t$

$H_1 = \frac{E^2}{(R_1+r)^2} R_1 t$

* $H_2 = \left(\frac{E}{R_2+r}\right)^2 R_2 t$ — (ii)

" $H_1 = H_2$ "

$\Rightarrow \frac{E^2}{(R_1+r)^2} R_1 t = \frac{E^2}{(R_2+r)^2} R_2 t$

$\frac{(R_2+r)^2}{(R_1+r)^2} = \frac{R_2}{R_1}$

$\frac{R_2+r}{R_1+r} = \frac{\sqrt{R_2}}{\sqrt{R_1}}$

$\sqrt{R_1} R_2 + \sqrt{R_1} r = \sqrt{R_2} R_1 + \sqrt{R_2} r$

$\sqrt{R_1} R_2 - \sqrt{R_2} R_1 = \sqrt{R_2} r - \sqrt{R_1} r$

$\sqrt{R_1}\sqrt{R_2}\left[\sqrt{R_2} - \sqrt{R_1}\right] = r\left(\sqrt{R_2} - \sqrt{R_1}\right)$

$r = \sqrt{R_1}\sqrt{R_2} = \sqrt{R_1 R_2}$

$$\int (a+bx)^2 \, dx = \frac{(a+bx)^{2+1}}{(2+1) \times b}$$

$$\int \sin(3x+4) \, dx = \frac{-\cos(3x+4)}{3}$$

QUESTION

The charge flowing through a resistance R varies with time t as $Q = at - bt^2$, where a and b are positive constants. The total heat produced in R is

NEET-2016

1. $\dfrac{a^3R}{2b}$
2. $\dfrac{a^3R}{b}$
3. $\dfrac{a^3R}{6b}$ Ans
4. $\dfrac{a^3R}{3b}$

R

$Q = at - bt^2$

$I = \dfrac{dQ}{dt} = a[1] - b\,2t$

$I = a - 2bt$ ← variable current

$dH = I^2 R\,dt$

$\int dH = \int_0^{a/2b} (a-2bt)^2 R\,dt$

$I = a - 2bt$ find time when current becomes zero

$0 = a - 2bt$

$a = 2bt$

$t = \dfrac{a}{2b}$

$H = \left[\dfrac{R\,(a-2bt)^3}{3\times(-2b)}\right]_0^{a/2b}$

$= \dfrac{R}{-6b}\left[0 - a^3\right] = \dfrac{Ra^3}{6b}$

GALVANOMETER

Unwant Part of circuit

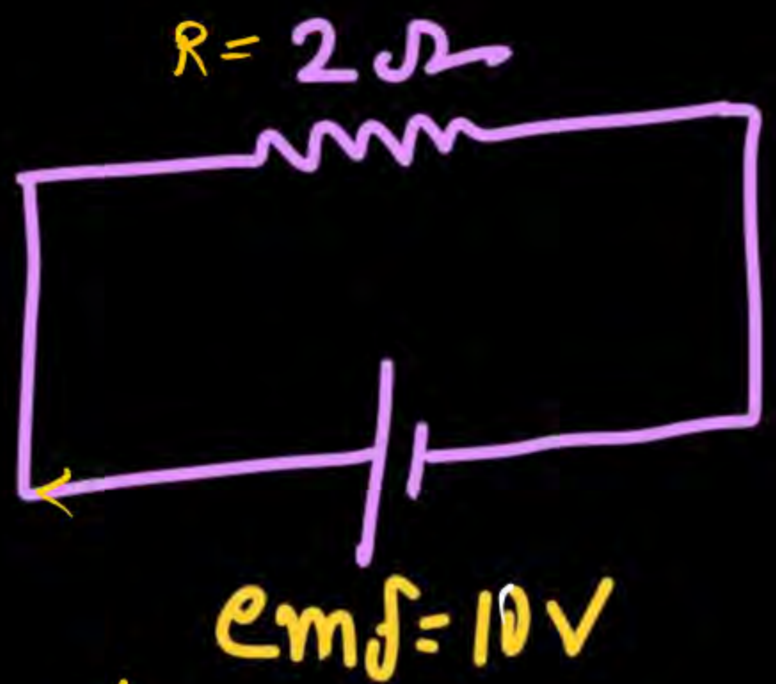
- Use to detect current, not to measure current.
- Vary sensitive, can measure small current (m Amp)
- Produce large error when connected in parallel or series

I_G = Maximum current can measure

G = Resistance of galvanometer.



Find current in "2Ω"



we have to measure current, so we will use galvanometre in series with 2Ω.



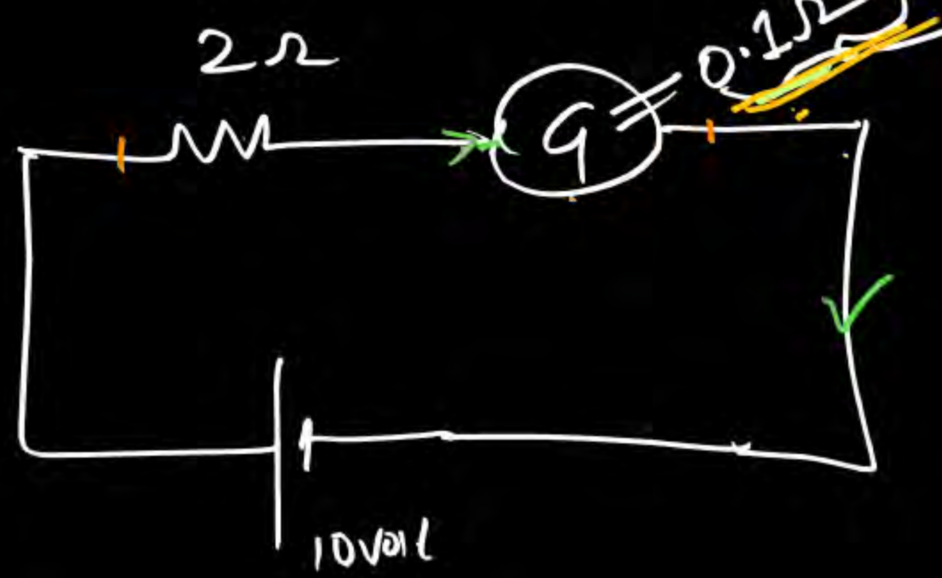
$I = \frac{10}{2} = 5\,Amp$ (True) ↳ (calculated value)

$I_m = \frac{10}{5} = 2\,Amp$

% error in measurement $= \frac{|5-2|}{5} \times 100$ = 60%

% error in measur $= \left|\frac{I_T - I_m}{I_T}\right| \times 100$

I_T ↑ (No galvanometer connected)



→ Not Possible value of resist

$I_{True} = 5\,Amp$

$$I = \frac{10}{2.1} = 4.76\ A$$

$$\%\ err = \frac{5 - 4.76}{5} \times 100$$

$= 0.23 \times 20$

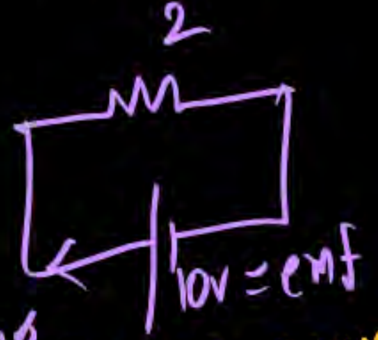
$= 4.7\%$ ✓



find % error in the measurment of galvanometre.

Sol

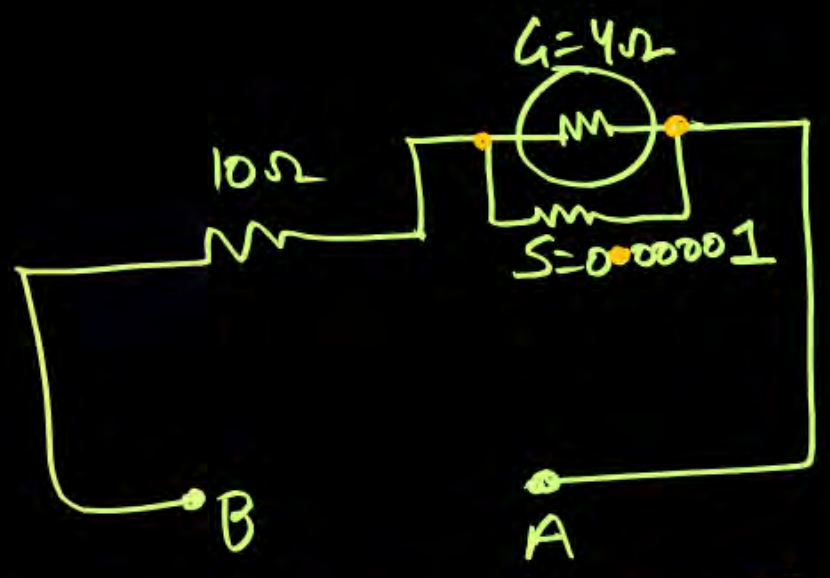
No galvanometre connected



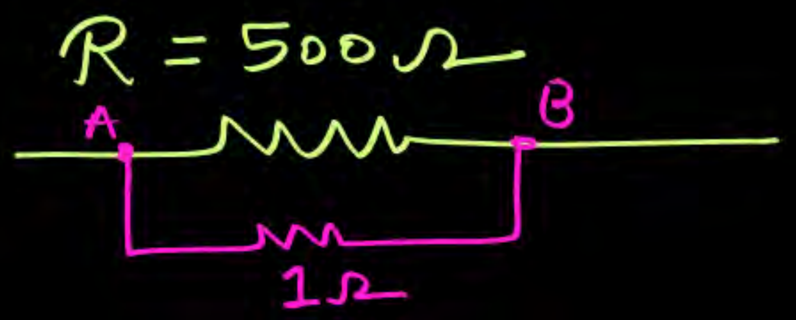
$I = \frac{10}{2} = 5\,Amp$ (True)

$$\%\ error = \frac{5 - 4}{5} \times 100$$

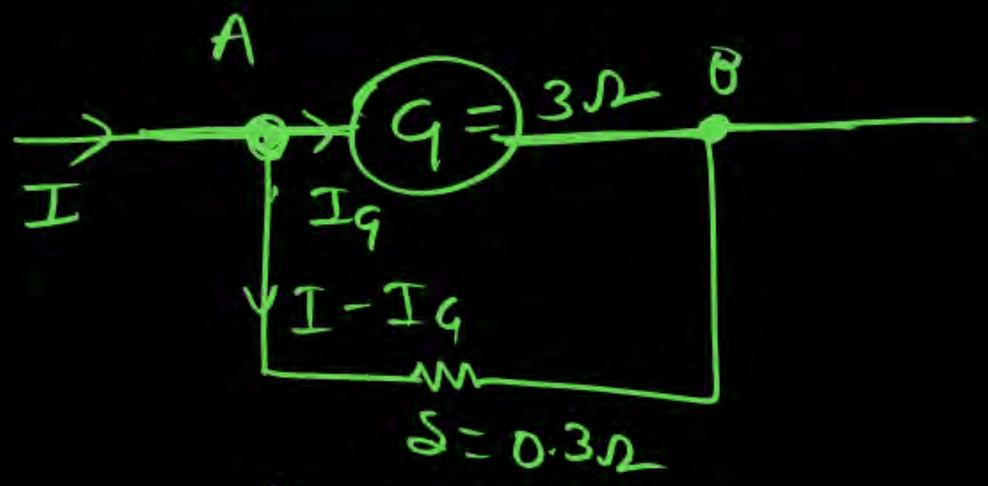
$= 20\%$ ✓



$R_{AB} = 10\Omega$



$$R_{AB\,(total)} = \frac{500 \times 1}{500+1} = \frac{500}{501} = 0.99\Omega$$

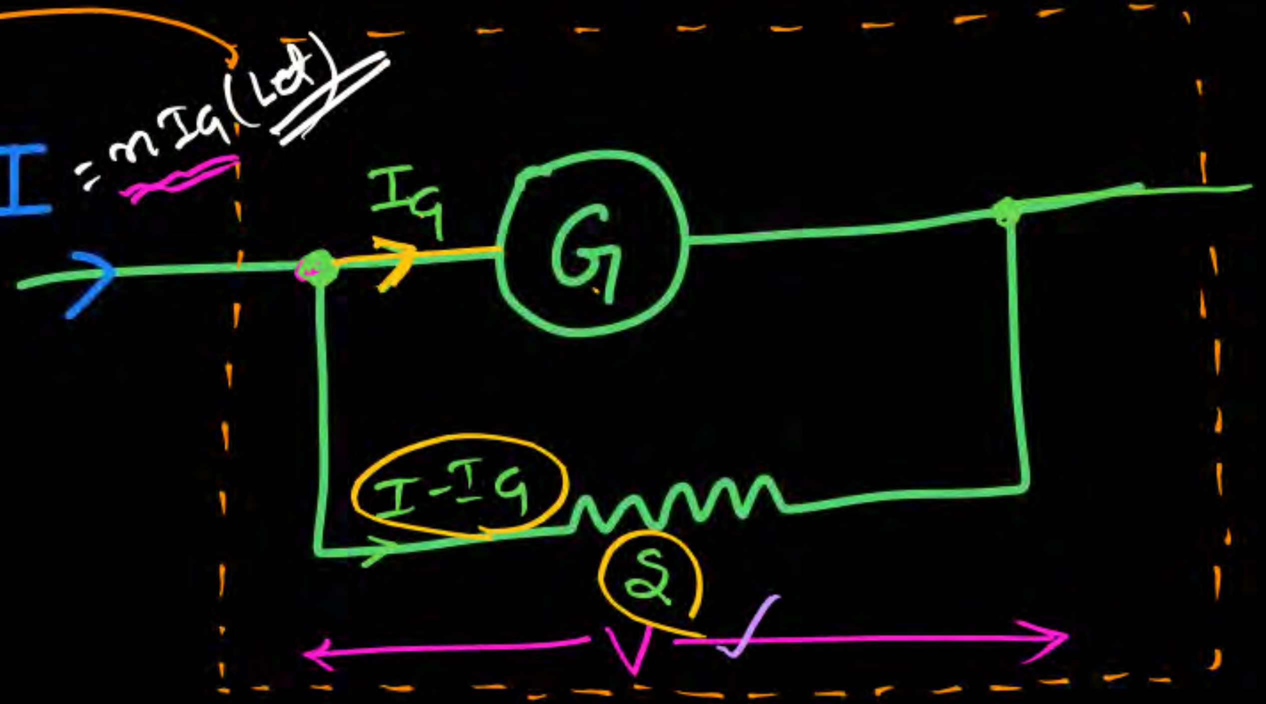


$R_{AB} = 0.29\Omega$

Conversion of Galvanometre into Ammetre

Ammeter (A)

$R_{Ammeter} = \frac{G \cdot S}{G+S}$



Working Principle

→ Potential drop same in Parallel combination

→ Small shunt resistance connected parallel with galvanometre.

→ Ammetre connected in series with Resistance where current have to measure

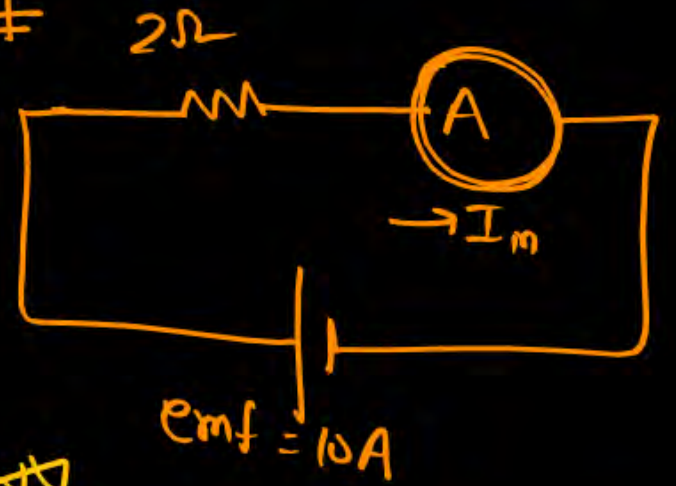
→ If $I = n[I_G]$ hence capacity to measure current Increases by n-times

$$G I_g = (I - I_g) S = V_{Ammeter} = I R_A$$

$$G I_g = (n I_g - I_g) S$$

$$G = (n-1) S$$

Shunt $S = \frac{G}{(n-1)}$ ← resistance of galvanometer



Ideal Ammeter

R = zero resistance

↳ behave as simple wire.

QUESTION

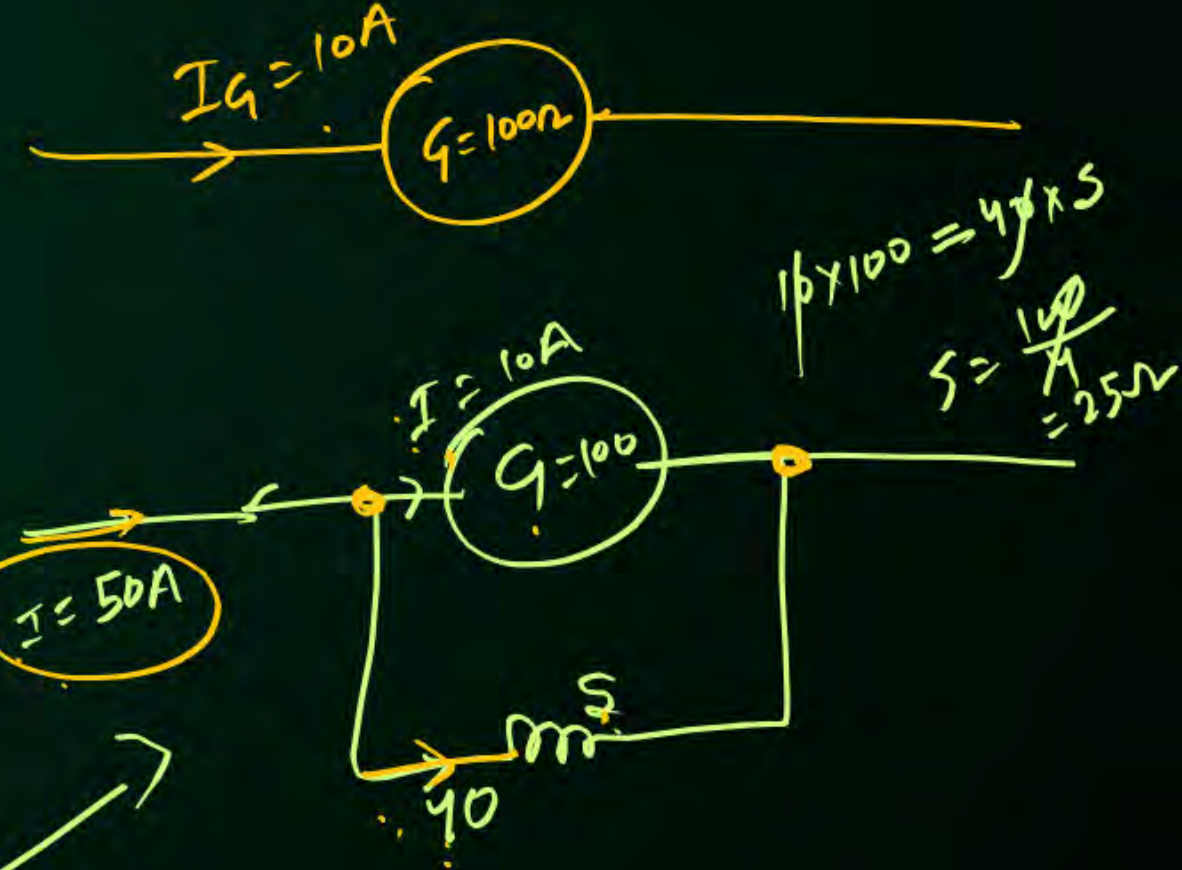
Galvanometer of resistance 100 Ω is used to measure 10 A. Find resistance of shunt if we want to measure 50 A.

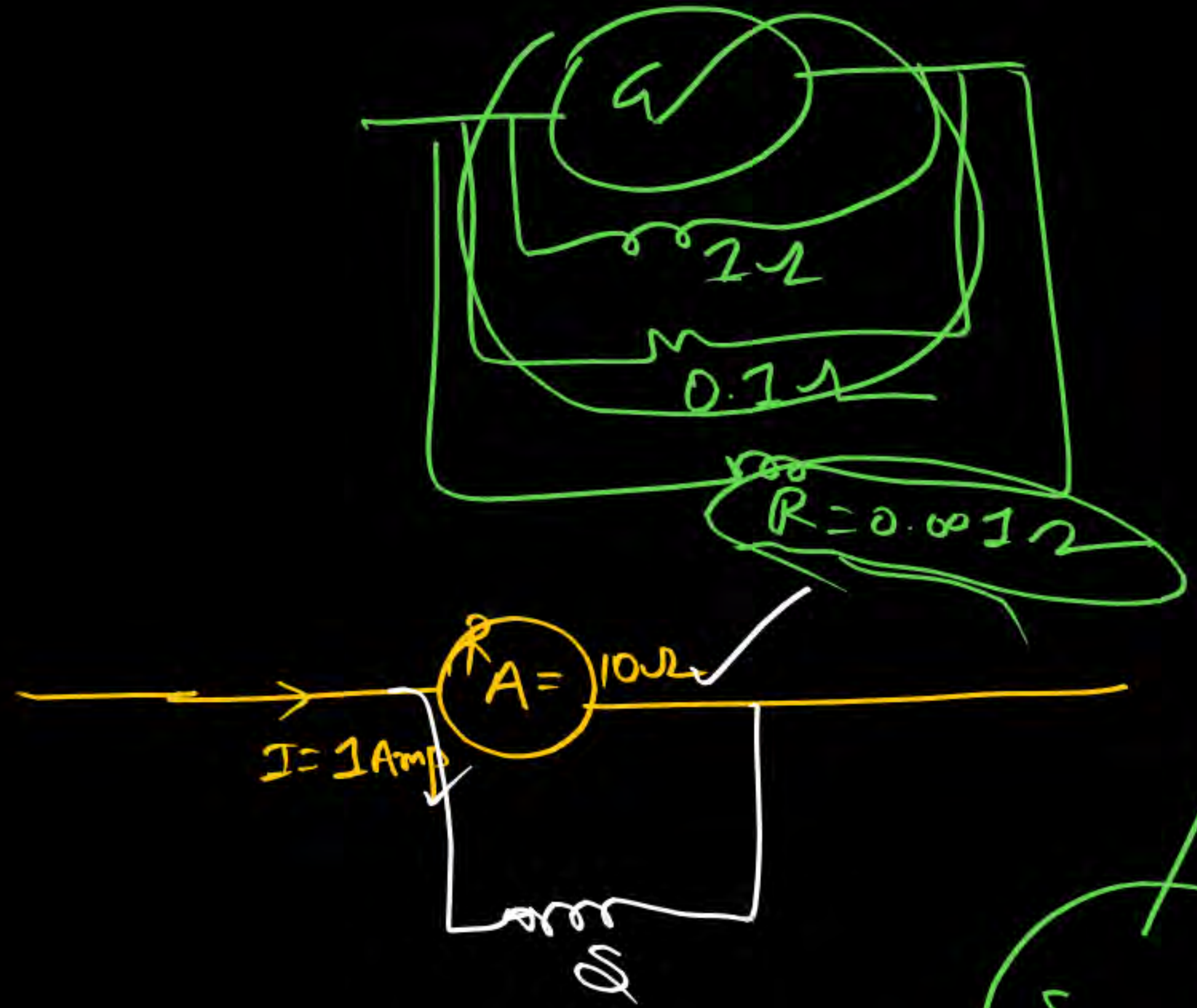
$$S = \frac{G}{n-1} = \frac{100}{5-1}$$

$$S = \frac{100}{4} = 25\,\Omega$$

IMP*

मजदूरी





$$S = \frac{A}{n-1}$$

↑ n-time capacity to measure Current Increase

$$S = \frac{G}{n-1}$$

$n >>> 1$

$$S = \frac{G}{n}$$

A Ammetre of Resistance 20Ω can measure 30 Amp, if we want to measure 150 Amp then find value of shunt connected in Parallel ??

$n = 5$

$$n = \frac{I_{find}}{I_{g/Ame}} = \frac{150\,A}{30\,A} = 5$$

$$S = \frac{20}{5-1} = \frac{20}{4} = 5\Omega$$

Ap

QUESTION

Ammeter of resistance 100 Ω is used to measure 1 mA. Find resistance of shunt if we want to measure 1 Ampere.

$$n = \frac{1\,A}{1\,mA} = 10^3$$

$$S = \frac{100}{10^3 - 1} = \frac{100}{1000} = 0.1\,\Omega$$

Test me sirf current electricity तक

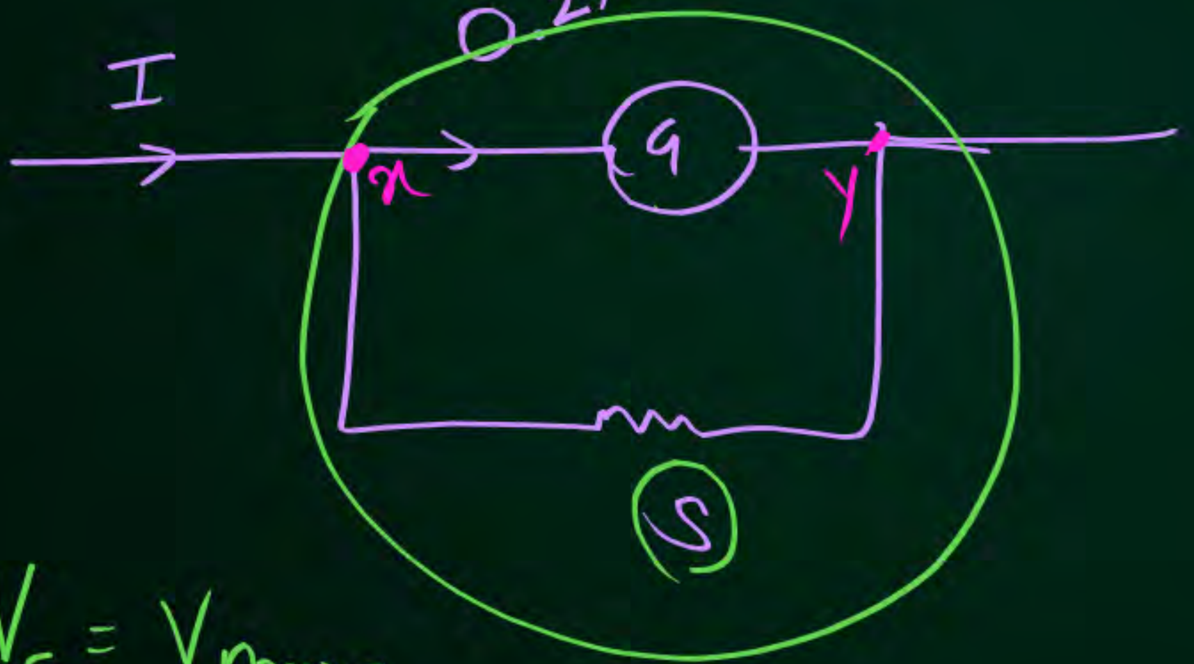
आयेगा

Complete

QUESTION

In an ammeter 0.2% of main current passes through the galvanometer. If resistance of galvanometer is G, the resistance of ammeter will be [AIPMT-2014]

1. $\frac{1}{499}G$
2. $\frac{499}{500}G$
3. $\frac{1}{500}G$
4. $\frac{500}{499}G$

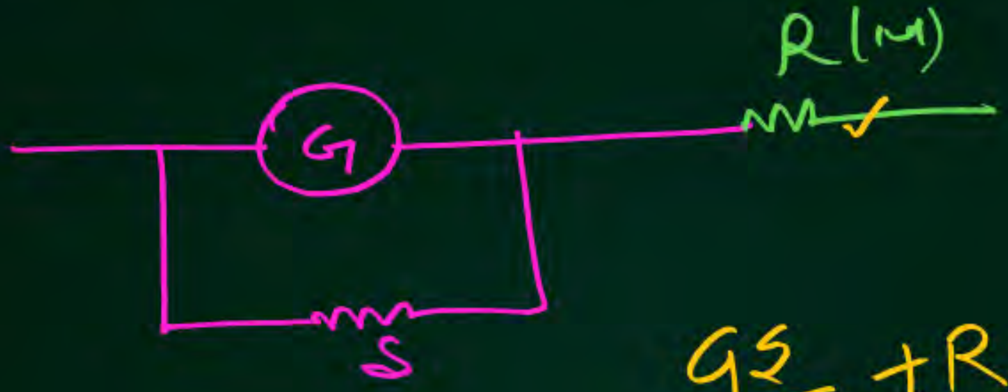


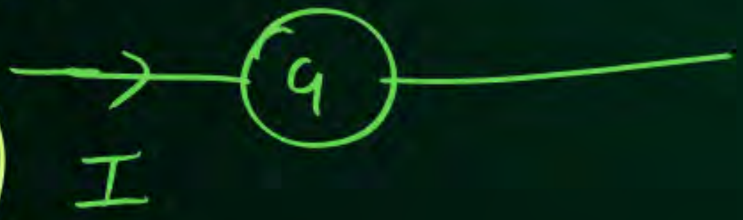
QUESTION

A galvanometer of resistance, G is shunted by a resistance S ohm. To keep the main current in the circuit unchanged, the resistance to be put in series with the galvanometer is

[AIPMT (Mains)-2011]

1. $\frac{G^2}{(S+G)}$
2. $\frac{G}{(S+G)}$
3. $\frac{G^2}{(S+G)}$
4. $\frac{SG}{(S+G)}$



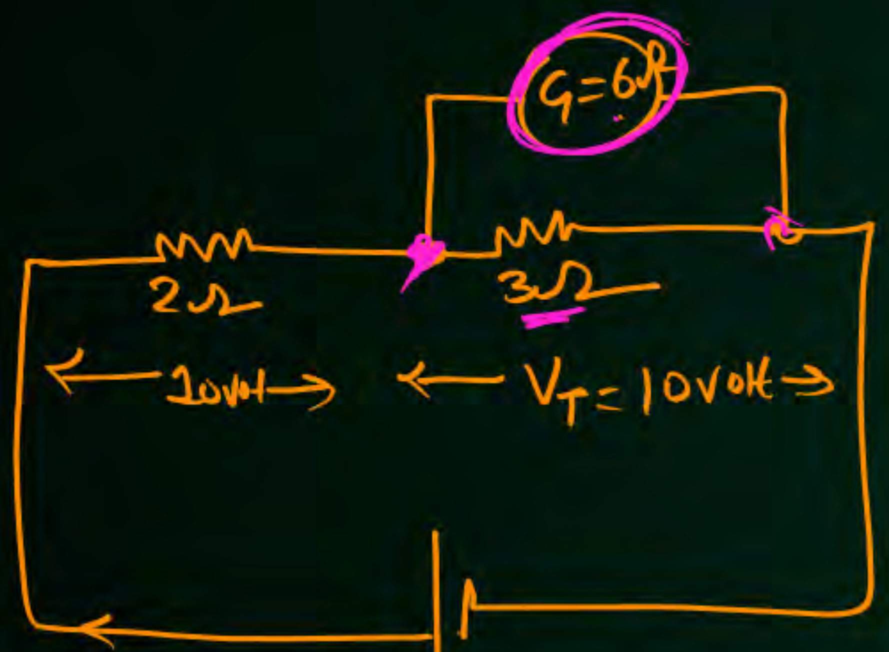


$$\frac{GS}{G+S} + R = G$$

$$R = G - \frac{GS}{G+S}$$

$$R = \frac{G^2 + GS - GS}{G+S} = \left(\frac{G^2}{G+S}\right)$$

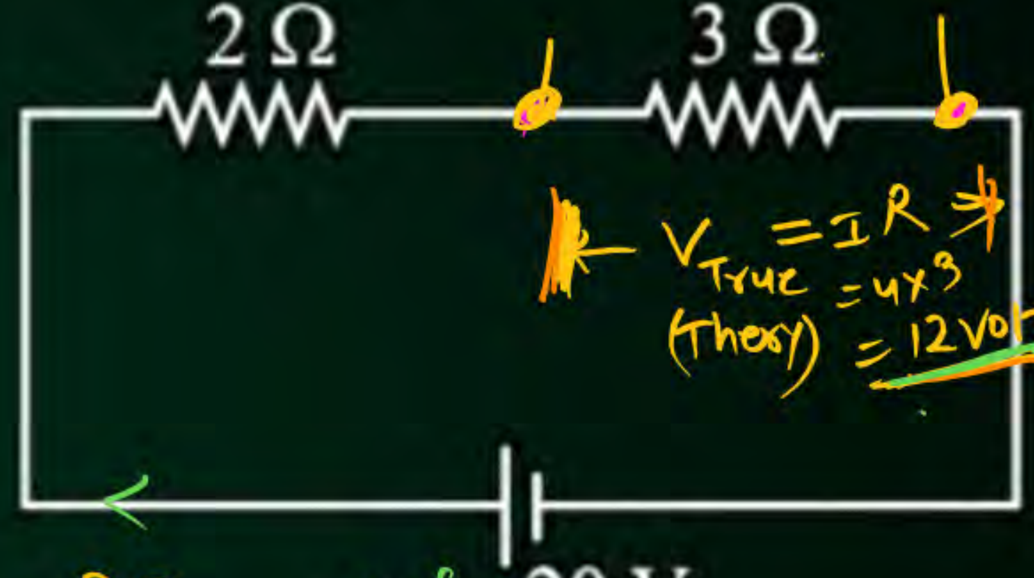
GALVANOMETER AS A VOLTMETRE



$I = \frac{20}{4} = 5\,Amp$

$V_{measure} = 10\,volt$

To measure potential across 3Ω resistance we connect Galvanometer parallel with 3Ω resistance.



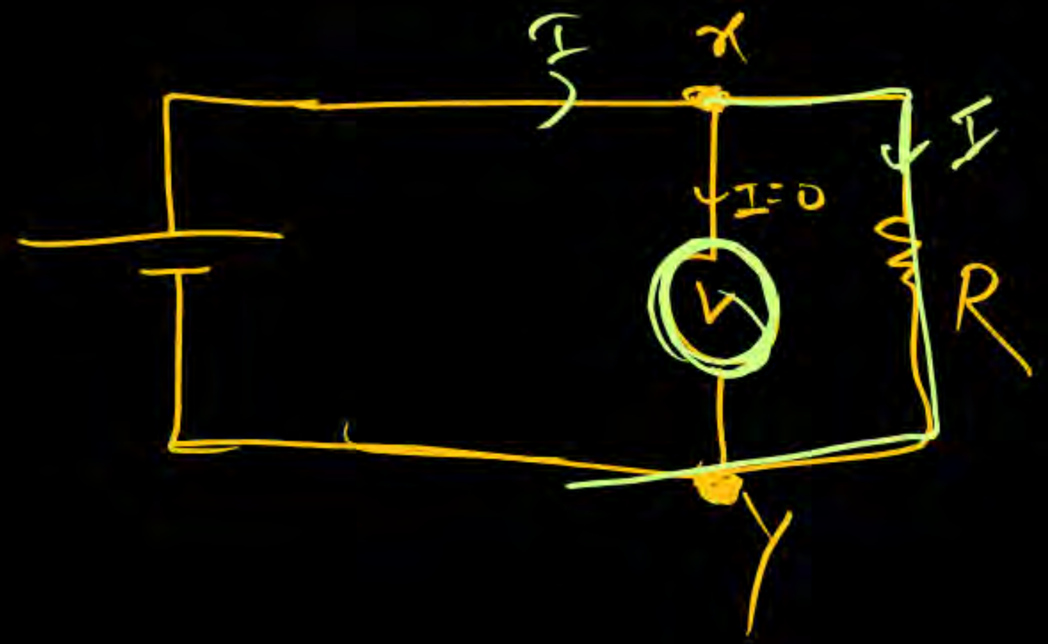
$V_{True} = IR = 4\times3 = 12\,volt$ (True) (Theory)

emf = 20 V

$I = \frac{20}{5} = 4\,Amp$

$$\%\,error = \frac{V_T - V_m}{V_T}\times100 = \frac{12-10}{12}\times100 = \frac{100}{6} = 16.6\%$$

→ Cause of error??

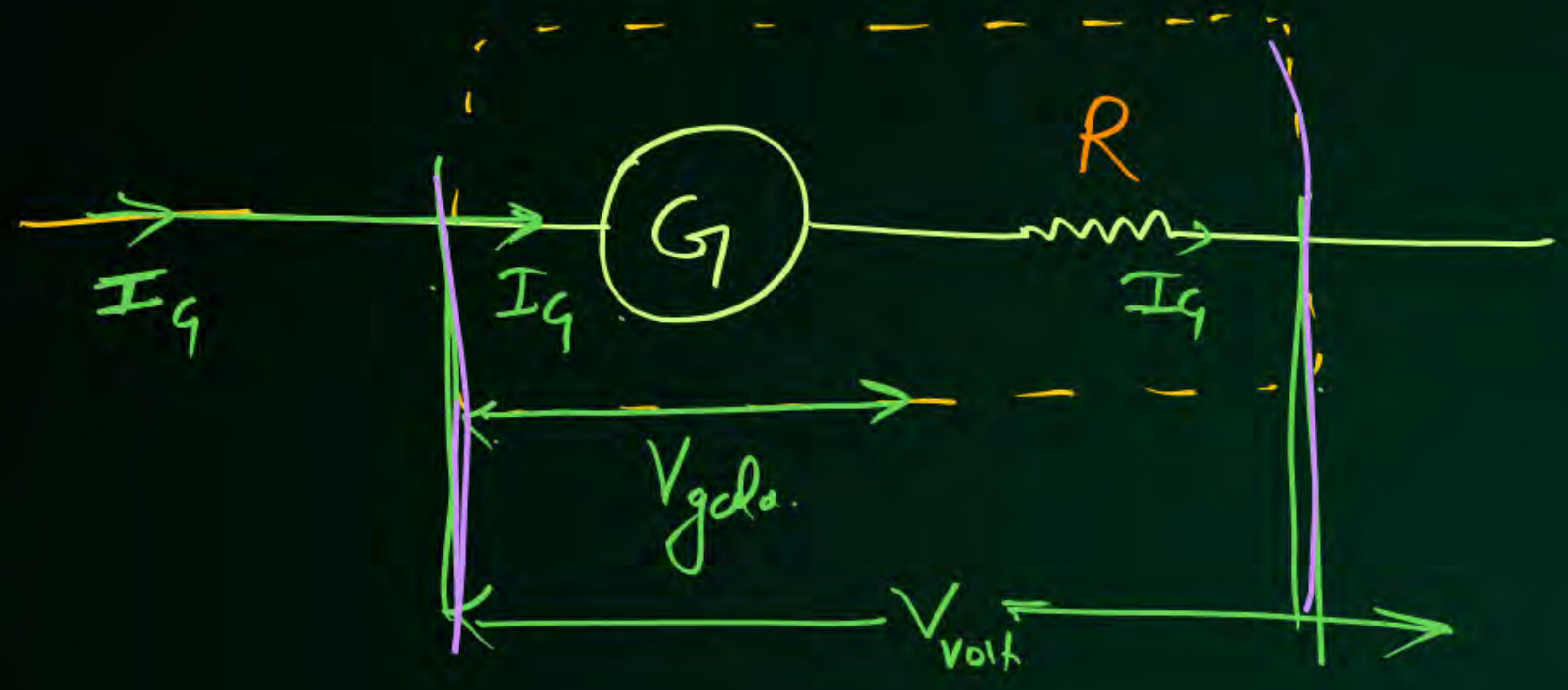


I
x
I
I=0
V
R
Y

➢ Conversion of galvanometer into Voltmeter:

→ Same current will flow

↳ large resistance connected in series with Galvanometre to convert galvanometre into voltmetre.



$R_{voltm} = R + G$

↳ voltmetre connected in parallel where voltage have to measure

* Ideal voltmetre $R_{volt} = \text{infinite}$

↳ behave as open wire

$$I_g = \frac{V_{Galvano}}{G} = \frac{V_{net}}{R+G}$$

$$\Rightarrow \frac{V_g}{G} = \frac{nV_g}{G+R}$$

$$nG = G + R$$

$R = nG - G$

$$R = G(n-1)$$

* If I assume $(V_{net} = nV_g)$

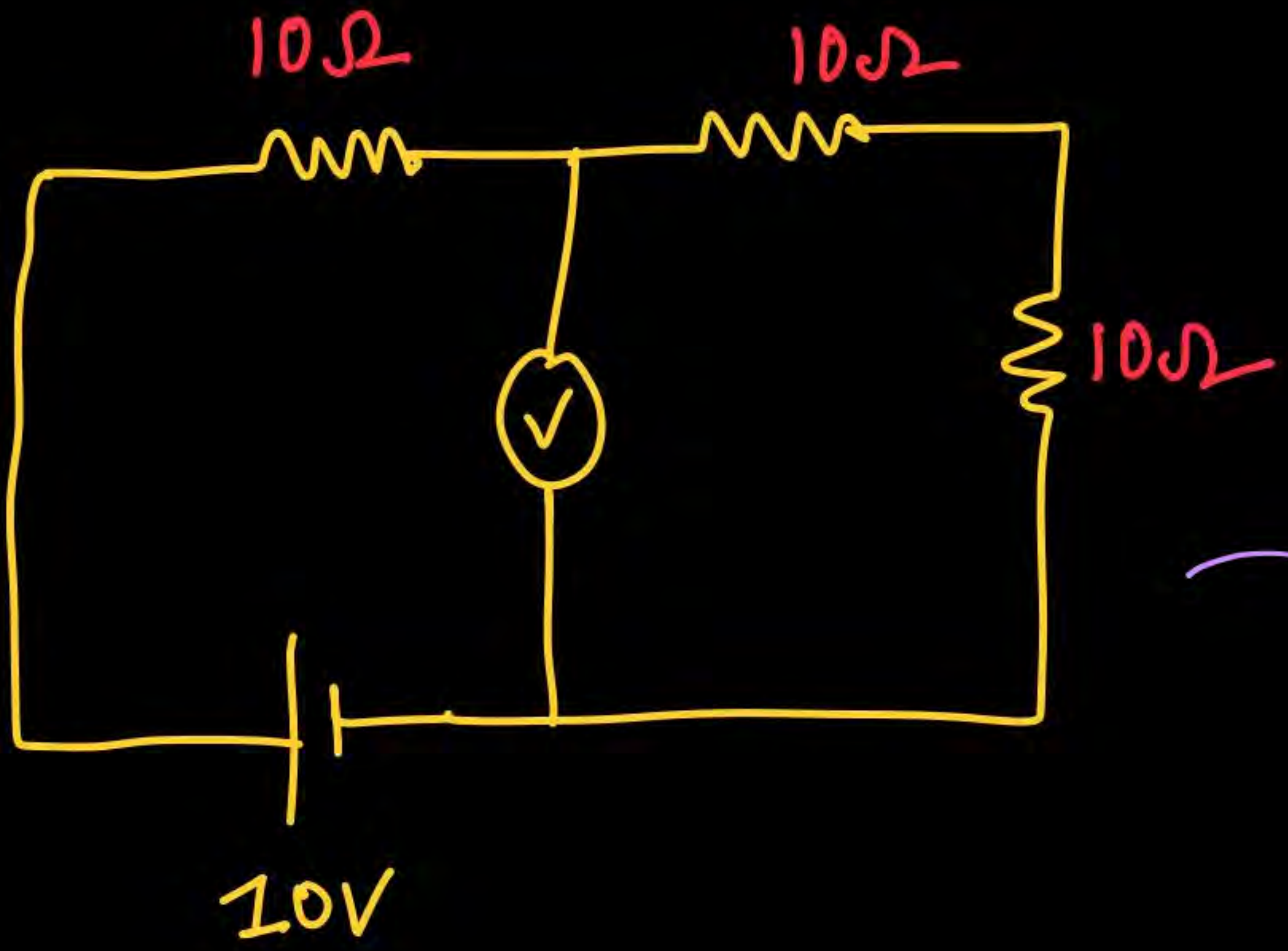
hence capacity to measure voltage increase by n-time

Ammetre

- use to measure current
- $R_{Ammeter} = \frac{R+G}{R+G}$ → small resist
- $R_{Ideal\ Ammeter} = 0$ (Simple wire)
- Small shunt connected parallel with galvanometre
- $S = \frac{G}{(n-1)}$ n → times capacity
- Ammetre connected in series with Resistance where current have to measure

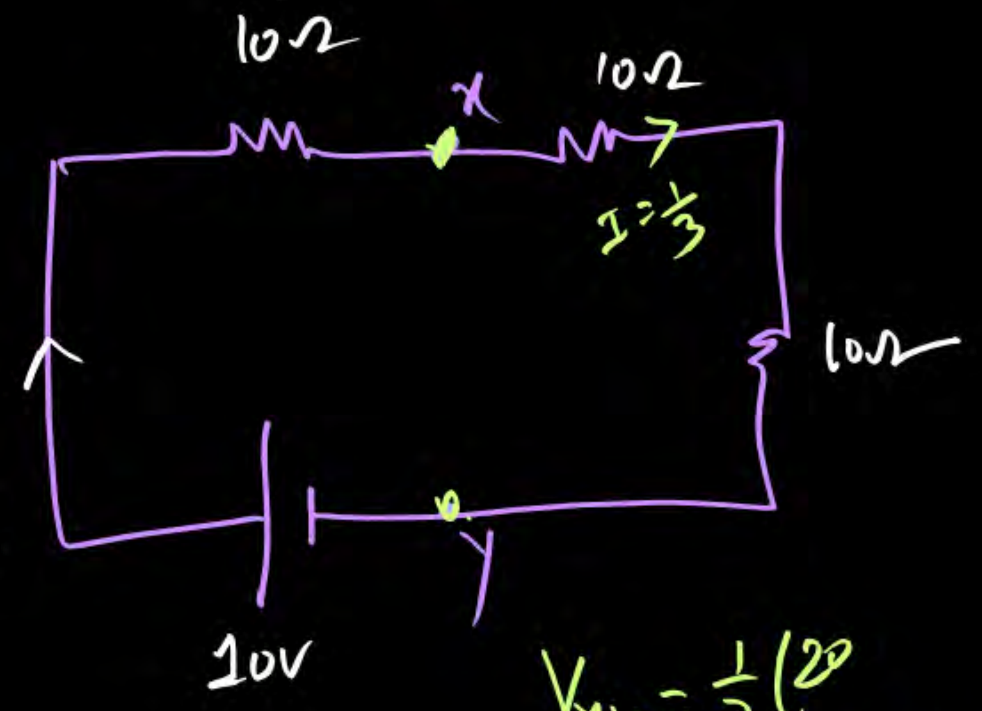
Voltmetre

- use to measure voltage ✓
- $R_{voltmeter} = R+G$ = (High) * $R_{Ideal\ voltmeter}$ = infinite (open wire)
- large resistance connected in series with galvanometre



find reading of Voltmetre.

Sol^n Ideal voltmeter open wire



$I = \frac{10}{30}$

$= \frac{1}{3} A$

$V_{xy} = \frac{1}{3}(20)$

$= \frac{20}{3}$ volt

QUESTION

A, B and C are voltmeters of resistance R, 1.5 R and 3R respectively as shown in the figure. When some potential difference is applied between X and Y, the voltmeter readings are V_A, V_B and V_C respectively, then [AIPMT-2015]

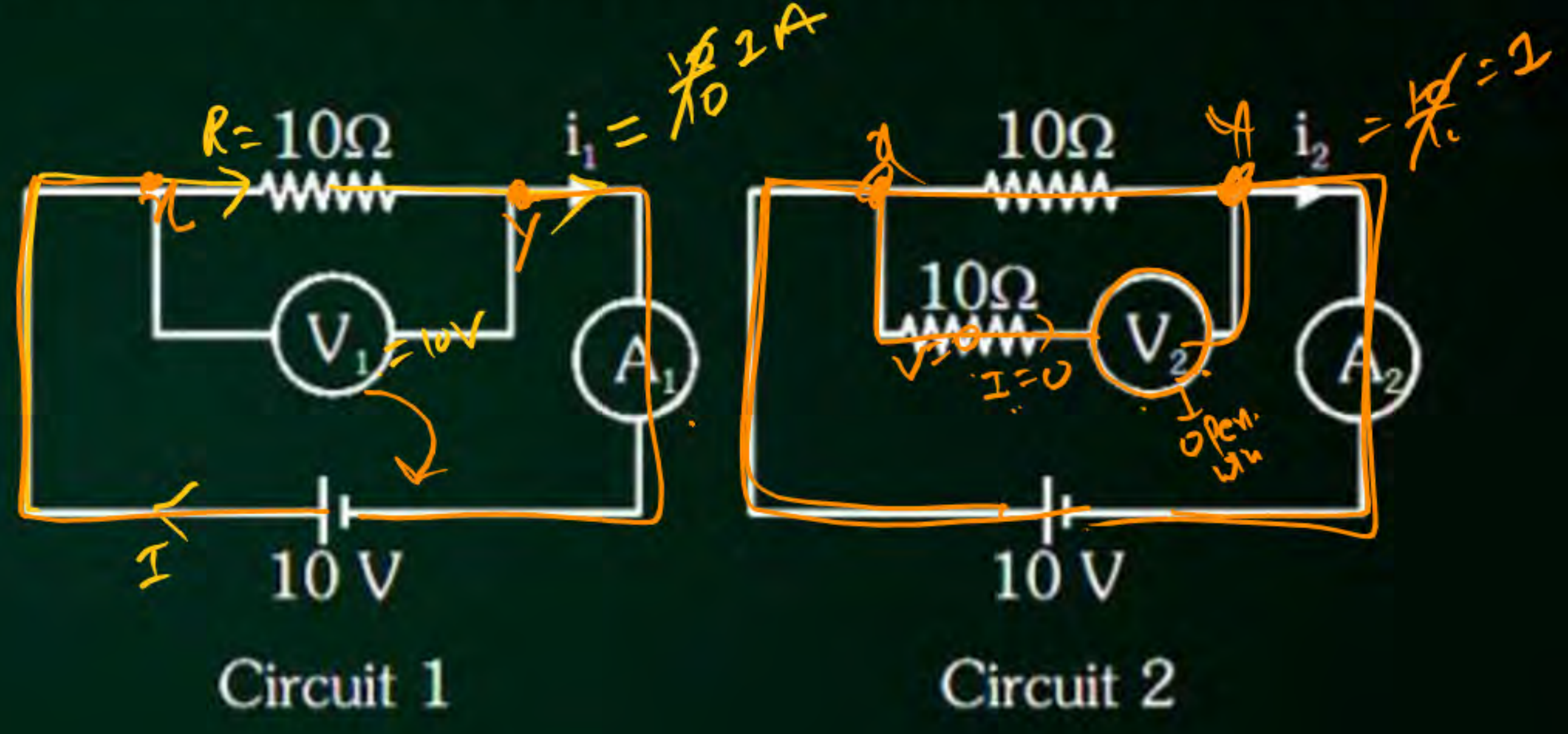


1. $V_A \neq V_B \neq V_C$
2. $V_A = V_B = V_C$
3. $V_A \neq V_B = V_C$
4. $V_A = V_B = V_C$

QUESTION

In the circuits shown below, the readings of the voltmeters and the ammeters will be:

1. $V_2 > V_1$ and $i_1 = i_2$
2. $V_1 = V_2$ and $i_1 > i_2$
3. $V_1 = V_2$ and $i_1 = i_2$
4. $V_2 > V_1$ and $i_1 > i_2$



QUESTION

A millivoltmeter of 25 millivolt range is to be converted into an ammeter of 25 ampere range. The value (in ohm) of necessary shunt will be [AIPMT(Prelims)-2012]

1. 1
2. 0.05
3. 0.001
4. 0.01

QUESTION

A galvanometer has a coil of resistance 100 Ω and gives a full scale deflection for 30 mA current. If it is to work as a voltmeter of 30 V range, the resistance required to be added will be

[AIPMT (Prelims)-2010]

1. 1000 Ω
2. 900 Ω
3. 1800 Ω
4. 500 Ω

$V_g = G \times I_g$

$= 100 \times 30\,mA$

$= 3 \times 10^{3}\,m$

$V_g = 3\,Volt$

$n = \frac{V_f}{V_g} = \frac{30}{3} = 10\,Volt$

$R = G(n-1)$

$= 100(10-1) = 100 \times 9$

$= 900\,\Omega$

QUESTION

A galvanometer of resistance 50 Ω is connected to a battery of 3 V along with a resistance of 2950 Ω in series. A full scale deflection of 30 divisions is obtained in the galvanometer. In order to reduce, this deflection to 20 divisions, the resistance in series should be

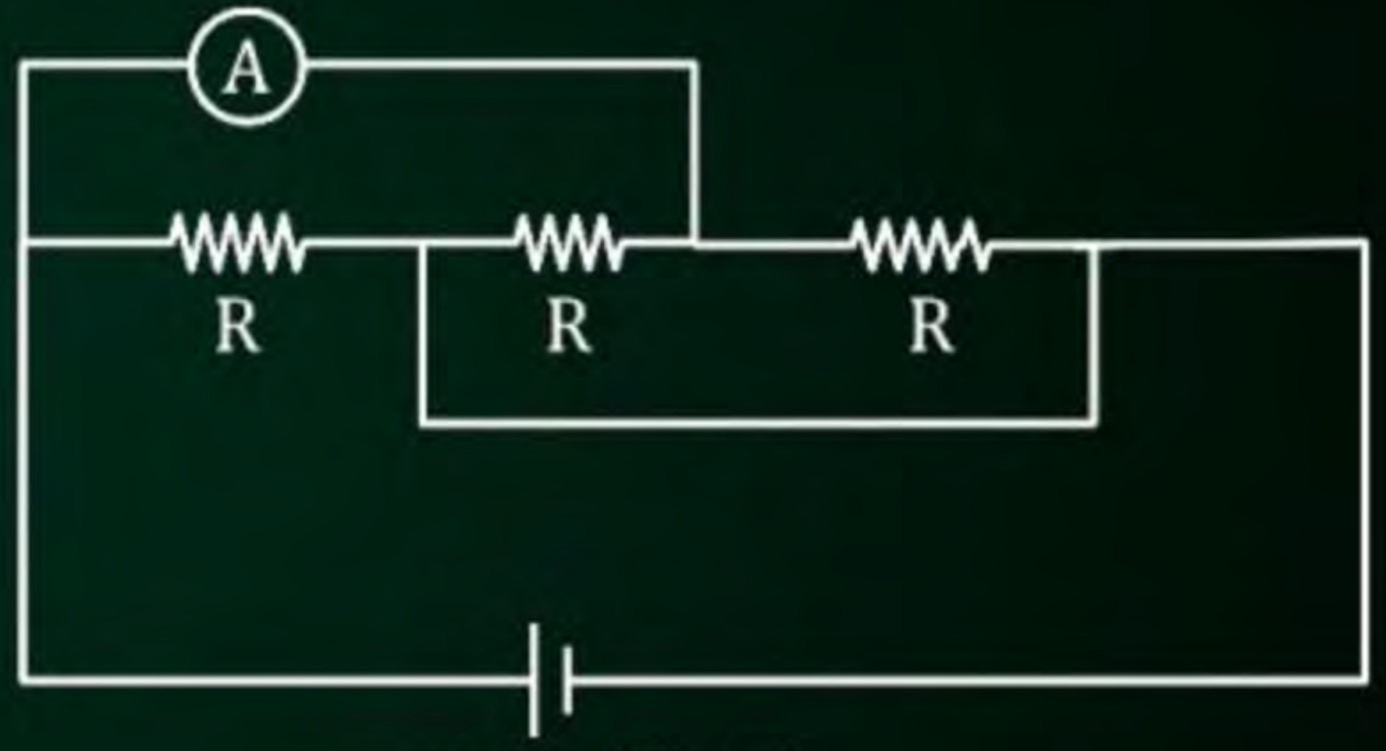
[AIPMT (Prelims)-2008]

1. 4450 Ω
2. 5050 Ω
3. 5550 Ω
4. 6050 Ω

QUESTION

(MR* Sawal)

Find ammeter reading $R = 5\Omega$



QUESTION

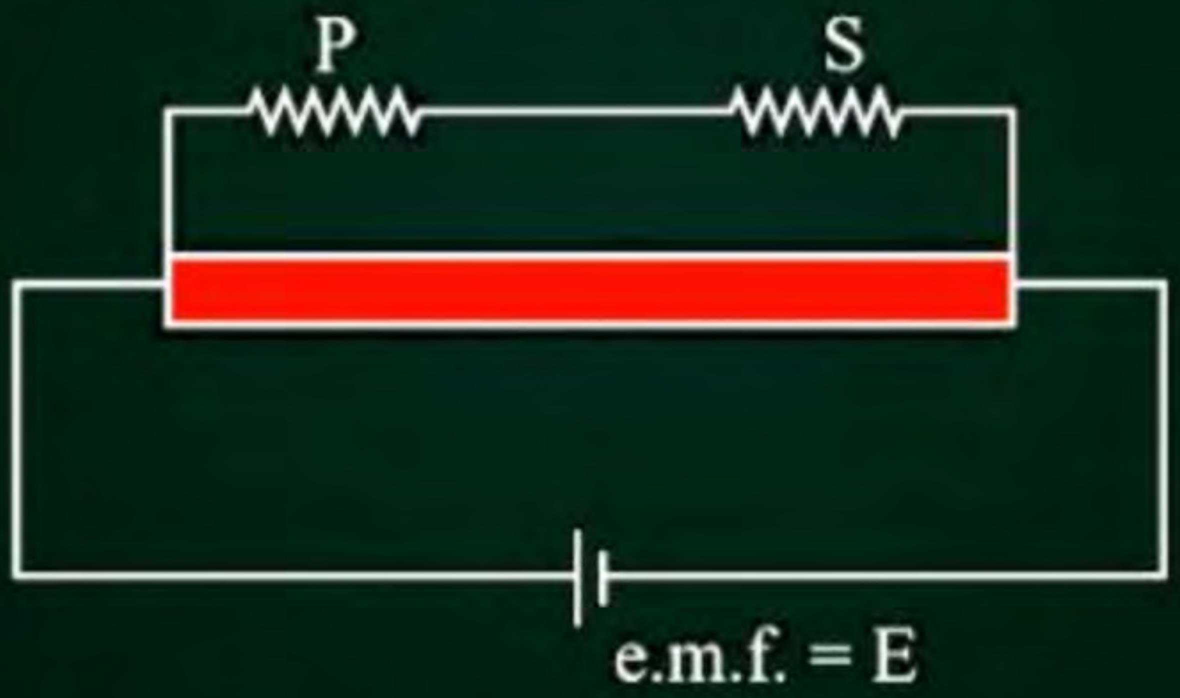
If current in ammeter is zero then find emf of unknown batter?



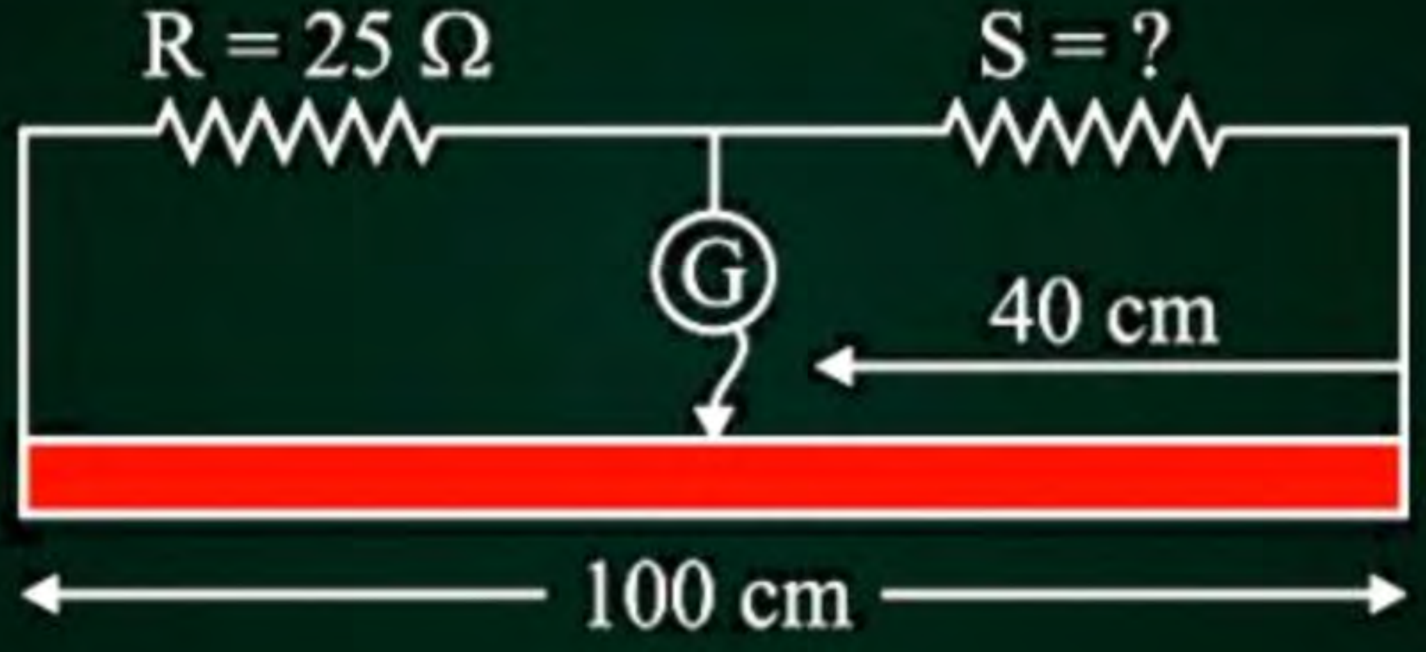
Wheatstone Bridge

Meter Bridge

- An instrument used to measure known resistance.
- Based on the concept of wheat stone bride.

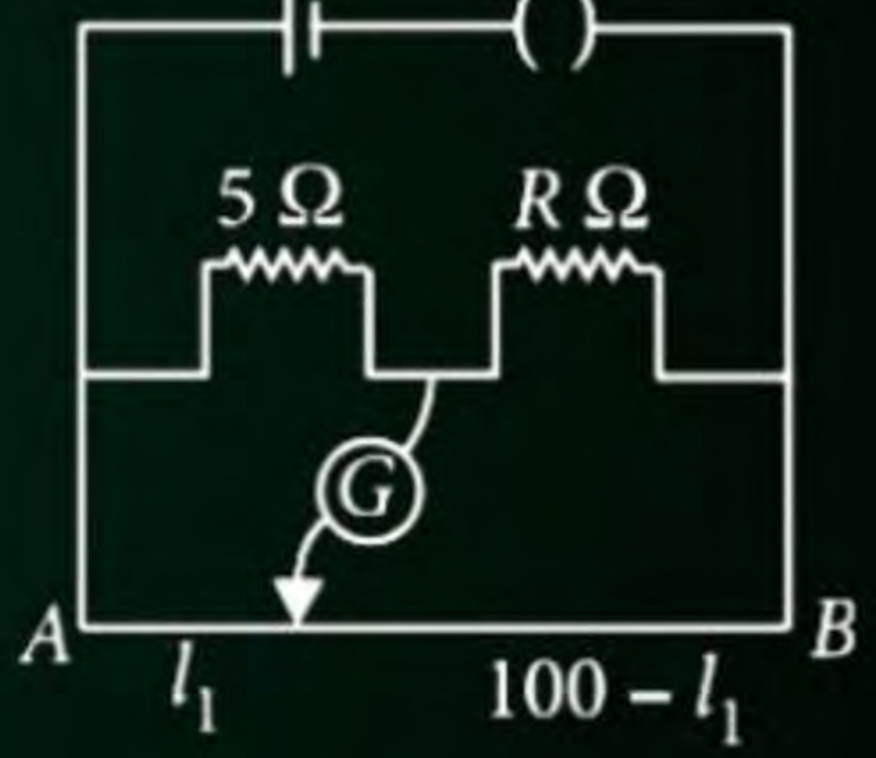


- Resistance per unit length $\lambda = \frac{R}{L}$


R = 25 Ω
S = ?
G
40 cm
100 cm

QUESTION

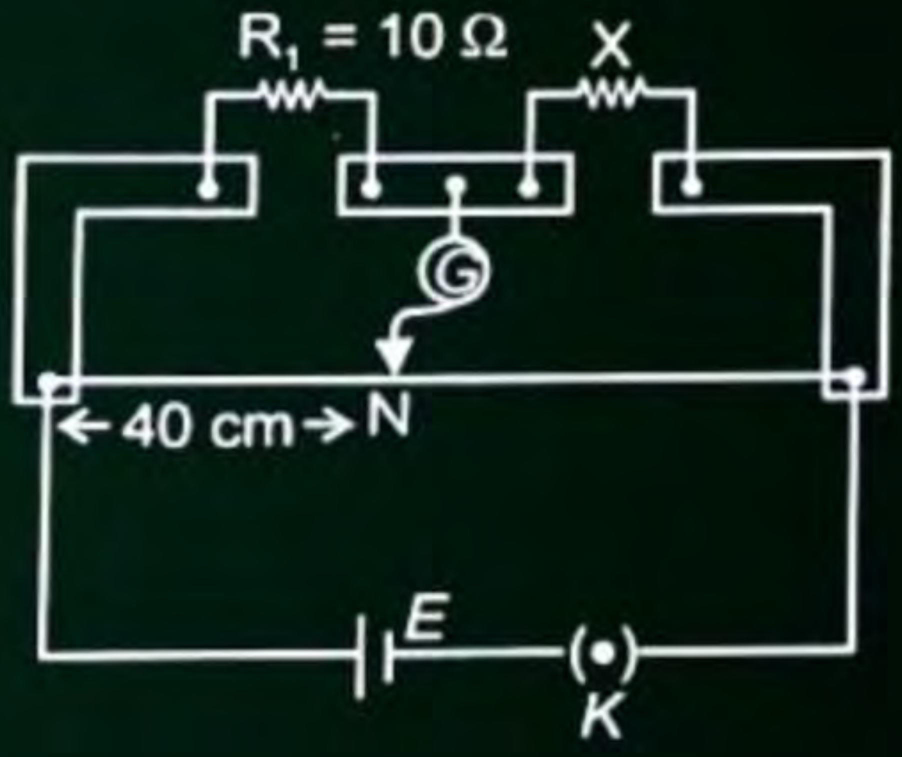
The resistance in the two arms of the meter bridge are 5Ω and $R\Omega$, respectively. When the resistance R is shunted with an equal resistance, the new balance point is at $1.6l_1$. The resistance 'R' is



1. $10\,\Omega$
2. $15\,\Omega$
3. $20\,\Omega$
4. $25\,\Omega$

QUESTION

In the meter bridge experiment, the null point is obtained at N. The value of unknown resistance X will



1. $60\ \Omega$
2. $40\ \Omega$
3. $6\ \Omega$
4. $15\ \Omega$

QUESTION

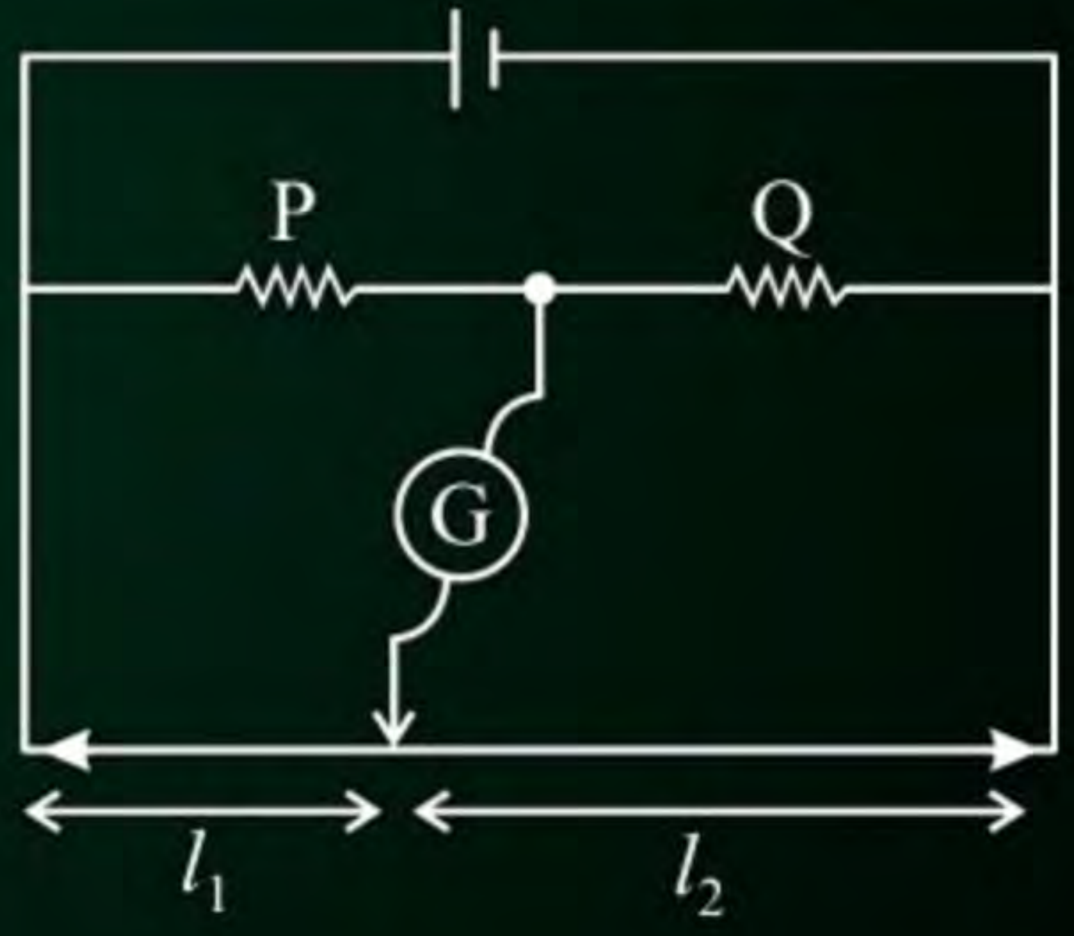
A resistance wire connected in the left gap of a meter bridge balances a 10 Ω resistance in the right gap at a point which divides the bridge wire in the ratio 3 : 2. If the length of the resistance wire is 1.5 m, then the length of 1 Ω of the resistance wire is

[NEET2020]

1. 1.0×10^{-2} m
2. 1.0×10^{-1} m
3. 1.5×10^{-1} m
4. 1.5×10^{-2} m

QUESTION

The metre bridge shown is in a balanced position with $\frac{P}{Q} = \frac{l_1}{l_2}$. If we now interchange the position of the galvanometer and the cell, will the bridge work ? If yes, what will be the balanced condition?



(1) Yes, $\frac{P}{Q} = \frac{l_1 - l_2}{l_1 + l_2}$

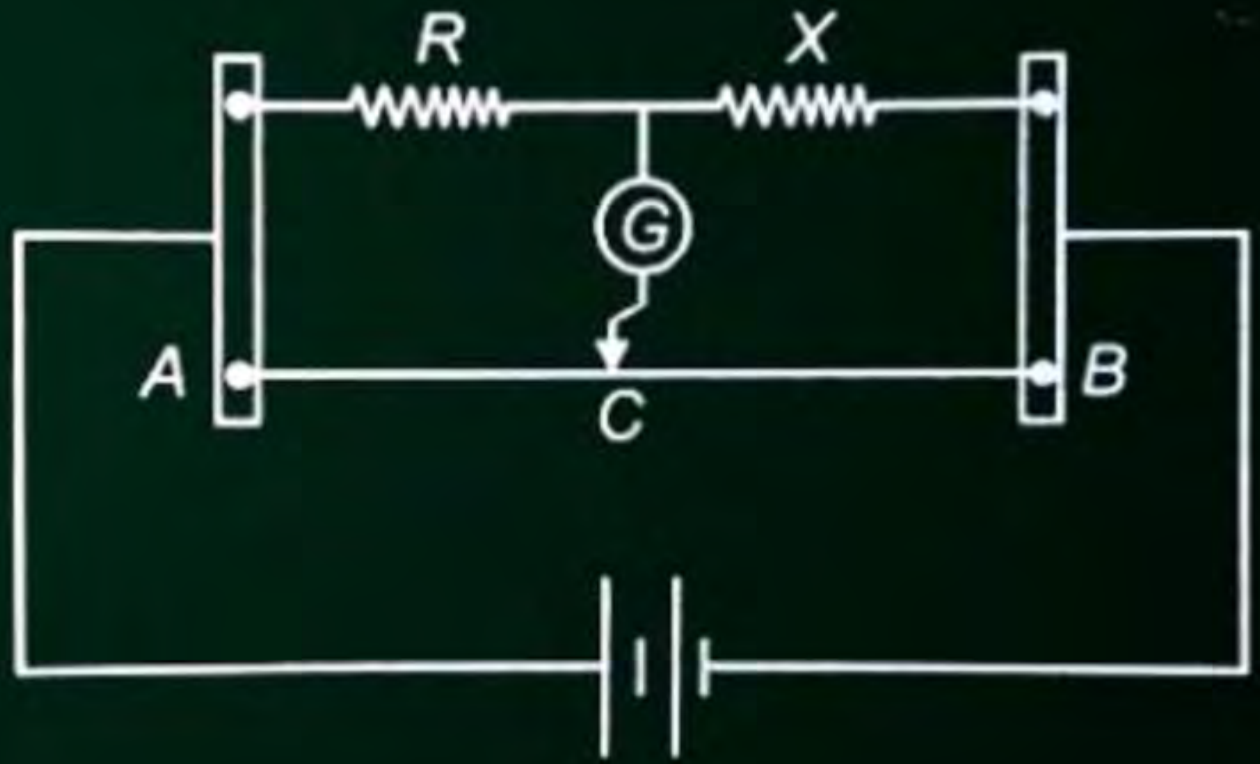
(2) No, no null point

(3) Yes, $\frac{P}{Q} = \frac{l_2}{l_1}$

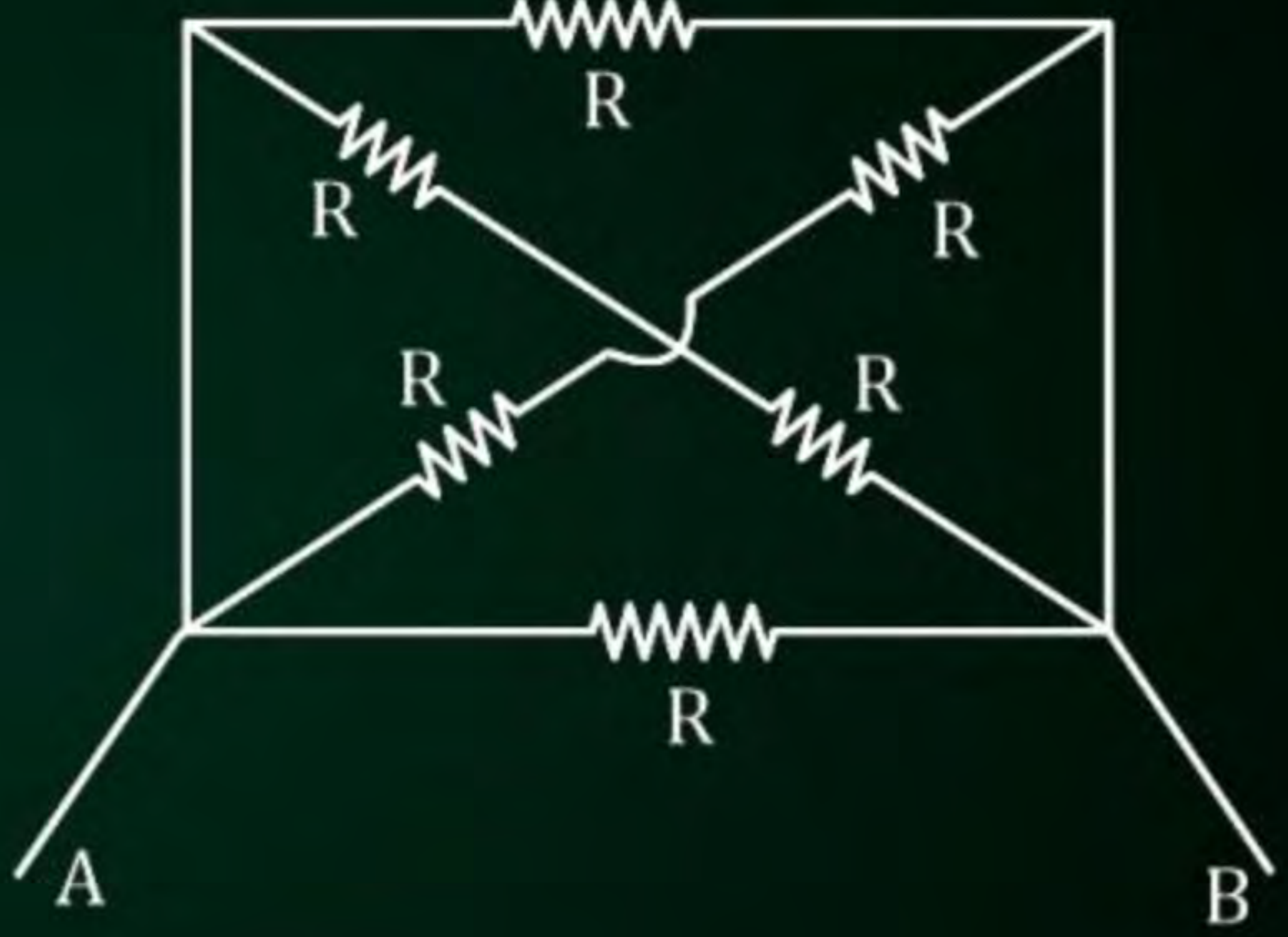
(4) Yes, $\frac{P}{Q} = \frac{l_1}{l_2}$

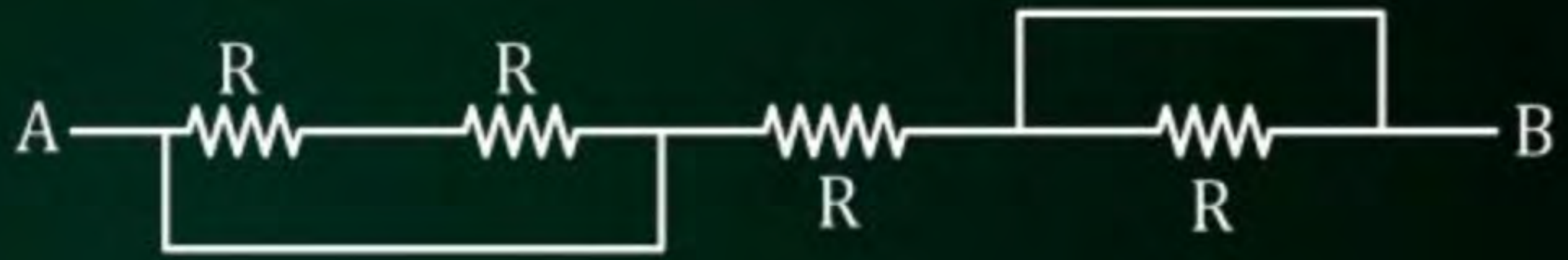
QUESTION

In the meter bridge shown, the resistance X has a negative temperature coefficient of resistance. Neglecting the variation in other resistor, when current is passed for some time, in the circuit balance point should shift towards

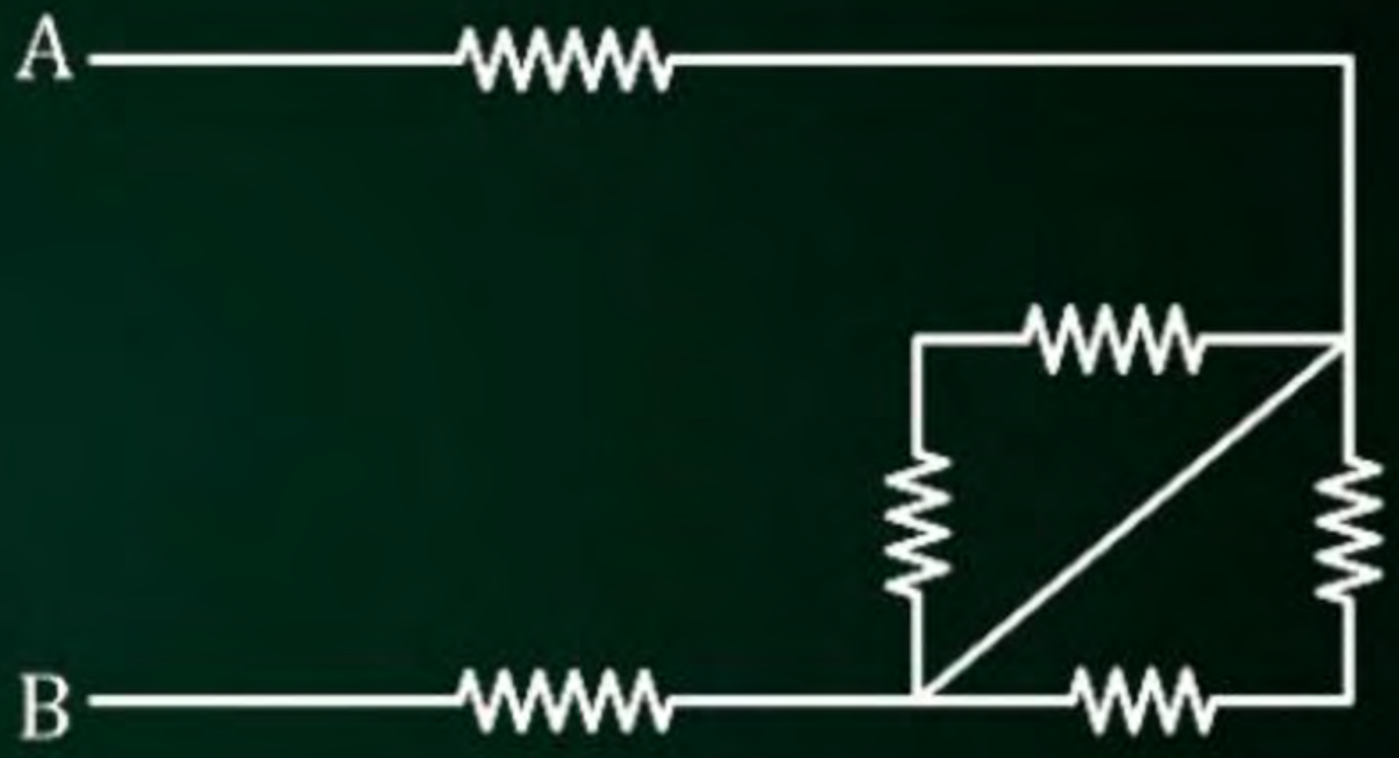


1. A
2. B
3. First A then B
4. It will remain at C


R
R
R
R
R
R
A
B



A
R
R
R
R
B


A
B


A
B


@MRPHYSICSS


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 10 | Physics

Current Electricity

By- Dr. Manish Raj (MR SIR)

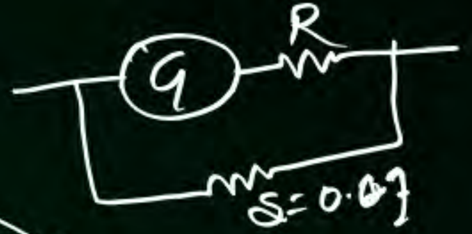


Topics to be covered

1. # ☆ Metre Bridge
2. # ☆ DC/RC circuit
3. #



QUESTION



A millivoltmeter of 25 millivolt range is to be converted into an ammeter of 25 ampere range. The value (in ohm) of necessary shunt will be [AIPMT(Prelims)-2012]

1. 1
2. 0.05
3. 0.001 (Ans)
4. 0.01

$V = 25 \times 10^{-3}$ Volt

$I_{initial} = \frac{V}{R} = \frac{25 \times 10^{-3}}{R}$

$I_{final} = 25$ Amp

$n = \frac{I_{final}}{I_{initial}} = \frac{25 R}{25 \times 10^{-3}}$

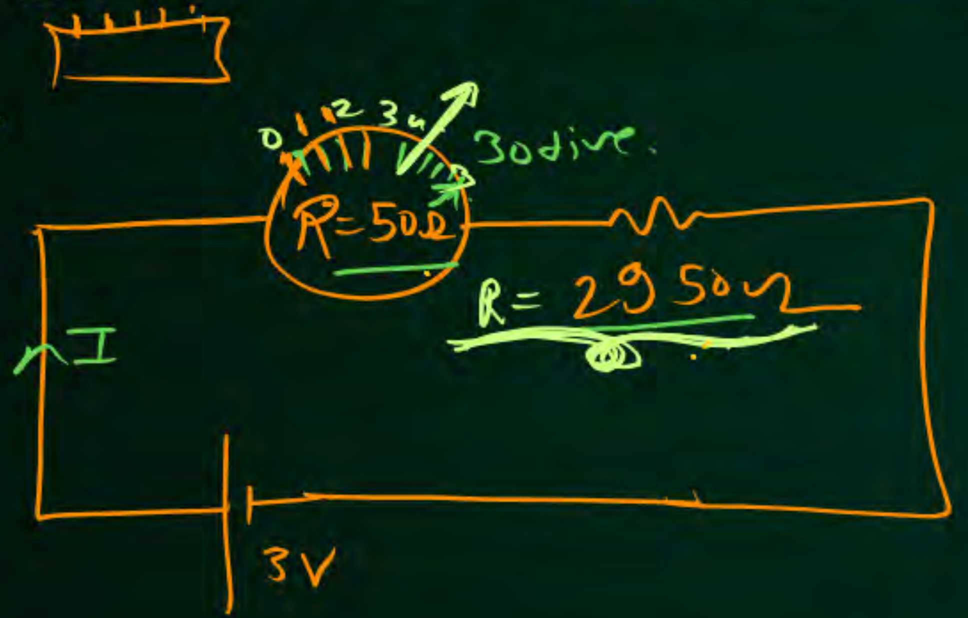
$n = 1000R$

$S = \frac{R}{n-1} = \frac{R}{n} = \frac{R}{1000R} = 10^{-3}\,\Omega$

QUESTION

A galvanometer of resistance 50 Ω is connected to a battery of 3 V along with a resistance of 2950 Ω in series. A full scale deflection of 30 divisions is obtained in the galvanometer. In order to reduce, this deflection to 20 divisions, the resistance in series should be

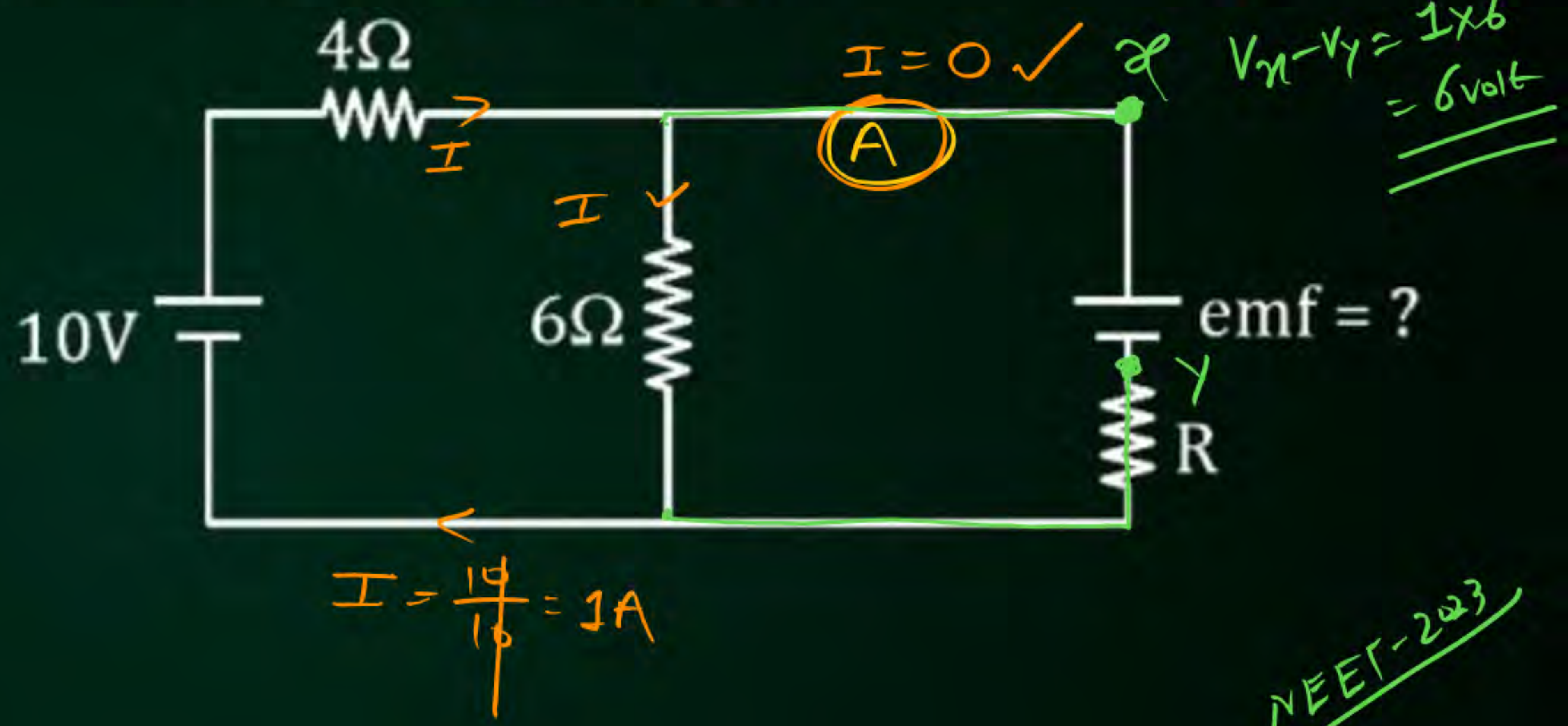
[AIPMT (Prelims)-2008]



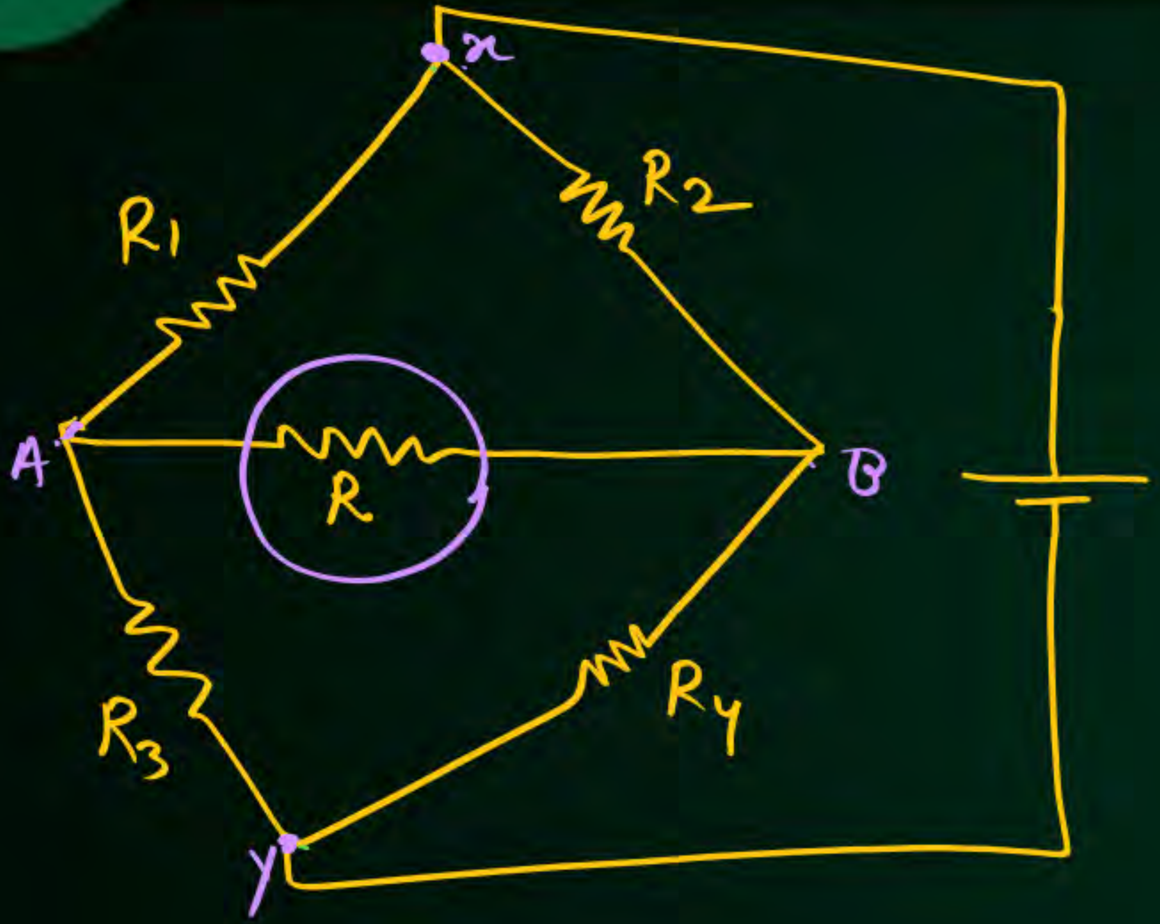
1. 4450 Ω
2. 5050 Ω
3. 5550 Ω
4. 6050 Ω

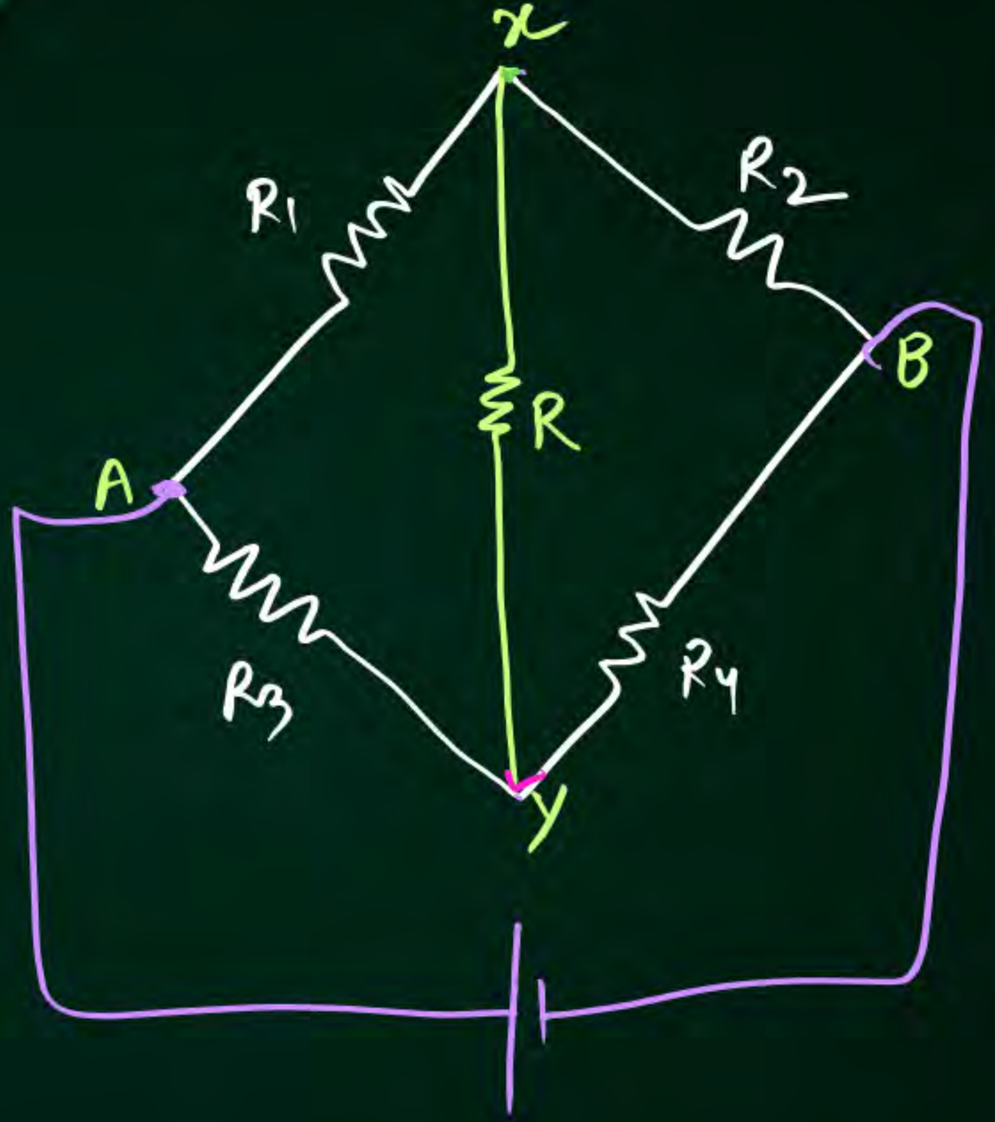
QUESTION

If current in ammeter is zero then find emf of unknown battery?



Wheatstone Bridge





Balance Wheatstone Bridge with same cond.

$\frac{R_1}{R_3} = \frac{R_2}{R_4}$

$\boxed{\frac{R_1}{R_2} = \frac{R_3}{R_4}}$

then $V_x = V_y$

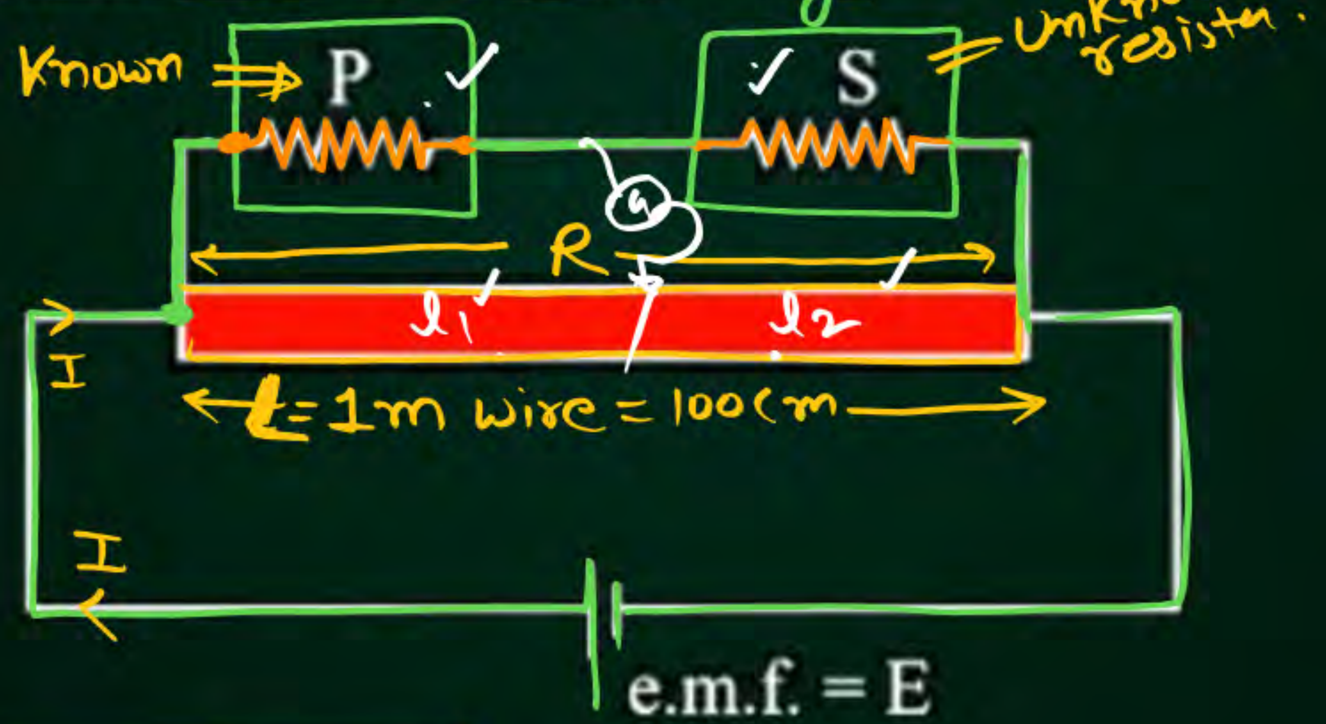
$I_{through}$ R is zero

If $\frac{R_1}{R_2} = \frac{R_3}{R_4}$

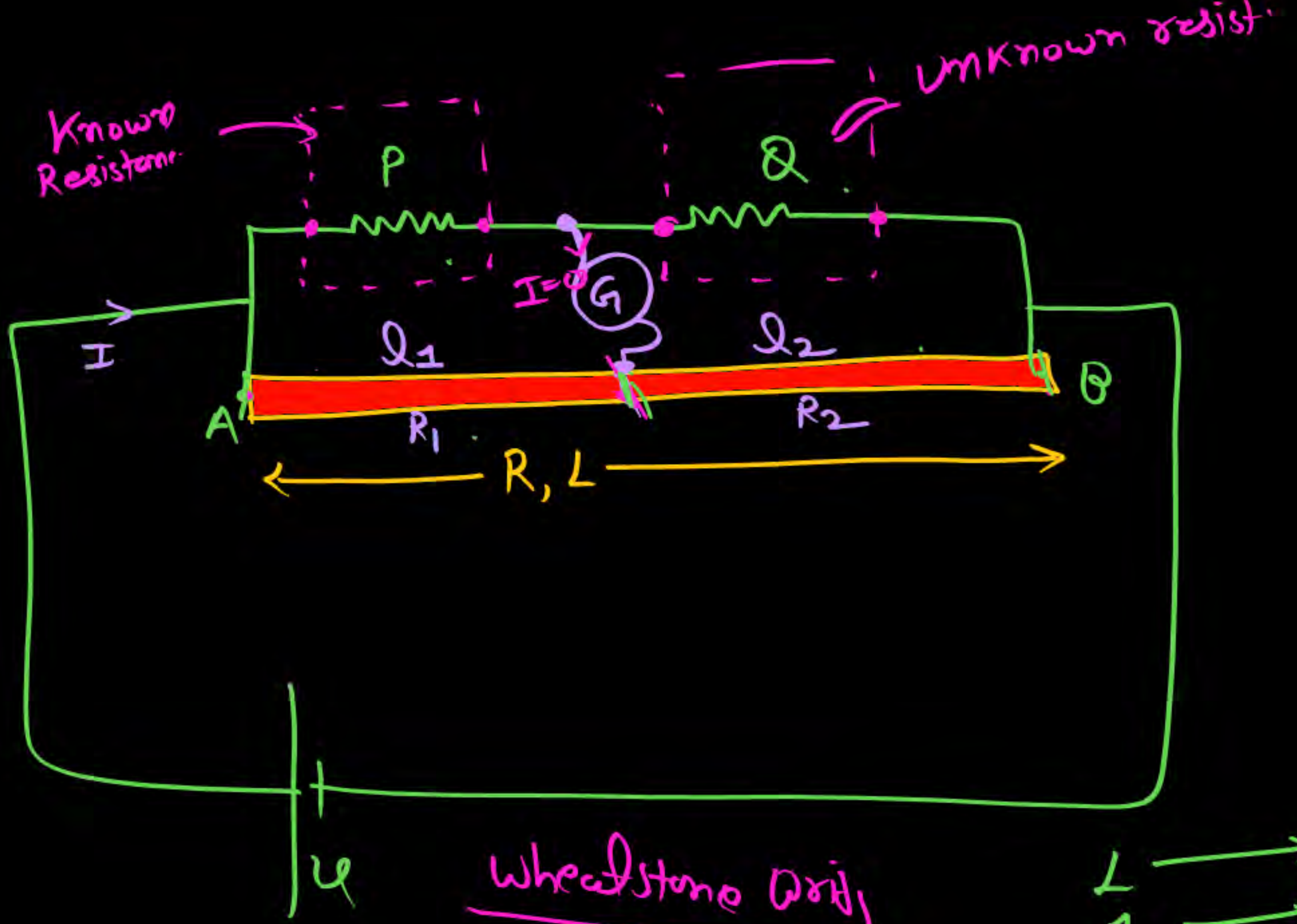
then this is Balance Wheatstone Bridge. hence current in R will be zero

Meter Bridge

- An instrument used to measure known resistance.
- Based on the concept of wheat stone bridge.



- Resistance per unit length $\lambda = \frac{R}{L}$



Wheatstone Bridge

At Balance cond^n

$$\frac{P}{R_1} = \frac{Q}{R_2}$$

$$\frac{P}{Q} = \frac{R_1}{R_2}$$

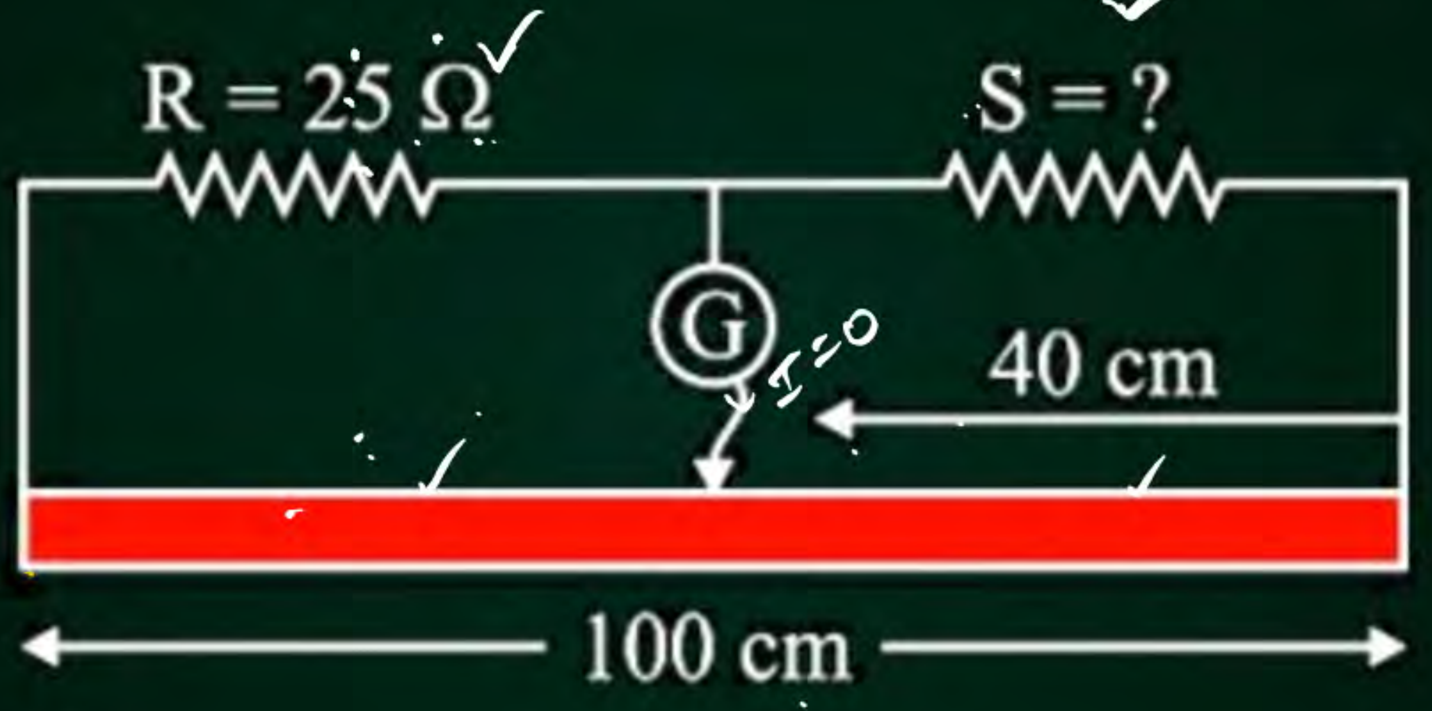
$$\frac{P}{Q} = \frac{\lambda l_1}{\lambda l_2}$$

$$\boxed{\frac{P}{Q} = \frac{l_1}{l_2}}$$

$L \longrightarrow R$

$1 \longrightarrow \frac{R}{L} = \lambda$

$l_1 \longrightarrow R_1 = \lambda l_1 \quad (R_2 = \lambda l_2)$



$$\frac{25}{60} = \frac{S}{40}$$

$$\frac{50}{3} = S$$

QUESTION

The resistance in the two arms of the meter bridge are 5Ω and RΩ, respectively. When the resistance R is shunted with an equal resistance, the new balance point is at $1.6l_1$. The resistance 'R' is

1. 10 Ω
2. 15 Ω ✓
3. 20 Ω
4. 25 Ω

Case-1

$\frac{5}{l_1} = \frac{R}{100 - l_1}$ — (1)

Case-2

$\frac{5}{1.6 l_1} = \frac{R}{2[100 - 1.6 l_1]}$

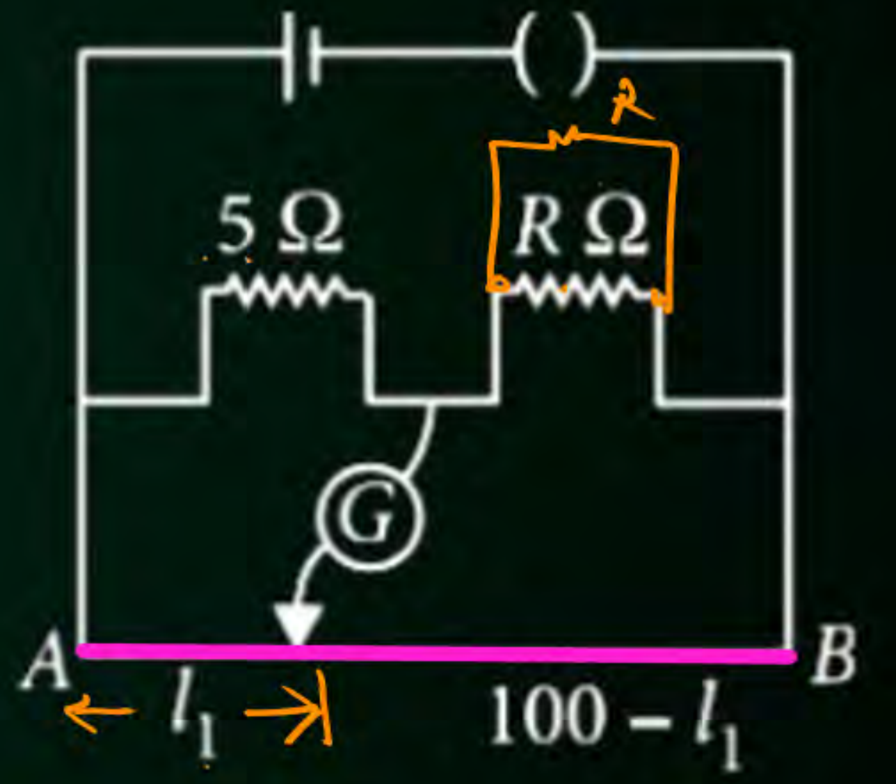
$R = \frac{5}{l_1}(100 - l_1) = \frac{5 \times 2}{1.6 l_1}(100 - 1.6 l_1)$

$100 - l_1 = \frac{2 \times 10}{16}(100 - 1.6 l_1)$

$400 - 4l_1 = 500 - 8l_1$

$4l_1 = 500 - 400 = 100$

$l_1 = 25$



Putting value of l_1 in eqn (1)

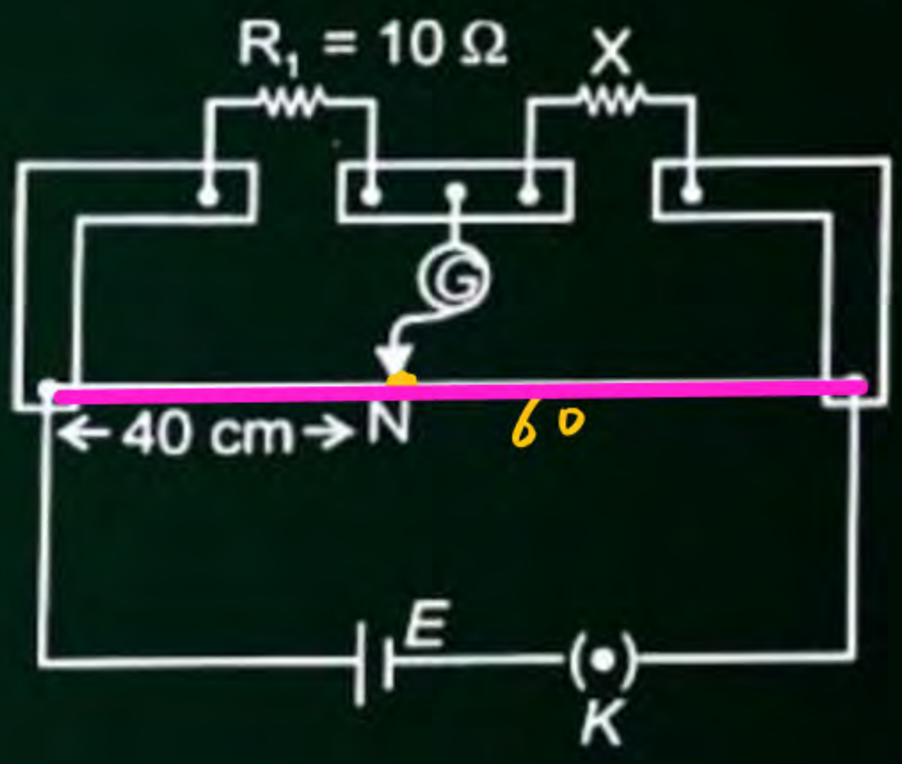
$\frac{5}{25} = \frac{R}{75}$

$R = 15\,\Omega$

QUESTION

In the meter bridge experiment, the null point is obtained at N. The value of unknown resistance X will

$\frac{10}{40} = \frac{x}{60}$



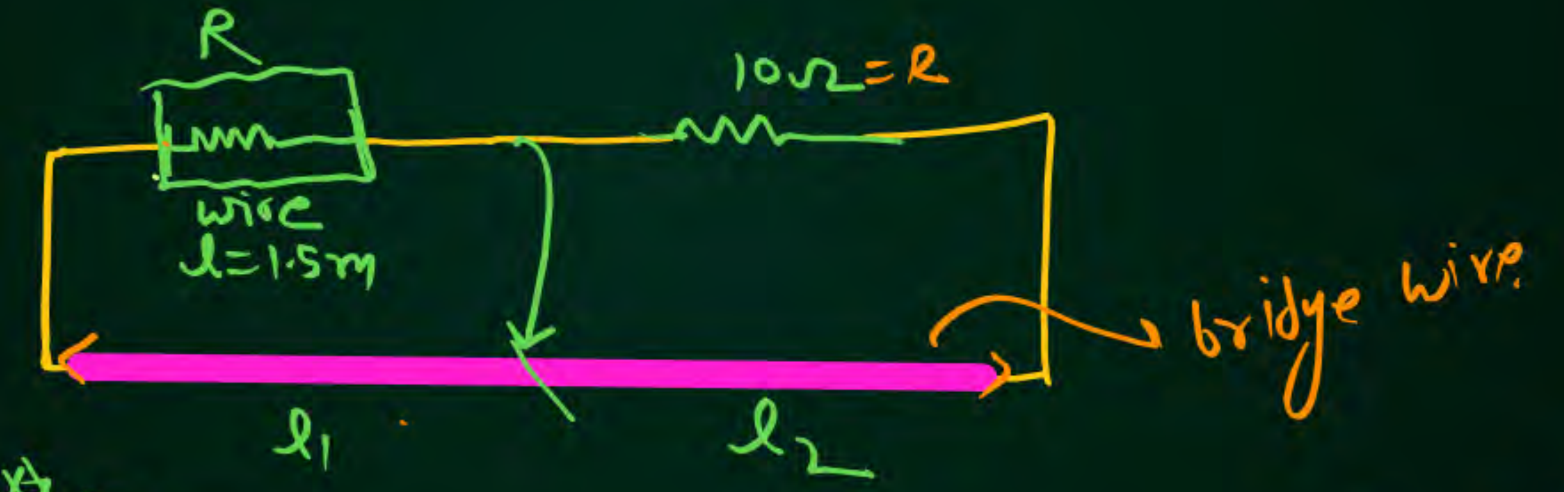
1. 60 Ω
2. 40 Ω
3. 6 Ω
4. 15 Ω

QUESTION

A resistance wire connected in the left gap of a meter bridge balances a 10 Ω resistance in the right gap at a point which divides the bridge wire in the ratio 3 : 2. If the length of the resistance wire is 1.5 m, then the length of 1 Ω of the resistance wire is

[NEET2020]

1. 1.0×10^{-2} m
2. 1.0×10^{-1} m ✓
3. 1.5×10^{-1} m
4. 1.5×10^{-2} m



$$\frac{l_1}{l_2} = \frac{3}{2}$$

$$\frac{R}{10} = \frac{l_1}{l_2} = \frac{3}{2}$$

$$R = 15\,\Omega$$

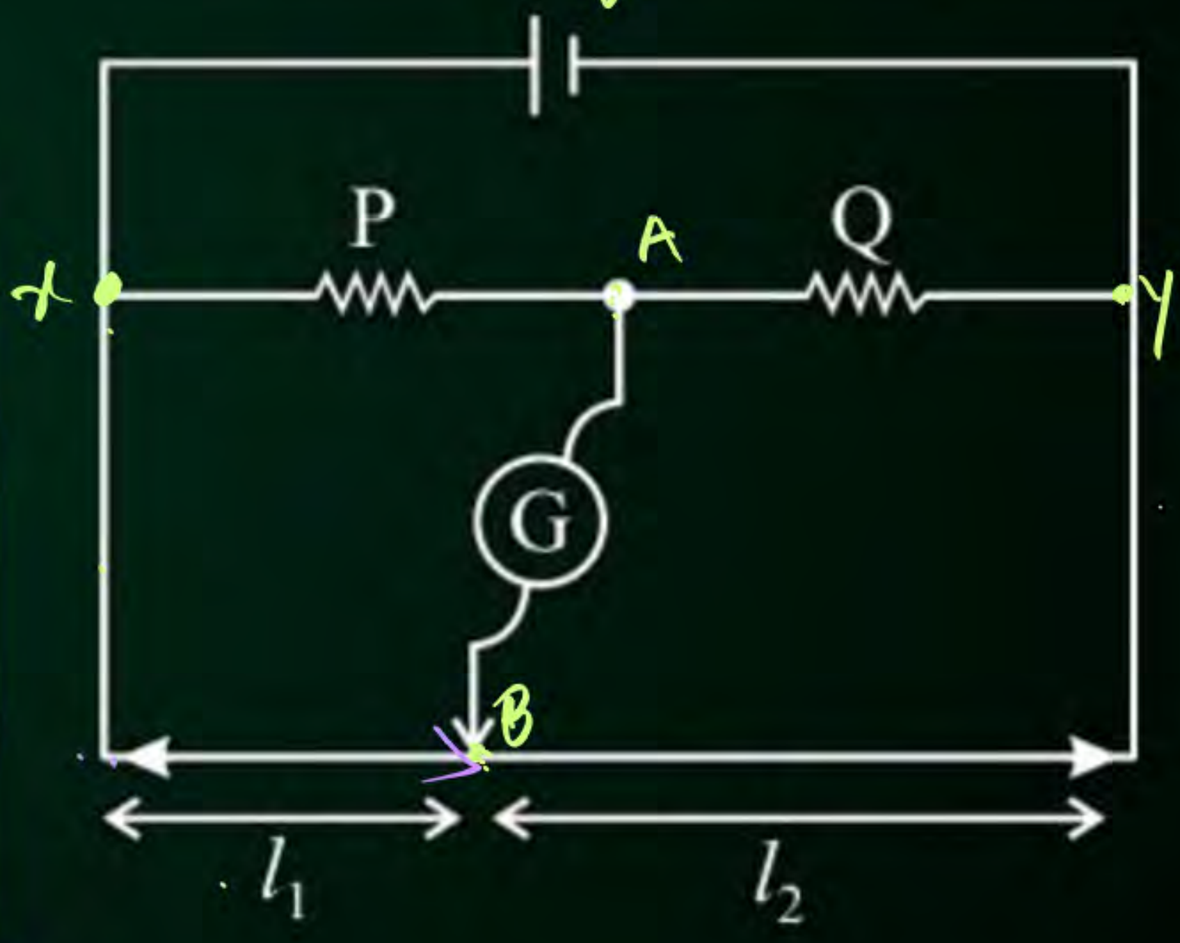
15Ω Resis Ka leng = 1.5m

1Ω Resi K $= \frac{1.5m}{15}$

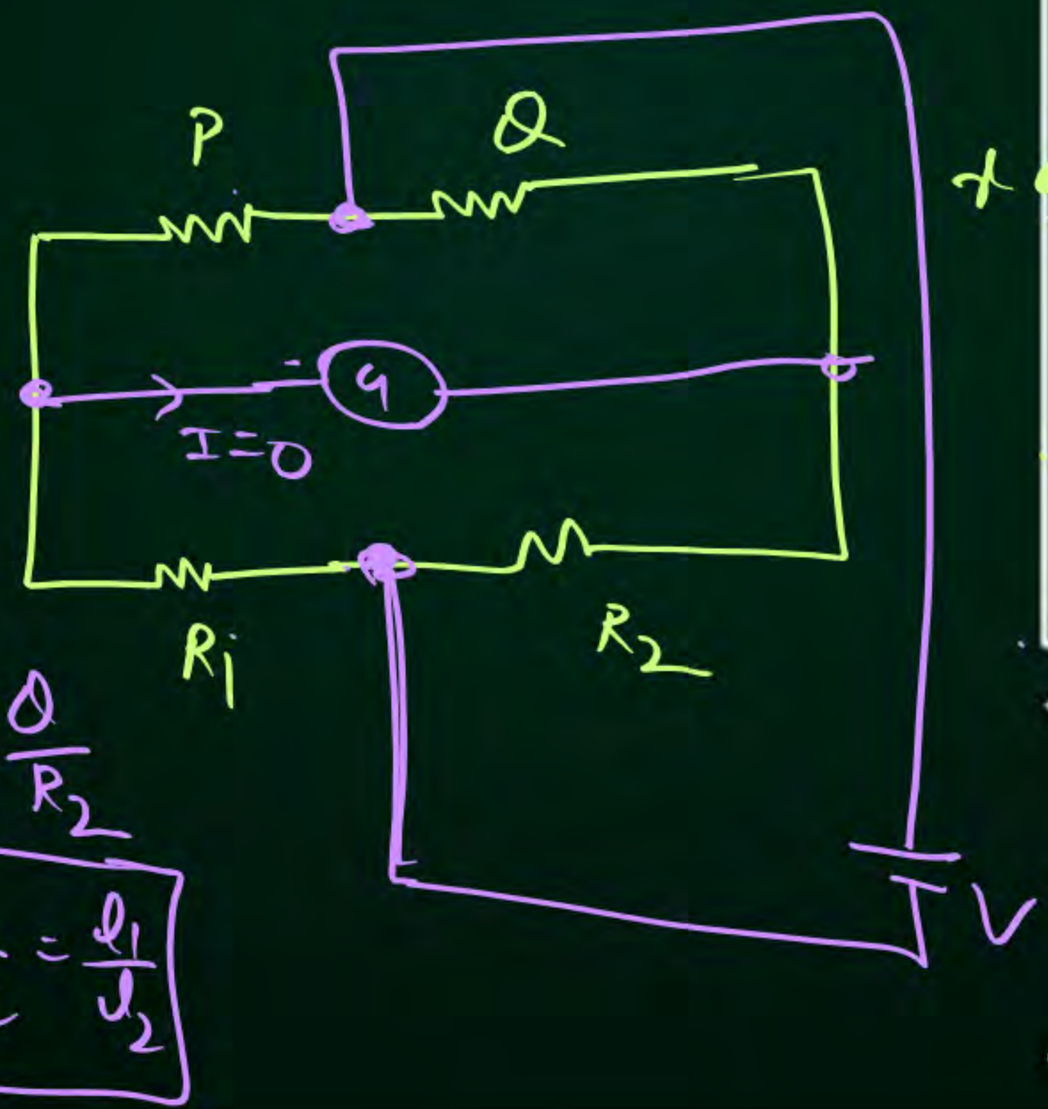
$= 0.1$ m

QUESTION

The metre bridge shown is in a balanced position with $\frac{P}{Q} = \frac{l_1}{l_2}$. If we now interchange the position of the galvanometer and the cell, will the bridge work ? If yes, what will be the balanced condition?

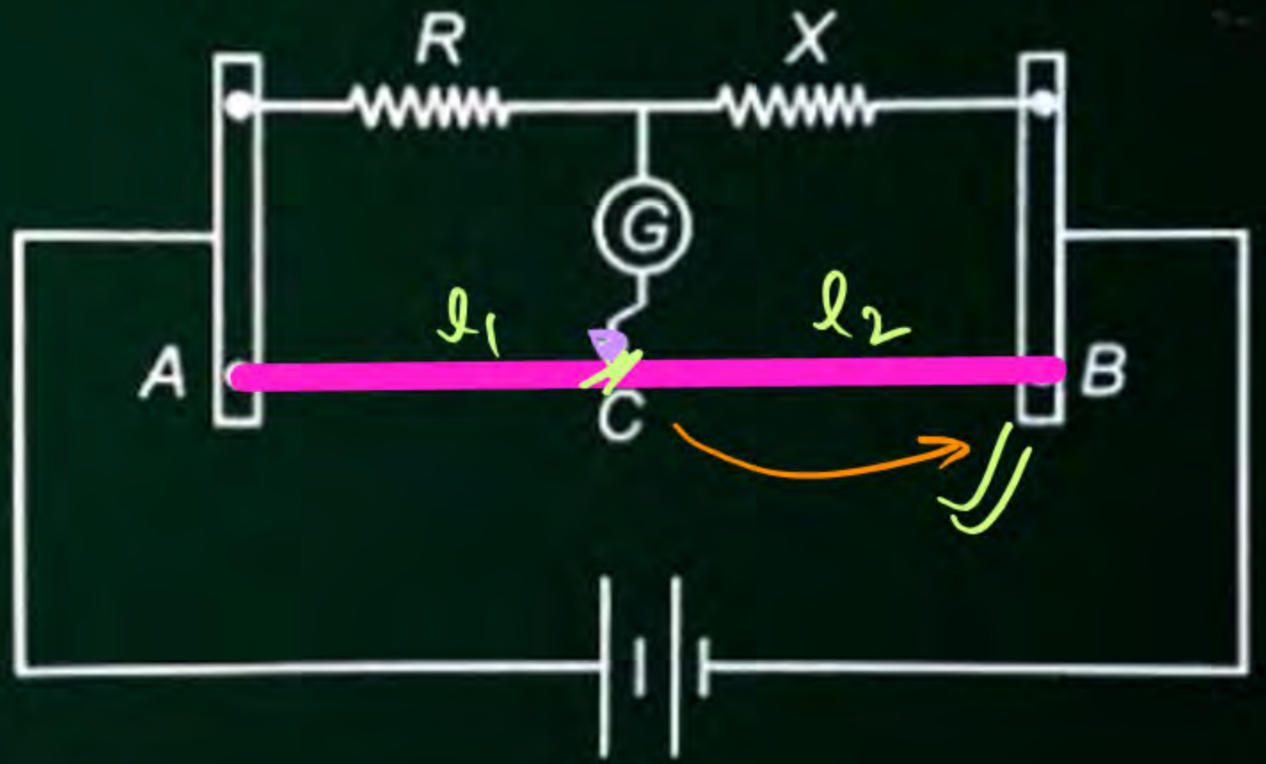


1. Yes, $\frac{P}{Q} = \frac{l_1 - l_2}{l_1 + l_2}$
2. No, no null point
3. Yes, $\frac{P}{Q} = \frac{l_2}{l_1}$
4. Yes, $\frac{P}{Q} = \frac{l_1}{l_2}$



QUESTION

In the meter bridge shown, the resistance X has a negative temperature coefficient of resistance. Neglecting the variation in other resistor, when current is passed for some time, in the circuit balance point should shift towards



1. A
2. B
3. First A then B
4. It will remain at C

QUESTION

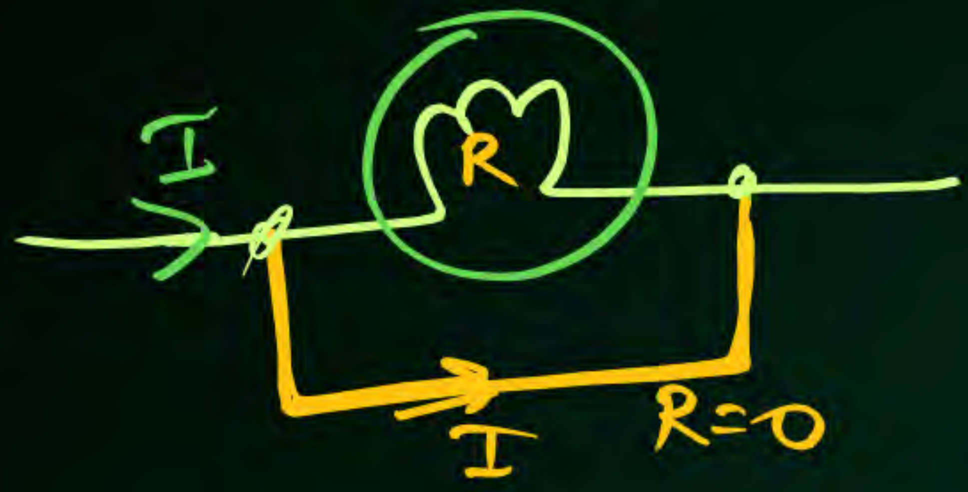
H/W max^n power → $r_{int} = R$ → only 5 min

There are a large number of cells available, each marked (6 V, 0.5 Ω) to be used to supply current to a device of resistance 0.75Ω, requiring 24 A current. How should the cells be arranged, so that power is transmitted to the load using minimum number of cells?

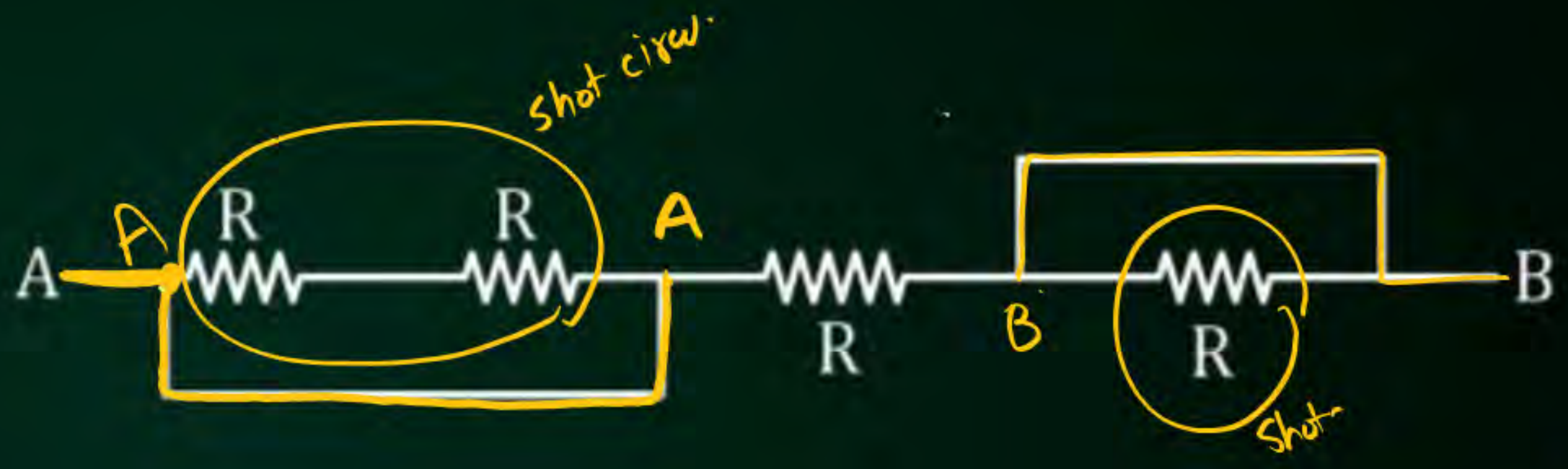
1. Six rows, each containing four cells
2. Four rows, each containing six cells
3. Four rows, each containing four cells
4. Six rows, each containing six cells



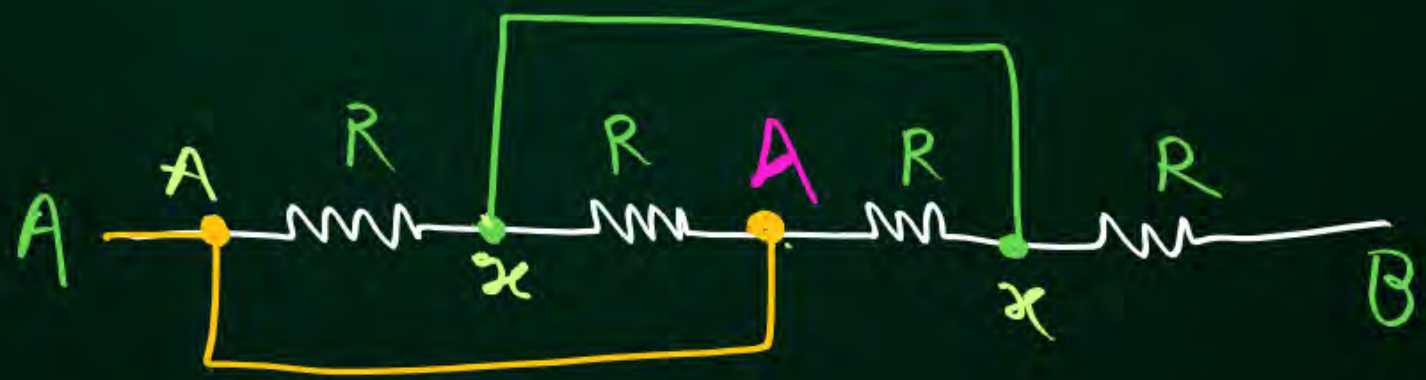
Shot circuit
→ same potential across resistance



$I = \frac{V}{R} = \frac{V}{0} \nearrow$ infr



$R_{AB} = R$

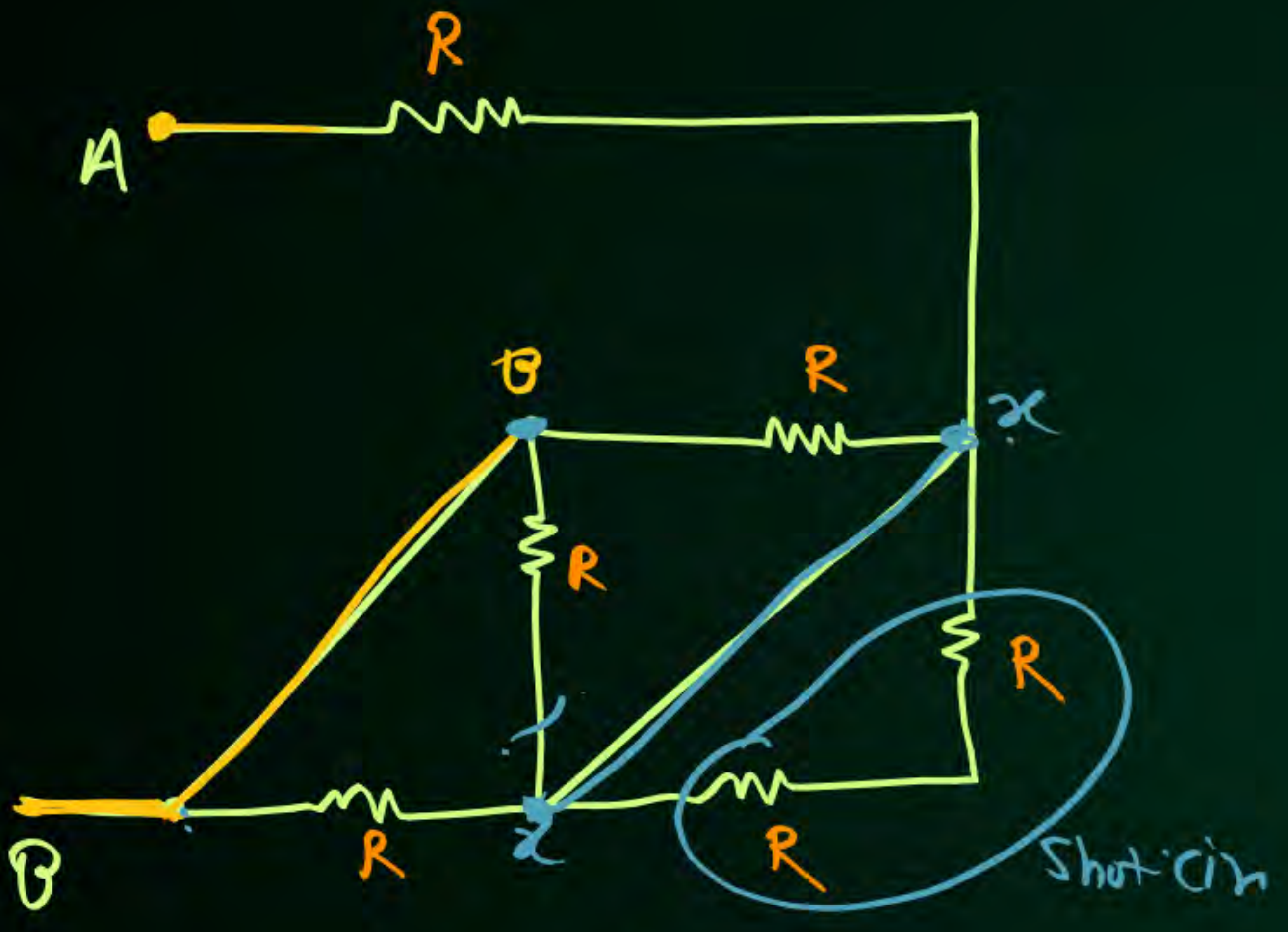


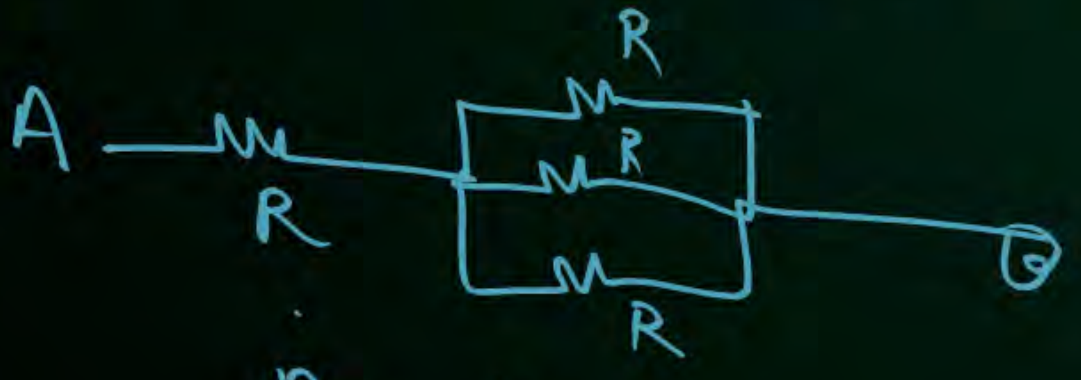
$R_{AB} = \frac{R}{3} + R$

$R_{AB} = \frac{4R}{3}$

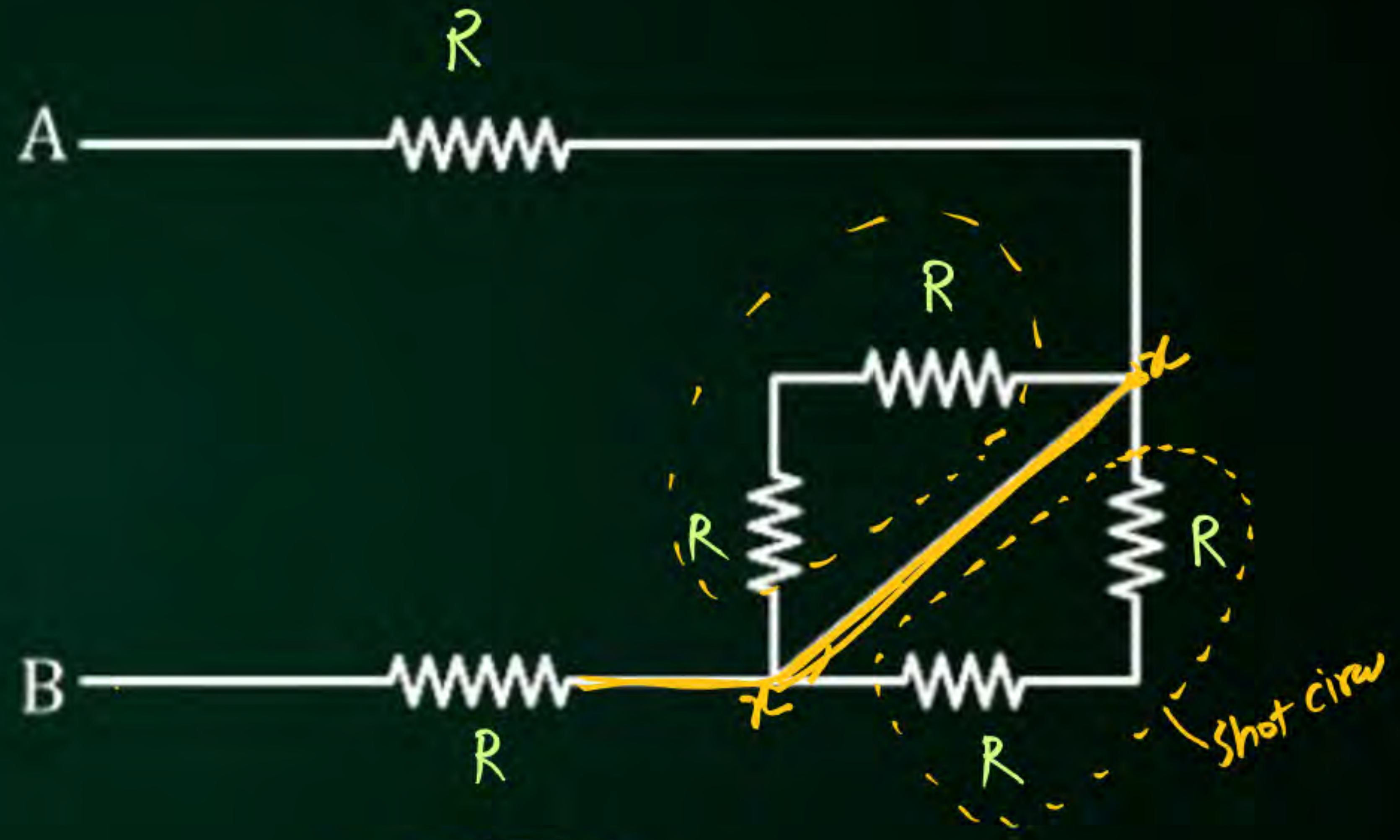
Ans.







$$R_{AB} = \frac{4R}{3}$$

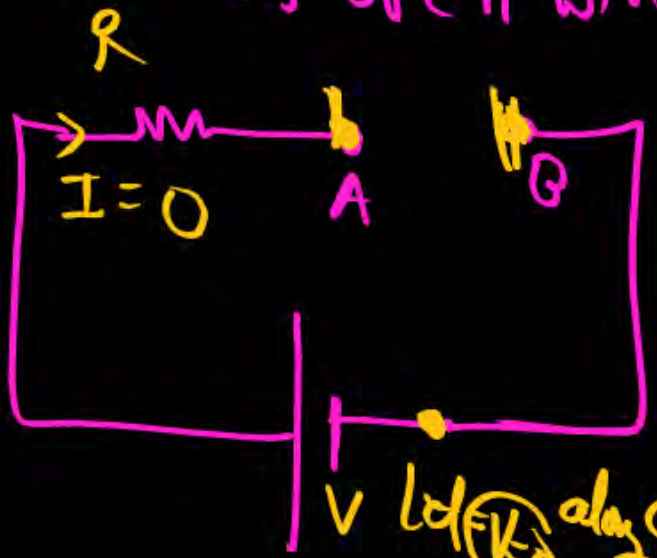


$$R_{AB} = 2R$$

DC → RC → circuit

→ capacitor behave as ekdam simple wire at $t=0$, when key is Just closed or charging starts.

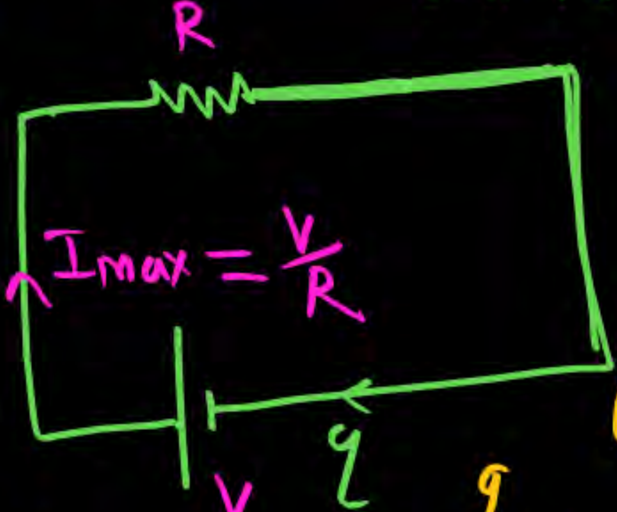
after (large time) steady state
after full charge
Capacitor behave as open wire.



$q_{m}=CV$

$V_{AB}=V$

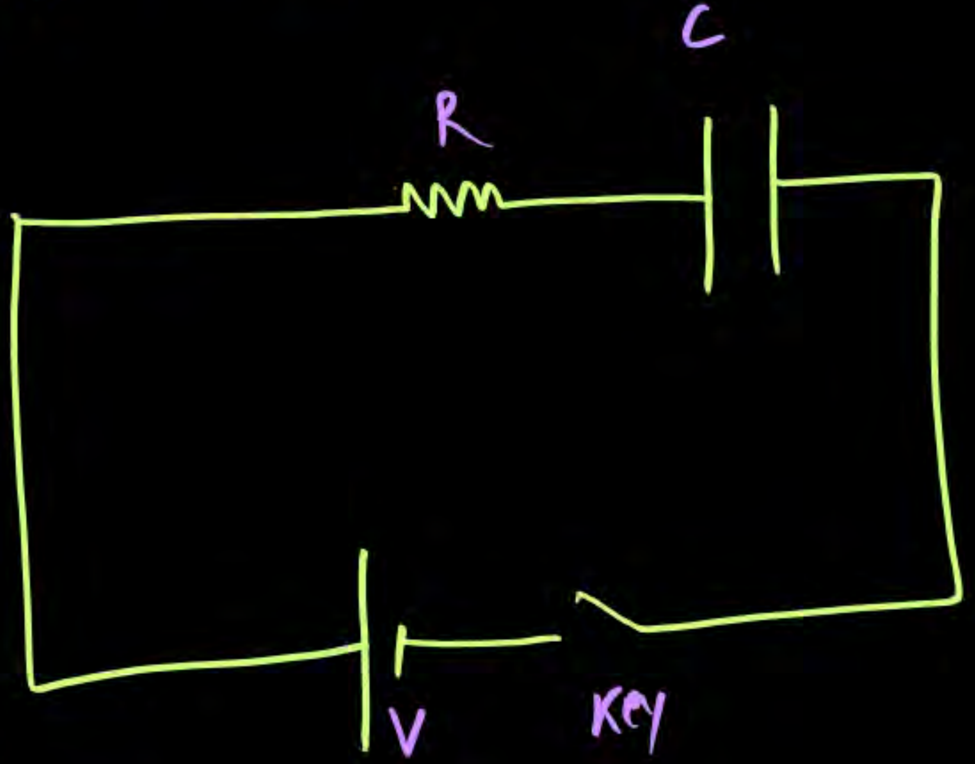
at $t=0$
Just Key is clos



at $t=0$

$q_{capacitor}=0$

$V_{capacitor}=0$

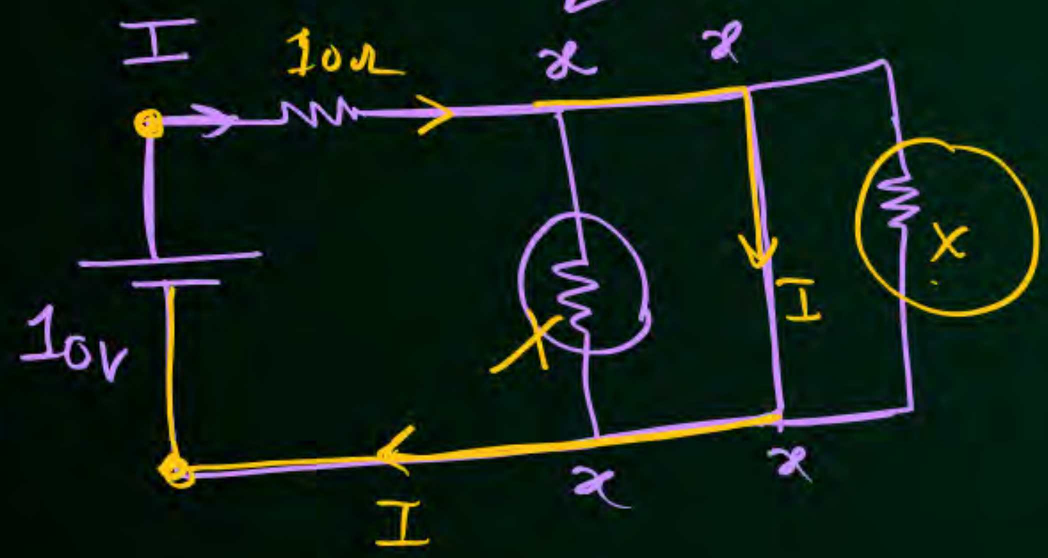


QUESTION

(i) Find I at $t = 0$

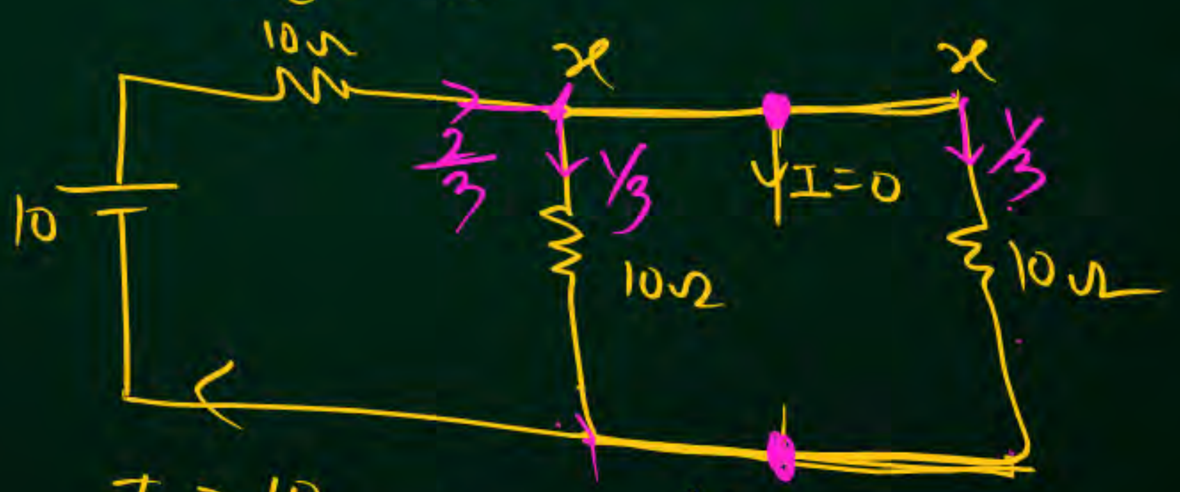
(ii) Find I at $t = \alpha$ (steady state)





$I = \frac{10}{10} = 1$ Amp

$t = \infty$



$I = \frac{10}{15} = \frac{2}{3}$ Amp

$V_{capacitor}$ at steady s. $= V_{xy} = 5 \times \frac{2}{3} = \frac{10}{3}$ Volt

$V_{xy} = 10 \times \frac{1}{3} = \frac{10}{3}$ Volt

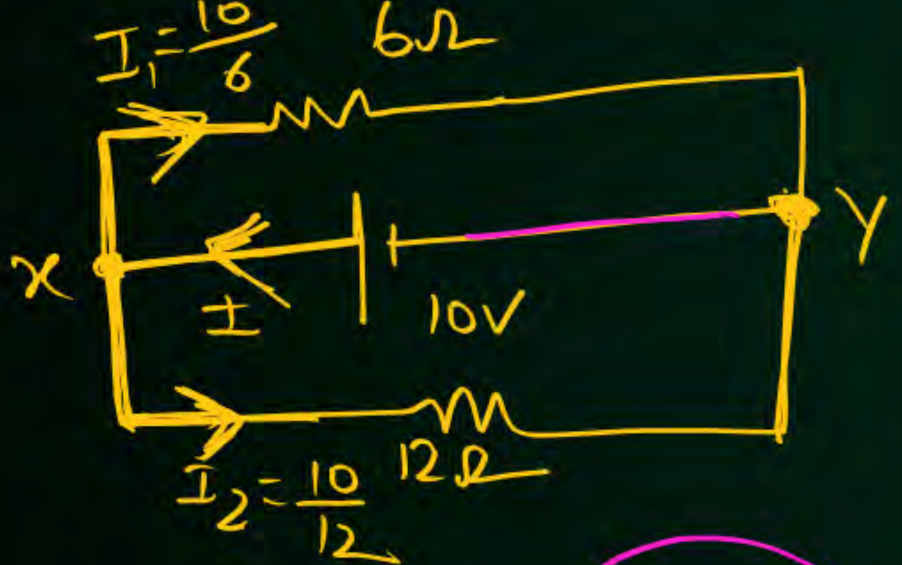
QUESTION

Find current at $t = 0$ and at $t = \alpha$. (steady state)



(a) zero
(b) 12 V
(c) 5 V
(d) 10 V
(e) 7 V

at t = 0



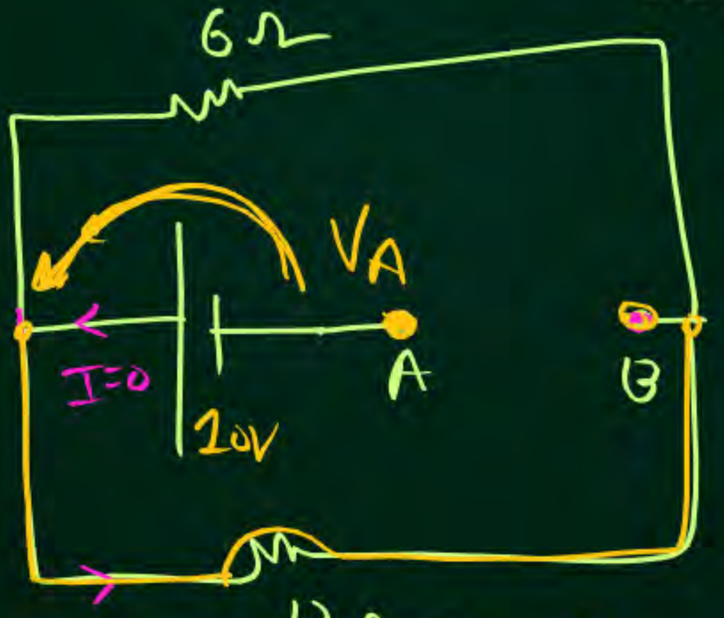
$I = \frac{10}{6} + \frac{10}{12}$

$= \frac{20+10}{12}$

$= \frac{30}{12} = \frac{15}{6}$ Amp.

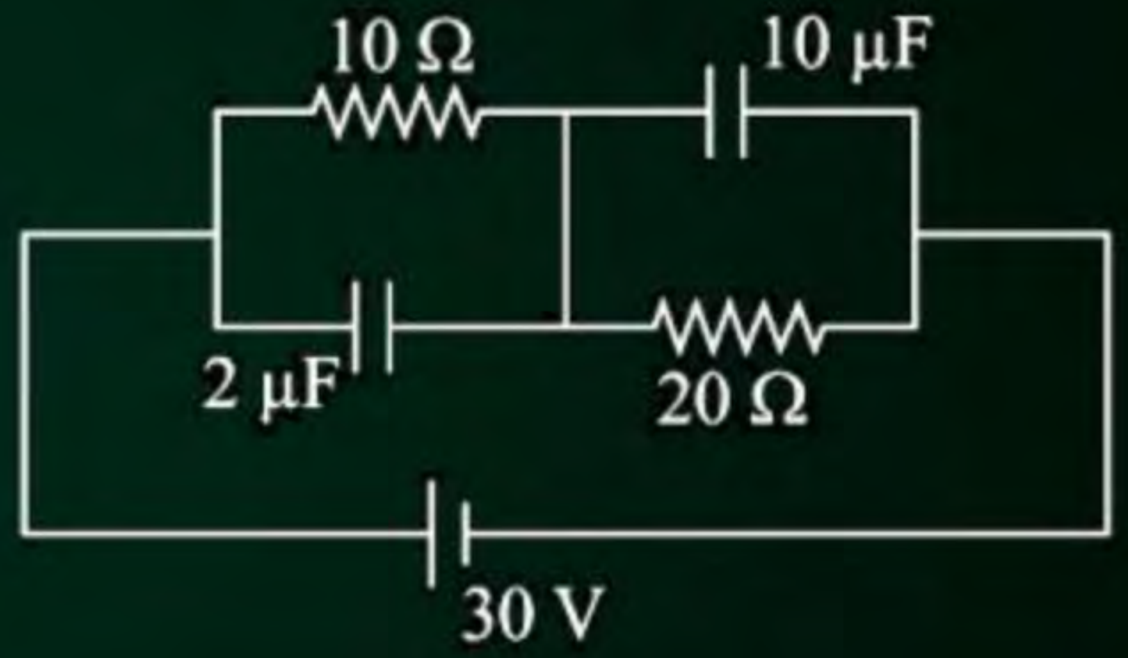
$V_{across\ capa} = 0$

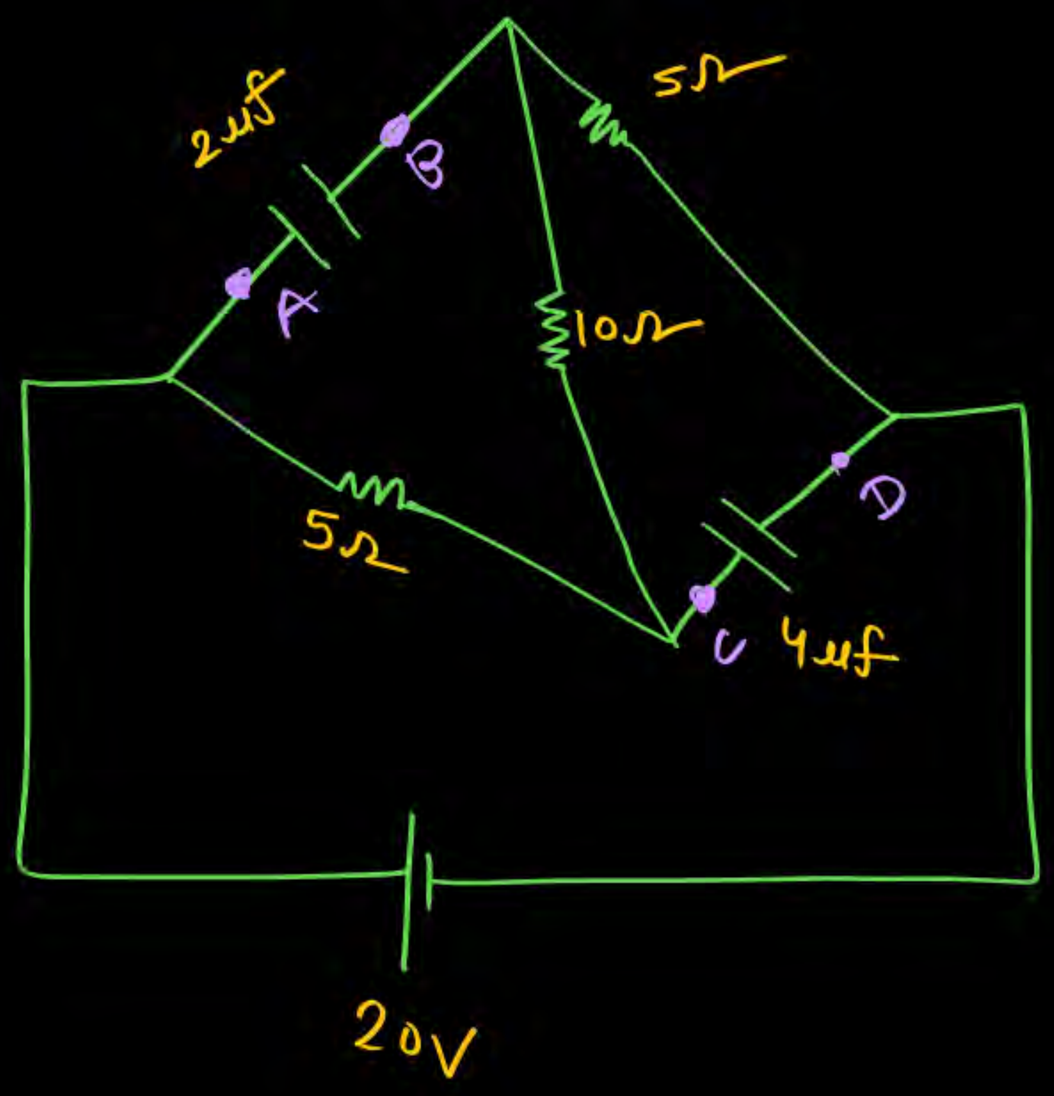
t = steady state



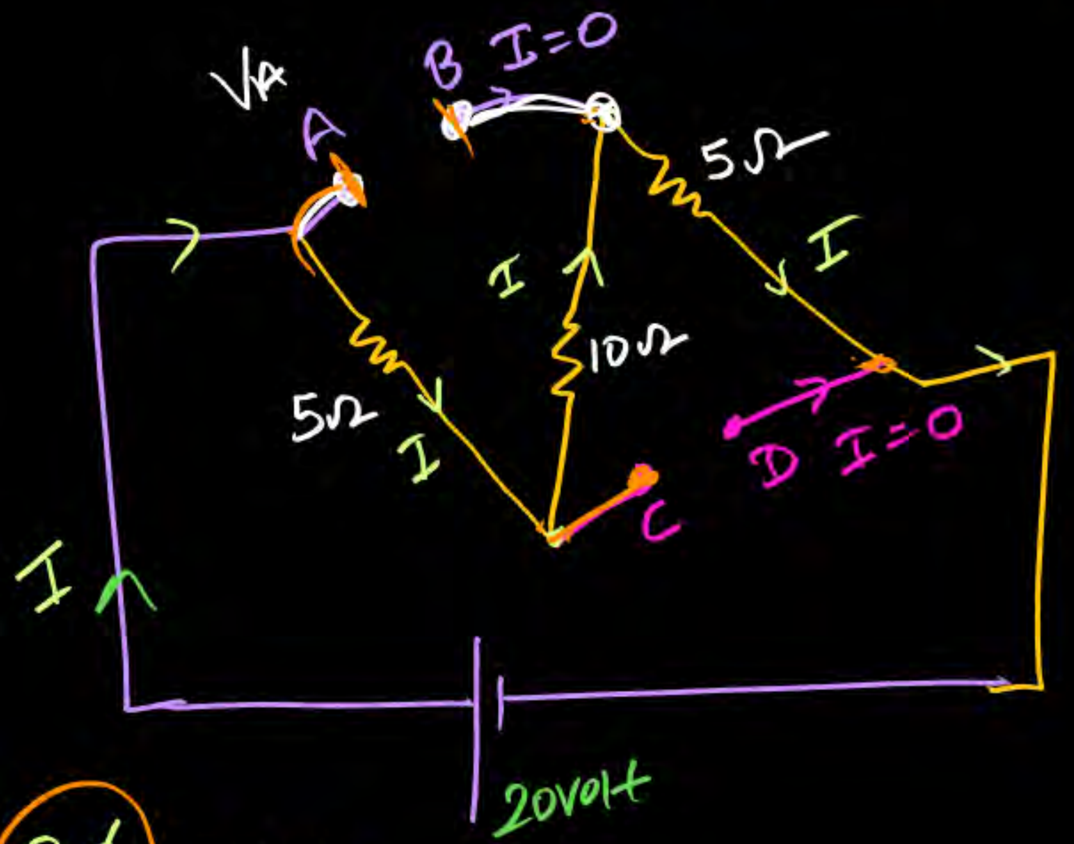
I = 0

Potential drop across capacitor


10 Ω
10 μF
2 μF
20 Ω
30 V



find charge on 2μf capacitor at $t=\infty$ (steady state)



$I = \frac{20}{20} = 1$ Amp

Soln

$V_A - 5\times1 - 10\times1 = V_B$

$V_A - V_B = 15$ volt

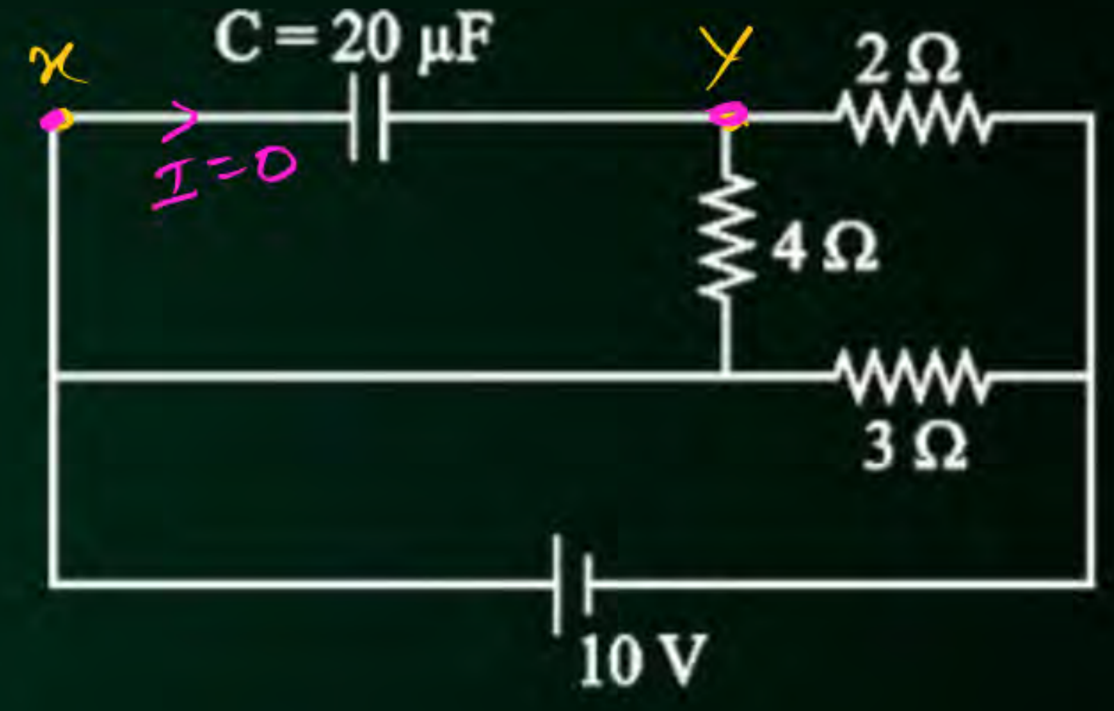
$q_A = CV = 2\mu f \times 15 = 30\mu C$

QUESTION

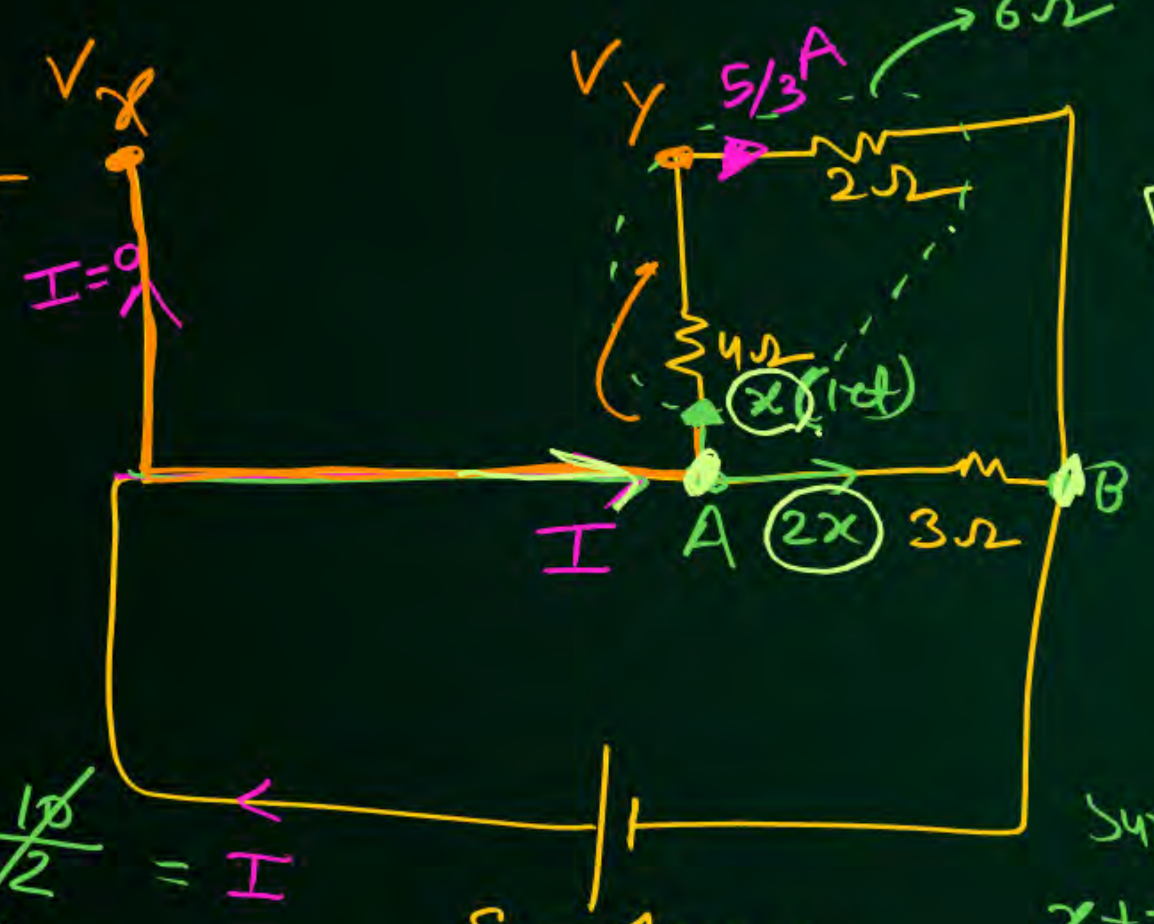
Find time when charge on capacitor is half of the maximum charge.

QUESTION

Find charge on capacitor at steady state.



Soln



V = same in parallel

$\downarrow I \propto \frac{1}{R}\uparrow$

$5A = \frac{10}{2} = I$

$\varepsilon = 10$ volt

Sum of curr

$x + 2x = 5A$

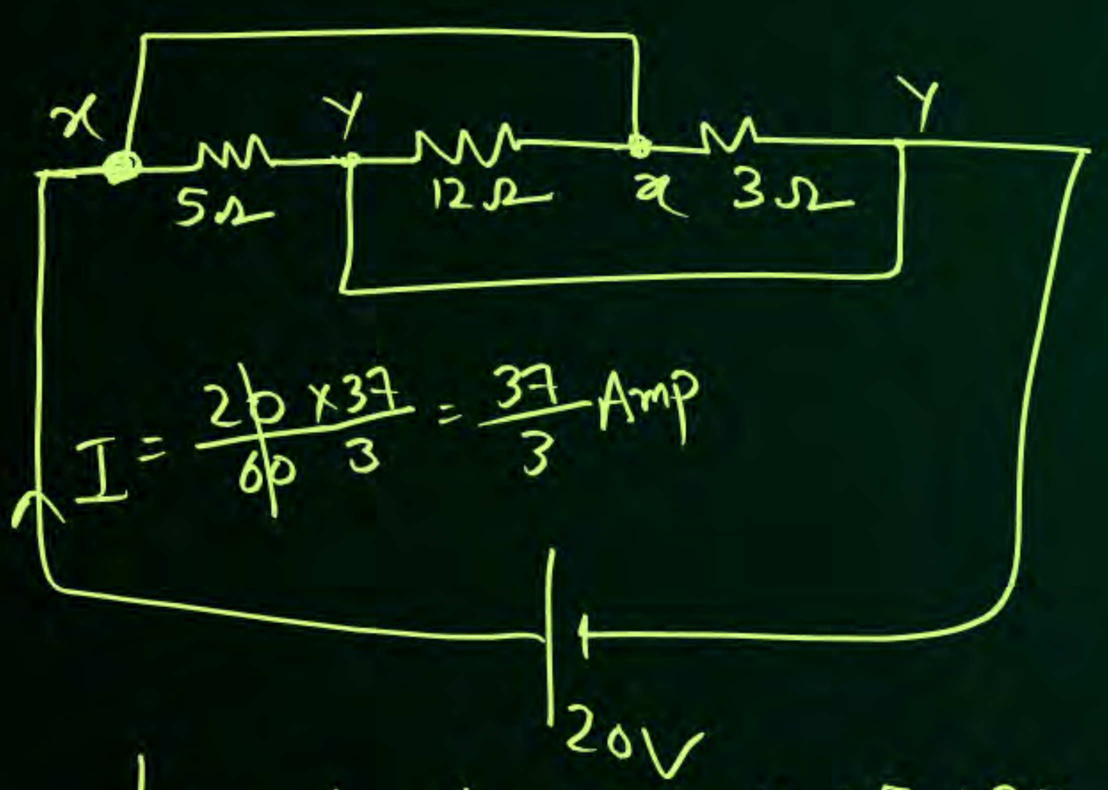
$3x = 5$

$x = \frac{5}{3}$ Amp

$V_x - \frac{5}{3} \times 4 = V_y$

$V_x - V_y = \frac{20}{3}$ Volt $\quad q = \frac{20 \times 20}{3}$ µC

at t = 0

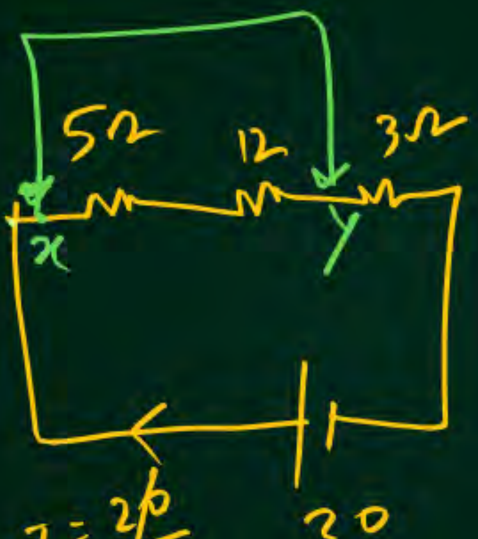


$I = \frac{20 \times 37}{60 \quad 3} = \frac{37}{3}$ Amp

$\frac{1}{R_{eq}} = \frac{1}{5} + \frac{1}{12} + \frac{1}{3} = \frac{12+5+20}{60}$

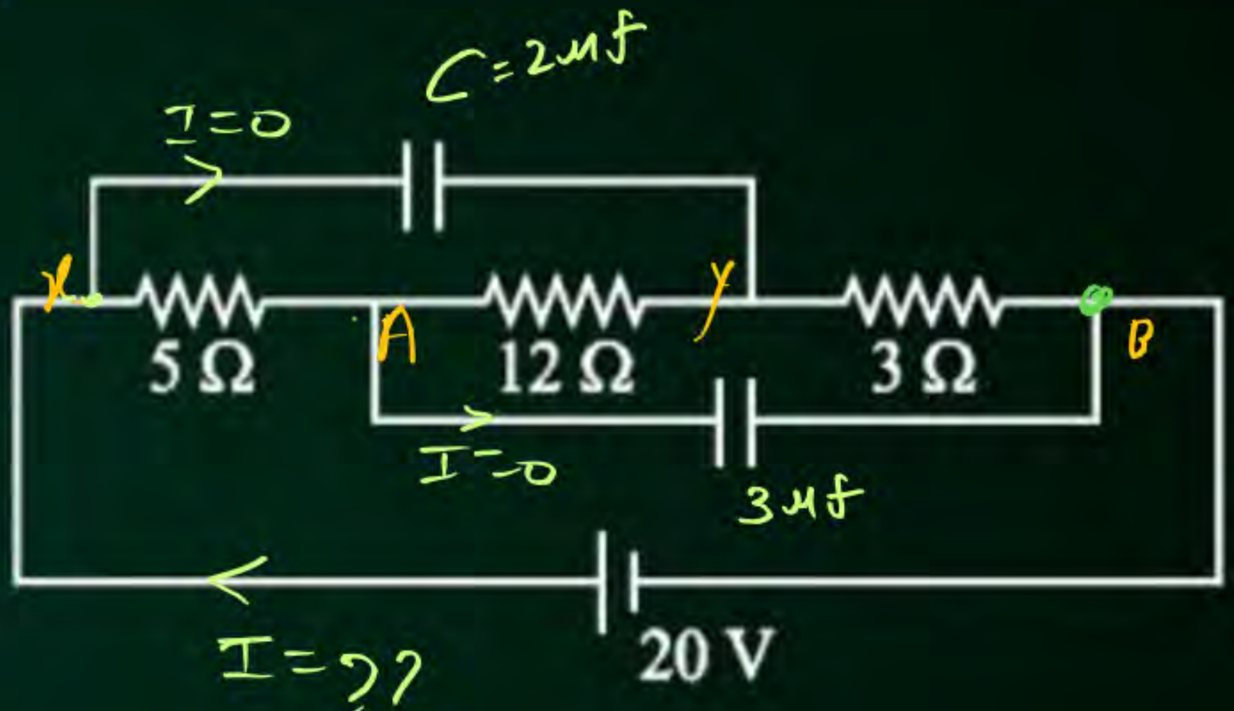
$R_{eq} = \left(\frac{60}{37}\right) \Omega$

$t = \infty$ (state)



$I = \frac{20}{20}$

$= 1A$



$V_{xy} = 17$ volt

$q_{2\mu F} = C V_{xy} = 34 \mu C$

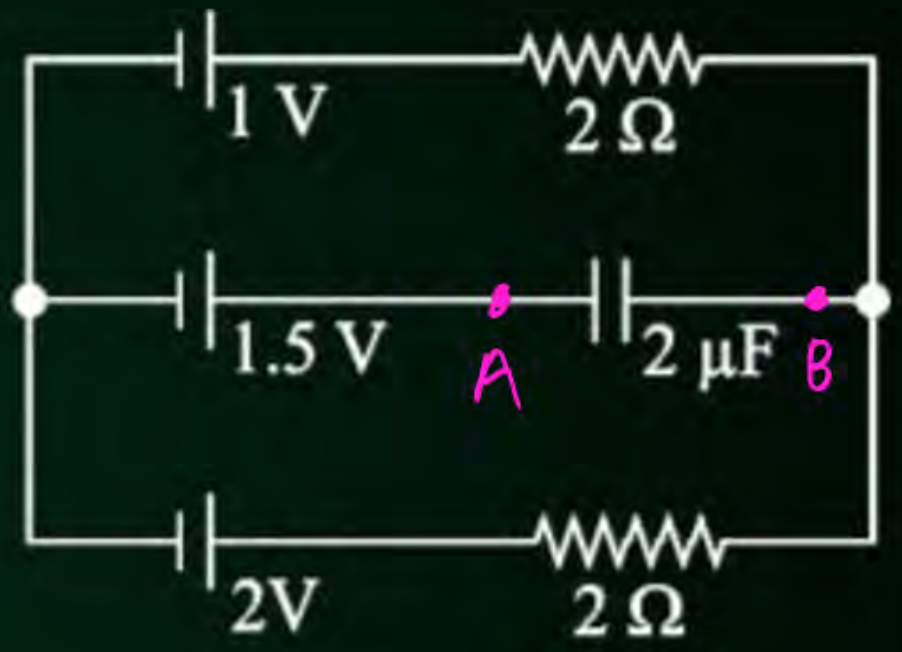
$V_{AB} = 15$ volt

$q_{3\mu F} = 15 \times 3 = 45 \mu C$

QUESTION

The charge in the 2 μF capacitor at steady state is

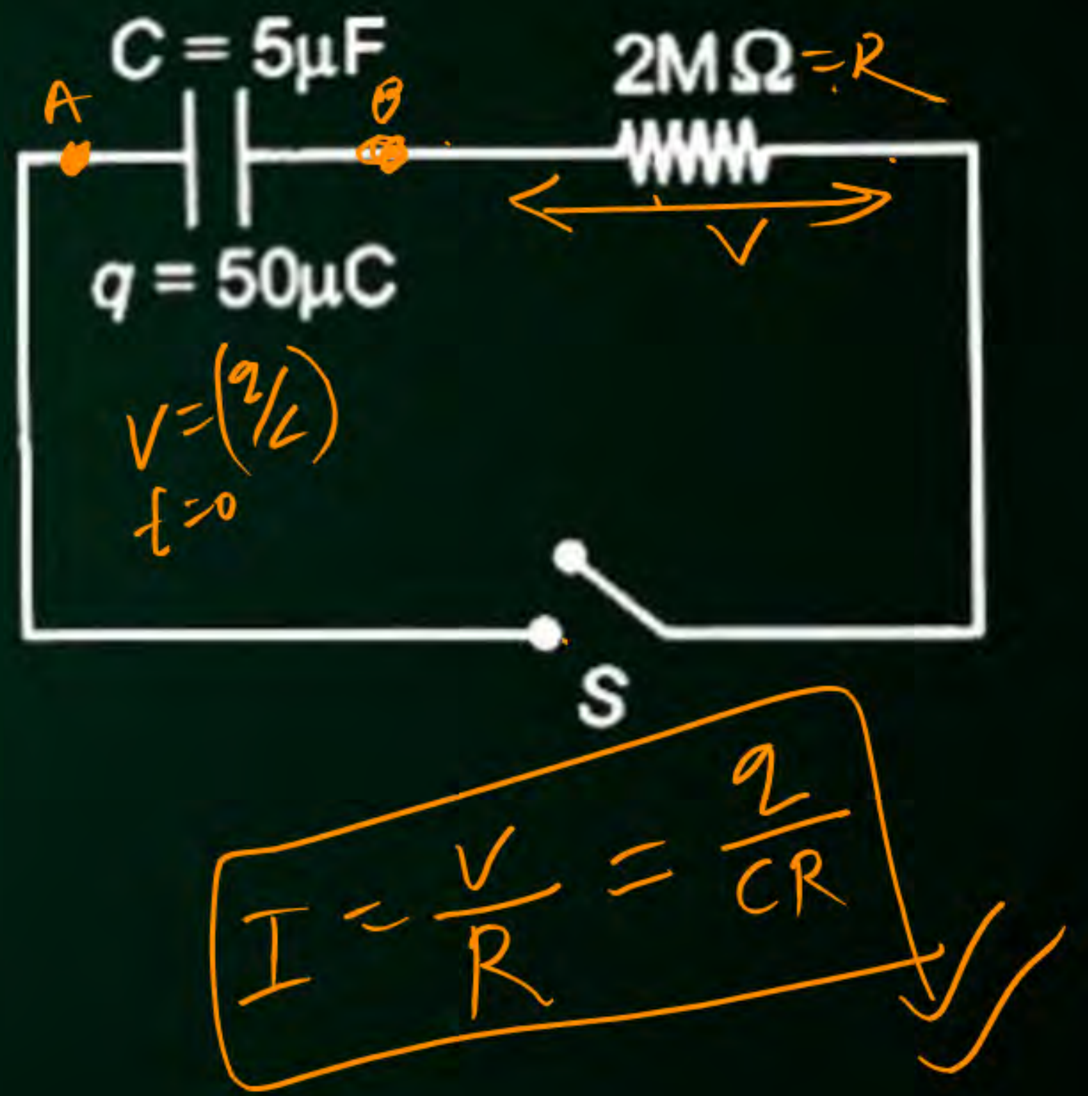
1. Zero
2. 2 μC
3. 4 μC
4. 6 μC



QUESTION

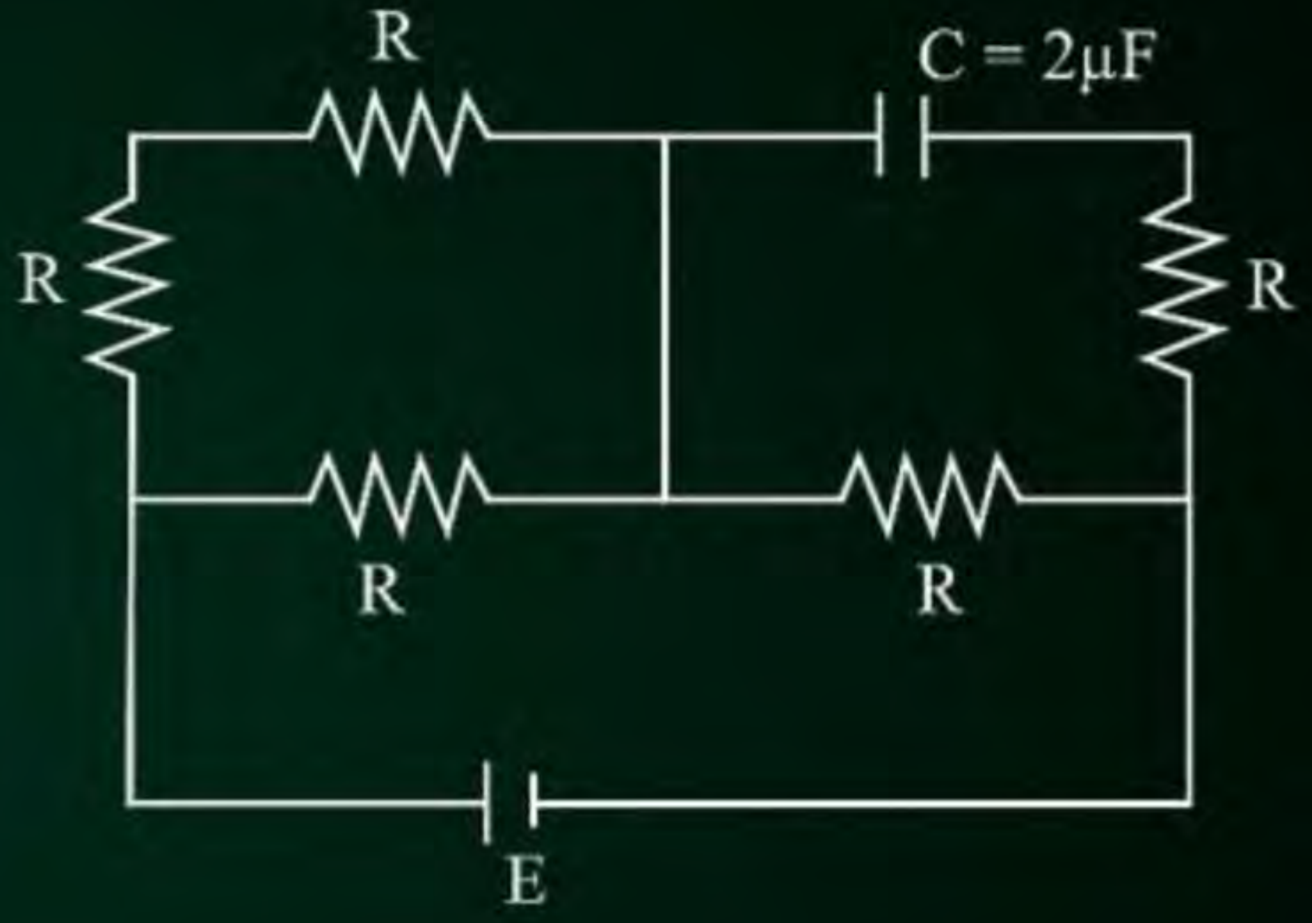
The following circuit consists of a 5 μF capacitor, having charge 50 μC as shown. The switch is closed at $t = 0$. The value of current in 2 MΩ resistor at $t = 0$ is

1. 1 μA
2. 2 μA
3. 5 μA
4. 5 A



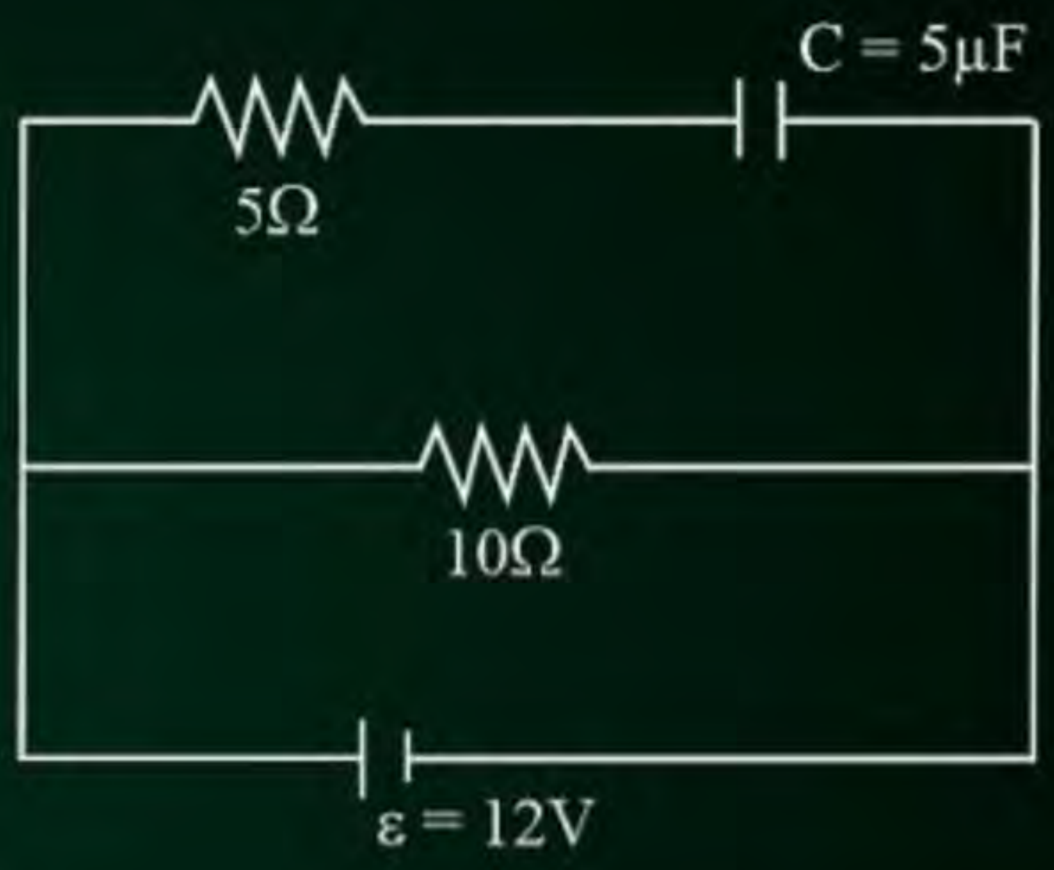
at steady state find charge on capacitor = ??

H/W



H/w

find chare on
Capacit at t=∞



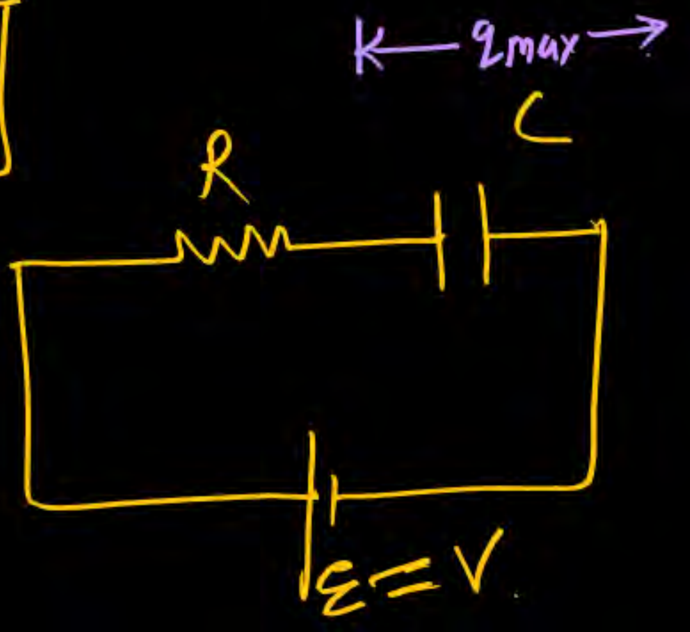
at $t = \infty$

$q = q_{max} = CV$

→ does not depends on (R)

at $t = 0$

$q = 0$



charge at time

$$q_t = q_{max}\left(1 - e^{-t/RC}\right)$$

$$q = CV\left(1 - e^{-t/RC}\right)$$

$e^{-0} = 1$	$e^{\infty} = \infty$
$e^{0} = 1$	$e^{-\infty} = 0$

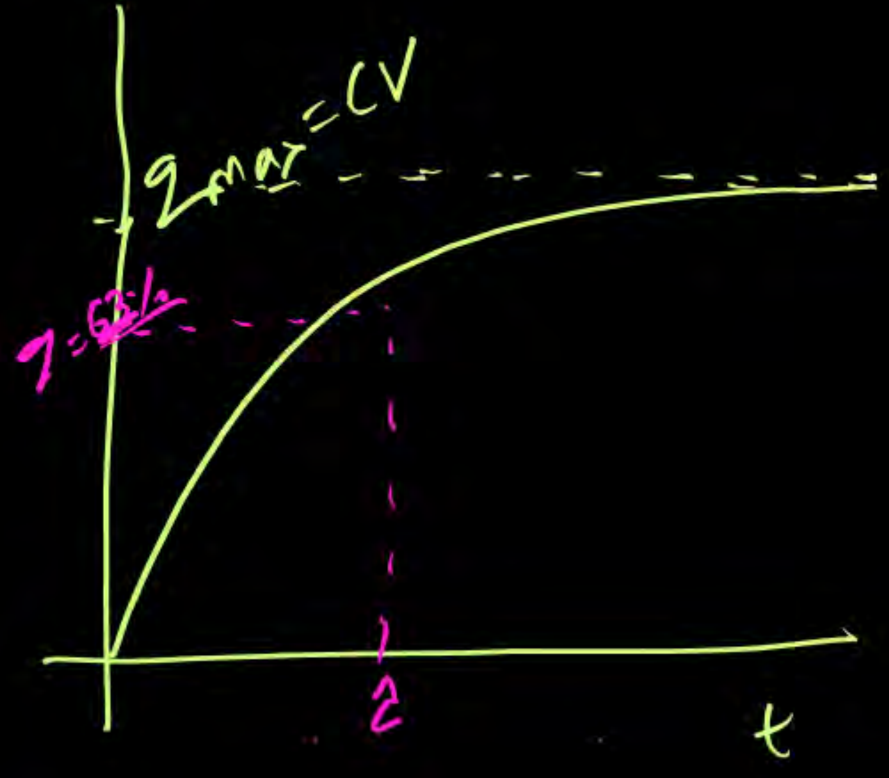
$\tau = RC$

time constant

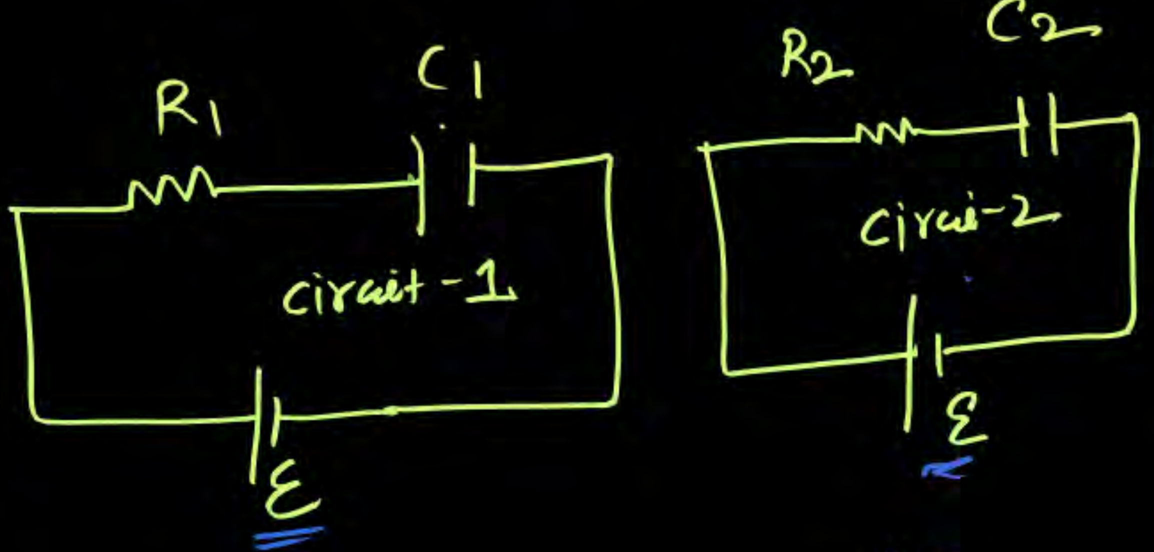
$$q = q\left(1 - e^{-1}\right)$$

$$= q\left(1 - \frac{1}{e}\right)$$

$$= q\left(\frac{e-1}{e}\right)$$



Not for NEET



find Relⁿ B/w C_1 & C_2, R_1 & C_2

Solⁿ

q_{max} = same (according to graph)

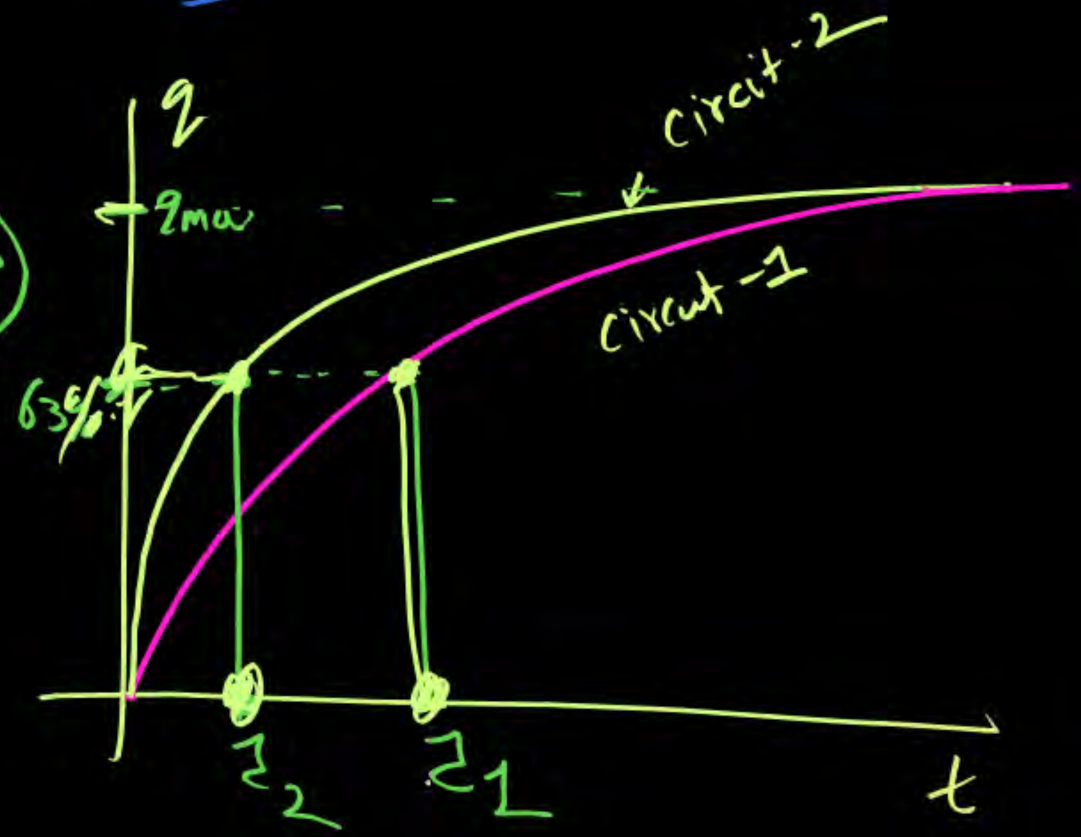
$q_{max_1} = C_1 V_1 = C_2 V_2$

$C_1 = C_2$

$\tau_2 < \tau_1$

$C_2 R_2 < C_1 R_1$

$R_2 < R_1$



DISCHARGING OF CAPACITOR

at $t = 0$

$q_{max} = Q_0 = CV$

$E_{max} = \frac{1}{2}CV^2$

Total energy loss $= \frac{1}{2}CV^2$

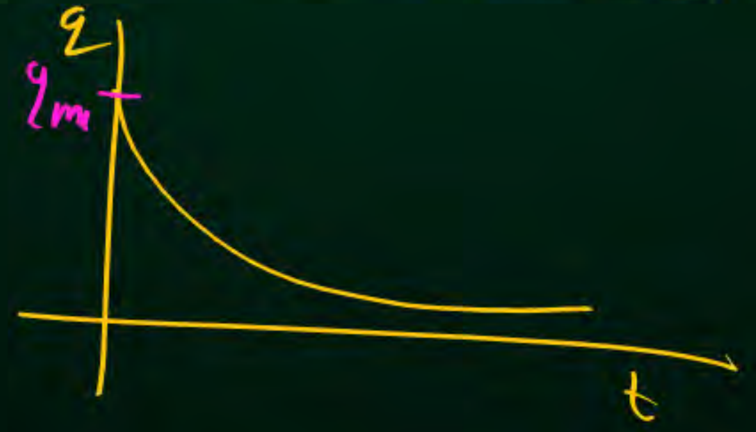
$= \frac{Q_0^2}{2C}$

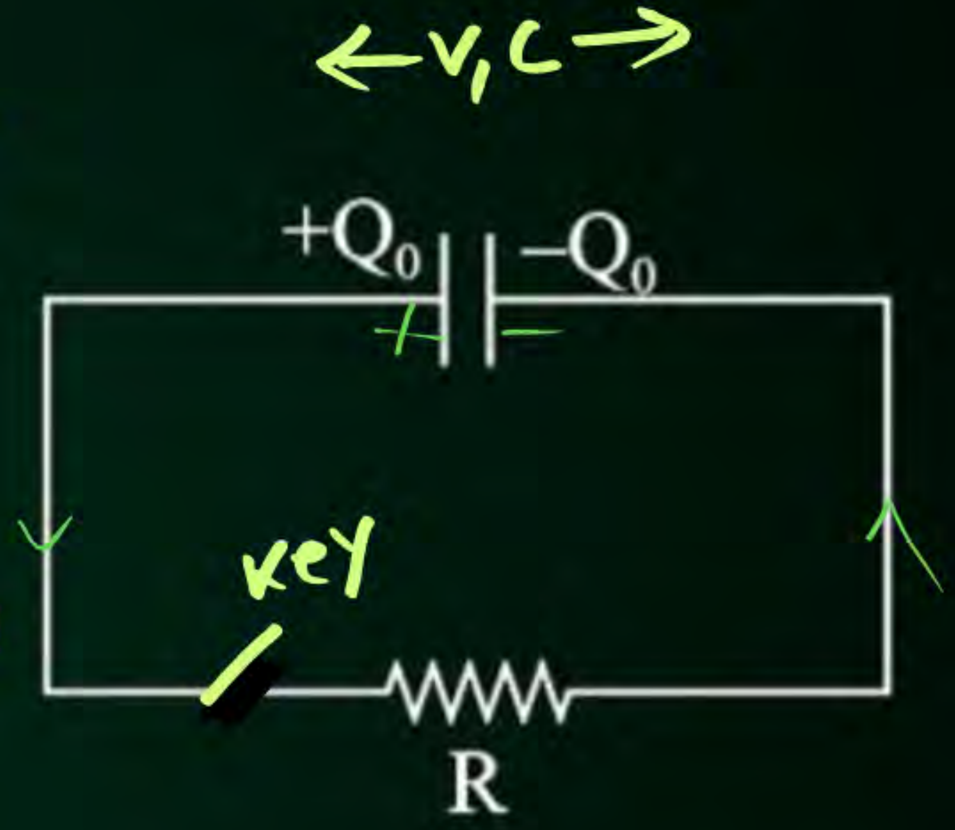
across 'R'

at $t = \infty$

$q_{fin} = 0$ ($U_{fin} = 0$)

$$q = q_{max}\, e^{-t/RC}$$





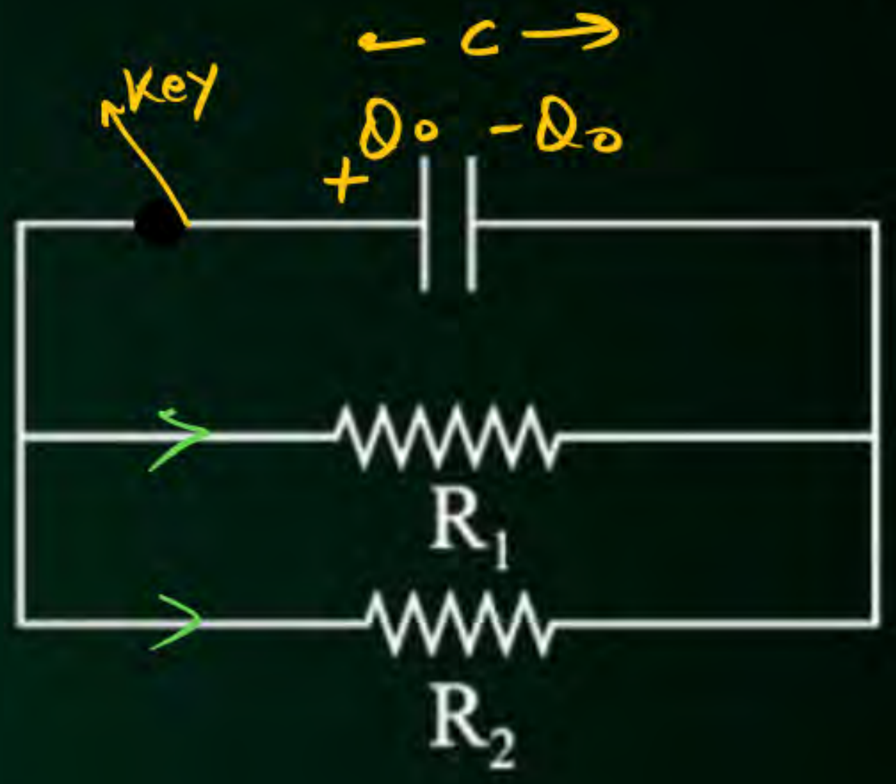
QUESTION

Find Ratio of heat loss in R_1 and R_2. also find total energy loss in R_1

$H_1 + H_2 = H = U_{loss} = \frac{1}{2}\frac{Q_0^2}{C}$ (total energy loss in R_1 & R_2)

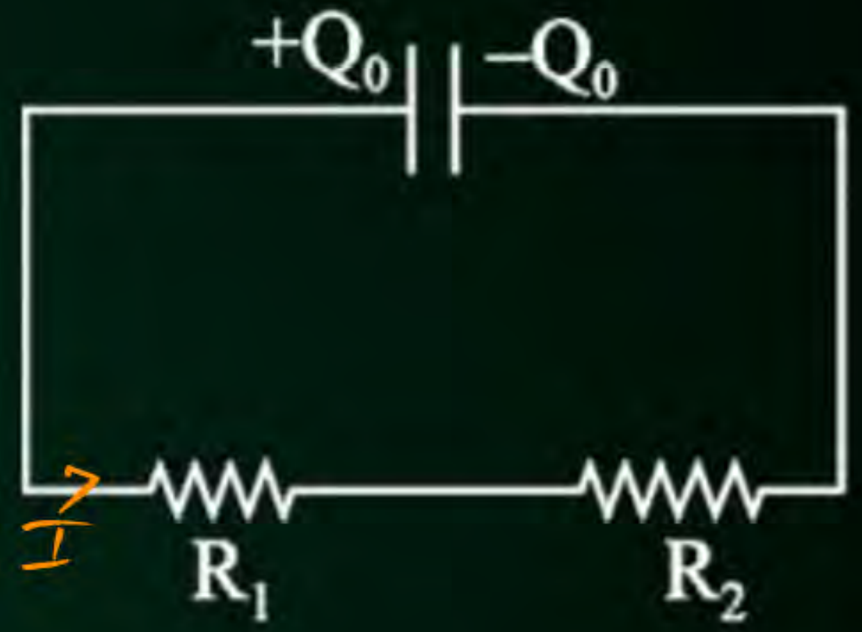
Parallel V = same. $H \propto \frac{1}{R}$

$\frac{H_1}{H_2} = \frac{R_2}{R_1}$



QUESTION

Find Ratio of heat.



$H \propto R$

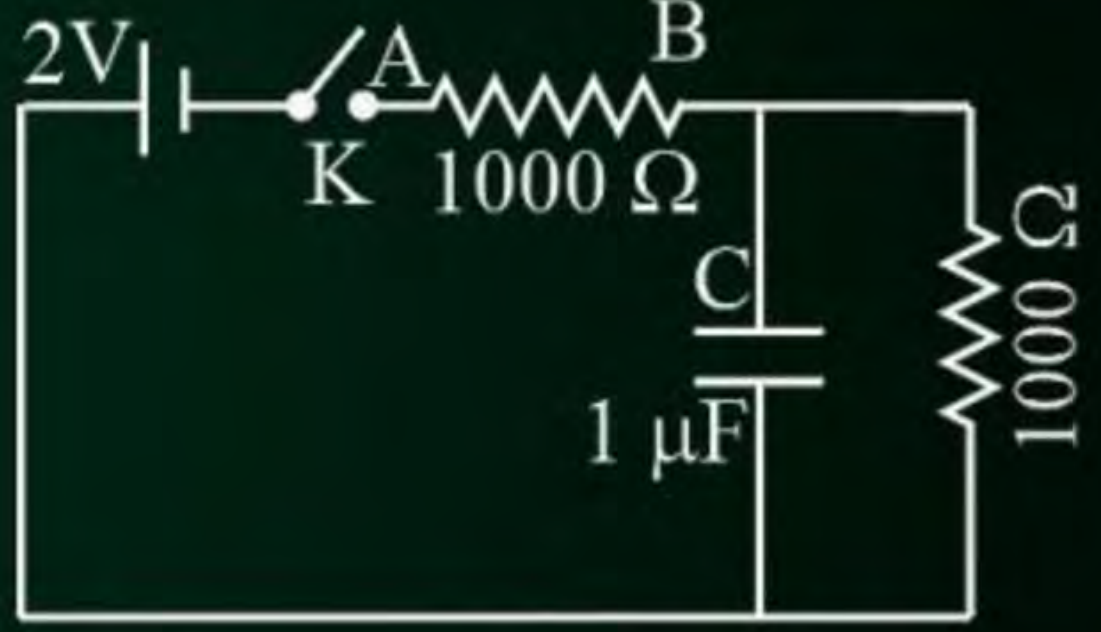
$H_{total} = H_1 + H_2 = \frac{Q_0^2}{2C}$

$\frac{H_1}{H_2} = \frac{R_1}{R_2}$

find H_1

QUESTION

When the key K is pressed at time $t = 0$, then which of the following statement about the current I in the resistance AB of resistance 1000 Ω of the given circuit is true?



1. I oscillates between 1 mA and 2 mA
2. At $t = 0$, $I = 2$ mA and with time it goes to 1 mA
3. $I = 1$ mA at all t
4. $I = 2$ mA at all t

H/W


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 01 | **Physics**

Moving Charges and Magnetism

By- Dr. Manish Raj (MR SIR)



Topics to be covered

1. # Biot-Savart Law
2. # Magnetic field due to circular & straight wire
3. #



Cross-Product [vector-Product]

$\hat{i} \to \hat{j} \to \hat{k} \to \hat{i}$

$$\vec{R} = \vec{A} \times \vec{B}$$

$R = AB\sin\theta\ \hat{n}$ → dir^n of $\vec{R}$

- → always ⊥r to the Plane of $\vec{A}$ & $\vec{B}$.
- → Angle B/w $\vec{R}$ & $\vec{A}$ is 90°
  & $\vec{R}$ & $\vec{B}$ is 90°

$\hat{i} \to \hat{j} \to \hat{k} \to \hat{i}$

$$\vec{R} \cdot \vec{A} = 0$$

$$(\vec{A} \times \vec{B}) \cdot \vec{A} = 0$$

$\hat{i} \times \hat{i} = 1 \times 1 \times \sin 0 = 0$

$\hat{j} \times \hat{j} = 0$

$\hat{k} \times \hat{k} = 0$

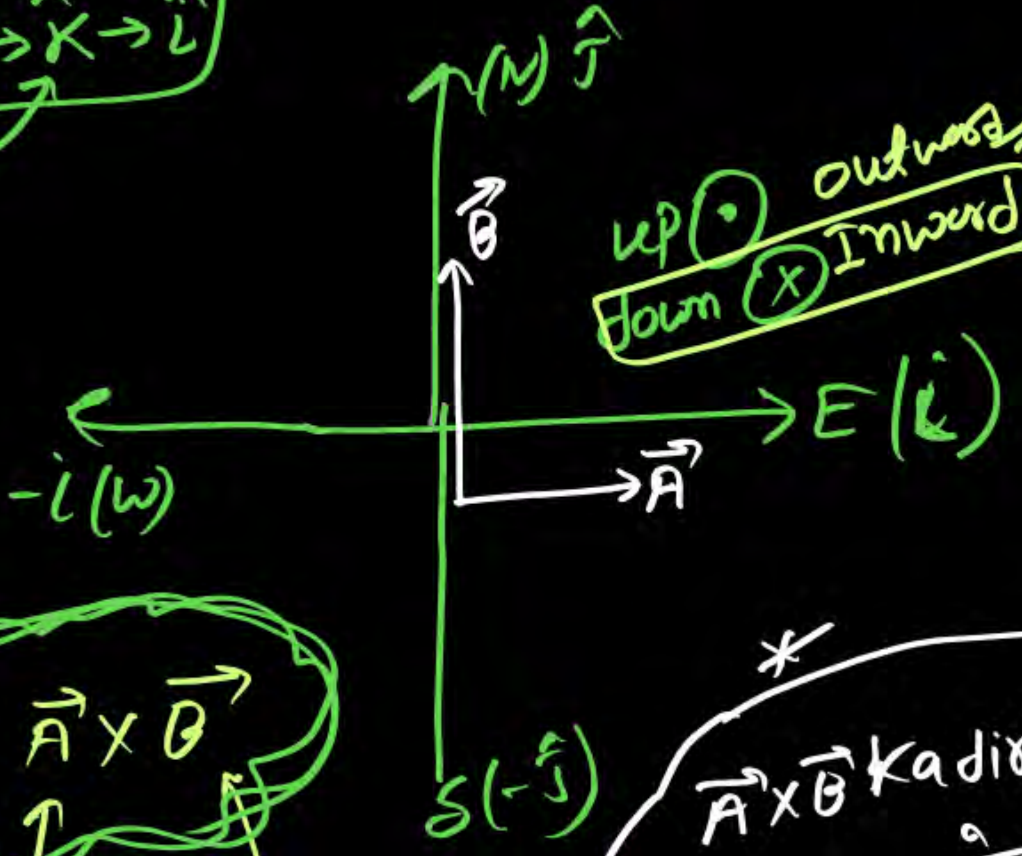
$\hat{k} \times \hat{j} = -\hat{i}$

$\hat{i} \times \hat{j} = +k$

$j \times k = +i$

$k \times i = +j$

$j \times i = -k$



up ⊙ outward

down ⊗ Inward

$\vec{R} = \vec{A} \times \vec{B}$

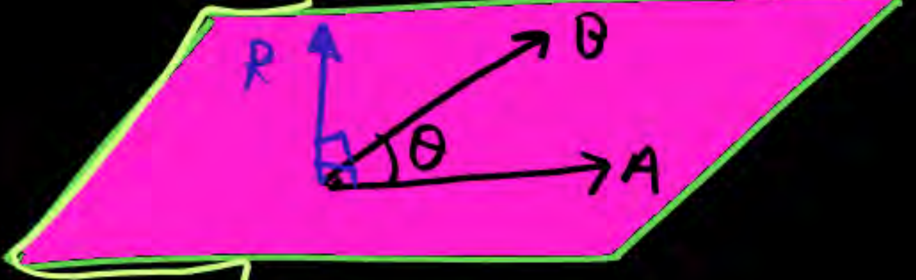
Result — thumb will represent dir^n of Result.

1st vector — place your Four finger along 1st vector [right hand]

2nd vector — slap 2nd vector

* $\vec{A} \times \vec{B}$ ka dir^n E/N/S/W मे नही होगा

Slap Rule



$\hat{N} \times \hat{E} = ??$

→ downword

Inword ⊗

$\vec{E} \times \vec{W} =$ zero

$\vec{W} \times \vec{S} =$ outword

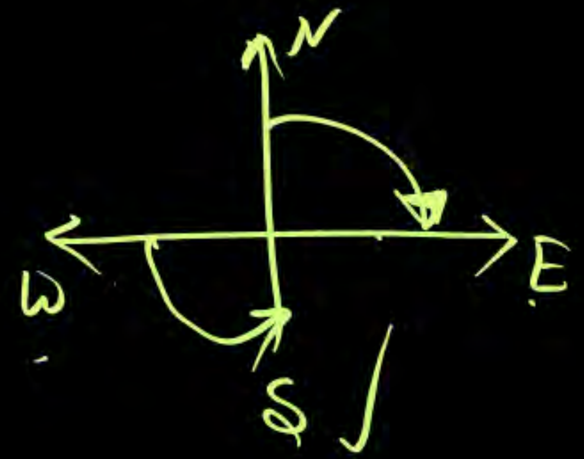
⊙

(out)up × N = west ✓



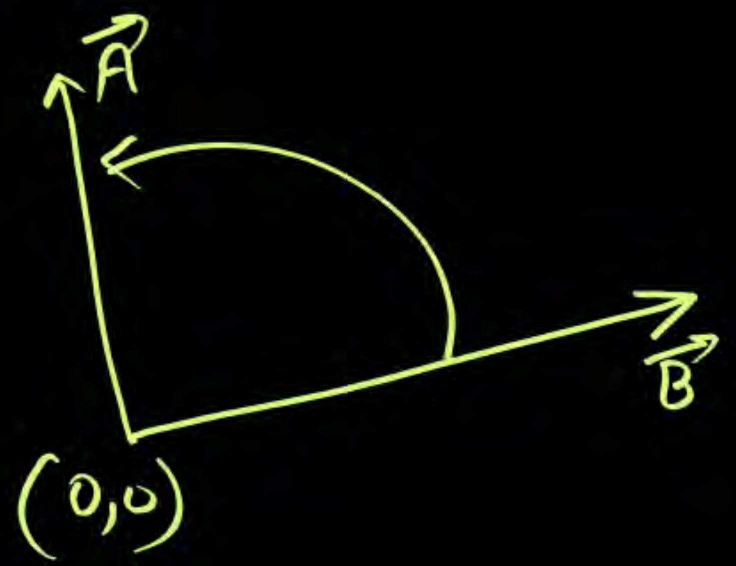
(Inword) × E = south





$\vec{E} \times \vec{S} =$ Inword ✓

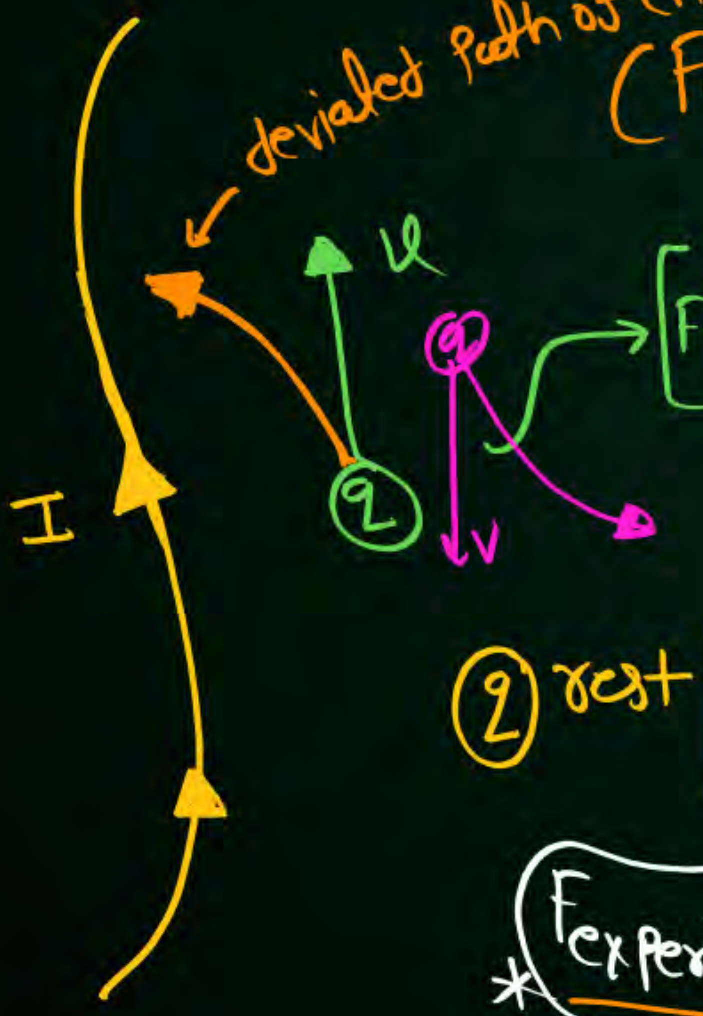




$\vec{B} \times \vec{A} = ??$ (outward)

MAGNETIC FIELD OF CURRENT

❖ Magnetic Field due to a current element [Bio-Savart Law:]

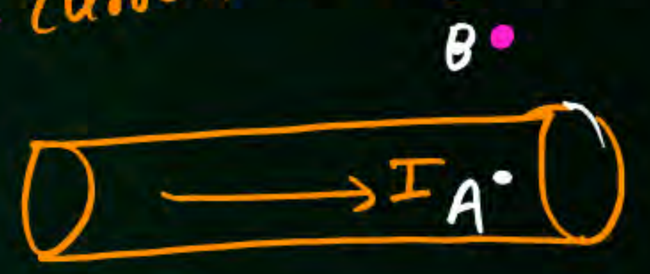


[Force must be zero because outside Electric field is zero]

q rest [Force on charge must be zero because electric field outside Conductor is zero] (theoretically)

* $F_{experiment} = zero$

Current carrying Conductor



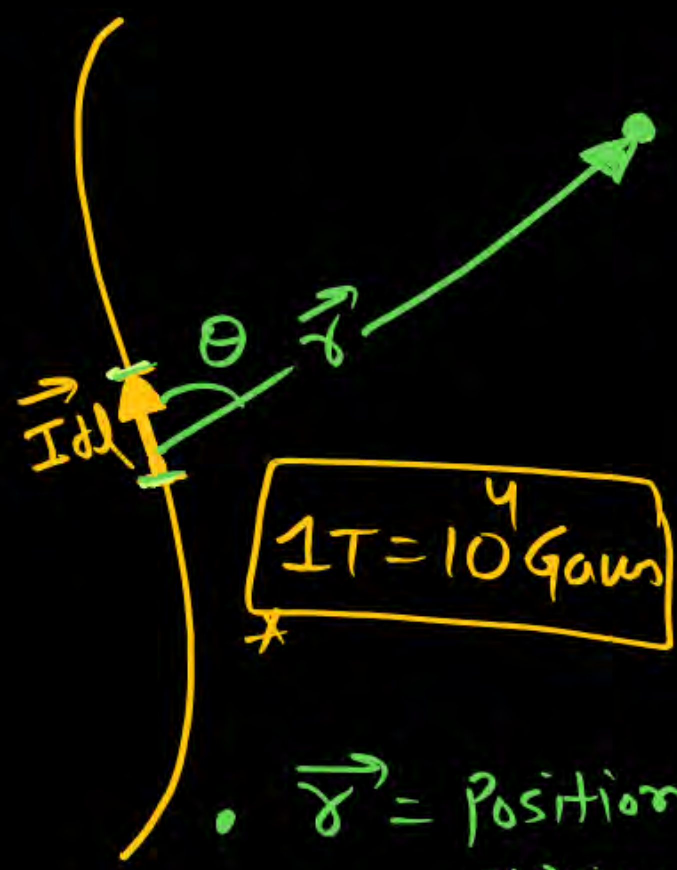
$E_A \neq 0$ (Inside)

$E_B = 0$ (zero) outside

→ Current carrying Conductor remain neutral.

Biot-Savart चाया काम पर लगा गये

(Small current element) I = scalar, $I\vec{dl}$ = vector



$dB \propto \frac{1}{r^2}$ — (I)

$dB \propto Idl$ — (II)

$dB \propto \sin\theta$ — (III)

$1T = 10^4$ Gauss *

dB → vector
→ Tesla → S.I
→ Gauss → C.G.S

- $\vec{r}$ = Position vector from current element where field have to calculate.
- $I\vec{dl}$ = Small current element

θ → Angle b/w $\vec{r}$ & $I\vec{dl}$.

$$dB = k\frac{Idl\sin\theta}{r^2}$$

Angle B/W $I\vec{dl}$ & $\vec{r}$

* Scalar form

$$dB = \frac{\mu_0}{4\pi}\frac{Idl\sin\theta}{r^2}$$

value of magnetic field

Value of $d\vec{B}$ by scalar form dig^n Thapor mar ke

$$\vec{dB} = \frac{\mu_0}{4\pi}\frac{(I\vec{dl})\times(\vec{r})}{r^3} = \frac{\mu_0}{4\pi}\frac{I\vec{dl}\times\hat{r}}{r^2}$$

vector form of Biot Savart Law

$$dB = \frac{\mu_0}{4\pi}\frac{Idl\cdot r\cdot\sin\theta}{r^3}$$ ($r^3 \to r^2$)

$$dB = \frac{\mu_0}{4\pi}\frac{Idl\sin\theta}{r^2}$$ *

free space/vaccum/air

$$K = \frac{\mu_0}{4\pi} = 10^{-7} \frac{T\text{-}m}{Amp}$$

$$\mu_0 = 4\pi \times 10^{-7}\ T\text{-}m/Amp$$
Permiablity Of free space

For other medium

$$K = \frac{\mu_m}{4\pi}$$

μ_m = Permiablity of medium

$$\mu_r = \frac{\mu_m}{\mu_0}$$

$$\mu_m = \mu_0 \mu_r$$

→ Relative Permiablety

→ Unit & dimn less

---

(1) → magnetic field follows Inverse-square law like electric & gravitational field.

(2) → long range field.

(3) → $d\vec{B}$ → Produced By Vector source ($Id\ell$); unlike Electric field due to Scalar source charge

(4) → $d\vec{B}$ → dirn of $d\vec{B}$ is ⊥r to the ($\vec{r}$) Position vector & $I\vec{d\ell}$ current element

(5) ⇒ $\vec{B}$, $\vec{E}$, $\vec{I}$ → line depends on Position Inside Source & Inversly Proportional to outside Source.

(6) ⇒ follow superPosition theorm

(7) medium dependent.

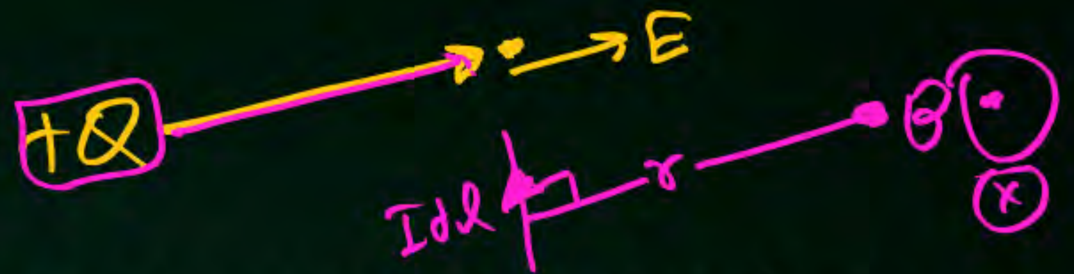
Similarities and differences between Biot-Savart Law and Coulomb's Law.

(i) Both are long range, since both depend inversely on square of distance from source to the point of interest.

(ii) The principle of superposition is applied to both fields.

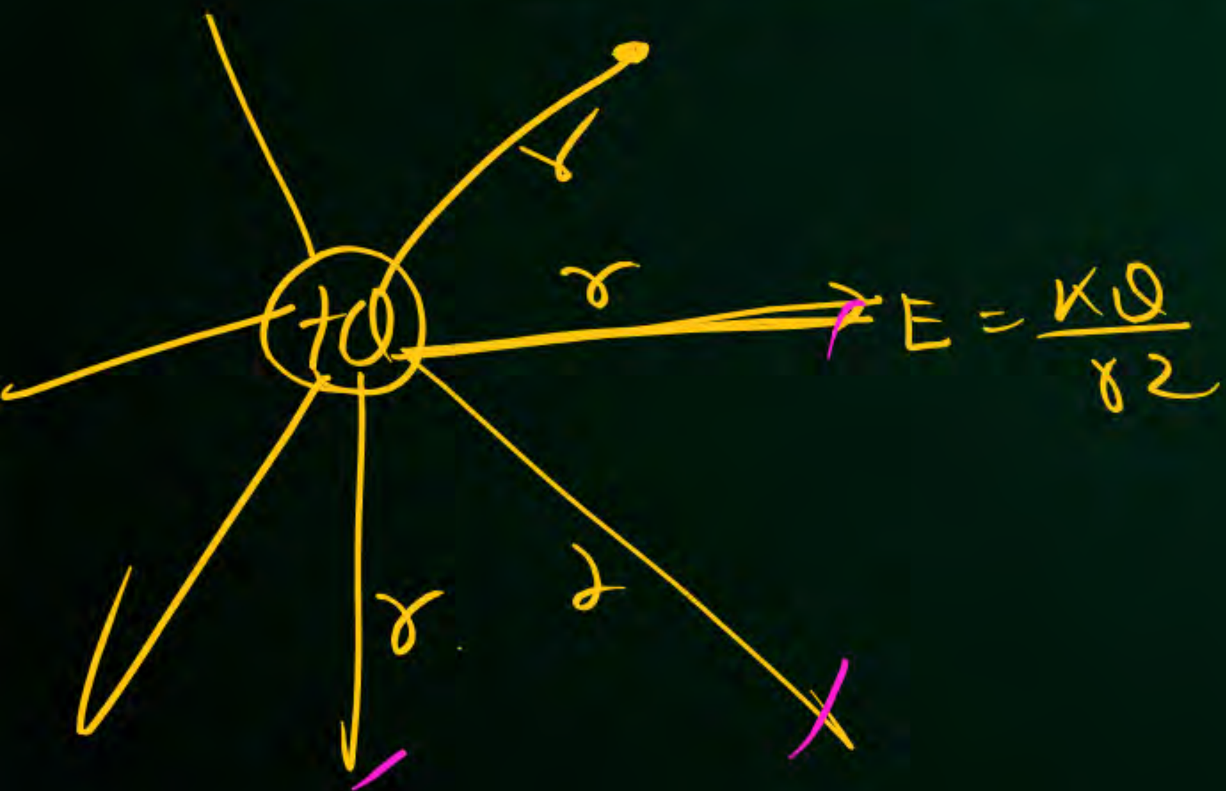
(iii) The magnetic field is linear inside the source ($I\vec{dl}$) just as the electrostatic field is linear inside its source (the charge)

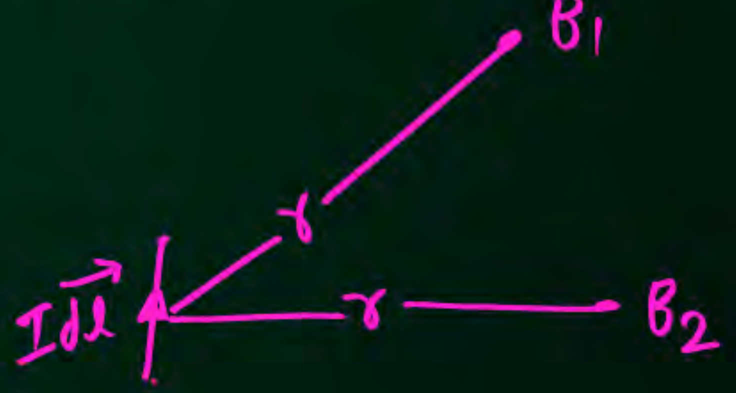
(Iv) Electrostatic field is produced by a scalar source namely the electric charge. The magnetic field is produced by a vector source ($I\vec{dl}$).



(v) The electrostatic field is along the displacement vector joining the source and the field point. The magnetic field is perpendicular to the plane containing displacement vector $\vec{r}$ and current element $I\vec{dl}$.

(vi) There is angle dependence in the Biot-Savarts law which is not present in the electrostatic field. Magnetic field at the point in the direction of $\vec{dl}$ is zero.

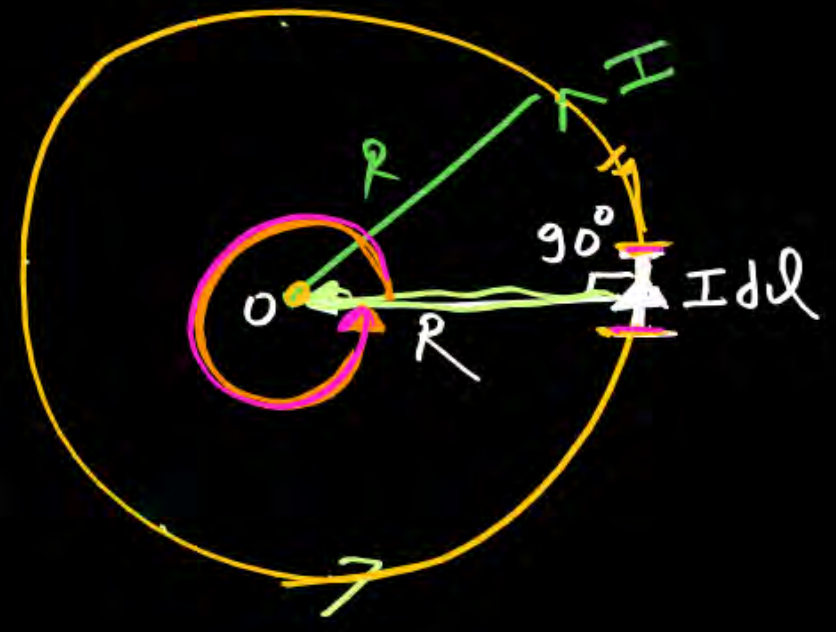


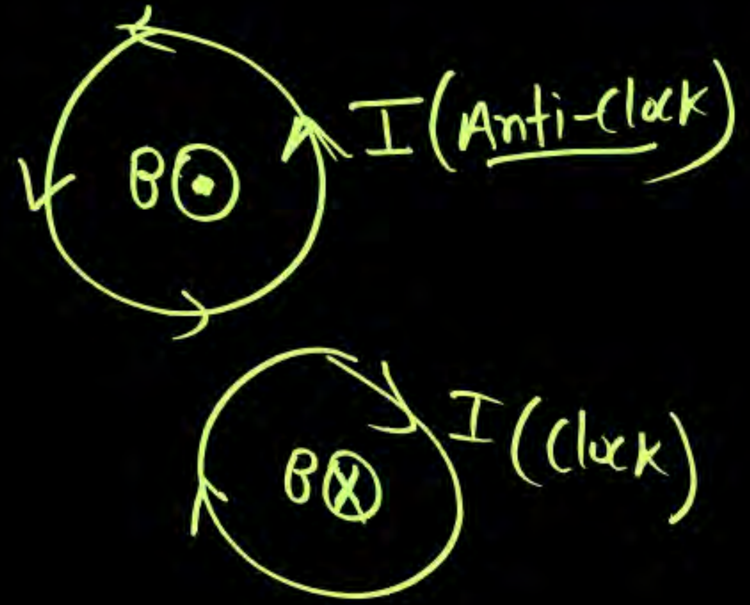


$B_1 \neq B_2$

Value same Nahi hoga

Magnetic field at centre of current carrying circular wire.





Biot-Savart Law

$$dB = \frac{\mu_0}{4\pi}\frac{I\,dl \sin 90^\circ}{R^2}$$

$$\int dB = \int \frac{\mu_0}{4\pi}\frac{I\,dl}{R^2}$$

Compt Ring $(2\pi R)$

$$B = \frac{\mu_0 I}{4\pi R^2}\int_0 dl$$

$$= \frac{\mu_0 I}{4\pi R^2} \times [2\pi R]$$

$$B = \frac{\mu_0 I}{2R} \quad (*)$$

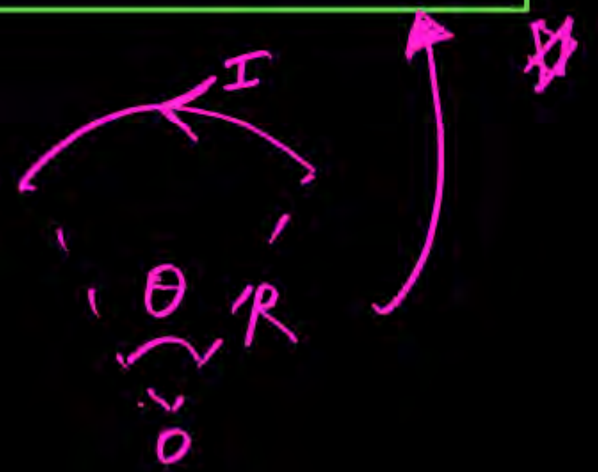
due to 2π Rad $B = \frac{\mu_0 I}{2R}$

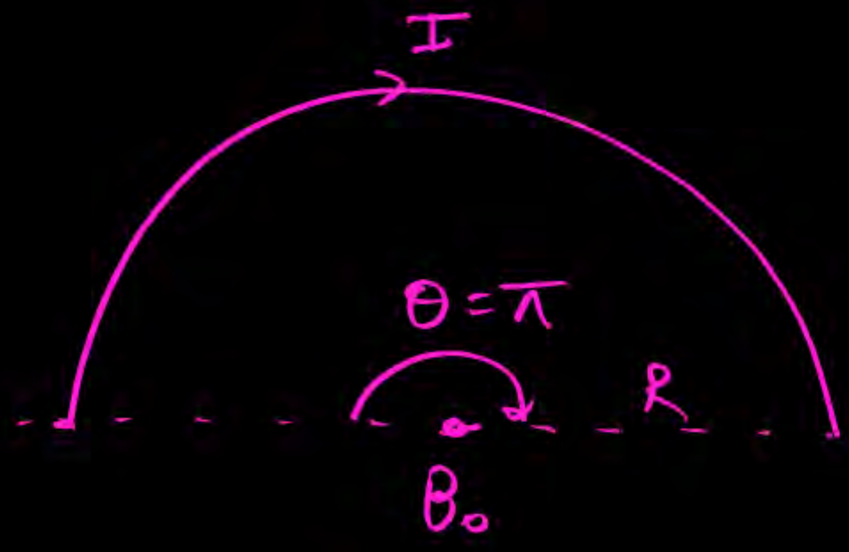
" " 1 rad $B = \frac{\mu_0 I}{2R}\left(\frac{1}{2\pi}\right)$

" " θ rad $B = \frac{\mu_0 I}{2R}\left(\frac{\theta}{2\pi}\right)$

magnetic field due to circular Arc.

$$B = \frac{\mu_0 I}{2R}\left(\frac{\theta}{2\pi}\right)$$

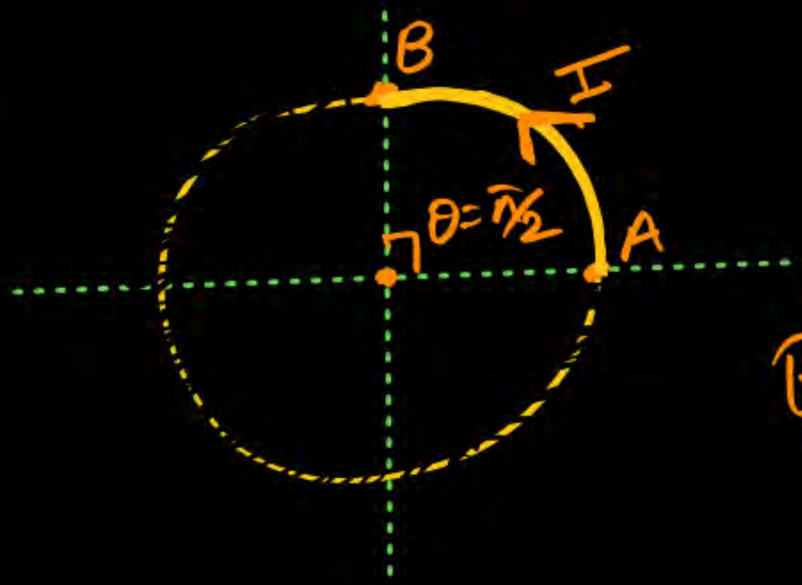




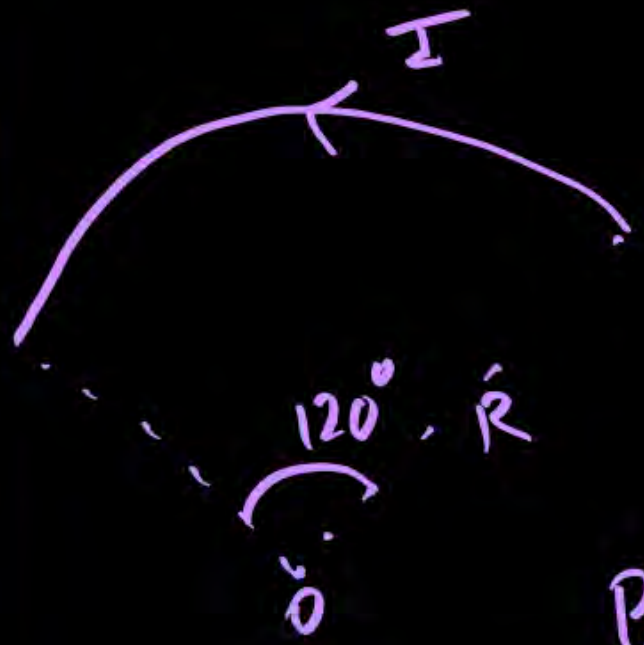
$$B_0 = \frac{\mu_0 I}{2R}\left(\frac{\theta}{2\pi}\right)$$

$$= \frac{\mu_0 I}{2R}\left[\frac{\pi}{2\pi}\right]$$

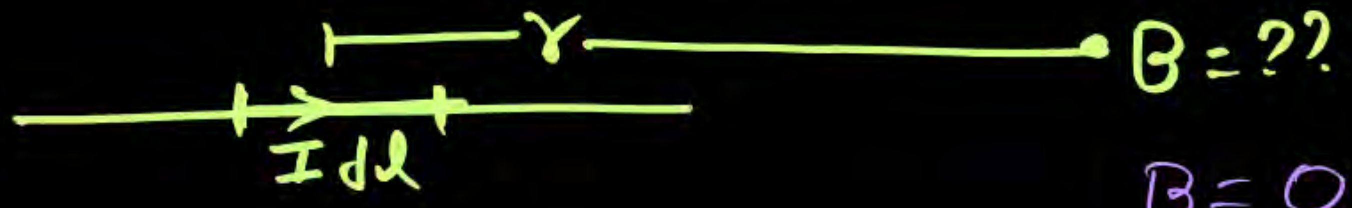
✡ $$\boxed{B_0 = \frac{\mu_0 I}{4R}}$$



$$B_0 = \frac{\mu_0 I}{2R}\left(\frac{\pi}{2\times 2\pi}\right) = \left[\frac{\mu_0 I}{8R}\right]$$



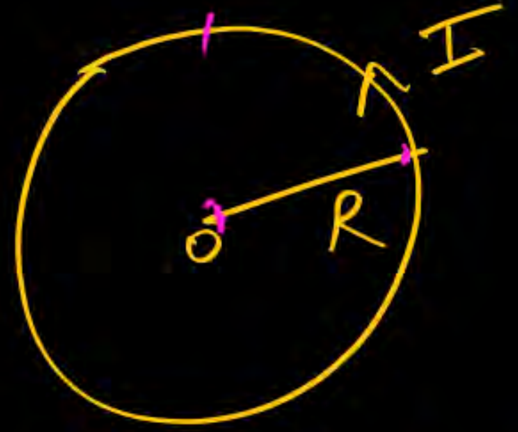
$$B = \frac{\mu_0 I}{2R}\left[\frac{120^\circ}{360^\circ}\right] = \left[\frac{\mu_0 I}{6R}\right]$$



$B = 0$ ✓

zero

Angle b/w $I\vec{dl}$ & $\vec{r}$ is $0°$ ✓



there N- number of loop keeping Radius const^n →

$$B = N B_0$$

$$B = N\left(\frac{\mu_0 I}{2R}\right)$$

Ans



$$B_0 = \frac{\mu_0 I}{2R}$$ (due to one loop)

there are N-loop keeping length (circumference) const^n →

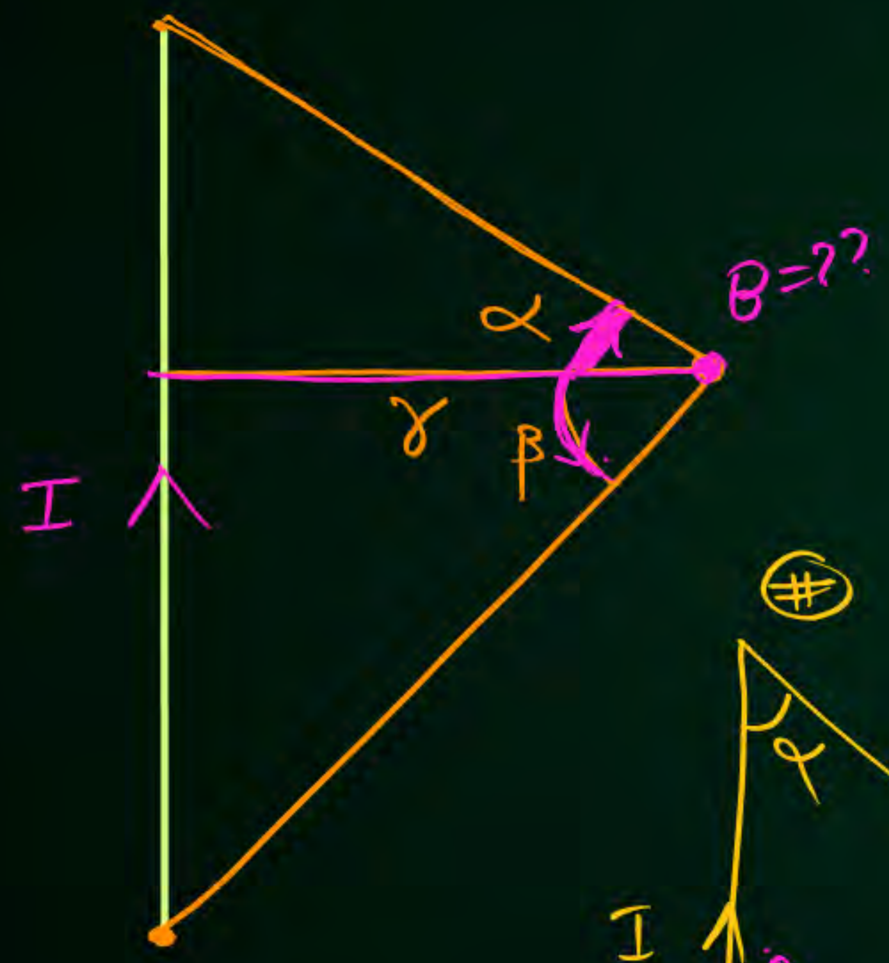
$$B = N^2\left(\frac{\mu_0 I}{2R}\right)$$

QUESTION

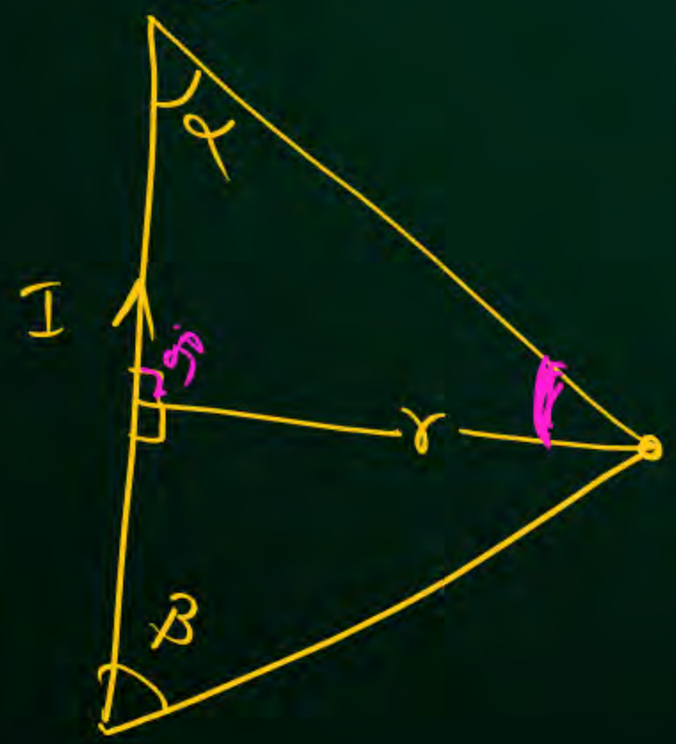
A long wire carrying a steady current is bent into a circular loop of one turn. The magnetic field at the centre of the loop is B. It is then bent into a circular coil of n turns. The magnetic field at the centre of this coil of n turns will be **[NEET-(Phase-2)-2016]**

1. nB
2. n^2B
3. 2nB
4. 2n^2B

MAGNETIC FIELD DUE TO FINITE STRAIGHT WIRE



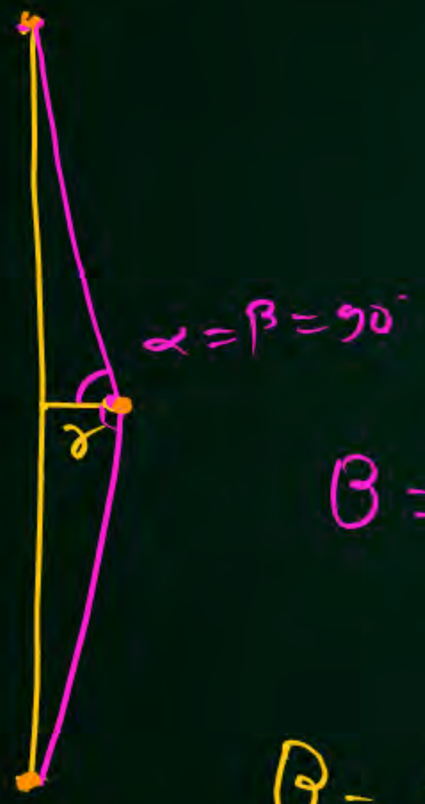
$$B = \frac{\mu_0 I}{4\pi r}\left[\sin\alpha + \sin\beta\right]$$



$$B = \frac{\mu_0 I}{4\pi r}\left[\sin(90-\alpha) + \sin(90-\beta)\right] = \frac{\mu_0 I}{4\pi r}\left[\cos\alpha + \cos\beta\right]$$



Infinite Wire Ka Field



$$B = \frac{\mu_0 I}{4\pi r}\left[\sin 90^\circ + \sin 90^\circ\right]$$

$$B = \frac{\mu_0 I}{4\pi r}(2)$$

$$B = \frac{\mu_0 I}{2\pi r}$$



$$B_0 = \frac{\mu_0 I}{2r}$$



$$B = \frac{\mu_0 I}{2\pi r}$$

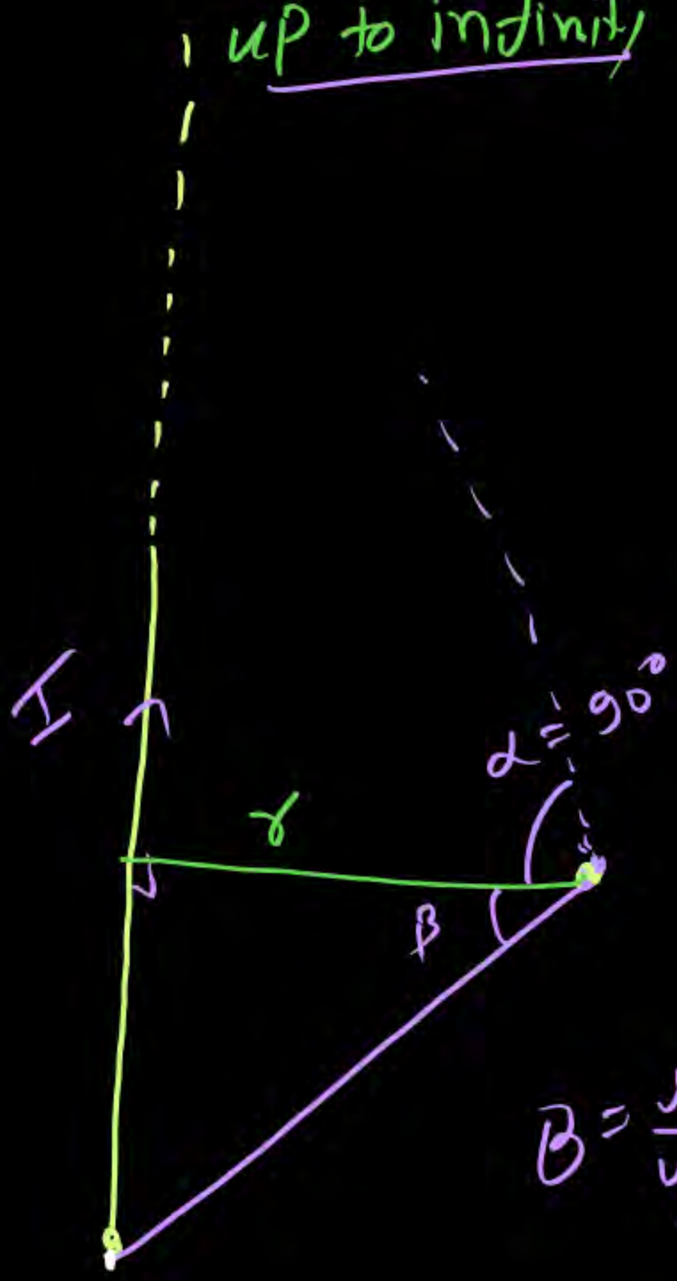
Semi Infinite wire





$$B = \frac{\mu_0 I}{4\pi r}\left[\sin 90° + \sin 0°\right]$$

$$B = \frac{\mu_0 I}{4\pi r}$$

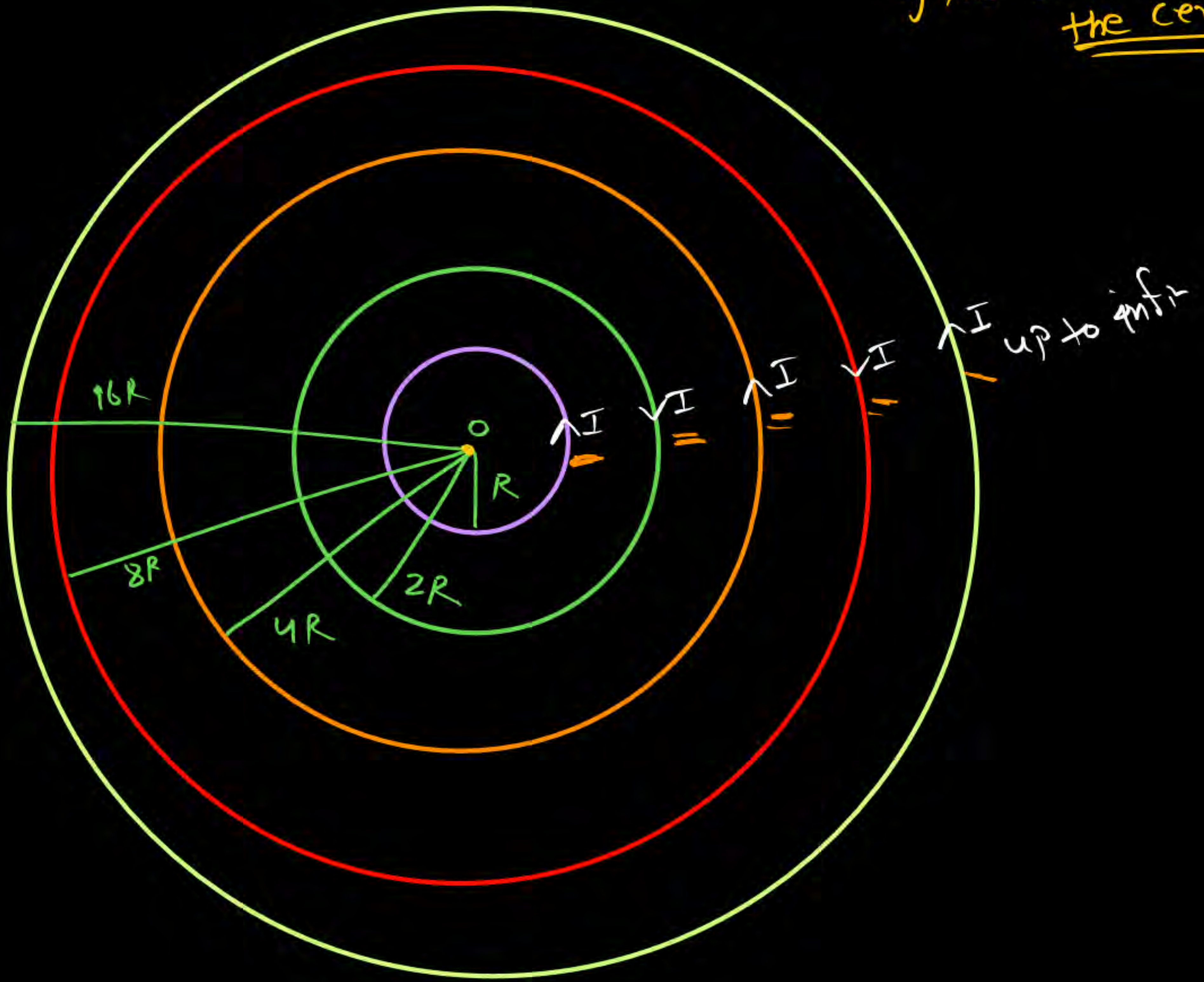


$$B = \frac{\mu_0 I}{4\pi r}\left[\sin 90 + \sin\beta\right]$$

$$B = \frac{\mu_0 I}{4\pi r}\left[1 + \sin\beta\right]$$

*

find field at the centre



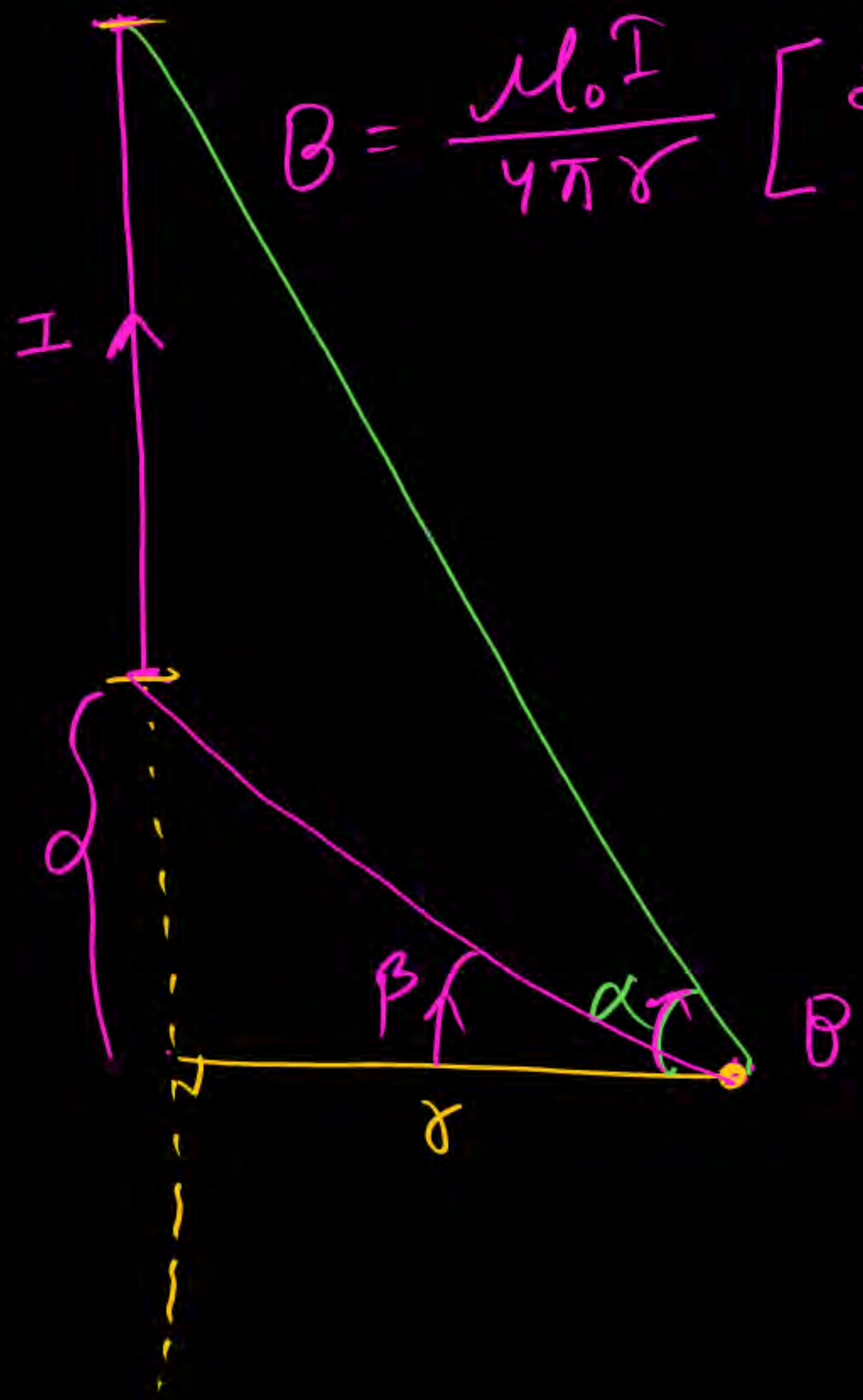
$$B = \frac{\mu_0 I}{2R} - \frac{\mu_0 I}{2(2R)} + \frac{\mu_0 I}{2(4R)} - \frac{\mu_0 I}{2(8R)} + \cdots$$

$$B = \frac{\mu_0 I}{2R}\left[1 - \frac{1}{2} + \frac{1}{4} - \frac{1}{8} + \frac{1}{16} - \cdots\right]$$

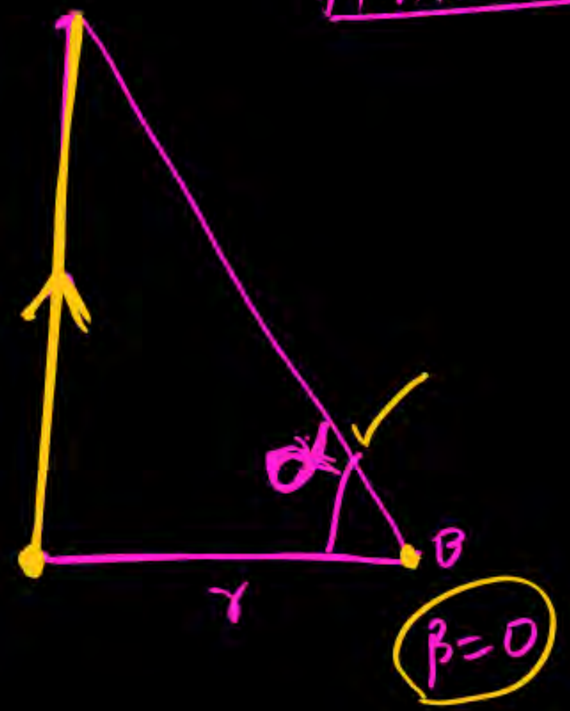
$$B = \frac{\mu_0 I}{2R}\left[\frac{1}{1-\left(-\frac{1}{2}\right)}\right] = \frac{\mu_0 I}{2R \times \frac{3}{2}}$$

$$= \frac{\mu_0 I}{3R}$$

$$B = \frac{\mu_0 I}{4\pi r}\left[\sin\alpha - \sin\beta\right]$$

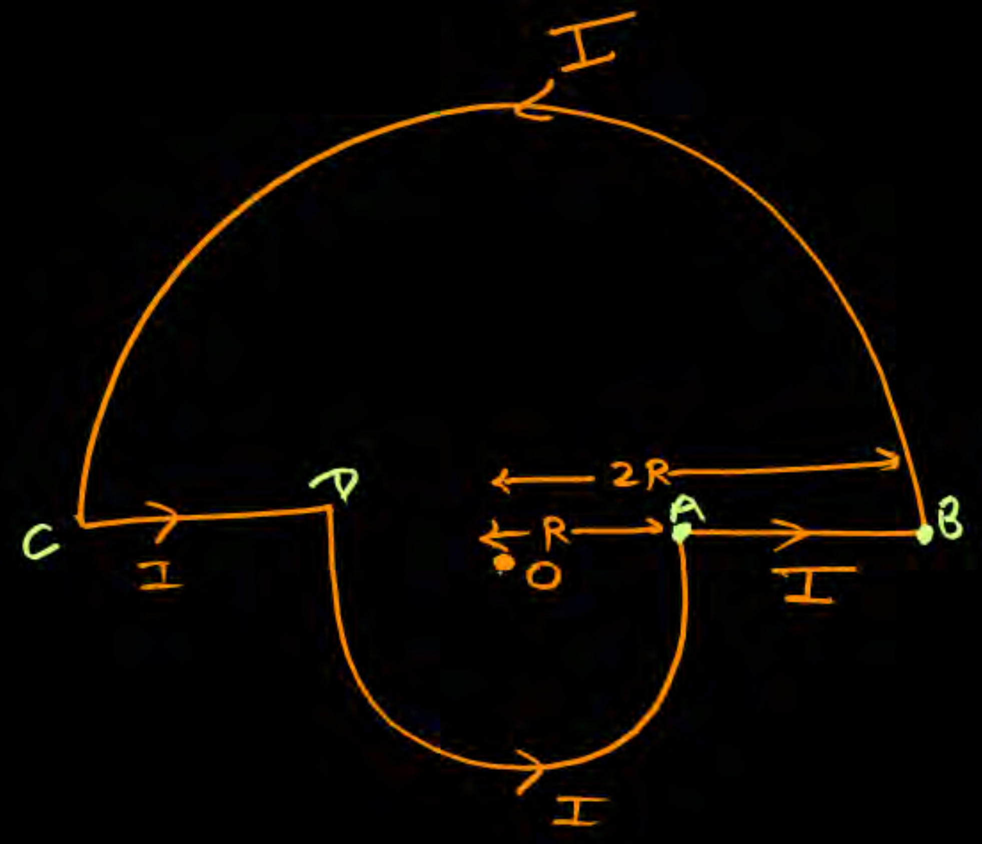


finite wire



$$B = \frac{\mu_0 I}{4\pi r}\left[\sin\alpha + \sin 0\right]$$

$$B = \frac{\mu_0 I}{4\pi r}\left[\sin\alpha\right]$$

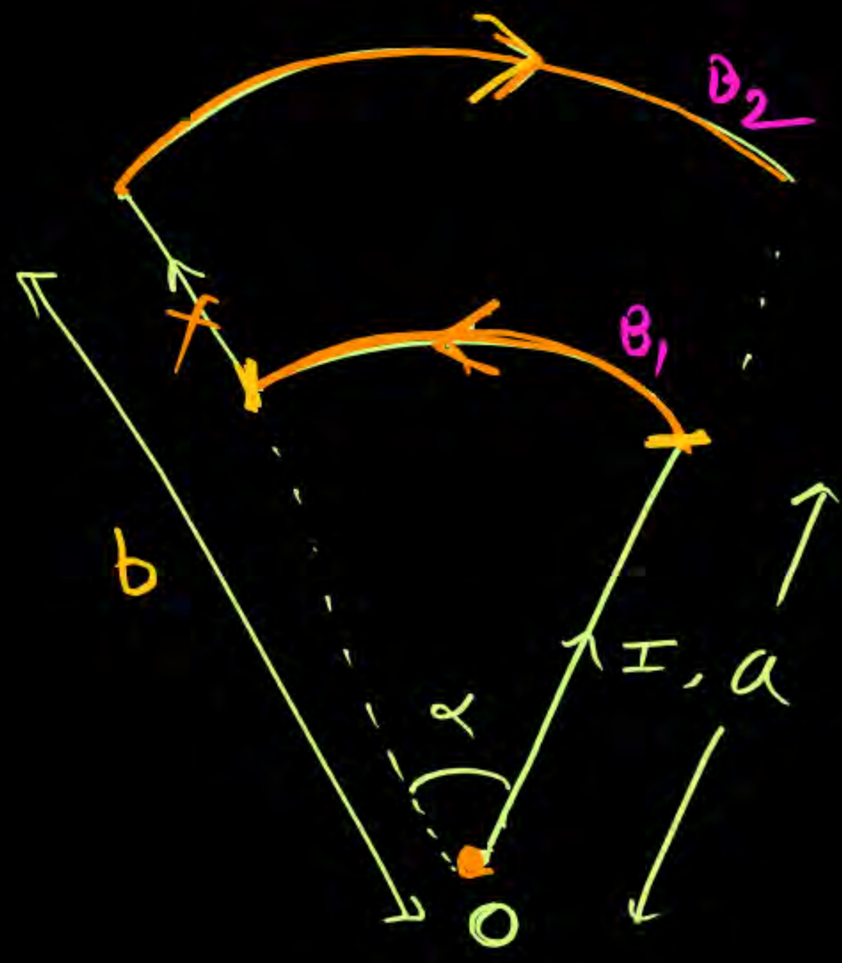


$\dot{B}=0 \quad \dot{B}=0 \quad \xrightarrow{I} \quad \dot{B}=0 \quad \dot{B}=0 \quad \dot{B}=0$

$$B = \frac{\mu_0 I}{2(2R)\times 2} \odot + \frac{\mu_0 I}{2R\times 2} \odot \quad ✓$$

$$= \left(\frac{\mu_0 I}{8R} + \frac{\mu_0 I}{4R}\right) \odot$$

$$= \left[\frac{3\mu_0 I}{8R}\right] \odot$$



$$B = \frac{\mu_0 I}{2a}\left(\frac{\alpha}{2\pi}\right) - \frac{\mu_0 I}{2b}\left(\frac{\alpha}{2\pi}\right)$$

$$\boxed{B = \frac{\mu_0 I \alpha}{4\pi}\left(\frac{1}{a} - \frac{1}{b}\right)}$$

QUESTION

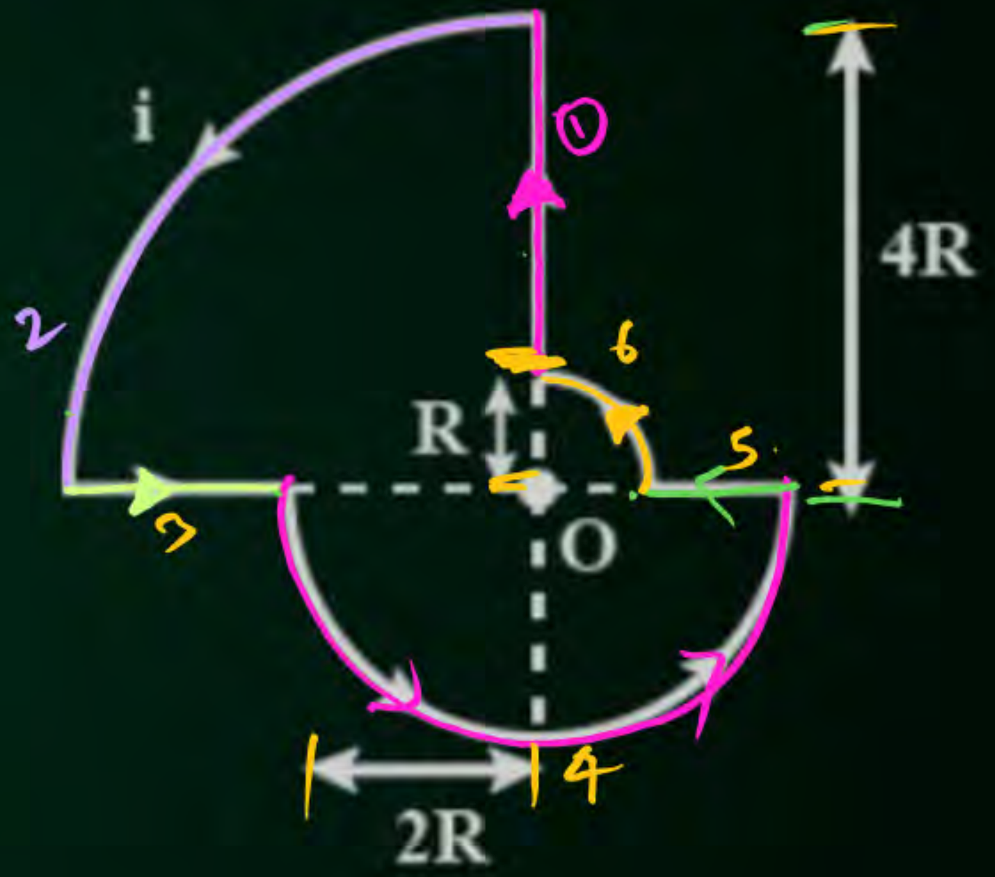
The figure below shows a current loop having two circular arcs joined by two radial lines. The magnetic field at O is

1. $\frac{\mu_0 i\theta}{2\pi ab}(b-a)$
2. $\frac{\mu_0 i\theta}{4\pi ab}(b-a)$
3. Zero
4. $\frac{\mu_0 i\theta}{3\pi ab}(b+a)$



QUESTION

Find the magnetic field at the centre O of the loop shown in the figure.



$$B_1 = B_3 = B_5 = 0$$

$$B_2 = \frac{\mu_0 I}{2(4R)}\left(\frac{\pi}{2(2\pi)}\right) = \frac{\mu_0 I}{32R}$$

$$B_4 = \frac{\mu_0 I}{2(2R)}\left(\frac{\pi}{2\pi}\right) = \frac{\mu_0 I}{8R}$$

$$B_6 = \frac{\mu_0 I}{2(R)}\left(\frac{\pi}{2(2\pi)}\right) = \frac{\mu_0 I}{8R}$$

$$B_{net} = \frac{9\mu_0 I}{32R}$$

QUESTION

A straight wire of diameter 0.5 mm carrying a current of 1 A is replaced by the another wire of 1 mm diameter carrying the same current. The strength of the magnetic field far away is [1999, 1997]

1. one-quarter of the earlier value
2. one-half of the earlier value
3. twice the earlier value
4. same as the earlier value.

QUESTION

The magnetic field at a distance r from a long wire carrying current i is 0.4 tesla. The magnetic field at a distance $2r$ is [1992]

1. 0.2 tesla
2. 0.8 tesla
3. 0.1 tesla
4. 1.6 tesla

QUESTION

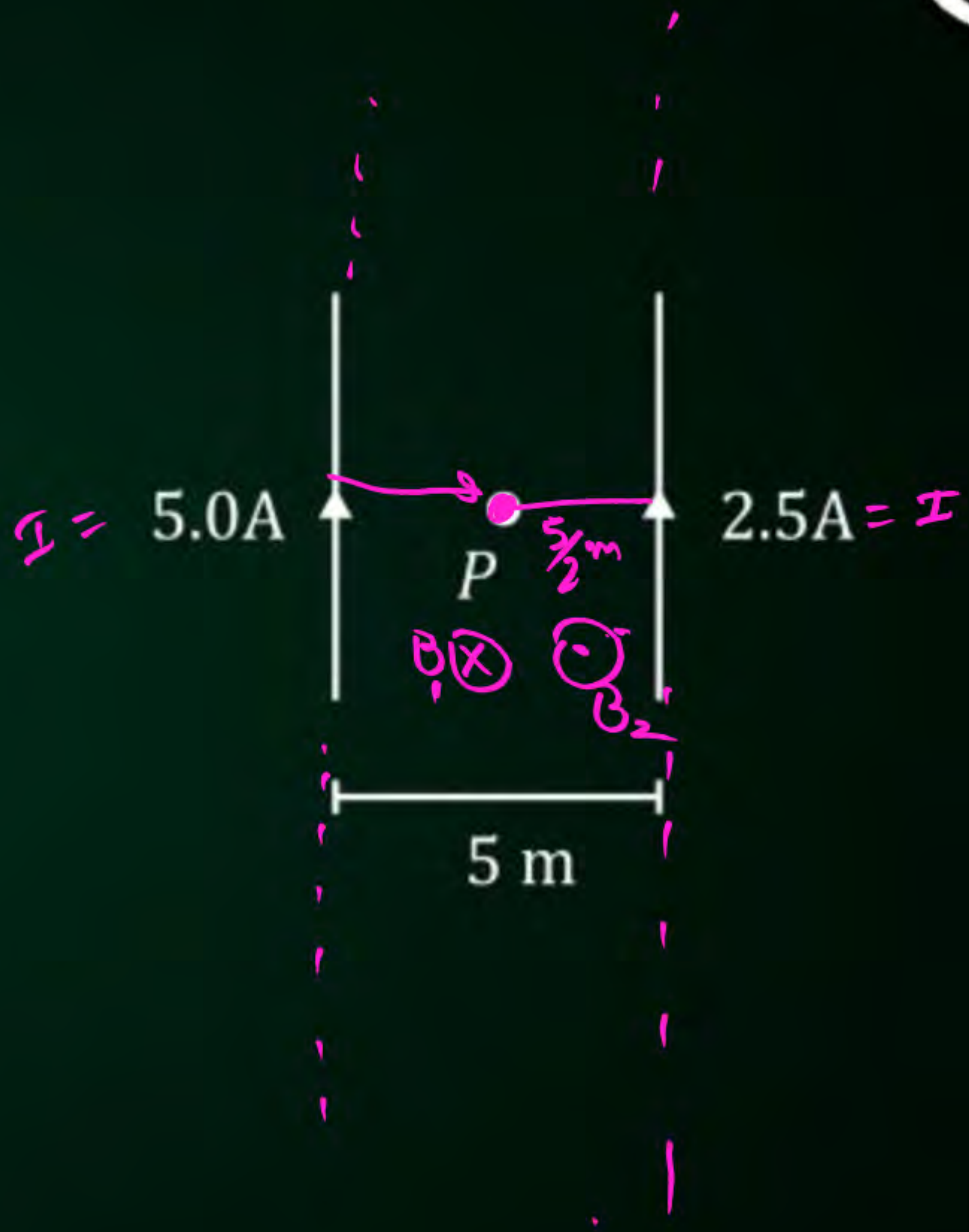
The magnetic field at centre, P will be

1. $\frac{\mu_0}{4\pi}$

2. $\frac{\mu_0}{\pi}$

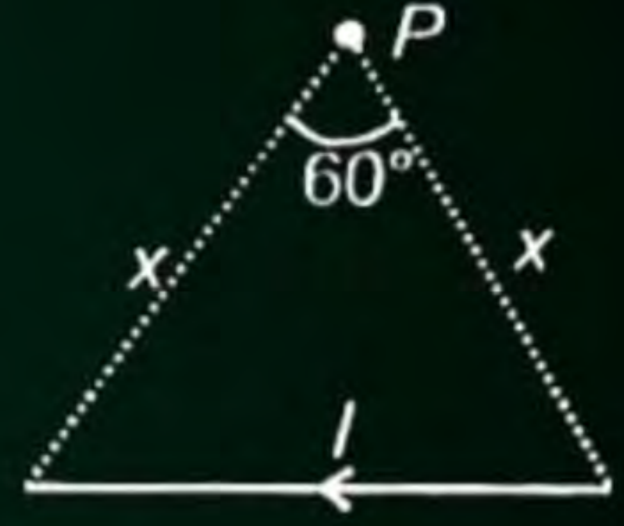
3. $\frac{\mu_0}{2\pi}$

4. $4\mu_0\pi$



QUESTION

A straight wire of finite length carrying current I subtends an angle of $60°$ at point P as shown. The magnetic field at P is



1. $\frac{\mu_0 I}{2\sqrt{3}\pi x}$
2. $\frac{\mu_0 I}{2\pi x}$
3. $\frac{\sqrt{3}\mu_0 I}{2\pi x}$
4. $\frac{\mu_0 I}{3\sqrt{3}\pi x}$

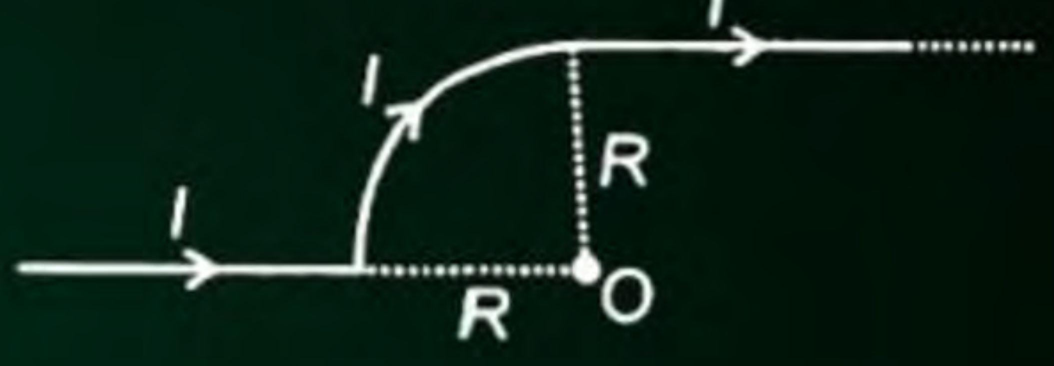


i
2r
O
r

QUESTION

Magnetic field at point O due to the given structure is

1. $\frac{\mu_0 I}{4\pi a}\left(\frac{\pi}{2}+1\right) \otimes$
2. $\frac{\mu_0 I}{4\pi a}\left(\frac{\pi}{2}+1\right) \odot$
3. $\frac{\mu_0 I}{2\pi a}(\pi+1) \otimes$
4. $\frac{\mu_0 I}{2\pi a}(\pi+1) \odot$



QUESTION

Magnetic field at the point O due to the given structure is



1. $\frac{\mu_0 I}{4R}\left[\frac{3}{2}\right] \odot$

2. $\frac{\mu_0 I}{2R}[3] \otimes$

3. $\frac{\mu_0 I}{4R}\left[\frac{3}{2}\right] \otimes$

4. $\frac{\mu_0 I}{4R}[3] \odot$

QUESTION

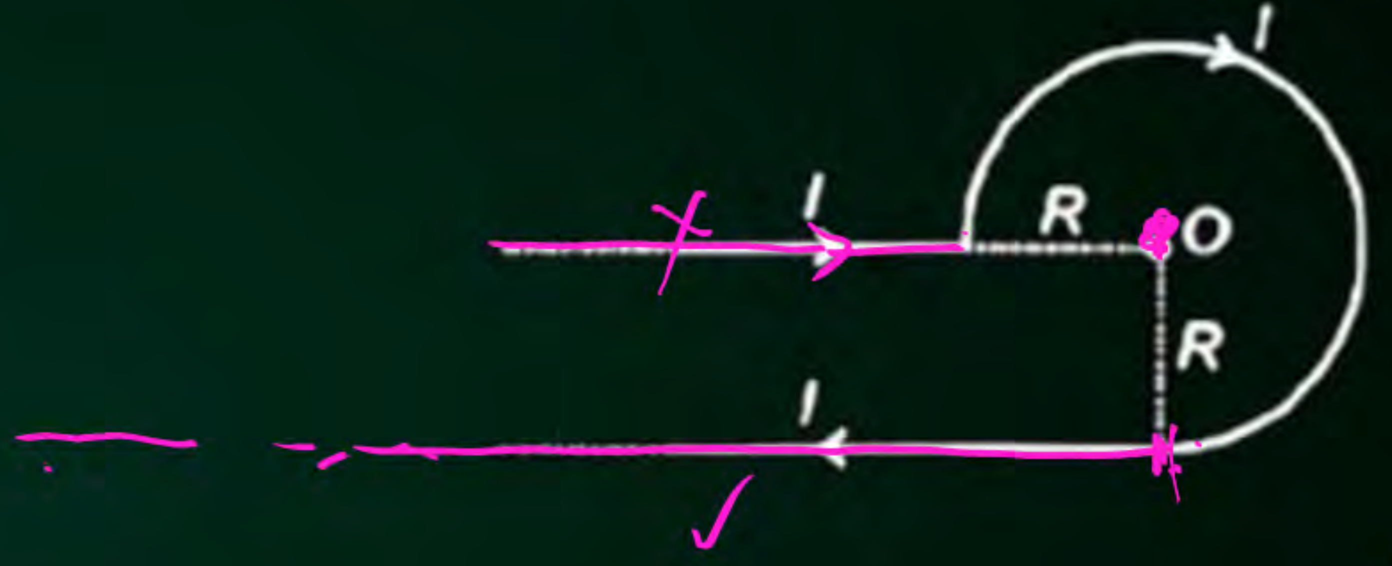
Magnetic field at the centre O due to the given structure is

1. $\frac{\mu_0 I}{4R}\left[\frac{3}{2}+\frac{1}{\pi}\right] \odot$

2. $\frac{\mu_0 I}{2R}\left[3+\frac{1}{\pi}\right] \otimes$

3. $\frac{\mu_0 I}{4R}\left[\frac{3}{2}+\frac{1}{\pi}\right] \otimes$

4. $\frac{\mu_0 I}{4R}\left[3+\frac{2}{\pi}\right] \odot$



QUESTION

An arrangement of three parallel straight wires placed perpendicular to plane of paper carrying same current 'I' along the same direction is shown in figure. Magnitude of force per unit length on the middle wire 'B' is given by [NEET-2017]

1. $\dfrac{\mu_0 I^2}{2\pi d}$

2. $\dfrac{2\mu_0 I^2}{\pi d}$

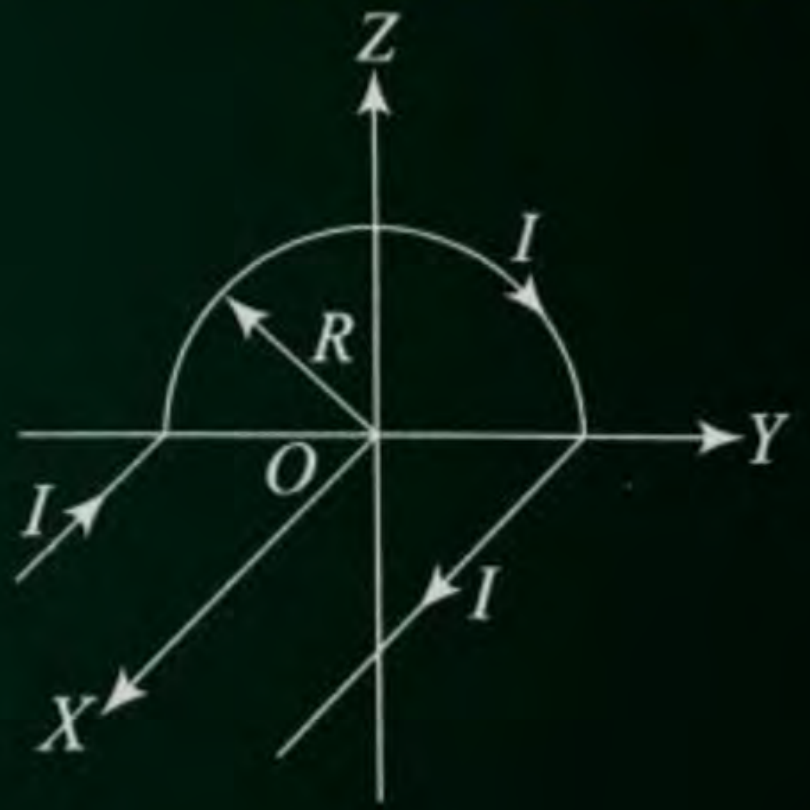
3. $\dfrac{\sqrt{2}\mu_0 I^2}{\pi d}$

4. $\dfrac{\mu_0 I^2}{\sqrt{2}\pi d}$

QUESTION

A wire carrying current I has the shapes as shown in adjoining figure. Linear parts of the wire are vary long and parallel to X-axis while semicircular portion of radius R is lying in Y-Z plane. Magnetic field at point O is

[AIMPT-2015]

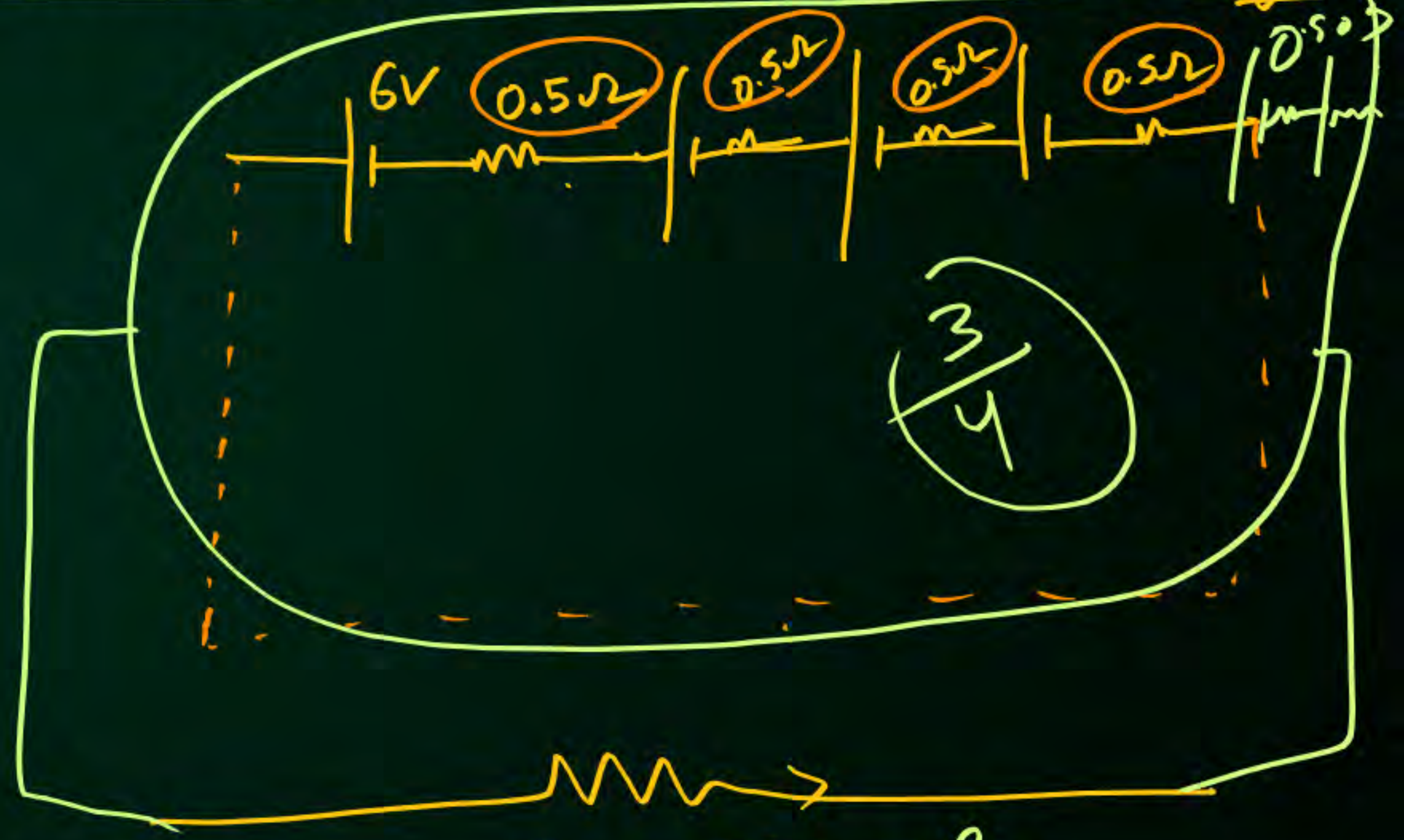


1. $\vec{B} = \frac{\mu_0}{4\pi}\frac{I}{R}(\pi\hat{\imath} - 2\hat{k})$
2. $\vec{B} = \frac{\mu_0}{4\pi}\frac{I}{R}(\pi\hat{\imath} + 2\hat{k})$
3. $\vec{B} = -\frac{\mu_0}{4\pi}\frac{I}{R}(\pi\hat{\imath} - 2\hat{k})$
4. $\vec{B} = -\frac{\mu_0}{4\pi}\frac{I}{R}(\pi\hat{\imath} + 2\hat{k})$

QUESTION

There are a large number of cells available, each marked (6 V, 0.5 Ω) to be used to supply current to a device of resistance 0.75Ω, requiring 24 A current. How should the cells be arranged, so that power is transmitted to the load using minimum number of cells?

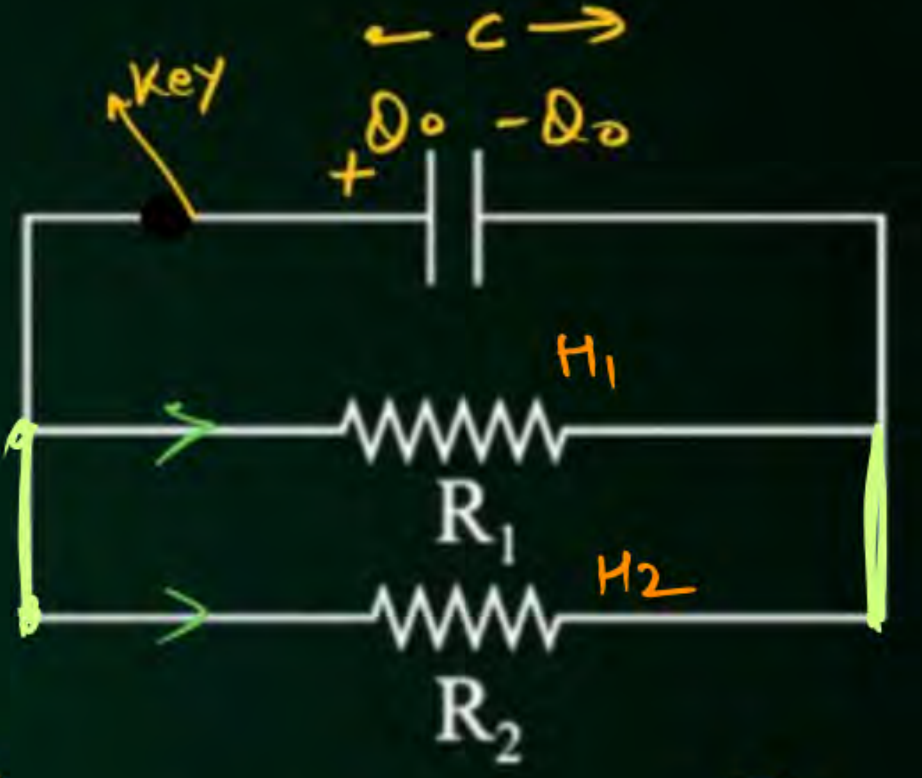
1. Six rows, each containing four cells
2. Four rows, each containing six cells
3. Four rows, each containing four cells
4. Six rows, each containing six cells



QUESTION

Find Ratio of heat loss in R_1 and R_2. also find total energy loss in R_1.

$$H_1 + H_2 = H = U_{loss} = \frac{1}{2}\frac{Q_0^2}{C}$$ (total energy loss in R_1 & R_2)



$$\# \quad \frac{Q_0^2}{2C} = H_1 + H_2 \quad \text{—— (1)}$$

$$H = \frac{V^2}{R} t$$

$$\frac{H_1}{H_2} = \frac{R_2}{R_1} \quad \text{— (1)}$$

$$H_2 = \frac{R_1 H_1}{R_2}$$

Putting value of H_2

$$H_1 + \frac{R_1 H_1}{R_2} = \frac{Q_0^2}{2C}$$

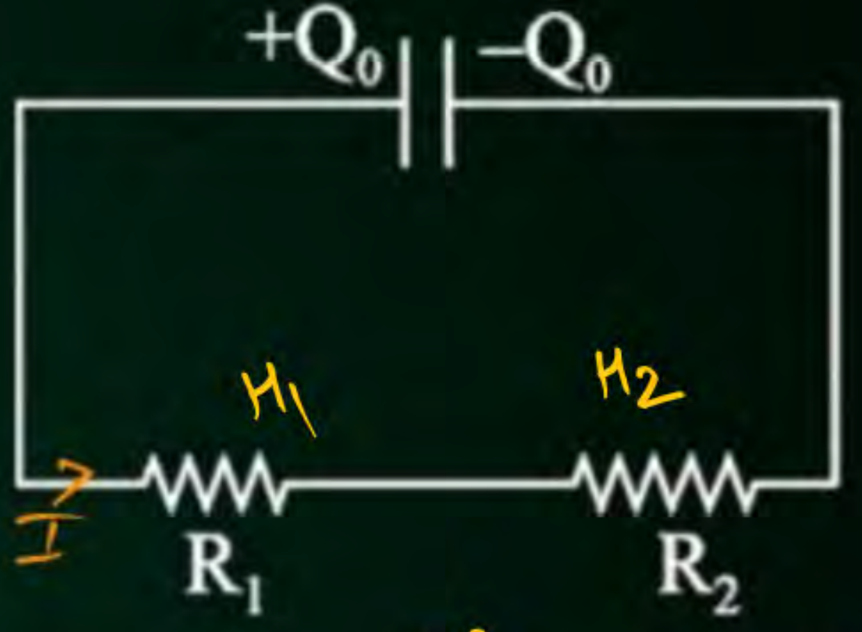
$$H_1\left(\frac{R_2 + R_1}{R_2}\right) = \frac{Q_0^2}{2C}$$

$$\# \quad H_1 = \left(\frac{R_2}{R_1 + R_2}\right)\frac{Q_0^2}{2C}$$

$$H_2 = \frac{R_1}{R_1 + R_2}\left(\frac{Q_0^2}{2C}\right)$$

QUESTION

Find Ratio of heat.



$H \propto R$

$H_{total} = H_1 + H_2 = \frac{Q_0^2}{2C}$

$\frac{H_1}{H_2} = \frac{R_1}{R_2}$

find H_1

$H_1 + H_2 = \frac{Q_0^2}{2C}$ = Total Heat Loss

Putting value of H_2

$H_1 = \frac{R_1}{R_1+R_2}\left(\frac{Q_0^2}{2C}\right)$

$H_2 = \frac{R_2}{R_1+R_2}\left(\frac{Q_0^2}{2C}\right)$

due to serial combn $H = I^2Rt$

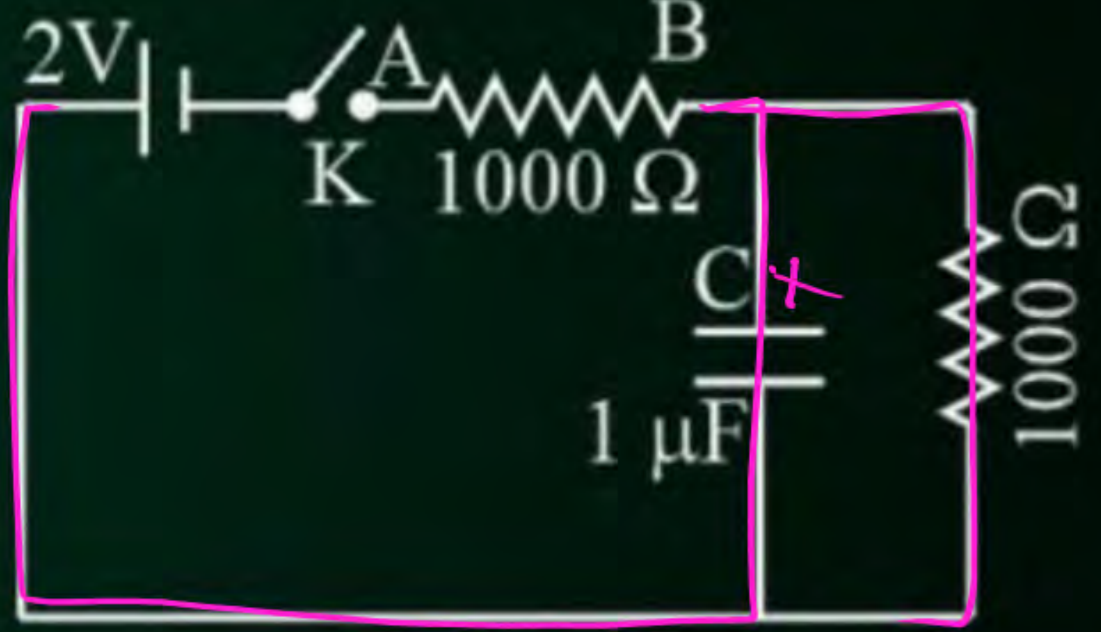
$H_1 \propto R_1$

$H_2 \propto R_2$

$H_2 = \frac{R_2 H_1}{R_1}$

QUESTION

When the key K is pressed at time $t = 0$, then which of the following statement about the current I in the resistance AB of resistance 1000 Ω of the given circuit is true?



1. I oscillates between 1 mA and 2 mA
2. At t = 0, I = 2 mA and with time it goes to 1 mA
3. I = 1 mA at all t
4. I = 2 mA at all t

H/W

$t=0 \rightarrow I = \frac{2V}{1000\Omega} = 2\times10^{-3}A$

at $t=\infty$

$I = \frac{2V}{2000\Omega}$

$I = 1mA$

QUESTION

Find time when charge on capacitor is half of the maximum charge.

$y = \log_e x$

$e^y = x$

$q = q_0 (1 - e^{-t/RC})$

$\frac{q_0}{2} = q_0 (1 - e^{-t/RC})$

$\frac{1}{2} = 1 - e^{-t/RC}$

$e^{-t/RC} = 1 - \frac{1}{2} = \frac{1}{2}$

$e^{-t/RC} = \frac{1}{2}$

taking log both.

$\log_e \frac{1}{2} = -\frac{t}{RC}$

$\log_e 2^{-1} = -\frac{t}{RC}$

$+1 \log_e 2 = +\frac{t}{RC}$

$t = RC \log_e 2$

Test ka syllabus
में moving charge & magnetism
Nahi aayga


THANK YOU


YAKEEN 2.0
FOR NEET 2025
Lecture- 02
Physics
Moving Charges and Magnetism
By- Dr. Manish Raj (MR SIR)

Todays Goal

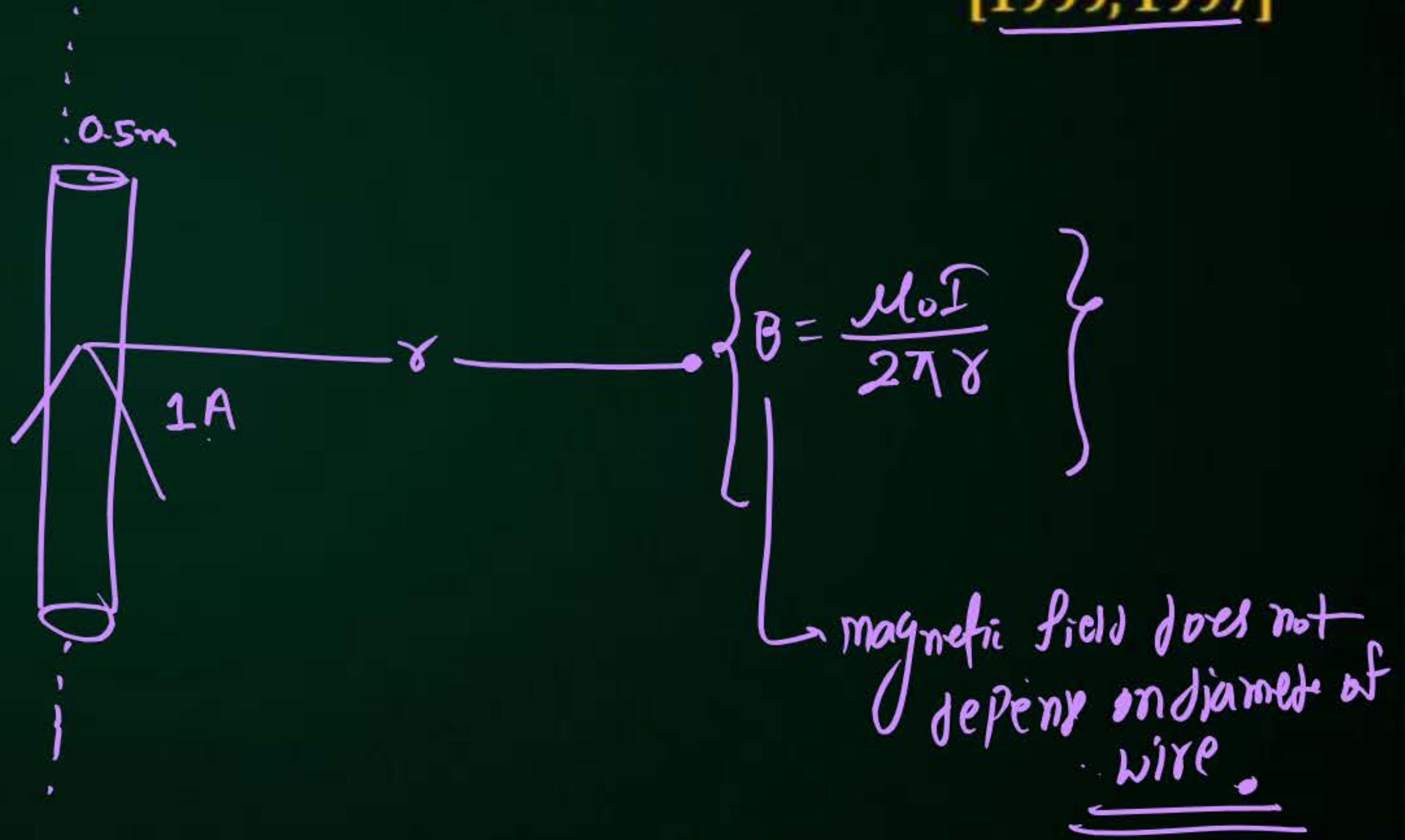
⟹ questions on magnetic field ✓✓

QUESTION

A straight wire of diameter 0.5 mm carrying a current of 1 A is replaced by the another wire of 1 mm diameter carrying the same current. The strength of the magnetic field far away is

[1999, 1997]

1. one-quarter of the earlier value
2. one-half of the earlier value
3. twice the earlier value
4. same as the earlier value



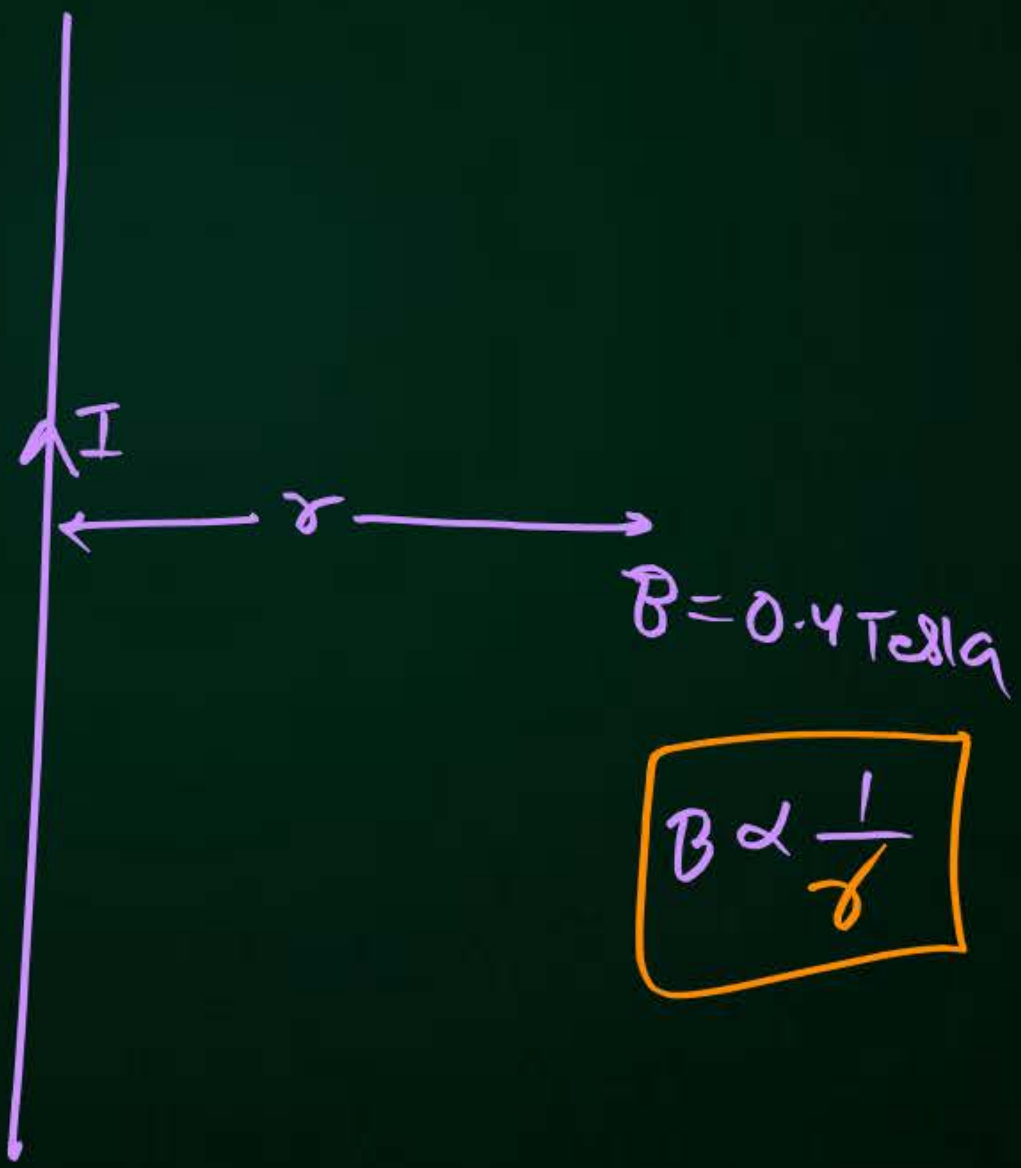
QUESTION

The magnetic field at a distance r from a long wire carrying current i is 0.4 tesla. The magnetic field at a distance $2r$ is [1992]

1. 0.2 tesla
2. 0.8 tesla
3. 0.1 tesla
4. 1.6 tesla

$B = \frac{\mu_0 I}{2\pi r}$

$B \propto \frac{1}{r}$



$B = \frac{\mu_0 I}{2\pi r}$

$B \propto \frac{1}{r}$

QUESTION

(Q) The magnetic induction at a point P which is at the distance of 4 cm from a long current carrying wire is 10^{-3} T. The field of induction at a distance 12 cm from the current will be [1992]

1. 3.33×10^{-4} T
2. 1.11×10^{-4} T
3. 33×10^{-3} T
4. 9×10^{-3} R

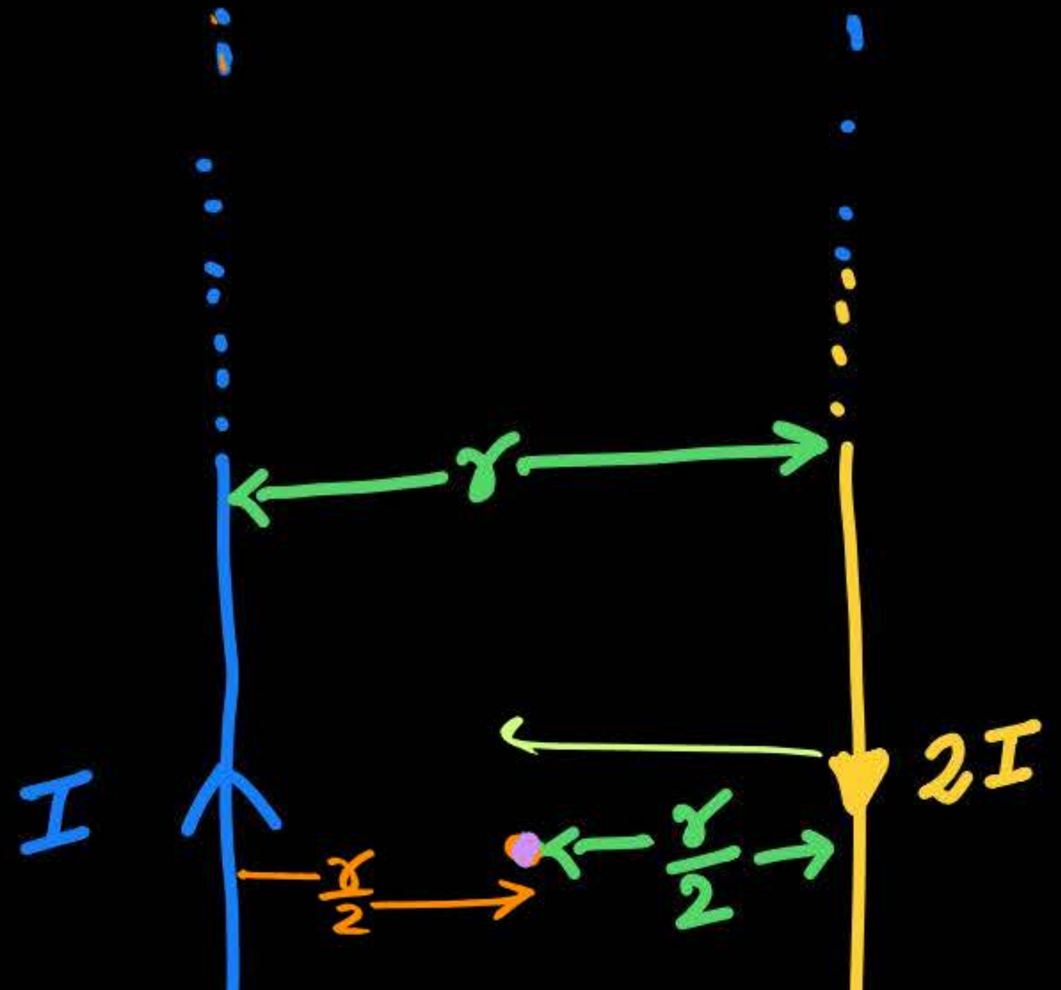
4cm

$\theta = 10^{-3}$ T

$\theta \propto \frac{1}{r}$

$B' = \frac{B}{3} = \frac{10^{-3}}{3} = \frac{10 \times 10^{-4}}{3} = 3.33 \times 10^{-4}$ Tesla

Find Field at centre due to two given infinite wire.

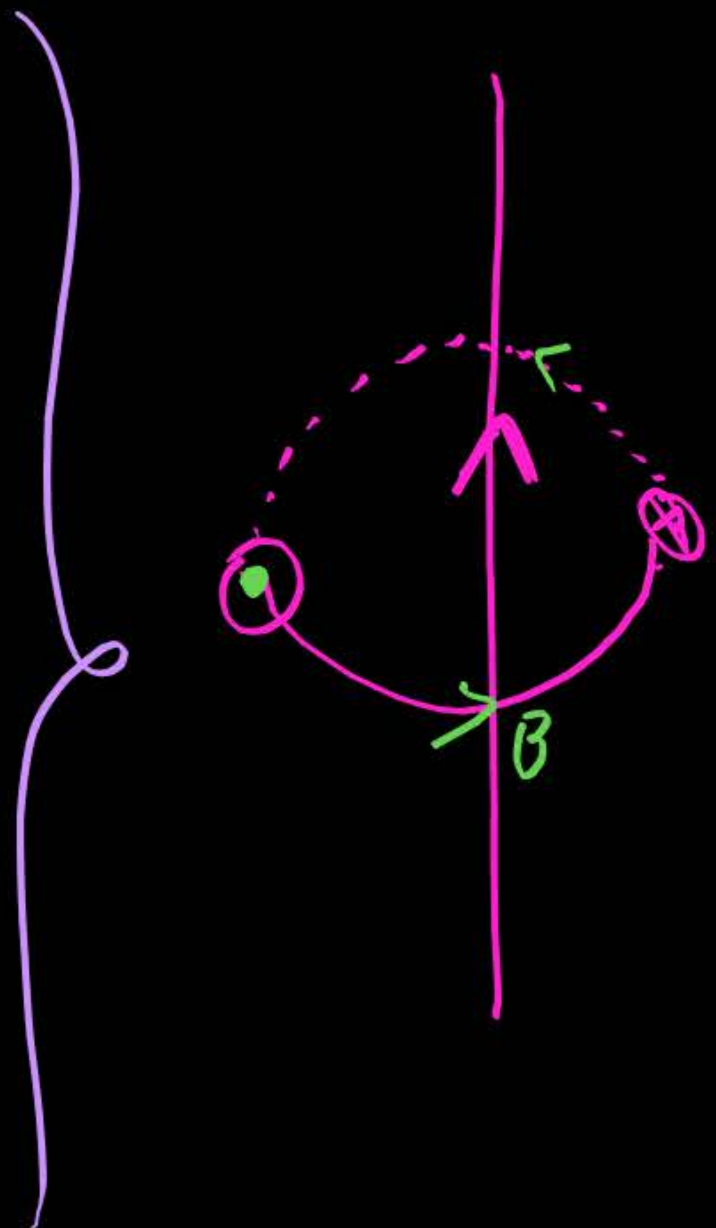


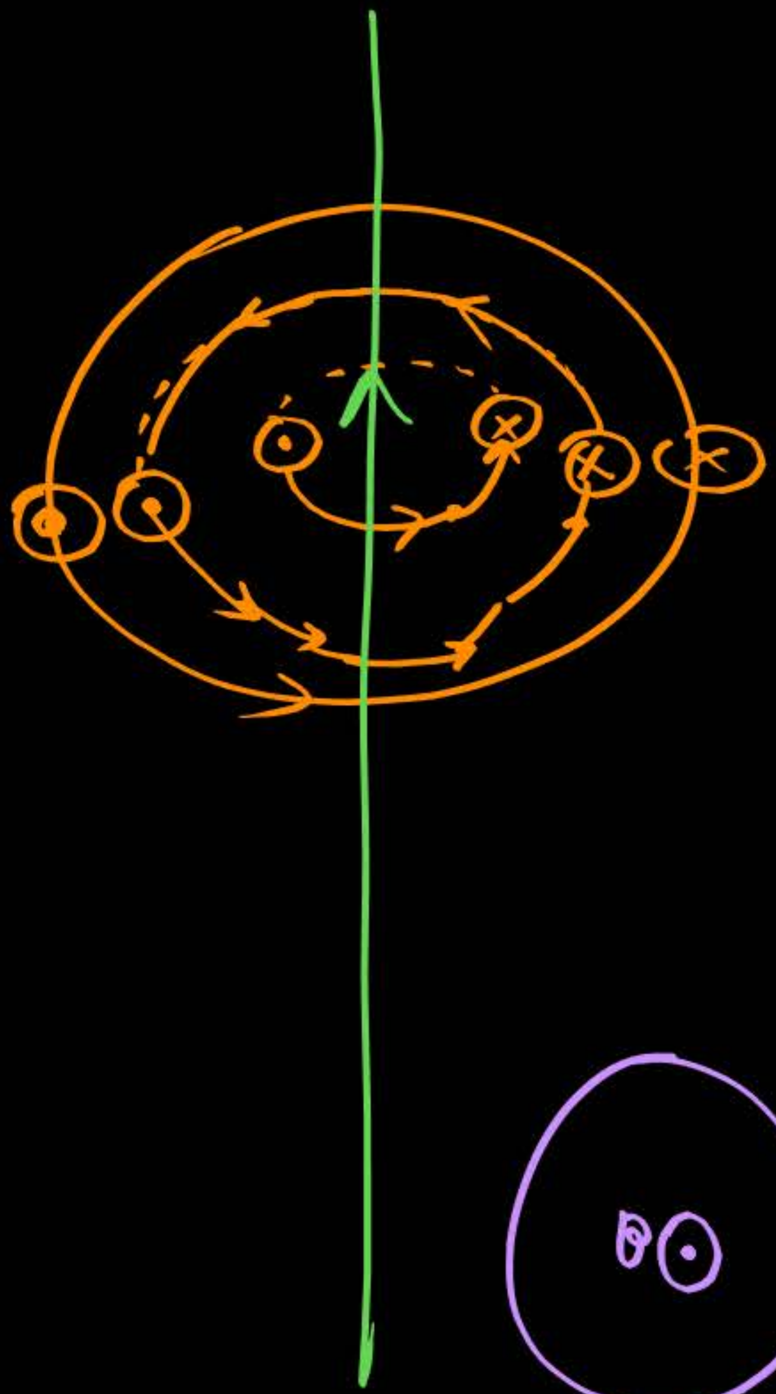
$$B_1 = \frac{\mu_0 I}{2\pi \frac{r}{2}}$$

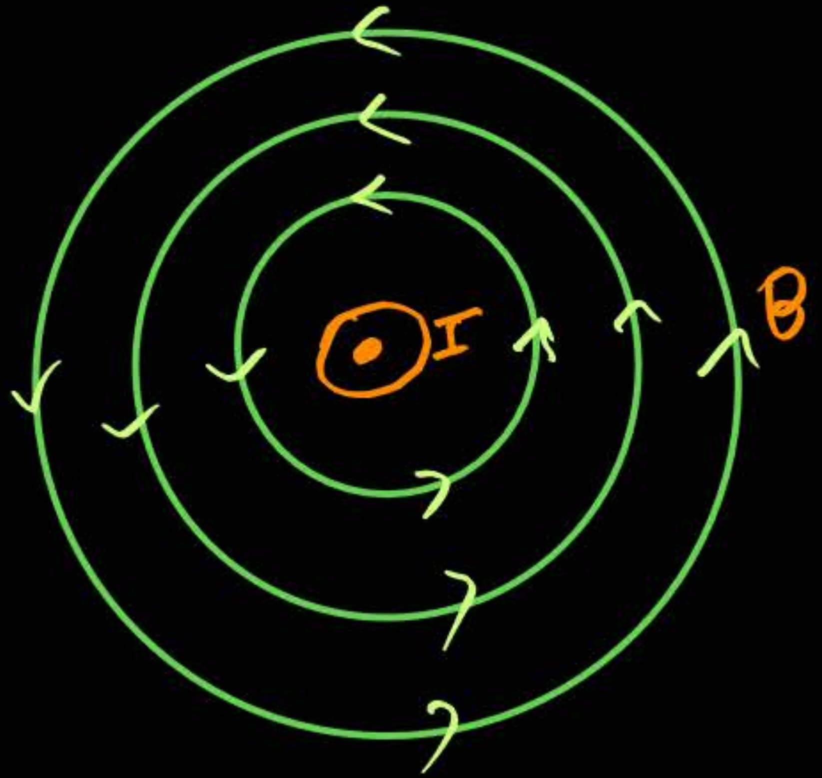
$$B_1 = \frac{\mu_0 I}{\pi r}$$

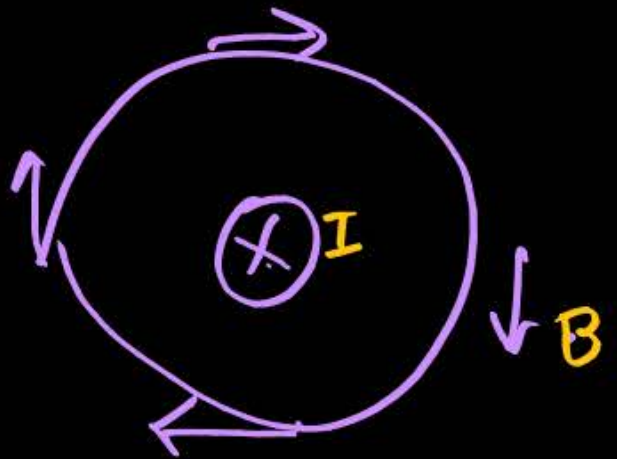
$$B_2 = \frac{\mu_0 2I}{2\pi \frac{r}{2}} = \frac{2\mu_0 I}{\pi r}$$

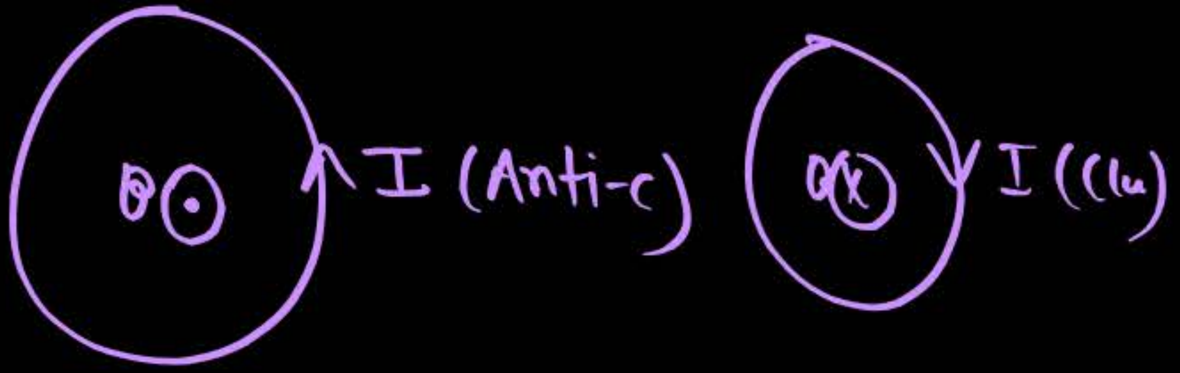
$$B_{net} = \frac{3\mu_0 I}{\pi r}$$



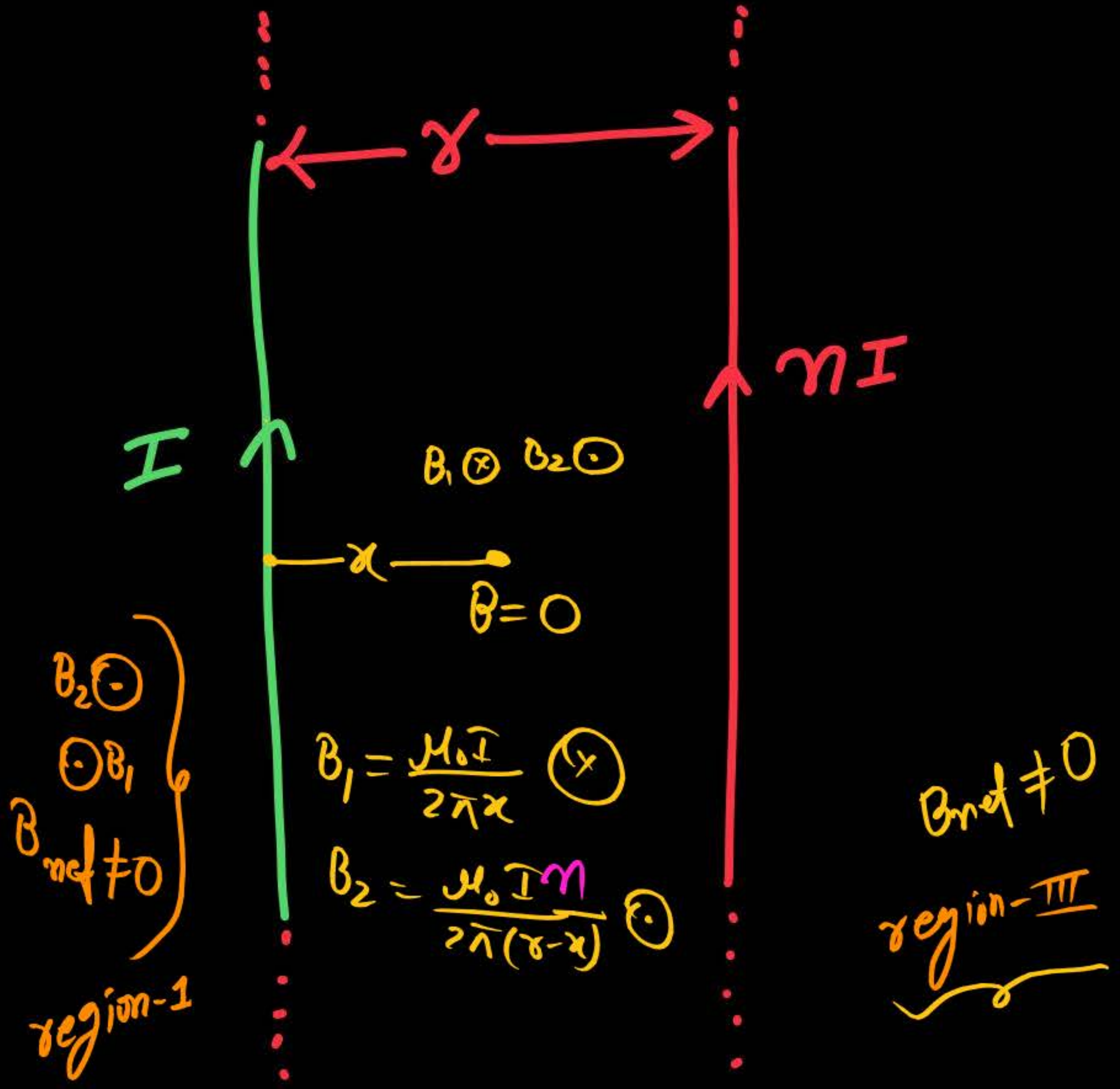








B



Two infinite wire as shown in figure. then find distance from 1st wire where field will be zero.

$B_{net} = 0$

$$\frac{\mu_0 I}{2\pi x} = \frac{\mu_0 I n}{2\pi (r-x)}$$

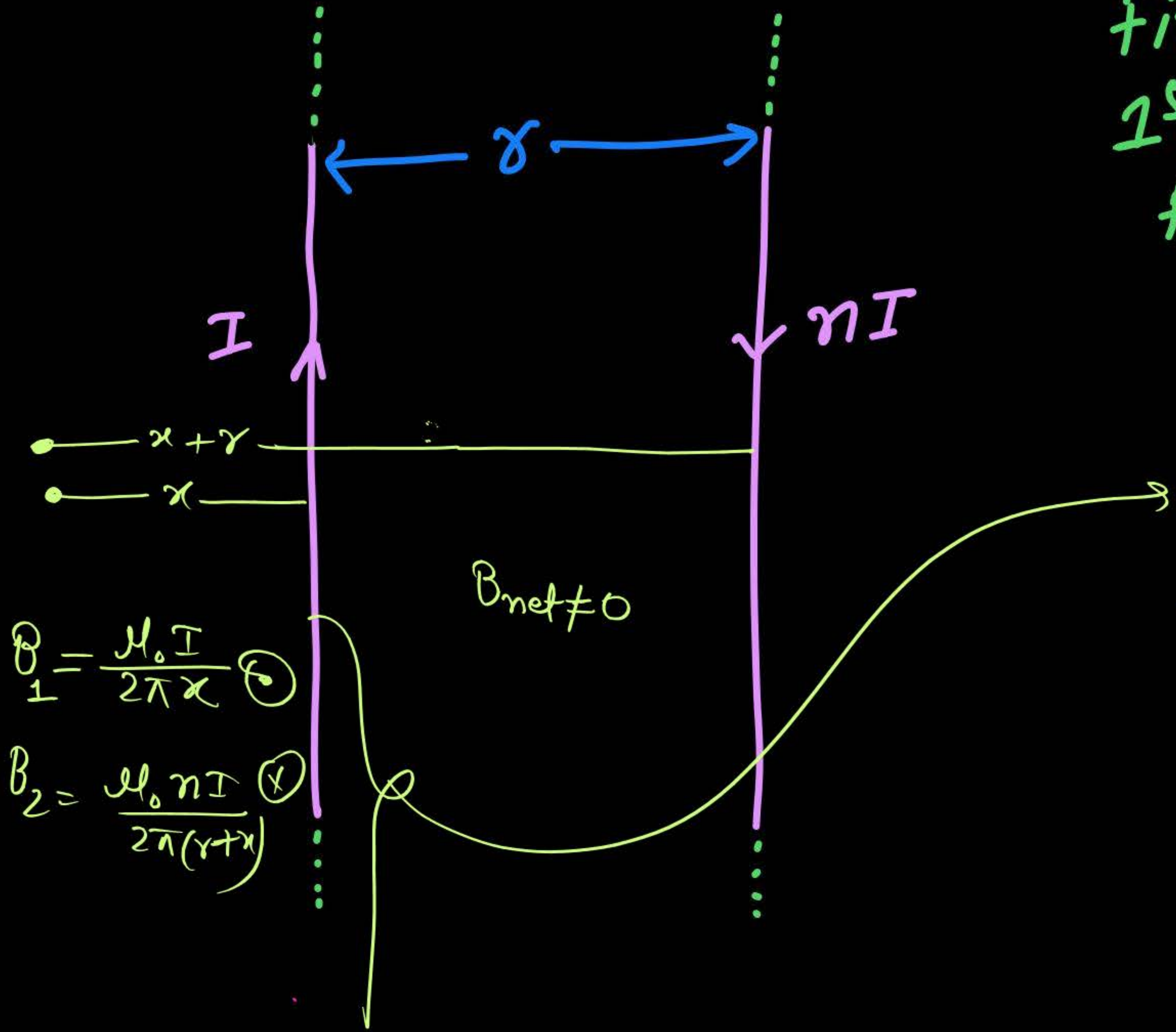
$$x = r - x \cdot \frac{1}{n} \quad \Rightarrow \quad nx = r - x$$

$$xn + x = r$$

$$x(n+1) = r$$

$$\left[x = \frac{r}{n+1}\right]$$

find distance from 1^{st} wire where field will be zero.



$B_{net} = 0$

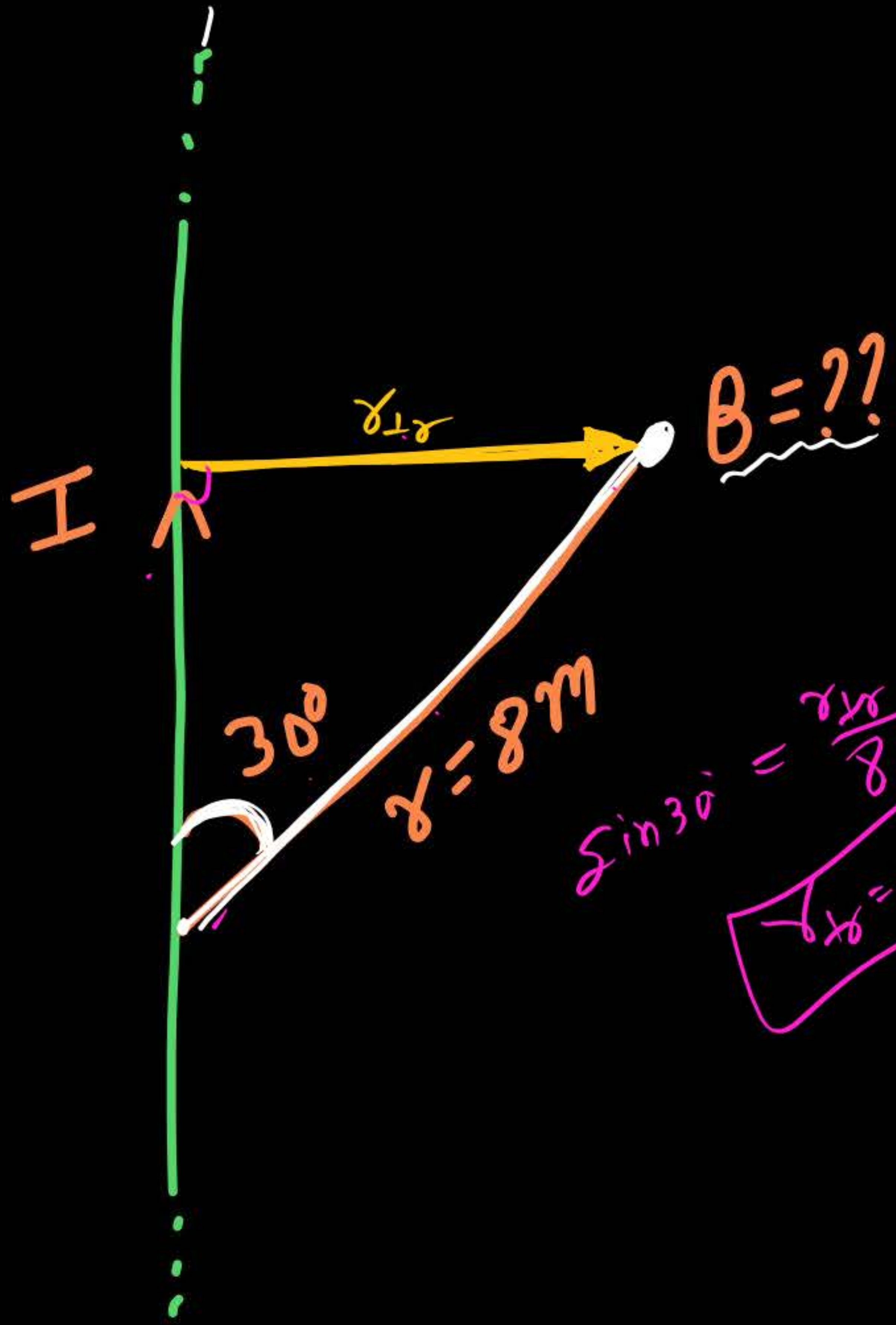
$$\frac{\mu_0 I}{2\pi x} = \frac{\mu_0 n I}{2\pi (r+x)}$$

$$nx = r + x$$

$$x(n-1) = r$$

$$x = \left(\frac{r}{n-1}\right) \text{ Ans.}$$

field due to infinite wire:



sol^n

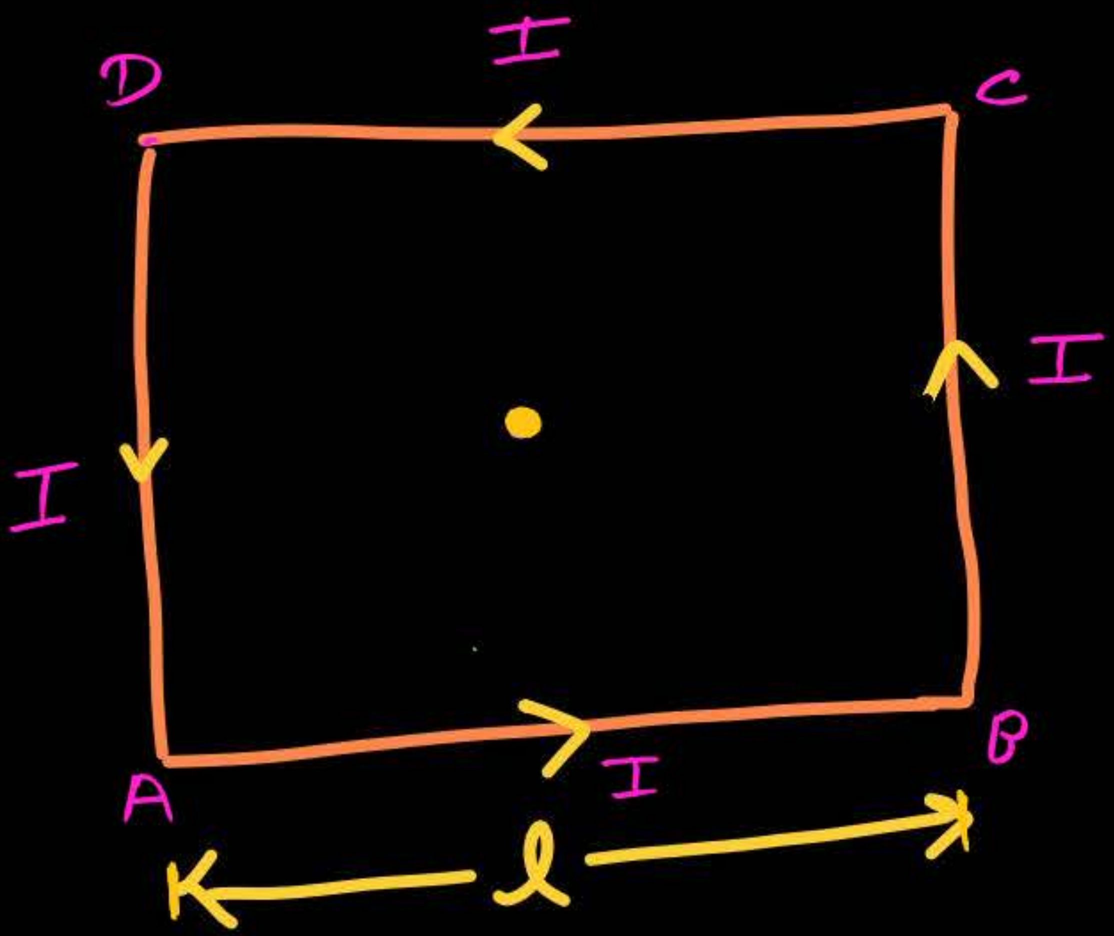
$$\sin 30^\circ = \frac{r_{\perp r}}{8}$$

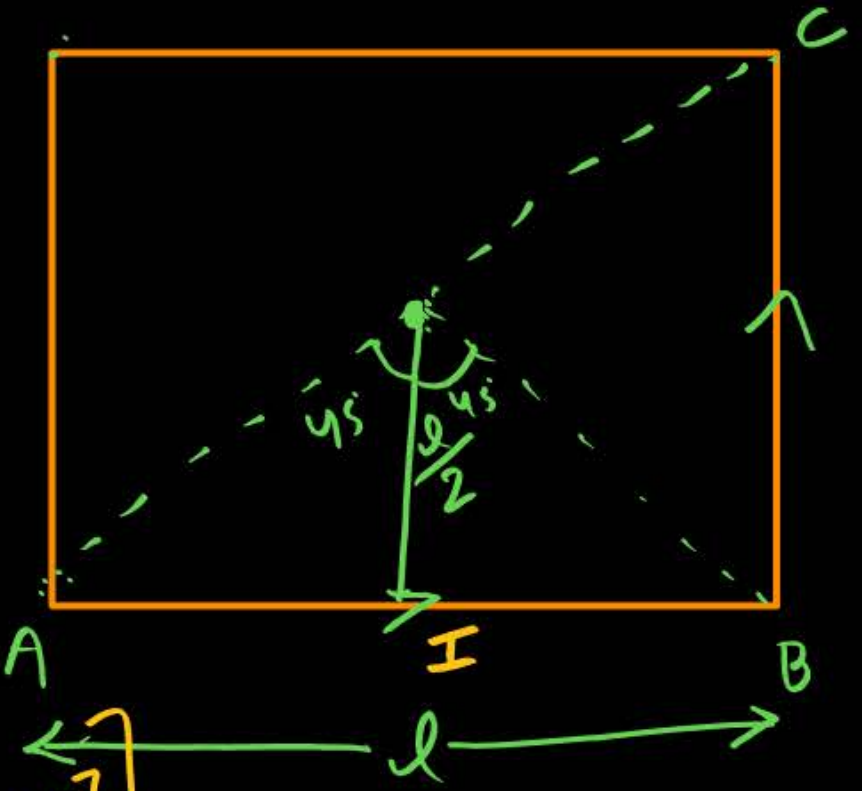
$$r_{\perp r} = 4$$

$$B = \frac{\mu_0 I}{2\pi (r_{\perp r})} = \frac{\mu_0 I}{2\pi\, 4}$$

$$= \frac{\mu_0 I}{8\pi}$$

find field at centre ?? of square loop.



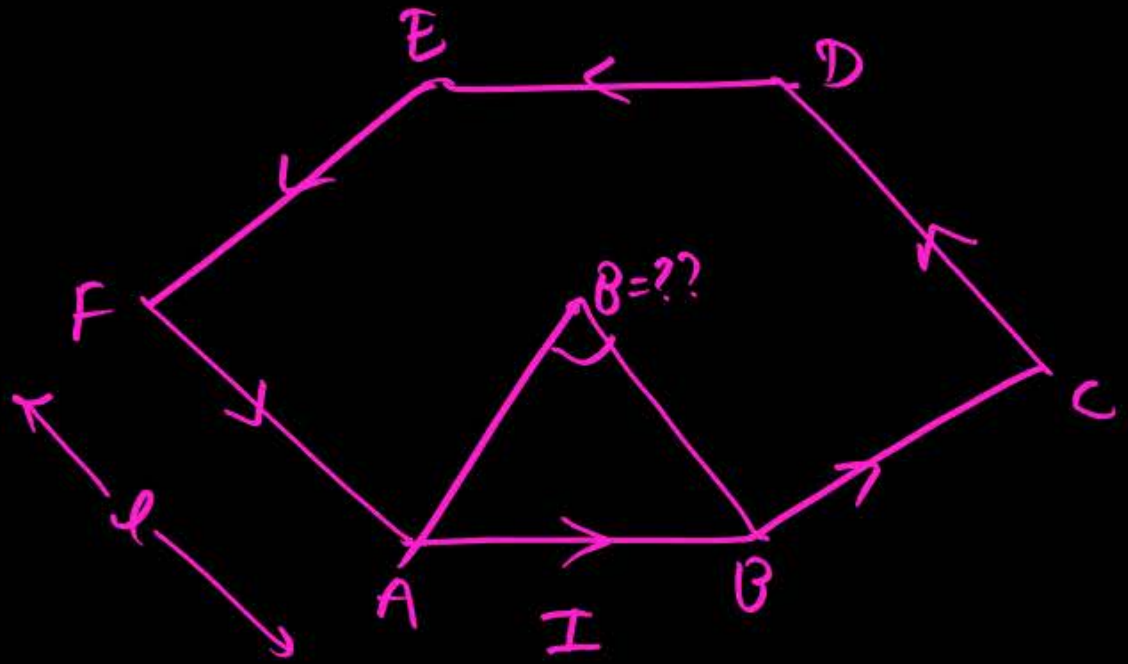


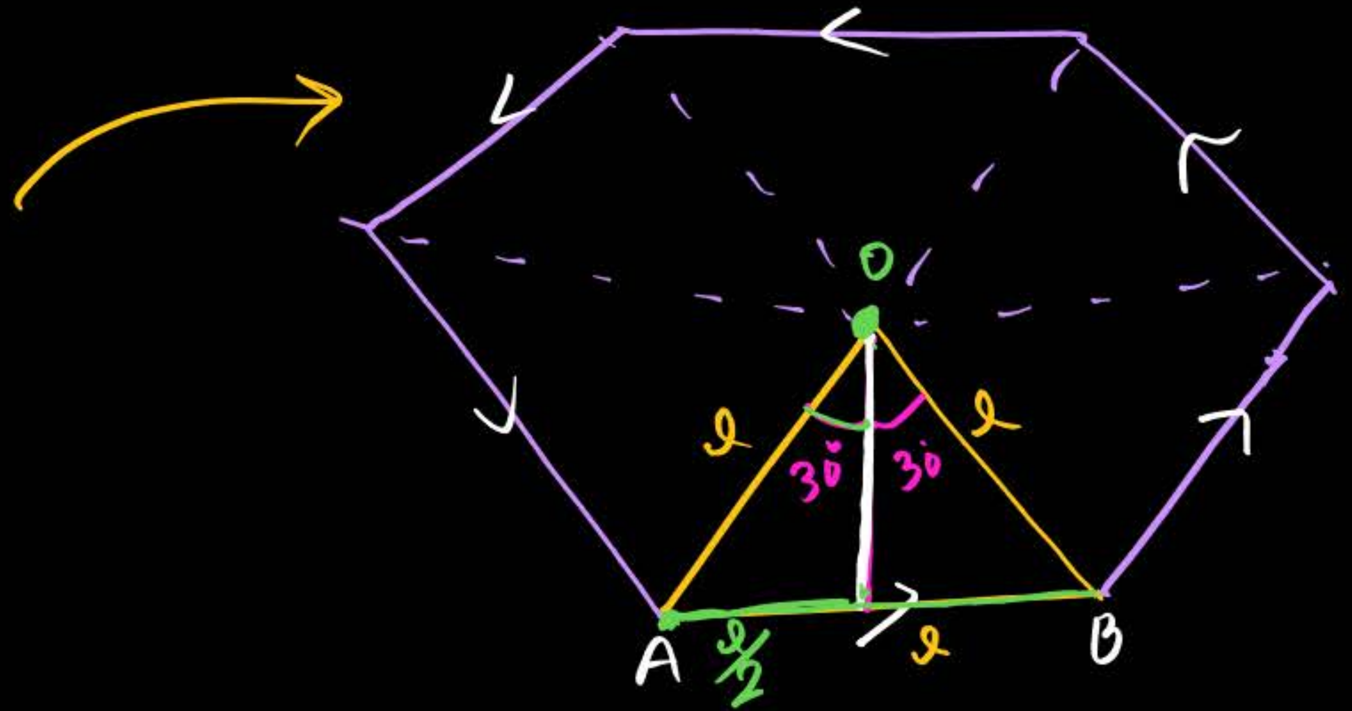
$$B_{net} = 4 \times B_{1\text{-side}}$$

$$= 4\left[\frac{\mu_0 I}{4\pi \frac{l}{2}}\left[\sin 45 + \sin 45\right]\right] = \frac{2\mu_0 I}{\pi l}\left[\frac{1}{\sqrt{2}} + \frac{1}{\sqrt{2}}\right] = \frac{2\sqrt{2}\,\mu_0 I}{\pi l} \quad \text{(Ans)}$$

*

$$\frac{1}{\sqrt{2}} + \frac{1}{\sqrt{2}} = \frac{2}{\sqrt{2}} = \sqrt{2}$$





$$\cos 30^\circ = \frac{r_\perp}{l}$$

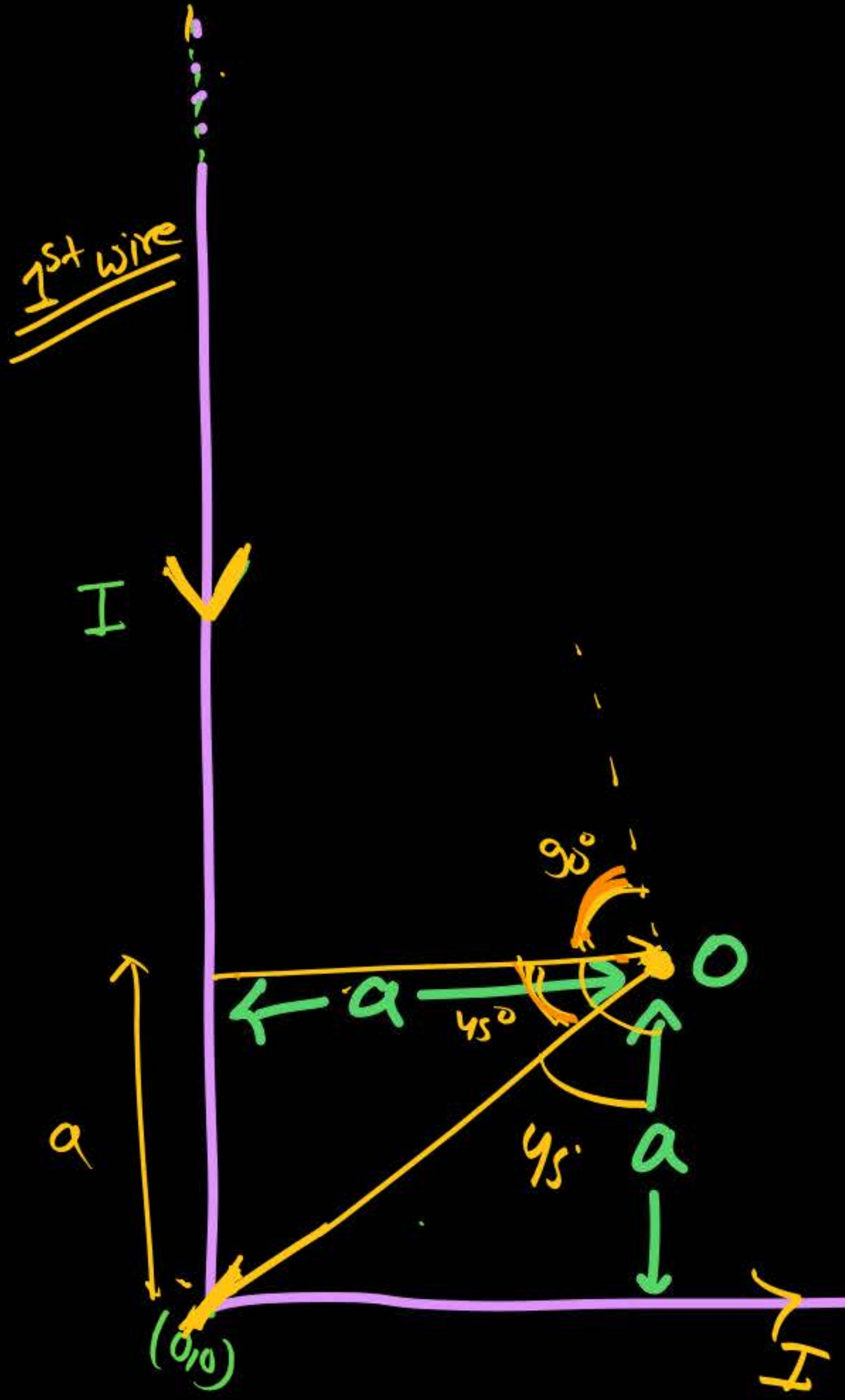
$$\frac{l \times \sqrt{3}}{2} = r_\perp$$

$$B = 6 \times B_{AB}$$

$$= 6\left[\frac{\mu_0 I}{4\pi r_\perp}\left[\sin 30^\circ + \sin 30^\circ\right]\right]$$

$$= \frac{3\,\cancel{6}\,\mu_0 I}{\cancel{2}\,\cancel{4}\,\pi \frac{\sqrt{3}\,l}{\cancel{2}}} = \frac{\sqrt{3}\,\mu_0 I}{\pi l}$$

find field at 'O'



$$B = \frac{\mu_0 I}{2\pi r}\left(\sin\alpha + \sin\beta\right)$$

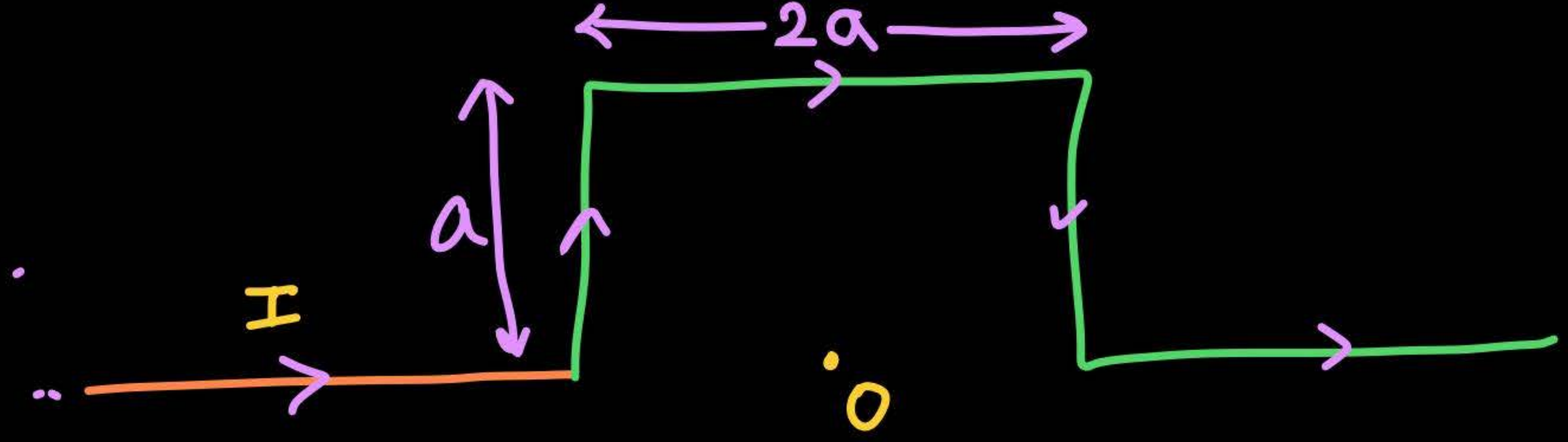
$$B = \frac{\mu_0 I}{4\pi a}\left[\sin 90° + \sin 45°\right]$$

$$= \frac{\mu_0 I}{4\pi a}\left[1 + \frac{1}{\sqrt{2}}\right]$$

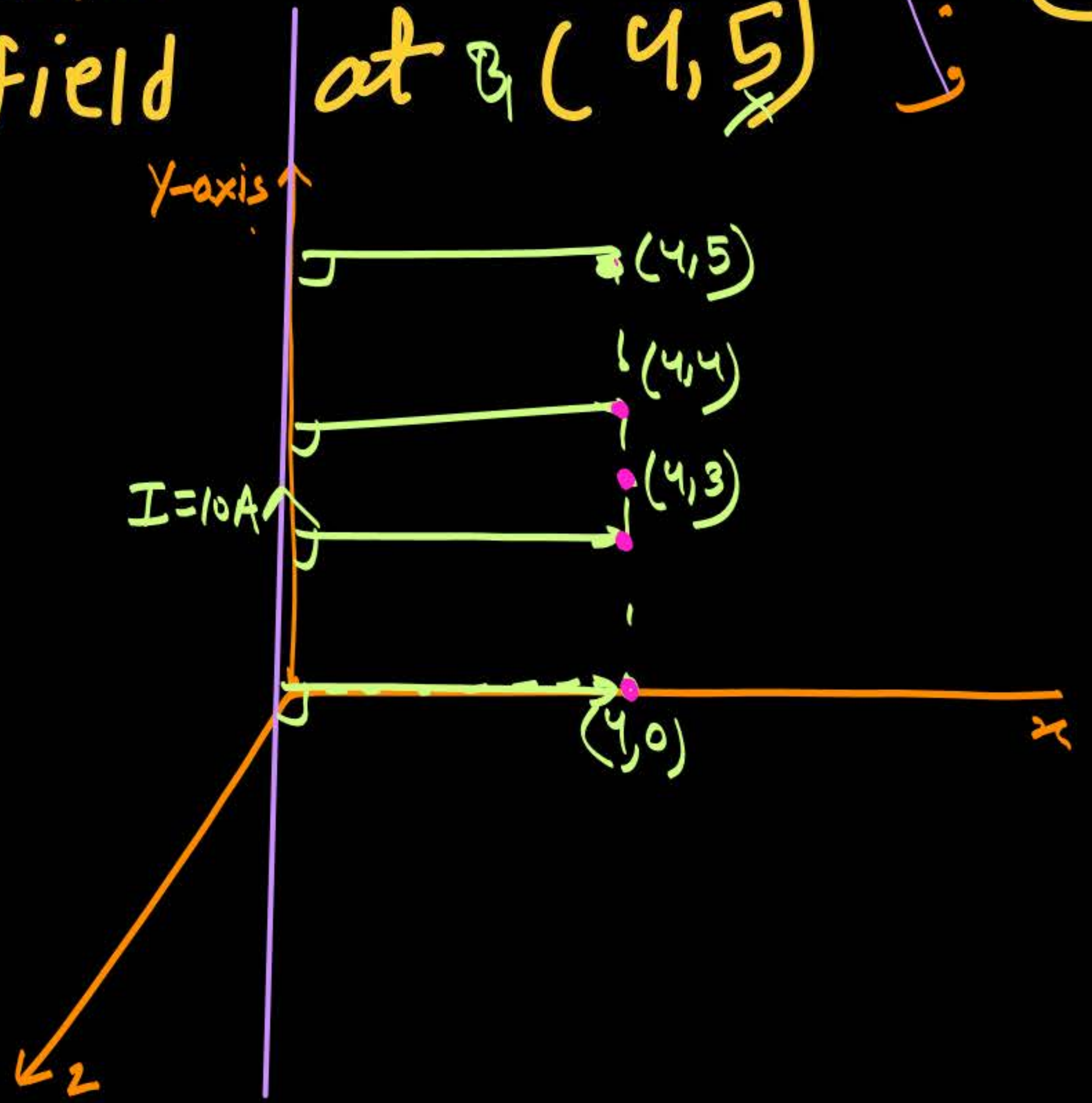
$$B_{net} = 2\left[\frac{\mu_0 I}{4\pi a} \times \left(1 + \frac{1}{\sqrt{2}}\right)\right]$$

Ans.

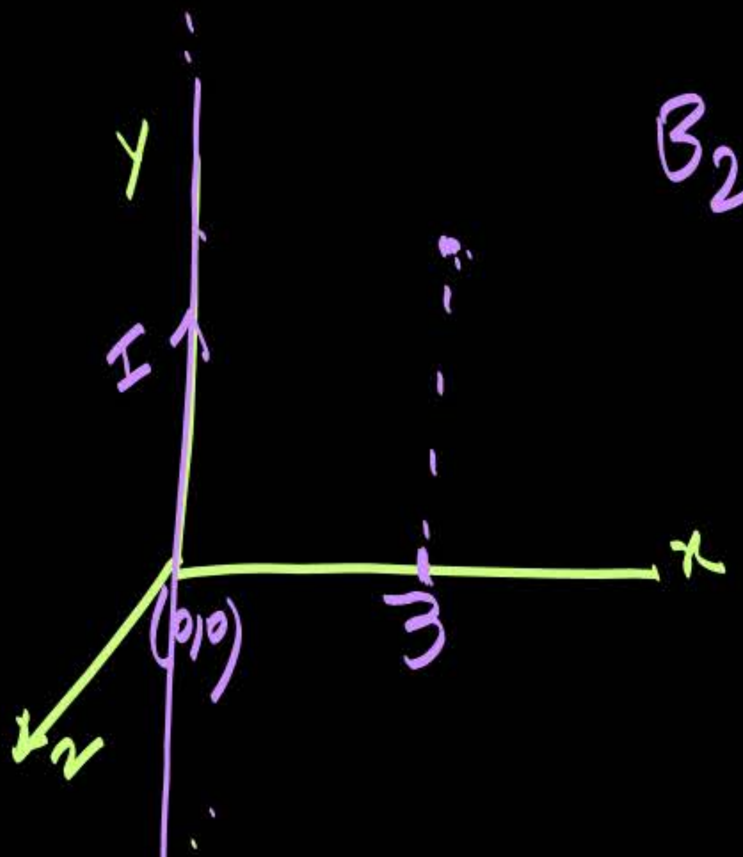
Find field at '0'



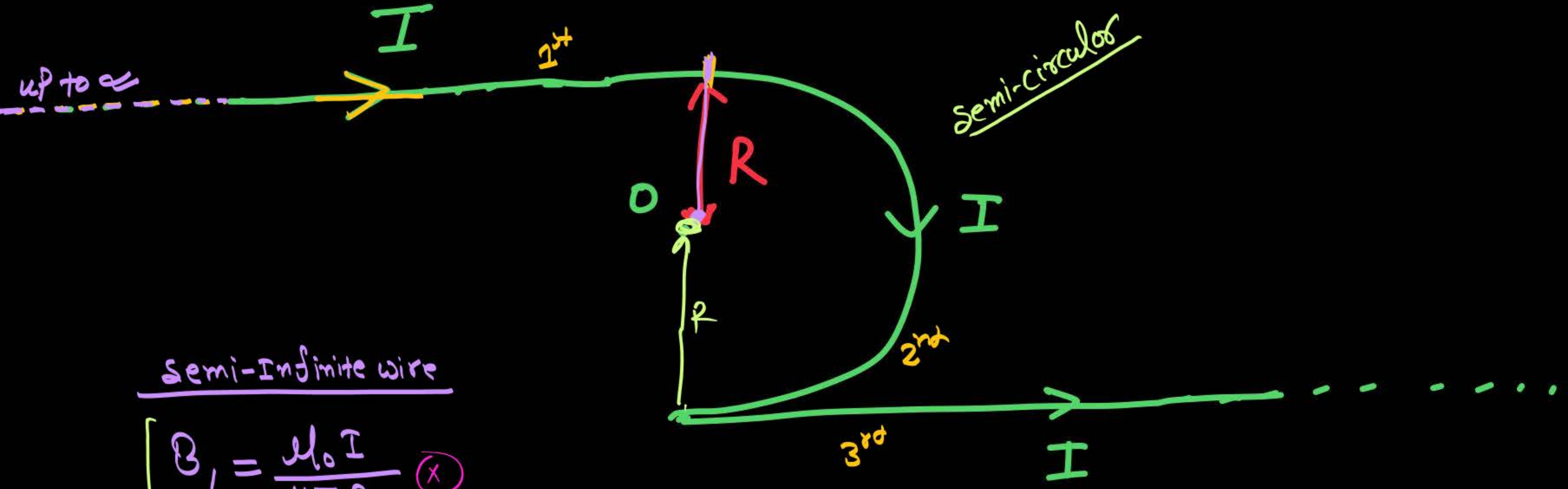
Infinite wire placed along y-axis and current 10 A flowing in it. find magnetic field at B_1 (4, 5) and B_2 (3, 4)



$$B_1 = \frac{\mu_0 I}{2\pi(4)} \text{ Ans}$$



$$B_2 = \frac{\mu_0 I}{2\pi(5m)}$$



semi-Infinite wire

$$B_1 = \frac{\mu_0 I}{4\pi R} \otimes$$

$$B_2 = \frac{\mu_0 I}{4R} \otimes$$

$$B_3 = \frac{\mu_0 I}{4\pi R} \odot$$

$$B_{net} = \frac{\mu_0 I}{4R} \otimes$$

QUESTION

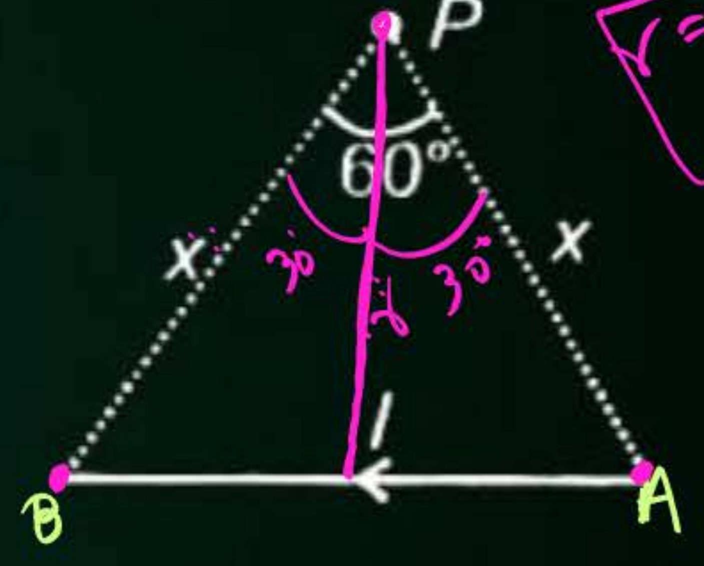
A straight wire of finite length carrying current I subtends an angle of $60°$ at point P as shown. The magnetic field at P is

1. $\dfrac{\mu_0 I}{2\sqrt{3}\pi x}$ ✓

2. $\dfrac{\mu_0 I}{2\pi x}$

3. $\dfrac{\sqrt{3}\mu_0 I}{2\pi x}$

4. $\dfrac{\mu_0 I}{3\sqrt{3}\pi x}$



✡ Same as hexagonal

$\cos 30° = \dfrac{r}{x}$

$r = \dfrac{x\sqrt{3}}{2}$

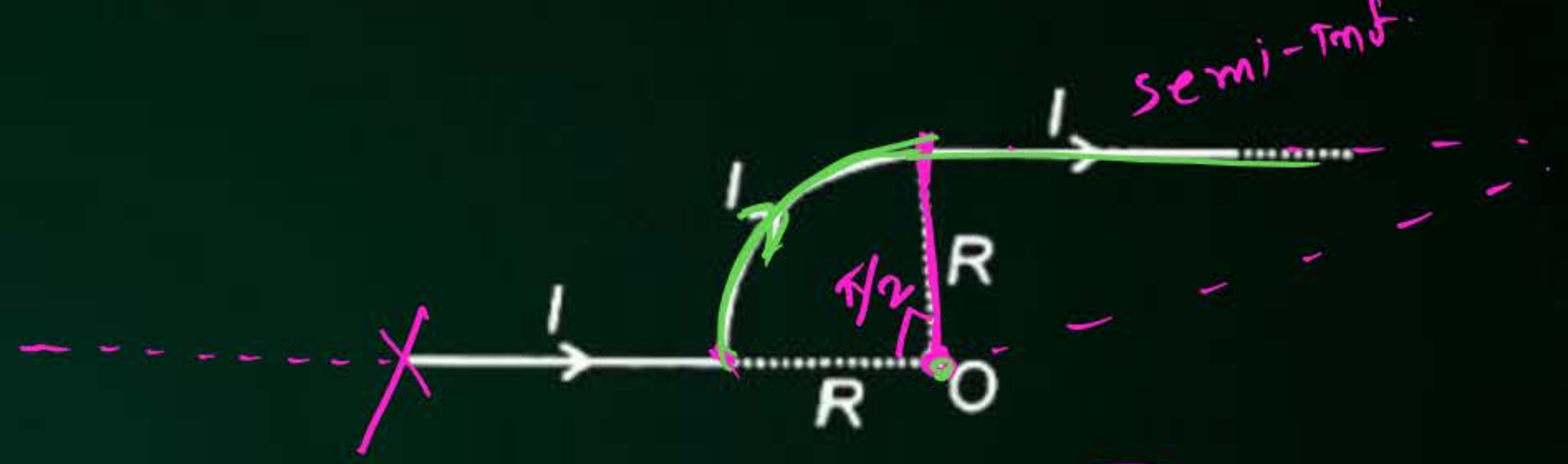
$B = \dfrac{\mu_0 I}{2\,4\pi \frac{\sqrt{3}x}{2}} \times [\sin 30° + \sin 30°]$

$B = \dfrac{\mu_0 I}{2\sqrt{3}\pi x}$

QUESTION

Magnetic field at point O due to the given structure is

1. $\frac{\mu_0 I}{4\pi a}\left(\frac{\pi}{2}+1\right)\otimes$
2. $\frac{\mu_0 I}{4\pi a}\left(\frac{\pi}{2}+1\right)\odot$
3. $\frac{\mu_0 I}{2\pi a}(\pi+1)\otimes$
4. $\frac{\mu_0 I}{2\pi a}(\pi+1)\odot$



$B = \frac{\mu_0 I}{8R}$

QUESTION

Magnetic field at the point O due to the given structure is

1. $\frac{\mu_0 I}{4R}\left[\frac{3}{2}\right] \odot$
2. $\frac{\mu_0 I}{2R}[3] \otimes$
3. $\frac{\mu_0 I}{4R}\left[\frac{3}{2}\right] \otimes$
4. $\frac{\mu_0 I}{4R}[3] \odot$



QUESTION

Magnetic field at the centre O due to the given structure is

(1) $\frac{\mu_0 I}{4R}\left[\frac{3}{2}+\frac{1}{\pi}\right] \odot$

(2) $\frac{\mu_0 I}{2R}\left[3+\frac{1}{\pi}\right] \otimes$

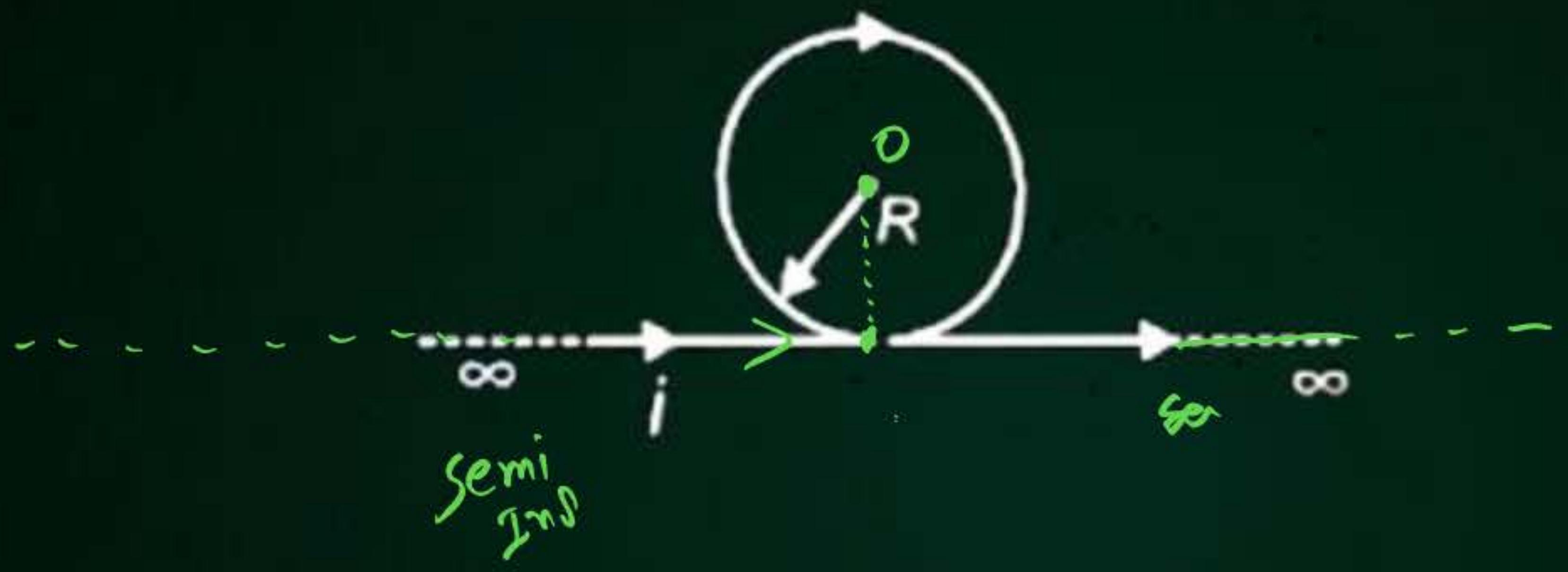
(3) $\frac{\mu_0 I}{4R}\left[\frac{3}{2}+\frac{1}{\pi}\right] \otimes$ Ans

(4) $\frac{\mu_0 I}{4R}\left[3+\frac{2}{\pi}\right] \odot$



QUESTION

Find the magnetic field at the centre of the circular loop shown in figure.

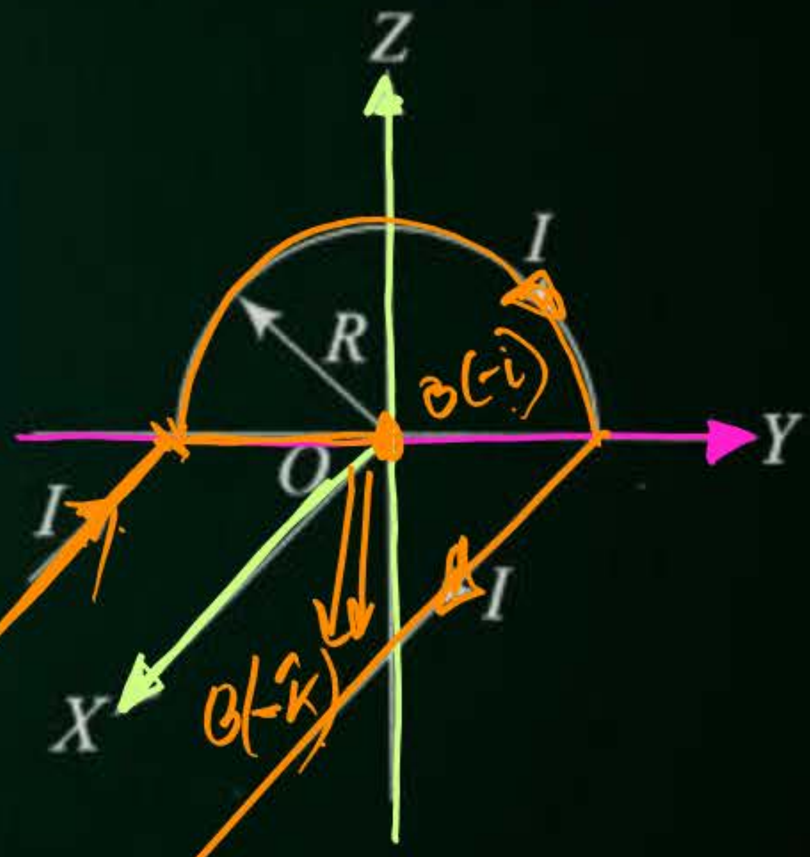


$$B = \frac{\mu_0 I}{4\pi r} \odot + \frac{\mu_0 I}{2R} \otimes + \frac{\mu_0 I}{4\pi r} \odot$$

H/W

QUESTION

A wire carrying current I has the shapes as shown in adjoining figure. Linear parts of the wire are vary long and parallel to X-axis while semicircular portion of radius R is lying in Y-Z plane. Magnetic field at point O is [AIMPT-2015]



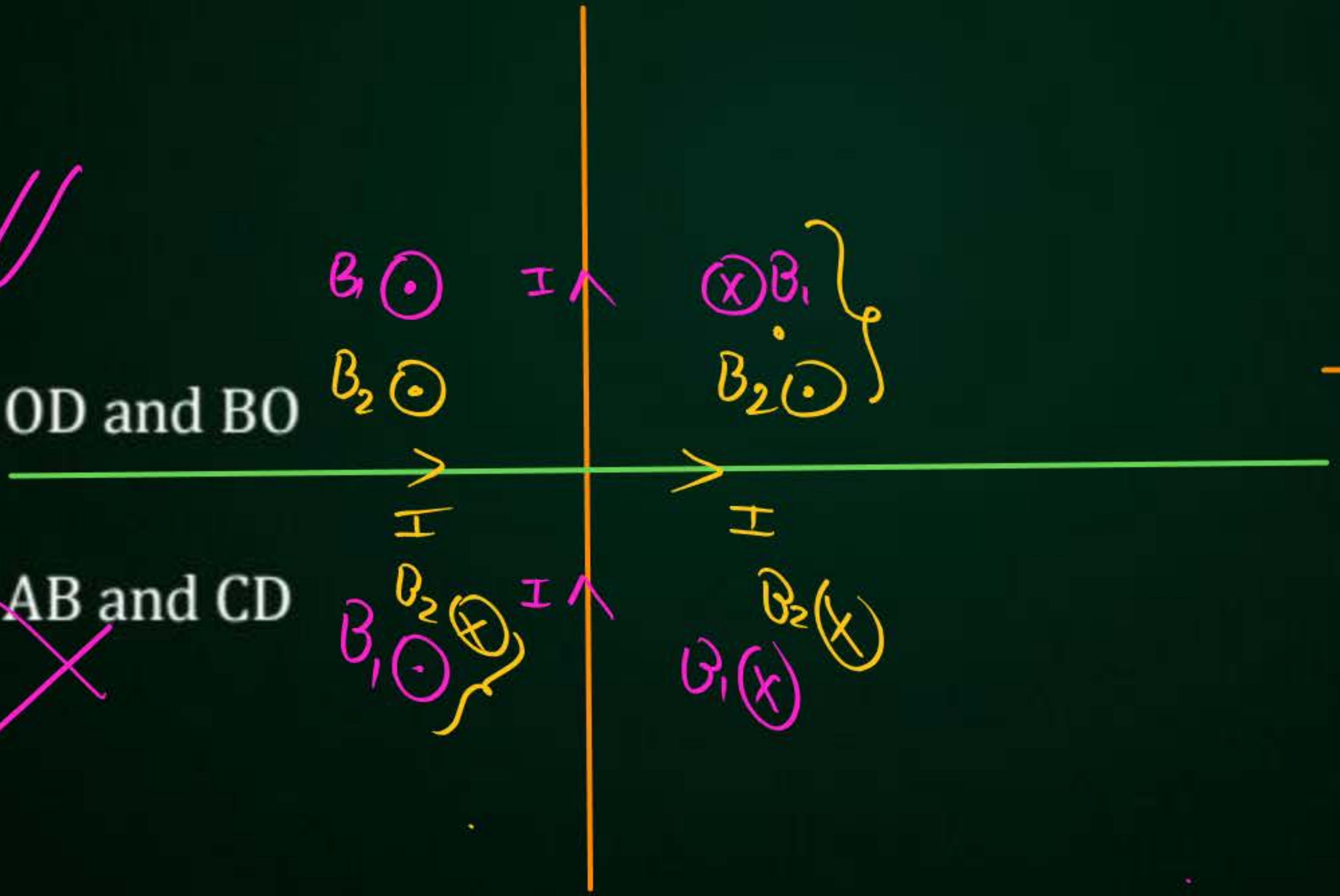
1. $\vec{B} = \frac{\mu_0}{4\pi}\frac{I}{R}(\pi\hat{\imath} - 2\hat{k})$
2. $\vec{B} = \frac{\mu_0}{4\pi}\frac{I}{R}(\pi\hat{\imath} + 2\hat{k})$
3. $\vec{B} = -\frac{\mu_0}{4\pi}\frac{I}{R}(\pi\hat{\imath} - 2\hat{k})$
4. $\vec{B} = -\frac{\mu_0}{4\pi}\frac{I}{R}(\pi\hat{\imath} + 2\hat{k})$

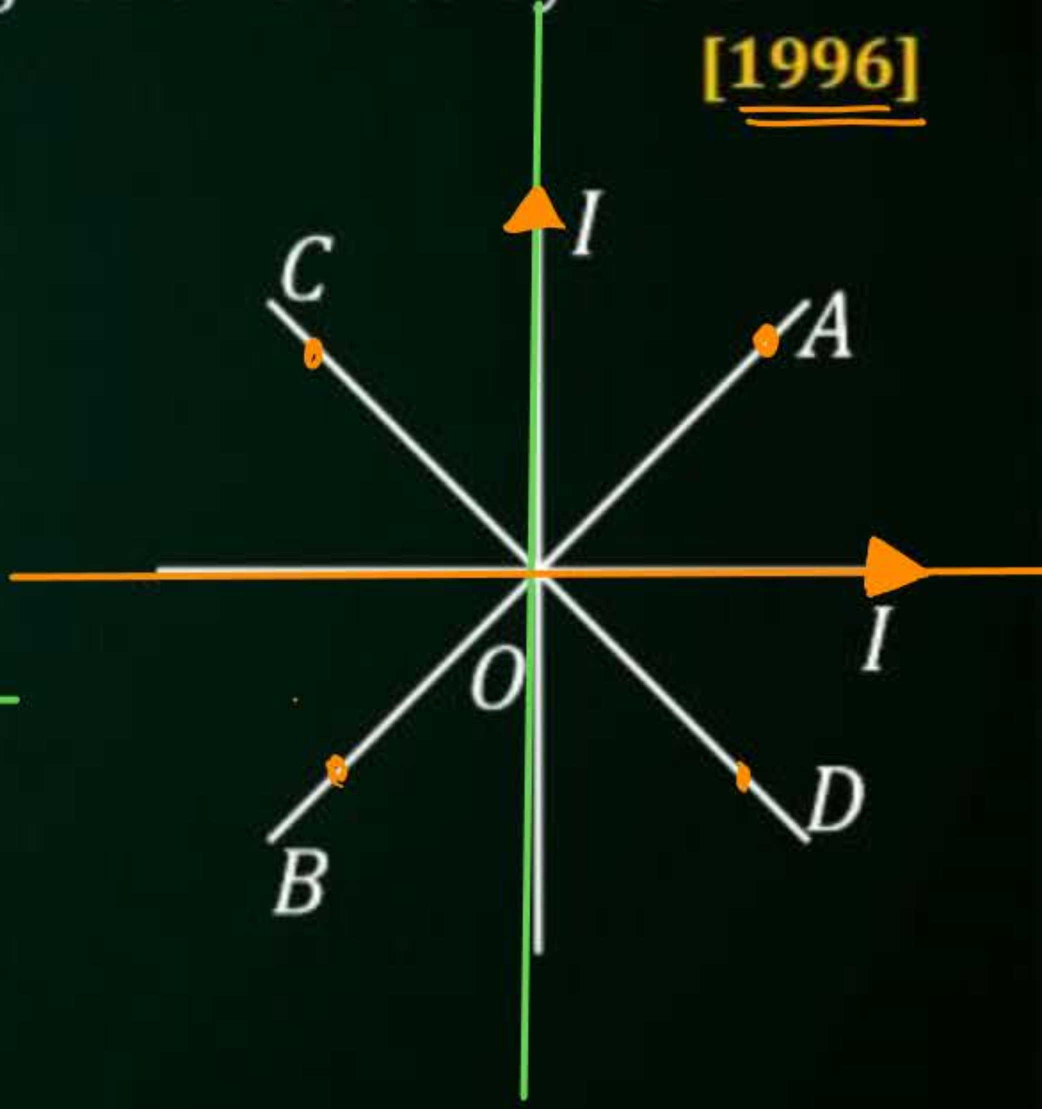
QUESTION

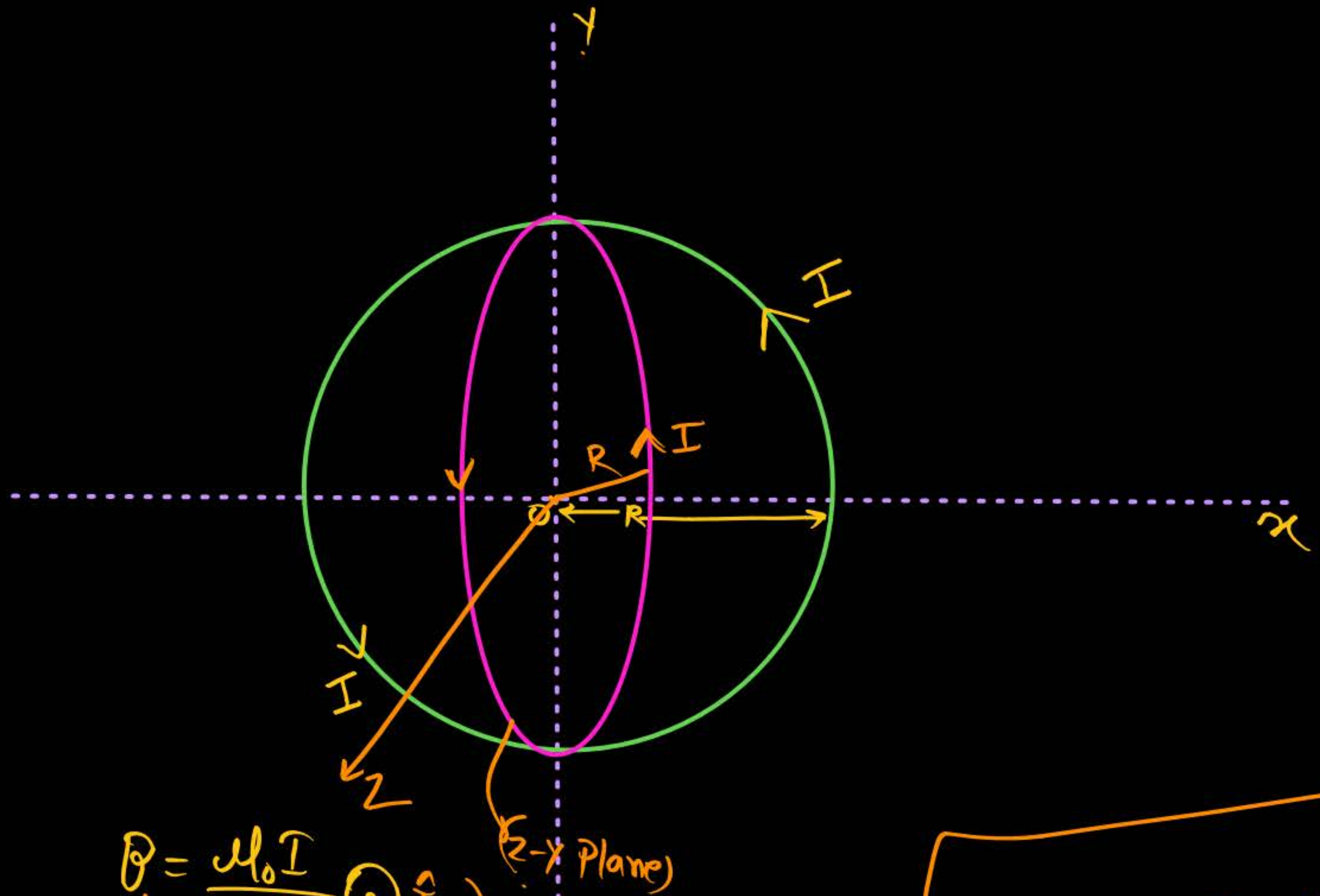
Two equal electric currents are flowing perpendicular to each other as shown in the figure. AB and CD are perpendicular to each other and symmetrically placed with respect to the currents. Where do we expect the resultant magnetic field to by zero?

[1996]

1. On CD
2. On AB
3. On both OD and BO
4. On both AB and CD







$B_1 = \frac{\mu_0 I}{2R} \odot \hat{j}$

$B_2 = \frac{\mu_0 I}{2R} \hat{i}$

$$B_{net} = \sqrt{2}\,\frac{\mu_0 I}{2R}$$

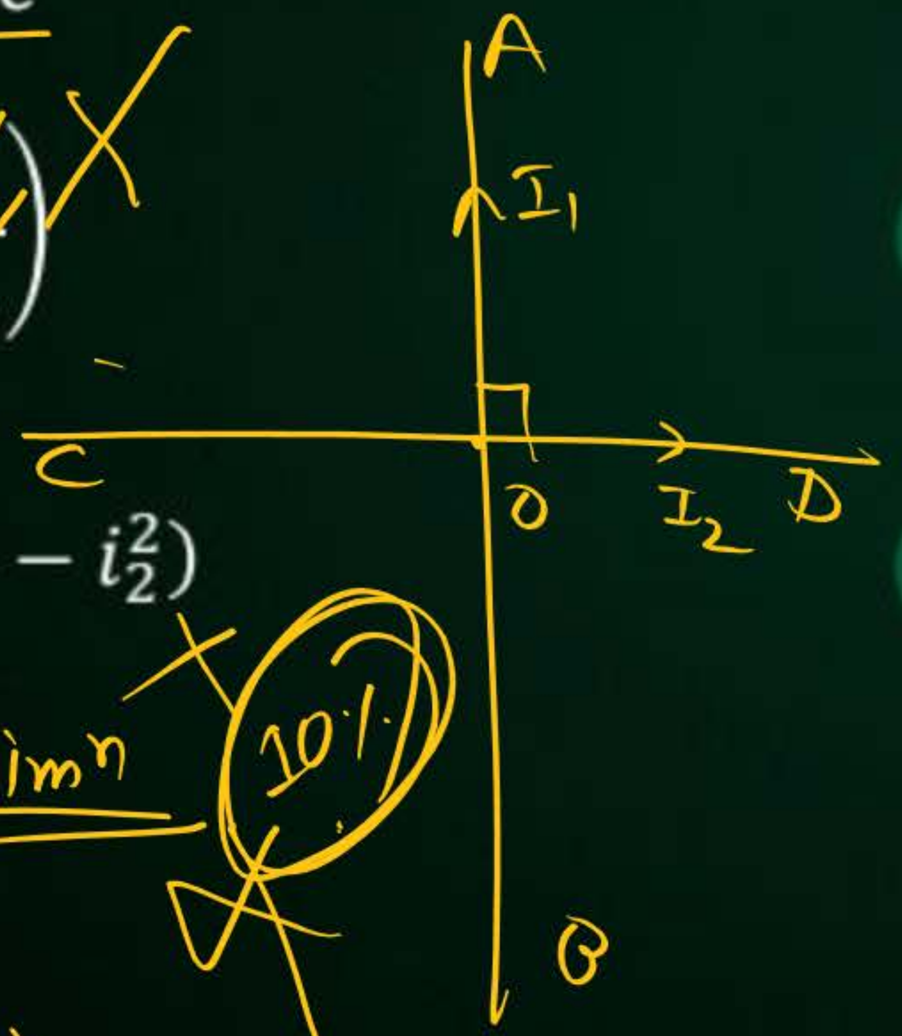
Three Identical current carrying circular loop placed ⊥r to each other of current I & radius R find magnetic field at centre.

$$|\vec{B}| = \sqrt{3}\,\frac{\mu_0 I}{2R}$$

QUESTION

Two identical long conducting wires AOB and COD are placed at right angle to each other, with one above other such that O is their common point for the two. The wires carry I_1 and I_2 currents, respectively. Point 'P' is lying at distance d from O along a direction perpendicular to the plane containing the wires. The magnetic field at the point P will be

[AIPMT-2014]



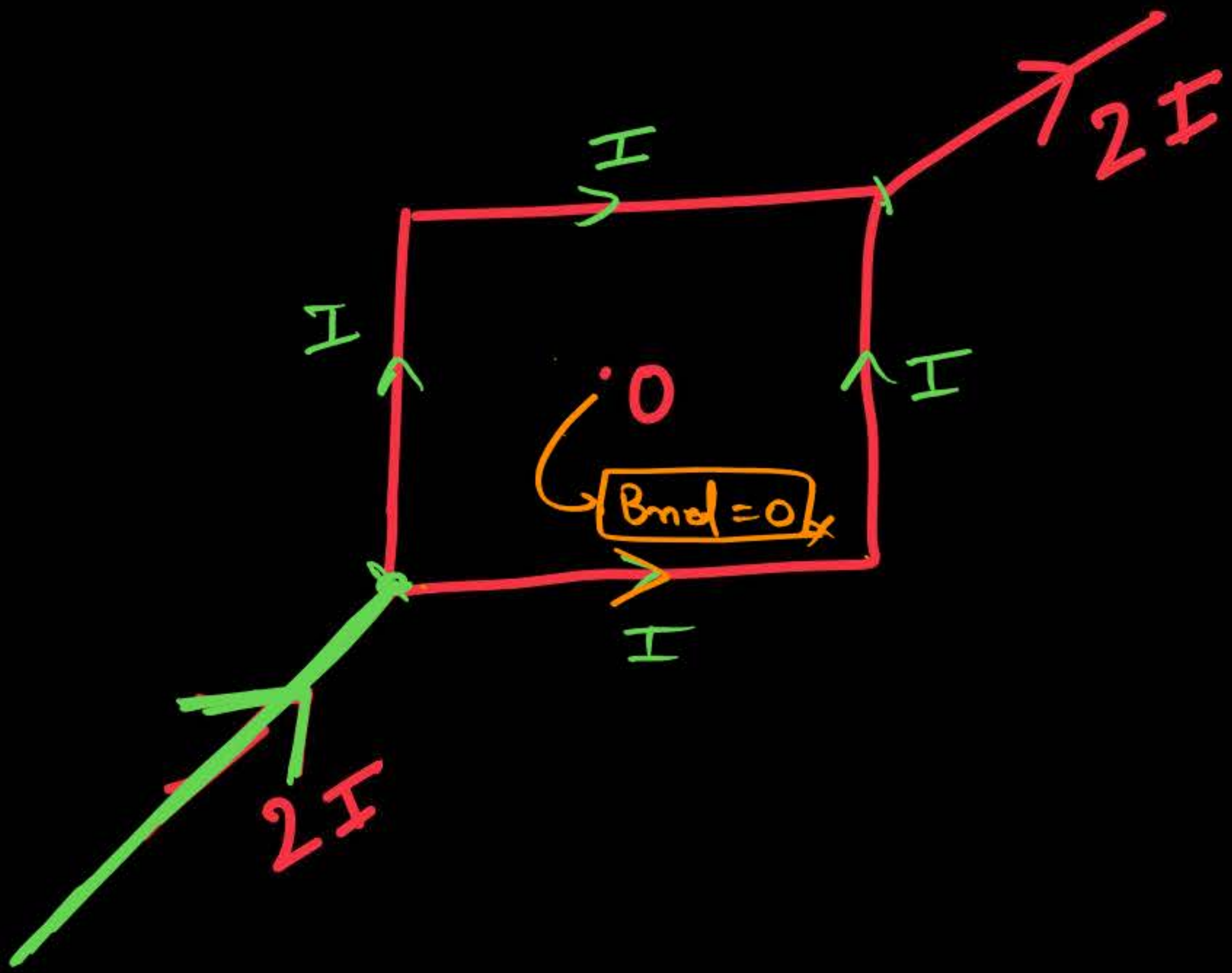
1. $\frac{\mu_0}{2\pi d}\left(\frac{i_1}{i_2}\right)$

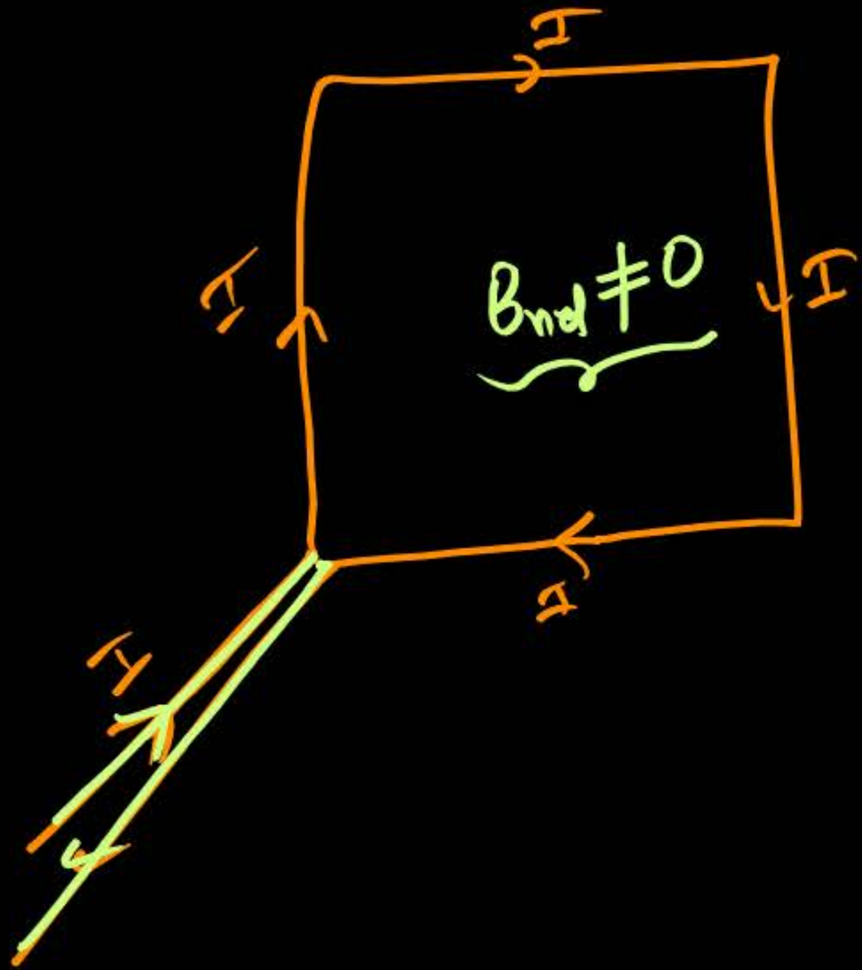
2. $\frac{\mu_0}{2\pi d}(i_1 + i_2)$

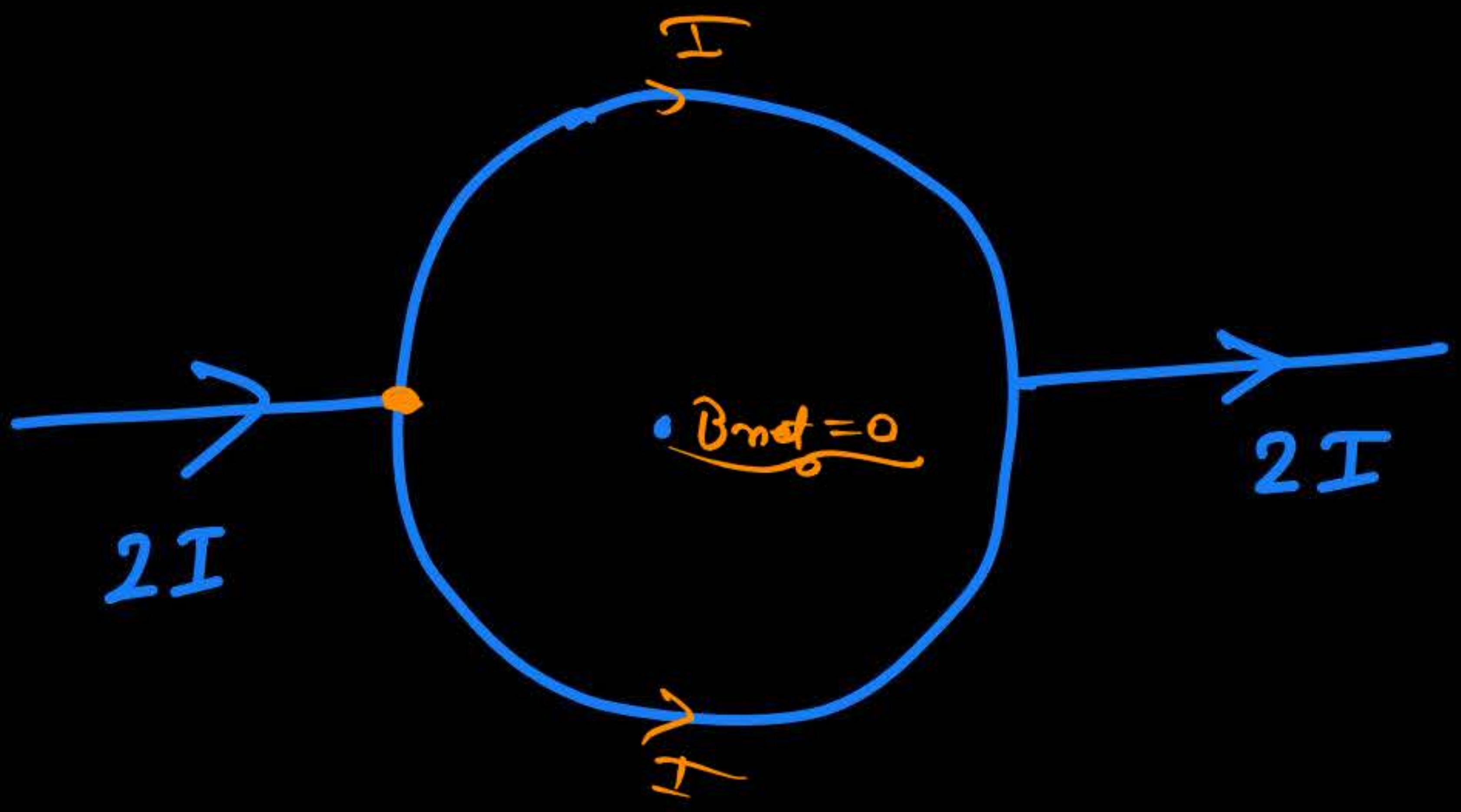
3. $\frac{\mu_0}{2\pi d}(i_1^2 - i_2^2)$

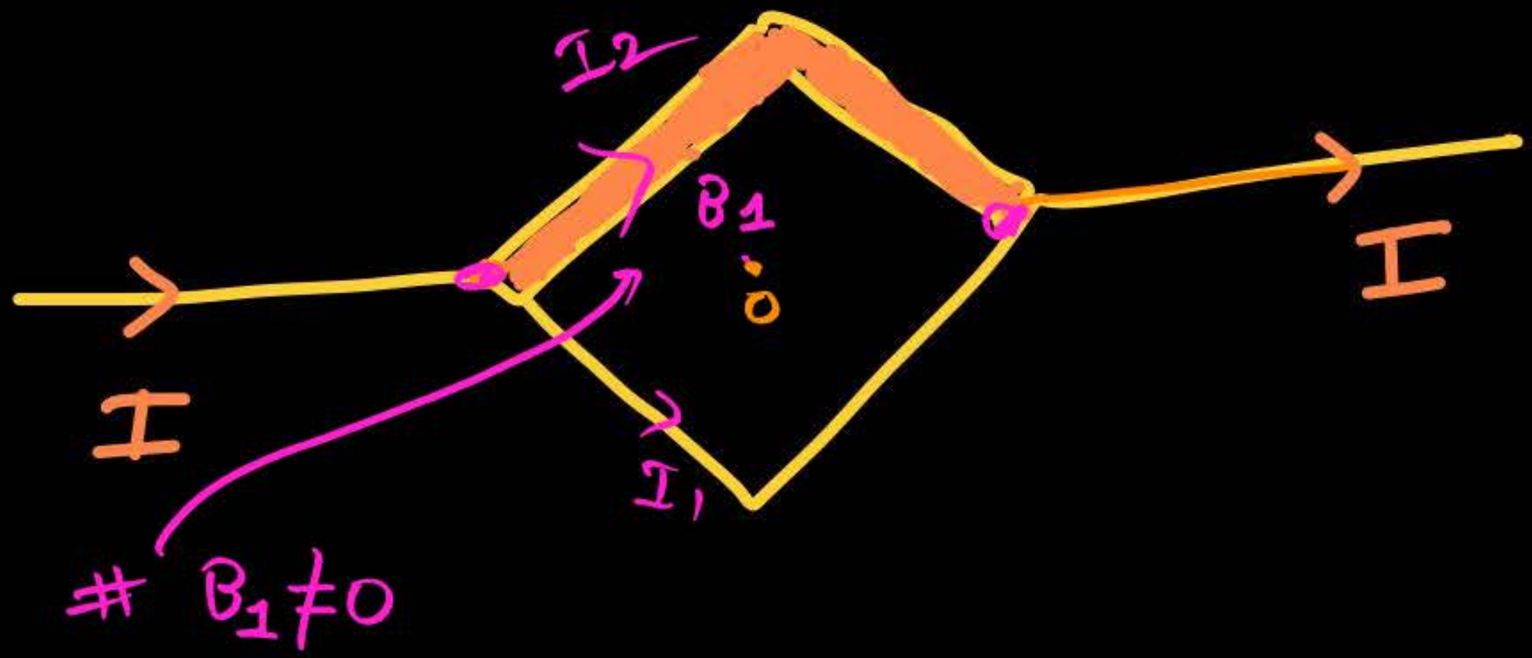
4. $\frac{\mu_0}{2\pi d}(i_1^2 + i_2^2)^{1/2}$

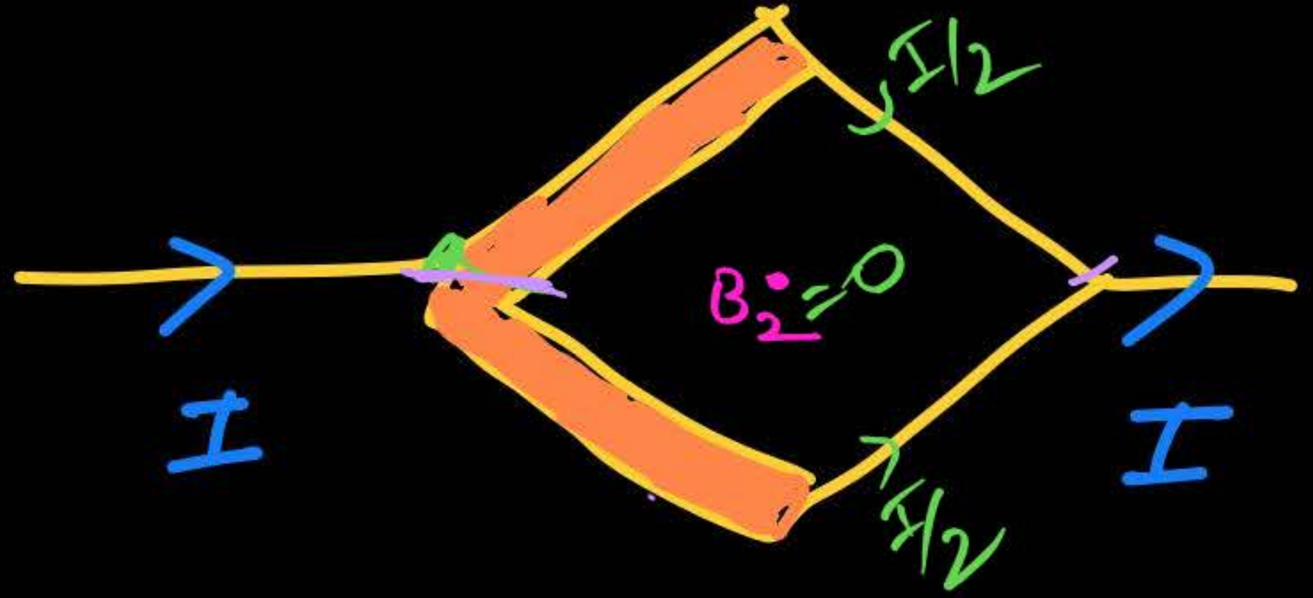
field at centre

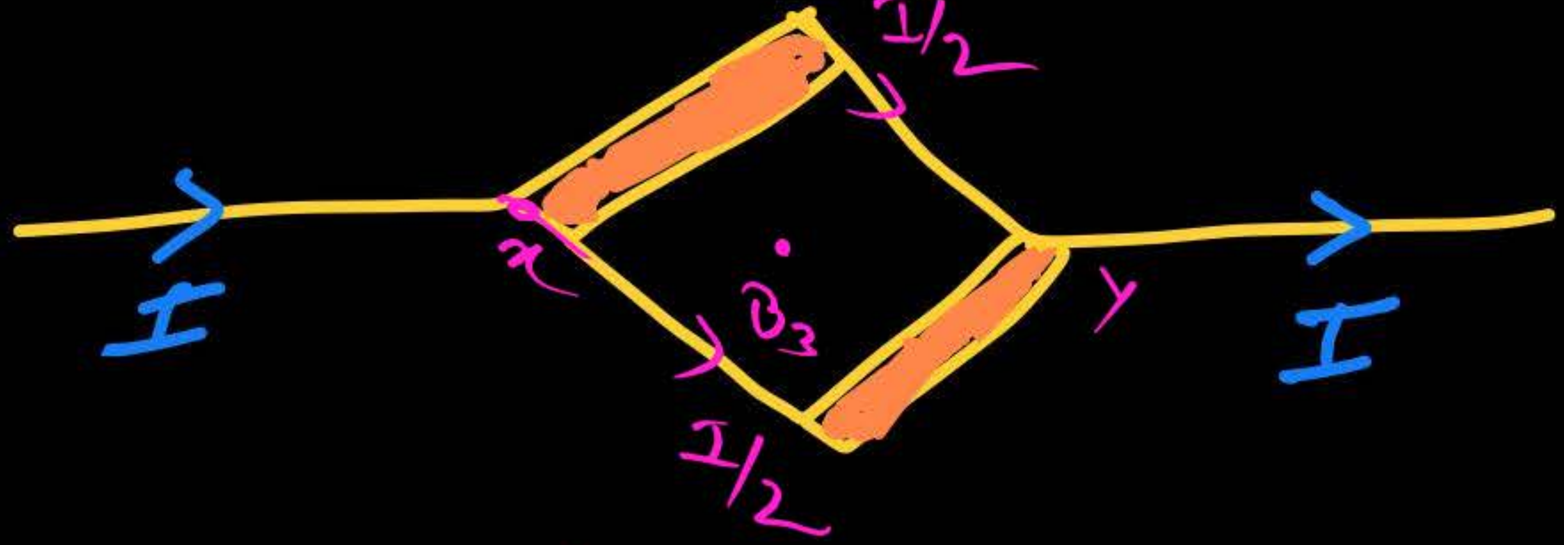





I
2I
Bnet = 0
2I
I

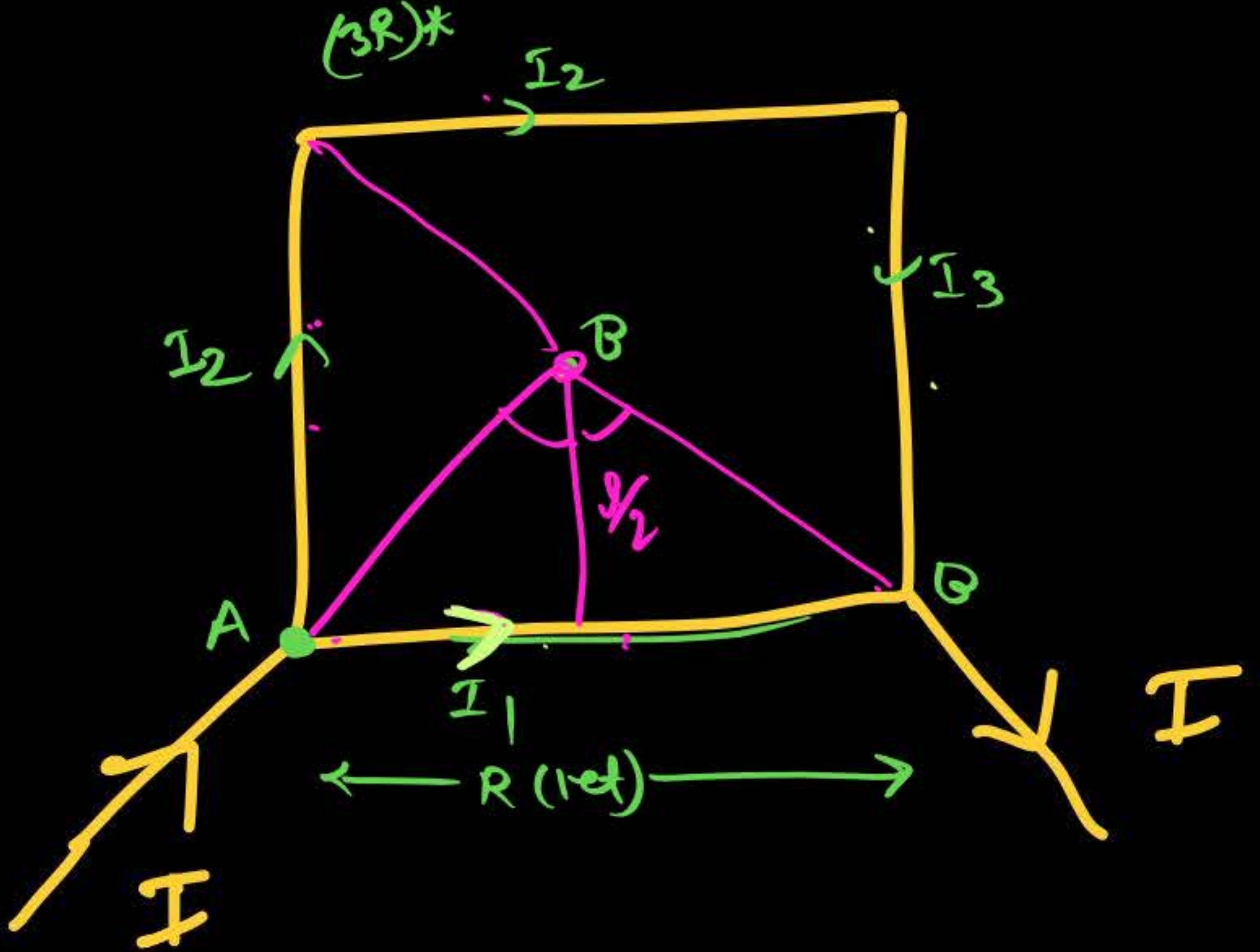






$B_3 = 0$

Find field at centre.



$$B_1 = \frac{\mu_0 3I}{4\left[\frac{l}{2}\right]}(2\sin\theta) \odot$$

57%

(a) B_0 = Non zero

(b) B_0 = zero 40%

$$B_2 = 3\left[\frac{\mu_0 I}{4\frac{l}{2}} 2\sin\theta\right] \otimes$$

$B_1 = B_2$ dir oppo.

$V = IR$ = Same

$I_1 R = I_2 3R$

$I_1 = 3I_2$

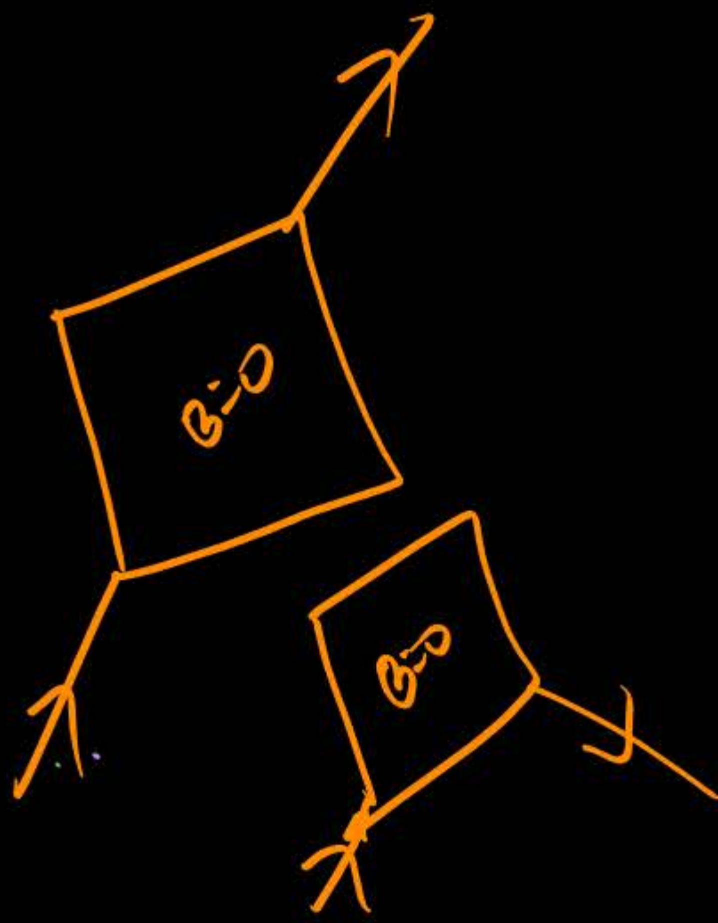
$I = I_1 + I_2$

$I = 3I_2 + I_2$

$4I_2 = I$

$I_2 = I/4$

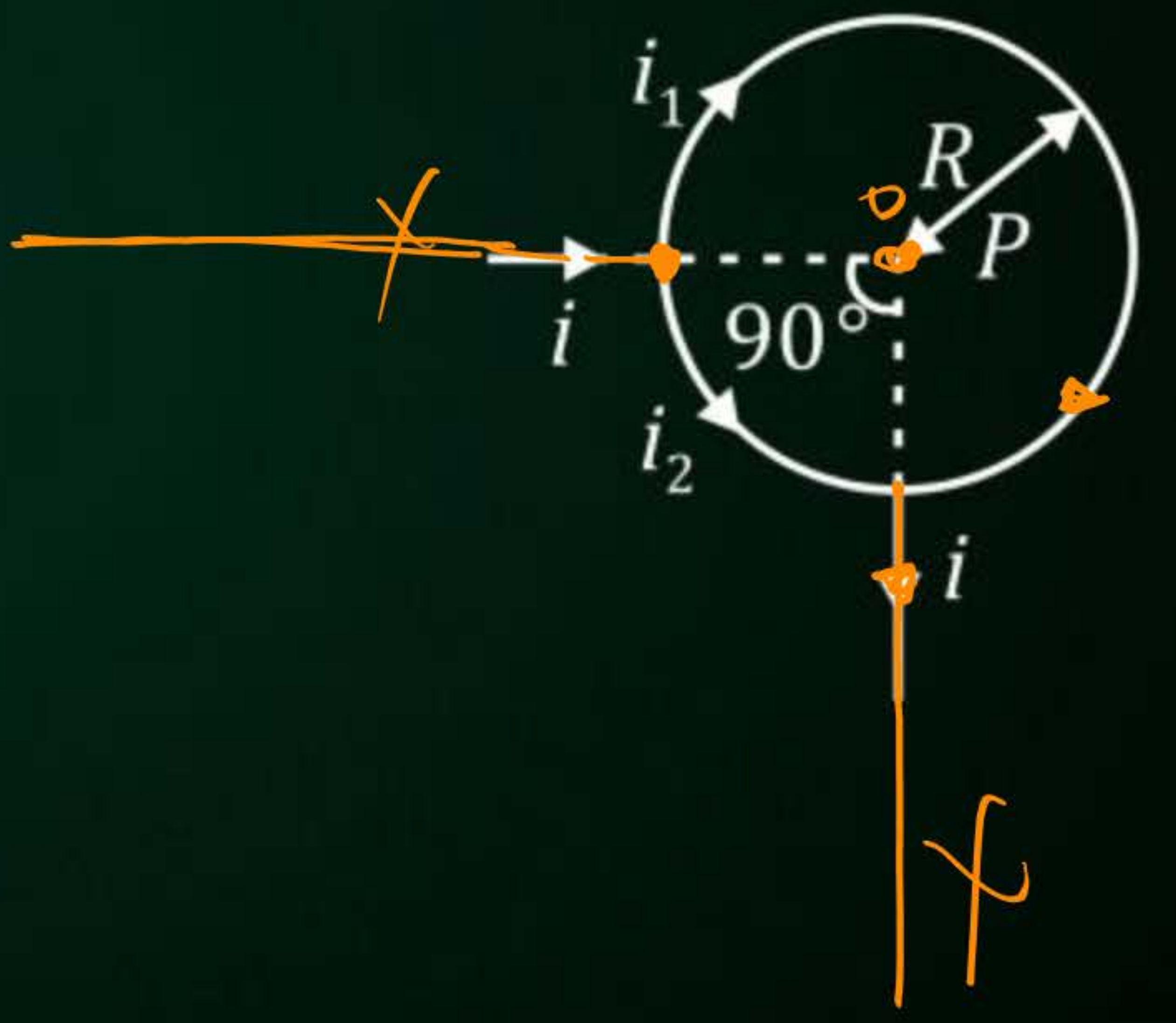
$I_1 = 3I/4$

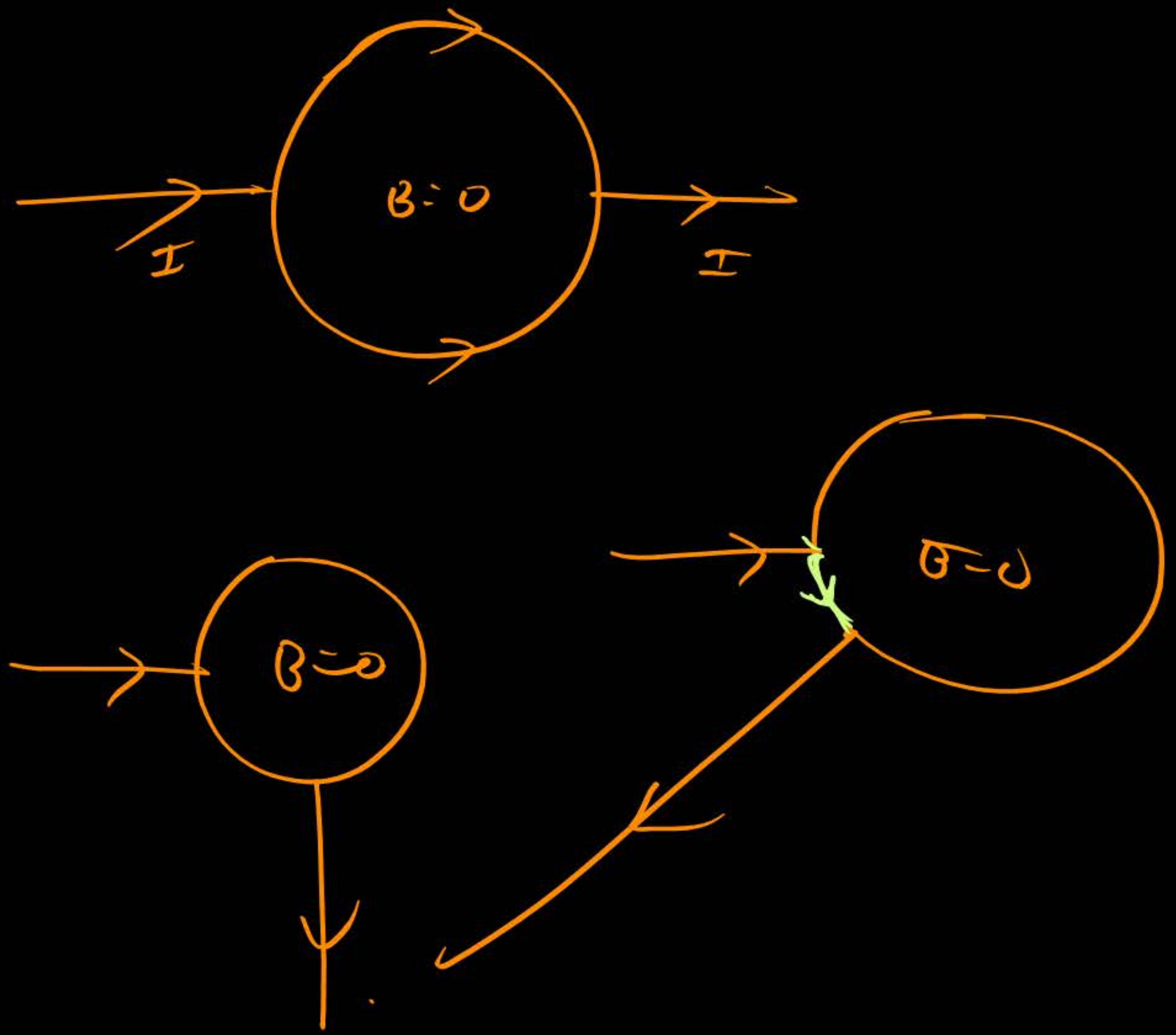


QUESTION

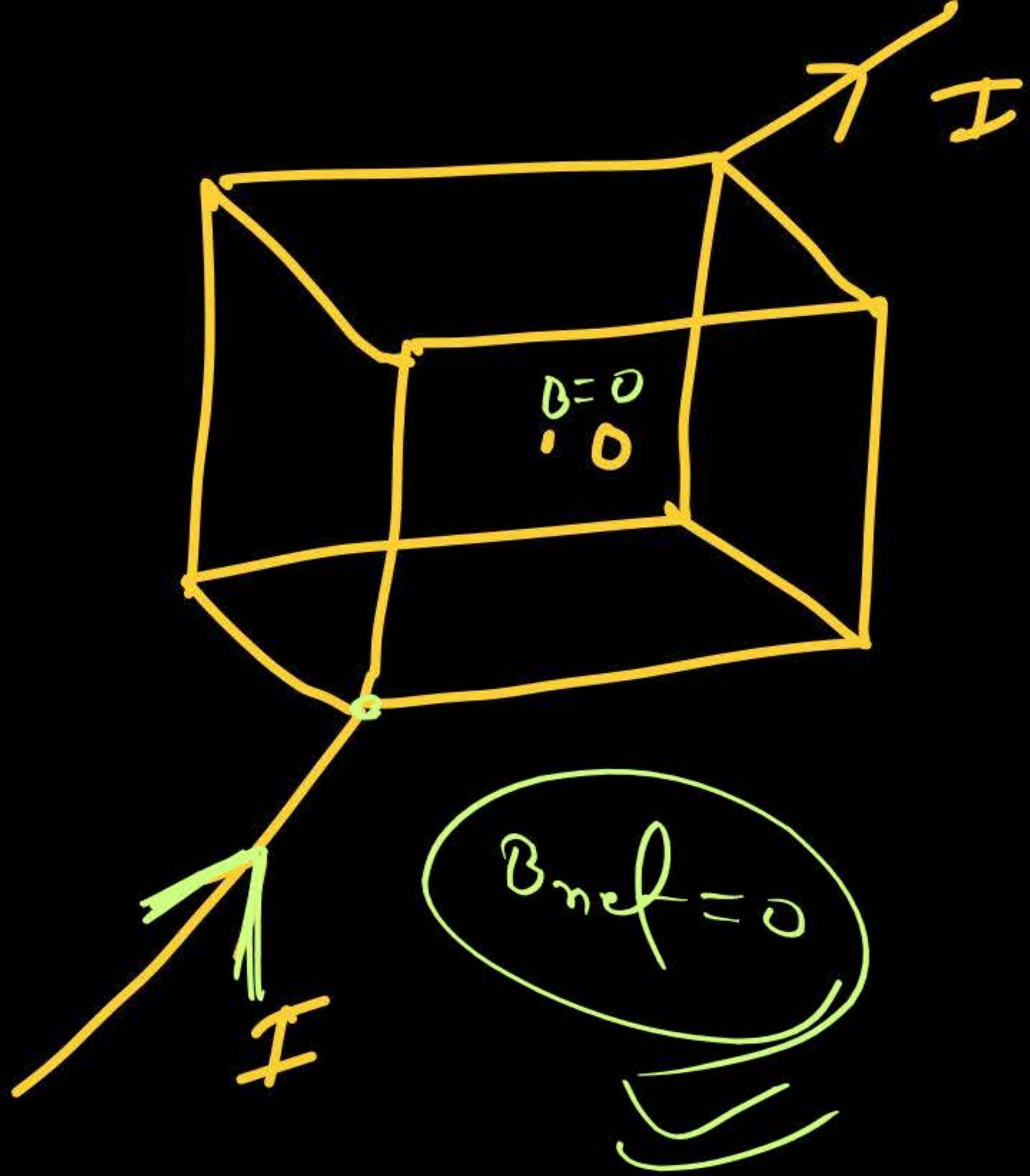
A straight conductor carrying current i splits into two parts as shown in the figure. The radius of the circular loop is R. The total magnetic field at the centre P at the loop is [NEET 2019]

1. Zero
2. $3\mu_0 i/32R$, outward
3. $3\mu_0 i/32R$, inward
4. $\frac{\mu_0 i}{2R}$, inward




B=0
I
I
B=0
B=0

Find field at centre of cube.

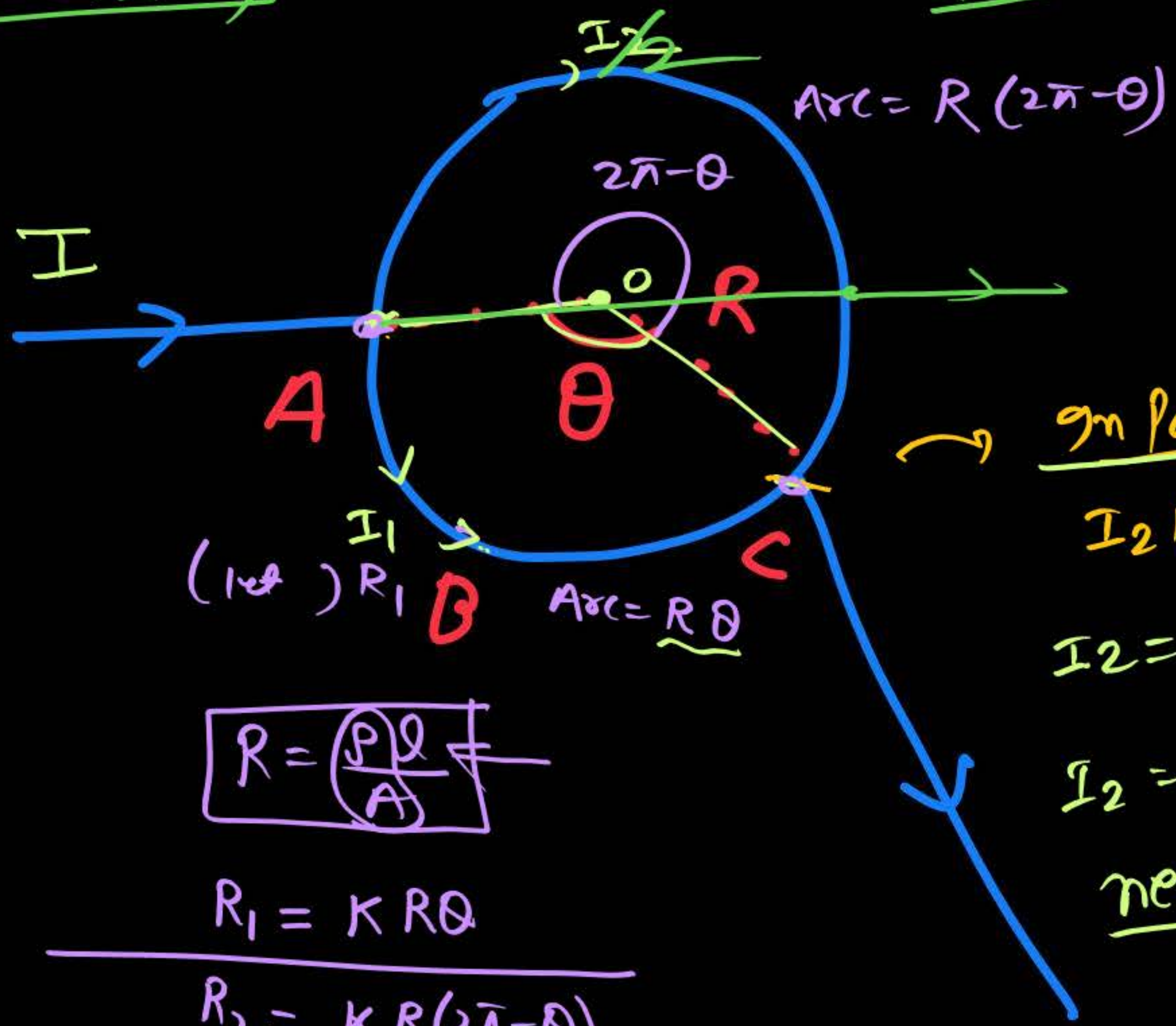


Find field due to Arc ABC

$$B = \frac{\mu_0 I}{4R \times 2}$$

If $\theta = \pi$

$$B = \frac{\mu_0 I}{8R}$$



$$R = \frac{\rho l}{A}$$

$$R_1 = K R\theta$$

$$R_2 = K R(2\pi - \theta)$$

$$\frac{R_1}{R_2} = \frac{\theta}{2\pi - \theta} \quad \text{--- (1)}$$

In Parallel comb^n

$$I_2 R_2 = I_1 R_1$$

$$I_2 = I_1\left(\frac{R_1}{R_2}\right)$$

$$I_2 = I_1\left(\frac{\theta}{2\pi - \theta}\right)$$

net current

$$I = I_1 + I_2$$

$$= I_1 + I_1\left(\frac{\theta}{2\pi - \theta}\right)$$

$$= I_1\left(\frac{2\pi - \theta + \theta}{2\pi - \theta}\right) = \frac{2\pi}{(2\pi - \theta)} I_1 = I$$

$$I_1 = \frac{I(2\pi - \theta)}{2\pi}$$

$$B_{(Arc\,ABC)} = \frac{\mu_0 I_1}{2R}\left(\frac{\theta}{2\pi}\right) \quad \text{--- (1)}$$

$$= \frac{\mu_0 I (2\pi - \theta)\theta}{4\pi R (2\pi)}$$

$$B = \frac{\mu_0 \theta (2\pi - \theta) I}{8\pi^2 R}$$

QUESTION

Two similar coils of radius R are lying concentrically with their planes at right angles to each other. The currents flowing in them are I and $2I$, respectively. The resultant magnetic field induction at the centre will be

[AIPMT (Prelims)-2012]

1. $\frac{\mu_0 I}{2R}$
2. $\frac{\mu_0 I}{R}$
3. $\frac{\sqrt{5}\mu_0 I}{2R}$
4. $\frac{3\mu_0 I}{2R}$

H/w

QUESTION

A thin ring of radius R metre has charge q coulomb uniformly spread on it. The ring rotates about its axis with a constant frequency f revolution/s. The value of magnetic field in tesla at the centre of the ring is

1. $\dfrac{\mu_0 q f}{2\pi R}$
2. $\dfrac{\mu_0 q}{2\pi f R}$
3. $\dfrac{\mu_0 q}{2 f R}$
4. $\dfrac{\mu_0 q f}{2R}$

H/W

QUESTION

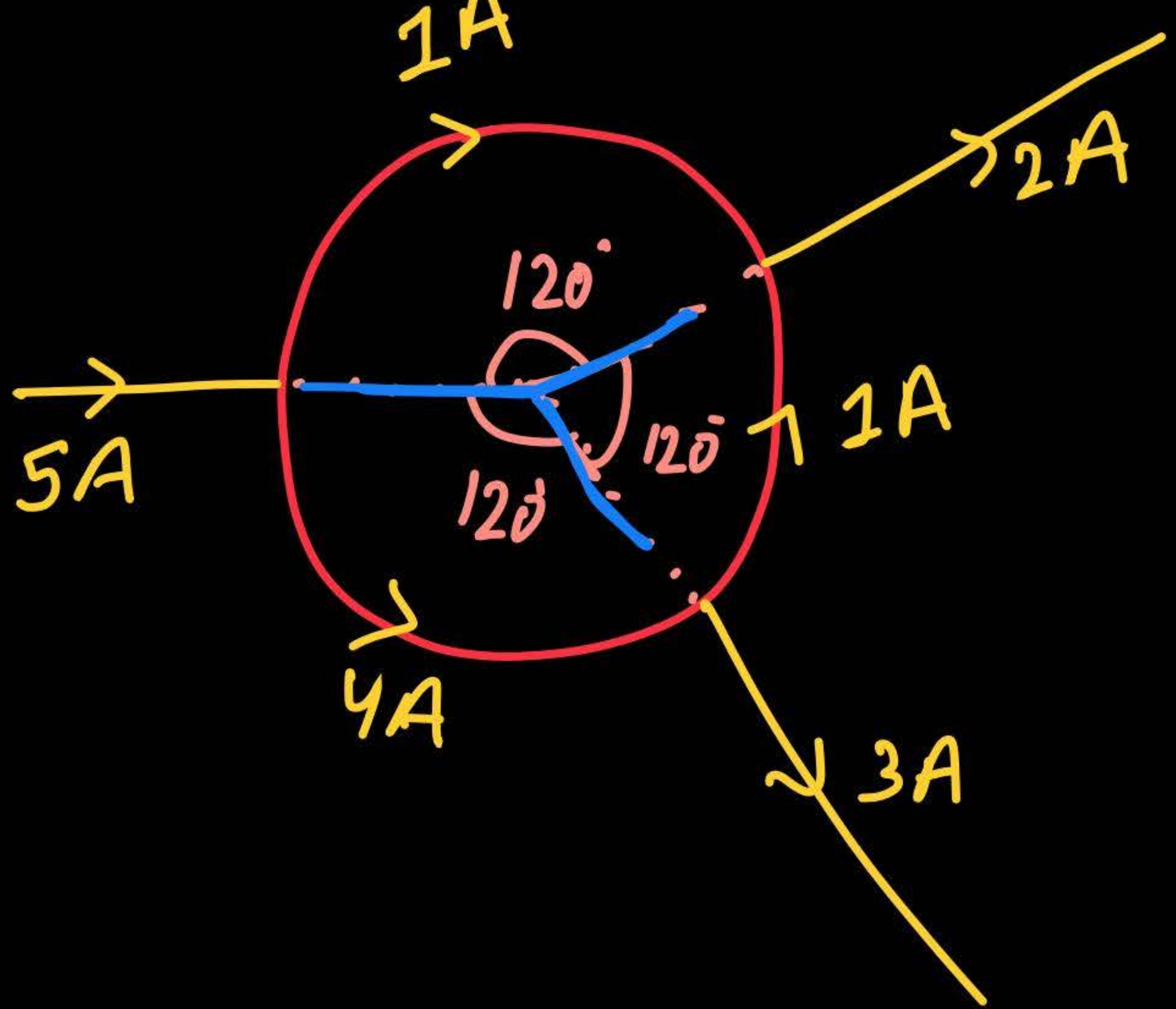
Two similar circular loops of radius R, are lying concentrically with their planes at right angles to each other. The currents flowing in them are I and $I\sqrt{3}$ respectively. The magnetic field at the centre of the coil is

1. $\frac{\mu_0 I}{2R}$
2. $\frac{\mu_0 I}{R}$
3. $\frac{4\mu_0 I}{R}$
4. $\frac{\sqrt{3}\mu_0 I}{R}$

QUESTION

Two similar coils of radius R are lying concentrically with their planes at right angles to each other. The currents flowing in them are I and $2I$, respectively. The resultant magnetic field induction at the centre will be [AIPMT (Prelims)-2012]

1. $\frac{\mu_0 I}{2R}$
2. $\frac{\mu_0 I}{R}$
3. $\frac{\sqrt{5}\mu_0 I}{2R}$
4. $\frac{3\mu_0 I}{2R}$



1A
2A
5A
120°
120°
120°
1A
4A
3A

QUESTION

Two long straight wires are placed along x-axis and y-axis. They carry current I_1 and I_2 respectively. The equation of locus of zero magnetic induction in the magnetic field produced by them is

1. $y = x$
2. $y = \left(\frac{I_2}{I_1}\right)x$
3. $y = \left(\frac{I_1}{I_2}\right)x$ H/W
4. $y = (I_1 I_2)\, x$


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 03 | Physics

Moving Charges and Magnetism

By- Dr. Manish Raj (MR SIR)

Todays Goal
↳ magnetic field on axis of circul loop.
→ Ampers circuital law

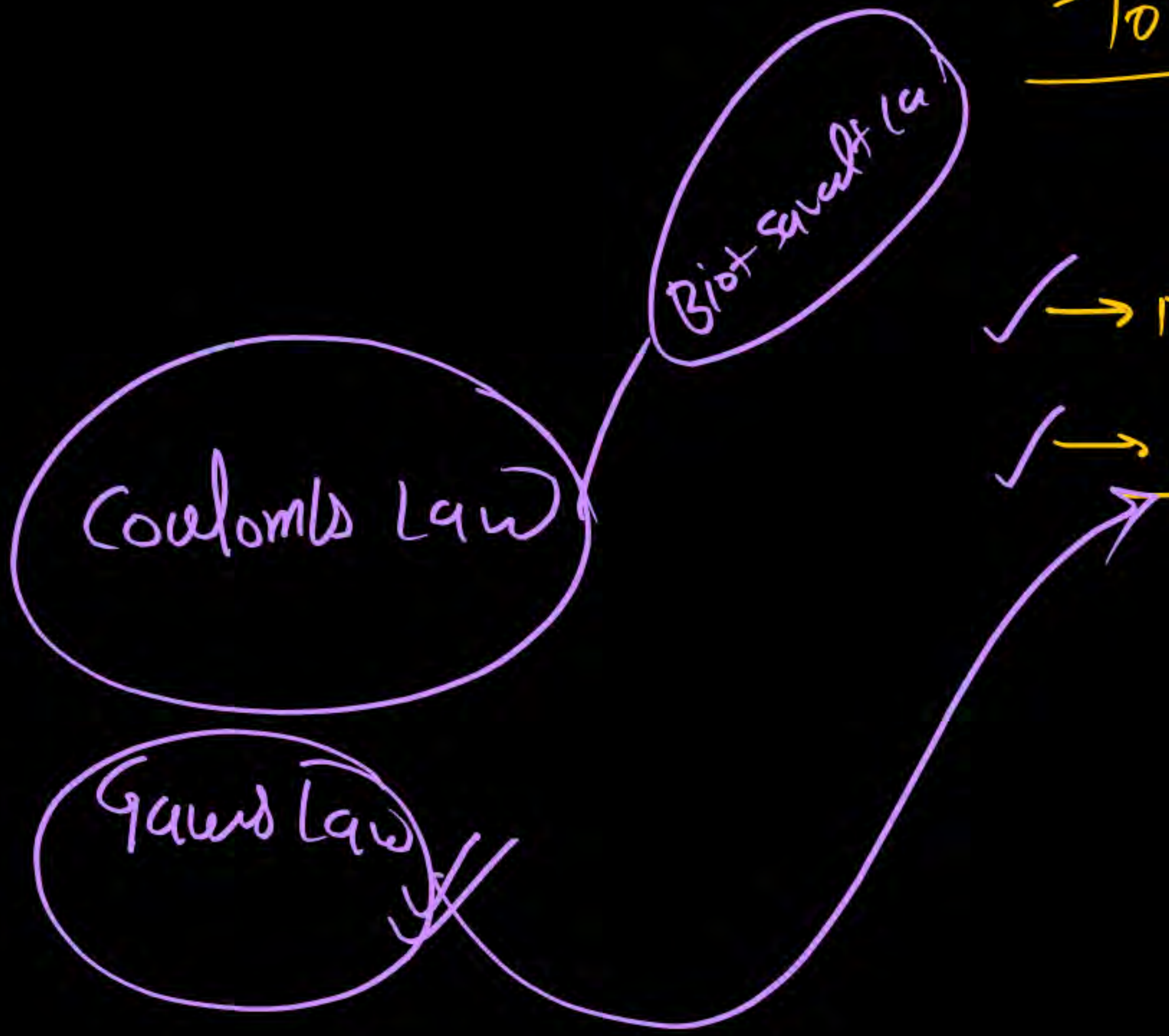


Todays Goal

H/W

✓ → magnetic field on axis of circular loop.

✓ → Amperes circuital law



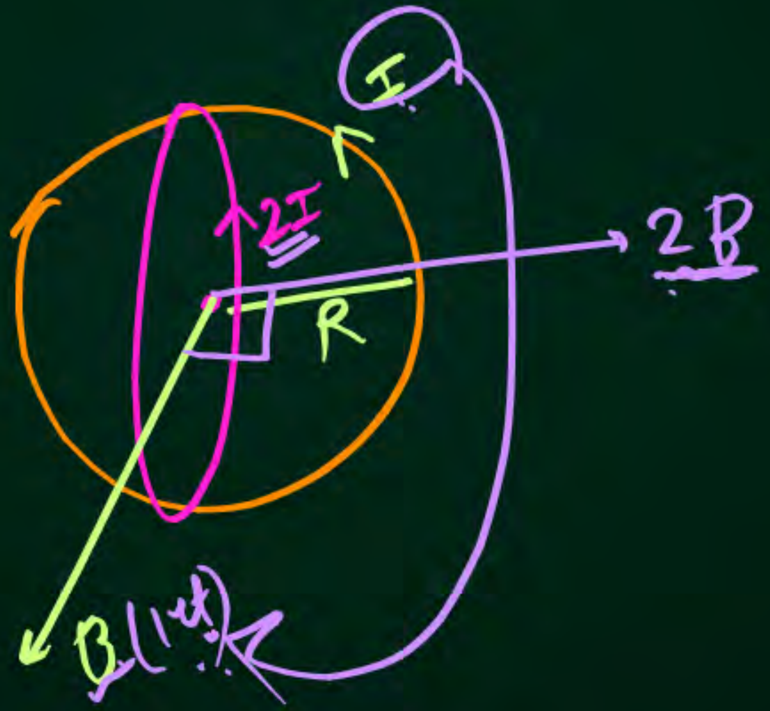

@MRPHYSICSS

QUESTION

Two similar coils of radius R are lying concentrically with their planes at right angles to each other. The currents flowing in them are I and $2I$, respectively. The resultant magnetic field induction at the centre will be

[AIPMT (Prelims)-2012]

1. $\frac{\mu_0 I}{2R}$
2. $\frac{\mu_0 I}{R}$
3. $\frac{\sqrt{5}\mu_0 I}{2R}$
4. $\frac{3\mu_0 I}{2R}$



$B_{net} = \sqrt{B^2 + (2B)^2}$

$= \sqrt{B^2 + 4B^2}$

$= \sqrt{5B^2}$

$= \sqrt{5} \times B$

$= \sqrt{5}\left[\frac{\mu_0 I}{2R}\right]$

QUESTION

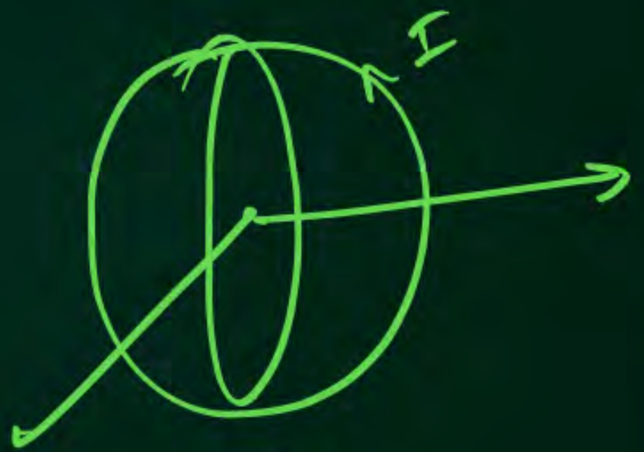
Two similar circular loops of radius R, are lying concentrically with their planes at right angles to each other. The currents flowing in them are I and $I\sqrt{3}$ respectively. The magnetic field at the centre of the coil is

1. $\frac{\mu_0 I}{2R}$

2. $\frac{\mu_0 I}{R}$

3. $\frac{4\mu_0 I}{R}$

4. $\frac{\sqrt{3}\mu_0 I}{R}$



$B = \frac{\mu_0 I}{2R}$ Let

$\sqrt{3}\frac{I\mu_0}{2R} = \sqrt{3}B$

$B_{net} = \sqrt{B^2 + 3B^2}$

$= \sqrt{4B^2}$

$= 2B$

QUESTION

Charge q is uniformly spread on a thin ring of radius R. The ring rotates about its axis with a uniform frequency f Hz. The magnitude of magnetic induction at the center of the ring is

[AIPMT (Mains)-2011]

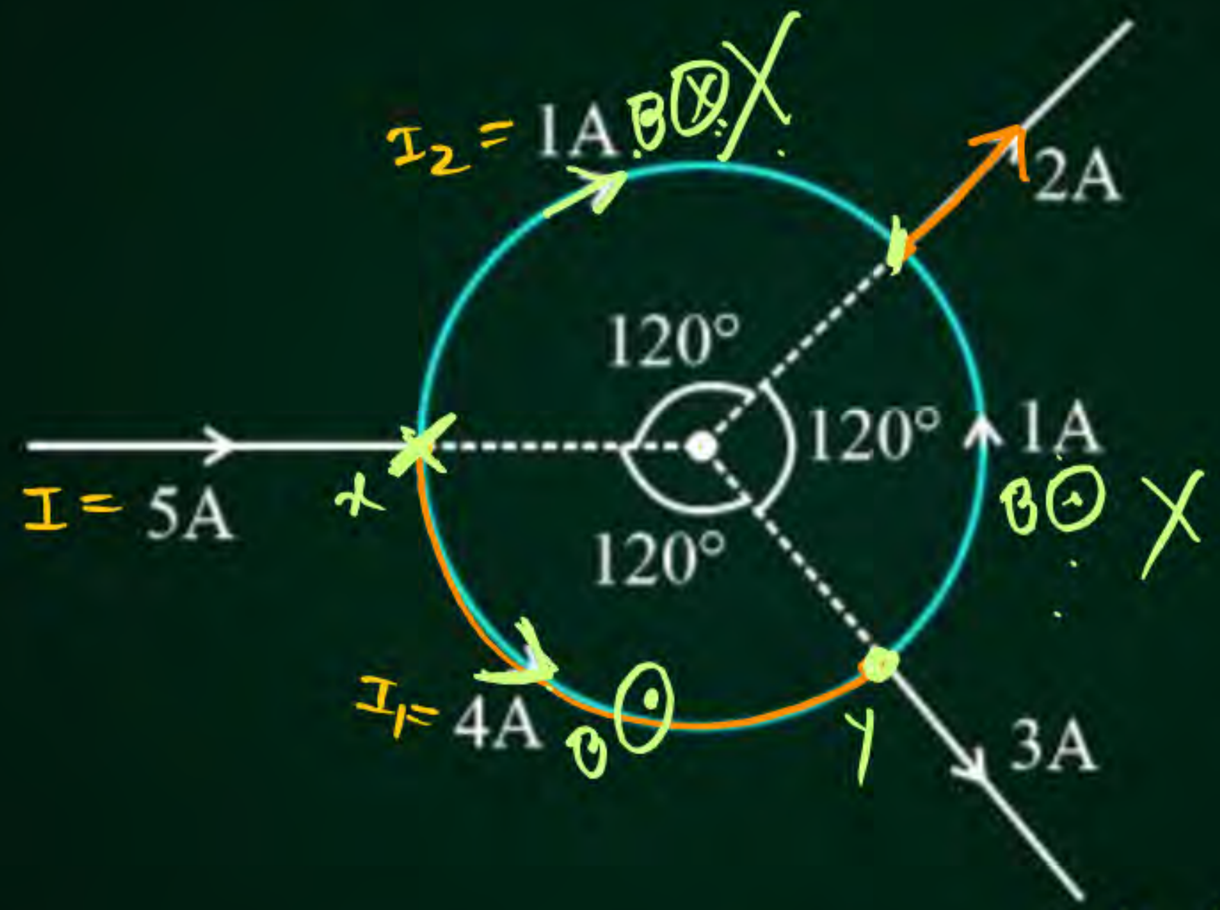
1. $\frac{\mu_0 q}{2\pi f R}$
2. $\frac{\mu_0 q f}{2\pi R}$
3. $\frac{\mu_0 q f}{2R}$ Ans
4. $\frac{\mu_0 q}{2fR}$



$$I_{Avg} = \frac{\Delta Q}{\Delta T} = \frac{q}{T} = qf$$

$$B = \frac{\mu_0 I}{2R} = \frac{\mu_0 q f}{2R} = \frac{\mu_0 q f}{2R}$$

find field at centre



(a) $B_{net} = 0$ ✗

(b) $B_{net} \neq 0$ ✓

$$B = \frac{\mu_0 I}{2R}\left(\frac{\theta}{2\pi}\right)$$

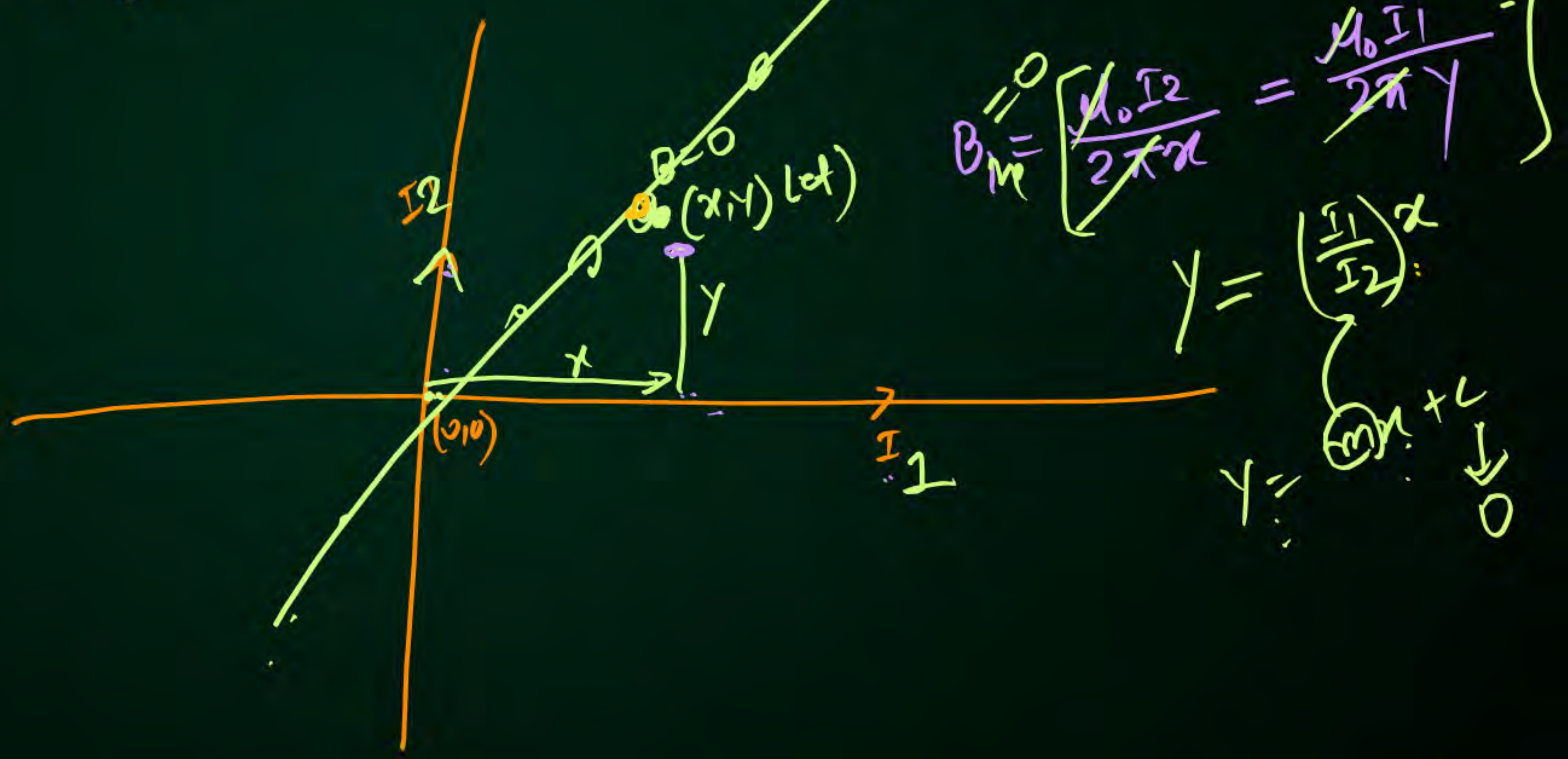
$$B_{net} = \frac{\mu_0 (4A)}{2(R)} \times \left(\frac{2\pi}{3(2\pi)}\right)$$

$$= \frac{4\mu_0}{6R} \text{ Ans.}$$

QUESTION

Two long straight wires are placed along x-axis and y-axis. They carry current I_1 and I_2 respectively. The equation of locus of zero magnetic induction in the magnetic field produced by them is

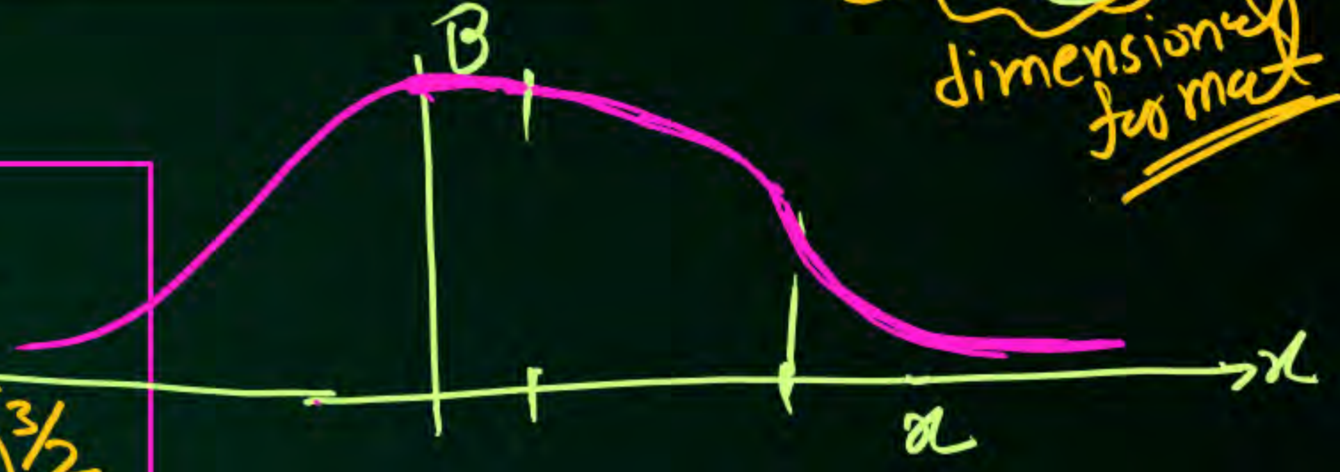
1. $y = x$
2. $y = \left(\frac{l_2}{l_1}\right)x$
3. $y = \left(\frac{l_1}{l_2}\right)x$
4. $y = (l_1\, l_2)\, x$



Magnetic Field on the Axis of Circular Loop



$$B = \frac{\mu_0 I R^2}{2(R^2+x^2)^{3/2}}$$



$B = \frac{\mu_0 I}{2R}$ dimensional format

If $x = 0$

$$B = \frac{\mu_0 I R^2}{2(R^2)^{3/2}}$$

Centre $B = \frac{\mu_0 I R^2}{2R^3} = \frac{\mu_0 I}{2R}$

If $x <<< R$

$$B = \frac{\mu_0 I}{2R}$$

$x >>>> R$

$$B = \frac{\mu_0 I R^2}{2(x^2)^{3/2}}$$

$$B = \frac{\mu_0 I R^2}{2x^3}$$

$B \propto \frac{1}{x^3}$ *

find magnetic field at distance $x = \sqrt{3}R$ ~~from~~ centre of ring.

$$[4R^2]^{\frac{1}{2}\times 3} = [2R]^3$$

M.R. Biyoyoya

$$B = \frac{\mu_0 I R^2}{2(R^2+x^2)^{3/2}}$$

$$B = \frac{\mu_0 I R^2}{2(R^2+3R^2)^{3/2}}$$

$$= \frac{\mu_0 I R^2}{2[4R^2]^{3/2}} = \frac{\mu_0 I R^2}{2(2R)^3} = \frac{\mu_0 I R^2}{2\times 8\times R^2 R} = \frac{\mu_0 I}{16R}$$

$$\frac{B_0}{8}$$

Ans

QUESTION

The magnetic field at the centre of a current carrying circular coil of radius 10 cm is $5\sqrt{5}$ times the magnetic field at a point on its axis. The distance of the point from the centre of the coil (in cm) is

1. 5
2. 10
3. 20
4. 25

$R = 10\text{ cm}$

$B_0 = 5\sqrt{5}\, B_{axis}$ $(x = ??)$

$B_0 = 5\sqrt{5}\, B_{axis}$

$\frac{\mu_0 I}{2R} = 5\sqrt{5} \frac{\mu_0 I R^2}{2(R^2+x^2)^{3/2}}$

$(R^2+x^2)^{3/2} = 5\sqrt{5} R^3$

$(R^2+x^2)^3 = 25 \times 5 R^6$

$(R^2+x^2) = (125 R^6)^{1/3} = 5R^2$

$(125)^{1/3} = (5)^{3 \times \frac{1}{3}} = 5$

$R^2 + x^2 = 5R^2$

$x^2 = 4R^2$

$x = \sqrt{4R^2}$

$x = 2R$

$x = 2 \times 10 = 20\text{ cm}$

QUESTION

A circular coil carrying a certain current produces a magnetic field B_0 at its centre. The coil is now rewound so as to have 3 turns and the same current is passed through it. The new magnetic field at the centre is

1. $\frac{B_0}{9}$
2. $9B_0$
3. $\frac{B_0}{3}$
4. $3B_0$



QUESTION

At what distance on the axis, from the centre of a circular current carrying coil of radius r, the magnetic field becomes $1/8^{\text{th}}$ of the magnetic field at centre?

1. $\sqrt{2}r$
2. $2^{3/2}\,r$
3. $\sqrt{3}r$ ✓
4. $3\sqrt{2}$

$$B_{axis} = \frac{B_0}{8}$$

$$\frac{\mu_0 I R^2}{2(R^2+x^2)^{3/2}} = \frac{1}{8}\frac{\mu_0 I}{2R}$$

$$8R^3 = (R^2+x^2)^{3/2}$$

$$(8R^3)^{1/3} = (R^2+x^2)^{1/2}$$

$$2R = (R^2+x^2)^{1/2}$$

$$4R^2 = R^2+x^2$$

$$3R^2 = x^2$$

$$x = \sqrt{3}R$$

Gauss Law

$\phi = \oint \vec{E} \cdot d\vec{S} = \frac{q_{in}}{\varepsilon_0}$

$d\vec{S}$ → Area element of gausian surface.

ϕ = flux through close surface

q_{in} = only enclosed charge by gaussian surface

→ Ex – Ring ✗ square loop ✗ disc ✗
→ sphere, cylinder, cube ✓

E = due to Inside and outside charge

Gauss law is valid & applicable ✓

Gauss law is alway applicable to calculate electric field ✗
↳ only for symmetric charge distribution ✓

Ampers circuital law

$\oint \vec{B} \cdot d\vec{l} = \mu_0 I_{in}$

$d\vec{l}$ → vector

→ This is not magnetic flux.

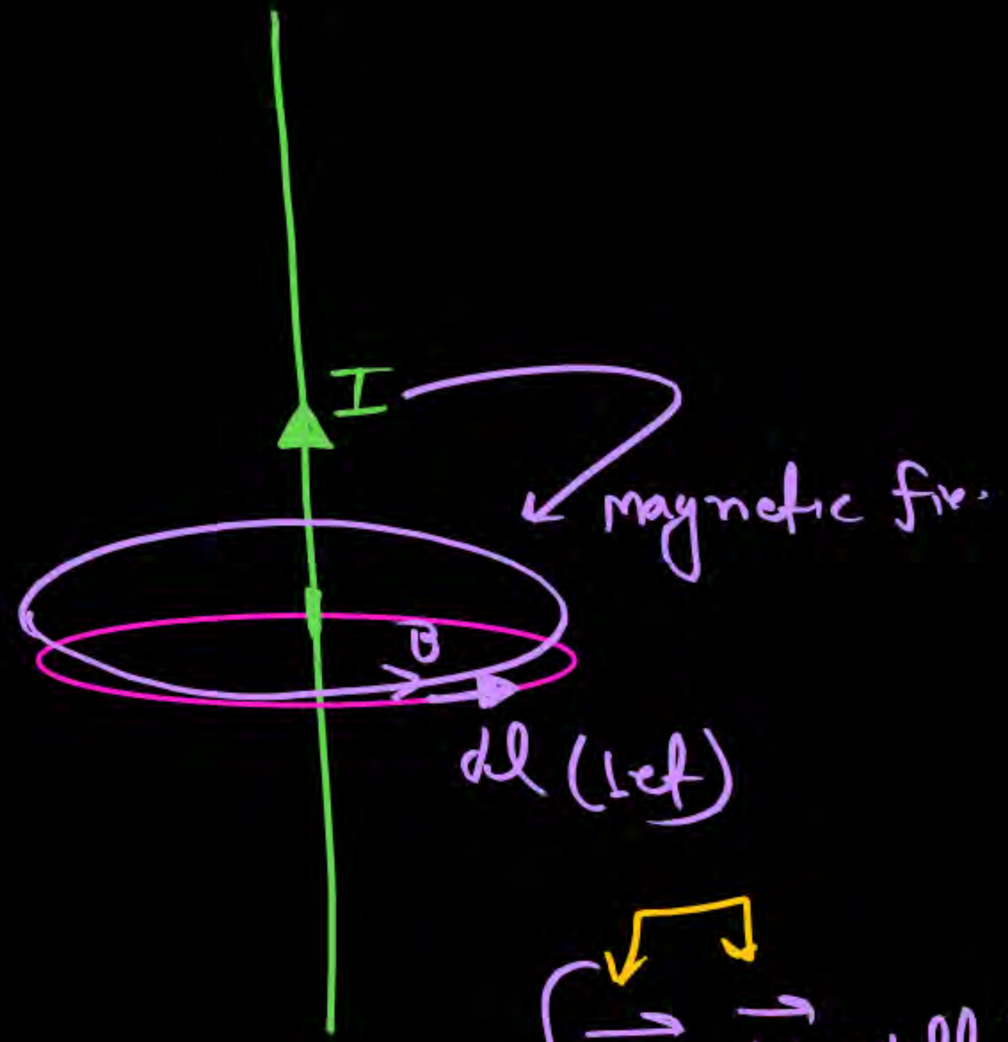
dl → small length element of Amperian loop.

Amperian loop → Ring ✓, square loop ✓
sphere ✗ disc ✗
cube ✗
cylinder ✗

I_{in} = only enclosed current.

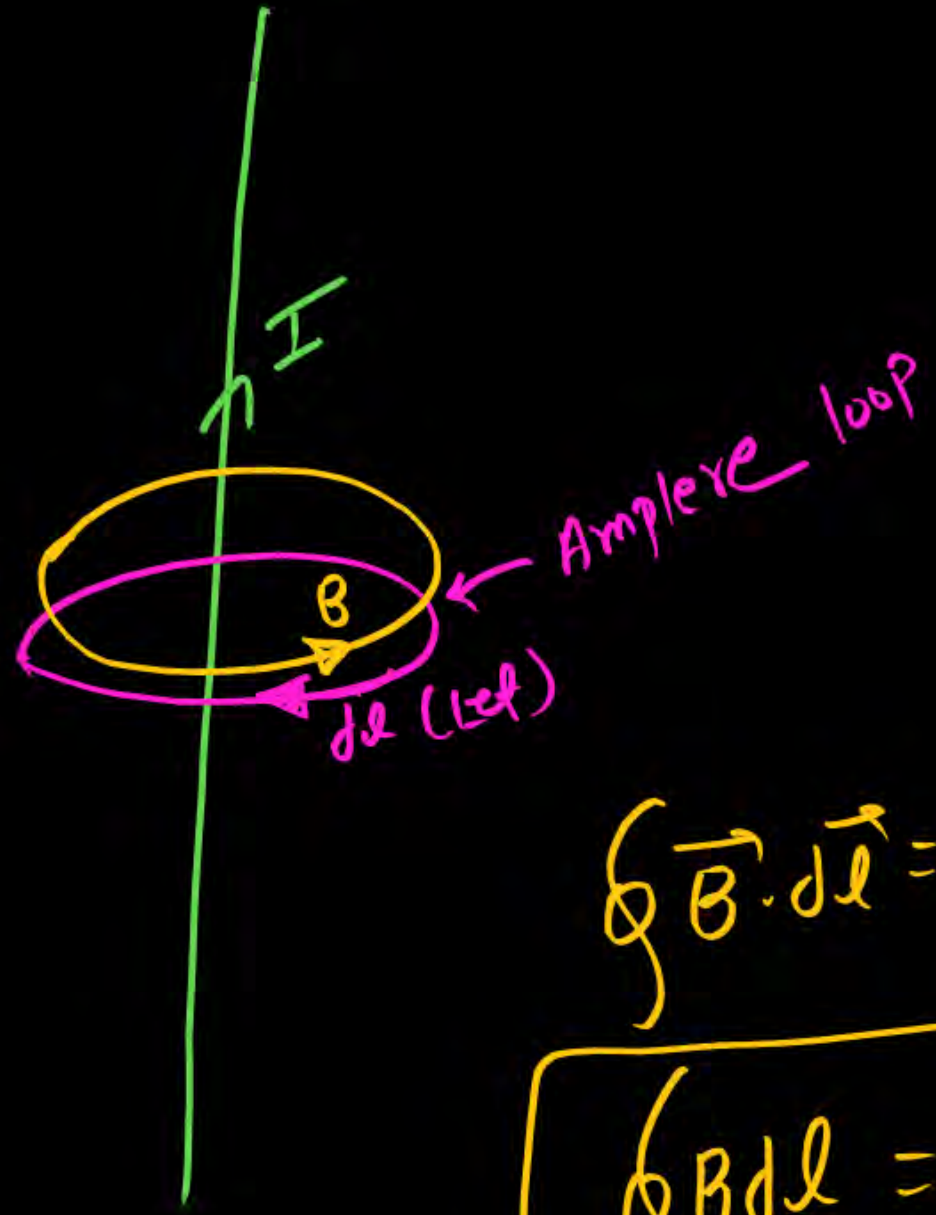
B = magnetic field due to all current.

* always valid, always applicable
↳ but only applicable to calculate magnetic field for symmetric current distribution.



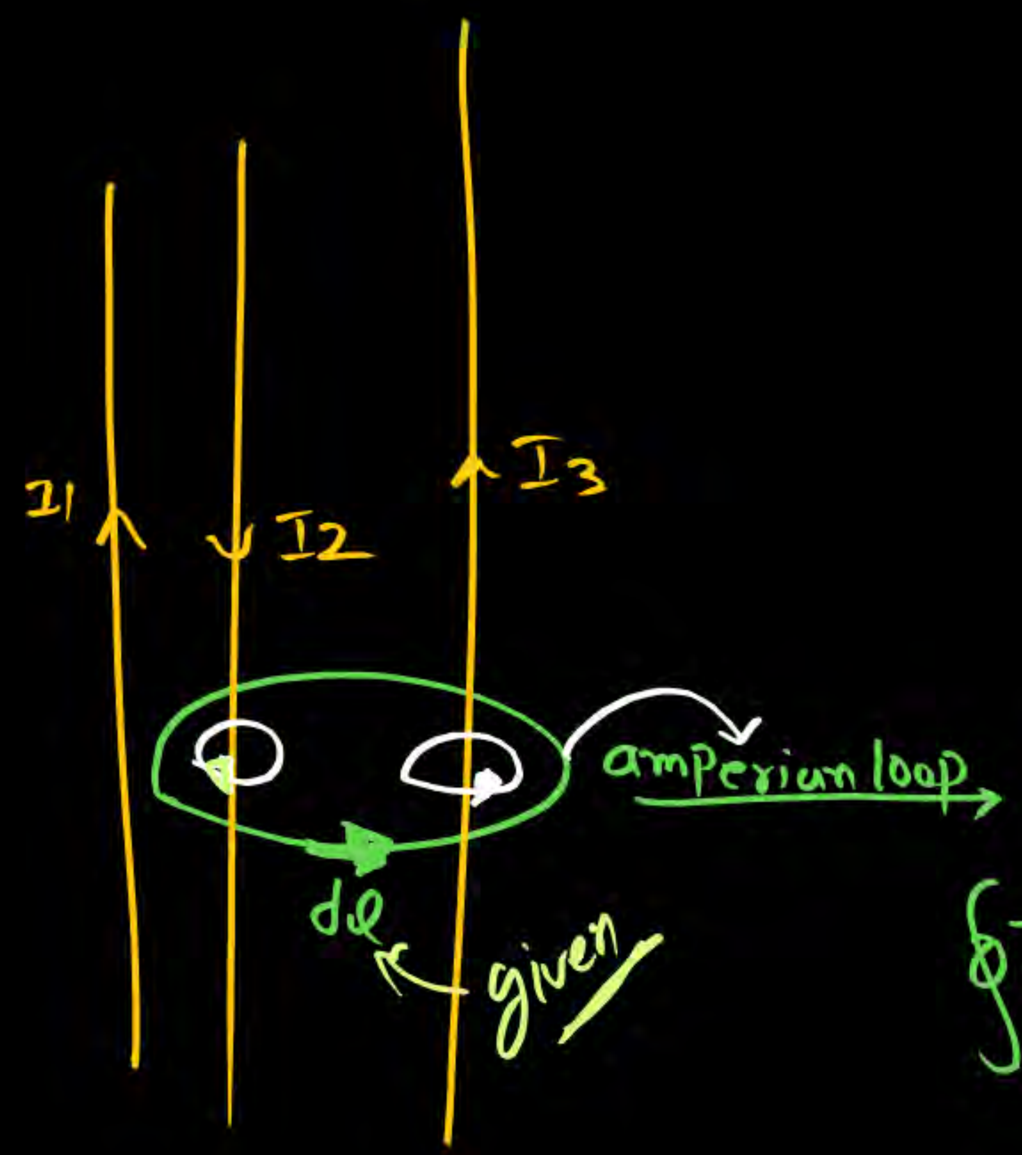
$$\oint \vec{B}\cdot\vec{dl} = +\mu_0 I_{in}$$

$$\oint \vec{B}\,\vec{dl} = \mu_0 I$$



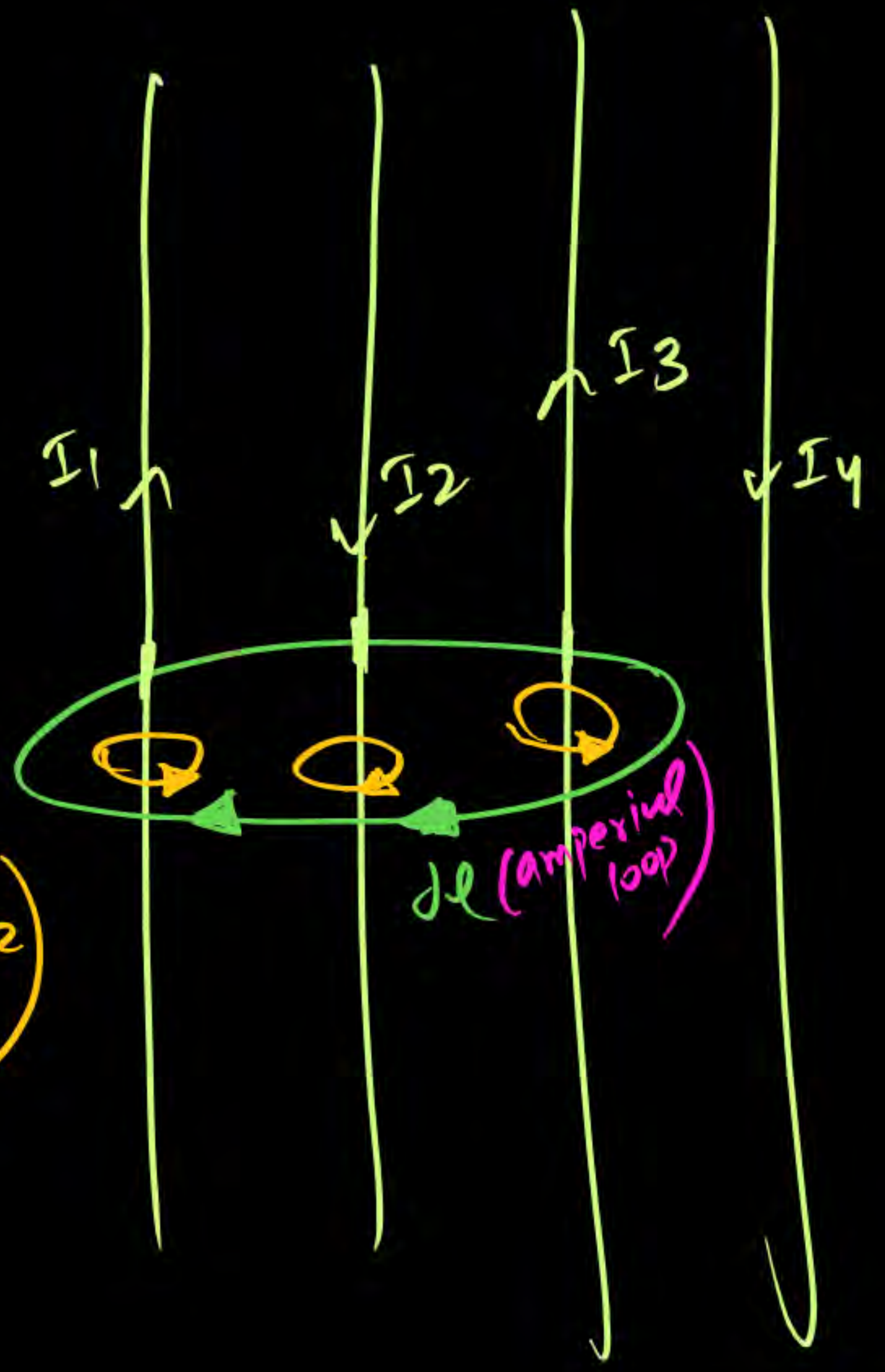
$$\oint \vec{B}\cdot\vec{dl} = \mu_0 I_{in}$$

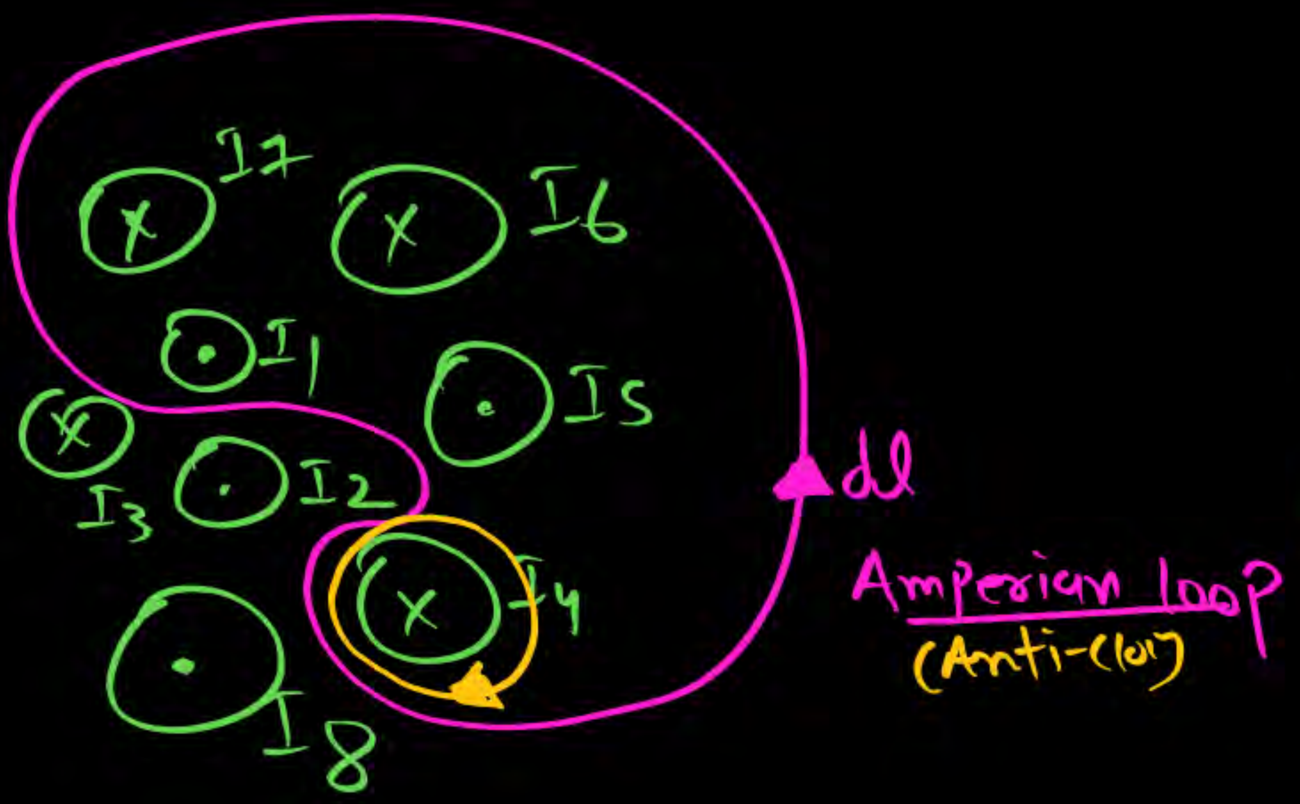
$$\boxed{\oint B\,dl = -\mu_0 I}$$



$$\oint \vec{B} \cdot d\vec{l} = \mu_0 (I_3 - I_2)$$

$$\oint \vec{B} \cdot d\vec{l} = \mu_0 \left[-I_1 - I_3 + I_2 \right)$$





Ampere circuital Law

$$\oint \vec{B} \cdot \vec{dl} = \mu_0 \left[I_1 + I_5 - I_6 - I_7 - I_4 \right]$$

$$\oint \vec{B}\cdot d\vec{l} = -\mu_0 I_2$$

$$\oint \vec{B}\cdot d\vec{l} = \mu_0\left[I_3 - I_4\right]$$

$$\oint \vec{B}\cdot d\vec{l} = +\mu_0 I_5$$



$$\oint \vec{B}\cdot \vec{dl} = \mu_0 I_1$$

Step to calculate magnetic field using Ampere circuital law

(1) Draw close symmetric Amperian loop ✓

(2) That loop must be passing through point where field have to be calculated

(3) Value of $\vec{B}$ must be constant at all point of loop ✓

(4) Angle b/w $\vec{dl}$ & $\vec{B}$ must be $0°, 180°, 90°$ ✓

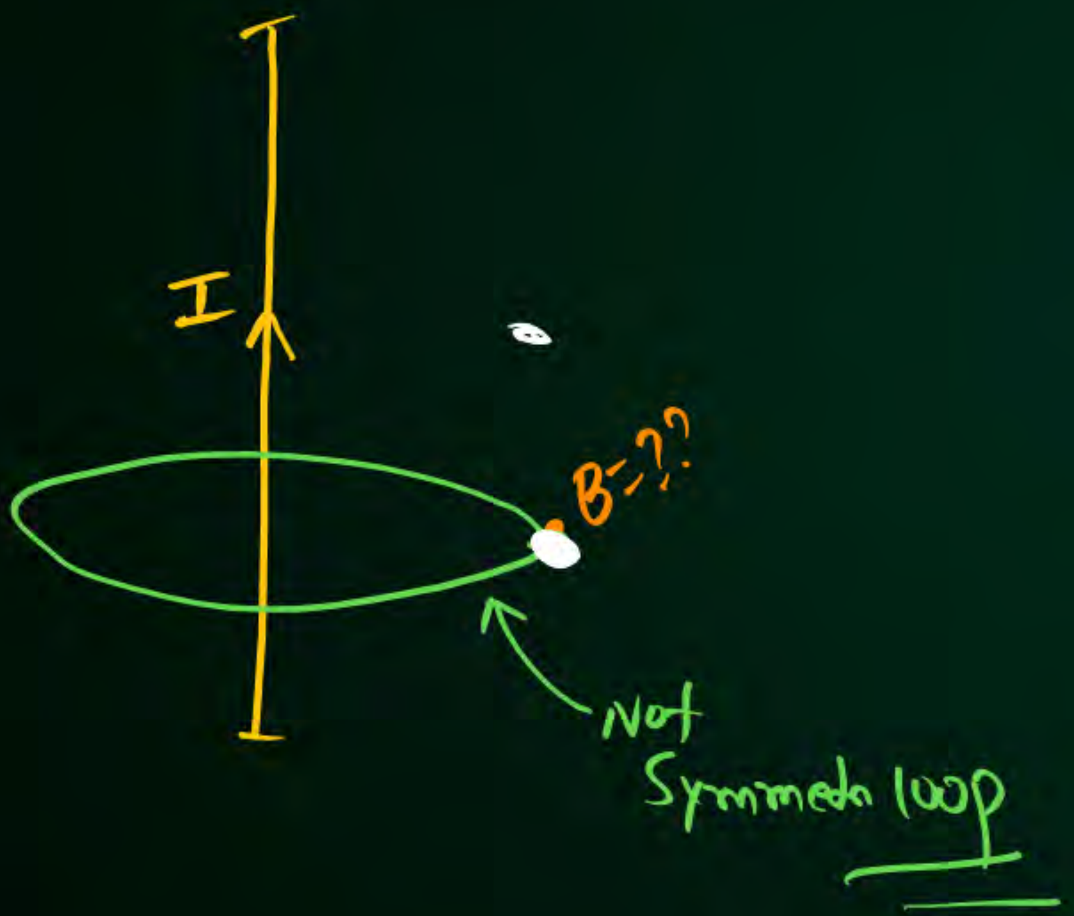
(5) apply $\oint \vec{B} \cdot \vec{dl} = \mu_0 I_{in}$

Ampere Circuital Law

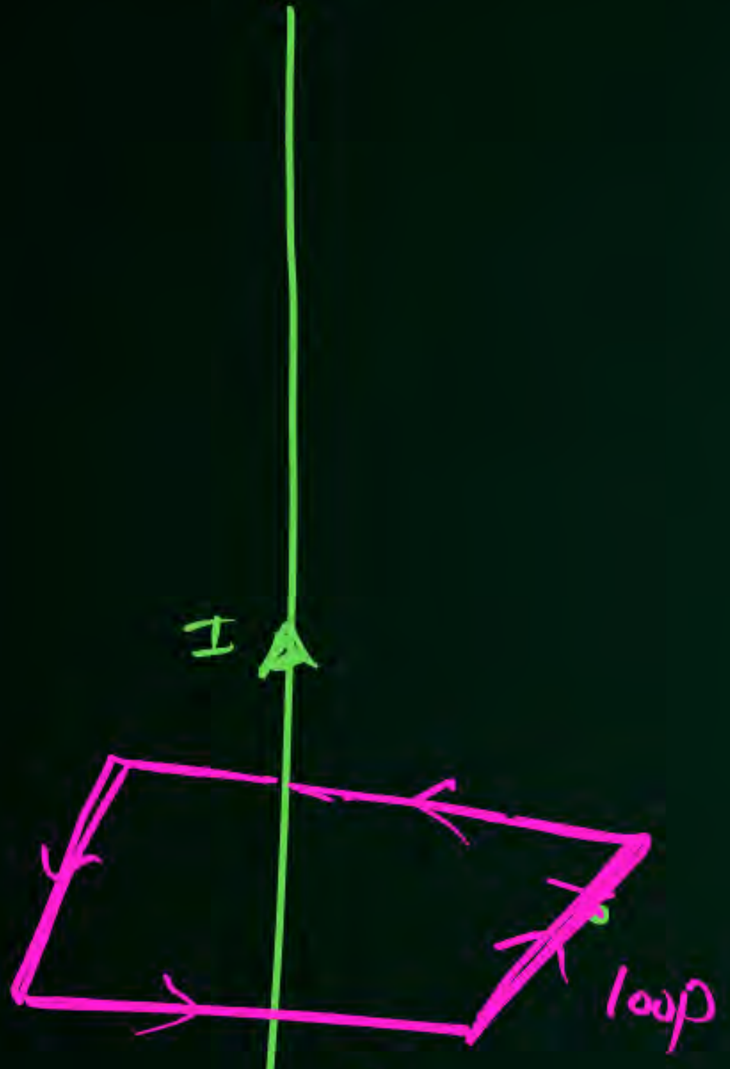
⇒ **Gauss Law:**

⇒ Magnetic Field due to finite Straight wire

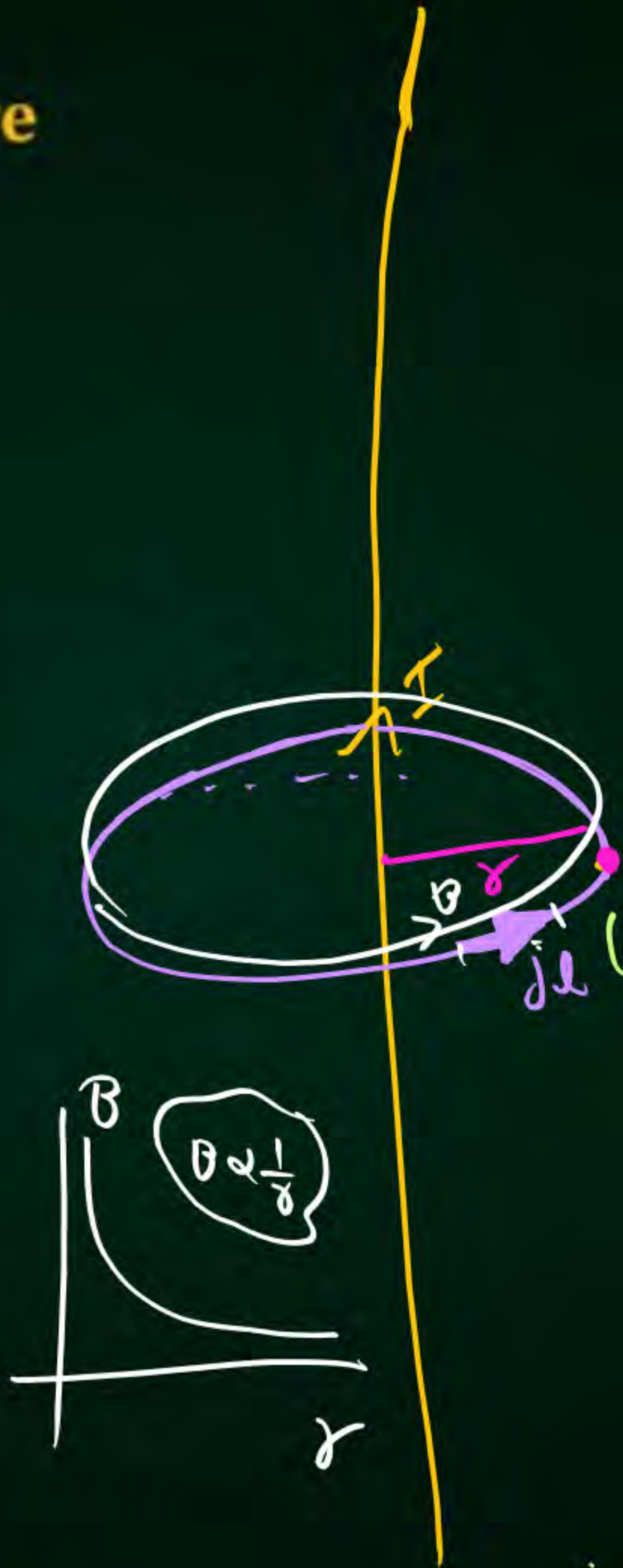
Amperes circuit law is valid for finite wire; but Not applicable to calculate field due to finite wire.



⇒ Magnetic Field due to Infinite Straight wire



↑ This is not symmetric with wire ✗



(Close symmetric Amperian loop)

$$\oint \vec{B} \cdot d\vec{l} = \mu_0 I_{in}$$

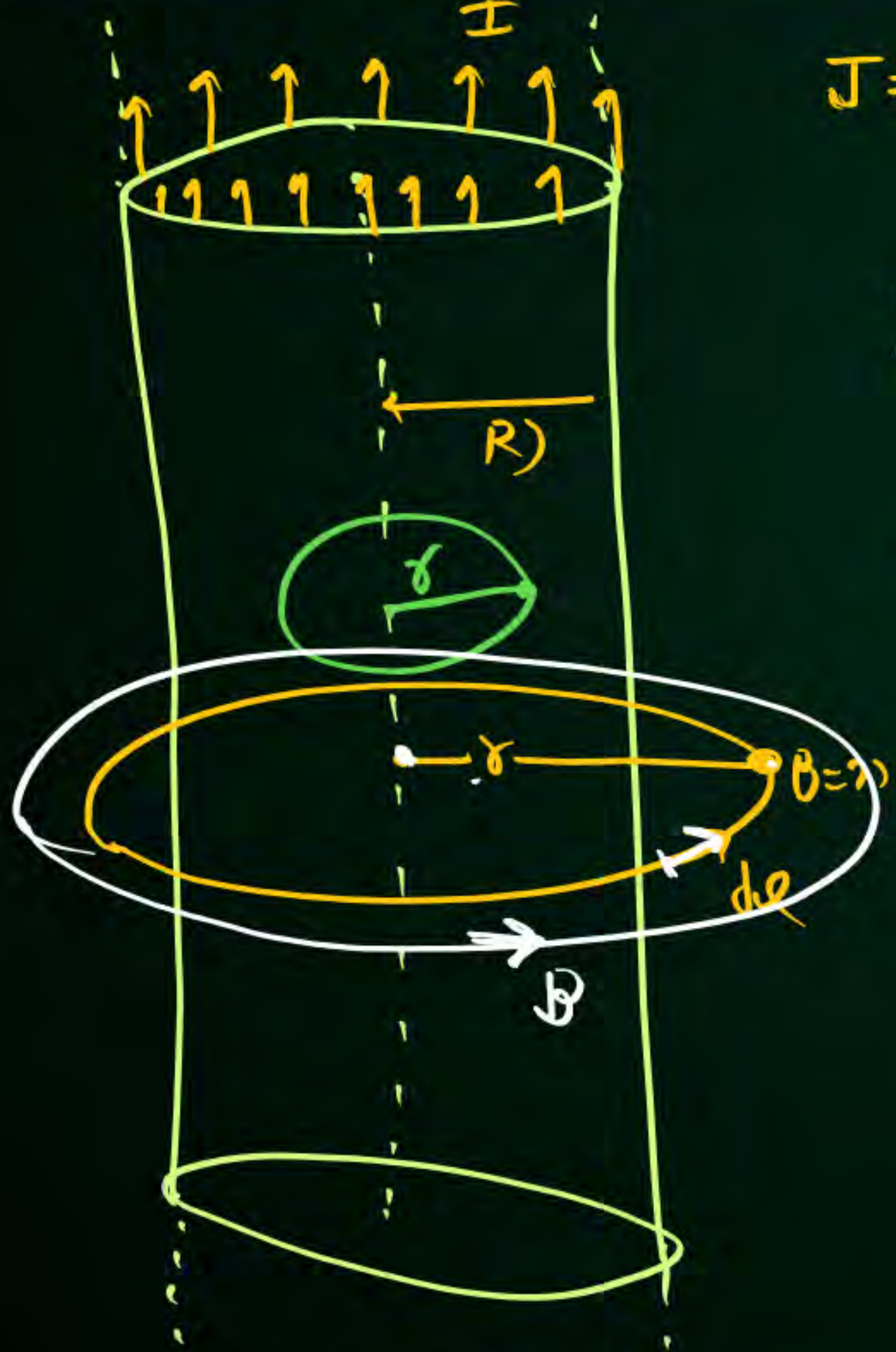
$$B \oint dl = \mu_0 I$$

$$B(2\pi r) = \mu_0 I$$

$$\boxed{B = \frac{\mu_0 I}{2\pi r}}$$

[redacted]

Infinite Hollow cylindrical wire



$J =$ linear current density $= \dfrac{I}{2\pi R}$

$B_{inside}\,(r<R)$

$\oint \vec{B}\cdot d\vec{l} = \mu_0 I_{in}$ (→ 0)

$B_{inside}\cdot dl = 0$

$$\boxed{B_{inside} = 0}$$

$B_{outside}\,(r>R)$

$\oint B\cdot dl = \mu_0 I_{in}$

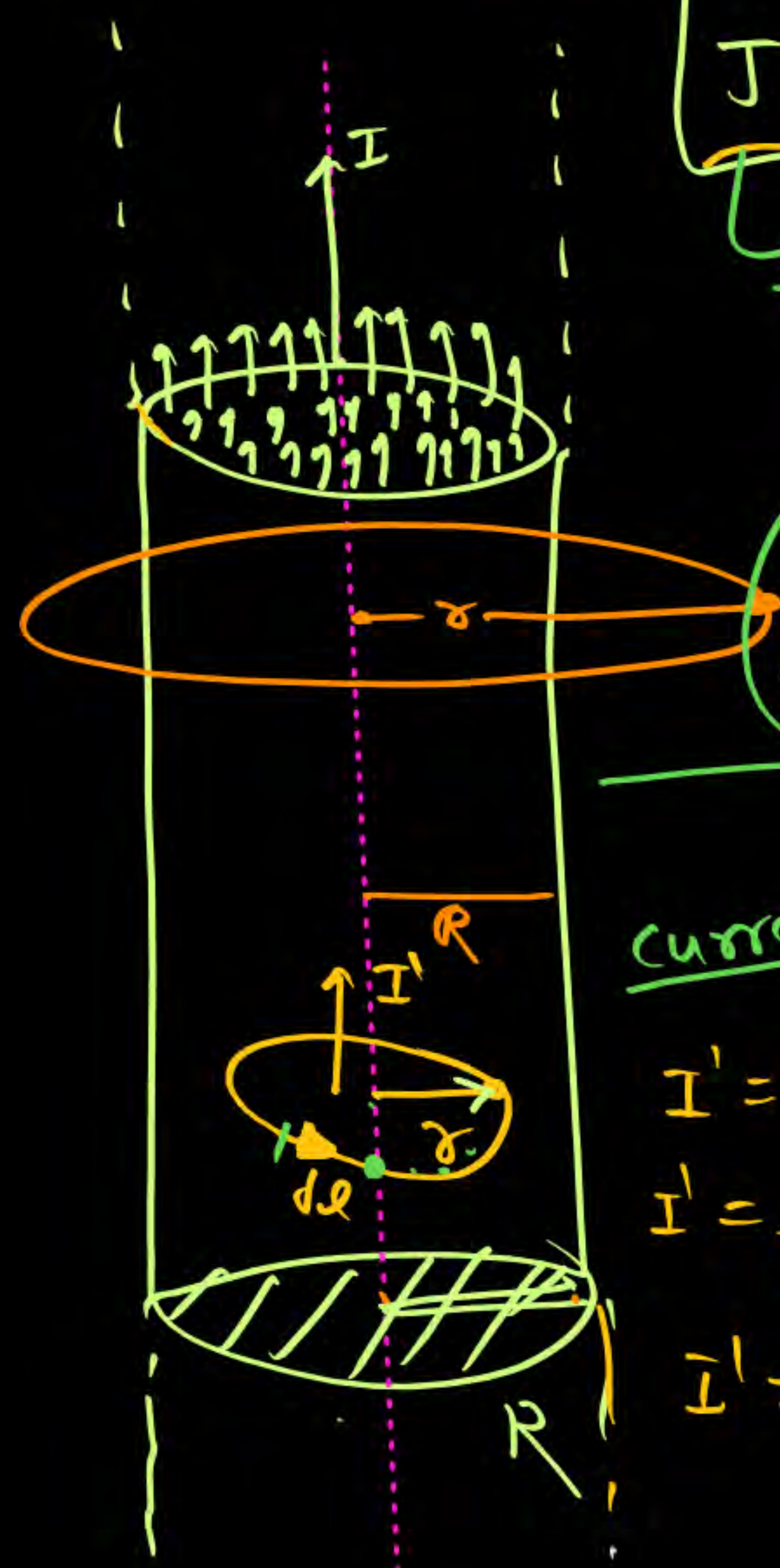
$B \oint dl = \mu_0 I$

$B(2\pi r) = \mu_0 I$ → $B_{surface} = \dfrac{\mu_0 I}{2\pi R}$

$$\boxed{B = \frac{\mu_0 I}{2\pi r}}$$ ← same as infinite wire



Infinite solid cylinder



$$J = \frac{I}{\pi R^2}$$ → uniform

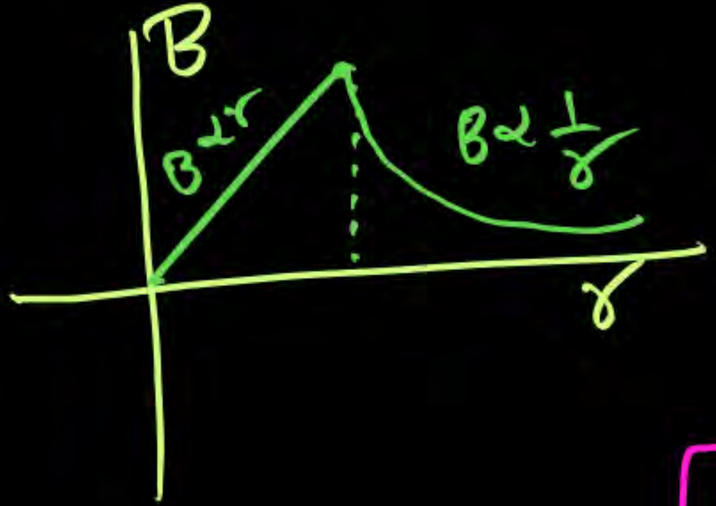
$$B_{out} = \frac{\mu_0 I}{2\pi r} \quad (r>R)$$

current

$$I' = J\pi r^2$$

$$I' = \frac{I}{\pi R^2}\pi r^2$$

$$I' = \frac{I r^2}{R^2} \quad \text{— (1)}$$



B_{inside} $(r<R)$

$$\oint B\cdot dl = \mu_0 I_{in}$$

$$B\oint dl = \mu_0 \frac{I r^2}{R^2}$$

$$B\, 2\pi r = \mu_0 \frac{I r^2}{R^2}$$

dim^n ✓

$$B_{inside} = \frac{\mu_0 I r}{2\pi R^2}$$

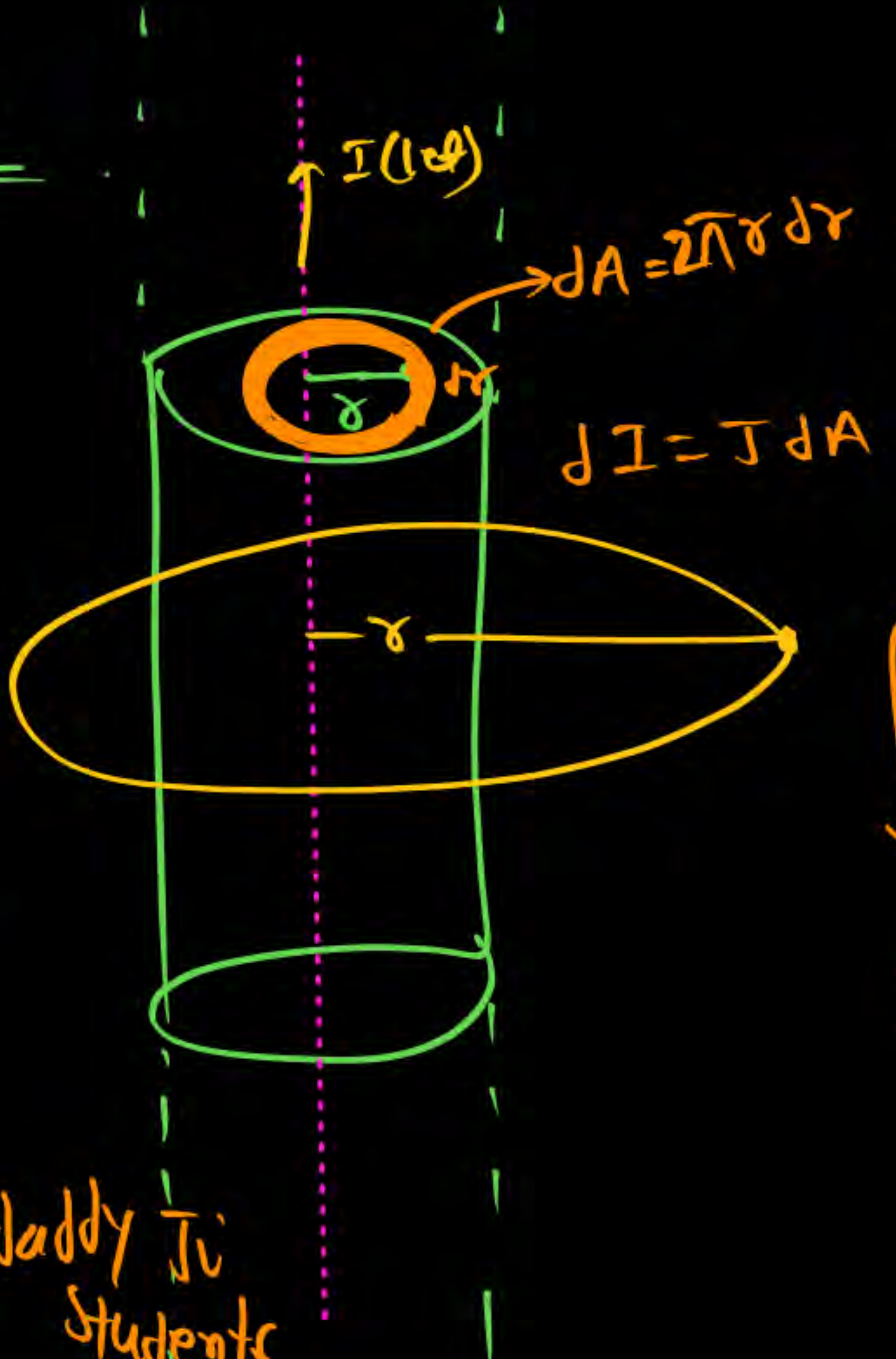
$B_{inside} \propto r$

$$B = \frac{\mu_0 J r}{2} \quad \text{(scalar)}$$

$$\vec{B}_{inside} = \frac{\mu_0 \vec{J}\times\vec{r}}{2}$$

(Q) If current density inside Infinite cylinder $J = J_0 r$ Non-uniform. depends upon radial distance, r from axis. then find magnetic field at distance $(r > R)$ outside.

Soln



outside

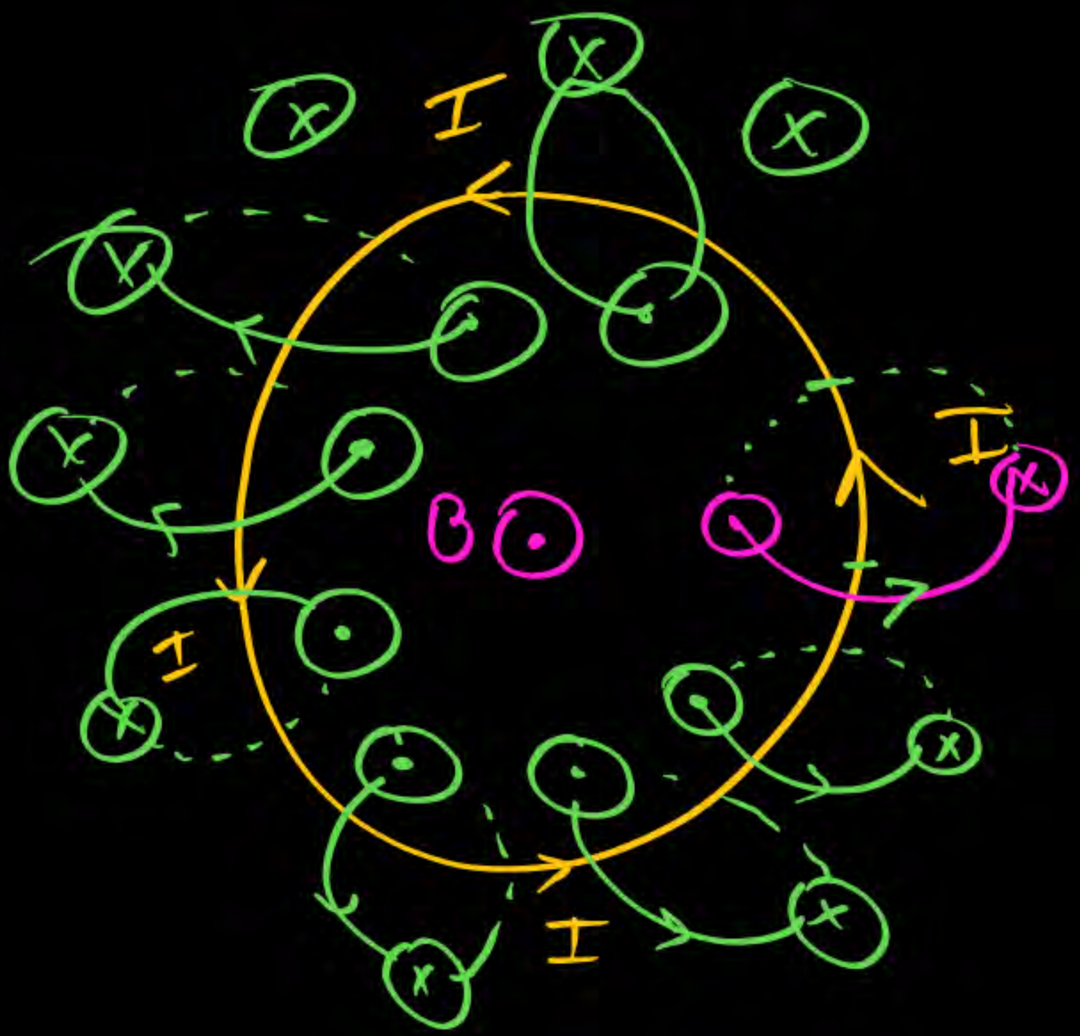
$$B = \frac{\mu_0 I}{2\pi r} = \frac{\mu_0}{2\pi r}\frac{2\pi J_0 R^3}{3} = \frac{\mu_0 J_0 R^3}{3r}$$

dimension correct

$$\int dI = \int J_0 r \, 2\pi r \, dr$$

$$I = J_0 2\pi \int_0^R r^2 dr = J_0 2\pi \left(\frac{r^3}{3}\right)_0^R = \frac{2\pi J_0 R^3}{3}$$

Level up
Not for NEET
only for daddy Ji students


I
I
B
I
I


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 04 | Physics

Moving Charges and Magnetism



By- Dr. Manish Raj (MR SIR)

Topics to be covered

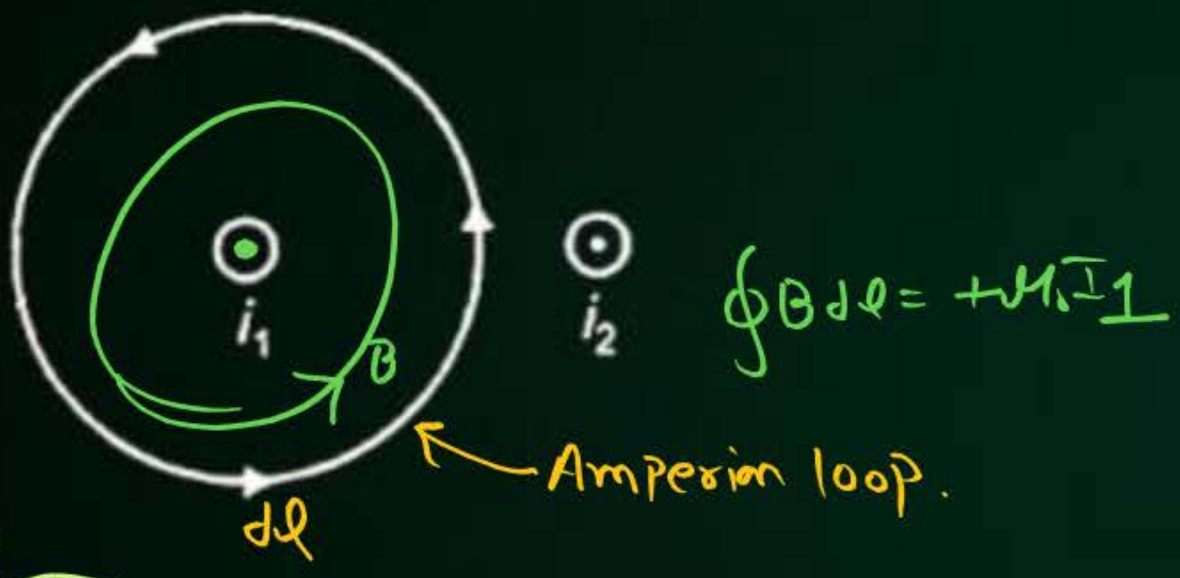
1. # Solenoid / Toroid
2. ## Magnetic force on charges
3. #



QUESTION

Find $\oint \vec{B} \cdot \vec{dl}$ over following loops (direction in which integration has to be performed is indicated by arrows)

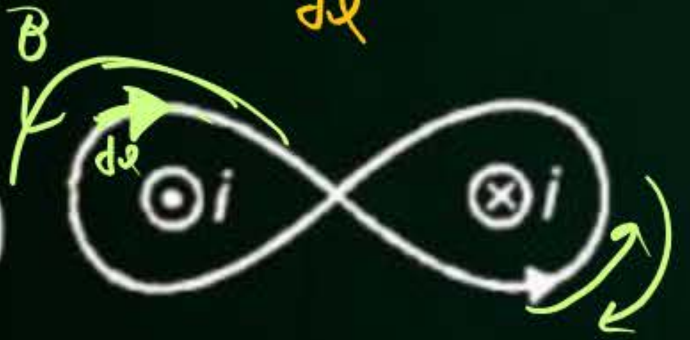
(i)



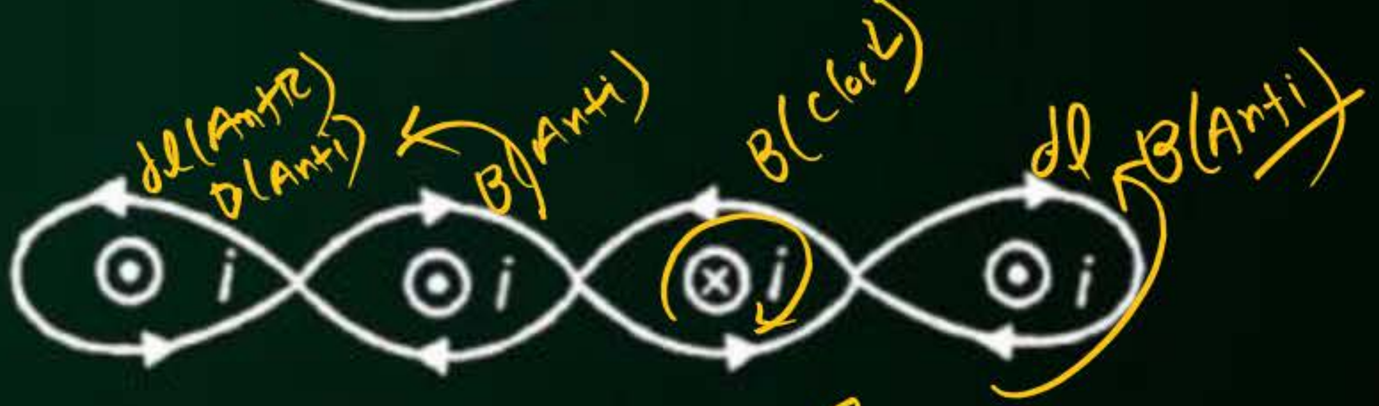
(ii)



(iii)

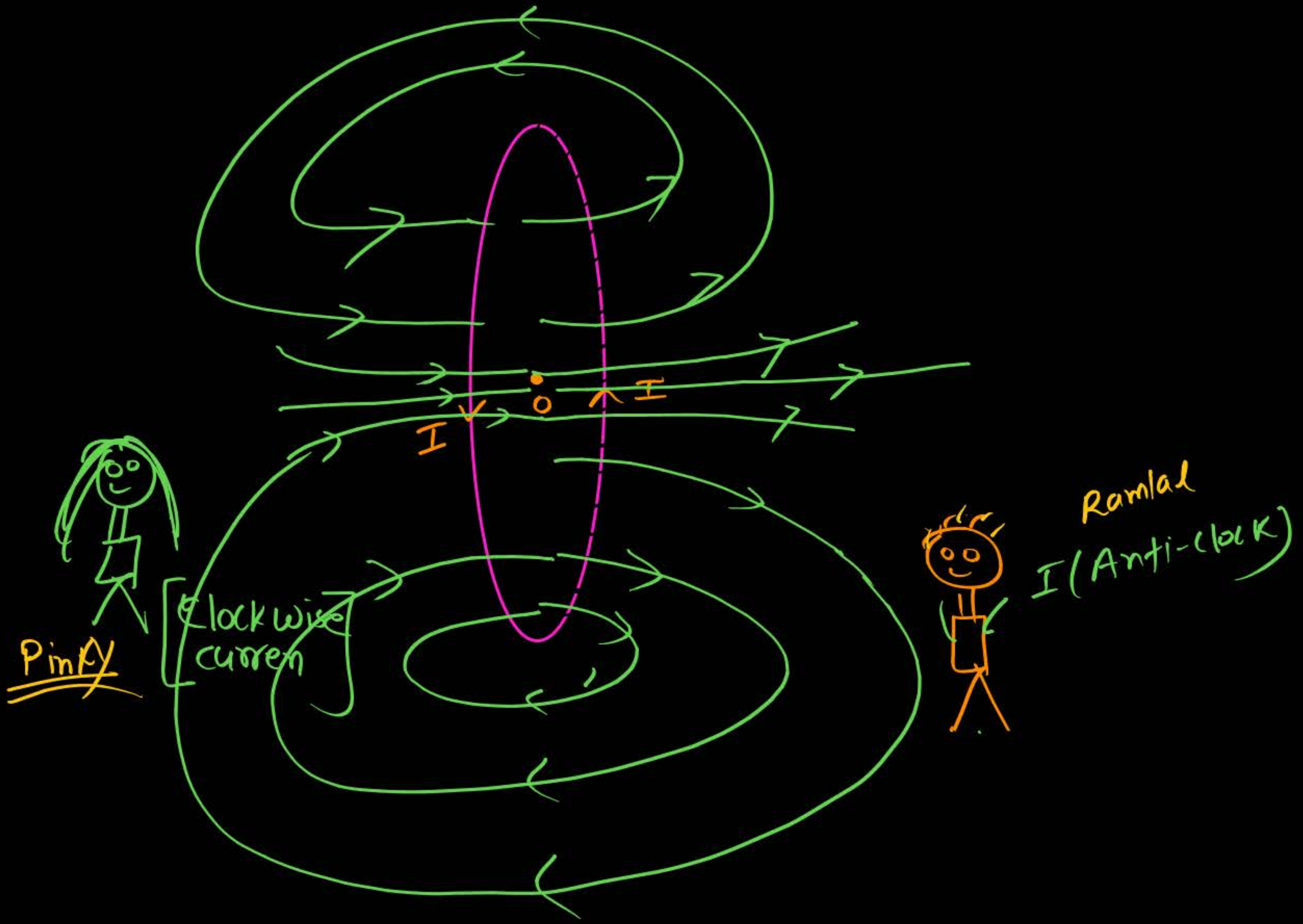


(iv)



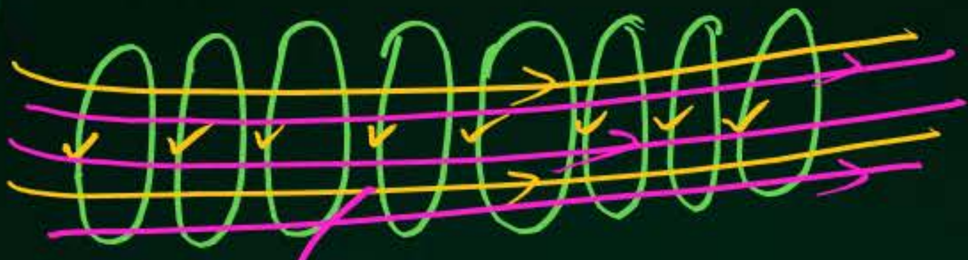
$$\oint \vec{B}\cdot\vec{dl} = \mu_0(-I-I) = -2\mu_0 I$$

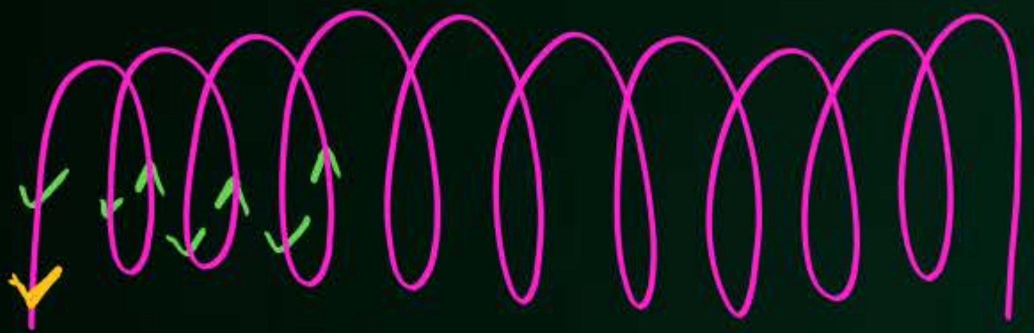
$$\oint B\,dl = \mu_0[+i - i - i - i] = -2\mu_0 i$$


Ramlal
I (Anti-clock)
Pinky
Clockwise current
I
O
I

Ideal (long)

Solenoid





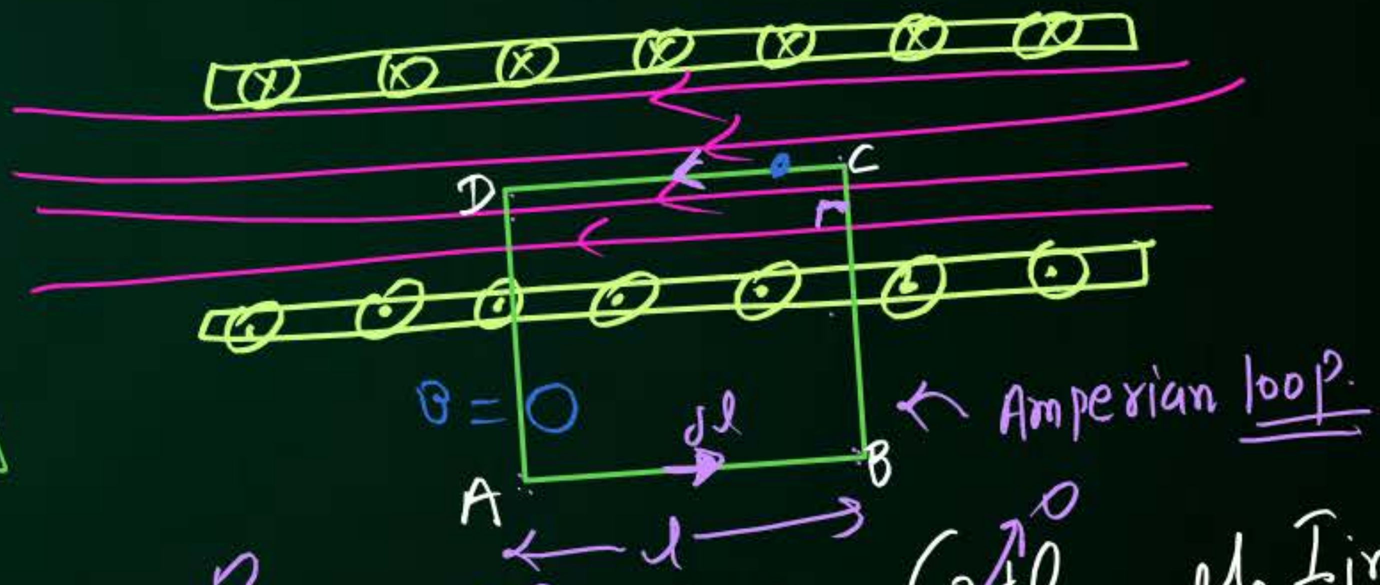
I = current

L = length of solenoid

N = Total no. of turn.

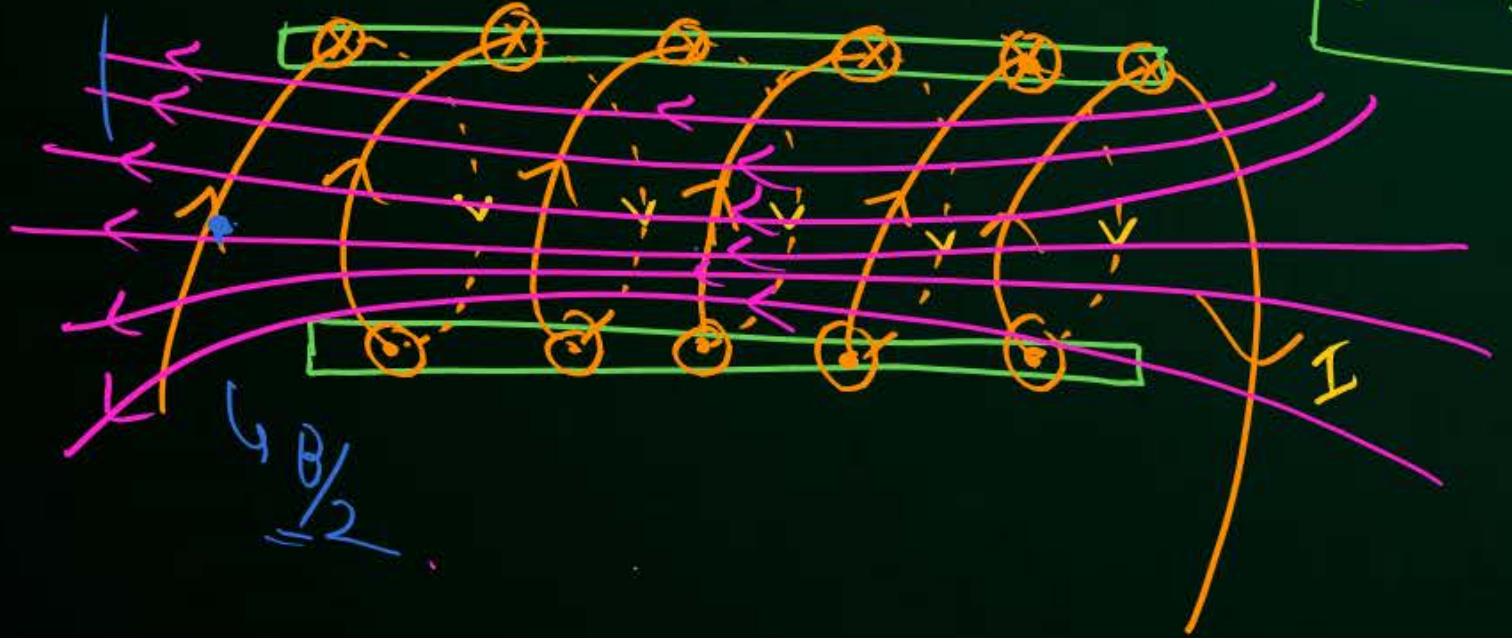
$n = \frac{N}{L}$ = no. of Turns per unit length.

using Ampers circuita law



$$B = \mu_0 n I$$

* $$\boxed{B = \mu_0 \frac{N}{L} I}$$



$$\oint_{AB} B\cdot dl + \int_{BC} B\,dl + \int_{CD} B\,dl + \int_{DA} B\,dl = \mu_0 I_{in}$$

$$B \int dl = \mu_0 n l I$$

$$\boxed{B = \mu_0 n I}$$

(Q) If length of solenoid becomes double then magnetic field inside solenoid will be

$B = \mu_0 n I = \frac{\mu_0 N I}{L}$

(a) double

(b) Half

(c) Same (70%) प्रहाई

(d) Can't say (only 8%)

$B = \mu_0 n I$ ✓

$B = \mu_0 n I$ — Length double keeping no. of turns per unit length const^n

$n = $ const^n

$B \propto$ does not depends on length

$B = \frac{\mu_0 N I}{L}$ — Length double keeping total no of turns const^n

$N = $ const

$B \propto \frac{1}{L}$

QUESTION

A large solenoid of windings of 400 turns per meter carries a current 5 A. The magnetic field at the centre of the solenoid is about

1. 1.2 mT
2. Zero
3. 5.0 mT
4. 2.5 mT

$B = \mu_0 n I$

$= 4\pi \times 10^{-7} \times 400 \times 5$

$= 80\pi \times 10^{-5}$ T

$= 2.5$ mT

QUESTION

A long solenoid of 50 cm length having 100 turns carries a current of 2.5 A. The magnetic field at the centre of the solenoid is ($\mu_0 = 4\pi \times 10^{-7}$ T m A^{-1}) **(NEET 2020)**

1. 6.28×10^{-4} T
2. 3.14×10^{-4} T
3. 6.28×10^{-5} T
4. 3.14×10^{-5} T

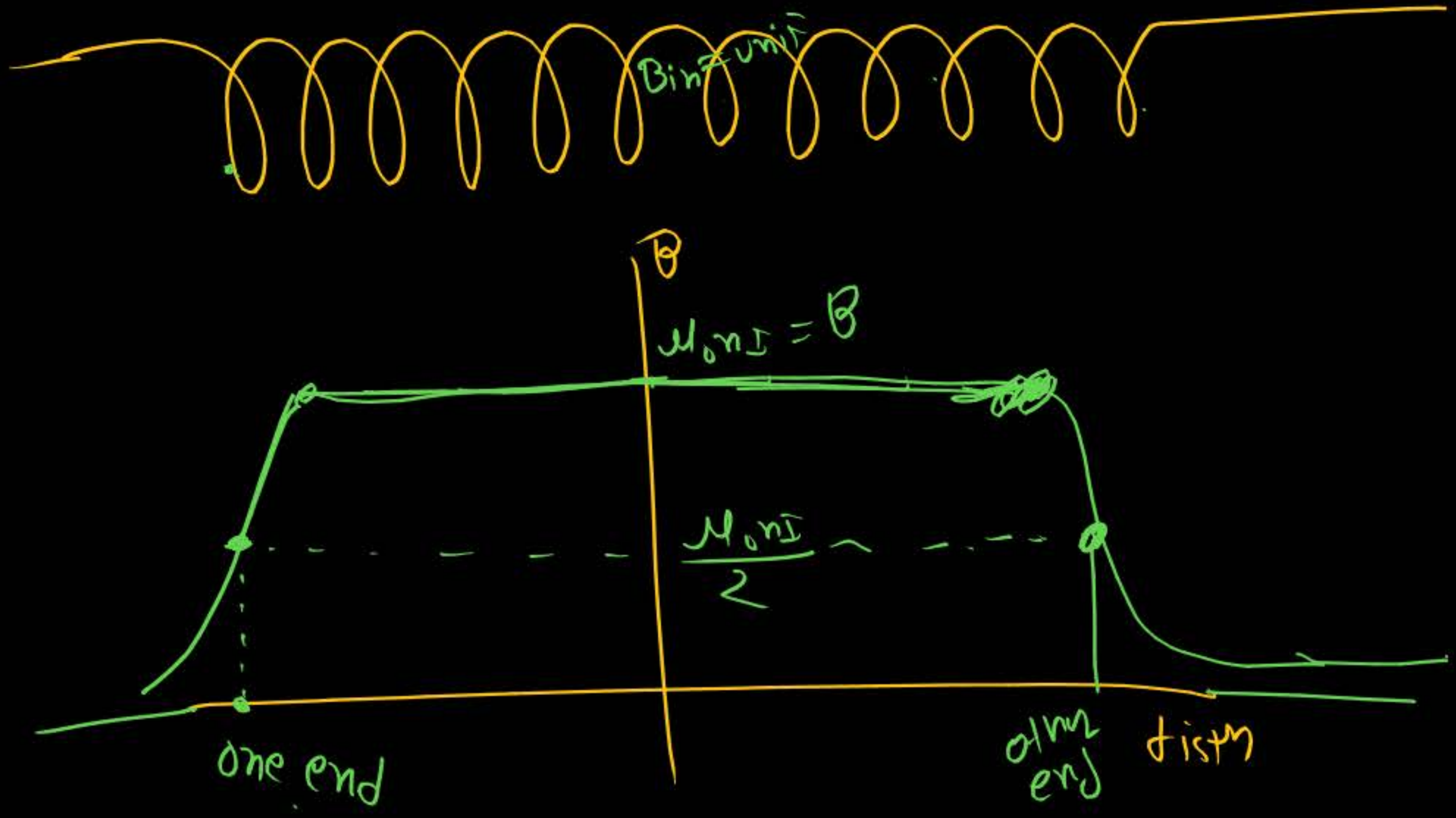


long Ideal solenoid

$B = \mu_0 n I$

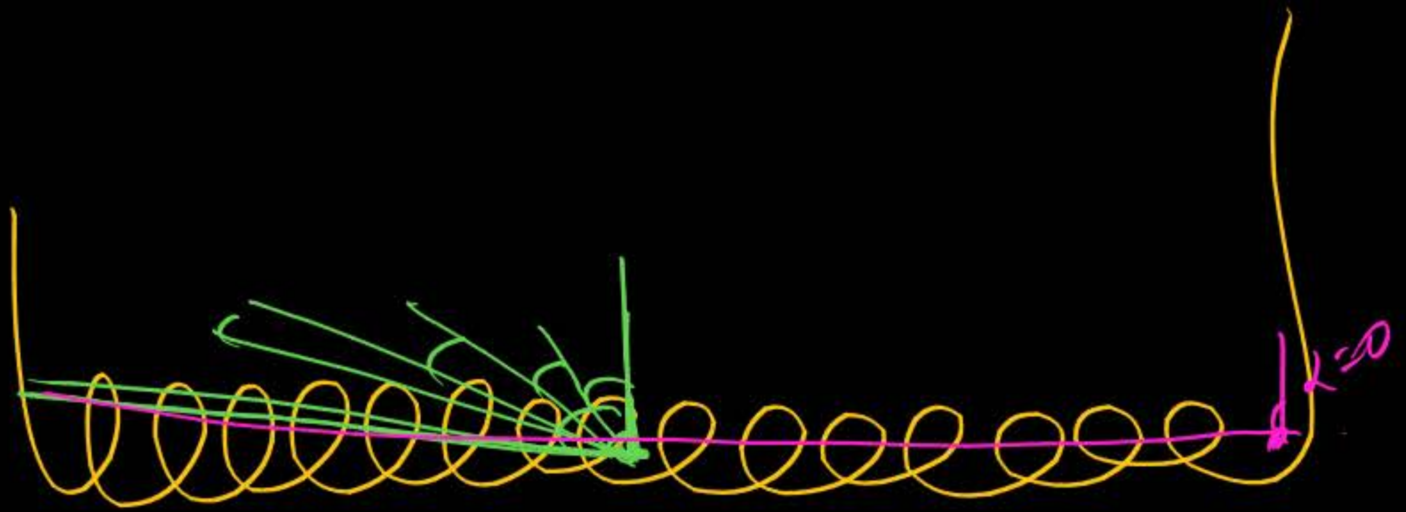
$= 4\pi \times 10^{-7} \times \frac{100}{\frac{1}{2} m} \times \frac{5}{2}$

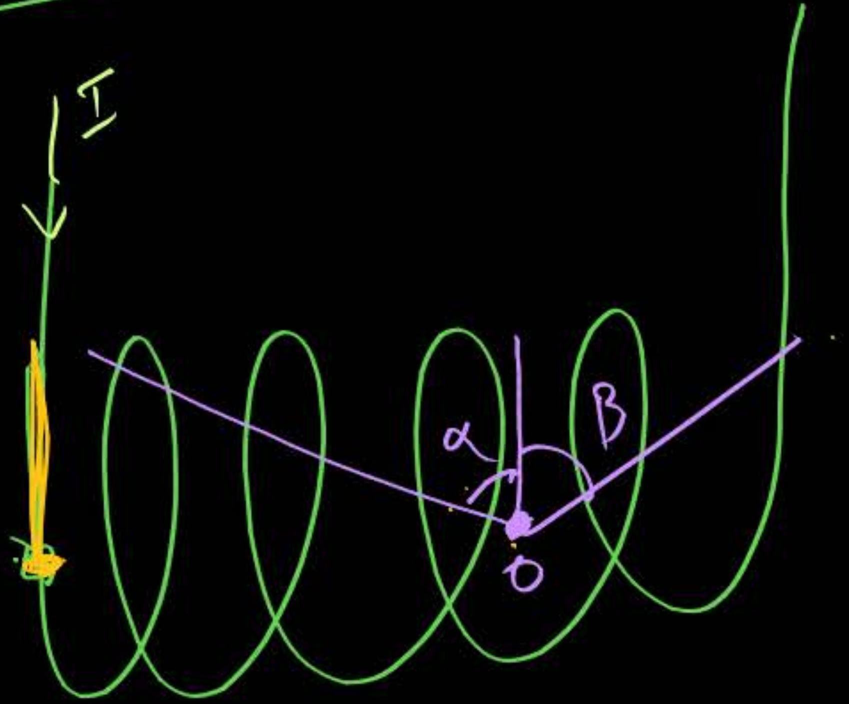
$= 20 \times \pi \times 10^{-5}$



B
$\mu_0 n I = B$
$\frac{\mu_0 n I}{2}$
one end

Extra level up (not for NEET)





$$B = \frac{\mu_0 n I}{2}\left[\sin\alpha + \sin\beta\right]$$

If $\alpha = \beta = 90^\circ$

Infinite long solenoid

$$B = \mu_0 n I$$

at one end of infinite solenoid

$\alpha = 0$ / $\beta = 90$

$$B = \frac{\mu_0 n I}{2}\left[\sin 0^\circ + \sin 90^\circ\right]$$

$$B = \frac{\mu_0 n I}{2}$$ Ans

QUESTION

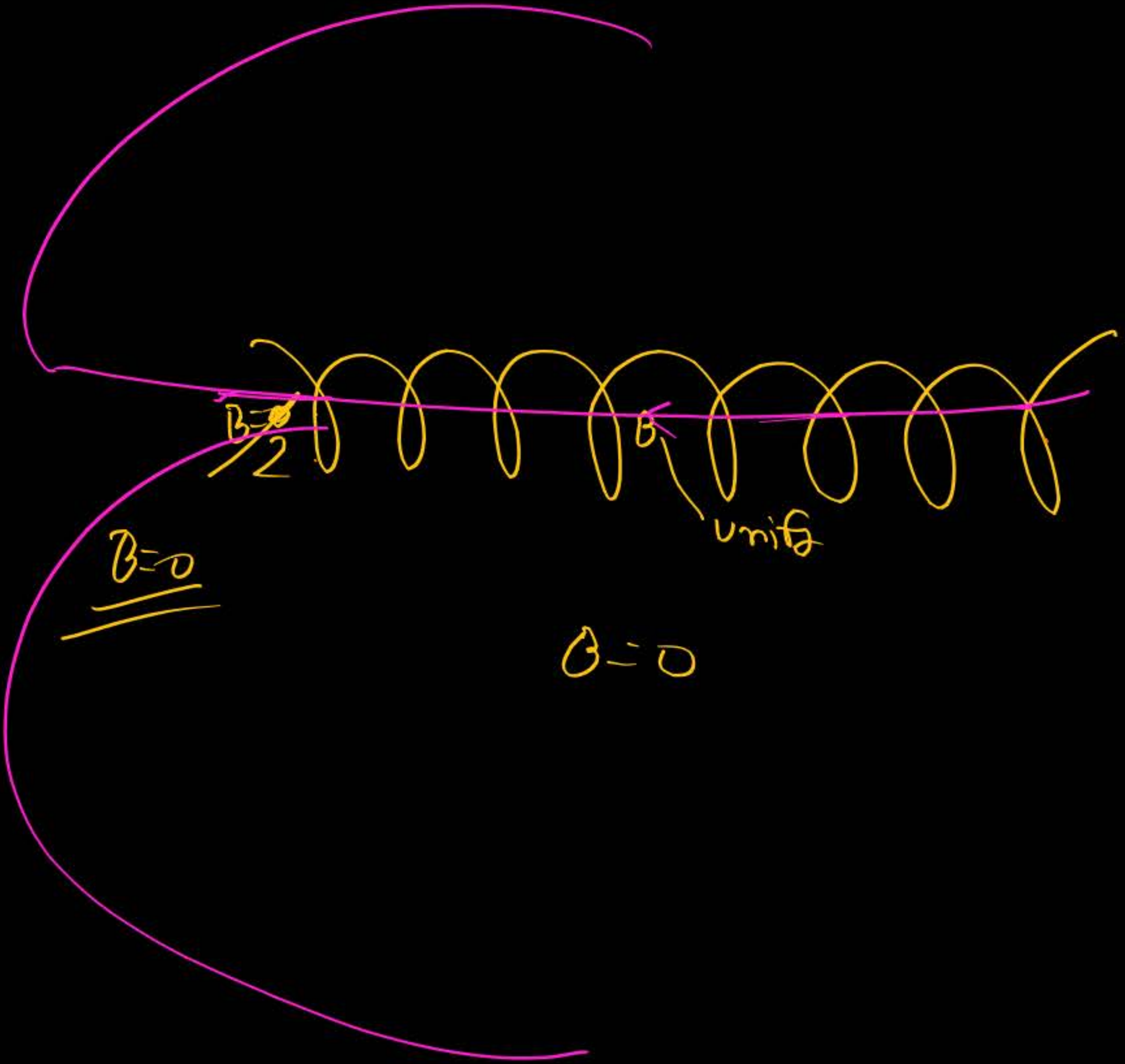
A long solenoid carrying a current produces a magnetic field B along its axis. If the current is doubled and the number of turns per cm is halved, the new value of the magnetic field is (2003)

1. B/2
2. B

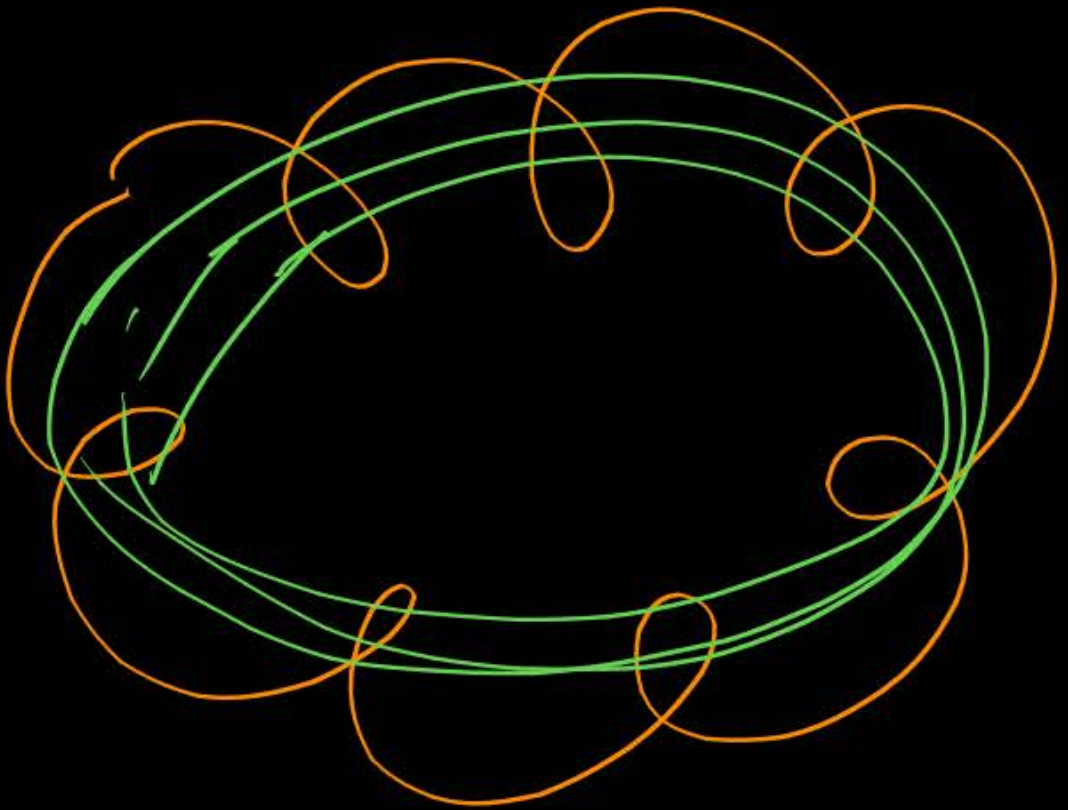
   Unchanged
3. 2B
4. 4B

$B = \mu_0 n I$

no of turns per cm is half



B
unif
B=0
B=0

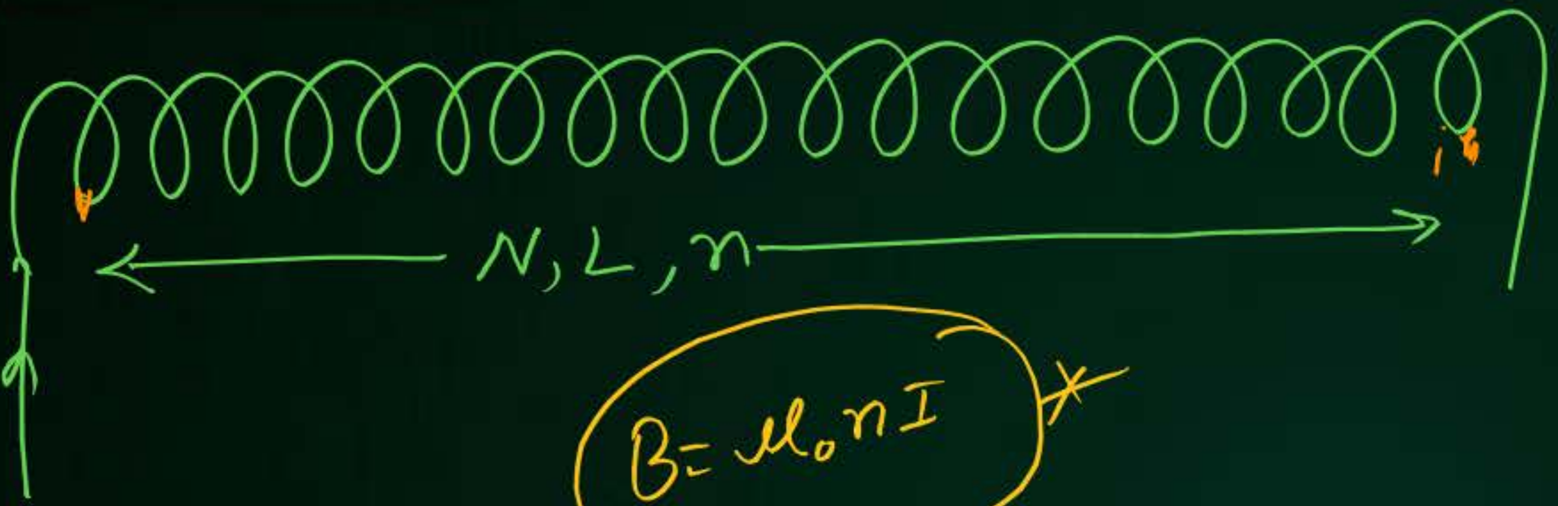


QUESTION

If length of solenoid doubled then magnetic field inside solenoid will be?

1. Same
2. Half
3. Doubled
4. Can't day

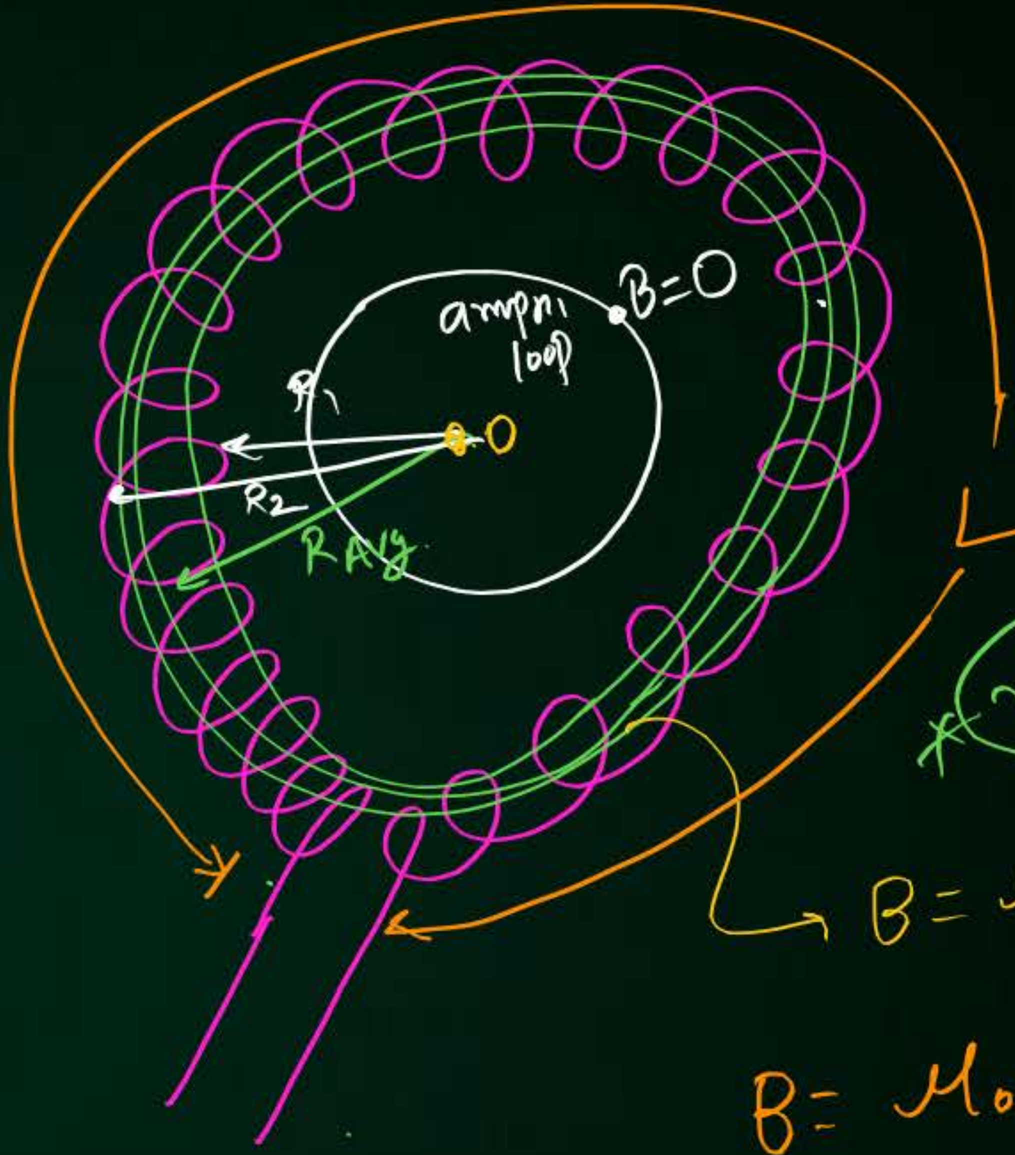
Toroide = goal solenoid



$$B = \mu_0 n I$$

$$B = \mu_0 n I = \frac{\mu_0 N}{2\pi R} I$$

$$R_{Avg} = \frac{R_1 + R_2}{2}$$



B = 0

L, N, $n = \frac{N}{L}$

$n = \frac{N}{L} = \frac{N}{2\pi R}$

$B = \mu_0 n I$

$B = \mu_0 \frac{N}{L} I$

$B = \frac{\mu_0 N}{2\pi R} I$

$B = \mu_0 n I$

QUESTION

Two toroids 1 and 2 have total number of turns 200 and 100 respectively with average radii 40 cm and 20 cm respectively. If they carry same current *i*, the radio of the magnetic fields along the two loops is

(Odisha NEET 2019)

1. 1 : 1
2. 4 : 1
3. 2 : 1
4. 1 : 2

$B = \mu_0 n I$

$B = \frac{\mu_0 N I}{2\pi R}$

$B \propto \frac{N}{R}$

$B = \mu_0 n I$

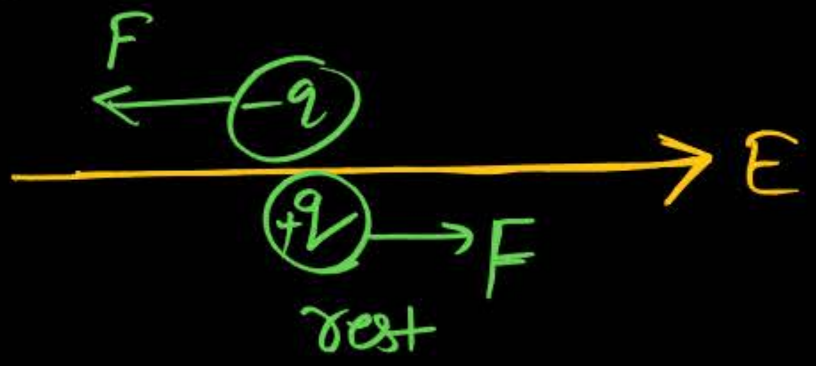
$B = \frac{\mu_0 N I}{2\pi R} \propto \frac{N}{R}$

$\frac{B_1}{B_2} = \frac{(N/R)_1}{(N/R)_2} = \frac{200/40}{100/20} = 1:1$

Electrostatic force on charge

→ does not depends on velocity of charge

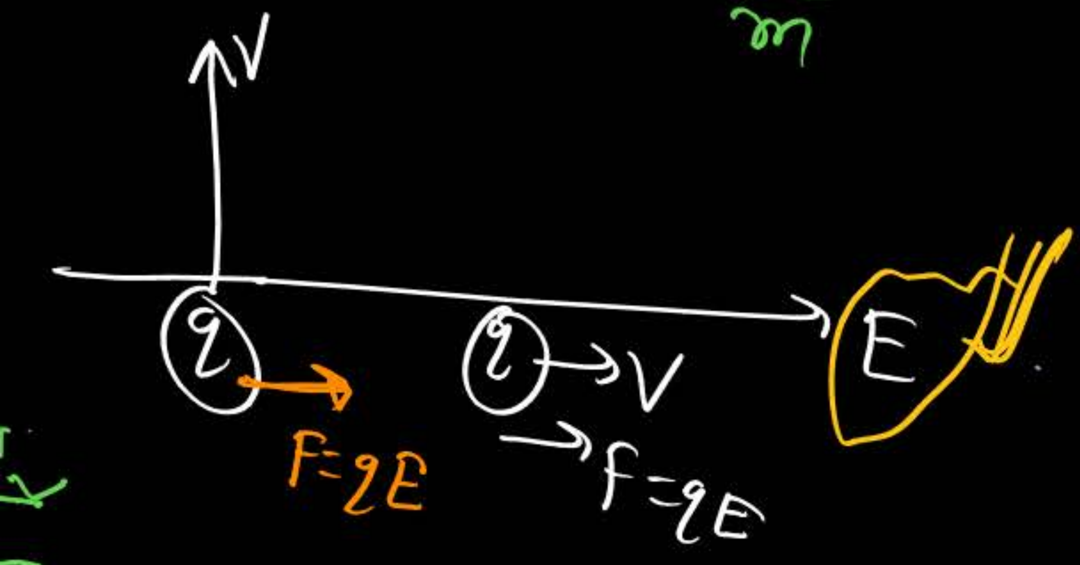
Case-1



$$\vec{Force} = q\vec{E}$$

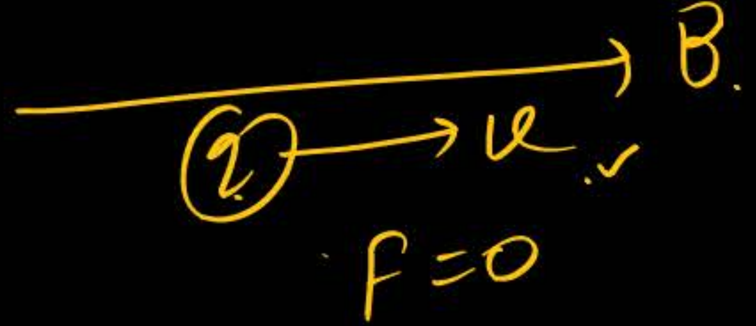
$$a = \frac{qE}{m}$$

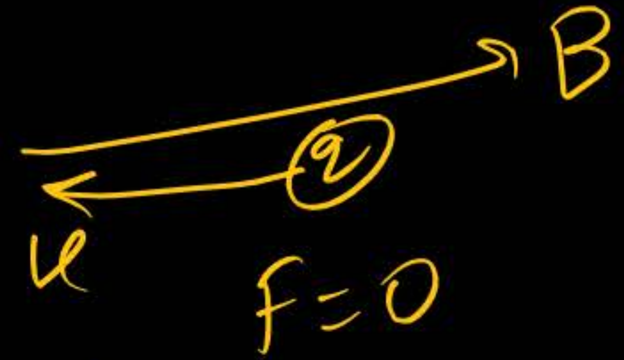
Force = q E



Magnetic force



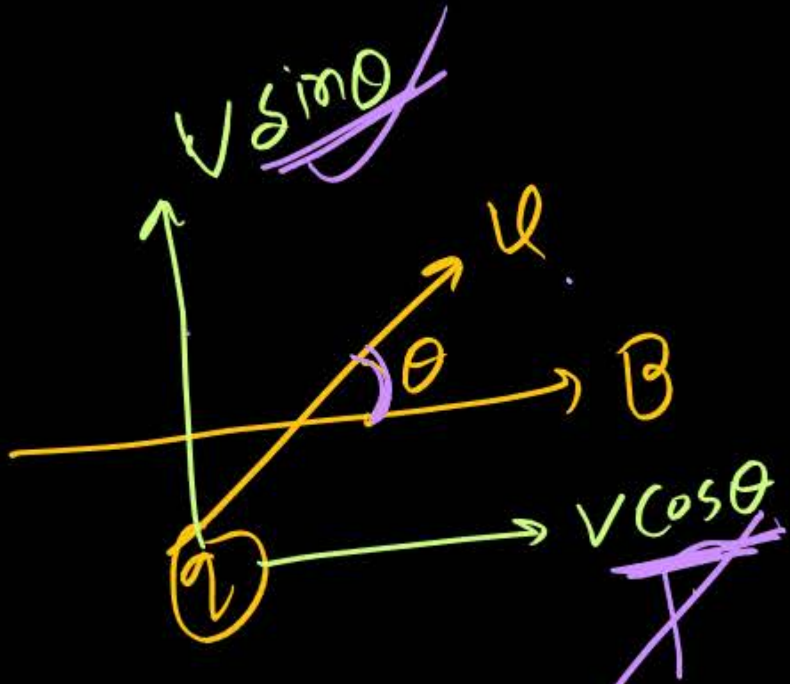






$$F = Bqv$$

$$\vec{F} =$$



$$F = qvB\sin\theta$$

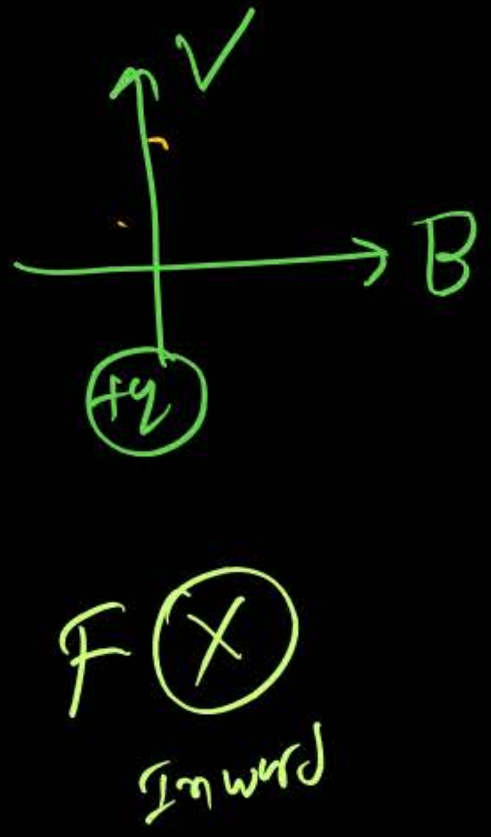
$$\vec{F} = q[\vec{v} \times \vec{B}]$$

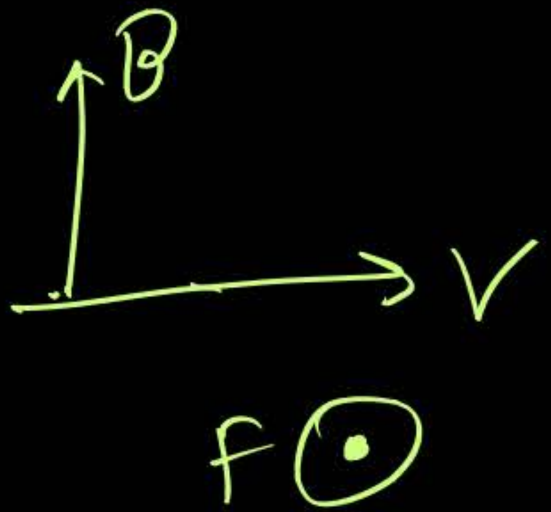
$\vec{F} \perp \vec{v}$ ✓

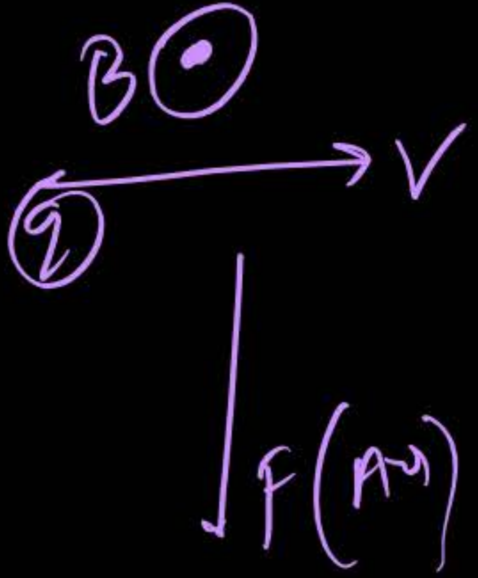
$F \perp \vec{B}$ ✓

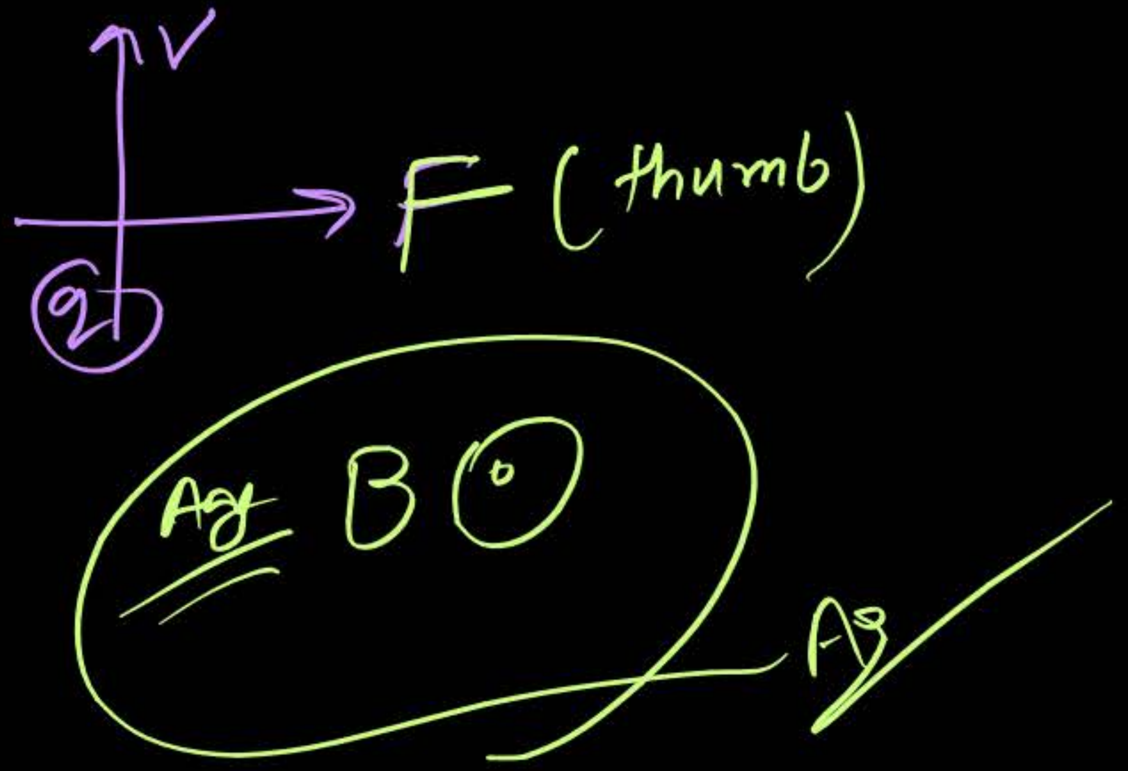
thumb

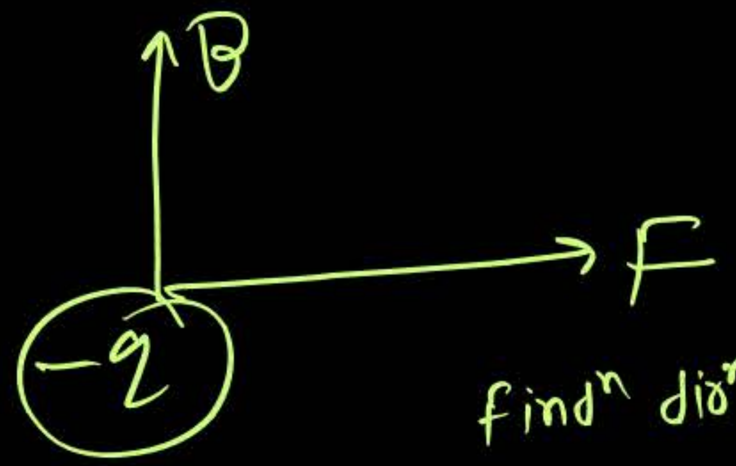
place your four finger in dirn velocity & slap magnetic field


V
B
+q
F
Inward


B
V
F


B
V
q
F


v
F (thumb)
q
Ag
B ⊙
Ag



find^n dir^n of velocity

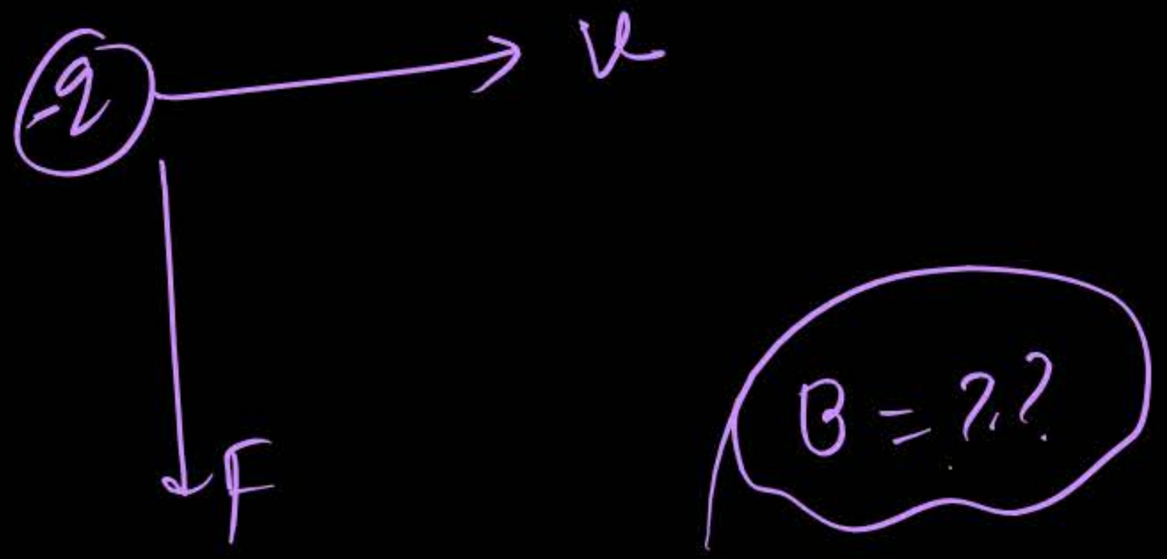
As v ⊙ outwa

B ⊙

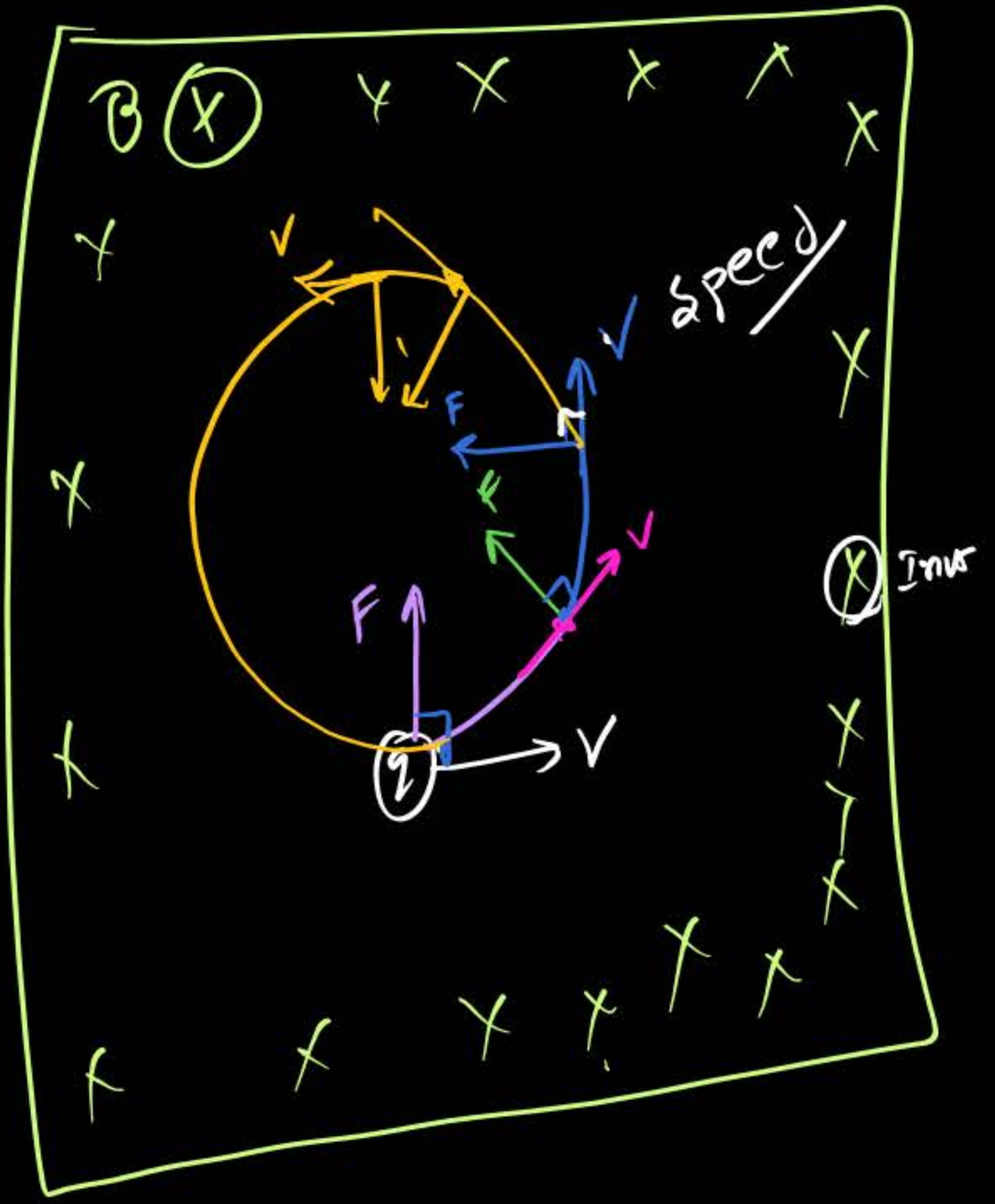
+q v ⊗

dir^n of force

~~Force = 0~~

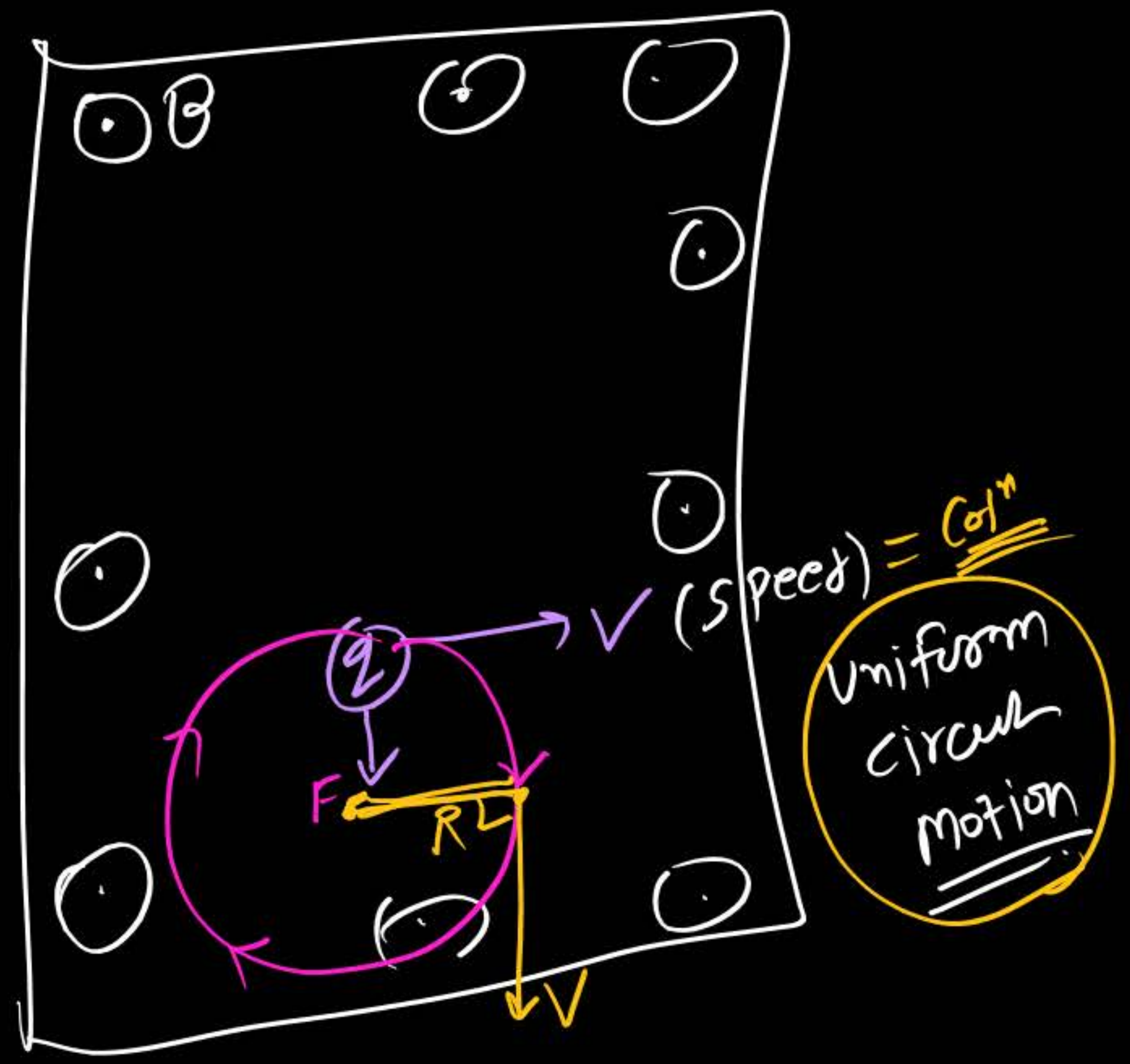


Ans B (Inside)



$F \perp r\ u$

$F \perp r\ B$

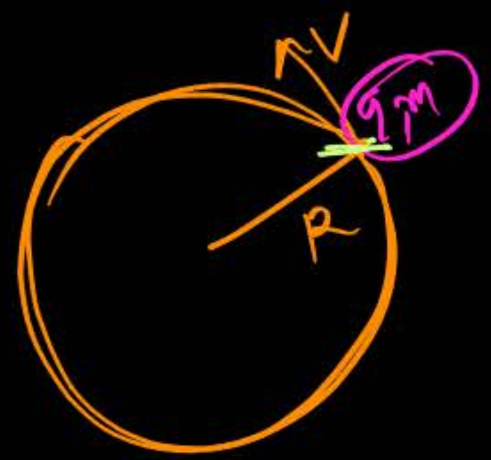


$$F = qvB = m a_c$$

$$q\cancel{v}B = \frac{m v^{\cancel{2}}}{R}$$

$$R = \frac{mv}{qB}$$

$$R = \frac{mv}{qB} = \frac{P}{qB} = \frac{\sqrt{2m\,K.E}}{qB} = \frac{\sqrt{2mq\Delta V}}{qB}$$



$$\text{Time} = \frac{\text{distance}}{\text{speed}} = \frac{2\pi R}{V}$$

$$T = \frac{2\pi}{V}\left(\frac{mv}{qB}\right)$$

$$T = \frac{2\pi m}{qB} \quad *$$

$$P = \sqrt{2m\,K.E}$$

$$K.E = q\Delta V \quad *$$

ΔV → Potential

time in 2π rad $= \frac{2\pi m}{qB}$

" " 1 rad $= \frac{m}{qB}$

time in θ angle $= \theta\left(\frac{m}{qB}\right)$

Time period → does not depends on time

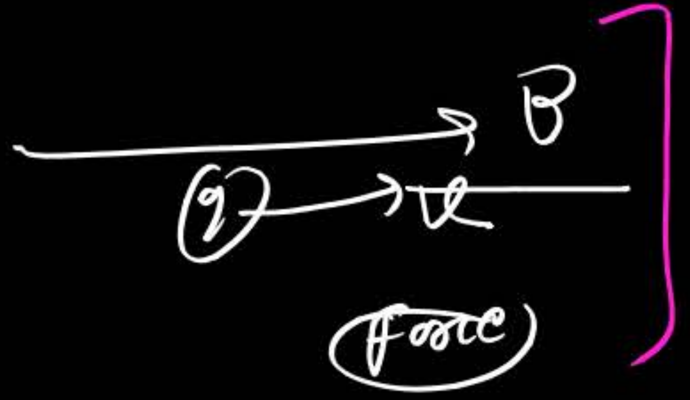
$$f = \frac{1}{T} = \frac{qB}{2\pi m}$$

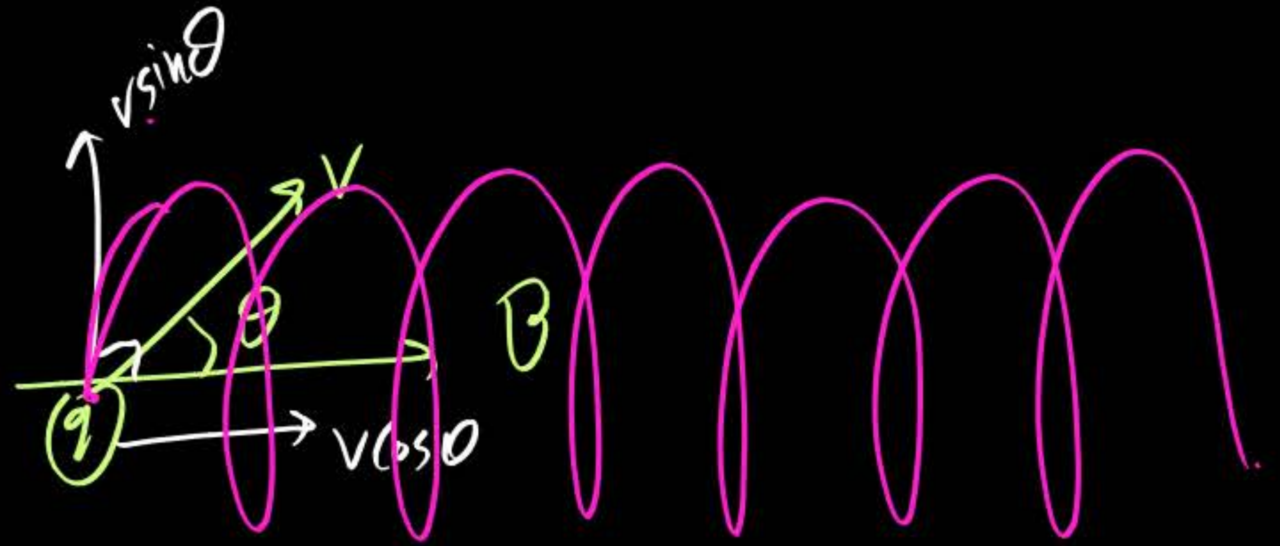
Path of charge Particle in magnetic field?

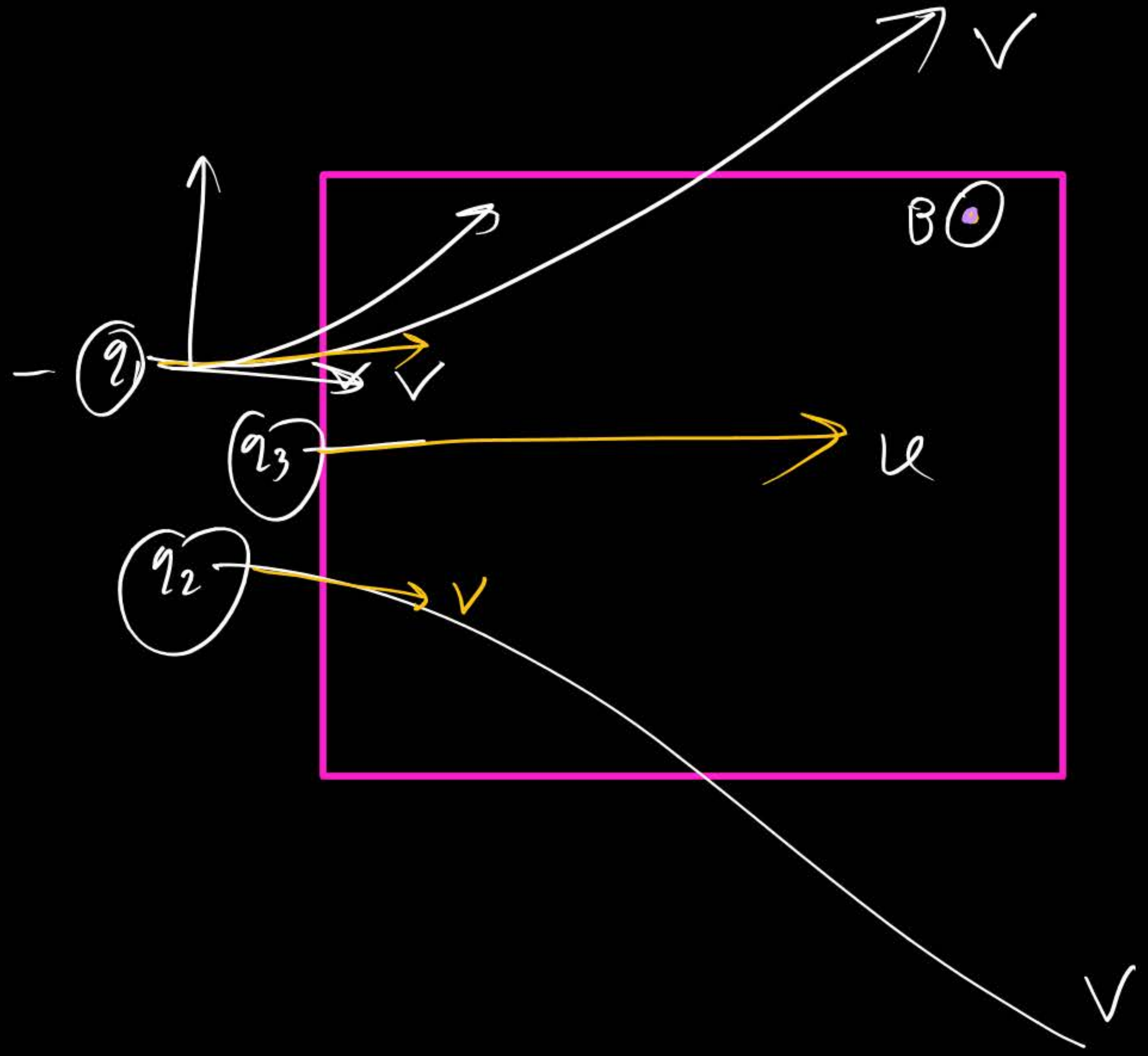
(a) circular ✓

(b) Straight line ✓

(c) helical Path ✓





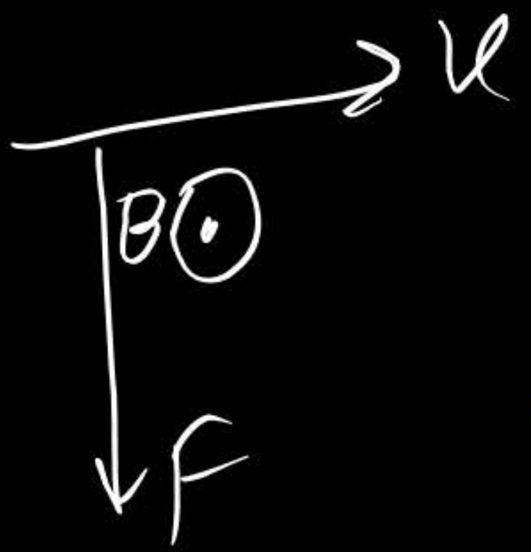


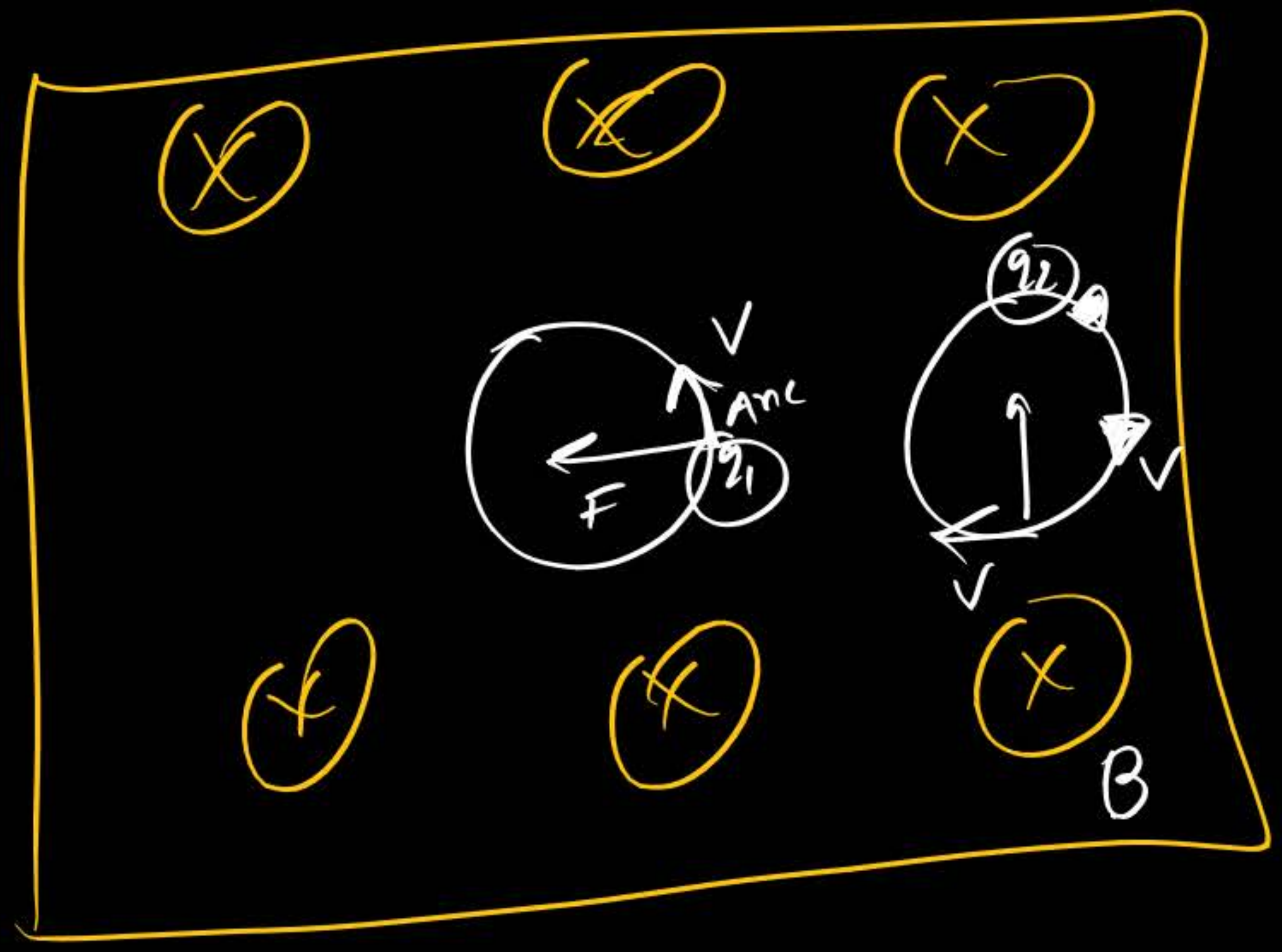
nature of charge

$q_3 \rightarrow$ Neutral

$q_1 = -ve$

$q_2 \rightarrow +ve$





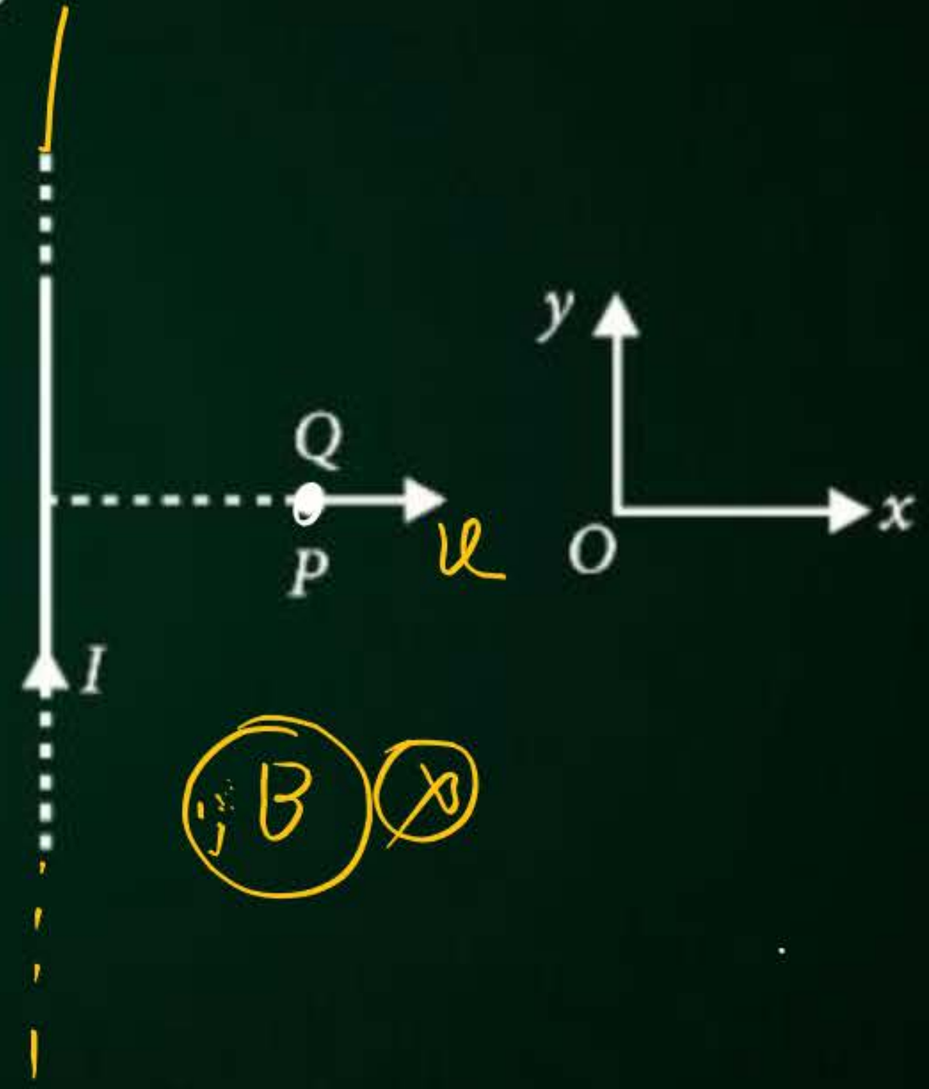
$q_1 = +ve$ ✓

$q_2 = -ve$

QUESTION

A very long straight wire carries a current I. At the instant when a charge +Q at point P has velocity $\vec{v}$, as shown, the force on the charge is (2005)

1. along Oy
2. opposite to Oy
3. along Ox
4. opposite to Ox



$\vec{F} = q(\vec{V} \times \vec{B}) = qvB \sin\theta \Rightarrow$ Angle between $\vec{V}$ and $\vec{B}$ (θ)

- force is always ⊥r to $\vec{V}$ and $\vec{B}$
- Speed is always constant, momentum is variable because of direction
- K.E. = constant, work = ΔK.E = 0, Power = W/t = zero
- If $\vec{u}$ is parallel or anti-parallel to magnetic field then force will be zero.
- If charge is at rest then magnetic force will be zero.
- Magnetic field can only change direction of motion of charge particle.
- $\vec{F}.\vec{B} = 0, \vec{F}.\vec{u} = 0$ $\quad$ $\boxed{\vec{a}.\vec{u} = 0}$

dot Product

$\vec{F}$ ⊥r $\vec{u}$

$\vec{a}$ ⊥r $\vec{V}$

$\vec{a}.\vec{u} = 0$

$a_t = 0$

Speed = const

work = 0

Pow = 0

Uniform circular motion

QUESTION

The magnetic force acting on a charged particle of charge $-2\ \mu C$ in a magnetic field of $2\ T$ acting in y direction, when the particle velocity is $(2\hat{i} + 3\hat{j}) \times 10^6\ ms^{-1}$ is **(2009)**

1. $4\ N$ in z direction
2. $8\ N$ in y direction
3. $8\ N$ in z direction
4. $8\ N$ in $-z$ direction.

Ans

$B = 2T\ \hat{j}$

$v = (2\hat{i} + 3\hat{j}) \times 10^6$

$q = -2\ \mu C$

$F = q(\vec{v} \times \vec{B})$ $(\hat{i} \times \hat{j})$

QUESTION

Velocity of charge particle $(2\hat{\imath} + 3\hat{\jmath})$ and acceleration $(3\hat{\imath} - \beta\hat{\jmath})$ in magnetic field then find value of β?

$\vec{v} \perp \vec{a}$

$\vec{v} \cdot \vec{a} = 0$

$6 - 3\beta = 0$

$3\beta = 6$

$\beta = 2$

QUESTION

Charge q is moving with $V = (3\hat{\imath} - 2\hat{\jmath})$ and B = $4\hat{\jmath}$ and $\vec{E} = 2\hat{\imath}$ then find net force?

$$\vec{F} = q\vec{E} + q(\vec{V} \times \vec{B})$$

QUESTION

When a charged particle moving with velocity $\vec{v}$ is subjected to a magnetic field of induction $\vec{B}$, the force on it is non-zero. This implies that (2006)

1. angle between is either zero or 180°
2. angle between is necessarily 90°
3. angle between can have any value other than 90°
4. angle between can have any value other than zero and 180°.

QUESTION

A charge q moves in a region where electric field and magnetic field both exist, then force on it is (2002)

1. $q(\vec{v} \times \vec{B})$
2. $q\vec{E} + (q(\vec{v} \times \vec{B}))$
3. $q\vec{E} + \vec{q}(\vec{B} + \vec{v})$
4. $q\vec{B} + q(\vec{E} + \vec{v})$

QUESTION

A charge moving with velocity v in X-direction is subjected to a field of magnetic induction in negative X-direction. As a result, the charge will (1993)

1. remain unaffected
2. start moving in a circular path Y-Z plane
3. retard along X-axis
4. moving along a helical path around X-axis.

QUESTION

Ionized hydrogen atoms and a-particles with same momenta enters perpendicular to a constant magnetic field, B. The ratio of their radii of their paths $r_H : r_\alpha$ will be

(NEET 2019)

1. $1:4$
2. $2:1$
3. $1:2$
4. $4:1$

QUESTION

A 10 eV electron is circulating in a plane at right angles to a uniform field at magnetic induction 10^{-4} Wb/m^2 (= 1.0 gauss), the orbital radius of electron is (1996)

1. 11 cm
2. 18 cm
3. 12 cm
4. 16 cm

QUESTION

A proton (m, e), deutron $(2m, e)$ and α-particle $(4m, 2e)$ are projected with same velocity in magnetic field, then find ratio of their radius of circular path.

$$R = \frac{mv}{qB}$$

$$R \propto \frac{m}{q}$$

QUESTION

A proton (m, e), deutron $(2m, e)$ and α-particle $(4m, 2e)$ are projected with same momentum in magnetic field, then find ratio of their radius of circular path.

$$R = \frac{mv}{qB} = \frac{p}{qB}$$ (same)

$$R \propto \frac{1}{q}$$

QUESTION

A proton (m, e), deutron $(2m, e)$ and α-particle $(4m, 2e)$ are projected with same kinetic energy in magnetic field, then find ratio of their radius of circular path.

$$R = \frac{\sqrt{2m\,(K.E)}}{q\,(B)}$$

$$R \propto \frac{\sqrt{m}}{q}$$

QUESTION

A proton (m, e), deutron $(2m, e)$ and α-particle $(4m, 2e)$ are accelerated with same potential and then projected in magnetic field, then find ratio of their radius of circular path.

QUESTION

A proton and an alpha particle both enter a region of uniform magnetic field B, moving at right angles to the field B. If the radius of circular orbits for both the particles is equal and the kinetic energy acquired by proton is 1 MeV, the energy acquired by the alpha particle will be (2015)

1. 1.5 MeV
2. 1 MeV
3. 4 MeV
4. 0.5 MeV

QUESTION

A proton carrying 1 MeV kinetic energy is moving in a circular path of radius R in uniform magnetic field. What should be the energy of an a-particle to describe a circle of same radius in the same field? **(Mains 2012)**

1. 2 MeV
2. 1 MeV
3. 0.5 MeV
4. 4 MeV

QUESTION

Under the influence of a uniform magnetic field, a charged particle moves with a constant speed v in a circle of radius R. The time period of rotation of the particle

(2009, 2007)

1. depends on R and not on v
2. is independent of both v and R
3. depends on both v and R
4. depends on v and not on R.

QUESTION

A charged particle moves through a magnetic field in a direction perpendicular to it. Then the (2003)

1. speed of the particle remains unchanged
2. direction of the particle remains unchanged
3. acceleration remains unchanged
4. velocity remains unchanged.

QUESTION

An electron having mass m and kinetic energy E enter in uniform magnetic field B perpendicularly, then its frequency will be (2001)

1. $\frac{eE}{qvB}$
2. $\frac{2\pi m}{eB}$
3. $\frac{eB}{2\pi m}$
4. $\frac{2m}{eBE}$

QUESTION

A charge having e/m equal to 10^8 C/kg and with velocity 3×10^5 m/s enters into a uniform magnetic field B = 0.3 tesla at an angle 30° with direction of field. The radius of curvature will be (1999)

1. 0.01 cm
2. 0.5 cm
3. 1 cm
4. 2 cm

QUESTION

A positively charged particle moving due East enters a region of uniform magnetic field directed vertically upwards. This particle will (1997)

1. move in a circular path with a decreased speed
2. move in a circular path with a uniform speed
3. get deflected in vertically upward direction
4. move in circular path with an increased speed.

QUESTION

A uniform magnetic field acts right angles to the direction of motion of electrons. As a result, the electron moves in a circular path of radius 2 cm. If the speed of electrons is doubled, then the radius of the circular path will be (1991)

1. 2.0 cm
2. 0.5 cm
3. 4.0 cm
4. 1.0 cm

QUESTION

A deuteron of kinetic energy 50 keV is describing a circular orbit of radius 0.5 metre in a plane perpendicular to magnetic field B. The kinetic energy of the proton that describes a circular orbit of radius 0.5 metre in the same plane with the same B is

(1991)

1. 25 keV
2. 50 keV
3. 200 keV
4. 100 keV

Nature of Charge Particle

QUESTION

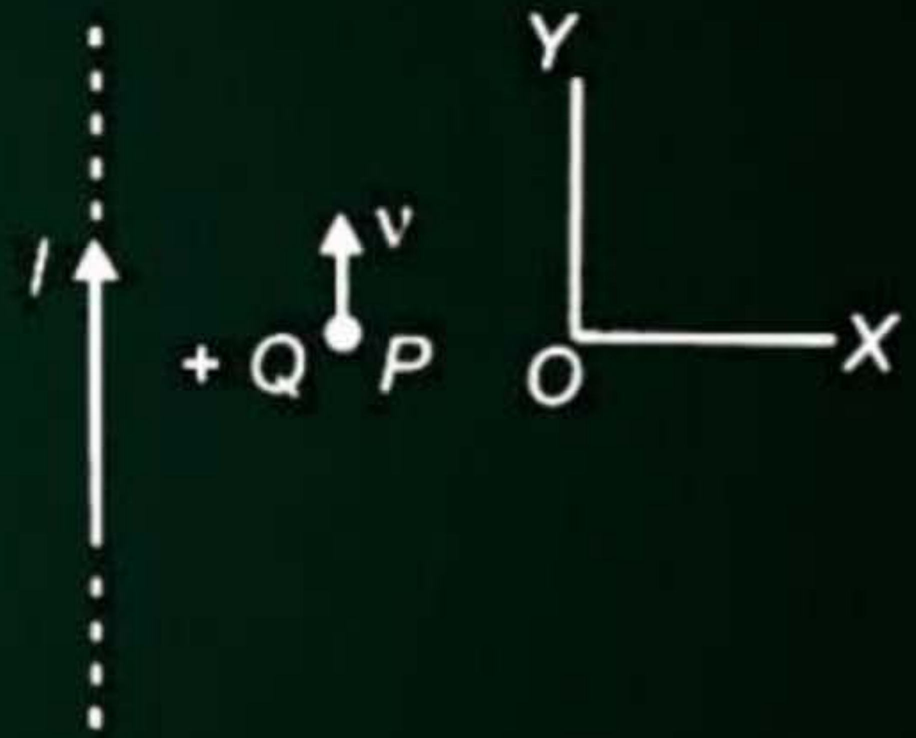
Now charge projected $\perp r$ to magnetic field but from outside of region of magnetic field.

- Angle between $\vec{B}$ and $\vec{v}$ is $90°$

QUESTION

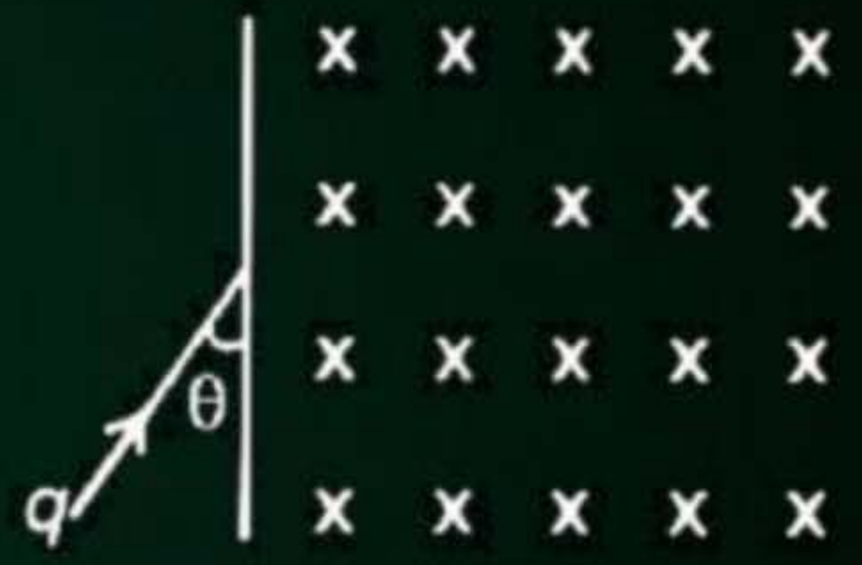
A charge Q moves parallel to a very long straight wire carrying a current I as shown. The force on the charge is

1. Opposite to OX
2. Along OX
3. Opposite to OY
4. Along OY



QUESTION

A charged particle enters a uniform magnetic field at some angle. The particle will be deviated from its path by angle 180°. Value of θ will be



1. 90°
2. 60°
3. 120°
4. 180°

QUESTION

A proton of mass m, charge q enters a magnetic field B with a velocity v at an angle θ with the direction of B. The radius of the resulting path is

1. $\frac{mv}{qB}$
2. $\frac{mv\sin\theta}{qB}$
3. $\frac{mv\cos\theta}{qB}$
4. $\frac{mv}{qv\sin\theta}$


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 05 | **Physics**

Moving Charges and Magnetism

By- Dr. Manish Raj (MR SIR)



F = q(B × V) ✗ wrong

Todys Goal

Motion of charge Particle in Magnetic

$\vec{F} = q(\vec{v} \times \vec{B}) = qvB\sin\theta$ → Angle B/w $\vec{v}$ & $\vec{B}$

$\vec{F} \perp \vec{B}$, $\vec{F} \perp \vec{v}$, $\vec{a} \perp \vec{v}$, $\vec{a} \cdot \vec{v} = 0$ → centripetal accn

→ only dirn will change, speed remain same, Power deliv = zero

K.E = Constn, Work = 0, Force = 0 (v → B, v ← B)

dir of force $(\vec{v} \times \vec{B})$

$F_{mag} = qvB$, $\theta = 90^\circ$

$R = \frac{mv}{qB} = \frac{P}{qB} = \frac{\sqrt{2mK.E}}{qB}$ → K.E = qΔV

$T = \frac{2\pi R}{v} = \frac{2\pi}{v}\left(\frac{mv}{qB}\right)$

$T = \frac{2\pi m}{qB}$

$f = \frac{1}{T} = \frac{qB}{2\pi m}$

time in θ circular Arc $= \theta\left(\frac{m}{qB}\right)$

QUESTION

Charge particle can't accelerate in the magnetic field?

Or, magnetic field can't accelerate the charge particle.

→ accⁿ = 0, $\vec{v}$ = const.

(a) True 31%

(b) false (68%)

but inside magnetic field

$F = qvB\sin\theta$

$a_c = v^2/r \neq 0$

$a_T = 0$

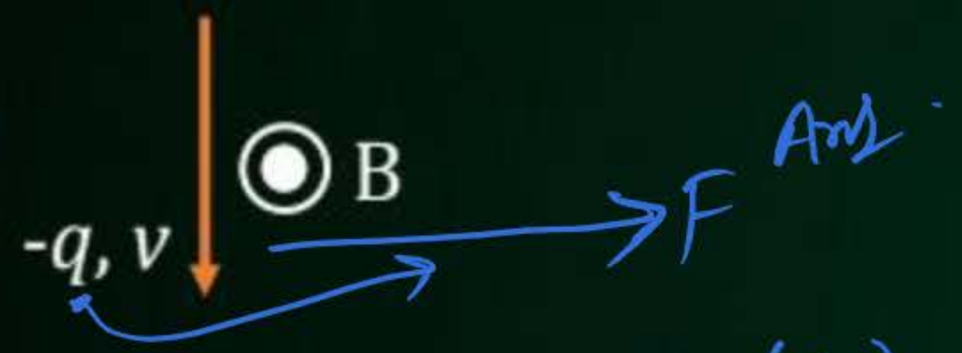
due to change in dirⁿ

QUESTION

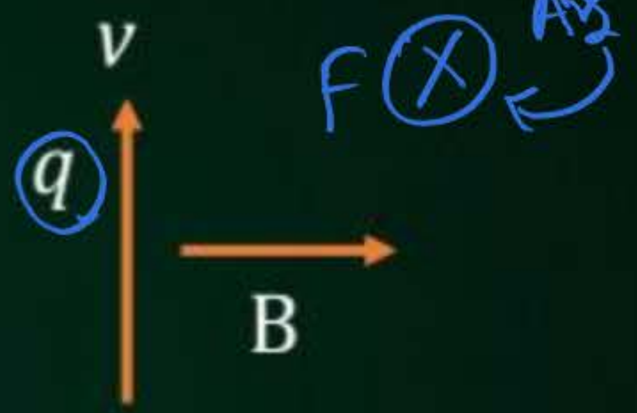
(•) जनता Ki taraf
(x) जनता से दूर

Find instantaneous direction of force in following cases (magnetic field and velocity are indicated).

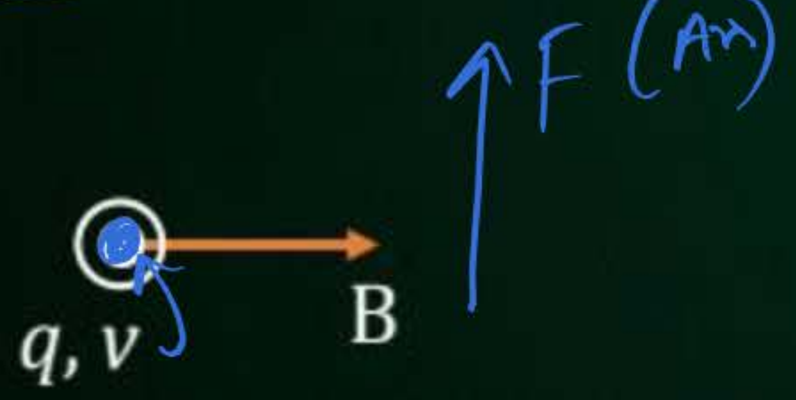
1



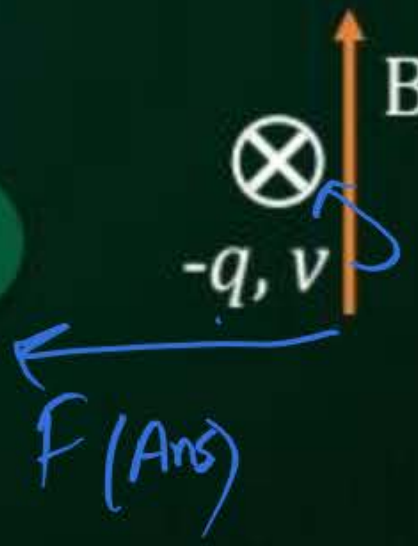
2



3



4



QUESTION

When a charged particle moving with velocity $\vec{v}$ is subjected to a magnetic field of induction $\vec{B}$, the force on it is non-zero. This implies that (2006)

1. angle between is either zero or 180°
2. angle between is necessarily 90°
3. angle between can have any value other than 90°
4. angle between can have any value other than zero and 180°

QUESTION

A charge q moves in a region where electric field and magnetic field both exist, then force on it is (2002)

1. $q(\vec{v} \times \vec{B})$
2. $q\vec{E} + (q(\vec{v} \times \vec{B}))$
3. $q\vec{E} + \vec{q}(\vec{B} + \vec{v})$
4. $q\vec{B} + q(\vec{E} + \vec{v})$

Lorntz force

$F = q\vec{E} + q(\vec{v} \times \vec{B})$

QUESTION

A charge moving with velocity v in X-direction is subjected to a field of magnetic induction in negative X-direction. As a result, the charge will (1993)

1. remain unaffected
2. start moving in a circular path Y-Z plane
3. retard along X-axis
4. moving along a helical path around X-axis.

QUESTION

Ionized hydrogen atoms and a-particles with same momenta enters perpendicular to a constant magnetic field, B. The ratio of their radii of their paths $r_H : r_\alpha$ will be

(NEET 2019)

1. $1:4$
2. $2:1$
3. $1:2$
4. $4:1$

QUESTION

$m_e = 10^{-30} kg = 9.1 \times 10^{-31} kg$

A 10 eV electron is circulating in a plane at right angles to a uniform field at magnetic induction 10^{-4} Wb/m^2 (= 1.0 gauss), the orbital radius of electron is (1996)

1. 11 cm ✓
2. 18 cm
3. 12 cm ✗
4. 16 cm

$B = 10^{-4}$ Wb/m^2 (SI unit)

$E_{ng} = 10 eV = 10e$ J

$$R = \frac{\sqrt{2m K.E}}{qB}$$

$$= \frac{\sqrt{2 \times 10^{-30} \times 10e}}{e \times 10^{-4}} = \frac{10^{-15}}{10^{-4}}\sqrt{\frac{2 \times 10}{1.6 \times 10^{-19}}}$$

$$= 10^{-11}\sqrt{\frac{20}{16 \times 10^{-20}}}$$

$$= \frac{10^{-11}}{10^{-10}}\sqrt{\frac{20}{16}} \quad (1.25)$$

$= 1.118 \times 10^{-1}$ m

QUESTION

A proton (m, e), deutron $(2m, e)$ and α-particle $(4m, 2e)$ are projected with same velocity in magnetic field, then find ratio of their radius of circular path.

Proton (m, e)

deutron $(2m, e)$

α-Parti) $(4m, 2e)$

$R = \frac{mv}{qB}$ → same

$R = \frac{mv}{qB}$

$R \propto \frac{m}{q}$

$R \propto \frac{m}{q}$

$R_p : R_D : R_\alpha = \frac{m}{e} : \frac{2m}{e} : \frac{4m}{2e}$

$= 1 : 2 : 2$

QUESTION

A proton (m, e), deutron $(2m, e)$ and α-particle $(4m, 2e)$ are projected with same momentum in magnetic field, then find ratio of their radius of circular path.

$$R = \frac{mv}{qB} = \frac{p}{qB} \rightarrow \text{same}$$

$$R \propto \frac{1}{q}$$

$$R_p : R_D : R_\alpha = \frac{1}{e} : \frac{1}{e} : \frac{1}{2e} = 1 : 1 : \frac{1}{2} = 2 : 2 : 1$$

QUESTION

A proton (m, e), deutron $(2m, e)$ and α-particle $(4m, 2e)$ are projected with same kinetic energy in magnetic field, then find ratio of their radius of circular path.

$$R = \frac{mv}{qB} = \frac{P}{qB} = \frac{\sqrt{2m\,K.E}}{qB}$$

$$R = \frac{\sqrt{m}}{q}$$

$$R_p : R_D : R_\alpha = \frac{\sqrt{m}}{e} : \frac{\sqrt{2m}}{e} : \frac{\sqrt{4m}}{2e}$$

$$= 1 : \sqrt{2} : 1$$

$$R = \frac{\sqrt{2m\,K.E}}{qB}$$

$$R \propto \frac{\sqrt{m}}{q}$$

QUESTION

A proton (m, e), deutron $(2m, e)$ and α-particle $(4m, 2e)$ are accelerated with same potential and then projected in magnetic field, then find ratio of their radius of circular path.

$$R = \frac{\sqrt{2mq\Delta V}}{qB}$$

$$R = \frac{\sqrt{mq}}{q}$$

$$R = \sqrt{\frac{m}{q}}$$

$$R_p : R_D : R_\alpha = \sqrt{\frac{m}{e}} : \sqrt{\frac{2m}{e}} : \sqrt{\frac{4m}{2e}} = 1 : \sqrt{2} : \sqrt{2} \text{ (Ans)}$$

QUESTION

A proton and an alpha particle both enter a region of uniform magnetic field B, moving at right angles to the field B. If the radius of circular orbits for both the particles is equal and the kinetic energy acquired by proton is 1 MeV, the energy acquired by the alpha particle will be (2015)

1. 1.5 MeV
2. 1 MeV
3. 4 MeV
4. 0.5 MeV

$$R = \frac{\sqrt{2mE}}{qB} = \text{same}$$

$$\frac{\sqrt{2 m_p E_p}}{eB} = \frac{\sqrt{2 \cdot 4 m_p E_\alpha}}{(2e)B}$$

$$\sqrt{E_p} = \frac{\sqrt{4E_\alpha}}{2}$$

$$E_p = \frac{4E_\alpha}{4}$$

$$E_p = E_\alpha$$

QUESTION

A proton carrying 1 MeV kinetic energy is moving in a circular path of radius R in uniform magnetic field. What should be the energy of an a-particle to describe a circle of same radius in the same field? (Mains 2012)

Same Repn.

1. 2 MeV
2. 1 MeV
3. 0.5 MeV
4. 4 MeV

QUESTION

Under the influence of a uniform magnetic field, a charged particle moves with a constant speed v in a circle of radius R. The time period of rotation of the particle

(2009, 2007)

1. depends on R and not on v
2. is independent of both v and R
3. depends on both v and R
4. depends on v and not on R.

$T = \frac{2\pi R}{v} = \frac{2\pi mv}{v\, qB}$

$T = \frac{2\pi m}{qB}$

QUESTION

A charged particle moves through a magnetic field in a direction perpendicular to it. Then the (2003)

1. speed of the particle remains unchanged
2. direction of the particle remains unchanged
3. acceleration remains unchanged
4. velocity remains unchanged.

QUESTION

An electron having mass m and kinetic energy E enter in uniform magnetic field B perpendicularly, then its frequency will be (2001)

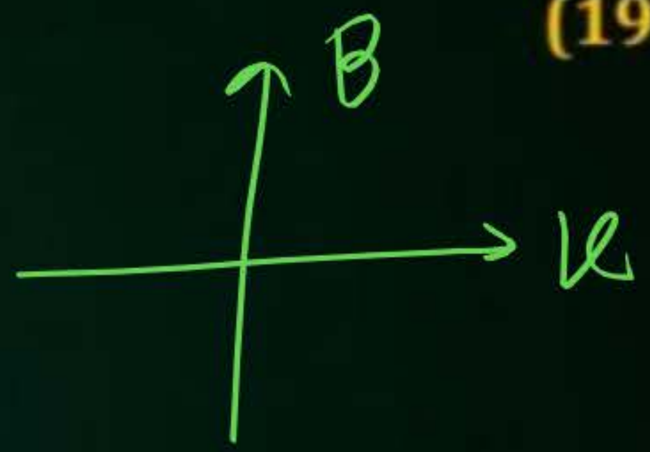
1. $\dfrac{eE}{qvB}$
2. $\dfrac{2\pi m}{eB}$
3. $\dfrac{eB}{2\pi m}$ ✓
4. $\dfrac{2m}{eBE}$

$$f = \frac{1}{T} = \frac{qB}{2\pi m}$$

$$f = \frac{eB}{2\pi m}$$

QUESTION

A positively charged particle moving due East enters a region of uniform magnetic field directed vertically upwards. This particle will (1997)



1. move in a circular path with a decreased speed
2. move in a circular path with a uniform speed
3. get deflected in vertically upward direction
4. move in circular path with an increased speed.

QUESTION

A uniform magnetic field acts right angles to the direction of motion of electrons. As a result, the electron moves in a circular path of radius 2 cm. If the speed of electrons is doubled, then the radius of the circular path will be (1991)

1. 2.0 cm
2. 0.5 cm
3. 4.0 cm
4. 1.0 cm

QUESTION

A deuteron of kinetic energy 50 keV is describing a circular orbit of radius 0.5 metre in a plane perpendicular to magnetic field B. The kinetic energy of the proton that describes a circular orbit of radius 0.5 metre in the same plane with the same B is

(1991)

1. 25 keV
2. 50 keV
3. 200 keV
4. 100 keV 63%

$R = \frac{\sqrt{2mE}}{eB}$

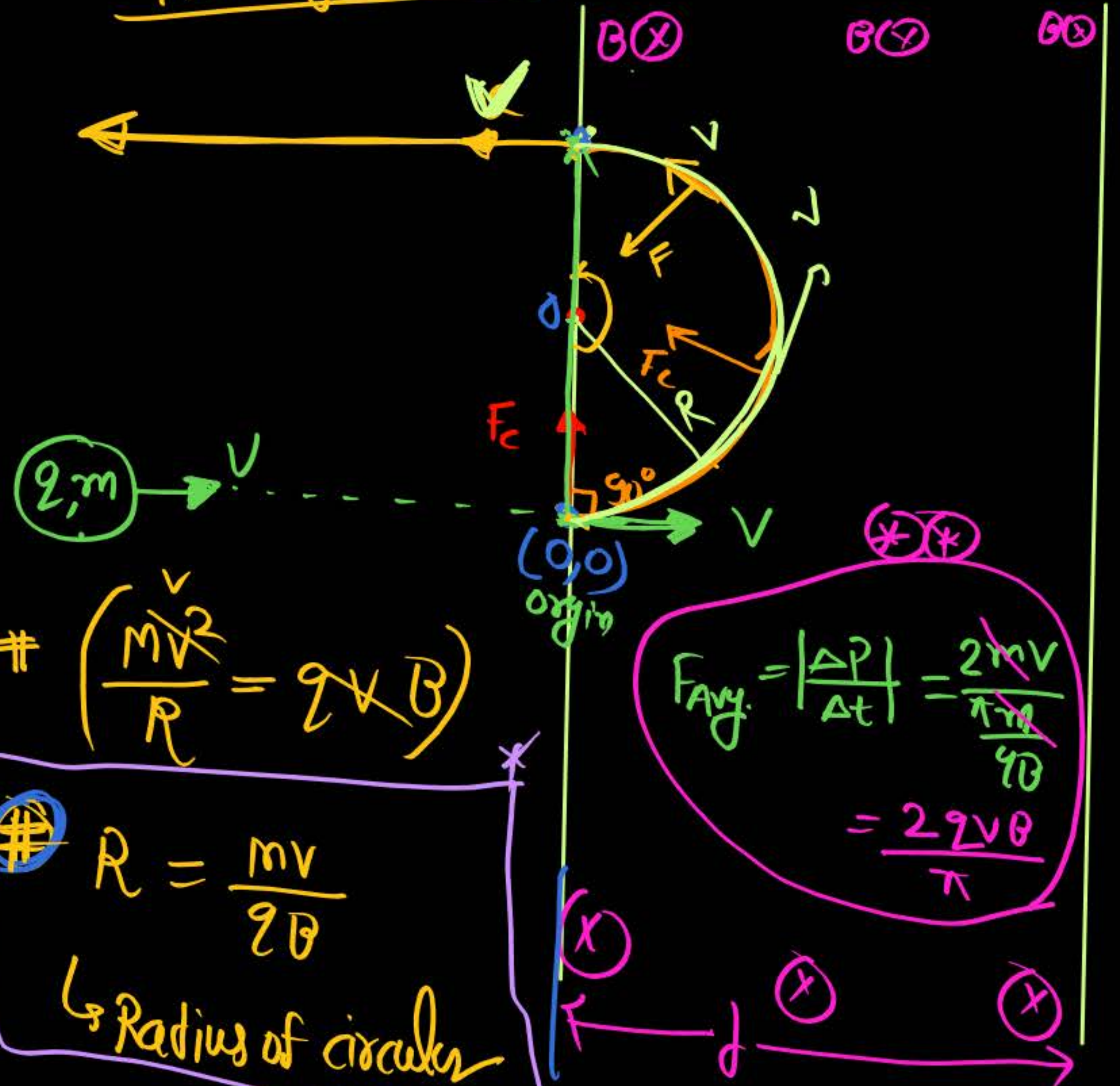
$\frac{\sqrt{2 \times 2m \times 50\,keV}}{eB} = \frac{\sqrt{2 \times m E}}{eB}$

$E = 100\,keV$

2025

Charge particle is project in magnetic field ⊥ to velocity from outside region of magnetic field.

No magnetic field



$$\frac{mv^2}{R} = qvB$$

$R = \dfrac{mv}{qB}$

↳ Radius of circular path

$$F_{Avg} = \left|\frac{\Delta P}{\Delta t}\right| = \frac{2mv}{\frac{\pi m}{qB}} = \frac{2qvB}{\pi}$$

$\text{Time} = \theta\left[\dfrac{m}{qB}\right) = \dfrac{\pi m}{qB}$

$$\text{time} = \frac{\text{distance}}{\text{speed}} = \frac{\pi R}{v} = \frac{\pi mv}{v\,qB} = \frac{\pi m}{qB}$$

* deviation = π rad = 180° only possible where $R < d$ ← width of magnetic

* Co-ordinate of exist point of charge particle

$$(0, 2R) = \left(0, \frac{2mv}{qB}\right)$$

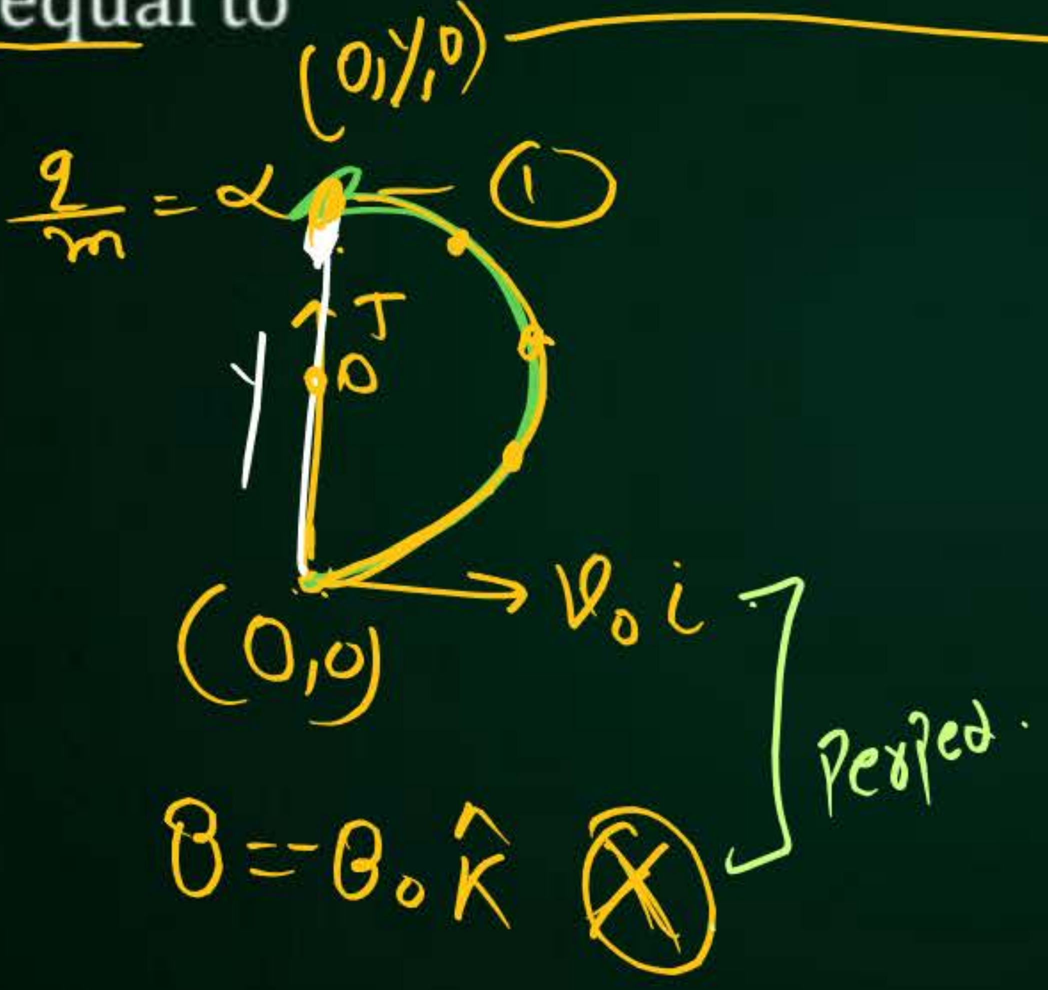
$F_{inst\ magnetic} = qvB$

$$F_{Avg\ magnetic\ force} = qvB \times \frac{\sin\theta/2}{\theta/2}$$

on semi-circular path $= qvB \times \dfrac{\sin(\pi/2)}{\pi/2} = \dfrac{2qvB}{\pi}$ (Ans)

QUESTION

A particle of charge per unit mass α is released from origin with a velocity $\vec{v} = v_0 i$ in a uniform magnetic field $\vec{B} = -B_0\hat{k}$. If the particle passes through $(0, y, 0)$ then y is equal to



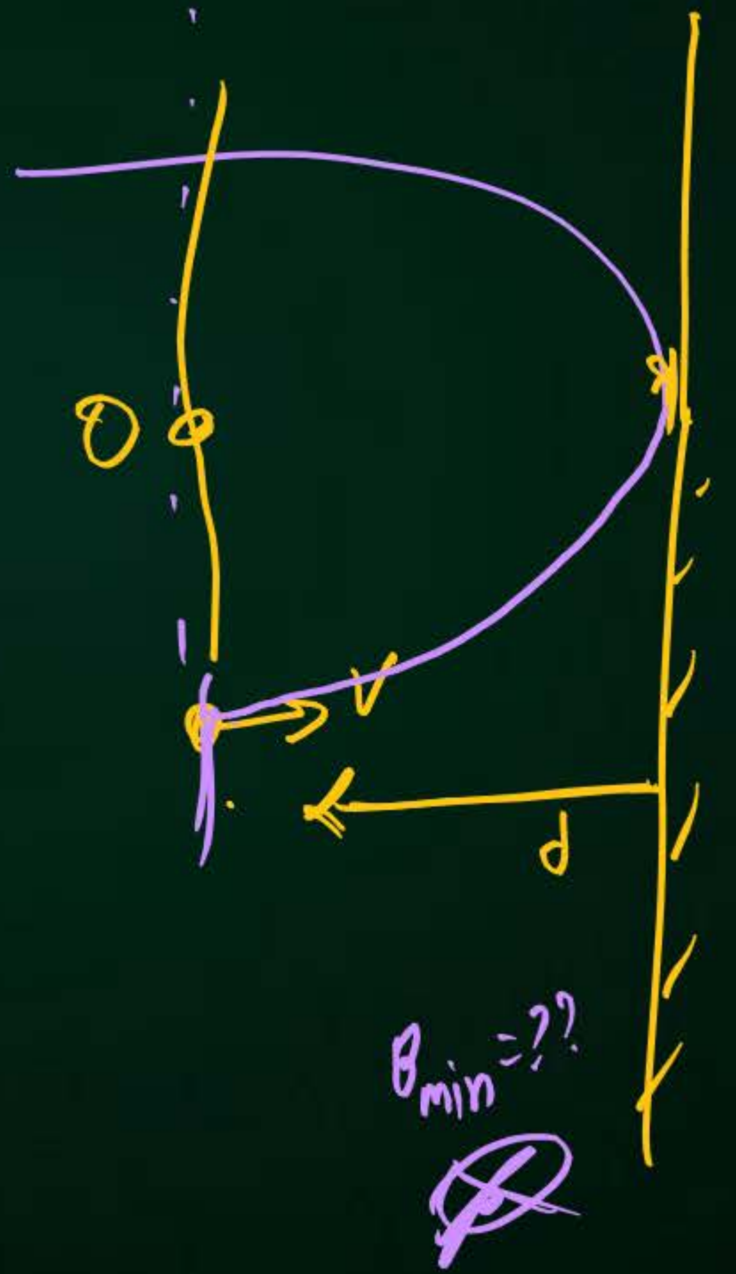
1. $-\dfrac{2v_0}{B_0 a}$
2. $\dfrac{v_0}{B_0 a}$
3. $\dfrac{2v_0}{B_0 a}$
4. $-\dfrac{v_0}{B_0 a}$

QUESTION

$s = \frac{q}{m}$

A particle with specific charges (s) is fired with a speed v towards a wall at a distance d, perpendicular to the wall. What minimum magnetic field must exist in this region for the particle doesn't hit the wall?

1. $\frac{v}{sd}$
2. $\frac{2v}{sd}$
3. $\frac{v}{2sd}$
4. $\frac{v}{4sd}$



$R = \frac{mv}{qB} = d$

$\frac{v}{sB} = d$

$B = \frac{v}{sd}$

QUESTION

A proton, an electron, a neutron, an α-particle and an unknown particle enter in a region of uniform magnetic field with equal momenta. Figure shows path (Marked 1 to 5) followed by these particles. Identify which path corresponds to which particle.

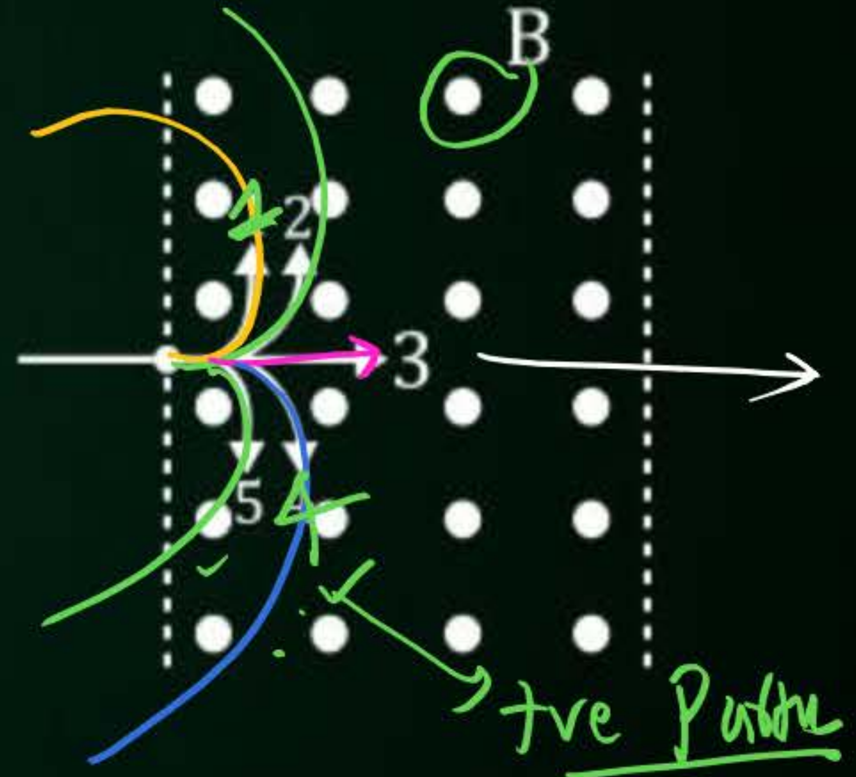
e^-, proton, neutral

$R = \frac{mv}{qB}$

$R = \frac{p}{qB}$

$R \propto \frac{1}{q}$

1) unknown particle
2) electron ← q (minimum charge)
3) neutron
4) proton ($q = e$)
5) α-Part.



charge particle is projected from outside at 90° from magnetic field.

But at angle θ with the boundary.



* deviation = 2θ

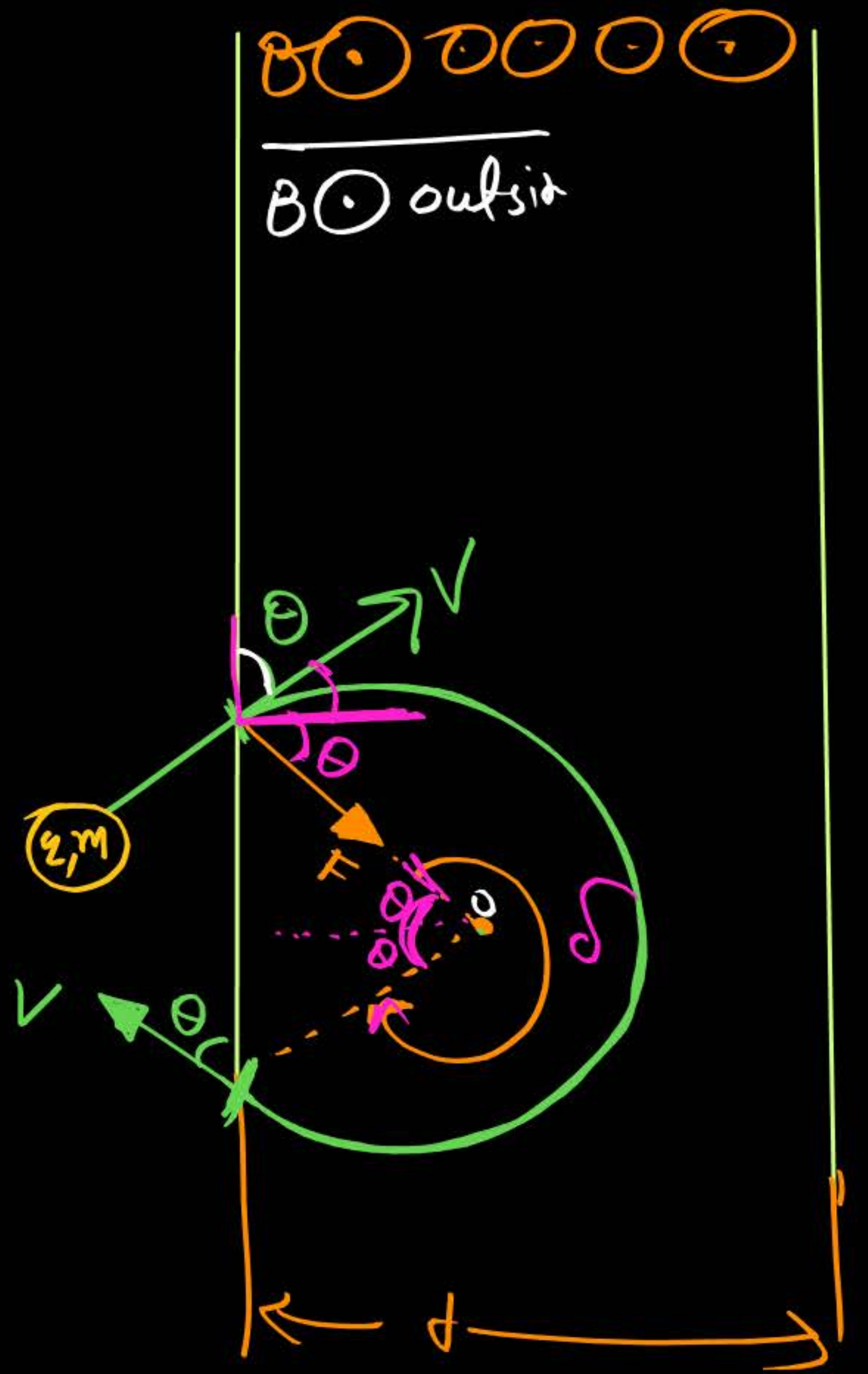
speed = const
K.E = const
W = ΔK.E = 0

Power = 0

work done by magnetic field = zero

deviation = 2θ

$$time = 2\theta \left(\frac{m}{qB}\right)$$



deviation = ??

$$\delta = 2\pi - 2\theta$$

$$\text{time} = \delta\left[\frac{m}{qB}\right] = 2\pi - 2\theta\left[\frac{m}{qB}\right]$$

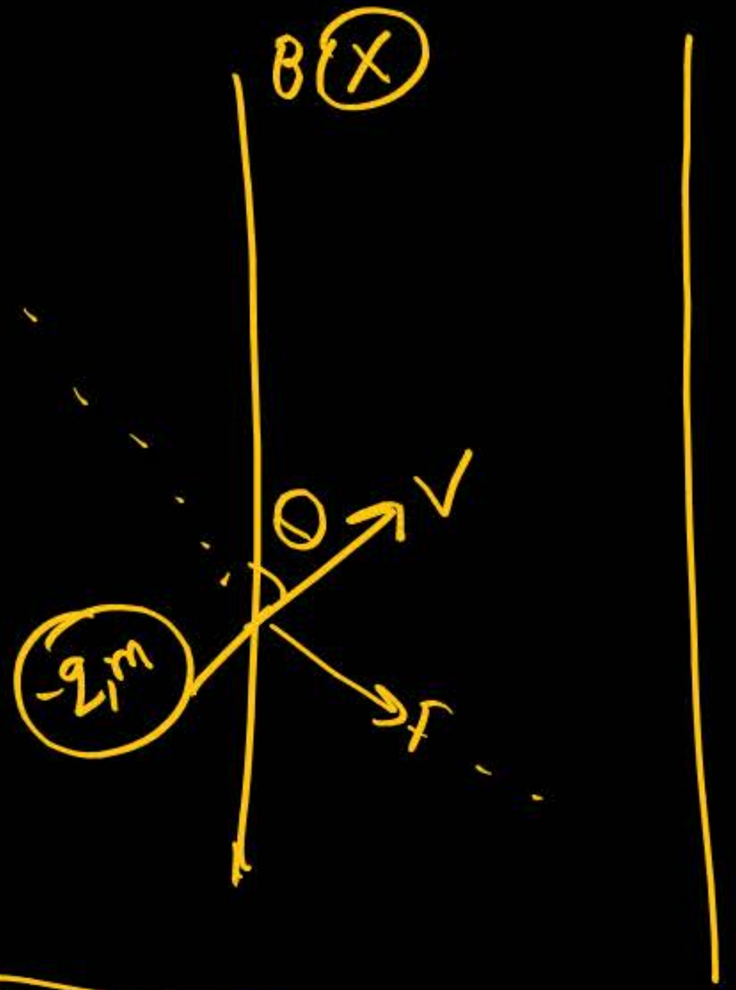
MR*

Force → outside

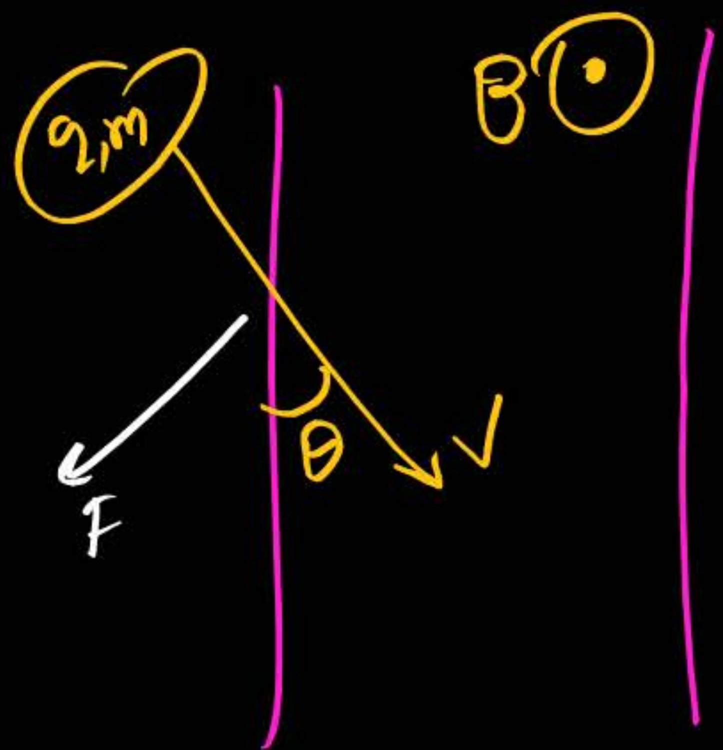
$\delta = 2\theta$

Force (inside)

$\delta = (2\pi - 2\theta)$



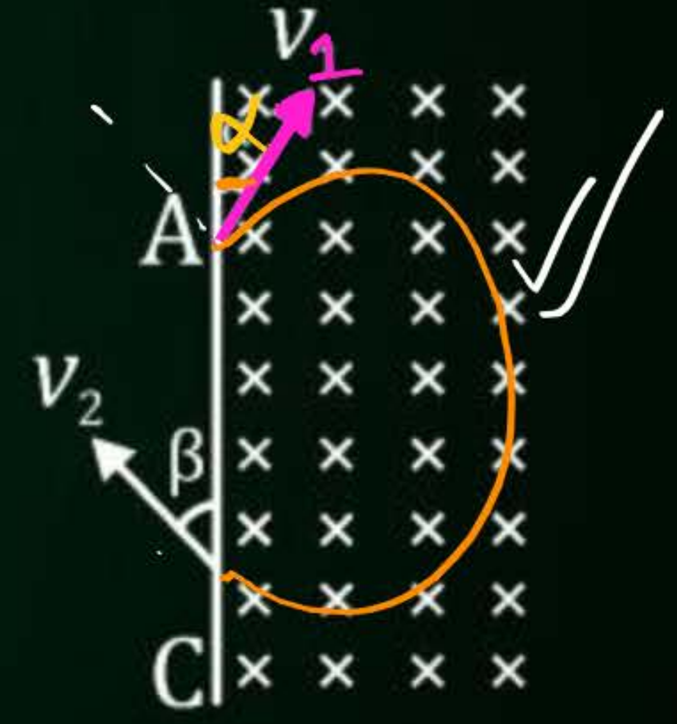
$$\delta = 2\pi - 2\theta$$



$$\delta = 2\theta$$

QUESTION

A particle of charge $-q$ and mass m enters a uniform magnetic field $\vec{B}$ at A with speed v_1 at an angle α and leaves the field at C with speed v_2 at an angle β as shown. Then



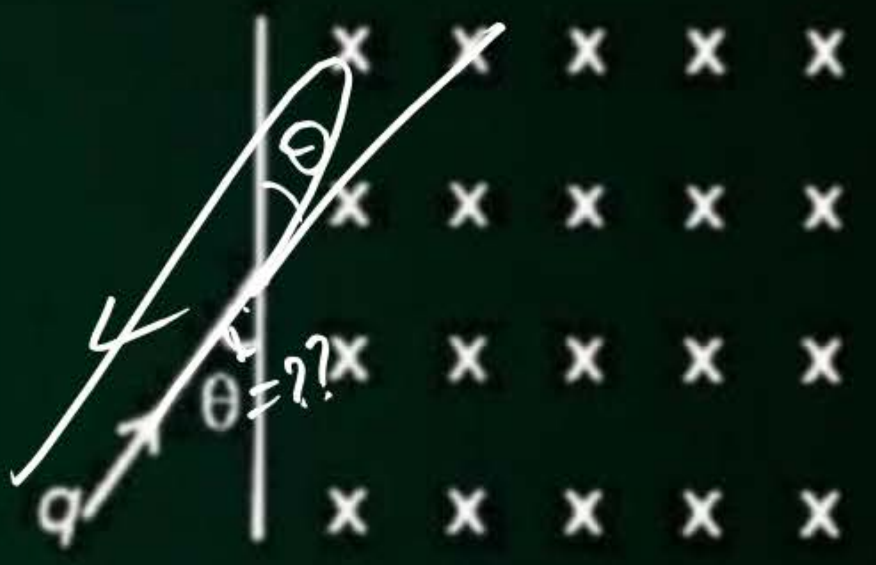
1. $\alpha = \beta$
2. $v_1 = v_2$
3. Particle remains in the field for time $= \dfrac{2m(\pi-\alpha)}{qB}$
4. All of these.

Ans (4)

QUESTION

A charged particle enters a uniform magnetic field at some angle. The particle will be deviated from its path by angle 180°. Value of θ will be

1. 90°
2. 60°
3. 120°
4. 180°



QUESTION

A proton of mass m, charge q enters a magnetic field B with a velocity v at an angle θ with the direction of B. The radius of the resulting path is

1. $\frac{mv}{qB}$

2. $\frac{mv\sin\theta}{qB}$

3. $\frac{mv\cos\theta}{qB}$

4. $\frac{mv}{qv\sin\theta}$

QUESTION

(17)

A charge having e/m equal to 10^8 C/kg and with velocity 3×10^5 m/s enters into a uniform magnetic field $B = 0.3$ tesla at an angle 30° with direction of field. The radius of curvature will be (1999)

$\frac{e}{m} = 10^8$ C/kg

$R = \frac{mv\sin\theta}{qB}$

1. 0.01 cm
2. 0.5 cm
3. 1 cm
4. 2 cm

QUESTION

Charge particle can't accelerate in the magnetic field?
Or, magnetic field can't accelerate the charge particle.

QUESTION

Find times spend in magnetic field.

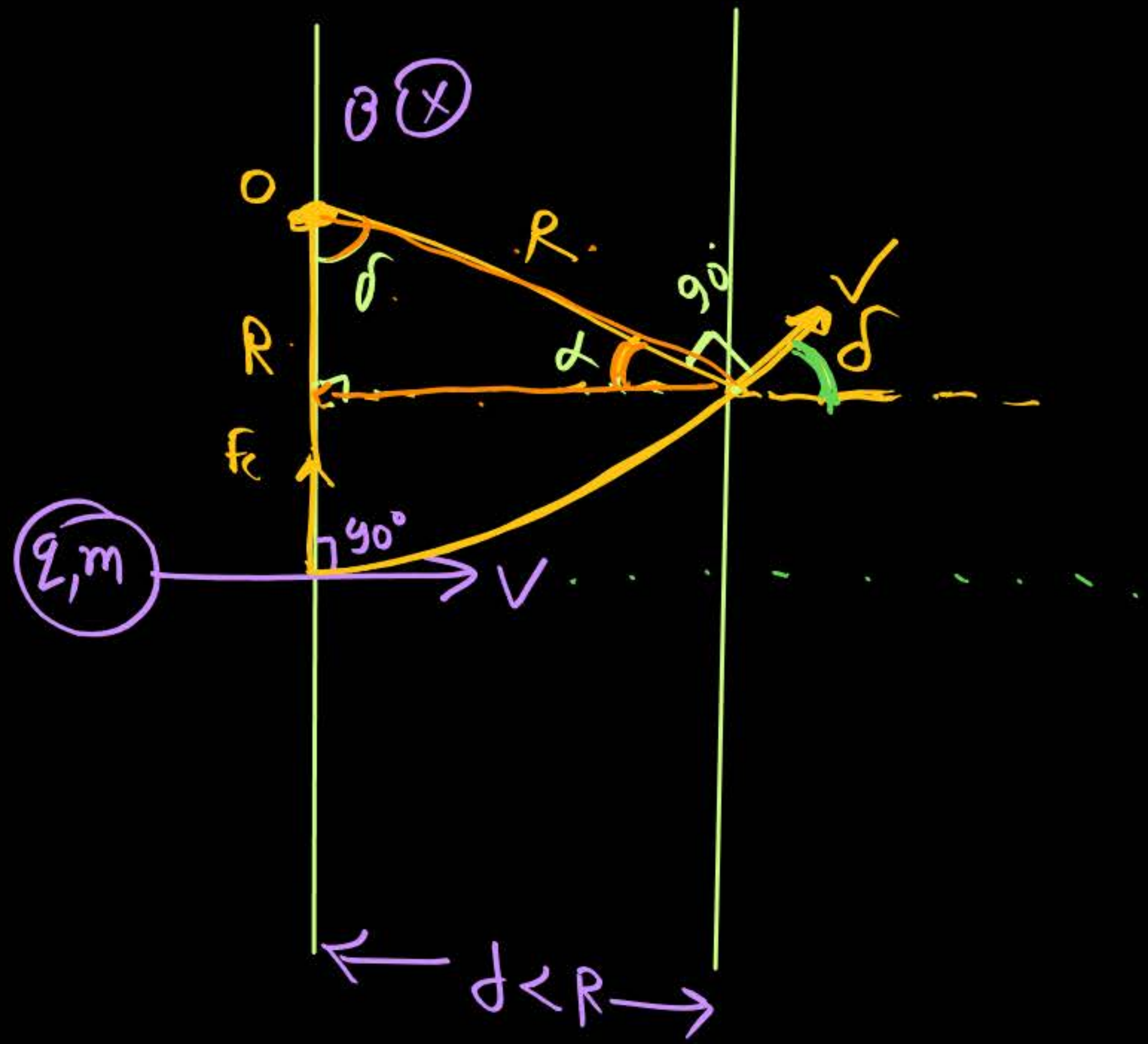
1. 120°
2. 60°
3. 240°
4. None of these



$\delta = 2 \times 60 = 120^\circ = \frac{2\pi}{3}$

$t = \delta\left(\frac{m}{qB}\right)$

$= \frac{2\pi m}{3qB}$ Ans



$\alpha + 90 + \delta = 180$

$$\alpha = 90 - \delta$$

Deviation ??

$\sin\delta = \frac{P}{H} = \frac{d}{R}$

$\delta = \sin^{-1}\left(\frac{d}{R}\right)$

$$\delta = \sin^{-1}\left(\frac{d\,qB}{mv}\right)$$

QUESTION

A charged particle is whirled in a horizontal circle by attaching it to a string fixed at one point. If a magnetic field is switched on the vertical direction, the tension in the string:

1. Will increase
2. Will decrease
3. Will remain the same
4. May increase or decrease

QUESTION

A particle having a charge of 10 μC and mass 1 μg moves in a horizontal circle of radius 10 cm under the influence of a magnetic field of 0.1 T. When the particle is at a point P, a uniform electric field is switched on so that the particle starts moving along the tangent with uniform velocity. The electric field is

1. 0.1 V/m
2. 1.0 V/m
3. 10.0 V/m
4. 100 V/m

QUESTION

A charged particle enters a magnetic field at right angles to the magnetic field. The field exists for a length equal to 1.5 times the radius of circular path of the particle. The particle with be deviated from its path by

1. 90°
2. $\sin^{-1}\left(\frac{2}{3}\right)$
3. 30°
4. 180°

QUESTION

A proton and an α-particle enter a uniform magnetic field perpendicular with the same speed. If proton takes 20 μs to make 5 revolutions, then the periodic time for the α-particle would be

1. 5 μs
2. 8 μs
3. 10 μs
4. 16 μs

QUESTION

A particle of mass m carrying charge q is accelerated by a potential difference V. It enters perpendicularly in a region of uniform magnetic field B and executes circular arc of radius R, then $\frac{q}{m}$ equals

1. $\frac{2V}{B_2R_2}$
2. $\frac{V}{2BR}$
3. $\frac{VB}{2R}$
4. $\frac{mV}{BR}$

- **Charge particle is projected outside from a region of magnetic field but ($d < R$) then find deviation**

➢ **Particle is projected at an angle ($\theta < 90°$) from magnetic field:**

➢ Motion of charge particle in combined electric and magnetic field:

QUESTION

When a proton is released from rest in a room, it starts with an initial acceleration a_0 towards west. When it is projected towards north with a speed v_0 it moves with an initial acceleration $3a_0$ towards west. The electric and magnetic fields in the room are:

[NEET-2013]

(1) $\frac{ma_0}{e}$ $west, \frac{2ma_0}{ev_0}$ $down$

(2) $\frac{ma_0}{e}$ $east, \frac{2ma_0}{ev_0}$ up

(3) $\frac{ma_0}{e}$ $east, \frac{2ma_0}{ev_0}$ $down$

(4) $\frac{ma_0}{e}$ $west, \frac{2ma_0}{ev_0}$ up


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture-6 | Physics

Moving Charges and Magnetism

By- Dr. Manish Raj (MR SIR)



Todays Goal

Motion of charge particle in combined electric & magnetic field

QUESTION

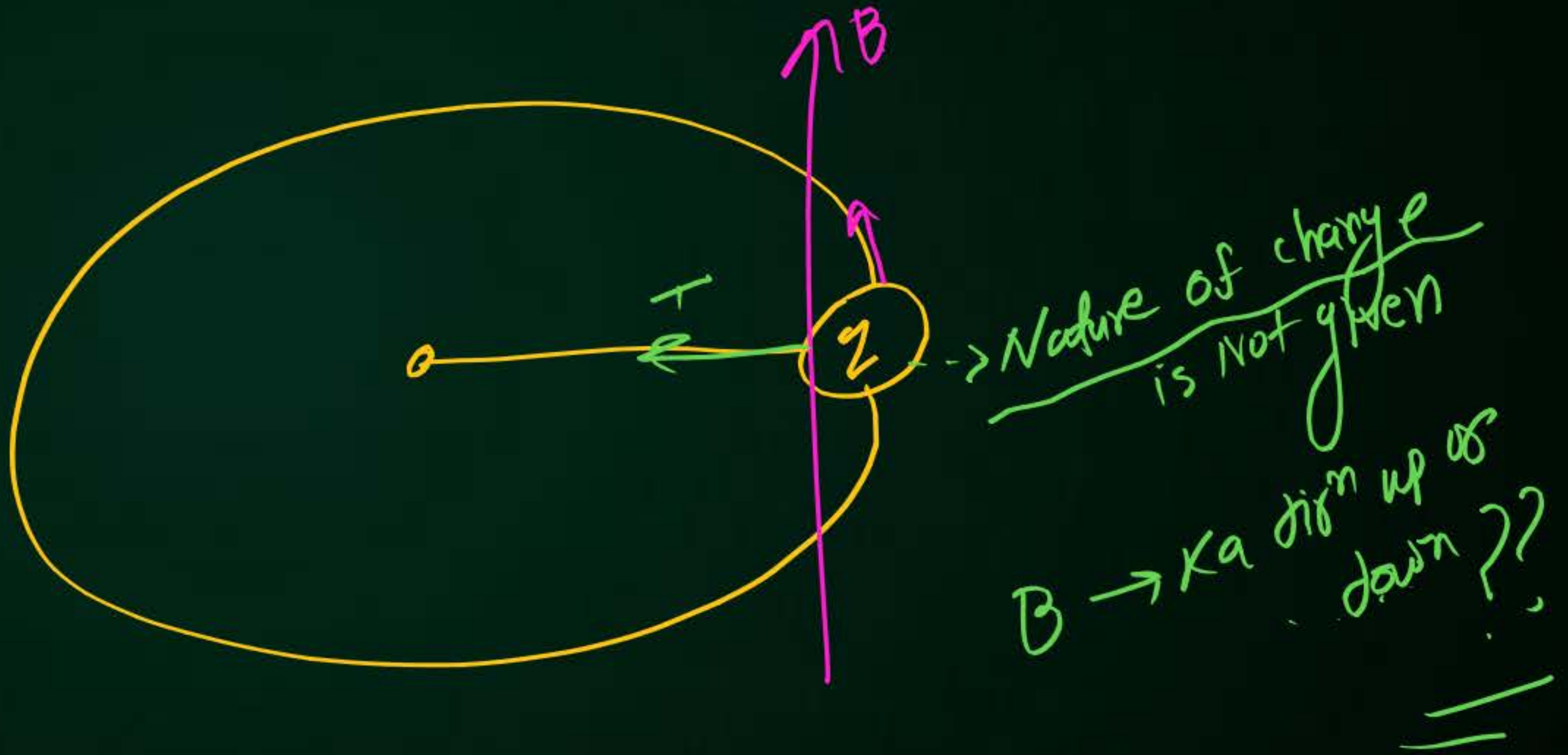
A particle of mass m carrying charge q is accelerated by a potential difference V. It enters perpendicularly in a region of uniform magnetic field B and executes circular arc of radius R, then $\frac{q}{m}$ equals

1. $\frac{2V}{B^2R^2}$
2. $\frac{V}{2BR}$
3. $\frac{VB}{2R}$
4. $\frac{mV}{BR}$

QUESTION

A charged particle is whirled in a horizontal circle by attaching it to a string fixed at one point. If a magnetic field is switched on the vertical direction, the tension in the string:

1. Will increase
2. Will decrease
3. Will remain the same
4. May increase or decrease



QUESTION

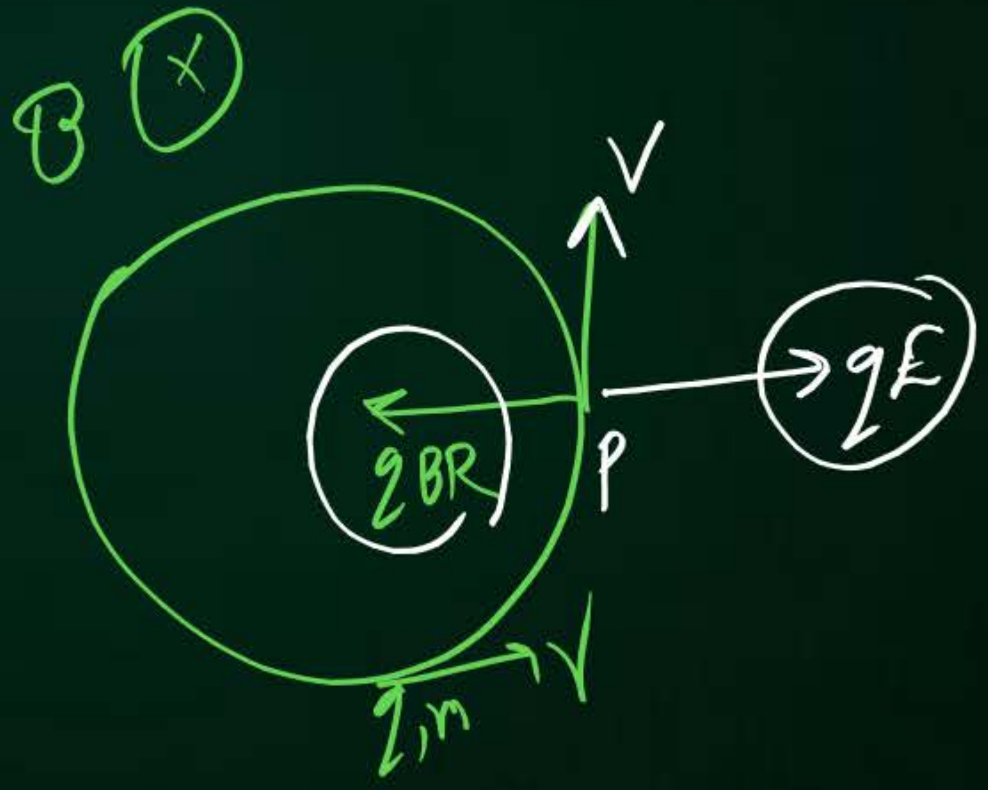
A particle having a charge of 10 μC and mass 1 μg moves in a horizontal circle of radius 10 cm under the influence of a magnetic field of 0.1 T. When the particle is at a point P, a uniform electric field is switched on so that the particle starts moving along the tangent with uniform velocity. The electric field is

1. 0.1 V/m
2. 1.0 V/m
3. 10.0 V/m
4. 100 V/m

$\vec{v} =$ const
$a = 0$
$F = 0$

$R = \frac{mv}{qB}$

$V = \frac{RqB}{m}$



$qE = qBV$

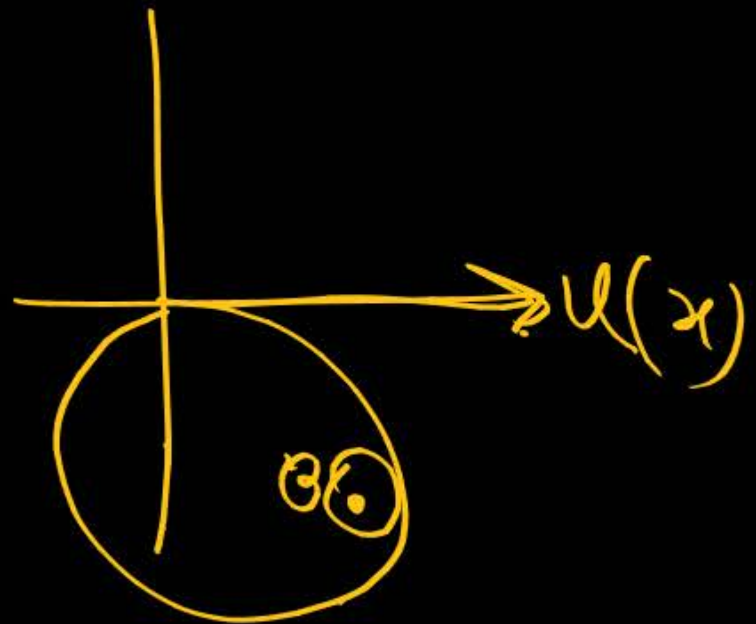
$E = BV$ ✓

$E = B\left(\frac{RqB}{m}\right) = \frac{B^2 qR}{m}$

$\vec{u} = u_0 \hat{i}$

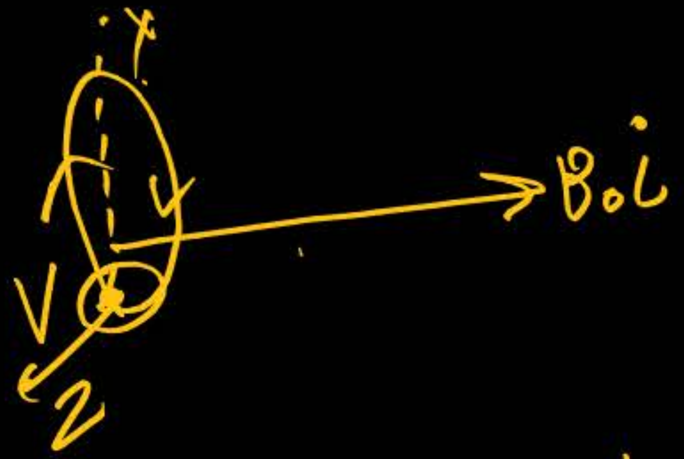
$B = B_0 \hat{k}$

circular Path ka plane XY plane hoga



$u = V_0 \hat{k}$

$B = B_0 \hat{i}$



circul Pahth YZ plane me hoga.

$u = u_0 \hat{j}$

$B = B_0 \hat{k}$

circular Path plane XY plane

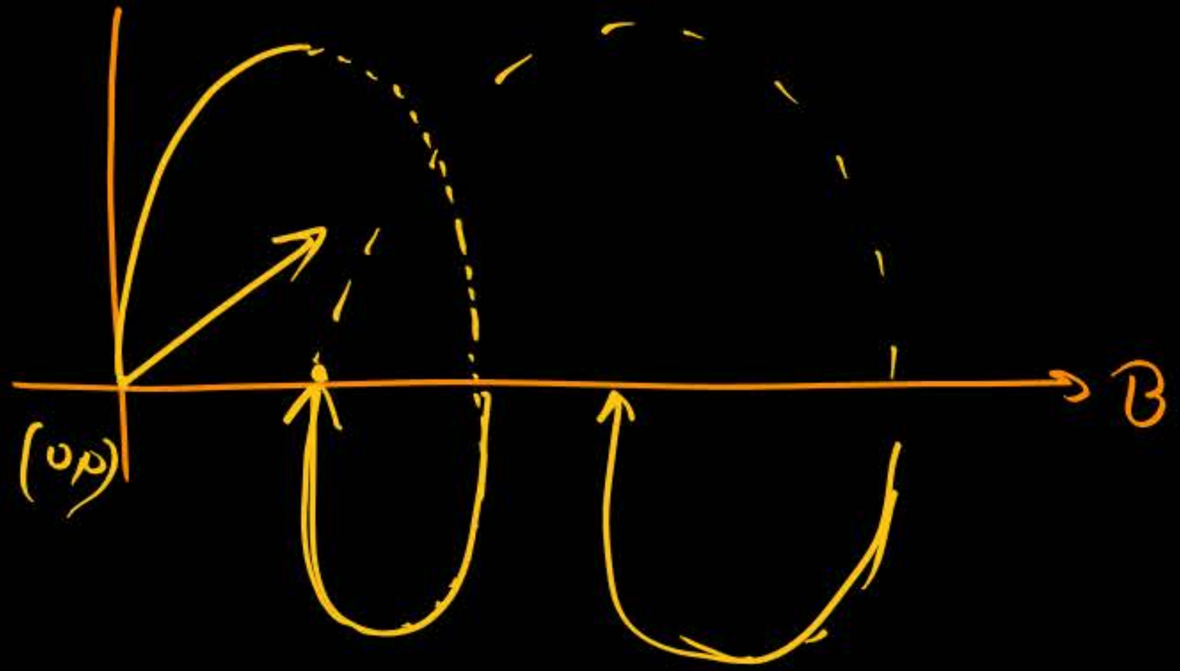


fig-① (a)
28%

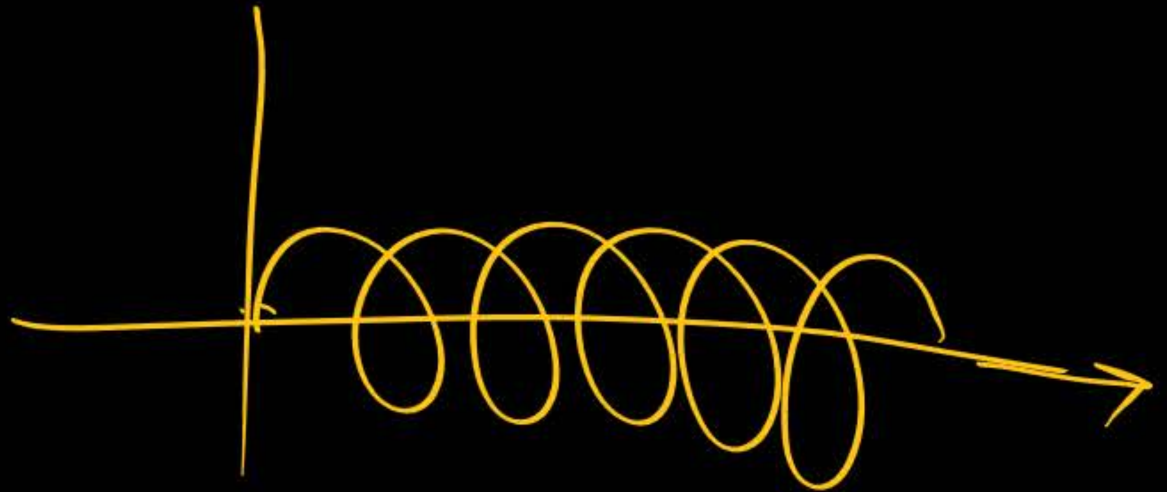
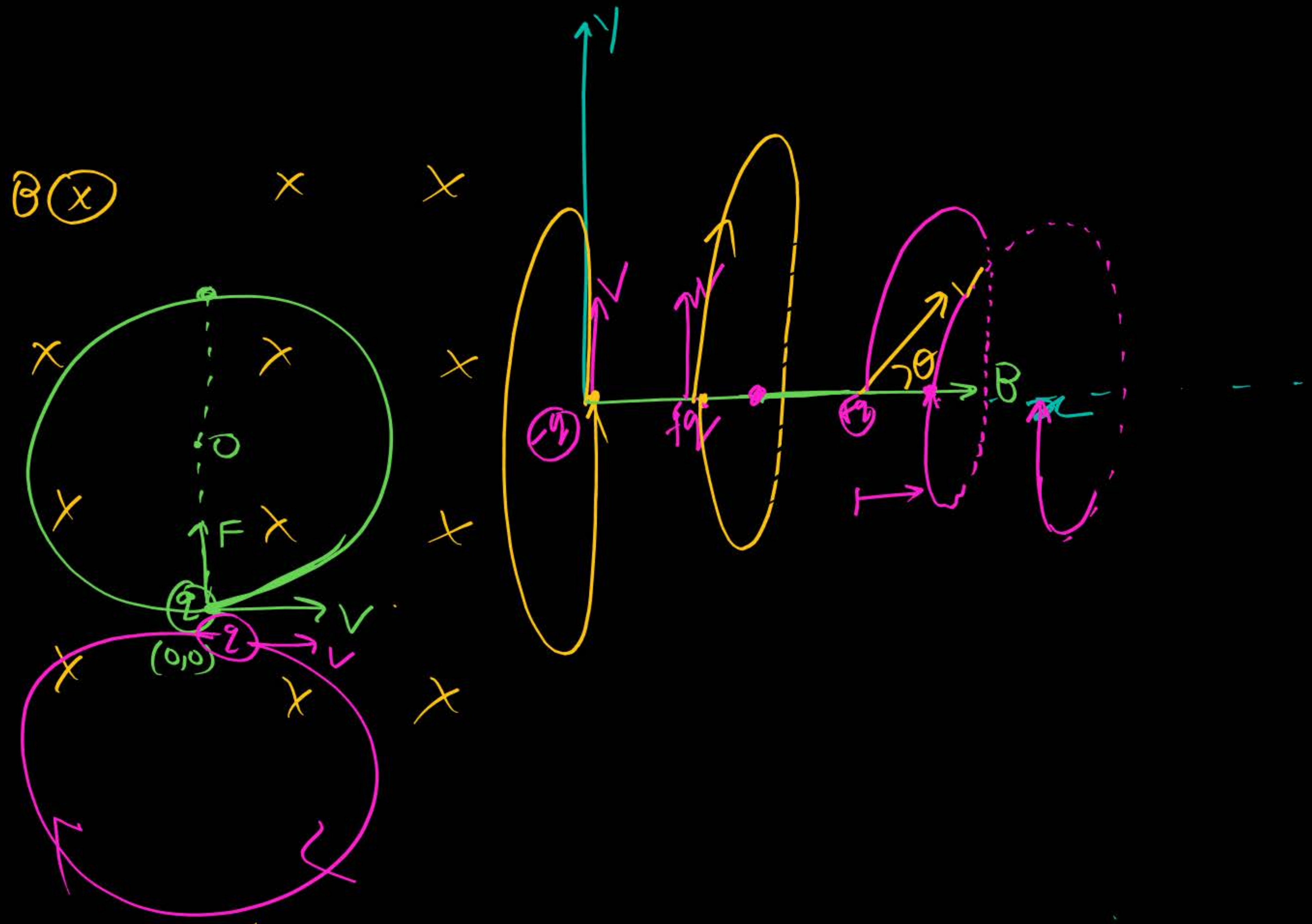
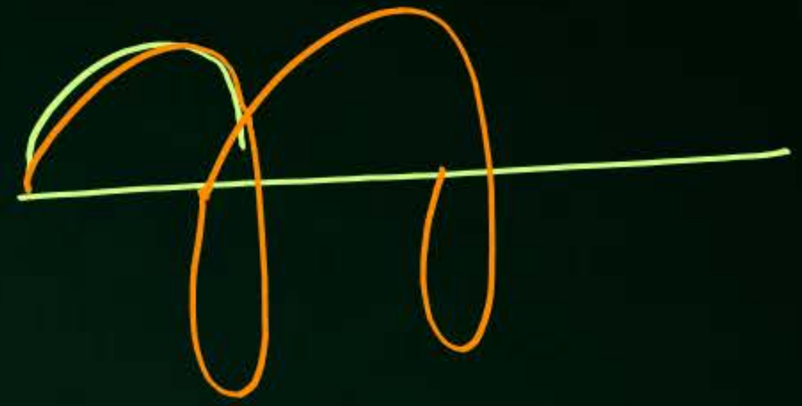


fig-① (b)

70% → मुड़ी और डुआ



B
F
V
(0,0)
Y
V
θ
B

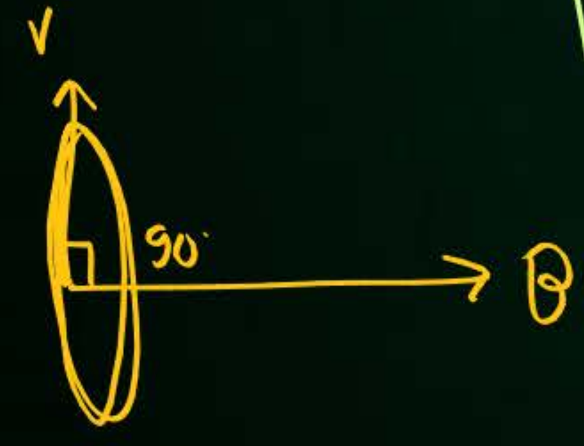


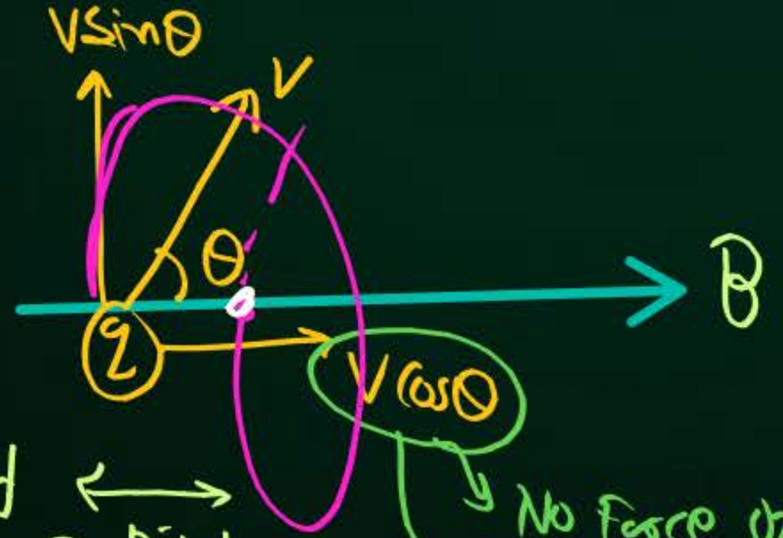
Path Followed: Helical

When a charged particle is projected in a uniform magnetic field such that its velocity is not parallel, antiparallel or perpendicular to the magnetic field, then it follows a helical path

Angle θ B/w $\vec{B}$ & $\vec{v}$ is zero or 180° ⟶ straight line path.

Angle B/w $\vec{B}$ & $\vec{v}$ is 90° ⟶ circle.





dist^n moved by Charge Particle in one Rotation along magnetic field ⟷ = Pitch.

v cosθ → No Force on x-axis
→ Uniform = co(n) Velocity

$$\frac{m(v\sin\theta)^2}{R} = q v\sin\theta B$$

$$R = \frac{mv\sin\theta}{qB}$$

$$T = \frac{2\pi m}{qB}$$ → Time period

$$\text{Pitch} = (u)\cos\theta \times T$$

$$\text{Pitch} = v\cos\theta \times \left[\frac{2\pi m}{qB}\right]$$

QUESTION

A charged particle P leaves the origin with speed $v = v_0$, at some inclination with the x-axis. There is a uniform magnetic field B along the x-axis. P strikes a fixed target T on the x-axis for a minimum value of $B = B_0$. P will also strike T if

(i) $B = 2B_0, v = 2v_0$

(ii) $B = 2B_0, v = v_0$

(iii) $B = B_0, v = 2v_0$

(iv) $B = B_0/2, v = 2v_0$



A (i), (ii)

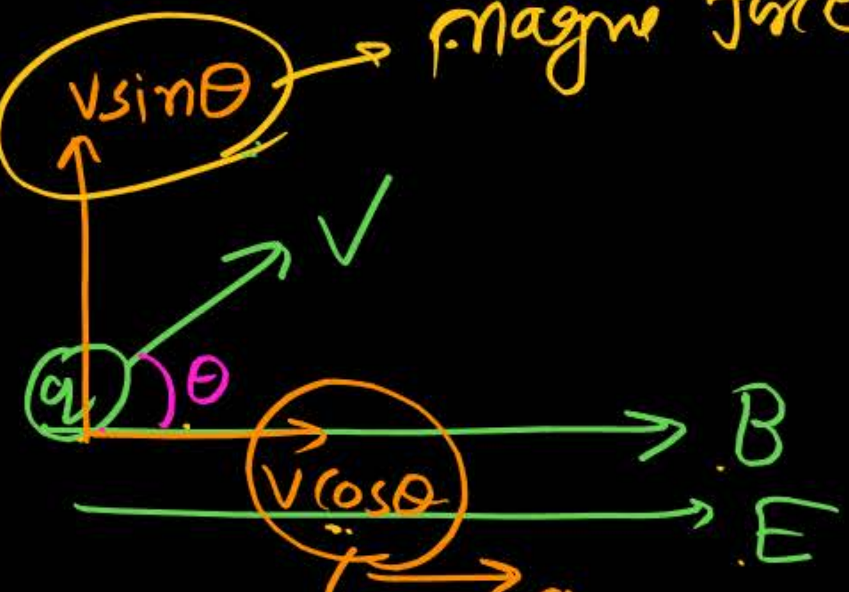
B (ii), (iii)

C (i), (iii)

D (ii), (iv)

Motion charge in electric & magnetic field

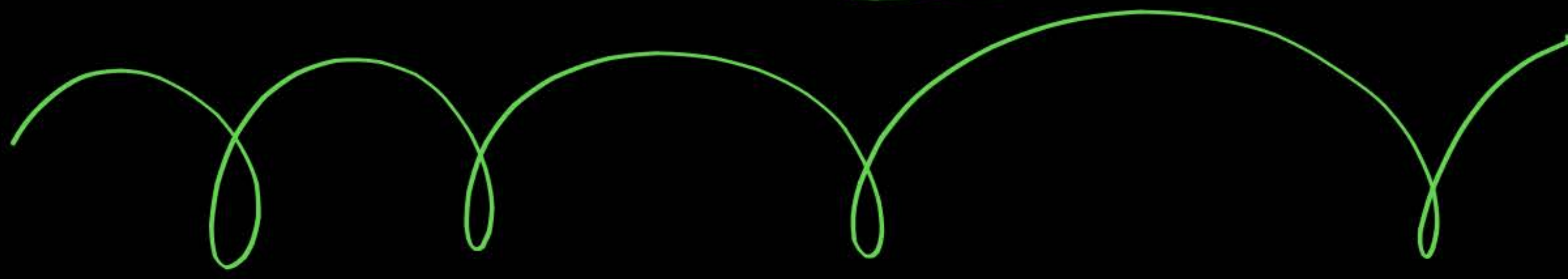
R = Same
Pitch → Inresing



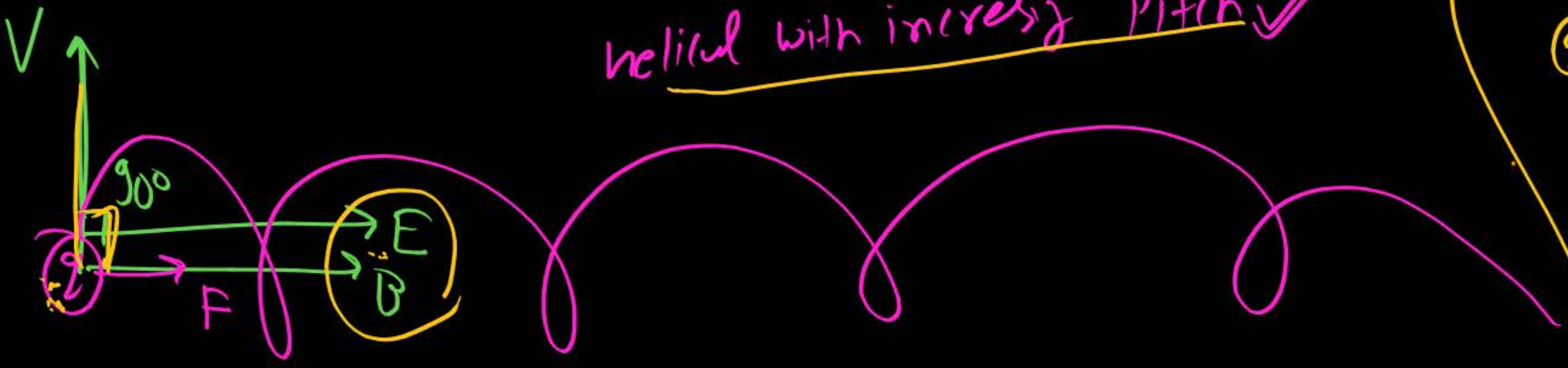
→ magnetic force will change dirⁿ

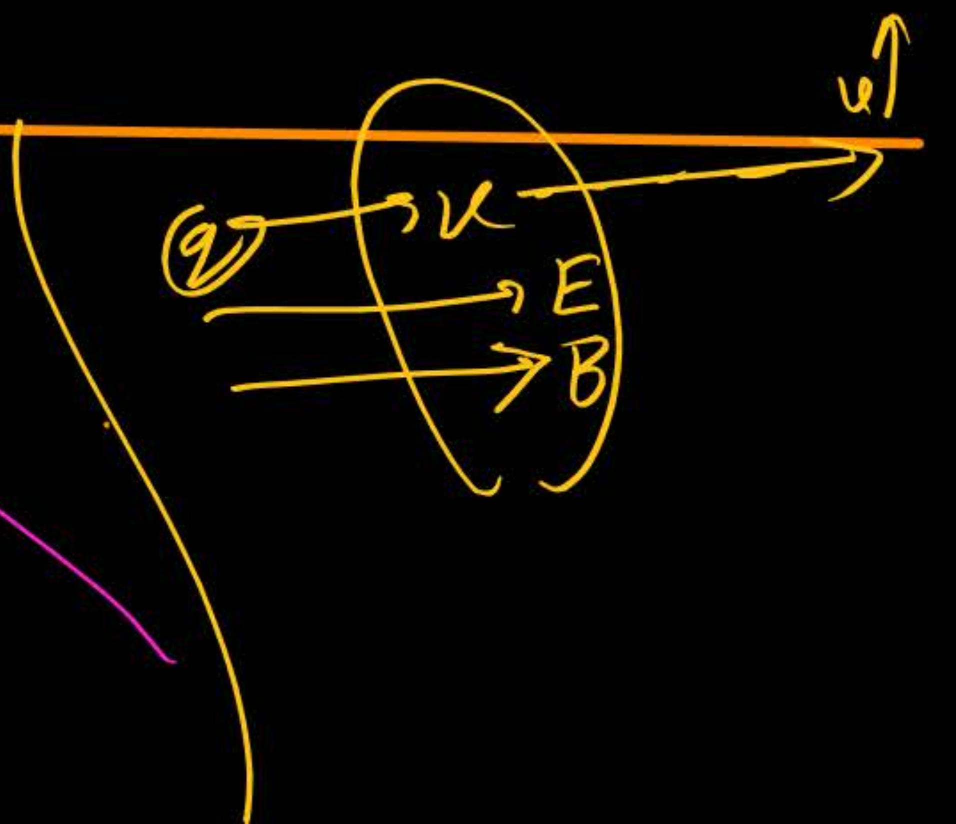
F = qE

→ speed will ↑ increase
dirⁿ remain same (v cosθ)



helical with increasing pitch ✓





QUESTION

Consider the motion of a positive point charge in a region where there are simultaneous uniform electric and magnetic fields $\vec{E} = E_0\hat{j}$ and $\vec{B} = B_0\hat{j}$. At time $t = 0$, this charge has velocity $\vec{v}$ in the $x - y$ plane, making an angle θ with the x-axis. Which of the following option(s) is(are) correct for time $t > 0$

(i) If $\theta = 0°$, the charge moves in a circular path in the $x - z$ plane

(ii) If $\theta = 0°$, the charge undergoes helical motion with constant pitch along the y-axis

(iii) If $\theta = 10°$, the charge undergoes helical motion with its pitch increasing with time, along the y-axis

(iv) If $\theta = 90°$, the charge undergoes linear but accelerated motion along the y-axis

A (i), (ii)

B (i), (iv)

C (ii), (iii)

D (iii), (iv)

QUESTION

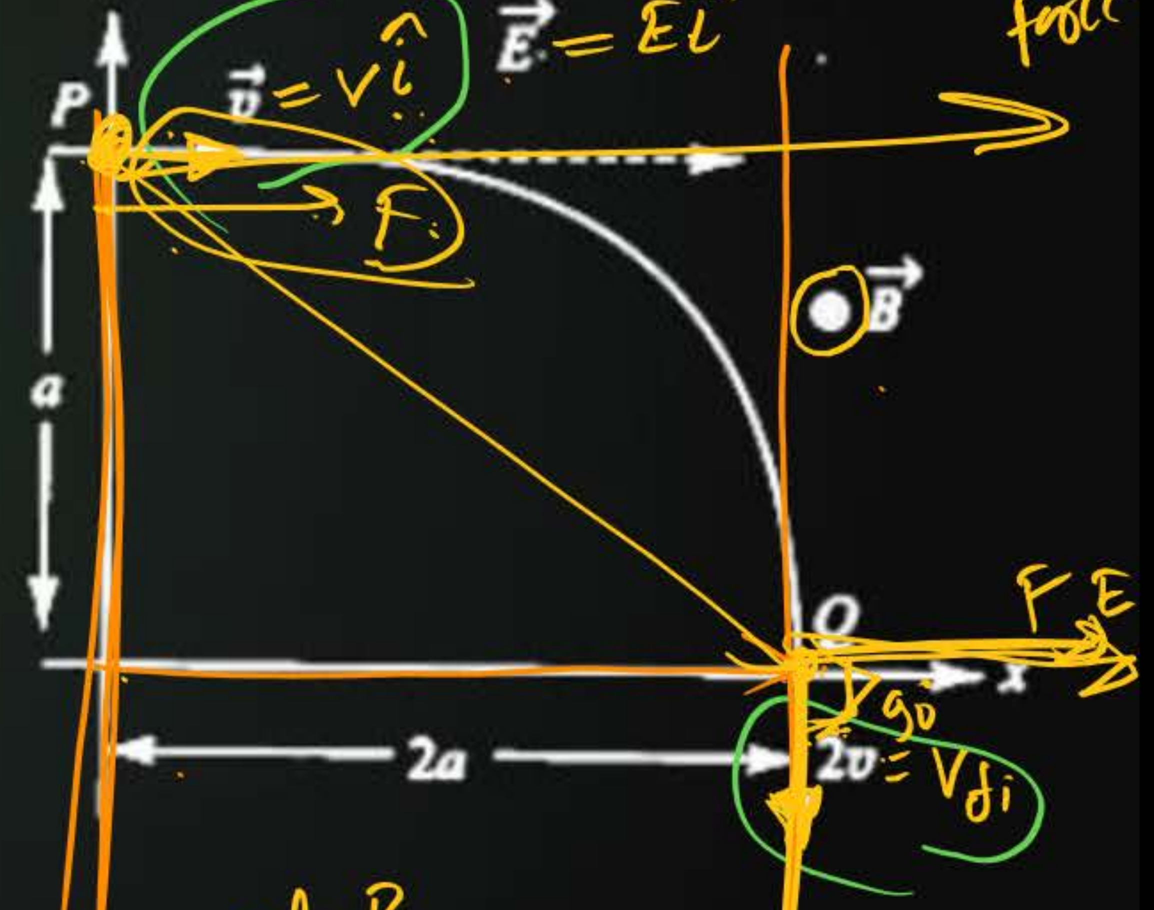
A particle of charge $+q$ and mass m moving under the influence of a uniform electric field $E\hat{i}$ and a uniform magnetic field $B\hat{k}$ follows trajectory from P to Q as shown in figure. The velocities at P and Q are $v\hat{i}$ and $-2v\hat{j}$ respectively. Which of the following statement(s) is/are correct

(i) $E = \frac{3}{4}\frac{mv^2}{qa}$

(ii) Rate of work done by electric field at P is $\frac{3}{4}\frac{mv^3}{a}$

(iii) Rate of work done by electric field at P is zero

(iv) Rate of work done by both the fields at Q is zero



A (i), (ii)

B (ii), (iv)

C (i), (ii), (iv)

D (i), (iv)

QUESTION

When a proton is released from rest in a room, it starts with an initial acceleration a_0 towards west. When it is projected towards north with a speed v_0 it moves with an initial acceleration $3a_0$ towards west. The electric and magnetic fields in the room are:

[NEET-2013]

1. $\frac{ma_0}{e}$ west, $\frac{2ma_0}{ev_0}$ down
2. $\frac{ma_0}{e}$ east, $\frac{2ma_0}{ev_0}$ up
3. $\frac{ma_0}{e}$ east, $\frac{2ma_0}{ev_0}$ down
4. $\frac{ma_0}{e}$ west, $\frac{2ma_0}{ev_0}$ up

e^+ (rest)

a_0 (west)

↳ due to electric force ∴

$eE = ma_0$

$E = \frac{ma_0}{e}$ (west)



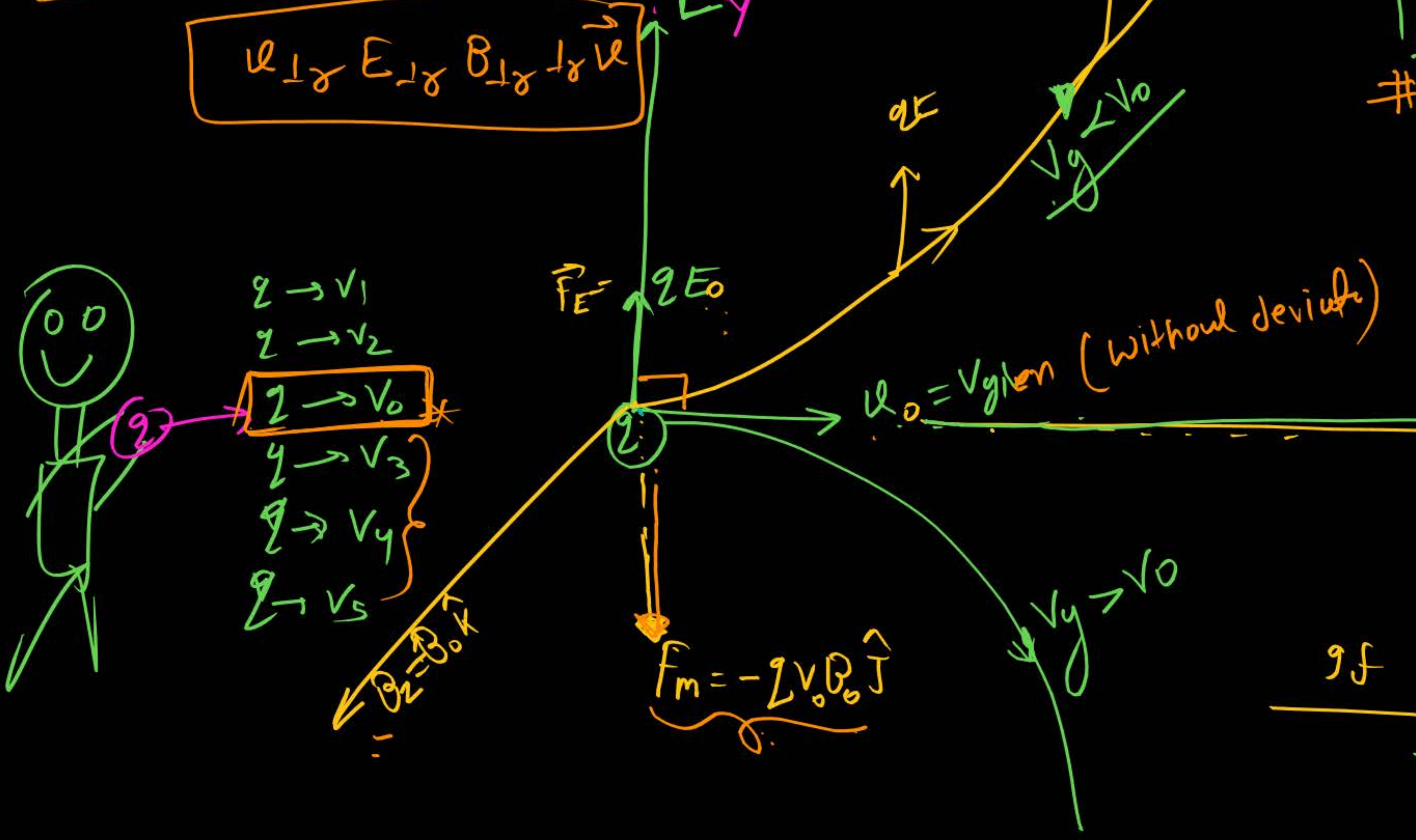
$3a_0 = a_0 + 2a_0$ → magnetic force $F = ma$

a_0: electric field

$qvB = m(2a_0)$

$B = \frac{2ma_0}{ev}$

→ Velocity selector



If $F_E > F_m$ ($v_{given} < v_0$)
charge will deviate in upward.

If $F_E = F_m$ ($F_{net} = 0$, $a = 0$, v = const)

$qE_0 = qv_0B_0$

$E_0 = v_0B_0$



If magnetic force is greater (than) electric force

$v_{given} > v_0$

$F_{magn} > F_{elec}$

deviated in downward

Concept

If a charged particle kept at rest experiences an electromagnetic force, then, The electric field must ~~not~~ be ~~zero~~ non-zero

OR

The magnetic field may or may not be zero.

rest

(2) → F = electromagnetic.

electric field must be zero

q (rest) → $F_{net} = 0$

E → must be zero

*B → may be zero or non-zero

q (rest) → $F_{net} \neq 0$

E → electric field must be non-

B → may or may not be zero.

Concept

If a charged particle at rest experiences no electromagnetic force, then The electric field must be zero

OR

The magnetic field may or may not be zero.

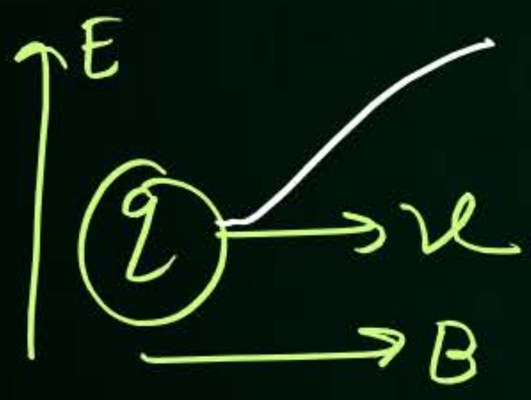
Concept

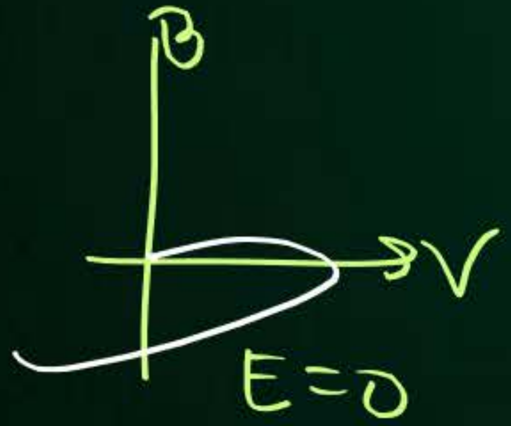
If a charged particle projected in a gravity-free room deflects, then Both fields cannot be zero

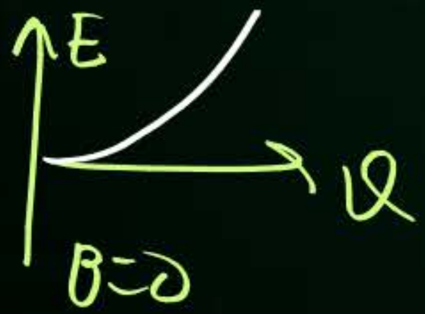
OR

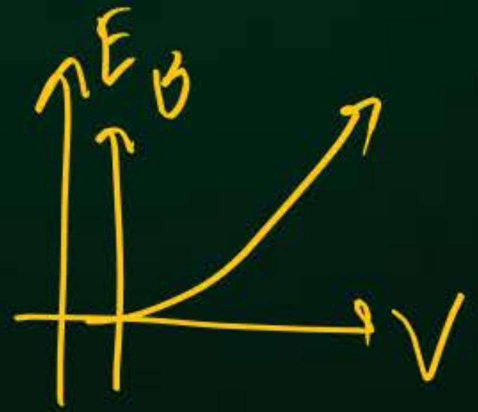
→ Both fields can be non-zero ✓

→ may be one field Non zero









concept

A charged particle moves in a gravity-free space without change in velocity. Possible cases are $E = 0, B = 0$ or $E = 0, B \neq 0$ or $E \neq 0, B \neq 0$

$\vec{v} = \text{const}^n$

$\hookrightarrow F = 0$

$a = 0$

$\longrightarrow E = 0$

$\longrightarrow B$

$\text{q} \longrightarrow v$

$F = 0$

qE

$F_{net} = 0$

qvB

$E \neq 0, B = 0$

only combined is not possible for constn velocity.

E

v

E

v

Concept

A charged particle moves along a circle under the action of possible constant electric and magnetic fields. Possible case is $E = 0, B \neq 0$

→ only this cond^n possible for circular mot^n

for circular motion

(×) $E = 0$, $B = 0$ → st. line / parallel

(×) $E \neq 0$, $B = 0$

(×) $E \neq 0$, $B \neq 0$ → helical

✓ $E = 0$, $B \neq 0$ → circular

Concept

If a charged particle goes un-accelerated in a region containing electric and magnetic field, then

a = 0

$\vec{E}$ must be perpendicular to $\vec{B}$ and $\vec{v}$ must be perpendicular to $\vec{E}$

Sol^n

Velocity Selector

QUESTION

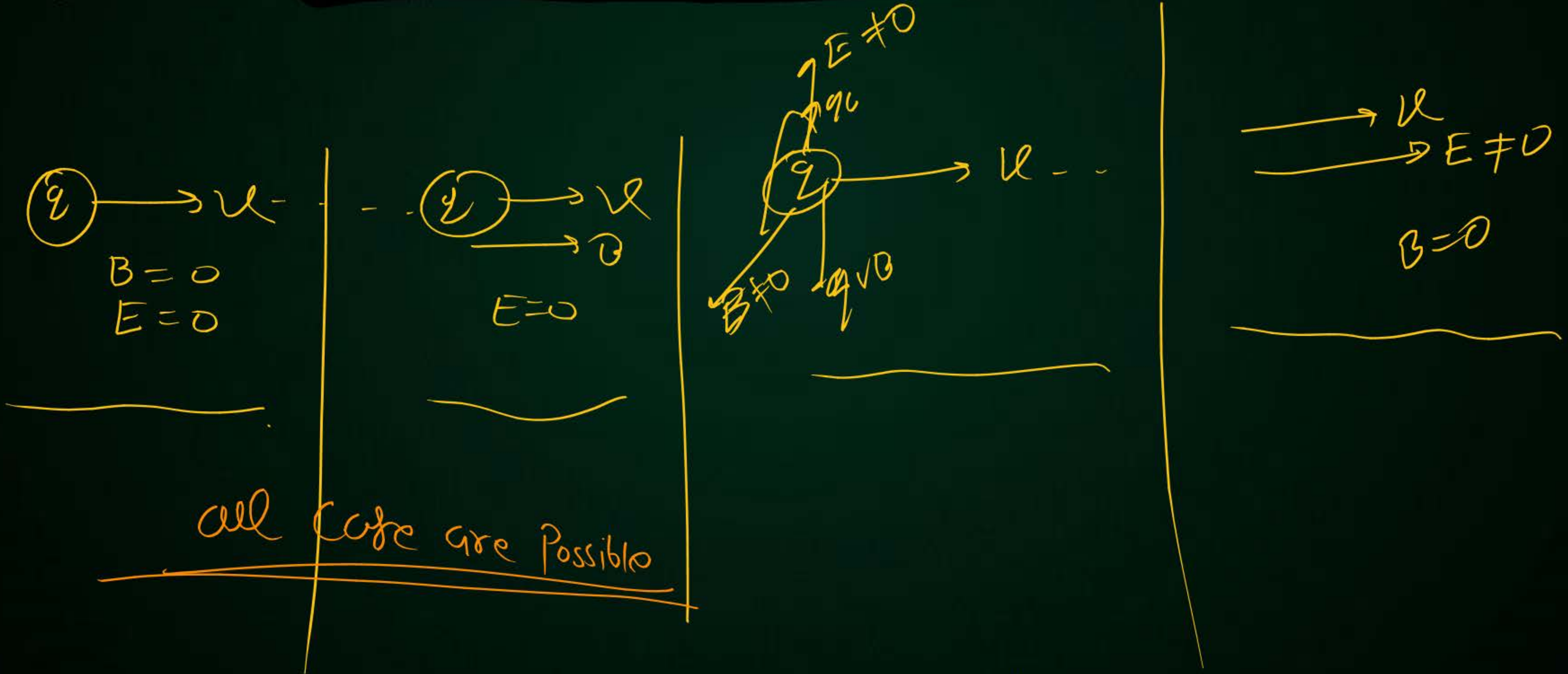
If an electron is not deflected in passing through a certain region of space, can we be sure that there is no magnetic field in that region?

Ans

No, can not sure about magnetic field

Concept

A charged particle goes undeflected in a region containing electric and magnetic field. It is possible that [redacted]



QUESTION

If a moving electron is deflected sideways on passing through a certain region of space, can we be sure that a magnetic field exists in that region?

Ans

NO, electric only can deflect charge Partv sideways

QUESTION

A beam of protons is deflected sideways. Could this deflection be caused

(1) By an electric field? Yes

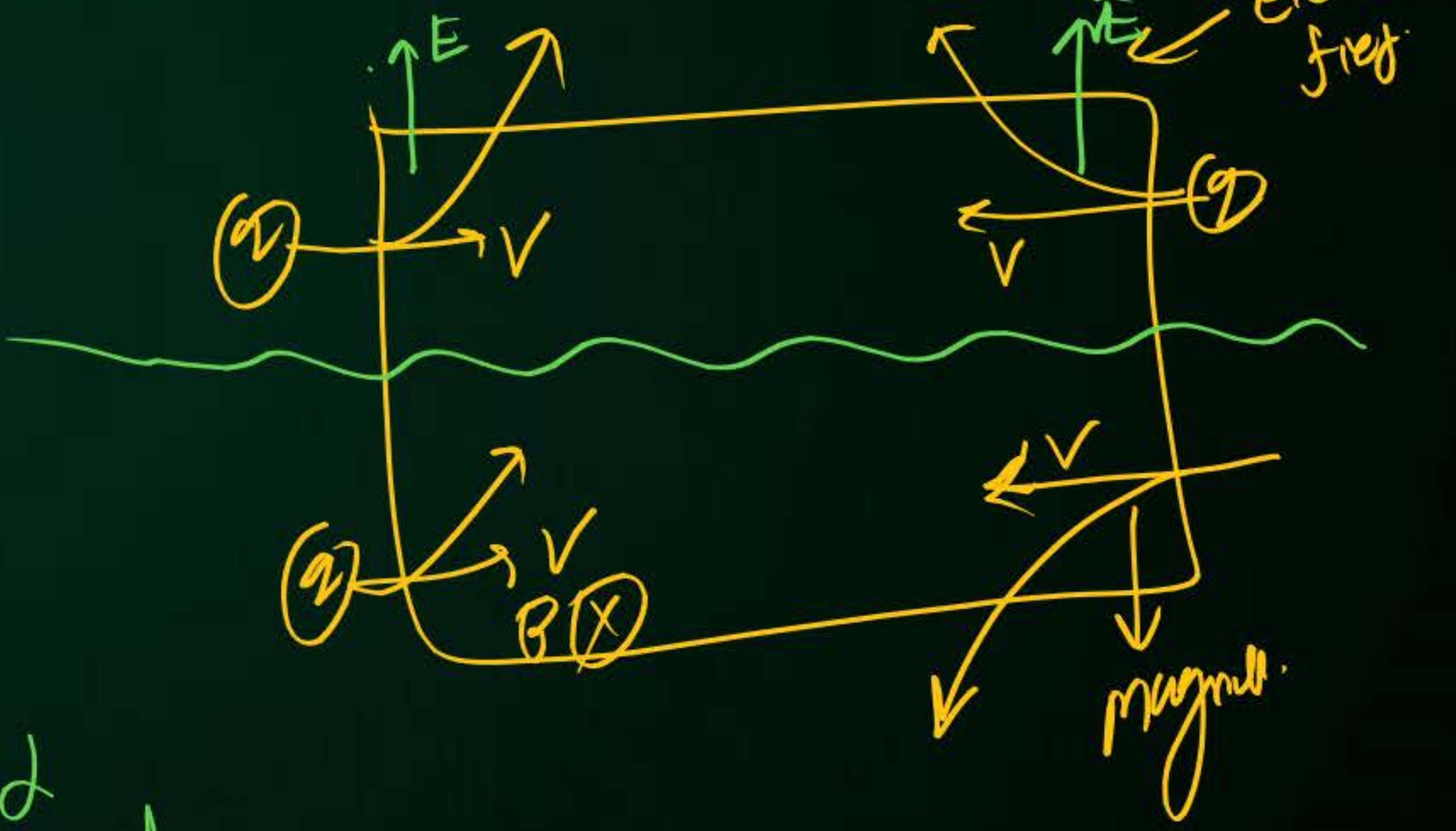
(2) By a magnetic field Yes

(3) If either could be responsible how would you be able to tell which was present

Ans By Projecting charge Particle from opposite dirn

If deflection occur in same direction → then this is due to electric field

If deflection occur in opposite dirn → This must be due to magnetic field.



QUESTION

True/False

32 Dec → 38 dec

S-1: Charge particle is at rest, experience zero electromagnetic force then electric field may be zero. (False)

S-2: Charge particle is at rest, experience zero electromagnetic force then magnetic field may be zero. (True)

S-3: Charge particle is at rest, experience electromagnetic force then electric field must be non-zero. True

S-4: Charge particle is at rest, experience electromagnetic force then magnetic field must be non-zero.

False

PW my card

QUESTION

S-5: Charge is moving in E-M field without deviation then electric field and magnetic field both may be non-zero or both may be zero (True)

S-6: Charge particle passes EM field without acceleration then three possible condition $(E = 0, B = 0)$; $(E = 0, B \neq 0)$, $(E \neq 0, B \neq 0)$.
This is not possible $(E \neq 0, B = 0)$ True

$a \neq 0$

S-7: Charge is moving on circular path in EM Field then only possible condition $(E = 0, B \neq 0)$

True

QUESTION

A charged particle moves in a gravity free space without change in velocity. Which of the following is not possible in the space?

1. $E = 0, B = 0$
2. $E \neq 0, B = 0$ (Not Poss) Ans
3. $E = 0, B \neq 0$
4. $E \neq 0, B \neq 0$

Ans (2)


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 7 | **Physics**

Moving Charges and Magnetism



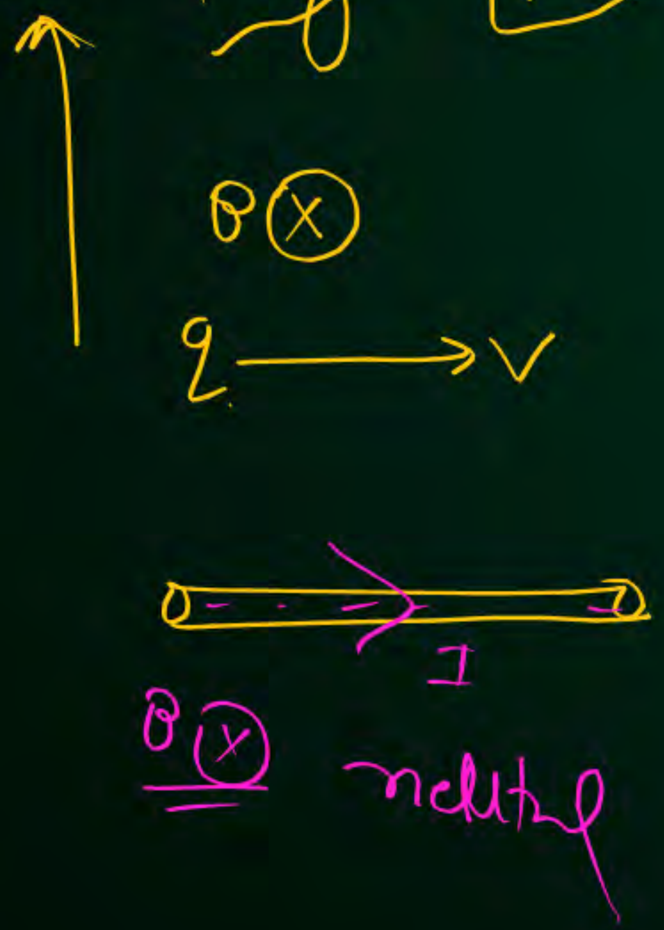
By- Dr. Manish Raj (MR SIR)

Topics to be covered

1 # $F_m = qvB$ Magnetic force on current carrying wire

2 #

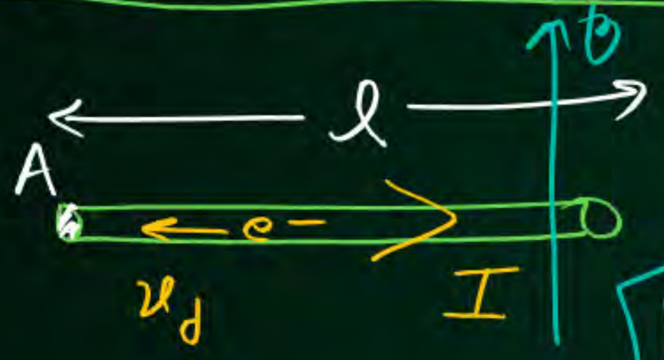
3 #





MAGNETIC FORCE ON A CURRENT CARRYING CONDUCTOR

- As we know that, magnetic field applies force on a moving charge Particle, hence it should apply force on a current carrying wire as well.



$N = nAl$

Force on one e^- due to magnetic field

$F = qvB$

$F = e v_d B$



n = no of e^- per unit volume.

A = cross-section Area

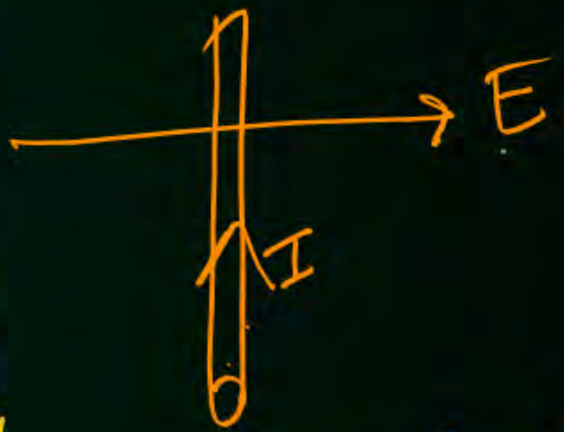
l = length of wire.

I = current

$F_{\text{on all } e^-} = nAl\,[e v_d B]$

$F = neAv_d\, l B$

$F_{magnet} = IlB = BIl$



electric force on current carrying wire is zero. (neutral)



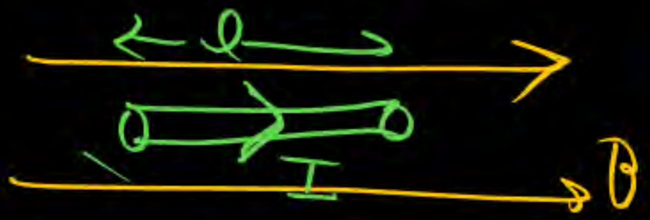
Force = BIl

$F = \vec{Il} \times \vec{B}$

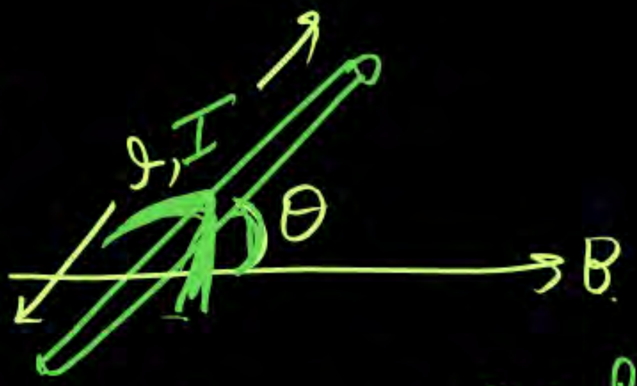
$F = Il B \sin\theta$

$\theta \rightarrow$ Angle b/w $\vec{Il}$ & $\vec{B}$

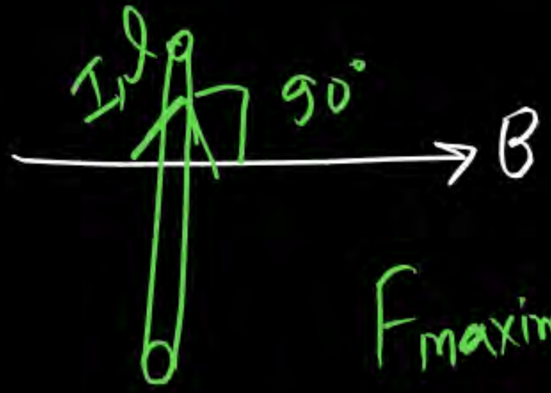
$F_{magnetic} = Bil \sin\theta$



$F = 0$



Force = $BIl \sin\theta$



$F_{maximum} = BIl$ ⊗

$\vec{F} = \vec{Il} \times \vec{B}$

thumb will represent force

four finger of right hand place along current element.

B (magnetic field) slap magnetic field

$\vec{F} \perp \vec{Il}$

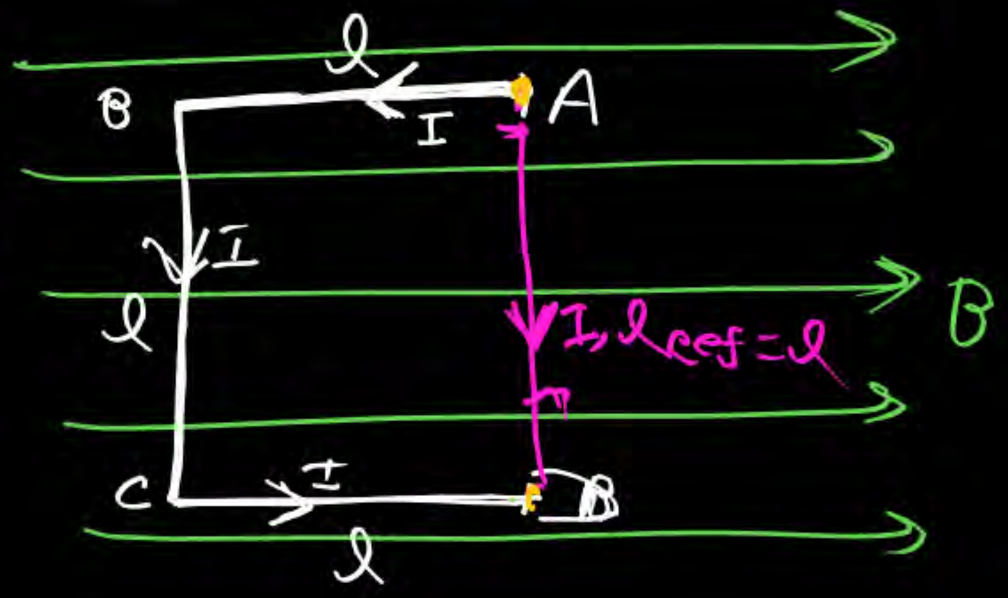
$\vec{F} \perp \vec{B}$

$\vec{F} \cdot \vec{B} = 0$ zero



F ⊙ Ans





$F_{AB} = 0$ (wire)

$F_{BC} = BIl$ ⊙

$F_{CD} = 0$

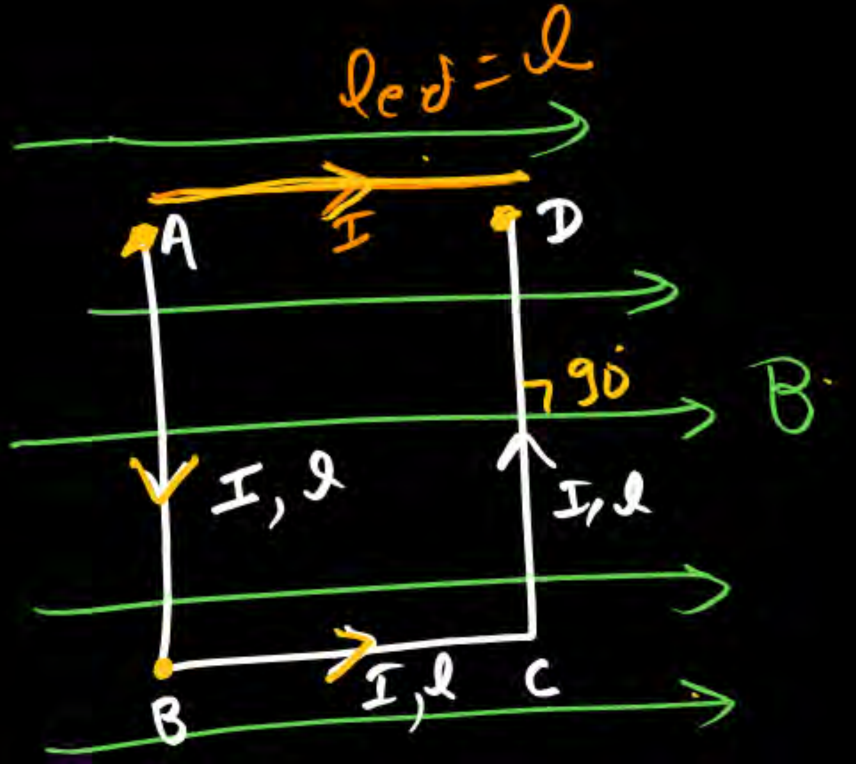
F_{net} on wire $= BIl$

MR*

$F = I\vec{l}_{eff} \times \vec{B}$

$= I(l_{eff} \perp r \text{ to } B) \times B$

$= IlB$



MR*

$F = 0$

$= B[l_{eff} \perp r\, B] \times B$

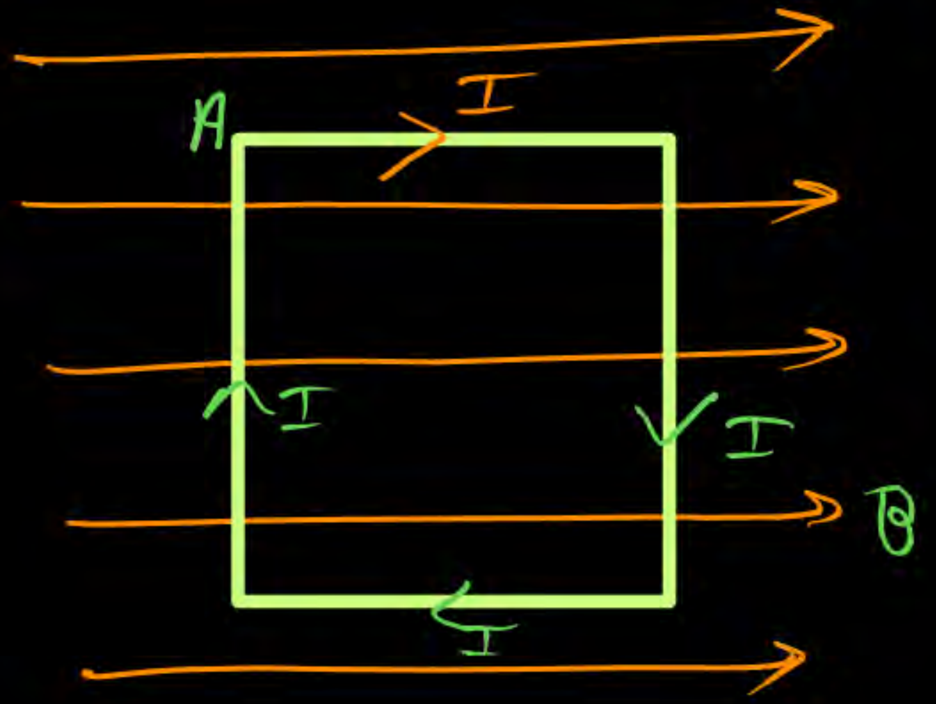
$F_{AB} = BIl \sin 90°$ ⊙

$F_{BC} = 0$

$F_{CD} = BIL \sin 90°$ ⊙

$F_{\text{net force on wire}} = \text{zero}$

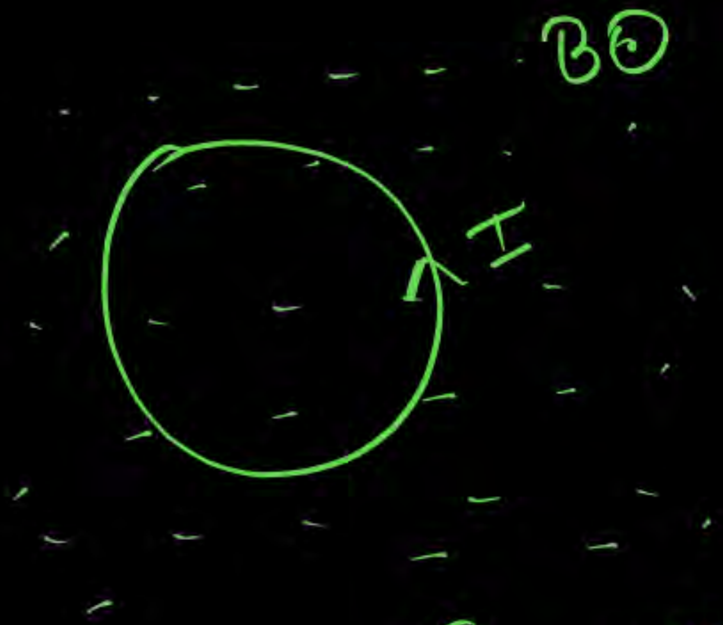
(*) magnetic force on close loop in uniform magnetic field is always zero.



$F_{\text{magnetic force on loop}} = 0$

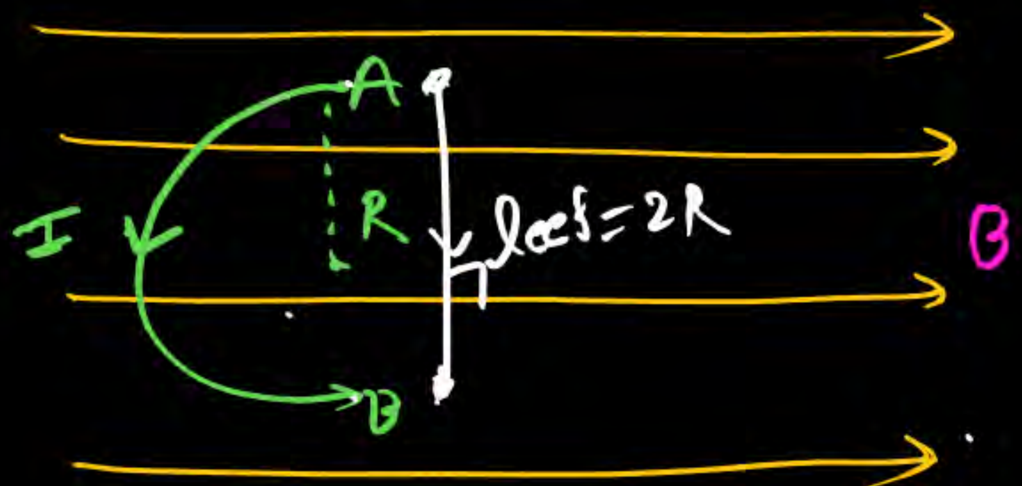
$= B \left(\vec{l}_{eff} \right) I$ ($\vec{l}_{eff} = 0$)

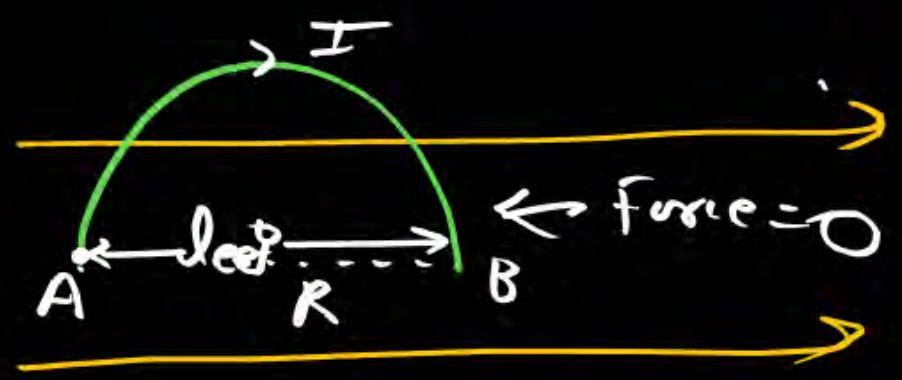
$=$ zero.

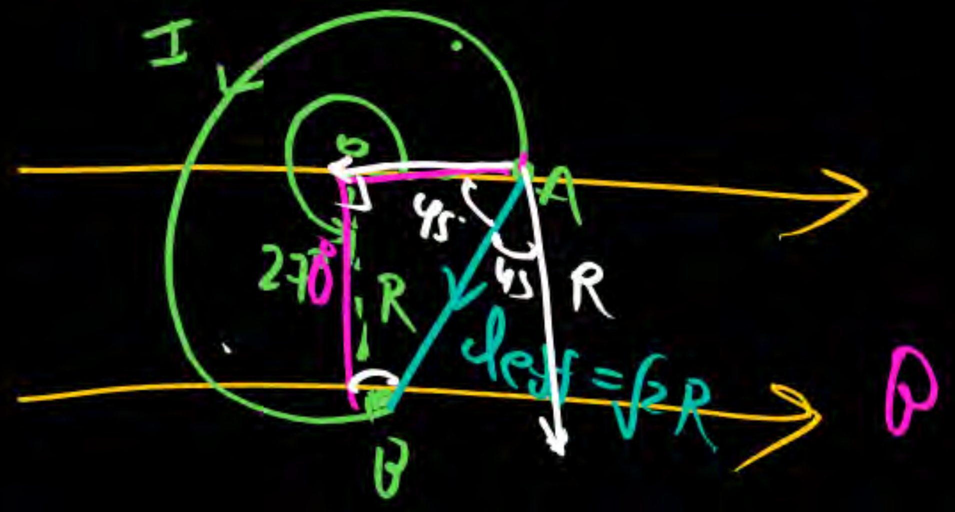


F on circular loop = 0

Force = $BI(2R)$ ✓

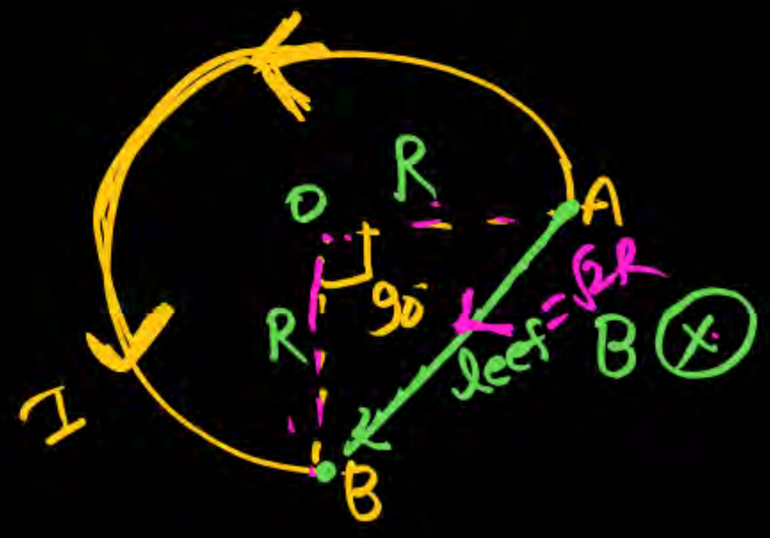






Force = $BI\sqrt{2}R$ (wrong) ✗

Force = BIR ✓



Force = $BI\sqrt{2}R$

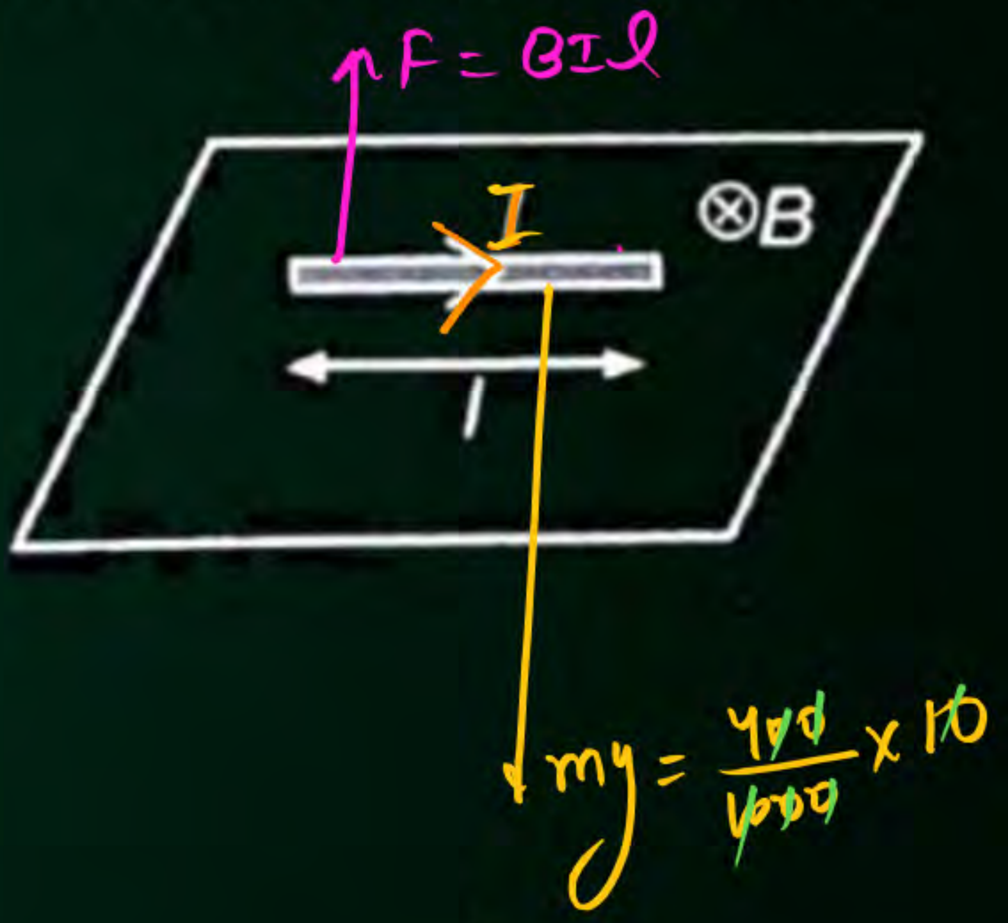
Ans

QUESTION

A straight wire of mass 400g and length 2 m carries a current of 2A. If is suspended in mid air by a uniform horizontal field B. What is the magnitude of the magnetic field?

$BIl = mg$

$B = \frac{mg}{Il} = \frac{4}{2 \times 2} = 1$ Telsa



QUESTION

A straight wire of length 0.5 metre and carrying a current of 1.2 ampere is placed in uniform magnetic field of induction 2 tesla. The magnetic field is perpendicular to the length of the wire. The force on the wire is (1992)

1. 2.4 N
2. 1.2 N ✓
3. 3.0 N
4. 2.0 N.

$F = BIl$

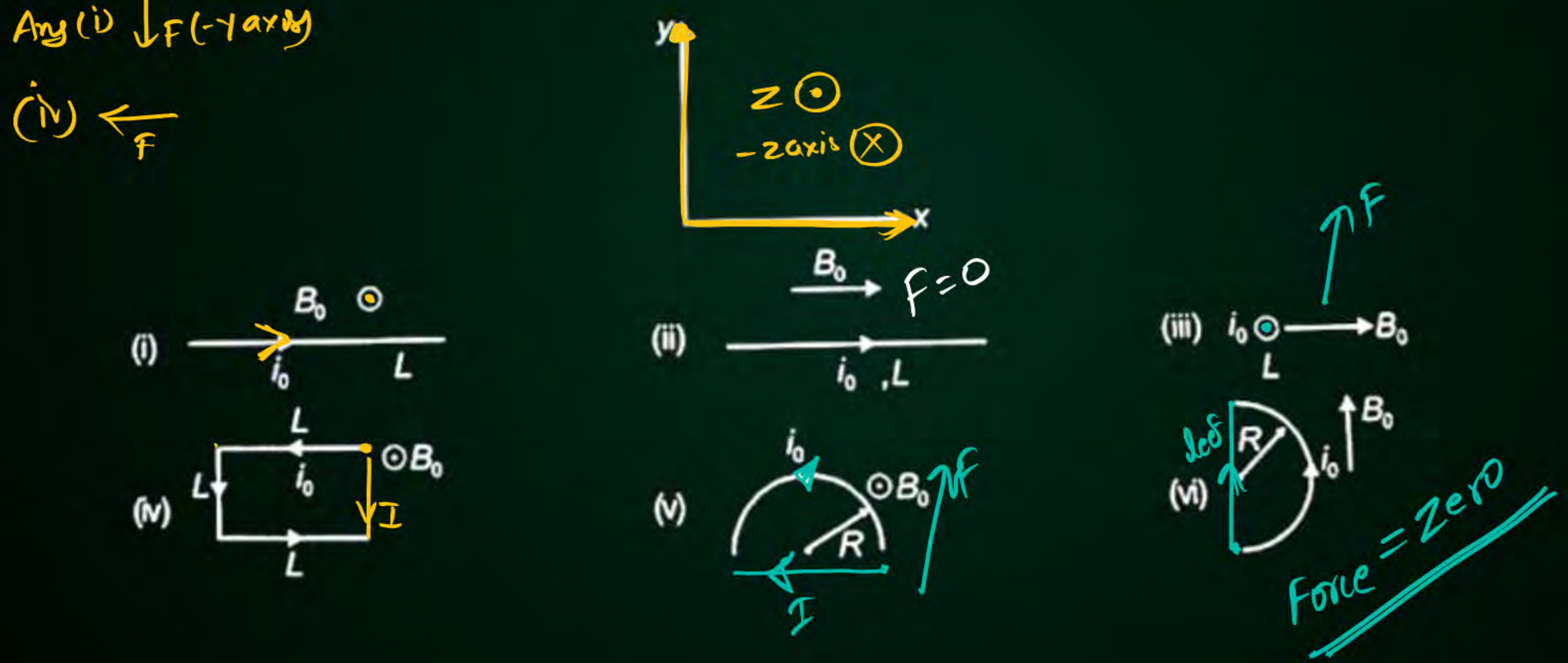
$= 2 \times \frac{12}{10} \times \frac{5}{10}$

$= \frac{120}{100}$

$= 1.2\ N$

QUESTION

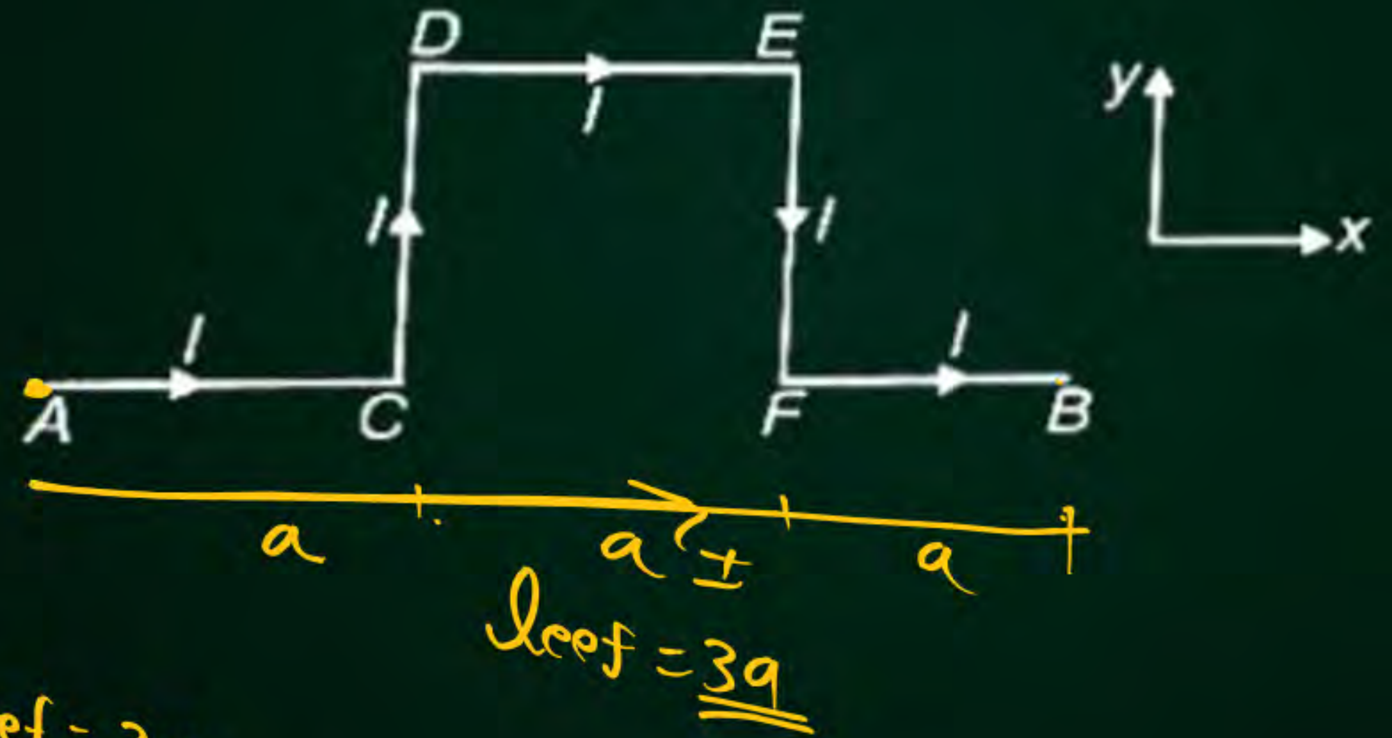
Find the magnetic direction of force on following current carrying wires. Direction of magnetic field is indicated in each case.



QUESTION

A uniform magnetic field $\vec{B} = B_0 \hat{k}$ exists in a region. A current carrying wire is placed in x-y plane as shown. Find the force acting on the wire AB, if each section of the wire is of length 'a'.

$B = B_0 \hat{k}$



leef = 3a

$F = BI3a$

magnetic field $B = 3T\hat{i}$ & intial Positi'n of wire (2,3) & end Point of wire (4,5) then find magnetic force on wire.

$(l_{eef})_{\perp r} = 5-3 = 2m$

Force $= I \times 3 \times 2$

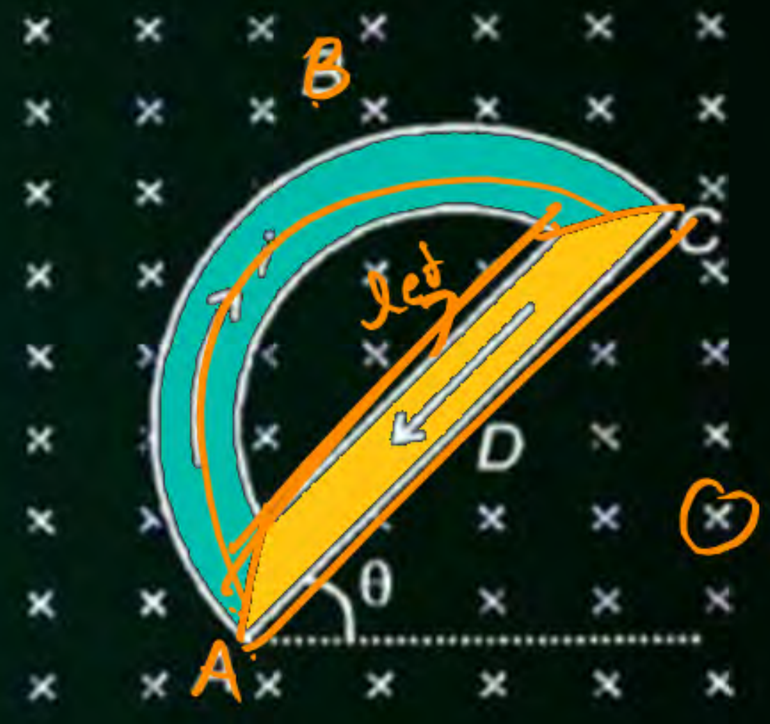
$= 6I\ N$

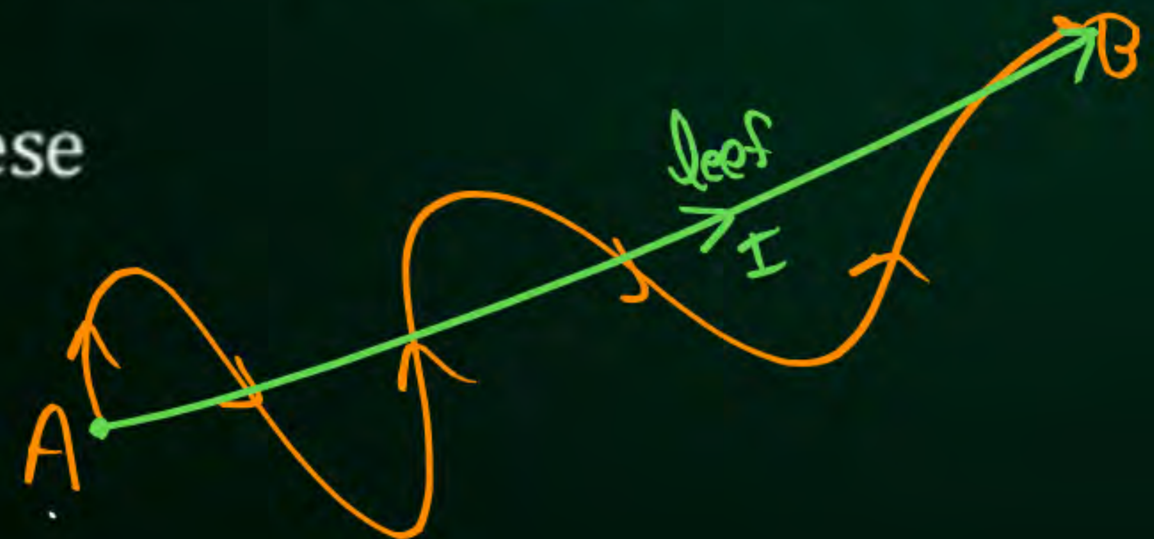


QUESTION

A circular wire ABC and a straight conductor ADC are carrying current i and are kept in the magnetic field B then considering points A and C.

1. Magnitude of force on ABC is more than ADC
2. Magnitude of force on ABC is less than ADC
3. Magnitude of force on ABC is equal to that on ADC
4. All of these





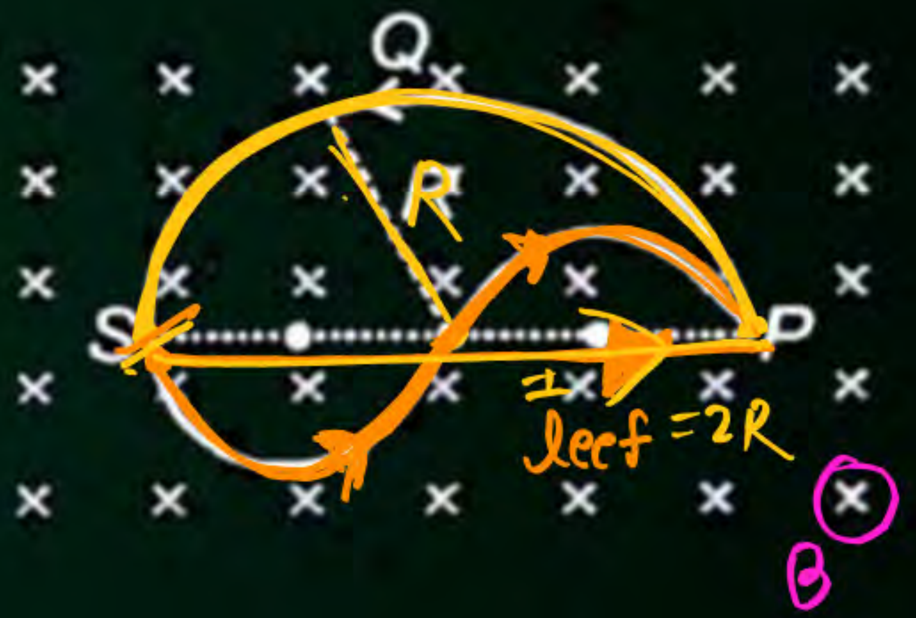
QUESTION

A semicircular wire PQS of radius R is connected to a wire bent in the form of a sine curve to form a closed loop as shown in the figure. If the loop carries a current i and is placed in a uniform magnetic field B, then the total force acting on the sine curve is

1. 2BiR(downward)
2. 2BiR(upward)
3. BiR(upward)
4. Zero

$F_{\text{total force on loop}} = \text{zero}$

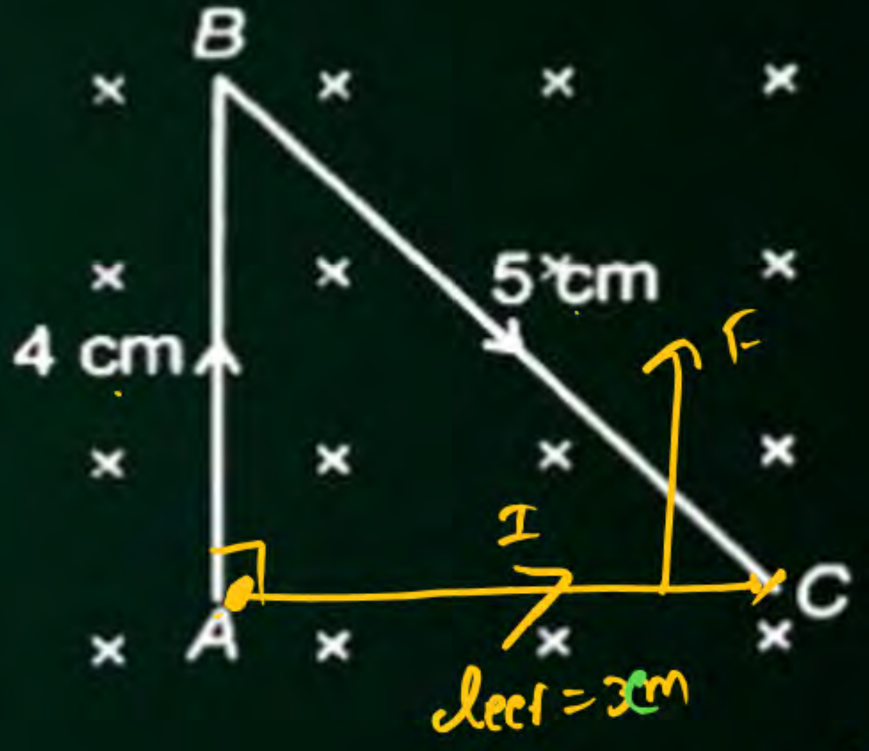
$F_{\text{on sine curve}} = B\, l_{eff}\, B$



QUESTION

A uniform conducting wire ABC has a mass of 10g. A current of 2A flows through it. The wire is kept in a uniform magnetic field B = 2T. The acceleration of the wire will be

1. Zero
2. $12\ ms^{-2}$
3. $1.2 \times 10^{-3}\ ms^{-2}$
4. $0.6 \times 10^{-3}\ ms^{-2}$



$$a = \frac{F}{m} = \frac{BIl}{m}$$

QUESTION

A current carrying closed loop in the form of a right angle isosceles triangle ABC is placed in a uniform magnetic field acting along AB. If the magnetic force on the arm BC is $\vec{F}$ the force on the arm AC is

(2011)

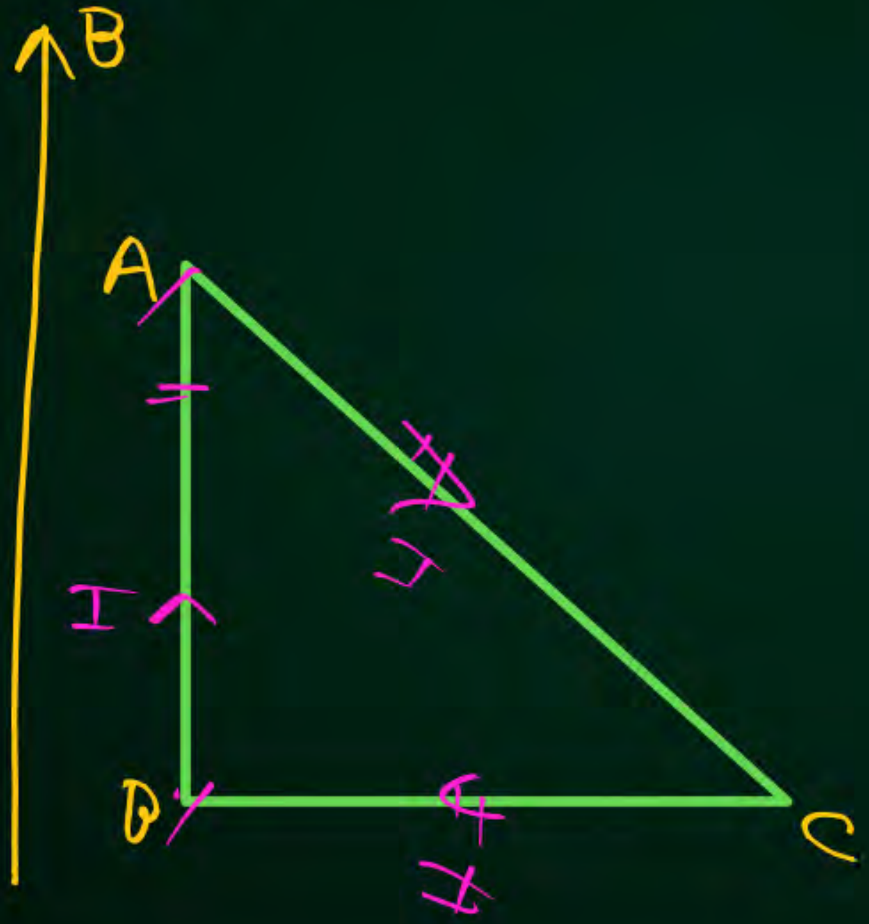
1
2
3
4

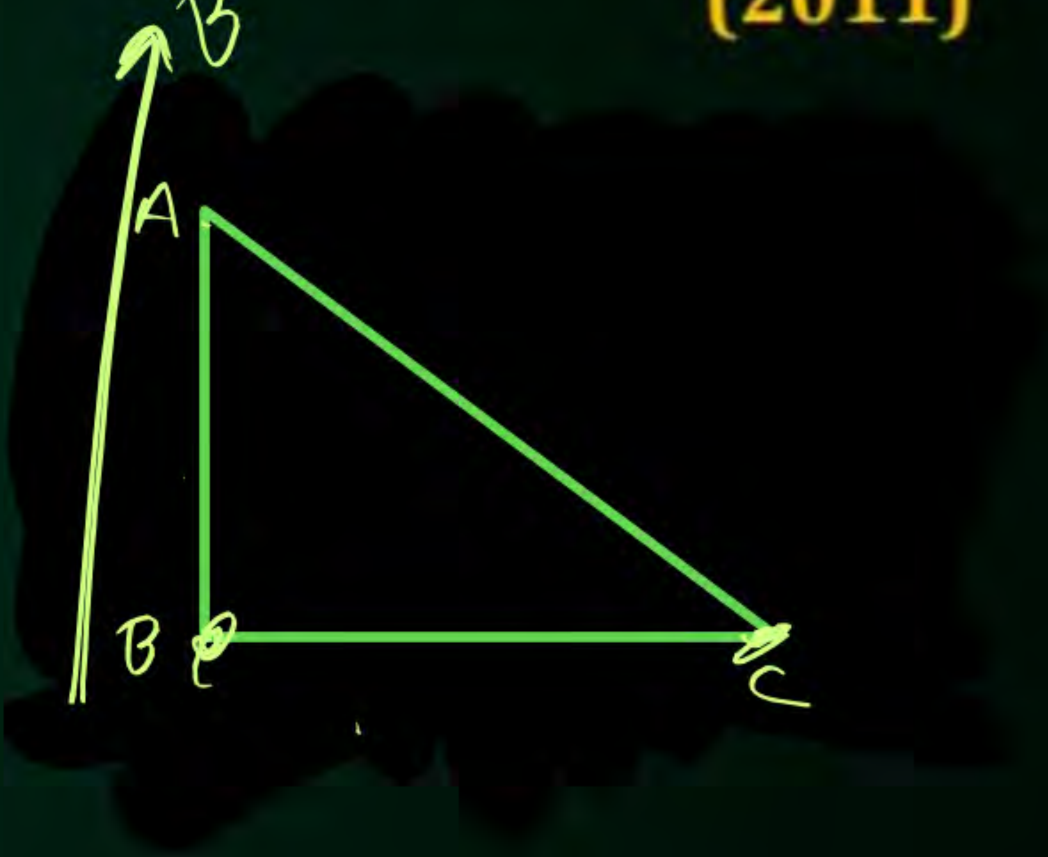
$F_{loop} = 0$

$F_{AB} + F_{AC} + F_{BC} = 0$

$0 + F_{AC} + F = 0$

$\vec{F}_{AC} = -\vec{F}$



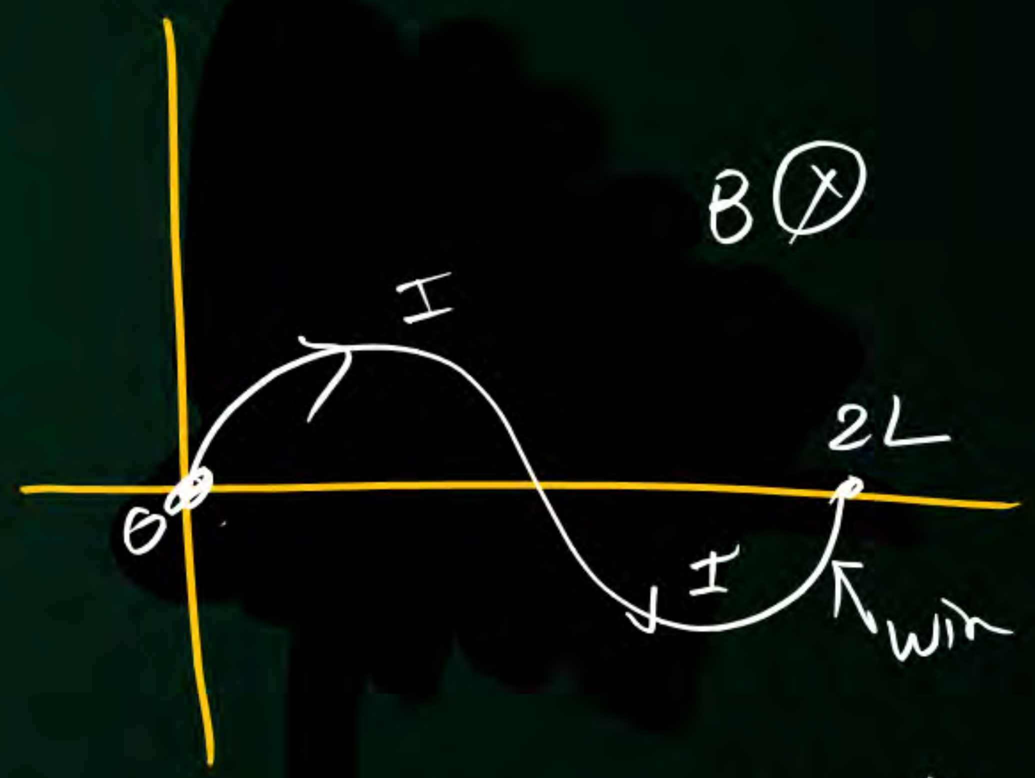


QUESTION

A wire carrying a current i is placed in a magnetic field in the form of the curve $y = a\sin\left(\frac{\pi x}{L}\right)$ $0 \leq x \leq 2L$. Force acting on the wire is

1. $-\sqrt{2}\,\vec{F}$
2. $-\vec{F}$
3. $\vec{F}$
4. $\sqrt{2}\,\vec{F}$

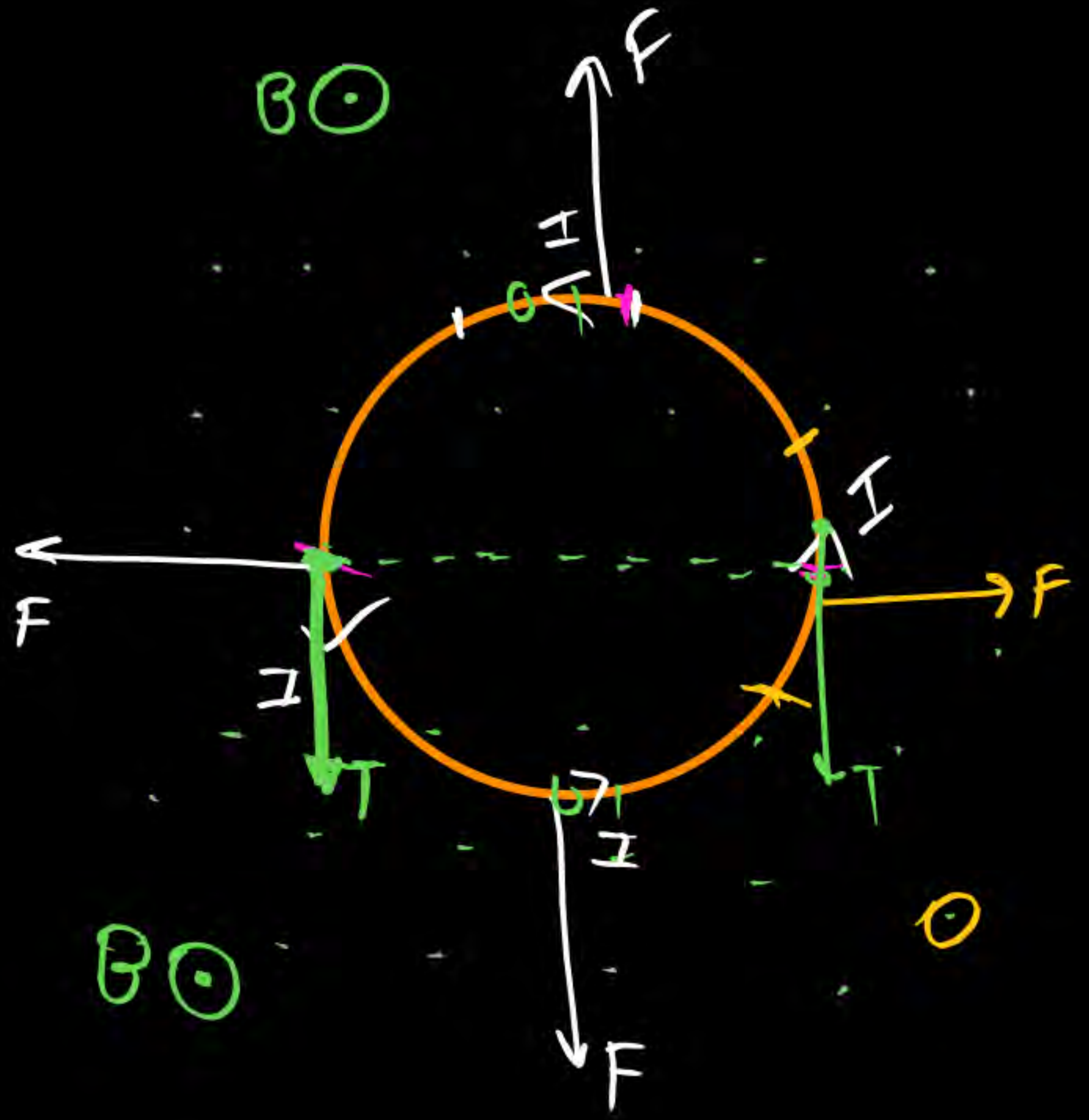
last question opt

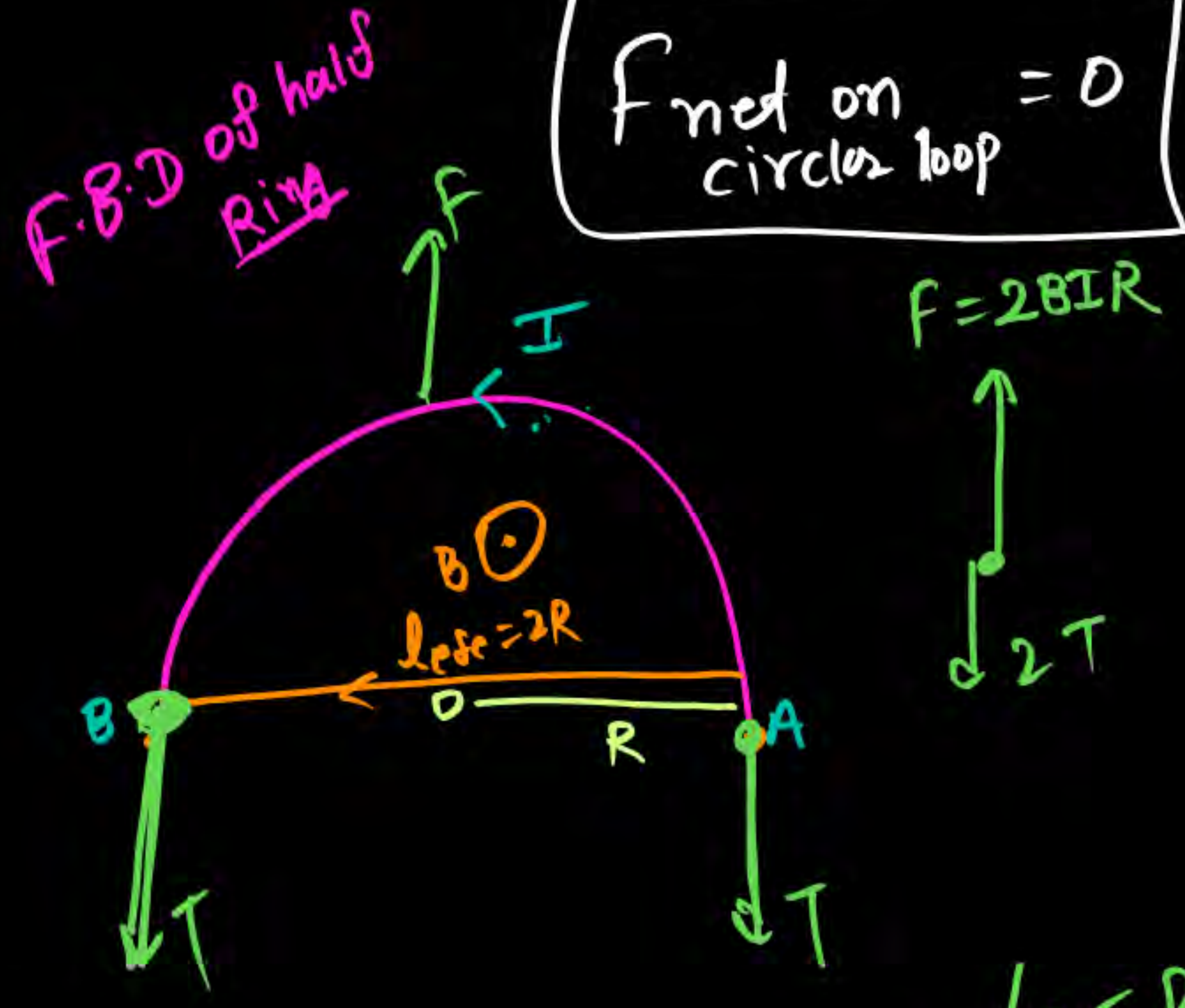


$F_{wire} = BI(2L)$

$l_{eff} \perp_{r B} = 2L$

(Q) Tension in a circular wire placed in uniform magnetic field





F_{net} on circular loop $= 0$

$2T = 2BIR$

Tension $= BIR$

QUESTION

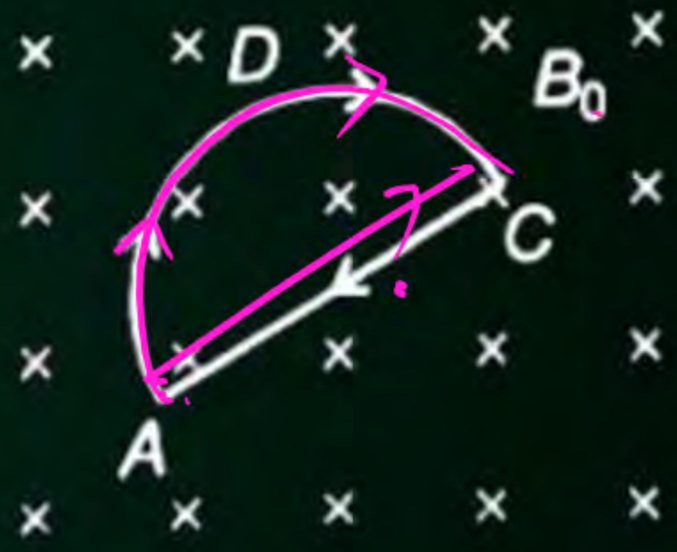
A small circular flexible loop of wire of radius R carries a current I. It is placed in a uniform magnetic field B. The tension in the loop will be doubled, if

1. I is doubled
2. B is doubled
3. R is doubled
4. All of these Ans

$T = BIR$

QUESTION

Figure shows a conducting loop ADCA carrying current i and placed in a region of uniform magnetic field B_0. The apart ADC forms a semicircle of radius R. The magnitude of force on the semicircle part of the loop is equal to

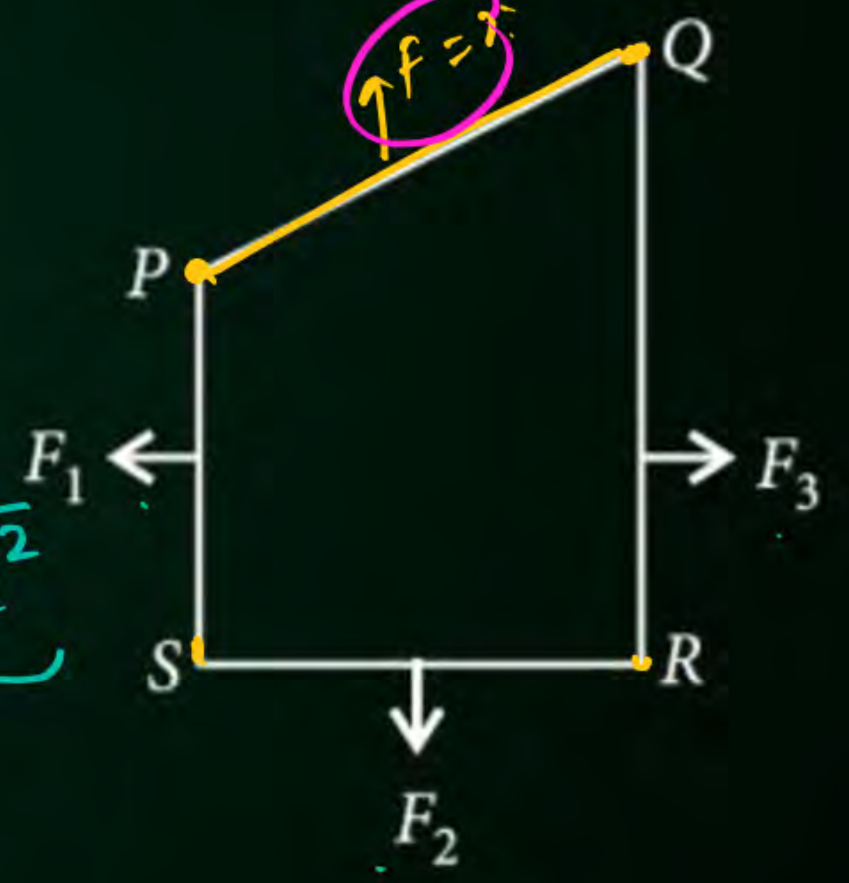


1. πRiB_0
2. Zero
3. $2\pi RiB_0$
4. $2iRB_0$

QUESTION

A closed loop PQRS carrying a current is placed in a uniform magnetic field. If the magnetic forces on segments PS, SR and RQ are F_1, F_2 and F_3 respectively an dare in the plane of the paper and along the directions shown, the force on the segment QP is

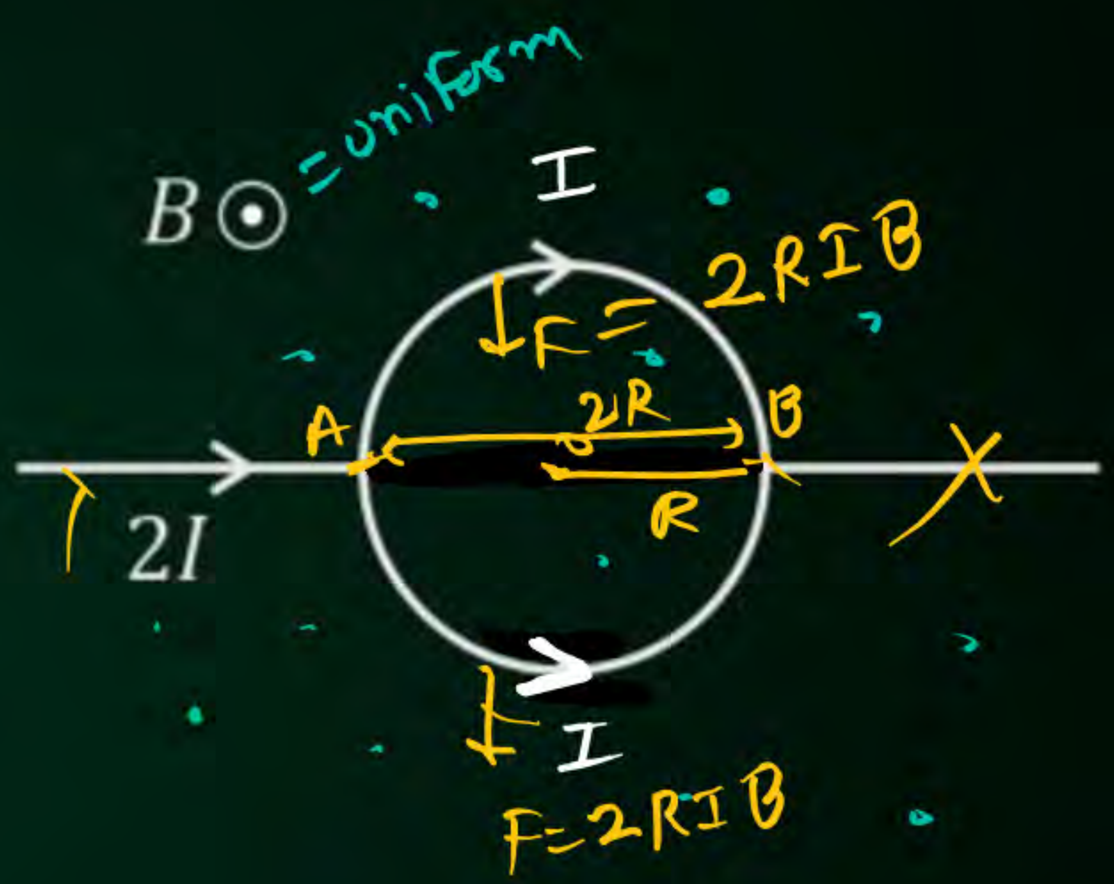
1. $F_3 - F_1 + F_2$
2. $F_3 - F_1 - F_2$
3. $\sqrt{(F_3 - F_1)^2 + F_2^2}$
4. $\sqrt{(F_3 - F_1)^2 - F_2^2}$



QUESTION

MR* Sawal

Net force on circular wire.



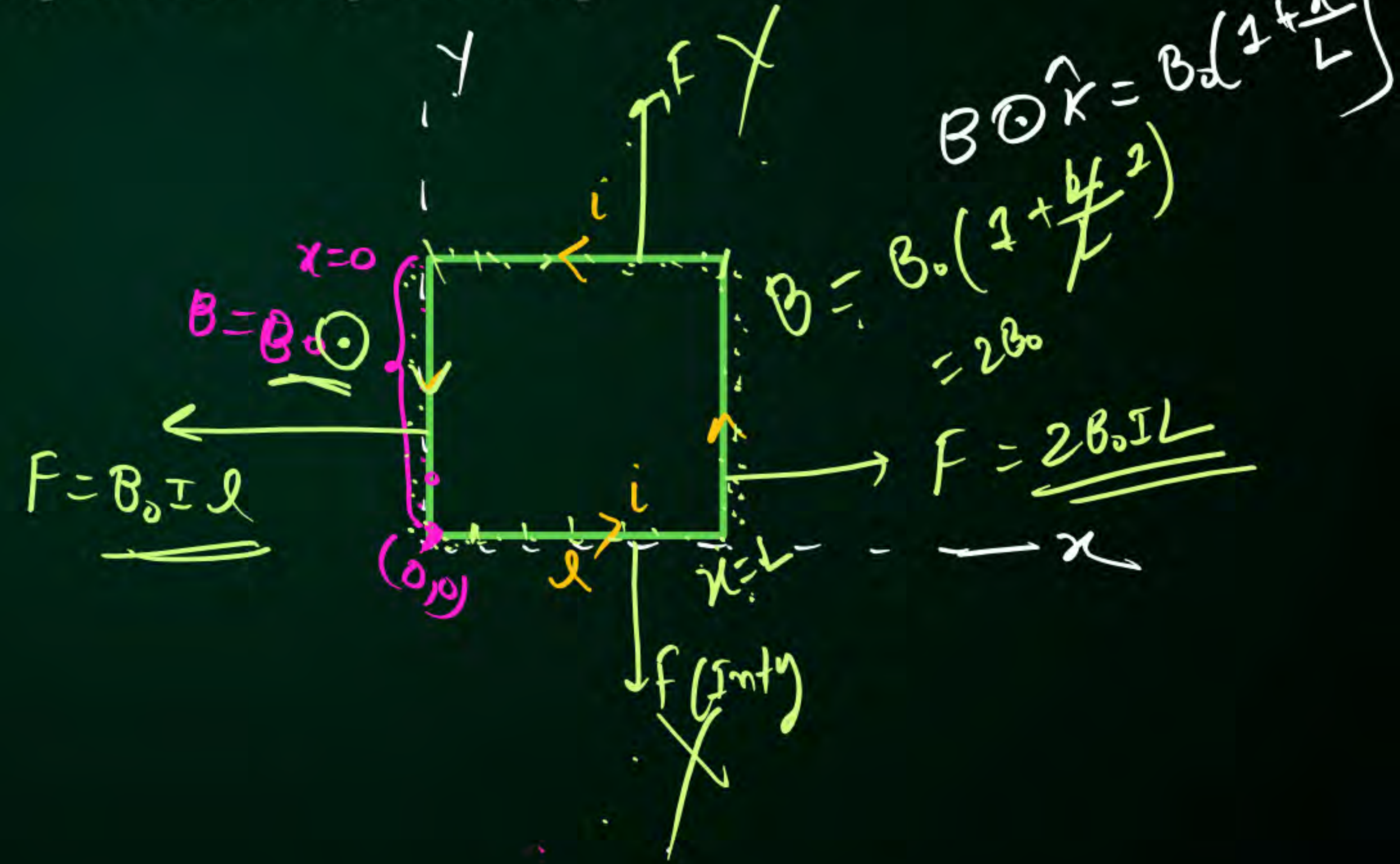
Fnet = 4BIR

Ans

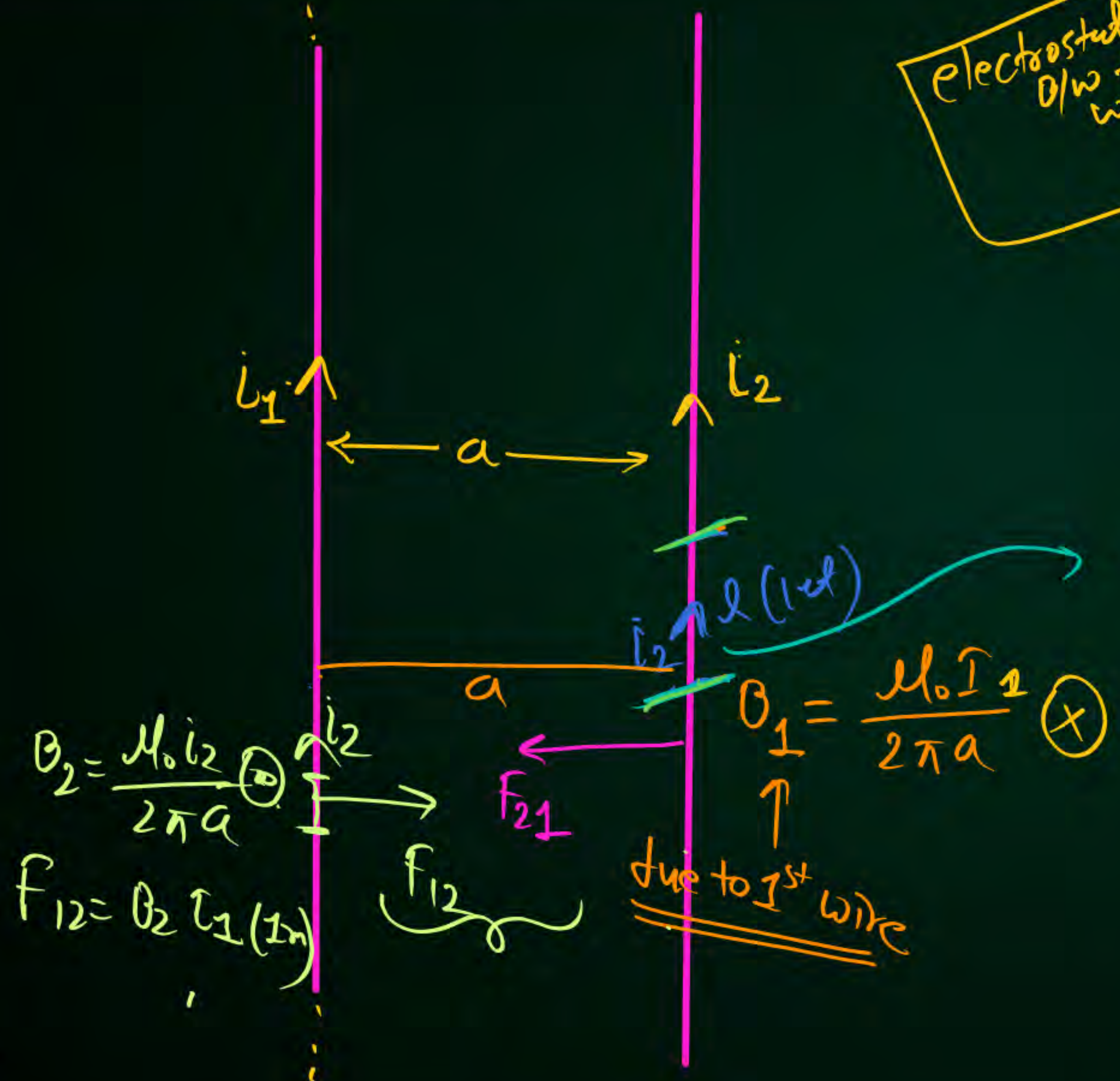
QUESTION

The magnetic field existing in a region is given by $\vec{B} = B_0\left(1 + \frac{x}{l}\right)\hat{k}$. A square loop of edge l and carrying a current i, is placed with its edge parallel to the x-y axes. Find the magnitude of the net magnetic force experienced by the loop

1. $\frac{1}{2} iB_0 l$
2. Zero
3. $iB_0 l$
4. $2iB_0 l$



Force between two parallel currents, infinite wire



electrostatic force b/w these two wire is zero

force on 1st wire per unit length $= \frac{\mu_0 i_1 i_2}{2\pi a}$

Attractive if current in same direction

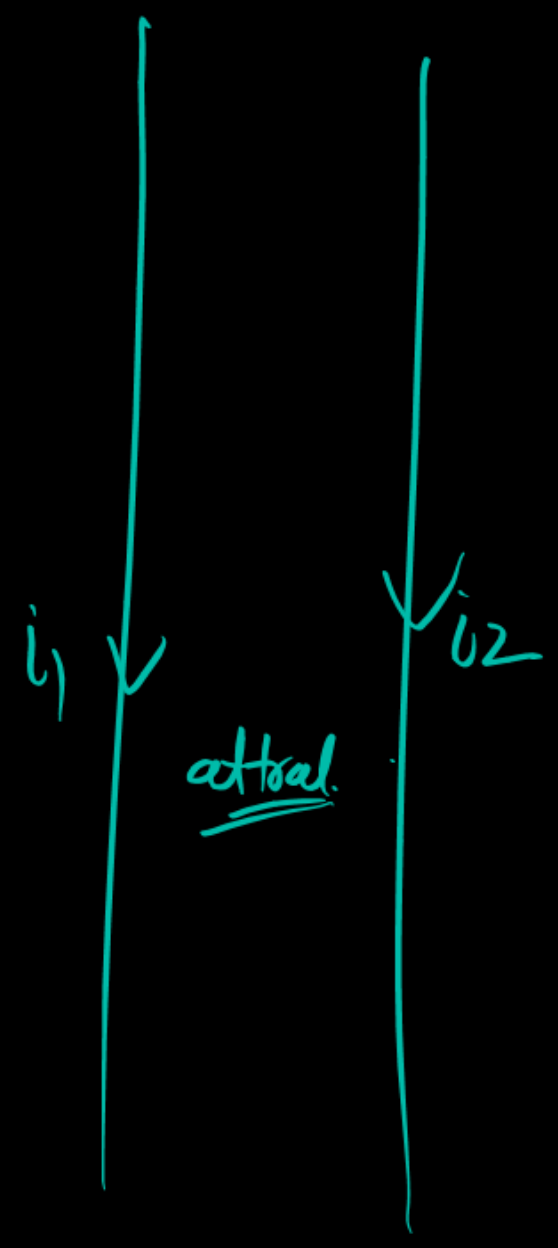
Repulsive if current in opposite dirn

force on l length of 2nd wire $= B_1 i_2 l_2$

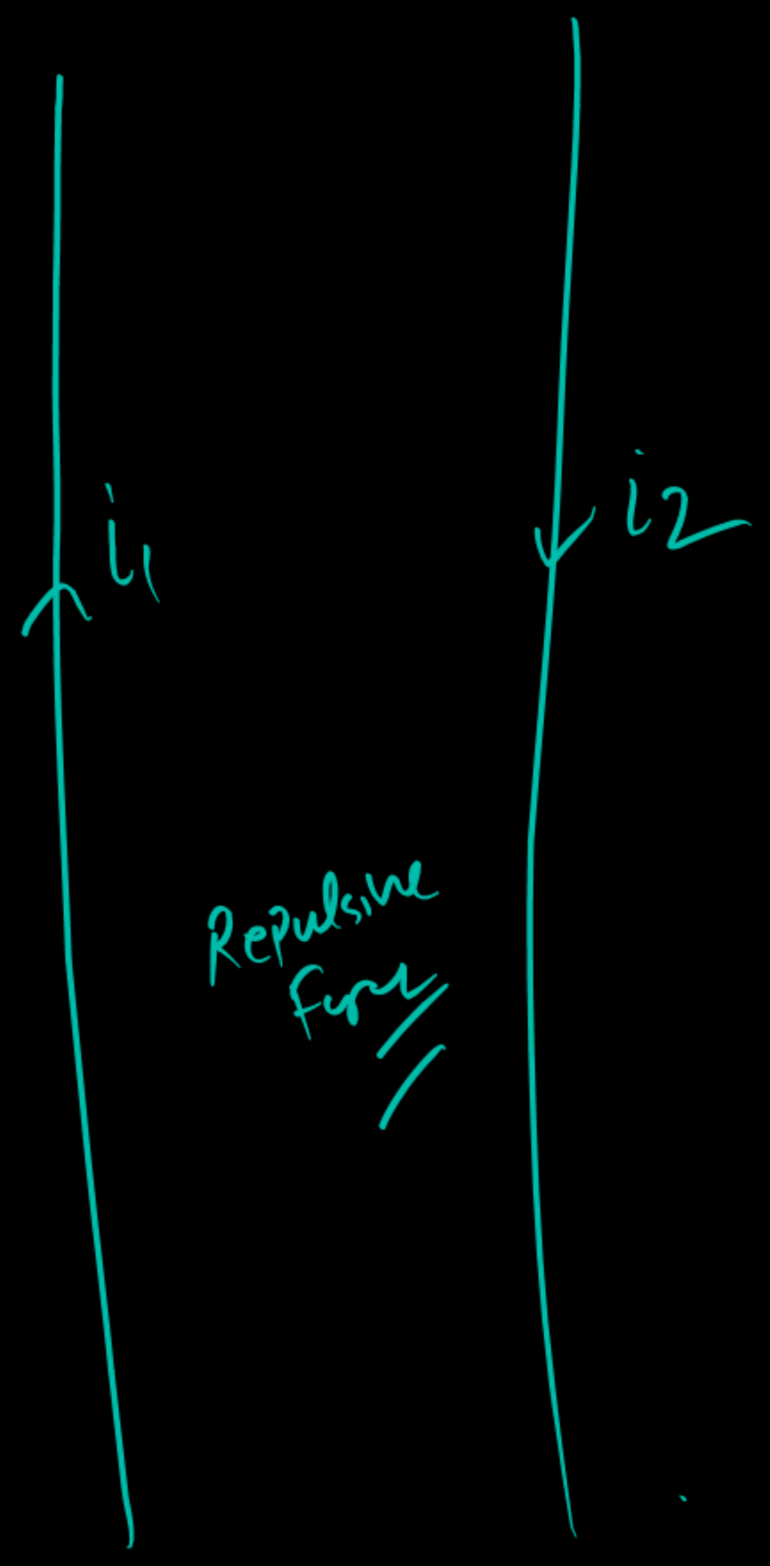
$F_{on\,l} = \frac{\mu_0 i_1}{2\pi a} i_2 l$

force on 2nd wire per unit leng $= \frac{\mu_0 i_1 i_2}{2\pi a}$

force b/w two parallel wire per unit length



i1
i2
attract.

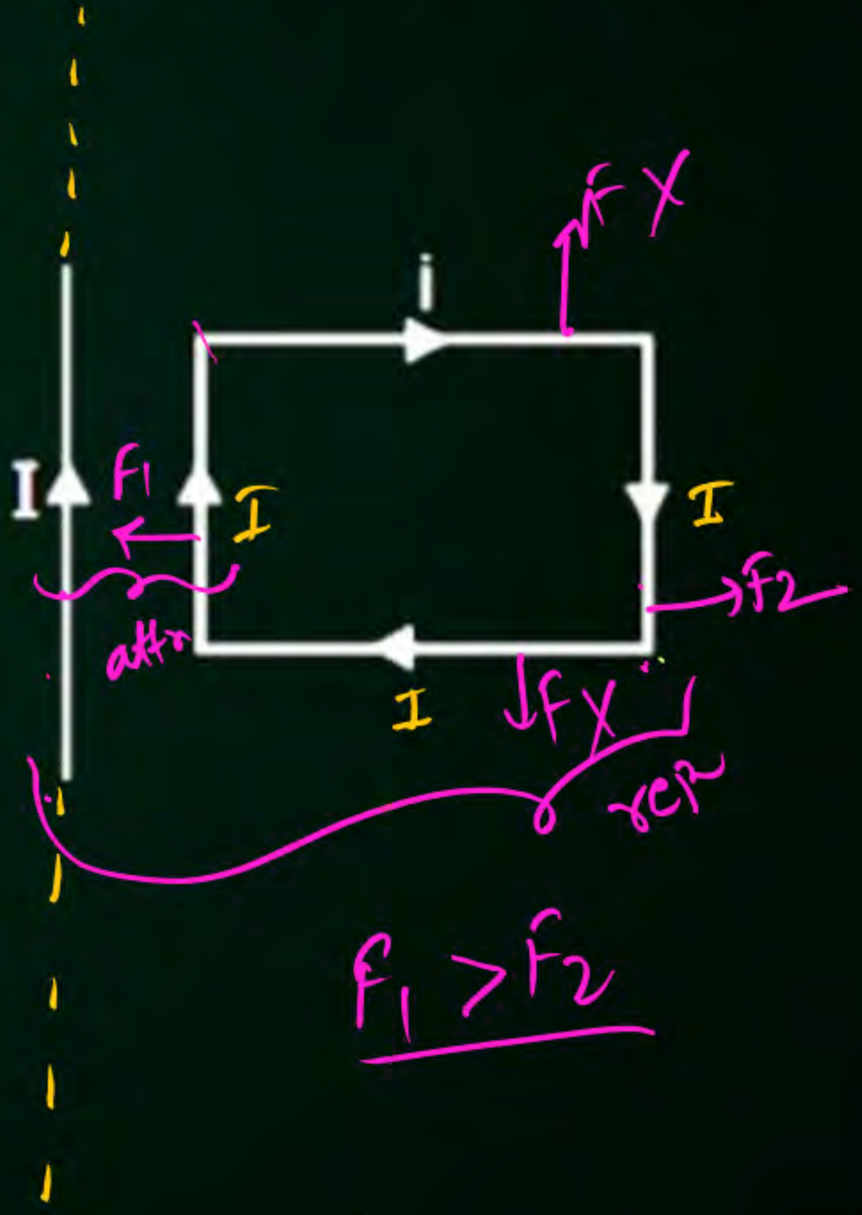


i1
i2
Repulsive force

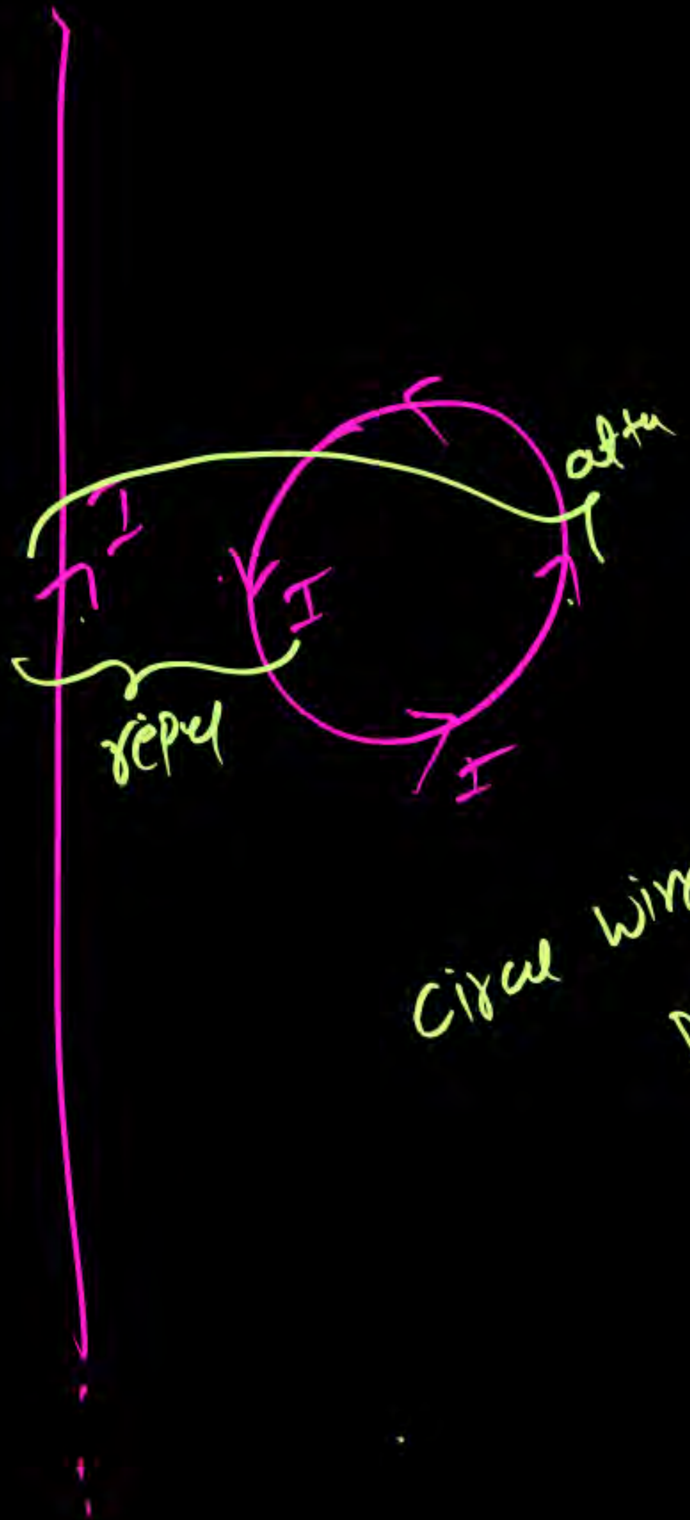
QUESTION

A rectangular loop carrying a current i is situated near a long straight wire such that the wire is parallel to one of the sides of the loop and is in the plane of the loop. If a steady current i is established in the wire, the loop will

1. Rotate about an axis parallel to the wire
2. Move away from the wire
3. Move towards the wire
4. Remain stationary

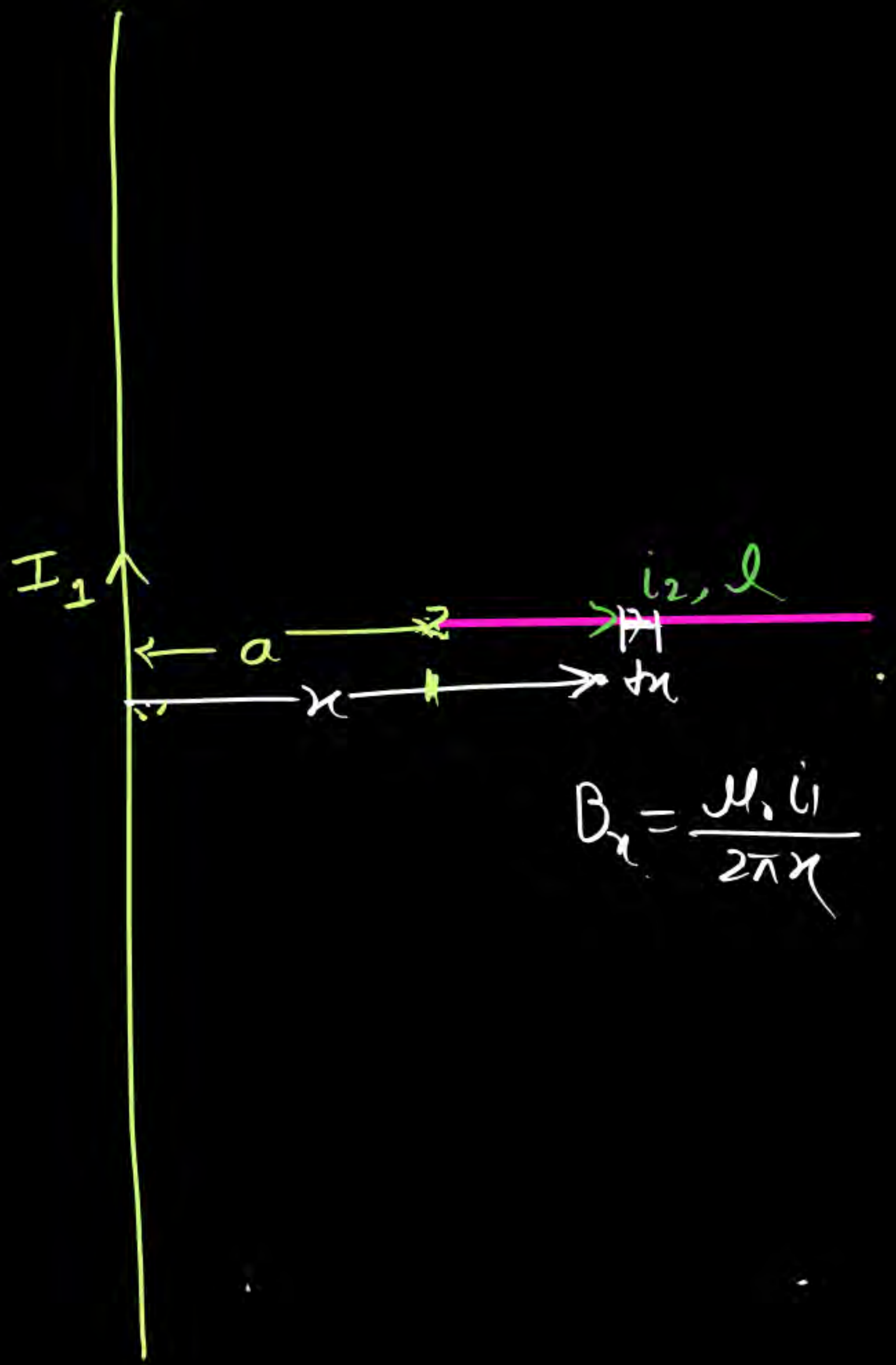


fixed infinite wire



Circle wire will move away

find net magnetic force on small wire of length l due to infinite wire.



$$B_x = \frac{\mu_0 i_1}{2\pi x}$$

$$dF = B_x I_2 \, dx$$

$$\int dF = \int \frac{\mu_0 i_1}{2\pi x} i_2 \, dx$$

$$F_{net} = \frac{\mu_0 i_1 i_2}{2\pi} \int_a^{a+l} \frac{1}{x} dx$$

$$= \frac{\mu_0 i_1 i_2}{2\pi} \log\left(\frac{a+l}{a}\right) \quad A$$


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 8 | Physics

Moving Charges and Magnetism



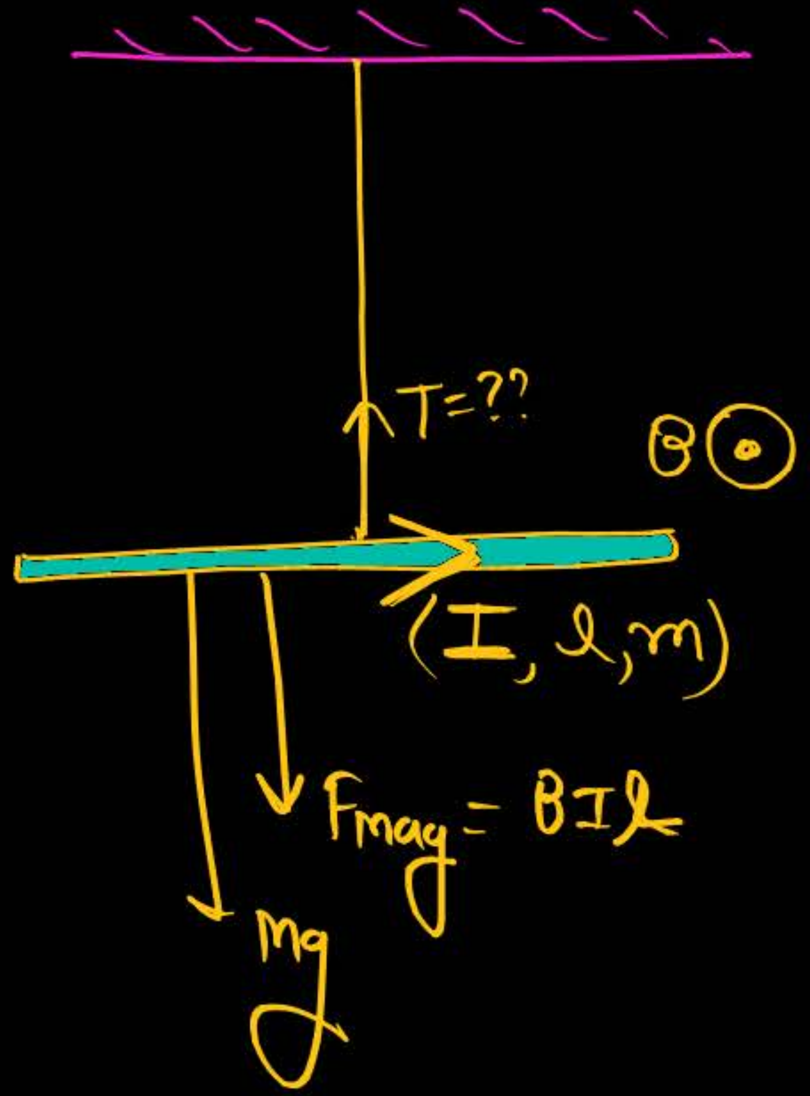
By- Dr. Manish Raj (MR SIR)

Topics to be covered

1. # Magnetic moment, & Torque
2. #
3. #

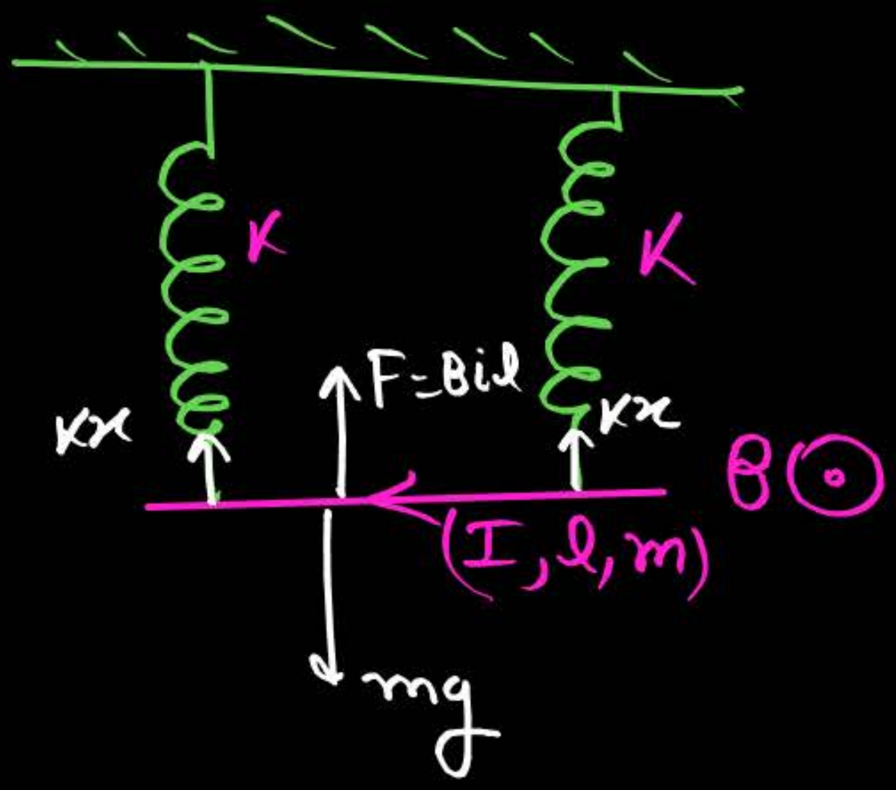


find Tension in wire ??



$$T = mg + BIl$$

find elongation in spring ??

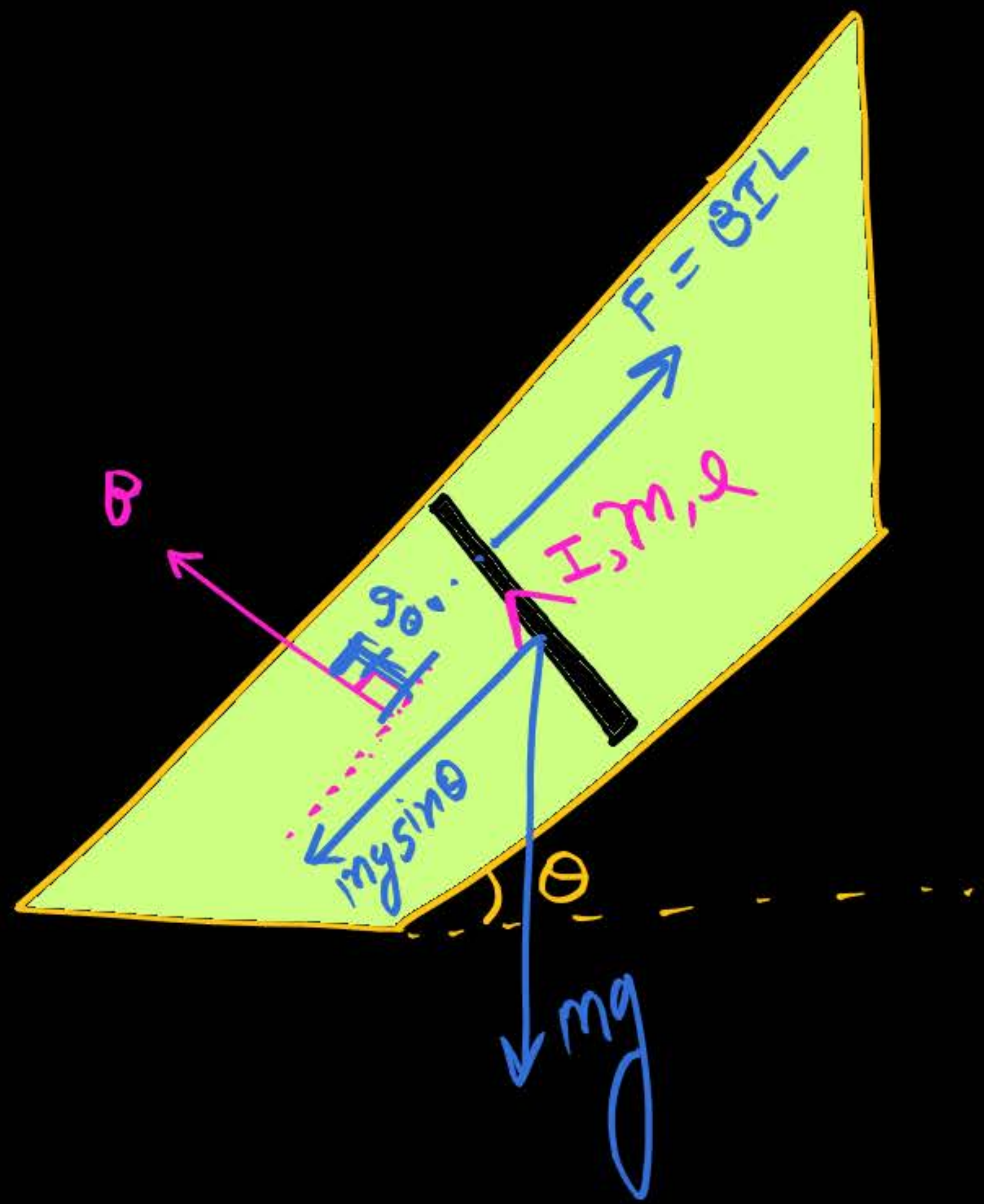


$$2kx + BIl = mg$$

$$2kx = mg - BIl$$

$$x = \frac{mg - BIl}{2k}$$

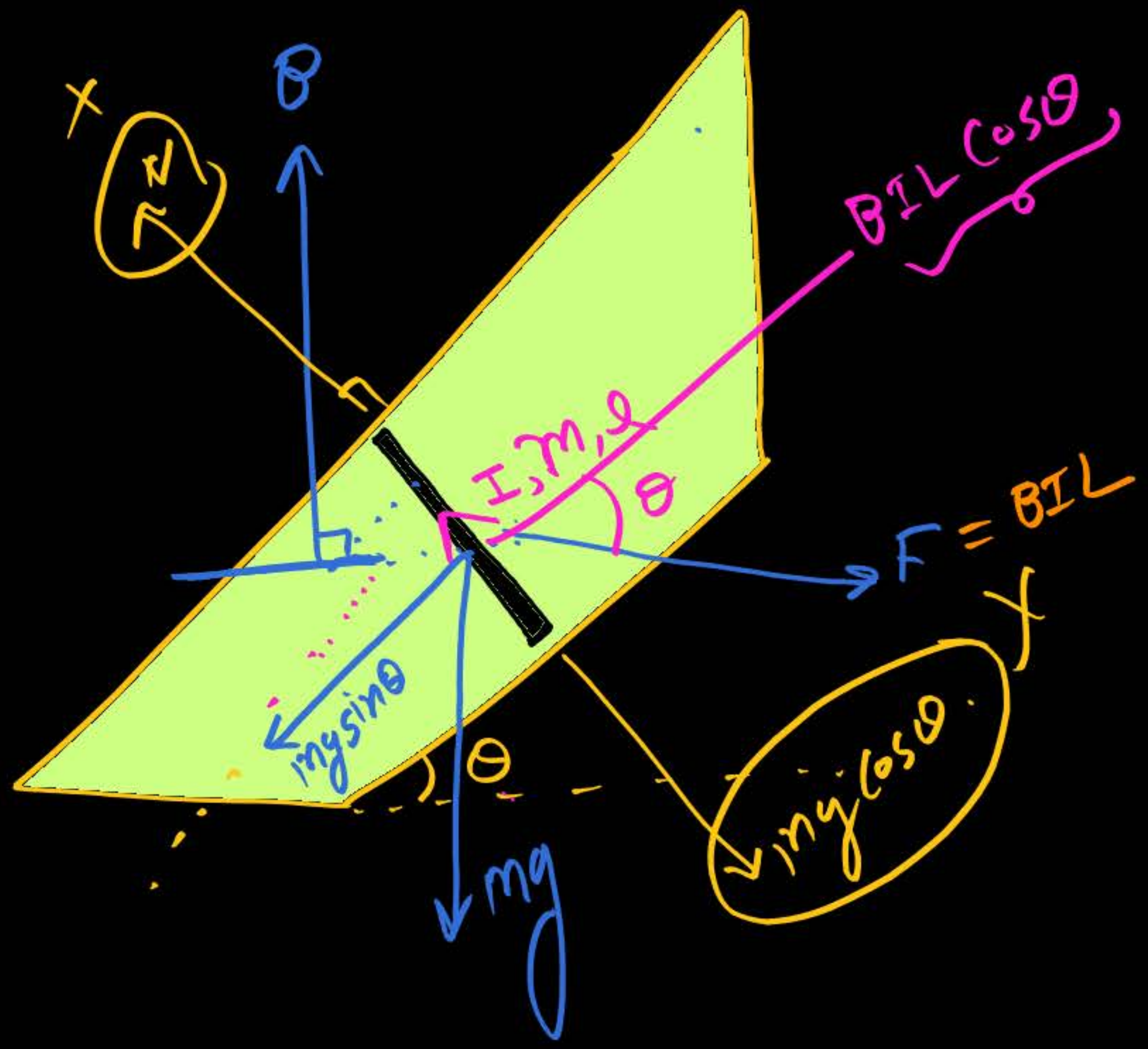
Wire is placed on smooth Inclined Plan, then find Minimum value B ?? so that wire will be at rest.



Fnet along Inclined Plane

$$BIL = mg\sin\theta$$

$$B = \frac{mg\sin\theta}{IL}$$



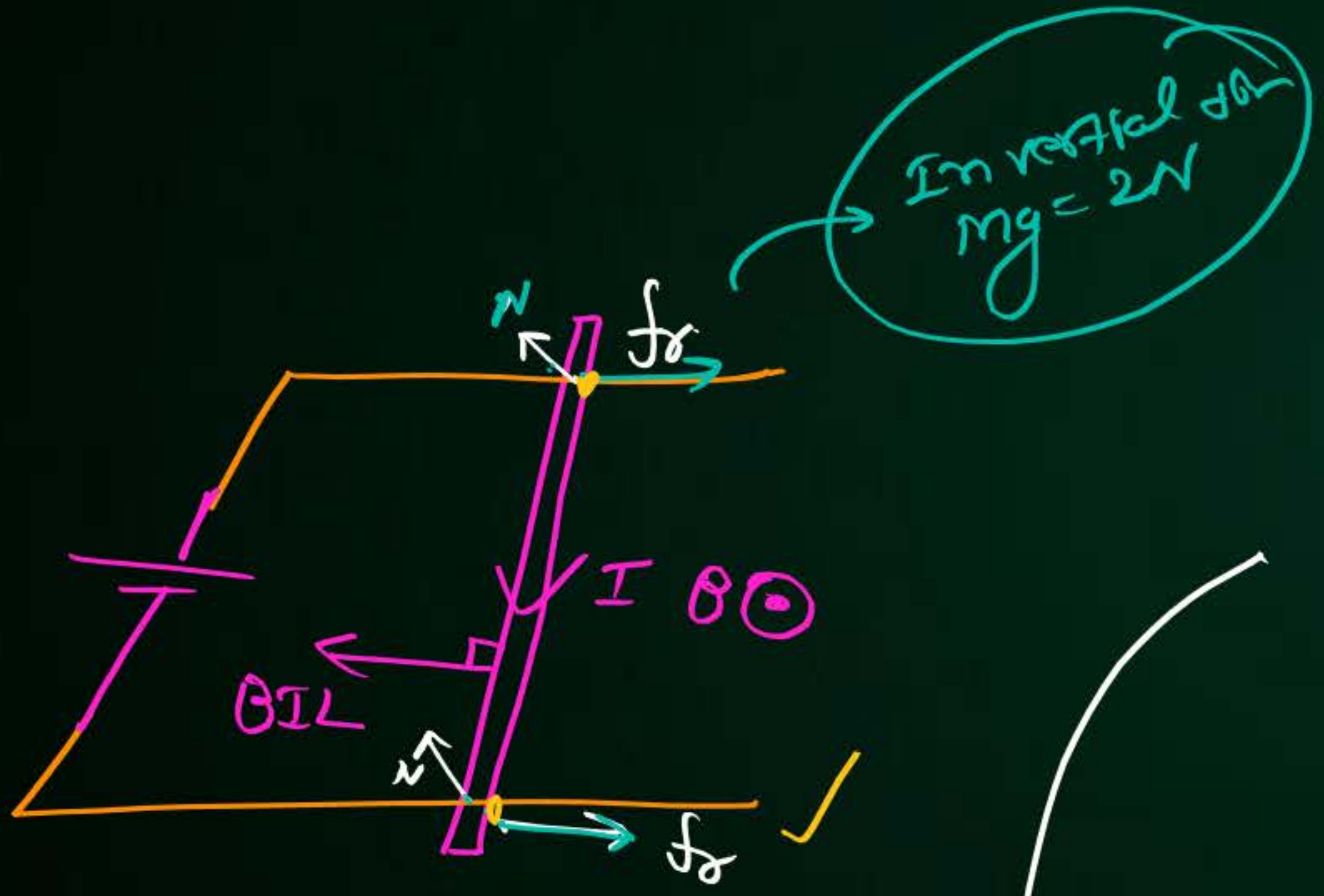
Wire is placed on smooth Inclined Plan, then find Minimum value B ?? so that wire will be at rest.

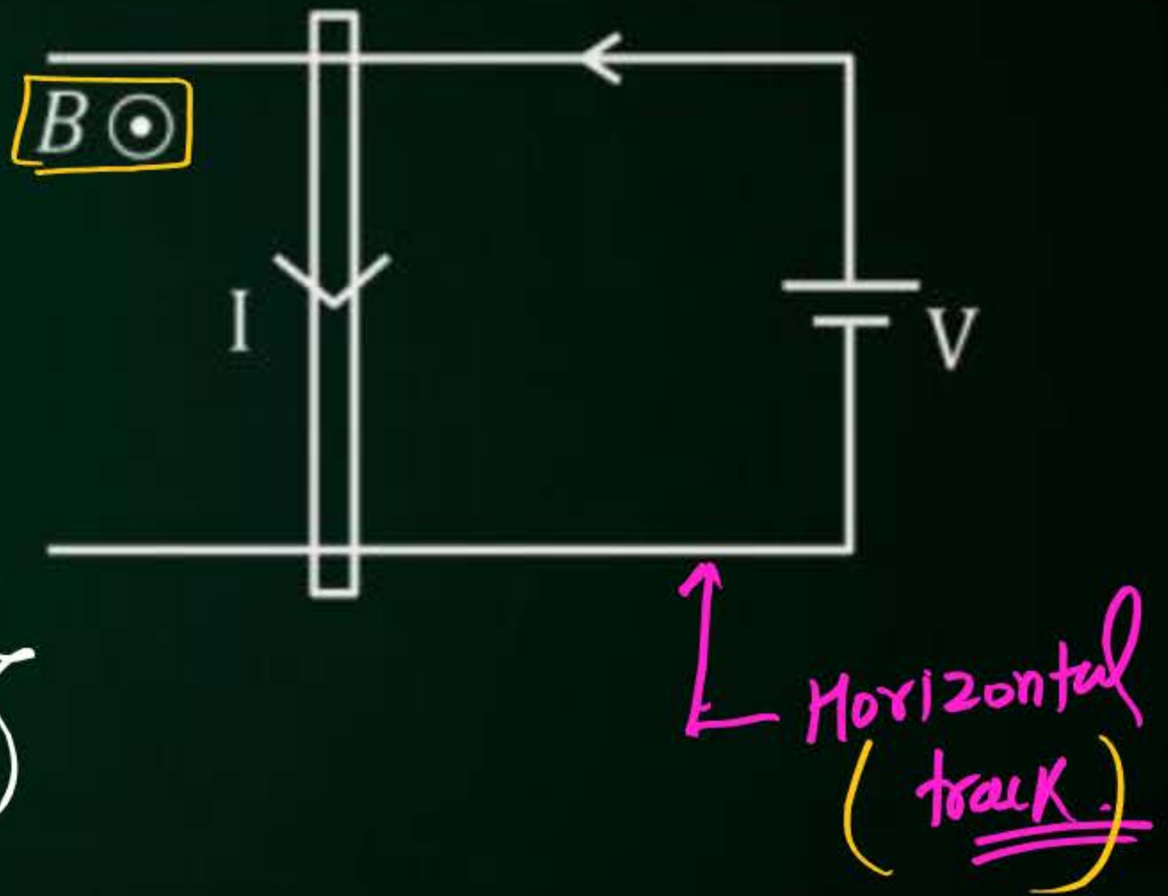
$$BIL\cos\theta = mg\sin\theta$$

$$B = \frac{mg}{IL}\tan\theta$$

QUESTION

Find coefficient of friction between/ wire[redacted], that wire will not move.





$$BIL = 2\,f_r$$

$$BIL = 2[\mu N]$$

$$BIL = 2\left(\mu \frac{mg}{2}\right)$$

$$\mu = \left\{\frac{BIL}{mg}\right\}$$

- **Force between two parallel currents, the ampere**

QUESTION

Two long wires carrying same currents are placed perpendicular to each other. The magnetic force on a small length dL of second wire is

(1) $\frac{\mu_0 I}{2\pi L}(dL)$

(2) $\frac{\mu_0 I^2}{2\pi L}(dL)$ ✓

(3) $\frac{\mu_0 I}{2\pi}(dL)$

(4) $\frac{\mu_0 I}{2\pi L}$

$F = B I dL$

$= \frac{\mu_0 I^2 dL}{2\pi L}$



QUESTION

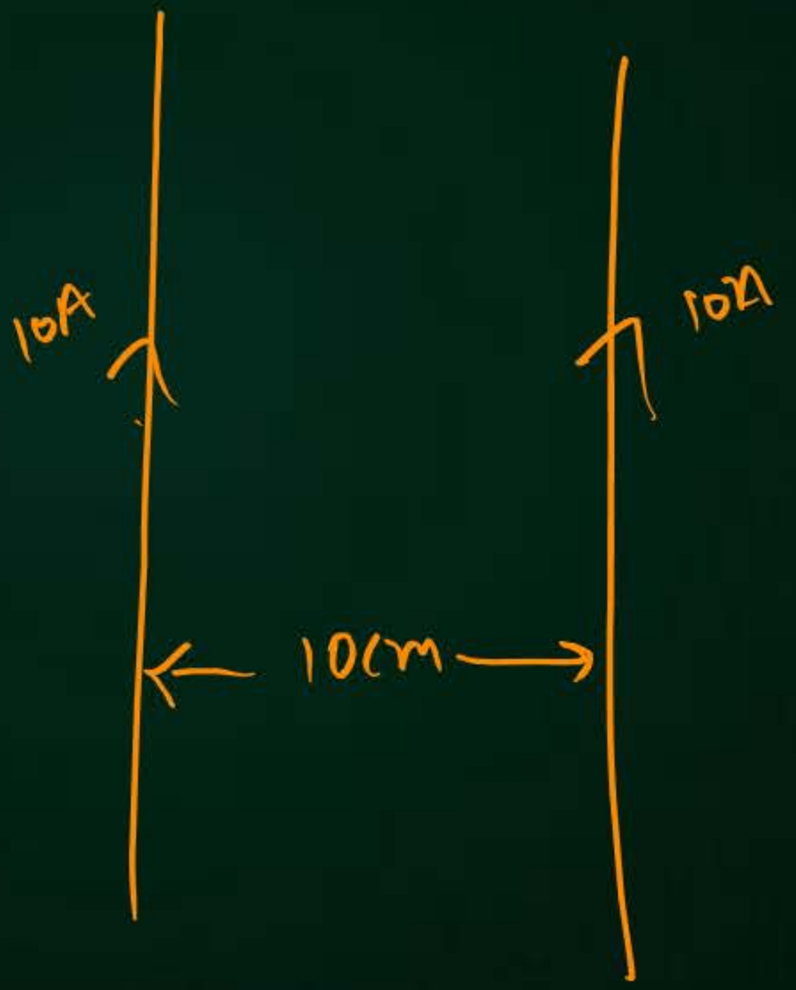
$\frac{\mu_0}{4\pi} = 10^{-7}$

NEET - mc 3 times

Two parallel wires in free space are 10 cm apart and each carries a current of 10 A in the same direction. The force exerted by one wire on the other, per metre length is

(1997)

1. 2×10^{-4} N, repulsive
2. 2×10^{-7} N, repulsive
3. 2×10^{-4} N, attractive
4. 2×10^{-7} N, attractive.



$$F = \frac{\mu_0 I_1 I_2}{2\pi (d)}$$

$$F = \left(\frac{\mu_0}{2\pi}\right)\frac{I^2}{d}$$

$$= \frac{2 \times 10^{-7} \times 10 \times 10}{10 \times 10^{-2}}$$

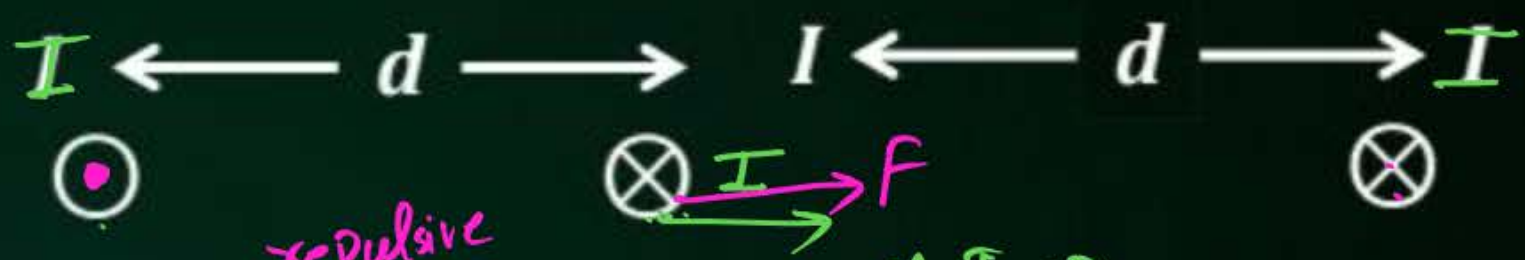
$$= 20 \times 10^{-5}$$

$$= 2 \times 10^{-4} \text{ (attra)}$$

QUESTION

Three infinite wire as shown in figure, find net force on middle wire.

on unit length



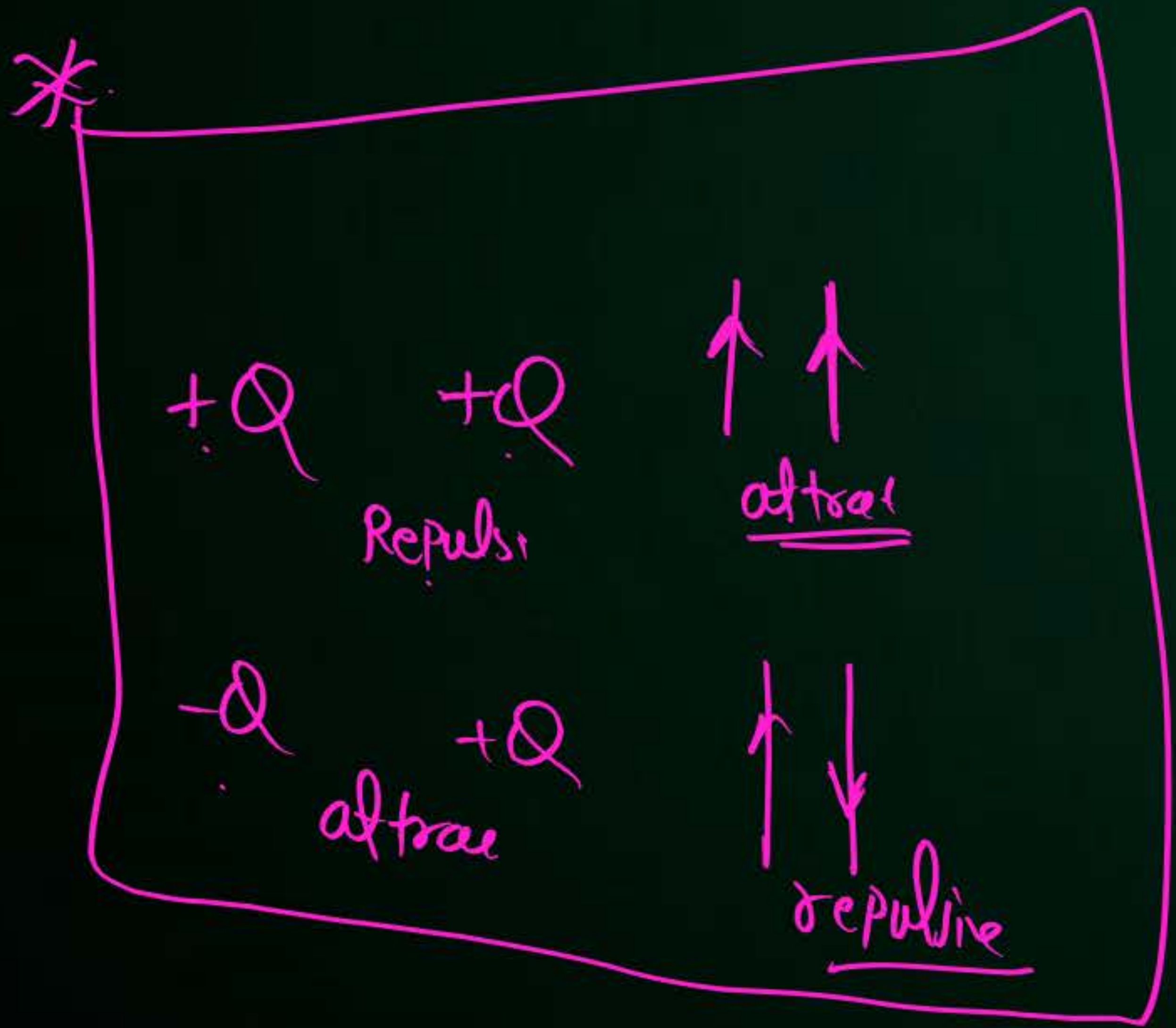
$$F = \frac{\mu_0 I \times I}{2\pi d} \times 1\,m$$

$$F = \frac{\mu_0 I^2}{2\pi d}$$

$$F_{net} = 2F$$

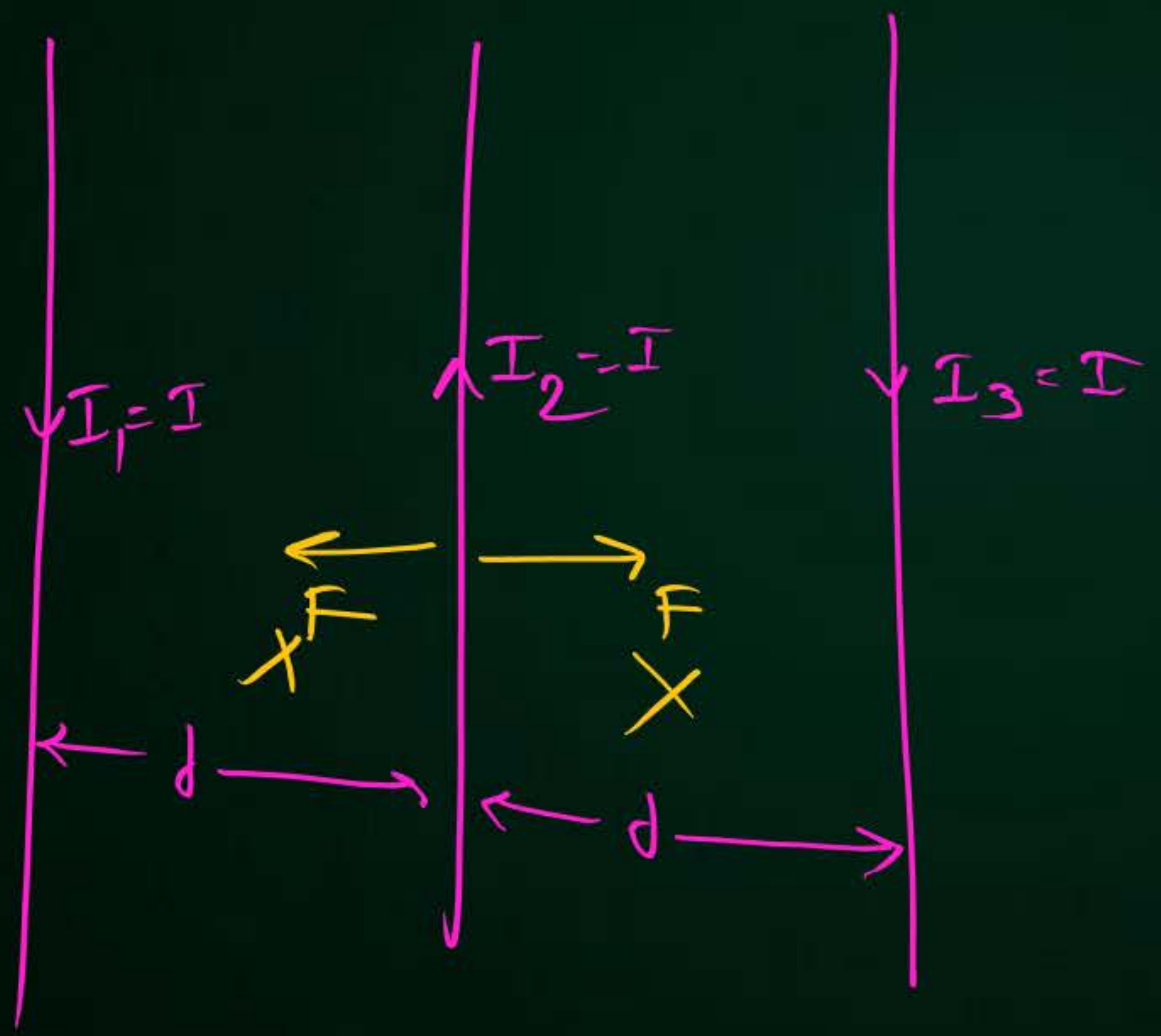
$$= \frac{\mu_0 I^2}{\pi d}$$

Ans



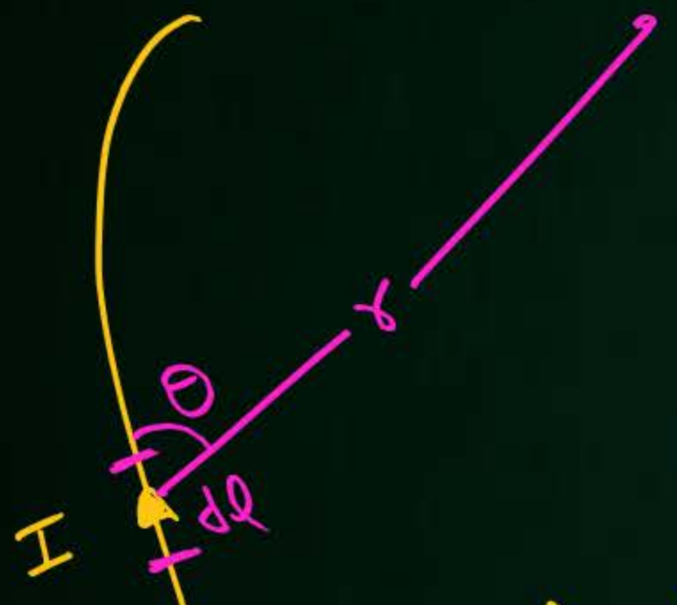
QUESTION

Find net force per unit length on middle wire



$F_{net} = \text{zero}$

Biot Savart Law for Moving Charge



$$dB = \frac{\mu_0}{4\pi} \frac{I\,dl\,\sin\theta}{r^2}$$

$$dB = \frac{\mu_0}{4\pi} \frac{I\,d\vec{l} \times \vec{r}}{r^3} = \frac{\mu_0}{4\pi} \frac{I\,d\vec{l} \times \hat{r}}{r^2}$$

$$\Rightarrow I\,dl = \frac{q}{t}\,dl = q\left(\frac{dl}{t}\right)$$

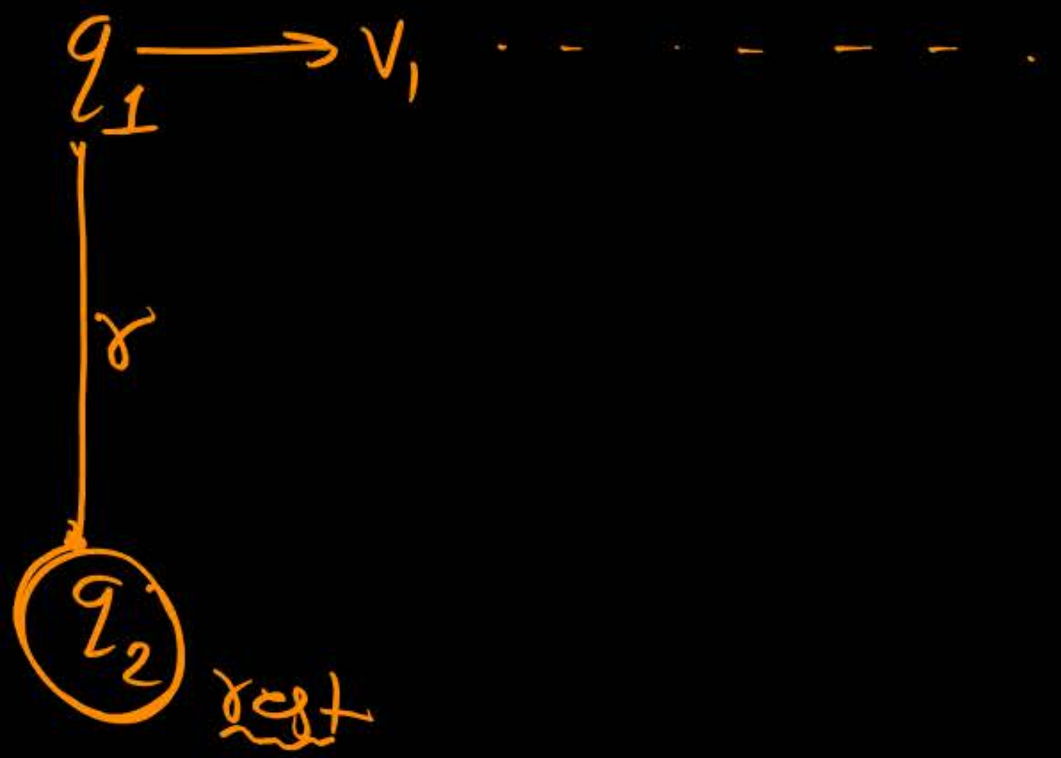
$$\boxed{I\,dl = qv}$$

$$\boxed{dB = \frac{\mu_0}{4\pi} \frac{q v \sin\theta}{r^2}}$$

angle b/w $\vec{r}$ & $\vec{v}$

magnetic force on q_2 due to q_1

$F = \text{zero}$ ✓

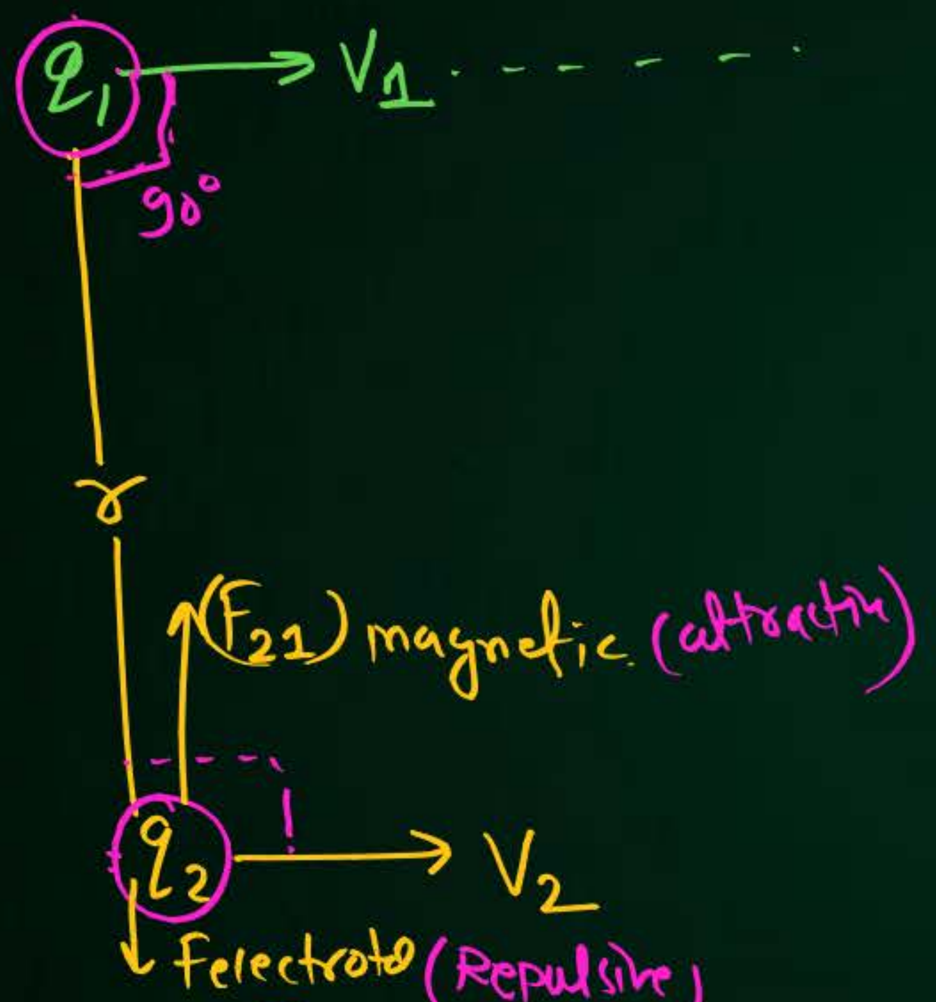




Magnetic Force B/W q_1 & q_2

Ans = zero

Force between the moving charge



$$F_{electro} = \frac{q_1 q_2}{4\pi\varepsilon_0 r^2}$$

$$c^2 = \frac{1}{\mu_0 \varepsilon_0}$$

$$F_{21} = q_2 V_2 B_1$$

$$= \frac{\mu_0 q_1 V_1 \, q_2 V_2}{4\pi r^2} = \frac{\mu_0 q_1 q_2 V_1 V_2}{4\pi r^2} \quad \text{(attractive)}$$

$$\frac{F_e}{F_m} = \frac{\frac{q_1 q_2}{4\pi\varepsilon_0 r^2}}{\frac{\mu_0}{4\pi}\frac{q_1 q_2 V_1 V_2}{r^2}}$$

$$\frac{F_e}{F_m} = \frac{1}{\mu_0\varepsilon_0 \times V_1 V_2}$$

$$\frac{F_e}{F_m} = \frac{c^2}{V_1 V_2} = \frac{c^2}{V^2}$$

$v \ll c$

$F_e \gg F_m$

Fnet force → Repulsive ✓

magnetic force ⇒ attractive

Net force B/w Two Beam of Proton moving in same direction → Repeal

$e^+ e^+ e^+ \longrightarrow v$

$e^+ e^+ e^+ \longrightarrow v$

Net force B/w Two Beam of Proton moving in opposite direction →

[illegible]

30%

✗ (a) attracti

✓ (b) Repulsive

QUESTION

Two protons A and B move parallel to the x-axis in opposite directions with equal speeds v. At the instant shown, the ratio of magnetic force and electric force acting on the proton A is (c = speed of light in vacuum)

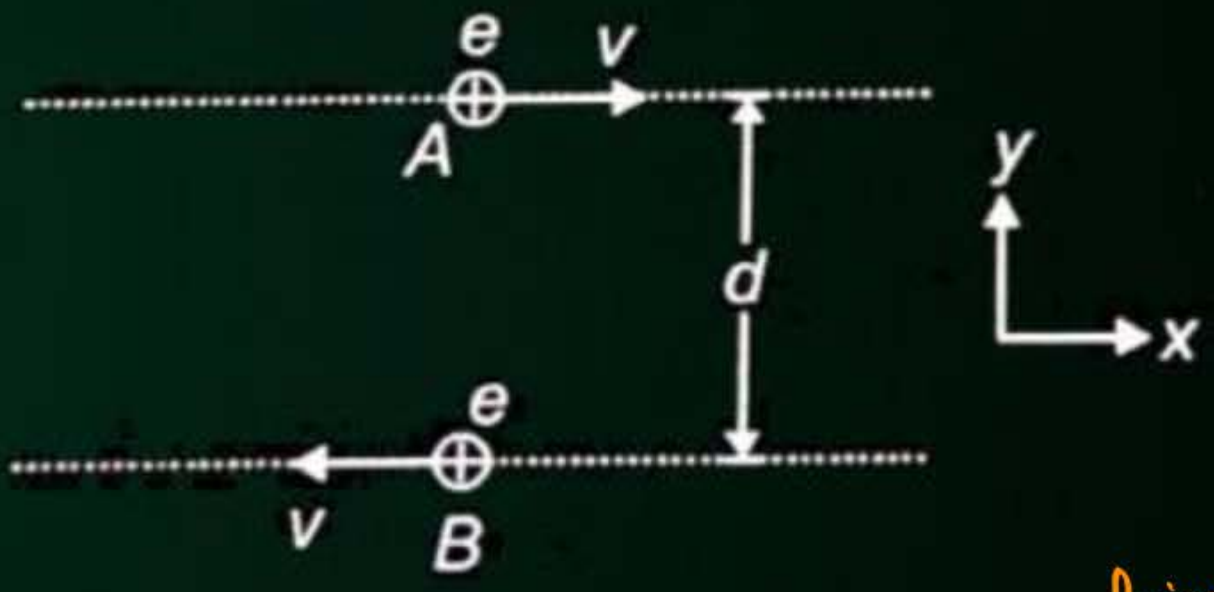
(1) $\frac{v}{c}$

(2) $\frac{v^2}{c^2}$

(3) $\frac{vd^2}{c}$

(4) $\frac{2v}{c}$

$$\frac{F_m}{F_e} = \frac{v^2}{c^2}$$



F magnetic = repulsion.

Fnet = repuls

F electric = repulsion

➢ Circular Current loop as a magnetic dipole

Magnetic field on the axis of a circular loop, of radius R, carrying a current *I* is

$$B = \frac{\mu_0 I R^2}{2(x^2 + R^2)^{3/2}}$$

Current Carrying loop behave as magnetic dipole



$$B = \frac{\mu_0 I R^2}{2(R^2+x^2)^{3/2}}$$

If $x >>> R$

$$B = \frac{\mu_0 I R^2}{2x^3}$$ (at large dist)

$$B = \frac{\mu_0 I R^2}{2x^3} \times \frac{[2\pi]}{[2\pi]}$$

$$= \frac{\mu_0}{4\pi} \frac{2I\pi R^2}{x^3}$$

$$B = \frac{2K[\vec{I\pi R^2}]}{x^3} = \frac{2K\{\vec{m}\}}{x^3}$$

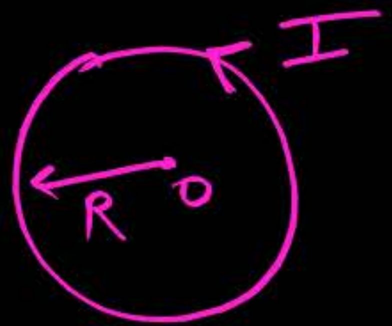
circular ring — magnetic dipole



$$E = \frac{2KP}{x^3}$$

$P = q\,l$

electric dipole



$M = I \, \text{Area}$

→ axial vector (⊥r to plane)

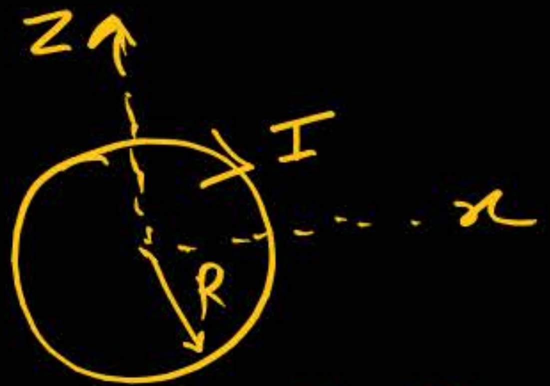
→ vector

→ dirⁿ → ⊙ (out) for Anti-clock current

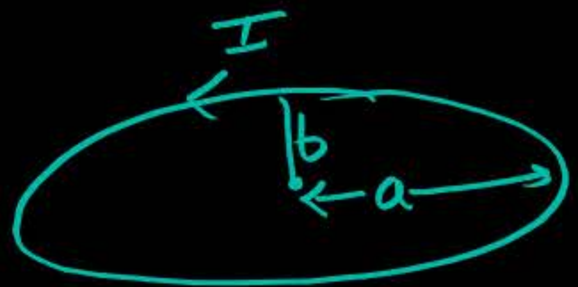
⊗ (Inward) for clock current

→ Unit (Amp-m²)

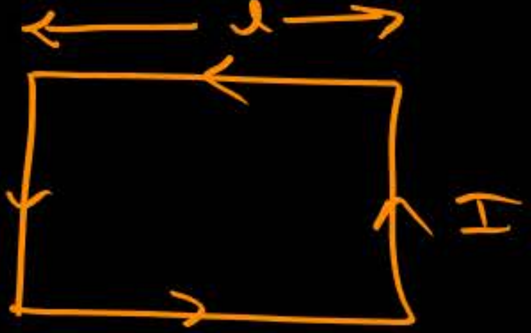
$\vec{M}$ = Current Area



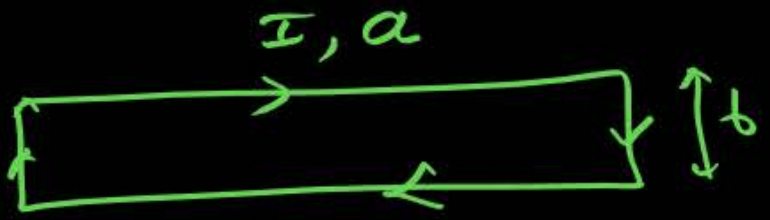
$M = I\pi R^2$ ⊗



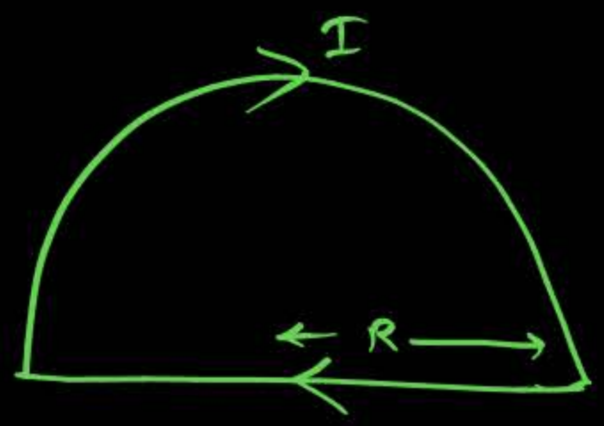
$M = I\pi ab$ ⊙



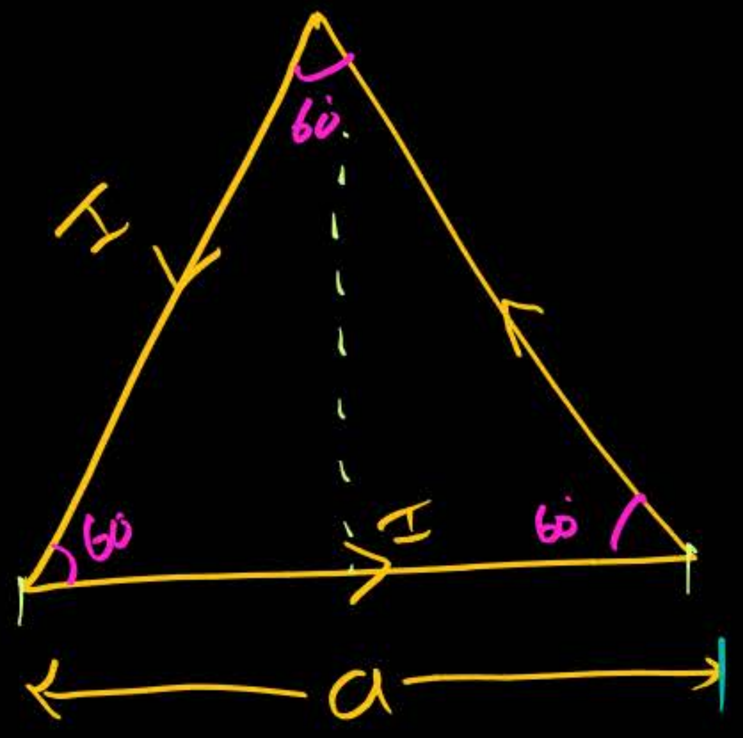
$M = I l^2$ ⊙



$M = I ab$ ⊗



$$M = \frac{I \pi R^2}{2} \; \otimes$$



$$M = \frac{I \sqrt{3} a^2}{4} \; \odot$$

$$\text{Area} = \frac{1}{2} \times a \times \frac{\sqrt{3} a}{2}$$

$$\text{Area} = \frac{\sqrt{3}\, a^2}{4}$$

QUESTION

If the planes of two identical concentric coils are perpendicular and the magnetic moment of each coil is M, then the resultant magnetic moment of the two coils will be

1. M
2. 2M
3. 3M
4. $\sqrt{2}$M

NEET



N = No of turns.

$$M = (I \pi R^2) N$$

A circular coil of Radius R having magnetic moment M if current in it is I, Now same coil is rebound in n-turns then find magnetic moment if current it is is also I,

$$M = I\pi R^2 \quad \text{— (1)}$$

R (first loop) → n-loop, $R' = \frac{R}{n}$

(a) $M' = nM$

(b) $M' = n^2 M$

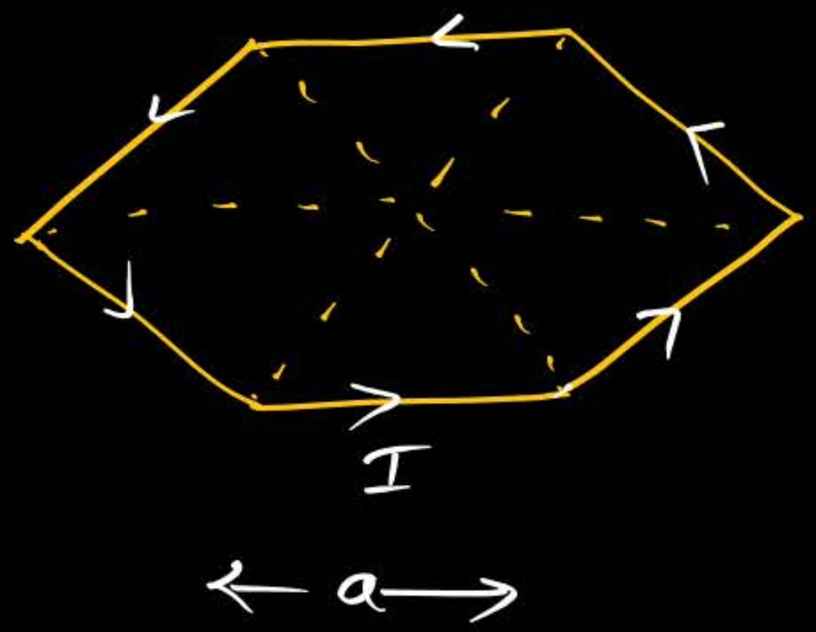
(c) $M' = M/n$ (17%)

(d) $M' = M/n^2$

$$M' = nI\pi R'^2$$

$$= nI\pi \frac{R^2}{n^2}$$

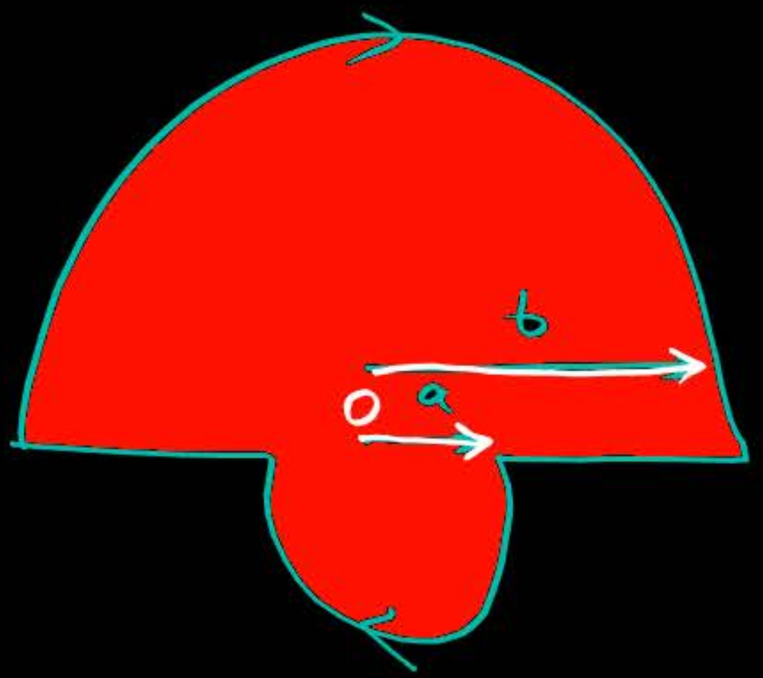
$$M' = \frac{I\pi R^2}{n} = \left(\frac{M}{n}\right)$$



Magnetic moment = ??

$$M = \frac{I\sqrt{3}a^2}{4} \times 6$$

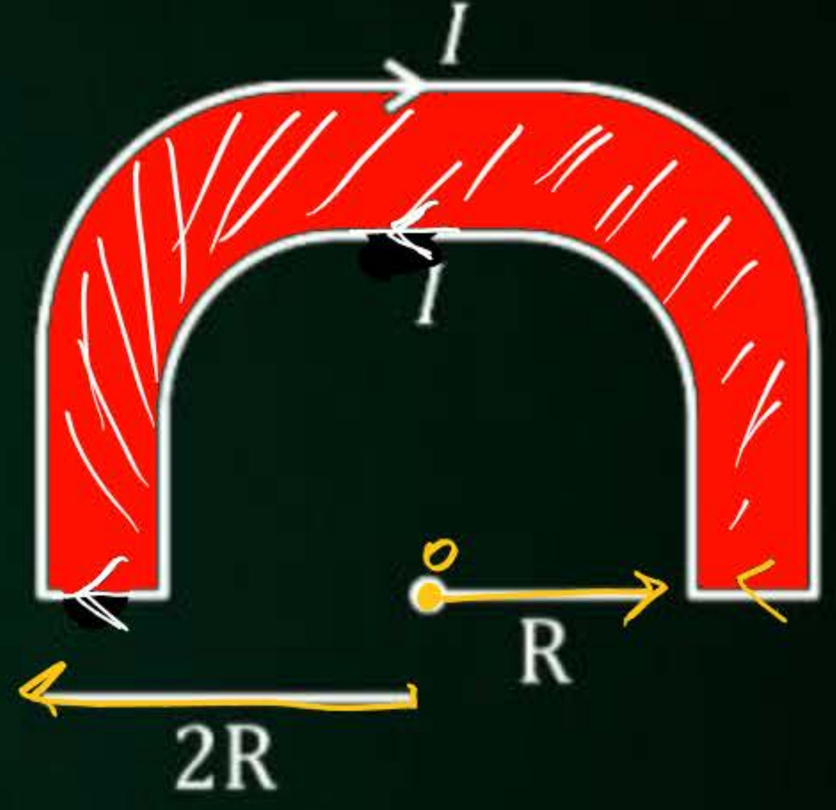
$$M = \frac{3\sqrt{3}\,I a^2}{2}$$



$$M = I\left[\frac{\pi b^2}{2} + \frac{\pi a^2}{2}\right] \otimes$$

QUESTION

Find magnetic moment.



$$M = I\left[\frac{\pi(2R)^2}{2} - \frac{\pi R^2}{2}\right]$$

$$= I\left[\frac{\pi 4R^2}{2} - \frac{\pi R^2}{2}\right]$$

$$= \frac{I\pi R^2}{2}\left[4-1\right]$$

$$= \frac{3}{2}\pi I R^2$$

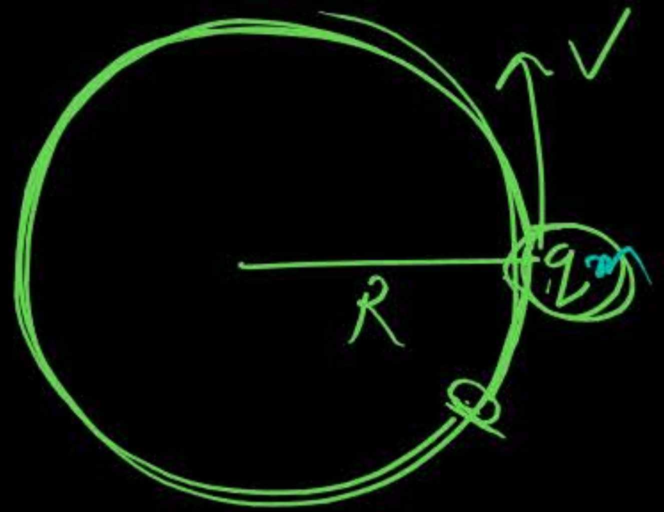
➢ The Magnetic Dipole Moment of Revolving Electron

QUESTION

If number of turns, area and current through a coil is given by n, A and i respectively then its magnetic moment will be (2001)

1. niA
2. $n^2 iA$
3. niA^2
4. $\frac{ni}{\sqrt{A}}$

Q) If charge q & mass m is moving on circular path with speed V then its magnetic moment.



$M = IA$

$= \frac{q}{T} \pi R^2$

$= \frac{q}{\frac{2\pi R}{V}} \pi R^2$

$M = \frac{qVR}{2}$

$$M = \frac{qVR}{2}$$ *

Angular momentum

$L = mvR$

$$\frac{M}{L} = \frac{qvR}{2mvR}$$

$$\frac{M}{L} = \frac{q}{2m}$$

→ Gyromagnetic Ratio

(*) What is the dimension of Ratio of magnetic moment to Angular momentum

$$\left[\frac{M}{L}\right] = \frac{q}{2m} = ATM^{-1}$$ Ans

$$\vec{M} = \frac{q}{2m}\vec{L}$$

→ dirn of magnetic moment along Angular moment.

$$\frac{M}{L} = \frac{\text{specific charge}}{2}$$ ✓

(Q) find magnetic moment of $\bar{e}$ revolving in n^{th} orbit of H-atom

$$\frac{M}{L} = \frac{q}{2m}$$

$$M = \frac{q}{2m} L$$

$$M = \frac{e}{2m}\left(\frac{nh}{2\pi}\right)$$

$$M = \frac{neh}{4\pi m}$$

n → no of orbit

↳ magnetic momentum

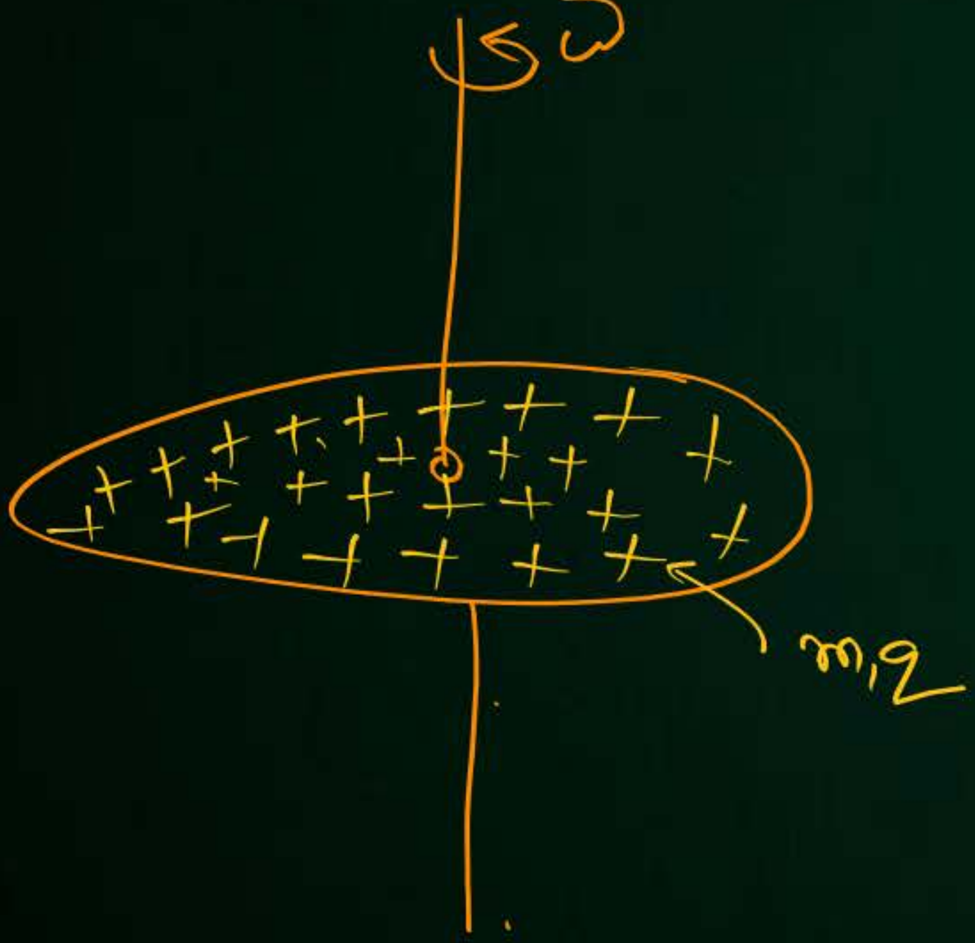
QUESTION

A charged particle (charge q) is moving in a circle of radius R with uniform speed v. The associated magnetic moment μ is given by (2007)

1. qvR^2
2. $qvR^2/2$
3. qvR
4. $qvR/2$

QUESTION

A massless disc of radius r and carrying charge q, is rotating with angular speed ω about an axis passing through its centre and perpendicular to its plane. Calculate its magnetic moment, where charge q is uniformly distributed and having mass (m).



$$\frac{M}{L} = \frac{q}{2m}$$

$$M = \frac{q}{2m}(L)$$

$$= \frac{q}{2m} I\omega$$

$$M = \frac{q\omega}{2m}\frac{mR^2}{2}$$

$$m = \frac{q\omega R^2}{4}$$

(Q) Magnetic force on current carrying loop in magnetic field is zero.

(a) True — 24%

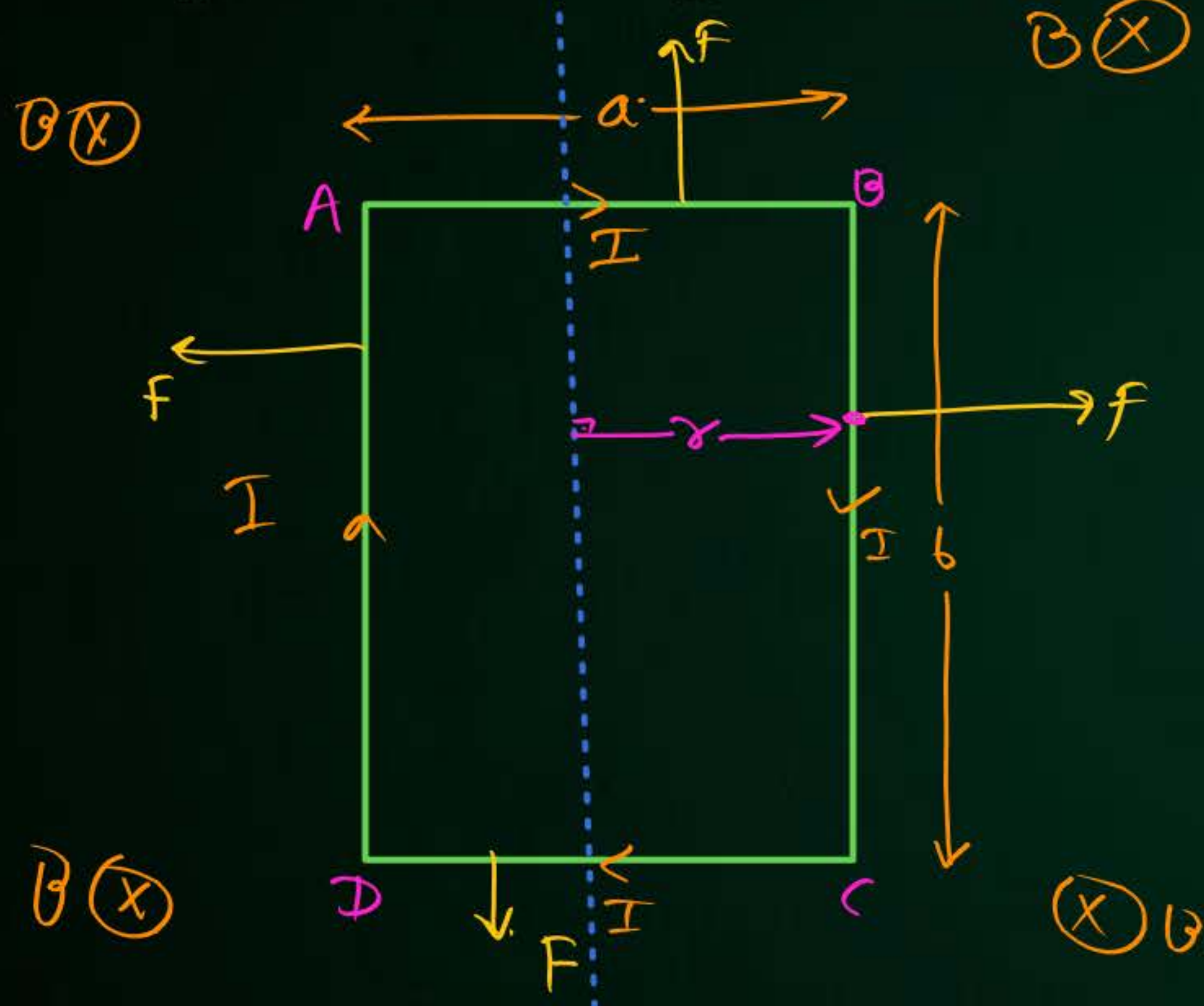
(b) false — 70%

Magnetic force on current carrying loop in uniform magnetic field is zero.

True

➢ TORQUE ON CURRENT LOOP, MAGNETIC DIPOLE

Torque on a rectangular current loop in a uniform magnetic field



$F_{AB} = B\,Ia \uparrow$, $F_{CD} =$

$F_{BC} = IBb \rightarrow$

$F_{DA} = IBb \leftarrow$

$F_{net} = zero$

$\tau_{net} = 0$

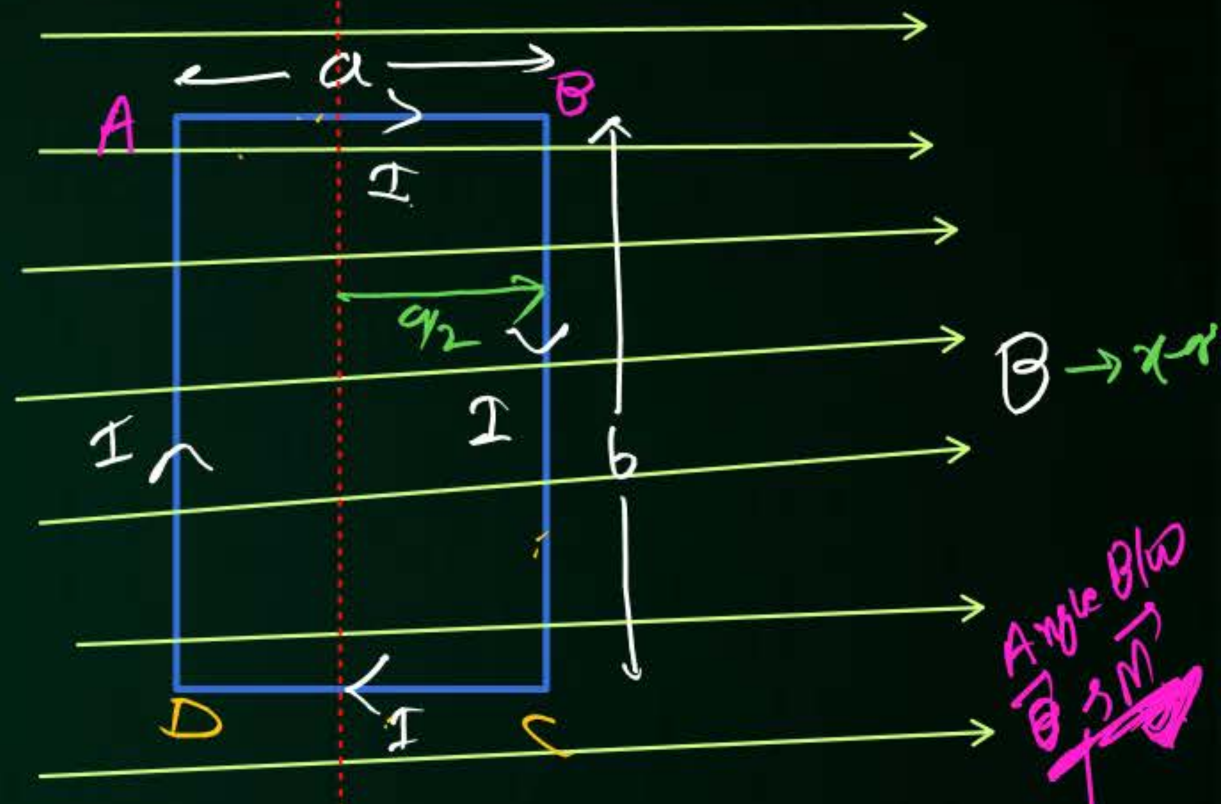
$F_{AB} = 0 = F_{CD}$

$F_{BC} = IbB$ ⊙

$F_{DA} = IbB$ ⊗

$F_{net} = 0$

axis of Rotⁿ



Angle b/w $\vec{B}$ & $\vec{M}$

$\tau = IbB\frac{a}{2} + IbB\frac{a}{2}$

$\tau = IbaB$

$\tau = IAB$

$\tau = MB$

$\tau = MB\sin\theta$

$\vec{\tau} = \vec{M} \times \vec{B}\sin\theta$

$\tau = \vec{p} \times \vec{E} = pE\sin\theta$

$U = -\vec{p} \cdot \vec{E} = -pE\cos\theta$

$W_{ext} = \Delta U$

$W_{c.f} = -\Delta U$

$\theta = 0°$, $\tau = 0$, $F = 0$, $U_{min} = -pE$

Stable eqm

$T = 2\pi\sqrt{\frac{I}{pE}}$

$\theta = 90°$, τ_{max}, $U = 0$

$\theta = 180°$, $\tau = 0$, $F = 0$, $U_{max} = +pE$

$\vec{\tau} = \vec{m} \times \vec{B} = mB\sin\theta$

$U = -\vec{m} \cdot \vec{B} = -mB\cos\theta$

scalar

$W_{mag} = -\Delta U$

$W_{ext\,F} = \Delta U$

$\theta = 0°$, $F = 0$, $\tau = 0$, $U_{min} = -mB$

stable eqm

$T = 2\pi\sqrt{\frac{I}{mB}}$

$\theta = 90°$, $F = 0$, $U = 0$, $\tau_{max} = mB$

$\theta = 180°$, $F = 0$, $\tau = 0$, $U_{max} = +mB$

unstable eqm

No S.H.M

I = M.O.I

$m \to$ magnetic moment

QUESTION

A rectangular coil of length 0.12 m and width 0.1 m having 50 turns of wire is suspended vertically in a uniform magnetic field of strength 0.2 Weber/m^2. The coil carries a current of 2 A. If the plane of the coil is inclined at an angle of 30° with the direction of the field, the torque required to keep the coil in stable equilibrium will be

(2015)

1. 0.24 N m
2. 0.12 N m
3. 0.15 N m
4. 0.20 N m

$\tau = mB\sin 60^\circ$



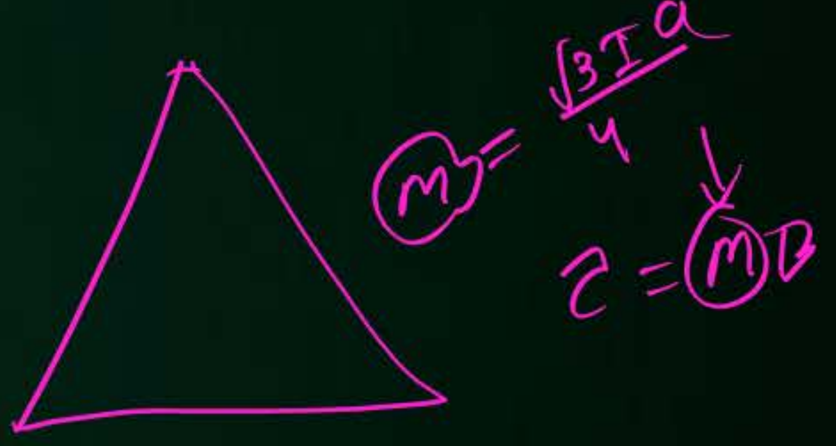
QUESTION

A current loop in a magnetic field (NEET 2013)

1. can be in equilibrium in two orientations, both the equilibrium states are unstable.
2. can be in equilibrium in two orientations, one stable while the other is unstable.
3. experiences a torque whether the field is uniform or non uniform in all orientations.
4. can be in equilibrium in one orientation.

QUESTION

A coil in the shape of an equilateral triangle of side l is suspended between the pole pieces of a permanent magnet such that $\vec{B}$ is in plane of the coil. If due to a current i in the triangle a torque τ acts on it, the side l of the triangle is (2005)



1. $\frac{2}{\sqrt{3}}\left(\frac{\tau}{Bi}\right)$
2. $2\left(\frac{\tau}{\sqrt{3}Bi}\right)^{1/2}$
3. $\frac{2}{\sqrt{3}}\left(\frac{\tau}{Bi}\right)^{1/2}$
4. $\frac{1}{\sqrt{3}}\frac{\tau}{Bi}$

QUESTION

A circular loop of area 0.01 m^2 carrying a current of 10 A, is held perpendicular to a magnetic field of intensity 0.1 T. The torque acting on the loop is (1994)

1. 0.001 N m
2. 0.8 N m
3. zero
4. 0.01 N m.

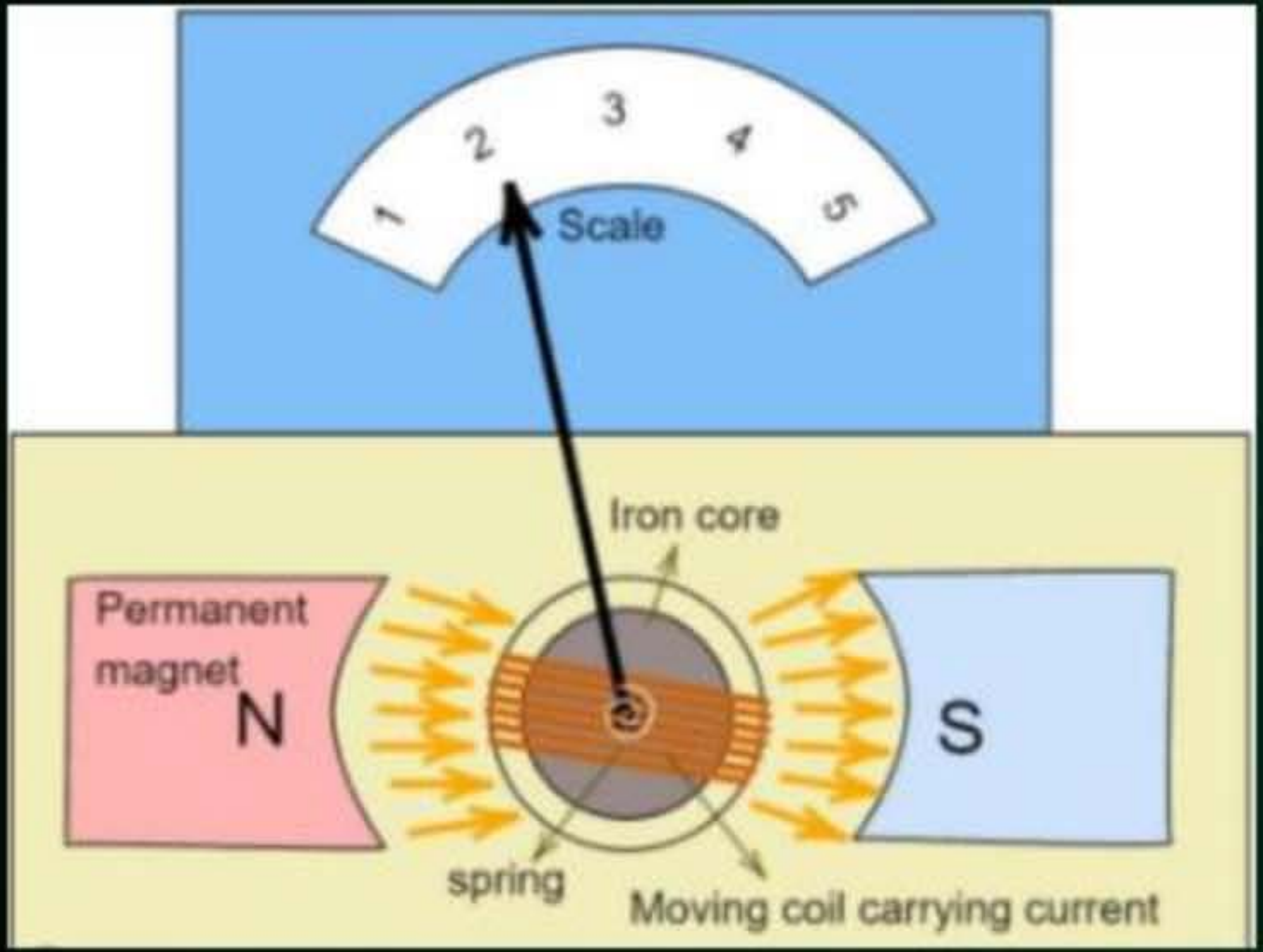
H/W

QUESTION

A coil carrying electric current is placed in uniform magnetic field (1993)

1. torque is formed
2. e.m.f is induced
3. both (1) and (2) are correct
4. none of these

Moving Coil Galvanometre



QUESTION

The relation between voltage sensitivity (σ_v) and current sensitivity (σ_i) of a moving coil galvanometer is (resistance of galvanometer is G).

1. $\frac{\sigma_i}{G} = \sigma_v$
2. $\frac{\sigma_v}{G} = \sigma_i$
3. $\frac{G}{\sigma_i} = \sigma_v$
4. $\frac{G}{\sigma_v} = \sigma_v$

QUESTION

Current sensitivity of a moving coil galvanometer is 5 div/mA and its voltage sensitivity (angular deflection per unit voltage applied) is 20 div/V. The resistance of the galvanometer is?

1. $250\,\Omega$
2. $40\,\Omega$
3. $500\,\Omega$
4. $25\,\Omega$


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 01 | **Physics**

Magnetism and Matter

By- Dr. Manish Raj (MR SIR)



Todays Goal

- Moving coil Galvanometre
- P.hD. on. BAR magnet

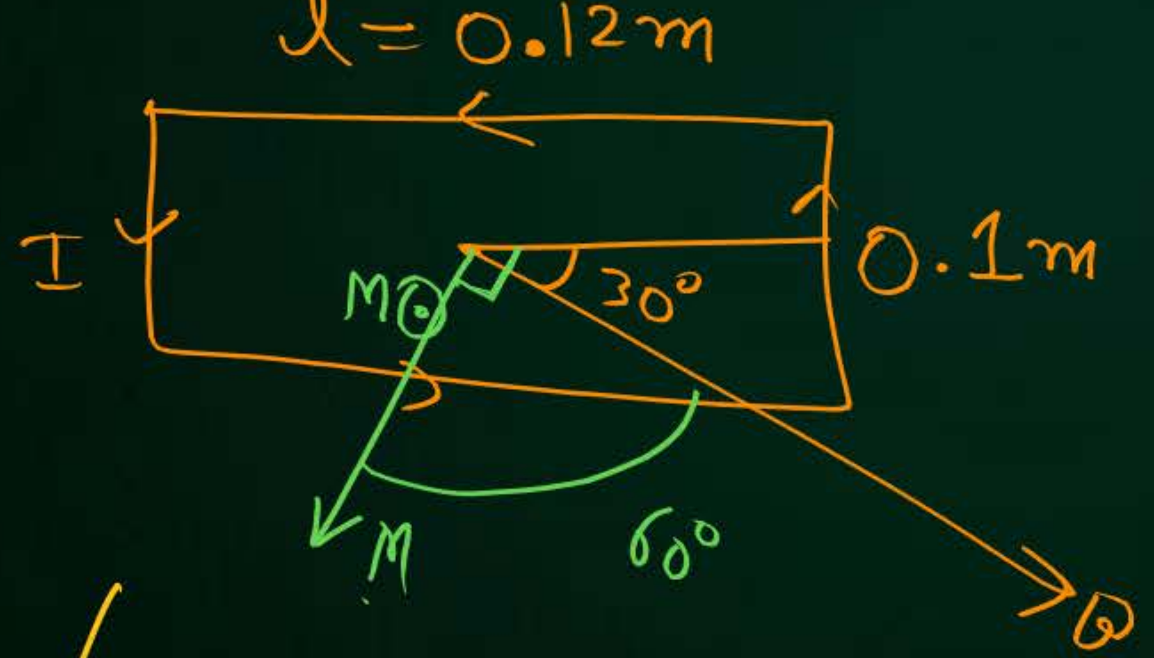
3

QUESTION

A rectangular coil of length 0.12 m and width 0.1 m having 50 turns of wire is suspended vertically in a uniform magnetic field of strength 0.2 Weber/m^2. The coil carries a current of 2 A. If the plane of the coil is inclined at an angle of 30° with the direction of the field, the torque required to keep the coil in stable equilibrium will be

(2015)

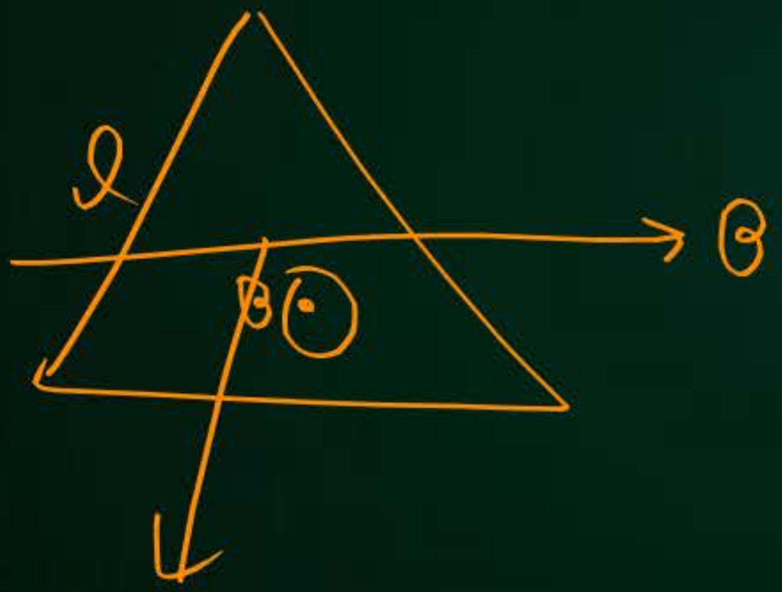
1. 0.24 N m
2. 0.12 N m
3. 0.15 N m
4. 0.20 N m



QUESTION

A coil in the shape of an equilateral triangle of side l is suspended between the pole pieces of a permanent magnet such that $\vec{B}$ is in plane of the coil. If due to a current i in the triangle a torque τ acts on it, the side l of the triangle is **(2005)**

1. $\frac{2}{\sqrt{3}}\left(\frac{\tau}{Bi}\right)$
2. $2\left(\frac{\tau}{\sqrt{3}Bi}\right)^{1/2}$
3. $\frac{2}{\sqrt{3}}\left(\frac{\tau}{Bi}\right)^{1/2}$
4. $\frac{1}{\sqrt{3}}\frac{\tau}{Bi}$



$\tau = mB\sin 90^\circ$

$\tau = I\frac{\sqrt{3}}{4}l^2 B$

$l^2 = \frac{4\tau}{\sqrt{3}IB}$

$= \sqrt{\frac{4\tau}{\sqrt{3}IB}} = 2\left(\frac{\tau}{\sqrt{3}Bi}\right)^{1/2}$

QUESTION

A coil carrying electric current is placed in uniform magnetic field (1993)

$B = const^n$

1. torque is formed
2. e.m.f is induced
3. both (1) and (2) are correct
4. none of these

Torque and stored P.E. on magnetic dipole

$\vec{\tau} = \vec{M} \times \vec{B} = MB\sin\theta$ → Angle b/w m & B

- → unit (J = Nm)
- → vector
- → dirⁿ ⊥r to $\vec{m}$ & $\vec{B}$
- → $\vec{\tau}\cdot\vec{M} = 0$ $\vec{\tau}\cdot\vec{B} = 0$
- → axis vector

τ ⊙ → Anti-clock Rotⁿ

τ ⊗ → clock Rotⁿ

$U = -\vec{M}\cdot\vec{B} = -MB\cos\theta$

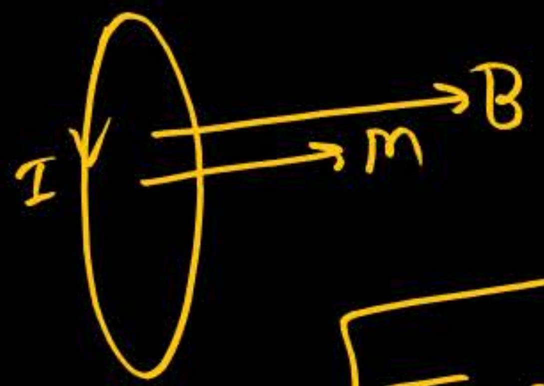
- → Unit (J or Nm)
- → scalar
- → No dirⁿ

$\theta = 0^\circ$

$\tau = 0$
$F = 0$

$U_{min} = -MB$

equilibriem stable → S.H.M



$T = 2\pi\sqrt{\frac{I}{M\cdot B}}$

$\theta = 90^\circ$

$\tau_{max} = MB,\ F = 0,\ U = 0$

$\theta = 180^\circ$

$\tau = 0,\ F = 0\quad U_{max} = MB$ ← unstable equilibrm, No SHM.

$W_{ext\ Force} = \Delta U = U_f - U_i$

$W_{C.F_{Magn}} = -\Delta U = U_i - U_f$ ✓

QUESTION

Initially magnetic dipole in the direction of field B, find work done to rotate it by 90°.

Solⁿ

$\theta_i = 0$

$U_i = -MB$

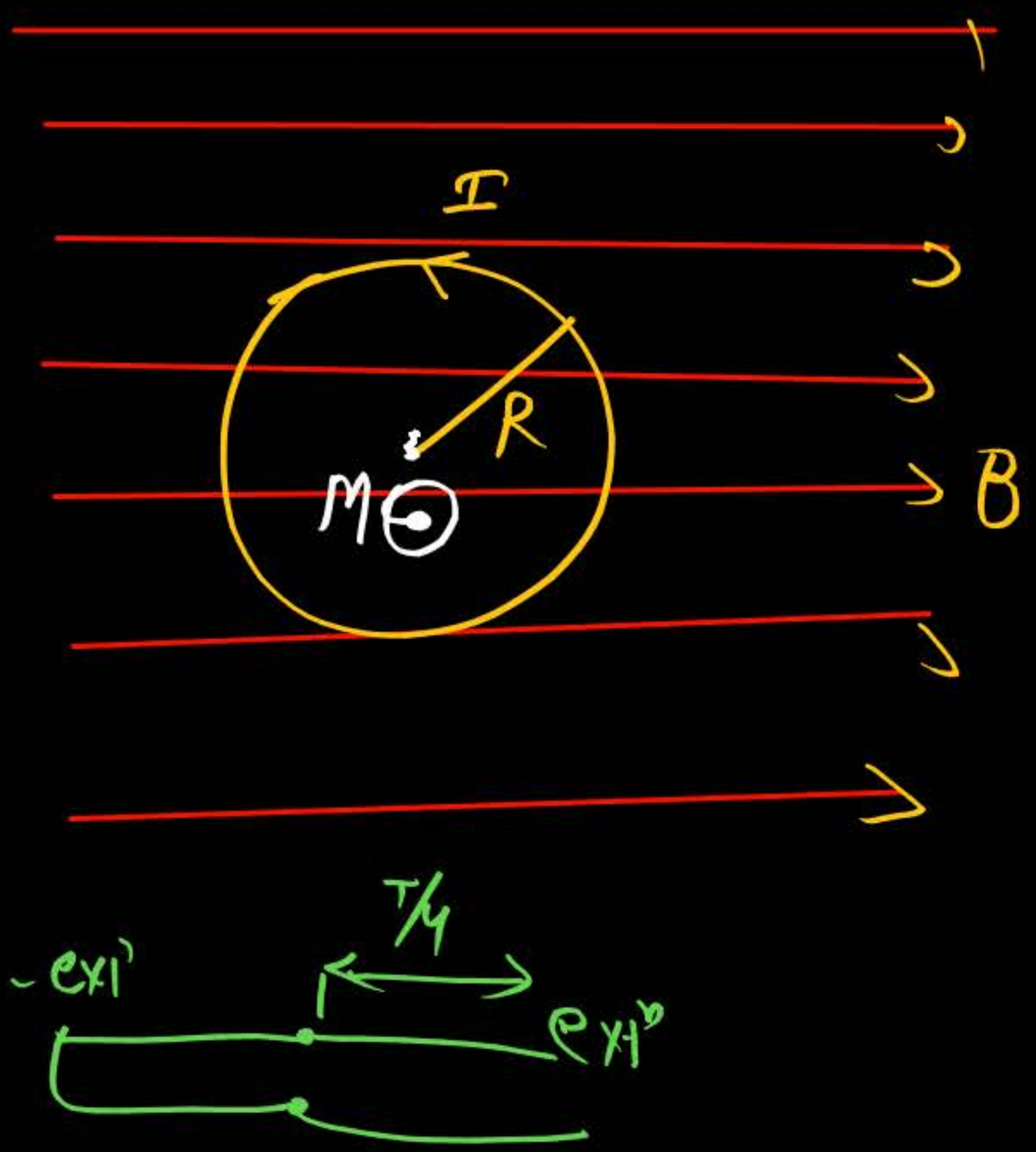
$\theta_f = 90°$

$U_f = 0 = -MB\cos 90°$

$W_{ext} = U_f - U_i$

$= 0 - (-MB)$

$= +MB$ Joule



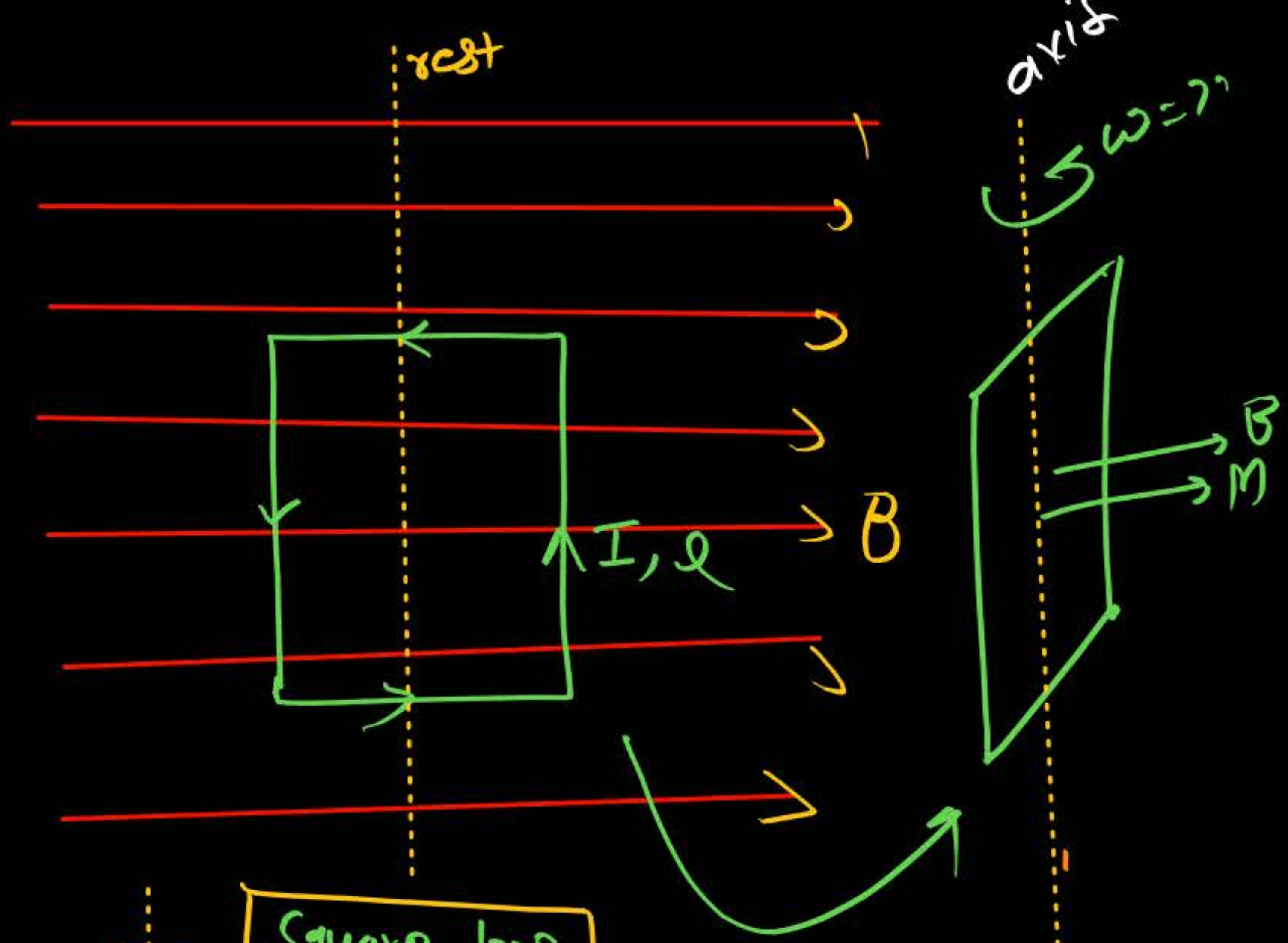
find time taken by circular loop to turn by angle 90° & becomes parallel to magnetic field.

$$t = \frac{T}{4}$$

$$t = \frac{1}{4} 2\pi \sqrt{\frac{I}{MB}}$$

$$= \frac{\pi}{2} \sqrt{\frac{I}{MB}}$$

find Angular speed of coil, when it turns by angle 90° & becomes parallel to magnetic field. each arm having mass (m, l).



Square loop.



$$I = \frac{1}{12} m l^2 \times 2 + m\left(\frac{l}{2}\right)^2 \times 2$$

$$I = m l^2\left[\frac{1}{6} + \frac{1}{2}\right] = m l^2\left(\frac{1+3}{6}\right) = \frac{4}{6} m l^2$$

C.O.M.E

$$(K.E + U)_i = (K.E + U)_f$$

$$0 + 0 = -MB + \frac{1}{2} I \omega^2$$

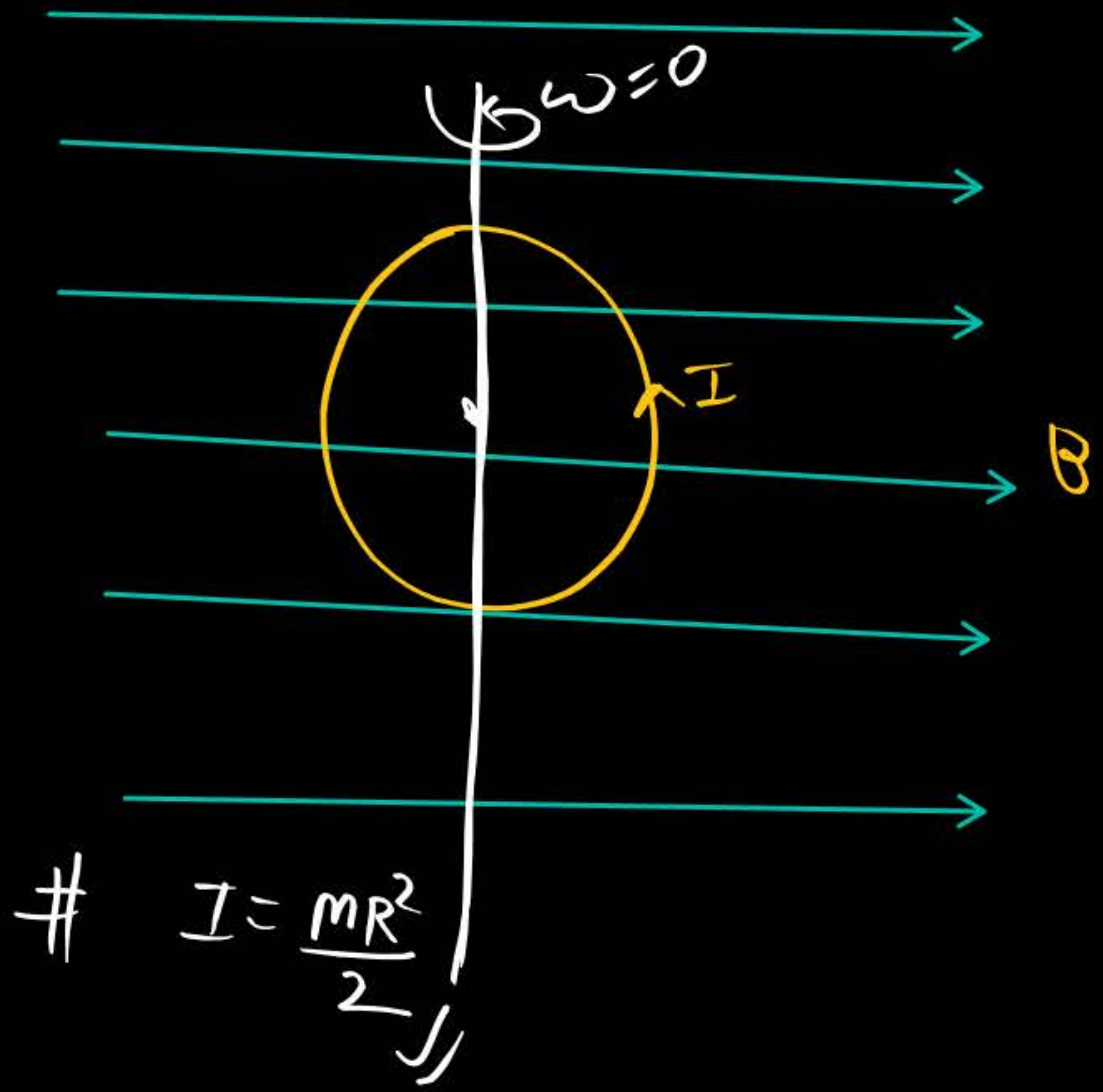
$$MB = \frac{1}{2} I \omega^2$$

$$MB = \frac{1}{2} \times \frac{4}{6} m l^2 \omega^2$$

$$I l^2 B = \frac{2 m l^2 \omega^2}{6}$$

$$\omega^2 = \frac{3IB}{m}$$

$$\omega = \sqrt{\frac{3IB}{m}}$$



C.O.M.E

$$(K.E + U)_i = (K.E + U)_f$$

$$0 + 0 = \frac{1}{2} I\omega^2 - MB$$

$$MB = \frac{1}{2} I \omega^2$$

$$\pi R^2 I B = \frac{1}{2} \frac{MR^2}{2} \omega^2$$

$$\sqrt{\frac{4\pi I B}{M}} = \omega$$

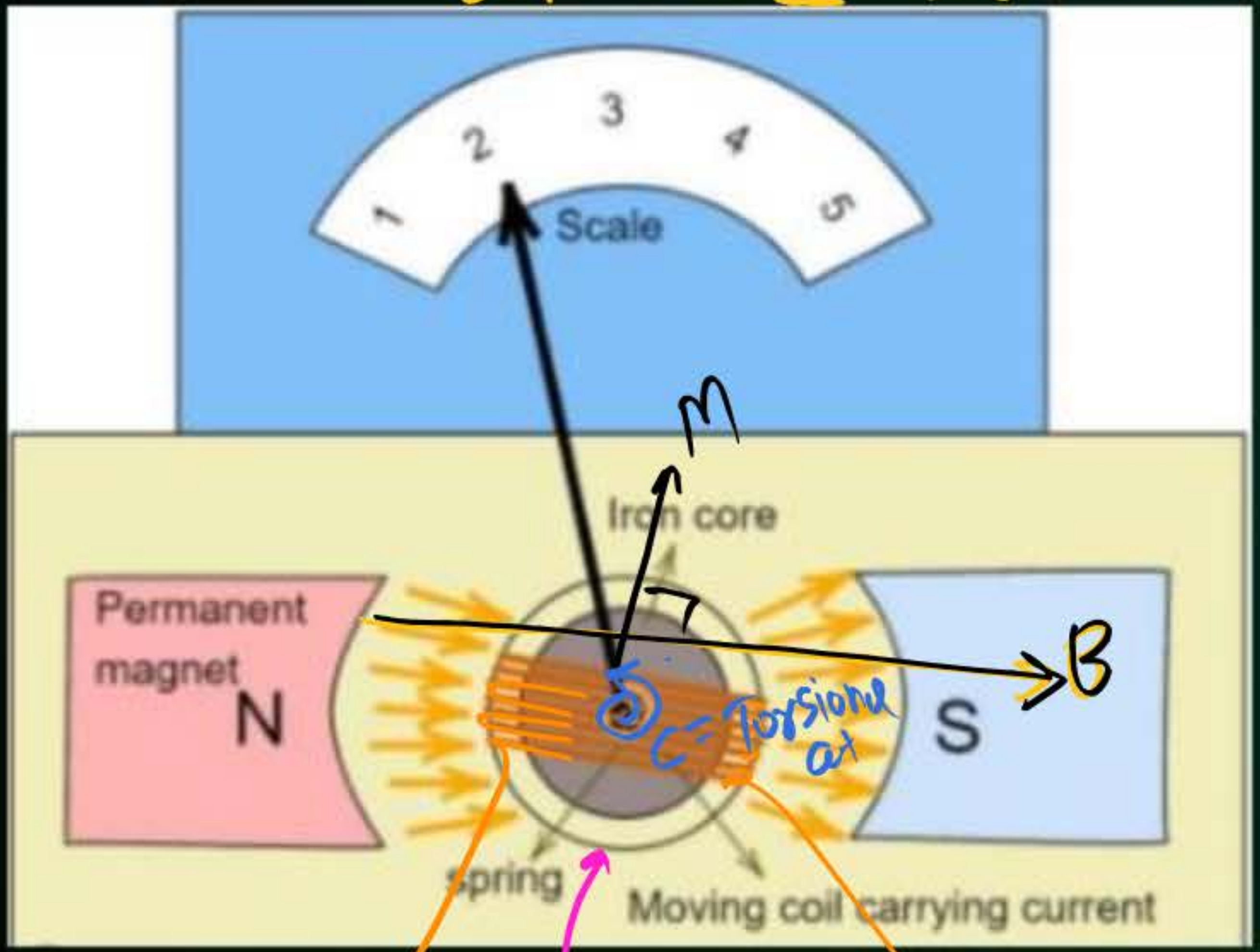
Moving Coil Galvanometre

Galvanometre → current electricity

Working

→ Torque on current carrying loop.

1A ⟶ 10° → High sensitivity
5A ⟶ 1° → low sensitivity



Current = I

Insulating spot

A = Area
N = No. of turns

$M = NIA$

$\tau = MB\sin 90°$

$\tau = NIAB$ — (i)

$\tau = C\theta$ — (ii)

$C\theta = NABI$

$\theta = \left[\frac{NAB}{C}\right] I$

$\theta \propto I$ (current) → linear scale

$\theta = \frac{NABI}{C}$

$\left[\frac{\theta}{I}\right] = \frac{NAB}{C}$

$\frac{\theta}{I}$ = current sensitivity (S_I)

$\left[\frac{\theta}{I}\right] = \left[\frac{NAB}{C}\right] = S_I$

Voltage sensitivity

$\frac{\theta}{V} = \frac{\theta}{IR} = \frac{NAB}{CR} = S_V$

$S_V = \frac{S_I}{R}$

QUESTION

The relation between voltage sensitivity (σ_v) and current sensitivity (σ_i) of a moving coil galvanometer is (resistance of galvanometer is G).

1. $\frac{\sigma_i}{G} = \sigma_v$

2. $\frac{\sigma_v}{G} = \sigma_i$

3. $\frac{G}{\sigma_i} = \sigma_v$

4. $\frac{G}{\sigma_v} = \sigma_v$

$\sigma_V = \frac{S_I}{G}$

QUESTION

If current sensitivity becomes double by keeping no of turns doubled then find change in [redacted] voltage sensitivity?

$$S_I = \frac{\theta}{I} = \frac{NAB}{C}$$

$$S_V = \frac{S_I}{R} = \frac{NAB}{CR} = \text{unchange}$$

N → double

R → Resis of turns

(a) double

(b) Half

(c) Same ✓

(d) 4-times

QUESTION

Current sensitivity of a moving coil galvanometer is 5 div/mA and its voltage sensitivity (angular deflection per unit voltage applied) is 20 div/V. The resistance of the galvanometer is?

1. 250 Ω ✓
2. 40 Ω
3. 500 Ω
4. 25 Ω

$S_I = 5$ div/mA

$S_V = 20$ div/V

$20 = \frac{5}{G}$

$G = \frac{5\ \text{div}}{10^{-3}\,A \times 20} = \frac{1000}{4}$

$= 250\,\Omega$

Electric Charge and field

Electrostatic

\# charge → $+Q$, $-Q$

\# force $= \dfrac{KQ_1Q_2}{r^2}$

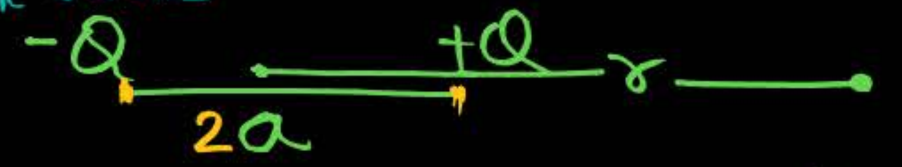
$K = \dfrac{1}{4\pi\varepsilon_0}$

→ Repulsive → B/w same charge

→ attractive → opposite nature of charge

\# $E = \dfrac{KQ}{r^2}$

electric dipole



\# $P = 2Qa$ (dir^n from $-Q$ to $+Q$)

\# $E_{axial} = \dfrac{4Kqar}{(r^2-a^2)^2} = \dfrac{2PrK}{(r^2-a^2)^2} = \dfrac{2KP}{r^3}$

\# $E_{equtr} = KP/r^3$

dipole in uniform field



$F = 0$

$\tau = \vec{P} \times \vec{E}$

$= PE\sin\theta$

$U = -P \cdot E$

$= -PE\cos\theta$

$W_{ext} = \Delta U$

$W_{electric} = -\Delta U$

$T = 2\pi\sqrt{\dfrac{I}{P \cdot E}}$

\#



$F = qE$

Magnetic & Matter

magnetic pole strength → $+m$ [North Pole), $-m$ [South Pole)

Force B/w two pole $F = \dfrac{K m_1 m_2}{r^2}$ $\left\{K = \dfrac{\mu_0}{4\pi}\right\}$

Repulsive force B/w same Nature of pole.

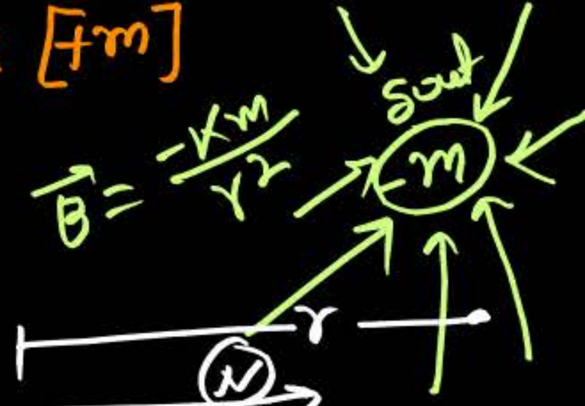
attrative force B/w opposit Nature of pole.

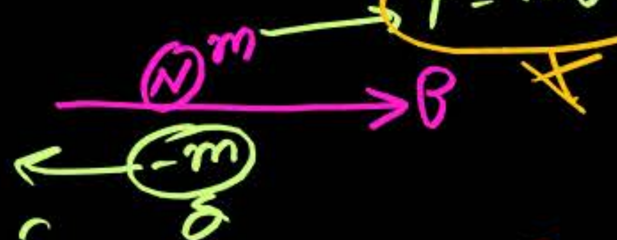
Magnetic field due to pole [$\pm m$]



$\vec{B} = \dfrac{Km}{r^2}$

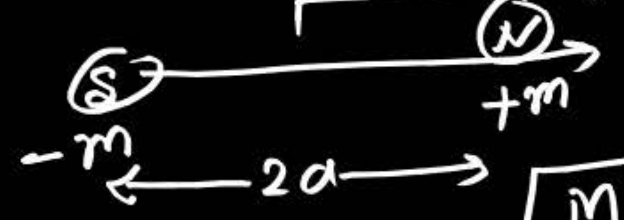
$\vec{B} = \dfrac{-Km}{r^2}$





$F = mB$

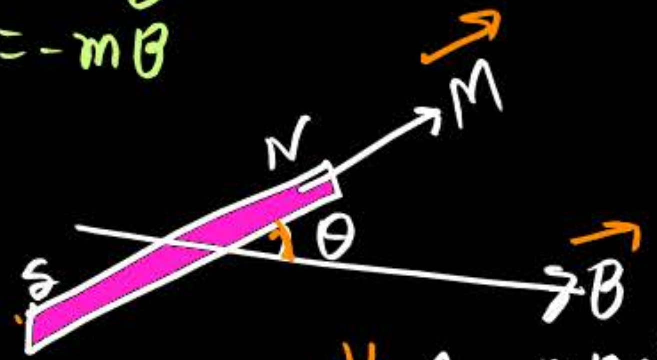
$F = -mB$



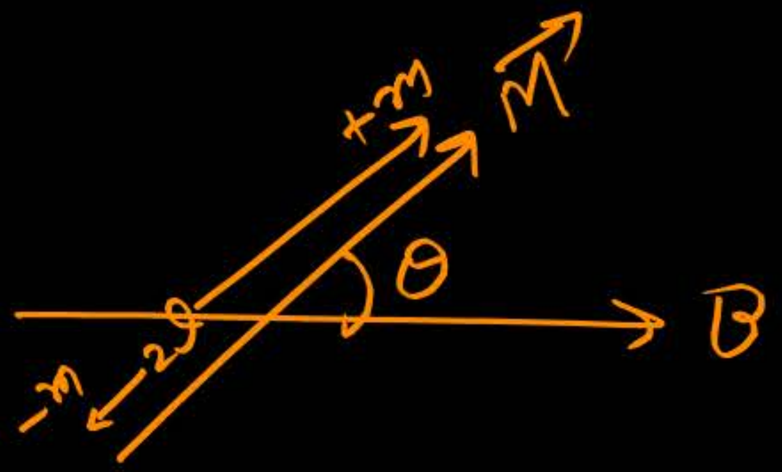
$M = m2a$

$B_{axial} = \dfrac{2KM}{r^3}$

$B_{equtr} = \dfrac{KM}{r^3}$



\# $\tau = MB\sin\theta$ $U = -MB\cos\theta$ $T = 2\pi\sqrt{\dfrac{I}{MB}}$



$\tau = \vec{m} \times \vec{B}$

$= mB\sin\theta$

$\tau = m(2l)\,B\sin\theta$

$U = -\vec{m}\cdot\vec{B}$

$U = -mB\cos\theta$

$\theta = 0°$



$F_{net} = 0$

$\tau = 0$

$U_m = -mB$

Stable equilibm

$T = 2\pi\sqrt{\dfrac{I}{mB}}$

$\theta = 90°$

$\tau_{max} = mB$

$U = 0$

$F = 0$

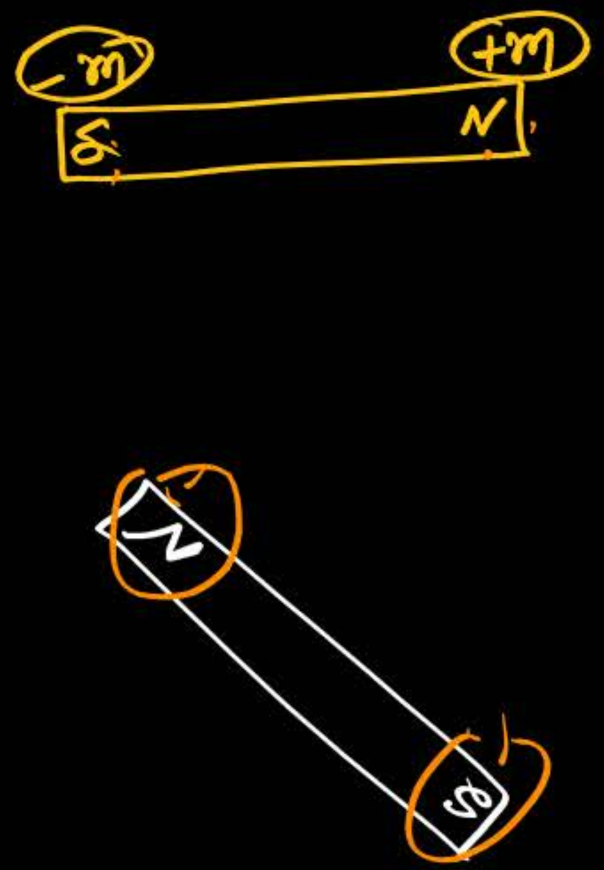
$\theta = 180°$

$F = 0$

$\tau = 0$

$U_m = +mB$

unstable equlim



-m
+m
S
N
N
S

Bar Magnet





m (Pole strength) ∝ Area

$\vec{M} = m l$

↑ magnetic moment (vector) → (Amp-m²) unit

dirⁿ → South Pole to North Pole.

MR^x feel

$M = (m)\, l$

$= \text{Area} \times l$

$M \propto$ [Volume of BAR magnet]

magnetic moment

#



l_G → Geometric distⁿ

$$\frac{l_m}{l_G} = 0.84$$

Unit of Pole strength

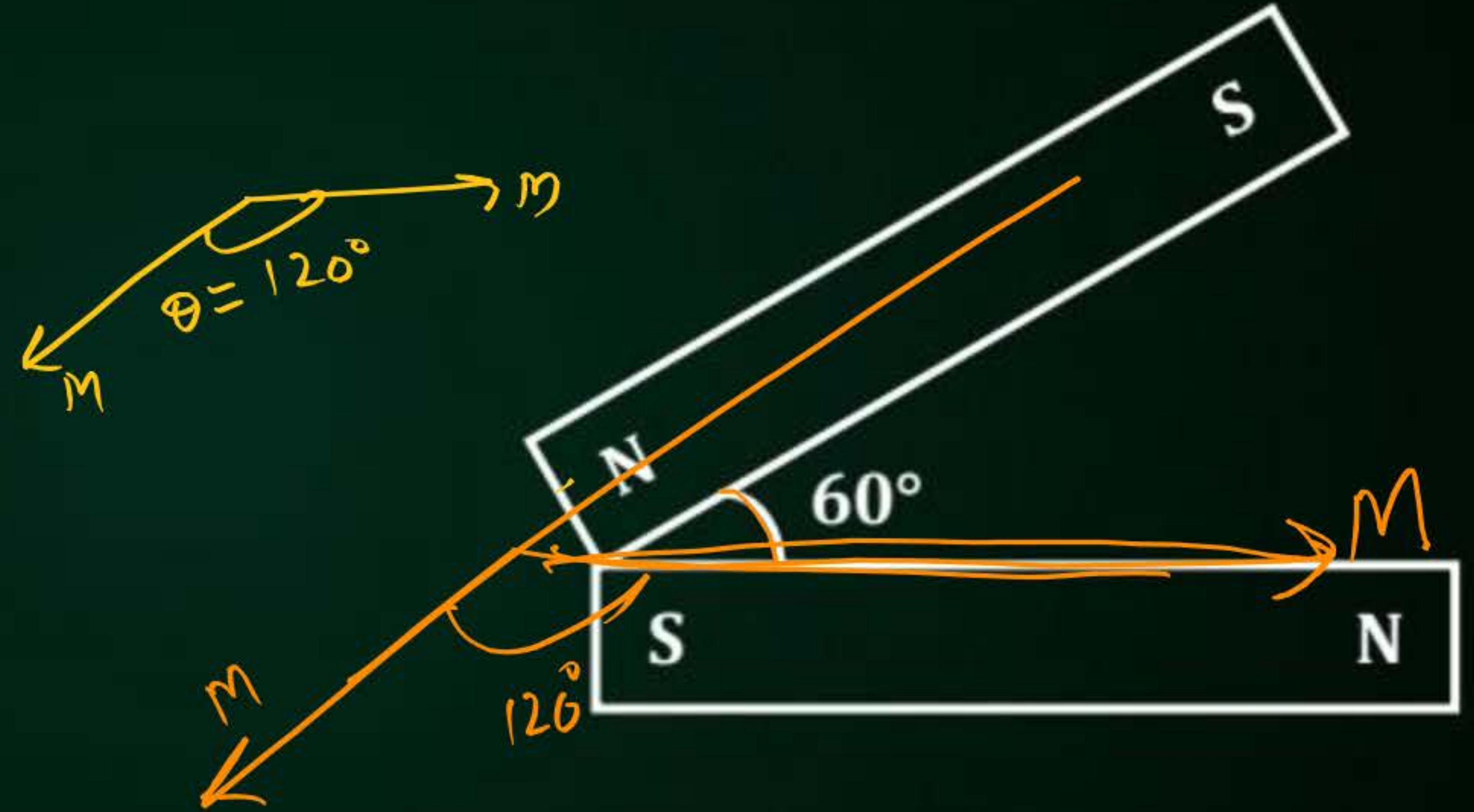
$M = m l$

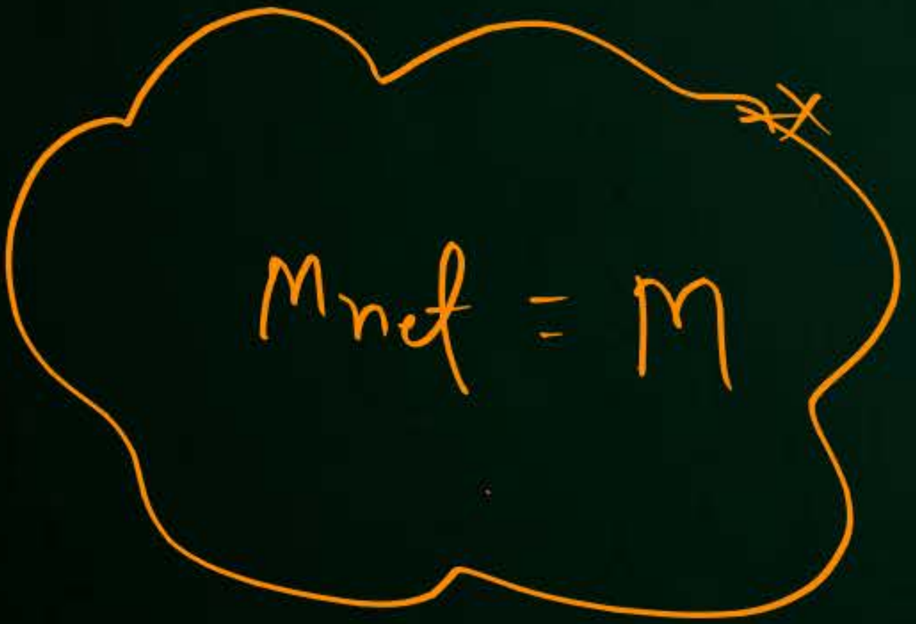
$m = \frac{M}{l} = \frac{A \cdot m^2}{m}$

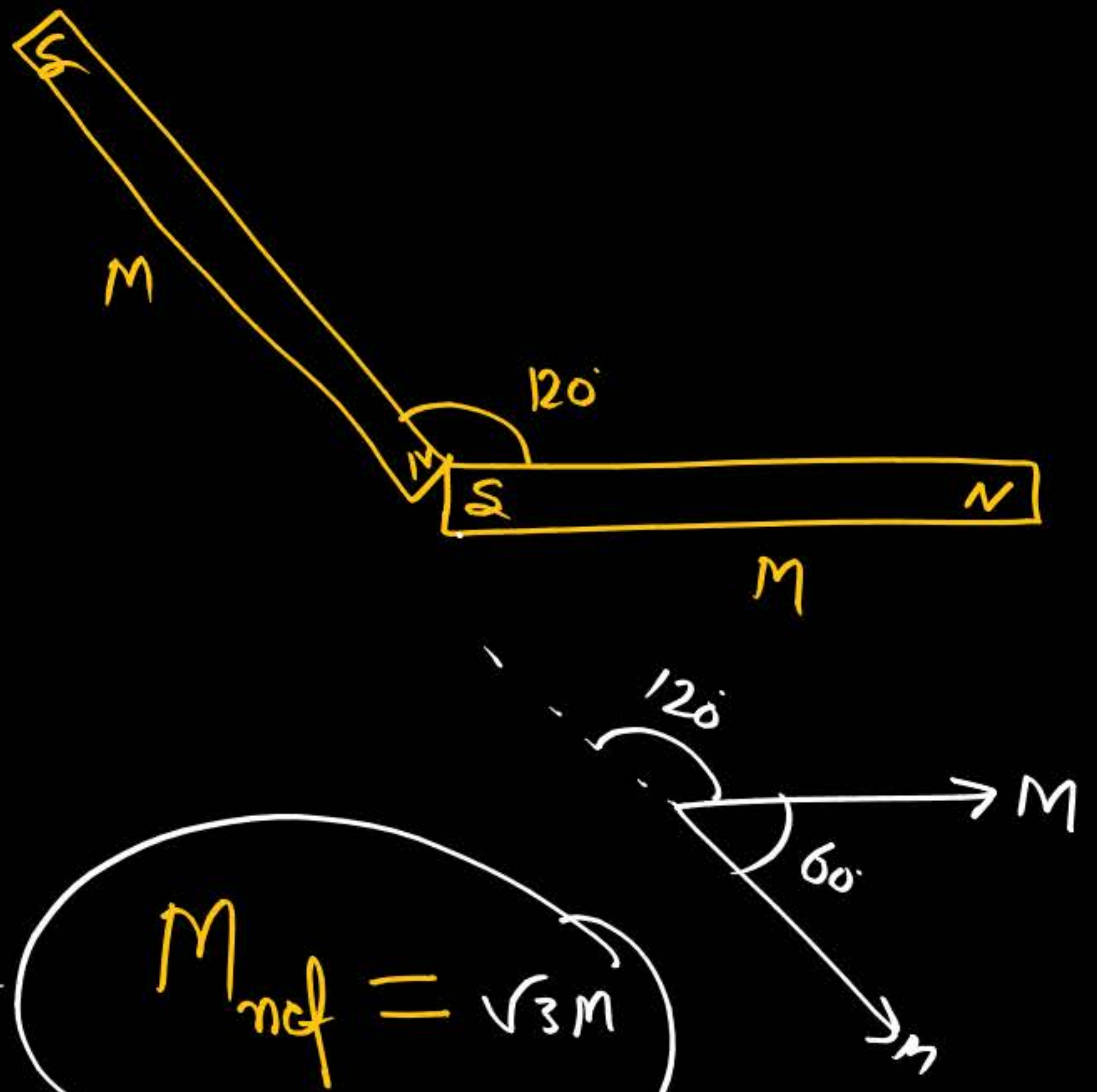
∴ $m \rightarrow$ Amp-metre

QUESTION

Find net magnetic dipole moment if each have magnetic dipole moment M.







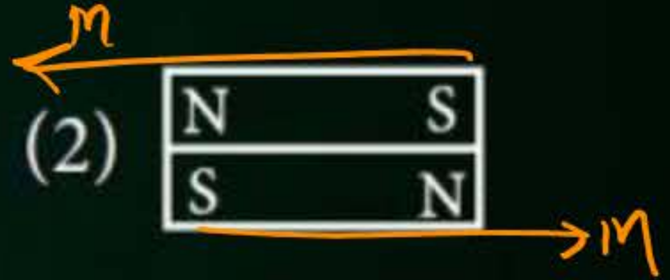
$M_{net} = \sqrt{3}M$

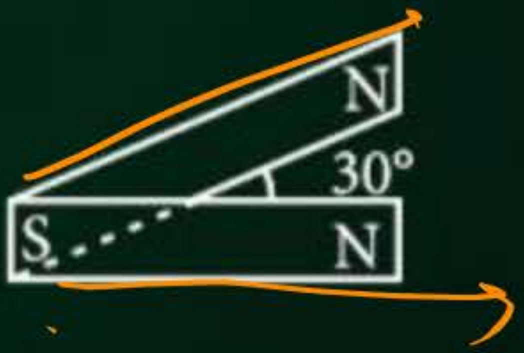
QUESTION

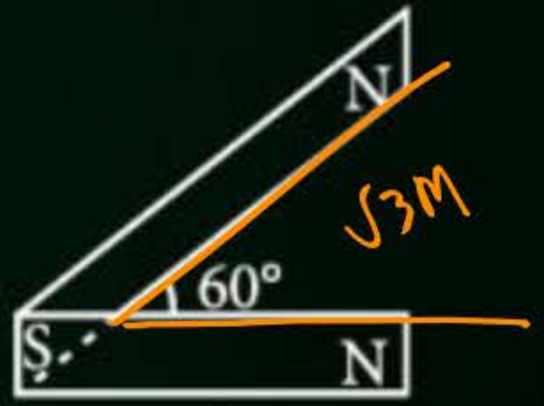
Following figures show the arrangement of bar magnets in different configurations. Each magnet has magnetic dipole moment $\vec{m}$. Which configuration has highest net magnetic dipole moment?

1. (1)
2. (2)
3. (3)
4. (4)

(1)

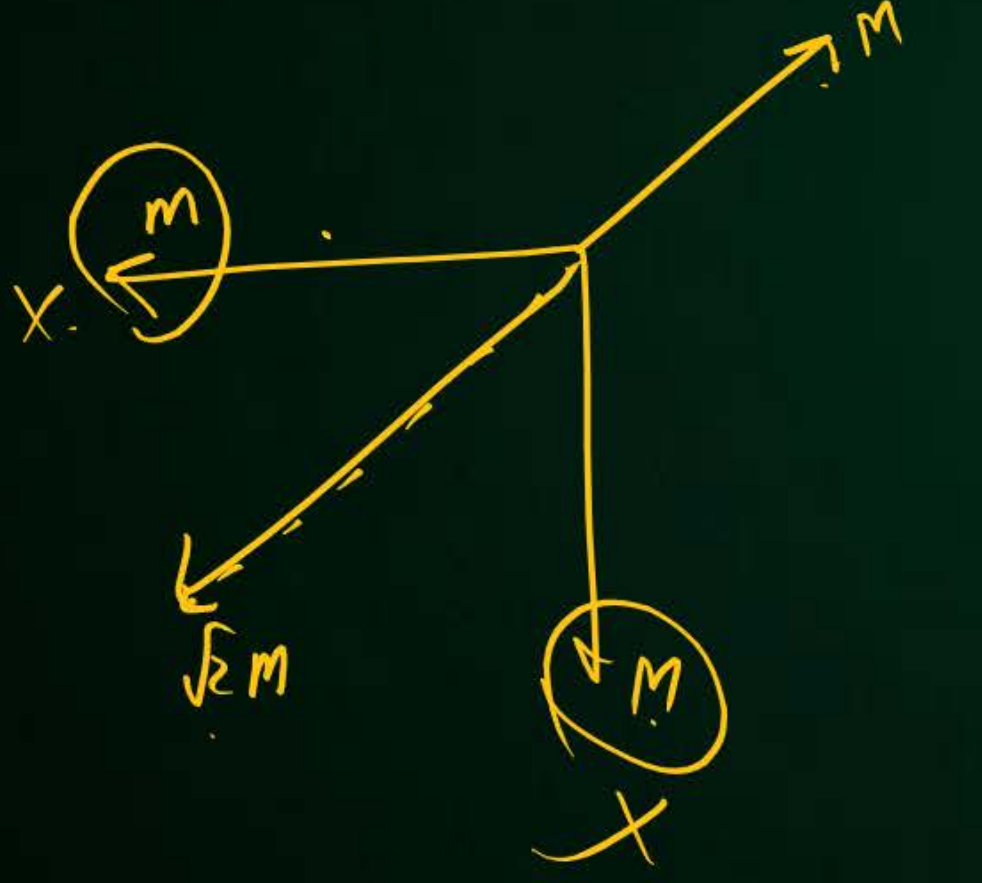

(2)


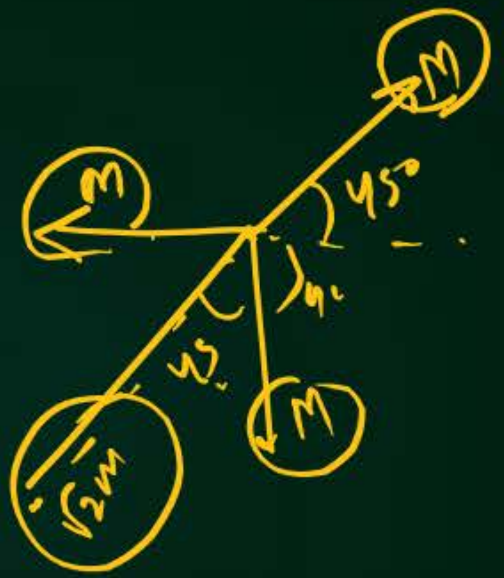
(3)


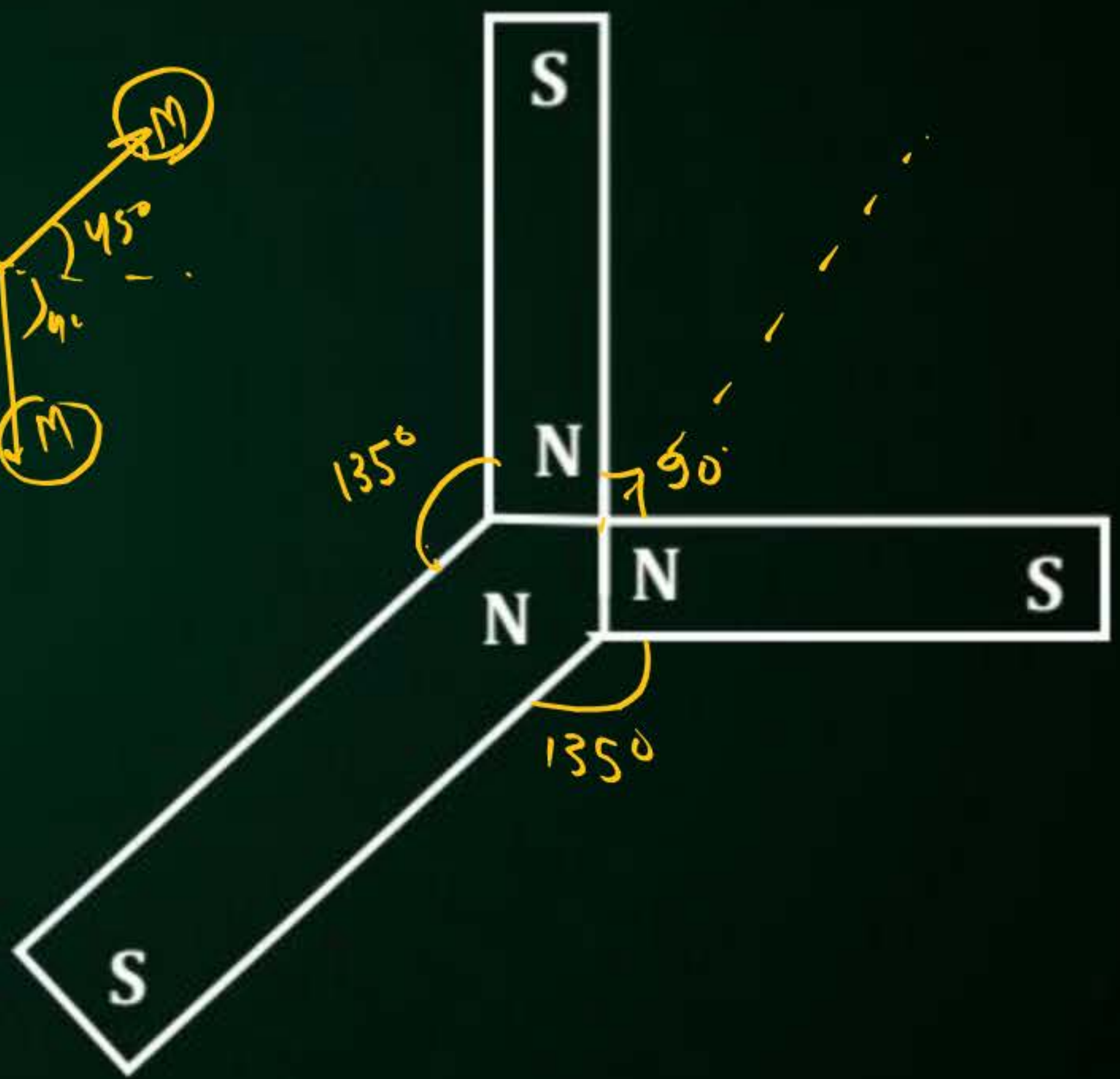
(4)


QUESTION

Magnetic moment of each magnet is M then net magnetic dipole moment is







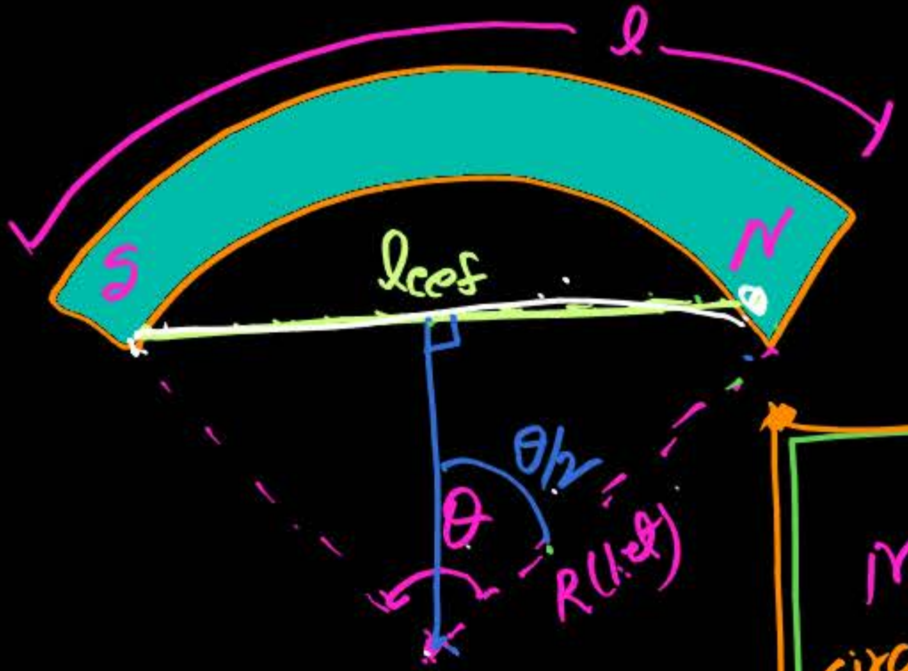
$M_{net} = (M - \sqrt{2}M)$



$M = ml$ — (1)

magnetic

Bend in circle Arc



$$M' = M \times \frac{\sin(\theta/2)}{\theta/2}$$

circular Arc mag.

* $R\theta = l$ — (1)

* $\sin\theta/2 = \frac{l_{eff}}{2R}$

$l_{eff} = 2R\sin(\theta/2)$

• $M' = m\, l_{eff} = m\, 2R\sin(\theta/2)$

$M' = 2m\frac{l}{\theta}\sin(\theta/2)$

$$M' = \frac{M\sin(\theta/2)}{\theta/2}$$

QUESTION

A bar magnet of length '*l*' and magnetic dipole moment '*M*' is bent in the form of an arc as shown in figure. The new magnetic dipole moment will be **[NEET 2013]**

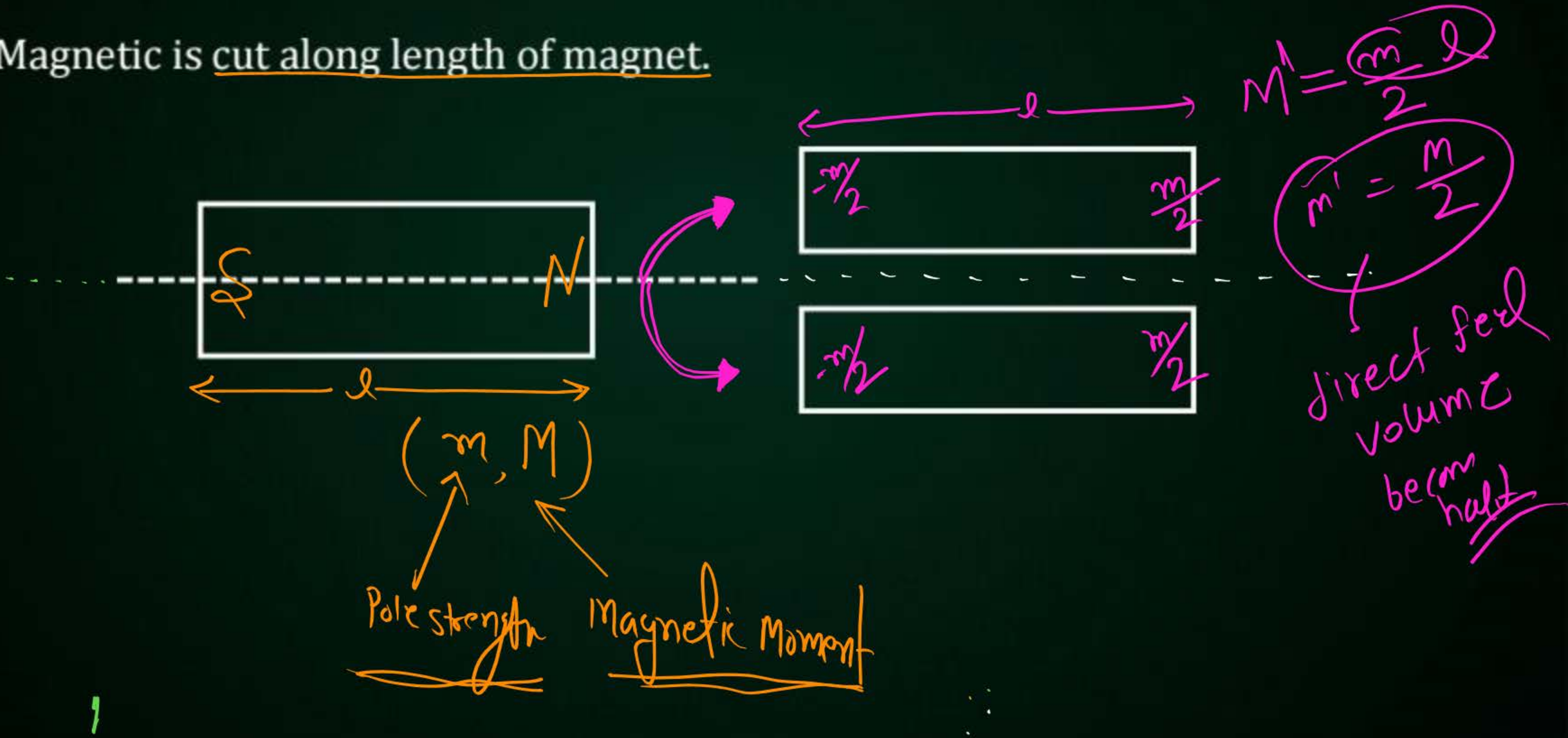


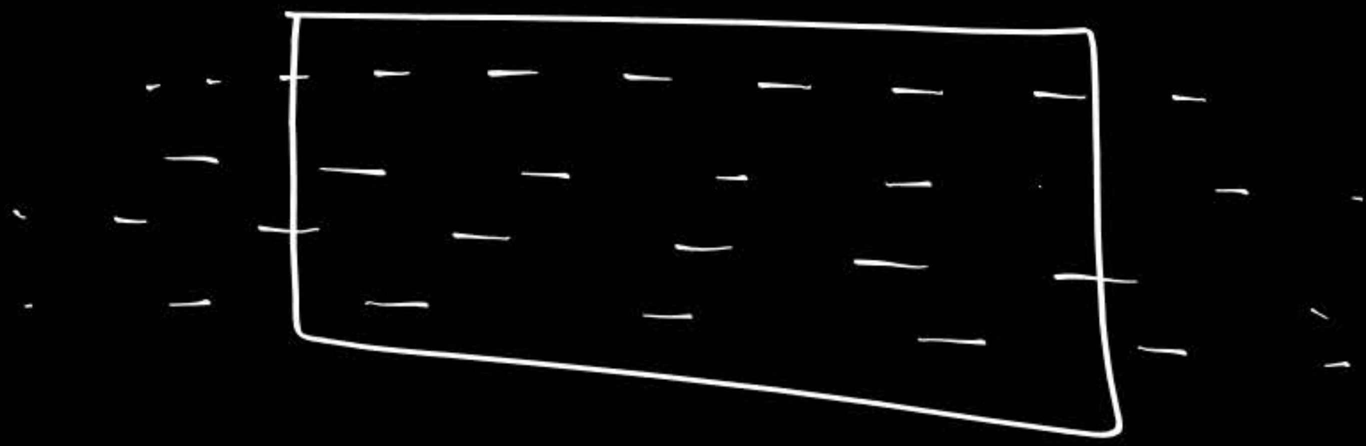
1. $\frac{2}{\pi}M$
2. $\frac{M}{2}$
3. M
4. $\frac{3}{\pi}M$

$M' = \frac{M \sin(60/2)}{\pi/(3\times 2)} = \frac{M \times \frac{1}{2}}{\pi/(3\times 2)} = \frac{3M}{\pi}$

Cutting of Bar Magnet

- Magnetic is cut along length of magnet.



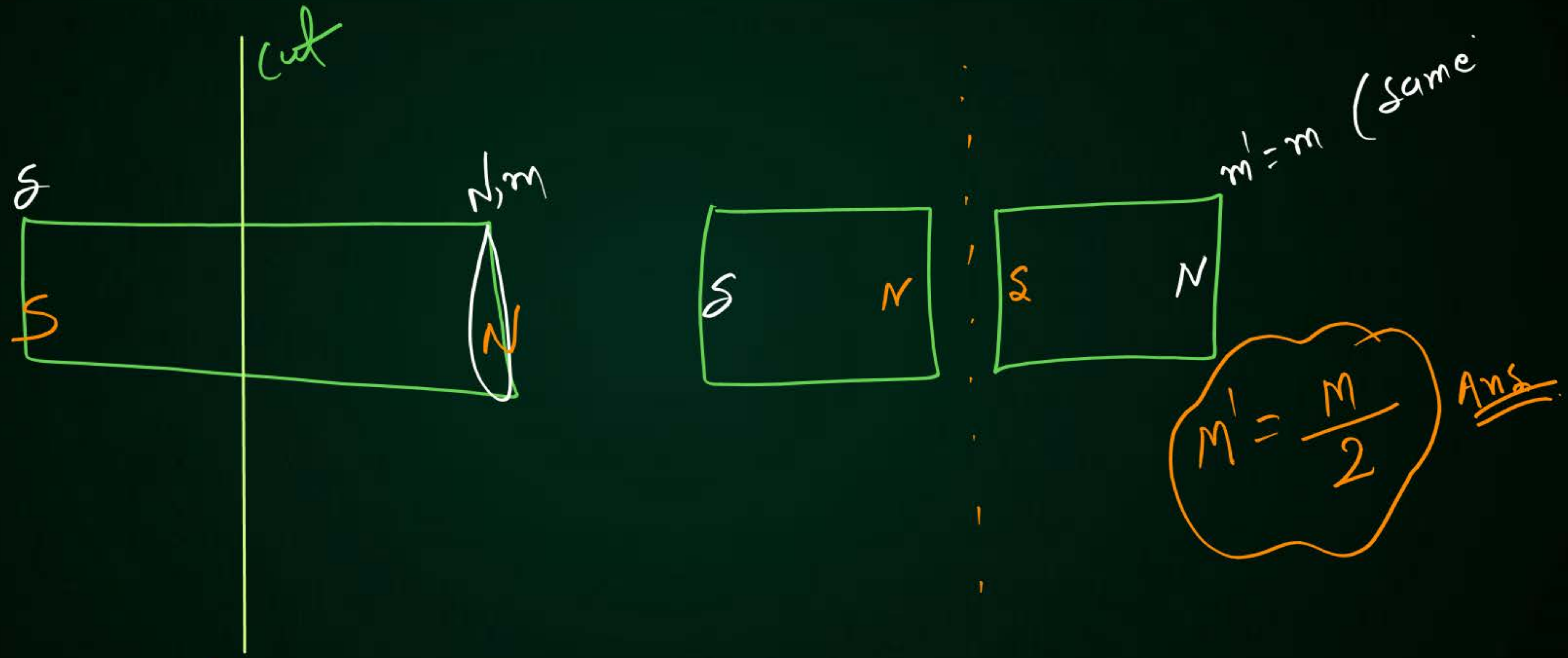


cut along length
in n equal part

$m' = \frac{m}{n}$

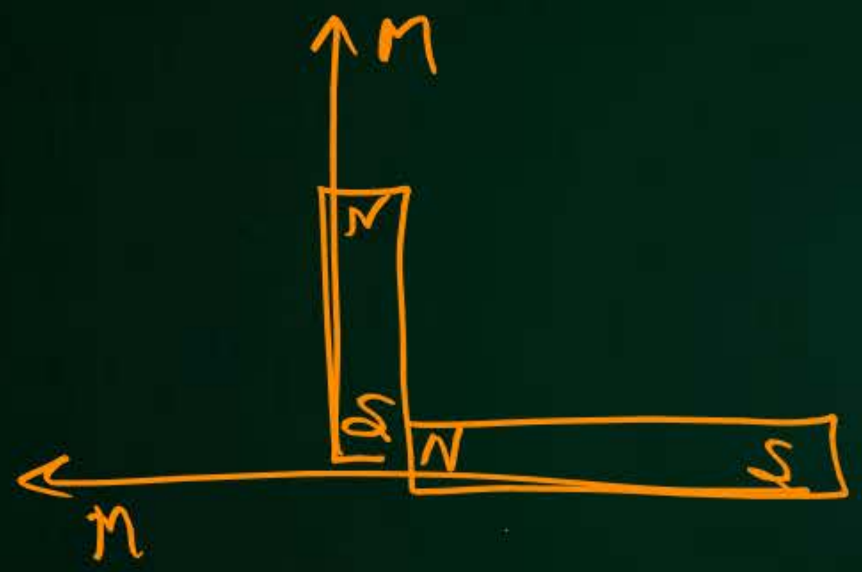


Cutting of Magnet Perpendicular to Length



QUESTION

Two identical thin bar magnets each of length l and pole strength m are placed at right angle to each other with north pole of one touching the south pole of the other. Magnetic moment of the system is

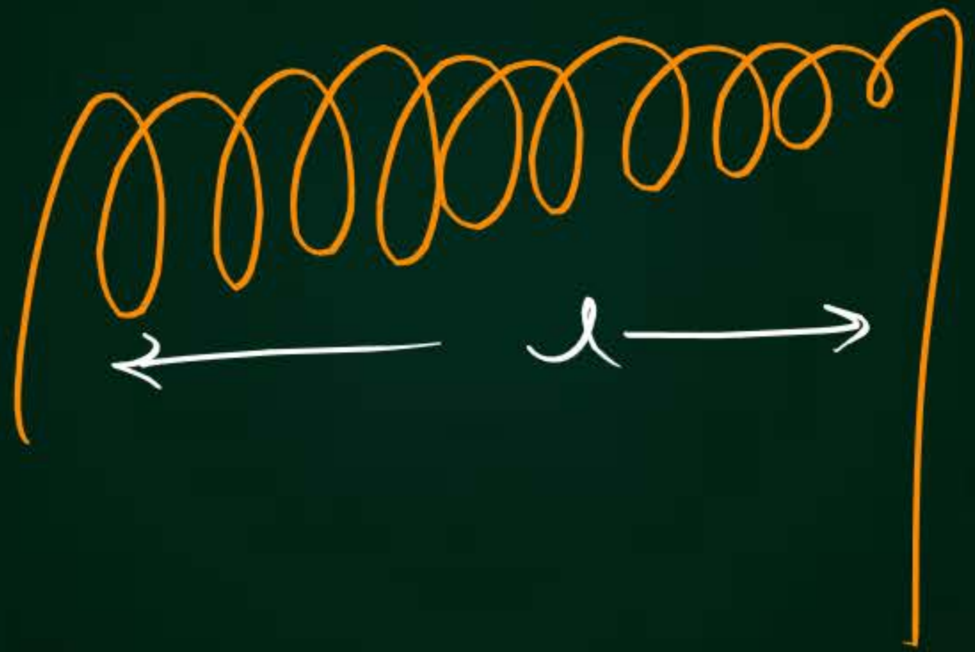


1. $2\,ml$
2. ml
3. $\sqrt{2}\,ml$
4. $\frac{ml}{2}$

QUESTION

A solenoid of length 10 cm and radius 1 cm contains 200 turns and carries a current of 10 A. The value of pole strength of each pole is

1. 2 Am
2. 2π Am
3. 4π Am
4. 10π Am



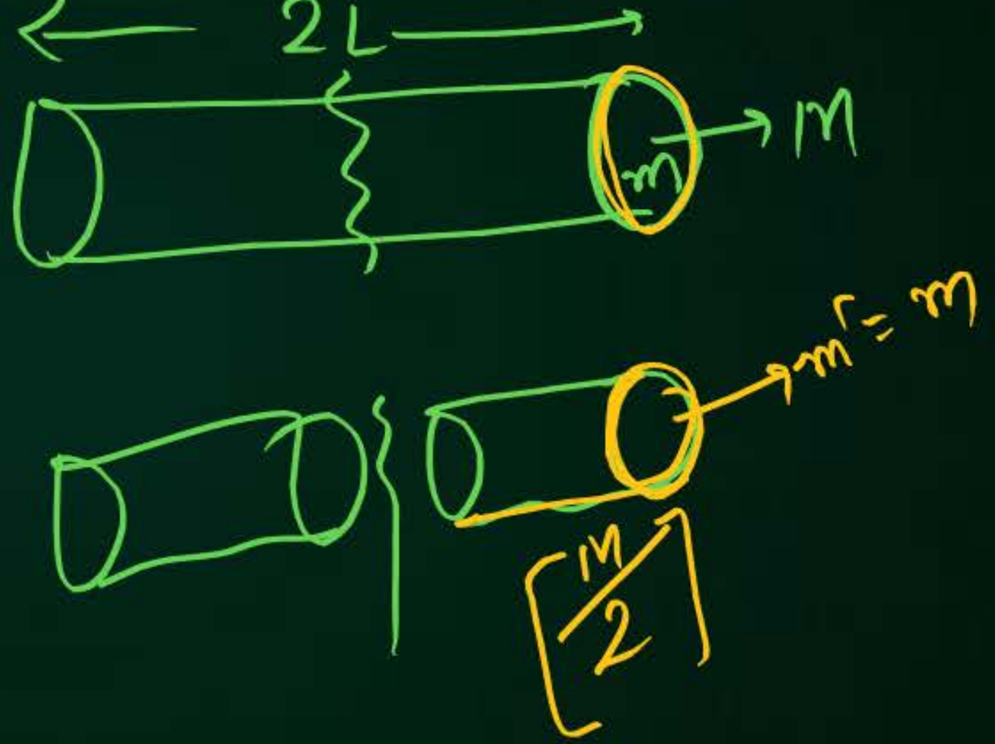
$$M = NIA = ml$$

$$m = \frac{NIA}{l}$$

QUESTION

A long magnetic needle of length $2L$, magnetic moment M and pole strength m unit is broken into two at the mid point. The magnetic moment and pole strength of each piece will be

1. $M/2, m/2$
2. $M, m/2$
3. $M/2, m$
4. M, m

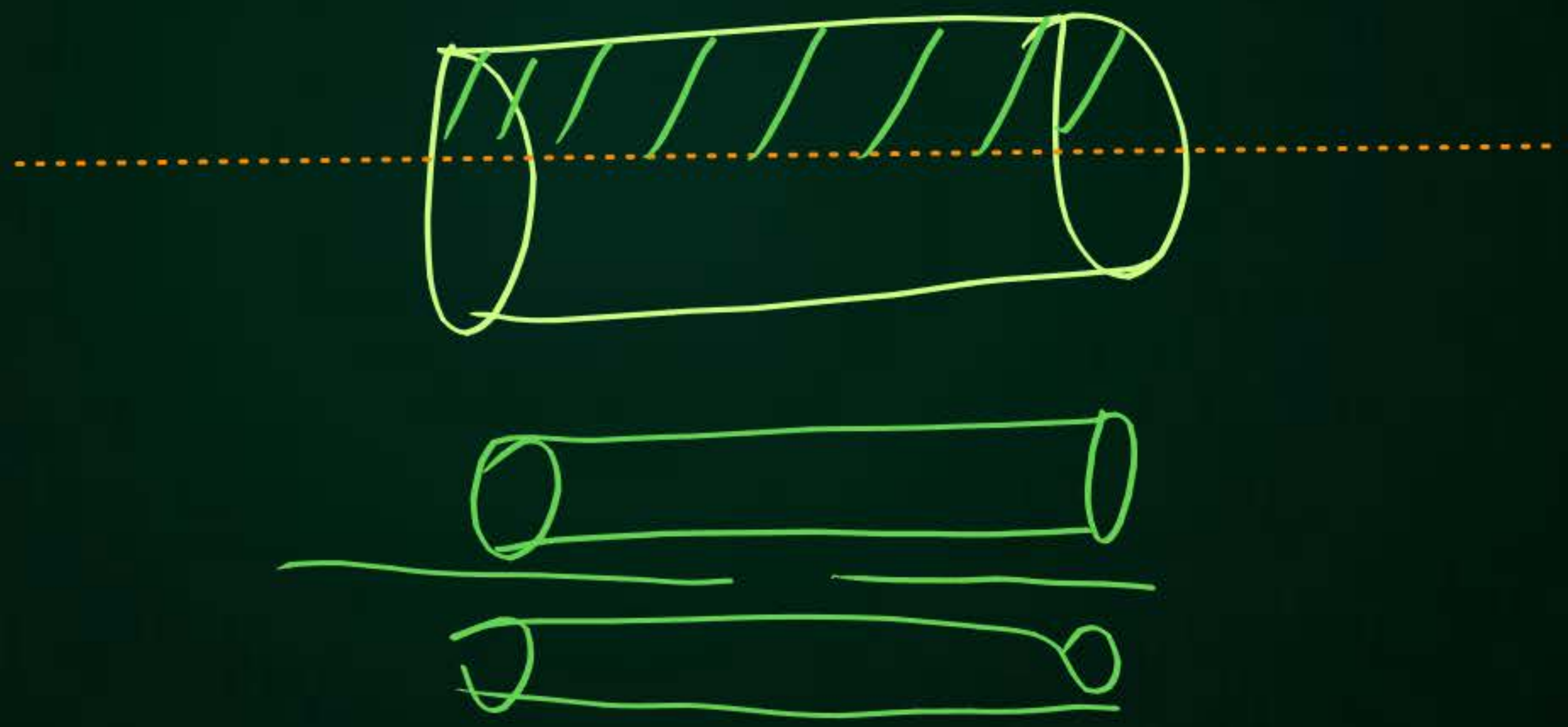




QUESTION

A bar magnet of magnetic moment M is cut into two equal parts along its length. The magnetic moment of either part is

1. 2M
2. M
3. M/2
4. Zero



QUESTION

A steel wire of length l has a magnetic moment M. It is then bent into a semi-circular arc. The new magnetic moment is

1. M
2. $2M/\pi$
3. M/π
4. $2M\pi$



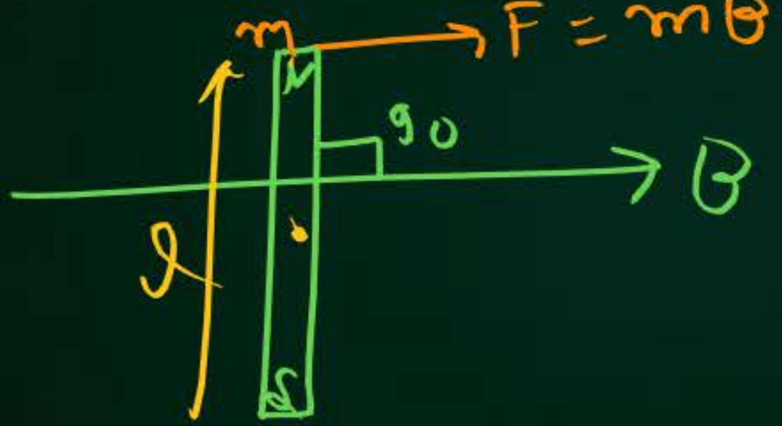
$$M' = \frac{M \sin \frac{\pi}{2}}{\frac{\pi}{2}} = \frac{2M}{\pi}$$

QUESTION

A bar magnet of magnetic moment M is placed at right angles to a magnetic induction B. If a force F is experienced by each pole of the magnet, the length of the magnet will be

(Karnataka NEET 2013)

1. MB/F
2. BF/M
3. MF/B
4. F/MB



QUESTION

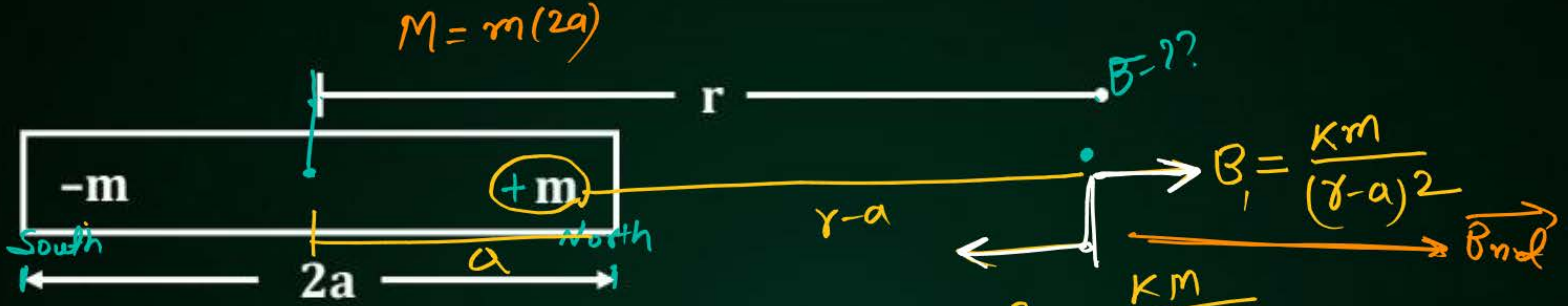
A bar magnet of magnetic moment M is cut into two parts of equal length. The magnetic moment of each part will be (1997)

1. M
2. 2M
3. zero
4. 0.5M

Electrostatics	Magnetism
$\frac{1}{\varepsilon_0}$	μ_0
Charge q	Magnetic Pole Strength (m)
Dipole Moment $\vec{p} = q\vec{l}$	Magnetic Dipole Moment $\vec{M} = m\vec{l}$
$F = \frac{q_1 q_2}{4\pi\varepsilon_0 r^2}$	$F = \frac{\mu_0}{4\pi}\frac{m_1 m_2}{r^2}$
$\vec{F} = q\vec{E}$	$\vec{F} = m\vec{B}$
Axial Field $\vec{E} = \frac{2\vec{p}}{4\pi\varepsilon_0 r^3}$	$\vec{B} = \frac{\mu_0}{4\pi}\frac{2\vec{M}}{r^3}$
Equatorial field $\vec{E} = \frac{-\vec{p}}{4\pi\varepsilon_0 r^3}$	$\vec{B} = -\frac{\mu_0}{4\pi}\frac{\vec{M}}{r^3}$
Torque $\vec{\tau} = \vec{p} \times \vec{E}$	$\vec{\tau} = \vec{M} \times \vec{B}$
Potential Energy $U = -\vec{p}\cdot\vec{E}$	$U = -\vec{M}\cdot\vec{B}$
Work $W = pE(\cos\theta_1 - \cos\theta_2)$	$W = MB(\cos\theta_1 - \cos\theta_2)$

➢ Magnetic field due to Bar Magnet on the axial line.

hint $(r-a)(r+a) = (r^2-a^2)$



$$B_1 = \frac{Km}{(r-a)^2}$$

$$B_2 = \frac{Km}{(r+a)^2}$$

$$B_{net} = B_1 - B_2$$

$$B_{net} = \frac{Km}{(r-a)^2} - \frac{Km}{(r+a)^2}$$

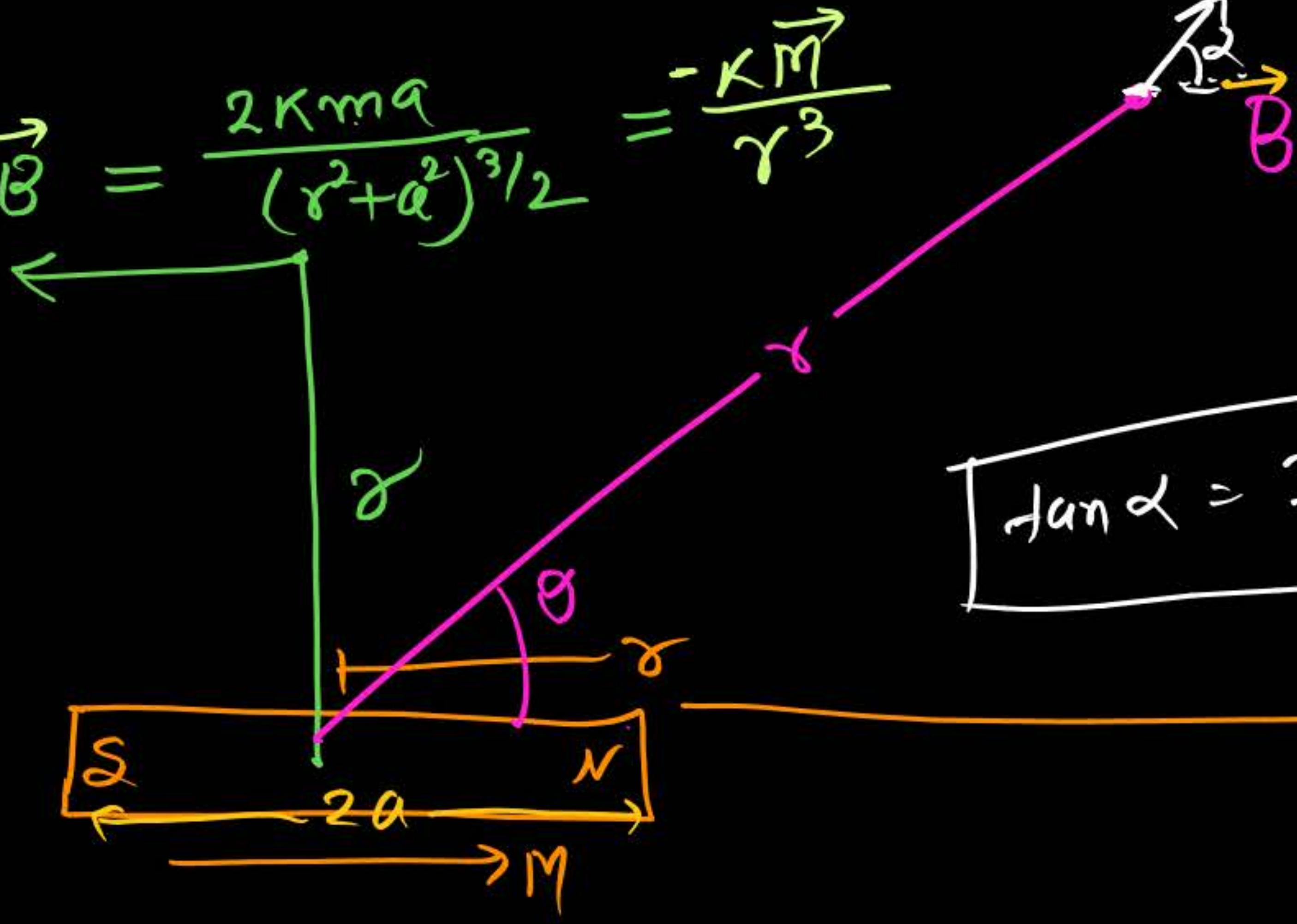
$$B = Km\left[\frac{1}{(r-a)^2} - \frac{1}{(r+a)^2}\right]$$

$$B = Km\left[\frac{r^2+a^2+2ra - r^2 - a^2 + 2ra}{(r-a)^2 \cdot (r+a)^2}\right]$$

$$= Km\left[\frac{4ra}{(r^2-a^2)^2}\right] = \frac{4Kmra}{(r^2-a^2)^2}$$

$$B = \frac{2KMr}{(r^2-a^2)^2} = \frac{2KM}{r^3}$$

$$\vec{B} = \frac{2Kma}{(r^2+a^2)^{3/2}} = \frac{-K\vec{M}}{r^3}$$



$$B = \frac{KM}{r^3}\sqrt{3\cos^2\theta + 1}$$

MR* if $\theta = 0° \rightarrow B_{axi} = \frac{2KM}{r^3}$

if $\theta = 90°$, $B_{equi} = \frac{KM}{r^3}$

$$\tan\alpha = \frac{\tan\theta}{2}$$

$$\vec{B} = \frac{2KM}{r^3} = \left(\frac{\mu_0}{4\pi}\right)\frac{2\vec{M}}{r^3}$$

find θ where $\vec{B}$ is ⊥r $\vec{M}$

$$\theta = \tan^{-1}\sqrt{2}$$

MAGNETIC FIELD DUE TO A BAR MAGNET

(A) On axial position:

(B) On normal bisector:

MAGNETIC FIELD LINES

(1) Magnetic field line is an imaginary curve, the tangent to which at any point gives direction of magnetic field B at the point.

(2) The magnetic field lines of a magnet (or of a solenoid carrying current) form close-continuous loops

(3) Outside the body of magnet, the direction of magnetic field lines are from north pole to south pole.

(4) No two magnetic field lines can intersect each other. This is because at the point of intersection, we can draw two tangents. This would mean two directions of magnetic field at the same point, which is not possible.

MAGNETIC FIELD LINES

(5) Larger the number of field lines crossing per unit area, the stronger is the magnitude of the magnetic field B. B is larger around region (ii) than in region (i).

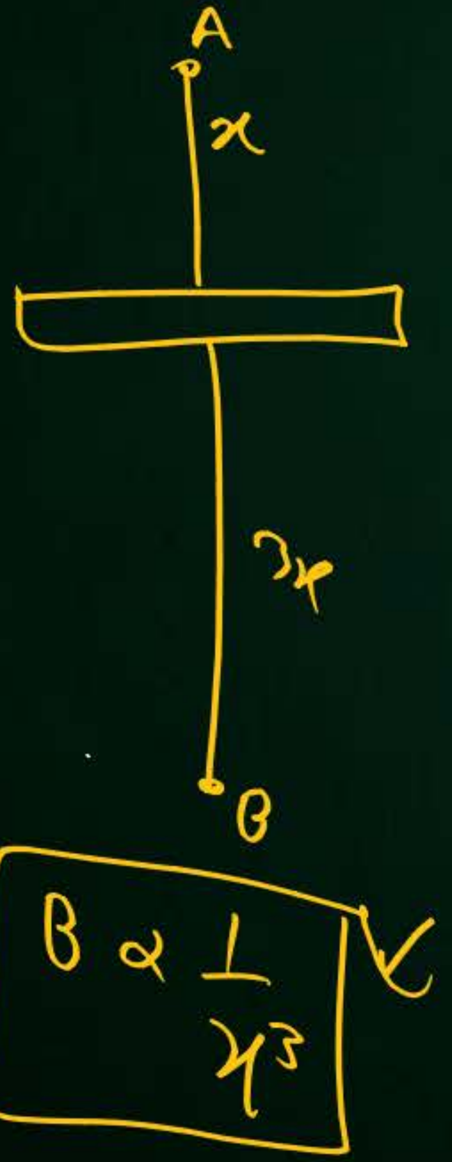
(6) Magnetic lines of force come out and go into a magnetic material at any angle.

(7) Electric field lines also called electric force line but magnet field line does not called magnetic force line.

QUESTION

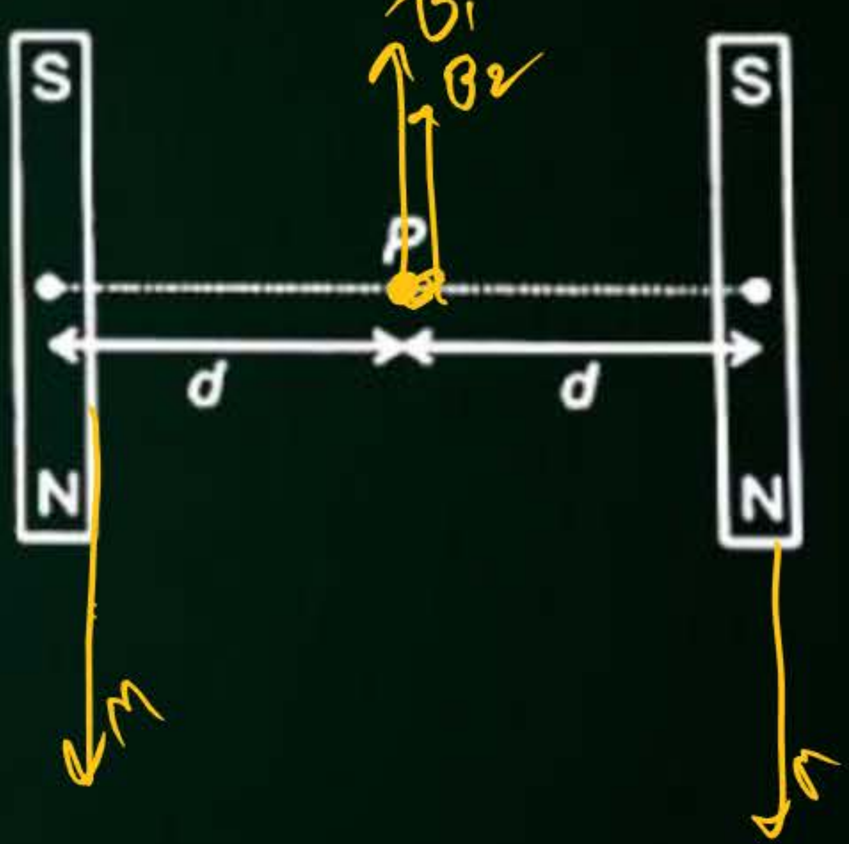
Point A and B are situated perpendicular to the axis of a small bar magnet at large distance x and $3x$ from its centre on opposite sides. The ratio of the magnetic fields at A and B will be approximately equal to

1. $2:9$
2. $1:9$
3. $27:1$
4. $9:1$



QUESTION

Two identical bar magnets, each of magnetic moment M, are placed as shown in figure. Magnetic field at point P is



(1) $2\left(\frac{\mu_0}{4\pi}\right)\frac{M}{d^3}$

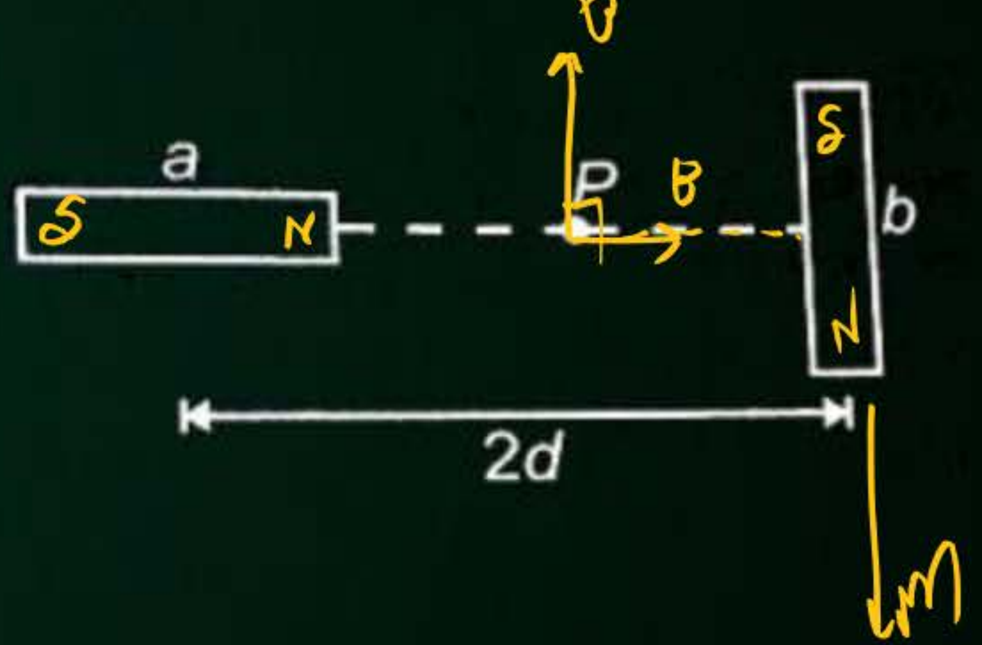
(2) $\sqrt{5}\left(\frac{\mu_0}{4\pi}\right)\frac{M}{d^3}$

(3) $\left(\frac{\mu_0}{4\pi}\right)\frac{M}{d^3}$

(4) $2\sqrt{5}\left(\frac{\mu_0}{4\pi}\right)\frac{M}{d^3}$

QUESTION

Figure shows two small identical magnetic dipoles a and b of magnetic moments M each, placed at a separation 2d, with their axes perpendicular to each other. The magnetic field at the point P mid way between the dipoles is



(1) $\frac{2\mu_0 M}{4\pi d^3}$

(2) $\frac{\mu_0 M}{4\pi d^3}$

(3) Zero

(4) $\sqrt{5}\mu_0 M$

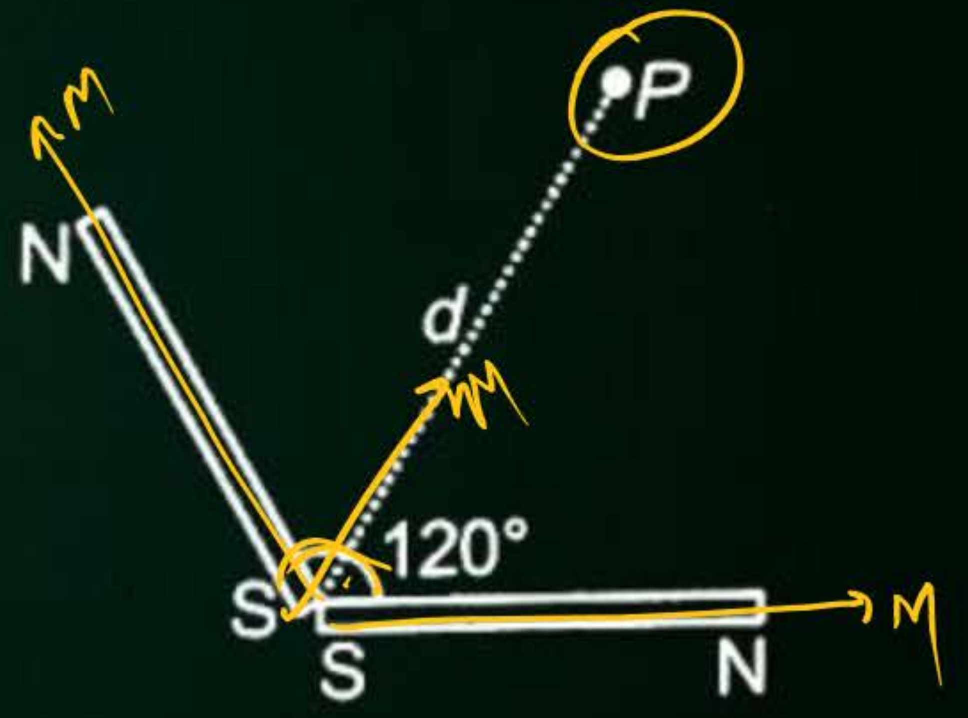
QUESTION

Two small bar magnets are placed in a line at certain distance d apart. If the length of each magnet is negligible compared to d, the force between them will be inversely proportional to

1. d^2
2. d
3. d^3
4. d^4

QUESTION

Two identical short bar magnets are placed at 120° as shown in the figure. The magnetic moment of each magnet is M. Then the magnetic field at the point P on the angle bisector is given by



1. $\frac{\mu}{4\pi}\cdot\frac{M}{d^3}$

2. $\frac{\mu}{4\pi}\cdot\frac{2M}{d^3}$

3. $\frac{\mu}{4\pi}\cdot\frac{2\sqrt{2}M}{d^3}$

4. Zero

QUESTION

A magnetic needle lying parallel to a magnetic field requires W units of work to turn it through 60°. The torque needed to maintain the needle in this position will be

1. W
2. $\sqrt{3}W$
3. $\frac{\sqrt{3W}}{2}$
4. 2W

QUESTION

A bar magnet is hung by a thin cotton thread in a uniform horizontal magnetic field and is in equilibrium state. The energy required to rotate it by 60° is W. Now the torque required to keep the magnet in this new position is

1. $\frac{W}{\sqrt{3}}$
2. $\sqrt{3}W$
3. $\frac{\sqrt{3}W}{2}$
4. $\frac{2W}{\sqrt{3}}$

QUESTION

Which of the following statement regarding magnetic lines of force is correct?

1. Total magnetic flux linked with a closed surface is always zero
2. They need not be perpendicular to the surface from where they start or where they meet
3. They may or may not pass through a conductor
4. All of these

QUESTION

A magnetic needle of negligible breadth and thickness compared to its length, oscillates in a horizontal plane with a period T. The period of oscillation of each part obtained on breaking the magnet into n equal parts perpendicular to the length is

1. T/n
2. T
3. Tn
4. $1/Tn$

QUESTION

The time period of a freely suspended magnet is 4 s. If it is broken in length into two equal parts and one part is suspended in the same way, then its time period will be

1. 2 s
2. 4 s
3. 0.5 s
4. 0.25 s

QUESTION

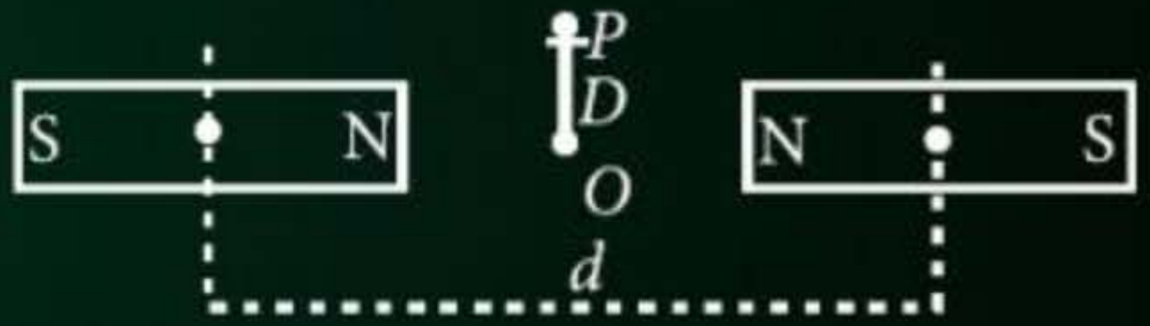
A short bar magnet of magnetic moment 0.4 J T^{-1} is placed in a uniform magnetic field of 0.16 T. The magnet is in stable equilibrium when the potential energy is **(Mains 2011)**

1. 0.064 J
2. –0.064 J
3. zero
4. –0.082 J

QUESTION

Two identical bar magnets are fixed with their centres at a distance d apart. A stationary charge Q is placed at P in between the gap of the two magnets at a distance D from the centre O as shown in the figure.

The force on the charge Q is (Mains 2010)



1. zero
2. directed along OP
3. directed along PO
4. directed perpendicular to the plane of paper

QUESTION

A bar magnet having a magnetic moment of 2×10^4 J T^{-1} is free to rotate in a horizontal plane. A horizontal magnetic field $B = 6 \times 10^{-4}$ T exists in the space. The work done in taking the magnet slowly from a direction parallel to the field to a direction $60°$ from the field is (2009)

1. 12 J
2. 6 J
3. 2 J
4. 0.6 J

QUESTION

A bar magnet is oscillating in the Earth's magnetic field with a period T. What happens to its period and motion if its mass is quadrupled? (2003, 1994)

1. Motion remains simple harmonic with time period = T/2
2. Motion remains S.H.M with time period = 2T
3. Motion remains S.H.M with time period = 4T
4. Motion remains S.H.M and period remains nearly constant

QUESTION

A vibration magnetometer placed in magnetic meridian has a small bar magnet. The magnet executes oscillations with a time period of 2 sec in earth's horizontal magnetic field of 24 microtesla. When a horizontal field of 18 microtesla is produced opposite to the earth's field by placing a current carrying wire, the new time period of magnet will be (2010)

1. 1 s
2. 2 s
3. 3 s
4. 4 s

QUESTION

The work done in turning a magnet of magnetic moment M by an angle of 90° from the meridian, is n times the corresponding work done to turn it through an angle of 60°. The value of n is given by (1995)

1. 1/2
2. 1/4
3. 2
4. 1

Vibrational Magnetometre

Application-2: To find ratio of magnetic moment of two magnet of same size.

QUESTION

Find ratio of magnetic moment of two magnet of same size, oscillate one by one.

QUESTION

Find ratio of magnetic moment of two bar magnet of unequal size.

QUESTION

Two bar magnets having same geometry with magnetic moments M and 2M, are firstly placed in such a way that their similar poles are in same side then its time period of oscillation is T_1. Now the polarity of one of the magnet is reversed then time period of oscillation is T_2, then (2002)

1. $T_1 < T_2$
2. $T_1 = T_2$
3. $T_1 > T_2$
4. $T_2 = \infty$


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 02 | Physics

Magnetism and Matter

By- Dr. Manish Raj (MR SIR)



Topics to be covered

- # Magnetic field lines
- # oscillation of magnet
- # magnetic Material

An iron bar of length L has magnetic moment M. It is bent at the middle of its length such that the two arms make an angle 60° with each other. The magnetic moment of this new magnet is :

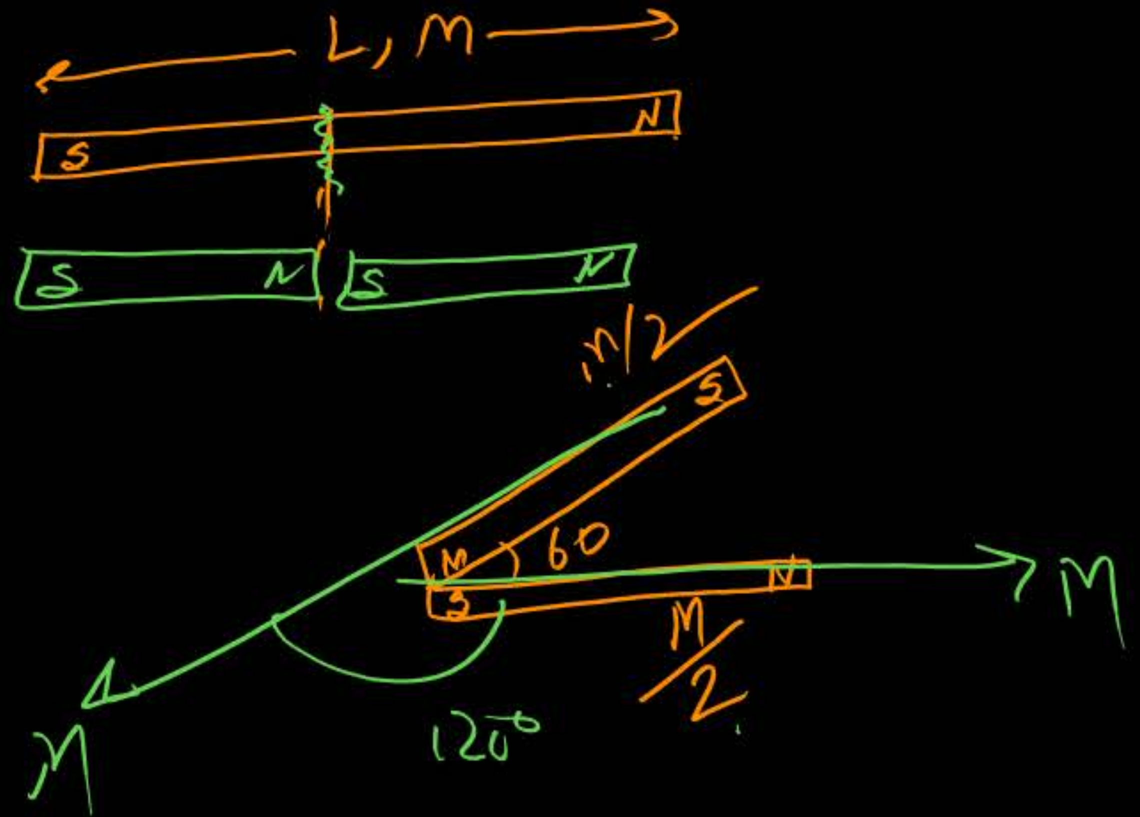
(1) M

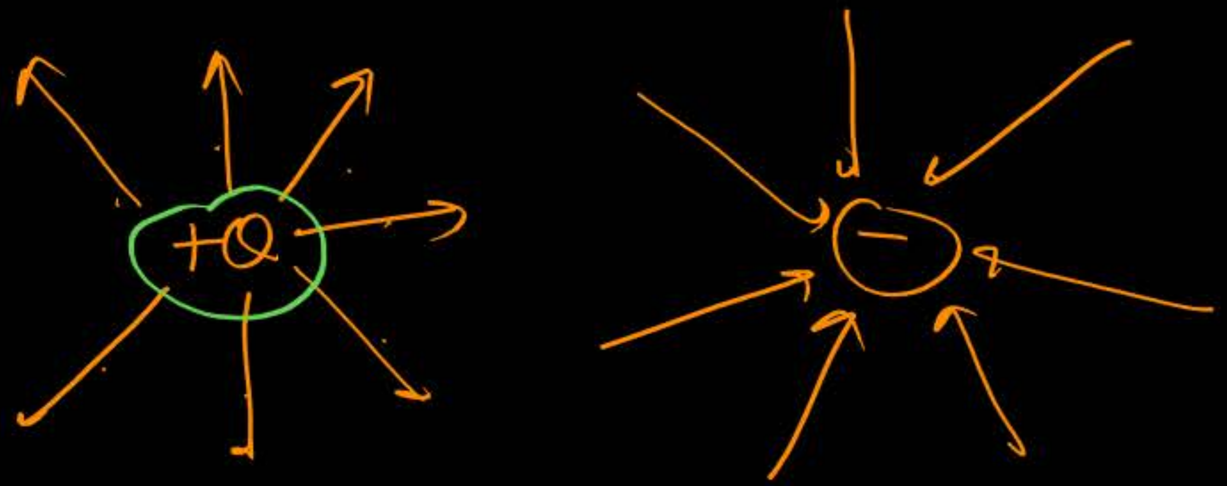
(2) $\frac{M}{2}$

(3) $2M$

(4) $\frac{M}{\sqrt{3}}$

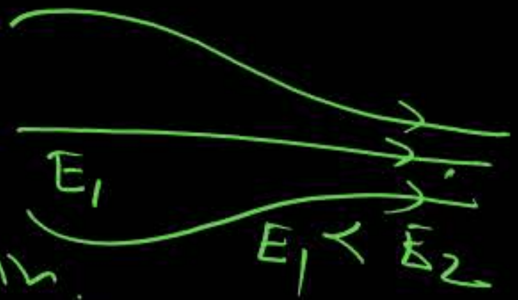
NEET-24







No of field line ∝ Q



E ∝ no of field lines per unit Area

$\vec{E}$ ⊥r at conducting surface.

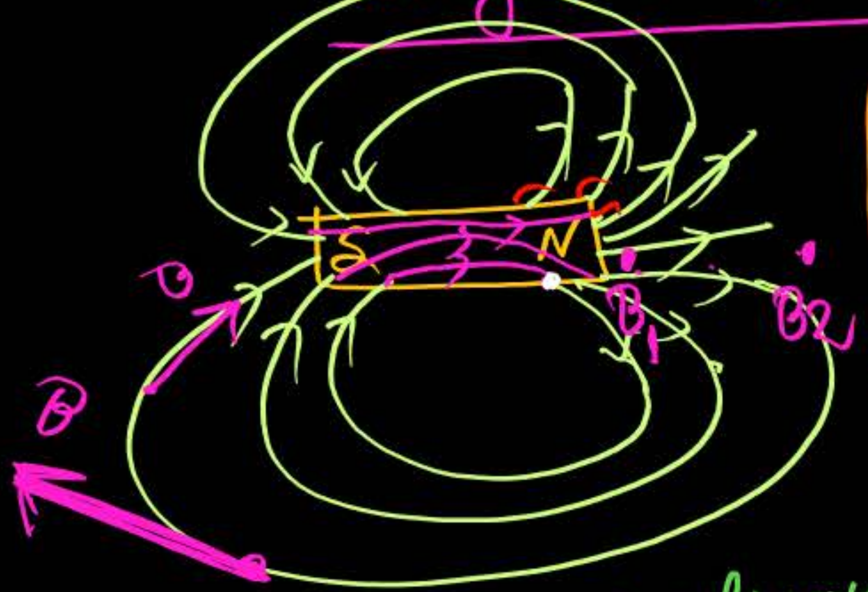
Inside conductor electric field line is zero

Electric field does not forms close loop

Two field lines never cut each other

Electric field lines is also called electric force line.

magnetic field lines



No of magnetic field line ∝ Pole strength

$B_1 > B_2$

magnetic field lines always from north to south (wrong)

magnetic field lines always from North to South outside magnet, and inside magnet magnetic field from south to North

magnetic field lines always forms close loop

magnetic field line can enter/exit at any angle.

magnetic field lines may or may not be zero inside conductor.

magnetic field lines is not a magnetic force lines.

Magnitude of field ∝ no. of field lines density

MAGNETIC FIELD LINES

(1) Magnetic field line is an imaginary curve, the tangent to which at any point gives direction of magnetic field B at the point.

(2) The magnetic field lines of a magnet (or of a solenoid carrying current) form close-continuous loops

(3) Outside the body of magnet, the direction of magnetic field lines are from north pole to south pole.

(4) No two magnetic field lines can intersect each other. This is because at the point of intersection, we can draw two tangents. This would mean two directions of magnetic field at the same point, which is not possible.

MAGNETIC FIELD LINES

(5) Larger the number of field lines crossing per unit area, the stronger is the magnitude of the magnetic field B. B is larger around region (ii) than in region (i).

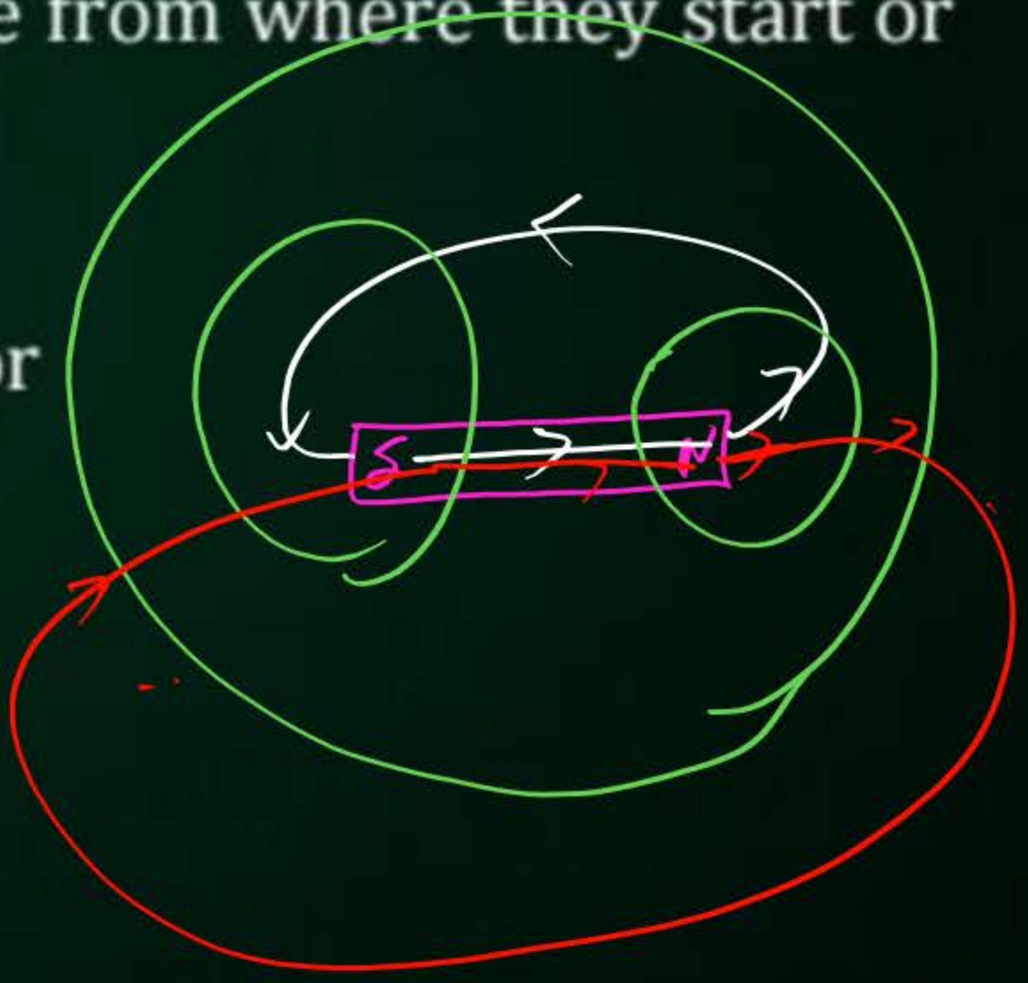
(6) Magnetic lines of force come out and go into a magnetic material at any angle.

(7) Electric field lines also called electric force line but magnet field line does not called magnetic force line.

QUESTION

Which of the following statement regarding magnetic lines of force is correct?

1. Total magnetic flux linked with a closed surface is always zero
2. They need not be perpendicular to the surface from where they start or where they meet
3. They may or may not pass through a conductor
4. All of these



Gauss Law in magnetism

$$\oint \vec{B} \cdot d\vec{A} = 0$$

(Monopole does not exit)

QUESTION

A short bar magnet of magnetic moment $0.4\ J\ T^{-1}$ is placed in a uniform magnetic field of 0.16 T. The magnet is in stable equilibrium when the potential energy is (Mains 2011)

1. 0.064 J
2. –0.064 J
3. zero
4. –0.082 J

$0°$

$U = -MB\cos 0°$

$= -\frac{4}{10} \times \frac{16}{100} \times 1$

$= 64 \times 10^{-3}$

$= -0.064\ J$

$180°$ unstable equilibrium

QUESTION

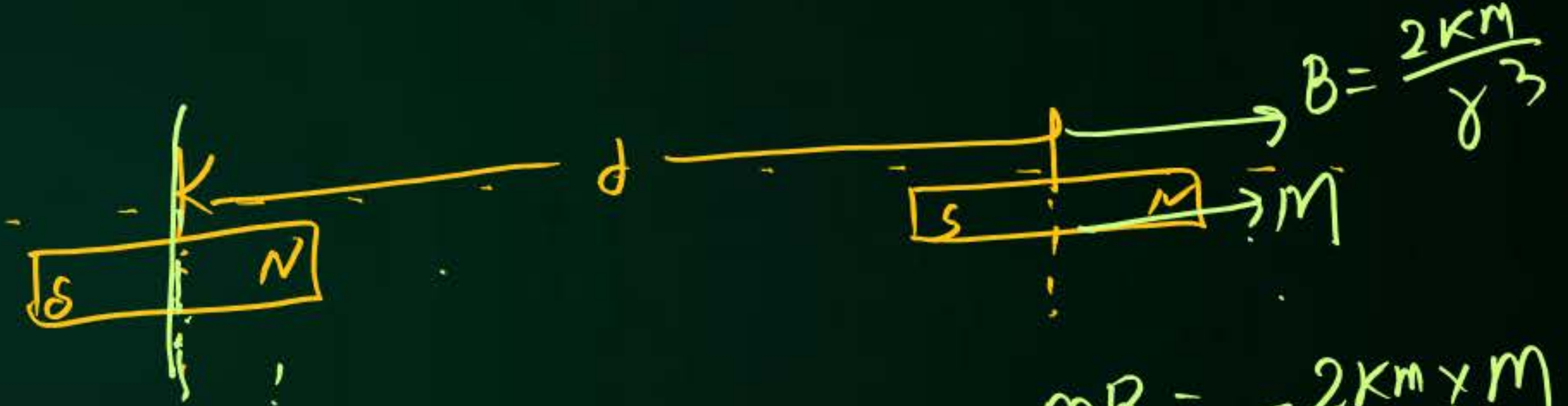
Two small bar magnets are placed in a line at certain distance d apart. If the length of each magnet is negligible compared to d, the force between them will be inversely proportional to

1. d^2
2. d
3. d^3
4. d^4 ✓

Two point force: $F \propto \frac{1}{r^2}$

dipole/point: $F \propto \frac{1}{r^3}$

Two dipole: $F \propto \frac{1}{r^4}$



$U = -MB = -\frac{2KM}{r^3} \times M$

$U \propto \frac{1}{r^3} \propto r^{-3}$

$F = -\frac{dU}{dr} = \frac{d\, r^{-3}}{dr} = -3 r^{-3-1} \propto \left(\frac{1}{r^4}\right)$

QUESTION

A magnetic needle lying parallel to a magnetic field requires W units of work to turn it through 60°. The torque needed to maintain the needle in this position will be

1. W
2. $\sqrt{3}W$ ✓
3. $\frac{\sqrt{3W}}{2}$
4. 2W

$\theta_i = 0$

$U = -MB\cos 0°$

$U_i = -MB$

$U_f = -MB\cos 60°$

$= -\frac{MB}{2}$

$W = U_f - U_i$

$W = -\frac{MB}{2} - (-MB) = \left(\frac{MB}{2}\right)$

$\tau = MB\sin 60°$

$\tau = \frac{MB \times \sqrt{3}}{2} = W\sqrt{3}$

QUESTION

A bar magnet having a magnetic moment of 2×10^4 J T^{-1} is free to rotate in a horizontal plane. A horizontal magnetic field $B = 6 \times 10^{-4}$ T exists in the space. The work done in taking the magnet slowly from a direction parallel to the field to a direction 60° from the field is **(2009)**

1. 12 J
2. 6 J ✓
3. 2 J
4. 0.6 J

$\theta_i = 0^\circ$

$\theta_i = 60^\circ$

$W = \frac{mB}{2} = \frac{2 \times 10^4 \times 6 \times 10^{-4}}{2}$

QUESTION

The work done in turning a magnet of magnetic moment M by an angle of 90° from the meridian, is n times the corresponding work done to turn it through an angle of 60°. The value of n is given by (1995)

1. 1/2
2. 1/4
3. 2
4. 1

$\theta_i = 0^\circ$

$\theta_i = 0 \longrightarrow \theta_f = 90^\circ$, $W_2 = nW_1$

$\theta_i = 0 \longrightarrow \theta_f = 60$, W_1

Work done $= U_f - U_i$

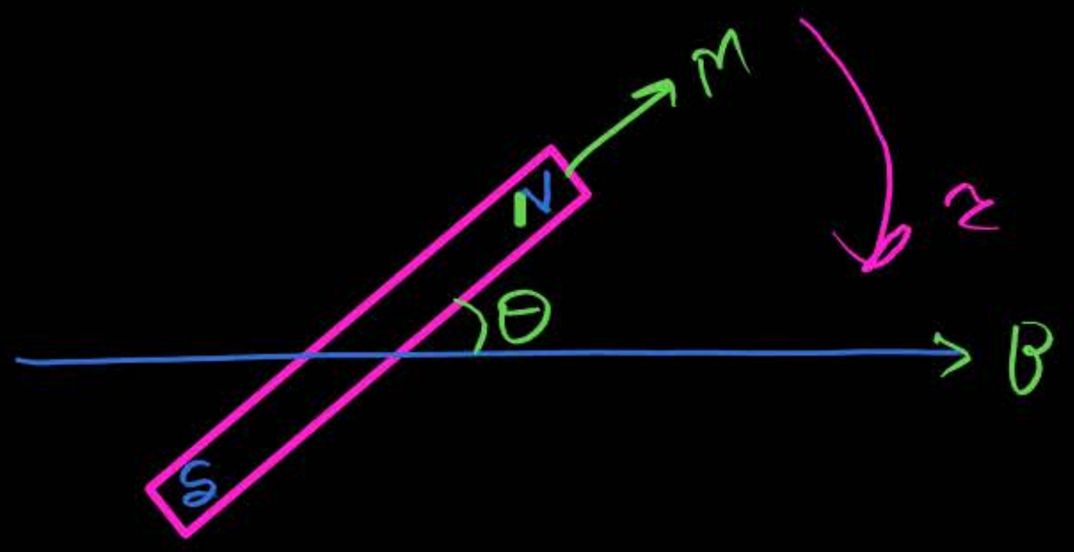
$W_2 = 0 - (-MB) = MB$

$W_1 = \frac{MB}{2}$

$\frac{MB}{2} n = MB$

$n = 2$

Oscillation of BAR magnet



$$T = 2\pi\sqrt{\frac{I}{MB}}$$

M = magnetic moment = ml

I = moment of Inertia = $\frac{ml^2}{12}$ (m = mass)

B = magnetic field.

- If this Bar magnet is cut along the length in two equal Part then find Time Period of one part



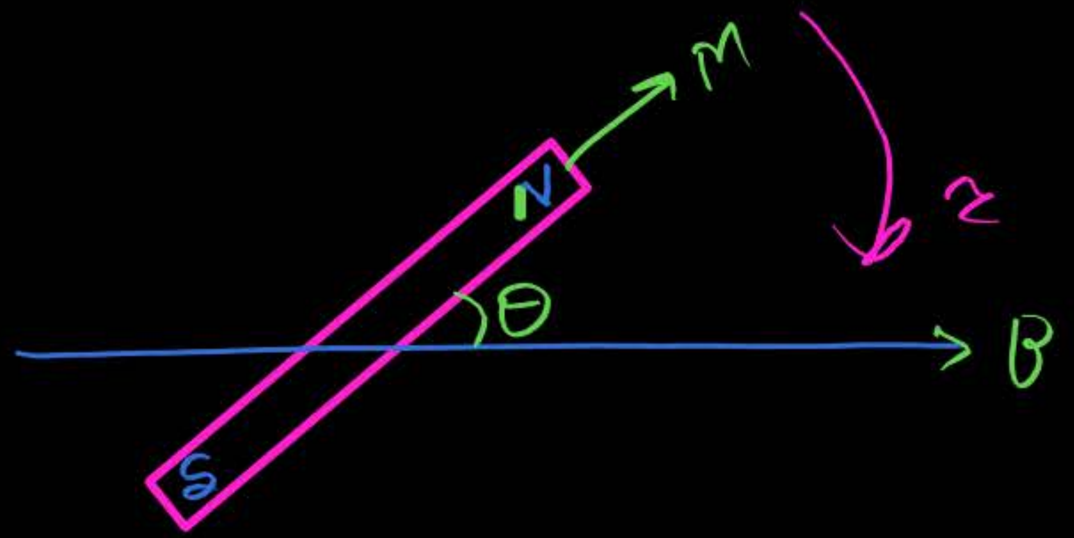
(Moment of Inertia) $I' = \frac{I}{2}$

$$T' = 2\pi\sqrt{\frac{I'}{M'B}}$$

$$T' = 2\pi\sqrt{\frac{I}{2 \times \frac{M}{2} B}}$$

- $T' = T$ same.

Oscillation of BAR magnet



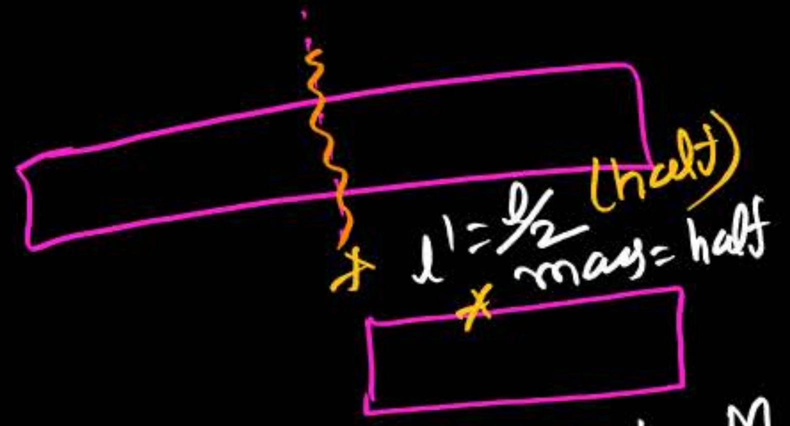
$$T = 2\pi\sqrt{\frac{I}{MB}}$$

M = magnetic moment = ml

I = moment of Inertia = $\frac{ml^2}{12}$ (m = mass)

B = magnetic field.

If This Bar magnet is cut ⊥r the length in equal Part then find Time Period of one Part



$$m' = \frac{M}{2}$$

$$\left[I' = \frac{I}{8}\right]$$

$$T' = 2\pi\sqrt{\frac{I'}{m'B}}$$

$$T' = 2\pi\sqrt{\frac{I}{\cancel{8}4 \times \frac{M}{\cancel{2}}B}}$$

$$T' = \frac{1}{2}\,2\pi\sqrt{\frac{I}{MB}}$$ ✓

$$\boxed{T' = T/2}$$

QUESTION

A magnetic needle of negligible breadth and thickness compared to its length, oscillates in a horizontal plane with a period T. The period of oscillation of each part obtained on breaking the magnet into n equal parts perpendicular to the length is

2nd case

(1) T/n

(2) T

(3) Tn

(4) $1/Tn$

QUESTION

The time period of a freely suspended magnet is 4 s. If it is broken in length into two equal parts and one part is suspended in the same way, then its time period will be

1. 2 s
2. 4 s
3. 0.5 s
4. 0.25 s





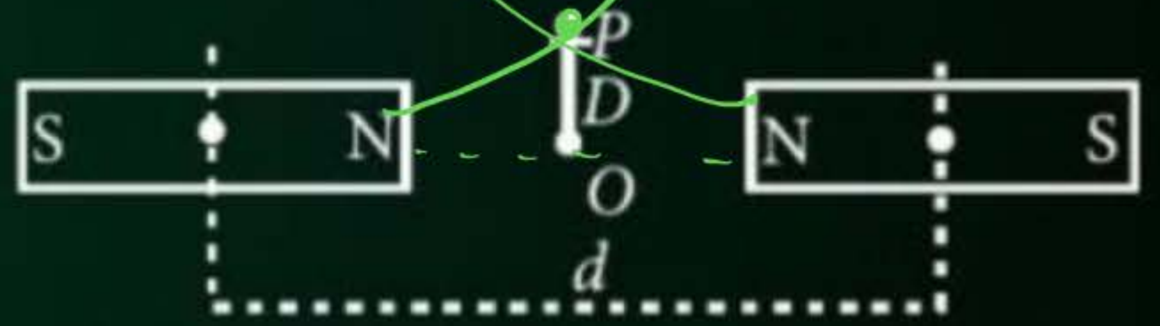
$T' = \frac{T}{2}$

QUESTION

Two identical bar magnets are fixed with their centres at a distance d apart. A stationary charge Q is placed at P in between the gap of the two magnets at a distance D from the centre O as shown in the figure.

The force on the charge Q is

(Mains 2010)



1. zero
2. directed along OP
3. directed along PO
4. directed perpendicular to the plane of paper

QUESTION

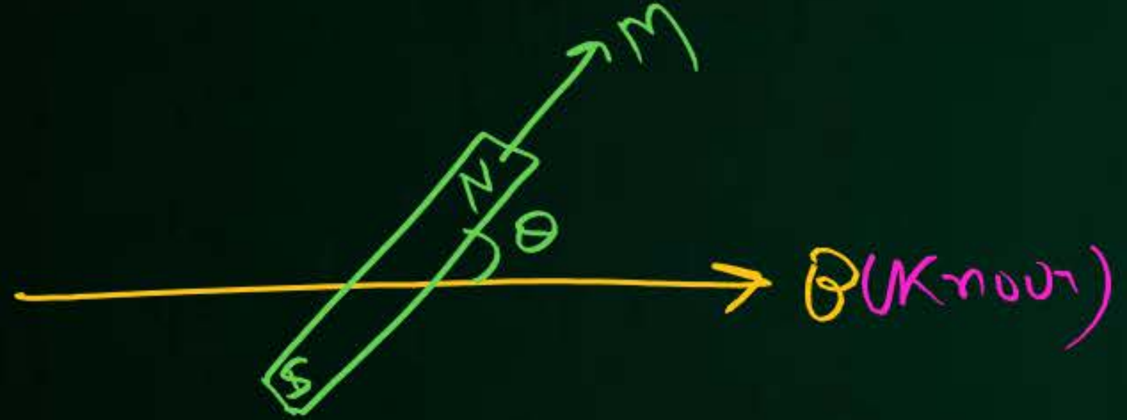
A bar magnet is oscillating in the Earth's magnetic field with a period T. What happens to its period and motion if its mass is quadrupled? **(2003, 1994)**

1. Motion remains simple harmonic with time period = T/2
2. Motion remains S.H.M with time period = 2T
3. Motion remains S.H.M with time period = 4T
4. Motion remains S.H.M and period remains nearly constant

Vibrational Magnetometre

→ Instrument, which use to find magnetic moment of magnet.

→ working Based of osscillation of BAR magnet in magnetic field



$$T = 2\pi\sqrt{\frac{I}{MB}}$$

Obtained by experien

$$\left(\frac{T}{2\pi}\right)^2 = \frac{I}{MB}$$

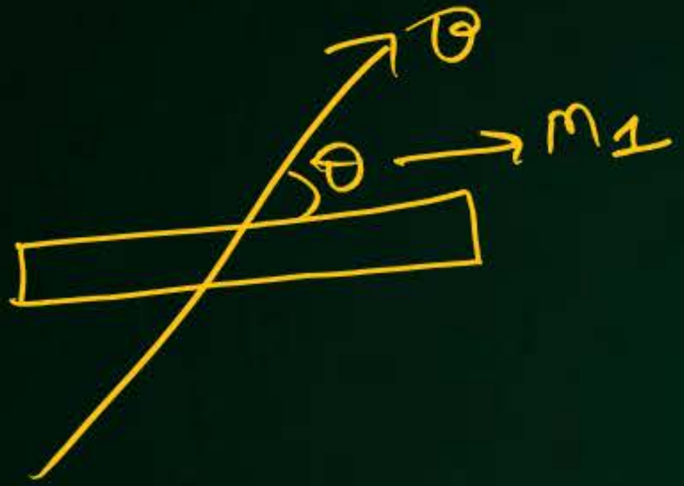
1st application

$$M = \frac{4\pi^2 I}{T^2 B}$$

Application-2: To find ratio of magnetic moment of two magnet of same size.

↳ we oscillate magnet one-by one

* ↳ moment of Inertia



$$T_1 = 2\pi\sqrt{\frac{I}{m_1 B}}$$

$$T_2 = 2\pi\sqrt{\frac{I}{m_2 B}}$$

$$\frac{T_1}{T_2} = \sqrt{\frac{m_2}{m_1}}$$

$$\left(\frac{m_1}{m_2}\right)^{1/2} = \frac{T_2}{T_1}$$

$$\frac{m_1}{m_2} = \left(\frac{T_2}{T_1}\right)^2$$

Ans

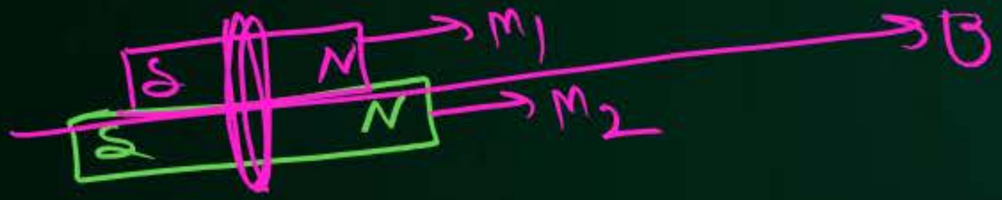
QUESTION

Find ratio of magnetic moment of two bar magnet of unequal size.

→ different M.O.I

Case-1

They place togeth with same Polarity



$$T_1 = 2\pi\sqrt{\frac{I_1 + I_2}{(m_1 + m_2)B}}$$

Case-2 Now they place togeth with opposite polarity



$$T_2 = 2\pi\sqrt{\frac{I_1 + I_2}{(m_1 - m_2)B}}$$

$$\frac{T_1}{T_2} = \sqrt{\frac{m_1 - m_2}{m_1 + m_2}}$$

$$\boxed{\frac{m_1 - m_2}{m_1 + m_2} = \frac{T_1^2}{T_2^2}}$$

QUESTION

Two bar magnets having same geometry with magnetic moments M and 2M, are firstly placed in such a way that their similar poles are in same side then its time period of oscillation is T_1. Now the polarity of one of the magnet is reversed then time period of oscillation is T_2, then **(2002)**

1. $T_1 < T_2$
2. $T_1 = T_2$
3. $T_1 > T_2$
4. $T_2 = \infty$

QUESTION

A vibration magnetometer placed in magnetic meridian has a small bar magnet. The magnet executes oscillations with a time period of 2 sec in earth's horizontal magnetic field of 24 microtesla. When a horizontal field of 18 microtesla is produced opposite to the earth's field by placing a current carrying wire, the new time period of magnet will be

(2010)

1. 1 s
2. 2 s
3. 3 s
4. 4 s

QUESTION

The time period of a freely suspended magnet is T. If it is broken along length into two equal parts and one part is suspended in the same way, then its time period will be

1. $\frac{T}{2}$
2. T (along length)
3. $2T$
4. $T\sqrt{2}$

QUESTION

The combination of two bar magnets makes 10 oscillations per second in an oscillation magnetometer when like poles are tied together and 2 oscillations per second when unlike poles are tied together. Find the ratio of the magnetic moments of the magnets.

Sol^n.

$f = 10 \text{ Hz}$

$T_1 = \frac{1}{10} \text{ sec} = 0.1 \text{ sec}$

$T_2 = \frac{1}{2} \text{ sec} = 0.5 \text{ sec}$

$$\frac{T_1 = 2\pi\sqrt{\frac{I_1+I_2}{m_1+m_2}}}{T_2 = 2\pi\sqrt{\frac{I_1+I_2}{m_1-m_2}}}$$

$$\frac{0.1}{0.5} = \sqrt{\frac{m_1-m_2}{m_1+m_2}}$$

$$\frac{1}{25} = \frac{m_1-m_2}{m_1+m_2}$$

$m_1+m_2 = 25m_1-25m_2$

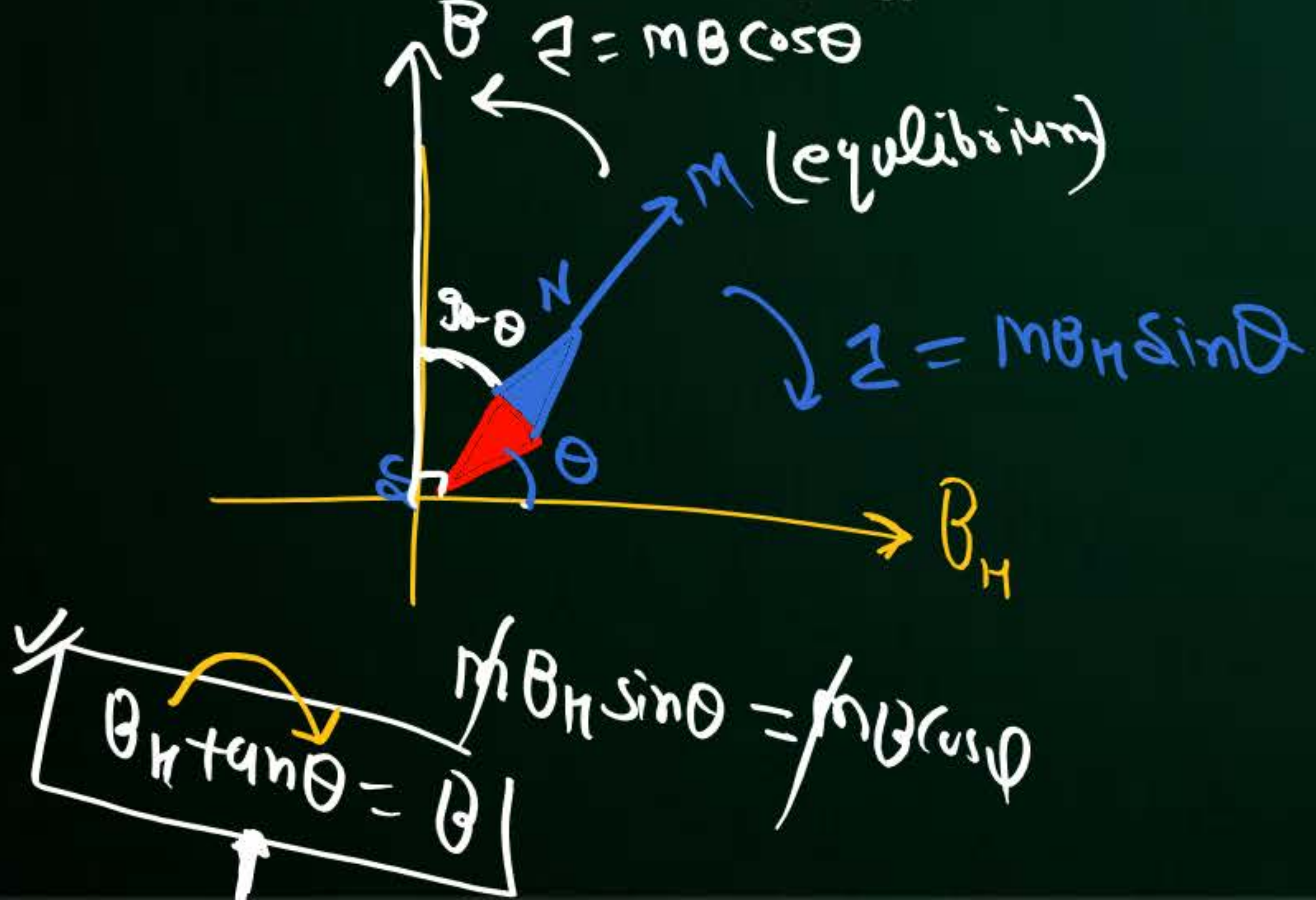
$26m_2 = 24m_1$

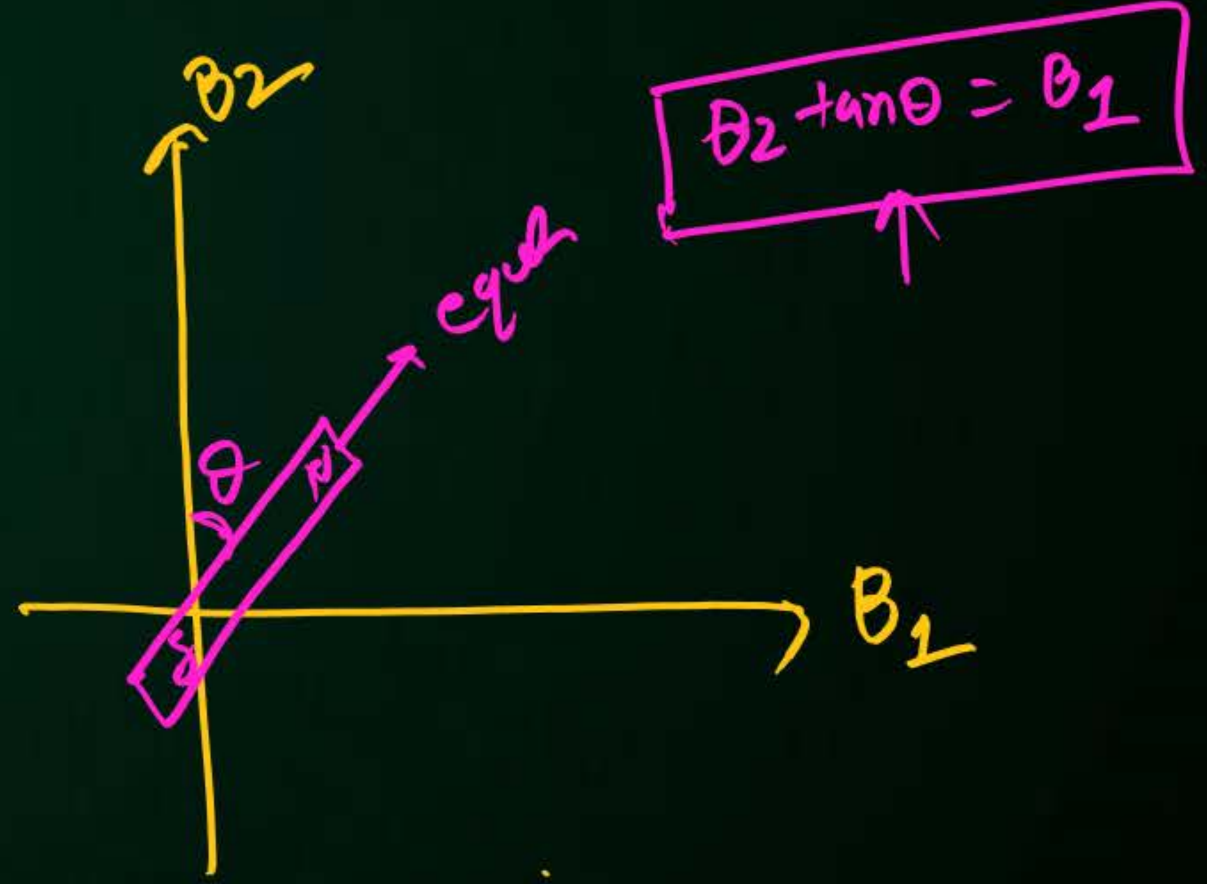
$$\frac{13}{12} = \frac{26}{24} = \frac{m_1}{m_2}$$

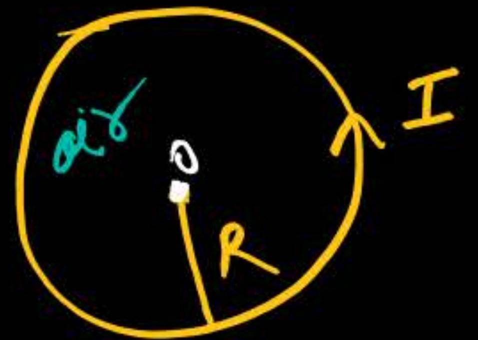
TANGENT LAW

When a magnet is simultaneously acted upon by two uniform fields at right angle to each other, it will be deflected through an angle θ, such that the tangent of the angle of deflection gives the ratio of the two fields

$$\tan\theta = B/B_H$$







magnetic field =
Magnetic Induction =
magnetic flux density =
~~magnetic Intensity =~~

$B_{air} = \frac{\mu_0 I}{2R}$

$B_{medm} = \frac{\mu_m I}{2R}$

(source + medium)

(Source ki aukad)

magnetic Intensity $H = \frac{B_0}{\mu_0} = \frac{B_m}{\mu_m}$

(only depends on source)

$H = \frac{B_0}{\mu_0} = \frac{\mu_0 I}{2R\,\mu_0} = \frac{I}{2R}$

$H = \frac{B_m}{\mu_m} = \frac{\mu_m I}{2R\,\mu_m} = \frac{I}{2R}$

Source + medium

Perimiability (medium)

(source)

$B_0 = \mu_0 H$

$B_m = \mu_m H$

Intensity of magnetic field or, magnetic Intensity does not depend on medium

Magnetic Permeability (μ)

It is defined as the ratio of the magnitude of total magnetic field (B) inside a material to that of magnitude of magnetic intensity (H)

$$\mu = \frac{B}{H}$$

1. It is a scalar quantity. Its unit is $\frac{Wb}{A-m}$ and dimensions are $[MLT^{-2}A^{-2}]$
2. The physical significance of magnetic permeability is that, it measures the extent to which a magnetising field can penetrate or permeated a given magnetic material

Magnetic Intensity (or Intensity or Magnetising Field) H

असली

Intensity of magnetic field [Intensity of magnetsiy field] → 'H'

Intensity of magnetisation

(*) I & H have same unit

I (only defined for magnetic material Not for magnet or magnetic source)



$I = \frac{\vec{M}}{V}$ = Induced magnetic moment per unit volume.

H

$\vec{I}$ = vector

= unit → $\frac{Amp\text{-}m^2}{m^3}$ = Amp/metre.

"$I \propto H$"

*$I = \chi H$

This is not magnet, but can be behave as magnet when it will magnetised.

$\chi = \frac{I}{H} = \frac{\text{Intensity of magnetisation } (I = m/V)}{\text{Intensity of magnetising field}}$

→ unitless & dimⁿless

→ scalar

$I = \chi H$

→ proportional constant

→ depends on nature of magnetic material

χ → very high for feromagnetic & Positive

χ → low & Positive for Paramagnetic

⇒ χ → −ve for dia-magnetic.

$B_0 = \mu_0 H$ / $B_m = \mu_m H$

- $\mu_m = \frac{B_m}{H}$

- $\vec{I} = \frac{\vec{m}}{V}$ ⇒ vector
  dirⁿ of I along $\vec{m}$
  → for magnetic matr

$\chi = \frac{I}{H}$ = unitless.

Relⁿ b/w Relative Permiability & Susstibility

$\mu_r = 1 + \chi$

unitless / unitless

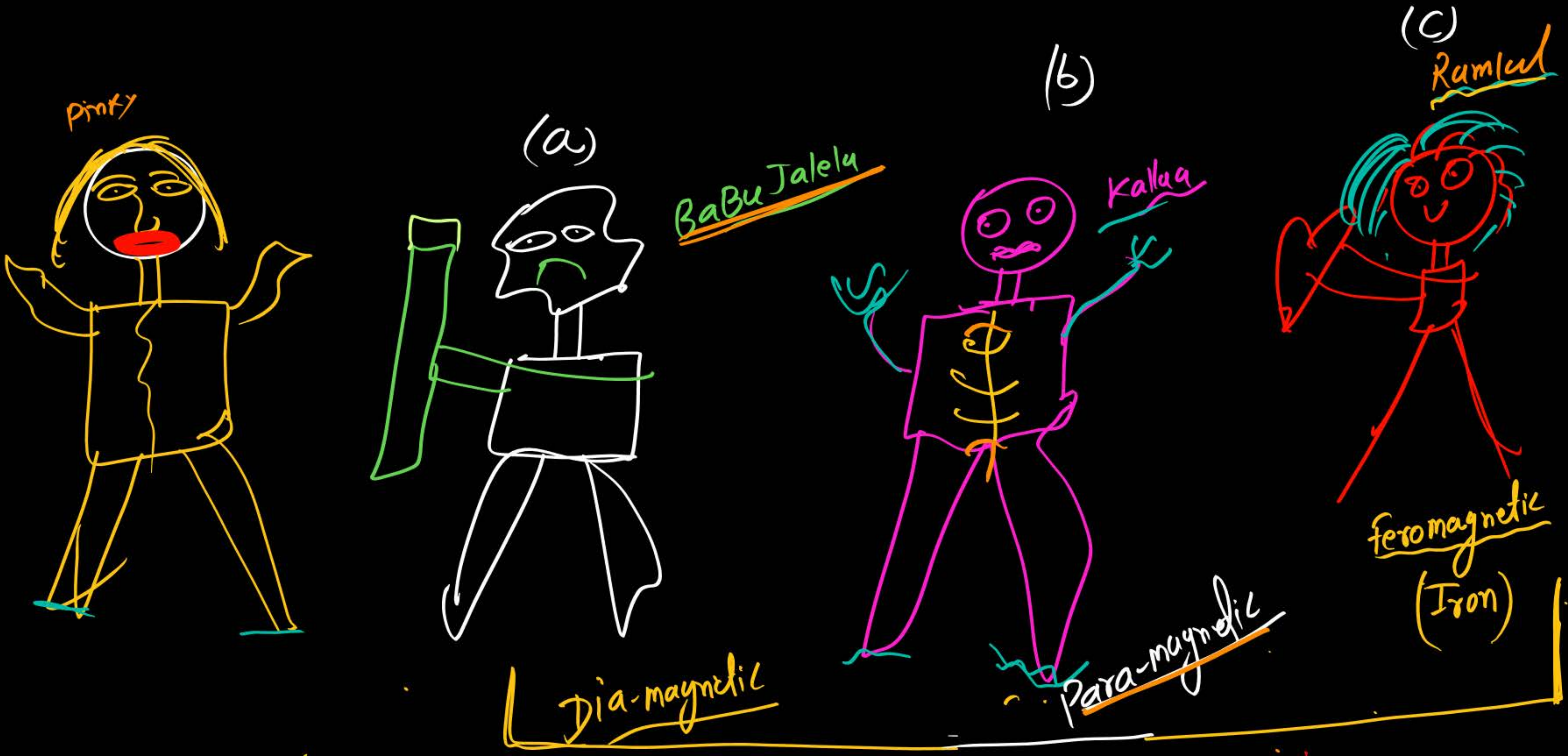
Magnetic Susceptibility [χ_m]

Not defined for magnet
only defined for magnetic material

It is defined as the "ratio of magnitude of intensity of magnetisation $|\vec{I}|$ to that of magnetic intensity $|\vec{H}|$".

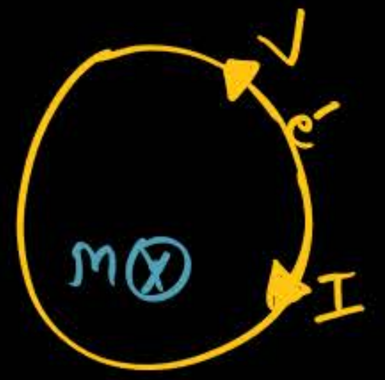
$$\chi_m = \frac{I}{H}$$

1. It is a scalar quantity with no dimension, no unit.
2. The physical significance of magnetic susceptibility is that it is the degree of ease with which a magnetic material can be magnetised. A material with higher value χ_m cam easily be magnetised.


pinky
(a)
BaBu Jalelu
(b)
Kallua
(c)
Ramlal
Dia-magnetic
Para-magnetic
feromagnetic
(Iron)

Cause of Magnetisation

→ electron revolvs around circular path inside atom, due to this current produced in circular path. Due this current there is magnetic moment associated. hence magnetic field produced.



atom

Paired e⁻ atom

ex- no of e⁻
2, 4, 6, 8, 10, 12, ..



$M_{one\ atom} = 0$

⇒ $M_{molecule/crystal} = 0$

⇒ Dia-magnetic Material

unpaired electron

no of e⁻ → 1, 3, 5, 7 . .



$M_{atom} \neq 0$

$M_{molecule/crystal} = 0$ (random oriantation)

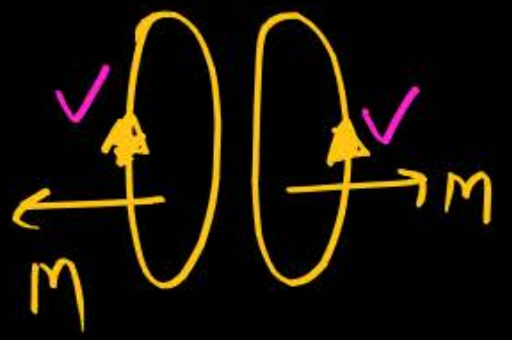
Paramagnetic / fermomagnetic

Dia-magnetism is universal property

Dia-magnetic material → Based on lentz law → will study next chapter

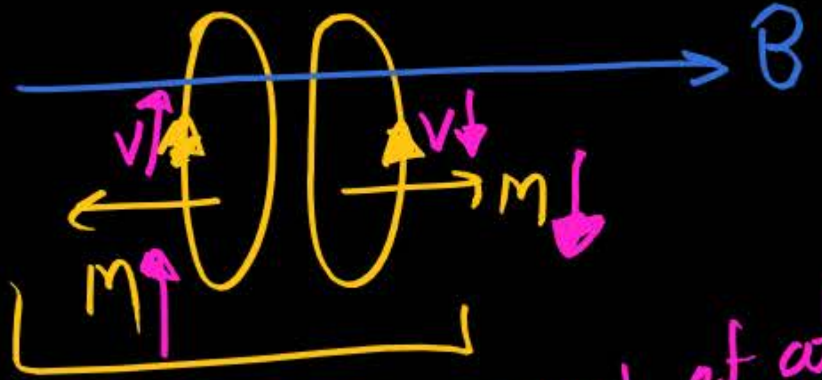
(magnetic Inertia)

- unpaire e^- ✗
- (Paired e^- atom) ✓



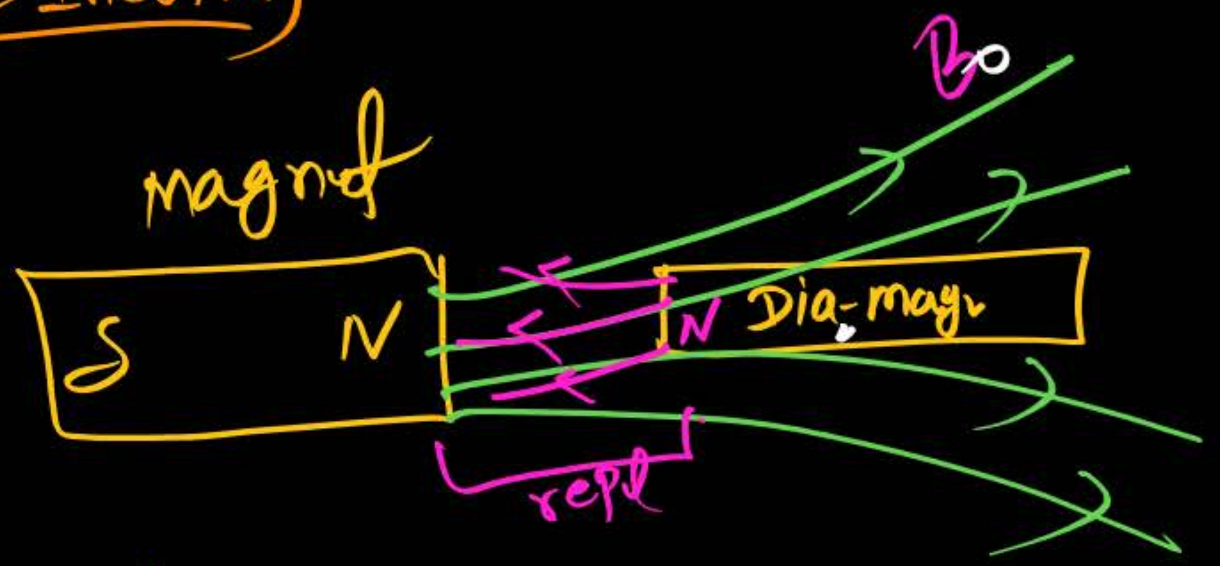
- $M_{atom} = 0$

No external field is applied.



magnetic of moment of atom becomes non-zero opposite to the applied field,

$M_{atom} \neq 0$



$B_{net} \downarrow < B_0$

diamagnet repel from magnet

$\chi = -ve$ [B/w 0 to -1]

$B_m < B_0$

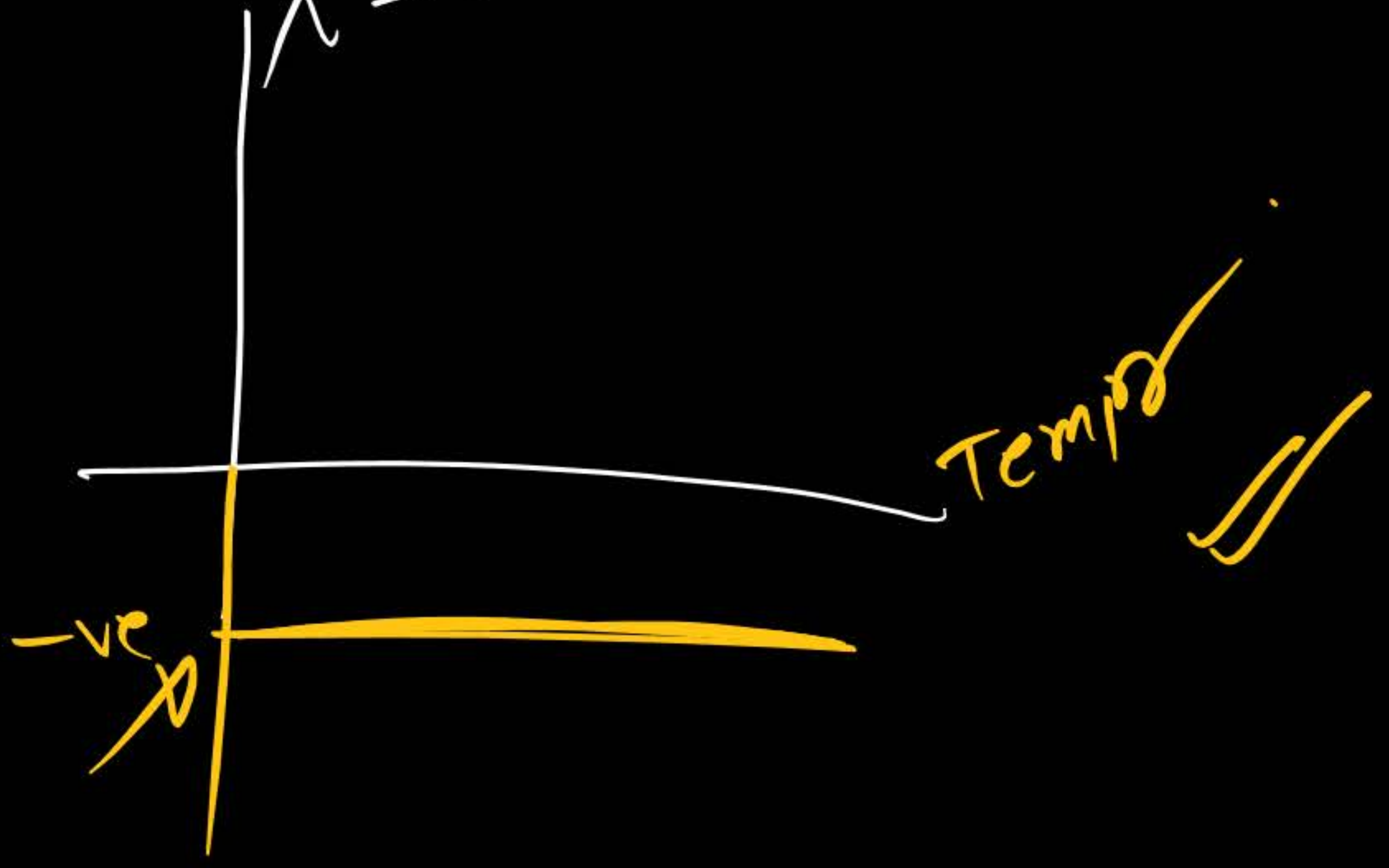
$\mu_r < 1$

$\mu_r = 1 + \chi$

$\mu_m (diamag) < \mu_0$

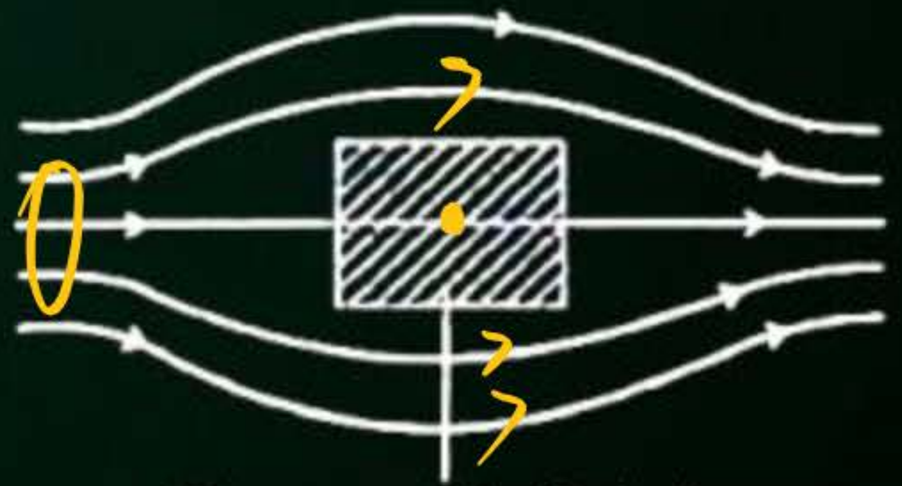
$\mu_m = \mu_r \mu_0$

χ = does not depend on Tempr.



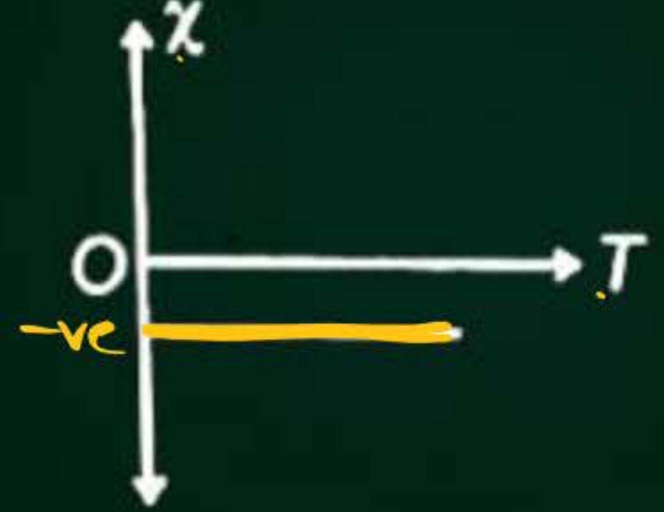
DIAMAGNETISM

- The substances which have tendency to move from stronger to weaker part of external magnetic field. They develop this tendency because they are feebly magnetised in a direction opposite to that of external magnetising field.
- Some of diamagnetic substances are as follows bismuth, copper, lead, silicon, nitrogen (at STP), water and sodium chloride.
- The magnetic field lines are expelled by these substance.
- Magnetic field inside diamagnetic substance (B) is less than in free space B_0, therefore $\frac{B}{B_0} < 1, \frac{\mu}{\mu_0} < 1, \mu_r < 1$



Diamagnetic Substance

- Relative permeability of diamagnetic substance is less than one. $\mu_r = 1 + \chi$
- As $\mu_r = (1 + \chi_m)$ $\mu_r < 1$, therefore χ_m is negative for diamagnetic material.
- Magnetic susceptibility χ_m of diamagnetic substance is independent of temperature.



- Diamagnetism is a (universal property) i.e., it is present in all substances. However, the effect is so weak in most cases that it gets shifted by other effects like paramagnetism, ferromagnetism etc.

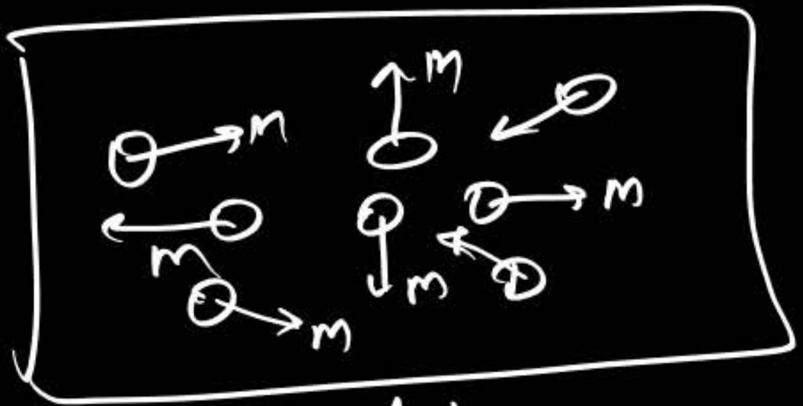
Paramagnetism

→ Based on torque experienced by magnetic moment in external magnetic.

→ Unpaire e^-

$M_{atom} \neq 0$

$M_{Momlecule / Cryst} = 0$

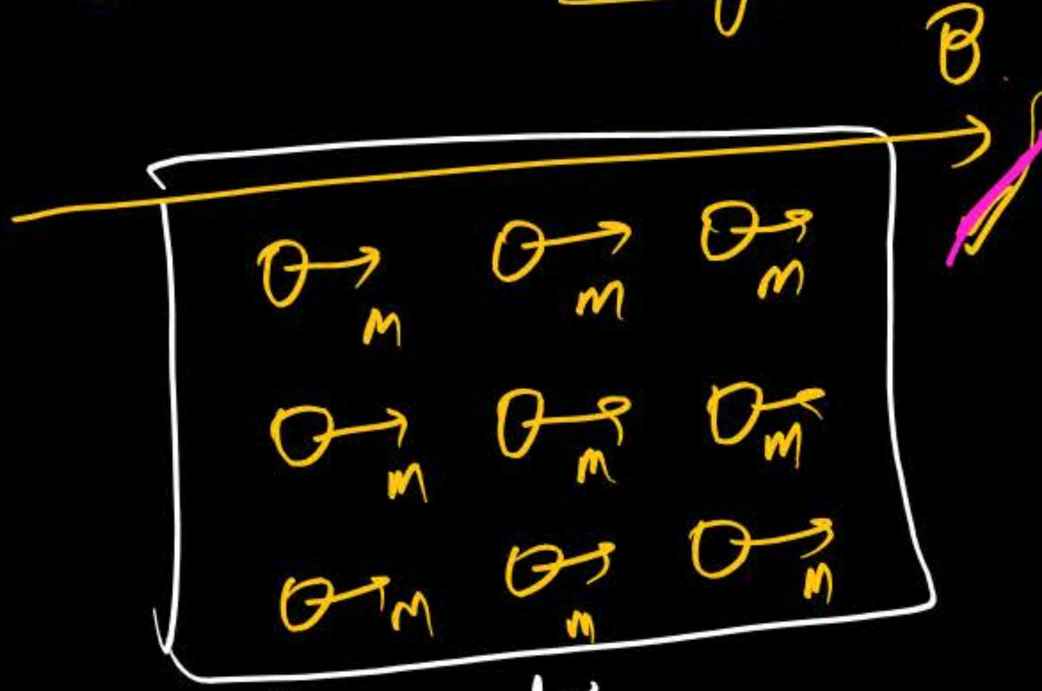


Paramagnetic

$M_{atom} \neq 0$

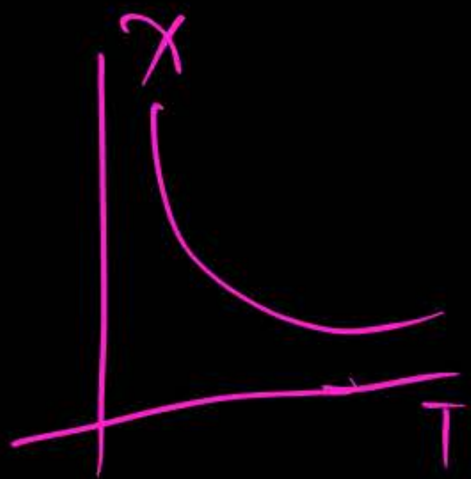
$M_{cryst} = 0$

$B_{extn} = 0$



Paramagnetic

$M_{Molecule / Cryst} \neq 0$



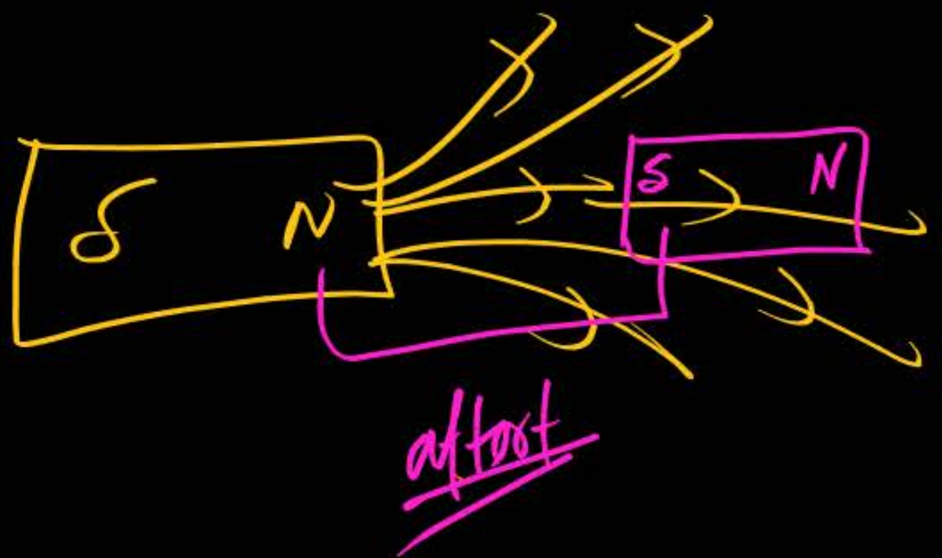
\# χ = small (+ve)

\# $\mu_r = 1 + \chi$ = small & +ve

Magnised in dir^n of ext^n field

\# $B > B_0$ [$\mu > \mu_0$]

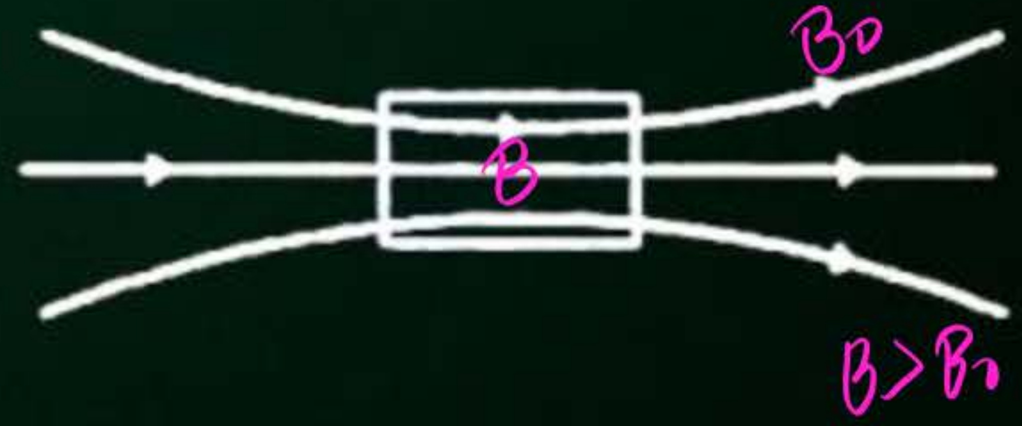
attracted by external field



magnetised

PARAMAGNETISM

- These are the substances which get feebly magnetised in the direction of applied external magnetic field. Therefore they have tendency to move from region of weak magnetic field to strong magnetic field i.e., they get weakly attracted to a magnet.
- Some paramagnetic substances are as follows: aluminium, sodium, calcium, oxygen (at STP) and copper chloride
- Magnetic field lines tend to pass through these substances therefore magnetic field inside substance is more than the outside.



- $B > B_0, \frac{B}{B_0} > 1, \mu > \mu_0, \frac{\mu}{\mu_0} > 1, \mu_r > 1$
- The relative permability of paramagnetic substances is greater than one.
- As $\mu_r = 1 + \chi_m$, χ_m is positive. (The magnetic susceptibility of paramagnetic substance is small and positive)

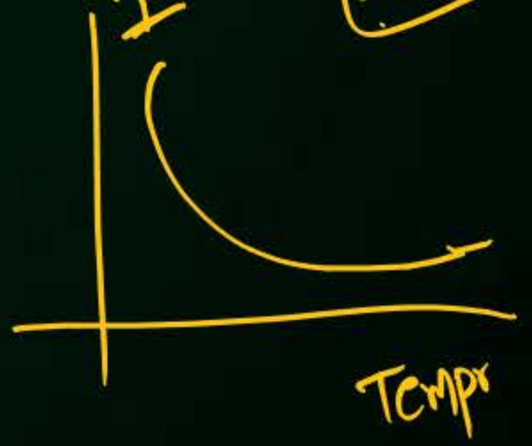
$\mu_r = 1 + \chi$ (small +ve no)

Curie law $\chi \propto \frac{1}{T}$

$\chi = \frac{C_m}{T}$



I (Intensity of magnetization) $I = \chi H$



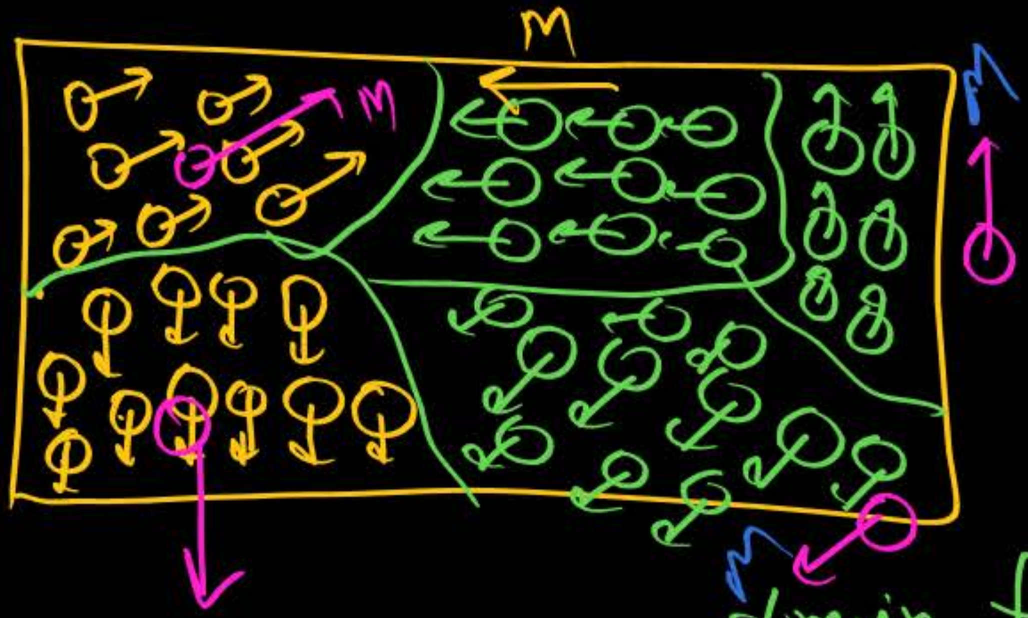
Fermagnetic substance

→ (domain formation)

→ unpaired e- atom

→ $M_{atom} \neq 0$

$M_{crystal} = 0$

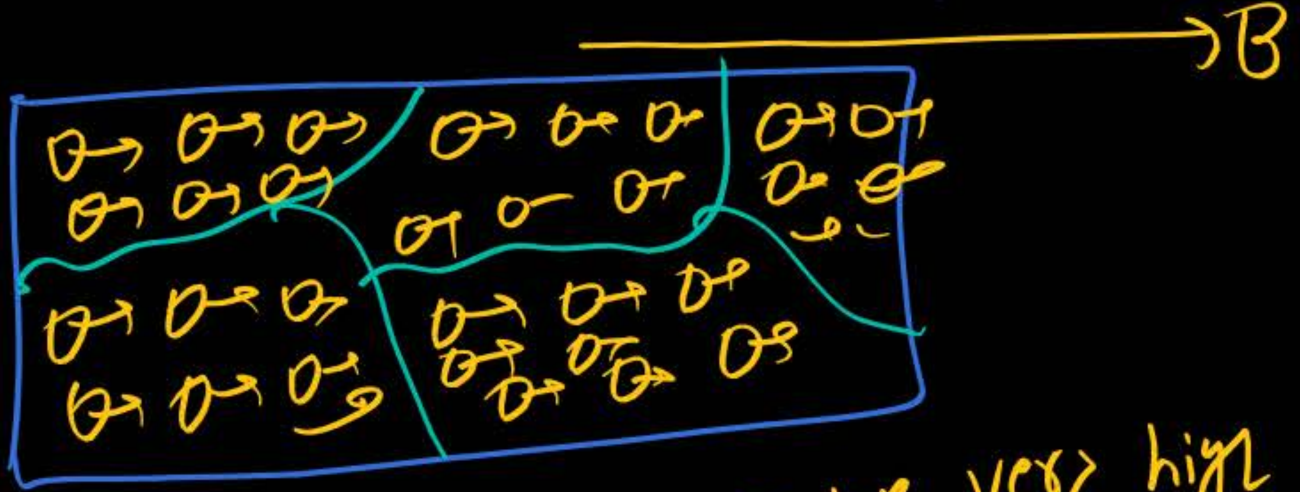


domain formation only in Feromagnetic

domain is also in random orientation

hence $M_{crystal} = 0$ #

Feromagnetic is placed in external field then Bext apply torque on domains



feromagnetic becomes Paramagnetic above curi Temp (T_c)

$\chi \rightarrow$ +ve very high

$\mu_r = 1 + \chi \rightarrow$ +ve very high

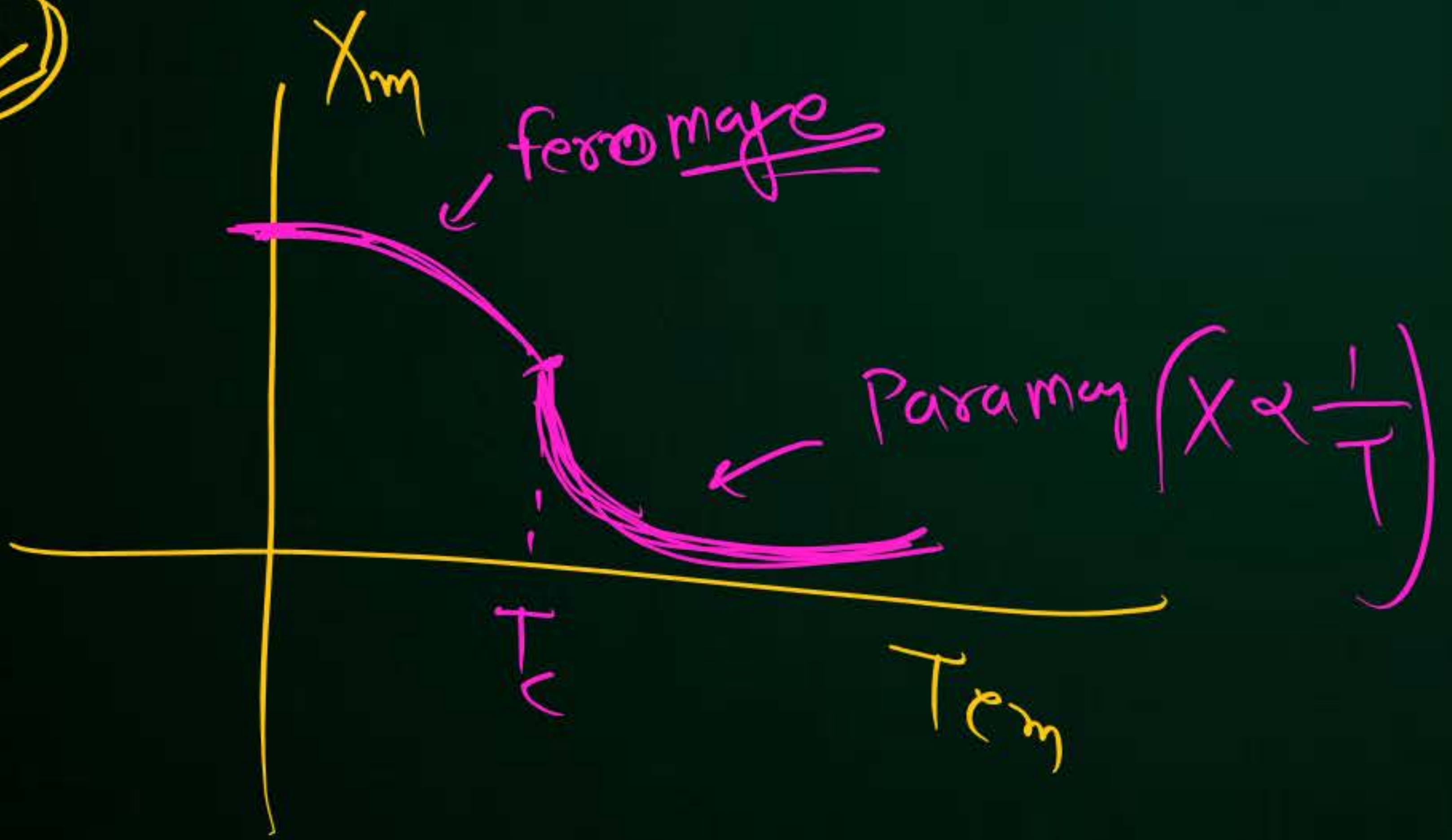
$B >> B_0$

Highly magnetic

FERROMAGNETISM

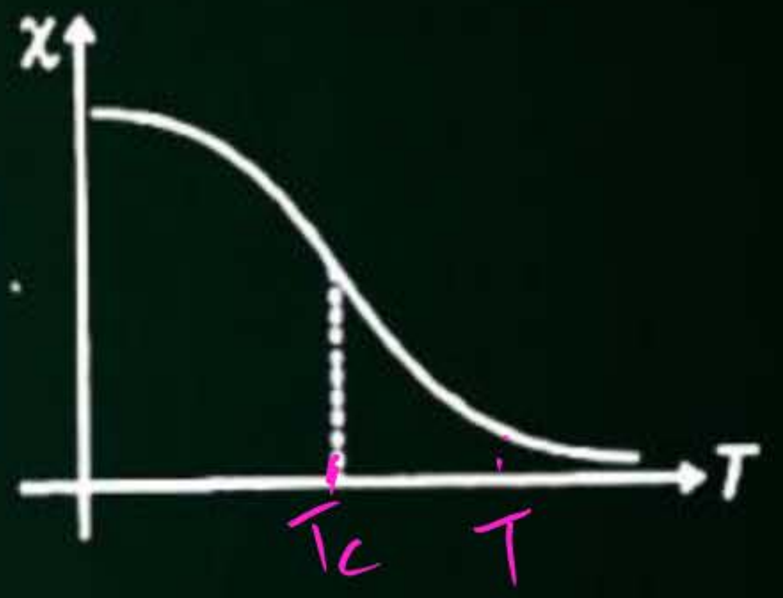
- These are the substances which get strongly magnetised when placed in an external magnetic field. So they have strong tendency to move a region of weak magnetic field to strong magnetic field. They get strongly attracted to the magnet
- Some of the ferromagnetic substances are as follows: iron, cobalt, nickel, alloys like alnico etc.
- Magnetic field lines tends to crowd into ferromagnetic material
- Permeability of ferromagnetic materials is very large, of the order of hundreds and thousands.

- Magnetic susceptibility χ_m of ferromagnetic substance is very high, therefore, they can be magnetised easily and strongly.
- With rise in temperature, susceptibility of ferromagnetic materials decreases. At a certain temperature ferromagnetic substance is converted into paramagnetic substance. This transition temperature is called Curie temperature or Curie point T_C



Curie-Weiss Law: At temperature above the Curie temperature, a ferromagnetic substance becomes an ordinary paramagnetic substance whose magnetic susceptibility obeys the curie-Weiss law according to which

$$\boxed{\chi_m = \frac{C}{T - T_C}}$$



$\mu_r = 1 + \chi$

Diamagnetic	Paramagnetic	Ferromagnetic
$-1 \leq \chi_m < 0$	$0 < \chi_m < \varepsilon$ → small +ve no	$\chi_m >> 1$
$0 \leq \mu_r < 1$	$1 < \mu_r < 1 + \varepsilon$	$\mu_r >> 1$
$\mu < \mu_0$	$\mu > \mu_0$ $B > B_0$	$\mu >> \mu_0$
$B < B_0$	(ε = small positive number)	$B >>> B_0$

I/H curve → only for fermagnetic substance [life of Ramlal]

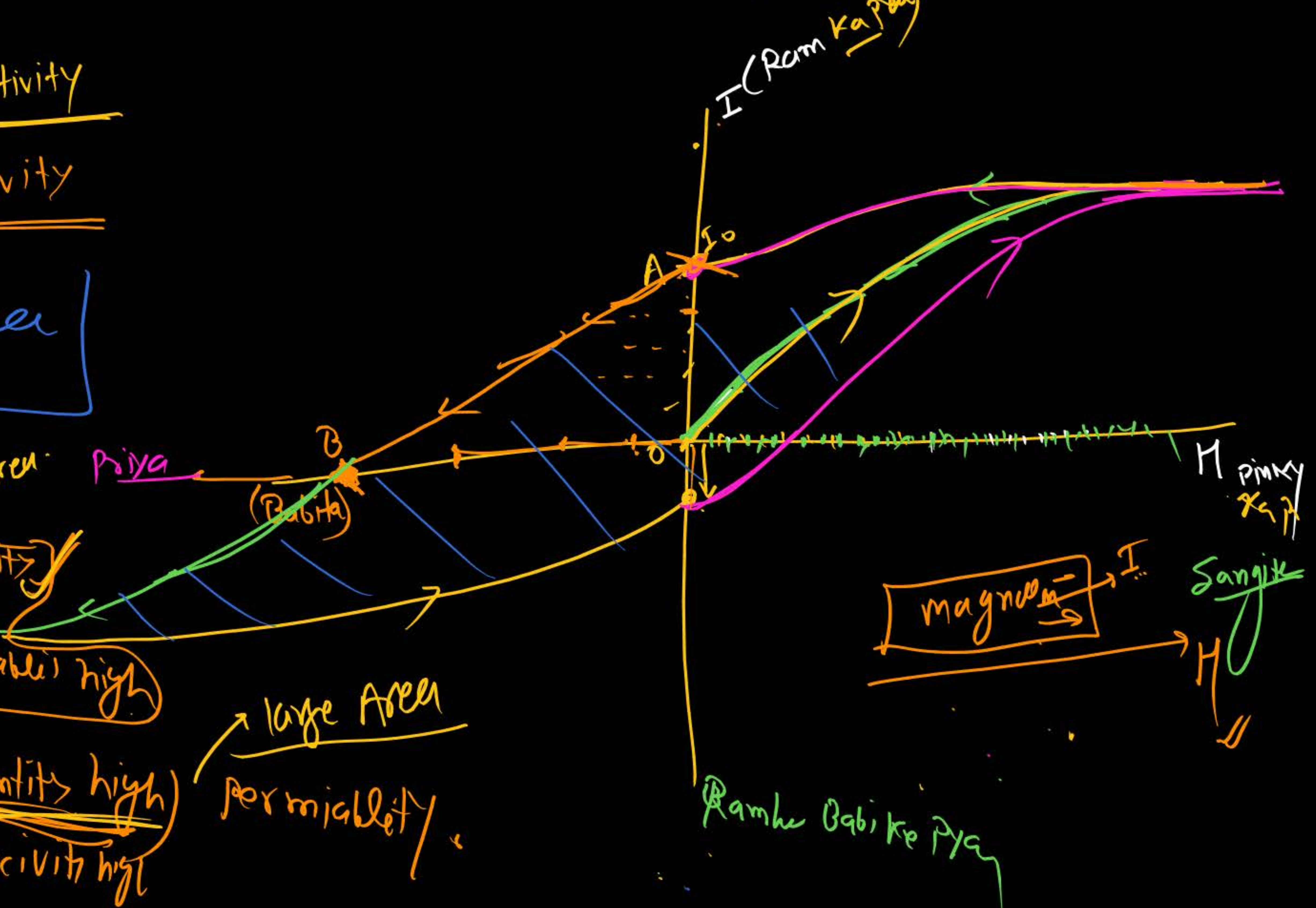
OA → retaintivity

OB → correcivity

energy loss ∝ Area

Soft Iron (electromagnet) = retentivity Low — small Area
= permiability high

Hard-Iron
Permanent mgn → (retentivity high, corecivity high) → large Area
permiablity



QUESTION

Domain formation is the necessary feature of

1. Diamagnetism
2. Paramagnetism
3. Ferromagnetism
4. All of these

QUESTION

They hysteresis curve is studied generally for

1. Paramagnetic materials
2. Diamagnetic materials
3. Ferromagnetic materials
4. All of these

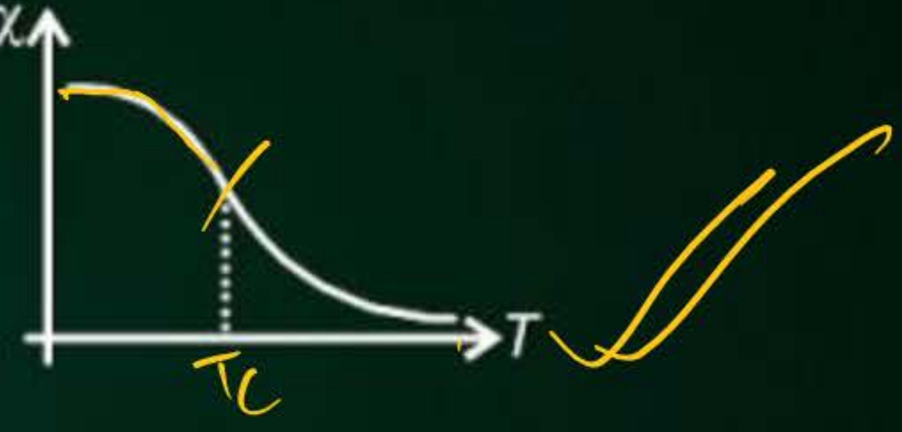
QUESTION

The variation of magnetic susceptibility (χ) with absolute temperature (T) for a ferromagnetic material is

(1)



(2)



(3)



(4)



QUESTION

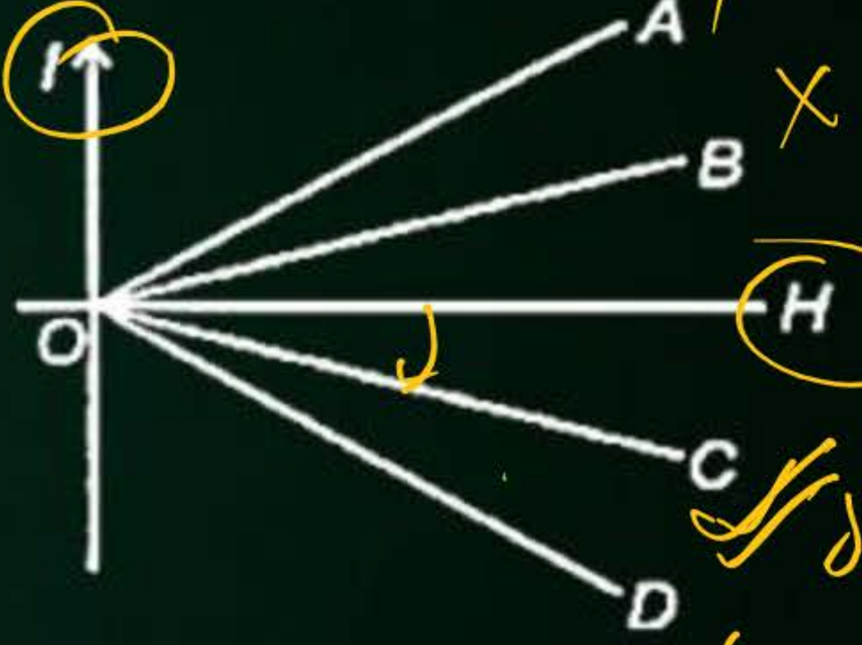
The universal property of all substances is

1. Diamagnetism
2. Ferromagnetism
3. Paramagnetism
4. All of these

QUESTION

The variation of the intensity of magnetisation (I) with respect to the magnetising field (H) in a diamagnetic substance is described by the graph.

1. OC
2. OD
3. OA
4. OB



QUESTION

A 250-turn rectangular coil of length 2.1 cm and width 1.25 cm carries a current of 85 μA and subjected to a magnetic field of strength 0.85 T. Work done for rotating the coil by 180° against the torque is

1. 9.1 μJ
2. 4.55 μJ
3. 2.3 μJ
4. 1.15 μJ

done
W = ΔU
H/W

QUESTION

The magnetic susceptibility is negative for

1. Paramagnetic and ferromagnetic material
2. Diamagnetic material only
3. Paramagnetic material only
4. Ferromagnetic material only

QUESTION

When a ferromagnetic substance is heated to a temperature above its Curie temperature, it

1. Behaves like a paramagnetic substance
2. Behaves like a diamagnetic substance
3. Remains ferromagnetic
4. Is permanently magnetized

QUESTION

Select the incorrect statement

1. In a diamagnetic substance net magnetic moment of each atom/ molecule is zero
2. In a paramagnetic substance net magnetic moment of each atom/ molecule is non-zero
3. In a ferromagnetic material net magnetic moment of each domain is zero
4. In a ferromagnetic material net magnetic moment of each domain is non-zero

QUESTION

Soft iron is used to manufacture electromagnets because their

1. Magnetic permeability is high and retentivity and coercive force are small
2. Retentivity is high
3. Coercive force is high
4. Area of the hysteresis curve is large

QUESTION

The magnetic susceptibility is negative for (NEET-I 2016)

1. ferromagnetic material only
2. paramagnetic and ferromagnetic materials
3. diamagnetic material only
4. paramagnetic material only

QUESTION

The magnetic moment of a diamagnetic atom is (Maim 2010)

Pair e^-

$M_{atom} = 0$

1. much greater than one
2. 1
3. between zero and one
4. equal to zero

QUESTION

If a diamagnetic substance is brought near the north or the south pole of a bar magnet, it is (2009, 1999)

1. repelled by the north pole and attracted by the south pole
2. attracted by the north pole and repelled by the south pole
3. attracted by both the poles
4. repelled by both the poles

QUESTION

Curie temperature above which (2008, 2006)

1. paramagnetic material becomes ferromagnetic material
2. ferromagnetic material becomes diamagnetic material
3. ferromagnetic material becomes paramagnetic material
4. paramagnetic material becomes diamagnetic material

done

QUESTION

Nickel shows ferromagnetic property at room temperature. If the temperature is increased beyond Curie temperature, then it will show (2007)

1. anti ferromagnetism
2. no magnetic property
3. diamagnetism
4. paramagnetism

QUESTION

A diamagnetic material in a magnetic field moves (2003)

1. from stronger to the weaker parts of the field
2. from weaker to the stronger parts of the field
3. perpendicular to the field
4. in none of the above directions

[repeal]

QUESTION

According to Curies law, the magnetic susceptibility of a substance at an absolute temperature T is proportional to [2003]

1. $1/T$
2. T
3. $1/T^2$
4. T^2

QUESTION

Among which the magnetic susceptibility does not depend on the temperature?

(2001)

1. Diamagnetism
2. Paramagnetism
3. Ferromagnetism
4. Ferrite.

QUESTION

Soft Iron

Electromagnets are made of soft iron because soft iron has (2010)

1. low retentivity and high coercive force ✗
2. high retentivity and high coercive force ✗
3. low retentivity and low coercive force ✓
4. high retentivity and low coercive force ✗

Ans (C)


THANK YOU
earth magnetism
is Not is syllabus

YAKEEN 2.0

FOR NEET 2025

Lecture- 01 | **Physics**

ELECTROMAGNETIC INDUCTION

By- Dr. Manish Raj (MR SIR)



Topics to be covered

1. # Magnetic flux
2. # Lentz law
3. #



Superconductor

- → Zero resistance
- → Ideal dia-magnetic
- → $\mu_r = 0 = \mu_m$
- → $\mu_r = 1 + \chi$

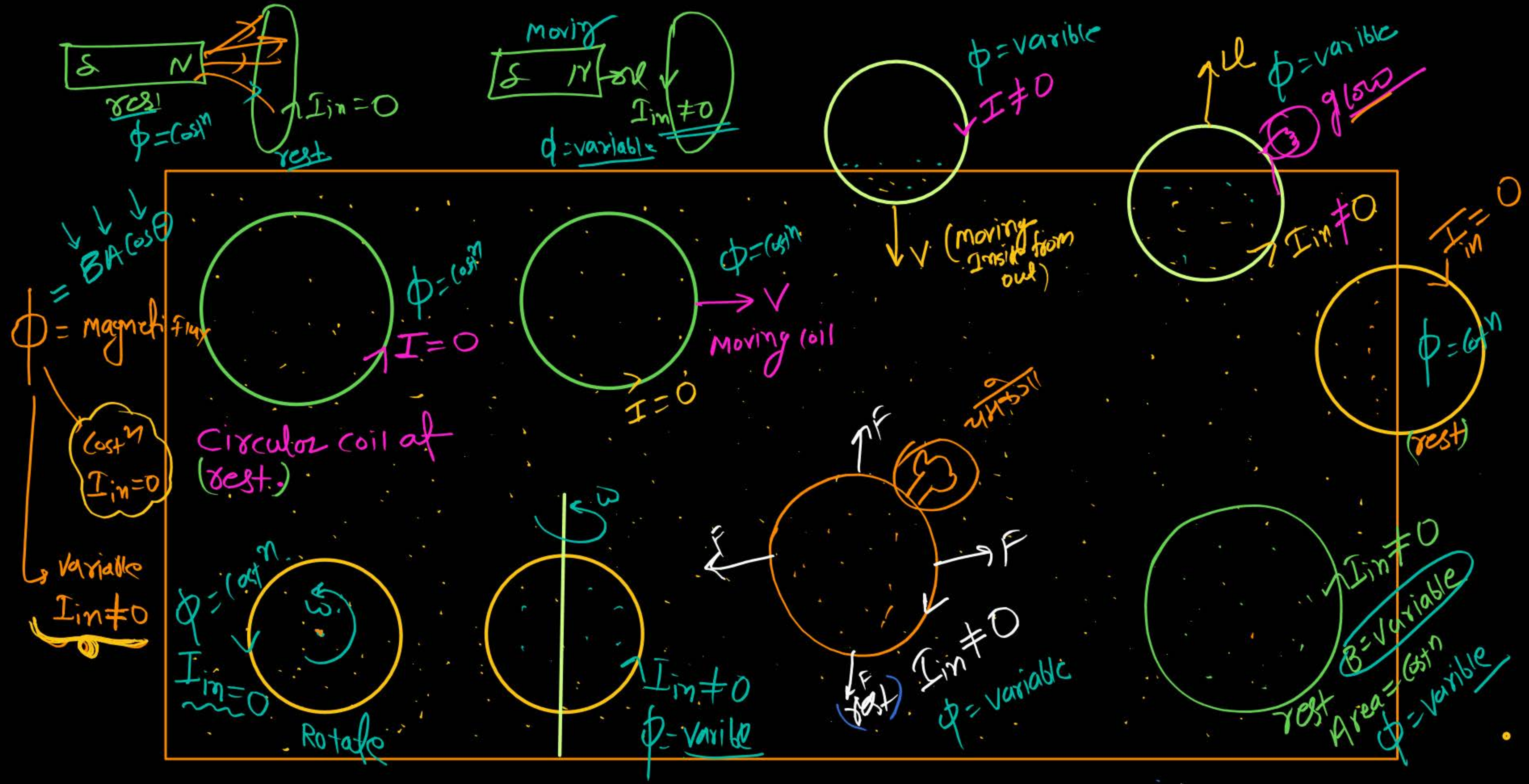
$\chi = -1$

$B_{\text{inside superconductor}} = 0$

$\mu_m = \mu_r \times \mu_0 = 0$



$$B = \frac{\mu_0 I r}{2\pi R^2}$$


S N
rest
φ = Const^n
I_in = 0
rest
Moving
S N
I_in ≠ 0
φ = variable
φ = varible
I ≠ 0
V (moving Inside from out)
u
φ = varible
glow
I_in ≠ 0
I_in = 0
φ = Const^n
(rest)
φ = BA cos θ
φ = magnetic flux
Const^n
I_in = 0
variable
I_in ≠ 0
φ = Const^n
I = 0
φ = Const^n
V
Moving coil
I = 0
circular coil at (rest.)
F
F
F
F
I_in ≠ 0
φ = variable
rest
ω
φ = Const^n
ω
I_in = 0
Rotate
I_in ≠ 0
φ = varible
I_in ≠ 0
B = Variable
rest
Area = Const^n
φ = varible

Magnetic Flux

$\phi = \vec{B} \cdot \vec{A}$

$\phi = BA\cos\theta$ ← θ = Angle B/w $\vec{B}$ & $\vec{A}$

- → scalar
- → Unit (Tesla-m^2) = 1 weber
- → (Gauss · cm^2) = 1 maxwell

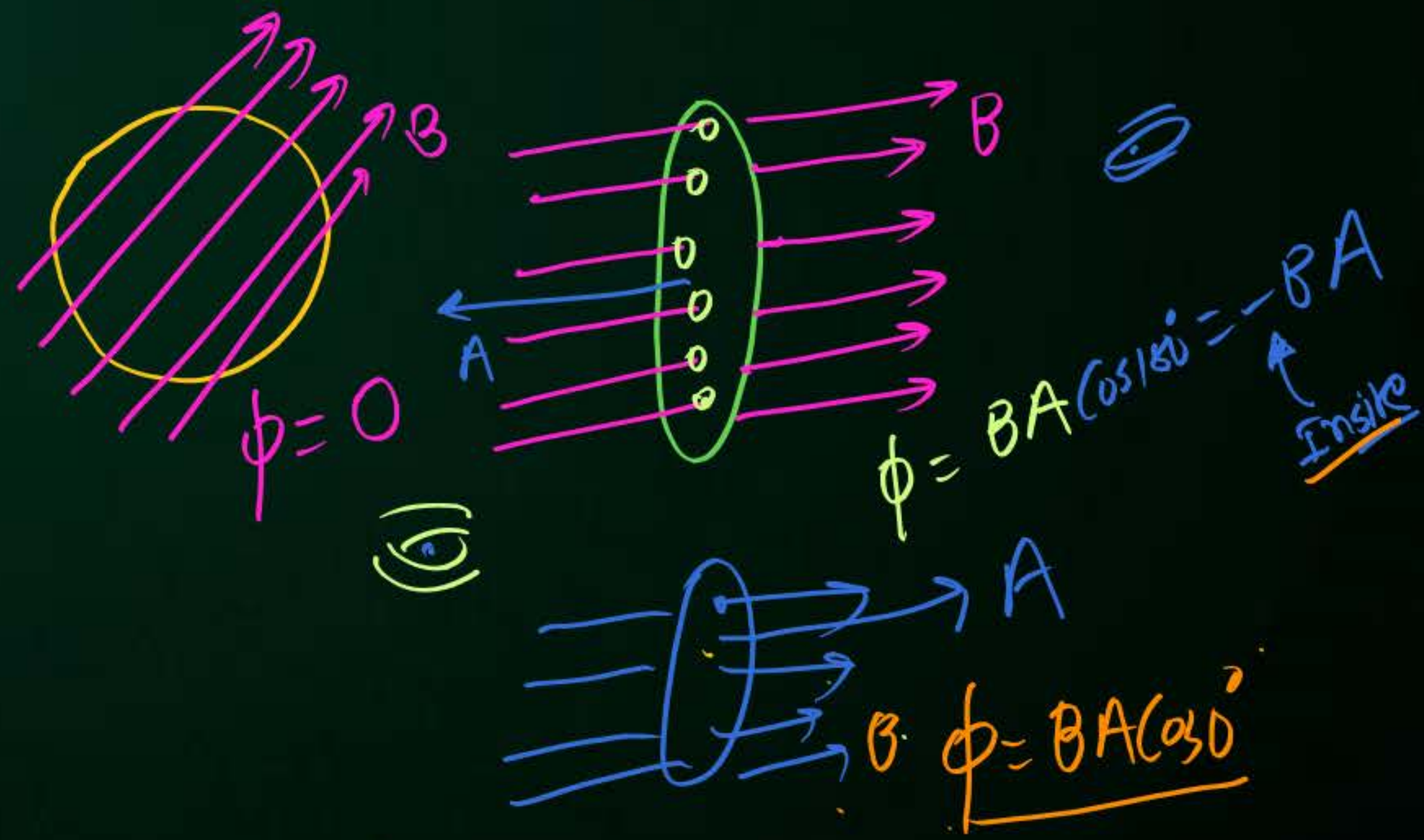
☆

$1\ \text{Tesla} = 10^4\ \text{Gauss}$

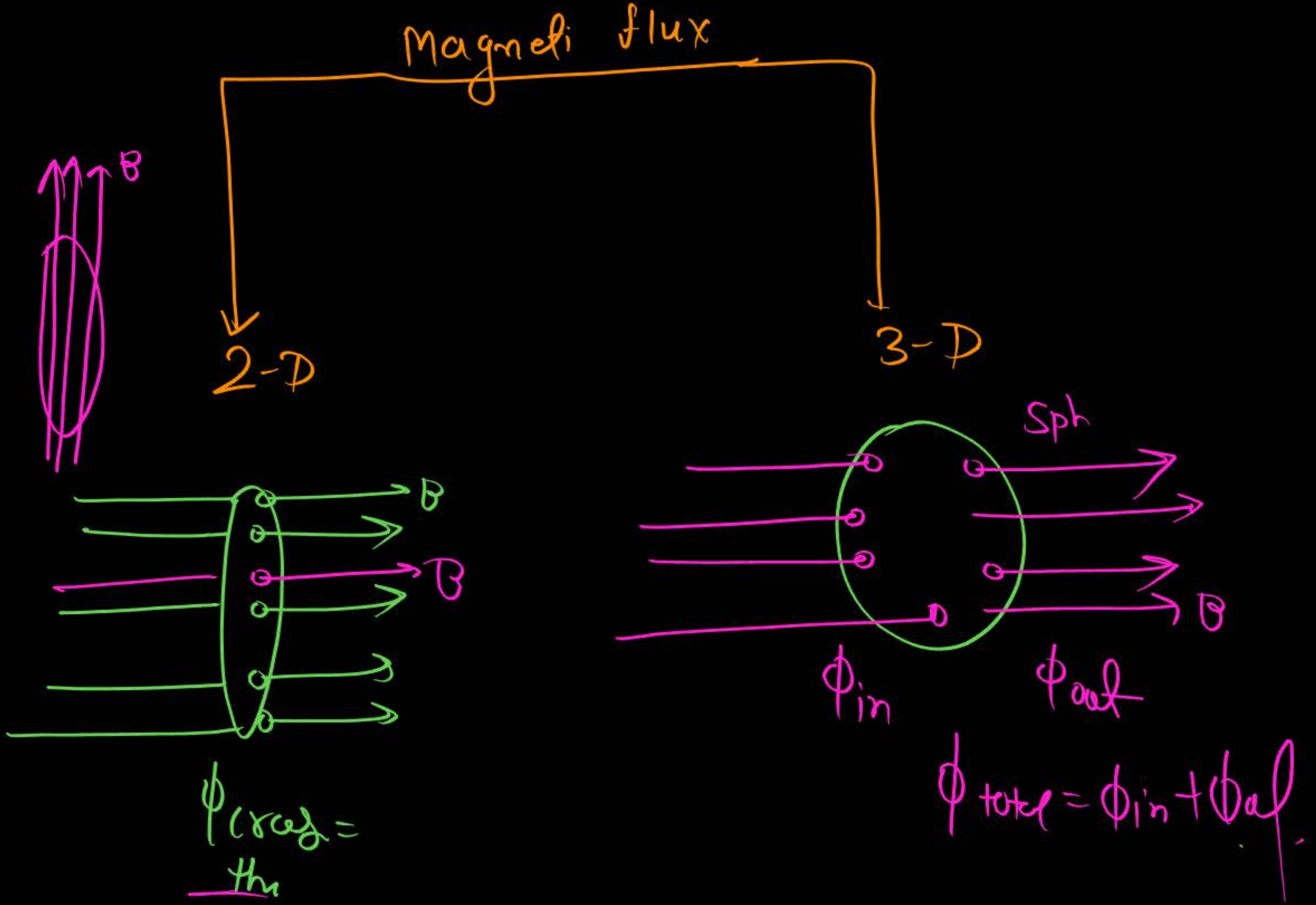
$1\ m^2 = 10^4\ cm^2$

$1\ \text{weber} = 10^8\ \text{maxwell}$

* Magnetic flux — Counting of Magnetic field lines passing through a given cross-section Area.



- SI unit of magnetic flux is weber (Wb). 1Wb = 1 tesla-m^2
- C.G.S. unit of magnetic flux is maxwell (1 maxwell = 1 gauss cm^2)
- 1 weber = 10^8 maxwell (How ? Do it yourself)
- Magnetic flux (like electric flux) is a scalar quantity
- Magnetic flux can also be calculated by integration method $\phi_B = \int d\phi_B = \int \vec{B} \cdot \overrightarrow{dA}$
- The dimensional formula of magnetic flux is $[ML^2 T^{-2} A^{-1}]$



Magneti flux
2-D
3-D
B
Sph
φin
φout
φ total = φin + φout

QUESTION

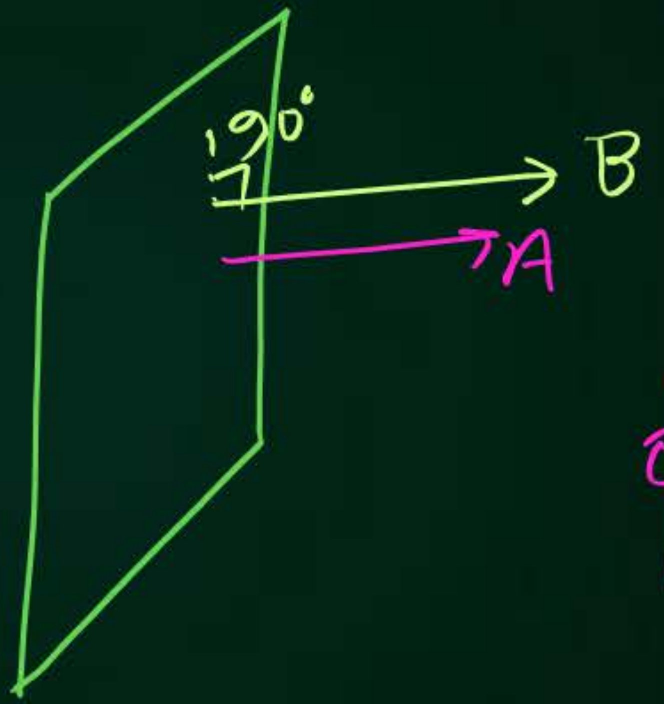
A rectangular loop of area 0.1 square meter is placed in a magnetic field 2T with its plane perpendicular to field direction. Find the flux linked with the plane of loop.

(a) zero (50%)

(b) 0.2 (40%)

(c) 0.02

(d) dont know



$\phi = BA\cos 0°$

$= 2T \times \frac{1}{10} \times 1$

$= 0.2$ Wb

QUESTION

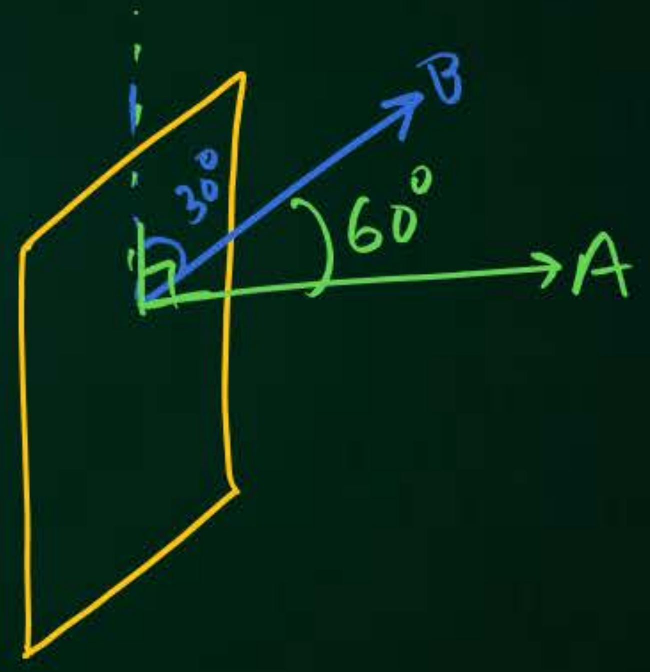
A circular surface of radius 2 m is placed in uniform magnet field of intensity 5 T in such a way that its plane makes an angle of 30° with the field lines, then what will be flux passing through the given surface area ??

$$\phi = BA\cos\theta$$

$$= 5 \times \pi (2)^2 \times \cos 60^\circ$$

$$= 5 \times \pi \times 4 \times \frac{1}{2}$$

$$= 10\pi$$



QUESTION

$\vec{B} = 2\hat{\imath} + 3\hat{\jmath}$ A surface of area 2m^2 is placed in xy plane than what will be flux passing through it

$B = 2\hat{i} + 3\hat{j}$

$\rightarrow A = 2\hat{k}$

$\phi = B \cdot A$

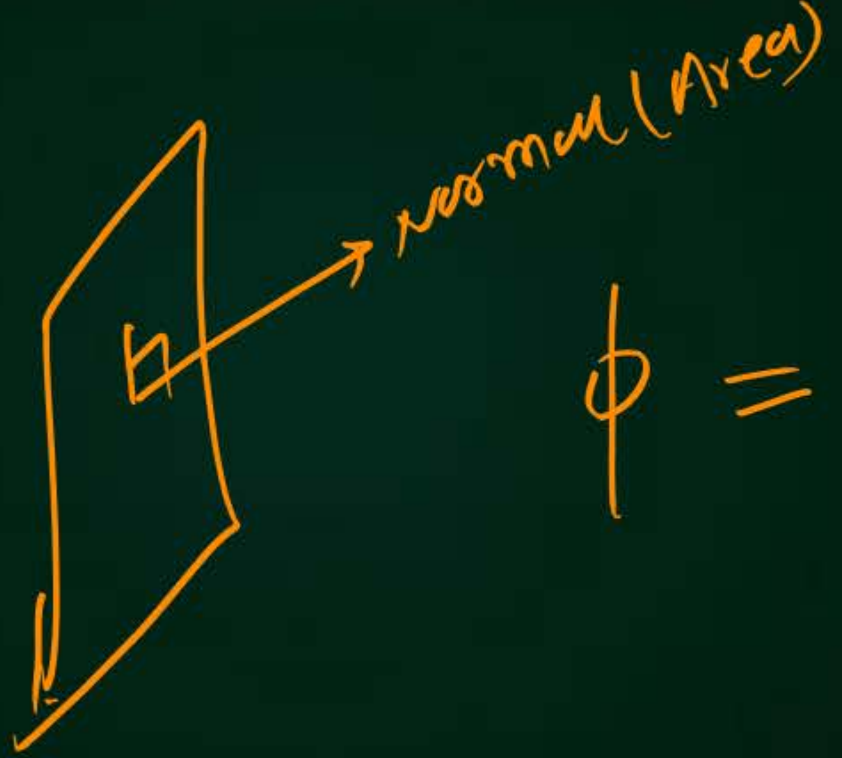
$= (2\hat{i} + 3\hat{j}) \cdot (2\hat{k})$

$=$ zero

QUESTION

A coil of 100 turns and area 5 square centimeter is placed in a magnetic field $B = 0.2$ T. The normal to the plane of the coil makes an angle of 60° with the direction of the magnetic field. The magnetic flux linked with the coil is **[MP PMT 1997]**

1. 5×10^{-3} Wb
2. 5×10^{-5} Wb
3. 10^{-2} Wb
4. 10^{-4} Wb



QUESTION

A uniform magnetic field exist in the space $\vec{B} = B_1\hat{\imath} + B_2\hat{\jmath} - B_3\hat{k}$. Find the magnetic flux through an area S if the area $\vec{S}$ is in

(i) x - y plane (ii) $y - z$ plane (iii) z - x plane

$\vec{S} = S\hat{k}$

$\phi = -SB_3$

$\vec{S} = S\hat{i}$

$\phi = B_1 S$

$\vec{S} = S\hat{j}$

$\phi = B_2 S$

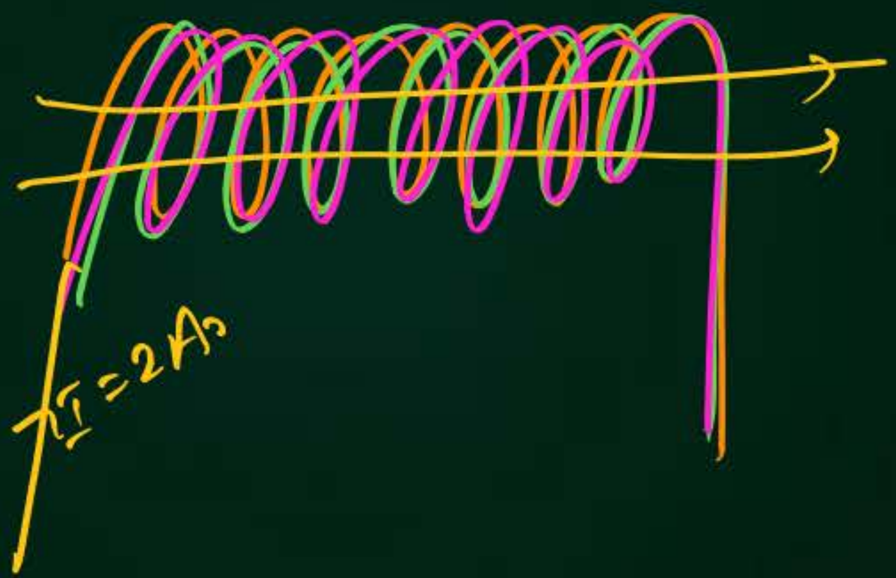
QUESTION

A solenoid is 1.5 m long and its inner diameter is 4.0 cm. It has three layers of windings of 1000 turns each and carries a current of 2.0 amperes. The magnetic flux for a cross-section of the solenoid is nearly. **[AMU 1995]**

$R = 2\,cm = 2 \times 10^{-2}\,m$ $\quad n = \frac{N}{L}$

$N = 3000$

1. 2.5×10^{-7} weber
2. 6.31×10^{-6} weber
3. 5.2×10^{-5} weber
4. 4.1×10^{-5} weber



$\phi = B \cdot Area \times N$

$= \left[\mu_0 \frac{N}{L} I\right] \pi (2 \times 10^{-2})^2 \times N$

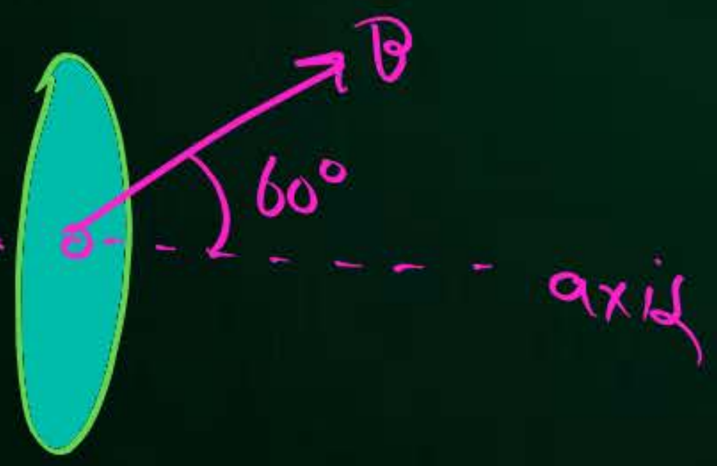
$= \frac{\mu_0 N^2}{L} I \pi\, 4 \times 10^{-4}$

$\mu_0 = 4\pi \times 10^{-7}$ H/m, Wb

QUESTION

A circular disc of radius 0.2 meter is placed in a uniform magnetic field of $1/\pi$ wb/m^2 in such way that its axis makes an angle of 60° with $\vec{B}$. The magnetic flux linked with the disc is:-

1. 0.08 wb
2. 0.01 wb
3. 0.02 wb
4. 0.06 wb



QUESTION

A square loop of side 1 m and resistance 1 Ω is placed in a magnetic field of 0.5 T. If the plane of loop is perpendicular to the direction of magnetic field, the magnetic flux through the loop is: [NEET 2022]

1. 0.5 weber
2. 1 weber
3. Zero weber
4. 2 weber

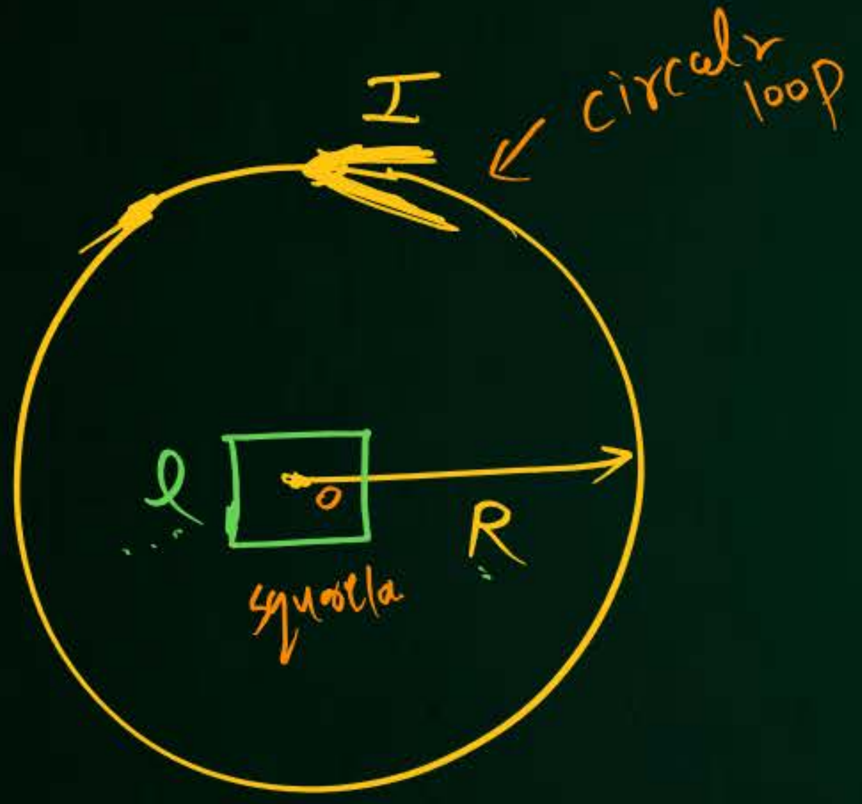
$\phi = (1)^2 \times \frac{5}{10} \times \cos 0^\circ$

$= \frac{5}{10} = 0.5\,W$

done

QUESTION

Find flux passing through square loop. $(R >> l)$



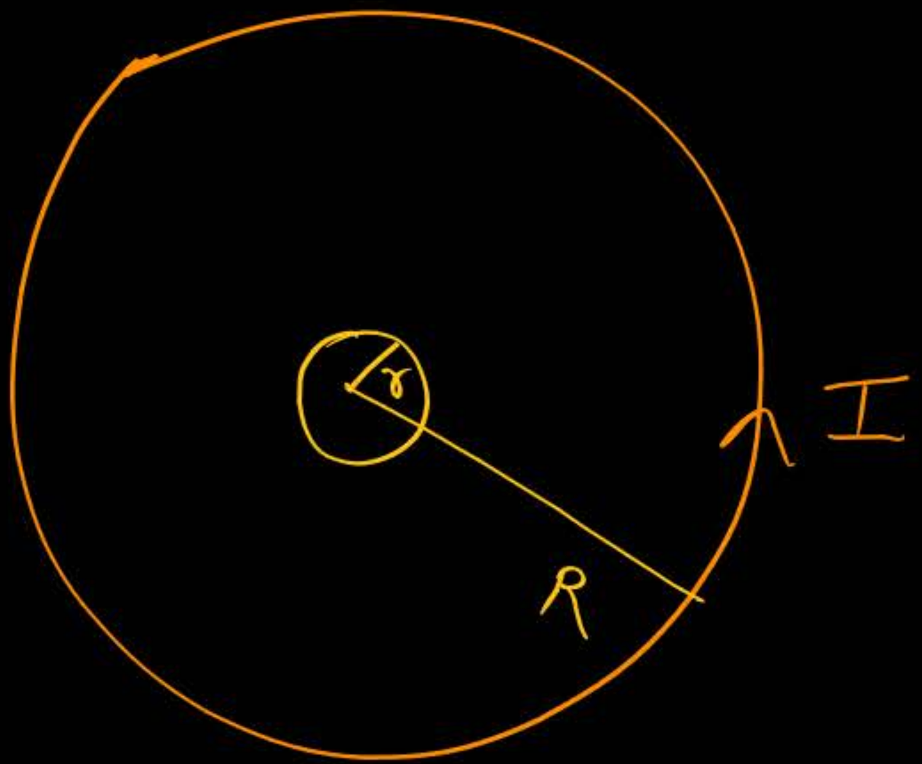
$$\phi = BA\cos\theta$$

$$= \left(\frac{\mu_0 I}{2R}\right) \times l^2 \cos 0^\circ$$

$$= \frac{\mu_0 I}{2R} l^2$$

$200 \times (0.000001) = 200$

~~Biology~~

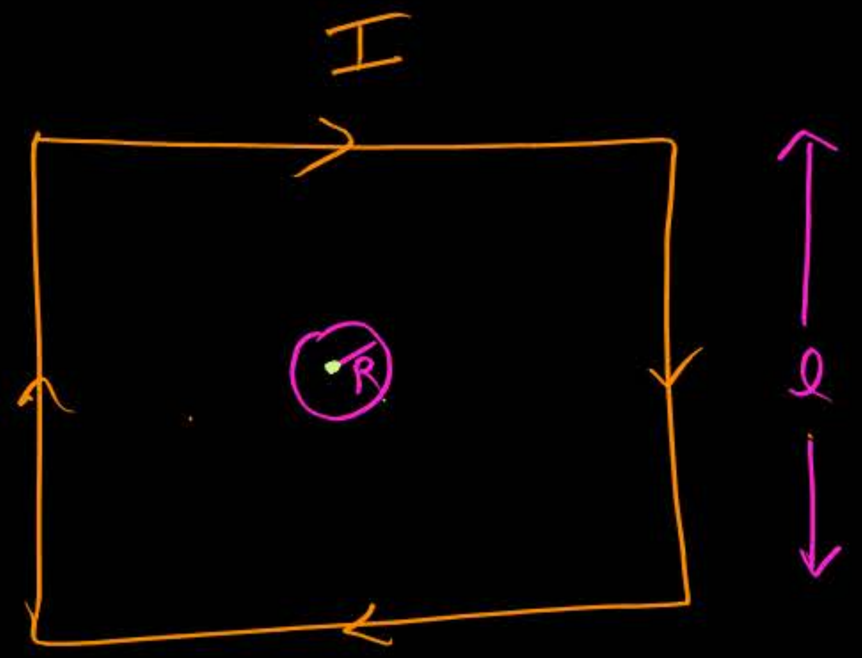


NEET-2022

find flux through circular wire $(r \lll R)$

$$= \left(\frac{\mu_0 I}{2R}\right) \times \pi r^2 \cos 0^\circ = \frac{\mu_0 I}{2R} \pi r^2$$

$$\phi \propto \frac{r^2}{R}$$



If $R << l$ then find flux through circular loop.

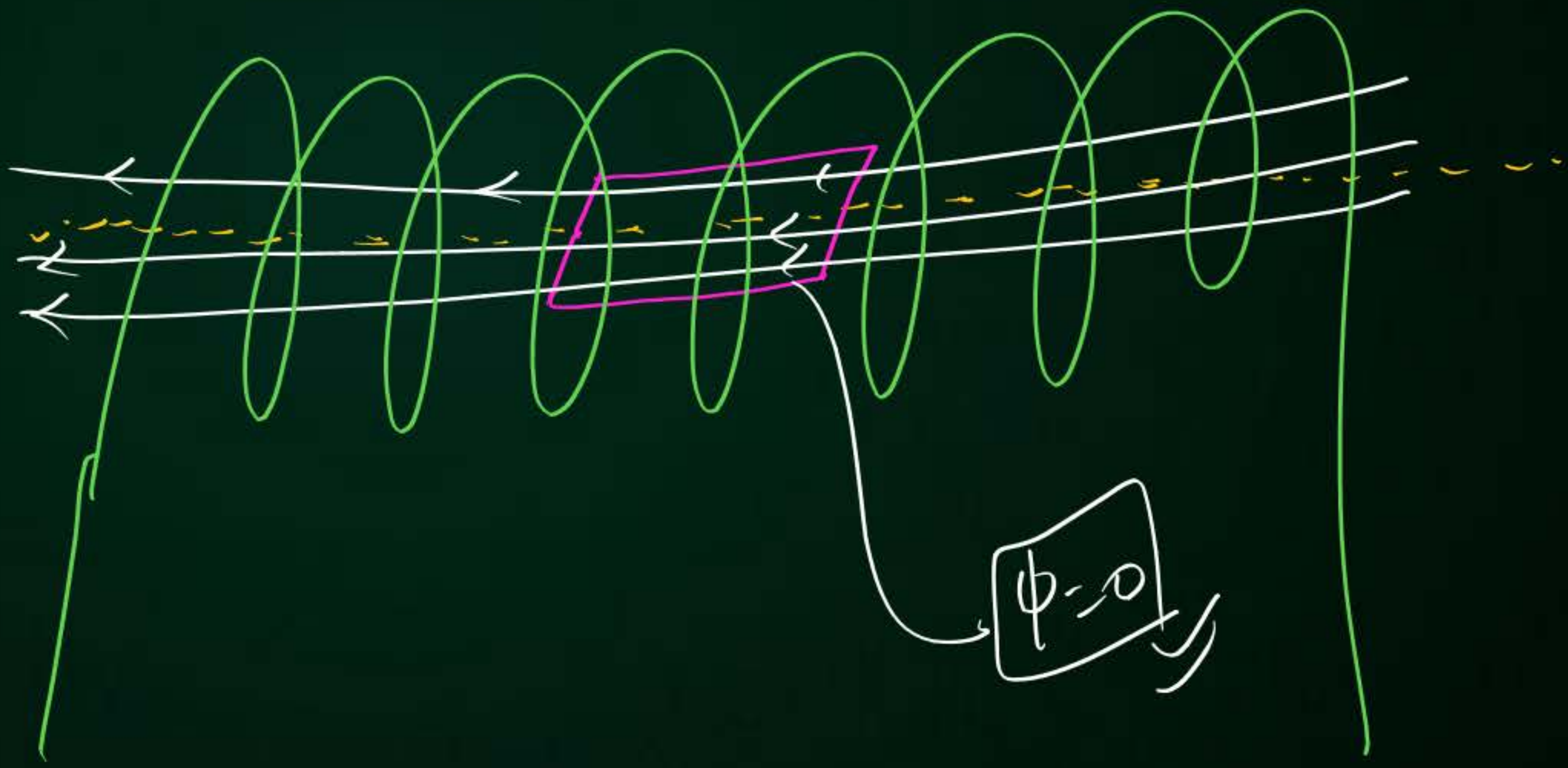
$$\phi = BA = \frac{2\sqrt{2}\mu_0 I}{\pi l} \times \pi R^2$$

$$= \frac{2\sqrt{2}\mu_0 I R^2}{l}$$

QUESTION

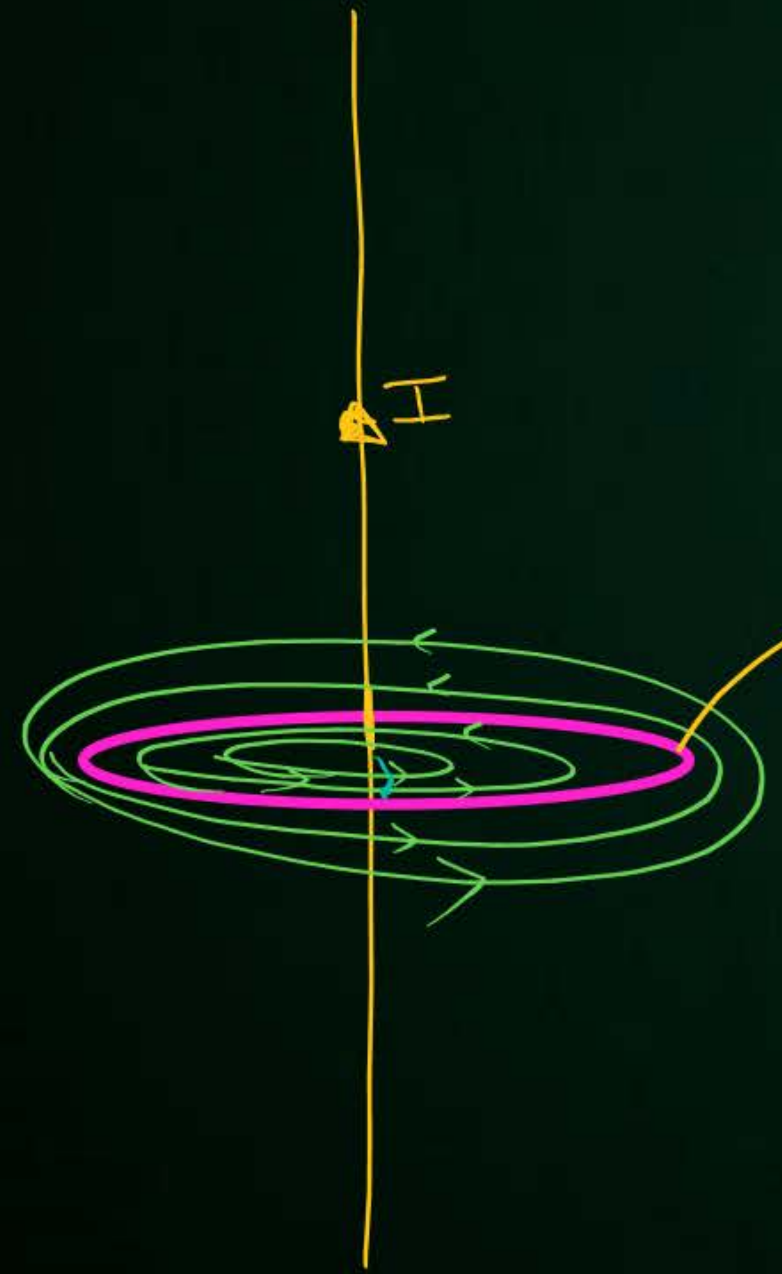
Square loop is placed at centre of solenoid such that plane of loop is parallel to the axis of solenoid? then find Flux through square loop.

Ans $\phi = \text{zero}$

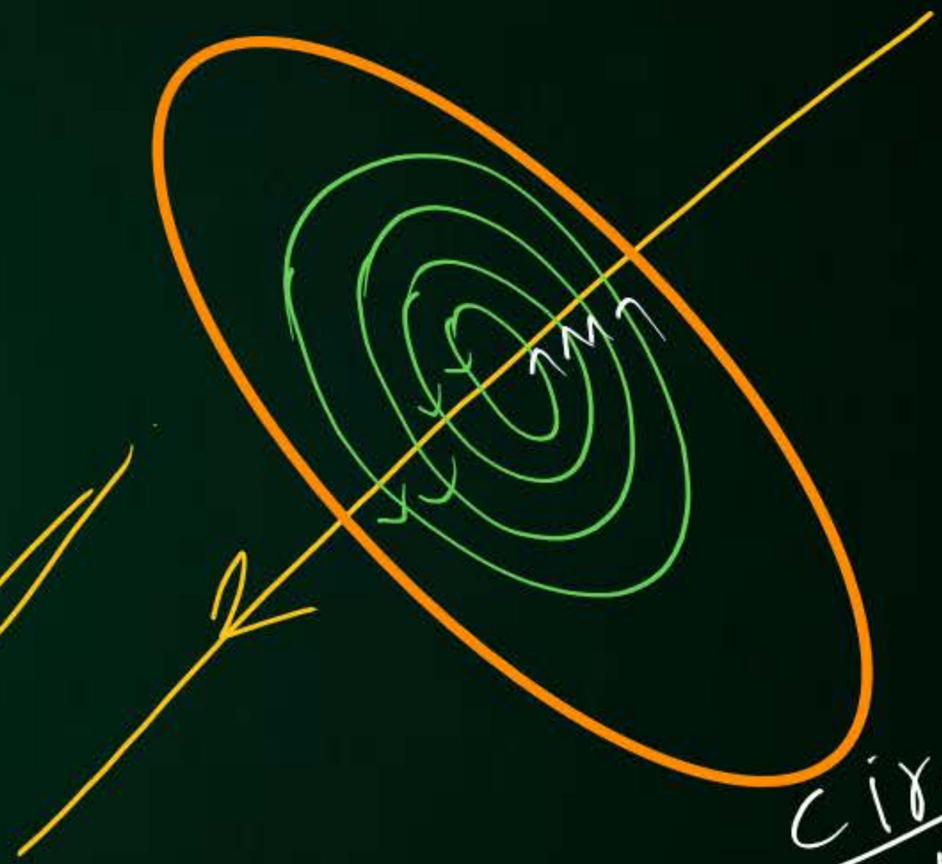


QUESTION

A circular loop is placed perpendicular to the straight current carrying wire then find flux passing through loop.

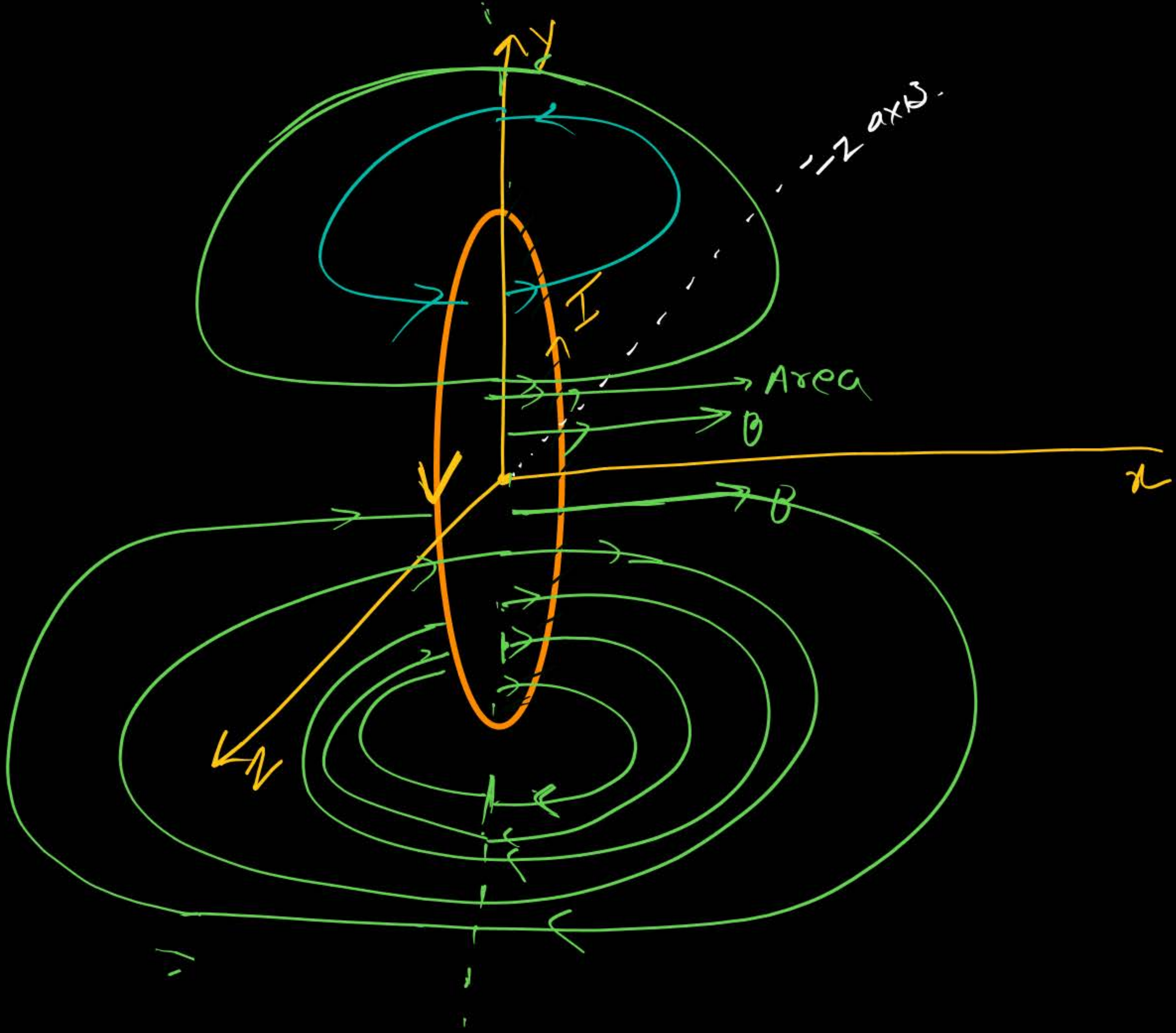


$\phi_{circl\ loop} = 0$ ✓



circl loop

$\phi = 0$



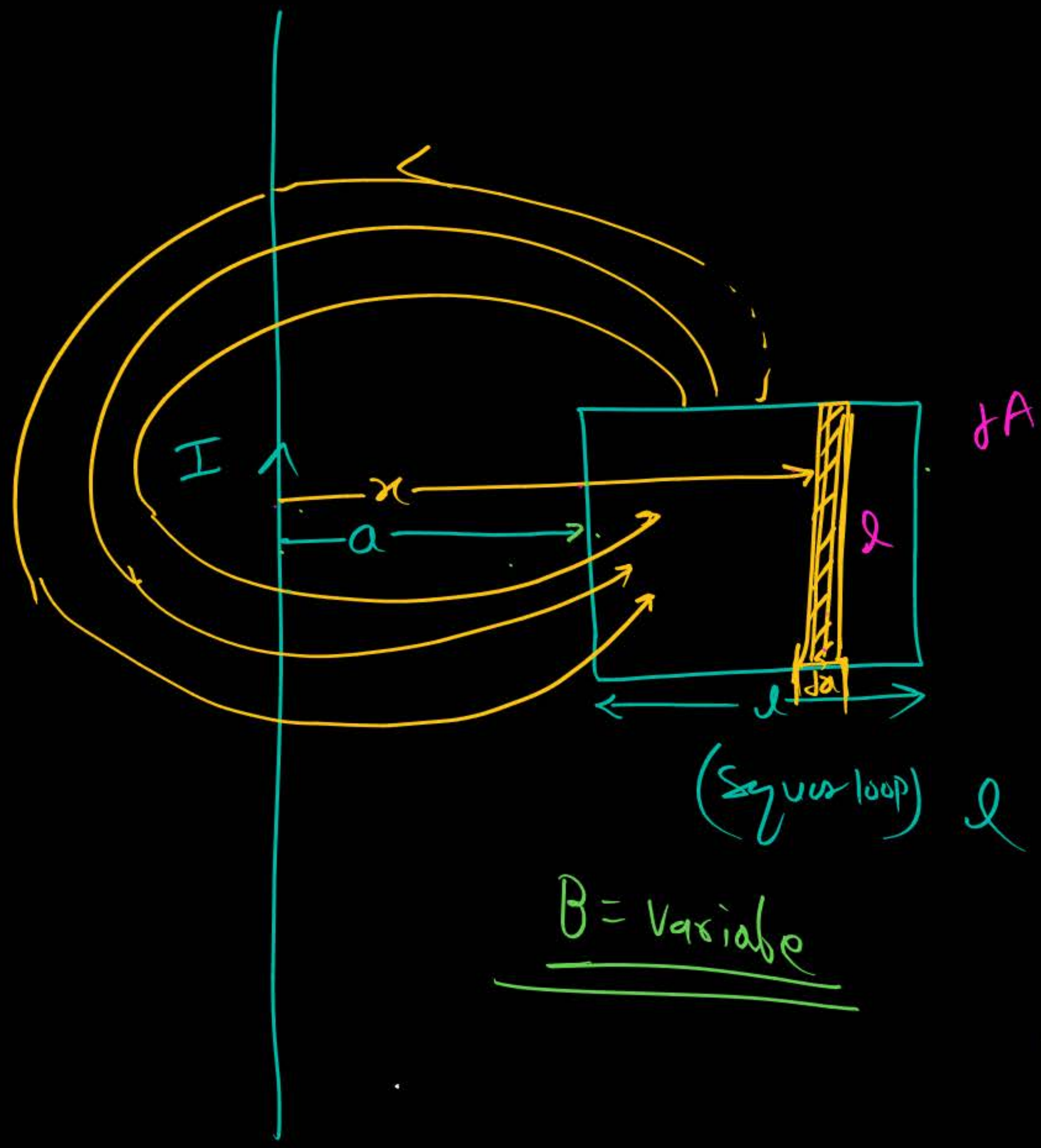
Find flux Passing throug compt y-z -plane

Area $\vec{x}$

(a) 86%

(b) (14%)

find flux passing through squar loop.



$dA = l\,dx$

B = variable

$$d\phi = B_x\,dA$$

$$d\phi = \frac{\mu_0 I}{2\pi x} \times l\,dx$$

$$\int d\phi = \frac{\mu_0 I l}{2\pi} \int_a^{a+l} \frac{1}{x}\,dx$$

$$= \frac{\mu_0 I l}{2\pi} \log\left(x\right)_a^{(a+l)}$$

$$\phi = \frac{\mu_0 I l}{2\pi} \log\left(\frac{a+l}{a}\right)$$

Yakeen Izzat

Lentz Law

Magnetic field, Area, Angle

$$\phi_{loop} = B A \cos\theta$$

ϕ = Con^n

$I_{induce} = 0$

ϕ = change

$I_{induce} \neq 0$

I → magnitude, farays law

I (dir^n) — Lent Law

ϕ ↳ Area

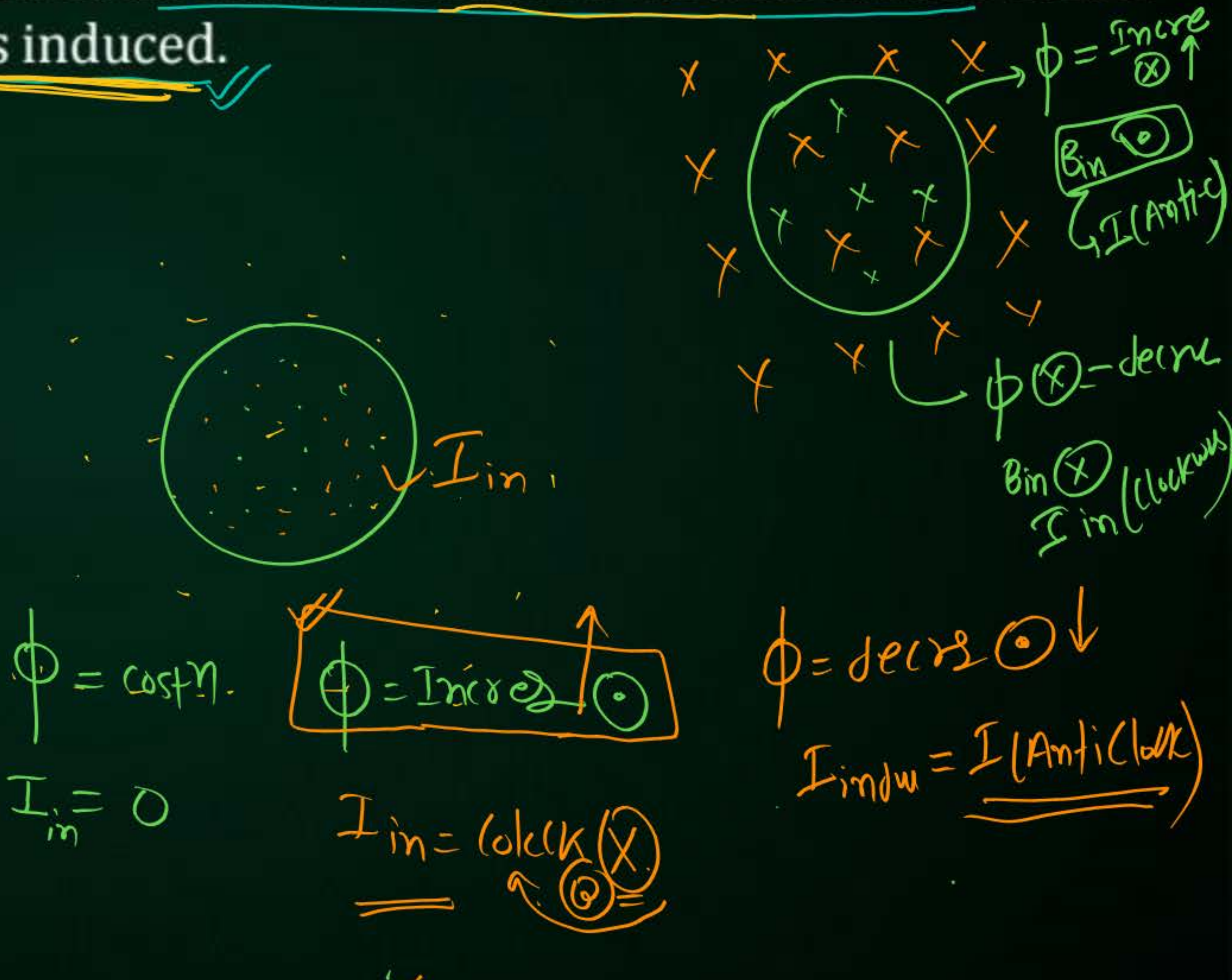
2-D

3-D

1-D

Lentz Law

When flux is variable through any loop then direction of induced current is such that it will oppose then cause due to which it is induced.



MR Law

Coil [redacted] Flux ke inertia mai hota hai flux change, then coil will oppose the change, by induced current

MR*

$\phi = \odot \uparrow$ → B in ⊗ (clock-wise current)

$\phi = \odot \downarrow$ → B in ⊙ → Anti-clock current

$\phi = \otimes \uparrow$ → B in ⊙ → Antic curr

$\phi = B\otimes \downarrow$ → B in ⊗ → clock wise current induced

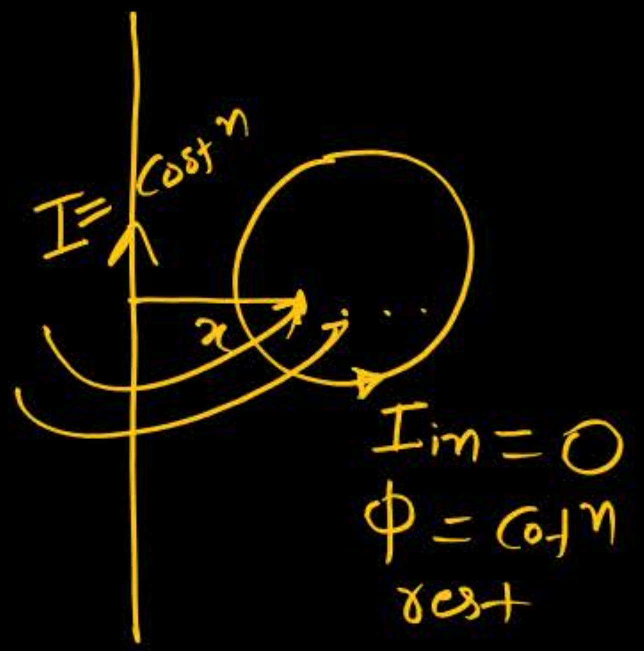
B ⊙ (Anti-clw)

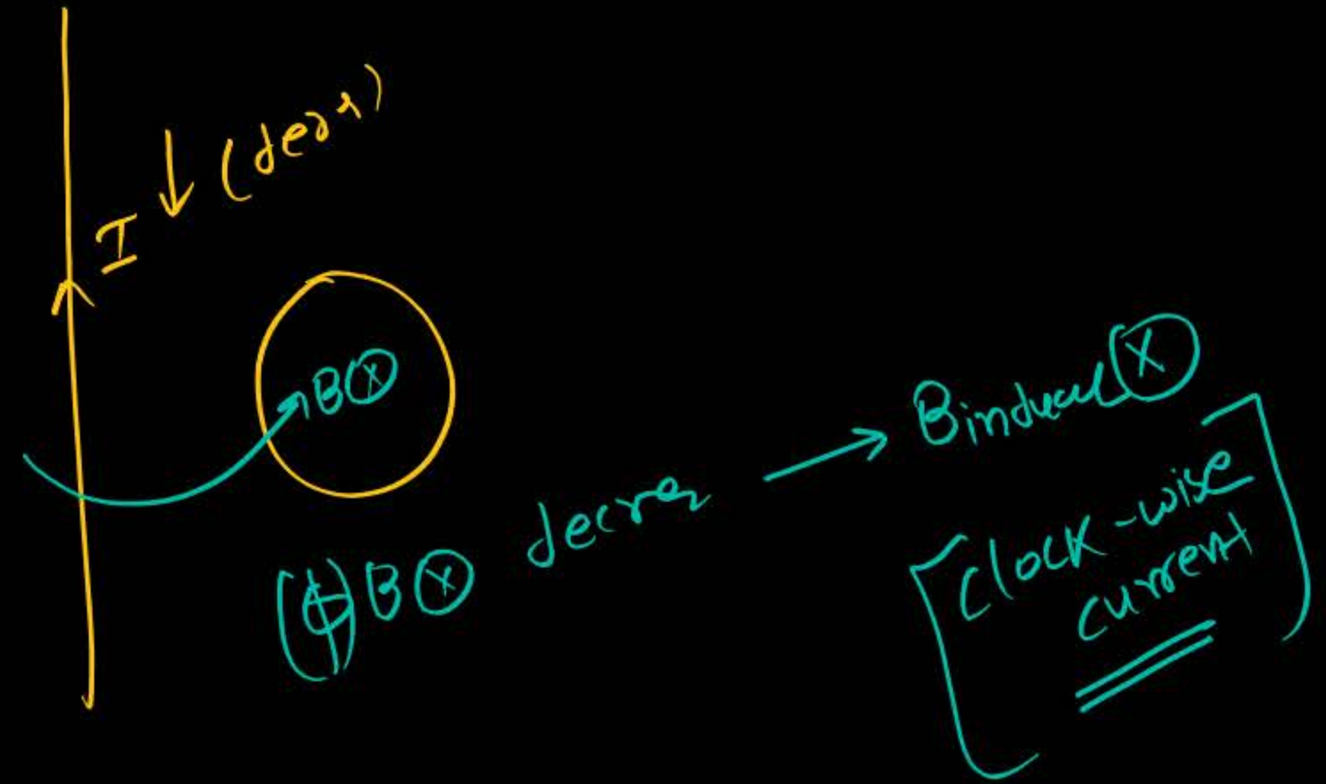
B ⊗ → clock wise

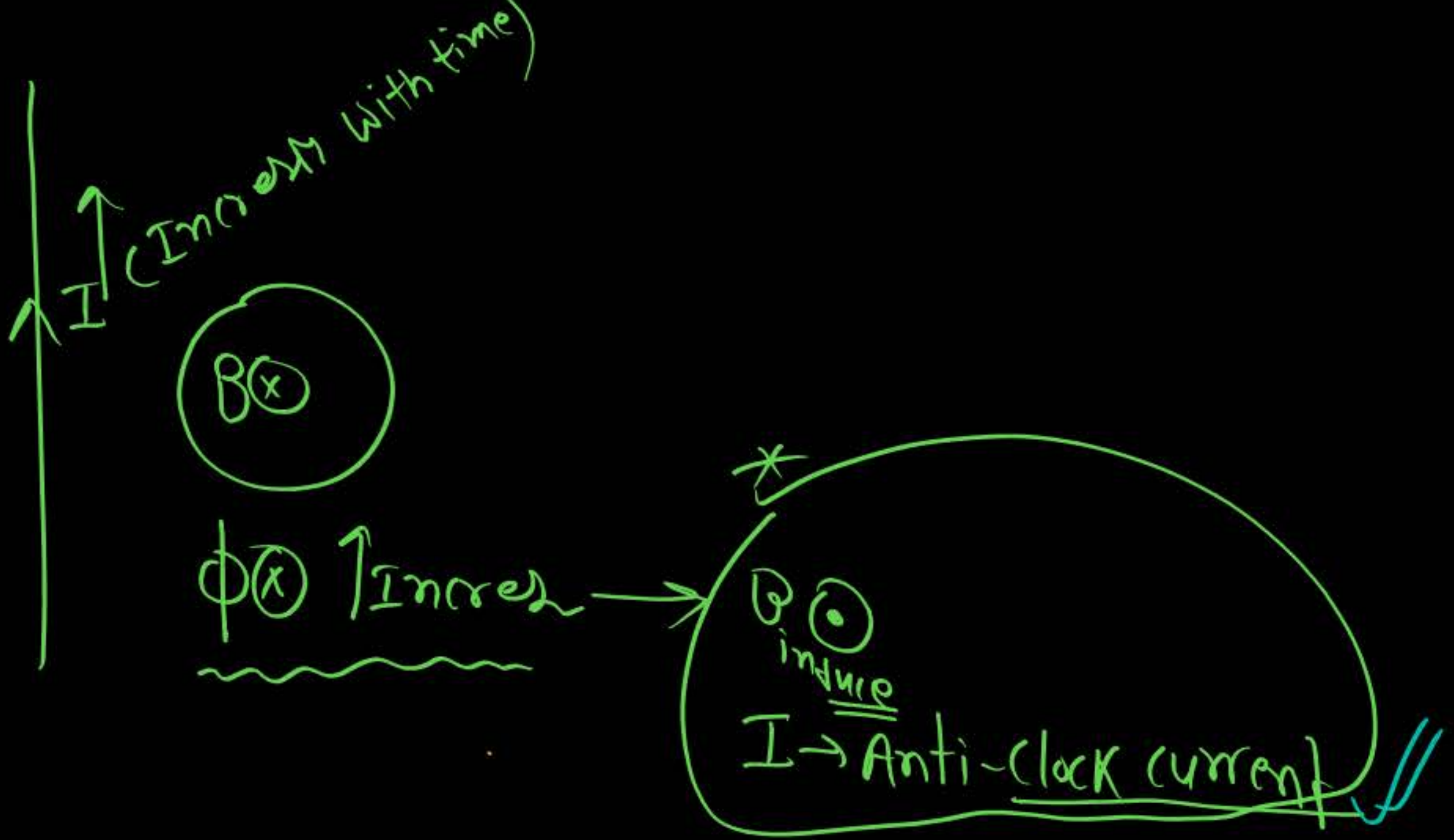
QUESTION

Lenz's law gives [MP PMT 1994]

1. The magnitude of the induced e.m.f.
2. The direction of the induced current
3. Both the magnitude and direction of the induced current
4. The magnitude of the induced current

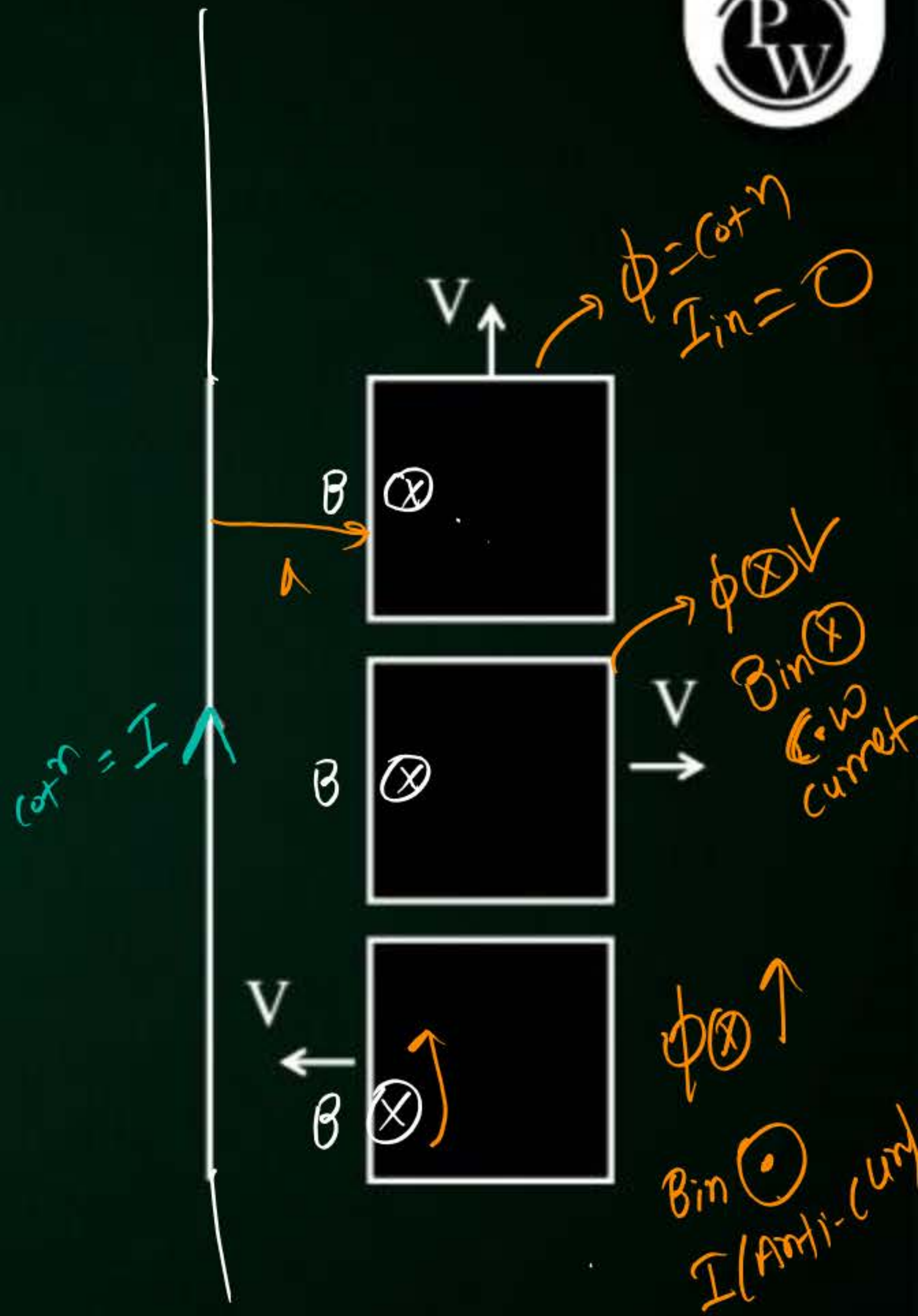

I = cost n
x
Iin = 0
φ = cost n
rest


I ↓ (decr)
B⊗
Binduced ⊗
(φ) B⊗ decre
clock-wise current


I ↑ (Increasing with time)
B⊗
φ⊗ ↑ Increase
B⊙ induce
I → Anti-clock current

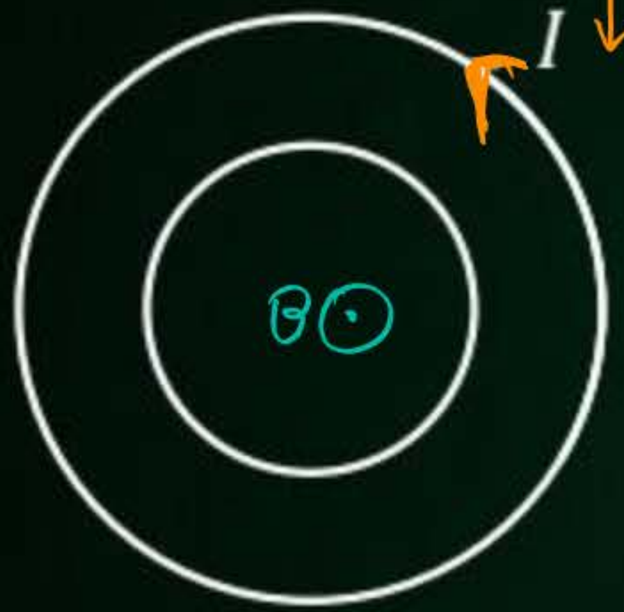
QUESTION

Find induced e.m.f.



QUESTION

Find direction of induced current in a inner loop?



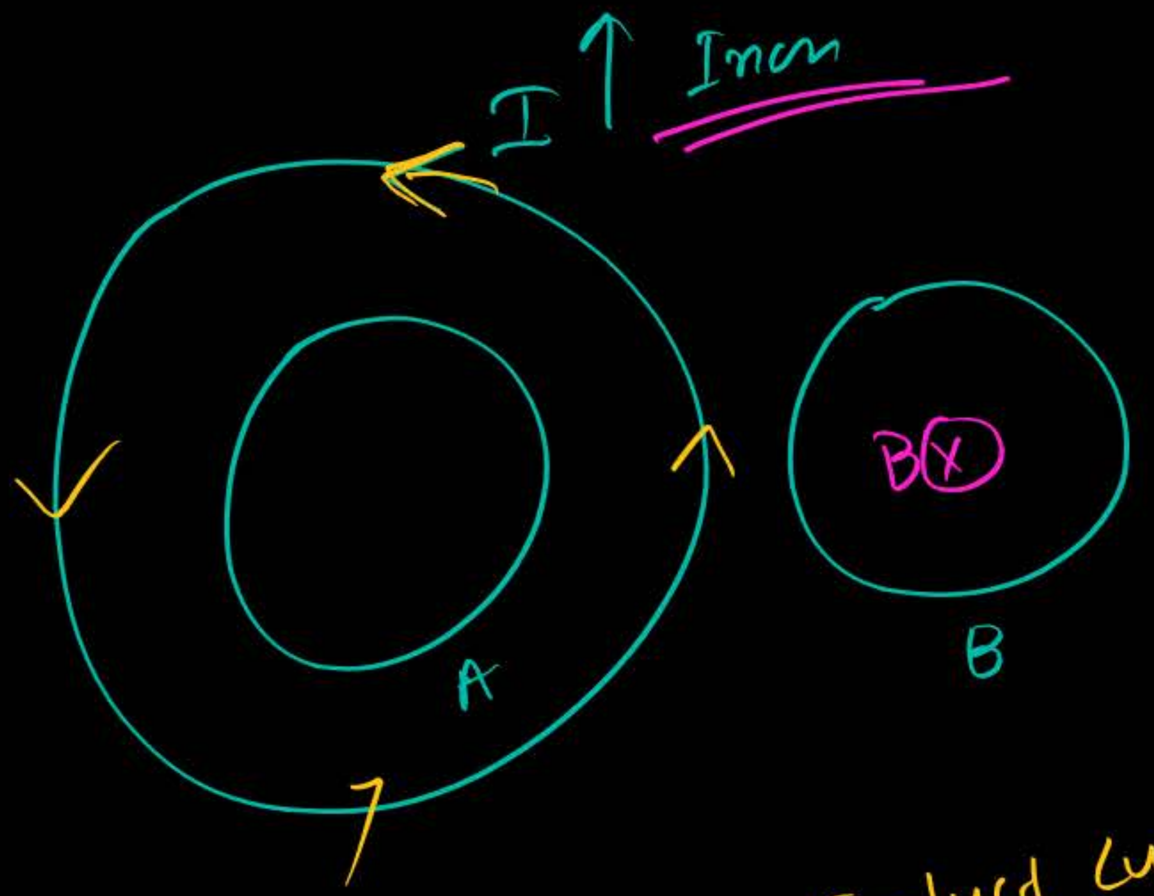
Sol^n

B → ⊙ ↓

B in ⊙

↳ Anti-current Ind^n

#



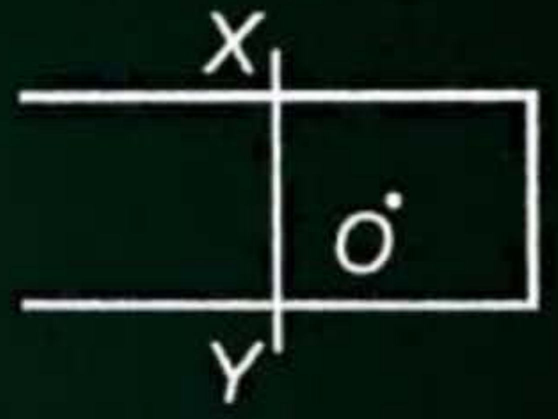
Induced current in loop A, B

\# A → Clock-wise

B → Anti-clock-wise

QUESTION

When a conducting wire XY is moved towards the right, a current flows in the anti-clockwise direction. Direction of magnetic field at point O is



1. Parallel to motion of wire
2. Along XY
3. Perpendicular outside the paper
4. Perpendicular inside the paper

QUESTION

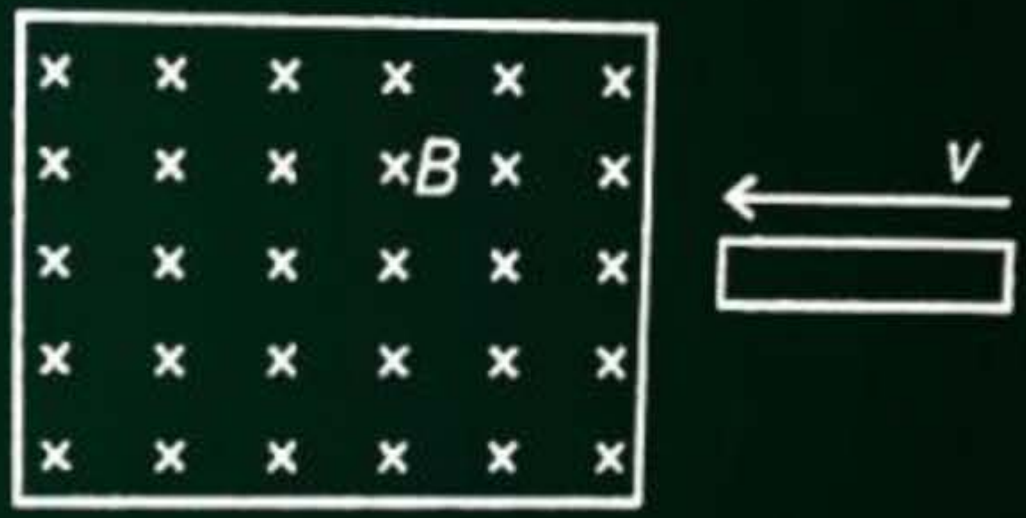
A loop of irregular shape of conducting wire PQRS (as shown in figure) placed in a uniform magnetic field perpendicular to the plane of the paper changes into a circular shape. The direction of induced current will be



1. Clockwise
2. Anti-clockwise
3. No current
4. None of these

QUESTION

A small rectangular loop is moving towards left with constant velocity through a uniform B field, as shown. Counting of time t begins the moment the loop starts entering the field. Plot the variation of flux through the loop with respect to time. Also plot the variation of induced emf w.r.t. time t.



QUESTION

Find direction of induced current in loop 1 and 2 and find direction of current in AB



QUESTION

Lenz's law is consequence of the law of conservation of

[JIPMER 1997; CPMT 1990; RPMT 1997; MP PET 1999; MP PMT 2000, 03; RPET 2003; AFMC; AFMC 2004]

1. Charge
2. Momentum
3. Mass
4. Energy


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 02 | Physics

ELECTROMAGNETIC INDUCTION



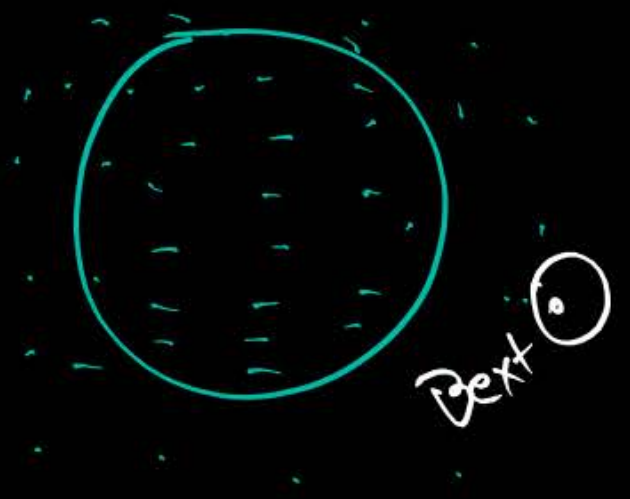
By- Dr. Manish Raj (MR SIR)

Topics to be covered

1. # Questions on Lentz law
2. # farads law of E.M.I
3. #



MR* Law → * for Induced current



Coil → kya magnetic flux ko pyar karta hai??

Kya Nafrat karta hai → NO → NO

→ Coil ko Magnetic flux ke change se nafrat hai

B ⊙ ↓ decr

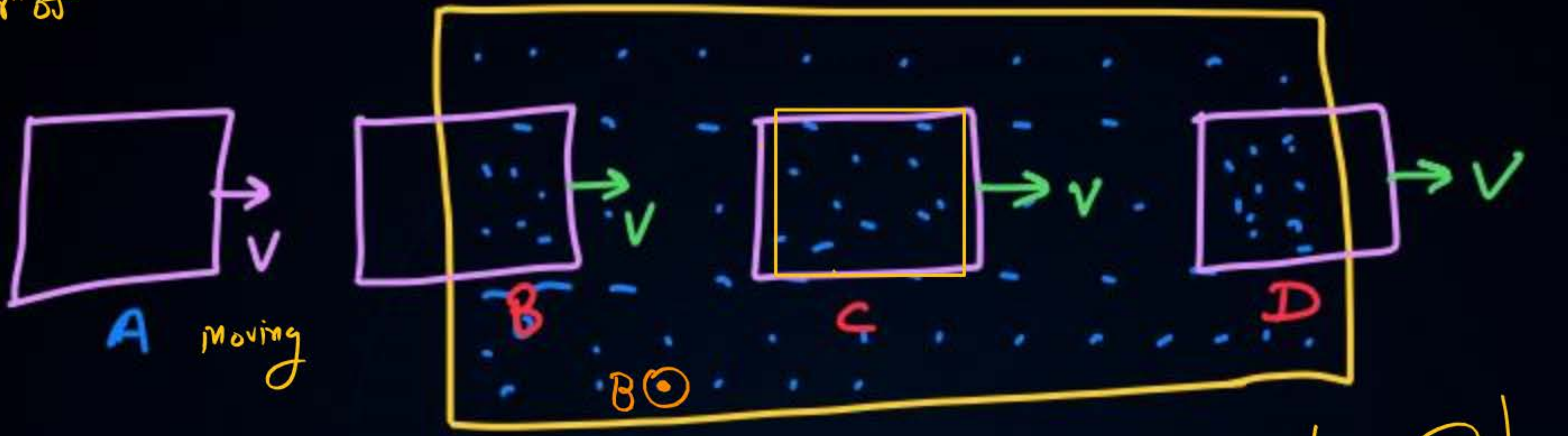
Bin ⊙ → Anti-clock Curr Indu.

B ⊙ → Incr

B ⊗ indun → Clockwise current Induced

- B ⊙ ↑ → B ⊗ Indu → clock wise
- B ⊙ ↓ → B ⊙ Indus Anti c.w
- B ⊗ ↑ → B ⊙ Indu → Anti c.w
- B ⊗ ↓ → B ⊗ Indu → clock w

find dir^n of Induced current in the square loop A, B, C, D



$\phi_A = const^n$

$I_A = 0$

$\phi_B = \odot \uparrow$

B ⊗ Induced

Clockwise.

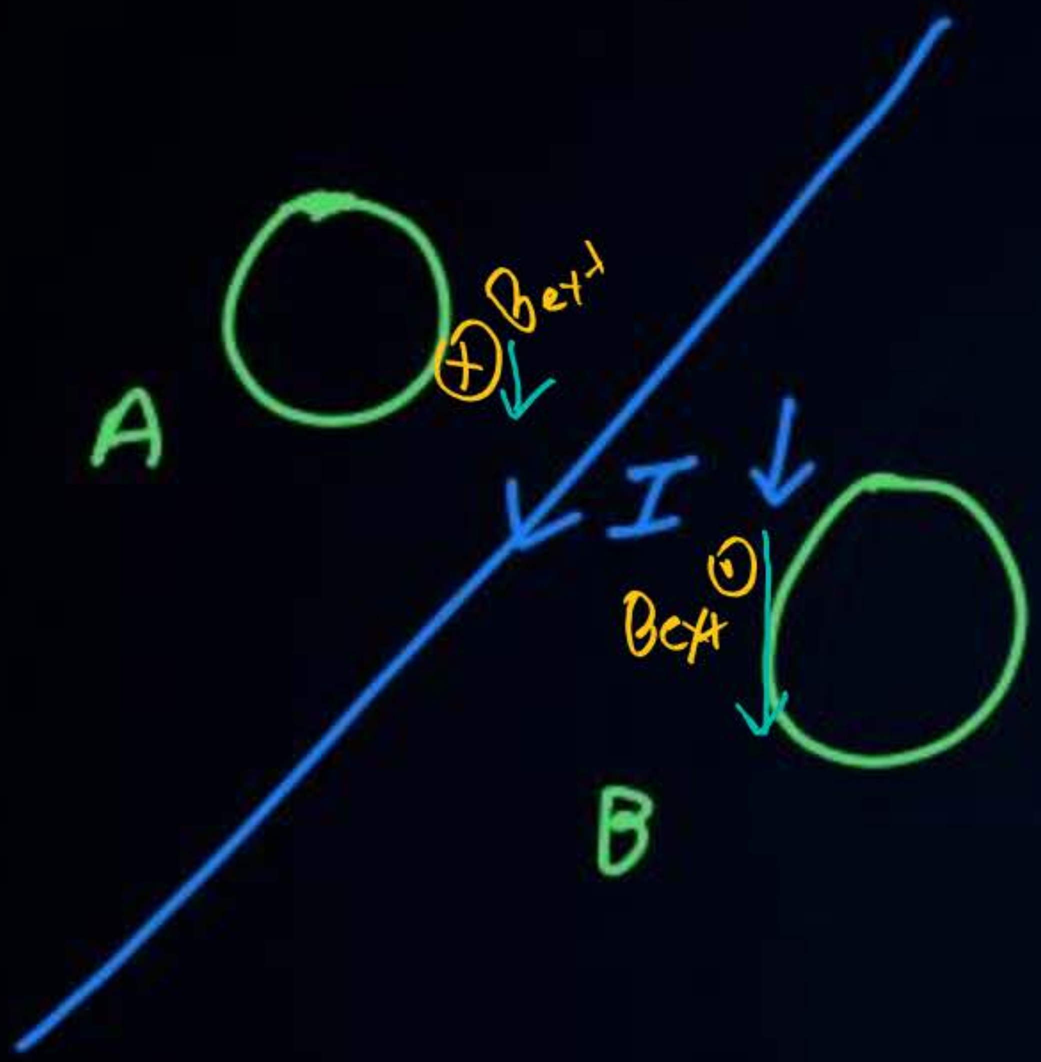
$\phi_C = const^n$

$I = 0$

$\phi = \odot \downarrow$

B in ⊙ $\longrightarrow$ I (Anti-clock)

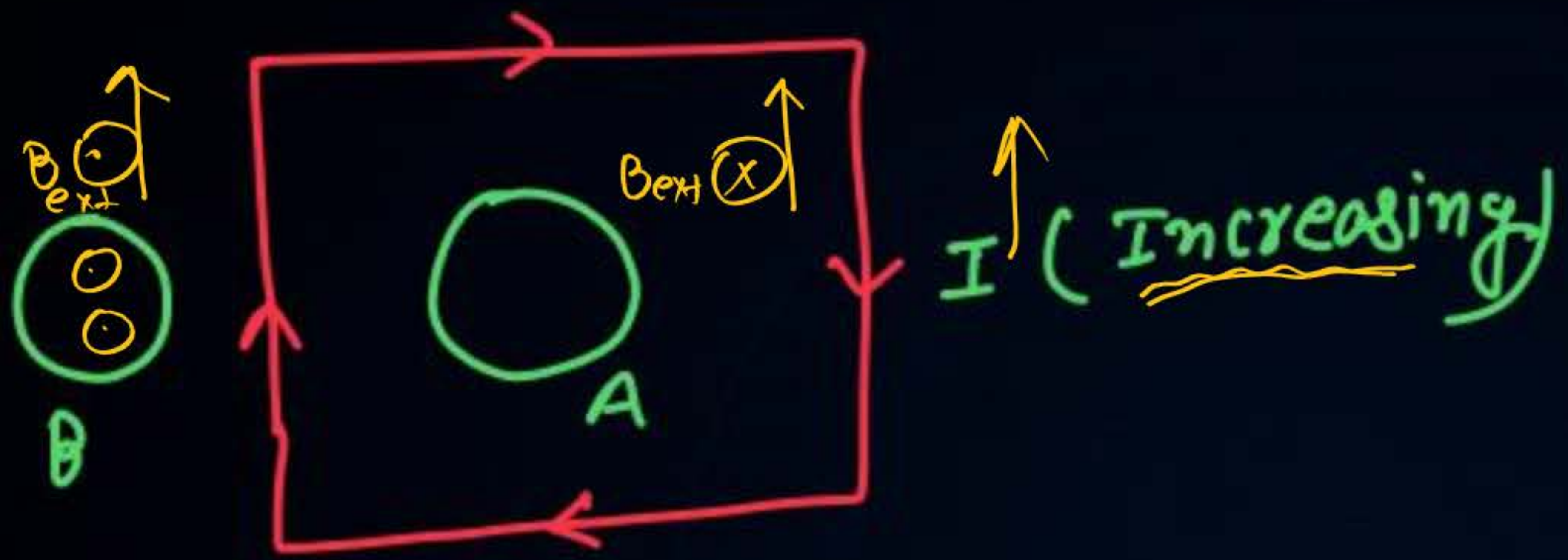
find Induced current in A and B



B → Anti-Clock

A → Clock wise

Ans



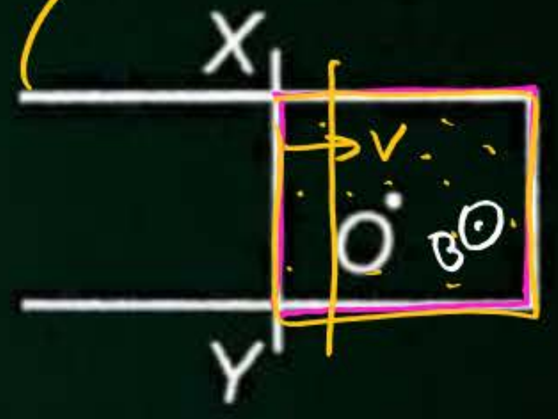
find dir^n of Induced current in A & B

Coil → A —— B_{in} ⊙ → Anti-clock.

Coil → B ⟶ $B_{induced}$ ⊗ → Clock-wise

QUESTION

When a conducting wire XY is moved towards the right, a current flows in the anti-clockwise direction. Direction of magnetic field at point O is

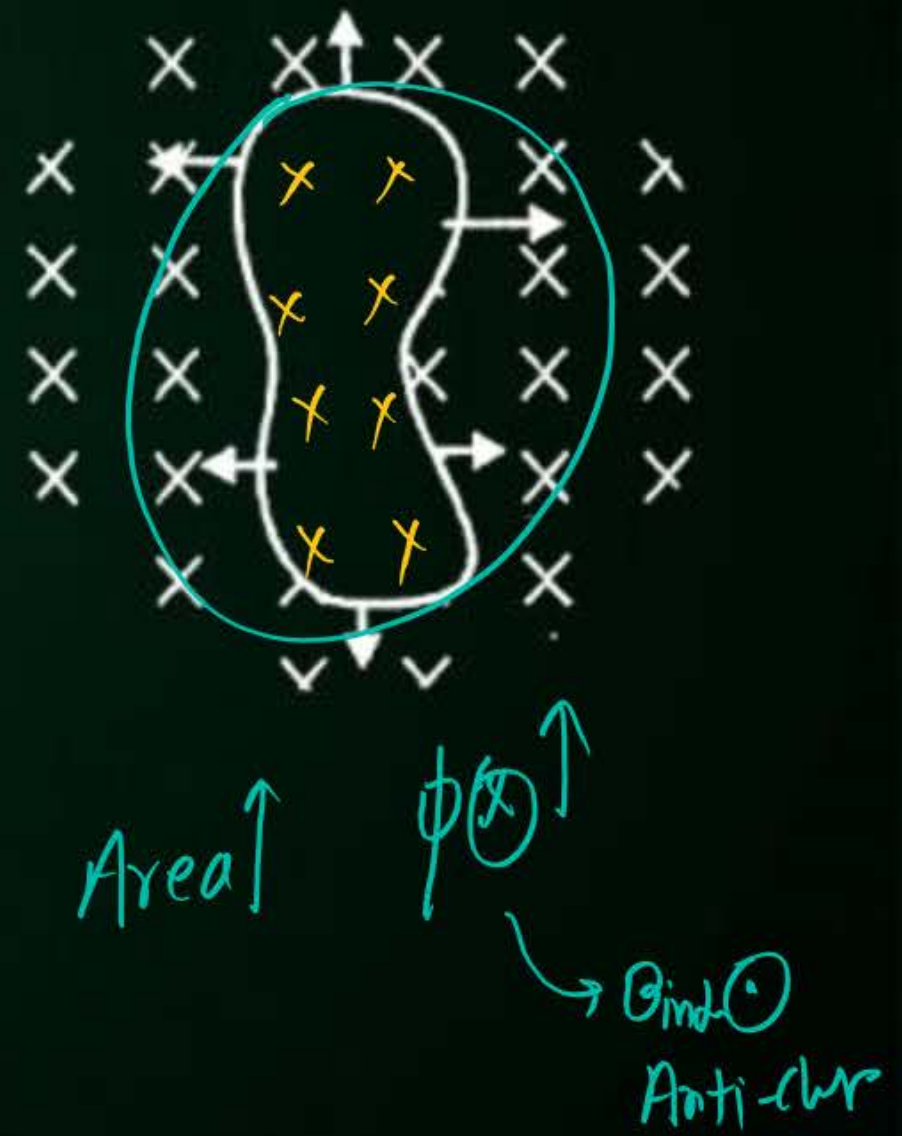


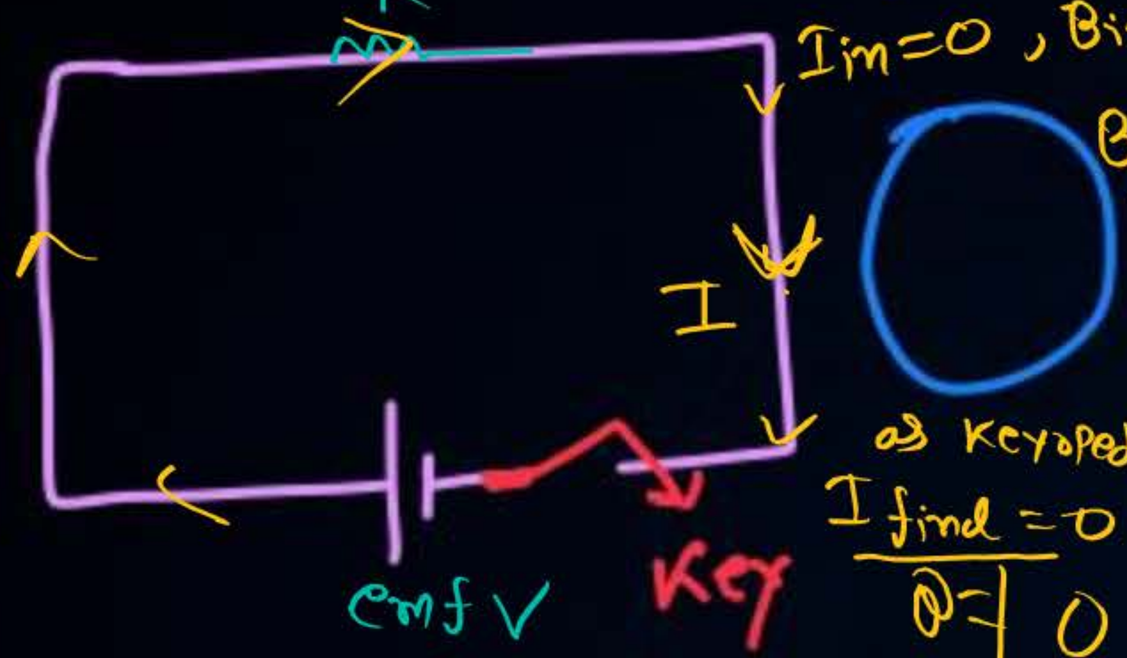
1. Parallel to motion of wire
2. Along XY
3. Perpendicular outside the paper
4. Perpendicular inside the paper

QUESTION

A loop of irregular shape of conducting wire PQRS (as shown in figure) placed in a uniform magnetic field perpendicular to the plane of the paper changes into a circular shape. The direction of induced current will be

1. Clockwise
2. Anti-clockwise
3. No current
4. None of these





Just key is closed ✓

$I_{in} = 0$, $B_{intial} = 0$ ✓

B ⊙ ext due to curnt

as key oped

$I_{find} = 0$

$\phi = 0$

find dirⁿ of Induced current when key is

(a) Just close ✓

→ B ⊗ Induced → clock-wise

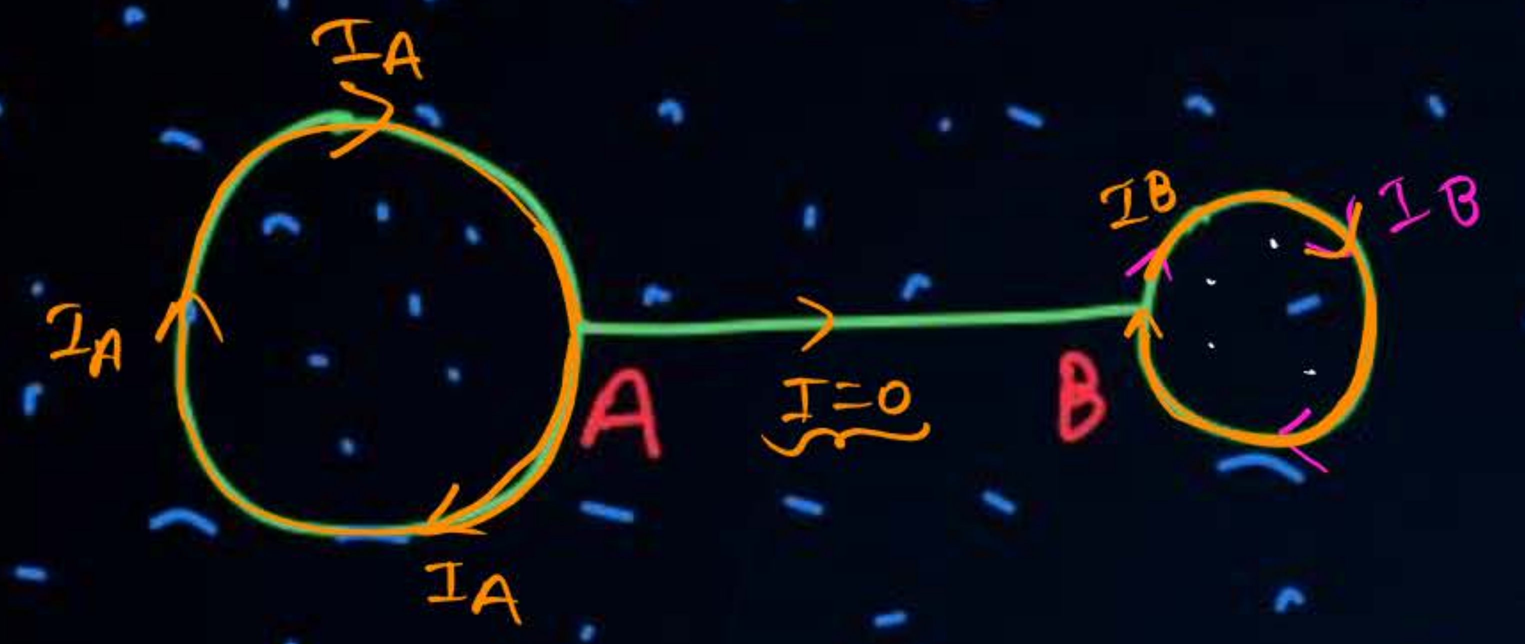
(b) Key Just open. ✓

→ ϕ ⊙ ↓ → B_{ind} ⊙

Indued Anti-current

MR*

find direction of current from A to B, & induced current in coil → 'A' & 'B'



B ⊙ = Incresing

Sol^n for coil A

$\phi = BA\cos\theta = ⊙\uparrow$

B_{ind} ⊗

↳ clockwise curr → same in coil-B

$I_A > I_B$

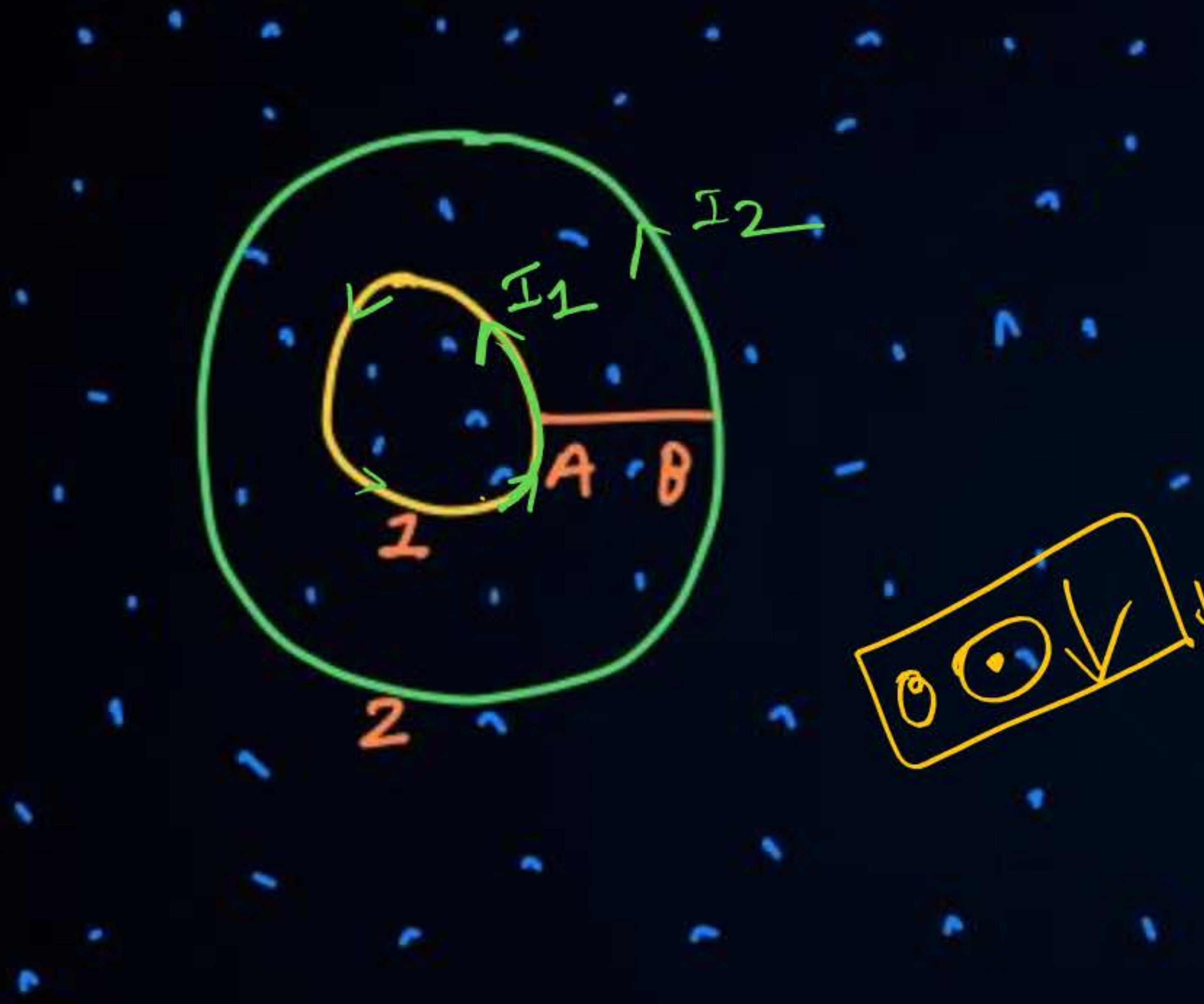
dir^n of current in 'AB'

(a) A to B 21%

(b) B to A 27%] wrong

(c) No current ✓

(d) dont know.



find direction of Induced current in loop 1 and loop 2 and find direction of current in AB wire

$\odot \downarrow$ decresy.

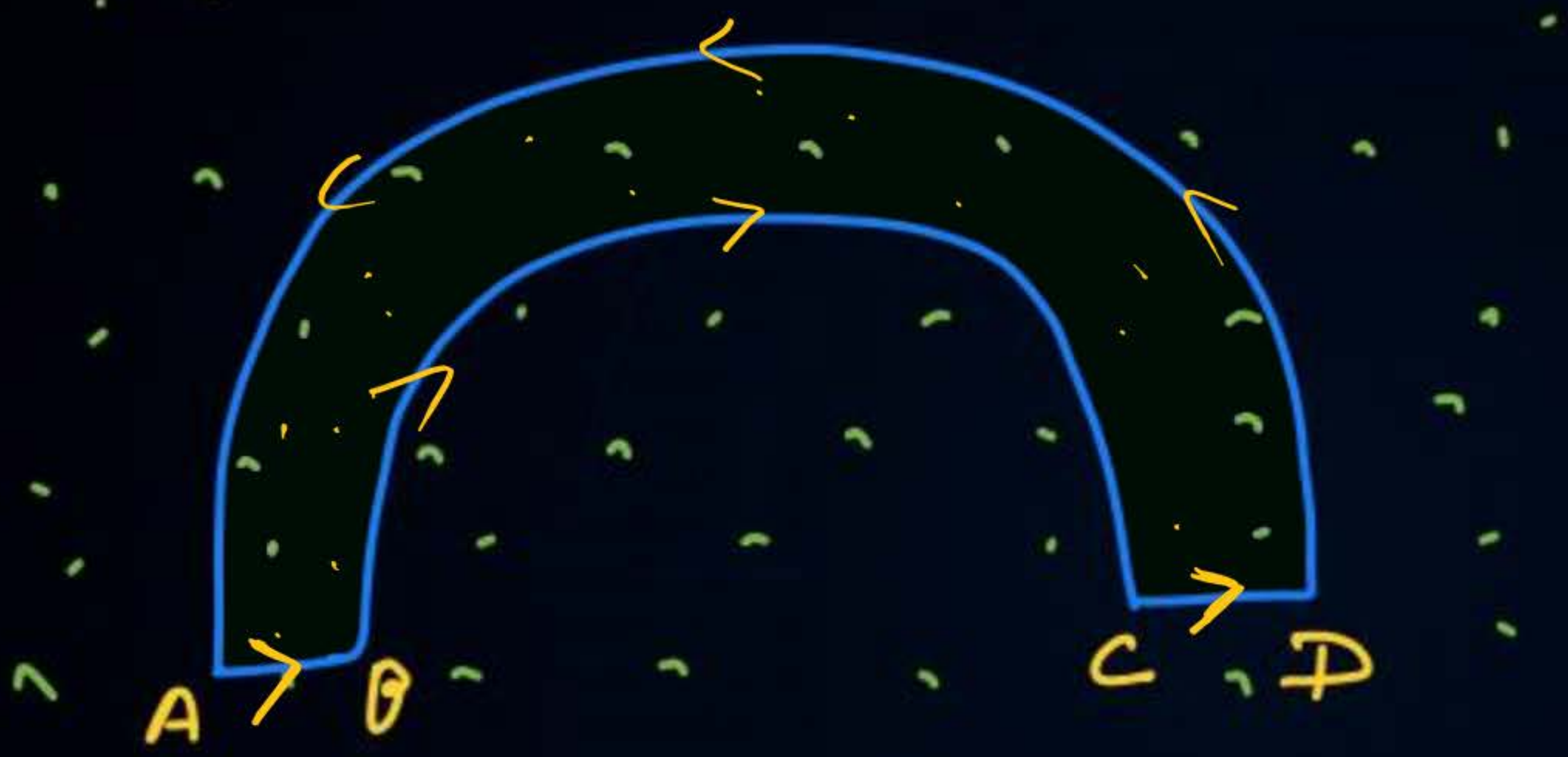
loop (2)

$\phi \odot$ decresy

↳ Bindu = $\odot$

Anti-clock → same in loop 1

wire AB = 0

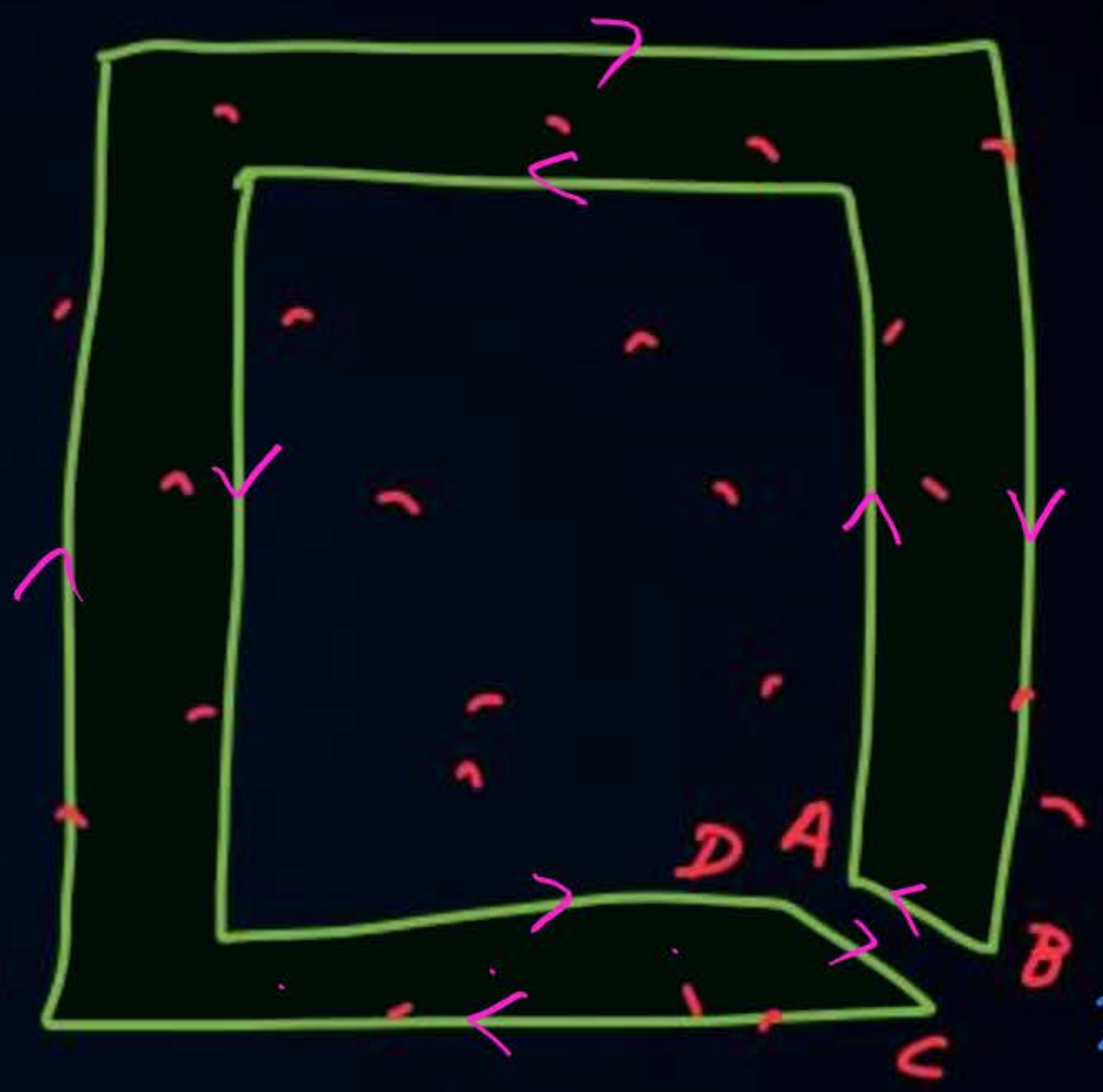


If magnetic field is decreasing then find dir of current in AB & CD.

$B \odot \downarrow$ (decreasing) → $B_{induce} = \odot$ Anti-clock

$I \Rightarrow A$ to B
$\Rightarrow C$ to D
} Answer

find direction of Induced current in AB & CD.



B ⊙ ↑ Incr

↓ B ⊗ Ind

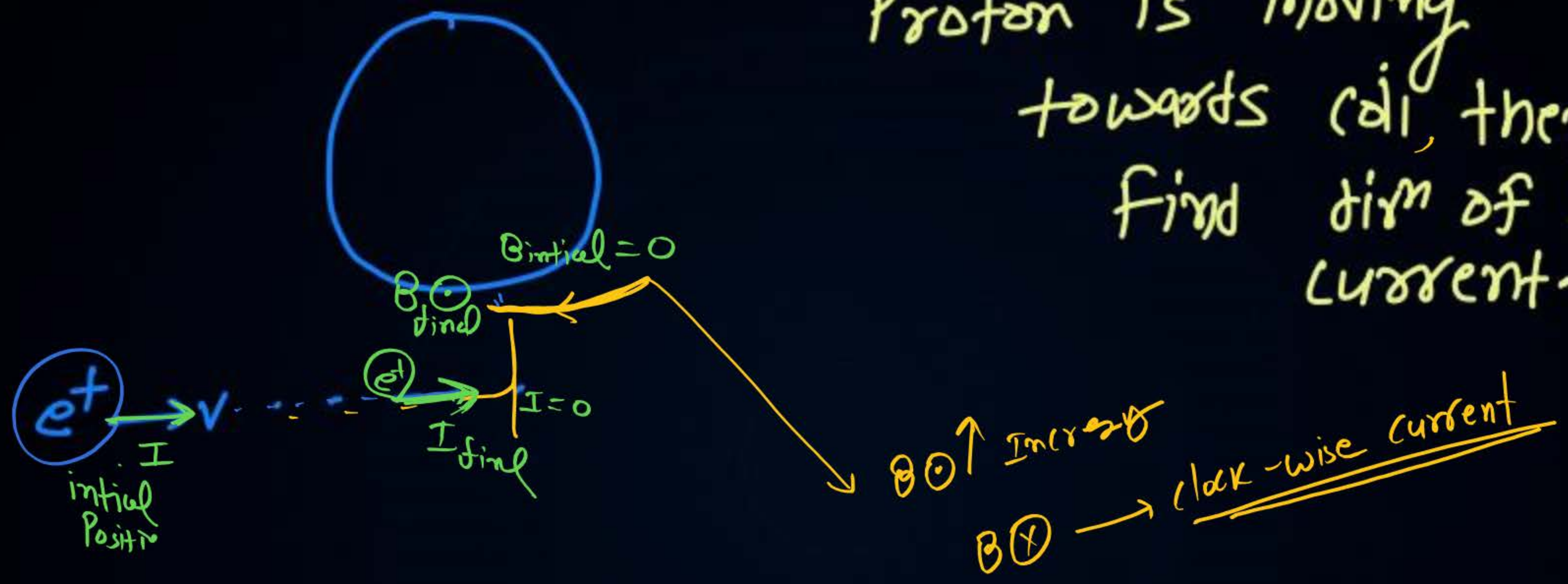
clock.

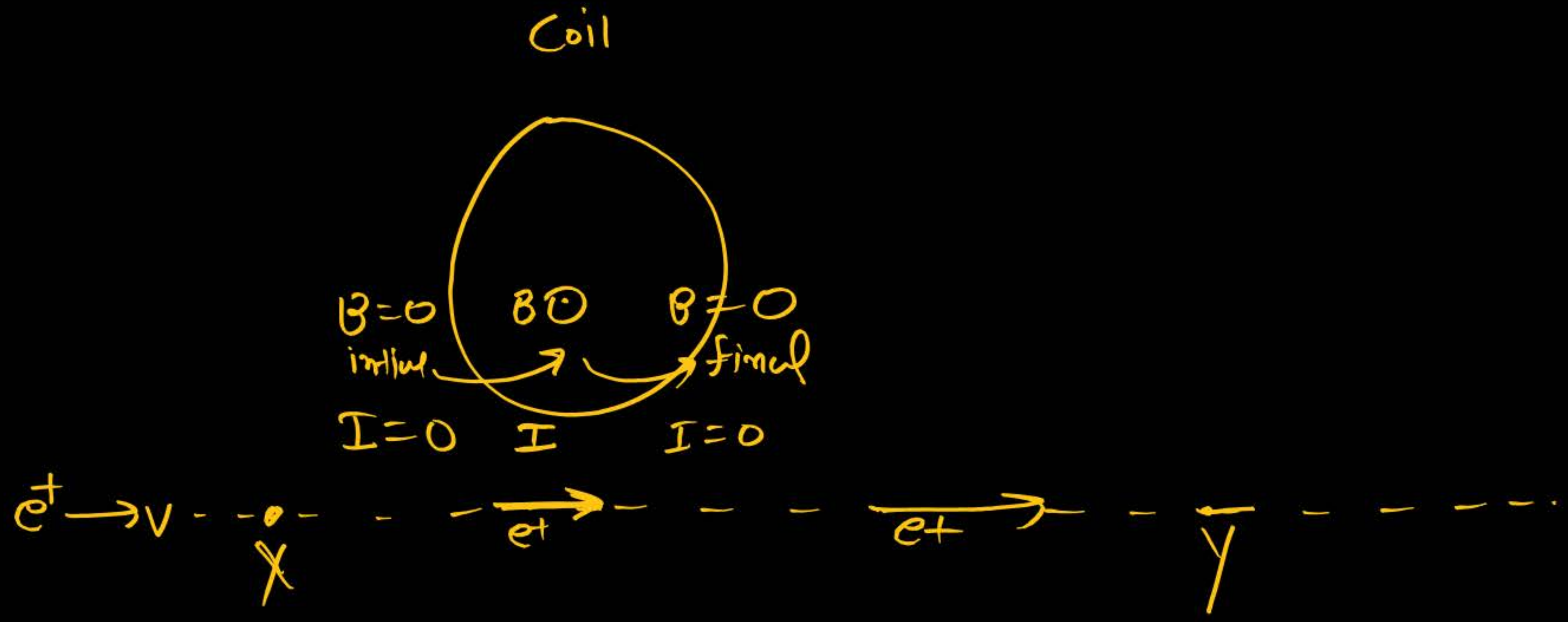
I (B to A)

I (D to C)

AS

Proton is moving towards coil, then find dir^n of Induced current.





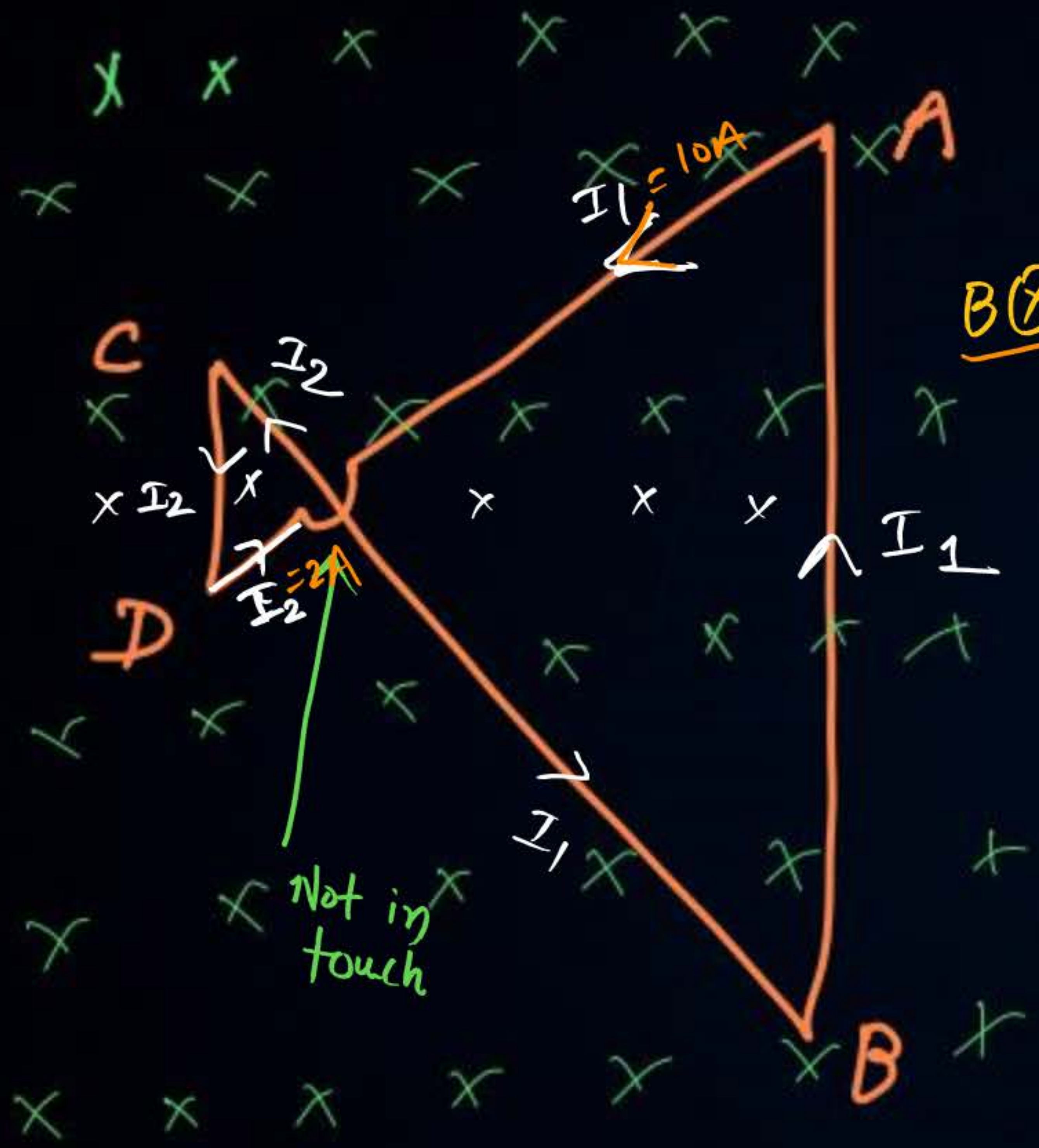
Proton is moving on XY line then dirn of induced curr

initial.

Clock-curre intid.

then B⊙↓ Bind ⊙

Anti-clock current



find dirⁿ of Induced current in CD and AB

B ⊗ Increasing

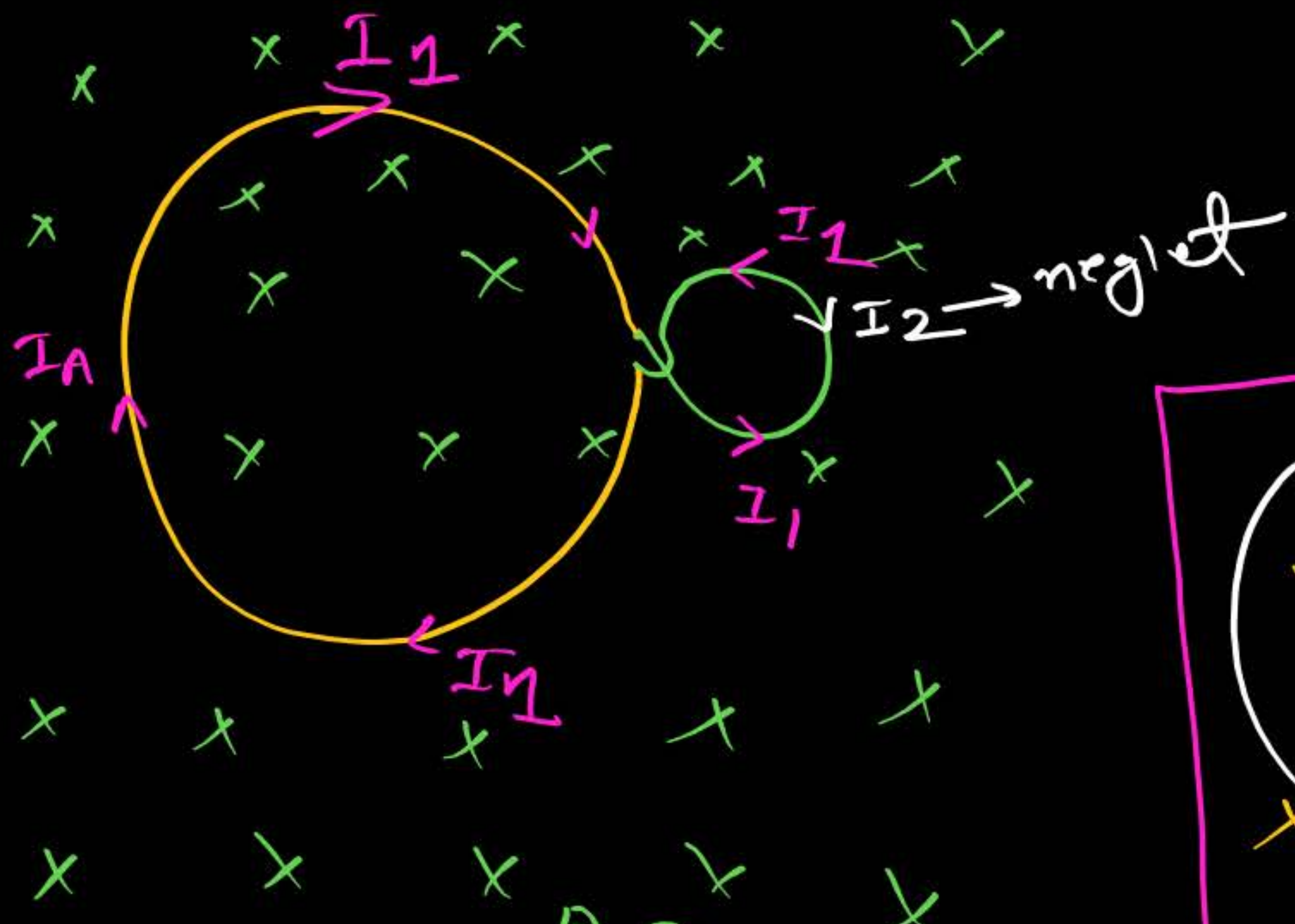
$\phi = B \otimes$ Incresr ⟶ B⊙ Indu → Anti-clock cycle

MR* → large loop me dirⁿ Nikalo or usko guma to close loop me

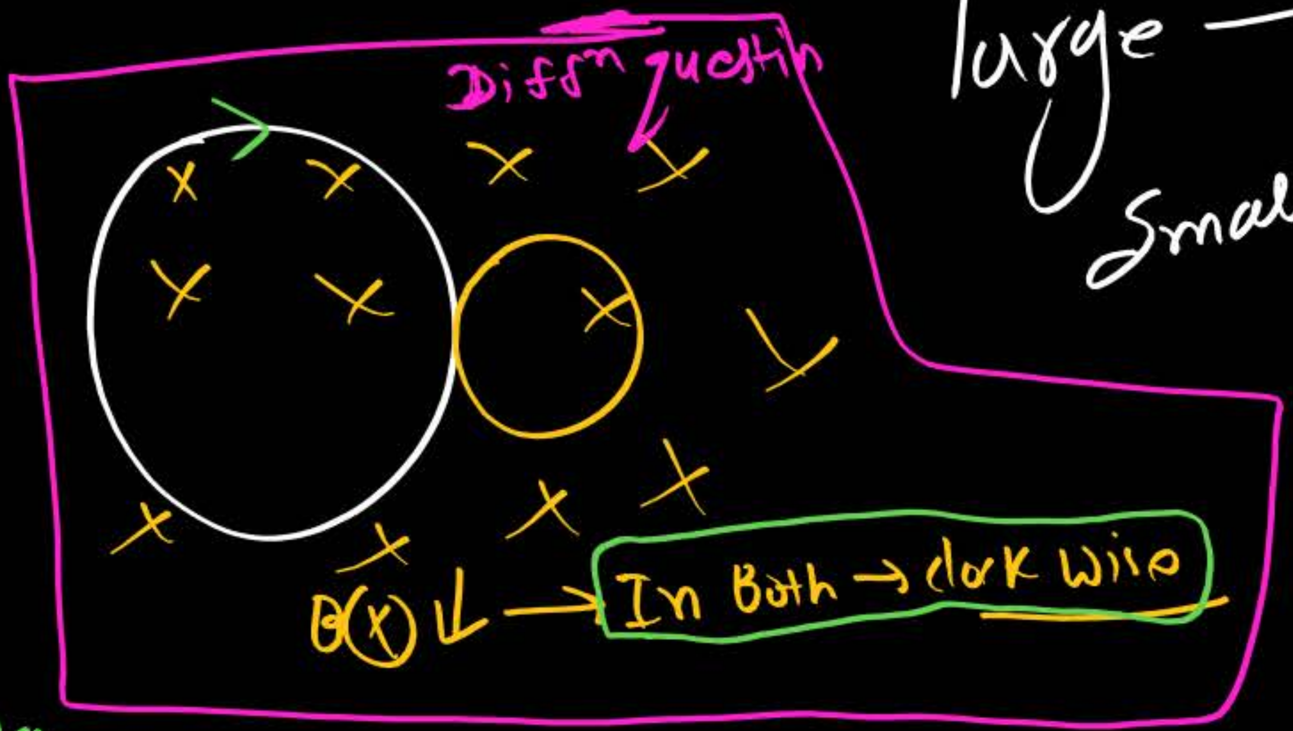
$I_1 > I_2$

Ans current flows from D to C and B to A

find dirn of Induced current



B (x) → decresing



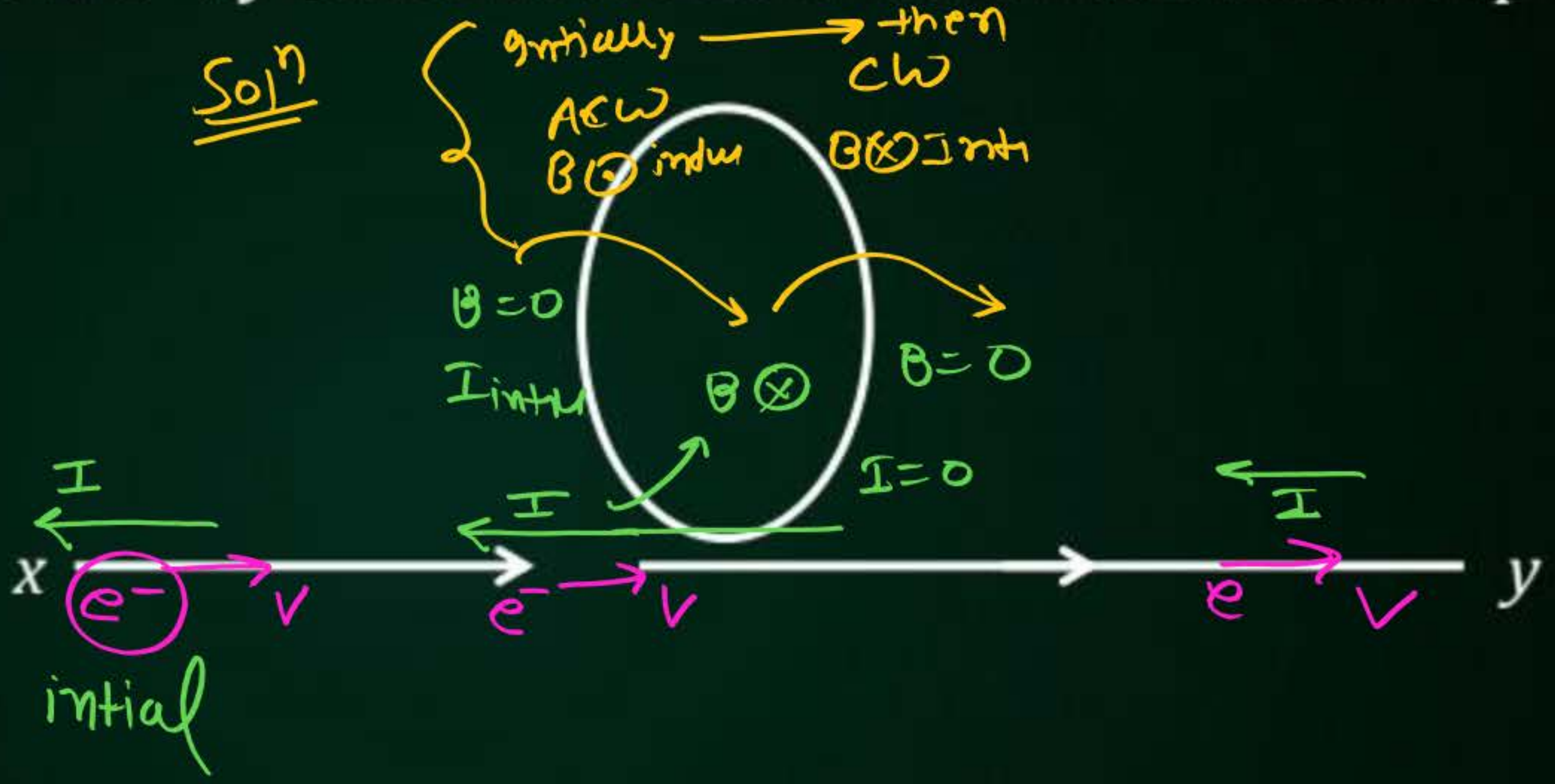
large → clock wise

Small → Anti-clock.

→ B indu (x) → Clock wise current

QUESTION

One electron is moving along path $x \to y$ then direction of induced current in loop.



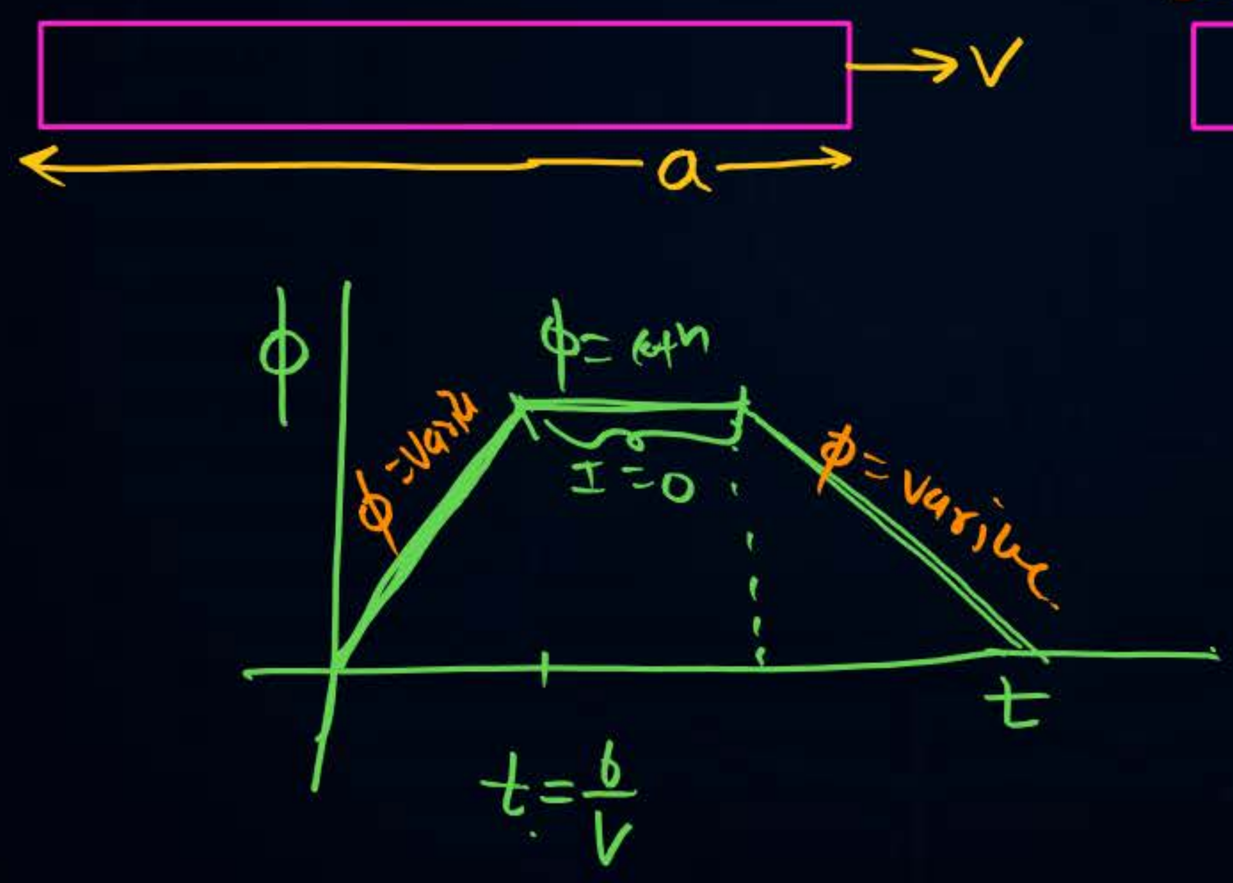
Find time for which current will induced in the loop, where loop is moving with velocity v (a>b) * given

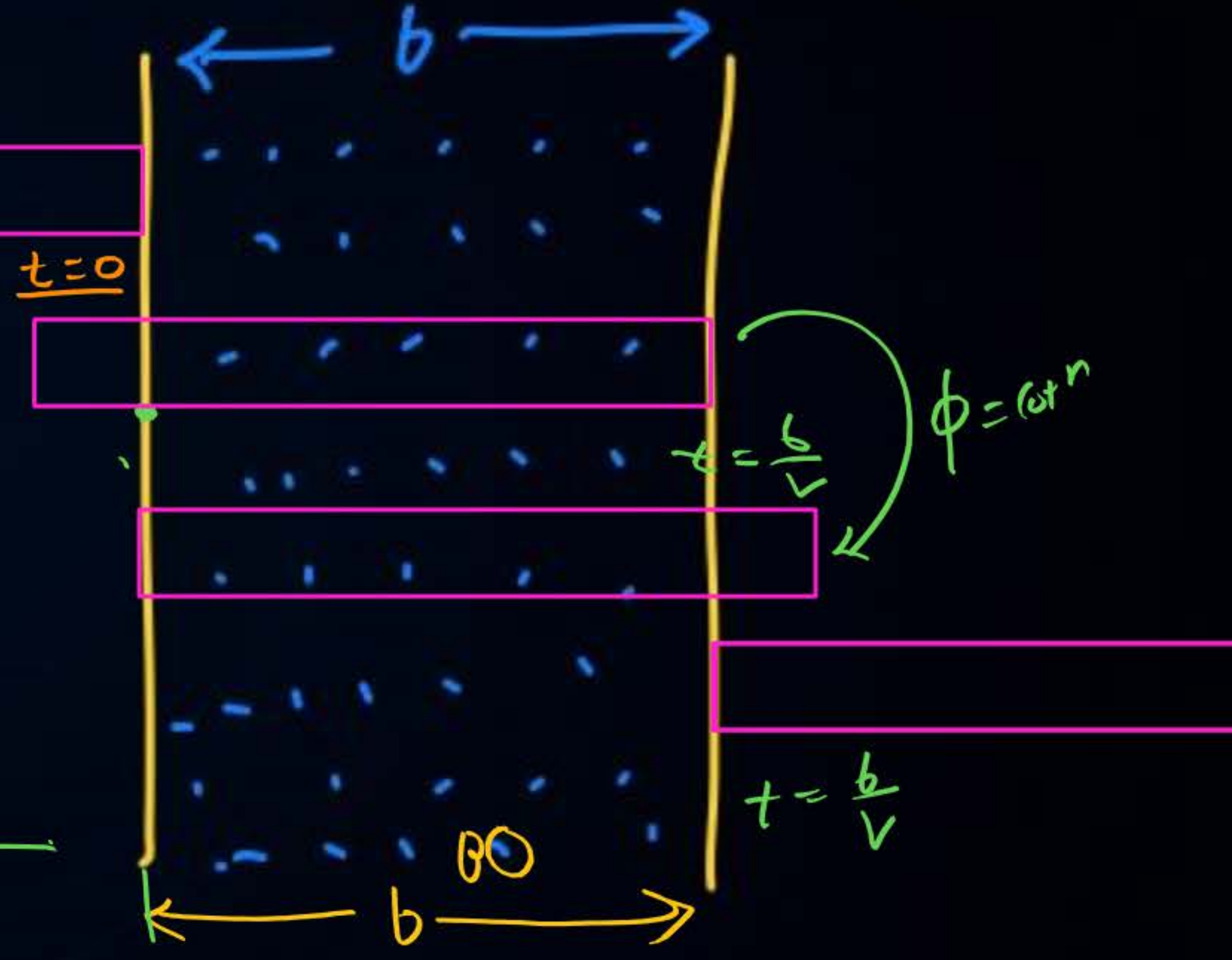
(a) $t = \frac{2b}{v}$ ✓

(b) $t = \frac{2a}{v}$

(c) $t = \frac{a+b}{v}$

(d) $t = \frac{a-b}{v}$





Find time for which current will induced in the loop, where loop is moving with velocity v

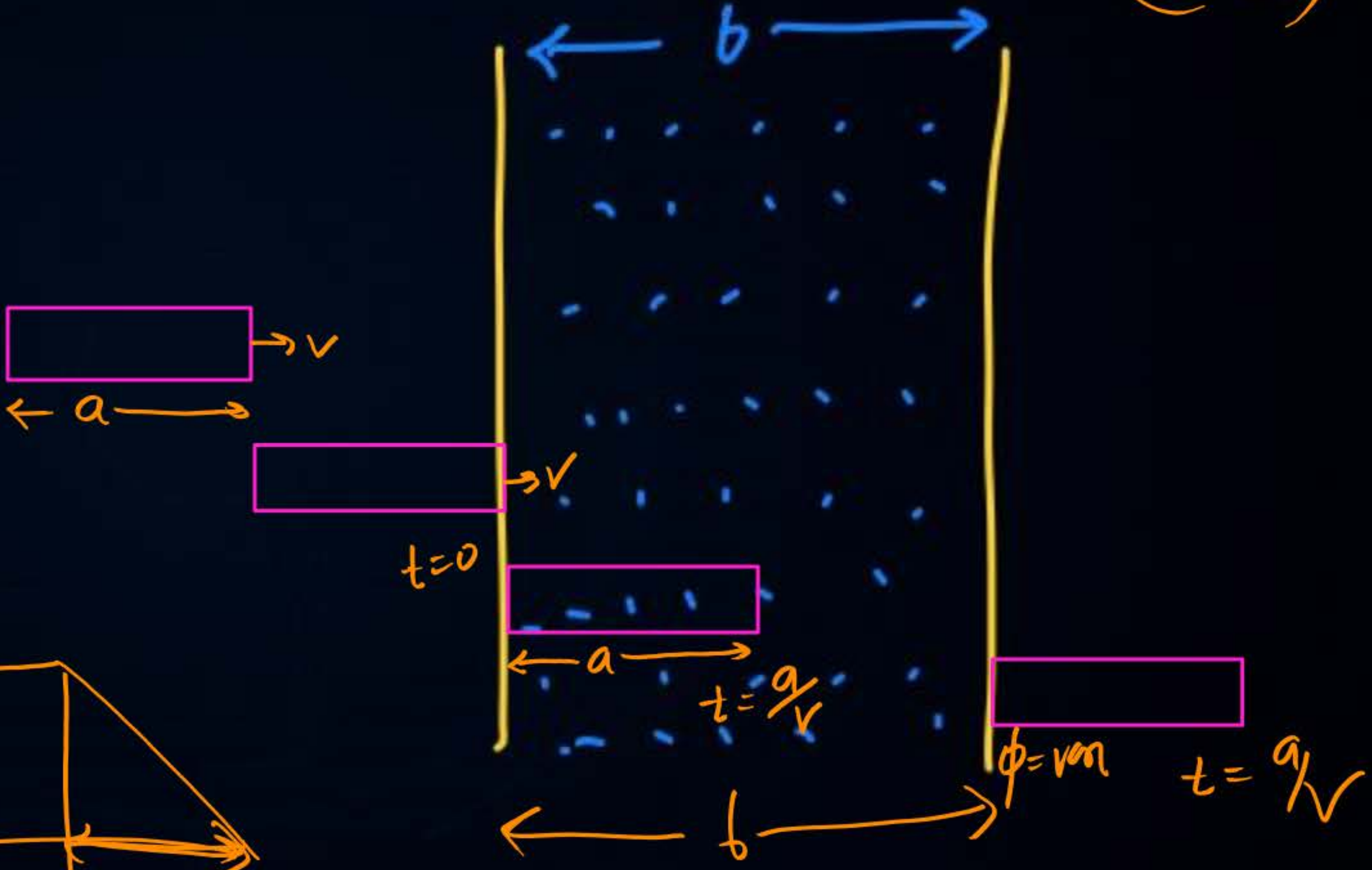
(b>a)

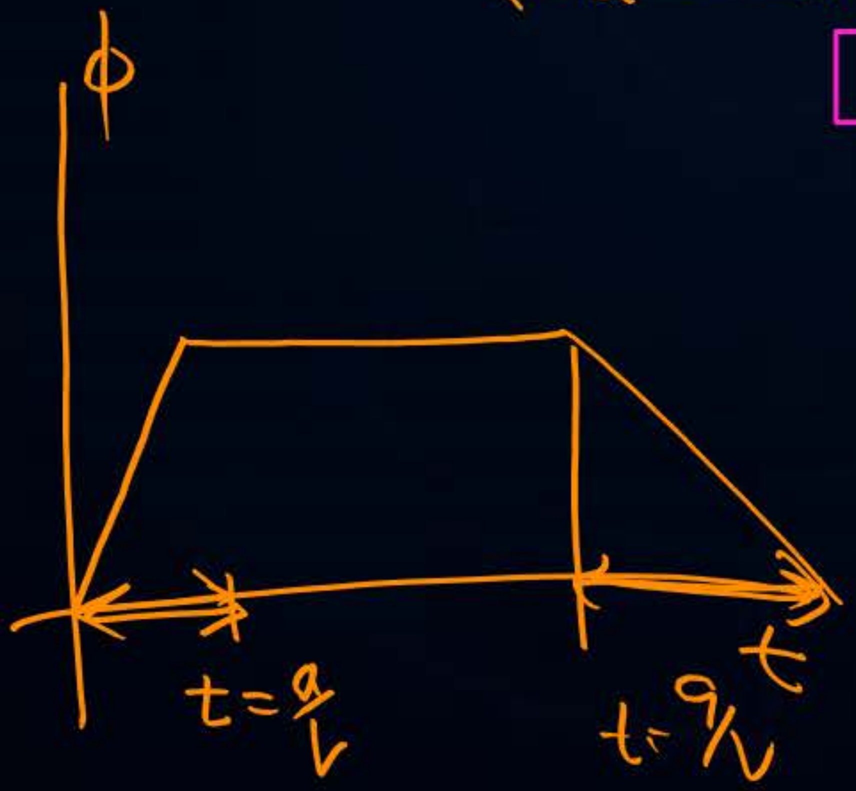
(a) $t = \frac{2b}{v}$

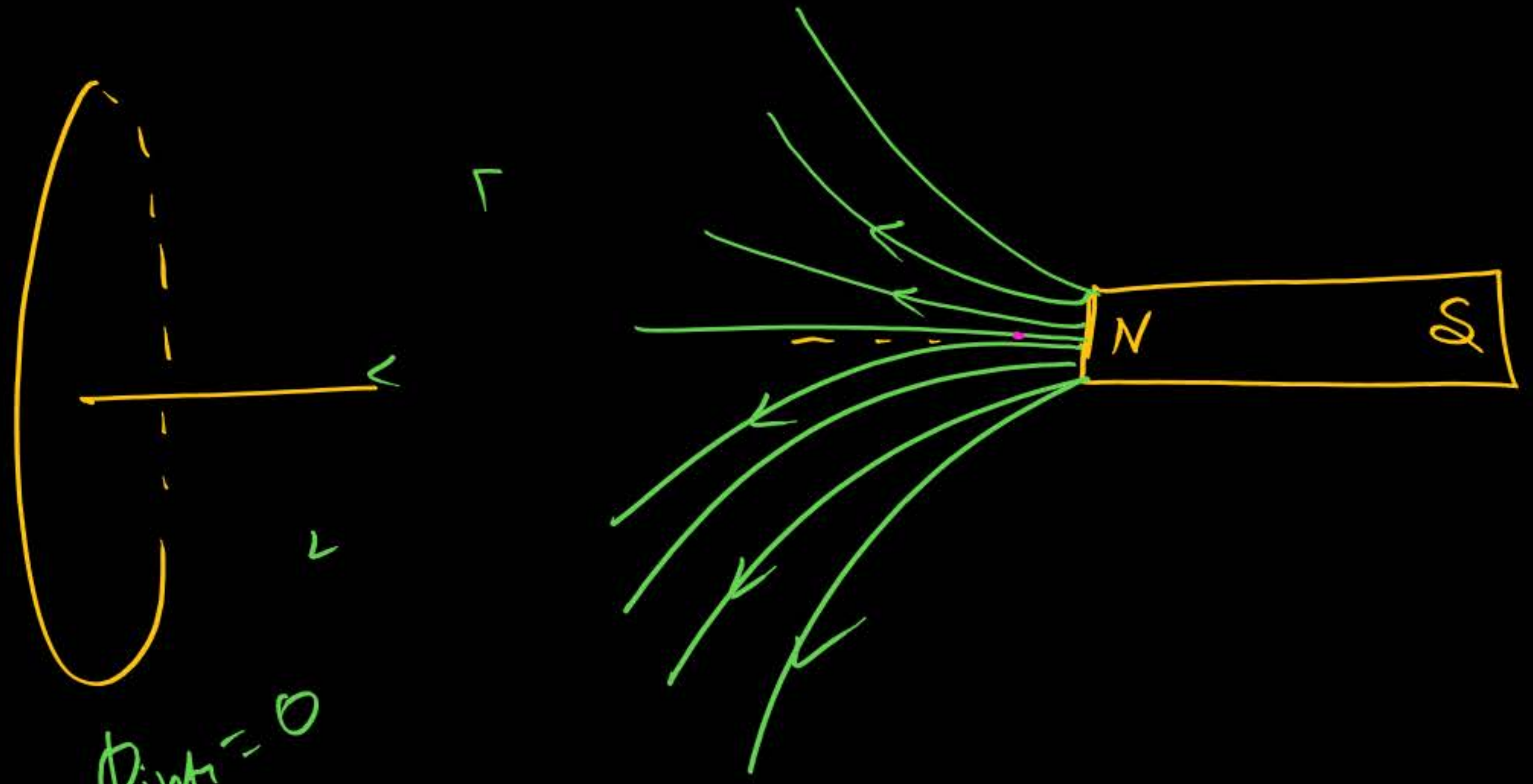
(b) $t = \frac{2a}{v}$ ✓

(c) $t = \frac{a+b}{v}$

(d) $t = \frac{a-b}{v}$







$\phi_{init} = 0$

Coyal Mami & Popu Mama ki Kahani

Coyal Mami — coil

Popu Mama — magnet

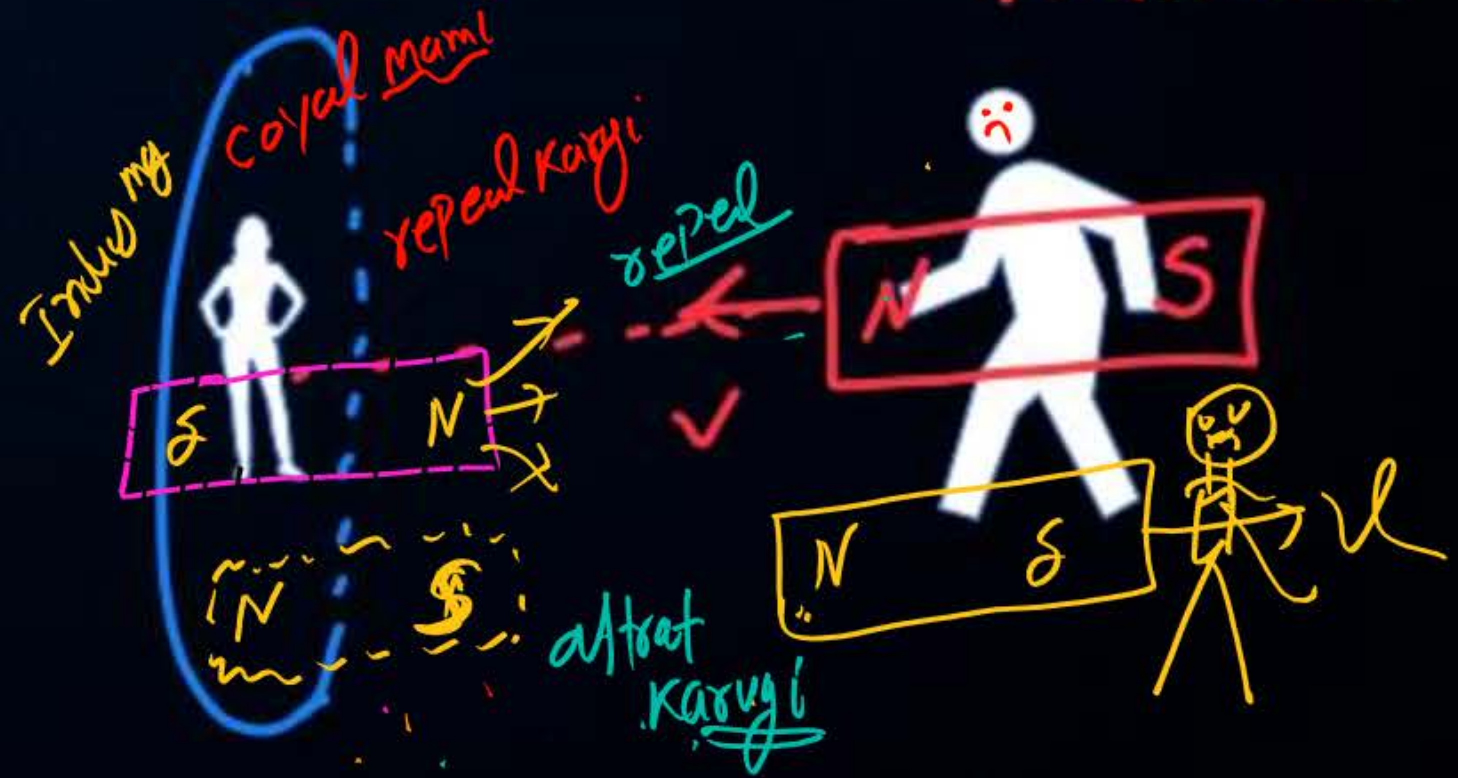
Dur mat Jao attract Karungi (opposite Polarity)

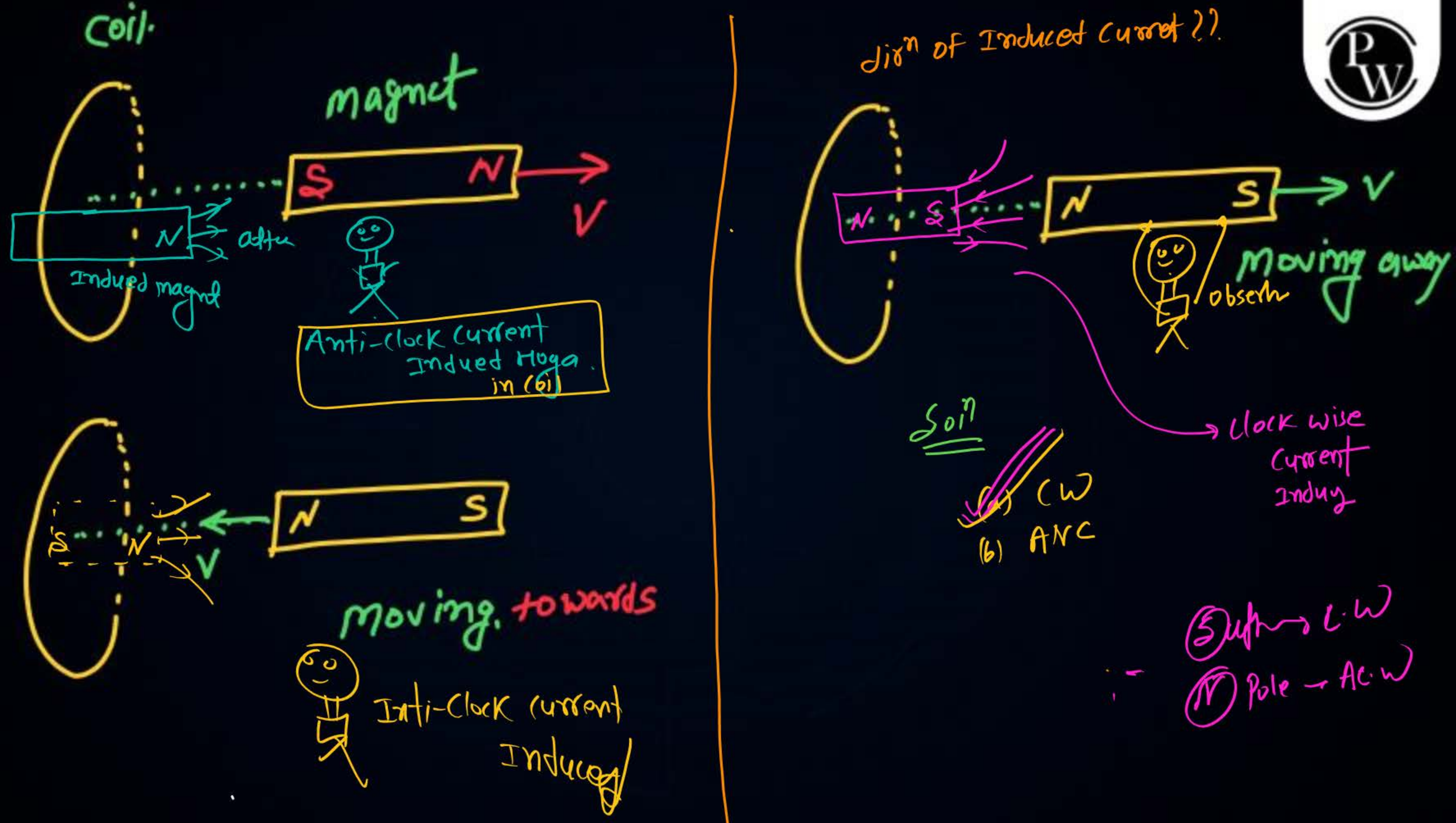
Pas mat aao repeal Karungi (same Polarity)

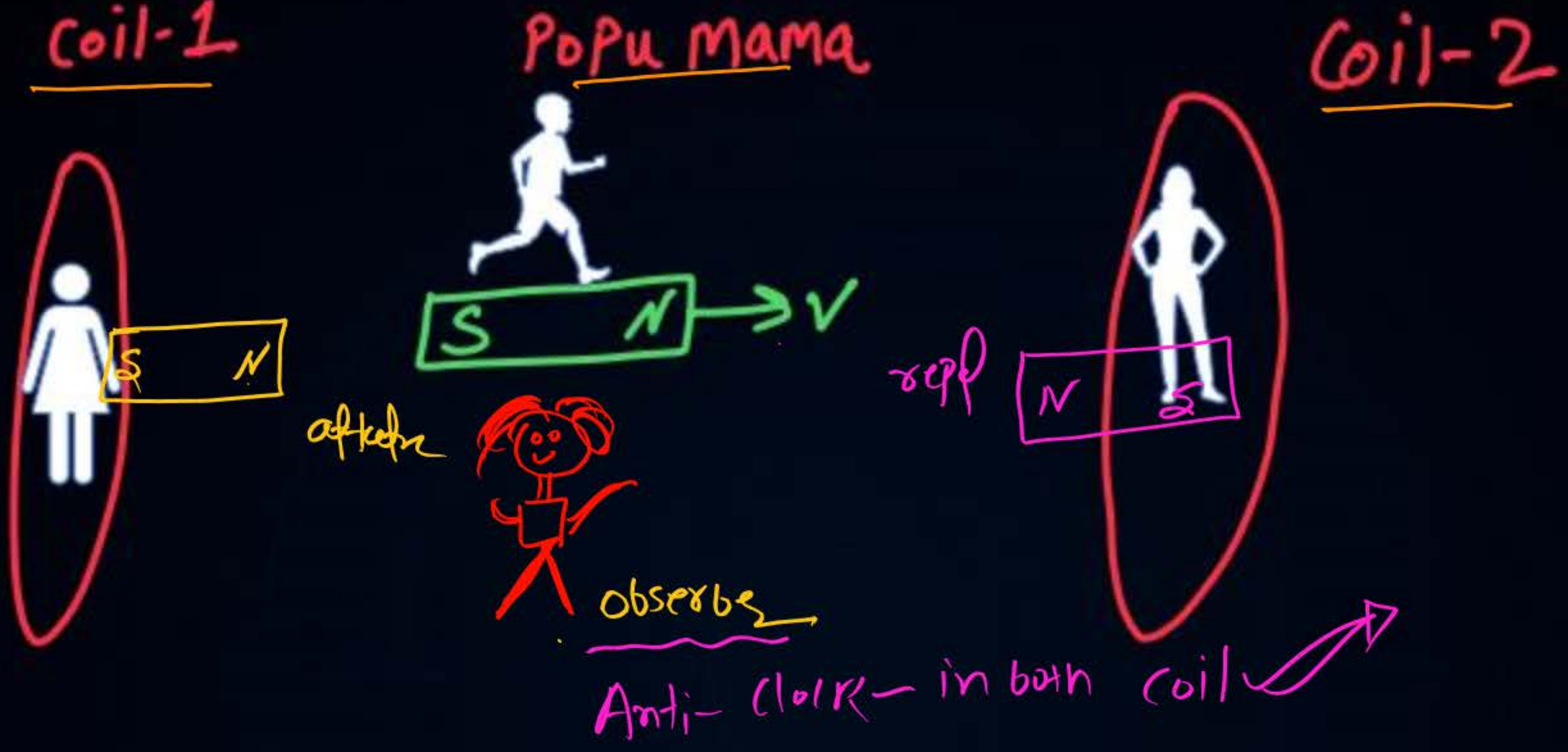
aise hi padhte raho exam ke bad hi date Karungi

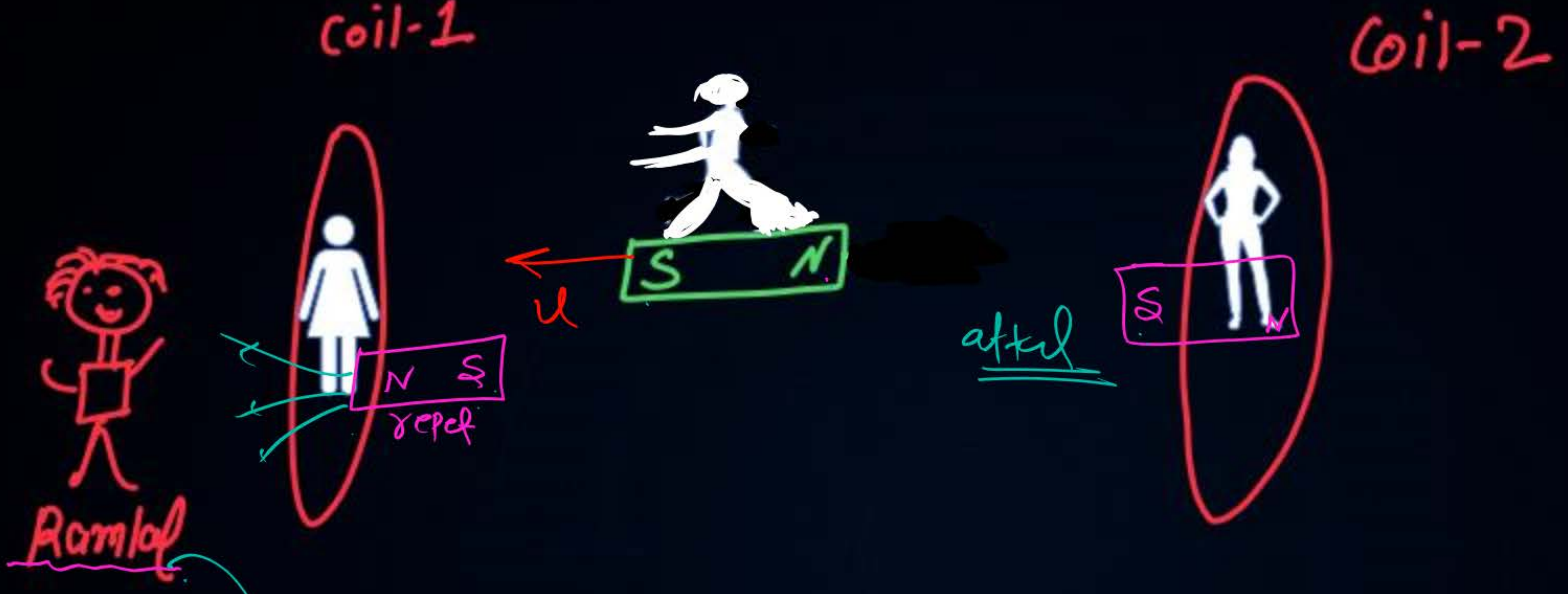


North (outward field)
Anti-clock



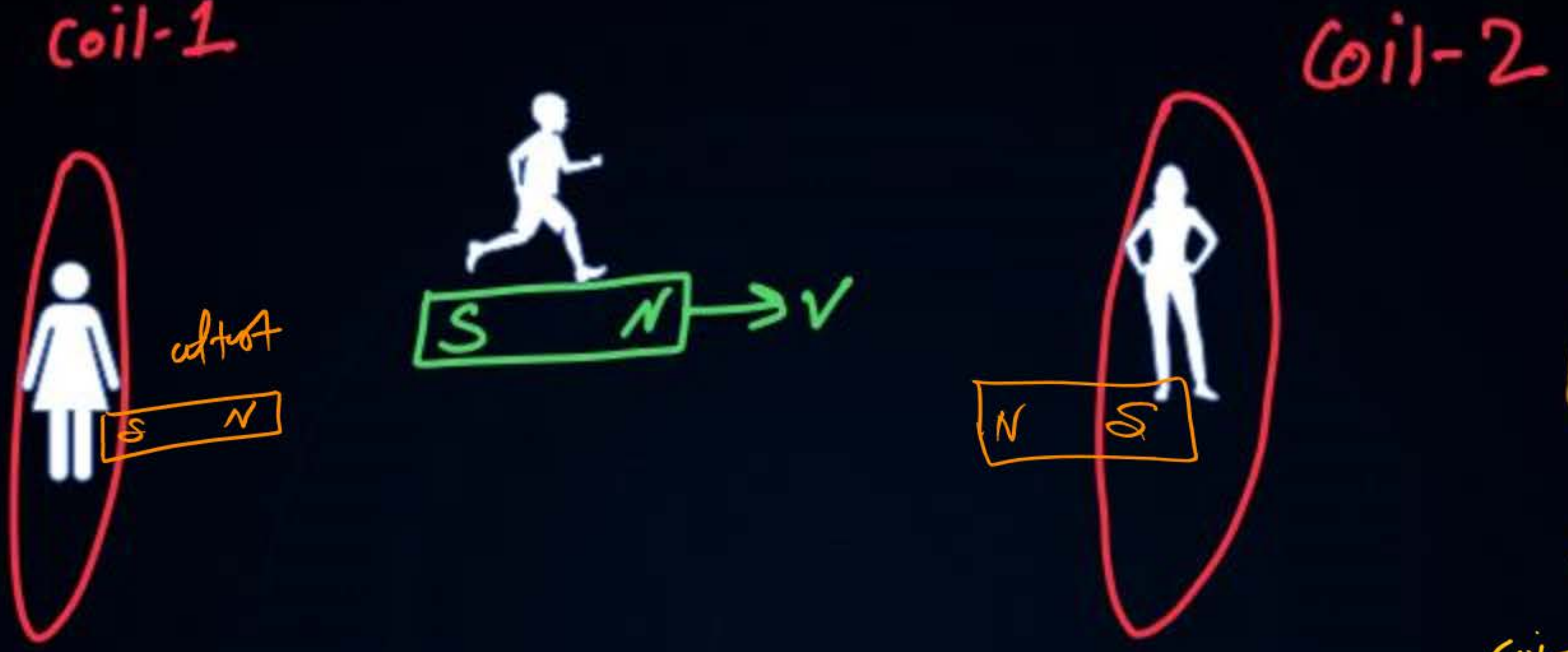

coil
magnet
S
N
V
N
after
Indued magnet
Anti-clock current Indued Hoga in coil
N
S
S
N
V
moving towards
Inti-Clock current Induced
dirn of Induced current ??
N
S
N
S
V
moving away
observer
clock wise current induy
Soln
(a) CW
(b) ANC
S upfr → C.W
N Pole → AC.W


coil-1
Popu Mama
Coil-2
S N
S N → V
N S
observer
Anti- clock- in both coil



Coil-1 → Anti-clock wise current

Coil-2 → clock wise current





Coil-1 → (N) → Anti-clok current

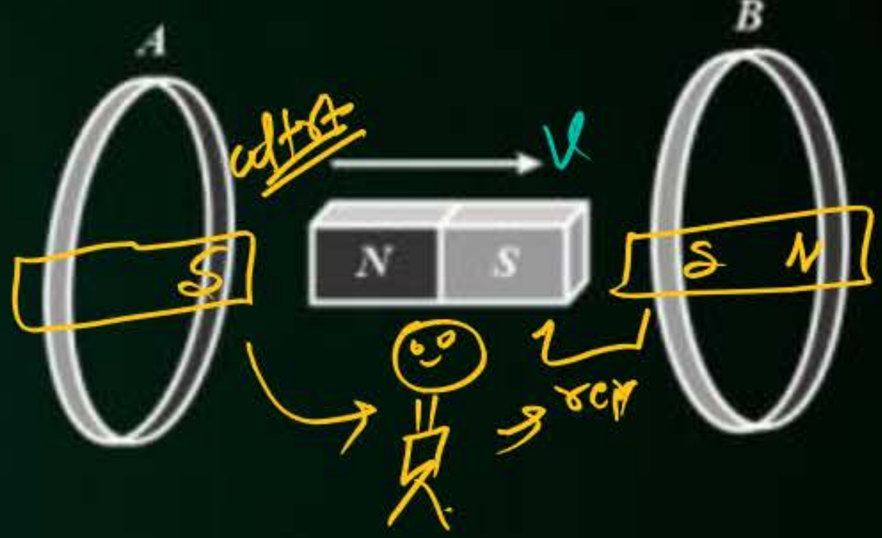
Coil-2 → (S) → clock wise current

Lentz law Based Conservation of energy

Machanical energy → electrical energy - magnetic

QUESTION

In the diagram shown if a bar magnet is moved along the common axis of two single turn coils A and B in the direction of arrow.



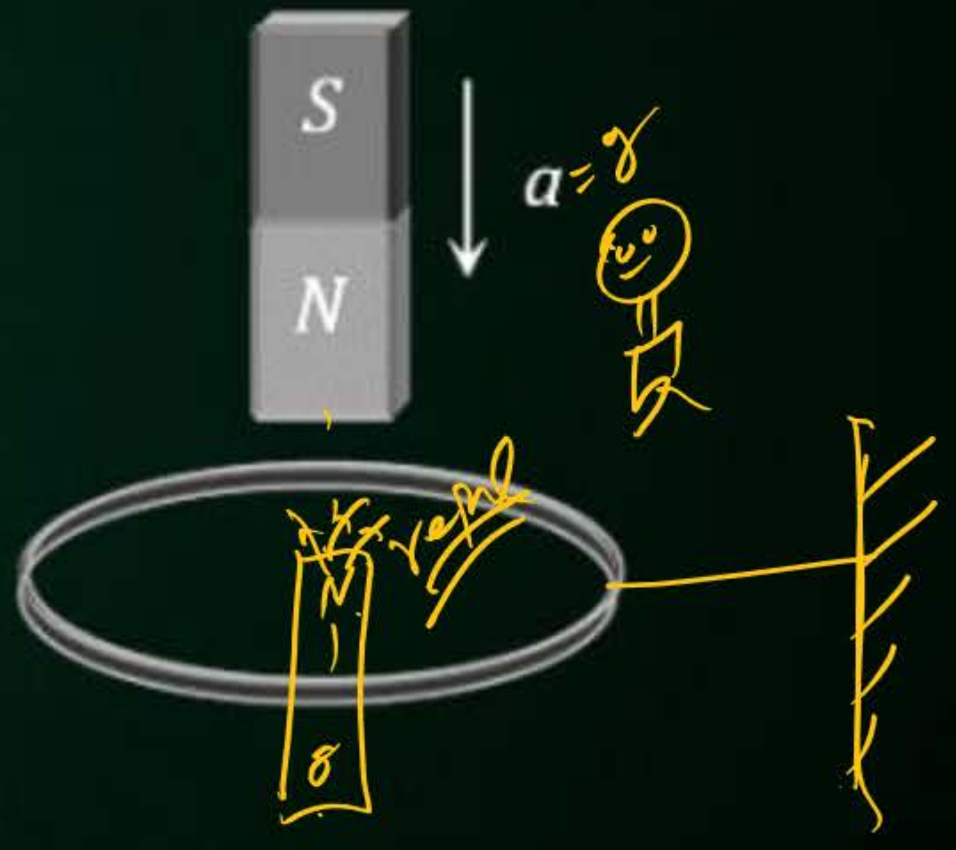
1. Current is induced only in A & not in B
2. Induced currents in A & B are in the same direction
3. Current is induced only in B and not in A
4. Induced currents in A& B are in opposite directions

QUESTION

A metallic ring is attached with the wall of a room. When the north pole of a magnet is brought near to it, the induced current in the ring with be

[AFMC 1993; MP PMT/PET 1998; Pb PET 2003]

1. First clockwise then anticlockwise
2. In clockwise direction
3. In anticlockwise direction
4. First anti clockwise then clockwise

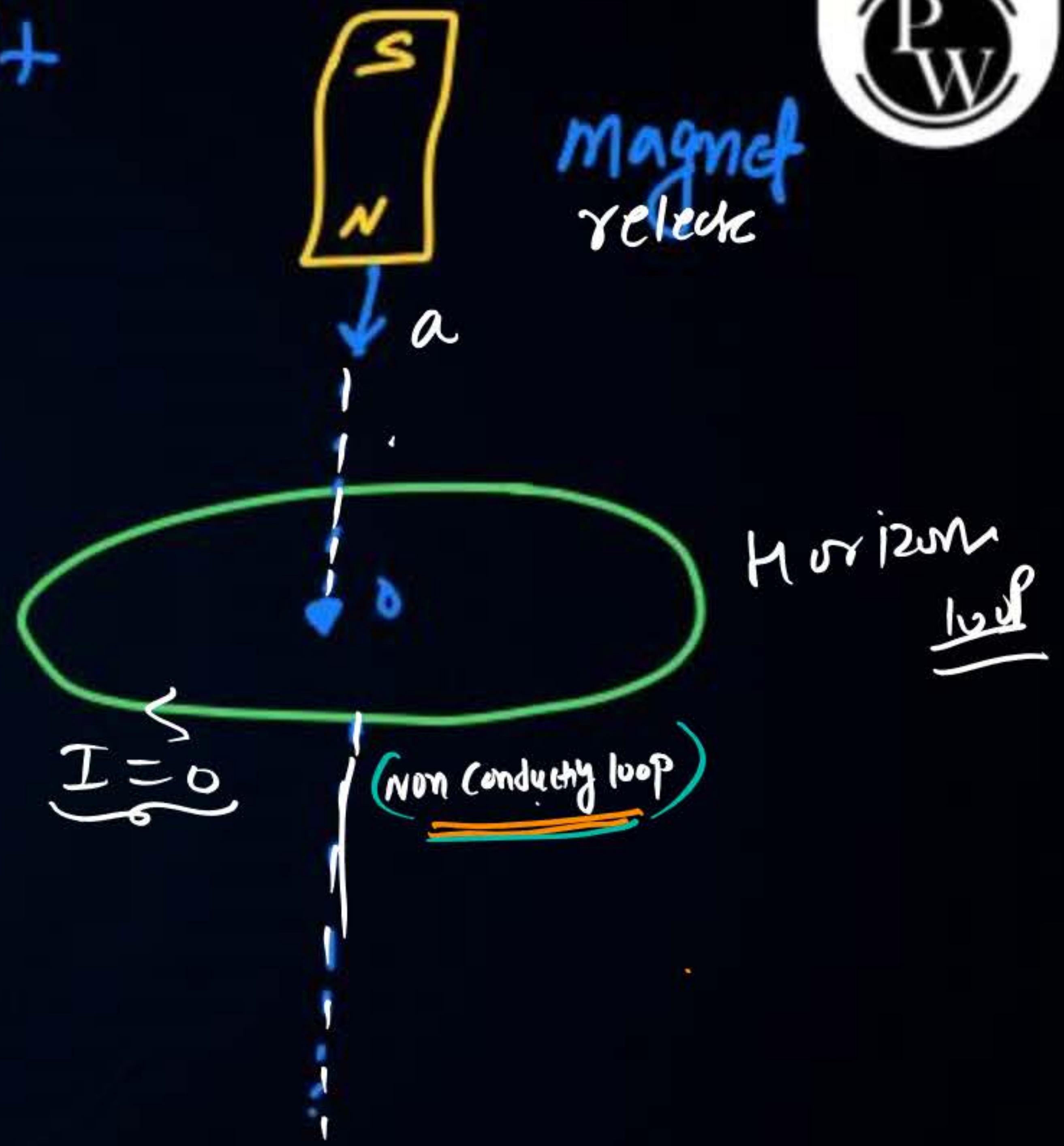


magnet is released as shown in Fig. in vertical direction direction it will move with accelration 'a' then;

(a) $a = g$ (14%) ✓

(b) $a < g$ (70%) ✗

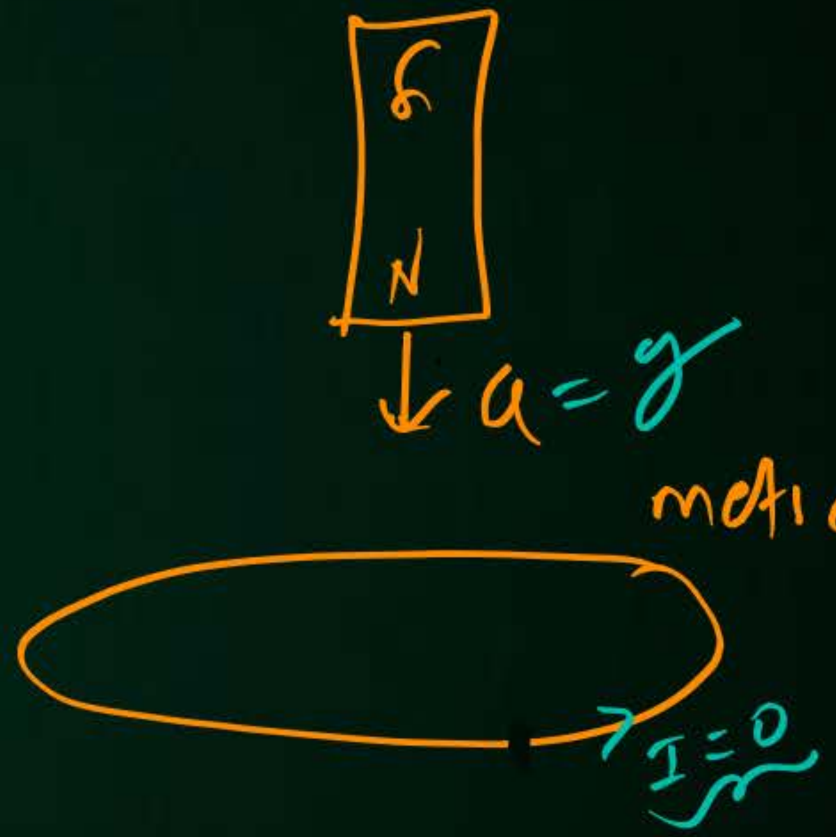
(c) $a > g$



QUESTION

A metallic ring with a cut is held horizontally and a magnet is allowed to fall vertically through the ring, then the acceleration of this magnet is

1. Equal to g
2. More than g
3. Less than g
4. Some times less and sometime more than g

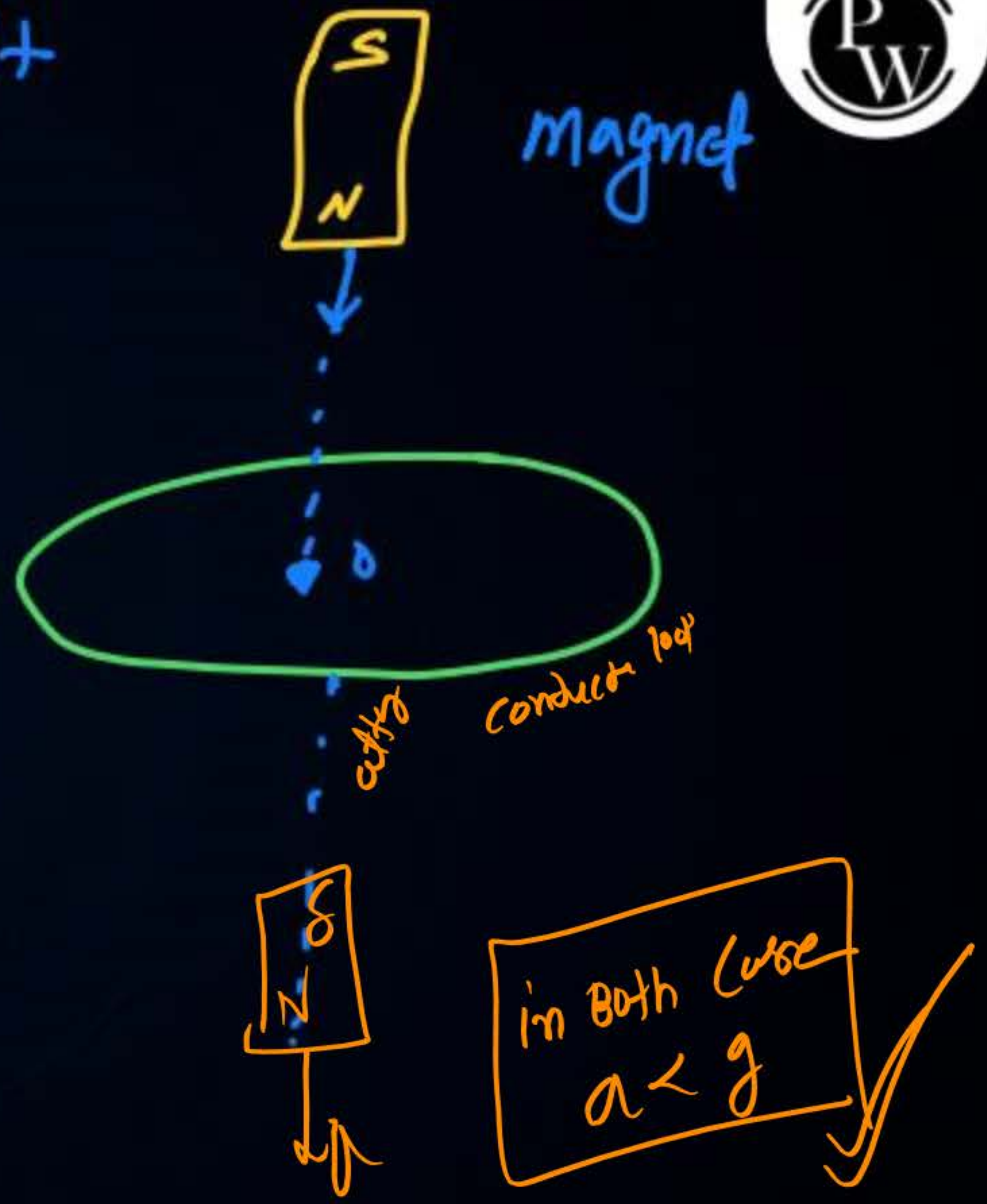


magnet is released as shown in Fig. in vertical direction ~~direction~~ it will move with accelration 'a' then

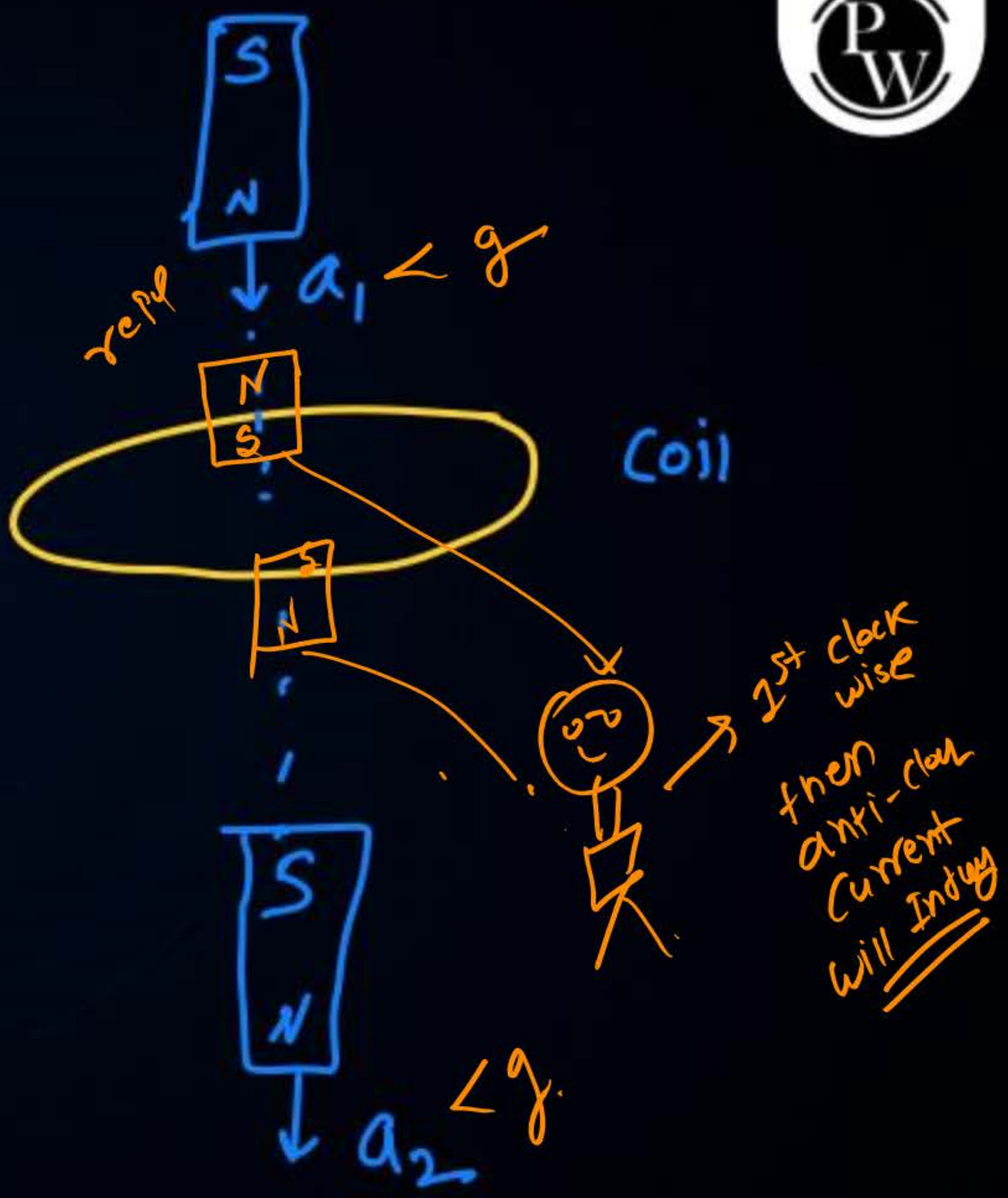
(a) $a = g$

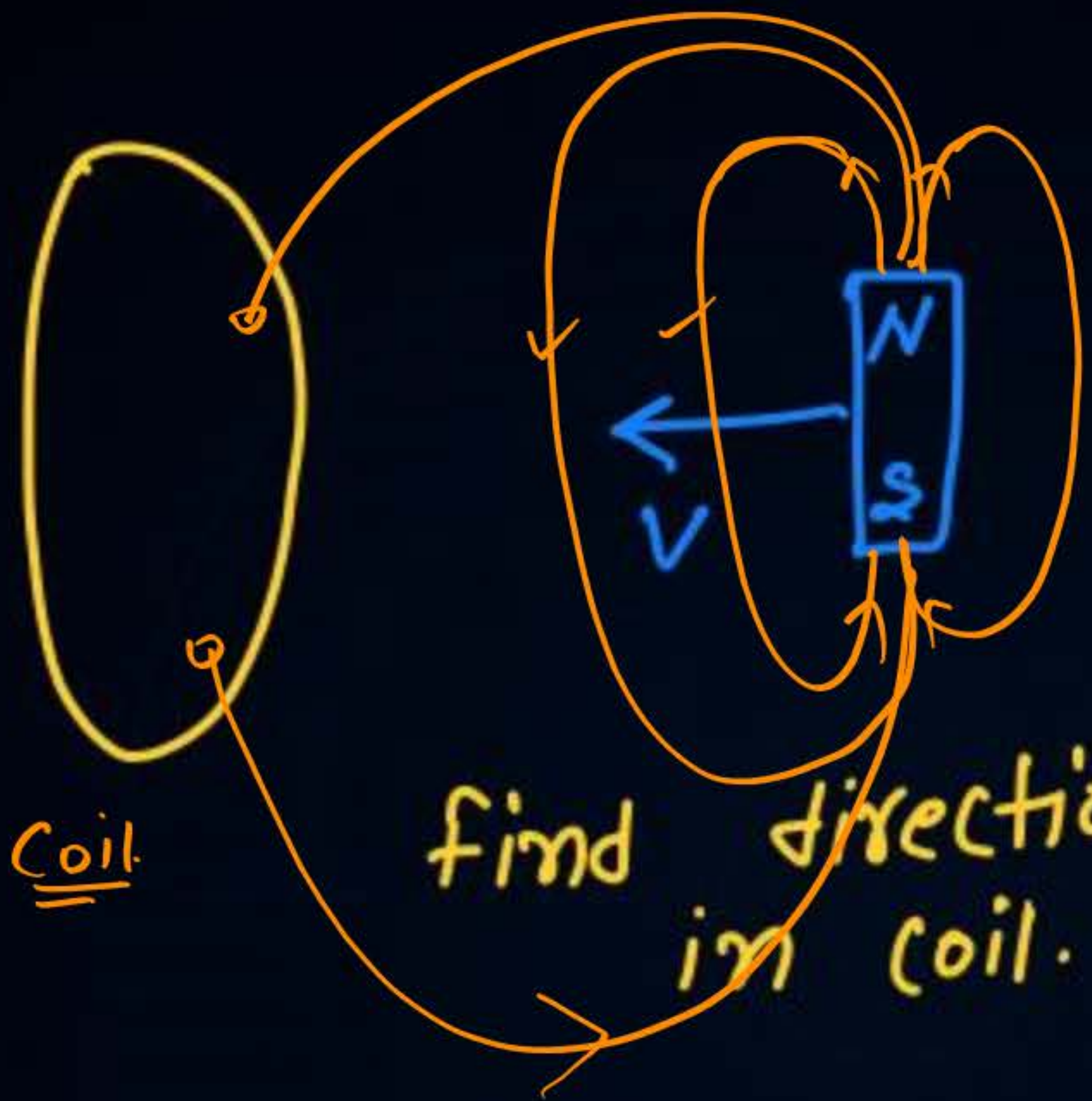
(b) $a < g$ ✓

(c) $a > g$



find direction of Induced current when magnet is moving towards the coil and when moving away.

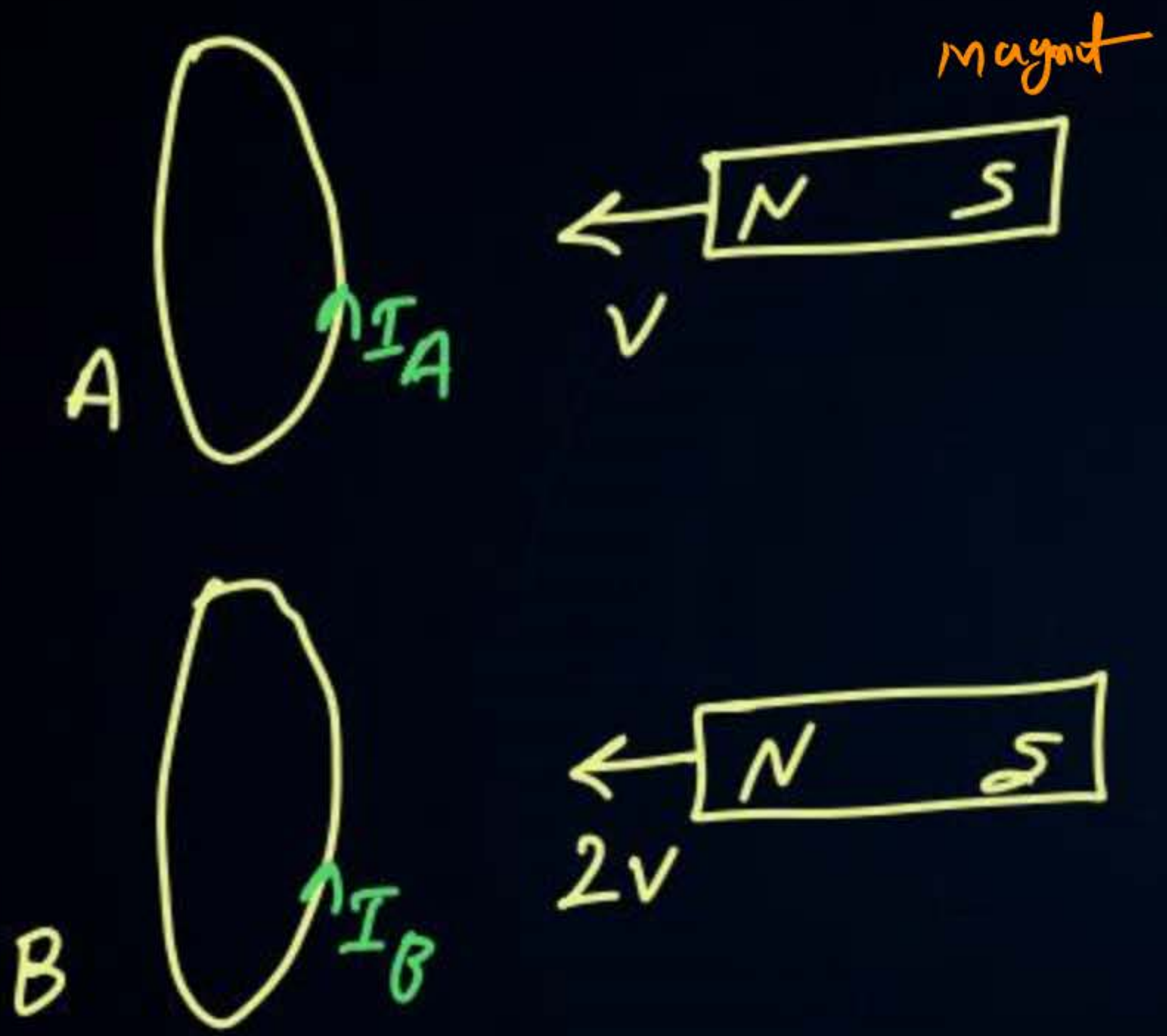




find direction of Induced current in coil.



$I_{indu} = zero$



$I_A < I_B$

Rate of change in flux in coil-2 is greater than coil-1

QUESTION

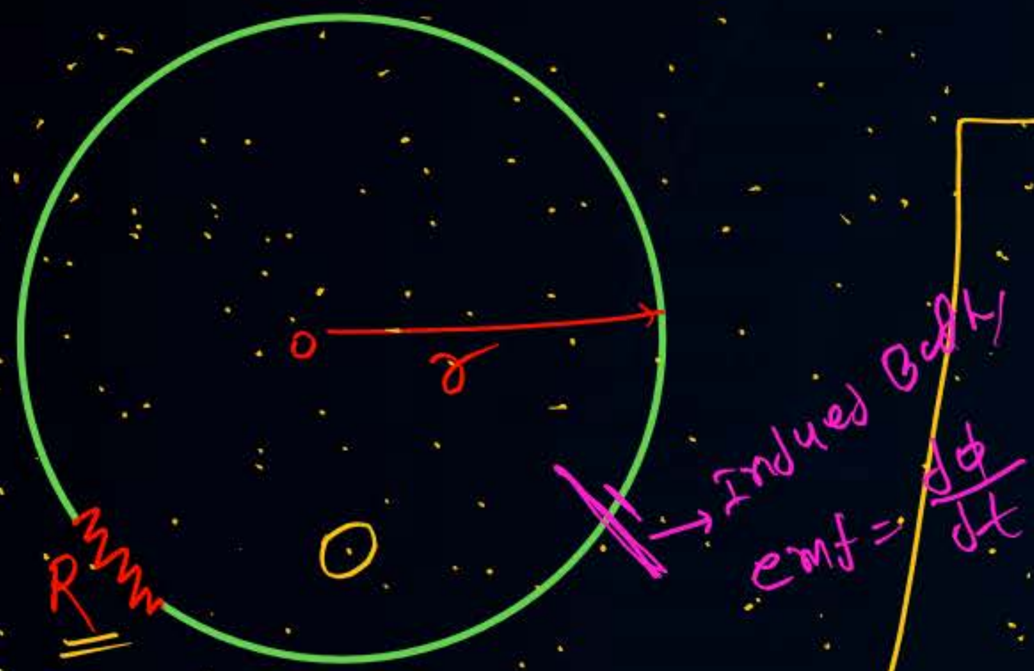
Magnetic field is Increasing with time then which plate of Capacitor becomes –Ve. charge



faradys चाचा Law of electromagnetic Induction

लोहा, लकड़ी, प्लास्टिक हो, टूटा हुआ तार, नाप पुराना स्य, copy

When flux is variable through any close-loop there is Induce emf (Potential diff) (Battery) in that loop.



B⊙ (change/varible)

$$emf = -\frac{d\phi}{dt}$$

↑ dir^n

$$|emf| = \frac{d\phi}{dt}$$

$$\phi = BA\cos\theta$$

$$emf = \frac{d(BA\cos\theta)}{dt}$$

$$I_{Ind} = \frac{emf}{R}$$

$$I = \frac{d\phi}{R\,dt}$$

$$emf = A\cos\theta \frac{dB}{dt}$$

if only B is varible

$$emf = \frac{d\phi}{dt}$$

→ emf does not depend on Nature of loop. | only depend on geometry of loop

emf

In time 't'

$$emf_{Avg} = -\frac{\Delta\phi}{\Delta t}$$

$$|emf|_{Avg} = \frac{\Delta\phi}{\Delta t}$$

$$I_{Avg} = -\frac{\Delta\phi}{R\,\Delta t}$$

$$\frac{\Delta Q}{\Delta t} = \frac{\Delta\phi}{R\,\Delta t}$$

$$\Delta Q_{Induced} = \frac{\Delta\phi}{R}$$

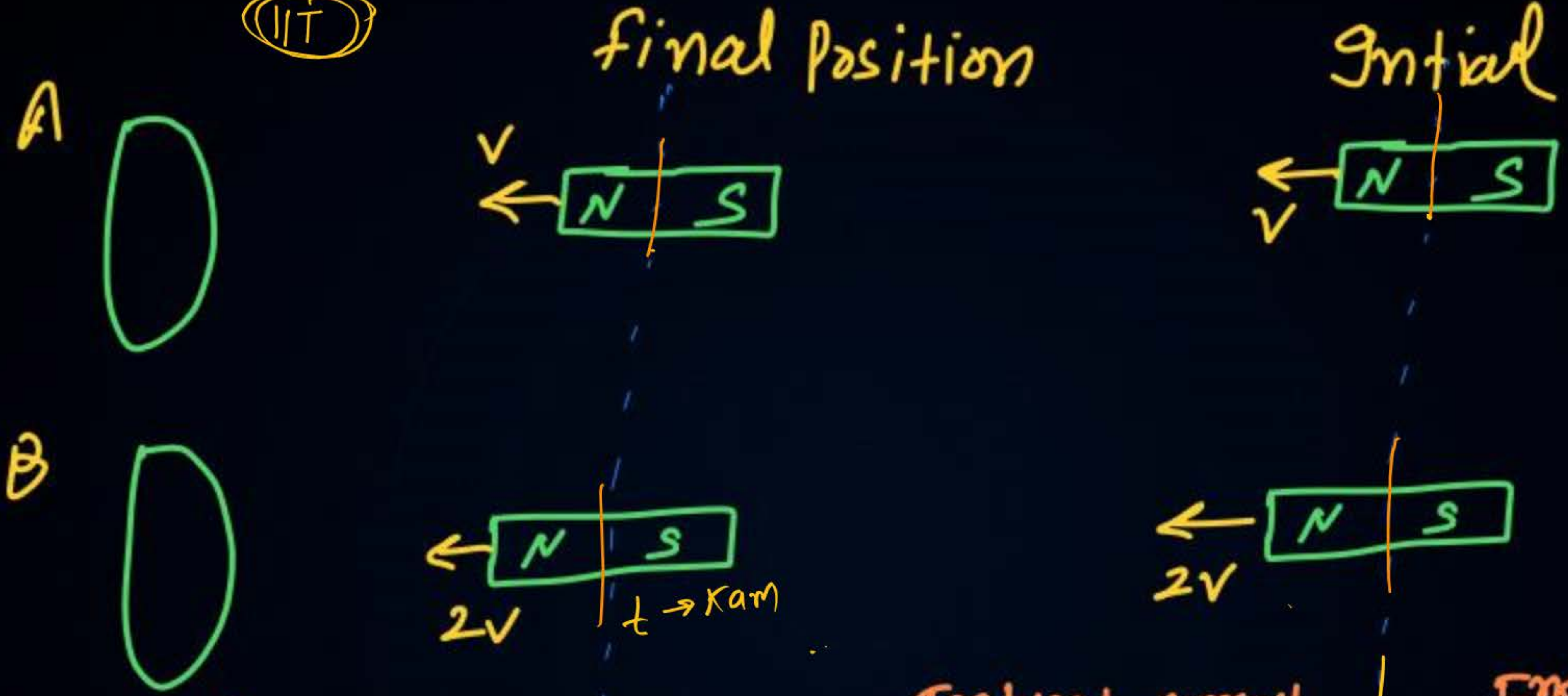
at time 't'

$$emf = -\frac{d\phi}{dt}$$

$$I_{in} = -\left(\frac{d\phi}{dt}\right)/R$$

$$dq = \frac{-d\phi}{R}$$

(IIT)



Induced emf

$$emf_A < emf_B$$

$$emf = \frac{d\phi}{dt}$$ (same)

Induced current

$$I_A < I_B$$

Induced charge

$$Q_{inA} = Q_{inB}$$

$$Q_{in} = \frac{\Delta\phi}{R}$$

Faradays Law of EMI

$$|emf| = \frac{d\phi}{dt}$$

$$emf = \frac{d(BA\cos\phi)}{dt}$$

only B is varible

$emf = A\cos\theta\left(\frac{dB}{dt}\right)$

only Area is varile

$$emf = B\cos\theta\,\frac{dA}{dt}$$

B & A are co

only $\theta \rightarrow$ varib

$$emf = BA\,\frac{d\cos\theta}{dt}$$

H/W

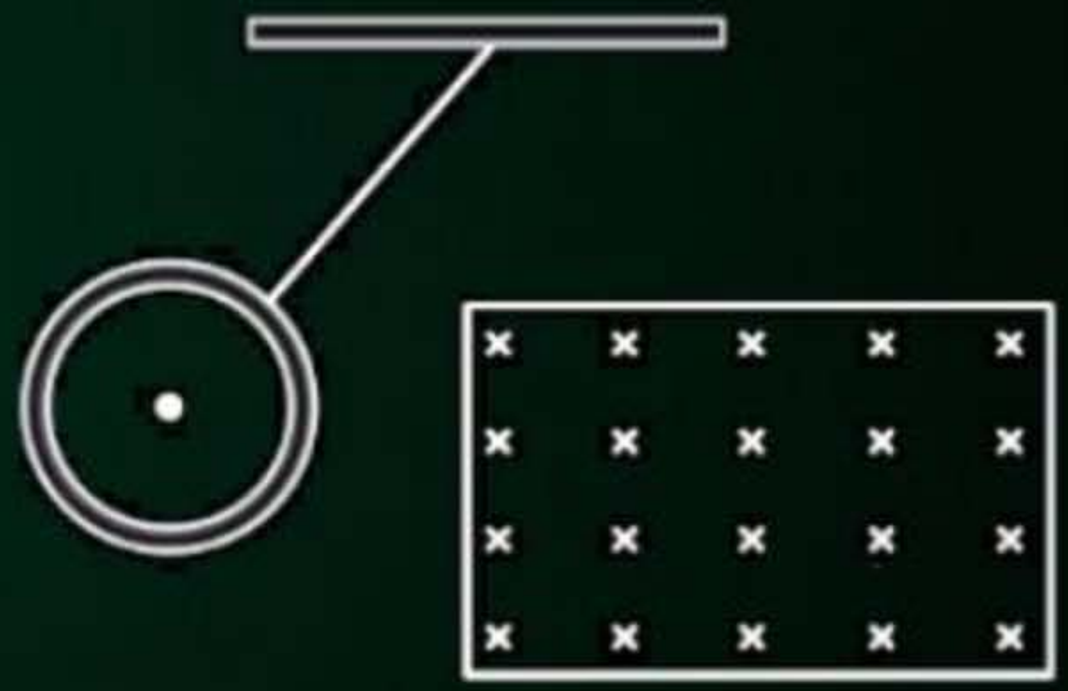
QUESTION

In which case induced current in constant magnitude.



QUESTION

A metallic ring connected to a rod oscillates freely like a pendulum. If now a magnetic field is applied in horizontal direction so that the pendulum now swings through the field, the pendulum will

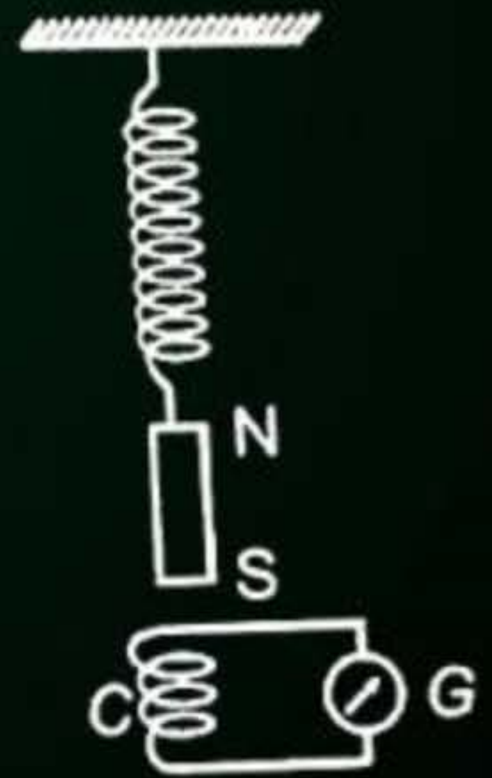


1. Keep oscillating with the old time period
2. Keep oscillating with a smaller time period
3. Keep oscillating with a larger time period
4. Come to rest very soon

QUESTION

A magnet N – S is suspended from a spring and when it oscillates, the magnet moves in and out of the coil C. The coil is connected to galvanometer G. Then, as the magnet oscillates, G shows

1. No deflection
2. Deflection to the left and right but the amplitude steadily decreases
3. Deflection to the left and right with constant amplitude
4. Deflection on one side



QUESTION

Lenz's law is consequence of the law of conservation of

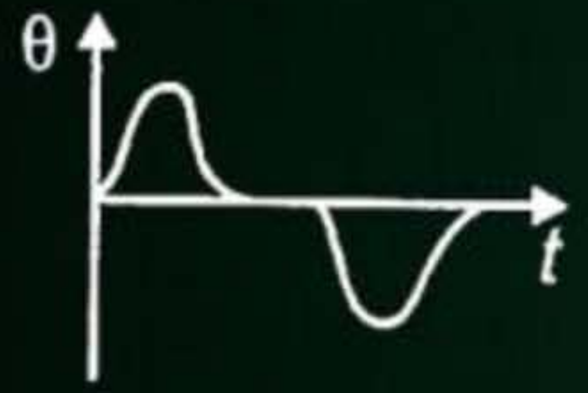
[JIPMER 1997; CPMT 1990; RPMT 1997; MP PET 1999; MP PMT 2000, 03; RPET 2003; AFMC; AFMC 2004]

1. Charge
2. Momentum
3. Mass
4. Energy

QUESTION

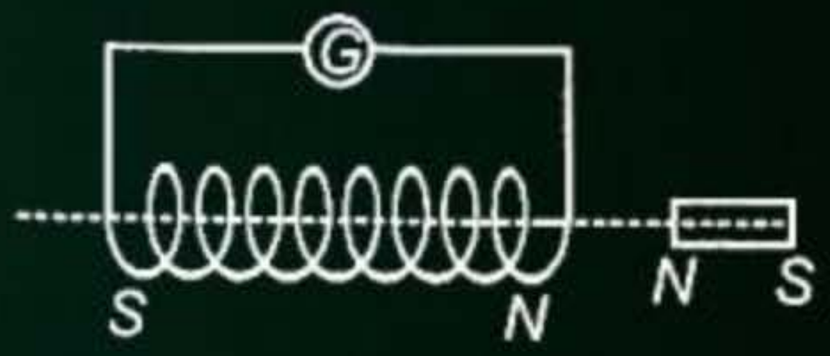
A short bar magnet passes at a steady speed right through a long solenoid. A galvanometer is connected across the solenoid. Which graph best represents the variation of the galvanometer deflection θ with time t?

(1)

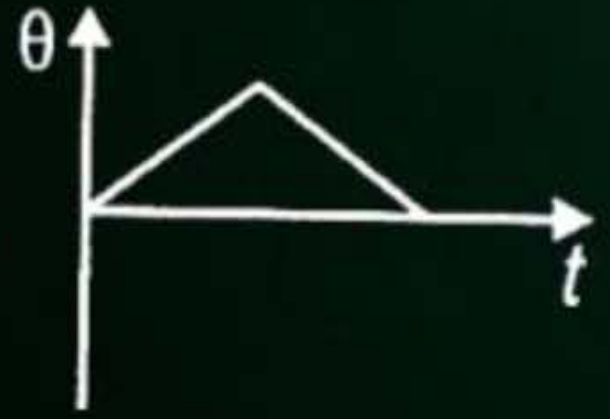


(2)

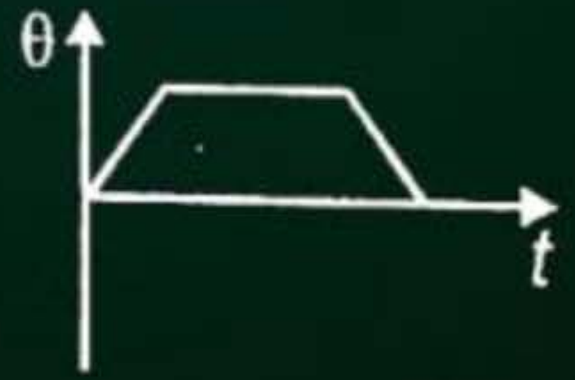




(3)



(4)



QUESTION

According to Faraday's law of electromagnetic induction [MP PET 1994]

1. The direction of induced current is such that it opposes the cause producing it
2. The magnitude of induced e.m.f. produced in a coil is directly proportional to the rate of change of magnetic flux
3. The direction of induced e.m.f. is such that it opposes the cause producing it.
4. None of the above

QUESTION

a coil having an area $2m^2$ is placed in a magnetic field which changes from $1Wb/m^2$ to $4Wb/m^2$ in a interval of 2 second. the e.m.f. induced in the coil will be

[DPMT 1999; MP PET 2002]

emf

1. 4V
2. 3V
3. 2V
4. 5V

QUESTION

a coil of area 100 cm^2 has 500 turns. Magnetic field of 0.1 weber/$metre^2$ is perpendicular to the coil. the field is reduced to zero in 0.1 second. The induced e.m.f. in the coil is

1. 1 V
2. 5 V
3. 50 V
4. Zero

QUESTION

Magnetic flux through a circuit of resistance 20Ω is changed form 20 Wb to 40 Wb in 5 ms. Charge passed through the circuit during this time is

1. 1 C
2. 2 C
3. Zero
4. 0.5 C

QUESTION

A coil having 500 square loops each of side 10 cm is placed with its plane perpendicular to a magnetic field which increases at a rate of 1.0 tesla/s. The induced e.m.f. (in volts) is

1. 0.5
2. 0.1
3. 1.0
4. 5.0

QUESTION

A conducting circular loop is placed in a uniform magnetic field, $B = 0.025$ T with its plane perpendicular to the loop. The radius of the loop is made to shrink at a constant rate of 1 mm s^{-1}. The induced emf when the radius is 2 cm is [AIPMT (Prelims)-2010]

$\frac{dr}{dt}$

1. $2\pi\ \mu V$
2. $\pi\ \mu V$
3. $\frac{\pi}{2}\ \mu V$
4. $2\ \mu V$

QUESTION

The magnetic flux through a circuit of resistance R changes by an amount $\Delta\phi$ in a time Δt. Then the total quantity of electric charge Q that passes nay point in the circuit during the time Δt is represented by

1. $Q = \frac{1}{R} \cdot \frac{\Delta\phi}{\Delta t}$
2. $Q = \frac{\Delta\phi}{R}$
3. $Q = \frac{\Delta\phi}{\Delta t}$
4. $Q = R . \frac{\Delta\phi}{\Delta t}$


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 3 | Physics

ELECTROMAGNETIC INDUCTION

By- Dr. Manish Raj (MR SIR)

magnetic flux ✓

(*) Lentz law ✓

(*) faradys law of EMI ✓

Hall effect & motion



Topics to be covered

1. # Questions on Faraday's Law
2. # Hall effect (motional emf)
3. #



QUESTION

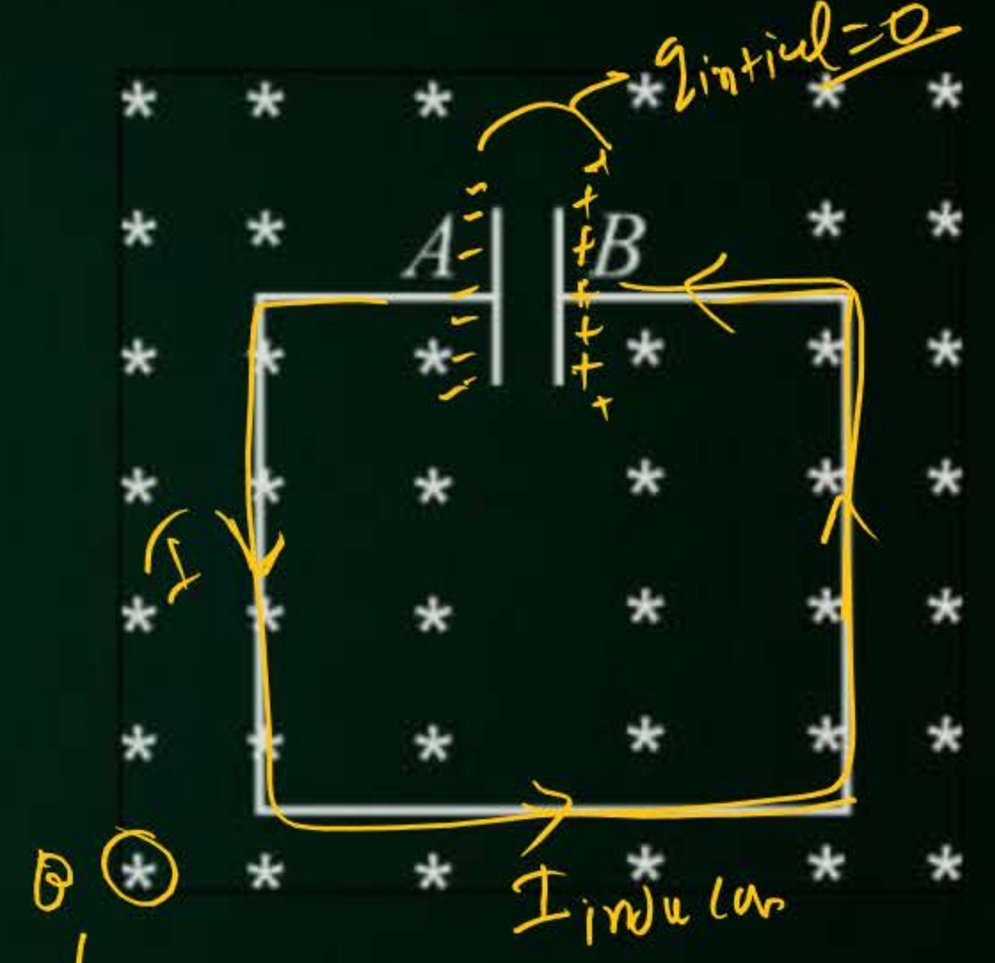
Magnetic field is Increasing with time then which plate of Capacitor becomes –Ve. charged

(a) A (46%)

(b) B

(c) may be A or B

(d) No plate becomes –ve charge → wrong

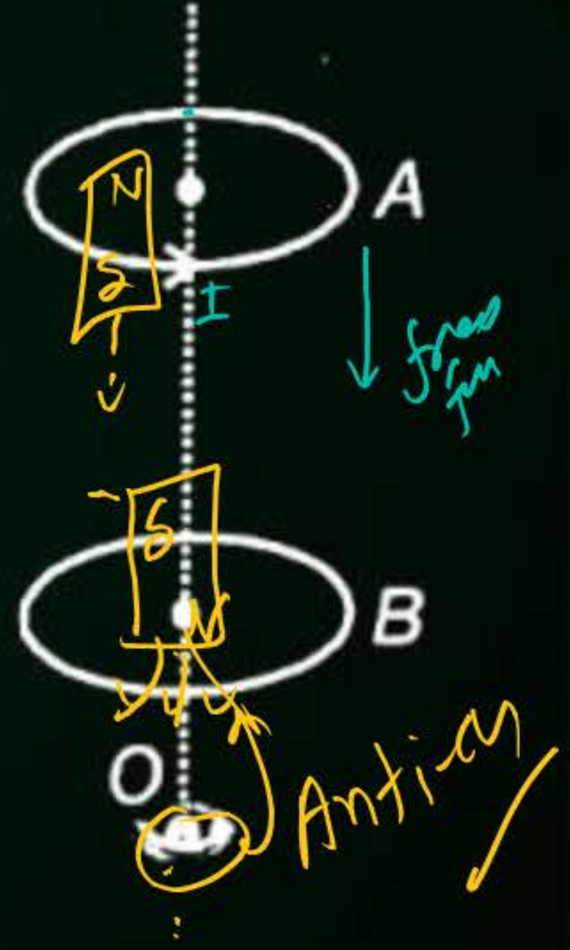


Bindu ⊙ — Anti-clock.

QUESTION

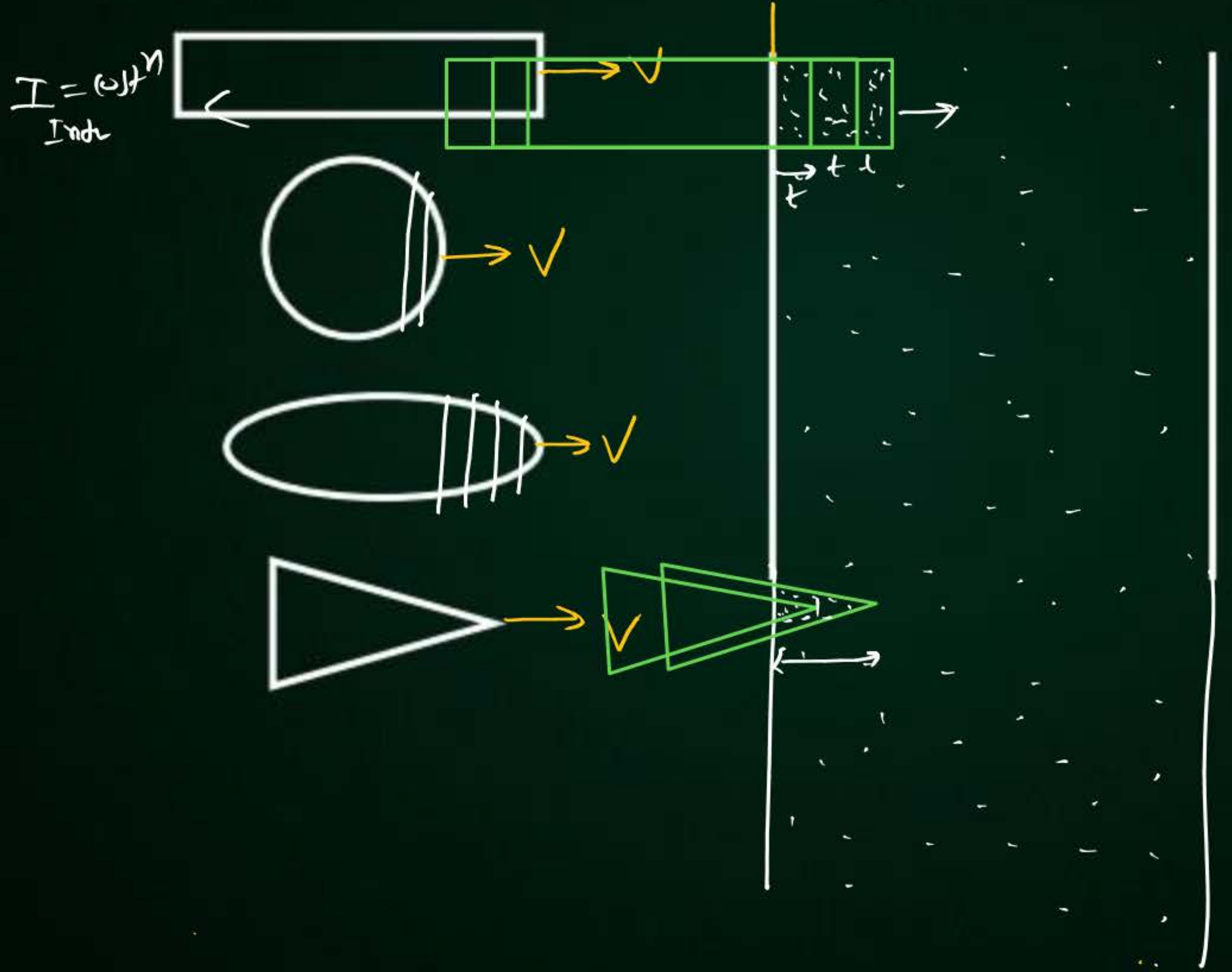
There are two loops A and B placed coaxially along vertical line. Loop A is allowed to fall freely towards loop B. If constant current flowing in loop A is as shown in the figure, then find the direction of flow of induced current in loop B as seen from the bottom of loop B

1. Clockwise
2. Anti-clockwise
3. No current will induce
4. Can't be determine



QUESTION

In which case induced current in constant magnitude. if moving with constⁿ velocity

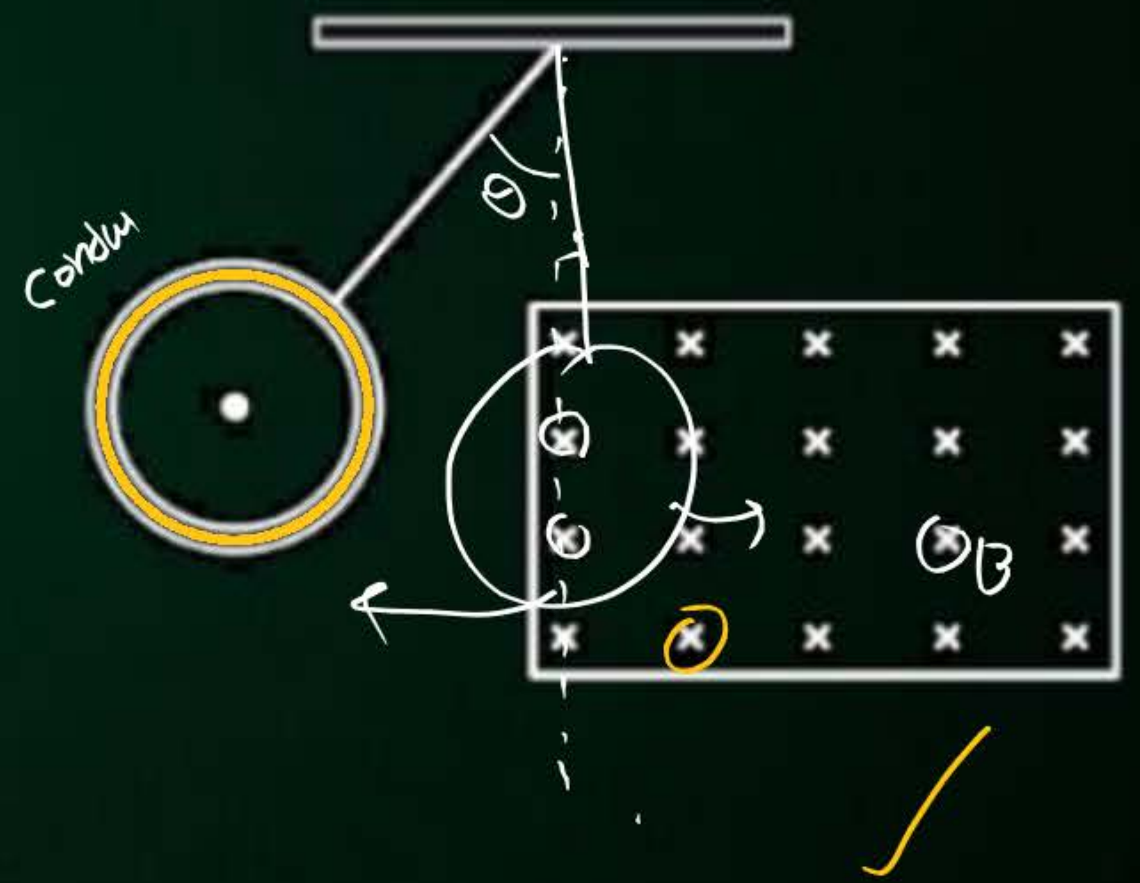


$$I = \frac{emf}{Resis} = \frac{1}{R}\frac{d\phi}{dt}$$

QUESTION

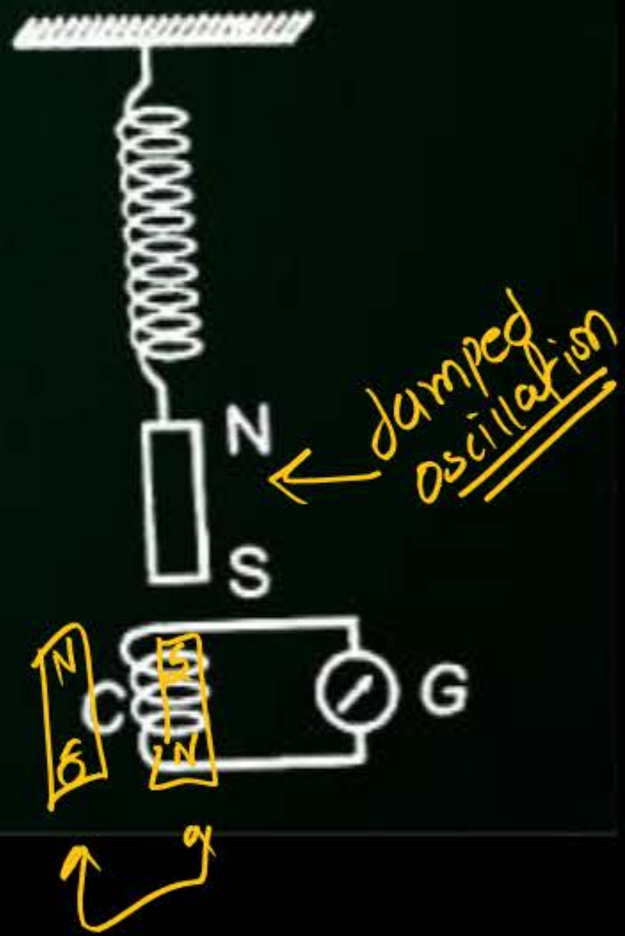
A metallic ring connected to a rod oscillates freely like a pendulum. If now a magnetic field is applied in horizontal direction so that the pendulum now swings through the field, the pendulum will

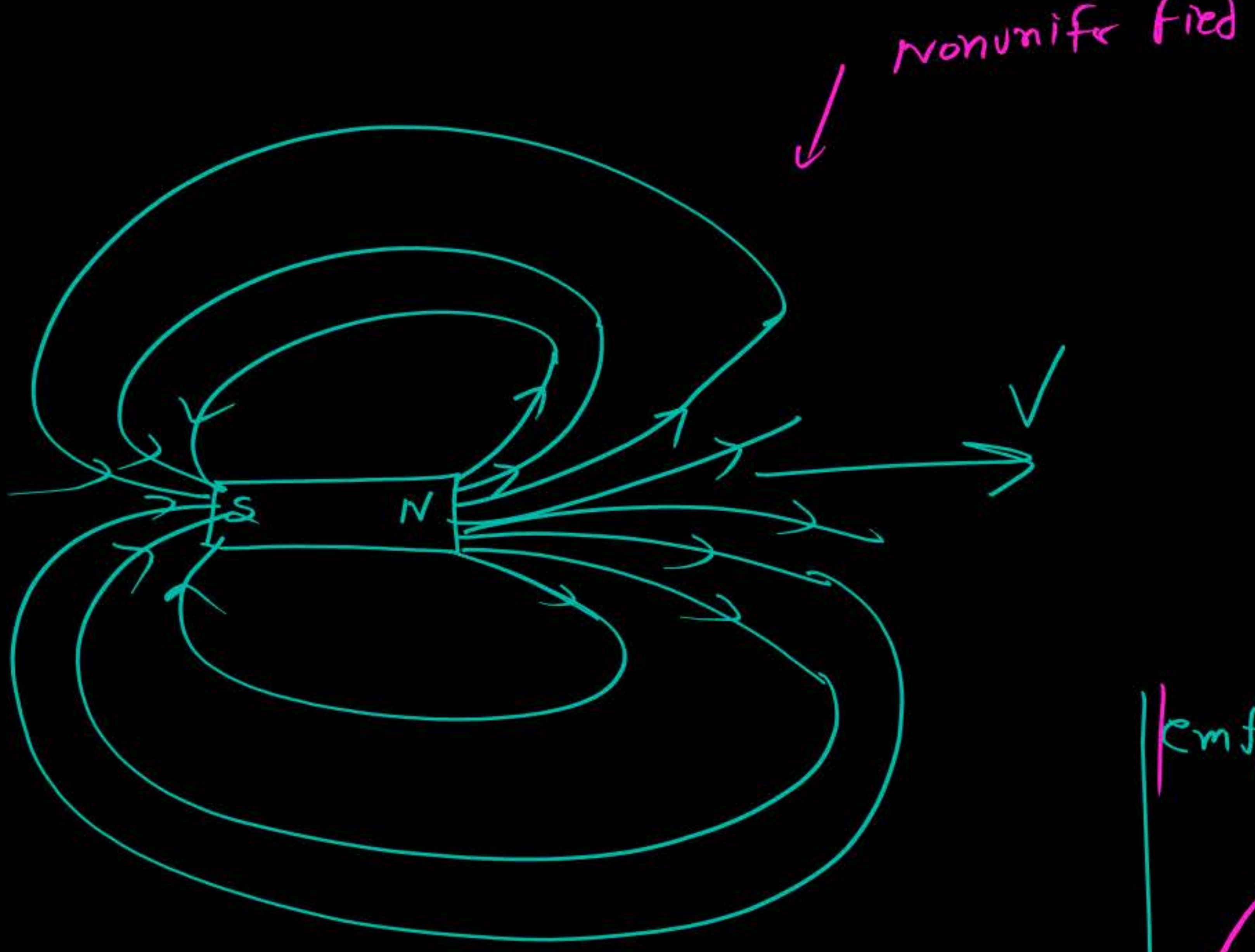
1. Keep oscillating with the old time period
2. Keep oscillating with a smaller time period
3. Keep oscillating with a larger time period
4. Come to rest very soon

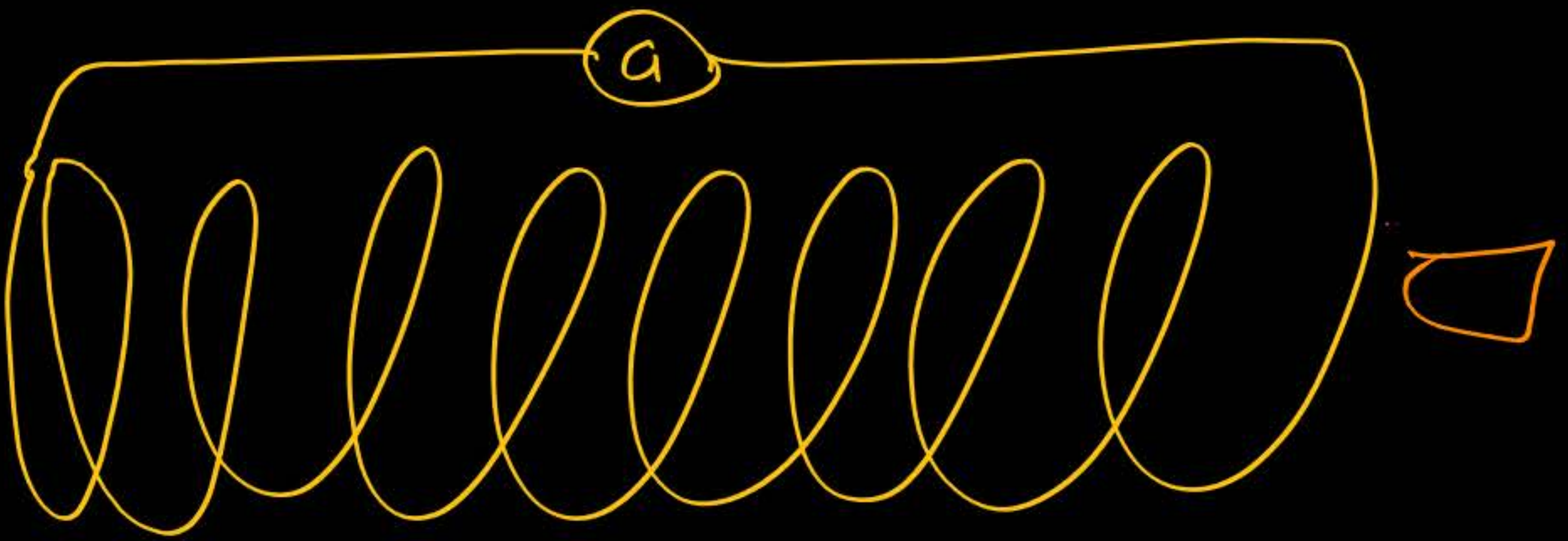


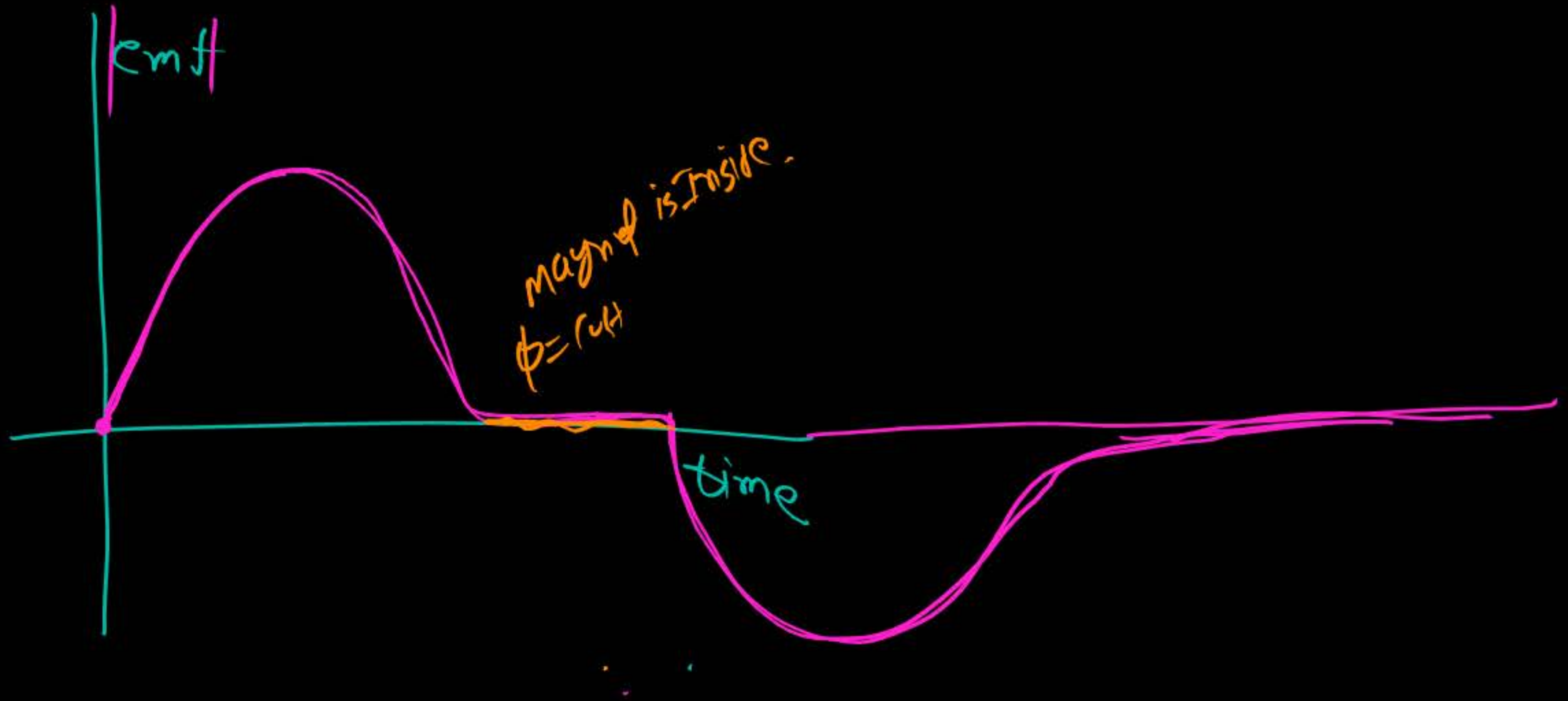
A magnet N – S is suspended from a spring and when it oscillates, the magnet moves in and out of the coil C. The coil is connected to galvanometer G. Then, as the magnet oscillates, G shows

1. No deflection
2. Deflection to the left and right but the amplitude steadily decreases
3. Deflection to the left and right with constant amplitude
4. Deflection on one side



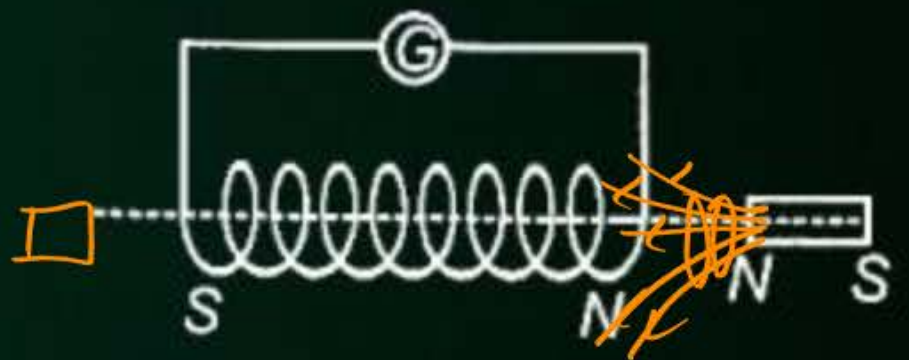

Nonunifr fied
S
N
V

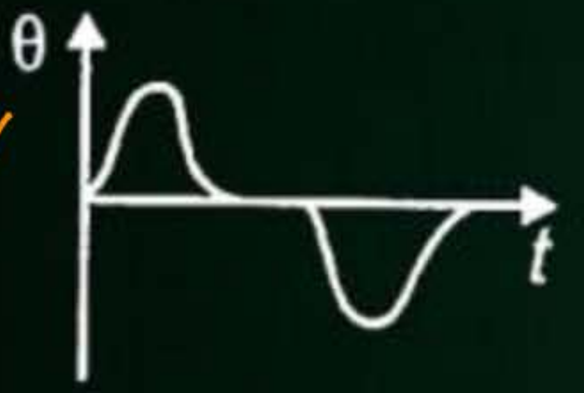


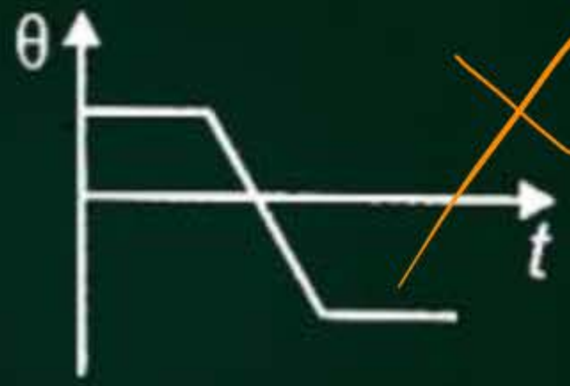

emf
time
magnet is inside.

QUESTION

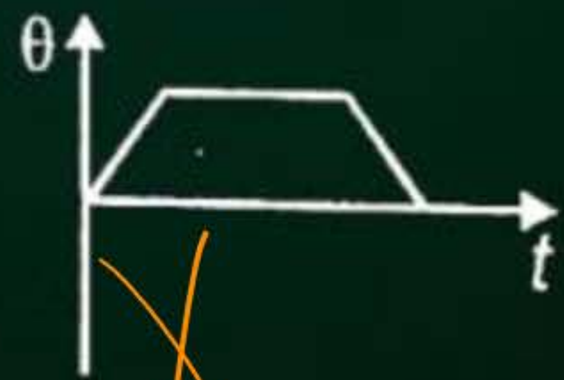
A short bar magnet passes at a steady speed right through a long solenoid. A galvanometer is connected across the solenoid. Which graph best represents the variation of the galvanometer deflection θ with time t?



(1) 

(2) 

(3) 

(4) 

QUESTION

If ϕ is zero at any instant then emf must be zero at that instant ⇒ True/False

Induced

(a) (b)

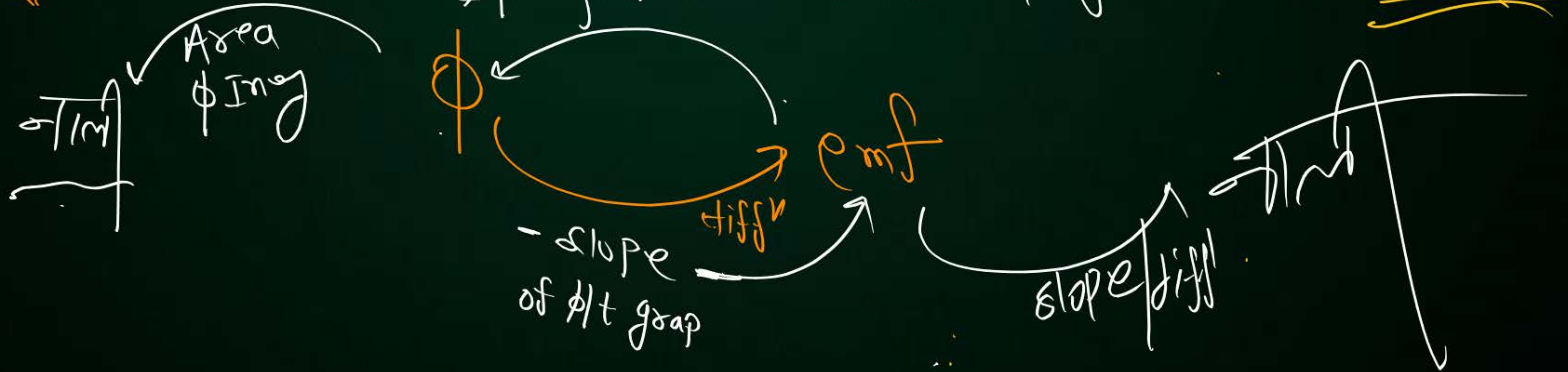
$$emf = -\frac{d\phi}{dt}$$

$$\vec{a} = \frac{d\vec{v}}{dt}$$

If flux is constant then emf must be zero (True)

If v is zero at any instant then acc must be zero ↳ False

$\Delta\phi = -\int emf\, dt = -$ Area of emf/t graph



QUESTION

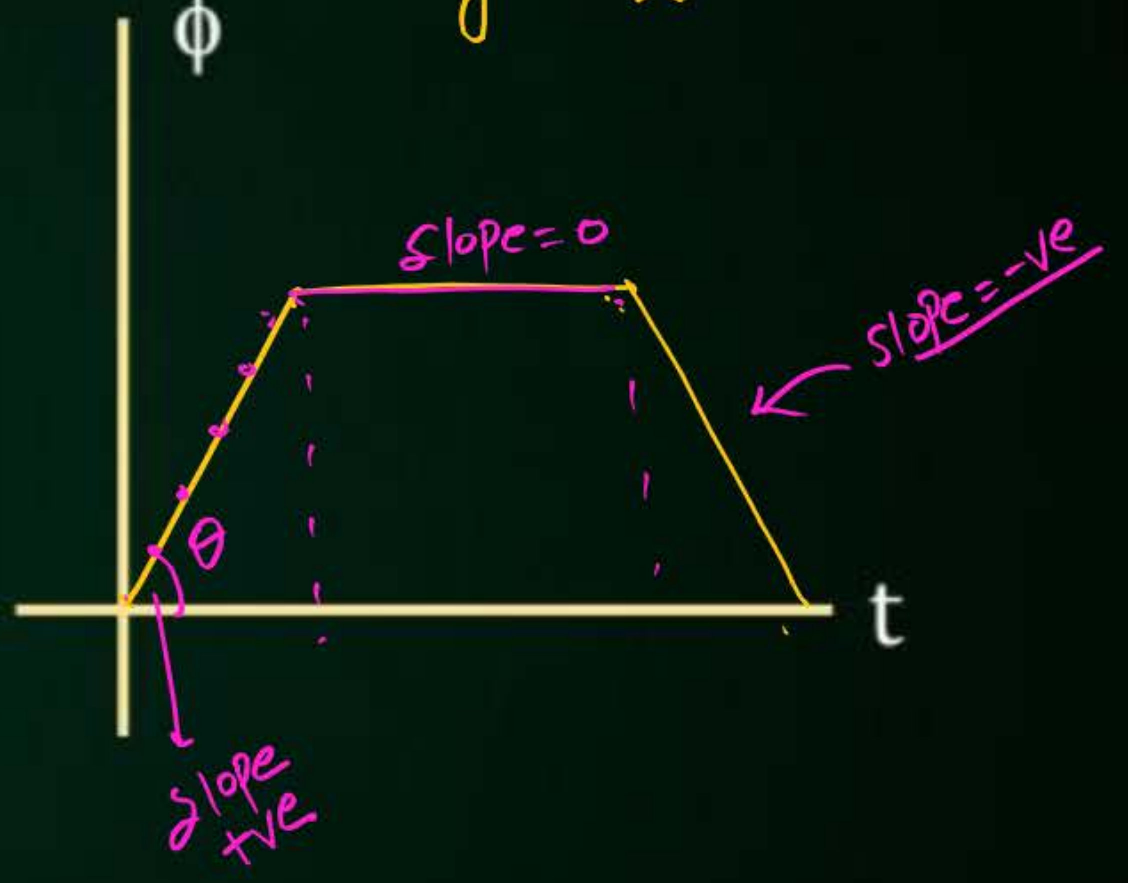
According to Faraday's law of electromagnetic induction [MP PET 1994]

1. The direction of induced current is such that it opposes the cause producing it
2. The magnitude of induced e.m.f. produced in a coil is directly proportional to the rate of change of magnetic flux
3. The direction of induced e.m.f. is such that it opposes the cause producing it.
4. None of the above

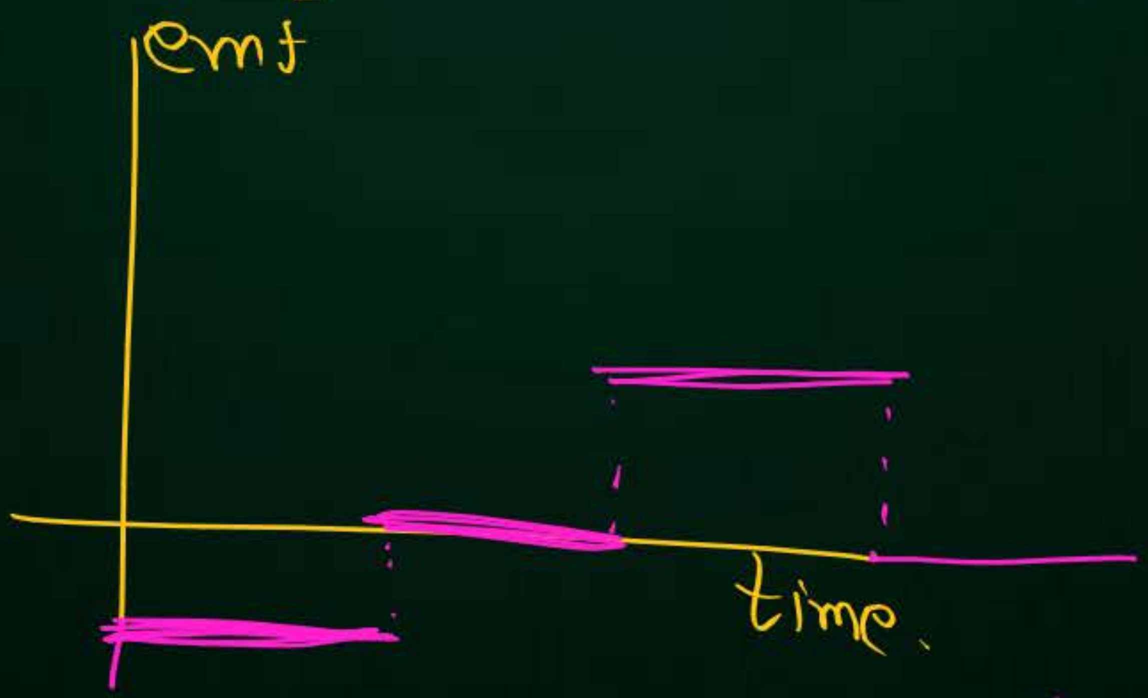
QUESTION

Convert ϕ/t graph into e.m.f. time graph.

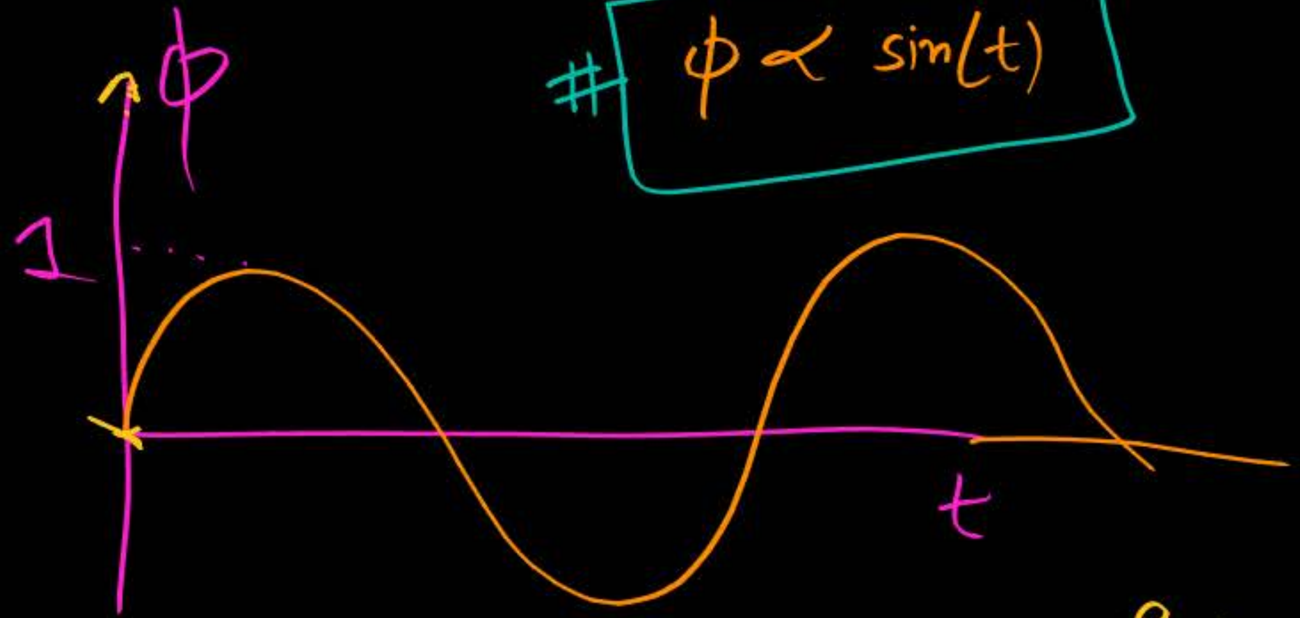
given graph



emf = - slope = dϕ/dt



$\phi \propto \sin(t)$



slope

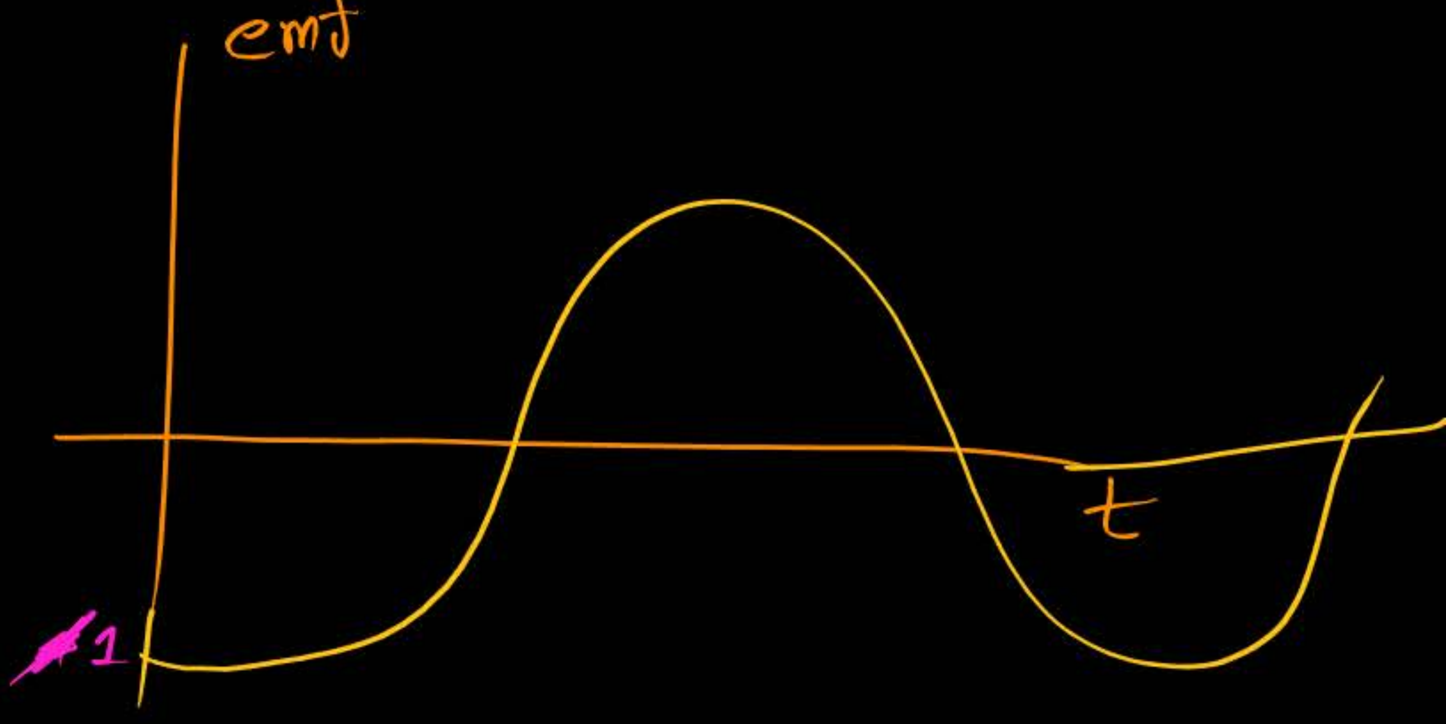
$$\frac{d\phi}{dt} = \frac{d\sin(t)}{dt}$$

$$= \cos(t)$$

$$\frac{d\phi}{dt}$$

$$emf = -\frac{d\phi}{dt}$$

$$= -\cos t$$



QUESTION

Faradys law

a coil having an area $2m^2$ is placed in a magnetic field which changes from $1Wb/m^2$ to $4Wb/m^2$ in a interval of 2 second. the e.m.f. induced in the coil will be

[DPMT 1999; MP PET 2002]

1. 4V
2. 3V
3. 2V
4. 5V

$$emf = -\frac{\Delta\phi}{\Delta t}$$

$$|emf| = \frac{\Delta\phi}{\Delta t}$$

$$(emf)_{Avg} = \frac{\phi_f - \phi_i}{\Delta t} = \frac{B_f A - B_i A}{\Delta t} = \frac{A(B_f - B_i)}{\Delta t} = \frac{2[4-1]}{2} = 3\,\text{volt}$$

QUESTION

a coil of area 100 cm^2 has 500 turns. Magnetic field of 0.1 weber/metre^2 is perpendicular to the coil. the field is reduced to zero in 0.1 second. The induced e.m.f. in the coil is

$B_f = 0$ Interval

1. 1 V
2. 5 V
3. 50 V
4. Zero

$$emf = \frac{\phi_f - \phi_i}{\Delta t} = \frac{-\phi_i}{\Delta t}$$

$$= \frac{BAN}{\Delta t}$$

$$= \frac{0.1 \times 100 \times 10^{-4} m^2 \times 500}{0.1}$$

$$= 5 \text{ volt}$$

QUESTION

The magnetic flux through a circuit of resistance R changes by an amount $\Delta\phi$ in a time Δt. Then the total quantity of electric charge Q that passes nay point in the circuit during the time Δt is represented by

1. $Q = \frac{1}{R} \cdot \frac{\Delta\phi}{\Delta t}$
2. $Q = \frac{\Delta\phi}{R}$
3. $Q = \frac{\Delta\phi}{\Delta t}$
4. $Q = R . \frac{\Delta\phi}{\Delta t}$

QUESTION

Magnetic flux through a circuit of resistance 20Ω is changed form 20 Wb to 40 Wb in 5 ms. Charge passed through the circuit during this time is

1. 1 C
2. 2 C
3. Zero
4. 0.5 C

$$Q = \frac{\Delta\phi}{R} = \frac{20}{20} = 1C$$

QUESTION

A coil having 500 square loops each of side 10 cm ($= 0.1\,m$) is placed with its plane perpendicular to a magnetic field which increases at a rate of 1.0 tesla/s. The induced e.m.f. (in volts) is

1. 0.5
2. 0.1
3. 1.0
4. 5.0 ✓



$\frac{dB}{dt} = 1\ T/s$

$\phi = NBA$

$emf = \frac{d\phi}{dt}$

$= \frac{d(NBA)}{dt}$

$= NA\left(\frac{dB}{dt}\right)$

$= 500 \times 10^{-2} m^2 \times 1$

$= 5\ volt$

QUESTION

A conducting circular loop is placed in a uniform magnetic field, B = 0.025 T with its plane perpendicular to the loop. The radius of the loop is made to shrink at a constant rate of 1 mm s^{-1}. The induced emf when the radius is 2 cm is **[AIPMT (Prelims)-2010]**

1. $2\pi\ \mu V$
2. $\pi\ \mu V$
3. $\frac{\pi}{2}\ \mu V$
4. $2\ \mu V$

Const^n

1×10^{-3} m/s

$\frac{dr}{dt} = -1 \times 10^{-3}$ m/s

$\phi = B\pi r^2$

$emf = \frac{d\phi}{dt} = B\pi \frac{dr^2}{dt}$

$= \frac{25}{1000} \times \pi\, 2r \frac{dr}{dt}$

$emf = \frac{25}{1000} \times \pi \times 2 \times 2 \times 10^{-2} \times 10^{-3}$

$= \frac{50}{1000} \pi \times 2 \times 10^{-2}$

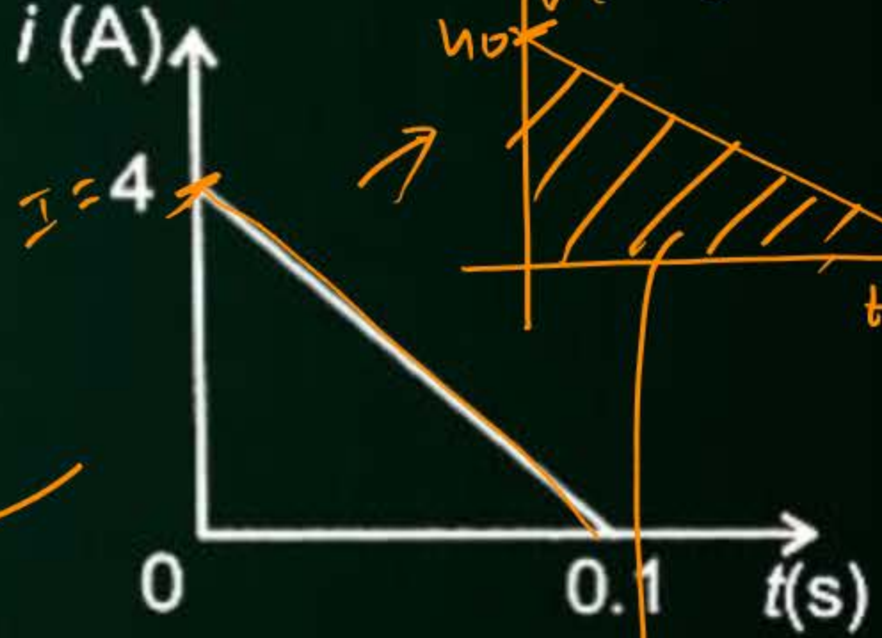
$= \pi \times 10^{-6}$ Volt

QUESTION

In a coil of resistance of 10Ω, the induced current developed by changing magnetic flux through it, is shown in figure as a function of time. The magnitude of change in flux through the coil in Weber is

[AIPMT (Main)-2012]

1. 8
2. 2
3. 6
4. 4



QUESTION

A current $I = 1.5$ A is flowing through a long solenoid of diameter 3.2 cm, having 220 turns per cm. At its centre, a 130 turn closely packed coil of diameter 2.1 cm is placed such that the coil is coaxial with the long solenoid. The current in the solenoid is reduced to zero at a steady rate in 25 ms. What is the magnitude of emf induced in the coil while the current in the solenoid is changing?

H/W

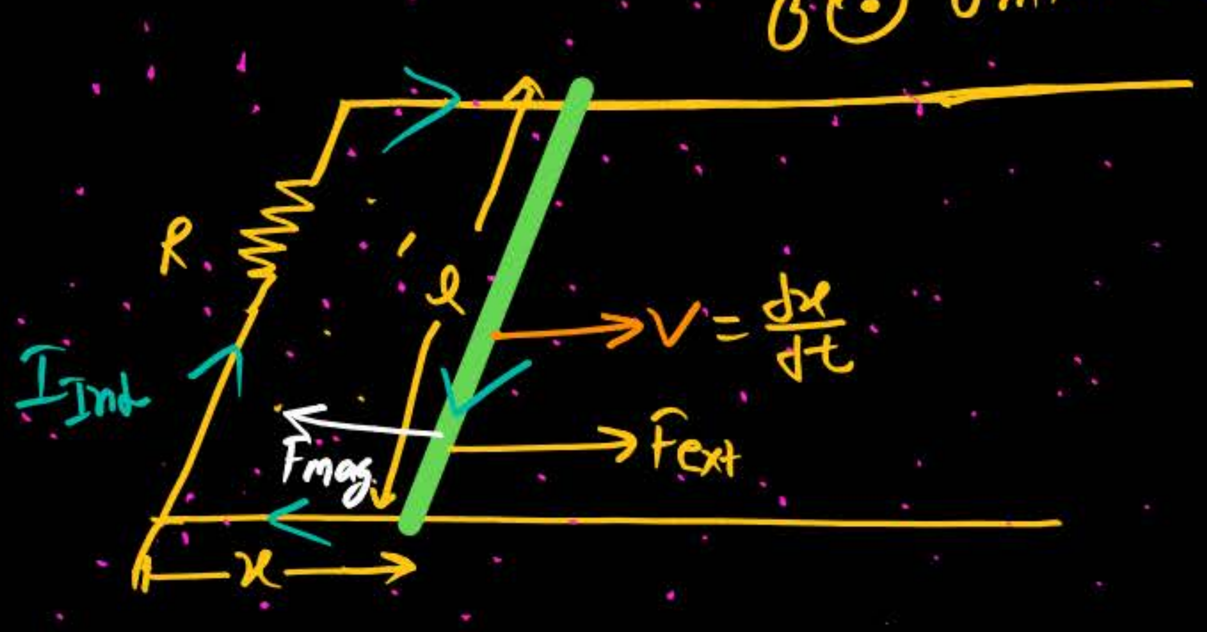
$emf_{Avg} = \frac{\Delta\phi}{\Delta t}$

hint

$\phi = NBA$

$\phi = N(\mu_0 n I)A$

Rail Prob^m [fixed Horizontal Rail]



Area at any instant $= lx$

$\phi = Blx \cos 0^\circ$

$\phi = Blx$

faradys चाचा ka Law

• $|emf| = \frac{d\phi}{dt} = Bl\frac{dx}{dt} = Blv$

Magnitude

$|emf|_{\text{induce emf in loop}} = Blv$

$I_{induce} = \frac{emf}{R} = \frac{Blv}{R}$

↳ clockwise (Lentz)

Magnetic field on current carrying wire.

$F = Bil = B\left(\frac{Blv}{R}\right)l$

$F_{mag} = \frac{B^2l^2v}{R}$

Fext force applied on wire So that wire can move with constant velocity.

$F_{ext} = \frac{B^2l^2v}{R}$

Power delivered by external force

$P = F \cdot V = \frac{B^2l^2V^2}{R}$

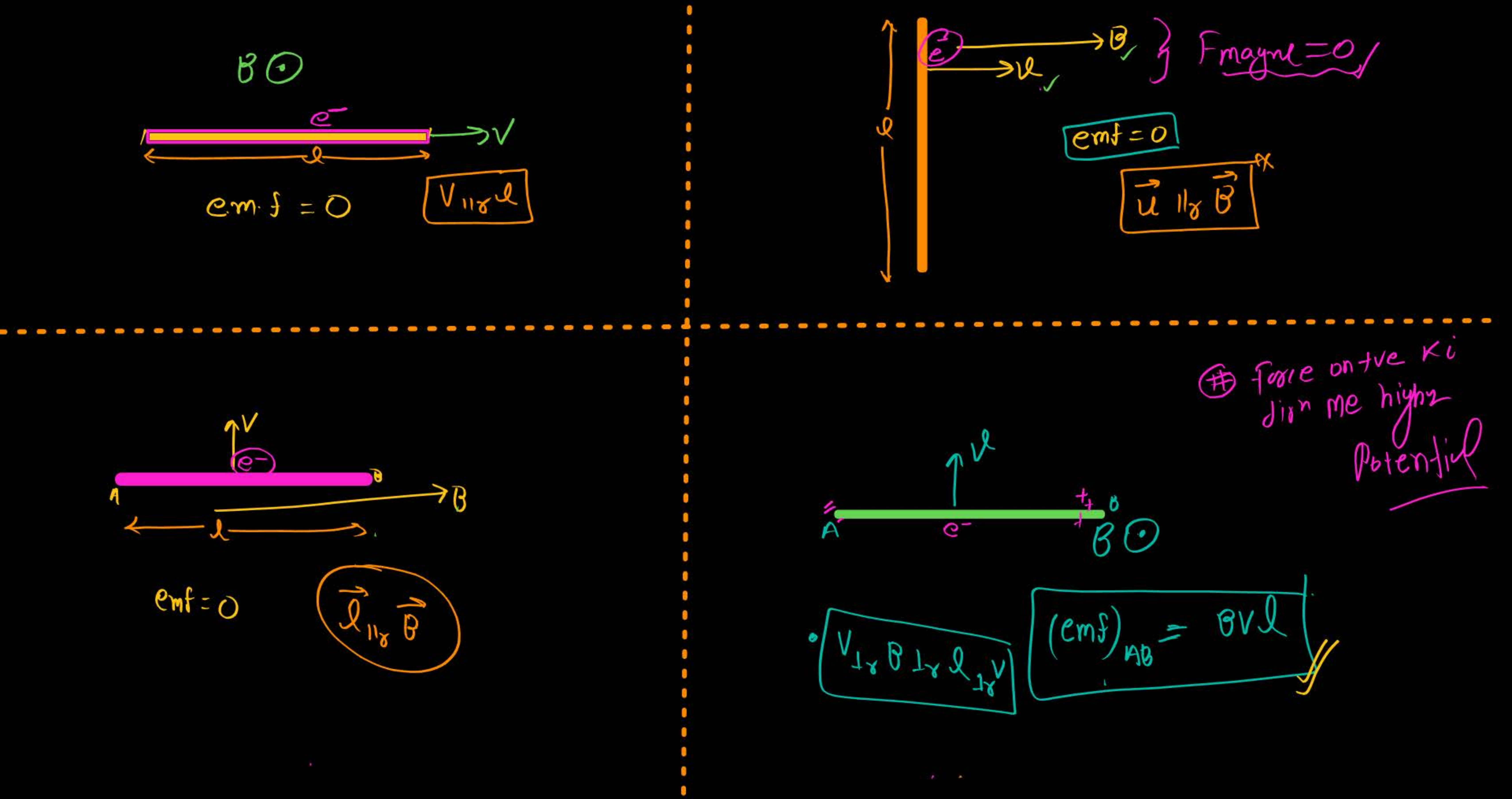
Rod is moving with velocity v then find Induced emf in loop.



$emf_{AB} = BlV$

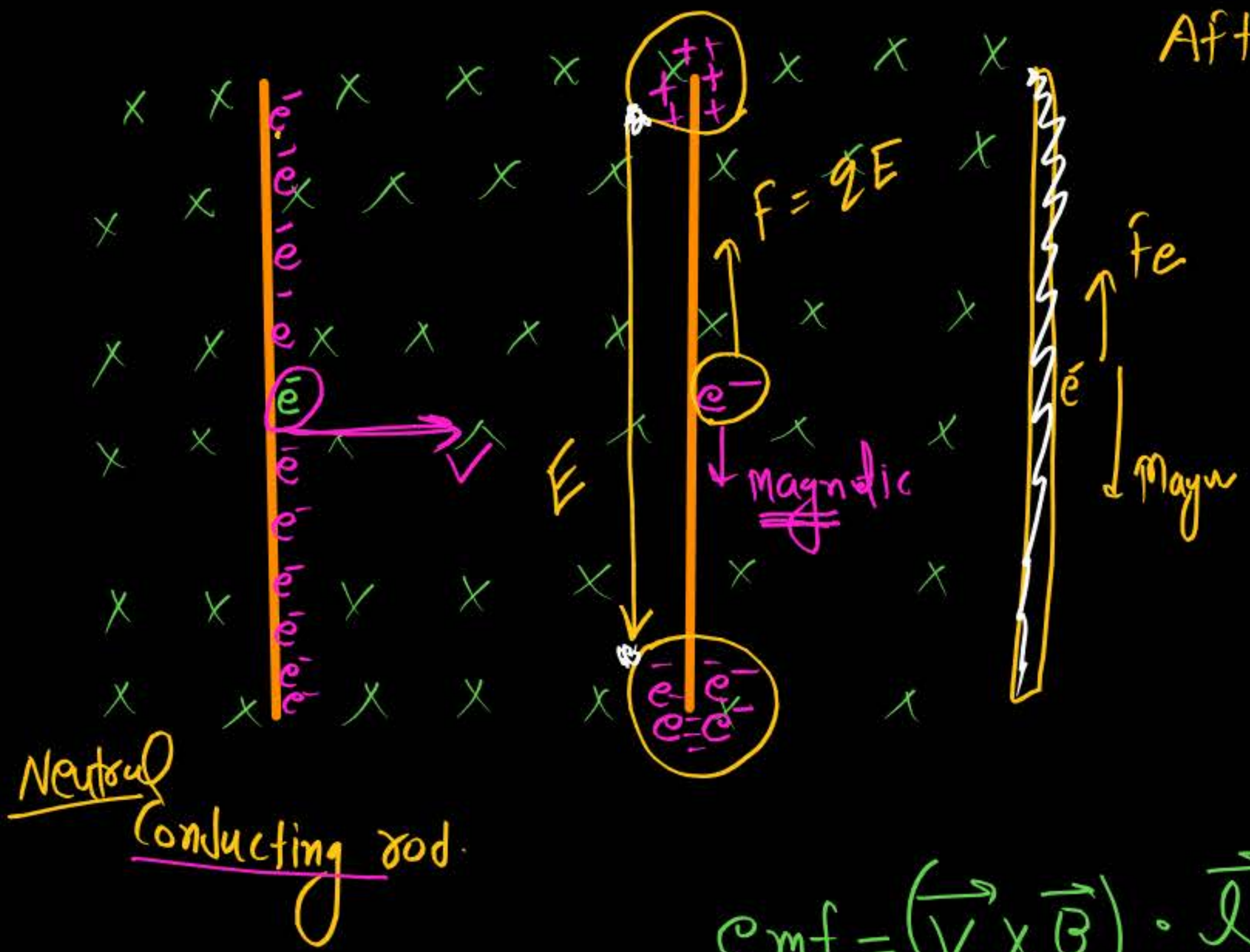
↳ motional emf

Hall effect



B ⊙
e⁻
V
l
e.m.f = 0
V ∥r l
e⁻
B
v
F magne = 0
l
emf = 0
u ∥r B
V
e⁻
A
B
B
l
emf = 0
l ∥r B
force on +ve ki dirn me higher Potential
v
A
B
e⁻
B ⊙
V ⊥r B ⊥r l ⊥r V
(emf)AB = BVl

Motional emf [The Hall effect]



After some time

$F_e = F_{mag}$ (equilibrium)

$qE = qVB$

$E = VB$

$\frac{\Delta V}{l} = VB$

ΔV (emf) $= VBl$ — Scalar form

$$emf = (\vec{V} \times \vec{B}) \cdot \vec{l}$$

$$emf = V_{\perp r} \times B_{\perp r} \times l_{\perp r}$$

$f_e = F_{mag}$

$qE = q(\vec{V} \times \vec{B})$

$\frac{\Delta V}{l} = (\vec{V} \times \vec{B})$

$\Delta V(emf) = (\vec{V} \times \vec{B}) \cdot \vec{l}$

$emf = (\vec{V} \times \vec{B}) \cdot \vec{l}$

$\hat{i} \times \hat{j}$ ... $\hat{j}$

↳ Scalar Triple Product

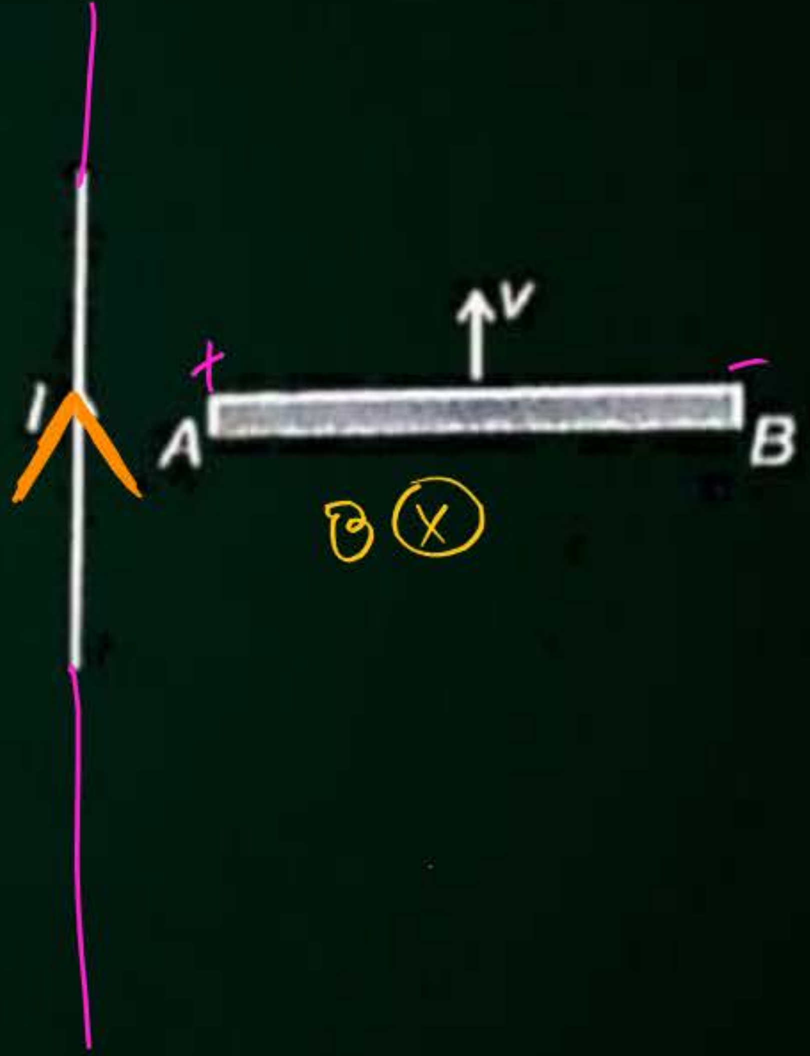
$emf = (\hat{i} \times \hat{j}) \cdot \hat{i}$

$= \hat{k} \cdot \hat{i} = 0$

QUESTION

$|E| = \frac{\Delta v}{\Delta l} = \frac{\Delta v}{l}$

The current carrying wire and the rod AB are in same plane. The rod moves parallel to the wire with a velocity v. Which one of the following statement is true about induced emf in the rod?



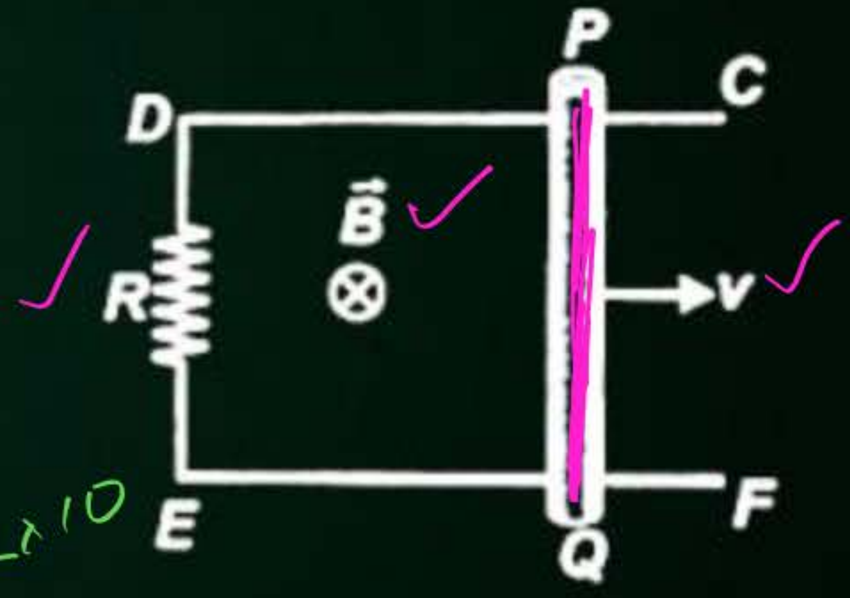
1. End A will be at lower potential with respect to B
2. A and B will be at same potential
3. There will be no induced emf in the rod
4. Potential at A will be higher than that at B

QUESTION

A frame CDEF is placed in a region where a magnetic field $\vec{B}$ is present. A rod of length one metre moves with constant velocity 20 m/s and strength of magnetic field is one tesla. The power spent in the process is (take $R = 0.2\ \Omega$ and all other wires and rod have zero resistance)

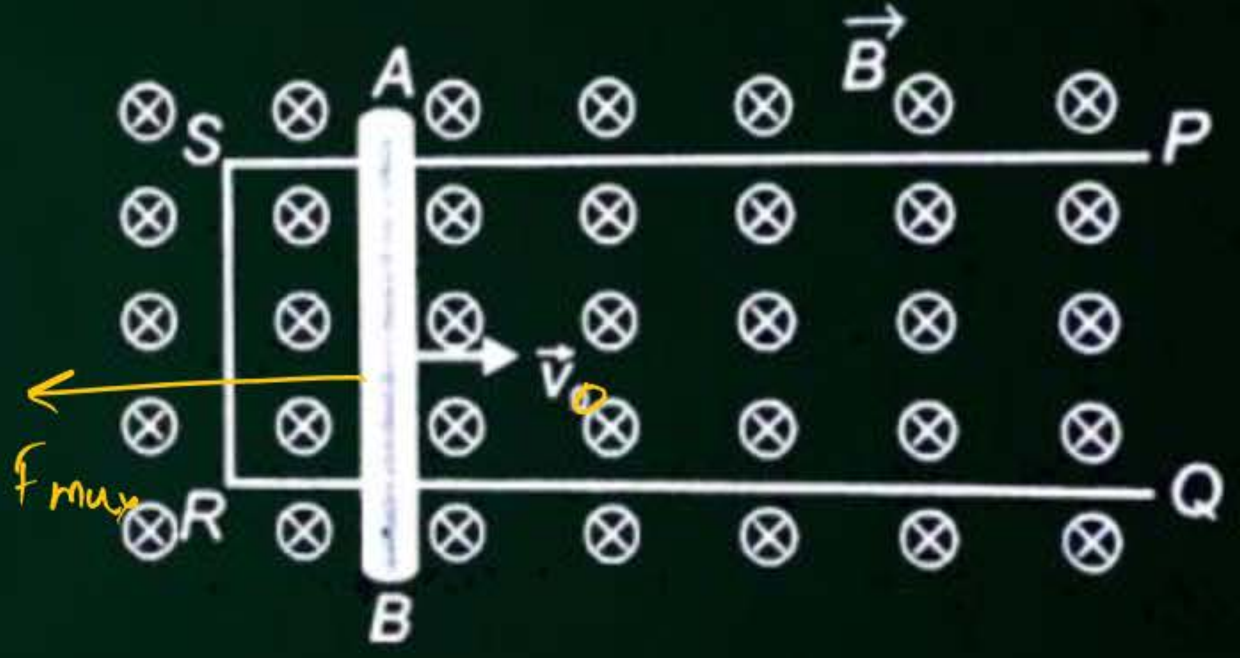
1. 1 kW
2. 2 kW
3. 3 kW
4. 4 kW

$$P = \frac{B^2 l^2 v^2}{R} = \frac{(1)^2 (1)^2 \times (20)^2}{\frac{2}{10}} = \frac{400 \times 10}{2} = 2 \times 10^3$$



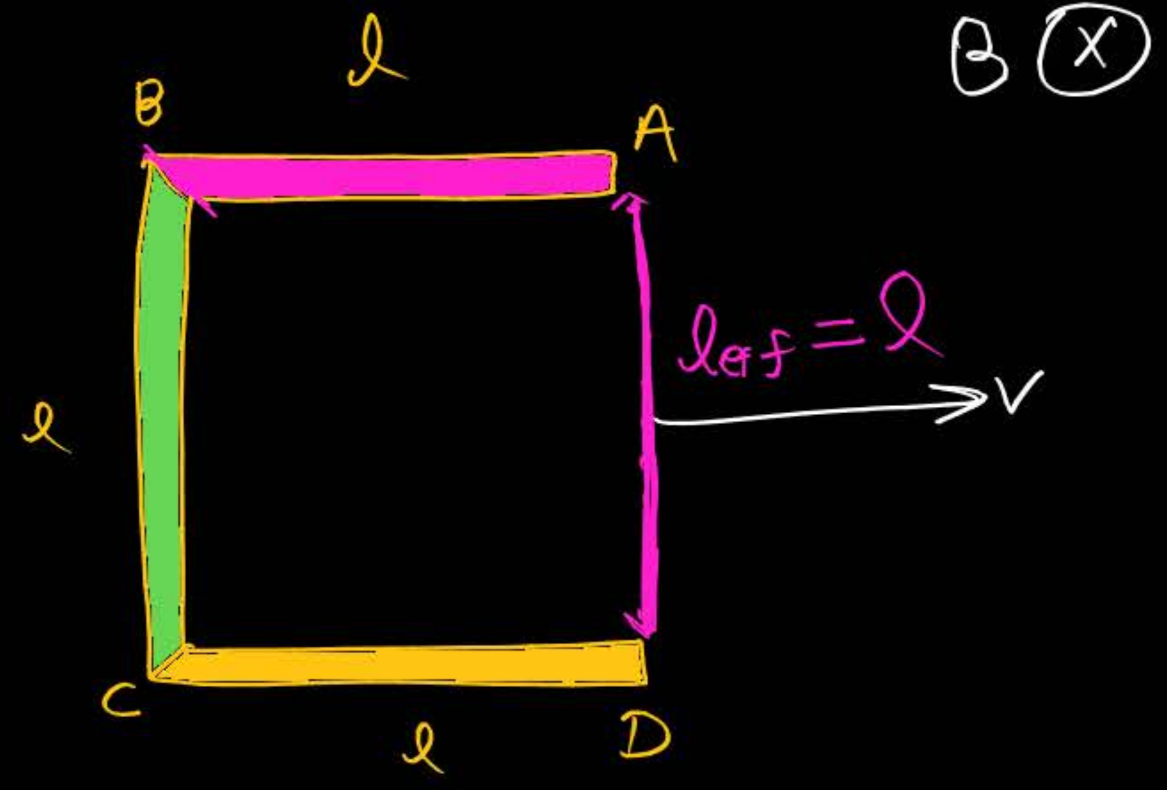
QUESTION

A conducting rod AB of length l is projected on a frictionless frame $PSRQ$ with velocity v_0 at any instant. The velocity of the rod after time t is



1. $v = v_0$
2. $v > v_0$
3. $v < v_0$
4. None of these

emf in const wire (A & CD)



$(emf)_{AB} = 0 = (emf)_{CD}$

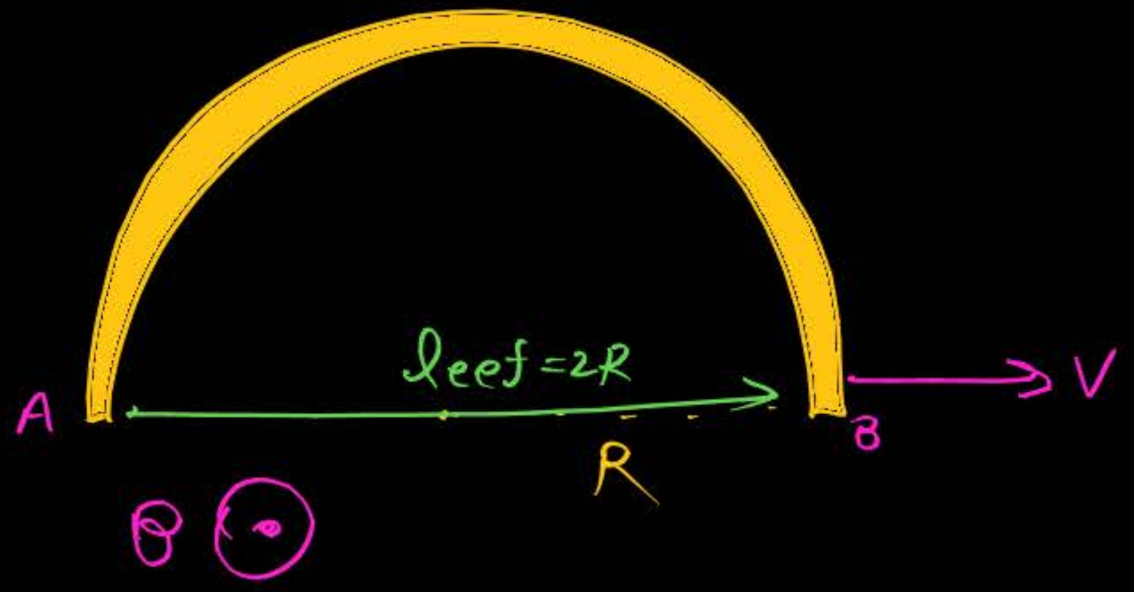
$emf_{BC} = BVl.$

$$\boxed{emf_{Total} = BVl}$$

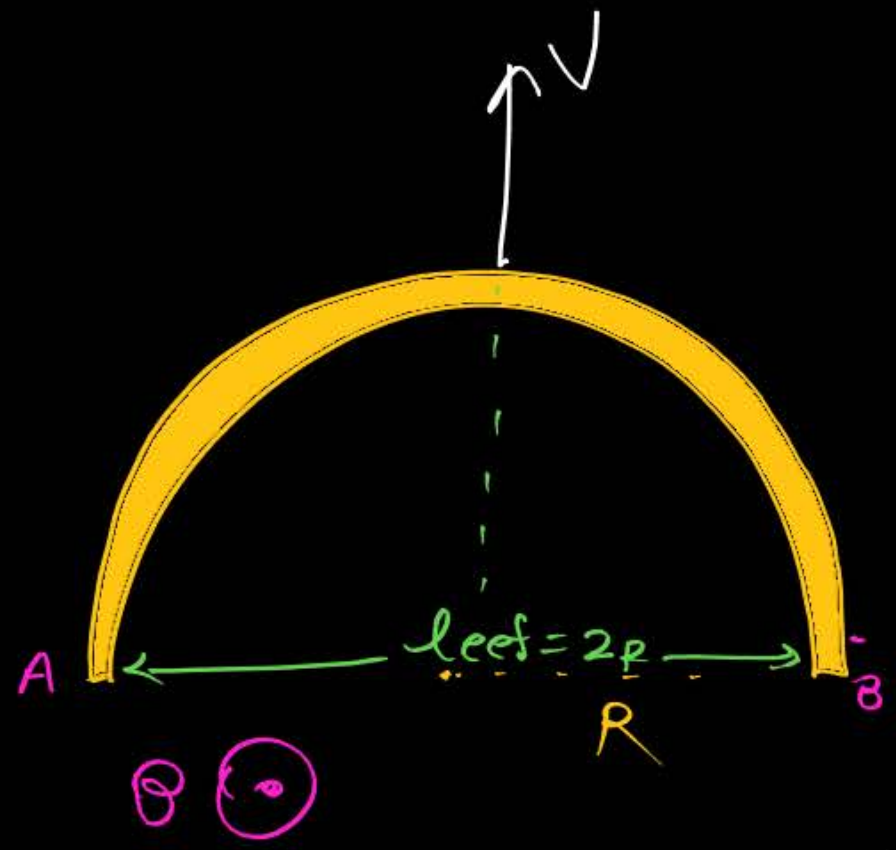
$V_A > V_D$

$(emf)_{AD} = B(l_{eff})_{\perp r} V$

$= \underline{\underline{BlV}}$

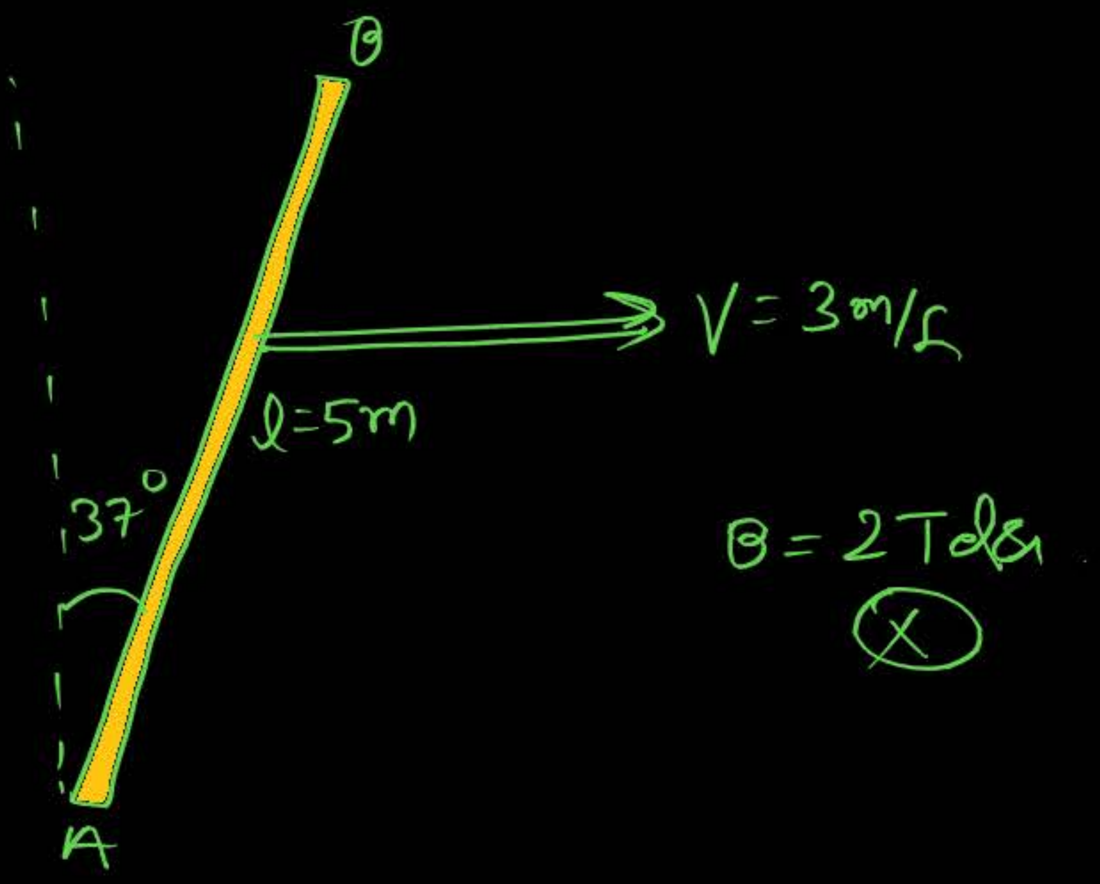


$(emf)_{AB} = 0$



$emf_{AB} = BV(2R)$

high potn of B



$$\text{emf} = V_x B_z (l\cos 37^\circ)$$

$$= 3 \times 2 \times 5 \times \frac{4}{5}$$

$$= 24 \text{ volt}$$

Q) A rod of length 2m along y axis moving with velocity $V = 2\hat{i} + 3\hat{j} + 4\hat{k}$ In a magnetic field $B = (2\hat{i} + 4\hat{j})$ find induced emf in Rod.

Soln

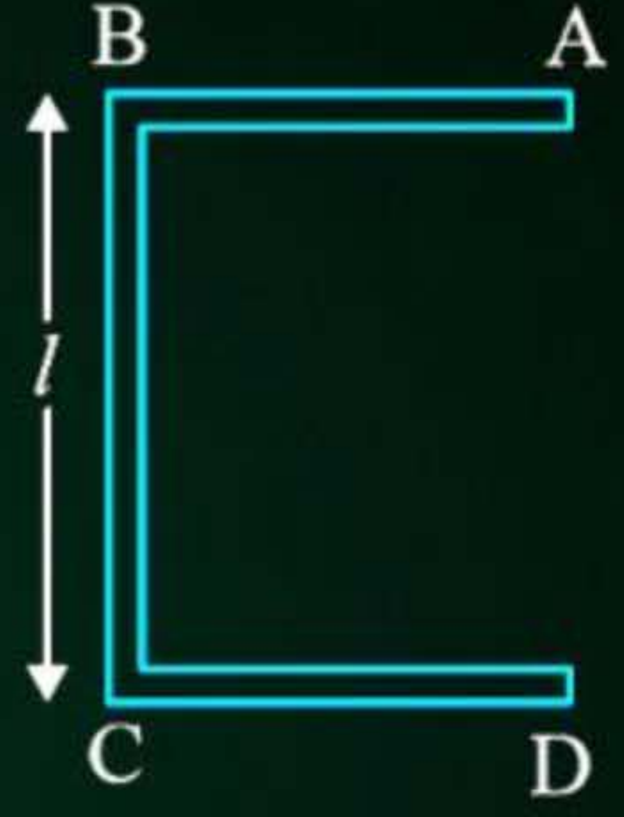
$$emf = 2 \times 4 \times 2$$

$$= 16 \text{ volt}$$

QUESTION

Find induced e.m.f. in:

1. Complete wire
2. In AB length
4. In BC
5. In CD





QUESTION

A copper disc of radius 0.1 m is rotated about its centre with 10 rev/s in a uniform magnetic field of 0.1T with its plane perpendicular to field. The emf induced across the radius of disc is

1. $\frac{\pi}{10}$ volt
2. $\frac{\pi}{100}$ volt
3. $\frac{\pi}{1000}$ volt
4. Zero

QUESTION

A copper disc of radius 0.1 m rotates about its centre with 10 revolutions per second in a uniform magnetic field of 0.1 Tesla. The emf induced across the radius of the disc is:

1. $\pi/10$ V
2. $2\pi/10$ V
3. 10π mV
4. 20π mV

QUESTION

A rod of length l rotates with a small but uniform angular velocity ω about its perpendicular bisector. A uniform magnetic field B exists parallel to the axis of rotation. The potential difference between the centre of the rod and an end is

1. zero
2. $\frac{1}{8}\omega B l^2$
3. $\frac{1}{2}\omega B l^2$
4. $B\omega l^2$

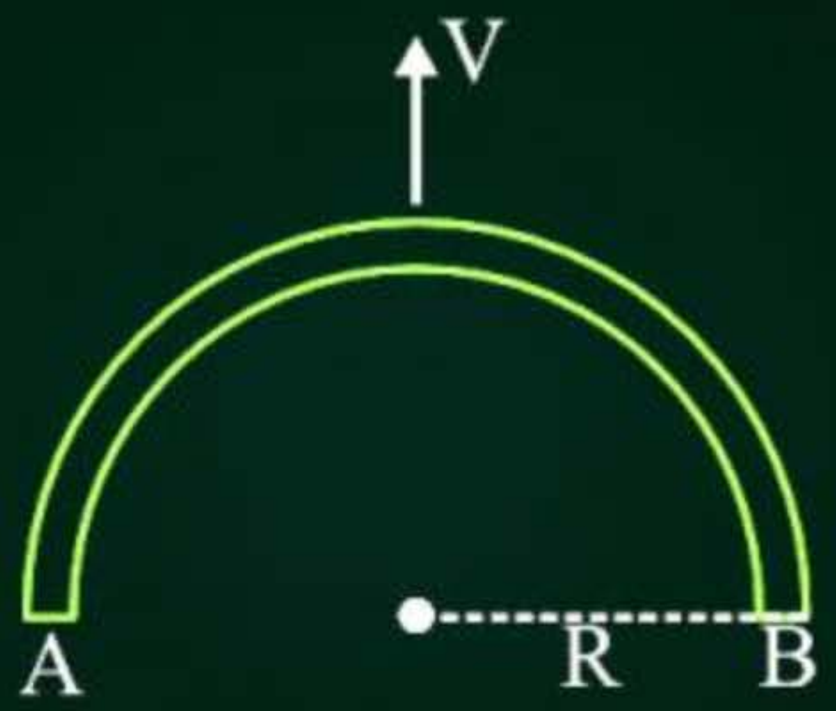
QUESTION

A rod of length l rotates with a uniform angular velocity ω about its perpendicular bisector. A uniform magnetic field B exists parallel to the axis of rotation. The potential difference between the two ends of the rod is

1. zero
2. $\frac{1}{2} Bl\omega^2$
3. $Bl\omega^2$
4. $2 B\omega l^2$

QUESTION

How to find which side of rod is at higher potential?


V
A
R
B

QUESTION

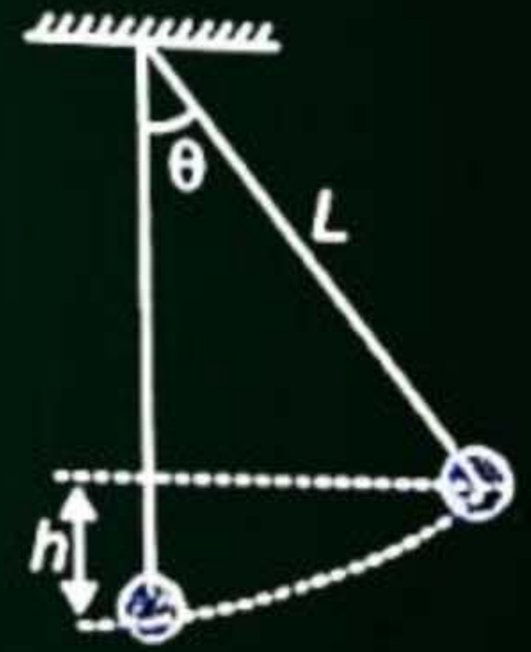
A simple pendulum with bob of mass m and conducting wire of length L swings under gravity through an angle 2θ. The earth's magnetic field component in the direction perpendicular to swing is B. The maximum potential difference induced across the pendulum is

1. $2\,\mathrm{BL}\sin\left(\frac{\theta}{2}\right).\sqrt{gL}$

2. $BL\sin\left(\frac{\theta}{2}\right)\sqrt{gL}$

3. $BL\sin\left(\frac{\theta}{2}\right).(gL)^{3/2}$

4. $BL\sin\left(\frac{\theta}{2}\right).(gL)^{2}$




THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture-4 | Physics

ELECTROMAGNETIC INDUCTION



By- Dr. Manish Raj (MR SIR)

Topics to be covered

1 # Motional and Rotational e.m.f

2 # Rotational Motion (Revision)

3 #



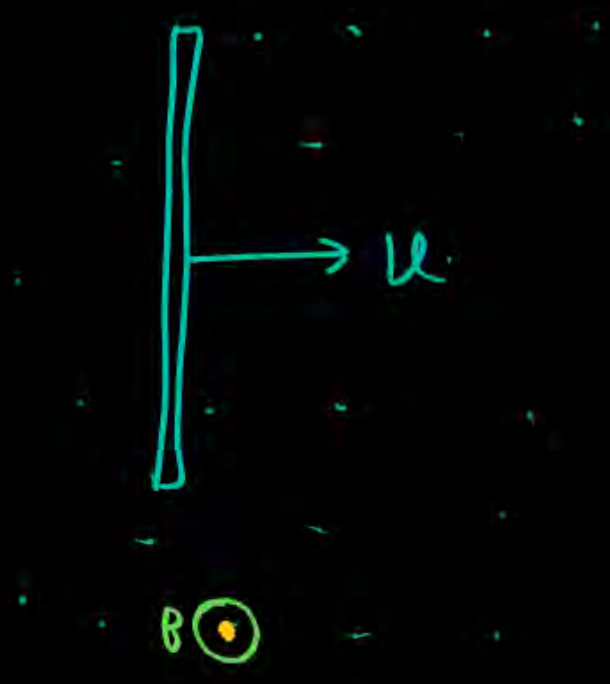


Rotation ka pdf.

full / Part Syllabus Test Paper

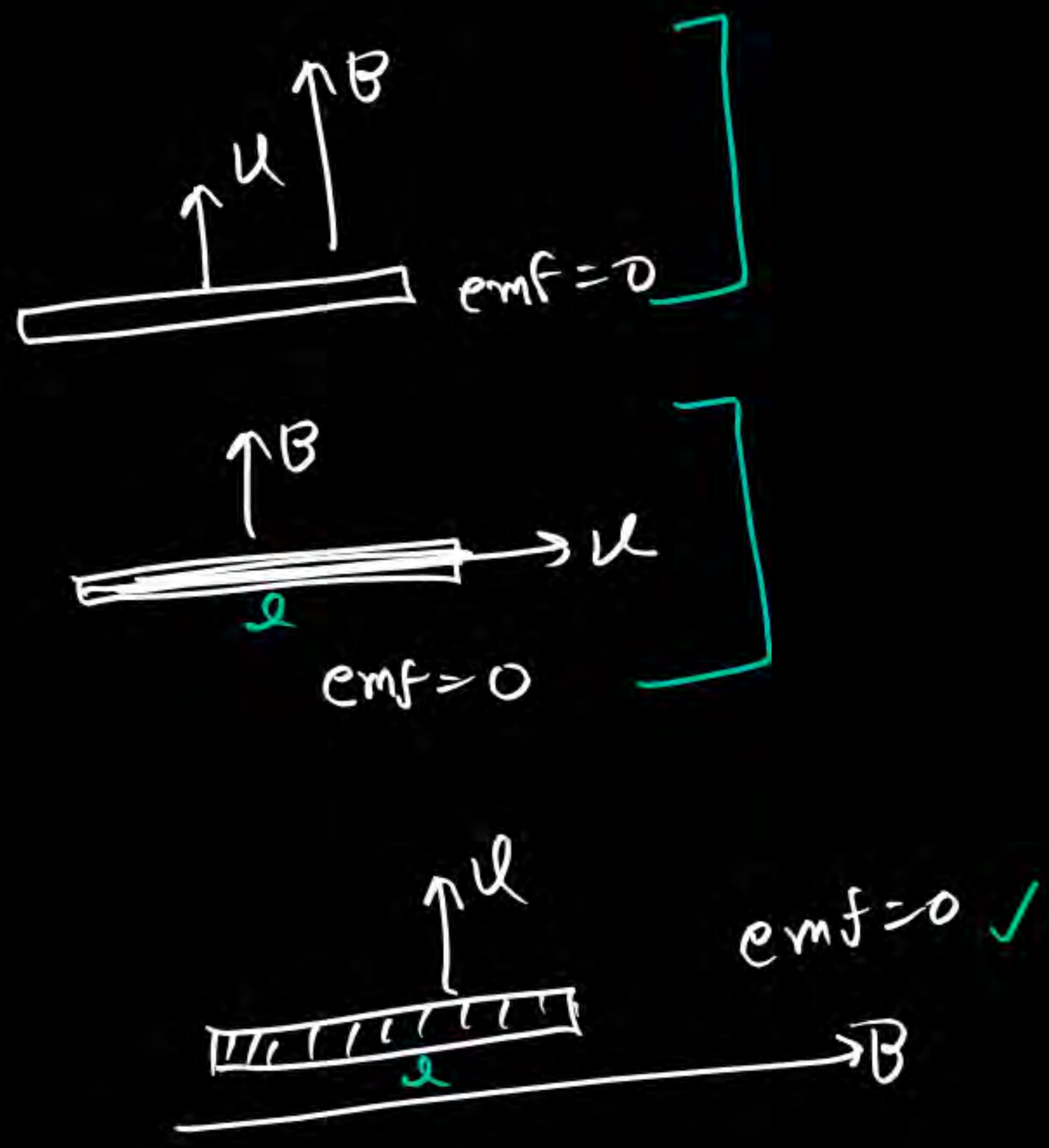
100/120+ ✓

Motional emf



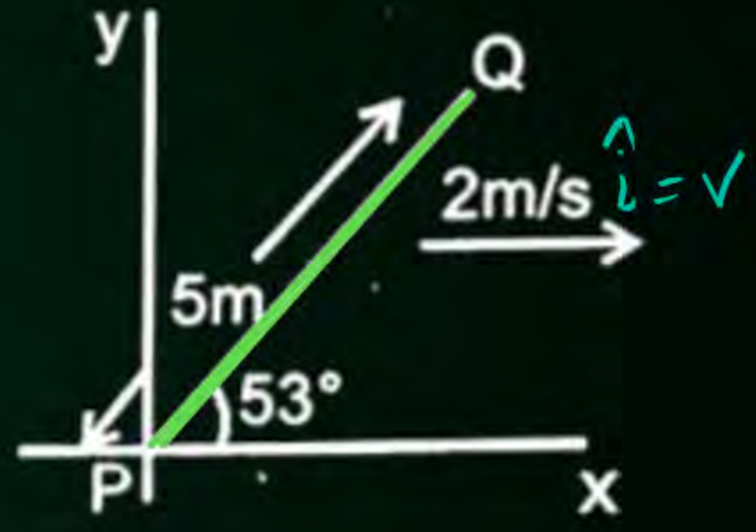
$$emf = (\vec{V} \times \vec{B}) \cdot \vec{l}$$

$$emf = V_{\perp r} B_{\perp r} l_{\perp r}$$



QUESTION

A conducting rod PQ of length 5 m oriented as shown in figure is moving with velocity $(2\text{m/s})\hat{\imath}$ without rotation in a uniform magnetic field $(3\hat{\jmath} + 4\hat{k})$ Tesla. Emf induced in the rod is



1. 32 Volts (77%)
2. 50 Volt
3. 40 Volt
4. none

$\text{emf} = u_x \, l_y \, [B_z]$

$= 2 \times 5\sin 53^\circ \times 4$

$= 2 \times 5 \times \frac{4}{5} \times 4$

$= 32$ Volt

QUESTION

A straight conductor of length 0.4 m is moved with a speed of 7 m/s perpendicular to the magnetic field of intensity of 0.9 Wb/m^2. The induced emf across the conductor will be:

1. 7.25 V
2. 3.75 V
3. 1.25 V
4. 2.52 V



$$emf = Bvl = \frac{9}{10} \times \frac{4}{10} \times 7$$

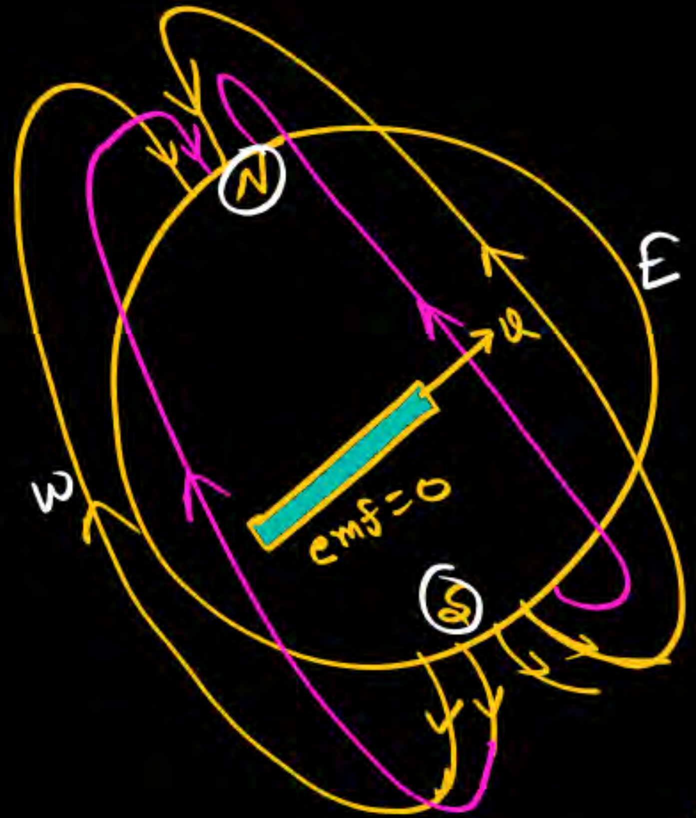
QUESTION

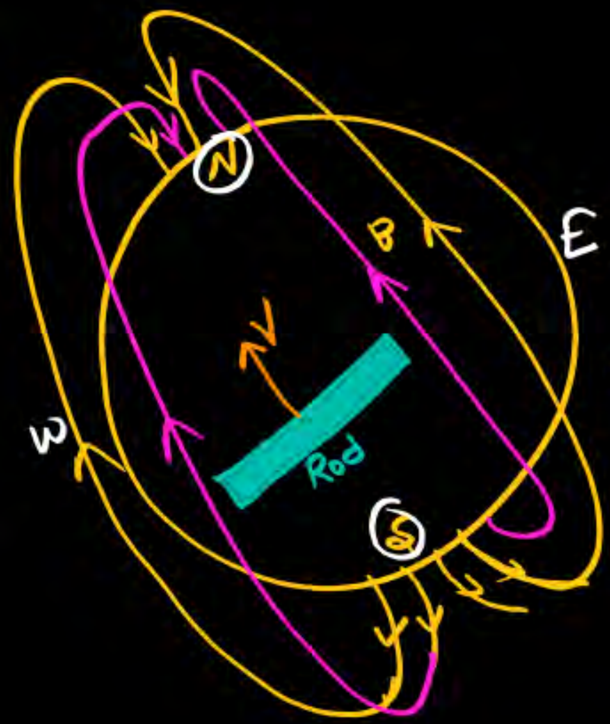
* Imp.

An aeroplane rises vertically with a speed of 100 m/s. The aeroplane has wings span 10 m and horizontal component of earth's magnetic field perpendicular to wings is 5×10^{-3} Wb/m^2. The induced emf across the ends of wings is

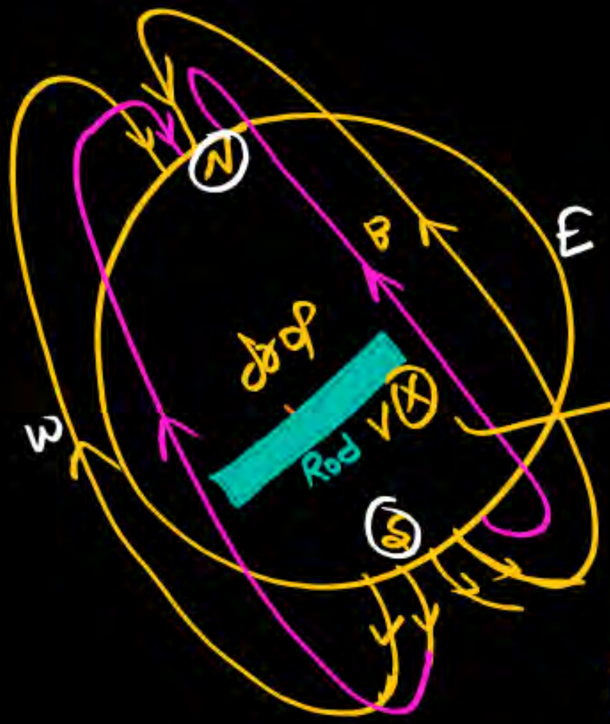
1. 50 V
2. 0.5 V
3. 5 V ✓
4. 25 V

$$emf = Bvl$$
$$= 5 \times 10^{-3} \times 100 \times 10$$
$$= 5 \text{ volt}$$



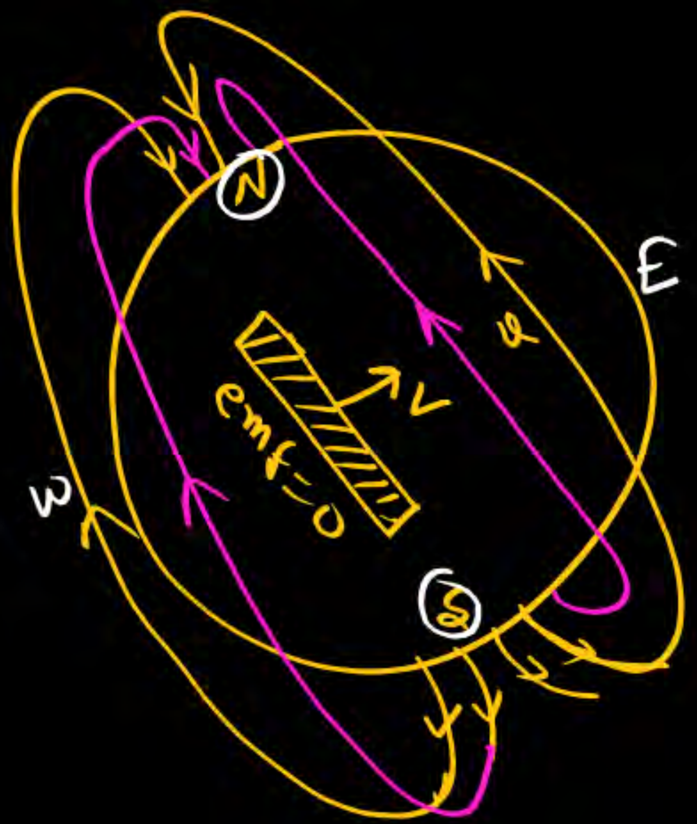


emf = 0



move Verticaly downward

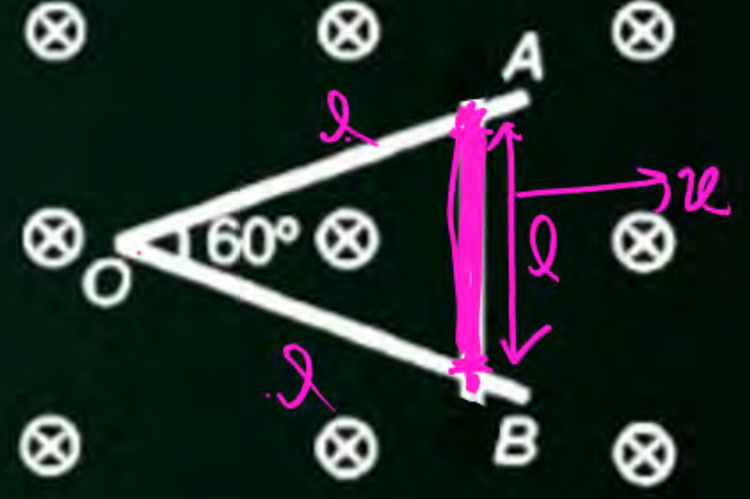
$emf = Bvl$

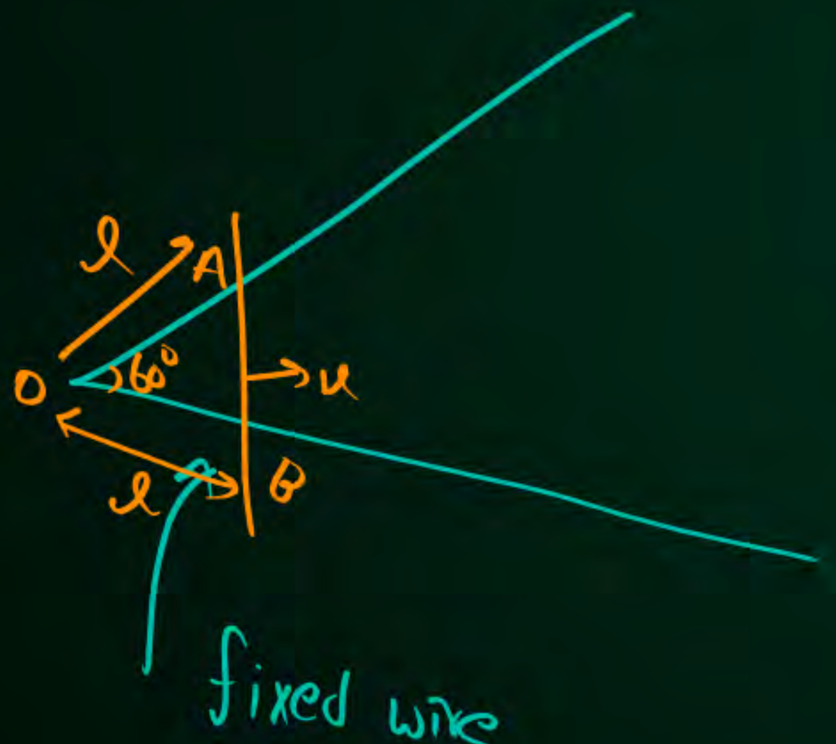


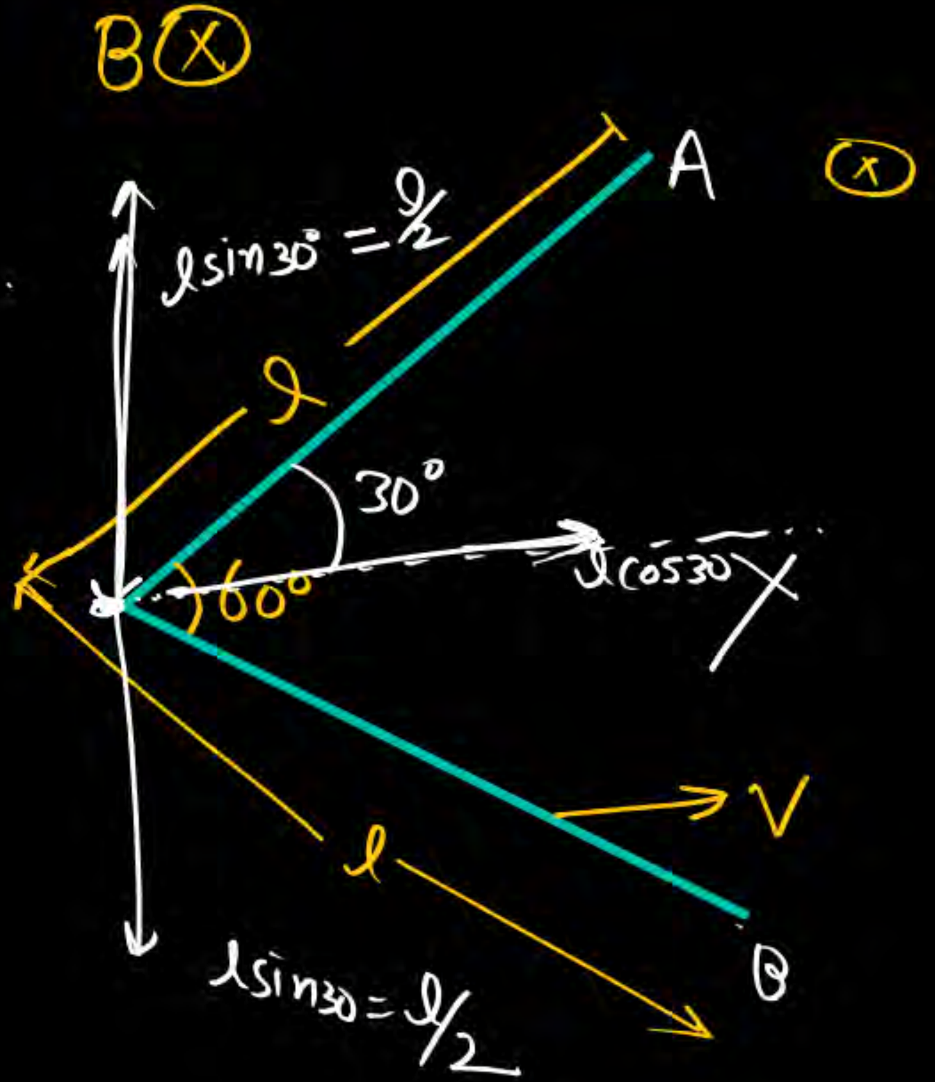
QUESTION

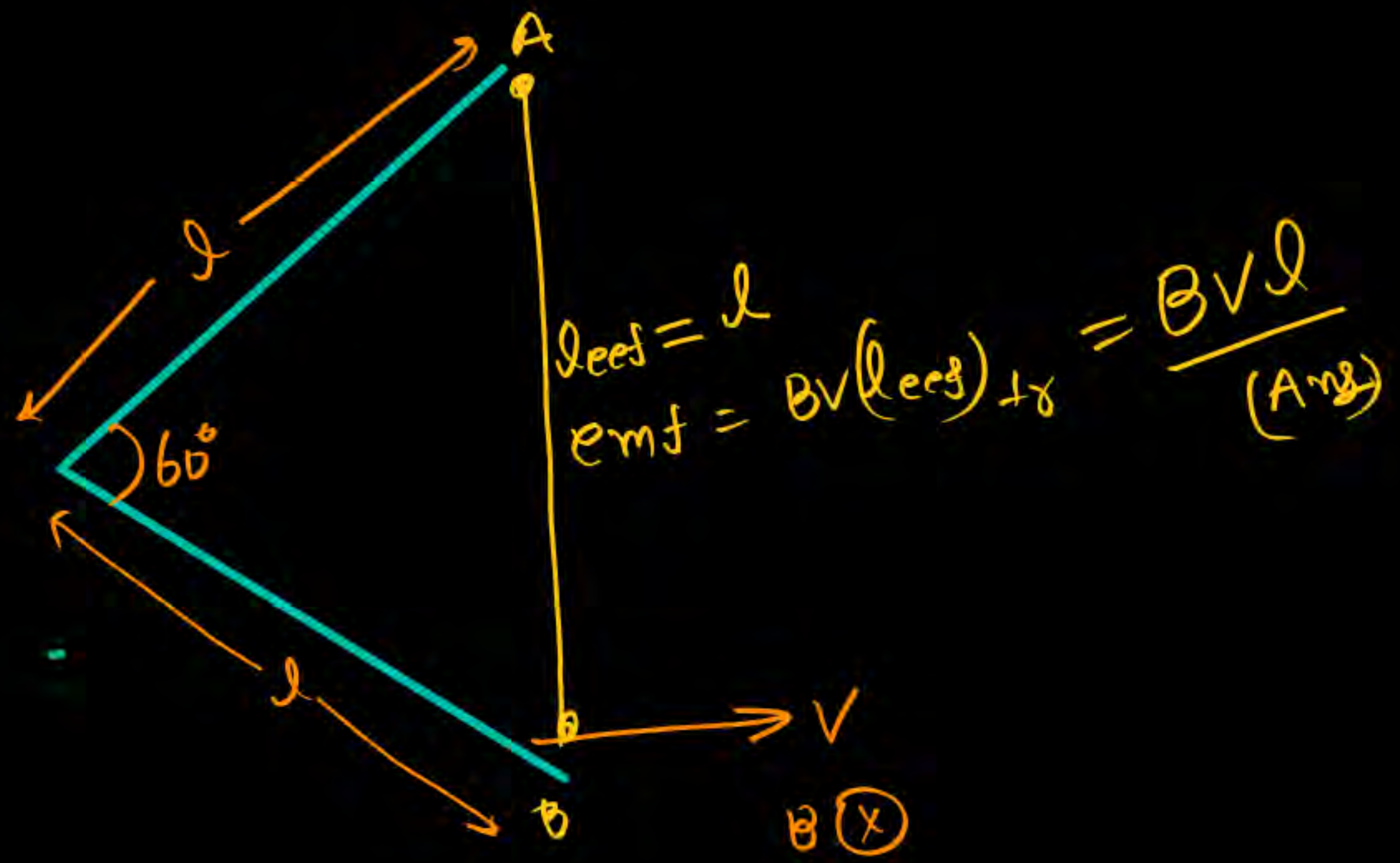
A rod AB slides on a V shaped wire with speed v as shown, such that at any time OA = OB = l. Magnetic field in the region is perpendicular downwards and has strength B, induced emf in the rod is

1. Zero
2. Bvl
3. $\frac{\sqrt{3}Bvl}{2}$
4. $\frac{Bvl}{2}$

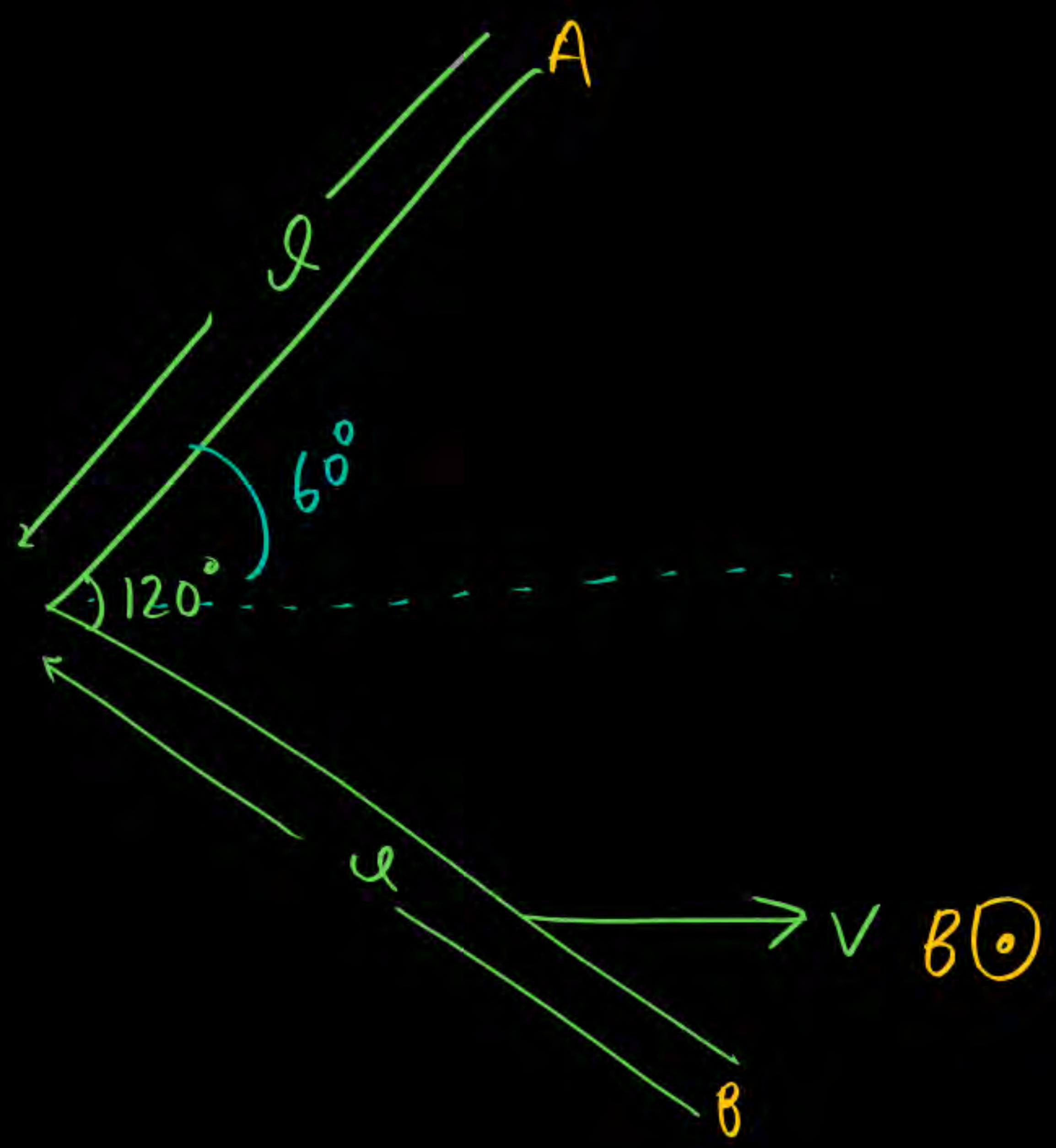








$$(emf)_{AB} = BV\left(\frac{l}{2}+\frac{l}{2}\right) = BVl$$



$$(emf)_{AB} = BV(2l\sin 60^\circ)$$

$$= BV\,2\,l\,\frac{\sqrt{3}}{2}$$

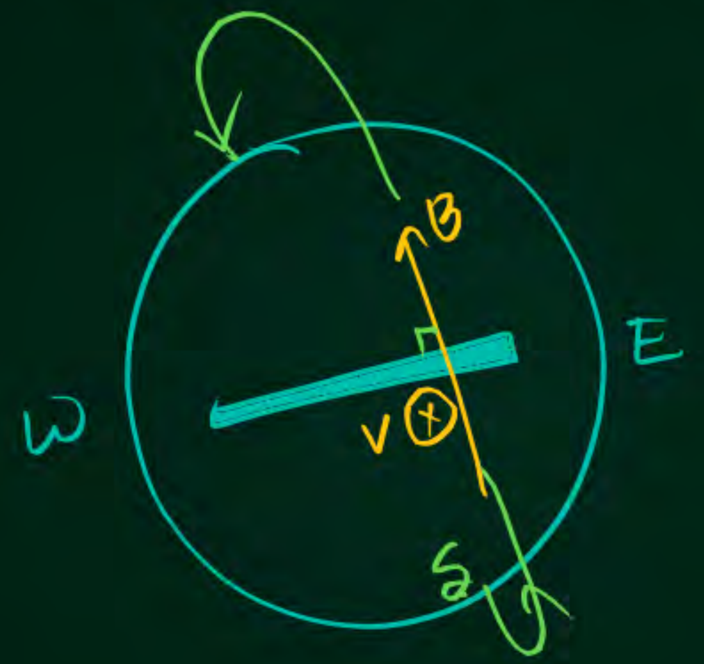
$$= \sqrt{3}\,BVl$$

Ans

QUESTION

A long horizontal metallic rod with length along the east-west direction is falling under gravity. The potential difference between its two ends will

1. Be zero
2. Be constant
3. Increase with time
4. Decrease with time



$emf = Bvl$

$emf = Bl(gt)$

QUESTION

Find induced e.m.f. in:

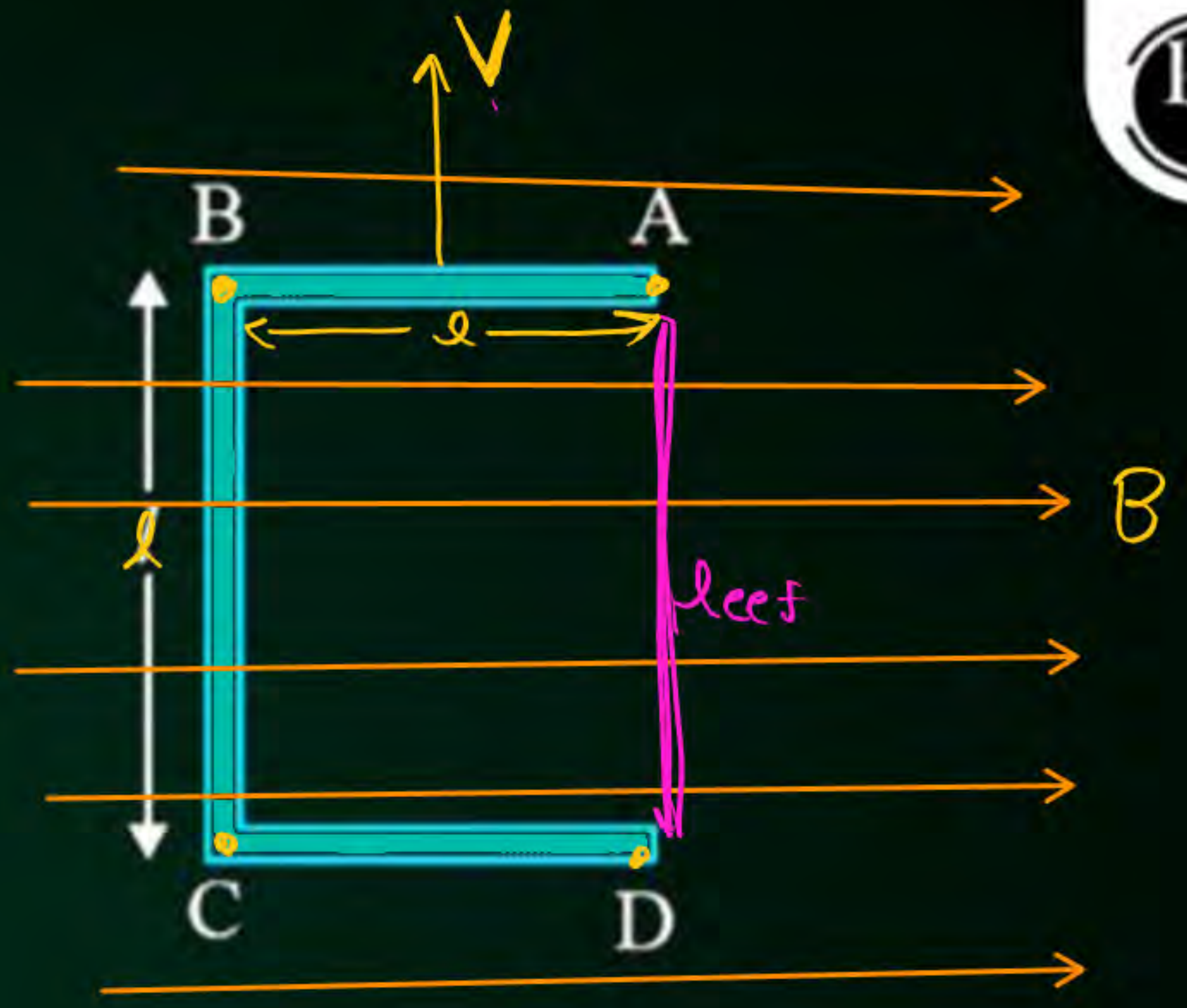
1. Complete wire → $BV(l_{eff}) = 0$

2. In AB length ⇒ emf = 0

4. In BC emf = 0

5. In CD ⇒ emf = 0

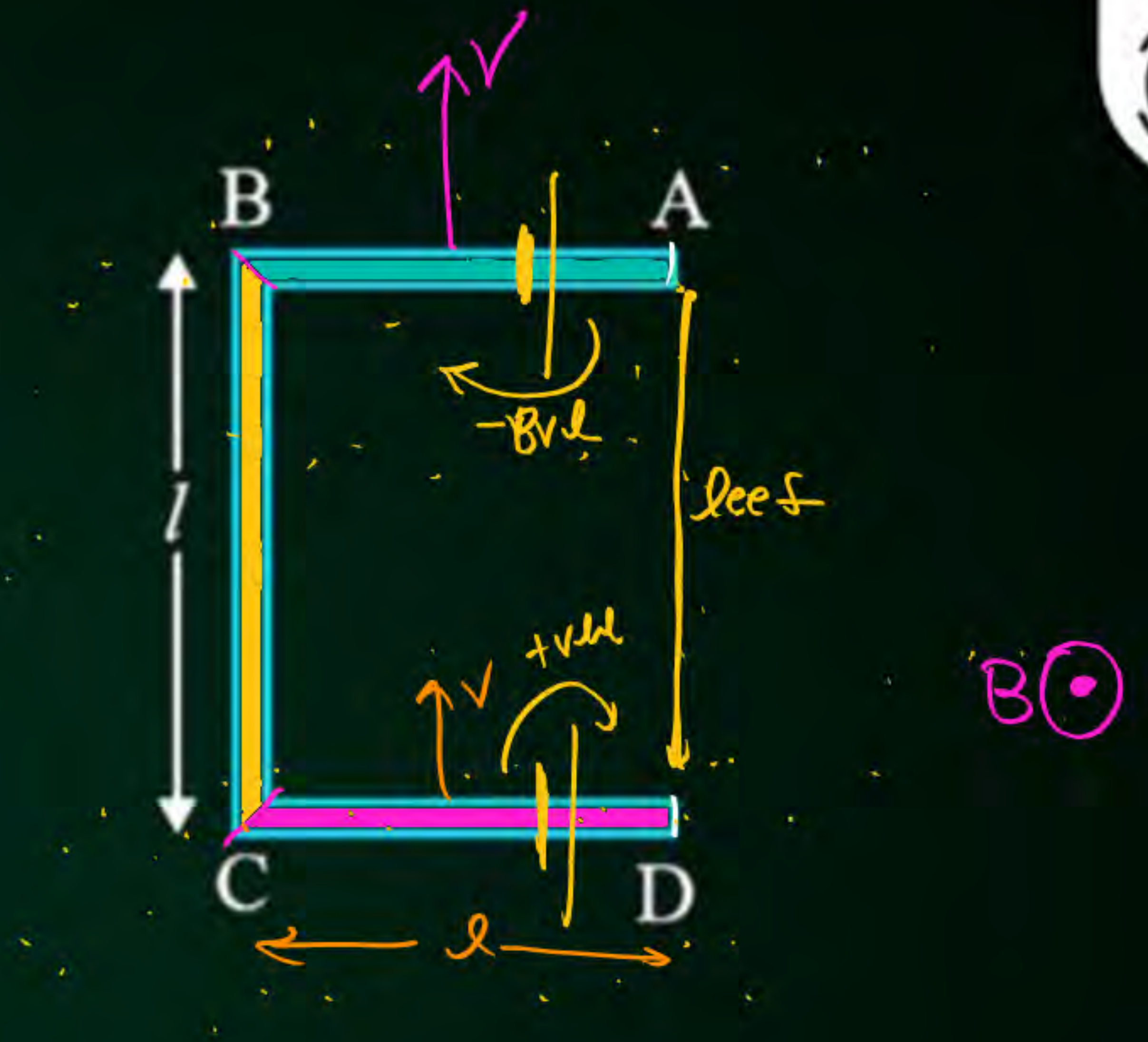
l_{eff} and velocity is parallel

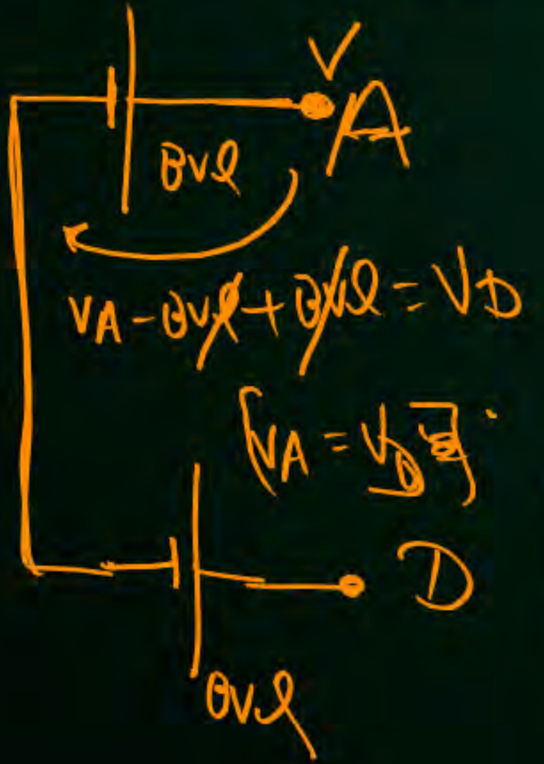


QUESTION

Find induced e.m.f. in:

1. Complete wire ⟶ $e.m.f = Bvl_{eff} = 0$
2. In AB length ⟶ $emf = Bvl$, $V_A > V_B$
4. In BC ⟶ $(emf) = 0$
5. In CD ⟶ $emf = emf$, $V_D > V_C$





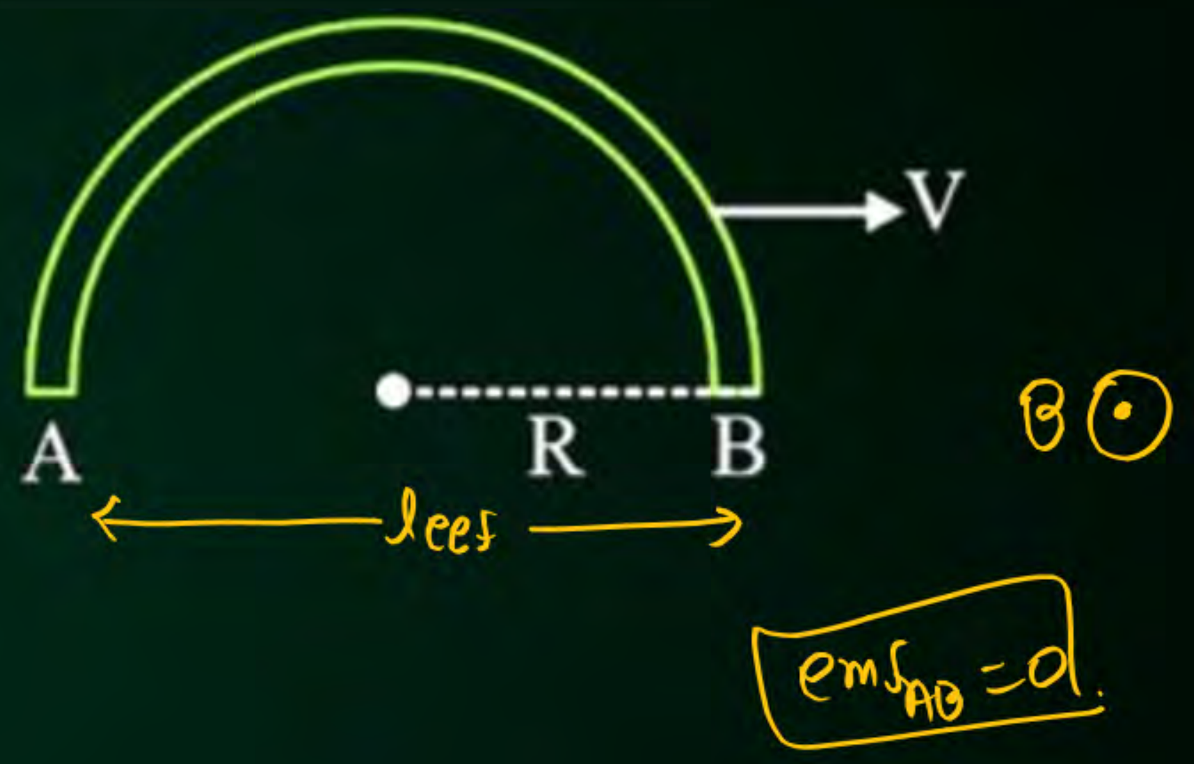
$V_A - Bvl + Bvl = V_D$

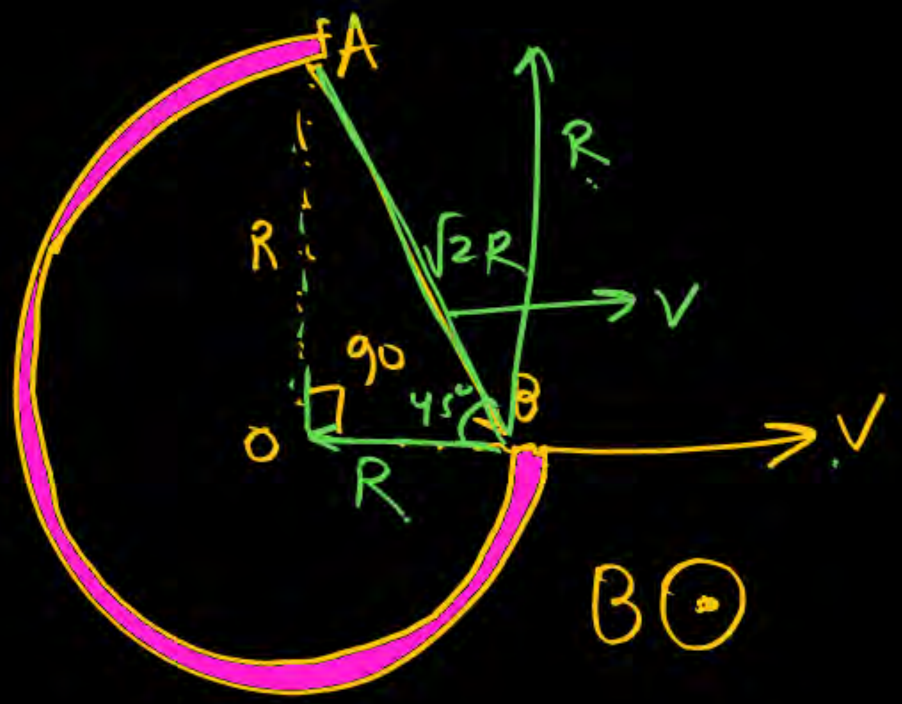
$V_A = V_D$

$V_A - V_D = 0$

QUESTION

Find induced e.m.f. in circular wire?



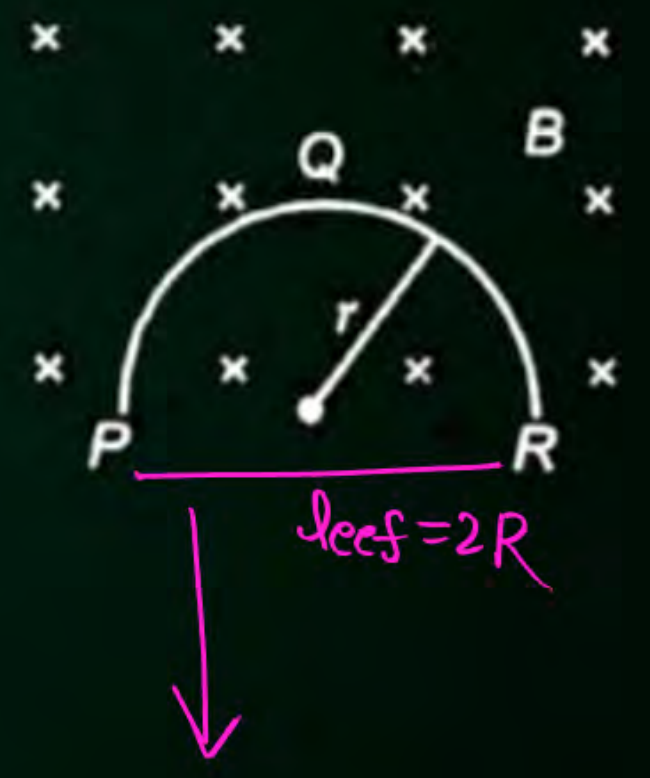


$$(emf)_{AB} = BVR$$

QUESTION

A thin semicircular conducting ring (PQR) of radius r is falling with its plane vertical in a horizontal magnetic field B, as shown in figure. The potential difference developed across the ring when its speed is v is [AIPMT-2014]

1. Zero
2. $Bv\pi l^2/2$ and P is at higher potential
3. πrBv and R is at higher potential
4. $2\,rBv$ and R is at higher potential



QUESTION

Find induced emf in AB, BC, CD, DA and in loop.

fardays चाचा

$(\text{emf})_{loop} = 0$

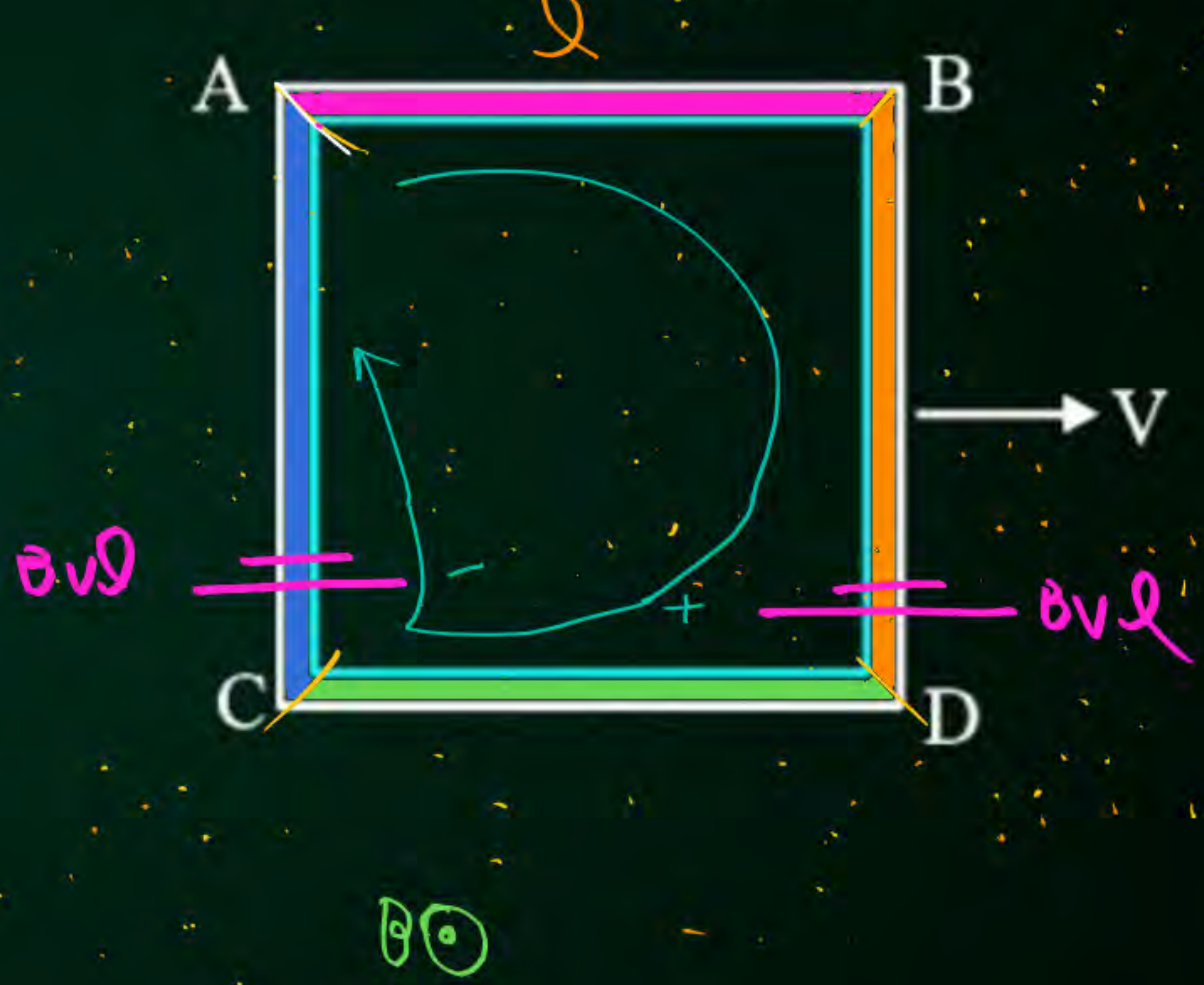
$\phi_{loop} = \text{const}^n$

Hall (Motional emf)

✓ $\text{emf}_{AB} = 0 = \text{emf}_{CD}$

✓ $\text{emf}_{BD} = BVl = \text{emf}_{CA}$

$\text{emf}_{loop} = 0 = BVl_{eff}$ ($l_{eff} \to 0$)



QUESTION

Circular loop of radius R is moving with velocity V in x-axis then induced

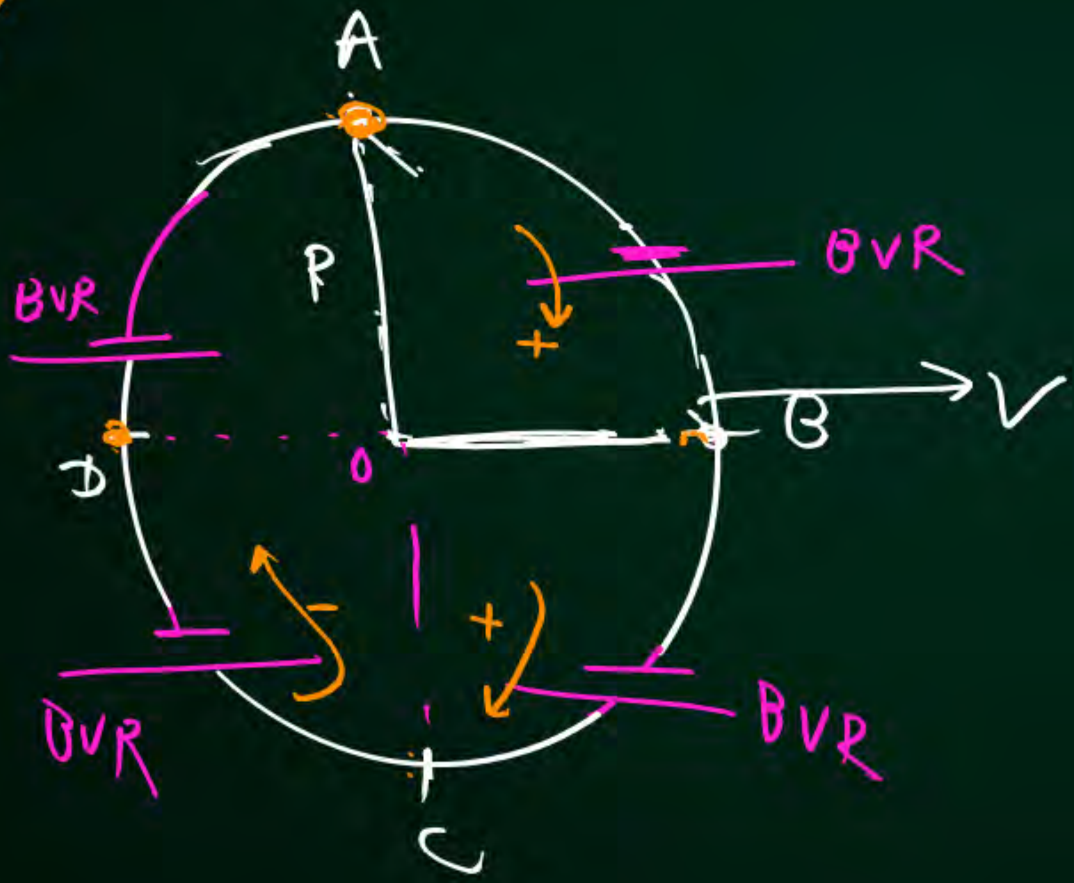
(i) emf in loop = 0

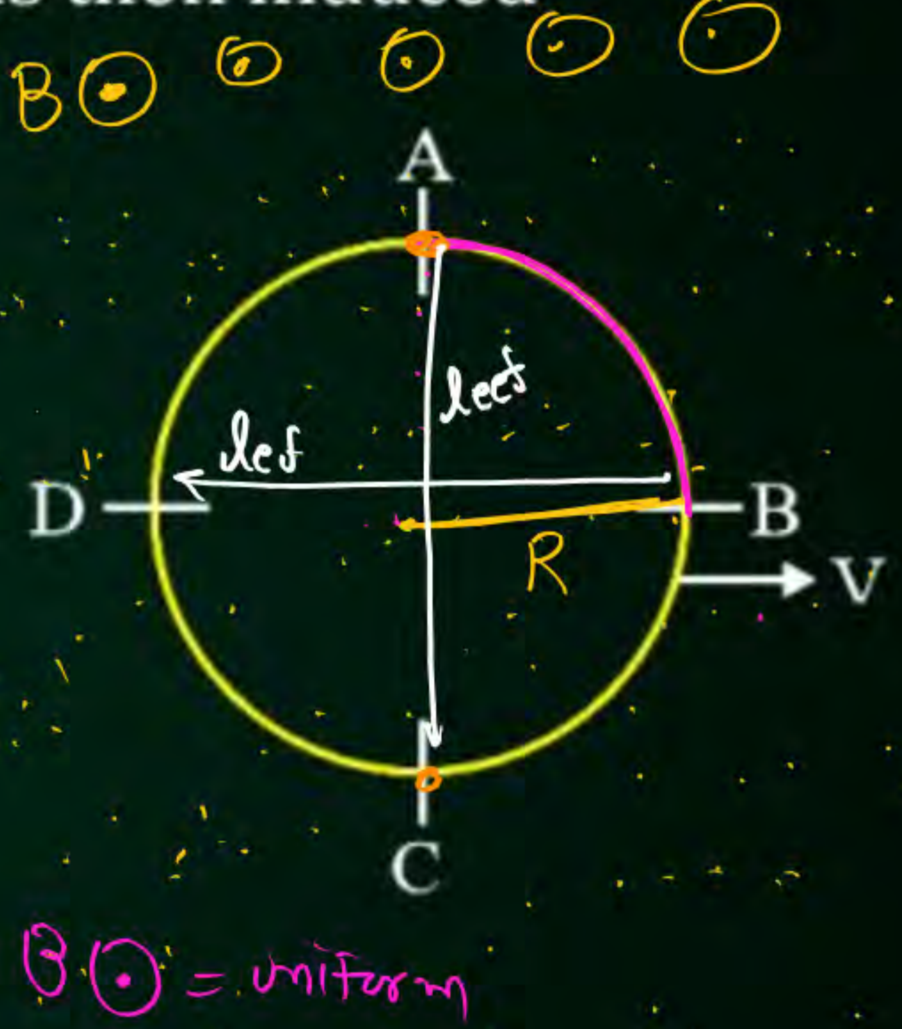
(ii) AB = BVR

(iii) AC = 2BVR

(iv) DA = BVR

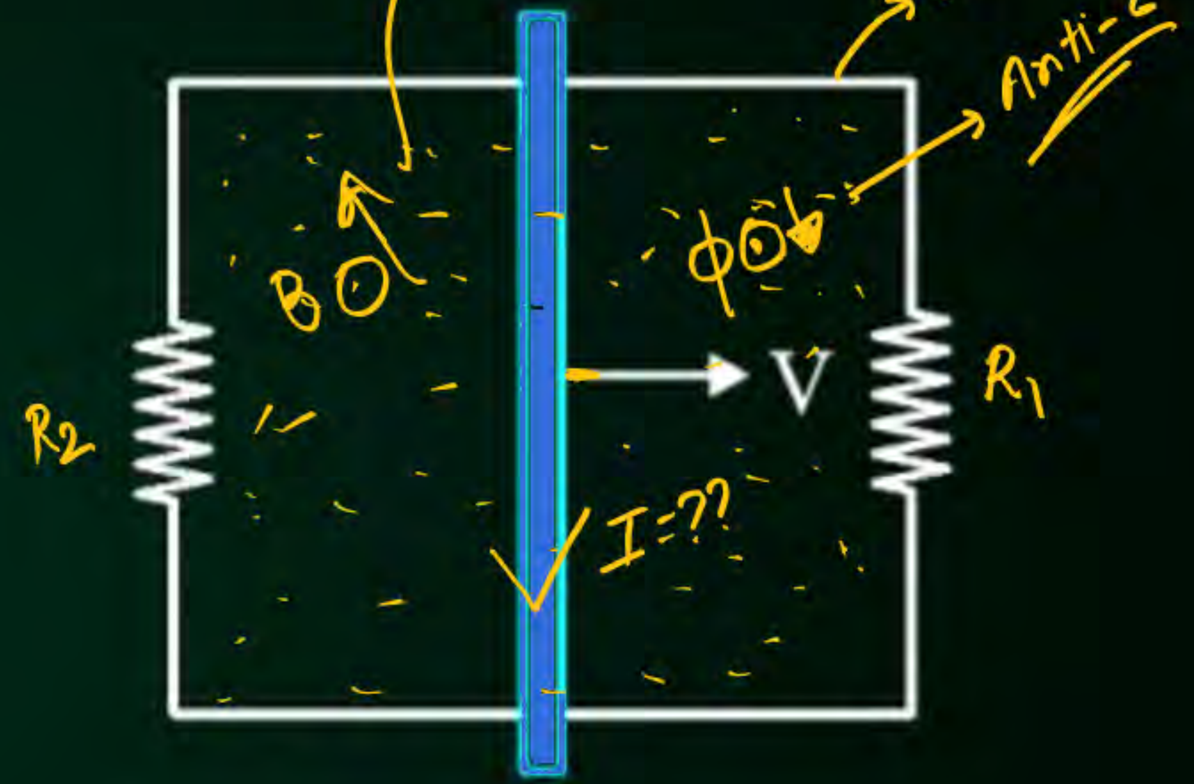
(v) $(\text{emf})_{BD} = 0$

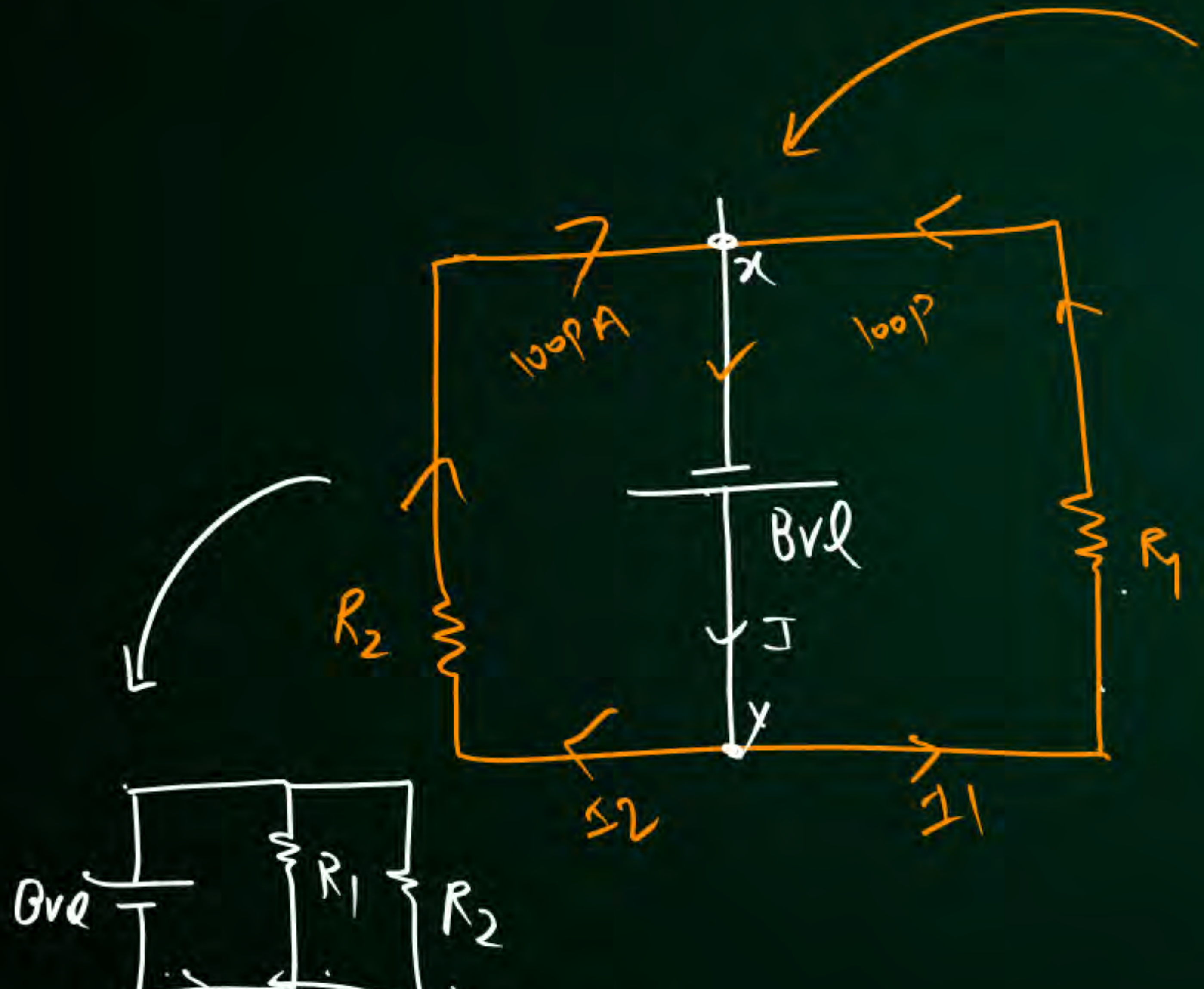




QUESTION

Find current flowing through this rod?





$I = \frac{Bvl}{R_1R_2}(R_1+R_2)$

QUESTION

Find induced emf in rod between AB?



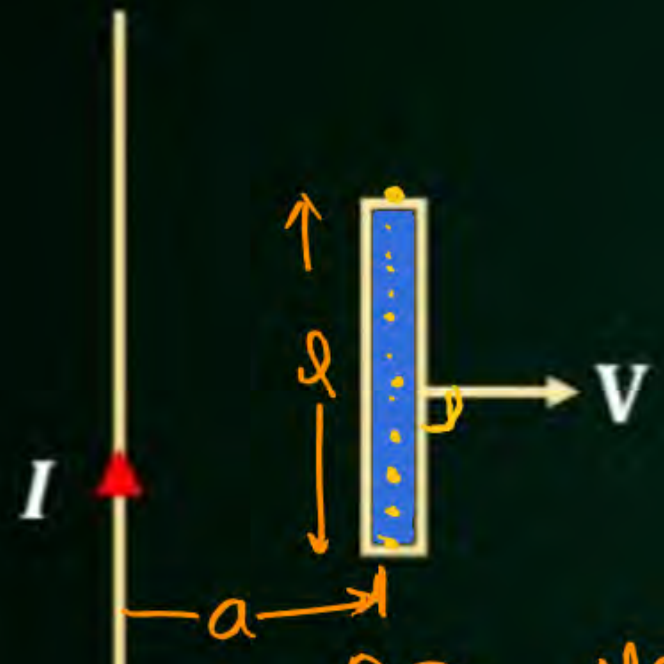
emf = 0

because l is $\parallel^r$ to Parall $\vec{v}$ Ans

P.W. my card

QUESTION

Find induced emf in a rod at this ~~insitana~~ instant?



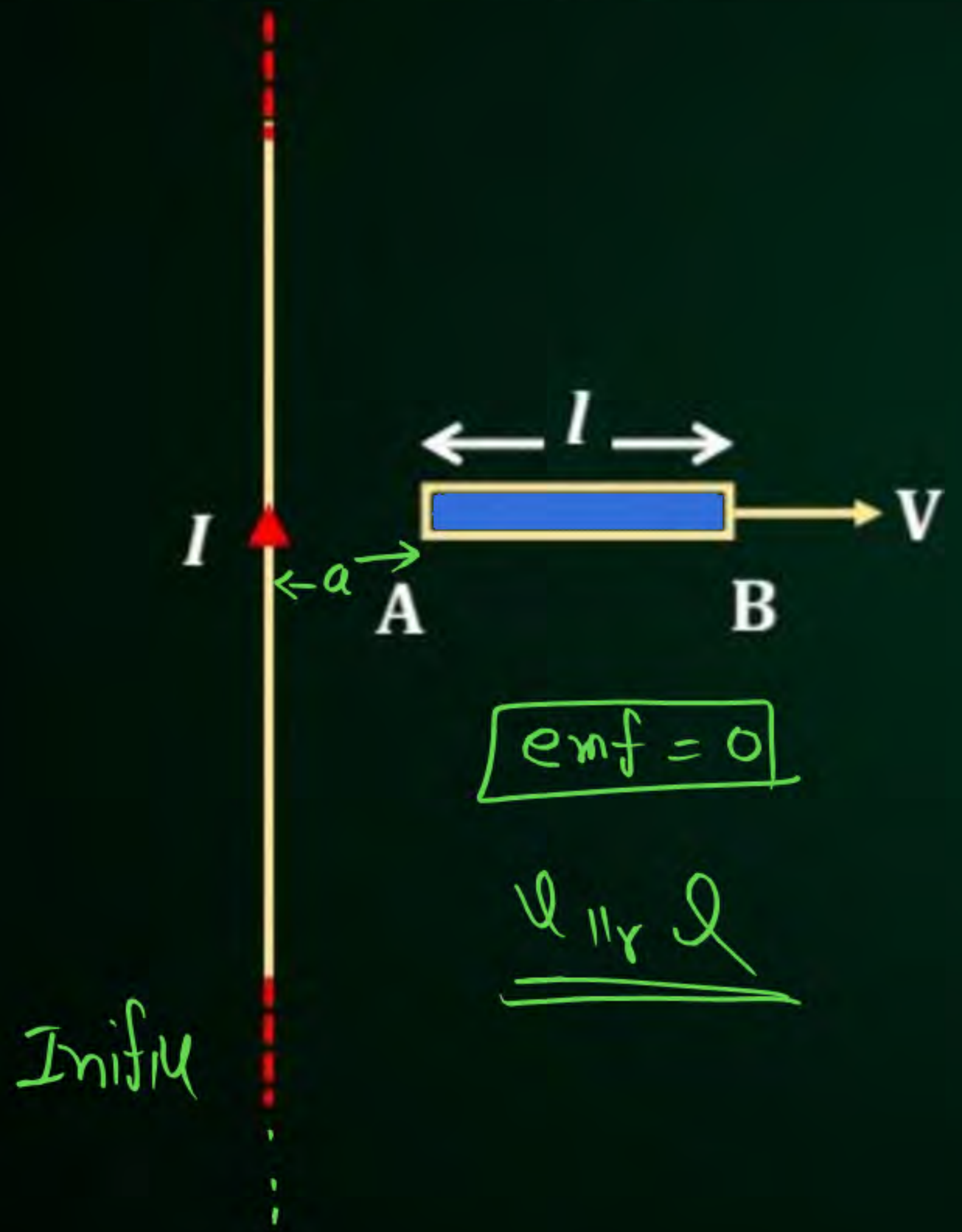
$$B \otimes = \frac{\mu_0 I}{2\pi a}$$

$$emf = Bvl$$

$$\boxed{emf = \frac{\mu_0 I v l}{2\pi a}} \quad \text{Ans}$$

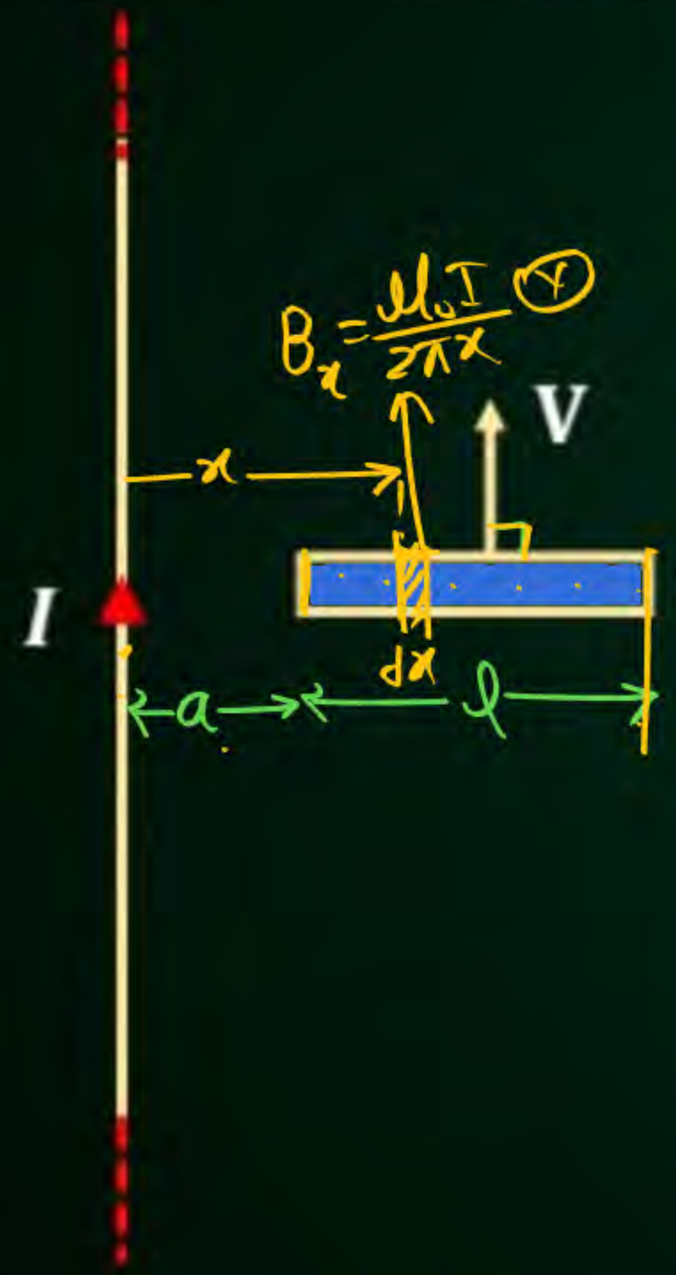
QUESTION

Find induced e.m.f. in Rod.



QUESTION

Find induced e.m.f. in Rod.



$$d\varepsilon = B V dx$$

$$\int d\varepsilon = \int \frac{\mu_0 I V \, dx}{2\pi x}$$

$$\varepsilon.mf = \frac{\mu_0 I V}{2\pi} \int_a^{a+l} \frac{1}{x} dx$$

$$= \frac{\mu_0 I V}{2\pi} \left(\log x\right)_a^{(a+l)}$$

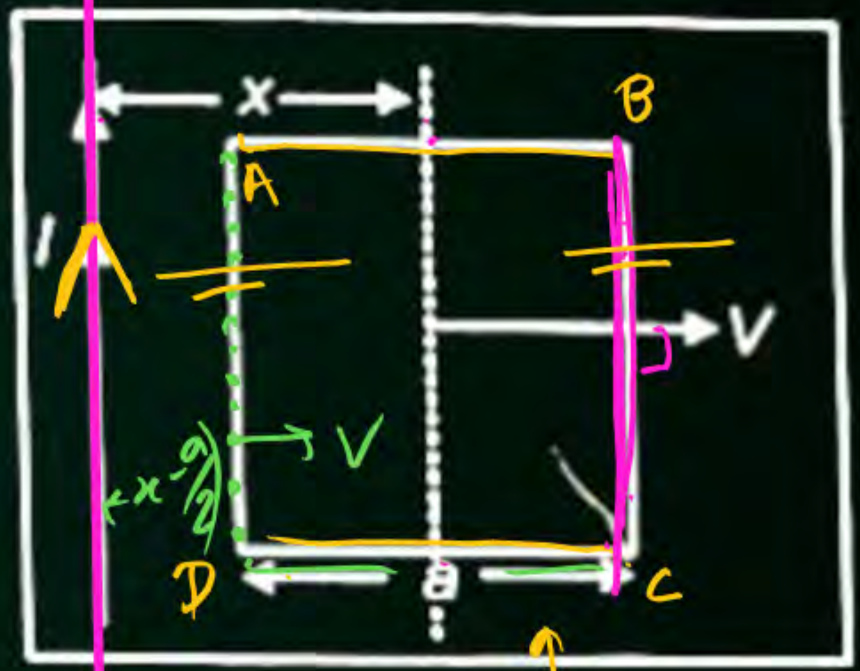
$$= \frac{\mu_0 I V}{2\pi} \log\left(\frac{a+l}{a}\right)$$

Ans

QUESTION

A conducting square frame of side a and a long straight wire carrying current I are located in the same plane as shown in the figure. The frame moves to the right with a constant velocity V. The emf induced in the frame will be proportional to **[AIPMT-2015]**

1. $\frac{1}{(2x-a)(2x+a)}$
2. $\frac{1}{x^2}$
3. $\frac{1}{(2x-a)^2}$
4. $\frac{1}{(2x+a)^2}$



$emf_{AB} = 0 = emf_{CD}$

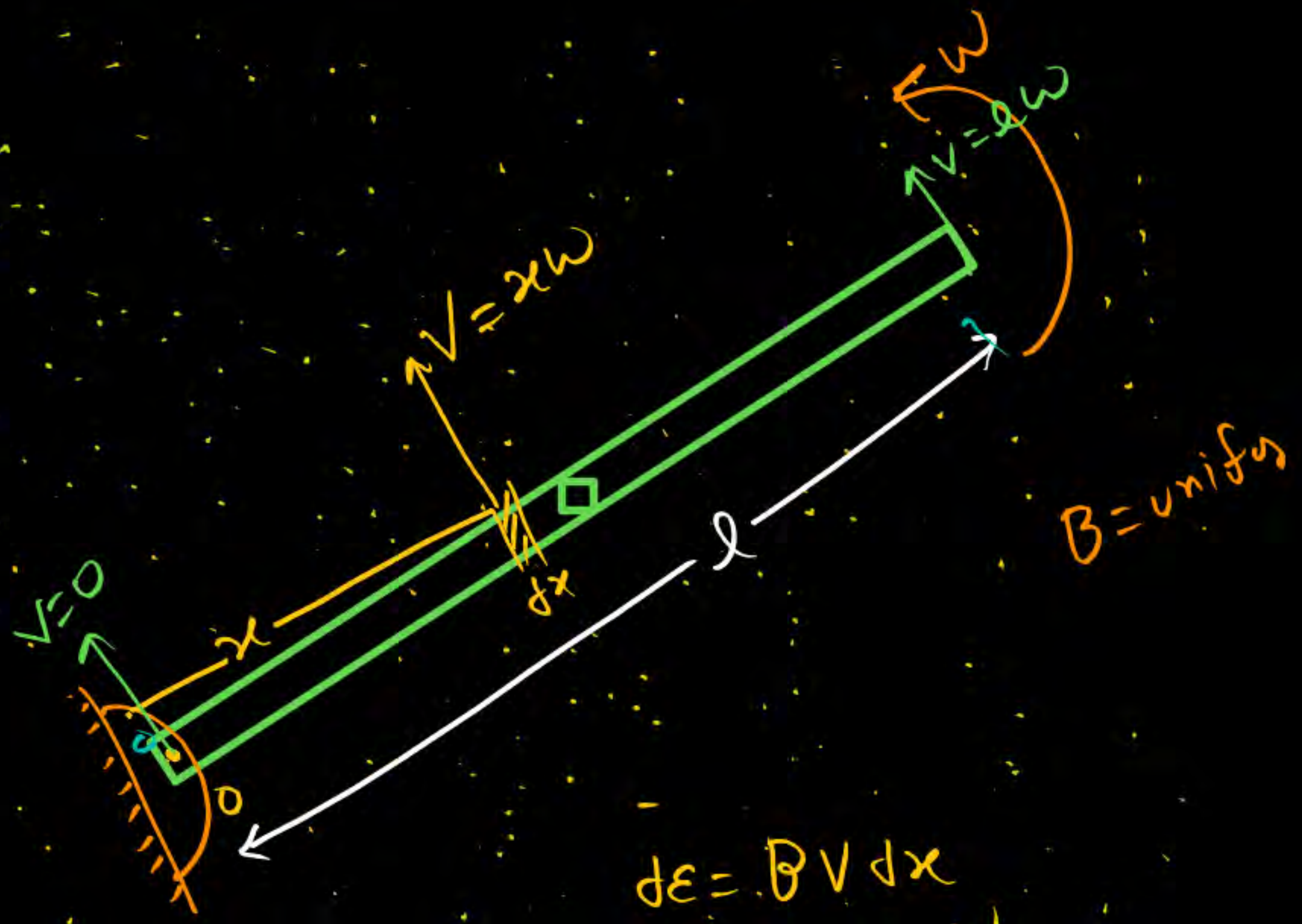
$emf_{BC} = Vl \frac{\mu_0 I}{2\pi(x + a/2)}$

$emf_{AD} = \frac{Vl \mu_0 I}{2\pi(x - a/2)}$

$emf = \frac{Vl\mu_0 I}{2\pi}\left[\frac{1}{x - a/2} - \frac{1}{(x + a/2)}\right] = \frac{Vl\mu_0 I}{2\pi}\left(\frac{2}{(2x-a)} - \frac{2}{(2x+a)}\right)$

square loop

A Rod (L) is Rotating in magnetic field with constant Angular speed.



$d\varepsilon = BV\,dx$

$\int d\varepsilon = \int B x \omega\, dx$

$emf = B\omega \int_0^{\ell} x\,dx = \frac{B\omega \ell^2}{2}$

$= \frac{1}{2} B\omega\ell^2$

$emf = B V \ell$ ✗

$emf = B\omega\ell$ ✗

$emf = B(\ell\omega)\times\ell$

$= B\omega\ell^2$ ✗

$emf = \frac{1}{2} B\omega\ell^2$

MR* → [physics med easy] (Basic math)

$emf = B\ell\left[\frac{\vec{V}_1 + \vec{V}_2}{2}\right] = \frac{B\ell}{2}(0 + \ell\omega)$

$= \frac{1}{2}B\ell^2\omega$

QUESTION

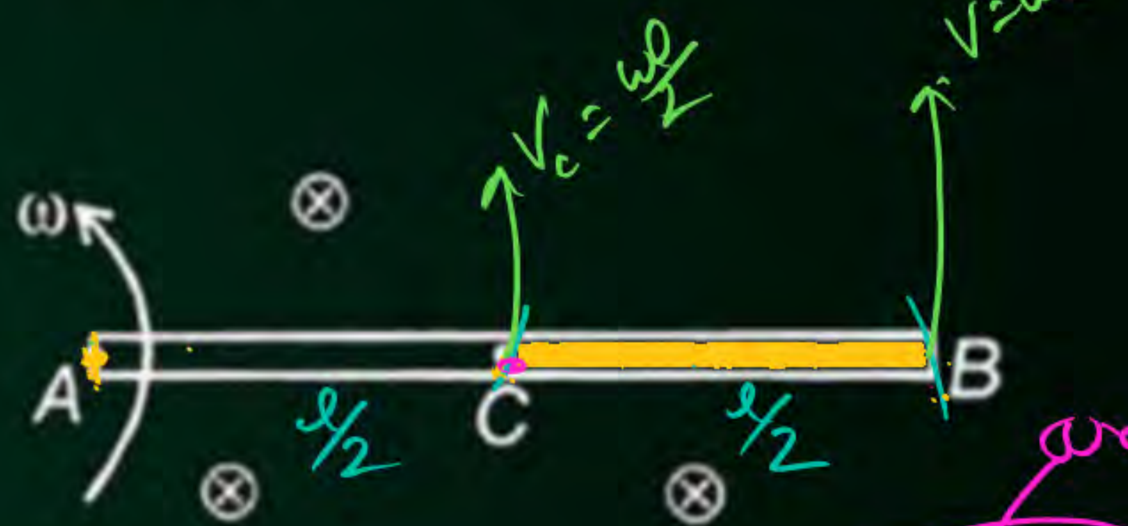
A copper rod of length l is rotated about one end perpendicular to the uniform magnetic field B with constant angular velocity ω. The induced e.m.f. between its two ends is

1. $B\omega l^2$
2. $\frac{3}{2} B\omega l^2$
3. $\frac{1}{2} B\omega l^2$
4. $2 B\omega l^2$

QUESTION

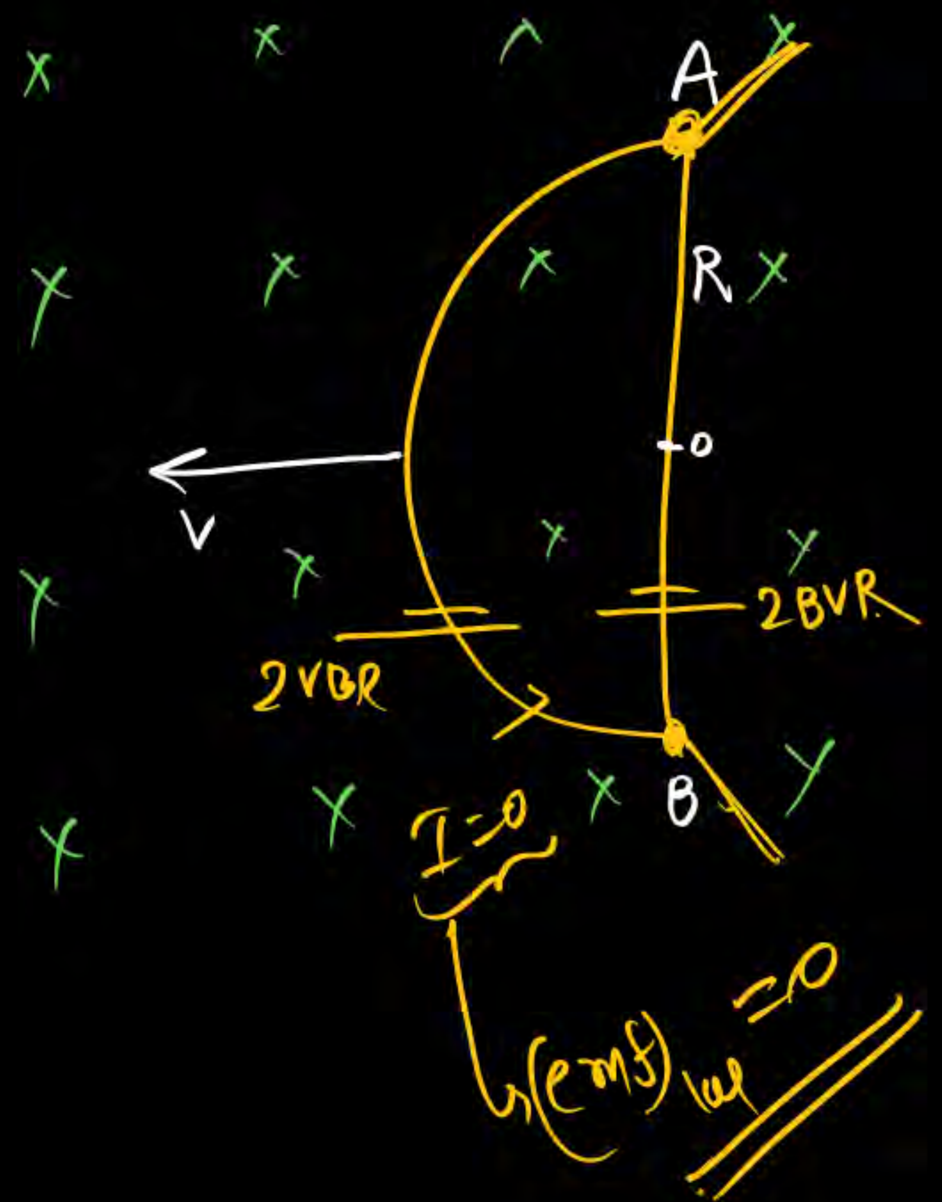
A copper rod AB of length l, pivoted at one end A, rotates at constant angular velocity ω, at right angles to a uniform magnetic field of induction B. The emf, developed between the mid point C of the rod and end B is

1. $\frac{B\omega l^2}{8}$
2. $\frac{3}{4}B\omega l^2$
3. $\frac{B\omega l^2}{4}$
4. $\frac{3}{8}B\omega l^2$



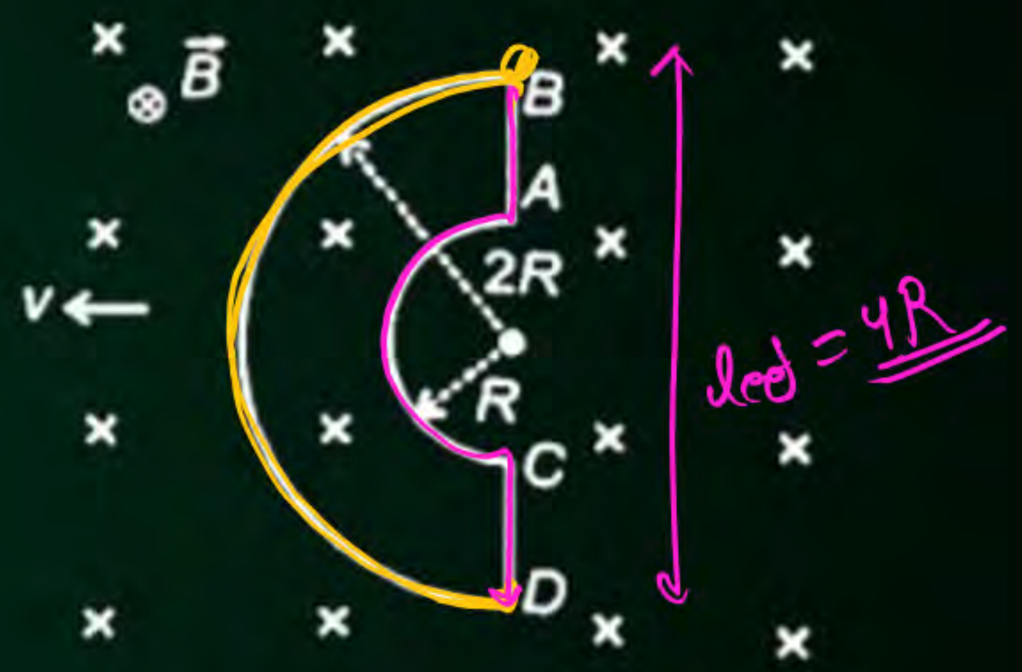
$$(emf)_{loop(Half\ circle)} = 0$$

$$(emf)_{AB} = 2BVR$$

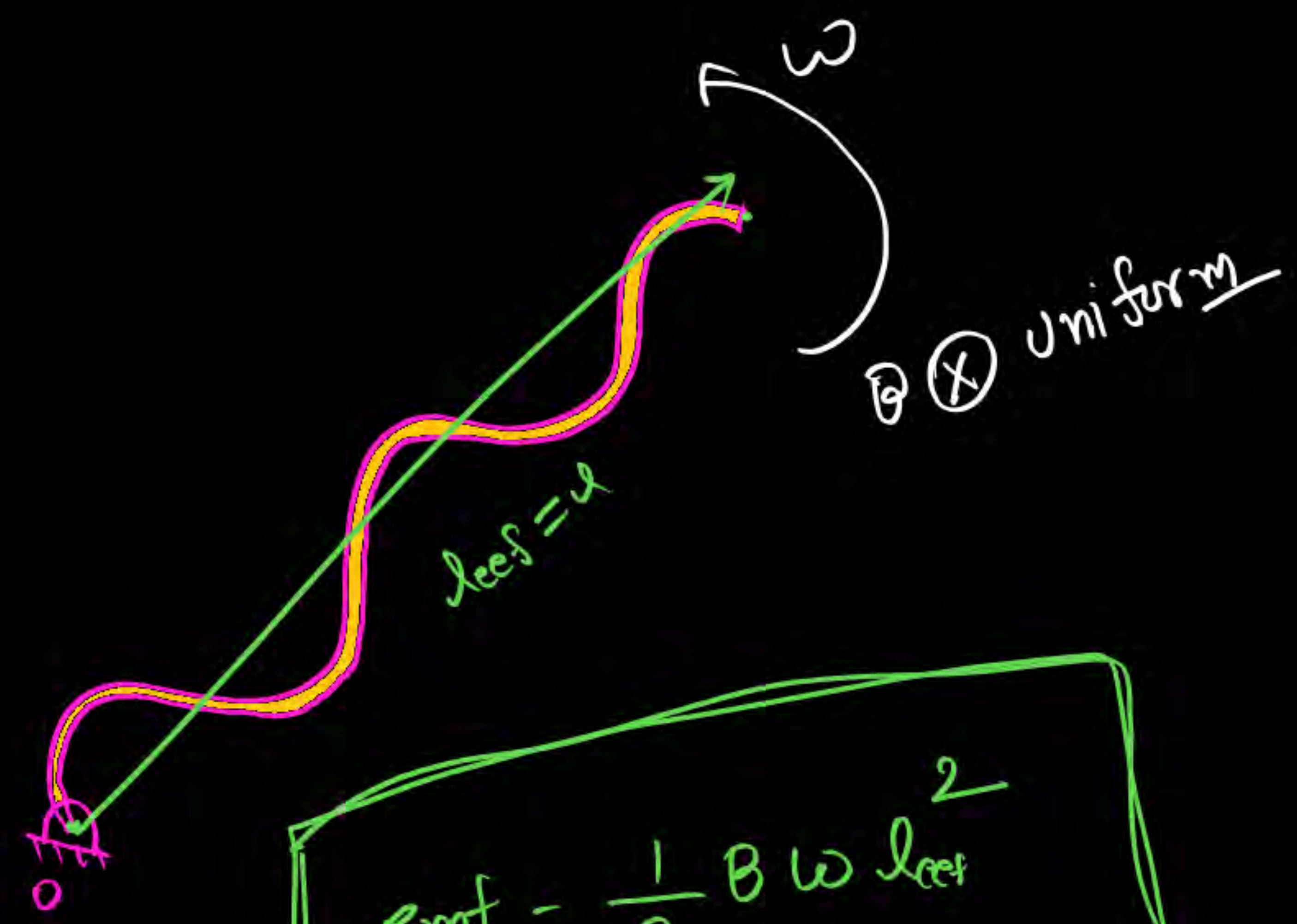


QUESTION

If given arrangement is moving towards left with speed v, then potential difference between B and D and current in the loop are respectively



1. BrR and non-zero
2. $2\,BvR$ and zero
3. $4\,BvR$ and non-zero
4. $4\,BvR$ and zero



$$emf = \frac{1}{2} B \omega l_{eff}^2$$

QUESTION

A semicircular wire of radius R is rotated with constant angular velocity ω about an axis passing through one end and perpendicular to the plane of the wire. There is a uniform magnetic field of strength B. The induced e.m.f. between the ends is :

1. $B\omega R^2/2$
2. $2B\omega R^2$ ✓
3. is variable
4. none of these



$$emf = \frac{1}{2} B\omega (l_{eff})^2$$
$$= \frac{1}{2} B\omega (2R)^2$$
$$= 2B\omega R^2$$

QUESTION

A conducting rod AC of length 4L is rotated about a point O in a uniform magnetic field $\vec{B}$ directed into the paper.

AO = L and OC = 3L. Then

1. $V_A - V_O = \frac{3B\omega L^2}{2}$

2. $V_O - V_C = \frac{5}{2} B\omega L^2$

3. $V_A - V_C = 4\, B\omega L^2$

4. $V_C - V_O = \frac{3}{2} B\omega L^2$



$B \odot$ uniform magnetic field.

$$\text{emf}_{OB} = \frac{1}{2} B\omega l^2 = \text{emf}_{OA}$$



$$\text{emf}_{AB} = 0$$

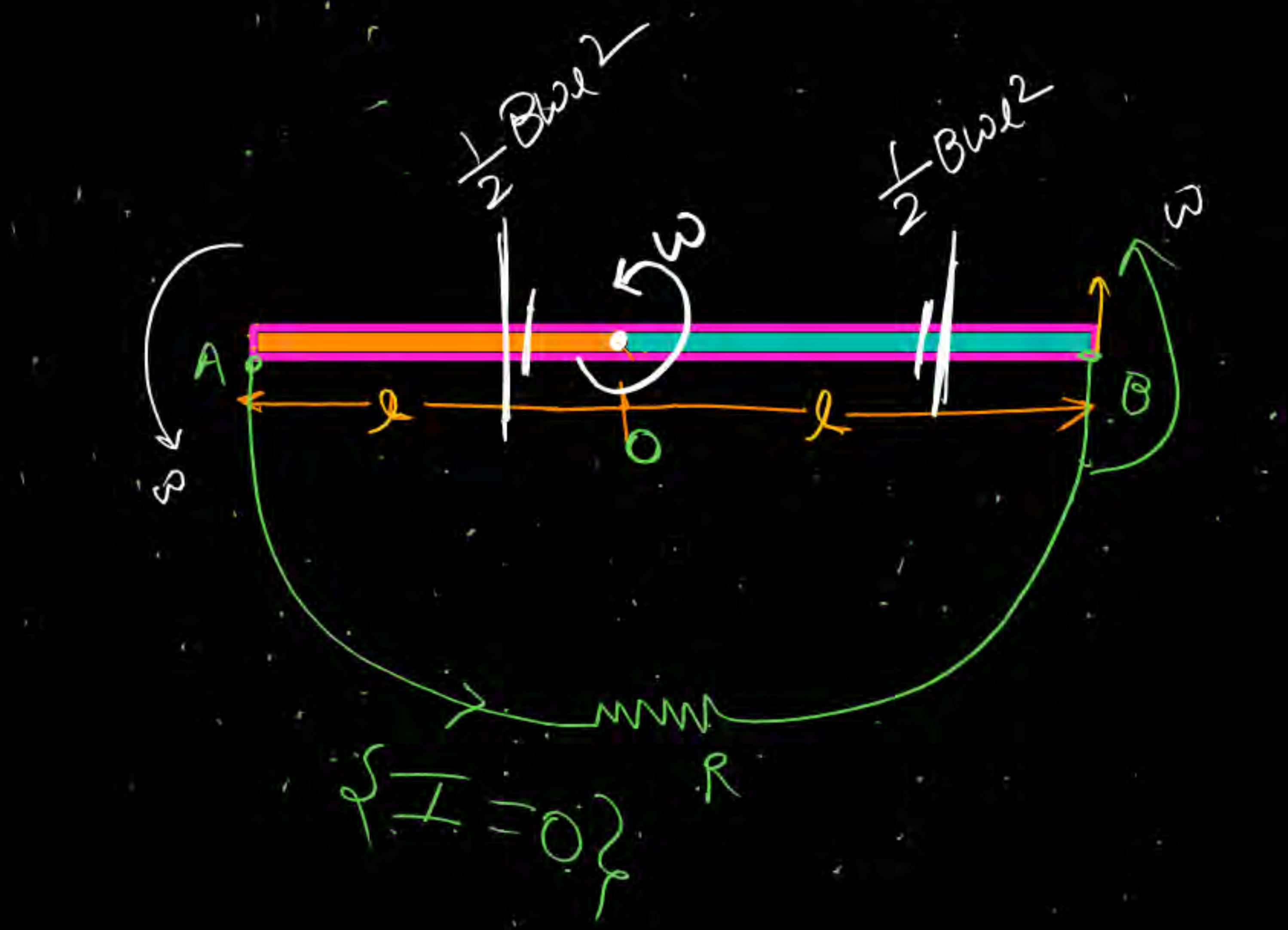
MR* $\text{emf}_{AB} = Bl\left[\frac{\vec{v}_1+\vec{v}_2}{2}\right]$

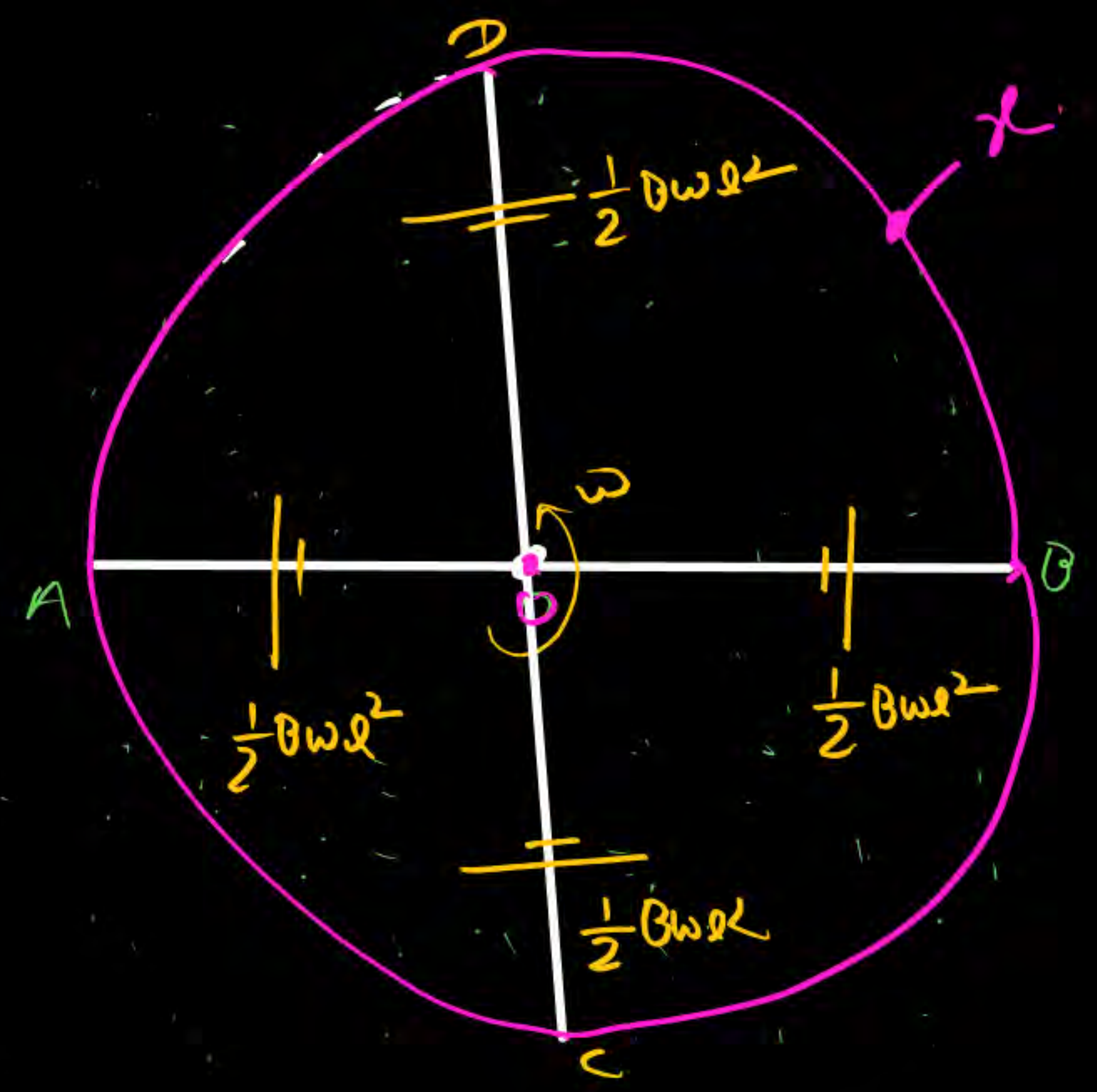
B ⊙ uniform magnetic field.

$emf_{OB} = \frac{1}{2} B\omega l^2 = emf_{OA}$

$emf_{AB} = 0$

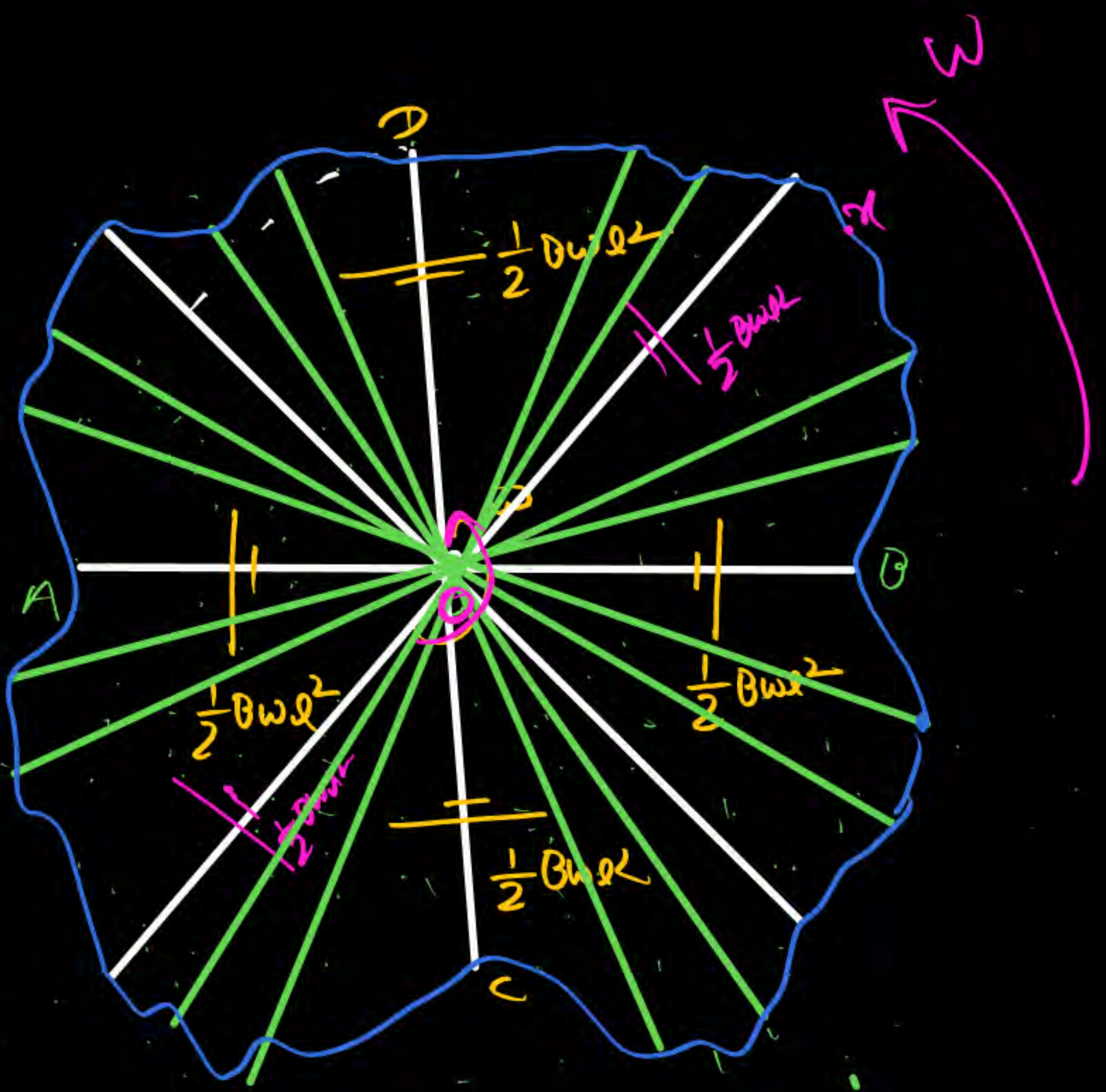
MR* $emf_{AB} = Bl\left[\frac{\vec{v_1}+\vec{v_2}}{2}\right]$





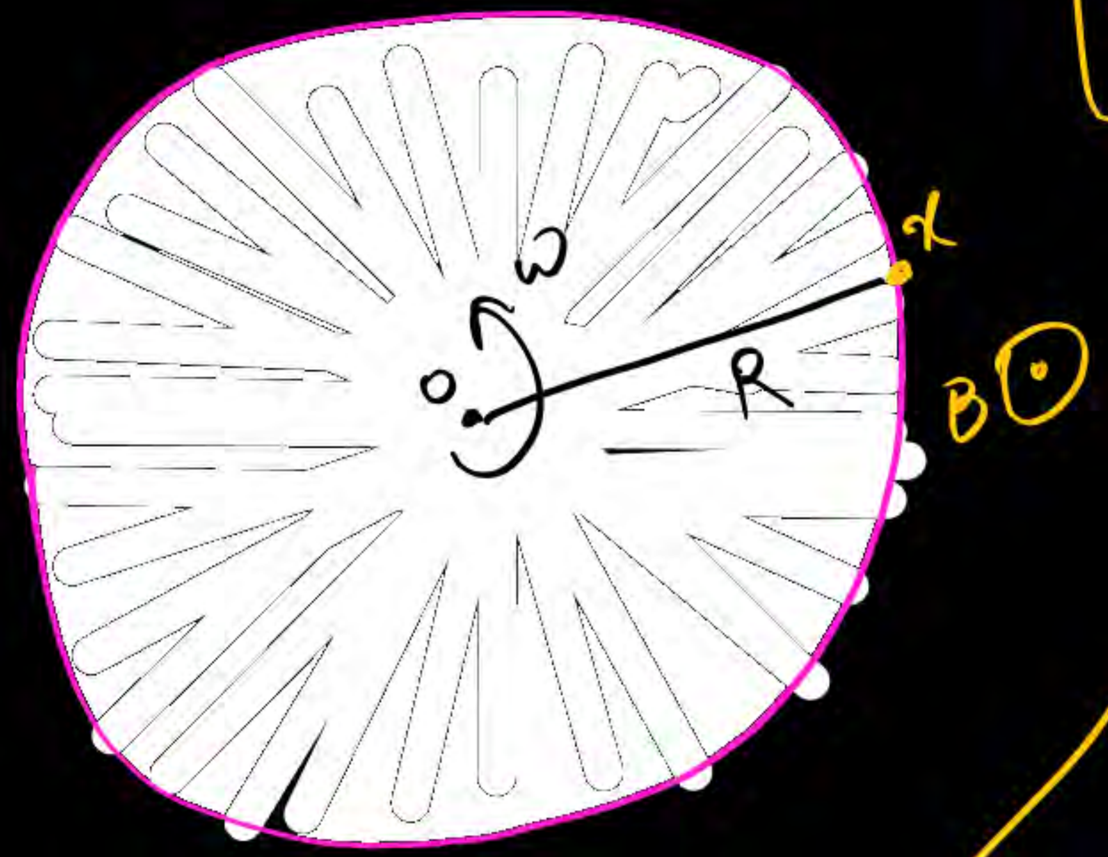
$$V_A = V_B = V_C = V_D$$

$$emf_{OX} = \frac{1}{2}B\omega l^2$$



$$V_A = V_B = V_C = V_D$$

$$(emf)_{Ox} = \frac{1}{2} B\omega l^2$$



$$\text{e.m.f on } = \frac{1}{2} B\omega R^2$$

Disc is Rotating with Angul speed 'ω' about centre.

QUESTION

A semicircular loop of radius R is rotated with an angular velocity to perpendicular to the plane of a magnetic field B as shown in the figure. Emf induced in the loop is



1. $B\omega R^2$
2. $\frac{1}{2} B\omega R^2$
3. $\frac{3}{2} B\omega R^2$
4. $\frac{1}{4} B\omega R^2$

QUESTION

A copper disc of radius 0.1 m rotates about its centre with 10 revolutions per second in a uniform magnetic field of 0.1 Tesla. The emf induced across the radius of the disc is:

1. $\pi/10$ V
2. $2\pi/10$ V
3. 10π mV
4. 20π mV

$f = 10$ Hz

$e = \frac{1}{2} B \omega R^2$

$= \frac{1}{2} \frac{1}{10} \times 2\pi \times 10 \frac{1}{100}$

$= \frac{\pi}{100} \times \frac{10}{10} = \frac{10\pi}{10^3} = 10\pi$ m volt

QUESTION

Figure shows a conducting disc rotating about its axis in a perpendicular magnetic field B. A resistor of resistance R is connected between the centre and the rim. The radius of the disc is 5.0 cm, angular speed $\omega = 40$ rad/s, $B = 0.10$ T and $R = 1\ \Omega$. The current through the resistor is



(1) 5 mA

(2) 50 A

(3) 5 A

(4) 10 mA

$I = \frac{emf}{R}$

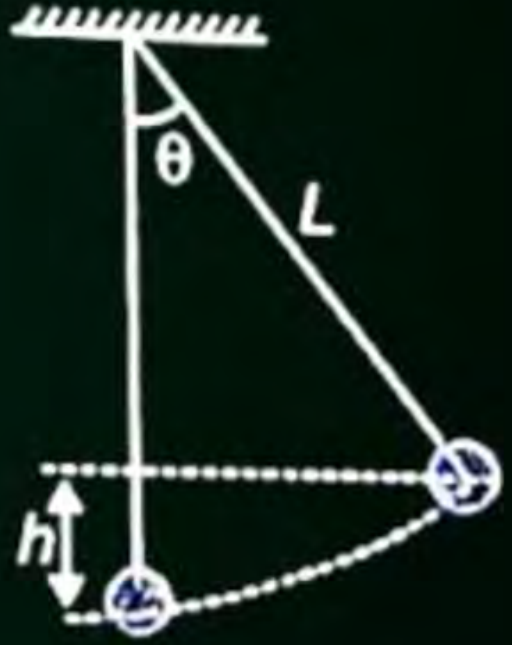
$I = \frac{1}{2}\frac{B\omega R_{adi}^2}{R_{asisi}}$

QUESTION

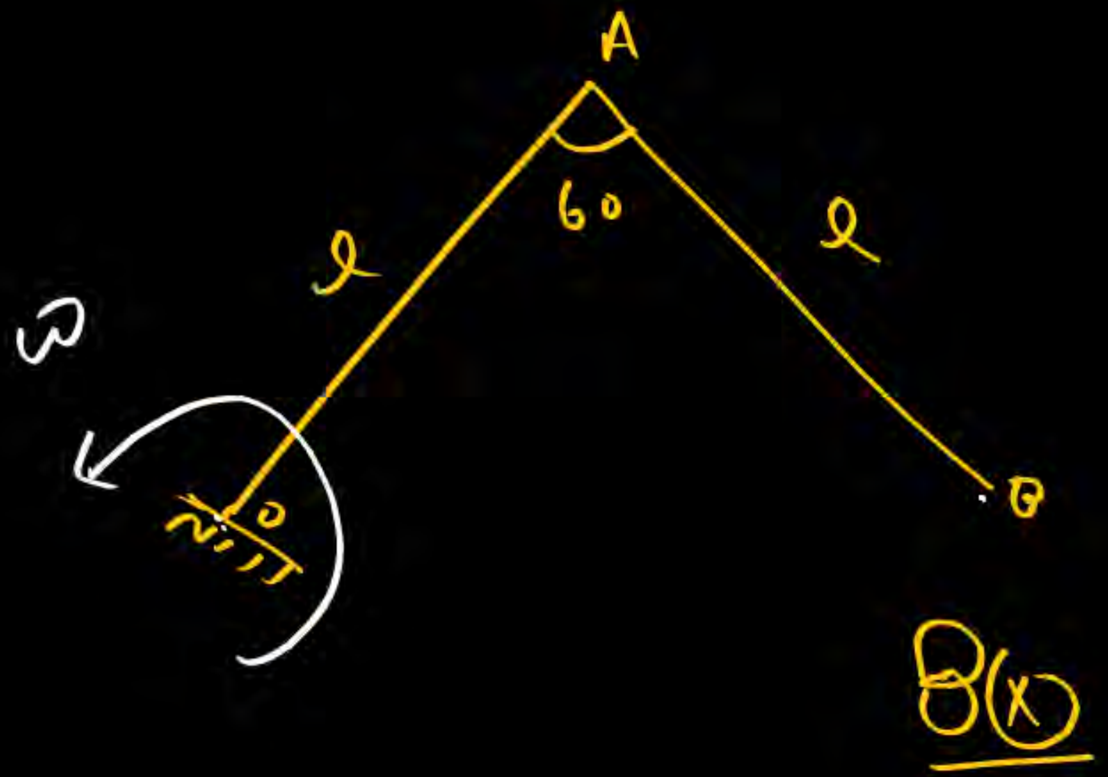
NEET-17

A simple pendulum with bob of mass m and conducting wire of length L swings under gravity through an angle 2θ. The earth's magnetic field component in the direction perpendicular to swing is B. The maximum potential difference induced across the pendulum is

IMP* → dim^n H/w



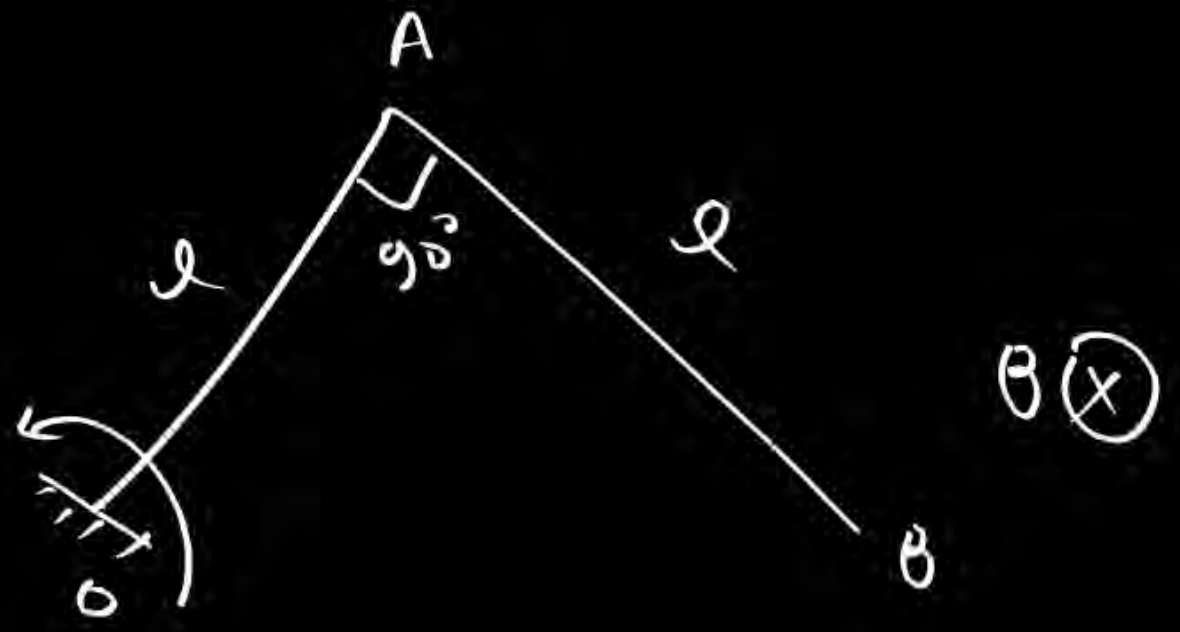
1. $2\,BL\sin\left(\frac{\theta}{2}\right).\sqrt{gL}$
2. $BL\sin\left(\frac{\theta}{2}\right)\sqrt{gL}$
3. $BL\sin\left(\frac{\theta}{2}\right).(gL)^{3/2}$
4. $BL\sin\left(\frac{\theta}{2}\right).(gL)^{2}$



$$\text{emf}_{AB} = 0$$

$$\text{emf}_{OA} = \frac{1}{2} B\omega l^2$$

$$\text{emf}_{OB} = \frac{1}{2} B\omega l^2$$





$$(emf)_{OA} = \frac{1}{2} B\omega l^2 = (emf)_{AB}$$

$$(emf)_{OB} = B\omega l^2$$

QUESTION

Consider the following statements:

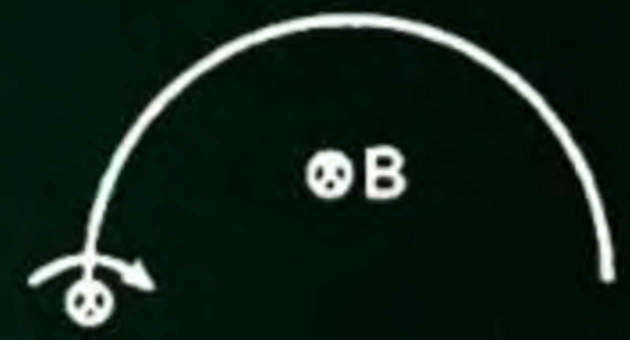
(A) An emf can be induced by moving a conductor in a magnetic field.

(B) An emf can be induced by changing the magnetic field.

1. Both A and B are true
2. A is true but B is false
3. B is true but A is false
4. Both A and B are false.

QUESTION

A semicircular wire of radius R is rotated with constant angular velocity ω about an axis passing through one end and perpendicular to the plane of the wire. There is a uniform magnetic field of strength B. The induced e.m.f. between the ends is :



1. $B\omega R^2/2$
2. $2B\omega R^2$
3. is variable
4. none of these

QUESTION

A copper disc of radius 0.1 m rotates about its centre with 10 revolutions per second in a uniform magnetic field of 0.1 Tesla. The emf induced across the radius of the disc is:

1. $\pi/10$ V
2. $2\pi/10$ V
3. 10π mV
4. 20π mV

QUESTION

Figure shows a conducting disc rotating about its axis in a perpendicular magnetic field B. A resistor of resistance R is connected between the centre and the rim. The radius of the disc is 5.0 cm, angular speed $\omega = 40$ rad/s, $B = 0.10$ T and $R = 1\ \Omega$. The current through the resistor is



1. 5 mA
2. 50 A
3. 5 A
4. 10 mA

Electric Field

असली	नकली
Electrostatic field	Induced electric field
Conservative field	Non-conservative field
$\oint \vec{E}.d\vec{l} = 0$	$\oint \vec{E}.d\vec{l} \neq 0$
Does not forms close loop.	always forms close loop.

QUESTION

There exists a uniform magnetic field in a circular region of radius R centred at O. The field is perpendicular to and out of the plane of paper and its strength varies with time as $B = B_0 t$. Find the induced electric field at a distance r from the centre for (1) $r < R$ (2) $r > R$

- "An electric field is induced in any region of space in which a magnetic field is charging with time".
- "A magnetic field is induced in any region of space in which an electric field is charging with time.
- In each case, the strength of the induced field is proportional to the rate of charge of the inducing field. Both field are perpendicular to each other.

QUESTION

A uniform magnetic field is restricted within a region of radius r. The magnetic field changes with time at a rate $\frac{d\vec{B}}{dt}$. Loop 1 of radius $R > r$ enclosed the region r and loop 2 of radius R is outside the region of magnetic field as shown in the figure below. Then the e.m.f. generated is

[NEET-(Phase-2)-2016]



1. Zero in loop 1 and zero in loop 2
2. $-\frac{d\vec{B}}{dt}\pi r^2$ in loop 1 and $-\frac{d\vec{B}}{dt}\pi r^2$ in loop 2
3. $-\frac{d\vec{B}}{dt}\pi R^2$ in loop 1 and zero in loop 2
4. $-\frac{d\vec{B}}{dt}\pi r^2$ in loop 1 and zero in loop 2


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 05 | Physics

ELECTROMAGNETIC INDUCTION

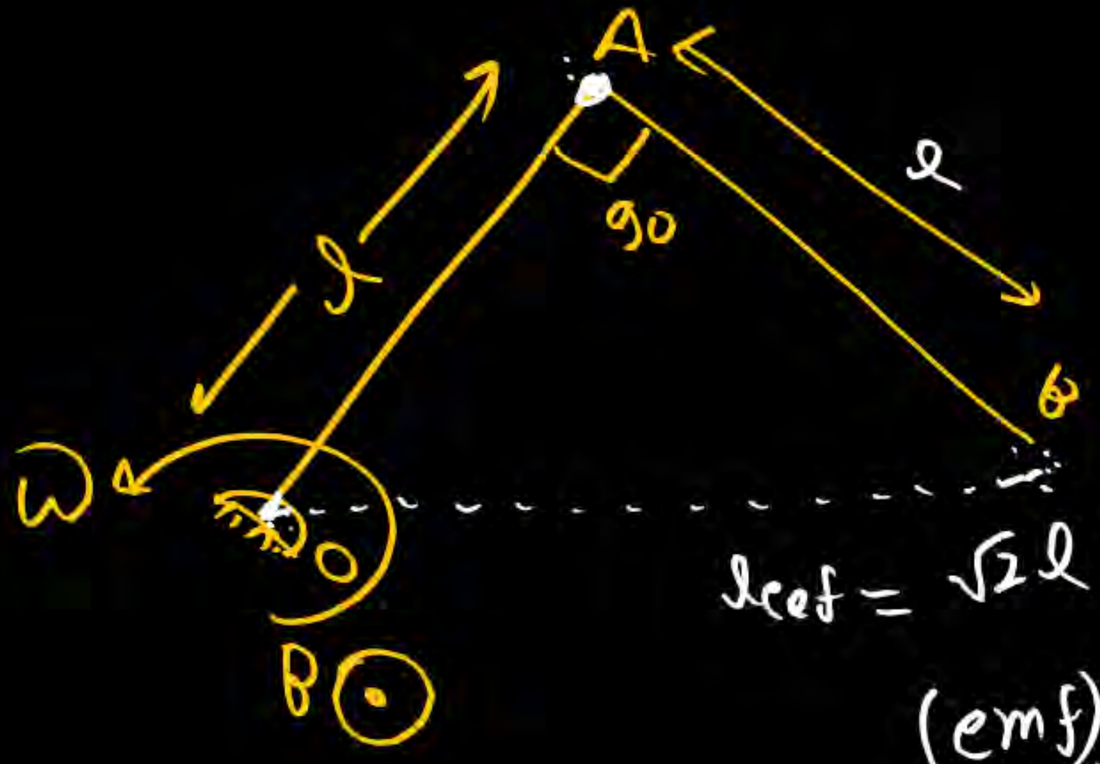


By- Dr. Manish Raj (MR SIR)

Todays Goal

Induced electric field

Self Inductor



$l_{eff} = \sqrt{2}\,l$

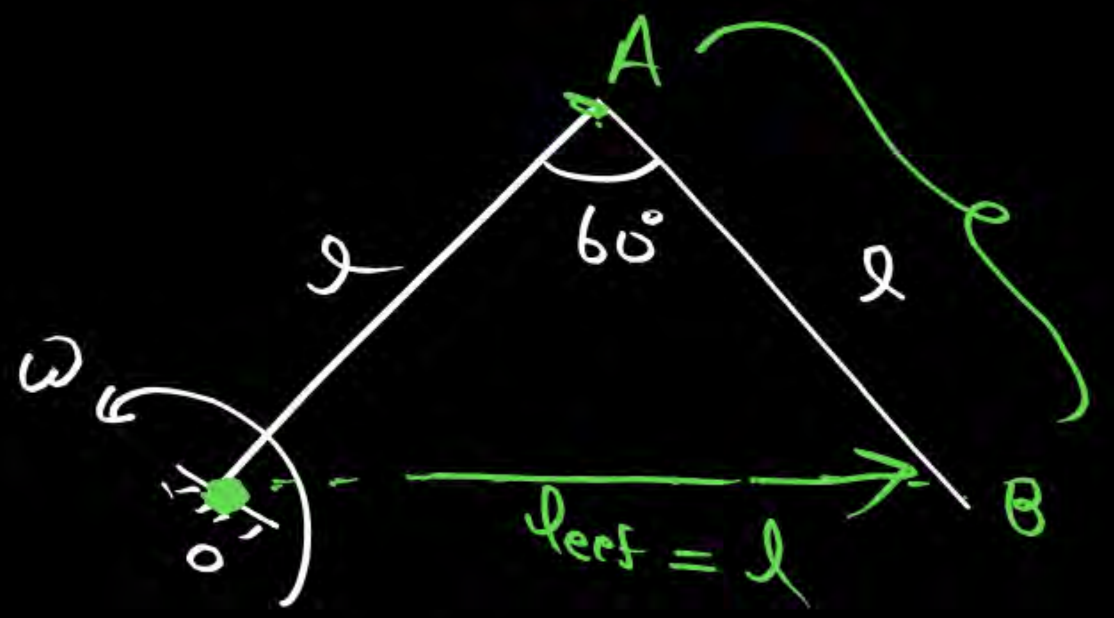
$(emf)_{OB} = \frac{1}{2} B\omega(\sqrt{2}l)^2 = B\omega l^2$ ✓

$(emf)_{OA} = \frac{1}{2} B\omega l^2$ ✓

$(emf)_{AB} = (emf)_{OB} - (emf)_{OA}$

$= B\omega l^2 - \frac{1}{2} B\omega l^2$

$= \frac{1}{2} B\omega l^2$



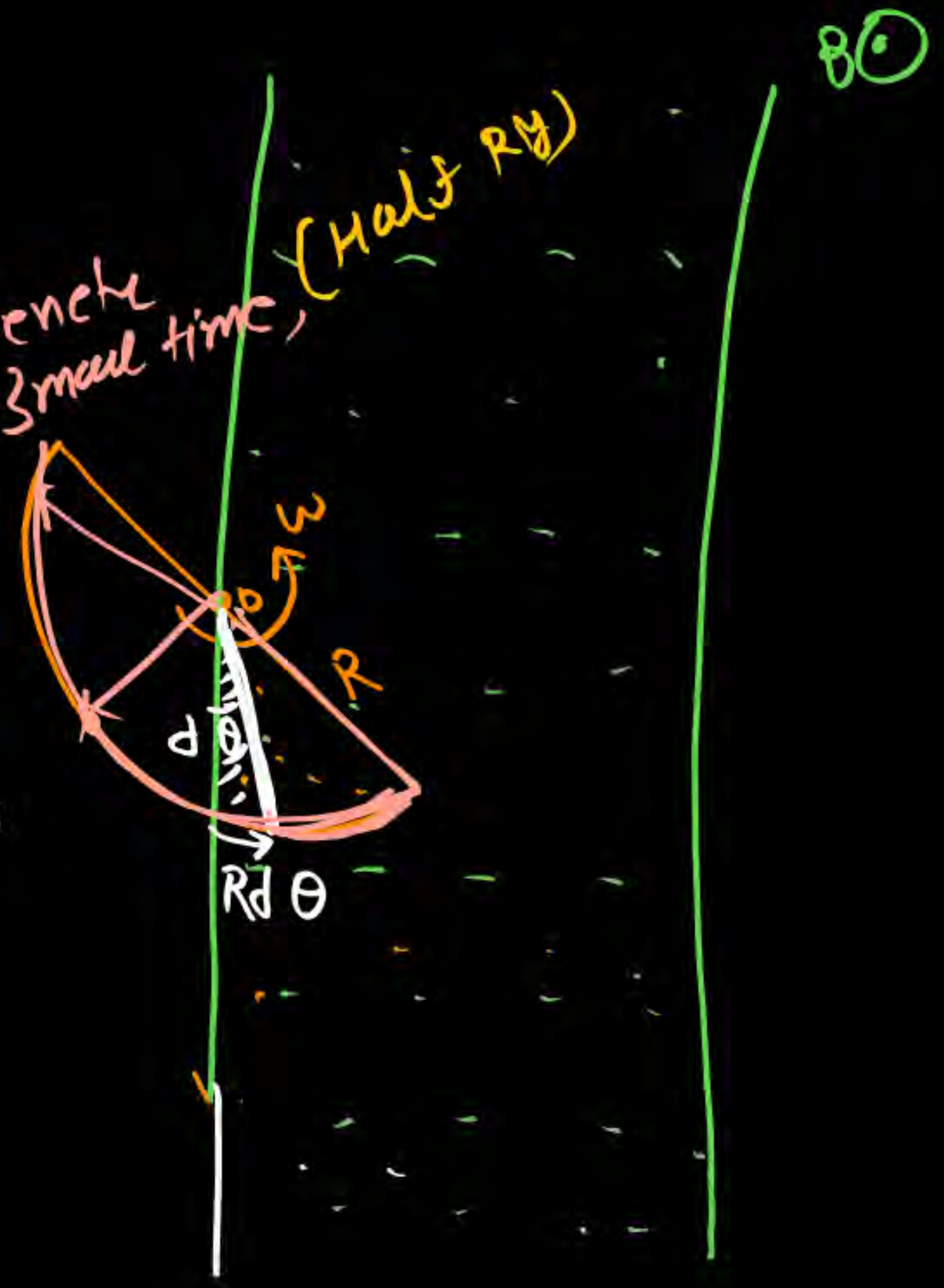
$B \odot$

$$(emf)_{OB} = \frac{1}{2} B \omega l^2$$

$$(emf)_{OA} = \frac{1}{2} B \omega l^2$$

$(emf)_{AB} = \text{zero}$

Small Area element enclo in magnetic is small time, (Half Ry)



$dA = \frac{1}{2} R \times R\,d\theta$

divided by dt both sides

$\frac{dA}{dt} = \frac{1}{2} R^2 \frac{d\theta}{dt}$

$emf = \frac{d\phi}{dt} = B \frac{dA}{dt}$

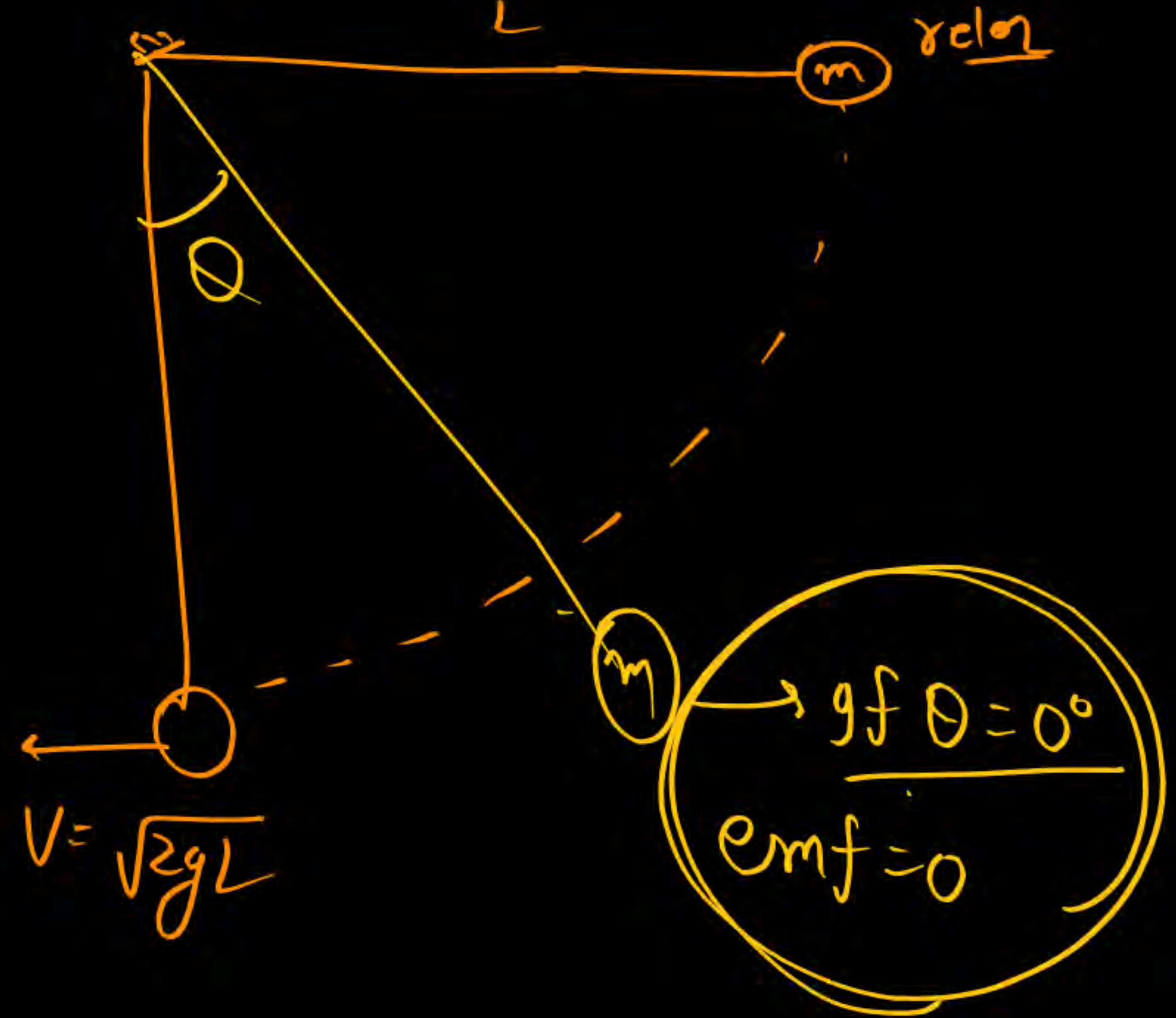
$= B \frac{1}{2} R^2 \frac{d\theta}{dt}$

* $emf = \frac{1}{2} B \omega R^2$

A simple pendulum with bob of mass m and conducting wire of length L swings under gravity through an angle 2θ. The earth's magnetic field component in the direction perpendicular to swing is B. The maximum potential difference induced across the pendulum is

1. $2BL\sin\left(\frac{\theta}{2}\right).\sqrt{gL}$
2. $BL\sin\left(\frac{\theta}{2}\right)\sqrt{gL}$
3. $BL\sin\left(\frac{\theta}{2}\right).(gL)^{3/2}$
4. $BL\sin\left(\frac{\theta}{2}\right).(gL)^2$

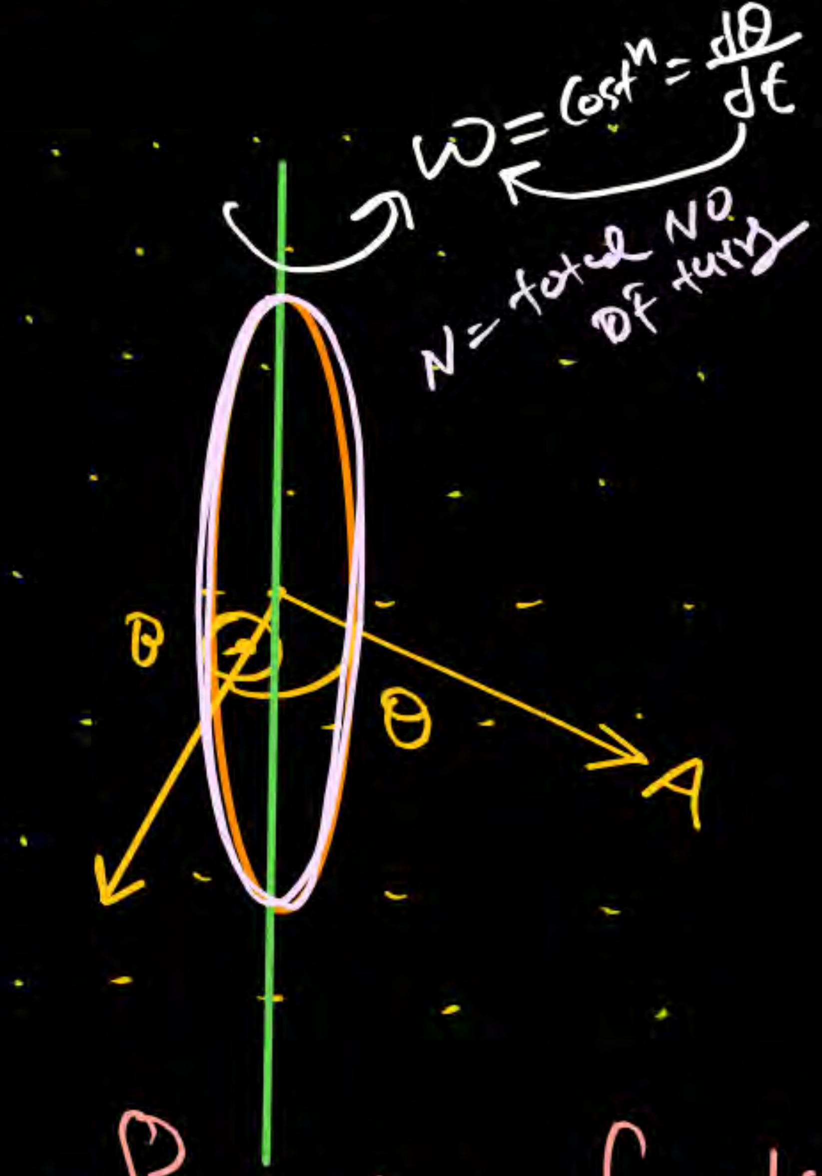




$$emf = BL\left[\frac{0+\sqrt{2gL}}{2}\right]$$

$$= BL\frac{\sqrt{gL}}{\sqrt{2}}$$

A/c generator (Alternatic current)



Based on farads law

Important for NEET

$$\phi = NBA\cos\theta$$

$$|emf| = \frac{d\phi}{dt} = NBA\frac{d(\cos\theta)}{dt} \times \left[\frac{d\theta}{d\theta}\right]$$

$$= BAN\frac{d(\cos\theta)}{d\theta} \times \frac{d\theta}{dt}$$

$$= NBA\left[-\sin\theta\right] \times \omega$$

$$emf = -BA\omega N \times \sin(\theta)$$

$$emf = NBA\omega \times \sin(\omega t)$$

$$|emf|_{max} = NBA\omega = NBA2\pi f$$

QUESTION

A coil having number of turns N and area A is rotated in a uniform magnetic field B with angular velocity ω about its diameter. Maximum e.m.f. induced in it is given by

1. $NAB\omega$
2. $\frac{NAB}{\omega}$
3. $\frac{NA\omega}{B}$
4. $\frac{B\omega}{NA}$

• Magneti flux

$\phi = BA\cos\theta$
$= \vec{B}\cdot\vec{A}$

• Lentz law

$\phi \rightarrow$ varible
$\hookrightarrow$ I (current flow) due to variable magnetic flux.

Faradys law

when thre is change in flux through loop then there is induced emf in the loop.

$emf = -\frac{d\phi}{dt}$

Hall effect

Not only in loop, emf can be induce in moving Rod

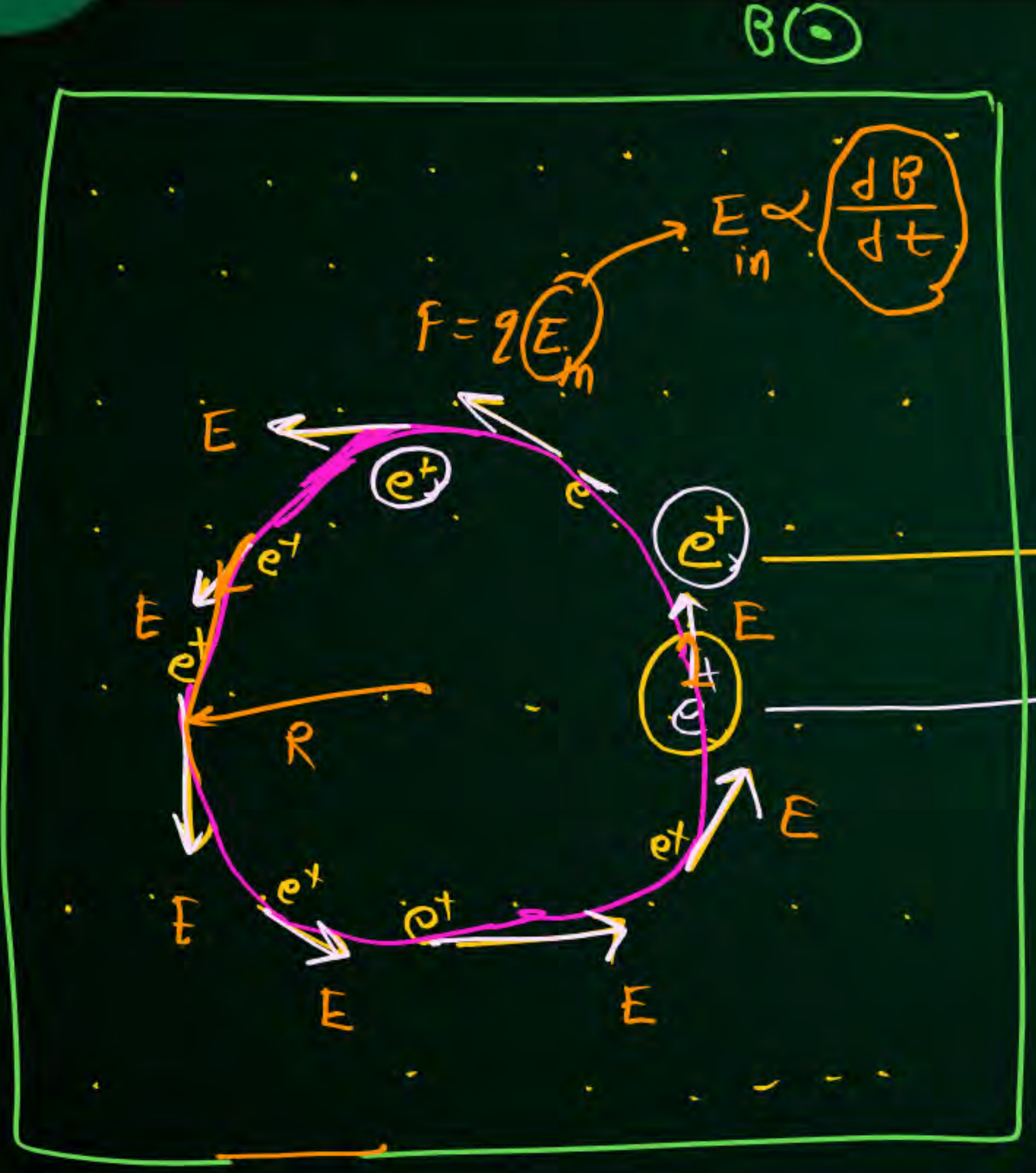
$emf = Bvl$

Motional emf

Rotational emf.

There is no need of any wire, Rod, emf etc. emf will indued in a air where magnetic field changing w.r.t to time. hence there is Indured electric field.

Induced Electric Field



charge is at rest & B⊙ = uniform then force on charge must be zero. (theory & experimently)

charge at rest B⊙ ↓ (varible) then force on charge must be zero (theory) but experimently force on that rest charge is not zero.

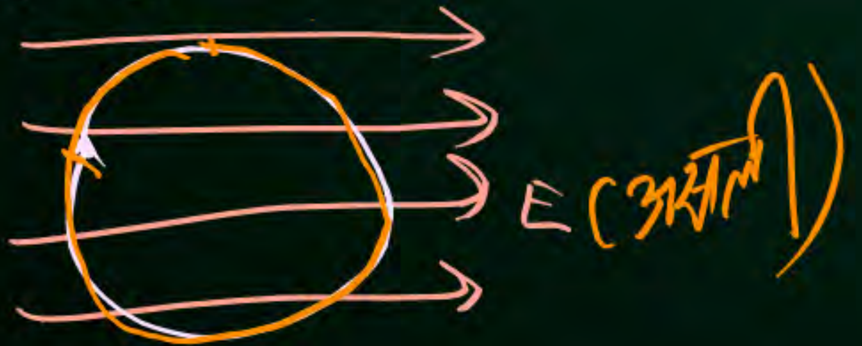
force ka magnitud not depends on B but but depends on $\left(\frac{dB}{dt}\right)$ ✓

Electric Field

असली

- due to rest charge/Moving charge
- Electrostatic field
- Conservative field
- $\oint \vec{E} . d\vec{l} = 0$
- Does not forms close loop.

$\oint E \cdot dl = \Delta V = 0$



नकली

- Induced electric field
- Non-conservative field
- $\oint \vec{E} . d\vec{l} \neq 0$
- always forms close loop.

$\oint \vec{E} \cdot \vec{dl} = \Delta V = \frac{d\phi}{dt}$

$\oint \vec{E}_{in} \cdot \vec{dl} = \frac{d\phi}{dt}$ (magnetic flux)

$E = -\frac{dV}{dl}$



Electric electric

असली electric field

Electrostatic field

due to charge.

Conservative field

$\oint E\,dl = 0$

Never forms close loop

Induced electric.

* time varying magnetic field
  - Non conservation f…

always form close loop

$$\oint \vec{E}_{In}\cdot d\vec{l} = -\frac{d\phi_{magnetic}}{dt}$$

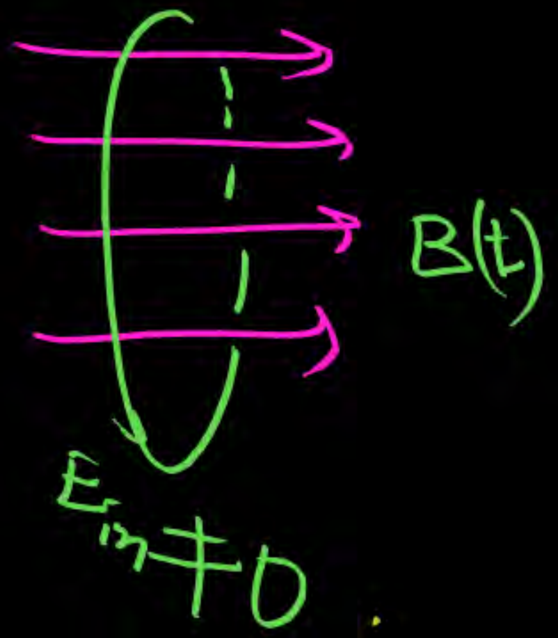
Variable magnetic field Induced Electric field :



(a) True ✗

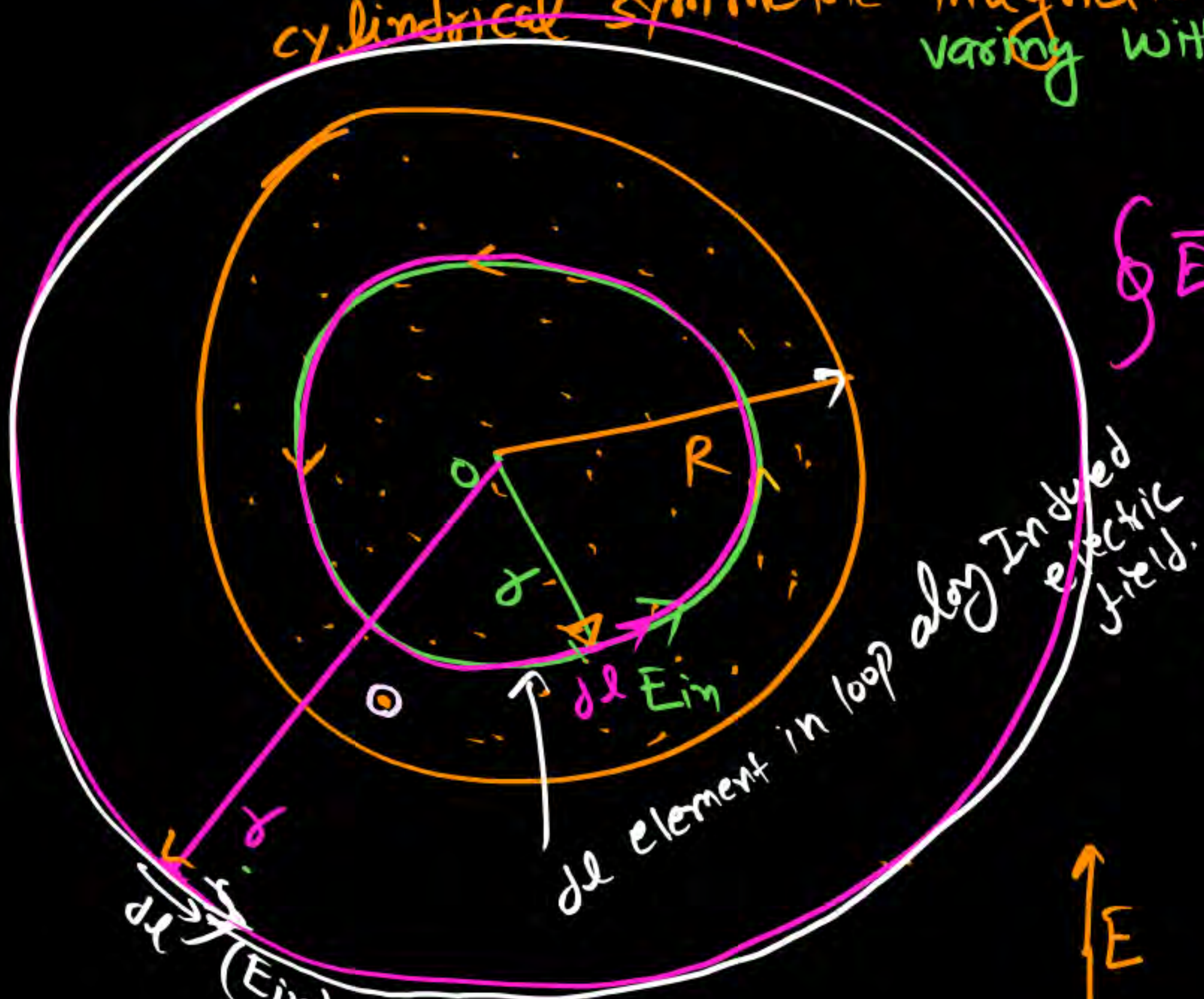
(b) false ✓

time varying magnetic field Induced electric field



derivation Induced electric field

cylindrical symmetric magnetic field varying with time



$(E = v B)$ ~~$qE = qvB$~~

$E = vB = \frac{L}{t}(B)$

Angle b/w Induced electric field & magnetic field ⇒ 90°

$\phi = \pi R^2 B$

E inside $(r < R)$

$\oint \vec{E}_{in} \cdot \vec{dl} \cos 0^\circ = \frac{d\phi_{mag}}{dt}$

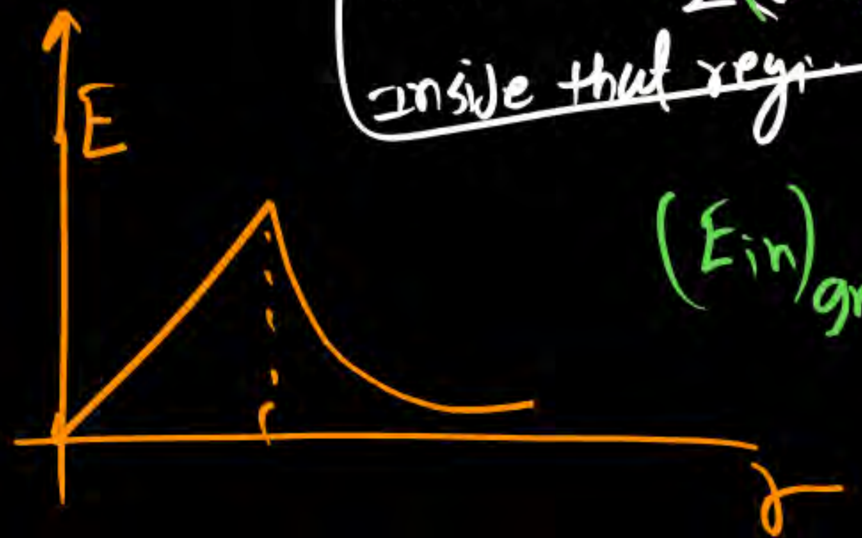
$E_{in} \oint dl = \pi r^2 \frac{dB}{dt}$

$E_{in}\, 2\pi r = \pi r^2 \frac{dB}{dt}$

$$\vec{E}_{in} = \frac{r}{2}\left(\frac{dB}{dt}\right)$$

inside that region

$(E_{in})_{gms} = \frac{r}{2}\left(\frac{dB}{dt}\right)$



E induced outside the region of magnetic field.

$\oint \vec{E}_{in} \cdot dl = \frac{d\phi}{dt}$

$\phi = B\pi R^2$ —— (1)

$E_{in} \oint dl = \pi R^2 \frac{dB}{dt}$

$E_{in}\, 2\pi r = \pi R^2 \frac{dB}{dt}$

$$\vec{E}_{in} = \frac{R^2}{2r}\left(\frac{dB}{dt}\right)$$

outside



$$\phi_{Inner} = B\pi R^2$$

$$\phi_{outer\ ring} = B\pi R^2$$

why same ?

QUESTION

There exists a uniform magnetic field in a circular region of radius R centred at O. The field is perpendicular to and out of the plane of paper and its strength varies with time as $B = B_0 t$. Find the induced electric field at a distance r from the centre for (1) $r < R$ (2) $r > R$



$B = B_0 t$

$(r < R)$

$$E_{in} = \frac{r}{2}\frac{dB}{dt} = \frac{r}{2}\frac{d(B_0 t)}{dt} = \frac{r B_0}{2} \times 1$$

$$E_{out} = \frac{R^2}{2r}\frac{dB}{dt} = \frac{R^2}{2r}\left(B_0 \frac{dt}{dt}\right) = \frac{B_0 R^2}{2r}$$ Ans

- "An electric field is induced in any region of space in which a magnetic field is changing with time". ✓

- "A magnetic field is induced in any region of space in which an electric field is changing with time. (next to next chapter → EM wave)

- In each case, the strength of the induced field is proportional to the rate of change of the inducing field. Both field are perpendicular to each other.

$$E_{in} \propto \frac{dB}{dt}$$

They are ⊥r to each other

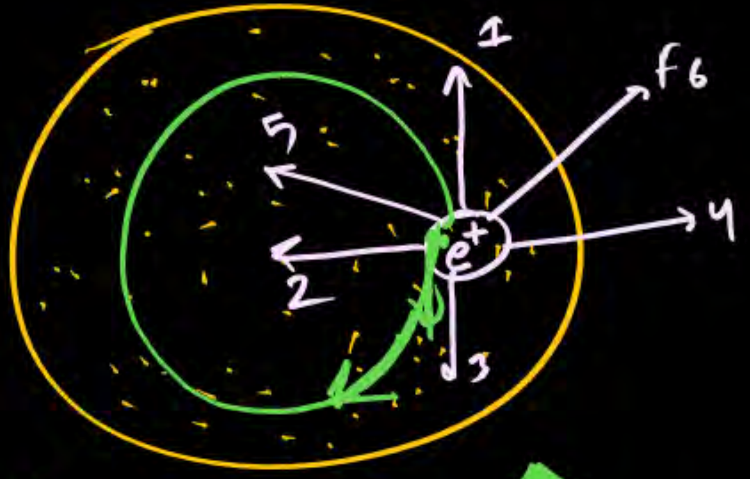
QUESTION

A uniform magnetic field is restricted within a region of radius r. The magnetic field changes with time at a rate $\frac{d\vec{B}}{dt}$. Loop 1 of radius $R > r$ enclosed the region r and loop 2 of radius R is outside the region of magnetic field as shown in the figure below. Then the e.m.f. generated is

[NEET-(Phase-2)-2016]

1. Zero in loop 1 and zero in loop 2
2. $-\frac{d\vec{B}}{dt}\pi r^2$ in loop 1 and $-\frac{d\vec{B}}{dt}\pi r^2$ in loop 2
3. $-\frac{d\vec{B}}{dt}\pi R^2$ in loop 1 and zero in loop 2
4. $-\frac{d\vec{B}}{dt}\pi r^2$ in loop 1 and zero in loop 2



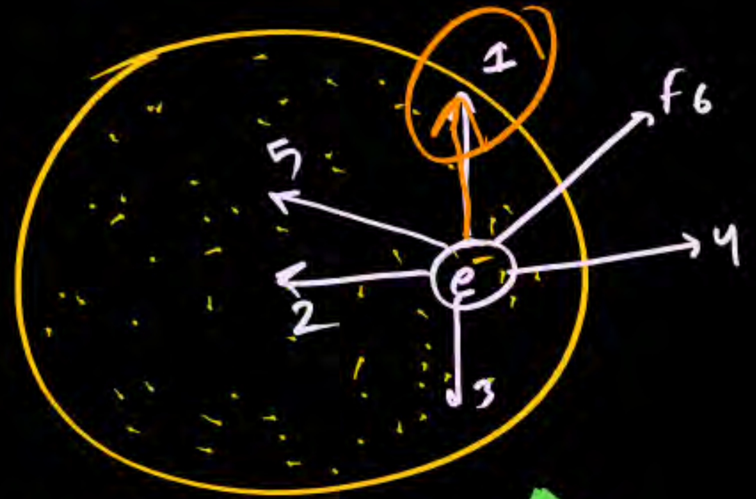


Magnetic B ⊙ ↑

→ E induce will apply force

$F_{Net\ for}$ = along 3rd line

B ind ⊗ clock clockwise



Magnetic B ⊙ ↑

→ B ⊗ In clock wise Cum

F_{net} = along 1st line



B ⊗

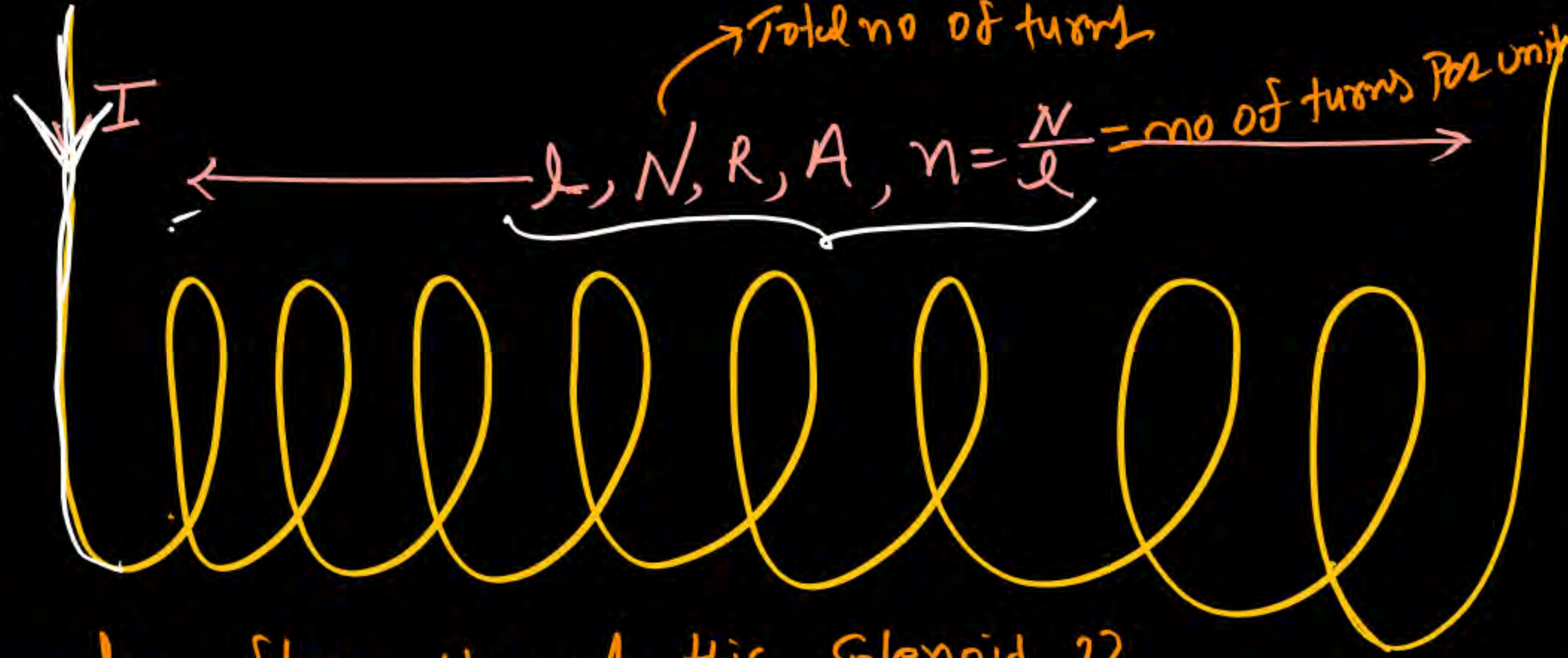
along x-axis

B ⊗ Induced

clock wise current

e⁻ will move Anti-clock wise

E induced clock wise



find magnetic flux through this solenoid ??

$\phi = B \, Area$

$\phi = (\mu_0 n I) \times A \times N$

$\phi = \mu_0 n I A n l$

$\phi = \mu_0 n^2 A l I$

$\phi = (\mu_0 n^2 A l) I$

Permiability

$\phi = L I$

Self-Inductance
Proportional const

$\phi \propto I$

$\phi = LI$

$L = \mu_0 n^2 A l$

When we change I (current) there is change in flux

Coil will oppose change in flow, induced emf.

$|emf| = \frac{d\phi}{dt} = L \frac{dI}{dt}$



$I = \text{cost}^n$

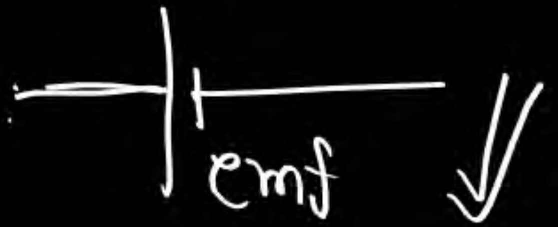
$\phi = \text{cost}^n$

emf = 0

Indu

$emf = L\frac{dI}{dt} = 0$





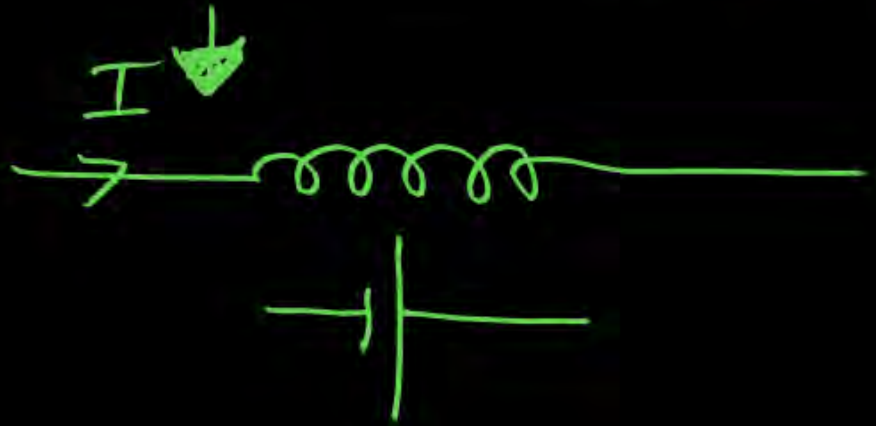
$emf = L\frac{d\phi}{dt}$

I↑ (उल्टा Battery)
I↓ (Same dir^n Battery)

$emf = -L\frac{dI}{dt}$

$|emf| = L\frac{dI}{dt}$

formula







QUESTION

Electric field always induce in varying magnetic field ⇒ True / False

QUESTION

Find magnetic flux through solenoid?



SELF INDUCTION AND SOLENOID

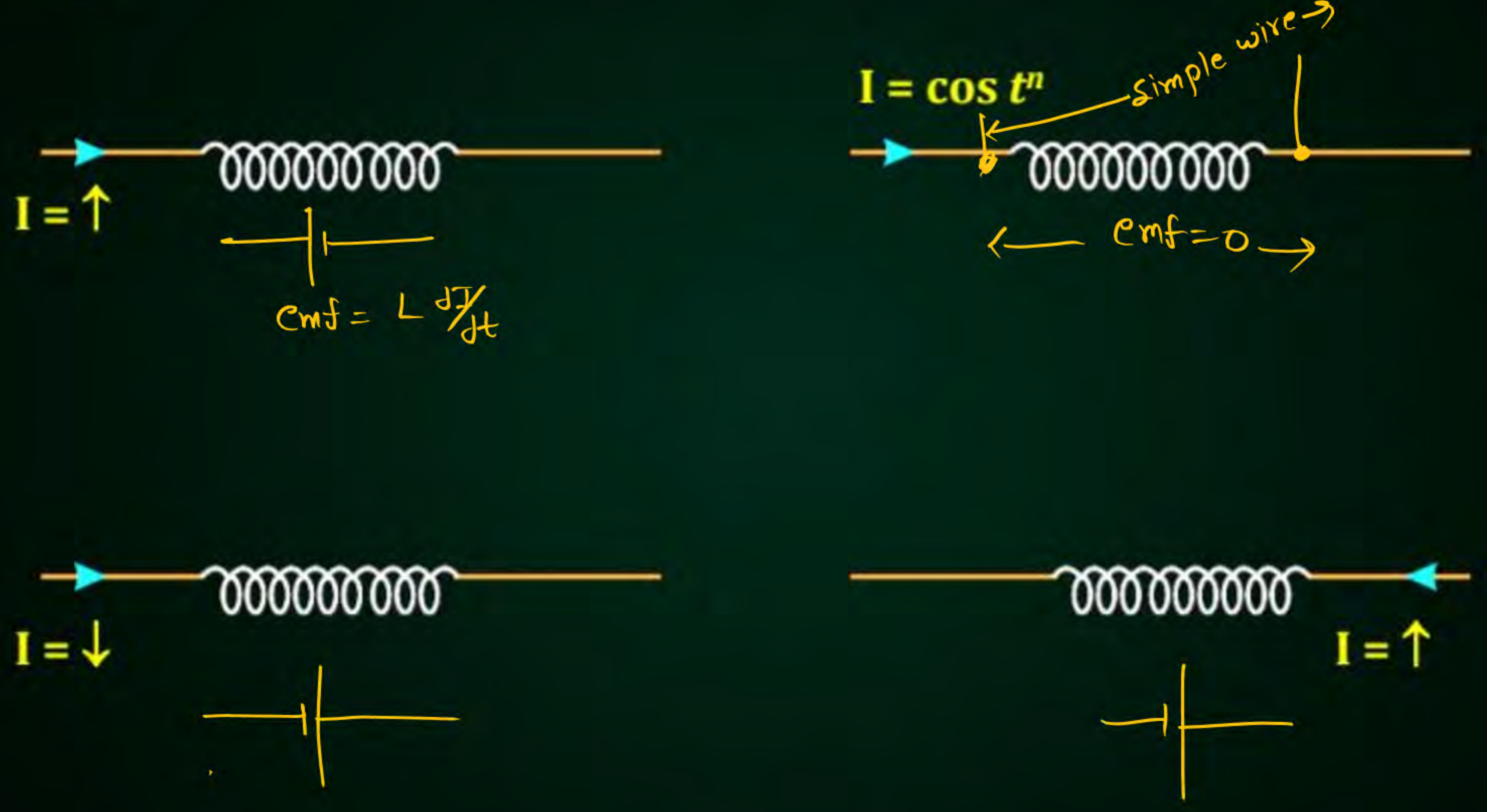
Find flux passing through solenoid ?



QUESTION

Is self-inductance $\left(L = \frac{\phi}{I}\right)$ depends on flux and current?

QUESTION



QUESTION

If length of inductor becomes doubled then it self-inductance becomes?

(a) Half

(b) double

(c) remain same

(d) Can't say

80%

(22%)

$L = \mu_0 n^2 A l$

$L = (\mu_0 n^2 A) l$

$L \propto l$

$n = const.$



$L = \frac{\mu_0 N^2}{l^2} A l$

$L \propto \frac{1}{l}$

$N = const^n$



QUESTION

The current passing through a choke coil of self inductance 5 H is decreasing at the rate of 2 A/s. The e.m.f. developed across the coil is

1. 10 V
2. –10 V
3. –2.5 V
4. 2.5 V

$L = 5\,H$

$\frac{dI}{dt} = -2\,A/s$

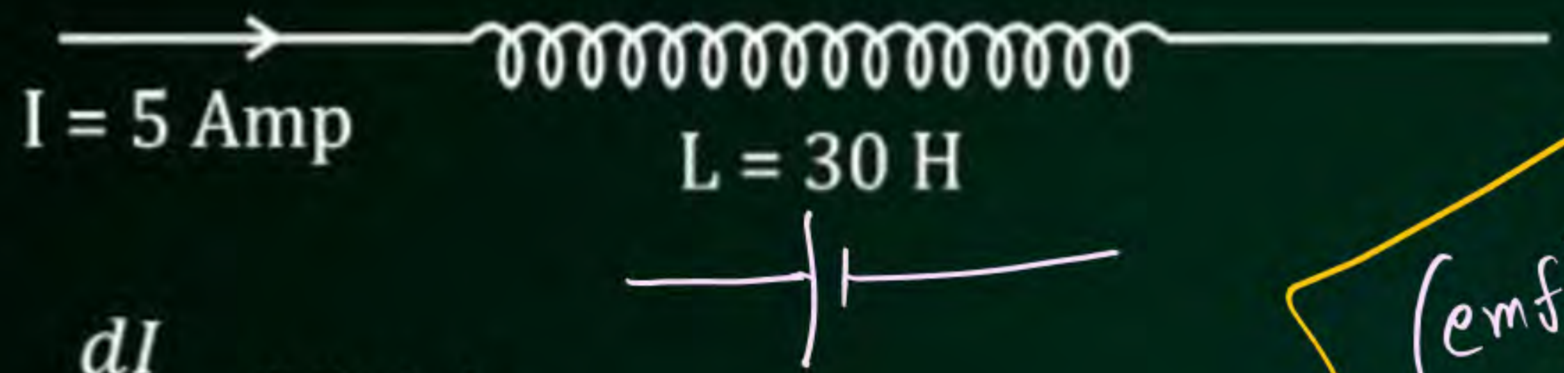
$emf = -L\frac{dI}{dt}$

$= -5 \times (-2)$

$= +10$ Volt

QUESTION

Find Back e.m.f. in given inductor.



$$\frac{dI}{dt} = 0.2\ \text{A/s}$$

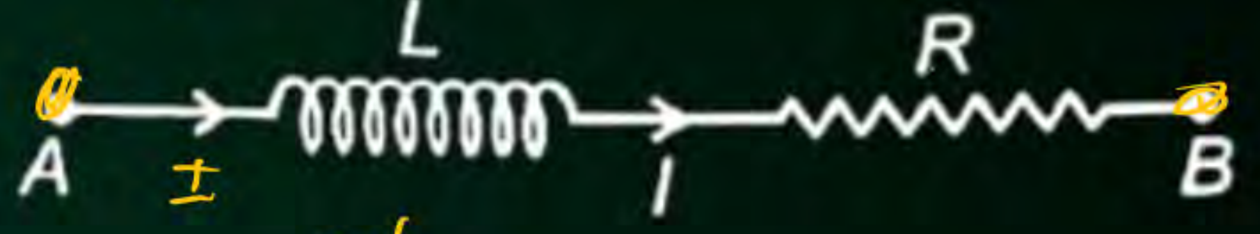
$$(\text{emf})_{\text{Back emf}} = L\frac{dI}{dt}$$

$$= 30 \times \frac{2}{10}$$

$$= 6\ \text{volt}$$

QUESTION

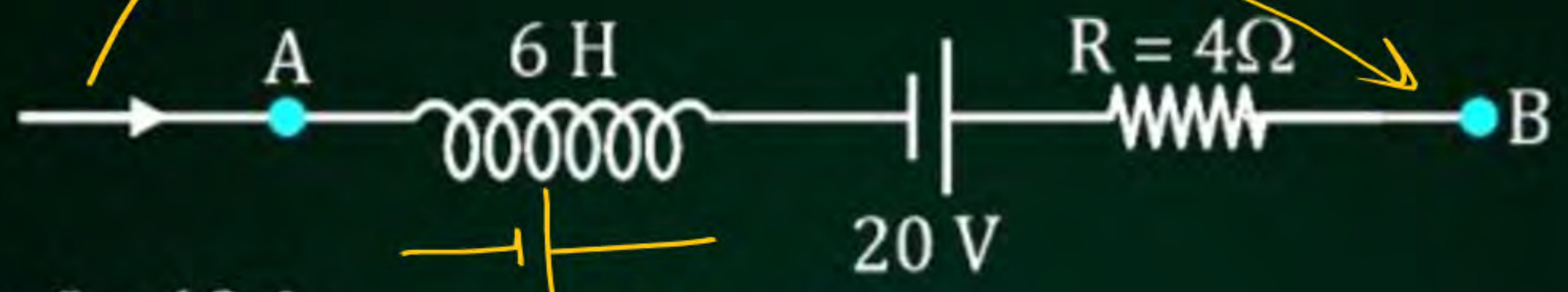
In an A.C. sub-circuit as shown in figure, the resistance $R = 0.2\ \Omega$. At a certain instant $V_A - V_B = 0.5$ V, $I = 0.5$ A, and current is increasing at the rate of $\Delta I / \Delta t = 8$ A/s The inductance of the coil is



1. 0.01 H
2. 0.02 H
3. 0.05 H
4. 05 H

QUESTION

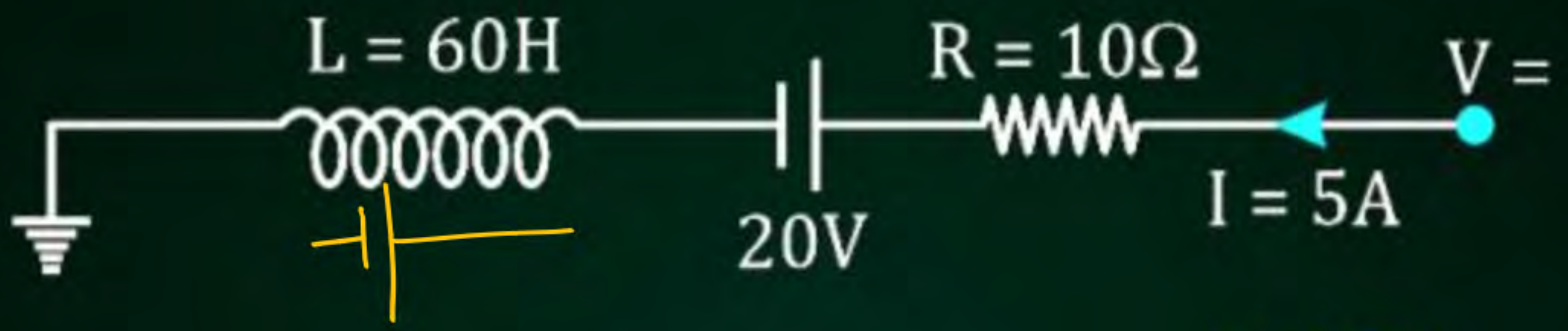
Find $V_A - V_B = ??$



$I = 10\ A$

$\left(\dfrac{dI}{dt}\right) = -0.5\ A/s$

QUESTION

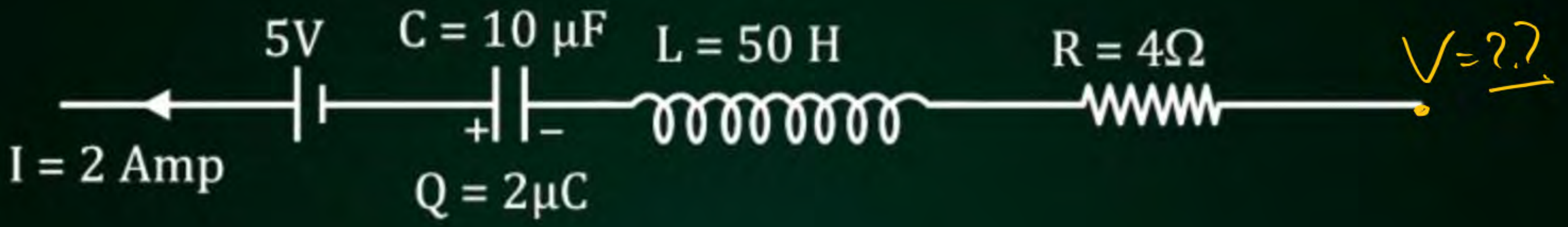


$I = 5\text{ A}$

$\frac{dI}{dt} = 0.2\text{ A/s}$

H/W

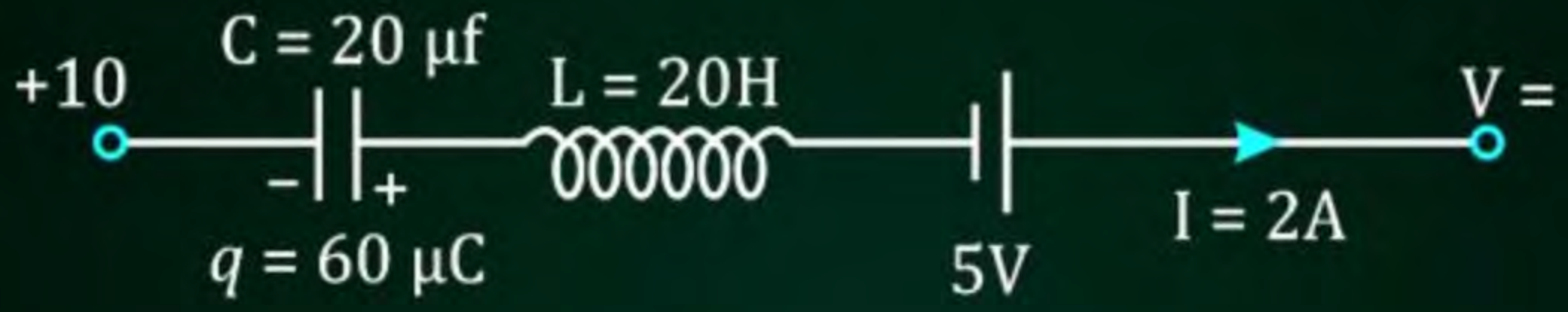
QUESTION



$$\frac{dI}{dt} = -0.5 \text{ A/S}$$

H/W

QUESTION



QUESTION

The network shown in figure is a part of a complete circuit. If at a certain instant, the current i is 4 A and is increasing at a rate of 10^3 A/S. Then $V_B - V_A$ will be



1. –11 V
2. 11 V
3. –21 V
4. 21 V

QUESTION

When the number of turns in a solenoid are doubled without any change in the length of the solenoid, its self inductance becomes

1. Half
2. Double
3. Four times
4. Eight times


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 06 | **Physics**

ELECTROMAGNETIC INDUCTION



By- Dr. Manish Raj (MR SIR)

Topics to be covered

1. # PhD on Inductor

   ✗ Mutual Inductance

2. #
3. #



QUESTION

When the number of turns in a solenoid are doubled without any change in the length of the solenoid, its self inductance becomes

1. Half
2. Double
3. Four times
4. Eight times

$L = \mu_0 n^2 A l = \frac{\mu_0 N^2 A}{l}$

$L \propto n^2$

$L \propto N^2$

$l = \text{const}$

QUESTION

A long solenoid has self inductance L. If its length is doubled keeping total number of turns constant then its self inductance will be

1. L/2
2. 2L
3. L
4. L/4

Bio- gas

Bio = gobar = gobar gas

QUESTION

Is self-inductance $\left(L = \frac{\phi}{I}\right)$ depends on flux and current?

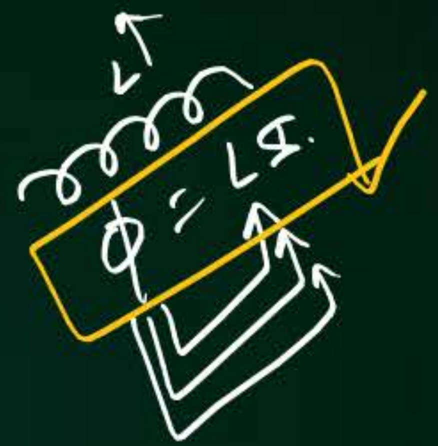
$\phi = L I$

$\rightarrow L = \phi / I$

Ans ⇒ NO

(φ) flux depends on self Inductance (L) ✓

but self Inductance does not depends on flux.



self ⇒ $L = \mu_0 n^2 A l$

L depends on Geometry & medium

$\phi = L I$

$V = I R$

$Q = C V$

QUESTION

If self-inductance of Inductor becomes n-times suddenly, then current in solenoid at that instant will be?

Sol^n



$\phi = \text{Cost}^n$ → Flux through Solenoid remains Constant at any instant

$LI = \text{Cost}^n$

$$L_1 I_1 = L_2 I_2$$

→ L becomes n-times $\left(I' = \frac{I}{n}\right)$

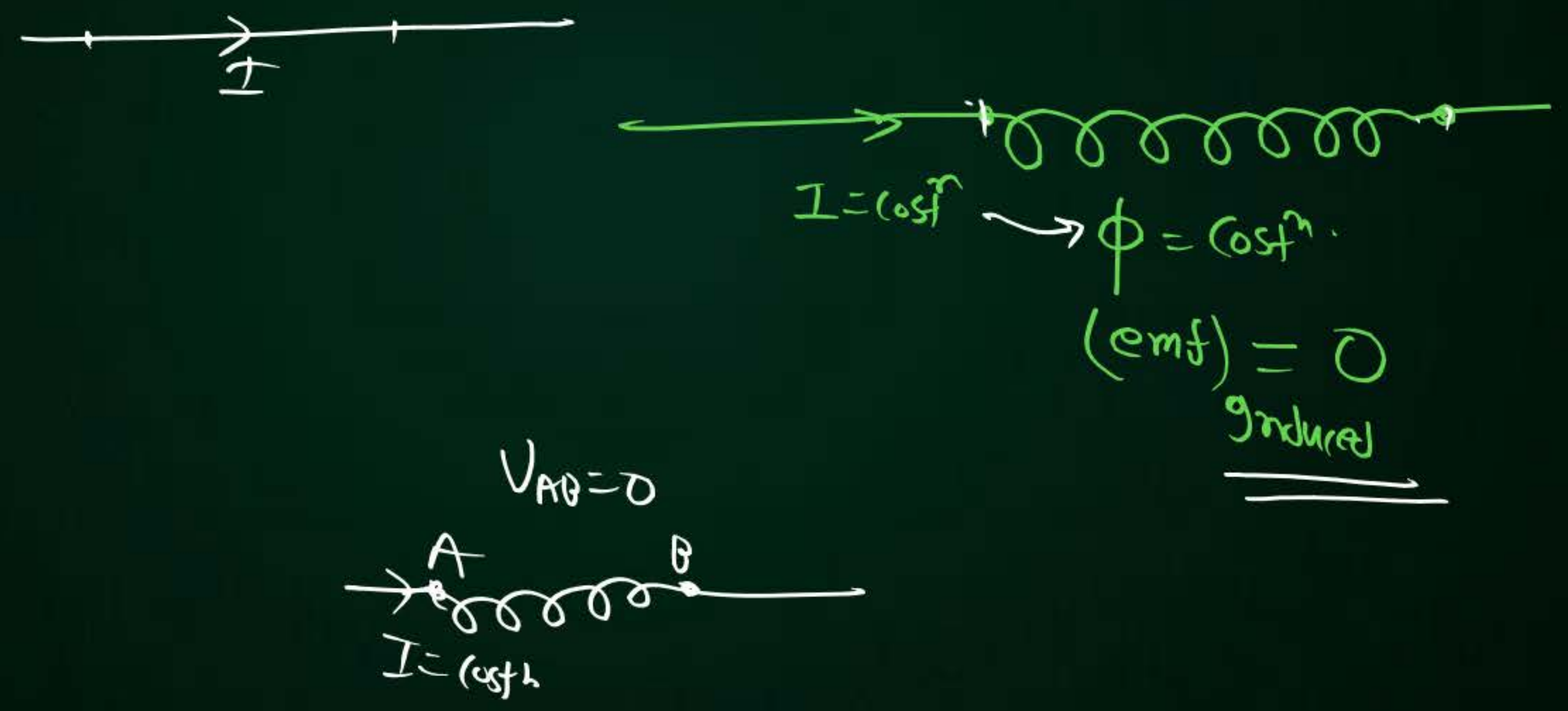
QUESTION

Why inductor behave as simple wire for D/C voltage supply or D/C current?

Constant

$I = \text{const}^n$

Unidir^n const^n current



QUESTION

If Iron is placed inside solenoid then its inductance will be:

Sol^n

Idenctance will Increase

$$L = \underset{\text{air}}{\mu_0} n^2 A l$$

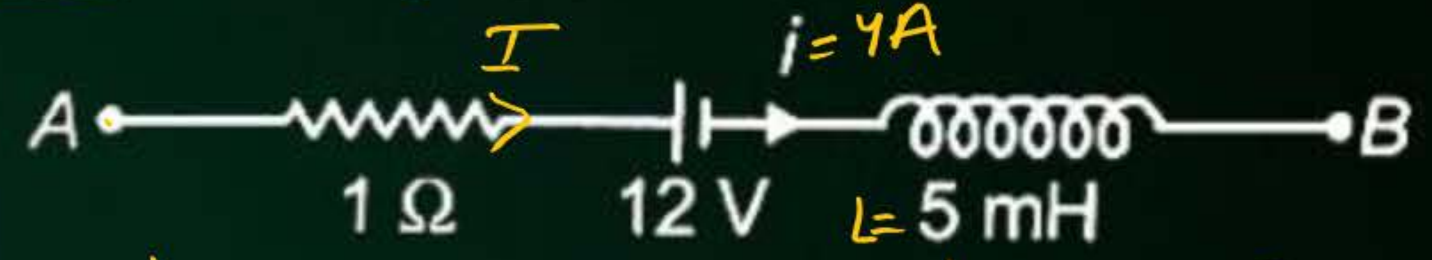
$$L = \mu_m n^2 A l$$

$$\underset{\text{Iron}}{\mu_m} > \mu_0$$

No Molodolo

QUESTION

The network shown in figure is a part of a complete circuit. If at a certain instant, the current i is 4 A and is increasing at a rate of 10^3 A/S. Then $V_B - V_A$ will be



1. –11 V
2. 11 V
3. –21 V
4. 21 V

$V_B - V_A = -21$ volt

Kudo concept

$V_A - IR - 12 - L\frac{dI}{dt} = V_B$

$V_A - 4\times1 - 12 - 5\times10^{-3}\times10^{3} = V_B$

$V_A - V_B = 21$ volt

1 पपपल खुद को मारेगे

QUESTION

A long solenoid has 1000 turns. When a current of 4 A flows through it, the magnetic flux linked with each turn of the solenoid is 4×10^{-3} Wb. The self-inductance of the solenoid is

[NEET-2016]

1. 1 H
2. 4 H
3. 3 H
4. 2 H

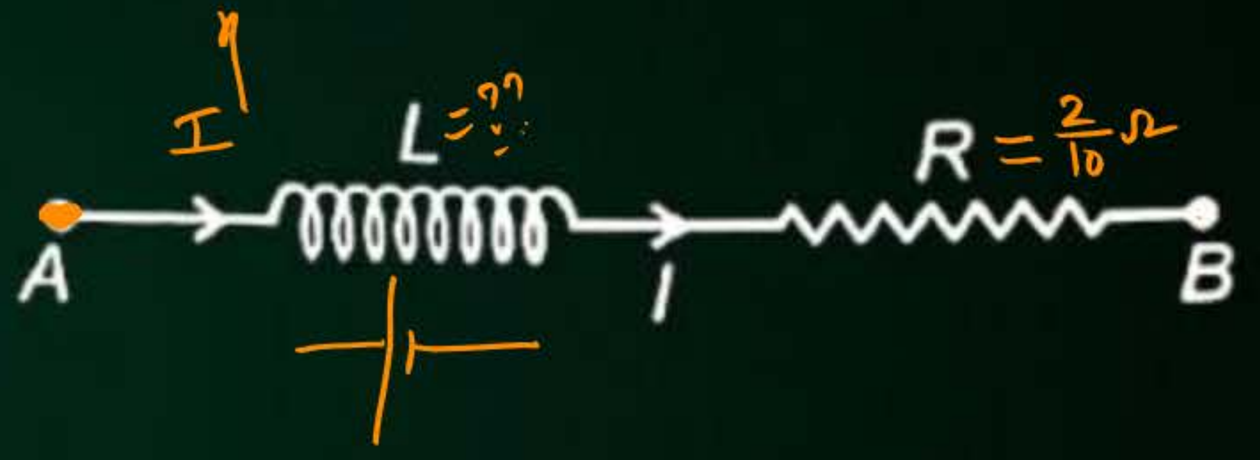
$\phi = LI$

$4 \times 10^{-3} \times 1000 = L \times 4$

$L = 1\,H$

QUESTION

In an A.C. sub-circuit as shown in figure, the resistance $R = 0.2\ \Omega$. At a certain instant $V_A - V_B = 0.5$ V, I = 0.5 A, and current is increasing at the rate of $\Delta I / \Delta t = 8$ A/s. The inductance of the coil is



1. 0.01 H
2. 0.02 H
3. 0.05 H
4. 05 H

$$V_A - L\frac{dI}{dt} - IR = V_B$$

$$V_A - V_B = 0.5\ \text{volt}$$

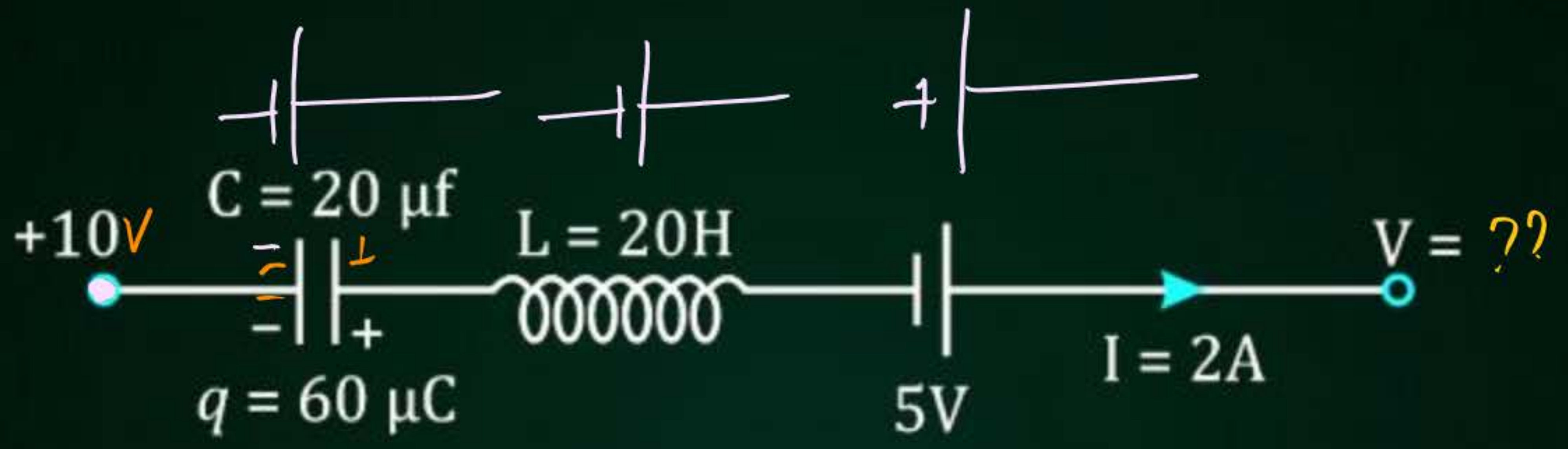
$$V_A - V_B = IR + L\frac{dI}{dt}$$

$$0.5 = \frac{1}{2} \times \frac{2}{10} + L \times 8$$

$$0.5 - 0.1 = L8$$

$$\frac{0.4}{8} = L$$

QUESTION



$$\frac{dI}{dt} = -0.5\ A/s$$

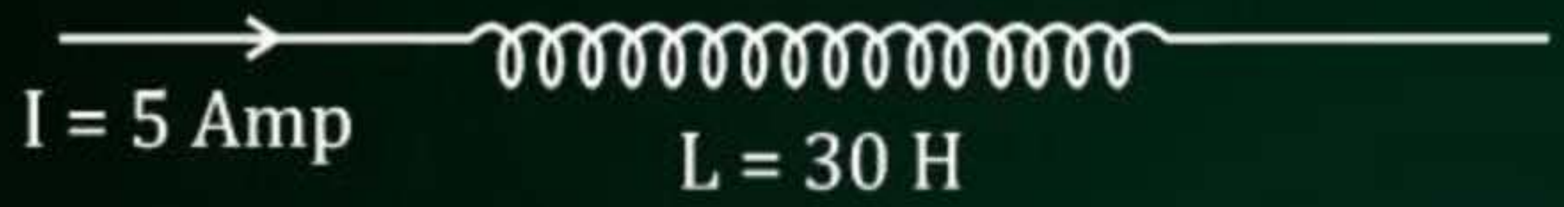
$$10V + \frac{q}{C} + L\frac{dI}{dt} + 5V = V$$

$$10 + \frac{60}{20} + 20 \times \frac{5}{10} + 5V = V$$

$$\boxed{28\ \text{volt} = V}$$ Ans

QUESTION

Find Back e.m.f. in given inductor.



$$\frac{dI}{dt} = 0.2 \text{ A/s}$$

$emf = L \frac{dI}{dt}$ *

QUESTION



$I = 5\text{ A}$

$\frac{dI}{dt} = 0.2\text{ A/s}$ ($I\uparrow$)

$V - 10\times5 + 20 - 60\times\frac{2}{10} = 0$

$V - 50 + 20 - 12 = 0$

$V = +42$ volt

QUESTION

Find $V_A - V_B = ??$



$I = 10\ A$ (↓)

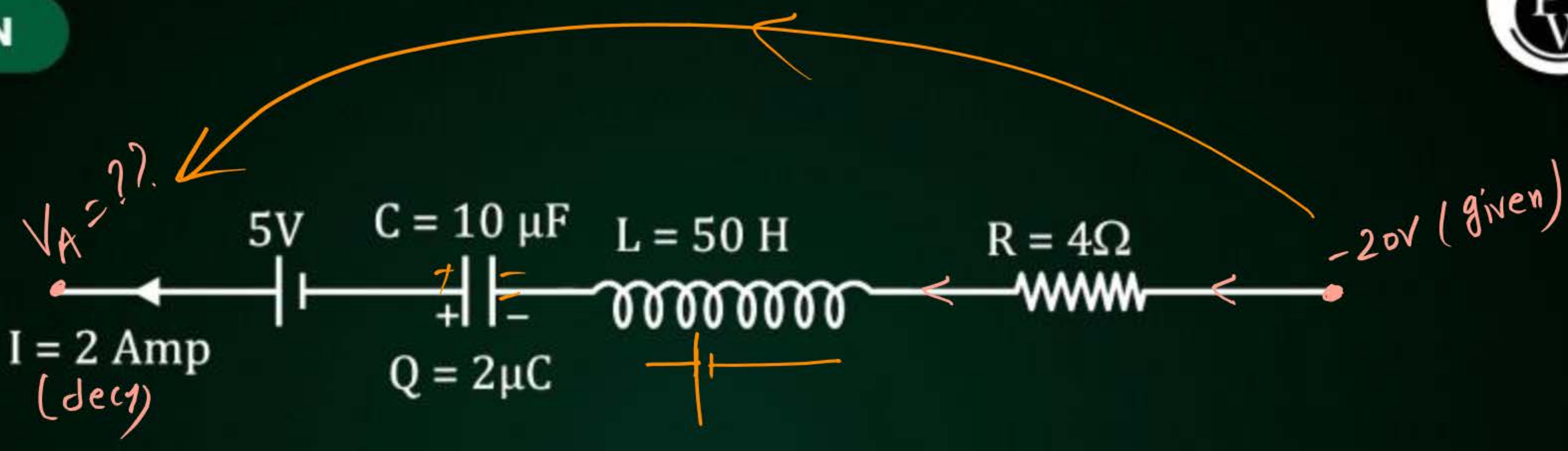
$\frac{dI}{dt} = -0.5\ A/s$

$V_A + 6 \times \frac{5}{10} + 20 - 4 \times 10 = V_B$

$V_A - V_B = +17$ volt

Biogas less Batch

QUESTION



$$\frac{dI}{dt} = -0.5\ A/S$$

↳ decrease

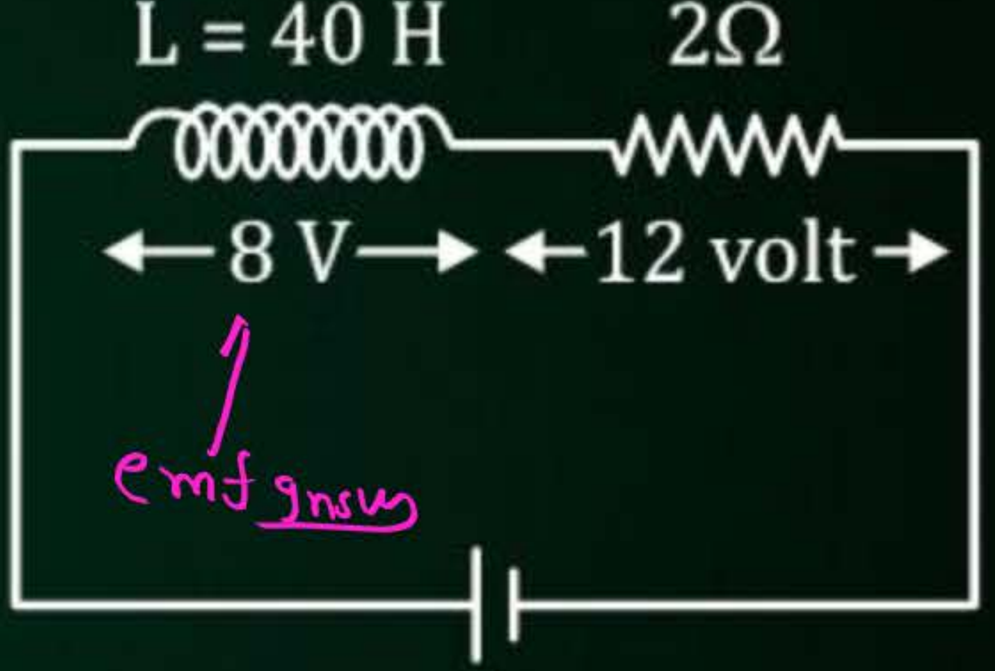
$$-20V - 2 \times 4 + 50 \times \frac{5}{10} + \frac{2}{10} + 5 = V_A$$

$$-20 - 8 + 25 + 5 + 0.2 = V_A$$

$$V_A = 2.2 \text{ volt}$$

QUESTION

Find $\frac{dI}{dt}$ in the circuit at a given instant?



Sol^n

$$L\frac{dI}{dt} = emf$$

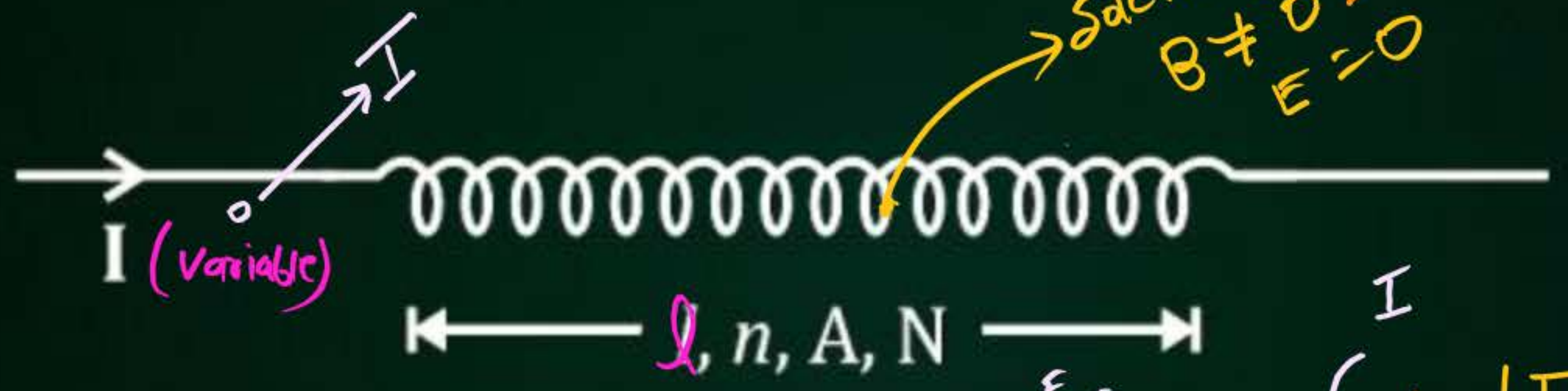
$$40 \times \frac{dI}{dt} = 8V$$

$$\frac{dI}{dt} = \frac{8}{40} = 0.2\ A/sec$$

Magnetic Energy store in Solenoid/ Magnetic Energy density/Power less in solenoid.

$\int x\,dx = \frac{x^2}{2}$

$\int I\,dI = \frac{I^2}{2}$



- Back emf / Induced emf $= L\frac{dI}{dt}$
- Power loss across Inductor $P = IV$

$P = I L \frac{dI}{dt}$

$\frac{dE}{dt} = I L \left(\frac{dI}{dt}\right)$

$\int_0^E dE = \int_0^I I L\, dI$

$E = L\int_0^I I\, dI$

$$E = \frac{1}{2} L I^2$$

→ I = current

Stored magnetic energy =

Same as electrostatic energy B/w capacitor plate

$U = \frac{1}{2}CV^2 = \frac{Q^2}{2C}$

$$E = \frac{1}{2} L I^2$$

$$L = \mu_0 n^2 A l$$

Putting value of 'L' in 'E'

$$E = \frac{1}{2} \mu_0 n^2 A l \times I^2$$

$$\frac{E}{Al} = \text{energy density } U_m = \frac{1}{2} \mu_0 n^2 I^2 \left[\frac{\mu_0}{\mu_0}\right]$$

$$U_m = \frac{E}{Al} = \frac{1}{2} \frac{\mu_0^2 n^2 I^2}{\mu_0}$$

$$B = \mu_0 n I$$

$$U_m = \frac{B^2}{2\mu_0}$$

magnetic energy density

$$U_E = \frac{1}{2} \varepsilon_0 E^2$$

capac

electrostatic energy density

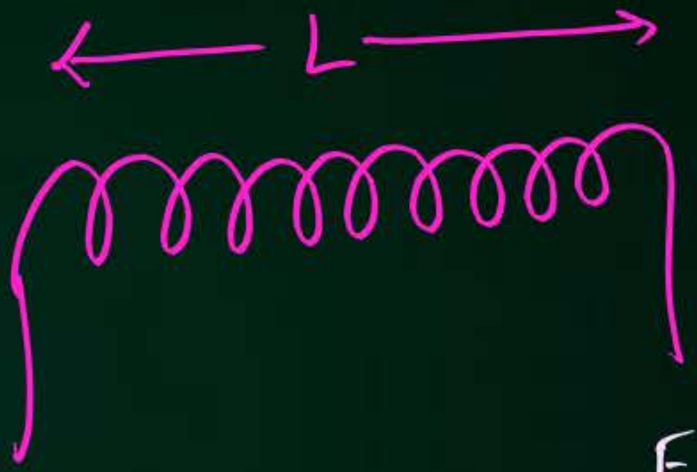
$$U_m = \frac{E}{Al} = \frac{B^2}{2\mu}$$

$$E = \frac{1}{2} L I^2 = \frac{B^2}{2\mu} A l$$

QUESTION

The magnetic energy stored in a long solenoid of area of cross-section A in a small region of length L is

1. $\dfrac{B^2 AL}{2\mu_0^2}$
2. $\dfrac{AL}{2\mu_0}$
3. $\dfrac{1}{2}\mu_0 B^2 AL$
4. $\dfrac{B^2 AL}{2\mu_0}$



$E = \frac{1}{2} L I^2 = \left[\frac{B^2}{2\mu_0}\right] \times A l$

QUESTION

In a circular conducting coil, when current increases from 2A to 18 A in 0.05 s, the induced emf is 20 V. The self inductance of the coil is

1. 62.5 mH
2. 6.25 mH
3. 50 mH
4. Zero

$$\text{emf} = L\frac{dI}{dt}$$

$$\text{emf} = L\frac{\Delta I}{\Delta t}$$

$$20 = L\frac{(18-2)}{0.05}$$

$$L = \frac{20 \times 0.05}{16}$$

QUESTION

The magnetic potential energy stored in a certain inductor is 25 mJ, when the current in the inductor is 60 mA. This inductor is of inductance [NEET-2018]

1. 0.138 H
2. 138.88 H
3. 13.89 H ✓
4. 1.389 H

$E = \frac{1}{2} L I^2 = \frac{B^2}{2\mu_0} A L$

$E = \frac{1}{2} L I^2$

$L = \frac{2E}{I^2} = \frac{2 \times 25 \times 10^{-3}}{(60 \times 10^{-3})^2}$

$= \frac{50 \times 10^{-3}}{60 \times 60 \times 10^{-6}} = \frac{500 \times 10}{360} = 13.89\ H$

SERIES COMBINATION OF INDUCTOR

current in series combination will same

→ then $\frac{dI}{dt}$ = same



$v_1 = L_1 \frac{dI}{dt}$

$v_2 = L_2 \frac{dI}{dt}$

⇓



$\left(\frac{dI}{dt}\right)$

$v = V_1 + V_2$

"$V = V_1 + V_2$"

$L \frac{dI}{dt} = L_1 \frac{dI}{dt} + L_2 \frac{dI}{dt}$

$\boxed{L_{eq} = L_1 + L_2}$ same as Resist

PARALLEL COMBINATION

Potential same in Parallel combination

$V_1 = V_2 = V_{net}$

$\Rightarrow \quad I = I_1 + I_2$

diff^n w.r.t time

$\frac{dI}{dt} = \frac{dI_1}{dt} + \frac{dI_2}{dt}$

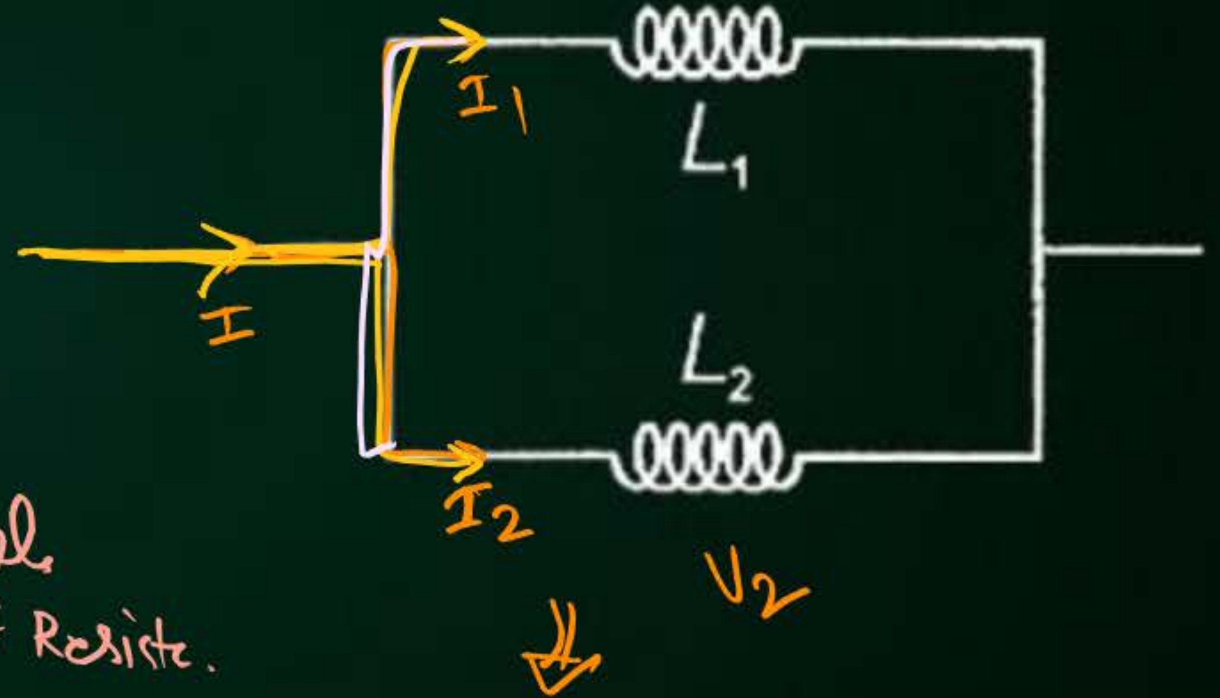
$\frac{V}{L_{eq}} = \frac{V_1}{L_1} + \frac{V_2}{L_2}$

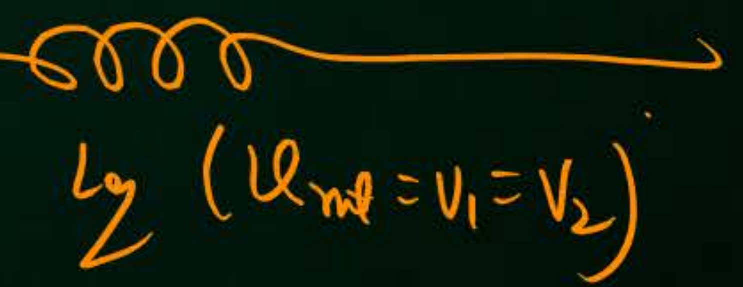
$\frac{1}{L_{eq}} = \frac{1}{L_1} + \frac{1}{L_2}$

$L_{eq} = \frac{L_1 L_2}{L_1 + L_2}$

Same as Parallel Combine of Resistr.

$v_1 = L_1 \frac{dI_1}{dt}$







find equivalent self Inducta ?)

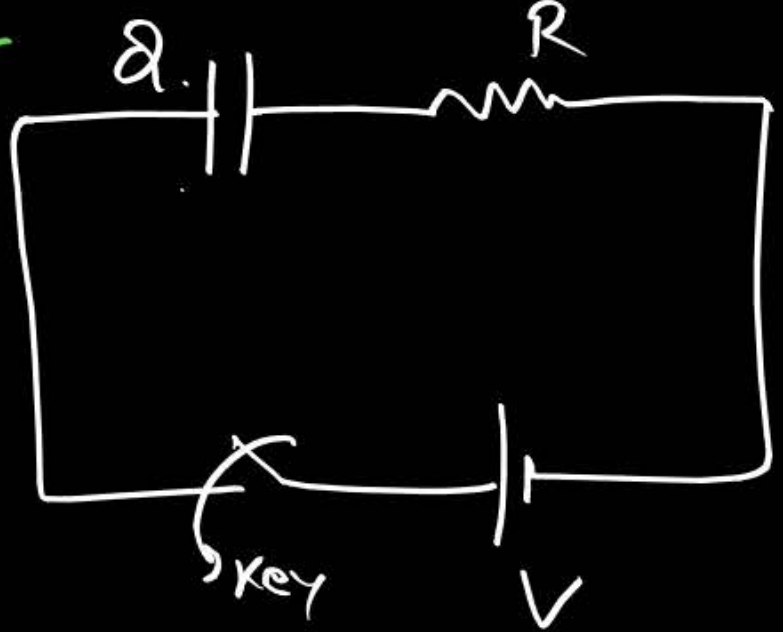
$$\frac{1}{L_{eq}} = \frac{1}{6} + \frac{1}{3} + \frac{1}{2}$$

$$\frac{1}{L_{eq}} = \frac{1+2+3}{6}$$

$$\boxed{L_{eq} = 1H}$$

charging of capacitor

(*) growth of charging



$$Q = Q_{max}\left(1 - e^{-t/RC}\right)$$

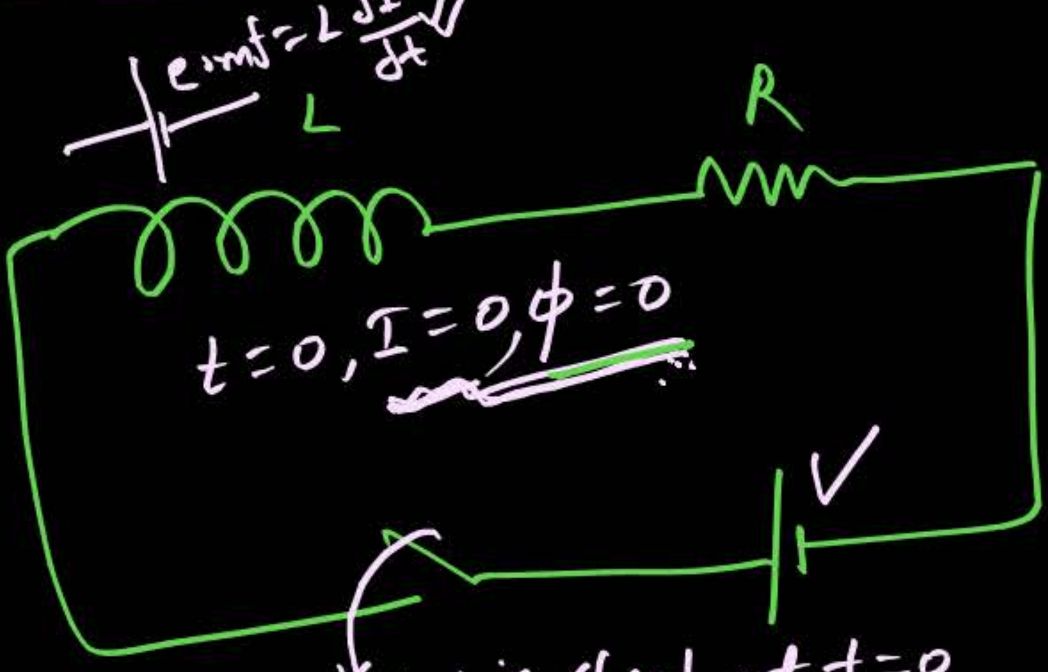
at $t=0$	at $t=\infty$
* $Q_c = 0$	$Q_{max} = CV$
capacitor behave as simple wire	$I = 0$ → open wire

$\tau = CR$ ✓

capacitor behave as open wire

Charging of Inductor

growth of current



$t=0,\ I=0,\ \phi=0$

key is closed at $t=0$

$I = 0$ (Inductor behave as open wire)

$$I = I_{max}\left(1 - e^{-\frac{tR}{L}}\right) \ *$$

$\tau = \frac{L}{R}$

time constant



CHARGING OR INDUCTOR

At $t = 0$; key is just close.

$I = 0$; $\phi = 0$

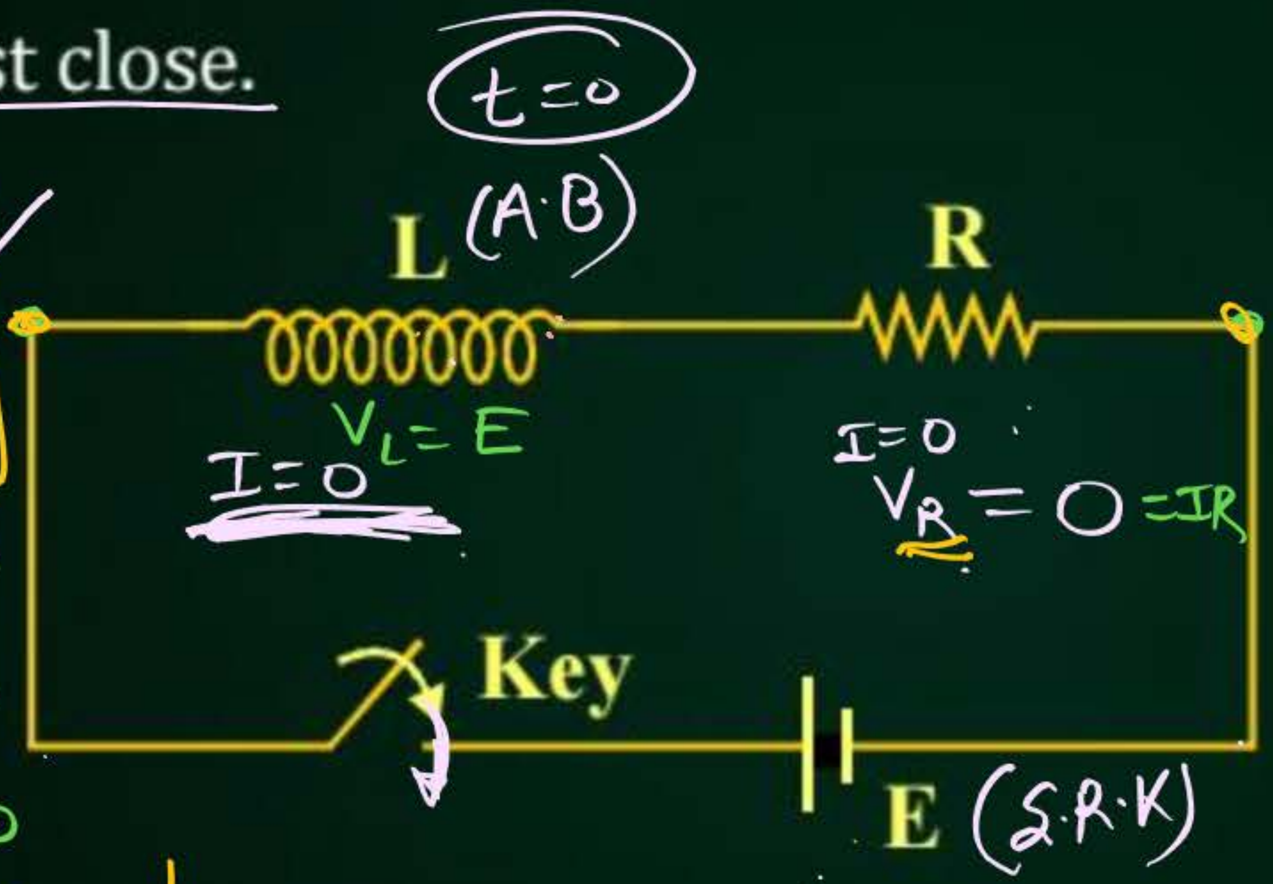
$V_{L\,Max} = L\frac{dI}{dt} = E$

open wire Jaisa behave Karega

$I = 0$ at $t = 0$

$\left(\frac{dI}{dt}\right)_{max\ at\ t=0} = \frac{E}{L}$

across Induc



as time Increase

$I\uparrow$ $E = \uparrow V_R + V_L \downarrow$

const^n

at steady state

$I_{max} = I = \text{const}^n$

$E = V_{R\,max} + V_L$ ($V_L \to 0$)

$E = V_{R\,max}$

$E = I_{max} R$

$I_{max} = \frac{E}{R}$

Inductor behave as simple wire

steady state

$I = \text{const}^n$

$V_L = 0$

$(V_R)_{max} = E = I_{max} R$

$I_m = \frac{E}{R}$

E

$$I = I_{max}\left(1 - e^{-tR/L}\right)$$

at $t=0$

$I = 0$

Inductor behaves as open wire

$V_R = 0$

$V_{L_{max}} = L\frac{dI}{dt} = E$

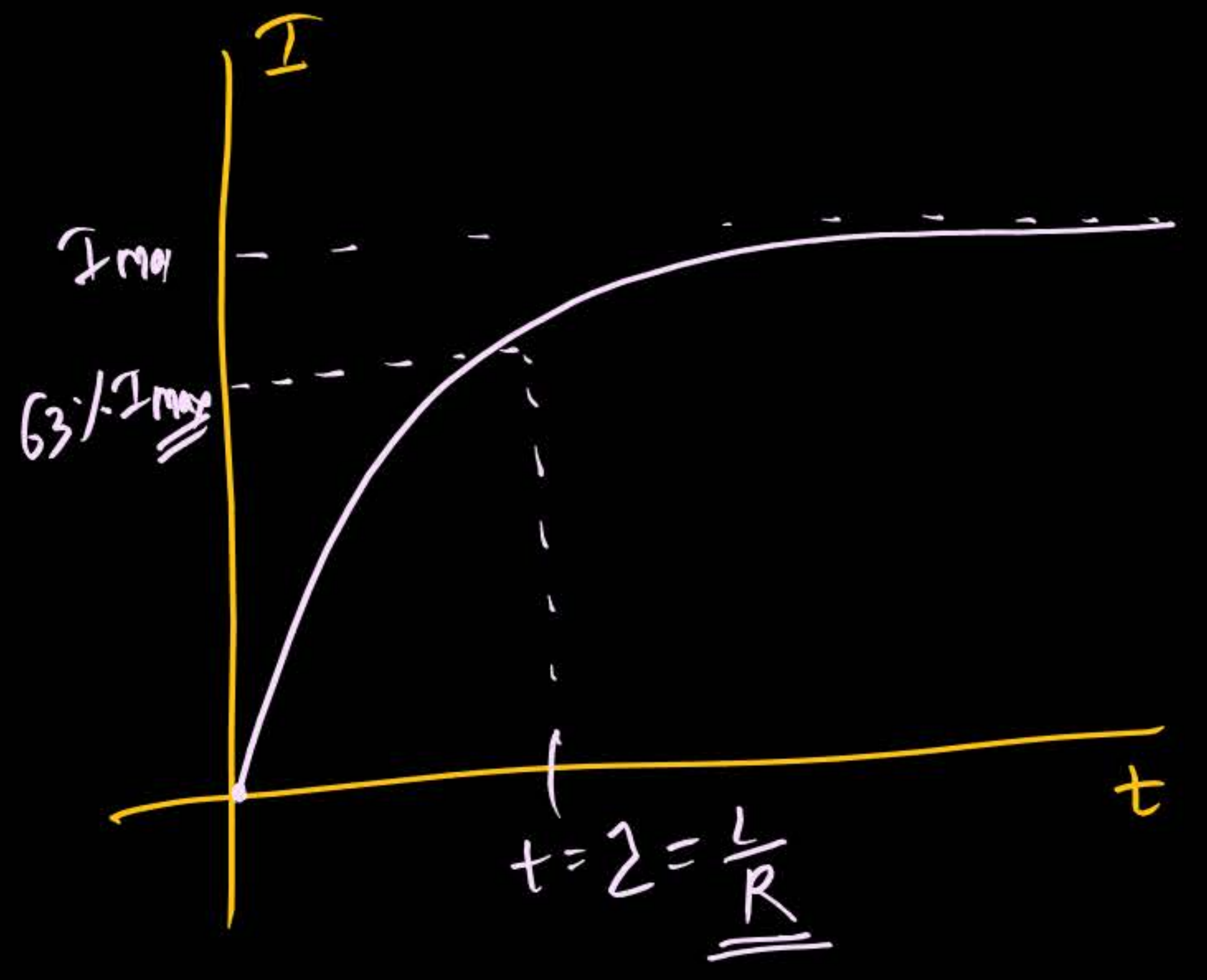
$t = \infty$

$I = I_{max} = \frac{E_{Bat}}{R}$

Inductor behave as simple wire

$V_{R_{max}} = E$

$V_L = \text{Zero}$

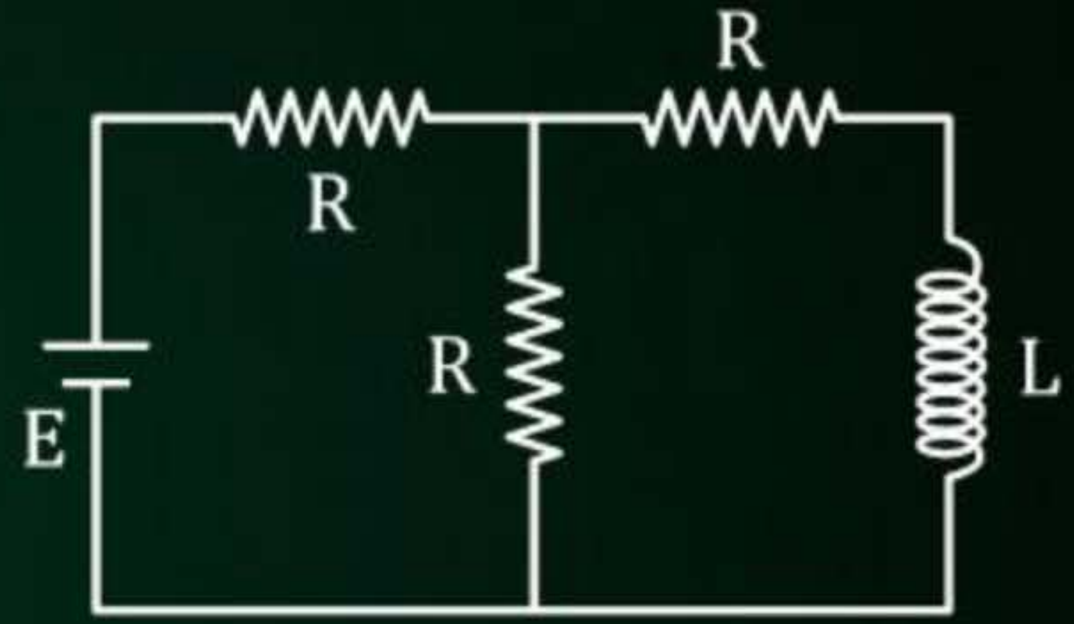


QUESTION

Find current flowing through battery?

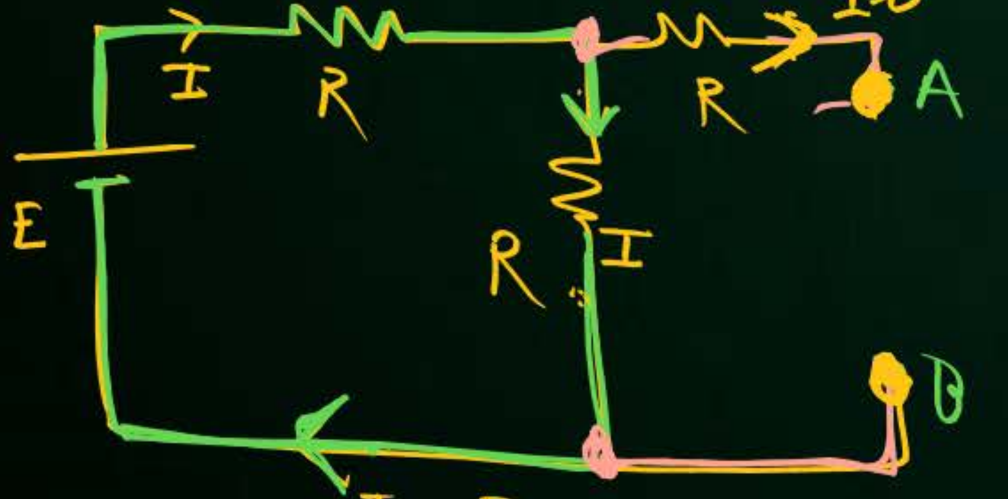
(i) $t = 0$

(ii) $t =$ steady state



$t = 0$

Induct open wire



$I = \frac{E}{2R}$

Potenial drop across Inductor

$V_{AB} = L\frac{dI}{dt} = \frac{E}{2}$

$t = \infty$ (steady state)



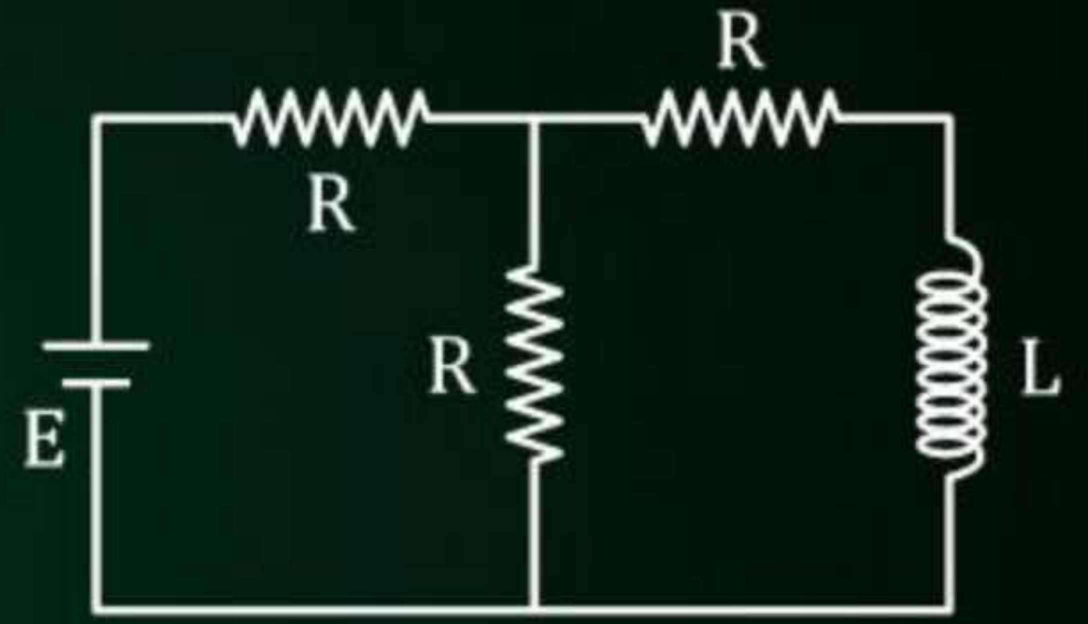
$I = \frac{E}{3R/2}$ $\quad I = \frac{2E}{3R}$ Amp.

QUESTION

Find Rate of change in current across inductor at

(i) $t = 0$

(ii) $t =$ steady state



Sol^n at $t=0$

$V_L = E/2$

$L\frac{dI}{dt} = E/2$

$\left(\frac{dI}{dt}\right) = \frac{E}{2L}$

$t = \infty$

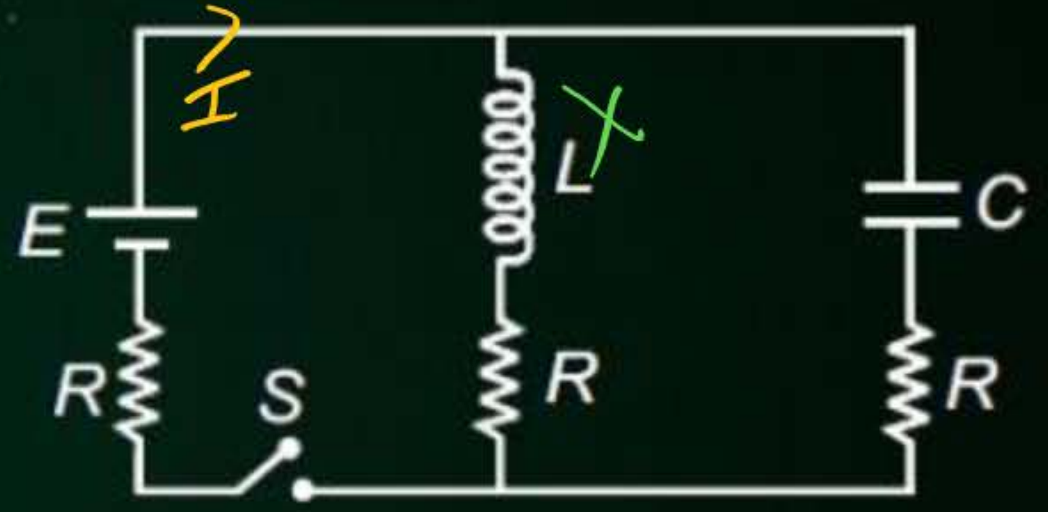
$I =$ const.

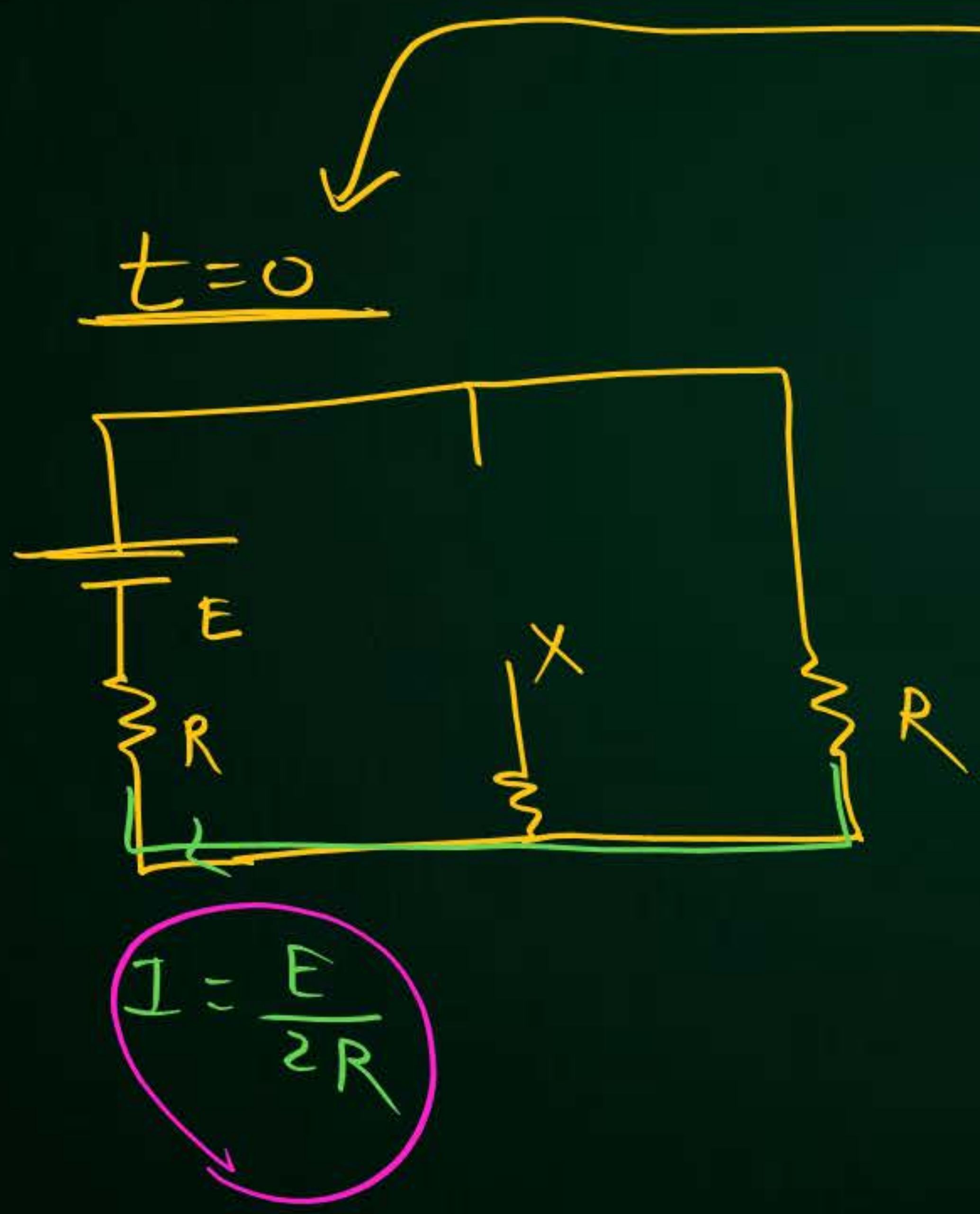
$\frac{dI}{dt} = 0$

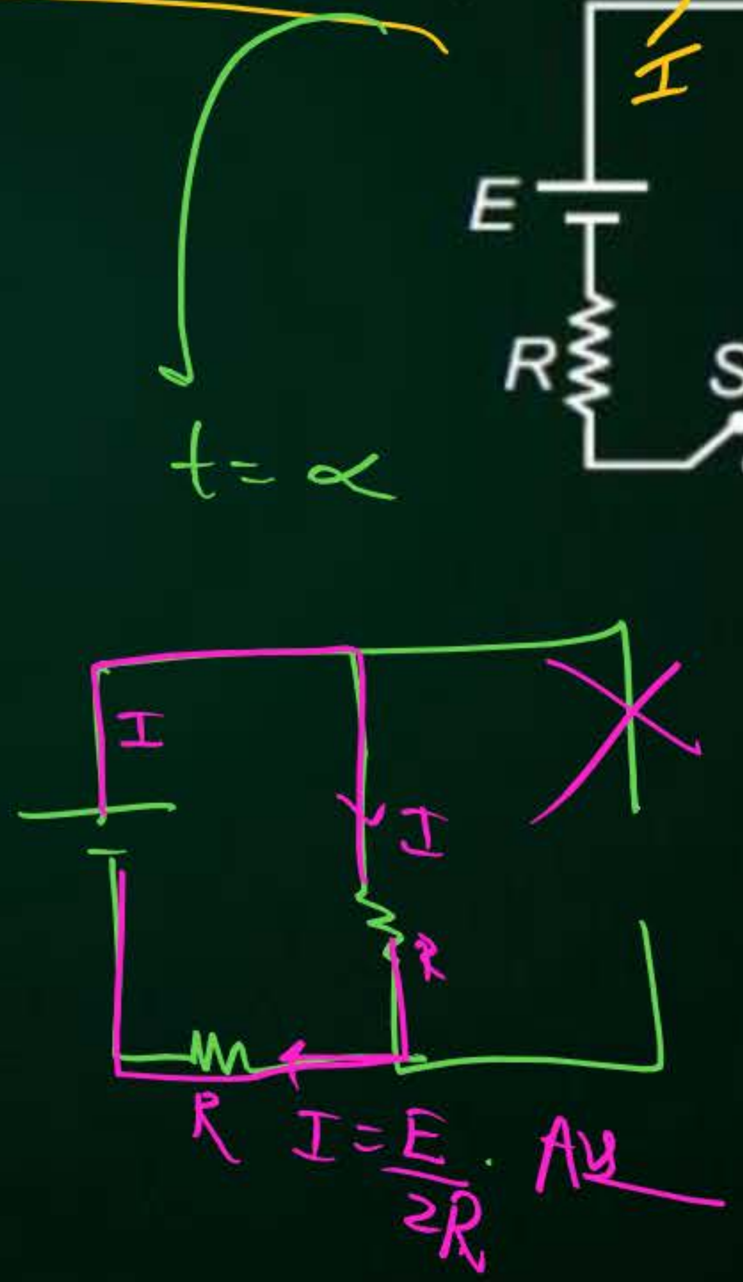
QUESTION

The switch shown in the circuit is closed at $t = 0$. The current drawn from the battery by the circuit at $t = 0$ and $t = \infty$ in the ratio

1. 2 : 1
2. 1 : 2
3. 1 : 1
4. 1 : 4

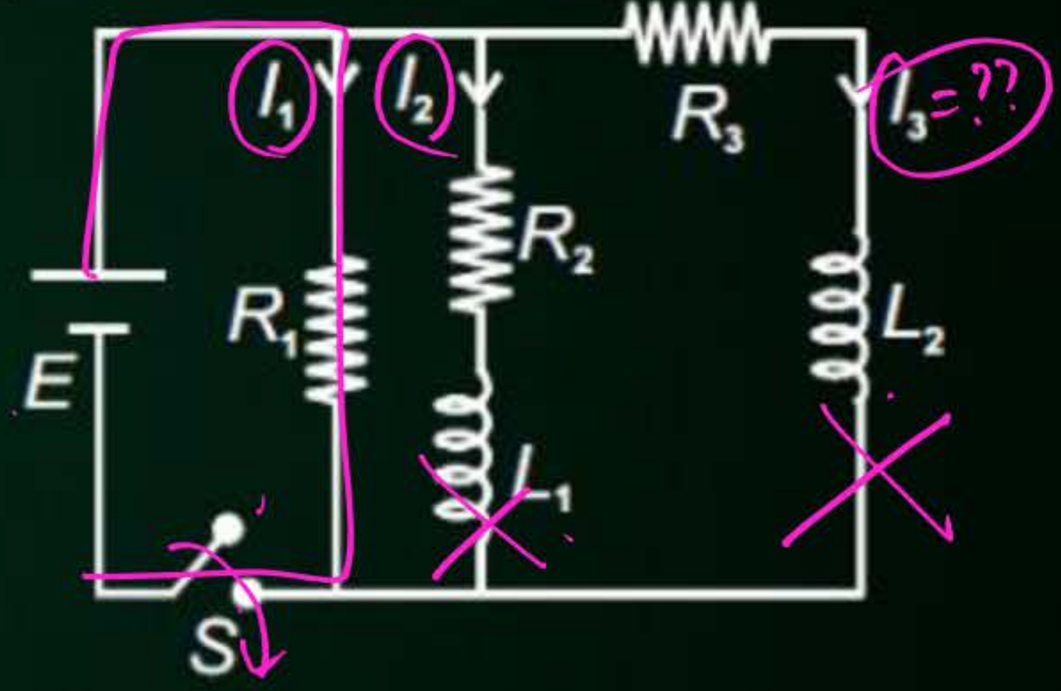






QUESTION

Figure shows an L-R circuit. When the switch S is closed, the current through resistor R_1, R_2 and r_3 are I_1, I_2 and I_3 respectively. The value of I_1, I_2 and I_3 at $t = 0$ s is



1. $I_1 = I_2 = I_3 = 0$

2. $I_1 = E/R_1$, $I_2 = I_3 = 0$

3. $I_1 = 0$, $I_2 = E/R_2$, $I_3 = E/R_3$

4. $I_1 = E/R_1$, $I_2 = E/R_2 + L_1$, $I_3 = E/R_3 + L_3$

QUESTION

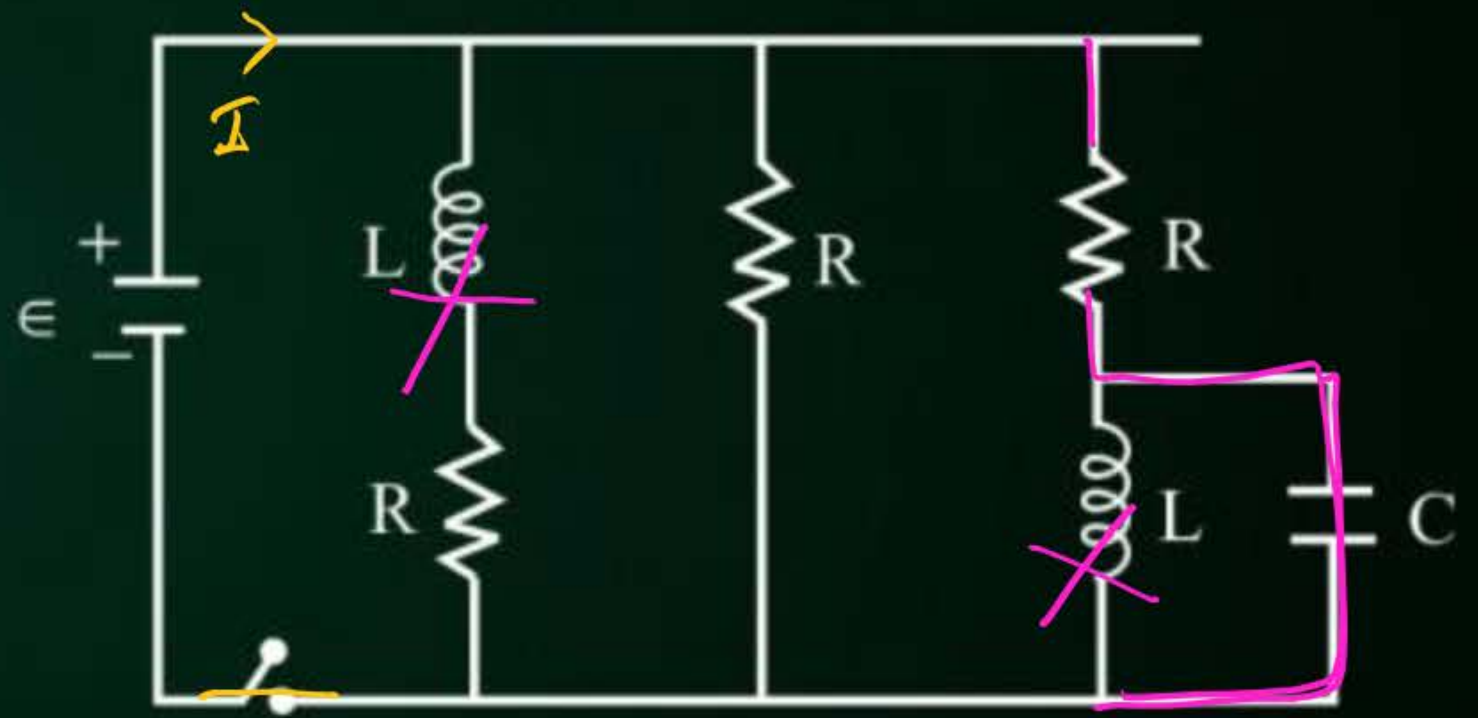
Figure shows a circuit contains three identical resistors with resistance R = 9.0 Ω each, two identical inductors with inductance $L = 2.0$ mH each, and an ideal battery with emf ε = 18 V. The current 'i' through the battery just after the switch closed is **[NEET-2017]**

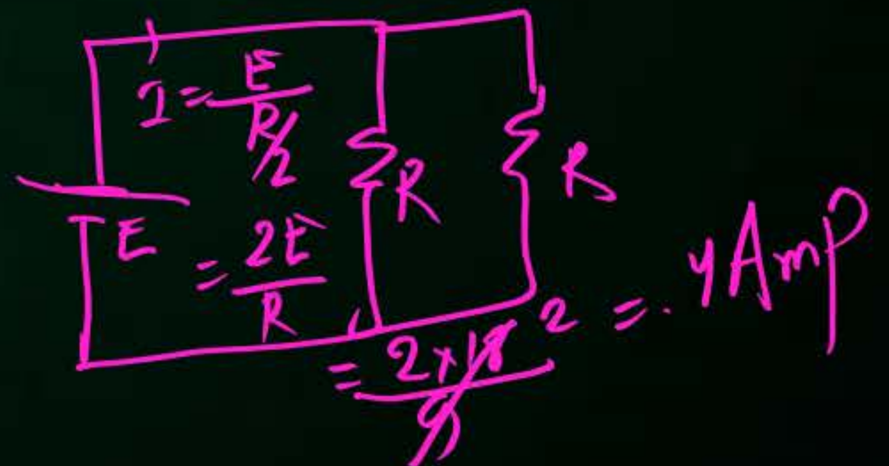
(1) 2 mA

(2) 0.2 A

(3) = 4 Amp

(4) 0 ampere



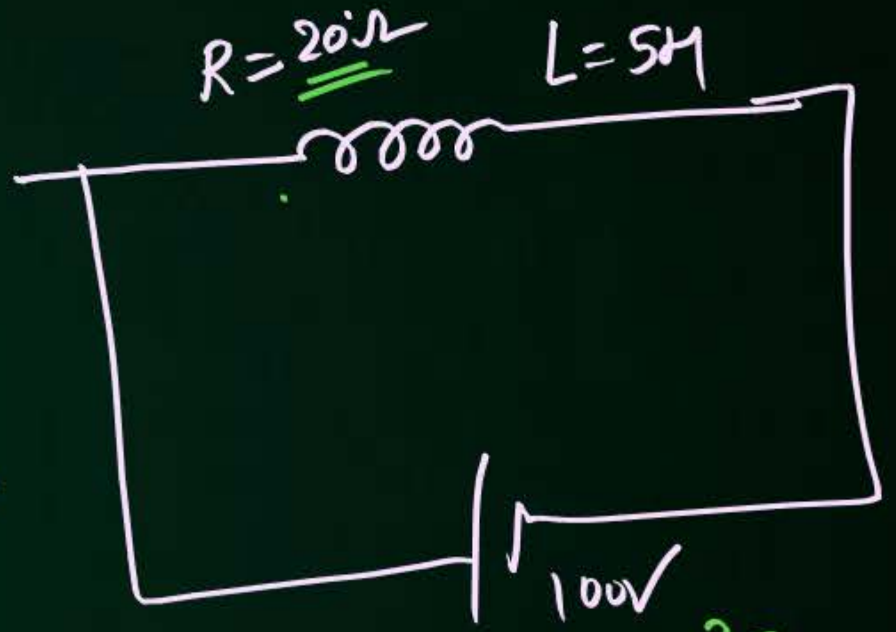


QUESTION

A coil of resistance 20 ohms and inductance 5 H has been connected to a 100 volt battery. The energy stored in the coil is

1. 31.25 J
2. 62.5 J
3. 125 J
4. 250 J

Sol^n



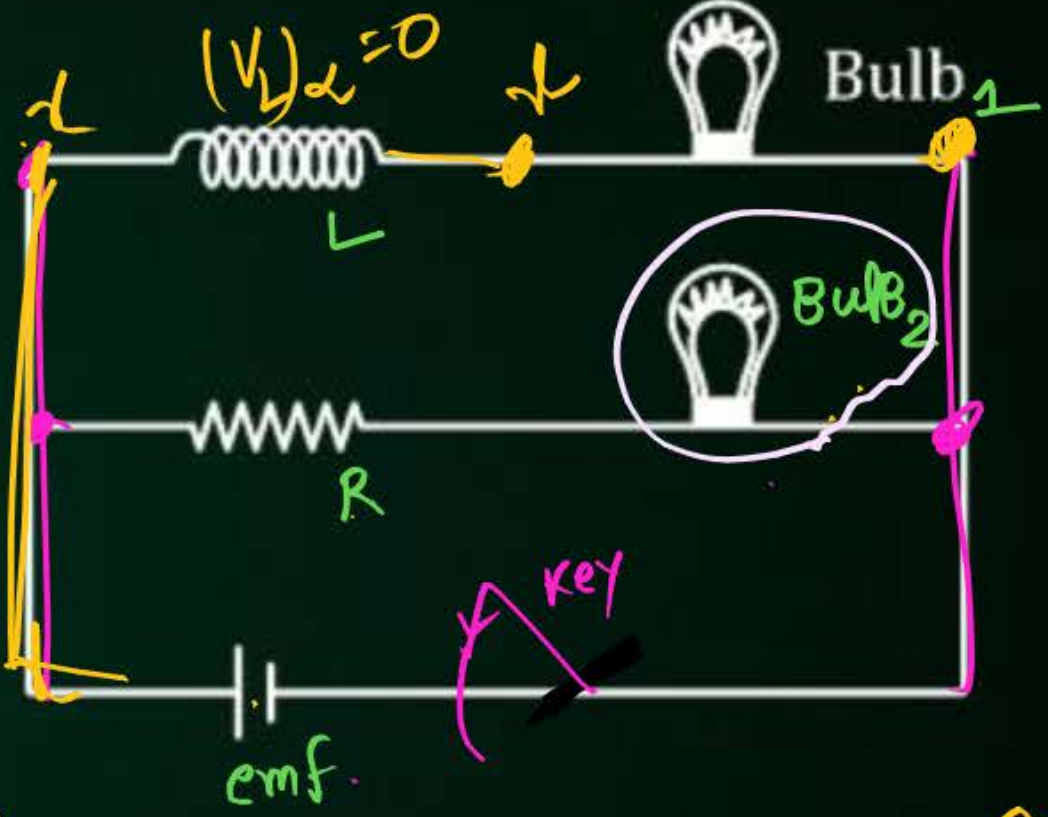
$t = \infty$

$I_{max} = \frac{emf}{R} = \frac{100}{20} = 5A$

$E = \frac{1}{2} L I^2 = \frac{1}{2} 5 (5)^2 = \frac{125}{2} = 62.5 J$

QUESTION

Compare Brightness of Bulb at $t = 0$ and $t = \infty$ (steady state)



at t=0

Key is just close.

→ Inductor open wire

I (Inductor) = 0

B_1 (Brightness) = 0

B_2 → चमकेगा

at time incr

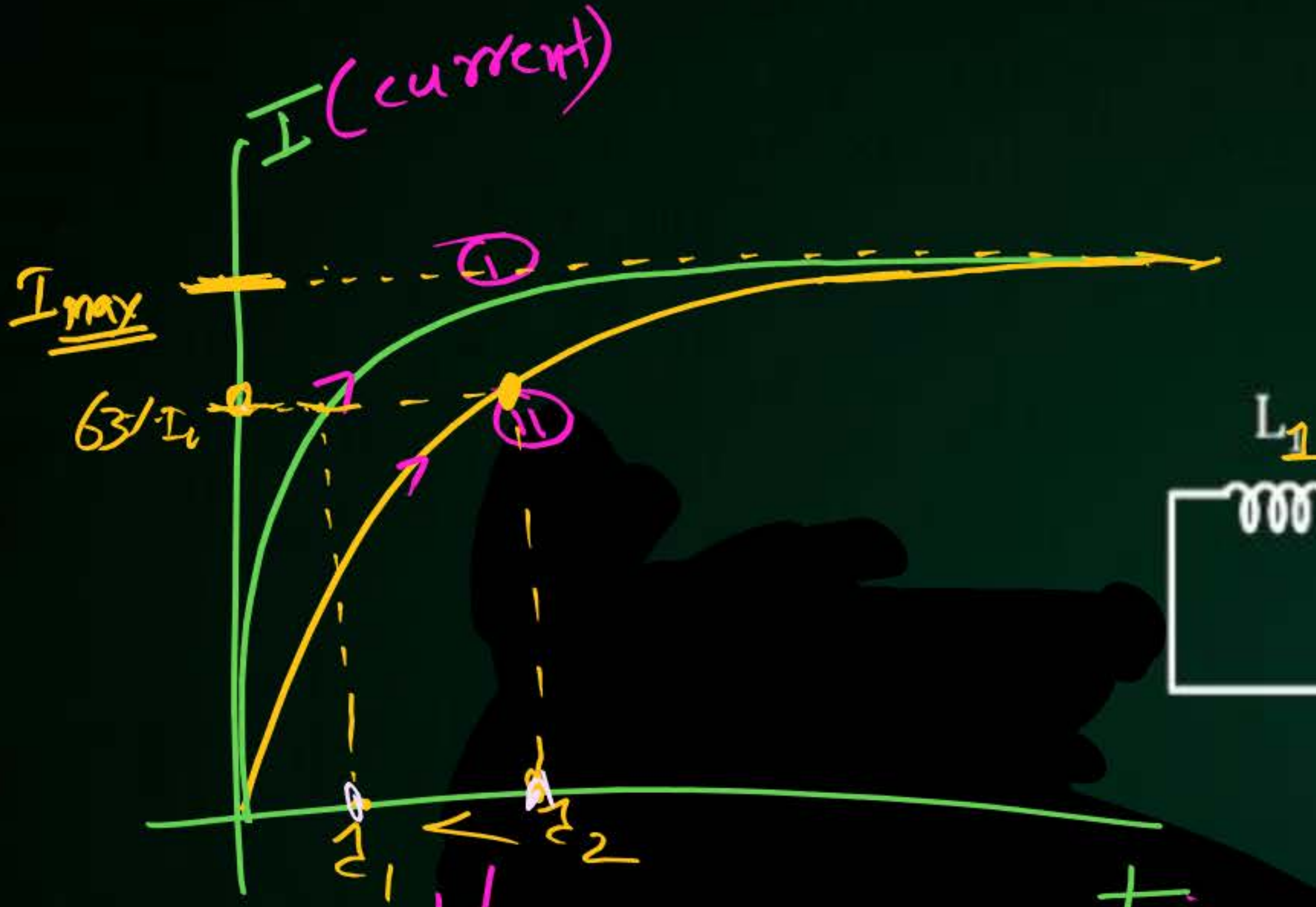
B_1 (Brightness) ↑

B_2 (Brightness) = same

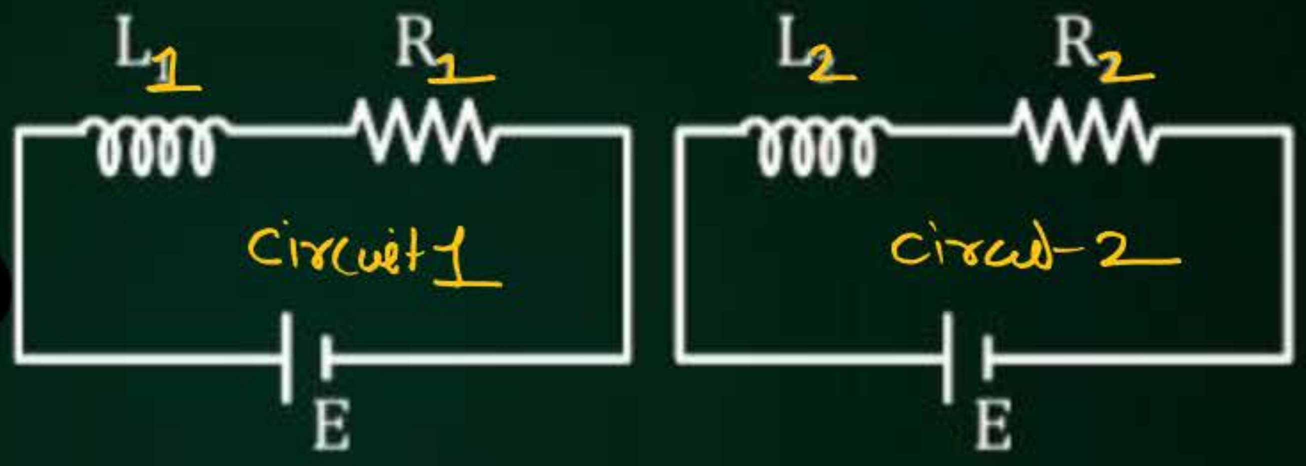
at steady state

$B_1 > B_2$

Brightness of B_1 is more than B_2 at steady state



current/time graph given for both the circuit then compare R_1 & R_2 and L_1 & L_2



→ I_{max} for Both ✓

$I_{max} = \frac{E}{R_1} = \frac{E}{R_2}$ — I_{max} same

$R_1 = R_2$ — same

$\tau_1 < \tau_2$

$\tau = \frac{L}{R}$ $\quad \frac{L_1}{R_1} < \frac{L_2}{R_2}$

Only Inductor and Battery is Present

R = 0 (Ideal Condition)

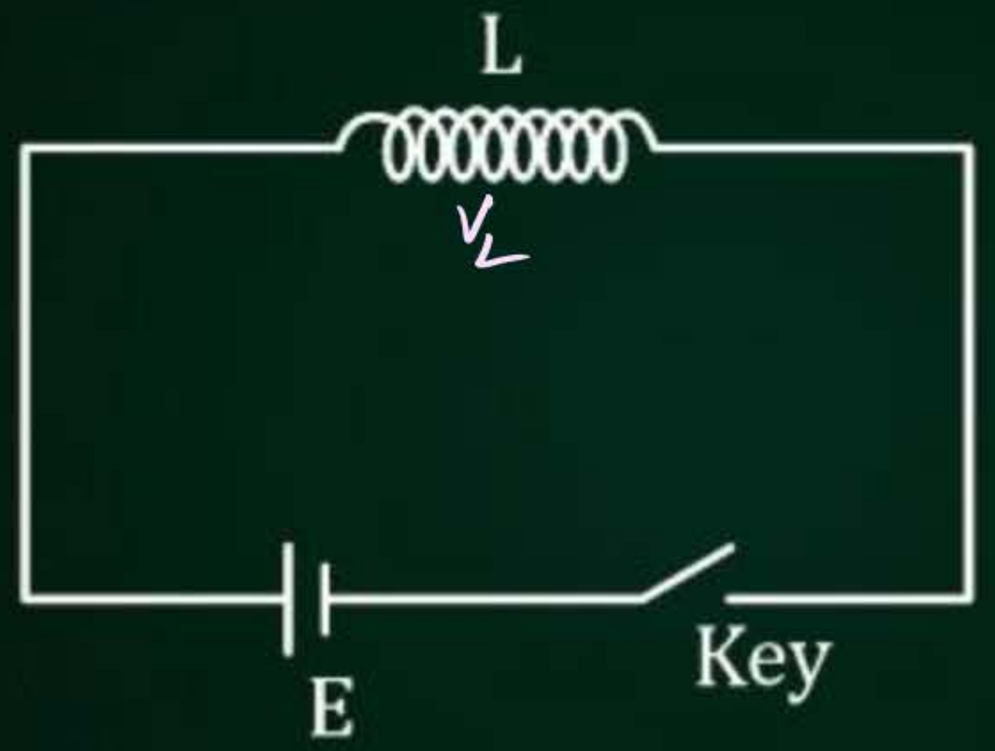
at $t=0$

Just key is closed

$V_{Batt} = V_L$

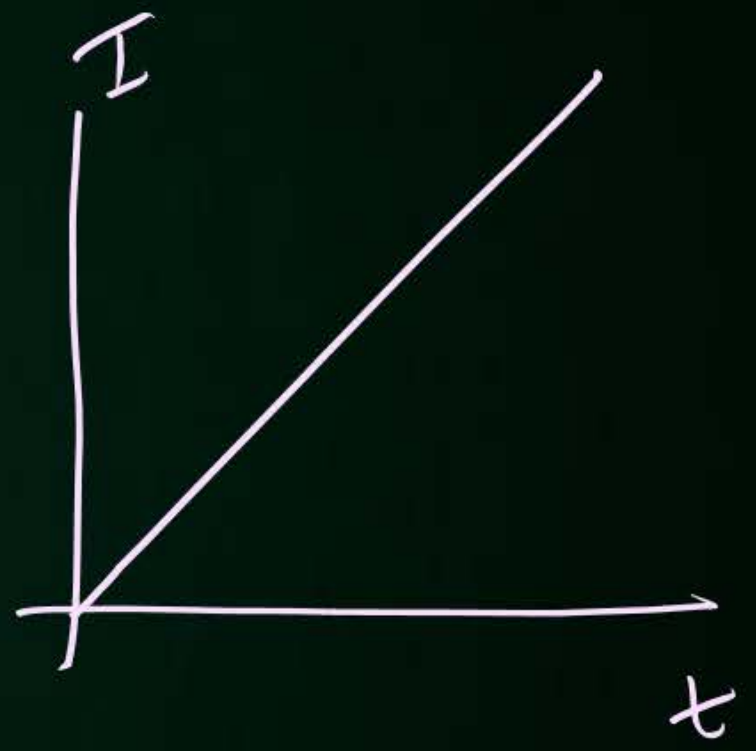
$E = L\frac{dI}{dt}$

$\int_{I=0}^{I} L\,dI = \int_{t=0}^{t} E\,dt$



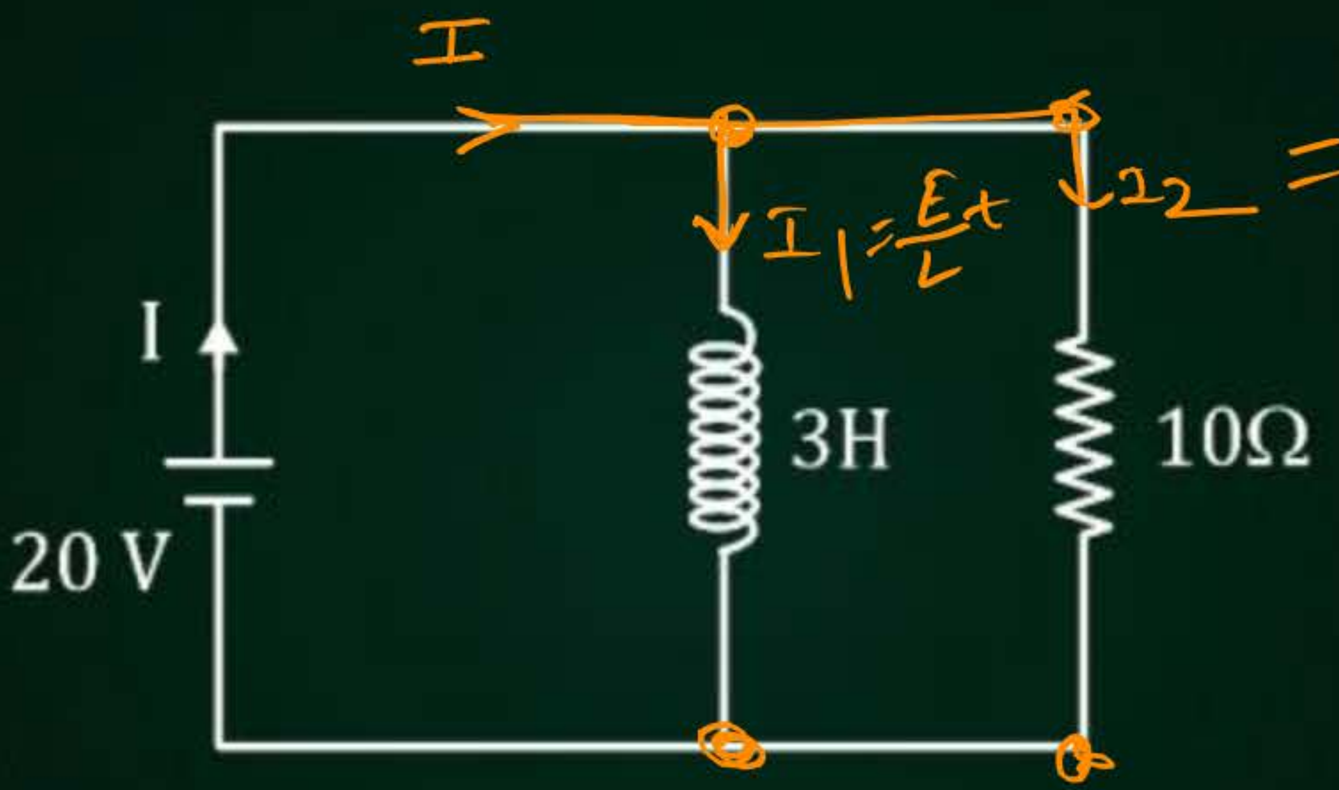
$LI = Et$

$I = \frac{E}{L}t$



QUESTION

Find current flowing through the battery at time ‘*t*’



$I_1 = \frac{E}{L}t$, $I_2 = \frac{20}{10} = 2A$

$I = \frac{E}{L}t + 2$

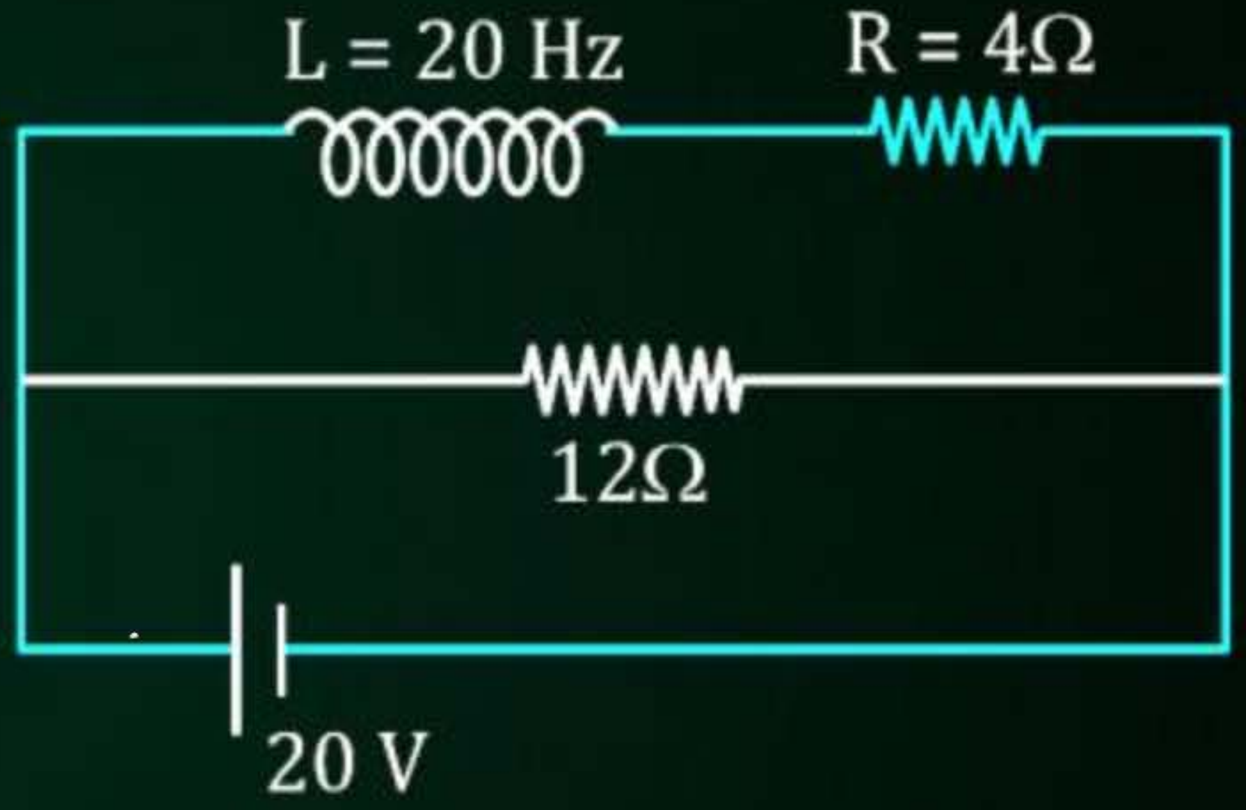
$I = \frac{20}{3}t + 2$

QUESTION

Find current of t = 0 and t = ∝.

$$\left(I_{Battery}\right)_{t=0} = \frac{20}{12}$$

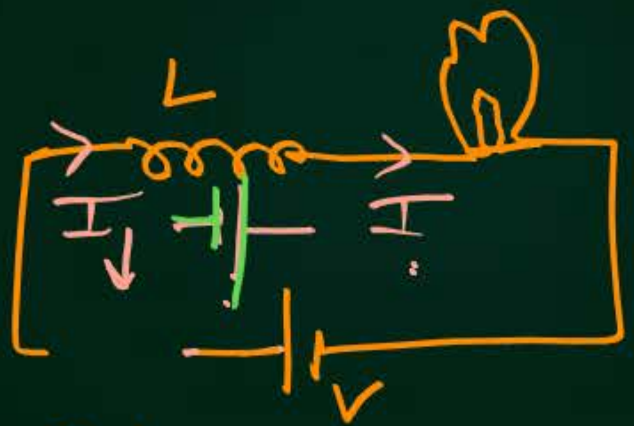
$$\underset{\text{at } t=\alpha}{I} = \frac{20}{3}$$



QUESTION

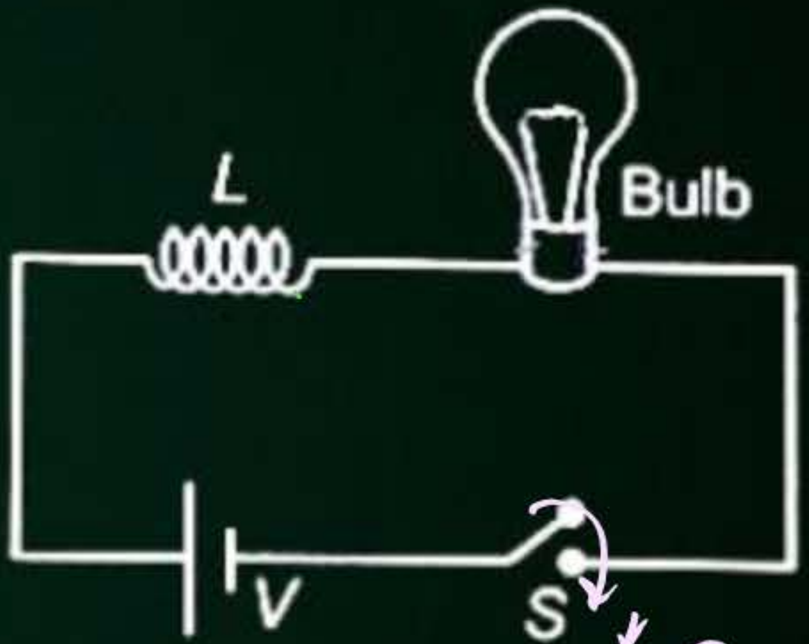
In The current circuit, bulb will become suddenly bright, if

1. Switch is closed or opened
2. Switch is closed
3. Switch is opened
4. None of these



→ Initially key was closed

Just key is open

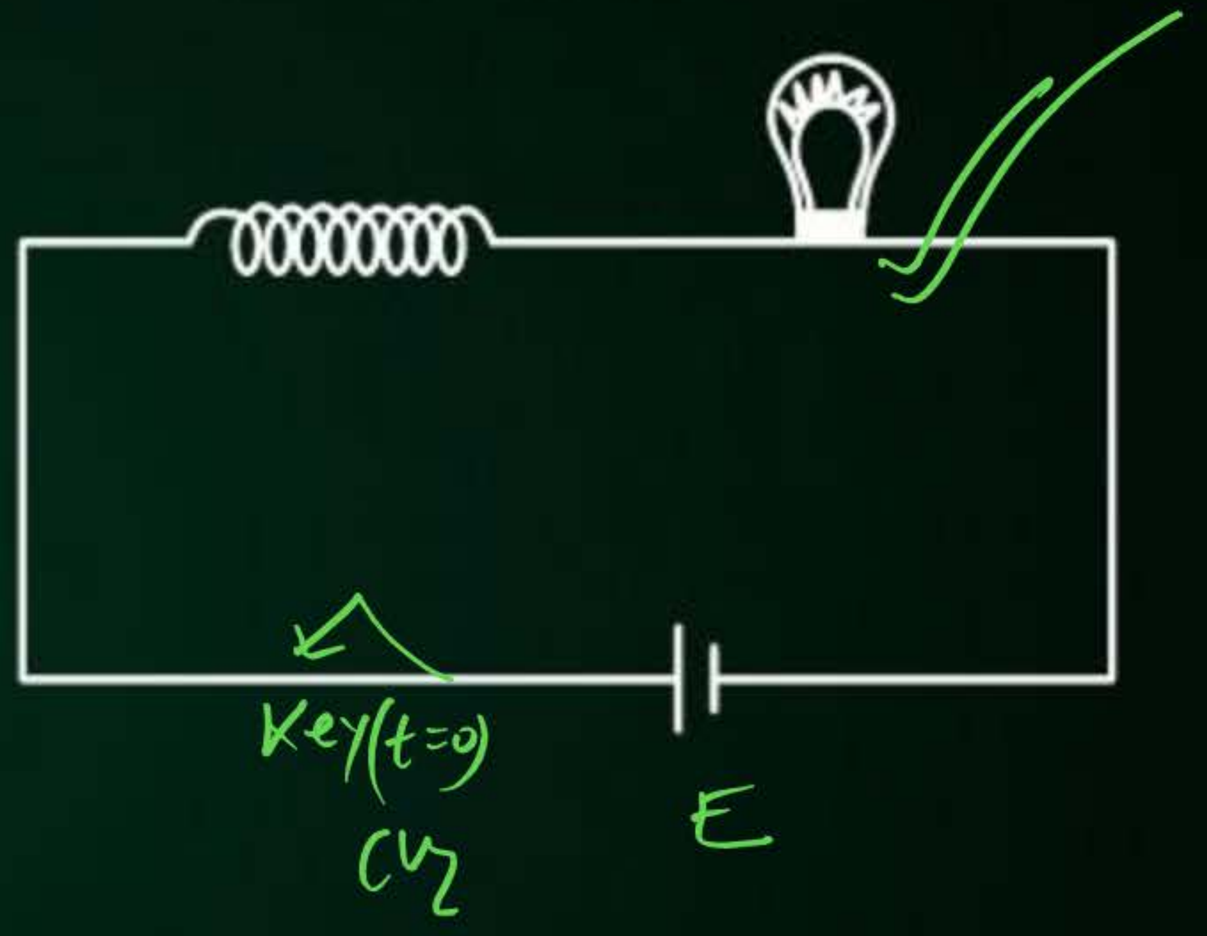


I=0

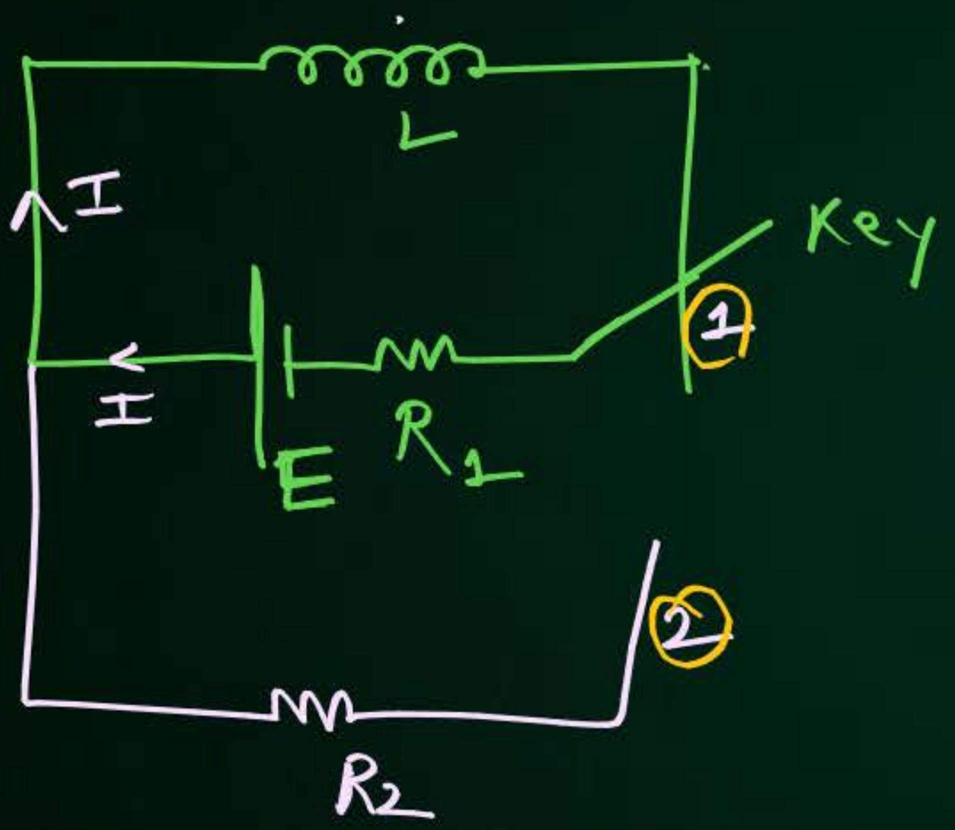
Initially key is open, key is just close

QUESTION

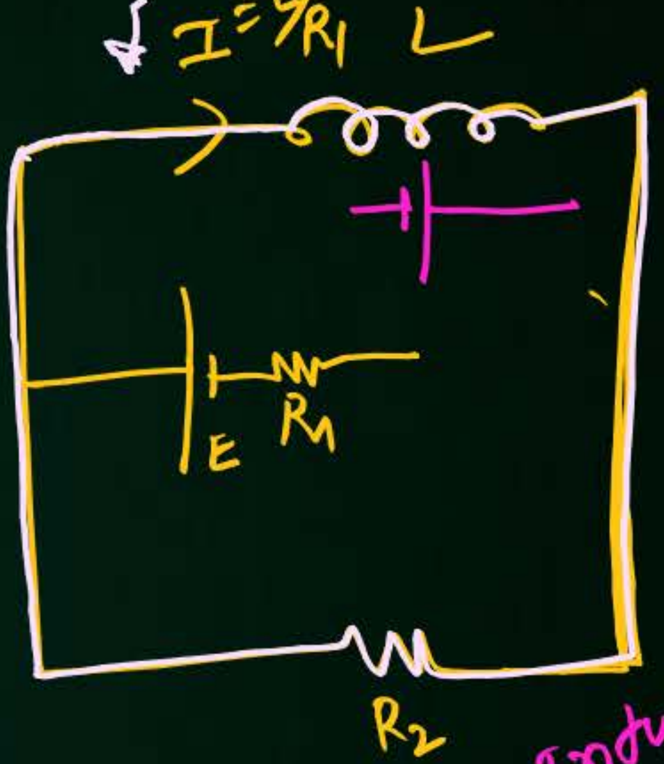
Comment on brightness of bulb with time?



Discharging of Inductor



Key (1) & 2 is conne



Now Inductor will discharge through R_2

at steady state when Inductor was full charged,

$I = \frac{E}{R_1}$ Energy stored in Inductor $= \frac{1}{2}LI^2 = \frac{1}{2}L\left(\frac{E}{R_1}\right)^2$

$V_L = V_R$

$-L\frac{dI}{dt} = IR_2$

$V_L = V_R$ at any inst

$$-L\frac{dI}{dt} = I R_2$$

$$-\frac{dI}{I} = \frac{R_2}{L}\,dt$$

$$\int_{I_{max}}^{I}\frac{dI}{I} = -\int_{0}^{t}\frac{R_2}{L}\,dt$$

$$\left(\log I\right)_{I_{max}}^{I} = -\frac{R_2}{L}t$$

How BY solving it

$$Q = Q_{max}\,e^{-t/RC}$$

discharging of capacitor

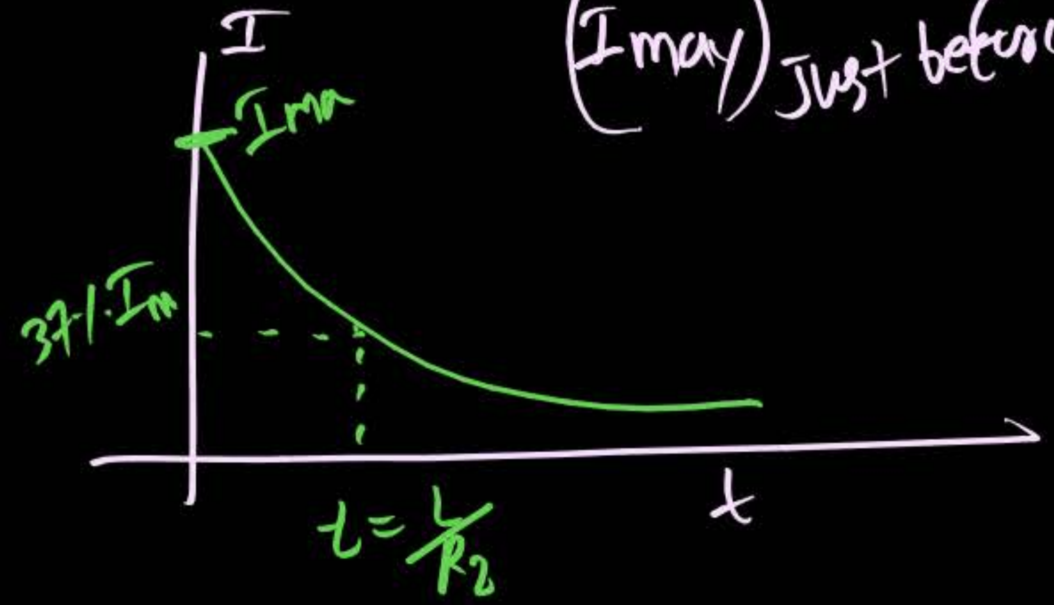
$$I = I_{max}\,e^{-t\frac{R_2}{L}}$$

$$\tau = \frac{L}{R_2}$$

$$I = \frac{E}{R_1}\,e^{-t\frac{R_2}{L}}$$

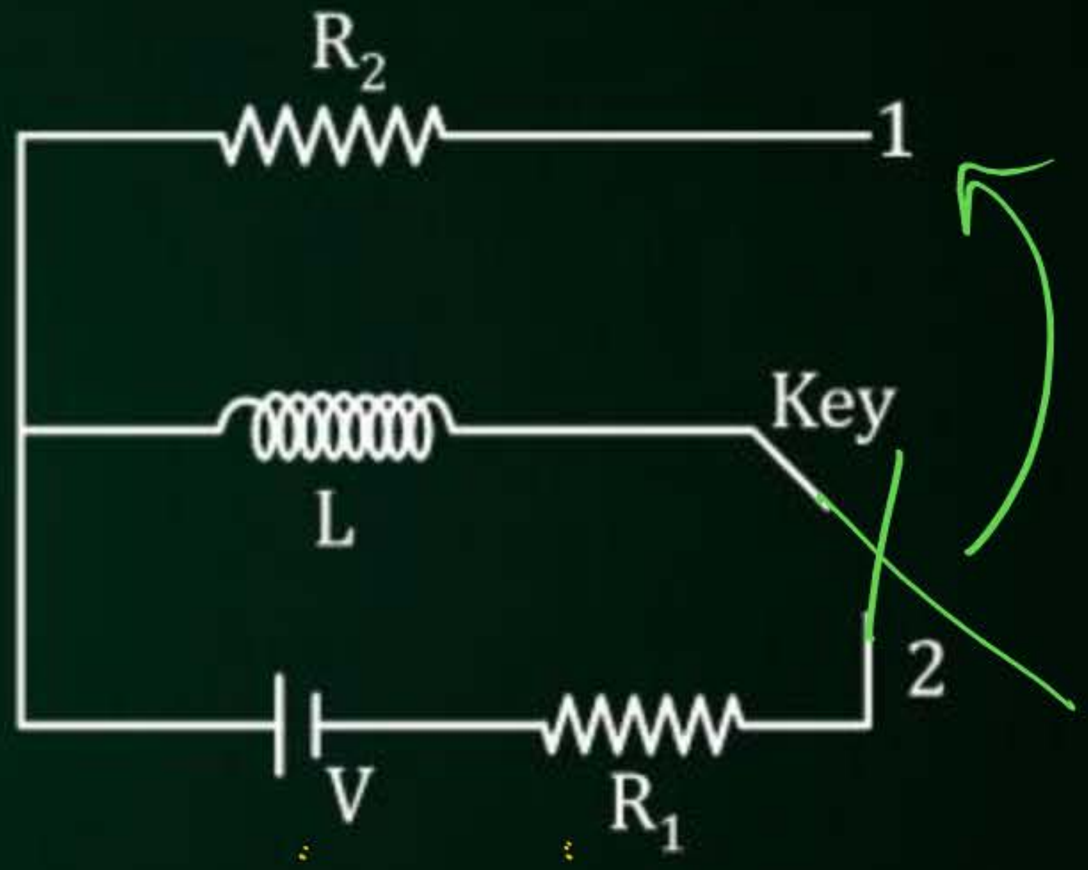
→ discharge across R_2

(I_{max}) just before charge depends on Battery & R_1



QUESTION

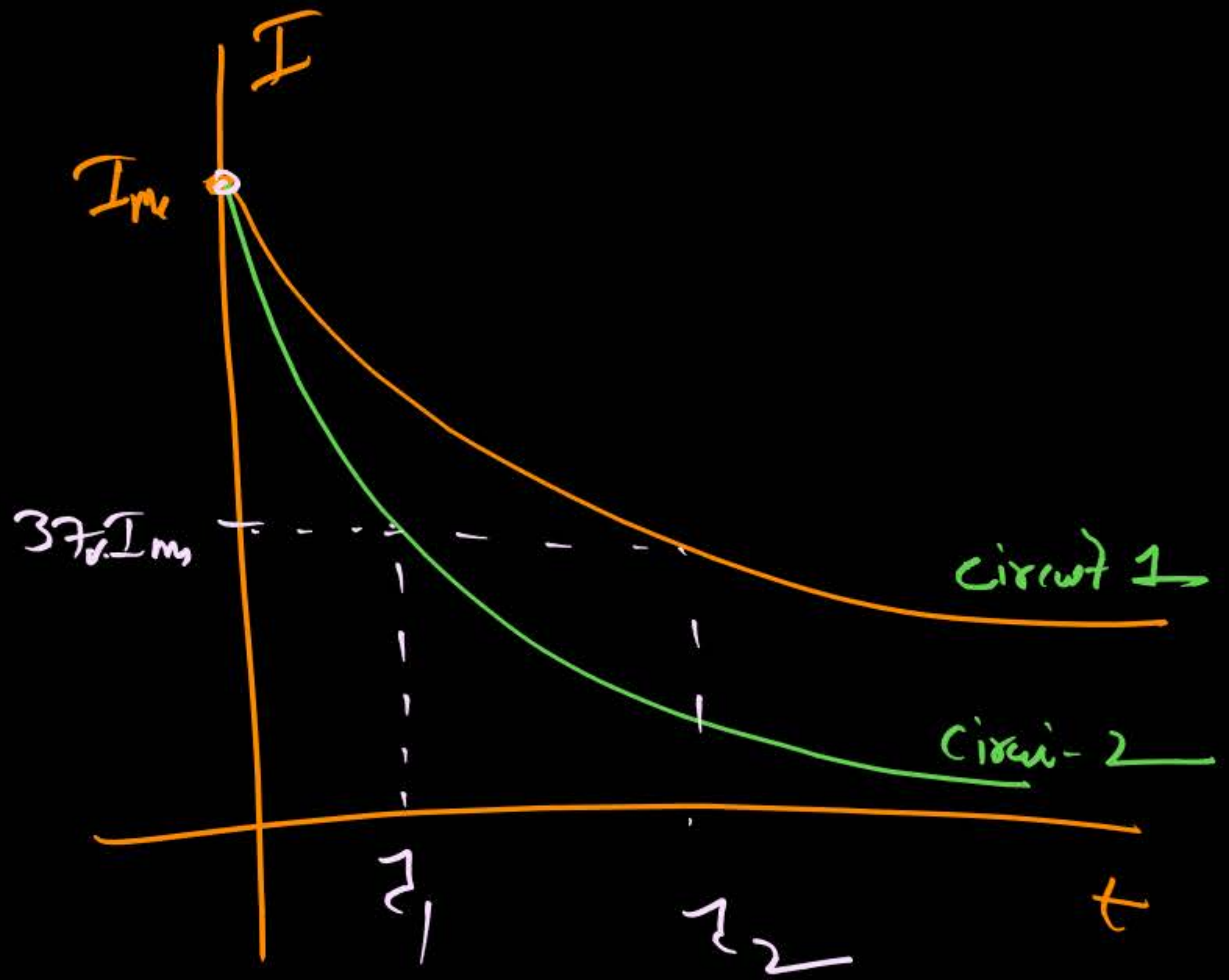
Find total heat loss across R_2 when key is shifted from (2) to (1) : at steady state





$U_{max\ store} = \frac{1}{2} L I_{max}^2 = \frac{1}{2} L \left(\frac{V}{R_1}\right)^2$

$U_{loss} = \frac{1}{2} L I_m^2 = \frac{1}{2} L \left(\frac{V}{R_1}\right)^2$



Which of the following is corr

(a) $\tau_1 = \tau_2$

(b) $\tau_1 > \tau_2$

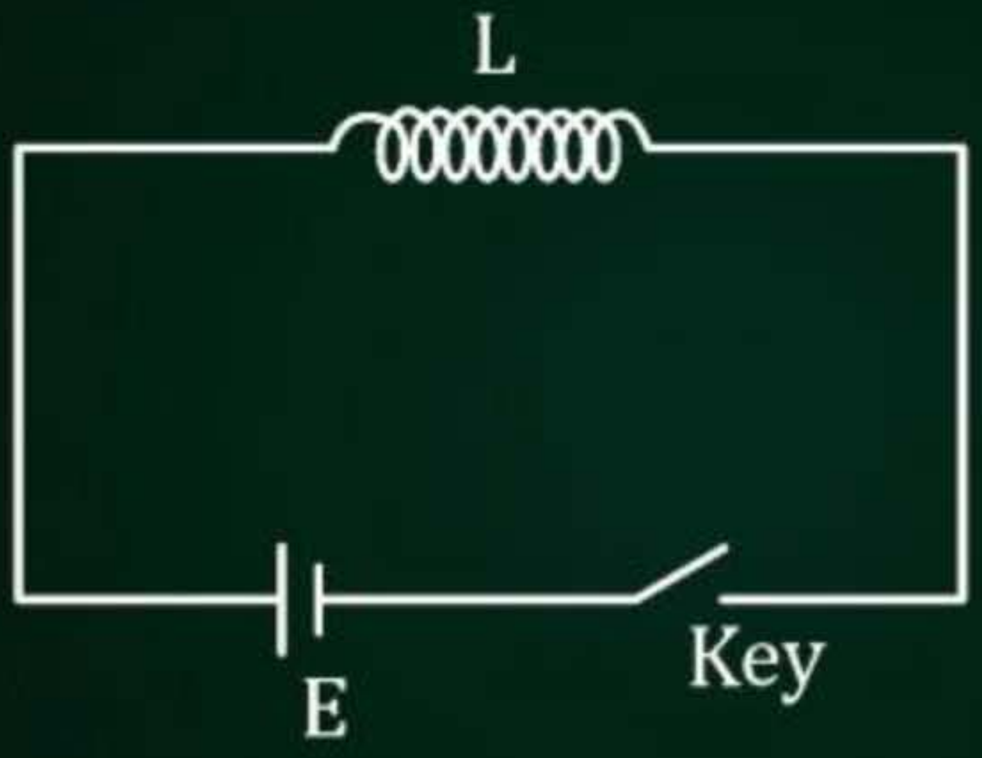
✓ (c) $\tau_1 < \tau_2$

QUESTION

Draw graph between V_R and time in the charging of inductor.

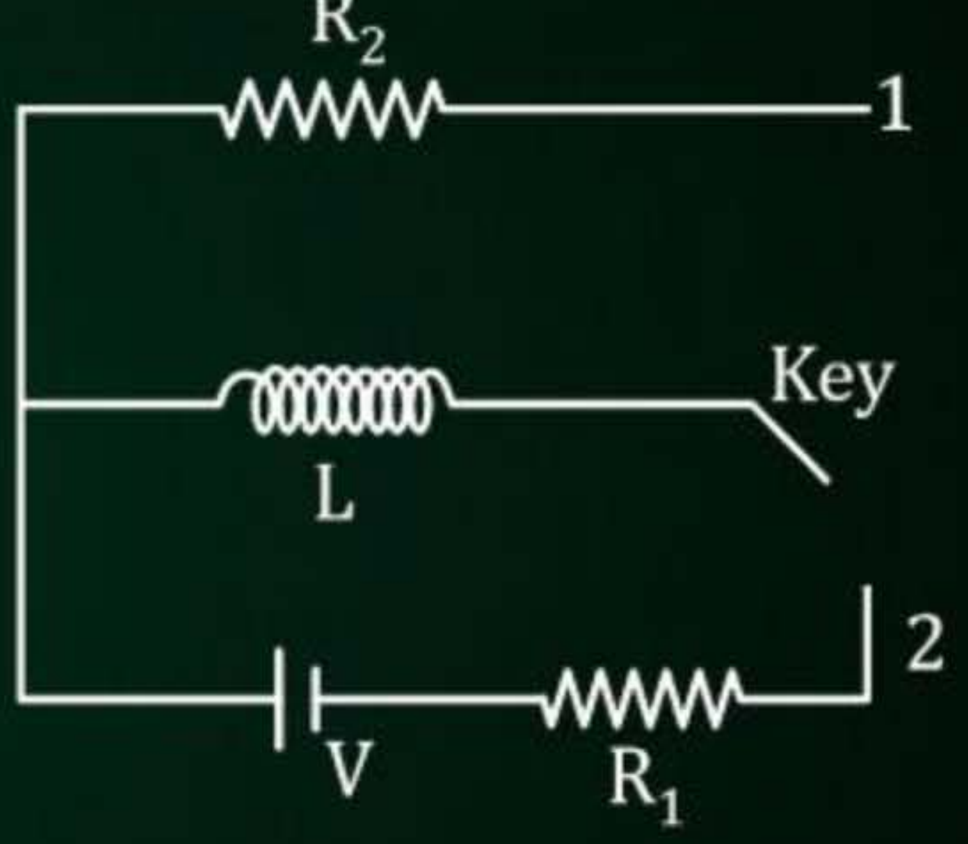
QUESTION

Write equation of current as a function of time.



QUESTION

Find total heat loss across R_2 when key is shifted from (1) to (2) :



Decay of current in the L-R circuit:

The equation of current is given by

$I = I_0 e^{-t/\tau}$ (where I_0 = initial current and $\tau = L/R$)

It $t = L/R$ = time constant, then $I = I_0 e^{-1} = I_0/e = 0.37 I_0$

Reciprocity Theorem

- **Series Combination of Inductor assuming mutual Inductance also:**

QUESTION

Figure shows two concentric loops of radii R and r(R >> r). A current i is passed through the outer loop. Find the flux linked with inner loop and the mutual inductance of the arrangement.



1. $\frac{\pi\mu_0 r^2}{4R}$
2. $\frac{\pi\mu_0 r^2}{R}$
3. $\frac{\pi\mu_0 R^2}{2r}$
4. $\frac{\pi\mu_0 r^2}{2R}$

QUESTION

With the decrease of current in the primary coil from 2 A to zero in 0.01s, the e.m.f. generated in the secondary coil is 1000 V. The mutual inductance of the two coil is

1. 1.25 H
2. 2.50 H
3. 5.00 H
4. 10.00 H

QUESTION

Two coaxial coils are very close to each other and their mutual inductance is 5 mH. If a current 50 sin 500f is passed in one of the coils then the peak value of induced e.m.f. in the secondary coil will be

1. 5000 V
2. 500 V
3. 150 V
4. 125 V

MUTUAL INDUCTANCE

Mutual inductance of two solenoids :

$$M = \frac{\mu_0 N_1 N_2 A}{l}$$

where,

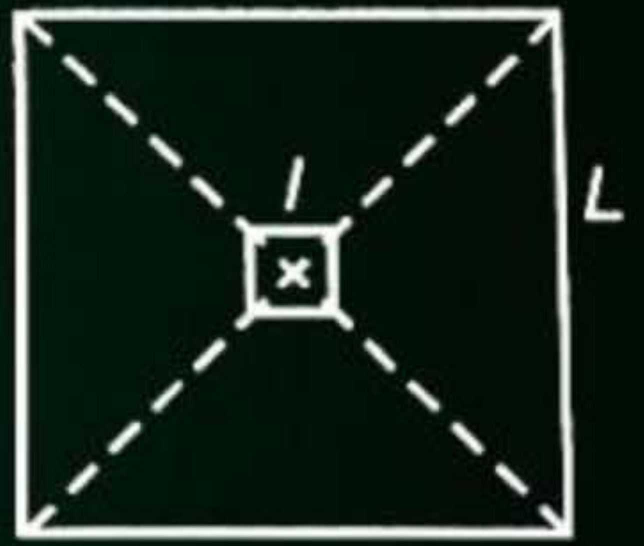
N_1 = Number of turns in one coil N_2 = Number of turns in other coil A = Area of cross-section

l = Length of smaller coil



QUESTION

A small square loop of wire of side l is placed inside a large square loop of wire of side L ($\gg l$). The loops are coplanar and their centres coincide. The mutual inductance of the system is



1. $\dfrac{2\sqrt{2}\mu_0 L}{\pi l}$

2. $\dfrac{2\sqrt{2}\mu_0 L^2}{\pi l}$

3. $\dfrac{2\sqrt{2}\mu_0 l}{\pi L}$

4. $\dfrac{2\sqrt{2}\mu_0 l^2}{\pi L}$

QUESTION

The coefficient of self induction of two inductor coils are 20 mH and 40 mH respectively. If the coils are connected in series so as to support each other and the resultant inductance is 80 mH then the value of mutual inductance between the coils will be

1. 5 mH
2. 10 mH
3. 20 mH
4. 40 mH

QUESTION

Two coils of self-inductances 2 mH and 8 mH are placed so close together that the effective flux in one coil is completely linked with the other. The mutual inductance between these coils is

1. 10 mH
2. 6 mH
3. 4 mH
4. 16 mH

QUESTION

The equivalent inductance of two inductor is 2.4 H when connected in parallel and 10 H when connected in series. The difference between two inductance is (Neglecting mutual induction between coils)

1. 2 H
2. 3 H
3. 4 H
4. 5 H

QUESTION

Two coils have self inductance $L_1 = 4$ mH and $L_2 = 1$ mH respectively. The currents in the two coils are increased at the same rate. At a certain instant of time both coils are given the same power. If I_1 and I_2 are the currents in the two coils, at that instant of time respectively, then the value of I_1/I_2 is

1. 1/8
2. 1/4
3. 1/2
4. 1

EDDY CURRENT

Magnetic flux associated with the plate keeps on changing as the plate moves in and out of the region between magnetic poles. The flux change induces eddy currents in the plate. Directions of eddy currents are opposite when the plate swings into the region between the poles and when it swings out of the region.



Cutting slotsin the copper plate reduces the effects of eddy currents.

Applications of Eddy Currents:

(i) Magnetic braking in trains

(ii) Electromagnetic damping

(iii) Induction furnace

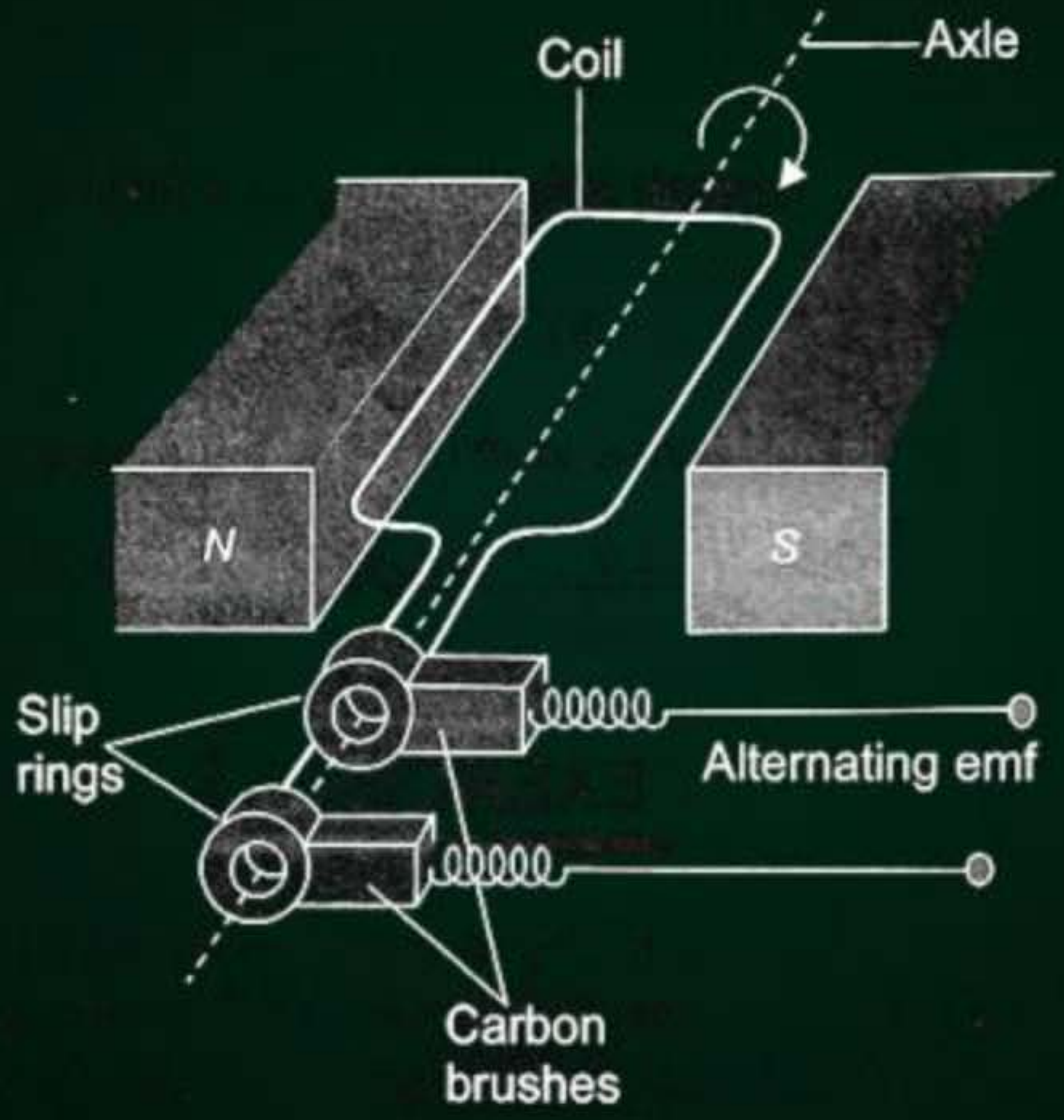
(iv) Electric power meters

QUESTION

Eddy currents are induced when

1. A metal block is kept in a changing magnetic field
2. A metal block is kept in a uniform magnetic field
3. A coil is kept in a uniform magnetic field
4. Current is passed in a coil

AC GENERATOR



QUESTION

A coil having number of turns N and area A is rotated in a uniform magnetic field B with angular velocity ω about its diameter. Maximum e.m.f. induced in it is given by

1. $NAB\omega$
2. $\frac{NAB}{\omega}$
3. $\frac{NA\omega}{B}$
4. $\frac{B\omega}{NA}$


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 7 | Physics

ELECTROMAGNETIC INDUCTION

By- Dr. Manish Raj (MR SIR)



Topics to be covered

1. # Mutual Inductance
2. # A/C genrator

   ~~D/C Motion~~ Not in syllabus
3. # eddy current



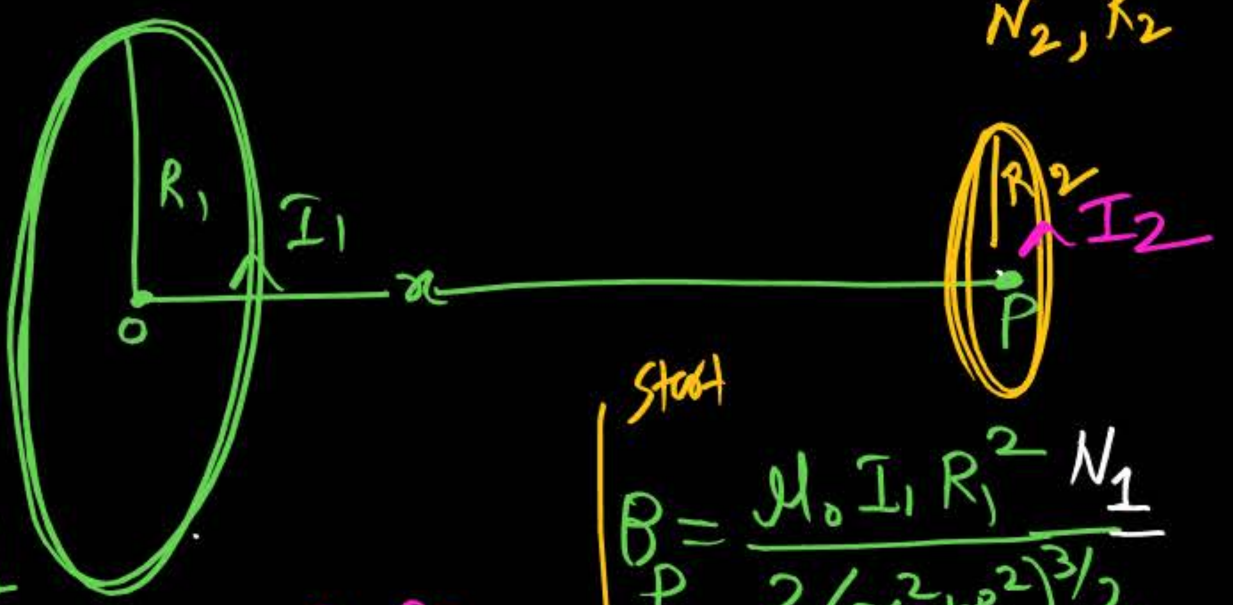
Mutual Induction

$$\phi = \mu_0 n^2 A l I$$

$$\phi = L I$$

Coil-1: N_1, R_1, I_1

Coil-2: N_2, R_2



Start

$$B_P = \frac{\mu_0 I_1 R_1^2 N_1}{2(x^2+R_1^2)^{3/2}}$$

$$\phi_{21} = B_P \times \pi R_2^2 N_2 = \frac{\mu_0 I_1 R_1^2 \pi R_2^2 N_2 N_1}{2(x^2+R_1^2)^{3/2}}$$

ϕ_{21}: flux in coil-2 due to coil-1

If $x \gg R_1$ & R_2

$$\phi_{21} = \frac{\mu_0 \pi R_1^2 R_2^2 N_1 N_2}{2x^3} I_1$$

$$\phi_{21} \propto I_1$$

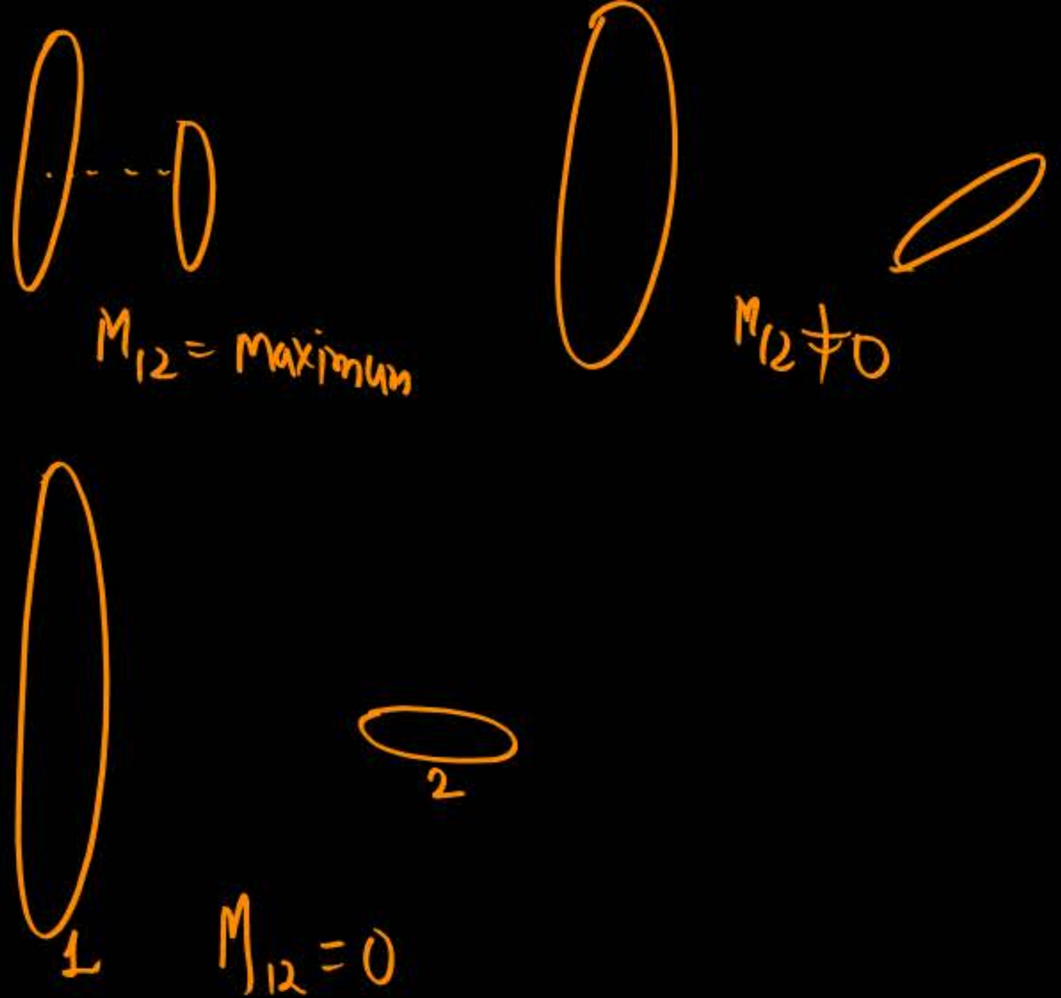
$$\phi_{21} = M_{21} I_1$$

$$M_{21} = \frac{\mu_0 \pi N_1 N_2 R_1^2 R_2^2}{2x^3}$$

Mutual Inductance of 2nd coil due to 1st

Reciprocity theorem: $M_{12} = M_{21}$

$$M_{12} = \frac{\mu_0 \pi N_1 N_2 R_1^2 R_2^2}{2x^3}$$



Mutual Inductance depends on (medium)

- → No of turn of each coil ✓
- → size of each coil.
- → distance B/w them.
- → Relative orientation.

$$\phi_{21} = \left(\frac{\mu_0 \pi N_1 N_2 R_1^2 R_2^2}{2x^3}\right) I_1$$

$$\phi_{12} = \left(\frac{\mu_0 \pi N_1 N_2 R_1^2 R_2^2}{2x^3}\right) I_2$$

$$\phi_{21} = M_{21} I_1$$

diff^n w.r.t. time

$$\frac{d\phi_{21}}{dt} = M_{21} \frac{dI_2}{dt}$$

- emf Induced in 2nd coil due to 1st coil. →

$$|emf_{21}| = M_{21} \frac{dI_1}{dt}$$

$$\phi_{12} = M_{12} I_2$$

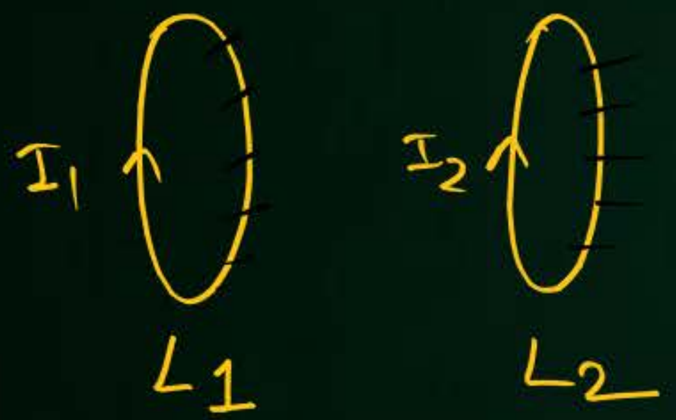
diff^n w.r.t. time

- emf Indued in 1st coil due 2nd coil →

$$emf_{12} = M_{12} \frac{dI_2}{dt}$$

Reciprocity Theorem

(#) $M_{12} = M_{21}$ ← always correct



$M_{12} = M_{21}$ = mutual Inductance

$M^2 = L_1 L_2$

$M_{21} = M_{21} = \sqrt{L_1 L_2}$ ✗

relation b/w mutual & self Inductance

$M = K\sqrt{L_1 L_2}$

MR. Rattu

→ K = coupling const^n

→ $0 \le K \le 1$

$K = 1$ perfect coupling

$K = 0$ No coupling

➢ Series Combination of Inductor assuming mutual Inductance also:



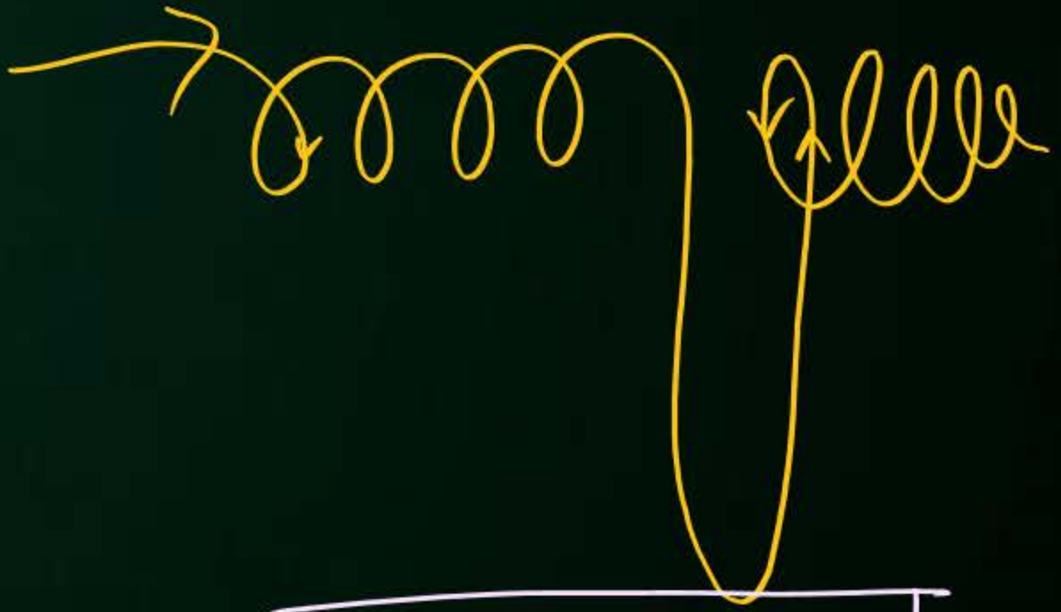
$L_{eq} = L_1 + L_2$ ← without considering mutual Inductance

$$L_{eq} = L_1 + L_2 + 2M$$

→ flux linked in same dirn

$$L_{eq} = L_1 + L_2 + 2K\sqrt{L_1 L_2}$$

K = 1 (If No information of K is given)



$$L_{eq} = L_1 + L_2 - 2M$$

opposite dirn of linked flux

QUESTION

With the decrease of current in the primary coil from 2 A to zero in 0.01s, the e.m.f. generated in the secondary coil is 1000 V. The mutual inductance of the two coil is

1. 1.25 H
2. 2.50 H
3. 5.00 H
4. 10.00 H

$emf = L\frac{dI}{dt}$

$emf_2 = M\frac{dI_1}{dt}$

$1000 = M\frac{2}{\left(\frac{1}{100}\right)}$

$M = 1000 \times \frac{1}{100 \times 2}$

$M = 5H$

QUESTION

Two coaxial coils are very close to each other and their mutual inductance is 5 mH. If a current 50 sin 500t is passed in one of the coils then the peak value of induced e.m.f. in the secondary coil will be

1. 5000 V
2. 500 V
3. 150 V
4. 125 V ✓

$emf_2 = M \frac{dI_1}{dt}$

$= 5 \times 10^{-3} \times 50 \times \cos 500t \times 500$

$= 125\,V$

QUESTION

Figure shows two concentric loops of radii R and r(R >> r). A current i is passed through the outer loop. Find the flux linked with inner loop and the mutual inductance of the arrangement.

1. $\frac{\pi\mu_0 r^2}{4R}$
2. $\frac{\pi\mu_0 r^2}{R}$
3. $\frac{\pi\mu_0 R^2}{2r}$
4. $\frac{\pi\mu_0 r^2}{2R}$

40%

$$\phi_{12} = M I_2$$

$$\phi_2 = BA$$

$$\phi_{21} = \frac{\mu_0 I}{2R} \times \pi r^2$$

$$M = \frac{\mu_0 \pi r^2}{2R}$$



QUESTION

A small square loop of wire of side l is placed inside a large square loop of wire of side L $L (>> l)$. The loops are coplanar and their centres coincide. The mutual inductance of the system is

1. $\dfrac{2\sqrt{2}\mu_0 L}{\pi l}$
2. $\dfrac{2\sqrt{2}\mu_0 L^2}{\pi l}$
3. $\dfrac{2\sqrt{2}\mu_0 l}{\pi L}$
4. $\dfrac{2\sqrt{2}\mu_0 l^2}{\pi L}$



QUESTION

The coefficient of self induction of two inductor coils are 20 mH and 40 mH respectively. If the coils are connected in series so as to support each other and the resultant inductance is 80 mH then the value of mutual inductance between the coils will be

1. 5 mH
2. 10 mH
3. 20 mH
4. 40 mH

$L_{eq} = L_1 + L_2 + 2M$

$80 = 20 + 40 + 2M$

$80 - 60 = 2M$

$20 = 2M$

$M = 10$

QUESTION

Two coils of self-inductances 2 mH and 8 mH are placed so close together that the effective flux in one coil is completely linked with the other. The mutual inductance between these coils is

1. 10 mH
2. 6 mH
3. 4 mH
4. 16 mH

$M = K\sqrt{L_1 L_2}$

$M = 1\sqrt{2 \times 8}$

$M = 4$

QUESTION

The equivalent inductance of two inductor is 2.4 H when connected in parallel and 10 H when connected in series. The difference between two inductance is (Neglecting mutual induction between coils)

$L_1 - L_2 = ??$

1. 2 H
2. 3 H
3. 4 H
4. 5 H

$\frac{L_1 L_2}{L_1 + L_2} = 2.4 \Rightarrow L_1 L_2 = 24$

$L_1 + L_2 = 10$

$L_1 = 6H$

$L_2 = 4H$

QUESTION

Two coils have self inductance $L_1 = 4$ mH and $L_2 = 1$ mH respectively. The currents in the two coils are increased at the same rate. At a certain instant of time both coils are given the same power. If I_1 and I_2 are the currents in the two coils, at that instant of time respectively, then the value of I_1/I_2 is

1. 1/8
2. 1/4
3. 1/2
4. 1

L_1 L_2

$P_1 = P_2$

$I_1 V_1 = I_2 V_2$

$\frac{I_1}{I_2} = \frac{V_2}{V_1} = \frac{L_2 \, dI/dt}{L_1 \, dI/dt}$

$\frac{I_1}{I_2} = \frac{1}{4}$

Mutal Inductance

flux in 2nd Soln due to 1st solenoid.

$$\phi_{21} = B_1 \times A_2$$

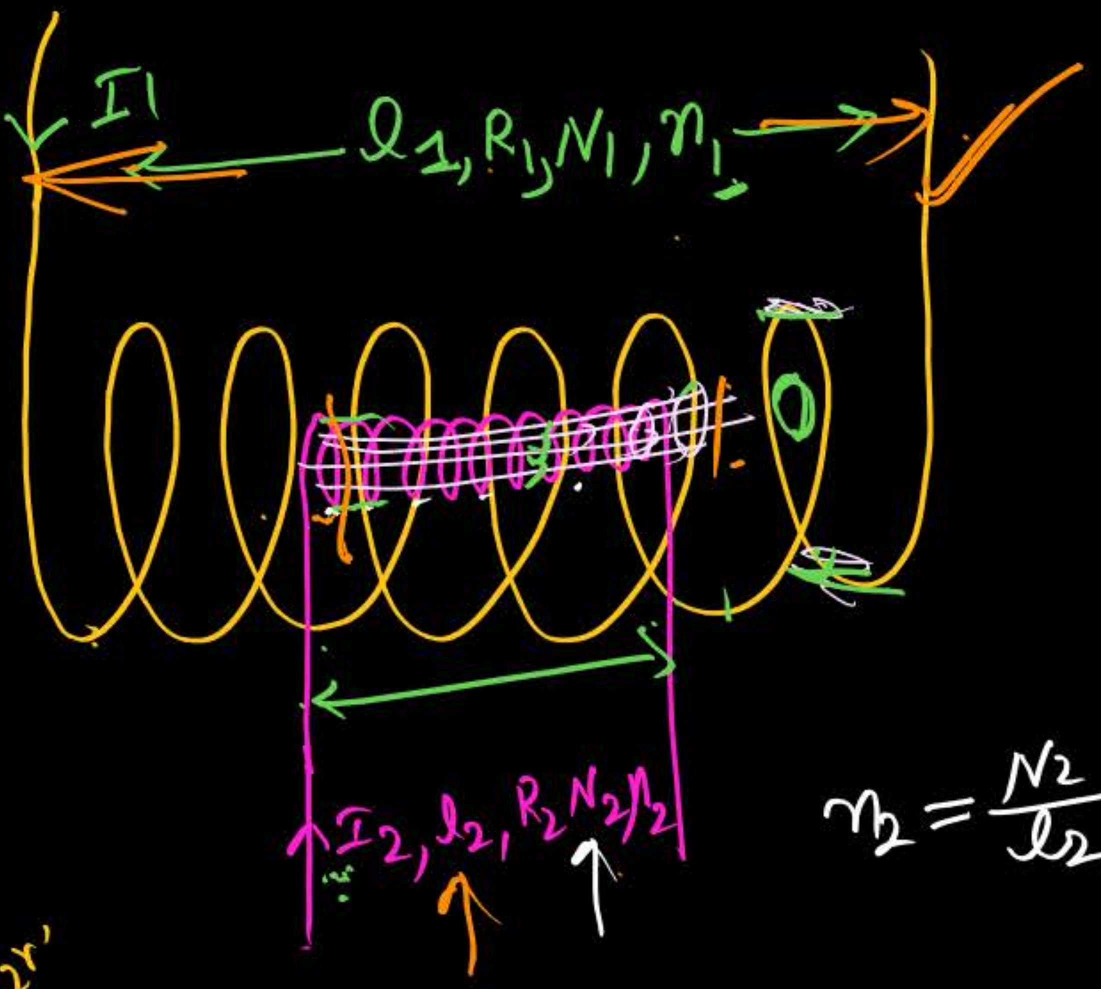
$$= (\mu_0 n_1 I_1) \times \pi R_2^2 N_2$$

$$\phi_{21} = \mu_0 n_1 N_2 \pi R_2^2 I_1$$

$$\boxed{M_{21} = \mu_0 n_1 n_2 l_2 \pi R_2^2}$$

mutual Inductan of 2nd coil

M_{12} → (a) diffn ✗
→ (b) Same (99%) ✓



$$n_2 = \frac{N_2}{l_2}$$

flux in 1st coil due to 2nd

$$\phi_{12} = B_2 A_1 = \mu_0 n_2 I_2 \pi R_2^2 N_1$$

$$= \mu_0 n_2 I_2 \pi R_2^2 (n_1 l_2)$$

$$\phi_{12} = \boxed{\mu_0 n_1 n_2 \pi R_2^2 l_2} I_2$$

$$\phi_{21} = M_{21} I_1$$

$$\phi_{12} = M_{12} I_2$$

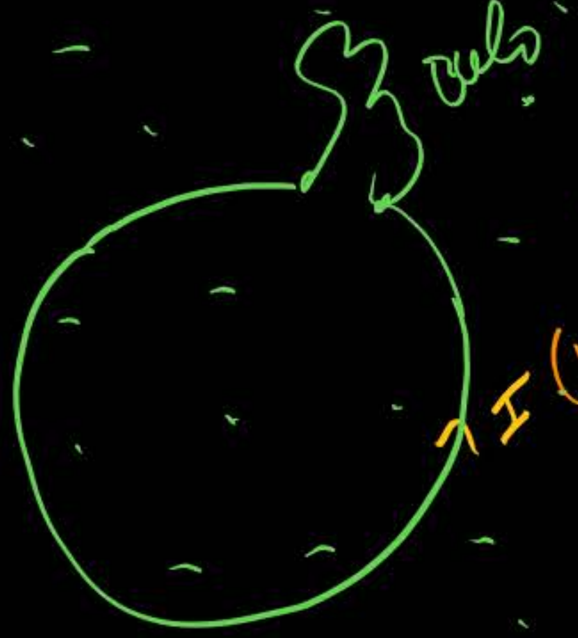
$$emf_2 = M_{21} \frac{dI_1}{dt}$$

$$emf_1 = M_{12} \frac{dI_2}{dt}$$

$$M_{12} = M_{21}$$

$$M = K\sqrt{L_1 L_2}$$

$$L_{eq} = L_1 + L_2 \pm 2M = L_1 + L_2 \pm 2K\sqrt{L_1 L_2}$$



Coil - Close loop.

I (loop) wire

ϕ = Cost^n → I = 0 Ind.

ϕ = variable → I induc ≠ 0

eddy current → plate





Conducting plate → Variable flux (B → time varible)

EDDY CURRENT

Magnetic flux associated with the plate keeps on changing as the plate moves in and out of the region between magnetic poles. The flux change induces eddy currents in the plate. Directions of eddy currents are opposite when the plate swings into the region between the poles and when it swings out of the region.





Cutting slotsin the copper plate reduces the effects of eddy currents.

Applications of Eddy Currents:

(i) Magnetic braking in trains

(ii) Electromagnetic damping

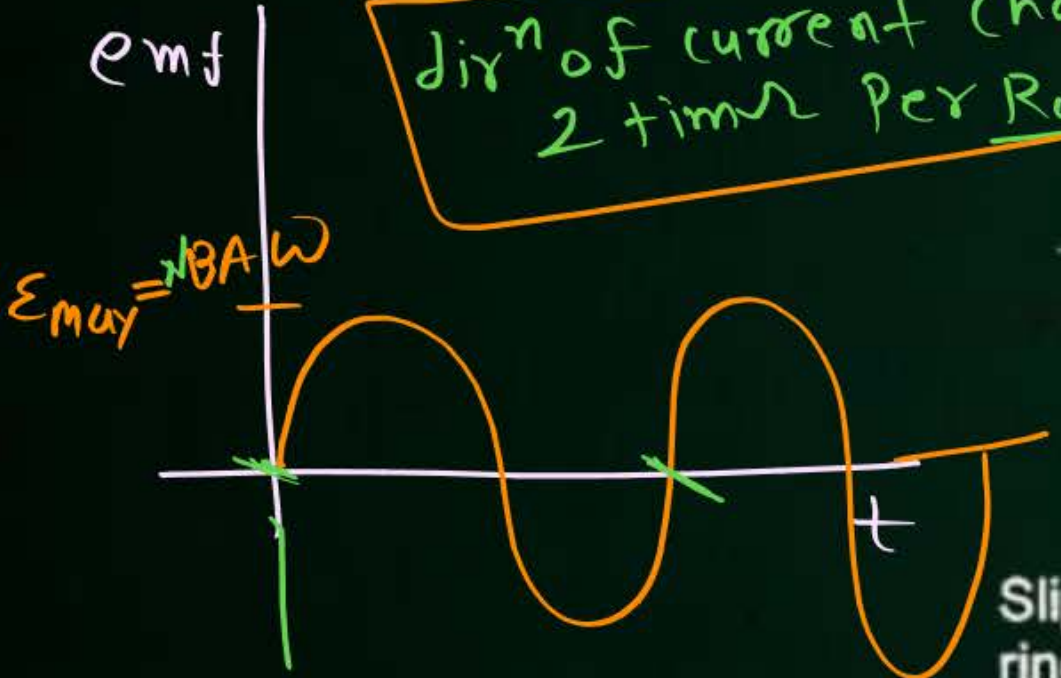
(iii) Induction furnace

(iv) Electric power meters

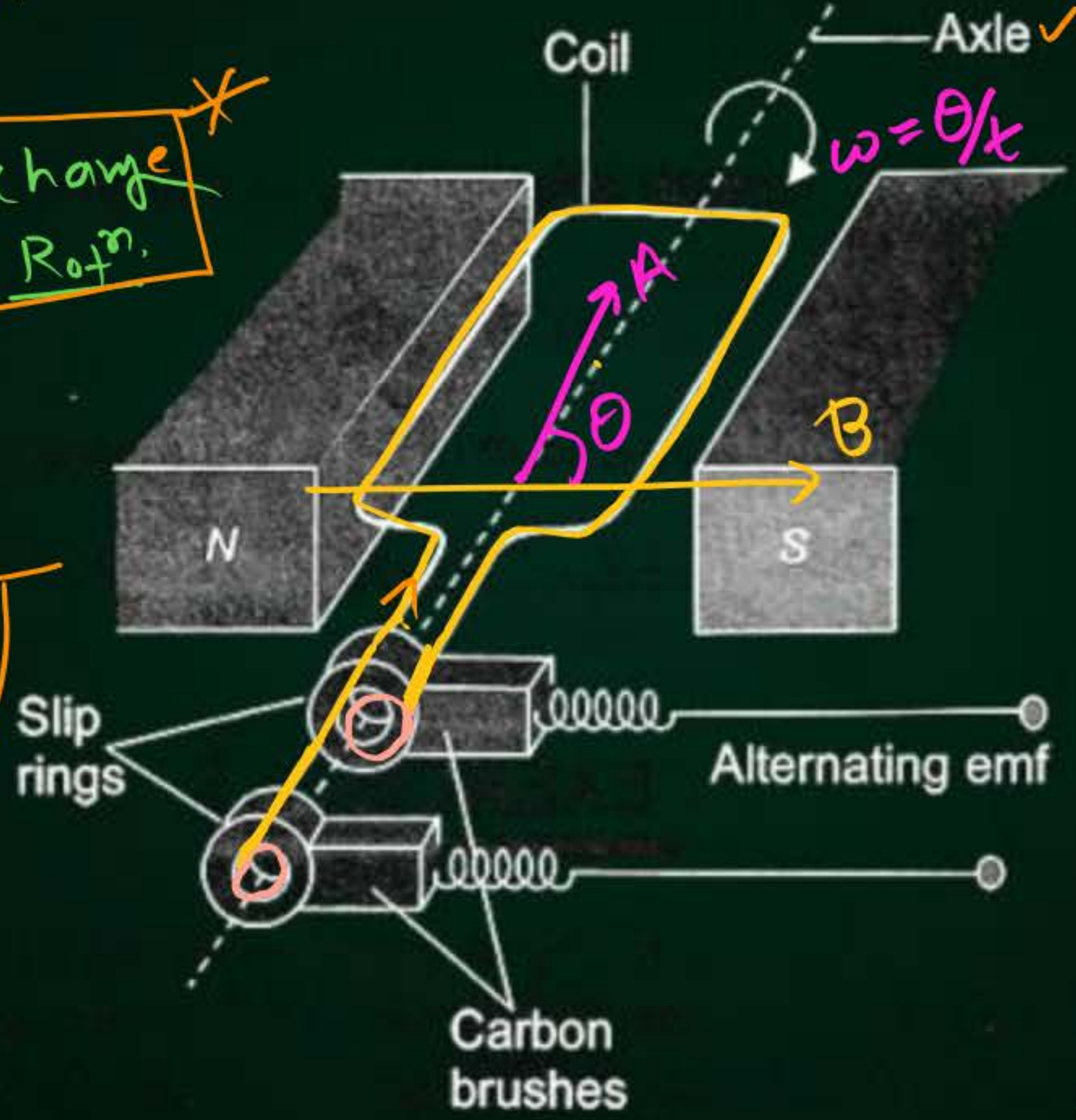


AC GENERATOR

→ work on the principle of faradys law → ϕ = varible → (emf) induces



dir^n of current change 2 timer per Rot^n.



$\phi = BA\cos\theta$

$\phi = BA\cos(\omega t)$

diff^n w.r.t time

$$\frac{d\phi}{dt} = BA\frac{d\cos(\omega t)}{dt}$$

$$\frac{d\phi}{dt} = -BA\sin(\omega t)\times\omega$$

$$emf = -\frac{d\phi}{dt} = +BA\omega\sin(\omega t)$$

N = total No of turn

$$Emf = NBA\omega\sin(\omega t)$$

$$(Emf)_{max} = NBA\omega = NBA2\pi f$$

QUESTION

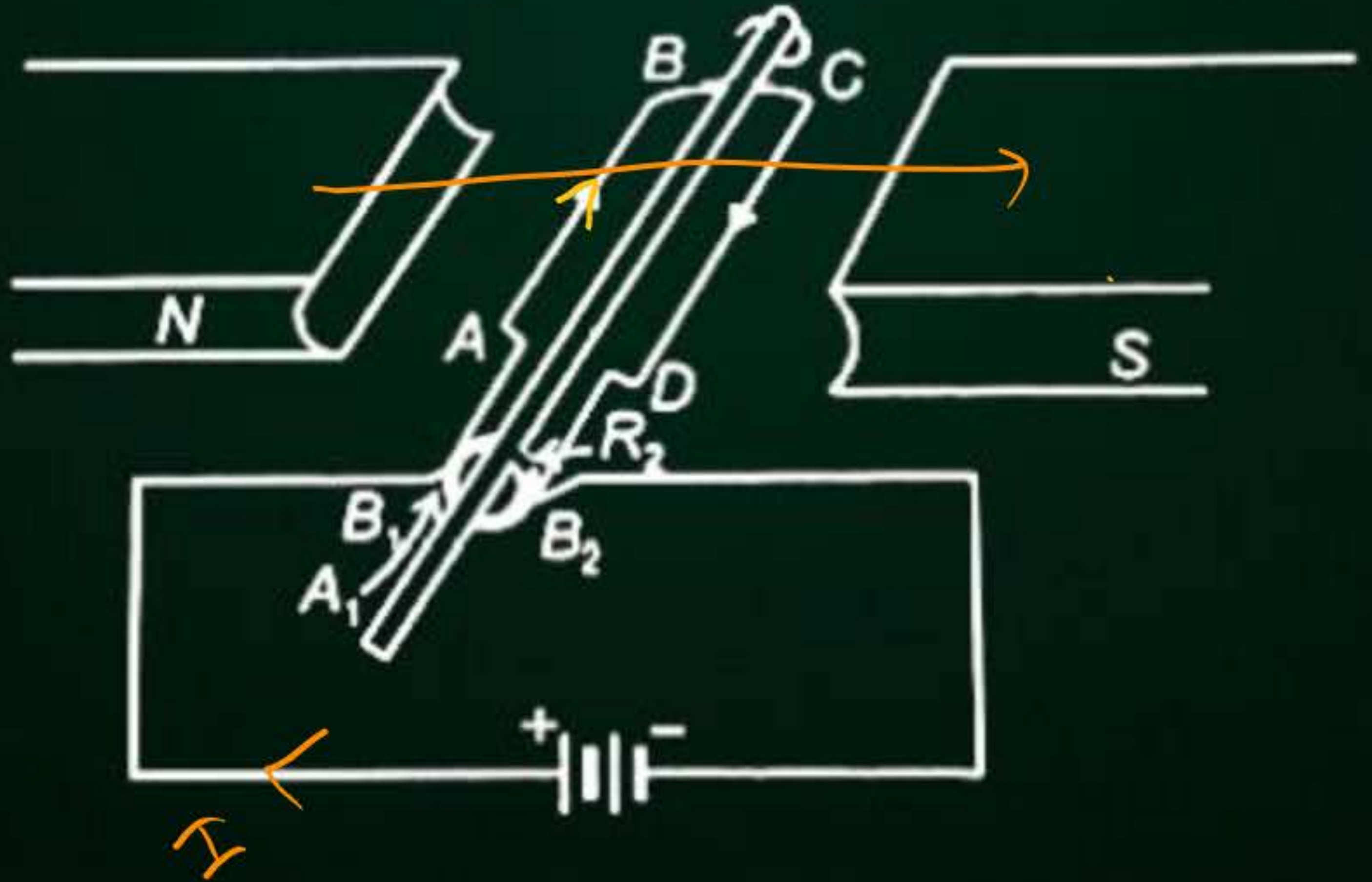
A coil having number of turns N and area A is rotated in a uniform magnetic field B with angular velocity ω about its diameter. Maximum e.m.f. induced in it is given by

1. $NAB\omega$
2. $\frac{NAB}{\omega}$
3. $\frac{NA\omega}{B}$
4. $\frac{B\omega}{NA}$

done

D.C. MOTOR

It is a device to convert electrical energy into mechanical energy. It is used to drive an electrical car, a printing press, a sewing machine, machinery in factories and any other machinery requiring mechanical energy. Like an AC generator, the motor also consists of (1) field magnet. (2) armature, (3) commutator and (4) brushes. The motor is connected to a battery or a DC line supply.



D/c motion → Torque on current carrying loop

Principle:

[redacted]

$$\tau = \vec{m} \times \vec{B}$$
$$= mB\sin\theta$$

QUESTION

Eddy currents are induced when

1. A metal block is kept in a changing magnetic field
2. A metal block is kept in a uniform magnetic field
3. A coil is kept in a uniform magnetic field
4. Current is passed in a coil

$$I_1 = 4\sin\left(\omega t + \frac{\pi}{6}\right)$$

$$I_2 = 5\cos\left(\omega t - \frac{\pi}{3}\right)$$

$$I_3 = 4\cos\left(\omega t - \frac{\pi}{2}\right)$$

$$I_4 = 3\cos(\omega t)$$

$$I_5 = -4\sin(\omega t)$$

$$I_6 = 4\cos\left(\omega t + \frac{\pi}{3}\right)$$

$$I_7 = 3\cos\left(\omega t - \frac{\pi}{6}\right)$$


THANK YOU

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FOR NEET 2025

Lecture- 01 | Physics

Alternating Current

By- Dr. Manish Raj (MR SIR)



Topics to be covered

Type of A/C

R.M.S / Avg. / current of A/C

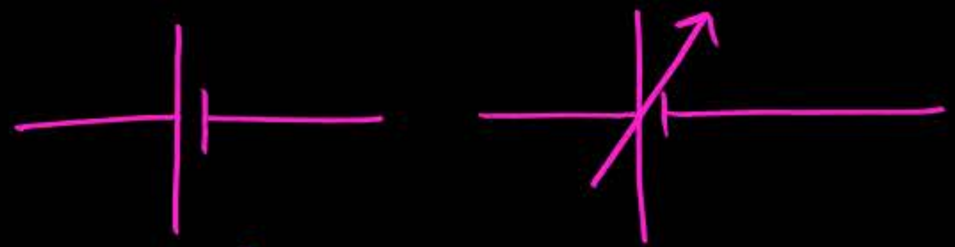
1. #
2. #
3. #

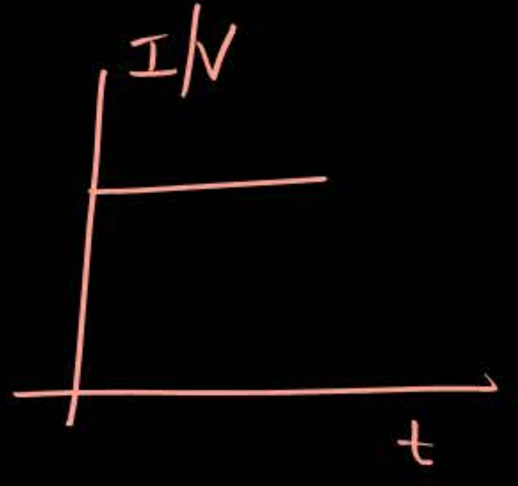


D/C current

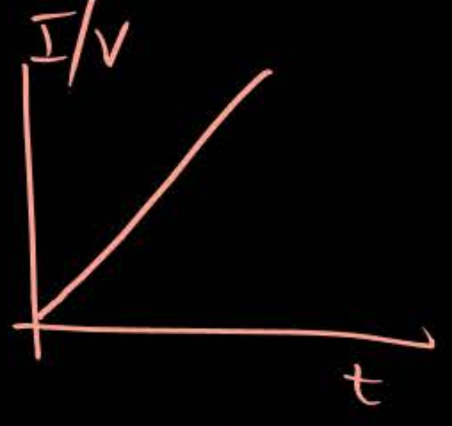
→ Direct current

→ Unidirectional current
(magnitude may be const^n & variable)

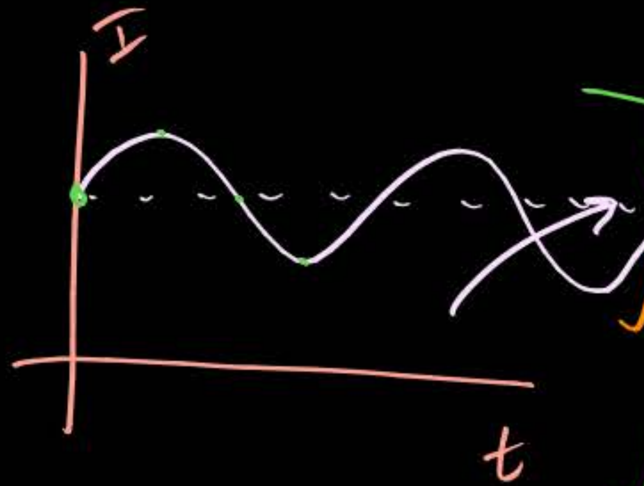




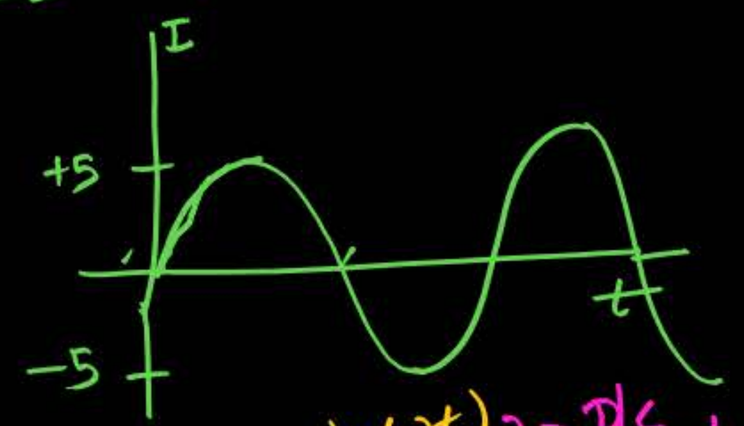
D/C



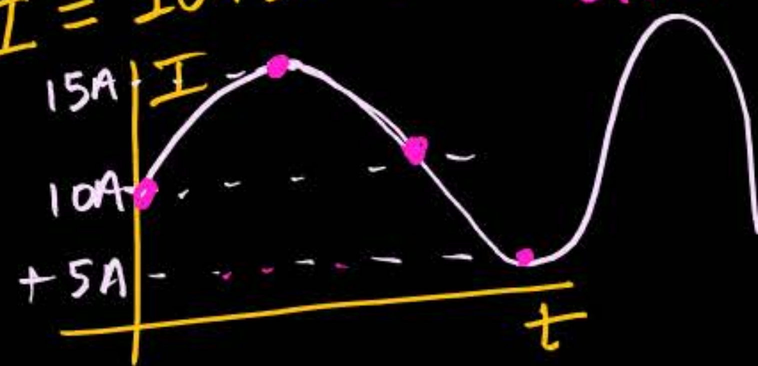
D/C



$I = 5\sin(\omega t)$



$I = 10 + 5\sin(\omega t)$ → D/C current



~~(a) A/C (32%)~~

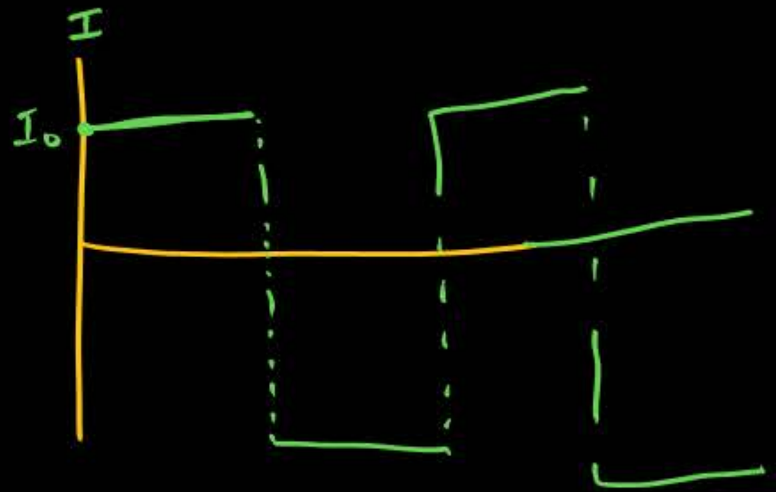
✓ (b) D/C (65%)

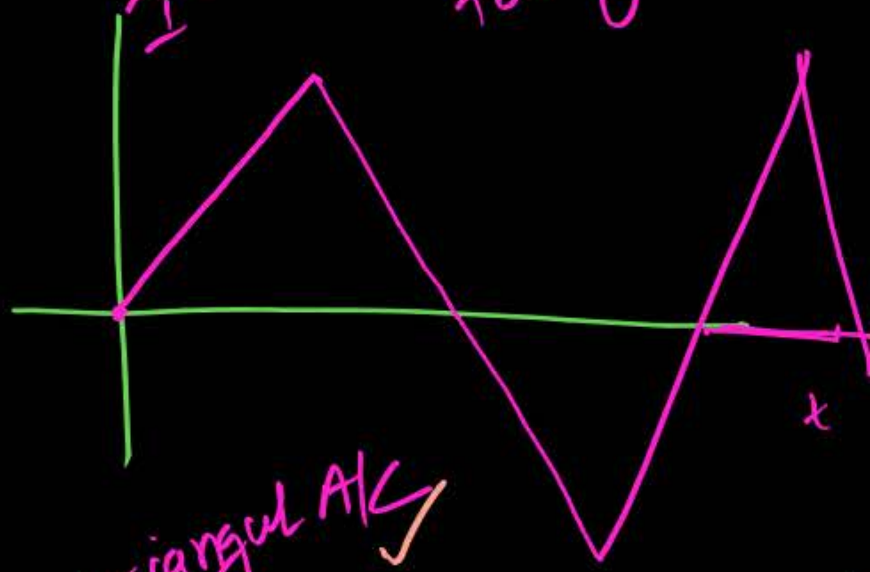
✓ (c) (AC + DC) = (mixture) DC

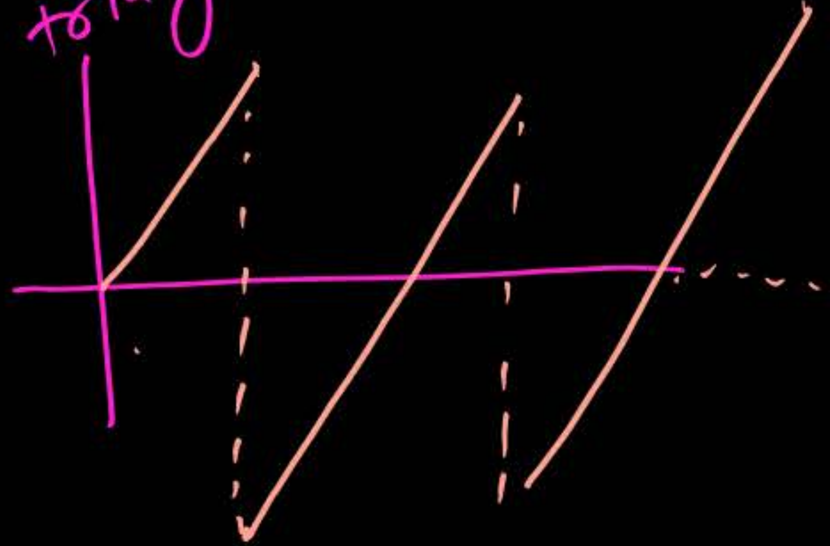
A/C ⟶ Bi-directional current

⟶ magnitude may $Const^n$ or varible



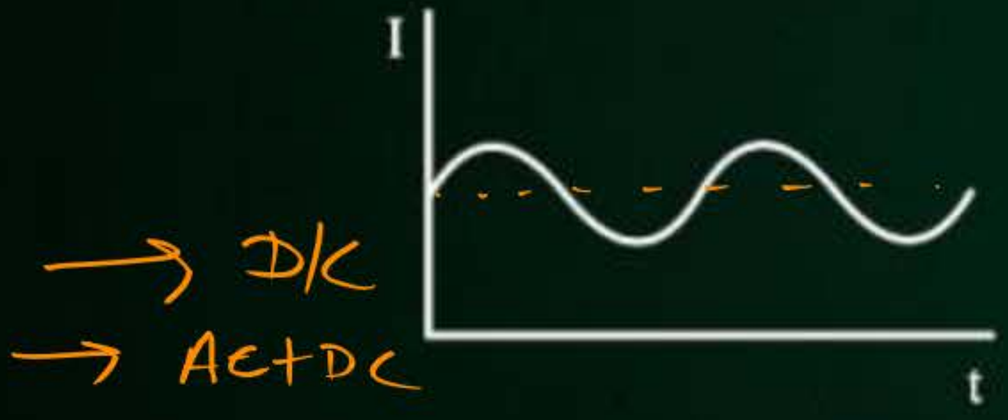


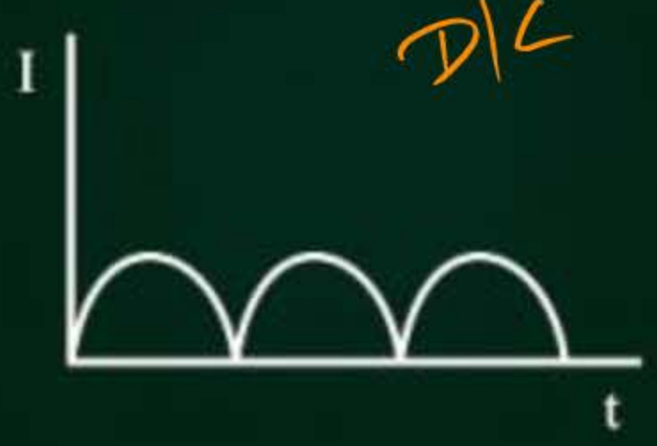


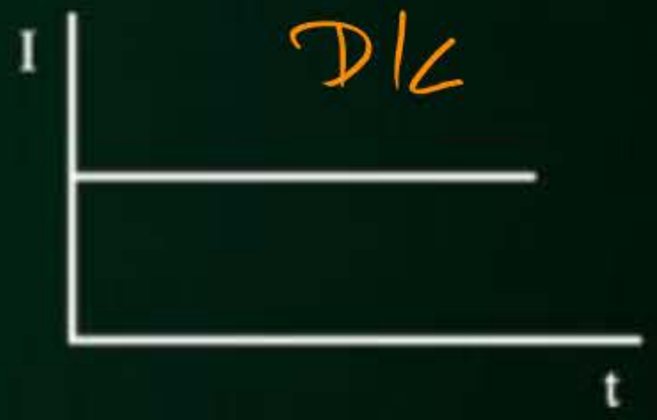


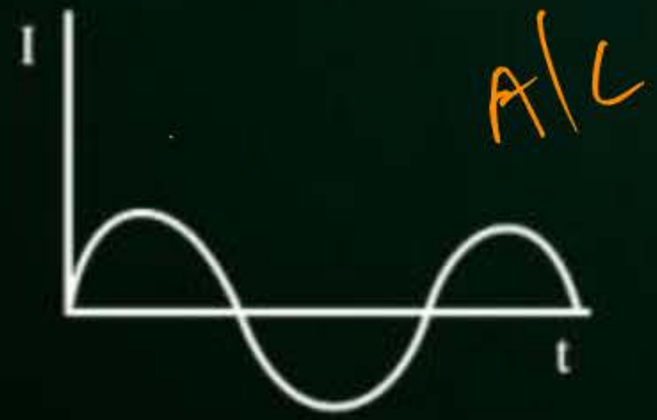
ALTERNATING CURRENT

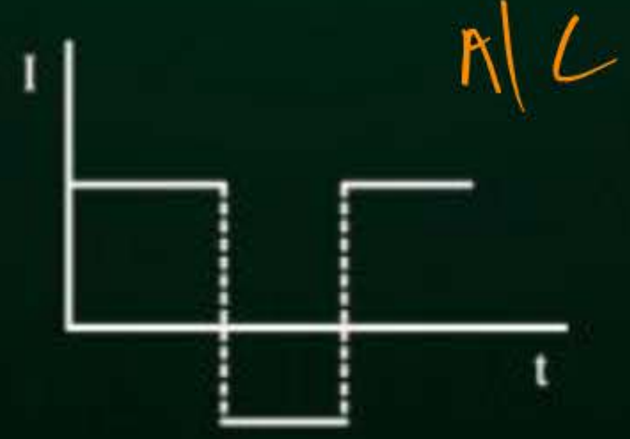
A/C → Bi-directional
D/C → Uni-diretio

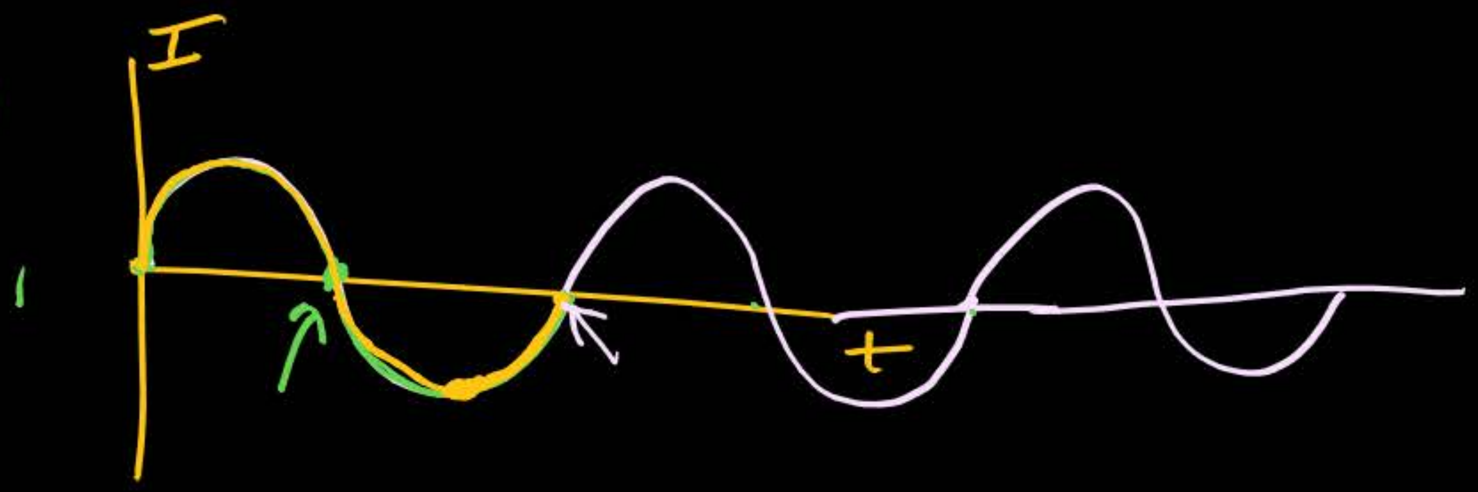












frequency of D/C → $f = 0$

frequency of A/C → Ex- $f = 100Hz$ → 100 oscillation per sec → dir^n change 200 per sec

$$f = \frac{1}{T}$$

Let → $f = 50Hz$

then dir^n will change 100 times in one sec.

↳ hence Bulb will 100 बार जलेगा 100 बंद होगा

220V A/C & 220V D/C which is more dangerous.

(a) A/C

→ r.m.s voltage = 220V = $\frac{V_0}{\sqrt{2}}$

$V_0 = 220 \times \sqrt{2} = 311V$

(B) D/C ↳ $V = 220V$ D/C

for D/C

PW my card

copy NTA

Disadvantage of D/C:

1. D/C can't be supply over large distance.
2. Power loss is maximum in transmission.
3. D/C supply at constant voltage.

$I_{D/C} \propto r^{3/2}$ cross-section Area

$I_{A/C} \propto$ surface Area

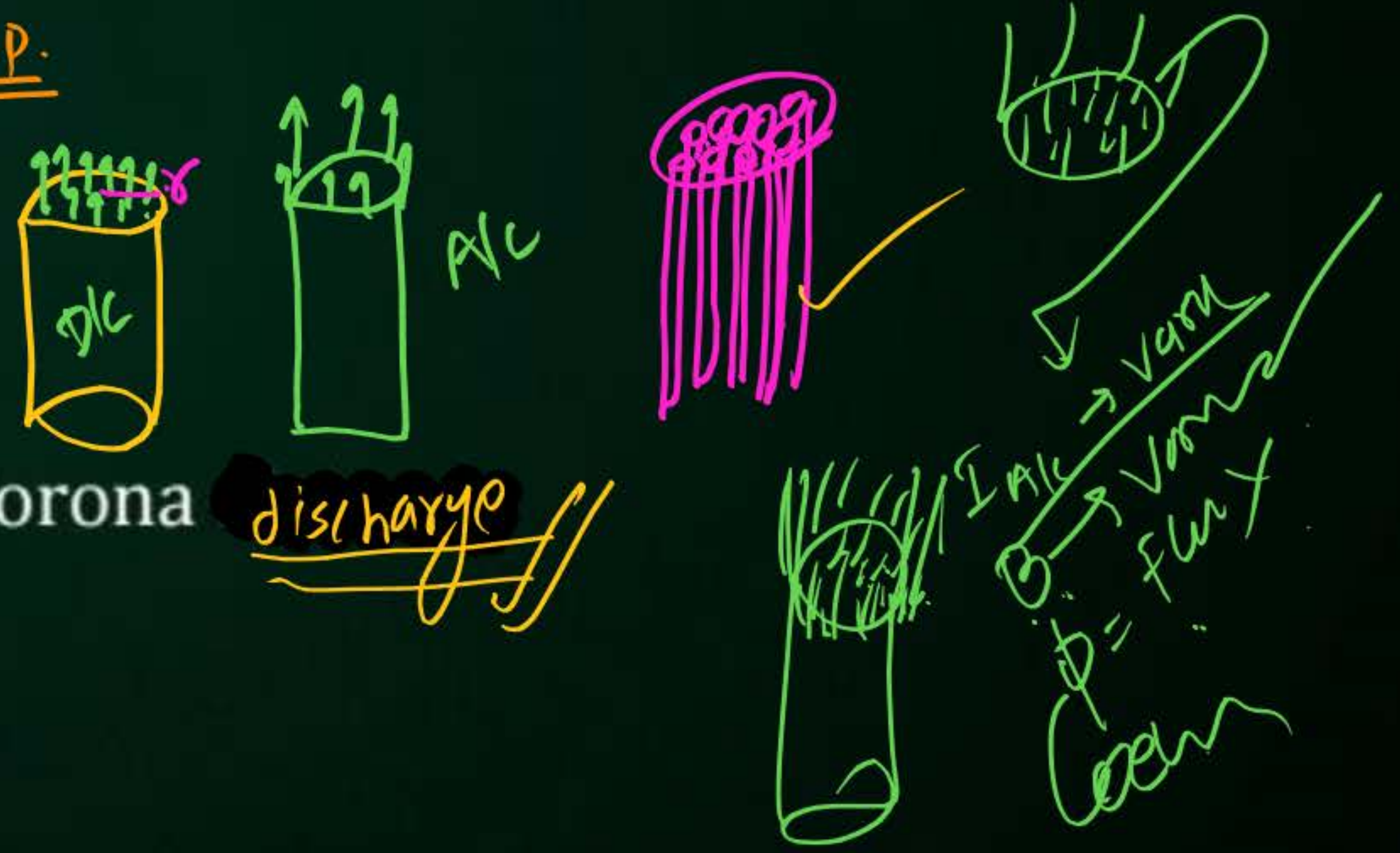
4. Disadvantage of A/C → Skin effect and Corona discharge

(1) But A/C can be supply over large distance.
(2) Low maintainice
(3) A/C can be step up or step down → A/C (using Transformer)

High maintainence

D/C can't be step-up or step-up.

(Surface)





I D/C → Cross Sectn Area

not A/C



I A/C → Surface Area

AC and DC both can flow

multiple wire

Moving coil galvanometer	Hot-wire ammeter
Torque on current carrying coil	Heat loss
Only D/C can be measure	AC/DC both can be measured
$\theta \propto I$	$H \propto \theta \propto I^2$
Linear scale	Non-linear scale

Working based on

$H = I^2Rt \propto \theta$

$I^2 \propto \theta$

→ A/c can't be masurured by moving coil galvanometre.
due to Inertia



A/c curent



Avg. value (discreate value)

$$\langle I \rangle = \frac{I_1 + I_2 + I_3 + I_4}{4}$$

Avg. value (continous value)

Ex $I = 2t$

$$\langle I \rangle_{time} = \frac{\int I\,dt}{\int dt}$$

(Q) $I_1 = 2A$ $I_2 = 3A$ $I_3 = 4A$ $I_4 = 1A$ $I_5 = 0A$

find Avg. current

$$\langle I \rangle = \frac{2+3+4+1+0}{5}$$

$$= \frac{10}{5} = 2\,Amp$$

find Avg current in 2-sec if $I = 2t$.

$$\langle I \rangle = \frac{\int I\,dt}{\int dt} = \frac{\int_0^2 2t\,dt}{\int_0^2 dt} = \frac{\left(2\frac{t^2}{2}\right)_0^2}{(t)_0^2}$$

$$= \frac{4-0}{2-0}$$

$$= \frac{4}{2} = 2\,Amp$$

QUESTION

If I = 2t + 3, find average current in 2 sec and current at t = 2 sec.

instantaneous current at $t = 2$ sec

$I = 2t + 3$

$I = 2 \times 2 + 3 = 4 + 3 = 7A$

$$\langle I \rangle_{(0 \text{ to } 2\text{ sec})} = \frac{\int_0^2 I\,dt}{\int_0^2 dt}$$

$$= \frac{\int_0^2 (2t+3)\,dt}{\int_0^2 dt} = \frac{\left(\frac{2t^2}{2} + 3t\right)_0^2}{(t)_0^2} = \frac{(4-0) + (3 \times 2 - 0)}{2-0} = \frac{10}{2} = 5A$$

MR*

linear variable

$$\langle I \rangle_{Avg} = \frac{I_i + I_f}{2} = \frac{3+7}{2} = \frac{10}{2} = 5A$$

R.M.S. current → (effective current) | virtual current

→ Reading of Ammeter

→ AC current = 2 A

↑ rms

Root ← mean ← square

Avg.

Heat ∝ I^2

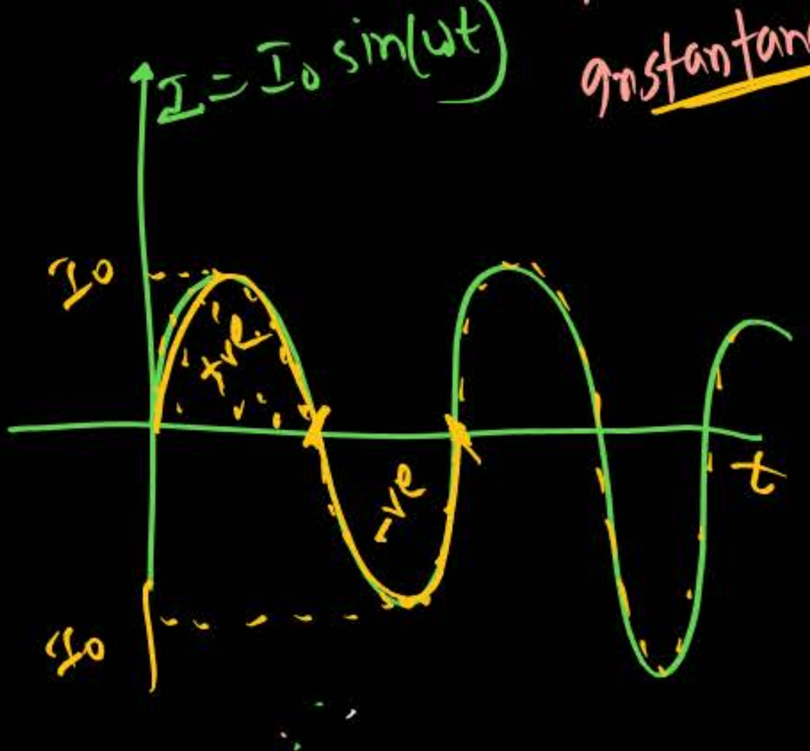
$I = I_0 \sin(\omega t + \phi)$

Peak current

Instantaneous curr.

$I_{rms} = \sqrt{\langle I^2 \rangle}$

I_{rms} = root mean squr curr $= \sqrt{\langle I^2 \rangle}$



$\langle I \rangle_{Avg}$ full cycle $= 0$

$\langle I \rangle_{r.m.s.}$

QUESTION

If $I = 2t$, then find rms current in 2 sec.

squre

$I^2 = 4t^2$

$$\langle I^2 \rangle = \frac{\int_0^2 I^2\,dt}{\int_0^2 dt} = \frac{\int_0^2 4t^2\,dt}{\int_0^2 dt} = \frac{4\left(\frac{t^3}{3}\right)_0^2}{(t)_0^2} = \frac{4(2^3-0)}{3(2-0)} = \frac{4\times 8}{3\times 2} = \frac{16}{3}$$

$$I_{rms} = \sqrt{\langle I^2 \rangle} = \sqrt{\frac{16}{3}} = \frac{4}{\sqrt{3}}\ A$$

ALTERNATING CURRENT

$I = I_0 \sin(\omega t + \phi)$ ✓

I_0 = Maximum Current ✓

I = Instantanous Current ✓

ω = Angular frequency ✓

ϕ = Phase difference ✓

[redacted]

r.m.s

full cycle

(1) $\langle \sin(\omega t)\rangle_{\text{full cycle } (0-T)} = 0$

(2) $\langle \cos(\omega t)\rangle_{\text{full cyc}} = 0$

(3) $\langle \sin(2\omega t)\rangle_{\text{full cy}} = 0$

(4) $\langle 2\sin(\omega t)\cos(\omega t)\rangle = 0$

full cycle

0 — T

$T/4 \rightarrow 5T/4$

$\langle \sin\omega t\rangle_{\text{Half cycle } 0-T/2} = \frac{2}{\pi}$

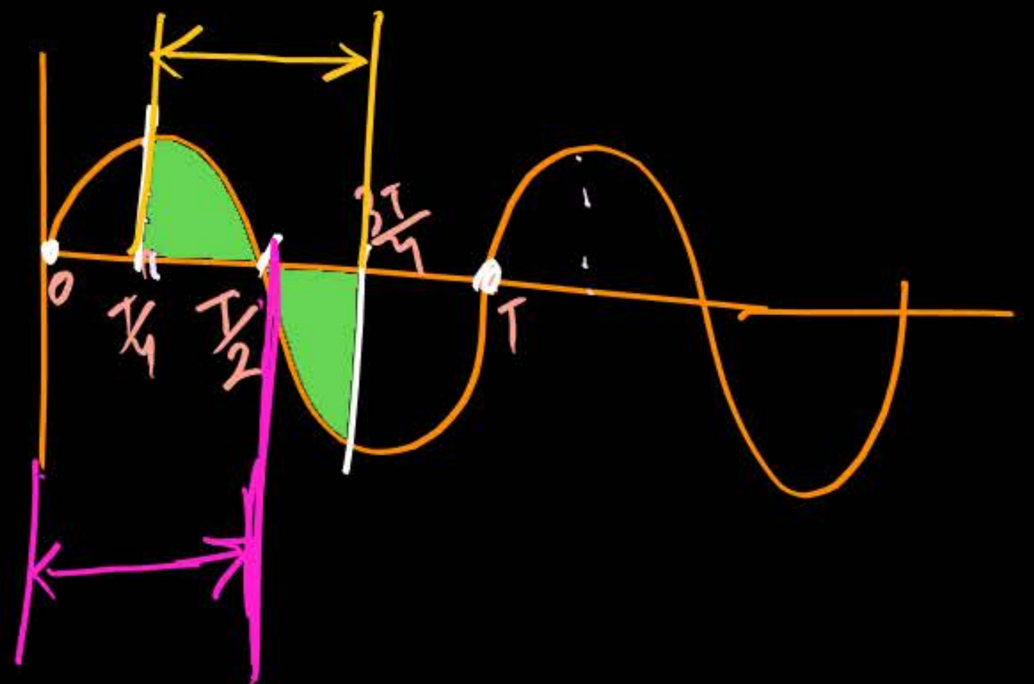
$$\langle \sin(\omega t)\rangle = \frac{\int_0^{T/2}\sin(\omega t)\,dt}{\int_0^{T/2}dt} = \frac{-\cos(\omega t)\big|_0^{T/2}}{\omega \times (t)\big|_0^{T/2}}$$

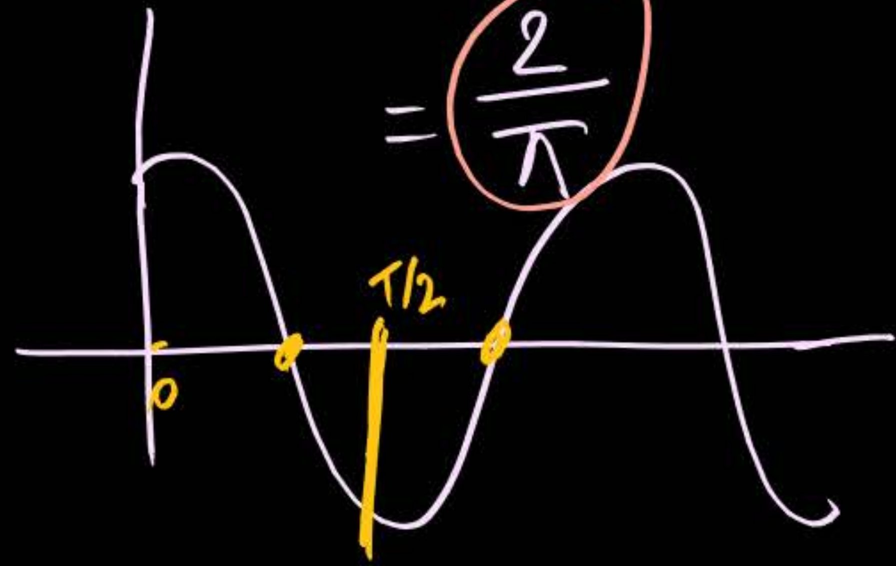
$$= \frac{-\left\{\left[\cos\left(\frac{2\pi}{T}\times\frac{T}{2}\right)\right] - \left[\cos 0\right]\right\}}{\frac{2\pi}{T}\times\frac{T}{2}}$$

$$= \frac{-(-2)}{\pi}$$

$$= \frac{2}{\pi}$$

$\langle \cos(\omega t)\rangle_{\text{Half cy}} = \frac{2}{\pi}$



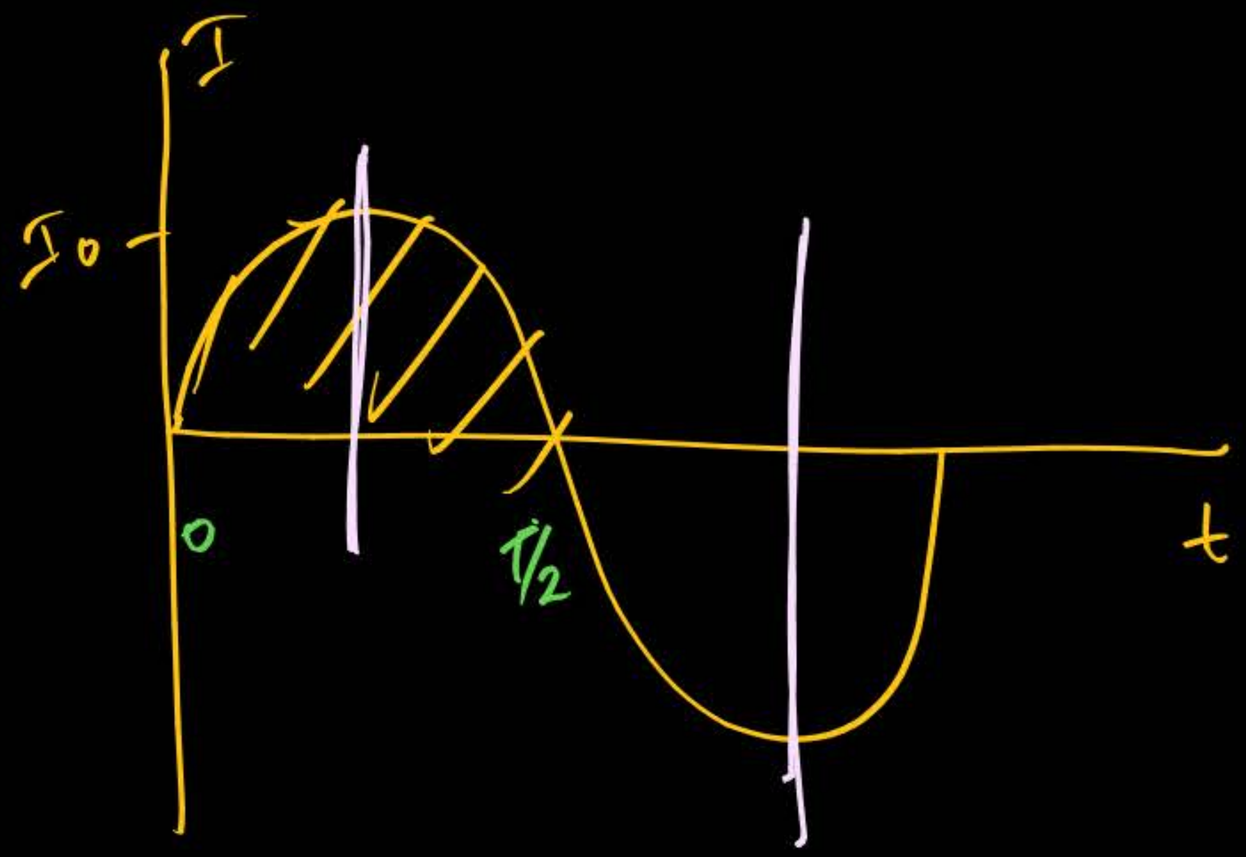


(Q) $I = I_0 \sin(\omega t)$

Avg cycle me Avg val

(a) zero (b) $\frac{2I_0}{\pi}$ (c) $\frac{I_0}{\pi}$ (d) Both (a) & (b)

Ans (d)



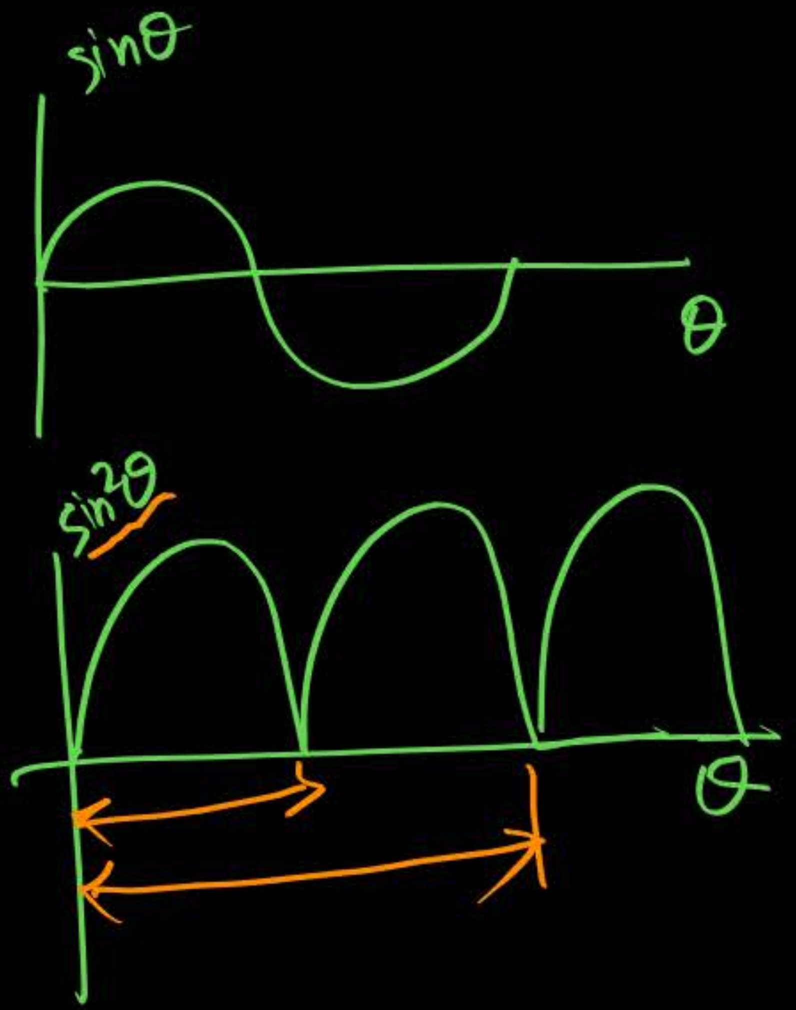
$$\langle \sin^2(\omega t)\rangle_{\text{full cycle}} = \langle \sin^2(\omega t)\rangle_{\text{Half cycle}} = \frac{1}{2}$$

$$I = I_0 \sin(\omega t)$$

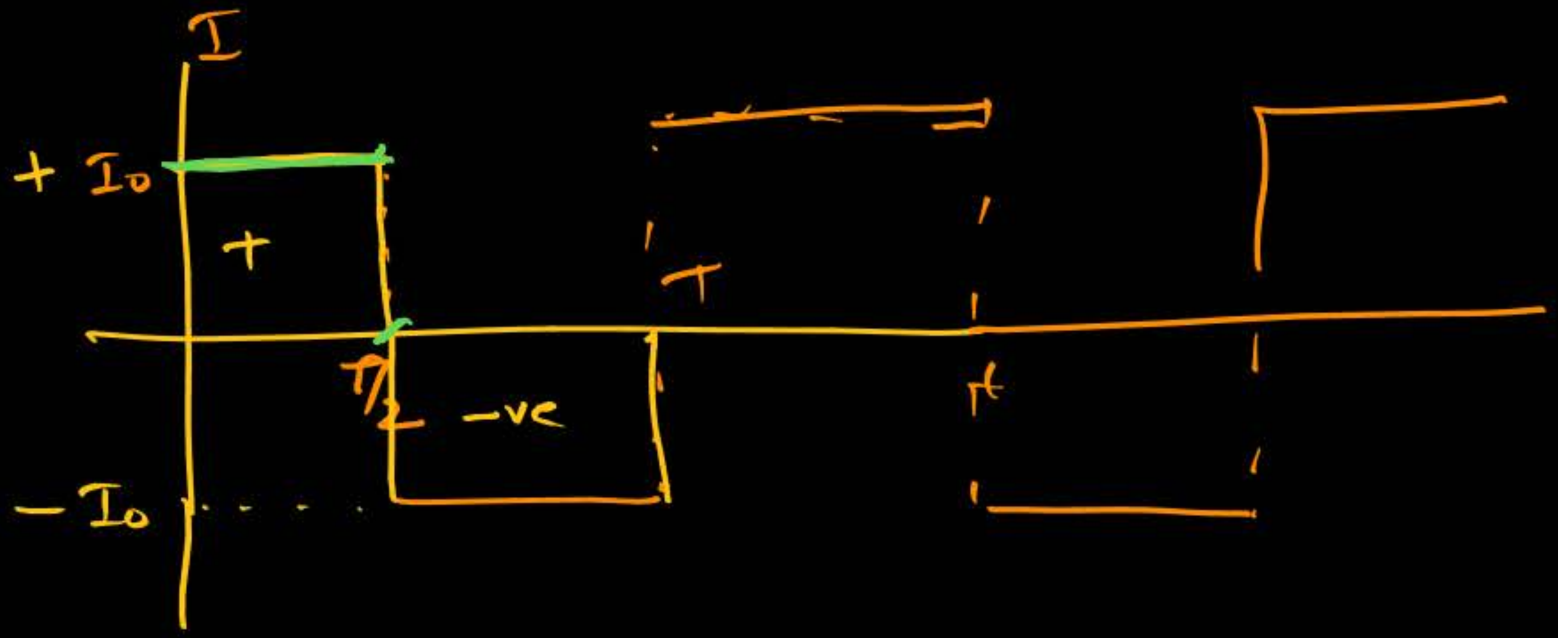
$$\langle I\rangle_{\text{full cycle}} = \langle I_0 \sin(\omega t)\rangle = I_0 \langle \sin(\omega t)\rangle_{\text{full cycle}} = 0$$

$$\langle I\rangle_{\text{Half cycle}} = I_0 \langle \sin(\omega t)\rangle_{\text{Half}} = \frac{2I_0}{\pi} \text{ or zero.}$$

$$I_{r.m.s} = \sqrt{\langle I_0^2 \sin^2(\omega t)\rangle_{\text{full cycle}}} = I_0\sqrt{\langle \sin^2(\omega t)\rangle} = I_0\sqrt{\frac{1}{2}} = \frac{I_0}{\sqrt{2}}$$



Square wave AC

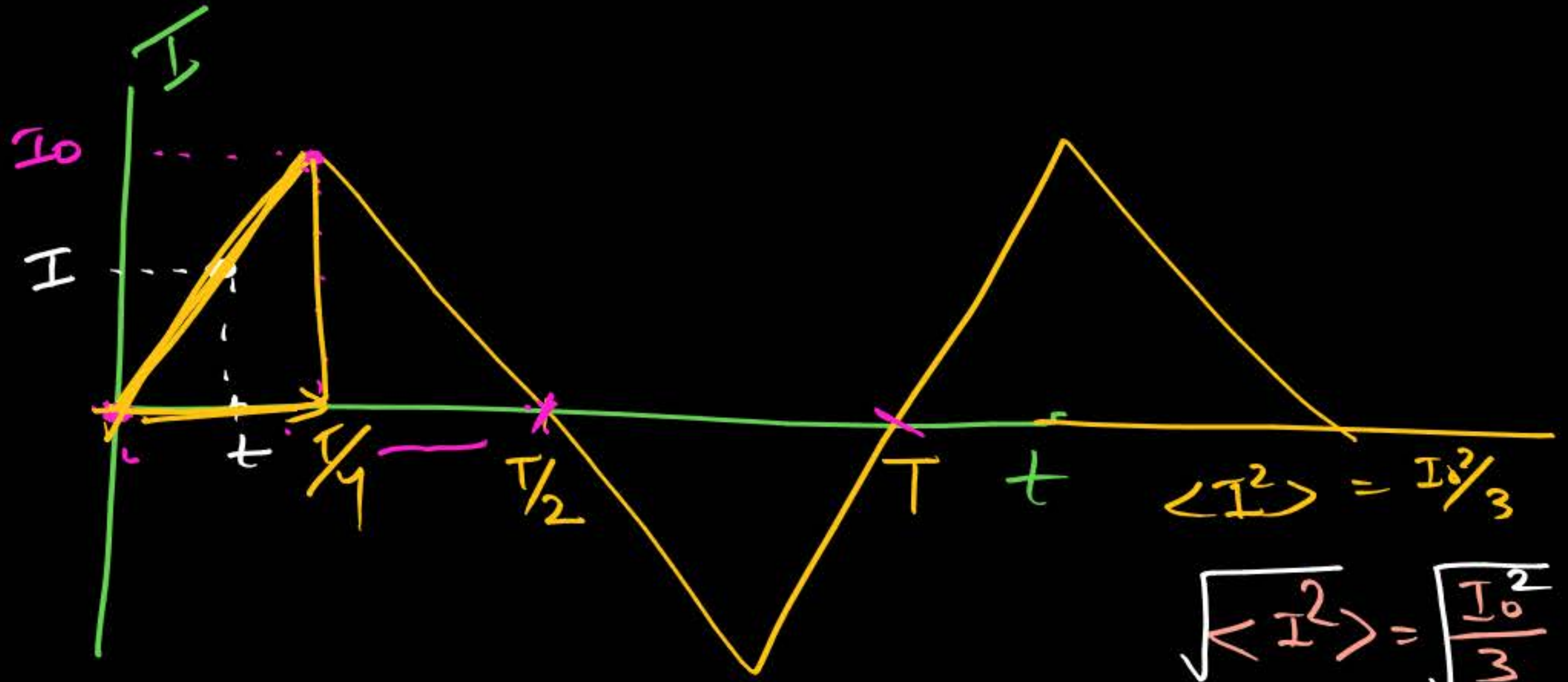


$$\langle I \rangle_{\text{full cycle}} = 0$$

$$\langle I \rangle_{\text{Half cycle}} = I_0$$

$$\langle I \rangle_{\text{rms}} = I_0$$

Triangular A/C



$$y = mx + c$$

$$I = \frac{I_0}{T/4} t + 0$$

$$\boxed{I = \frac{4 I_0}{T} t} \checkmark$$

Square

$$I^2 = \frac{16 I_0^2}{T^2} t^2$$

Avg

$$\langle I^2 \rangle = \frac{\frac{16 I_0^2}{T^2} \int_0^{T/4} t^2 \, dt}{\int_0^{T/4} dt}$$

$$= \frac{\frac{16 I_0^2}{T^2} \times \left[\frac{t^3}{3}\right]_0^{T/4}}{(T/4)}$$

$$= \frac{4 \times 16 I_0^2 \, T^3}{3 T^2 \times T \times 64}$$

$$\langle I^2 \rangle = \frac{I_0^2}{3}$$

$$\langle I^2 \rangle = \frac{I_0^2}{3}$$

$$\sqrt{\langle I^2 \rangle} = \sqrt{\frac{I_0^2}{3}}$$

$$\boxed{I_{rms} = \frac{I_0}{\sqrt{3}}}$$

$$\boxed{\langle I_{r.m.s} \rangle = \frac{I_0}{\sqrt{3}}}$$

(#) $\langle I \rangle_{\text{full cycle}} = 0 = \frac{\int I \, dt}{\int dt}$

MR* $\langle I \rangle_{\text{Half cycle}} = \frac{I_0}{2}$

QUESTION

The voltages of domestic ac is 220 V. What does this represent?

1. Mean voltage
2. Peak voltage
3. Root mean voltage
4. Root mean square voltage

2220V, 100Hz

R.m.s voltage

QUESTION

The equation of an alternating voltage is $V = 100\sqrt{2}\ \sin 100\pi t$ volt. The RMS value of voltage and frequency will be respectively

1. 100 V, 50 Hz
2. 50 V, 100 Hz
3. 150 V, 50 Hz
4. 200 V, 50 Hz

$V = V_0 \sin(\omega t)$

$\omega = 100\pi = 2\pi f$

$50 = f$

$V_0 = 100\sqrt{2}$

$V_{rms} = \frac{V_0}{\sqrt{2}} = \frac{100\sqrt{2}}{\sqrt{2}} = 100\,V$

$I = I_0 \sin(\omega t)$

$V = V_0 \cos(\omega t)$



QUESTION

Equation of alternating current is given by $I = 10\sqrt{2}\sin\left(100\pi t + \frac{\pi}{6}\right)$. The time taken by current to reach the root mean square value from $t = 0$ is t then the value of t is

1. $\frac{1}{1200}s$
2. $\frac{1}{250}s$
3. $\frac{1}{200}s$
4. $\frac{1}{800}s$

$I = 10\sqrt{2}\sin\left(100\pi t + \frac{\pi}{6}\right)$

$\frac{10\sqrt{2}}{\sqrt{2}} = 10\sqrt{2}\sin\left(100\pi t + \pi/6\right)$

$\frac{1}{\sqrt{2}} = \sin\left(100\pi t + \pi/6\right)$

$100\pi t + \frac{\pi}{6} = \frac{\pi}{4}$

$100 t = \frac{1}{4} - \frac{1}{6} = \frac{1}{12}$

$t = \frac{1}{1200}$

QUESTION

In the AC circuit, the current is expressed as $I = 100 \sin 200\pi t$. In this circuit the current rises from zero to peak value in time

1. $\frac{1}{400} s$
2. $\frac{1}{300} s$
3. $\frac{1}{100} s$
4. $\frac{1}{200} s$

$100 = 100 \sin(200\pi t)$

$1 = \sin(200\pi t)$

$200\pi t = \frac{\pi}{2}$

$t = \frac{1}{400}$

QUESTION

The phase difference between current and voltage in an AC circuits is $\frac{\pi}{4}$ radian. If the frequency of AC is 50 Hz, then the phase difference is equivalent to the time difference of

1. 0.75 s
2. 10.5 ms
3. 2.5 ms
4. 0.25 ms

$f = \frac{1}{T}$

$\Delta\phi = \frac{\pi}{4}$

$\frac{(\Delta\phi)}{2\pi} = \frac{(\Delta x)}{\lambda} = \frac{(\Delta t)}{T}$

$\frac{\Delta\phi}{2\pi} = \frac{\Delta t}{T}$

QUESTION

Hot wire ammeters are used for measuring

1. Both AC and DC
2. Only AC
3. Only DC
4. Neither AC nor DC

QUESTION

In alternating current circuits, the a.c. meters measure

1. r.m.s. value
2. Peak value
3. Mean value
4. Mean square value

QUESTION

The peak value of an alternating e.m.f. $E = E_0 \sin \omega t$ is 10 volt and its frequency is 50 Hz. At a time $t = \frac{1}{600}$ s the instantaneous value of the e.m.f. is

1. 1 volt
2. $5\sqrt{3}$ volt
3. 5 volt
4. 10 volt

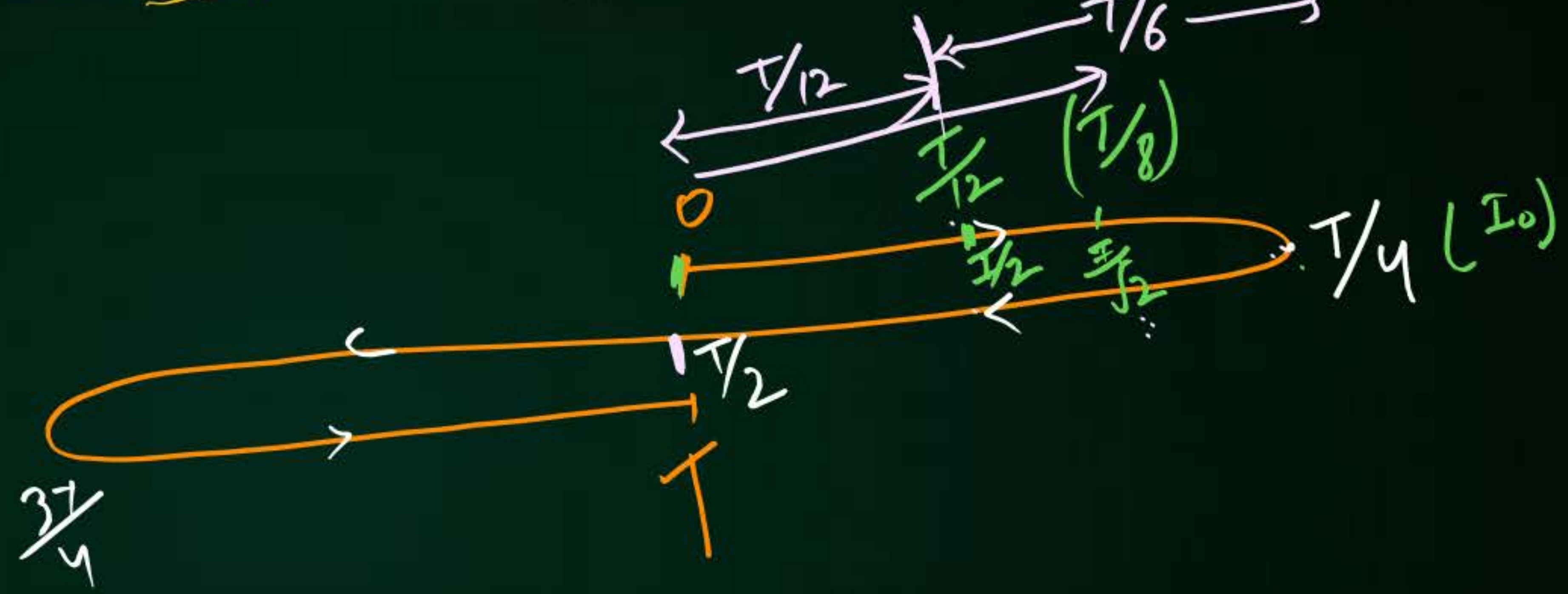
$\omega = 2\pi f$
$= 2\pi \times 50$

$E = 10 \sin(100\pi t)$
$= 10 \sin\left(100\pi \times \frac{1}{600}\right)$
$= 10 \sin\left(\frac{\pi}{6}\right)$
$E = 10 \times \frac{1}{2} = 5$ volt

QUESTION

The time required for a 50 Hz sinusoidal alternating current to change its value from zero to the r.m.s. value

$T = \frac{1}{f}$



1. 1.5×10^{-2} s
2. 2.5×10^{-3} s
3. 10^{-1} s
4. 10^{-6} s

$t = \frac{T}{8} = \frac{1}{50 \times 8}$

- If I = 10 sin $(\omega t + \frac{\pi}{6})$ then find Avg. Current.

Paltu sir ??

$\langle I \rangle_{\text{full cycle}} = 0$

$\langle I \rangle_{\text{half cycle}} = \frac{2 \times 10}{\pi}$

$\langle I \rangle_{\text{rms}} = \frac{10}{\sqrt{2}}$

QUESTION

If current $I = I_0 \sin(\omega t)$ then find average value in half circle?

1. Zero
2. $\frac{I_0}{\pi}$
3. $\frac{2I_0}{\pi}$
4. Both (1) and (3)

(Q) $I = 4 + 5\sin(\omega t)$

current → A/C + D/C mix.

$< I >_{\text{Full cycle Avg}} = \langle 4 + 5\sin(\omega t) \rangle = \langle 4 \rangle + 5\langle \sin(\omega t) \rangle_{full}$ (→ 0)

$= 4$ Amp

$< I >_{\text{Half cycle}} \Rightarrow \langle 4 + 5\sin(\omega t) \rangle = \langle 4 \rangle + 5\langle \sin(\omega t) \rangle$

$= 4 + 5 \times \frac{2}{\pi} = 4 + \frac{10}{\pi}$ ✓

$\sqrt{< I^2 >}_{\text{R.M.S}}$ full →

$I^2 = 4^2 + 2 \times 4 \times 5 \sin(\omega t) + 25\sin^2(\omega t)$

$\langle I^2 \rangle = \langle 16 \rangle + 40\langle \sin(\omega t) \rangle_{full} + 25\langle \sin^2(\omega t) \rangle$ (→ 0)

$\langle I^2 \rangle = 16 + \frac{25}{2}$

$I_{rms} = \sqrt{\langle I^2 \rangle} = \sqrt{16 + \frac{25}{2}}$

$$I = I_1 + I_2 \sin(\omega t) \quad (AC + DC)$$

$$I_{rms} = \sqrt{I_1^2 + \frac{I_2^2}{2}}$$

$$I = I_1 \sin(\omega t) + I_2 \cos(\omega t)$$

$$I_{rm} = \frac{\sqrt{I_1^2 + I_2^2}}{\sqrt{2}}$$

$$= \sqrt{\frac{I_1^2 + I_2^2}{2}}$$

QUESTION

An alternating current is given by $I = I_1 \cos \omega t + I_2 \sin \omega t$. The RMS value of current is given by

1. $\dfrac{I_1 + I_2}{\sqrt{2}}$

2. $\dfrac{(I_1 + I_2)^2}{2}$

3. $\sqrt{\dfrac{I_1^2 + I_2^2}{2}}$

4. $\dfrac{\sqrt{I_1^2 + I_2^2}}{2}$

QUESTION

If instantaneous current in a circuit is given by $I = (2 + 3\sin\omega t)$A, then the effective value of resulting current in the circuit is

1. $\sqrt{\frac{17}{2}}$ A ✓
2. $\sqrt{\frac{2}{17}}$ A
3. $\sqrt{\frac{3}{\sqrt{2}}}$ A
4. $3\sqrt{2}$ A

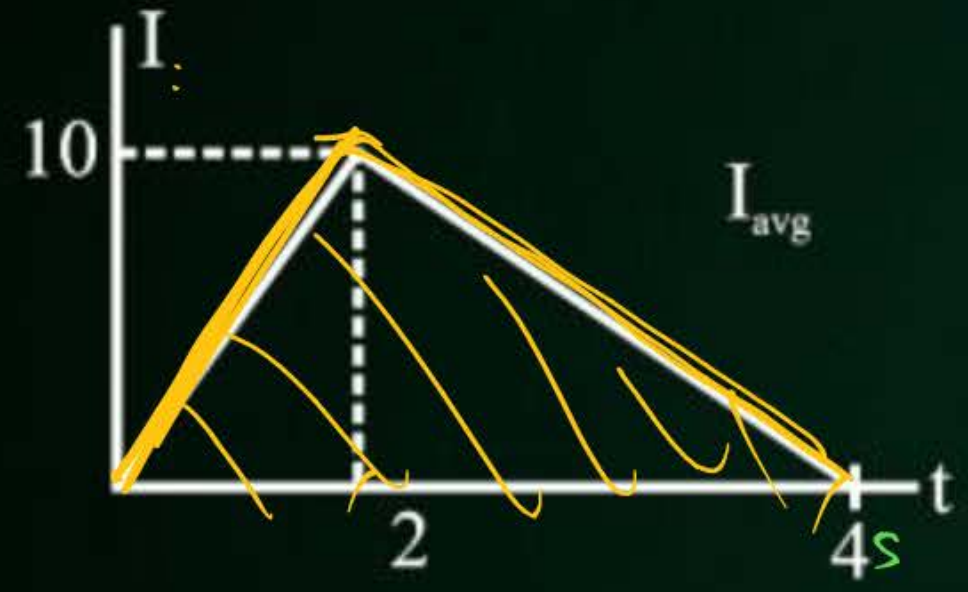
$I_{rm} = \sqrt{4 + \frac{9}{2}}$

$= \sqrt{\frac{17}{2}}$

$= \sqrt{\frac{17}{2}}$

QUESTION

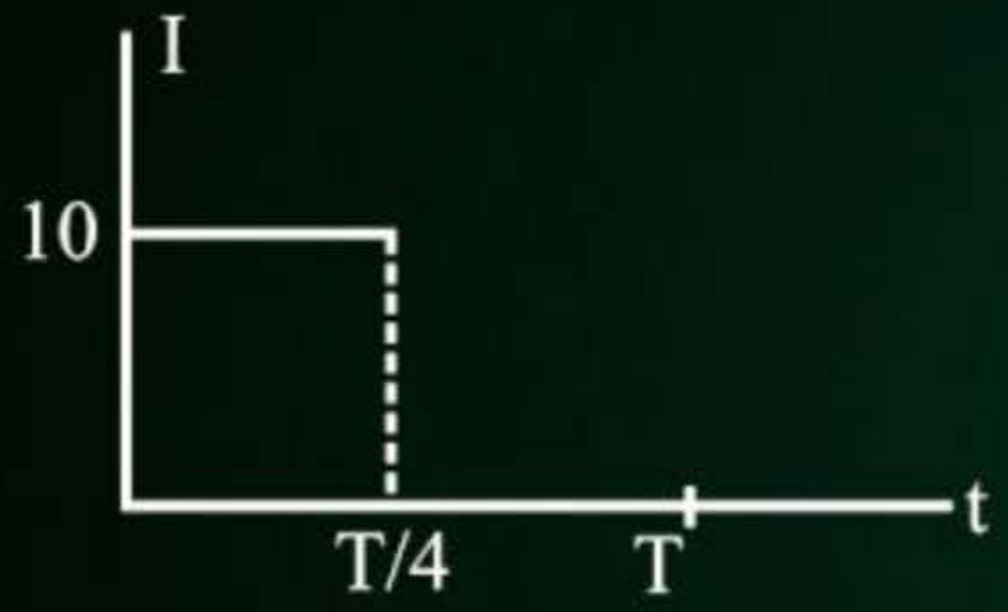
Find average current in 4 sec?



$$\langle I_{avg} \rangle = \frac{\int I\,dt}{\int_0^T dt} = \frac{\text{Area of } I\text{-}t}{T}$$

QUESTION

Find rms current in time 'T' for a given graph.



Phasor Diagram

H/W Basic

$$I_1 = 4 \sin\left(\omega t + \frac{\pi}{6}\right)$$

$$I_2 = 5 \cos\left(\omega t - \frac{\pi}{3}\right)$$

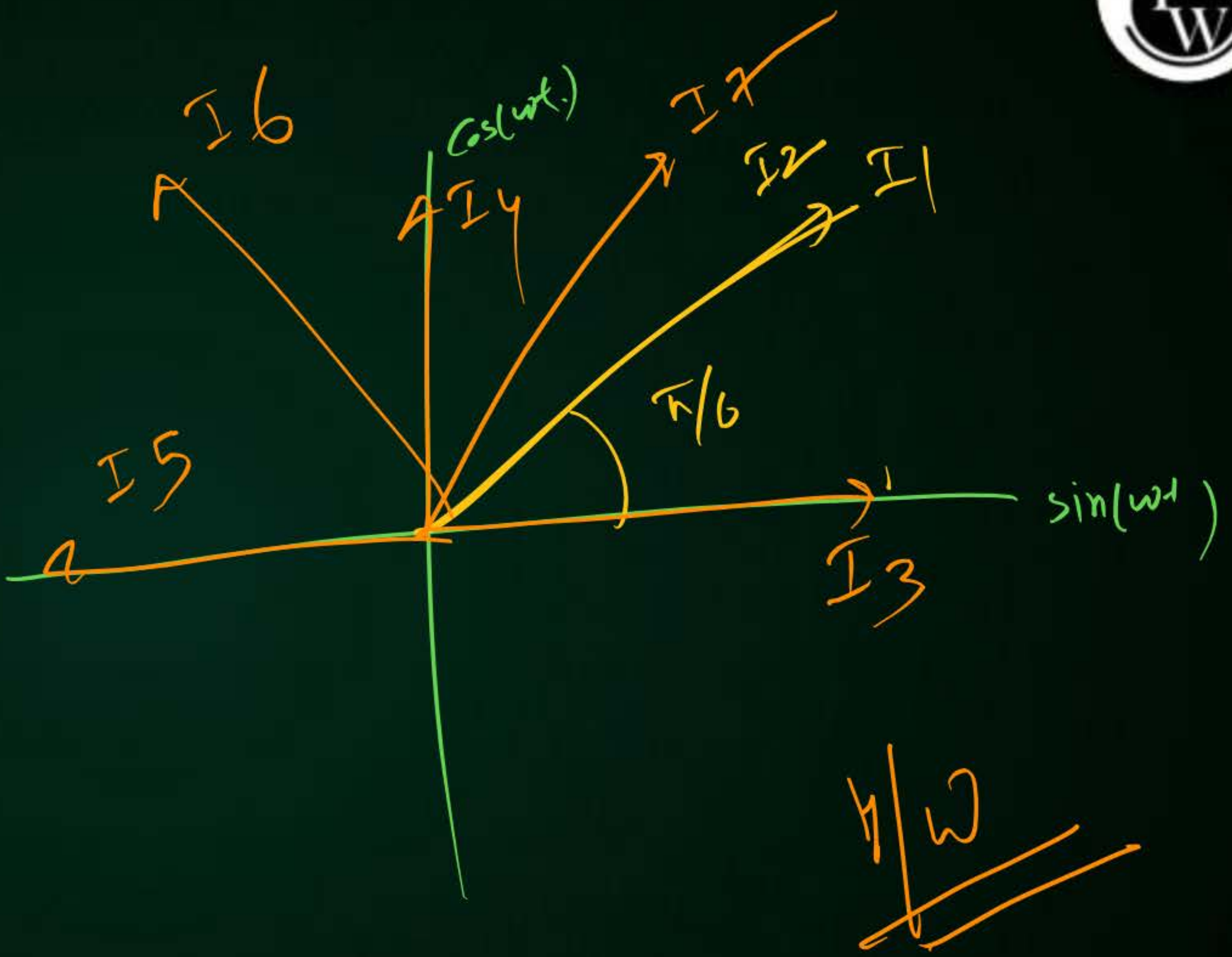
$$I_3 = 4 \cos\left(\omega t - \frac{\pi}{2}\right)$$

$$I_4 = 3 \cos(\omega t)$$

$$I_5 = -4 \sin(\omega t)$$

$$I_6 = 4 \cos\left(\omega t + \frac{\pi}{3}\right)$$

$$I_7 = 3 \cos\left(\omega t - \frac{\pi}{6}\right)$$



$I_1 = 3\sin(\omega t)$

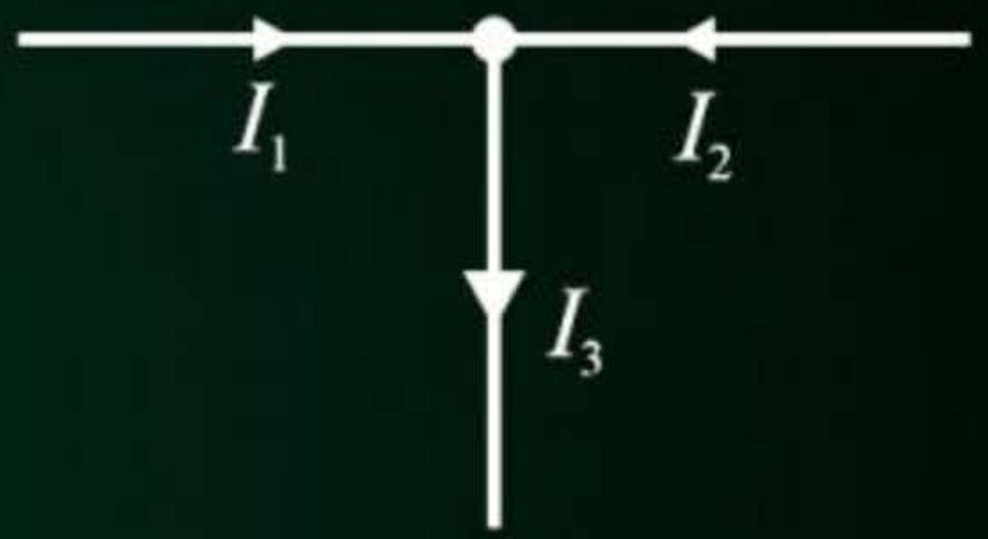
$I_2 = 3\cos\left(\omega t + \frac{\pi}{6}\right)$

$I_1 = 4\sin\left(\omega t - \frac{\pi}{6}\right)$

$I_2 = 4\cos\left(\omega t - \frac{\pi}{3}\right)$

QUESTION

If current $I_1 = 3A \sin \omega t$ and $I_2 = 4A \cos$



1. $5A \sin(\omega t + 53°)$
2. $5A \sin(\omega t + 37°)$
3. $5A \sin(\omega t + 45°)$
4. $5A \sin(\omega t + 30°)$

- **AC Source Across Pure Resistance**

- **A/C source across Pure Capacitor**

- **A/C source across Pure Inductor**

QUESTION

What is the approximate peak value of an alternating current producing four times the heat produced per second by a steady current of 2 A in a resistor?

(1) 2.8 A

(2) 4.0 A

(3) 5.6 A

(4) 8.0 A

QUESTION

Two coils have self inductance $L_1 = 4$ mH and $L_2 = 1$ mH respectively. The currents in the two coils are increased at the same rate. At a certain instant of time both coils are given the same power. If I_1 and I_2 are the currents in the two coils, at that instant of time respectively, then the value of I_1/I_2 is

1. 1/8
2. 1/4
3. 1/2
4. 1


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 02 | Physics

Alternating Current

By- Dr. Manish Raj (MR SIR)



Topics to be covered

Phasor diagram

A/c source across, R, L, C,

1. #
2. #
3. #





D/C Battery

\# $(V, f) = (20V, 50Hz)$

rms



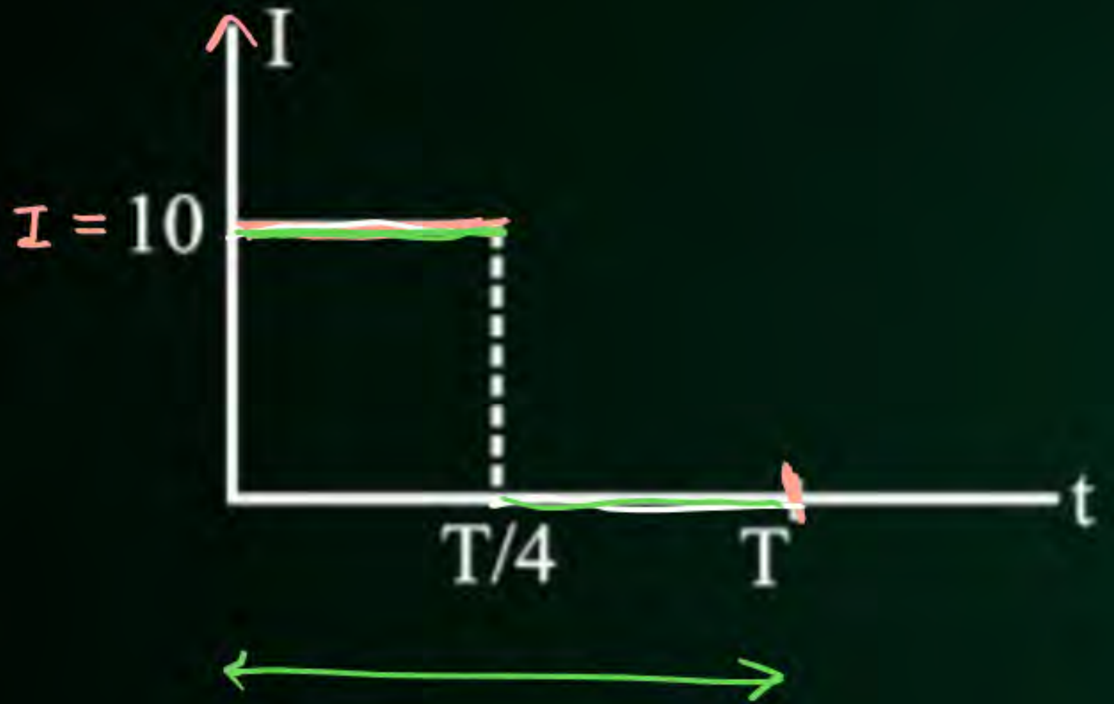
A/C Battery

\# $V = V_0 \sin(\omega t)$

Peak Voltage $\left(V_{rms} = \frac{V_0}{\sqrt{2}} \right)$ ✓

QUESTION

Find rms current in time 'T' for a given graph.



$I = 10\,Amp$ but from 0 to T/4 & $I = 0$ from $\frac{T}{4}$ to T

$I^2 = (10)^2$

$$\langle I^2 \rangle = \frac{\int_0^T I^2 dt}{\int_0^T dt} = \frac{\int_0^{T/4} I^2 dt + \int_{T/4}^{T} I^2 dt}{T}$$

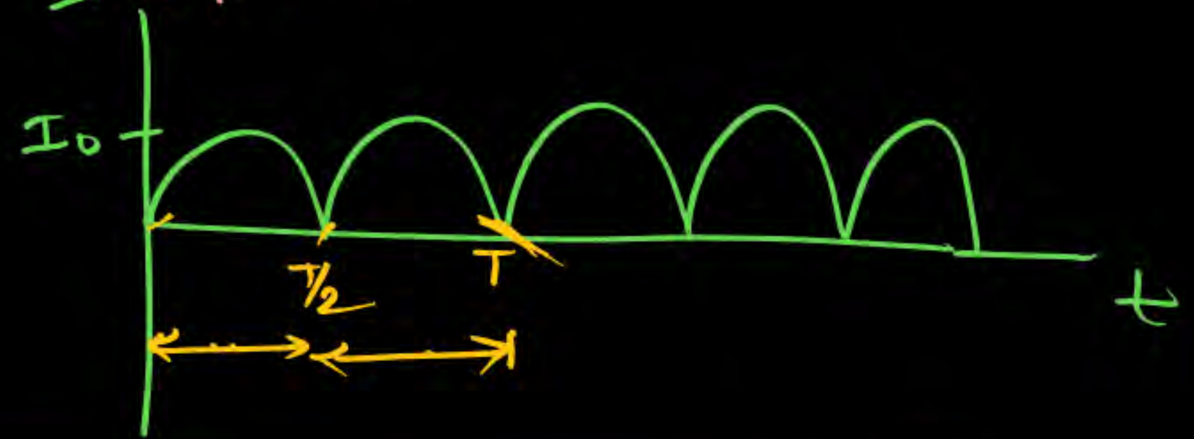
$$= \frac{100(t)_0^{T/4}}{T} = \frac{100 \times T}{4 \times T}$$

$$\langle I^2 \rangle = 25$$

$$\sqrt{\langle I^2 \rangle} = \sqrt{25} = 5\,Amp$$

full wave rectifier

$I = |\sin t|$



★ $\langle I \rangle_{full\ cycle} = \langle I \rangle_{Half\ cycle} = \frac{2I_0}{\pi}$

$I_{rms} = \frac{I_0}{\sqrt{2}}$

Half wave rectifier



$\langle I \rangle_{Half\ cycle} = \frac{2I_0}{\pi}$

$\langle I \rangle_{full\ cycle} = \frac{\frac{2I_0}{\pi} + 0}{2} = \frac{I_0}{\pi}$

$\langle I \rangle_{r.m.s} = \frac{I_0}{\sqrt{2} \times (\sqrt{2})} = \frac{I_0}{2}$

Phasor Diagram

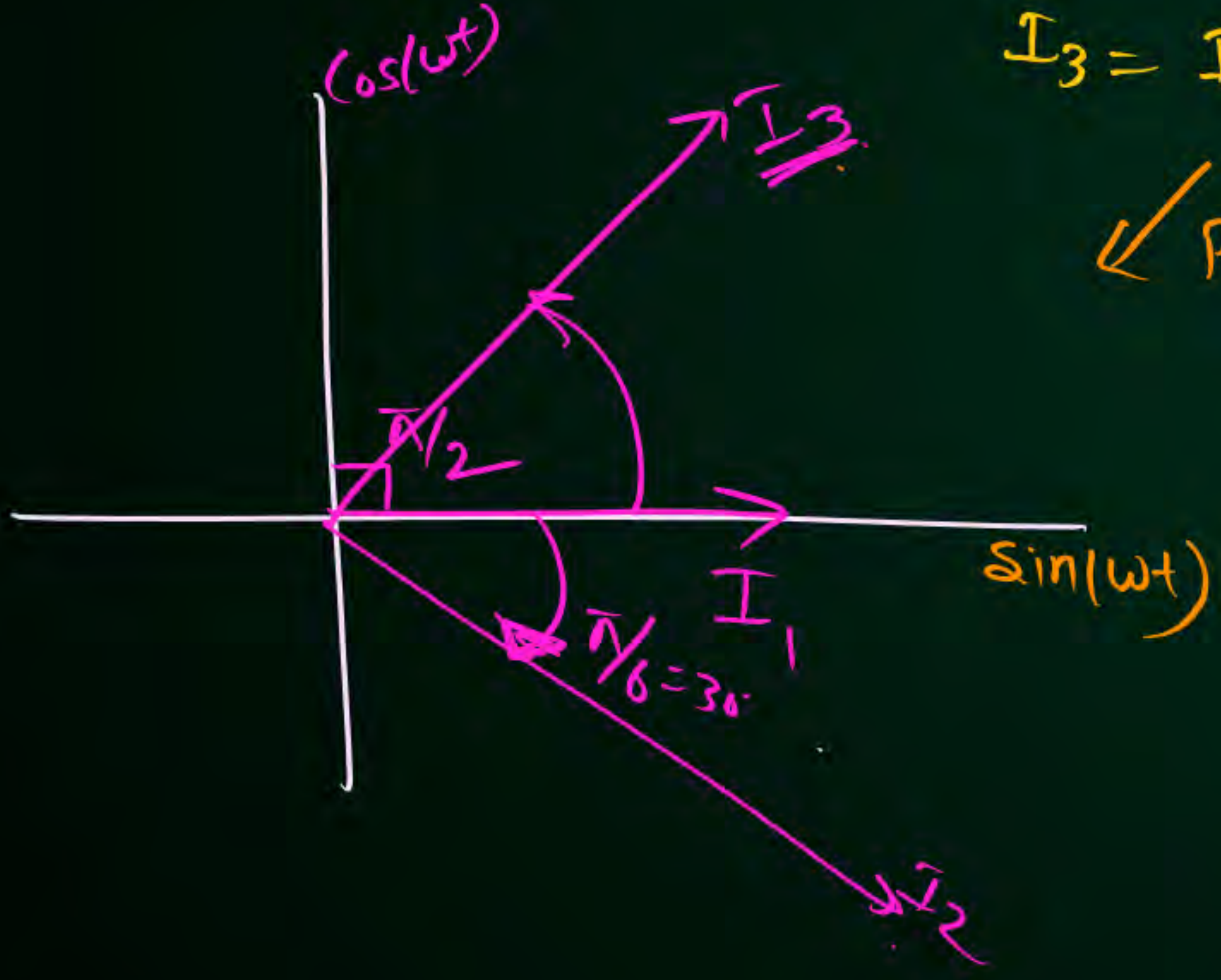
$I_1 = I_0 \sin(\omega t) = I_0 \cos(\omega t - \pi/2)$

$I_2 = I_0 \sin(\omega t - \pi/6)$

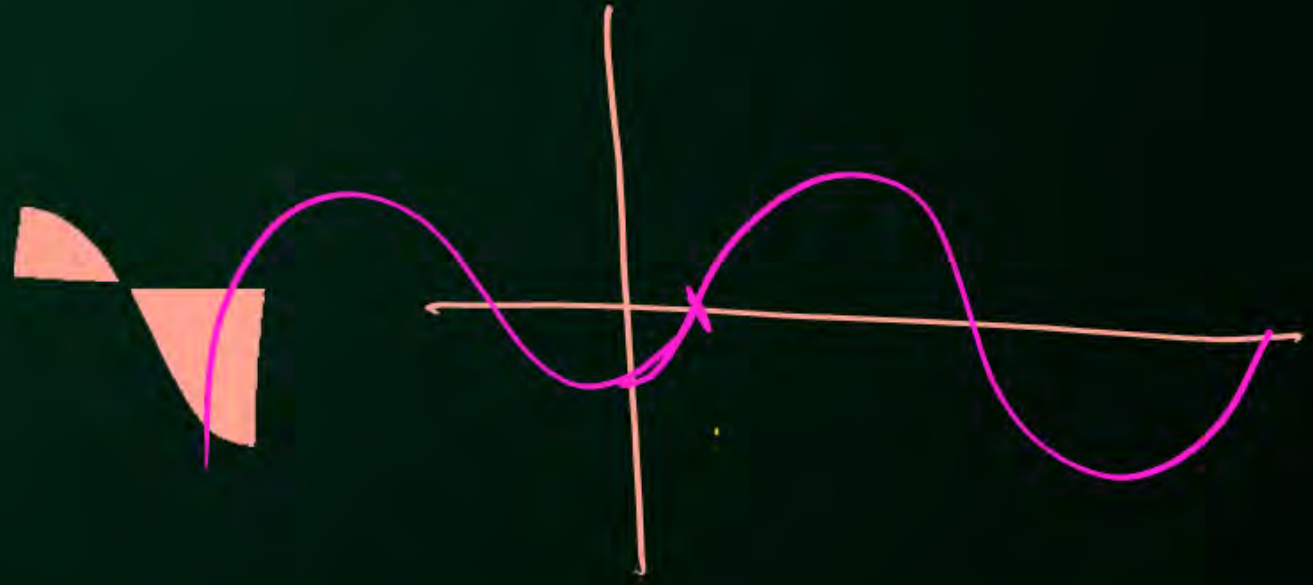
$I_3 = I_0 \sin(\omega t + \pi/6)$

→ graph

↙ Phasor diagram







$I_1 = 4\sin\left(\omega t + \frac{\pi}{6}\right)$

$I_2 = 5\cos\left(\omega t - \frac{\pi}{3}\right)$ *

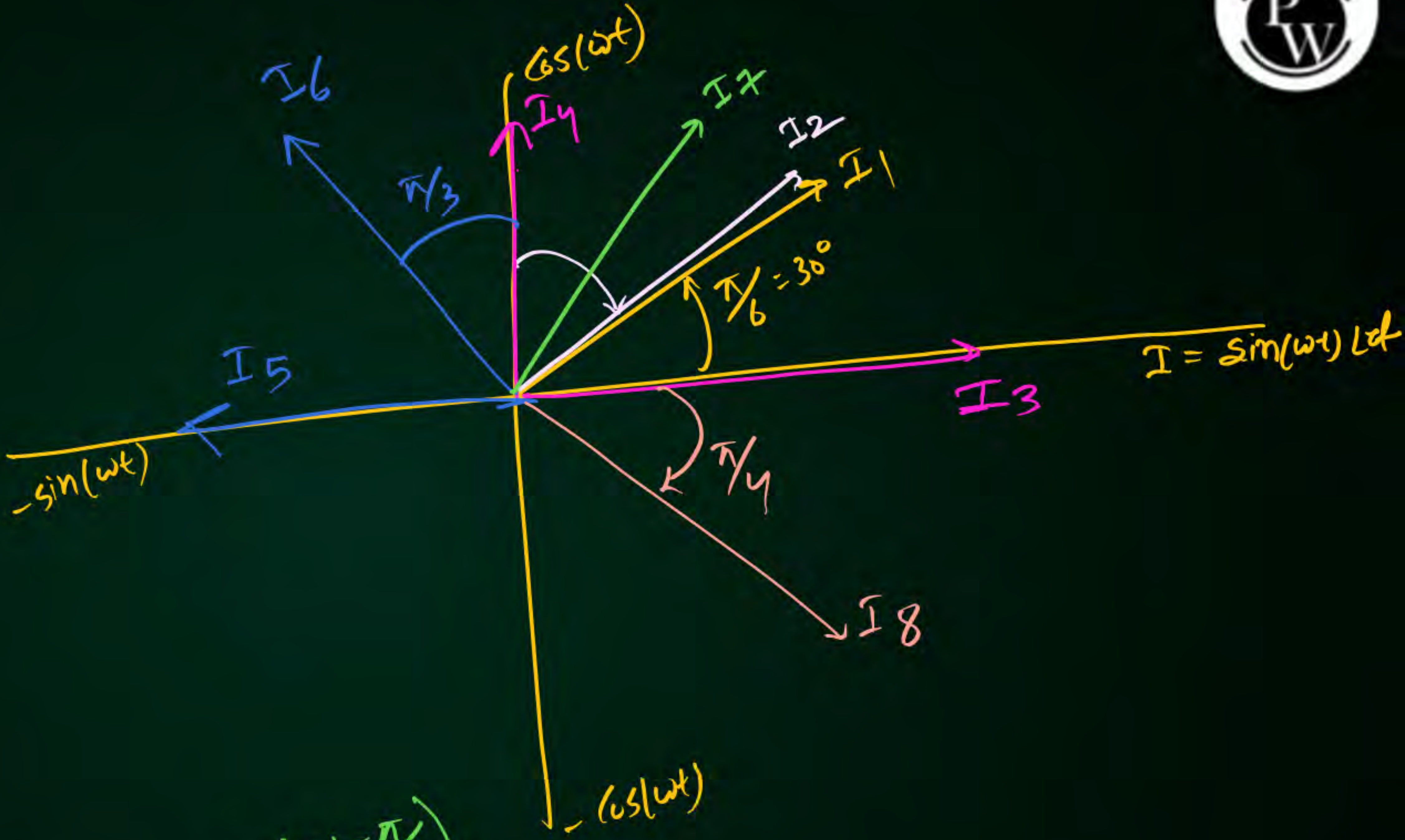
$I_3 = 4\cos\left(\omega t - \frac{\pi}{2}\right)$ *

$I_4 = 3\cos(\omega t)$

$I_5 = -4\sin(\omega t)$

$I_6 = 4\cos\left(\omega t + \frac{\pi}{3}\right)$ *

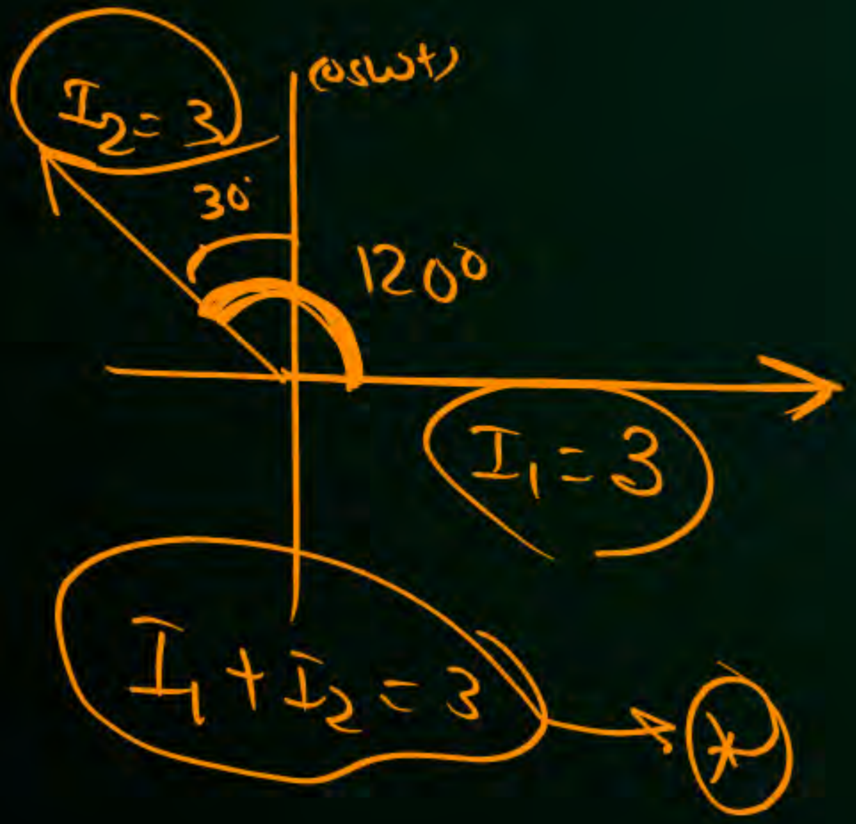
$I_7 = 3\cos\left(\omega t - \frac{\pi}{6}\right)$ $4 \cdot 30°$



$I_8 = I_0 \sin\left(\omega t - \frac{\pi}{4}\right)$

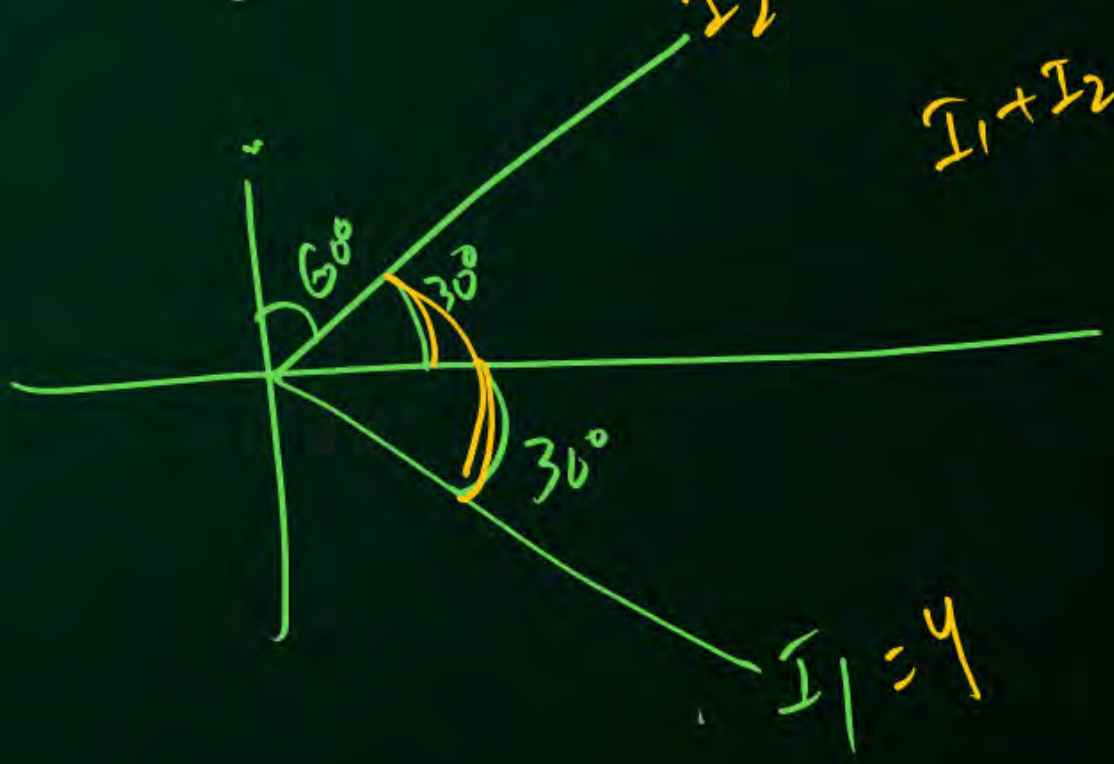
$$\begin{cases} I_1 = 3\sin(\omega t) \\ I_2 = 3\cos\left(\omega t + \frac{\pi}{6}\right) \end{cases}$$

$I = I_1 + I_2$



$$\begin{cases} I_1 = 4\sin\left(\omega t - \frac{\pi}{6}\right) \\ I_2 = 4\cos\left(\omega t - \frac{\pi}{3}\right) \end{cases}$$

Find $I_1 + I_2 = ??$

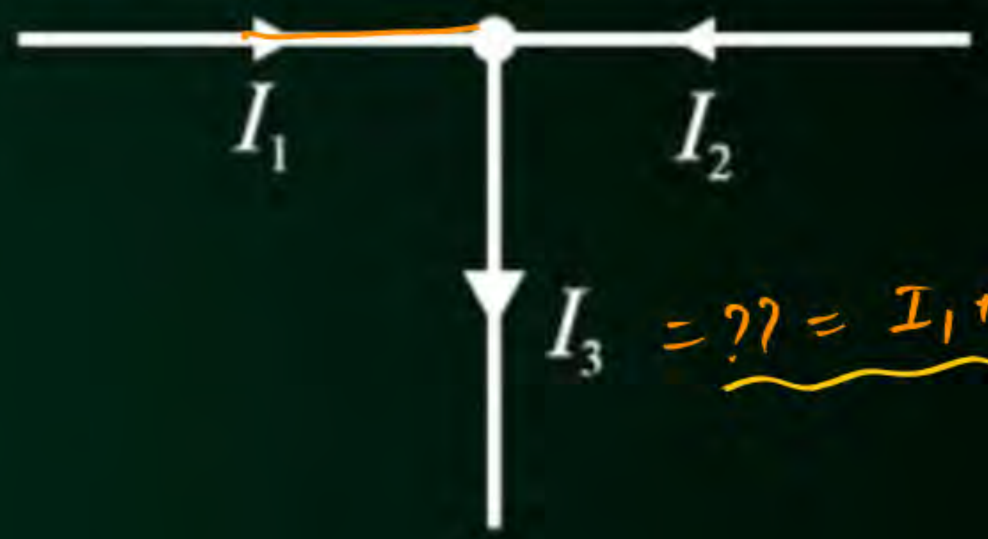


$I_1 + I_2 = 4\sqrt{3}$

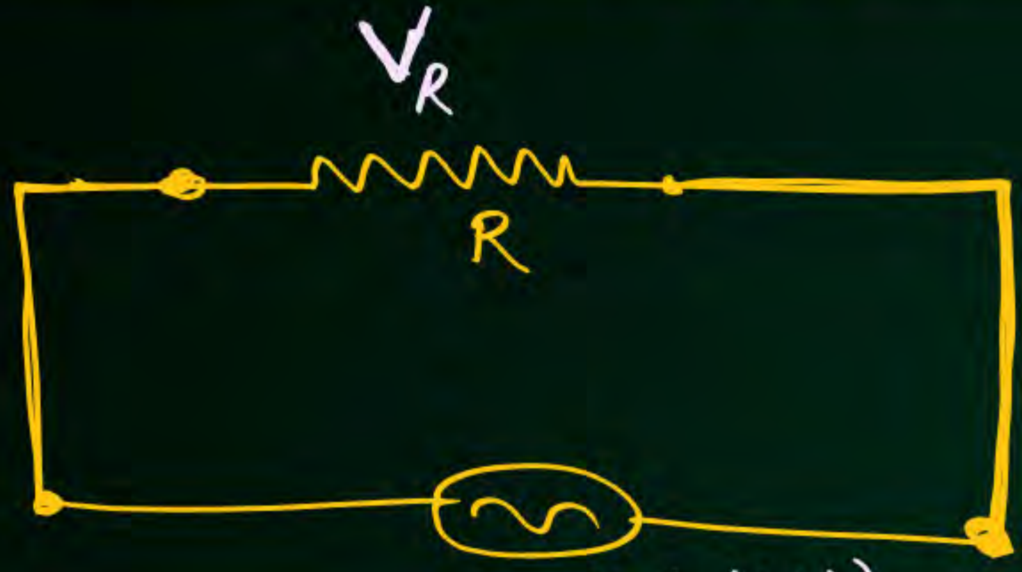
QUESTION

If current $I_1 = 3A \sin \omega t$ and $I_2 = 4A \cos$

1. $5A \sin(\omega t + 53°)$
2. $5A \sin(\omega t + 37°)$
3. $5A \sin(\omega t + 45°)$
4. $5A \sin(\omega t + 30°)$



➢ AC Source Across Pure Resistance



at any time

$V_R = V_B = V_0 \sin(\omega t)$

$IR = V_0 \sin(\omega t)$

$I = \left(\frac{V_0}{R}\right) \sin(\omega t)$

$I_0 = \frac{V_0}{R}$

$I_{rms} = \frac{I_0}{\sqrt{2}}$

$I_R = I_0 \sin(\omega t)$

$V_R = V_0 \sin(\omega t)$

I / V in same Phase





Power loss in resistance

$P_t = I_t V_t$

$= I_0 \sin(\omega t) V_0 \sin(\omega t)$

$P_t = I_0 V_0 \sin^2(\omega t)$

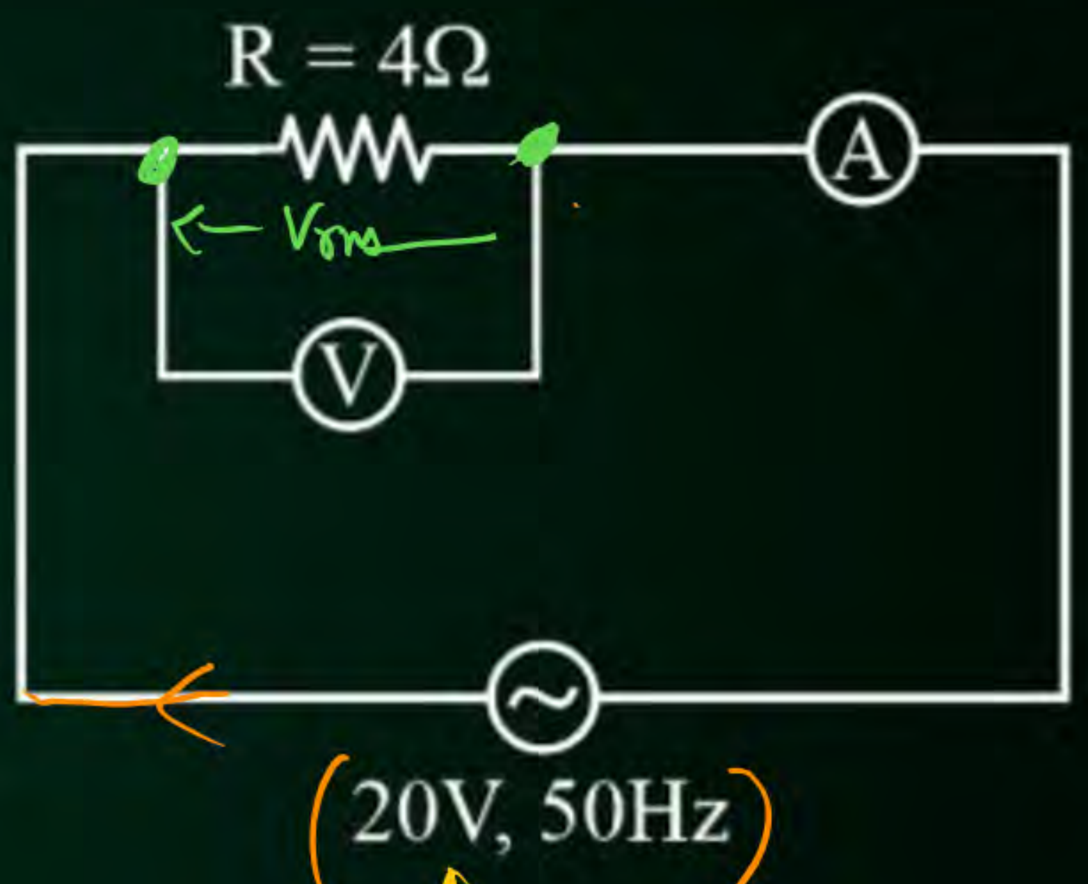
$\langle P \rangle = I_0 V_0 \langle \sin^2(\omega t) \rangle$

$P_{Avg} = \frac{I_0 V_0}{2} = \frac{I_0 V_0}{\sqrt{2} \times \sqrt{2}}$

$P_{Avg} = I_{rms} V_{rms}$

QUESTION

Reading of A and V and power loss across resistance?



$I_{rms} = \frac{V_{rms}}{R}$

$= \frac{20}{4}$

$= 5$ Amp

$V_{rms} = I_{rms} \times R$

$= 5 \times 4 = 20$ volt

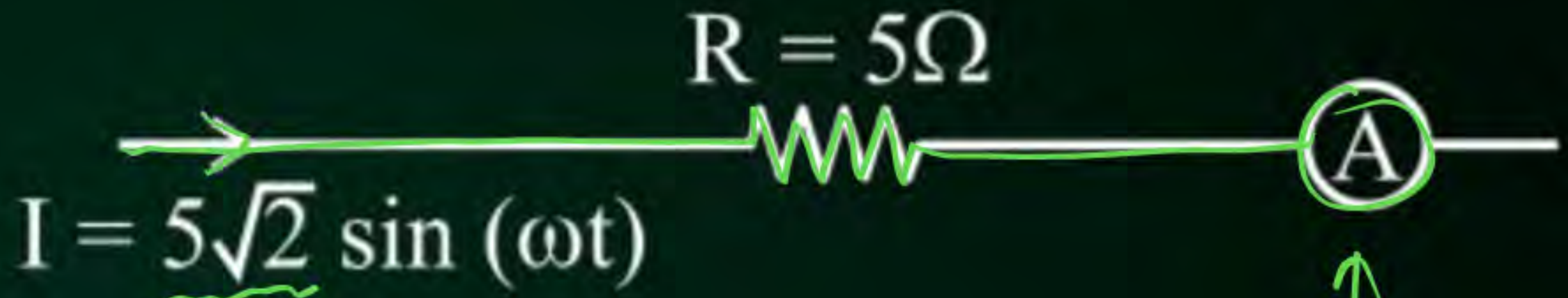
$\langle P \rangle = I_{rms} \times V_{rms}$

$= 5 \times 20$

$= 100$ W

QUESTION

Find power drop and reading of A?



$$\langle P \rangle = V_{rms} \times I_{rms}$$

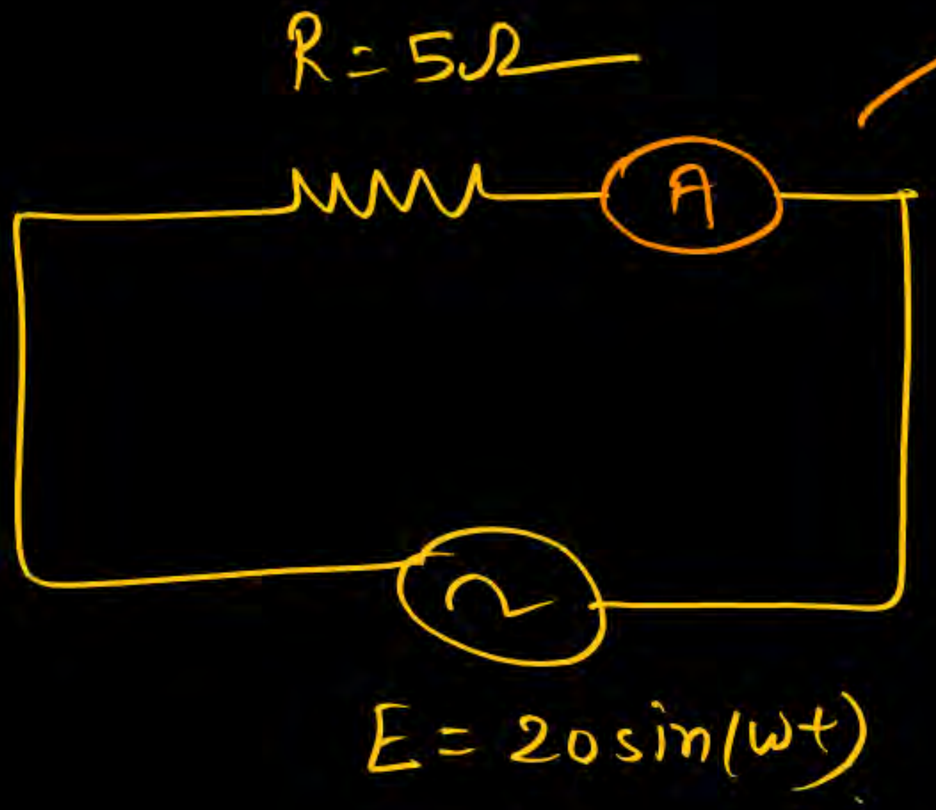
$$= I_{rms} R \times I_{rms}$$

$$= I_{rms}^2 R$$

$$= (5)^2 \times 5$$

$$= 125\,W$$

$$I(\text{Reading})_{rms} = \frac{I_0}{\sqrt{2}} = \frac{5\sqrt{2}}{\sqrt{2}} = 5$$



$$I_{ready} = \frac{20}{5\sqrt{2}} = \frac{4}{\sqrt{2}} = 2\sqrt{2}$$

QUESTION

What is the approximate peak value of an alternating current producing four times the heat produced per second by a steady current of 2 A in a resistor?

1. 2.8 A
2. 4.0 A
3. 5.6 A
4. 8.0 A

$(I_0)_{A/C} = ??$

$H_{A/C} = 4 H_{D/C}$

$I_{rms}^2 R = 4 I_{DC}^2 R$

$I_{rms}^2 = 4(2)^2$

$I_{rms}^2 = 4 \times 4$

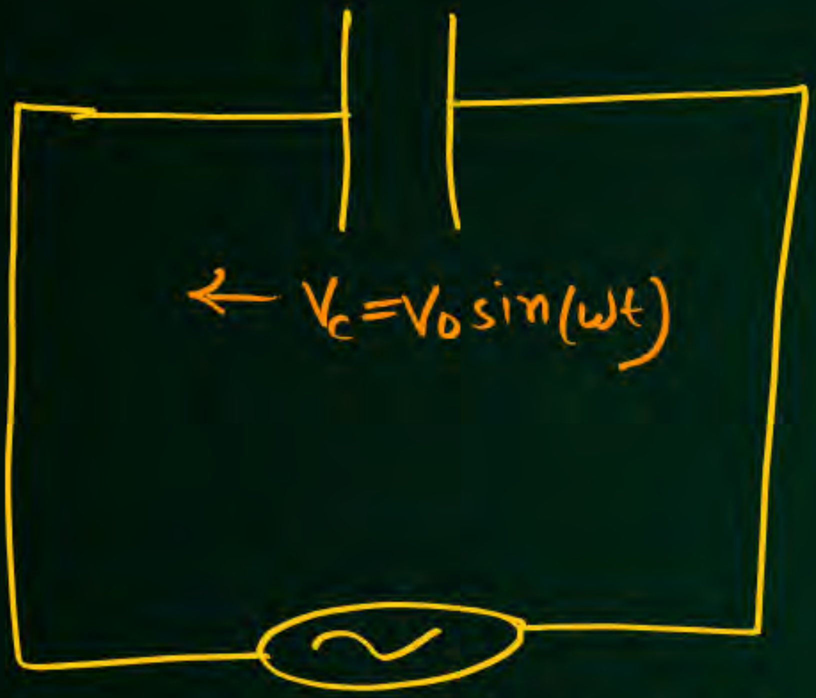
$I_{rms} = \sqrt{16} = 4A$

$\frac{I_0}{\sqrt{2}} = 4$

➢ AC Source Across Pure Resistance

➢ A/C source across Pure Capacitor

C = Capacitance



$V_B = V_0 \sin(\omega t)$

$(V_c)_t = V_{Bt}$

$V_c = V_0 \sin(\omega t)$

$I_0 = \frac{V_0}{X_c}$

$q = CV$ ✓

$q = C V_0 \sin(\omega t)$

$I = \frac{dq}{dt} = C V_0 \frac{d \sin(\omega t)}{dt}$

$I = C V_0 \times \cos(\omega t) \times \omega$

$I = C\omega V_0 \cos(\omega t)$

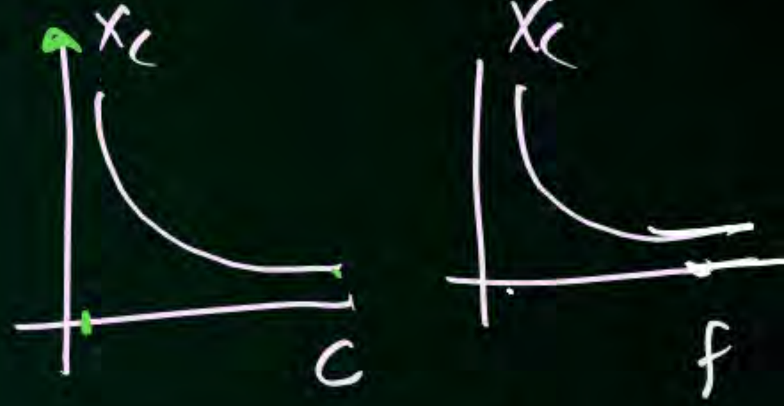
$I = \frac{V_0}{(X_c)} \cos(\omega t)$

Compair $X_c = \frac{1}{\omega C}$

$X_c = \frac{1}{\omega C}$

↳ capacitive Rectance

$X_c \propto \frac{1}{C}$ $X_c = \frac{1}{\omega} = \frac{1}{2\pi f}$



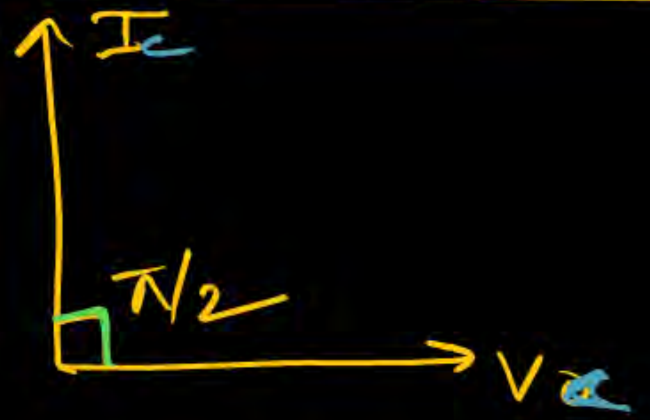
for D/C f = 0 X_c = infinite

capacitor will behave as open wire for D/C.

capacitor → D/C filter instrument

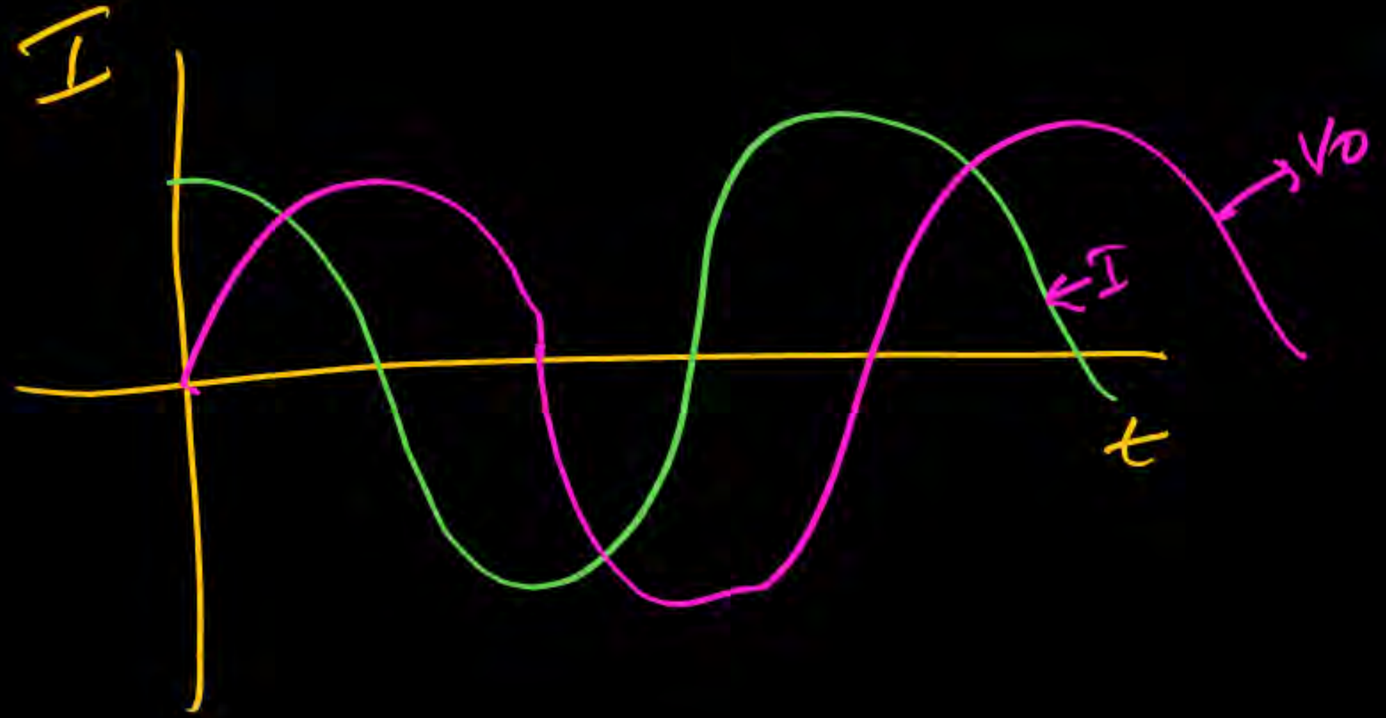
for high frequency A/C capacitor offer less resistance.

$$I = I_0 \cos(\omega t)$$
$$V = V_0 \sin(\omega t)$$



current leads by voltage by $\pi/2$ angle





$$\langle P \rangle = I_t \; V_t$$
$$= \langle I_0 \cos(\omega t) \; V_0 \sin(\omega t) \rangle$$
$$\langle P \rangle = I_0 V_0 \langle \cos(\omega t) \cdot \sin(\omega t) \rangle \rightarrow 0$$

$$\langle P \rangle = 0$$
↳ wattless instrument

➤ Power Loss Across Capacitor



$V = V_0 \sin(\omega t)$

$V_c = V_0 \sin(\omega t)$

$q = CV$

$q = CV_0 \sin(\omega t)$

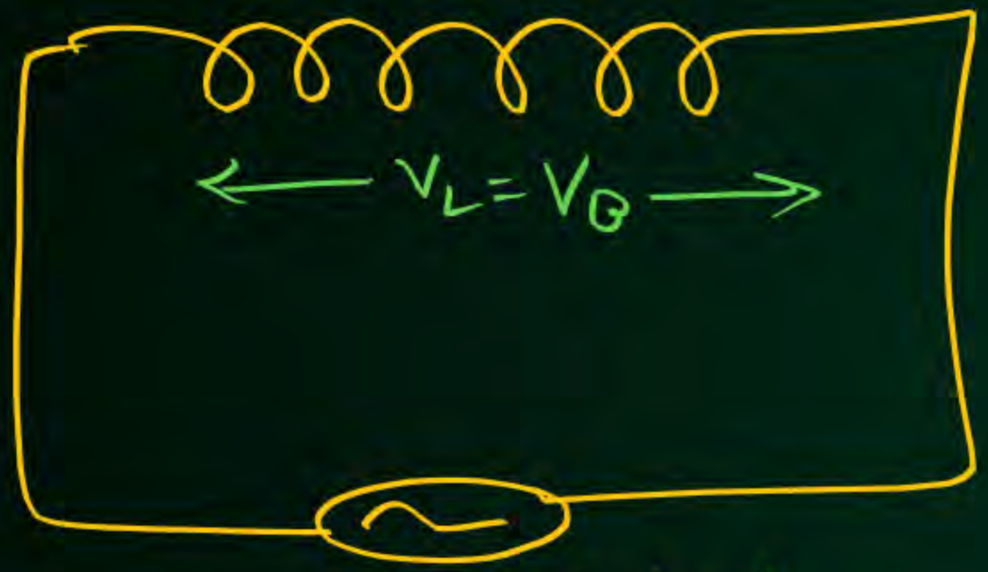
$\frac{dq}{dt} = I = CV_0 \cos(\omega t)$

$I = C\omega V_0 \cos(\omega t)$

$I = \frac{V_0}{\left(\frac{1}{\omega C}\right)} \cos(\omega t) = \frac{V_0}{X_C} \cos(\omega t)$

$X_C = \frac{1}{\omega C}$

➢ A/C source across Pure Inductor



$V_B = V_0 \cos(\omega t)$

$$V_L = V_B = V_0 \cos(\omega t)$$

$$L \frac{dI}{dt} = V_0 \cos(\omega t)$$

$$\int L\, dI = V_0 \int \cos(\omega t)\, dt$$

$$LI = \frac{V_0}{\omega} \sin(\omega t)$$

$$I = \frac{V_0}{(\omega L)} \sin(\omega t)$$

$$I = \frac{V_0}{X_L} \sin(\omega t)$$

$$I_L = I_0 \sin(\omega t)$$

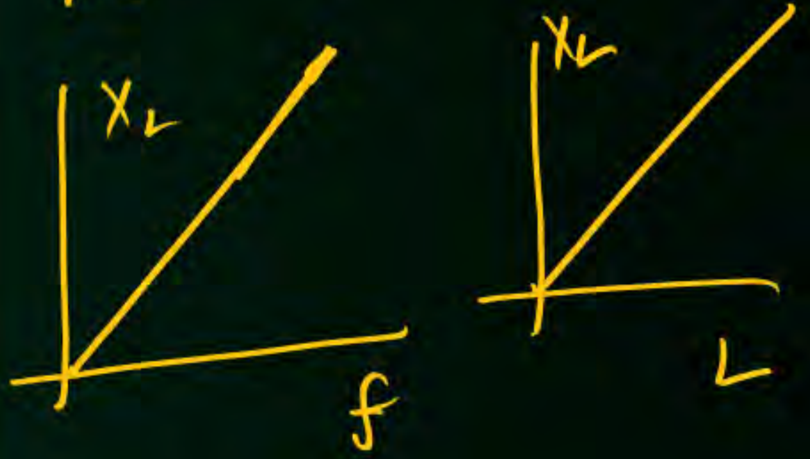
$$V_L = V_0 \cos(\omega t)$$

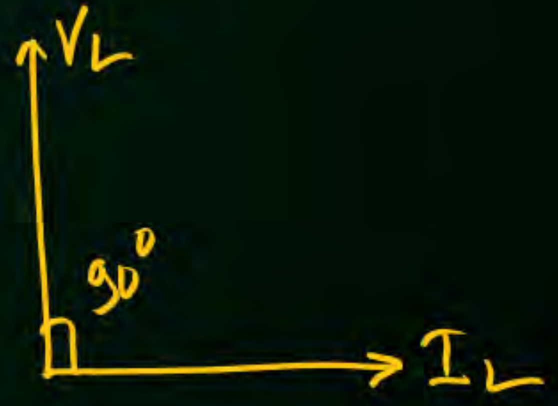
$$\langle P \rangle_{Induc} = 0$$

X_L = Inductive Reacta

$X_L = \omega L = 2\pi f L$

$X_L \propto f$ $X_L \propto L$





Voltage leads by current in inductor.

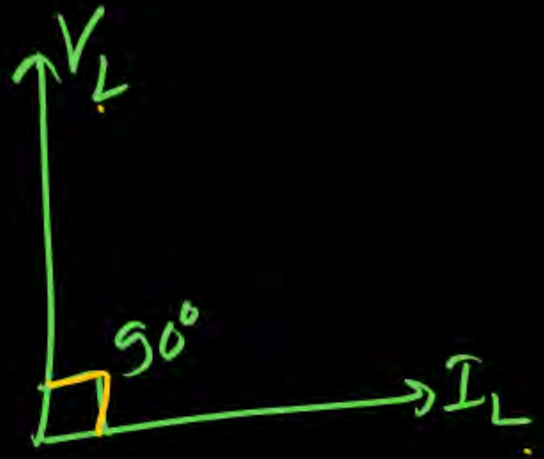
Pure Resistance



$\phi = 0$

$\langle P \rangle = I_{rms} V_{rms}$

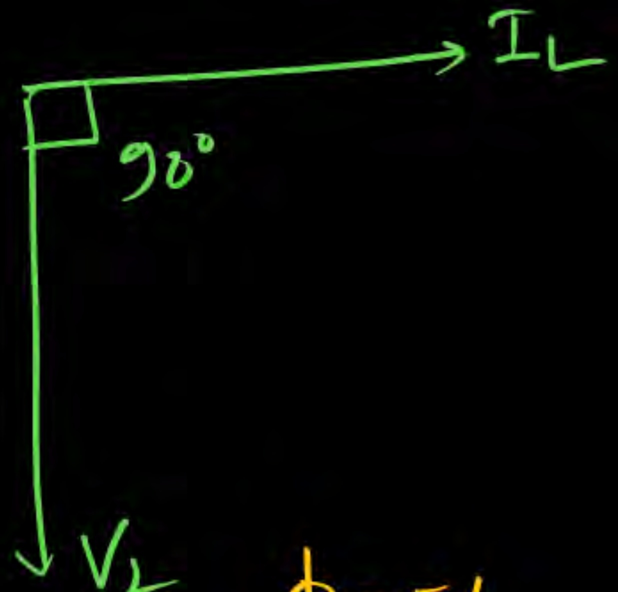
Pure Inductor



$\phi = \pi/2$

$\langle P \rangle = 0$

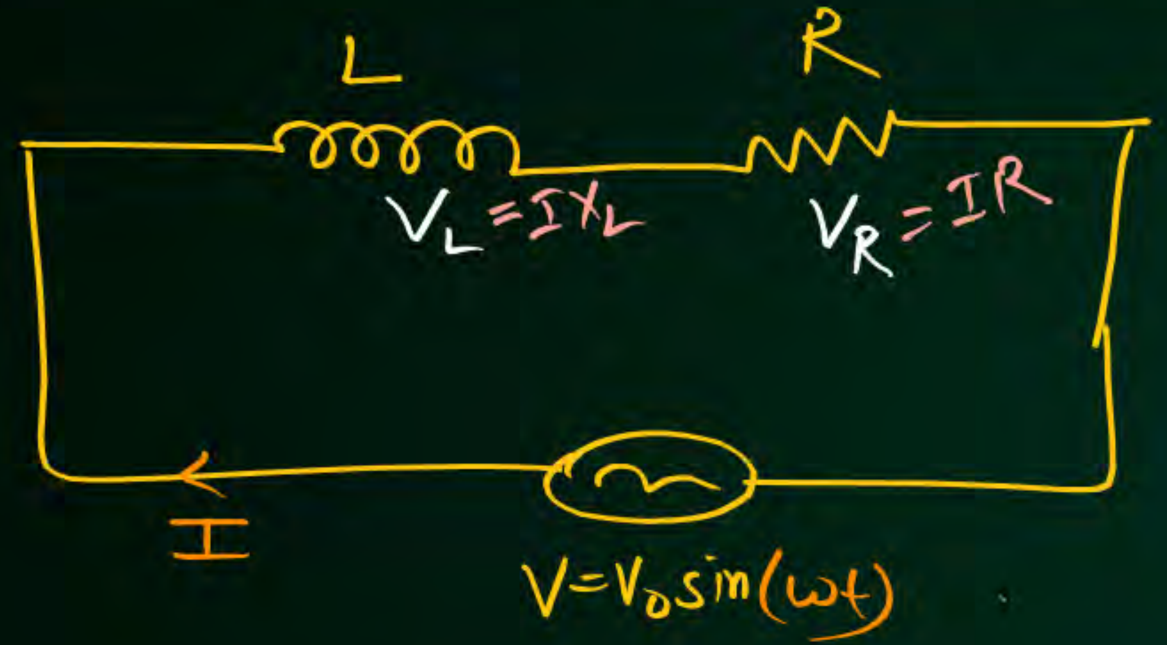
Pure Capacitor



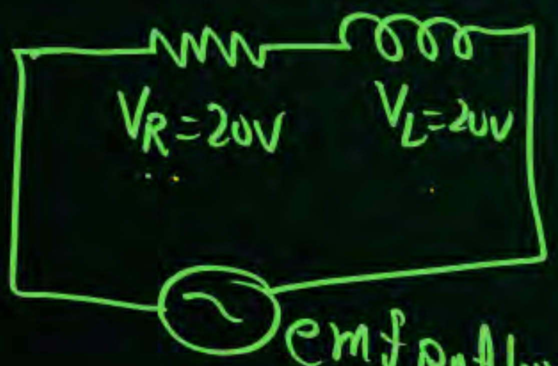
$\phi = \pi/2$

$\langle P \rangle = 0$

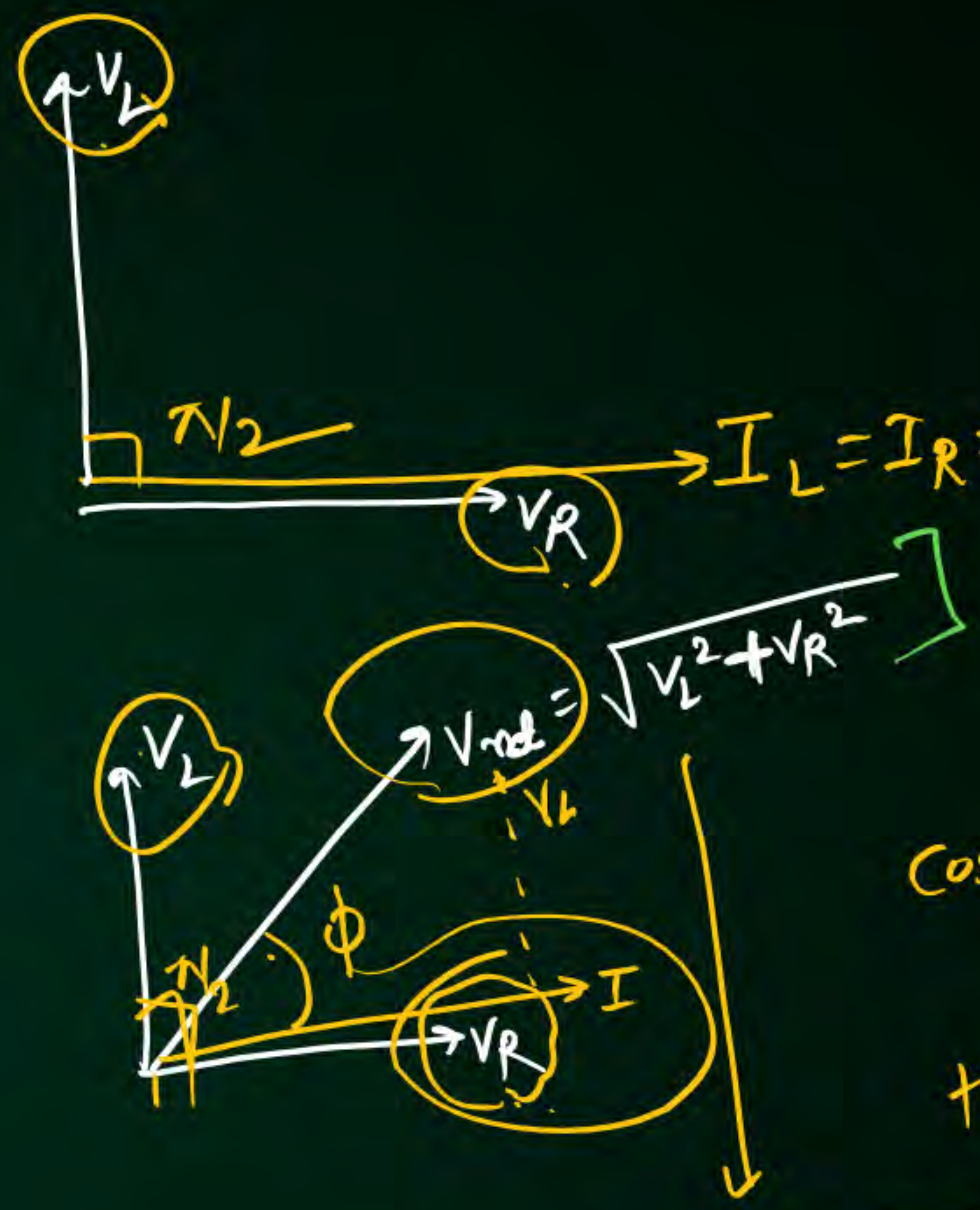
Pure RL Circuit (Coil)



I (Same in Inductor & Capacitor)



emf battery = ?? = $20\sqrt{2}$



$$\cos\phi = \frac{V_R}{\sqrt{V_L^2 + V_R^2}}$$

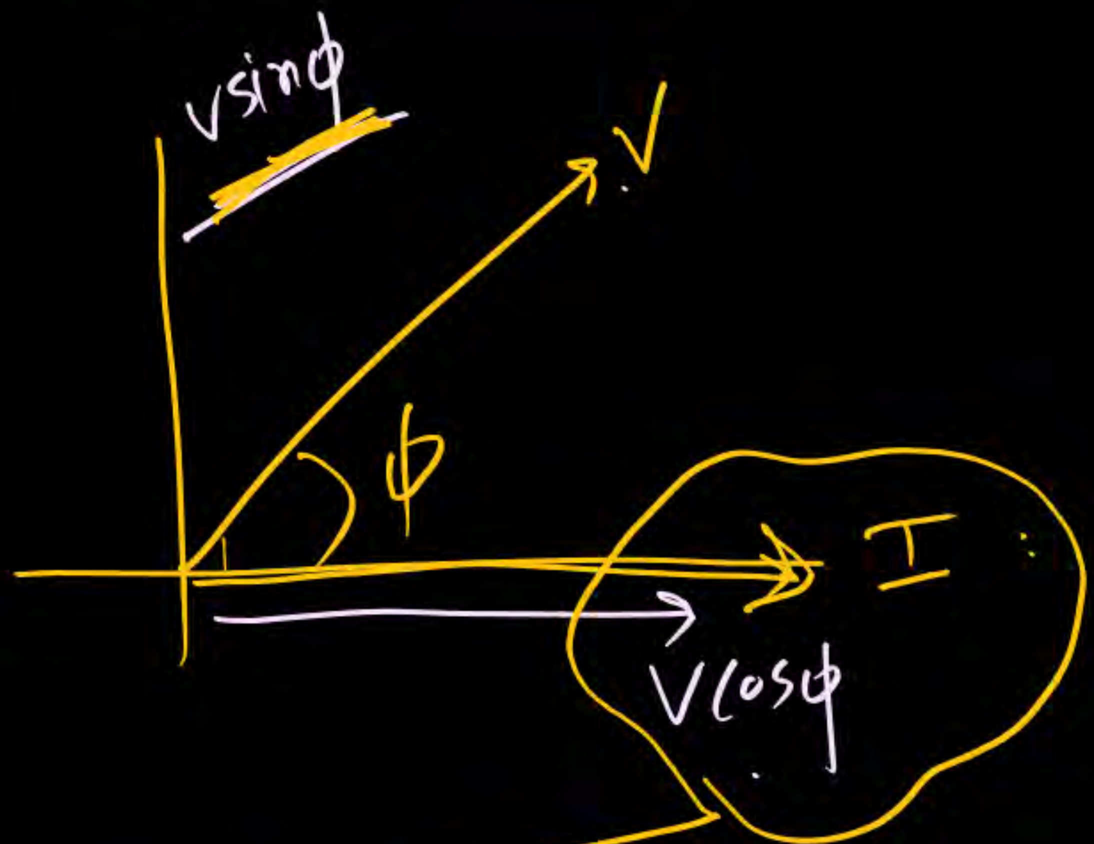
$$\tan\phi = \frac{V_L}{V_R}$$

$$IZ = \sqrt{(IX_L)^2 + (IR)^2}$$

$$Z = \sqrt{X_L^2 + R^2}$$

↳ Impedance

Power loss in R-L



Pure resist

$\phi = 0$

$\cos 0 = 1$

$\langle P \rangle = I_{rms} V_{rms}$ ✓

Pure Capac.

Pure Indi

$\phi = 90$

$\cos 90 = 0$

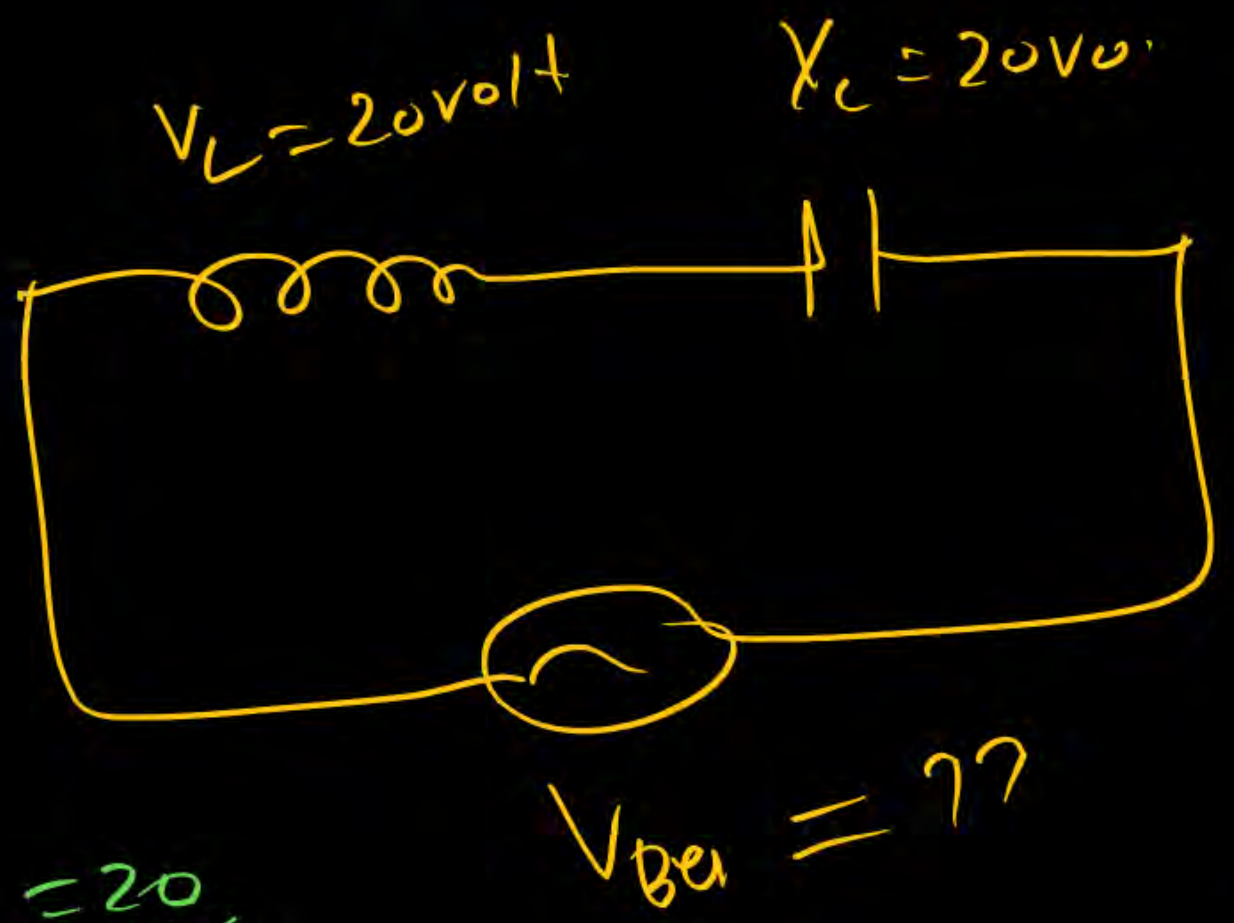
$\langle P \rangle = 0$

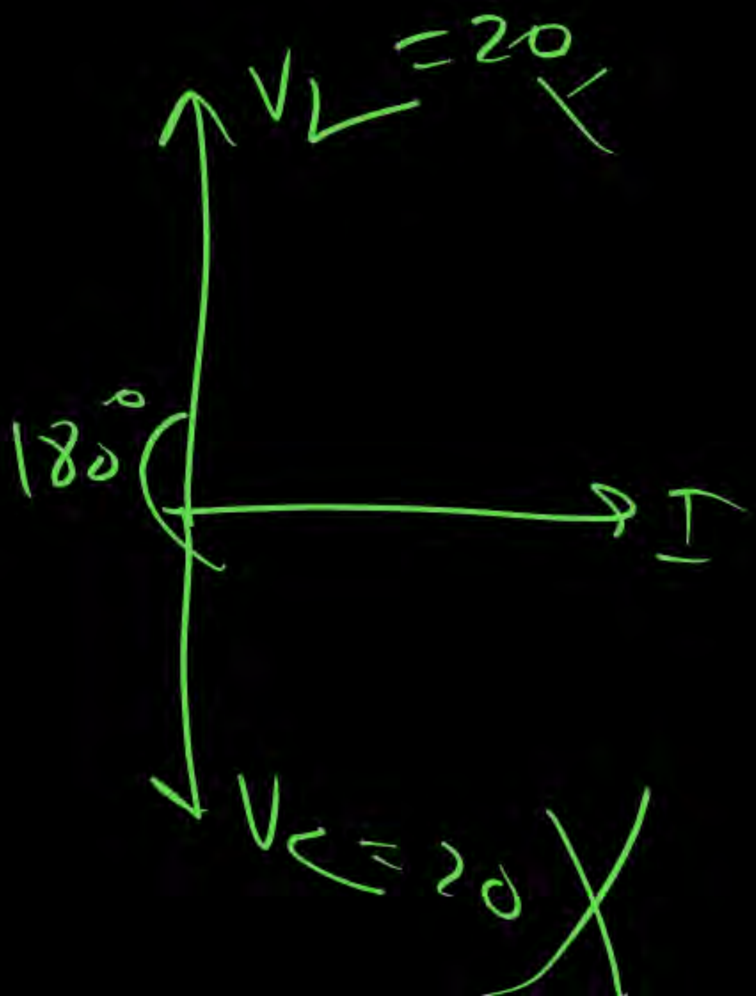
$\langle P \rangle = I_{rms} V_{rms} \cos\phi$

In general A/C circuit

Power factor $= \cos\phi$

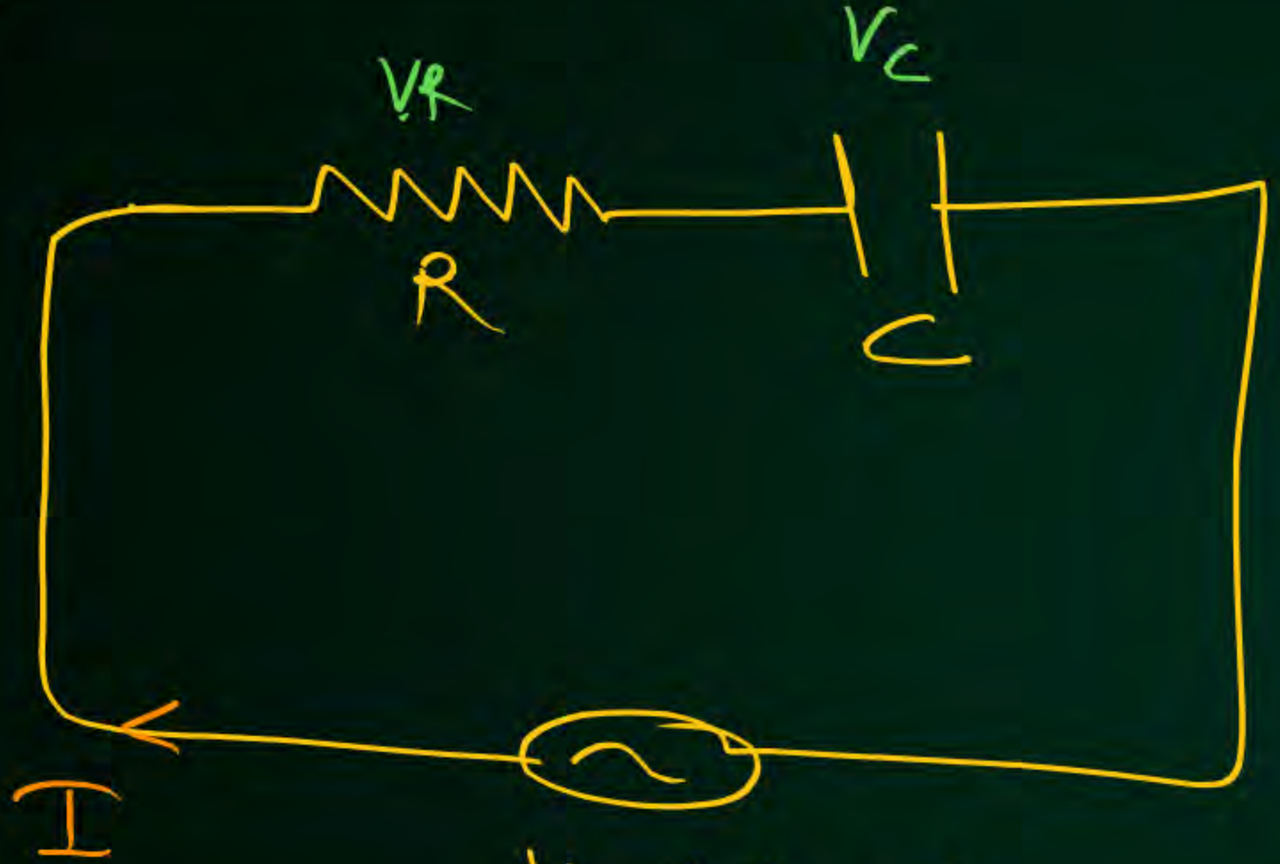
ϕ = phase diffⁿ





$V_{Bw} = zero$

RC Circuit



$V = V_0 \sin(\omega t)$

$\langle P \rangle = I_{rms} V_{rms} \cos\phi$

Phasor diagram



$\sqrt{V_R^2 + V_C^2} = V_{rms}$

$I\sqrt{R^2 + X_C^2}$

$\cos\phi = \dfrac{V_R}{\sqrt{V_R^2 + V_C^2}}$

$Z = \sqrt{R^2 + X_C^2}$

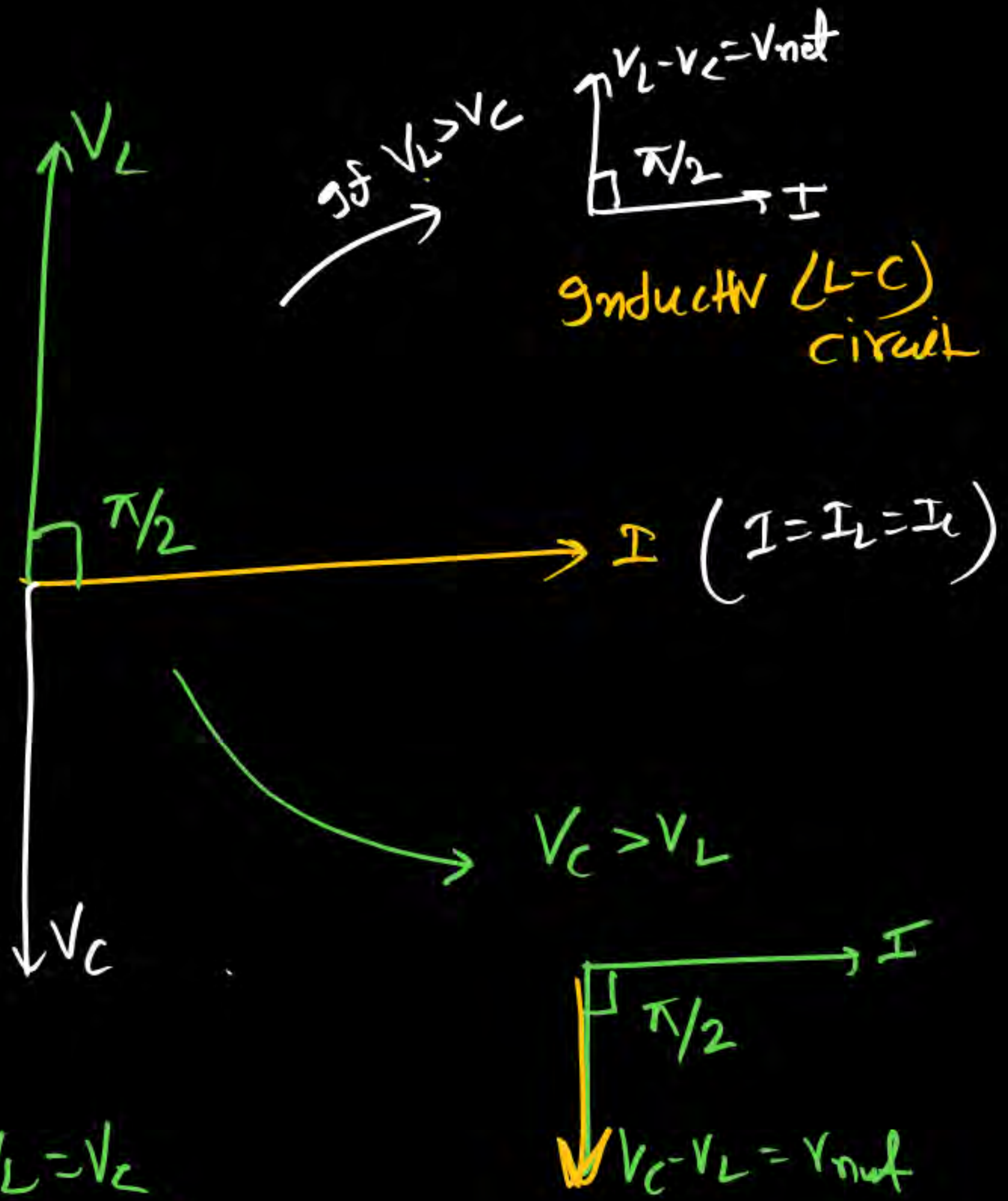
L-C circuit



$$V_{net} = V_L - V_C$$

$$\cancel{I} Z = \cancel{I}(X_L - X_C)$$

$$\boxed{Z = X_L - X_C}$$

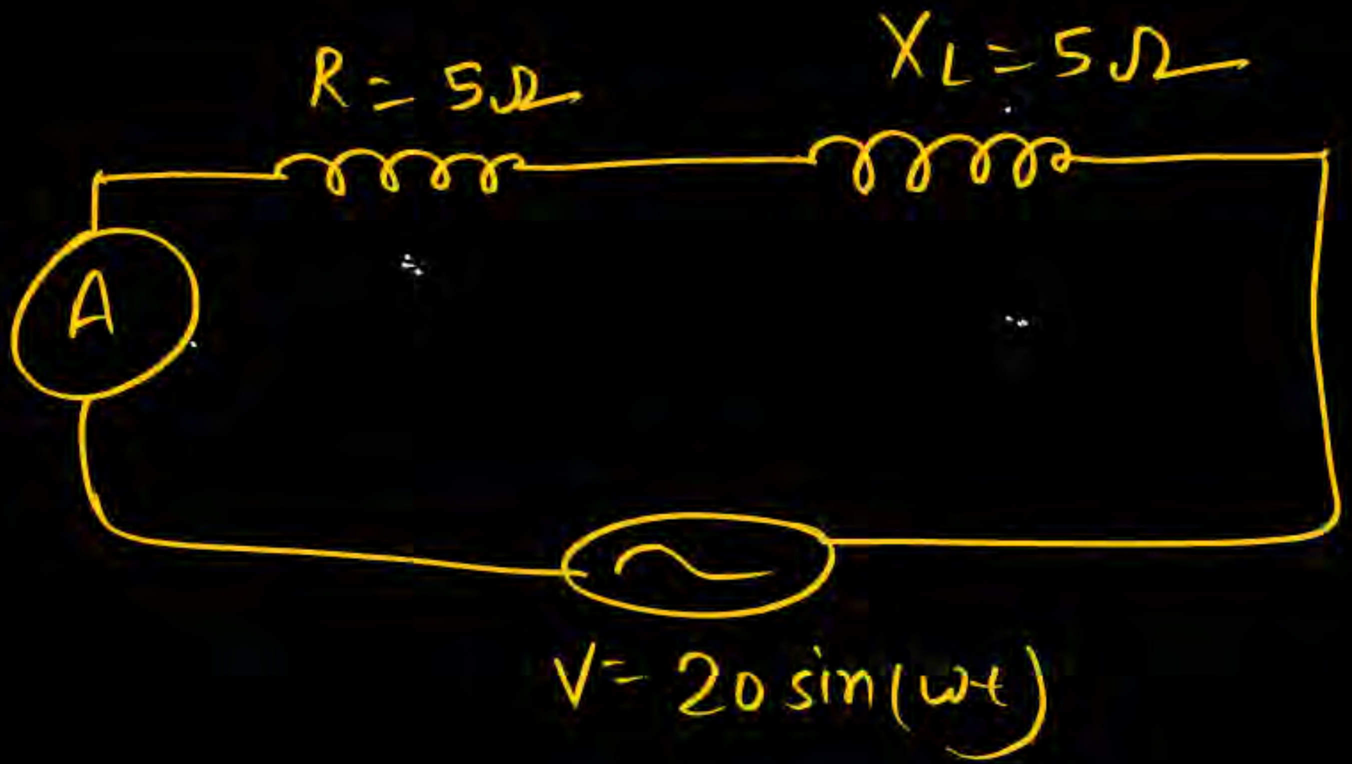


If $V_L = V_C$

$V_{net} = 0$

Capacitive circuit

LC Circuit



Reading of Ammetre

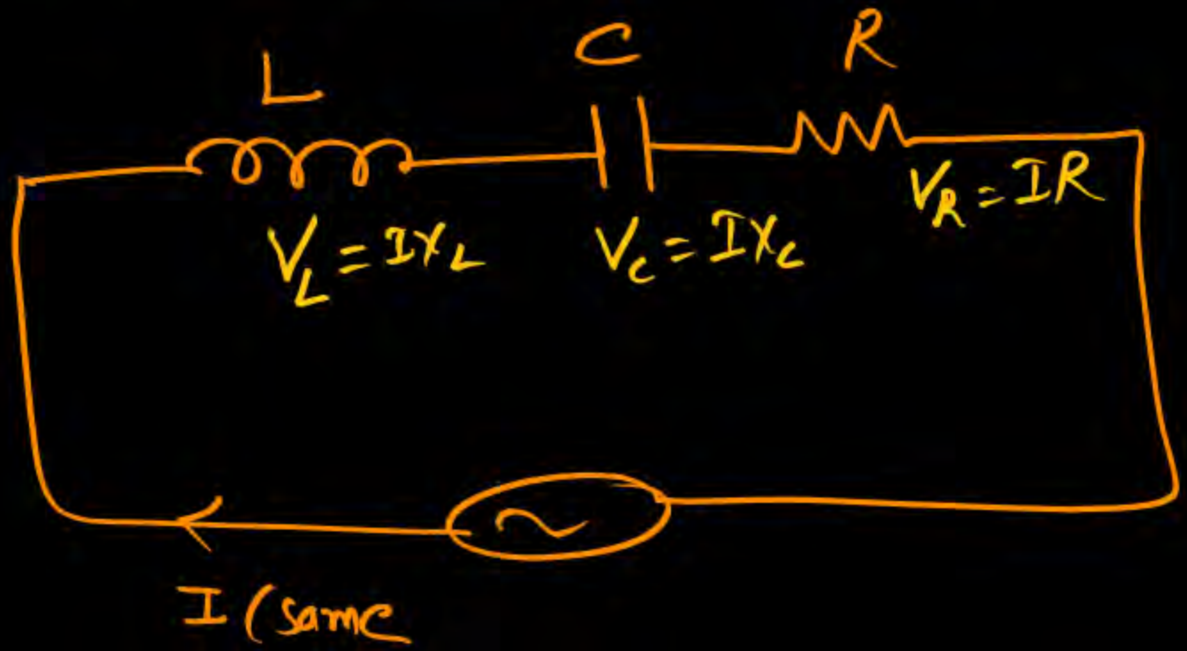
$$Z = \sqrt{R^2 + X_L^2} = \sqrt{5^2 + 5^2}$$

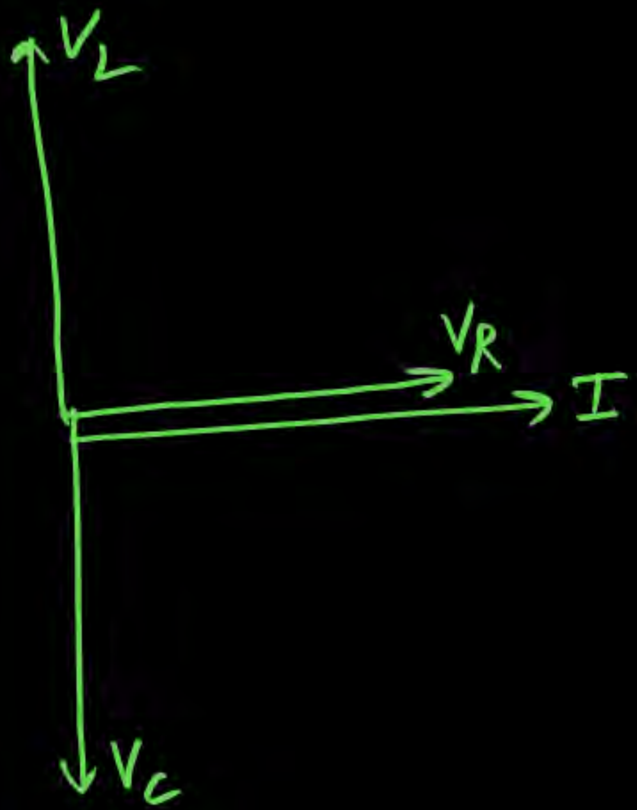
$$Z = 5\sqrt{2}$$

$$I_0 = \frac{V_0}{Z} = \frac{20}{5\sqrt{2}} = \frac{4}{\sqrt{2}}$$

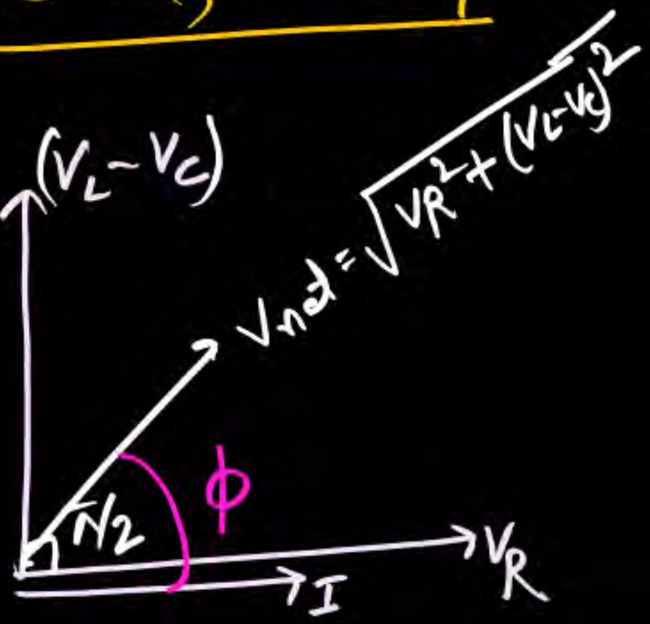
$$I_{rms} \text{ reading} = \frac{I_0}{\sqrt{2}} = \frac{4}{\sqrt{2} \times \sqrt{2}} = 2A$$

Series L·C·R





Case (1), $V_L > V_c$



$$V_{net} = \sqrt{V_R^2 + (V_L - V_c)^2}$$

$$V_{net} = \sqrt{V_R^2 + (V_L - V_c)^2}$$



$$IZ = \sqrt{I^2R^2 + (IX_L - IX_c)^2}$$

*

$$I_0 = \frac{V_0}{Z}$$

$$I_{rms} = \frac{V_{rms}}{Z}$$

$$Z = \sqrt{R^2 + (X_L - X_c)^2}$$

$$\cos\phi = \frac{V_R}{V_{net}}$$

$$\tan\phi = \frac{V_L - V_c}{V_R}$$


THANK YOU

YAKEEN 2.0

6:30 Am

FOR NEET 2025

Lecture- 03 | **Physics**

Alternating Current

By- Dr. Manish Raj (MR SIR)



Todays Goal

PhD on L·C·R circuit

Pure Resistance



$V = V_0 \sin(\omega t)$

at any instant ✓

$$V_R = V_{Battery}$$

$V_R = V_0 \sin(\omega t)$ ✓✓

$IR = V_0 \sin(\omega t)$

$I = \frac{V_0}{R} \sin(\omega t)$

$$I_0 = \frac{V_0}{R}$$ ✗

$I_R = I_0 \sin(\omega t)$

$V_R = V_0 \sin(\omega t)$



Same phase $\phi = 0$ ✓✓



$$\langle P \rangle_{Avg} = I_{rms} V_{rms}$$

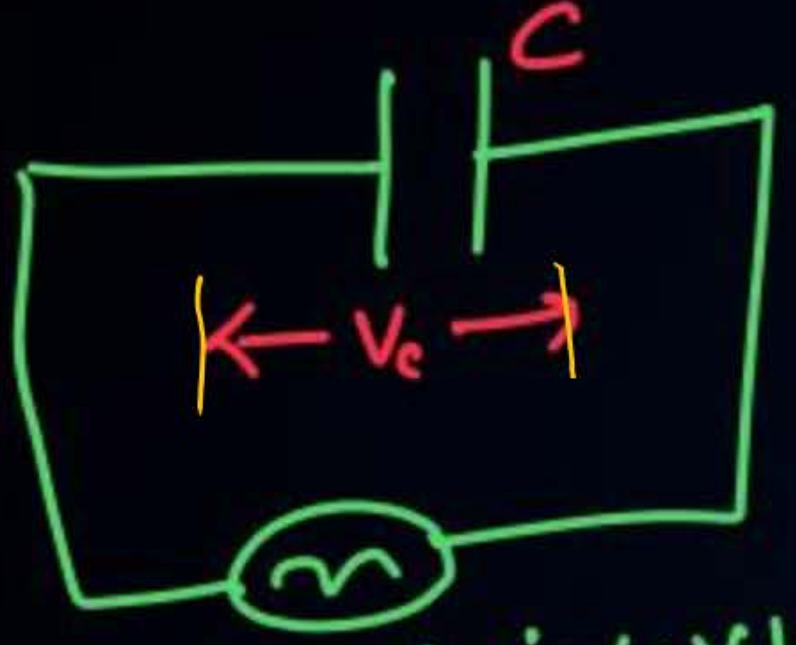
Phase diff^n B/w current & voltage = 0

Power factor $\langle \cos\phi \rangle = 1$ ✓✓

#



Pure Capacitor



$V_\theta = V_0 \sin(\omega t)$

At any instant

$V_c = V_{Battery}$

$V_c = V_0 \sin(\omega t)$

we know $q = CV$

$q = CV_0 \sin(\omega t)$

$I_c = \left[\frac{dq}{dt}\right] = CV_0 \frac{d\sin(\omega t)}{dt}$

$I_c = CV_0 \cos(\omega t) \times \omega$

$I_c = CV_0\omega \cos(\omega t)$

$I_0 = \frac{V_0}{X_c} = \frac{V_0}{(1/\omega C)}$

X_c capacitive (React)

$I_c = I_0 \cos(\omega t)$

$V_c = V_0 \sin(\omega t)$

Phase difference b/w current and voltage is $\pi/2$

current leads by voltage



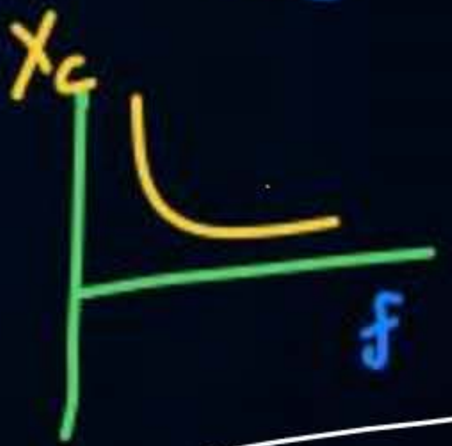
Phase digrm

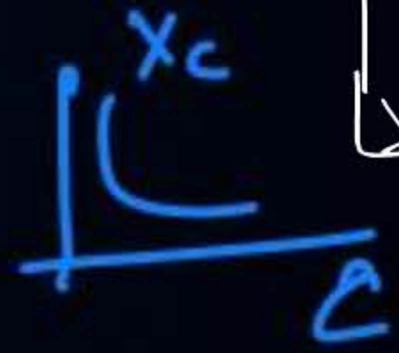


for D/C X_c = infinite

$X_c = \frac{1}{\omega C}$

$X_c = \frac{1}{2\pi f C}$



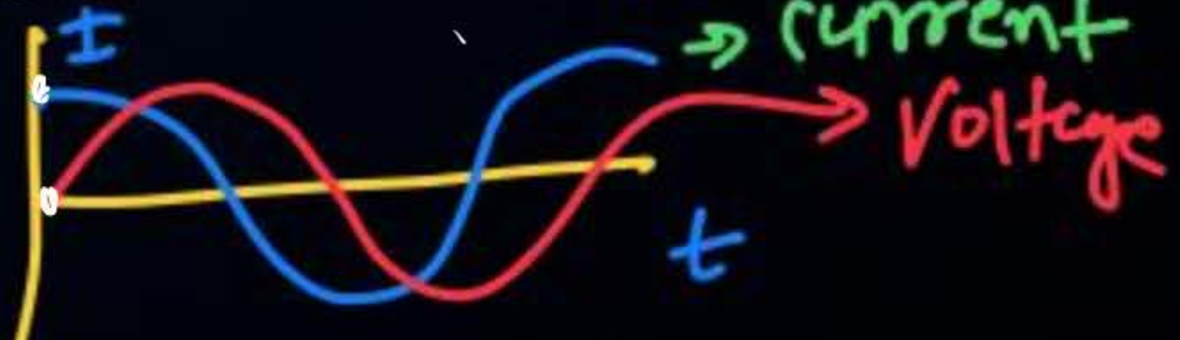


$\phi = 90$

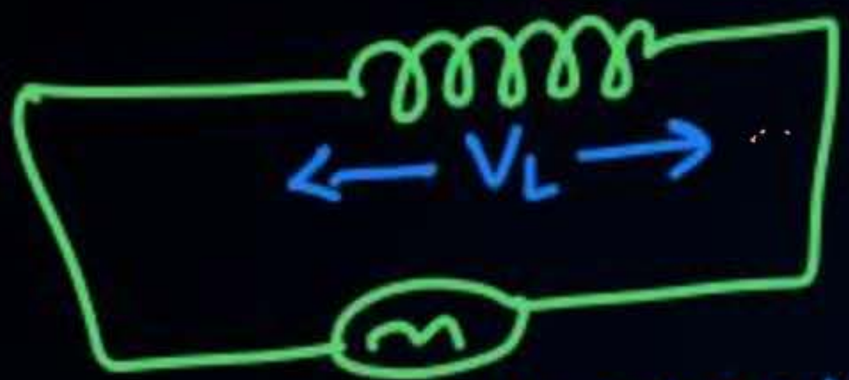
$\langle P \rangle = 0$

$\cos 90° = 0$

Power factor



Pure Inductor



$$V = V_0 \cos(\omega t)$$

at any instant

$$\boxed{V_L = V_0 \cos(\omega t)}$$

$$L\frac{dI}{dt} = V_0 \cos(\omega t)$$

$$\int dI = \frac{V_0}{L}\int \cos(\omega t)\, dt$$

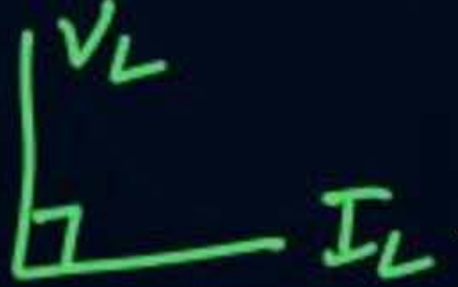
$$I_L = \frac{V_0}{L\omega}\sin(\omega t)$$

$$* \; I_0 = \frac{V_0}{\omega L} = \frac{V_0}{(X_L)}$$

$$I_L = I_0 \sin(\omega t)$$

$$V_L = V_0 \cos(\omega t)$$

Phase diff^n b/w current & voltage is $\pi/2$.

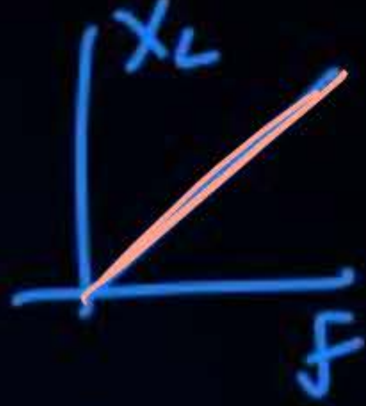




$$X_L = \omega L = 2\pi f L$$

$X_L \propto f$ $X_L \propto L$





* X_L = zero for D/C, behave as simple wire for D/C



$\langle P \rangle_{Avg} = 0$ wattless circuit

Behave as A/C filter for High frequency A/C (X_L = High)

X_L = Infinite (High)

R-L circuit



$V = V_0 \sin(\omega t)$

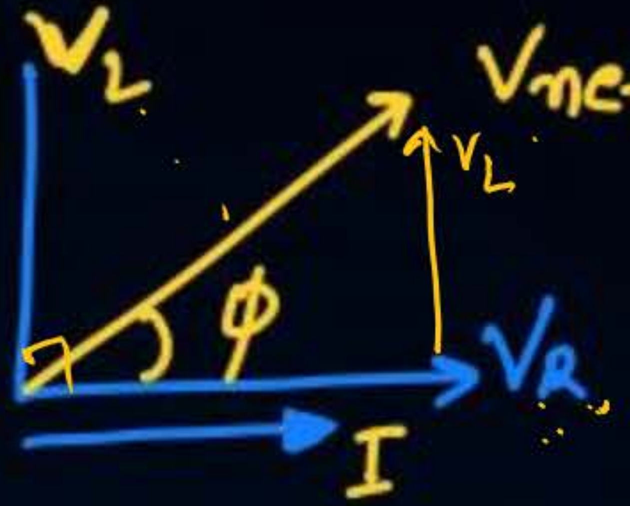
* $I_L = I_R = I$ (same)

$V_{R_0} + V_{L_0} = V_0$ (wrong) for peak

$V_{R\,rms} + V_{L\,rms} = V_{rms}$ Batt ✗

$V_{Rt} + V_{Lt} = V_{0t}$

(instantaneous voltage)



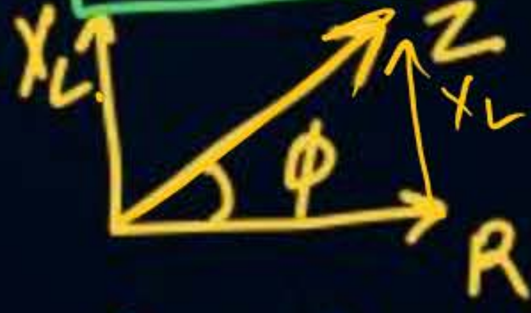
$V_{net} = \sqrt{V_R^2 + V_L^2}$

$\tan\phi = \dfrac{V_L}{V_R}$

$\cos\phi = \dfrac{V_R}{V_{net}}$

* $Z = \sqrt{R^2 + X_L^2}$

$\langle P \rangle = I_{rms} V_{rms} \cos\phi$



Impedance Triangle

$I_0 = \dfrac{V_0}{Z}$

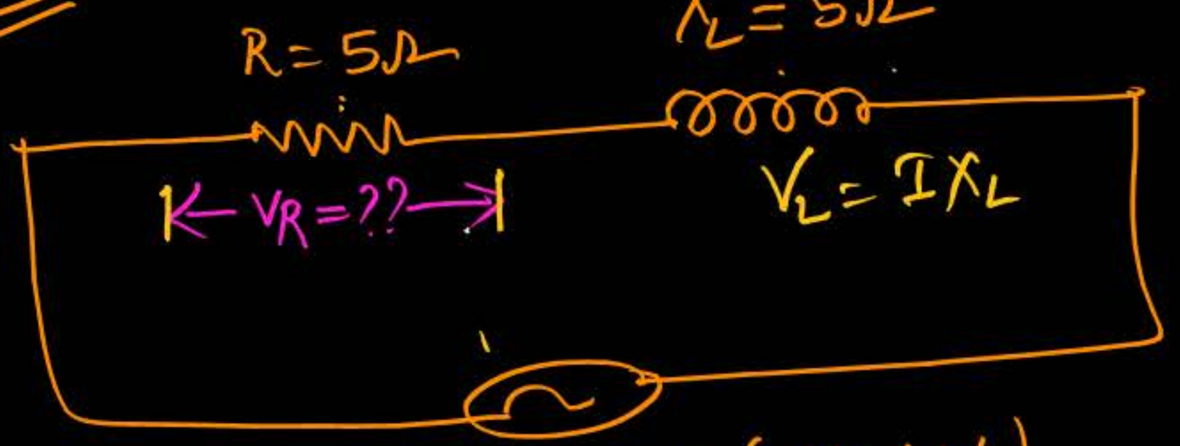
$\cos\phi = \dfrac{V_R}{V_{net}} = \dfrac{R}{Z}$

$I_0 = \dfrac{V_0}{Z}$

~~$V_{L\,rms} + V_{R\,rms} = V_{B(rms)}$~~ wrong

~~$V_{L0} + V_{R0} = V_{B0}$~~ Both are wrong

Sol^n



$\mathcal{E}_B = 10\sqrt{2}\sin(\omega t)$

$V_{L0} + V_{R0} = \mathcal{E}_{Batt\,0}$

$10V + 10V = 10\sqrt{2}$

Not equal

$I_0 = 2\ Amp$

\# $(V_L)_{Peak} = (I_0 X_L)$

$= 2 \times 5 = 10\ volt$

$(V_R)_{Peak} = I_0 R$

$= 2 \times 5 = 10\ volt$

\# $Z = \sqrt{R^2 + (X_L)^2} = 5\sqrt{2}$

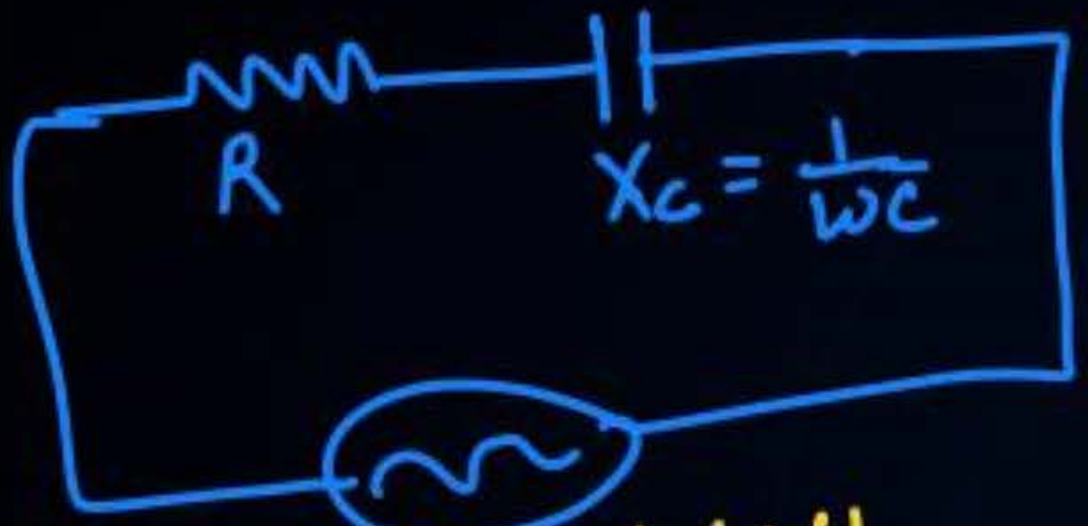
\# $I_0 = \frac{\mathcal{E}_0}{Z} = \frac{10\sqrt{2}}{5\sqrt{2}} = 2\ Amp$

$I_{rms} = \frac{2}{\sqrt{2}} = \sqrt{2}\ Amp$

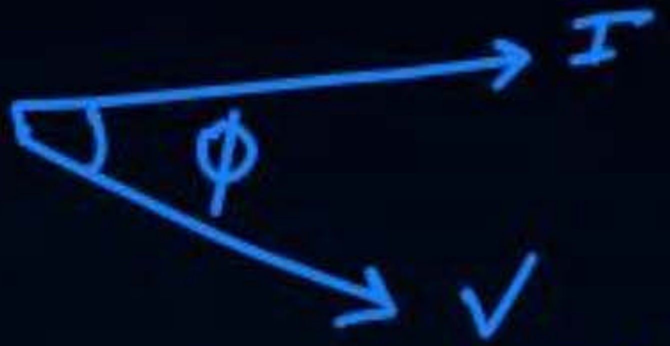
$(V_R)_{rms} = I_{rms} R = \sqrt{2} \times 5$

$= 5\sqrt{2}\ Volt$

R–C circuit



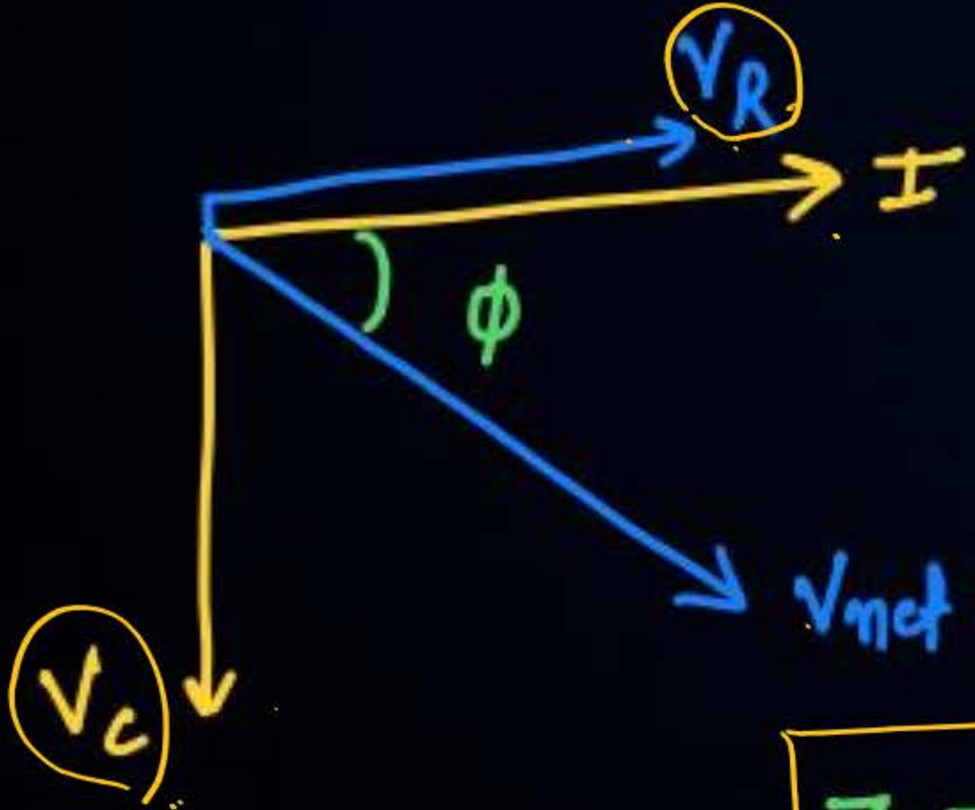
$V = V_0 \sin(\omega t)$



current leads by voltage.

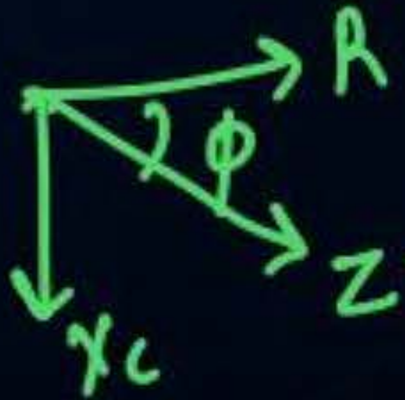
$\tan\phi = \frac{V_C}{V_R}$

$\cos\phi = \frac{V_R}{V_{net}} = \frac{R}{Z}$



$V_{net} = \sqrt{V_R^2 + V_C^2}$

$Z = \sqrt{R^2 + X_C^2}$

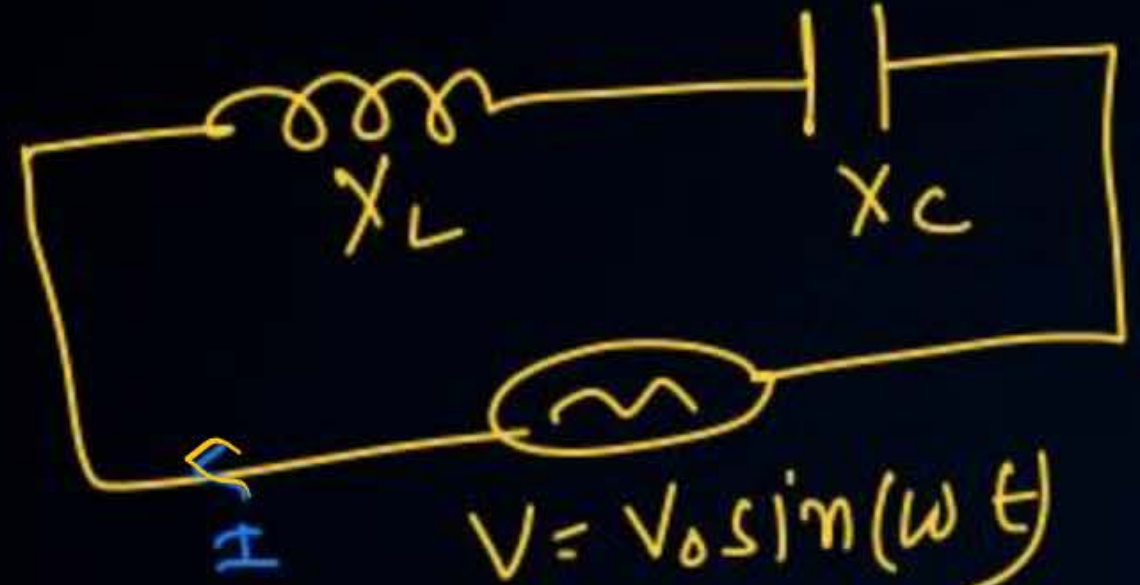


$Z = \sqrt{R^2 + X_C^2}$

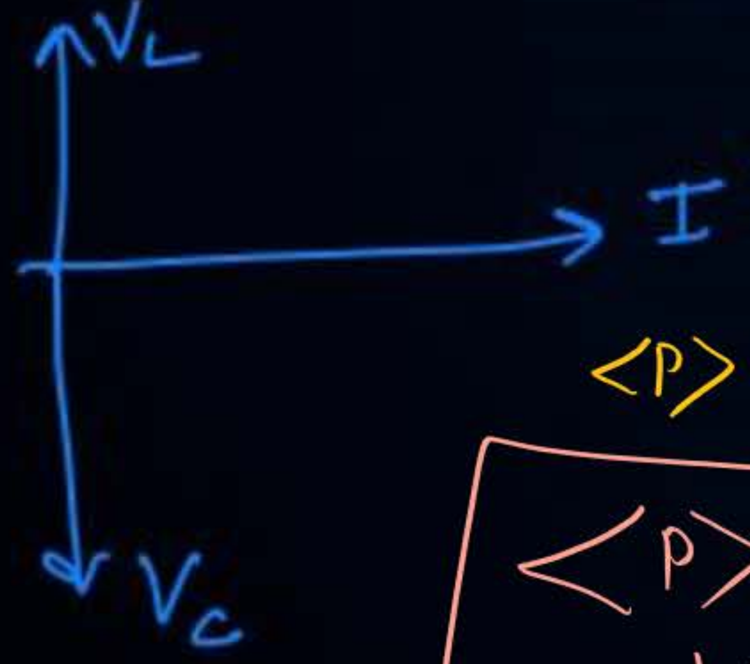
$\langle P \rangle = I_{rms} V_{rms} \cos\phi$

$I_0 = \frac{V_0}{Z}$

L-C circuit

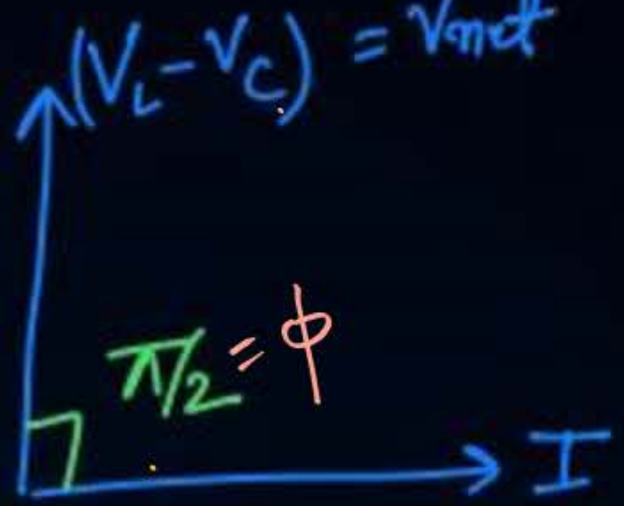


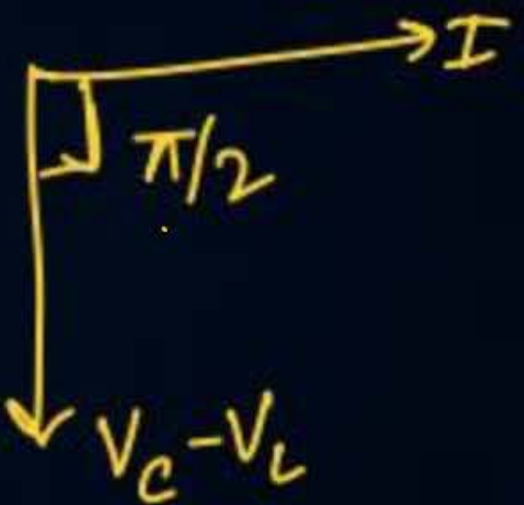
$V = V_0 \sin(\omega t)$

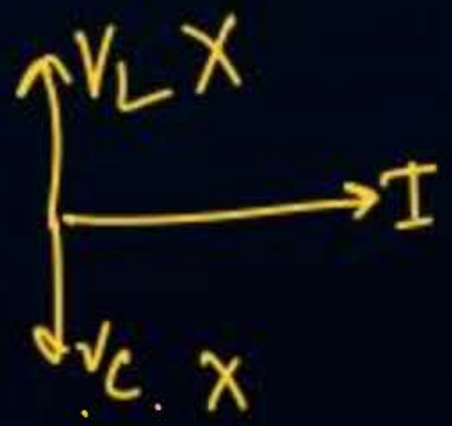


$\langle P \rangle = I_{rms} V_{rms} \cos\phi$

$\langle P \rangle_{L\text{-}C\ circuit} = 0$ always







$V_{net} = 0$

I = infin

$(V_L = V_C)$

If $(V_L > V_C)$

Inductive L-C circuit

If $(V_C > V_L)$

capacitive L-C circuit

$Z = |X_C - X_L|$

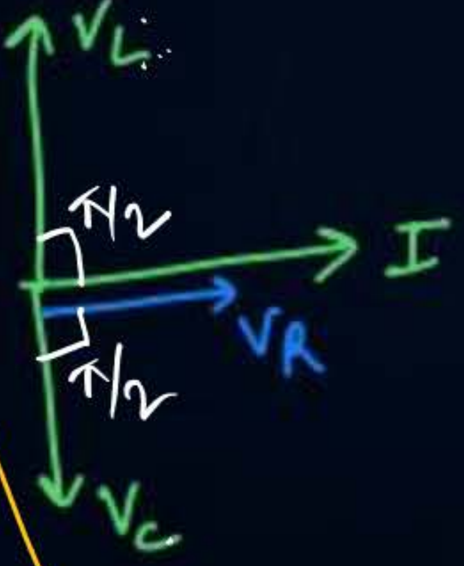
$I_0 = \dfrac{V_0}{Z}$

Series L·C·R· circuit



$V = V_0 \sin(\omega t)$

$I_B = I_R = I_L = I_C$ ✓



$V_0 = V_{L0} + V_{C0} + V_{R0}$ (peak)

Battey

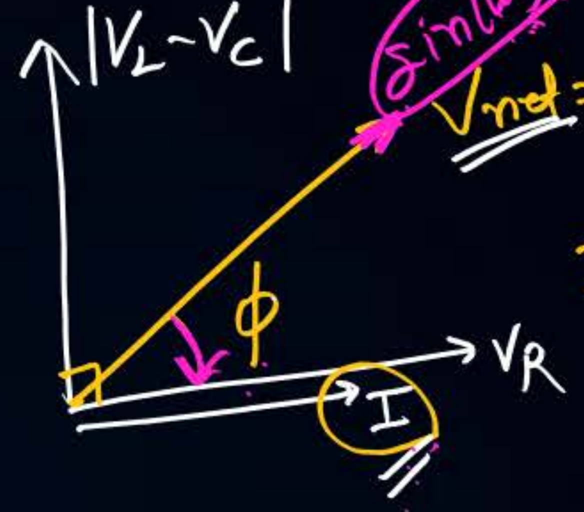
$V_{rms} = V_{L\,rms} + V_{C\,rms} + V_{R\,rms}$

Bath

↳ Both are wrong

$V_{constant} = V_{Lt} + V_{Ct} + V_{Rt}$ → correct

If $V_L > V_C$

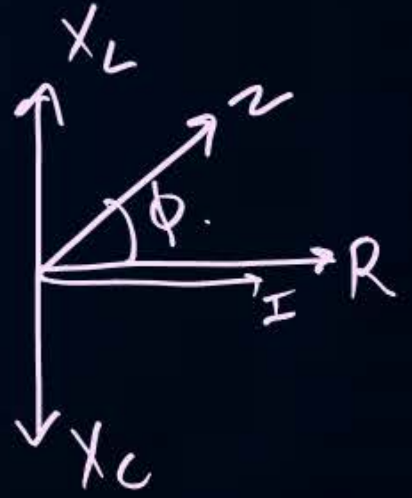


$V_{net} = \sqrt{V_R^2 + (V_L - V_C)^2}$

$IZ = \sqrt{(IR)^2 + (IX_L - IX_C)^2}$

$Z = \sqrt{R^2 + (X_L - X_C)^2}$

* impedance



$I_0 = \frac{V_0}{Z}$

$I_{rms} = \frac{V_{rms}}{Z}$ *

$\cos\phi = \frac{R}{Z} = \frac{V_R}{V}$ *

$\langle P \rangle = I_{rms} V_{rms} \cos\phi$ *

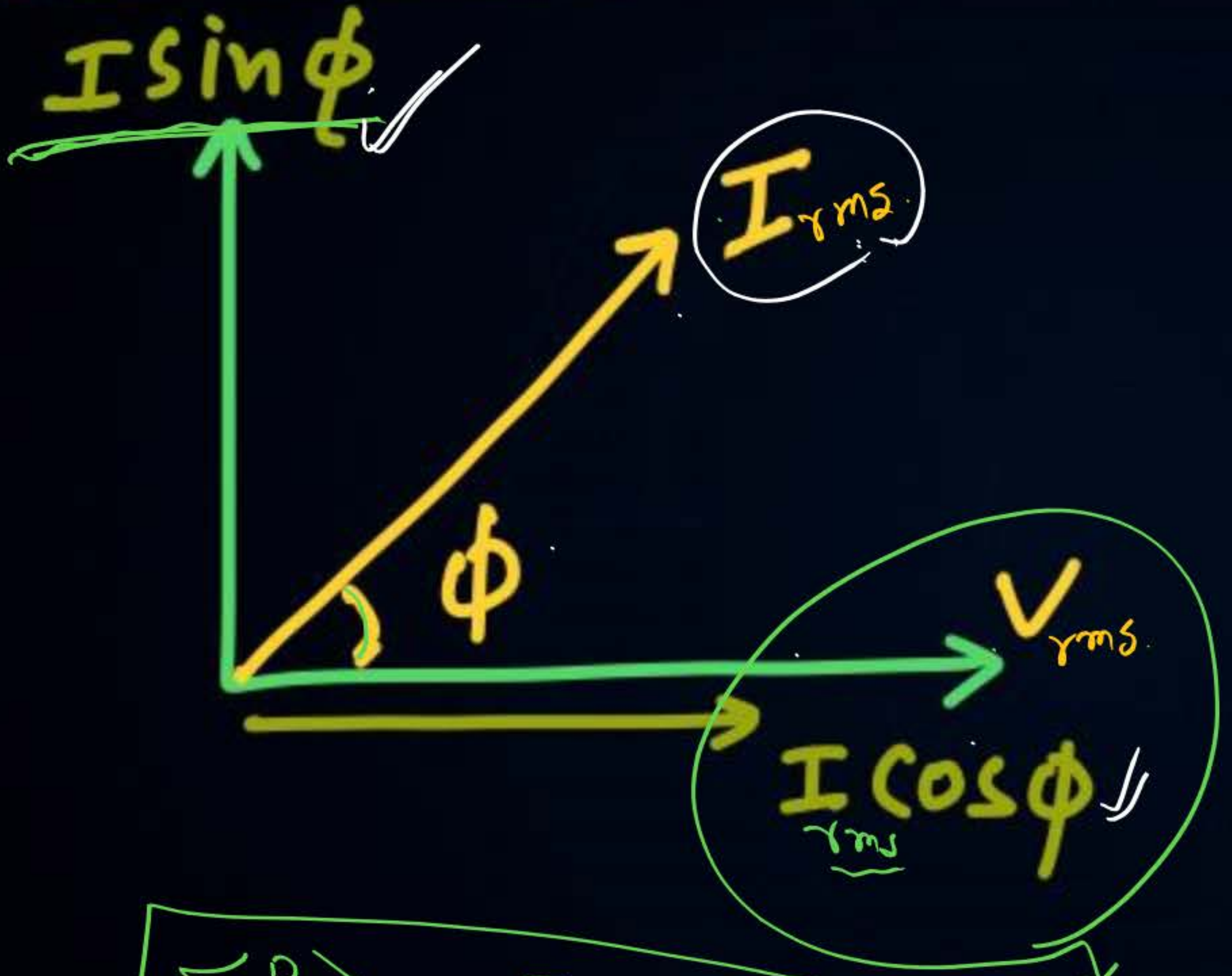
- Write eqⁿ of current??

$I = I_0 \sin(\omega t - \phi)$

$V_R = V_{R0} \sin(\omega t - \phi)$

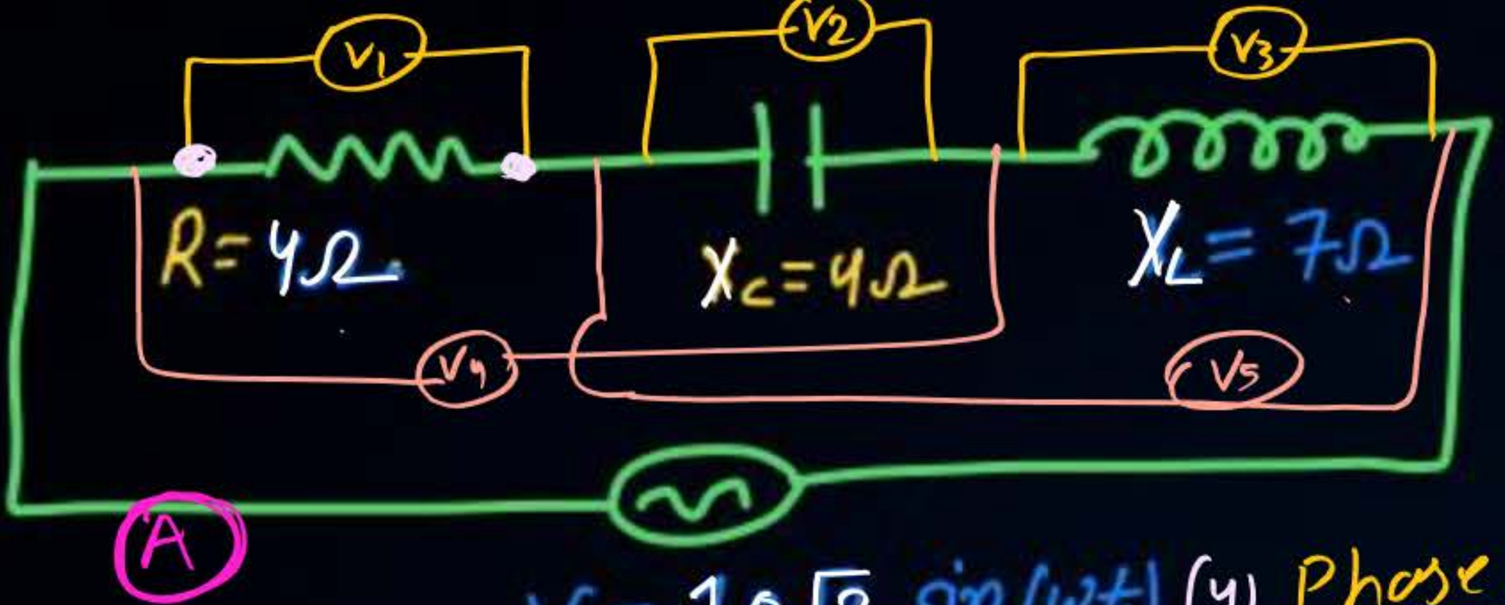
Wattless current

→ current at a phase difference of $\pi/2$ from voltage is called wattless current – $I\sin\phi$



ϕ = phase diffⁿ

$$\langle P \rangle_{Avg} = I_{rms} V_{rms} \cos\phi$$



$V = 10\sqrt{2}\sin(\omega t)$

find Sabkuchh.

(1) $Z = \sqrt{R^2 + (X_L - X_C)^2}$

$= \sqrt{4^2 + (7-4)^2}$

$= \sqrt{16+9} = 5\Omega$

(2) $I_0 = \frac{V_0}{Z} = \frac{10\sqrt{2}}{5} = 2\sqrt{2}$

(3) $I_{rms} = \frac{V_{rms}}{Z} = \frac{10}{5} = 2\ \text{Amp}$ (reading of Ammeter)

(4) Phase diff

$\cos\phi = \frac{R}{Z} = \frac{4}{5}$

$\cos\phi = \frac{4}{5}$

$\boxed{\phi = 37^\circ}$ *

$\tan\phi = \frac{|X_L - X_C|}{R} = \frac{7-4}{4} = \frac{3}{4}$

$\boxed{\phi = 37^\circ}$ ✓

(5) Power factor $\cos\phi = \frac{4}{5}$

(6) $\langle P \rangle = I_{rms} V_{rms} \cos\phi$

$= 2 \times 10 \times \frac{4}{5} = 16W$

(7) $V_1 = (V_R)_{rms} = I_{rms} R = 2\times 4 = 8\ \text{volt}$

(8) $V_2 = (V_C)_{rms} = I_{rms} X_C = 2\times 4 = 8\ \text{volt}$

(9) $V_3 = (V_L)_{rms} = I_{rm} X_L = 2\times 7 = 14\ \text{volt}$

Series L.C.R circuit ⇄ Amplifier *

(10) $V_4 = V_{rms}(RC) = \sqrt{V_{R\,rms}^2 + V_{C\,rms}^2}$

$= 8\sqrt{2}$

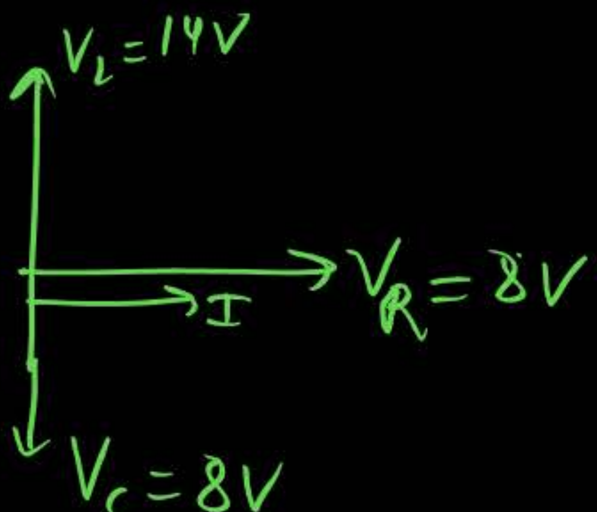
(11) $(V_5) = V_{rms}(LC) = 6\ \text{volt} = |V_L - V_C|_{rms}$

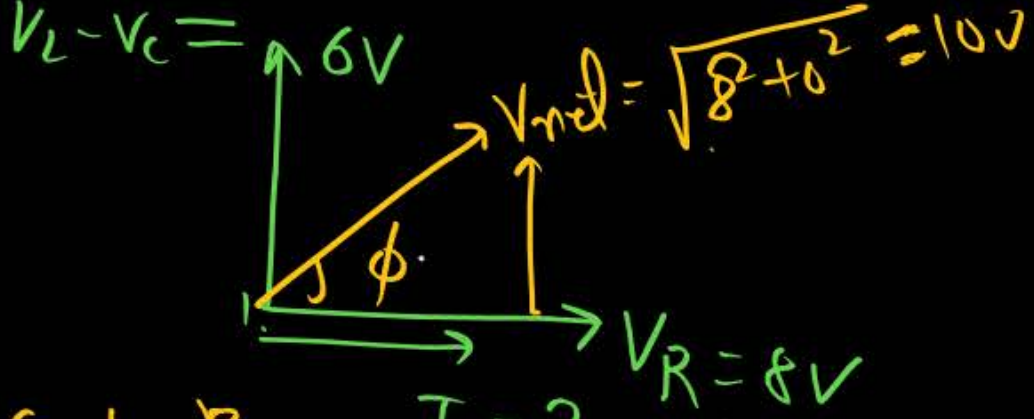
(12) $(V_6) = V_{rms}(L\text{-}R) = \sqrt{14^2 + 8^2}$

(14) Inductive L-C-R circuit

(15) voltage is leading by current by angle 37°.

(16) Phase diagram





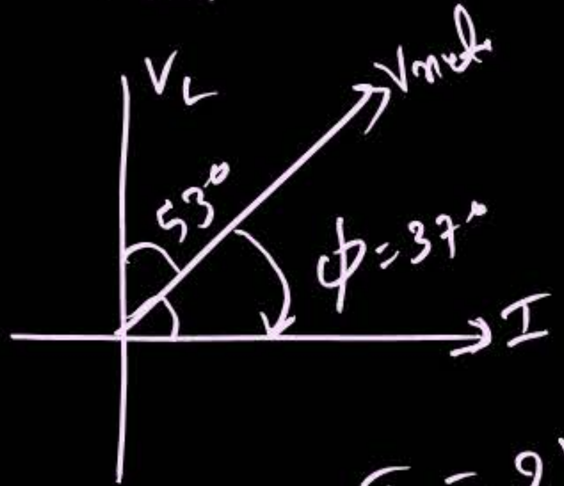
$\cos\phi = \frac{8}{10} = \frac{4}{5}$

$I = 2\sqrt{2}$

$\phi = 37^\circ$

(17) eqn of current

$V_{net} = 10\sqrt{2} \sin(\omega t)$



$I_{BAR} = 2\sqrt{2} \sin(\omega t - 37^\circ)$

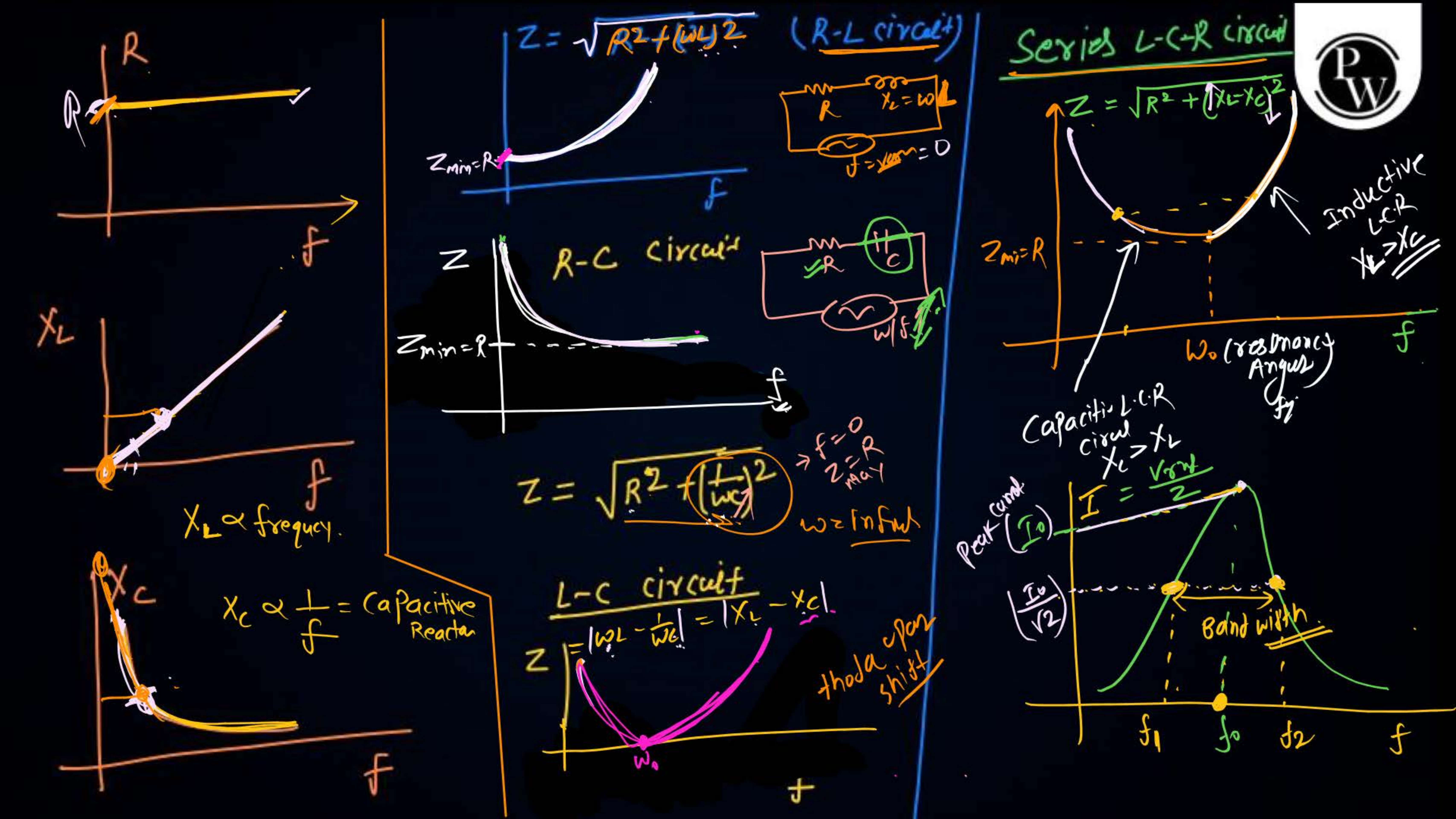
$V_R = V_{R0} \sin(\omega t - 37^\circ)$

$= 8\sqrt{2} \sin(\omega t - 37^\circ)$

(18) eqn of $V_L(t) = ??$

$V_L = V_{L0} \sin(\omega t + 53^\circ)$

$= 14\sqrt{2} \sin(\omega t + 53^\circ)$



R
f
X_L
f
$X_L \propto$ frequcy.
X_C
$X_C \propto \frac{1}{f}$ = Capacitive Reactan
f
$Z = \sqrt{R^2 + (\omega L)^2}$
(R-L circuit)
$Z_{min} = R$
f
R
$X_L = \omega L$
f = 0
Z
R-C circuit
R
C
$Z_{min} = R$
f
$Z = \sqrt{R^2 + \left(\frac{1}{\omega C}\right)^2}$
f = 0
Z = R
max
ω = infinity
L-C circuit
$Z = |\omega L - \frac{1}{\omega C}| = |X_L - X_C|$
Z
ω_0
f
thoda upar shift
Series L-C-R circuit
$Z = \sqrt{R^2 + (X_L - X_C)^2}$
$Z_{min} = R$
Inductive LCR
$X_L > X_C$
ω_0 (resonancy Angular)
f
Capacitive L-C-R circuit
$X_C > X_L$
Peak current
(I_0)
$\left(\frac{I_0}{\sqrt{2}}\right)$
Band width
f_1
f_0
f_2
f

Resonance condition

\# If $X_L = X_C$ → $Z_{min} = R$

$V_L = V_C$

$V_{net} = V_R$

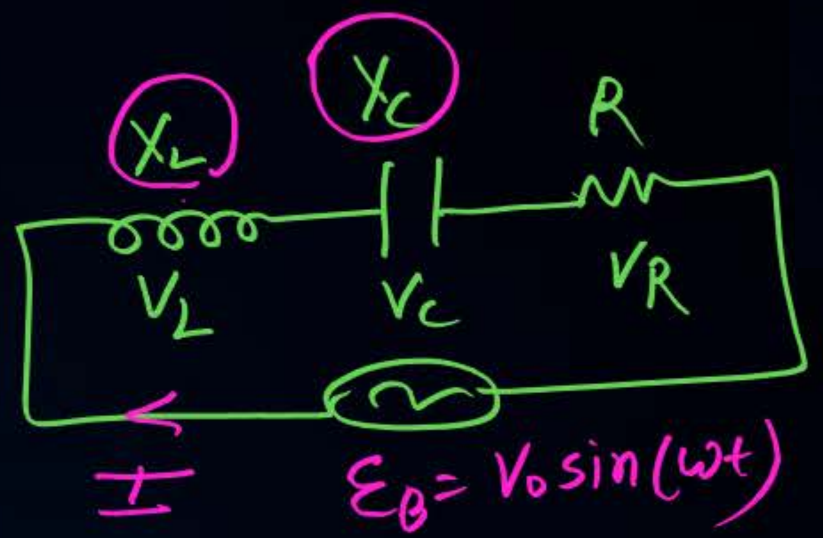


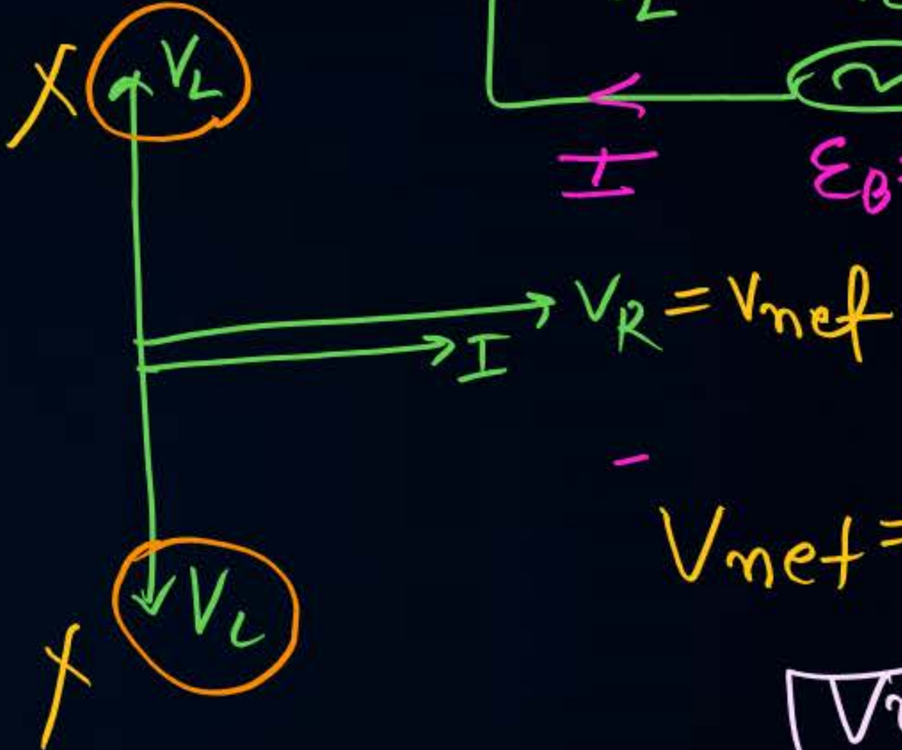
$\phi = 0$

- current & voltage in same phase
- ✓ $\cos\phi = 1$
- ✓ P_{loss} maximum
- ✓ current maximum
- ✓ Impedance minimum

$Z_{min} = R$

- $V_{net} = V_R$





$V_{net} = \sqrt{V_R^2 + (V_L - V_C)^2}$

$V_{net} = V_R$

$X_L = X_C$

$\omega L = \frac{1}{\omega C}$

$\omega^2 = \frac{1}{LC}$

$\omega = \frac{1}{\sqrt{LC}}$

$2\pi f = \frac{1}{\sqrt{LC}}$

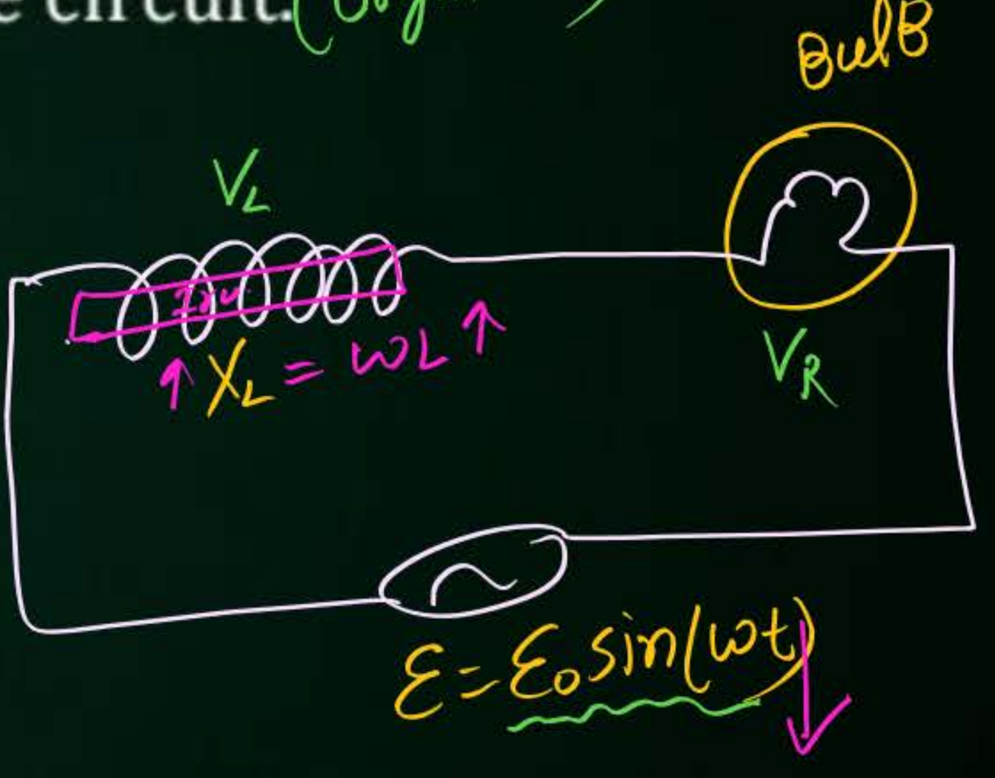
$$f = \frac{1}{2\pi\sqrt{LC}}$$

QUESTION

A coil of self-inductance L is connected in series with a bulb B and an AC source. Brightness of the bulb decreases when

[NEET 2013]

1. a capacitance of reactance $X_C = X_L$ is included in the same circuit.
2. an iron rod is inserted in the coil.
3. frequency of the AC source is decreased.
4. number of turns in the coil is reduced.



QUESTION

A 40 μF capacitor is connected to a 200 V, 50 Hz ac supply. The r.m.s value of the current in the circuit is, nearly [NEET 2020]

1. 1.7 A
2. 2.05 A
3. 2.5 A
4. 25.1 A

Pure capa

$X_c = \frac{1}{\omega C}$

$I_{rms} = \frac{V_{rms}}{X_c} = 200 \times \omega C$

$I_{rms} = 200 \times 2\pi \times 50 \times 40 \mu F$

$= 20 \times 10 \times \pi \times 10^{-6}$

$= 8\pi \times 10^{-1}$

$= 8 \times 3.14 \times 10^{-1}$

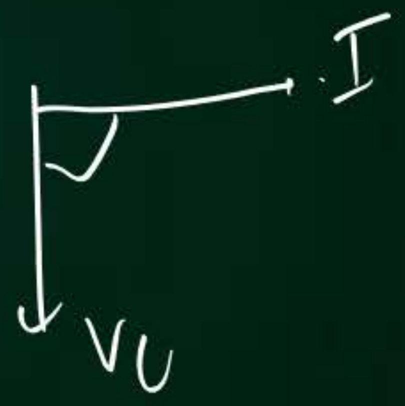
$= 2.25$

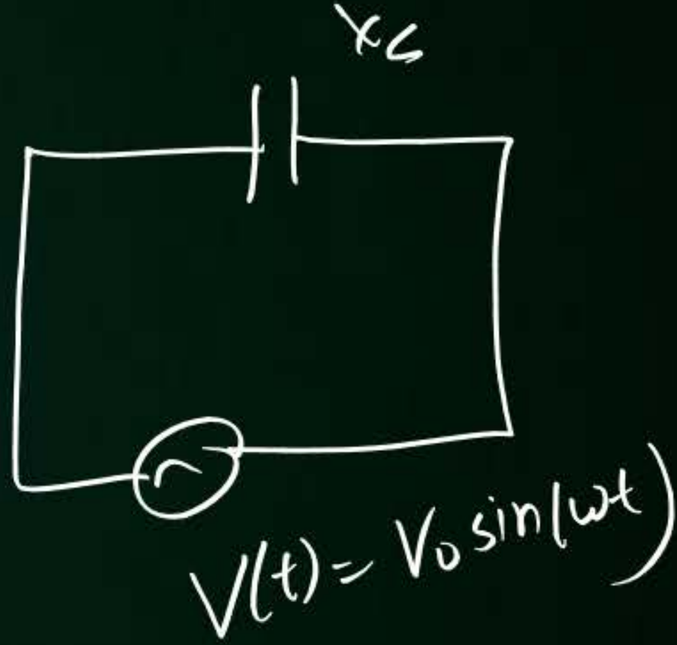
QUESTION

A small signal voltage $V(t) = V_0 \sin\omega t$ is applied across an ideal capacitor C

[NEET-I 2016]

1. Current $I(t)$ is in phase with voltage $V(t)$. ✗
2. Current $I(t)$ leads voltage $V(t)$ by 180°. ✗
3. Current $I(t)$, lags voltage $V(t)$ by 90°. ✗
4. Over a full cycle the capacitor C does not consume any energy from the voltage source. ✓



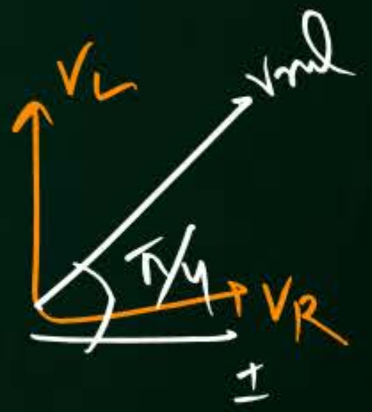


Ans (4)

QUESTION

An ac voltage is applied to a resistance R and an inductor L in series. If R and the inductive reactance are both equal to 3 Ω, the phase difference between the applied voltage and the current in the circuit is **[2011]**





1. $\pi/6$
2. $\pi/4$
3. $\pi/2$
4. zero

QUESTION

A coil has resistance 30 ohm and inductive reactance 20 ohm at 50 Hz frequency. If an ac source, of 200 volt, 100 Hz, is connected across the coil, the current in the coil will be

[Mains 2011]

1. 2.0 A
2. 4.0 A
3. 8.0 A
4. $\frac{20}{\sqrt{3}}$ A

QUESTION

In an A.C. circuit, the current flowing is $I = 5\sin(100t - \pi/2)$ ampere and the potential difference is $V = 200\sin(100t)$ volts. The power consumption is equal to [1995]

1. 20 W
2. 0 W
3. 1000 W
4. 40 W

$\phi = \pi/2$

$\cos \pi/2 = 0$

QUESTION

The instantaneous values of alternating current and voltages in a circuit are given as

$$i = \frac{1}{\sqrt{2}} \sin(100\pi t) \text{ ampere}$$

$$e = \frac{1}{\sqrt{2}} \sin\left(100\pi t + \frac{\pi}{3}\right) \text{volt}$$

The average power in watts consumed in the circuit is **[Mains 2012]**

1. $\frac{1}{4}$
2. $\frac{\sqrt{3}}{4}$
3. $\frac{1}{2}$
4. $\frac{1}{8}$ ✓

$\phi = \pi/3$

$\langle P \rangle = I_{rm} V_{rm} \cos(\pi/3)$

$= \frac{1}{\sqrt{2}\times\sqrt{2}} \times \frac{1}{\sqrt{2}\times\sqrt{2}} \times \frac{1}{2}$

$= \frac{1}{8} W$

QUESTION

A circuit when connected to an AC source of 12 V gives a current of 0.2 A. The same circuit when connected to a DC source of 12 V, gives a current of 0.4 A. The circuit is

[Odisha NEET 2019]

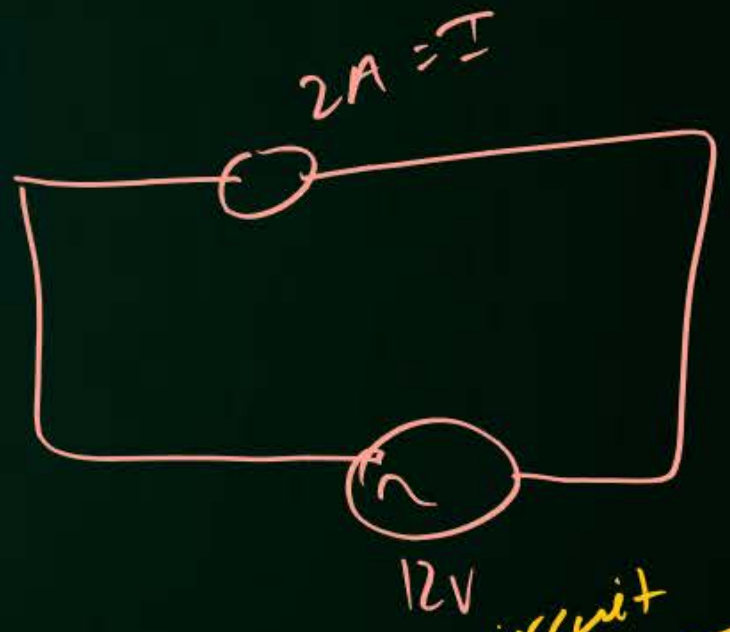
1. series LR (30%)
2. series RC
3. series LC
4. series LCR (42%)

अगर C हुआ तो D/C मे

$X_c = \text{inf.}$

$I = 0$

∞



capaci → D/C filter circuit

QUESTION

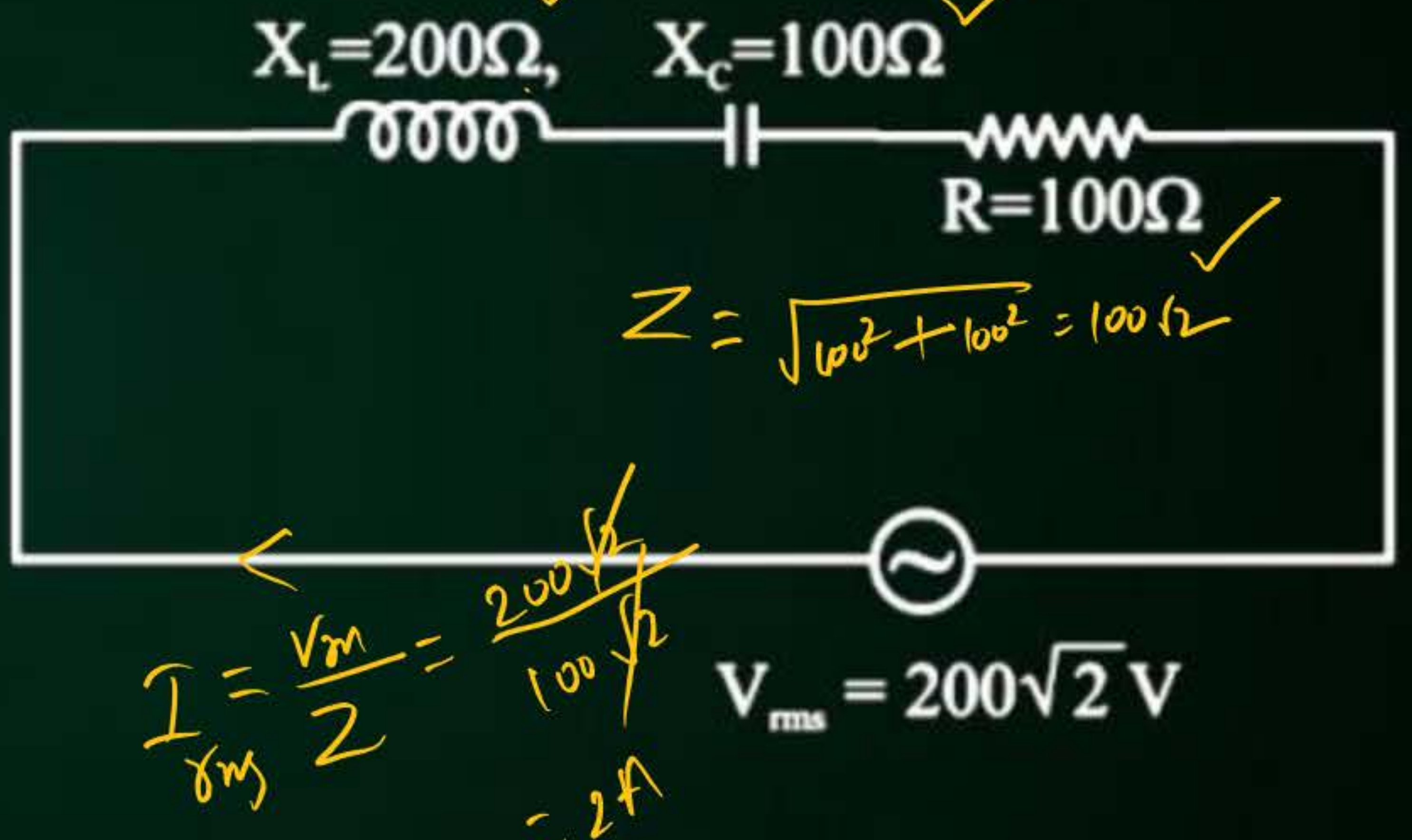
Two cables of copper are of equal lengths. One of them has a single wire of area of cross-section A, while other has 10 wires of cross-sectional area $A/10$ each. Give their suitability for transporting A.C. and D.C. [1994]

1. only multiple strands for A.C., either for D.C.
2. only multiple strands for A.C., only single strand for D.C.
3. only single strand for D.C., either for A.C.
4. only single strand for A.C., either for D.C.

QUESTION

In the given circuit, rms value of current (I_{rms}) through the resistor R is:

[JEE Mains-2023]



1. 2A
2. $\frac{1}{2}$A
3. 20A
4. $2\sqrt{2}$A

QUESTION

If wattles current flows in the AC circuit, then the circuit is . [JEE Mains-2022]

1. Purely resistive circuit
2. Purely inductive circuit
3. LCR series circuit
4. RC series circuit only



QUESTION

For a series LCR circuit, I vs ω curve is shown:

(a) To the left of ω_r, the circuit is mainly capacitive.

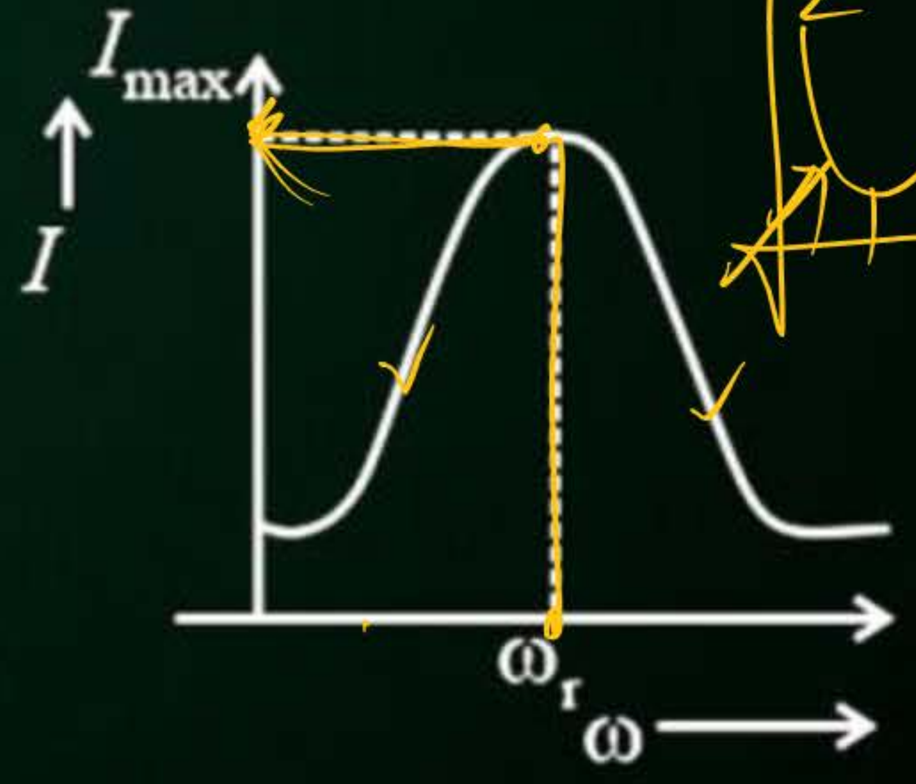
(b) To the left of ω_r, the circuit is mainly inductive

(c) At ω_r, impedance of the circuit is equal to the resistance of the circuit

(d) At ω_r, impedance of the circuit is 0.

Choose the most appropriate answer from the options given below: **[JEE Mains-2022]**

1. (a) and (d) only
2. (b) and (d) only
3. (a) and (c) only
4. (b) and (c) only

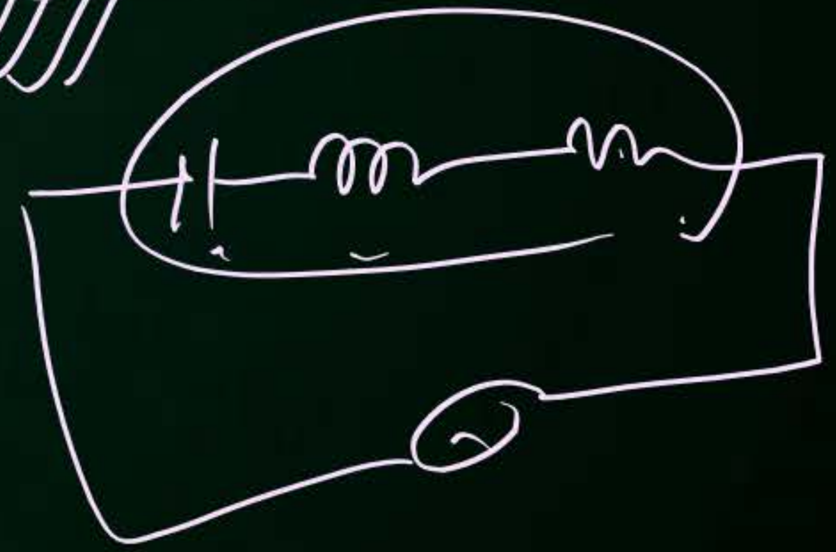


QUESTION

To increase the resonant frequency in series LCR circuit, **[JEE Mains-2022]**

$$f_0 = \frac{1}{2\pi\sqrt{LC}}$$

1. Source frequency should be increased
2. Another resistance should be added in series with the first resistance
3. Another capacitor should be added in series with the first capacitor
4. The source frequency should be decreased



QUESTION

What happens to the inductive reactance and the current in a purely inductive circuit if the frequency is halved? [JEE Mains-2021]

1. Both, inductive reactance and current will be halved
2. Inductive reactance will be halved and current will be doubled
3. Inductive reactance will be doubled and current will be halved
4. Both, inducting reactance and current will be doubled

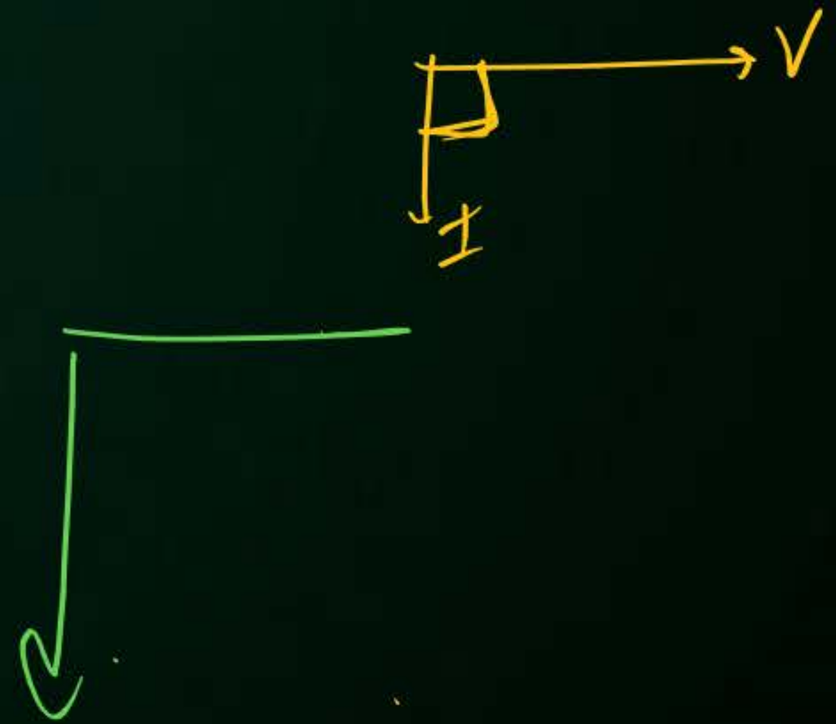
QUESTION

An a.c. source given by $V = V_m \sin \omega t$ is connected to a pure inductor L in a circuit and I_m is the peak value of the ac current. The instantaneous power supplied to the inductor is:

1. $\frac{V_m I_m}{2} \sin(2\omega t)$
2. $-\frac{V_m I_m}{2} \sin(2\omega t)$
3. $V_m I_m \sin^2(\omega t)$
4. $-V_m I_m \sin^2(\omega t)$

$\langle P \rangle = I_t V_t$

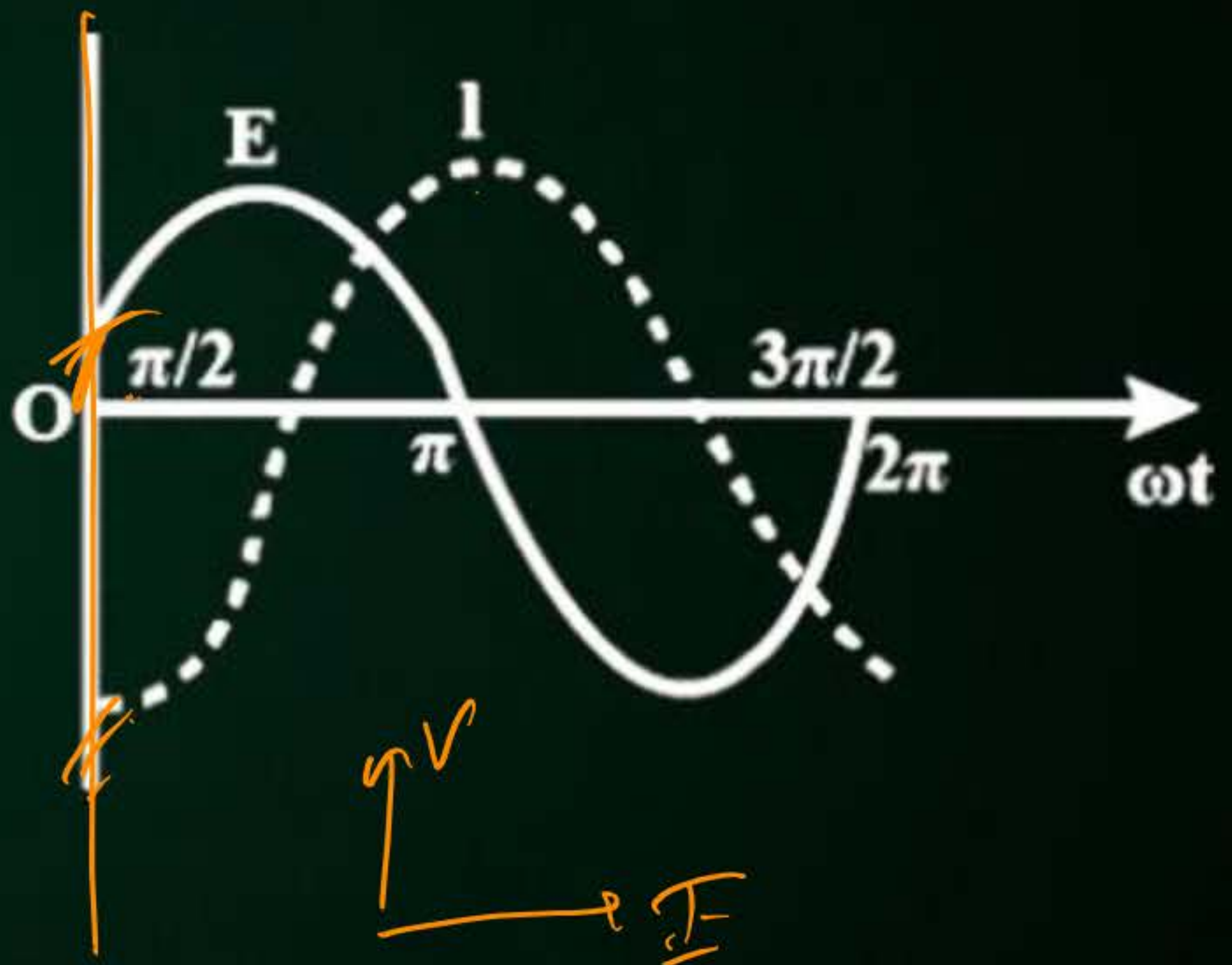
$= -V_m \sin(\omega t) I_m \cos(\omega t)$



QUESTION

The variation of the instantaneous current (I) and the instantaneous emf (E) in a circuit are shown in the figure. Which of the following statements is correct?

1. The voltage lags behind the current by $\pi/2$
2. The voltage leads the current by $\pi/2$
3. The voltage and the current are in phase
4. The voltage leads the current by π



QUESTION

The equation of an alternating voltage is $V = 220 \sin\left[\omega t + \frac{\pi}{6}\right]$ and the equation for current is $I = 10 \sin\left[\omega t + \frac{\pi}{6}\right]$. The impedance (in ohm) of the circuit is

(1) 11

(2) 44

(3) 20

(4) 22 ✓

$I = \frac{V}{Z}$

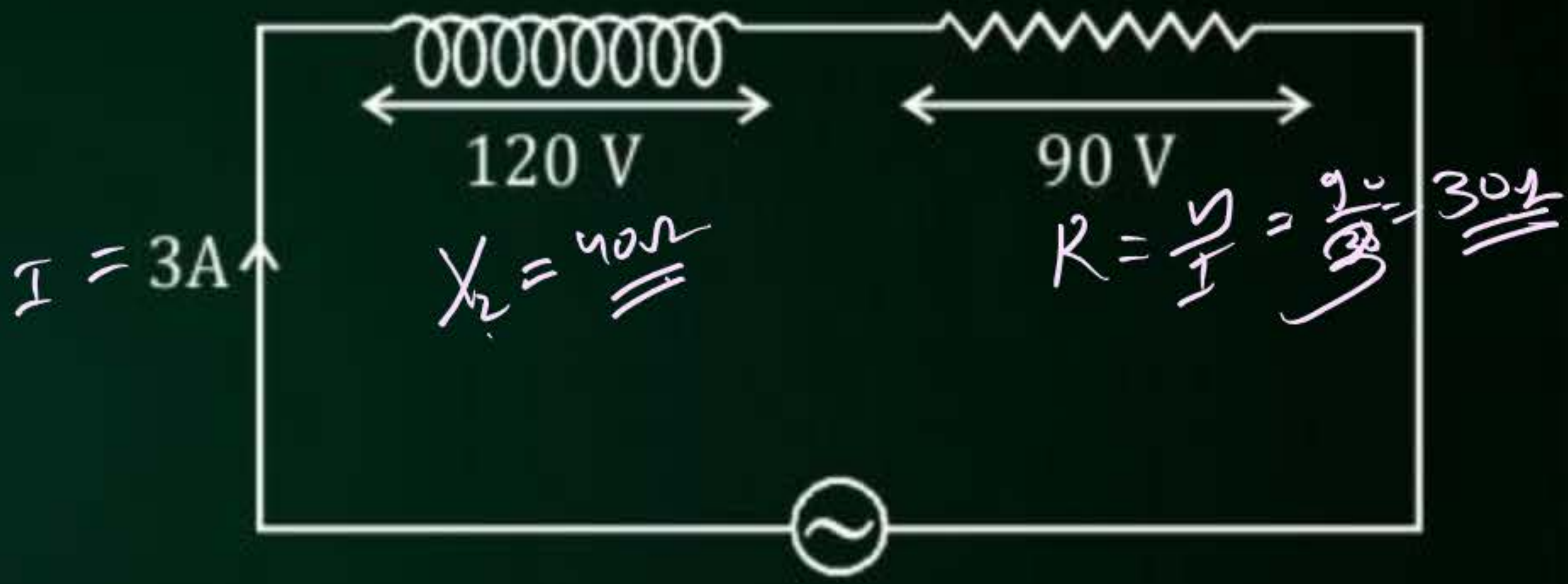
$Z = \frac{V_0}{I_0} = \frac{220}{10}$

$Z = \sqrt{R^2 + (X_L - X_C)^2}$ ✓

QUESTION

Impedance of the circuit shown in the figure is

1. $100\,\Omega$
2. $50\,\Omega$
3. $30\,\Omega$
4. $40\,\Omega$



QUESTION

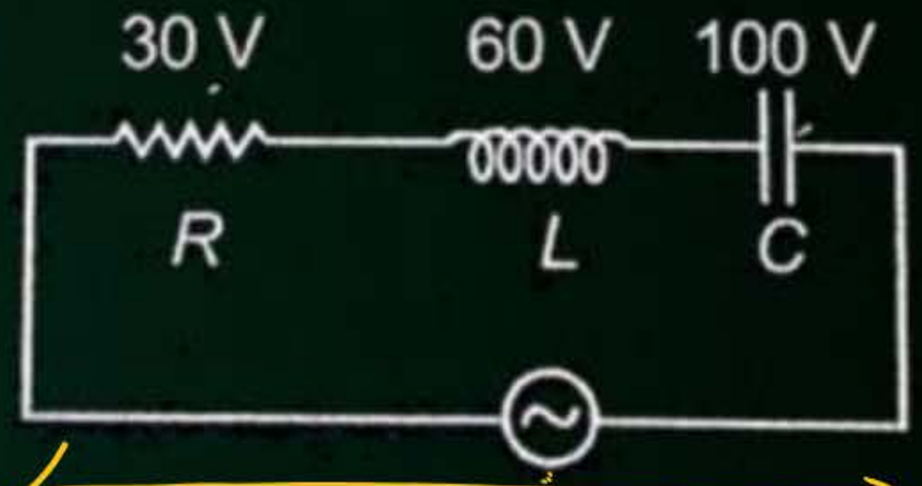
In an A.C. circuit V and I are given by $V = 100 \sin (100t)$ volts. $I = 100 \sin \left(100t + \frac{\pi}{3}\right)$ mA. The power dissipated in the circuit is

1. 10^4 watt
2. 10 watt
3. 2.5 watt
4. 5.0 watt



QUESTION

In a series RLC circuit, potential differences across R, L and C are 30 V, 60 V and 100 V respectively as shown in figure. The e.m.f. of source (in volts) is



1. 190
2. 70
3. 50
4. 40

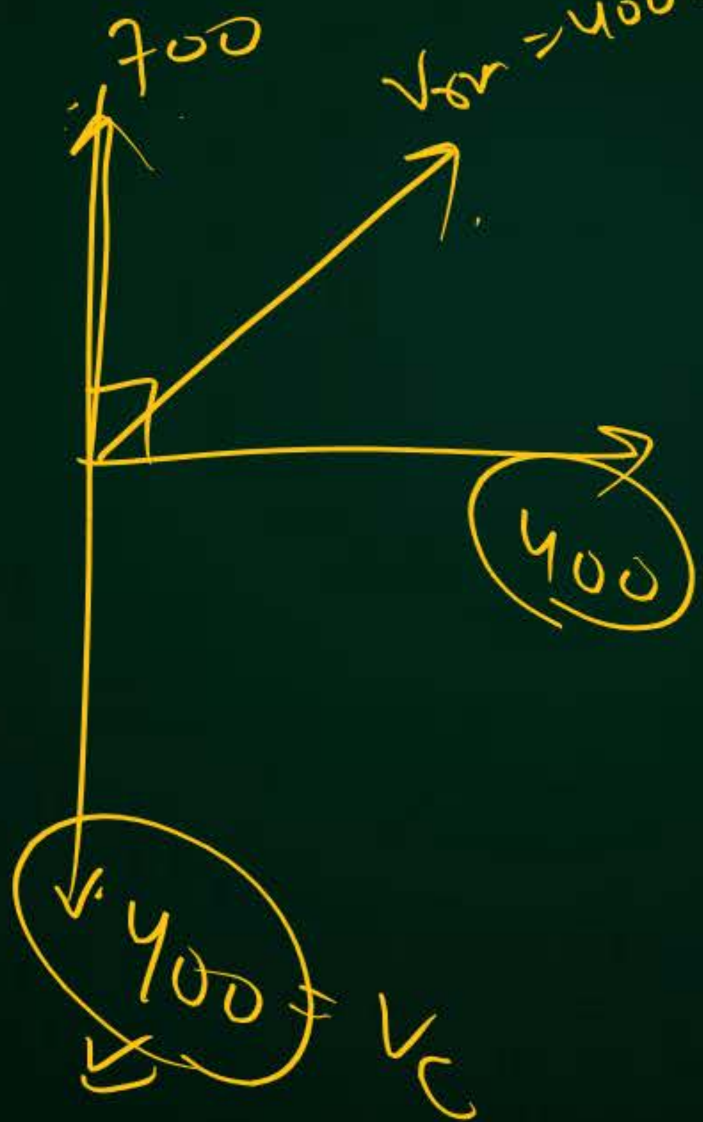
$(emf)_{rms} = \sqrt{V_R^2 + (V_L - V_C)^2}$

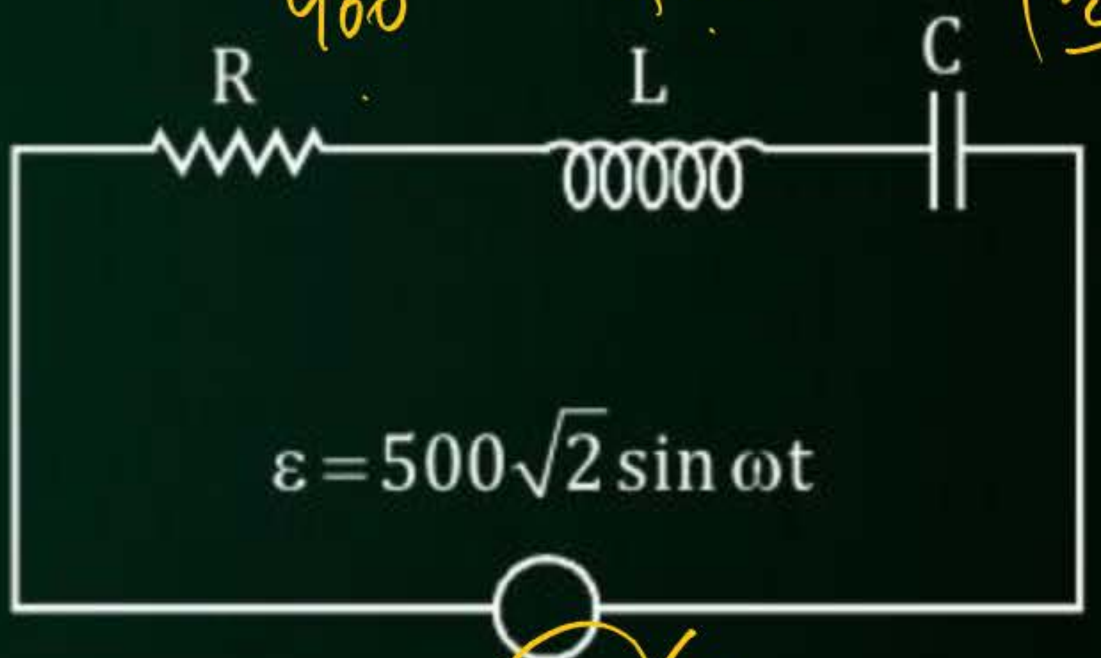
$= \sqrt{(30)^2 + (100-60)^2}$

QUESTION

In a series RLC circuit, the r.m.s. voltage across the resistor and the inductor are respectively 400 V and 700 V. If the equation for the applied voltage is $\varepsilon = 500\sqrt{2}\sin\omega t$, then the peak voltage across the capacitor is

1. 1200 V
2. $1200\sqrt{2}$ V
3. 400 V
4. $400\sqrt{2}$ V

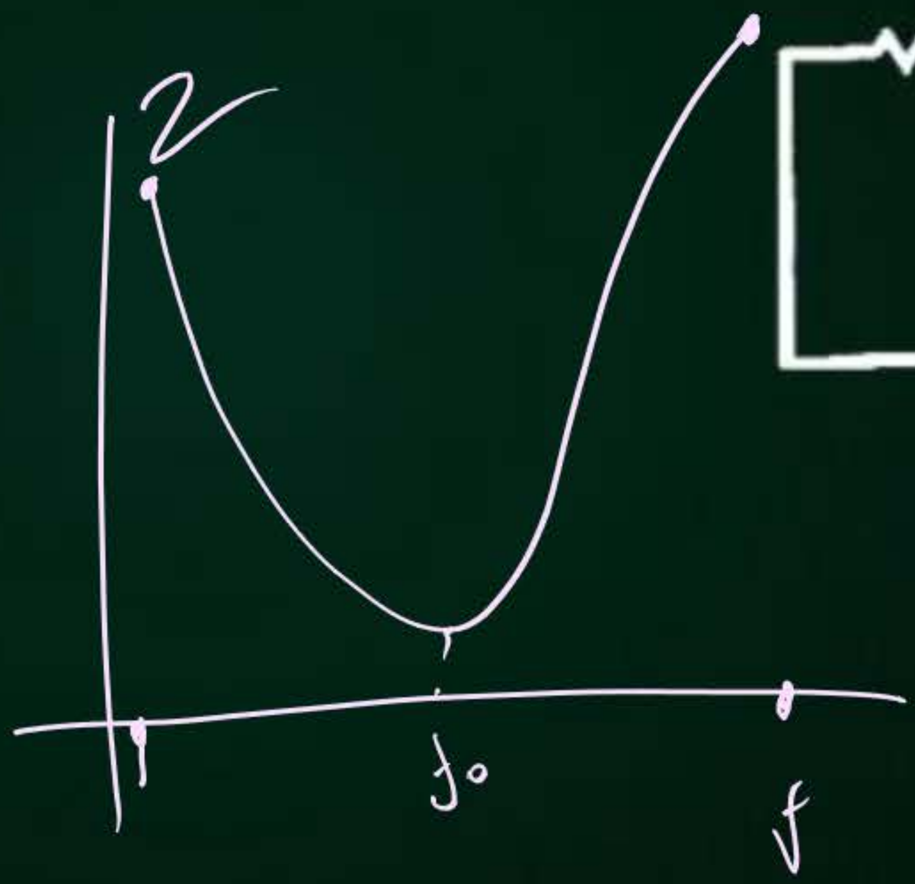


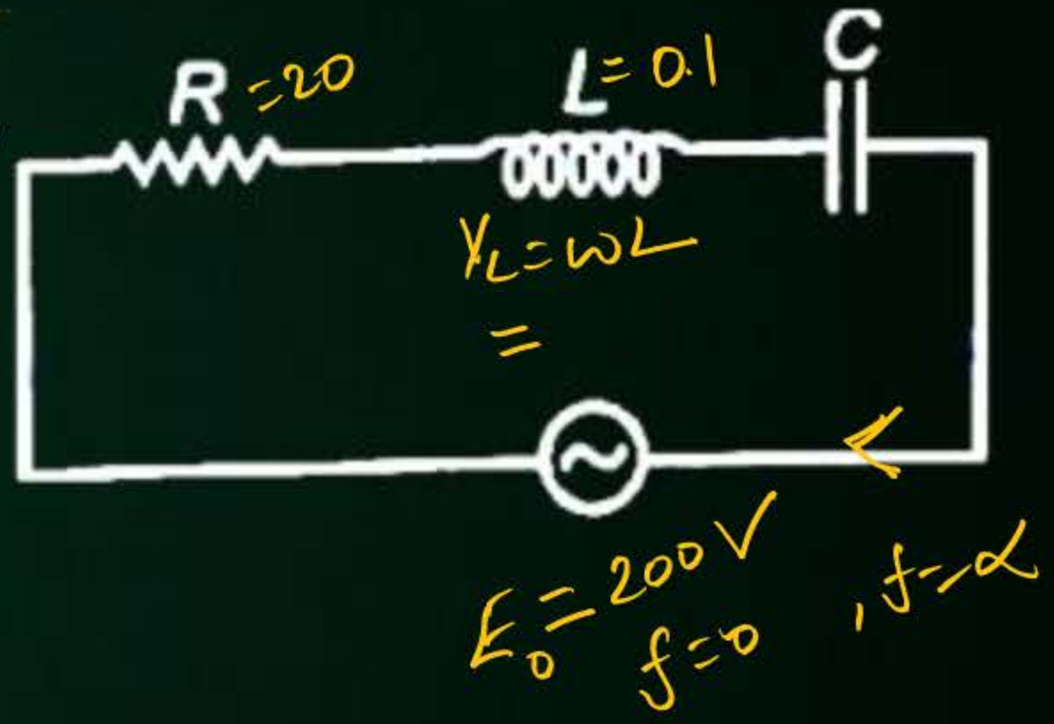


QUESTION

In the following circuit the emf of source is $E_0 = 200$ volt, $R = 20\ \Omega$, $L = 0.1$ henry, $C = 10.6$ farad and frequency is variable then the current at frequency $f = 0$ and $f = \infty$ is

1. Zero, 10 A
2. 10 A, zero
3. 10 A, 10 A
4. Zero, zero

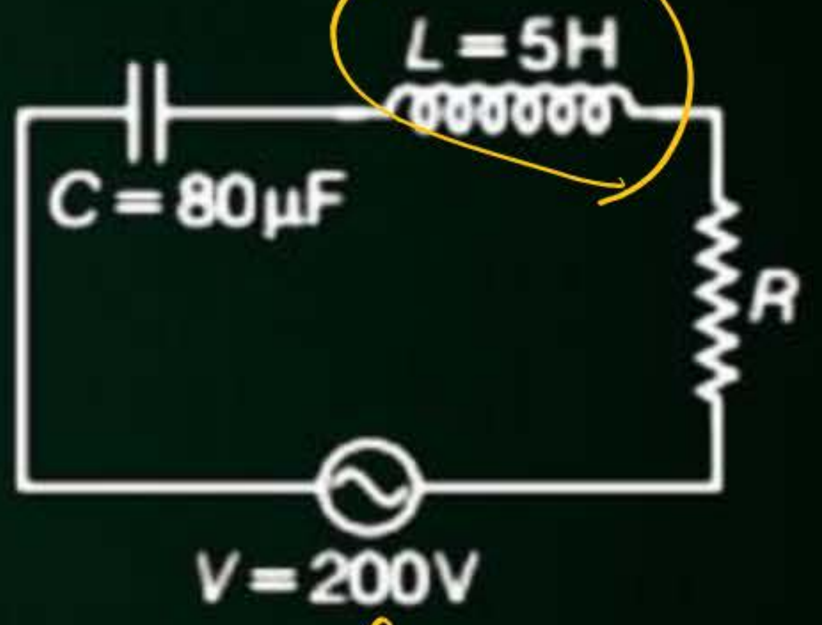




QUESTION

Figure shows a series L-C-R circuit, connected to a variable frequency 200 V source. C = 80 μF and R = 40 Ω. The source frequency which drives the circuit at resonance is

1. 25 Hz
2. $\frac{25}{\pi}$ Hz
3. 50 Hz
4. $\frac{50}{\pi}$ Hz



$$f = \frac{1}{2\pi\sqrt{LC}}$$

$$= \frac{1}{2\pi\sqrt{5 \times 80 \times 10^{-6}}}$$

$$= \frac{1}{2\pi} \times \frac{1}{\sqrt{400 \times 10^{-6}}}$$

$$= \frac{1}{2 \times \pi \times 20} 10^{3} = \frac{1000}{40\pi} = \frac{25}{\pi}$$

circuit	ϕ	Power factor	Leads ?? / or lag	Phasor dig	Z (gm) / Z vs f	$\langle P \rangle_{loss}$
Pure R						
Pure L						
Pure C						
R-L						
R-C						
L-C						
L-C-R						


THANK YOU
3:00 Am
1hr

YAKEEN 2.0

FOR NEET 2025

Lecture- 04 | **Physics**

Alternating Current



By- Dr. Manish Raj (MR SIR)

Todys Goal

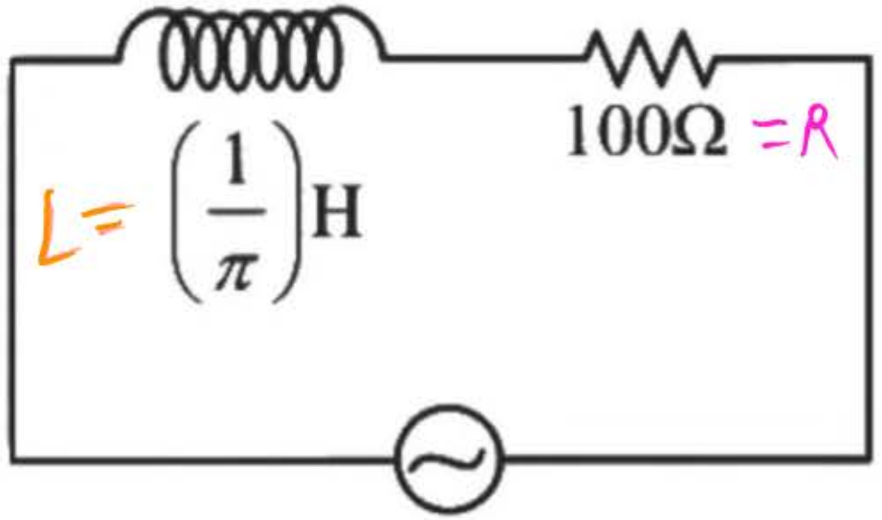
Quality factr

Band width

Question Practice

2023

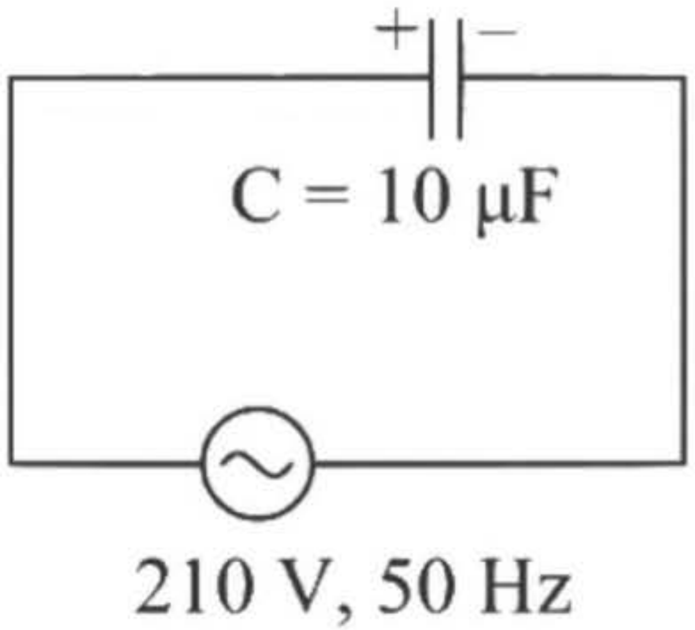
Q1: An ac source is connected in the given circuit. The value of � ϕ will be :



$$V = 220 \sin(100\pi t + \phi) \text{ Volt}$$

(a) 60o
(b) 90o
(c) 30o
(d) 45o

Q2: A 10μF capacitor is connected to a 210V, 50 Hz source as shown in figure. The peak current in the circuit is nearly (π=3.14) :



(a) 0.58 A

(b) 0.93 A

(c) 1.20 A

(d) 0.35 A [2024]

$I_{rms} = \frac{V_{rms}}{X_C} = 210 \times \omega \times C$

$= 210 \times 2\pi \times 50 \times 10 \times 10^{-6}$

$I_{rms} = 42 \times 5 \times 3.14 \times 10^{-3}$

$I_0 = I_{rms}\sqrt{2}$

$= 208 \times 3.14 \times 1.41 \times 10^{-3}$

Q2: If Z_1 and Z_2 are the impedances of the given circuits (a) and (b) as shown in figures, then choose the correct option

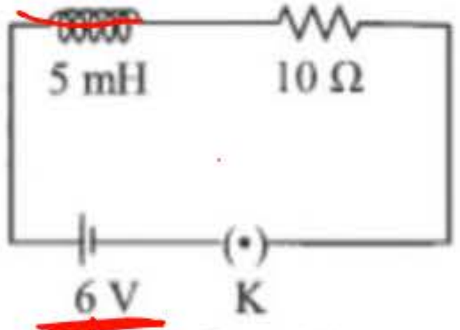


figure (a)

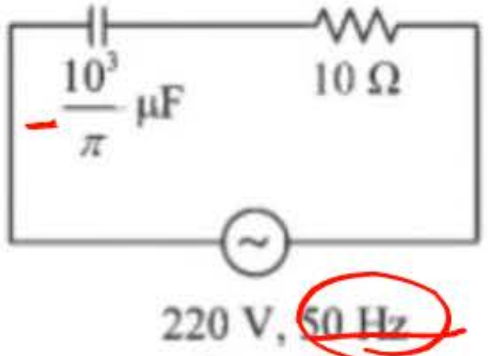


figure (b)

(a) $Z_1 < Z_2$
(b) $Z_1 + Z_2 = 20\,\Omega$
(c) $Z_1 = Z_2$
(d) $Z_1 > Z_2$

Q3: The maximum power is dissipated for an ac in a/an:

(a) resistive circuit

(b) LC circuit

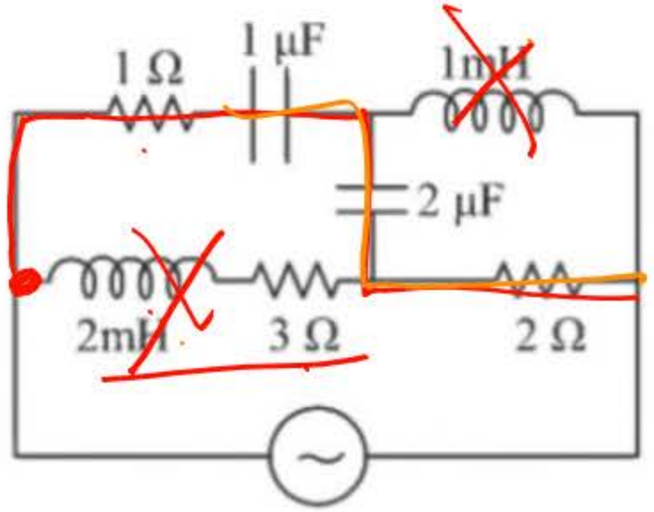
(c) inductive circuit

(d) capacitive circuit

(a)

NEET- 2022

Q4: For very high frequencies, the effective impedance of the circuit (shown in the figure) will be:-



(a) 4 Ω

(b) 6 Ω

(c) 1 Ω

(d) 3 Ω

Q6: In a series LCR circuit, the inductance L is 10 mH, capacitance C is 1 μF, and resistance R is 100 Ω. The frequency at which resonance occurs is

(a) 15.9 rad/s

(b) 15.9 kHz

(c) 1.59 rad/s

(d) 1.59 kHz

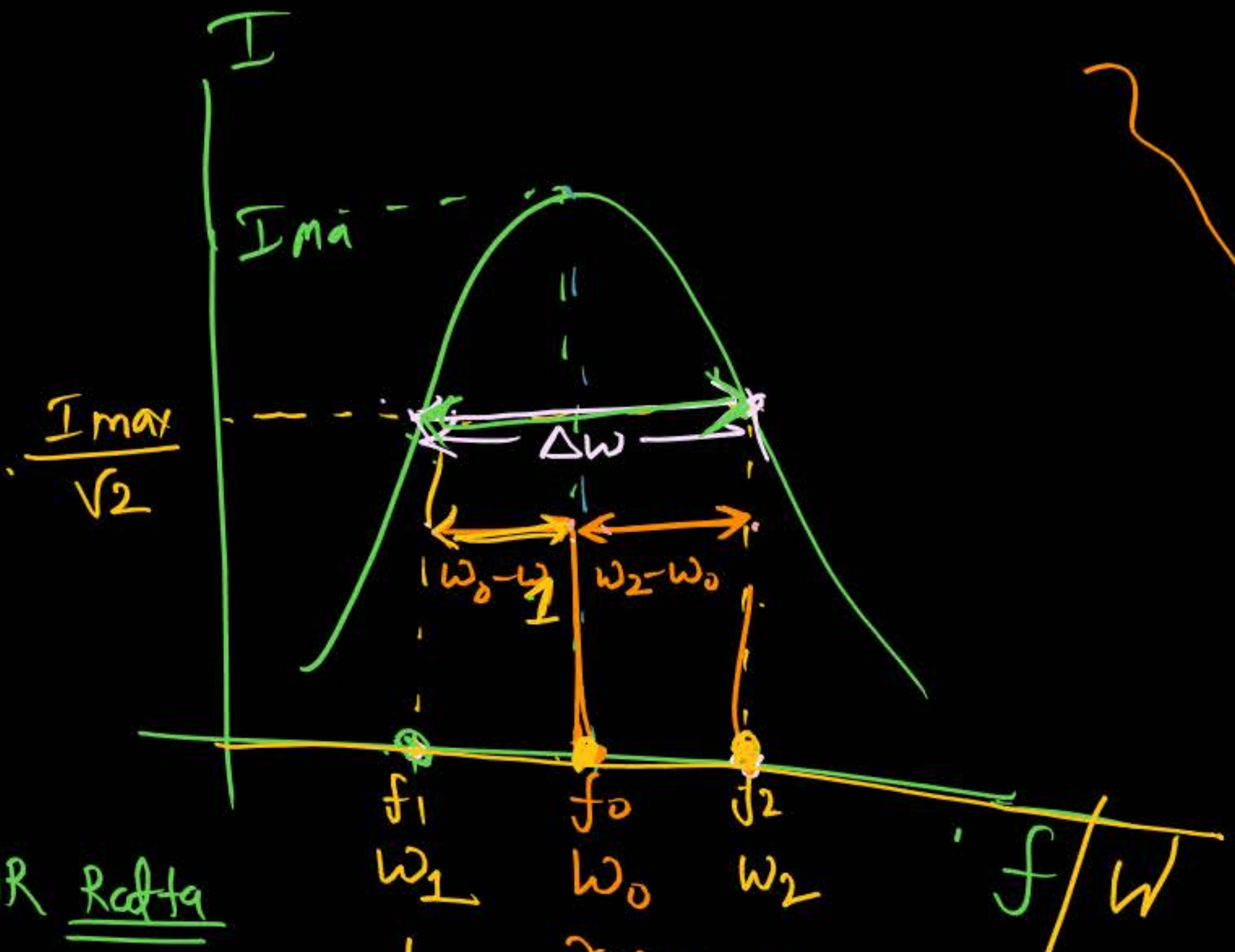
$$f = \frac{1}{2\pi\sqrt{LC}}$$

Band Width

$$\Delta\omega = \omega_2 - \omega_1$$

$$\omega_2 - \omega_1 = \Delta\omega = \frac{R}{L}$$

MR Rafta



resonance Angular $f^n = \omega_0$

$$2(\omega_0 - \omega_1) = \frac{R}{L} = \Delta\omega$$

$$\omega_0 - \omega_1 = \frac{R}{2L}$$

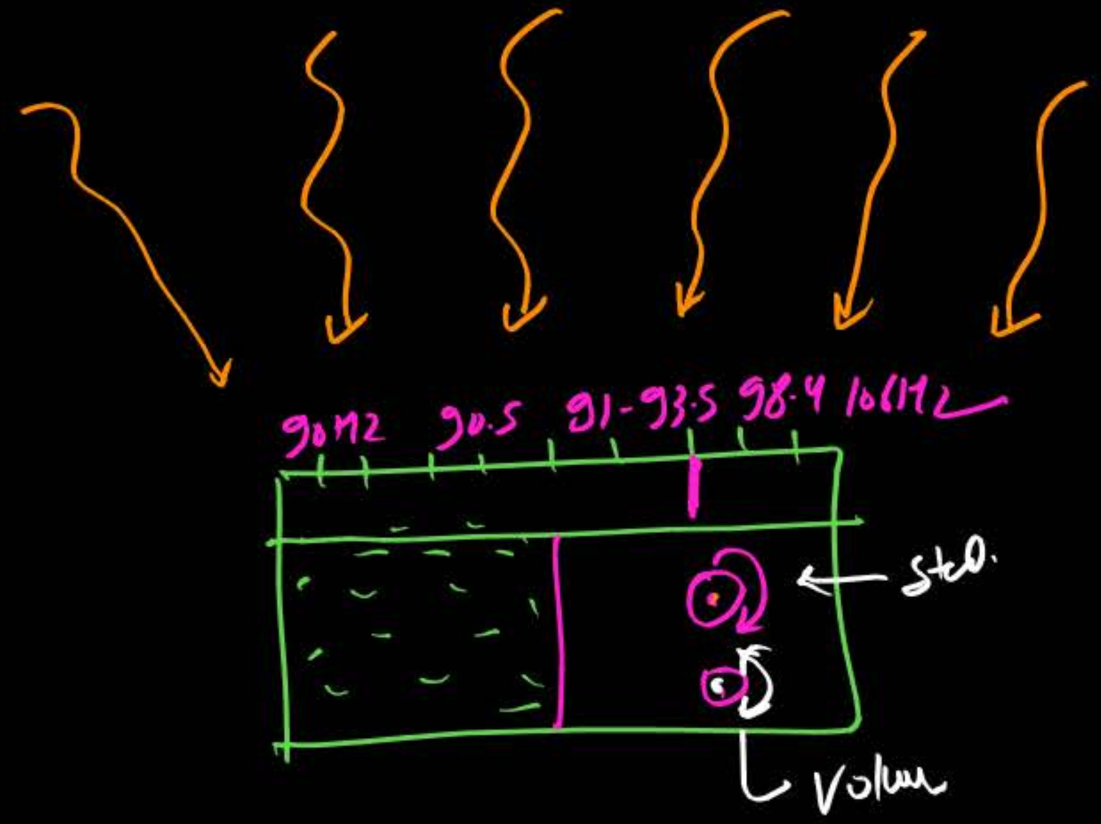
$$\omega_1 = \frac{R}{2L} + \omega_0$$

$$2(\omega_2 - \omega_0) = \frac{R}{L}$$

$$\omega_2 - \omega_0 = \frac{R}{2L}$$

$$\omega_2 = \omega_0 - \frac{R}{2L}$$

→ Half Power Angu. frequency ω_1 & ω_2.

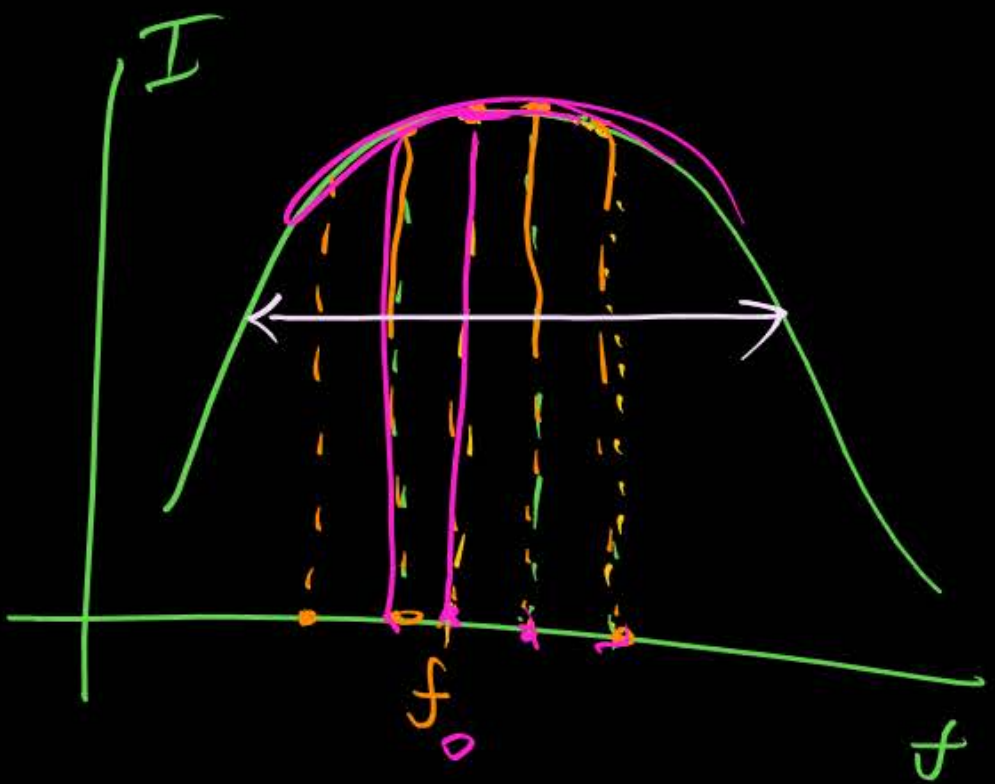


Radio → चलता फिरता

L·C·R circuit

$$f_0 = \frac{1}{2\pi\sqrt{LC}}$$

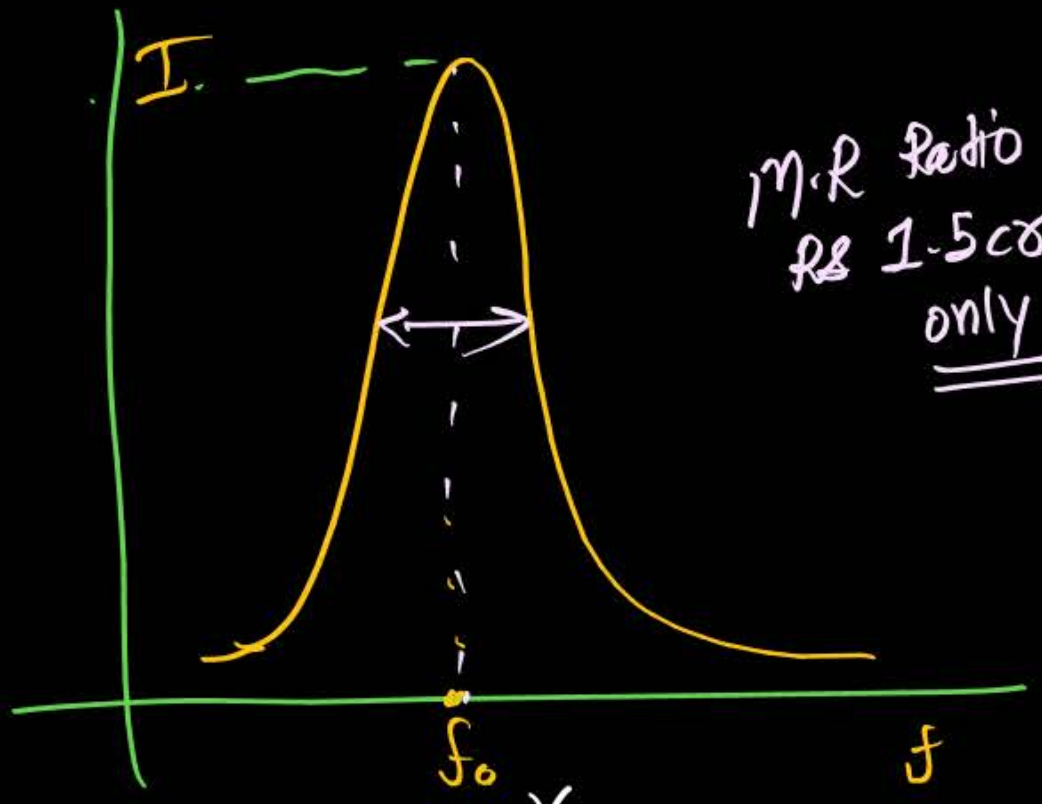
resonance frequ



Ramlal the garibe आपकी Rs → 150/-

$Q_{\text{Ramlal Radio}} \ll Q_{\text{M.R Radio}}$

M.R Radio Rs 1.5cr only



quality factor

$$Q \propto \frac{1}{\Delta\omega}$$

Unit & dimensionless

$$Q = \frac{\omega_0}{\Delta\omega}$$

$$Q = \frac{\omega_0}{\Delta\omega} = \frac{\omega_0 L}{R} = \frac{(X_L)_{reson}}{R} = \frac{X_C}{R}$$

$$Q = \frac{X_L I}{R I} = \frac{V_L}{V_R} = \frac{V_C}{V_R}$$

$$Q = \frac{\omega_0 L}{R} = \frac{L}{R\sqrt{LC}} = \frac{1}{R}\sqrt{\frac{L}{C}}$$ *

QUESTION

Which of the following combinations should be selected for better tuning of an L-C-R circuit used for communication?

[NEET-II 2016]

1. $R = 20\,\Omega, L = 1.5\,H, C = 35\,\mu F$
2. $R = 25\,\Omega, L = 2.5\,H, C = 45\,\mu F$
3. $R = 15\,\Omega, L = 3.5\,H, C = 30\,\mu F$
4. $R = 25\,\Omega, L = 1.5\,H, C = 45\,\mu F$

$Q \rightarrow High = \frac{1}{R}\sqrt{\frac{L}{C}}$

Ans (3)

Q4: A series LCR circuit containing a 5.0 H inductor, 80 μF capacitor, and 40 Ω resistor is connected to a 230 V variable frequency AC source. The angular frequencies of the source at which power transferred to the circuit are half the power at the resonant angular frequency are likely to be

(a) 46 rad/s and 54 rad/s ✓ Ans (a)

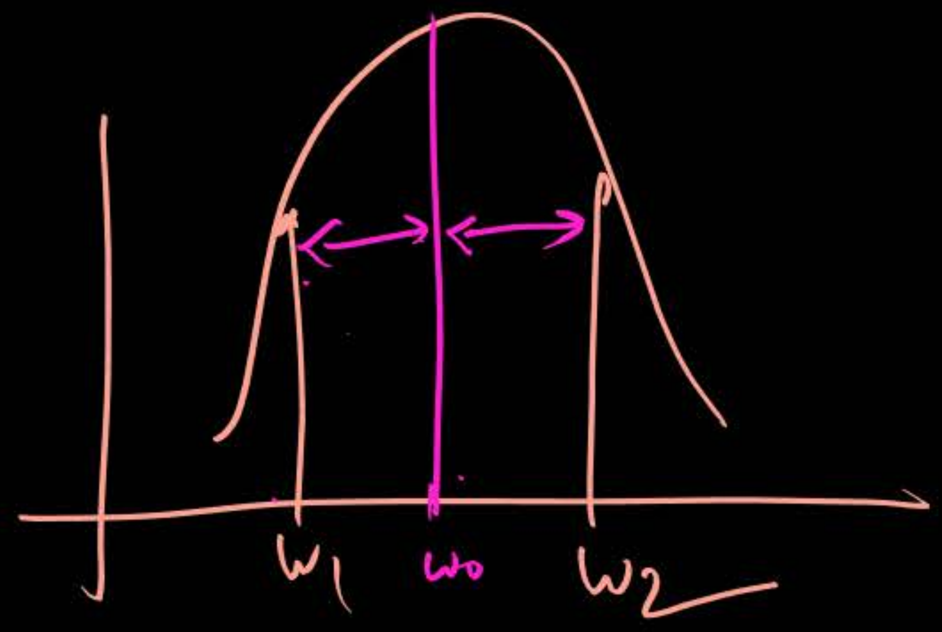
(b) 42 rad/s and 58 rad/s

(c) 25 rad/s and 75 rad/s

(d) 50 rad/s and 25 rad/s

NEET

Sol^n



$2(\omega_0 - \omega_1) = \Delta\omega$

$2(\omega_0 - \omega_1) = \frac{R}{L}$

$\omega_0 - \omega_1 = \frac{R}{2L}$

$\omega_1 = \omega_0 - \frac{R}{2L} = 50 - \frac{40}{2 \times 5} = 50 - 4 = 46$

$\omega_0 = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{5 \times 80 \times 10^{-6}}} = \frac{1}{20 \times 10^{-3}} = \frac{10^3}{20} = 50$

The MR* Table

find err

Circuit	Phase difference between I and V	Power factor $\cos\phi = \frac{R}{Z}$	Impedance	Who Leads	Power Loss
Pure	0	1	R	Same phase	$P = I_{rms} = V_{rms}$
Pure Capacitive	$\pi/2$	Zero	$X_C = \frac{1}{\omega C}$	Current	Zero
Pure Inductive	$\pi/2$	Zero	$X_L = \omega L$	Voltage	Zero
R–L	$0 < \phi < \pi/2$	between 0 to 1	$\sqrt{R^2 + X_L^2}$	Voltage	$P = I_{rms} = V_{rms} \frac{R}{Z}$
R–C	$0 < \phi < \pi/2$	between 0 to 1	$\sqrt{R^2 + X_C^2}$	Current	
L–C	$\pi/2$	Zero	$X_L - X_C$	Depends*	
Series L.C.R	$0 \leq \phi < \pi/2$	1 or Between 0 to 1	$\sqrt{R^2 + (XL - XC)}$	Depends *	

QUESTION

Find reading of voltmeter?

1. 25 V
2. 30 V
3. 40 V
4. $40\sqrt{2}$ V



$Z = \sqrt{6^2 + 8^2}$

$= \sqrt{36 + 64}$

$Z = \sqrt{100} = 10\Omega$

$I_{rms} = \frac{V_{rms}}{Z} = \frac{50}{10} = 5$ Amp

$(V_{X_L}) = I X_L = 5 \times 8 = 40$ Volt.

QUESTION

Find power factor of given circuit

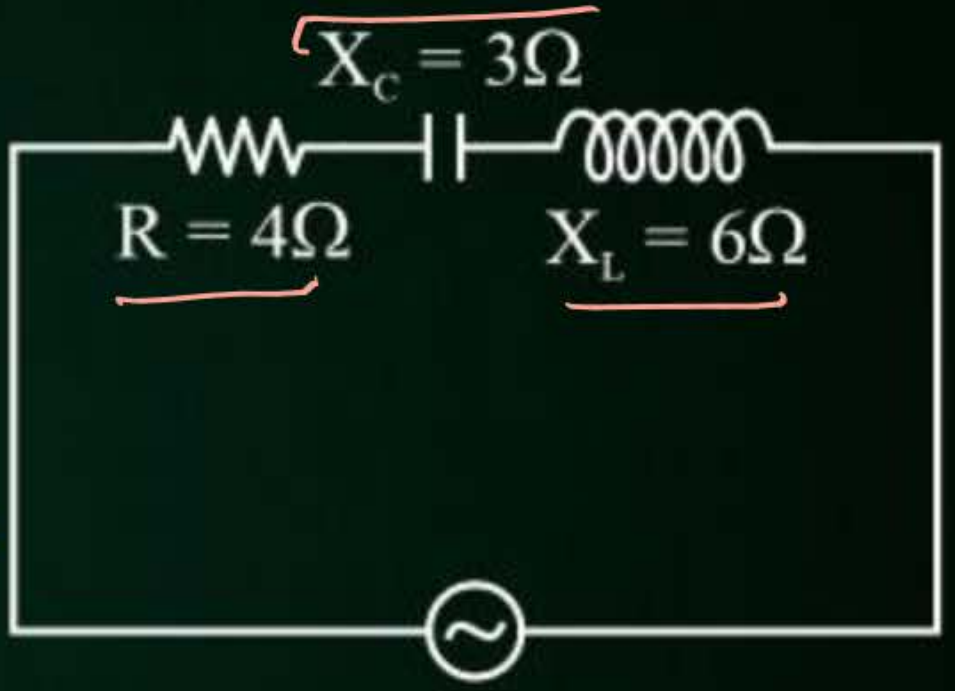
(1) 37

(2) 4/5 ✓

(3) 3/5

(4) 4/3





$$\cos\phi = \frac{R}{Z} = \frac{4}{\sqrt{4^2 + (6-3)^2}} = \frac{4}{5}$$

↑ Power factor

$$\cos\phi = \frac{4}{5}$$

QUESTION

The reactance of a 20 μF capacitor at frequency of 8000 Hz.

1. 1 Ω
2. 4 Ω
3. 5 Ω
4. 0.5 Ω

$$X_C = \frac{1}{\omega C} = \frac{1}{2\pi \times 8000 \times 20 \times 10^{-6}}$$

$$= \frac{1}{32\pi \times 10^{-2}}$$

$$= \frac{10^2}{32\pi}$$

$$= \frac{100}{32 \times 3.14}$$

$$= \frac{100}{96.4}$$

R = Resistance

X_L = Inductive Reactance → unit (Ω)

X_C = Capacitive Reactance → unit (Ω)

QUESTION

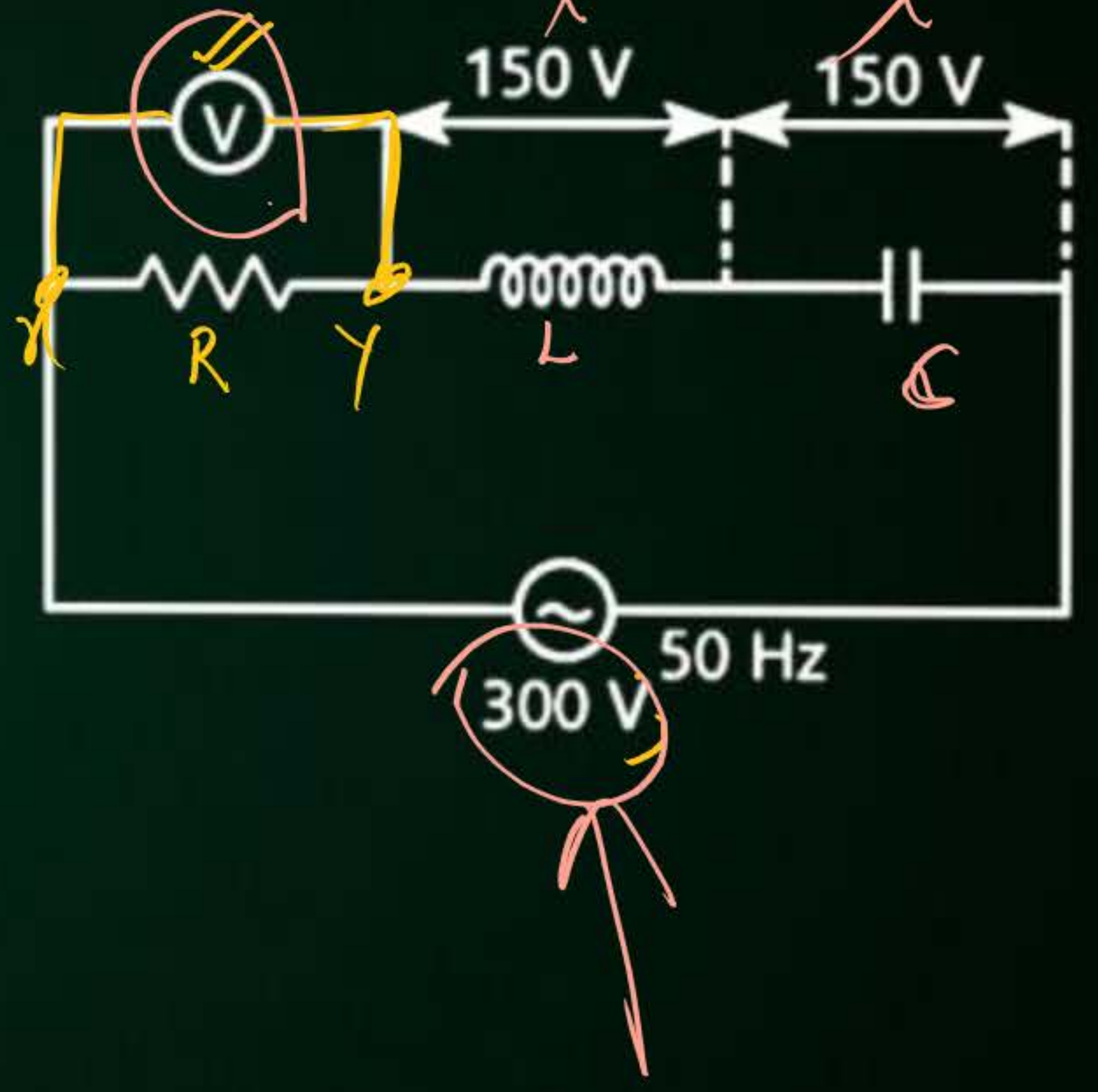
A capacitor of capacitance 8 μF connected with DC source find capacitive reactance.

1. Zero
2. 8 Ω
3. Infinite
4. 16 πΩ

$X_C = \frac{1}{\omega C} = \frac{1}{2\pi f C} = \text{infinite}$

QUESTION

The voltage reading on the voltmeter V in the circuit shown below will be:

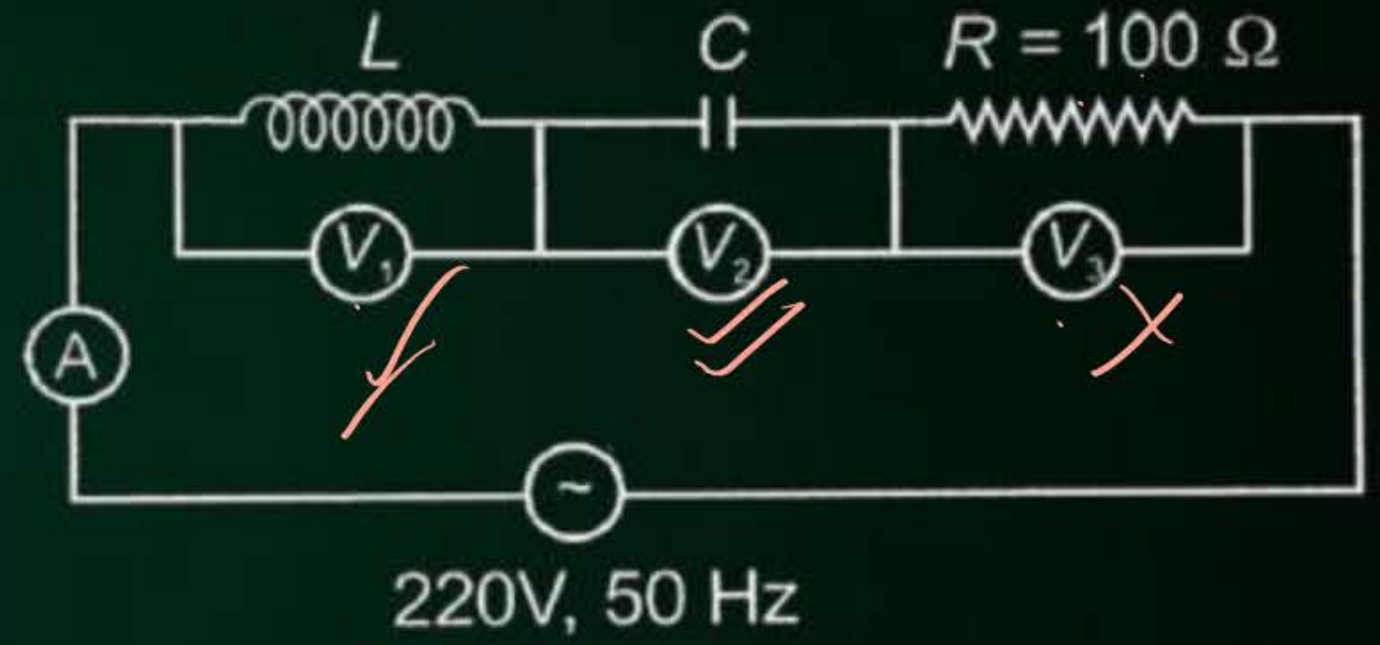


1. zero
2. 100 V
3. 200 V
4. 300 V

QUESTION

In the given circuit the reading of voltmeter V_1 and V_2 are 300 volts each. The reading of the voltmeter V_3 and ammeter A are respectively:

1. 150 V, 2.2 A
2. 220 V, 2.2 A // Ans.
3. 220 V, 2.0 A
4. 100 V, 2.0 A



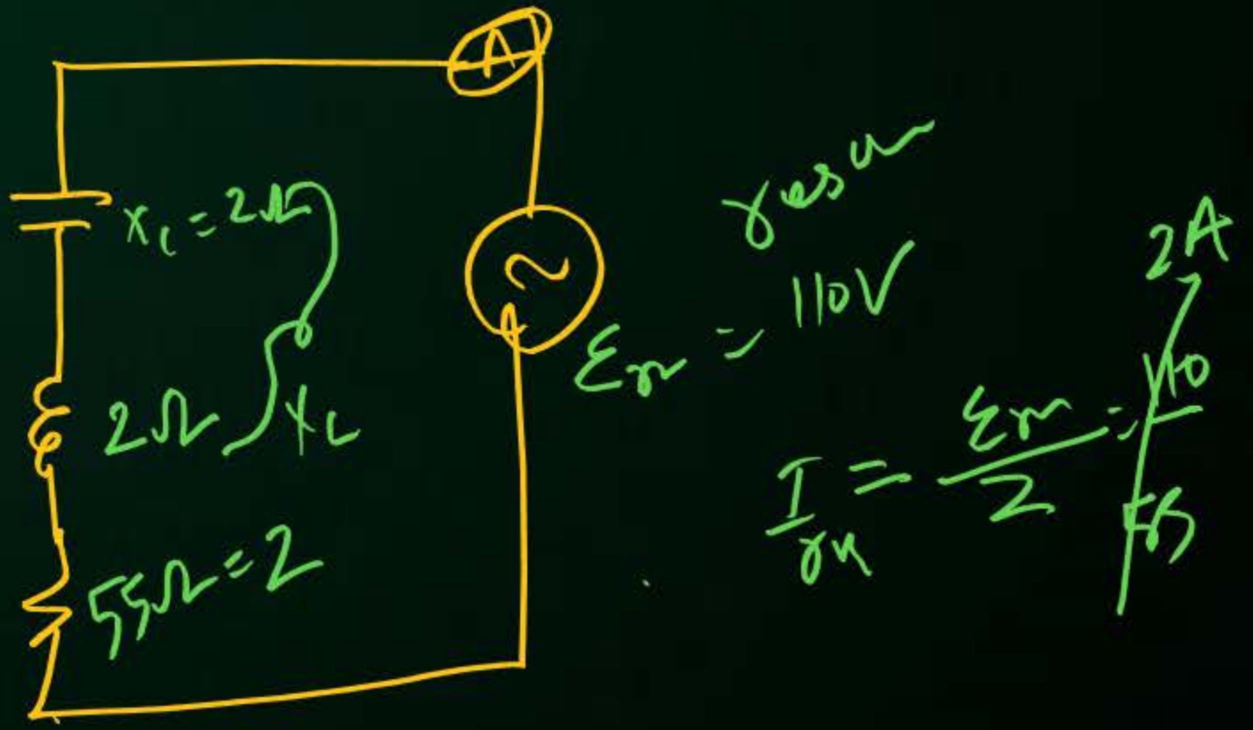
Resonance condⁿ ki circuit hai

QUESTION

The reading of ammeter in the circuit is

1. 2 A
2. 3 A
3. Zero
4. 1 A





QUESTION

In a series LCR circuit which is connected to an AC voltage source, choose the incorrect statement

1. Algebraic sum of instantaneous voltage across L, C, R is a variable
2. $V_{L_{inst}} + VC_{inst} + VR_{inst} = V_{Source_{inst}}$
3. Voltage across inductor, capacitor, resistance behave as a vector
4. Current is same in inductor, capacitor and resistance

$V_{L_t} + V_{C_t} + V_{R_t} = V_{B_t}$

Ans (3)

QUESTION

Bandwidth of the resonant L-C-R circuit is:

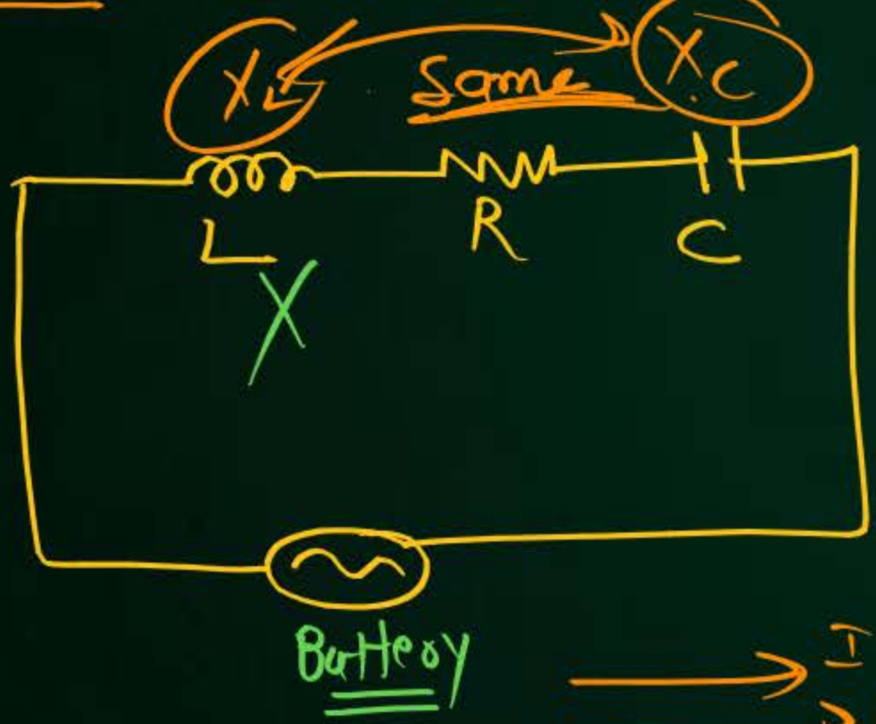
1. R/L
2. R/2L
3. 2R/L
4. 4R/L

$\Delta\omega = \frac{R}{L}$

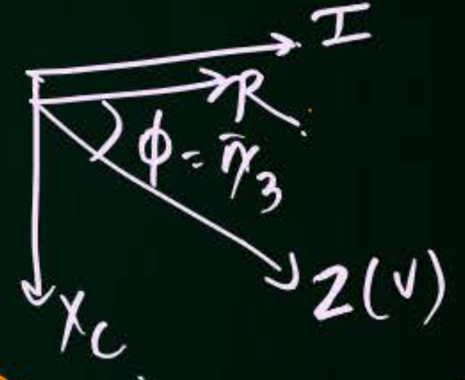
QUESTION

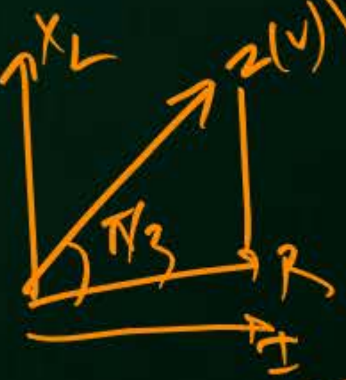
A series *LCR* circuit is connected to an ac voltage source. When L is removed from the circuit, the phase difference between current and voltage is $\pi/3$. If instead C is removed from the circuit, the phase difference is again $\pi/3$ between current and voltage. The power factor of the circuit is **[NEET 2020]**

1. zero
2. 0.5
3. 1.0
4. –1.0









I, V } Same Phase

$\phi = 0$

Power :: $\cos\phi = \cos 0^\circ = 1$

$\tan\phi = \frac{X_C}{R}$ — (I)

$\tan\frac{\pi}{3} = \frac{X_C}{R}$ — (I)

$\tan\frac{\pi}{3} = \frac{X_L}{R}$ — (II)

(I) = (II)

$X_C = X_L$

QUESTION

A series LCR circuit consists of $R = 80\Omega$, $X_L = 100\Omega$ and $X_C = 40\Omega$. The input voltage is $2500 \cos(100\,\pi t)$ V. The amplitude of current, in the circuit, is __________ A.

[JEE Mains-2023]

V_0

$I_0 = ??$

$Z = \sqrt{(100-40)^2 + (80)^2}$

$Z = 100$

$I_0 = \frac{2500}{100} = 25\text{A}$

QUESTION

To increase the resonant frequency in series LCR circuit, [JEE Mains-2022]

$$f_0 = \frac{1}{2\pi\sqrt{LC}}$$

1. Source frequency should be increased
2. Another resistance should be added in series with the first resistance
3. Another capacitor should be added in series with the first capacitor ✓
4. The source frequency should be decreased

done

QUESTION

Given below are two statements:

Statement-I: In an circuit, the current through a capacitor leads the voltage across it.

Statement-II: In ac circuits containing pure capacitance only, the phase difference between the current and the voltage is π.



1. Both statement-I and statement-II are correct
2. Both statement-I and statement-II are incorrect
3. Statement-I is correct but statement-II is incorrect
4. Statement-I is incorrect but statement-II is correct

QUESTION



A lamp is connected in series with a capacitor. AC and DC sources are connected to the circuit one by one, then mark the correct statement/s.

1. When the DC source is connected to the capacitor, the lamp will not glow in a steady-state condition.

2. When the AC source is connected to the capacitor and the capacitance of the capacitor is reduced, the lamp will glow less brightly

3. When the DC source is connected to the capacitor and the capacitance of the capacitor is reduced, the lamp will glow less brightly

4. Both (1) and (2)

QUESTION

Assertion (A): Average value of current in half the cycle of an AC circuit cannot be zero.

Reason (R): For positive half cycle average value of current is i_0/π, where i_0 is the peak value current.

(1) Both A and R are true and R is the correct explanation of A.

(2) Both A and R are true but R is not the correct explanation of A.

(3) A is true but R is false.

(4) A is false and R is also false.



QUESTION

Assertion (A): The alternating current lags behind the emf by a phase angle of $\pi/2$, when AC flows through an inductor.

Reason (R): The inductive reactance increases as the frequency of AC source decreases.

(1) Both A and R are true and R is the correct explanation of A.

(2) Both A and R are true but R is not the correct explanation of A.

(3) A is true but R is false.

(4) A is false and R is also false.

$X_L \propto f$

QUESTION

Assertion (A): Inductive reactance of an inductor in DC circuit is zero.

Reason (R): Angular frequency of DC circuit is zero.

(1) Both A and R are true and R is the correct explanation of A.

(2) Both A and R are true but R is not the correct explanation of A.

(3) A is true but R is false.

(4) A is false and R is also false.

QUESTION

Assertion (A): If an inductor coil is connected to DC source, the current supplied by it is I_1. If the same coil is connected with an AC source of same voltage. Then, current is I_2. Then, $I_2 < I_1$.

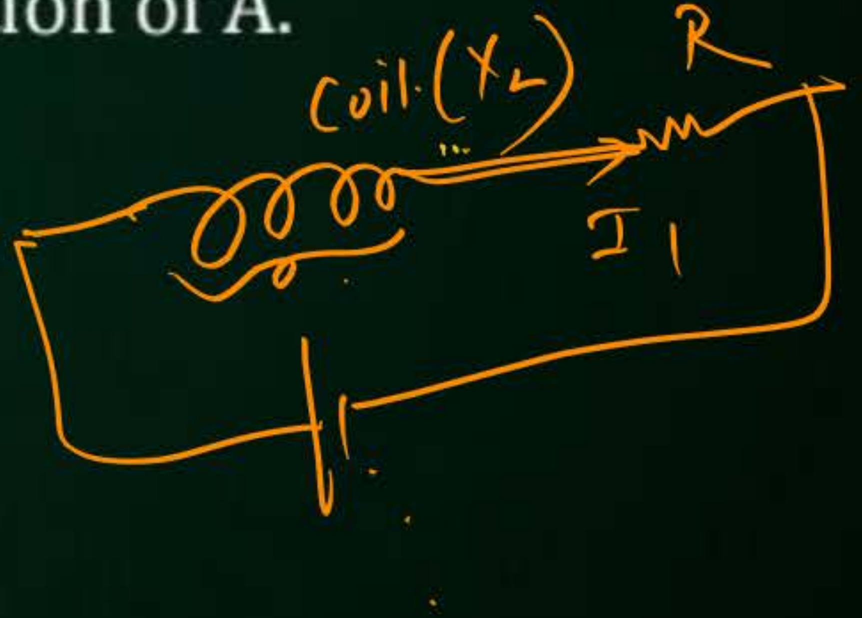
Reason (R): In AC circuit, inductor coil offers more resistance.

(1) Both A and R are true and R is the correct explanation of A.

(2) Both A and R are true but R is not the correct explanation of A.

(3) A is true but R is false.

(4) A is false and R is also false.



QUESTION

Assertion (A): When the capacitor is connected to an AC source, it limits or regulates the current, but does not completely prevent the flow of charge.

Reason (R): The capacitor is alternately charged and discharged as the current reverses each half-cycle.

(1) Both A and R are true and R is the correct explanation of A.

(2) Both A and R are true but R is not the correct explanation of A.

(3) A is true but R is false.

(4) A is false and R is also false.

H|W

QUESTION

Assertion (A): In series, L-C-R circuit, voltage across capacitor is always less than the applied voltage.

Reason (R): In series, L-C-R circuit, $V = \sqrt{V^2 + (V_L + V_C)^2}$

(1) Both A and R are true and R is the correct explanation of A.

(2) Both A and R are true but R is not the correct explanation of A.

(3) A is true but R is false.

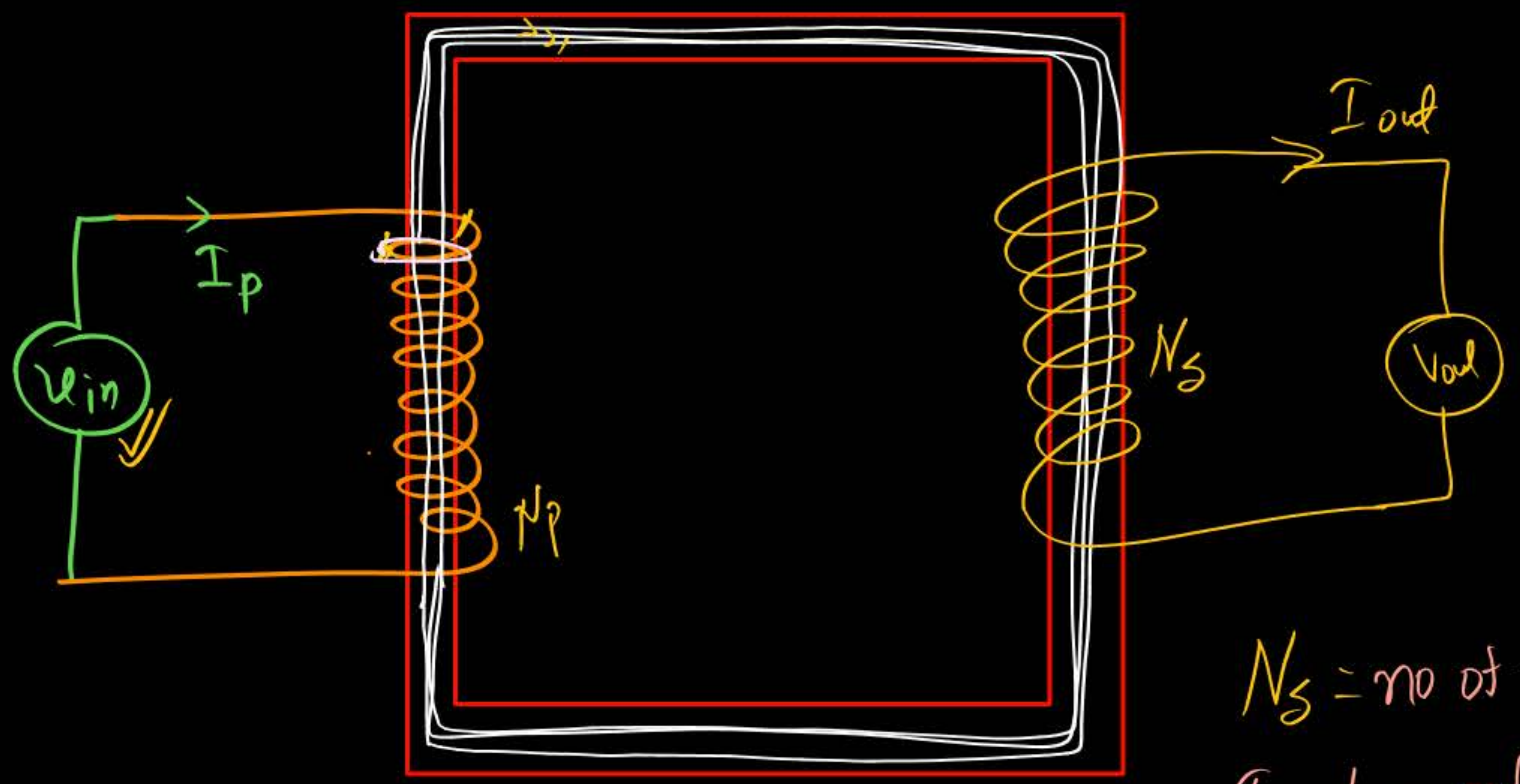
(4) A is false and R is also false.

Transformer

→ Instrument Based on mutual Inductance

→ use to regulate voltage. (step up (voltage↑)

(step down (voltage↓)



N_p = No of turns in Primary coil

V_{in} = input voltage

I_p = Input curren.

N_s = no of turns in Secondary coil.

I_{out} = output curr.

V_{out} = Output Voltage

Ideal Transformer

$P_{input} = P_{output}$ [No Power loss]

$$\eta = \frac{P_{out}}{P_{in}}$$

flux through one turn of primary coil = flux through one turns of secondary coil = ϕ_0 (let)

$$\phi_{primary\,coil} = \phi_0 N_p \quad \text{—(I)}$$

$$\phi_{secondary\,coil} = \phi_0 N_s \quad \text{—(II)}$$

$$\frac{\frac{d\phi_p}{dt} = \frac{d\phi_0}{dt} N_p}{\frac{d\phi_s}{dt} = \frac{d\phi_0}{dt} N_s}$$

$$\frac{V_{in}}{V_{out}} = \frac{N_p}{N_s}$$

* $$\frac{V_{out}}{V_{in}} = \frac{N_s}{N_p}$$

Voltge ∝ No of turns

Step up

$V_{out} > V_{in}$

$N_s > N_p$

$$\frac{V_{out}}{V_{in}} = \frac{N_s}{N_p}$$

$\eta = 100\%$ (Ideal)

$P_{in} = P_{out}$

$I_{in} V_{in} = I_{out} V_{out}$

$$\frac{I_{out}}{I_{in}} = \frac{V_{in}}{V_{out}} = \frac{N_p}{N_s}$$

Current $\propto \frac{1}{\text{No of turns}}$

Step up

$V_{out} > V_{in}$

$N_s > N_p$

$I_{out} < I_{in}$

$P_{in} = P_{out}$

Step down

$V_{out} < V_{in}$

$N_s < V_p$

$I_s > I_p$

$P_{in} = P_{out}$

$$\eta = \frac{P_{out}}{P_{in}} = \frac{I_{out} V_{op}}{I_{in} V_{in}}$$

2024

Q1: In an ideal transformer, the turns ratio is $N_P / N_S = 1/2$. The ratio $V_S : V_P$ is equal to (the symbols carry their usual meaning) :

(a) 1 : 2

(b) 2 : 1 ✓

(c) 1 : 1

(d) 1 : 4 [2024]

$\frac{N_p}{N_s} = \frac{1}{2}$

$\Rightarrow \frac{V_s}{V_p} = \frac{N_s}{N_p} = \frac{2}{1}$


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 01 | Physics

Electromagnetic Waves

By- Dr. Manish Raj (MR SIR)



Topics to be covered

1 # Questions on Transformer

2 # Displacement current

3 # Choke coil.



→ Archmedies Principle (Basic concept padhna hai)

→ Potentiometre wire
→ colour code of risista.
→ Earth magnetism
→ Rolling motion on Horizontal surfa
→ Transistor
→ magnifying powr of instru
→ Human eye.
→ L-C oscillation
→ Heat pump/refrigrator
→ Doppler effect
→ vendegraf genrator

* Kinematics of Radioactiv Half life

Cyclotron *

Thermodynamics

S.L.O.T

* 2nd Law of thermodynamics In the syllabus

→ Heat engine (efficiency)

refrigrator Nahi hai syllabus me

Heat Pump

Transformer

Step-up transformer

(1) $V_{out} > V_{in}$

$N_s > N_p$

$I_{out} < I_{in}$

$[P_{in} = P_{out}]$ → Ideal

$\eta = \frac{P_{out}}{P_{in}} \times 100$

Step-down transformer

$V_{out} < V_{in}$

$N_s < N_p$

$I_s > I_p$

$P_{in} = P_{out}$

$\left(\frac{V_{out}}{V_{in}}\right) = \left(\frac{N_s}{N_p}\right)$ → always correct

$\frac{I_{out}}{I_{in}} = \frac{N_p}{N_s}$ ← but only correct for Ideal Transfr.

energy loss in Transformer

(1) due to eddy current

(2) flux leakage

(3) due to Hysterisis curve

Question

The primary of a transformer when connected to a dc battery of 10 volt draws a current of 1 mA. The number of turn of the primary and secondary windings are 50 and 100 respectively. The voltage in the secondary and the current drawn by the circuit in the secondary are respectively.

Transform does not works for D/C

A. 20 V and 0.5 mA

B. 20 V and 2.0 mA

C. 10 V and 0.5 mA

D. Zero and therefore no current

(Ans).

Question

An ideal transformer has 100 turns in the primary and 250 turns in the secondary. The peak value of the ac is 28 V. The rms secondary voltage is nearest to-

A 50 V

B 70 V

C 100 V

D 40 V

$$\frac{V_{in}}{V_{out}} = \frac{100}{250}$$

$$\frac{28}{V_{out}} = \frac{100}{250}$$

$$70\text{ V} = (V_{out})_0$$

$$V_{rms} = \frac{V_0}{\sqrt{2}} = \frac{70}{1.41}$$

Question

A transformer having efficiency of 90% is working on 200V and 3kW power supply. If the current in the secondary coil is 6A, the voltage across the secondary coil and the current in the primary coil respectively are:

A. 300 V, 15 A

B. 450 V, 15 A

C. 450 V, 13.5 A

D. 600 V, 15 A

$\eta = 90\%$

$V_{in} = 200V$

$P_{in} = 3kW$

$I_s = 6A$

$I_p = ??$

$V_s = ??$

$\frac{V_{out}}{V_{in}} = \frac{N_s}{N_p} = \frac{I_{in}}{I_{out}}$

$P_{in} = V_{in} \times I_{in}$

$3 \times 10^3 = 200 \times I$

$I = 15 Amp$ Ans

$P_{out} = V_{out} \times I_{out}$

$\eta = \frac{P_{out}}{P_{in}} \times 100$

$90 = \frac{V_{out} I_s}{3kW} \times 100$

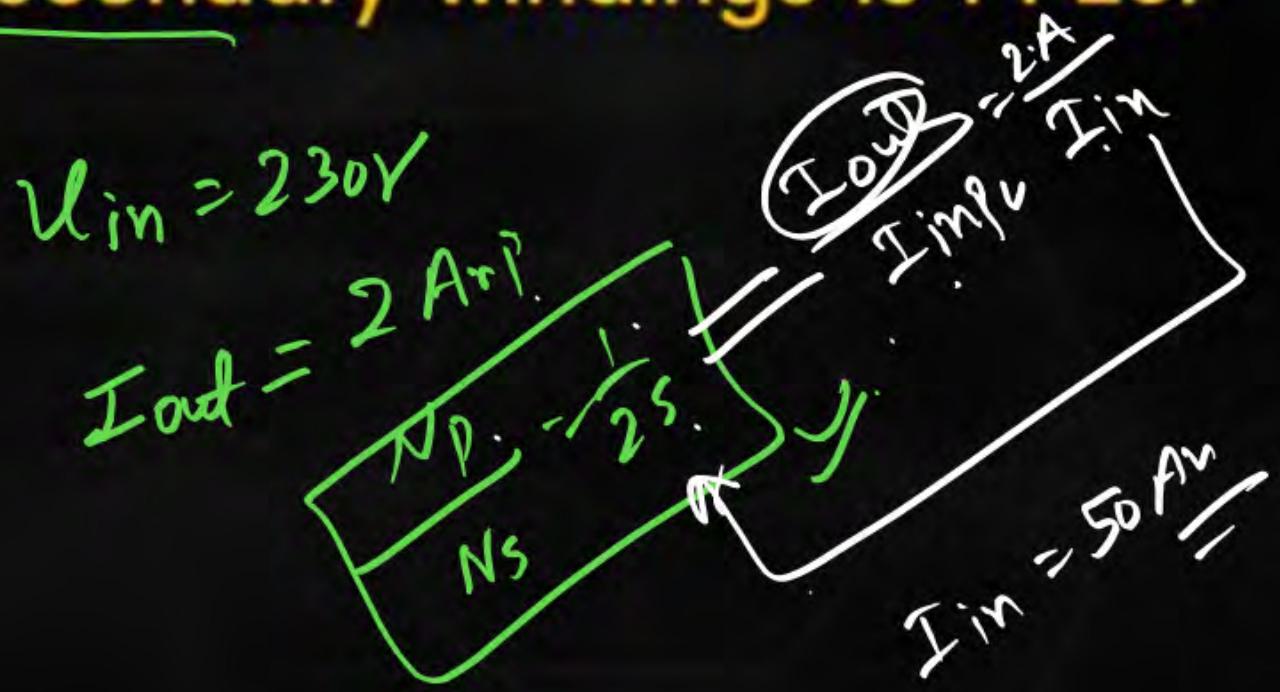
$V_{out} = \frac{9 \times 3 \times 10^3}{10 \times 6}$

$= 450 Volt$

Question

A step-up transformer operates on a 230 V line and supplies a load of 2 ampere. The ratio of the primary and secondary windings is 1 : 25. The current in the primary is:

- **A** 25 A
- **B** 50 A
- **C** 15 A
- **D** 1.5 A



Question

A 220 volts input is supplied to a transformer. The output circuit draws a current of 2.0 ampere at 440 volts. If the efficiency of the transformer is 80%, the current drawn by the primary windings of the transformer is-

- **A** 3.6 ampere
- **B** 2.8 ampere
- **C** 2.5 ampere
- **D** 5.0 ampere

Question

A transformer is used to light a 100 W and 110 V amp from a 220 V mains. If the main current is 0.5 amp, the efficiency of the transformer is approximately

A. 50%

B. 90%

C. 10%

D. 30%

$$\eta = \frac{P_{out}}{P_{in}} \times 100$$

$$= \frac{100 \times 100}{220 \times \frac{1}{2}}$$

$$= \frac{200}{22} \times 10$$

$$= 90\%$$

Question

The primary and secondary coils of a transformer have 50 and 1500 turns respectively. If the magnetic flux ϕ linked with the primary coil is given by $\phi = \phi_0 + 4t$, where ϕ is in Weber's, t is time in seconds and ϕ_0 is a constant, the output voltage across the secondary coil is

A 120 volts

B 220 volts

C 30 volts

D 90 volts

Question

The core of a transformer is laminated because-

A Ratio of voltage in primary and secondary may be increased

B Energy losses due to eddy currents may be minimized

C The weight of the transformer may be reduced

D Rusting of the core may be prevented



Question

A step-down transformer connected to an AC mains supply of 220 V is made to operate at 11 V, 44 W lamp. Ignoring power losses in the transformer, what is the current in the primary circuit?

A 0.2 A

B 0.4 A

C 2 A

D 4 A

$P_{in} = P_{out}$

$220 \times I = 44 W$

$I = \frac{44}{220}$

A power transmission line feeds input power at 2300 V to a step down transformer with its primary windings having 4000 turns, given the output power at 230 V. If the current in the primary winding of the transformer is 5A, and its efficiency is 90%, the output current would be

[9 Jan, 2019 (Shift-II)]

(*a*) 20 A (*b*) 40A

(*c*) 45A (*d*) 25A

H/W

Question

The primary winding of transformer has 500 turns whereas its secondary has 5000 turns. The primary is connected to an AC supply of 20V–50 Hz. The secondary will have an output of

A 2 V, 5 Hz

B 200 V, 500 Hz

C 2 V, 50 Hz

D 200 V, 50 Hz ✓✓

N_p, N_s

$$\frac{V_s}{V_p} = \frac{5000}{500}$$

$$\frac{V_s}{20} = \frac{5000}{500} = 10$$

$$V_s = 200V$$

The primary and secondary coils of an ideal transformer have 100 and 5000 turns respectively. The magnetic flux linking the primary coil is given by $\phi = 20t + 10$. The output voltage across the secondary coil is

$v_{in} = \frac{d\phi_p}{dt} = 20$

a. 20 V

b. 500 V

c. 1000 V

d. 10000 V

easy hai

Solution:

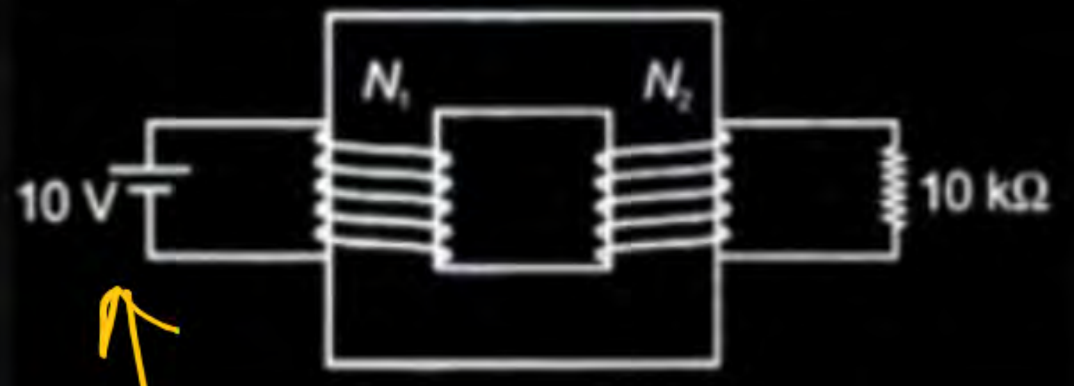
In the transformer shown in figure, ratio of number of turns of primary to the secondary is $\frac{N_1}{N_2} = \frac{1}{50}$. If a battery of emf 10 V is connected across primary, then induced current through the load of 10 kΩ in secondary is

a. $\frac{1}{20} A$

b. Zero

c. $\frac{1}{10} A$

d. $\frac{1}{5} A$



Solution:

Question

A transformer is used to light a 100 W and 110 V lamp from a 220 V mains. If the main current is 0.5 amp, the efficiency of the transformer is approximately

[2007]

(1) 50% (2) 90%

(3) 10% (4) 30%

$\eta = \frac{P_o}{P_{in}}$

Choke coil. → divide Potential without Power loss.

→ A R-L circuit

→ 



Choke coil → R-L circuit

Voltage lead kar

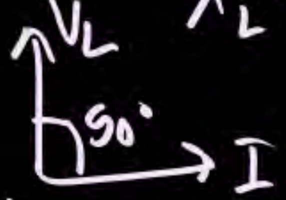
$Z = \sqrt{R^2 + X_L^2}$

Ideal choke coil

$R = 0$



$X_L \Rightarrow$ high



$\phi = 90°$ $\cos\phi = \cos 90 = 0$

Practical

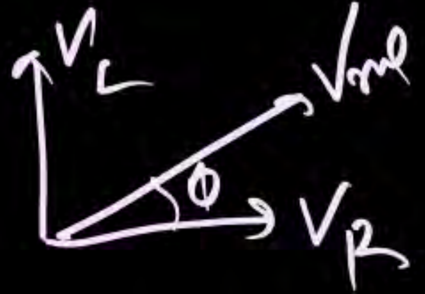
R → small Resis



Low power loss

Better choke coil

R → High



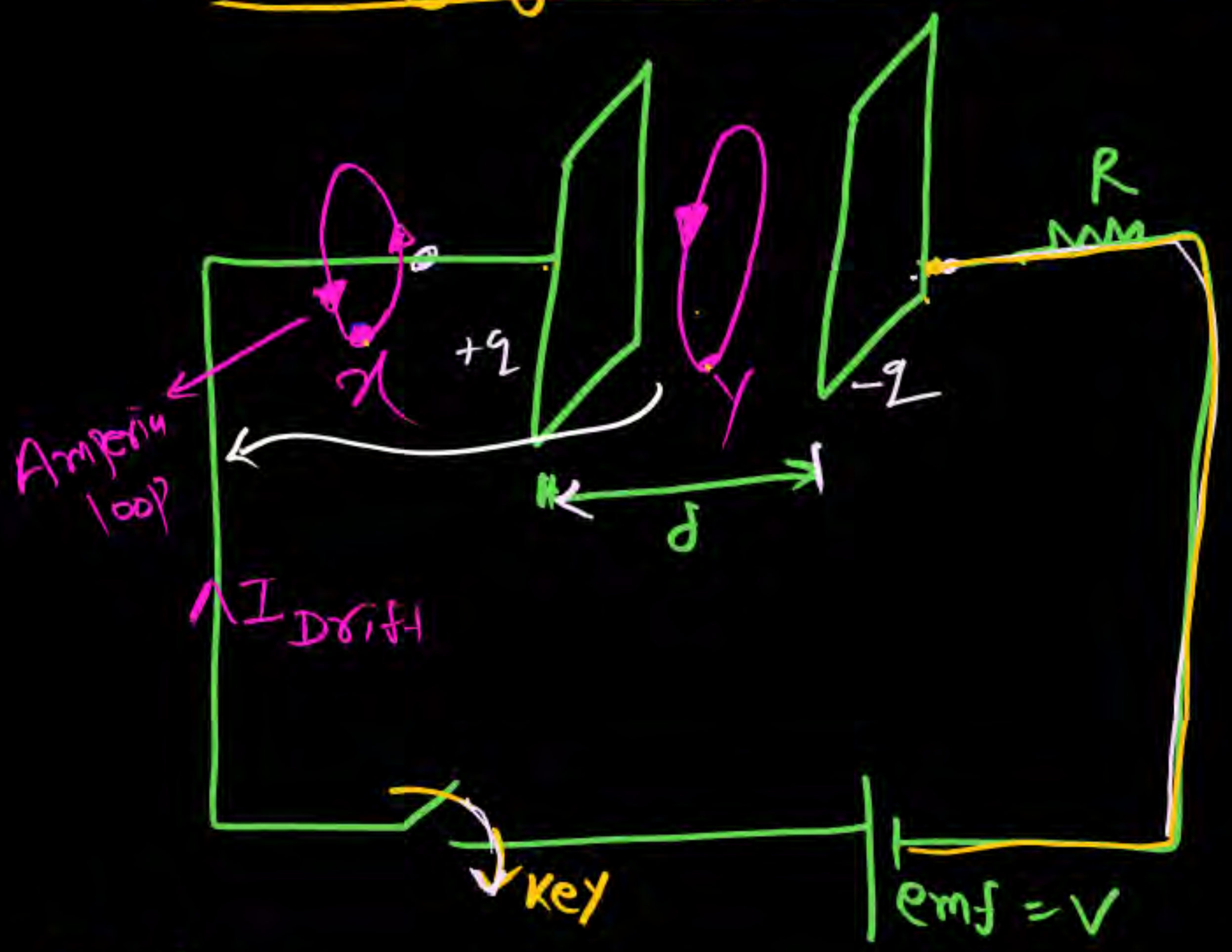
ϕ = small

$\cos\phi$ → large

large power loss

EM Wave

Charging of capacitor



- At $t=0$ key is Just Close.

  then $I_{Max} = \frac{V}{R}$

according to Maxwell this current can't flow due to discontinuity of circuit.

According to Ampers circuital Law

at point 'x' $\oint \vec{B} \cdot dl = \mu_0 I_{in}$

$B_x \neq 0$ (theory)

According to maxwell $B_x \neq 0$ (experimenty)

According to Amper circuital law

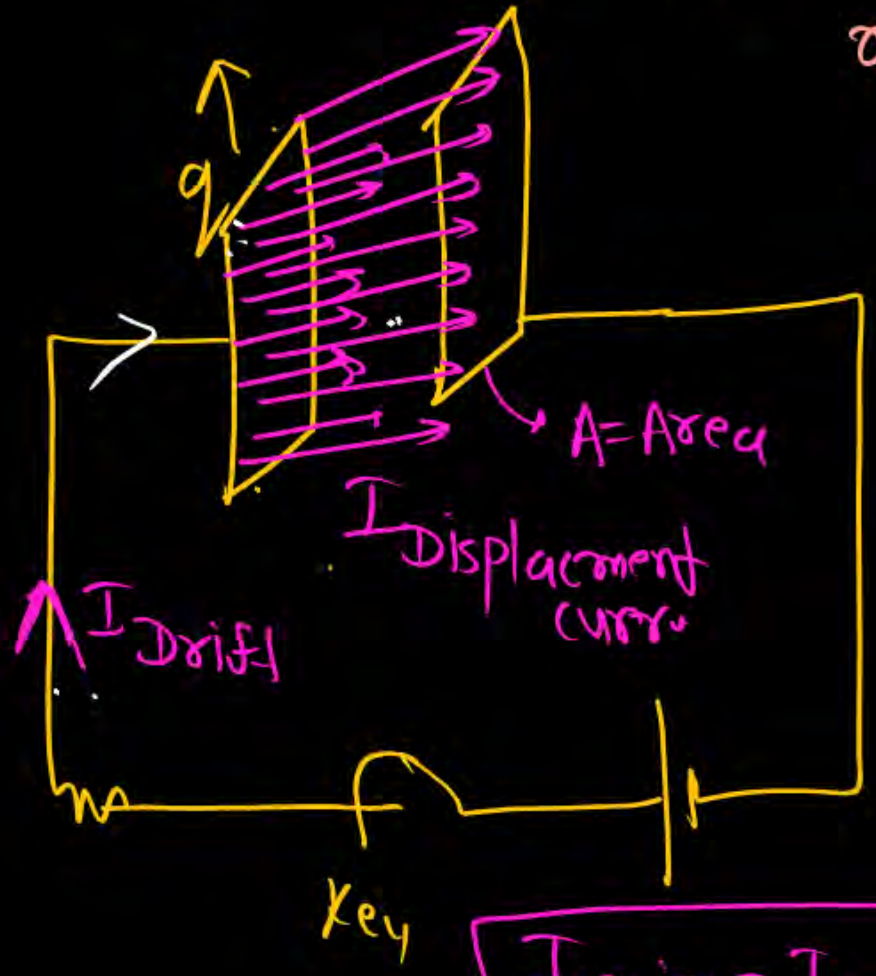
at Point 'y' $\oint \vec{B_y} \cdot dl = \mu_0 I_{in}$ → 0

$B_y = 0$ (theory)

According to maxwell $B_y \neq 0$ (experimentaly)

Maxwell gives the concept of Displacement current → due to Variable electric field

→ during charging of capacitor there a current B/w plate of capacitor is called displacement current. which satisfy the continuity of circuit and gives reason of magnetic field B/w the plate of capacitor.



$$I_{Displacement} = \varepsilon_0 \frac{d\phi}{dt}$$

$$C = \frac{\varepsilon_0 A}{l}$$

$$I_{Drift} = I_{Displacement}$$

Electric flux

$$\phi = E \cdot A$$

$$\phi = \frac{q}{A\varepsilon_0} A$$

$$\phi = \frac{q}{\varepsilon_0}$$

$$q = \phi \varepsilon_0$$

diffn w.r.t time

$$\frac{dq}{dt} = I = \varepsilon_0 \frac{d\phi}{dt}$$

electric flux

$$\phi = E \cdot A$$

$$\phi = \frac{q}{A\varepsilon_0} A$$

$$\phi = \frac{q}{\varepsilon_0}$$

$$q = \phi \varepsilon_0$$

diffⁿ w.r.t time

$$\frac{dq}{dt} = I = \varepsilon_0 \frac{d\phi}{dt}$$

$$I_{Displacement} = \varepsilon_0 \frac{d\phi}{dt}$$

$$I_{Dipⁿ} = \varepsilon_0 \frac{dEA}{dt}$$

$$I_D = \varepsilon_0 A \left(\frac{dE}{dt}\right)$$

$$I_D = \varepsilon_0 A \frac{dV/l}{dt}$$

$$I_D = \frac{\varepsilon_0 A}{l} \frac{dV}{dt}$$

$$I_D = C \frac{dV}{dt}$$

Electric field $E = V/l$

MR* flow

$q = CV$ ← sab janta hai

diffⁿ w.r.t. time

$$\frac{dq}{dt} = I_D = C \frac{dV}{dt}$$

$$I_D = \frac{\varepsilon_0 A}{l} \frac{dV}{dt}$$

$$I_D = \varepsilon_0 A \frac{d(V/l)}{dt}$$

$$I_D = \varepsilon_0 A \frac{dE}{dt}$$

$$I_D = \varepsilon_0 \left(\frac{d\phi}{dt}\right)$$

4 - Maxwell equation

→ MR* Electric field, magnetic field → Areal Integra, length Integral *

(1) 1st equation (Gauss law)

$$\oint \vec{E} \cdot d\vec{s} = \frac{q_{in}}{\varepsilon_0}$$

(2)

$$\oint \vec{B} \cdot d\vec{s} = 0$$

Mono pole does not exist

(3)

$$\oint \vec{E}_{Induc} \cdot d\vec{l} = \frac{d\phi_m}{dt} = A\frac{dB}{dt}$$

emf — Faraday law — Area — magnetic field

(4)

$$\oint \vec{B} \cdot d\vec{l} = \mu_0 I_{in}$$

(Ampere circuit law)

$$\oint \vec{B} \cdot d\vec{l} = \mu_0 \left[I_{Drift} + I_{Displa} \right]$$

$$\oint \vec{B} \cdot d\vec{l} = \mu_0 \left[I_{Drift} + \varepsilon_0 \frac{d\phi_E}{dt} \right]$$

$$\oint \vec{B} \cdot d\vec{l} = \mu_0 I_{Drift} + \mu_0 \varepsilon_0 A \left(\frac{dE}{dt} \right)$$

time varying electric field

FARADAYS LAW OF E.M.I.

$$\oint \vec{E} \cdot d\vec{l} = \frac{d\phi_m}{dt}$$

- Time varying magnetic field produced electric field.
- Both are perpendicular to each other and Induced Field is proportional to Rate of change in Magnetic field.

- Varying electric field produced magnetic field unification of electric and magnetic field.

ELECTROMAGNETIC WAVE

1. Electrostatic → Electric field
2. M.E.C. (Magnetism) → Magnetic field
3. E.M.I. —— faraday law → Time varying magnetic field produce electric field.
4. E.M.wave → time varying Electric field produce magnetic field.

Charge	Electric field	Magnetic current	E.M. wave
Rest	✓	✗	✗
Constant Vel.	✓	✓	✗
Acceleration	✓	✓	✓

CHARGING OF CAPACITOR

- **Charging of Capacitor (Max well example):**

DISPLACEMENT CURRENT

- Formed using changing electric field.
- Proves continuity of current.
- Explains existence of magnetic field.
- It does not exist under steady current. ($I_D = 0$)
- $I_D = \varepsilon_0 \dfrac{d\phi_E}{dt}$
- Flows between cross-section area of capacitor plate.

FOUR MAXWELL'S EQUATION

1. **Gauss Law of electrostatic**

$$\phi = \oint \vec{E}.d\vec{A} = \frac{q_{in}}{\varepsilon_0}$$

Total flux passing through any close surface is $1/\varepsilon_0$ of charge enclose.

2. **Gauss Law in magnetism**

$$\oint \vec{B}.d\vec{S} = 0$$

Monopole does not exist; magnetic field lines always forms close loop.

3. **Induced Electric Field**

$$\text{e.m.f.} = -\frac{d\phi}{dt}$$

$$\left[\oint E_{in} \cdot dl = \frac{d\phi}{dt}\right]$$

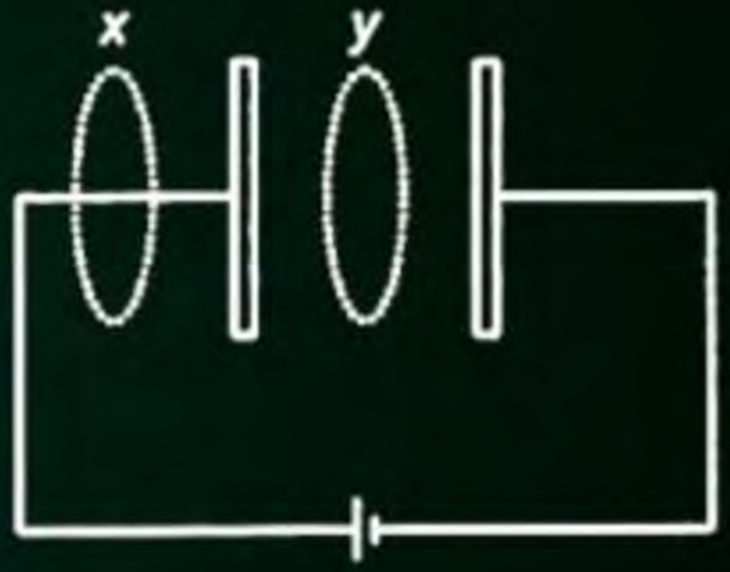
4. **Amperes – Maxwell Law** [Ampere's circuit law]

$$\oint \vec{B} \cdot dl = \mu_0 \left[I_{\text{Drift}} + I_{\text{displacement}} \right]$$

$$I_{dis} = \varepsilon_0 \frac{d\phi}{dt}$$

QUESTION

A parallel plate capacitor is charged by a battery as shown in the figure. If two circular amperian loops x and y are drawn then $\oint \vec{B}.d\vec{l}$ will be zero along



1. x only
2. y only
3. Both x and y
4. Neither x nor y

QUESTION

A parallel plate capacitor with plate area A and separation between the plates d, is charged by a current I. Displacement current through a plane surface of area $A/2$ parallel to the plates and drawn symmetrically between the plates, is

1. I
2. $I/4$
3. $I/2$
4. $3I/2$

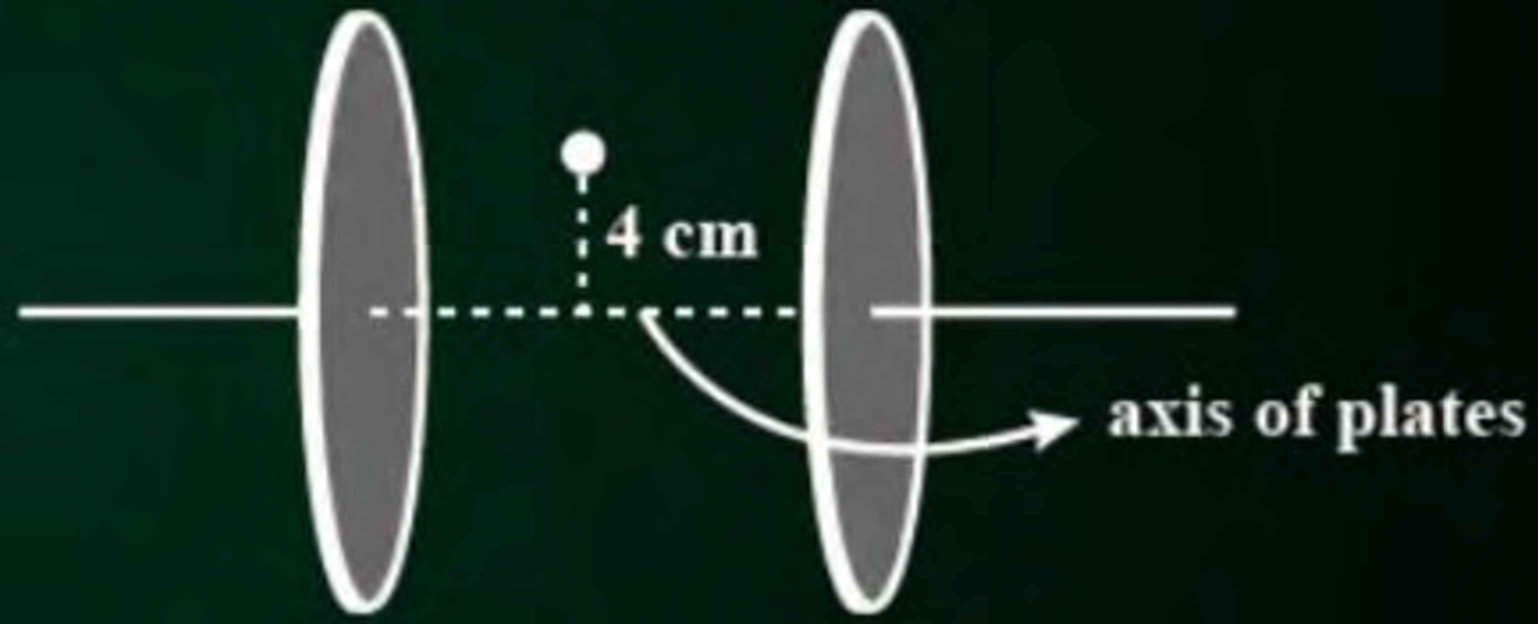
QUESTION

A parallel plate capacitor is charged to 60 μC. Due to a radioactive source, the plate loses charge at the rate of $1.8 \times 10^{-8}\ Cs^{-1}$. The magnitude of displacement current is

1. $3.6 \times 10^{-8}\ Cs^{-1}$
2. $1.8 \times 10^{-8}\ Cs^{-1}$
3. $4.1 \times 10^{-11}\ Cs^{-1}$
4. $5.7 \times 10^{-12}\ Cs^{-1}$

QUESTION

Two circular plates of radius 0.1 m are used to form a parallel plate capacitor. If displacement current between the plates is 2π ampere, then find magnetic field produced by displacement current 4 cm from the axis of the plates.



QUESTION

A parallel plate capacitor consists of two circular plates of radius 0.05 m. If electric field between the plates is changed as $\frac{dE}{dt} = 10^{10}\ \frac{V}{m-s}$, then find displacement current between the plates.


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 2 | **Physics**

Electromagnetic Waves



By- Dr. Manish Raj (MR SIR)

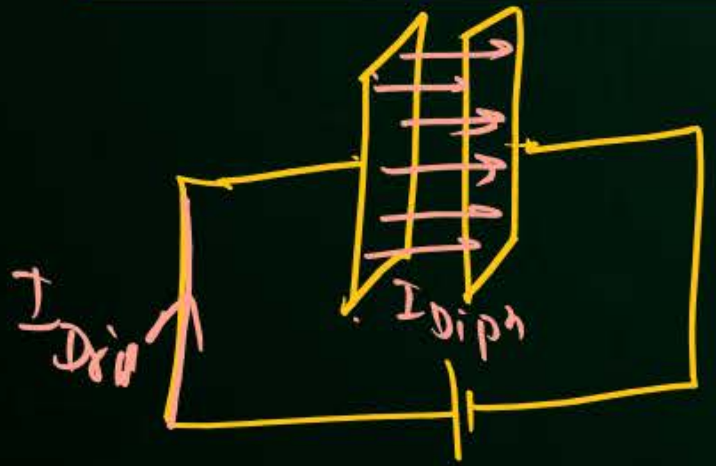
Todays Goal

✡ PhD on EM wave

DISPLACEMENT CURRENT

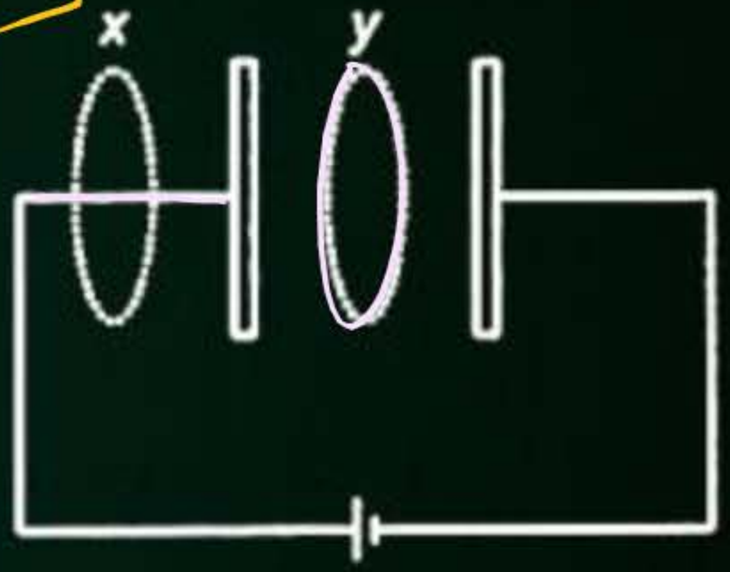
$$I_D = \varepsilon_0\left(\frac{d\phi_E}{dt}\right) = \varepsilon_0 A\left(\frac{dE}{dt}\right) = \left(\frac{\varepsilon_0 A}{L}\right)\left(\frac{dV}{dt}\right) = C\frac{dV}{dt}$$

$$I_{\text{Drif}} = I_{\text{displacement}}$$



QUESTION

A parallel plate capacitor is charged by a battery as shown in the figure. If two circular amperian loops x and y are drawn then $\oint \vec{B}.d\vec{l}$ will be zero along



1. x only
2. y only
3. Both x and y
4. Neither x nor y

$\oint B.dl = \mu_0 [I_{D} + I_{D}]$

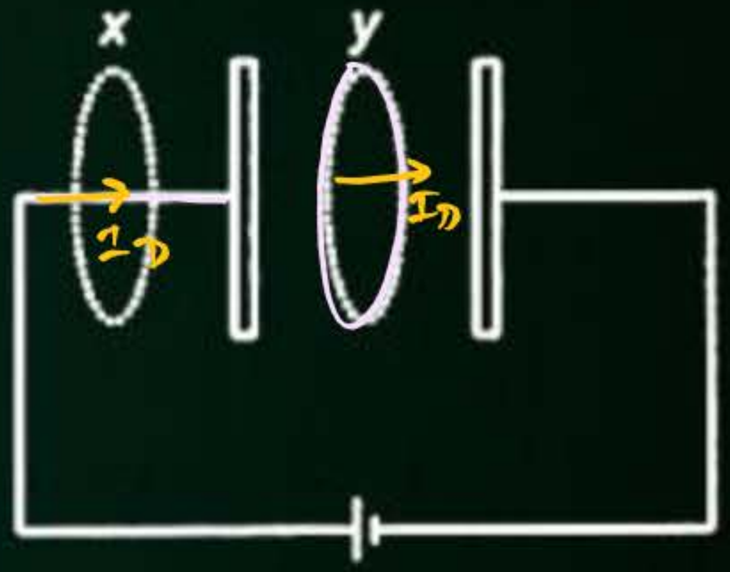
Charged ??

full charging complt

$I_D = 0 = I_D$

QUESTION

A parallel plate capacitor is charging by a battery as shown in the figure. If two circular amperian loops x and y are drawn then $\oint \vec{B}.d\vec{l}$ will be zero along



1. x only
2. y only
3. Both x and y
4. Neither x nor y

QUESTION

A parallel plate capacitor with plate area A and separation between the plates d, is charged by a current I. Displacement current through a plane surface of area $A/2$ parallel to the plates and drawn symmetrically between the plates, is

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4. $3I/2$

QUESTION

A parallel plate capacitor is charged to 60 μC. Due to a radioactive source, the plate loses charge at the rate of $1.8 \times 10^{-8}\ Cs^{-1}$. The magnitude of displacement current is

$I = \frac{dq}{dt} = 1.8 \times 10^{-8}$ C/s

1. $3.6 \times 10^{-8}\ Cs^{-1}$
2. $1.8 \times 10^{-8}\ Cs^{-1}$ ✓
3. $4.1 \times 10^{-11}\ Cs^{-1}$
4. $5.7 \times 10^{-12}\ Cs^{-1}$

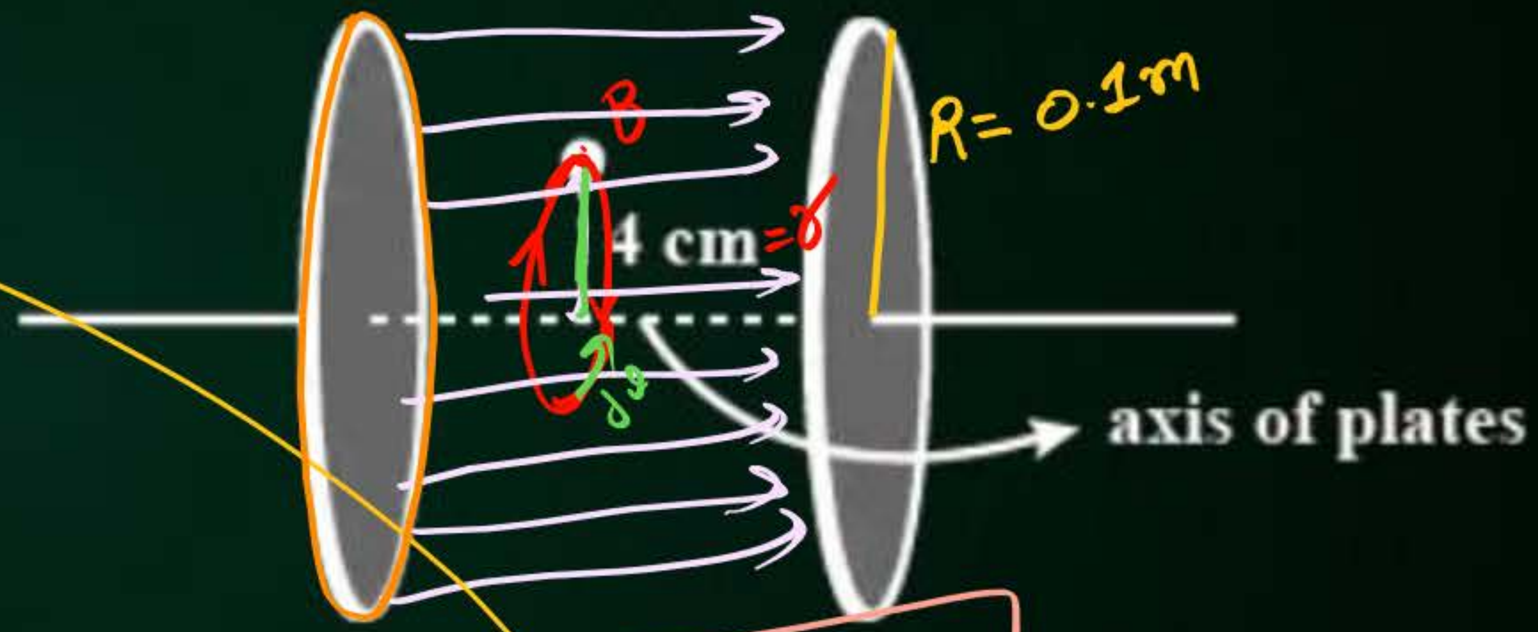
QUESTION

Two circular plates of radius 0.1 m are used to form a parallel plate capacitor. If displacement current between the plates is 2π ampere, then find magnetic field produced by displacement current 4 cm from the axis of the plates.

$\pi R^2 \longrightarrow 2\pi$ Amp

$1 \longrightarrow \frac{2\pi}{\pi R^2}$

$I' = \frac{2\pi}{\pi R^2} \times \pi r^2 = \frac{2\pi r^2}{R^2}$



$B = \frac{\mu_0 I r}{2\pi R^2}$

Inside infinite solid cylinder

$B = \frac{\mu_0 2\pi \, 4\times10^{-2}}{2\pi (0.1)^2}$

$= \mu_0 \times 4$

$B = 4\mu_0 = 16\pi \times 10^{-7}$

QUESTION

A parallel plate capacitor consists of two circular plates of radius 0.05 m. If electric field between the plates is changed as $\frac{dE}{dt} = 10^{10}\ \frac{V}{m-s}$, then find displacement current between the plates.

$$I = \varepsilon_0 A \frac{dE}{dt}$$

$$I = \varepsilon_0 (\pi R^2) \times 10^{10}$$

SOURCE OF E-M WAVE





(i) Accelerating charge

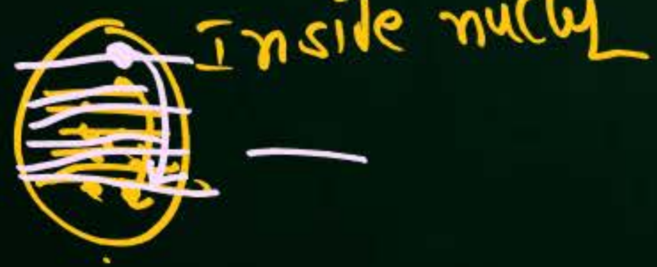
(ii) L-C oscillation

(iii) Transition of e^- m orbit

(iv) Retardation of e^- when it enters into a target of height atomic weight.

(v) De-excitation of nucleus in radioactivity.

MR Rafta



Wave

$$V_{wave} = \frac{\lambda}{T} = \lambda f = \frac{\omega}{k}$$

➢ Longitudinal Wave

dir^n of Propagation of wave along the dir^n of osscillation of Medium Particle

Ex – Sound wave

$$y = A_0 \sin(ky - \omega t)$$

$$x = A_0 \sin(\omega t + kx)$$

➢ Transverse Wave

Particle ossillate Perpendicular to the Propagation of wave

Ex – light, Transverse wave in string

$$y_{partr.} = A \sin(kx - \omega t)$$

(wave)

$$z = A \sin(ky - \omega t)$$

EM wave → Non mechanical wave (no medium is required)

→ Transverse wave

→ electric & magnetic field ka variation

→ electric & magnetic field is ⊥r to the dirn of wave.

→ dirn of oscillation of $\vec{E}$ & $\vec{B}$

→ $Q_{net} = 0$

→ EM wave does not deviate in external electric & magnetic field

→ Electric & magnetic field oscillate in same Phase.

$\cancel{q}E = \cancel{q} V B$

$E_0 = V B_0$

$B_0 = \frac{E_0}{V}$ ← speed of wave

$$V_{EM\ wave} = \frac{\lambda}{T} = \lambda f = \frac{E_0}{B_0} = \frac{1}{\sqrt{\mu_m \varepsilon_m}} = \frac{1}{\sqrt{\mu_0 \mu_r \varepsilon_0 \varepsilon_r}} = \frac{c}{\sqrt{\mu_r \varepsilon_r}} = \frac{\omega}{K}$$

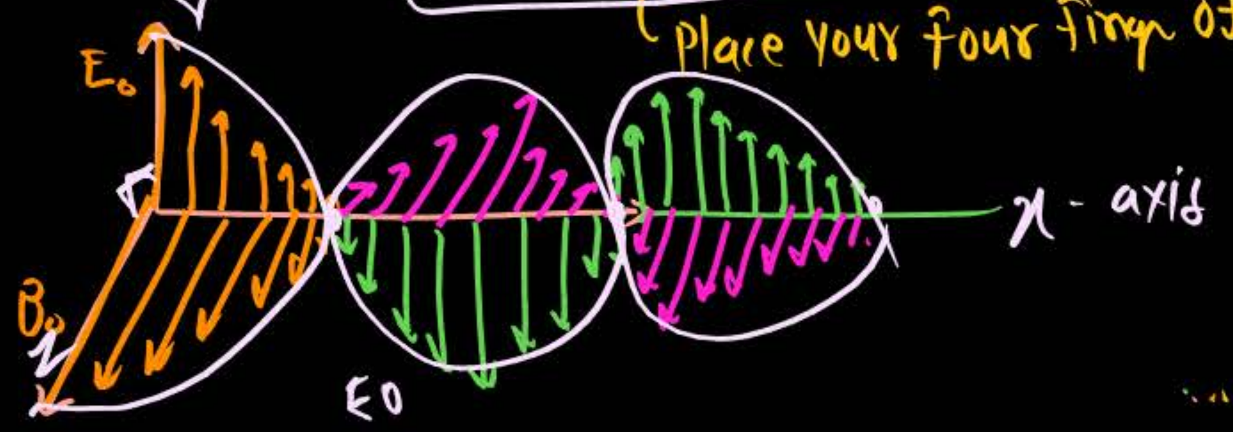
$$c = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}$$

speed of light/EM wave in vaccume

→ dirn of EM wave always ⊥r to the dirn of oscillati. of $\vec{E}$ & $\vec{B}$

→ dirn of wave $\hat{V} = \hat{E} \times \hat{B}$

Place your four finger of right hand along electric field, slap $\vec{B}$ thumb will represent dirn of wave.



K.B.D............

दंगल

QUESTION

The oscillating magnetic field in a plane electromagnetic wave is given as

$$B_y = 8 \times 10^{-6} \sin(5000\,\pi x - 3 \times 10^{11}\,\pi t)\ \text{T}.$$

Calculate

(a) Frequency

(b) Wavelength

(c) Speed of the wave

(d) Electric field amplitude

(e) Write down expression for oscillating electric field

$B_y = B_0 \sin(kx - \omega t)$

$E_z = E_0 \sin(kx - \omega t)$

$\hat{i} = \hat{E} \times \hat{J}$

$(\hat{E}) \to (-\hat{k})$

$B_0 = 8 \times 10^{-6}\ \text{T}$

$k = \frac{2\pi}{\lambda} = 5000\pi$

$\omega = 2\pi f = 3 \times 10^{11}\pi$

$f = 1.5 \times 10^{11}$ Hz

$v = \frac{\omega}{k} = \frac{3 \times 10^{11}\pi}{5000\pi} = \frac{3 \times 10^{8}}{5} = 0.6 \times 10^{8}$

$E_0 = vB_0$

$E_0 = 0.6 \times 10^{8} \times 8 \times 10^{-6}$

QUESTION

Velocity of electromagnetic waves in a medium is

1. $(\varepsilon_0\mu_0)^{-1/2}$ ✗
2. $(\varepsilon_0\varepsilon_r\mu_0\mu_r)^{-1/2}$ ✓
3. 3×10^8 m/s ✗
4. $(\varepsilon_0\varepsilon_r/\mu_0\mu_r)^{+1/2}$ ✗

$$c = \frac{1}{\sqrt{\mu_0 \varepsilon_0}} = (\mu_0 \varepsilon_0)^{-1/2}$$

$$V = \frac{1}{\sqrt{\mu_m \varepsilon_m}} = \frac{1}{\sqrt{\mu_0 \mu_r \varepsilon_0 \varepsilon_r}}$$

QUESTION

The speed of electromagnetic wave in a medium (whose dielectric constant is 2.25 and relative permeability is 4) is equal to

$\varepsilon_r =$

$\mu_r = 4$

1. $0.5 \times 10^8 \text{ m/s}$
2. $0.25 \times 10^8 \text{ m/s}$
3. $0.75 \times 10^8 \text{ m/s}$
4. $1 \times 10^8 \text{ m/s}$ ✓

$$V = \frac{c}{\sqrt{\mu_r \varepsilon_r}} = \frac{3\times 10^8}{\sqrt{\frac{225}{100}\times 4}}$$

$$= \frac{3\times 10^8}{\sqrt{9}}$$

$$= 10^8$$

QUESTION

An electromagnetic wave is propagating in vacuum along z-axis, the electric field component is given by $E_x = E_0 \sin(kz - \omega t)$ then magnetic component is

wave (+z-axis ($\hat{k}$)

$\vec{E}$ ($\hat{i}$)

$E_0 = c B_0$

$B_0 = \frac{E_0}{c}$

1. $B_x = \frac{E_0}{C} \sin(kz - \omega t)$

2. $B_y = \frac{B_0}{C} \sin(kz - \omega t)$ — dim^n wrong ×

3. $B_y = \frac{E_0}{C} \sin(kz - \omega t)$ Ans

4. $B_y = B_0 C \sin(kz - \omega t)$ — dim^n wrng

QUESTION

If $\vec{E}$ and $\vec{B}$ represent the electric and magnetic field vectors of an electromagnetic wave, then the direction of propagation of the electromagnetic wave is in the direction of

1. $\vec{E}$
2. $\vec{B}$
3. $\vec{E} \times \vec{B}$
4. $\vec{B} \times \vec{E}$

QUESTION

An em wave is propagating in a medium with a velocity $\vec{V} = V\hat{i}$. The instantaneous oscillating electric field of this em wave is along +y axis. Then the direction of oscillating magnetic field of the em wave will be along [NEET-2018]

1. –z direction

2. +z direction



3. –x direction

4. –y direction

QUESTION

In an electromagnetic wave in free space the root mean square value of the electric field is $E_{rms} = 6\ V/m$. The peak value of the magnetic field is [NEET-2017]

1. 1.41×10^{-8} T
2. 2.83×10^{-8} T
3. 0.70×10^{-8} T
4. 4.23×10^{-8} T

$E_{rms} = 6\ v/m$

$\frac{E_0}{\sqrt{2}} = 6\ v/m$

$E_0 = 6\sqrt{2}\ v/m$

$B_0 = \frac{E_0}{c} = \frac{6\sqrt{2}}{3 \times 10^8}$

$= 2\sqrt{2} \times 10^{-8}$

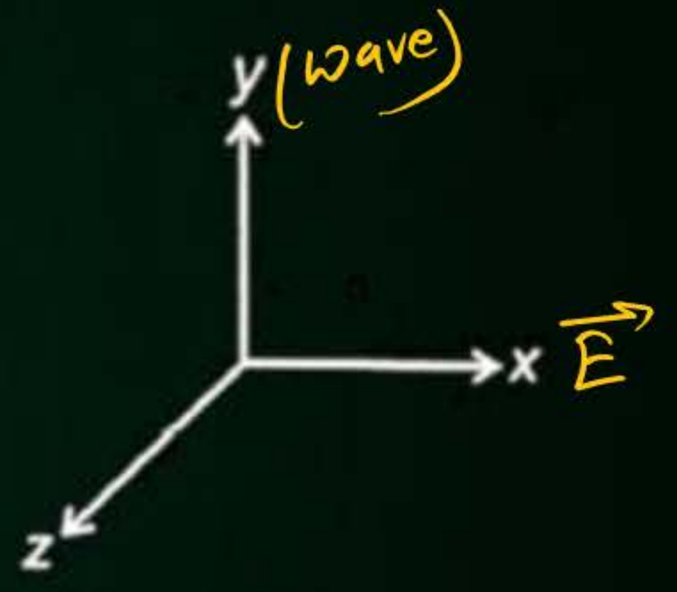
$= 2 \times 1.41 \times 10^{-8}$

$= 2.82 \times 10^{-8}$

QUESTION

Light wave travelling along y-direction. If the corresponding $\vec{E}$ vector at any time is along x-axis, the direction of $\vec{B}$ vector at that time is along

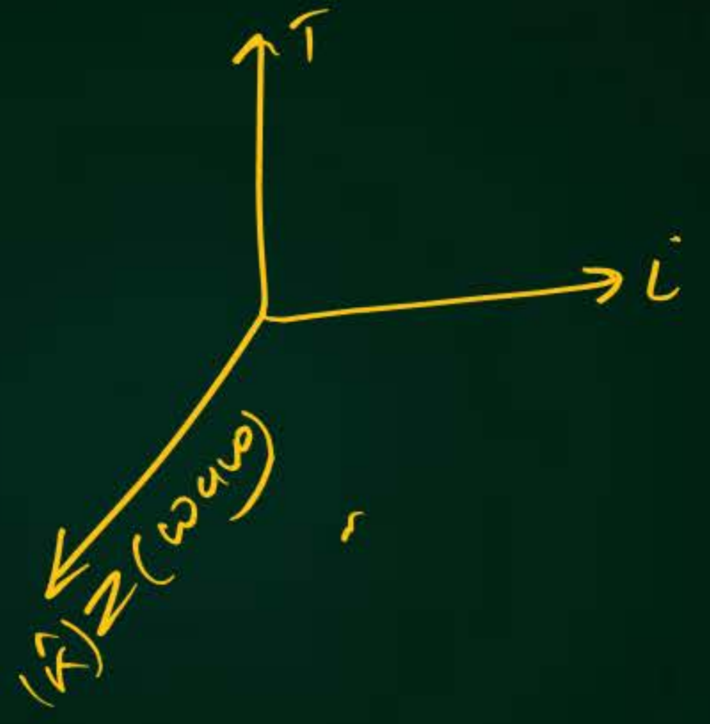
1. y-axis
2. x-axis
3. z-axis
4. $-z$-axis



QUESTION

The electric and the magnetic field, associated with an e.m. wave, propagating along the +z-axis, can be represented by

[AIPMT (Prelims)-2011]



1. $[\vec{E} = E_0\,\hat{j}, \vec{B} = B_0\,\hat{k}]$
2. $[\vec{E} = E_0\,\hat{i}, \vec{B} = B_0\,\hat{j}]$
3. $[\vec{E} = E_0\,\hat{k}, \vec{B} = B_0\,\hat{i}]$
4. $[\vec{E} = E_0\,\hat{j}, \vec{B} = B_0\,\hat{i}]$

QUESTION

The electric and magnetic field of an electromagnetic wave are in

1. Phase and parallel to each other
2. Opposite phase and perpendicular to each other
3. Opposite phase and parallel to each other
4. Phase and perpendicular to each other

QUESTION

In an apparatus, the electric field was found to oscillate with an amplitude of 18 Vm^{-1}. The magnitude of oscillating magnetic field will be

1. 4×10^{-6} T
2. 6×10^{-8} T
3. 9×10^{-9} T
4. 11×10^{-11} T

$E_0 = 18\ V/m$ ✓

$B_0 = ??$

$B_0 = \frac{E_0}{c} = \frac{\cancel{18}\ 6}{\cancel{3} \times 10^8}$

QUESTION

Electromagnetic waves are produced due

NEET- 19

1. A charge at rest
2. A moving charge
3. An accelerated charge
4. None of these

Energy ↑ ←

Gamma ray | X-ray | Ultra voilet | Visible light | Infra red | Microwave | Radio wave

→ λ (wavelength) ↑, f (frequency) ↓, Energy ↓ $\left(E = \frac{hc}{\lambda\uparrow}\right)$

10^{20} Hz | 10^{18} Hz | 10^{16} Hz | 10^{15} Hz | 10^{12} Hz | 10^{8} Hz | 10^{4} Hz

1 mev | 1 kev | (10 - 100) ev | (E = 1 ev - 2 ev) | 1 mev | 1 μev | 10^{-9} ev - 10^{-12} ev

$$f = \frac{c}{\lambda}$$

$$\lambda = \frac{c}{f}$$

$$E = \frac{hc}{\lambda}$$

R	1 m → 10^4 m
M	10^{-3} m → 1 m
I	700 nm — 10^{-3} m
V	400 nm — 700 nm
U	10^{-8} m → 400 nm
X	10^{-11} m — 10^{-8} m
G	10^{-14} m — 10^{-11} m

1, 3, 8, 11, 14

QUESTION

λ_v, λ_x and λ_m represent the wavelengths of visible light x-rays and microwaves respectively then

1. $\lambda_m > \lambda_x > \lambda_v$
2. $\lambda_k > \lambda_m > \lambda_x$
3. $\lambda_m > \lambda_v > \lambda_x$
4. $\lambda_y > \lambda_x > \lambda_m$

QUESTION

Frequency of a wave is 6×10^{15} Hz. The wave is

1. Radiowave
2. Microwave
3. X-ray
4. Infrared

QUESTION

Which of the following is not transported by electromagnetic waves?

1. Energy ✓
2. Momentum ✓
3. Charge ✗
4. Information ✓

Ans (3)

QUESTION

Electromagnetic wave is deflected by

1. Electric field
2. Magnetic field
3. Both (1) & (2)
4. Neither electric field nor magnetic field

QUESTION

Out of the following, choose the ray which does not travel with the velocity of light

1. X-ray
2. Microwave
3. γ-rays
4. β-rays (Not EM wave)

→ fast moving Beam of e^-

QUESTION

Red light differs from blue light in its

1. Speed ✓
2. Frequency → Ans (2)
3. Intensity ✓
4. Amplitude ✓

VIBGYOR

→ f ↓

QUESTION

[JEE MAIN 2020]

I (Radiation)		II (Wavelength)	
(a)	Microwave	(i)	100 m
(b)	Gamma rays	(ii)	10^{-15} m
(c)	A.M. radio waves	(iii)	10^{-10} m
(d)	X = rays	(iv)	10^{-3} m

1. (a) – (ii), (b) – (i), (c) – (iv), (d) – (iii)
2. (a) – (iv), (b) – (ii), (c) – (i), (d) – (iii) ← Ans (2)
3. (a) – (iii), (b) – (ii), (c) – (i), (d) – (iv)
4. (a) – (i), (b) – (iii), (c) – (iv), (d) – (ii)

G X U V I M R

QUESTION

If an electromagnetic wave propagating through vacuum is described by $E_y = E_0 \sin(kx - \omega t)$; $B_z = B_0 \sin(kx - \omega t)$, then

1. $E_0 k = B_0 \omega$ (Ans)
2. $E_0 B_0 = \omega k$
3. $E_0 \omega = B_0 k$
4. $E_0 B_0 = \omega / k$

$E_y = E_0 \sin(kx - \omega t)$

$B_z = B_0 \sin(kx - \omega t)$

$V = \frac{E_0}{B_0} = \frac{\omega}{k}$

QUESTION

If $\vec{E}$ and $\vec{B}$ represent the electric and magnetic field vectors of an electromagnetic wave, then the direction of propagation of the electromagnetic wave is in the direction of

1. $\vec{E}$
2. $\vec{B}$
3. $\vec{E} \times \vec{B}$
4. $\vec{B} \times \vec{E}$

QUESTION

Which of the following has the largest wavelength?

1. Radio wave
2. X-ray
3. Ultraviolet ray
4. Infra-red ray

QUESTION

The magnetic field in a plane electromagnetic is given by

$$B = 2 \times 10^{-7} \sin(0.5 \times 10^{3} x + 1.5 \times 10^{11} t).$$

This electromagnetic wave is

1. Visible light
2. Infrared
3. Microwave
4. Radiowave

QUESTION

To establish an instantaneous displacement current of I ampere in the space between the plates of a parallel plate capacitor of $\frac{1}{2}$ farad, the value of $\frac{dV}{dt}$ is

1. $2I$ ✓ Ans
2. $\frac{I}{2}$
3. $\frac{1}{2I}$
4. I

$$I_{Disp} = C\frac{dV}{dt}$$

$$I = \frac{1}{2}\frac{dV}{dt}$$

$$\frac{dV}{dt} = 2I$$

QUESTION

Out of the following options which one can be used to produce a propagating electromagnetic wave? [NEET-2016]

1. An accelerating charge
2. A charge moving at constant velocity
3. A stationary charge
4. A chargeless particle

QUESTION

Which of the following statement is false for the properties of electromagnetic waves?

[AIPMT (Prelims)-2010]

1. These waves do not require any material medium for propagation
2. Both electric and magnetic field vectors attain the maxima and minima at the same place and same time
3. The energy in electromagnetic wave is divided equally between electric and magnetic vectors
4. Both electric and magnetic field vectors are parallel to each other and perpendicular to the direction of propagation of wave

QUESTION

The decreasing order of wavelength of infrared, microwave, ultraviolet and gamma rays is

[AIPMT (Prelims)-2011]

1. Infrared, microwave, ultraviolet, gamma rays
2. Microwave, infrared, ultraviolet, gamma rays
3. Gamma rays, ultraviolet, infrared, microwaves
4. Microwaves, gamma rays, infrared, ultraviolet

Electrostatic energy density of EM wave $U_E = \frac{1}{2}\varepsilon_0 E^2 = \frac{1}{2}\varepsilon_0 E_0^2 \sin^2(kx-\omega t)$

Magnetic energy density of EM wave $U_B = \frac{B^2}{2\mu_0} = \frac{B_0^2 \sin^2(kx-\omega t)}{2\mu_0}$

Avg. Electrostatic energy density of EM wave $\langle U_E \rangle = \frac{1}{2}\varepsilon_0 E_0^2 \langle \frac{1}{2} \rangle = \frac{1}{4}\varepsilon_0 E_0^2$

Avg. magnetic energy densi of EM wave $\langle U_m \rangle = \frac{B_0^2}{4\mu_0}$

$$\varepsilon_0 E^2 = \frac{B^2}{\mu_0}$$

energy density of EM wave $U = U_E + U_m = 2U_E = 2U_m$

$$U = 2\left(\frac{1}{2}\varepsilon_0 E_0^2 \sin^2(\omega t - kx)\right) = \varepsilon_0 E_0^2 \sin^2(\omega t - kx) = \frac{B_0^2 \sin^2(kx-\omega t)}{\mu_0}$$

Avg. energy density of EM wave

$$\langle U_{EM} \rangle = 2\langle U_E \rangle = 2\,\frac{1}{4}\varepsilon_0 E_0^2 = \left[\frac{\varepsilon_0 E_0^2}{2}\right] = \frac{B_0^2}{2\mu_0}$$

Avg electric static energy density $\langle U_E \rangle = \frac{1}{4}\varepsilon_0 E_0^2$

Energy density of EM wave

$$U_{EM} = 2U_E = 2U_B$$

Avg energy density of EM wave

$$\langle U_{EM} \rangle = 2\langle U_E \rangle = 2\langle U_B \rangle$$

$$\langle U_{EM} \rangle = 2\left(\frac{1}{4}\varepsilon_0 E_0^2\right) = \frac{\varepsilon_0 E_0^2}{2}$$

$$E = E_0 \sin(kx - \omega t)$$

$$\langle E \rangle = E_0 \langle \sin(kx - \omega t) \rangle \rightarrow 0$$

$\langle E \rangle = 0 =$ Avg. value of electric field

QUESTION

In a plane electromagnetic wave, which following has/have zero average value i complete cycle?

(a) Magnetic field

(b) Magnetic energy

(c) Electric field

(d) Electric energy

1. (a), (c)
2. (b), (c)
3. (a), (d)
4. All of these

Intensity of EM wave

Total energy of EM wave crossing per unit Area per sec.

$$I = \frac{E}{At} = \frac{U_{EM} A l}{A t}$$

$$I = U_{EM} \, C$$

Intensity — Energy density

$$\langle I \rangle = \langle U_{EM} \rangle C$$

$$= \frac{1}{2}\varepsilon_0 E_0^2 C = \frac{B_0^2}{2\mu_0} C$$

energy density of EM wave $= U_{EM}$

energy per unit volume $= U_{EM} = \varepsilon_0 E^2 = \frac{E}{Al}$

- Avg. energy density of EM wave $= \frac{1}{2}\varepsilon_0 E_0^2$

$$\langle I \rangle = \frac{B_0 (B_0 C)}{2\mu_0}$$

$\langle I \rangle = \frac{B_0 E_0}{2\mu_0}$

magnitude of Insit — dirn of wav

Poynting vector $\vec{S} = |I| \times \hat{v}$

$$= \frac{B_0 E_0}{2\mu_0} \hat{v}$$

$$\vec{S} = \frac{\vec{E_0} \times \vec{B_0}}{2\mu_0}$$

Energy of EM wave

$$E = \frac{hc}{\lambda} = hf$$

$$E = \frac{2\times10^{-25}}{\lambda(m)}\ J$$

$$E = \frac{12400\ eV}{\lambda(A^\circ)}$$

$$E = pc$$

E: energy of EM wave

p = momentum

$$p = \frac{E}{c} = \frac{hc}{\lambda c} = \frac{h}{\lambda}$$

Momentum of EM wave / Photon

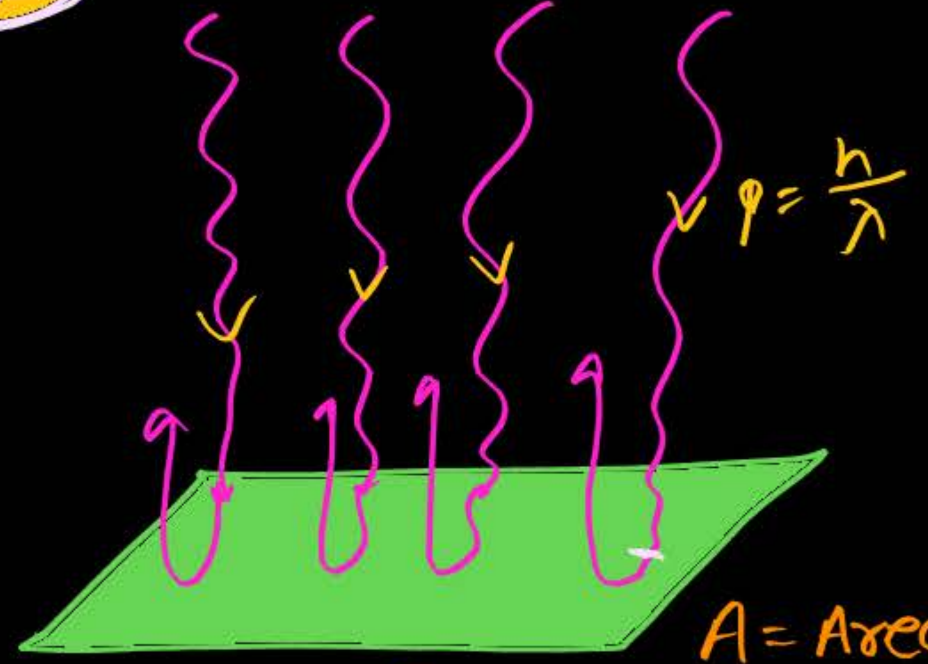
Power of EM wave radiation

$$P(\text{Power}) = \frac{E}{t} = \frac{nhc}{\lambda t}$$

$$P = \frac{EA}{tA} = IA$$

Power = Intensity × Area

# #



[Compt reflecting Surface]

$$\Delta p = \frac{2h}{\lambda}$$ total change in momentum

$$\text{Force} = \frac{\Delta p}{\Delta t} = \frac{2h}{\lambda \Delta t} = \frac{2h \times c}{\lambda \Delta t \times c}$$

$$\text{force} = \frac{2 \times \text{Powr}}{c}$$

$$\text{Pressure} = \frac{\text{force}}{\text{Area}} = \frac{2\ \text{Powr}}{c \times \text{Area}}$$

$$P = \frac{2(I A)}{c A}$$

$$\text{Pressure} = \frac{2I}{c}$$

$$\text{Pressure} = \frac{2I}{c}$$

$$\text{force} = \text{Press} \times \text{Ar} = \frac{2I \times A}{c} = \frac{2P}{c}$$

Compt absorbing surface

$$\text{Pressu} = \frac{I}{c}$$

MR Rafta

QUESTION

A radiation of energy E falls normally on a perfectly reflecting surface. The momentum transferred to the surface is (C = velocity of light) **[AIPMT-2015]**

1. E/C^2
2. E/C
3. $2E/C$
4. $2E/C^2$

QUESTION

Light with an energy flux of $25 \times 10^4 \text{ Wm}^{-2}$ falls on a perfectly reflecting surface at normal incidence. If the surface area is 15 cm^2, the average force exerted on the surface is

[AIPMT-2014]

1. 1.25×10^{-6} N
2. 2.50×10^{-6} N
3. 1.20×10^{-6} N
4. 3.0×10^{-6} N

Intensity

$\text{Pres} = \frac{2I}{c}$

$\text{Force} = \frac{2I}{c} \times \text{Area}$

$= \frac{2 \times 25 \times 10^4}{3 \times 10^8} \times 15 \times 10^{-4}$

$= 250 \times 10^{-8}$

QUESTION

Light with an energy flux of 25×10^4 Wm^{-2} falls on a perfectly reflecting surface at normal incidence. If the surface area is 15 cm^2, the average force exerted on the surface is

[AIPMT-2014]

1. 1.25×10^{-6} N
2. 2.50×10^{-6} N
3. 1.20×10^{-6} N
4. 3.0×10^{-6} N

NATURE OF ELECTROMAGNETIC WAVE

(i) Speed of E-M wave = 3×10^8 m/s = $\frac{1}{\sqrt{\mu_0 \varepsilon_0}}$

(ii) Speed of E-M wave in medium = $\frac{1}{\sqrt{\mu \varepsilon}}$

(iii) Electric and magnetic field oscillate in same phase.

(iv) Direction of E-M wave $\vec{E} \times \vec{B}$.

(v) Energy of E-M wave equally divided in Electric and Magnetic field.

(vi) (Energy density) of E-M wave = $\varepsilon_0 E^2 = \frac{B^2}{\mu_0}$.

(vii) Total average energy density of E-M wave $= \frac{1}{2}\varepsilon_0 E^2 = \frac{1}{2\mu_0} B_0^2$

(viii) Electrostatic energy density in E-M wave $= \frac{1}{2}\varepsilon_0 E^2$

(ix) Average Electrostatic energy density in E-M wave $= \frac{1}{4}\varepsilon_0 E_0^2$

(x) Average Intensity is given by $I = \frac{1}{2}\varepsilon_0 E_0^2 C = \frac{1}{2}\frac{B_0^2}{\mu_0} C$

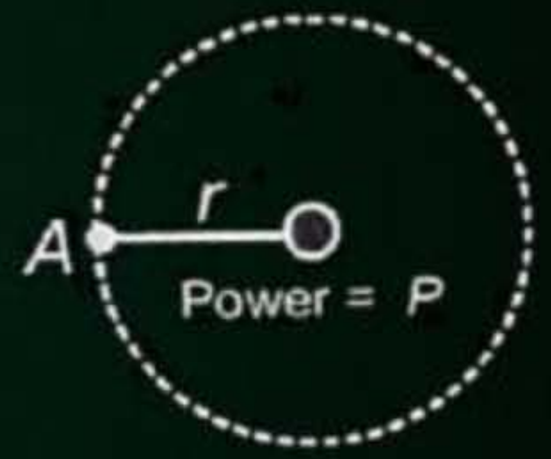
(xi) Net charge zero. Hence does not deflects in electric and magnetic field.

INTENSITY DUE TO A POINT SOURCE

The power of source = P

Distance of point A where intensity to be calculated = r

$$I = \frac{E}{A \times t} = \frac{P}{A} = \frac{P}{4\pi r^2}\ \mathrm{W/m^2}$$



POYNTING VECTOR

$$\vec{S} = \left(\frac{1}{2}\varepsilon_0 E_0^2 C\right) \text{ direction of wave}$$

$$\vec{S} = \frac{\vec{E}_0 \times \vec{B}}{2\mu_0}$$

QUESTION

Light with an average flux of 20 W/cm^2 falls on a non-reflecting surface at normal incidence having surface area 20 cm^2. The energy received by the surface during time span of 1 minute is [NEET 2020]

1. 10×10^3 J
2. 12×10^3 J
3. 24×10^3 J
4. 48×10^3 J

QUESTION

The ratio of contributions made by the electric field and magnetic field components to the intensity of an electromagnetic wave is (c = speed of electromagnetic waves)

[NEET 2020]

1. $c : 1$
2. $1 : 1$
3. $1 : c$
4. $1 : c^2$

QUESTION

A plane electromagnetic wave of frequency 500 MHz is travelling in vacuum along y-direction. At a particular point in space and time, $\vec{B} = 8.0 \times 10^{-8} \hat{z} T$. The value of electric field at this point is: (speed of light $= 3 \times 10^8$ ms^{-1}) $\hat{x}, \hat{y}, \hat{z}$ are unit vectors along x, y and z direction.

[JEE MAIN 2021]

1. $-24\,\hat{x}$ V/m
2. $2.6\,\hat{x}$ V/m
3. $24\,\hat{x}$ V/m
4. $-2.6\,\hat{y}$ V/m

QUESTION

For an electromagnetic wave travelling in free space, the relation between average energy densities due to electric (U_e) and magnetic (U_m) fields as: [JEE MAIN 2021]

1. $U_e = U_m$
2. $U_e > U_m$
3. $U_e < U_m$
4. $U_e \neq U_m$

QUESTION

Red light differs from blue light as they have: [JEE MAIN 2021]

1. Different frequencies and different wavelengths
2. Different frequencies and same wavelengths
3. Same frequencies and same wavelengths
4. Same frequencies and different wavelengths

QUESTION

A plane electromagnetic wave propagating along y-direction can have the following pair of electric field ($\vec{E}$) and magnetic field ($\vec{B}$) components. [JEE MAIN 2021]

1. E_y, B_y or E_z, B_z
2. E_y, B_x or E_x, B_y
3. E_x, B_z or E_z, B_x
4. E_x, B_y or E_y, B_x

QUESTION

If $\vec{E}$ and $\vec{K}$ represent electric field and propagation vectors of the EM waves in vacuum, then magnetic field vector is given by: (ω - angular frequency): **[JEE MAIN 2023]**

1. $\frac{1}{\omega}(\vec{K} \times \vec{E})$
2. $\omega(\vec{E} \times \vec{K})$
3. $\omega(\vec{K} \times \vec{E})$
4. $\vec{K} \times \vec{E}$

QUESTION

The electric field and magnetic field components of an electromagnetic wave going through vacuum is described by

$E_x = E_0 \sin(kz - \omega t)$

$B_y = B_0 \sin(kz - \omega t)$

Then the correct relation between E_0 and B_0 is given by [JEE MAIN 2023]

1. $kE_0 = \omega B_0$
2. $E_0 B_0 = \omega k$
3. $\omega E_0 = kB_0$
4. $E_0 = kB_0$

QUESTION

Which of the following are true?

(A) Speed of light in vacuum is dependent on the direction of propagation.

(B) Speed of light in a medium in independent of the wavelength of light.

(C) The speed of light is independent of the motion of the source.

(D) The speed of light in a medium is independent of intensity.

Choose the correct answer from the option given below: [JEE MAIN 2023]

1. A and C only
2. B and D only
3. B and C only
4. C and D only

QUESTION

The ratio of average electric energy density and total average energy density of electromagnetic wave is: [JEE MAIN 2023]

1. 2
2. 1
3. 3
4. 1/2

QUESTION

The electromagnetic waves travel in a medium at a speed of 2.0×10^8 m/s. The relative permeability of the medium is 1.0. The relative permittivity of the medium will be:

[JEE MAIN 2023]

1. 2.25
2. 4.25
3. 6.25
4. 8.25

QUESTION

Which of the correct ascending order of wavelengths? [JEE MAIN 2022]

1. $\lambda_{\text{visible}} < \lambda_{\text{X-ray}} < \lambda_{\text{gamma-ray}} < \lambda_{\text{microwave}}$
2. $\lambda_{\text{gamma-ray}} < \lambda_{\text{X-ray}} < \lambda_{\text{visible}} < \lambda_{\text{microwave}}$
3. $\lambda_{\text{X-ray}} < \lambda_{\text{gamma-ray}} < \lambda_{\text{visible}} < \lambda_{\text{microwave}}$
4. $\lambda_{\text{microwave}} < \lambda_{\text{visible}} < \lambda_{\text{gamma-ray}} < \lambda_{\text{X-ray}}$

QUESTION

Identify the correct statements from the following descriptions of various properties of electromagnetic waves.

(A) In a plane electromagnetic wave electric field and magnetic field must be perpendicular to each other and direction of propagation of wave should be along electric field or magnetic field.

(B) The energy in electromagnetic wave is divided equally between electric and magnetic fields.

(C) Both electric field and magnetic field are parallel to each other and perpendicular to the direction of propagation of wave.

(D) The electric field, magnetic field and direction of propagation of wave must be perpendicular to each other.

(E) The ratio of amplitude of magnetic field to the amplitude of electric field is equal to speed of light.

Choose the most appropriate answer from the options given below: [JEE MAIN 2022]

1. D only
2. B and D only
3. B, C and E only
4. A, B and E only


THANK YOU
Ray optics
H/W

YAKEEN 2.0

FOR NEET 2025

Lecture-01 | Physics

Ray Optics and Optical Instruments

By- Dr. Manish Raj (MR SIR)



Ray optics

Lec- 1

Todays Goal

→ EM Ka H/W

→ Reflection from plane mirror.

QUESTION

Light with an average flux of 20 W/cm^2 falls on a non-reflecting surface at normal incidence having surface area 20 cm^2. The energy received by the surface during time span of 1 minute is

[NEET 2020]

1. 10×10^3 J
2. 12×10^3 J
3. 24×10^3 J (Ans)
4. 48×10^3 J

$I = 20\ W/cm^2$

$I = 20 \times 10^4\ W/m^2$

$A = 20 \times 10^{-4}\ m^2$

$t = 60\ sec$

$I = \frac{E}{At}$

$E = IAt$

$= 20 \times 10^4 \times 20 \times 10^{-4} \times 60$

$= 400 \times 60$

$= 24 \times 10^3$

QUESTION

The ratio of contributions made by the electric field and magnetic field components to the intensity of an electromagnetic wave is (c = speed of electromagnetic waves)

[NEET 2020]

1. $c : 1$
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[JEE MAIN 2021]

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1. E_y, B_y or E_z, B_z
2. E_y, B_x or E_x, B_y
3. E_x, B_z or E_z, B_x
4. E_x, B_y or E_y, B_x

y (wave)

(Ans)

QUESTION

If $\vec{E}$ and $\vec{K}$ represent electric field and propagation vectors of the EM waves in vacuum, then magnetic field vector is given by: (ω - angular frequency): [JEE MAIN 2023]

1. $\frac{1}{\omega}(\vec{K} \times \vec{E})$
2. $\omega(\vec{E} \times \vec{K})$
3. $\omega(\vec{K} \times \vec{E})$
4. $\vec{K} \times \vec{E}$

$\hat{K}$ = Angular wave no = Propagation vector $= \frac{2\pi}{\lambda}$ = rad/m

$B = \frac{sec}{rad} \times \frac{rad}{m} \times V/B$

$\hat{K} = \hat{E} \times \hat{B}$, $\hat{B} = \hat{K} \times \hat{E}$ } dir^n

$\hat{i} = \hat{j} \times \hat{k}$, $\hat{k} = \hat{i} \times \hat{j}$, $\hat{j} = \hat{k} \times \hat{i}$

$v = \frac{\omega}{K} = \frac{E}{B}$

$B = \frac{K}{\omega} E$

→ step(1) dir^n of magnetic

step(2) dim^n verification

QUESTION

The electric field and magnetic field components of an electromagnetic wave going through vacuum is described by

$E_x = E_0 \sin(kz - \omega t)$

$B_y = B_0 \sin(kz - \omega t)$

Then the correct relation between E_0 and B_0 is given by

[JEE MAIN 2023]

(1) $kE_0 = \omega B_0$ ✓ $\frac{E_0}{B_0} = \frac{\omega}{k}$

(2) $E_0 B_0 = \omega k$ ✗

(3) $\omega E_0 = kB_0$ ✗

(4) $E_0 = kB_0$ ✗

JEE नोट है।

QUESTION

Which of the following are true?

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(B) Speed of light in a medium in independent of the wavelength of light.

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Choose the correct answer from the option given below: [JEE MAIN 2023]

1. A and C only
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3. B and C only
4. C and D only

QUESTION

The ratio of average electric energy density and total average energy density of electromagnetic wave is: [JEE MAIN 2023]

1. 2
2. 1
3. 3
4. 1/2 ✓

$$\frac{\langle U_E \rangle = \frac{1}{4}\varepsilon_0 E_0^2}{\langle U_{EM} \rangle = \frac{1}{2}\varepsilon_0 E_0^2} = \frac{1}{2}$$

QUESTION

The electromagnetic waves travel in a medium at a speed of 2.0×10^8 m/s. The relative permeability of the medium is 1.0. The relative permittivity of the medium will be:

[JEE MAIN 2023]

1. 2.25
2. 4.25
3. 6.25
4. 8.25

$$V = \frac{c}{\sqrt{\mu_r \varepsilon_r}}$$

$$\mu_r \varepsilon_r = \frac{c^2}{v^2} = \frac{(3 \times 10^8)^2}{(2 \times 10^8)^2}$$

$$\mu_r \times 1 = \frac{9}{4}$$

$$\mu_r = 2.25$$

QUESTION

Which of the correct ascending order of wavelengths?

[JEE MAIN 2022]

1. $\lambda_{visible} < \lambda_{X\text{-}ray} < \lambda_{gamma\text{-}ray} < \lambda_{microwave}$
2. $\lambda_{gamma\text{-}ray} < \lambda_{X\text{-}ray} < \lambda_{visible} < \lambda_{microwave}$
3. $\lambda_{X\text{-}ray} < \lambda_{gamma\text{-}ray} < \lambda_{visible} < \lambda_{microwave}$
4. $\lambda_{microwave} < \lambda_{visible} < \lambda_{gamma\text{-}ray} < \lambda_{X\text{-}ray}$

QUESTION

Identify the correct statements from the following descriptions of various properties of electromagnetic waves.

(A) In a plane electromagnetic wave electric field and magnetic field must be perpendicular to each other and direction of propagation of wave should be along electric field or magnetic field.

(B) The energy in electromagnetic wave is divided equally between electric and magnetic fields.

(C) Both electric field and magnetic field are parallel to each other and perpendicular to the direction of propagation of wave.

(D) The electric field, magnetic field and direction of propagation of wave must be perpendicular to each other.

(E) The ratio of amplitude of magnetic field to the amplitude of electric field is equal to speed of light.

$\frac{B}{E} = v$

Choose the most appropriate answer from the options given below: [JEE MAIN 2022]

1. D only
2. B and D only
3. B, C and E only
4. A, B and E only

Bauaa chapter completed

The Ray optics

→ Suru से sure kar sakte hai.

→ 3 to 4 question आते हैं।

Optics → form of enegy

light → wave

Ray optics (Geometrical optics)

Wavelength of light much smaller than size of obstacles.

(1) Reflection from plane mirror and curved mirror
(2) Refraction from plane and curved surface
(3) Refraction from Lens | (4) Prism | (5) optical instrument

Wave optics → Wavelength of light compairable to size of obstacles.

(1) Huygen Law (2) Interference (3) Y.D.S.E (4) Diffraction
(5) polarisation.

Quantum optics → Light Interacts with relativistic particle (e^-, p+, α)

(1) Photoelectric effect (2) Dual Nature

Reflection of light

light is visible ??

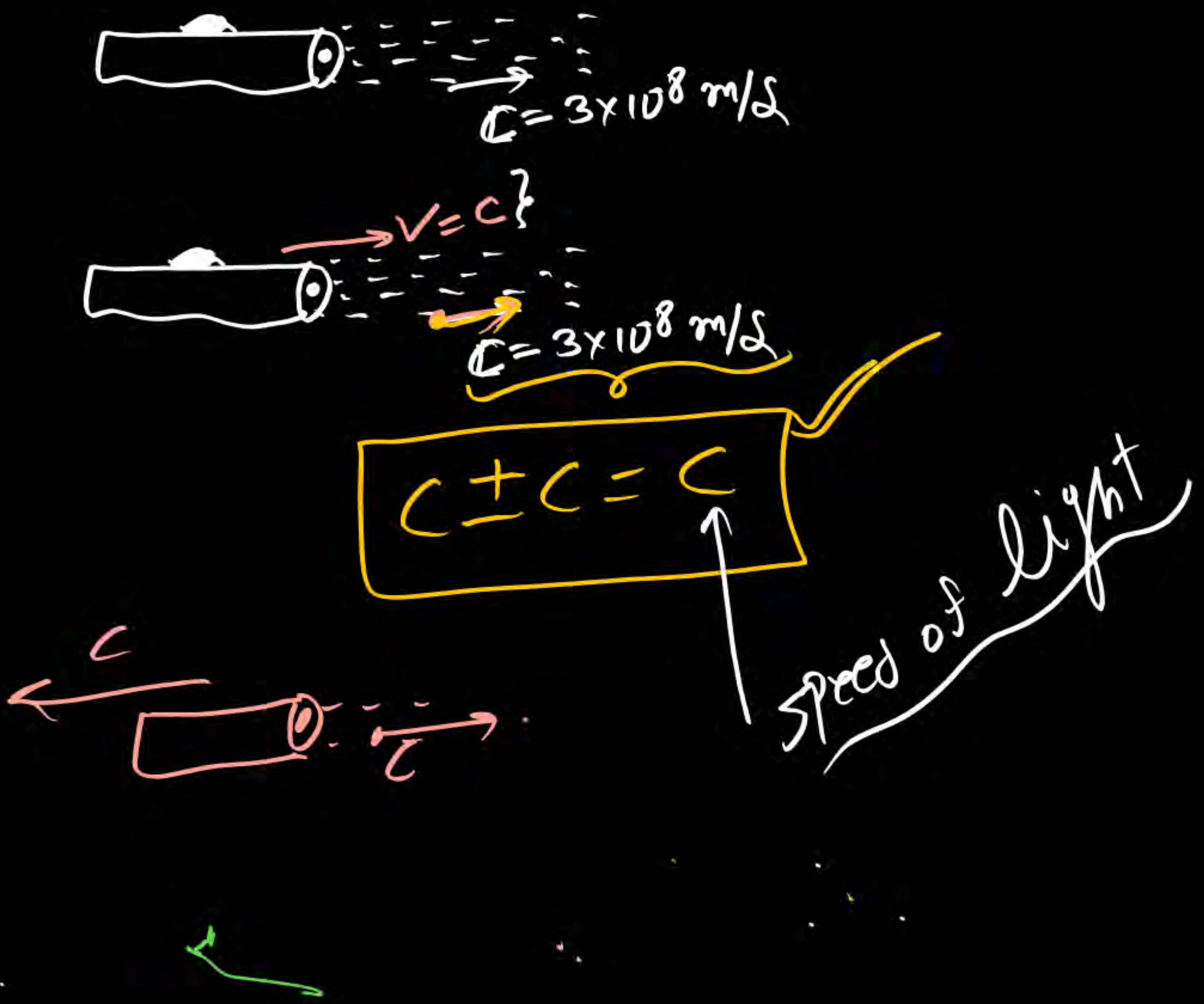
✗ (a) Yes (20%)

✓ (b) No 78%

EM wave

{VIBGYOR}

400nm → 700nm



(1) Light is an EM wave, No medium required for propagation.

(2) c (speed in free space) $= 3\times10^{8}$ m/s $= \frac{1}{\sqrt{\mu_0 \epsilon_0}} = c$

$\rightarrow v\mu = c$ (ca')
$\rightarrow v_1\mu_1 = v_2\mu_2$

(3) $V = \lambda f = \frac{\lambda}{T} = \frac{\omega}{K} = \frac{E_0}{B_0} = \frac{1}{\sqrt{\mu_m \epsilon_m}} = \frac{1}{\sqrt{\mu_0 \mu_r \epsilon_r \epsilon_0}} = \frac{c}{\sqrt{\mu_r \epsilon_r}} = \frac{c}{\mu}$ (refractive Index)

(4) wavelength of visible light is 400nm to 700nm

(5) speed of light does not depends on speed of source and observer

(6) Colour of light defined by frequency, when light travel from one to other medium it frequency and colour do not change but wavelength, Amplitude, speed changes.

(7) Light itself is not visible, but make object visible.

(8) opaque → does not allow light to pass, Transparent – light can pass.

(9) $v_1\mu_1 = v_2\mu_2$

(10) $\mu \propto \frac{1}{\lambda}$ *

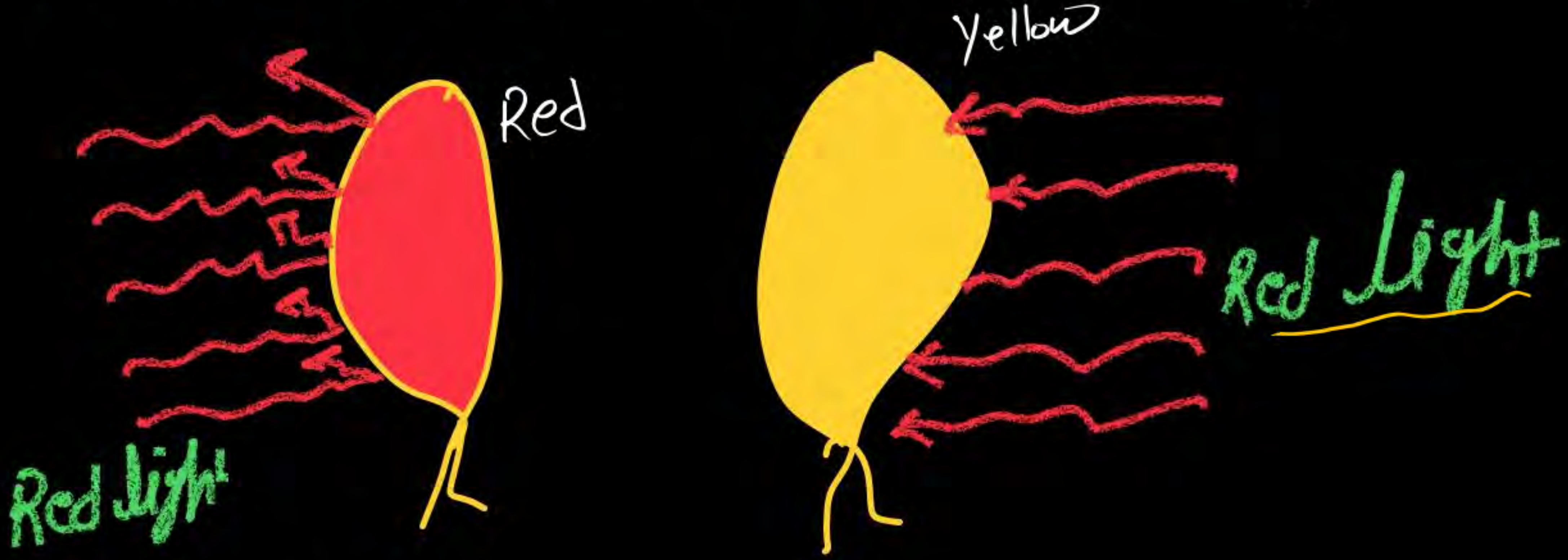
(11) Monochromatic → Light of single 'λ'

(12) white light → combination of all wavelength

(13) At crossing point direction of ray do not changes



which Balloon will Burst first ??



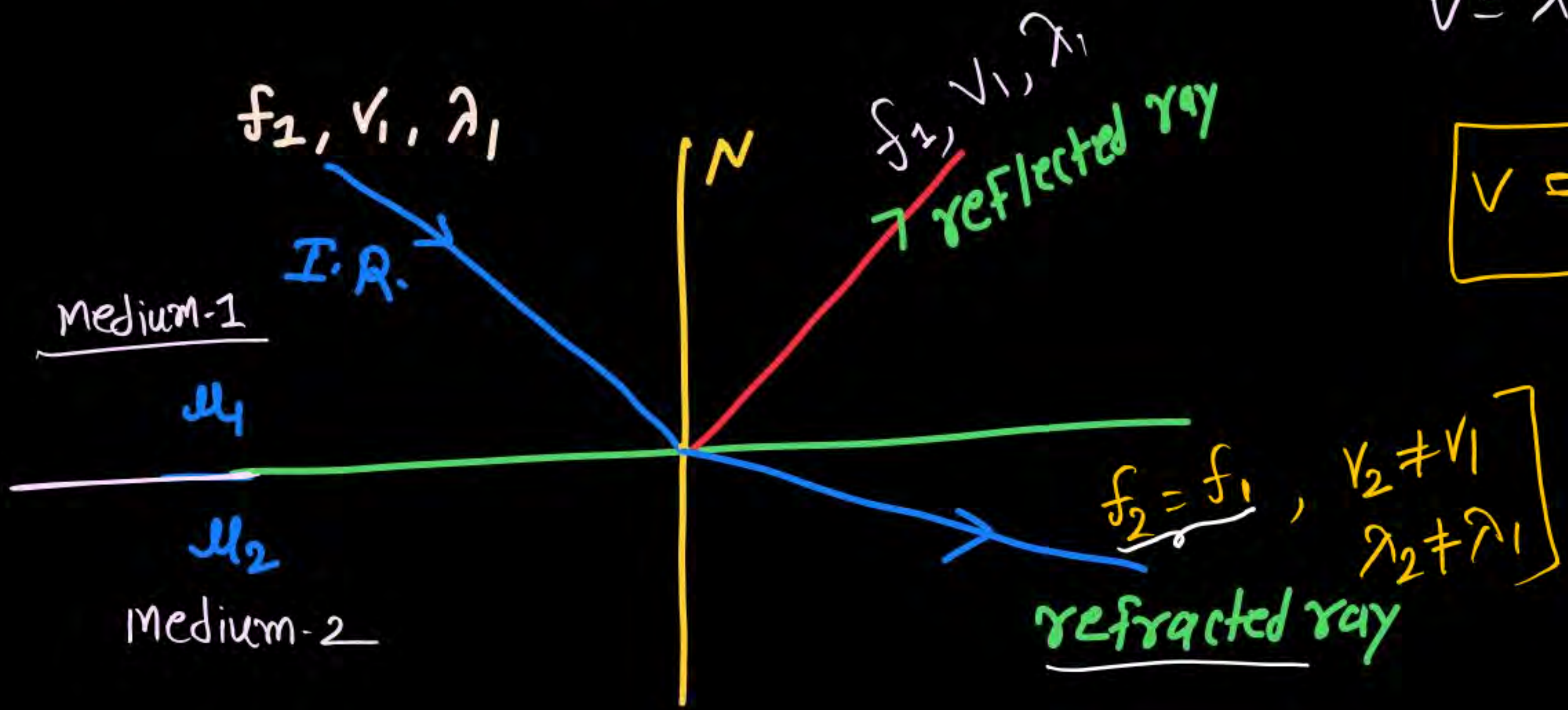
(a) yellow 60%

(b) Red 30%

(c) Both at same time

(d) No Balloon will burst

effect of light in reflection and refraction



$v = \lambda \boxed{f}$ → does not depends on medium
only depends on source

$$\boxed{v \propto \lambda \propto \frac{1}{\mu}}\ *$$

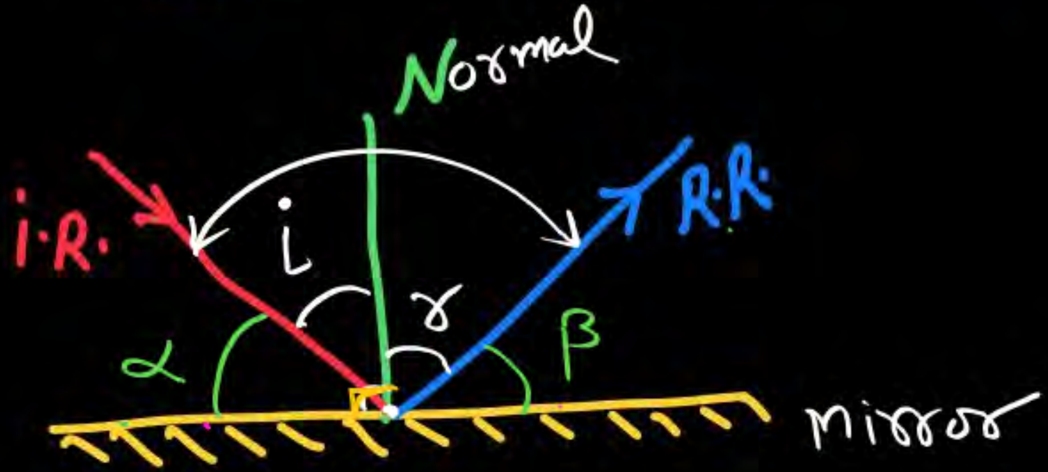
Laws of (Reflection) → light Bounce Back in a same medium.

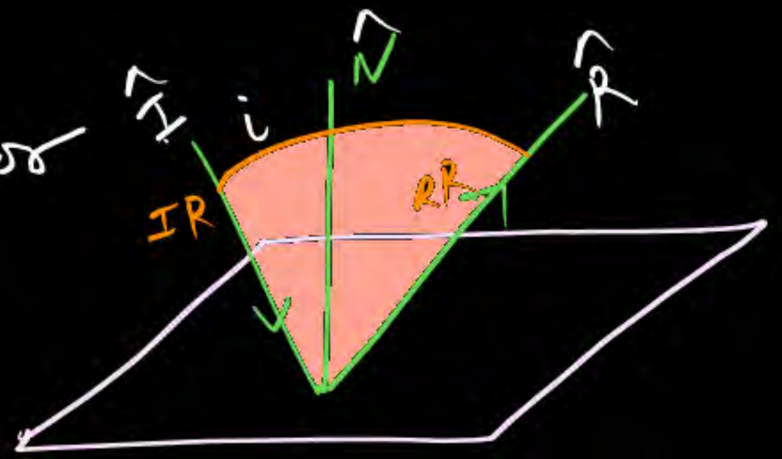
(1) Angle of incident = Angle of reflection

(2) Normal, Incident ray (I.R) & Reflected ray (R.R) all are lies in same plane.

$$(\hat{I} \times \hat{R}) \cdot \hat{N} = (\hat{I} \times \hat{N}) \cdot \hat{R} = 0 = (\hat{R} \times \hat{N}) \cdot \hat{i}$$

Law of reflection in vector form.





$\angle \hat{i} = \angle \hat{r}$

$\angle \alpha = \angle \beta$ *

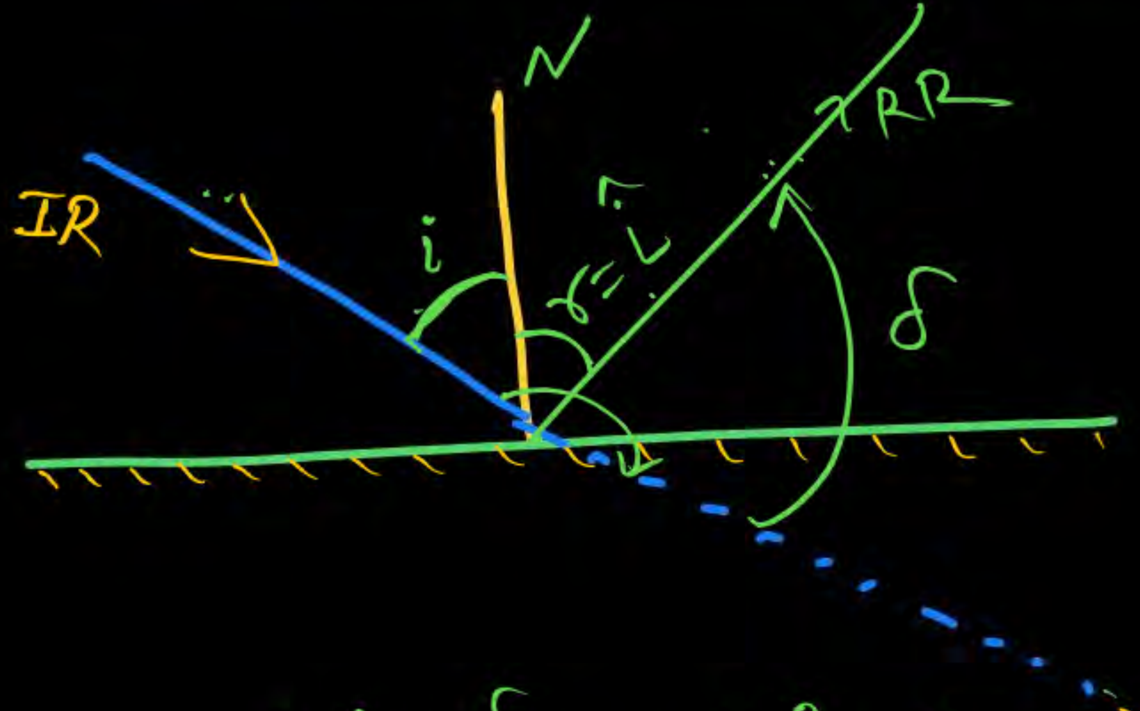
$\alpha = 90^\circ - i$

Angle b/w IR and RR always $= 2i = 2r$ *

Incident Angle → Angle b/w Incident ray and Normal.

Angle of reflection → Angle b/w reflected ray and Normal.

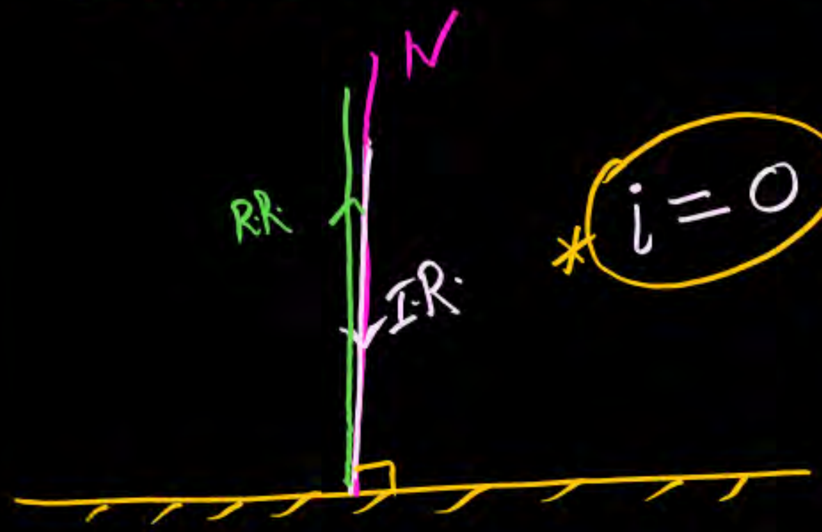
Deviation by plane mirror



$2i + \delta = 180°$ ← in this diagram

$\delta = 180° - 2i$

Deviation for Normal Incidence By plane mirror



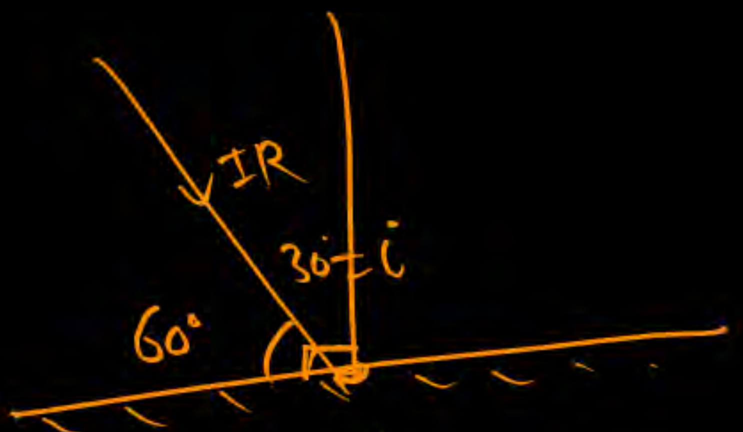
* $i = 0$

$\delta = 180° - 2 \times i$

$\delta = 180 - 2 \times 0$

$\delta = 180°$ Answer

A light falls on a mirror at an angle 60° from surface of mirror then find angle of deviatio



$$\delta = 180 - 2 \times i$$
$$= 180 - 2 \times 30°$$
$$= 180 - 60$$
$$= 120°$$

(a) 60° (20%) ✗

(b) 120° (72%) ✓

(c) 30°

(d) 150°

find deviation



(a) $\delta = 30°$

(b) $120°$

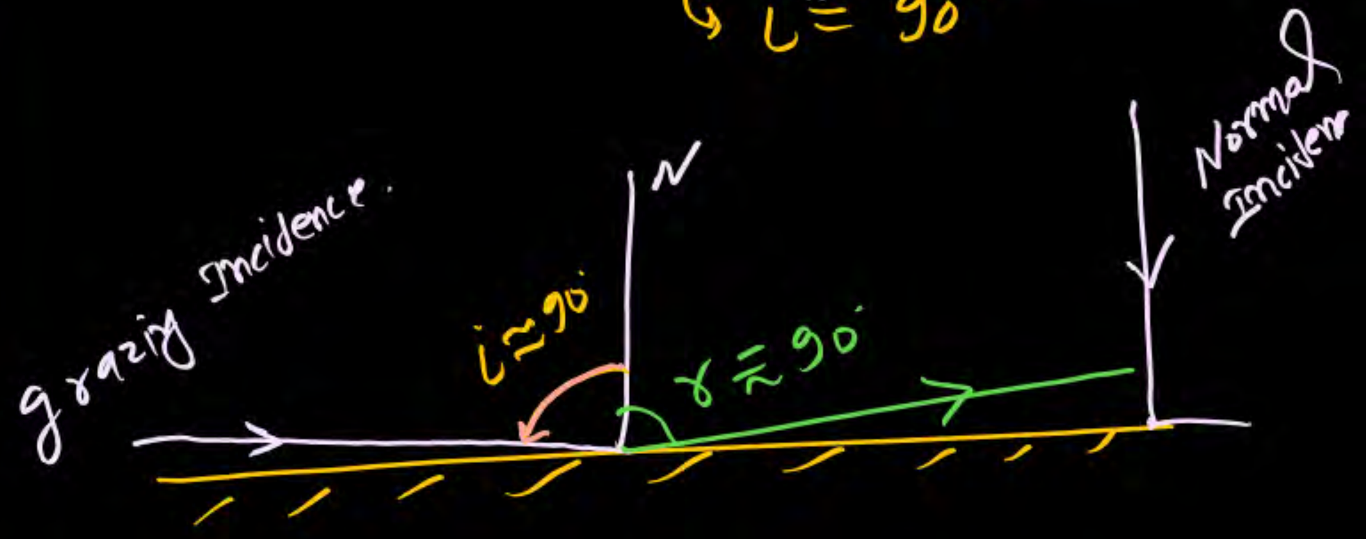
(c) $60°$

(d) $90°$

$$\delta = 180 - 2i$$
$$= 180 - 2\times 60$$
$$= 180 - 120°$$
$$= 60°$$

deviation in Grazing Incidence

$\rightarrow i \simeq 90°$

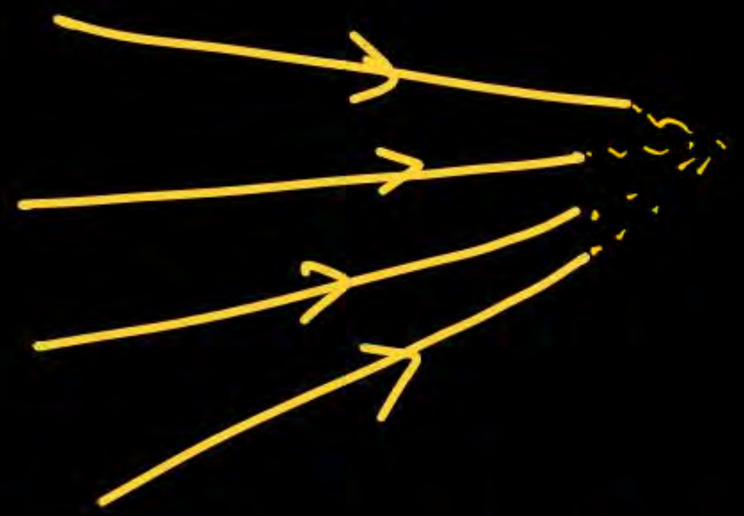


$$\delta = 180 - 2\times i$$

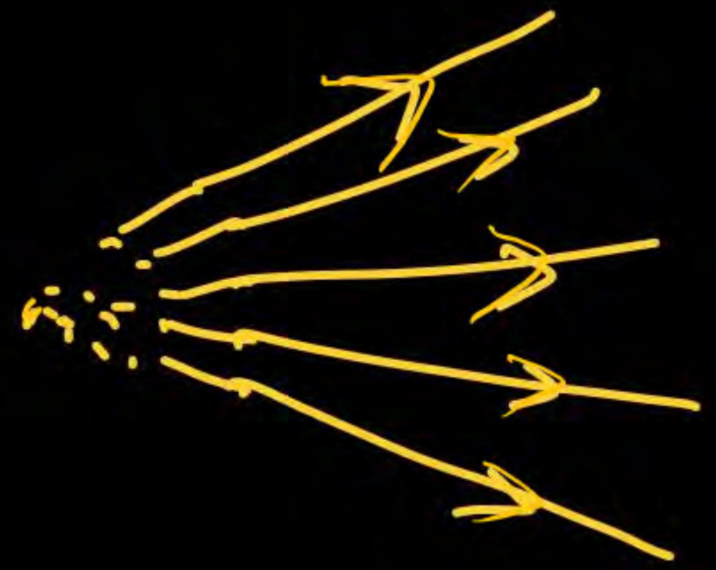
δ = very small or tens to zero



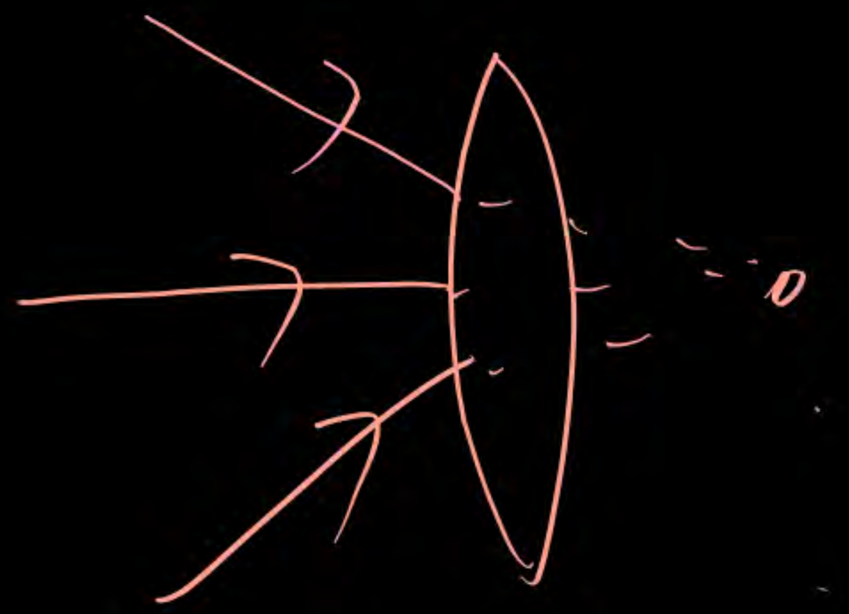
Parallel rays



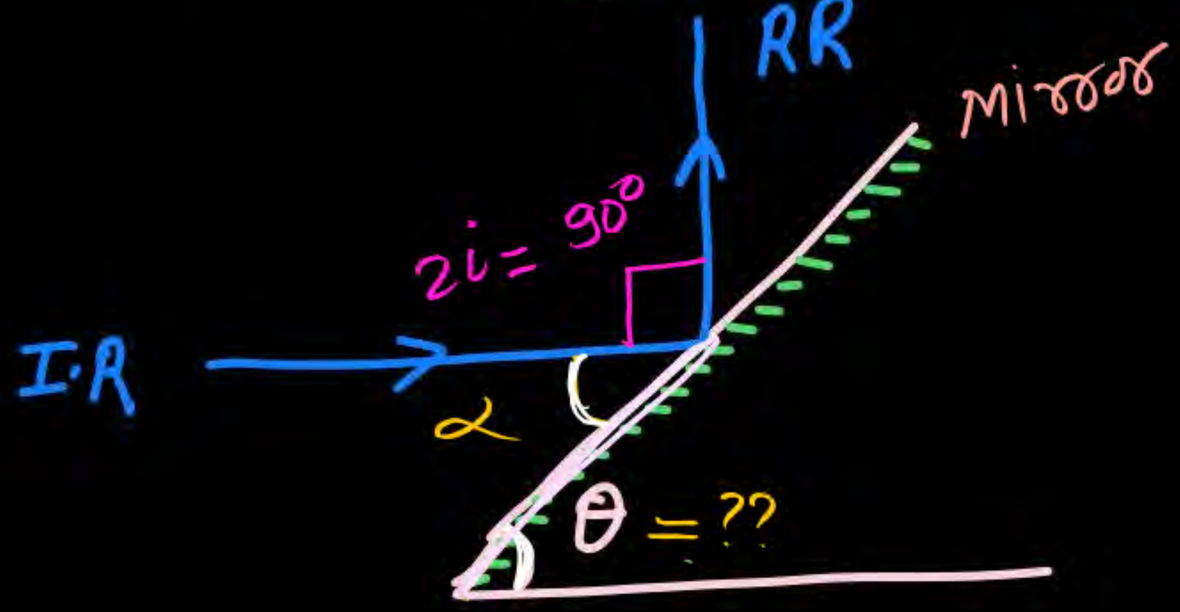
Converging rays



Diverging ray



find Angle b/w mirror and x-axis ??



Sol^n

$2i = 90^\circ$

$i = 45^\circ$

we know that

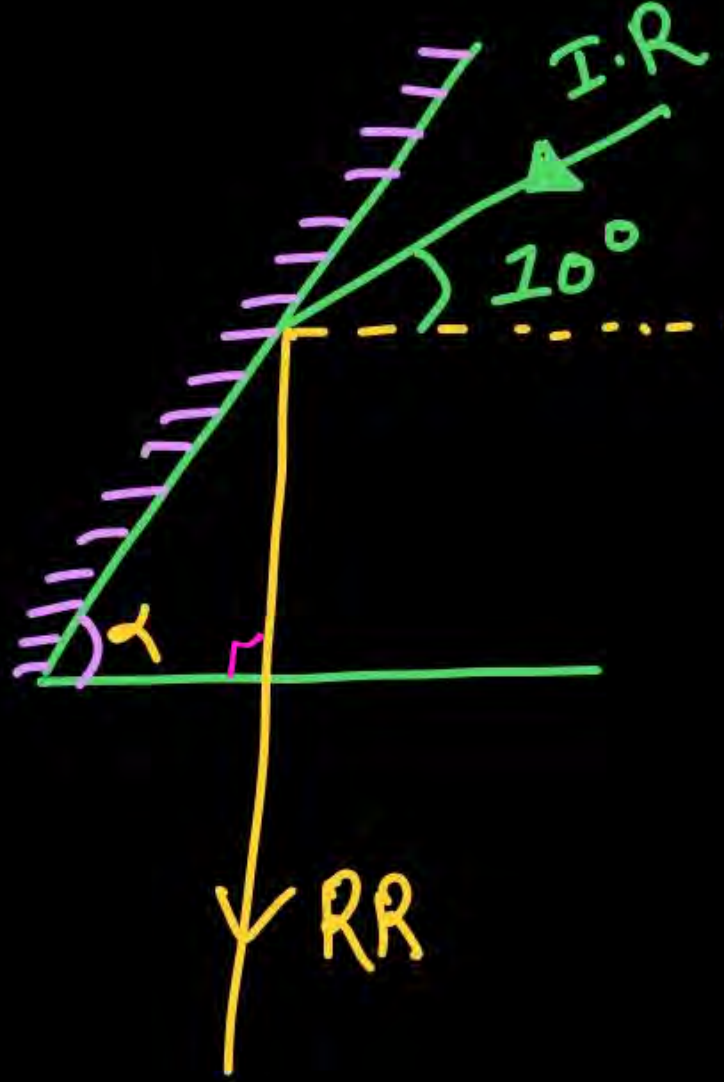
$\alpha = 90^\circ - i$

$\alpha = 90 - 45^\circ = 45^\circ$

$\theta = \alpha$

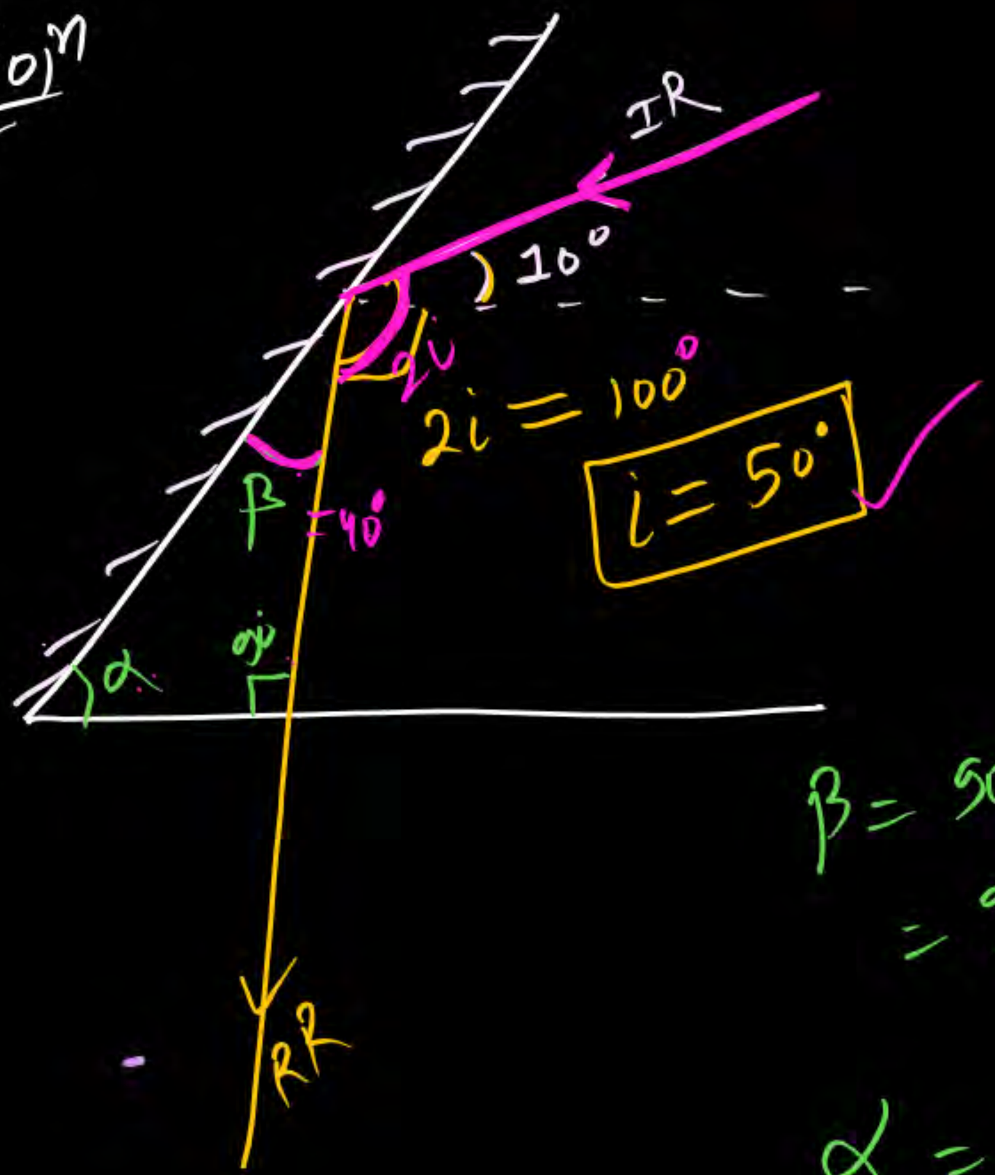
$\theta = 45^\circ$ Ans

find Angle α in given figure??



α = Angle b/w plane mirror & x-axis.

→ Sol^n



$\beta = 90 - i$
$= 90 - 50 = 40°$

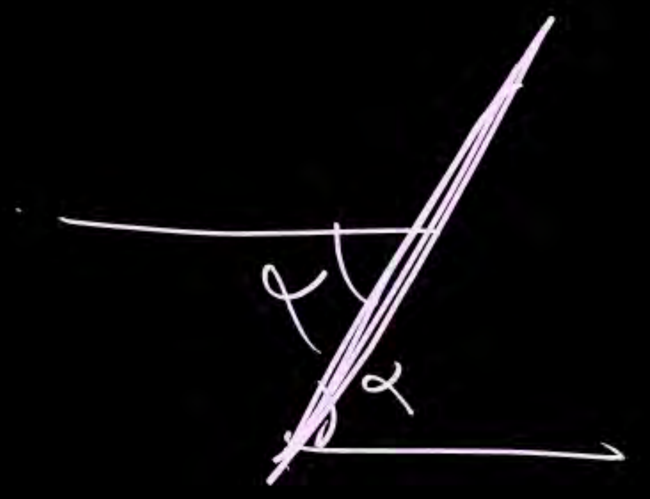
$\alpha = 90 - \beta =$
$= 90 - 40 = 50°$

find 'α' = ??

20°/35°/70°/55°



Angle B/w plane mirror & x-axis ??



Sol^n $2i = 70°$

$i = 35°$ Ans

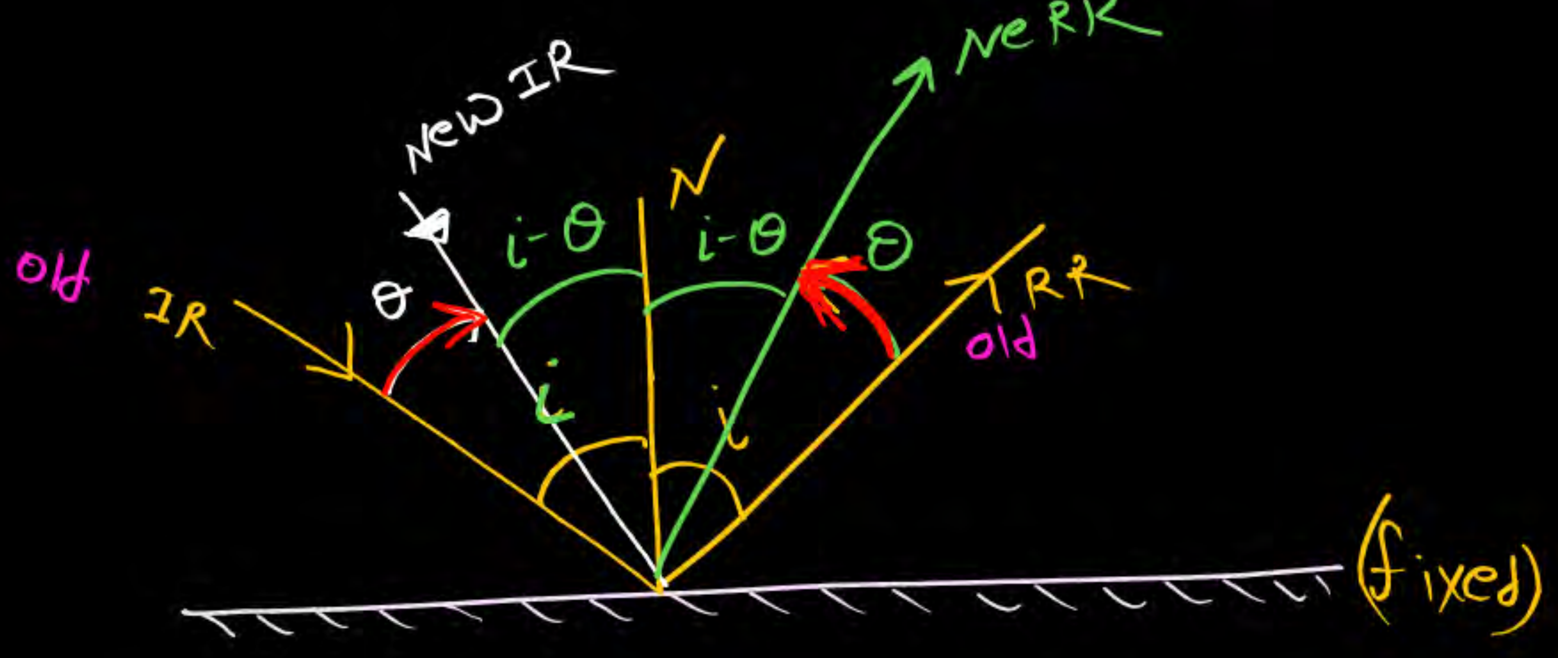
$\beta = 90 - i$

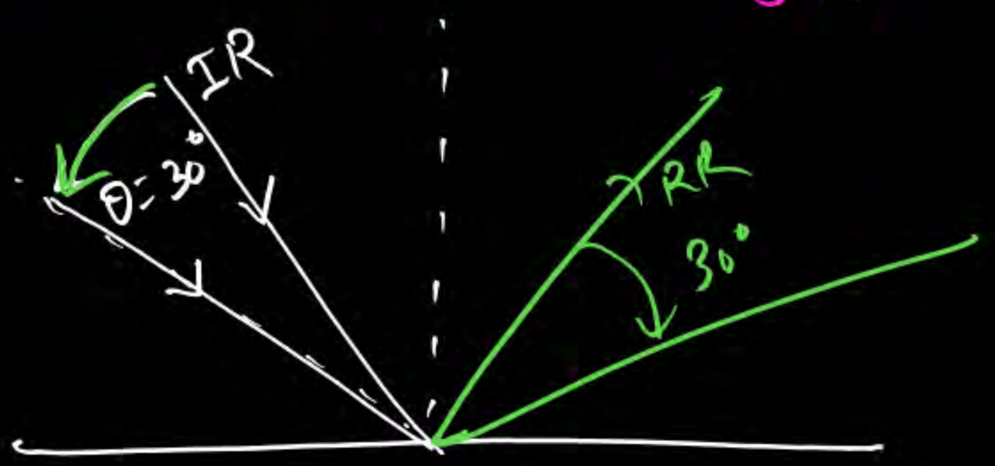
$= 90 - 35$

$\beta = 55°$

$\alpha = 35°$ Ans

If mirror is fixed and I.R. Rotated by angle 'θ' clockwise then reflected ray will ?? → Rotate same angle in opposite dir^n.



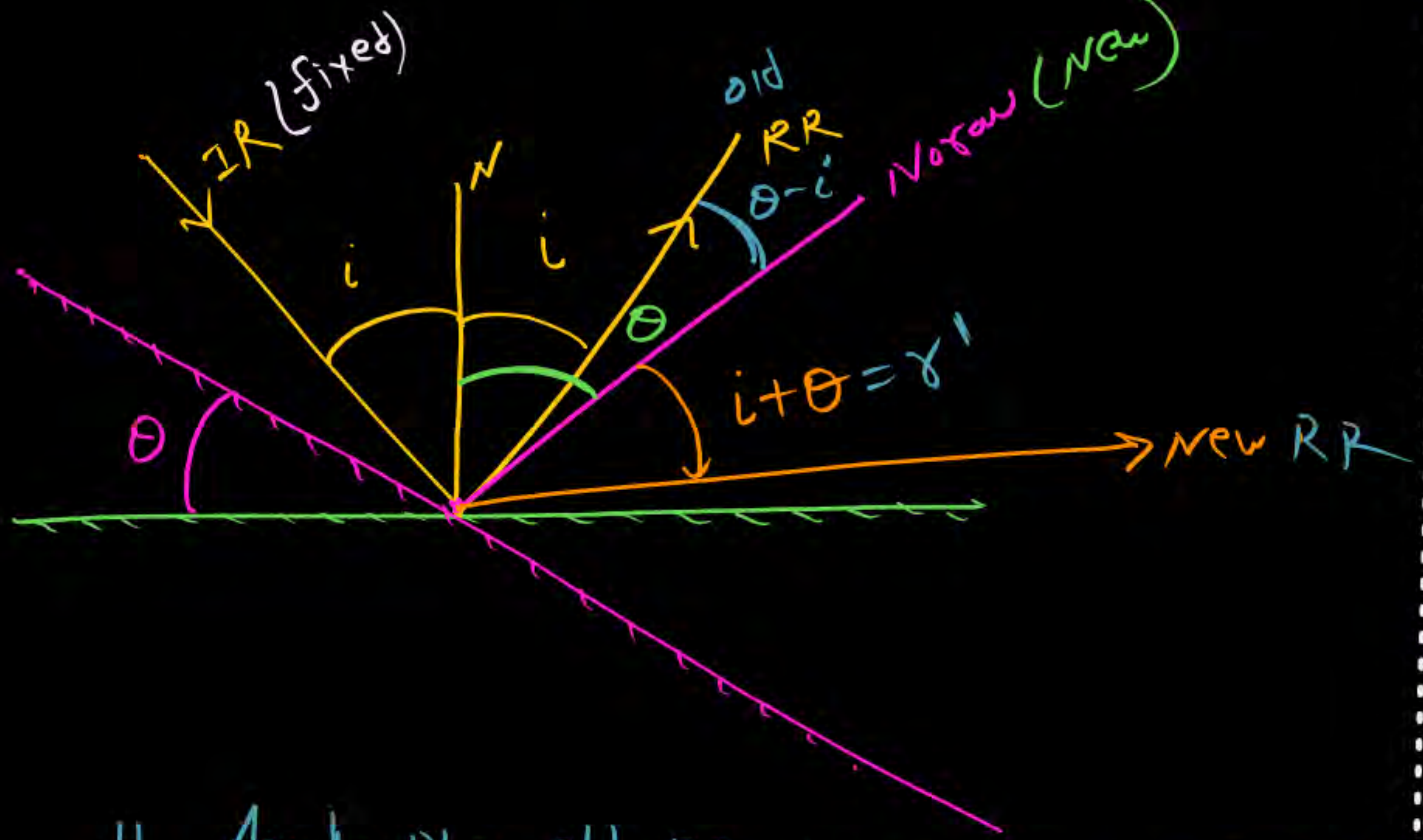


RR will rotate 30° in clockwise if incidented ray rotate by 30° ACW

If incident ray rotated by angle 15° A.C.W then reflected ray will rotated by an angle.

Ans – 15° (C.W)

Incident ray is fixed and mirror is rotated by an angle 'θ' then new angle of reflection will be ??

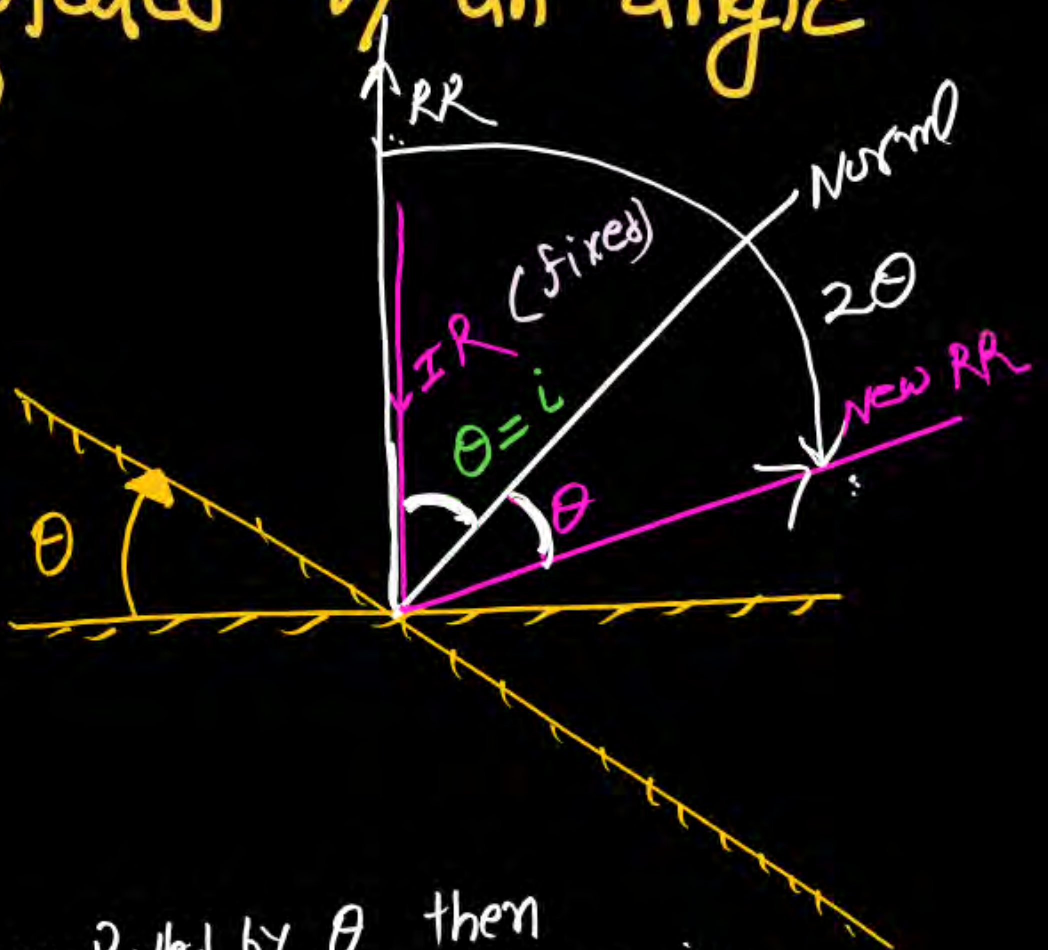


Angle B/w old RR & New RR

$\alpha = \theta - i + i + \theta$

$\alpha = 2\theta$

Complex visualised



if mirror Rotated by θ then RR will Rotated by 2θ in Same dirn.

Simple visualisation

Mirror is Rotated by an angle 30° CW in its Plane & Incident ray is fixed then reflected ray will be rotated by.

Ans zero°

Reflection by two plane Mirror (Two reflection considered)

Image → Intersection Point of reflected / refracted ray

→ Real Image Acctual Intersection Point reflected ray

→ virtual Image → Reflected ray assume to be intersect

Object →

H/W


THANK YOU
Ray optics
H/w

YAKEEN 2.0

FOR NEET 2025

Lecture-02 | **Physics**

Ray Optics and Optical Instruments



By- Dr. Manish Raj (MR SIR)

Todays Goal

☆ Image formation by Plane mirror

- Basic math ✓
- vector ✓
- UdM ✓
- 1-D ✓
- 2-D ✓
- Laws of motion (friction) ✓
- circular motn ✓
- work Eng Pow ✓
- C.O.M & collision ✓
- Rotn ✓
- gravitation ✓
- S.H.M ✓
- thermal Prop

solid: Wave | Thermal, Fluid

MEC, Current

Compt thermal Properties of matter (upload)

→ 3hr 8 mint

80% of 11th class Revision done

JEE main — 2 shift

Yakeen 2.0

NEET 2025 ka Paper easy hoga.

- 30 to 35 question direction formula one line calculation

- 3-4 question → theory Based
- 3-4 → statement | A R | matrix match.
- 3-4 → lengthy

LIVE STREAM

JEE MAIN 2025 PAPER DISCUSSION

JEE ULTIMATE CRASH COURSE 2025

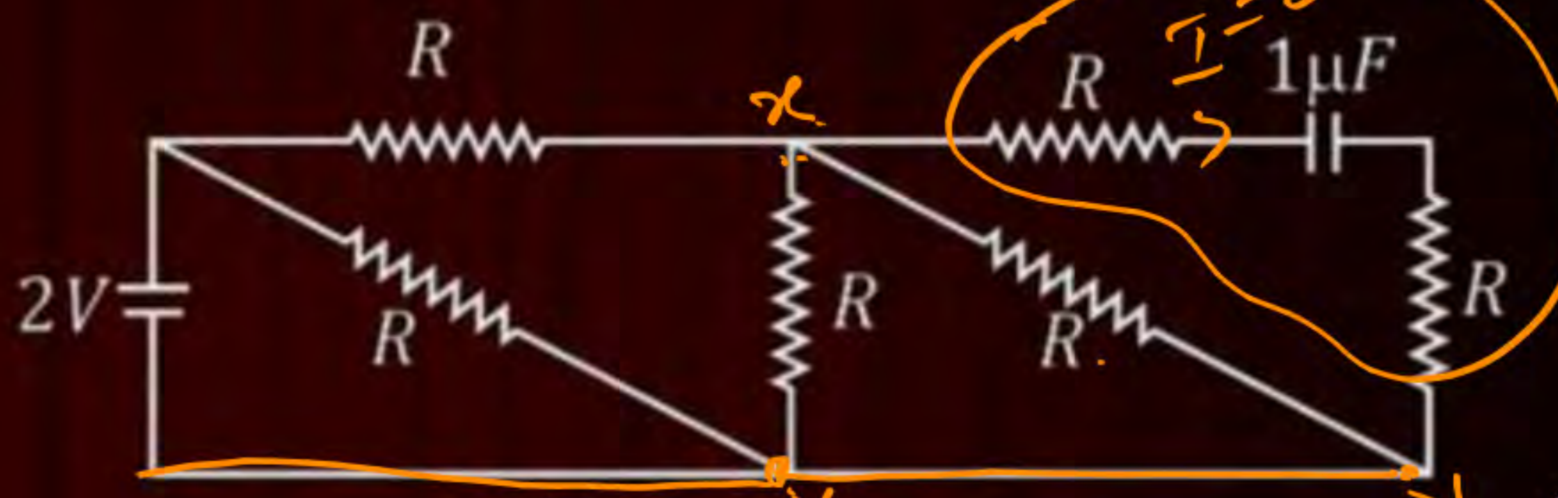
In the circuit shown below, the capacitor has a value of 1 μF and R = 2Ω. The circuit is powered by a 2V battery. Determine the current in the circuit at steady state.

(A) 1. 0 A

(B) 5/3 A

(C) 2.0 A

(D) 4/3 A



LIVE STREAM JEE MAIN 2025 PAPER DISCUSSION

JEE ULTIMATE CRASH COURSE 2025

Find the dimensions of $\frac{B}{\mu_0}$

$B = \frac{\mu_0 I}{2R}$ → dim^n pattern

$\frac{B}{\mu_0} = I/R$

(A) [AL]

(B) $[AL^{-1}]$ ✓

(C) [MAL]

(D) $[MALT^{-1}]$



LIVE STREAM

JEE MAIN 2025 PAPER DISCUSSION

JEE ULTIMATE CRASH COURSE 2025

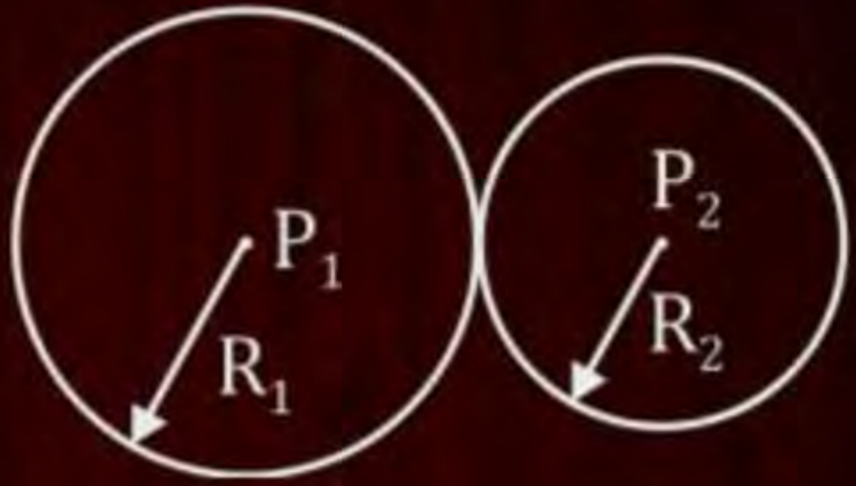
Find the radius of curvature of the common surface of two bubbles $(R_1 > R_2)$

(A) $R = \frac{R_1 R_2}{R_1 + R_2}$

(B) $R = \frac{2R_1 R_2}{R_1 - R_2}$

(C) $R = \frac{R_1 R_2}{R_1 - R_2}$ ✓

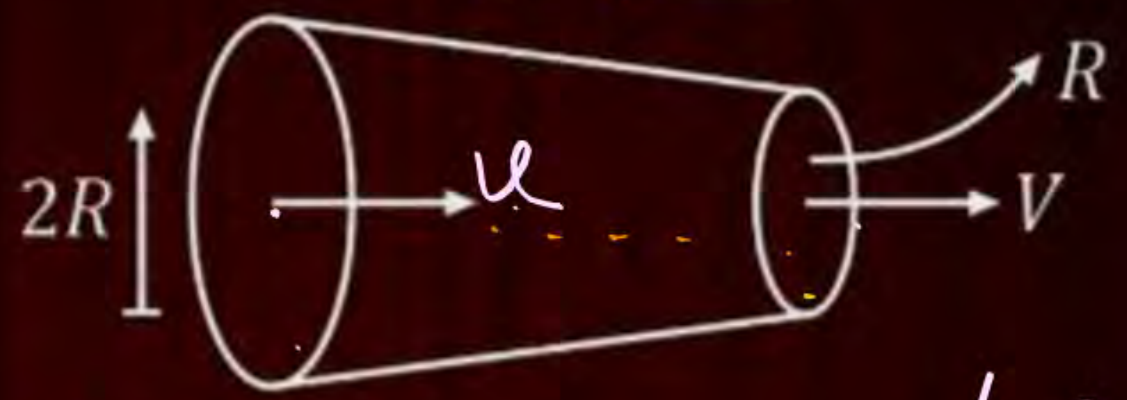
(D) $R = \frac{2R_1 R_2}{(R_1 + R_2)}$



$\frac{1}{R} = \frac{1}{R_1} - \frac{1}{R_2}$

$R = \frac{R_1 R_2}{R_2 - R_1}$

Radius of a tube decrease from $2R$ to R in which ideal liquid is flowing at same level. it's speed at left end is 2 m/s, find speed v at other end



(A) 4 m/s

(B) 1 m/s

(C) 2 m/s

(D) 8 m/s

LIVE STREAM

JEE MAIN 2025 PAPER DISCUSSION

JEE ULTIMATE CRASH COURSE 2025

A charge of value q is placed at the edge of a imaginary cube of side a as shown in figure. find the net flux through the cube.

(A) $q/6\varepsilon_0$

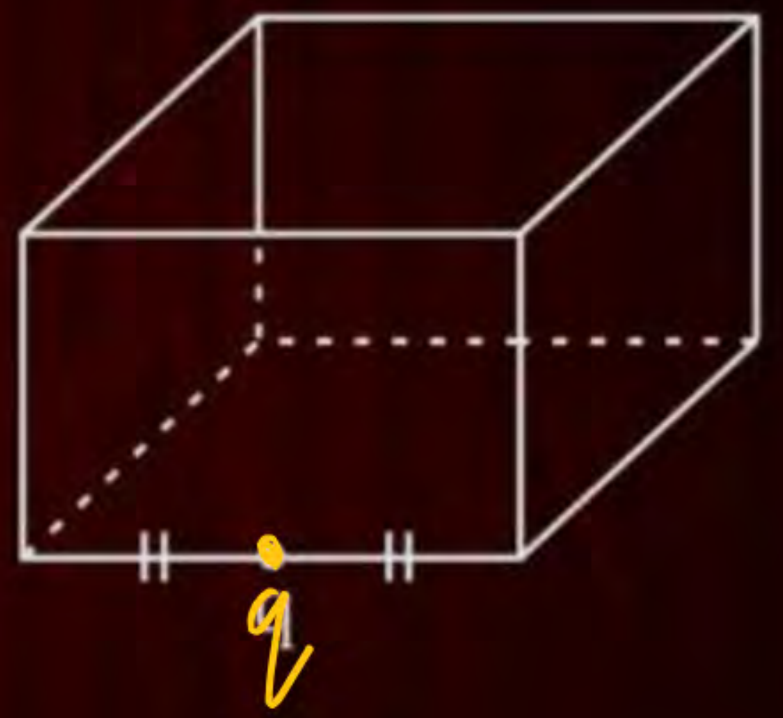
(B) $q/4\varepsilon_0$

(C) $q/8\varepsilon_0$

(D) $q/2\varepsilon_0$

Yakeen plus

close now



LIVE STREAM

JEE MAIN 2025 PAPER DISCUSSION

JEE ULTIMATE CRASH COURSE 2025

What amount of heat is required to convert 1 gm of ice at –10°C into steam at 110°C?

A $\Delta Q = 730$ cal

B $\Delta Q = 1100$ cal

C $\Delta Q = 930$ cal

D $\Delta Q = 900$ cal

LIVE STREAM

JEE MAIN 2025 PAPER DISCUSSION

A conducting circular ring is moving with a constant velocity in a uniform magnetic field as shown. Identify the correct graph between induced emf vs time



(A)


(B)


(C)

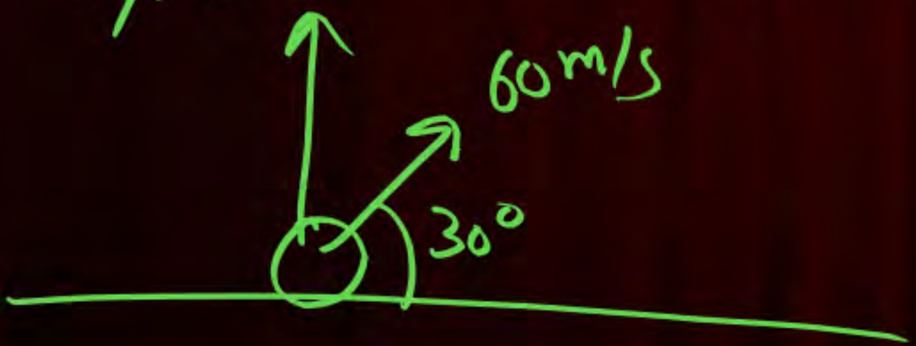

(D)

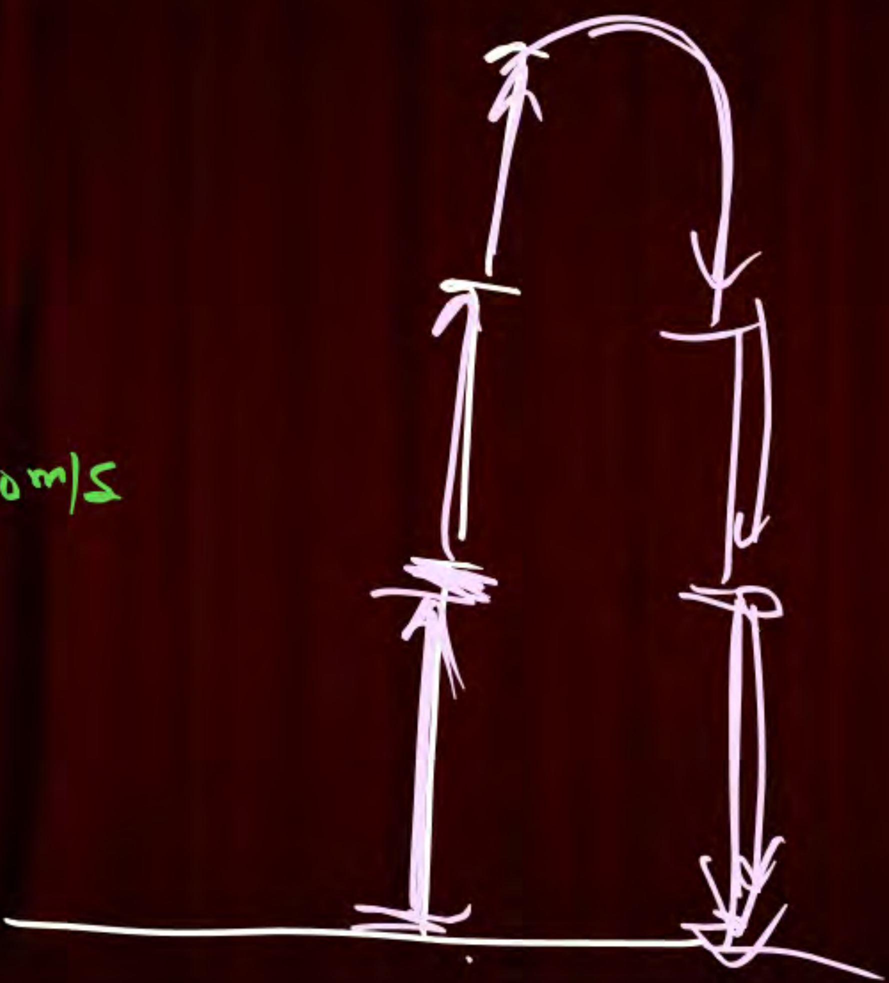

LIVE STREAM

JEE MAIN 2025 PAPER DISCUSSION

A particle is projected with velocity 60 m/s at an angle 30° with respect to horizontal. It reaches height h_1 in 1^{st} second and height h_2 in last second during its motion. Find the ratio of h_1/h_2

$u_y = 60 \times \sin 30 = 60 \times \frac{1}{2} = 30\ m/s$





$h_1 : h_2 = 1:1.$

JEE MAIN 2025 PAPER DISCUSSION

Two spherical black bodies of radius 0.8 m and 0.2 m are at temperatures of 400 K and 800 K respectively. Find ratio of rate of heat loss.

$$\frac{Q_1}{Q_2} = \frac{\text{Area}_1 T_1^4}{\text{Area}_2 T_2^4} = \frac{4\pi (0.8)^2 \times (400)^4}{4\pi (0.2)^2 \times (800)^4}$$

$$= 16\left(\frac{1}{2}\right)^4$$

$$= \frac{16}{2\times2\times2\times2}$$

1 : 1

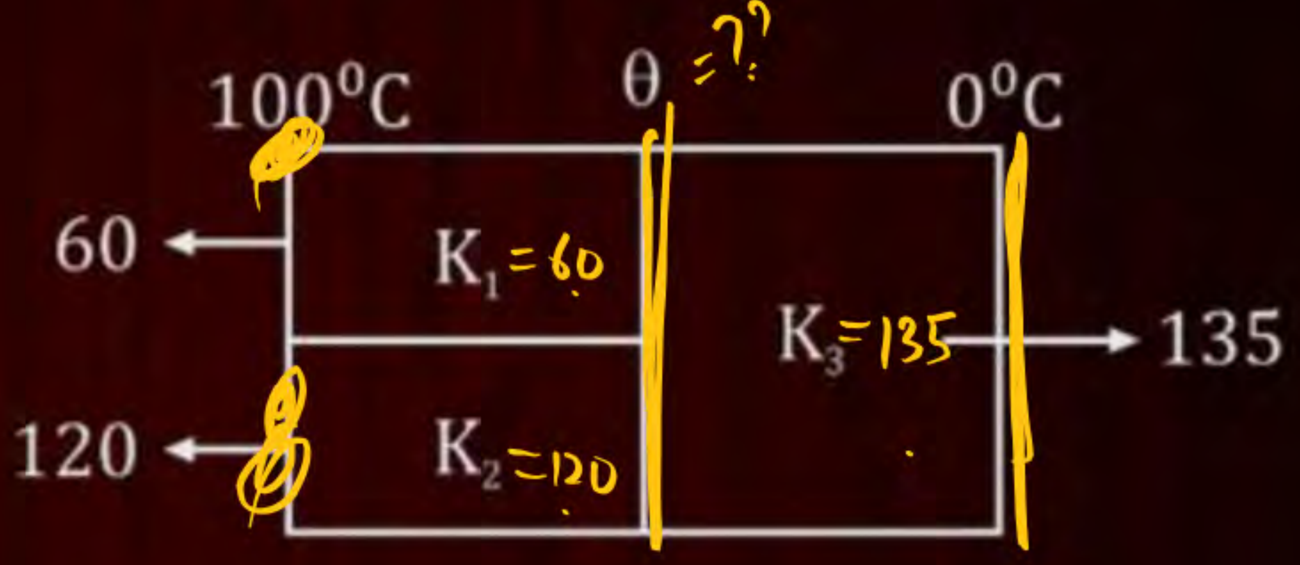
In the diagram given below, the value of coefficients of thermal conductivity, $K_1 = 60$, $K_2 = 120$ W/mC, $K_3 = 135$ W/mC. The temperature at the left most end is 100 °C and rightmost end is 0 °C find the temperature θ.

(A) 40°C

(B) 45°C

(C) 55°C

(D) 60°C



LIVE STREAM

JEE MAIN 2025 PAPER DISCUSSION

false

Statement I- When non – ideal batteries are connected in parallel then the resultant emf is lesser than either of the battery

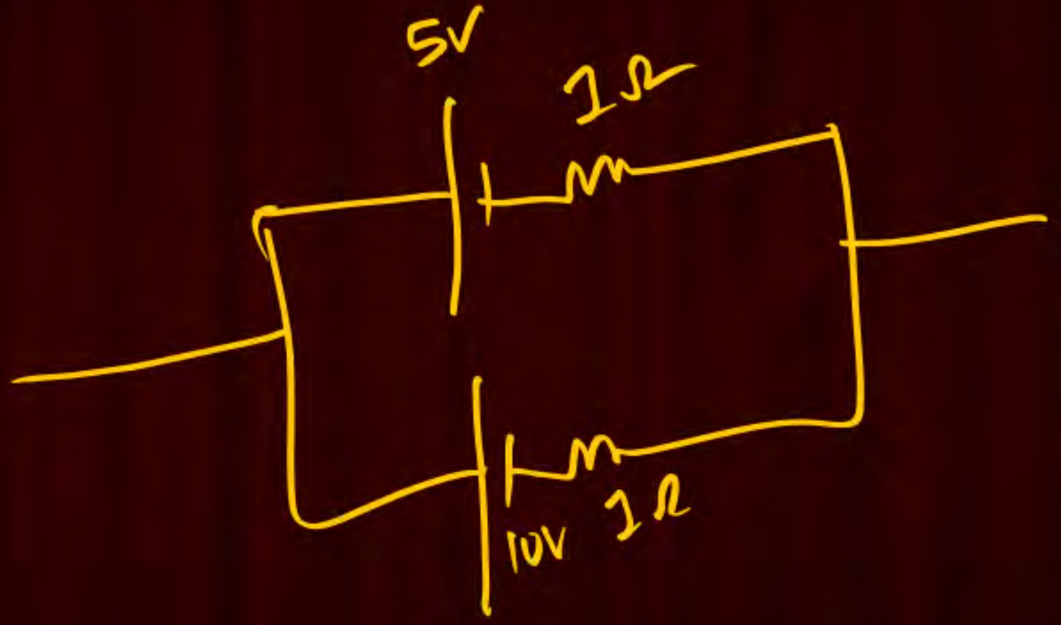
Statement II- When non – ideal batteries are connected in parallel then the resultant resistance of their internal resistance is smaller than either of the resistance

(A) I true , II false

(B) I false, II true

(C) Both true

(D) Both false



$$\text{emf} = \frac{\frac{10}{1} + \frac{5}{1}}{\frac{1}{1} + \frac{1}{1}} = \frac{15}{2} = 7.5V$$

LIVE STREAM

JEE MAIN 2025 PAPER DISCUSSION

JEE ULTIMATE CRASH COURSE 2025

A proton is moving with uniform velocity of 2×10^8 m/s in uniform magnetic and electric fields which are perpendicular to each other. If electric field is switched off then proton moves in circular path of radius 1.6×10^{-5} m. Then magnetic field is B

(A) 5×10^{-5}T

(B) 1.2×10^5 T

(C) 2.5×10^4 T

(D) 2.5×10^2T

$R = \frac{mv}{qB}$

$B = \frac{mv}{qR} =$

LIVE STREAM

JEE MAIN 2025 PAPER DISCUSSION

JEE ULTIMATE CRASH COURSE 2025

A force $\vec{F} = 2\hat{i} + \hat{j} + 2\hat{k}$ N is acting at a point (1,1,1). Find the torque of this force about the origin (0,0,0).

(A) $\vec{\tau} = \hat{i} - \hat{k}$

(B) $\vec{\tau}' = 3\hat{i} - \hat{j} - \hat{k}$

(C) $\vec{\tau} = \hat{i} + \hat{j} + 2\hat{k}$

(D) $\vec{\tau} = 3\hat{i} + \hat{j} - 3\hat{k}$

LIVE STREAM

JEE MAIN 2025 PAPER DISCUSSION

Find the correct dimensional formula for the capacitance in terms of M, L, T, and C, where they stand for units of mass, length, time, and charge.

(A) $[M^{-1}L^{-2}T^{-1}C^{2}]$

(B) $[M^{-1}L^{-2}T^{2}C^{2}]$

(C) $[M^{-1}L^{-1}T^{3}C]$

(D) $[M^{0}L^{1}T^{-1}C^{-1}]$

$$U = \frac{Q^2}{2C}$$

$$C = \frac{Q^2}{U} = \frac{C^2}{ML^2T^{-2}}$$

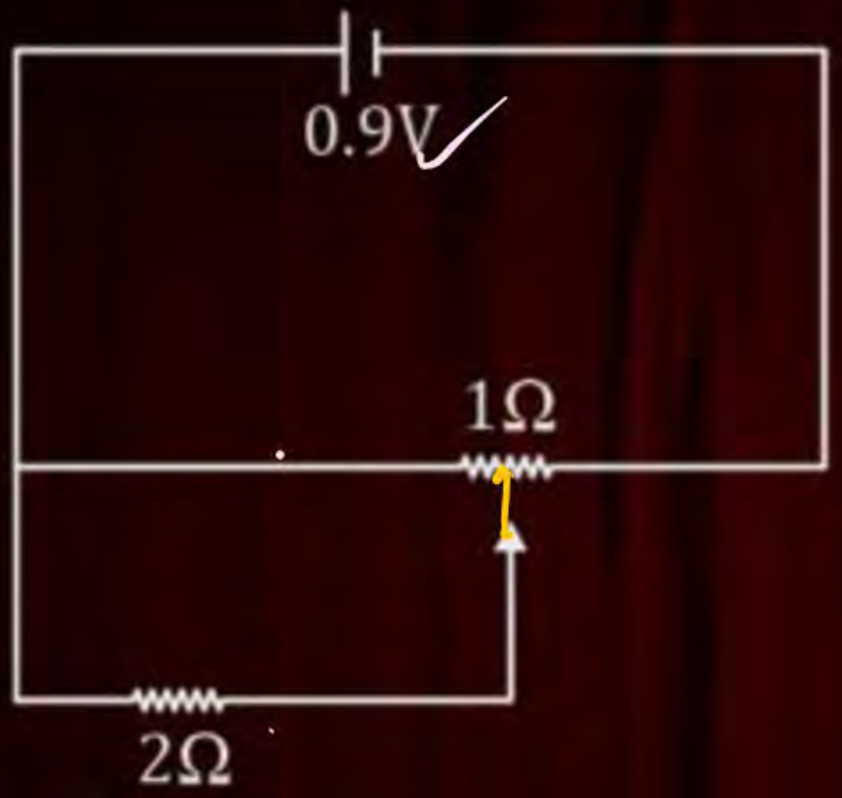
$$= M^{-1}L^{-2}T^{2}C^{2}$$

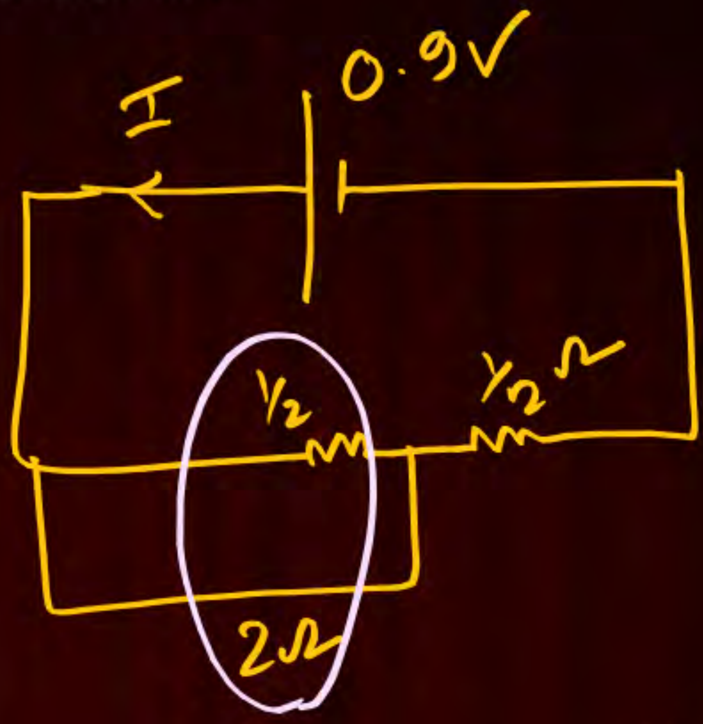


LIVE STREAM

JEE MAIN 2025 PAPER DISCUSSION

Find current in the circuit, Jockey is at middle point on 1Ω





$$\frac{2\times\frac{1}{2}}{2+\frac{1}{2}} = \frac{2}{5}\,\Omega$$

$$R = \frac{2}{5}+\frac{1}{2} = \frac{4+5}{10} = \frac{9}{10}$$

$$I = \frac{V}{R} = \frac{9}{10\times\frac{9}{10}} = 1A$$

A closed organ pipe of length 10 cm is in 9th harmonic resonates with 4th harmonic of open organ pipe. Find the length of open organ pipe.

(A) $L_0 = 15$ cm

(B) $L_0 = \frac{100}{9}$ cm

(C) $L_0 = \frac{80}{9}$ cm ✓

(D) $L_0 = \frac{110}{7}$ cm

$f = \frac{(2n+1)v}{4l}$

$n \rightarrow$ overtone

$(2n+1) \rightarrow$ harmonic

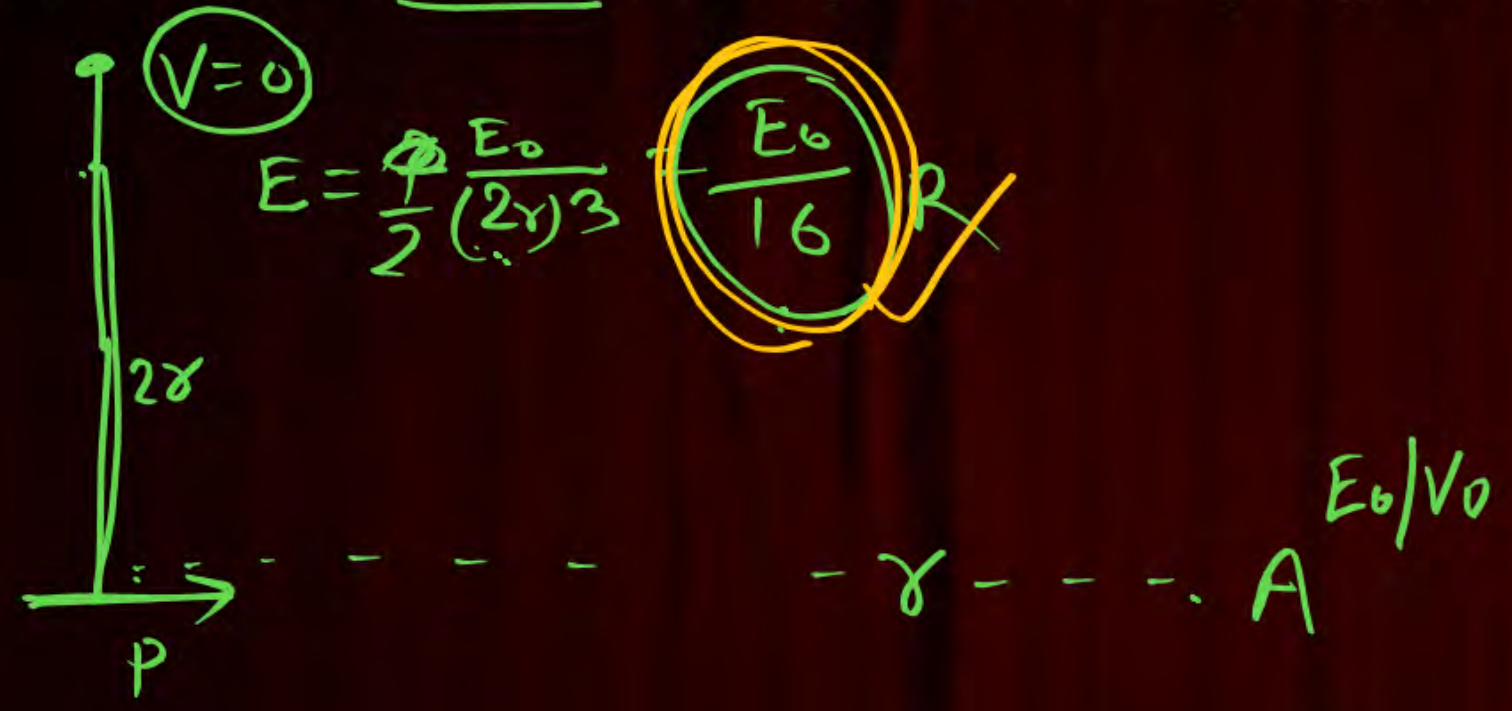
$\frac{v}{4l}$, $\frac{3v}{4l}$, $\frac{5v}{4l}$, $\frac{9v}{4l}$

$\frac{9v}{4l} = \frac{4v}{2l}$

$\frac{9}{4 \times 10} = \frac{2}{l}$

$l = \frac{80}{9}$

The point A is situated on the axis of dipole at a distance 'r' from the dipole with E_0 and V_0 the electric field and electric potential at A. Find the electric field and potential at point B at distance '$2r$' from dipole on its perpendicular bisector in terms of E_0 and V_0



LIVE STREAM

JEE MAIN 2025 PAPER DISCUSSION

JEE ULTIMATE CRASH COURSE 2025

A force $\vec{F} = 2\hat{i} + \hat{j} + 2\hat{k}$ acting at a point (1, 1, 1). Find torque of this force about the origin

In a series LCR circuit the maximum amplitude of current is I_0 when the resistance is R. What is the maximum amplitude of current if the resistor is replaced by a resistor of resistance 2R

(A) I_0

(B) $2I_0$

(C) $I_0/2$

(D) $2I_0/3$

The displacement of a particle moving under the action of a force $\hat{F} = 2\hat{i} + b\hat{j} + \hat{k}$ is $\vec{d} = \hat{\imath} + \hat{j} + \hat{k}$. Find the value of b if the work done by the force is zero.

(A) 0

(B) +3

(C) −3 ✓

(D) −1

$2 + b + 1 = 0$

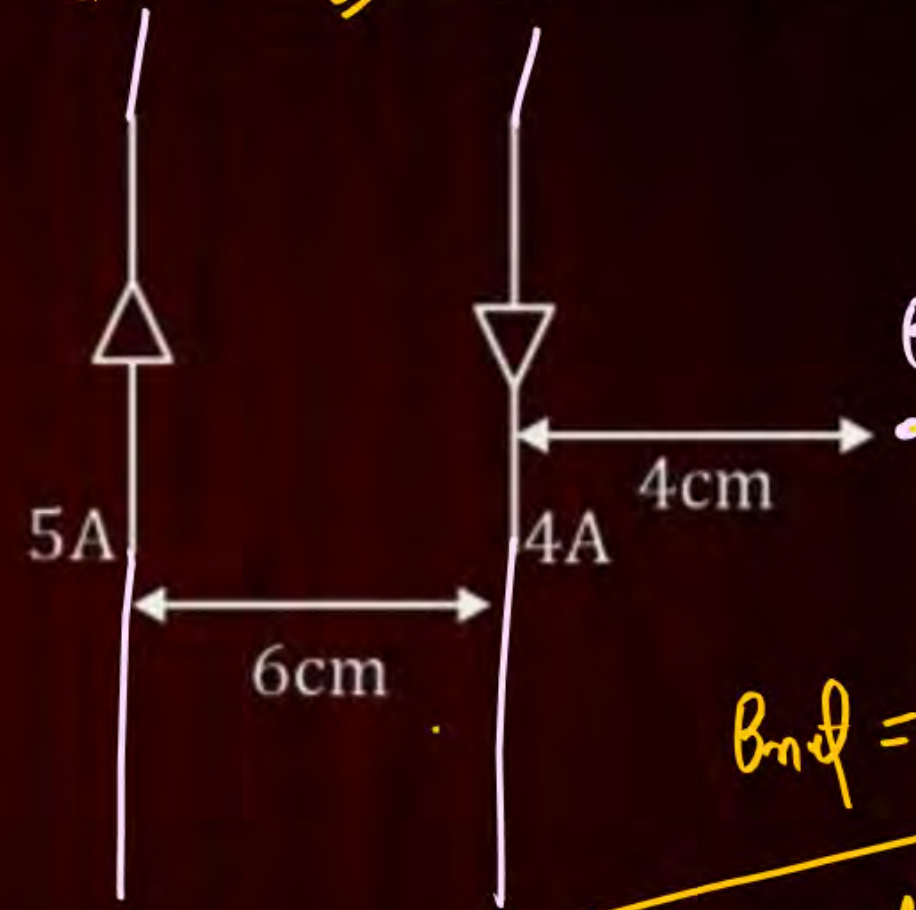
$b + 3 = 0$

$b = -3$ ✓

Vector

JEE MAIN 2025 PAPER DISCUSSION

Here are two wires held parallel to each other carrying current as shown in the diagram. The value of resultant magnetic field at point P is $n \times 10^{-5}$ T. Find the value of n.



LIVE STREAM

JEE MAIN 2025 PAPER DISCUSSION

An electron in the group state of the hydrogen atom has the orbit, radius of 5.0×10^{-10} m while that for the electron in third excited state is 8.48×10^{-10} m. The radio of the de-Broglie wavelength is electron om the ground state to that in the excited state is:

(A) 9

(B) 3

(C) 4

(D) 16

LIVE STREAM

JEE MAIN 2025 PAPER DISCUSSION

Statement I- In a vernier callipers, one vernier scale division is smaller than one main scale division.

Statement II- The vernier constant is given by one main scale division multiplied by the number of vernier scale divisions.

(A) Statement I is true and Statement II is false.

(B) Statement I is false and Statement II is true.

(C) Both the statements are true.

(D) Both the statements are false.

A bob of mass m is suspended at a point 'O' by a light string of length 'l' and left to perform vertical motion (circular) as shown in figure. Initially by applying horizontal velocity V_0 at the point 'A', the string becomes slack when the bob reaches at the point 'D'. The ratio of the K.E of the bob at the points B and C is

(A) 2

(B) 4

(C) 1

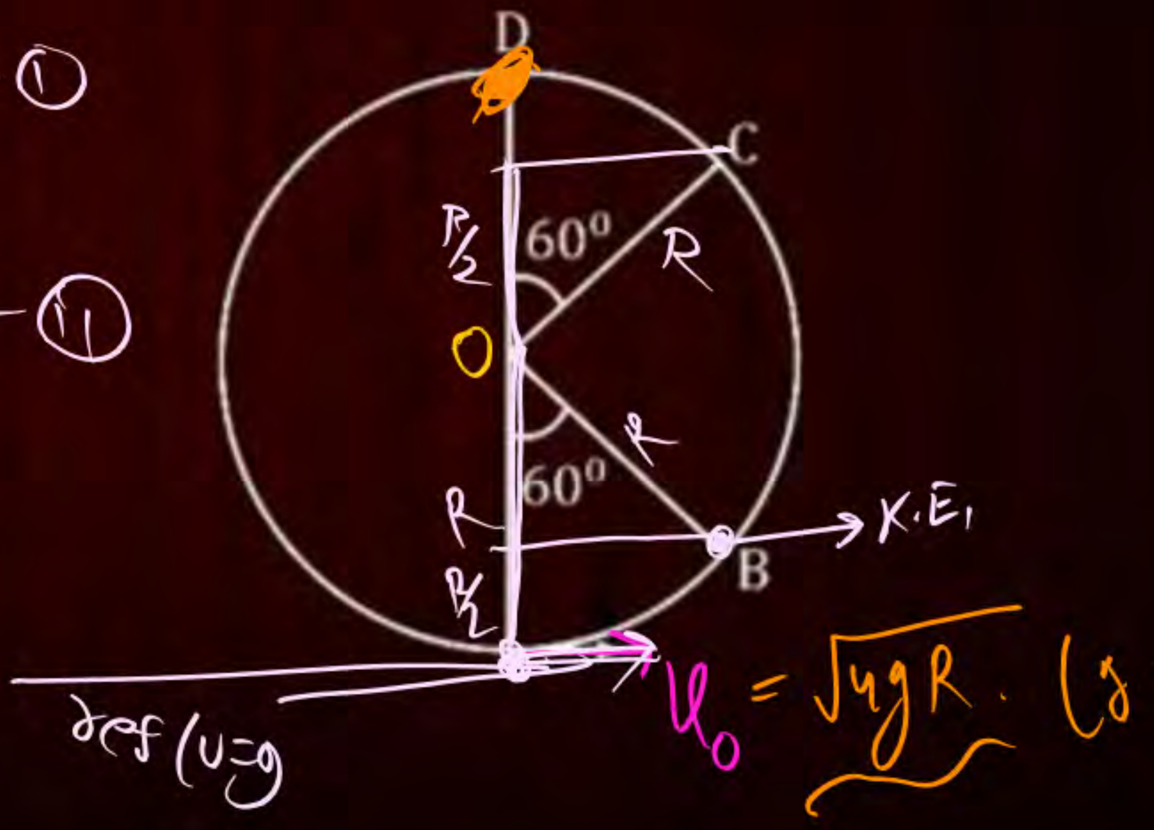
(D) 3

$$\frac{1}{2}mv_0^2 = mg\frac{R}{2} + \frac{1}{2}mv_1^2 \quad - (I)$$

$$\frac{1}{2}mv_0^2 = 3mg\frac{R}{2} + \frac{1}{2}mv_2^2 \quad - (II)$$

$$v_1^2 = v_0^2 - gR \quad - (1)$$

$$v_2^2 = v_0^2 - 3gR \quad - (II)$$



LIVE STREAM

JEE MAIN 2025 PAPER DISCUSSION

JEE ULTIMATE CRASH COURSE 2025

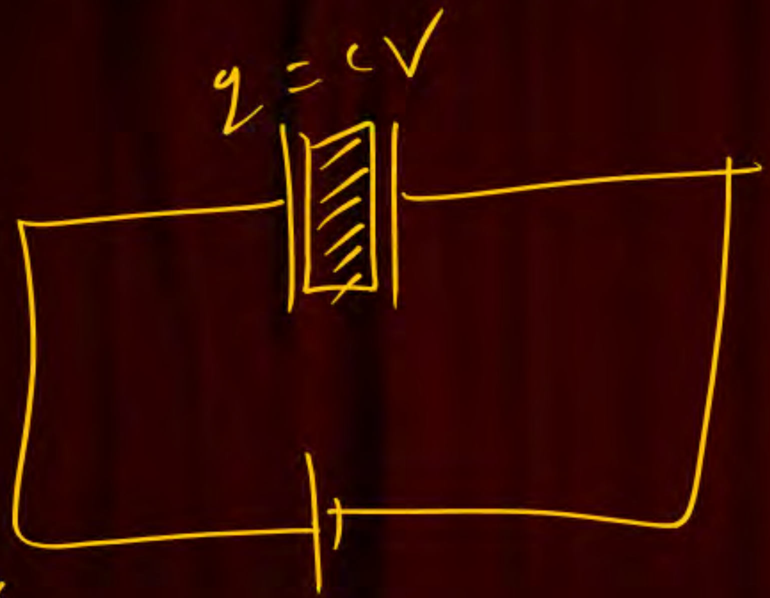
A Parallel plate capacitor of capacitance 40 μF is connected to a 100 V power supply now the intermediate space between the plates is filled with a dielectric material of dielectric constant K = 2. So due to the introduction dielectric the extra charge and the change in electrostatic energy in the capacitor respectively is:

(A) 2 mc and 0.4 J

(B) 2 mc and 0.2 J

(C) 4 mc and 0.2 J ✓

(D) 8 mc and 2 J



$q_i = CV = 40 \times 100$

$q_f = KCV = 8000$

LIVE STREAM

JEE MAIN 2025 PAPER DISCUSSION

JEE ULTIMATE CRASH COURSE 2025

From a sphere of mass M and radius R, a cavity of radius R/2 is created. Find the moment of inertia about an axis passing through the centre of sphere.



$$I_{remain} = I_{compl} - I_{remov}$$

$$= \frac{2}{5}MR^2 - \left[\frac{2}{5}\frac{M}{8}\left(\frac{R}{2}\right)^2 + \frac{M}{8}\left(\frac{R}{2}\right)^2\right]$$

$$= MR^2\left[\frac{2}{5} - \frac{1}{80} - \frac{1}{32}\right]$$

$$= MR^2\left(\frac{64-2-5}{160}\right) = \frac{57MR^2}{160}$$

LIVE STREAM

JEE MAIN 2025 PAPER DISCUSSION

JEE ULTIMATE CRASH COURSE 2025

Identify the correct graph between the resistivity of conductor and temperature

$\rho \rightarrow$ Increase with Temp

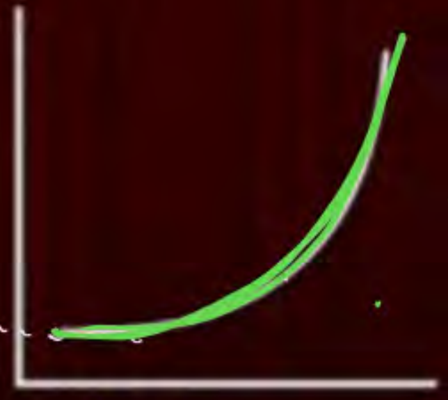
$\rho = \rho_0(1 + \alpha(\Delta T))$

A

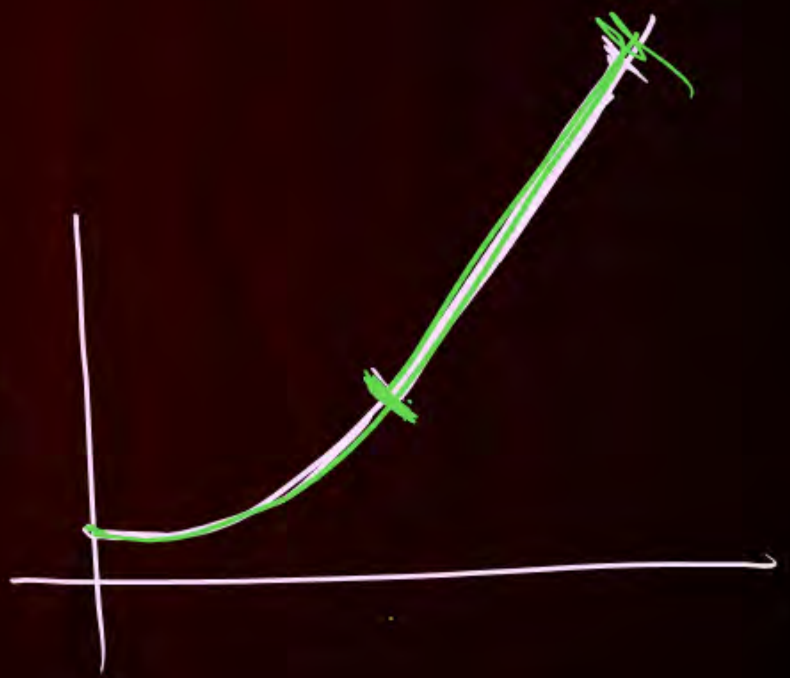

B


(Nichr)

C


D


(Cu)



Most Probobily (D)

LIVE STREAM

JEE MAIN 2025 PAPER DISCUSSION

JEE ULTIMATE CRASH COURSE 2025

A ball of mass 100 grams throw m at speed 20 m/s with angle 60 percent degree with horizontal. Find the decrease in kinetic energy from point of throwing to the ball when it reaches to Max height ?

(A) 15 J

(B) 20 J

(C) 0 J

(D) 10 J

$\rightarrow u\cos\theta$

$K.E = \frac{1}{2}m(u\cos\theta)^2$

$\nearrow u$

$K.E = \frac{1}{2}mu^2$

$\Delta K.E = \frac{1}{2}mu^2(1-\cos^2\theta)$

$\Delta KE = \frac{1}{2}mu^2(1-\cos^2\theta)$

Assertion (A): A simple pendulum is taken to a planet of mass 4 times that of Earth and radius 2 times that of Earth; the time period remains constant.

Reason R : The time period of a simple pendulum is constant on Earth and any other planet.

- **A** Both Assertion (A) and Reason (R) are true, and (R) is the correct explanation of (A).
- **B** Both Assertion (A) and Reason (R) are true, but (R) is not the correct explanation of (A).
- **C** Assertion (A) is true, but Reason (R) is false.
- **D** Assertion (A) is false, and Reason (R) is false.

LIVE STREAM

JEE MAIN 2025 PAPER DISCUSSION

The measurements for a wire are given as:

- Mass, $m = (0.60 \pm 0.003)$ g
- Radius, $r = (0.50 \pm 0.01)$ cm
- Length, $l = (10.00 \pm 0.05)$ cm

Find the maximum percentage error in the measurement of the density of the wire.

(A) 2%

(B) 3%

(C) 4%

(D) 5%

$$d = \frac{m}{\pi R^2 l}$$

$$100 \times \frac{\Delta d}{d} = \left[\frac{\Delta m}{m} + 2\frac{\Delta R}{R} + \frac{\Delta l}{l}\right] \times 100$$

$$\%\ \text{error in density} = \left[\frac{0.003}{0.60} + \frac{2(0.01)}{0.5} + \frac{0.05}{10}\right] \times 100$$

LIVE STREAM

JEE MAIN 2025 PAPER DISCUSSION

JEE ULTIMATE CRASH COURSE 2025

Heat energy + Buoyant force

(Terminal velocity) fluid

A sphere of mass M is glycerine the density of glycerin is half of the sphere.offer some time it moves down with constant velocity then what is viscous force

(A) Mg/2

(B) Mg/3

(C) Mg/4

(D) Mg/6

$$Mg = F_B + f_{fr}$$

$$f_{fr} = mg - F_B$$

$$= mg - \rho V g = mg - \frac{mg}{2}$$



LIVE STREAM

JEE MAIN 2025 PAPER DISCUSSION

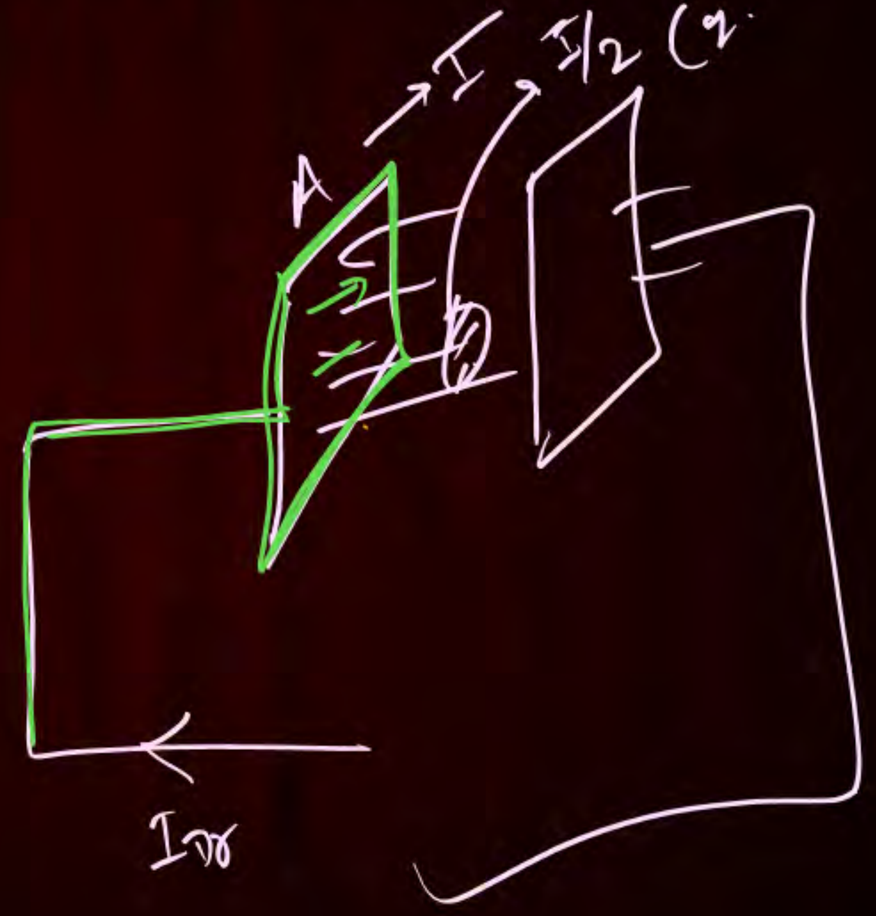
JEE ULTIMATE CRASH COURSE 2025

A parallel plate capacitor had a area of 16 cm^2 and distance between them is 10cm now this capacitor is connected across a AC source At an instant the current in the circuit is 6A. at this instant assume a area of 3.2 cm^2 between and parallel to the plates then find the displacement current in this area

$$I_{Disp} = \frac{6}{5} \text{ Amp}$$

$= 1.2$ Amp

→ done



When a metal surface is illuminated by wavelength λ, the maximum kinetic energy is 2 eV . When illuminated by λ/2. the maximum kinetic energy will be:
(Work function =1ev)

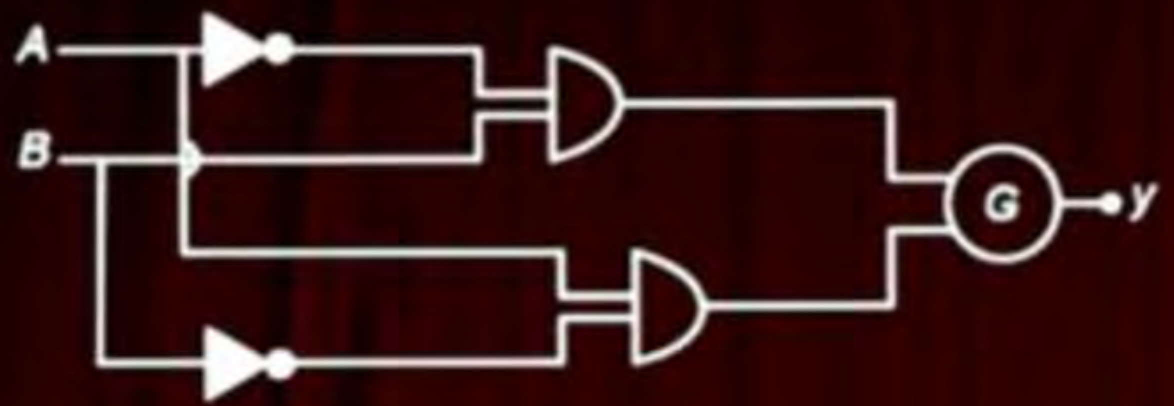
modern

LIVE STREAM

JEE MAIN 2025 PAPER DISCUSSION

JEE ULTIMATE CRASH COURSE 2025

For a given logic circuit truth table is given identify the gate.



(A) NOR

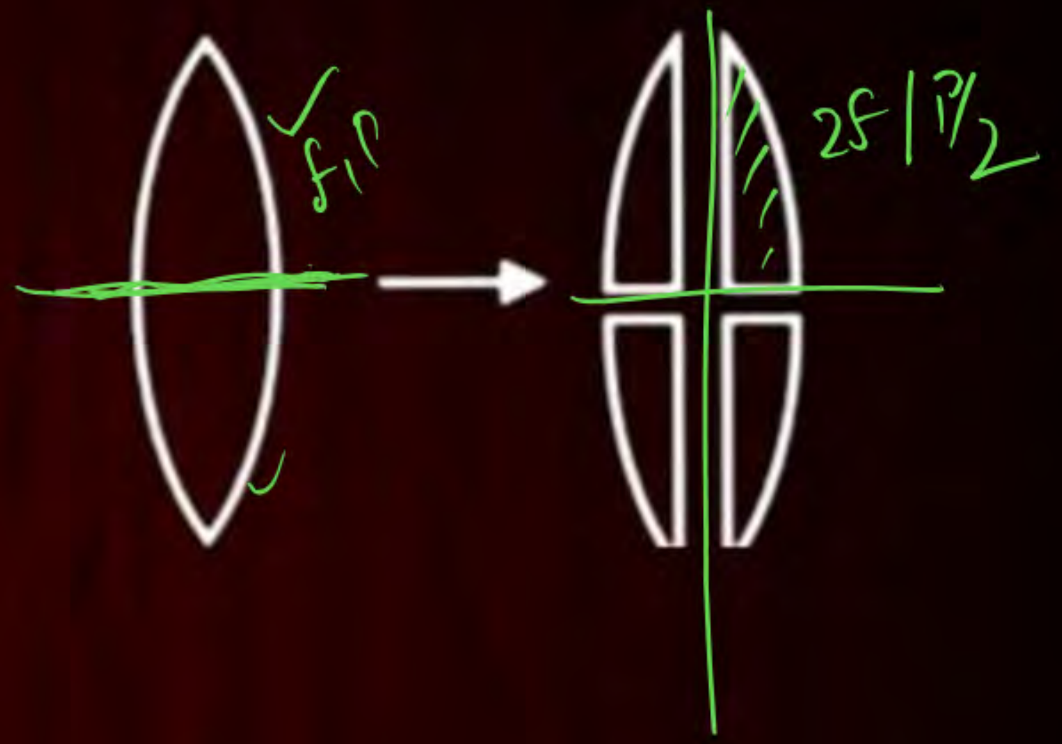
(B) NOT

(C) NAND

(D) AND

A	B	Y
0	0	1
1	0	0
0	1	0
1	1	1

An equiconvex lens of power 4D, is cut into four parts as shown in the diagram. The Power of each part is



(A) 4D

(B) $2D$

(C) $8D$

(D) $5D$

Identify the diode connected in forward bias

(A) 

(B) 

(C) 

(D) 

Assertion: When YDSE set up is dipped in a denser medium than the fringe width decreases.

Reason: Speed of light decreases in denser medium but frequency of light remains same.

LIVE STREAM

JEE MAIN 2025 PAPER DISCUSSION

Assertion: Fringe width of red is less than blue.

Reason: Fringe width is directly proportional to wavelength.

$\beta \propto \frac{1}{\mu}$

$\beta \propto \lambda$

Ray optics

$\delta = 180^\circ - 2i$

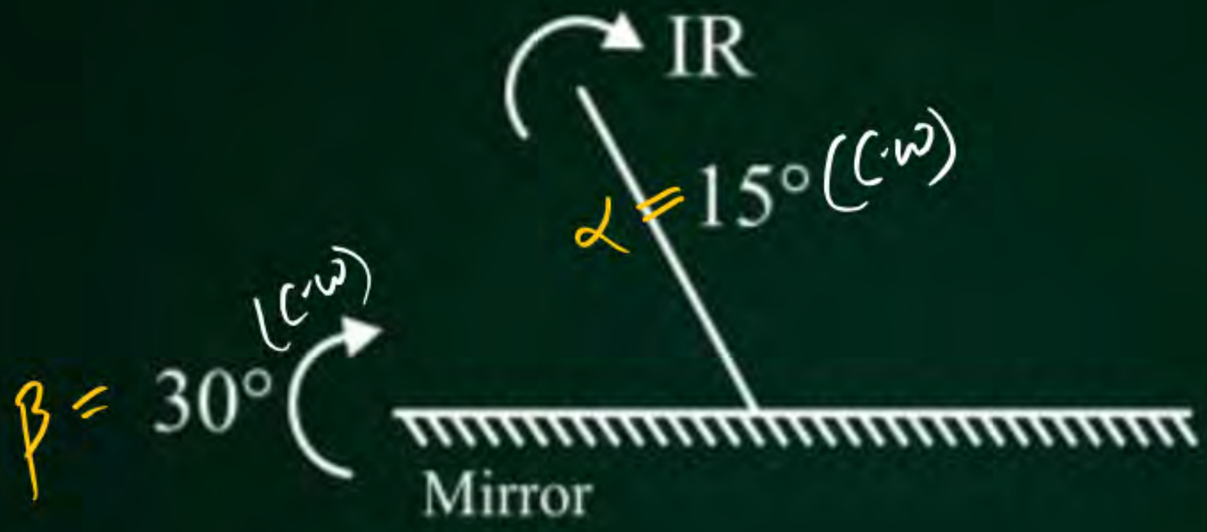
[IR → θ (CW)
RR → θ (ACW)] mirror Fixed

mirror Rotated by θ then RR Rotated by 2θ in same sense

IR → fixed

QUESTION

Find angle by which reflected ray will rotate for given figure.



$\delta_{\text{Rotated by reflect ray}} = 60 (C.W) - 15 (A.C.W)$

$= 45$ C.W

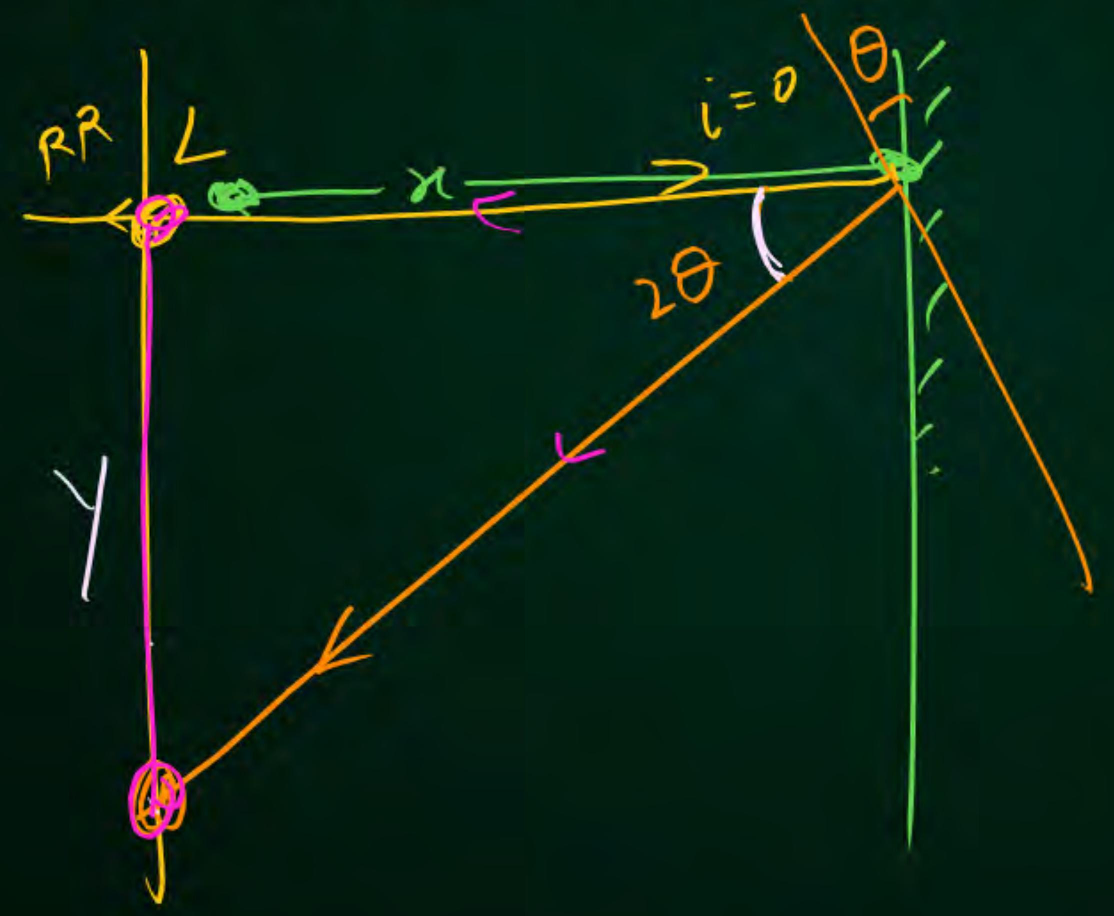
Ans

QUESTION

A beam of light from a source L is incident normally on a plane mirror fixed at a certain distance x from the source. The beam is reflected back as a spot on a scale placed just above the source L. When the mirror is rotated through a small angle θ, the spot of the light is found to move through a distance y on the scale. The angle θ is given by

[NEET 2017]

1. $\frac{y}{x}$
2. $\frac{x}{2y}$
3. $\frac{x}{y}$
4. $\frac{y}{2x}$



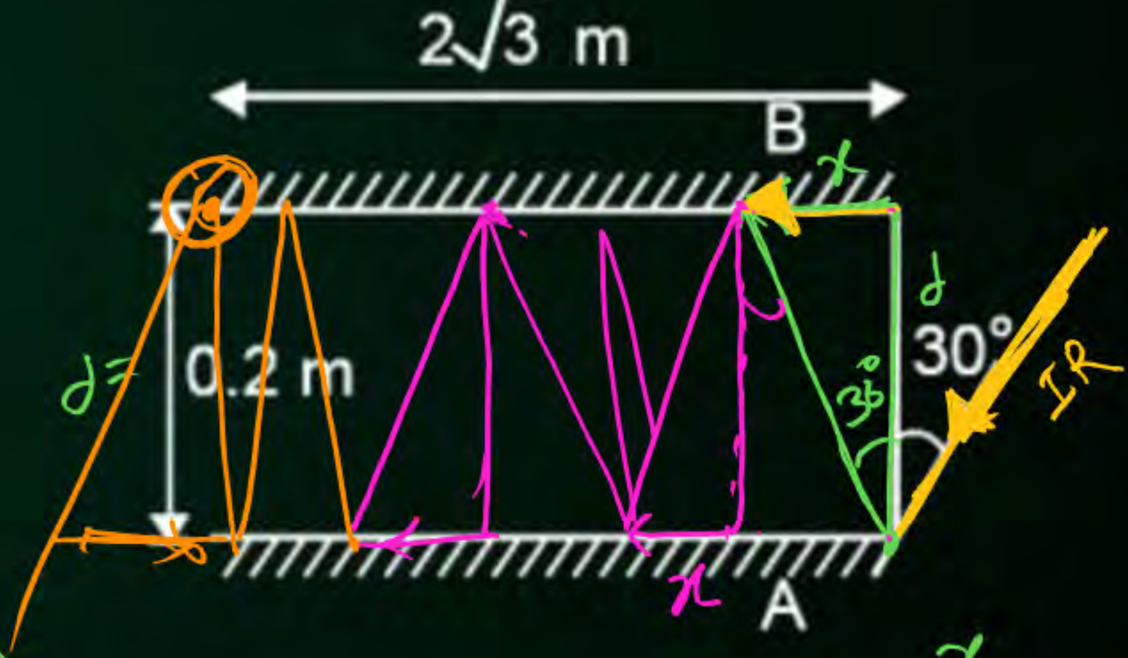
$2\theta = \frac{y}{x}$

$\theta = \frac{y}{2x}$

QUESTION

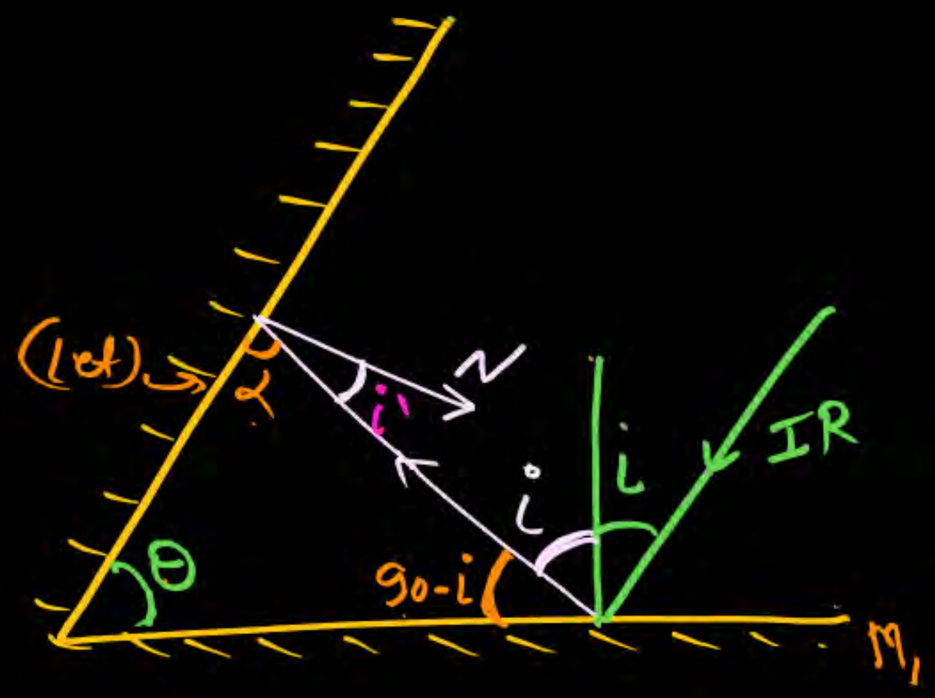
(JEE)

Two plane mirrors A and B are aligned parallel to each other as shown in the figure. A light ray is incident at an angle of 30° at a point just inside one end of A. The plane of incidence coincides with the plane of the figure. The maximum number of time the ray undergoes reflections (including the first one) before it emerges out is:



1. 28
2. 30
3. 32
4. 34

Reflection from Two plane mirror



$$\theta + 90 - i + \alpha = 180^\circ$$

$$\alpha = 180 - 90 - \theta + i$$

$$\boxed{\alpha = 90 - \theta + i}$$

$$90 - \alpha = (\theta - i)$$

$$i' = 90 - \alpha$$

$$\boxed{i' = \theta - i}$$

$$\delta_1 = 180 - 2i$$

$$\delta_2 = 180 - 2i'$$

$$\delta_{tot} = 180 - 2i + 180 - 2i'$$

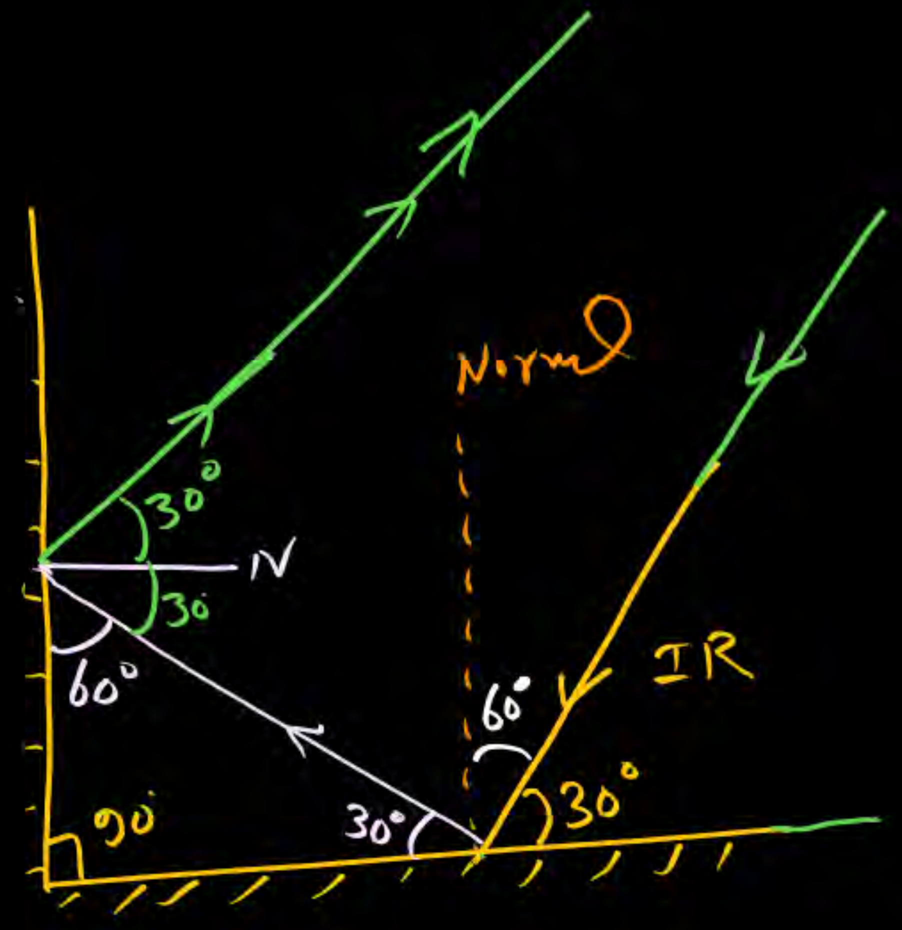
$$= 360^\circ - 2i - 2(\theta - i)$$

$$= 360^\circ - 2i - 2\theta + 2i$$

$$\boxed{\delta = 360^\circ - 2\theta}$$

MR Rafty

δ does not depend on 'i'



$$\delta = 360^\circ - 2\theta$$

$$= 360^\circ - 2 \times 90^\circ$$

$$\delta = 360 - 180$$

$$\boxed{\delta = 180^\circ}$$



$$\delta = 360^\circ - 2 \times \theta$$

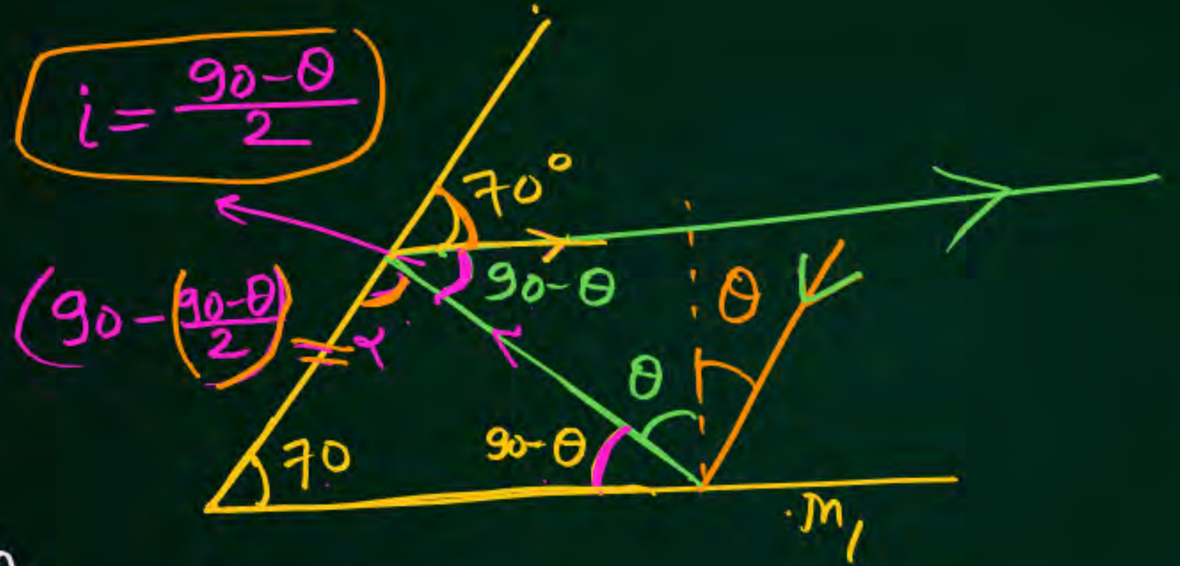
$$= 360^\circ - 2 \times 70$$

$$= 120^\circ$$

QUESTION

Two plane mirrors are inclined at 70°. A ray incident on one mirror at angle, θ after reflection falls on second mirror and is reflected from there parallel to first mirror. The value of θ is

[Karnataka NEET 2013]

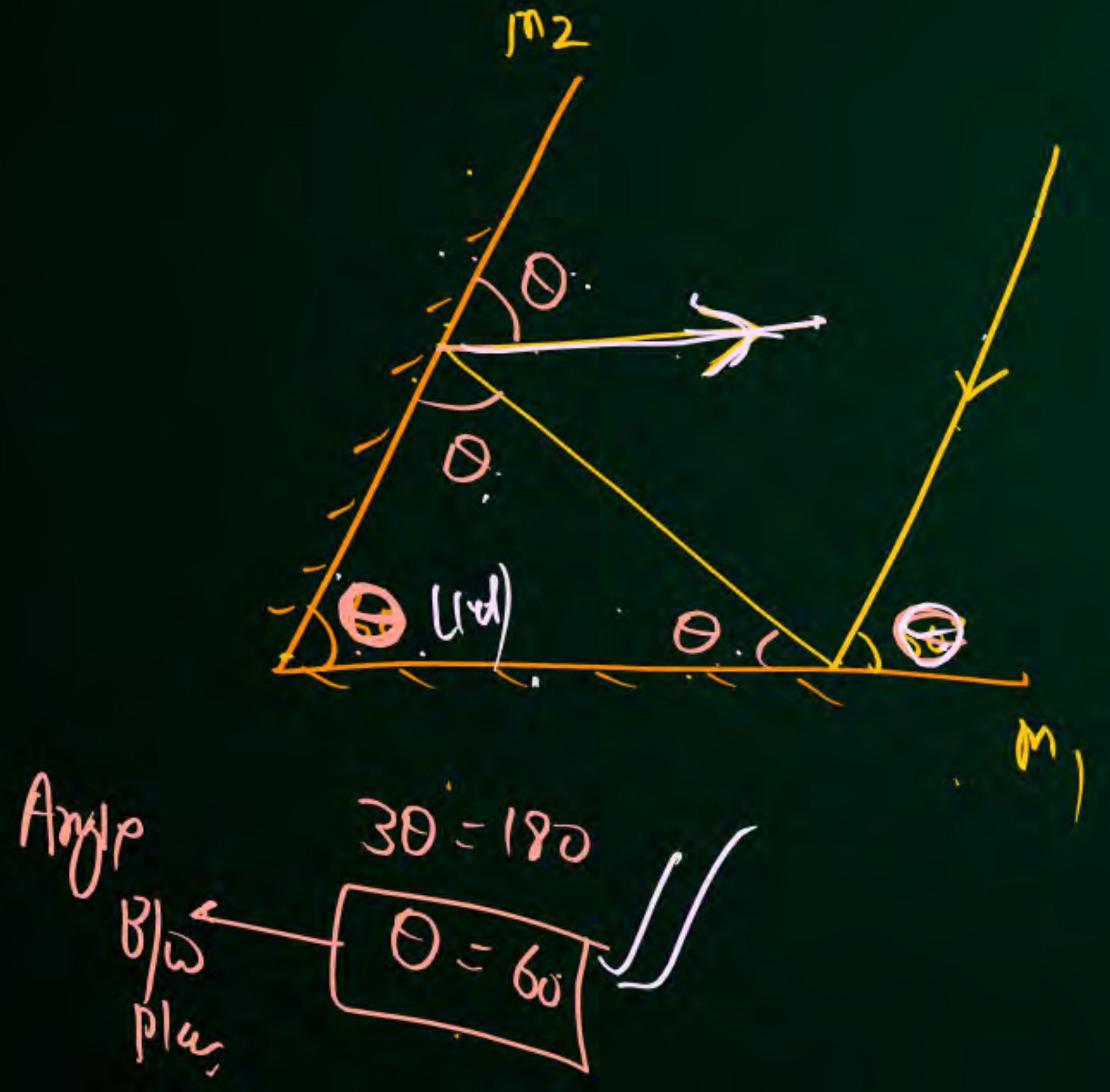




1. 45°
2. 30°
3. 55°
4. 50°

QUESTION

If two plane mirror are inclined at 60° and a ray of light is incident on one mirror parallel to other, then reflected ray from two mirror becomes parallel to the first mirror.




THANK YOU
Ray optics
H/w

YAKEEN 2.0

FOR NEET 2025

Lecture-3 | Physics

Ray Optics and Optical Instruments

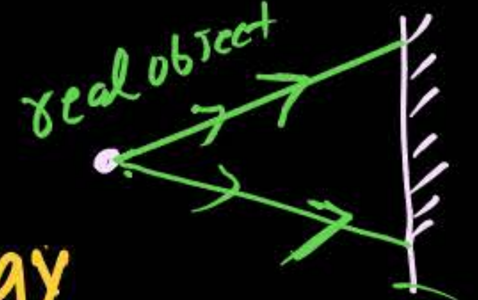
By- Dr. Manish Raj (MR SIR)

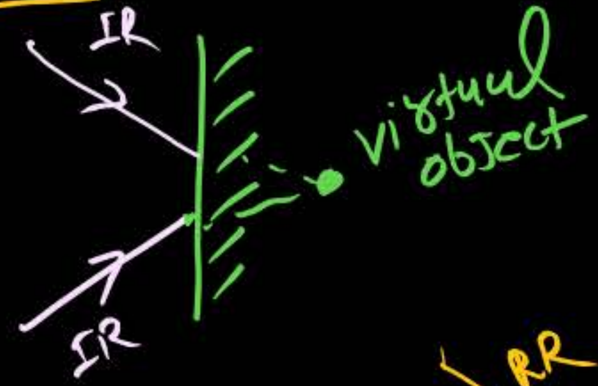


Todays Goal

Ph.D on Plane mirror

Object defined by Incident ray → Intersection Point of I.R.





(1) real object → diverging Incident ray

(2) virtual object → Converging Incident ray

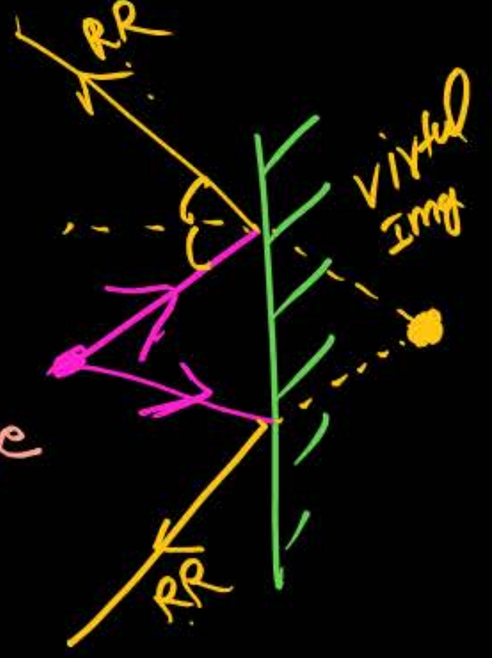
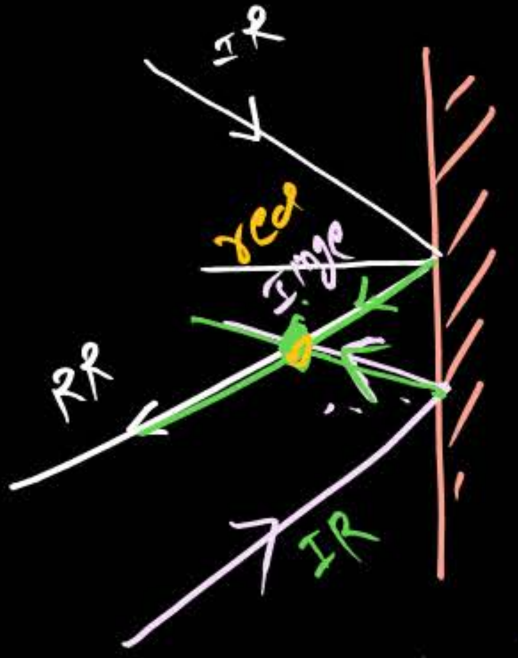


Image defined by Reflected ray → Intersection point of R.R is called Image

(1) real Image → Converging R.R.

(2) virtual Image → diverging Reflected ray



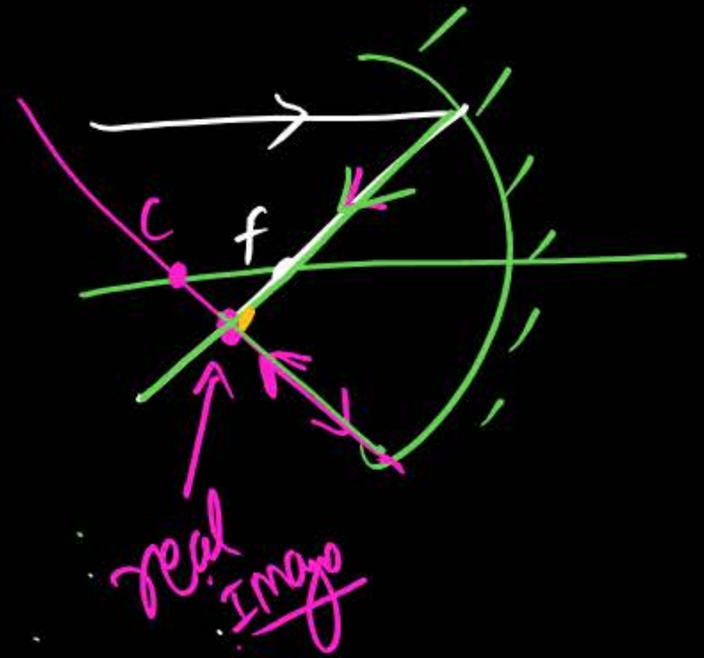
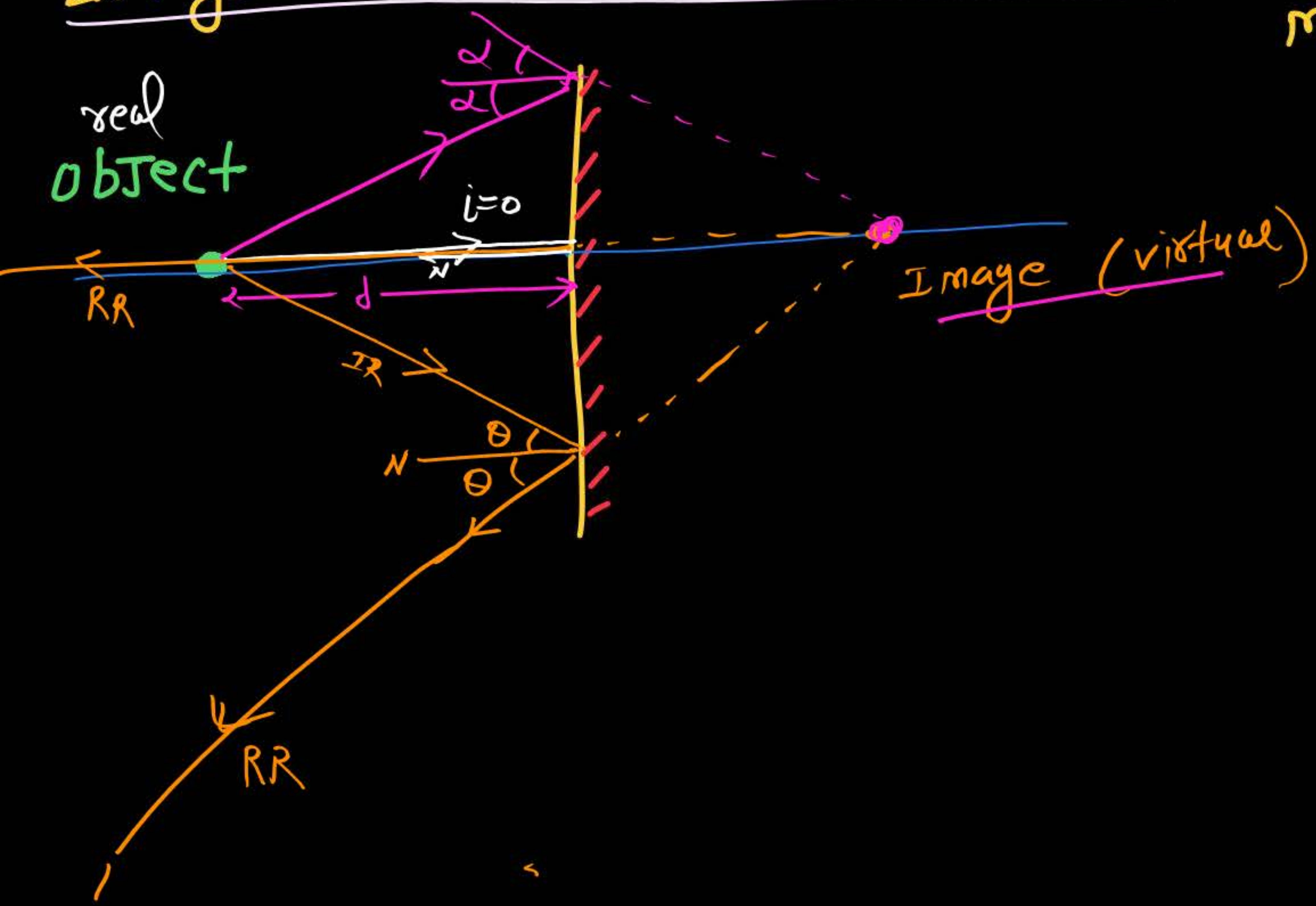
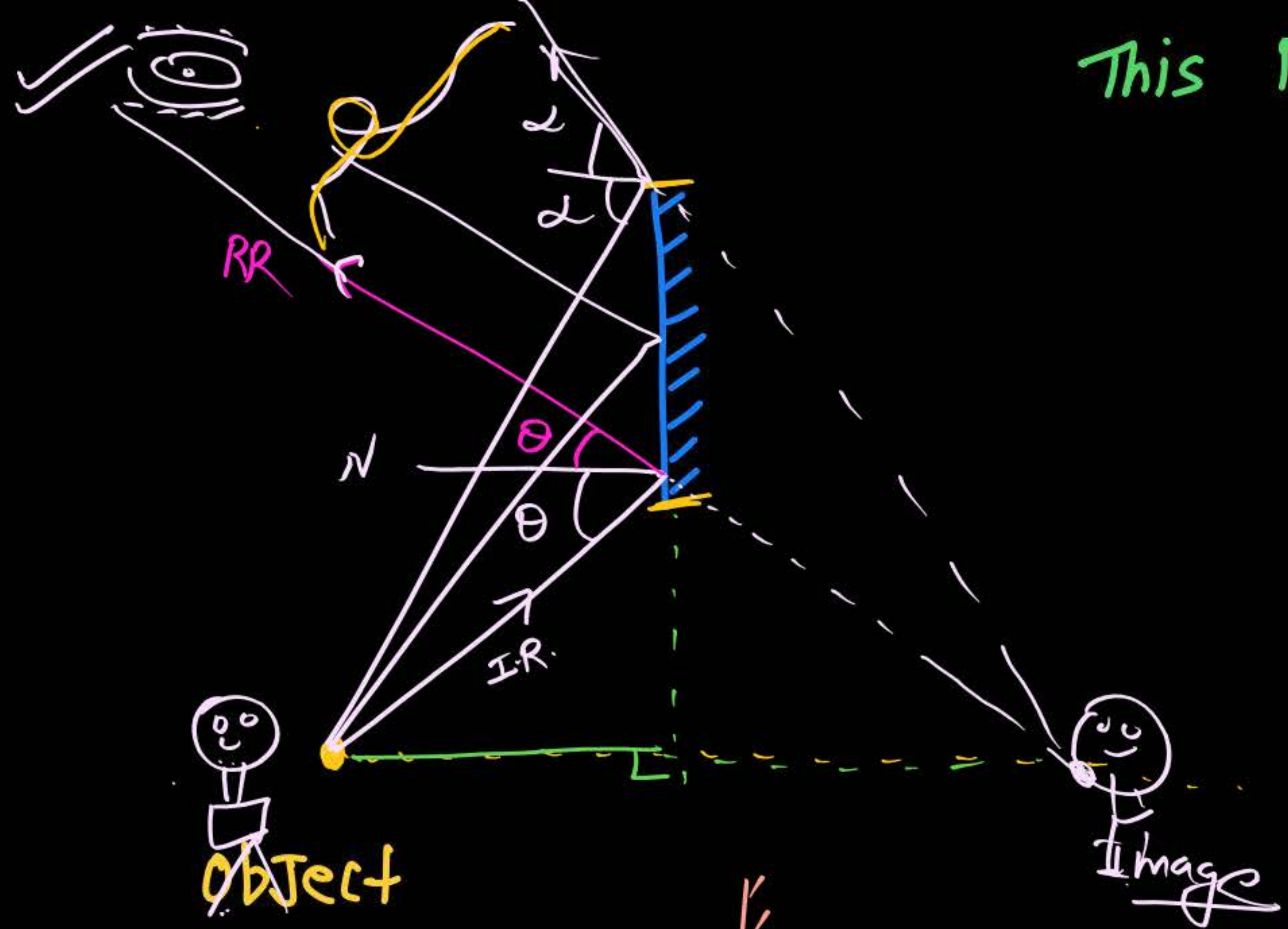


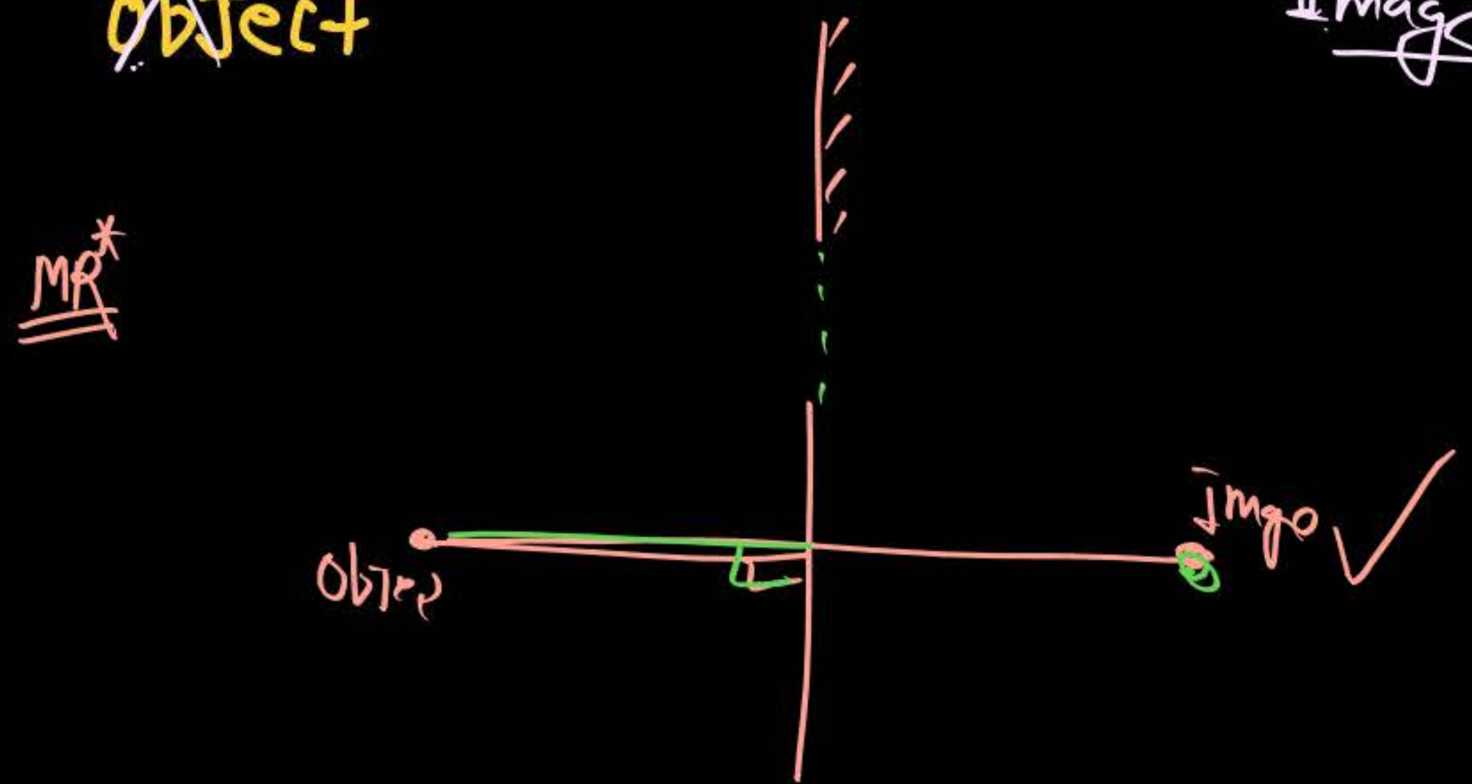
Image formation by plane mirror → Always take Two IR's on mirror one normal & other is oblique.

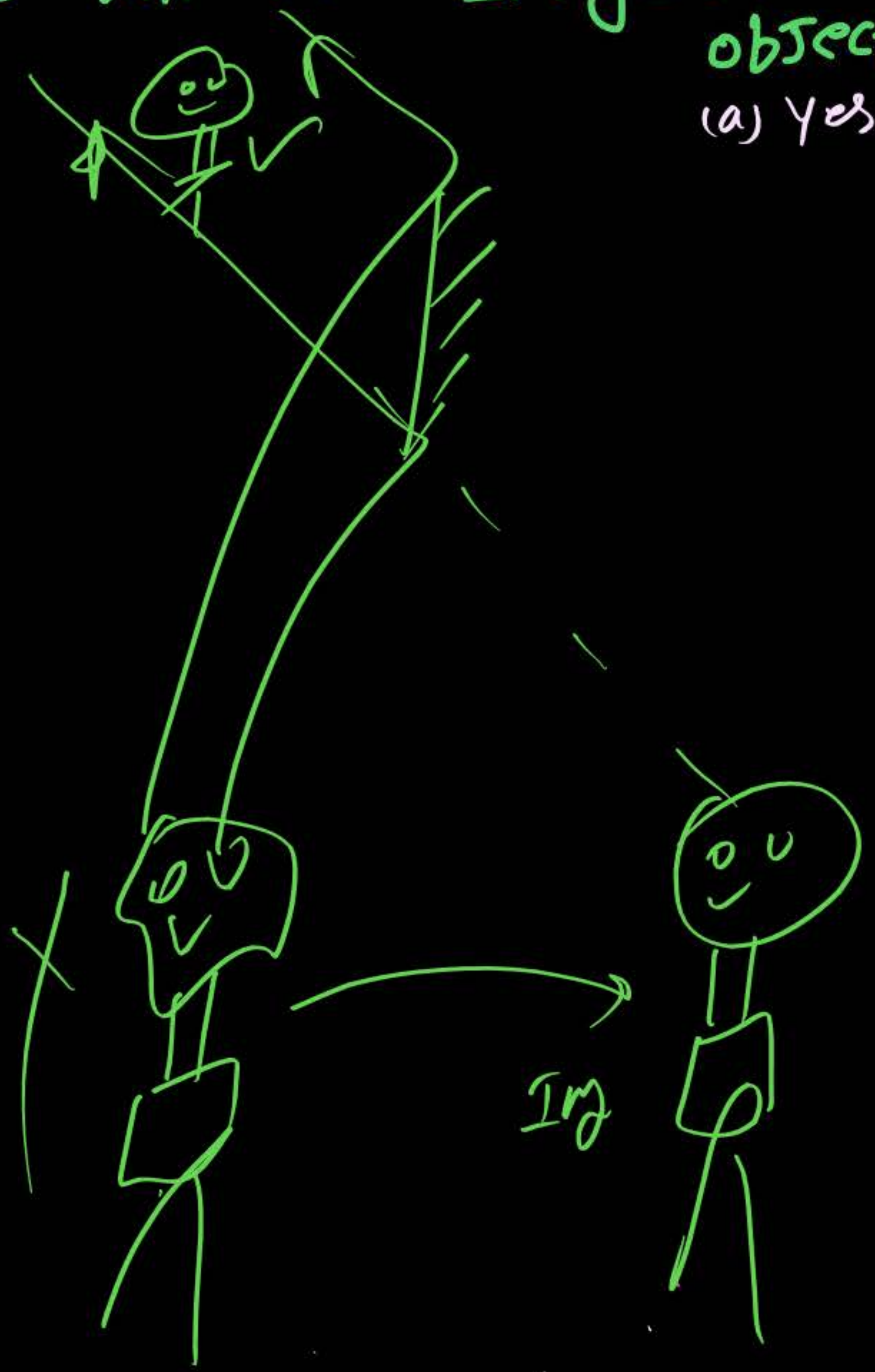


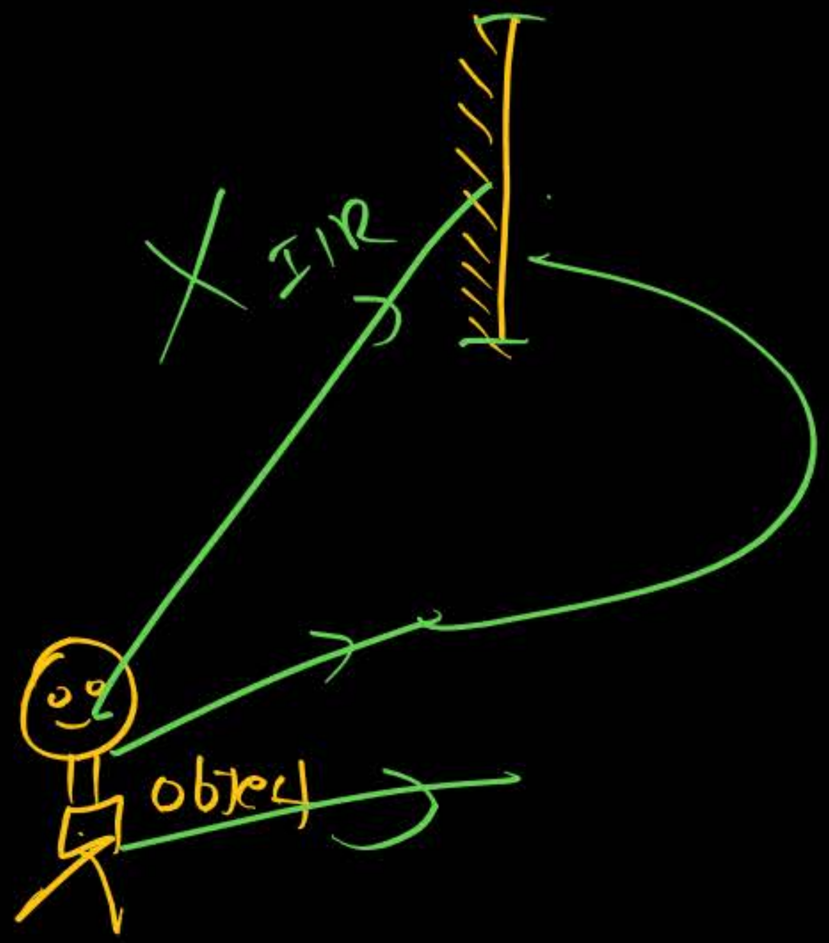
- {Image distⁿ = object distⁿ}

This Mirror will form Image of this object.
(a) Yes (b) NO

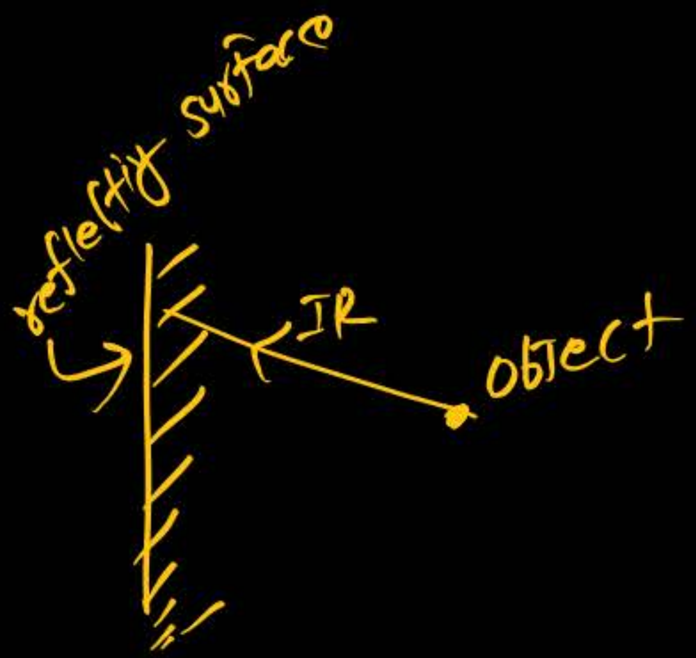




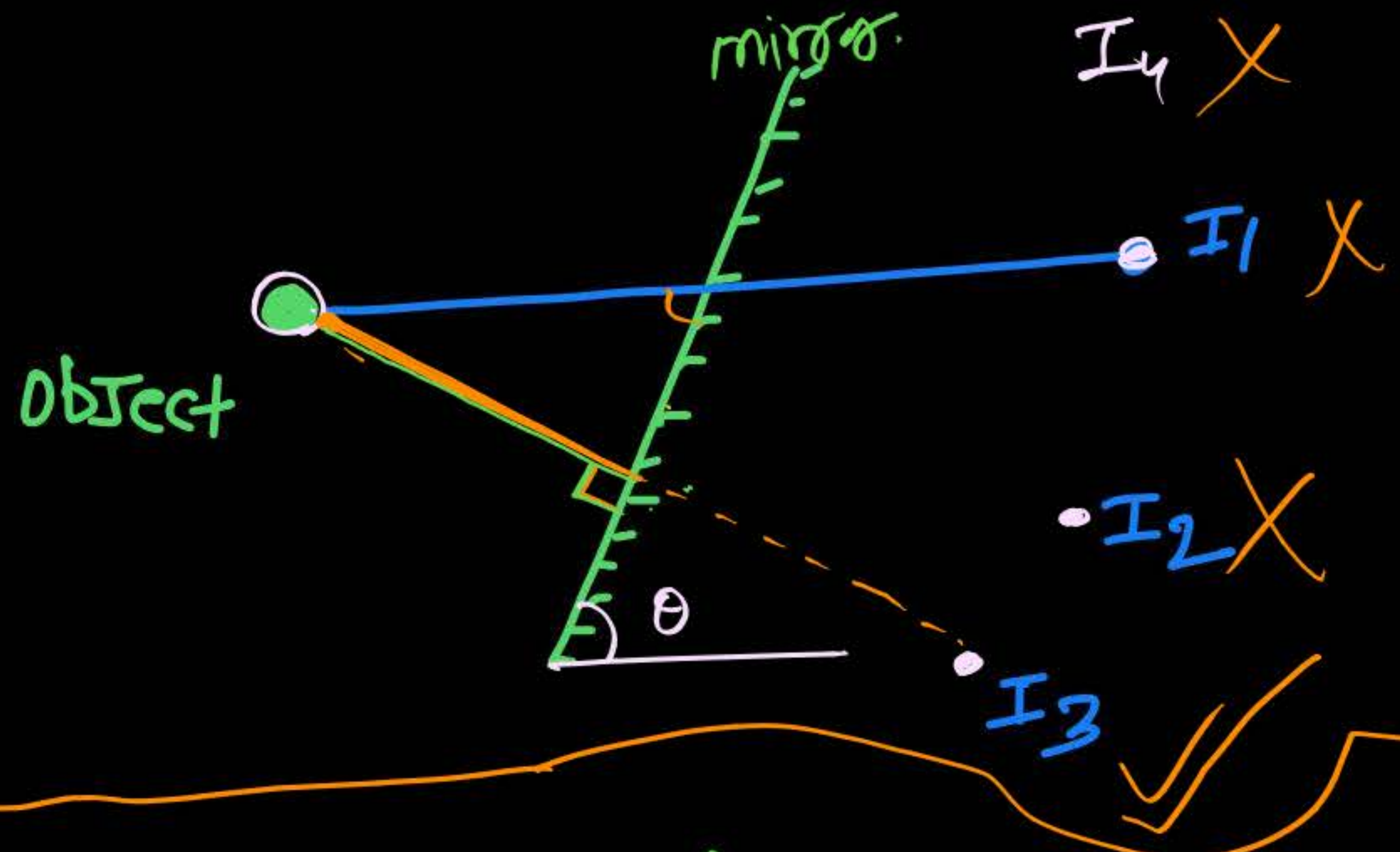




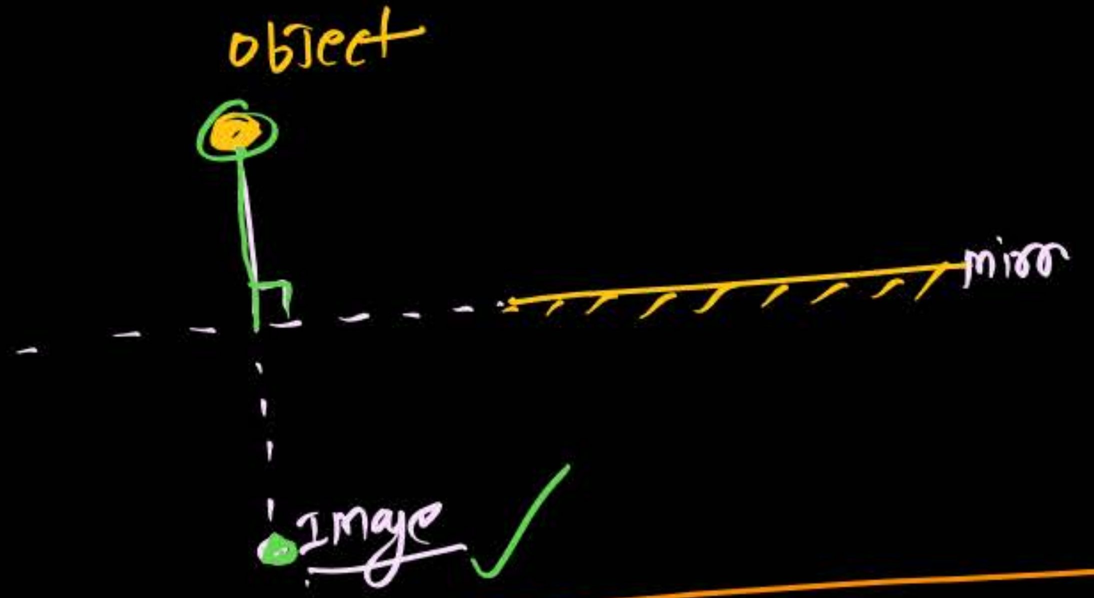
IR
object



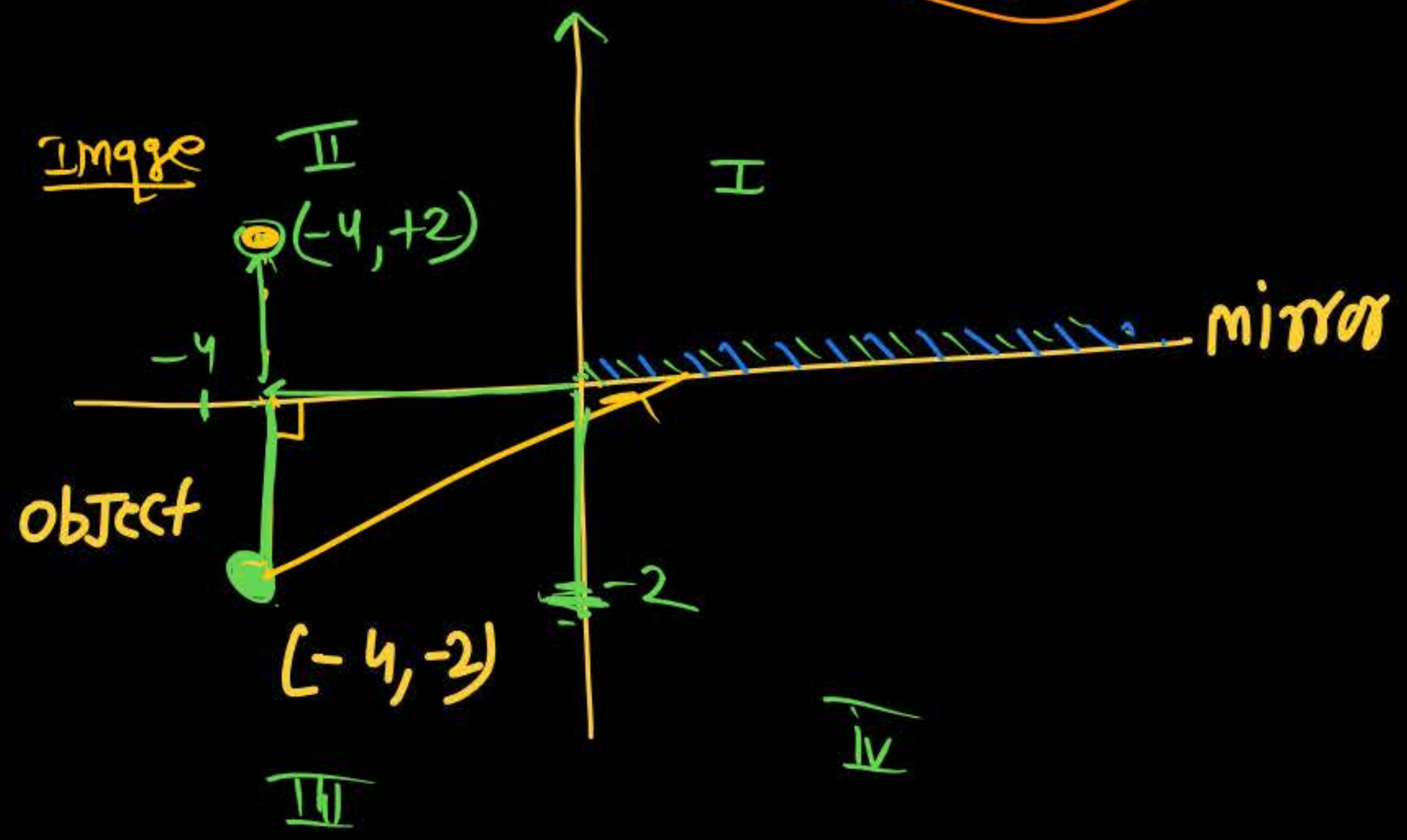
reflectiy surface
IR
object

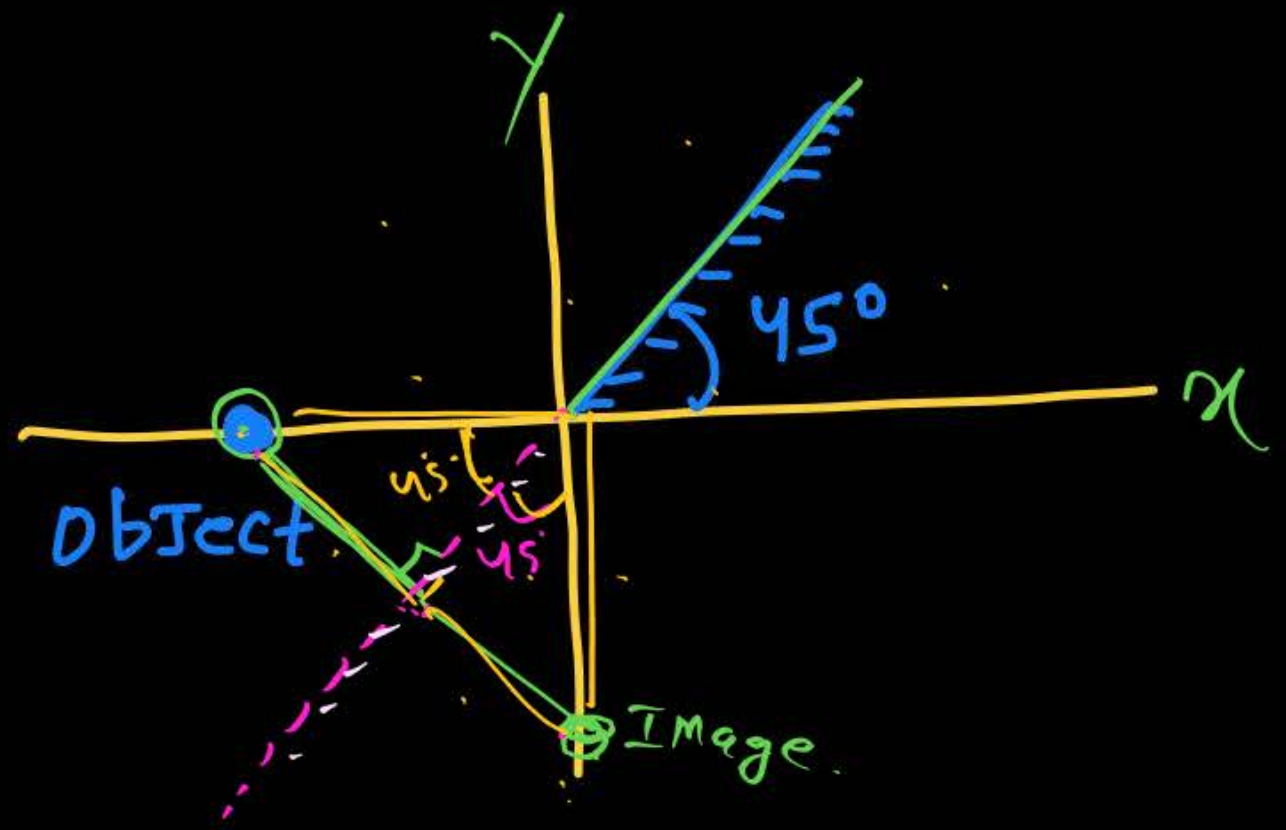


Where Image will form.



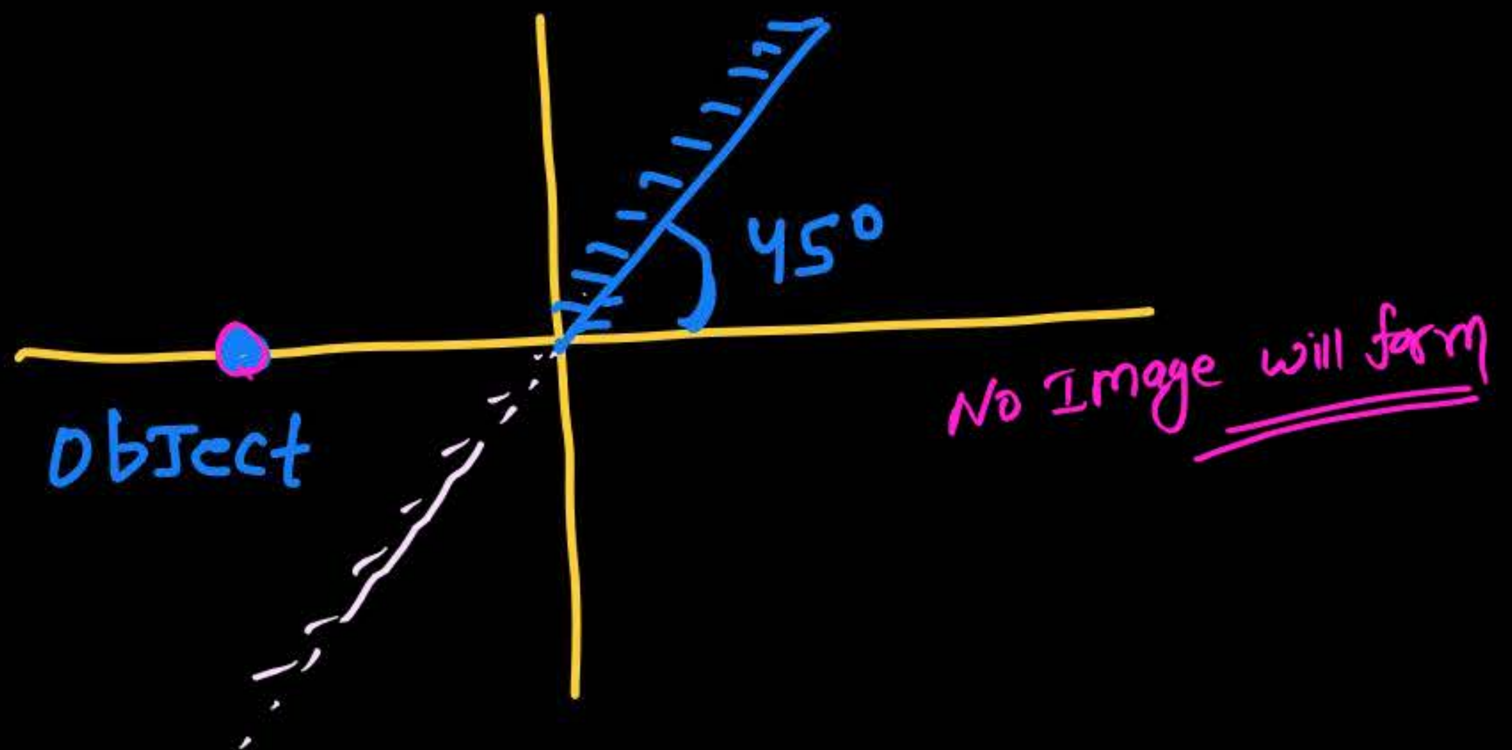
(Q) find co-ordinate of Image

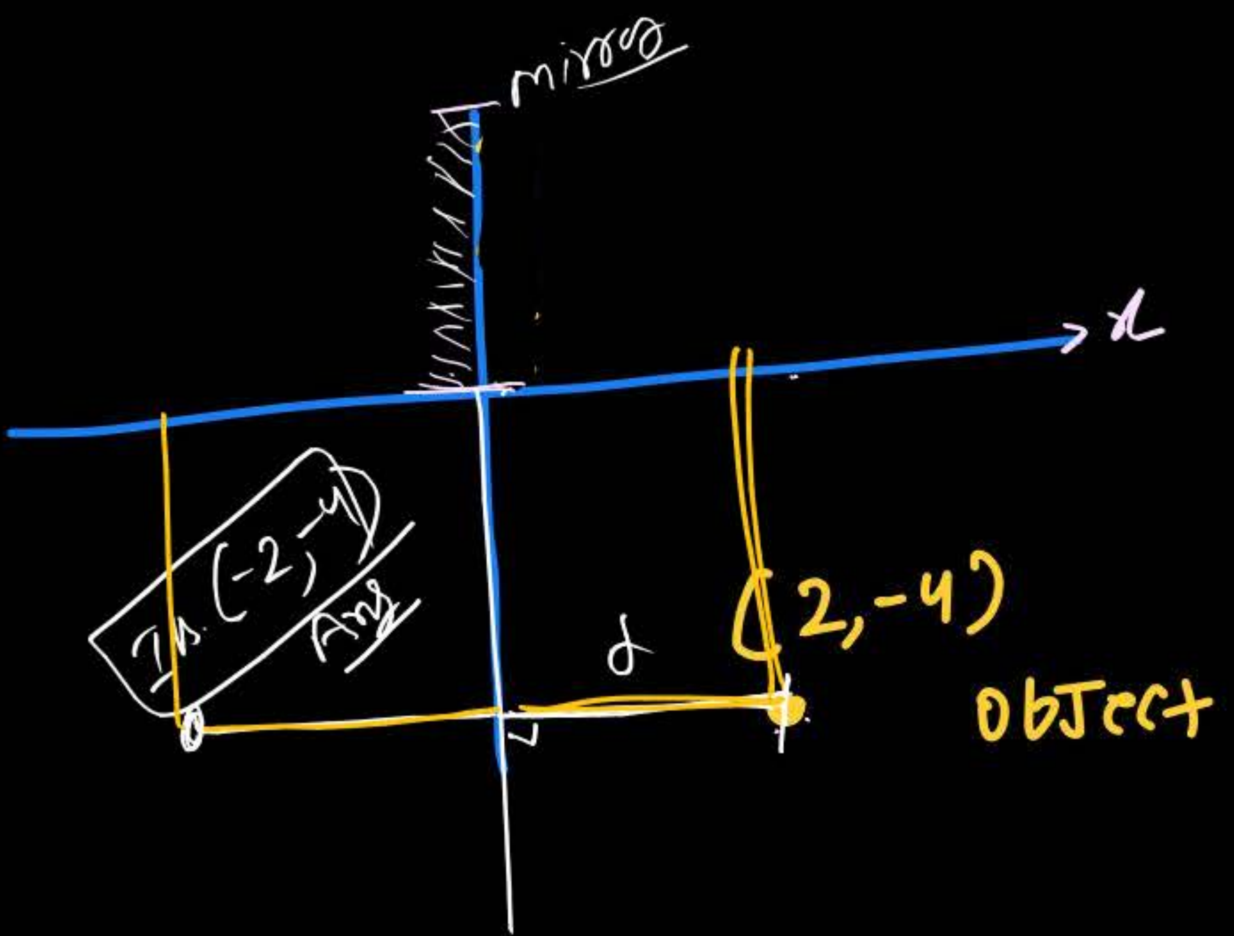


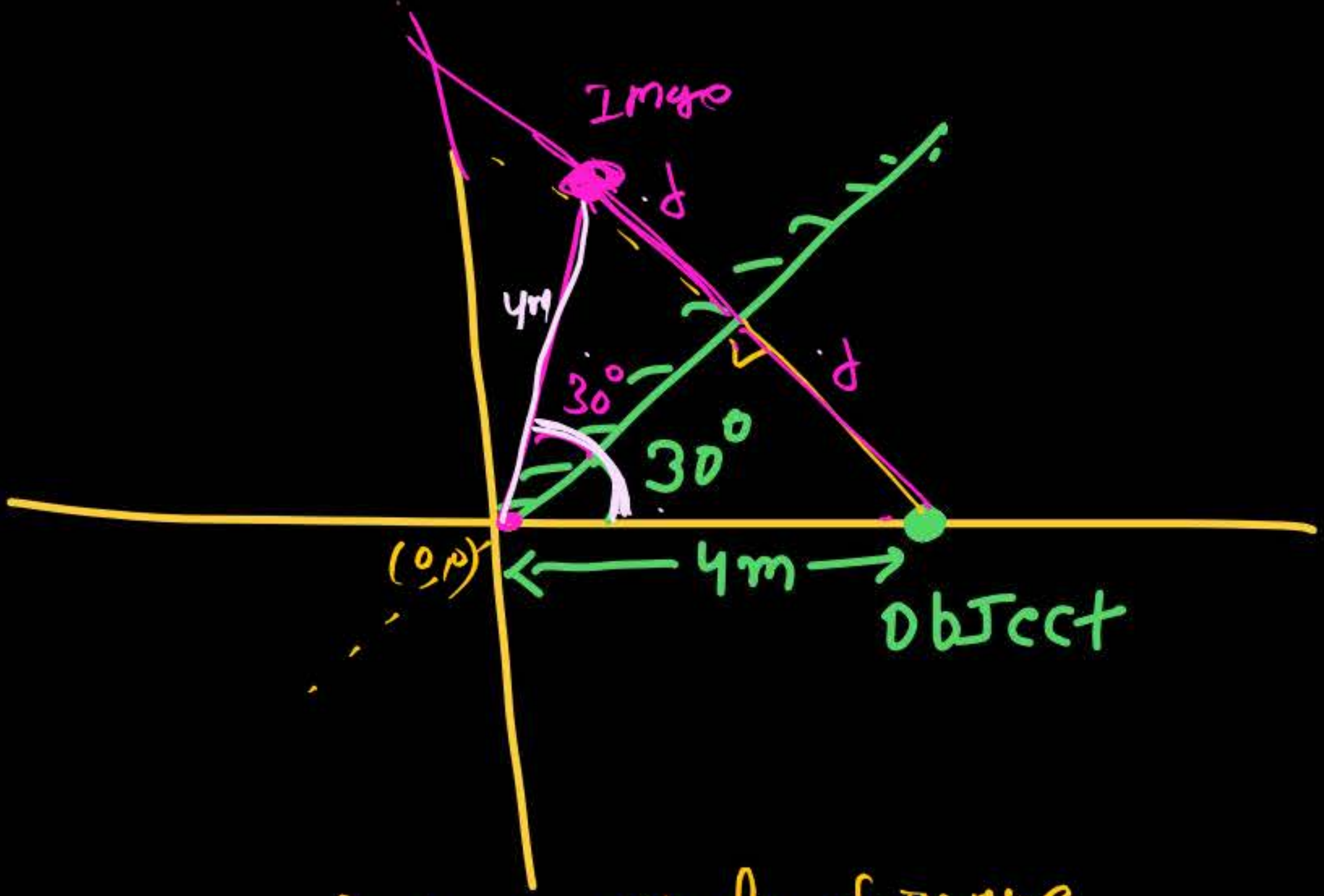


find location of Image

Image on (-y) axis







find co-ordinate of Image

find co-ordinate of Image.

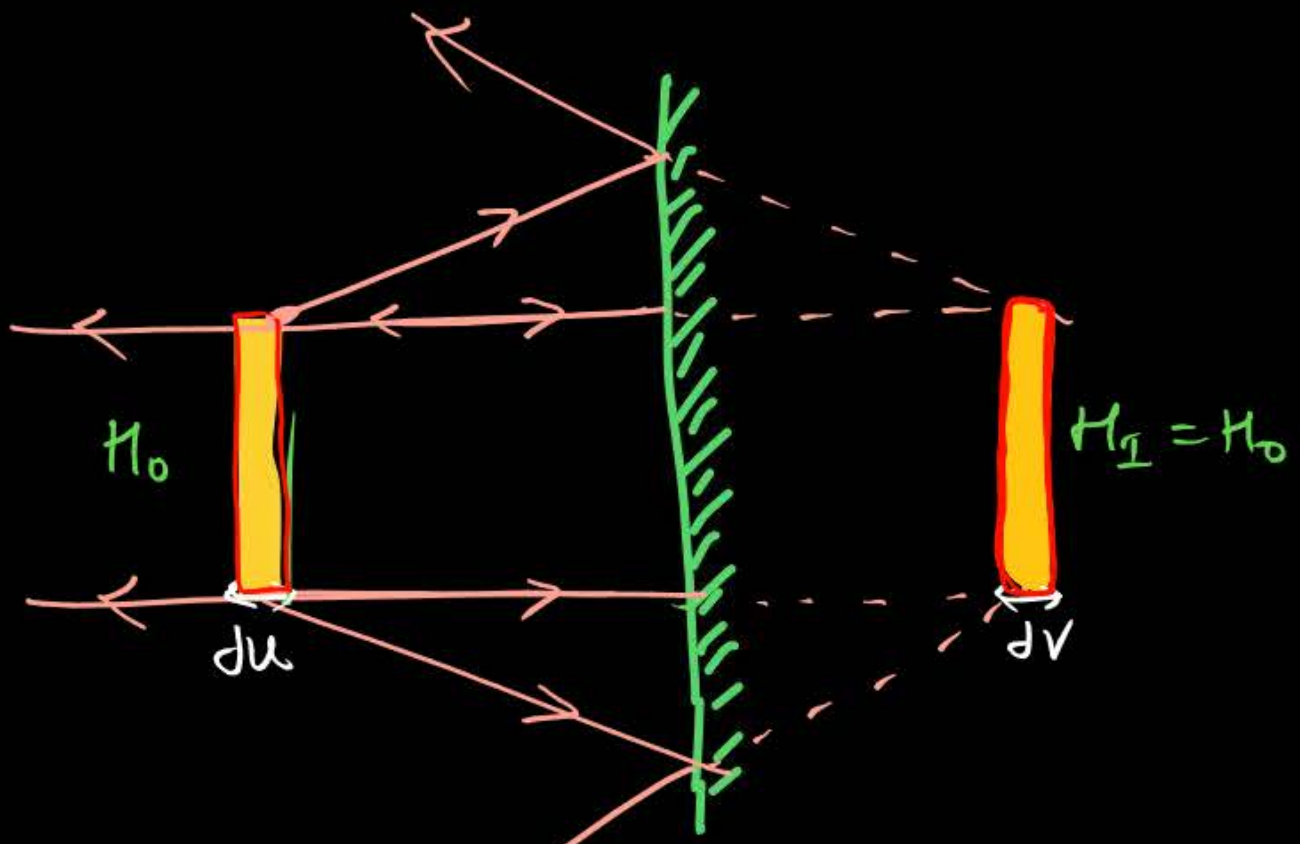
Image (0,4) ✗

$x = 4\cos 60° = 2$

$y = 4\sin 60° = 2\sqrt{3}$

$(x, y) = (2, 2\sqrt{3})$

IMAGE of extended object



$$\text{Magnification } m_T = +1 = \frac{H_I}{H_0}$$

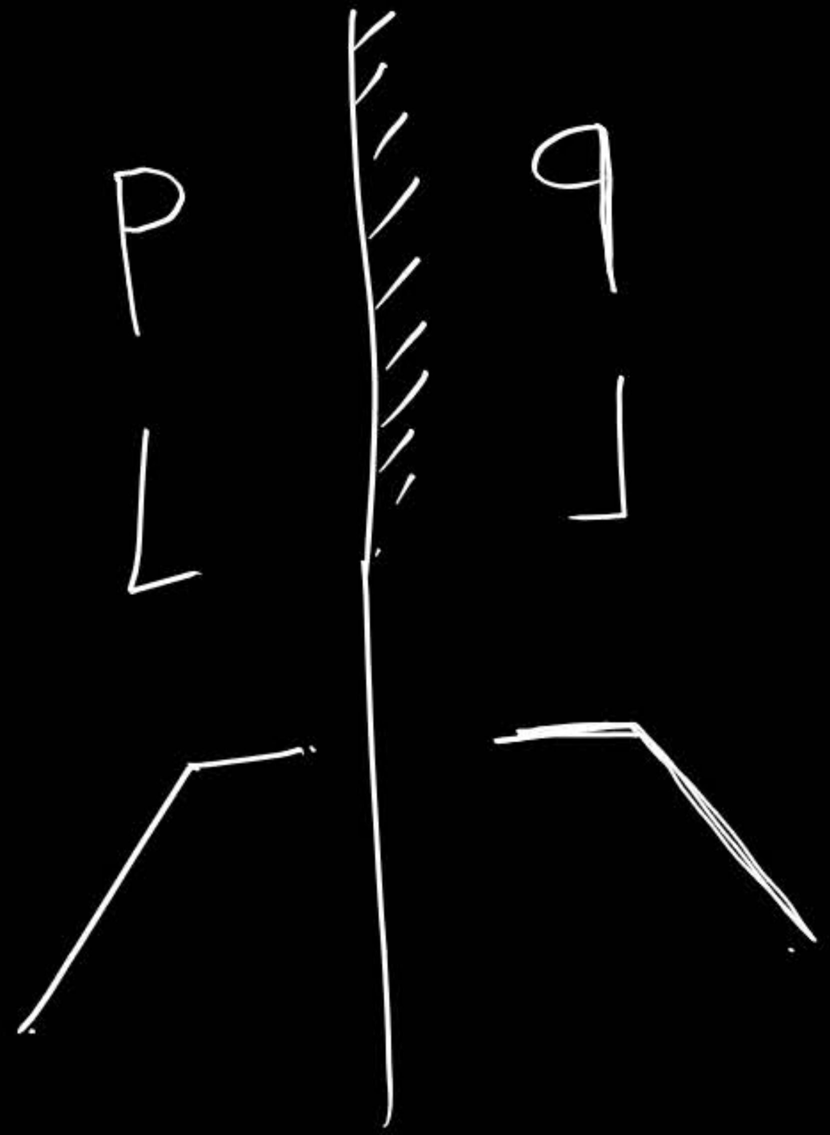
$$(m_{Transverse}) = \frac{H_I}{H_0} = \frac{H_0}{H_0} = +1$$

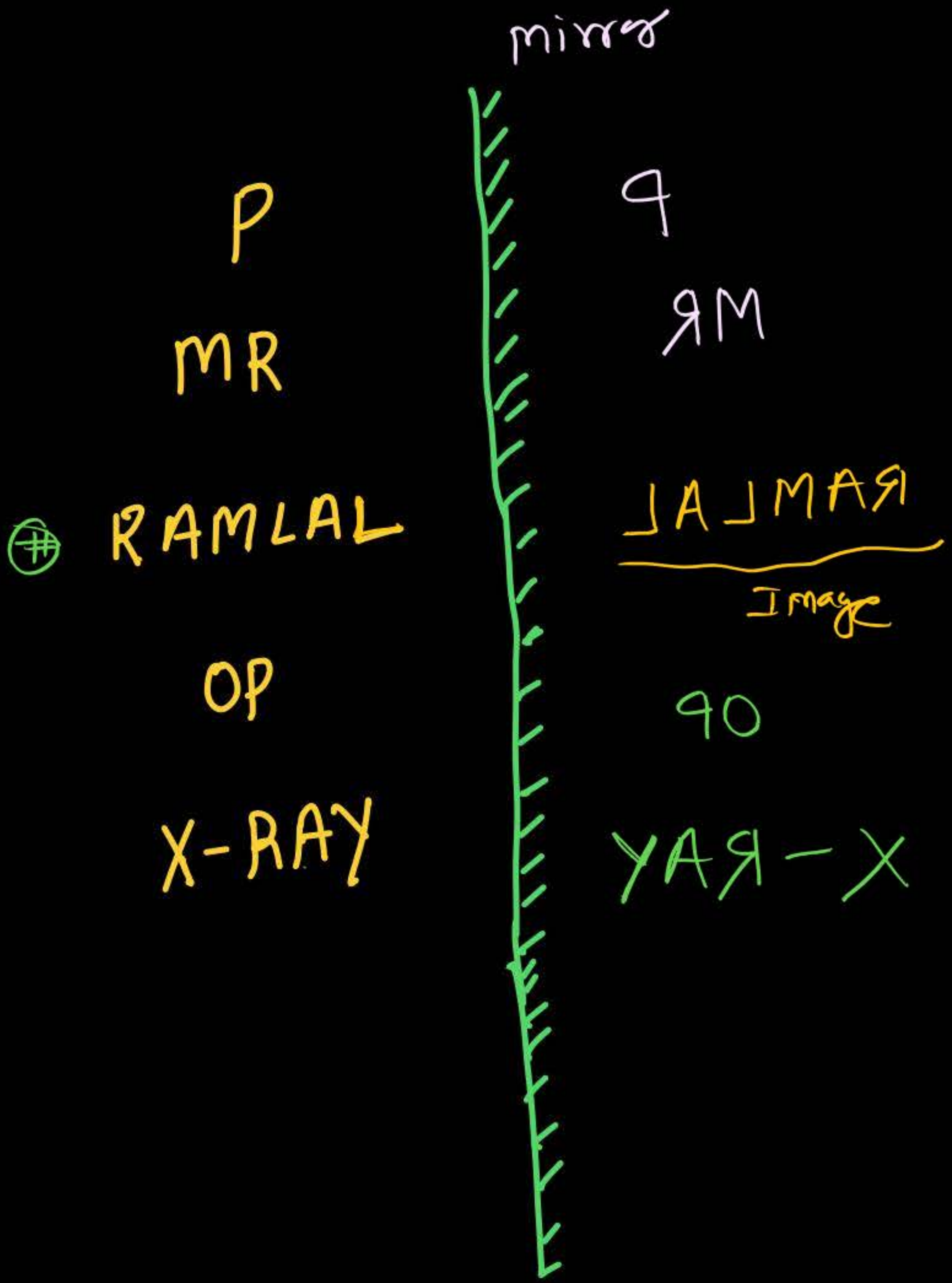
→ errect
→ virtual
→ Lateral Inverte.

⊥r magnifical to line of Joing of mirror & object

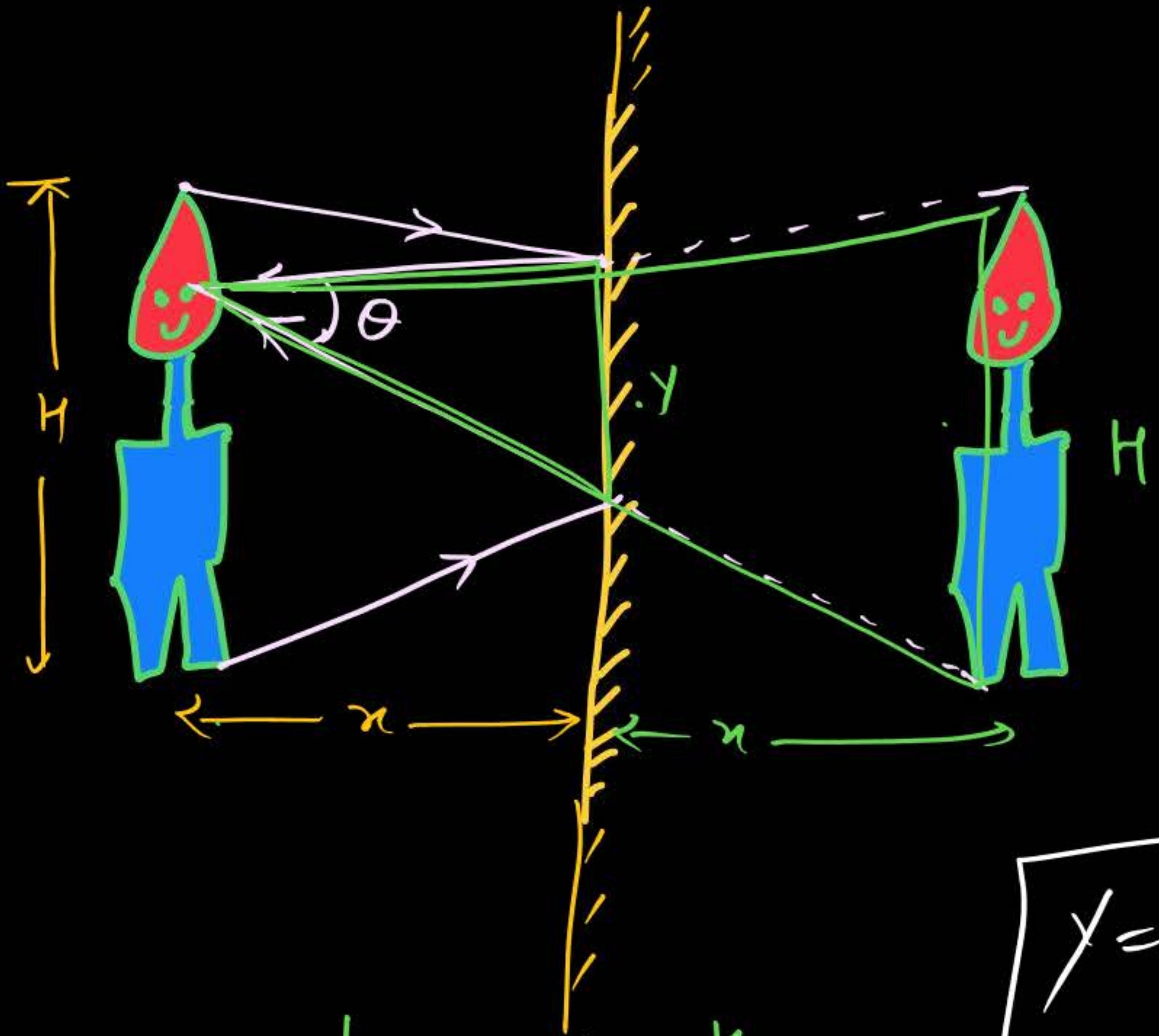
$$m_l = \frac{dv}{du}$$

→ along the line joining of mirror and object.


p
q


mirror
P
MR
RAMLAL
Image
OP
X-RAY

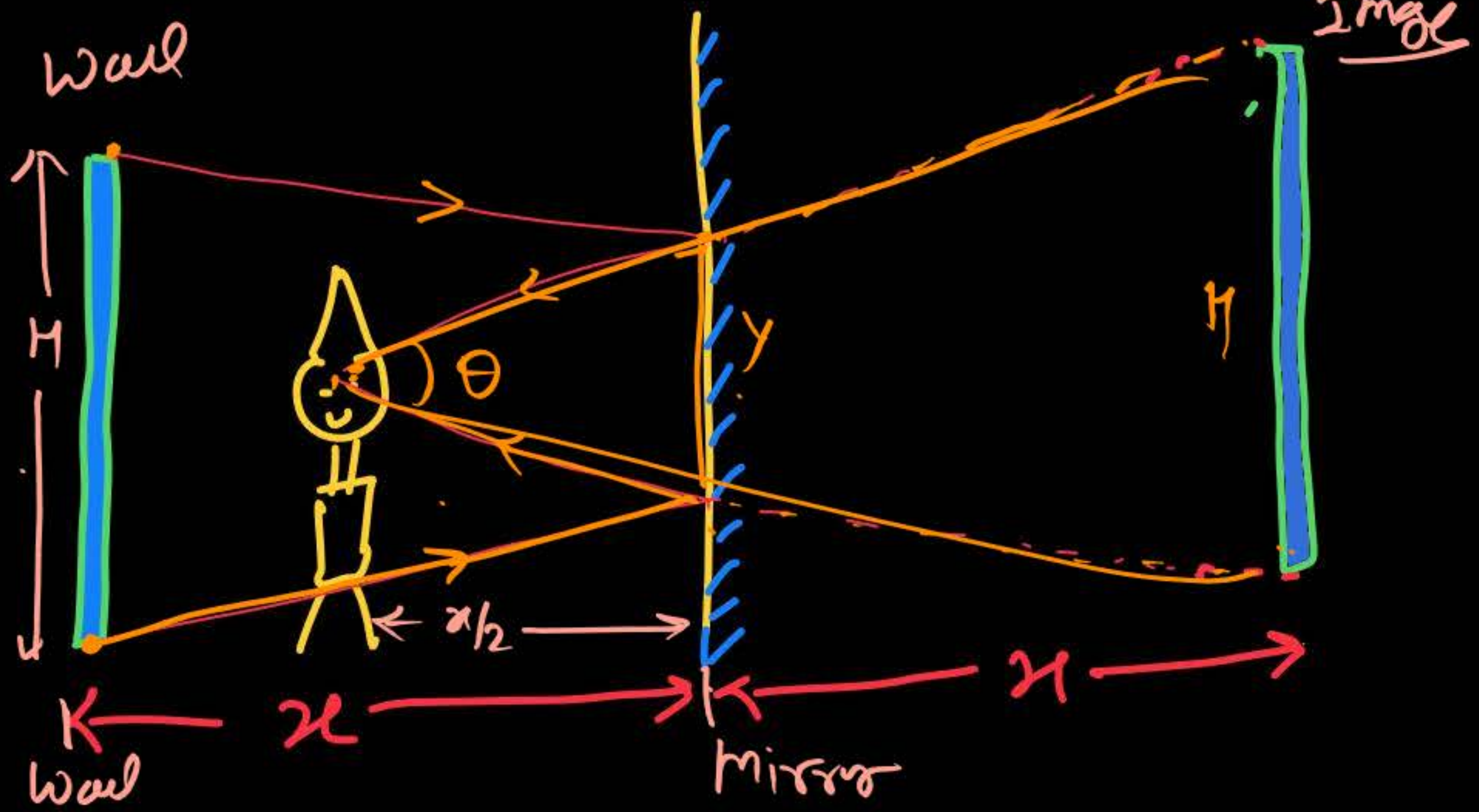
Boy wants to see his full Image, then minimum size of mirror is required??



$\tan\theta = \frac{y}{x} = \frac{H}{2x}$

$y = \frac{H}{2}$

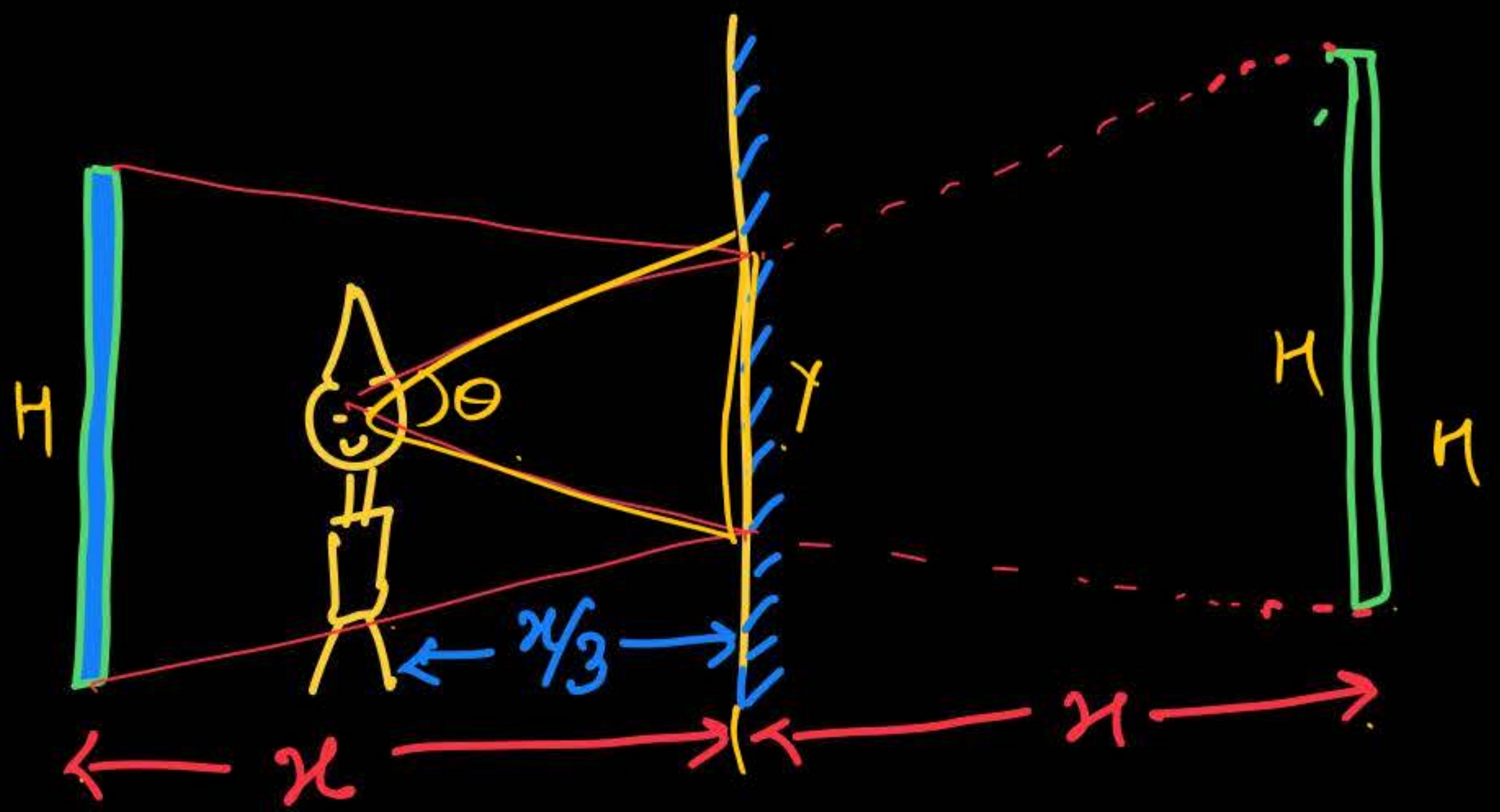
If observer wants to see Full Image of Wall behind him. Observer is standing B/w Wall and Mirror



$$\tan\theta = \frac{y}{x/2} = \frac{H}{\frac{3x}{2}}$$

$$\boxed{y = H/3}$$

If observer wants to see full image of wall behind him. observer is



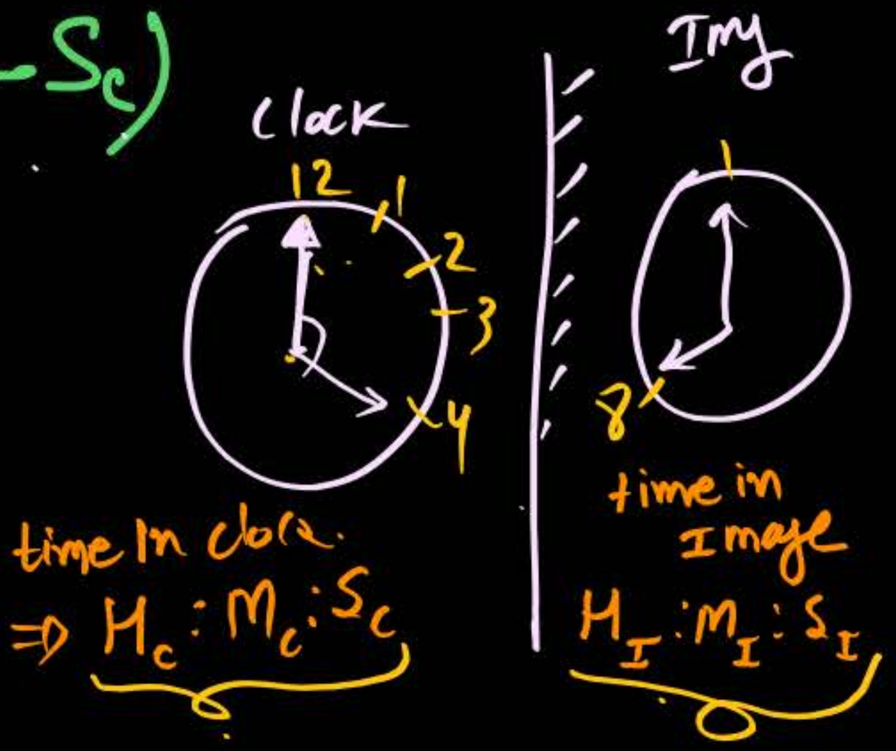
$$\frac{y}{x/3} = \frac{H}{4x/3}$$

$$y = H/4$$

The sum of time shown by a clock and its Image is 12 hr

$$H_I : M_I : S_I + H_c : M_c : S_c = 11 \text{ hr} : 59 \text{ mint} : 60 \text{ sec}$$

$$H_I : M_I : S_I = (11 - H_c) \text{ hr} : (59 - M_c) : (60 - S_c)$$



if hr hand, mint hand is given

$$H_I : M_I + H_c : M_c = 11 \text{ hr} + 60 \text{ min}$$

only hr hand given

$$H_I + H_c = 12 \text{ hr}$$

(Q) If time in clock is 7hr : 40mint then time in Image of clock will be ??

$$H_I : M_I = (11 - 7) : (60 - 40)$$

$$= 4 : 20$$



QUESTION

An unnumbered wall clock shows time 04 : 25 : 37, where 1st term represents hours, 2nd represents minutes and the last term represents seconds. What time will its image in a plane mirror show.

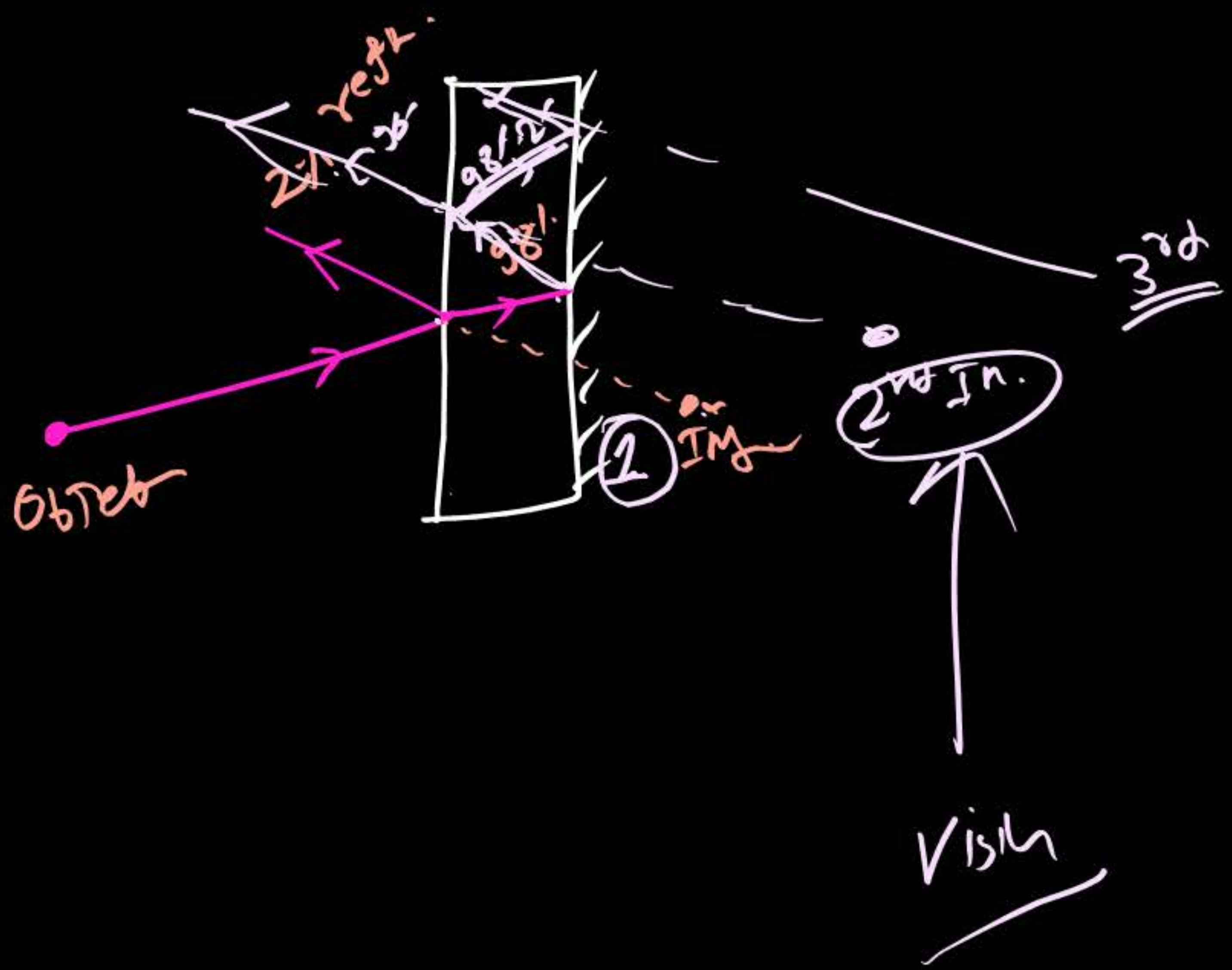
$H_I : m_I : S_I = 11-4 : 59-25 : 60-37$

$= 7 : 34 : 23$

1. 08 : 35 : 23
2. 07 : 35 : 23 ✗
3. 07 : 34 : 23 ✓
4. None of these

- → Focal length of plane mirror is infinite. (formation of Image does not depends on size of mirror)
- → On covering a part of mirror, no change in size of image but brightness changes, every part of mirror forms Image.
- → Image by plane mirror always erect, virtual, same size of object
- → Object and Image distance same from plane mirror.
- → Image formed by plane mirror is laterally Inverted.
- → It can form (may) real Image of virtual object, virtual Image of real object but can't form real → image of real object
- → minimum size of plane mirror to see full Image of observer is half of the Height of observer.
- → minimum size of mirror fixed on wall of room, in which observer at centre of room can see full Image of wall H is H/3
- → { Image formed by thick plane mirror due to multiple reflection in which 2nd Image is much brighter and visible.
- → out of 26 alphabets, 11 alphabets A, H, I, M, O, T, U, V, W, X, Y have same Image

thick. plane mir.



Plane mirror always form erect ??

→ Yes can

Plane mirror can form Inverted Image

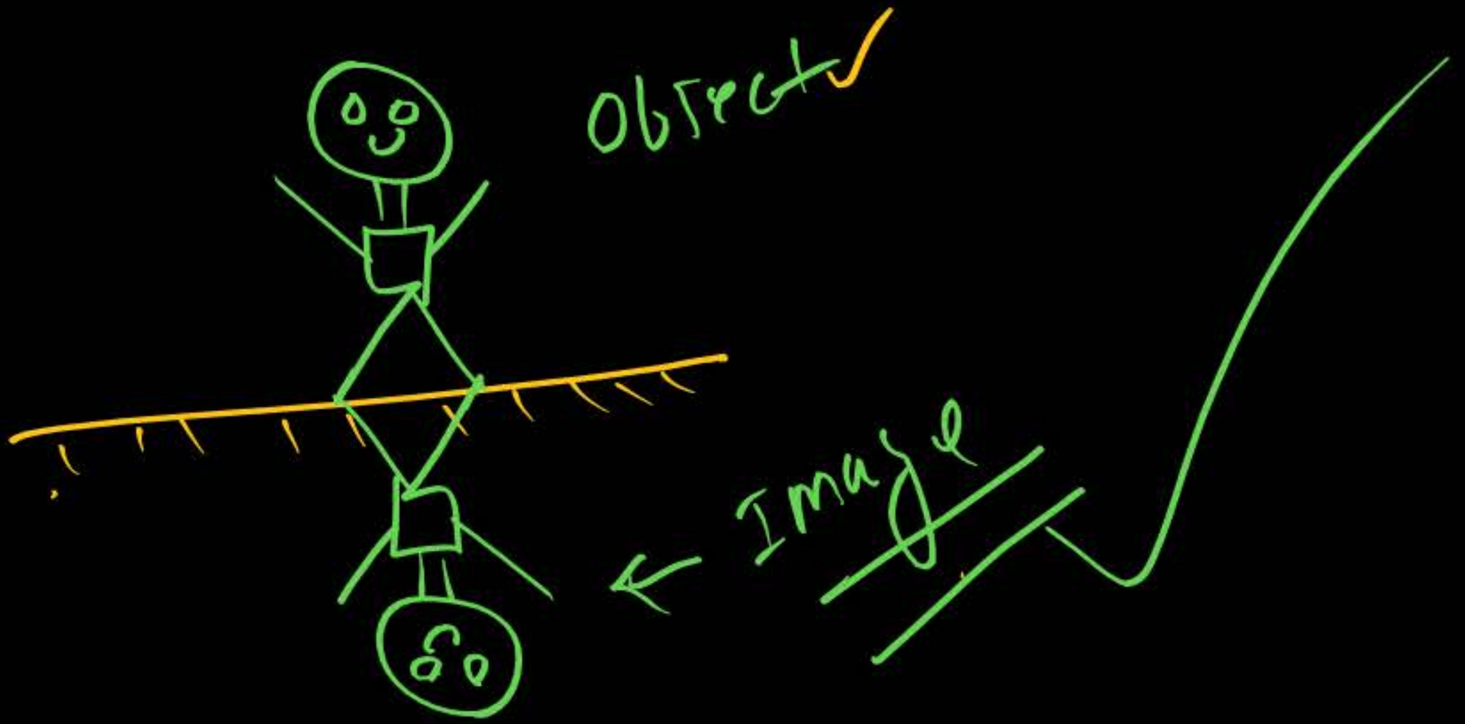
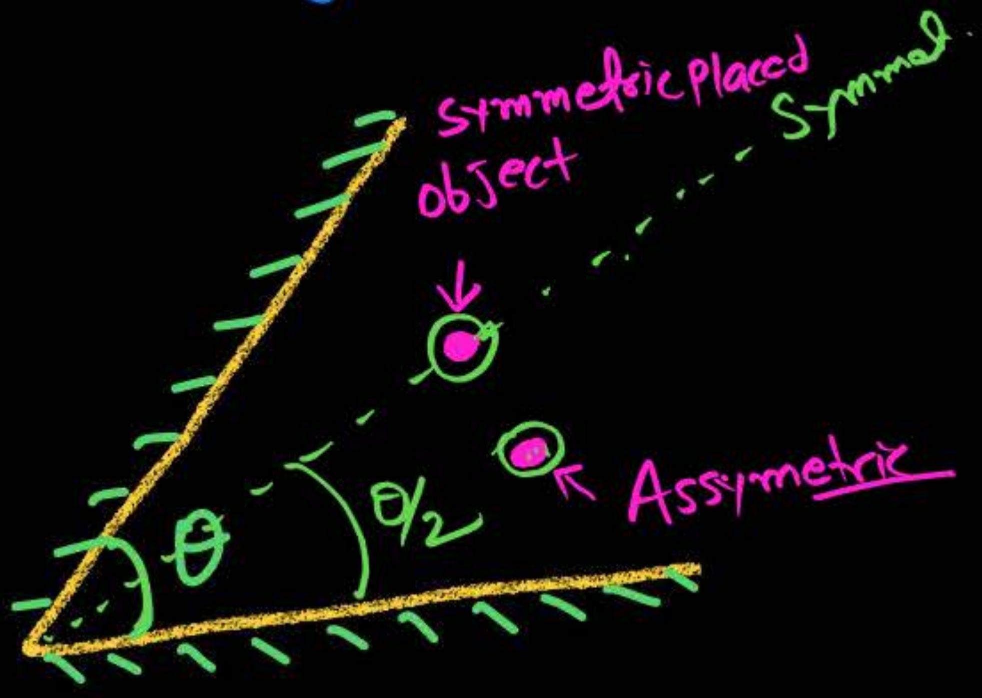


Image formation by {Two Plane mirror}



θ = Angle B/w plane mirrors

$x = \frac{360}{\theta}$

$n = x - 1$

If $\frac{360^\circ}{\theta} = x$;

if x is even integar then no. of image $n = x - 1$

in x is odd integar and Placed symmetric $n = x - 1$

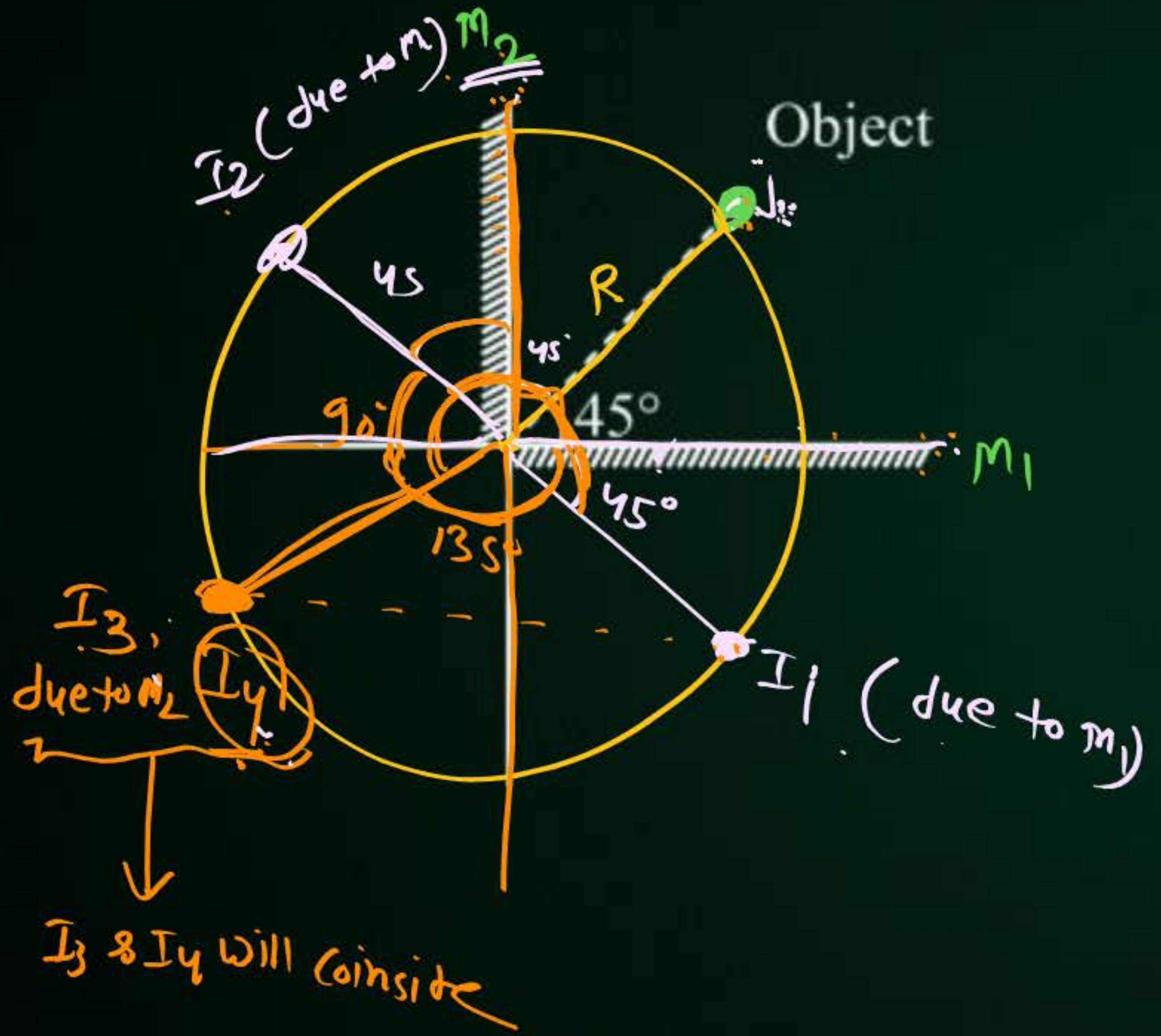
not symmetric $n = x$

if it is fraction then.

$x = 3.21 = 3$

$= 3.9 = 3$ ✓

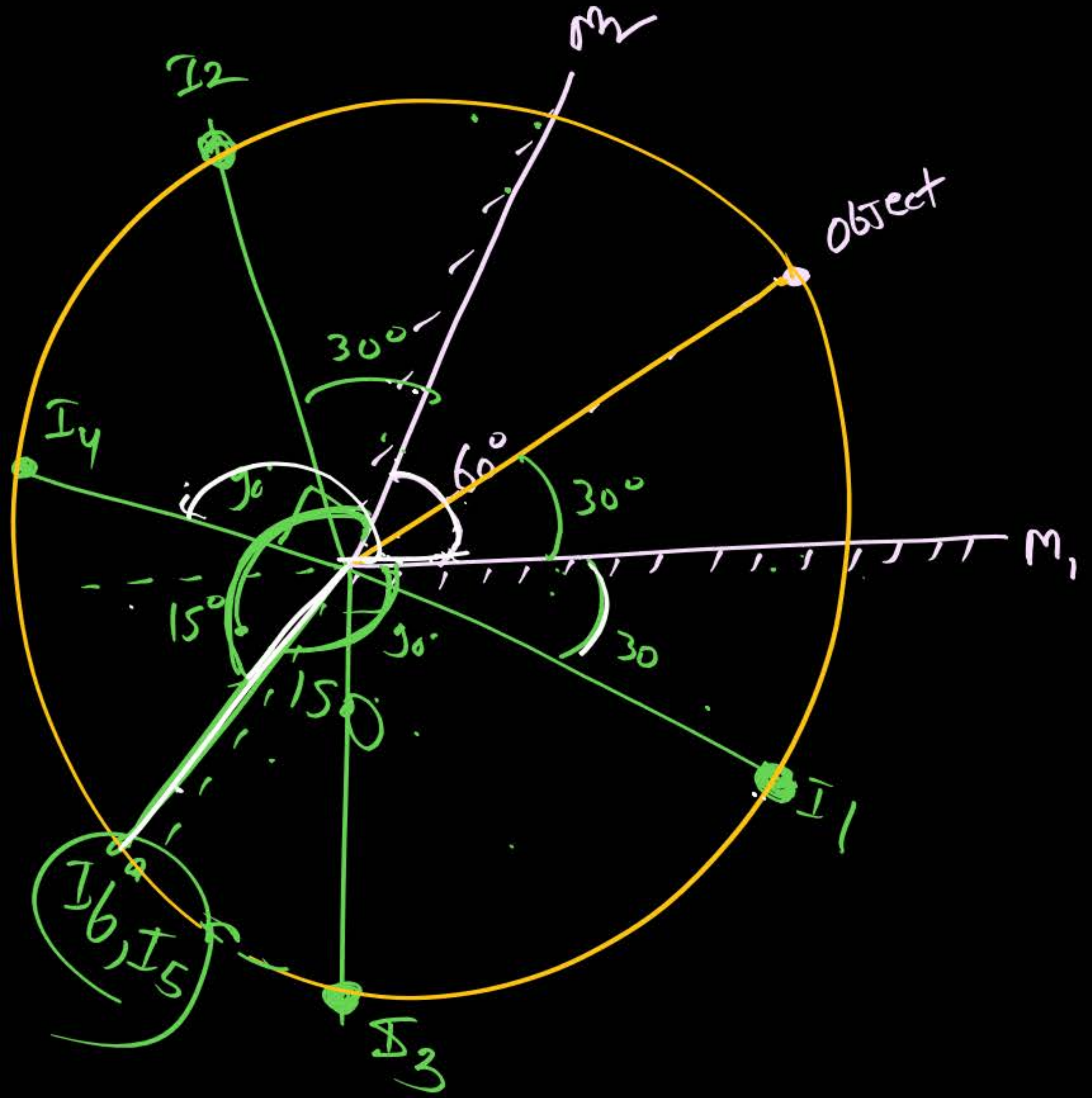
$= 4.85 = 4$ ✓



$$x = \frac{360^\circ}{\theta} = \frac{360^\circ}{90} = 4 \text{ even}$$

no. of Image = 3

MR* → all Image will form on circle at symmetric angle



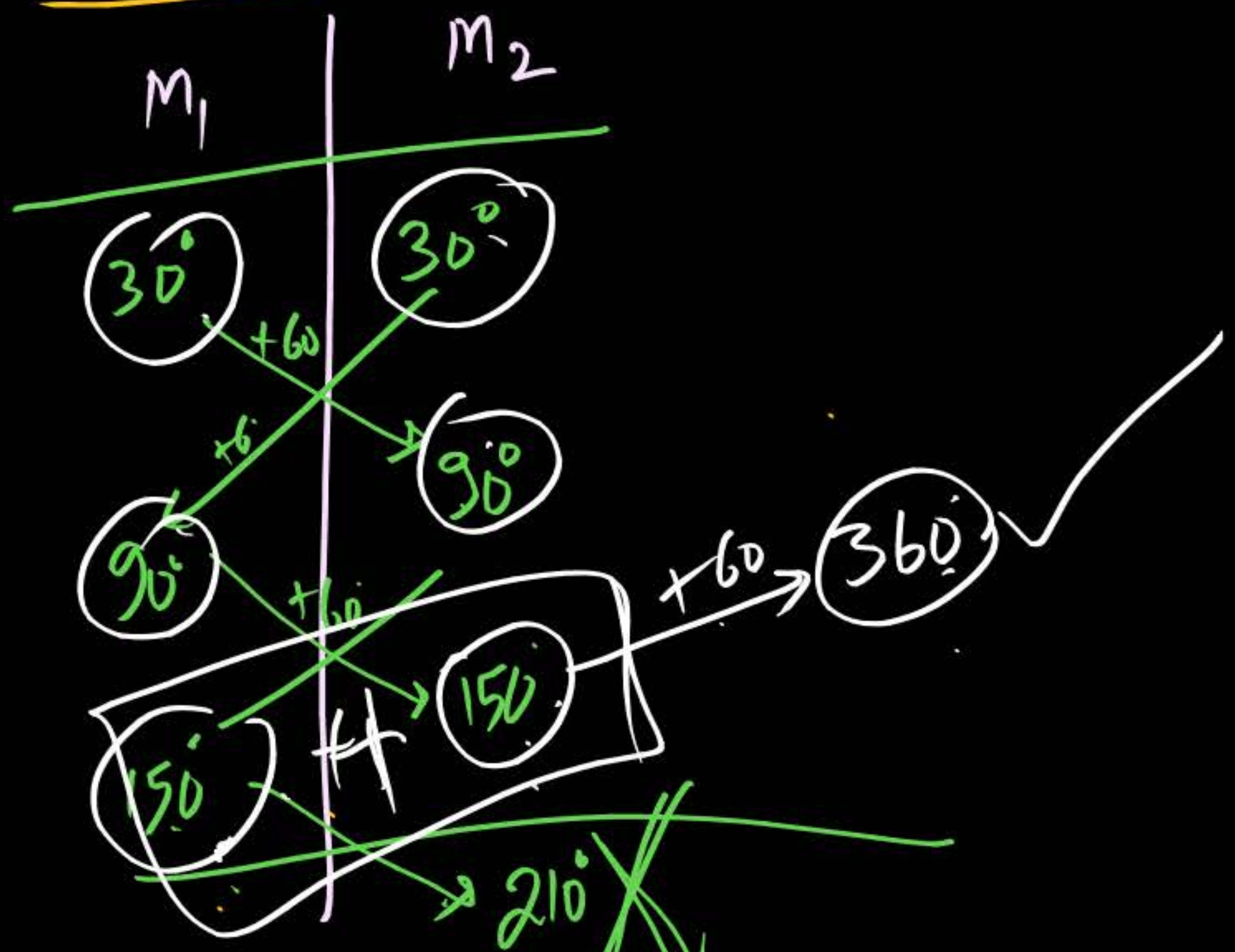
$$x = \frac{360}{60} = 6 \text{ eve.}$$

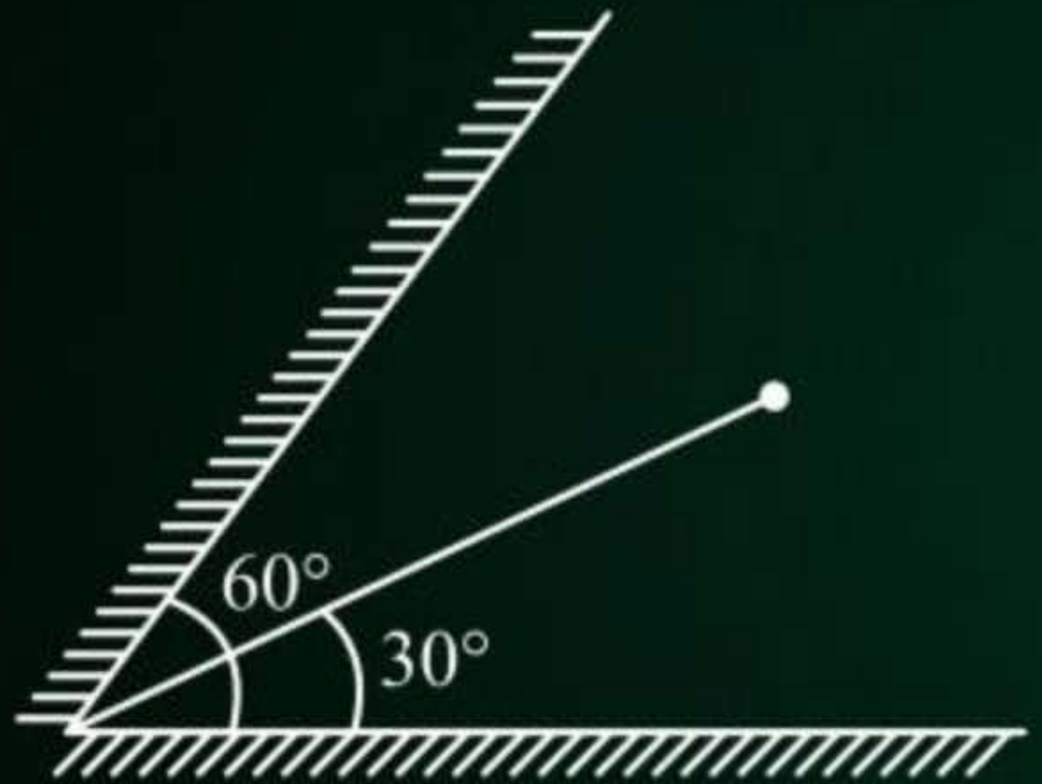
$$n = 6 - 1 = 5$$

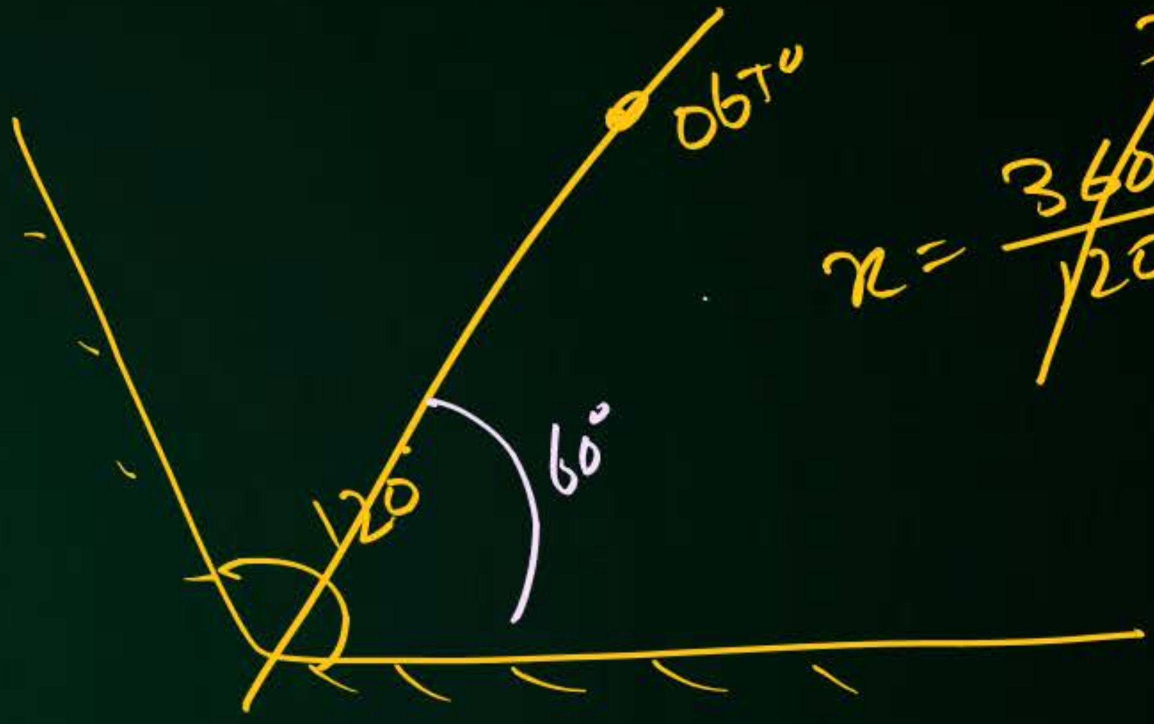
Total 5 img

Dhaag

The MR*







$n = \frac{360°}{120} = 3$

no of $I = 3 - 1$
$= 2$

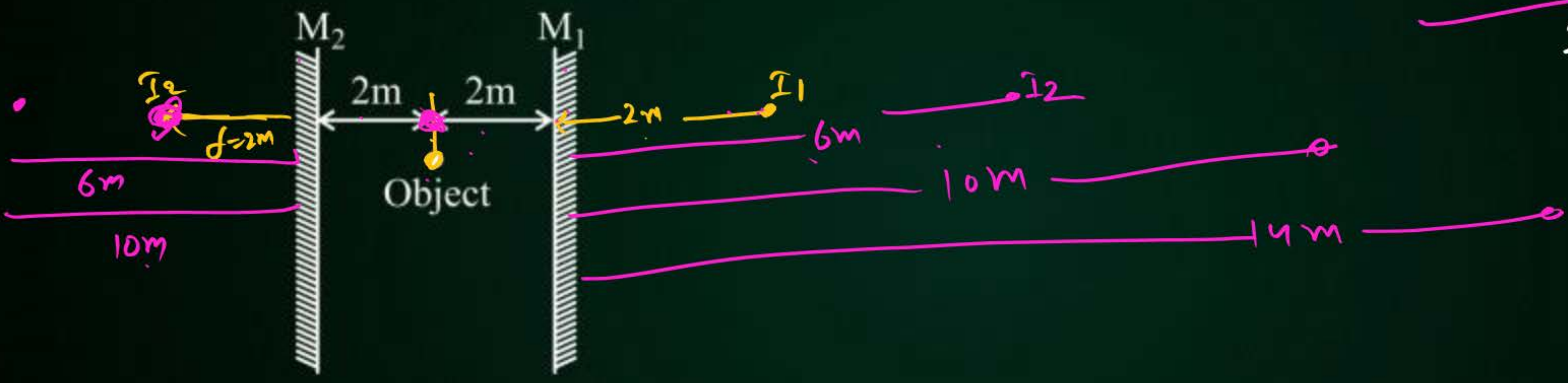


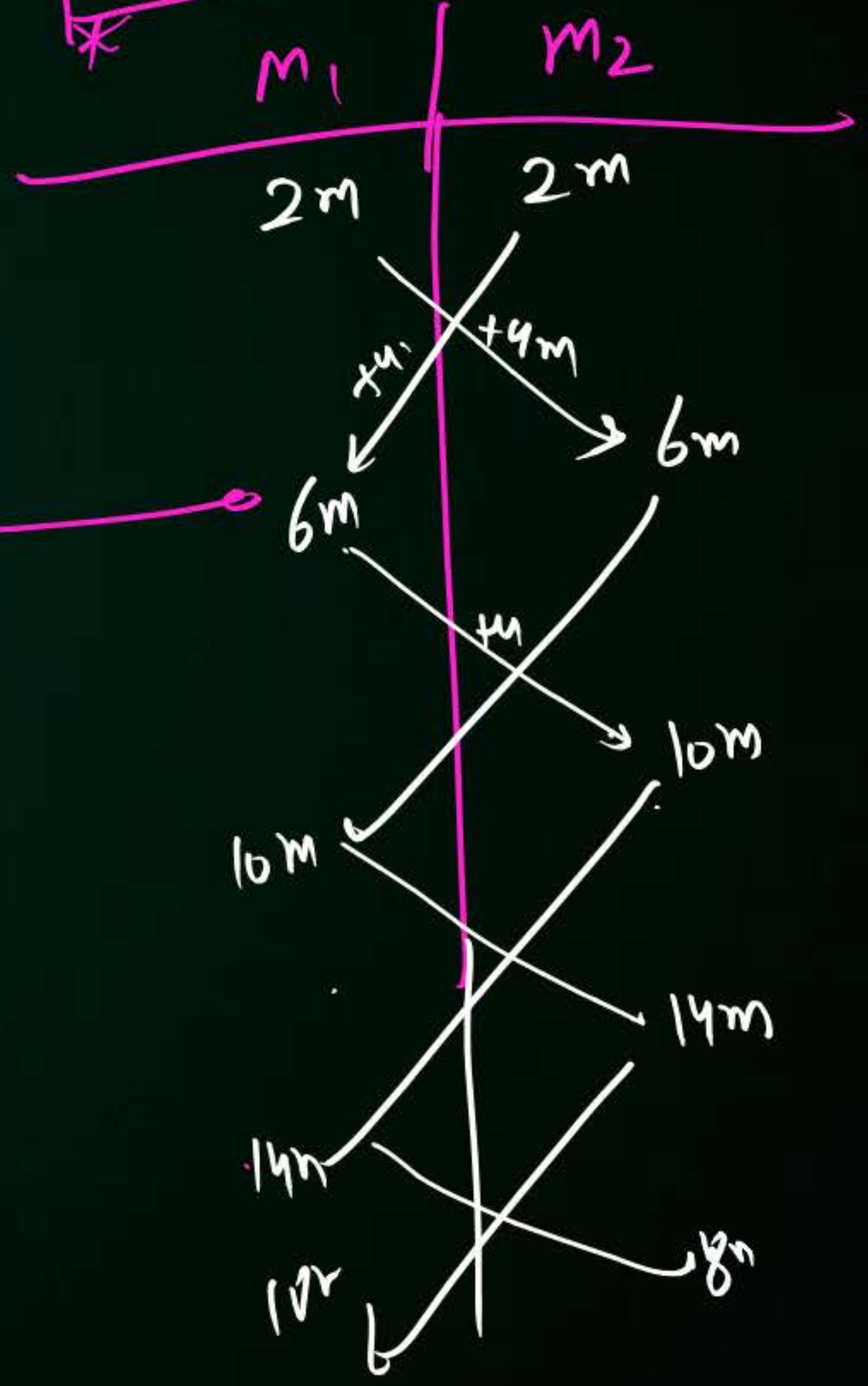
$n = 3$

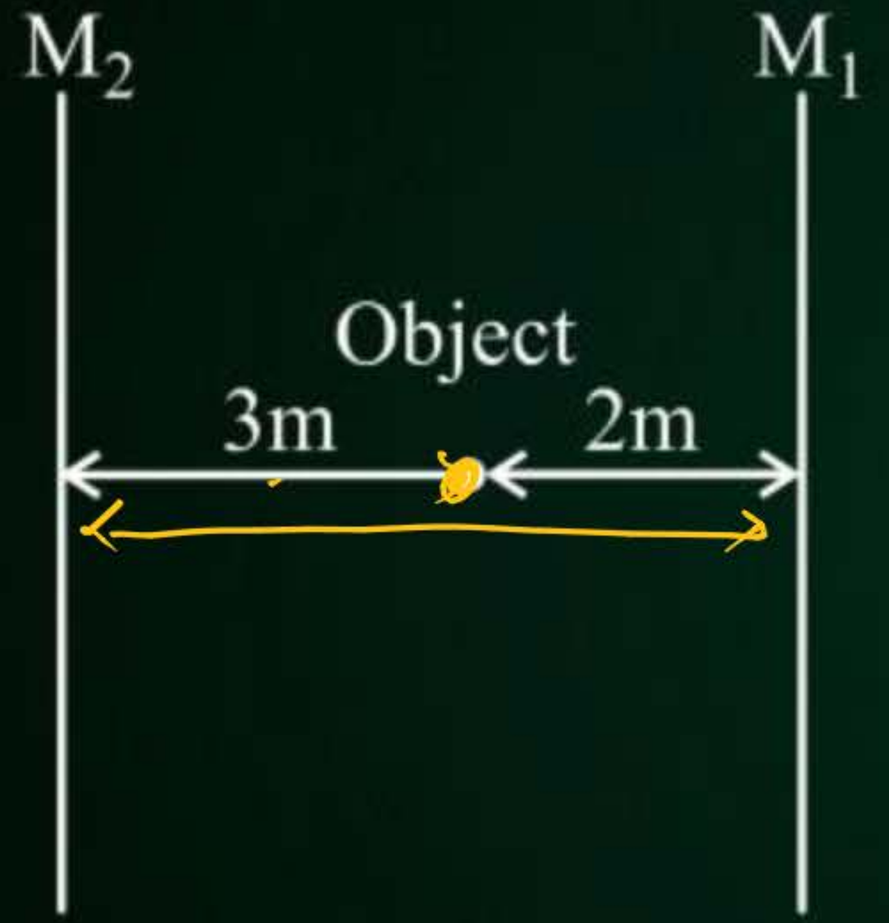
➢ Infinite image when two plane mirror is parallel :

$\theta = 0^\circ$

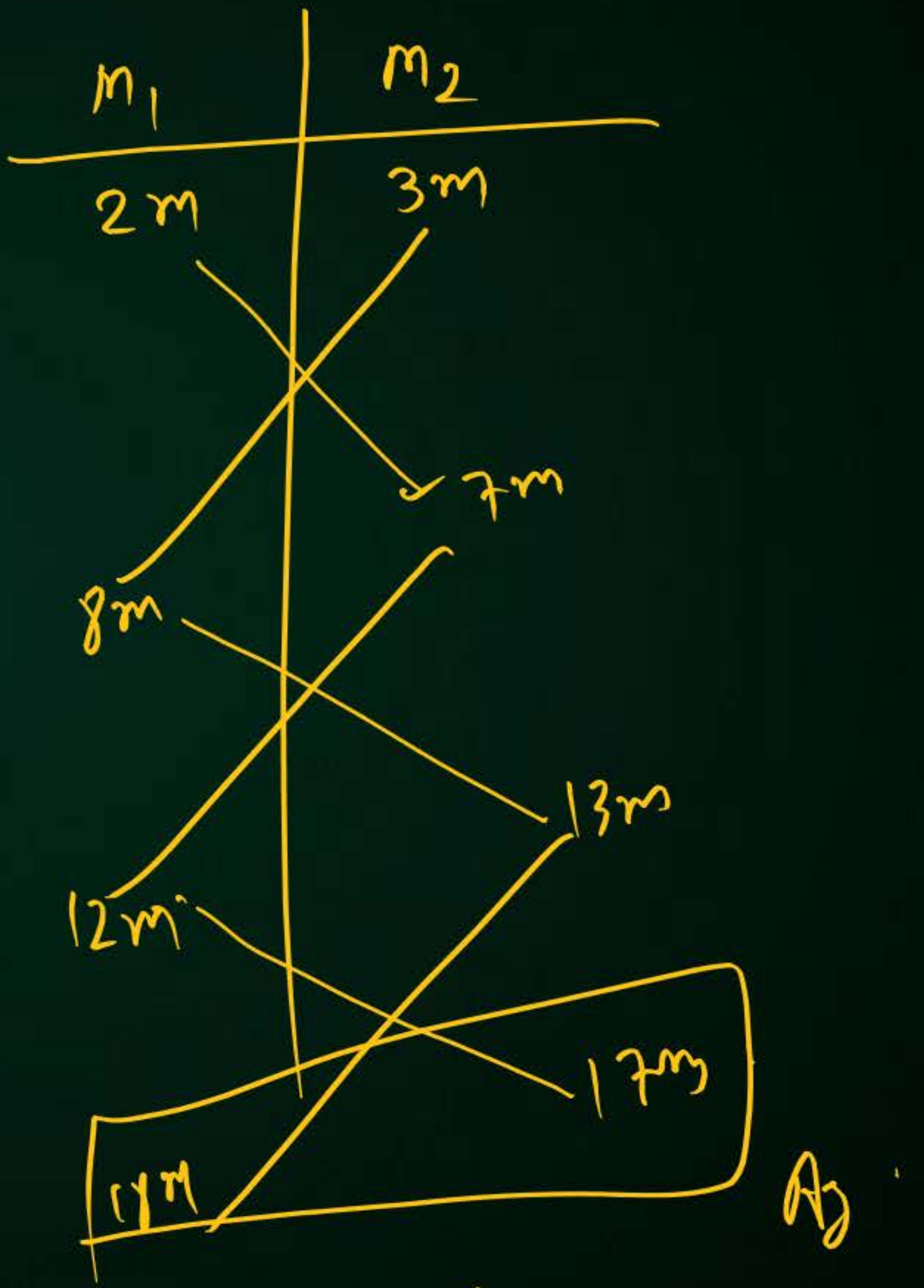
$x = \frac{360^\circ}{0^\circ} = \text{infin.}$



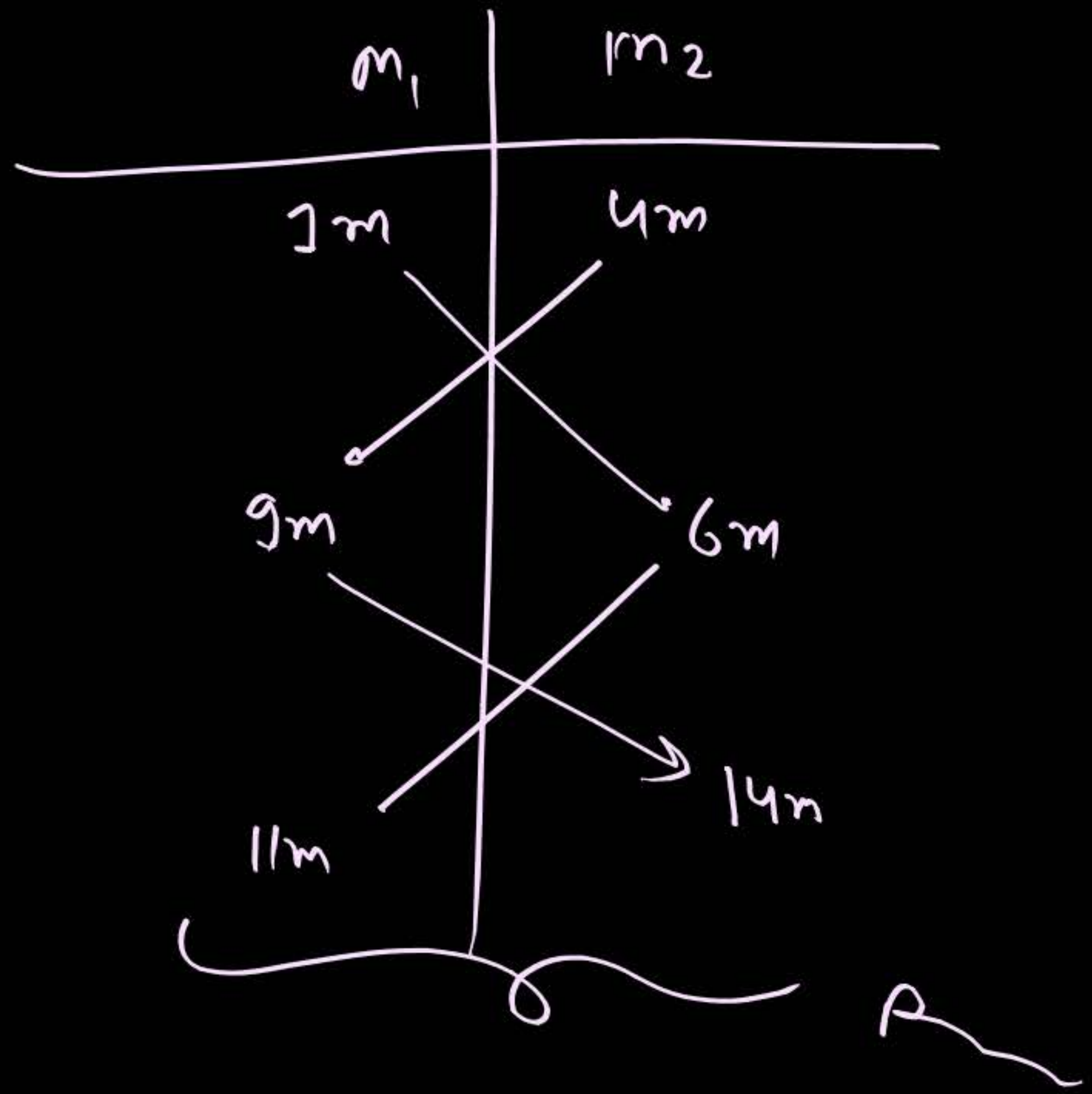




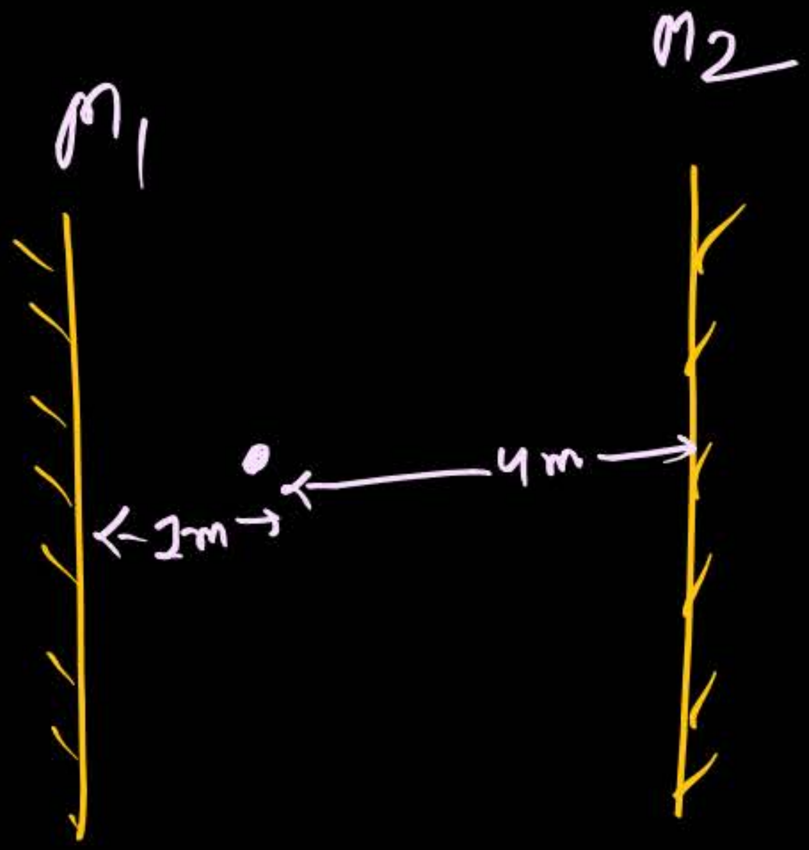
M_2
M_1
Object
3m
2m



M_1
M_2
2m
3m
7m
8m
13m
12m
17m
17m

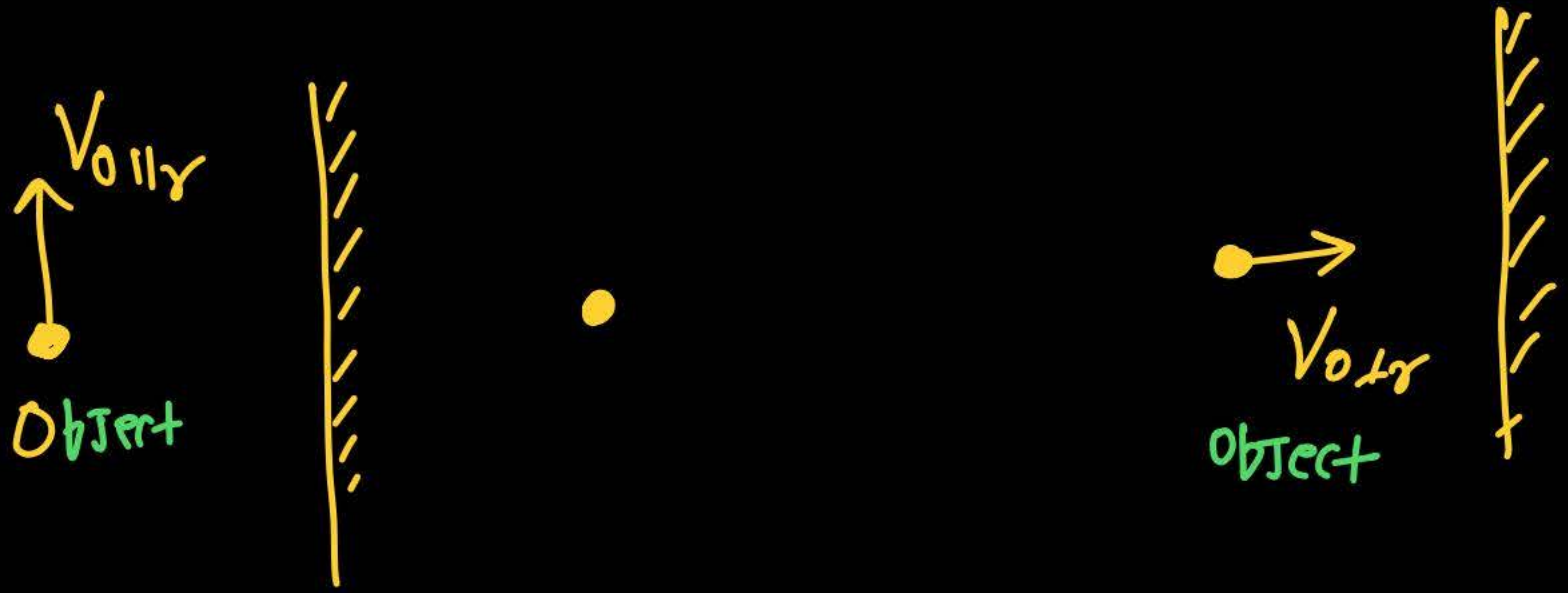


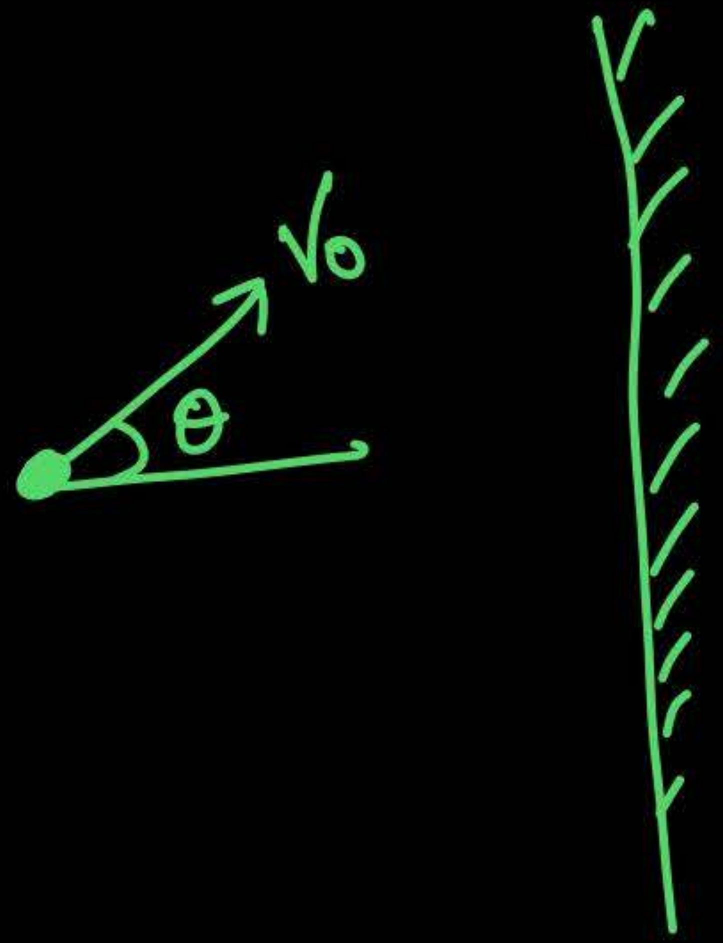
m1
m2
1m
4m
9m
6m
11m
14m



m1
m2
1m
4m

Velocity of Image in Plane Mirror



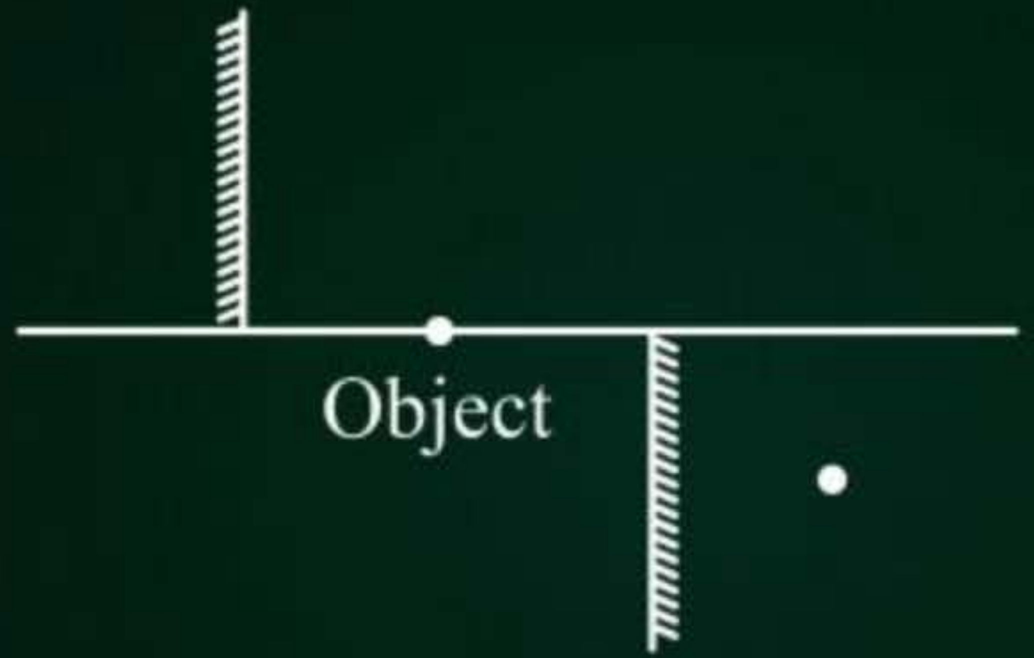


v_0
θ

Mirror is Moving object is at rest

QUESTION

Find total no. of image due to those two parallel mirror.



QUESTION

Object is placed in front of 3 plane mirror which are perpendicular to each other, then find no. of image formed?

$V_M = 4\ m/s$



$V_0 = 2\ m/s$

$V_{IO} =$

$V_{IG} =$

QUESTION

A tall man of height 6 feet, want to see his full image. Then required minimum length of the mirror will be [2000]

1. 12 feet
2. 3 feet
3. 6 feet
4. any length


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture-4 | Physics

Ray Optics and Optical Instruments

By- Dr. Manish Raj (MR SIR)



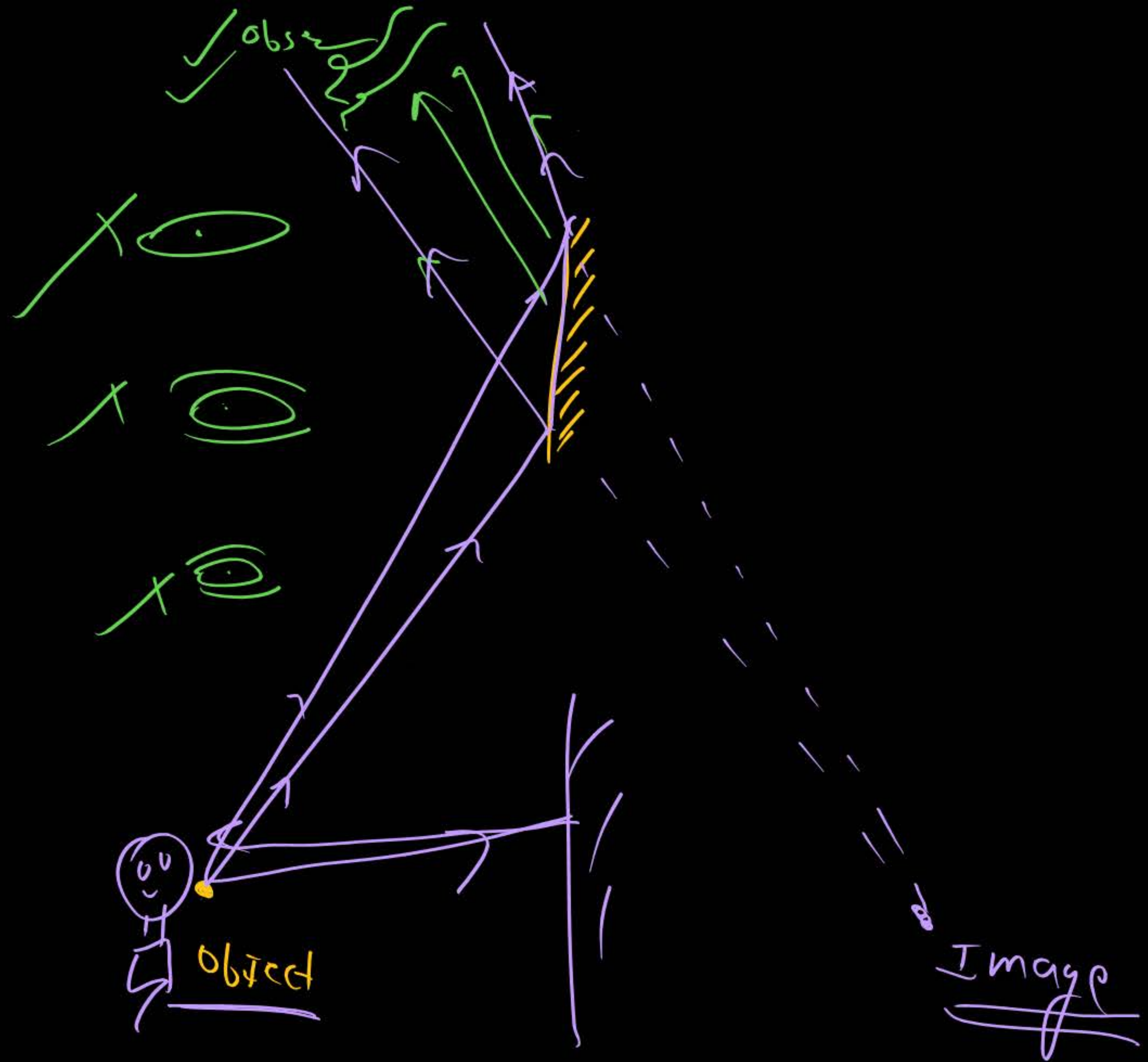
Topics to be covered

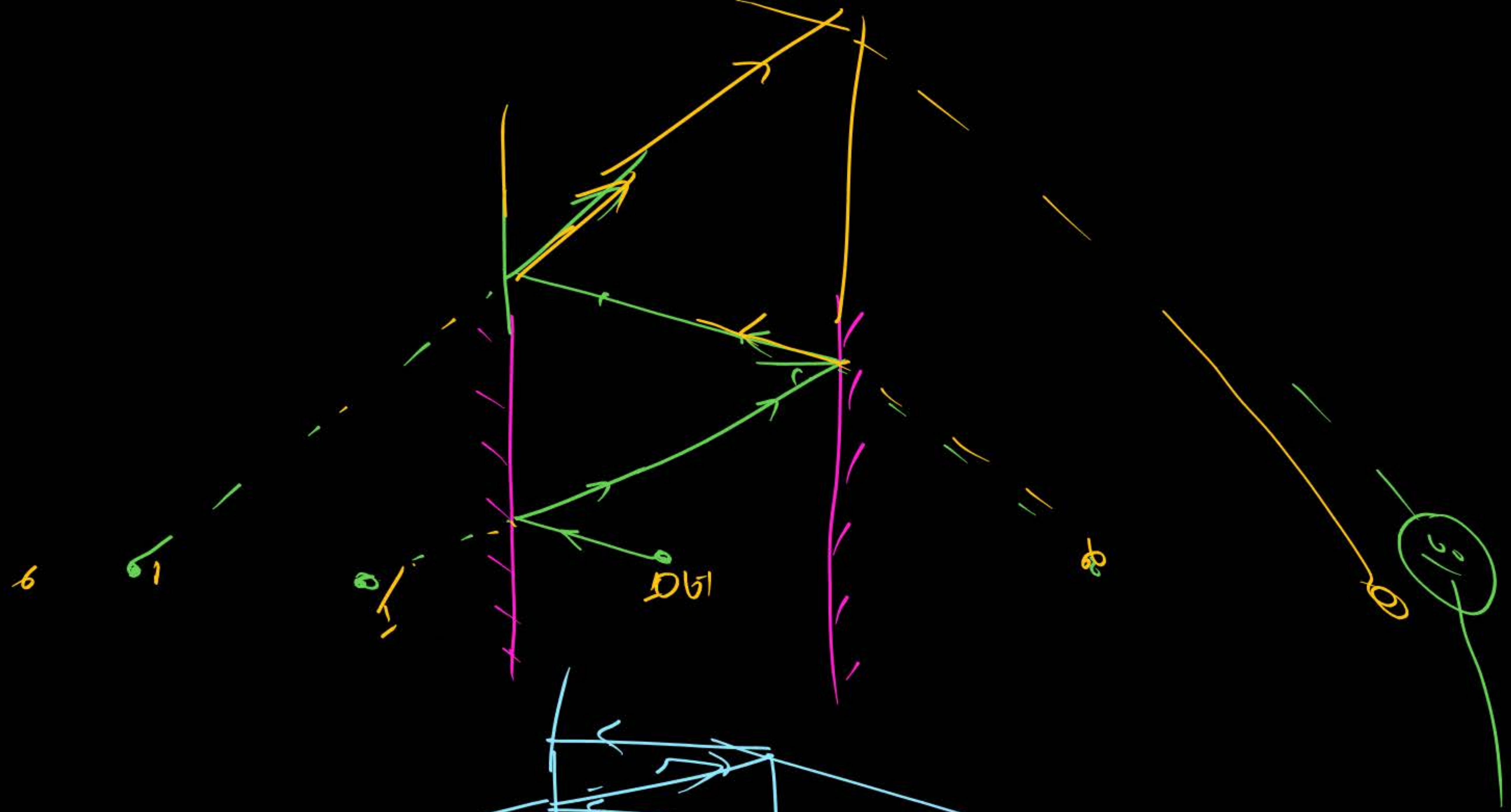
1. #
2. #
3. #

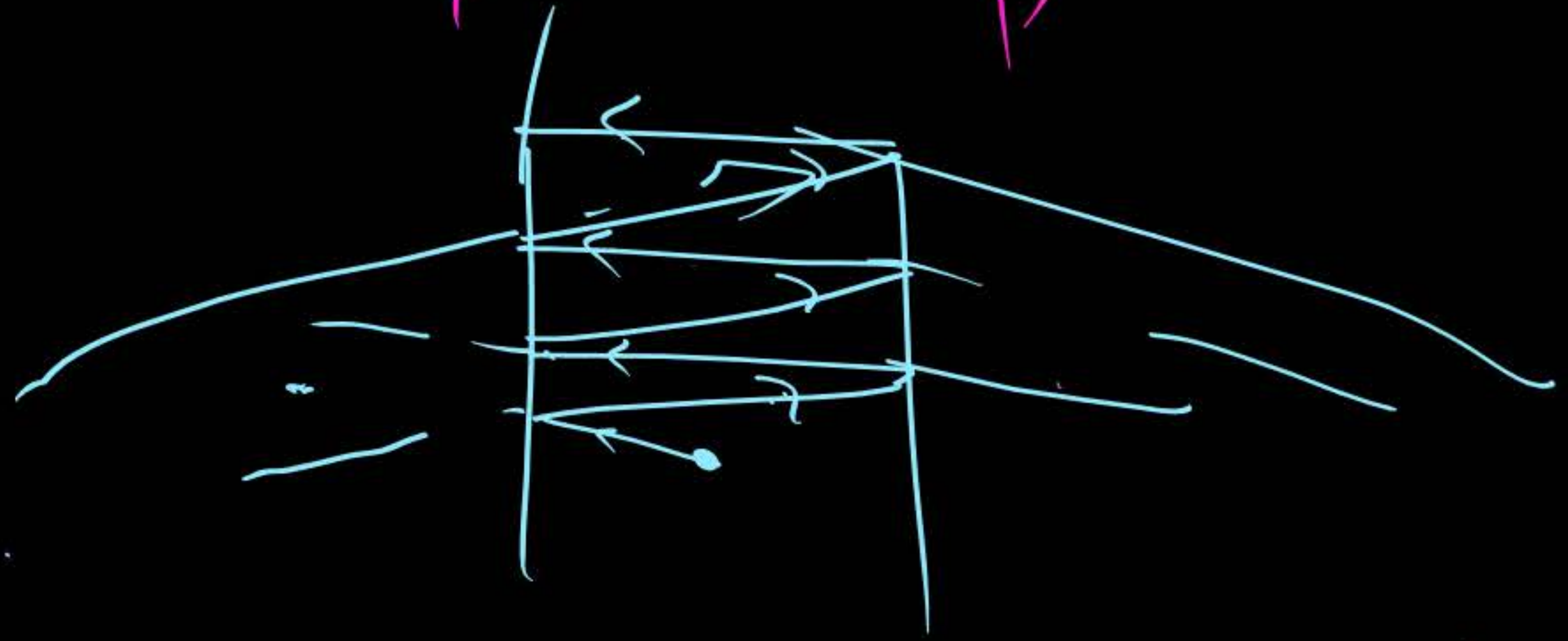
Velocity of Image

Curved mirror




Object
Image


Obj

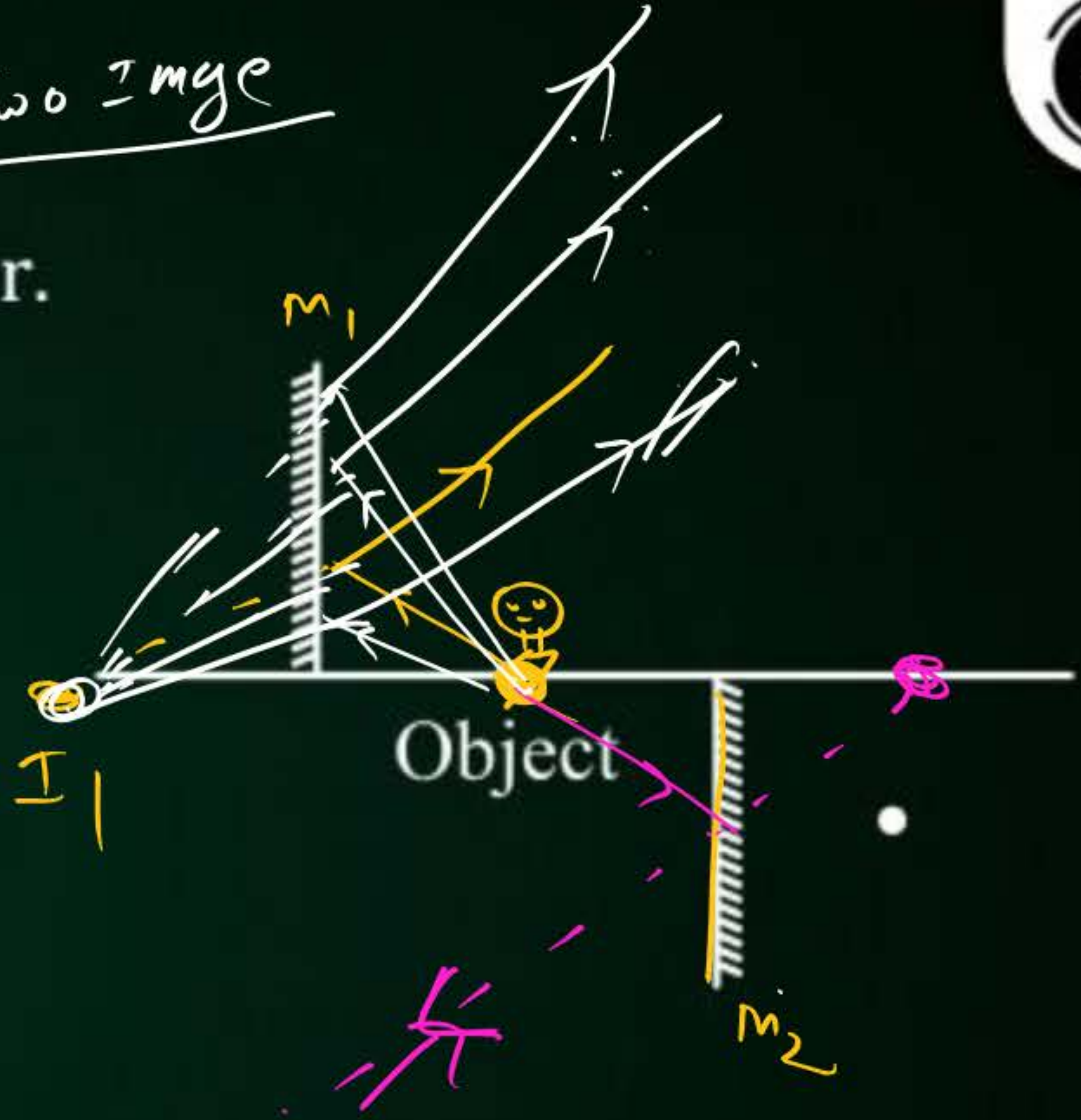


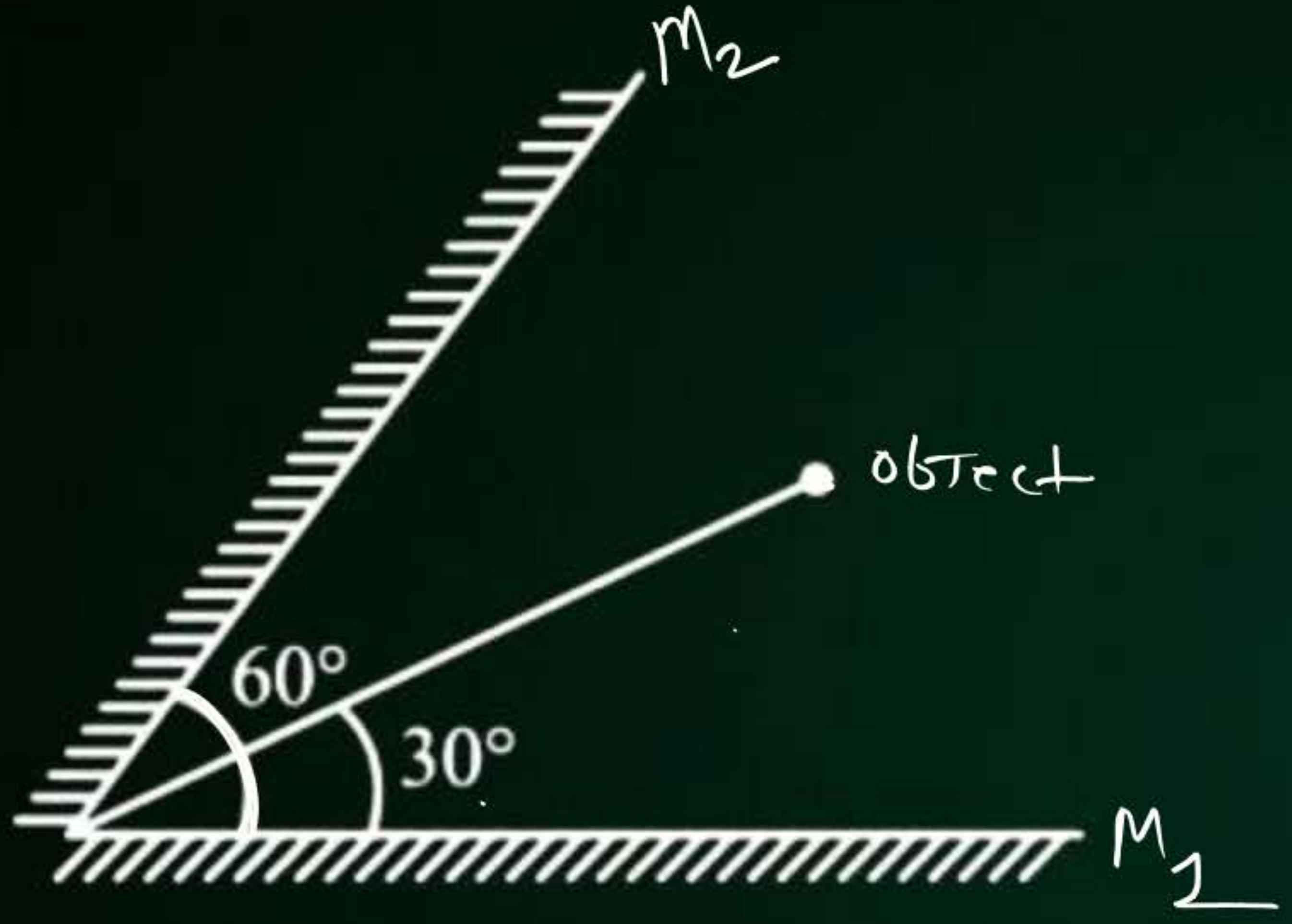
QUESTION

→ Ans Two Image

Find total no. of image due to those two parallel mirror.



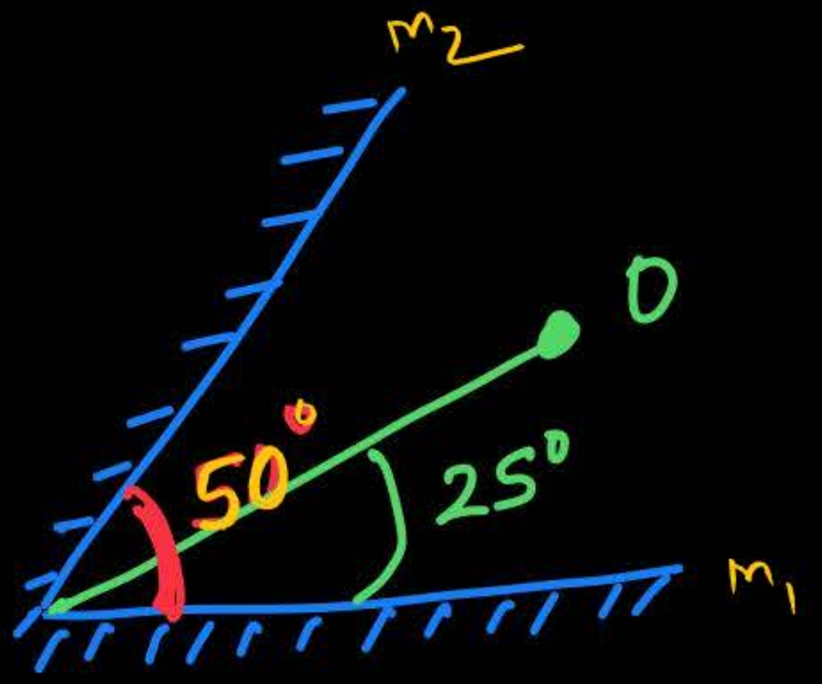




$x = \frac{360}{60} = 6$ even

no. of Image $= 6 - 1 = 5$

(Q) Find no. of Image in given figure ??

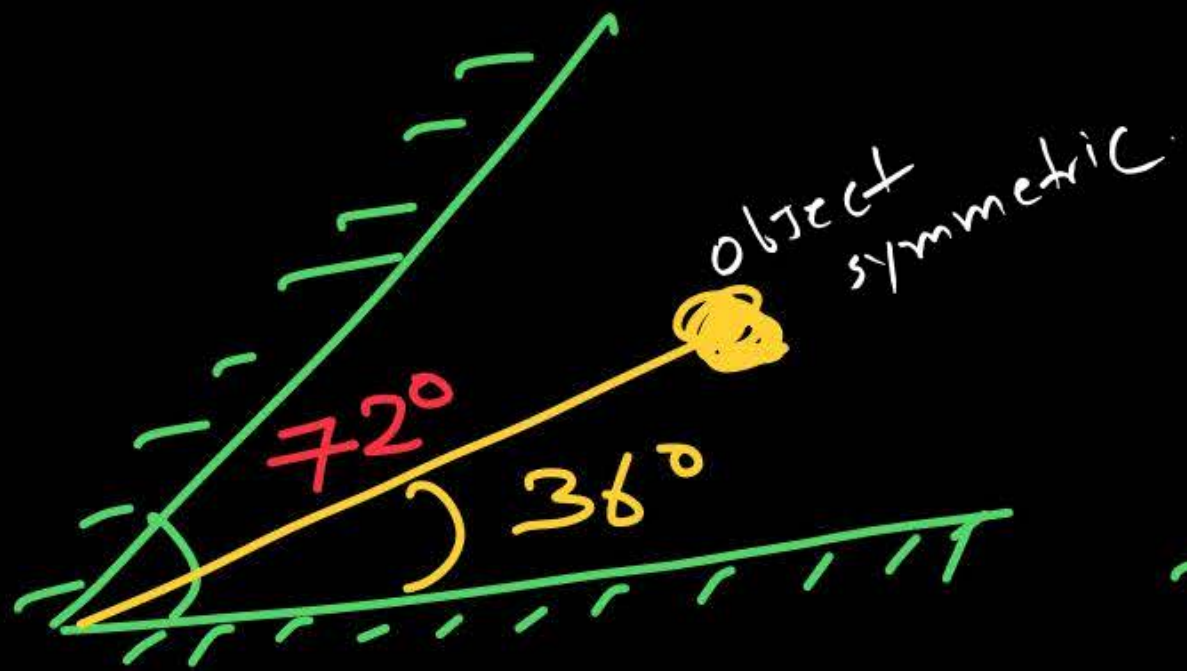


$$x = \frac{360}{50}$$

$$= 7.2$$

$$= 7 \text{ Image}$$

Ans

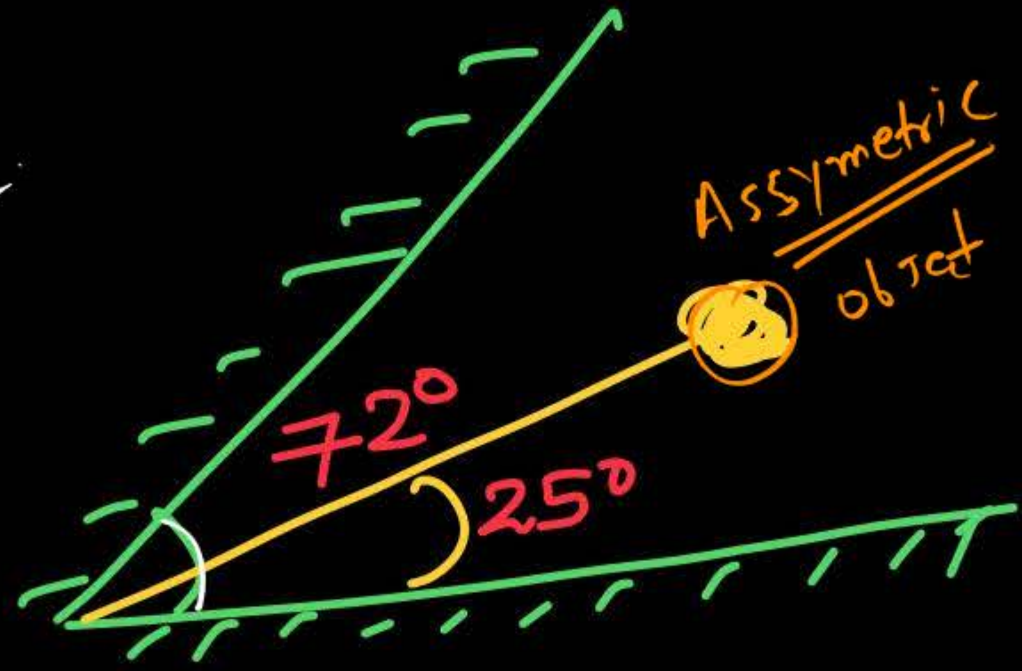


$$x = \frac{360}{72} = 5 \checkmark$$

odd

$$n = 5-1$$

$$= 4$$



$$x = \frac{360}{72} = 5$$

(odd)

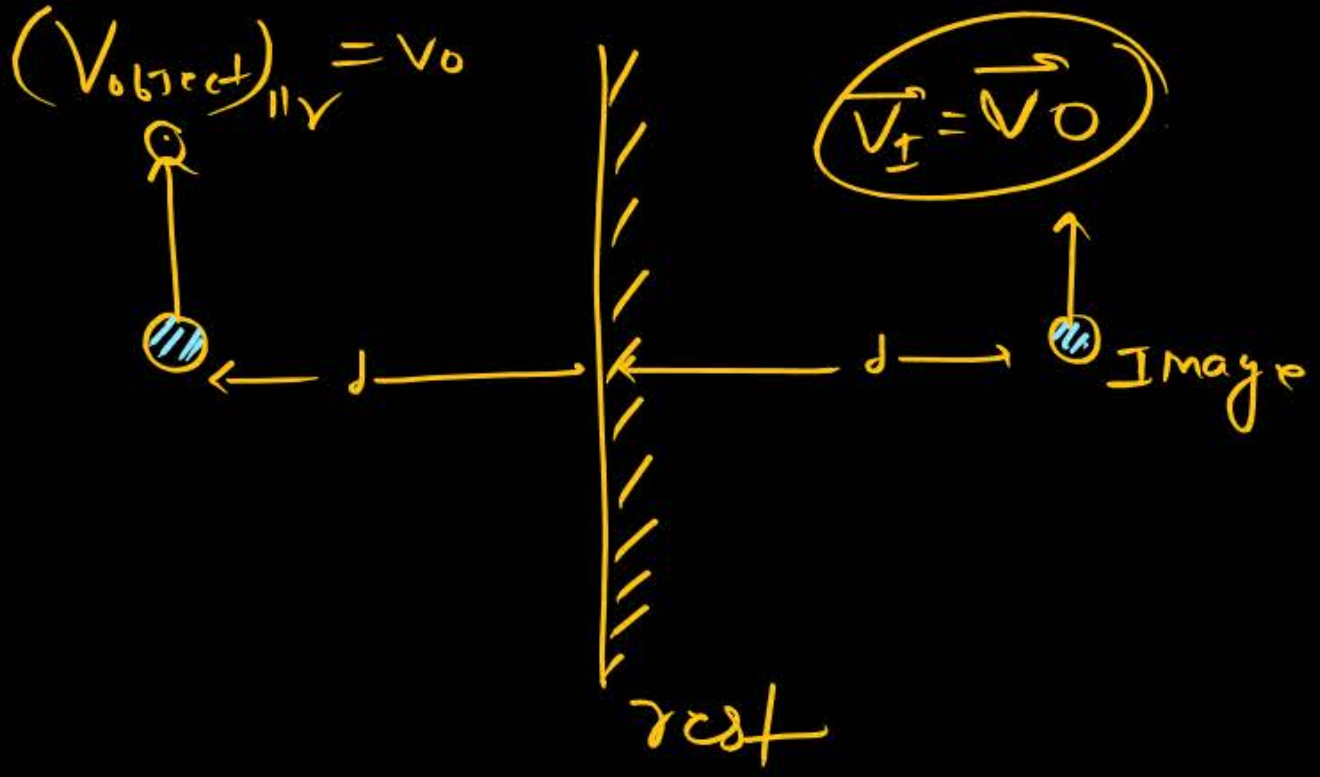
$$n = 5$$

Image

Angle (θ)		Plared symmetric	Plared Assymetric
$\theta = 0$		∞	∞
15°	$x = \frac{360}{15} = 24$ even	23	23
30°	$x = \frac{360}{30} = 12$ even	11	11
45°	$x = \frac{360}{45} = 8$ even	7	7
60°	$x = 6$	5	5
72	$x = 5$ odd	4	5
90	$x = 4$	3	3
120	$x = 3$ odd	2 ✓	3 ✓
150	$x = \frac{360}{150} = 2.2$	2	2



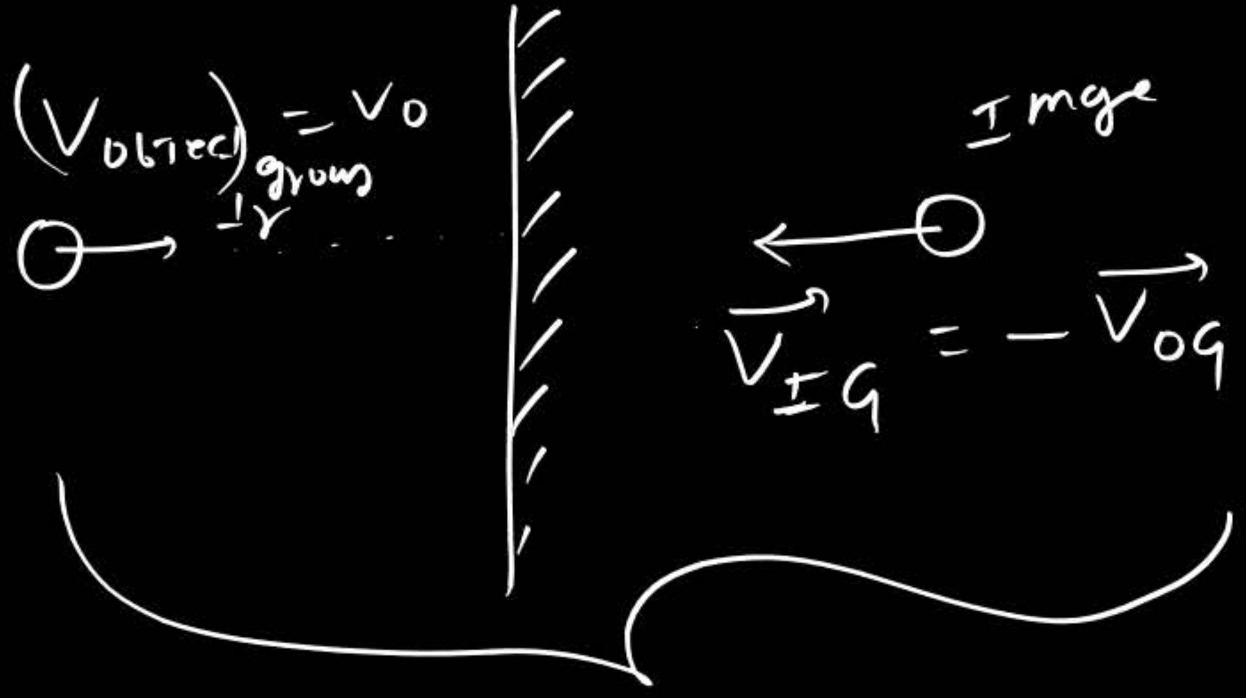
Object is moving Parallel to Plane mirror



$\vec{u}_{IG} = \vec{V}_{OG}$

$\vec{u}_{I\,object} = 0$

↑ velocity of Image w.r.t. Object



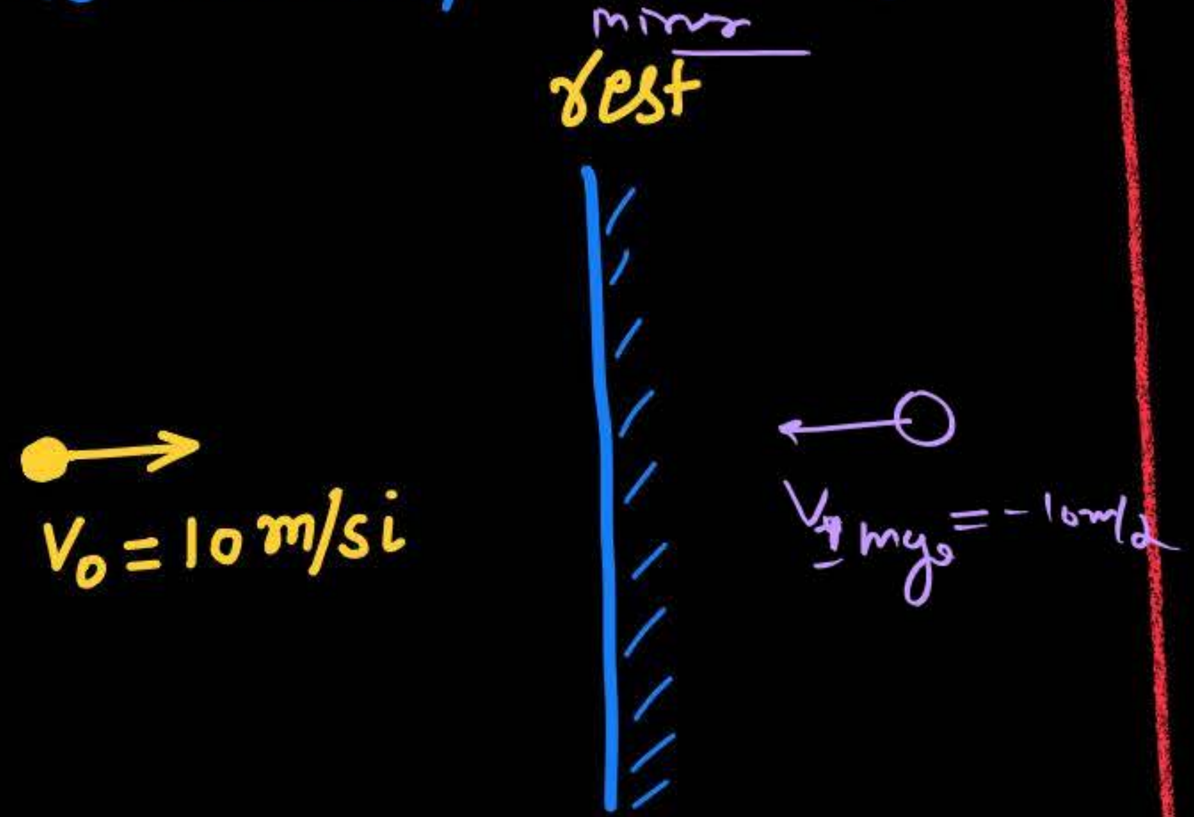
$\vec{u}_{IG} = -\vec{V}_{OG}$

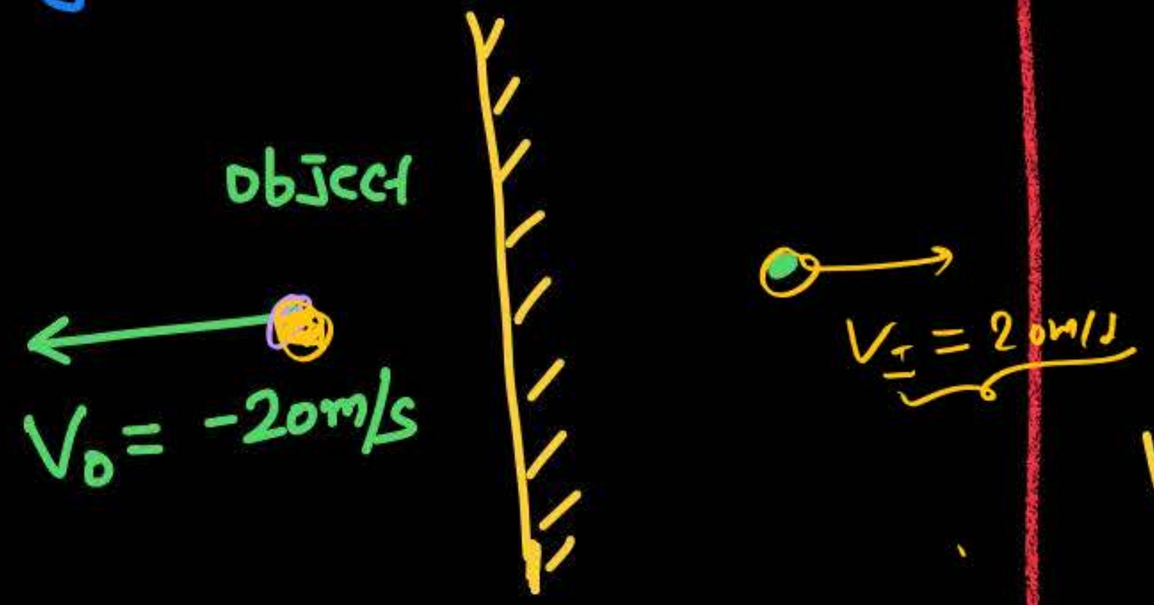
velocity of Image w.r.t ground

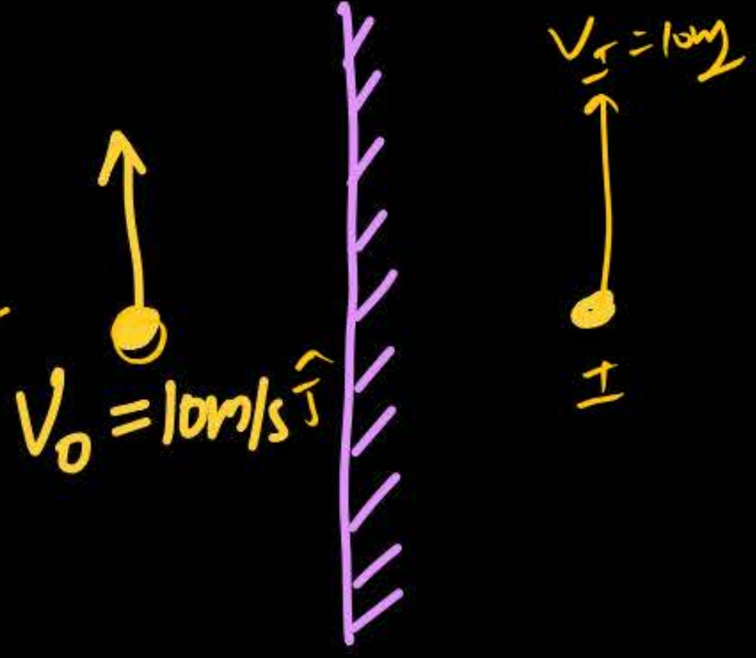
$\vec{u}_{IO} = \vec{u}_I - \vec{u}_o = -\vec{u}_o - \vec{u}_o$

$= -2\vec{u}_o$

find velocity of Image w.r.t. ground and w.r.t. of object.







$\vec{V}_{IG} = -10 m/s\, i$ Ans

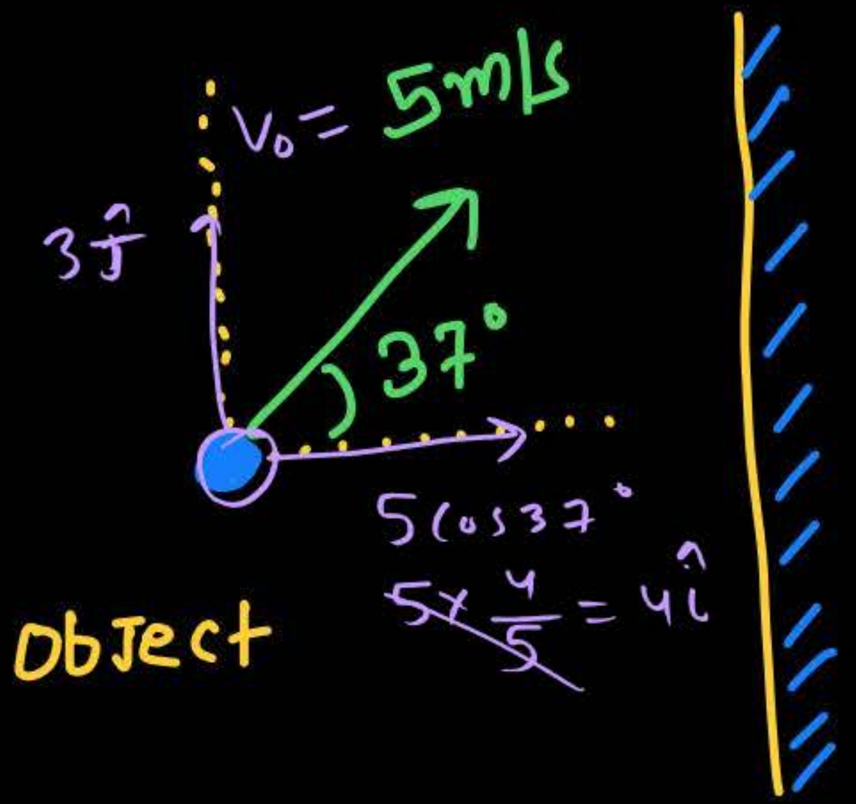
$\vec{V}_{IO} = \vec{V}_{IG} - \vec{V}_{OG} = -2 m/s\, i$

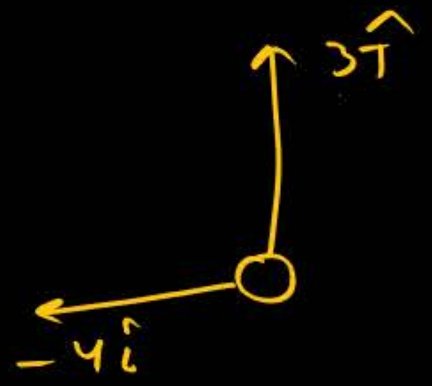
$\vec{V}_{IG} = 20 m/s\, \hat{i}$

$\vec{V}_{IO} = +40 m/s\, i$

$\vec{V}_{IG} = 10 m/s\, \hat{j}$

$\vec{V}_{IO} = 0$



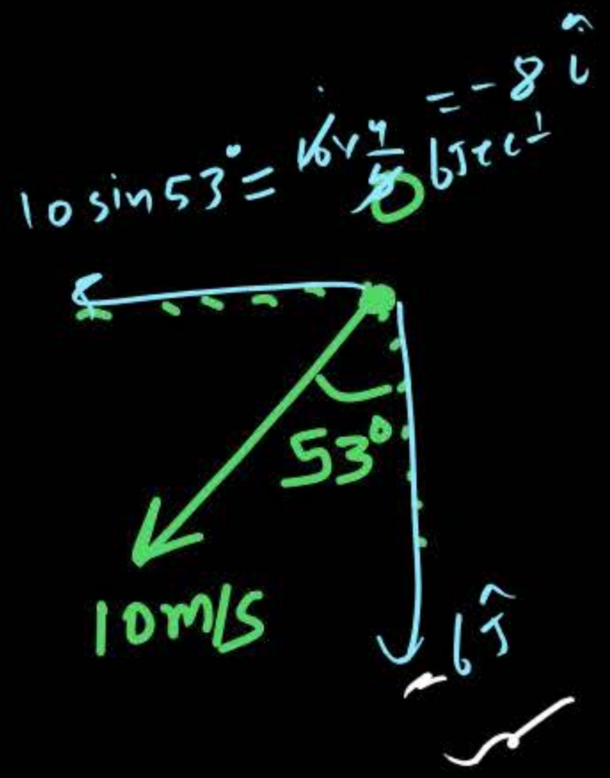


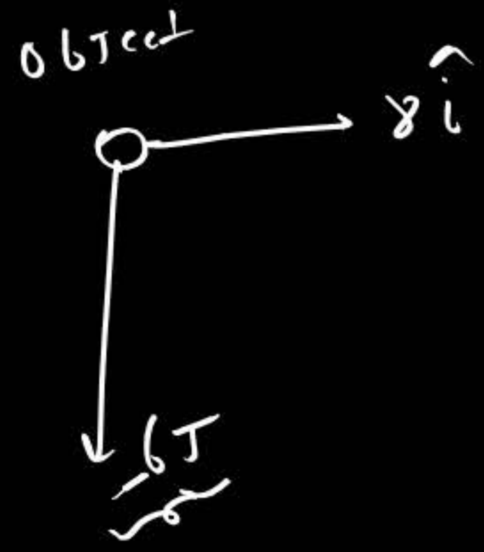
$\vec{V}_{IG} = ?? = -4\hat{i} + 3\hat{j}$

$\vec{V}_{IO} = ?? = u_I - u_o = -4i + 3\hat{j} - 4i - 3\hat{j}$

$= -8\hat{i}$

velocity of Image w.r.t. gr

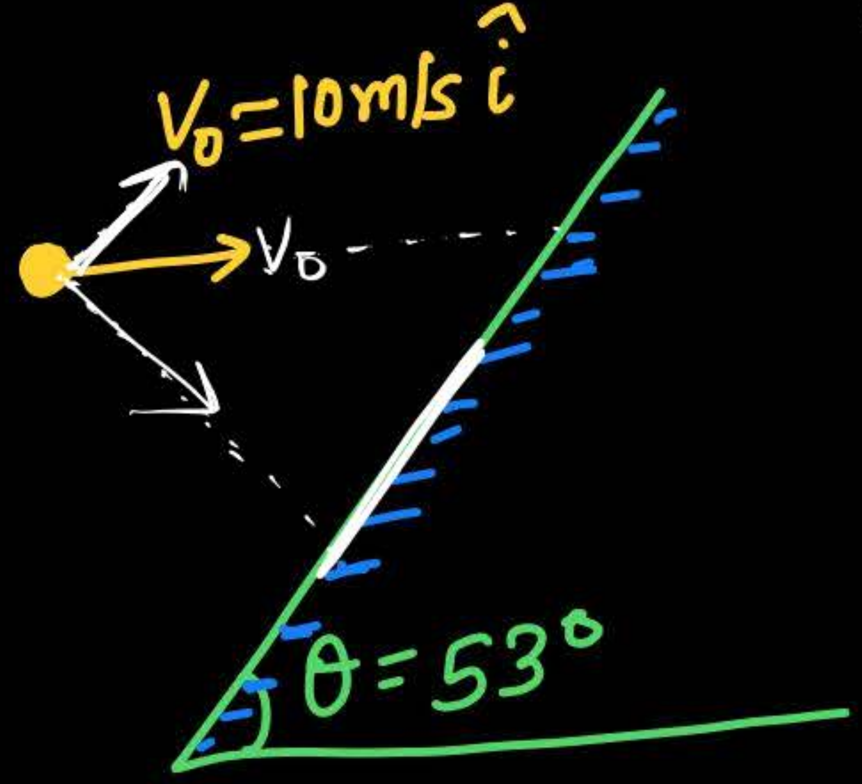




$u_I = 8i - 6\hat{j}$

$\vec{u}_{IO} = 16\hat{i}$

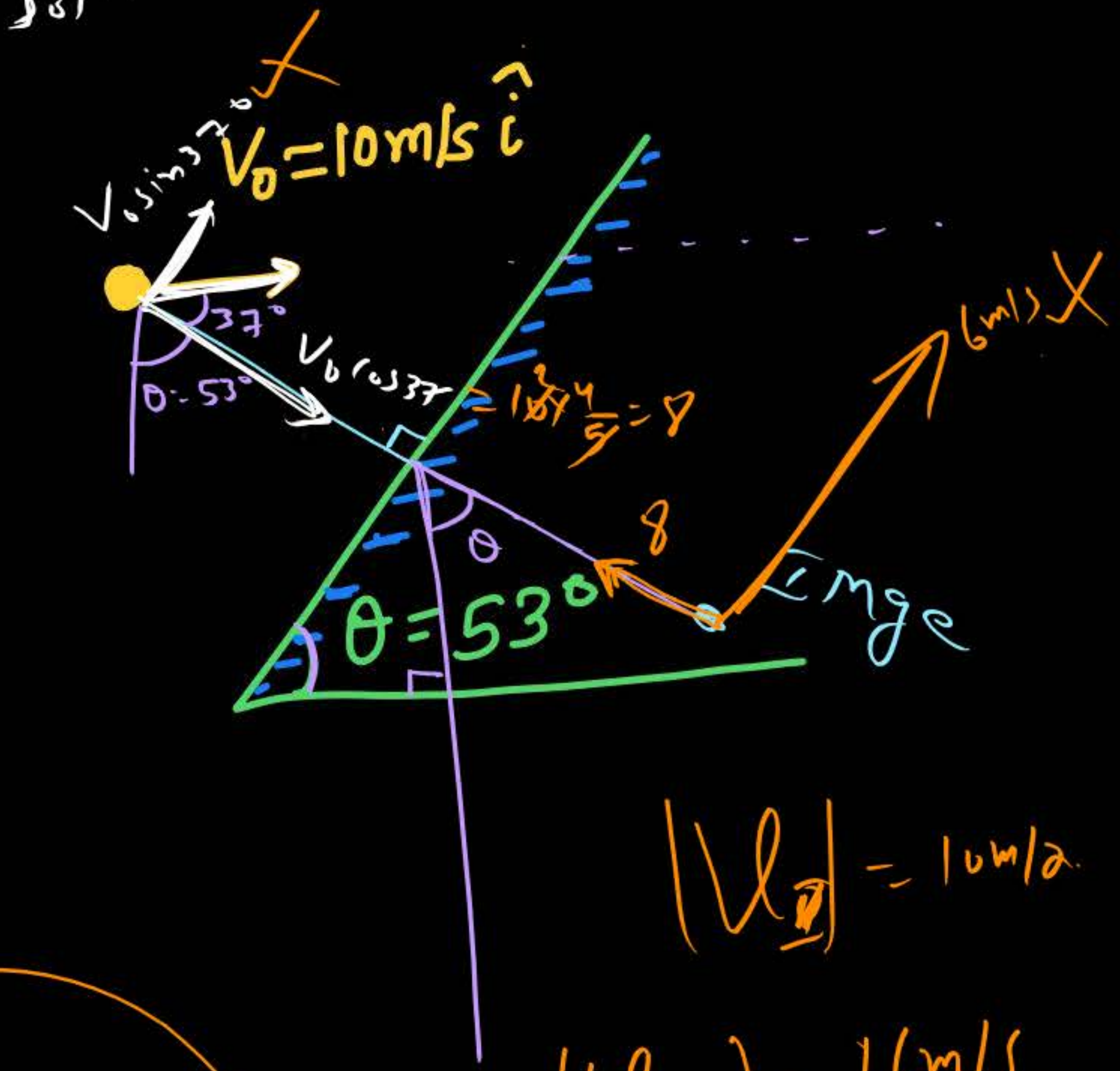
Question



find velocity of Image ??

w.r.t ground & w.r.t. object.

Sol^n

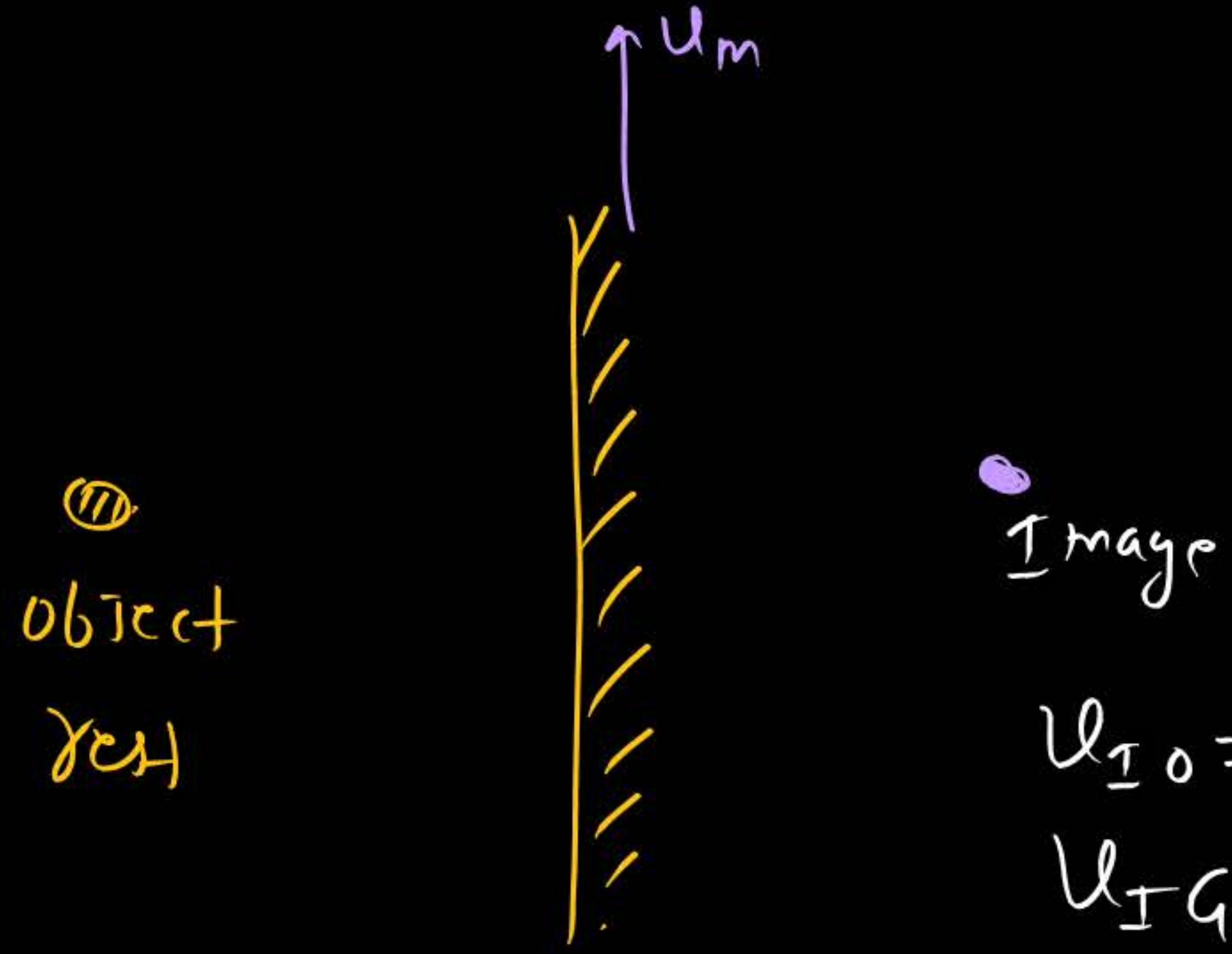


$|U_I| = 10 m/s$

$|U_{I-O}| = 16 m/s$

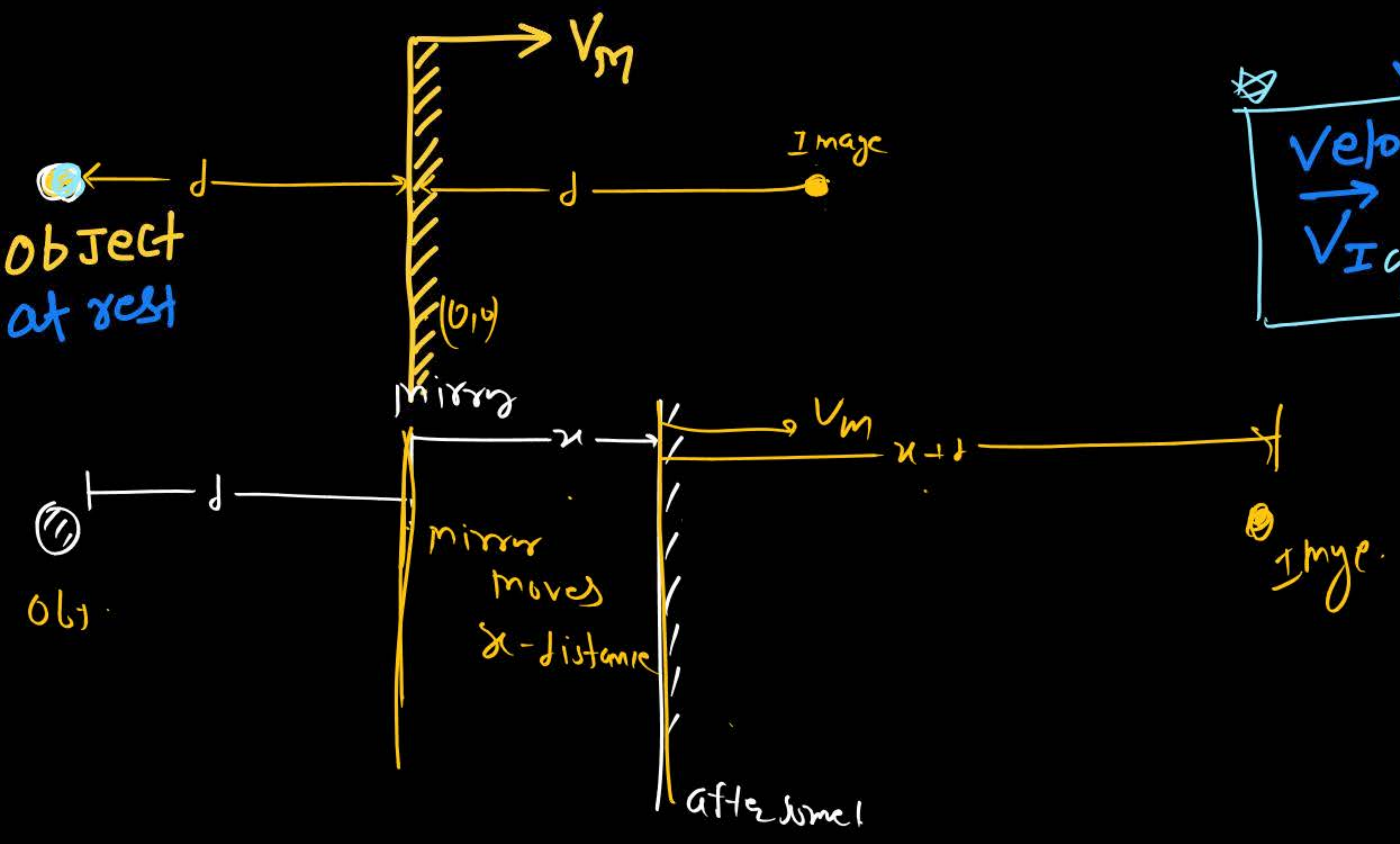
Not for NEET

Mirror is moving along its length



$$v_{IO} = 0$$
$$v_{IG} = 0$$

(Mirror is Moving) ⊥r to lens and object is at rest



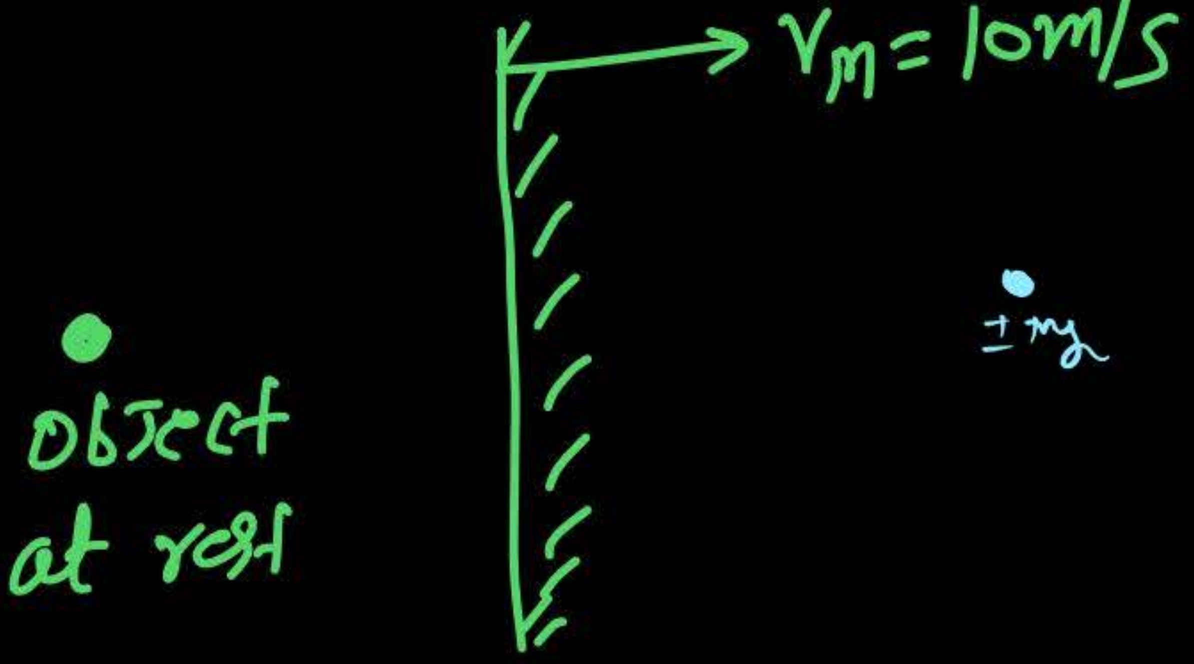
Velocity of Image

$$\vec{V}_{Ig} = 2 \times \vec{V}_m = \vec{u} \pm 0$$

$x_i = d$

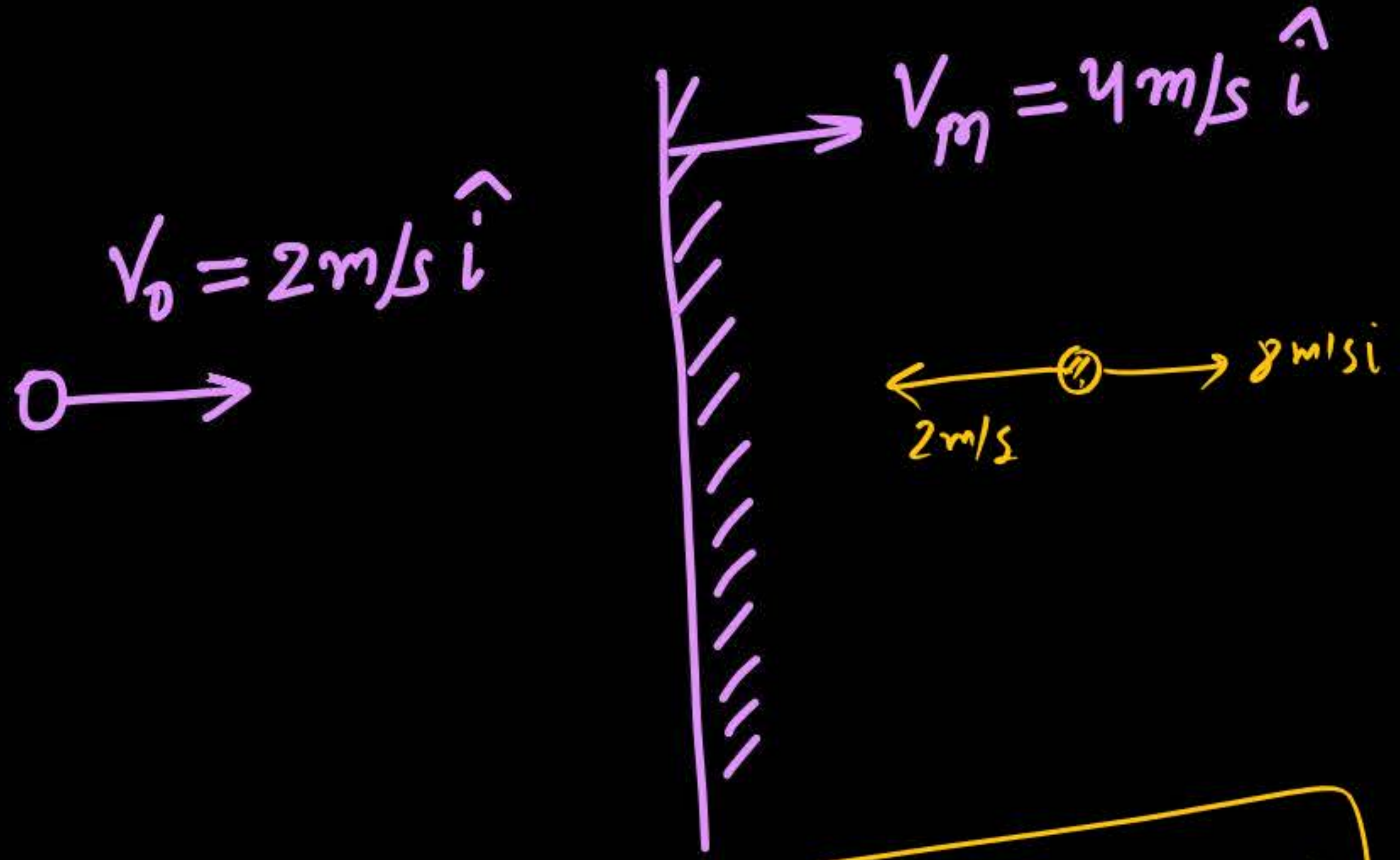
$x_f = 2x + d$

$\Delta x = 2x$ of Img



$\vec{V}_{IG} = 20\,m/s\,\hat{i}$

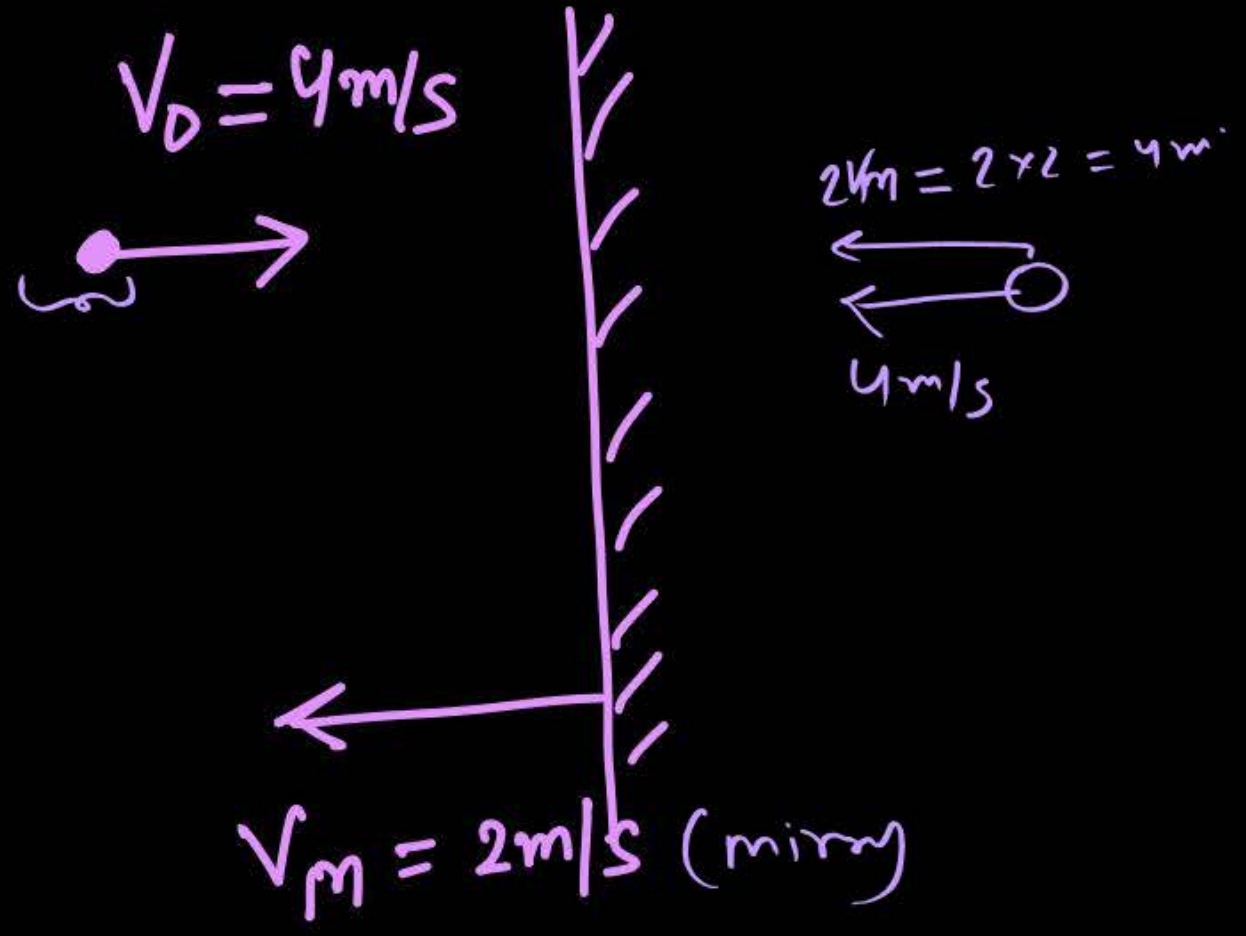
$\vec{V}_{IO} = 20\,m/s\,i$ Ans



$\vec{u}_{I\,ground} = (8-2) = 6\,m/s\,\hat{i}$

$\vec{u}_{IO} = 6 - 2$

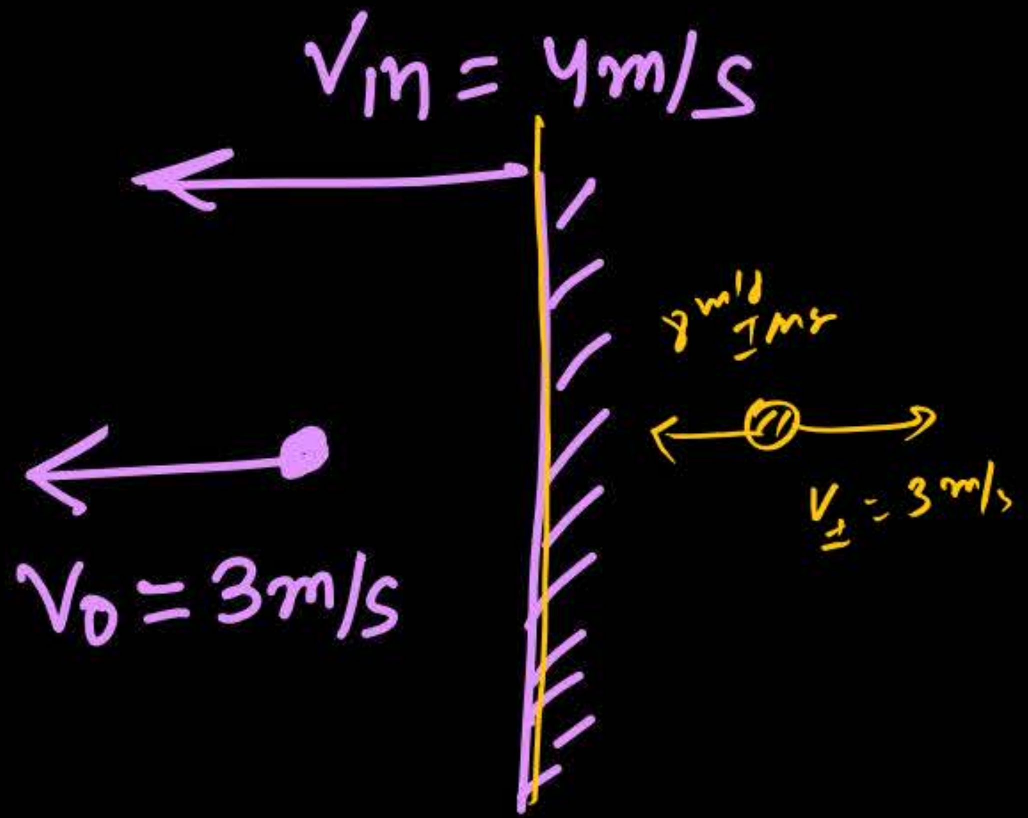
$= 4\,m/s$ Ans



$u_{Img} = -8 \, m/s \, \hat{i}$

$u_{I\,object} = -8 - 4$

$= -12 \, m/s$

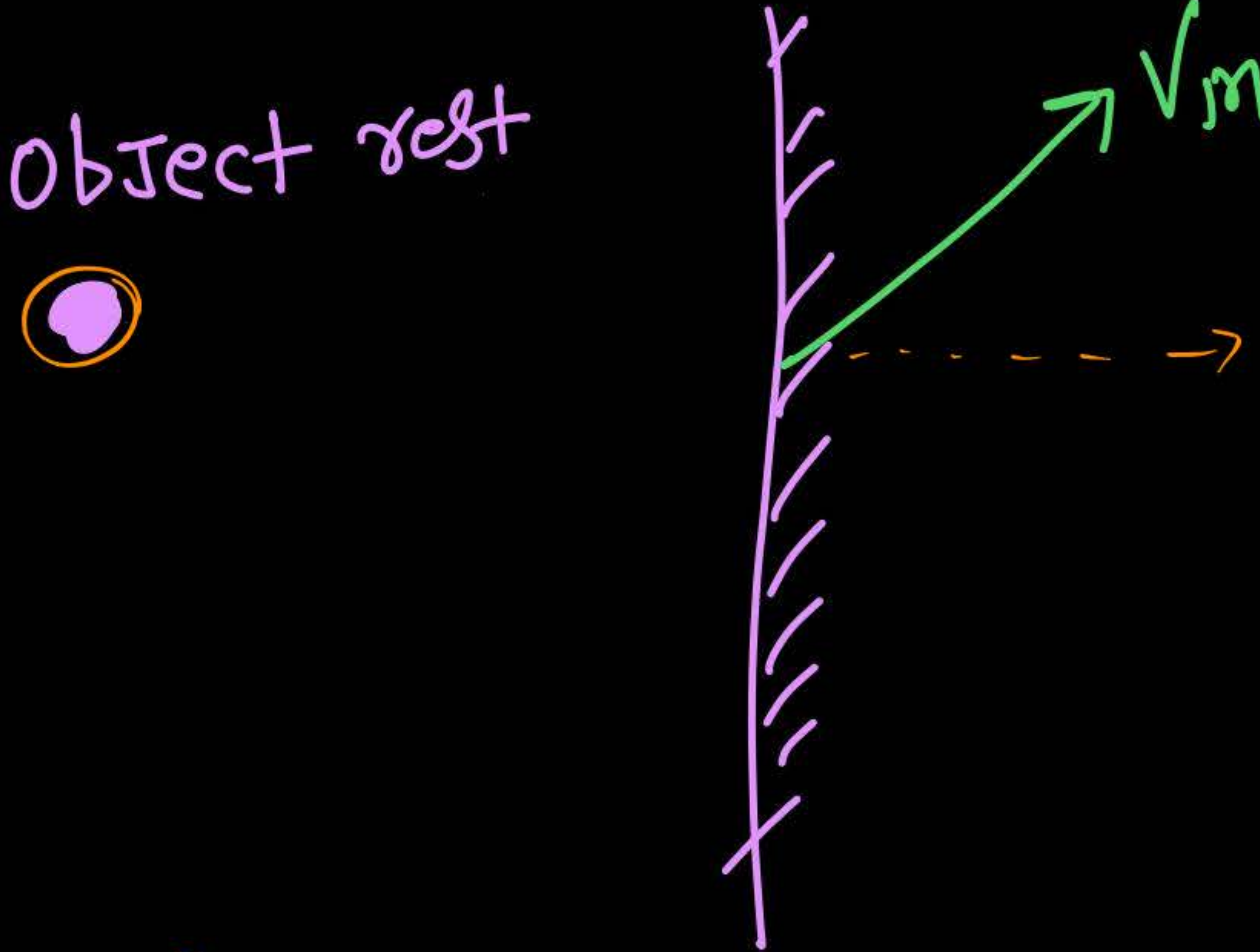


$u_{Img} = -8 + 3$

$= -5 \, m/s \, \hat{i}$

$u_{I\,obj} = -5 + 3$

$= -2 \, m/s$



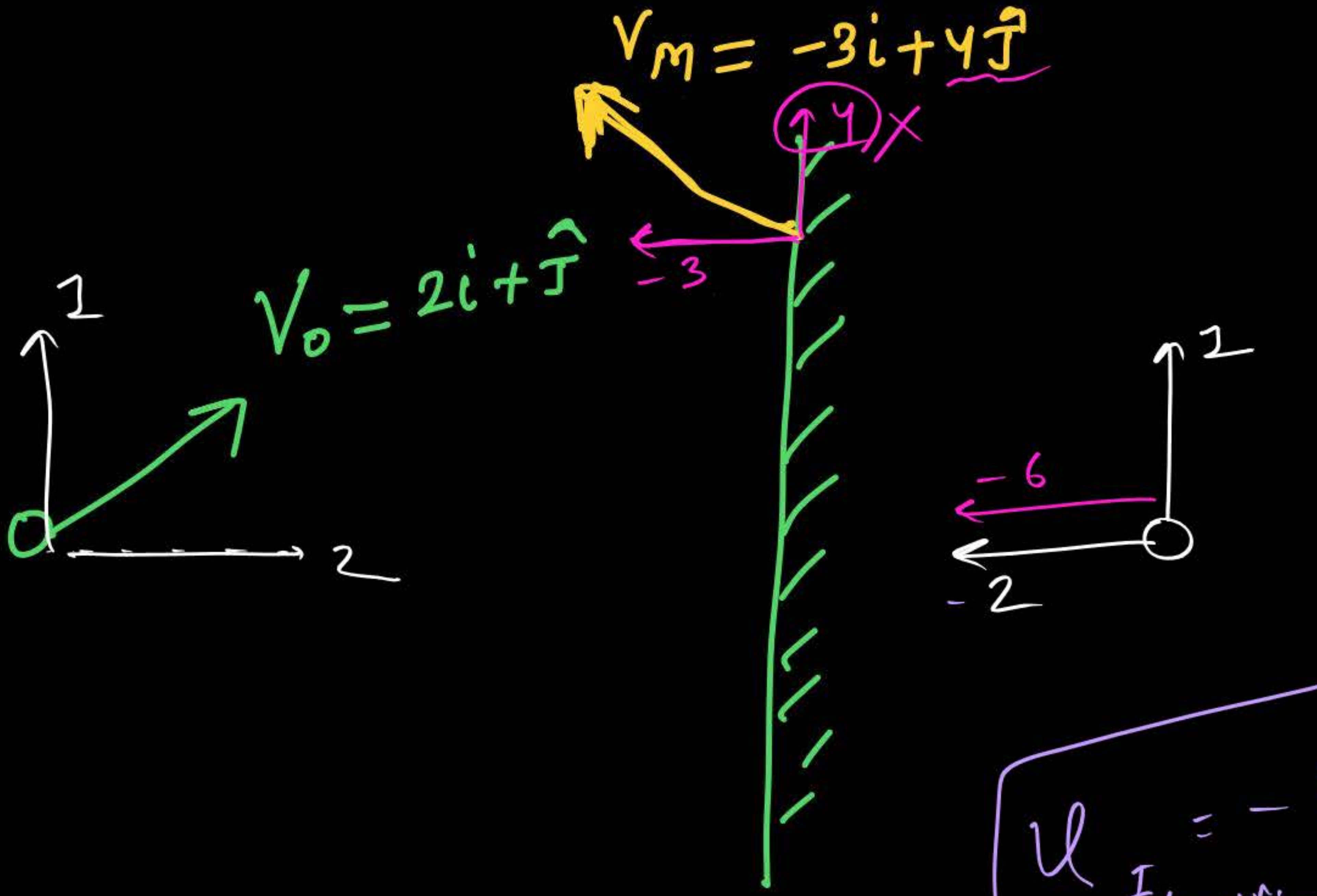
$V_m = 3\hat{i} + 4\hat{j}$

find velocity of Image.

Sol^n $u_I = 2u_m + 0$

$= 6\hat{i}$ Ans

find velocity of Image.



$u_{I_{your}} = -8\hat{i} + 1\hat{j}$

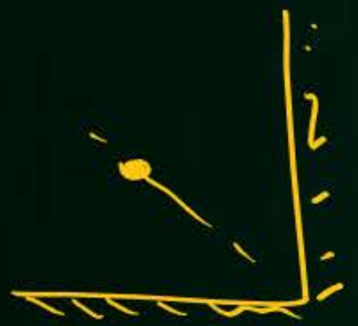
H/W

Level up

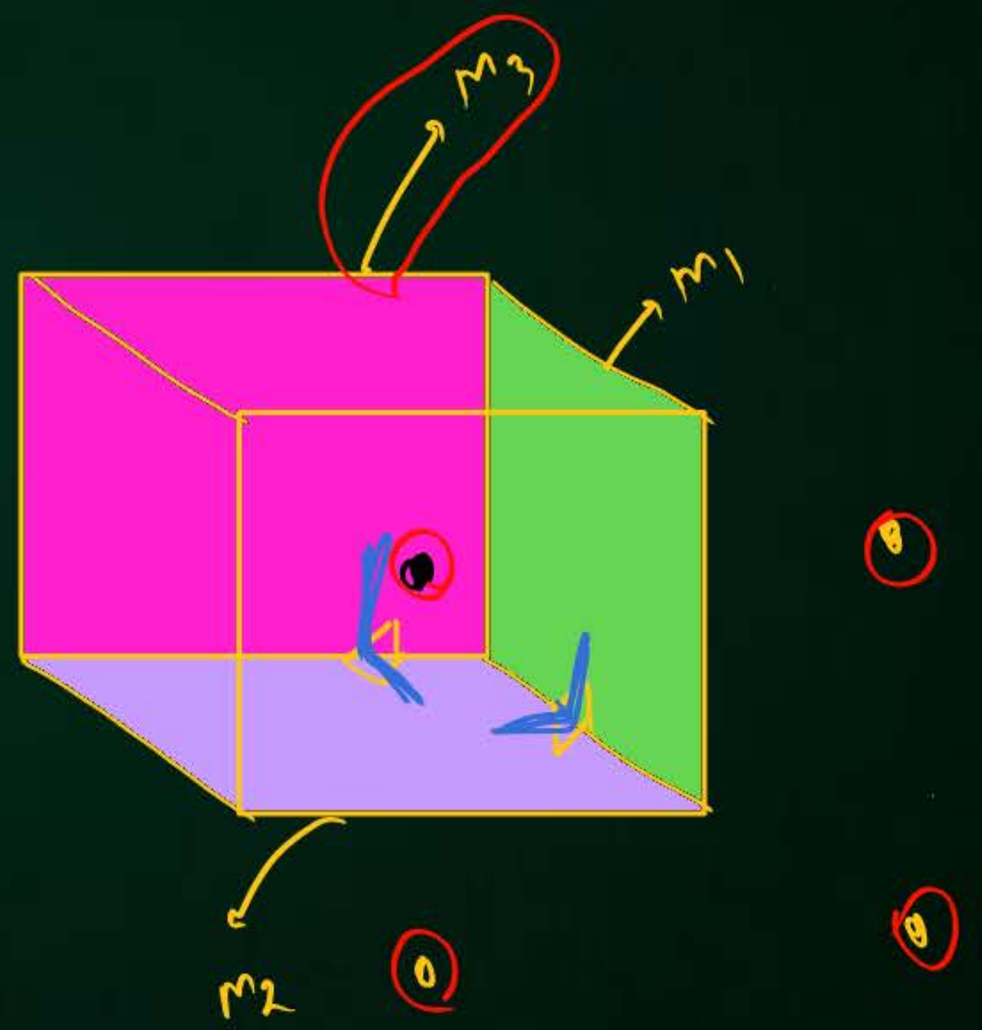
QUESTION

Object is placed in front of 3 plane mirror which are perpendicular to each other, then find no. of image formed ?

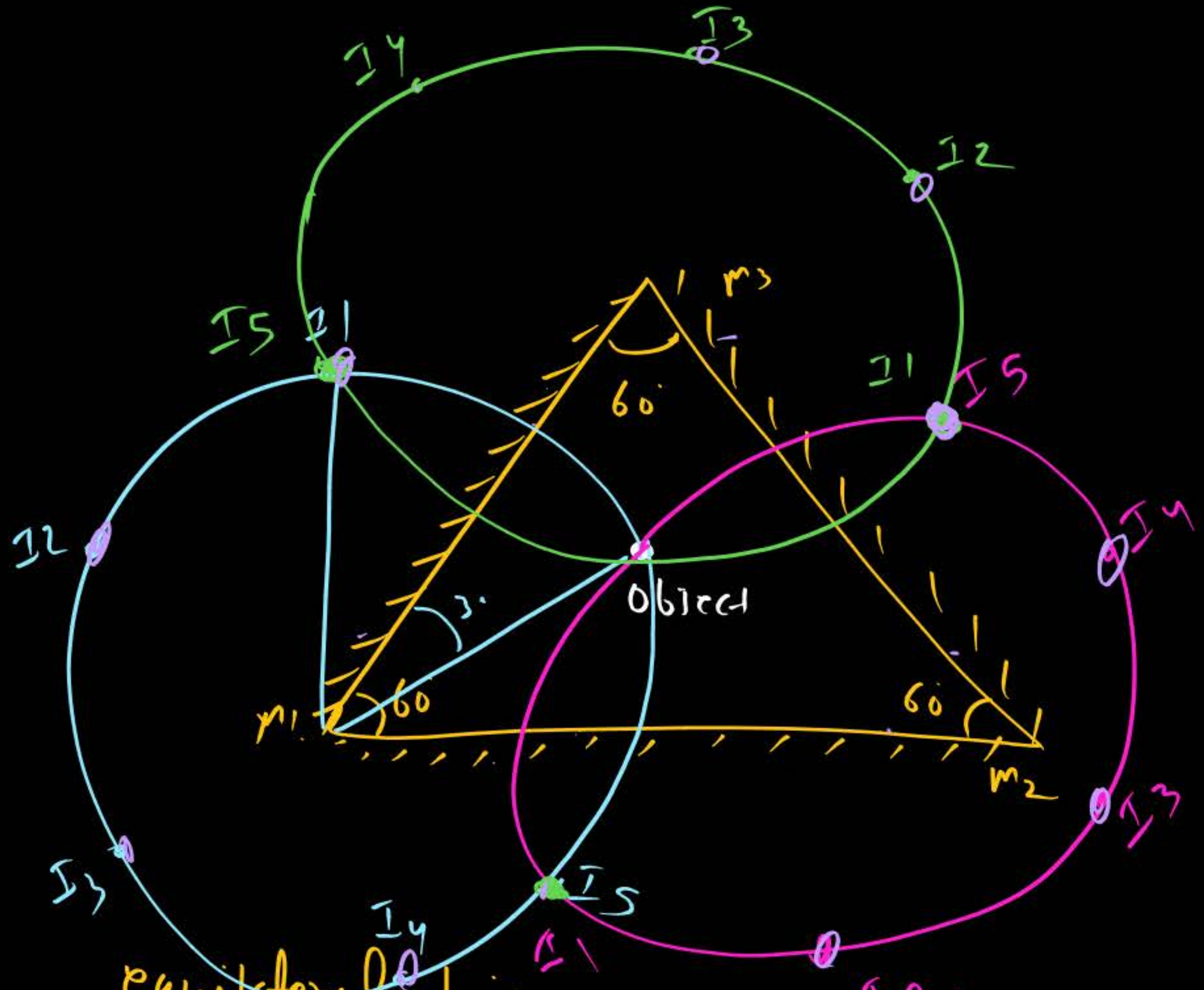
for Two $\perp_r$ Plane mirror



$n = 3$ Image



7 Image will form



equilateral triangle formed by three identical plane mirror

due to two plane mirror at 60°
→ n = 5

→ Total 12 Image will form

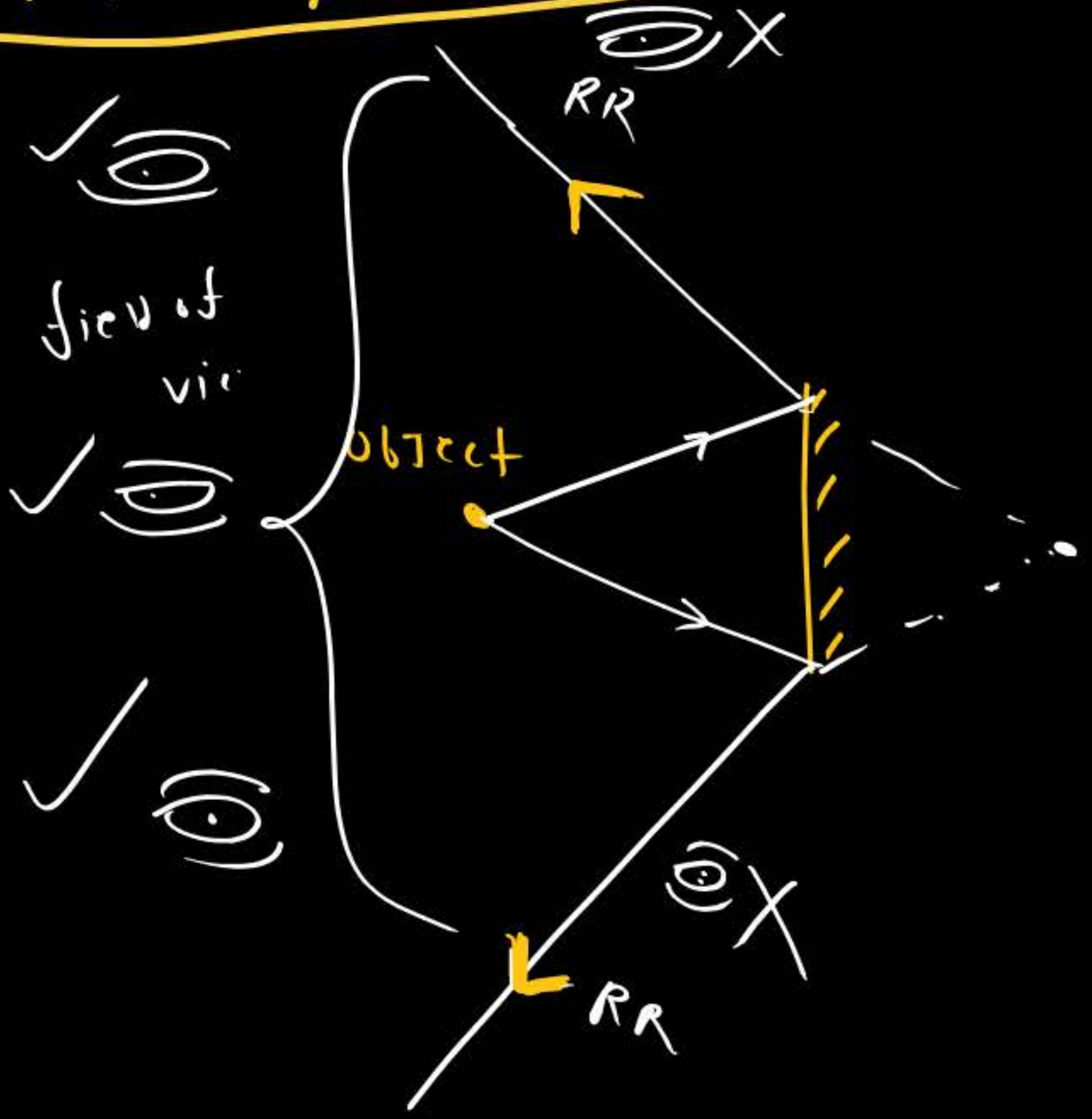
~~Ans → 15 Img~~

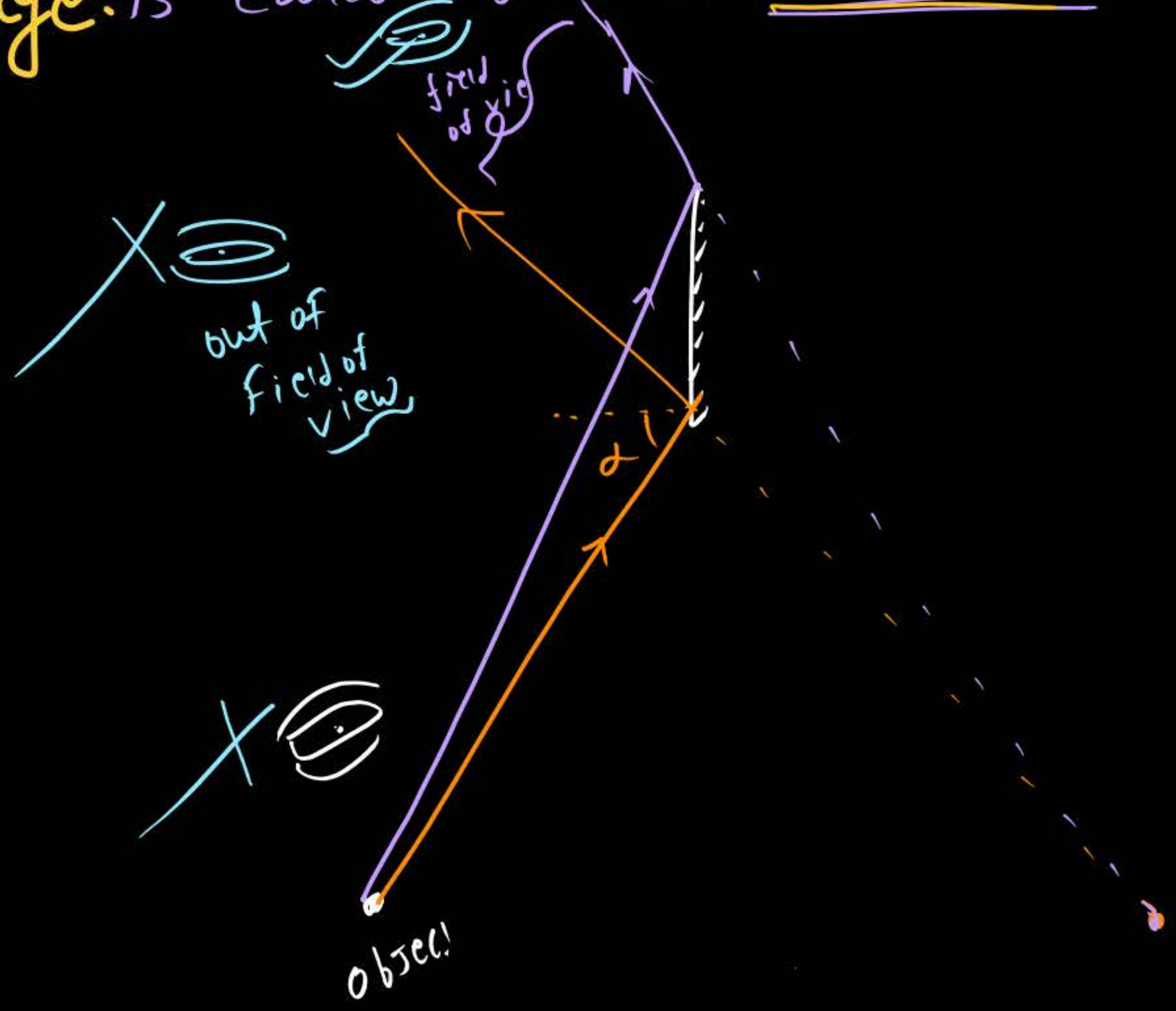
Ans → 12 Img

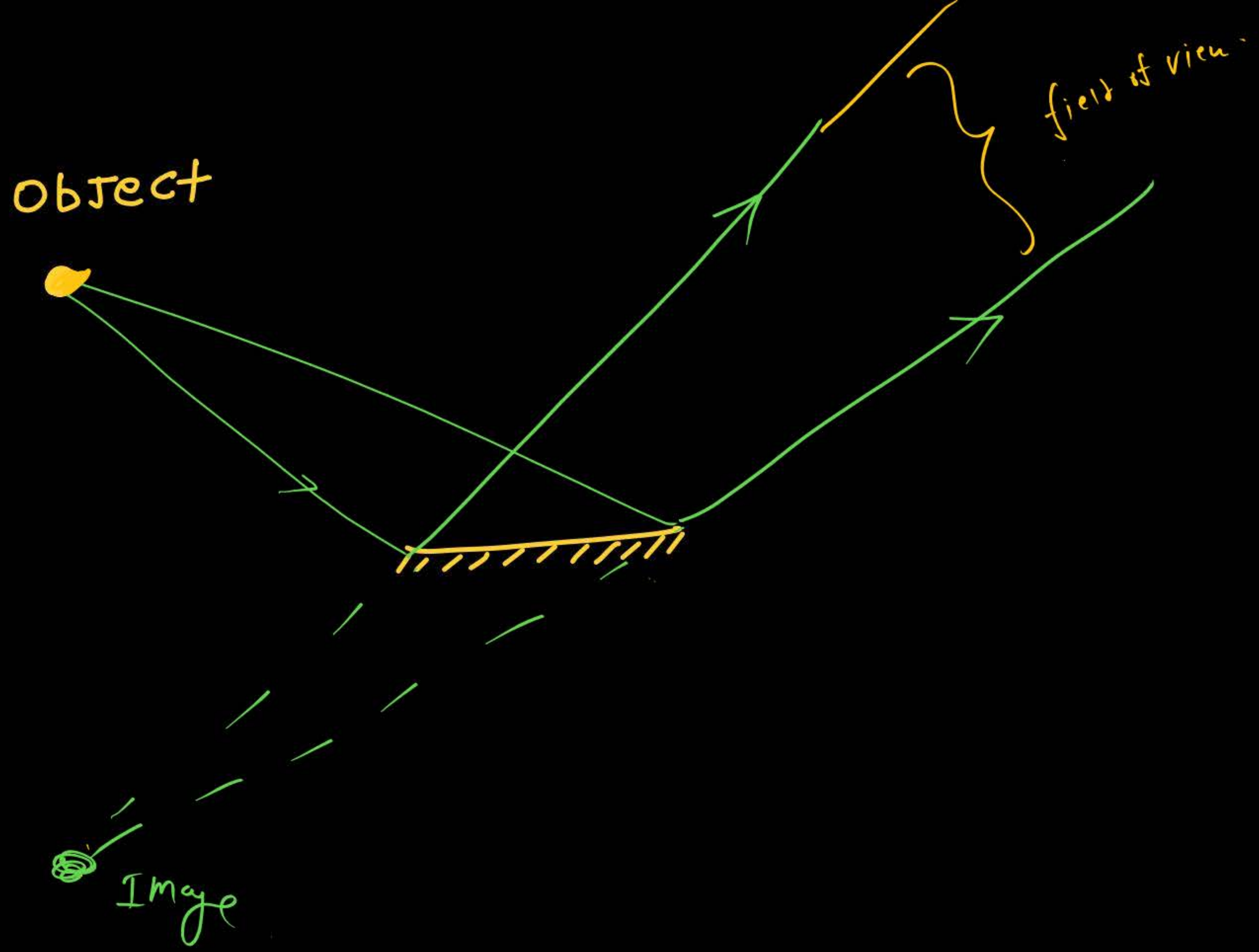
How ??

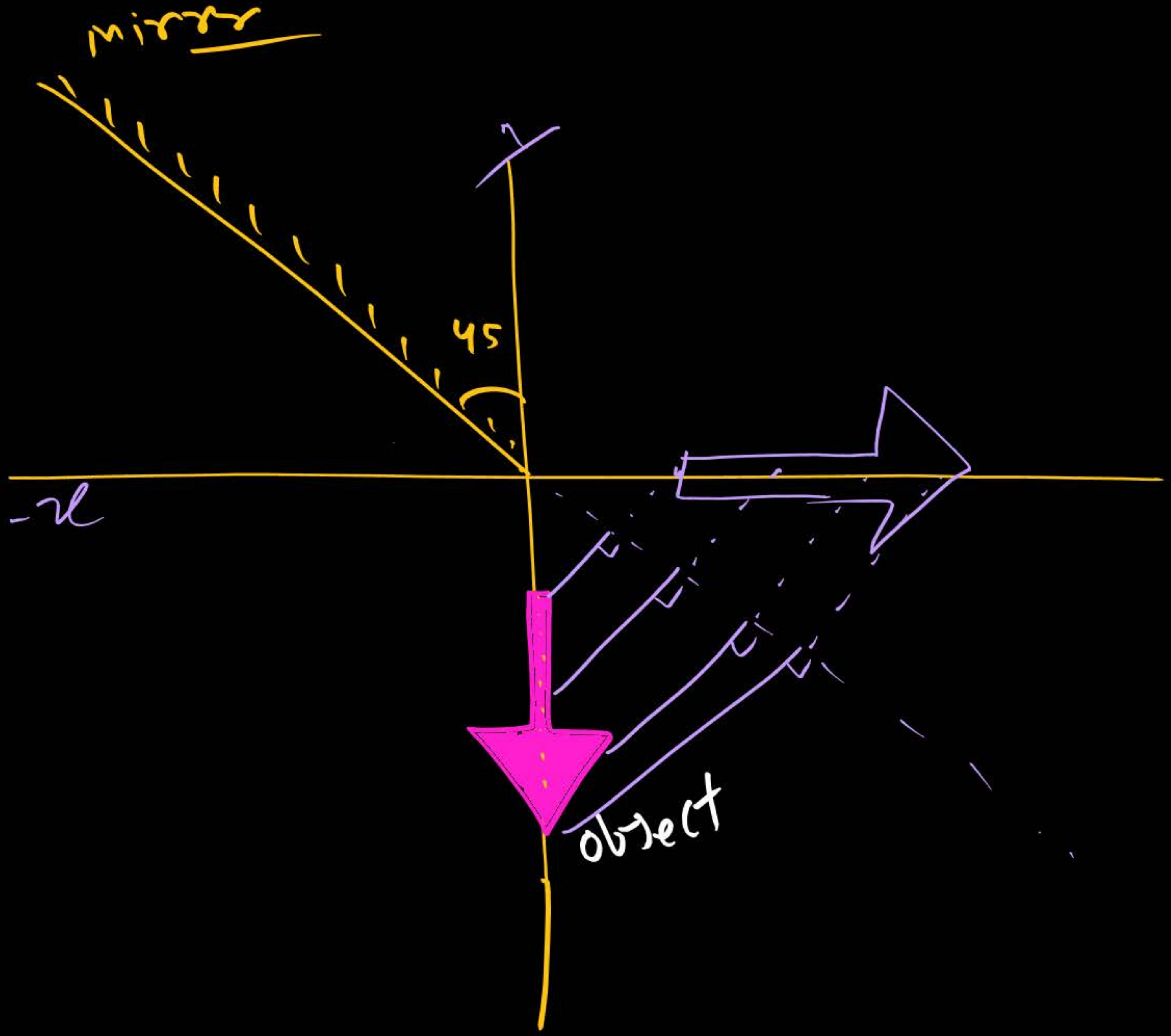
field of view → A region from where observer can see Image. is called field of view.

for Point object

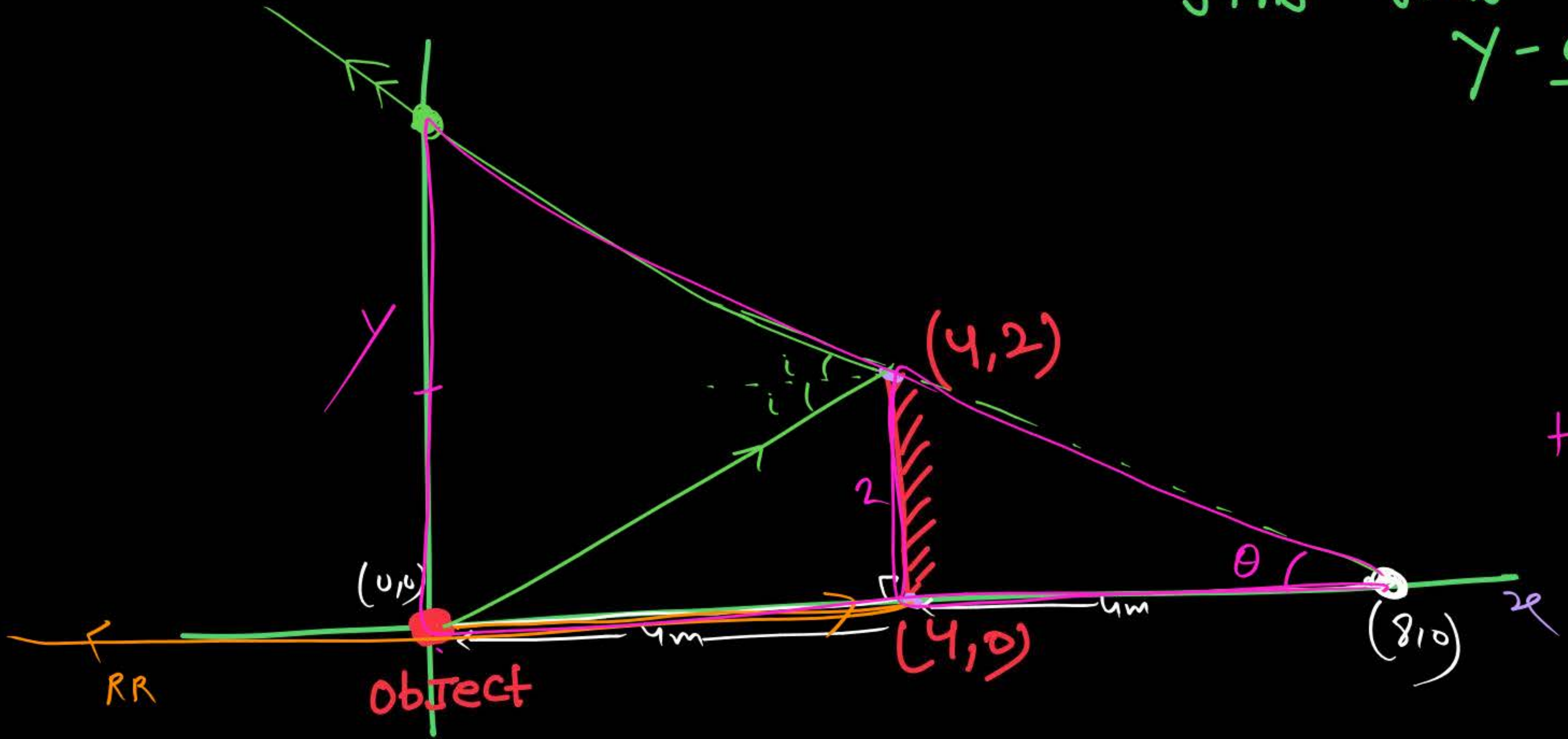





Object
field of view
Image


mirror
y
45
-x
object

find field of view on Y-axis.



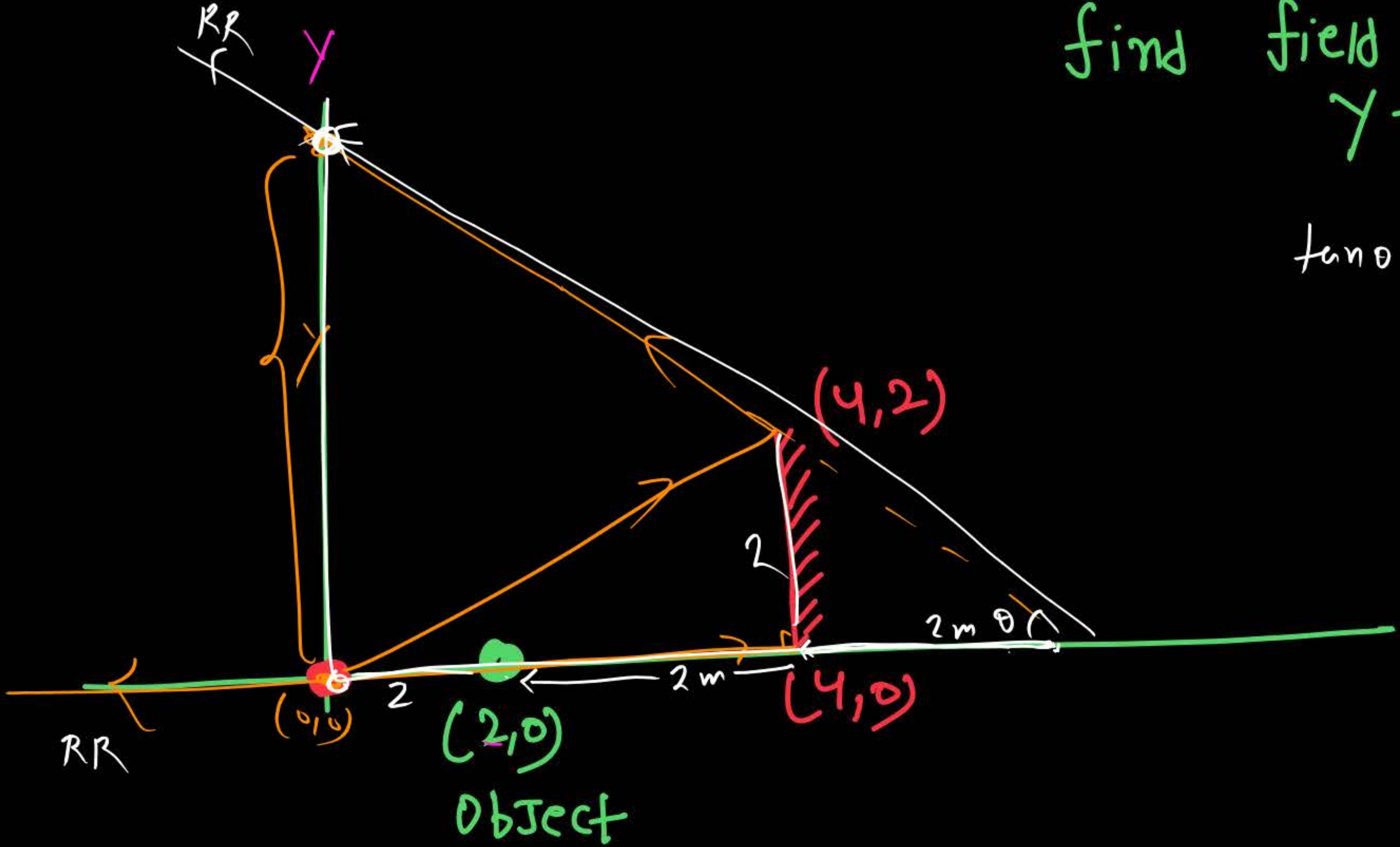
length of field of view on Y-axis??

$\tan\theta = \frac{2}{4} = \frac{Y}{8}$

$Y = 4m$

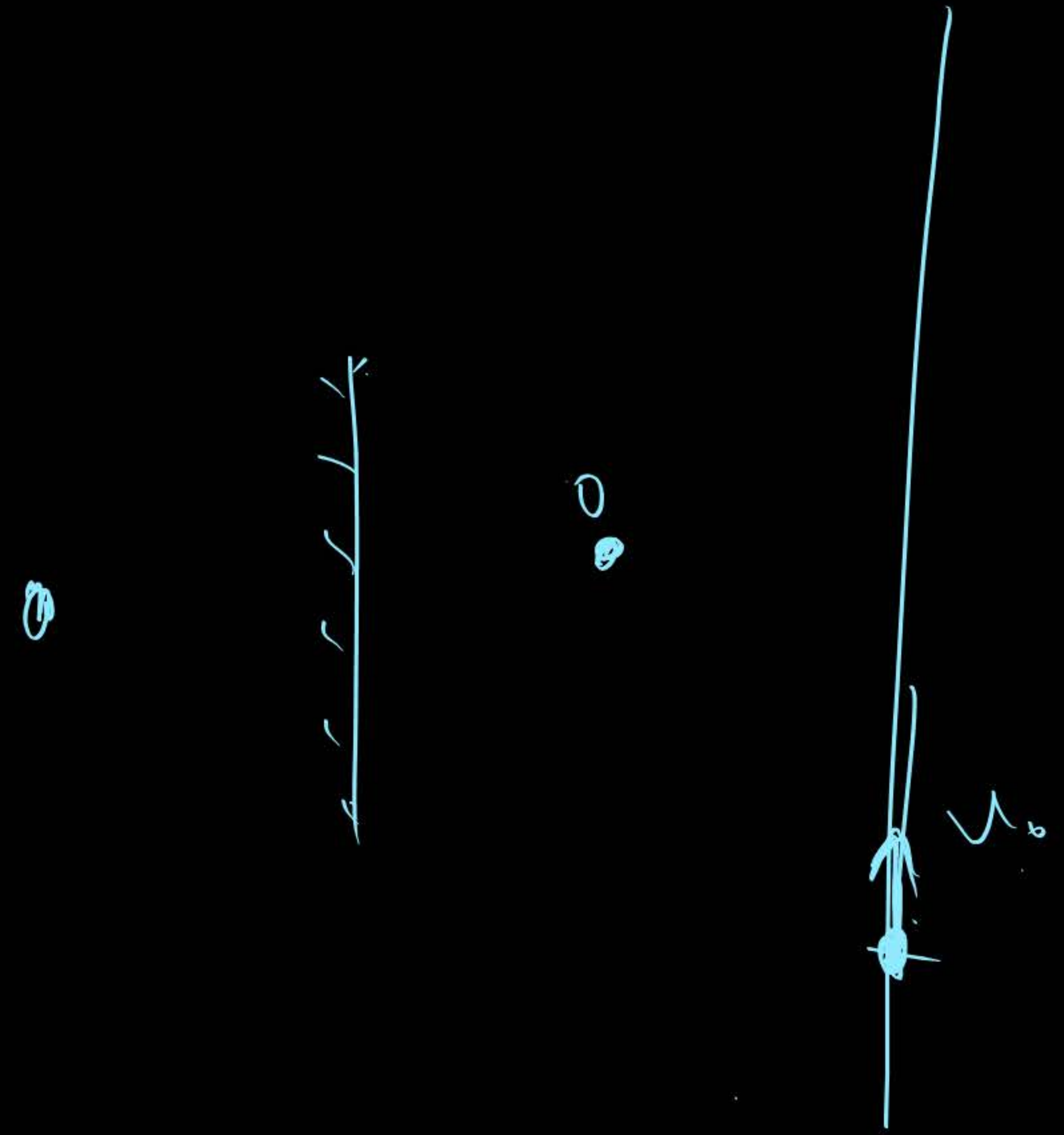
Ans → 4m

find field of view on Y-axis.

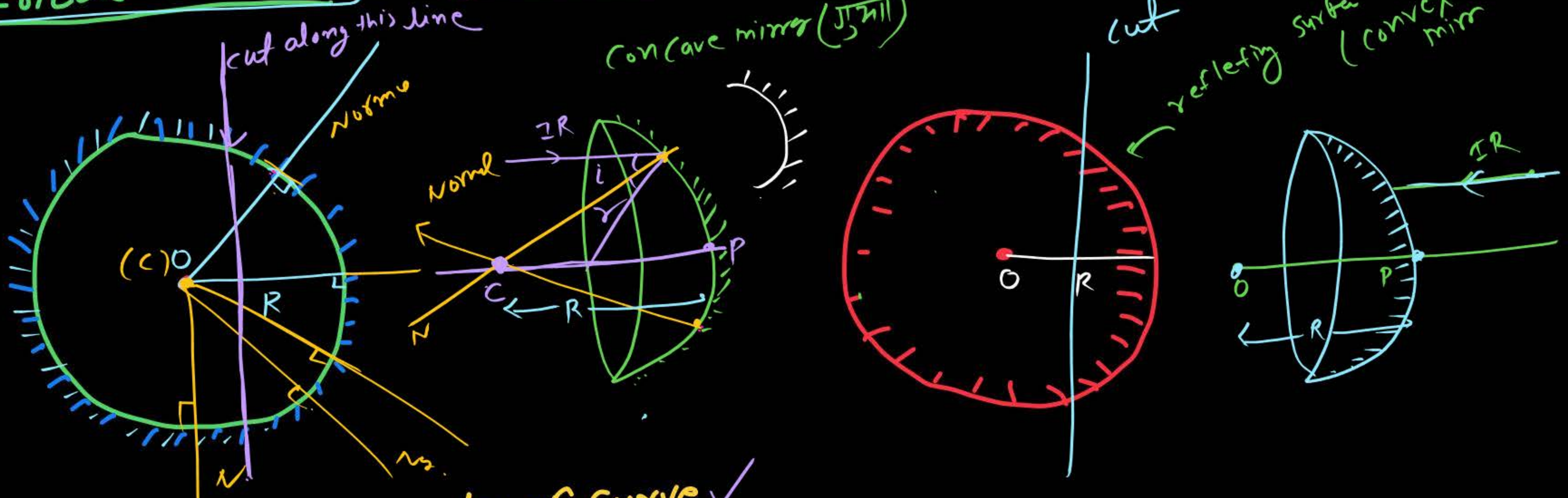


$\tan\theta = \frac{2}{2} = \frac{y}{6}$

$Y = 6m$



Spherical mirror → [Curved mirror]



centre of sphere = centre of curve ✓

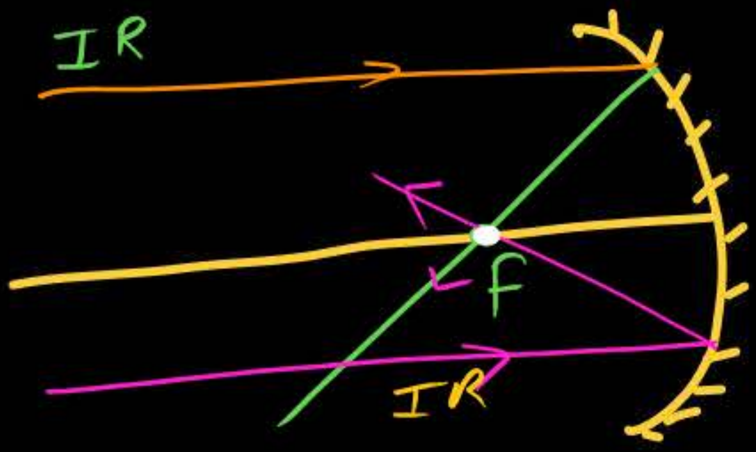
Pole = mid point of mirror

Principle axis = line b/w centre to pole

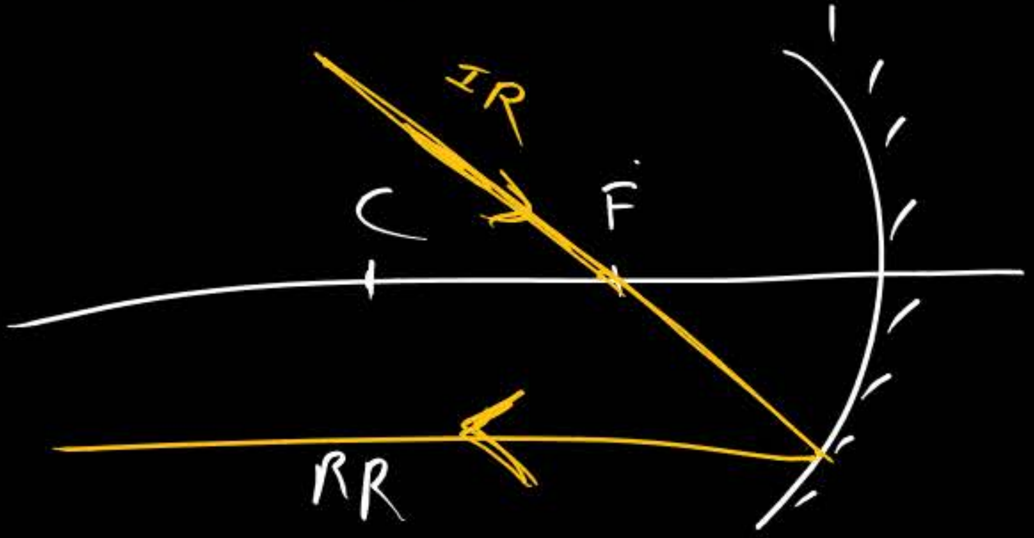
R = Radius of curvature

Four Ray diagram is important for concave mirror

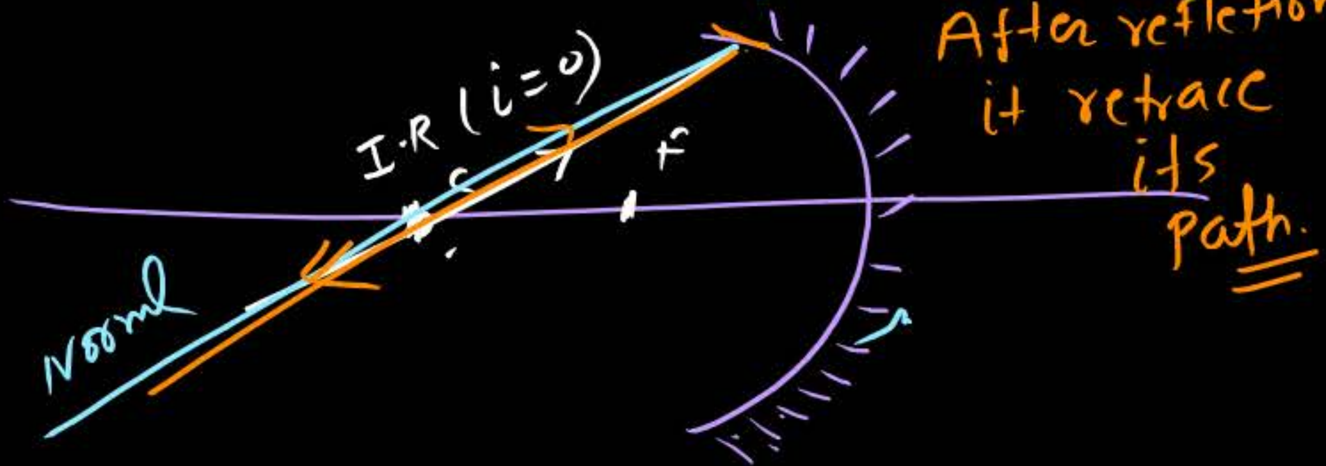
(A) Paraxial rays → $\parallel_r$ to Principle axis & very close to Pole.



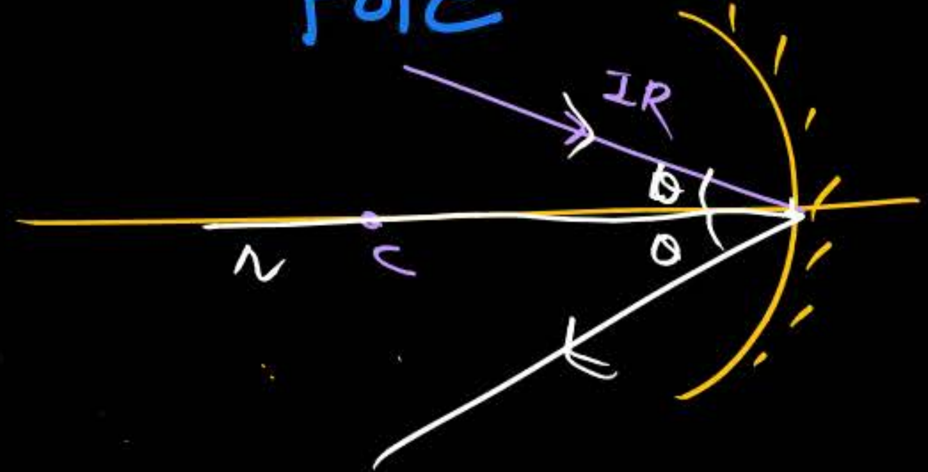
(A) Ray Passing through focus



(C) ~~Incident~~ Ray Passing through centre of Curvature

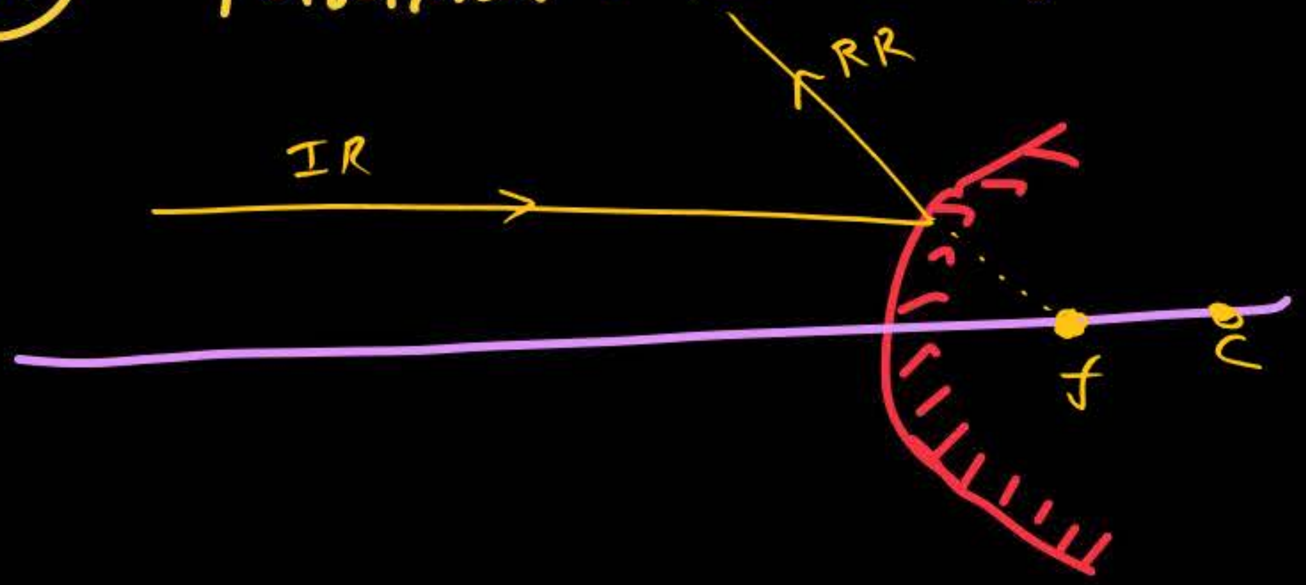


(D) Ray Incident on Pole

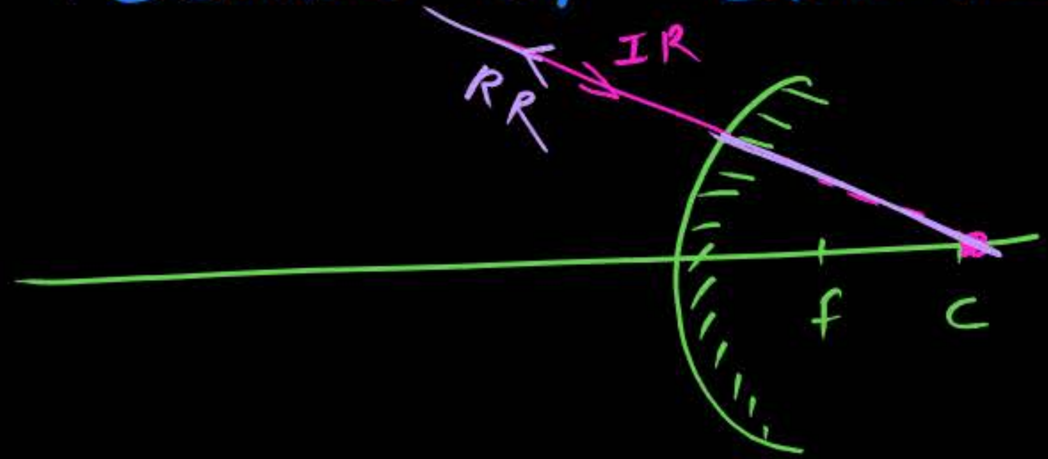


four Ray diagram is gmportant

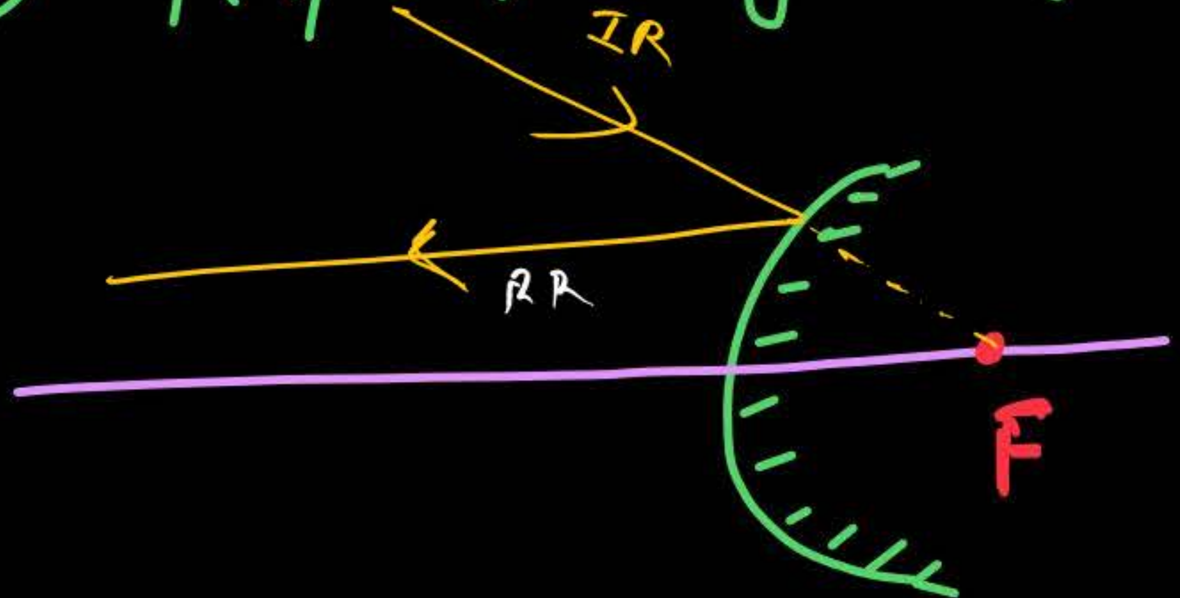
Ⓐ Paraxial rays → ||r to principle axis & very close to Pole.



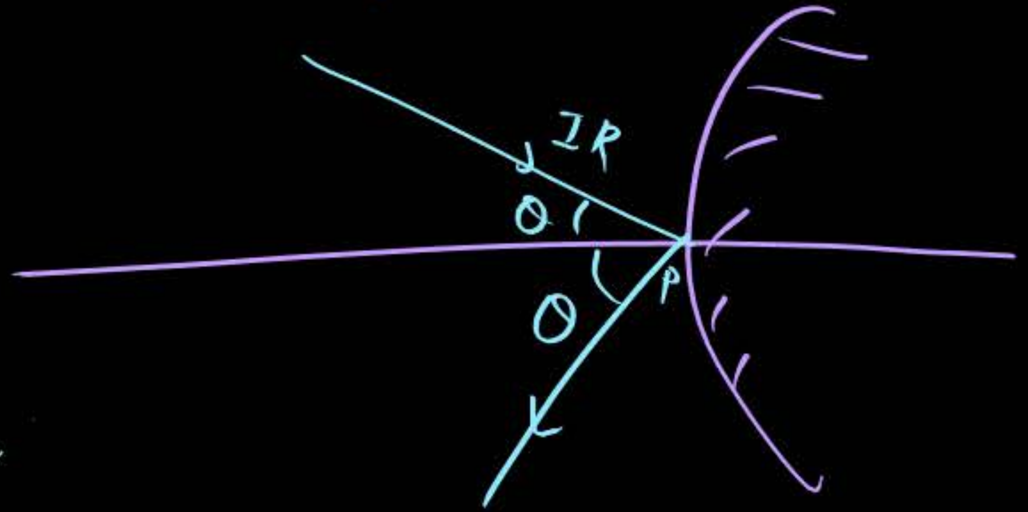
Ⓒ { Ray Passing through centre of curvature



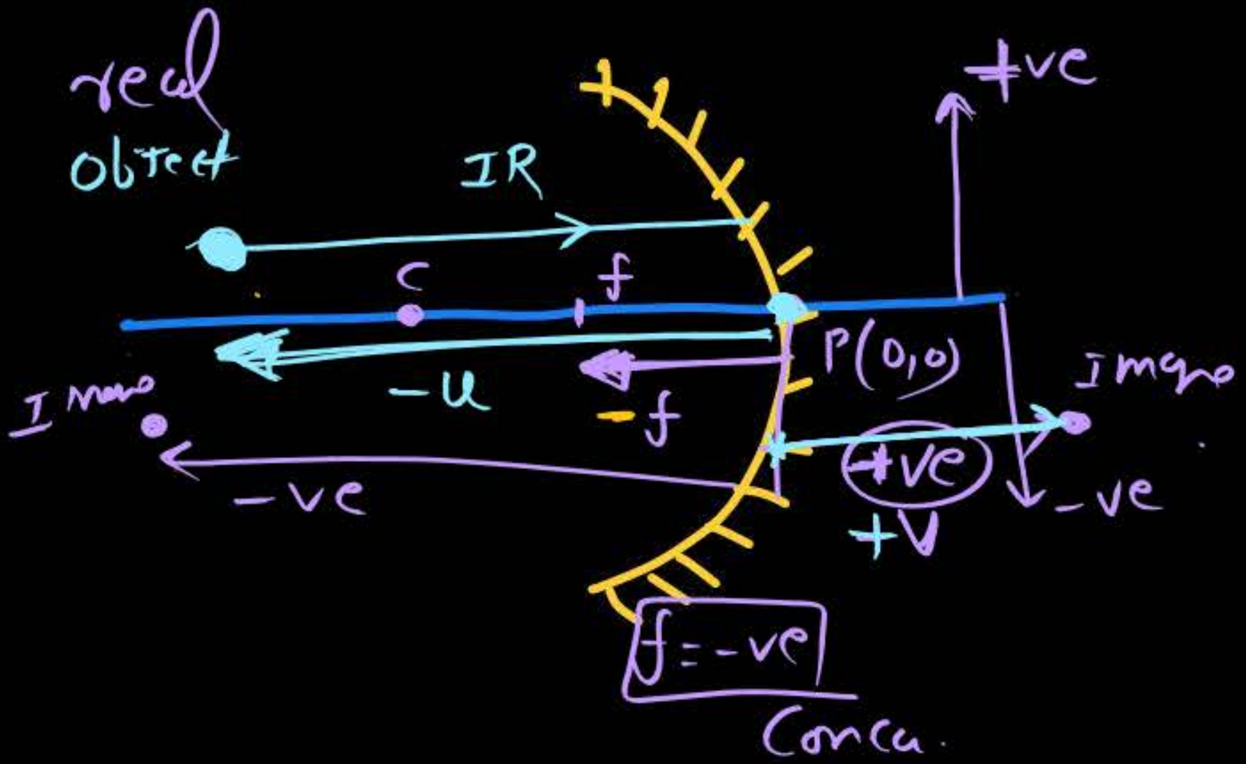
Ⓐ Ray Passing through focus

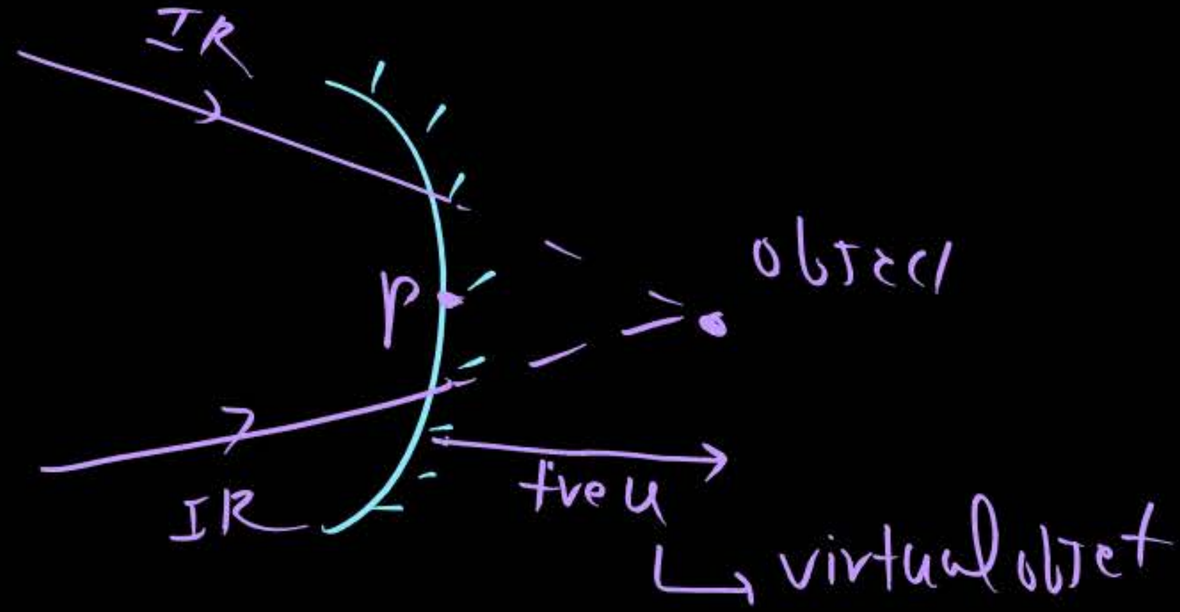


Ⓓ Ray Incident on Pole



Sign Convension





(1) All distance measured from Pole. ✓

(2) from Pole if we move Along I.R. distance taken as +ve ✓

(3) from Pole if we move opposite I.R. distance taken as -ve

(4) object distance always -ve for real object, for virtual it is +ve

(5) Concave mirror f = -ve ✓

(6) convex mirror f = +ve ✓

(7) Image dist^n -ve for real Imge, & +ve for virtual Imge

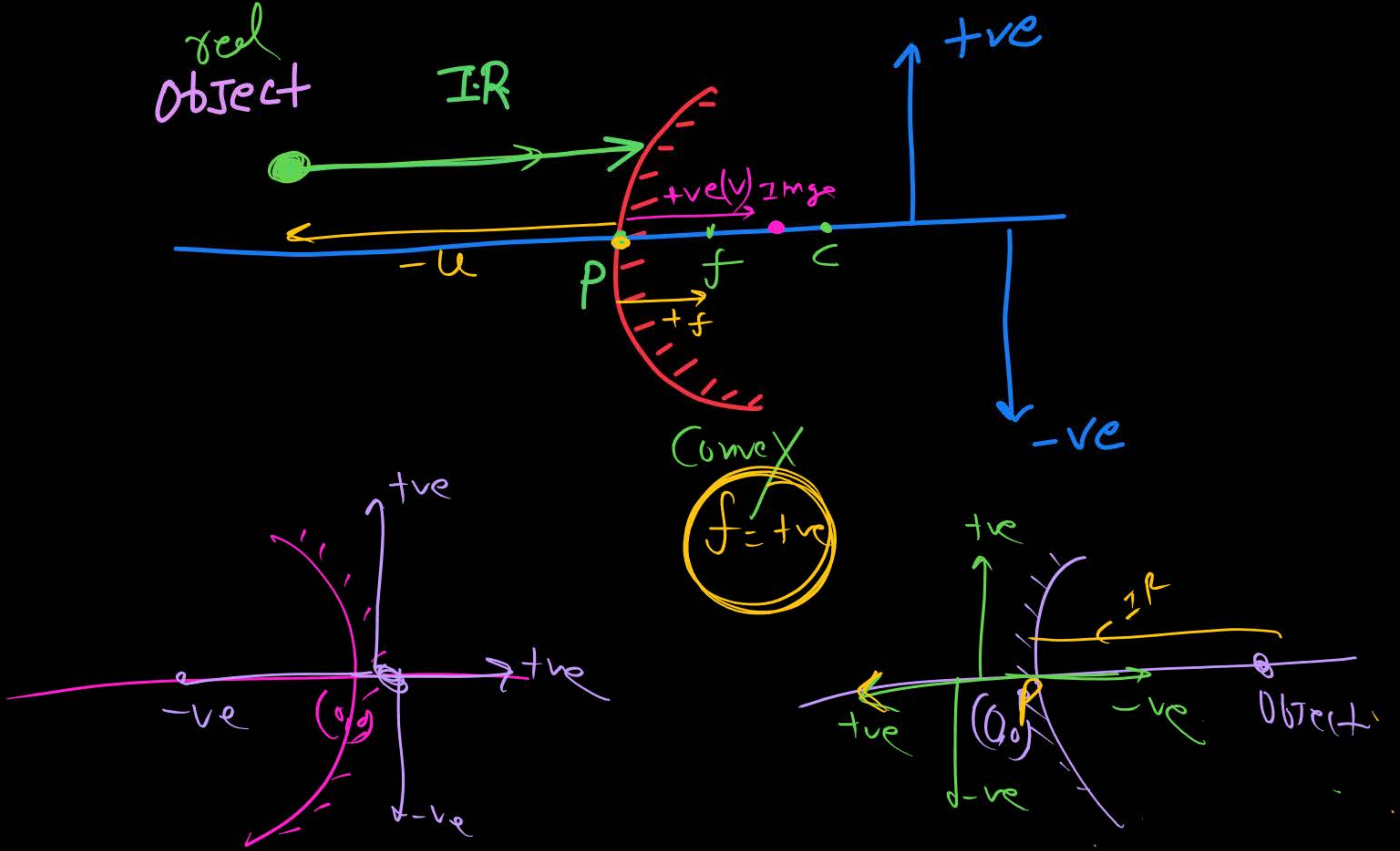
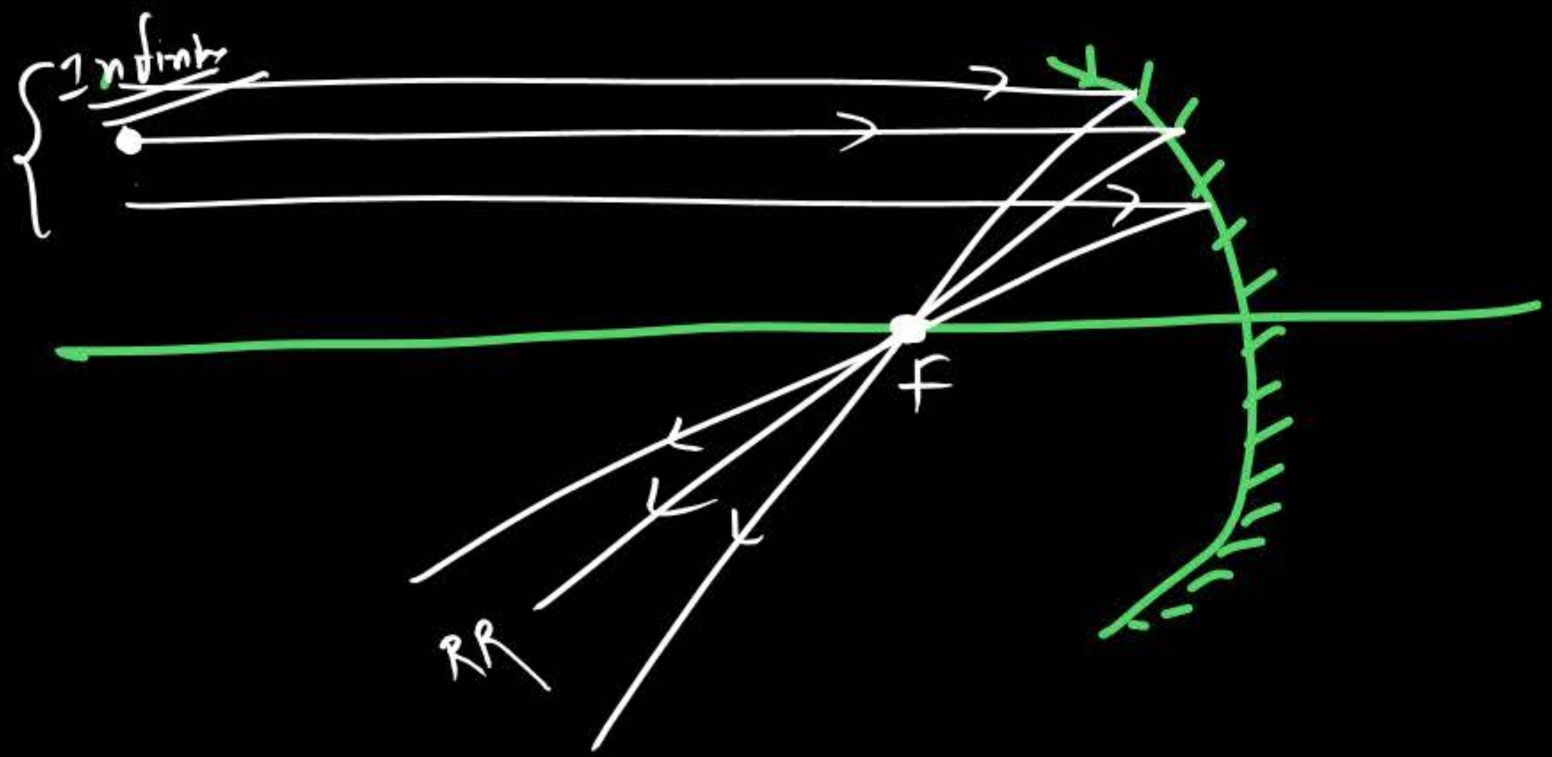

real
Object
I.R
+ve(v) Image
-u
P
f
C
+f
+ve
-ve
Convex
f = +ve
+ve
-ve
+ve
(0,0)
-ve
+ve
I.R
+ve
(0,0)
P
-ve
Object
-ve

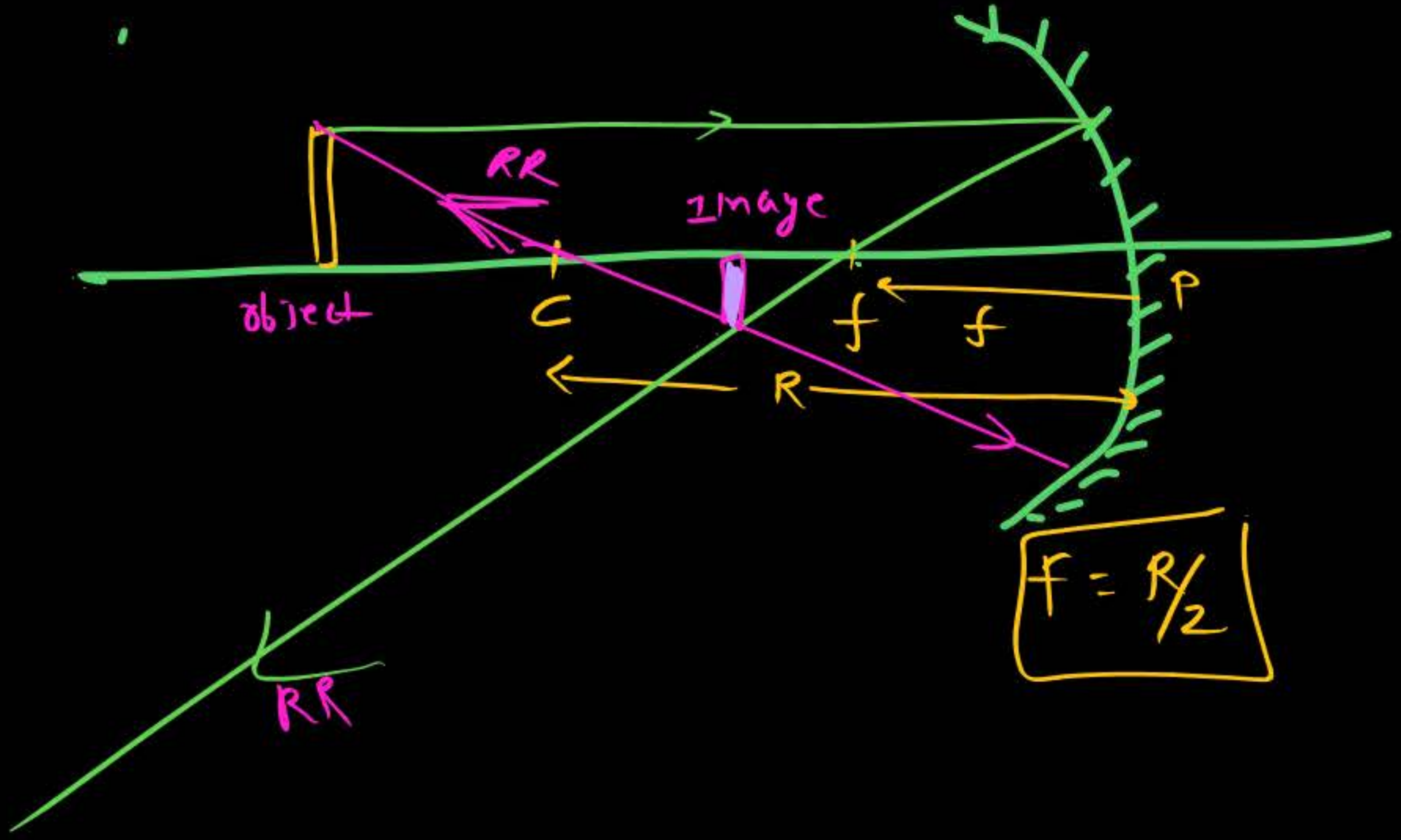
Image formation by concave mirror



Ⓐ object is at infinity

Image is at focus
Real, small (diminished)

Image formation by concave mirror



$F = R/2$

(A) Object is b/w infinity and centre of curvature

Image is b/w 'C' & 'F'

⇒ Real, Inverted

⇒ small,

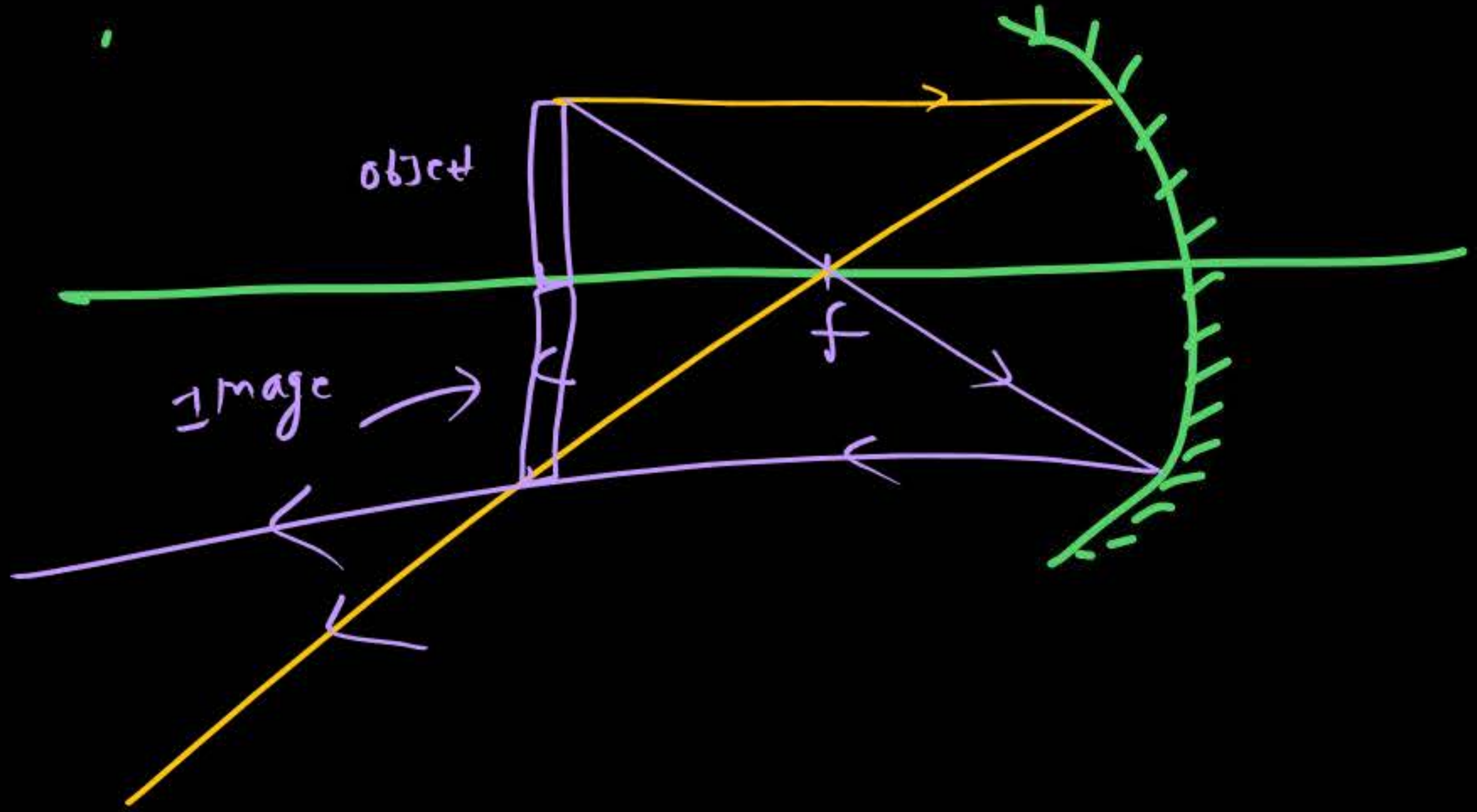
⇒ $m < 1$ (-ve)

$m = +ve$ (errect virtual)

$m = -ve$ (Inverted, real)

Image formation by concave mirror

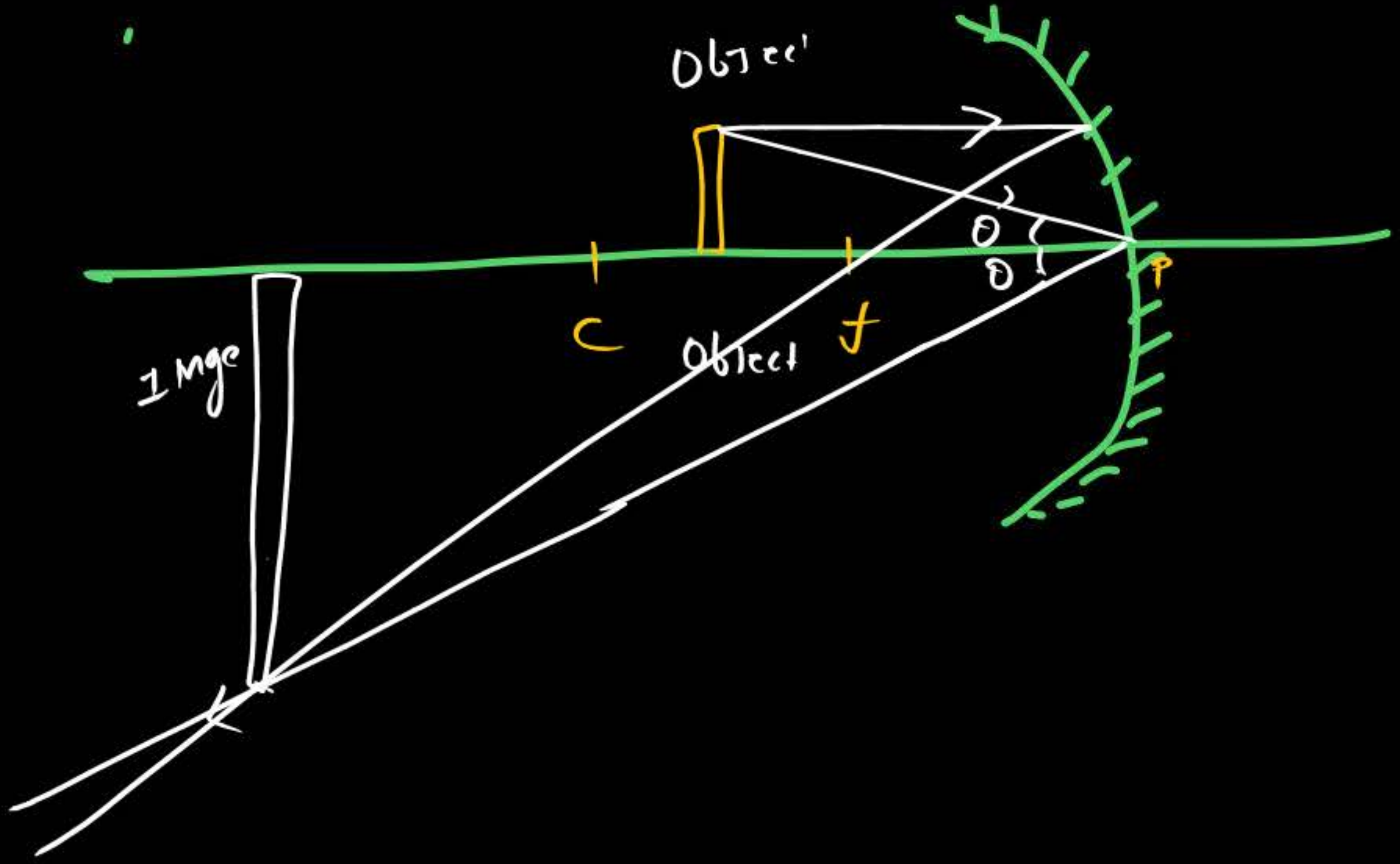
Ⓐ object is at (C)



- Image is at 'C'
- same size ✓
- real, Inverted ✓
- $m = -1$

Image formation by concave mirror

Ⓐ object is b/w 'C' & 'f'



- Image b/w 'C' & infinity
- Inverted, real
- m > 1 (-ve)
- {large}

Image formation by concave mirror

(A) object is at 'f'

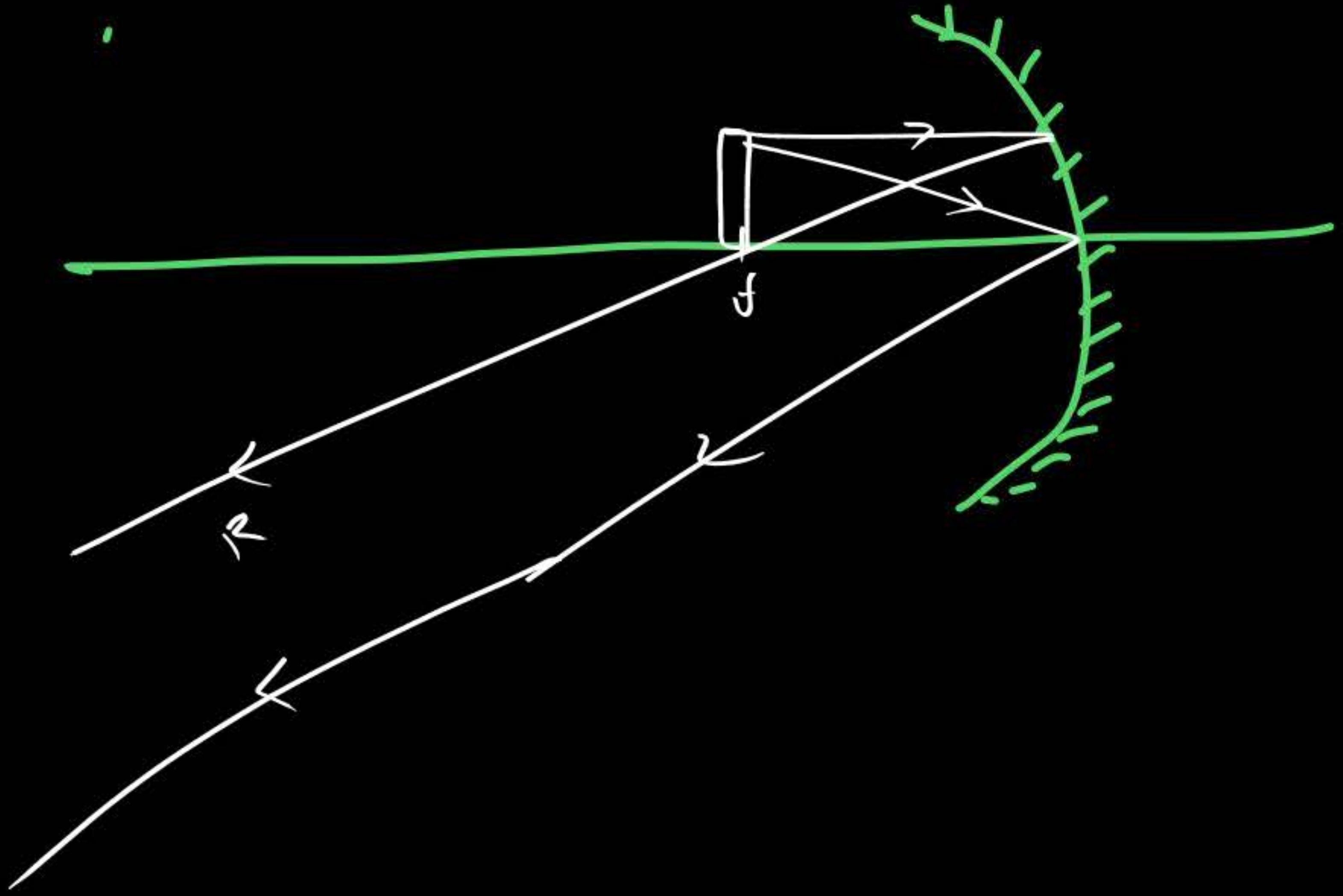


Image is at infinity

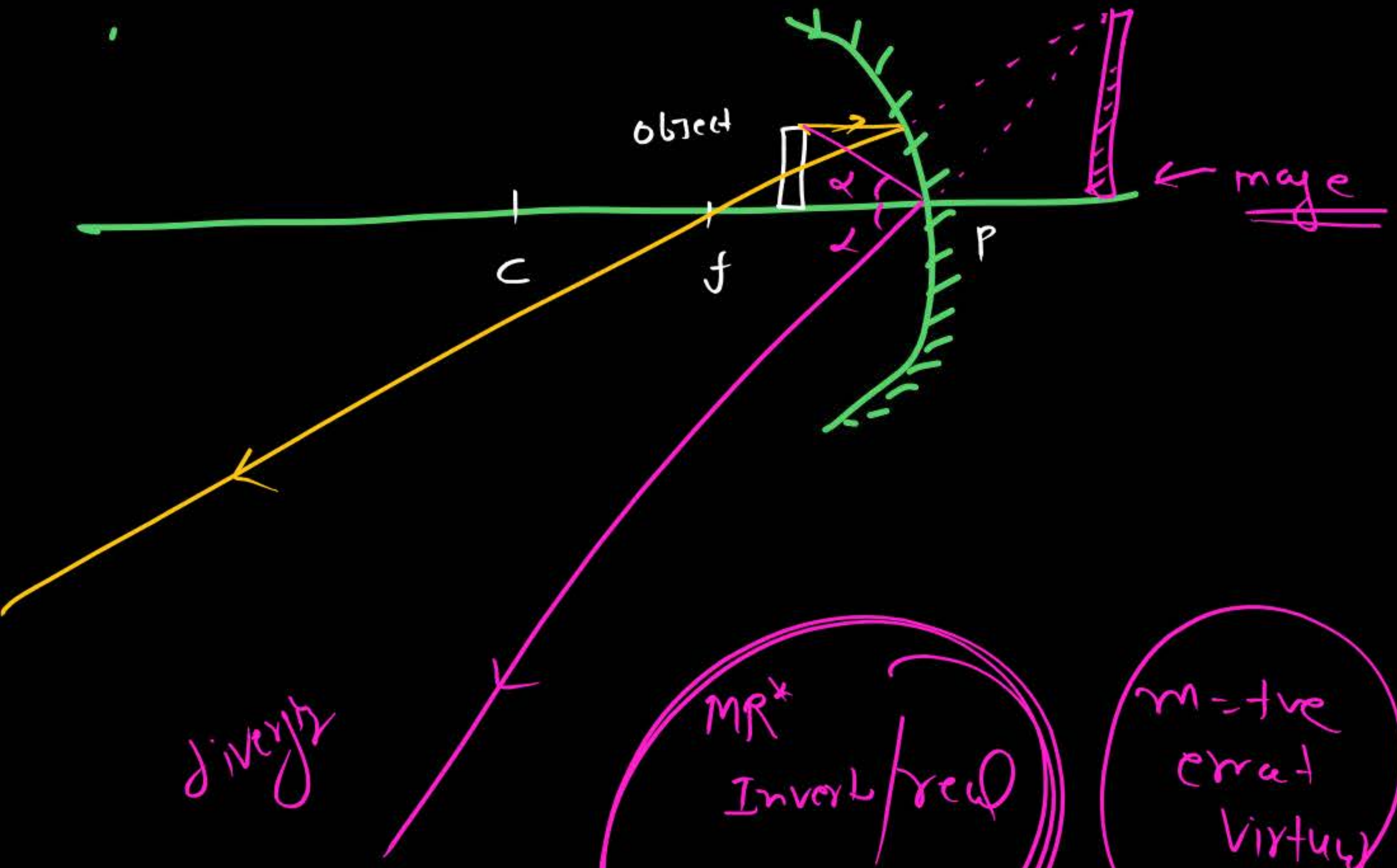
Inverted, real

$m >> 1$ (-ve)

very large

Image formation by concave mirror

Ⓐ object is b/w F & Pole



MR*
Invert / real
m = -ve

m = +ve
erect
Virtual

→ large
→ virtual, erect
→ m = +ve ✓
→ m > 1 //

Object very close to the Pole

→ at pole

→ Image is at Pole

→ same size & erect

Virtual

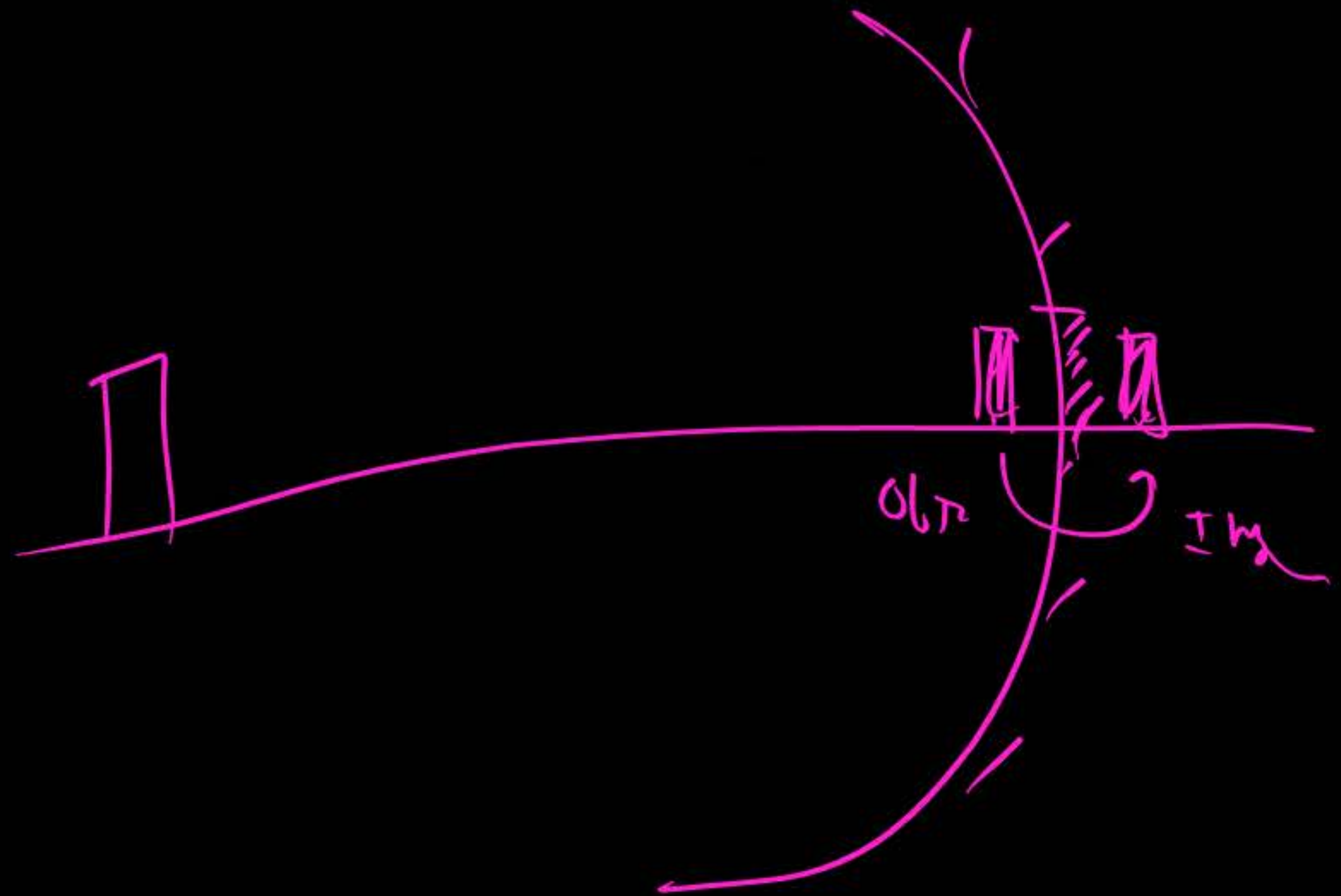
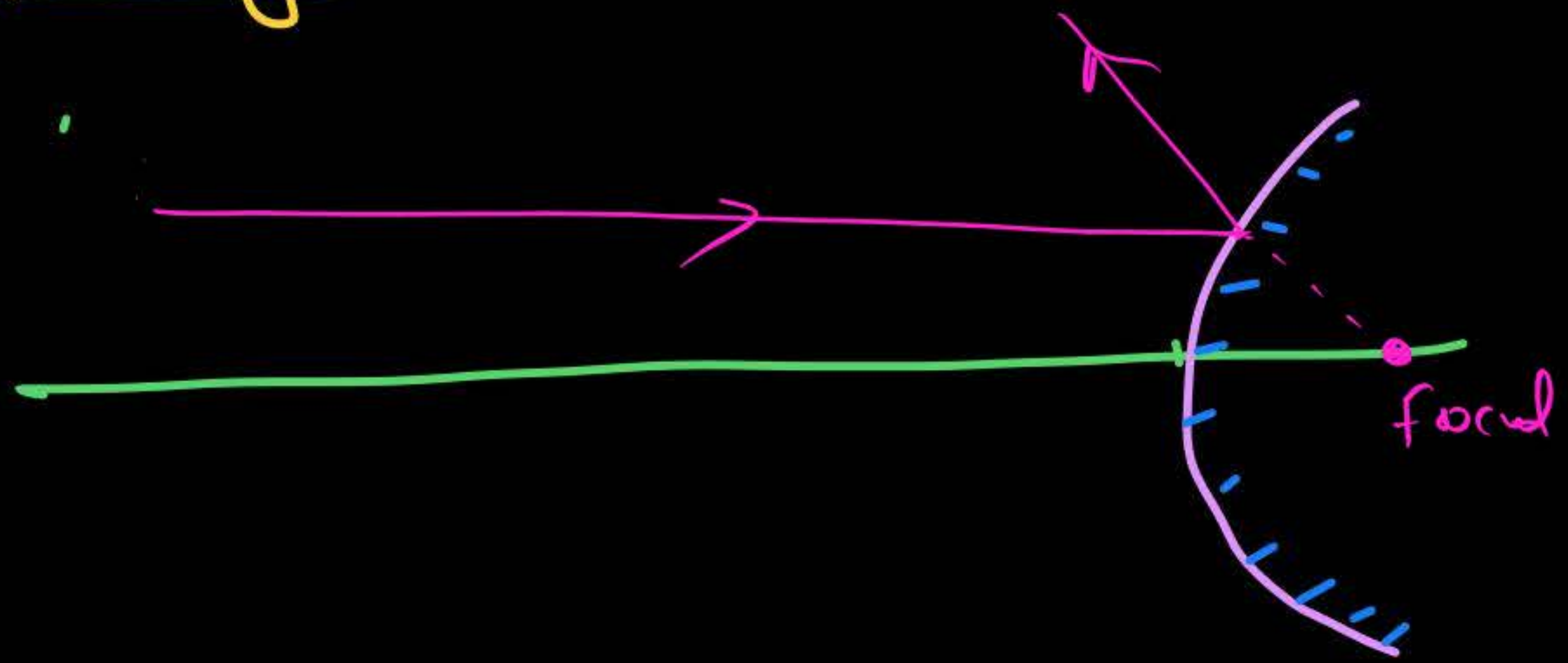


Image formation by Convex mirror



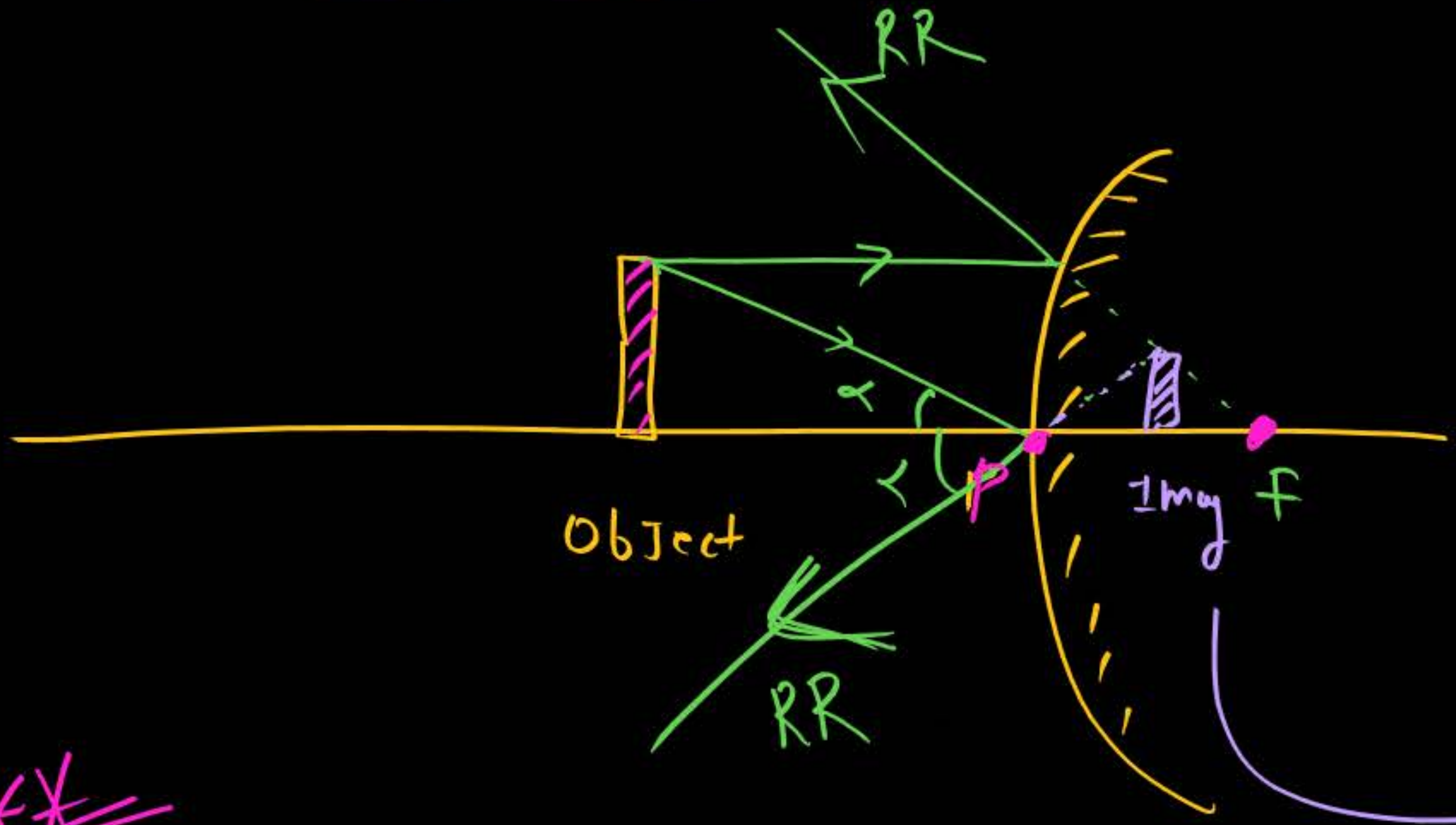
Ⓐ object is at infinity

✓ Image is virtual

✓ and at focus

✓ erect,

if object is B/w infinity & Pole.



→ errect, virtual

m = +ve

always B/w Pole & Focus

Ans

**

plane mirror & Convex mirror does not form real Image (real object)

mirror formula

$$f = R/2$$

- $f = -ve$ for concave mirror
- $f = +ve$ convex mirror

$$\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$$

use with proper sign ✓

$$f = \sqrt{uv}$$

→ Newton Mirror form

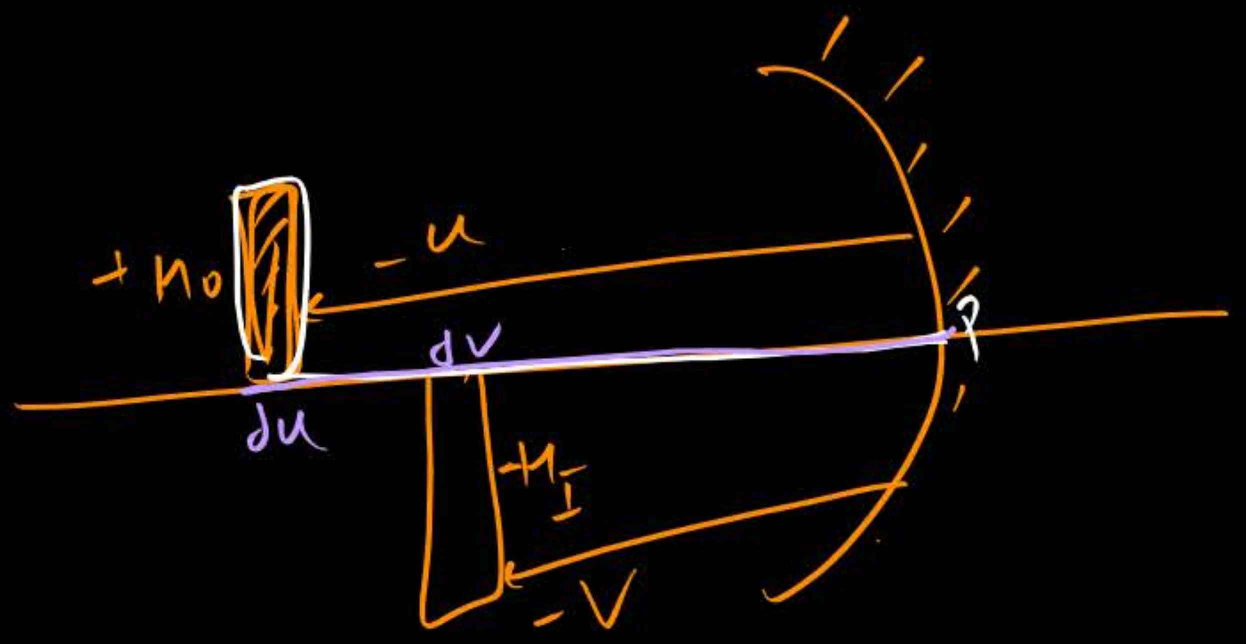
u, v → measured from focus

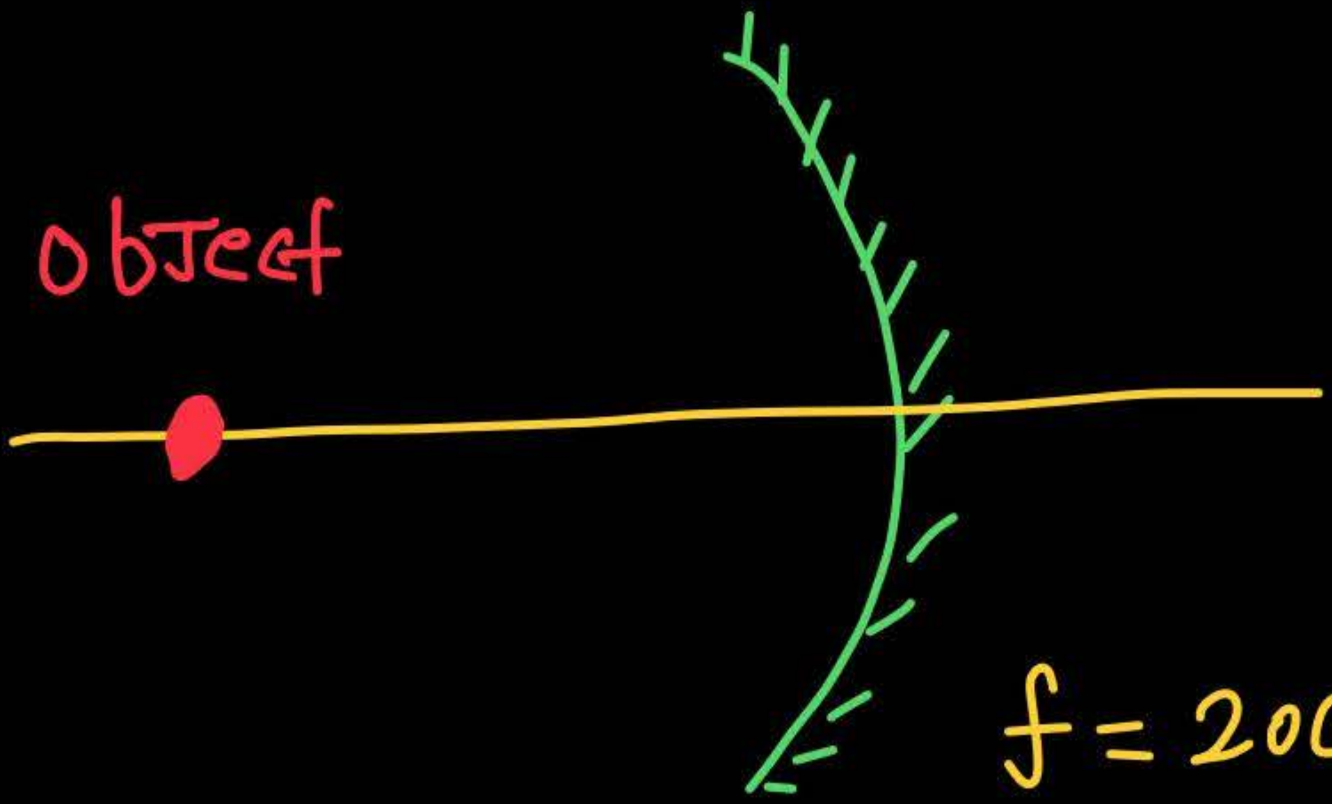
* Transverse magnification

$$m_T = \frac{H_I}{H_O} = -\frac{v}{u}$$ *

* Longitudinal mag.

$$m_l = \frac{dv}{du}$$





$f = 20 cm$

$u = 30 cm$

Find magnification and distance of Image.

H/W

for real object & Image distance always -ve

for virtual object & Image distance always +ve

but why ??

field of view
Curved mirrors

Thank You

YAKEEN 2.0

FOR NEET 2025

Lecture-5 | Physics

Ray Optics and Optical Instruments



By- Dr. Manish Raj (MR SIR)

Topics to be covered

1. #
2. #
3. #

Mirror Formula
Question

K.B.D.



Mirror formula

$$f = \frac{R}{2}$$

→ does not depends on medium.

800 → marks

3hr

50 question mandatory

2-5 hr

Sec-B → Removed kardiya

Sec-A → 45 Question

Cut-off

time → 3hr

Distraction

time → 24hr

??

30 question one line formula.

3-4 → theory base

4-5 → statement / AR / matrix

{3-4 → lengthy होगा}

Mirror formula

$f = \frac{R}{2}$

→ focus does not depend on medium.

→ $f = -ve$ for Concave mirror

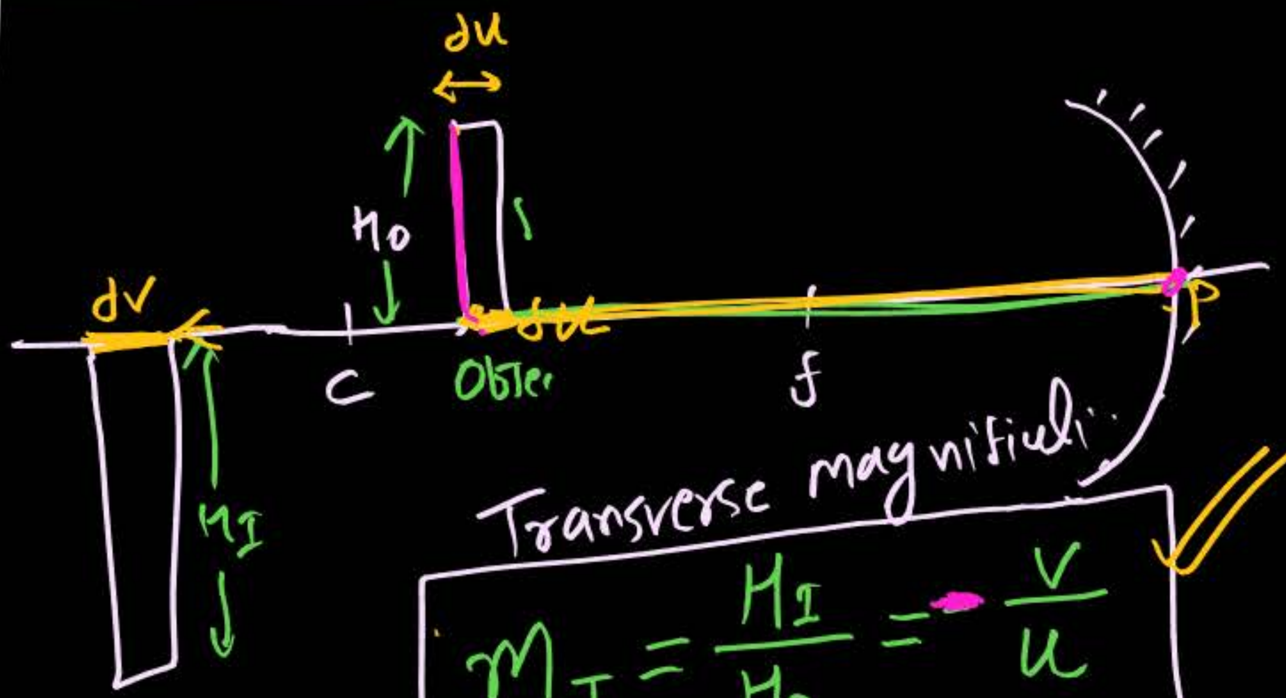
→ $f = +ve$ for Convex mirror

$\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$

Newtons mirror formula

$$f = \sqrt{u \cdot v}$$

← u & v measures from focus.



Transverse magnification

$$m_T = \frac{H_I}{H_o} = -\frac{v}{u}$$

longitudinal magnification

$$m_l = \frac{dv}{du} = m_T^2$$

← only for small object

dv = width of Image

du = width of object.

$$\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$$ ← cotn

Partial diffⁿ

$$-\frac{1}{v^2}dv - \frac{du}{u^2} = 0$$

$$-\frac{dv}{v^2} = +\frac{du}{u^2}$$

$$\left[\frac{dv}{du}\right] = -\frac{v^2}{u^2}$$

$$m_l = m_T^2$$

$$\left[\frac{1}{v} + \frac{1}{u} = \frac{1}{f}\right] \times u$$

mirror formula multiplied by u

$$m_T = \frac{h_I}{h_O} = -\frac{v}{u} = \frac{f}{f-u}$$ *

$$\frac{u}{v} + 1 = \frac{u}{f}$$

$$1 - \frac{u}{f} = -\frac{u}{v}$$

$$\frac{f-u}{f} = \left(-\frac{u}{v}\right)$$

$$m_T = -\frac{v}{u}$$

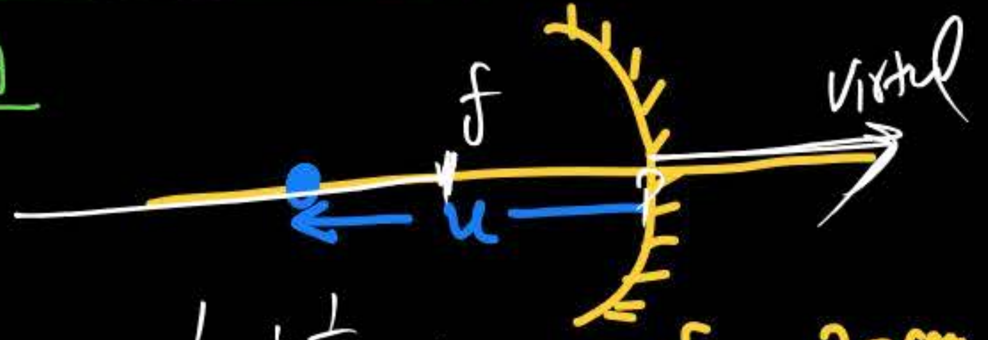
$$\frac{f}{f-u} = -\frac{v}{u}$$

$$m_T = \frac{f}{f-u}$$

Find Position of Image, Size and Magnification, formed by concave mirror of focal length 20 cm for a given position of object.

(i) 5 cm (ii) 10 cm (iii) 15 cm (iv) 20 cm (v) 25 cm (vi) 30 cm (vii) 40 cm (viii) 50 cm (x) 60 cm

(i)–(iii) → virtual, erect; (iv) → at infinity; (v)–(x) → real & Inverted



$f = -20$ cm

Soln

(i) $f = -20$ cm

$$\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$$

$$\frac{1}{v} = \frac{1}{f} - \frac{1}{u}$$

$$\frac{1}{v} = -\frac{1}{20} - \frac{1}{(-5)}$$

$$\frac{1}{v} = -\frac{1}{20} + \frac{1}{5} =$$

→ $v = +ve$

$$\frac{1}{v} = \frac{-1+4}{20}$$

$$v = +\frac{20}{3}$$ → virtual

$$m_T = -\frac{v}{u} = +\frac{\left(\frac{20}{3}\right)}{+5}$$

$$m_T = +\frac{4}{3}$$

$$m_\ell = m_T^2 = \frac{16}{9}$$

(ii) $\frac{1}{v} = \frac{1}{f} - \frac{1}{u}$

$$= -\frac{1}{20} - \left(-\frac{1}{10}\right)$$

$$\frac{1}{v} = \frac{-1+2}{20}$$

$$v = 20$$

$$m_T = +2$$

(iii) $\frac{1}{v} = -\frac{1}{20} + \frac{1}{15}$

$$\frac{1}{v} = \frac{-3+4}{60}$$

$$v = +60 \text{ cm}$$

virtual

$$m_T = \frac{+60}{+15} = +4$$

→ virtual erect

(iv) $\frac{1}{v} = \frac{1}{-20} - \left(\frac{-1}{20}\right)$

$$\frac{1}{v} = -\frac{1}{20} + \frac{1}{20}$$

v = infinite

Sol^n (I)

$$\frac{1}{v}+\frac{1}{u}=\frac{1}{f}$$

$$\frac{1}{v}=\frac{1}{f}-\frac{1}{u}$$

$$=-\frac{1}{20}-\frac{1}{(-5)}$$

$$=\frac{-1+4}{20}$$

$$\frac{1}{v}=\frac{+3}{20}$$

$$v=+\frac{20}{3} \rightarrow \text{virtual, errect}$$

$$m=-\frac{v}{u}=\frac{-20}{3(-5)}=\frac{4}{3}$$

Sol^n (II) $u=-10\,cm$

$$\frac{1}{v}=-\frac{1}{20}+\frac{1}{10}$$

$$\frac{1}{v}=\frac{-1+2}{20}$$

$$v=+20$$

$$m=-\frac{v}{u}=\frac{-20}{-10}=+2$$

(iii) $$\frac{1}{v}=-\frac{1}{20}-\left(\frac{1}{-15}\right)$$

$$\frac{1}{v}=\frac{-3+4}{60}$$

$$v=+60$$

$$m=-\frac{v}{u}=+4$$

errect, virtual

(IV) $f=-20\,cm$ $u=-20\,cm$

$$\frac{1}{v}=-\frac{1}{20}-\left(-\frac{1}{20}\right)=0$$

$$v=\frac{1}{0}=\infty$$

(V) $$\frac{1}{v}=-\frac{1}{20}-\left(-\frac{1}{25}\right)$$

$$\frac{1}{v}=\frac{-5+4}{100}=\frac{-1}{100}$$

$$v=-100 \qquad m=-\left(\frac{-100}{-25}\right)$$

real, Inverted

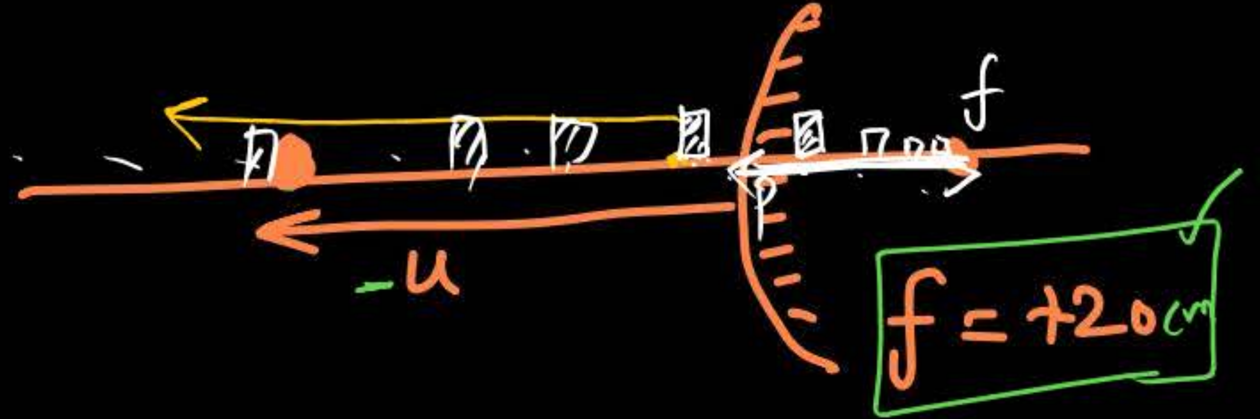
(VI) $$\frac{1}{v}=\frac{1}{f}-\frac{1}{u}=-\frac{1}{20}+\frac{1}{30}$$

$$\frac{1}{v}=\frac{-3+2}{60}=-\frac{1}{60}$$

$$v=-60\,cm \qquad m=\frac{+60}{-30}=-2$$

Find Position of Image, and Magnification, formed by convex mirror of focal length 20 cm for a given position of object.

(i) 5 cm (ii) 10 cm (iii) 15 cm (iv) 30 cm (v) 40 cm (vi) 60 cm



Sol^n H/W

$\frac{1}{v} = \frac{1}{20} + \frac{1}{5}$

$\frac{1}{v} = \frac{1+4}{20} = \frac{1}{4}$

$v = +4$

$m_T = \frac{4}{5}$

Sol^n Mirror formula

$$\frac{1}{v} + \frac{1}{u} = \frac{1}{F}$$

$$\frac{1}{v} = \frac{1}{F} - \frac{1}{(-u)}$$

(for real object u will be in -ve)

for real object

$$\frac{1}{v} = \frac{1}{F} + \frac{1}{u} = \frac{1}{20} + \frac{1}{60} = \frac{3+1}{60} = \frac{4}{60} = 15$$

both term is +ve

(v = +15 cm)

$m_T = \frac{15}{60} = \frac{1}{4}$

So 3rd exe open karo.

Solⁿ mirror formula

$$\frac{1}{V} = \frac{1}{f} - \frac{1}{u}$$

for real object (u = -ve)
& convex mirror (f = +ve)

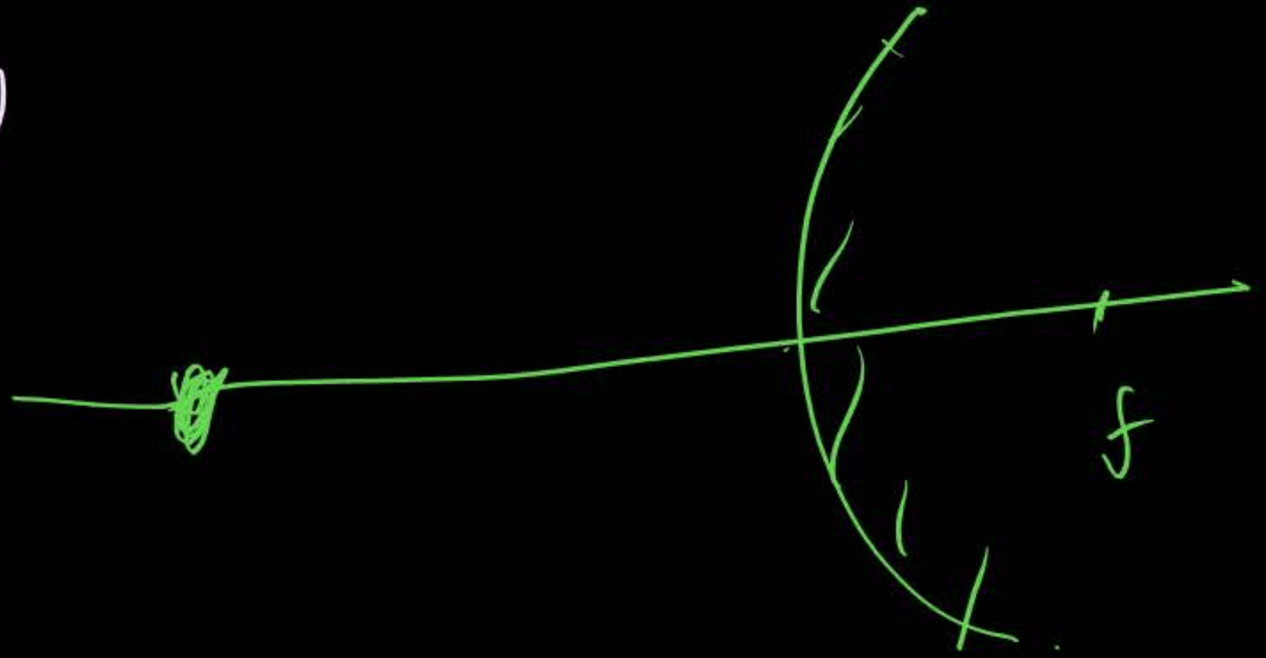
$$\frac{1}{V} = \frac{1}{f} + \frac{1}{u}$$

↳ always Positi.

V = +ve (must be)

→ erect / virtual Image

always virtual Image for real object by convex mirror



K.B.D

QUESTION

The light rays from an object have been reflected towards an observer from a standard flat mirror, the image observed by the observer are: [25 Jan, 2023 (Shift-II)]

A. Real

B. Erect

C. Smaller in size then object

D. Laterally inverted

Choose the most appropriate answer from the options given below.

1. B and D only
2. B and C only
3. A and D only
4. A, C and D only

QUESTION

Check the wrong statement(s), if object is real

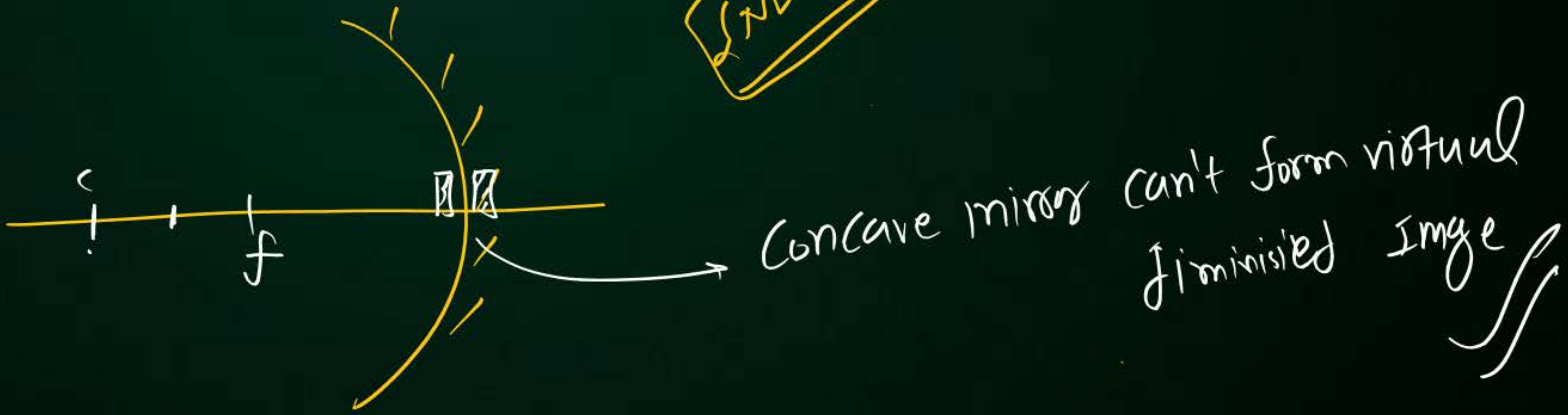
(i) A concave mirror can give a virtual image

(ii) A concave mirror can give a diminished virtual image

(iii) A convex mirror can give a real image

(iv) A convex mirror can give a diminished virtual image

1. (i), (ii)
2. (ii), (iii)
3. (iii), (iv)
4. (i), (iv)

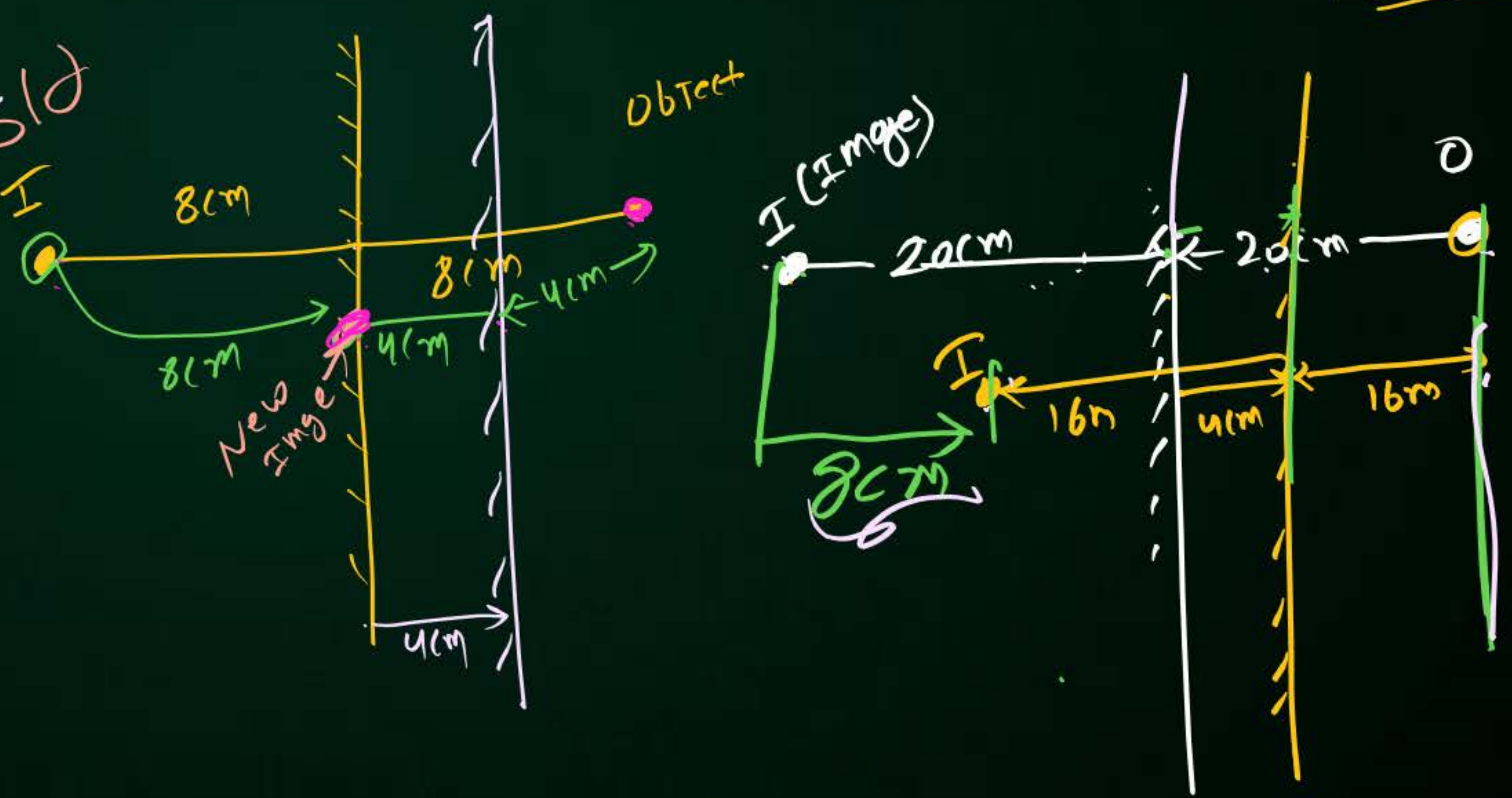


QUESTION

An object is placed at a distance of 8 cm in front of a plane mirror. The virtual and erect image is formed by the mirror. Now the mirror is moved by 4 cm towards the stationary object. The distance by which the position of image would be shifted, will be:

[10 Apr, 2023 (Shift-I)]

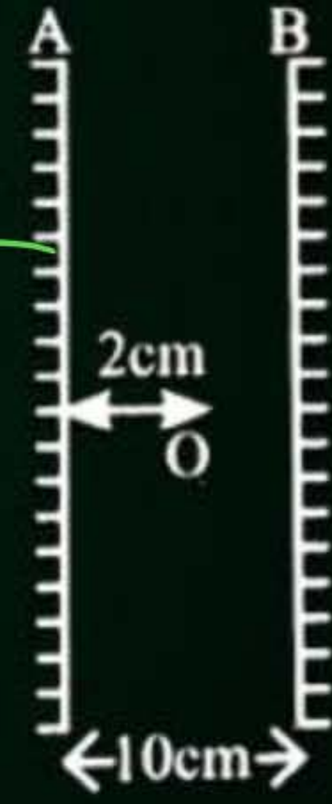
1. 4 cm towards mirror
2. 8 cm towards mirror
3. 8 cm away from mirror
4. 2 cm towards mirror



QUESTION

Two vertical parallel mirrors A and B are separated by 10 cm. A point object O is placed at a distance of 2 cm from mirror A. The distance of the second nearest image behind mirror A from the mirror A is ______ cm.

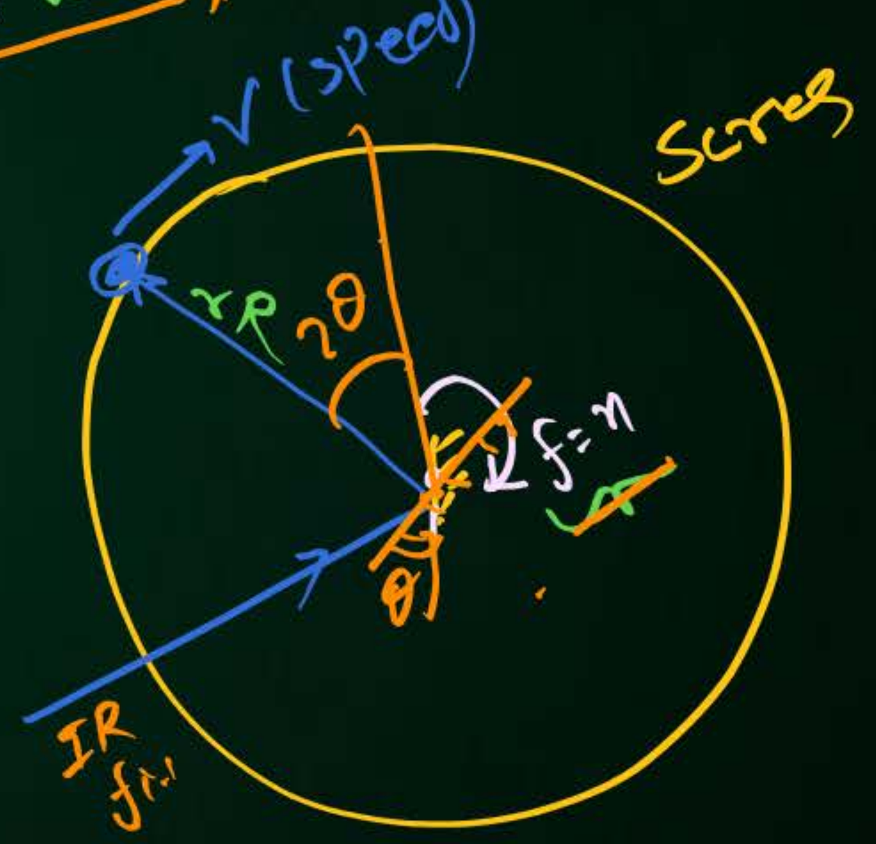
[8 Apr, 2023 (Shift-I)]



QUESTION

A small plane mirror placed at the centre of a spherical screen of radius R. A beam of light is falling on the mirror. If the mirror makes n revolution per second, the speed of light on the screen after reflection from the mirror will be

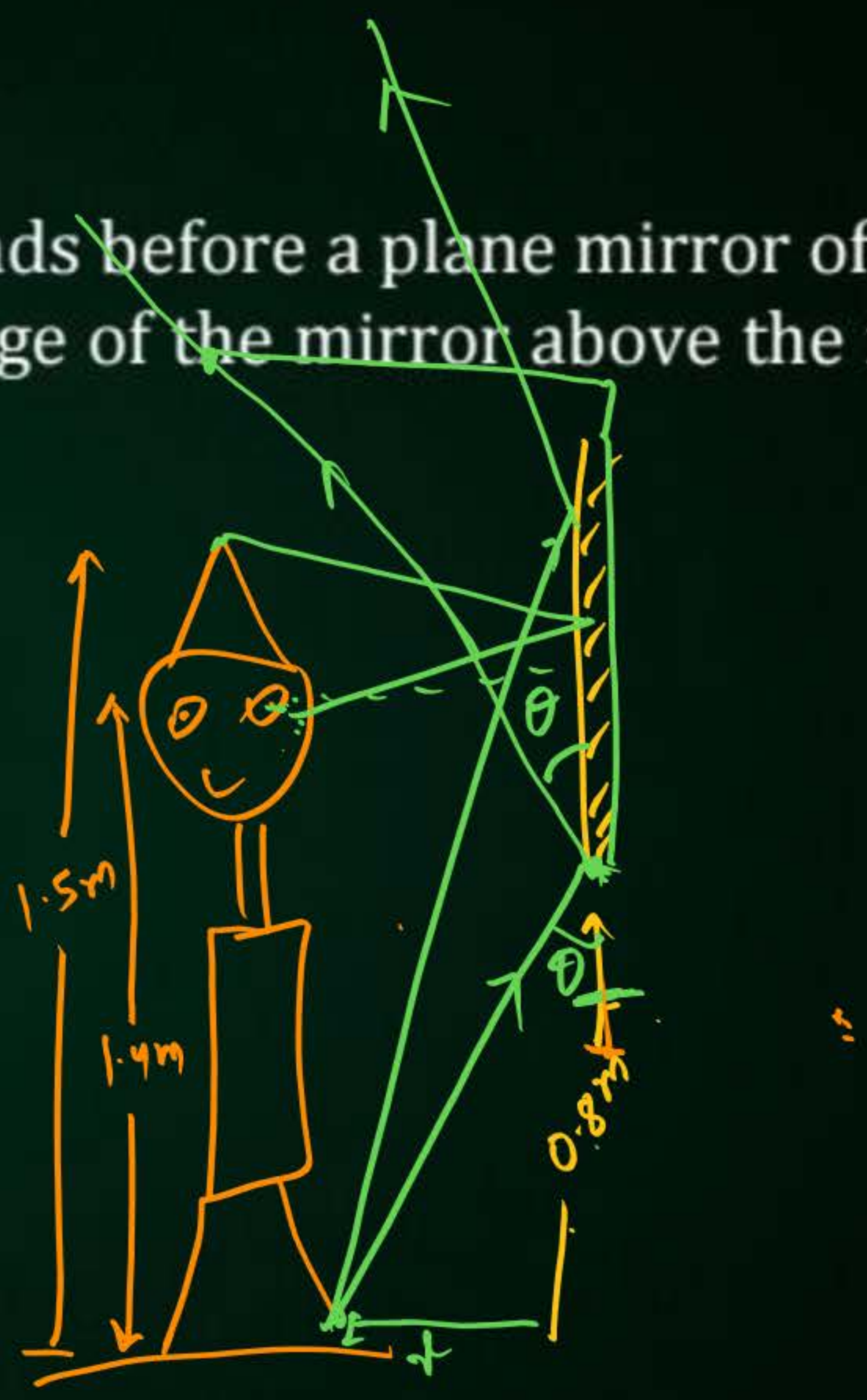
1. $4\pi nR$
2. $2\pi nR$
3. $\frac{nR}{2\pi}$
4. $\frac{nR}{4\pi}$

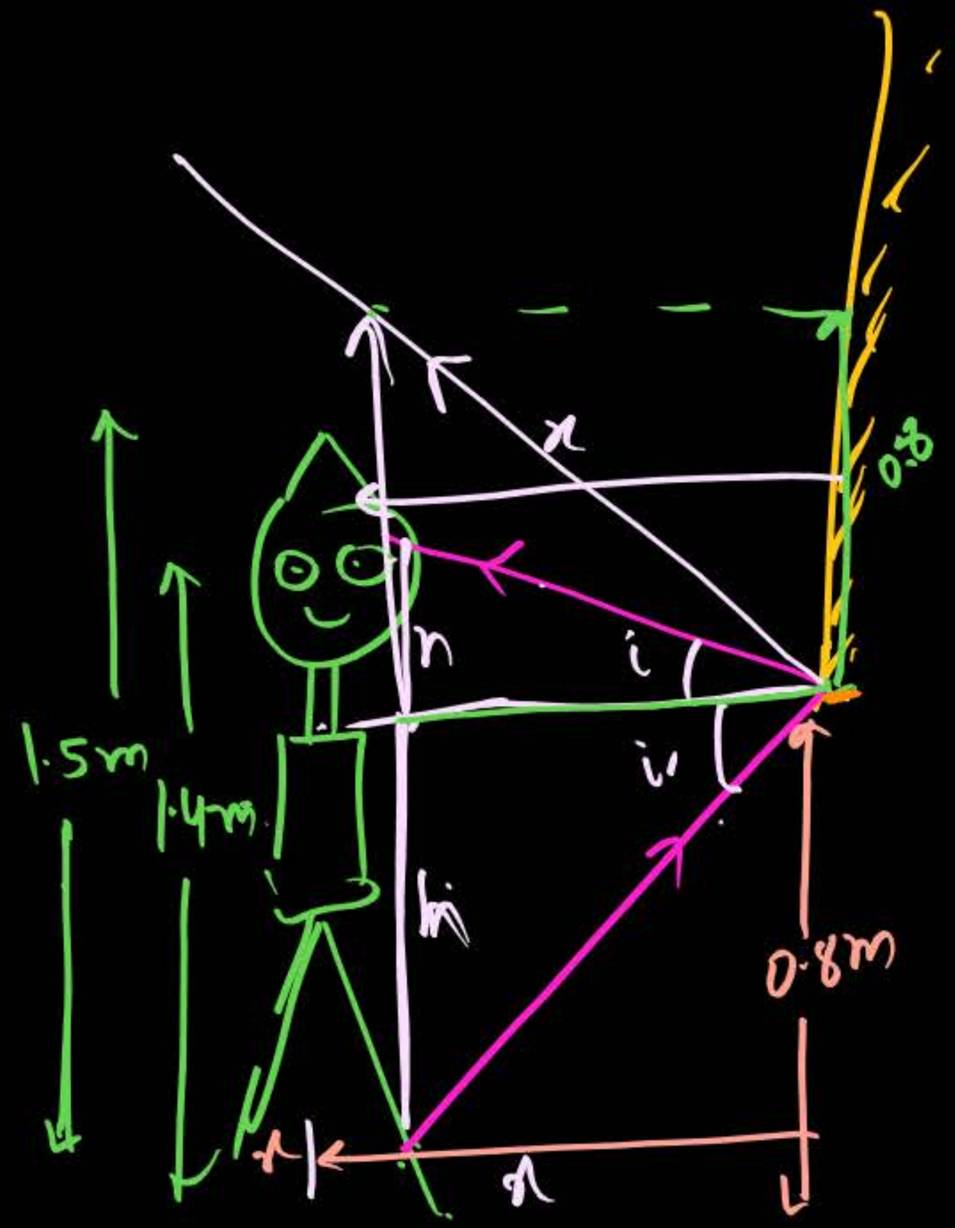


QUESTION

A boy of height 1.5 m with his eye level at 1.4 m stands before a plane mirror of length 0.75 m fixed on the wall. The height of the lower edge of the mirror above the floor is 0.8 m. Then

1. the boy will see his full image
2. the boy cannot see his hair
3. the boy cannot see his feet
4. the boy can see neither his hair nor his feet



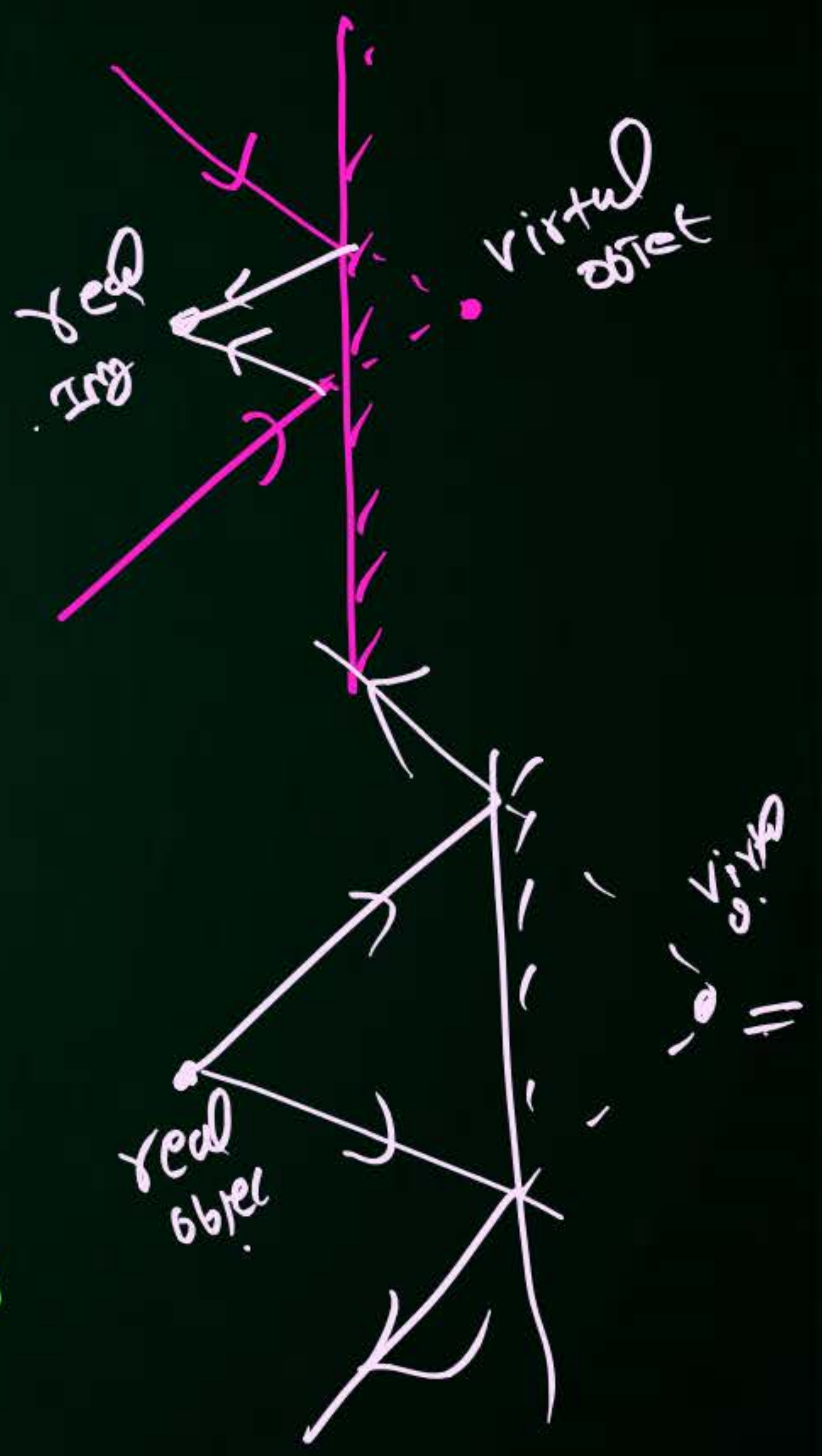

x
0.8
i
i
h
h
1.5m
1.4m
0.8m
x

QUESTION

The light reflected by a plane mirror may form a real image,

1. if the rays incident on the mirror are converging
2. if the rays incident on the mirror are diverging
3. if the object is placed very close to the mirror
4. under no circumstances

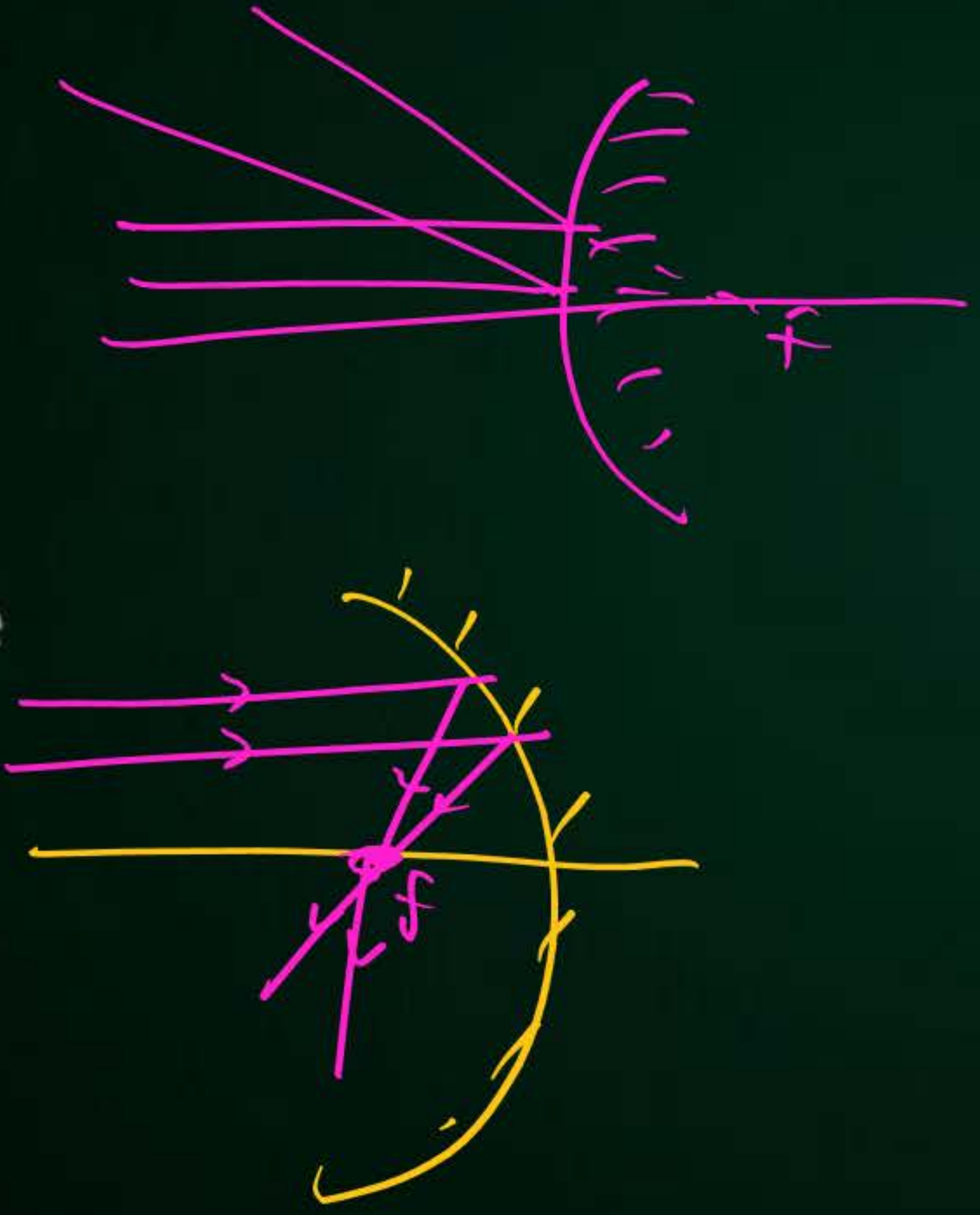
plane mirror always from virtual Image → True

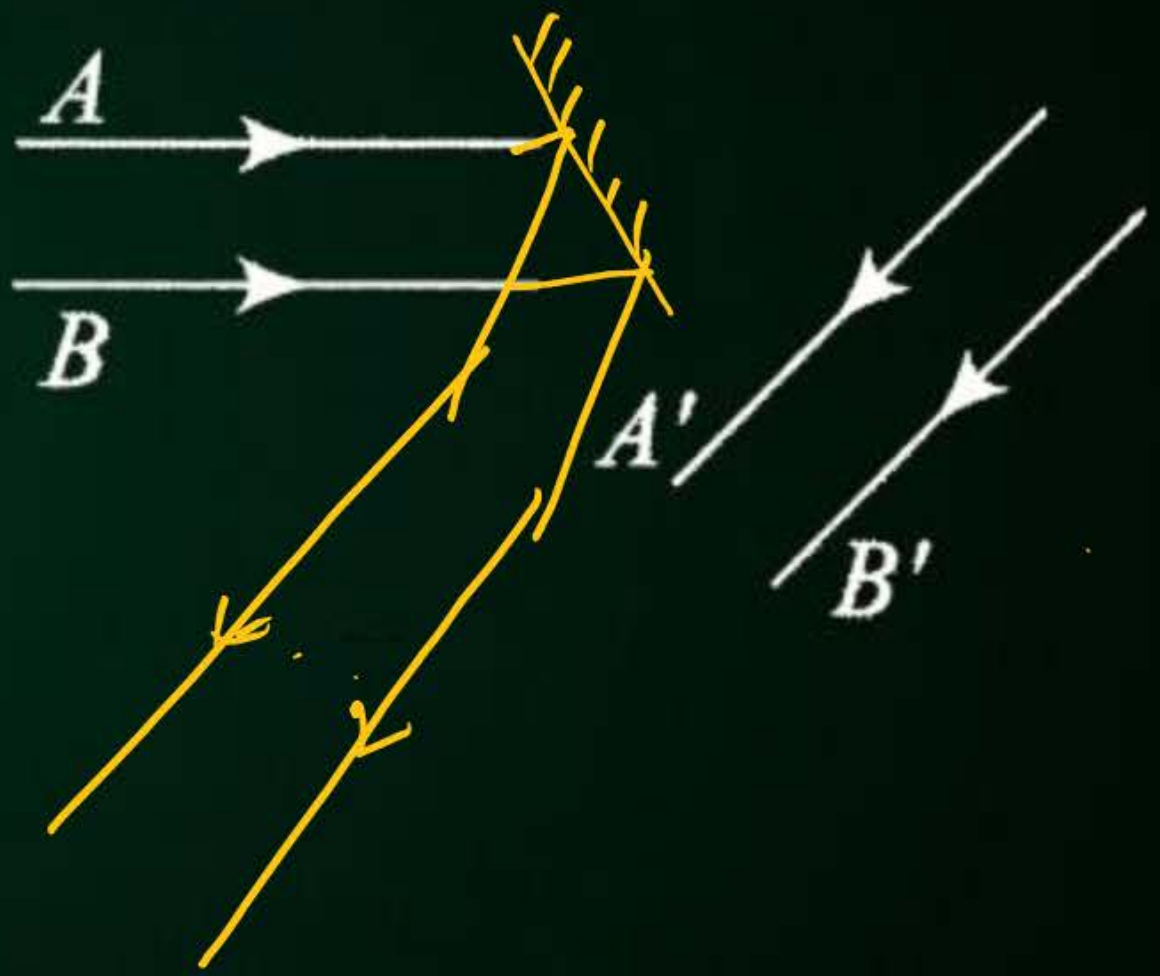


QUESTION

Figure shows two rays A and B being reflected by a mirror and going as A and B. The mirror is

1. plane
2. convex
3. concave
4. none





QUESTION

A convex mirror is used to form an image of a real object. The image

(i) always lies between the pole and the focus

(ii) is diminished in size

(iii) is erect

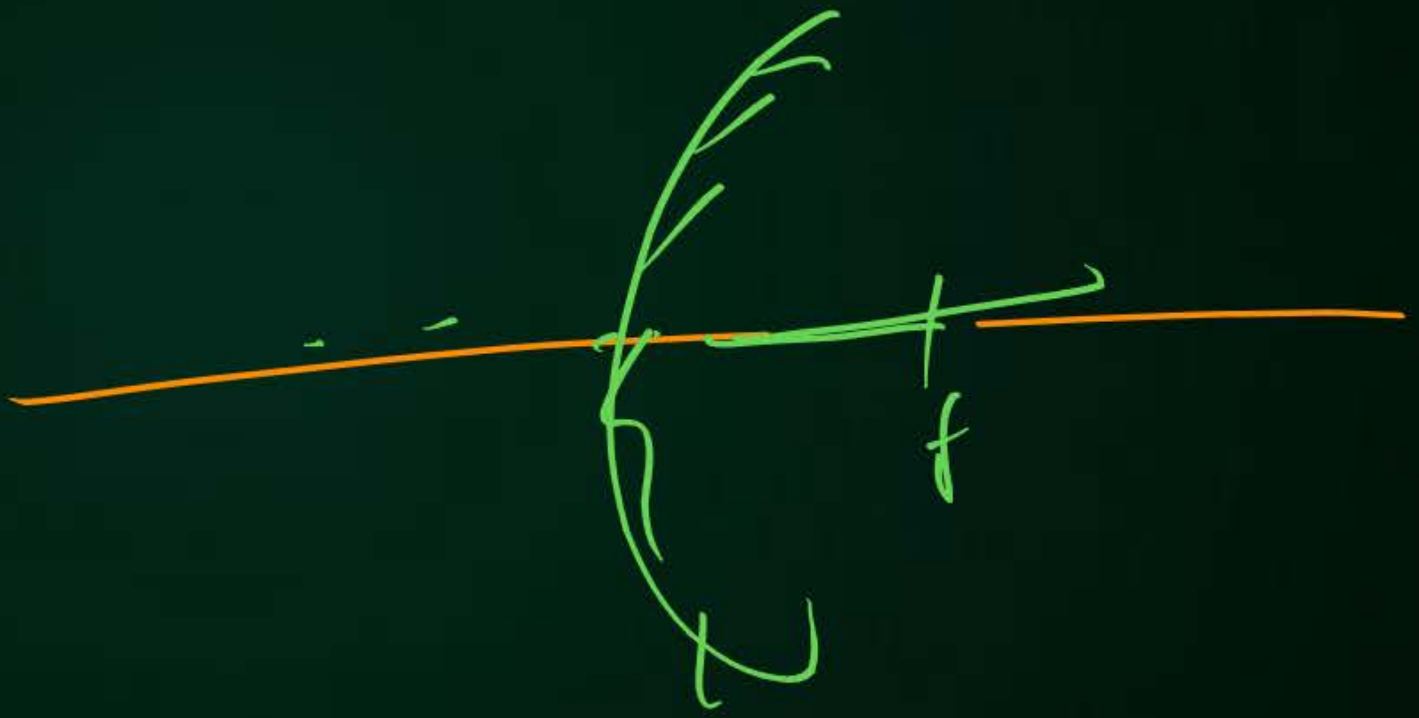
(iv) is real

1. (i), (ii)

2. (ii), (iii)

3. (iii), (iv)

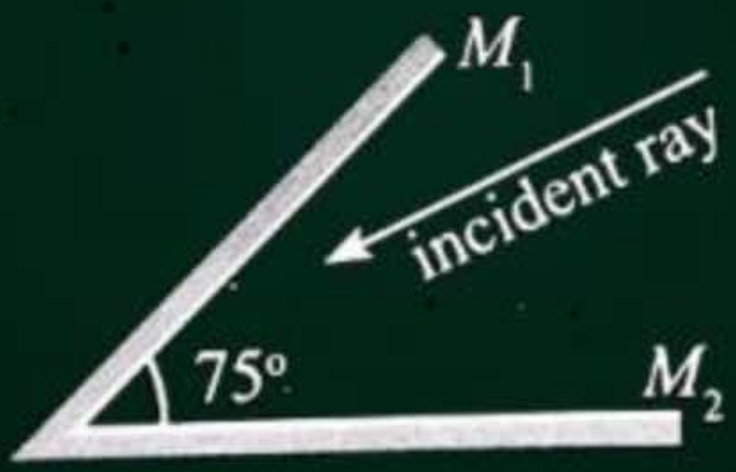
4. (i), (ii), (iii)



QUESTION

A light ray is incident, at an incident angle θ_1, on the system of two plane mirrors M_1 and M_2 having an inclination angle 75° between them (as shown in figure). After reflecting from mirror M_1 it gets reflected back by the mirror M_2 with an angle of reflection 30°. The total deviation of the ray will be ______ degree.

[26 June, 2022 (Shift-I)]



$\delta = 360° - 2\theta$

$= 360° - 150$

$\delta = 210°$

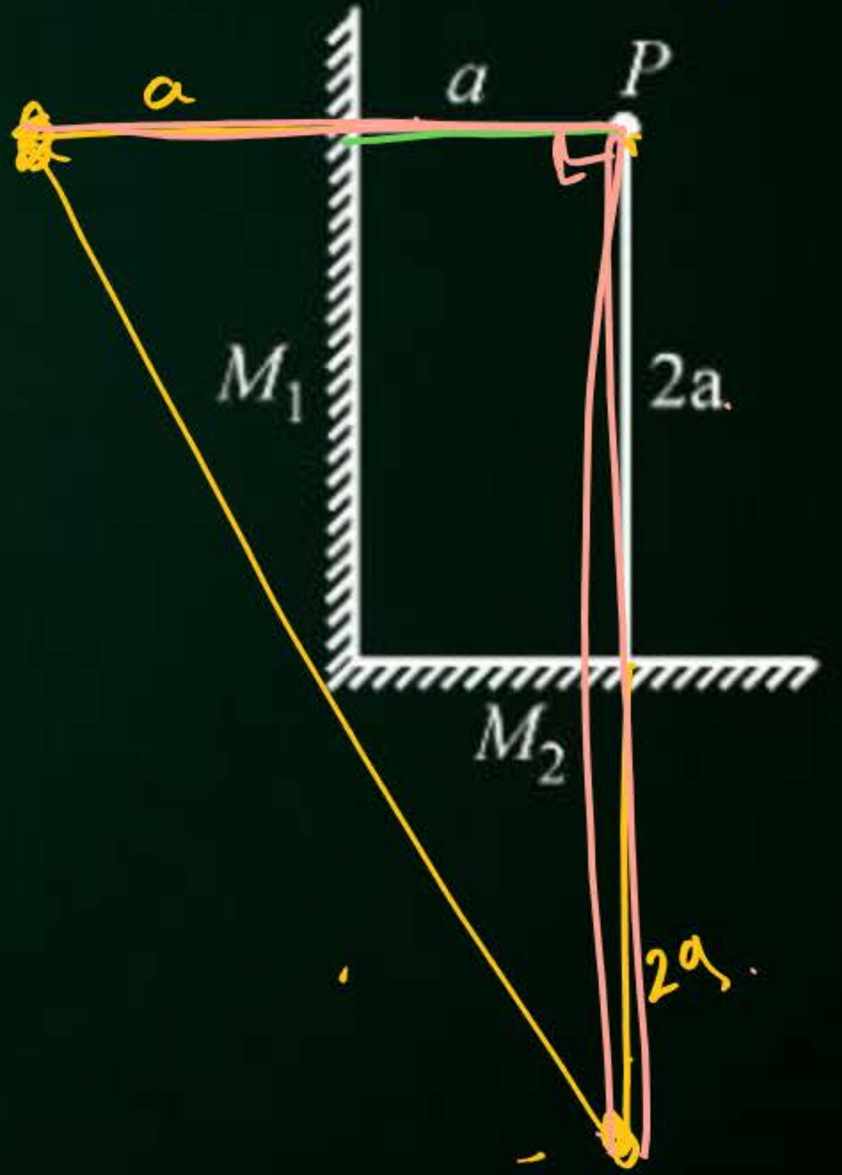
Ans

QUESTION

Two plane mirrors M_1 and M_2 are at right angle to each shown. A point source 'P' is placed at 'a' and '2a' meter away from M_1 and M_2 respectively. The shortest distance between the images thus formed is : (Take $\sqrt{5} - 2.3$) **[31 Aug, 2021 (Shift-I)]**

1. $2\sqrt{10}\,a$
2. $2.3\,a$
3. $4.6\,a$
4. $3\,a$

$$\sqrt{(4a)^2+(2a)^2} = \sqrt{16a^2+4a^2} = \sqrt{20a^2} = \sqrt{5\times4\,a^2} = 2\times2.3\,a = 4.6a$$



QUESTION

Two plane mirrors are inclined to each other such that a ray of light incident to the first mirror (M_1) and parallel to the second mirror (M_2) is finally reflected from the second mirror (M_2) parallel to the first mirror (M_1). The angle between the two mirrors will be:

[9 Jan. 2019 (Shift-II)]

NEET - 2013

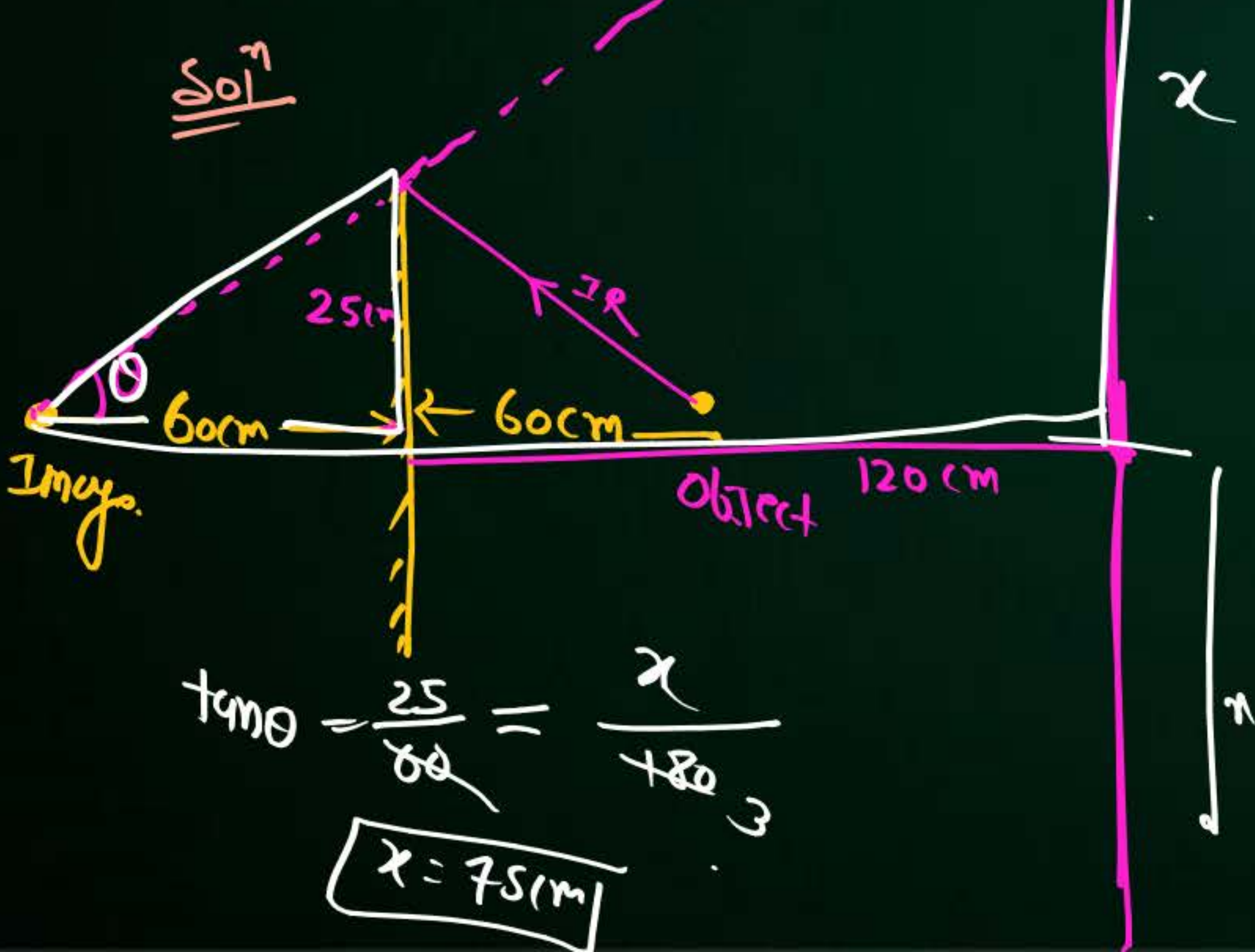
1. 45°
2. 60°
3. 75°
4. 90°

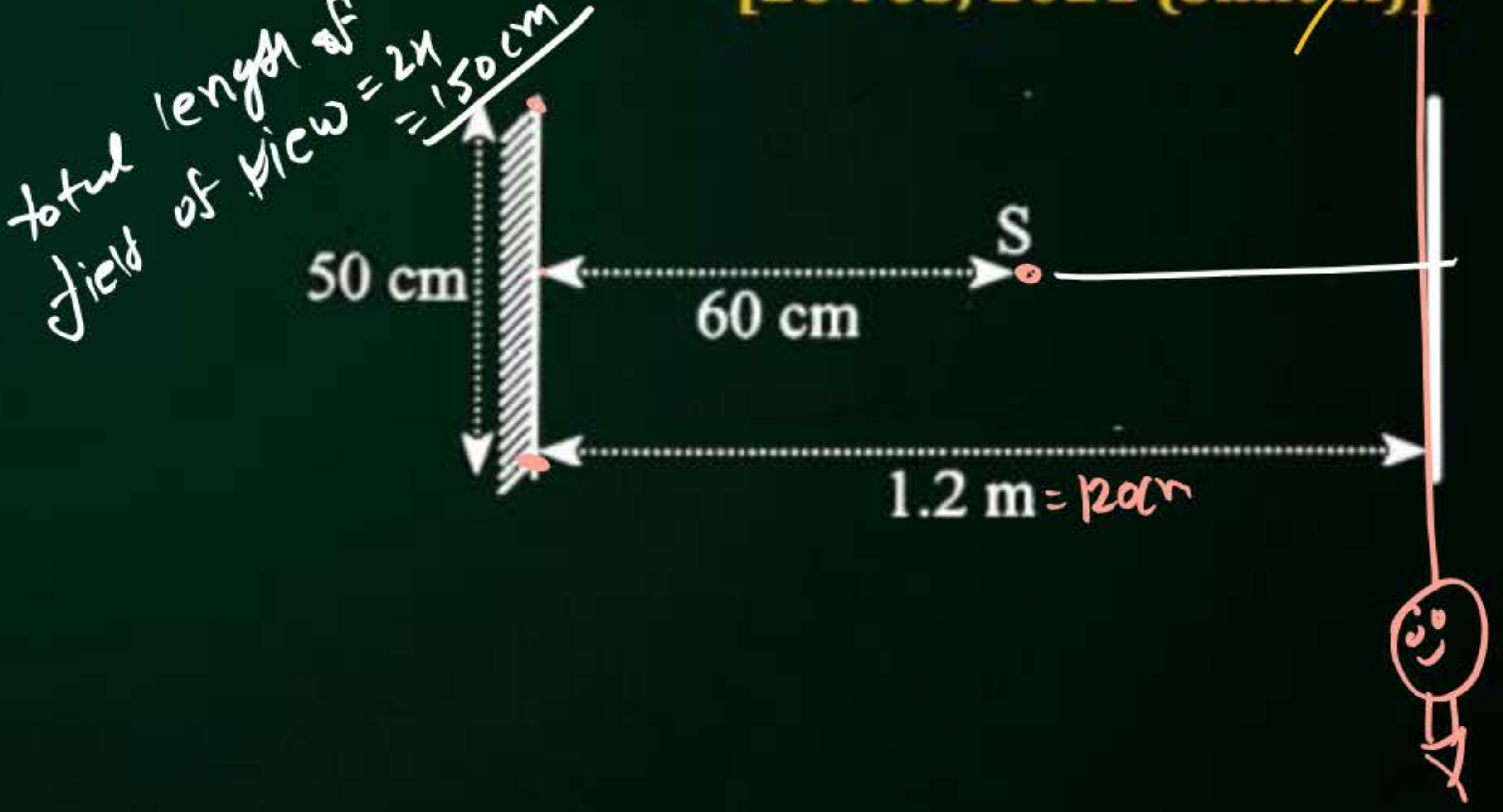
done.

QUESTION

A point source of light S, placed at a distance 60 cm infront of the centre of a plane mirror of width 50 cm, hangs vertically on a wall. A man walks infront of the mirror along a line parallel to the mirror at a distance 1.2 m from it (see in the figure). The distance between the extreme points w here he can see the image of the light source in the mirror is ______ cm.

[26 Feb, 2021 (Shift-II)]



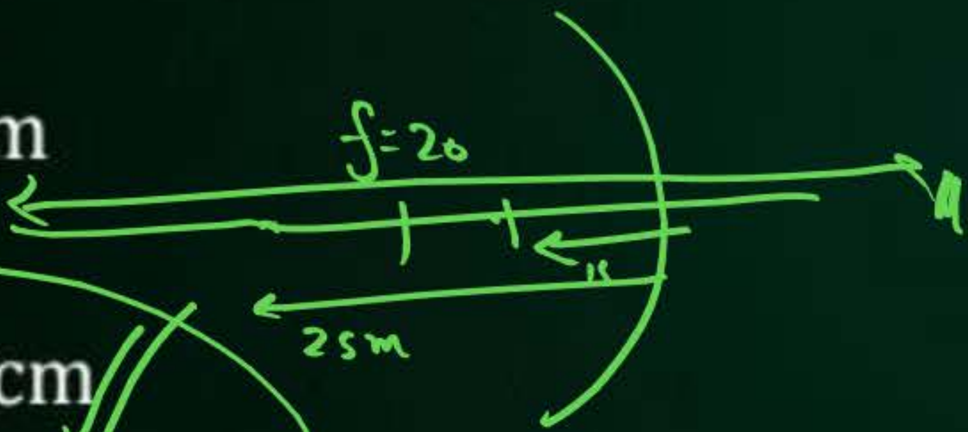


QUESTION

Two objects A and B are placed at 15 cm and 25 cm from the pole in front of a concave mirror having radius of curvature 40 cm. The distance between images formed by the mirror is:

[1 Feb, 2023 (Shift-II)]

1. 40 cm
2. 60 cm
3. 160 cm
4. 100 cm



$f = -\frac{R}{2} = -20\,cm$

$u_A = -15\,cm$

$u_B = -25\,cm$

$\frac{1}{v} = \frac{1}{f} - \frac{1}{u}$

$\frac{1}{v} = -\frac{1}{20} + \frac{1}{15} = \frac{-3+4}{60}$

$v = \frac{60}{1} = +60\,cm$ virtual Im

$\frac{1}{v} = -\frac{1}{20} + \frac{1}{25} = \frac{-5+4}{100} = \frac{-1}{100}$

$v = -100\,cm$

QUESTION

The focal length f is related to the radius of curvature r of the spherical convex mirror by:

[24 Feb, 2021 (Shift-I)]

1. $f = r$
2. $f = -\frac{1}{2}r$
3. $f = -r$
4. $f = +\frac{1}{2}r$

Match List-I with List-II and select the correct answer using the codes given below the lists:

	List-I		List-II
(i)	An object is placed at focus before a convex mirror	(A)	Magnification is $-\infty$
(ii)	An object is placed at centre of curvature before a concave mirror	(B)	Magnification is 0.5
(iii)	An object is placed at focus before a concave mirror	(C)	Magnification is +1
(iv)	An object is placed at centre of curvature before a convex mirror	(D)	Magnification is –1
		(E)	Magnification is 0.33

1. (i)-(B); (ii)-(D); (iii)-(A); (iv)-(E)
2. (i)-(A); (ii)-(D); (iii)-(C); (iv)-(B)
3. (i)-(C); (ii)-(B); (iii)-(A); (iv)-(E)
4. (i)-(B); (ii)-(E); (iii)-(D); (iv)-(C)

QUESTION

A virtual image three times the size of the object is obtained with a concave mirror of radius of curvature 36 cm. The distance of the object from the mirror is -

1. 5 cm
2. 12 cm
3. 10 cm
4. 20 cm



$\frac{1}{v} = \frac{1}{f} - \frac{1}{u}$

$f = 18\,cm$

$m_T = \frac{H_I}{H_0} = \frac{3H_0}{H_0}$

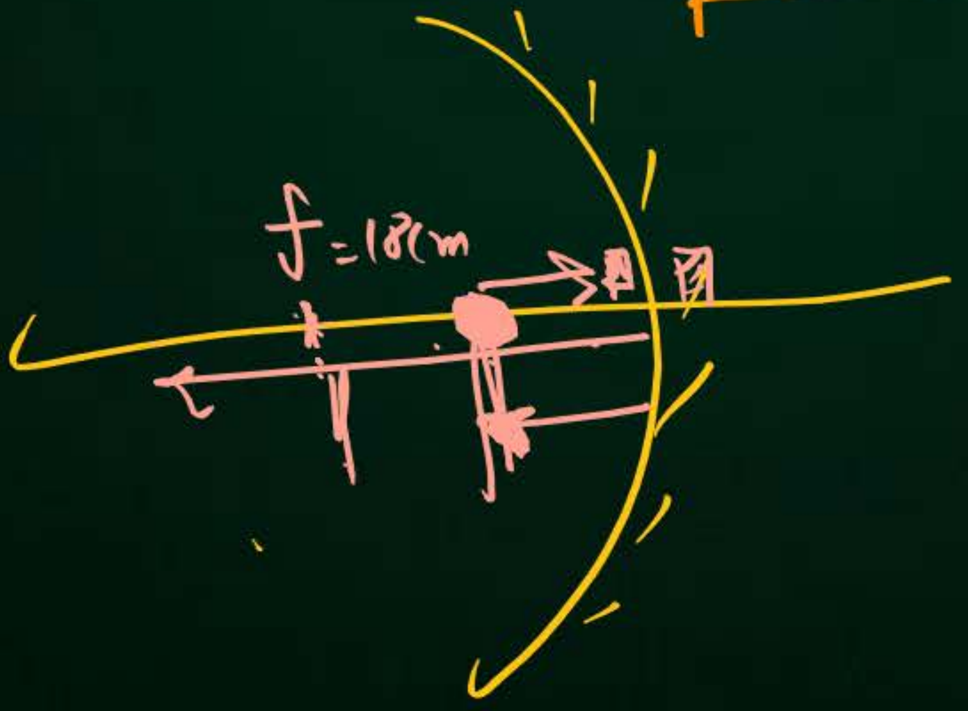
$m = \frac{f}{f-u}$

$3 = \frac{-18}{-18-u}$

$-18-u = -6$

$-18+6 = u$

$-12\,cm = u$



QUESTION

A convex mirror of focal length f forms an image which is $1/n$ times the object. The distance of the object from the mirror is

1. $(n-1)f$
2. $\sqrt{2}$
3. $\left(n+\frac{1}{n}\right)f$
4. $(n+1)f$

$m = \frac{f}{f-u}$

$\frac{1}{n} = \frac{f}{f-u}$

$nf = f-u$

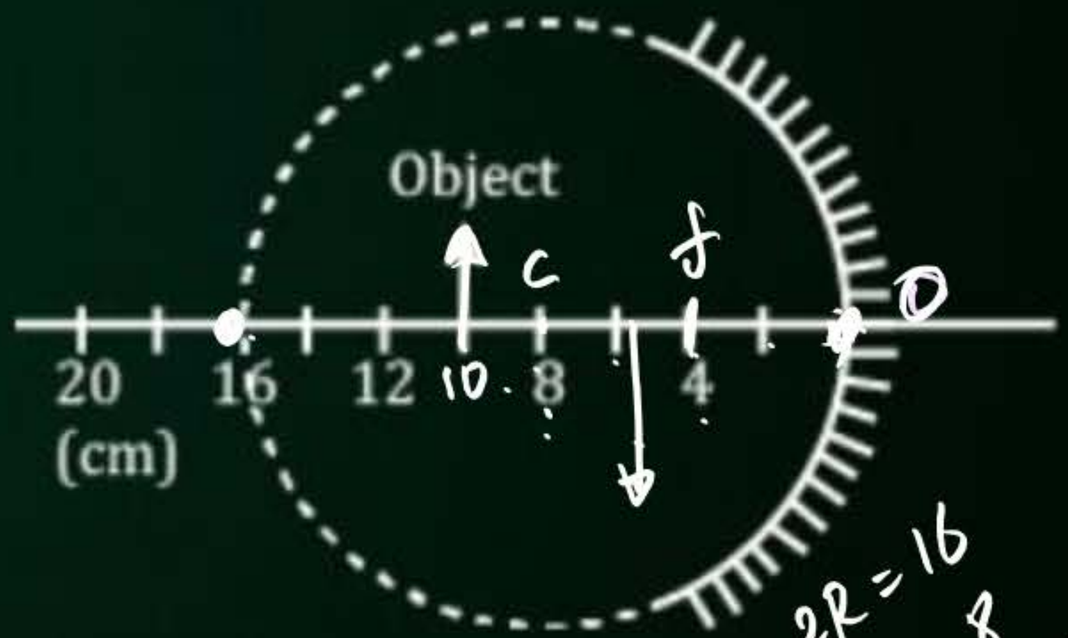
$u = f - nf$

$u = f(1-n)$

QUESTION

A spherical mirror is obtained as shown in the figure from a hollow glass sphere, if an object is positioned infront of the mirror, what will be the nature and magnification of the image of the object? (Figure drawn as schematic and not to scale)

[2 Sep, 2020 (Shift-I)]



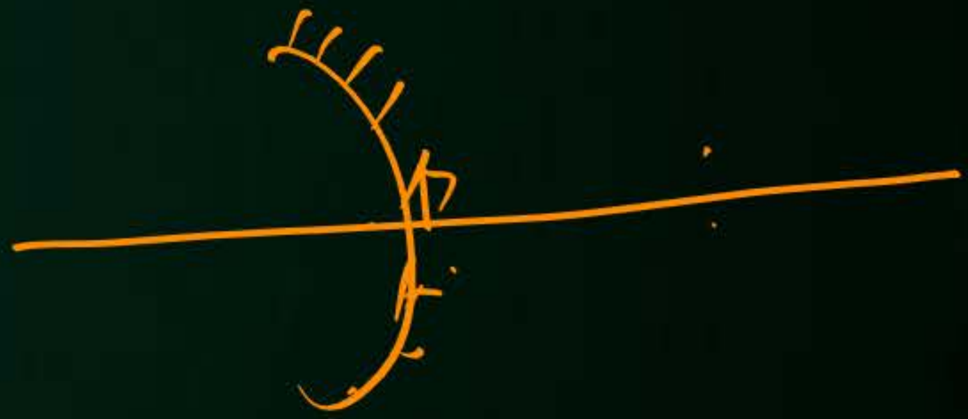
1. Inverted, real and magnified
2. Erect, virtual and unmagnified
3. Inverted, real and unmagnified
4. Erect, virtual and magnified

QUESTION

A short straight object of height 100 cm lies before the central axis of a spherical mirror whose focal length has absolute value $|f| = 40$ cm. The image of object produced by the mirror is of height 25 cm and has the same orientation of the object. One may conclude from the information.

[26 Feb, 2021 (Shift-I)]

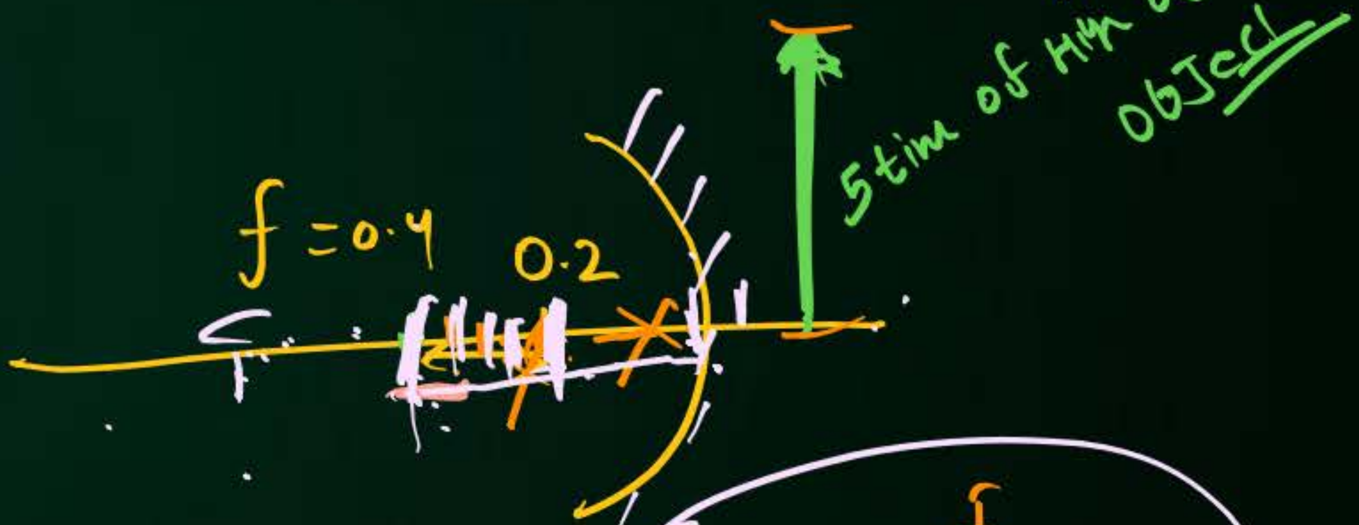
1. Image is virtual, opposite side of concave mirror.
2. Image is real, same side of convex mirror.
3. Image is real, same side of concave mirror.
4. Image is virtual, opposite side of convex mirror.



QUESTION

A concave mirror for face viewing has focal length of 0.4 m. The distance at which you hold the mirror from your face in other to see your image upright with a magnification of 5 is : [9 April, 2019 (Shift-I)]

1. 1.60 m
2. 0.24 m
3. 0.16 m
4. 0.32 m



$$m = \frac{f}{f-u}$$

$$5 = \frac{-0.4}{-0.4-u}$$

$$-2-5u = -0.4$$

$$-2+0.4 = 5u$$

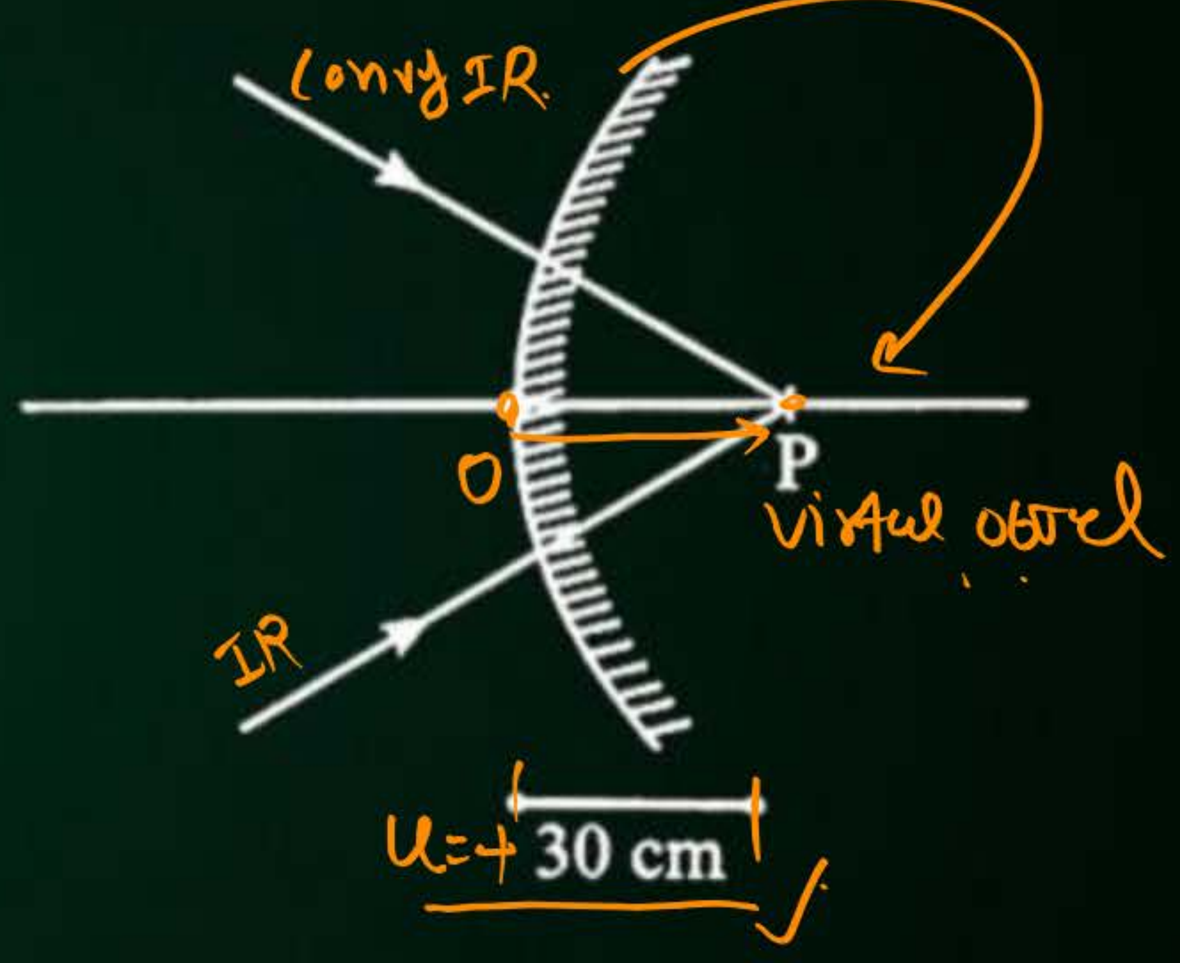
$$\frac{-1.6}{5} = u$$

$$u = 0.32\,m$$

QUESTION

A light beam converges towards a convex mirror of focal length 20 cm as shown in the figure below, the position of the image is

$f = +20\text{ cm}$



(1) 60 cm ✓

(2) 90 cm

(3) 75 cm

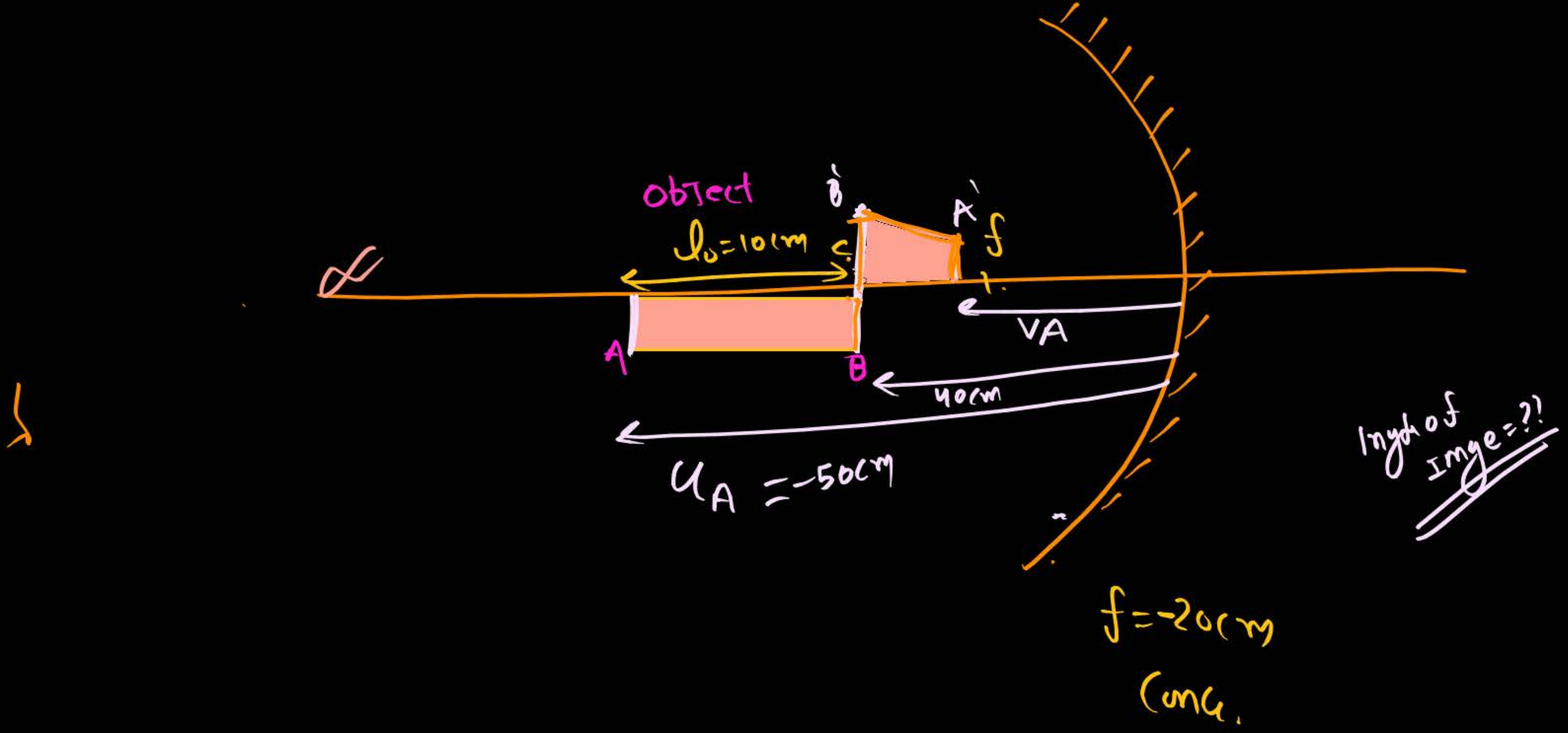
(4) 45 cm

$$\frac{1}{v} = \frac{1}{f} - \frac{1}{u}$$

$$= \frac{1}{20} - \frac{1}{30}$$

$$\frac{1}{v} = \frac{3-2}{60} = \frac{1}{60}$$

$v = 60$ cm



Object
$l_0 = 10\,cm$
A
B
B'
A'
f
VA
40cm
$u_A = -50\,cm$
lngth of Imge = ??
f = -20cm
Conc.

QUESTION

An object of height 1.5 cm is situated a, a distance of 15 cm from a concave mirror. The concave mirror forms its real image of height 3.0 cm. The focal length of concave mirror will be

1. –10 cm
2. –20 cm
3. 20 cm
4. 30 cm

QUESTION

A point object is placed at a distance of 10 cm and its real image is formed at a distance of 20 cm from a concave mirror. If the object is moved by 0.1 cm towards the mirror, the image will shift by about.

1. 0.4 cm away from the mirror
2. 0.4 cm towards the mirror
3. 0.8 cm away from the mirror
4. 0.8 cm towards the mirror

QUESTION

A concave mirror of focal length f produces an image n times the size of the object. If the image is real then the distance of the object from the mirror is

1. $(n-1)f$
2. $\left\{\frac{(n-1)}{n}\right\}f$
3. $\left\{\frac{(n+1)}{n}\right\}f$
4. $(n+1)f$

QUESTION

Magnification produced by a convex mirror is 1/3, then distance of the object from mirror is

1. $f/3$
2. $2f/3$
3. $1f$
4. $2f$

QUESTION

A convex mirror has a focal length f. A real object is placed at a distance f in front of it, from the pole. It produces an image at

1. Infinity
2. f
3. $f/2$
4. $2f$

QUESTION

An object placed in front of a concave mirror of focal length 0.15 m produces a virtual image, which is twice the size of the object. The position of the object with respect to the mirror is

1. –5.5 cm
2. –6.5 cm
3. –7.5 cm
4. –8.5 cm

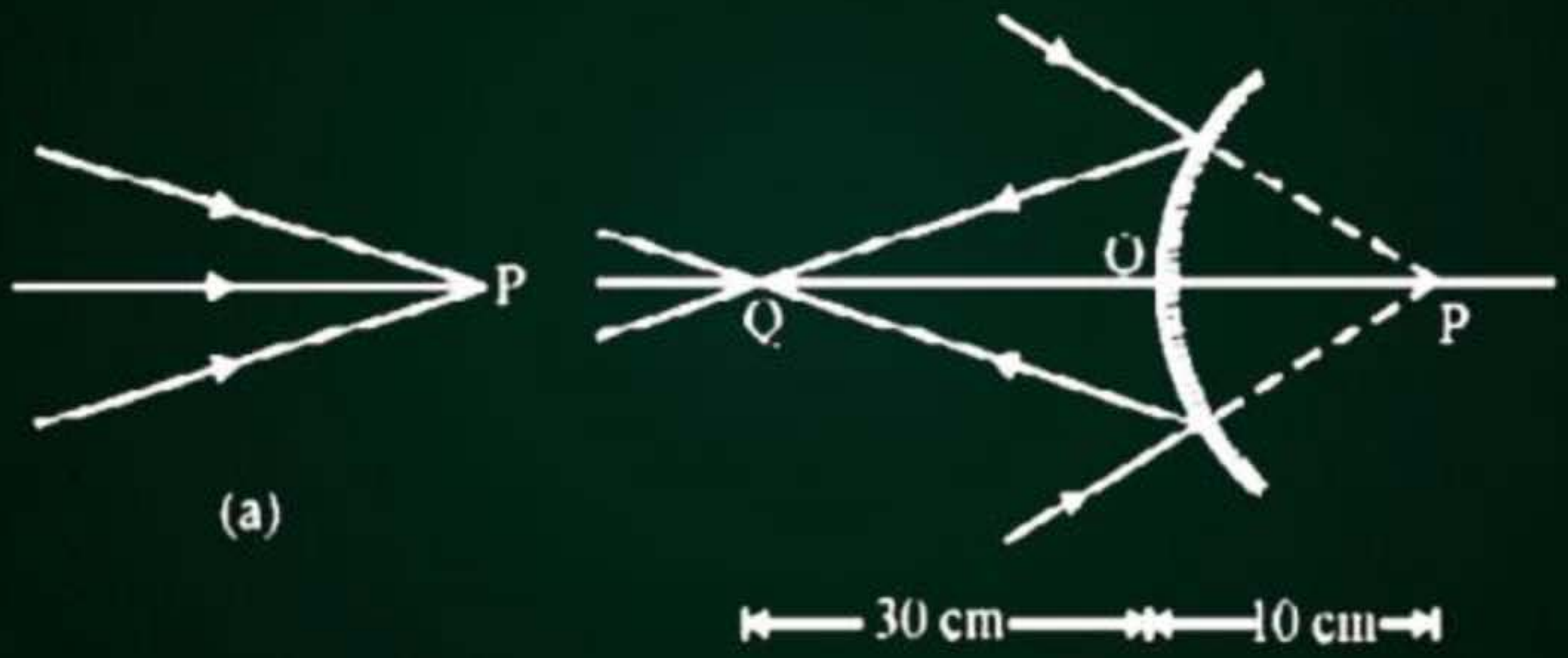
QUESTION

A rod of length 10 cm lies along the principal axis of a concave mirror of focal length 10 cm in such a way that its end closer to the pole is 20 cm away from the mirror. The length of the image is (Mains 2012)

1. 10 cm
2. 15 cm
3. 2.5 cm
4. 5 cm

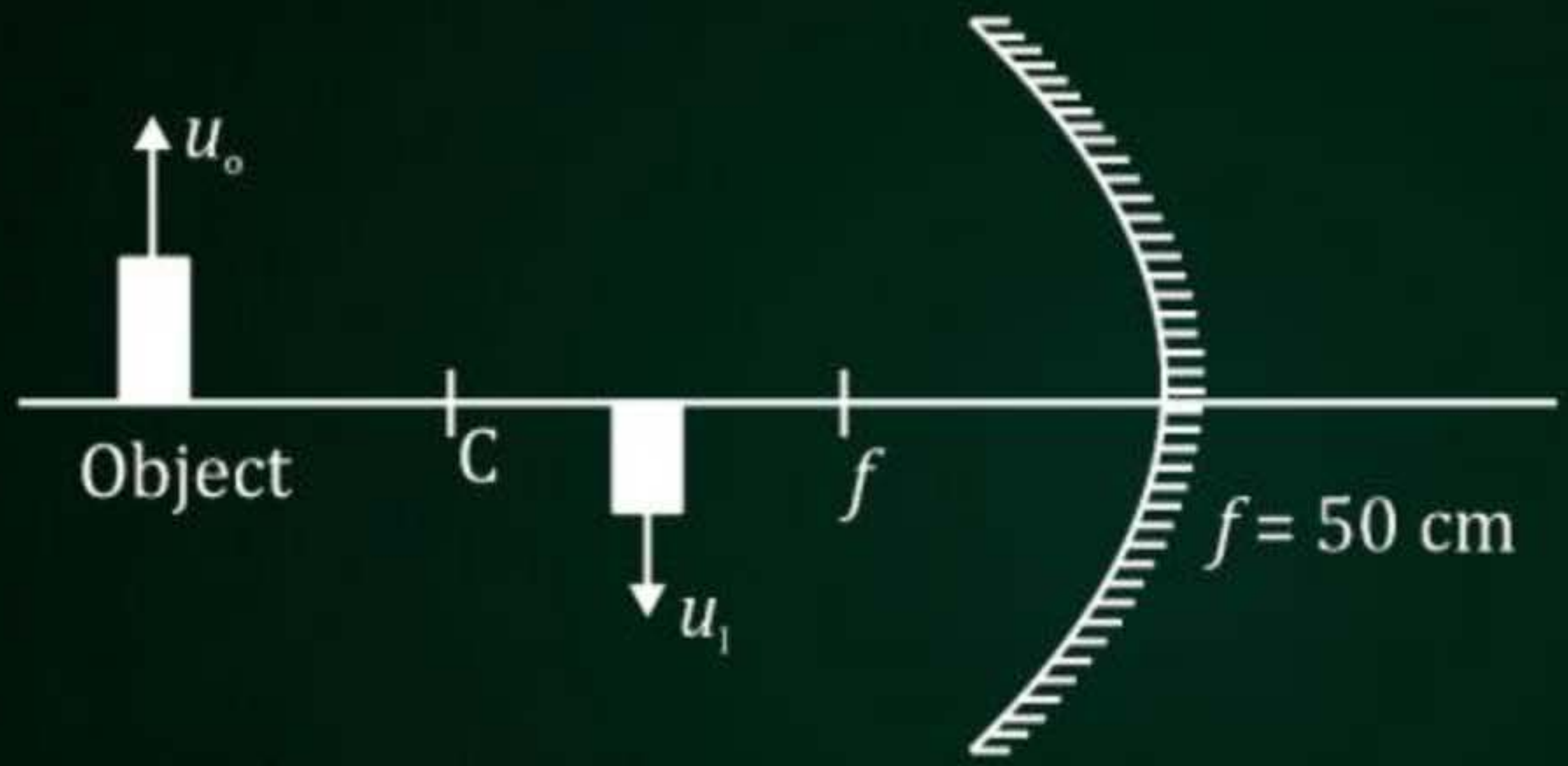
QUESTION

A beam of light converges towards a point P as shown in figure. A convex mirror is placed in the path of beam at distance of 10 cm in front of P. What is position and nature of image formed ? Radius of curvature of mirror is 30 cm.



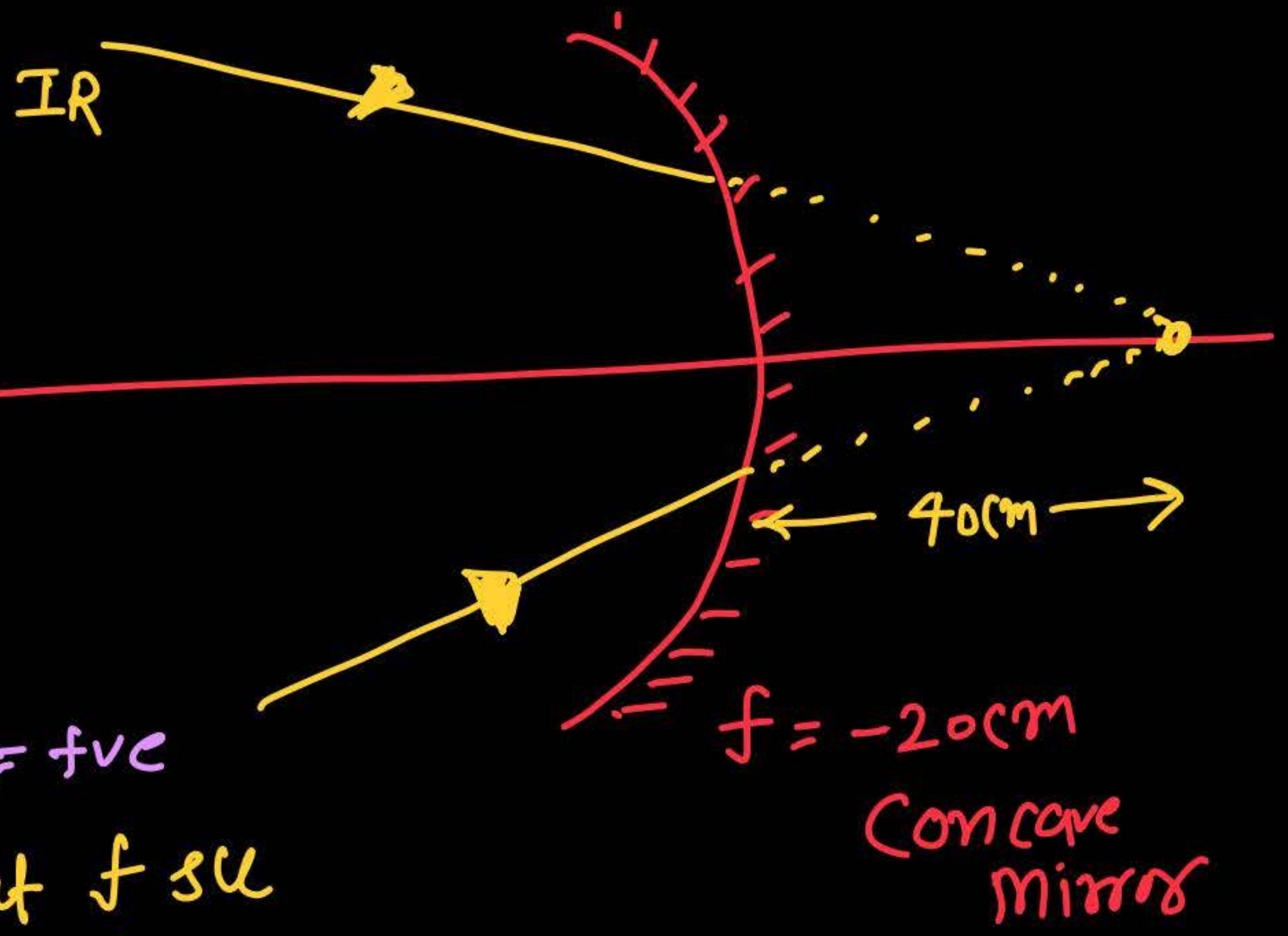
QUESTION

Velocity of image in case of concave mirror.



Object is moving perpendicular to principle axis.

for given I.R. if mirror was not there then, it will converges at 40cm from mirror then find Image distance.



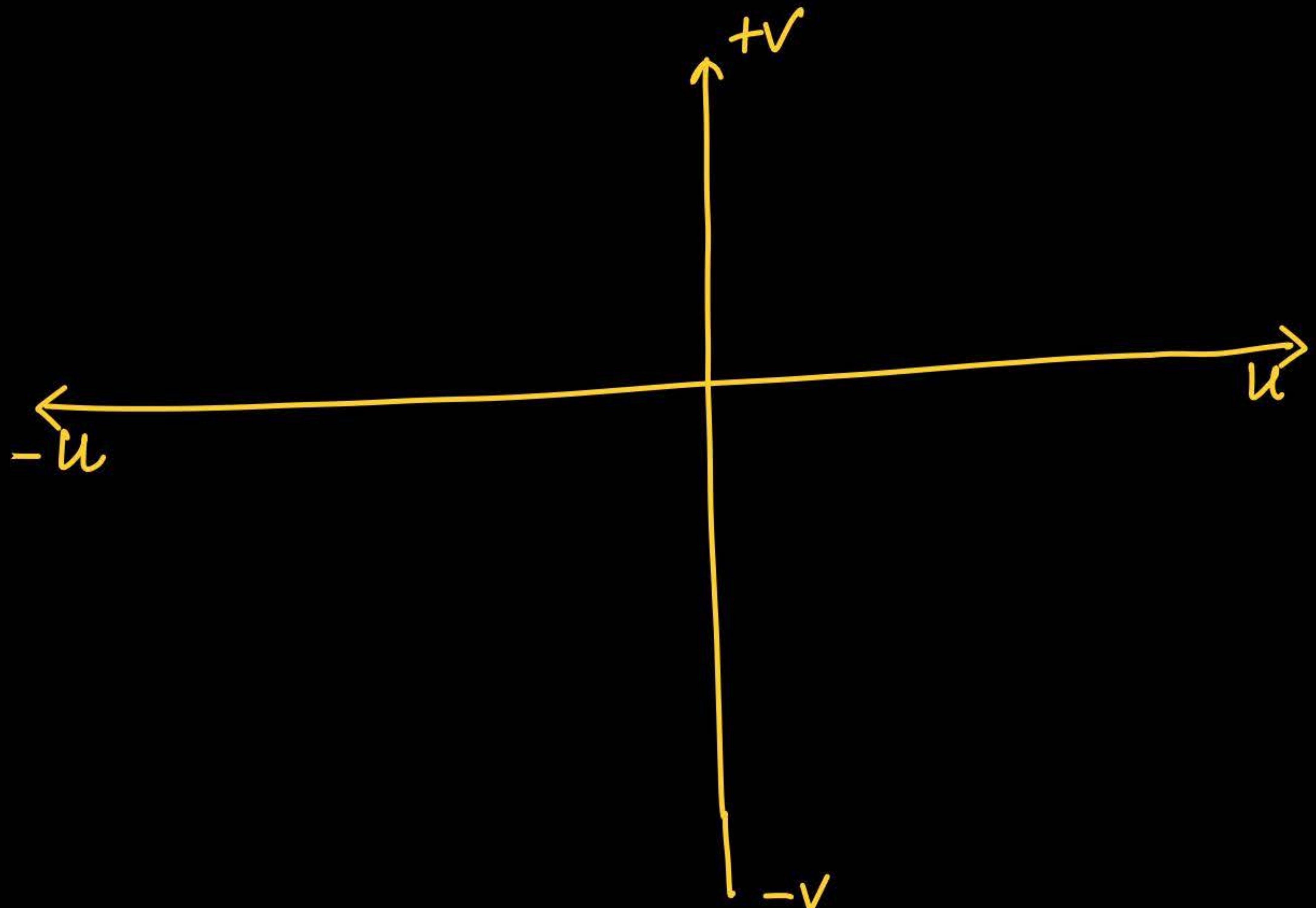
hint:- virtual object is here
here u = +ve

$$\frac{1}{v} = \frac{1}{f} - \frac{1}{u}$$ (Now put f & u with sign)

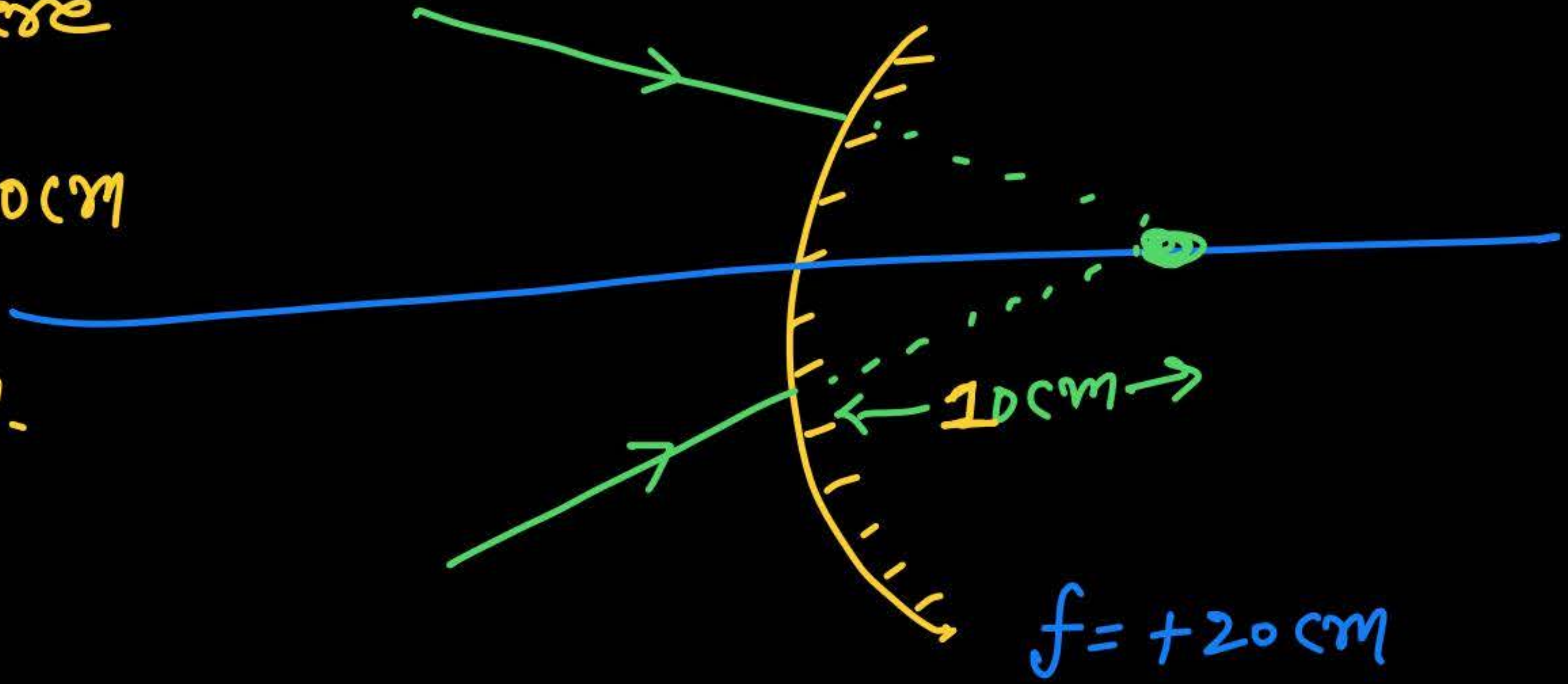
$$\frac{1}{v} = -\frac{1}{20} - \frac{1}{u}$$

dono term –ve hoga to open your 3rd eye.

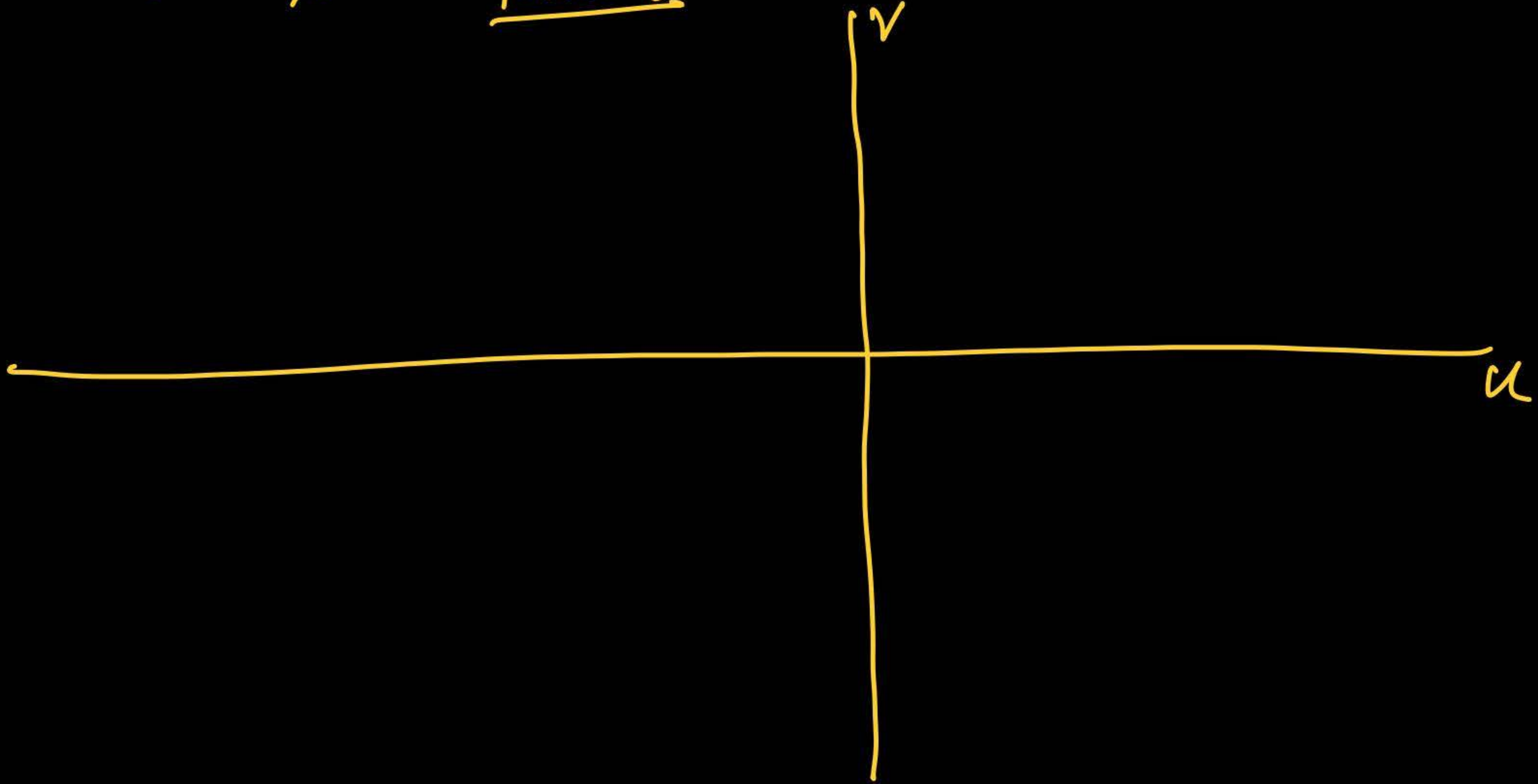
use data of above two question draw u/v grap for concave mirror.



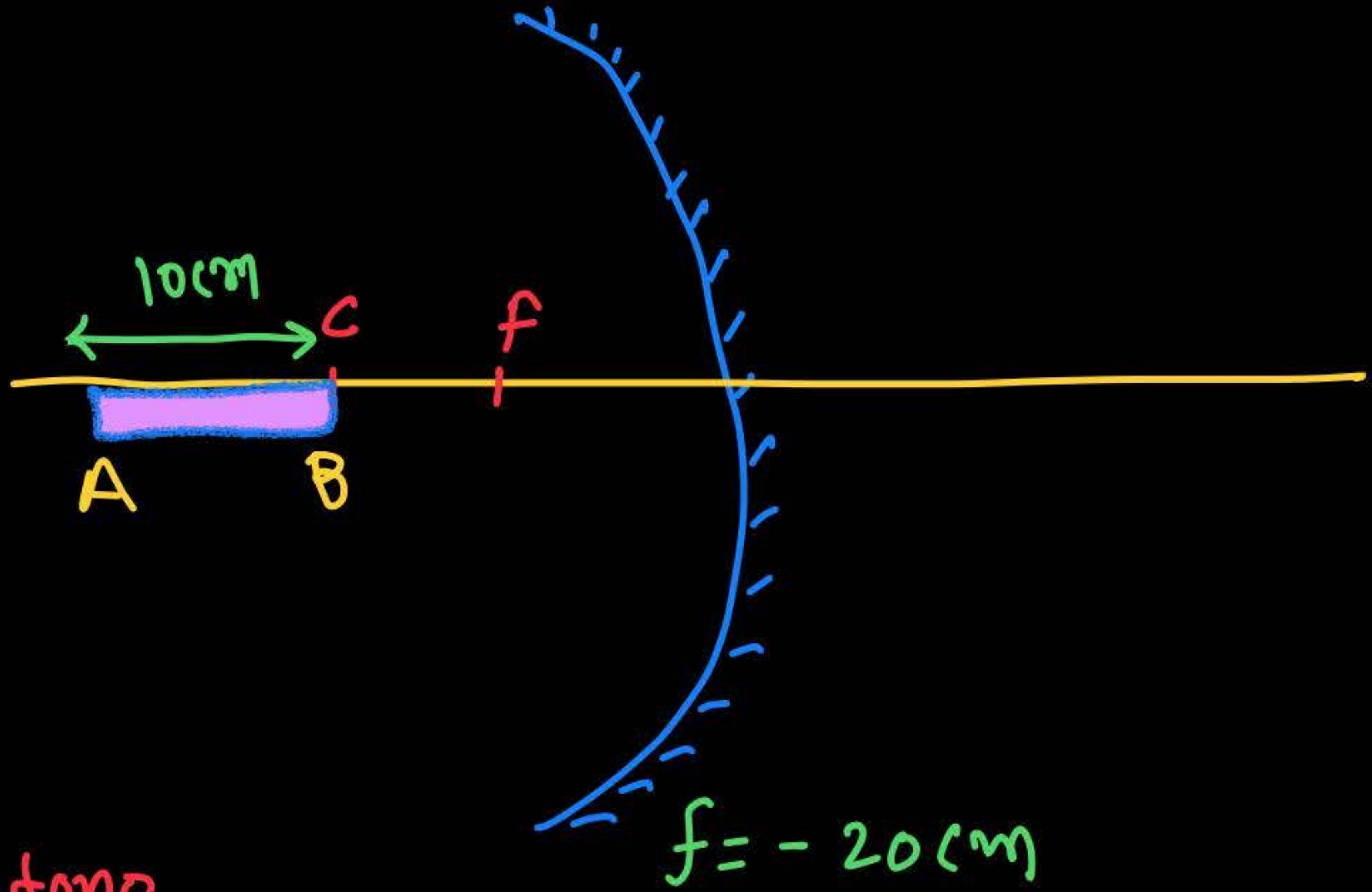
if mirror was not there then incident rays conveg. at distance 10cm from mirror then find Image distn.



use above two question and Draw u/v graph for convex mirror

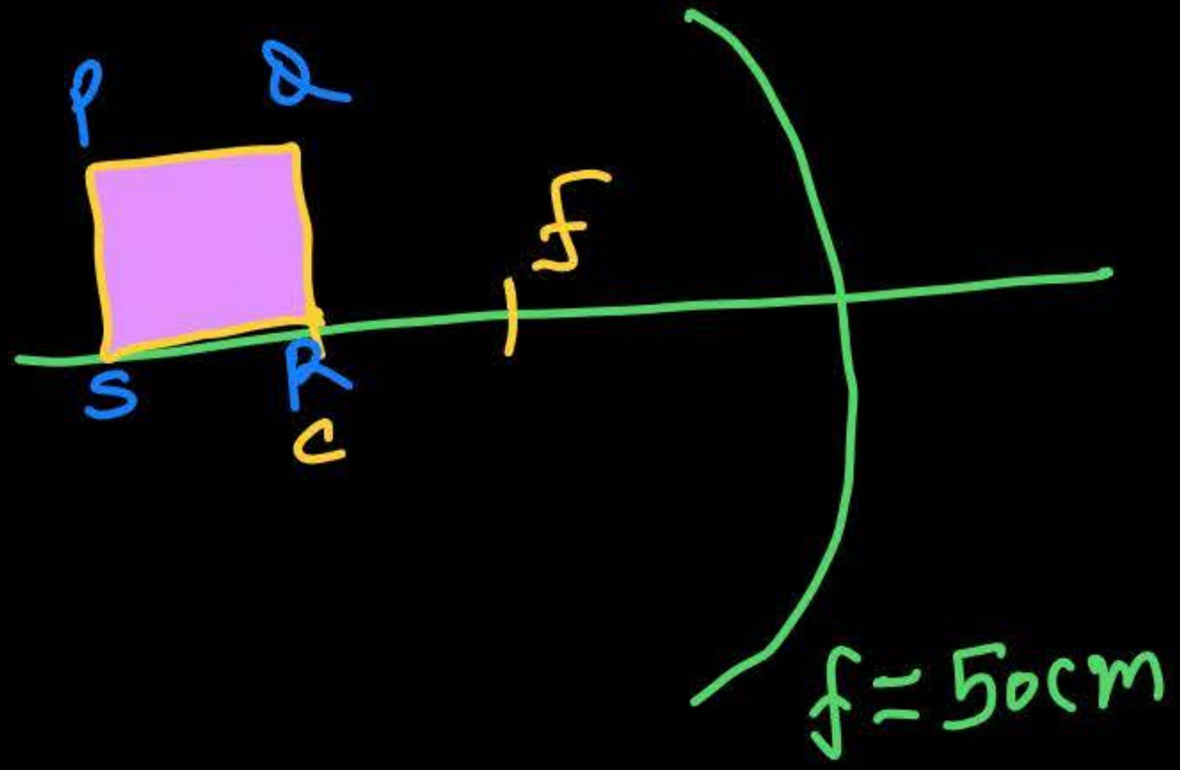


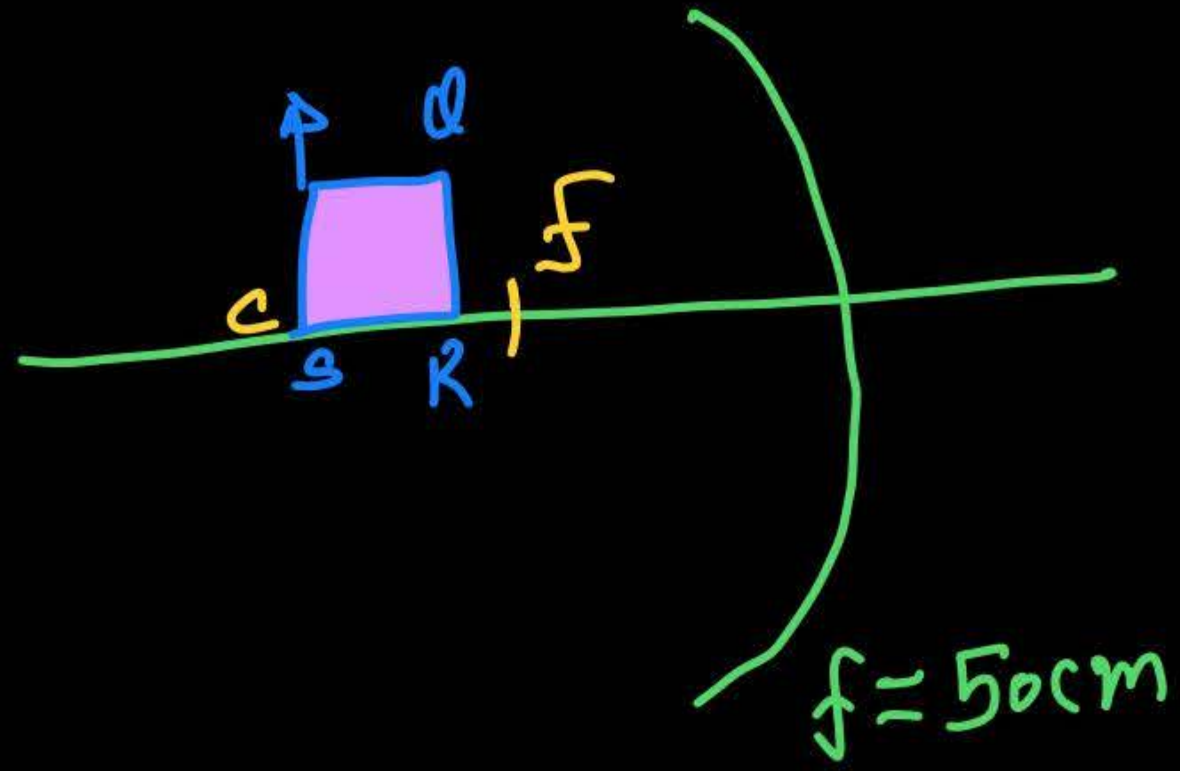
object of length 10 cm placed along principle axis as shown in figure. then find length of Image of Rod.



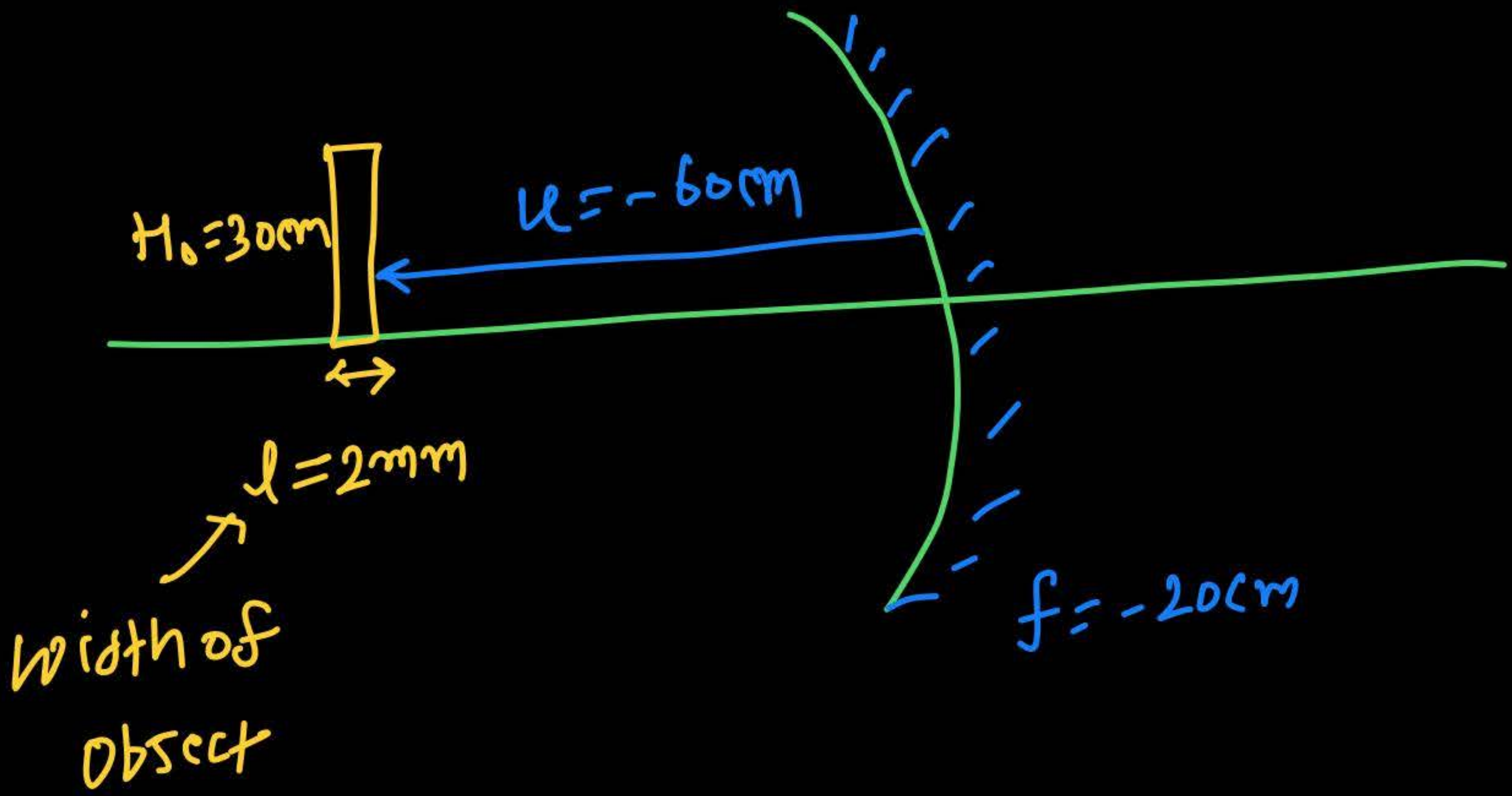
Soln

hint Rod ke dono end ka Image bna lo uske bich ka length length of Image hoga.





Draw rough Image of cube in each case.



find width of Image


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 06 | Physics

Ray Optics and Optical Instruments



By- Dr. Manish Raj (MR SIR)

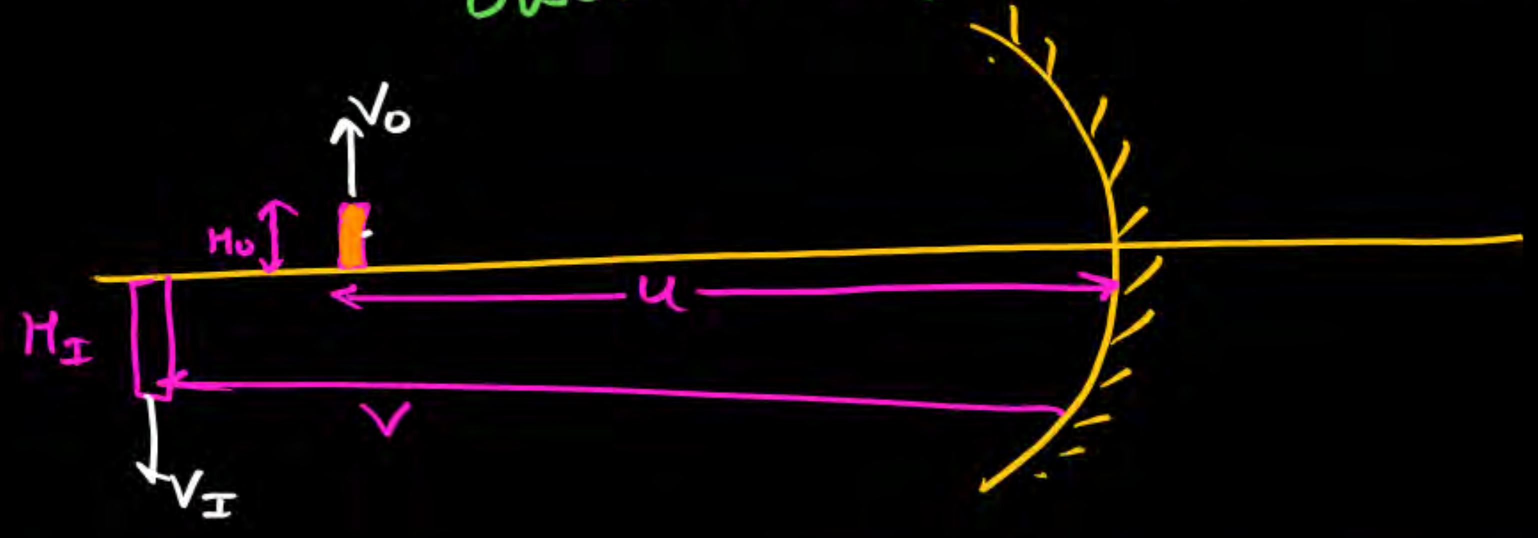
Todays Topic

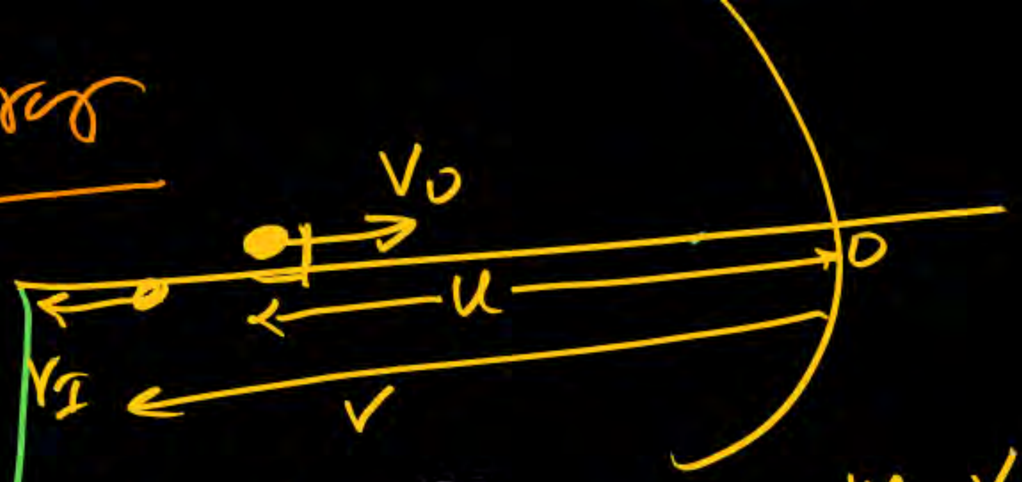
H/W

Refraction

Velocity of Image in concave & convex mirror

object is moving ⊥r to the mirror





$$m_T = \frac{H_I}{H_0}$$

$$H_I = H_0 m_T$$

diff^n w.r.t time

$$\frac{dH_I}{dt} = m_T \frac{dH_0}{dt}$$

$$\boxed{V_I = m_T V_0}$$

$$\frac{dv}{dt} = V_I \quad \text{— (1)}$$

$$\frac{du}{dt} = V_0 \quad \text{— (2)}$$

$$\frac{\frac{dv}{dt}}{\frac{du}{dt}} = \frac{V_I}{V_0}$$

$$m_T^2 = m_l = \left(\frac{dv}{du}\right) = \frac{V_I}{V_0}$$

$$\boxed{V_I = V_0 m_T^2}$$

#

Object at 'C'	object is b/w infinity & C	object b/w 'C' & 'f'
$m_T = 1$	$m_T < 1$	$m_T > 1$
$V_I = V_0$	$V_I < V_0$	$V_I > V_0$

QUESTION

A point object is placed at a distance of 10 cm and its real image is formed at a distance of 20 cm from a concave mirror. If the object is moved by 0.1 cm towards the mirror, the image will shift by about.

1. 0.4 cm away from the mirror
2. 0.4 cm towards the mirror
3. 0.8 cm away from the mirror
4. 0.8 cm towards the mirror

$m_T = \frac{v}{u} = \frac{20}{10} = 2$

$\frac{dv}{du} = m_L = m_T^2$

$dv = (2)^2 \times 0.1$

$= 0.4 \text{ cm}$



QUESTION

An object is moving towards a concave mirror of focal length 24 cm. When it is at a distance of 60 cm from the mirror its velocity is 9 cm/sec. The speed of its image at that instant, is

1. 4 cm/sec towards the mirror
2. 9 cm/sec towards the mirror
3. 4 cm/sec away from the mirror
4. 9 cm/sec away from the mirror

$f = 24\text{cm}$

$f = -24\text{cm}$

$u = -60\text{cm}$

$m_T = \frac{f}{f-u} = \frac{-24}{-24-(-60)} = \frac{-24}{36} = -\frac{2}{3}$

$m_T = -\frac{2}{3}$ Real Img (Inv)

$v_I = m_T^2 v_O$

$v_I = \frac{4}{9} \times 9$

QUESTION

An object of height 1.5 cm is situated a, a distance of 15 cm from a concave mirror. The concave mirror forms its real image of height 3.0 cm. The focal length of concave mirror will be

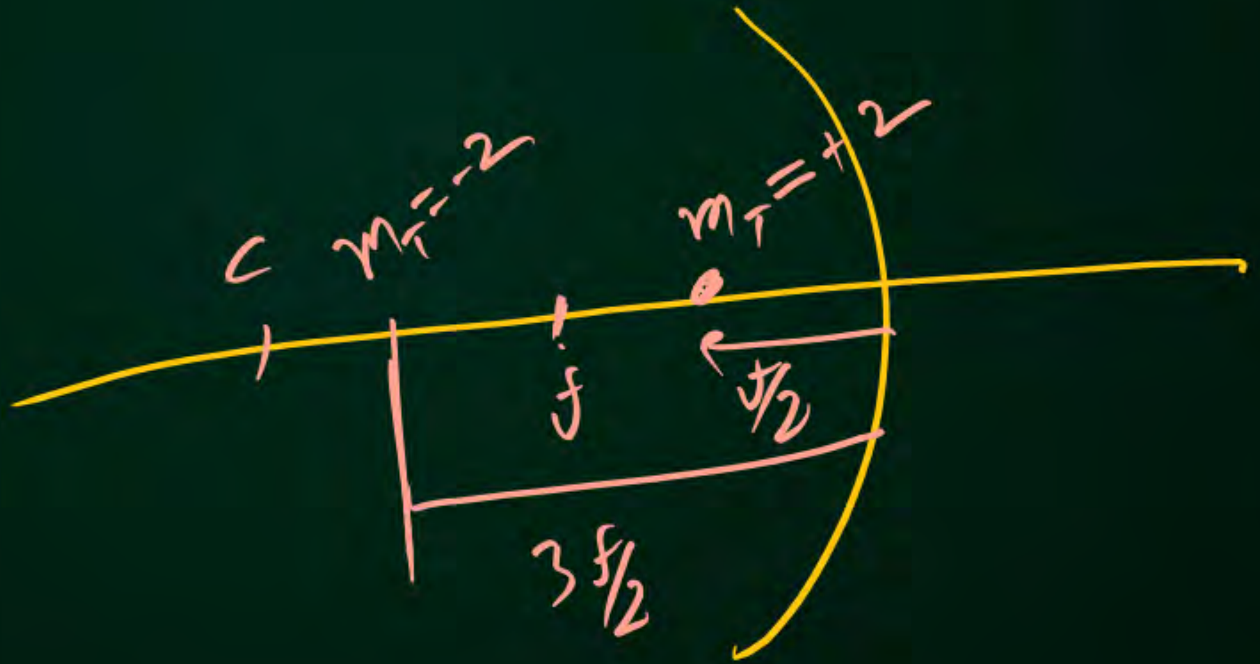
1. –10 cm
2. –20 cm
3. 20 cm
4. 30 cm

QUESTION

An object placed in front of a concave mirror of focal length 0.15 m produces a virtual image, which is twice the size of the object. The position of the object with respect to the mirror is

15cm

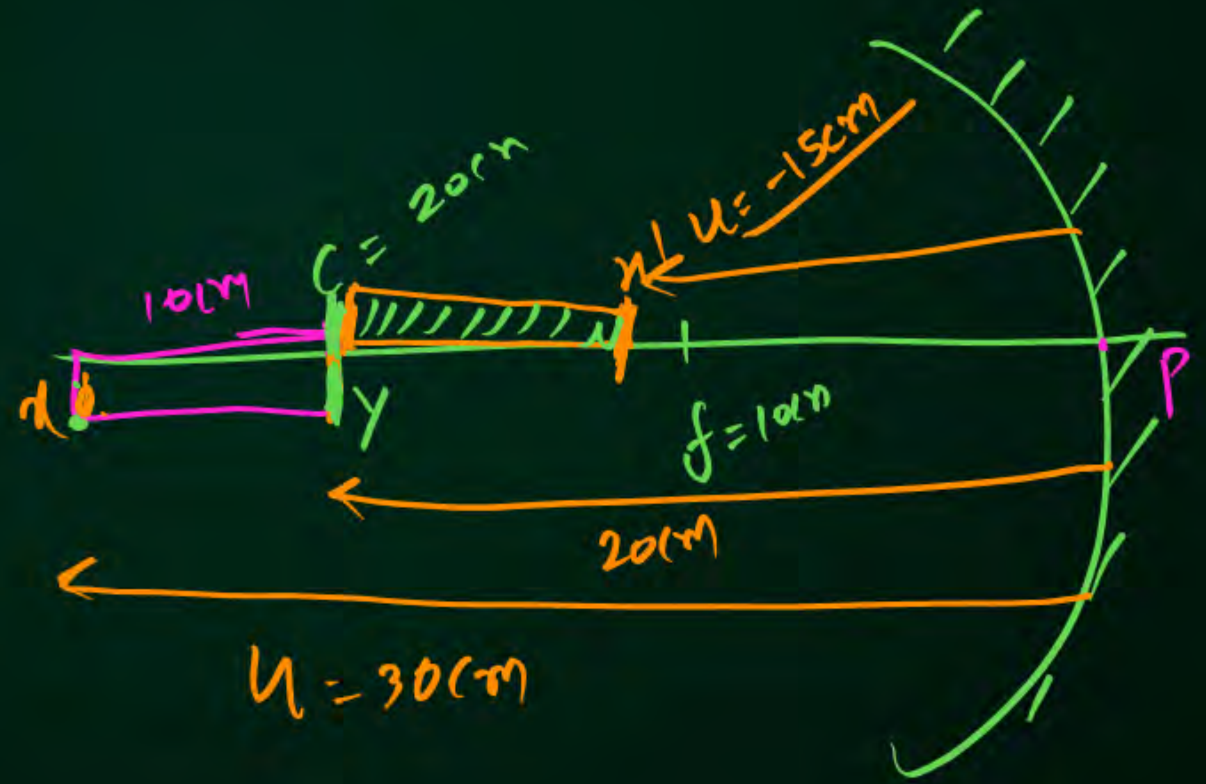
1. –5.5 cm
2. –6.5 cm
3. –7.5 cm (Ans)
4. –8.5 cm



QUESTION

A rod of length 10 cm lies along the principal axis of a concave mirror of focal length 10 cm in such a way that its end closer to the pole is 20 cm away from the mirror. The length of the image is (Mains 2012)

1. 10 cm
2. 15 cm
3. 2.5 cm
4. 5 cm



$\frac{1}{v} = \frac{1}{f} - \frac{1}{u}$

$= -\frac{1}{10} + \frac{1}{30}$

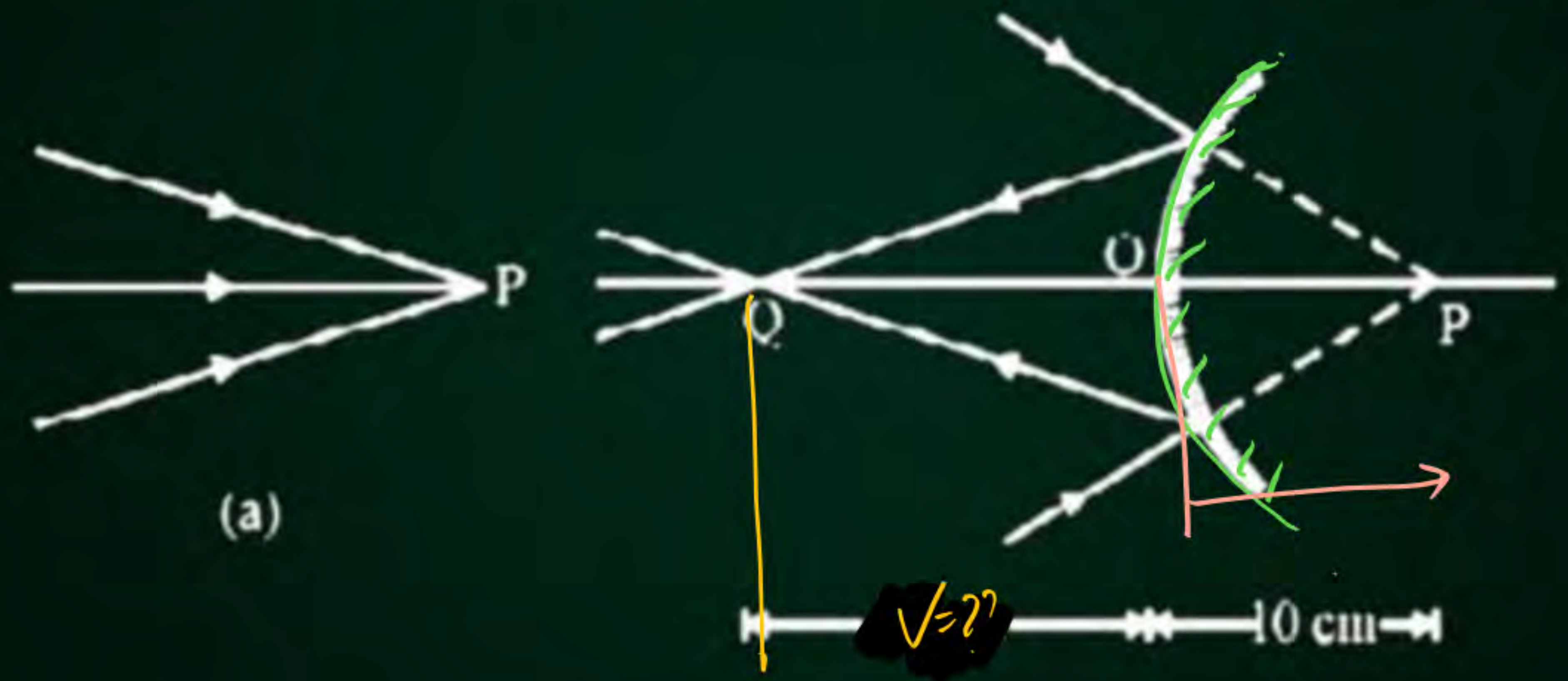
$= \frac{-3+1}{30}$

$v = \frac{30}{-2} = -15$

QUESTION

$$\frac{1}{v}+\frac{1}{u}=\frac{1}{f}$$

A beam of light converges towards a point P as shown in figure. A convex mirror is placed in the path of beam at distance of 10 cm in front of P. What is position and nature of image formed ? Radius of curvature of mirror is 30 cm. $\Rightarrow f = +15\,cm$



$u = 10\,cm$

$\frac{1}{v} = \frac{1}{f} - \frac{1}{u}$

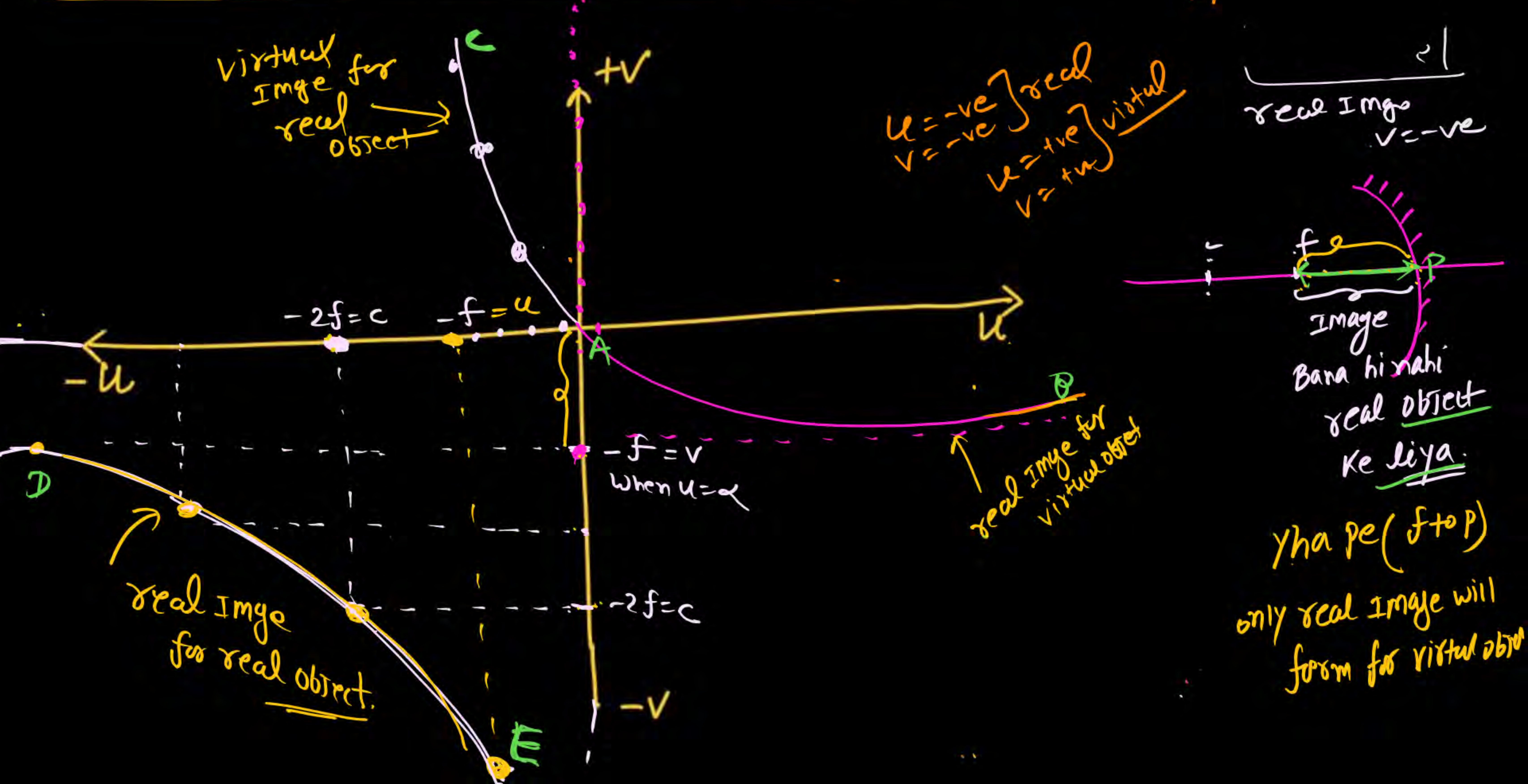
$\frac{1}{v} = \frac{1}{15} - \frac{1}{10}$

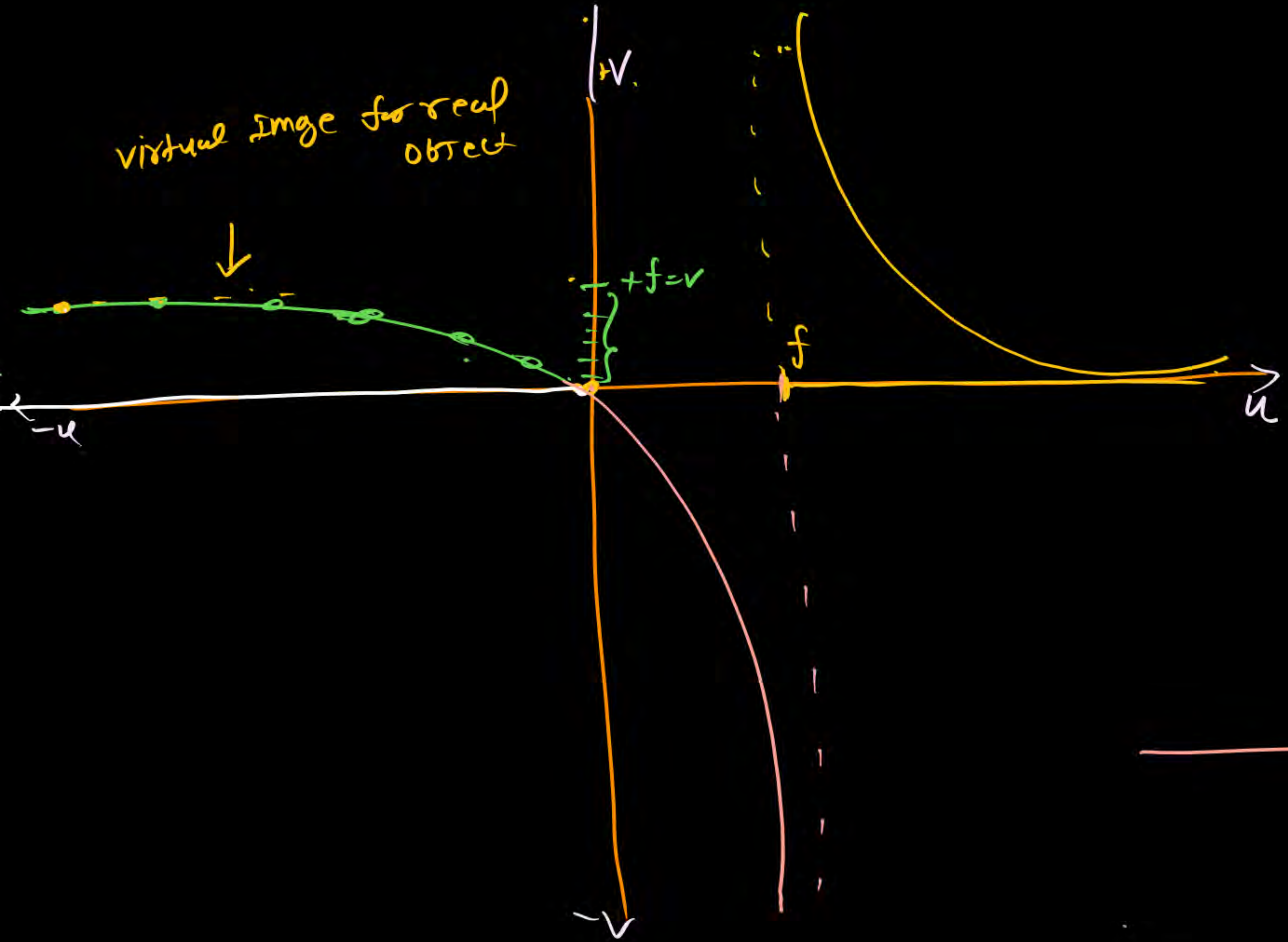
$\frac{1}{v} = \frac{2-3}{30}$

$v = \frac{30}{-1}$

$v = -30$ → real Img

Concave mirror





Convex mirror

u = -ve (real obj)

V = must be +ve only B/w Pole & focus

for virtual object

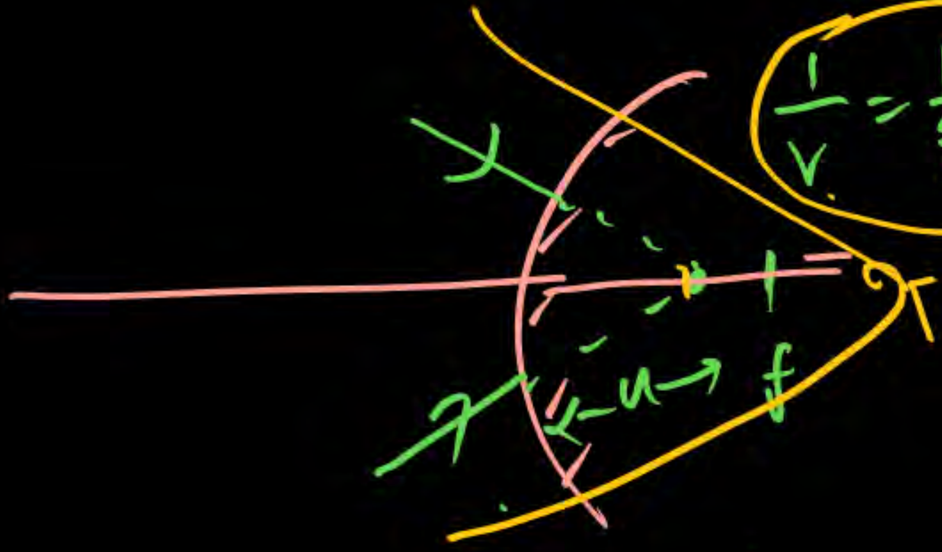
u = +ve

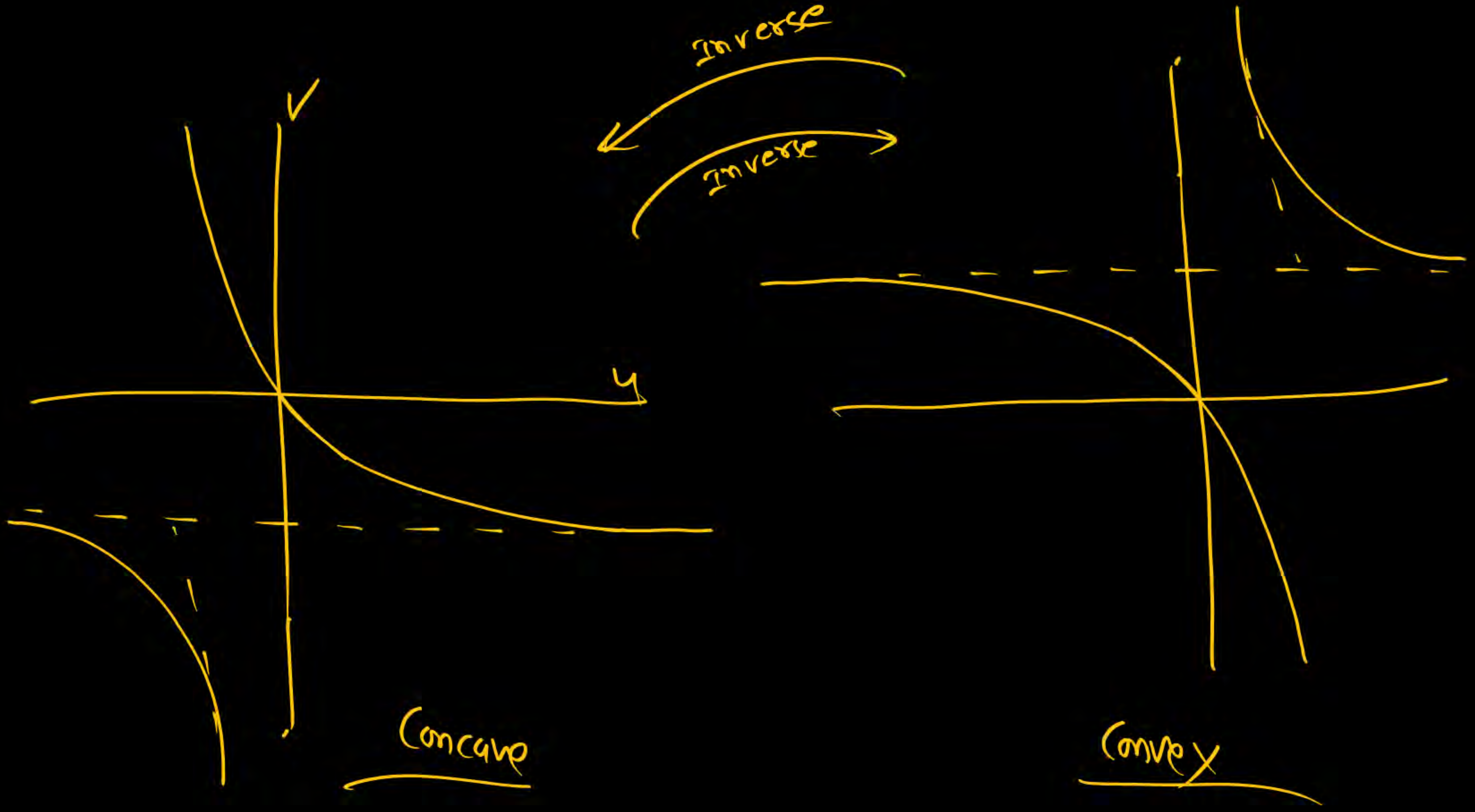
Convex

f = +ve

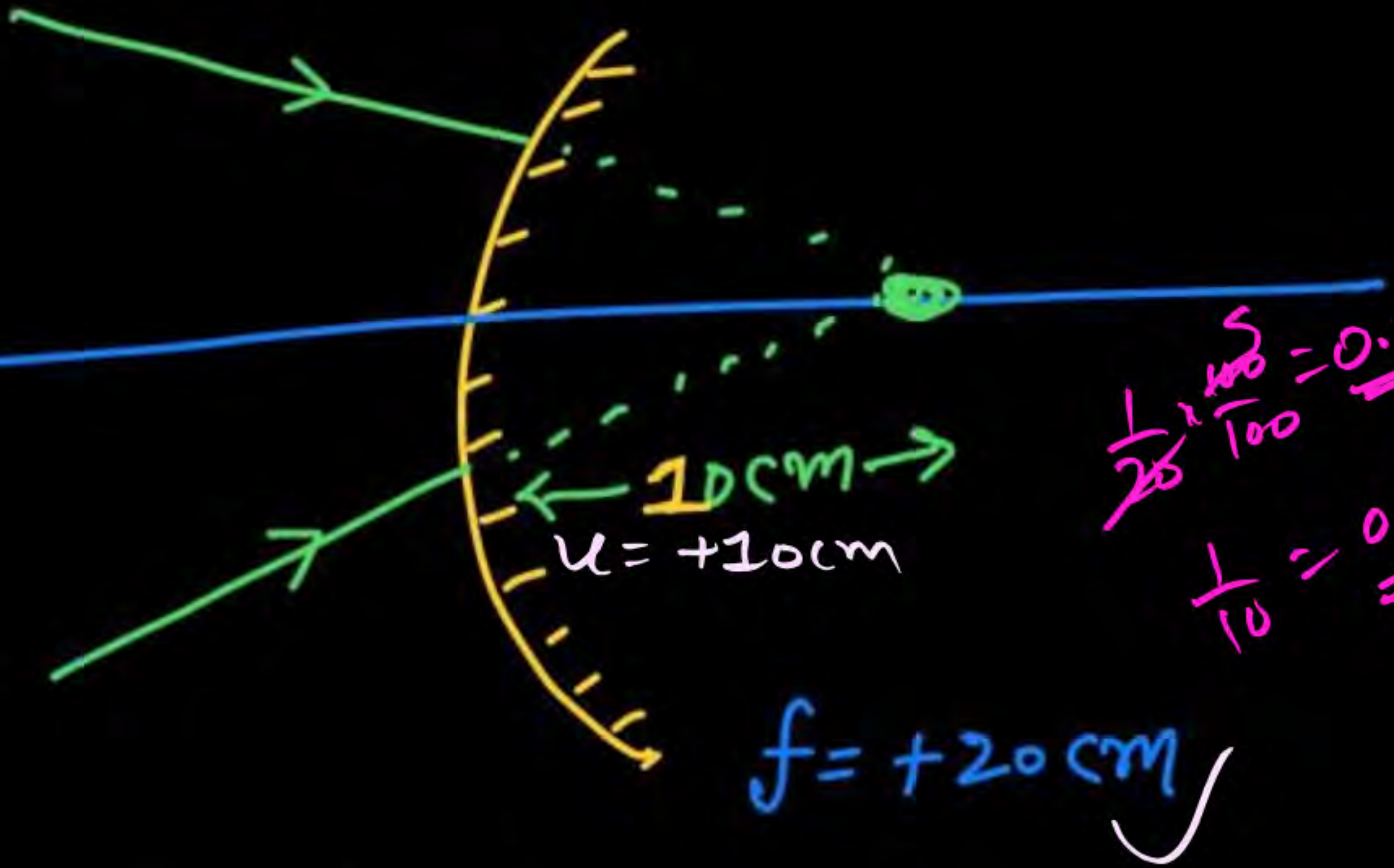
u < f

$\frac{1}{v} = \frac{1}{f} - \frac{1}{u}$




Inverse
Inverse
y
Concave
Convex

if mirror was not there then incident rays converg. at distance 10 cm from mirror then find Image distn.



$\frac{1}{20} \times \frac{100}{100} = \frac{5}{100} = 0.05$

$\frac{1}{10} = 0.1$

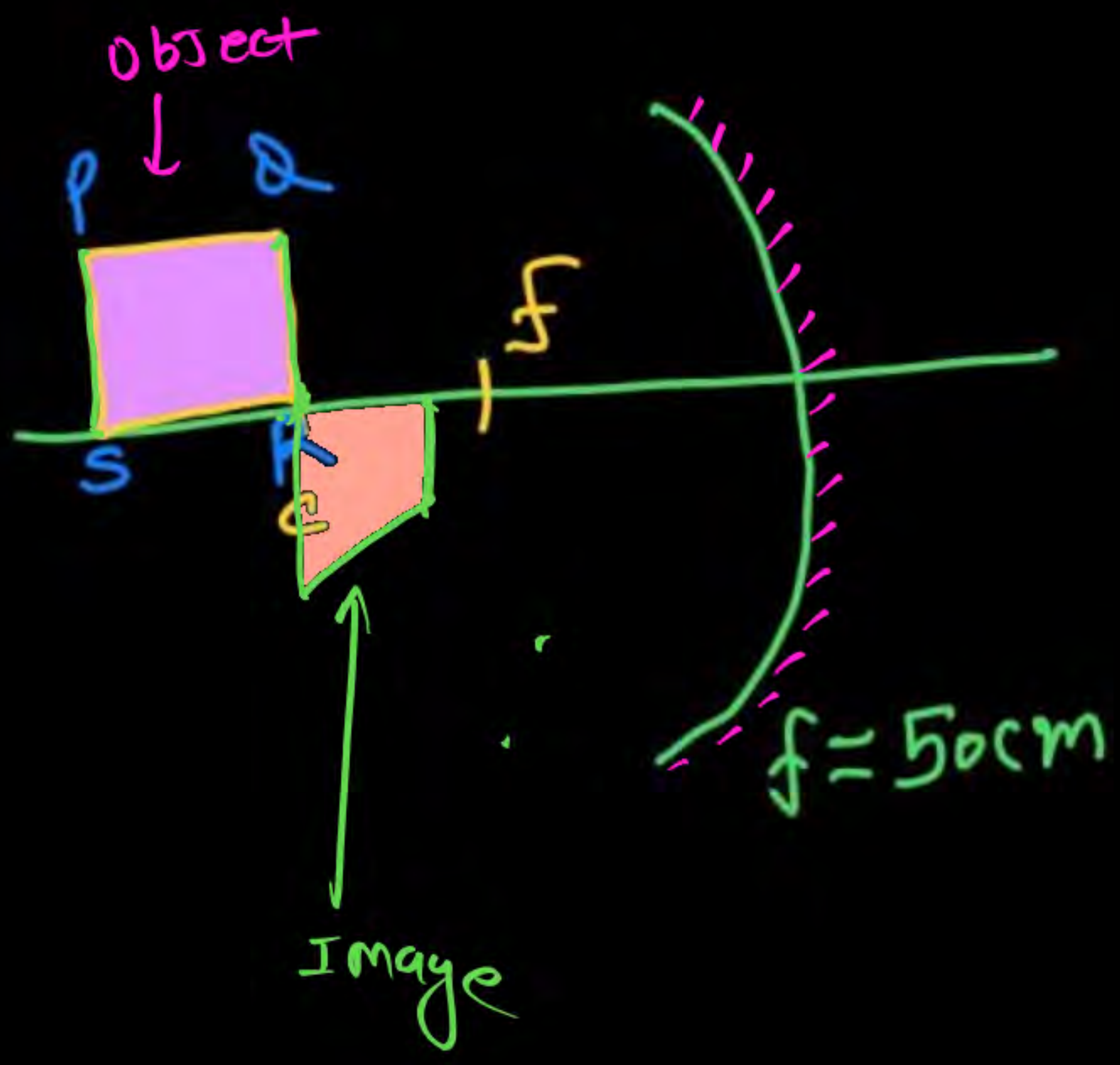
$$\frac{1}{v} = \frac{1}{f} - \frac{1}{u}$$

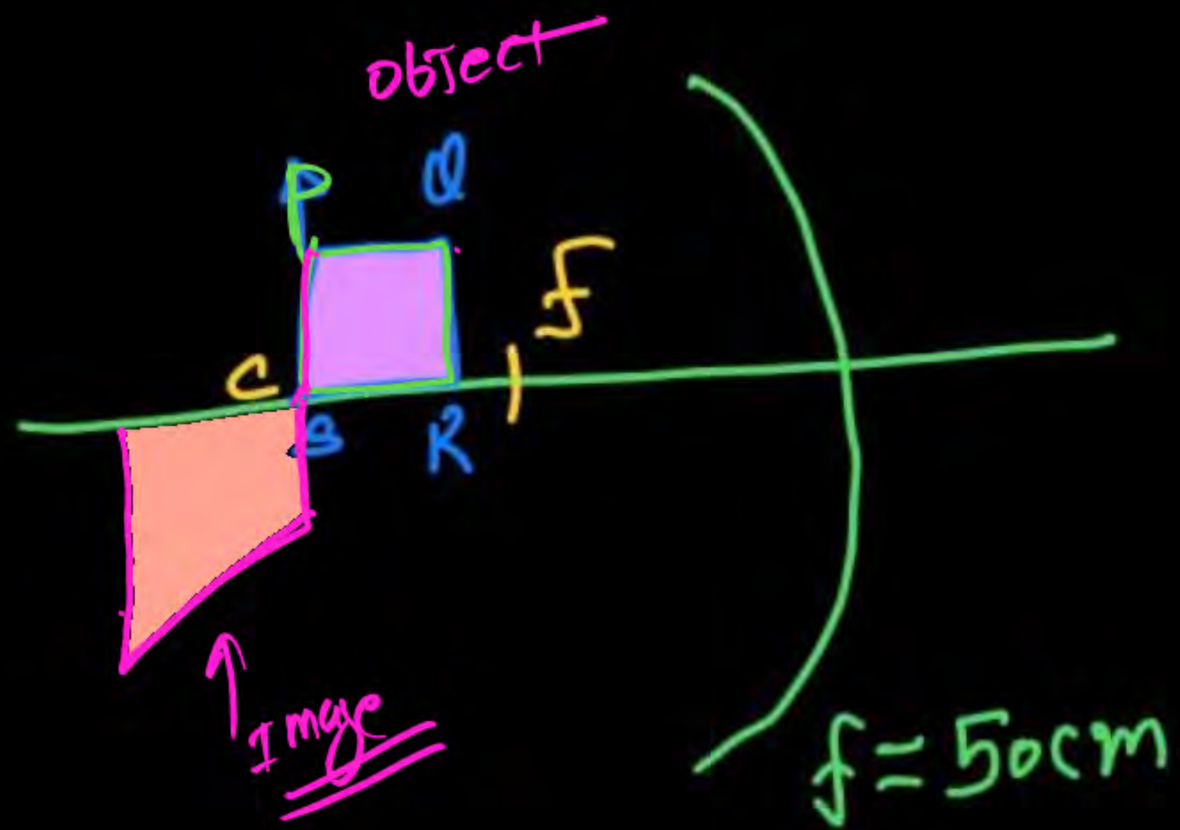
$$\frac{1}{v} = \frac{1}{20} - \frac{1}{10}$$

$$\frac{1}{v} = \frac{1-2}{20} = \frac{-1}{20}$$

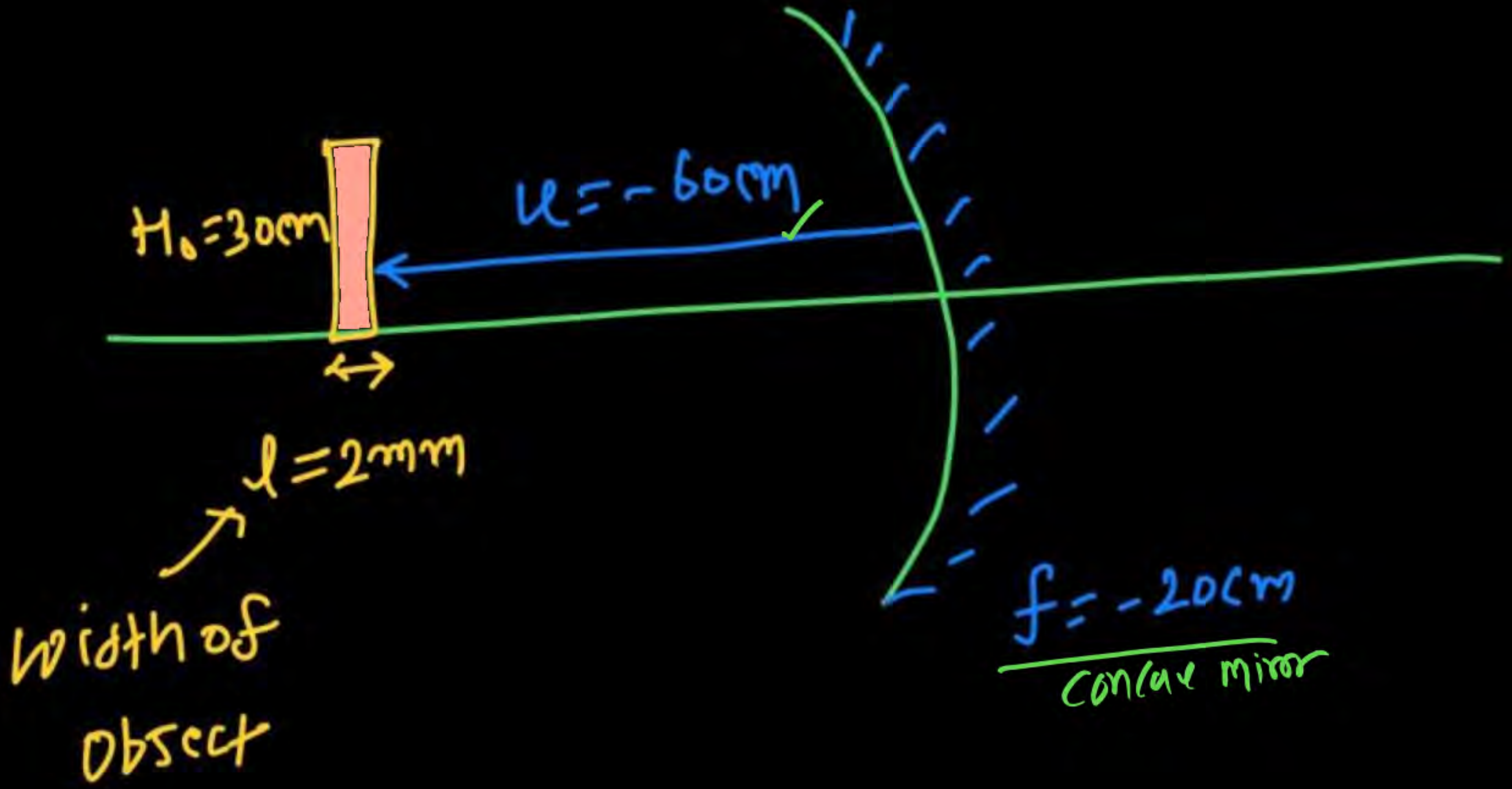
$$v = -20\text{ cm}$$

v = −ve real Image





Draw rough Image of cube in each case.



find width of Image

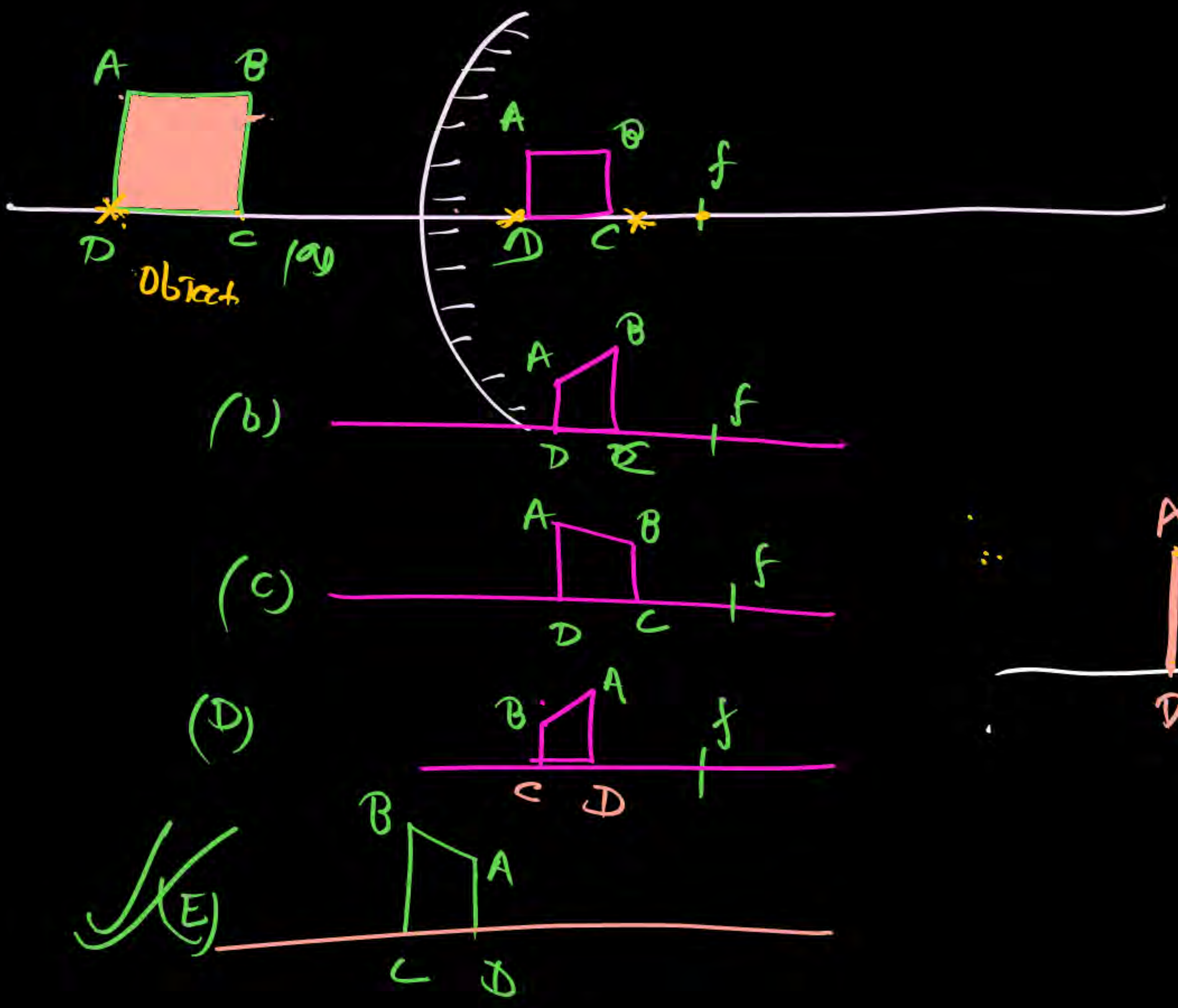
$$m_T = \frac{f}{f-u}$$

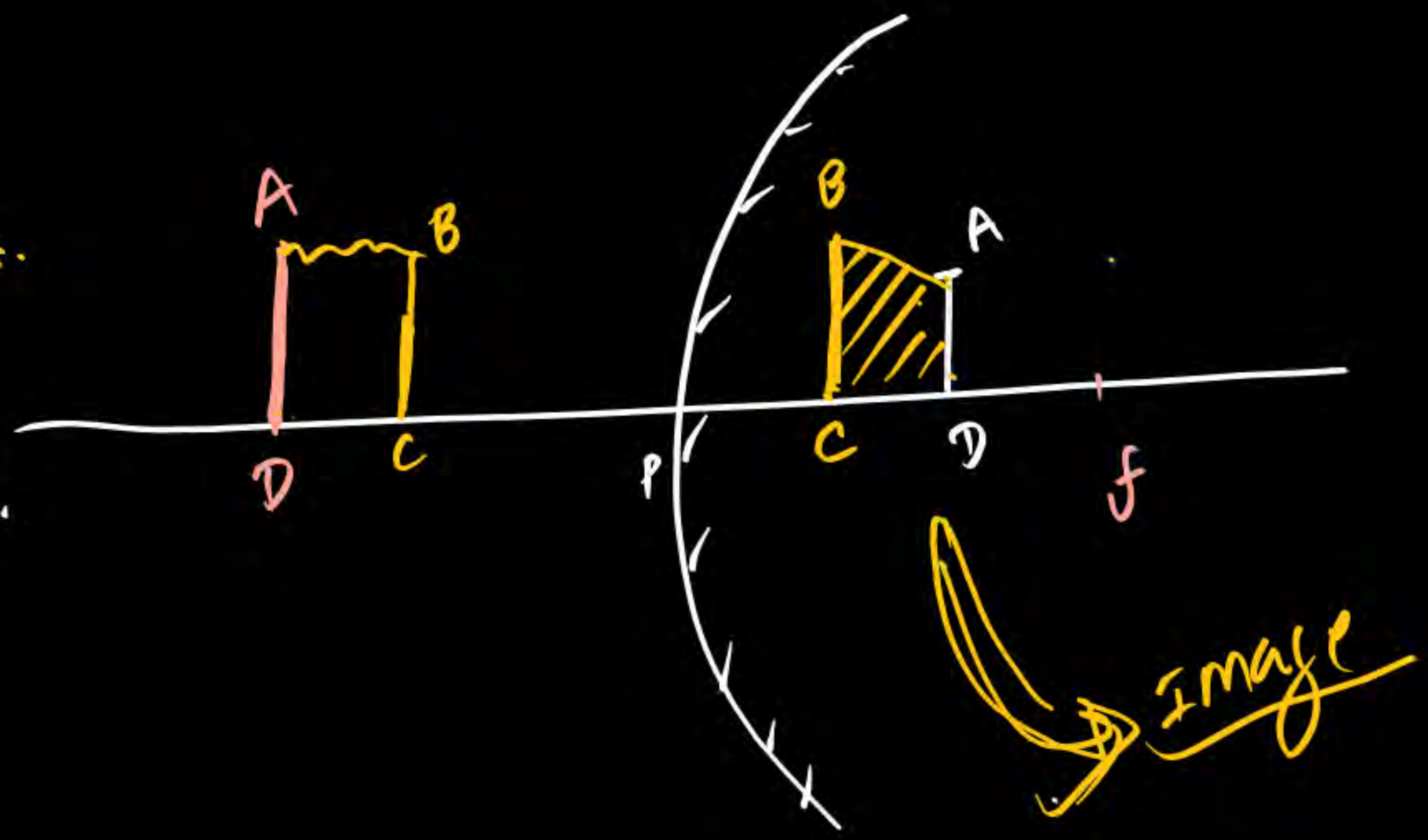
$$\boxed{dv = m_T^2\, du}$$

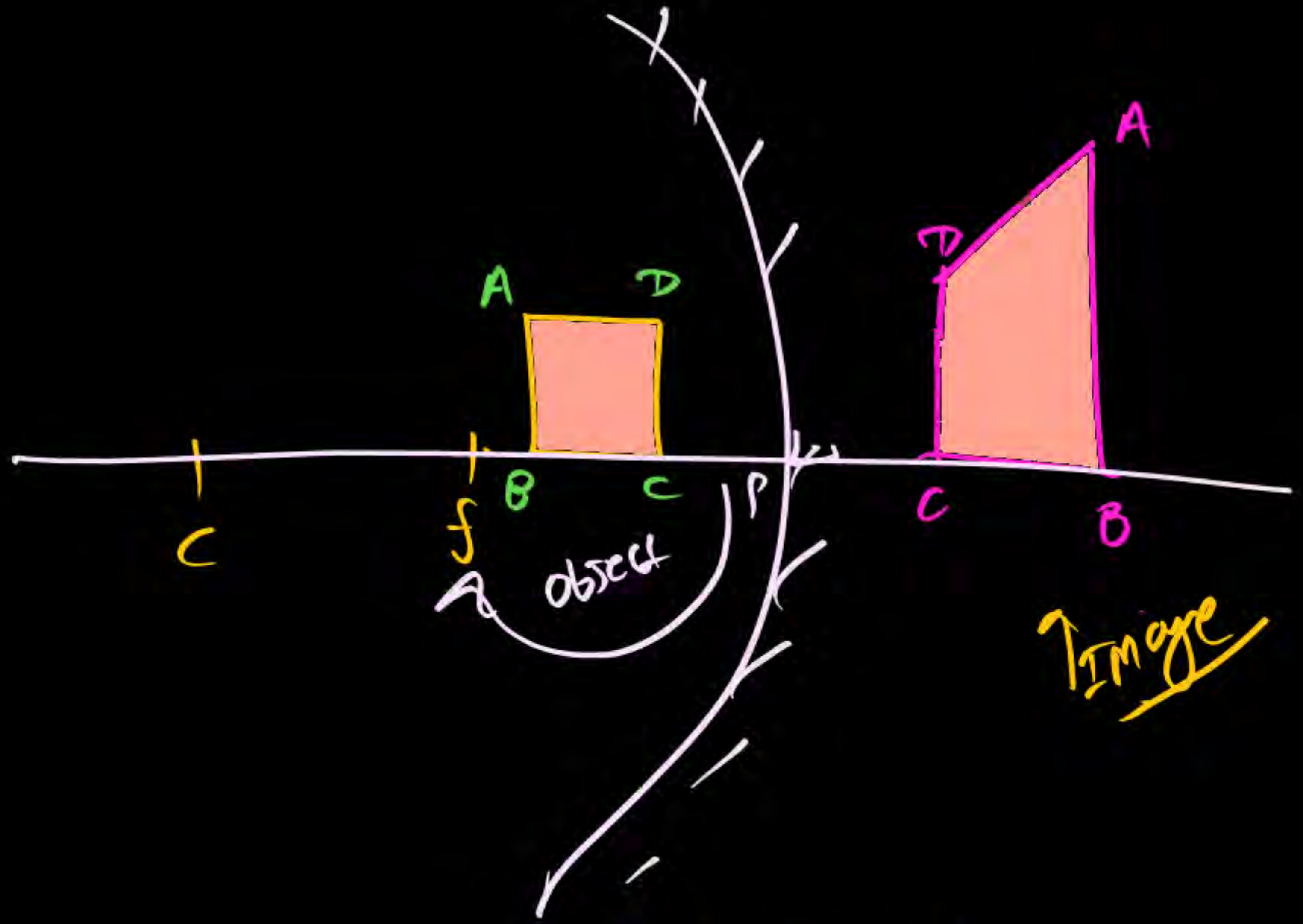
$$\boxed{H_I = m_T \times H_0}$$

for real object

↳ Image will be form b/w Pole & focus for convex mirrors





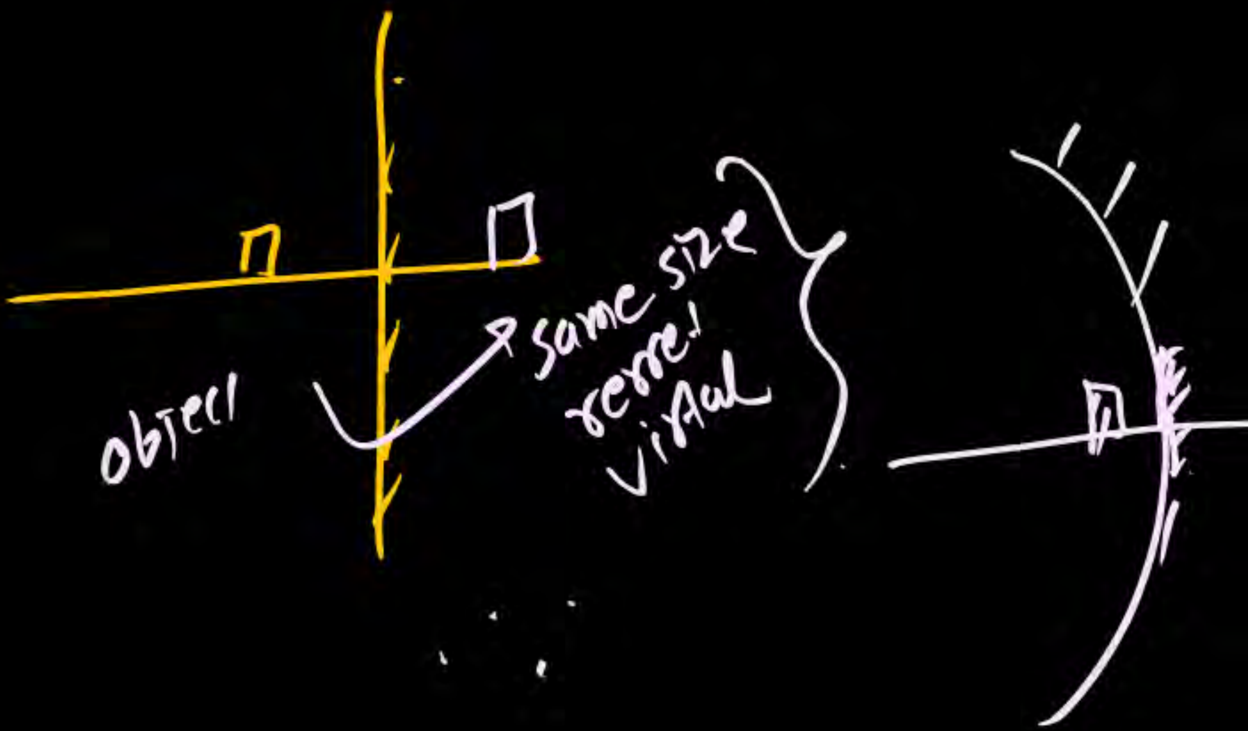


Concave mirror

MP*

* Concave mirror
* Convex mirror
* plane mirror

same if object is placed at pole (very near to pole)

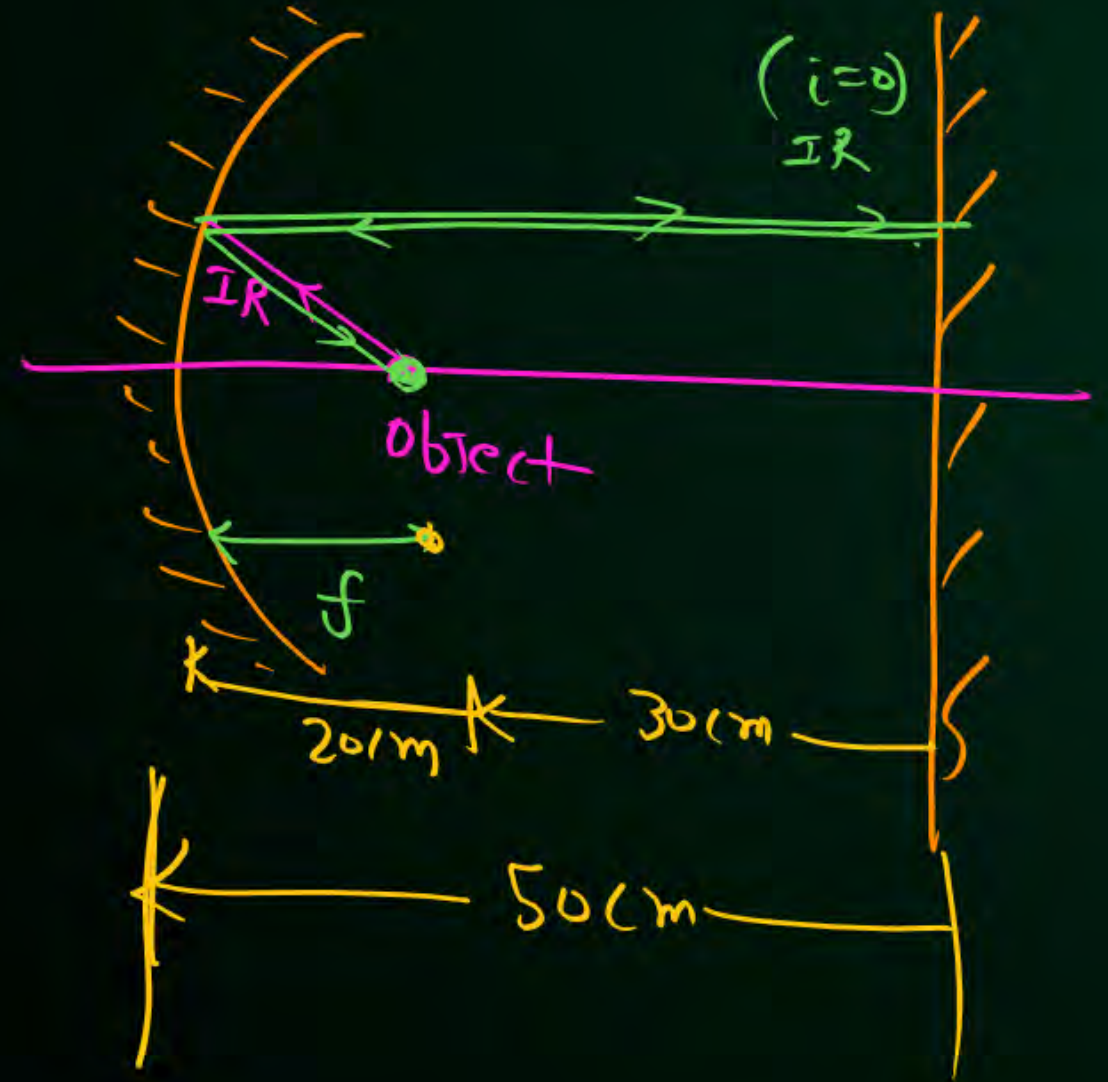


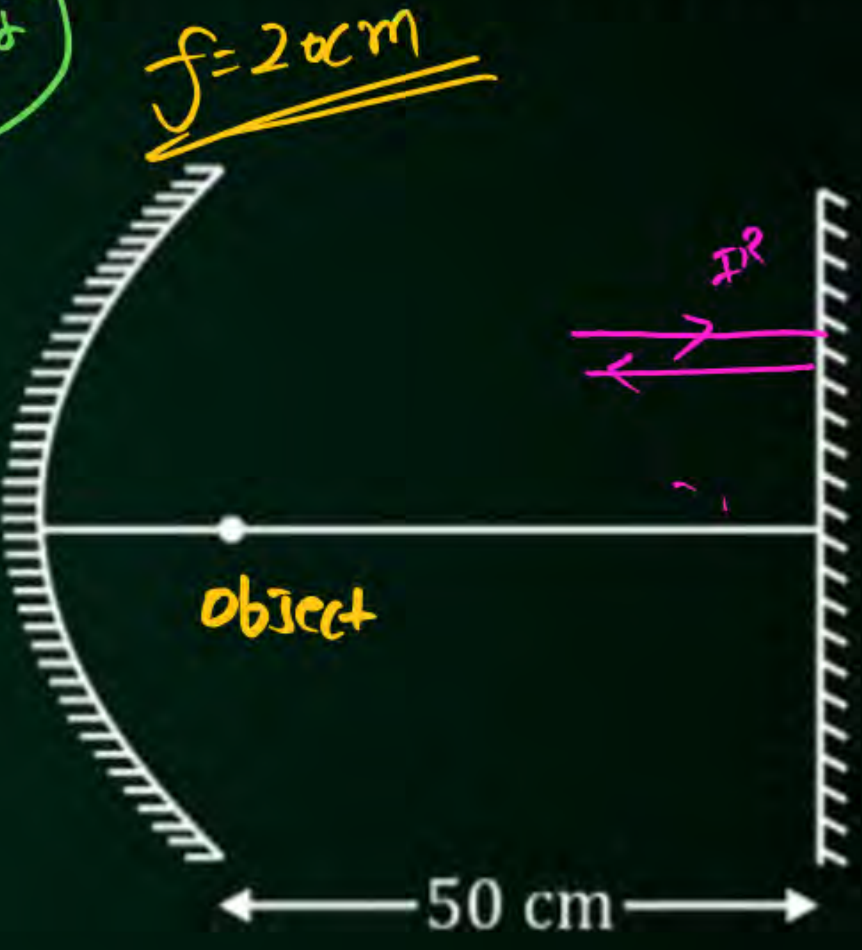
QUESTION

Find position of object from plane mirror so that object and image will coincide assuming 1^{st} reflection from concave mirror. (Consider 2-reflection 1st from curve 2nd plane)

↳ concept

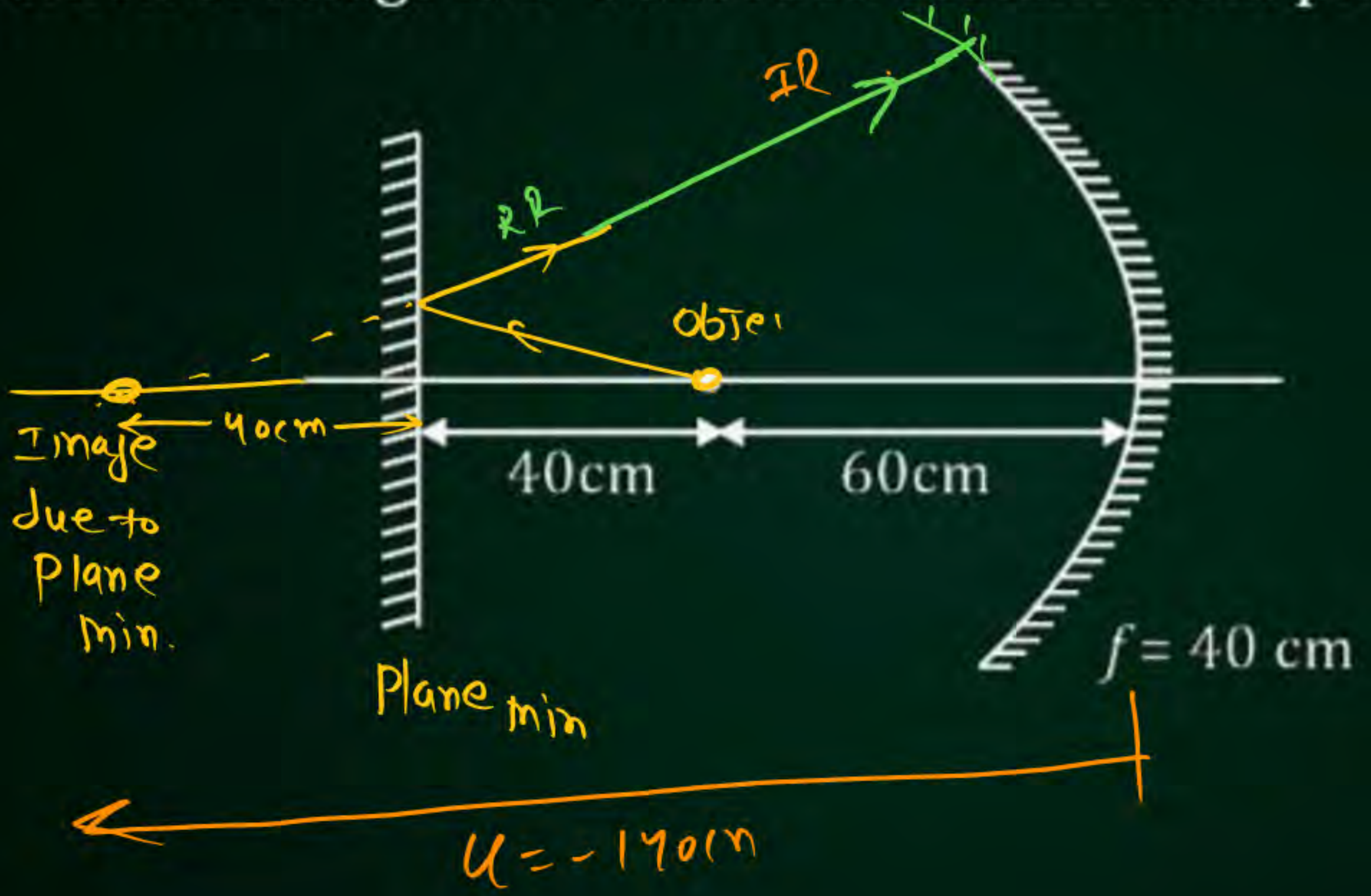
↳ final Reflected ray must retrace its Path.





QUESTION

Find final position of image if 1st reflection assume from plane mirror. (Two refn is consider)



$\frac{1}{v} = \frac{1}{f} - \frac{1}{u}$

$= \frac{1}{-40} + \frac{1}{140}$

$= \frac{-7+2}{280}$

$\frac{1}{v} = \frac{-5}{280}$

$v = -\frac{280}{5} = -56\text{ cm}$

Refraction

Refraction

☆ Change in direction of ray/light wave when it travel from one medium to other medium

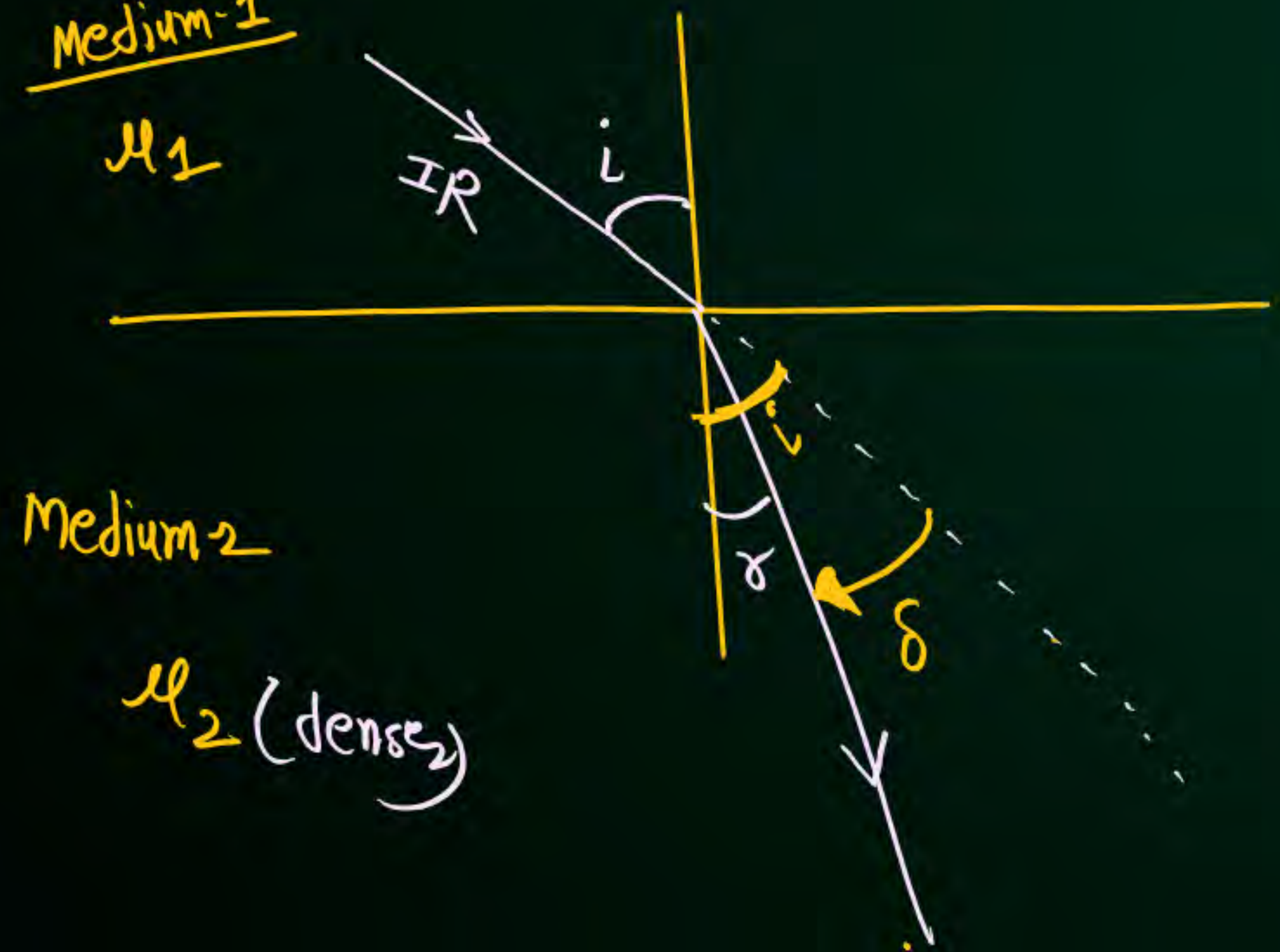
$\mu v = \text{const}^n$

$v = \lambda f$

$v = \frac{c}{\mu}$

$\mu_1 v_1 = \mu_2 v_2$

$\delta = |i - r|$ ← always valid in refraction



Snells law

$$\mu_1 \sin i = \mu_2 \sin r$$

$$\frac{\sin i}{\sin r} = \frac{\mu_2}{\mu_1} = \frac{v_1}{v_2} = \frac{\lambda_1}{\lambda_2}$$

QUESTION

A monochromatic light wave with wavelength λ_1 and frequency v_1 in air enters another medium. If the angle of incidence and angle of refraction at the interface are 45° and 30° respectively, then the wavelength λ_2 and frequency v_2 of the refracted wave are:

[06 Apr, 2023 (Shift-I)]

1. $\lambda_2 = \lambda_1, v_2 = \sqrt{2} v_1$
2. $\lambda_2 = 1/\sqrt{2}\, \lambda_1, v_2 = v_1$
3. $\lambda_2 = \sqrt{2}\lambda_1, v_2 = v_1$
4. $\lambda_2 = \lambda_1, v_2 = 1/\sqrt{2} v_1$

QUESTION

If the refractive index of glass is 1.5. Find the velocity of light in glass. (Velocity of light in vacuum = 3×10^8 m/s)

$$V = \frac{c}{\mu}$$

$$V = \frac{3 \times 10^8}{1.5}$$

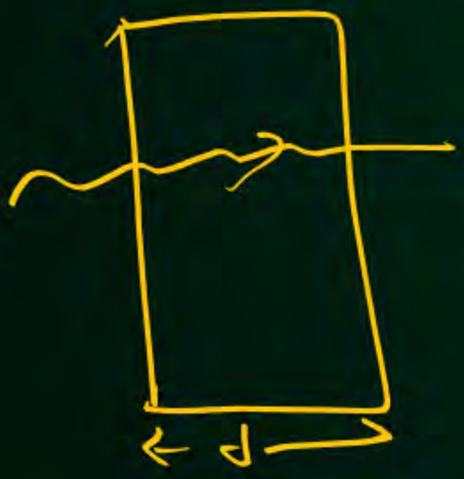
$$\boxed{V = 2 \times 10^8}$$

Ans

QUESTION

A ray of light takes 10^{-9} second to cross a glass slab of refractive index 1.5. The thickness of the slab (w) be:

1. 0.1 m
2. 0.2 m ✓
3. 0.3 m
4. 0.4 m



$d = v \times t$

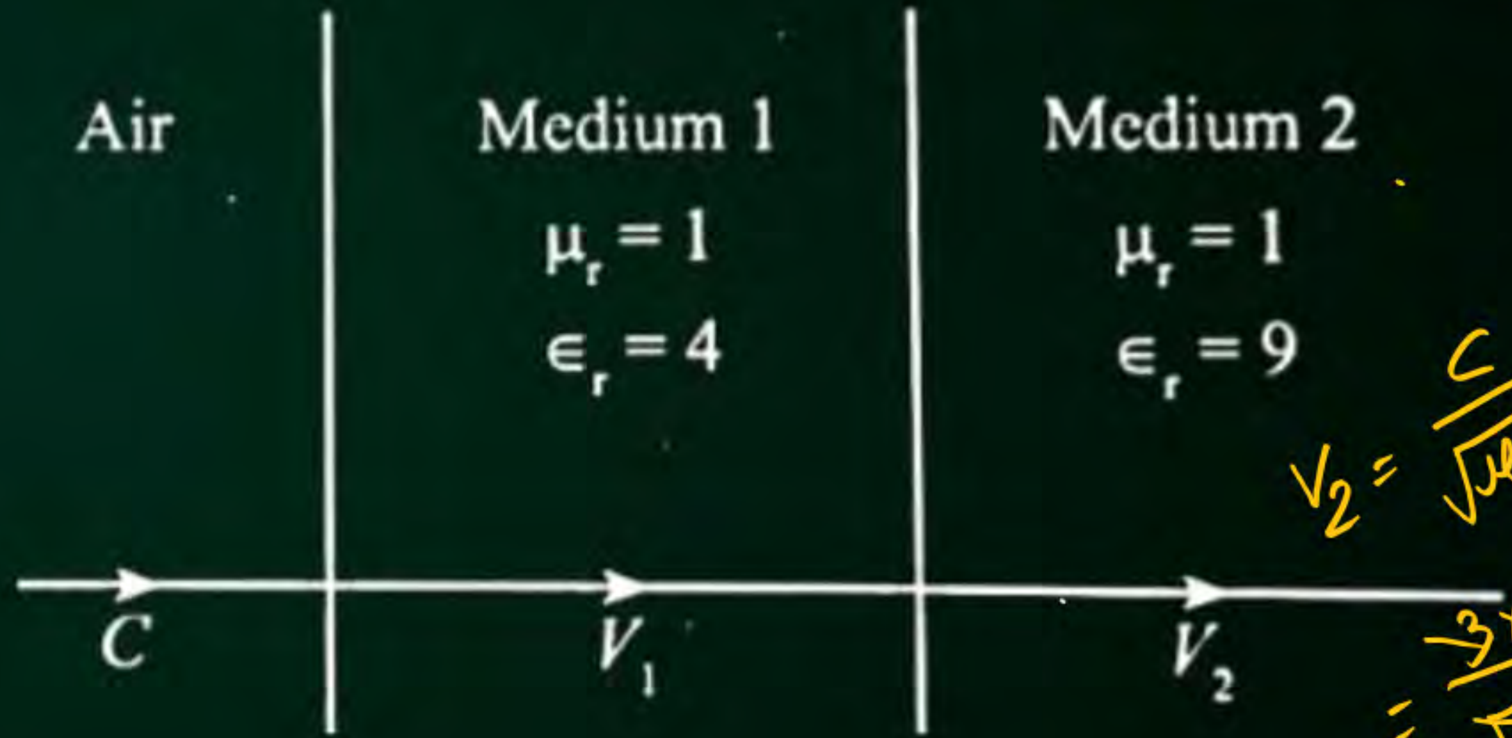
$d = \frac{c}{\mu} t = \frac{3 \times 10^{8}}{1.5} \times 10^{-9} = 0.2\ m$

QUESTION

As shown in the figure, after passing through the medium 1. The speed of light v_2 in medium 2 will be :

(Given $c = 3 \times 10^8 \text{ ms}^{-1}$)

[JEE Main 2022]



1. $1.0 \times 10^8 \text{ ms}^{-1}$
2. $0.5 \times 10^8 \text{ ms}^{-1}$
3. $1.5 \times 10^8 \text{ ms}^{-1}$
4. $3.0 \times 10^8 \text{ ms}^{-1}$

QUESTION

Time taken by light to travel in two different materials A and B refractive indices μ_A and μ_B of same thickness is t_1 and t_2 respectively. If $t_2 - t_1 = 5 \times 10^{-10}$ s and the ratio of μ_A and μ_B is 1 : 2. Then, the thickness of material, in meter is: (Given υ_A and υ_B are velocities of light in A and B materials respectively.) **[JEE Main 2022]**

1. $5 \times 10^{-10} \upsilon_A$ m
2. 5×10^{-10} m
3. 1.5×10^{-10} m
4. $5 \times 10^{-10} \upsilon_B$ m

QUESTION

The difference of speed of light in the two media A and B $(v_A - v_B)$ is 2.6×10^7 m/s. If the refractive index of medium B is 1.47, then the ratio of refractive index of medium B to medium A is: (Given: speed of light in vacuum $c = 3 \times 10^8\ ms^{-1}$)

[JEE Main 2022]

1. 1.303
2. 1.318
3. 1.13
4. 0.12

QUESTION

The time taken by a monochromatic light to travel a certain distance in air in 9×10^{-6} seconds. The time taker by the light ray to travel the same distance in water of refractive index 4/3 is

1. 12 s
2. 12μ s
3. $\frac{27}{4}$ μ s
4. $\frac{27}{2}$ μ s

QUESTION

Light takes t_1 second to travel a distance x cm in vacuum and the same light takes t_2 second to travel $10x$ cm in medium. The critical angle for the corresponding medium is

(1) $\sin^{-1}\left[\frac{10t_2}{t_1}\right]$

(2) $\sin^{-1}\left[\frac{t_2}{10t_1}\right]$

(3) $\sin^{-1}\left[\frac{10t_1}{t_2}\right]$

(4) $\sin^{-1}\left[\frac{t_1}{10t_2}\right]$

QUESTION

A monochromatic light passes through a glass slab ($\mu = 3/2$) of thickness 90 cm in time t_1. If it takes a time t_2 to travel the same distance through water ($\mu = 4/3$). The value of $(t_1 - t_2)$ is

1. 5×10^{-8} s
2. 5×10^{-10} s
3. 2.5×10^{-10} s
4. 2.5×10^{-8} s

QUESTION

Light enters from air into a given medium at an angle of $45°$ with interface of the air-medium surface. After refraction, the light ray is deviated through an angle of $15°$ from its original direction. The refractive index of the medium is: [JEE Main 2022]

1. 1.732
2. 1.333
3. 1.414
4. 2.732

QUESTION

When light of wavelength 5000 Å in vacuum travels through same thickness in glass and water, the difference in the number of waves is 400. Find thickness. (Refractive indices of glass and water are $\frac{3}{2}$ and $\frac{4}{3}$ respectively)

QUESTION

A my of light is incident on a glass plate at an angle of 60°. What would be the refractive index of glass, if reflected and refracted rays are perpendicular to each other?

1. $\sqrt{3}$
2. $3/2$
3. $\sqrt{3}/2$
4. $1/2$

QUESTION

Consider a light ray travelling in air in incident into a medium of refractive index $\sqrt{2n}$. The incident angle is twice that of refracting angle. Then, the angle of incidence will be:

[JEE Main 2022]

1. $\sin^{-1}(\sqrt{n})$
2. $\cos^{-1}(\sqrt{n/2})$
3. $\sin^{-1}(\sqrt{2n})$
4. $2\cos^{-1}(\sqrt{n/2})$

Image formation by Refraction

QUESTION

A glass slab of thickness 12 mm is placed on a table. The lower surface of the slab has a black spot. At what depth from the upper surface will the spot appear when viewed from above? (Refractive index of glass = 1.5)

1. 2 mm
2. 4 mm
3. 6 mm
4. 8 mm


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 07 | Physics

Ray Optics and Optical Instruments

By- Dr. Manish Raj (MR SIR)



Todays Goal

M/W

Image formation by refraction ✓

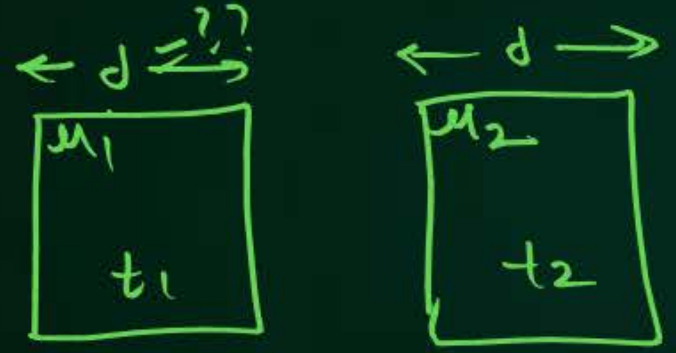
QUESTION

Time taken by light to travel in two different materials A and B refractive indices μ_A and μ_B of same thickness is t_1 and t_2 respectively. If $t_2 - t_1 = 5 \times 10^{-10}$ s and the ratio of μ_A and μ_B is 1 : 2. Then, the thickness of material, in meter is: (Given υ_A and υ_B are velocities of light in A and B materials respectively.) **[JEE Main 2022]**

1. $5 \times 10^{-10}\, \upsilon_A$ m (Ans)
2. 5×10^{-10} m
3. 1.5×10^{-10} m
4. $5 \times 10^{-10}\, \upsilon_B$ m

Kinematic + Ray optics + diagram

$v = \frac{d}{t}$



$t_2 - t_1 = 5 \times 10^{-10}$

$\frac{\mu_A}{\mu_B} = \frac{1}{2} = \frac{V_B}{V_A}$

$2V_B = V_A$ — (ii)

$\frac{d}{V_2} - \frac{d}{V_1} = 5 \times 10^{-10}$ — (i)

$d\left[\frac{1}{V_B} - \frac{1}{V_A}\right] = 5 \times 10^{-10}$

$d\left[\frac{2}{V_A} - \frac{1}{V_A}\right] = 5 \times 10^{-10}$

$d\left(\frac{1}{V_A}\right] = 5 \times 10^{-10}$

$d = 5 \times 10^{-10} \times V_A$

QUESTION

The time taken by a monochromatic light to travel a certain distance in air in 9×10^{-6} seconds. The time taker by the light ray to travel the same distance in water of refractive index 4/3 is

1. 12 s
2. 12μ s
3. $\frac{27}{4}$ μ s
4. $\frac{27}{2}$ μ s

QUESTION

The difference of speed of light in the two media A and B ($v_A - v_B$) is 2.6×10^7 m/s. If the refractive index of medium B is 1.47, then the ratio of refractive index of medium B to medium A is: (Given: speed of light in vacuum $c = 3 \times 10^8$ ms^{-1})

[JEE Main 2022]

1. 1.303
2. 1.318
3. 1.13 ✓
4. 0.12

$\frac{\mu_B}{\mu_A} = ??$

$V_A - V_B = 2.6 \times 10^7$

$\frac{c}{\mu_A} - \frac{c}{\mu_B} = 2.6 \times 10^7$

multiply by μ_B both side

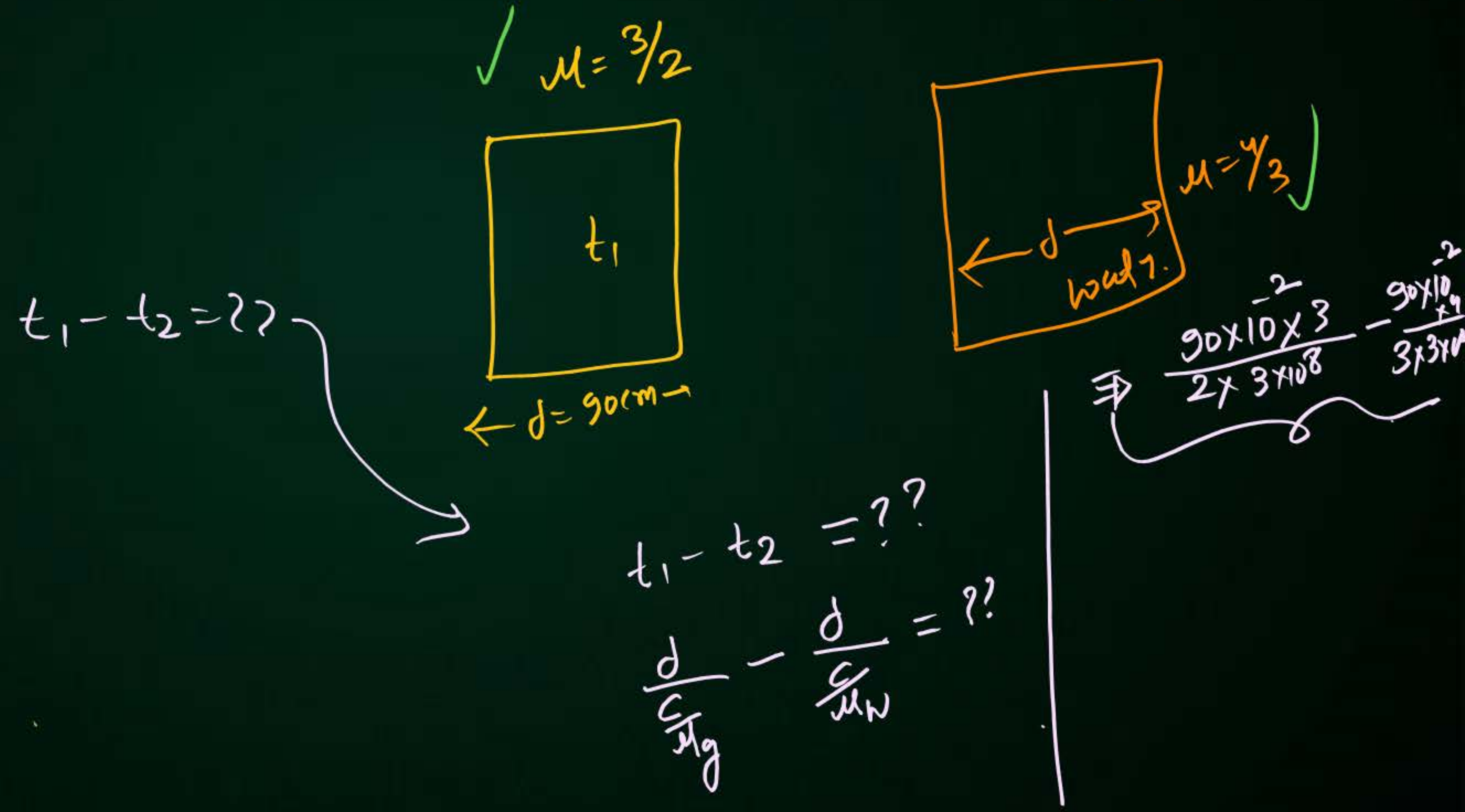
$c\left[\frac{\mu_B}{\mu_A} - 1\right] = 2.6 \times 10^7 \times \mu_B$

$\frac{\mu_B}{\mu_A} = \left\{\frac{2.6 \times 10^7 \times 1.47}{3 \times 10^8} + 1\right\}$

QUESTION

A monochromatic light passes through a glass slab $(\mu = 3/2)$ of thickness 90 cm in time t_1. If it takes a time t_2 to travel the same distance through water $(\mu = 4/3)$. The value of $(t_1 - t_2)$ is

1. 5×10^{-8} s
2. 5×10^{-10} s
3. 2.5×10^{-10} s
4. 2.5×10^{-8} s

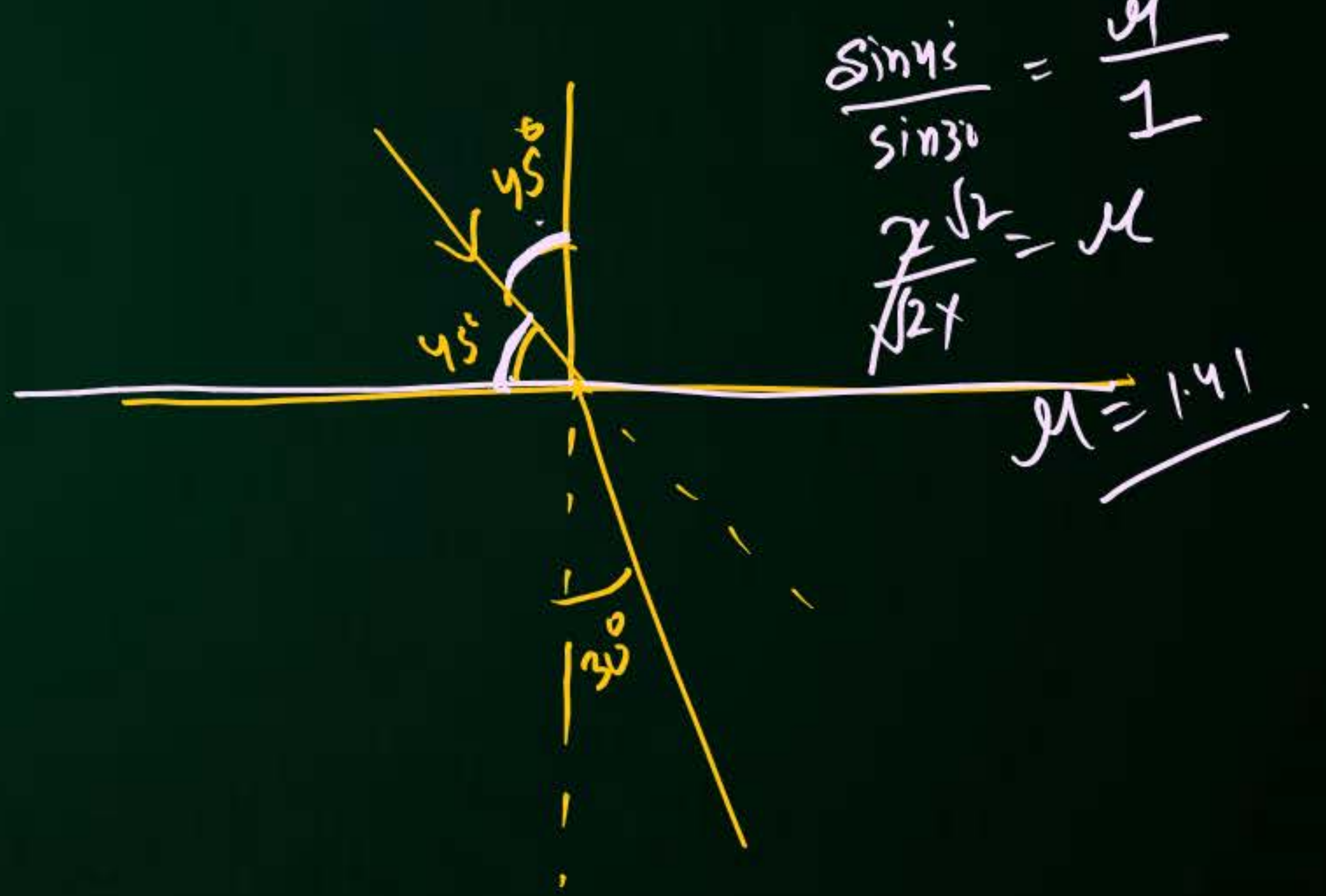


QUESTION

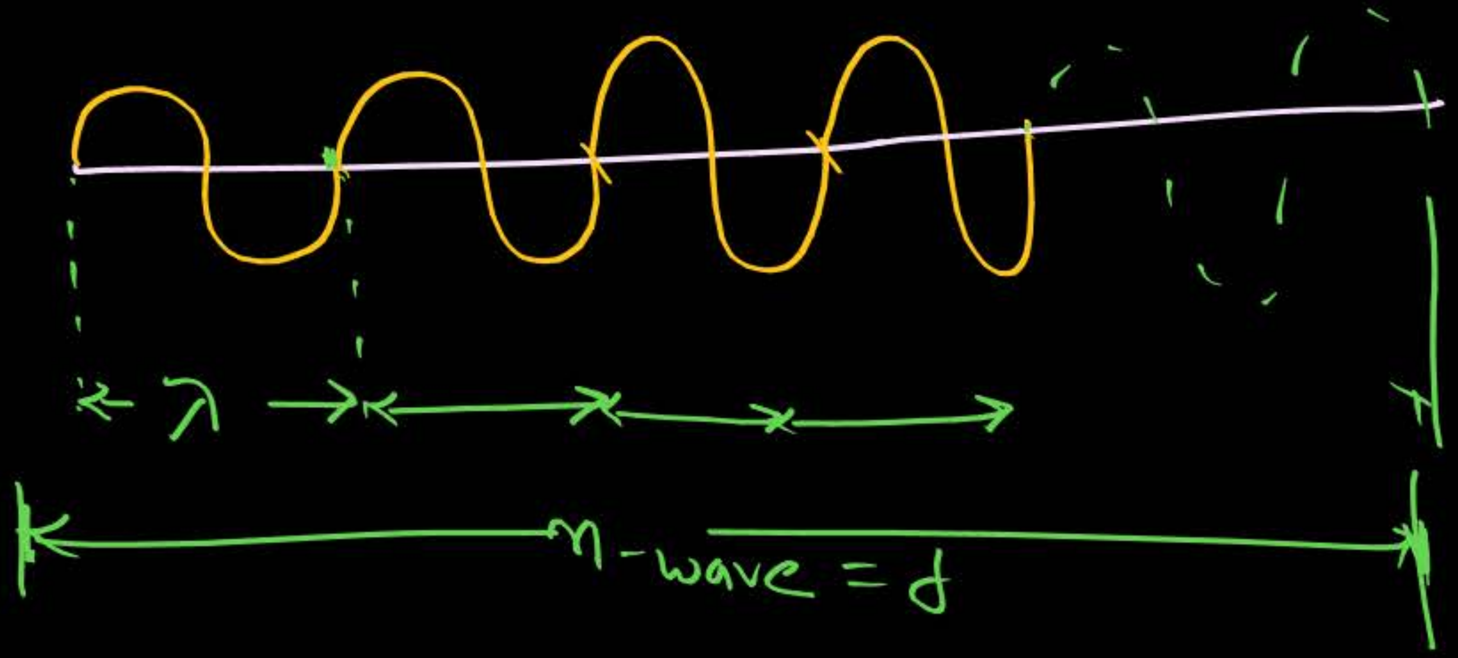
Light enters from air into a given medium at an angle of 45° with interface of the air-medium surface. After refraction, the light ray is deviated through an angle of 15° from its original direction. The refractive index of the medium is: ??

[JEE Main 2022]

1. 1.732
2. 1.333
3. 1.414 ✓
4. 2.732



NO of wave in width 'd'



$$n\lambda = d$$

$$n = \frac{d}{\lambda}$$

↑ no. of wave.

QUESTION

When light of wavelength 5000 Å in vacuum travels through same thickness in glass and water, the difference in the number of waves is 400. Find thickness. (Refractive indices of glass and water are $\frac{3}{2}$ and $\frac{4}{3}$ respectively)

μ_g μ_w

Sol^n

$$n_1 - n_2 = 400$$

$$\frac{d}{\lambda_{glass}} - \frac{d}{\lambda_{water}} = 400$$

$$d\left[\frac{\mu_g}{\lambda_0} - \frac{\mu_w}{\lambda_0}\right] = 400$$

$$\frac{d}{\lambda_0}\left[\frac{3}{2} - \frac{4}{3}\right] = 400$$

$$d\left[\frac{9-8}{6}\right] = 400 \times \lambda_0$$

$$d \times \frac{1}{6} = 400 \times 5000 \times 10^{-10}$$

$$d = 120 \times 10^{-5}$$

$$= 12 \times 10^{-4}\,m = 1.2\,mm$$



$V = \lambda f$ (f const^n)

$V \propto \lambda \propto \frac{1}{\mu}$

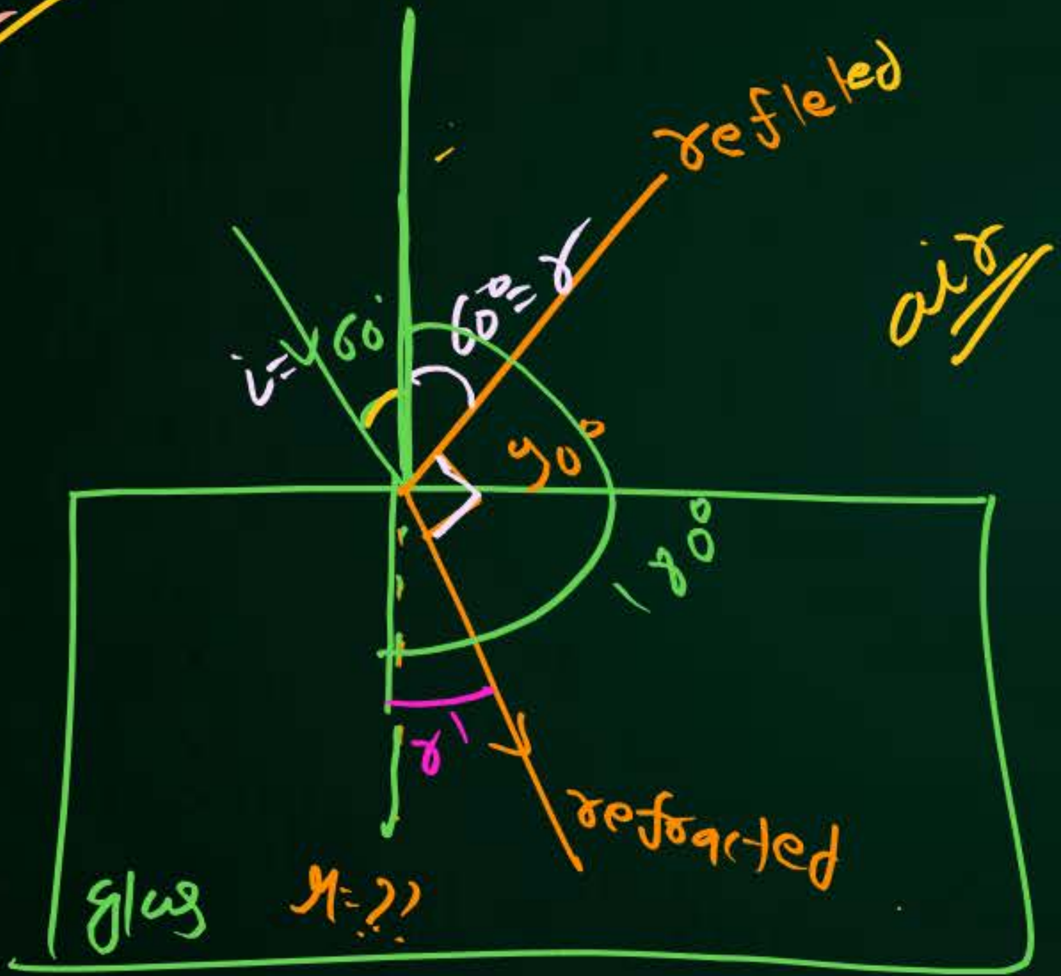
$V_m = \frac{c}{\mu}$

$\lambda_m = \frac{\lambda_0}{\mu_m}$

QUESTION

A ray of light is incident on a glass plate at an angle of 60°. What would be the refractive index of glass, if reflected and refracted rays are perpendicular to each other?

1. $\sqrt{3}$
2. $3/2$
3. $\sqrt{3}/2$
4. $1/2$



AIR-420

QUESTION

Consider a light ray travelling in air in incident into a medium of refractive index $\sqrt{2n}$. The incident angle is twice that of refracting angle. Then, the angle of incidence will be: **[JEE Main 2022]**

$\mu = 1$

$i = 2r$

1. $\sin^{-1}(\sqrt{n})$
2. $\cos^{-1}(\sqrt{n/2})$
3. $\sin^{-1}(\sqrt{2n})$
4. $2\cos^{-1}(\sqrt{n/2})$



$\mu = \sqrt{2n}$ — (1)

$\frac{\sin i}{\sin r} = \frac{\sqrt{2n}}{1}$

$\frac{\sin 2r}{\sin r} = \sqrt{2n}$

$\frac{2 \sin r \cdot \cos r}{\sin r} = \sqrt{2n}$

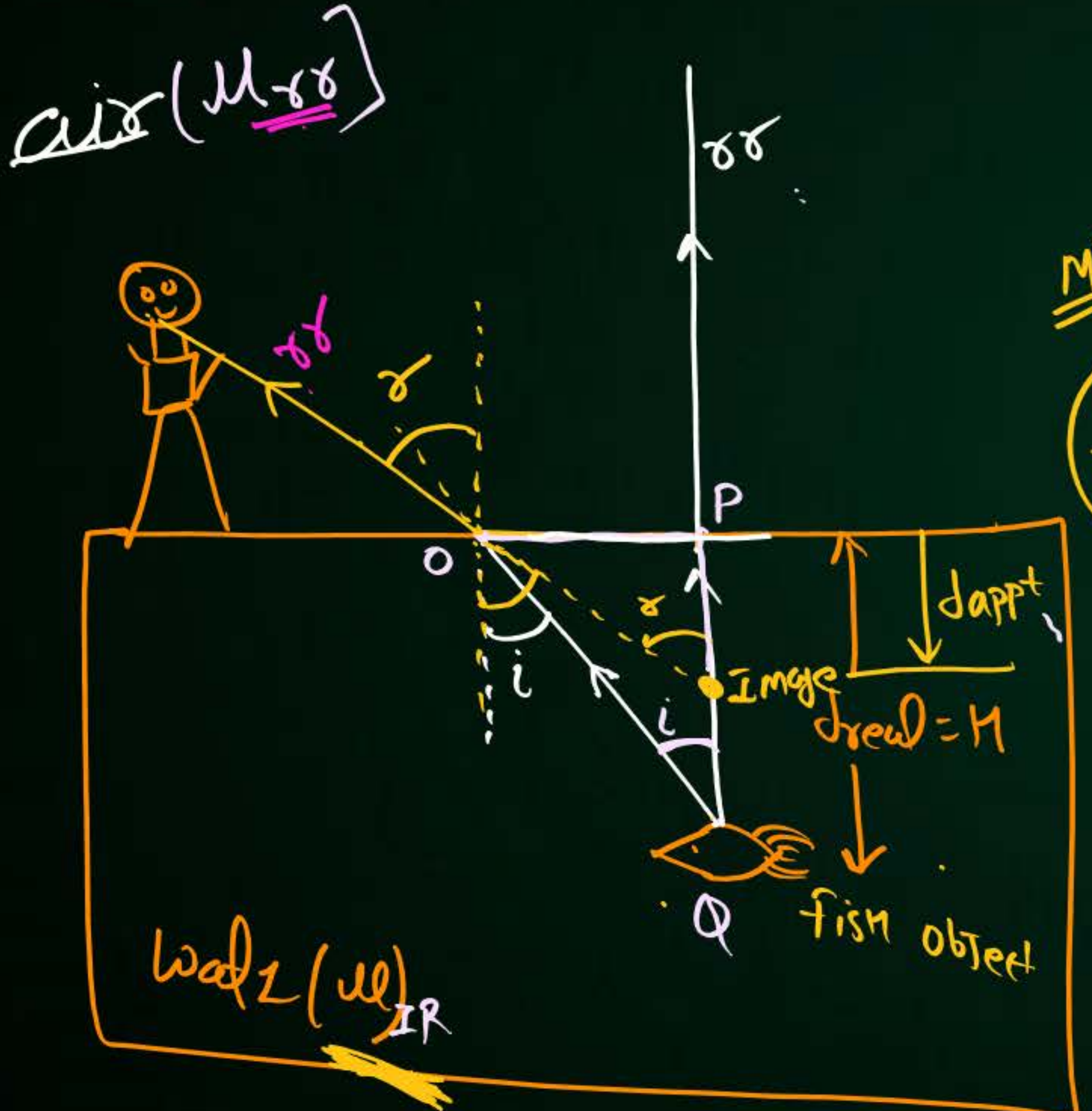
$\cos r = \sqrt{\frac{n}{2}}$

$\cos\frac{i}{2} = \frac{\sqrt{n}}{\sqrt{2}}$

$\frac{i}{2} = \cos^{-1}\sqrt{\frac{n}{2}}$

Waooo

Image formation by Refraction



MR *

$$\frac{d_{appt}}{\mu_{rr}} = \frac{d_{real}}{\mu_{IR}}$$

$\triangle OPQ$

$$\tan i = \frac{OP}{QP} \quad — (1)$$

$$\tan r = \frac{OP}{d_{app}}$$

$i \rightarrow$ small angle

$$\sin i = \frac{OP}{d_{real}}$$

$r \rightarrow$ small

$$\sin r = \frac{OP}{d_{app}}$$

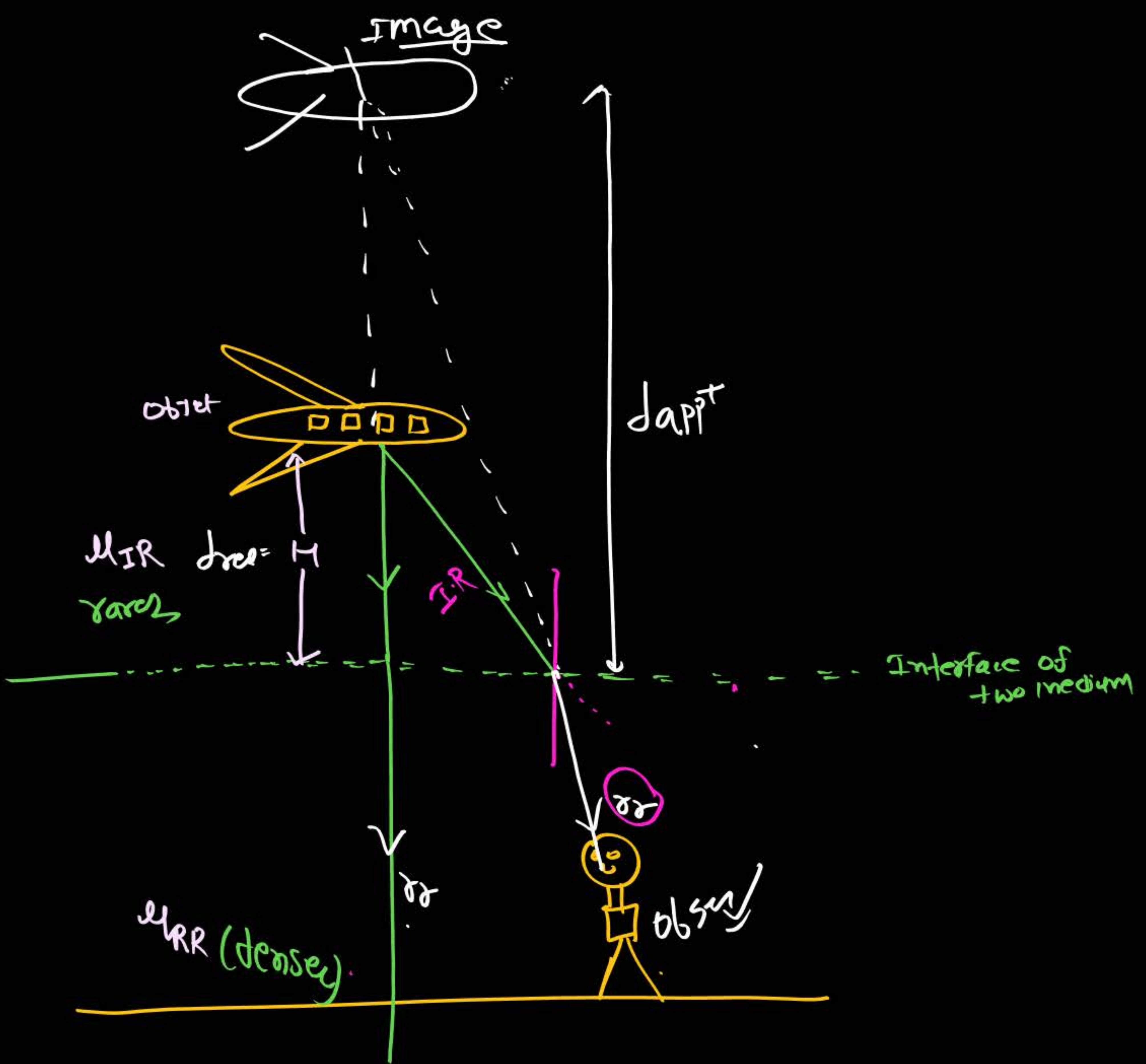
Snell law

$$\frac{\sin i}{\sin r} = \frac{\mu_{rr}}{\mu_{IR}}$$

$$\frac{OP}{d_{real}} \times \frac{d_{app}}{OP} = \frac{\mu_{rr}}{\mu_{IR}}$$

$$d_{appt} = \frac{d_{real}\,\mu_{rr}}{\mu_{IR}}$$

$$\frac{(d_{appt})}{\mu_{rr}} = \frac{d_{real}}{\mu_{IR}}$$



$$\frac{d_{appt}}{\mu_{RR}} = \frac{d_{real}}{\mu_{IR}}$$

$$d_{appt} = d_{real} \times \frac{\mu_{RR}}{\mu_{IR}}$$

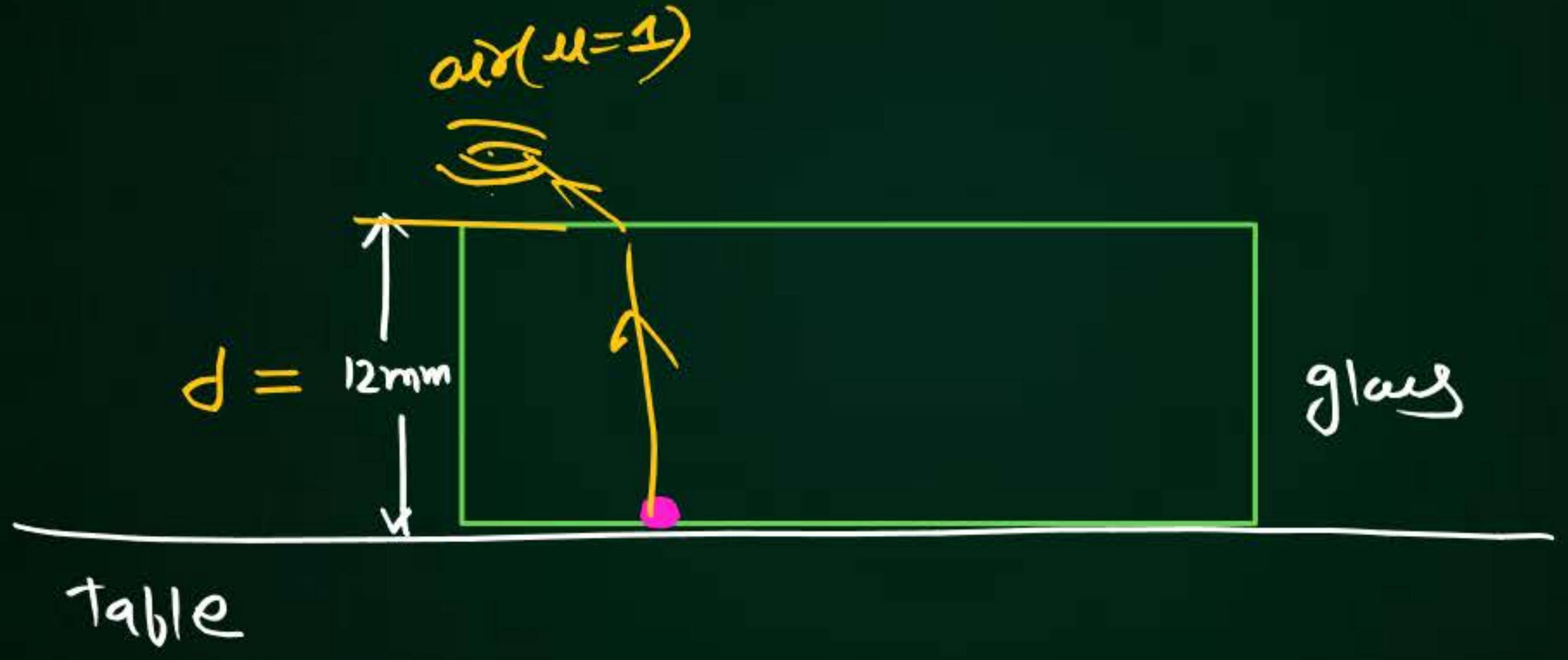
observer

Visualisation

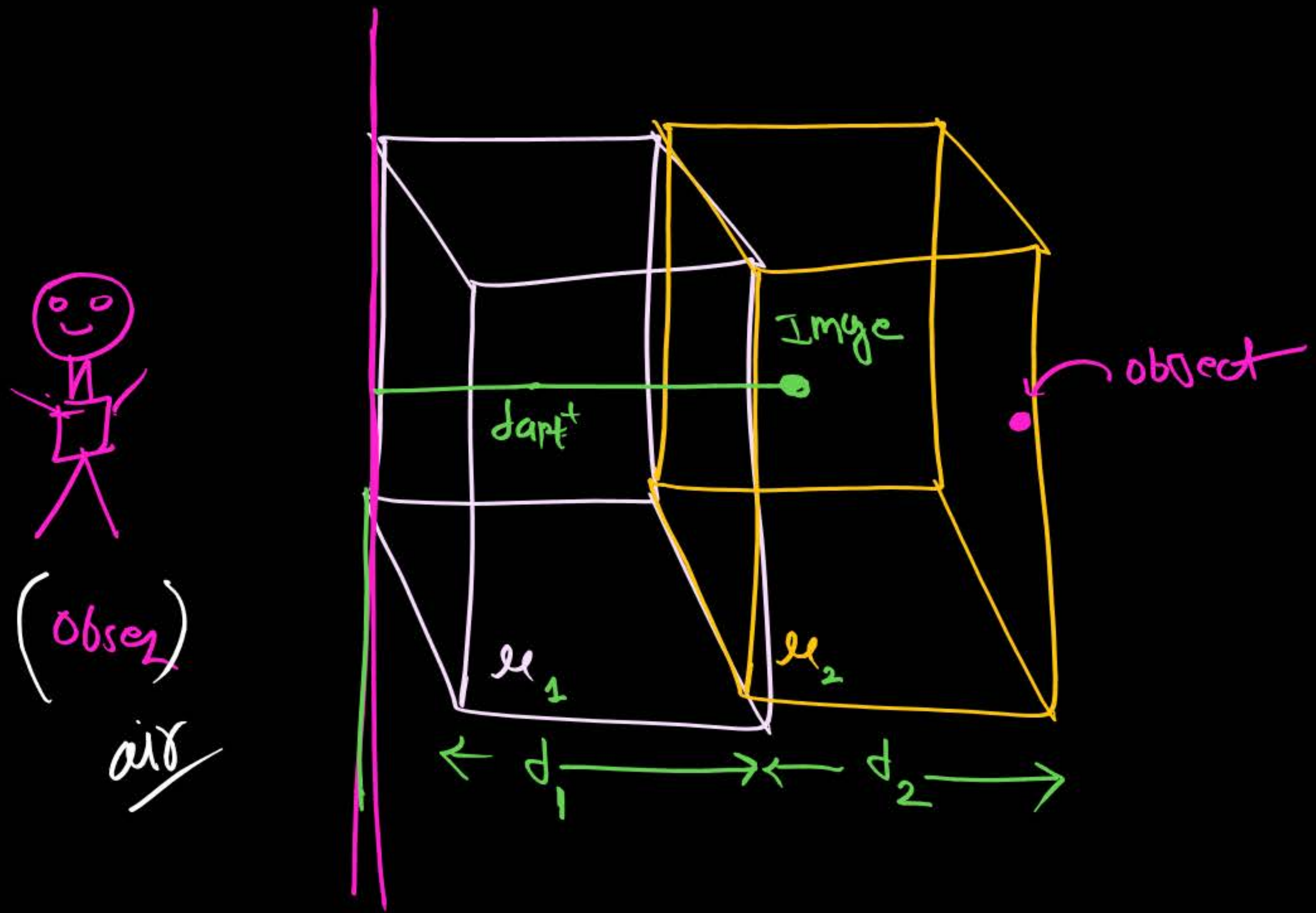
QUESTION

A glass slab of thickness 12 mm is placed on a table. The lower surface of the slab has a black spot. At what depth from the upper surface will the spot appear when viewed from above? (Refractive index of glass = 1.5)

1. 2 mm
2. 4 mm
3. 6 mm
4. 8 mm

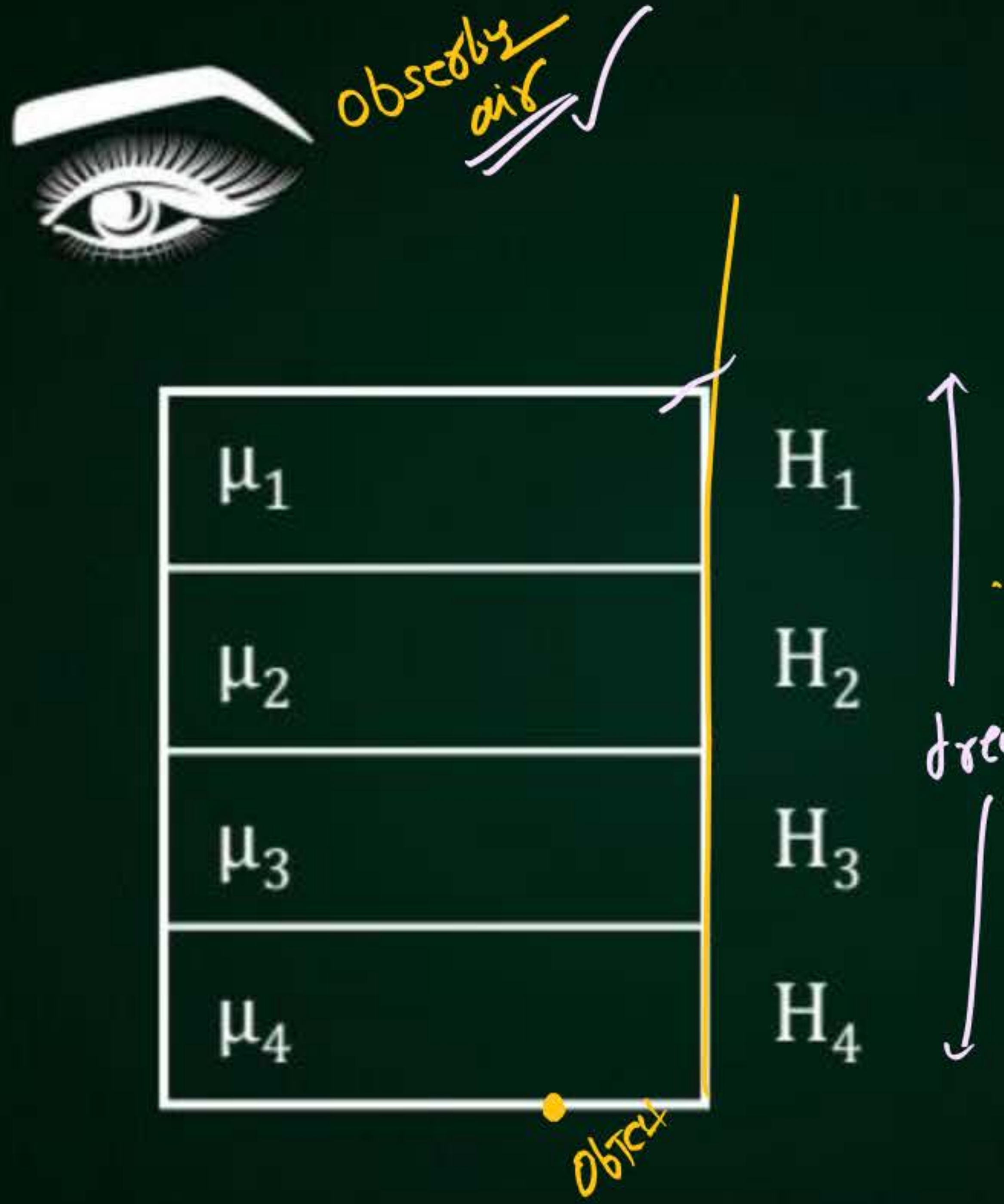


$$\frac{d_{app}}{1} = \frac{12\text{ mm}}{3/2} = 8\text{ mm}$$



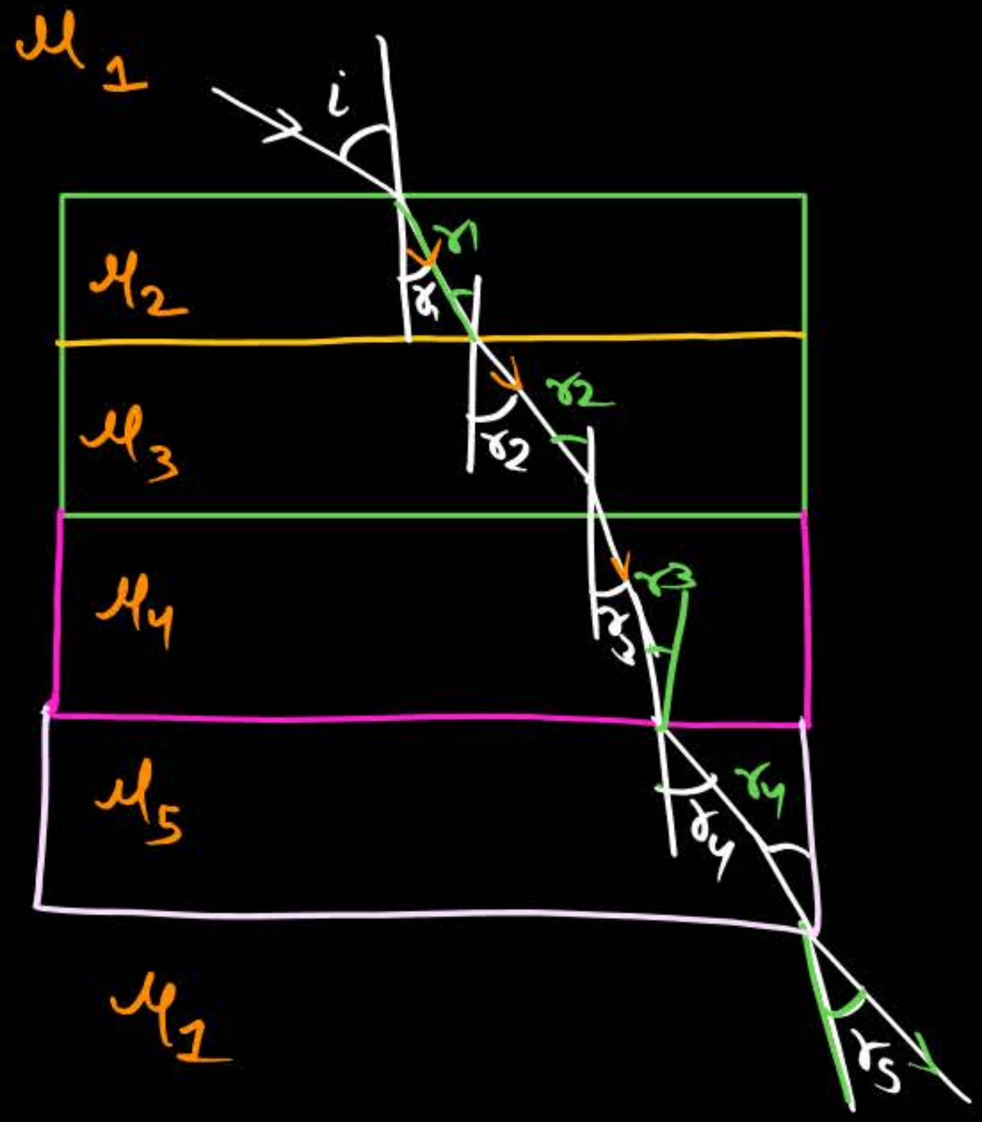
$$\frac{d_{appt}}{1} = \frac{d_2}{\mu_2} + \frac{d_1}{\mu_1}$$

$$d_{app}^{t} = \frac{d_2}{\mu_2} + \frac{d_1}{\mu_1}$$



$$d_{appt} = \frac{H_1}{\mu_1} + \frac{H_2}{\mu_2} + \frac{H_3}{\mu_3} + \frac{H_4}{\mu_4}$$

$$d_{real} = H_1 + H_2 + H_3 + H_4$$



$$r_5 = i$$ ✗

* Snell law

$$\sin i \times \mu_1 = \mu_2 \sin r_1 = \mu_3 \sin r_2 = \mu_4 \sin r_3 = \mu_5 \sin r_4 = \mu_1 \times \sin r_5$$

Image Formation by Refraction

QUESTION

Find distance of bird from fish as seen by fish. Distance of bird from boundary as seen by fish.



d_{app} from fish seen by fish $= 160 + 24$

$= 184\,m$

$\frac{d_{appt}}{\mu_{rr}} = \frac{d_{real}}{\mu_{IR}}$

$\frac{d_{appt}}{\frac{4}{3}} = \frac{120}{1}$

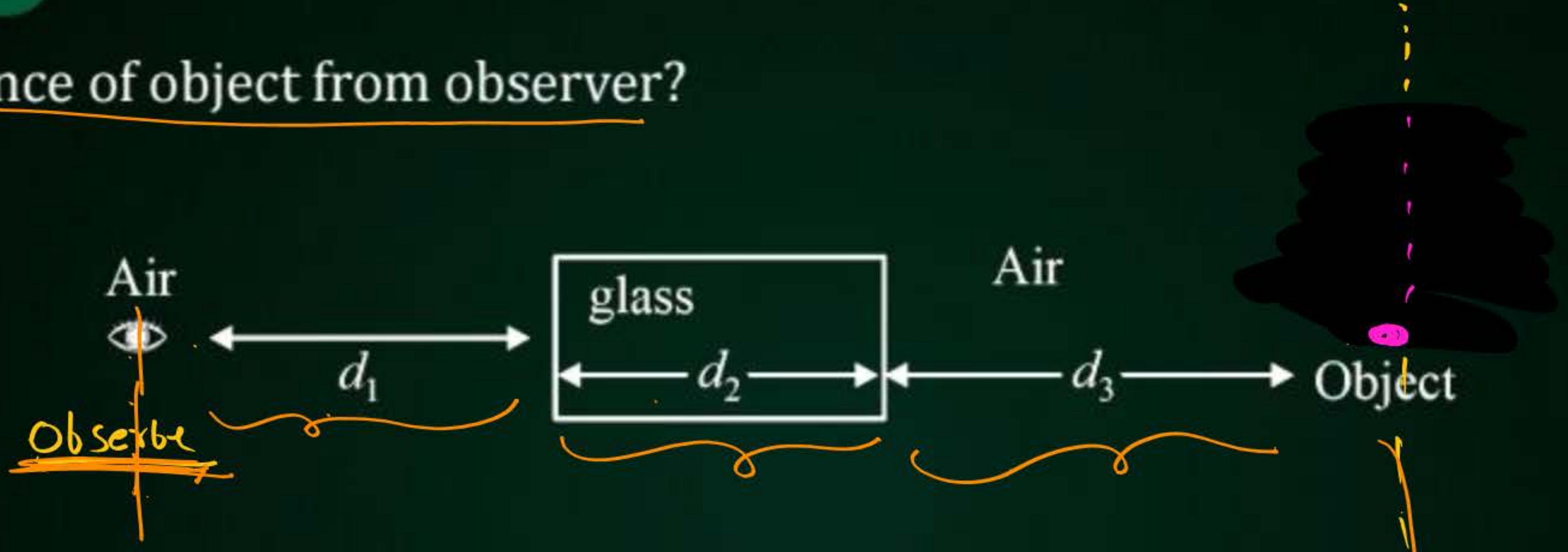
$d_{appt} = 120 \times \frac{4}{3} = 160\,cm$

appt depth of fish as seen by bird $= \frac{24}{4/3} \times 1 = 18\,cm$

appt depth of fish due to $= 18 + 120$

QUESTION

Find distance of object from observer?



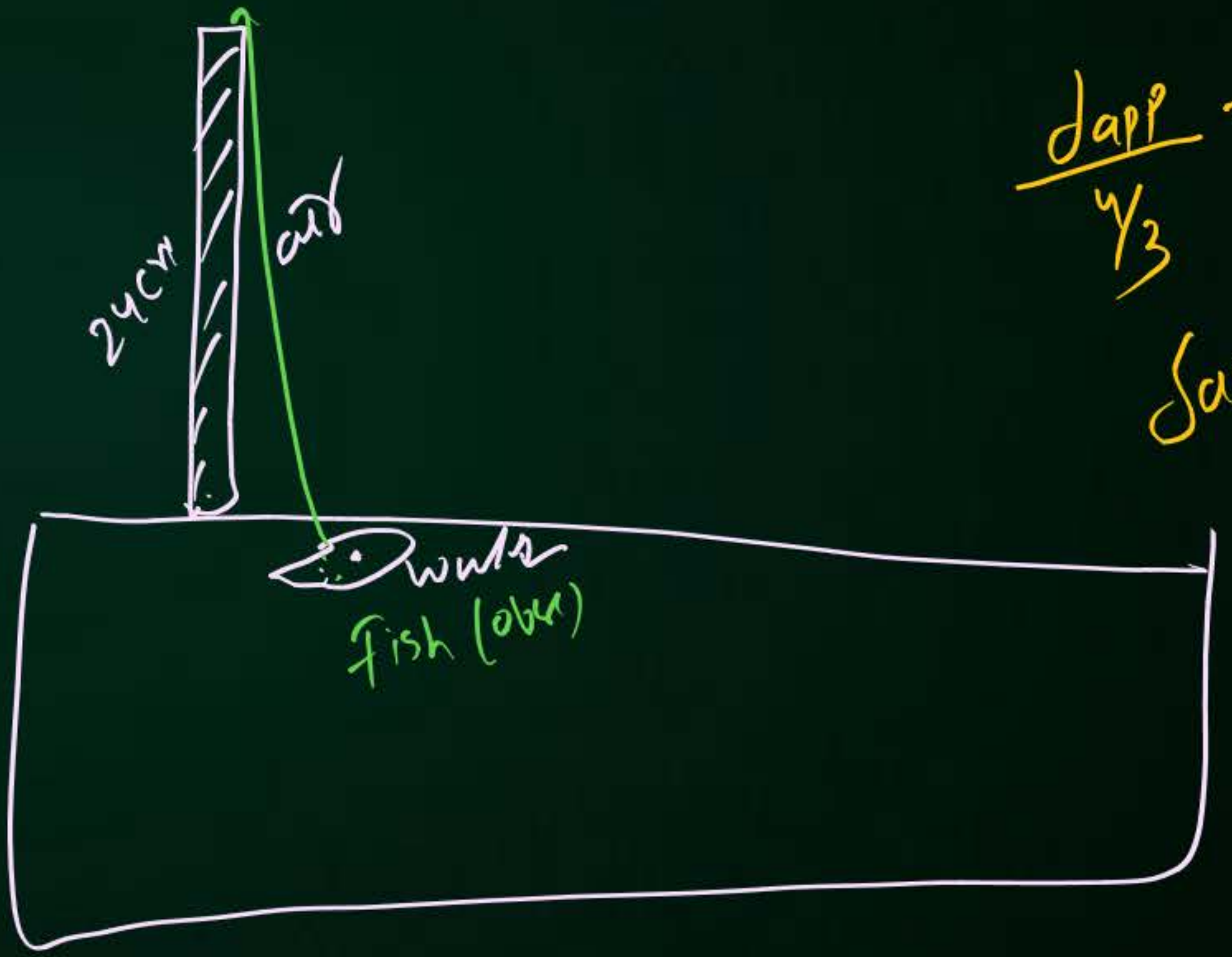
$$\frac{d_{app}}{1} = \frac{d_1}{1} + \frac{d_2}{\mu} + \frac{d_3}{1}$$

$$d_{appt} = d_1 + d_3 + \frac{d_2}{\mu}$$

QUESTION

The length of a vertical pole at the surface of a lake of water ($\mu = 4/3$) is 24 cm. Then to an under-water fish just below the water surface the tip of the pole appears to be

1. 18 cm above the surface
2. 24 cm above the surface
3. 32 cm above the surface
4. 36 cm above the surface

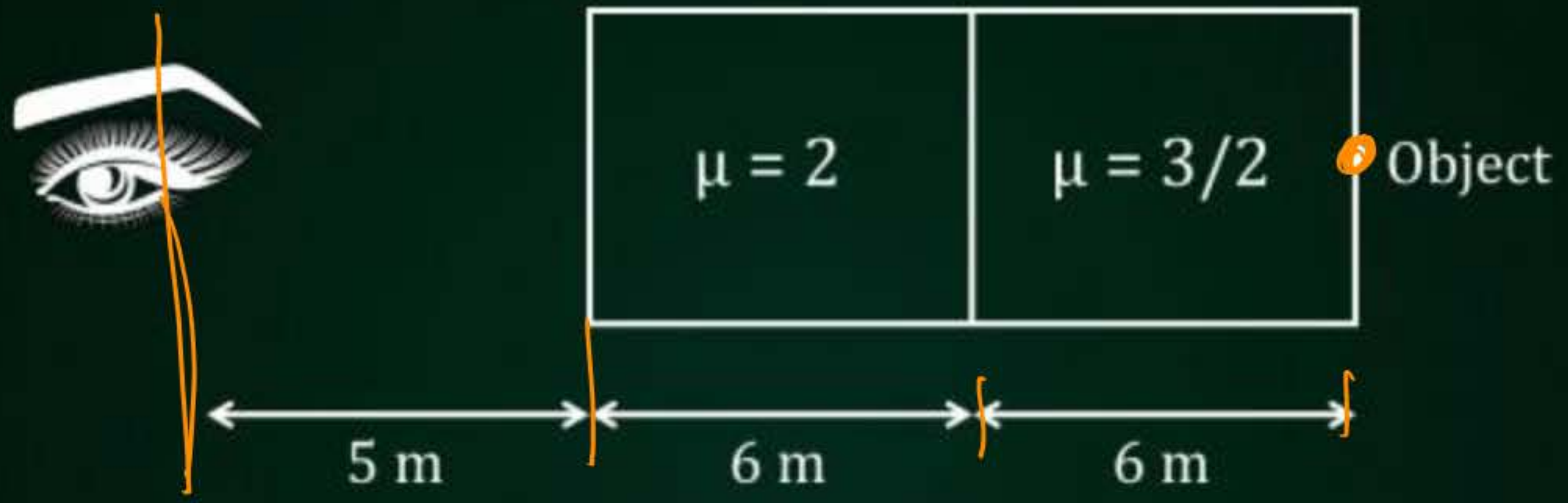


$$\frac{d_{app}}{4/3} = \frac{24}{1}$$

$$d_{app} = 24 \times \frac{4}{3} = 32$$

QUESTION

Find position of image of given object from observer?



$d_{app} = 5 + \frac{6}{2} + \frac{6}{3/2}$

$= 5 + 3 + 4$

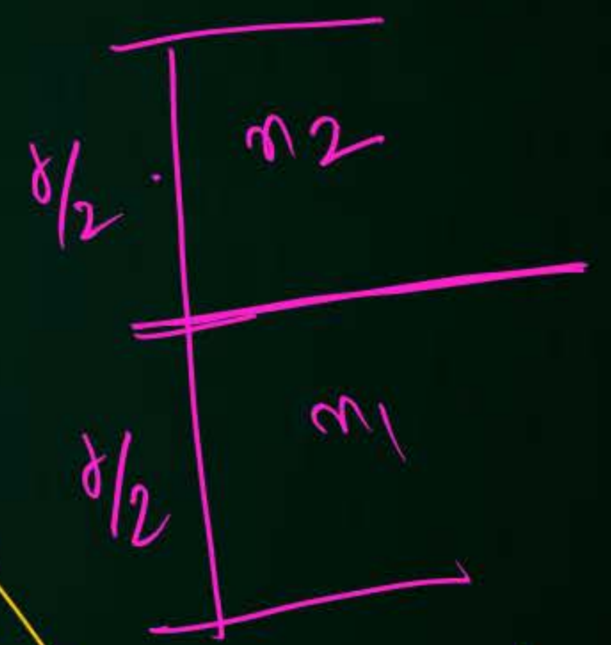
$d_{app} = 12\ m$

QUESTION

A vessel of depth 'd' is half filled with oil of refractive index n_1 and the other half is filled with water of refractive index n_2. The apparent depth of this vessel when viewed from above will be

[13 Apr 2023 (Shift-I)]

1. $\dfrac{dn_1n_2}{(n_1+n_2)}$
2. $\dfrac{d(n_1+n_2)}{2n_1n_2}$
3. $\dfrac{dn_1n_2}{2(n_1+n_2)}$
4. $\dfrac{2d(n_1+n_2)}{n_1n_2}$



QUESTION

A vessel of depth $2h$ is half filled with a liquid of refractive index $2\sqrt{2}$ and the upper half with another liquid of refractive index $\sqrt{2}$. The liquid are immiscible. The apparent depth of the inner surface of the bottom of vessel will be **[9 Jan, 2020 (Shift-I)]**

1. $\frac{h}{\sqrt{2}}$

2. $\frac{h}{2(\sqrt{2}+1)}$

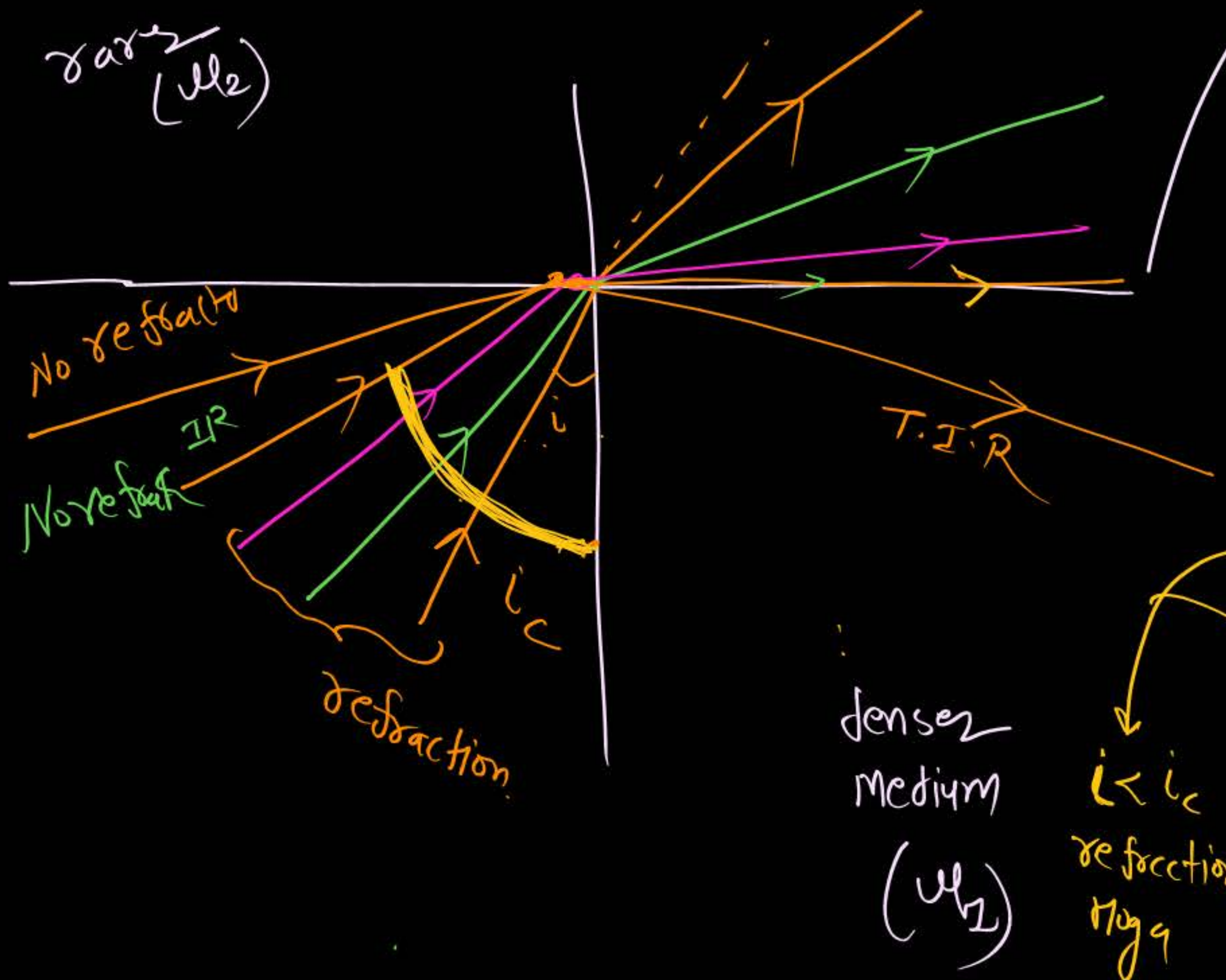
3. $\frac{3}{4}h\sqrt{2}$

4. $\frac{h}{3\sqrt{2}}$

Critical Angle [Total internal reflection]

→ when ray moves from denser to rarer then there exist a critical angle at which or above that angle incident ray completely reflected back in same medium.

[there is no refraction] //



for $r = 90°$

Just for T.I.R at critical angle.

$$\frac{\sin i_c}{\sin 90°} = \frac{\mu_2}{\mu_1}$$

$$\sin i_c = \frac{\mu_2}{\mu_1}$$

$i < i_c$ refraction Hoga

$i \geq i_c$ no refraction

$$\sin i_c = \frac{1}{(\mu_{12})} = \frac{1}{\text{refractive Index of 1st medium w.r.t 2nd medium}}$$

$$\mu_{12} = \frac{\mu_1}{\mu_2}$$ //

velocity of Incident ray

$$\sin i_c = \frac{\mu_2 \,(\text{rare})}{\mu_1 \,(\text{dense})} = \frac{v_1}{v_2} = \frac{\lambda_1}{\lambda_2} = \frac{d_1 t_2}{t_1 d_2}$$

velocity of refract

$$\frac{\mu_2}{\mu_1} = \frac{v_1}{v_2} = \frac{\lambda_1}{\lambda_2} = \frac{d_1 \, t_2}{t_1 \, d_2}$$

QUESTION

There is a small air bubble inside a glass sphere ($\mu = 1.5$) of radius 10 cm. The bubble is 4 cm below the surface and is viewed normally from the outside the apparent depth of the bubble is:

1. 3 cm below the surface
2. 5 cm below the surface
3. 8 cm below the surface
4. 10 cm below the surface

QUESTION

The apparent depth of water in cylindrical water tank of diameter $2R$ cm is reducing at the rate of x cm/min when water is being drained out at a constant rate. The amount of water drained in cc/minute is: (n_1 = refractive index of air, n_2 = refractive index of water)

1. $\dfrac{x\pi R^2 n_1}{n_2}$

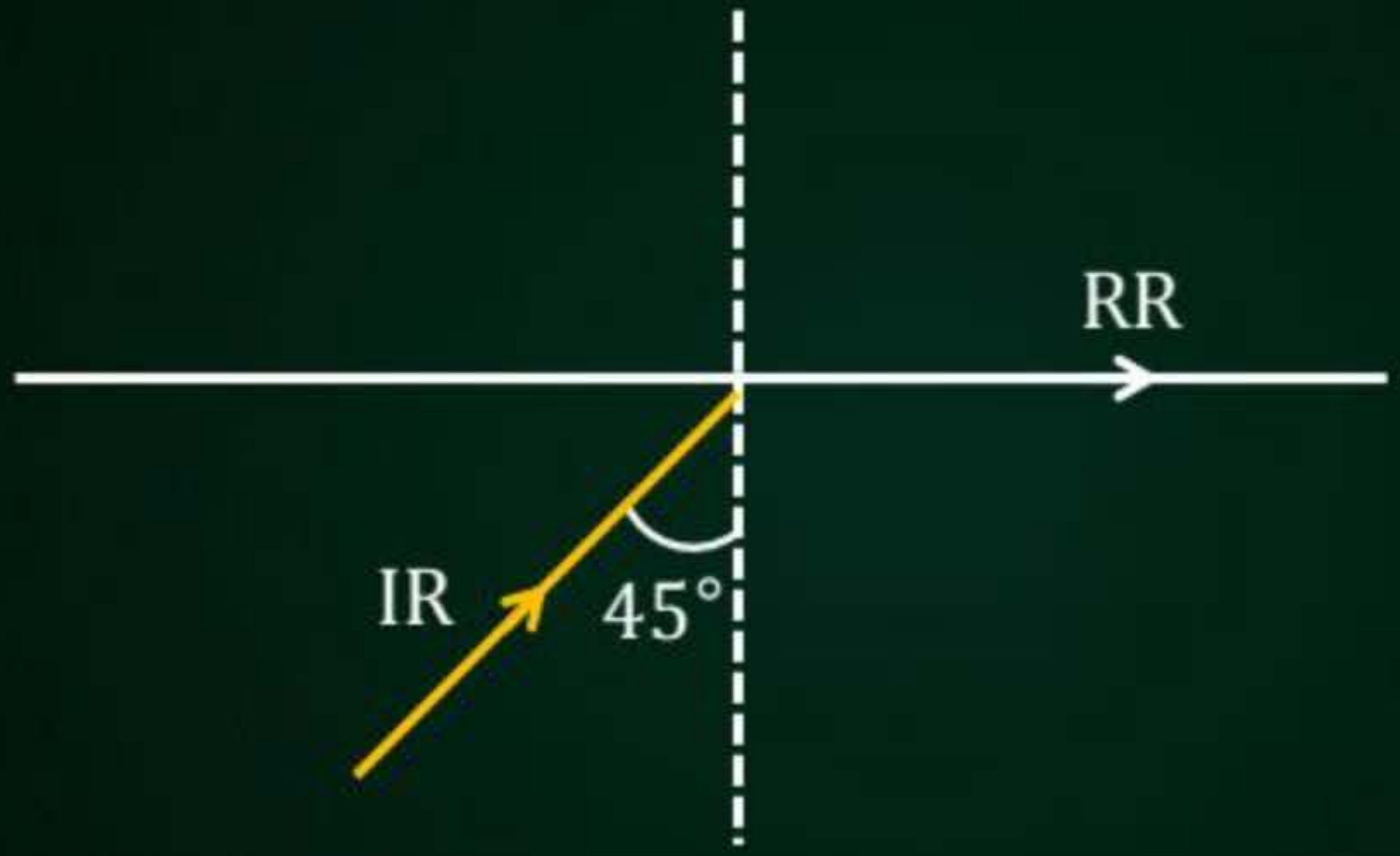
2. $\dfrac{x\pi R^2 n_2}{n_1}$

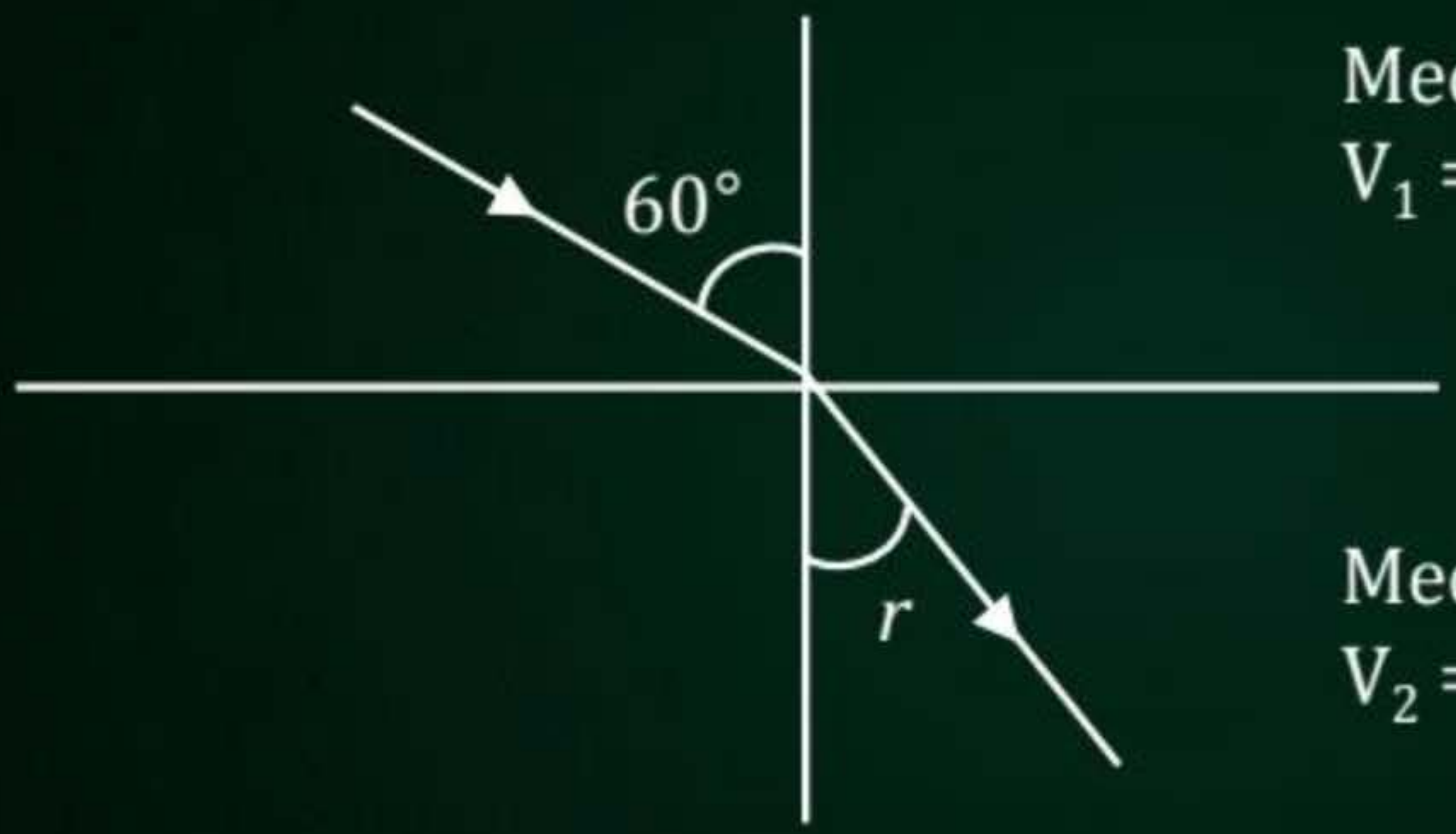
3. $\dfrac{2\pi R n_1}{n_2}$

4. $\pi R^2 x$

QUESTION

Find refractive index?





Medium = 1
$V_1 = 3 \times 10^8$ m/s

Medium = 2
$V_2 = 2 \times 10^8$ m/s

QUESTION

Light takes t_1 second to travel a distance x cm in vacuum and the same light takes t_2 second to travel $10x$ cm in medium. The critical angle for the corresponding medium is

1. $\sin^{-1}\left[\frac{10t_2}{t_1}\right]$

2. $\sin^{-1}\left[\frac{t_2}{10t_1}\right]$

3. $\sin^{-1}\left[\frac{10t_1}{t_2}\right]$

4. $\sin^{-1}\left[\frac{t_1}{10t_2}\right]$

QUESTION

Light travels in two media M_1 and M_2 with speeds 1.5×10^8 ms^{-1} and 2.0×10^8 ms^{-1} respectively. The critical angle between them is: [26 July, 2022 (Shift-II)]

1. $\tan^{-1}\left(\frac{3}{\sqrt{7}}\right)$
2. $\tan^{-1}\left(\frac{2}{3}\right)$
3. $\cos^{-1}\left(\frac{3}{4}\right)$
4. $\sin^{-1}\left(\frac{2}{3}\right)$

QUESTION

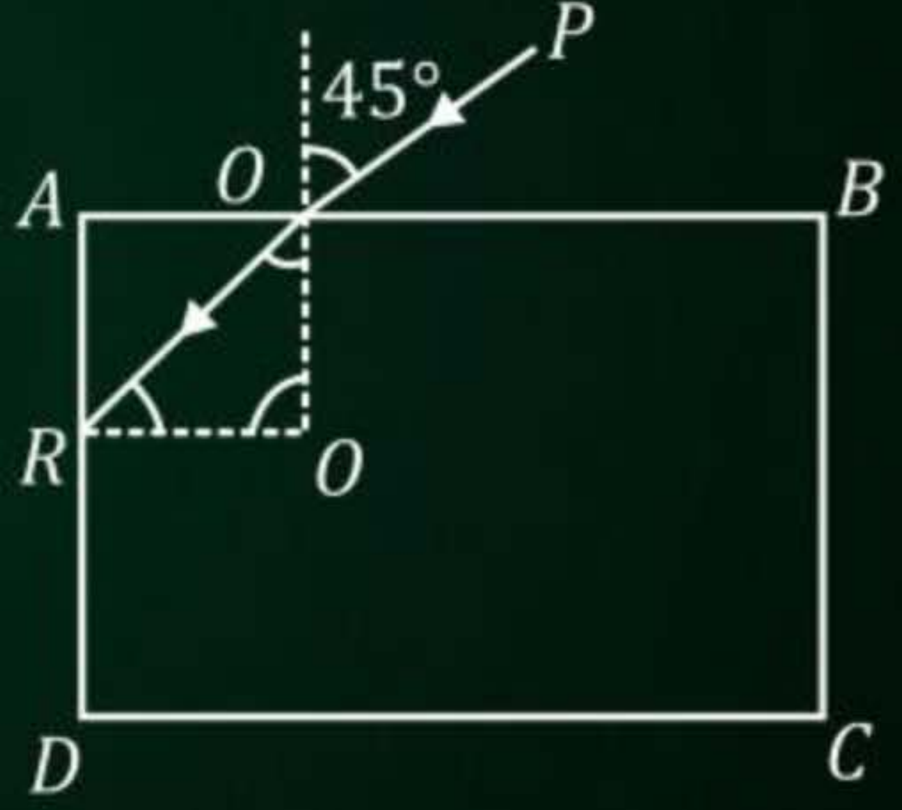
In a medium the speed of light wave decreases to 0.2 times to its speed in free space. The ratio of relative permittivity to the refractive index of the medium is $x : 1$. The value of x is ________.

(Given speed of light in free space = 3×10^8 ms^{-1} and for the given medium $\mu_r = 1$)

[JEE Main 2023]

QUESTION

A light ray falls an a square glass slab as shown in figure, making an angle of incidence 45°. What must be index of refraction of glass if total internal reflection occurs at the vertical face?



1. $\sqrt{\frac{3}{2}}$
2. $\sqrt{\frac{2}{3}}$
3. $\sqrt{\frac{5}{2}}$
4. None of these


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 08 | **Physics**

Ray Optics and Optical Instruments

By- Dr. Manish Raj (MR SIR)



Todays Goal

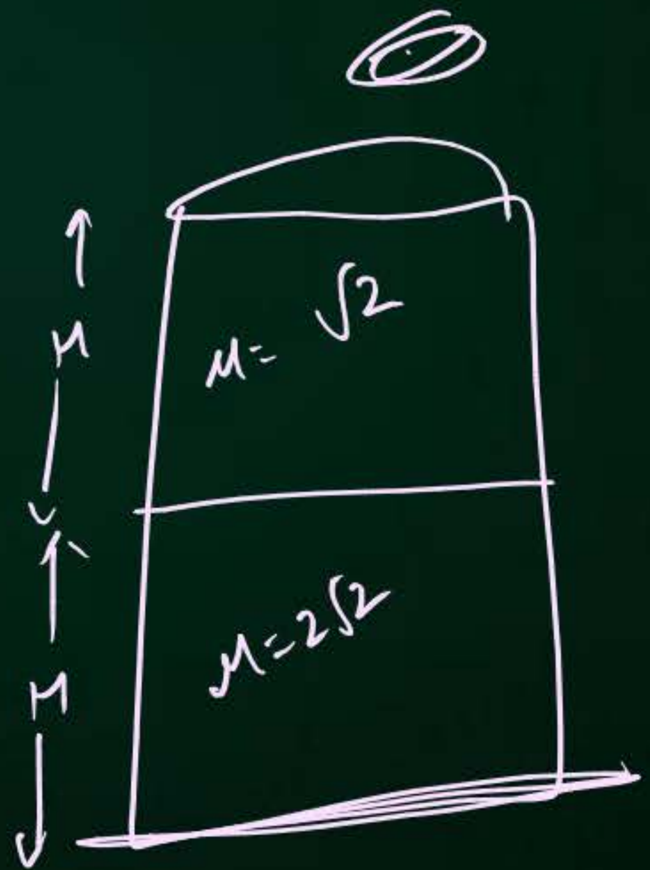
H/W ✓

velocity of Image in refraction ✓

QUESTION

A vessel of depth $2h$ is half filled with a liquid of refractive index $2\sqrt{2}$ and the upper half with another liquid of refractive index $\sqrt{2}$. The liquid are immiscible. The apparent depth of the inner surface of the bottom of vessel will be **[9 Jan, 2020 (Shift-I)]**

1. $\dfrac{h}{\sqrt{2}}$
2. $\dfrac{h}{2(\sqrt{2}+1)}$
3. $\dfrac{3}{4}h\sqrt{2}$
4. $\dfrac{h}{3\sqrt{2}}$



$$d_{app} = \frac{H}{\sqrt{2}} + \frac{H}{2\sqrt{2}} = H\left[\frac{2+1}{2\sqrt{2}}\right] = \frac{3H}{2\sqrt{2}}$$

$$= \frac{3H}{2\sqrt{2}} \times \frac{\sqrt{2}}{\sqrt{2}} = \frac{3H\sqrt{2}}{4}$$

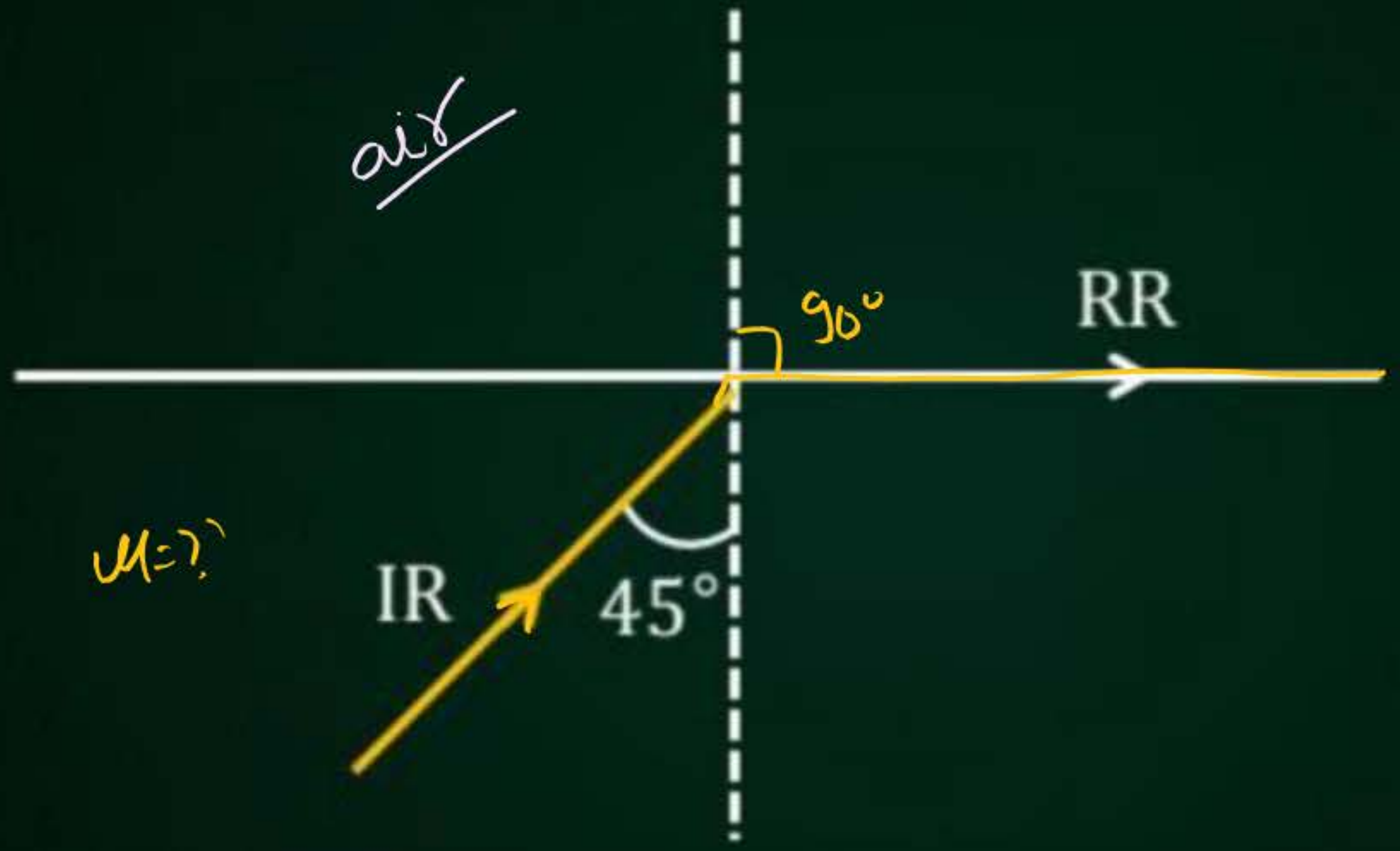
QUESTION

The apparent depth of water in cylindrical water tank of diameter $2R$ cm is reducing at the rate of x cm/min when water is being drained out at a constant rate. The amount of water drained in cc/minute is: (n_1 = refractive index of air, n_2 = refractive index of water)

1. $\dfrac{x\pi R^2 n_1}{n_2}$
2. $\dfrac{x\pi R^2 n_2}{n_1}$
3. $\dfrac{2\pi R n_1}{n_2}$
4. $\pi R^2 x$

QUESTION

Find refractive index? Of medm

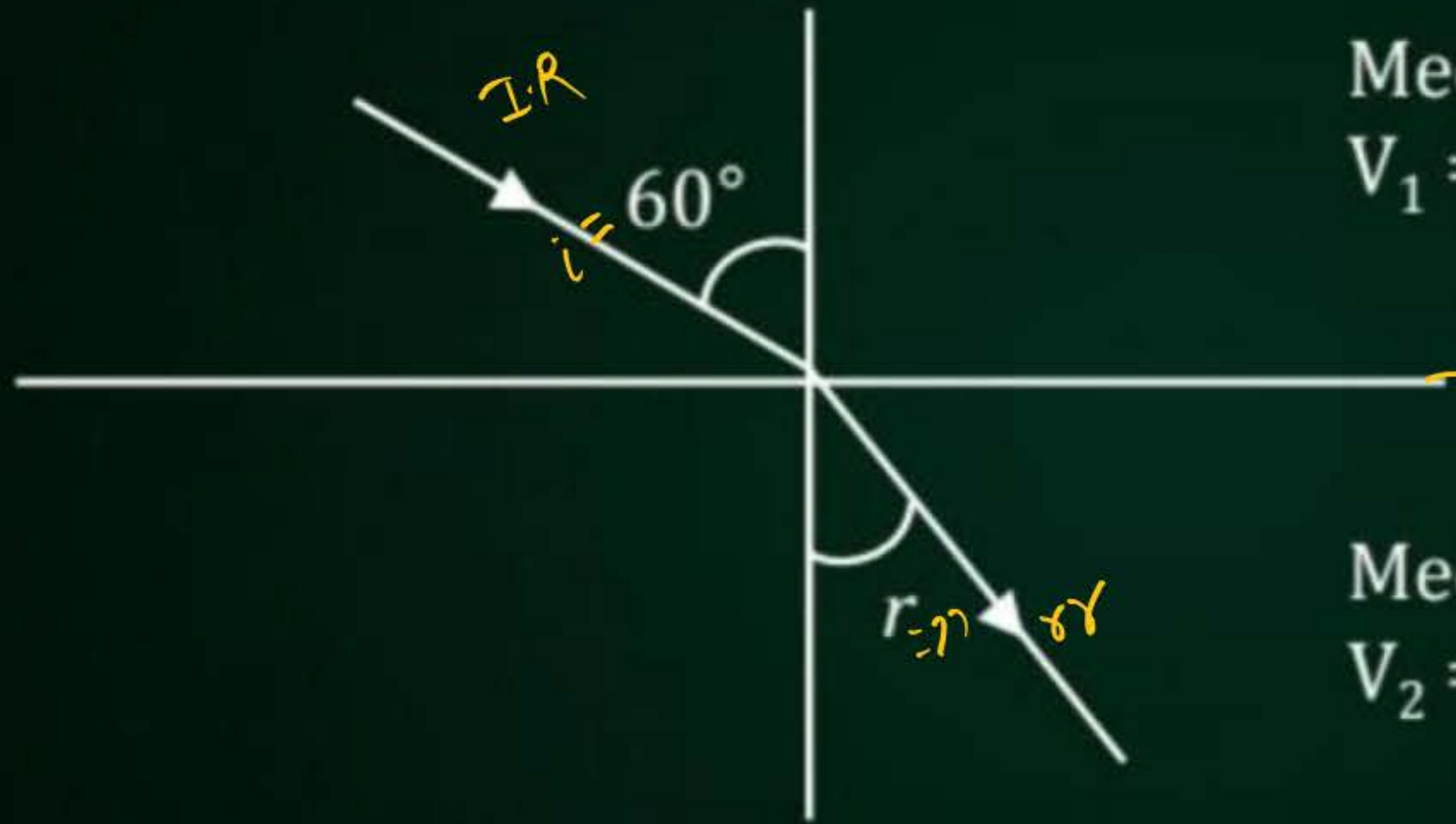


Snells law

$$\frac{\sin 45^\circ}{\sin 90} = \frac{1}{\mu}$$

$$\frac{1}{\sqrt{2}\times 1} = \frac{1}{\mu}$$

$$\mu = \sqrt{2}$$



Medium = 1
$V_1 = 3 \times 10^8$ m/s

Medium = 2
$V_2 = 2 \times 10^8$ m/s

$$\frac{\sin i}{\sin r} = \frac{\mu_2}{\mu_1} = \frac{V_1}{V_2}$$

$$\frac{\sin 60^\circ}{\sin r} = \frac{3 \times 10^8}{2 \times 10^8}$$

$$\frac{\sqrt{3}}{2 \sin r} = \frac{3}{2}$$

$$\sin r = \frac{\sqrt{3}}{3}$$

$$\sin r = \frac{1}{\sqrt{3}}$$

$$r = \sin^{-1}\left(\frac{1}{\sqrt{3}}\right)$$

QUESTION

NEET-24

Light takes t_1 second to travel a distance x cm in vacuum and the same light takes t_2 second to travel $10x$ cm in medium. The critical angle for the corresponding medium is

1. $\sin^{-1}\left[\frac{10t_2}{t_1}\right]$
2. $\sin^{-1}\left[\frac{t_2}{10t_1}\right]$
3. $\sin^{-1}\left[\frac{10t_1}{t_2}\right]$
4. $\sin^{-1}\left[\frac{t_1}{10t_2}\right]$

$t_1 \rightarrow x$ cm in vac

$t_2 \rightarrow 10x$ cm in medm

Critical Angle

$$\frac{\sin i_c}{\sin 90} = \frac{\mu_2}{\mu_1} = \frac{v_1}{v_2} = \frac{\lambda_1}{\lambda_2} = \frac{d_1}{t_1}\frac{t_2}{d_2}$$



$$\frac{\sin i_c}{\sin 90} = \frac{\mu_2}{\mu_1} = \frac{v_1}{v_2}$$

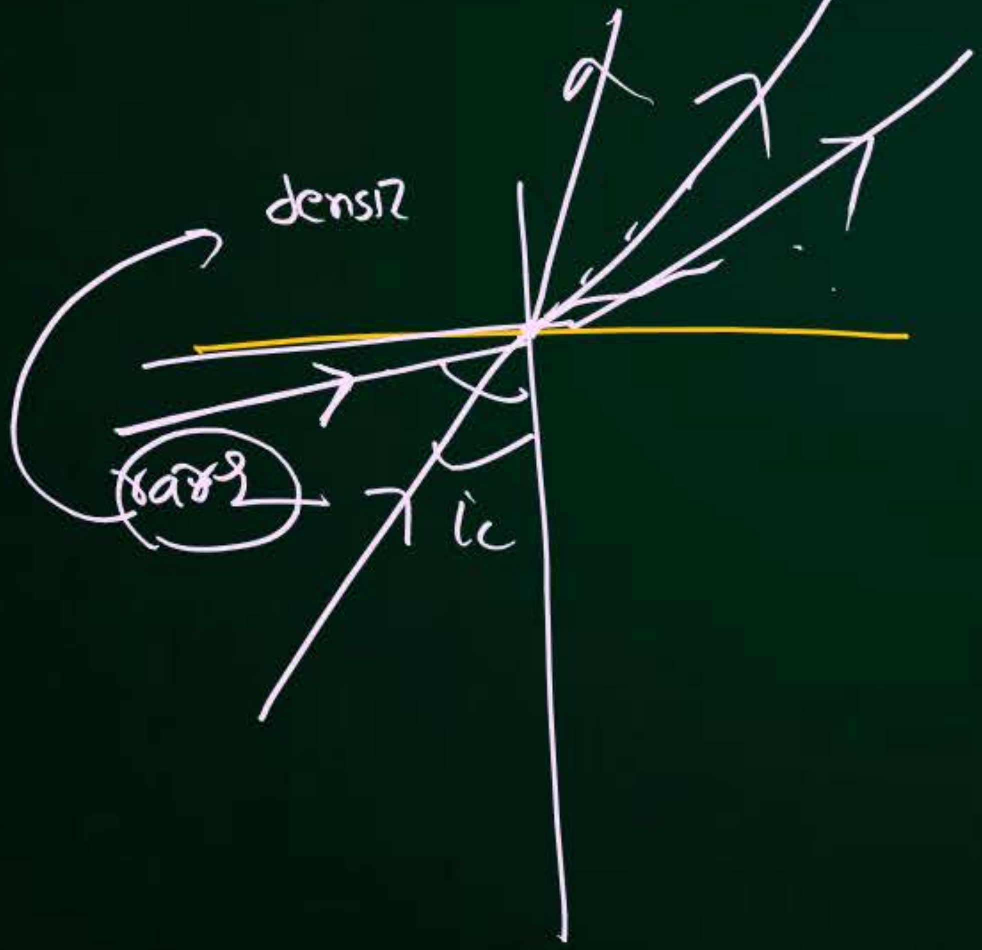
$$\sin i_c = \frac{x\, t_2}{t_1 \times 10x}$$

$$i_c = \sin^{-1}\left(\frac{t_2}{10t_1}\right)$$

QUESTION

Light travels in two media M_1 and M_2 with speeds $1.5 \times 10^8\ ms^{-1}$ and $2.0 \times 10^8\ ms^{-1}$ respectively. The critical angle between them is: [26 July, 2022 (Shift-II)]

1. $\tan^{-1}\left(\frac{3}{\sqrt{7}}\right)$
2. $\tan^{-1}\left(\frac{2}{3}\right)$
3. $\cos^{-1}\left(\frac{3}{4}\right)$
4. $\sin^{-1}\left(\frac{2}{3}\right)$



$\frac{\sin i_c}{\sin 90°} = \frac{\mu_2}{\mu_1}$

$\sin i_c = \frac{\mu_2}{\mu_1} = \frac{v_1}{v_2} = \frac{1.5 \times 10^8}{2 \times 10^8}$

$\sin i_c = \frac{3}{4} = \frac{P}{H}$

$i_c = \sin^{-1}\left(\frac{3}{4}\right)$

$B = \sqrt{4^2 - P^2} = \sqrt{16-9} = \sqrt{7}$

$\tan i = \frac{3}{\sqrt{7}}$

$i = \tan^{-1}\left(\frac{3}{\sqrt{7}}\right)$

QUESTION

In a medium the speed of light wave decreases to 0.2 times to its speed in free space. The ratio of relative permittivity to the refractive index of the medium is $x : 1$. The value of x is ________.

(Given speed of light in free space $= 3 \times 10^8\ \text{ms}^{-1}$ and for the given medium $\mu_r = 1$)

[JEE Main 2023]

simple

$$V = \frac{1}{\sqrt{\mu_m \varepsilon_m}} = \frac{c}{\sqrt{\mu_r \varepsilon_r}} = \frac{c}{\mu_{ref}}$$

$$0.2c = \frac{c}{\sqrt{\varepsilon_r}} = \frac{c}{\mu_{ref}}$$

$$\frac{1}{\sqrt{\varepsilon_r}} = \frac{2}{10} = \frac{1}{5}$$

$$\varepsilon_r = 25 \quad \text{— (1)}$$

$$\frac{2}{10} = \frac{1}{5} = \frac{1}{\mu_{r}}$$

$$\mu_{ref} = 5$$

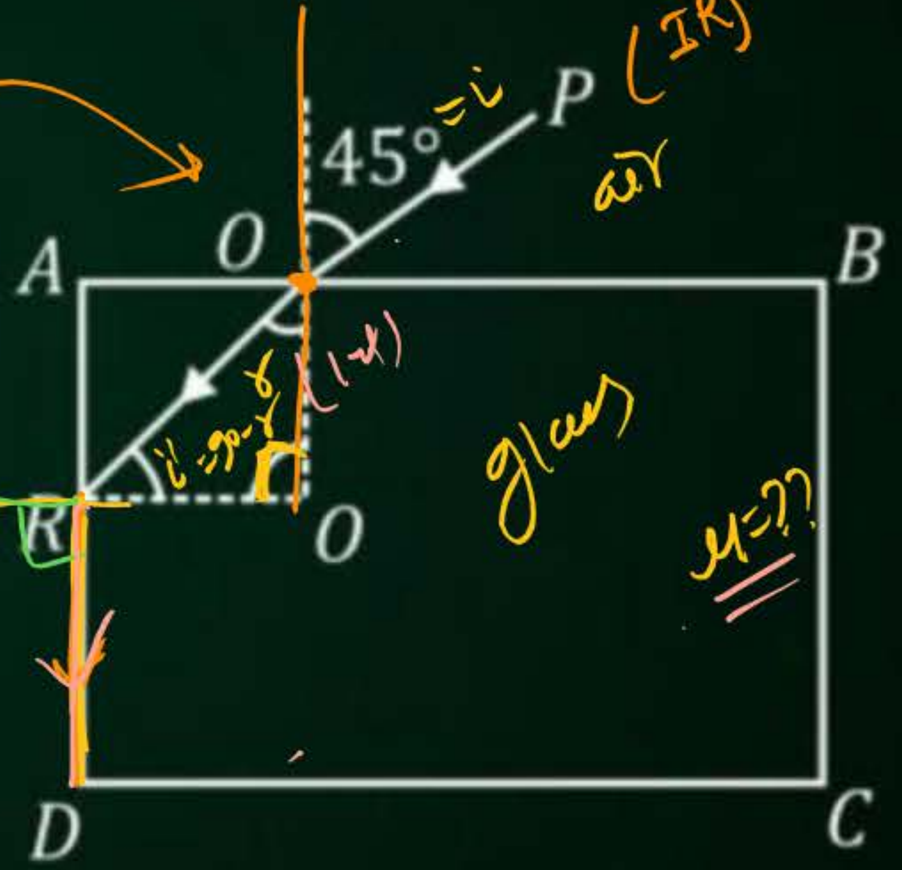
$$\frac{\varepsilon_r}{\mu_{ref}} = \frac{x}{1}$$

given

NEET-24

QUESTION

A light ray falls an a square glass slab as shown in figure, making an angle of incidence 45°. What must be index of refraction of glass if total internal reflection occurs at the vertical face?



1. $\sqrt{\frac{3}{2}}$
2. $\sqrt{\frac{2}{3}}$
3. $\sqrt{\frac{5}{2}}$
4. None of these

$1 \times \sin 45° = \mu \sin r$ — (1)

$\frac{1}{\mu\sqrt{2}} = \sin r$ — (1)

$\mu \times \sin i' = \sin 90° \times 1$

$\mu \sin i' = 1$

$\mu \sin(90 - r) = 1$

$\cos r = \frac{1}{\mu}$ — (11)

NEET-2024

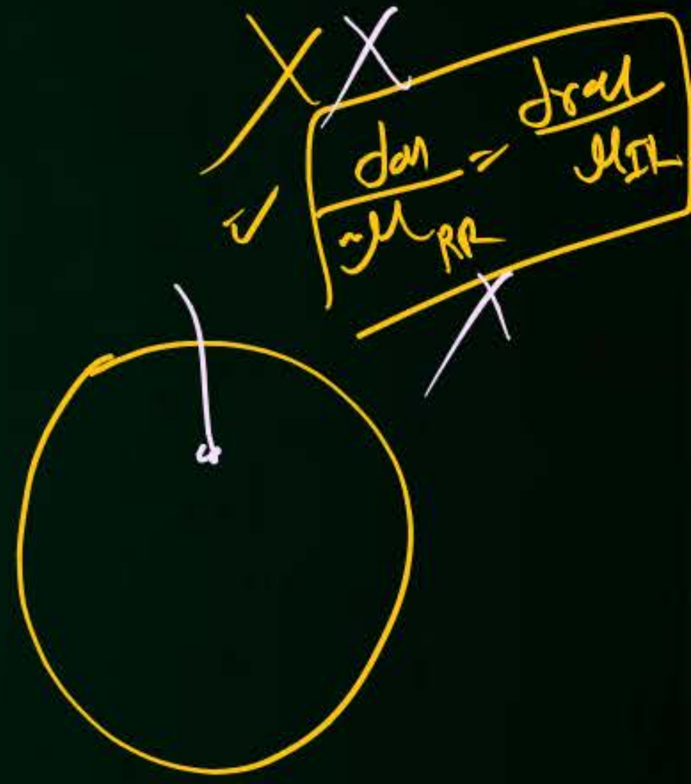
$(1)^2 + (11)^2$: $1 = \frac{1}{\mu^2 2} + \frac{1}{\mu^2}$

$\mu^2 = \frac{1}{2} + 1 = \frac{3}{2}$

$\mu = \sqrt{\frac{3}{2}}$

QUESTION

There is a small air bubble inside a glass sphere ($\mu = 1.5$) of radius 10 cm. The bubble is 4 cm below the surface and is viewed normally from the outside the apparent depth of the bubble is:



1. 3 cm below the surface
2. 5 cm below the surface
3. 8 cm below the surface
4. 10 cm below the surface

QUESTION

The speed of light in medium 'A' and 'B' are 2.0×10^{8} cm/s and 1.5×10^{10} cm/s respectively. A ray of light enters from the medium B to A an incident angle 'θ'. If they ray suffers total internal reflection, then

[JEE Main 2022]

1. $\theta = \sin^{-1}\left(\frac{3}{4}\right)$
2. $\theta > \sin^{-1}\left(\frac{2}{3}\right)$
3. $\theta < \sin^{-1}\left(\frac{3}{4}\right)$
4. $\theta > \sin^{-1}\left(\frac{3}{4}\right)$

B

A

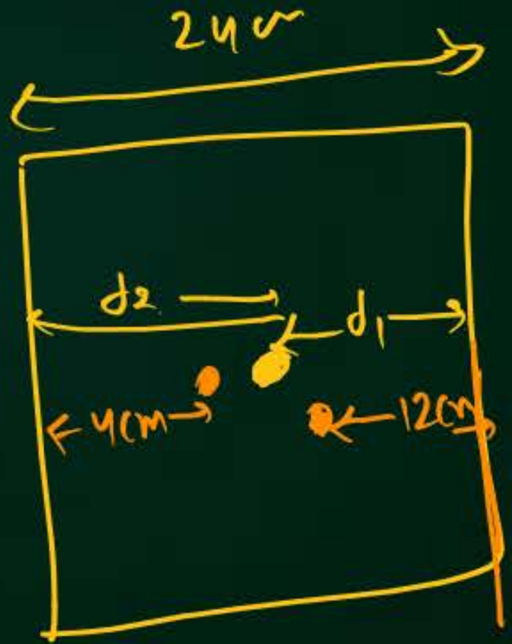
Done

QUESTION

An ice cube has a bubble inside. When viewed from one side the apparent distance of the bubble is 12 cm. when limed from the opposite side, the apparent distance of the bubble is observed as 4 cm. If the side of the ice cube is 24 cm, the refractive index of the ice cube is

[12 Apr, 2023 (Shift-I)]

1. 4/3
2. 3/2
3. 2/3
4. 6/5



$d_1 + d_2 = 24\ cm$

$12\mu + 4\mu = 24$

$16\mu = 24$

$\mu = \frac{24}{16} = \frac{3}{2} = 1.5$

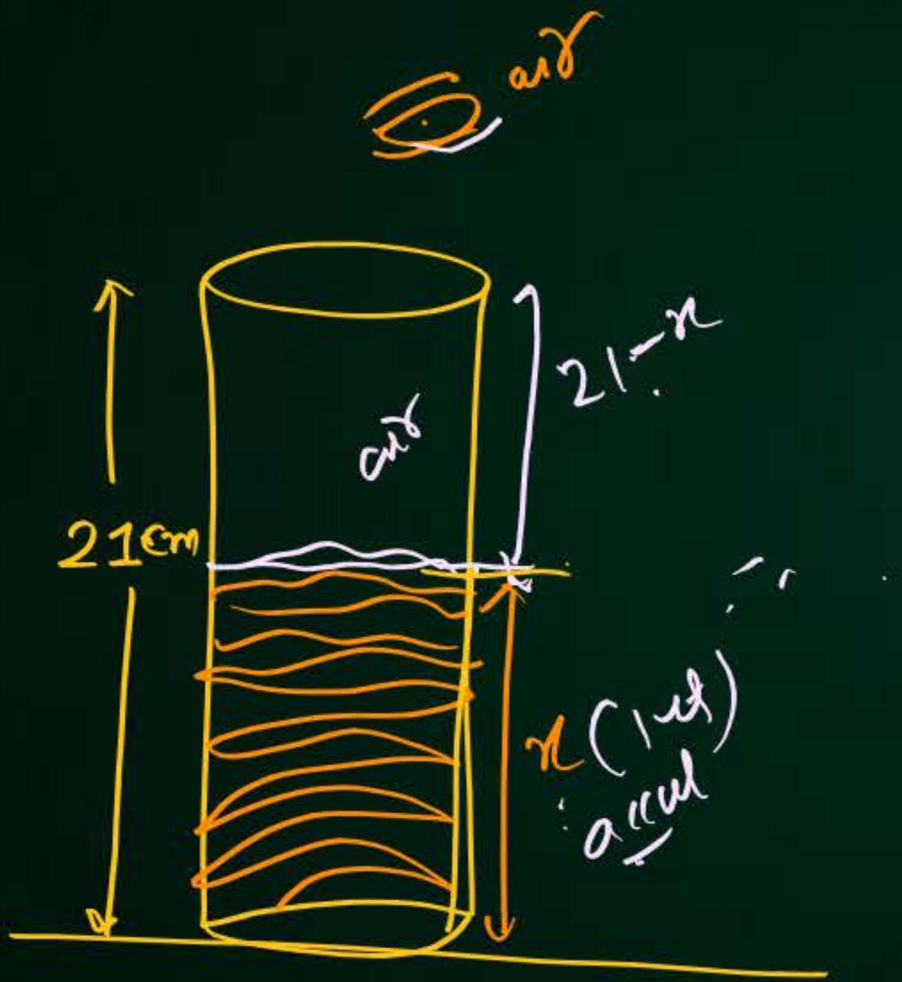
$\frac{12}{1} = \frac{d_1}{\mu}$ — (i)

$\frac{4}{1} = \frac{d_2}{\mu}$ — (ii)

QUESTION

How much water should be filled in a container 21 cm in height, so that it appears half filled when viewed from the top of the container (given that ${}_a\mu_\omega = 4/3$)

1. 8.0 cm
2. 10.5 cm
3. 12.0 cm
4. 15.0 cm



$$21 - x = \frac{x}{\mu}$$

$$21 - x = \frac{3x}{4}$$

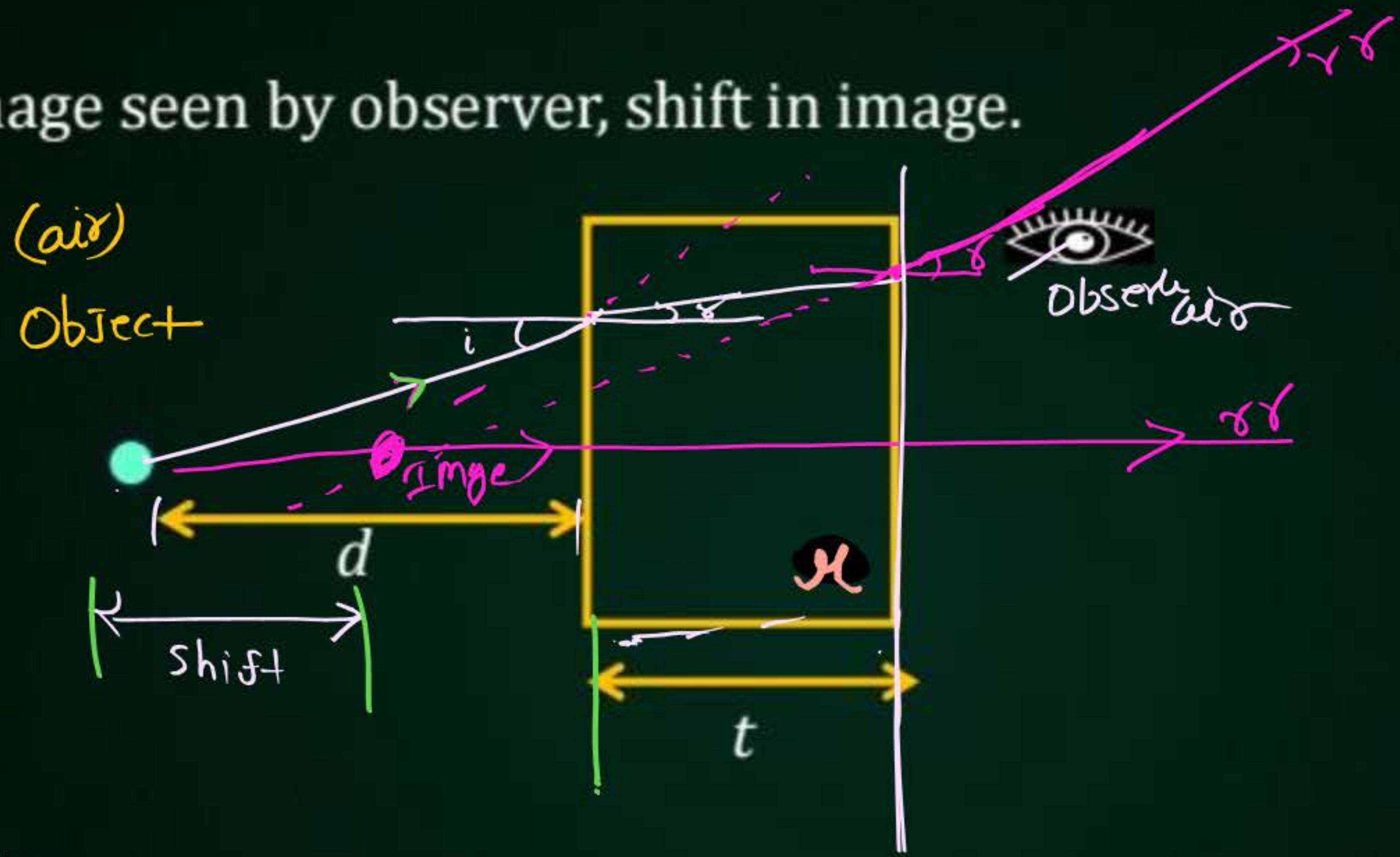
$$84 - 4x = 3x$$

$$84 = 7x$$

$$x = \frac{84}{7} = 12 \text{ cm}$$

QUESTION

Distance of image seen by observer, shift in image.



$$d_{app} = d + \frac{t}{\mu}$$

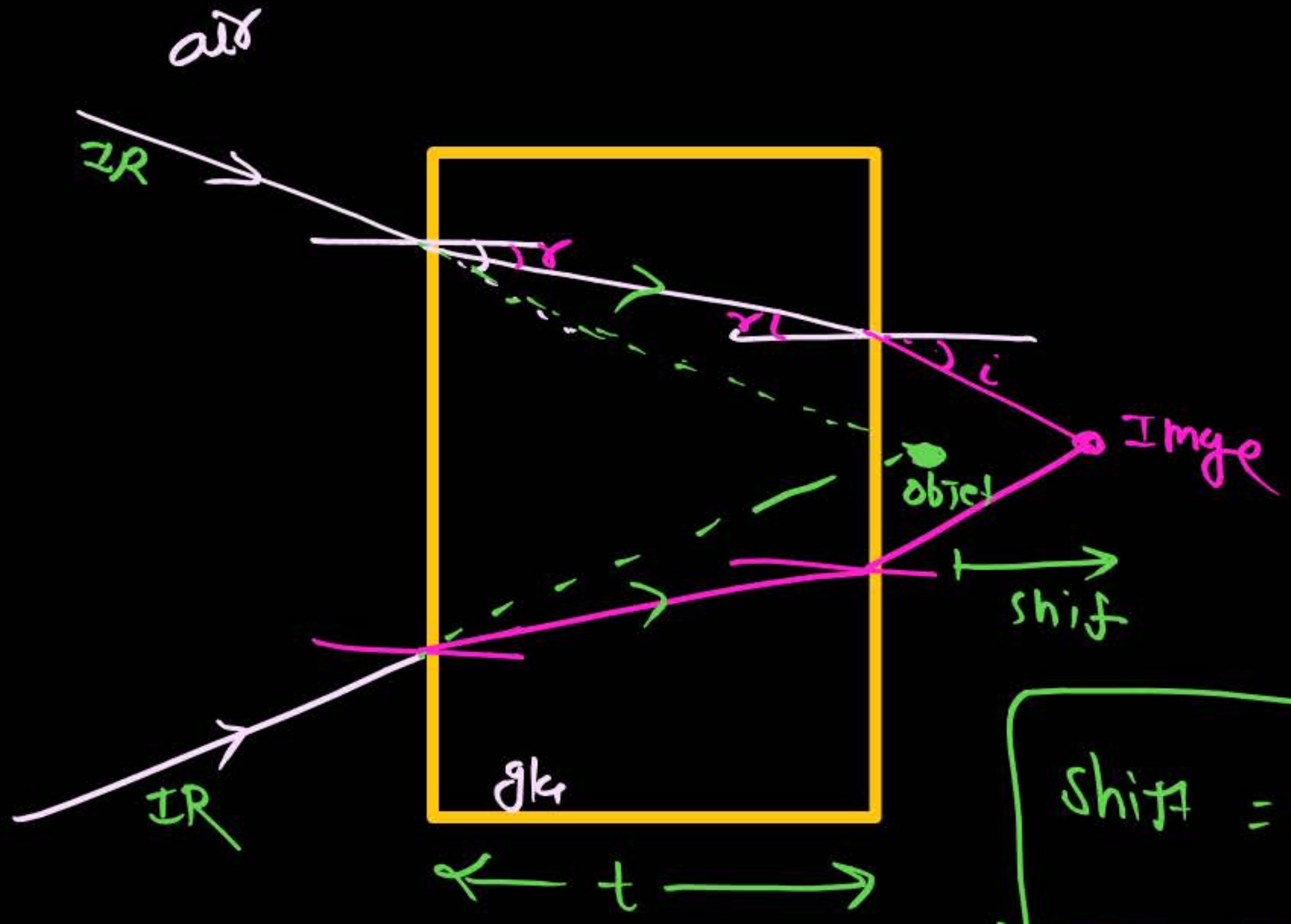
$$d_{real} = d + t$$

$$\text{Shift} = d_{real} - d_{app}$$

$$= d + t - d - \frac{t}{\mu}$$

$$\text{Shift} = \left\{t - \frac{t}{\mu}\right\}$$

Converging incident ray falling on glass



Shift $= t - \frac{t}{\mu}$

QUESTION

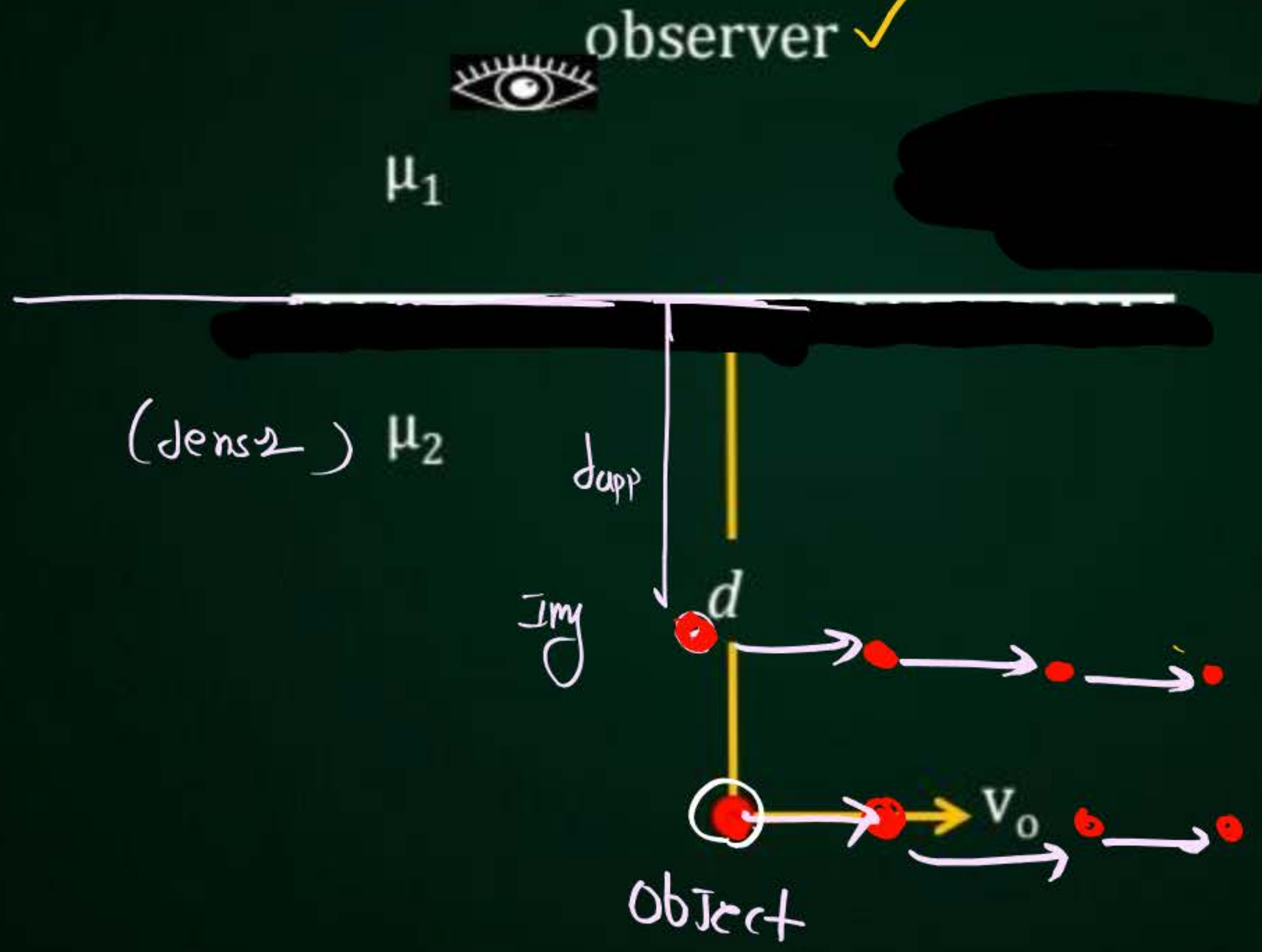
A narrow, paraxial beam of light is converging towards a point I on a screen. A plane parallel plate of glass of thickness t, and refractive index μ is introduced in the path of the beam. The convergence point is shifted by

1. $t(1 - 1/\mu)$ away
2. $t(1 + 1/\mu)$ away
3. $t(1 - 1/\mu)$ nearer
4. $t(1 + 1/\mu)$ nearer



Velocity of image in refraction

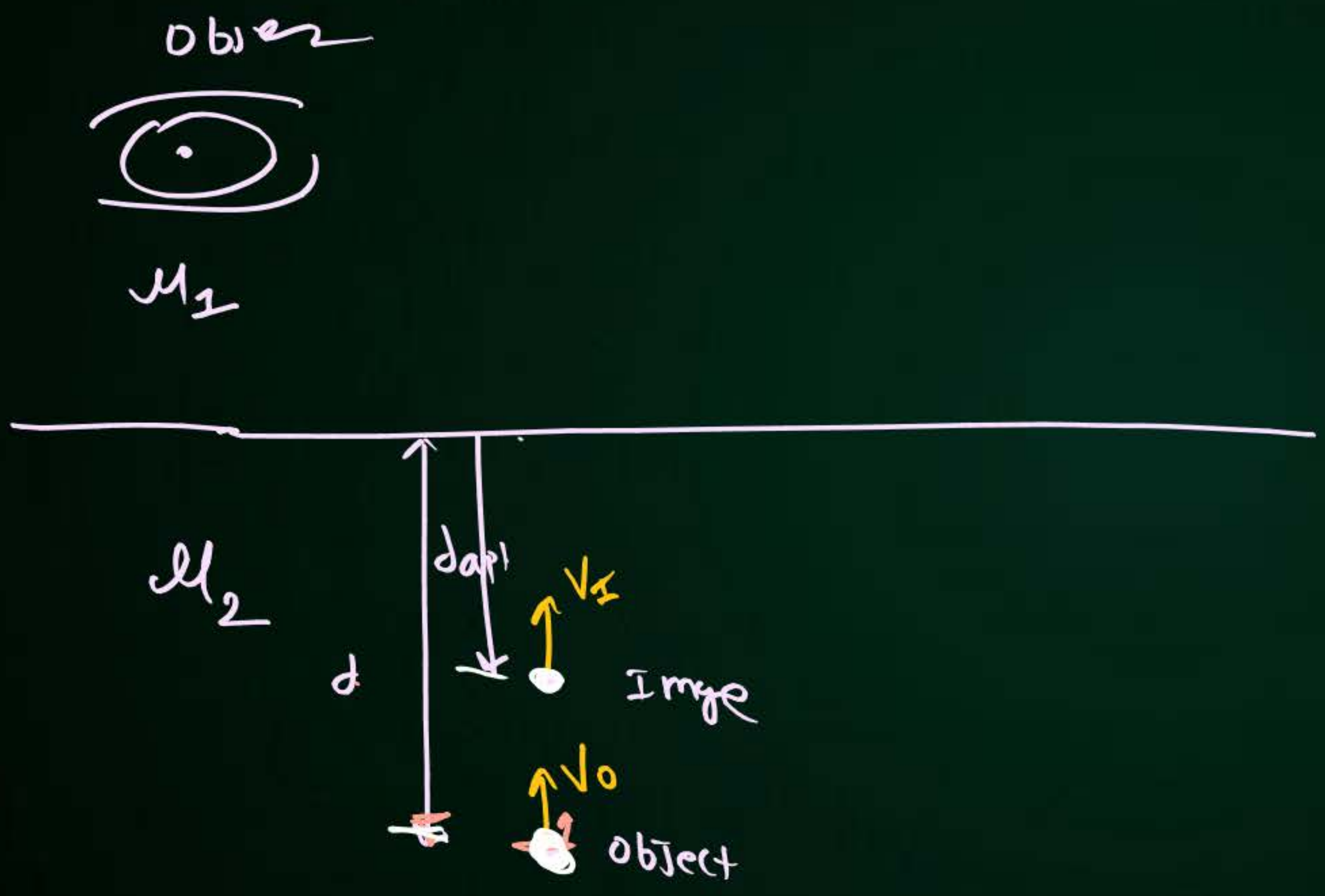
(i) Object is moving parallel to boundary



$$v_{IG} = v_0$$

velocity of Image w.r.t observer in medium (1)

(ii) Velocity of image of object moving towards boundary



$$\frac{d_{appt}}{\mu_{1(obs)}} = \frac{d_{real}}{\mu_{2(object)}}$$

$$\frac{d_{app}}{\mu_1} = \frac{d}{\mu_2}$$

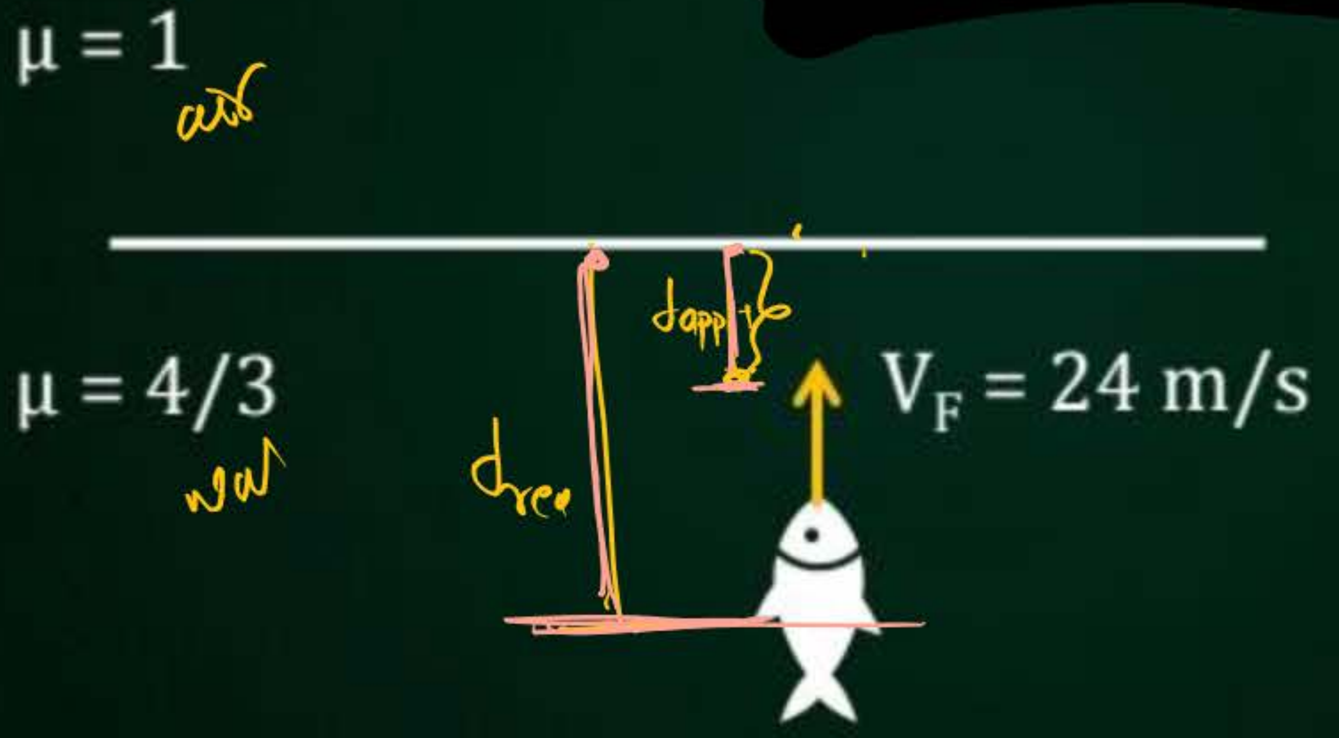
diffⁿ w.r.t. time

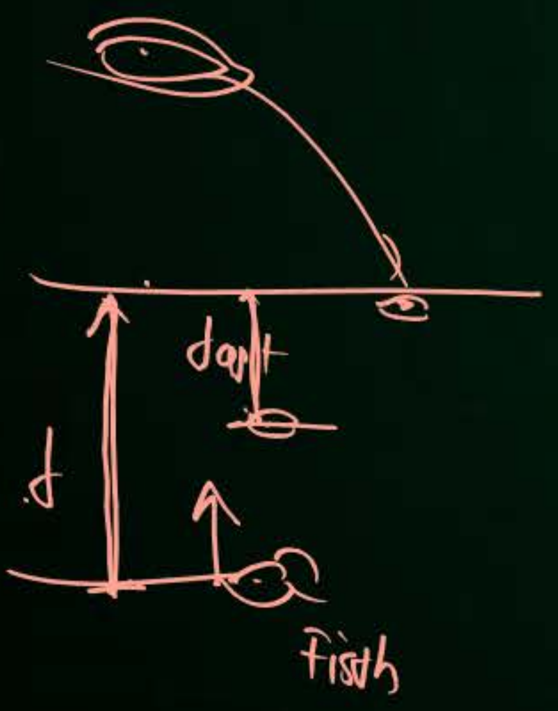
$$\frac{V_I}{\mu_1} = \frac{V_O}{\mu_2}$$

$$\boxed{\frac{V_I}{\mu_1} = \frac{V_O}{\mu_2}}$$ → IMP*

QUESTION

(i) Velocity of fish w.r.t. stationary observer in air.





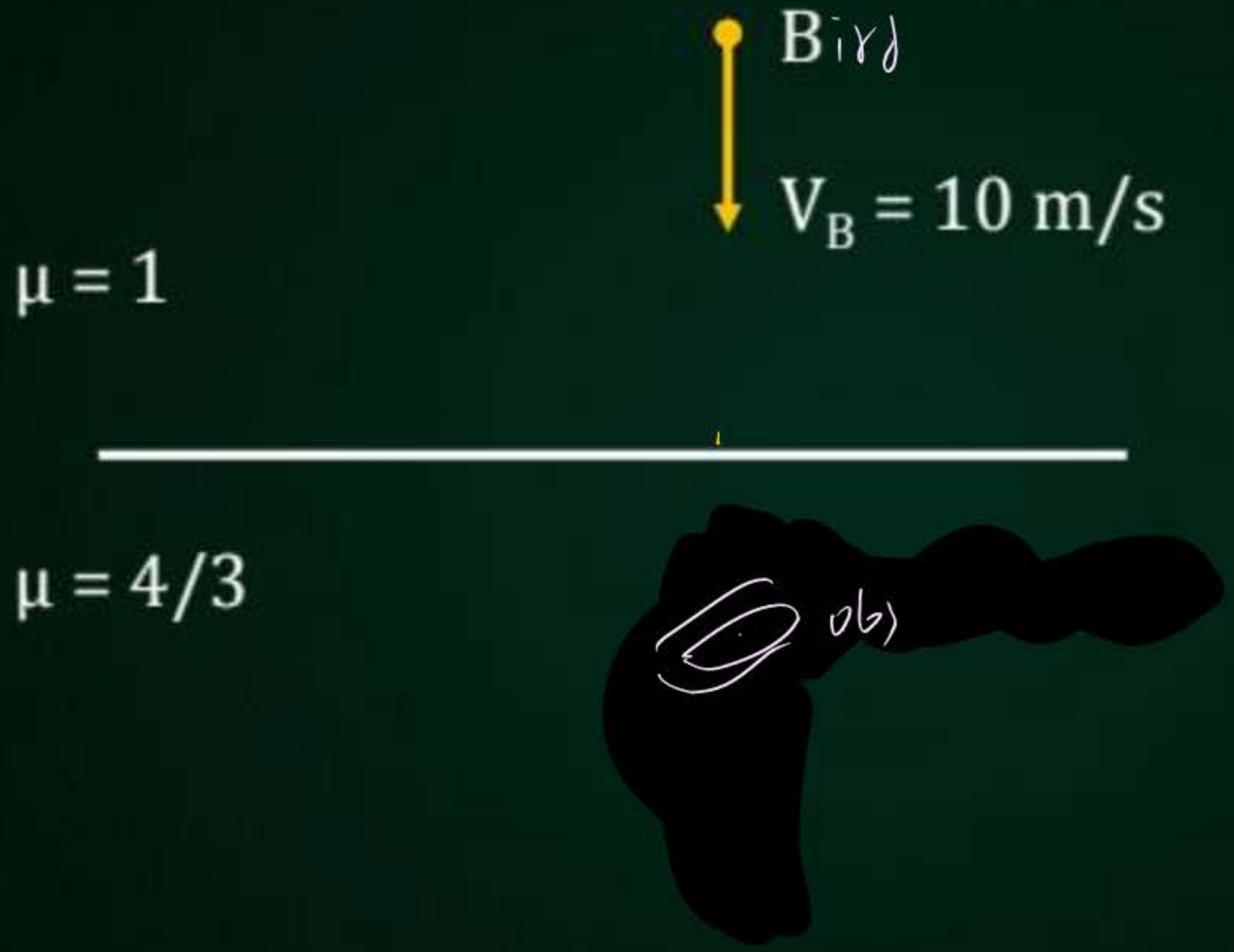
$$\frac{v_{I\,obs}}{1} = \frac{24}{4/3}$$

$$v_I = 18 \text{ m/s}$$

IMP*

QUESTION

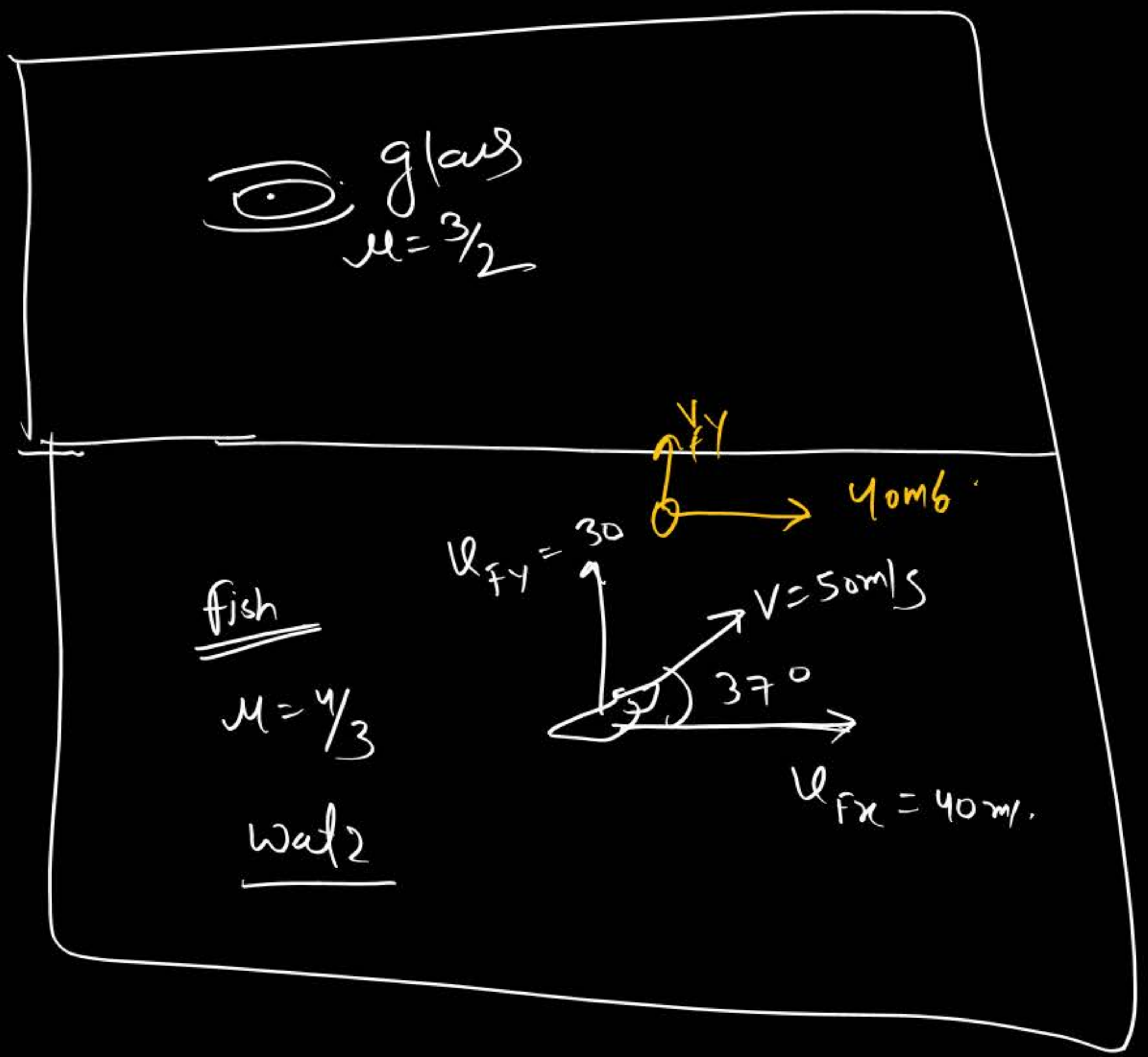
(ii) Velocity of bird stationary observer in water.



$$\frac{v_I}{4/3} = \frac{v_0}{1}$$

$$v_I = \frac{4}{3} \times 10$$

$$v_I = \frac{40}{3} \text{ m/s}$$



Velocity of fish as seen by observer in glass

$$\frac{u_{fy}}{3/2} = \frac{30}{4/3}$$

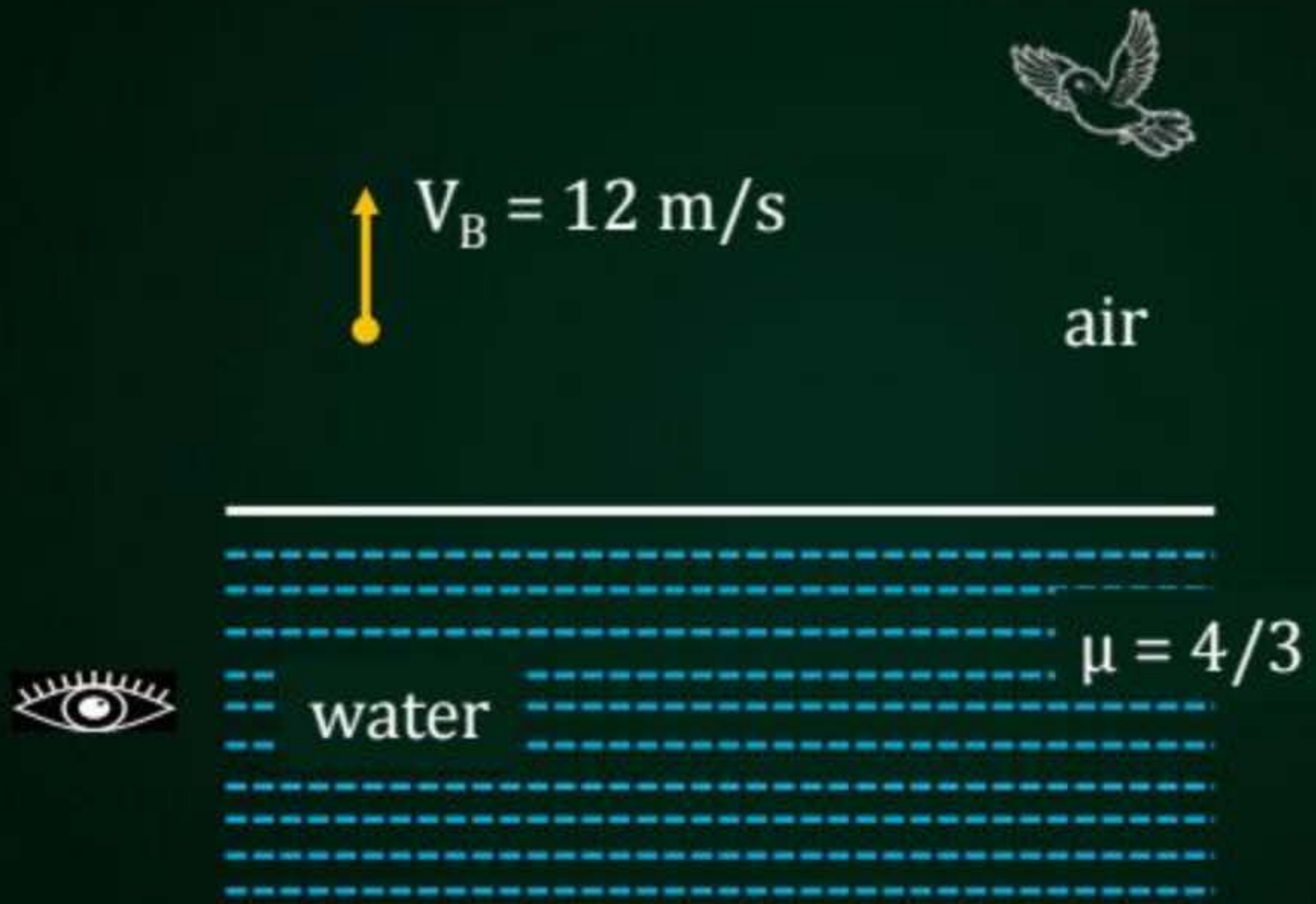
$$u_{fy} = \frac{\overset{15}{\cancel{30}} \times 3 \times 3}{4 \times \cancel{2}}$$

$$= \frac{15 \times 9}{4} \text{ m/s}$$

$$\boxed{u_{f\,obs} = \frac{135}{4}\hat{j} + 40\hat{i}}$$

QUESTION

Velocity of bird which is in air w.r.t. observer in water.




THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 9 | **Physics**

Ray Optics and Optical Instruments



By- Dr. Manish Raj (MR SIR)

Todays Goal

Refraction from curved surface

optical fibr

(Q) Why T.I.R. does not occurs when light travel from rarer to denser medium.

Ans When light inter into denser medium it bend towards normal hence ($r < i$)

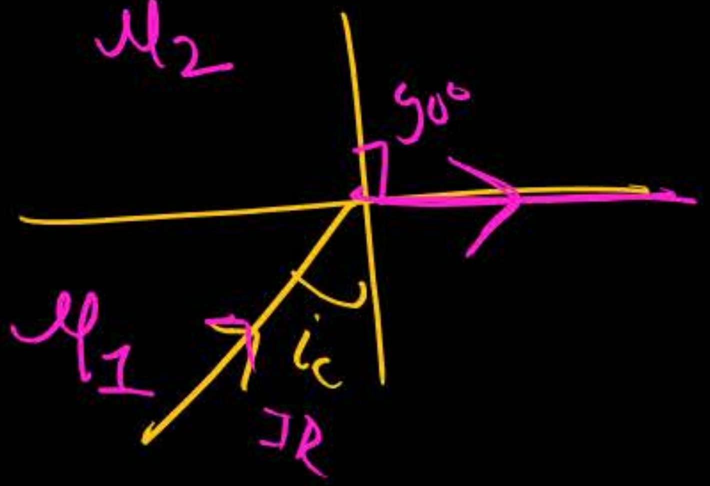
hence $r \rightarrow$ never approache to 90°

$$\sin i = \frac{\mu_2}{\mu_1} \sin r_2$$

T.I.R

when light enter into rarer medium, it bends away from normal ($i < r$)

$$\sin i_c = \frac{\mu_2}{\mu_1} = \frac{v_1}{v_2} = \frac{\lambda_1}{\lambda_2}$$

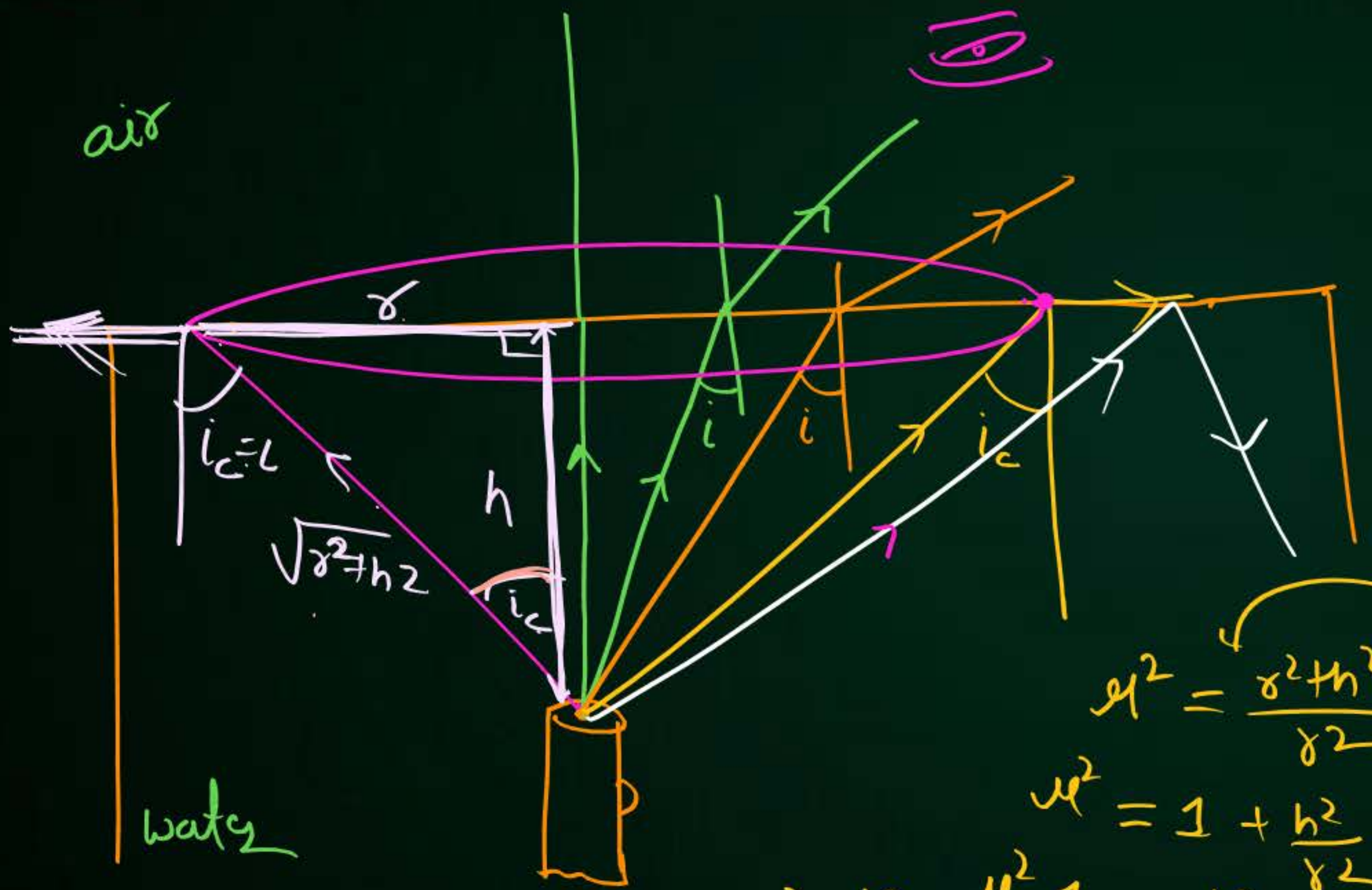


$$\frac{\sin i_c}{\sin 90} = \frac{\mu_2}{\mu_1} = \frac{\mu_{chhota}}{\mu_{Bada}}$$

Radius of Visibility

$$r = \frac{h}{\sqrt{\mu^2 - 1}}$$

Area $= \pi r^2$



Jus T.I.R

$$\frac{\sin i_c}{\sin 90^\circ} = \frac{1}{\mu}$$

$\sin i_c = \frac{1}{\mu}$ — (i)

$\sin i_c = \frac{r}{\sqrt{r^2+h^2}}$ — (ii)

(i) = (ii)

$$\frac{1}{\mu} = \frac{r}{\sqrt{r^2+h^2}}$$ (Square Both sides)

$$\frac{1}{\mu^2} = \frac{r^2}{r^2+h^2}$$

$$\mu^2 = \frac{r^2+h^2}{r^2}$$

$$\mu^2 = 1 + \frac{h^2}{r^2}$$

$$\mu^2 - 1 = \frac{h^2}{r^2}$$

$$r^2 = \frac{h^2}{\mu^2 - 1}$$

MR Ratta → $r = \frac{h}{\sqrt{\mu^2 - 1}}$

QUESTION

A small bulb is placed at the bottom of a tank containing water to a depth of $\sqrt{7}$ m. The refractive index of water is 4/3. The area of the surface of water through which light from the bulb can emerge out is $x\pi$ m^2. The value of x is ________.

[26 June, 2022 (Shift-II)]

$h = \sqrt{7}\ m$

$\mu = 4/3$

$$r = \frac{h}{\sqrt{\mu^2 - 1}} = \frac{\sqrt{7}}{\sqrt{\frac{16}{9} - 1}} = \frac{\sqrt{7}}{\sqrt{\frac{16-9}{9}}} = \frac{\sqrt{7}}{\sqrt{\frac{7}{9}}} = 3$$

$$\text{Are} = \pi r^2 = \pi (3)^2 = x\pi$$

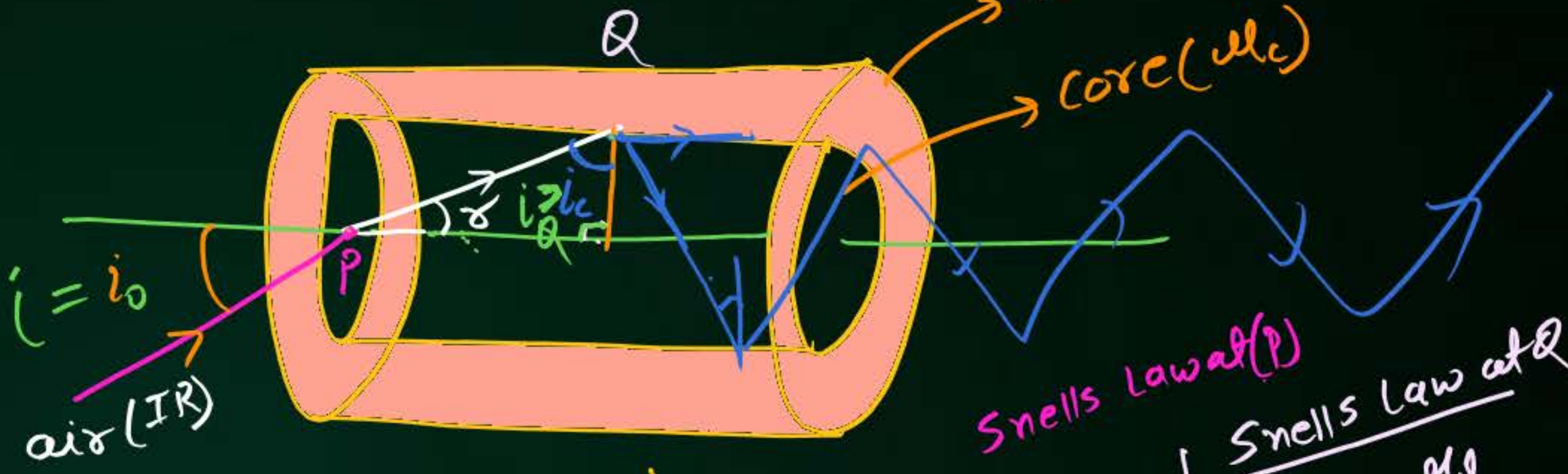
$$x = 9$$

Optical Fiber

working → Based on T.I.R.

$\mu_c > \mu_e$

$\gamma + i_c + 90 = 180$



Snells Law at (P)

$\frac{\sin i_0}{\sin\gamma} = \frac{\mu_c}{1}$

$\sin\gamma = \frac{\sin i_0}{\mu_c}$ — (I)

Snells Law at Q

$\sin i_c = \frac{\mu_e}{\mu_c}$

$\sin(90-\gamma) = \frac{\mu_e}{\mu_c}$

$\cos\gamma = \frac{\mu_e}{\mu_c}$ — (II)

$\Rightarrow$ (I)^2 + (II)^2

$1 = \frac{\sin^2 i_0}{\mu_c^2} + \frac{\mu_e^2}{\mu_c^2}$

$\mu_c^2 = \sin^2 i_0 + \mu_e^2$

$\mu_c^2 - \mu_e^2 = \sin^2 i_0$

$\sin i_0 = \sqrt{\mu_c^2 - \mu_e^2}$

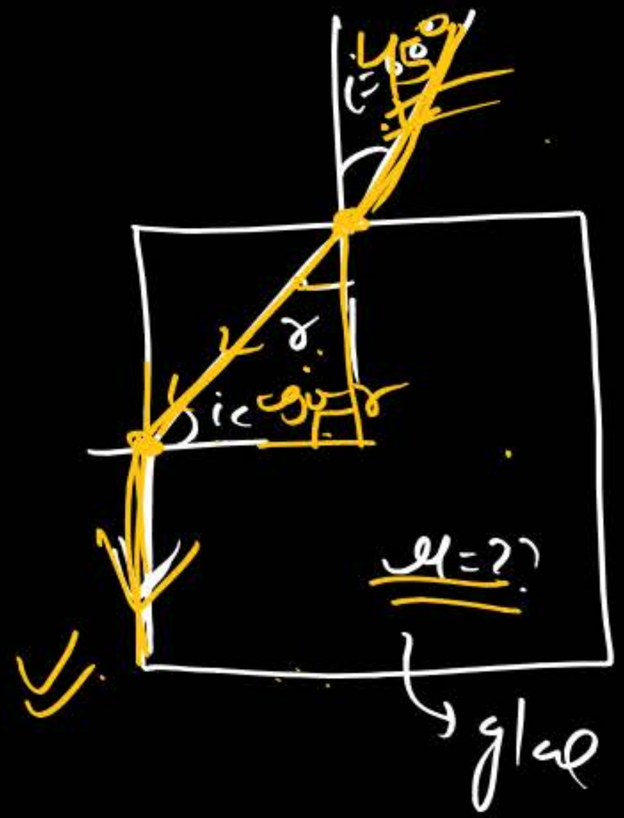
Condition of Angle of Incident (i) for Just T.I.R at 'Q'.

$\sin i_0 = \sqrt{\mu_c^2 - \mu_e^2}$

$i_0 = \sin^{-1}\left(\sqrt{\mu_c^2 - \mu_e^2}\right)$ *

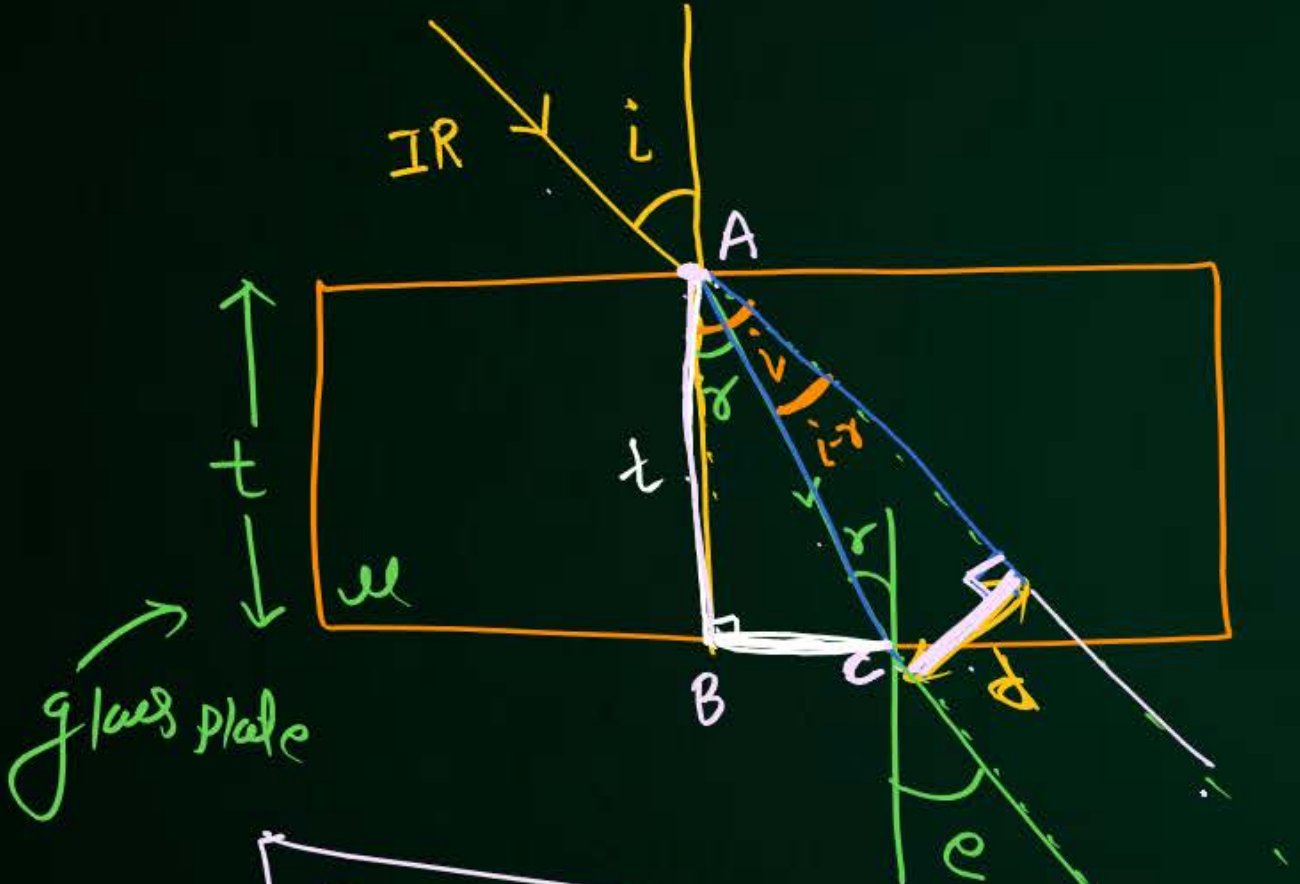
for better communication. $i < i_0$ $i_Q \geq i_c$

* If $i > i_0$ then no communicw



$$i \le \sin^{-1}\sqrt{\mu_c^2 - \mu_e^2}$$

Lateral Shift



$[i = e]$

emerging ray parallel to incident ray

$$\sin(i-r) = \frac{d}{AC} \quad \text{— (I)}$$

$$\cos(r) = \frac{t}{AC} \quad \text{— (II)}$$

(II)/(I)

$$\frac{\cos r}{\sin(i-r)} = \frac{t}{AC} \times \frac{AC}{d}$$

$$d = t\,\frac{\sin(i-r)}{\cos r}$$

i, r → small

Small Angle $\sin\theta \simeq \theta$, $\cos\theta = 1$

$d = t\,(i-r)$

Snell's law

$$\frac{\sin i}{\sin r} = \frac{\mu}{1}$$

$$\frac{i}{r} = \mu$$

$$d = t\,(i-r)$$

$$d = ti\left(1 - \frac{r}{i}\right)$$

$$* \; d = ti\left(1 - \frac{1}{\mu}\right)$$

refraction from plane surface

Snells Law

$$\frac{\sin i}{\sin r} = \frac{\mu_2}{\mu_1} = \frac{V_1}{V_2} = \frac{\lambda_1}{\lambda_2} = \frac{d_1}{t_1} \times \frac{t_2}{d_2}$$

Image formation

$$\frac{d_{appt}}{\mu_{obsr(RR)}} = \frac{d_{real}}{\mu_{iR(object)}}$$

$d_{appt} = d_{real}\left(\frac{\mu_{RR}}{\mu_{IR}}\right) = \frac{d_{real}}{\mu_{IR/obsr}}$

Shift in Image $= d_{real} - \frac{d_{re}}{\mu}$

$= d\left(1 - \frac{1}{\mu}\right)$

lateral shift

$$d = \frac{t \sin(i - r)}{\cos r}$$

velocity of Image.

object is moving $\parallel$ to boundary

$$v_I = v_0$$

object is moving $\perp$ to boundary

$$\frac{v_I}{\mu_{RR/obsr}} = \frac{v_0}{\mu_{IR/obj}}$$

T.I.R

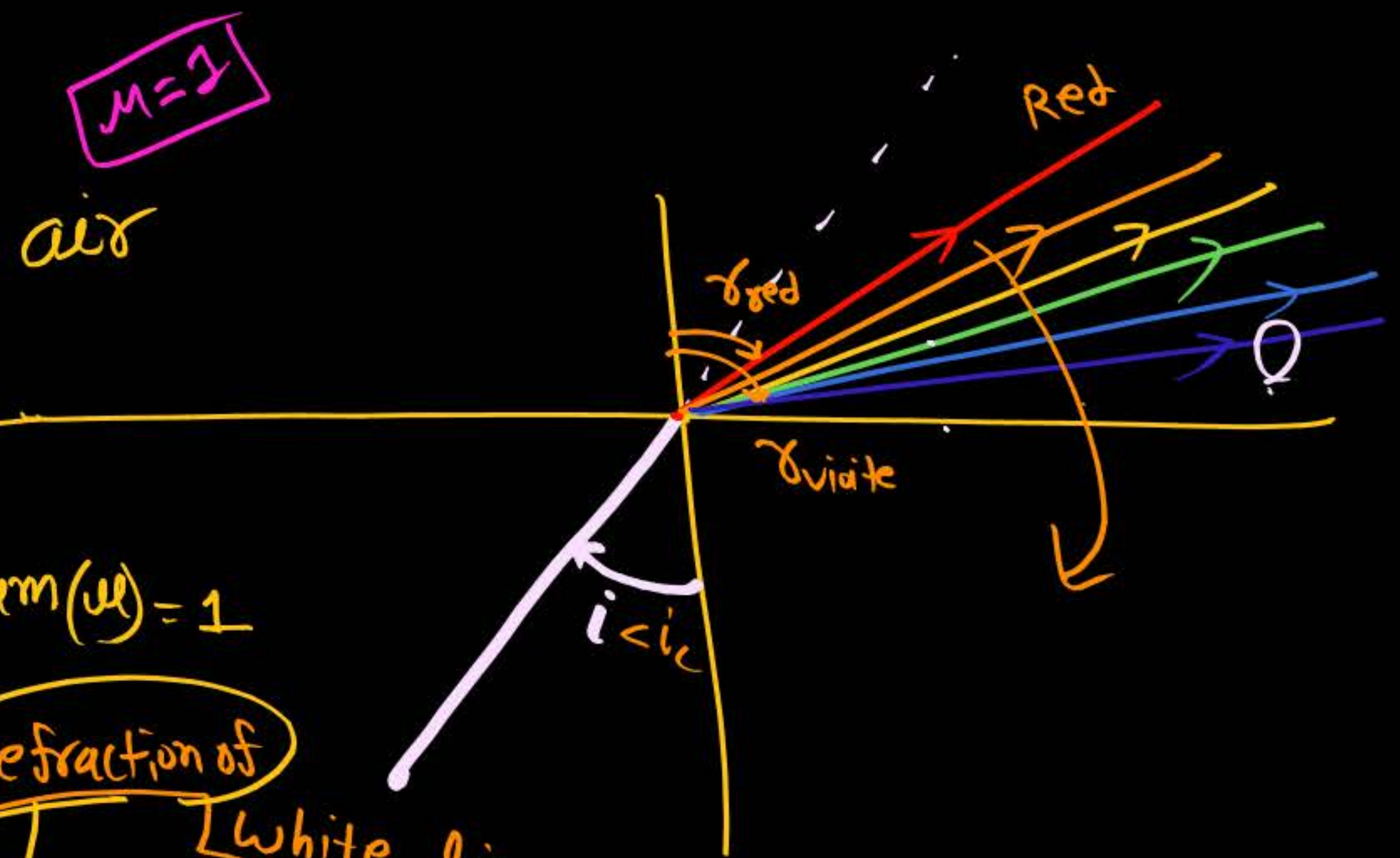
$$\sin i_c = \frac{\mu_{Rarr}}{\mu_{densi}} = \frac{\mu_{Rarr}}{\mu_{Ja}} = \frac{\mu_2}{\mu_1} = ??$$

$$r = \frac{h}{\sqrt{\mu^2 - 1}}$$

$$i_0 \leq \sin^{-1}\sqrt{\mu_c^2 - \mu_j^2}$$

optical fib.

refraction for diffrent colour (white light)



medium (μ) = 1

refraction of white light → Bending of light when light move from one Medium to other

$$\mu \propto \frac{1}{\lambda}$$

$$\downarrow \mu \propto \frac{1}{\lambda \uparrow}$$

r → घटा

$$\mu \uparrow \propto \frac{1}{\lambda \downarrow}$$

Condition of T.I.R

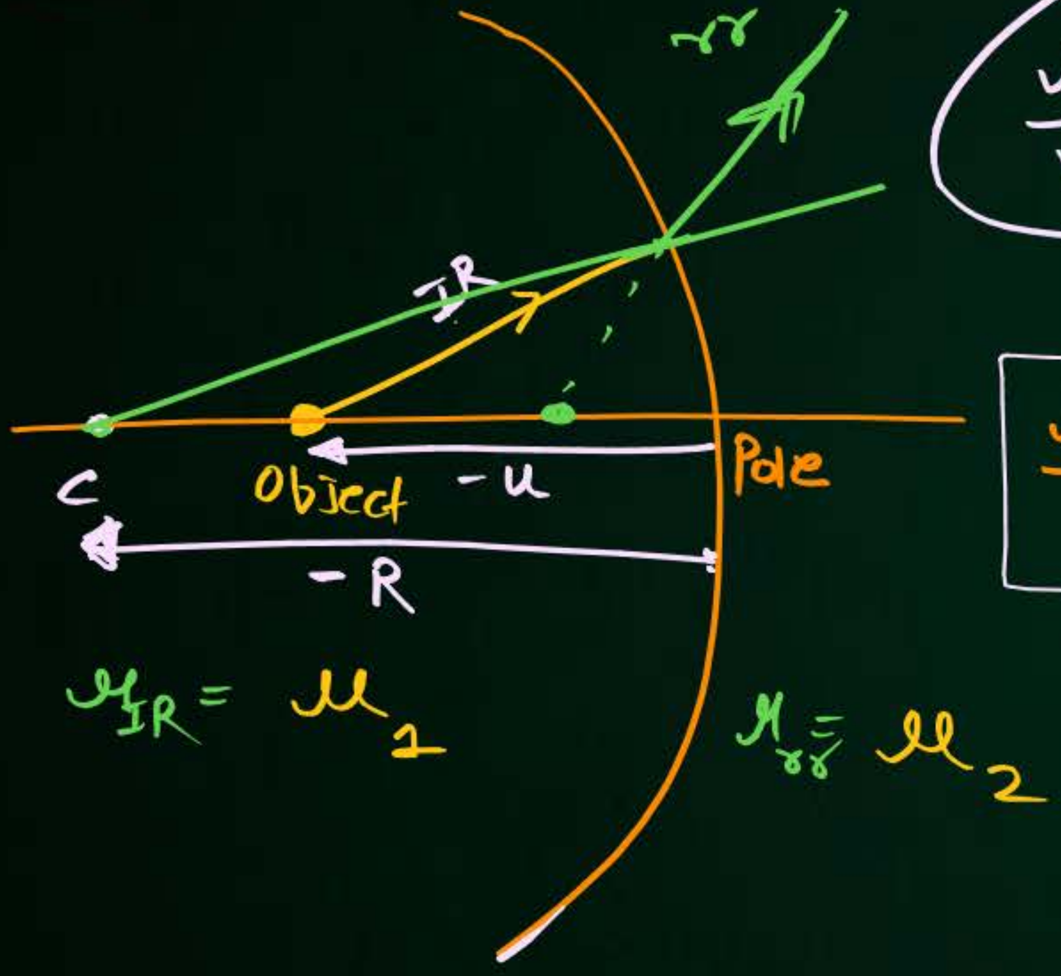
$$\sin i_c = \frac{1}{\mu} \propto \lambda$$

$$\sin i_c \propto \lambda$$

$$i_{c\,(Red)} > i_{c\,Gre} > i_{c\,Vio}$$

Refraction from Curved Surface

$$\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}$$

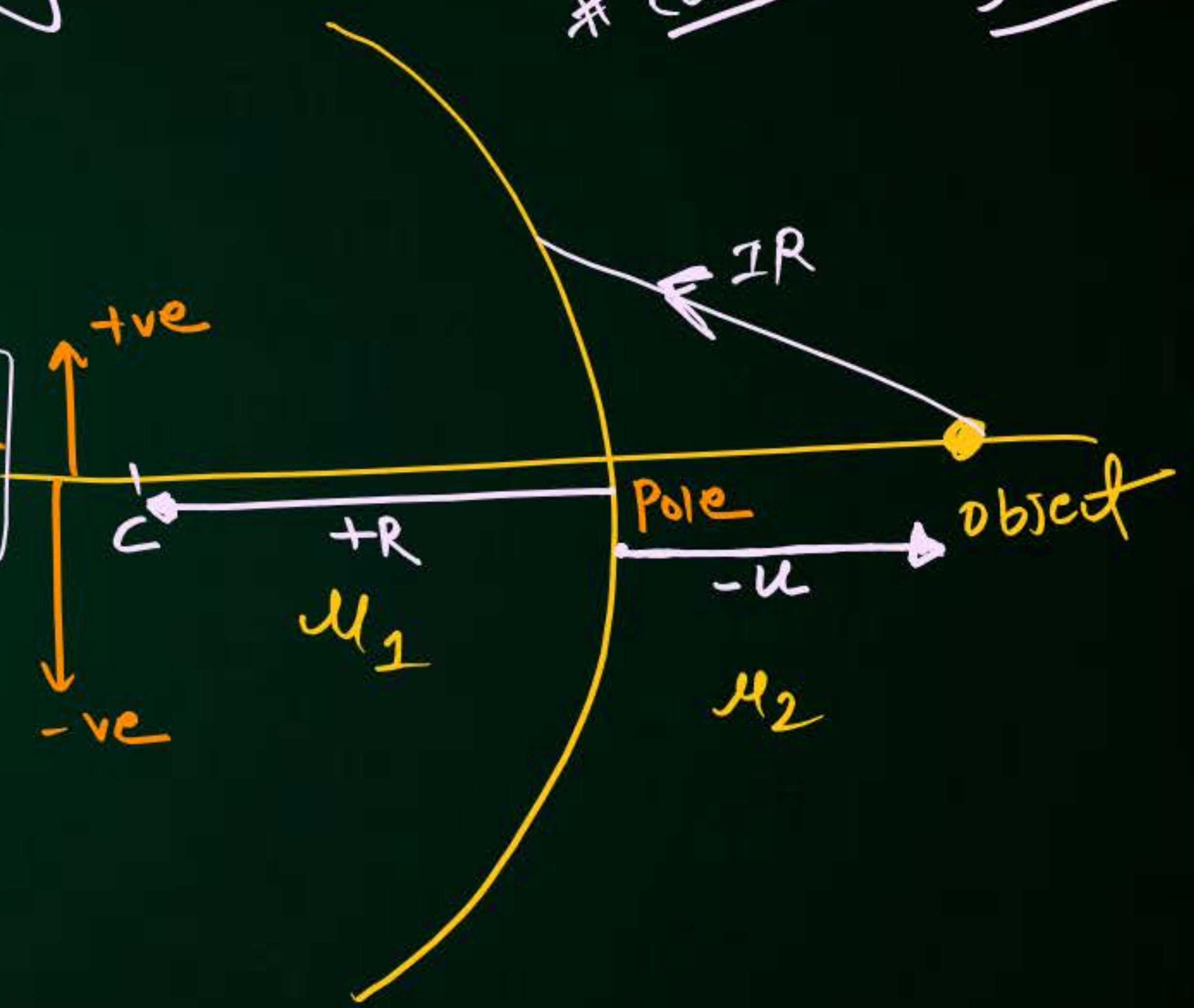


Concave refracting surface (I-R)

$$\frac{\mu_{RR}}{V} - \frac{\mu_{IR}}{u} = \frac{\mu_{RR} - \mu_{IR}}{R}$$

use this with proper
\# sign convension

\# Convex refracting surface



QUESTION

Find value of 'u' from pole so that refracted ray becomes parallel to principle axis.

$\mu_{IR} = 1$

$\mu_{rr} = 3/2$

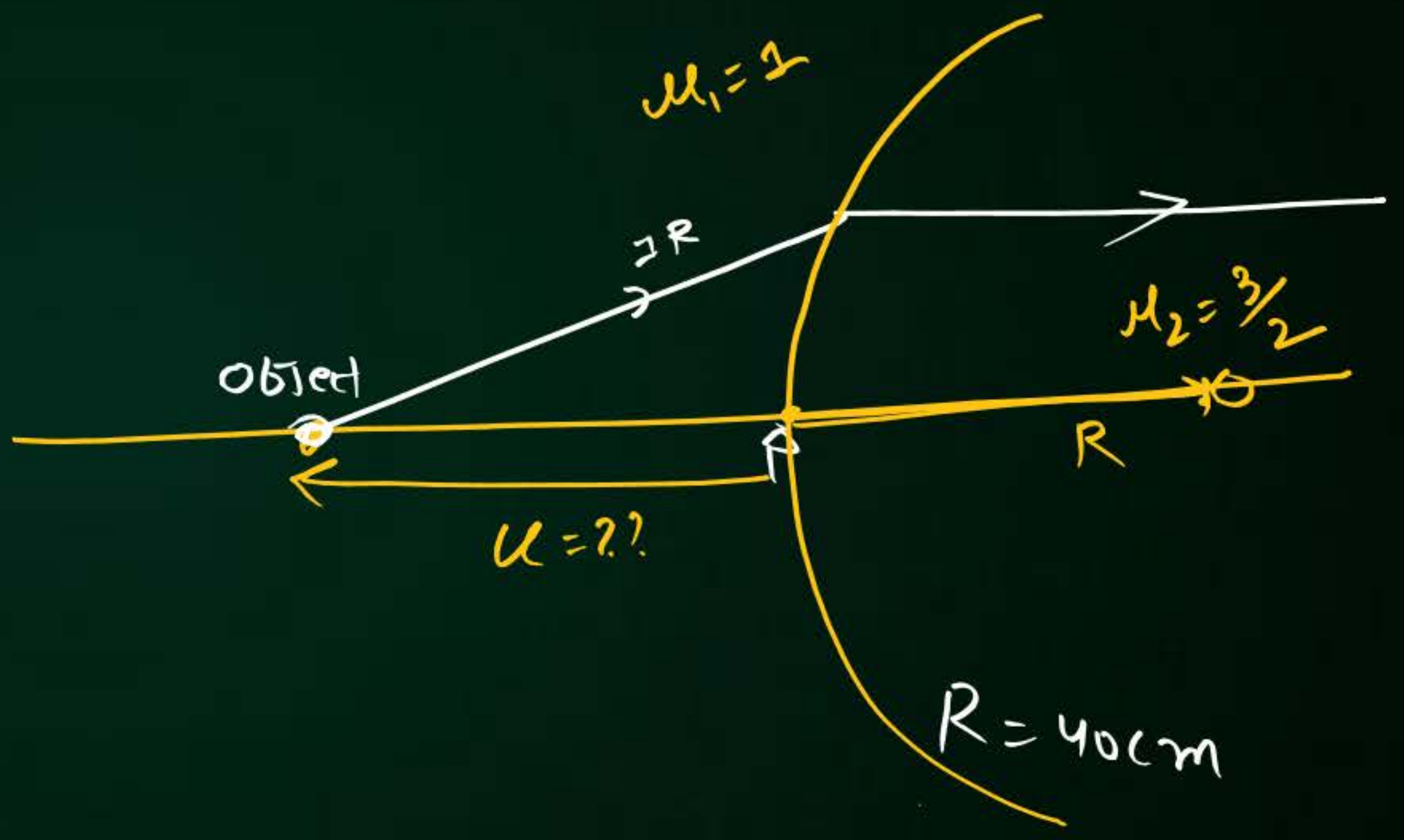
$V = \infty$

$u = ??$

$$\frac{\mu_{rr}}{v} - \frac{\mu_{IR}}{u} = \frac{\mu_{rr} - \mu_{IR}}{R}$$

$$\frac{3}{2\times\infty} - \frac{1}{u} = \frac{\frac{3}{2} - 1}{R}$$

$$-\frac{1}{u} = \frac{1}{2R} \longrightarrow u = -2R = -2\times 40 = -80\text{cm}$$

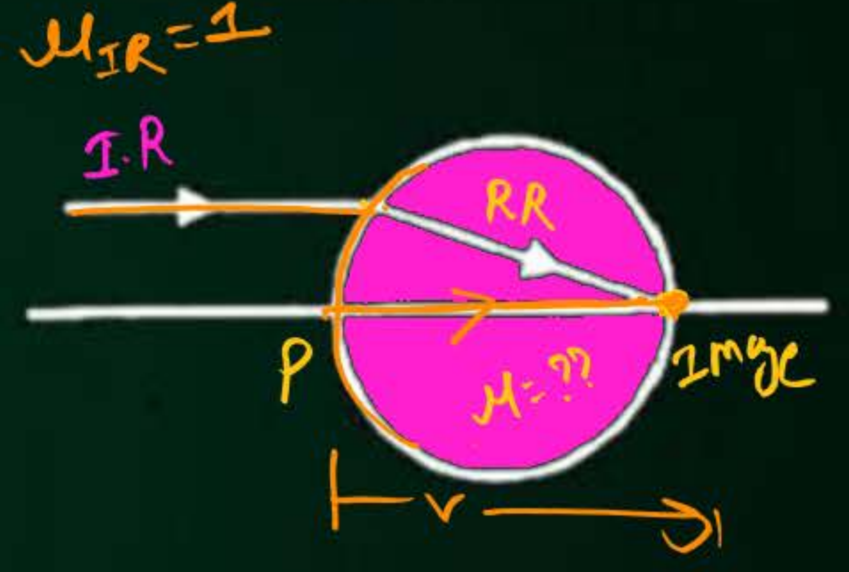


QUESTION

The following diagram shows a glass sphere of radius 10 cm with a paraxial incident ray. The refractive index of the material of the glass is

1. 2
2. 1.5
3. 1.75
4. 1.3

Ans: 1



$$\Rightarrow \frac{\mu}{+2R} - \frac{1}{\infty} = \frac{\mu - 1}{R}$$

$$\frac{\mu}{2R} = \frac{\mu - 1}{R}$$

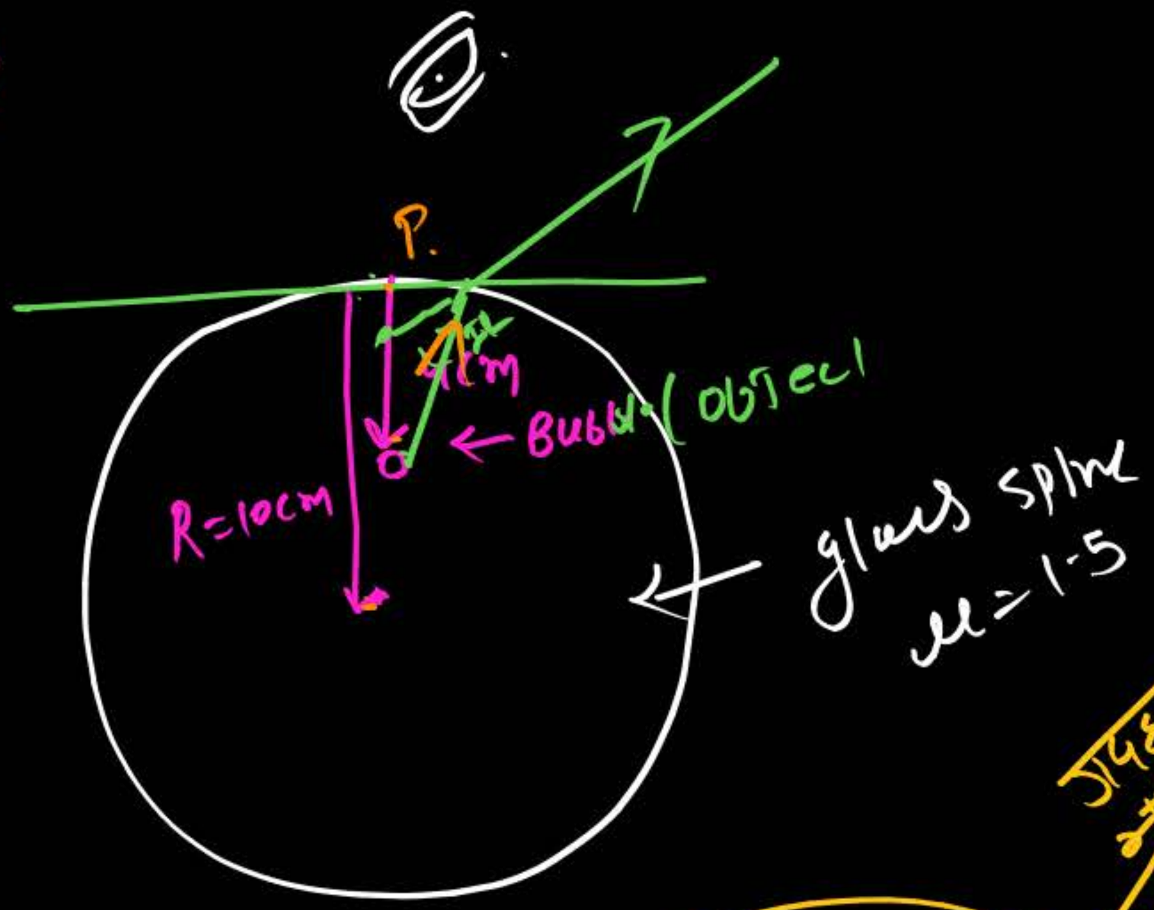
$$\frac{\mu}{20} = \frac{\mu - 1}{10}$$

$$\mu = 2\mu - 2$$

$$2 = 2\mu - \mu$$

$$\mu = 2$$

Small air bubble inside glass sphere ($\mu = 1.5$) of Radius 10 cm, then find appt depth of bubble?



$\mu_{IR} = 1.5$

$\mu_{or} = 1$

$u = -4\,cm$

$R = -10\,cm$

Concave refracting surface.

$$\frac{1}{v} - \frac{1.5}{-4} = \frac{1 - 1.5}{-10}$$

$$\frac{1}{v} + \frac{3}{8} = \frac{1}{20}$$

$$\frac{1}{v} = \frac{1}{20} - \frac{3}{8} = \frac{2 - 15}{40} = \frac{-13}{40}$$

$$v = \frac{-40}{13} = 3.07 = 3\,cm$$

(a) 3 cm ✓

(b) 2.67 cm ✗

जयदा लागू वैद्य

$$\frac{d_{app}}{1} = \frac{4}{3/2}$$

$$d_{app} = \frac{4 \times 2}{3} = 2.66$$

QUESTION

A convex surface of radius of curvature 40 cm separates two media of refractive indices 4/3 and 1.50. An object is kept in the first medium at a distance of 20 cm from the surface. Calculate the position of the image.

1. 20 cm
2. 24 cm
3. 30 cm
4. 32 cm

Soln

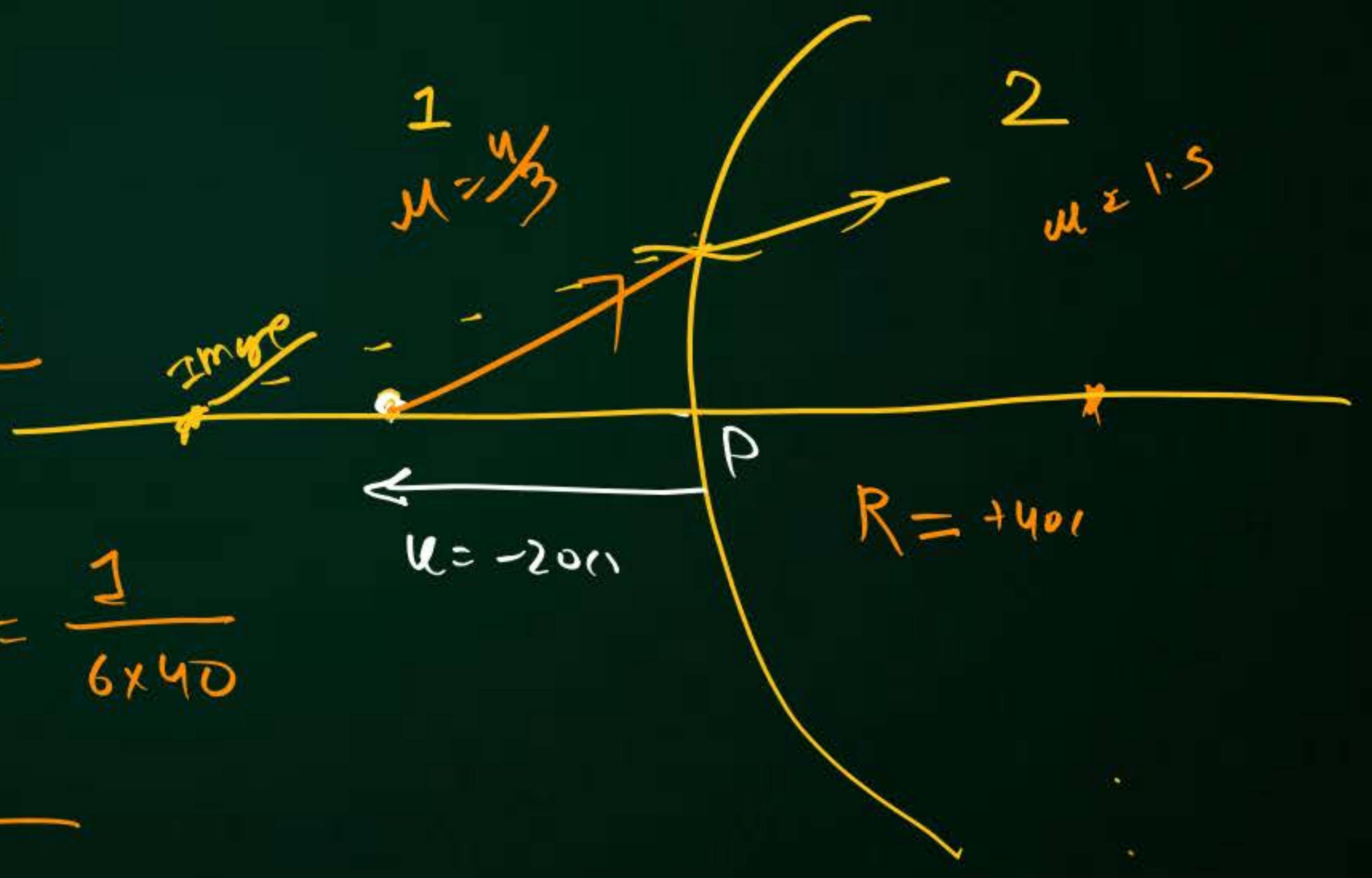
$$\frac{3}{2v} - \frac{4}{3(-20)} = \frac{\frac{3}{2} - \frac{4}{3}}{40}$$

$$\frac{3}{2v} + \frac{4}{60} = \frac{\frac{9-8}{6}}{40} = \frac{1}{6\times 40}$$

$$\frac{3}{2v} = \frac{1}{240} - \frac{1}{15} = \frac{1-16}{240}$$

$$\frac{3}{2v} = \frac{-15}{240}$$

$$V = -24$$



QUESTION

Region I and II are separated by a spherical surface of radius 25 cm. An object is kept in region I at a distance of 40 cm from the surface. The distance of the image from the surface is:

[20 July, 2021 (Shift-I)]

(1) 9.52 cm

(2) 18.23 cm

(3) 37.58 cm ✓

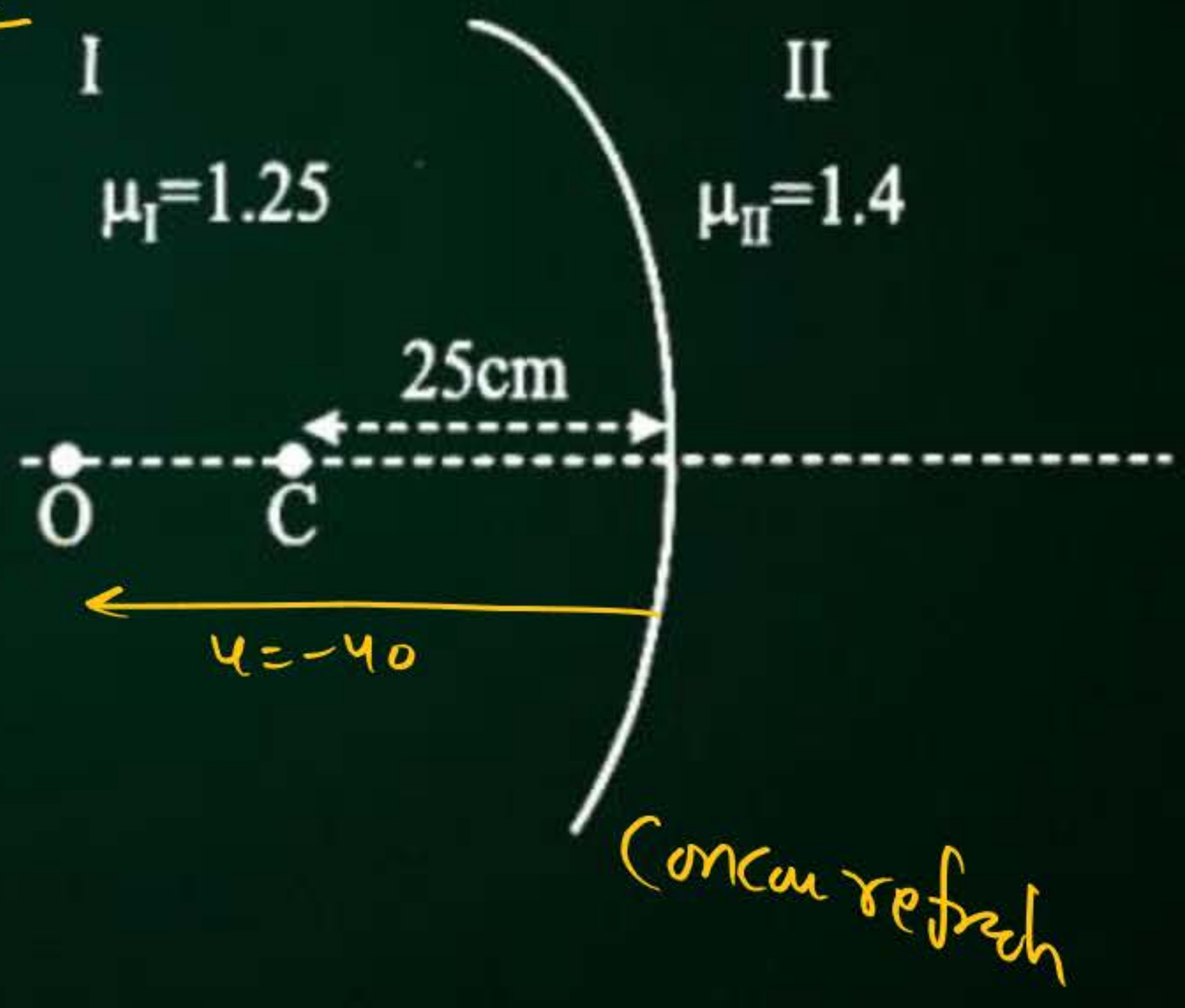
(4) 55.44 cm

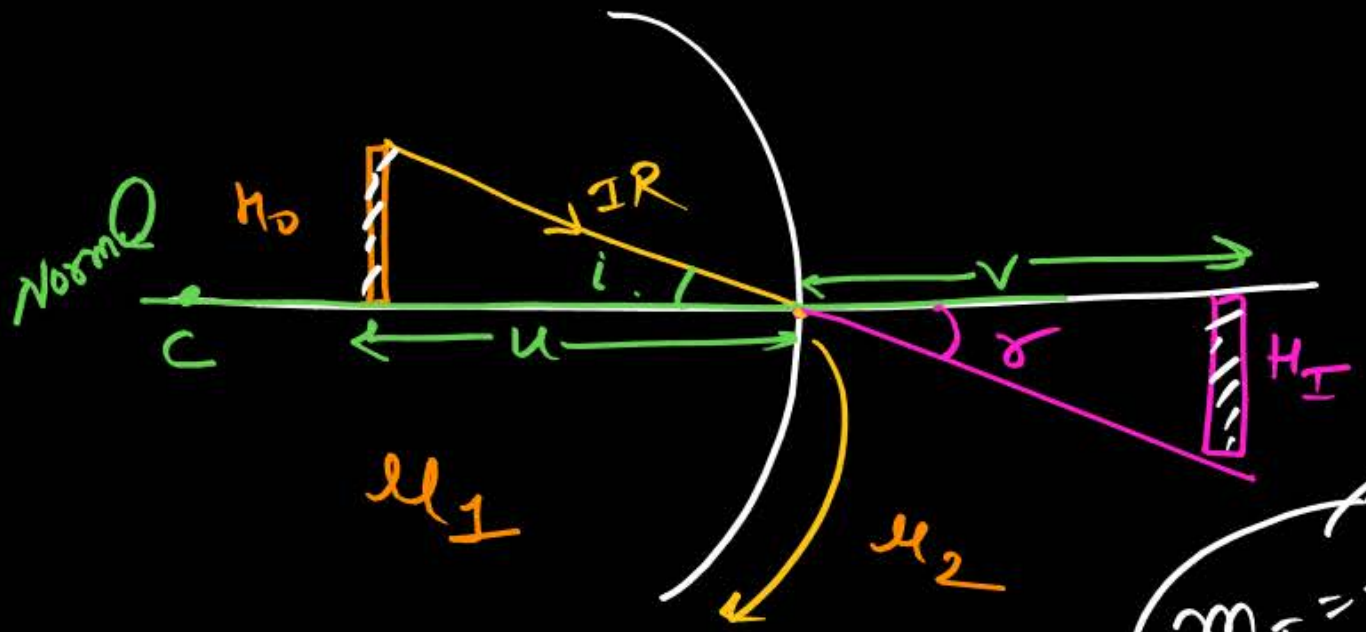
$$\frac{\mu_{II}}{v} - \frac{\mu_{IR}}{u} = \frac{\mu_{II} - \mu_{IR}}{R}$$

$$\frac{1.4}{v} - \frac{1.25}{(-40)} = \frac{1.4 - 1.25}{-25}$$

$$\frac{1.4}{v} + \frac{125}{4000} = \frac{0.15}{-25}$$

$$\boxed{\frac{1.4}{v} = -\frac{15}{2500} + \frac{125}{4000}}$$





$$m_T = \frac{H_I}{H_o}$$

Snells law

$$\frac{\sin i}{\sin r} = \frac{\mu_2}{\mu_1}$$

$$\frac{H_o}{u} \times \frac{v}{H_I} = \frac{\mu_2}{\mu_1}$$

(small angle $\sin i = \tan i$

$$m_T = \frac{H_I}{H_o} = \frac{\mu_1 v}{\mu_2 u}$$

Ray optics

9 lecture

25%-30% quest.

Not import

(3) refractn mirror

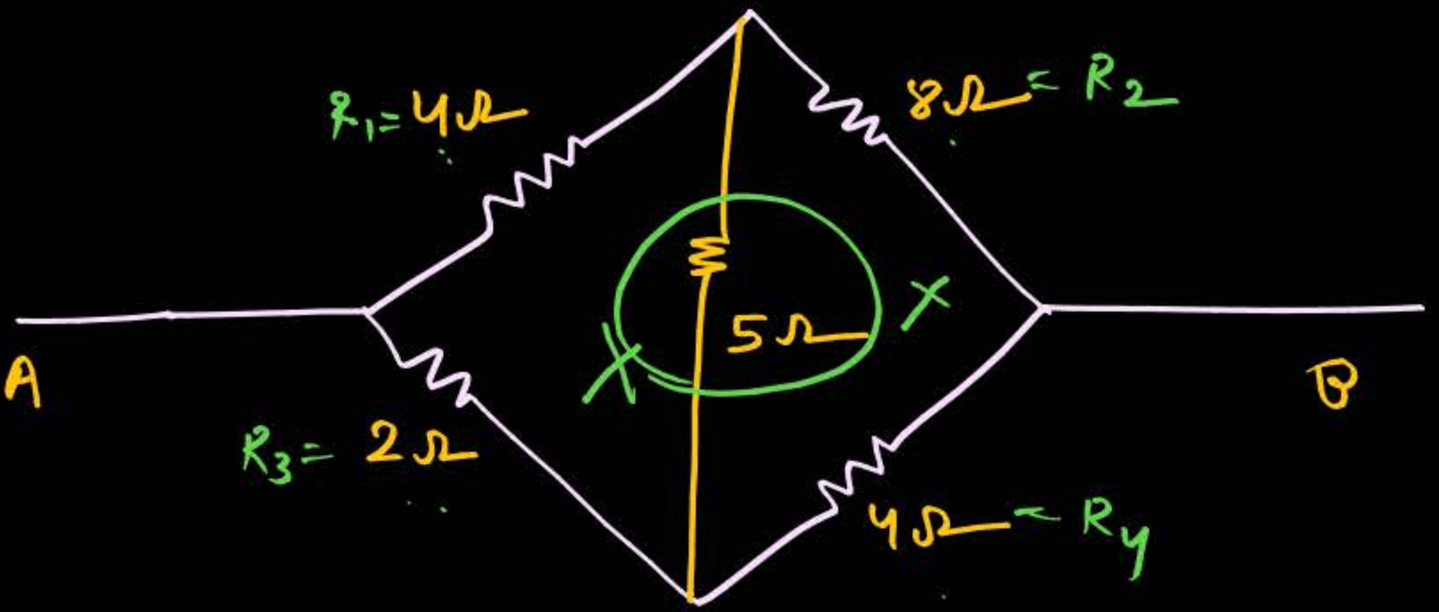
4- lectr

70%-75%

very import for NEET.

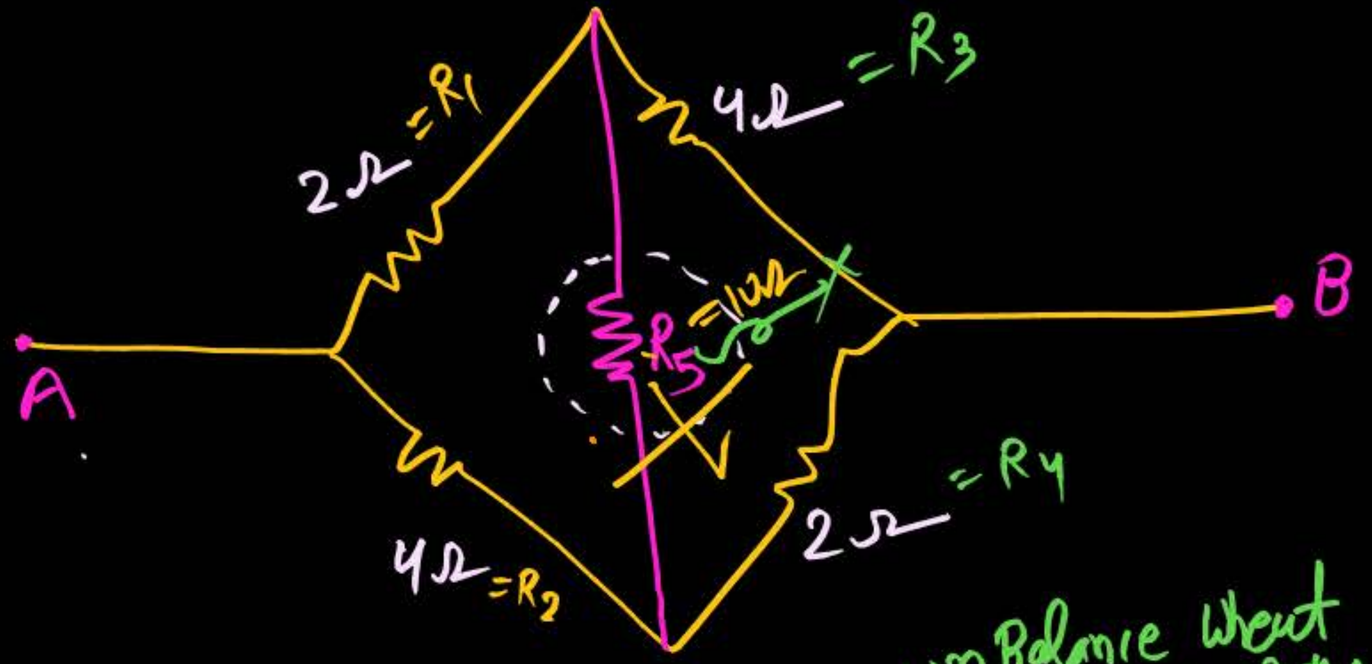
1. Lens
2. Prism
3. optical instr.

{Un Balance} Wheatstone Bridge



Balance Wheatstone bridge.

$$R_{eq} = \frac{12 \times 6}{12 + 6} = \frac{72}{18} = 4\Omega$$



Un Balance Wheatstone Bridge



$(R_{eq})_{AB} = 3\Omega$ → By Balance cond'.

2.8 ✓

2.6 ✗

MR*

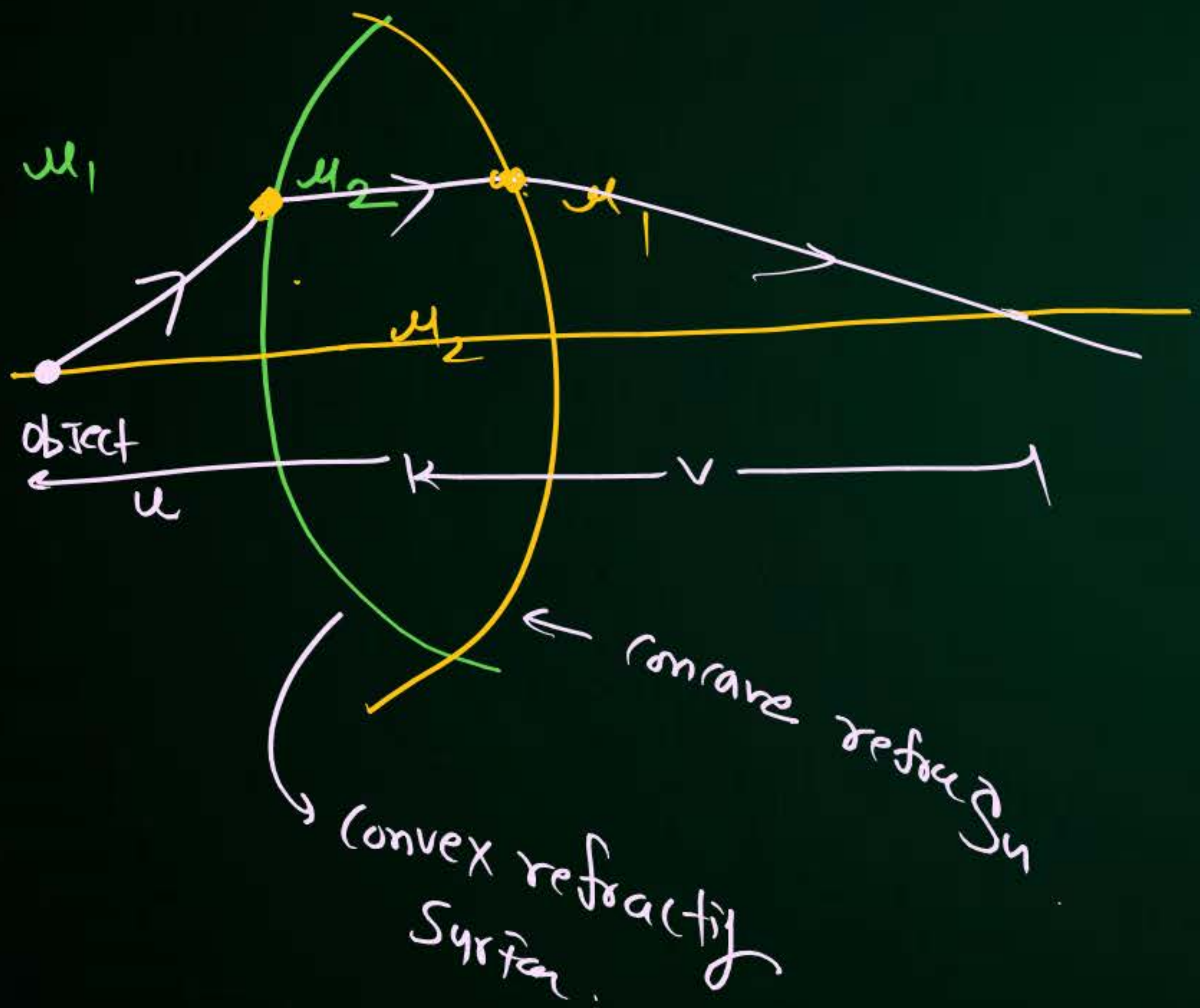
$(R_{eq})_{AB} < 3\Omega$ → Just less than 3Ω

Important

Lens → Combination Two curved refracting surface

$$\frac{1}{v} - \frac{1}{u} = \left(\frac{\mu_2}{\mu_1} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

Lens maker form
mR Ratta



QUESTION

Find focal length of glass lens in water if its radius of curvature is 12 cm.


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 10 | Physics

Ray Optics and Optical Instruments

By- Dr. Manish Raj (MR SIR)

8:30 Am uplod

Fluid Mechanics → 3hr 32 minit

Solid

thermo K.T.G
wave

Detailed Revision

→ Compt 11th class

→ 12th Ke 4-chapter

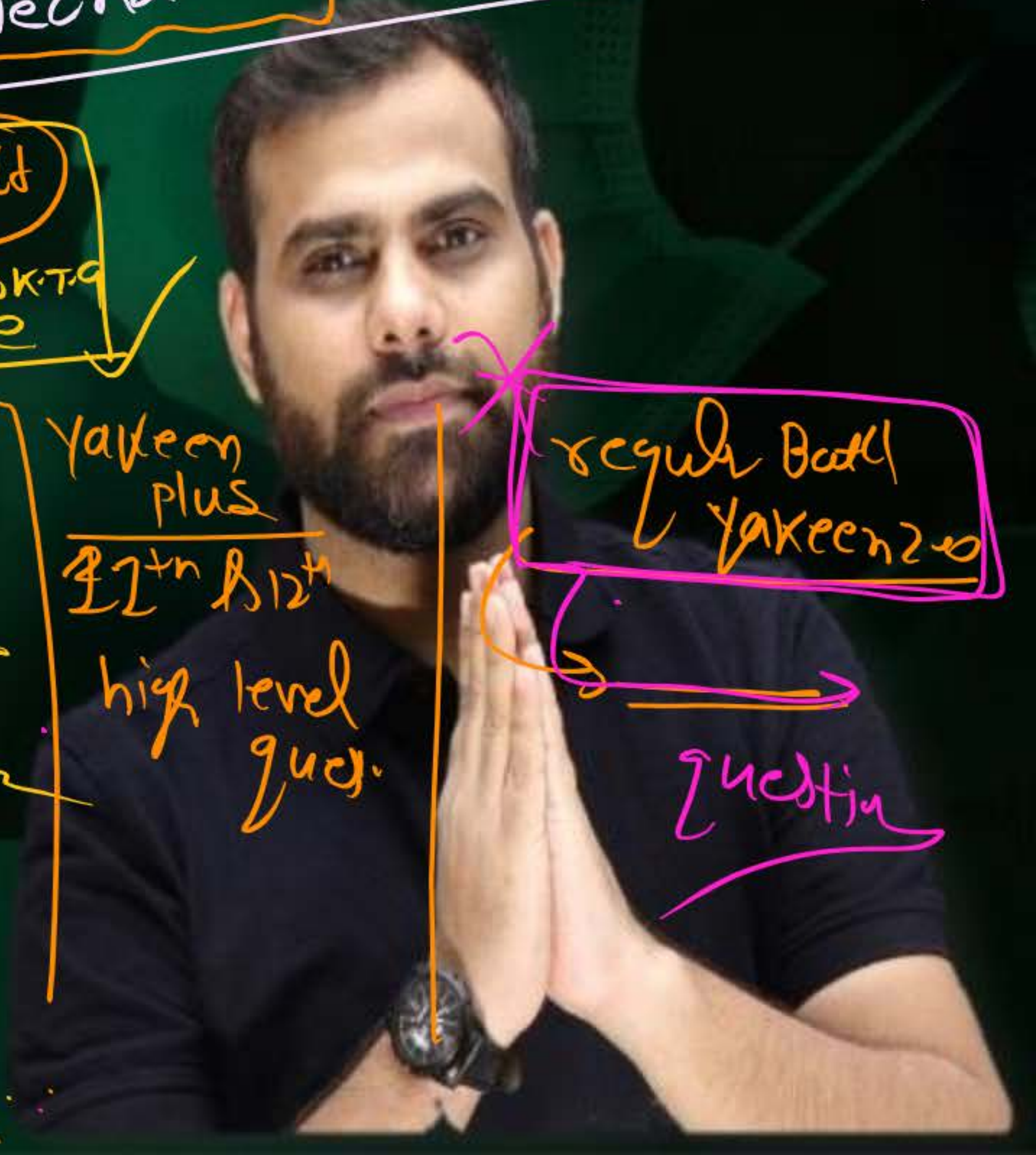
Yakeen plus

11th & 12th

high level ques.

regular Batch
Yakeen 2.0

Question

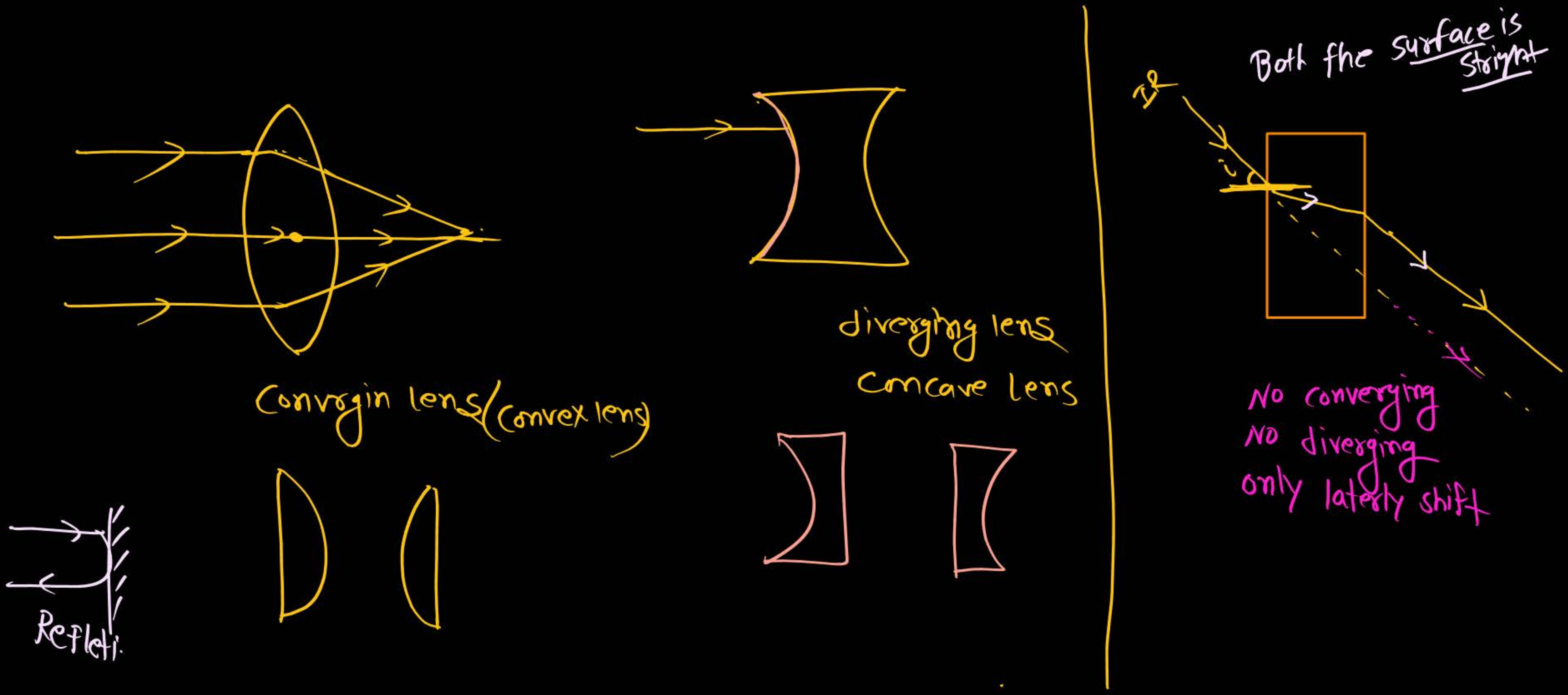


Topics to be covered

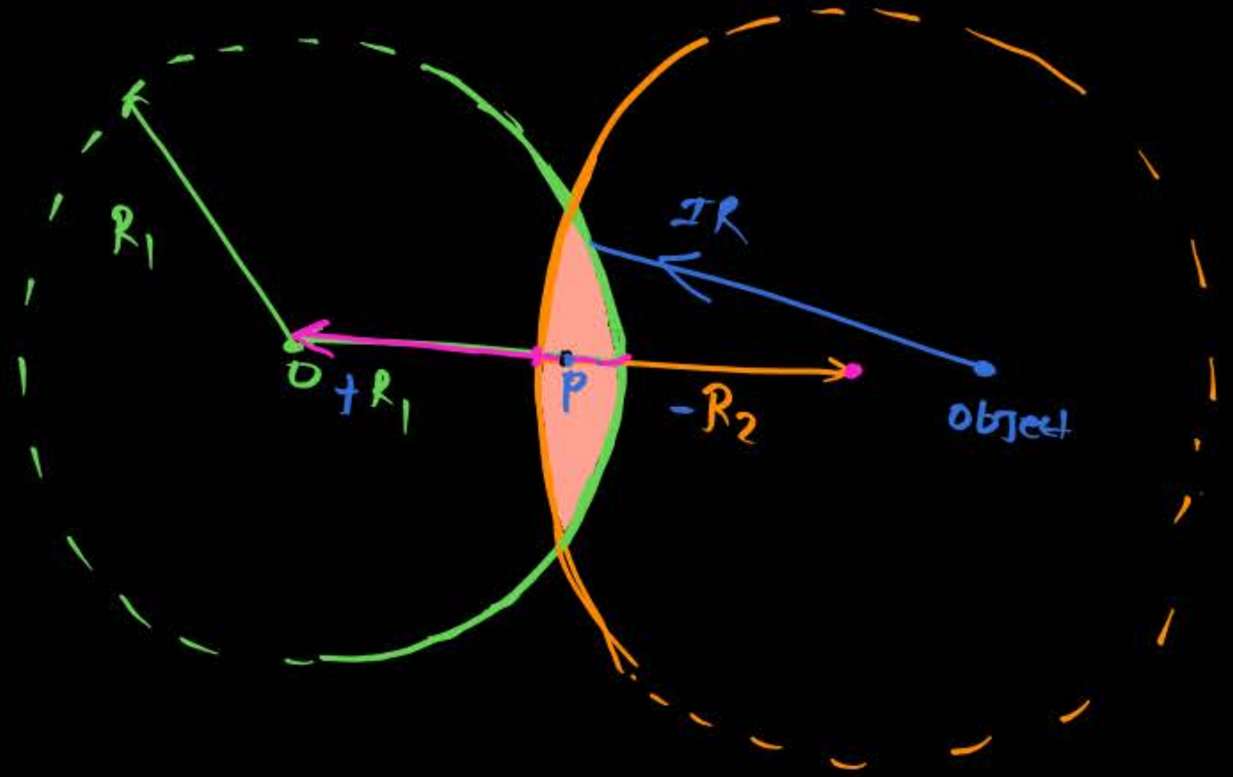
1. # PhD on lens
2. #
3. #



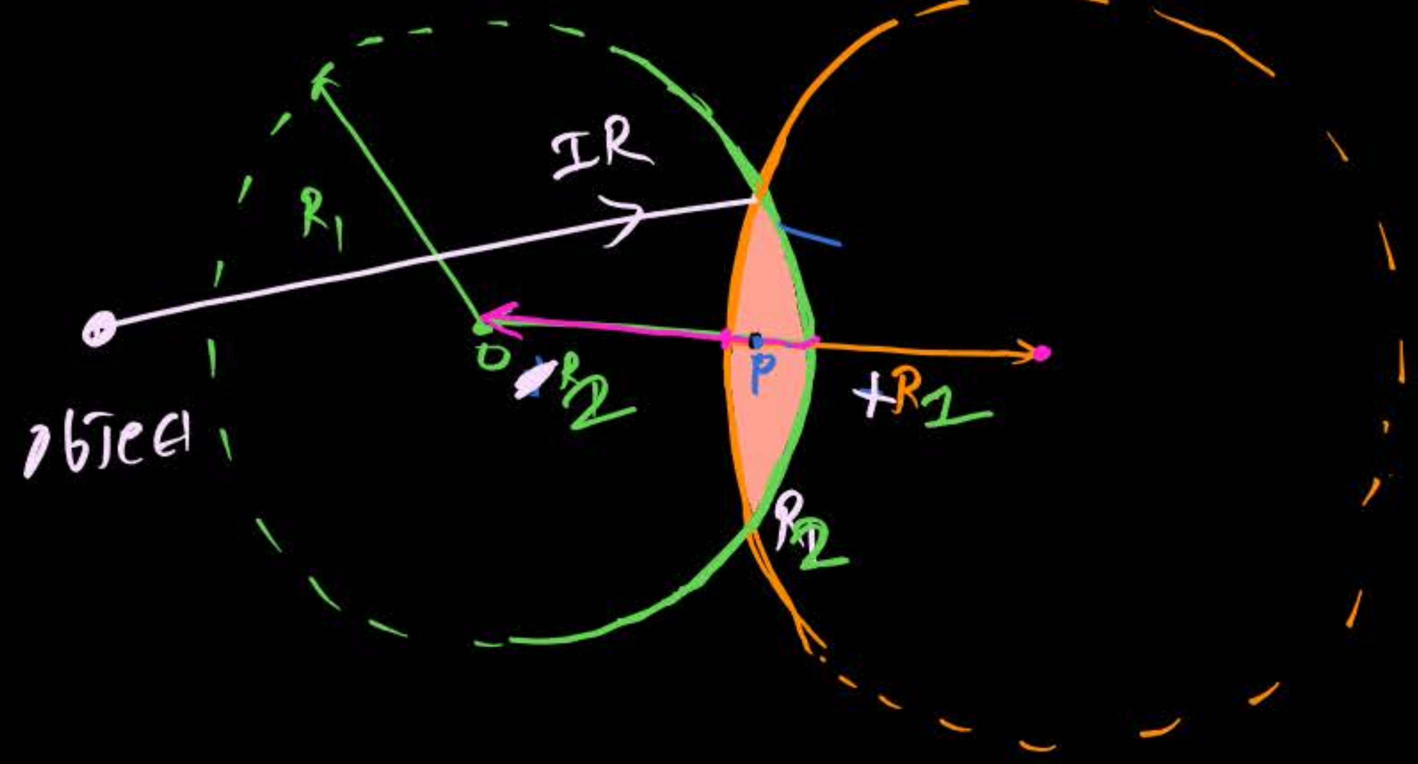
Lens → A refracting sheet in which one of the surface must be curved.



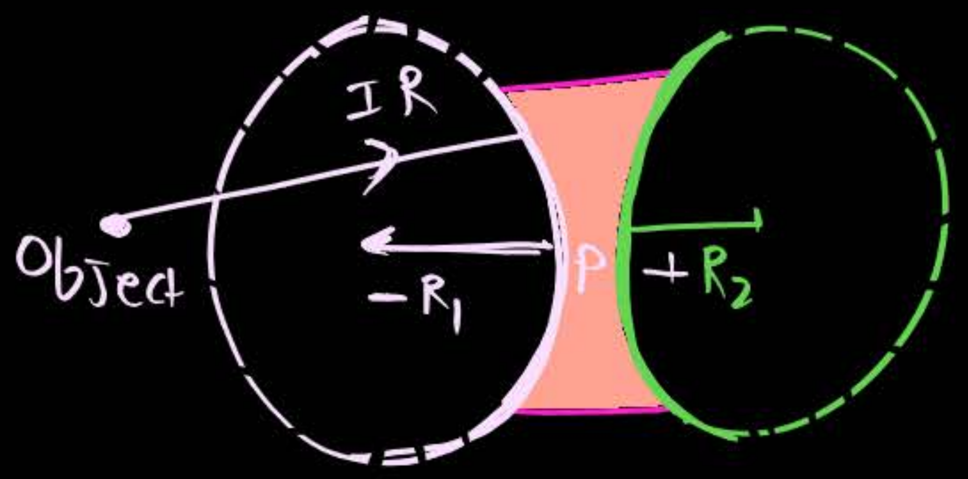
Bi convex lens



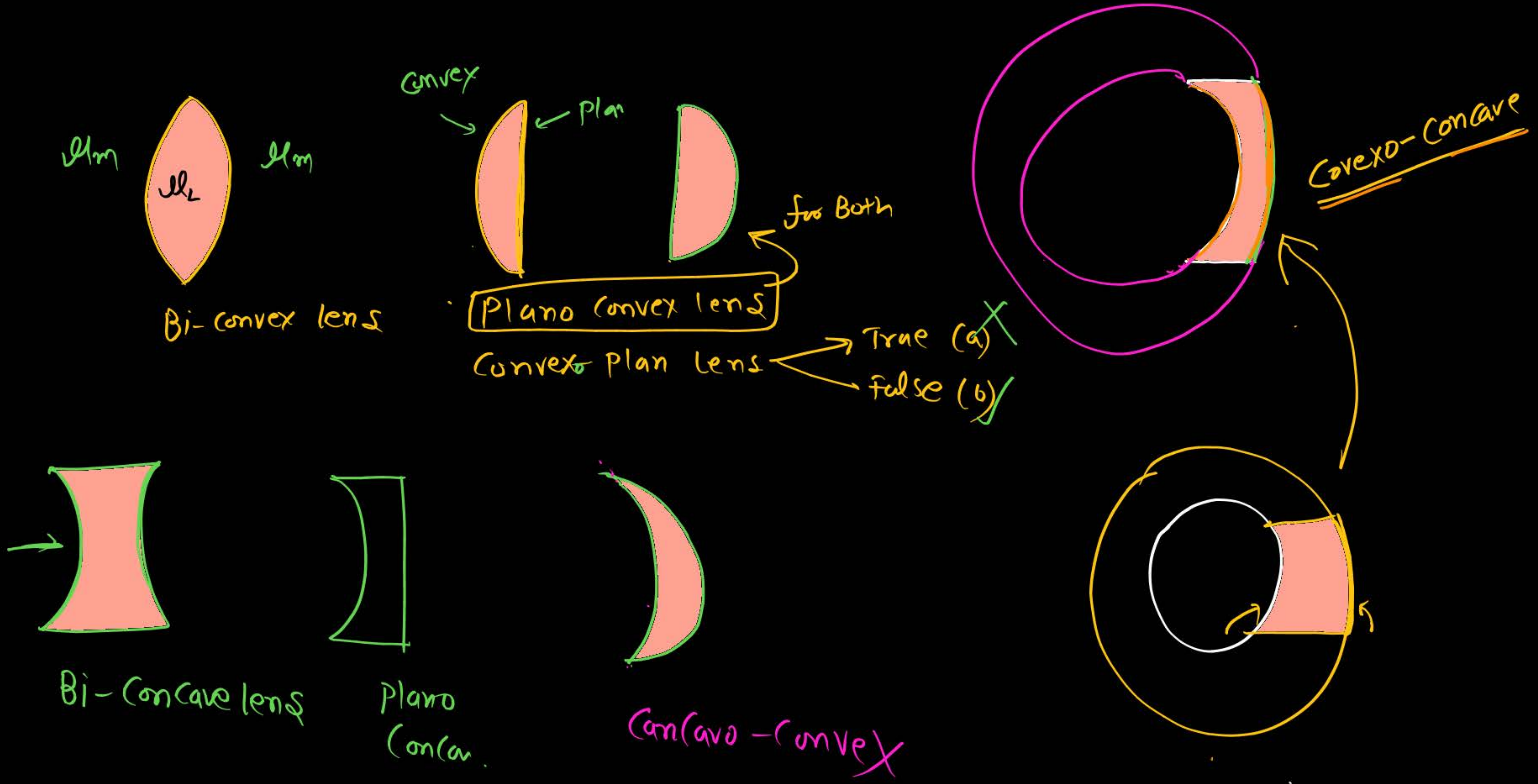
thin lens → पतला



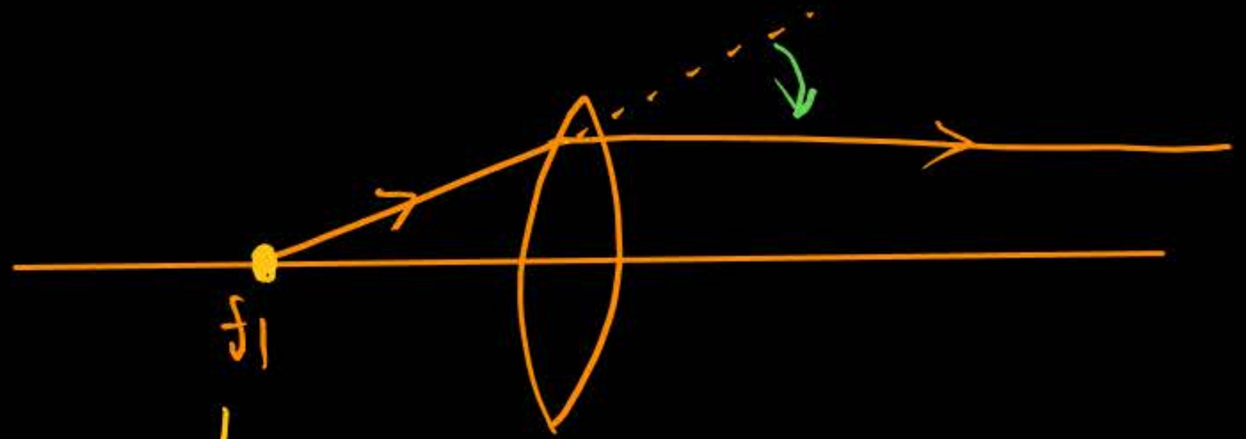
Jis Par IR fall karta hai usko R_1 Lete hai

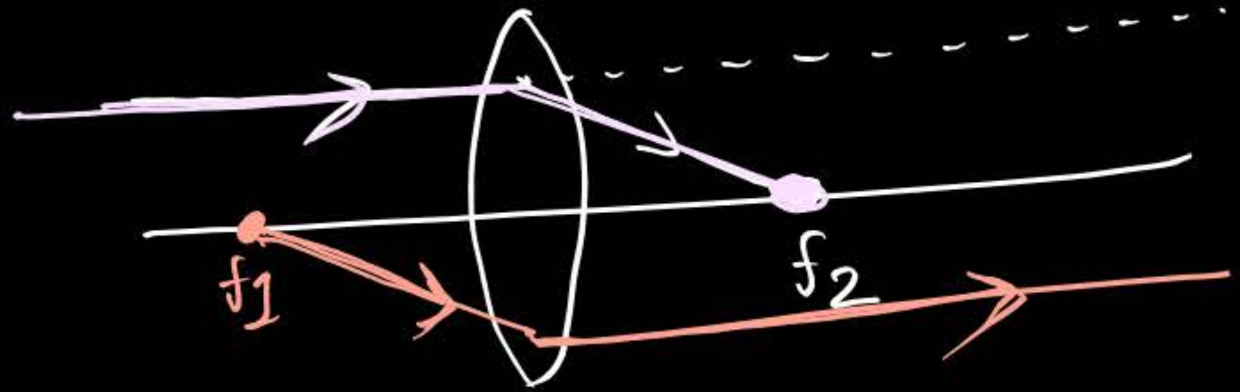


Bi-concave lens



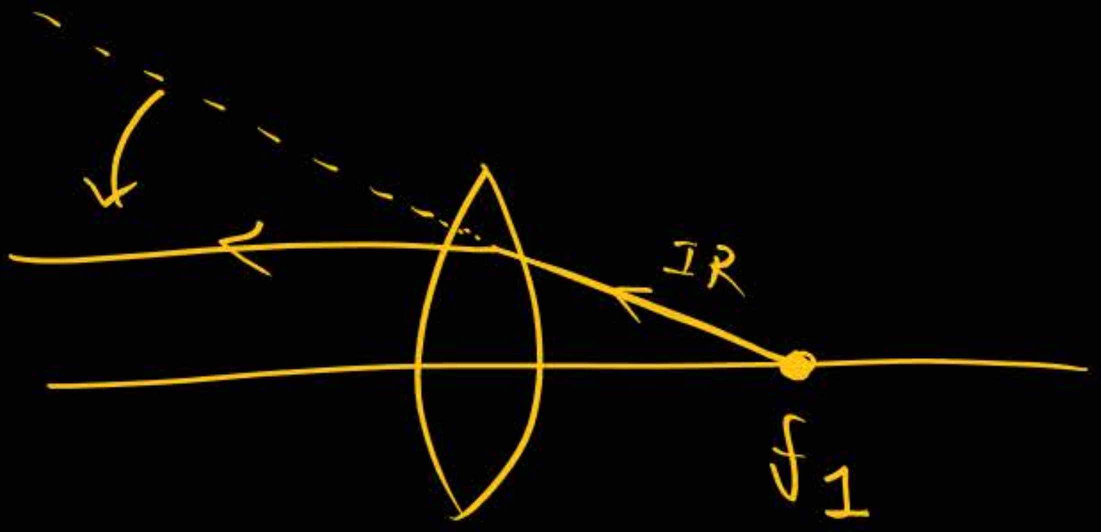
μm
μL
μm
Bi-convex lens
Convex
Plan
Plano convex lens
for Both
Convexo plan lens
True (a)
False (b)
Covexo-Concave
Bi-Concave lens
Plano Concav.
Concavo-Convex



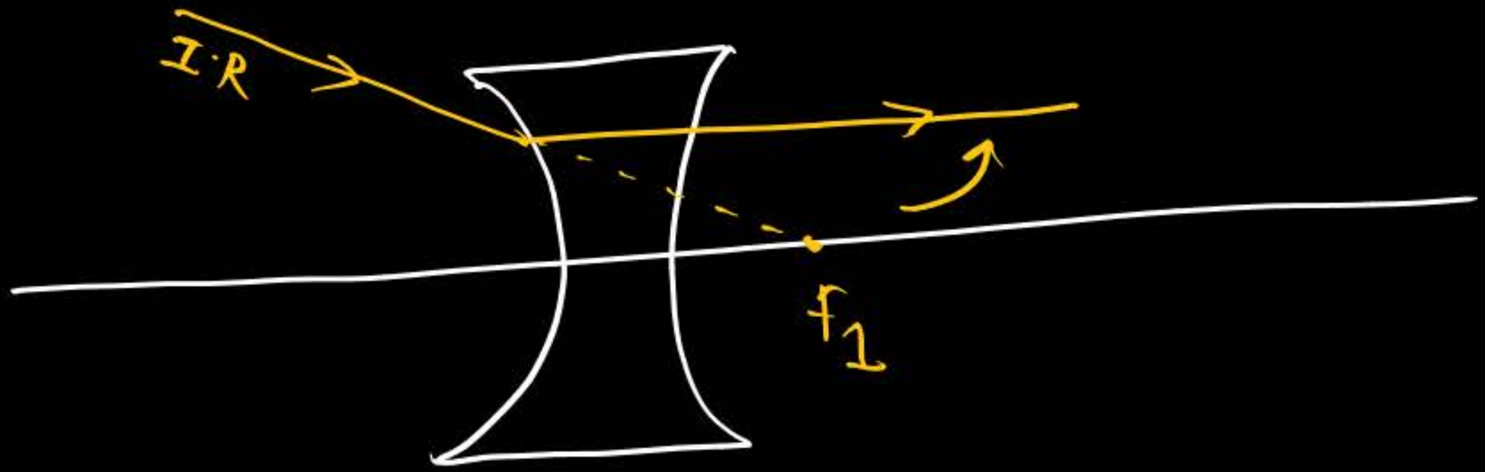


Biconvex lens.
Converging lens

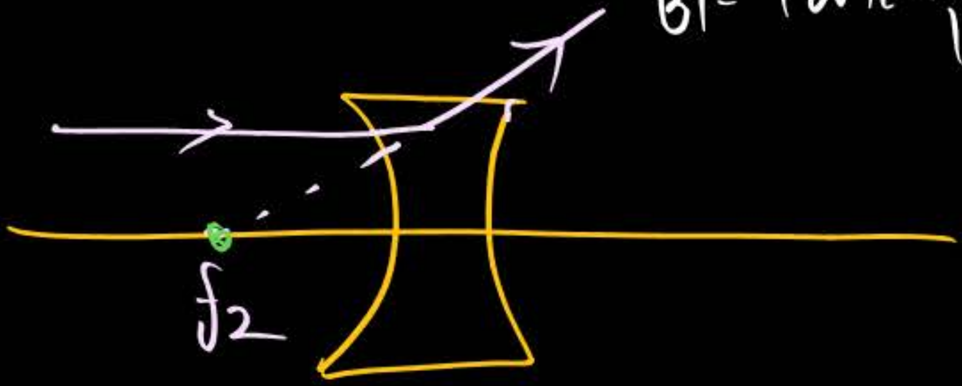
→ Primary focus or 1st focus

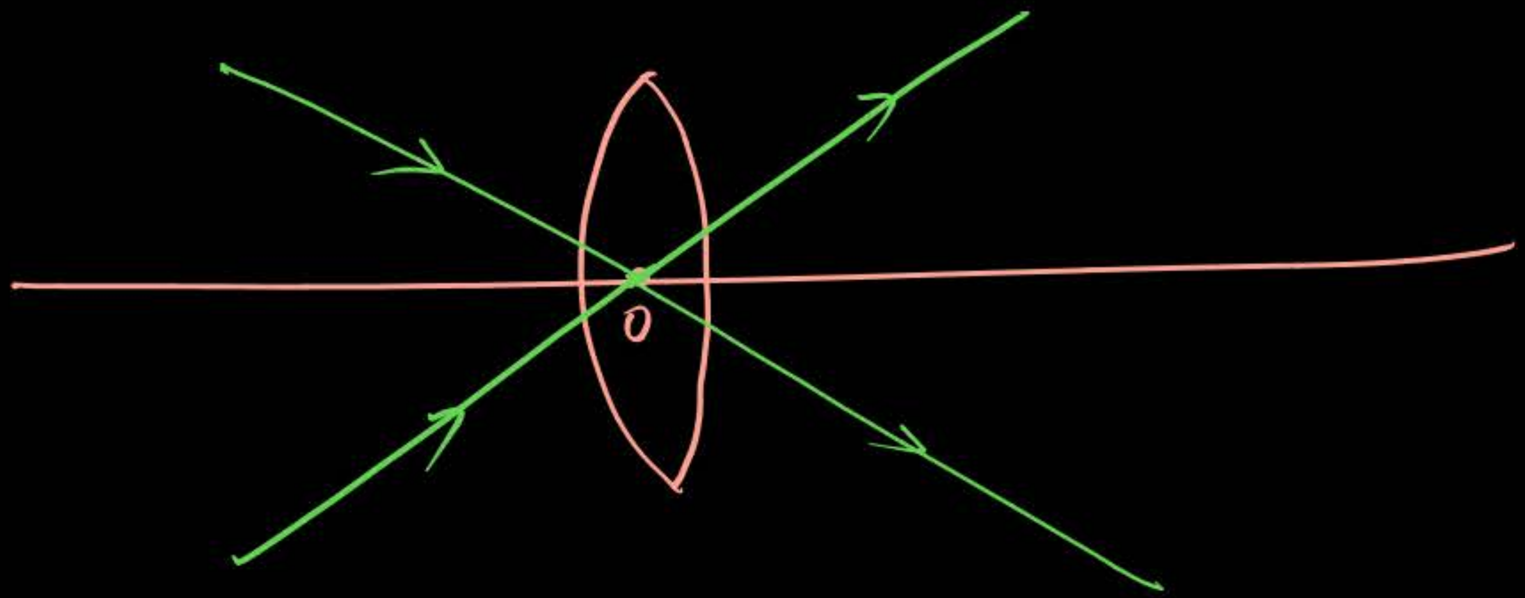


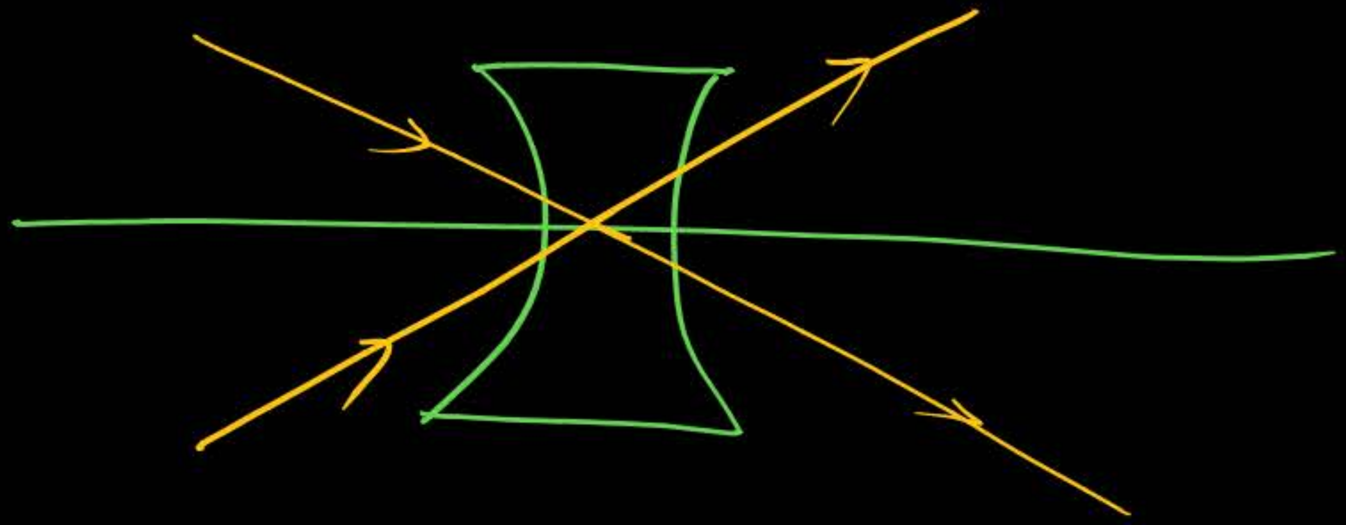
#



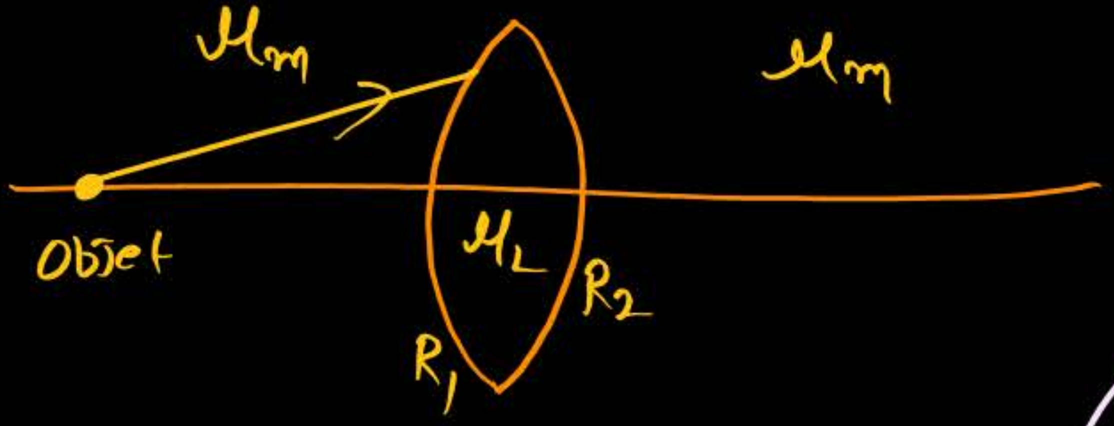
Bi- concave lens (diverging lens)




O



Lens maker formula



Bi convex lens

Lens formula

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

$$\frac{1}{v} - \frac{1}{u} = \left(\frac{\mu_L}{\mu_m} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

If object is at infinity $u = \infty$
then Image must be at focus $v = f$

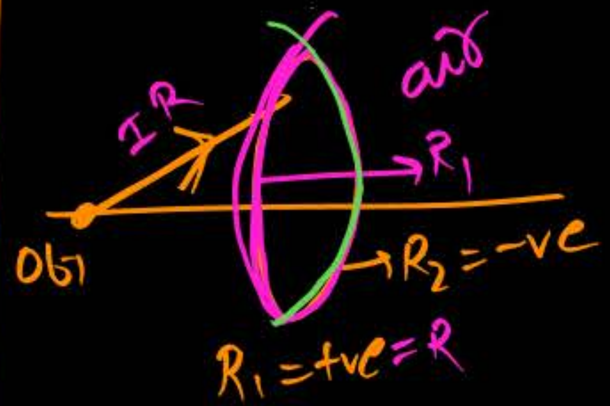
$$\frac{1}{f} - \frac{1}{\infty} = \left(\frac{\mu_L}{\mu_m} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\frac{1}{f} = \left(\frac{\mu_L}{\mu_m} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

→ formula of focus → valid for all lens

Bi-convex Lens (equiconvex Lens)

$R_1 = R_2 = R$



$$\frac{1}{f} = \left(\frac{\mu_L}{1} - 1\right)\left(\frac{1}{R} - \frac{1}{(-R)}\right)$$

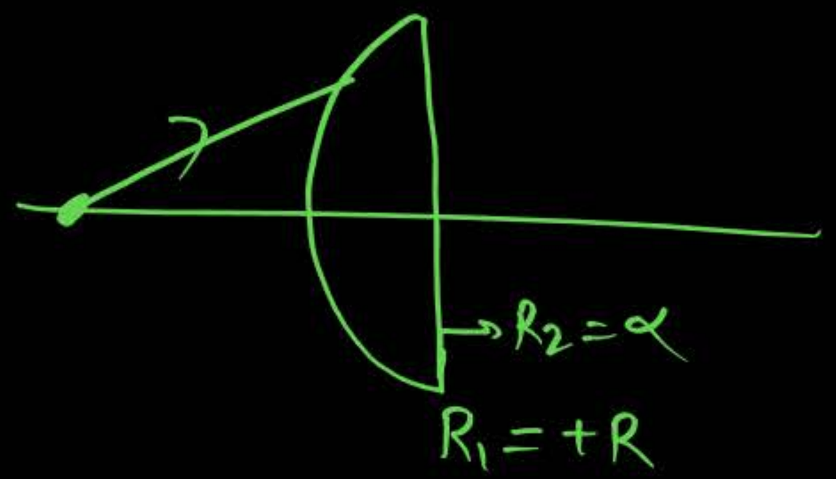
$$\frac{1}{f} = (\mu_L - 1)\left(\frac{1}{R} + \frac{1}{R}\right)$$

$$\frac{1}{f} = (\mu_L - 1)\frac{2}{R}$$

$$f = \frac{R}{2(\mu_L - 1)} \quad *$$

MRR

$$f = \frac{R}{2\left(\frac{\mu_L}{\mu_m} - 1\right)}$$



$$\frac{1}{f} = (\mu_2 - 1)\left(\frac{1}{R} - \frac{1}{\infty}\right)$$

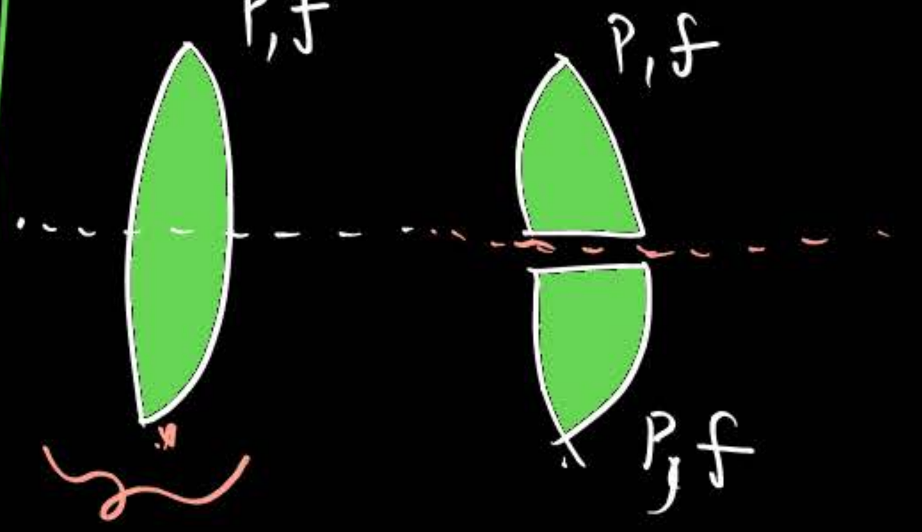
$$\frac{1}{f} = \frac{(\mu_2 - 1)}{R}$$

$$f = \frac{R}{(\mu_2 - 1)}$$

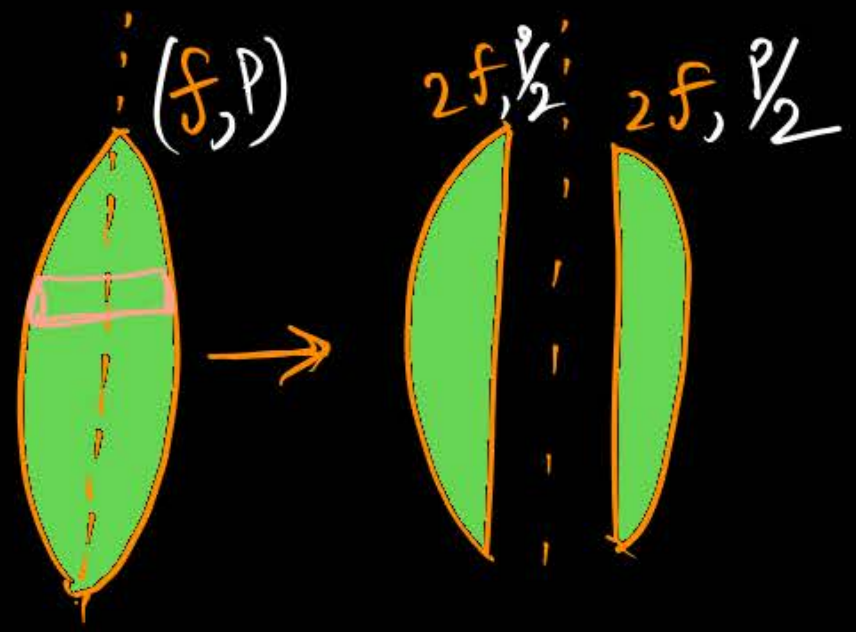


$$f = \frac{R}{2(\mu_2 - 1)}$$

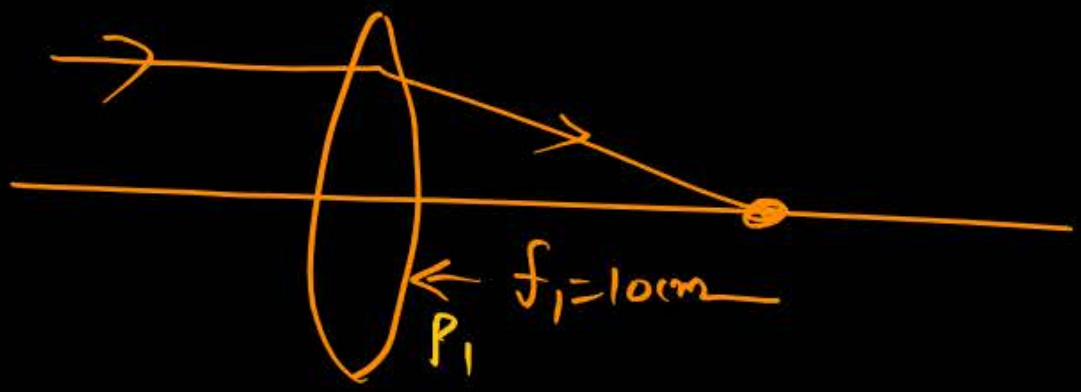
(Biconvex lens)



$$2 \times f_{Biconvex} = f_{plano\ convex}$$

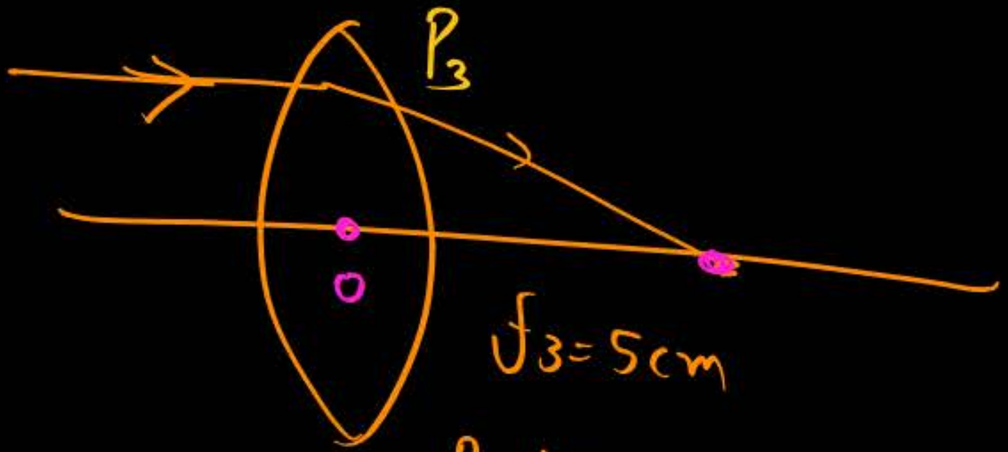


cutting along vertical line



बेकार lens





Badhiya lens

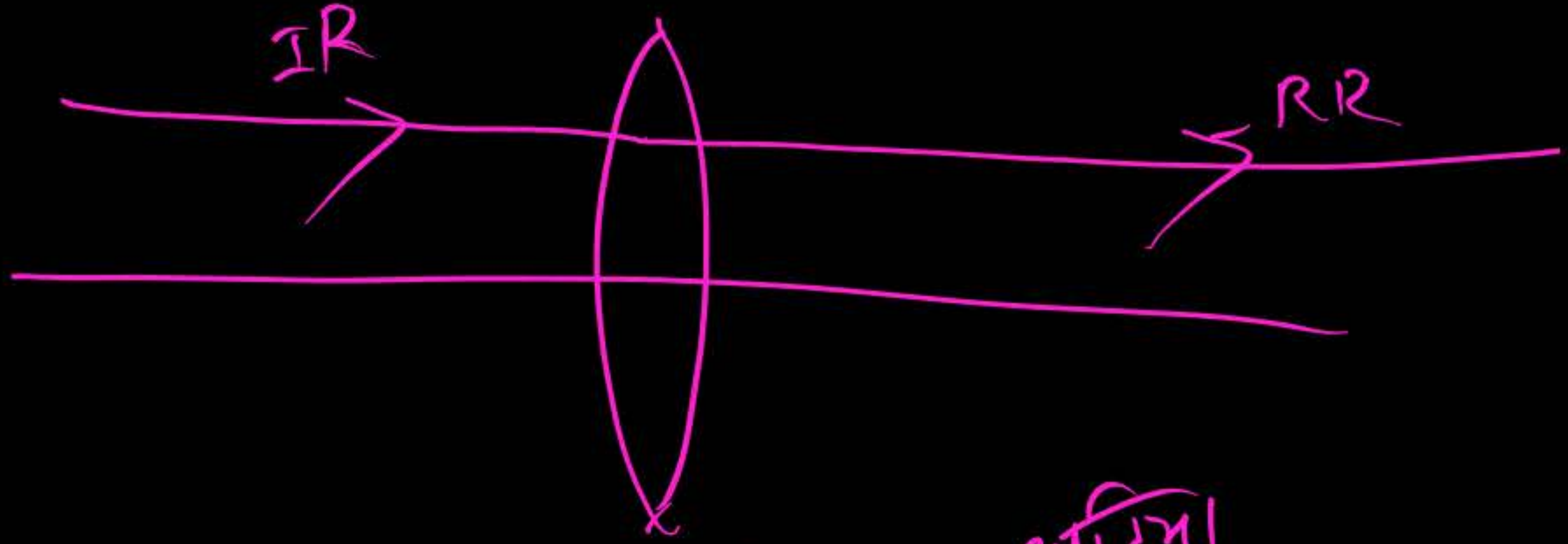
$$f_2 > f_1 > f_3$$

$$P_3 > P_1 > P_2$$

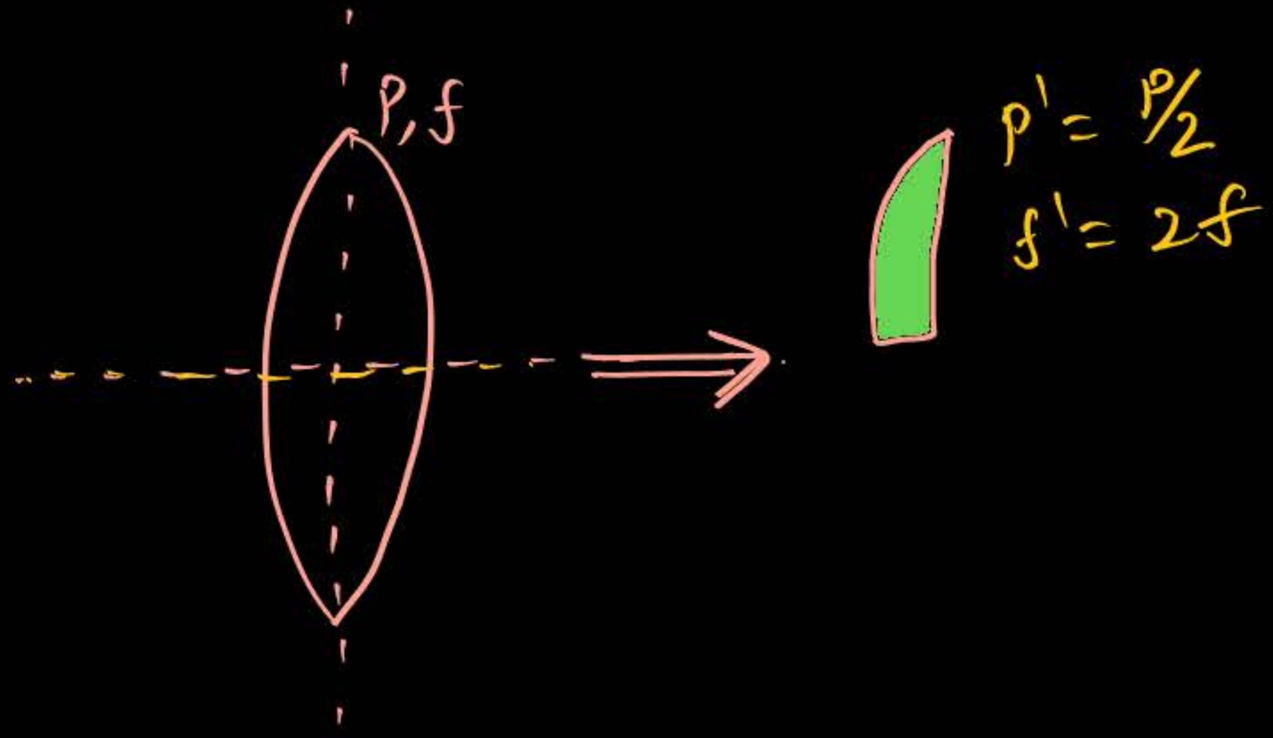
$$P = \frac{1}{f(m)}$$

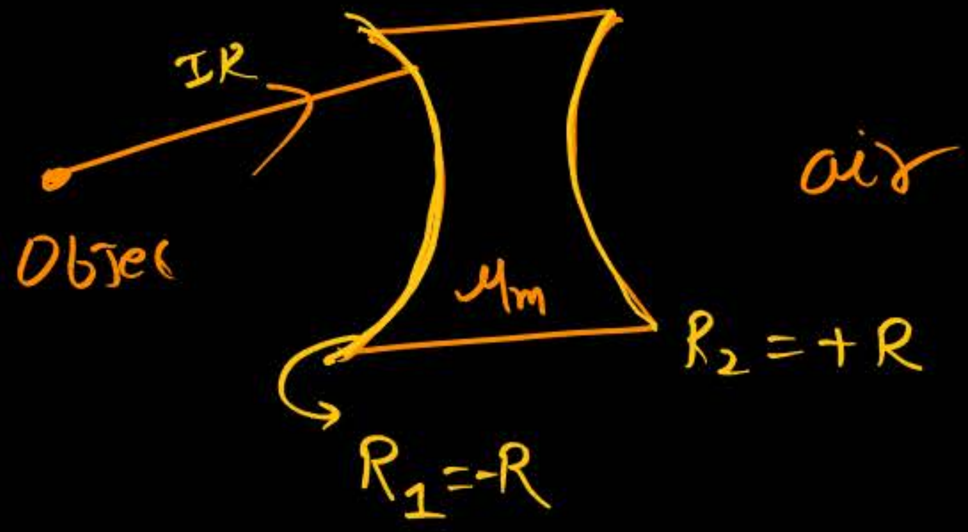
$$P = \frac{100}{f(cm)}$$

↳ Diopter



Sala घटिया
किरण दूर
जाकिया
और टेढ़ा
हुआ


P, f
P' = P/2
f' = 2f



equi concave lens

$$\frac{1}{f} = \left[\frac{\mu_L}{1} - 1\right]\left(-\frac{1}{R} - \frac{1}{R}\right)$$

$$\frac{1}{f} = (\mu_L - 1)\left(-\frac{2}{R}\right)$$

$$\boxed{f = \frac{-R}{2(\mu_L - 1)}}$$ *



$$f = \frac{+R}{2(\mu_L - 1)}$$



$$f = \frac{R}{(\mu_L - 1)}$$



$$f = \frac{-R}{(\mu_L - 1)}$$

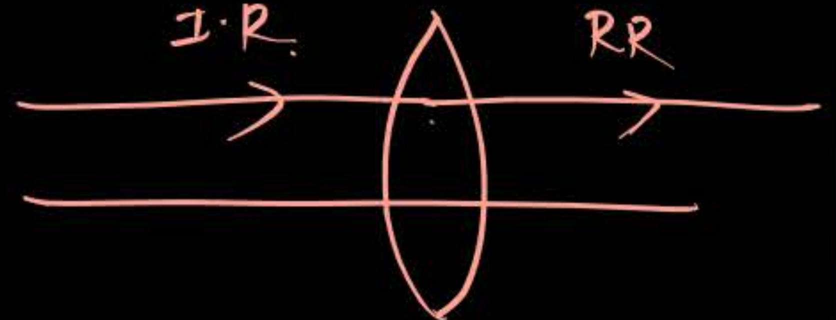
{ Convex lens is converging → True
{ Concave lens is diverging → True.

Convex lens is always converging → false

glass lens is placed in glass medium

$$\frac{1}{f} = \left(\frac{\mu_L}{\mu_m} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

(with $\frac{\mu_L}{\mu_m} = 1$)



$$\frac{1}{f} = 0$$

$f = \infty$ → It behave as thick glass sheet

Lens ka nature ulta ho jata hai if $\mu_m > \mu_L$.

→ $\mu_m > \mu_L$





water lens in glass medium ($\mu_m > \mu_L$)

If $\mu_m > \mu_L$

$$f = \frac{R}{2\left(\frac{\mu_L}{\mu_m} - 1\right)}$$

↳ $f = -ve$ for Biconvex lens

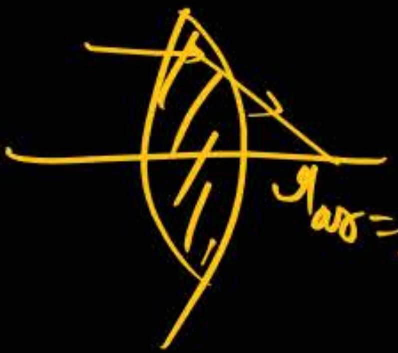
↳ diverging lens.

glass Biconvex lens of Radius of Curvature R Placed in air then find its focal length.

Soln

$$f = \frac{R}{2(\mu - 1)}$$

$$f = \frac{R}{2\left[\frac{3}{2} - 1\right]}$$



$\mu_{air} = 1$

$$f = \frac{R}{2\left[\frac{1}{2}\right]}$$

$$f = R$$

glass lens in air → MR Rafta

(Q) Same glass lens placed in water then find its focal length of lens??

Soln

$$f = \frac{R}{2\left[\frac{\mu_L}{\mu_m} - 1\right]} = \frac{R}{2\left[\frac{3 \times 3}{2 \times 4} - 1\right]} = \frac{R}{2\left[\frac{9-8}{8}\right]}$$

$$f = 4R$$

glass lens in water

QUESTION

Find focal length of Bi-convex lens and plan convex lens made of glass ($\mu = 3/2$) of radius $R = 20$ cm placed in air.

* Biconvex lens

$f = R = 20cm$

Plano convex.

$f = 2 f_{Biconvex}$

$f = 2 \times 20 = 40cm$

QUESTION

Find focal length of Bi-convex lens and plan convex lens made of glass ($\mu = 3/2$) of radius $R = 20$ cm placed in water.

$f_{\text{Biconvex in wal}} = 4R$

$= 4 \times 20$

$= 80\,\text{cm}$

$f_{\text{plano Com}} = 2 f_{\text{Biconvex lo.}}$

$= 2 \times 80 = 160$

QUESTION

If glass lens placed in glass medium then its focal length will be?

(a) Zero

(b) Infinite

QUESTION

Find focal length of glass lens in water if its radius of curvature is 12 cm.

Biconvex

$f_{Biconvex} = 4R$

$= 4 \times 12$

$= 18$ cm.

QUESTION

If f_1 is focal length of Bi-concave lens and f_2 is focal length of plano convex then correct option is:

1. $2f_1 = f_2$
2. $-f_1 = 2f_2$
3. $f_1 = 2f_2$
4. $2f_1 = -f_2$

$$f_1 = \frac{-R}{2(\mu-1)}$$

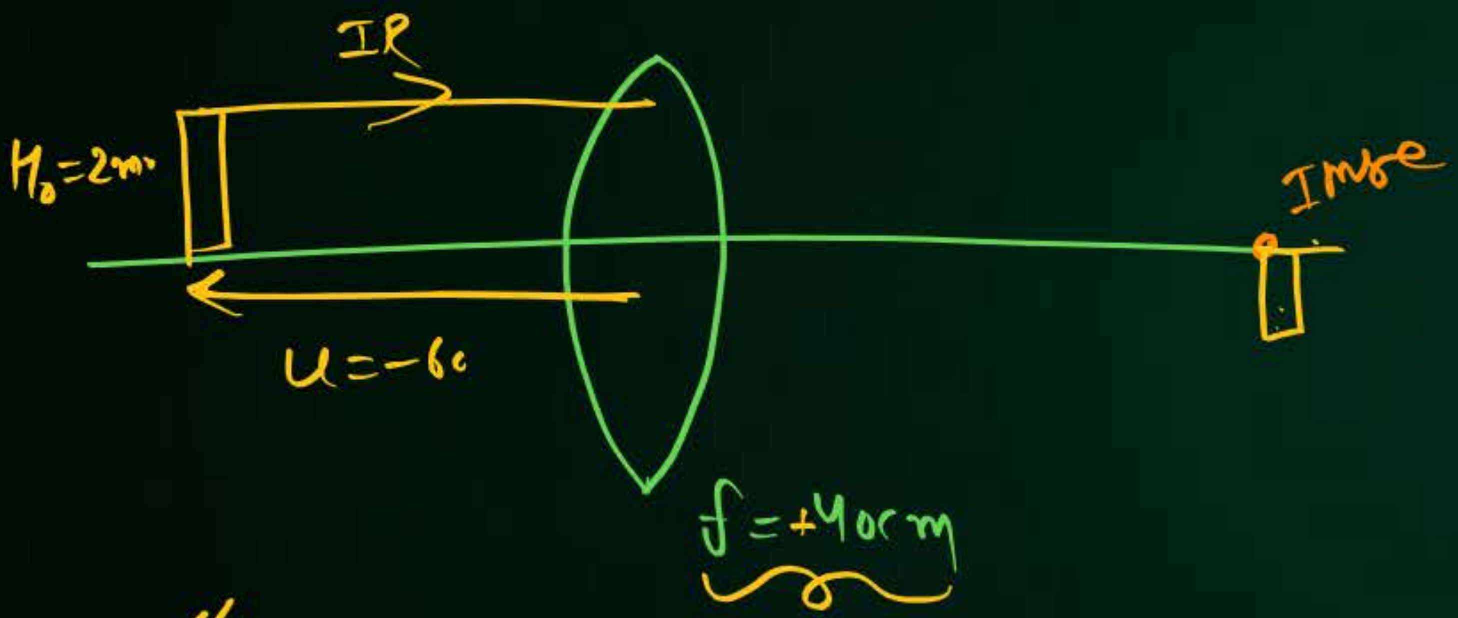
$$f_2 = \frac{R}{(\mu-1)}$$

$$2f_1 = -f_2$$

	Mirror	Lens
#	$f = R/2$ (does not depend on medium)	$f = \left[\frac{\mu_L}{\mu_m} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$
#	$\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$	$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$
#	$m_T = \frac{H_I}{H_o} = -\frac{v}{u} = \frac{f}{f-u} = \frac{f-v}{f}$	$m_T = \frac{H_I}{H_o} = \frac{v}{u} = \frac{f}{f+u} = \frac{f-v}{f}$
#	$m_e = m_T^2 = \frac{dv}{du}$	$m_e = m_T^2 = \frac{dv}{du}$

QUESTION

An object of height 2 mm is placed at distance 60 cm from a convex lens of focal length 40 cm. Find image and height of image.



lens form

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

$$\frac{1}{v} + \frac{1}{60} = \frac{1}{40}$$

$$\frac{1}{v} = \frac{1}{40} - \frac{1}{60} = \frac{3-2}{120}$$

$$\frac{1}{v} = \frac{1}{120}$$

$$v = +120$$

$$m_T = \frac{H_I}{H_0} = \frac{v}{u} = \frac{120}{-60}$$

$$H_I = -2 \times H_0$$

Convex → $f = +ve$

Concave lens $f = -ve$

$m_T = -ve$ (Inverted, real)

$m_T = +ve$ (erect, virtual)

Image Formation by Convex Lens

Object is at infinity

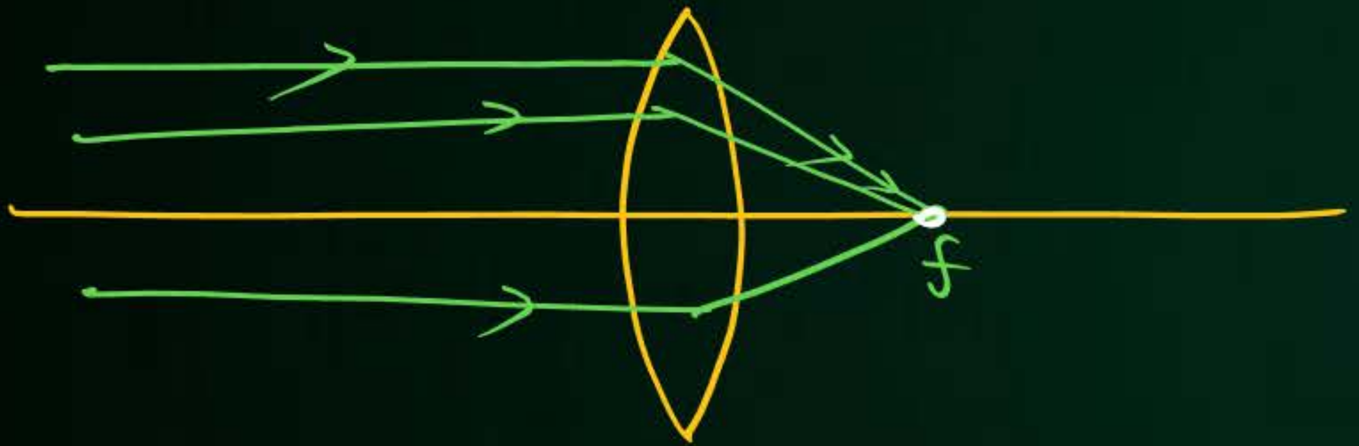
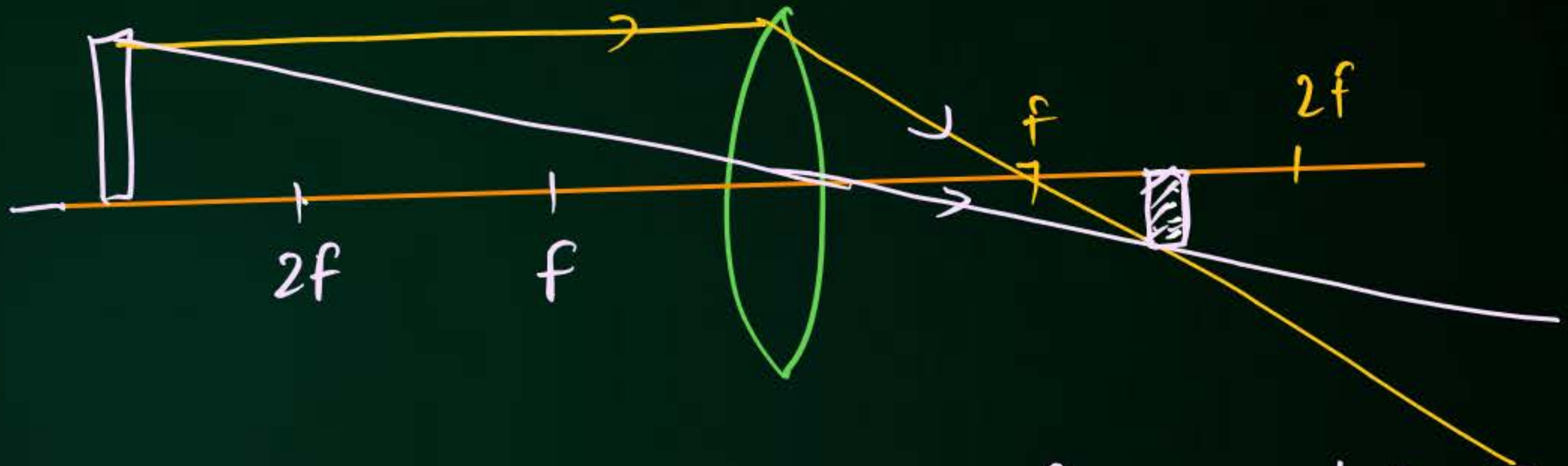


Image is at focus
- real Imag
- diminished (Small)

Object is B/w ∞ & 2f → Image is b/w f & 2f



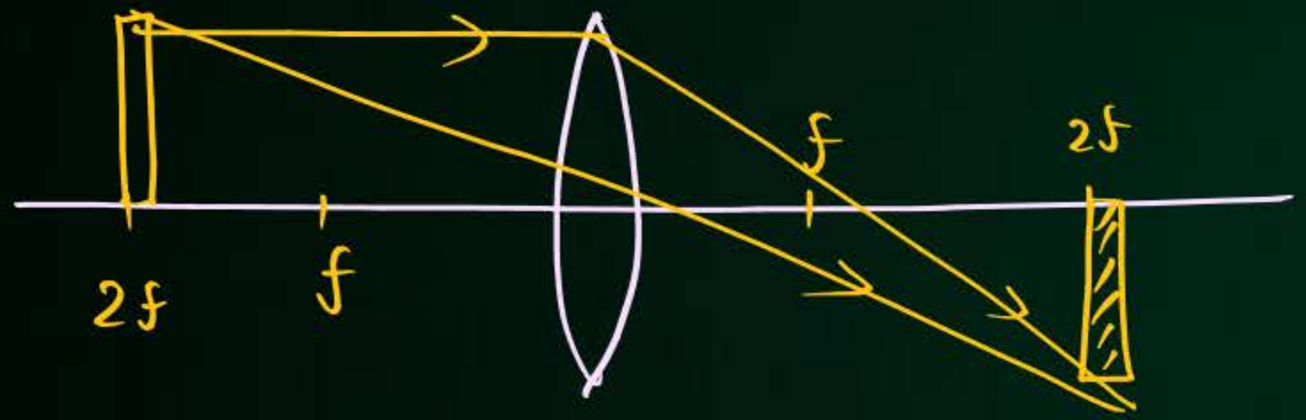
real Image → B/w f & 2f
Inverted, Small

$|m_T| < 1$

$m = -ve$

Image Formation by Convex Lens

Object is at '2f'



$m_T = -1$

→ Same size
→ Inverted
→ real.

Object is B/w 2f & f

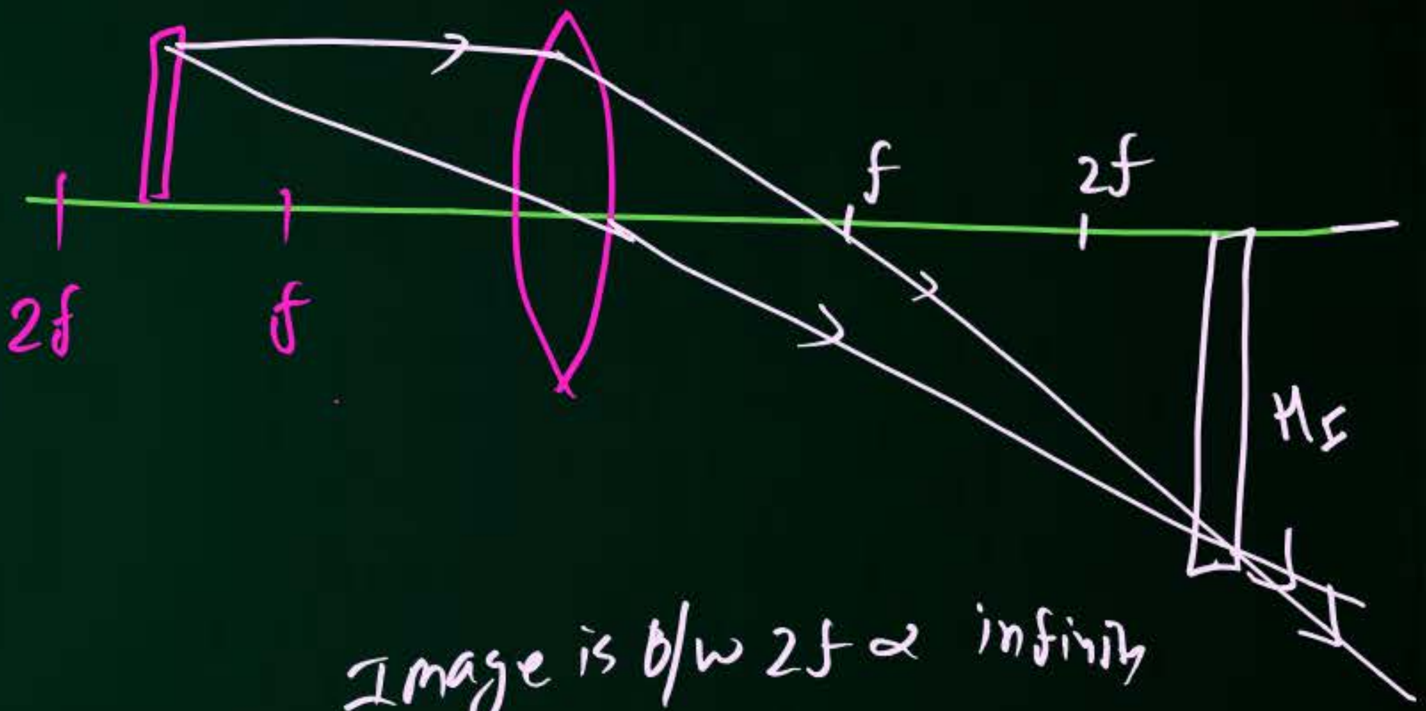


Image is b/w 2f & infinity

Inverted, real, large

$|m_T| > 1$

$m_T = -ve$

Image Formation by Convex Lens

Object is at focus

→ Image is at infinity

Convex lens → concave mirror
←

real Image → Inverted
Opposite side
Virtual Image → erect → Same side

concave mirror:
→ real Image side
→ virtual Image opposite side

object is B/w f & Optical centre.

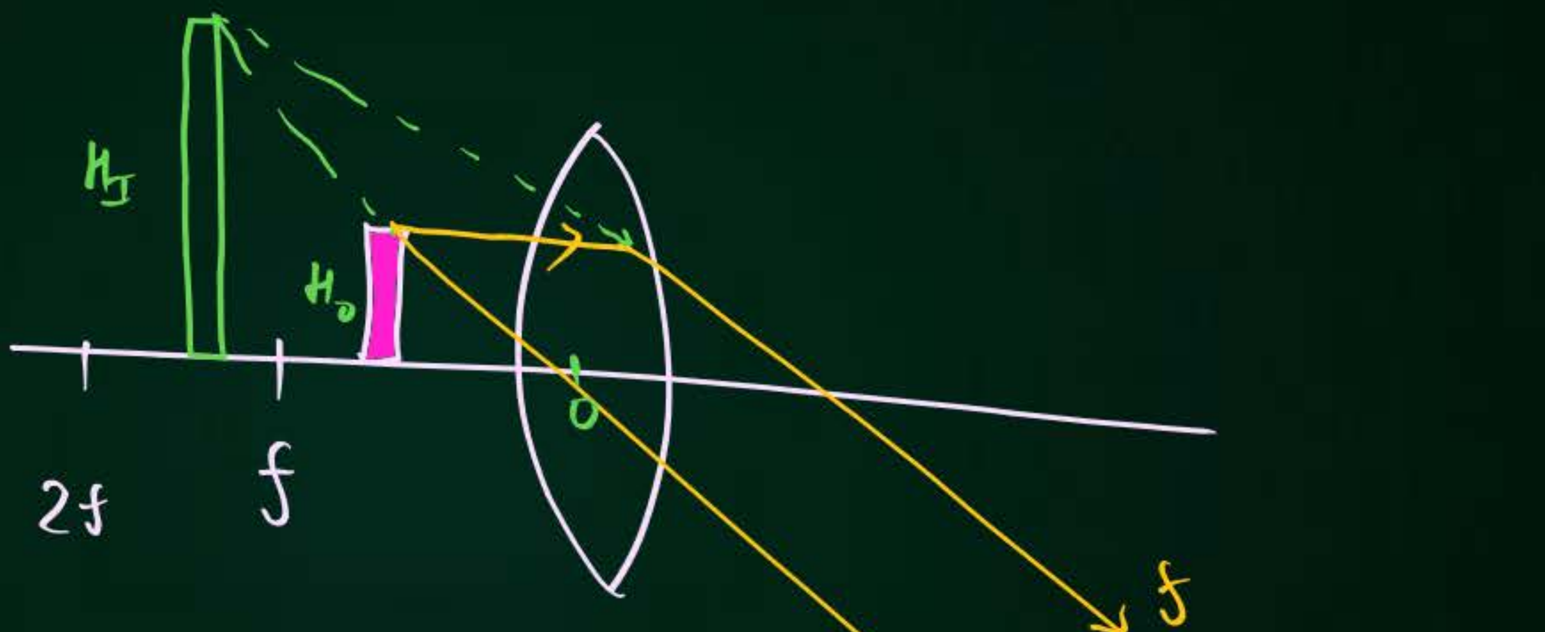


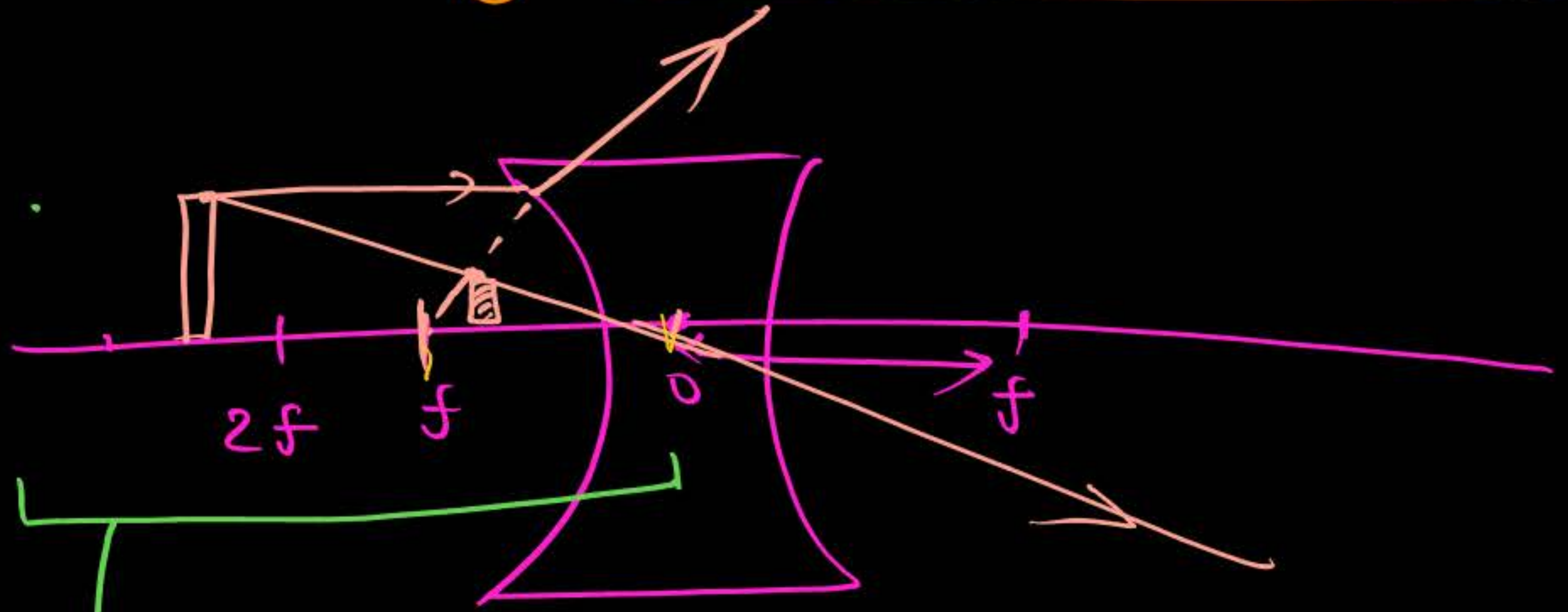
Image is B/w O & ∝

Same side → Virtual Image
→ large, erect

Image formation by convex lens.

Object Position	Image Position	Size of Image
Infinity	Focus	Small, real inverted
Between 2F and infinity	Between F and 2F	Small, real inverted m = –ve
Between 2F and F	Between 2F & infinity	Large, real inverted
at 2F	at 2F	same size (m = –ve)
at F	at infinity	very large inverted
Between F and optical centre	Same side	Large, erect virtual m = +ve

Image formation due to concave lens



Object ko kahi bhi rakh do

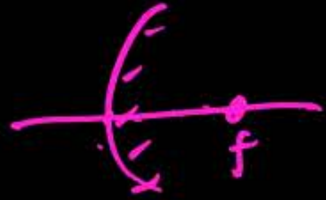
Image virtual, small & O & F ke bich banega (same side), erect



Convex lens

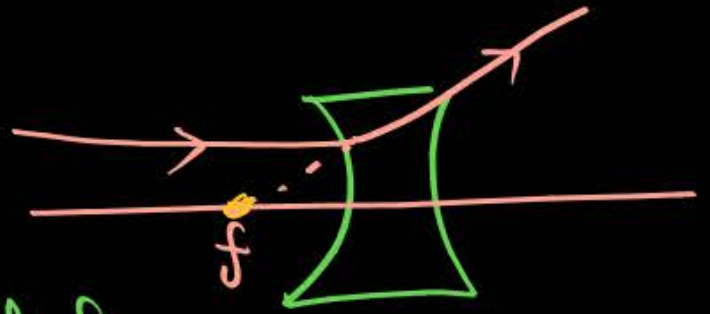
↑↓

concave mirror



Object is at infinity

↓ Image at focus



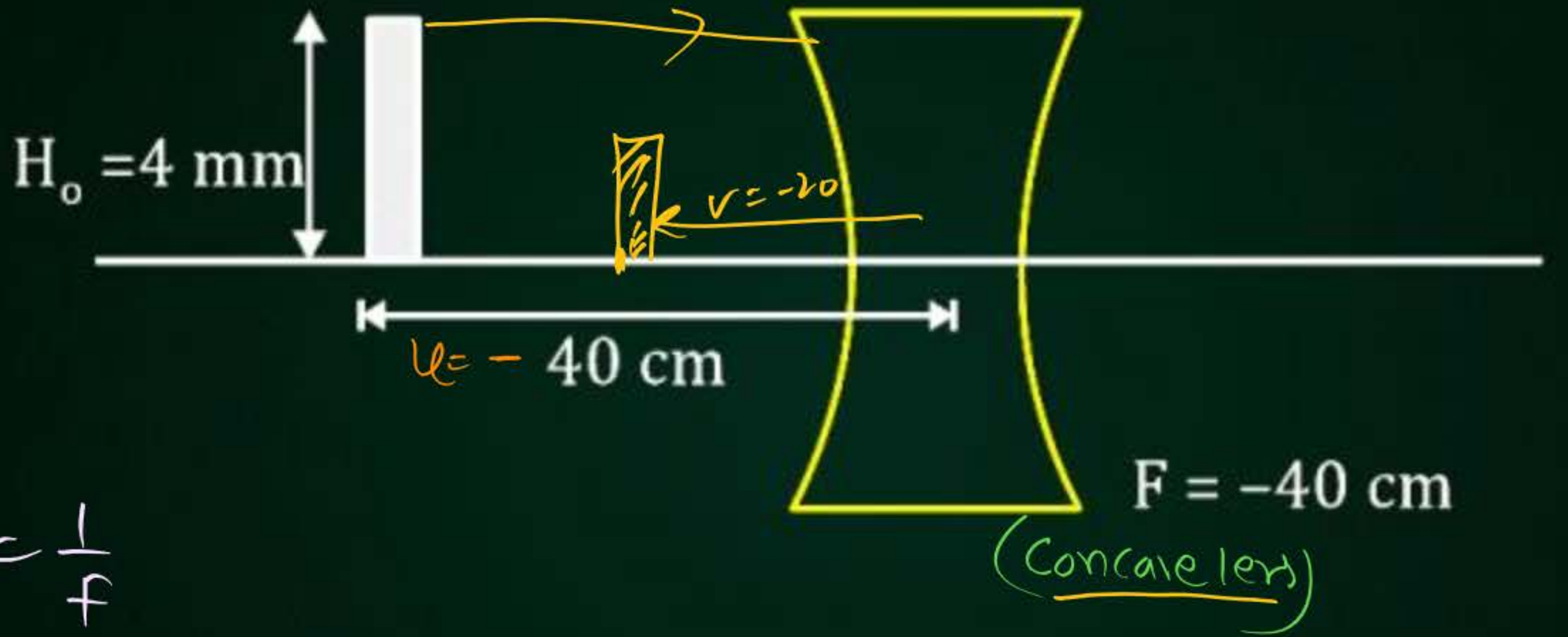
Convex mirror

↓↑

Concave lens

QUESTION

Find position of image, nature and height of image.



$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

$$\frac{1}{v} + \frac{1}{40} = \frac{-1}{40}$$

$$\frac{1}{v} = -\frac{1}{40} - \frac{1}{40} = \frac{-2}{40} = \frac{-1}{20}$$

$$V = -20$$

$$m_i = \frac{v}{u} = \frac{-20}{-40} = +\frac{1}{2}$$

erect, virtual, small, same side

QUESTION

A biconvex lens has a radius of curvature of magnitude 20 cm. Which one of the following options describe best the image formed of an object of height 2 cm placed 30 cm from the lens?

glass assume $\mu = 3/2$, $f = R$

1. Virtual, upright, height = 1 cm
2. Virtual, upright height = 0.5 cm
3. Real, inverted, height = 4 cm
4. Real, inverted, height = 1 cm

QUESTION

In order to obtain a real image of magnification 2 using a converging lens of focal length 20 cm, where should an object be placed?

1. 50 cm
2. 30 cm
3. –50 cm
4. –30 cm


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture-11 | Physics

Ray Optics and Optical Instruments

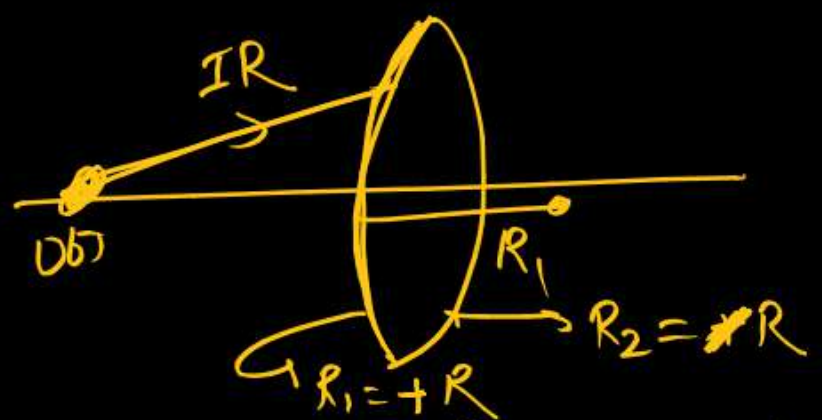
By- Dr. Manish Raj (MR SIR)



Topics to be covered

1. # Revision of Lens
2. #
3. #

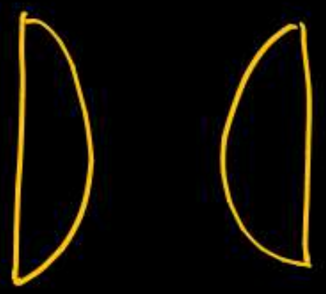




Bi-convex lens

(eque convex lens)

$$f = \frac{+R}{2(\mu_L - 1)}$$



Plano convex lens

$$f = \frac{R}{(\mu - 1)}$$

glass les

$f = R$

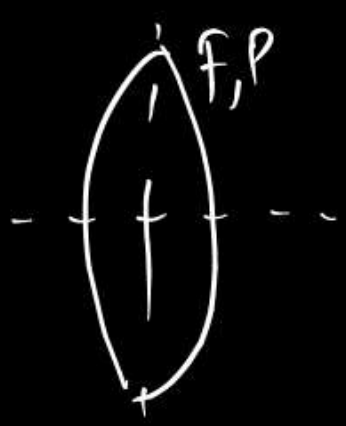


Bi- concave len.

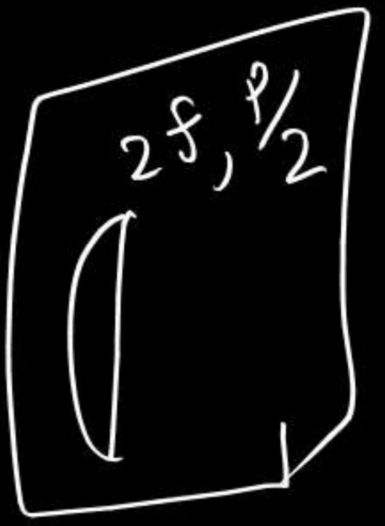
$$f = \frac{-R}{2(\mu_L - 1)}$$



$$f = \frac{-R}{(\mu_L - 1)}$$







* $$\frac{1}{v} - \frac{1}{u} = \left(\frac{\mu_L}{\mu_m} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

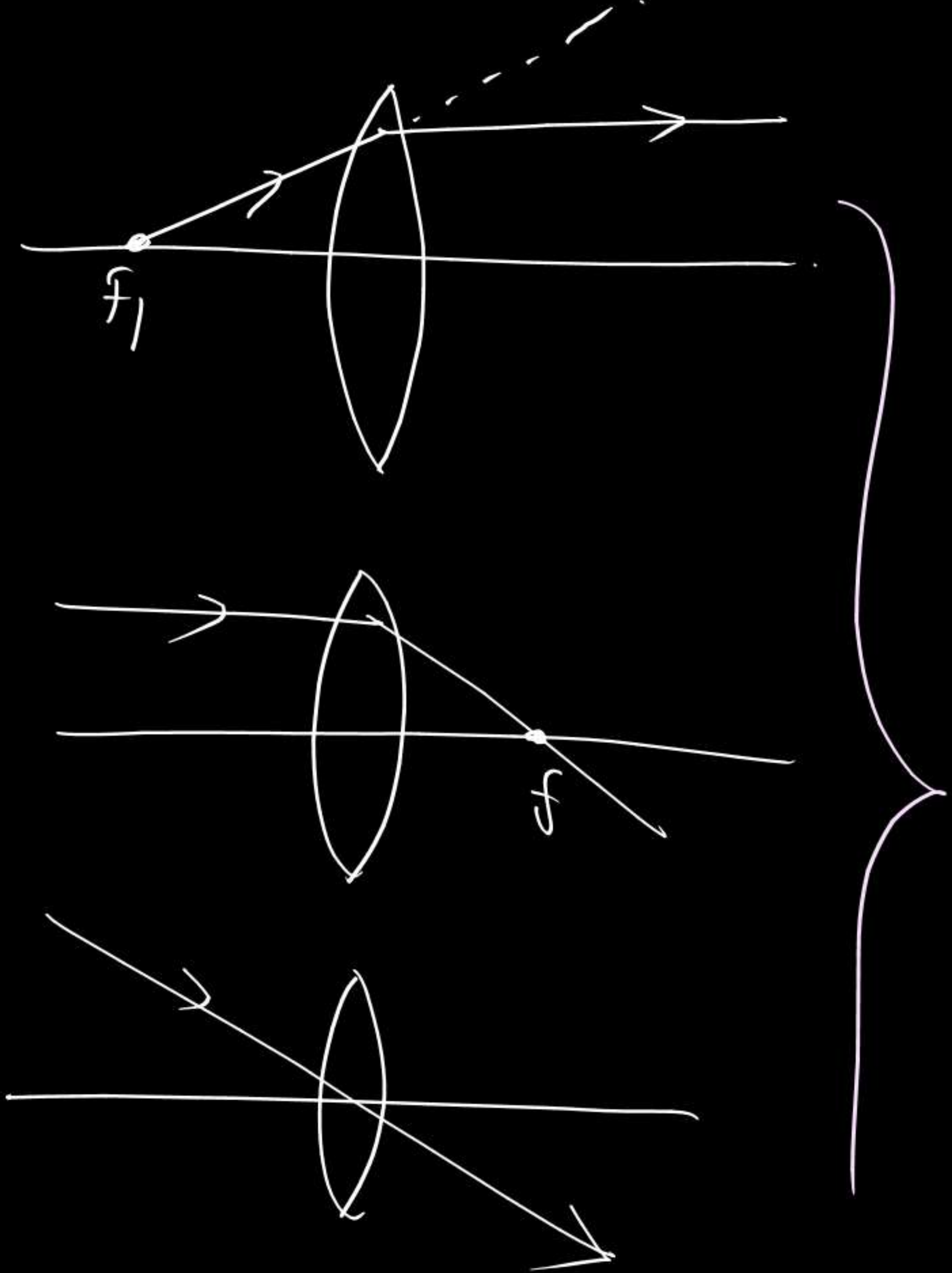
If $u = \infty$
$v = f$

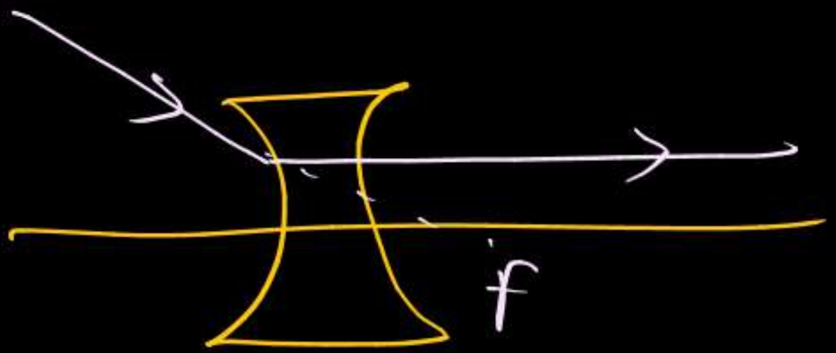
* $$\frac{1}{f} = \left(\frac{\mu_L}{\mu_m} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

* $$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

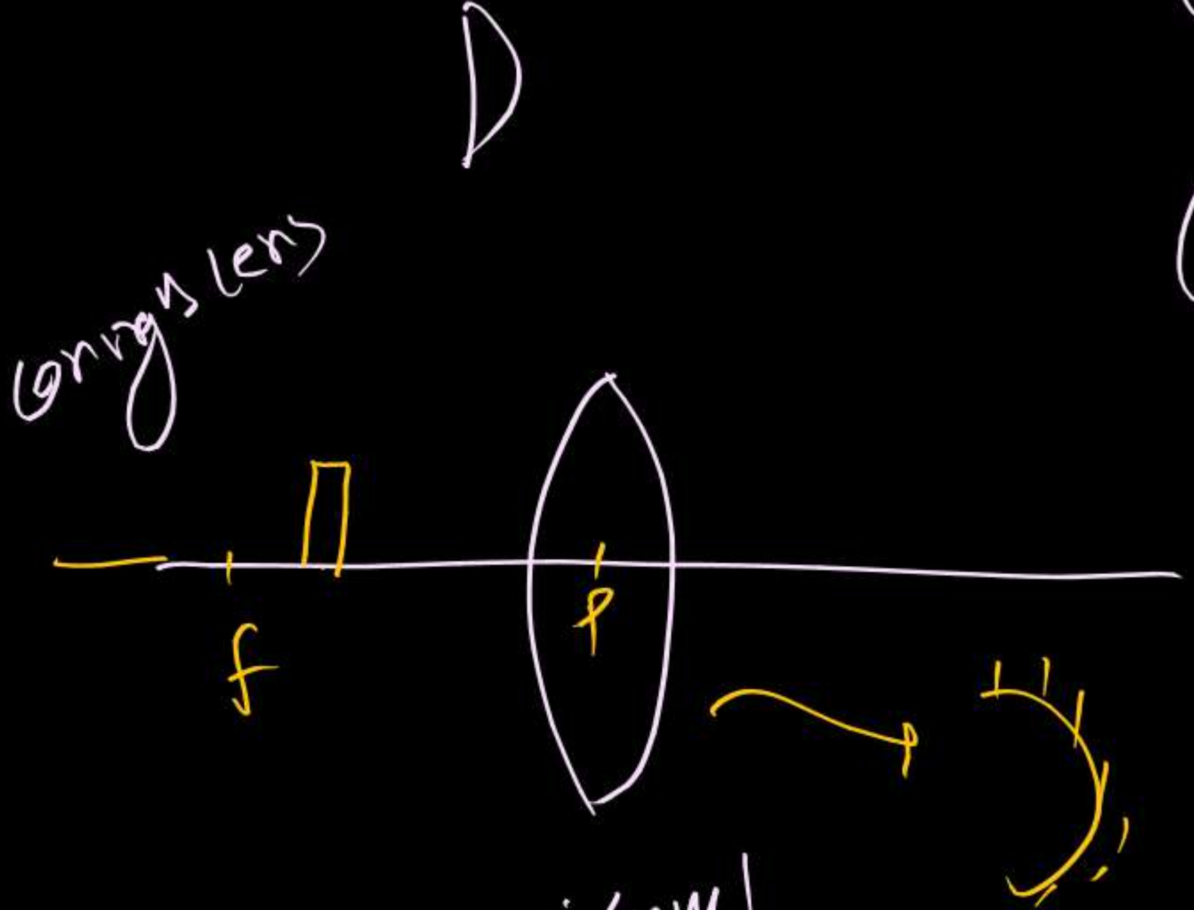
* $$m_T = \frac{H_I}{H_O} = \frac{v}{u} = \frac{f}{f+u} = \frac{f-v}{f}$$

* $$m_l = \frac{dv}{du} = m_T^2$$





diverging lens



Biconvex

If $\mu_L < \mu_m$

→ then nature of lens will be opposite

Convex lens can't form enlarged virtual Image ✓ (True)

Power of lens

$$P = \pm \frac{1}{f(m)}$$

- → scalar
- → unit (m^{-1}) = Diopter
- → for concave lens −ve
- → for convex lens +ve

~~$P = \frac{100}{f(cm)}$~~ do not use

~~$P = \frac{100}{40} D$~~

for mirror

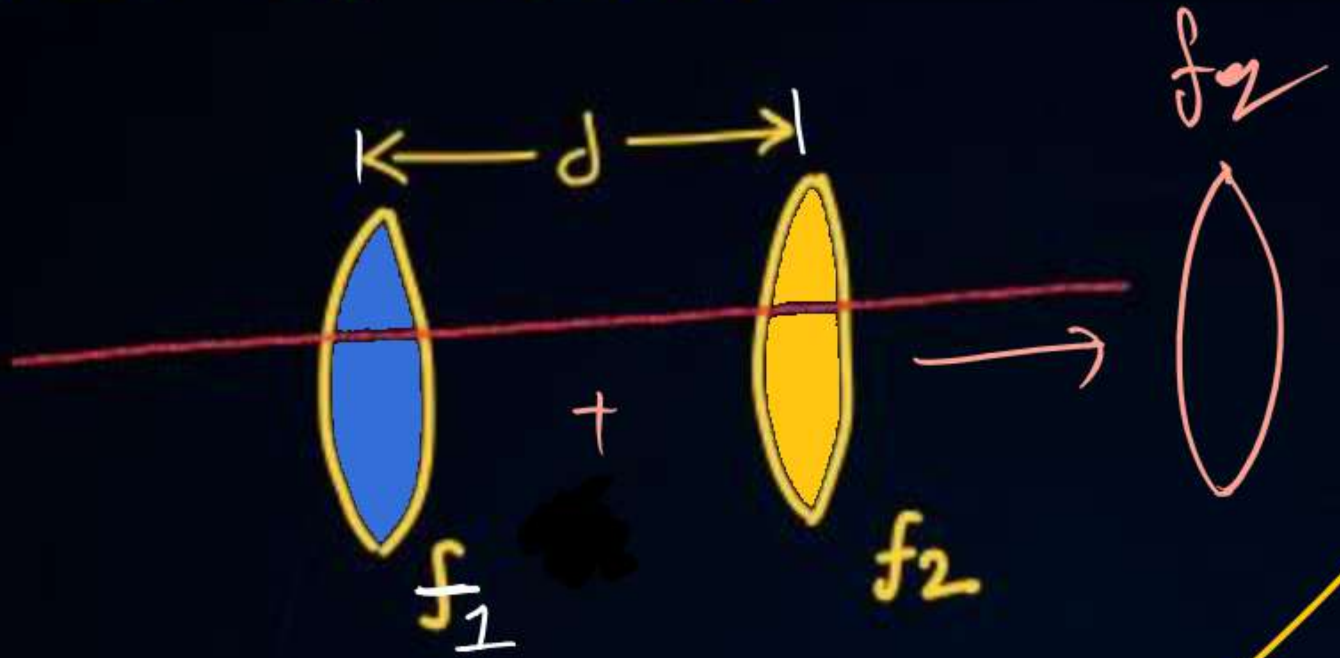
(Q) find power of concave lens of focal length 40cm

$$P = -\frac{1}{40\,cm} = \frac{1}{-40\times10^{-2}\,m} = -\frac{100}{40} = -\frac{10}{4} = -2.5\,D \checkmark$$

(Q) find power of convex lens of focal length 75cm

$$P = \frac{1}{75\times10^{-2}\,m} = \frac{100}{75} = +\frac{4}{3}\,D$$

Combination of lens

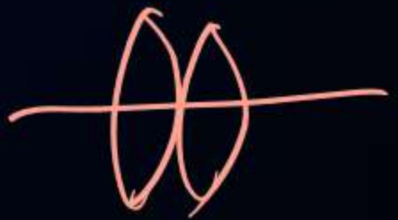


$$\frac{1}{f_{net}} = \frac{1}{f_1} + \frac{1}{f_2} - \frac{d}{f_1 \cdot f_2}$$

- use with Proper sign

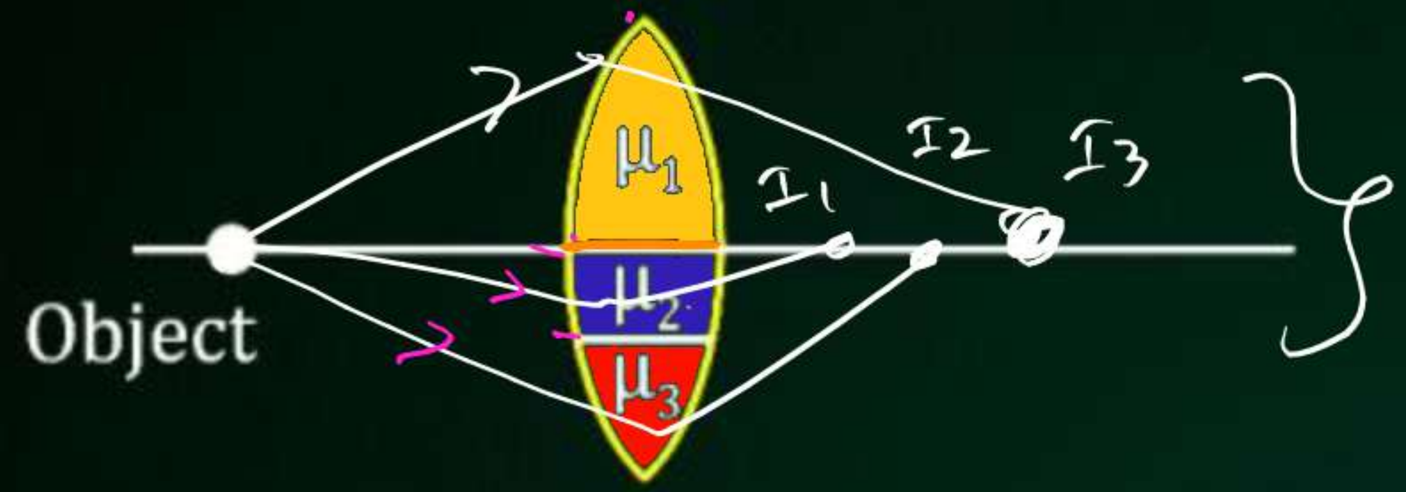
if d=0 lens placed in contact

$$\frac{1}{f_{net}} = \frac{1}{f_1} + \frac{1}{f_2}$$

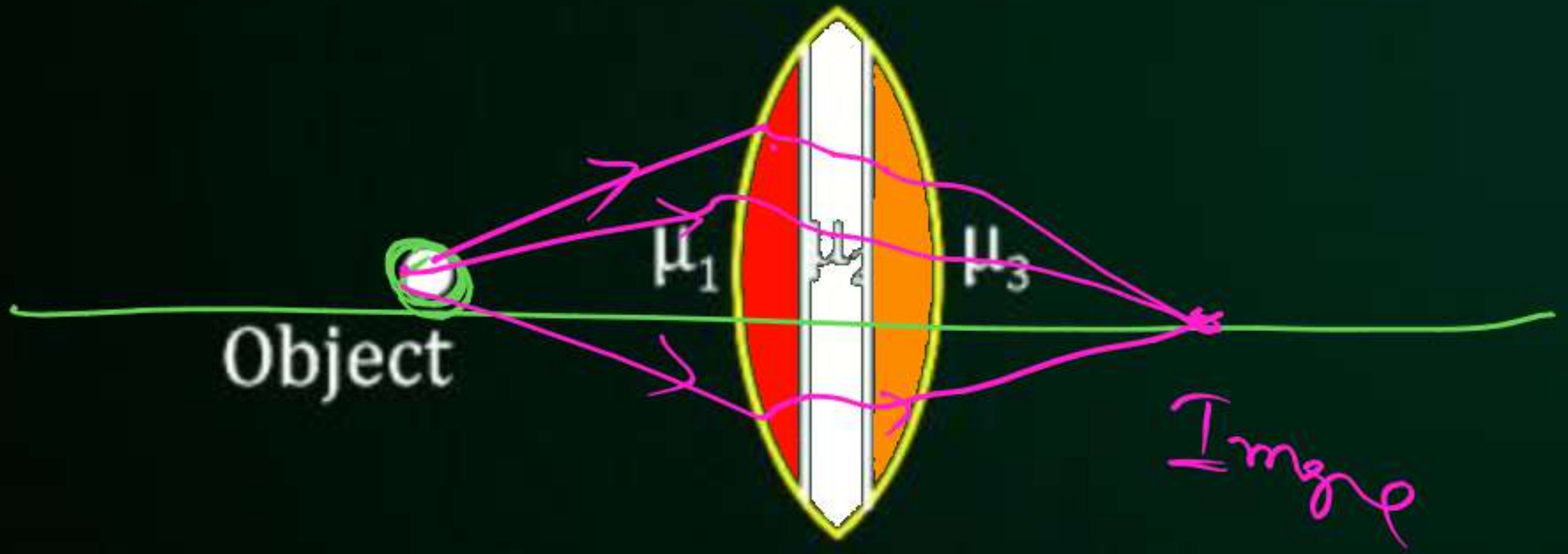


$$P_{net} = P_1 + P_2 - d P_1 P_2$$

Total no. of image formed by lens .

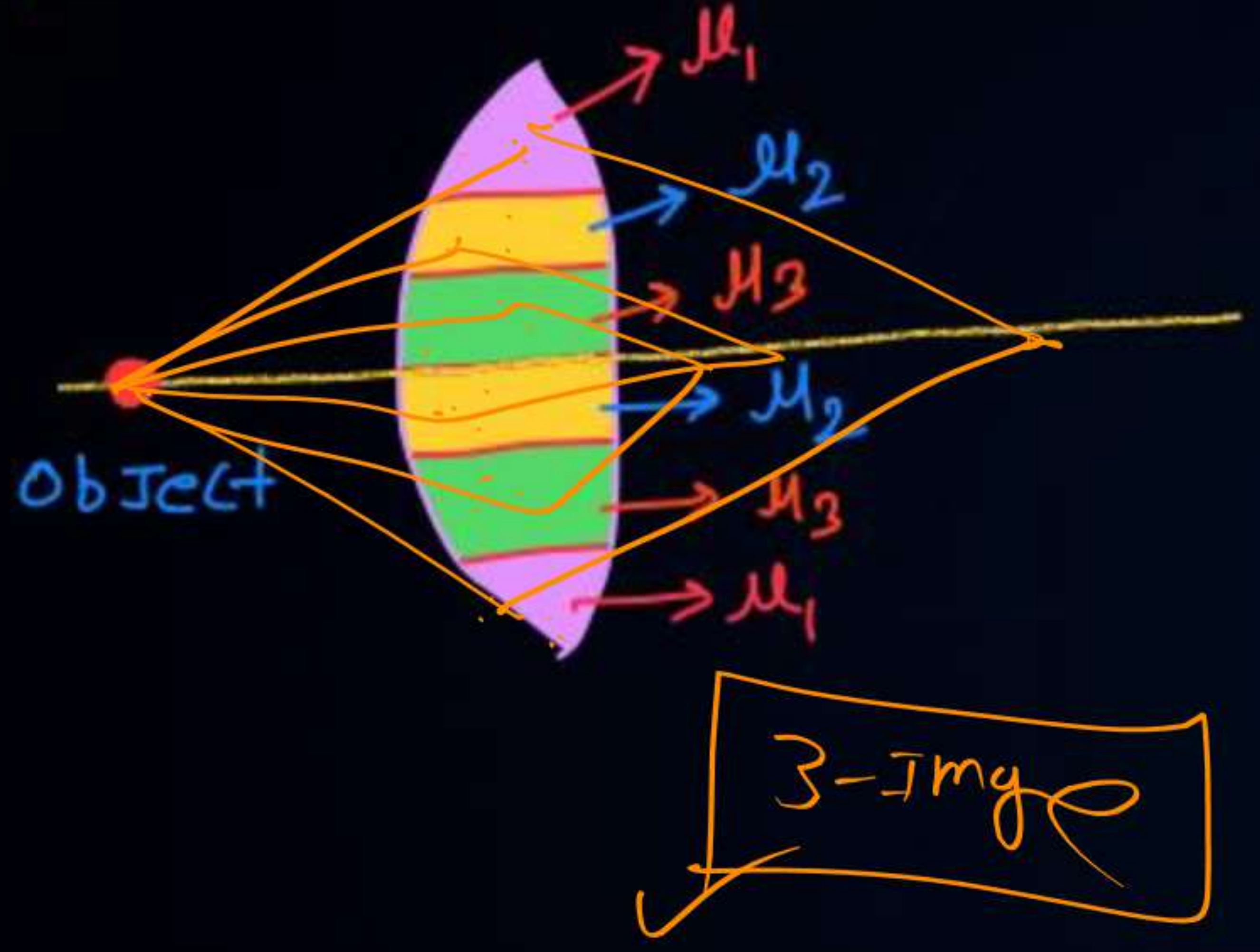


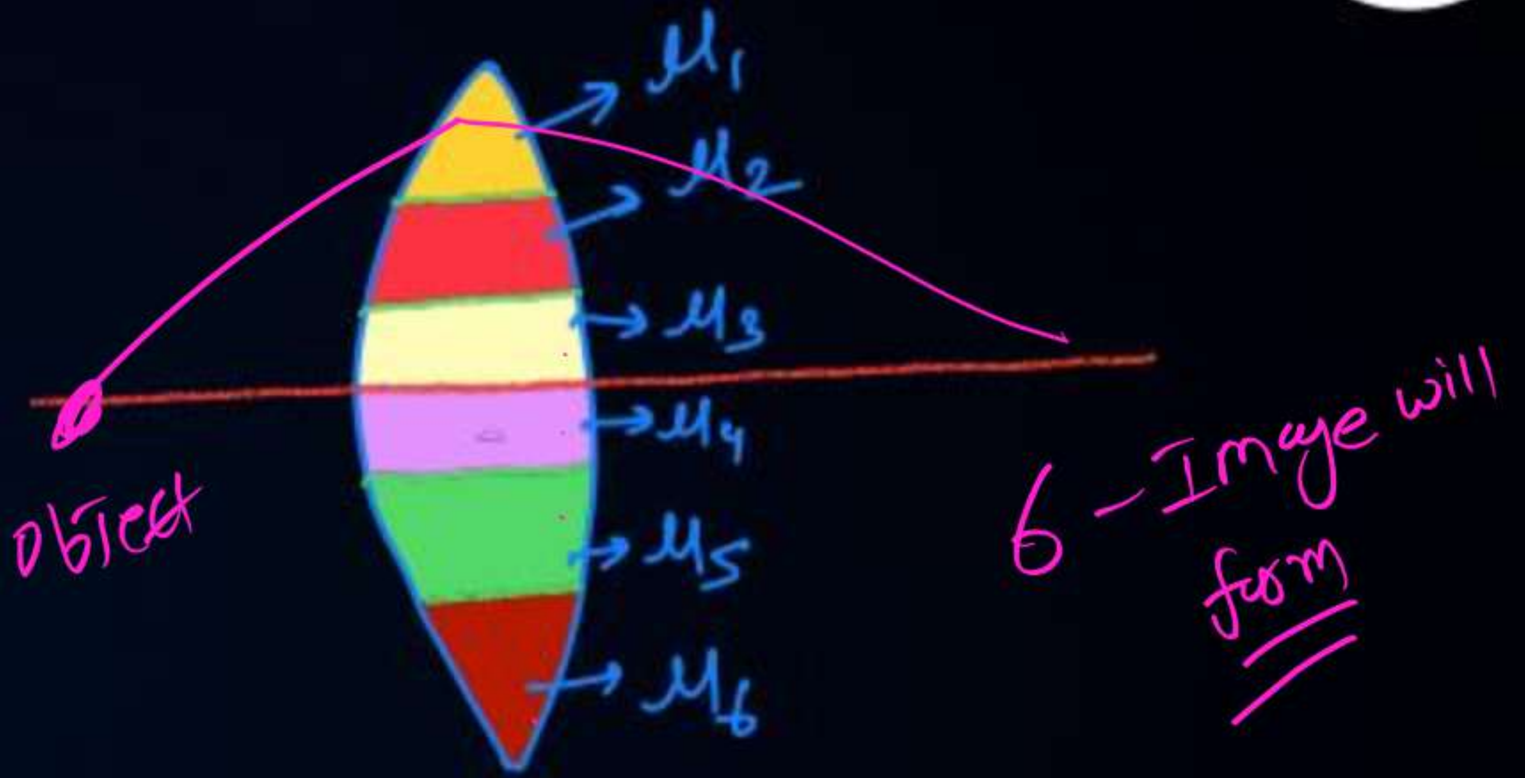
3 Image will be form for one object.

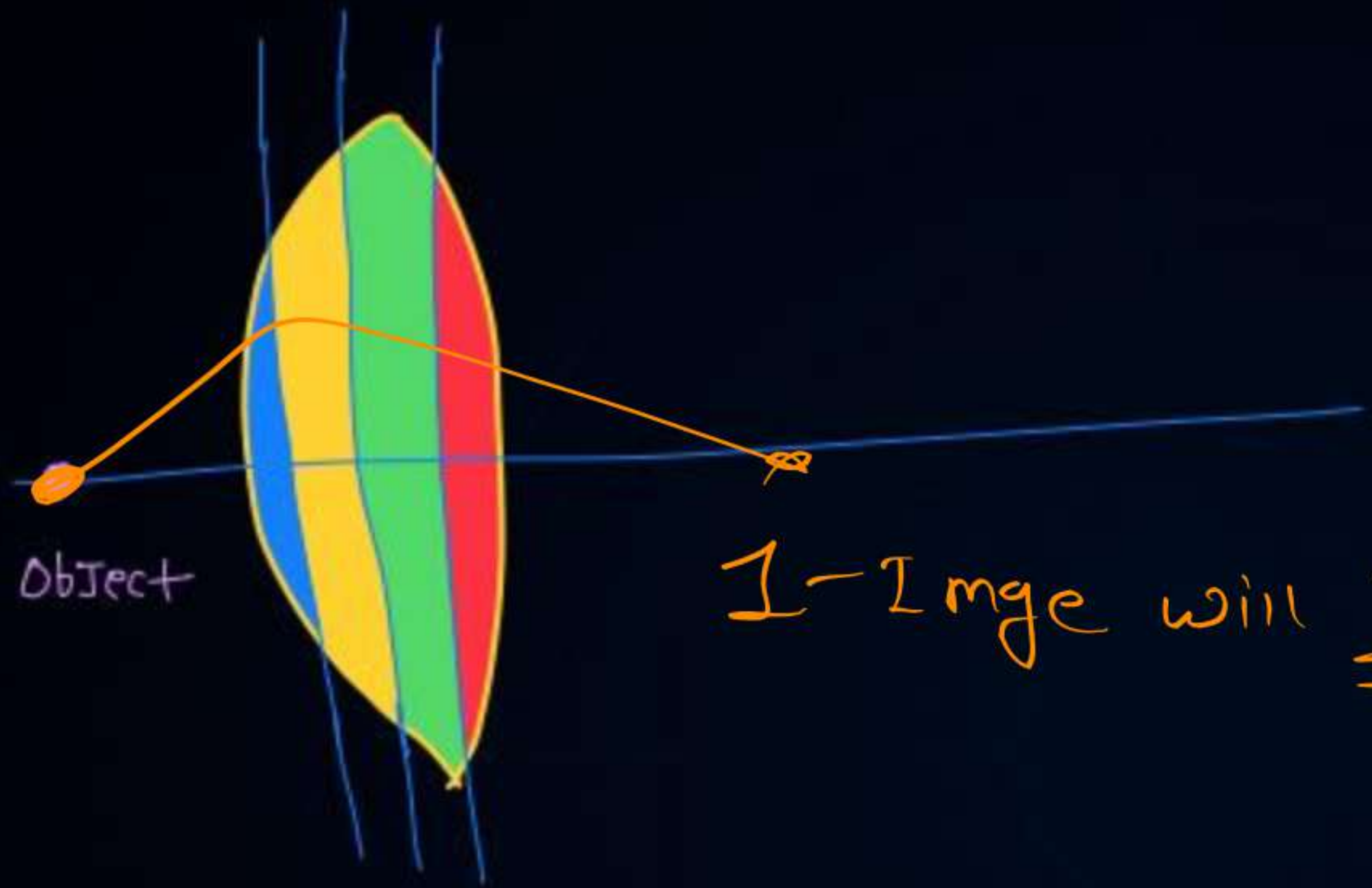


One Image will form

Total no. of Image formed by lens

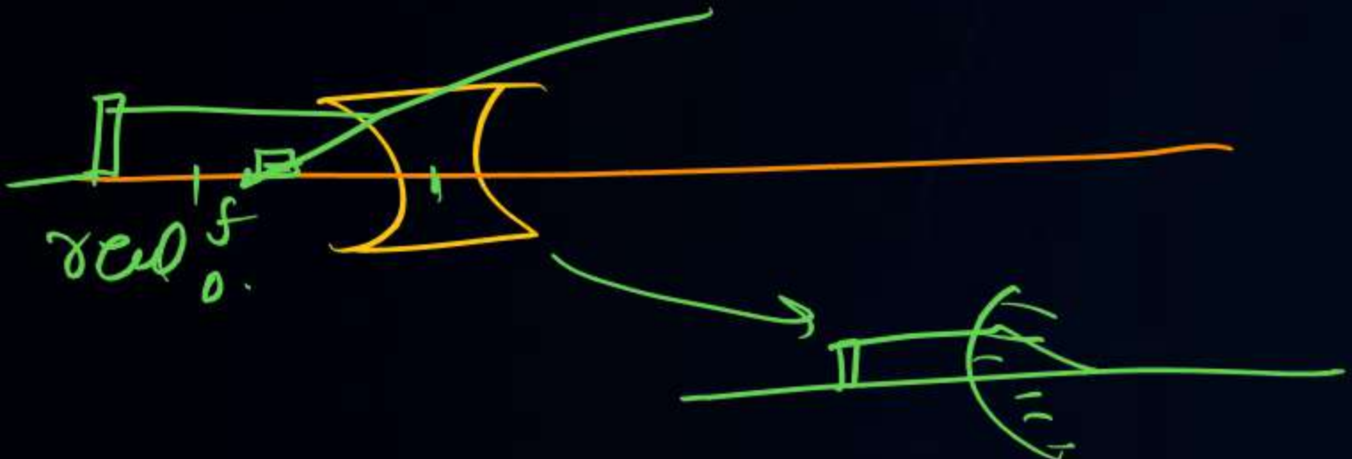






1- Imge will form

Concave lens only form virtual Image of real object → True.



Convex mirror (Concave lens)



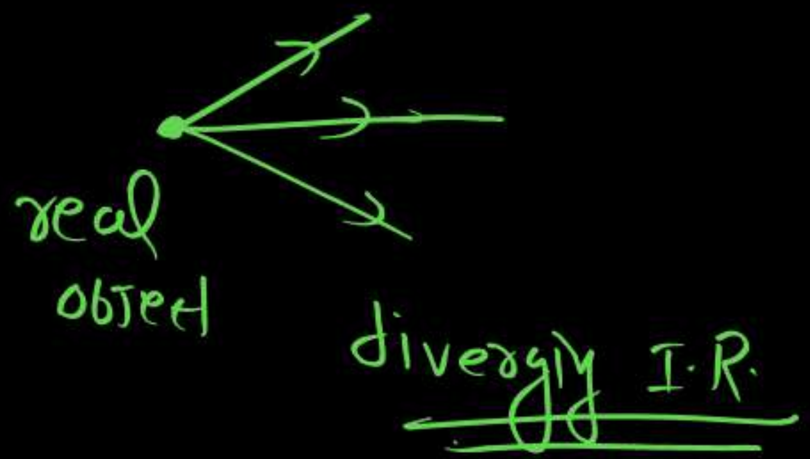
Convex lens — Concave mirror

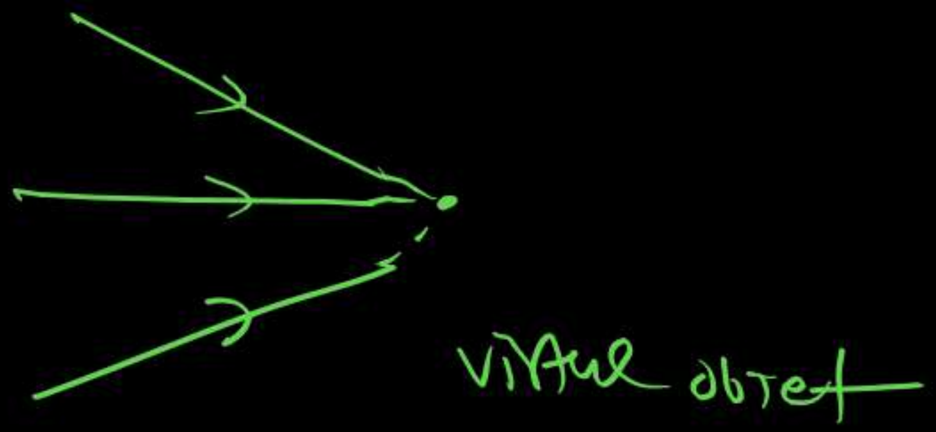
QUESTION

When a biconvex lens of glass having refractive index 1.47 is dipped in a liquid, it acts as a plane sheet of glass. This implies that the liquid must have refractive index.

1. Greater than that of glass
2. Less than that of glass
3. Equal to that of glass
4. Less than one

real object | virtual object





QUESTION

If the focal length of the lens is 20 cm, what is the distance of the image from the lens in the following figure?

1. 5.5 cm
2. 7.5 cm
3. 12.0 cm
4. 20.0 cm

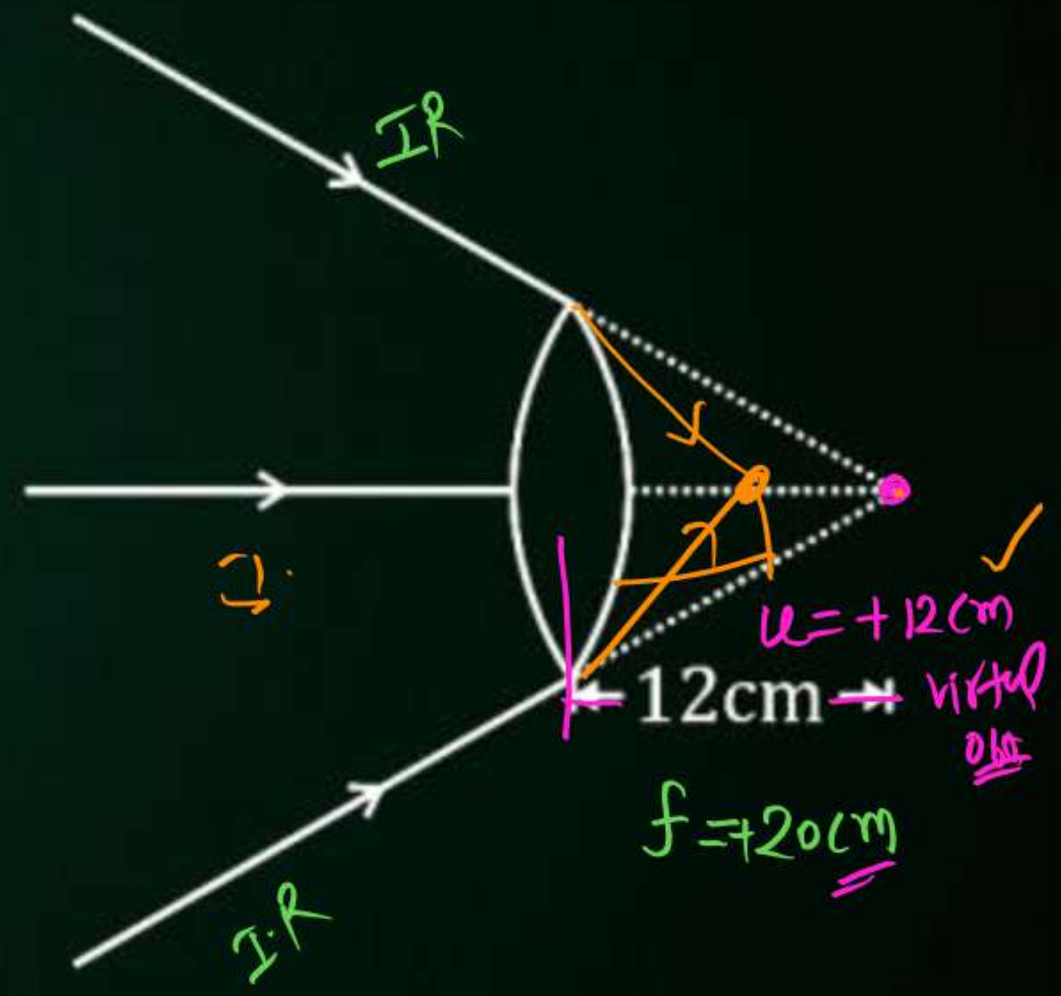
$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

$$\frac{1}{v} = \frac{1}{f} + \frac{1}{u}$$

$$\frac{1}{v} = \frac{1}{20} + \frac{1}{12} = \frac{3+5}{60}$$

$$v = \frac{60}{8} = 7.5$$

MR: $v < 12\,cm$



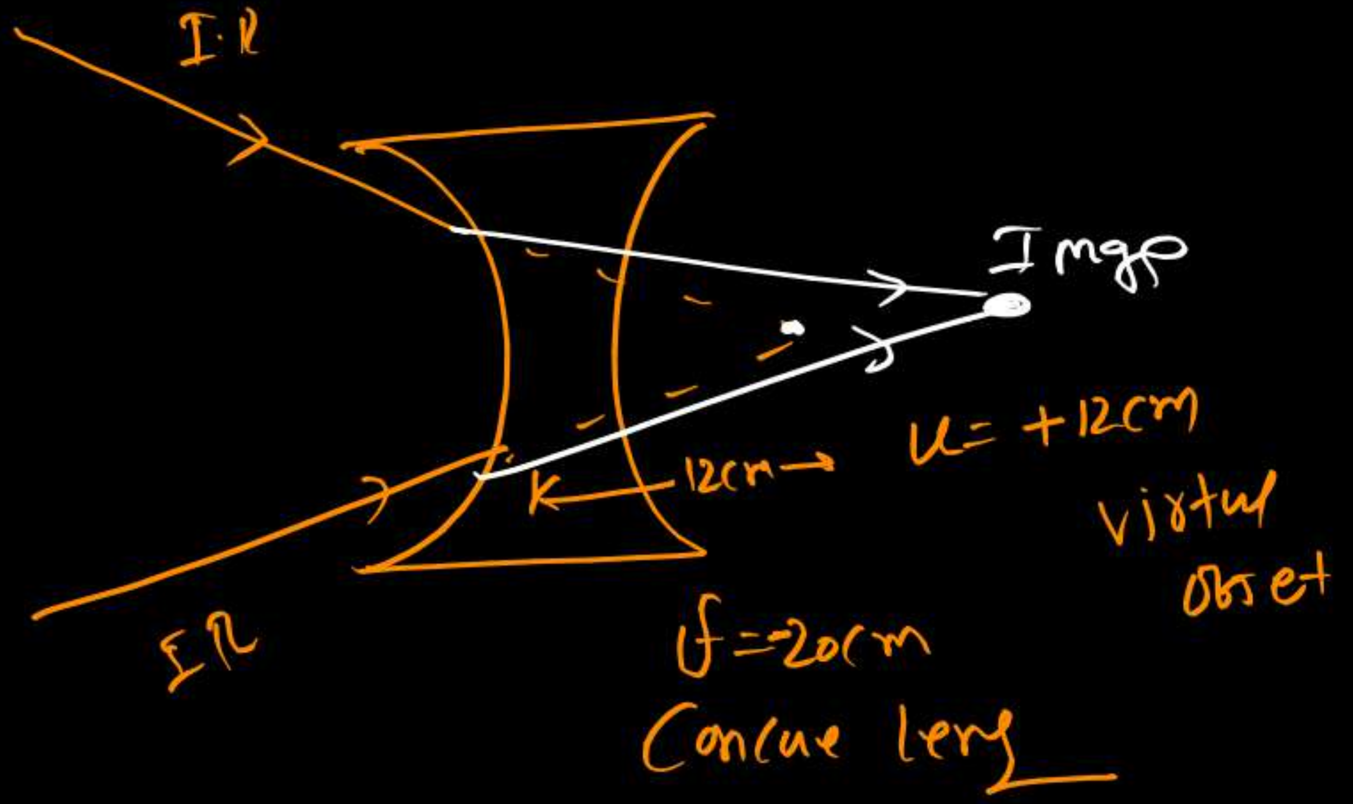
Lens formula

$$\frac{1}{v} = \frac{1}{u} + \frac{1}{f}$$

$$\frac{1}{v} = \frac{1}{12} - \frac{1}{20} = \frac{5-3}{60}$$

$$\frac{1}{v} = \frac{2}{60}_{30}$$

$$v = 30$$



QUESTION

Hard

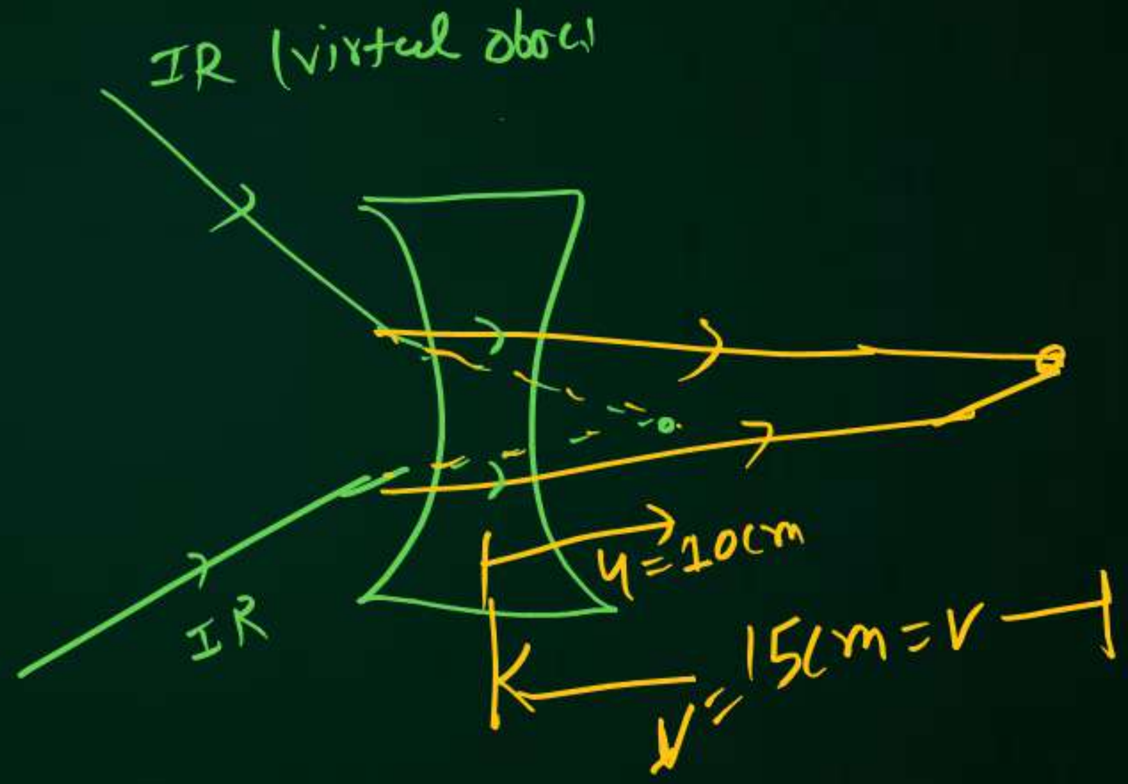
A converging beam of rays is incident on a diverging lens. Having passed through the lens the rays intersect at a point 15 cm from the lens on the opposite side. If the lens is removed the point where the rays meet will move 5 cm closer to the lens. The focal length of the lens is

(1) –30 cm ✓ Ans

(2) 5 cm

(3) –10 cm

(4) 20 cm



$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

$$\frac{1}{15} - \frac{1}{10} = \frac{1}{f}$$

$$\frac{2-3}{30} = \frac{1}{f}$$

$$-\frac{1}{30} = \frac{1}{f}$$

$f = -30$ cm

QUESTION

Two lenses are placed in contact with each other and the focal length of combination is 80 cm. If the focal length of one is 20 cm, then the power of the other will be:

1. 1.66 D
2. 4.00 D
3. –1.00 D
4. –3.75 D

Ans

$$\frac{1}{f_{net}} = \frac{1}{f_1} + \frac{1}{f_2}$$

$$\frac{1}{80} = \frac{1}{20} + \frac{1}{f_2}$$

$$\frac{1}{f_2} = \frac{1}{80} - \frac{1}{20} = \frac{1-4}{80}$$

$$f_2 = \frac{80}{-3} \text{ cm}$$

$$P = \frac{1}{f} = \frac{-3}{80 \times 10^{-2}}$$

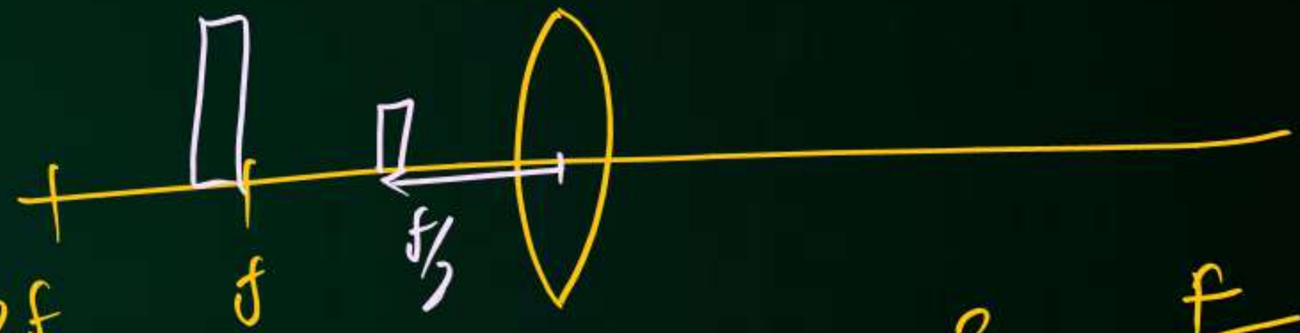
$$P = -\frac{300}{80}$$

$$P = -\frac{30}{8} = 3.75$$

QUESTION

An object is placed at a distance of $f/2$ from a convex lens. The image will be

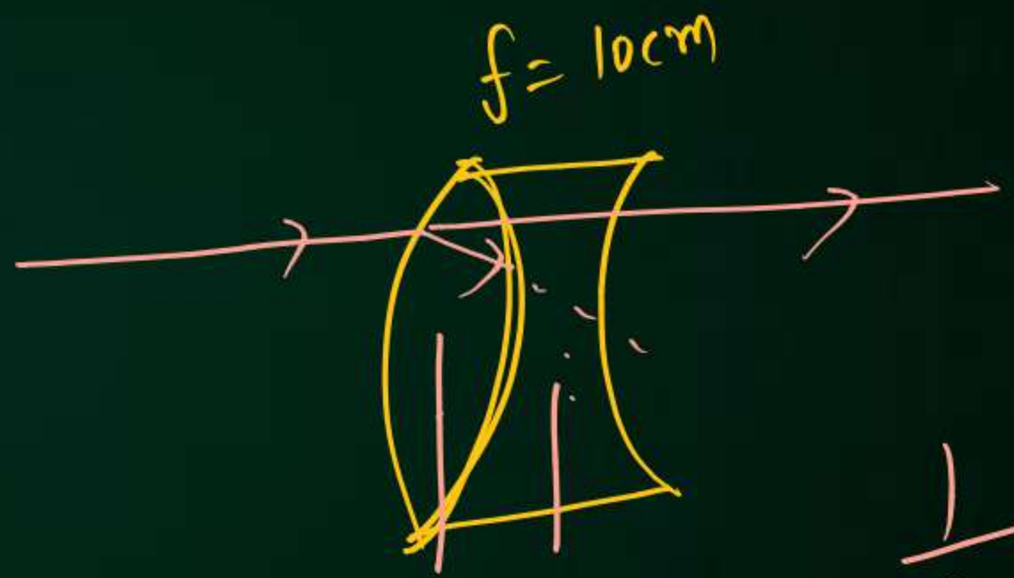
1. At one of the foci, virtual and double its size
2. At $3f/2$, real and inverted
3. At $2f$, virtual and erect
4. At f, real and inverted



QUESTION

A thin convex lens of focal length 10 cm is placed in contact with the concave lens of same material and of same focal length. The focal length of combination will be:

1. Zero
2. Infinity ✓
3. 10 cm
4. 20 cm



$$\frac{1}{f_{net}} = \frac{1}{f_1} + \frac{1}{f_2}$$

$$\frac{1}{f_{net}} = \frac{1}{f} - \frac{1}{f} = 0$$

$$f_{net} = \frac{1}{0} = \infty$$

QUESTION

real obj. Convex lens

A needle placed 45 cm from a lens forms an image on the screen placed 90 cm on the other side of the lens. What is the size of image if the size of needle is 5 cm? And what is the focal length of lens?

1. 10 cm, 30 cm ✓
2. 20 cm, 30 cm ✗
3. 100 cm, 10 cm ✗
4. 1 m, 100 cm ✗

$u = -45\,cm$

$v = +90\,cm$

$m_T = \frac{v}{u} = \frac{H_I}{H_o}$

$= \frac{90}{45} = \frac{H_I}{H_o}$

$H_I = 2 \times H_o = 2 \times 5 = 10$

$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$\frac{1}{90} + \frac{1}{45} = \frac{1}{f}$

$\frac{1+2}{90} = \frac{1}{f}$

$\frac{3}{90} = \frac{1}{f}$

$f = 30\,cm$

for real object magnification can be +ve & -ve for (convex mirror) → false

for real object magnific can be +ve & -ve for convex lens → True

for real object magnification can be +ve & -ve for concave mirror – True

QUESTION

When an object is at ac distance u_1 and u_2 from a lens, real image and a virtual image is formed respectively having same magnification. The focal length of the lens is

1. $u_1 - u_2$
2. $\frac{u_1 - u_2}{2}$
3. $\frac{u_1 + u_2}{2}$
4. $u_1 + u_2$

$m = -ve$ Inverts

$m = +ve$ erect

Convex lens

$m_T = \frac{f}{f - u_1}$ — (I)

$m_T = \frac{f}{f - u_2}$ — (II)

$\frac{f}{f - u_1} = -\frac{f}{f - u_2}$

$-f + u_1 = f - u_2$

$u_1 + u_2 = 2f$

$f = \frac{u_1 + u_2}{2}$

QUESTION

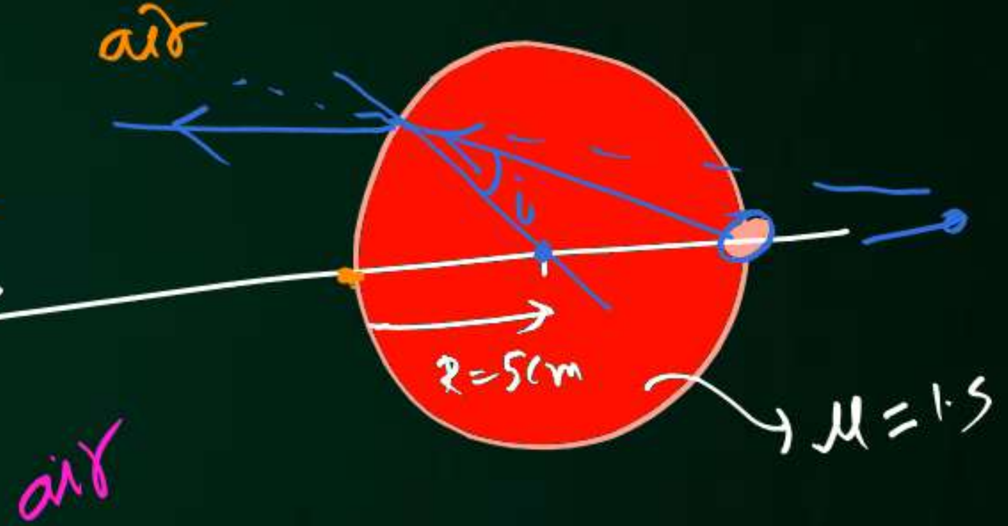
A mark placed on the surface of a sphere is viewed through glass from a position directly opposite. If the diameter of the sphere is 10 cm and refractive index of glass is 1.5, find the position of the image.

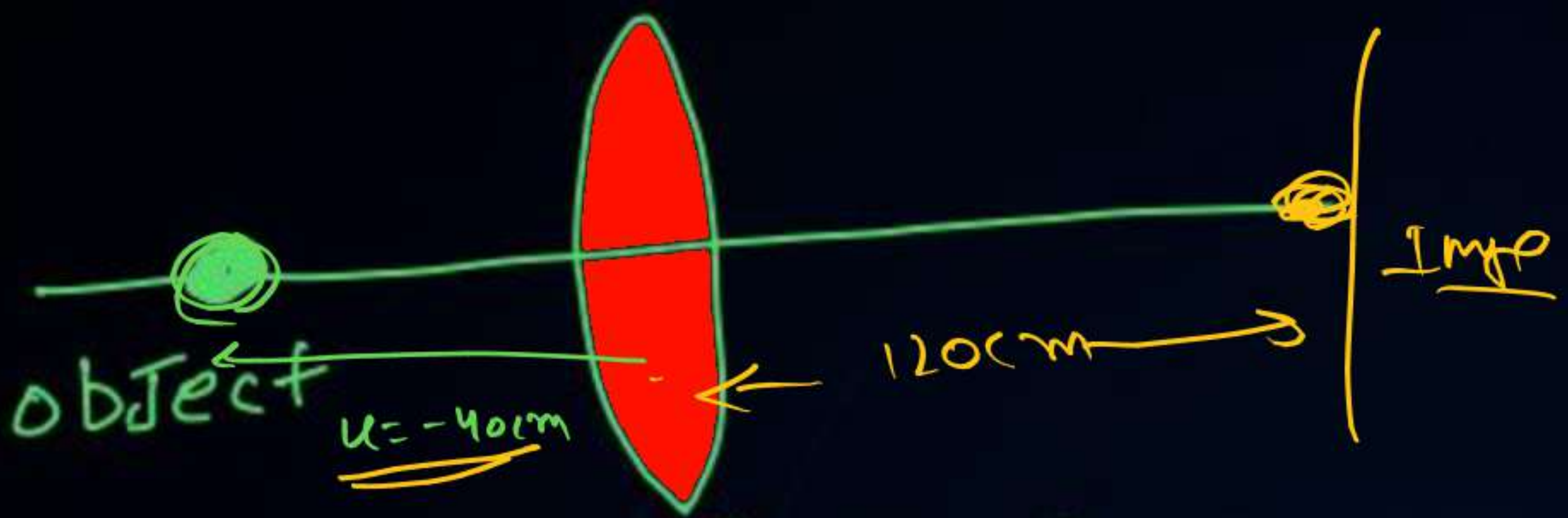
1. –20 cm
2. 10 cm
3. 40 cm
4. –30 cm

$$\frac{\mu_r}{v} - \frac{\mu_{IR}}{u} = \frac{\mu_r - \mu_{IR}}{R}$$

$$\frac{1}{v} - \frac{3}{2(-10)} = \frac{1 - 3/2}{-5}$$

find (v)





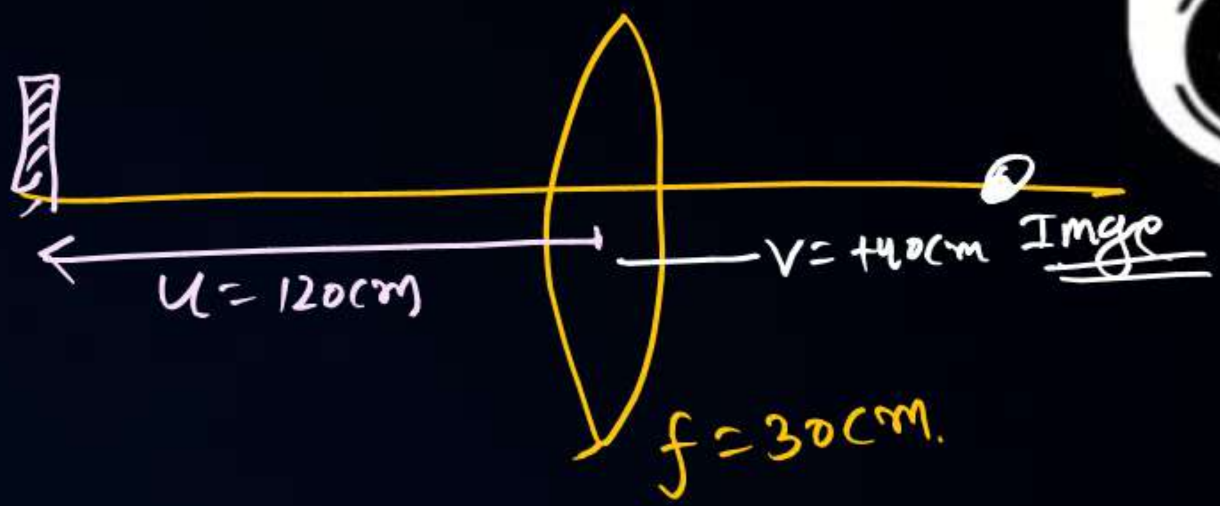
f = 30 cm

u = -40 cm (given in questn)

$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$\frac{1}{v} = \frac{1}{30} - \frac{1}{40} = \frac{4-3}{120} = \frac{1}{120}$

$v = 120$ ✓



Soln

$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$\frac{1}{v} = \frac{1}{f} + \frac{1}{u}$

$\frac{1}{v} = \frac{1}{30} - \frac{1}{120} = \frac{4-1}{120}$

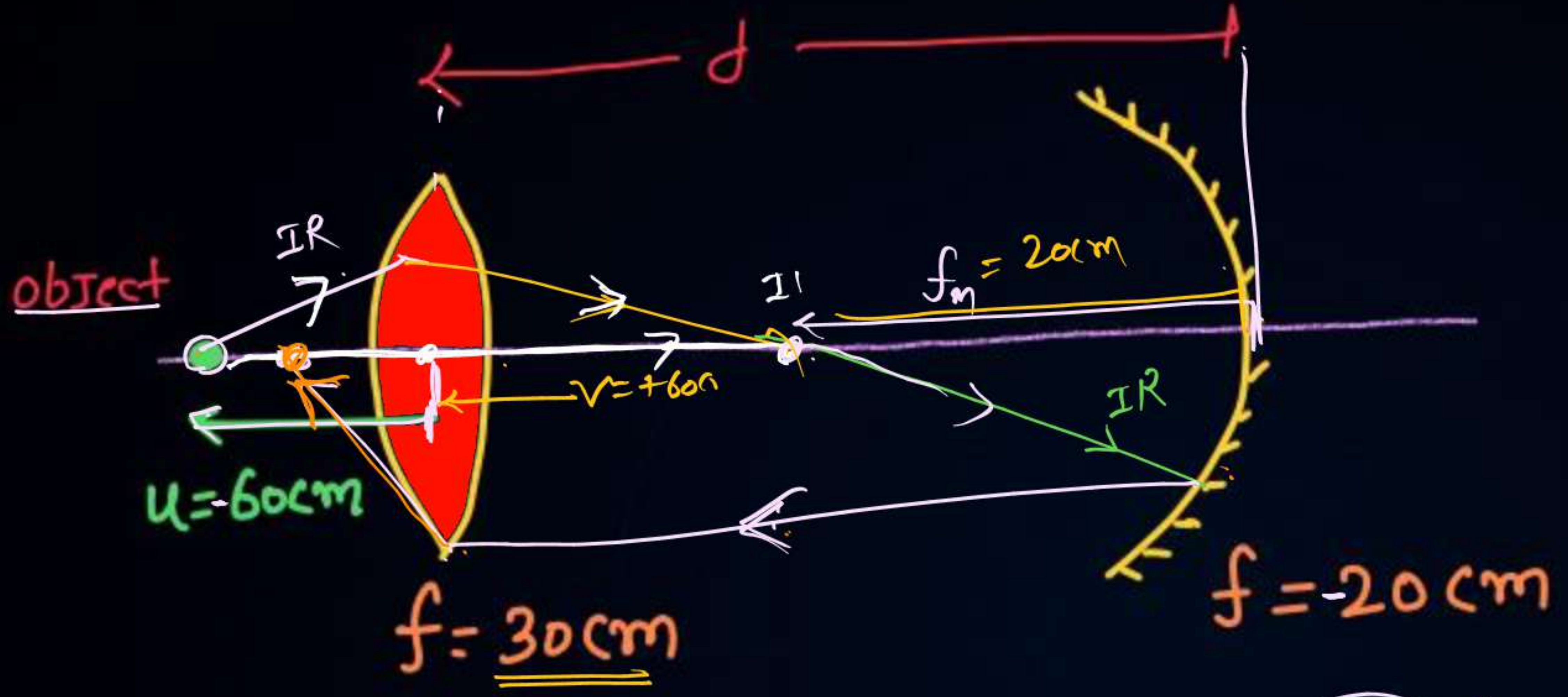
$\frac{1}{v} = \frac{3}{120}$ (40)

$v = 40 cm$

H/W

What is unique in both the quest.

Image formation due to {Lens + mirror}



Find d(?) so that final Image formed at focus of lens in same side of object.

Consider (Two-refraction) one-refletion

Sol^n Consider 1^st refraction from lens

$\frac{1}{v} = \frac{1}{f} + \frac{1}{u}$

$\frac{1}{v} = \frac{1}{30} - \frac{1}{60} = \frac{2-1}{60}$

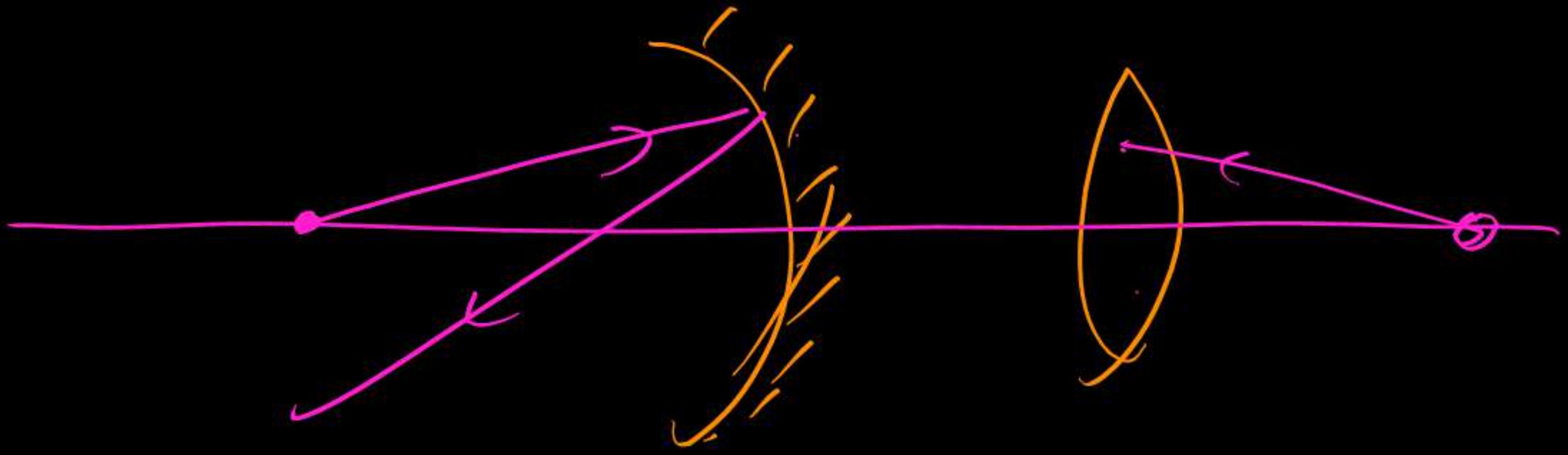
$v = 60cm$

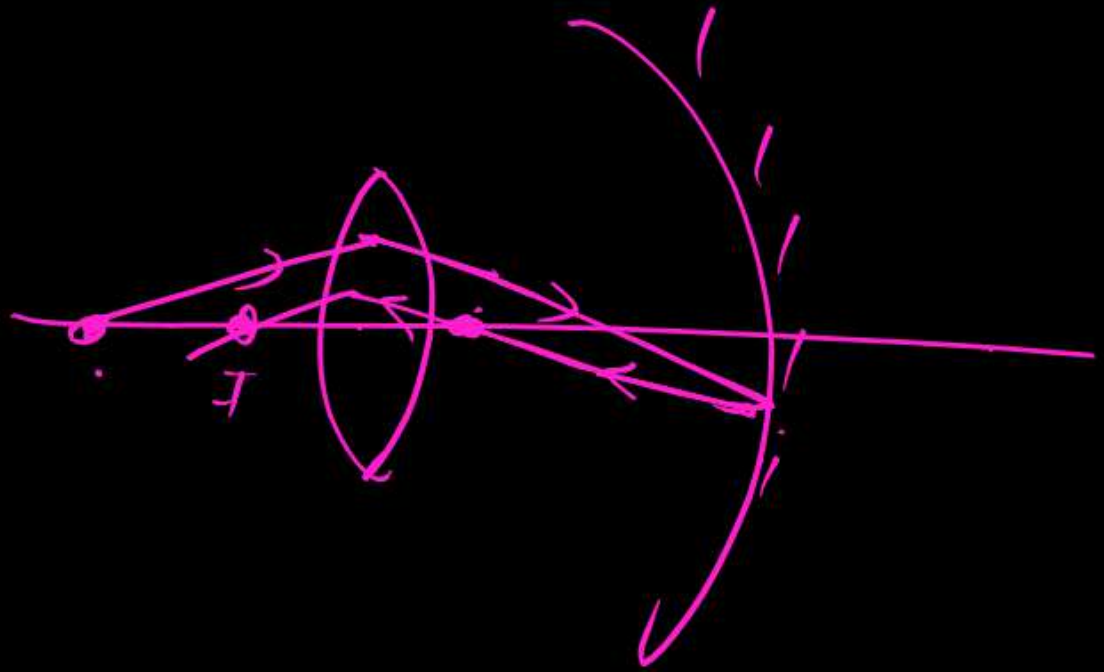
consider refletion from mi

dist^n B/w mirror & lens
= 60+20
= 80cm

(Q) When lens form Image at its focus??

Object is at ∞ or Paraxial rays falls on lens

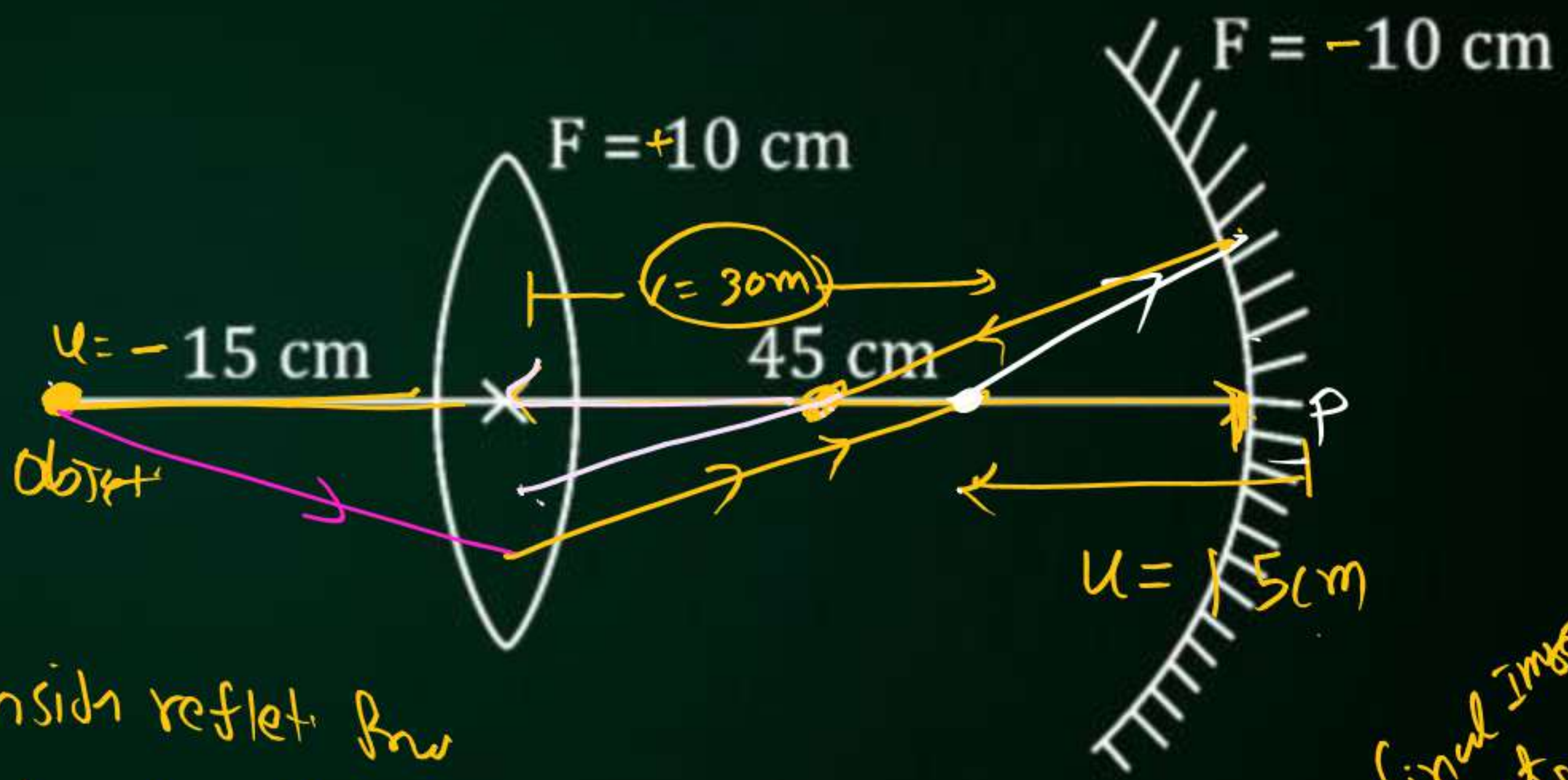




Not Poss

QUESTION

Find position of image formed by lens and mirror, ~~coincide~~ Consider one refraction and one reflection from mirror



Sol[n]

Consider refraction from lens

$$\frac{1}{v} = \frac{1}{f} + \frac{1}{u}$$

$$\frac{1}{v} = \frac{1}{10} - \frac{1}{15} = \frac{3-2}{30}$$

$$v = +30$$

Consider reflection from mirror

$$\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$$

$$\frac{1}{v} - \frac{1}{15} = -\frac{1}{10}$$

$$\frac{1}{v} = \frac{1}{15} - \frac{1}{10} = \frac{2-3}{30}$$

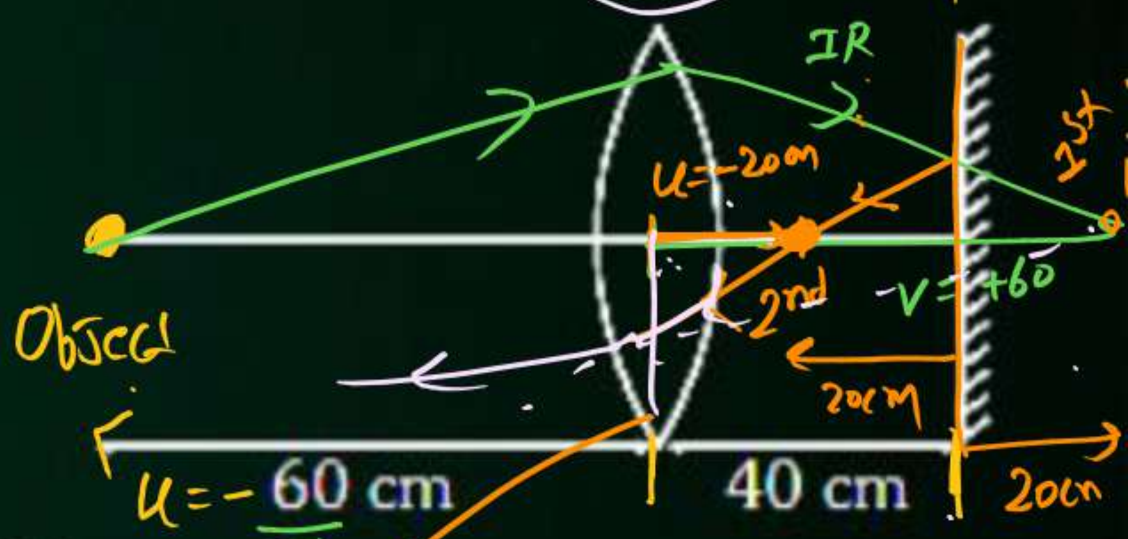
$$v = -30\text{ cm}$$

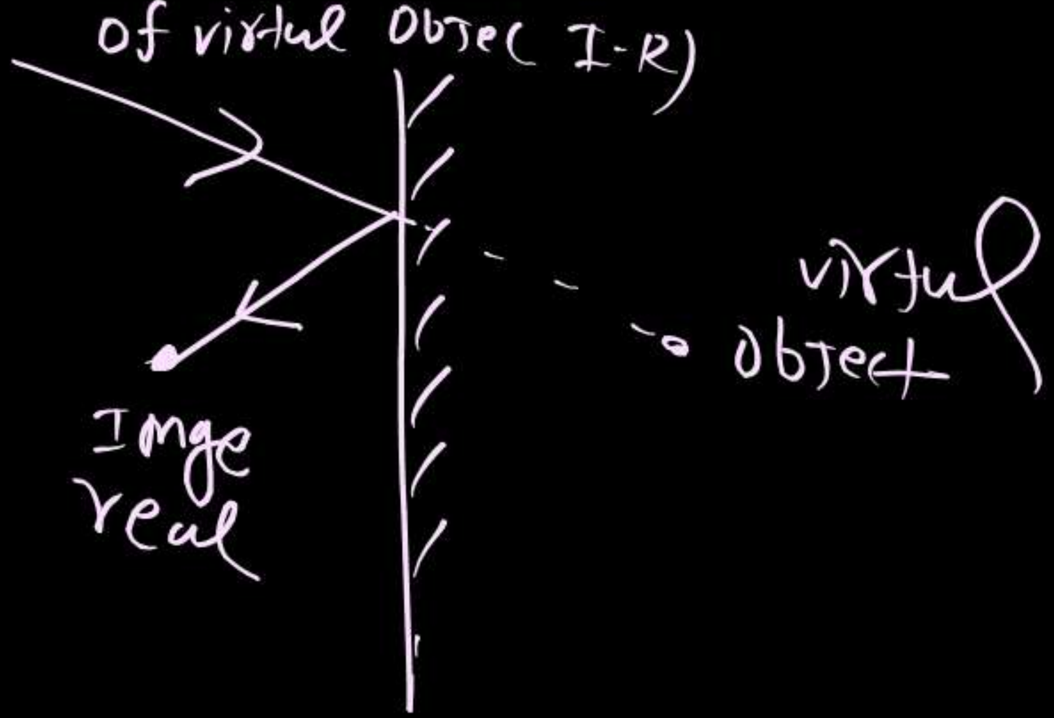
final image is at 30 cm from mirror, 15 cm from lens

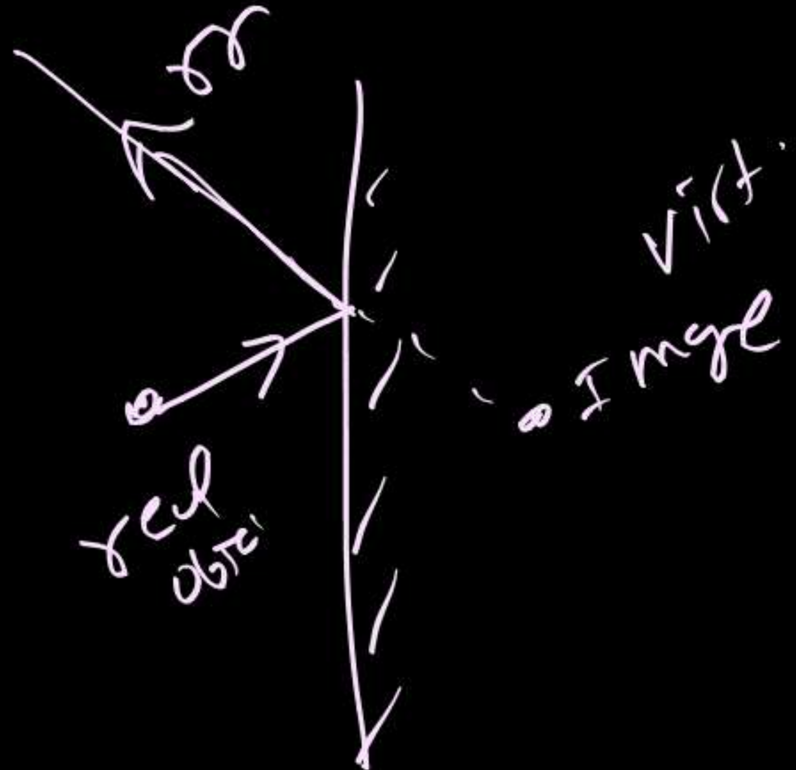
QUESTION

A point object is placed at a distance of 60 cm from a convex lens of focal length 30 cm. If a plane mirror were put perpendicular to the principal axis of the lens and at a distance of 40 cm from it, the final image would be formed at a distance of:

1. 20 cm from the lens, it would be a real image.
2. 30 cm from the lens, it would be a real image
3. 30 cm from the plane mirror, it would be a virtual image.
4. 20 cm from the plane mirror, it would be a virtual image.



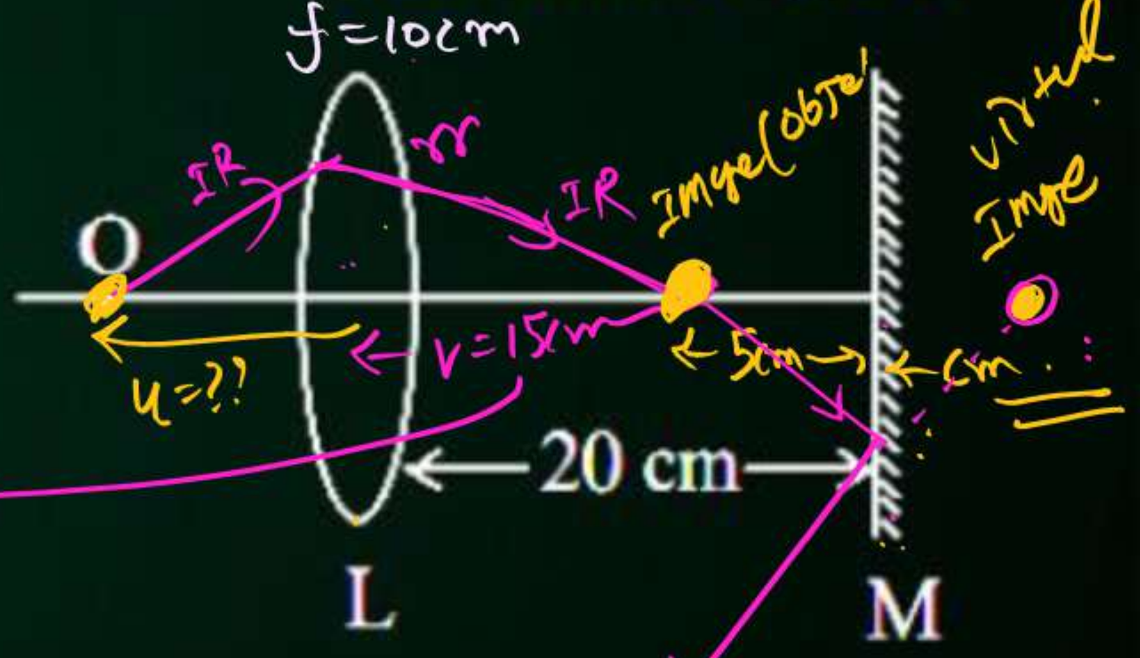

of virtul objec(I-R)
virtul
object
Imge
real


virt.
Imge
real
obje

QUESTION

An object is placed on the principal axis of convex lens of focal length 10 cm as shown. A plane mirror is placed on the other side of the lens at a distance of 20 cm. The image produced by the plane mirror is 5 cm inside the mirror. The distance of the object from the lens is ________ cm.

[JEE Main 2023]



$$\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$$

$$\frac{1}{15}-\frac{1}{u}=\frac{1}{10}$$

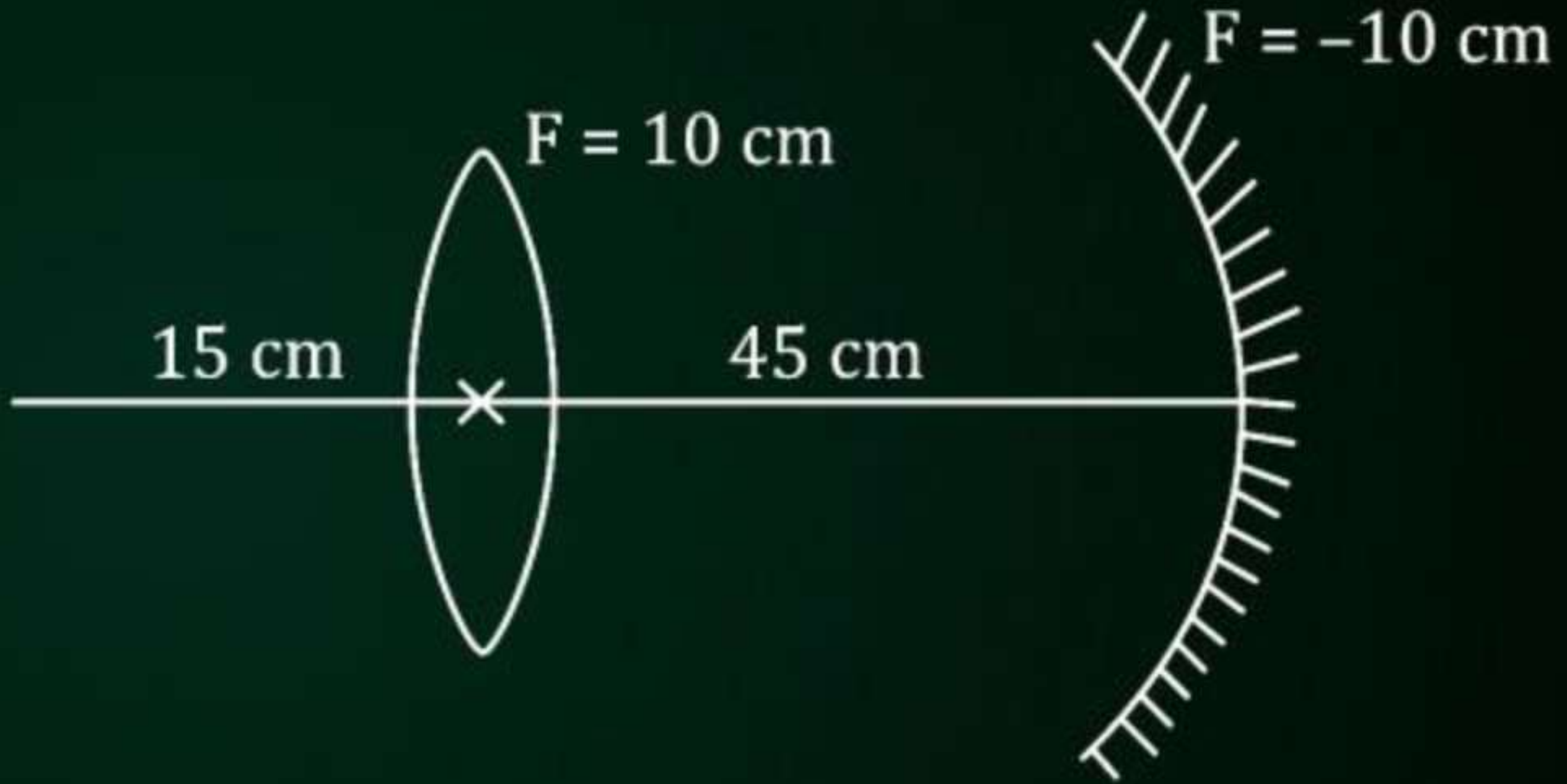
$$\frac{1}{u}=\frac{1}{15}-\frac{1}{10}$$

$$\frac{1}{u}=\frac{2-3}{30}=\frac{-1}{30}$$

$u=-30cm$

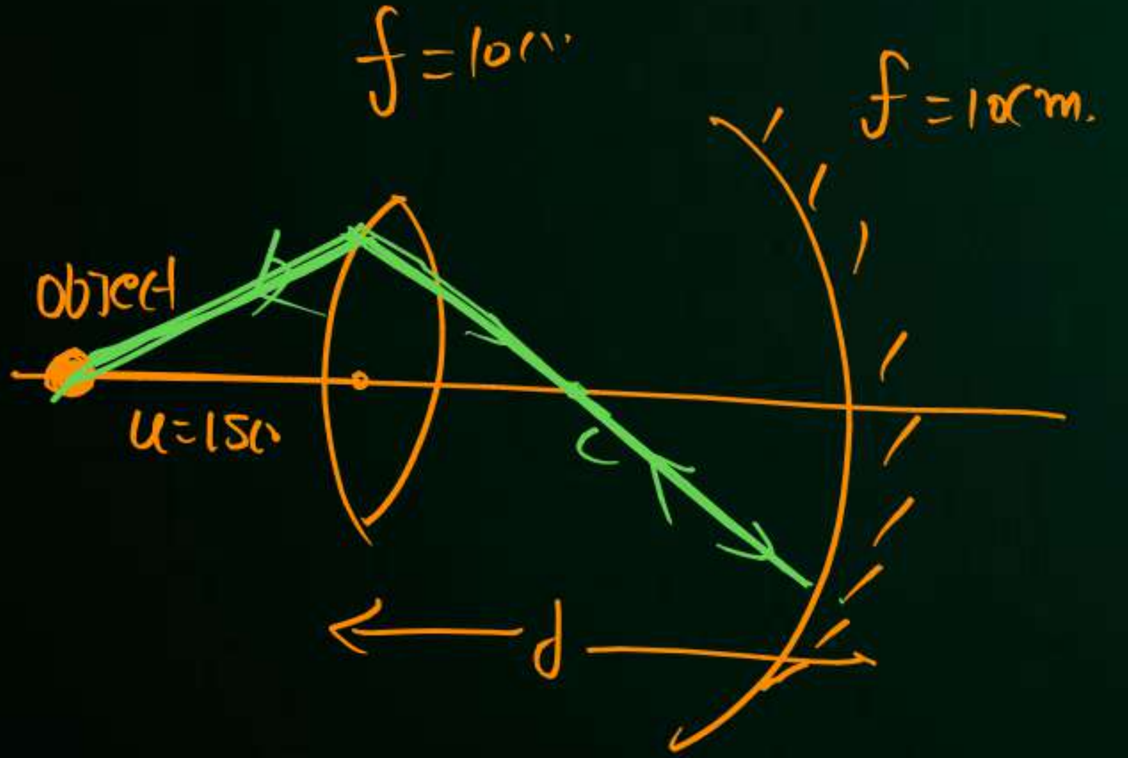
QUESTION

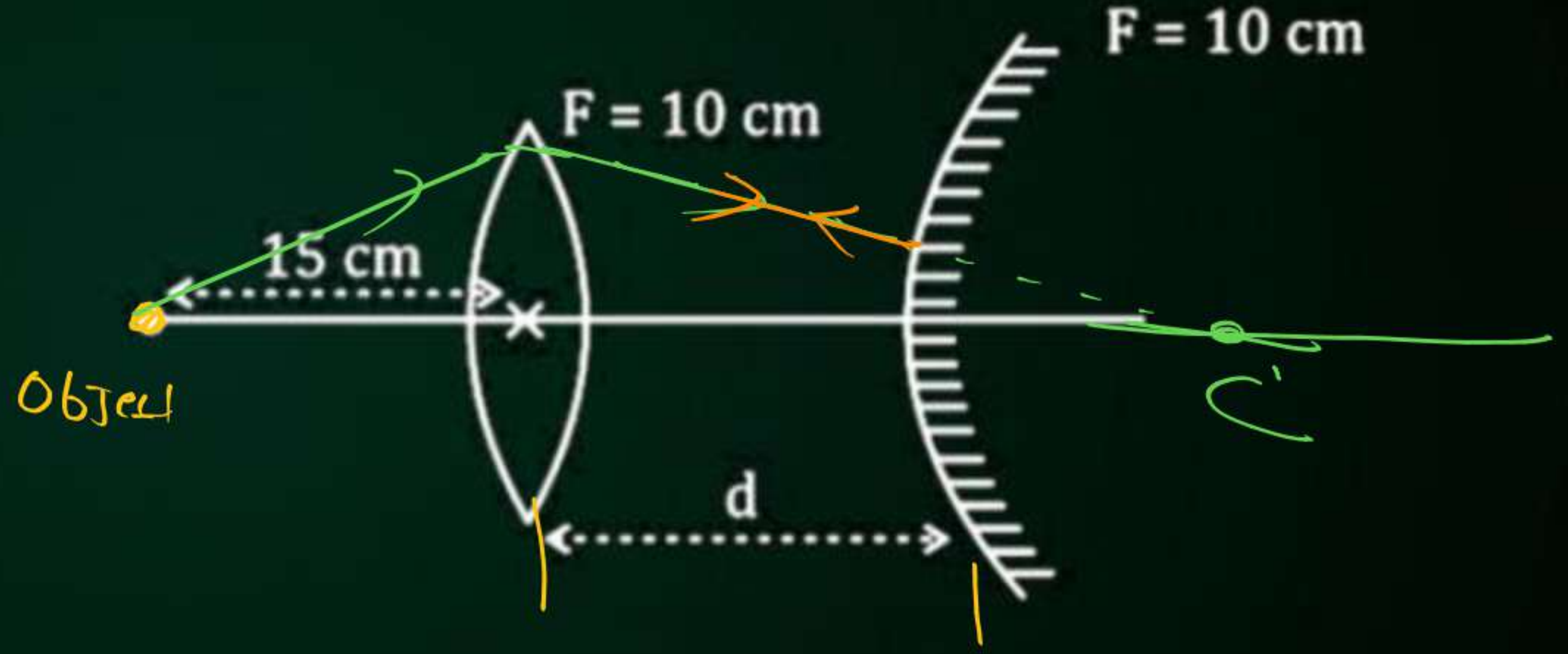
Find position of image formed by two refraction and one reflection?



QUESTION

Find value of d so that object and image will coincide (image formed on the object itself)

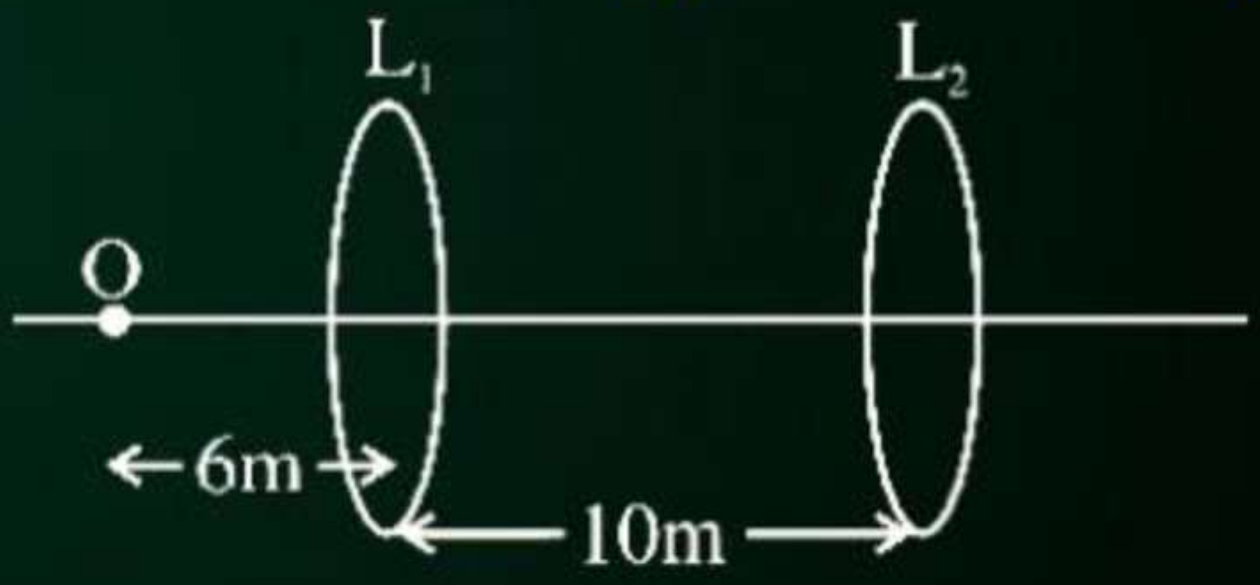




QUESTION

A point object, '0' is placed in front of two thin symmetrical coaxial convex lenses L_1 and L_2 with focal length 24 cm and 9 cm respectively. The distance between two lenses is 10 cm and the object is placed 6 cm away from lens L_1 as shown in the figure. The distance between the object and the image formed by the system of two lenses is __________ cm.

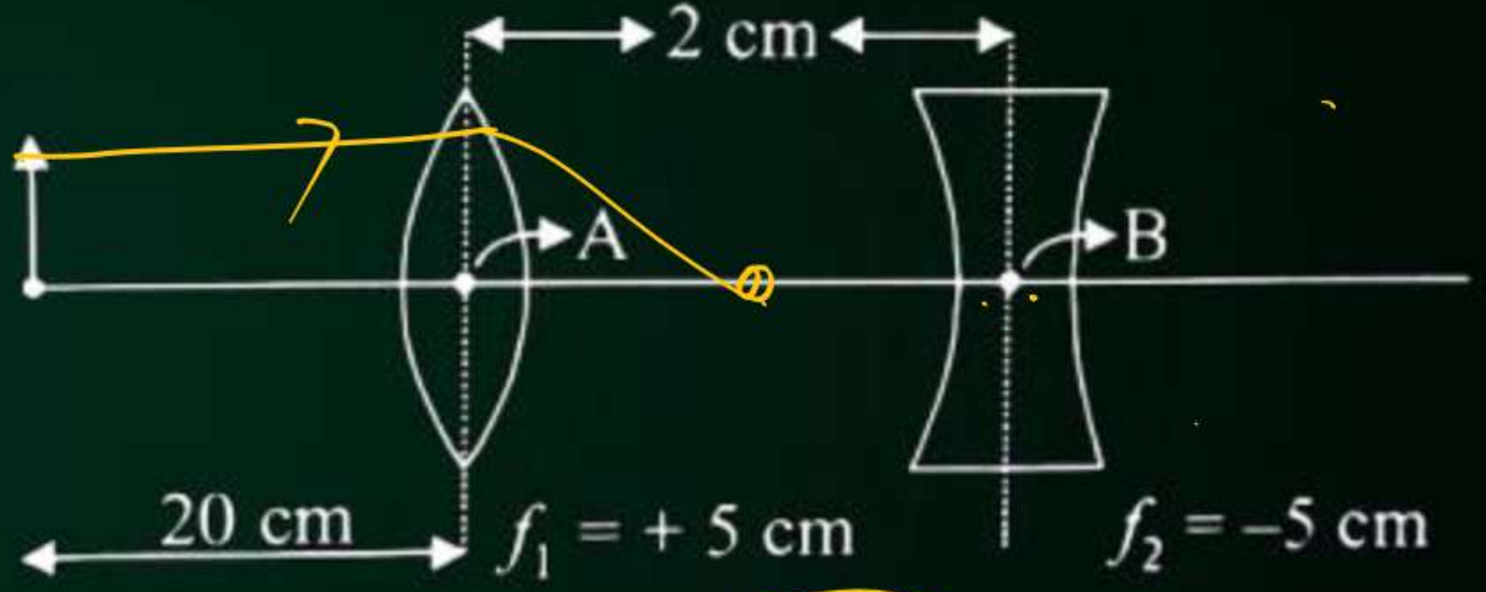
[JEE Main 2023]



QUESTION

What is the position and nature of image formed by lens combination shown in figure? (f_1, f_2 are focal lengths) **[JEE Main 2019]**

1. 70 cm from point B at left, virtual
2. 40 cm from point B at right, real
3. 20/3 cm from point B at right, real
4. 70 cm from point B at right, real



QUESTION

A convex lens of focal length 20 cm is placed in front of a convex mirror with principal axis coinciding each other. The distance between the lens and mirror is 10 cm. A point object is placed on principal axis at a distance of 60 cm from the convex lens. The image formed by combination coincides the object itself. The focal length of the convex mirror is ________ cm. **[JEE Main 2022]**


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 12 | **Physics**

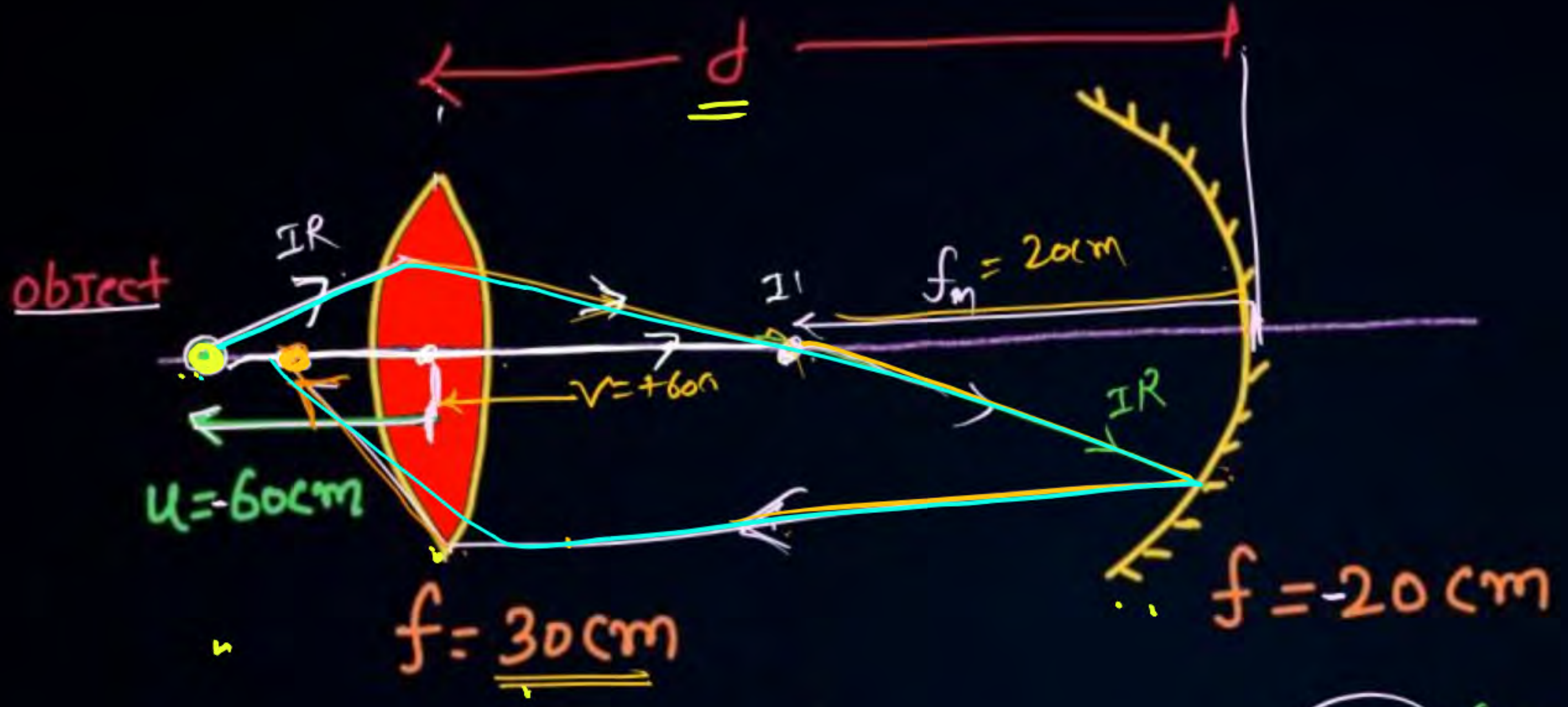
Ray Optics and Optical Instruments



By- Dr. Manish Raj (MR SIR)

Today Goal

- Last lecture ka revision
- Silvering of lens
- Prism



Q) Find d so that final Image formed at focus of lens in same side of object.

Consider (Two-refraction, one-refletion)

Solⁿ Consider 1st refraction from lens

$$\frac{1}{v} = \frac{1}{f} + \frac{1}{u}$$

$$\frac{1}{v} = \frac{1}{30} - \frac{1}{60} = \frac{2-1}{60}$$

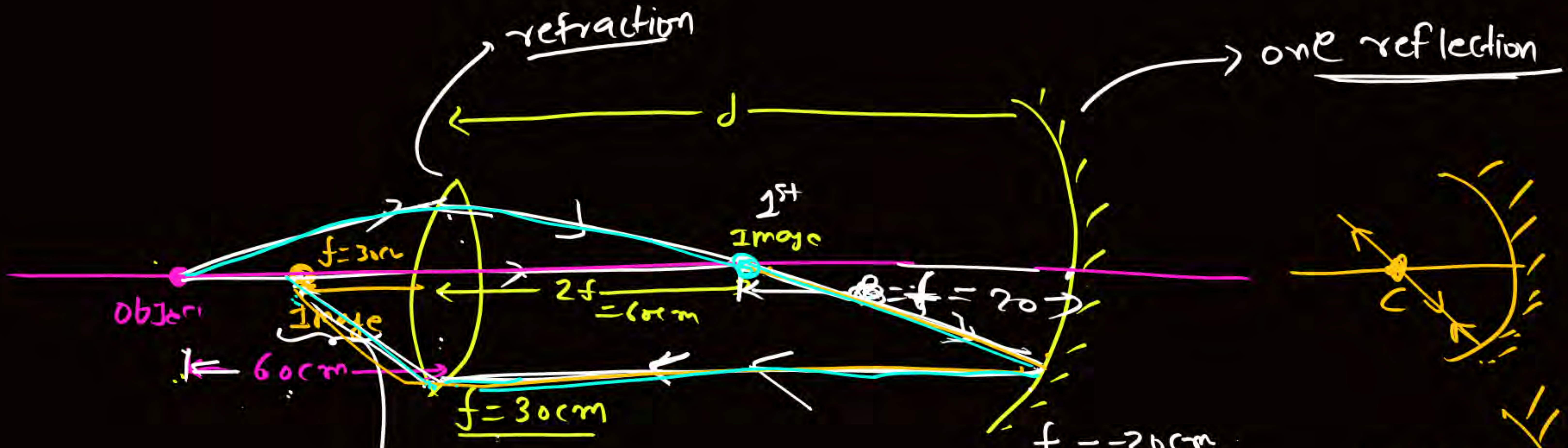
$v = 60cm$

Consider refletion from mi

distⁿ b/w miror & lens
= 60+20
= 80cm

(Q) When lens form Image at its focus??

object is at ∞ or Paraxial rays falls on lens





final Image is formed due to lens.

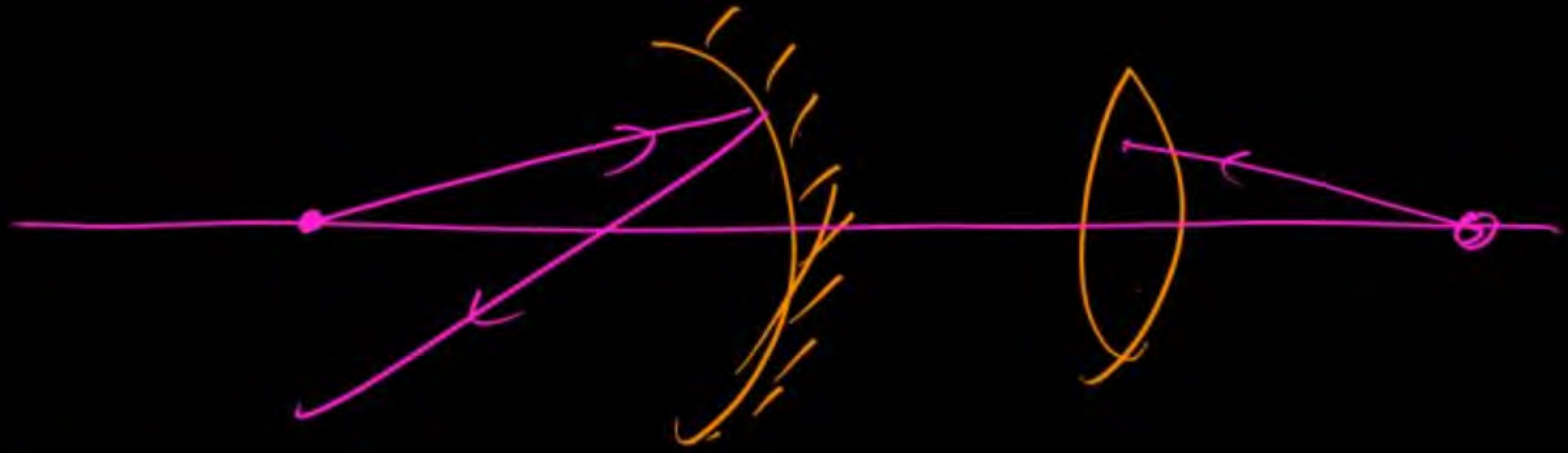
for 1^{st} Image due to lens

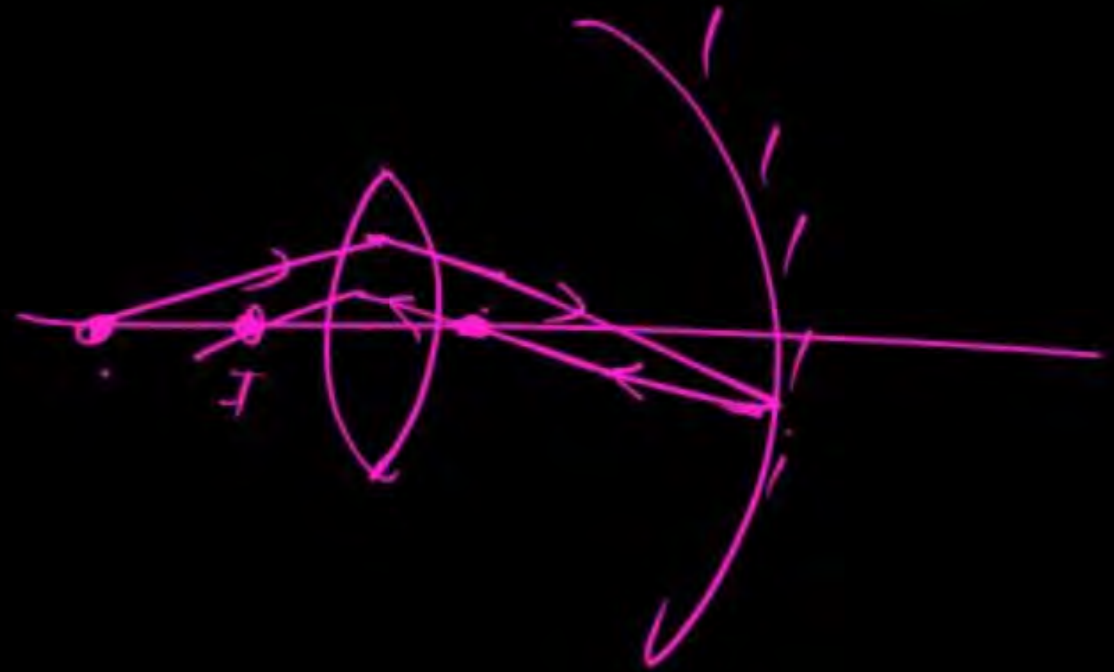
Think & write Ans

$d = 60 + 20$

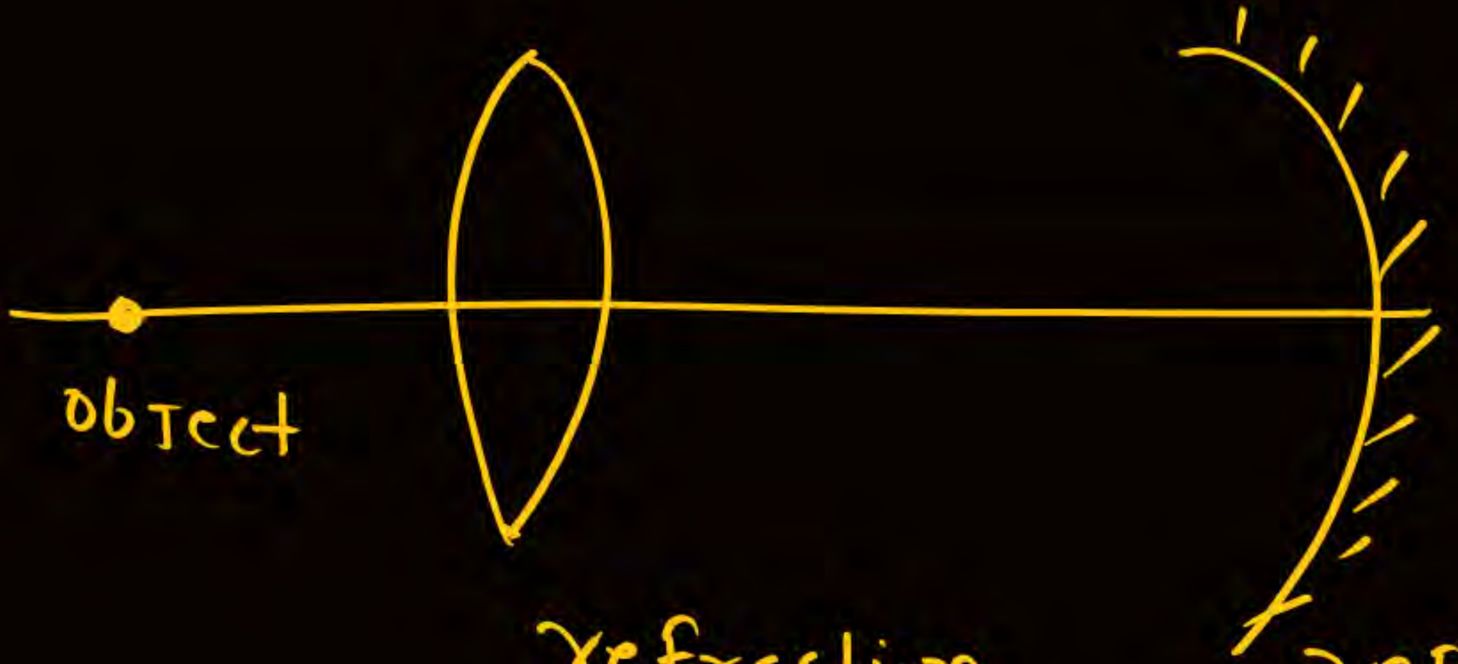
80cm

Two refration one refletion





Not Poss

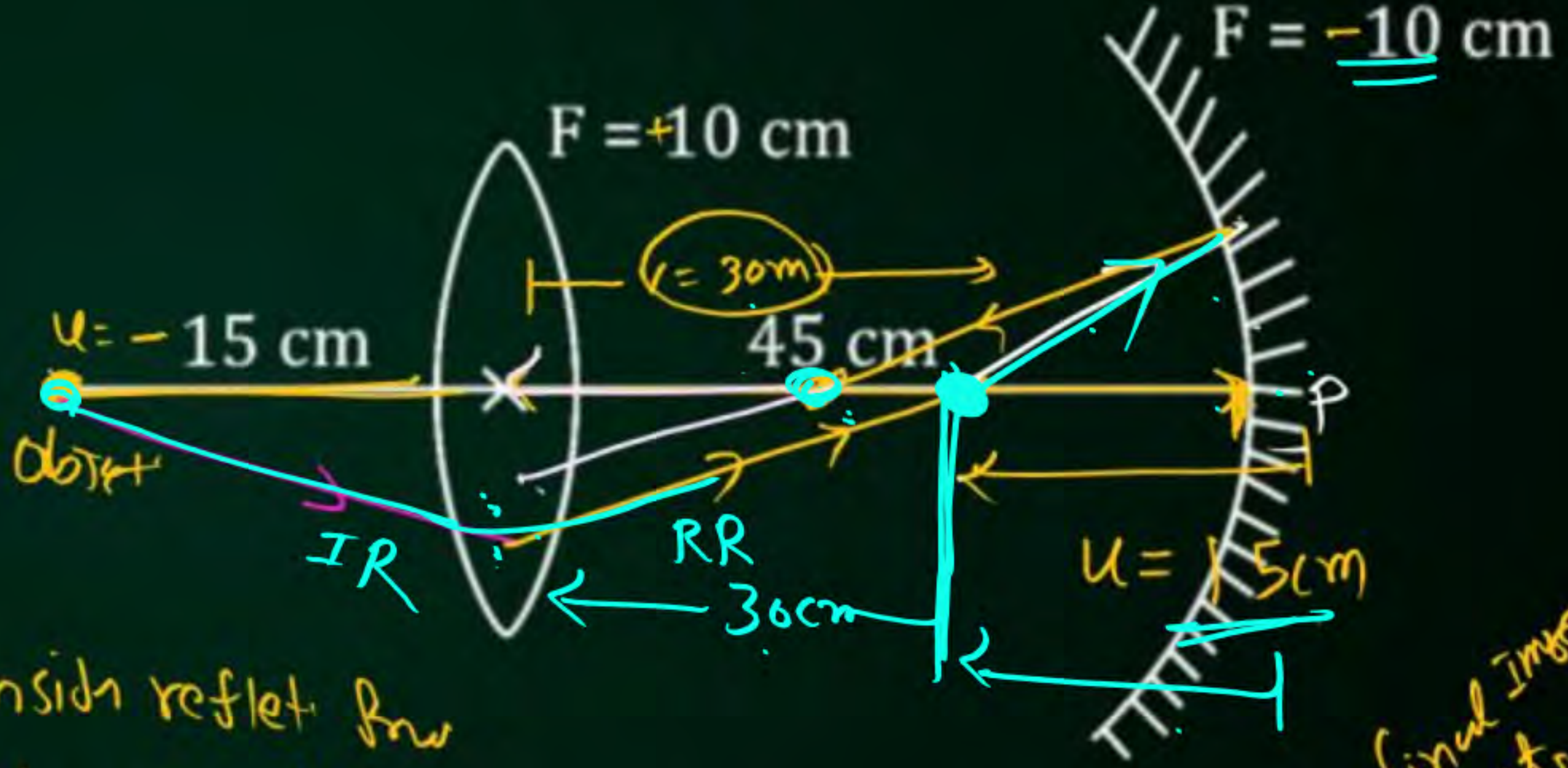


refraction   refletion

If No Condition is given in question → Two refration & one refletion

QUESTION

Find position of image formed by lens and mirror, ~~coincide~~ Consider one refraction and one reflection from mirror



Sol^n

Consider refraction from lens

$$\frac{1}{v} = \frac{1}{f} + \frac{1}{u}$$

$$\frac{1}{v} = \frac{1}{10} - \frac{1}{15} = \frac{3-2}{30}$$

$$V = +30$$

Consider reflect from mirror

$$\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$$

$$\frac{1}{v} - \frac{1}{15} = -\frac{1}{10}$$

$$\frac{1}{V} = \frac{1}{15} - \frac{1}{10} = \frac{2-3}{30}$$

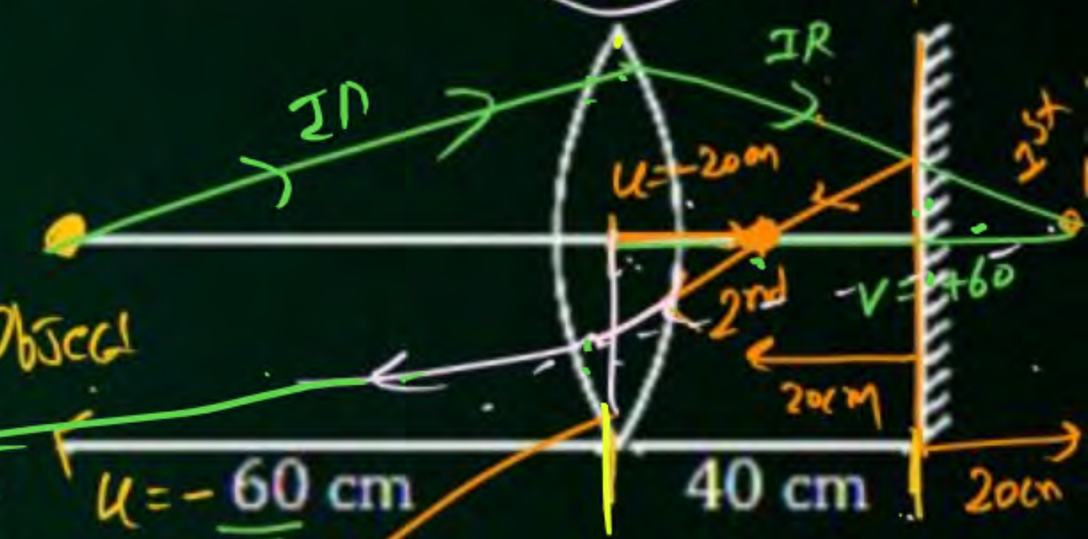
$$V = -30\,cm$$

final Image is at 30 cm from mirror 15 cm from lens

QUESTION

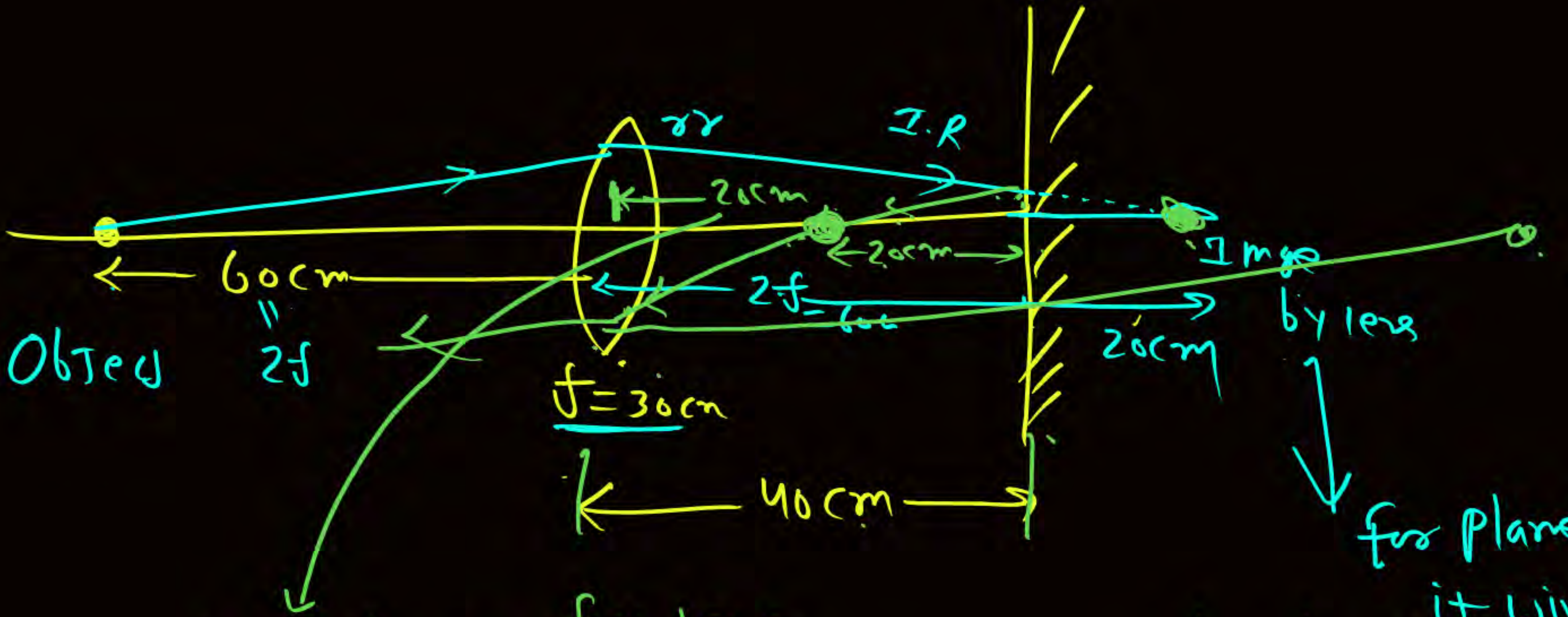
A point object is placed at a distance of 60 cm from a convex lens of focal length 30 cm. If a plane mirror were put perpendicular to the principal axis of the lens and at a distance of 40 cm from it, the final image would be formed at a distance of:

1. 20 cm from the lens, it would be a real image.
2. 30 cm from the lens, it would be a real image
3. 30 cm from the plane mirror, it would be a virtual image.
4. 20 cm from the plane mirror, it would be a virtual image.



One refratl
on reflecti

Two refractin
one refletion



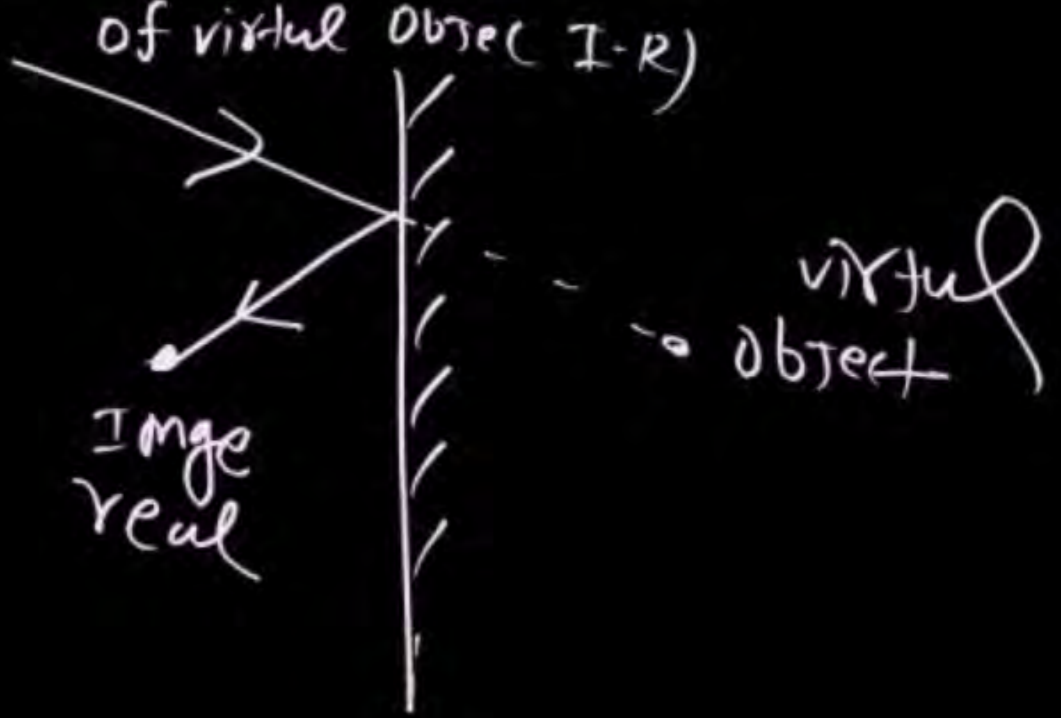
for Plane mirror it will behave as Object

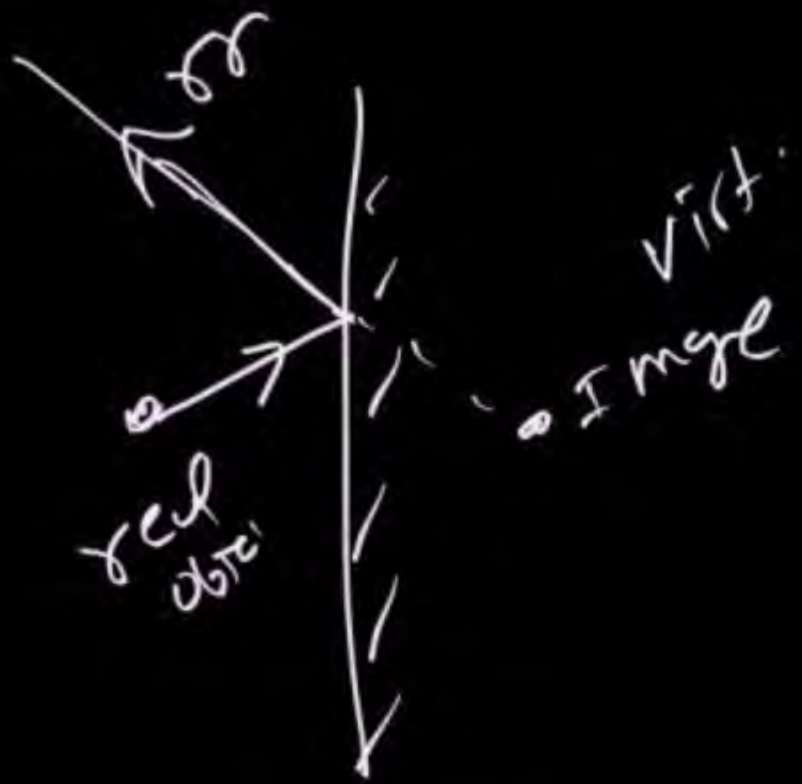
2nd refraction for lens

$u = -20$ cm $\rightarrow$ $\frac{1}{v} - \frac{1}{u} = \frac{1}{f} \Rightarrow \frac{1}{v} + \frac{1}{20} = \frac{1}{30}$

$\frac{1}{v} = \frac{1}{30} - \frac{1}{20} = \frac{2-3}{60} = -\frac{1}{60}$

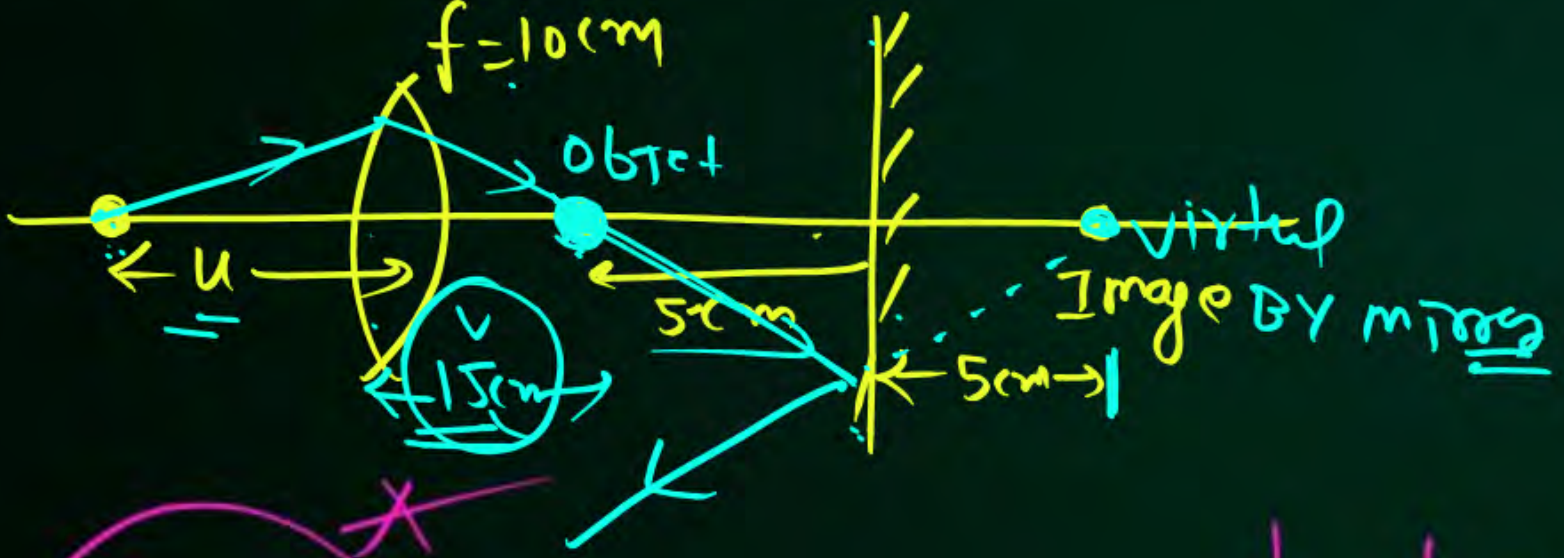
$v = -60$

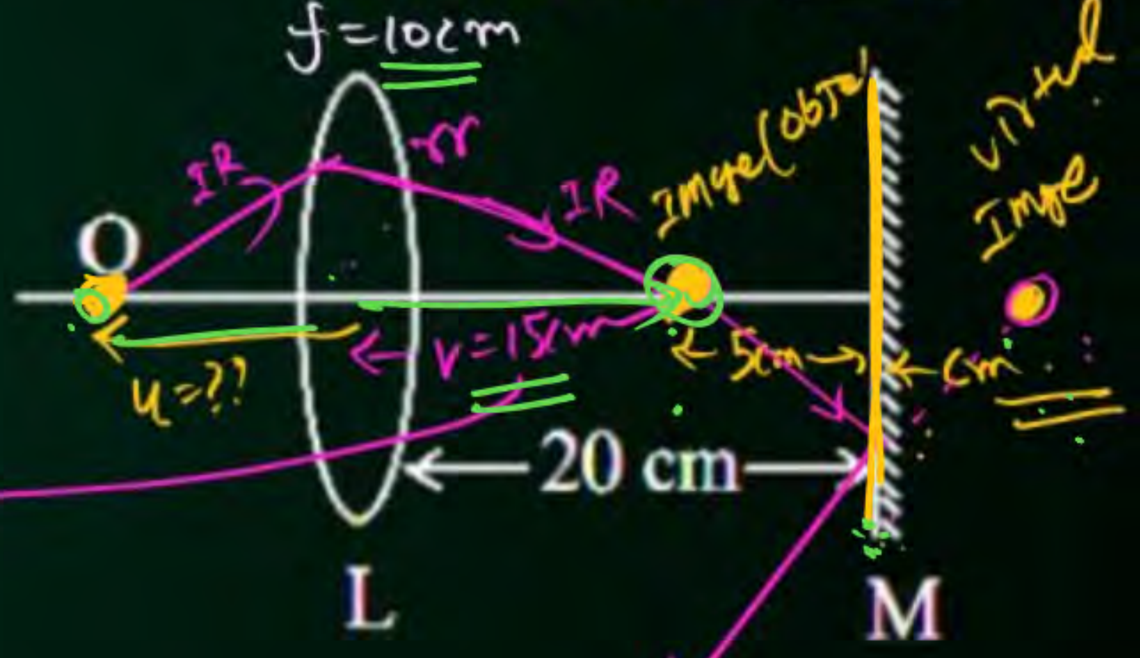

of virtul objec (I-R)
virtul
object
Imge
reul


virt.
Imge
reul
objec

Q An object is placed on the principal axis of convex lens of focal length 10 cm as shown. A plane mirror is placed on the other side of the lens at a distance of 20 cm. The image produced by the plane mirror is 5 cm inside the mirror. The distance of the object from the lens is ____ cm.

[JEE Main 2023]





$u = -30\ \text{cm}$

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

$$\frac{1}{15} - \frac{1}{u} = \frac{1}{10}$$

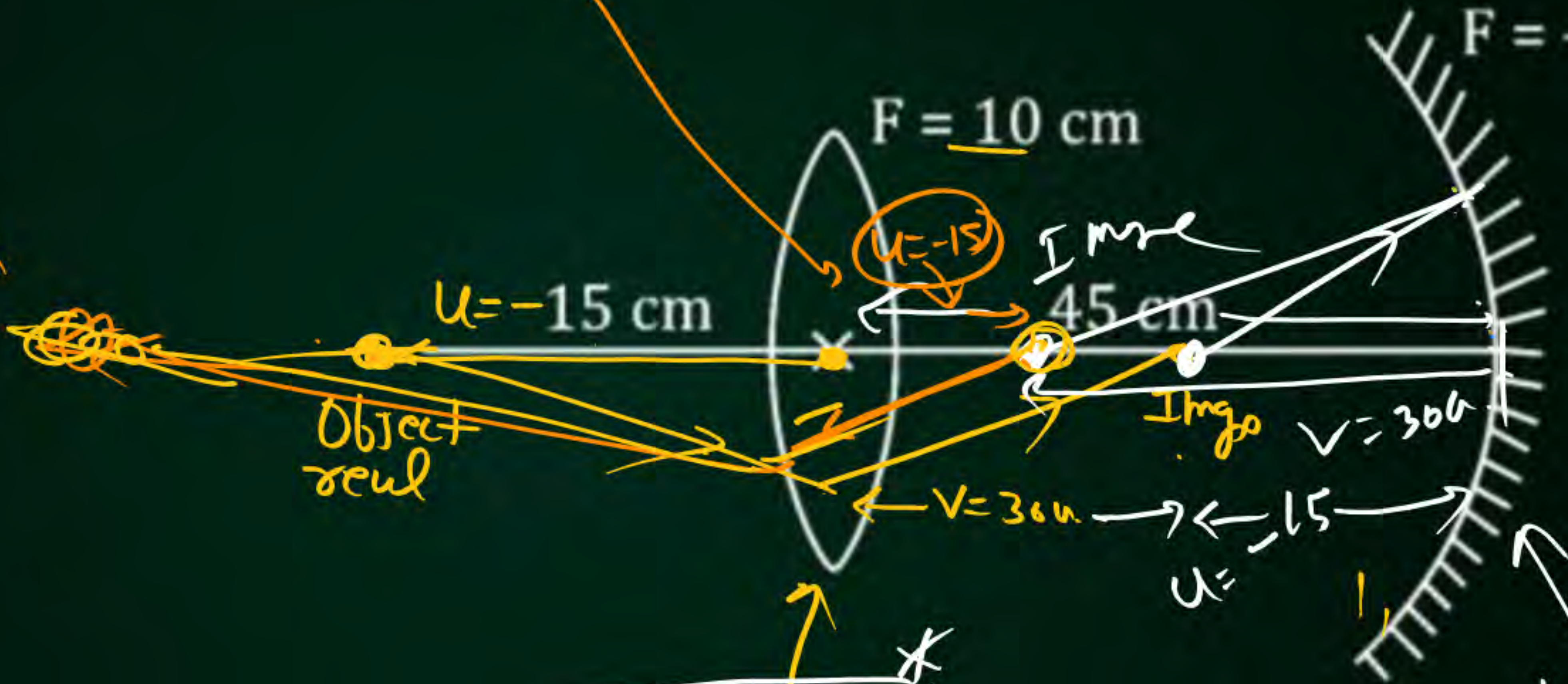
$$\frac{1}{u} = \frac{1}{15} - \frac{1}{10}$$

$$\frac{1}{u} = \frac{2-3}{30} = \frac{-1}{30}$$

QUESTION

Find position of image formed by two refraction and one reflection?

Two refraction + Two refletion → No Never Possible



2nd refration from lens

$u = -15$

By solving it

$u = +30\ cm$

real Image

$V = +30$

$$\frac{1}{v} = \frac{1}{f} + \frac{1}{u}$$

$$\frac{1}{v} = \frac{1}{10} - \frac{1}{15} = \frac{3-2}{30} = \frac{1}{30}$$

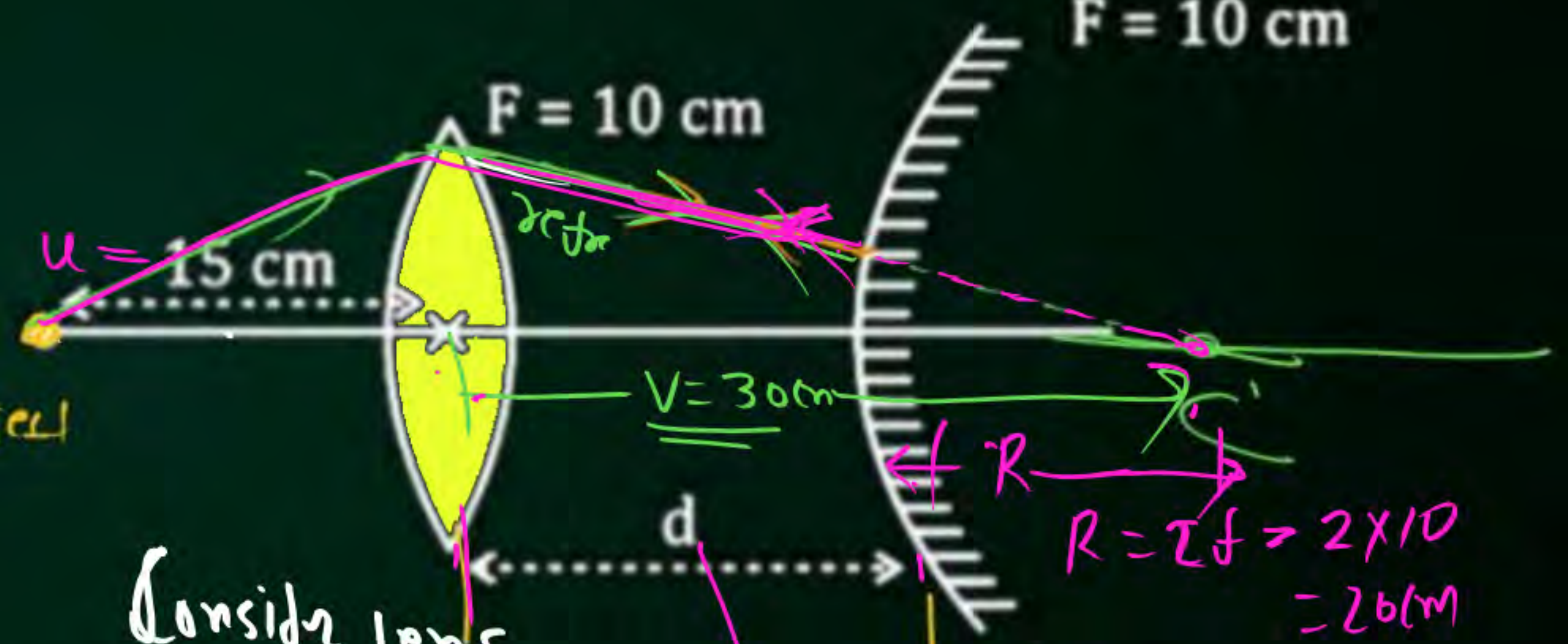
$$\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$$

$$\frac{1}{v} = \frac{1}{f} - \frac{1}{u}$$

$$\frac{1}{v} = -\frac{1}{10} + \frac{1}{15} = -\frac{1}{30}$$

QUESTION

Find value of d so that object and image will coincide (image formed on the object itself)



Concept

Incident ray must retrace it's path.

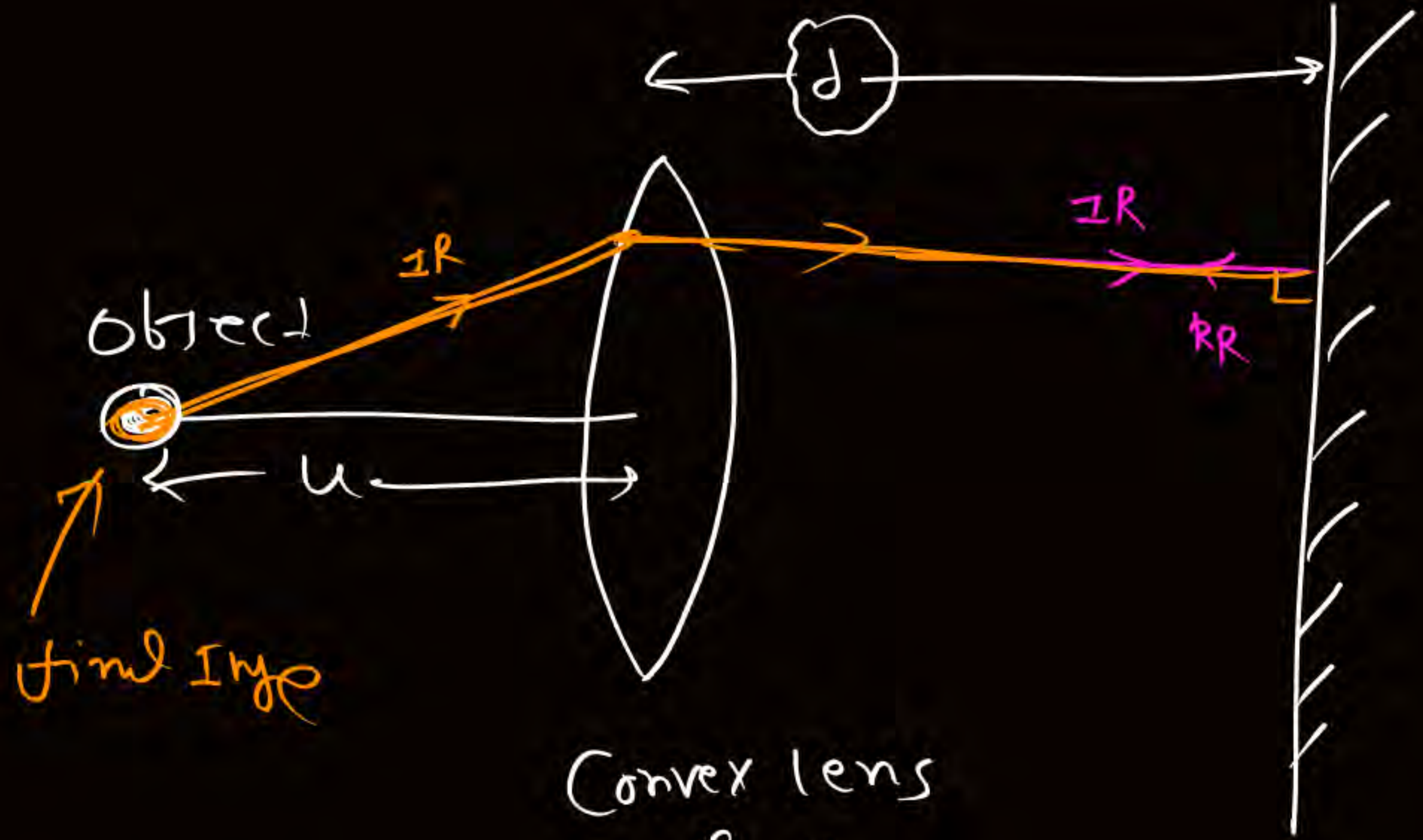
Consider lens

$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$\frac{1}{v} + \frac{1}{15} = \frac{1}{10}$

By solving $V = 30\text{ cm}$

only $d = 10\text{ cm}$



Convex lens

$f = 20cm$

find u so that

final Image will form at object (Image object Conic)

Sol^n

$u = f$

(a) $u = 40cm$

~~(b)~~ ✓ $u = 20cm$

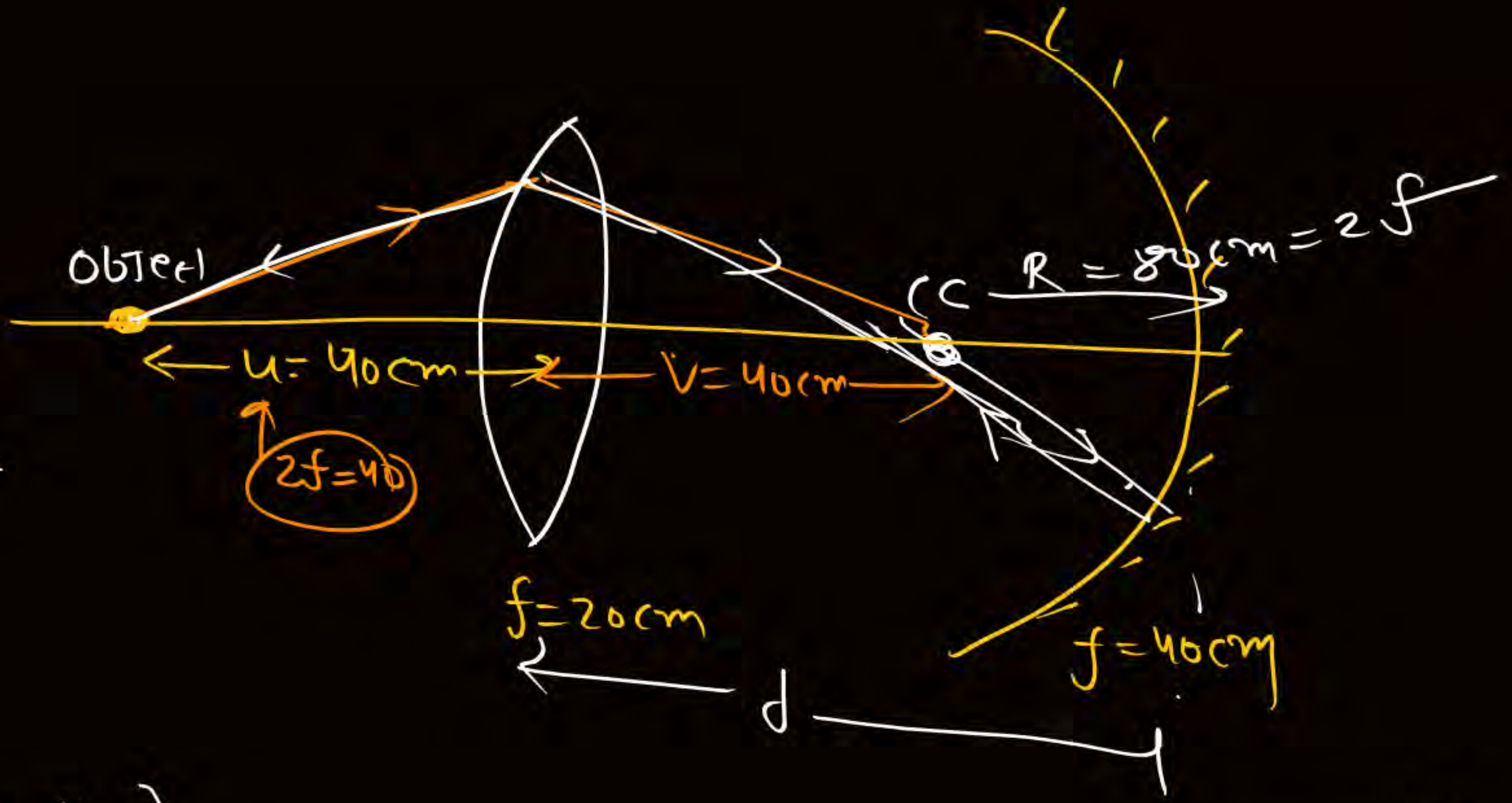
(c) $u = 10cm$

(d) question Incompt

Sol^n

find d so that final Image will form at object itself

(2 refraltion + 1 refletion)



d = 120 cm

Ans

QUESTION

A point object, '0' is placed in front of two thin symmetrical coaxial convex lenses L_1 and L_2 with focal length 24 cm and 9 cm respectively. The distance between two lenses is 10 cm and the object is placed 6 cm away from lens L_1 as shown in the figure. The distance between the object and the image formed by the system of two lenses is ________ cm.

[JEE Main 2023]

for 1st lens

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

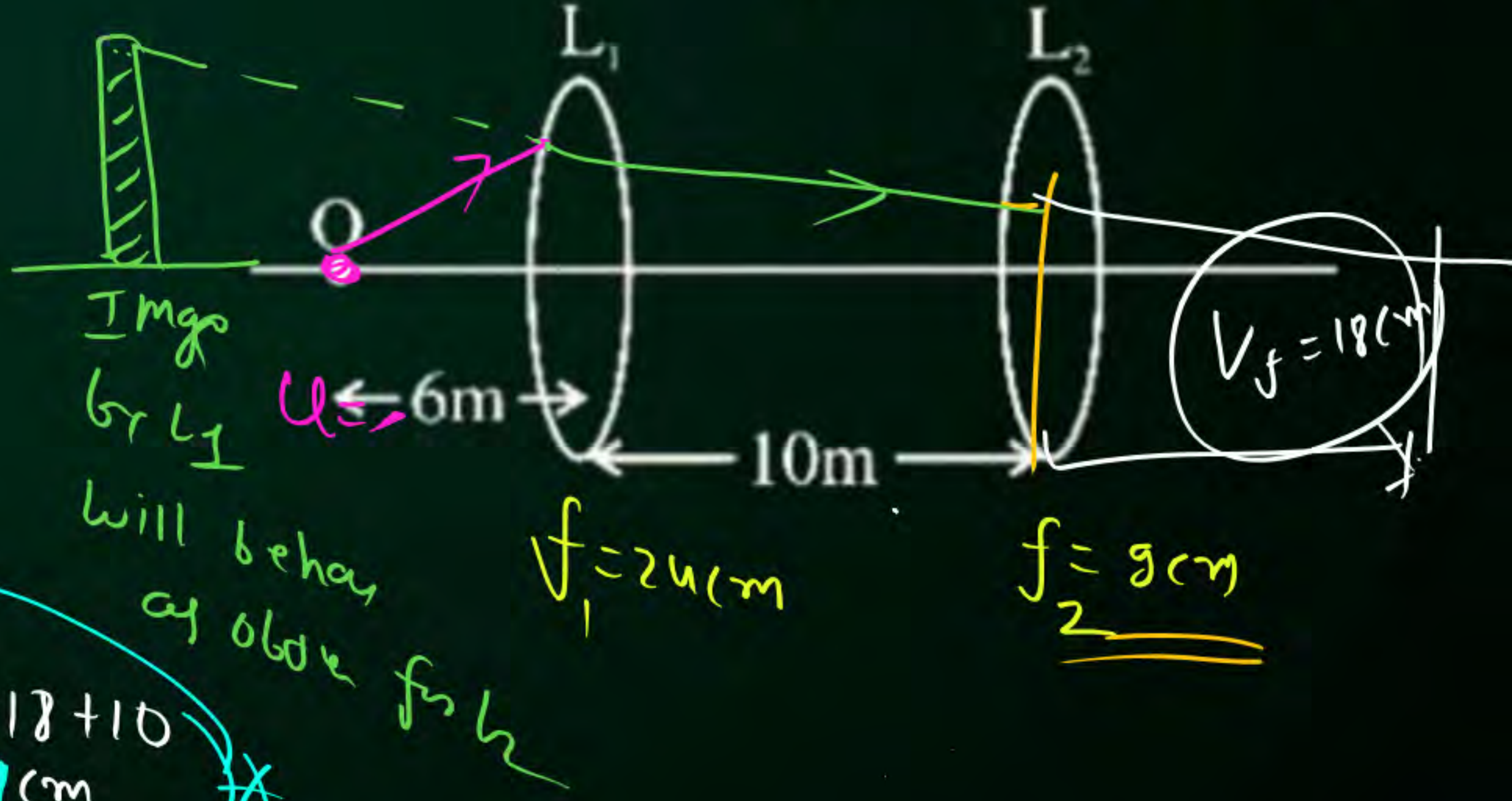
$$\frac{1}{v} = \frac{1}{24} - \frac{1}{6}$$

$$\frac{1}{v} = \frac{1-4}{24}$$

$$v = \frac{24}{-3}$$

$$v = -8\text{ cm}$$

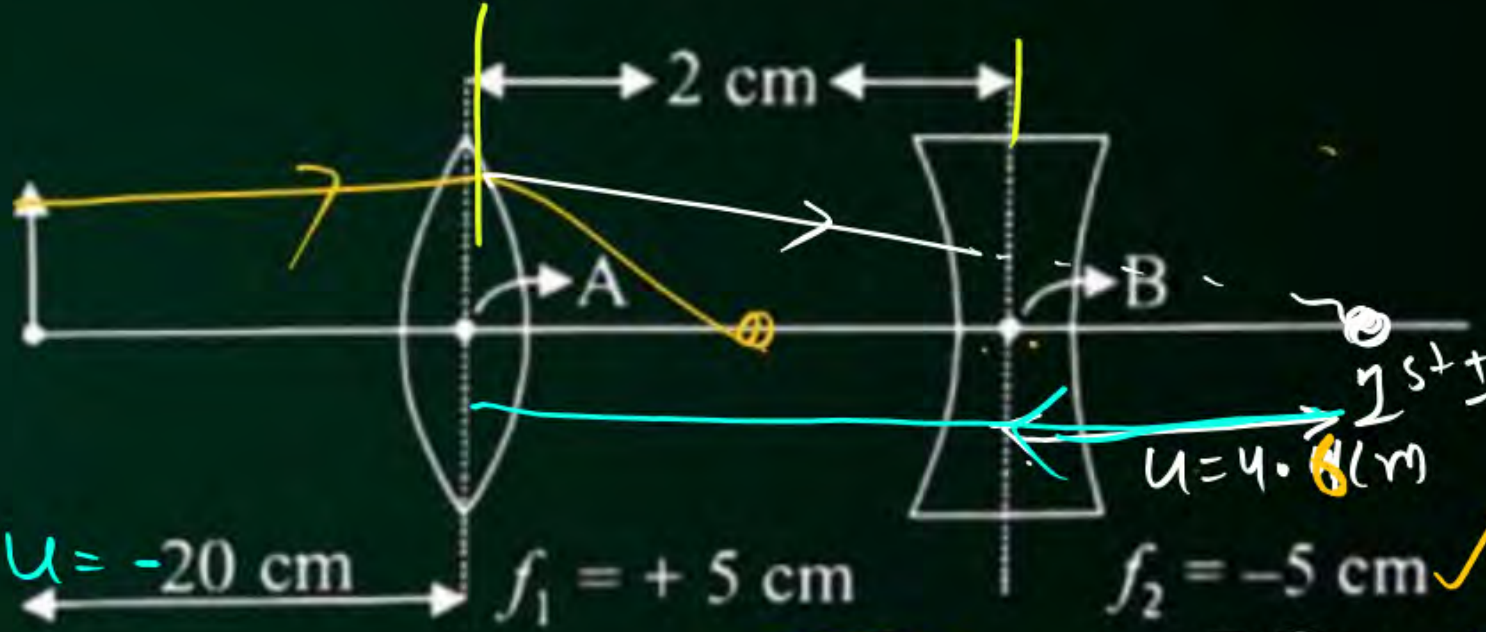
$$V = 6+18+10 = 34\text{ cm}$$



QUESTION

What is the position and nature of image formed by lens combination shown in figure? (f_1, f_2 are focal lengths) **[JEE Main 2019]**

1. 70 cm from point B at left, virtual
2. 40 cm from point B at right, real
3. 20/3 cm from point B at right, real
4. 70 cm from point B at right, real



$$\frac{1}{v} - \frac{3}{14} = -\frac{1}{5}$$

$$\frac{1}{v} = \frac{3}{14} - \frac{1}{5}$$

$$\frac{1}{v} = \frac{15-14}{70}$$

$$v = +\frac{70}{1}$$

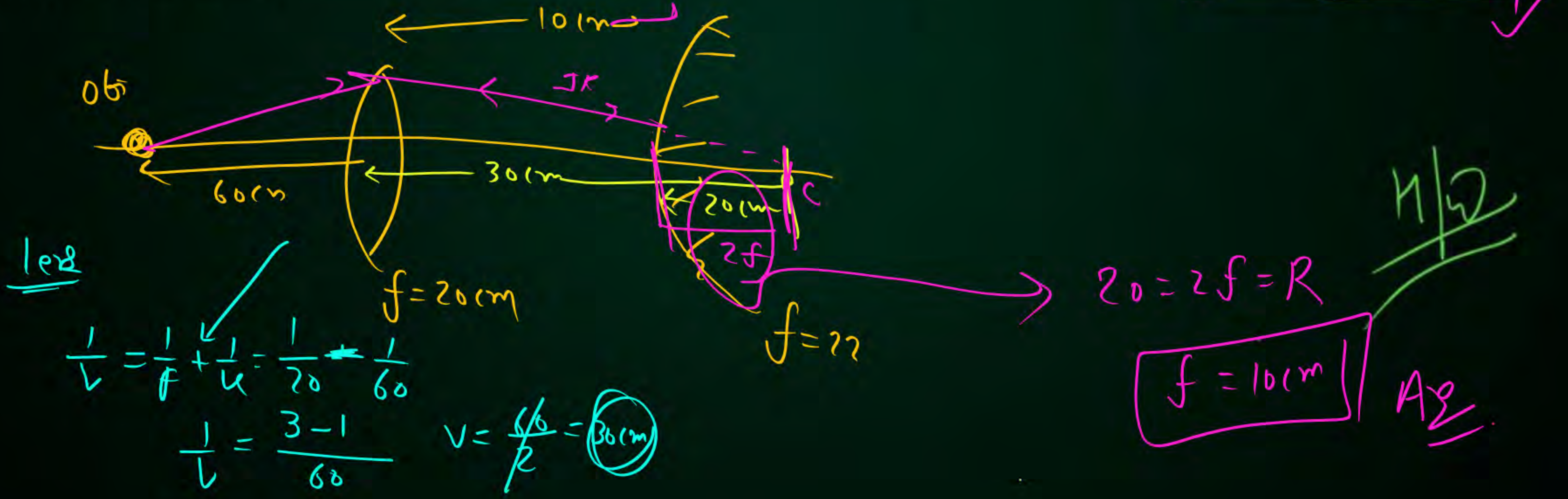
real



QUESTION

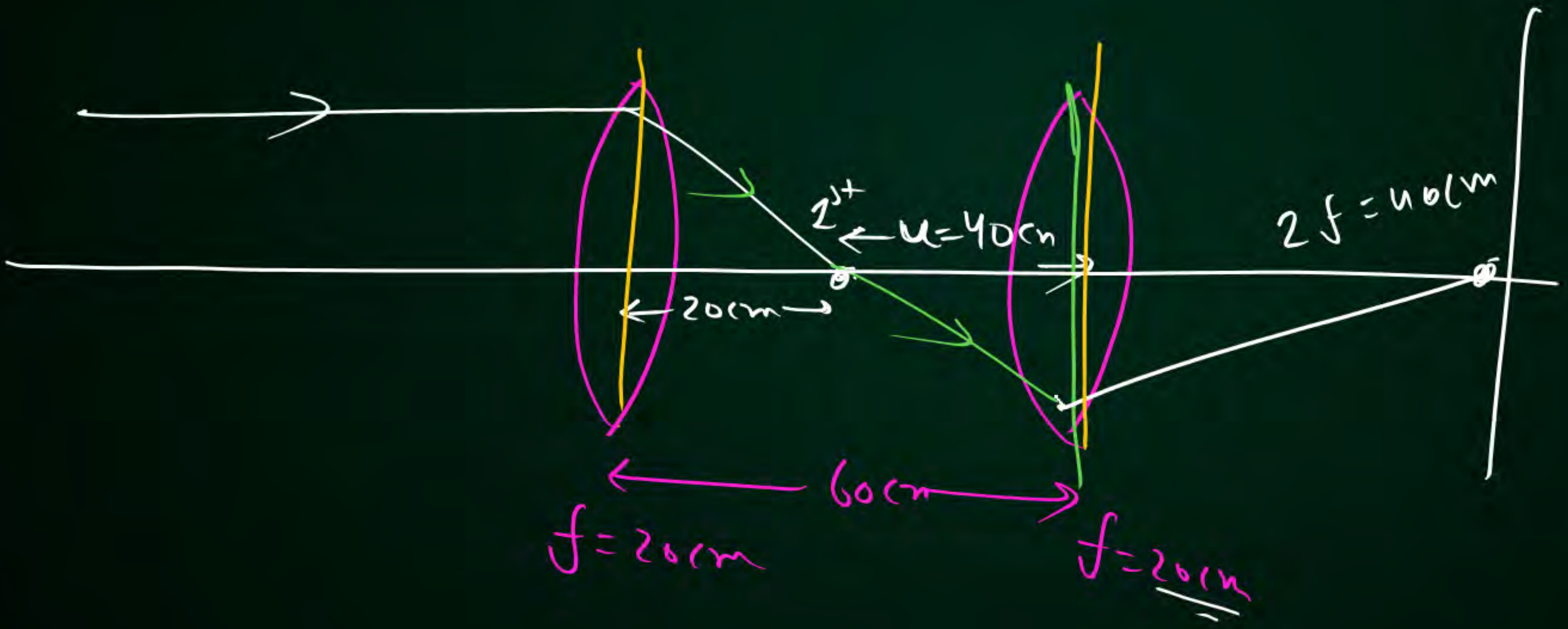
A convex lens of focal length 20 cm is placed in front of a convex mirror with principal axis coinciding each other. The distance between the lens and mirror is 10 cm. A point object is placed on principal axis at a distance of 60 cm from the convex lens. The image formed by combination coincides the object itself. The focal length of the convex mirror is ________ cm.

[JEE Main 2022]



QUESTION

Two convex lenses of focal length 20 cm each are placed coaxially with a separation of 60 cm between them. The image of the distance object formed by the combination is at ________ cm from the first lens. [JEE Main 2023]



QUESTION

A convex lens of refractive index 1.5 and focal length 18 cm in air is immersed in water. The change in focal length of the lens will be ______ cm.

(Given refractive index of water = 4/3)

[JEE Main 2023]

$\mu = 1.5$

$f = 18\text{ cm}$

$f_1 = 4f$

$\Delta f = 4f - f = 3f = 54\text{ cm}$

QUESTION

An object is placed at the focus of convex lens having focal length f. What is the magnification and distance of the image from the optical centre of the lens?

[JEE Main 2021]

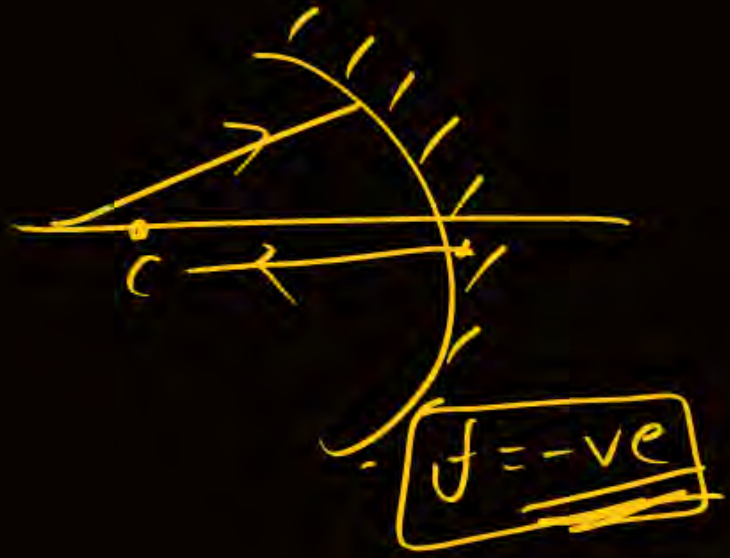
1. Very high, ∞
2. $1/4, f/4$
3. $1/2, f/2$
4. $1, \infty$

Power of Lens

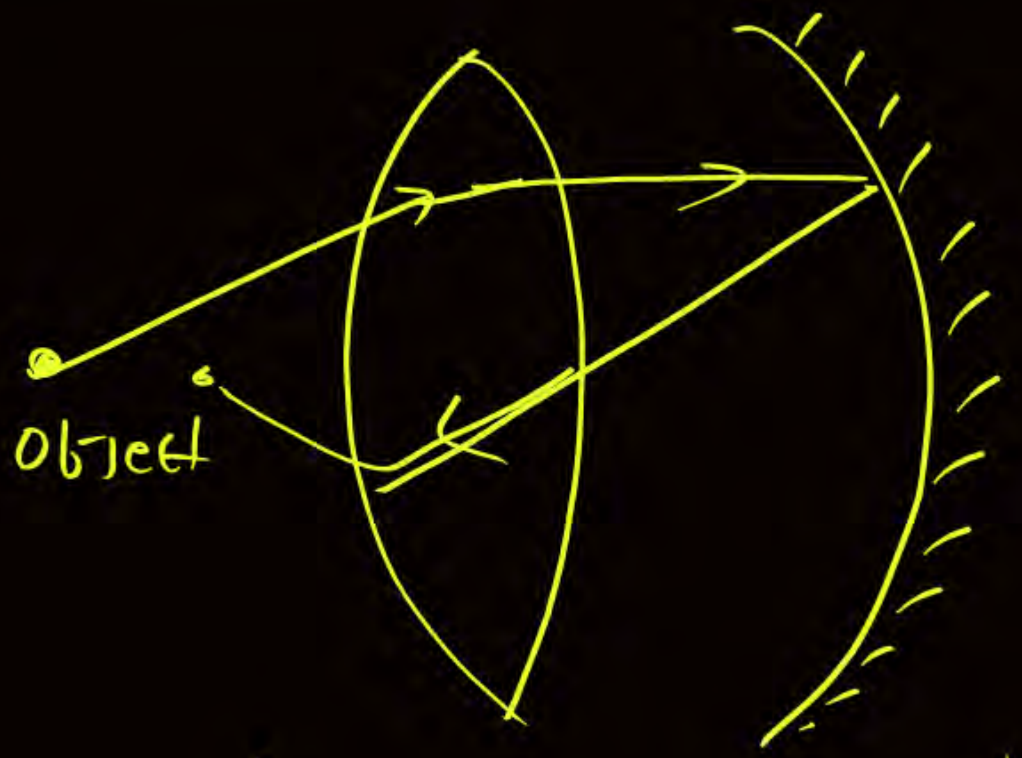
$$P_L = \frac{1}{f_L}$$

Power of mirror

$$P_m = -\frac{1}{f_m}$$



Silvering of lens

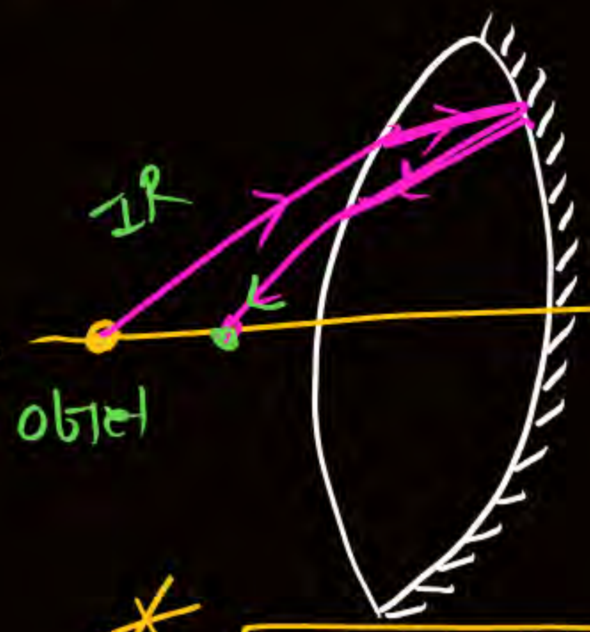


Two refration & one refletion.

[Thick curved mirror] ⟸ Silvergiy of lens

refration + refletion + refraction

⇓



* Two refraction & one refletion

$$P_{net} = 2P_L + P_m$$

$$-\frac{1}{f_{net}} = \frac{2}{f_L} - \frac{1}{f_m}$$ → NCERT



$$P_{net} = 2P_L + P_m$$



$$-\frac{1}{f_{net}} = \frac{2}{f_L} - \frac{1}{f_M}$$



$$\frac{1}{f_{net}} = -\frac{2}{f_L} + \frac{1}{f_M}$$

NCERT

MR*

$$\frac{1}{f_{net}} = \frac{2}{|f_L|} + \frac{1}{f_m}$$

f_L & f_m ka magnitude put kr



Bi-convex lens (R)

$$f_L = \frac{R}{2(\mu-1)}$$

Concave mirror

$$\frac{1}{f_{net}} = \frac{2\times 2(\mu-1)}{R} + \frac{2}{R}$$

$$\frac{1}{f_{net}} = \frac{4\mu-4+2}{R}$$

$$f_{net} = \frac{-R}{4\mu-2}$$

Ans

Plano Covex Lens



$$\frac{1}{f_{nd}} = \frac{2(\mu-1)}{R} + \frac{1}{\infty}$$

$$f_{nd} = \frac{R}{2(\mu-1)}$$

(Concave mirror)

$f = -ve$

$$\frac{1}{f_{nd}} = \frac{2}{f_L} + \frac{1}{f_m}$$

$$\frac{1}{f_{nd}} = \frac{2(\mu-1)}{R} + \frac{2}{R}$$

$$\frac{1}{f_{nd}} = \frac{2\mu - 2 + 2}{R}$$

$$f_{nd} = \frac{-R}{2\mu}$$



(+) $f = \frac{R}{2(\mu-1)}$



(+) $f = \frac{R}{(\mu-1)}$



→ $f = \frac{+R}{4\mu-2}$

Bi concave lens

plano Concave lens



$f = \frac{+R}{2\mu}$



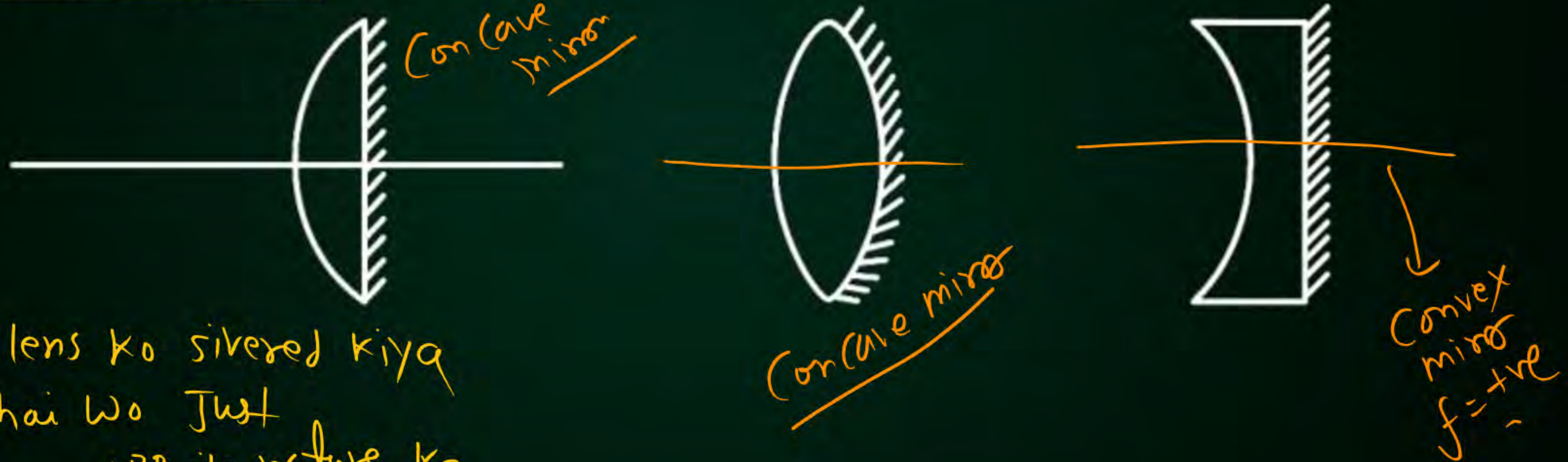
$f = \frac{+R}{2(\mu-1)}$

Convex mirror

Combination of a Lens and a Mirror

$$\frac{1}{f_{net}} = \frac{2}{|f_L|} + \frac{1}{f_m}$$

Silvering of lens – there will be two refraction and one reflection on silvering, and each lens behaves as a mirror.



Jis lens ko silvered kiya hai wo Just opposite nature ka mirror ban Jayga.

Combination of a Lens and a Mirror

Case - (a)



Case - (b)



$$\frac{1}{f_{net}} = \frac{2(\mu-1)}{R} + \frac{1}{\infty}$$

$$f_{net} = +\frac{R}{2(\mu-1)}$$

Case - (c)



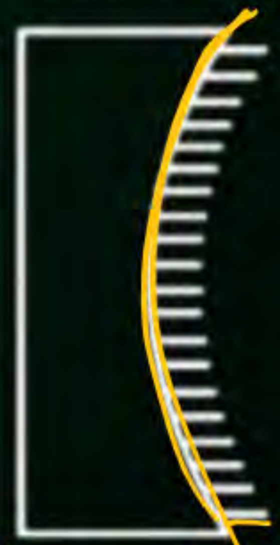
Plano-concave lens

Case - (d)

$$\frac{1}{f_{net}} = \frac{2(\mu-1)}{R} + \frac{2}{R}$$

$$\frac{1}{f_{net}} = \frac{2\mu-2+2}{R}$$

$$f_n = \frac{R}{2\mu}$$



Plano concave lens

Combination of a Lens and a Mirror

Case - (e)

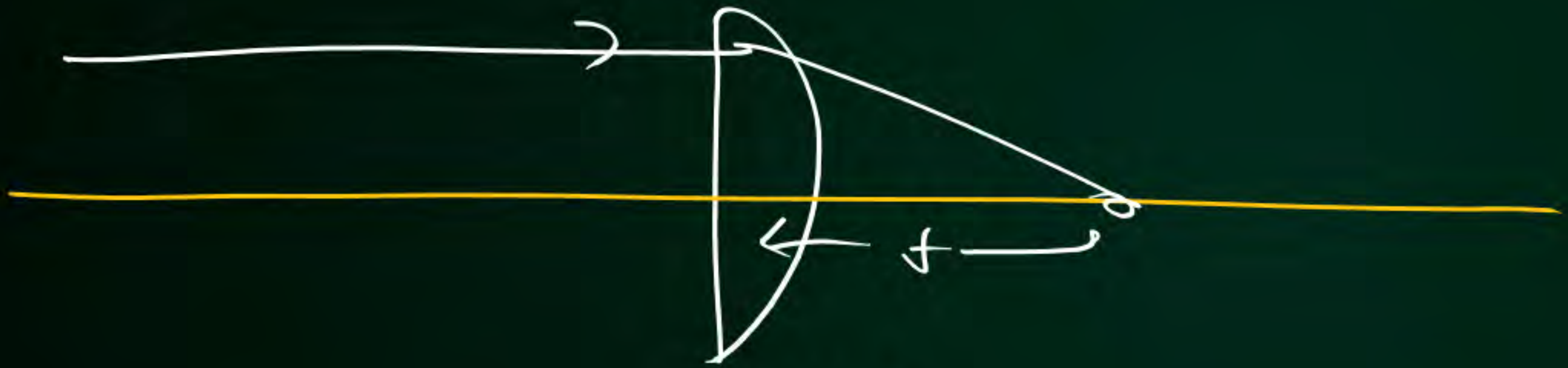


Case - (f)



QUESTION

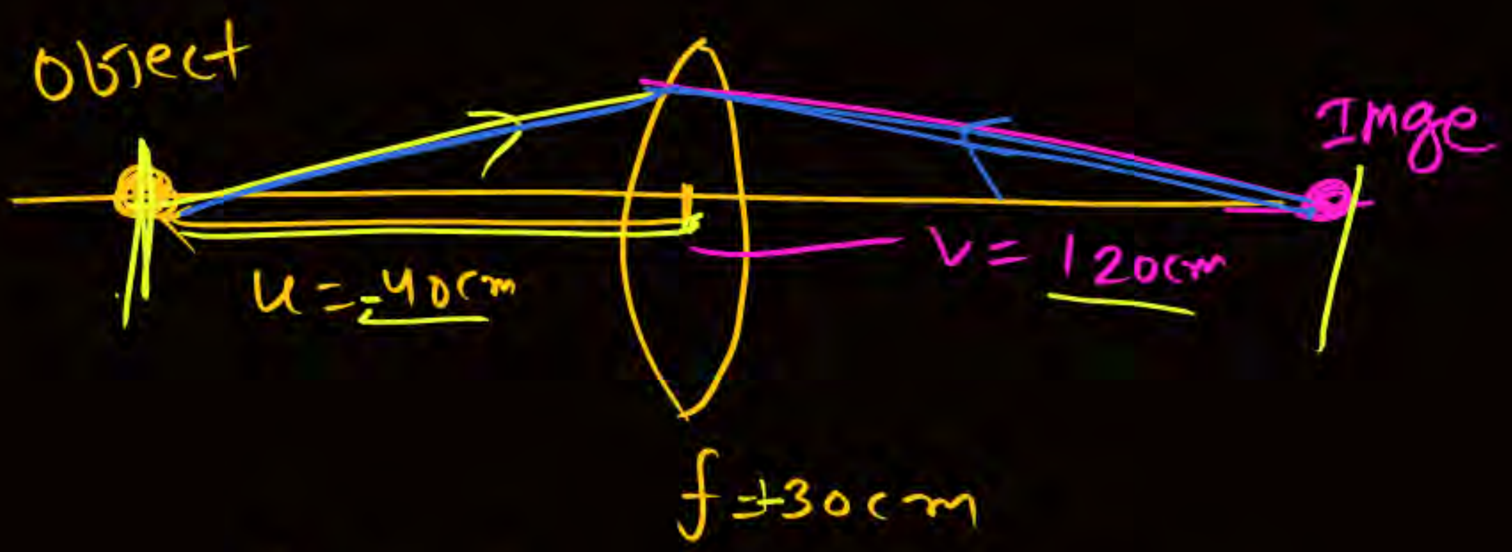
The radius of curvature of the face of a plano-convex lens is 12 cm and its refractive index is 1.5. At what distance from the lens will parallel rays incident on the convex face converge?



$R = 12\,cm$

$\mu = 1.5$

$$f = \frac{R}{(\mu - 1)} = \frac{12}{\left(\frac{3}{2} - 1\right)} = \frac{12}{1/2} = 24\,cm$$



Find Position of Image ??

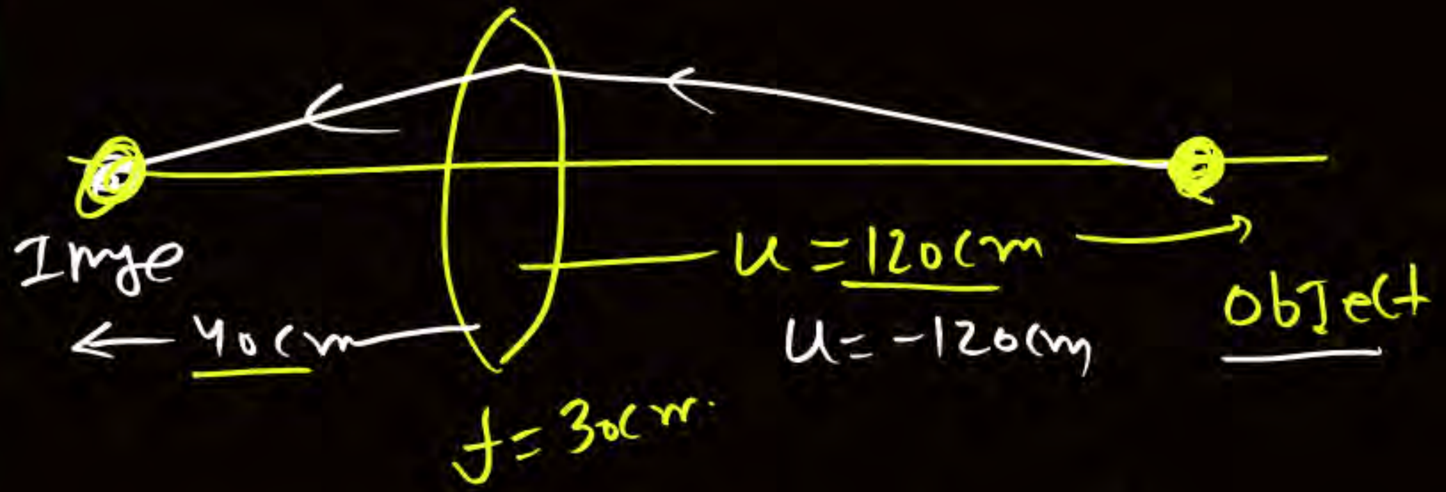
Sol^n Lens formula

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

$$\frac{1}{v} = \frac{1}{f} + \frac{1}{u} = \frac{1}{30} - \frac{1}{40} = \frac{4-3}{120}$$

$$\frac{1}{v} = \frac{1}{120}$$

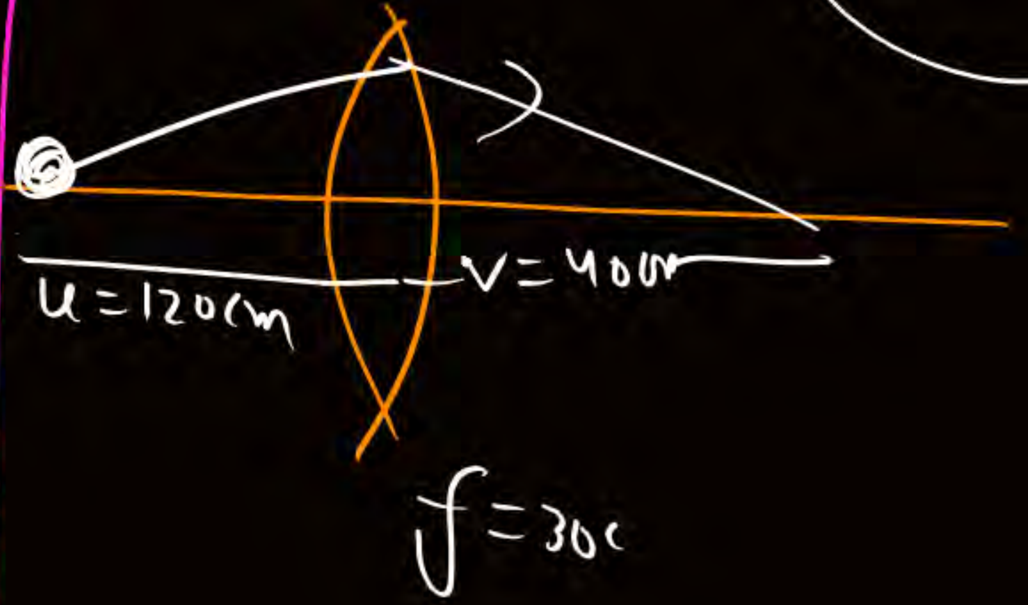
$$\boxed{v = 120\text{ cm}}$$



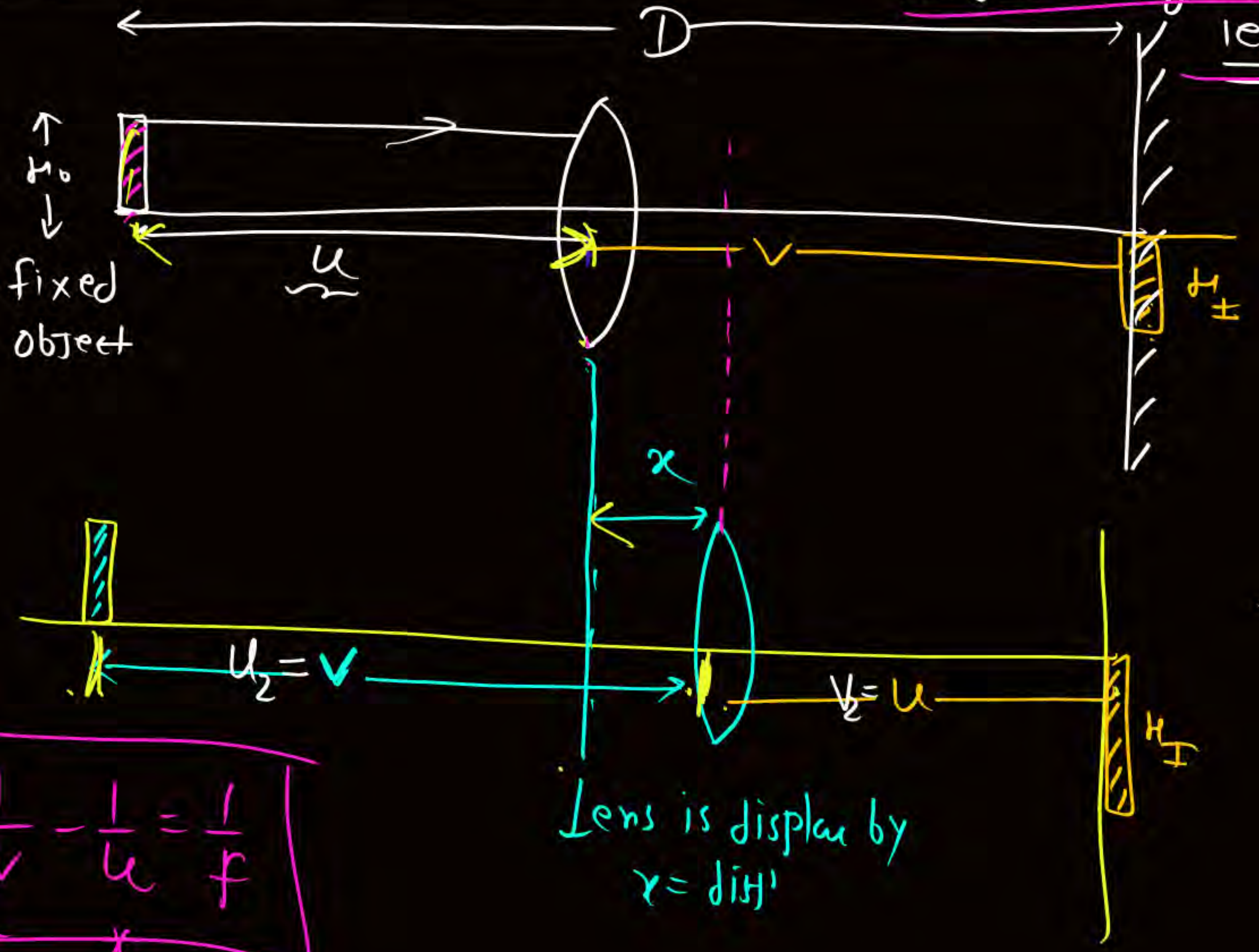
$$\frac{1}{v} = \frac{1}{f} + \frac{1}{u}$$

$$\frac{1}{v} = \frac{1}{40}$$

$$v = 40\text{ cm}$$



Displacement method → experimental tecnique to focal length of lens



D = dist^n B/W object & screen

u = object dist^n

v = Imge dist^n

f = focal lengd

x = dist^n B/w two Posidin of lens

$v - u = x$ — (I)

$v + u = D$ — (II)

(I) + (II) → $2v = D + x$

$$v = \frac{D+x}{2}$$

(II) − (I) ↳ $2u = D - x$

$$u = \frac{D-x}{2}$$

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

using lens formula in 1st case -

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

Putn valr of v & u

$$\frac{x}{D+x} + \frac{2}{D-x} = \frac{1}{f}$$

$$\Rightarrow \frac{2[D-x+D+x]}{D^2-x^2} = \frac{1}{f}$$

$$\frac{1}{f} = \frac{2 \times 2D}{D^2-x^2}$$

$$f = \frac{D^2-x^2}{4D}$$

mR Ratte
Jimn varil

Unique kuchh chamak raha hai??

$$f = \frac{D^2-x^2}{4D}$$

$$m_1 = \frac{v}{u}$$

$$m_2 = \frac{u}{v}$$

$$m_1 \times m_2 = \frac{v}{u} \times \frac{u}{v} = 1$$

$$m_1 = \frac{H_{I1}}{H_0}, \quad m_2 = \frac{H_{I2}}{H_0}$$

$$m_1 \times m_2 = \frac{H_{I1}}{H_0} \times \frac{H_{I2}}{H_0}$$

$$1 = \frac{H_{I1} \times H_{I2}}{H_0^2}$$

$$H_0 = \sqrt{H_{I1} \times H_{I2}}$$

$$f = \frac{D^2 - x^2}{4D}$$

$$f = \frac{D}{m_1 - m_2}$$

(Q) find $m_1 - m_2 = ??$

$$m_1 - m_2 = ??$$

$$m_1 - m_2 = \frac{v}{u} - \frac{u}{v} = \frac{v^2 - u^2}{uv}$$

$$m_1 - m_2 = \frac{(v+u)\,(v-u)}{uv}$$

$$m_1 - m_2 = x\left[\frac{v-(-u)}{uv}\right]$$

$$m_1 - m_2 = \frac{x}{f}$$

$$f = \frac{x}{m_1 - m_2}$$

$$f = \frac{D^2 - x^2}{4D}$$

$$m_1 \times m_2 = 1$$

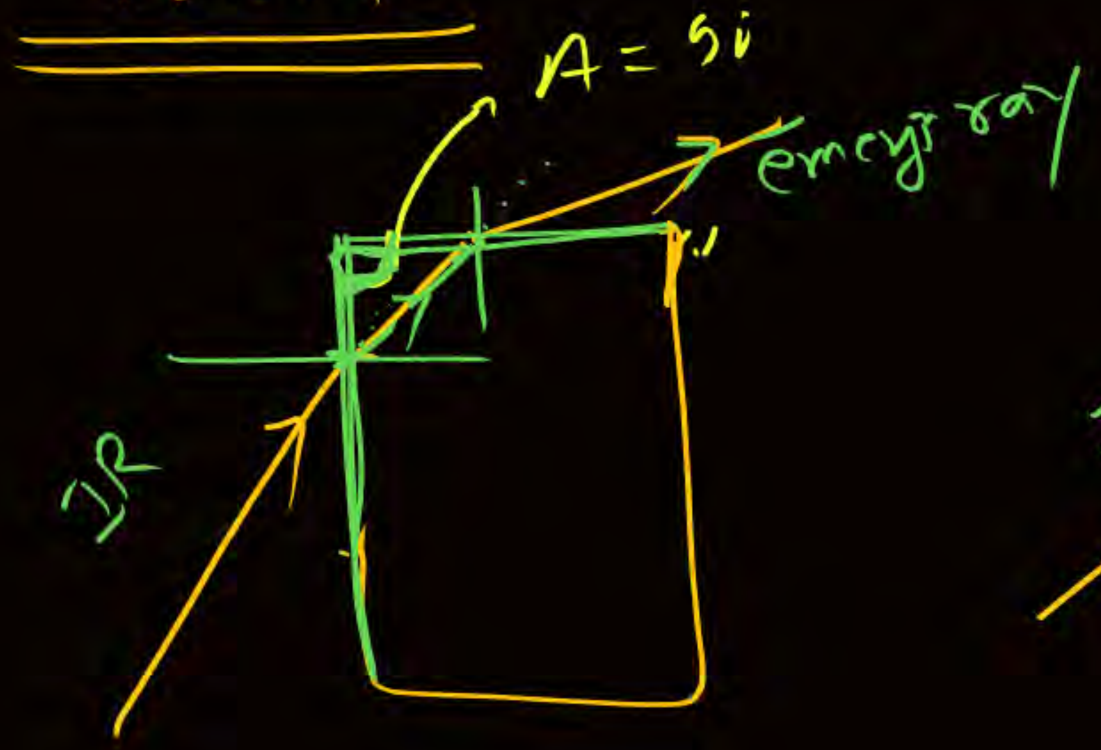
$$H_0 = \sqrt{H_{I1} \times H_{I2}}$$

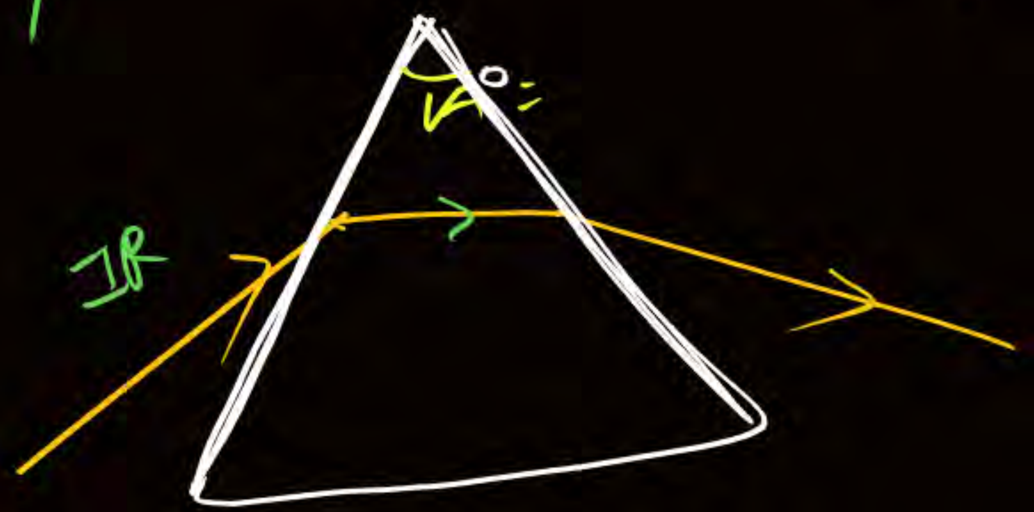
$$f = \frac{x}{m_1 - m_2}$$

Dimn

→ Direct formula Based

Prism

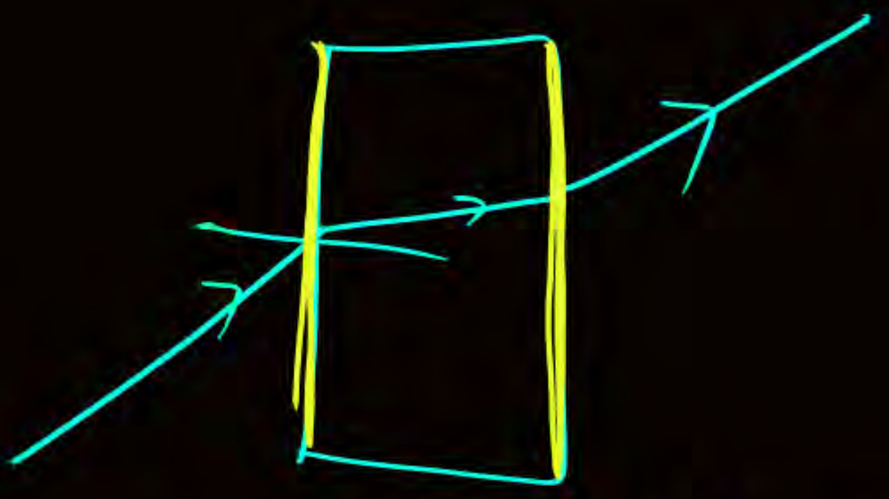




Kya Ye Prism Hai

(a) NO 46% ✗

(b) Yes → 50%

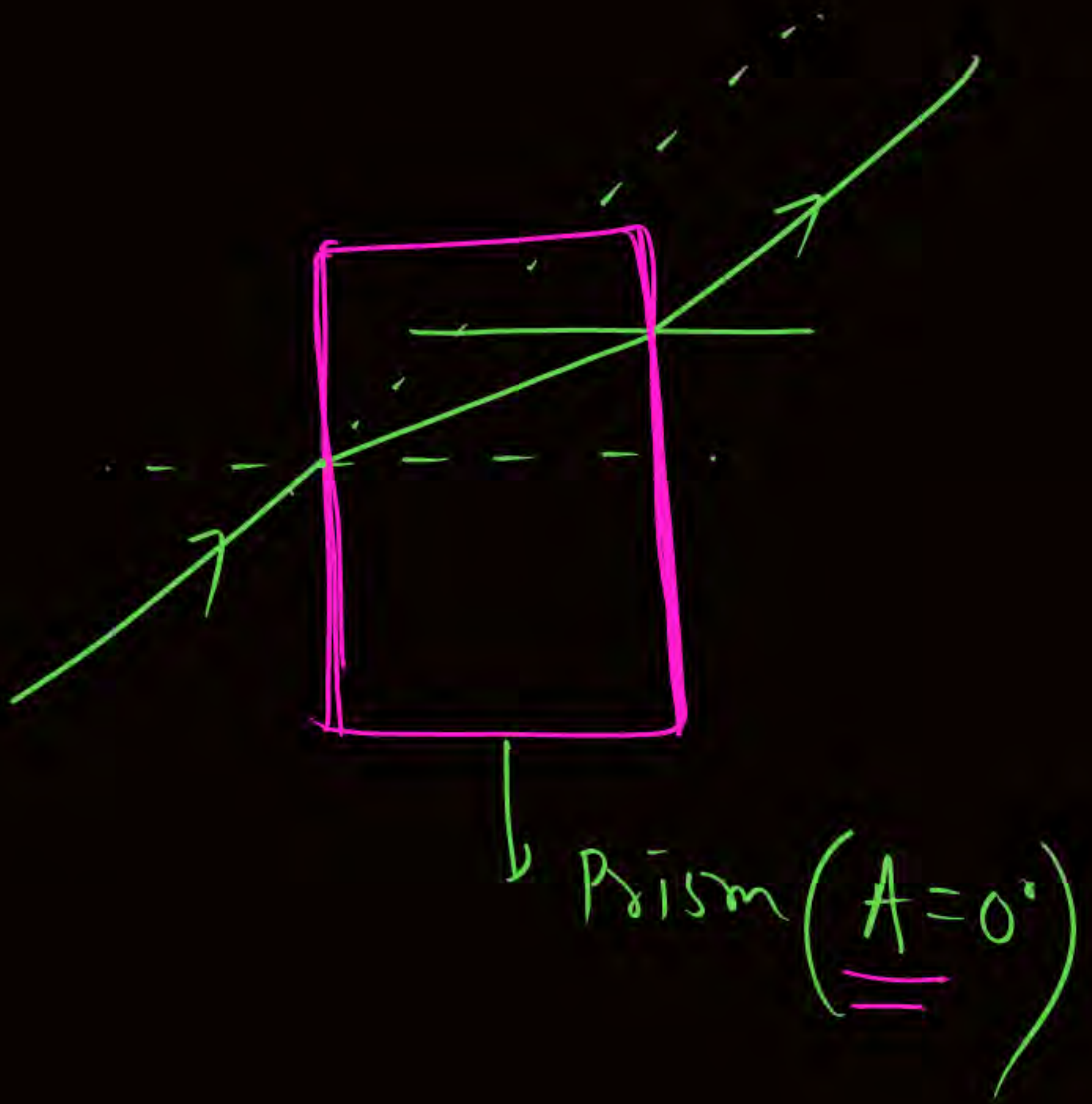


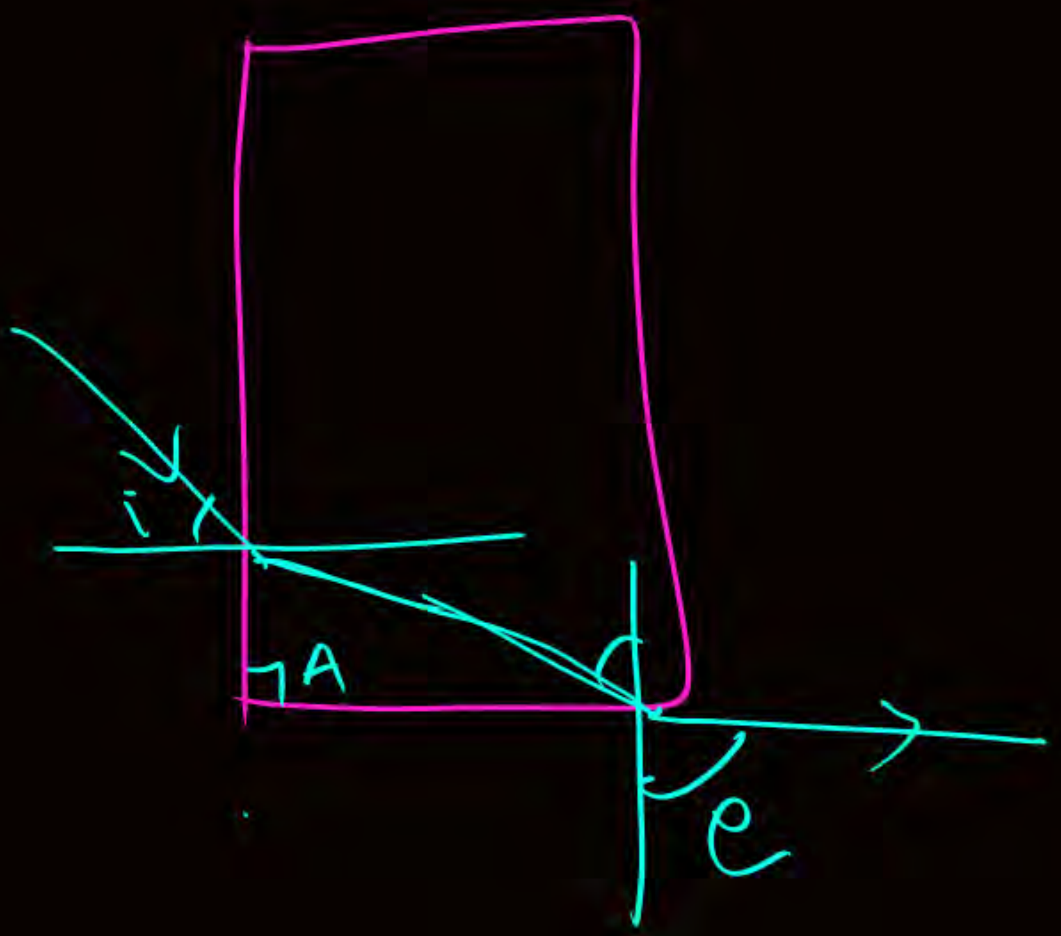
Prism $(A = 0^\circ)$

Angle of Prism

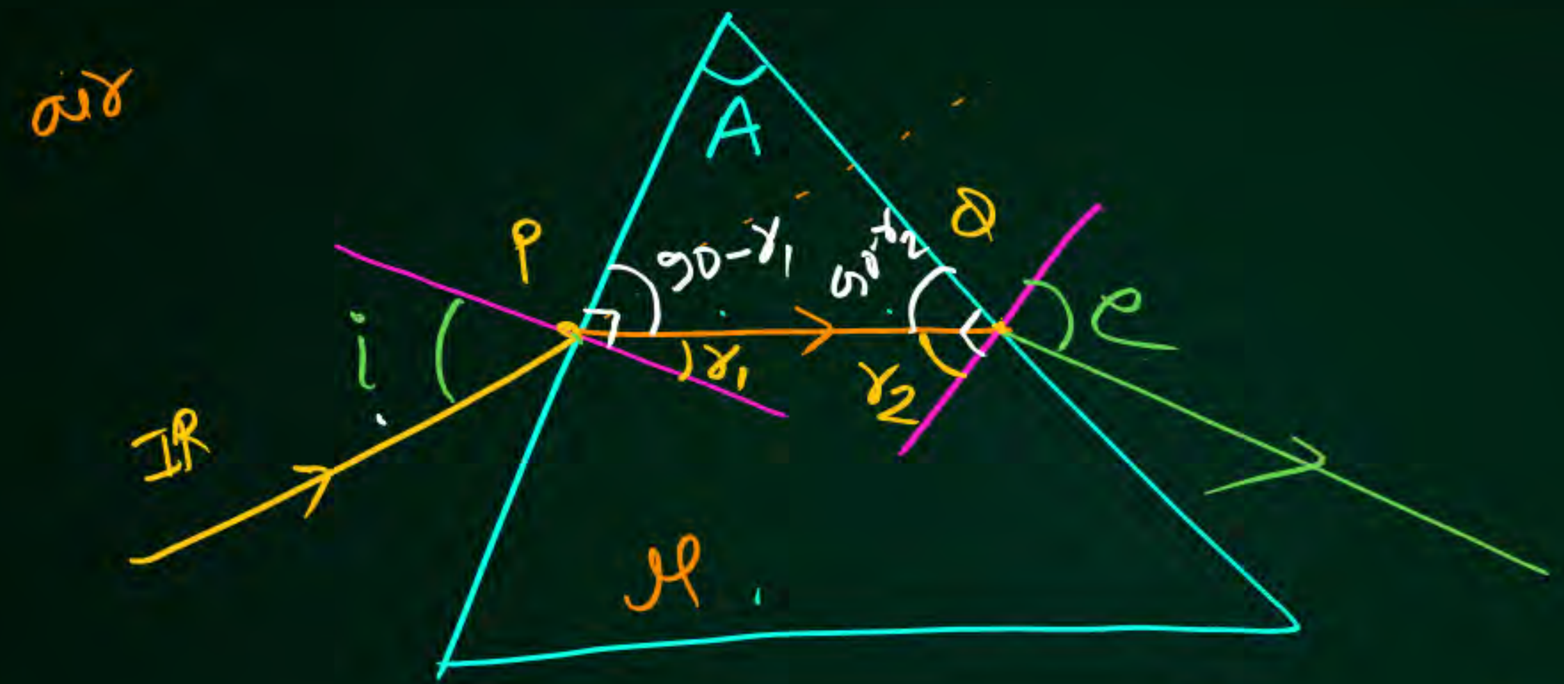
= Angle B/w two refracting Angle is called Angle of Prism.

= refracting angle.


Prism (A = 0°)


i
A
e

PRISM



$\# \ A + 90 - r_1 + 90 - r_2 = 180°$

$A - r_1 - r_2 = 0$

$A = r_1 + r_2$ — (1)

always valid

$\delta_1 = i - r_1$ $\quad \delta_2 = e - r_2$

$\delta = \delta_1 + \delta_2 = i - r_1 + e - r_2$

$\delta = i + e - (r_1 + r_2)$ *

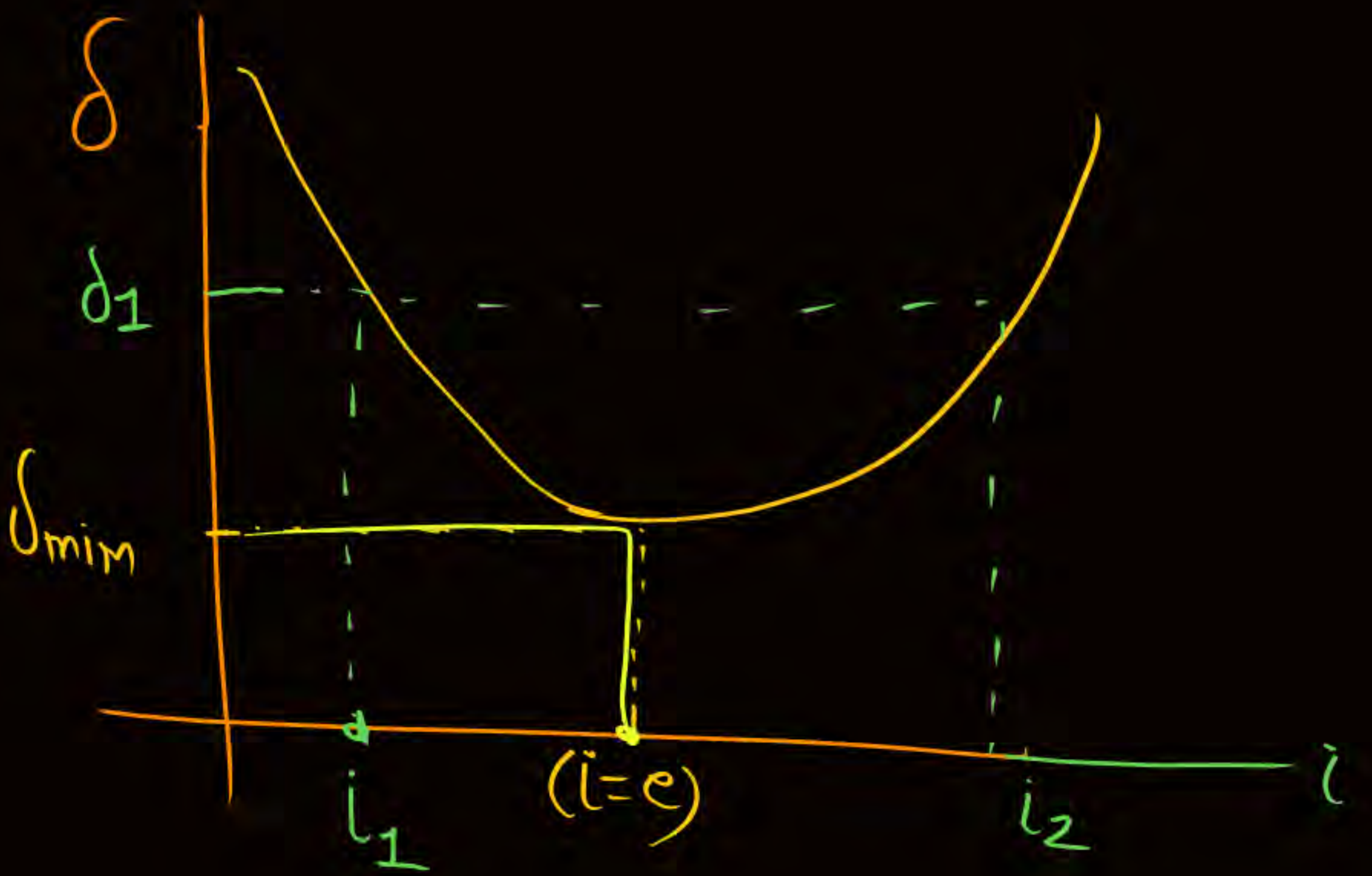
$\delta = i + e - A$

Is i and e will be always same ⟶ No

at P	at Q
$\frac{\sin i}{\sin r_1} = \frac{\mu}{1}$	$\frac{\sin r_2}{\sin e} = \frac{1}{\mu}$

Q) If i and e is same then is r_1 & r_2 will be equal??

Ans ⟶ yes $r_1 = r_2 = A/2$



$$\delta = i + e - (r_1 + r_2)$$

$$\boxed{\delta = i + e - A}$$ *

$\delta_{min} = ??$

at δ_{min} $(i = e)$

$$\boxed{r_1 = r_2 = A/2}$$

$$\boxed{\delta_{min} = 2i - A}$$

* $i = \dfrac{\delta_{min} + A}{2}$

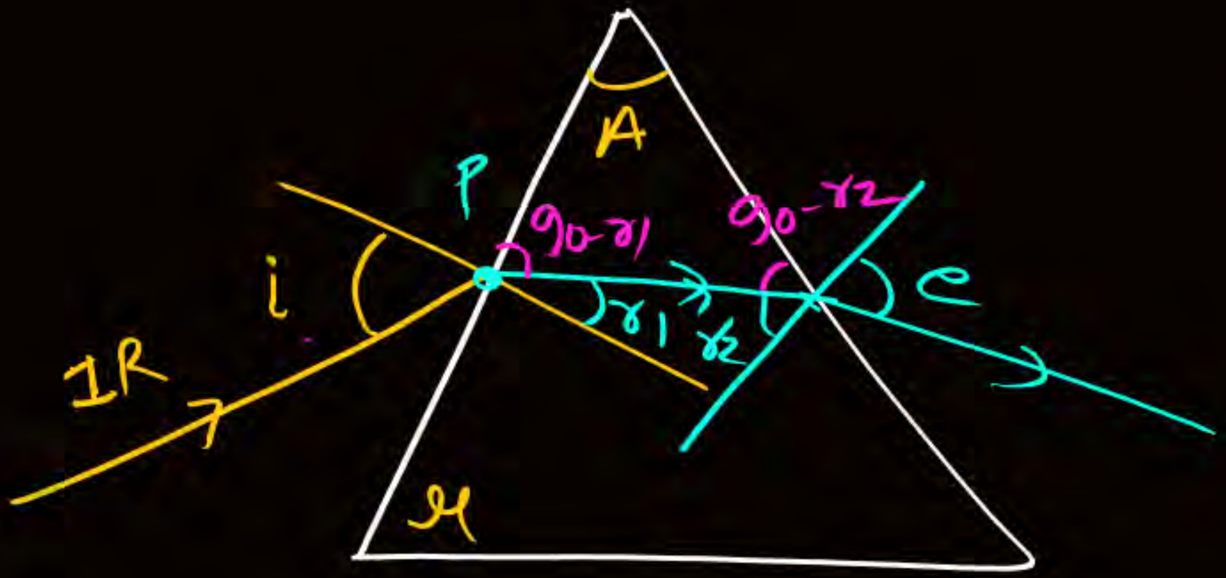
$r_1 = r_2 = A/2$

Snells law

$$\frac{\sin i}{\sin r_1} = \frac{\mu}{1}$$

*

$$\boxed{\mu = \frac{\sin\left(\frac{\delta_m + A}{2}\right)}{\sin(A/2)}}$$



$r_1 + r_2 = A$

$$\delta = i + e - (r_1 + r_2)$$

$\delta = i + e - A$

If $i = e$ then $r_1 = r_2 = A/2$

at this cond^n only

$$\delta_{min} = 2i - A$$

$$i = \frac{\delta_m + A}{2}$$

Snells law at 'P'

$$\frac{\sin i}{\sin r_1} = \frac{\mu}{1}$$

$$\mu = \frac{\sin\left(\frac{\delta_m + A}{2}\right)}{\sin(A/2)}$$

By solving it

Small Angle of prism

$A \simeq$ small

$$\mu = \frac{\frac{\delta_m + A}{2}}{A/2}$$

$$\delta_m = A(\mu - 1)$$

QUESTION

A prism of refractive index $\sqrt{2}$ has a refracting angle of $60°$. At what angle must a ray incident on it so that it suffers minimum deviation?

1. $30°$
2. $45°$
3. $60°$
4. $75°$

QUESTION

A prism of refracting angle $4°$ is made of a material of refractive index. Find its angle of minimum deviation.

QUESTION

A light is incident on a equilateral prism at angle of incidence $60°$. Then find r_1, r_2, e, d, if refractive index of prism is $\sqrt{3}$.

QUESTION

The angle of minimum deviation produced by a 60° prism is 40°. Calculate the refractive index of the material of the prism.

QUESTION

Find angle of minimum deviation in terms of A. If $\mu = \operatorname{cosec}(A/2)$.

QUESTION

For a ray of light refracted through a prism of angle $60°$, the angle of incidence is equal to the angle of emergence, each equal to $45°$. Find the refractive index of the material of the prism.

QUESTION

The angle of incidence for a ray of light at a refracting surface of a prism is 45°. The angle of prism is 60°. If the ray suffers minimum deviation through the prism, the angle of minimum deviation and refractive index of the material of the prism respectively, are

[NEET 2016]

1. $45°, \sqrt{2}$
2. $30°, 1/\sqrt{2}$
3. $45°, 1/\sqrt{2}$
4. $30°, \sqrt{2}$

QUESTION

The least angle of deviation for a glass prism is equal to its refracting angle. The refractive index of glass is 1.5. Then the angle of the prism is

1. $2 \cos^{-1}(3/4)$
2. $\sin^{-1}(3/4)$
3. $\sin^{-1}(3/2)$
4. $\cos^{-1}(3/2)$

QUESTION

The refracting angle of a prism is A, and refractive index of the material of the prism is cot (A/2). The angle of minimum deviation is [2015]

1. $90° - A$
2. $180° + 2A$
3. $180° - 3A$
4. $180° - 2A$

QUESTION

The angle of a prism is A. One of its refracting surfaces is silvered. Light rays falling at an angle of incidence 2A on the first surface returns back through the same path after suffering reflection at the silvered surface. The refractive index μ, of the prism is [2014]

1. 2 sin A
2. 2 cos A
3. 1/2 cos A
4. tan A


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture-13 | Physics

Ray Optics and Optical Instruments

By- Dr. Manish Raj (MR SIR)



Todays Goal

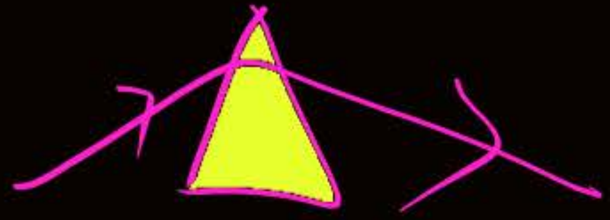
PhD on Prism

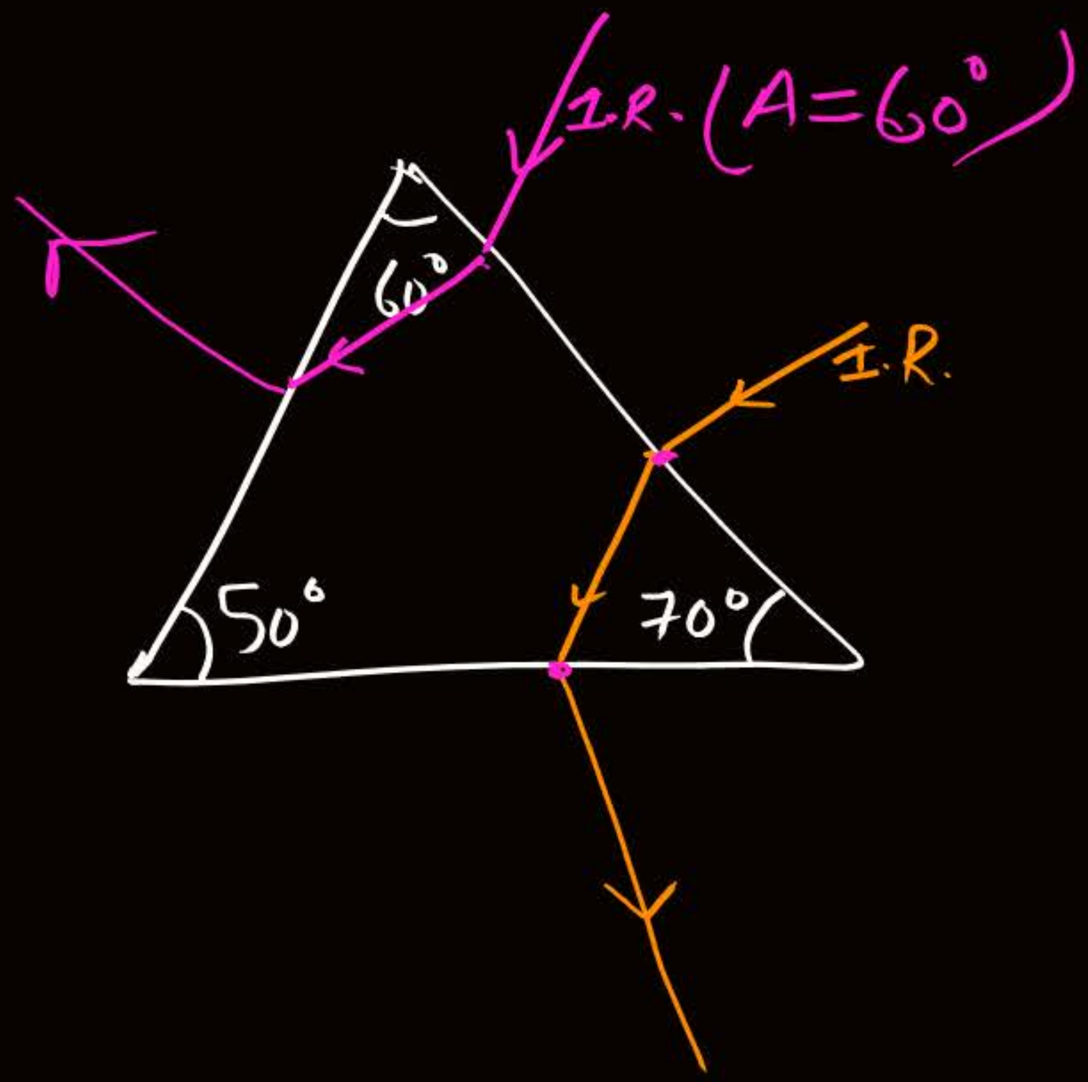


Refraction

Lens	Prism
Combination of Two curved refracting surface	Combination of two plane refracting surface







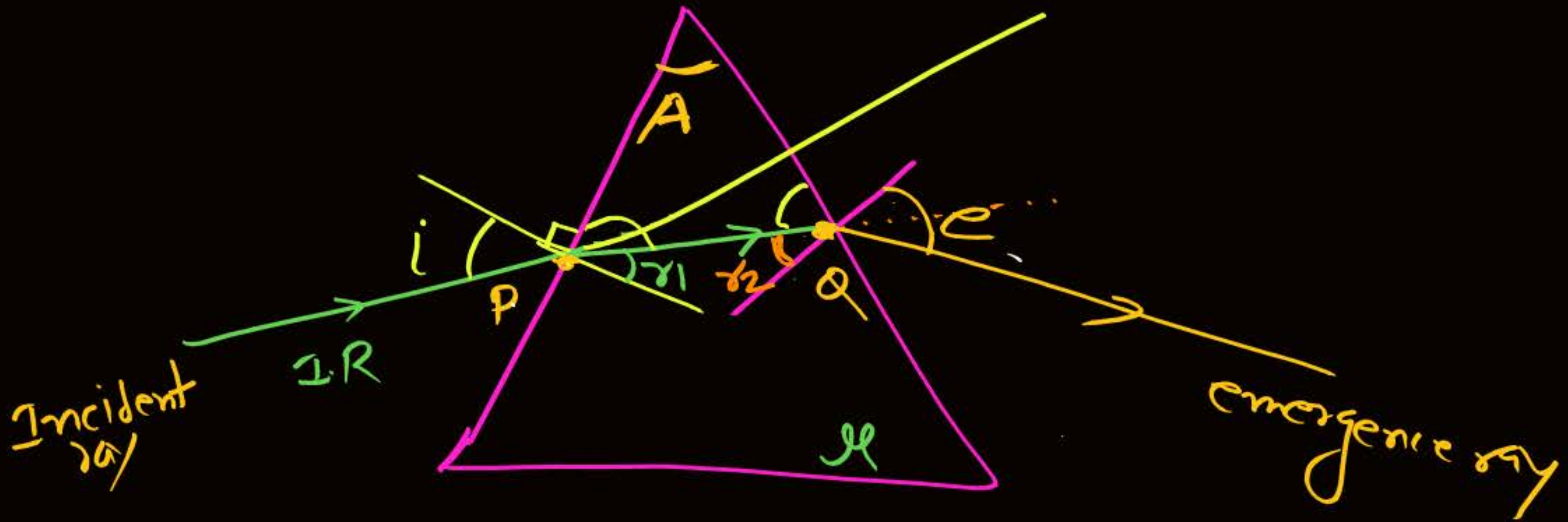
Angle of Prism = ??

= 70°

Angle Of Prism

= Refracting Angle.

Prism





at P

$$\frac{\sin i}{\sin r_1} = \frac{\mu}{1} \quad \text{— (I)}$$

at Q

$$\frac{\sin r_2}{\sin e} = \frac{1}{\mu} \quad \text{— (II)}$$

$$A + 90 - r_1 + 90 - r_2 = 180^\circ$$

$$\boxed{A = r_1 + r_2} \longleftarrow \text{(III)}$$

$$\delta_1 = i - r_1 \qquad \delta_2 = e - r_2$$

$$\delta = i + e - (r_1 + r_2)$$

$$\boxed{\delta = i + e - A}$$

for minimum deviation

$\boxed{i = e}$ then $r_1 = r_2 = \frac{A}{2}$

$$\boxed{\delta_{min} = 2i - A}$$

$$\frac{\delta_m + A}{2} = i$$

$$r_1 = A/2$$

for minimum

$$\boxed{\mu = \frac{\sin\left(\frac{\delta_m + A}{2}\right)}{\sin\left(\frac{A}{2}\right)}}$$

$$\boxed{\delta_{min} = A(\mu - 1)}$$

QUESTION

NEET

A prism of refractive index $\sqrt{2}$ has a refracting angle of 60°. At what angle must a ray incident on it so that it suffers minimum deviation?

1. 30°
2. 45°
3. 60°
4. 75°

$A = 60°$

$\mu = \sqrt{2}$

Cond^n → minimum deviation

$i = ??$

$r = A/2 = 30°$

$1 \times \sin i = \sqrt{2} \sin(30°)$

$\sin i = \sqrt{2} \times \frac{1}{2} = \frac{1}{\sqrt{2}}$

$(i = 45°)$

$\delta_{min} = 2i - A$

$\mu = \dfrac{\sin\left(\frac{\delta_m + A}{2}\right)}{\sin(A/2)}$

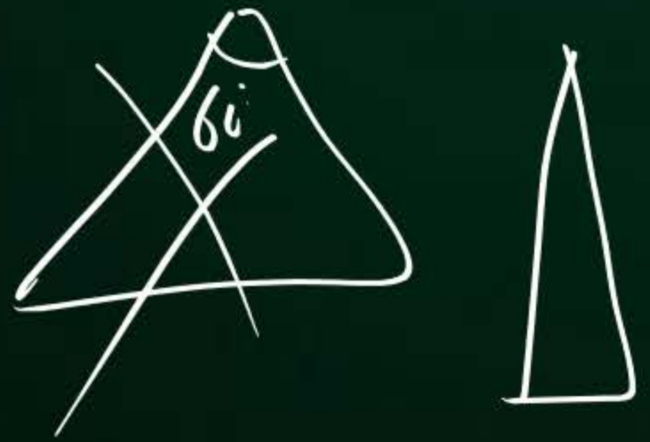
$\sqrt{2} = \dfrac{\sin\left(\frac{\delta_m + 60°}{2}\right)}{\sin\left(\frac{60°}{2}\right)}$

QUESTION

A prism of refracting angle 4° is made of a material of refractive index. Find its angle of minimum deviation.

$\mu = 1.5$

$A = 4^\circ$ (thin prism)



$$\delta_{min} = A(\mu - 1)$$

$$\delta_{min} = 4(1.5 - 1)$$

$$= 4 \times \frac{1}{2} = 2^\circ$$

QUESTION

A light is incident on a equilateral prism at angle of incidence 60°. Then find r_1, r_2, e, d_{evr} if refractive index of prism is $\sqrt{3}$.

$A = 60^\circ$

$i = 60^\circ$

$A = 60^\circ$

$i = 60^\circ$

$\mu = \sqrt{3}$

$1 \sin 60^\circ = \sin r_1 \times \sqrt{3}$

$\frac{\sqrt{3}}{2} = \sin r_1 \times \sqrt{3}$

$r_1 = 30^\circ$

$r_1 + r_2 = A$

$30 + r_2 = 60^\circ$

$r_2 = 60 - 30^\circ = 30^\circ$

$r_1 = r_2 \Rightarrow \delta_{min} = 2i - A = 2 \times 60 - 60^\circ = 120 - 60 = 60^\circ$

$i = e$

QUESTION

The angle of minimum deviation produced by a 60° prism is 40°. Calculate the refractive index of the material of the prism.



$\delta_{min} = 40°$

$\sin 50° \simeq \sin 53°$

$\delta_m = A(\mu - 1)$

Not applicable

only for thin Prism ($A = \delta_{min}$)

$$\mu = \frac{\sin\left(\frac{40+60}{2}\right)}{\sin\left(\frac{60}{2}\right)} = \frac{\sin 50°}{\sin 30°} = \frac{4}{5 \times \frac{1}{2}}$$

$$\mu = \frac{8}{5}$$

NEET

QUESTION

Find angle of minimum deviation in terms of A. If $\mu = \text{cosec}(A/2)$. (JEE)

fin δ_{min} in terms of (A)

$$\mu = \frac{\sin\left(\frac{\delta_m + A}{2}\right)}{\sin A/2}$$

$$\text{cosec}(A/2) = \frac{\sin\left(\frac{\delta_m + A}{2}\right)}{\sin A/2}$$

$$\sin\left(\frac{\delta_m + A}{2}\right) = 1$$

$$\frac{\delta_m + A}{2} = \frac{\pi}{2}$$

$$\boxed{\delta_{min} = \pi - A}$$

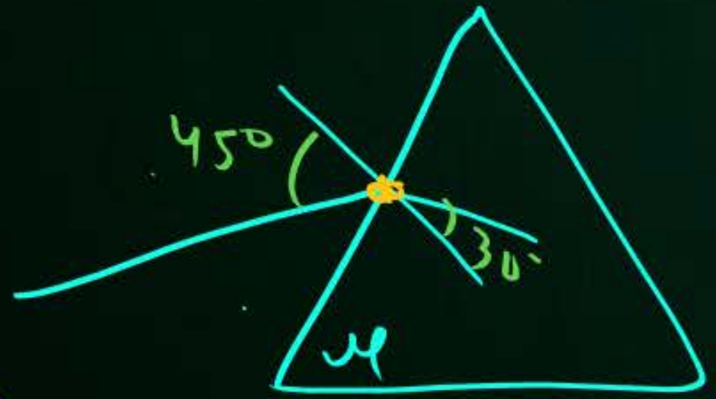
QUESTION

For a ray of light refracted through a prism of angle 60°, the angle of incidence is equal to the angle of emergence, each equal to 45°. Find the refractive index of the material of the prism.

$i = e = 45°$

δ_{min} ki cond.

$r = A/2 = 60/2$



$1 \sin 45 = \mu \sin 30°$

$\frac{1}{\sqrt{2}} = \mu \times \frac{1}{2}$

$\mu = \sqrt{2}$ Ans

QUESTION

The angle of incidence for a ray of light at a refracting surface of a prism is 45°. The angle of prism is 60°. If the ray suffers minimum deviation through the prism, the angle of minimum deviation and refractive index of the material of the prism respectively, are

[NEET 2016]

1. $45°, \sqrt{2}$
2. $30°, 1/\sqrt{2}$
3. $45°, 1/\sqrt{2}$
4. $30°, \sqrt{2}$

$i = 45°$ → $r = \frac{A}{2}$

$A = 60°$

δ_{min} ki cu

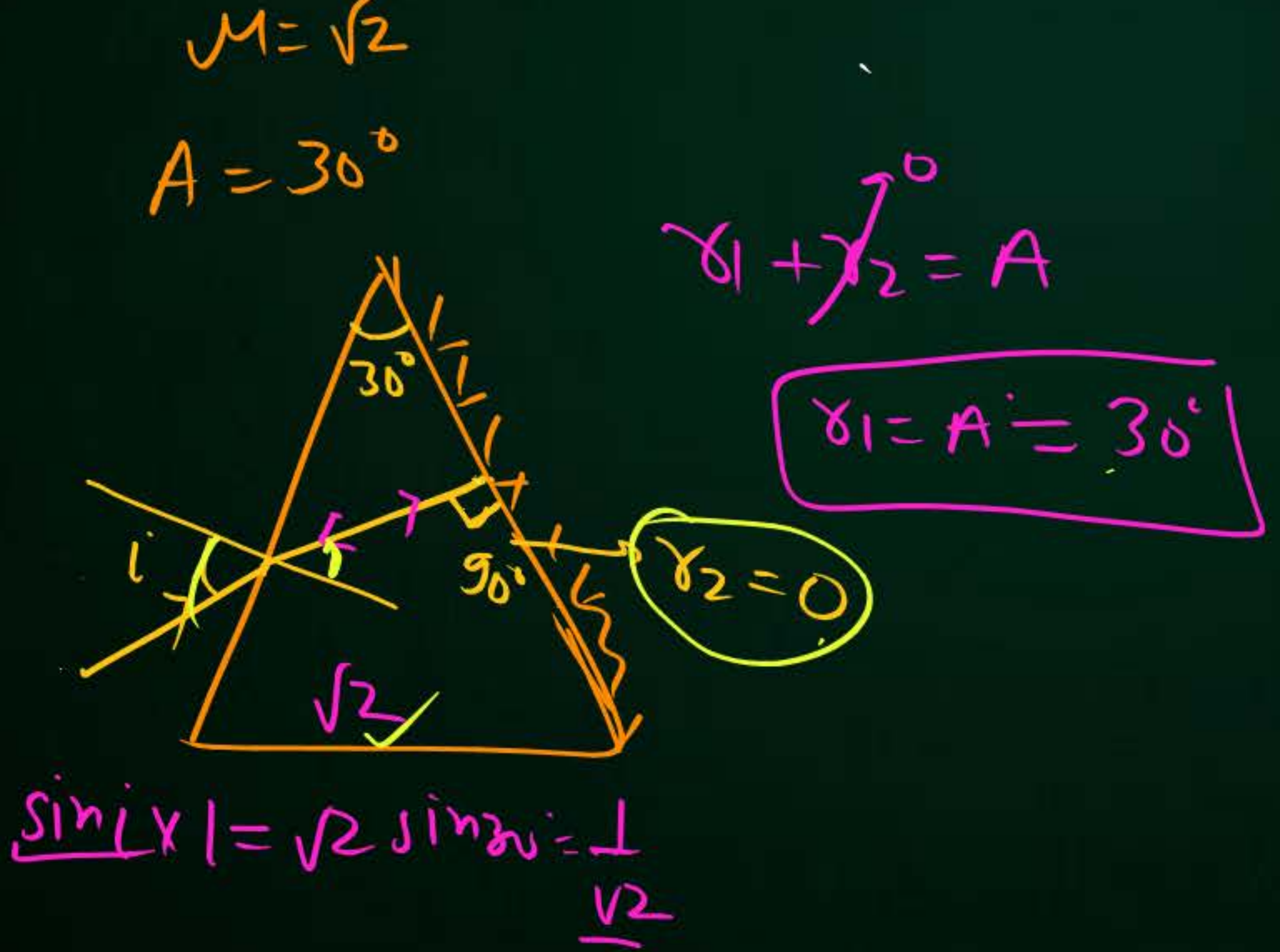
$\delta_{min} = 2i - A$

$= 90 - 60 = 30°$

QUESTION

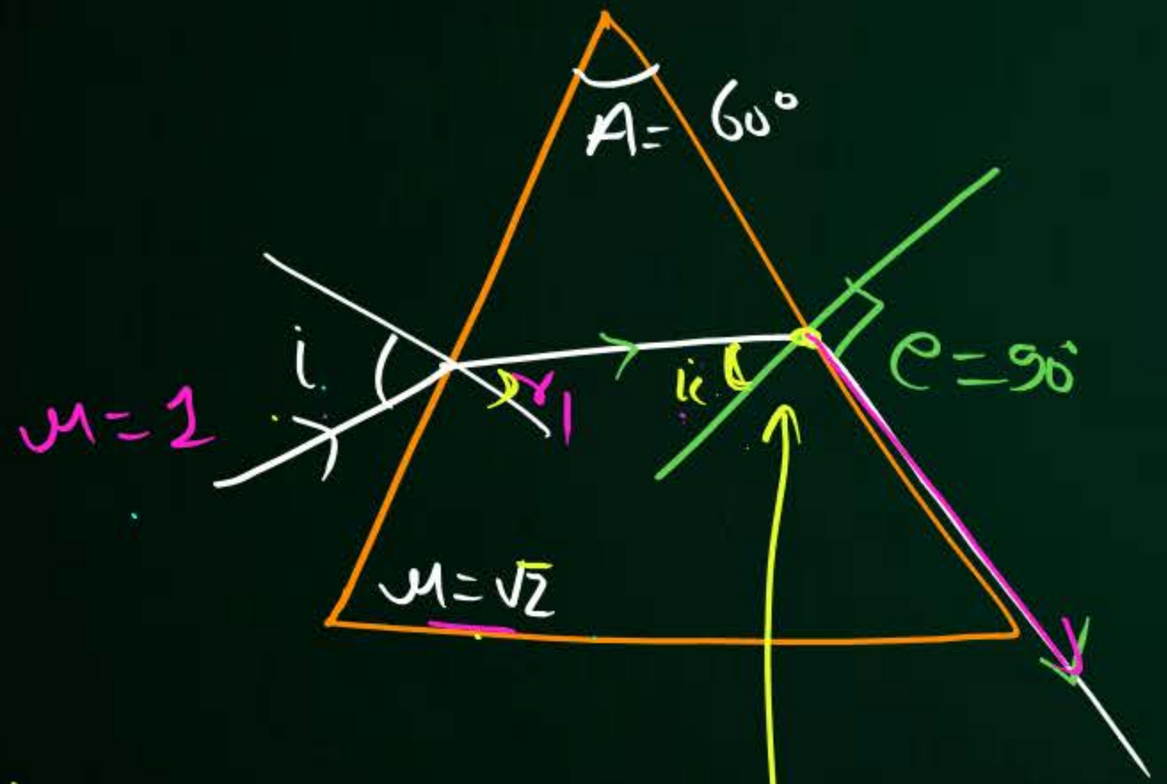
The refractive index of the material of a prism is $\sqrt{2}$ and the angle of the prism is 30°. One of the two refracting surfaces of the prism is made a mirror inwards, by silver coating. A beam of monochromatic light entering the prism from the other face will retrace its path (after reflection from the silvered surface) if its angle of incidence on the prism is: **(2018)**

1. 30°
2. 45°
3. 60°
4. zero



QUESTION

Find angle of incidence so that there is grazing emergence ($\mu = \sqrt{2}$) for equilatral Prism.



$A = r_1 + r_2$

$r_1 = 15°$

No need to solve further.

$r_2 = i_c = 45°$

$\mu \times \sin i_c = \sin 90 \times 1$

$\sin i_c = \frac{1}{\mu} = \frac{1}{\sqrt{2}}$

QUESTION

The least angle of deviation for a glass prism is equal to its refracting angle. The refractive index of glass is 1.5. Then the angle of the prism is

A

1. $2\cos^{-1}(3/4)$ Ans
2. $\sin^{-1}(3/4)$
3. $\sin^{-1}(3/2)$
4. $\cos^{-1}(3/2)$

$$\mu = \frac{\sin\left(\frac{\delta_m + A}{2}\right)}{\sin(A/2)}$$

$$\delta_{min} = A \quad \text{--- (1)}$$

$$\frac{3}{2} = \frac{\sin A}{\sin(A/2)}$$

$$\frac{3}{2} = \frac{2\sin A/2 \cos(A/2)}{\sin A/2}$$

$$\frac{3}{4} = \cos(A/2)$$

$$\frac{A}{2} = \cos^{-1}\left(\frac{3}{4}\right)$$

$$A = 2\cos^{-1}\left(\frac{3}{4}\right)$$

QUESTION

The refracting angle of a prism is A, and refractive index of the material of the prism is cot (A/2). The angle of minimum deviation is [2015]

1. 90° – A
2. 180° + 2A
3. 180° – 3A
4. 180° – 2A ✓

$\mu = \cot(A/2)$ $\quad \delta_{min} = ??$

$$\mu = \frac{\sin\left(\frac{A+\delta_m}{2}\right)}{\sin(A/2)} = \frac{\cos A/2}{\sin A/2}$$

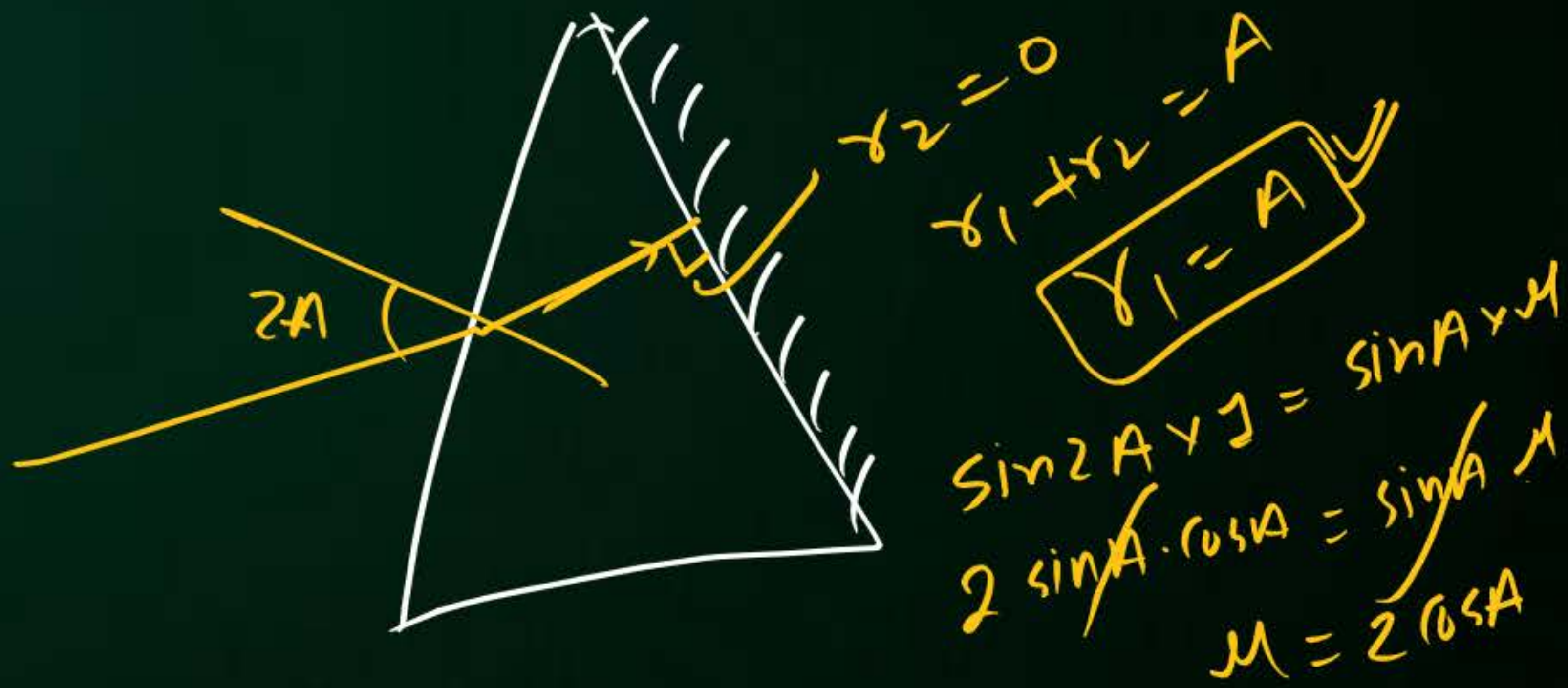
$$\sin\left(\frac{A+\delta_m}{2}\right) = \cos(A/2) = \sin\left(90 - \frac{A}{2}\right)$$

$$\frac{A+\delta_m}{2} = 90 - \frac{A}{2}$$

QUESTION

The angle of a prism is A. One of its refracting surfaces is silvered. Light rays falling at an angle of incidence 2A on the first surface returns back through the same path after suffering reflection at the silvered surface. The refractive index μ, of the prism is **[2014]**

1. 2 sin A
2. 2 cos A
3. 1/2 cos A
4. tan A



QUESTION

A prism of refractive index μ and angle of prism A is placed in the position of minimum angle of deviation. If minimum angle of deviation is also A, then in terms of refractive index value of A is: **[25 July, 2021 (Shift-II)]**

1. $2\cos^{-1}\left(\frac{\mu}{2}\right)$
2. $\cos^{-1}\left(\frac{\mu}{2}\right)$
3. $\sin^{-1}\left(\frac{\mu}{2}\right)$
4. $\sin^{-1}\left(\sqrt{\frac{\mu -}{2}}\right)$

μ

A

$\delta_{min} = A$

$\delta_{min} = 2i - A$

$A = 2i - A$

$i = A$

$r_1 = \frac{A}{2}$

$\frac{\sin A}{\sin \frac{A}{2}} = \mu$

$\frac{2\sin\frac{A}{2}\cdot\cos\frac{A}{2}}{\sin\frac{A}{2}}$

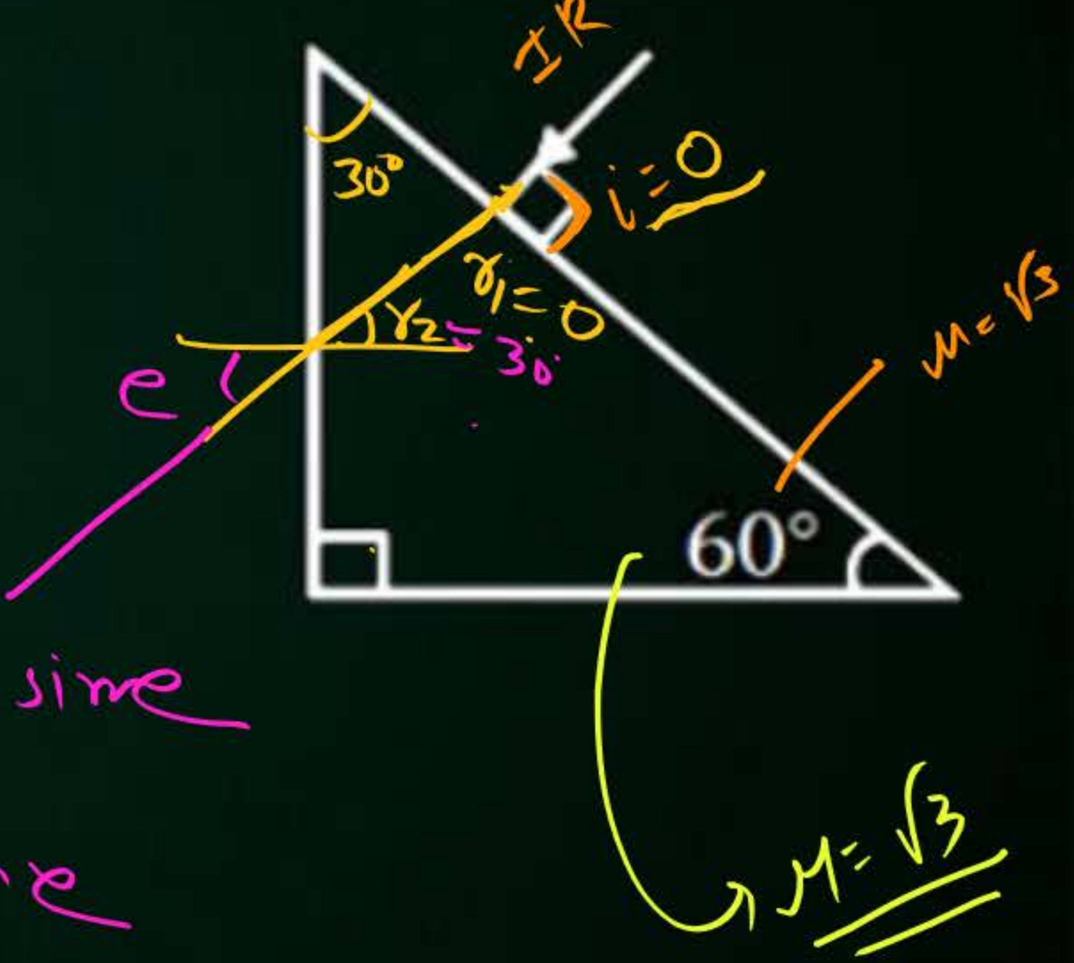
$\cos\frac{A}{2} = \frac{\mu}{2}$

QUESTION

Find the value of the angle of emergence from the prism. Refractive index of the glass is $\sqrt{3}$.

[2021]

1. $30°$
2. $45°$
3. $90°$
4. $60°$



$\sqrt{3}\sin 30° = 1 \sin e$

$\sqrt{3} \times \frac{1}{2} = \sin e$

$e = 60$

QUESTION

The angle of a prism is A. One of its refracting surfaces is silvered. Light rays falling at an angle of incidence 2A on the first surface returns back through the same path after suffering reflection at the silvered surface. The refractive index μ, of the prism is **[2014]**

1. 2 sin A
2. 2 cos A
3. 1/2 cos A
4. tan A

done

QUESTION

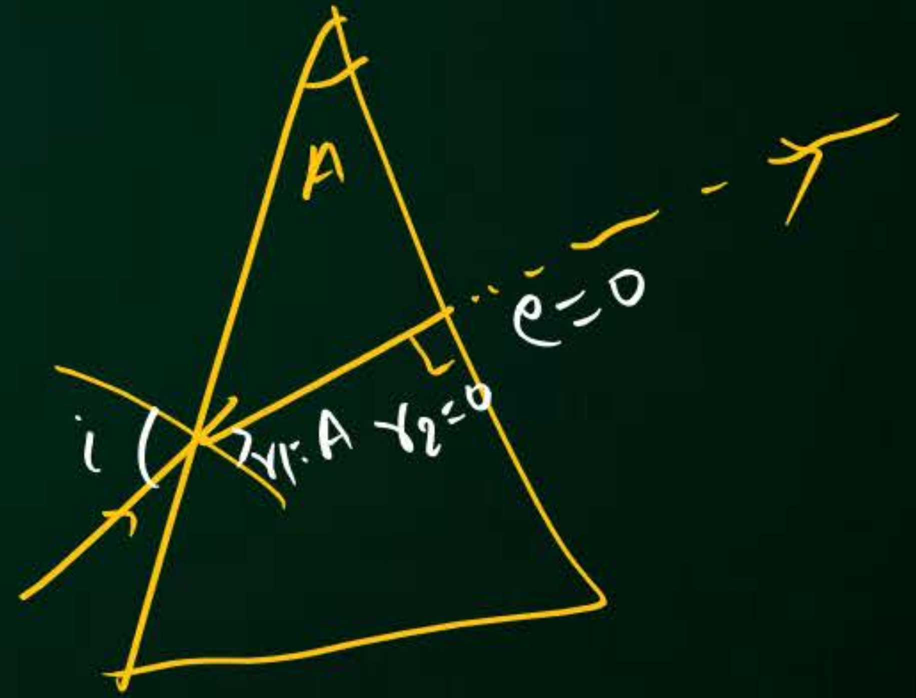
A ray is incident at an angle of incidence *i* on one surface of a small angle prism (with angle of prism A) and emerges normally from the opposite surface. If the refractive index of the material of the prism is μ, then the angle of incidence is nearly equal to:

[2020]

1. $2A/\mu$
2. μA
3. $2A/2$
4. $A/2\mu$

$$1 \times \sin i = \mu \sin A$$

$$i = \mu A$$



QUESTION

The refractive index of transparent liquid filled in an equilateral hollow prism is $\sqrt{2}$. The angle of minimum deviation for the liquid will be________.

[15 April, 2023 (Shift-I)]

Sol^n



$\mu = \sqrt{2}$

$$\sqrt{2} = \frac{\sin\left(\frac{\delta_m + A}{2}\right)}{\sin(A/2)}$$

$$\sqrt{2}\sin 30^\circ = \sin\left(\frac{\delta_m + 60}{2}\right)$$

$$\sqrt{2} \times \frac{1}{2} = \sin\left(\frac{\delta_m}{2} + 30^\circ\right)$$

$$\frac{1}{\sqrt{2}}$$

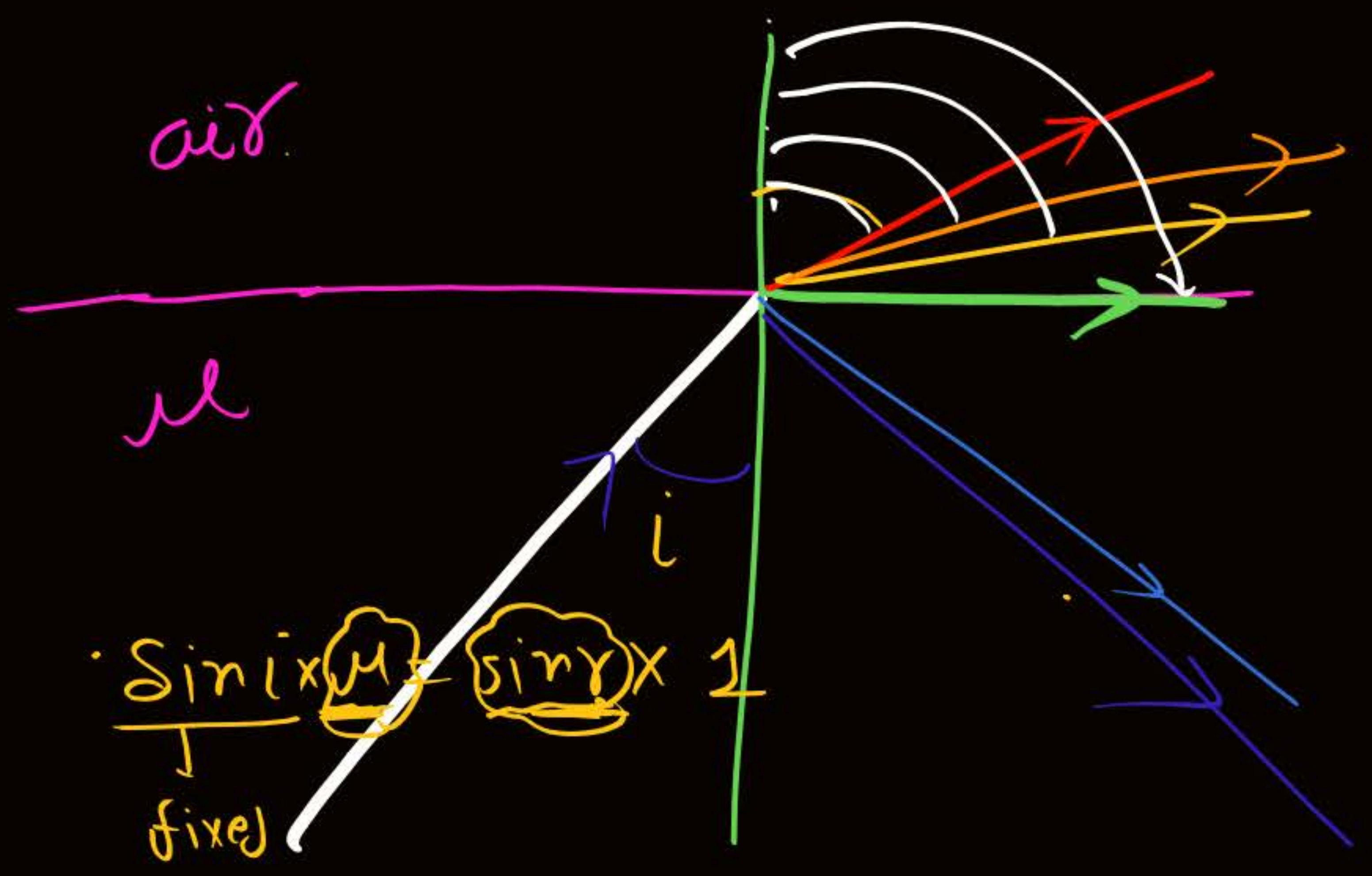
$$\frac{1}{\sqrt{2}} = \sin\left(\frac{\delta_m}{2} + 30^\circ\right)$$

$$45^\circ = \frac{\delta_m}{2} + 30^\circ$$

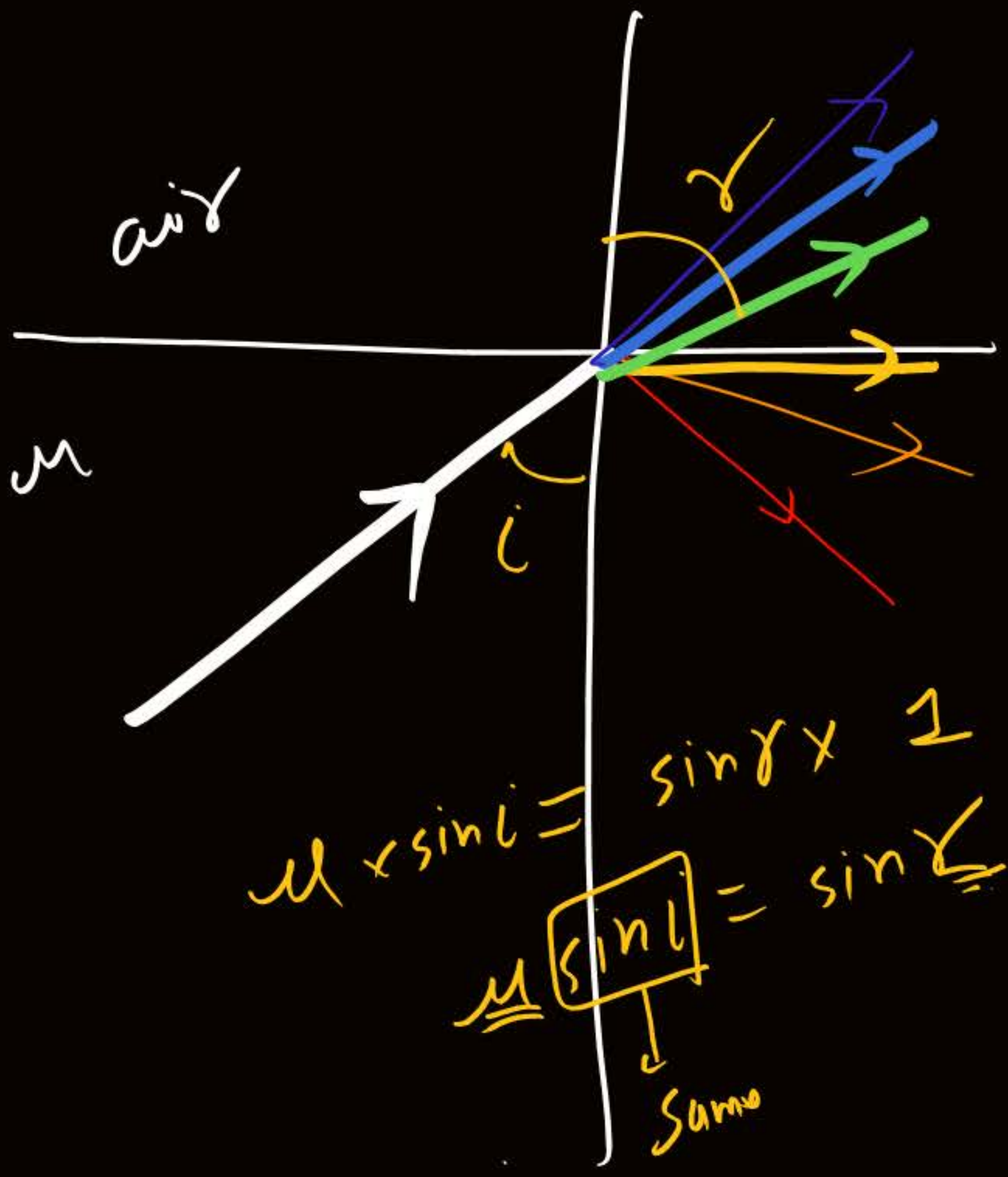
$$15 = \frac{\delta_m}{2}$$

$$\delta_m = 30$$

correct



wrong



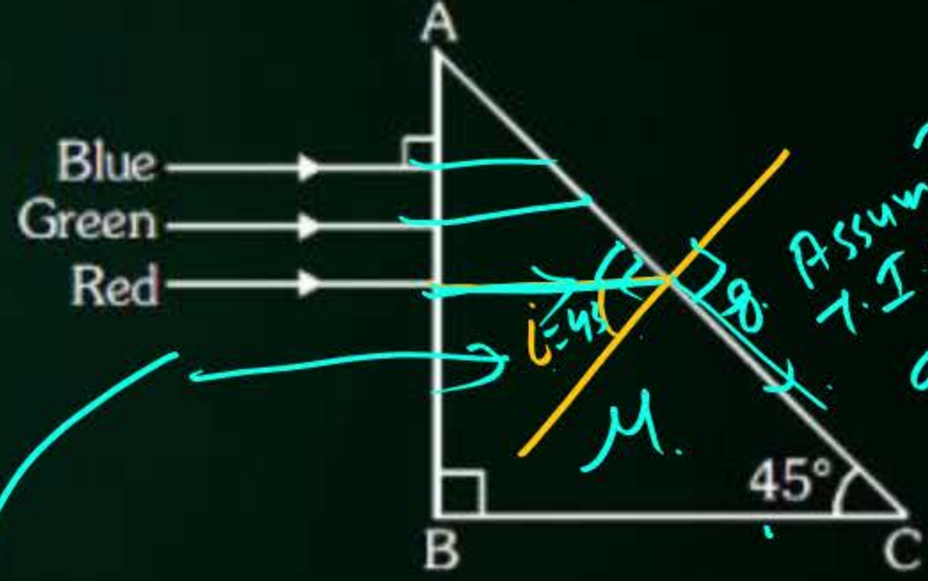
$$\mu \propto \frac{1}{\lambda}$$

$\mu_R < \mu_O < \mu_Y < \mu_G < \mu_B < \mu_V$

QUESTION

A beam of light consisting of red green and blue colours is incident on a right angled prism. The refractive index of the material of the prism for the above red, green and blue wavelengths are 1.39, 1.44 and 1.47 respectively. The prism will **[2015]**

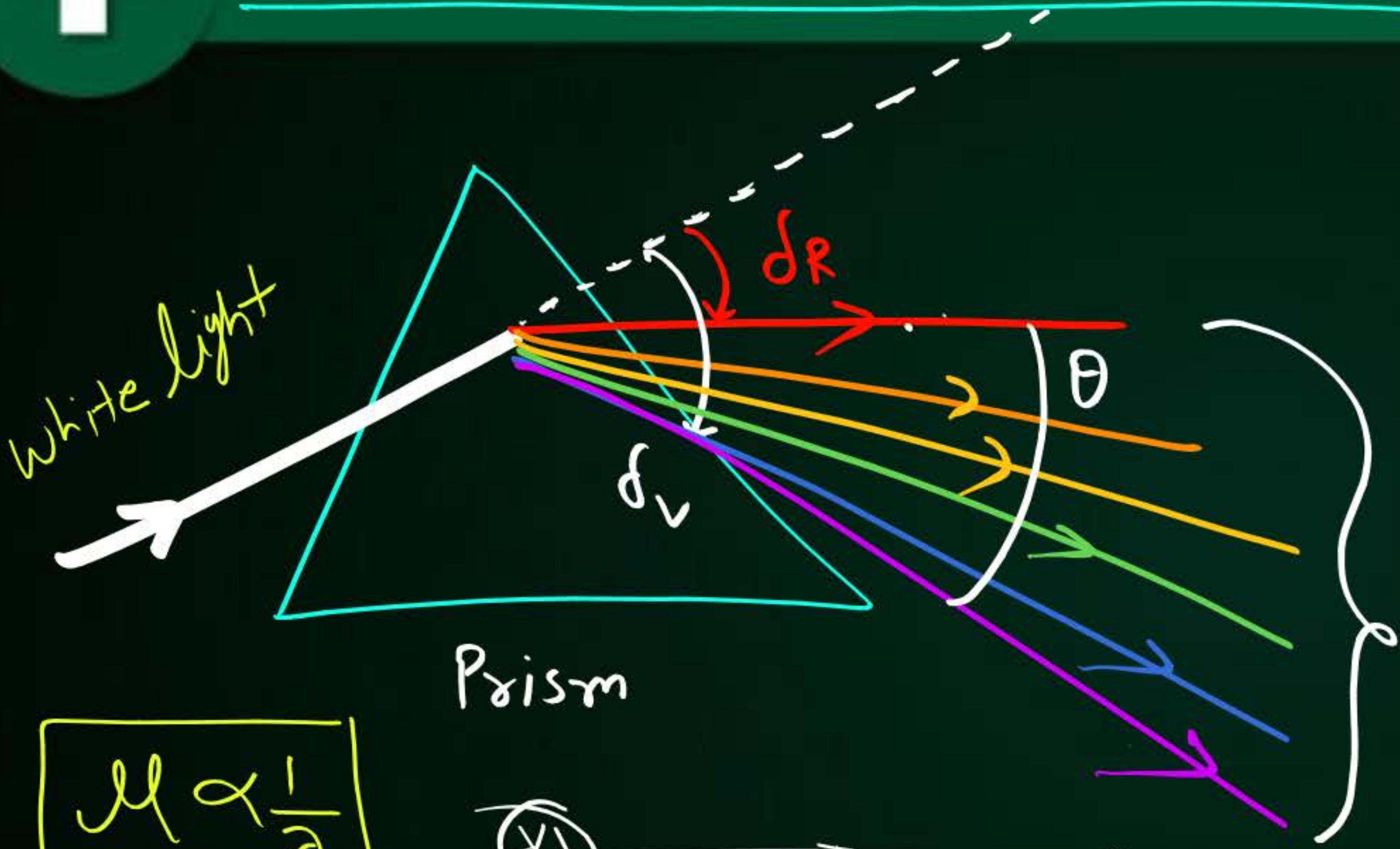
1. not separate the three colours at all
2. separate the red colour part from the green and blue colours
3. separate the blue colour part from the red and green colours
4. separate all the three colours from one another



DISPERSION THROUGH THE PRISM

(Thin Prism) A = small

$\delta = A(\mu - 1)$



Dispersion

$\theta = \delta_V - \delta_R$

$\theta = A[\mu_V - 1) - A[\mu_R - 1]$

$= A[\mu_V - 1 - \mu_R + 1]$

$\theta = A[\mu_V - \mu_R]$

$\mu \propto \frac{1}{\lambda}$

VIBGYOR

$\lambda \uparrow$ ($\mu \downarrow$) (deviation $\downarrow$)

$\mu_V > \mu_R$

$\mu_{Avg} = \mu_{yellow} = \frac{\mu_R + \mu_V}{2}$

δ_{mean} deviation $= \frac{\delta_R + \delta_V}{2}$

$\delta_{mean} = A[\mu_{Avg} - 1]$

$\delta_{mean} = A[\mu_Y - 1]$

Dispersive Power = ?? (ω)

* $\theta = \delta_V - \delta_R$
  $= A(\mu_V - \mu_R)$
* $\delta_{mean} = A(\mu_y - 1)$
* $\omega = \dfrac{\mu_V - \mu_R}{\mu_y - 1}$
*

$\omega \propto \theta$

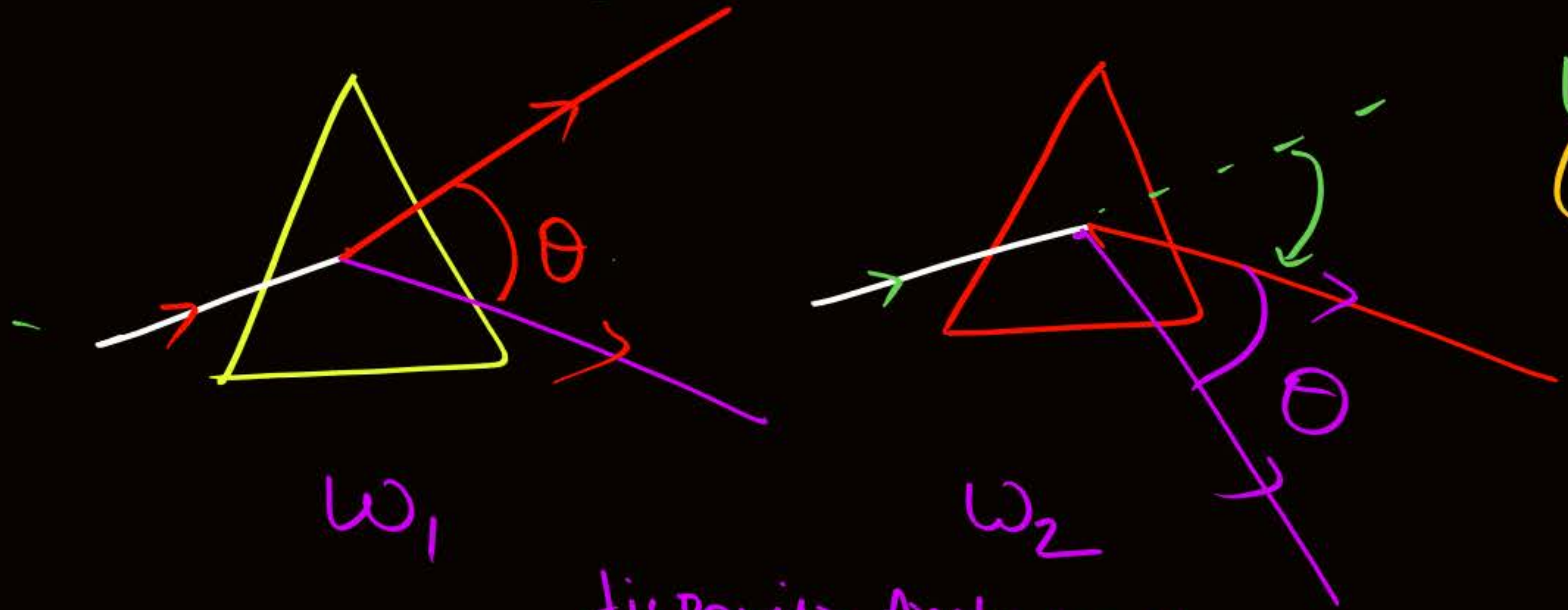
$\omega \propto \dfrac{1}{\delta_{mean}}$

$$\omega = \frac{\theta}{\delta_{mean}} = \frac{A[\mu_V - \mu_R]}{A[\mu_y - 1]}$$

↳ unitless

* $$\omega = \frac{\mu_V - \mu_R}{\mu_{Avg} - 1}$$

$\mu_{yellow} = \mu_{Avg}$



dispersion Angle same

$\omega_1 > \omega_2$

QUESTION

Find mean deviation, Angular dispersion and dispersive power (W). Given $\mu_V = 1.56$, $\mu_R = 1.5$, $A = 5°$.

$\mu_Y = \mu_{Avg} = \frac{\mu_V + \mu_R}{2}$

$\mu_Y = \frac{1.56 + 1.50}{2}$

$\delta_{mean} = A[\mu_Y - 1]$

$\theta = A[\mu_V - \mu_R]$

$W = \frac{\theta}{\delta_{mean}} = \frac{A[\mu_V - \mu_R]}{A[\mu_Y - 1]}$

$W = \frac{\mu_V - \mu_R}{\mu_Y - 1}$

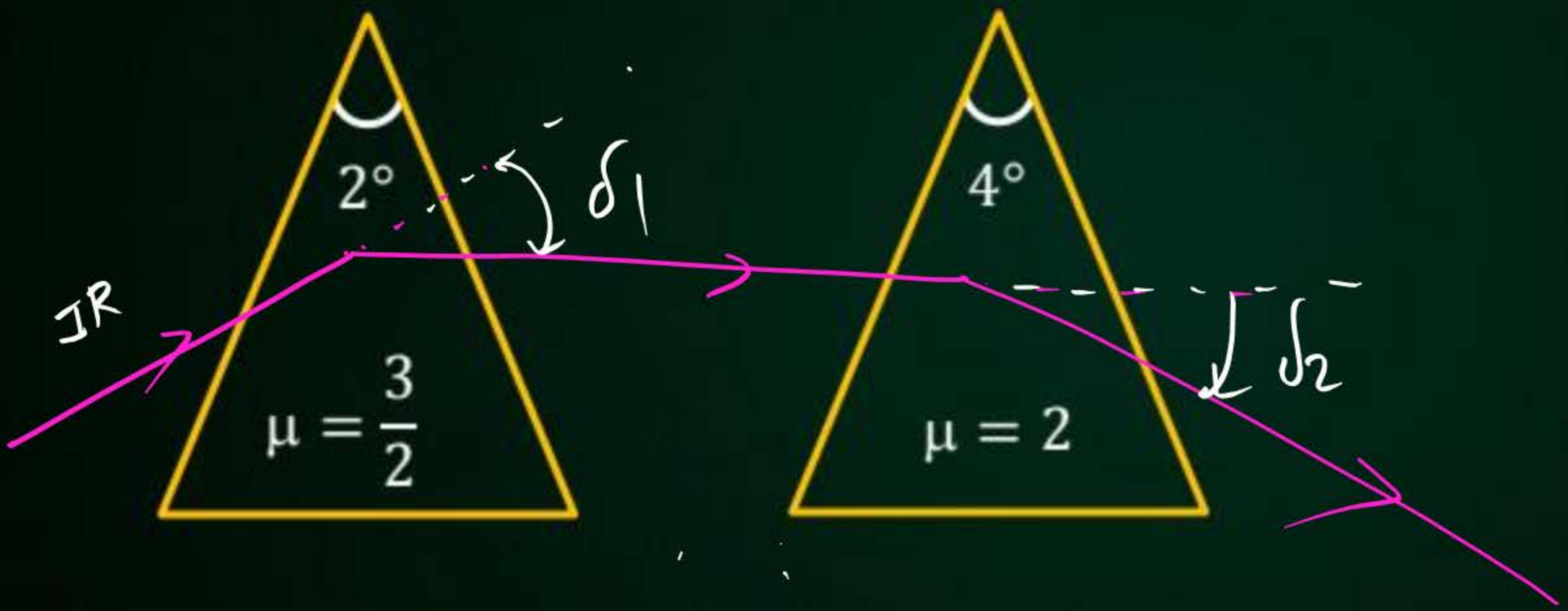
Dispersion

- In vacuum speed of all colour is same equal to 3×10^8 m/s.
- But in medium, different colour travel with different speed, because refractive index is different for different colour.
- $\mu = A + \frac{B}{\lambda^2}$

$$\mu \propto \frac{1}{\lambda^2}$$

QUESTION

Find total deviation:



$\delta_{Total} = \delta_1 + \delta_2$

$= A_1(\mu_1 - 1) + A_2(\mu_2 - 1)$

$= 2\left[\frac{3}{2} - 1\right] + 4\left[2 - 1\right]$

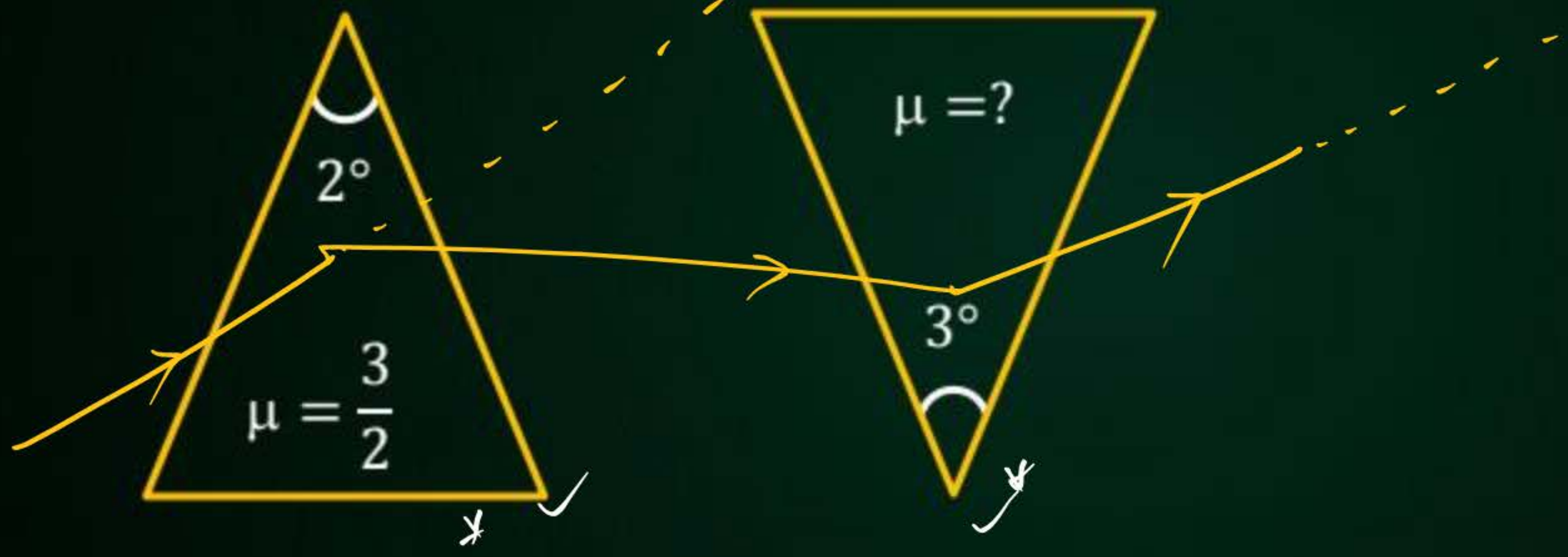
$= 2\left[\frac{3-2}{2}\right] + 4 \times 1$

$= 2 \times \frac{1}{2} + 4$

$= 5^0$

QUESTION

Find μ for No deviation:

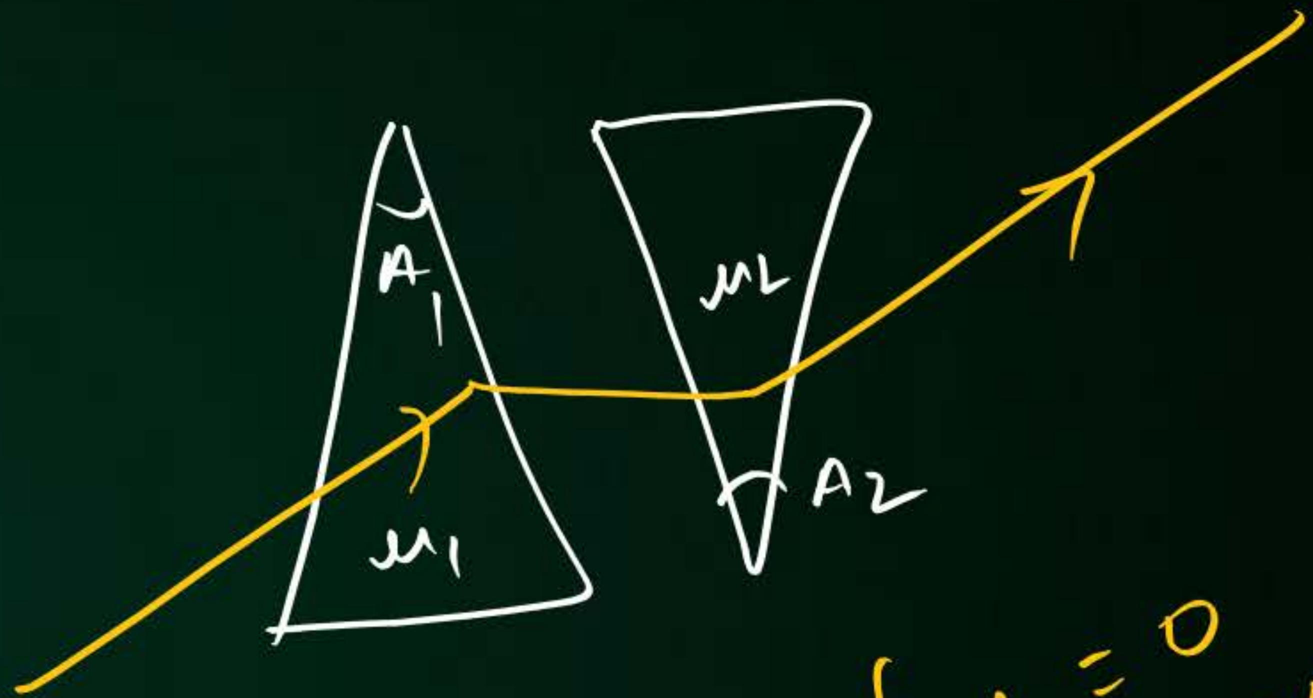


$A_1(\mu_1 - 1) = A_2(\mu_2 - 1)$

Angular Dispersion (θ)

$$\theta = \delta_v - \delta_R$$

Condition for No Deviation



$$\delta_{net} = 0$$

$$A_1(\mu_1 - 1) + A_2(\mu_2 - 1) = 0$$

QUESTION

A thin prism having refracting angle 10° is made of glass of refractive index 1.42. This prism is combined with another thin prism of glass of refractive index 1.7. This combination produces dispersion without deviation. The refracting angle of second prism should be [NEET 2017]

1. 6°
2. 8°
3. 10°
4. 4°

QUESTION

A thin prism of angle 15° made of glass of refractive index $\mu_1 = 1.5$ is combined with another prism of glass of refractive index $\mu_2 = 1.75$. The combination of the prisms produces dispersion without deviation. The angle of the second prism should be

[Mains 2011]

Same

1. 5°
2. 7°
3. 10°
4. 12°

QUESTION

Find mean deviation, Angular dispersion and dispersive power (W). Given $\mu_V = 1.56$, $\mu_R = 1.5$, $A = 5°$.

QUESTION

A thin prism P_1 with an angle $6°$ and made of glass of refractive index 1.54 is combined with another prism P_2 made from glass of refractive index 1.72 to produce dispersion without average deviation. The angle of prism P_2 is: **[30 Jan 2023]**

1. $6°$
2. $1.3°$
3. $7.8°$
4. $4.5°$

SIMPLE MICROSCOPE

- Use as a magnifier.
- Converging lens of short focal length.
- Erect, magnified and virtual image.

(i) Image is at infinity

- relaxed eye position
- comfortable eye
- for point

(ii) Image is at 25 cm

- strained eye
- near point

$$M(\text{Magnifying power}) = \frac{\text{visual angle formed by final image}}{\text{visula angle formed by the object where it is at D}}$$

Simple microscope has a limited magnification ($m \leq 9$) for realistic focal length. For much larger magnification, we use two lens called compound microscope.

COMPOUND MICROSCOPE

Objective lens

- Near the object
- Forms real, inverted, magnified image of object
- Small focal length

The eyepiece

- Large focal length
- Use as a simple microscope or magnifier.
- Forms large virtual image.


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 14 | Physics

Ray Optics and Optical Instruments

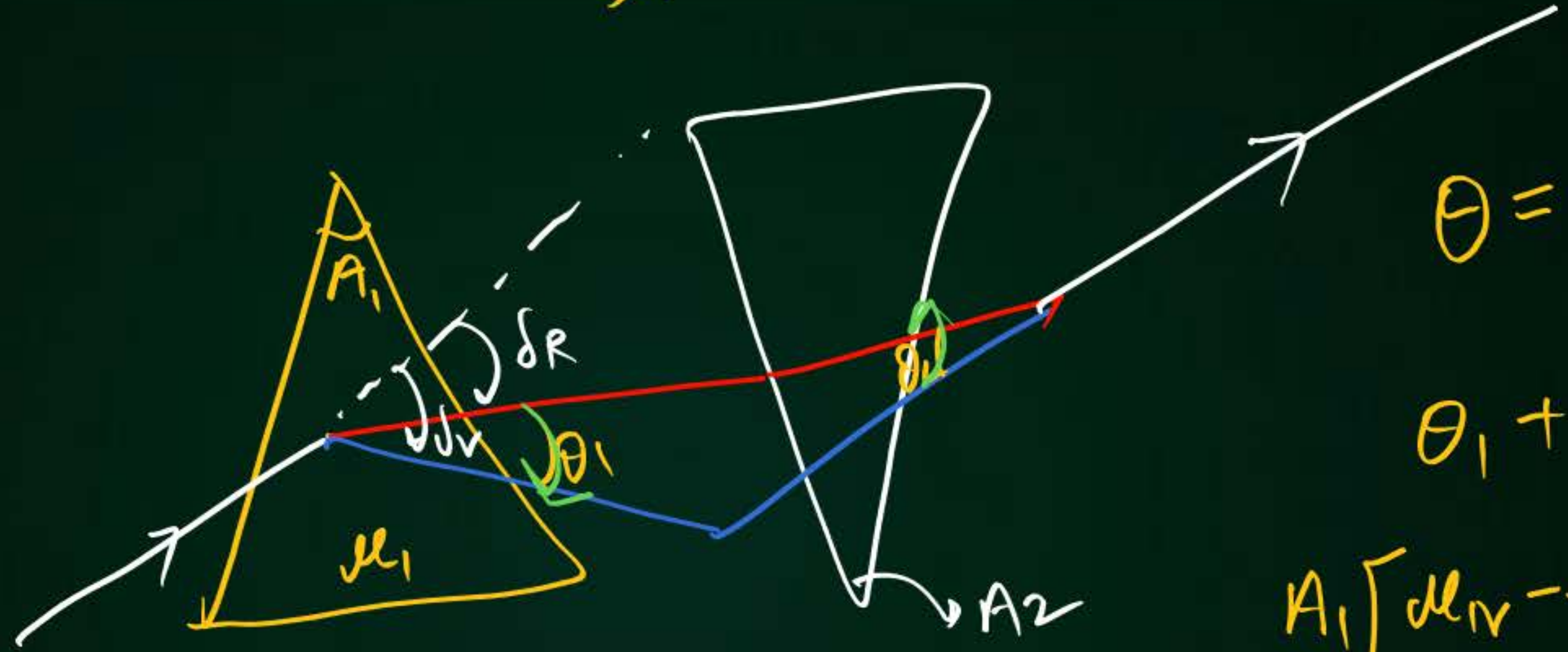


By- Dr. Manish Raj (MR SIR)

Todays Goal

- H/W
- Simple microscope
- Compound microscope
- Telescope

Condition of No Dispersion (Achromatic Combination)



$$\theta = A(\mu_V - \mu_R)$$

$$\theta_1 + \theta_2 = 0$$

$$A_1[\mu_{1V} - \mu_{1R}] + A_2[\mu_{2V} - \mu_{2R}] = 0$$

↓ due to dispers^n in opposite dir

$$A_1[\mu_{1V} - \mu_{1R}] - A_2(\mu_{2V} - \mu_{2R}) = 0$$

$$\theta = \delta_V - \delta_R$$

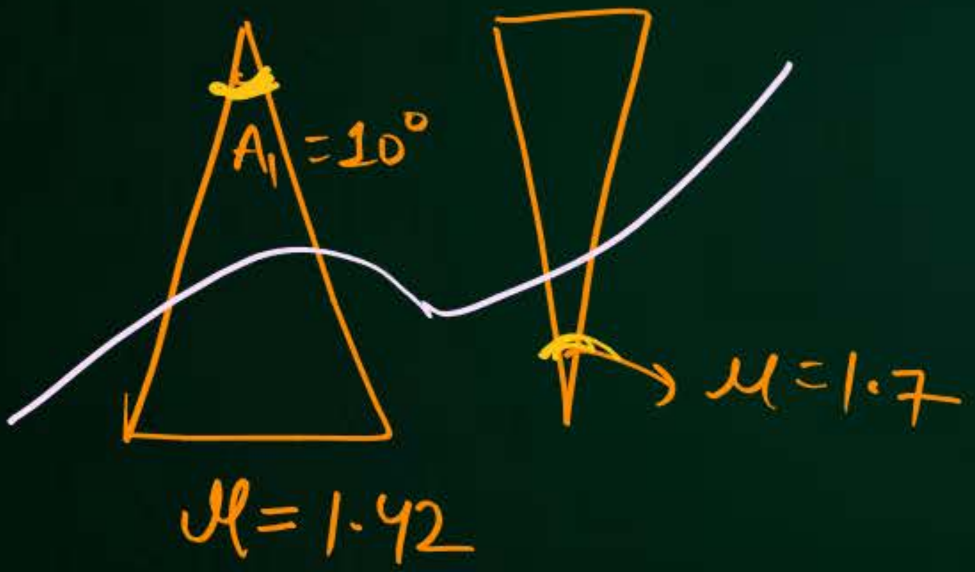
$$\theta = A[\mu_V - \mu_R]$$

$$\delta_{net} = \delta_1 + \delta_2$$

QUESTION

A thin prism having refracting angle 10° is made of glass of refractive index 1.42. This prism is combined with another thin prism of glass of refractive index 1.7. This combination produces dispersion without deviation. The refracting angle of second prism should be **[NEET 2017]**

1. 6° ✓
2. 8° ✗
3. 10° ✗
4. 4° ✗



$$\delta_1 + \delta_2 = 0$$

$$\delta_1 = -\delta_2$$

$$A_1[\mu_{Avg_1} - 1] = -A_2[\mu_{Avg_2} - 1]$$

$$10[1.42 - 1] = -A_2[1.7 - 1]$$

$$10 \times 0.42 = -A_2 \; 0.70$$

$$A_2 = -\frac{10 \times 42}{70}$$

$$A_2 = -6^\circ$$

QUESTION

A thin prism of angle 15° made of glass of refractive index $\mu_1 = 1.5$ is combined with another prism of glass of refractive index $\mu_2 = 1.75$. The combination of the prisms produces dispersion without deviation. The angle of the second prism should be

[Mains 2011]

1. 5°
2. 7°
3. 10°
4. 12°

$\delta_{net} = 0$

$15°(1.5-1) = A_2[1.75-1]$

$15 \times 0.50 = A_2\, 0.75$

$A_2 = 10°$

QUESTION

Find μ for No deviation:



digram.

$A_1(\mu_1 - 1) = A_2(\mu_2 - 1)$

$2°\left[\frac{3}{2} - 1\right] = 3\,[\mu - 1]$

$2 \times \frac{1}{2} = 3(\mu - 1)$

$\frac{1}{3} = \mu - 1$

$\mu = 1 + \frac{1}{3} = \frac{4}{3}$

QUESTION

A thin prism P_1 with an angle 6° and made of glass of refractive index 1.54 is combined with another prism P_2 made from glass of refractive index 1.72 to produce dispersion without average deviation. The angle of prism P_2 is: **[30 Jan 2023]**

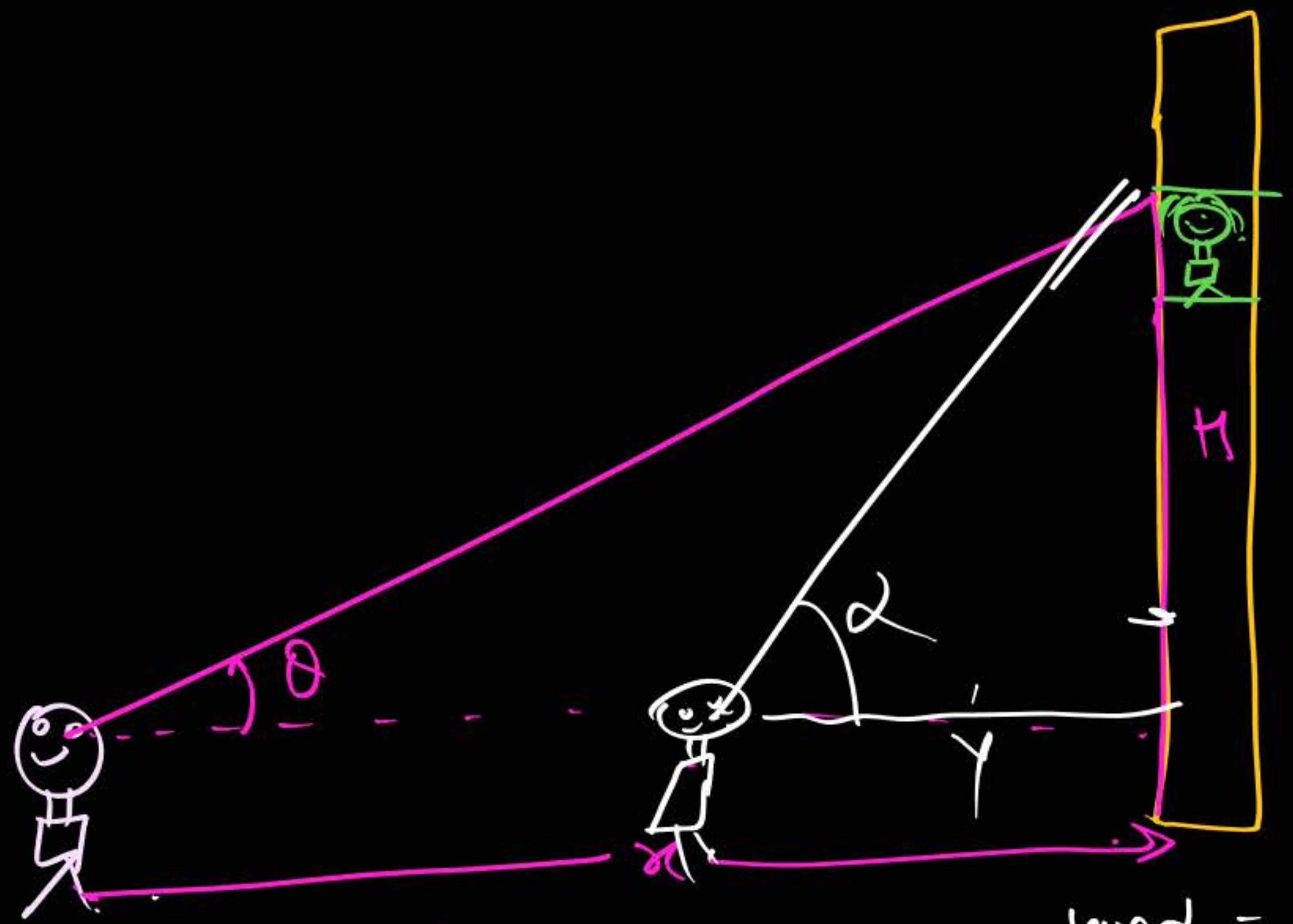
1. 6°
2. 1.3°
3. 7.8°
4. 4.5° ✓

$\delta_{net} = 0$

$6^\circ (1.54 - 1) = A (1.72 - 1)$

$6 \times 0.54 = A \, 0.72$

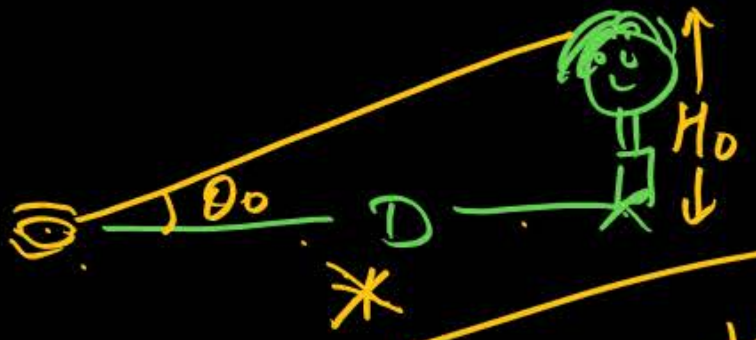
$A = \frac{6 \times 6}{8} = \frac{36}{8} = 4.5$



$$\tan\alpha = \alpha = \frac{H}{Y}$$

$$\tan\theta = \frac{H}{x}$$

$$\boxed{\theta = \frac{H}{x}}$$

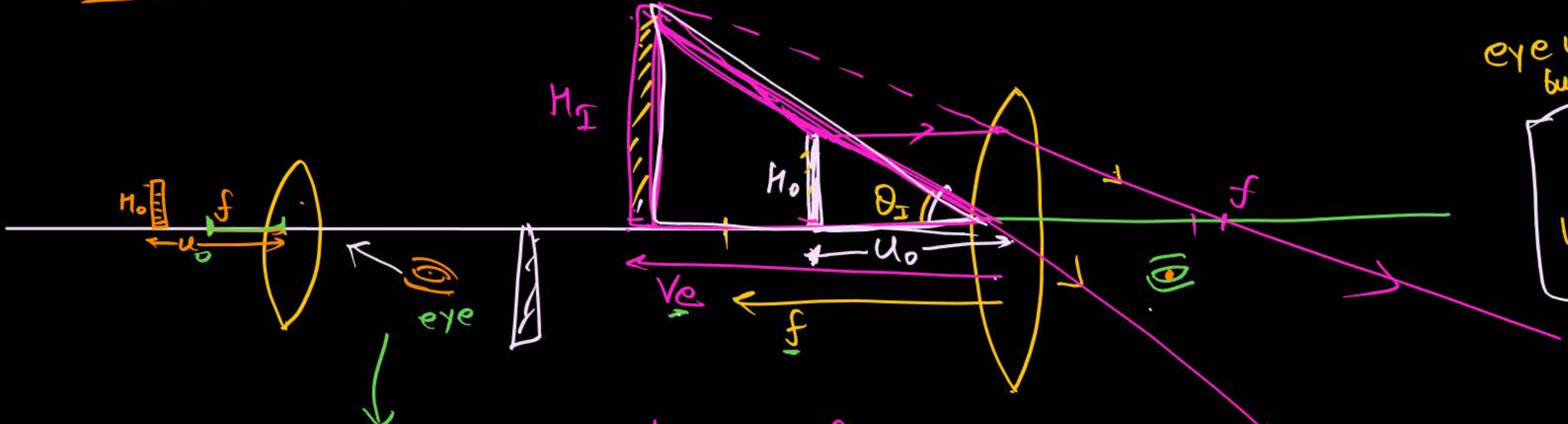


$$\boxed{\theta_0 = \frac{H_0}{D} = \frac{H_0}{25\,cm}}$$

visual angle of object for normal eye

Angle of elevation

Optical instrument → simple microscope → (convex lens)



eye will see Image but not object

$$\theta_0 = \frac{H_0}{u_0}$$ (wrong)

visual angle of object → Not correct

$$\theta_0 = \frac{H_0}{D} \quad \text{— (1)}$$

visual angle correct

No, this eye will not able to see object & his Image

virtual
erect
Magnified
Same side

Angular magnification

$$M = \frac{\theta_I}{\theta_0} = \frac{H_0}{u_0} \times \frac{D}{H_0}$$

$$M = \frac{D}{u_0}$$ #

$$\theta_I = \frac{H_I}{V_e} = \frac{H_0}{u_0} \quad \text{— (II)}$$

$$M = \frac{\theta_I}{\theta_0} = \frac{h}{h} \times \frac{D}{u_e} = \frac{D}{u_e}$$

Angular magnification

$$M = \frac{D}{u_0}$$

using lens formula

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

$$-\frac{1}{v} + \frac{1}{u_0} = \frac{1}{f}$$

$$\frac{1}{u_0} = \frac{1}{f} + \frac{1}{v}$$

$$M = D\left[\frac{1}{f} + \frac{1}{v}\right]$$

Maximum magnification

$V = D$ — (1)

Strained eye position

$$M = D\left[\frac{1}{f} + \frac{1}{D}\right]$$

$$M = \frac{D}{f} + 1$$

Maximum

minium maximum

rexaed eye Position

Parallel ray Condition

Image is at infinity

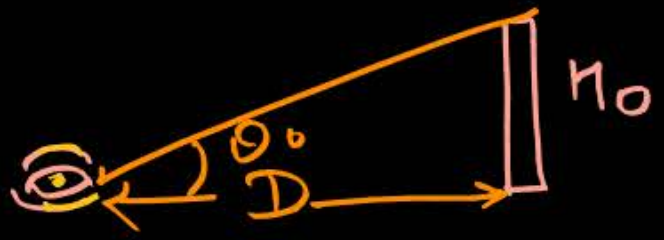
$V = \infty$

$$M = D\left[\frac{1}{f} + \frac{1}{\infty}\right]$$

$$M = \frac{D}{f}$$

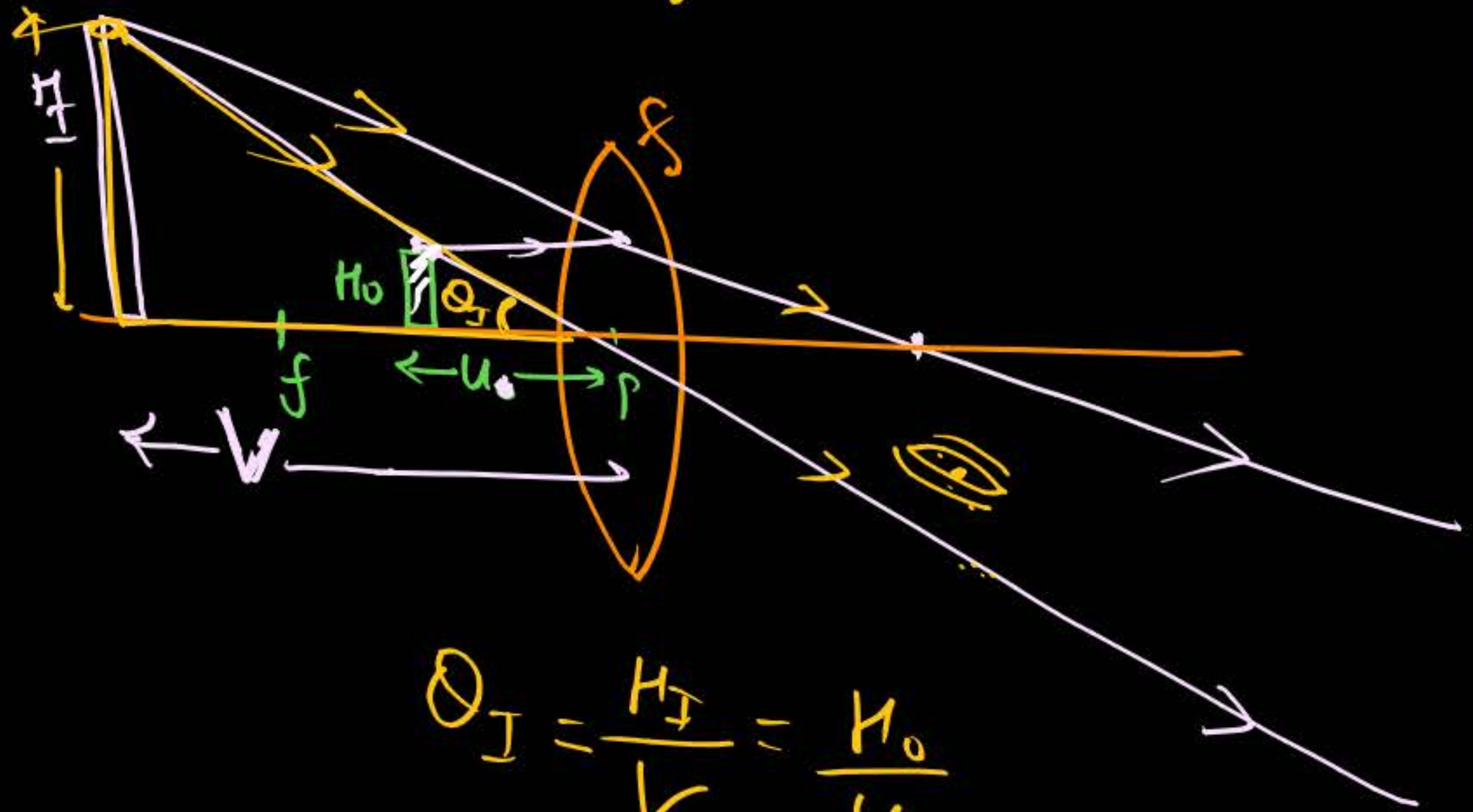
minium

Revision of simple microscope



$$\theta_o = \frac{H_o}{D}$$

visual angle of object



$$\theta_I = \frac{H_I}{V} = \frac{H_o}{u}$$

$$M = \frac{\text{visual angle of Image}}{\text{visual angle of object}}$$

$$M = \frac{\theta_I}{\theta_o} = \frac{H_o}{u} \times \frac{D}{H_o}$$

$$M = \frac{D}{u}$$ ✓ MR Ratta

Lens formula

$$-\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$$

$$\frac{1}{u} = \frac{1}{f} + \frac{1}{v}$$

$$M = D\left[\frac{1}{f} + \frac{1}{v}\right]$$

Image is at infinity

$$M = \frac{D}{f}$$

minimum

Image is at $v = D$

$$M = D\left[\frac{1}{f} + \frac{1}{D}\right]$$

$$M = 1 + \frac{D}{f}$$

max

SIMPLE MICROSCOPE

- Use as a magnifier.
- Converging (convex) lens of short focal length.
- Erect, magnified and virtual image.

(i) Image is at infinity

- relaxed eye position
- comfortable eye
- for point

$m = D/f$

(ii) Image is at 25 cm $= D$

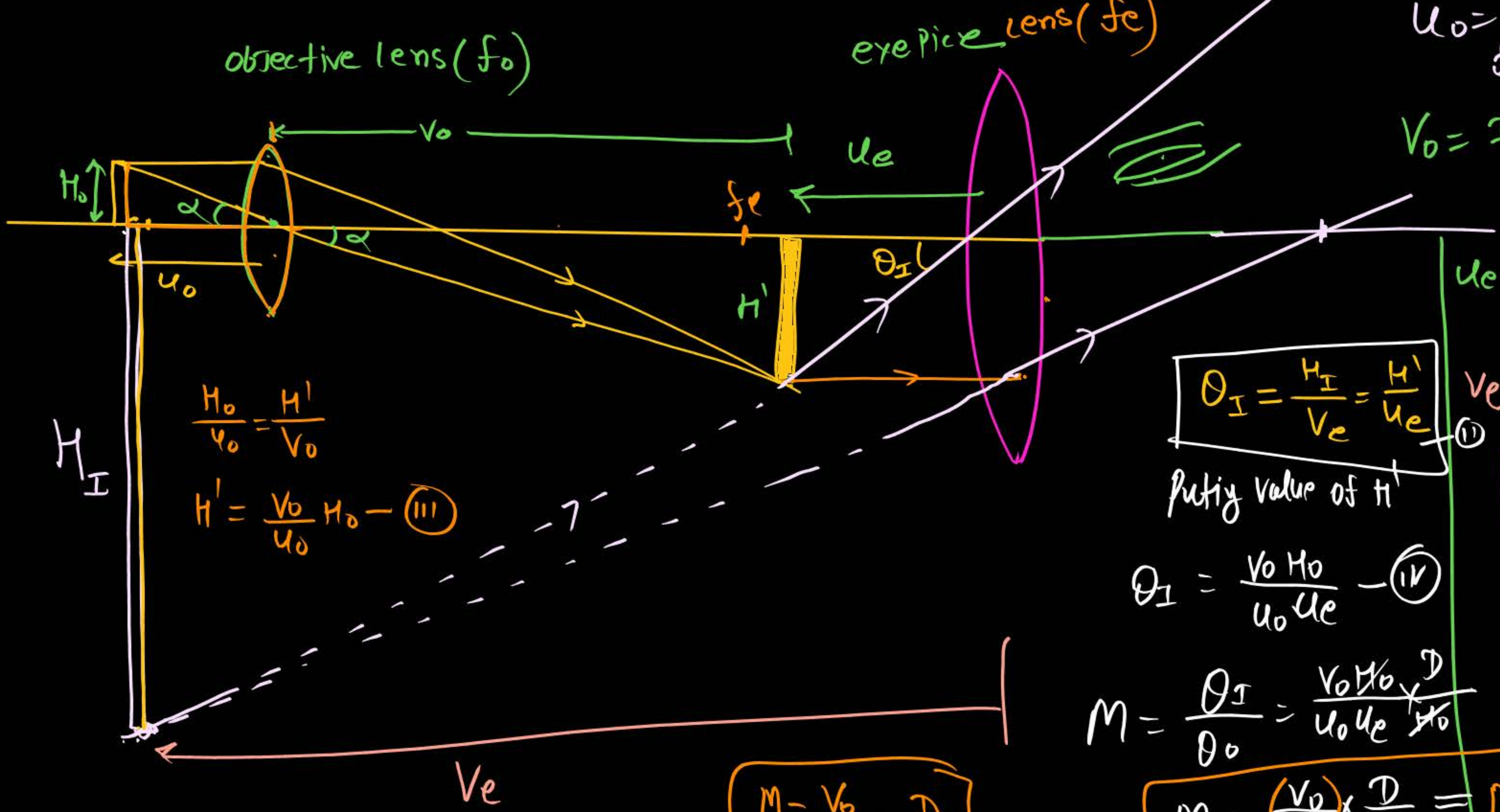
- strained eye
- near point

$m = 1 + D/f$

$$M(\text{Magnifying power}) = \frac{\text{visual angle formed by final image}}{\text{visula angle formed by the object where it is at D}}$$

Simple microscope has a limited magnification ($m \leq 9$) for realistic focal length. For much larger magnification, we use two lens called compound microscope.

Compound microscope → combination of two convex lens



u_o = object distance from objective lens

V_o = Image dist^n from objective

u_e = object dist^n from eyepice

V_e = Image dist^n for eyepice

$$\frac{H_o}{u_o} = \frac{H'}{V_o}$$

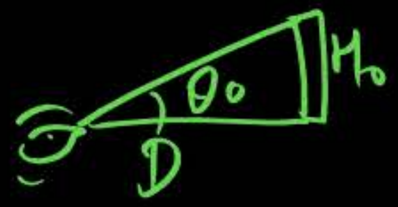
$$H' = \frac{V_o}{u_o} H_o \quad \text{— (III)}$$

$$\theta_I = \frac{H_I}{V_e} = \frac{H'}{u_e} \quad \text{— (II)}$$

Putiy value of H'

$$\theta_I = \frac{V_o H_o}{u_o u_e} \quad \text{— (IV)}$$

$$\theta_o = \frac{H_o}{D} \quad \text{— (I)}$$



$$M = \frac{\theta_I}{\theta_o} = \frac{V_o H_o}{u_o u_e} \times \frac{D}{H_o}$$

$$M = \left(\frac{V_o}{u_o}\right) \times \frac{D}{u_e} = M_{object} \times M_{eyepiece}$$

$$M = \frac{V_o}{u_o} \times \frac{D}{u_e}$$

using lens formule for exepice lens

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

$$-\frac{1}{v_e} + \frac{1}{u_e} = -\frac{1}{f_e}$$

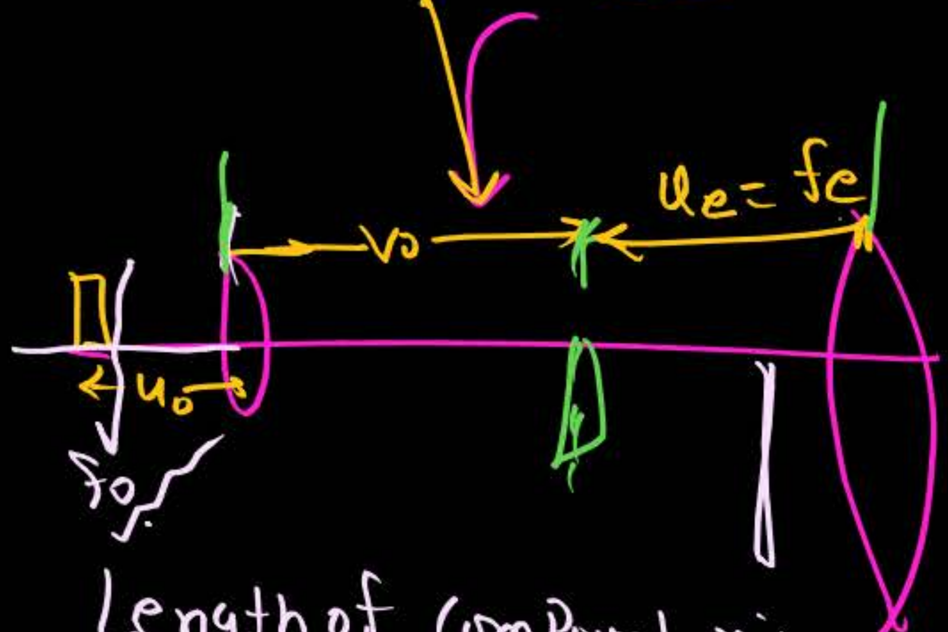
$$\left(\frac{1}{u_e}\right) = \frac{1}{f_e} + \frac{1}{v_e}$$

$$M = \frac{v_0 D}{u_0 u_e}$$

$$M = \frac{v_0 D}{u_0}\left[\frac{1}{f_e} + \frac{1}{v_e}\right]$$

for point
rexal eye pun.
paral ray covg
Image is at inif.

$$M = \frac{v_0 D}{u_0 f_e}$$



Length of compound microsope $= v_0 + f_e$

* for maximum magnifiw $u_0 \cong f_0$

$[L \cong v_0]$

near point

$$M = \frac{v_0 D}{u_0}\left[\frac{1}{f_e} + \frac{1}{D}\right]$$

$$M = \frac{v_0}{u_0}\left[1 + \frac{D}{f_e}\right]$$

$$M = \frac{v_0}{u_0} \times \left(1 + \frac{D}{f_e}\right)$$

$$L = v_0 + u_e$$

length of microsc

COMPOUND MICROSCOPE

Objective lens

- Near the object
- Forms real, inverted, magnified image of object
- Small focal length

The eyepiece

- Large focal length
- Use as a simple microscope or magnifier.
- Forms large virtual image

QUESTION

The focal length of a converging lens is 8 cm. Find its magnification power when it is used as a reading lens to form the image at near point.

$v = D$

$M = 1 + \frac{D}{f}$

$= 1 + \frac{25}{8}$ 3.1

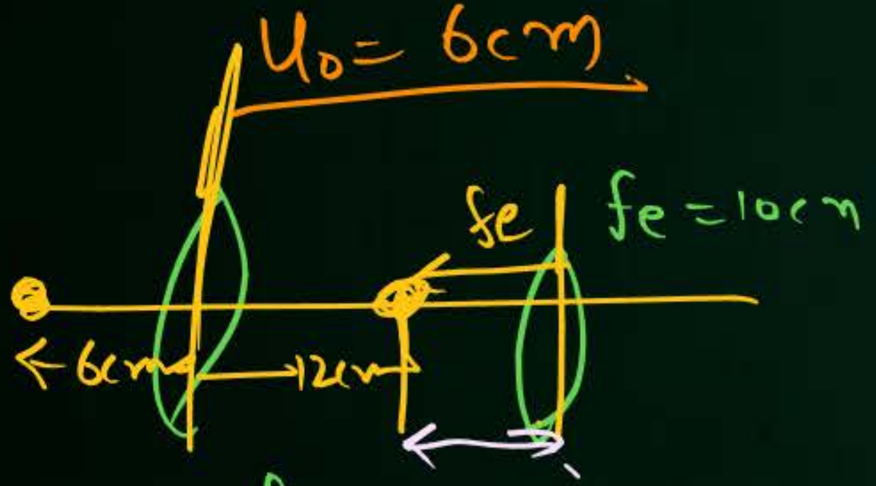
$= 1 + 3.1$

$= 4.1$

QUESTION

A compound microscope uses an objective lens of focal length 4 cm and eyepiece lens of focal length 10 cm. An object Is placed at 6 cm from the objective lens. Calculate the magnifying power of the compound microscope. Also, calculate the length of the microscope.

[All India 2011]



$f_0 = 4cm$

$\frac{1}{v} + \frac{1}{6} = \frac{1}{4}$

$\frac{1}{v} = \frac{1}{4} - \frac{1}{6} = \frac{6-4}{24} = \frac{2}{24} = \frac{1}{12}$ $\quad$ $v = 12cm$

Assume for point cond^n

$L = f_e + 12 = 12 + 10 = 22cm$

$M = \frac{v_0}{u_0}\left(\frac{D}{u_e}\right) = \left[\frac{v_0}{u_0} \times \frac{D}{f_e}\right]$

$= \frac{12}{6} \times \frac{25}{10}$

$= 2 \times 2.5$

$= \boxed{5}$

QUESTION

In a compound microscope the focal length of an objective lens is 1.2 cm and focal length of eyepiece is 3 cm. When the object is kept at 1.25 cm in front of the objective, the final image is formed at infinity. Magnifying power of the compound microscope should be:

1. 400
2. 200
3. 150
4. 100

Simple micro.

$$\theta_I = \frac{H_0}{u}$$

$$\theta_0 = \frac{H_0}{D}$$

$$M = \frac{\theta_I}{\theta_0} = \frac{H_0}{u} \times \frac{D}{H_0}$$

$$M = \frac{D}{u} = D\left[\frac{1}{f} + \frac{1}{v}\right]$$

$v = \infty$ (for point) $M = \frac{D}{f}$

near point $M = 1 + \frac{D}{f}$

Compound microscope

$$M = M_{object} \times M_{exepic}$$

M_{object} → normal lens

M_{exepic} → simple micro

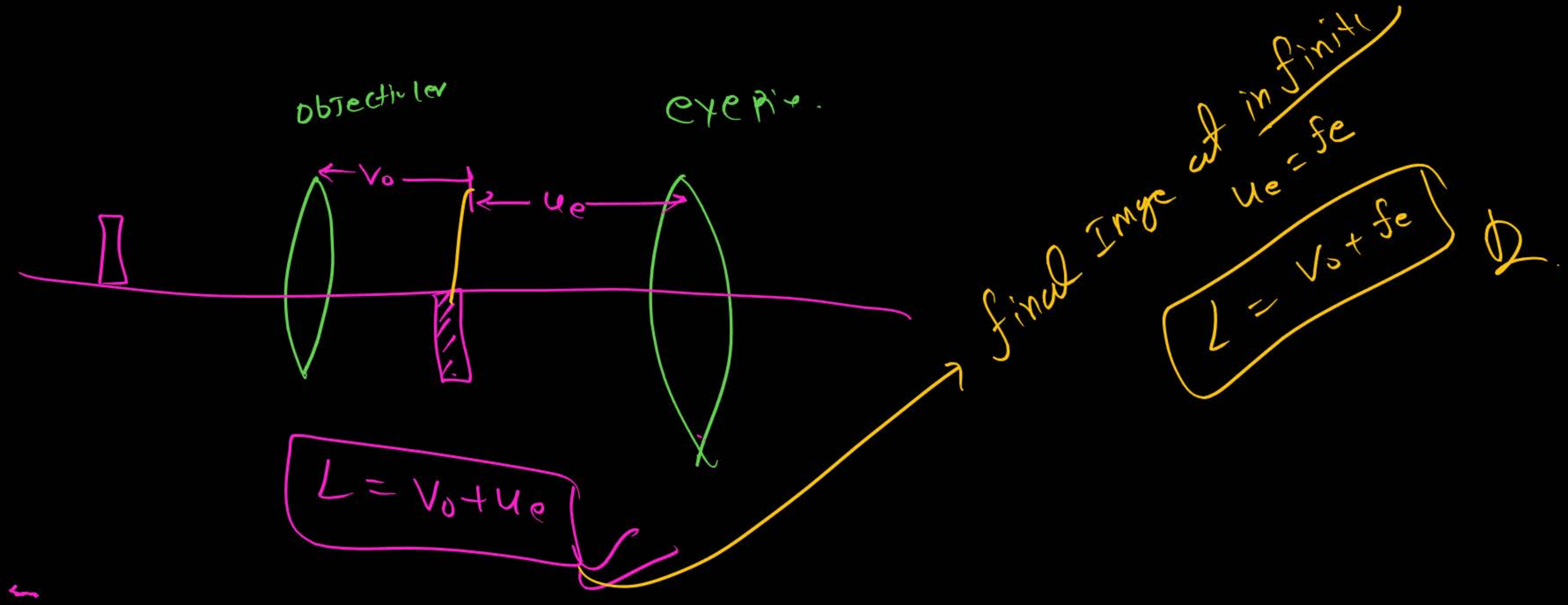
$$M = \frac{v_0}{u_0} \times \frac{D}{u_e}$$

$$M = \frac{v_0 D}{u_0}\left[\frac{1}{f_e} + \frac{1}{v_e}\right]$$

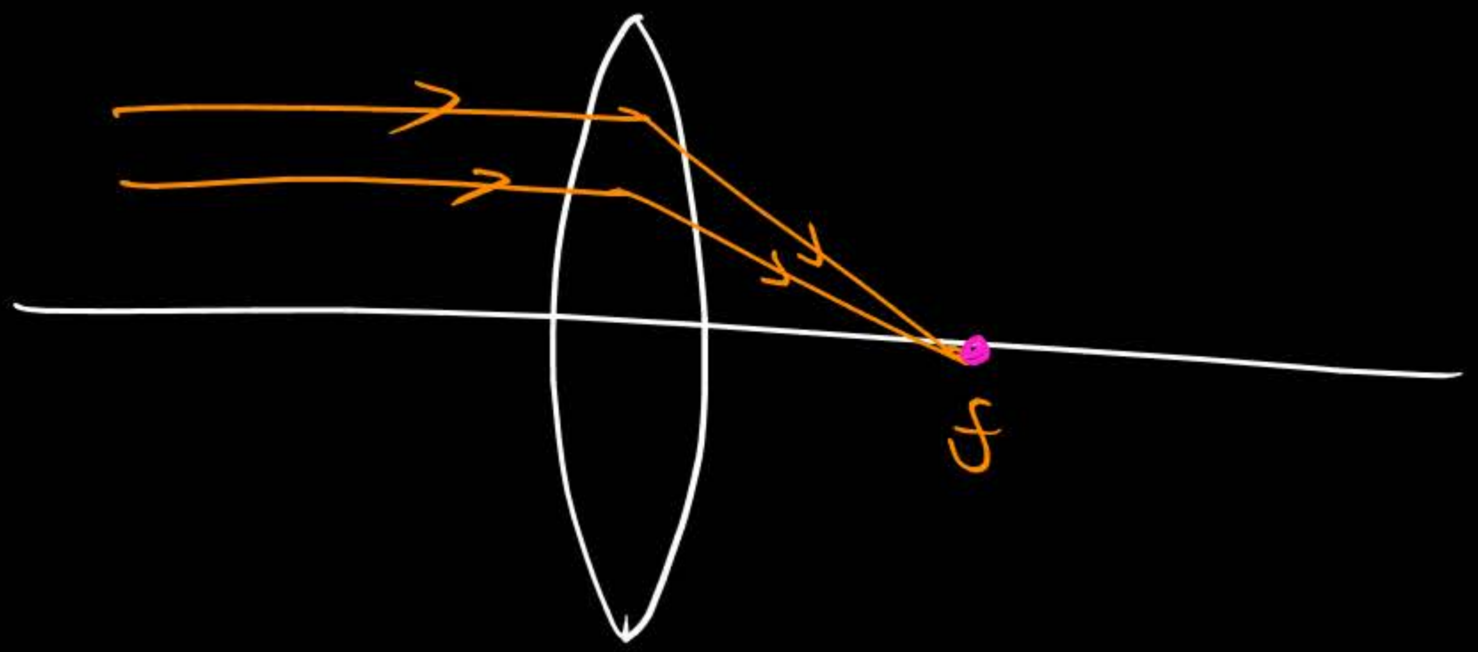
image is at infi (for point)

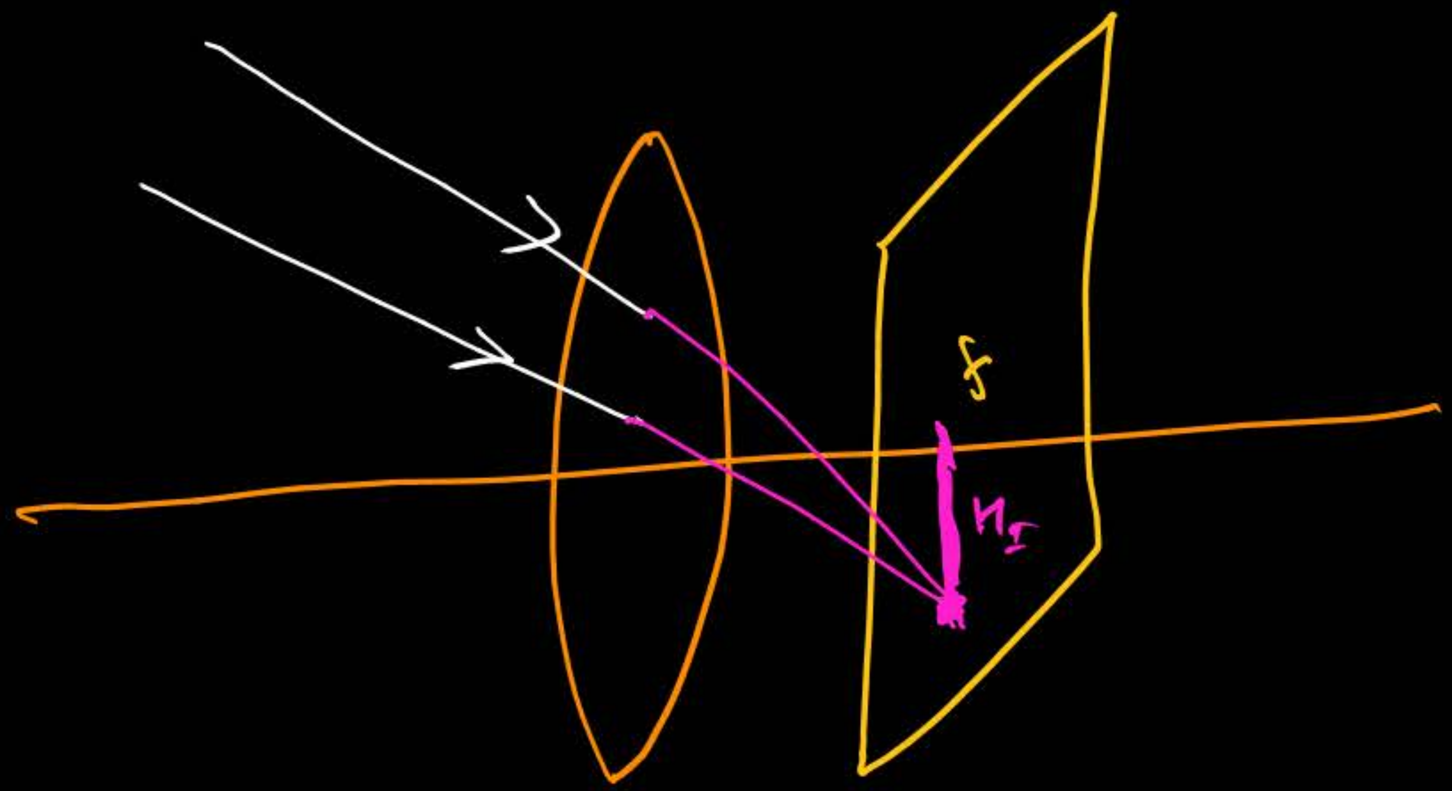
$$M = \frac{v_0 D}{u_0}\left[\frac{1}{f_e} + \frac{1}{\infty}\right] = \frac{v_0 D}{u_0 f_e}$$

$$M = \frac{v_0}{u_0}\left(1 + \frac{D}{f_e}\right)$$



V_o
u_e
$L = V_o + u_e$
final Image at infinite
$u_e = f_e$
$L = V_o + f_e$


f

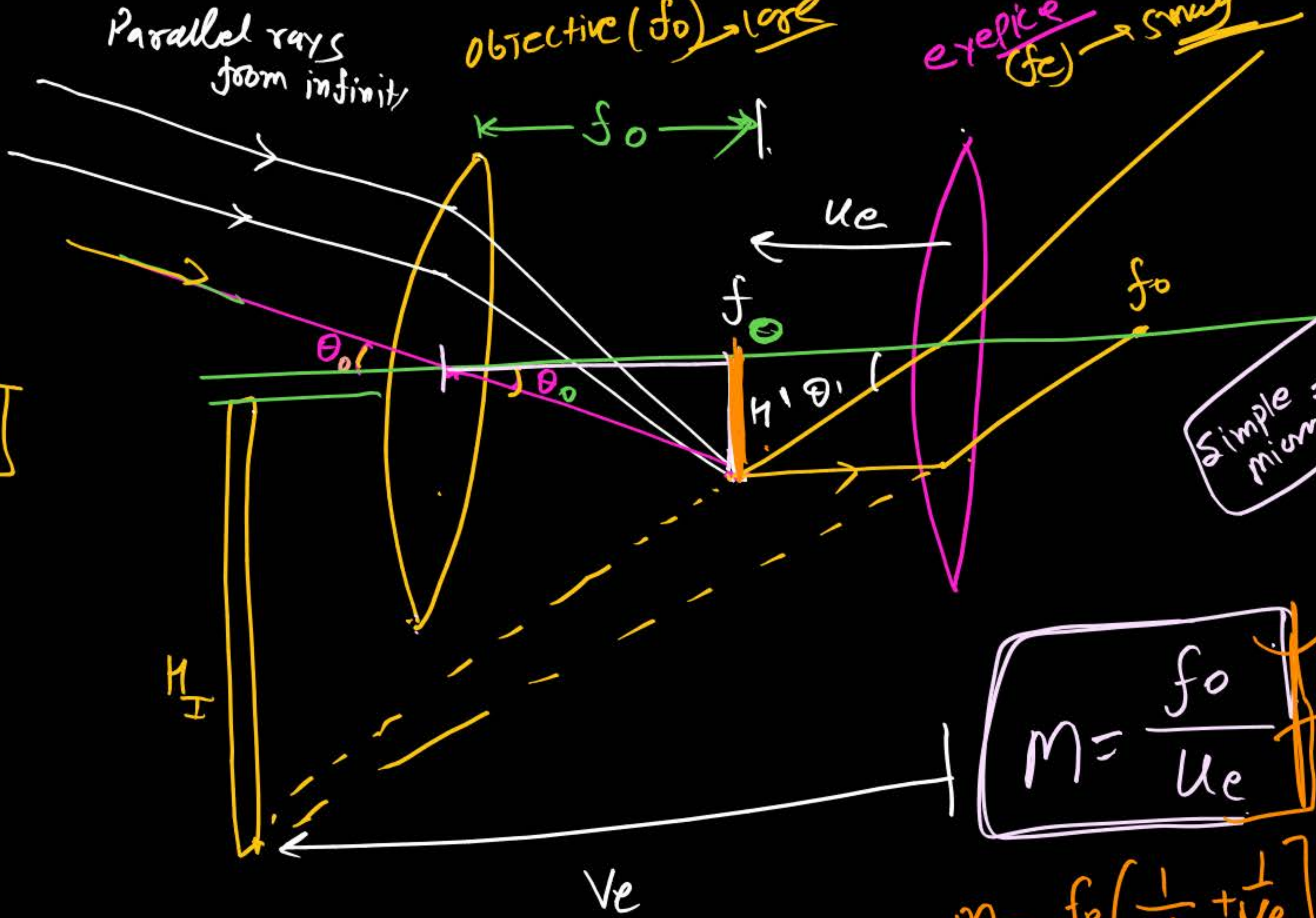

f
M_I

Telescope

(simple microscope)

for Telescope $\theta_0 = \frac{H_0}{D}$ — ✗ wrong

$* \quad L = f_0 + u_e$



Simple micro $= \frac{D}{u_e}$

$$M = \frac{f_0}{u_e}$$

lens formula

$$M = f_0\left(\frac{1}{f_e} + \frac{1}{V_e}\right)$$

image at infinity → near point

$$M = \frac{f_0}{f_e} \qquad M = 1 + \frac{f_0}{f_e}$$

$$\theta_0 = \frac{H'}{f_0} \quad \text{— (I)}$$

$$\theta_I = \frac{H_I}{V_e} = \frac{H'}{u_e} \quad \text{— (II)}$$

Angular magnification $\Rightarrow M = \frac{\theta_I}{\theta_0} = \frac{H'}{u_e} \times \frac{f_0}{H'} = \left\{\frac{f_0}{u_e}\right\}$

Telescope

f_o

$m = \frac{f_o}{u_e}$

$m = f_o\left[\frac{1}{f_e} + \frac{1}{v_e}\right]$

$v = \infty$

$M = \frac{f_o}{f_e}$

near: $1 + \frac{f_o}{f_e}$

Simple microscope

$D =$

$m = \frac{D}{u_e}$

$m = D\left[\frac{1}{f} + \frac{1}{v}\right]$

inf: $m = D/f_e$

$m = 1 + \frac{D}{f}$ near

Large magnification

f_o large

$f_e \rightarrow$ small

TELESCOPE

Angular magnification of distant objects.

Objective $\rightarrow$ large focal length and large aperture, real, inverted, magnified.

Eyepiece $\rightarrow$ small eyepiece, magnified virtual image

QUESTION

The focal lengths of the objective and eyepiece of a telescope are 60 cm and 5 cm respectively. Find its magnifying power (P) for normal adjustment and when the image forms at near point.

f_o f_e

far point

$M = \frac{f_o}{u_e} = \frac{f_o}{f_e} = \frac{60}{5} = 12$

$L = f_o + u_e$
$= 60 + 5$
$= 65 cm$

$M_{np} = 1 + \frac{f_o}{f_e}$
$= 1 + \frac{60}{5}$
$= 13$

QUESTION

A telescope with objective of focal length 60 cm and eye piece of focal length 5 cm focused on a far distance object such that the parallel rays emerge from eye piece. If object subtends an angle 2° on objective, then angular width of the image is

1. 62°
2. 48°
3. 24°
4. 12°

far point

$M = \frac{\theta_I}{\theta_0} = \frac{f_0}{f_e}$

$\frac{\theta_I}{2^\circ} = \frac{60}{5}$ 12

$\theta_I = 24^\circ$

QUESTION

Four lenses having the focal length of +15 cm, +20 cm, +150 cm and +250 cm respectively are provided to make an astronomical telescope. Then, focal length of the eye piece to produce the largest magnification should be

1. 250 cm
2. 150 cm
3. 20 cm
4. 15 cm

$m = \frac{f_o}{f_e}$

Ans

QUESTION

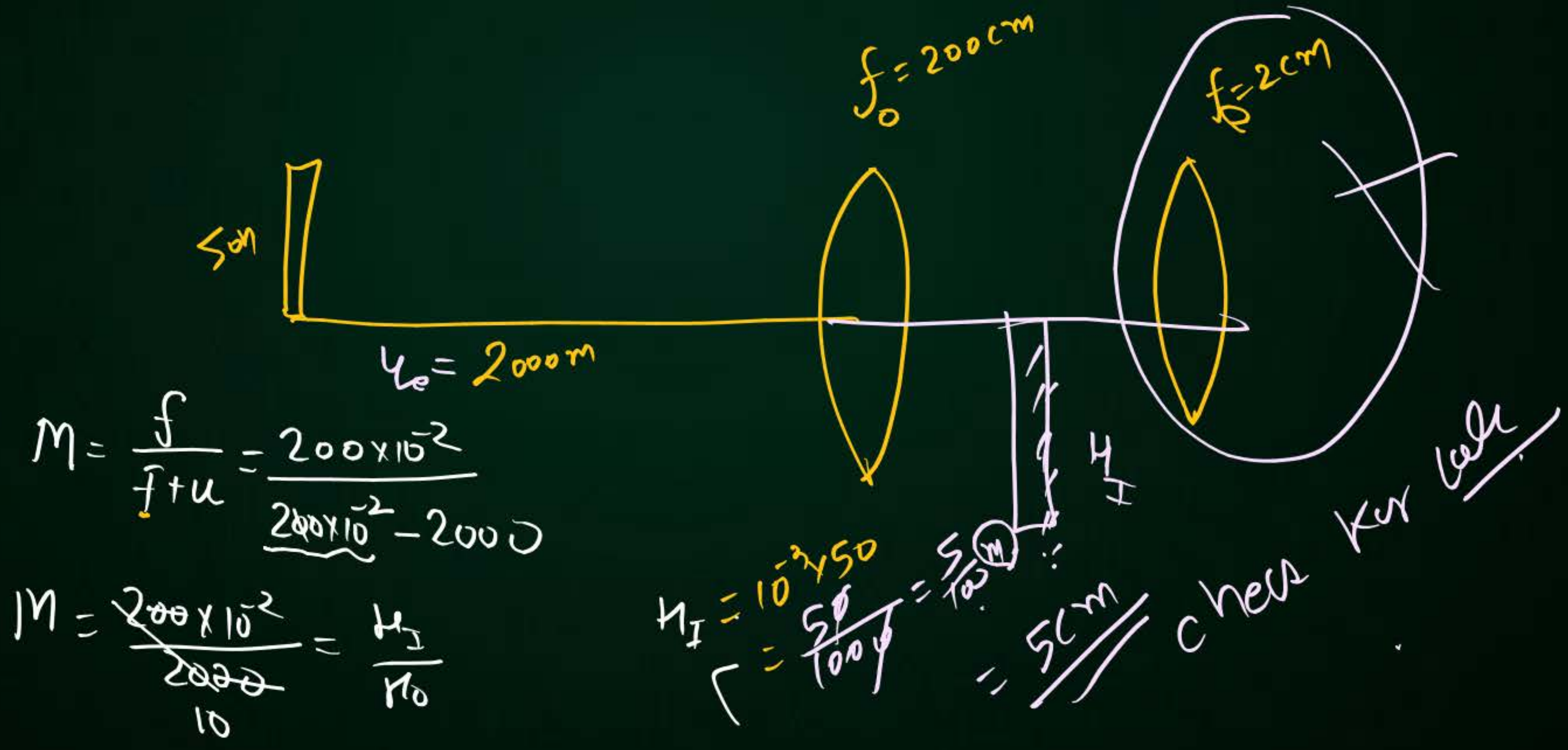
The optical length of an astronomical telescope with magnifying power of 10, for normal vision is 44 cm. What is focal length of the objective?

1. 4 cm
2. 40 cm
3. 44 cm
4. 440 cm

QUESTION

A telescope has an objective lens of focal length 200 cm and an eye piece with focal length 2 cm. If this telescope is used to see a 50 m tall building at a distance of 2 km, what is the height of the image of the building formed by the objective lens?

1. 5 cm
2. 10 cm
3. 1 cm
4. 2 cm



QUESTION

A astronomical telescope has objective and eyepiece of focal lengths 40 cm and 4 cm respectively. To view an object 200 cm away from the objective, the lenses must be separated by a distance (NEET-I 2016)

1. 50.0 cm
2. 54.0 cm
3. 37.3 cm
4. 46.0 cm

H/W

QUESTION

The magnifying power of a telescope is 9. When it is adjusted for parallel rays the distance between the objective and eyepiece is 20 cm. The focal length of lenses are

(2012)

1. 10 cm, 10 cm
2. 15 cm, 5 cm
3. 18 cm, 2 cm
4. 11 cm, 9 cm

QUESTION

An astronomical telescope of tenfold angular magnification has a length of 44 cm. The focal length of the objective is

1. 44 cm
2. 440 cm
3. 4 cm
4. 40 cm

QUESTION

In an astronomical telescope in normal adjustment a straight black line of length L is drawn on inside part of objective lens. The eye-piece forms a real image of this line. The length of this image is I. The magnification of the telescope is (2015)

1. $\frac{L+I}{L-I}$
2. $\frac{L}{I}$
3. $\frac{L}{I}+1$
4. $\frac{L}{I}-1$

RAY OPTICS

Corpuscular theory given by Newton

1. Very small particle emitted by light Source
2. That particle moves with speed of light-in Straight line.
3. Velocity more in optically denser medium
4. Different colour due to different size of corpuscular Particle.
5. It explain rectilinear propagation, reflection, refraction
6. It fail to explain Interference, diffraction and polarisation.

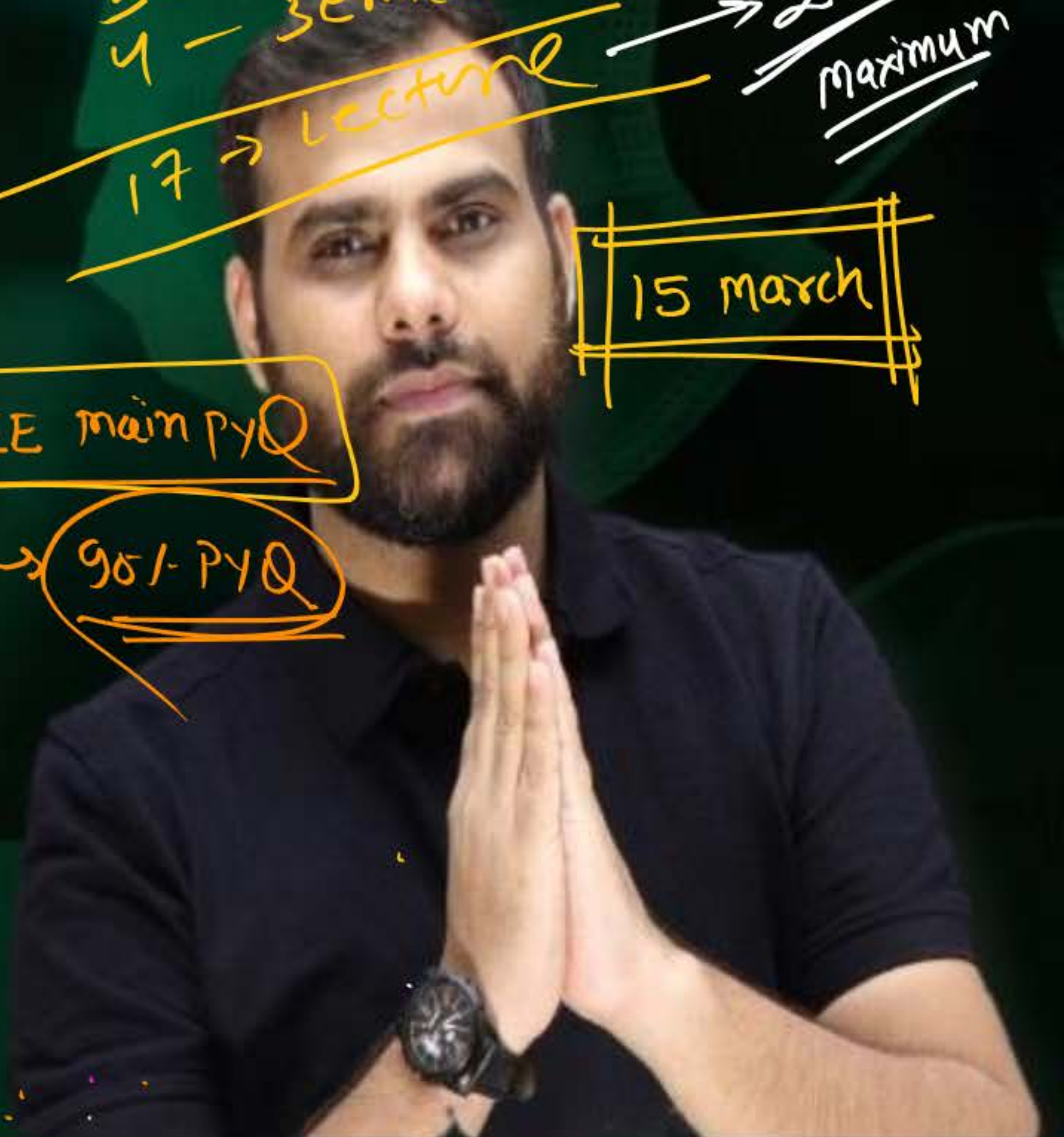

THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 01 | **Physics**

Wave Optics



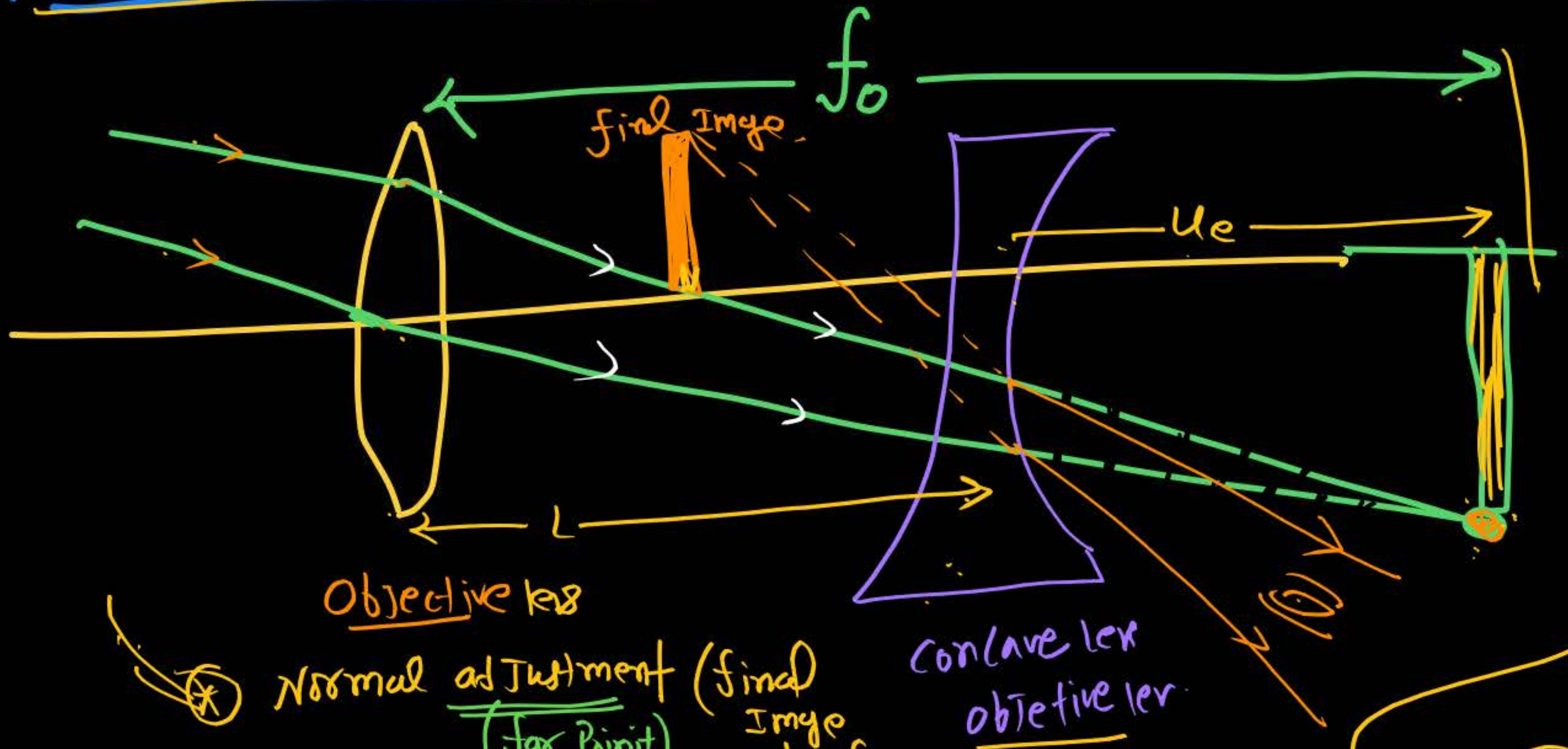
By- Dr. Manish Raj (MR SIR)

Todays Goal

→ Rainbow, Scattering (H/W)

→ Hugen Principle

Galilean Telescope (same as astronomical)

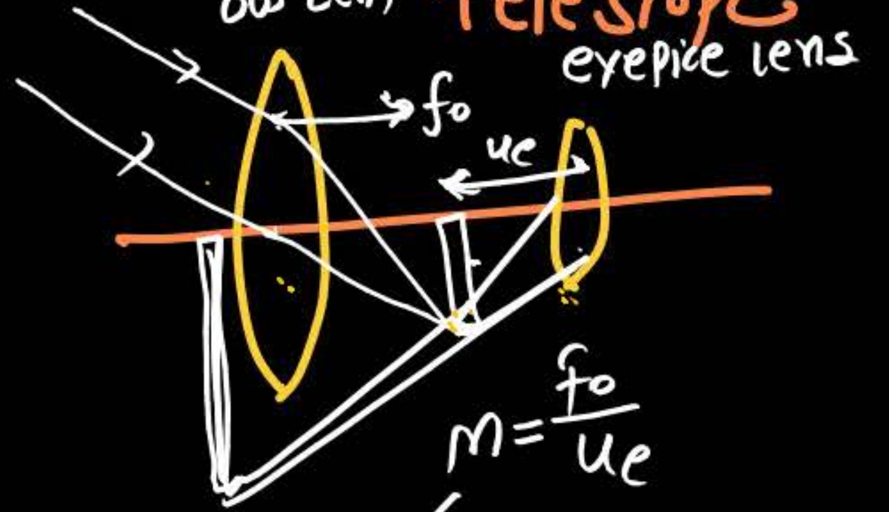


(*) Normal adjustment (far Point) (final Image at Infinity)

$u_e = f_e$

$$L = f_o - f_e$$

astronomical Telescope



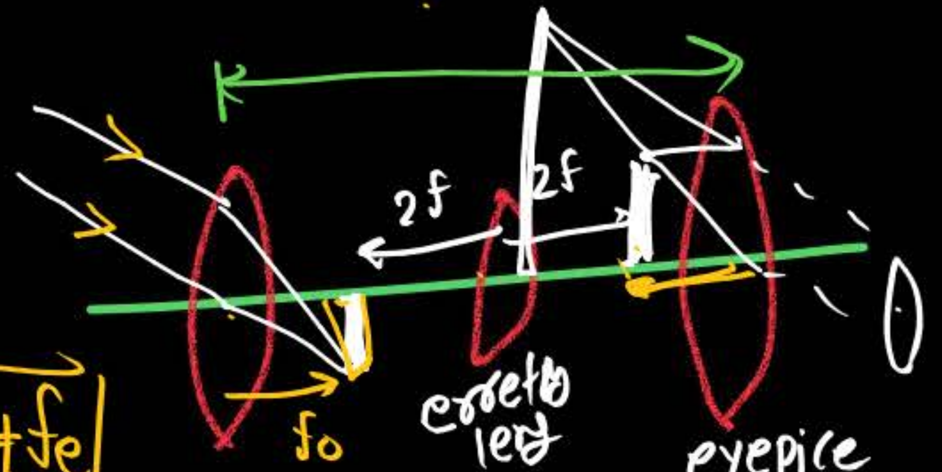
$M = \frac{f_o}{u_e}$

normal adJ for Point

$M = \frac{f_o}{f_e}$

$L = f_o + f_e$

Terrestial telescope



normal adJust

$$L = f_o + 4f + f_e$$

QUESTION

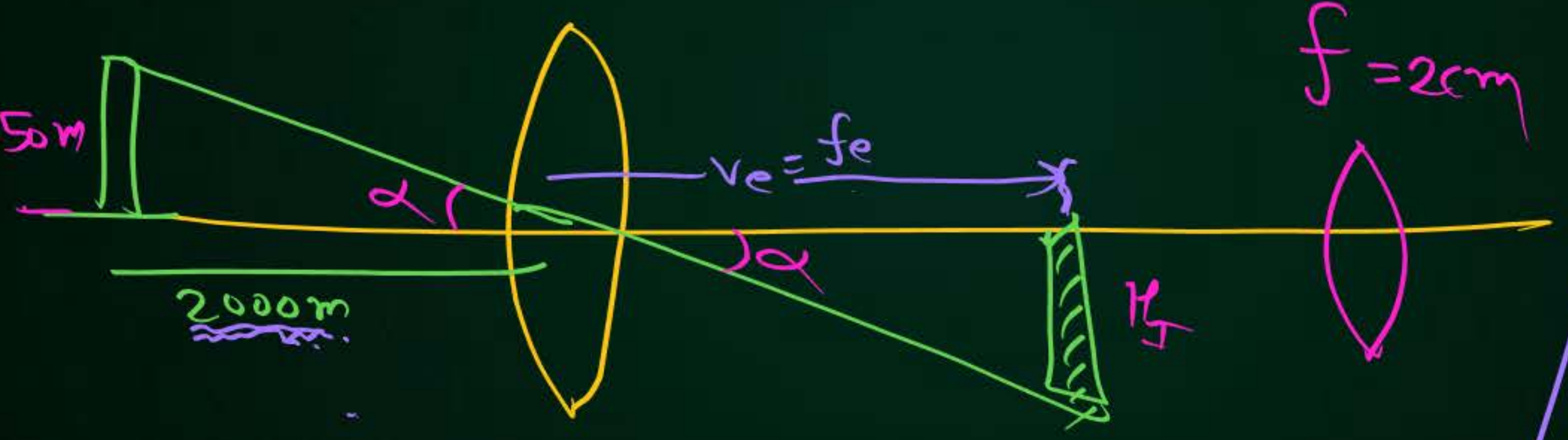
A Galileo telescope has an objective of focal length 100 cm and magnifying power 50. The distance between the two lenses in normal adjustment will be

1. 106 cm
2. 102 cm
3. 92 cm
4. 98 cm

QUESTION

A telescope has an objective lens of focal length 200 cm and an eye piece with focal length 2 cm. If this telescope is used to see a 50 m tall building at a distance of 2 km, what is the height of the image of the building formed by the objective lens?

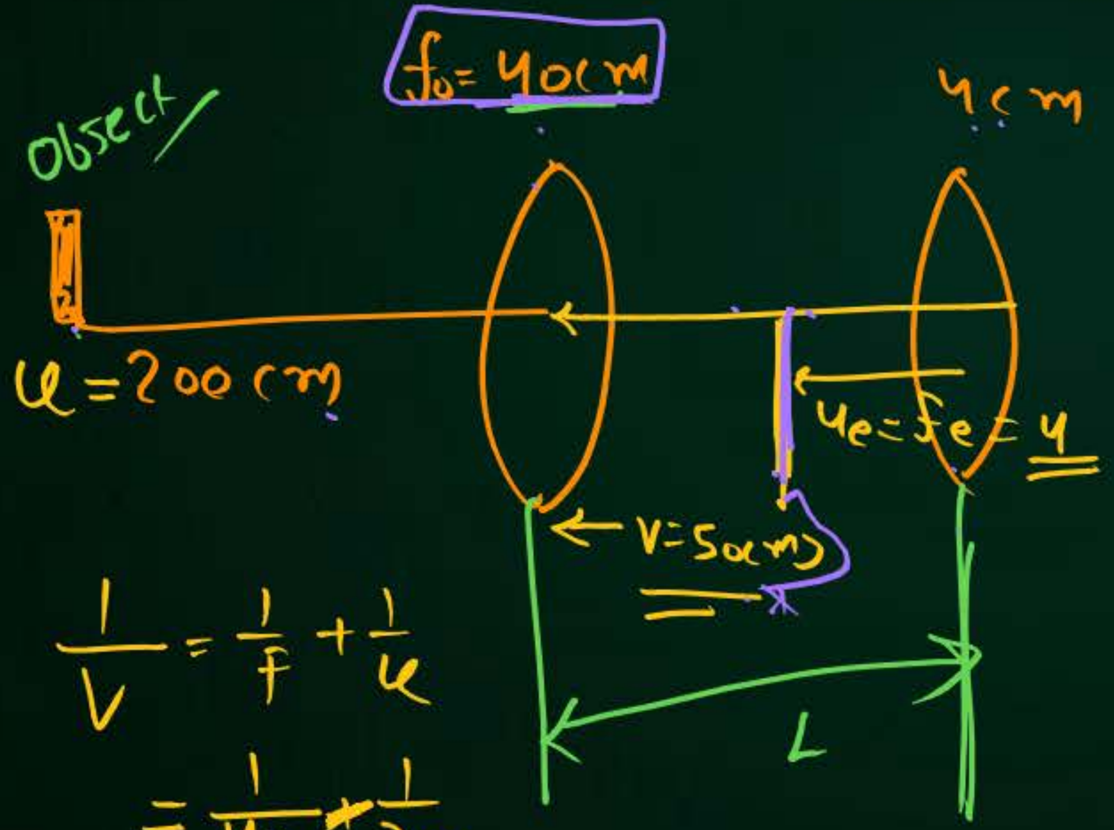
1. 5 cm
2. 10 cm
3. 1 cm
4. 2 cm



QUESTION

A astronomical telescope has objective and eyepiece of focal lengths 40 cm and 4 cm respectively. To view an object 200 cm away from the objective, the lenses must be separated by a distance (for normal adjustment) (NEET-I 2016)

1. 50.0 cm
2. 54.0 cm
3. 37.3 cm
4. 46.0 cm



$\frac{1}{v} = \frac{1}{f} + \frac{1}{u}$

$= \frac{1}{40} - \frac{1}{200}$

$\frac{1}{v} = \frac{5-1}{200}$

$v = \frac{200}{4} = 50$ cm

$L = f_o + f_e = 40 + 4 = 44$ cm

because object is not at infinity

QUESTION

The magnifying power of a telescope is 9. When it is adjusted for parallel rays the distance between the objective and eyepiece is 20 cm. The focal length of lenses are

(2012)

1. 10 cm, 10 cm
2. 15 cm, 5 cm
3. 18 cm, 2 cm
4. 11 cm, 9 cm

QUESTION

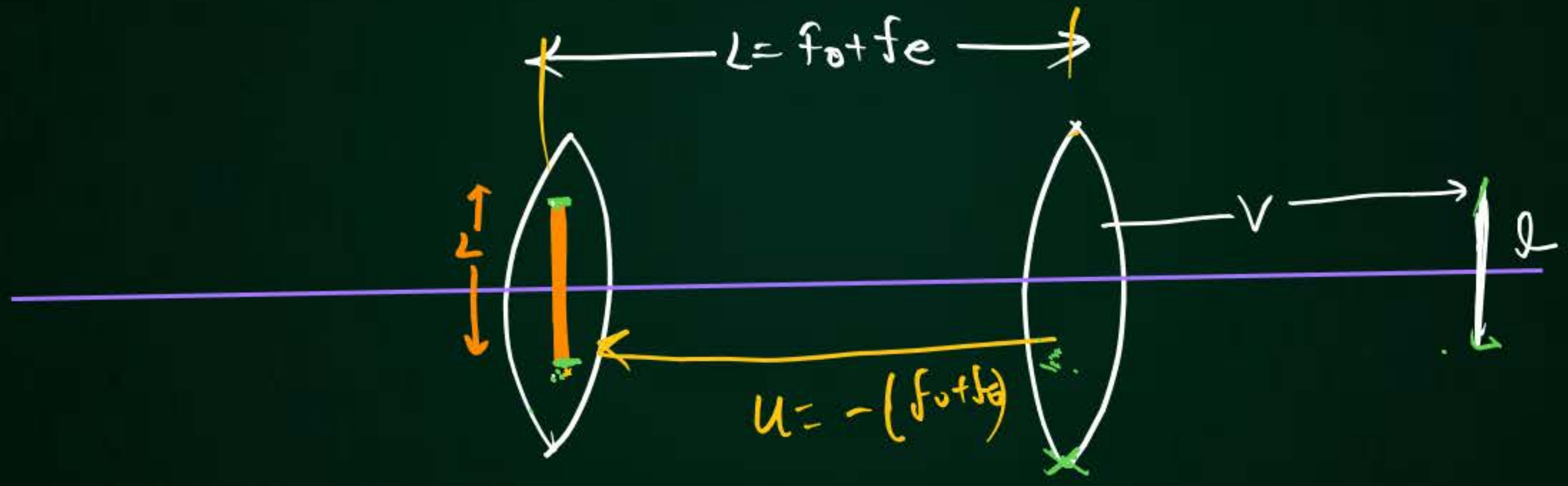
In an astronomical telescope in normal adjustment a straight black line of length L is drawn on inside part of objective lens. The eye-piece forms a real image of this line. The length of this image is I. The magnification of the telescope is **(2015)**

1. $\frac{L+I}{L-I}$

2. $\frac{L}{I}$

3. $\frac{L}{I}+1$

4. $\frac{L}{I}-1$

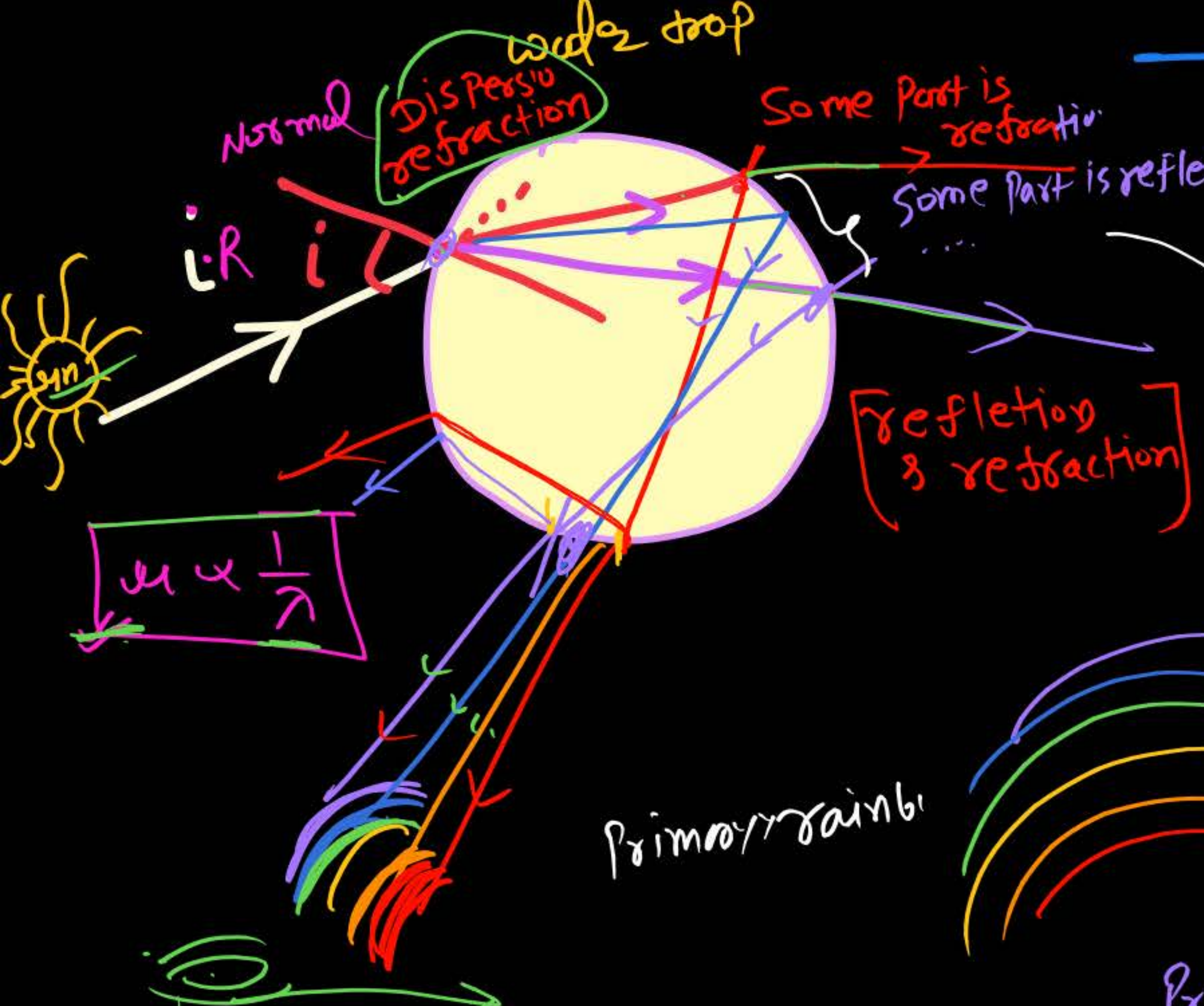


Rainbow formation → * There is no T.I.R. here

→ Dispersion + refraction then reflection again refraction

There is Internal refletion but No Total interal refletion

→ (2 refraction + 1 refletion)

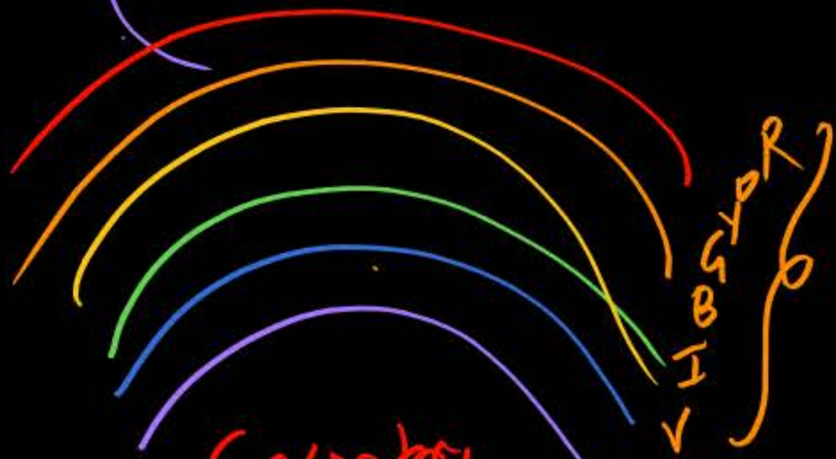


VIBGYOR

Sun ke opposite dekhoge tavi ranbow.



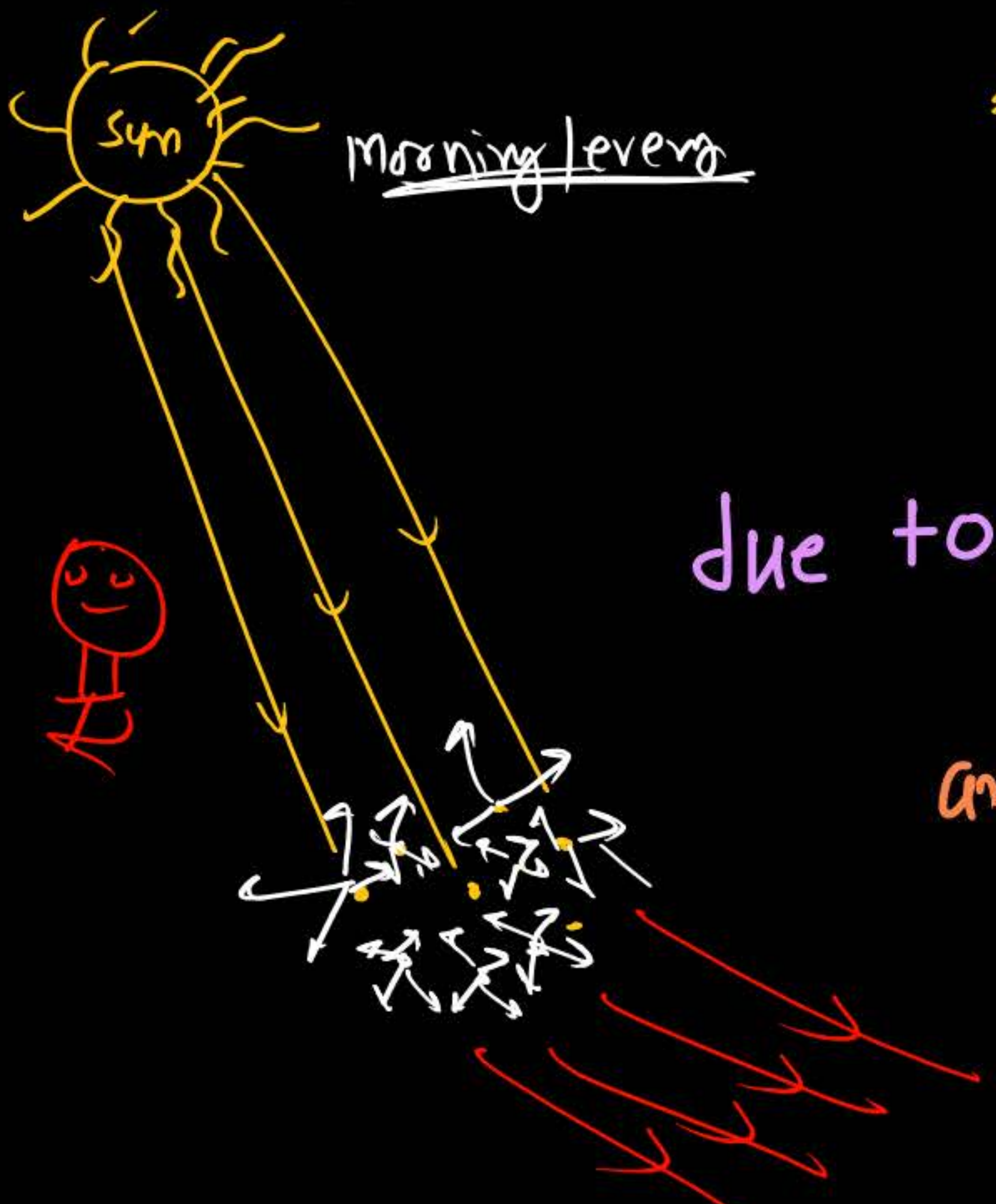
Primary rainbow 1° rain



Secondary rainbow → 2° rainb

Intensity low

Scattering of Light → Process in which medium particle absorb light and re-emits in all direction.

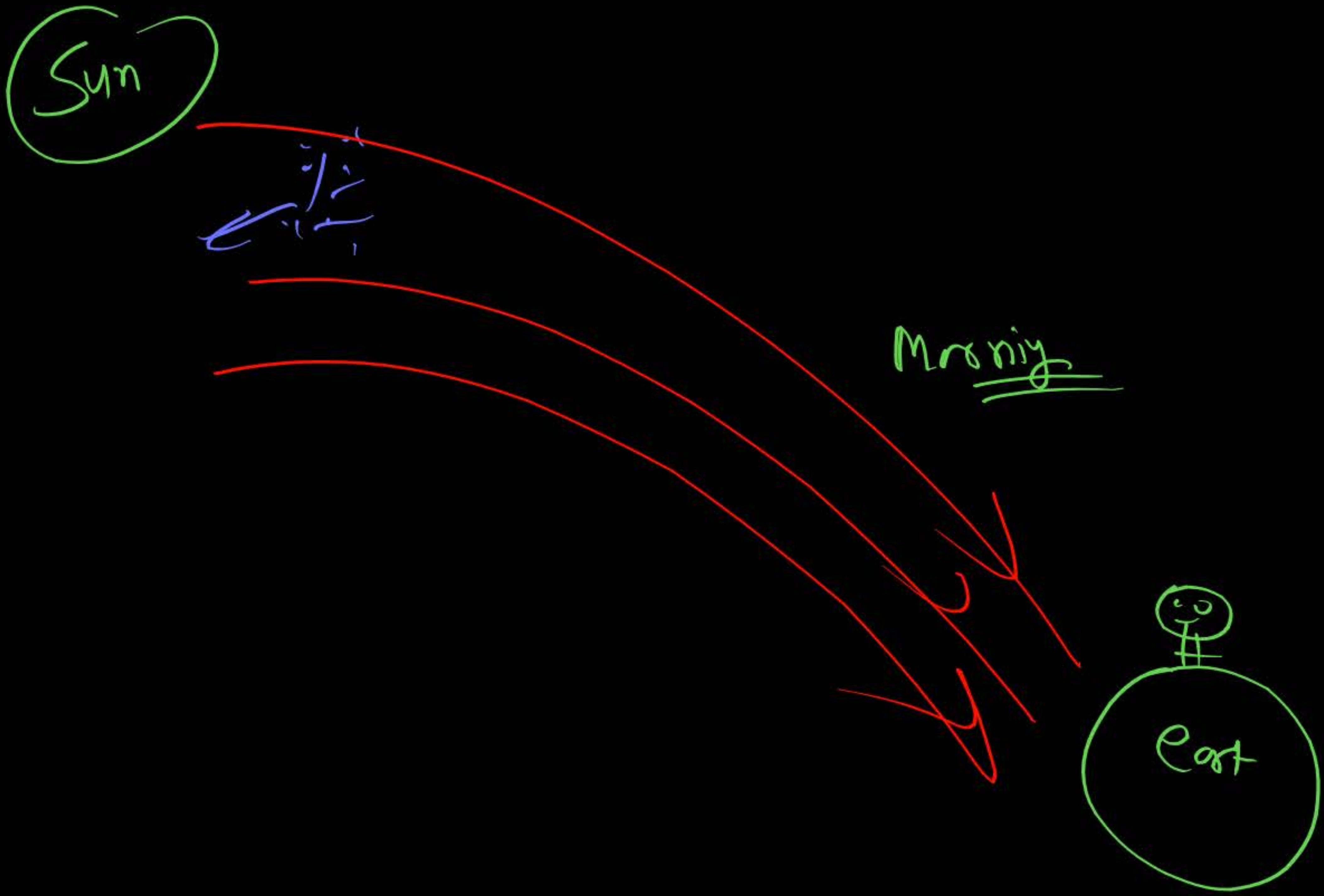


$\boxed{\text{Scattering} \propto \frac{1}{\lambda^4}}$

Bulue colour more scatter than Red

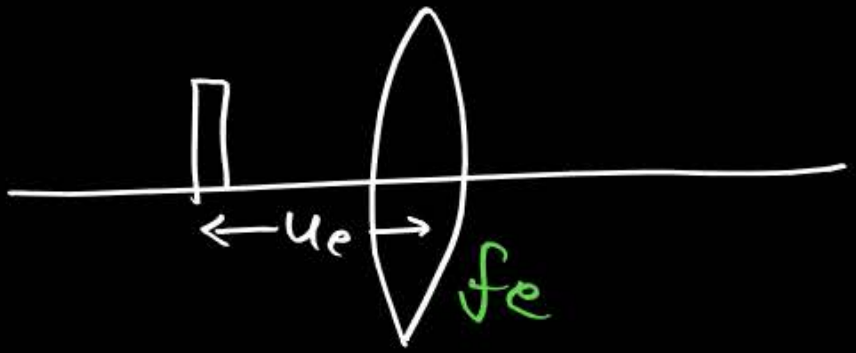
due to scattering Red sky in the time of sunset & sunrise

and In day time Blue colour of sky.


Sun
eart


sun

Simple microscope



$$M = \frac{D}{u_e}$$

$$M = D\left[\frac{1}{f} + \frac{1}{v}\right]$$

infinity

$$M = \frac{D}{f}$$

near Poi

$$M = 1 + \frac{D}{f}$$

Compound microsco

$$M = \frac{v_o}{u_o} \times \frac{D}{u_e}$$

$$M = \frac{v_o}{u_o} D\left[\frac{1}{f_e} + \frac{1}{v_e}\right]$$

eyepic simple..

Infinity

$$M = \frac{v_o}{u_o}\frac{D}{f_e}$$

Astronomical Telesele

Terestil Teles

Galileo Telesc

$L = f_o - f_e$

O IS

$$M = \frac{f_o}{u_e}$$ ← dis fom

$$M = \frac{f_o}{f_e}$$

at infi

Wave optics

light behave as wave

Interfernce, diffraction.

$l_{object} \approx \lambda_{light}$.

Huygen wave thory

Ray optics.

$l_{object} >> \lambda_{wave}$

Newtons Shahab

Corpusculer Particle

light as a Particle

when light intracts with e^-, P, α-part.
then it shows Particle natiure

RAY OPTICS

Corpuscular theory given by Newton

1. Very small particle emitted by light Source which is called corpuscular Particle.
2. That particle moves with speed of light-in Straight line. (ray)
3. Velocity more in optically denser medium. → $\downarrow V = \frac{c}{\mu (\text{denser}) \uparrow}$ → Yahi pe Newton Baba gulal ho gye.
4. Different colour due to different size of corpuscular Particle. → Colour is due to frequency
5. It explain rectilinear propagation, reflection, refraction
6. It fail to explain Interference, diffraction and polarisation.

HUYGEN WAVE THEORY

$y = A\sin(ky - \omega t)$ → wave

$x = A\sin(kx - \omega t)$

- Assume Light is a mechanical and longitudinal wave
- Requires medium for propagation. (ether medium)
- Us concept of wavelet & wavefront

  wavelet ↓ Point of ossillo
- He explain
  - → Rectilinear propagation
  - → Interference (YDSE)
  - → Reflection
  - → Refraction
  - → Diffraction

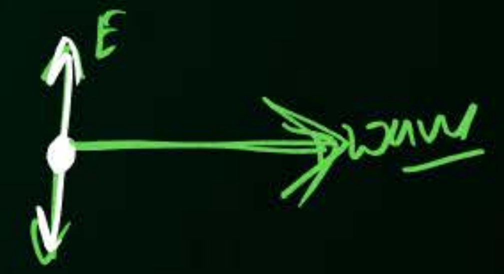
But huygen fail to explain → Polarisation. and Photoelectric, Compton effect.

EM wave

light is an Transverse, Non-mechanic wave.

according to maxwell

$E_y = E_0 \sin(kx - \omega t)$



Sound wave

- Mechanical wave
- longitudinal

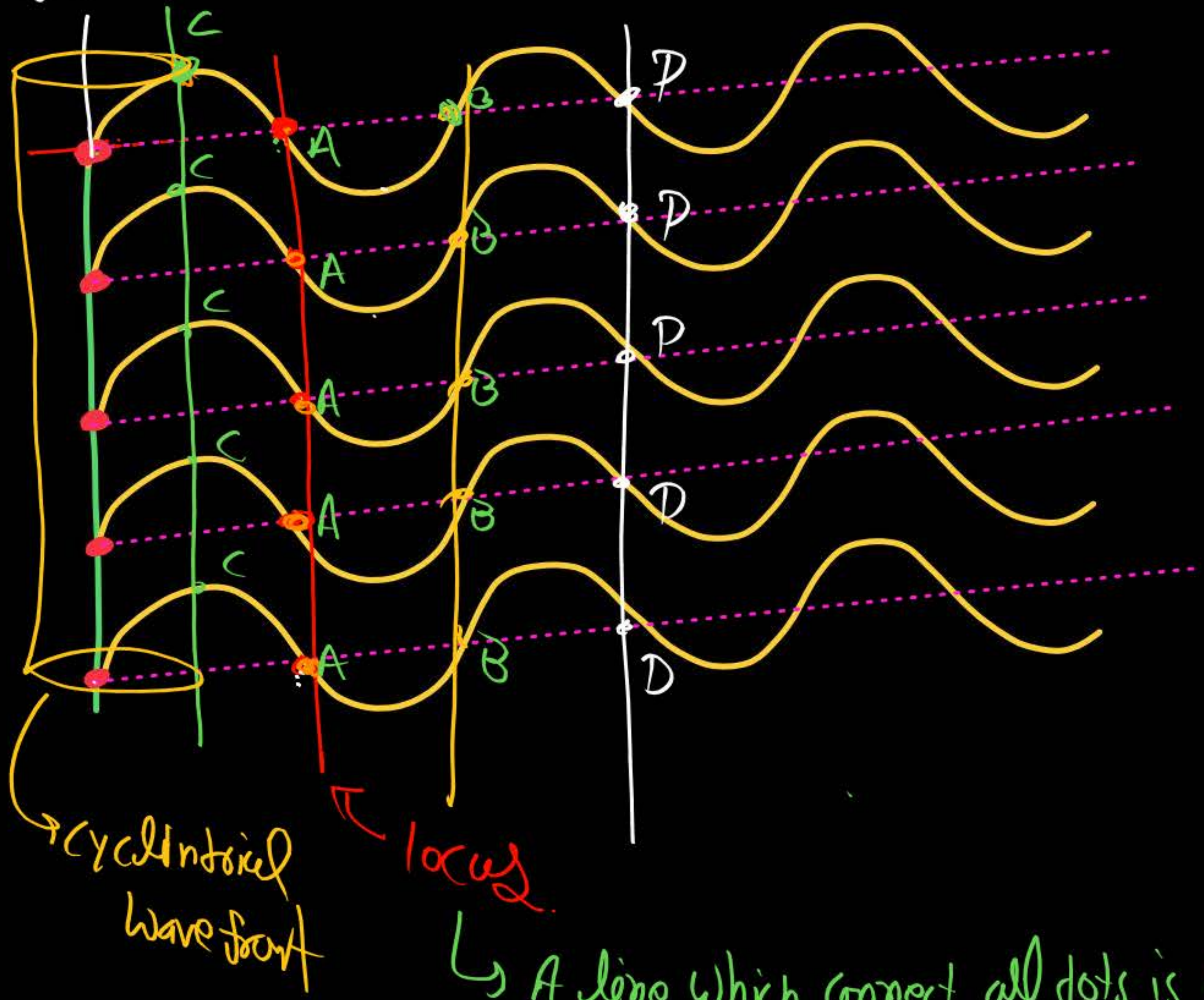
light

- Mechanical wave
- longintiul wave

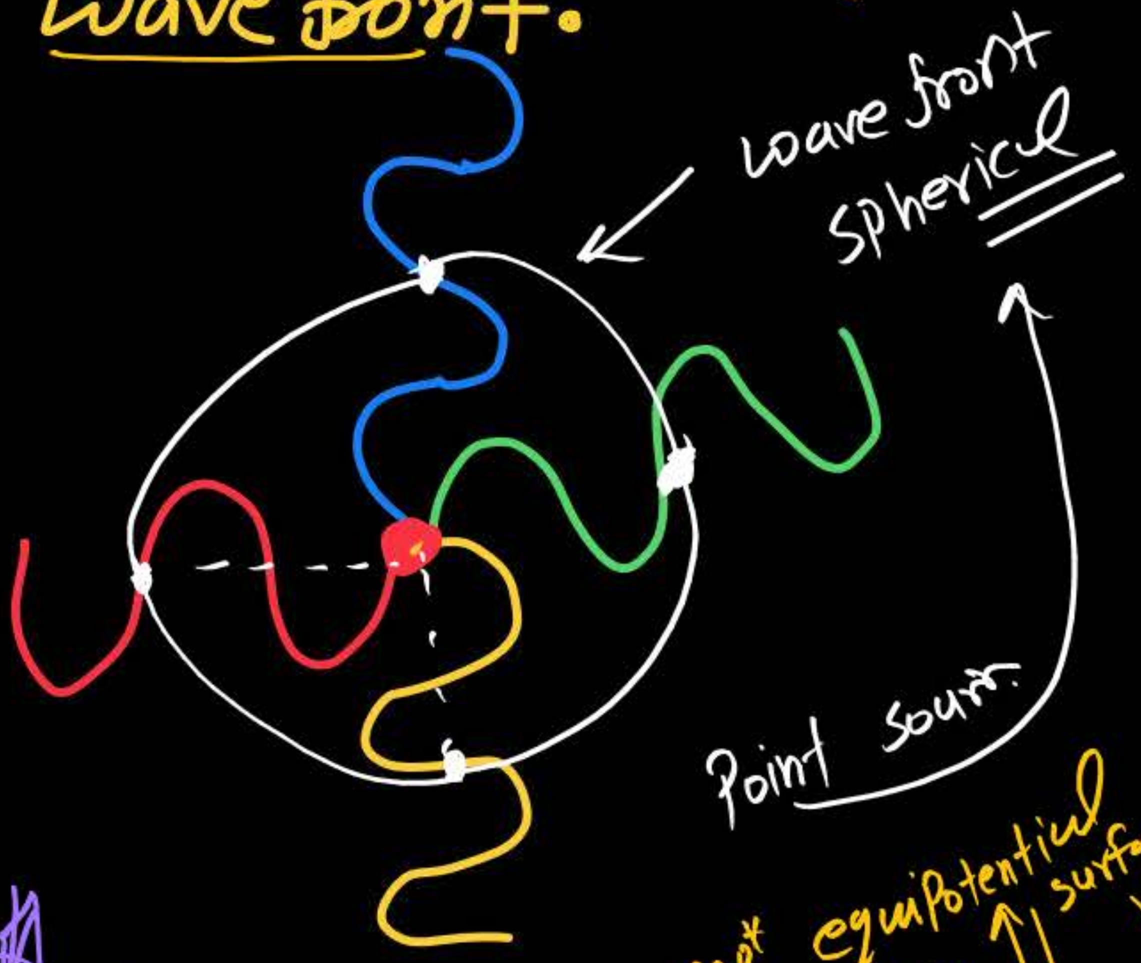


every medium Particle is called wavelet.

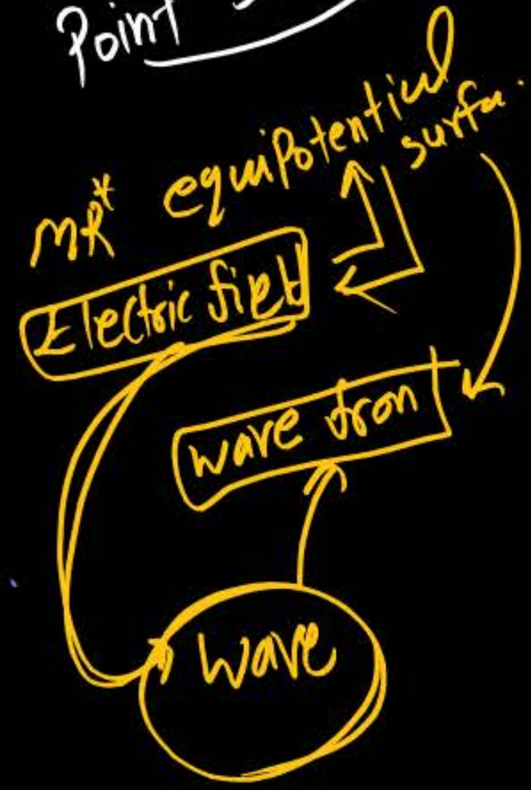
Wave front → locus of all the Point (wavelet) oscillating in same Phase is called wave front.

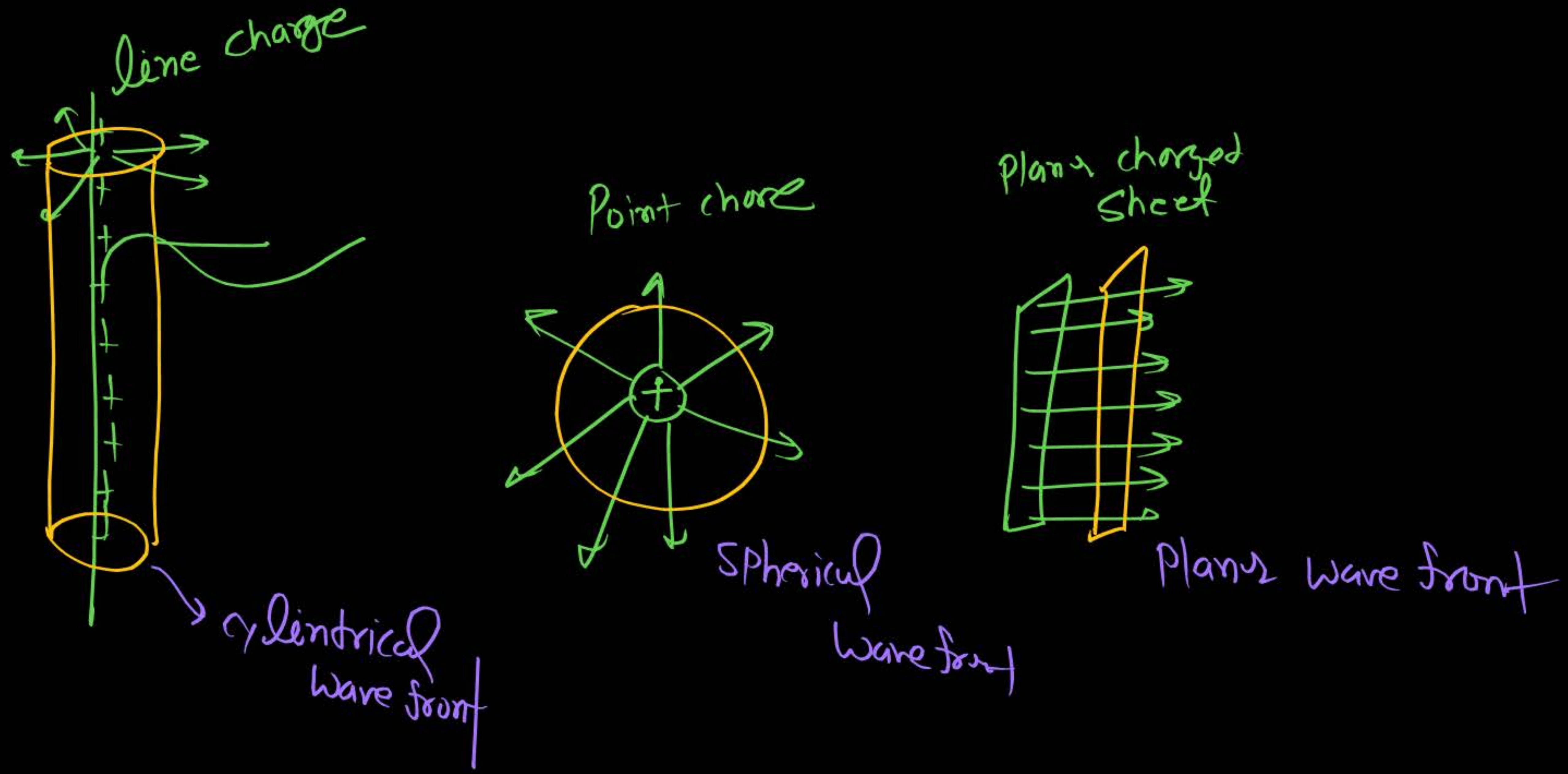


A line which connect all dots is called locus







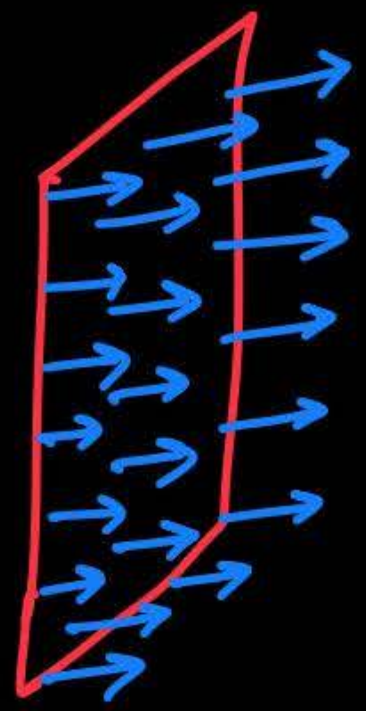

line charge
cylindrical wave front
Point charge
Spherical wave front
Planar charged sheet
Planar wave front

Wave Front

- Wavelet is the point of disturbance due to propagation
- Wavefront is the locus of all points (wavelet) which oscillate in a same phase
- A line perpendicular to a wavefront is a ray
- Wave travel perpendicular to wavefront
- Electric Field (Wave/ray)
- Equipotential surface (wavefront)

electric field perpendicular to equipotential surface

Ray ⊥r to wavefront



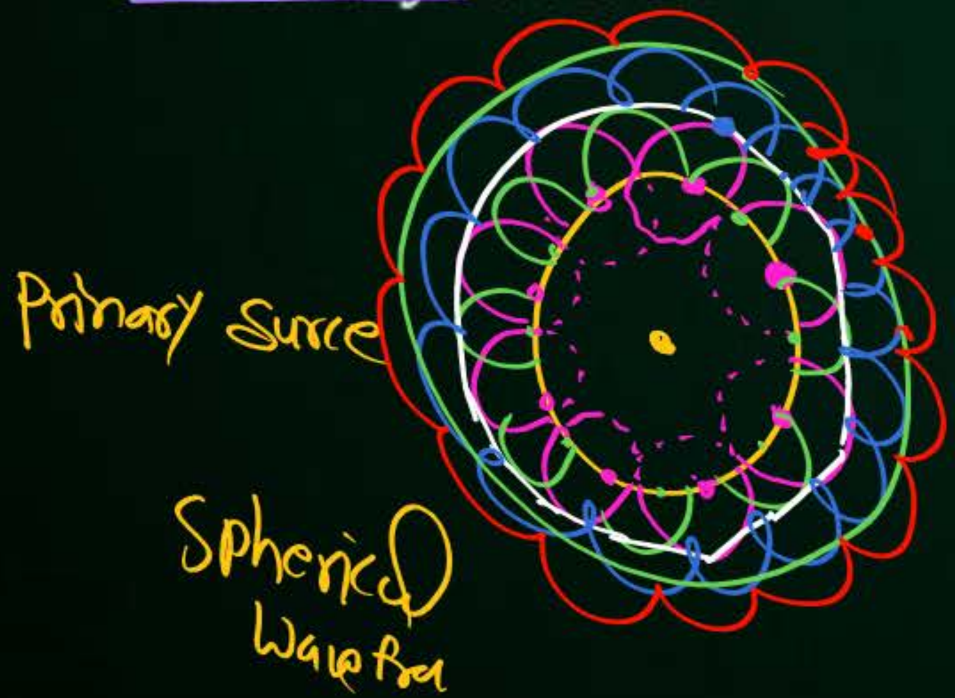
SECONDARY WAVELETS (SOURCE)

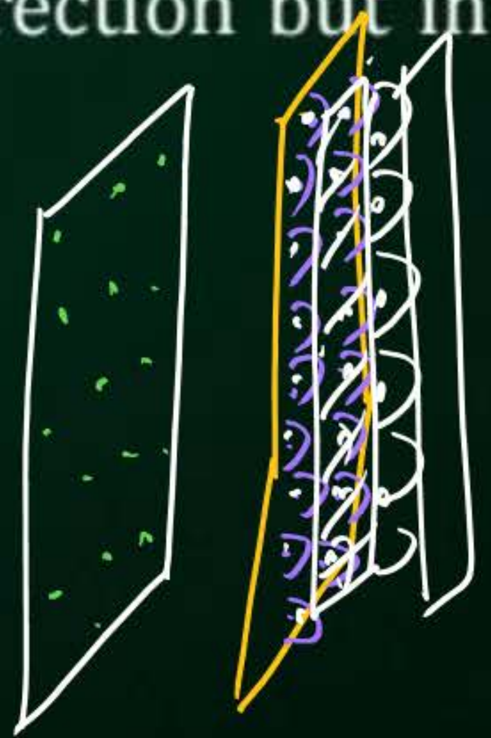
Secondary Wavelets (Source) / Huygens Construction

(1) Each and every point of wavefront behave as a secondary source.

(2) Those point (wavelet) are spherical and travel with speed of light.

(3) The secondary wavelets speeds in all direction but in backward direction intensity is zero.





HUYGEN's PRINCIPLE

Main points of Huygen's Principle:

- Every point on the wave front becomes a source of secondary disturbance and generates wavelets which spread out in the medium with the same velocity as that of light in the forward direction only.
- The envelope of these secondary waves at any instant of time gives the position of the new wave front at that instant.
- The wave front in medium is always perpendicular to the direction of wave propagation.

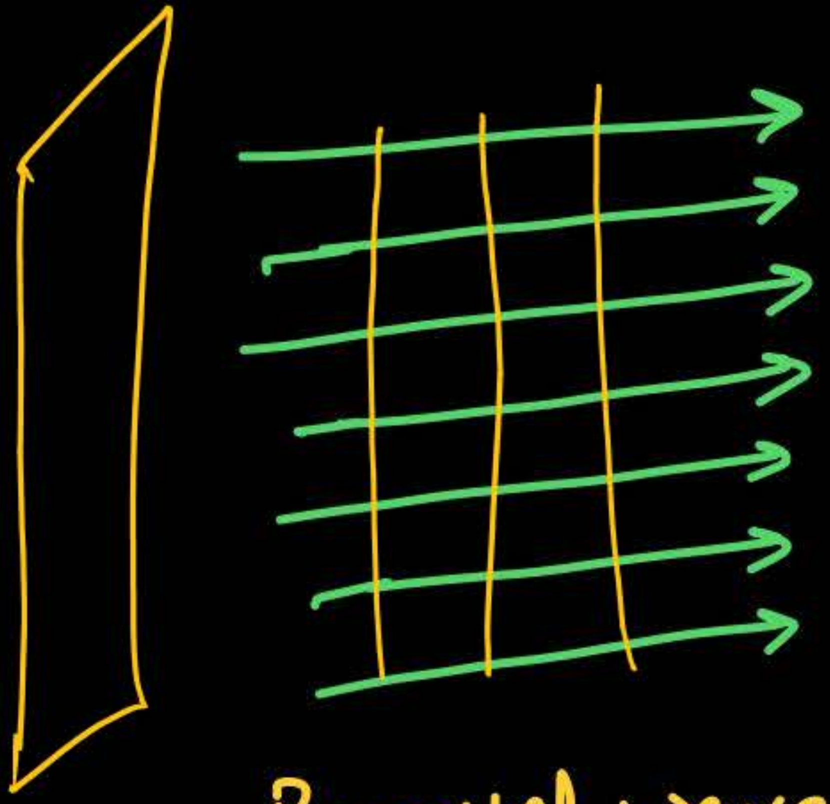
DEMERITS OF HUYGENS WAVE THEORY

(1) Unable to explain polarization of light. Which can be only explain by transverse nature.

(2) He can't explain electromagnetic nature of light

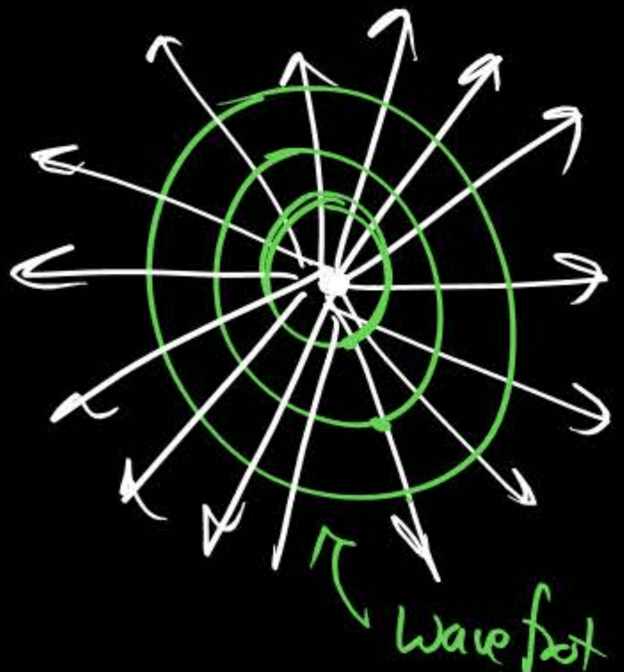
(3) Why secondary wavelets are formed in forward direction.

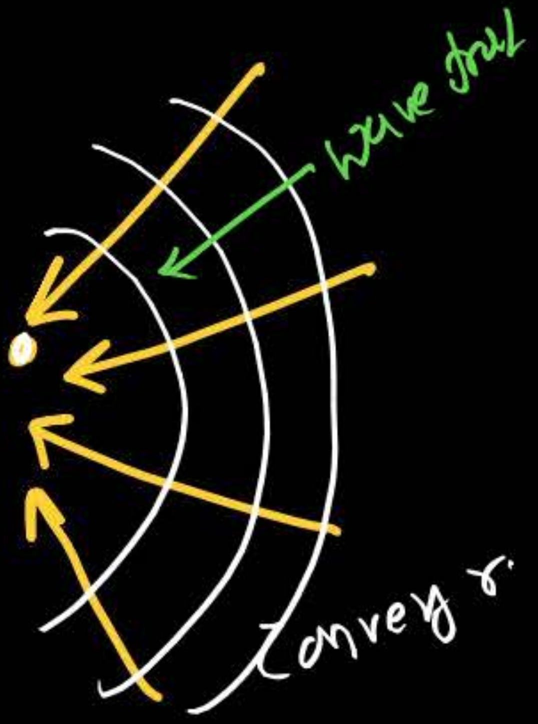
Newton ka drawback

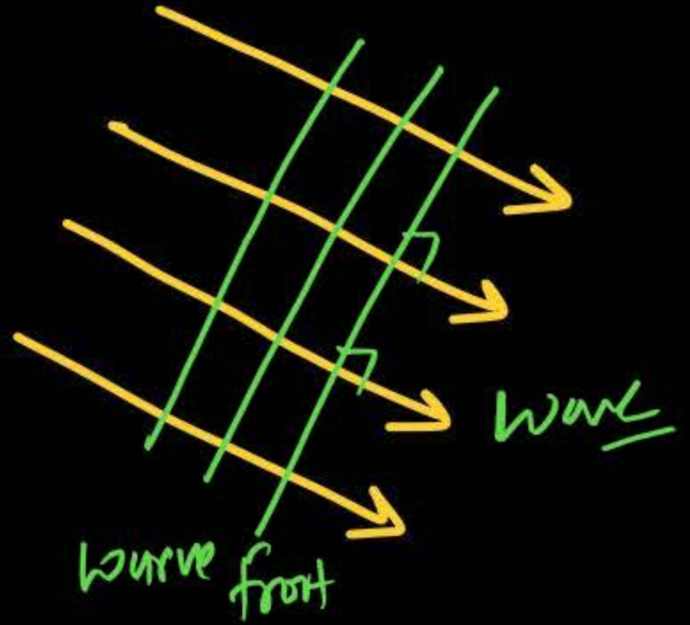


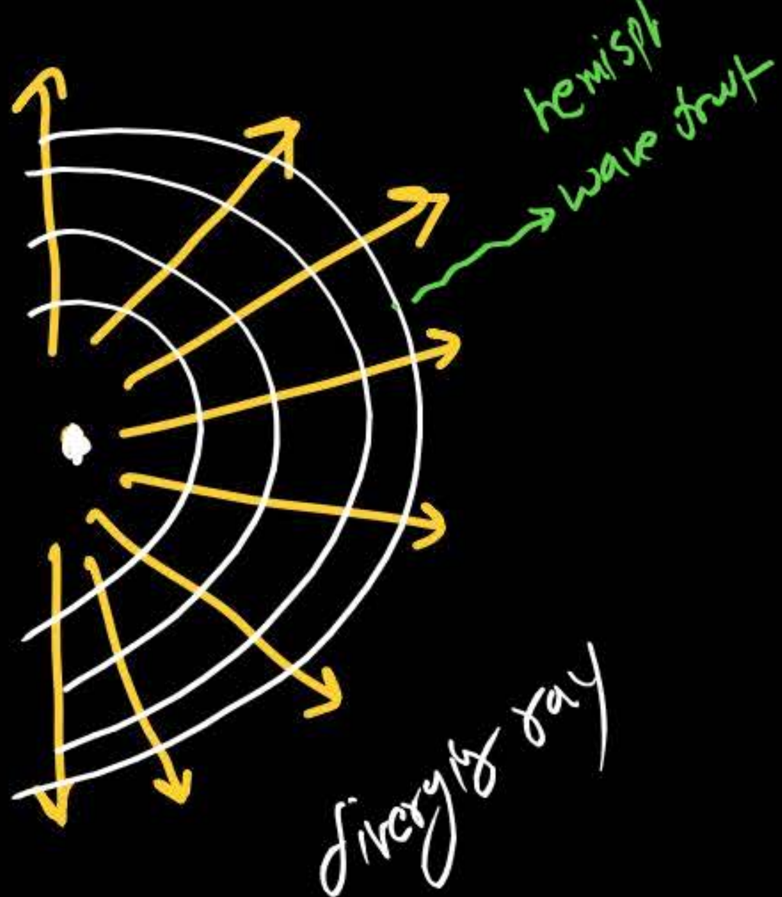
Parallel wave

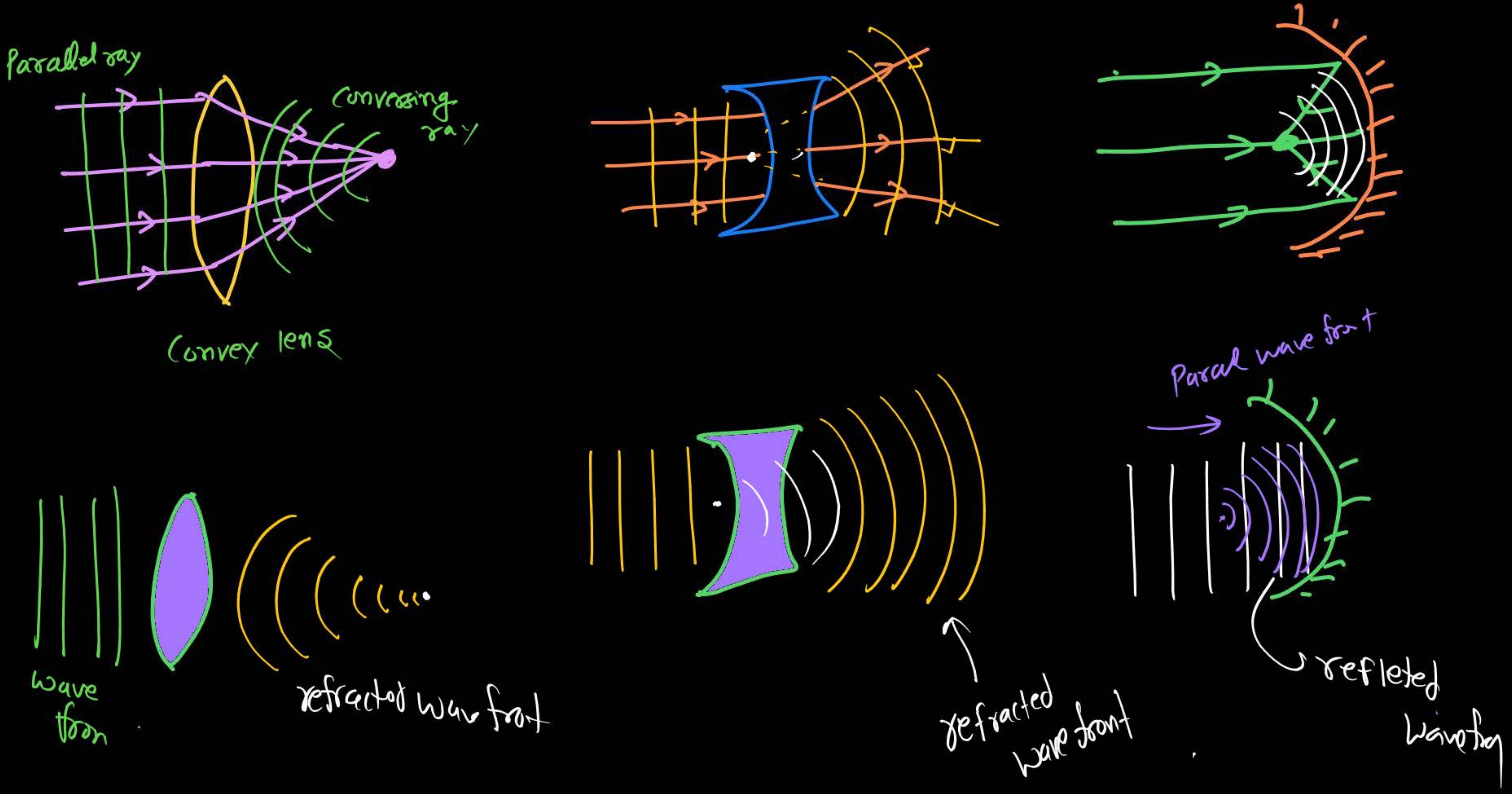
Planer soan





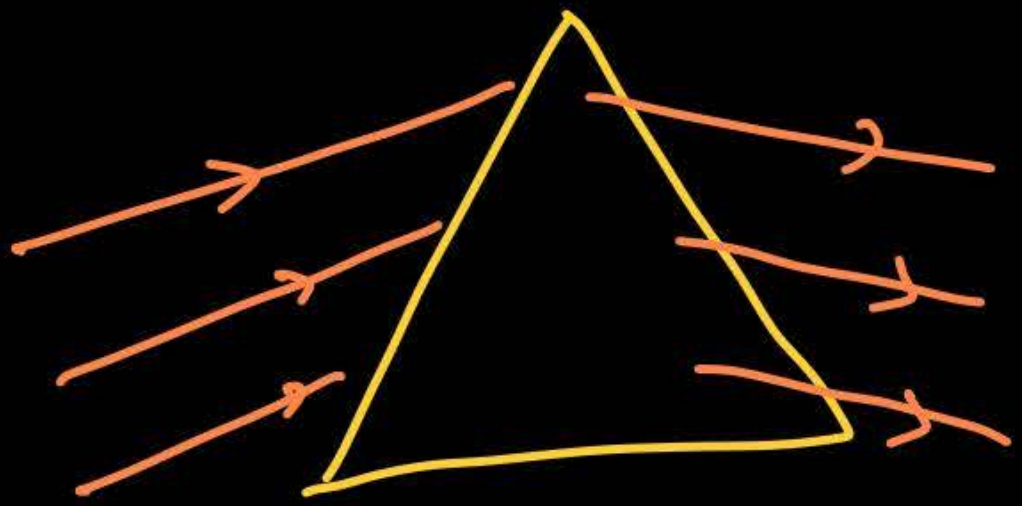


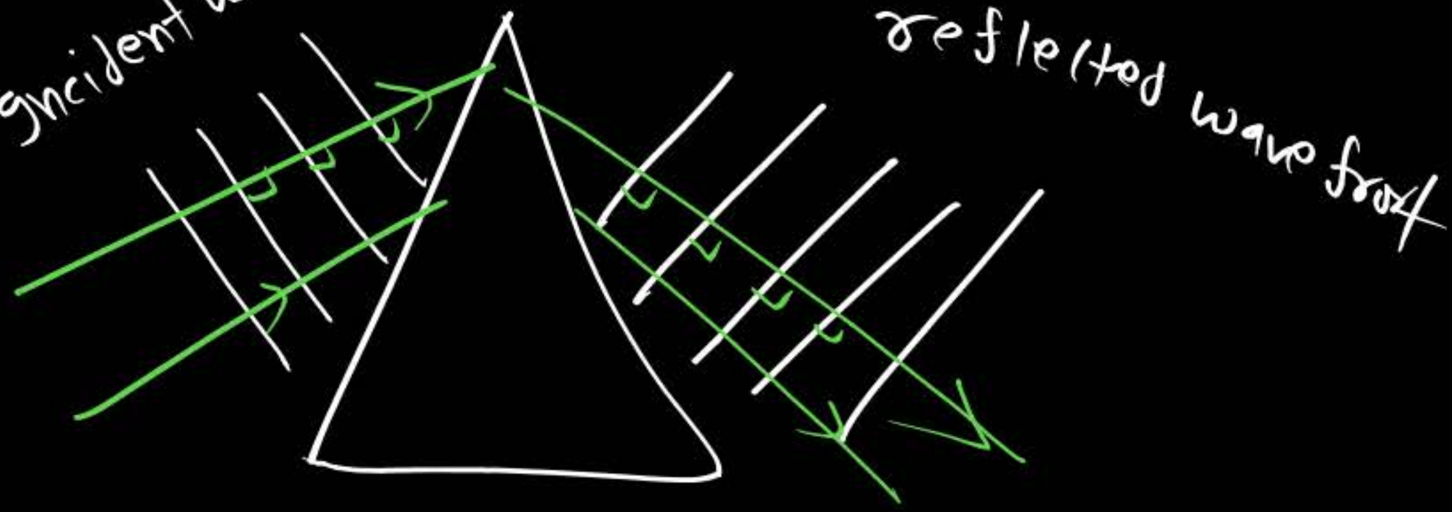



Parallel ray
Converging ray
Convex lens
Paral wave front
wave
refracted wave front
refracted wave front
refleted

wave front due to Sun at surface of earth

→ Plane wave fr.

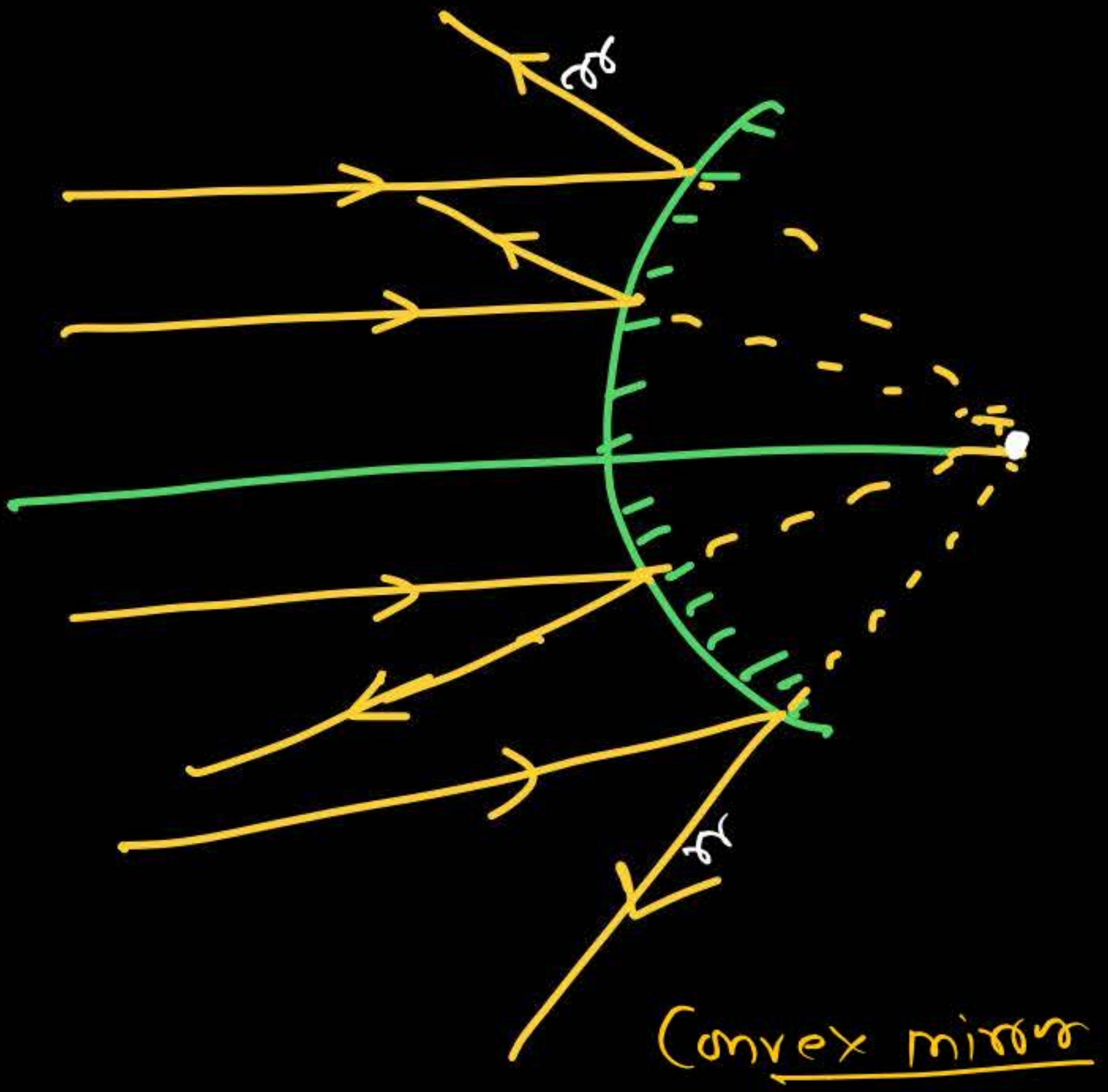




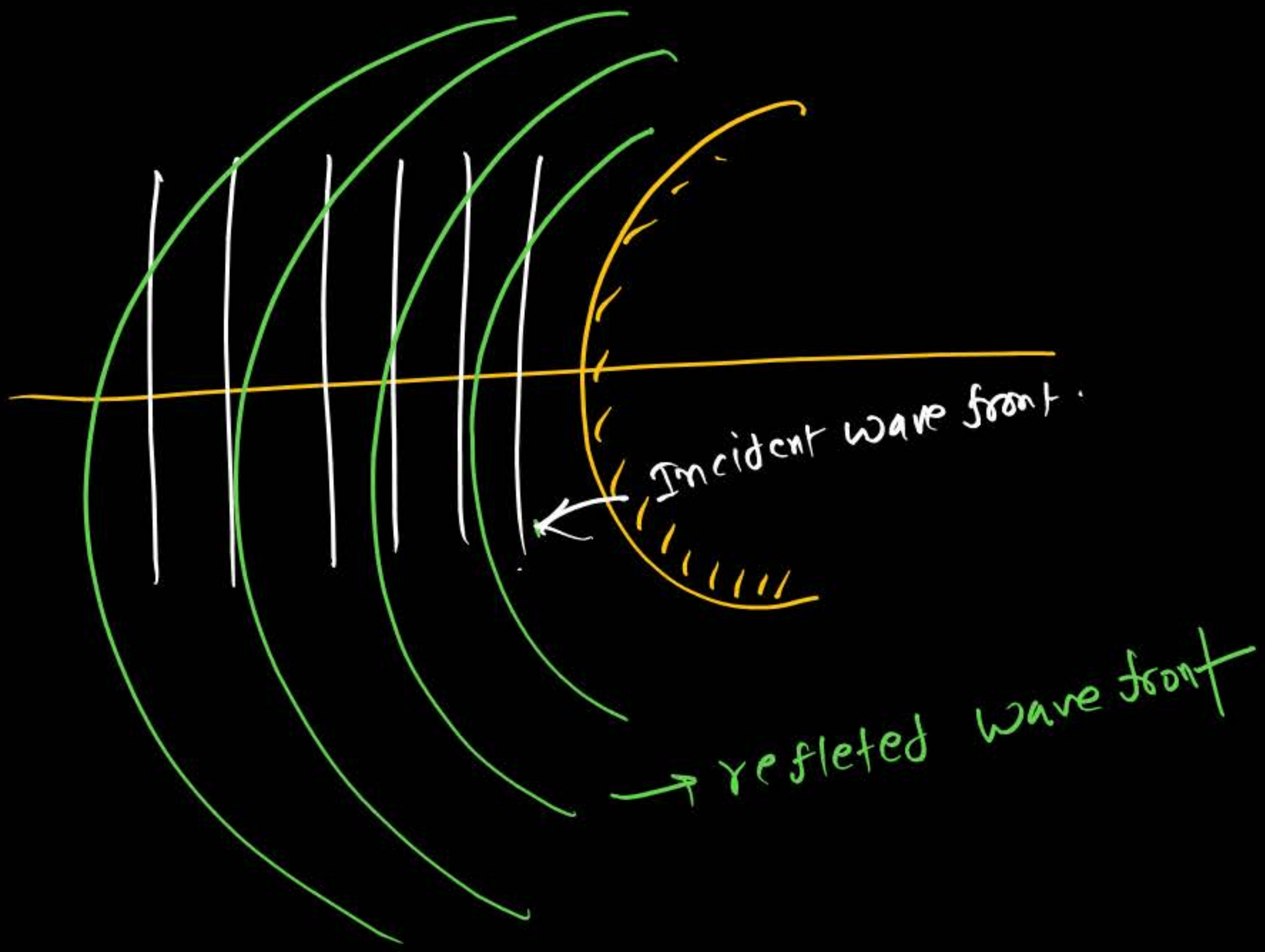


at large distance from Point source (colletion of Point source)

nature of wavefront ⟶ Plane ✓



Convex mirror



Incident wave front.
refleted wave front

Intensity of wave

$$I = \frac{1}{2} \rho v A^2 \omega^2$$

$\omega = 2\pi f$

$I = 2 \rho v A^2 \pi^2 f^2$

$I \propto \rho$ $\quad I \propto v$

$I \propto f^2$ $\quad I \propto A^2$

$\rho \rightarrow$ density of medium

$v \rightarrow$ velocity of wave

$\omega \rightarrow$ Angular frequency

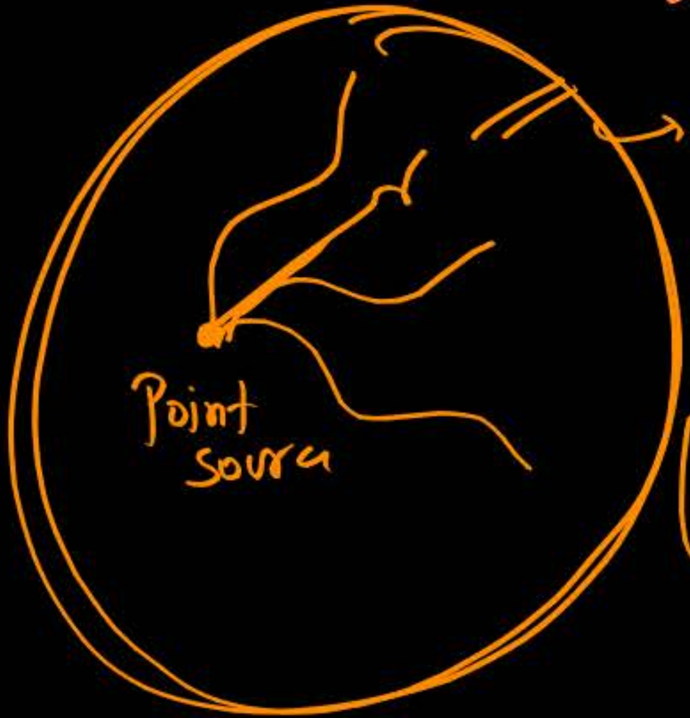
$A \rightarrow$ Amplitude

$\frac{4}{2} = 2$

$\frac{4}{2} = 4$ ✗

Point source

$$I \propto A^2 \propto \frac{1}{r^2}$$



$$I = \frac{E}{\text{Area}\, t}$$

$$I = \frac{E}{4\pi r^2 t}$$

$$I \propto \frac{1}{r^2}$$

$$I \propto A^2 \propto \frac{1}{r^2}$$

$$A \propto \frac{1}{r}$$

line source

$$I \propto A^2 \propto \frac{1}{r}$$

$$I \propto \frac{1}{r}$$

$$A \propto \frac{1}{\sqrt{r}}$$

Planer source

$$I \propto A^2 \propto r^0$$

$$A \propto r^0$$

$$I \propto r^0$$

MR Ratta

$$\frac{2\pi}{\phi} = \frac{\lambda}{\Delta x} = \frac{T}{\Delta t}$$

ϕ = Phase diff^n B/w two point.

Δx = Path diff^n

Δt = time diff.

(Q) If phase diff B/w Two point is $\frac{\pi}{4}$ then find Path diff^n

Sol^n $\Delta x = \frac{\lambda}{2\pi}\phi$

$$\Delta x = \frac{\lambda}{2\pi} \times \frac{\pi}{4}$$

$$\boxed{\Delta x = \frac{\lambda}{8}}$$

(Q) If $\boxed{\phi = 2n\pi}$ then find Path diff^n

$$\Delta x = \frac{\lambda}{2\pi}\Delta\phi$$

$$= \frac{\lambda}{2\pi} \times 2n\pi = n\lambda$$

QUESTION

A wavefront of a wave has direction with wave motion ??

1. Parallel
2. Perpendicular ✓
3. At 45°
4. Opposite

QUESTION

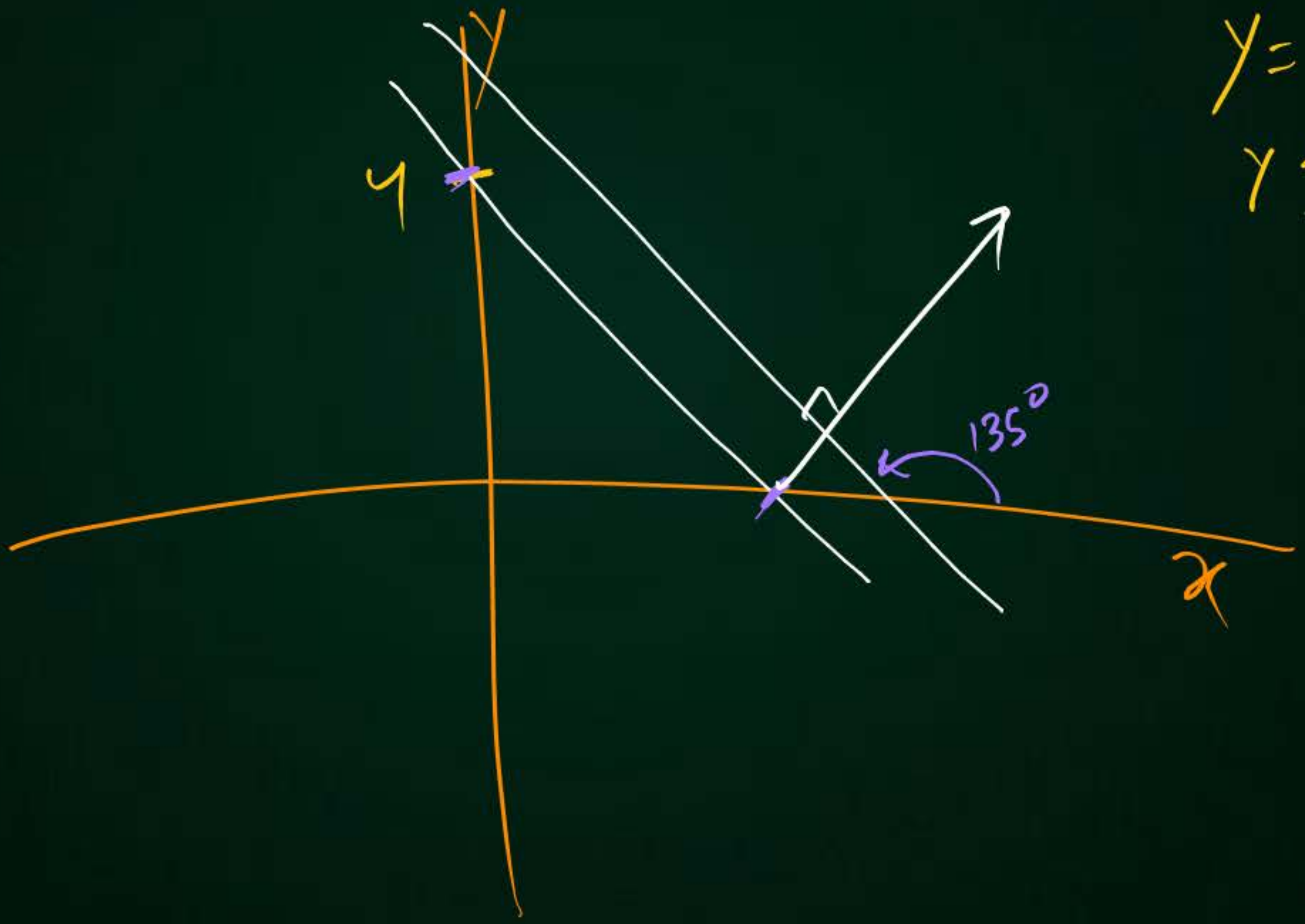
Wavefront is a locus of all the point vibrate with same

1. Amplitude
2. Phase
3. Period
4. Frequency

QUESTION

A wavefront is parallel to line Y = $-x + 4$ then direction of propagation of wave with $+x$ axis is

1. 120°
2. 45°
3. 145°
4. 125°



$y = -x + 4$

$y = mx + c$

$\tan\theta = -1$

$\theta = 135°$

QUESTION

The wavefront of source which is at infinity is

1. Spherical
2. Cylindrical
3. Planer
4. Circular

$$y_1 = A\sin(\omega t + kx - \pi/4)$$

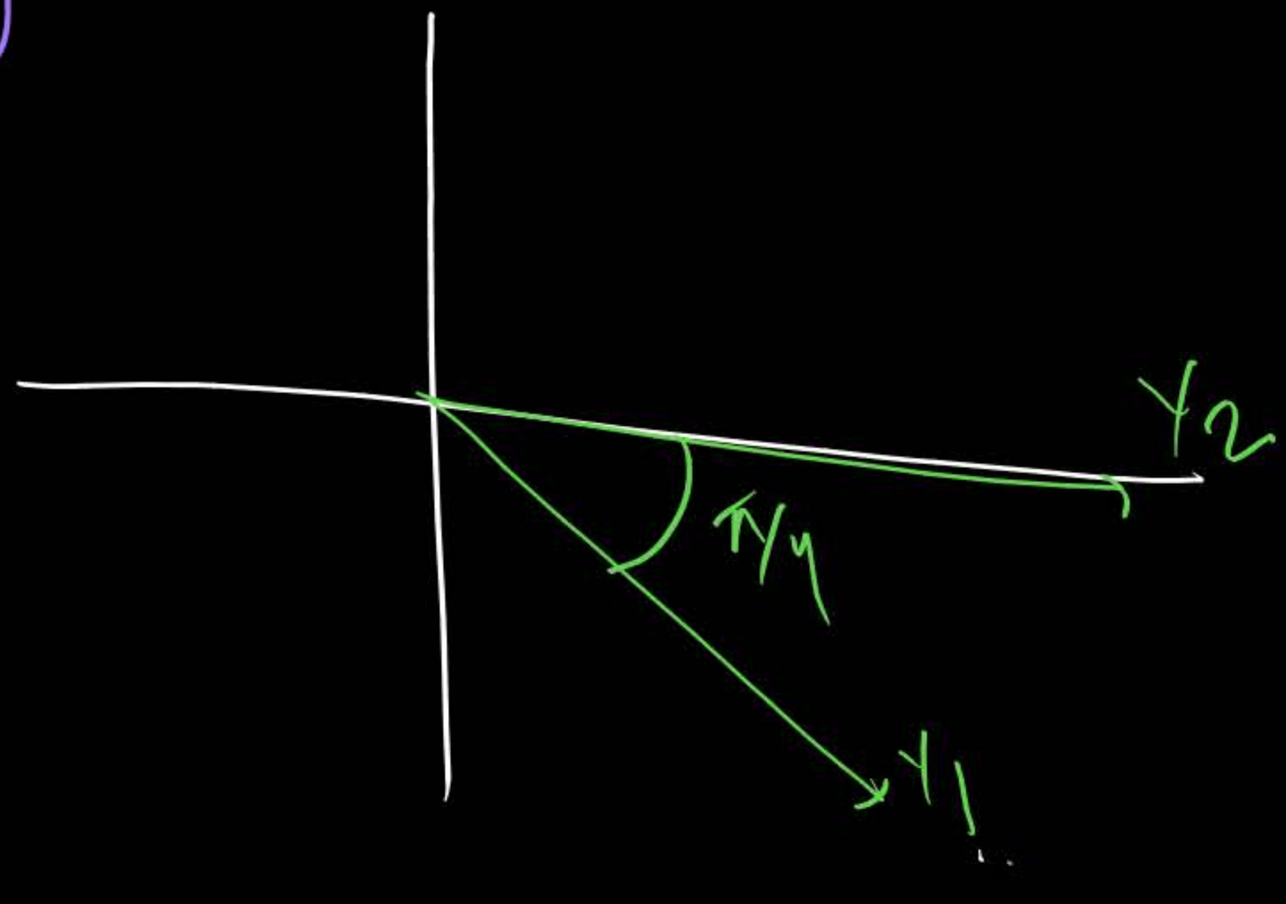
$$y_2 = A\sin(\omega t + kx)$$

→ wrong wave eqⁿ for light wave. according to hygen

$$y_1 = A\sin(\omega t + ky - \pi/4)$$

$$y_2 = A\sin(\omega t + ky)$$

$\Delta\phi = ??$



$\Delta\phi = \pi/4$

Y_2 is leading

QUESTION

The path difference between two waves

$y_1 = A_1 \sin \omega t$ and $y_2 = A_2 \cos(\omega t + \phi)$ will be

1. $(\lambda/2\pi)\,\phi$
2. $(\lambda/2\pi)\,(\phi + \pi/2)$
3. $(2\pi\lambda)\,(\phi - \pi/2)$
4. $(2\pi/\lambda)\,\phi$

QUESTION

The displacements of two interfering light waves are $y_1 = 4 \sin$ or and $y_2 = 3 \cos (\omega t)$. The amplitude of the resultant wave is (y_1 and y_2 are in CGS system)

1. 5 cm
2. 7 cm
3. 1 cm
4. Zero

QUESTION

The equation for two waves obtained by two light sources are as given below: $y_1 = A_1 \sin 3\omega t, y_2 = A_2 \cos(3\omega t + \pi/6)$. What will be the value of phase difference at the time t:

1. $3\pi/2$
2. $2\pi/3$
3. π
4. $\pi/2$

QUESTION

Two wave of equation $y_1 = 4\sin(Kx + \omega t + 30°)$, $y_2 = 3\sin(Kx + \omega t + 120°)$ find ____________ wave equation.

QUESTION

Two wave of equation $y_1 = 3\sin(\omega t + Kx)$

$y_2 = 3\cos(\omega t + Kx + 30°)$

QUESTION

$y_1 = 5\sin(Kx + \omega t - 30), y_2 = 5\cos(\mathrm{K}x + \omega t)$

Find $y = y_1 + y_2$.

QUESTION

$y_1 = 4\sin(Kx + \omega t + 30°), y_2 = 4\cos(Kx + \omega t)$

Find $y = y_1 + y_2$.

$\Delta\phi = 60°$


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 02 | Physics

Wave Optics

By- Dr. Manish Raj (MR SIR)



Todays Goal

Revision of Interference

- Phasor diagm
- Analyt
- wave → 11th class chu
- Inter
- Imax / Imin

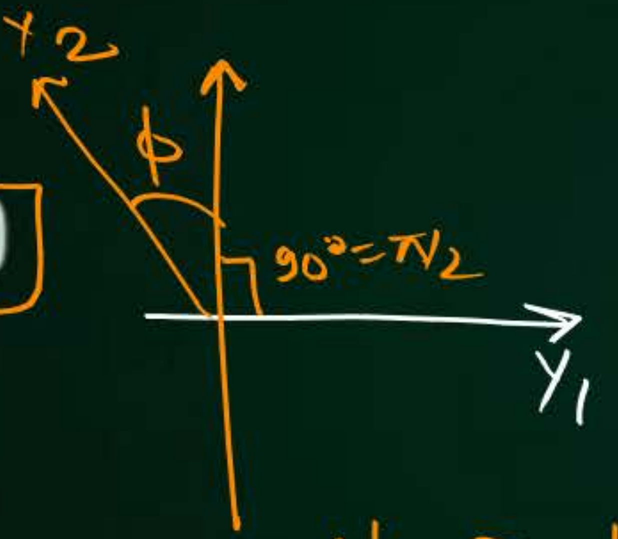
Y. D. S. E.

Young Double slite experiment

QUESTION

The path difference between two waves $y_1 = A_1 \sin \omega t$ and $y_2 = A_2 \cos(\omega t + \phi)$ will be

1. $(\lambda/2\pi)\,\phi$
2. $(\lambda/2\pi)\,(\phi + \pi/2)$
3. $(2\pi\lambda)\,(\phi - \pi/2)$
4. $(2\pi/\lambda)\,\phi$



$\Delta\phi = \frac{\pi}{2} + \phi$

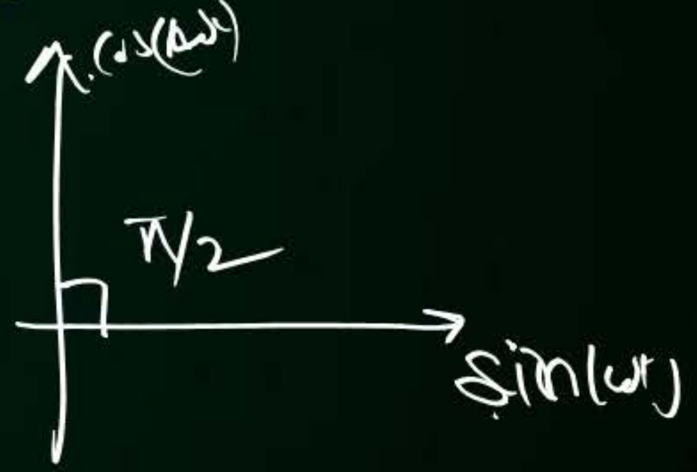
$\frac{\lambda}{\Delta x} = \frac{2\pi}{\Delta\phi}$

$\frac{\lambda}{\Delta x} = \frac{2\pi}{\left(\frac{\pi}{2} + \phi\right)}$

$\Delta x = \frac{\lambda}{2\pi}\left(\frac{\pi}{2} + \phi\right)$

$Y_1 = A \sin(\omega t)$

$Y_2 = A \cos(\omega t)$

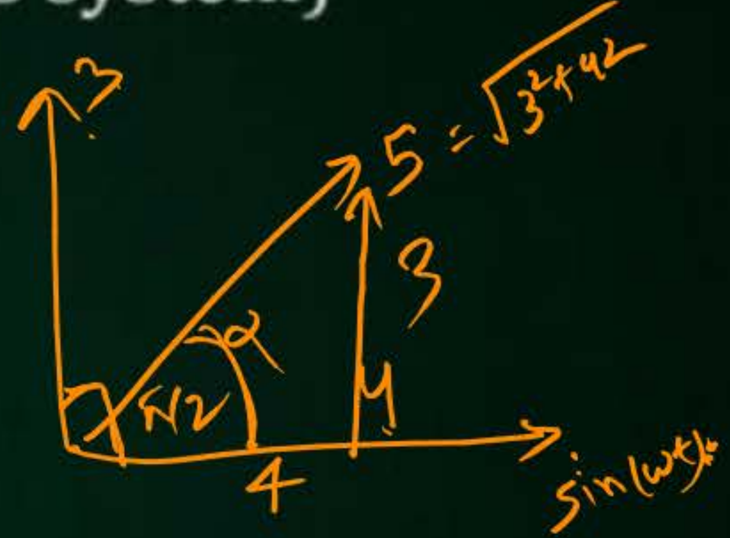


$\frac{\lambda}{\Delta x} = \frac{2\pi}{\Delta\phi}$

QUESTION

The displacements of two interfering light waves are $y_1 = 4 \sin \omega t$ and $y_2 = 3 \cos(\omega t)$. The amplitude of the resultant wave is (y_1 and y_2 are in CGS system)

1. 5 cm ✓
2. 7 cm
3. 1 cm
4. Zero



$\tan\alpha = \frac{3}{4}$

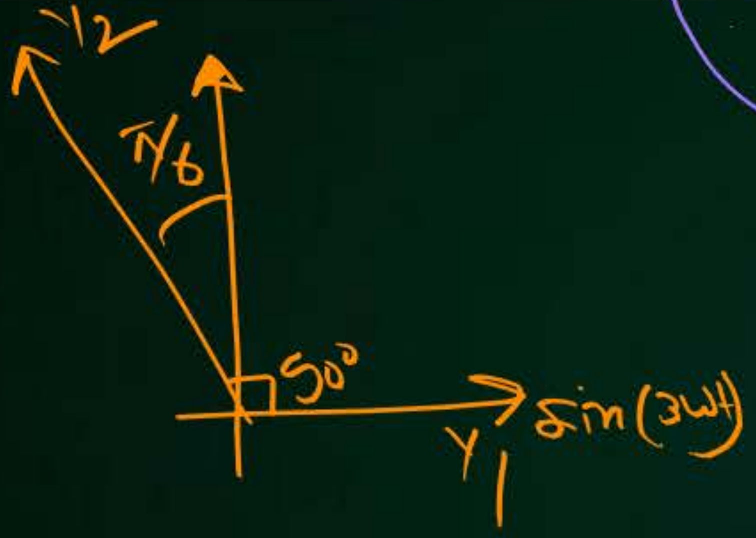
$\alpha = 37^\circ$

$5\cos(\omega t - 53^\circ) = Y_{net} = Y_1 + Y_2 = 5\sin(\omega t + 37^\circ)$

QUESTION

The equation for two waves obtained by two light sources are as given below:
$y_1 = A_1 \sin 3\omega t$, $y_2 = A_2 \cos(3\omega t + \pi/6)$. What will be the value of phase difference at the time t:

1. $3\pi/2$
2. $2\pi/3$
3. π
4. $\pi/2$



Is this wave equation → (a) No (58%) (b) Yes (37%) (c) don't know

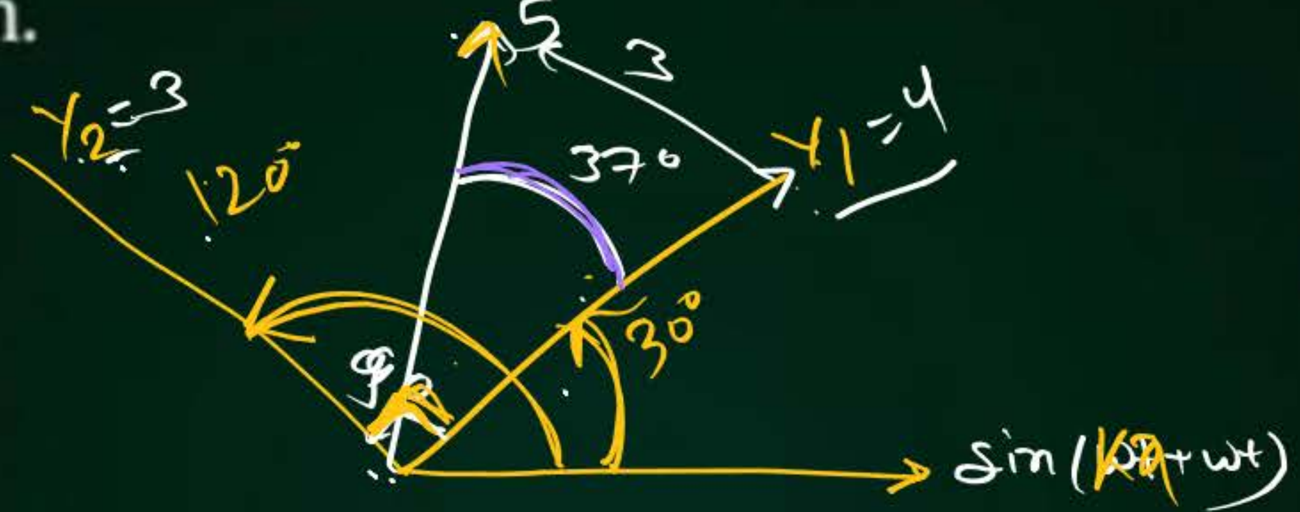
Ans

$\frac{\pi}{2} + \frac{\pi}{6} = \frac{4\pi}{6} = \frac{2\pi}{3}$

QUESTION

JEE Ma

Two wave of equation $y_1 = 4\sin(Kx + \omega t + 30°)$, $y_2 = 3\sin(Kx + \omega t + 120°)$ find ____________ wave equation.



$y = y_1 + y_2$

$$y_{net} = 5\sin(kx + \omega t + 30 + 37°)$$

$$= 5\sin(kx + \omega t + 67°)$$

QUESTION

Two wave of equation $y_1 = 3\sin(\omega t + Kx)$

$y_2 = 3\cos(\omega t + Kx + 30°)$

$\Delta\phi = 30°$ ✗

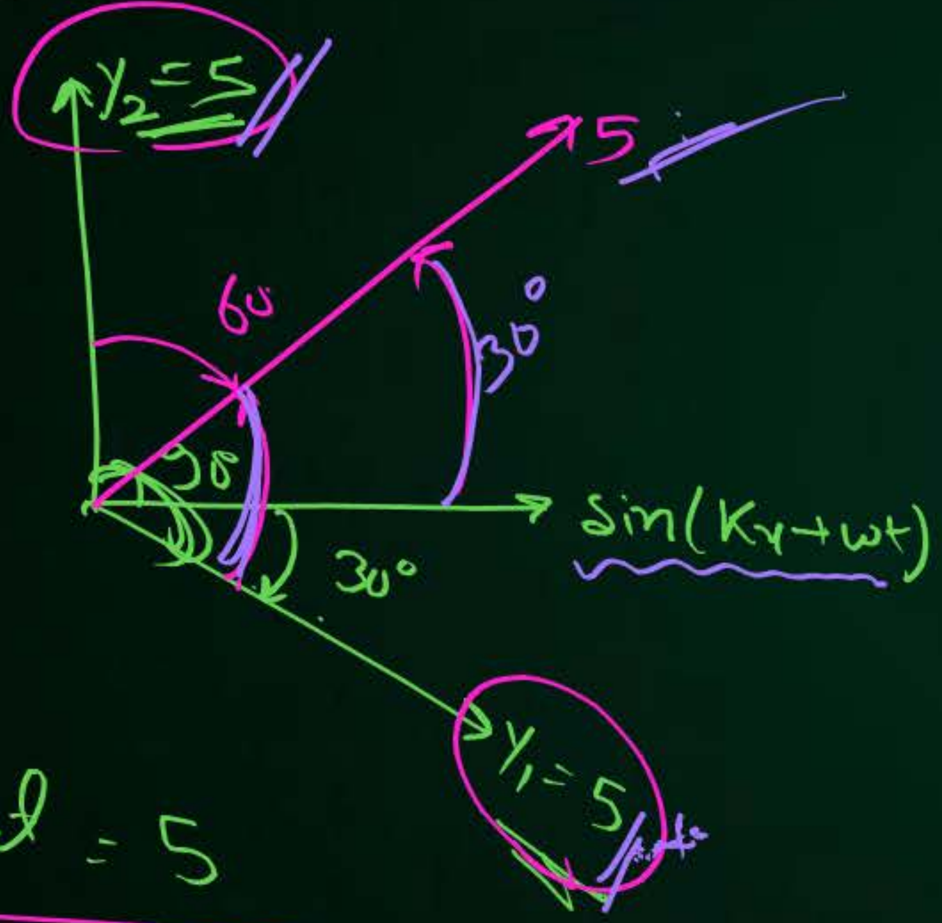
$\Delta\phi = 120°$ $= 4 \times 30°$ ✗

$|y_1 + y_2| = 3$ ✗

QUESTION

$y_1 = 5\sin(Kx + \omega t - 30)$, $y_2 = 5\cos(Kx + \omega t)$

Find $y = y_1 + y_2$.



A net = 5

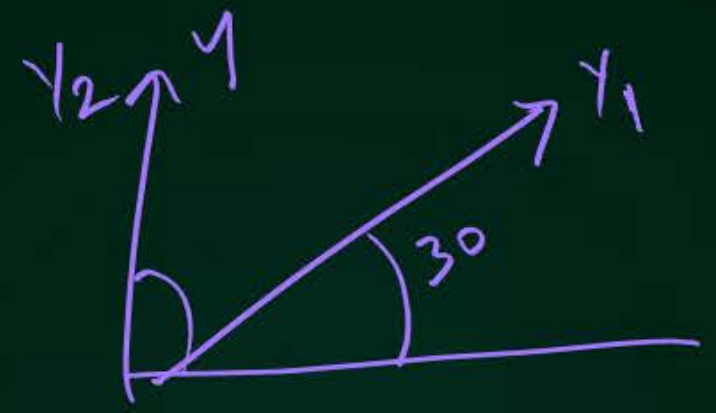
Y = 5 sin(Kx + ωt + 30°)

Ans

QUESTION

$y_1 = 4\sin(Kx + \omega t + 30°)$, $y_2 = 4\cos(Kx + \omega t)$

Find $y = y_1 + y_2$.



$\Delta\phi = 60°$

Ans

$A_{net} = 4\sqrt{3}$

$A_{net} = 2A\cos(\theta/2)$

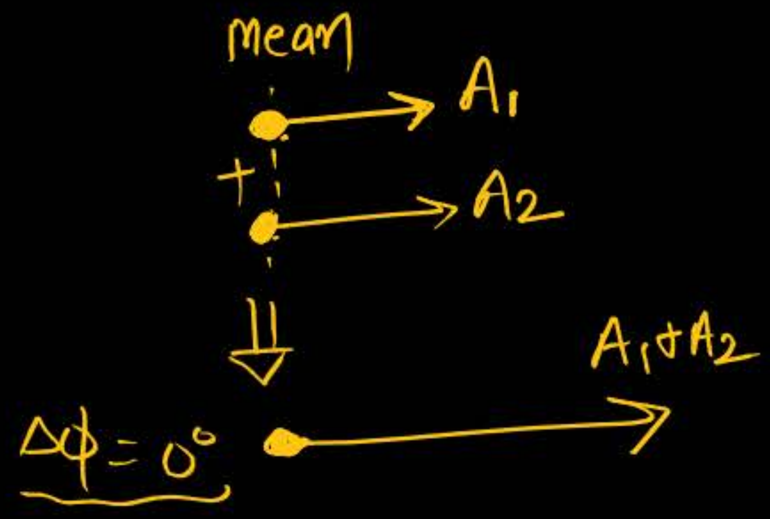
$\theta = 0$, $A_{net} = 2A$

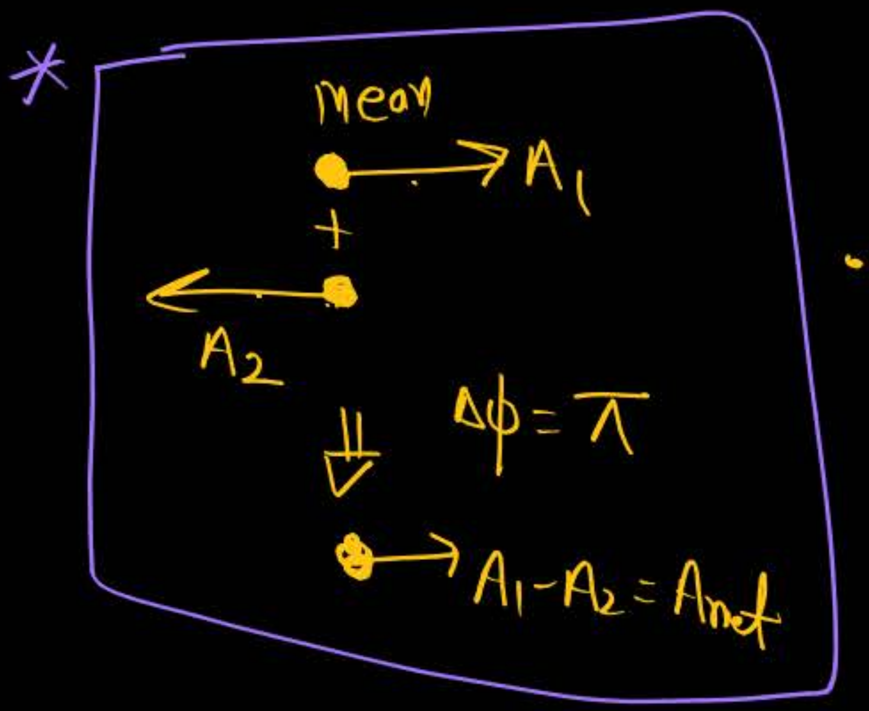
$\theta = 60°$, $A_{net} = \sqrt{3}A$

$\theta = 90°$, $A = \sqrt{2}A$

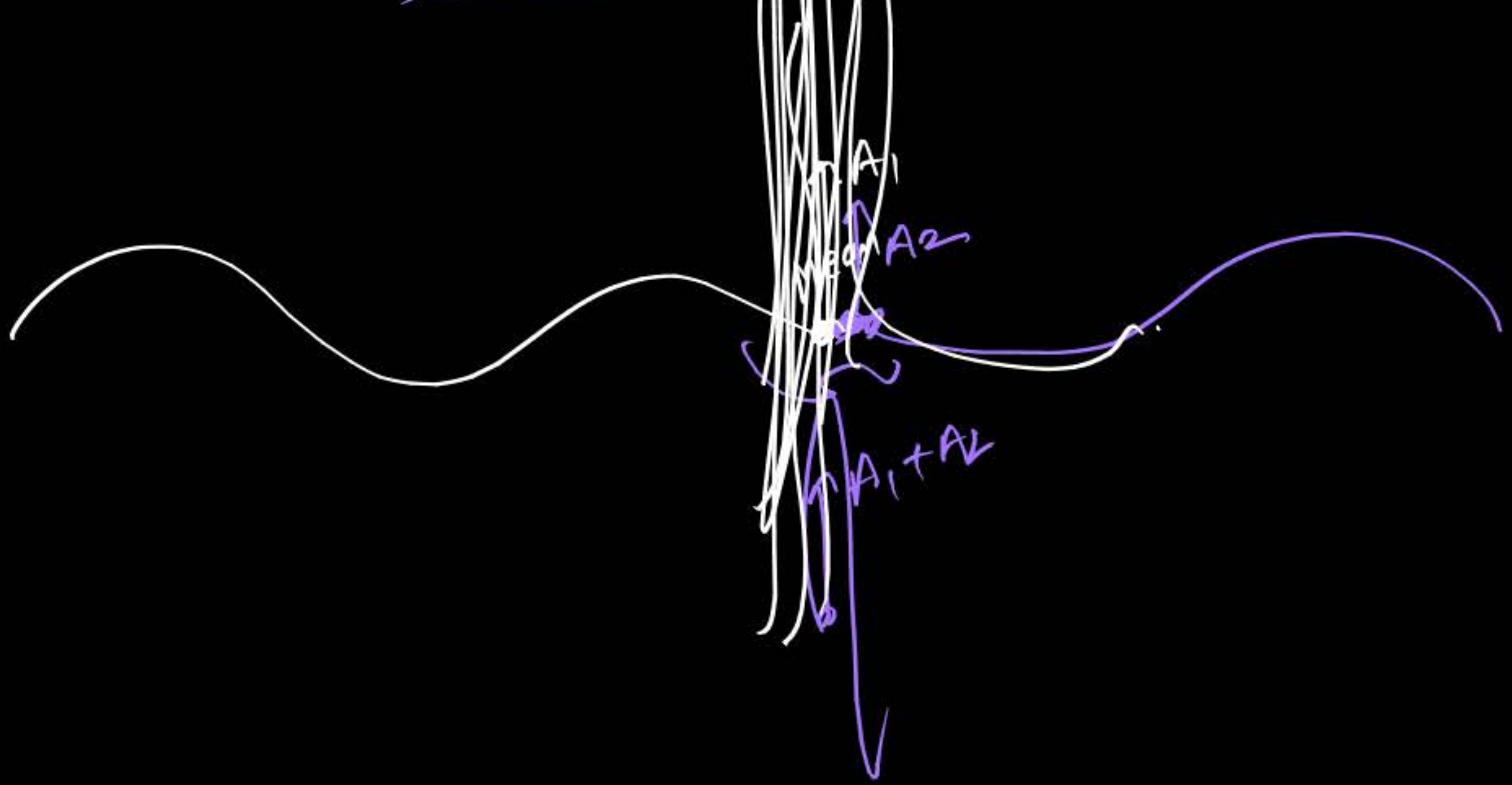
$\theta = 120°$, $A_{net} = A$

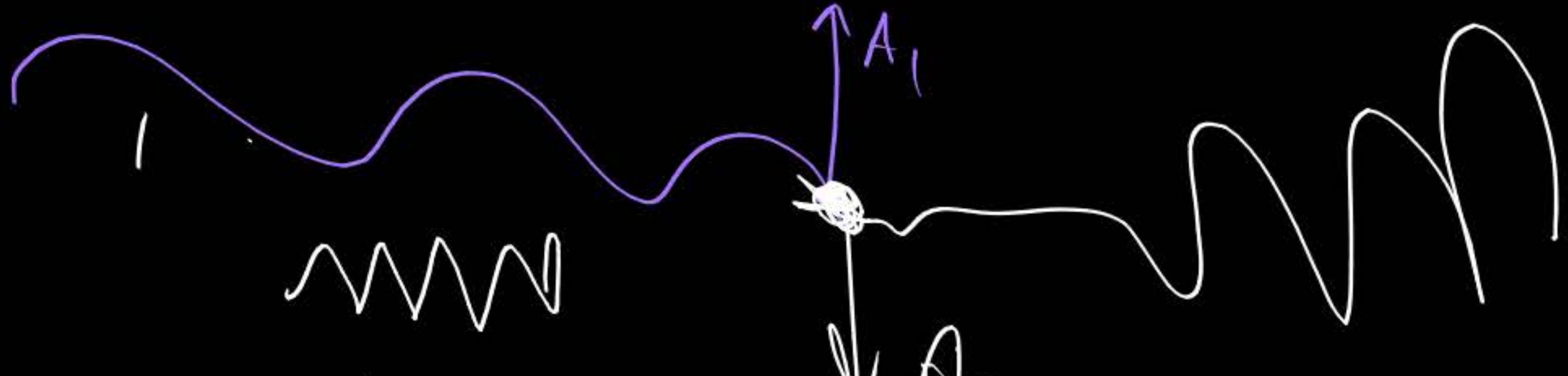
Superposition of S.H.M



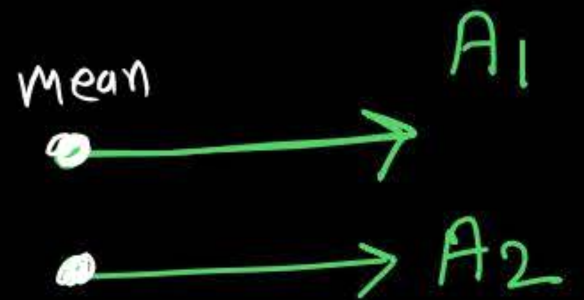


Superpositio Mechanical wave





distructiv Interf.



$\Delta\phi = 0, 2\pi, 4\pi, \dots$

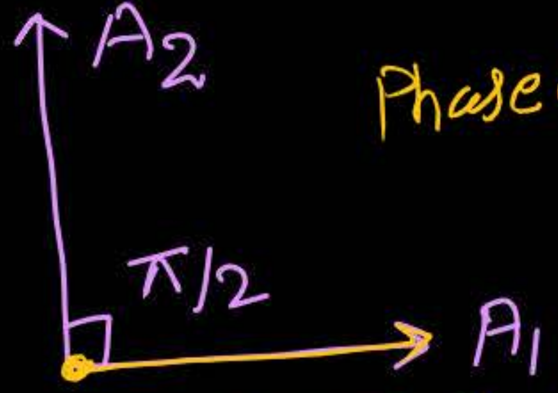
Constructiv Interferre

$A_{net} = A_1 + A_2$

$\Delta\phi = n(2\pi)$ $(n = 0, 1, 2, 3, 4)$

$\Delta x = \frac{\lambda}{2\pi}\Delta\phi = n\lambda$

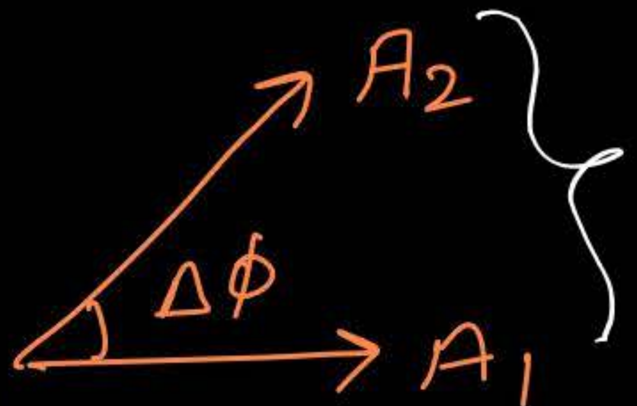
Phase diag



$\Delta\phi = \pi/2$

$A_{net} = \sqrt{A_1^2 + A_2^2}$





$\Delta\phi = \pi, 3\pi, 5\pi, 7\pi, 9\pi$

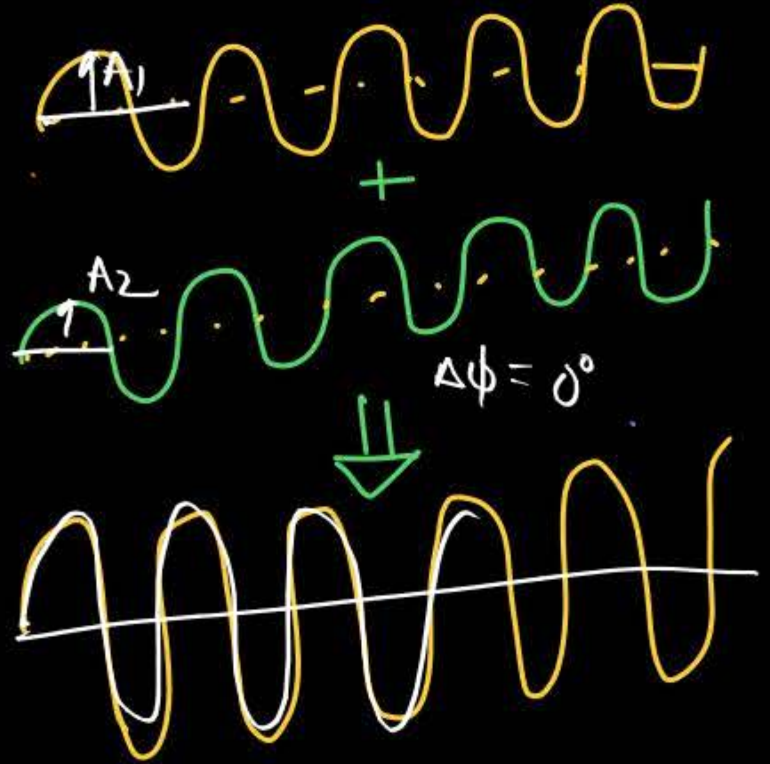
$\Delta\phi = (2n-1)\pi$ $(n = 1, 2, 3, 4)$

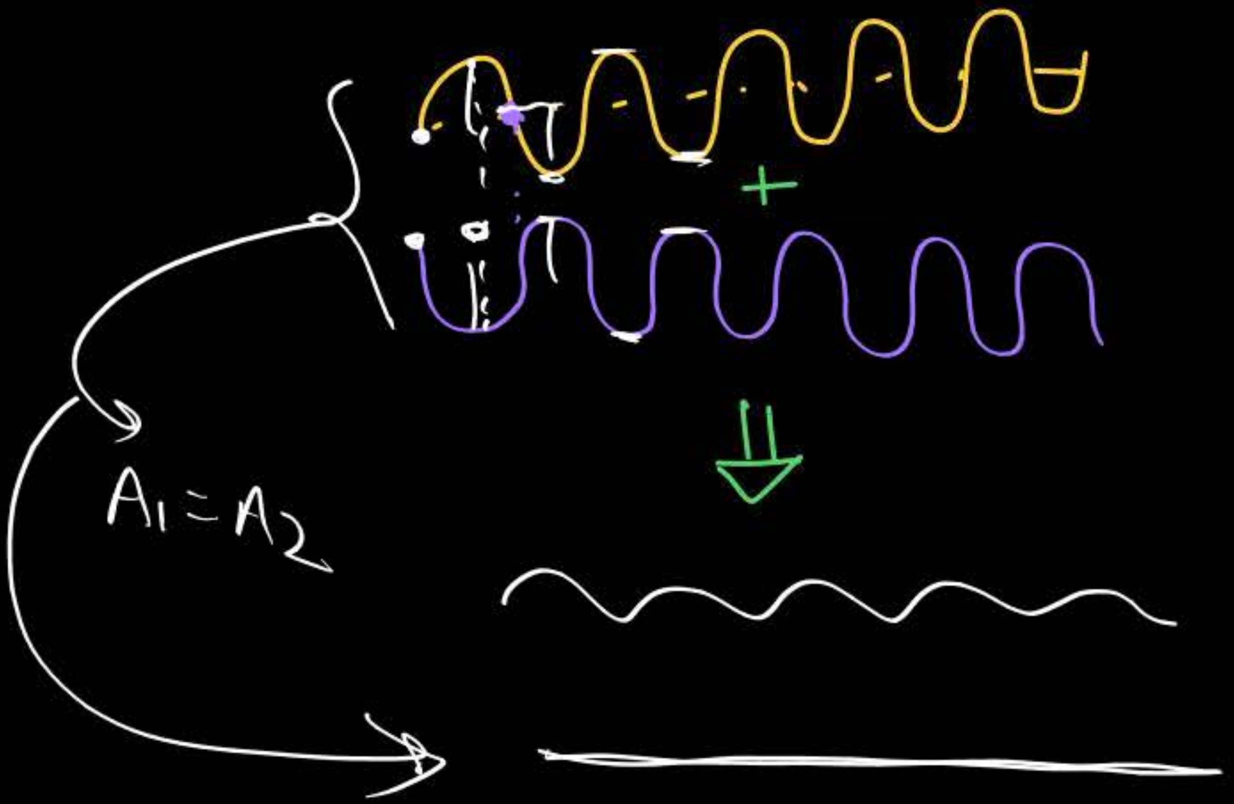
$\Delta\phi = (2n+1)\pi$ $(n = 0, 1, 2, 3, 4)$

$\Delta x = \frac{\lambda}{2\pi}\Delta\phi = \frac{\lambda}{2\pi}(2n-1)\pi$

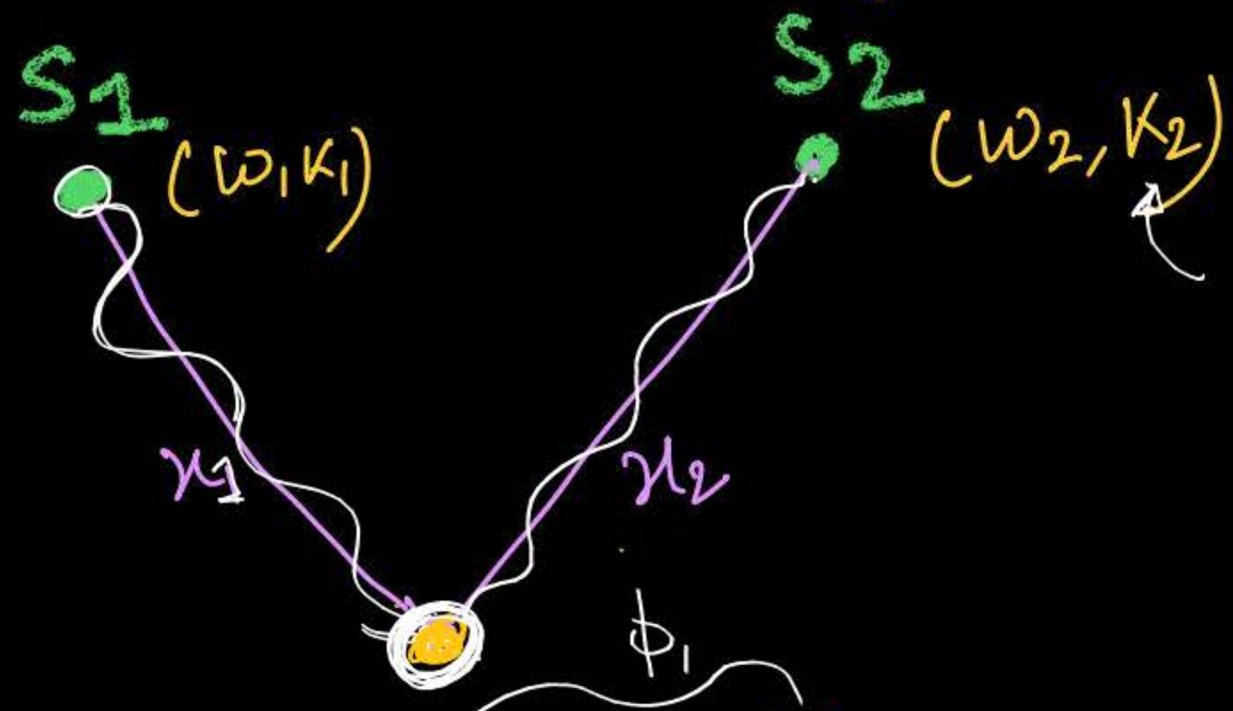
$\Delta x = (2n-1)\frac{\lambda}{2}$

distructive Interfer





Wave from two light source Superposition at a Point



$$Y_1 = A_1 \sin(\underbrace{K_1 X_1 + \omega_1 t}_{\phi_1})$$

$$Y_2 = A_2 \sin(\underbrace{K_2 x_2 + \omega_2 t}_{\phi_2})$$

Phase difference

$$\Delta\phi = \phi_1 - \phi_2$$

$$= K_1 x_1 + \omega_1 t - K_2 x_2 - \omega_2 t$$

$$\Delta\phi = (\omega_1 - \omega_2)t + K_1 x_1 - K_2 x_2$$

$$\boxed{\Delta\phi = (\omega_1 - \omega_2)t + K_1 x_1 - K_2 x_2}$$

→ Phase difference depends on time.
→ Inchorent source
→ Interferce can't be obtain

\# If $\omega_1 = \omega_2$ → frequency Same

$$\boxed{\Delta\phi = K_1 x_1 - K_2 x_2}$$

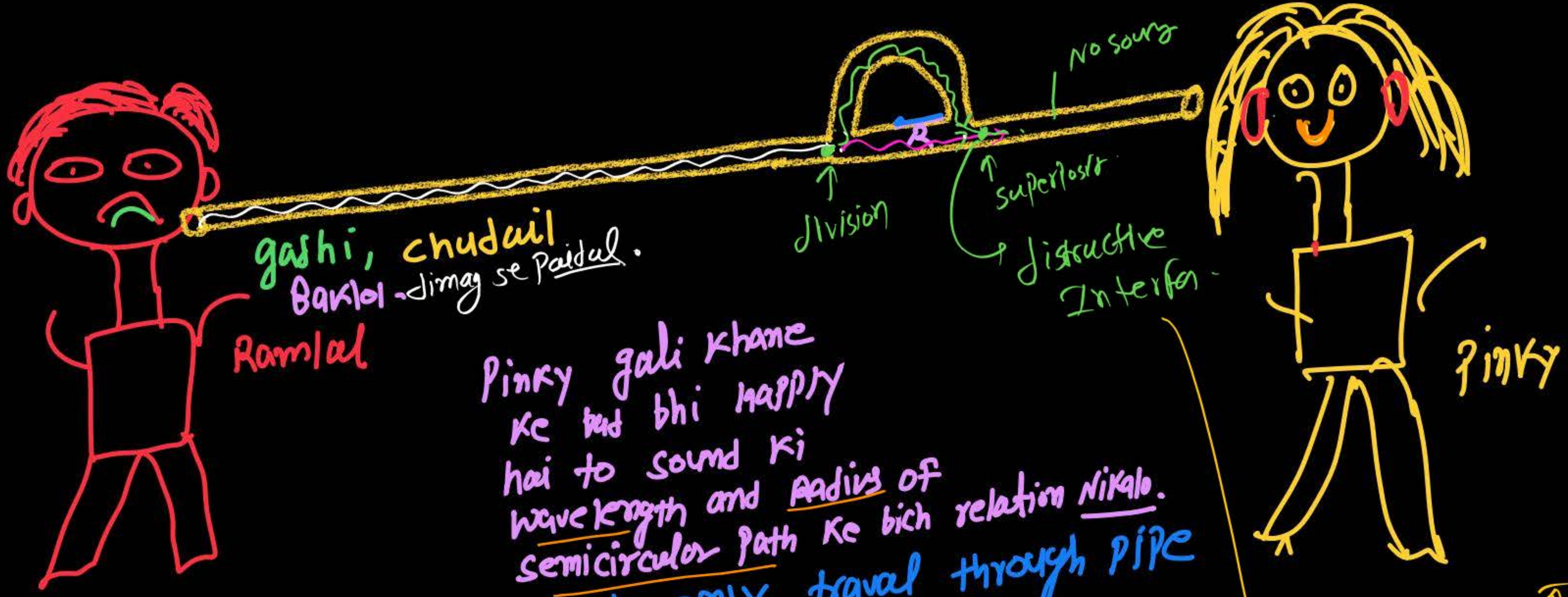
→ Phase diff^n is const^n
→ chorent source

If $K_1 = K_2 = K$

$$\Delta\phi = K(x_1 - x_2) \Rightarrow \boxed{\Delta\phi = \frac{2\pi}{\lambda}\Delta x}$$

COHERENT SOURCE

- Two wave of zero phase difference is coherent source. → wrong ✗
- Two wave have constant phase difference is coherent source. ✓ → Have same frequency
- Two independent light source must not be coherent. ✓



Pinky gali khane ke bad bhi happy hai to sound ki wavelength and Radius of semicircular path ke bich relation Nikalo.

sound only travel through pipe

λ = wavelength of sound.

$\Delta\phi = \pi, 3\pi, 5\pi$

$\boxed{\Delta x = \lambda/2}, 3\lambda/2$

$\pi R - 2R = \frac{\lambda}{2}$ → for D.I

$R(\pi - 2) = \frac{\lambda}{2}$

$\boxed{R = \frac{\lambda}{2(\pi - 2)}}$

QUESTION

Two independent monochromatic sodium lamps cannot produce interference because

1. The frequencies of two sources are different
2. The phase difference between two sources changes with respect to time
3. The two sources become coherent
4. The amplitudes of two sources are different

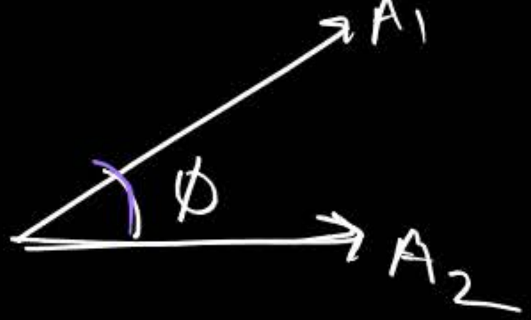
Interference → Superposition of two wave having same Angular frequency, same wave no., constant phase difference, but amplitude may or may be different.

$$y_1 = A_1 \sin(kx + \omega t + \phi)$$

$$y_2 = A_2 \sin(kx + \omega t)$$

$$\Delta\phi = \phi$$

$$\frac{\Delta\phi}{2\pi} = \frac{\Delta x}{\lambda}$$



$$A_{net} = \sqrt{A_1^2 + A_2^2 + 2A_1A_2\cos\phi}$$

$$A_{net}^2 = A_1^2 + A_2^2 + 2A_1A_2\cos\phi$$

$$A_{net}^2 = A_1^2 + A_2^2 + 2A_1A_2\cos\phi$$

$$A_{net}^2 = A_1^2 + A_2^2 + 2A_1A_2\cos\left(\frac{2\pi}{\lambda}\Delta x\right)$$

$$I_{net} = I_1 + I_2 + 2\sqrt{I_1}\sqrt{I_2}\cos\phi$$

$I_{net} \propto A_{net}^2$

$I_1 \propto A_1^2$

$I_2 \propto A_2^2$

Constructive Interference

$$\Delta\phi = 0, 2\pi, 4\pi = n(2\pi)$$

$$\Delta x = 0, \lambda, 2\lambda = n\lambda$$

$$A_{net}^2 = (A_1 + A_2)^2 \Rightarrow A_{net} = A_1 + A_2$$

$\underset{\text{Maximum}}{I_{net}} = (\sqrt{I_1} + \sqrt{I_2})^2 = (A_1 + A_2)^2$

Distructive Interfer

$$\Delta\phi = \pi, 3\pi, 5\pi = (2n-1)\pi$$

$$\Delta x = \frac{\lambda}{2}(2n-1)$$

$$A_{net}^2 = (A_1 - A_2)^2$$

$$I_{net\,min} = (A_1 - A_2)^2 = (\sqrt{I_1} - \sqrt{I_2})^2$$

QUESTION

Light from two sources, each of same frequency and travelling in same direction, but with intensity in the ratio 4 : 1 interfere. Find ratio of maximum to minimum intensity.

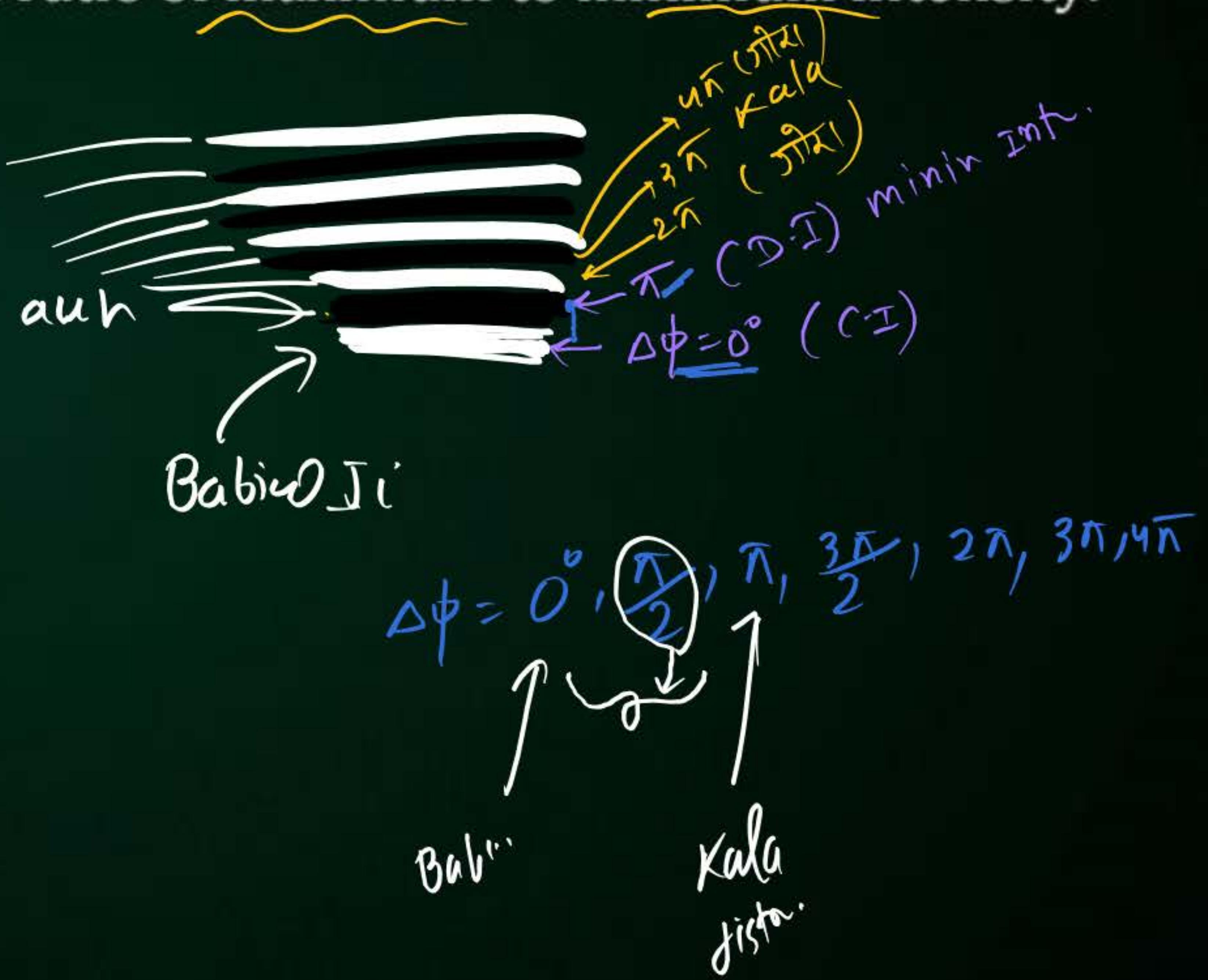
$$\frac{I_1}{I_2} = \frac{4}{1}$$

$$I_{max} = \left(\sqrt{I_1} + \sqrt{I_2}\right)^2 = \left(\sqrt{4} + \sqrt{1}\right)^2$$

$$= 3^2 = 9$$

$$I_{min} = \left(\sqrt{4} - \sqrt{1}\right)^2 = 1$$

$$\frac{I_{max}}{I_{min}} = 9/1$$



QUESTION

Two periodic waves of intensities I_1 and I_2 pass through a region at the same time in the same direction. The sum of the maximum and minimum intensities is:

1. $I_1 + I_2$
2. $(\sqrt{I_1} + \sqrt{I_2})$
3. $(\sqrt{I_1} - \sqrt{I_2})^2$
4. $2(I_1 + I_2)$ ✓

$I_{max} = (\sqrt{I_1} + \sqrt{I_2})^2$

$= I_1 + I_2 + 2\sqrt{I_1}\sqrt{I_2} + I_1 + I_2 - 2\sqrt{I_1}\sqrt{I_2}$

$I_{min} = I_1 + I_2$

QUESTION

In Young's double slit interference experiment, using two coherent waves of different amplitudes, the intensities ratio between bright and dark fringes is 3. Then, the value of the ratio of the amplitudes of the wave that arrive there is:

1. $\left(\frac{\sqrt{3}+1}{\sqrt{3}-1}\right)$
2. $\left(\frac{\sqrt{3}-1}{\sqrt{3}+1}\right)$
3. $\sqrt{3}:1$
4. $1:\sqrt{3}$

$\frac{I_{max}}{I_{min}} = \frac{3}{1}$ $\quad \frac{I_1}{I_2} = ??$

$\left(\frac{A_1+A_2}{A_1-A_2}\right)^2 = \frac{3}{1}$

$\frac{A_1+A_2}{A_1-A_2} = \frac{\sqrt{3}}{1}$

$A_1+A_2 = \sqrt{3}A_1 - \sqrt{3}A_2$

$(\sqrt{3}-1)A_1 = (\sqrt{3}+1)A_2$

$\frac{A_1}{A_2} = \left(\frac{\sqrt{3}+1}{\sqrt{3}-1}\right)$

$\frac{A_1}{A_2} = \frac{\sqrt{I_1}}{\sqrt{I_2}} = \frac{\sqrt{3}+1}{\sqrt{3}-1}$

QUESTION

Two coherent source of intensity ratio α interfere. The value of $\frac{(I_{max}-I_{min})}{(I_{max}+I_{min})}$ is: **[2017]**

1. $2\sqrt{\frac{\alpha}{1+\alpha}}$
2. $\frac{2\sqrt{\alpha}}{1+\alpha}$ Ans
3. $\frac{1+\alpha}{2\sqrt{\alpha}}$
4. $\frac{1-\alpha}{1+\alpha}$

$\left(\frac{I_1}{I_2}\right) = \alpha$

$= \frac{I_1 + I_2 + 2\sqrt{I_1}\sqrt{I_2} - I_1 - I_2 + 2\sqrt{I_1}\sqrt{I_2}}{I_1 + I_2 + 2\sqrt{I_1}\sqrt{I_2} + I_1 + I_2 - 2\sqrt{I_1}\sqrt{I_2}}$

$= \frac{4\sqrt{I_1}\sqrt{I_2}}{2(I_1+I_2)} = \frac{4\sqrt{\alpha I_2}\sqrt{I_2}}{2(\alpha I_2 + I_2)} = \frac{2 I_2\sqrt{\alpha}}{I_2(\alpha+1)} = \frac{2\sqrt{\alpha}}{\alpha+1}$

MR*

If $\alpha = 1$

$I_1 = I_2$

$I_{max} = 4I$

$I_{min} = 0$

→ 1

$\alpha = 4$

QUESTION

The displacements of two interfering light waves are $y_1 = 4 \sin \omega t$ and $y_2 = 3 \cos(\omega t)$. The amplitude of the resultant wave is (y_1 and y_2 are in CGS system)

1. 5 cm
2. 7 cm
3. 1 cm
4. Zero

QUESTION

If an interference pattern has maximum and minimum intensities in 36 : 1 ratio then what will be the ratio of amplitudes?

1. 5 : 7
2. 7 : 4
3. 4 : 7
4. 7 : 5

$$\frac{I_{max}}{I_{min}} = \frac{36}{1}$$

$$\frac{(A_1+A_2)^2}{(A_1-A_2)^2} = \frac{36}{1}$$

$$\frac{A_1+A_2}{A_1-A_2} = \frac{6}{1}$$

$$\frac{A_1}{A_2} = \frac{10}{8} = 7/5$$

QUESTION

Two coherent sources have intensity ratio of 100 : 1, and are used for obtaining the phenomenon of interference. Then the ratio of maximum and minimum intensity will be

(1) 100 : 1

(2) 121 : 81 ✓

(3) 1 : 1

(4) 5 : 1

$$\frac{I_1}{I_2} = \frac{100}{1}$$

$$\frac{I_{max}}{I_{min}} = \left(\frac{\sqrt{100}+\sqrt{1}}{\sqrt{100}-\sqrt{1}}\right)^2 = \left(\frac{11}{9}\right)^2 = \frac{121}{81}$$

QUESTION

Two coherent sources each emitting light of intensity I_0 interfere in a medium at a point where phase difference between them is $\frac{2\pi}{3}$. Then the resultant intensity at that point would be

each of Inten

$\rightarrow 120°$

$I_{net} = I_0$

Ans

QUESTION

Two sources of intensity $2I$ and $8I$ are used in an interference experiment. The intensity at a point where the waves from two sources superimpose with a phase difference of (a) zero (b) $\pi/2$ and (c) π is:

1. $18I, 10I, 2I$
2. $5I, 4I, I$
3. $2I, I, I/2$
4. $2I, 10I, 18I$

$I_{net} = I_1 + I_2 + 2\sqrt{I_1}\sqrt{I_2}\cos\phi$

(a) $\phi = 0$

$I_{net} = I_1 + I_2 + 2\sqrt{I_1}\sqrt{I_2}$

$= 2I + 8I + 2\sqrt{2I \times 8I}$

$= 18I$

(b) $\phi = \pi/2$

$I_{net} = 10I$

(c) $2I$

The MR*

QUESTION

The intensity of interference waves in an interference pattern is same as I_0. The resultant intensity at the point of observation will be:

1. $I = 2I_0\,[1 + \cos\phi]$
2. $I = I_0\,[1 + \cos\phi]$
3. $I = \dfrac{[1 + \cos\phi]}{I_0}$
4. $I = \dfrac{[1 + \cos\phi]}{2I_0}$

If $A_1 = A_2 = A_0$

$A_{net} = 2A_0 \cos(\phi/2)$

square both side

$A_{net}^2 = 4A_0^2 \cos^2(\phi/2)$

$I_{net} = 4I_0 \cos^2(\phi/2)$

$I_{net} = I_1 + I_2 + 2\sqrt{I_1}\sqrt{I_2}\cos\phi$

$= 2I_0 + 2I_0\cos\phi$

$I_{net} = 2I_0(1 + \cos\phi)$

$= 2I_0\, 2\cos^2(\phi/2)$

$I_{net} = 4I_0 \cos^2(\phi/2)$

There is Superimposition of Two Incoherent source of Intensity I_1 & I_2. then find I_{net} ??

ϕ = varible

Masi Ji

Sol^n

$$I_{net} = I_1 + I_2 + 2\sqrt{I_1}\sqrt{I_2}\cos\phi$$

$$\langle I_{net} \rangle = \langle I_1 \rangle + \langle I_2 \rangle + 2\langle \sqrt{I_1}\sqrt{I_2}\cos\phi \rangle$$

($\cos\phi$ → 0)

$$\langle I_{net} \rangle = I_1 + I_2$$

Mami

n-Identical Incoherent source superImposed then find resultant Intensity ??

$$I_{net} = I_1 + I_2 + I_3 + I_3 + - \quad nI$$

Ans

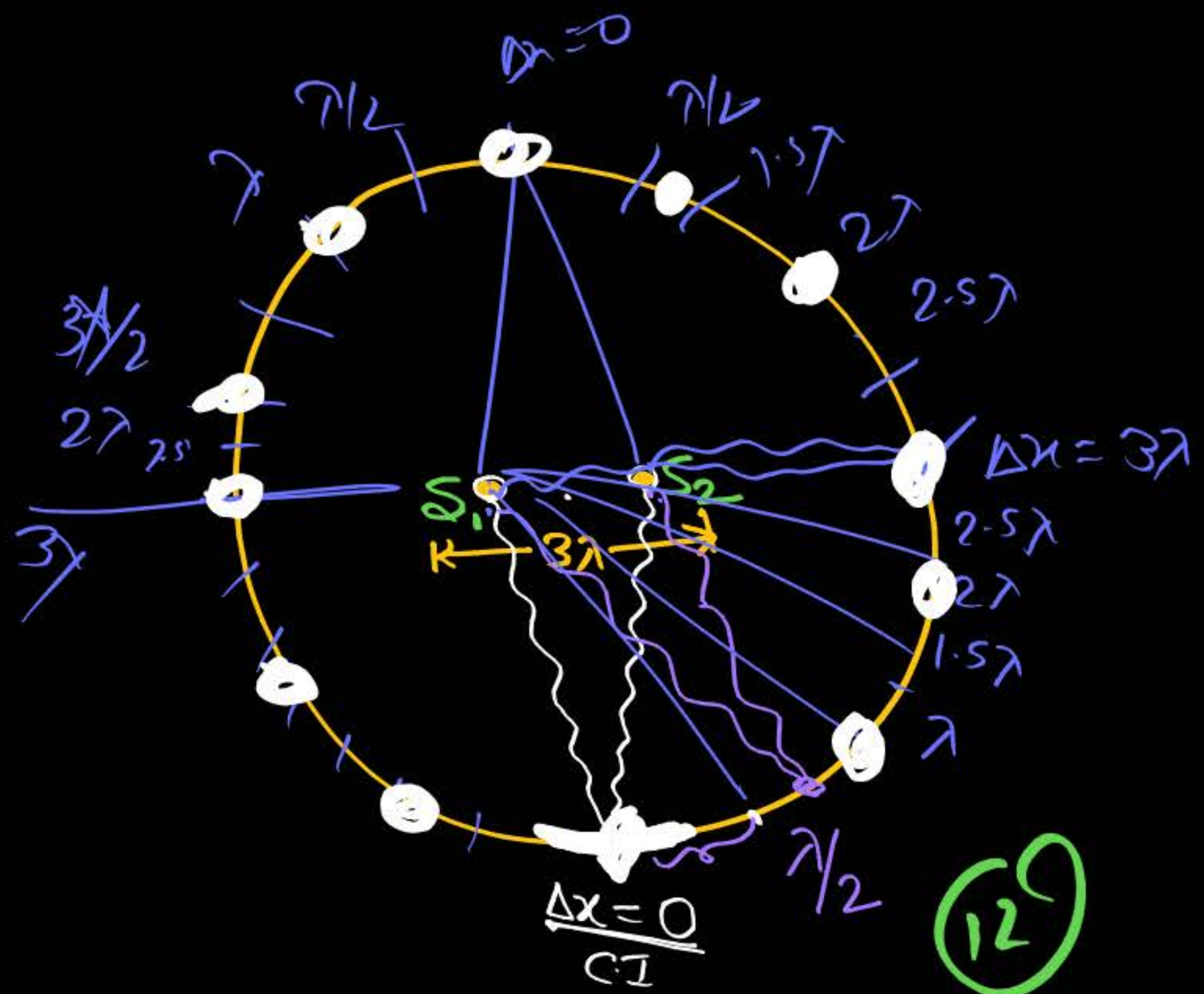
QUESTION

Two incoherent sources of tight emitting light of intensity I_0 and $3I_0$ interfere in a medium. Then the resultant intensity at any point wilt be

$I_{net} = I_0 + 3I_0$
$= 4I_0$

$\Delta x = 0, \frac{\lambda}{6}, \frac{\lambda}{3}, \frac{\lambda}{2}, \lambda, \frac{3\lambda}{2}, 2\lambda, \frac{5\lambda}{2}, 3\lambda$

- $\Delta x = 0$ → C.I गोरी
- $\frac{\lambda}{2}$ → D.I काली
- λ → C.I
- $\frac{3\lambda}{2}$ → काली
- 2λ → गोरी

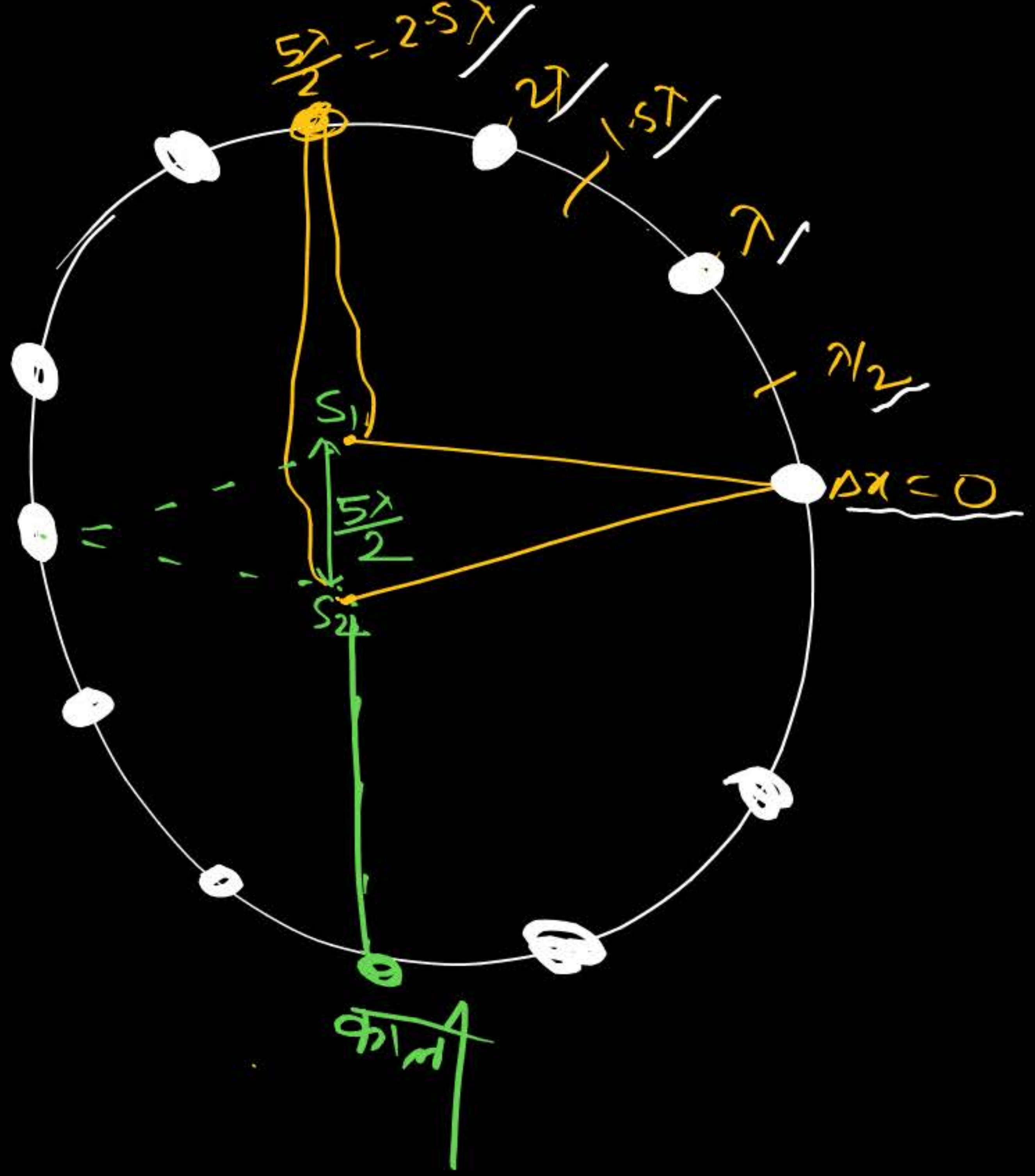


Two Identical source

have wave length (λ)

12 12

गोरी | काली

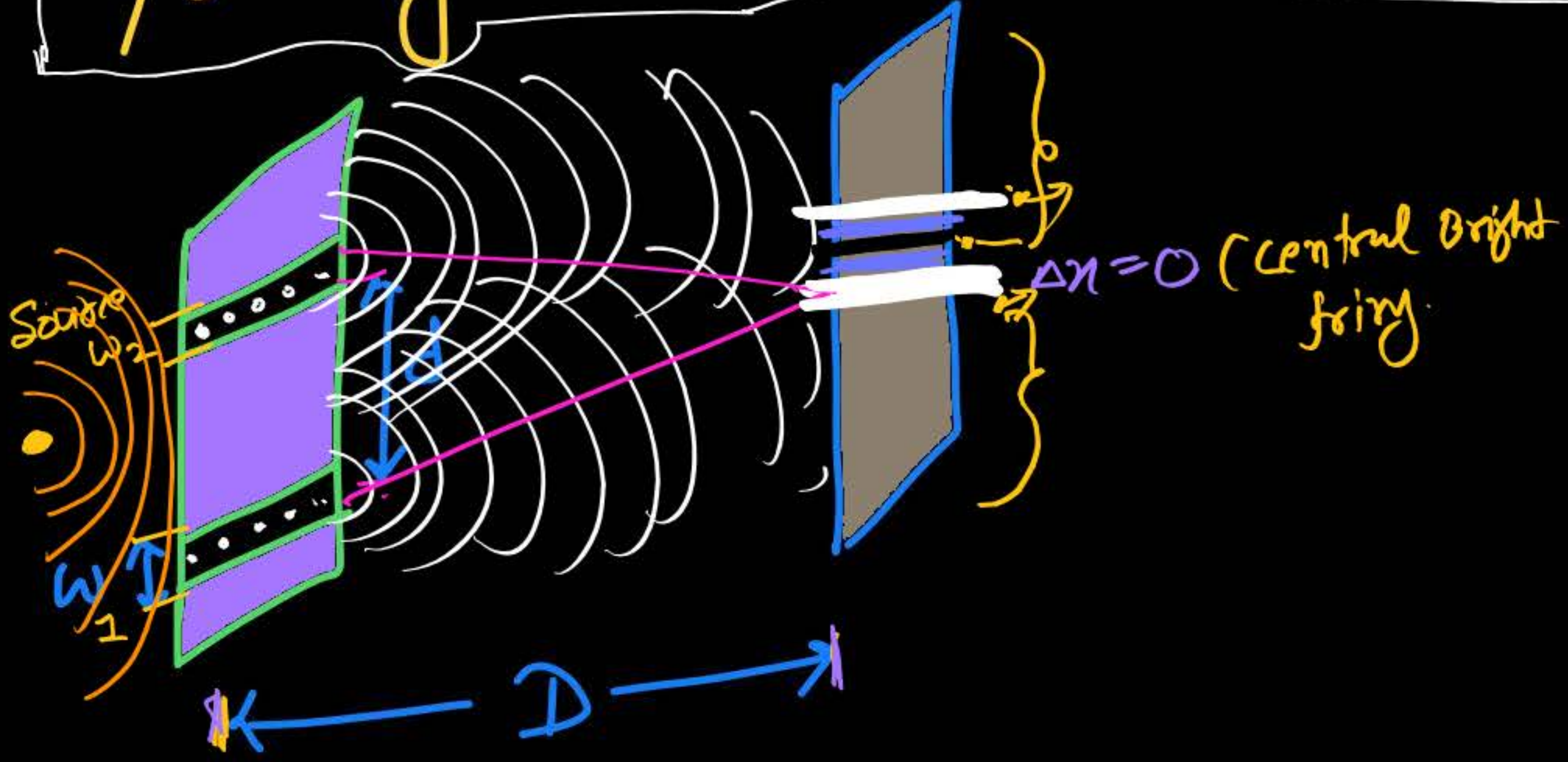


10 गोरी

10 काली

Ans.

youngs double slit experiment



w_1 & w_2 = width of ractangur slit.

equal width $w_1 = w_2 = w$

d = distance B/w slit.

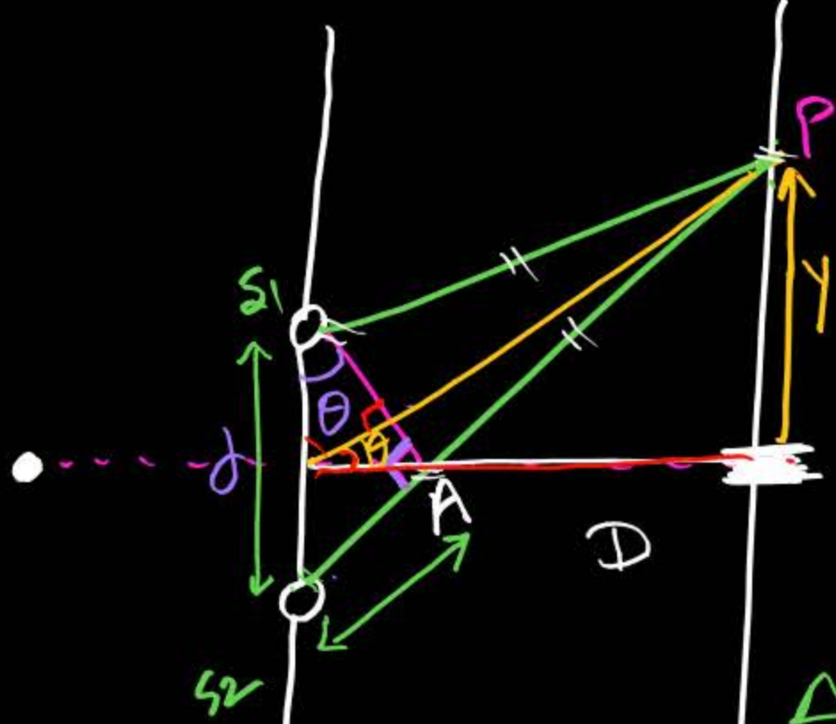
D = dist^n B/w slit and screen

$w << d <<< D$

* Condition of YDSE

$S_1P \neq S_2P$

$\Delta x = S_2P - S_1P$
Path diff.



$S_1P = AP$
as given in diagr.

$\Delta x = S_2A$

$$\sin\theta = \frac{S_2A}{d}$$

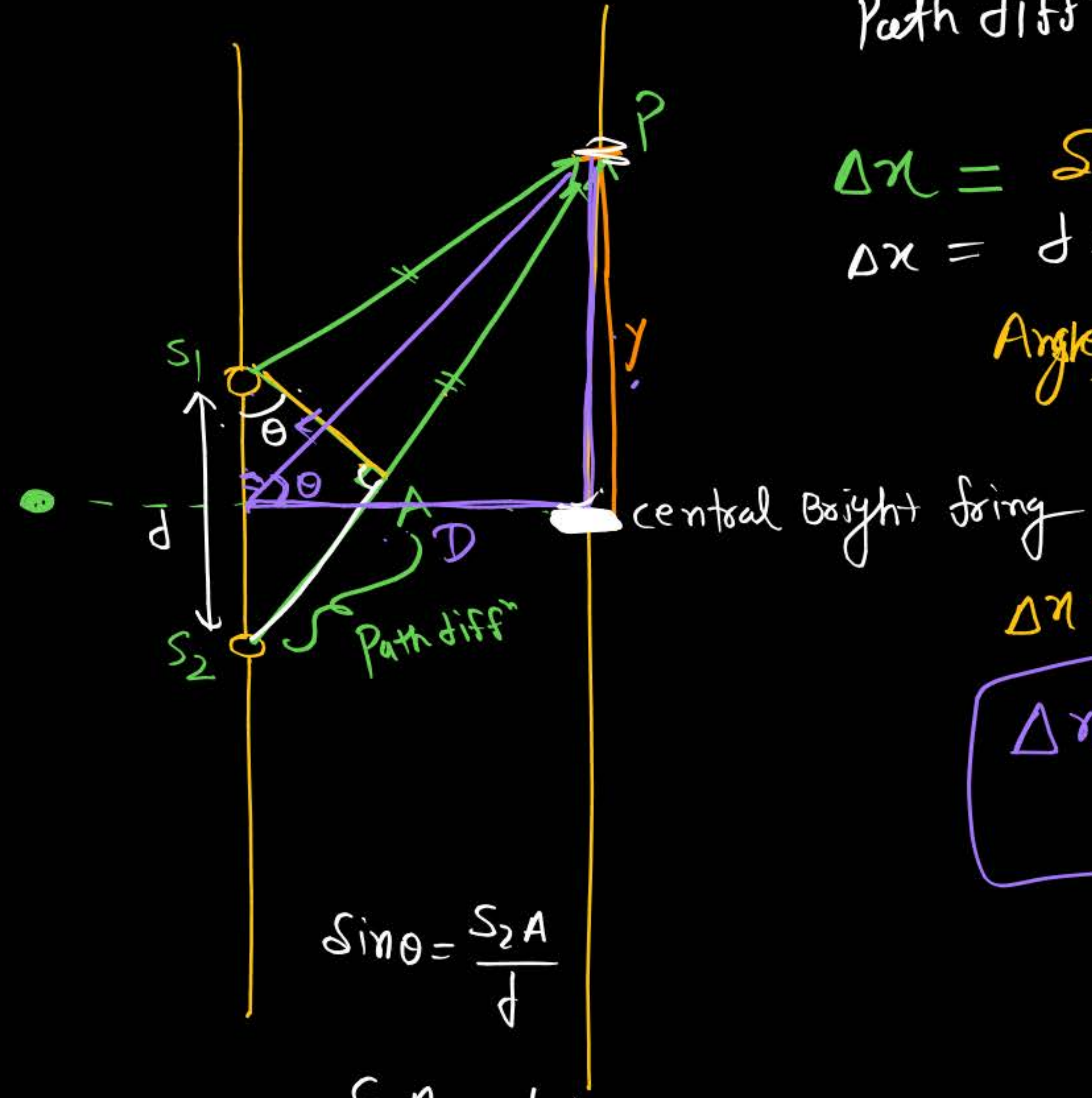
$$S_2A = d\sin\theta$$

$\Delta x = d\sin\theta$

If Angle is small
$(D >> d)$

$\Delta x = d\tan\theta$

$$\Delta x = \frac{dY}{D}$$



Path diff^n at Point 'P'

$\Delta x = S_2 A$

$\Delta x = d \sin\theta$

Angle is small.
$\sin\theta \simeq \tan\theta$

$\Delta x = d \tan\theta$

$$\Delta x = \frac{dY}{D}$$

$$\sin\theta = \frac{S_2 A}{d}$$

$S_2 A = d \sin\theta$.

Y.D.S.E

Path diff^n

$$\Delta x = \frac{dY}{D}$$??

$\Delta x = \frac{dY}{D} = (2n-1)\frac{\lambda}{2}$
D.I

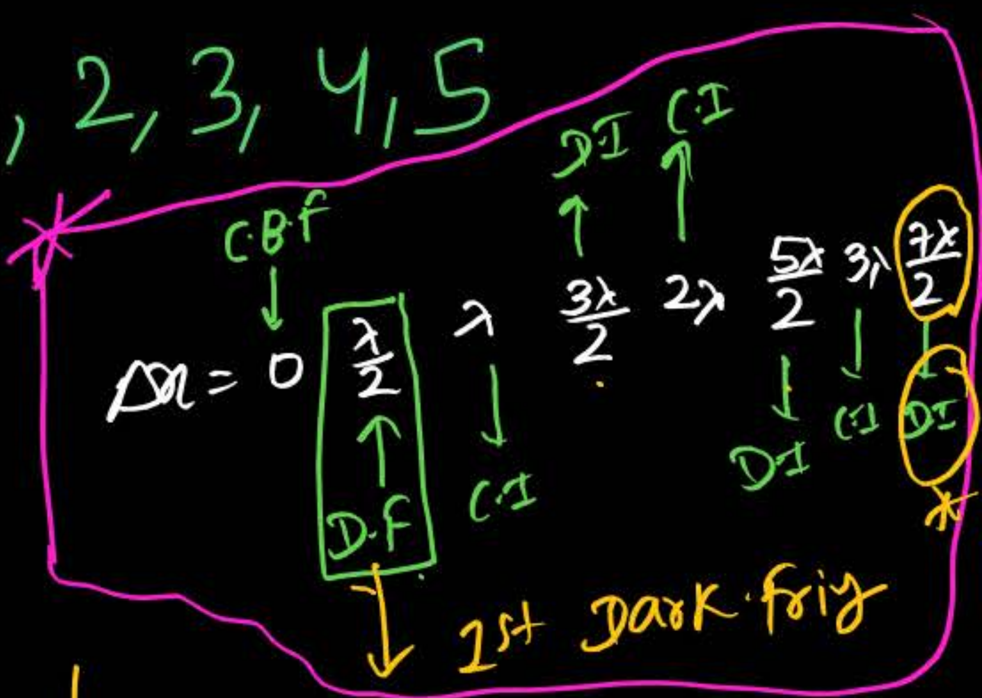
$\Delta x = \frac{dY}{D} = n\lambda$
C.I

d = dist^n B/w slit

D = dist^n B/w screen & slite.

for Constructive Interference

Path difference $\Delta x = \frac{dy}{D} = n\lambda$ $\quad n = 0, 1, 2, 3, 4, 5$



for central maxima $n = 0$

$$\frac{dy}{D} = 0$$

$$\boxed{y = 0} \rightarrow \text{central B.F.}$$

for 1st B.F. → $n = 1$

$$\frac{dy}{D} = \lambda \Rightarrow \boxed{y = \frac{1 D\lambda}{d}} \text{ (Position of 1st B.F)}$$

for 2nd B.F → $n = 2$

$$\boxed{y = \frac{2D\lambda}{d}} \text{ (Position of 2nd B.F)}$$

for 3rd B.F. →

$$\boxed{y = \frac{3D\lambda}{d}} \rightarrow \text{Position of 3rd B.F}$$

for nth B.F

$$\boxed{y = \frac{nD\lambda}{d}}$$

$\frac{dy}{D} = \frac{\lambda}{2}$

$$\boxed{y = \frac{\lambda D}{2d}} \text{ — Position of 1st Dark}$$

$\frac{dy}{D} = \frac{3\lambda}{2}$

$$\boxed{y = \frac{3\lambda D}{2d}} \text{ — Position of 2nd Dark}$$

for Distructive Interference

$$\Delta x = \frac{dy}{D} = (2n-1)\frac{\lambda}{2}$$

1st Distructive Interference → $y_{1^{st} D.P} = \frac{\lambda D}{2d}$

1st minima

2nd D.I (2nd minima) $= \frac{3\lambda D}{2d}$

3rd D.I (3rd minima) $= \frac{5\lambda D}{2d}$

nth D.I (nth minima) $= \frac{7\lambda D}{2d}$

$$\Delta x = \frac{dy}{D} = n\lambda$$

$$y = \frac{n\lambda D}{d}$$ *

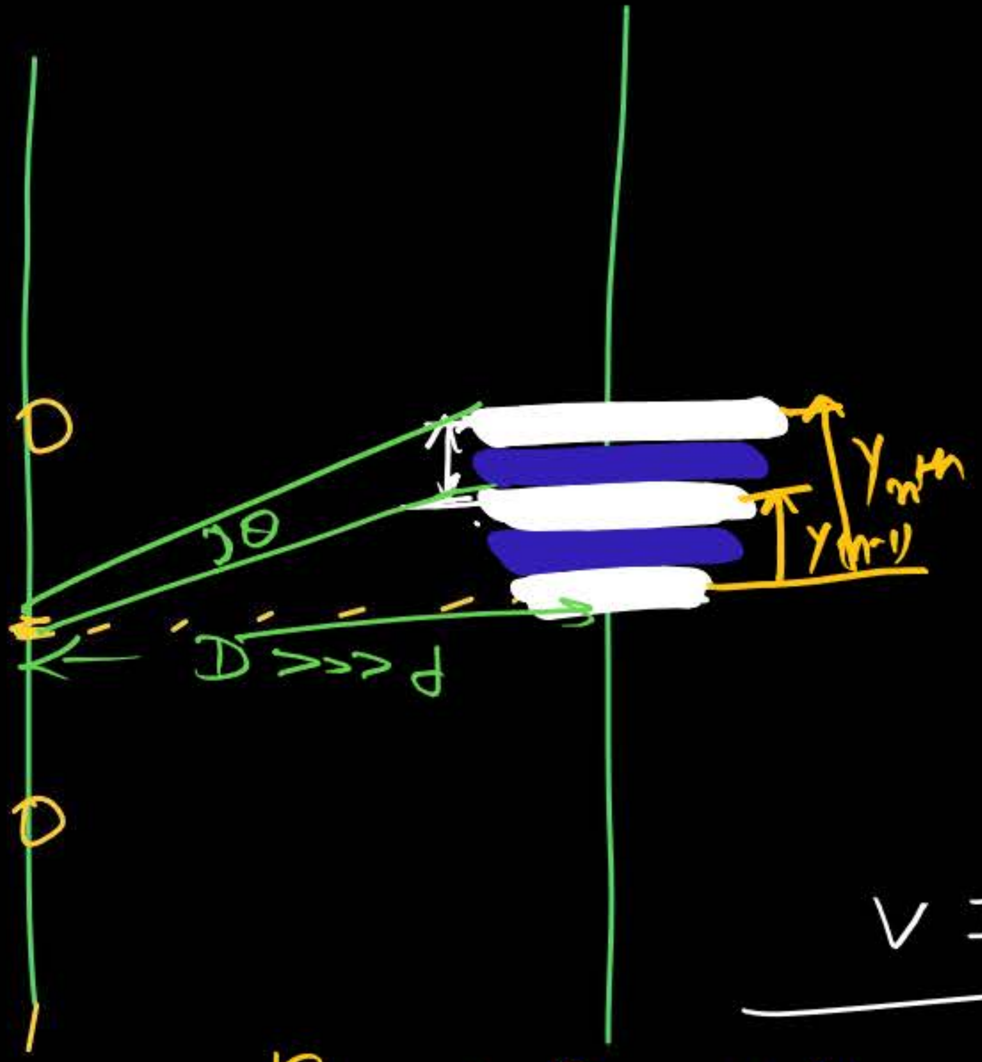
→ Position of n^{th} B.F

$$\Delta x = \frac{dy}{D} = (2n-1)\frac{\lambda}{2}$$

$$y = \frac{(2n-1)\lambda D}{2d}$$

→ Positi of n^{th} Dark frin

fring width $\beta = Y_{n BF} - Y_{(n-1)^{th} BF}$



$$\beta = Y_{n^{th} B.F} - Y_{(n-1)^{th} B.F}$$

$$= \frac{n\lambda D}{d} - \frac{(n-1)\lambda D}{d}$$

$$= \frac{n\lambda D}{d} - \frac{n\lambda D}{d} + \frac{\lambda D}{d}$$

$$\boxed{\beta = \frac{\lambda D}{d}}$$

$\beta \propto \lambda$ $\beta \propto D$ $\boxed{\beta \propto \frac{1}{d}}$

VIBGYOR

$\beta_{voilt} < \beta_{Grn} < \beta_{Yelw} < \beta_{org} < \beta_{Red}$

$$\tan\theta = \frac{\beta}{D} = \frac{\lambda D}{d \cdot D}$$

Angular fring wid $\Rightarrow \boxed{\theta = \frac{\lambda}{d}}$ #

Angular D.F.

$$\beta = \frac{\lambda D}{d}$$

$$\theta = \frac{\lambda}{d}$$

*

➢ If w_1 and w_2 are widths of two slits from which intensities of light I_1 and I_2 then

$$\frac{w_1}{w_2} = \frac{I_1}{I_2} = \frac{A_1^2}{A_2^2}$$

Amplit· of wav·

$I_{min} \neq 0$

$I_{max} < 4I$

If $w_1 = w_2 = w$

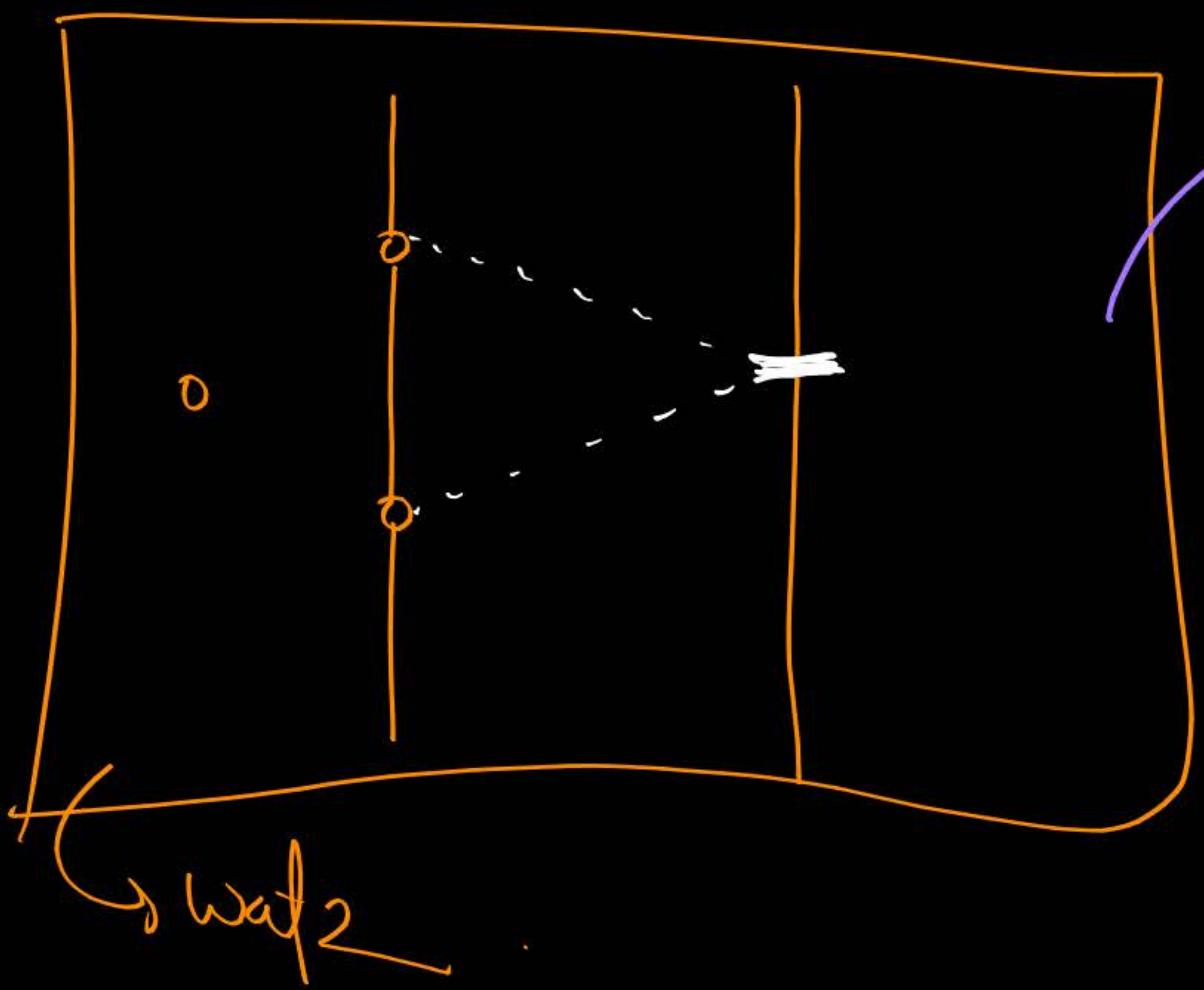
$I_1 = I_2 = I_0$

$I_{max} = 4I_0$

$I_{min} = 0$

High visibility

Y.D.S.E in another Medium



$v = \lambda f \rightarrow$ same

$\lambda \propto v \propto \frac{1}{\mu}$

$$\lambda \propto \frac{1}{\mu}$$

$$\lambda_m = \frac{\lambda_0}{\mu}$$

$$Y_{n^{th} Br} = \frac{n \lambda D}{\mu d}$$

$$\beta_{air} = \frac{\lambda D}{d}$$

$$\beta_{med} = \frac{\beta_{air}}{\mu}$$

QUESTION

In an interference pattern, the slit widths are in the ratio 1 : 9. Then find out the ratio of minimum and maximum intensity.

1. 1 : 2
2. 1 : 6
3. 1 : 3
4. 1 : 4

QUESTION

Interference was observed in interference chamber where air was present, now the chamber is evacuated, and if the same light is used, a careful observer will see [1999]

1. no interference
2. interference with brighter bands
3. interference with dark bands
4. interference fringe with larger width

QUESTION

In Young's double slit experiment, if the separation between coherent sources is halved and the distance of the screen from the coherent sources is doubled, then the fringe width becomes: **[2020]**

1. half
2. four times
3. one-fourth
4. double

QUESTION

In a Young's double slit experiment, if there is no initial phase difference between the light from the two slits, a point on the screen corresponding to the fifth minimum has path difference

[NEET Odisha 2019]

1. $11\frac{\lambda}{2}$
2. $5\frac{\lambda}{2}$
3. $10\frac{\lambda}{2}$
4. $9\frac{\lambda}{2}t$

QUESTION

Two slits in Young's experiment have widths in the ratio 1 : 25. The ratio of intensity at the maxima and minima in the interference pattern, $\frac{I_{\text{max}}}{I_{\text{min}}}$ max is: [2015 RS]

1. $\frac{121}{49}$
2. $\frac{49}{121}$
3. $\frac{4}{9}$
4. $\frac{9}{4}$

QUESTION

In the Young's double-slit experiment, the intensity of light at a point on the screen where the path difference is λ is K, (λ being the wave length of light used). The intensity at a point where the path difference is $\lambda/4$, will be: [2014]

1. K
2. K/4
3. K/2
4. zero

QUESTION

The intensity at the maximum in a Young's double slit experiment is I_0. Distance between two slits is $d = 5\lambda$, where λ is the wavelength of light used in the experiment. What will be the intensity in front of one of the slits on the screen placed at a distance $D = 10\,d$? [2016]

1. I_0
2. $I_0/9$
3. $\frac{3}{4}I_0$
4. $I_0/2$

QUESTION

In Young's double slit experiment the distance between the slits and the screen is doubled. The separation between the slits is reduced to half. As a result the fringe width [NEET Kar. 2013]

1. is doubled
2. is halved
3. becomes four times
4. remains unchanged

QUESTION

In Young's double slit experiment carried out with light of wavelength $(\lambda) = 5000$ Å, the distance between the slits is 0.2 mm and the screen is at 200 cm from the slits. The central maximum is at $x = 0$. The third maximum (taking the central maximum as zeroth maximum) will be at x equal to [1992]

1. 1.67 cm
2. 1.5 cm
3. 0.5 cm
4. 5.0 cm

QUESTION

In Young's experiment, two coherent sources are placed 0.90 mm apart and fringe are observed one metre away. If it produces second dark fringe at a distance of 1 mm from central fringe, the wavelength of monochromatic light used would be [1991, 1992]

1. 60×10^{-4} cm
2. 10×10^{-4} cm
3. 10×10^{-5} cm
4. 6×10^{-5} cm

QUESTION

The wavelength of the light used in Young's double slit experiment is λ. The intensity at a point on the screen is I, where the path difference is $\lambda/6$. If I_0 denotes the maximum intensity, then the ratio of I and I_0 is:

1. 0.866
2. 0.5
3. 0.707
4. 0.75

QUESTION

In a double slit experiment, when light of wavelength 400 nm was used, the angular width of the first minima formed on a screen placed 1 m away, was found to be 0.2°. What will be the angular width of the first minima, if the entire experimental apparatus is immersed in water? ($\mu_{water} = 4/3$) **(NEET 2019)**

1. 0.1°
2. 0.266°
3. 0.15°
4. 0.05°

QUESTION

In Young's double slit experiment the separation d between the slits is 2 mm, the wavelength λ of the light used is 5896 Å and distance D between the screen and slits is 100 cm. It is found that the angular width of the fringes is $0.20°$. To increase the fringe angular width to $0.21°$ (with same λ and D) the separation between the slits needs to be changed to

(NEET 2018)

1. 1.8 mm
2. 1.9 mm
3. 2.1 mm
4. 1.7 mm

QUESTION

Young's double slit experiment is first performed in air and then in a medium other than air. It is found that 8^{th} bright fringe in the medium lies where 5^{th} dark fringe lies in air. The refractive index of the medium is nearly (NEET 2017)

1. 1.59
2. 1.69
3. 1.78
4. 1.25

QUESTION

In Young's double slit experiment the distance between the slits and the screen is doubled. The separation between the slits is reduced to half. As a result the fringe width

(Karnataka NEET 2013)

1. is halved
2. becomes four times
3. remains unchanged
4. is doubled.

QUESTION

In Young's double slit experiment, the slits are 2 mm apart and are illuminated by photons of two wavelengths $\lambda_1 = 12000$ Å and $\lambda_2 = 10000$ Å. At what minimum distance from the common central bright fringe on the screen 2 m from the slit will a bright fringe from one interference pattern coincide with a bright fringe from the other?

(NEET 2013)

1. 4 mm
2. 3 mm
3. 8 mm
4. 6 mm

QUESTION

In Young's double slit experiment, the fringes width is found to be 0.4 mm. If the whole apparatus is immersed in water of refractive index 4/3, without disturbing the geometrical arrangement, the new fringe width will be (1990)

1. 0.30 mm
2. 0.40 mm
3. 0.53 mm
4. 450 micron.

QUESTION

The Young's double slit experiment is performed with blue and with green light of wavelengths 4360 Å and 5460 Å respectively. If x is the distance of 4th maxima from the central one, then (1990)

1. $x(\text{blue}) = x(\text{green})$

2. $x(\text{blue}) > x(\text{green})$

3. $x(\text{blue}) < x(\text{green})$

4. $\dfrac{x\ (\text{blue})}{x\ (\text{green})} = \dfrac{5460}{4360}$

Conditions for Interference

- The two sources of light should emit continuous waves of same wavelength and same time period *i.e.* the sources should have phase coherence.
- The two sources of light should be very close to each other.
- The waves emitted by two sources should either have zero phase difference or constant phase difference.


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 3 | Physics

Wave Optics

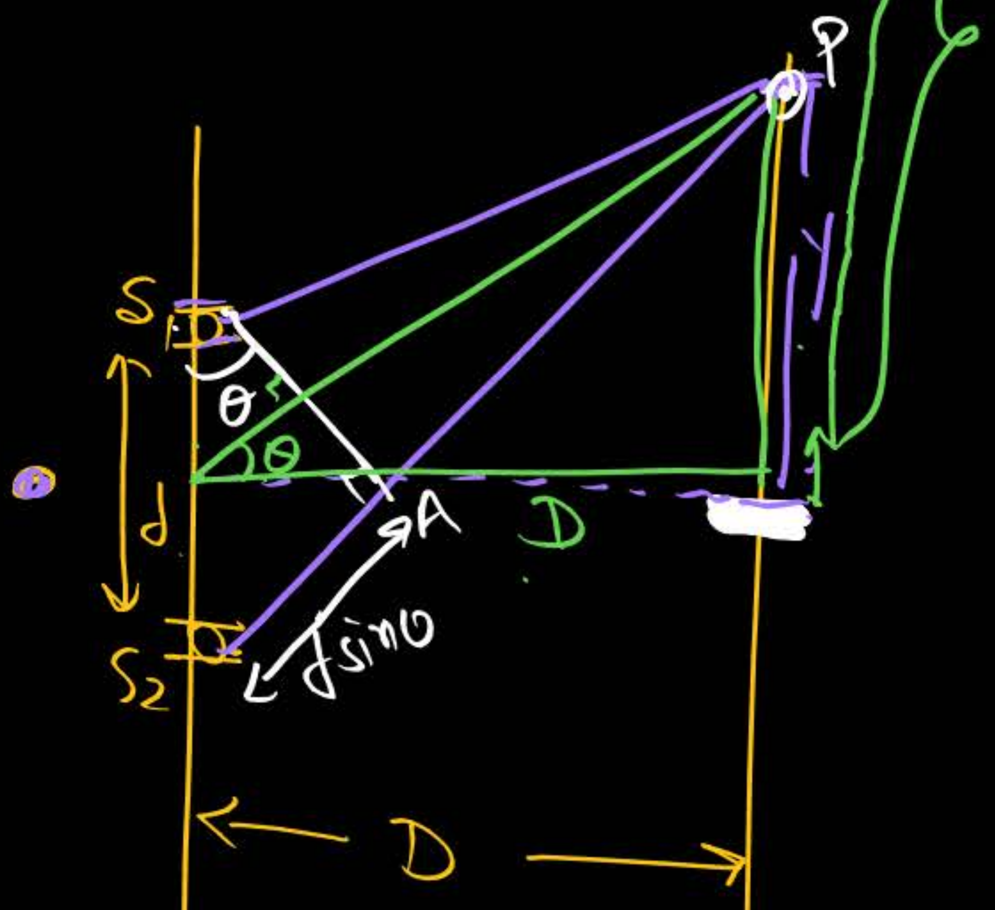
By- Dr. Manish Raj (MR SIR)



Todays Goal

M/W of 2nd class

Y.D.S.E



$\omega << d << D$

(n.m) (c.m) ↑ meter

Two light source

$\Delta x = S_2P - S_1P = S_2A$

$\Delta x = d\sin\theta$

$\Delta x = d\tan\theta$

$\Delta x = \left[\frac{dy}{D}\right]$

Path difference $= \frac{dy}{D}$

$\Delta x = \frac{dy}{D} = n\lambda$

Cond^n of CI

central B.F → $n = 0$ $y = 0$

1st B.F → $n = 1$ $y = \frac{\lambda D}{d}$

2^n B.F. → $n = 2$ $y = \frac{2\lambda D}{d}$

3rd B.F $n = 3$ $y = \frac{3\lambda D}{d}$

n^{th} B.F $y = \frac{n\lambda D}{d}$

$\frac{dy}{D} = (2n-1)\frac{\lambda}{2}$

$y = \frac{\lambda D}{2d}(I.D)^2$

$y_{n^{th} D.F} = \frac{(2n-1)\lambda D}{2d}$

$$\beta = \frac{\lambda D}{d}$$

$$\theta = \frac{\lambda}{d}$$

$$\alpha' = \frac{\lambda}{\mu d}$$

QUESTION

Interference was observed in interference chamber where air was present, now the chamber is evacuated, and if the same light is used, a careful observer will see [1999]

↓ vaccum

1. no interference ✗
2. interference with brighter bands ✗
3. ✗ interference with dark bands
4. ✓ interference fringe with larger width ✓

Ans (4)

$\mu_{air} > \mu_{vacuum}$

$I_{max} = (\sqrt{I_1} + \sqrt{I_2})^2$

$I_m = (\sqrt{I_1} - \sqrt{I_2})^2$

$\beta_{vacu} = \frac{\lambda D}{d\,\mu_{vacu}}$ $\beta_{air} = \frac{\lambda D}{d\,\mu_{air}}$

QUESTION

In a Young's double slit experiment, if there is no initial phase difference between the light from the two slits, a point on the screen corresponding to the fifth minimum has path difference

[NEET Odisha 2019]

(1) $11\frac{\lambda}{2}$

(2) $5\frac{\lambda}{2}$

(3) $10\frac{\lambda}{2}$

(4) $9\frac{\lambda}{2}$

QUESTION

Two slits in Young's experiment have widths in the ratio 1 : 25. The ratio of intensity at the maxima and minima in the interference pattern, $\frac{I_{max}}{I_{min}}$ max is: **[2015 RS]**

(1) $\frac{121}{49}$

(2) $\frac{49}{121}$

(3) $\frac{4}{9}$

(4) $\frac{9}{4}$

$\frac{\omega_1}{\omega_2} = \frac{1}{25} = \frac{I_1}{I_2}$

$\frac{I_{max}}{I_{min}} = \left(\frac{\sqrt{I_1} + \sqrt{I_2}}{\sqrt{I_1} - \sqrt{I_2}}\right)^2$

$= \left(\frac{\sqrt{1} + \sqrt{25}}{\sqrt{1} - \sqrt{25}}\right)^2 = \left(\frac{1+5}{1-5}\right)^2$

$= \frac{36}{16}$

$= \frac{18}{8} = \frac{9}{4}$

QUESTION

In the Young's double slit experiment, the intensity of light at a point on the screen where the path difference is λ is K, (λ being the wave length of light used). The intensity at a point where the path difference is λ/4, will be: **[2014]**

1. K
2. K/4
3. K/2 ✓ Ans
4. zero

Soln

$I_{net} = 4I\cos^2(\phi/2)$

$\phi = \frac{2\pi}{\lambda}\Delta x$

$I_{net} = 4I\cos^2\left(\frac{2\pi\Delta x}{2\lambda}\right)$

$I_{net} = 4I\cos^2\left(\frac{\pi\Delta x}{\lambda}\right)$

$K = 4I\cos^2\left(\frac{\pi\lambda}{\lambda}\right)$

$K = 4I$

$I_{net} = 4I\cos^2\left[\frac{\pi}{\lambda}\frac{\lambda}{4}\right]$

$= K\left(\frac{1}{\sqrt{2}}\right)^2 = \frac{K}{2}$

QUESTION

The intensity at the maximum in a Young's double slit experiment is I_0. Distance between two slits is $d = 5\lambda$, where λ is the wavelength of light used in the experiment. What will be the intensity in front of one of the slits on the screen placed at a distance $D = 10\,d$?

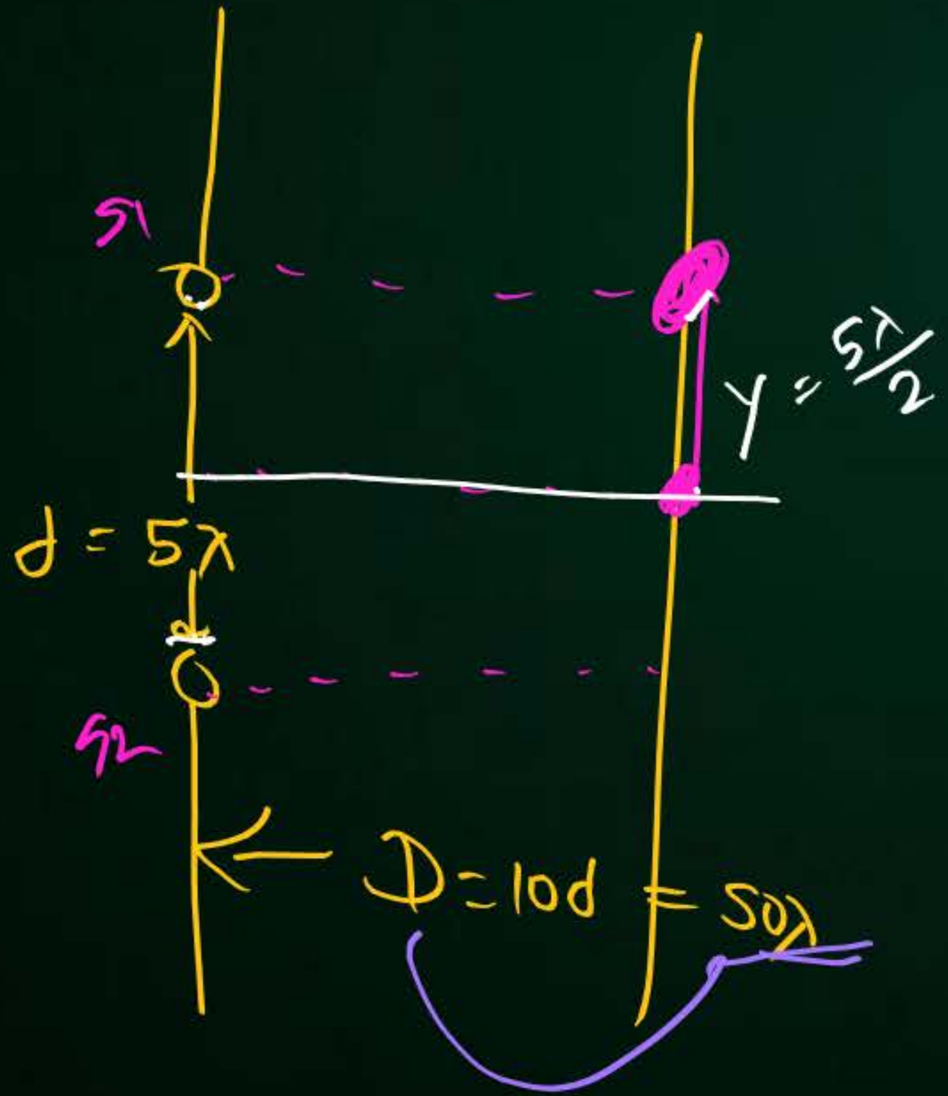
[2016]

(1) I_0

(2) $I_0/9$

(3) $\frac{3}{4} I_0$

(4) $I_0/2$



I = one source

$I_0 = 4I$ — (1)

$\Delta x = \frac{d \cdot y}{D} = \frac{d \times d}{2D} = \frac{d^2}{2D} = \frac{25\lambda^2}{2 \times 50\lambda}$

$\Delta x = \frac{\lambda}{4}$

$I_{net} = 4I \cos^2\left(\frac{\pi}{4}\right)$

$= I_0 \times \left(\frac{1}{\sqrt{2}}\right)^2 = \frac{I_0}{2}$

QUESTION

In Young's double slit experiment the distance between the slits and the screen is doubled. The separation between the slits is reduced to half. As a result the fringe width

[NEET Kar. 2013]

1. is doubled
2. is halved
3. becomes four times ✓
4. remains unchanged

$$\Delta x = \frac{dy}{D} = n\lambda$$

$$y = \frac{n\lambda D}{d}$$

$$\beta = \frac{\lambda D}{d}$$

D → doubl; d → half

D → double

d → half

QUESTION

In Young's double slit experiment carried out with light of wavelength $(\lambda) = 5000$ Å, the distance between the slits is 0.2 mm and the screen is at 200 cm from the slits. The central maximum is at $x = 0$. The third maximum (taking the central maximum as zeroth maximum) will be at x equal to [1992]

(1) 1.67 cm

(2) 1.5 cm ✓

(3) 0.5 cm

(4) 5.0 cm

$d = 0.2\ mm \quad D = 200\ cm$

$$x = \frac{n\lambda D}{d}$$

$$= \frac{3 \times 5000 \times 10^{-10} \times 200 \times 10^{-2}}{0.2 \times 10^{-3}}$$

$$= 3 \times 5 \times 10^{3} \times 10 \times 10^{2} \times 10^{-7} \times 10^{-2}$$

$$= 15 \times 10^{-3}\ m = 15 \times 10^{-1}\ cm = 1.5\ cm$$

QUESTION

In Young's experiment, two coherent sources are placed 0.90 mm apart and fringe are observed one metre away. If it produces second dark fringe at a distance of 1 mm from central fringe, the wavelength of monochromatic light used would be [1991, 1992]

1. 60×10^{-4} cm
2. 10×10^{-4} cm
3. 10×10^{-5} cm
4. 6×10^{-5} cm

$\Delta x = 3\lambda/2$

$d = 0.9$ mm

$D = 1$ m

$y = 1$ mm

$\Delta x = d \tan\theta$

$\Delta x = \frac{dy}{D} = \frac{3\lambda}{2}$

$\lambda = \frac{2dy}{3D}$

QUESTION

The wavelength of the light used in Young's double slit experiment is λ. The intensity at a point on the screen is I, where the path difference is $\lambda/6$. If I_0 denotes the maximum intensity, then the ratio of I and I_0 is:

1. 0.866
2. 0.5
3. 0.707
4. 0.75

$\Delta x = \lambda/6$

$I_{net} = I$

$I' =$ Intensity at one sl

$I_{max} = 4I' = I_0$

$\Delta\phi = \frac{2\pi}{\lambda}\Delta x = \frac{2\pi}{\lambda}\times\frac{\lambda}{6} = \frac{\pi}{3}$

$I_{net} = 4I' \cos^2(\phi/2)$

$= I_0 \cos^2\left[\frac{\pi}{3\times 2}\right]$

$= I_0 \times \left[\frac{\sqrt{3}}{2}\right]^2$

$I_{net} = I_0 \times \frac{3}{4}$

$\frac{I_{net}}{I_0} = \frac{3}{4} = 0.75$

QUESTION

In a double slit experiment, when light of wavelength 400 nm was used, the angular width of the first minima formed on a screen placed 1 m away, was found to be 0.2°. What will be the angular width of the first minima, if the entire experimental apparatus is immersed in water? ($\mu_{water} = 4/3$)

(NEET 2019)

1. 0.1°
2. 0.266°
3. 0.15° exact
4. 0.05°

$\theta = \frac{\lambda}{d}$

$\lambda = 400\ nm$

$\frac{\theta_{air}}{\theta_{med}} = \frac{\lambda_{air}}{\lambda_{med}}$

$\frac{0.2}{\theta_{med}} = \mu = \frac{4}{3}$

$\theta = \frac{3}{4} \times \frac{2}{10} = 0.15°$

QUESTION

In Young's double slit experiment the separation d between the slits is 2 mm, the wavelength λ of the light used is 5896 Å and distance D between the screen and slits is 100 cm. It is found that the angular width of the fringes is 0.20°. To increase the fringe angular width to 0.21° (with same λ and D) the separation between the slits needs to be changed to (NEET 2018)

1. 1.8 mm
2. 1.9 mm
3. 2.1 mm
4. 1.7 mm

$d = 2\text{ mm}$, $d' = ?$

$\beta = \frac{\lambda D}{d}$

$\theta = \frac{\lambda}{d}$ (λ → same)

$\frac{\theta_1}{\theta_2} \propto \frac{d_2}{d_1}$

$\frac{0.20}{0.21} = \frac{d_2}{2\text{ mm}}$

$\frac{20}{21} = \frac{d_2}{2\text{ mm}}$

$d_2 = \frac{20}{21} \times 2\text{ mm} = 1.9$

QUESTION

Young's double slit experiment is first performed in air and then in a medium other than air. It is found that 8^{th} bright fringe in the medium lies where 5^{th} dark fringe lies in air. The refractive index of the medium is nearly **(NEET 2017)**

1. 1.59
2. 1.69
3. 1.78
4. 1.25

air

$y = \frac{8\lambda D}{\mu d}$

medium

$y = \frac{(2n-1)\lambda D}{2d}$

$y = \frac{9\lambda D}{2d}$

$\frac{8\lambda D}{\mu d} = \frac{9\lambda D}{2d}$

$\mu = \frac{16}{9} = 1.77$

QUESTION

In Young's double slit experiment the distance between the slits and the screen is doubled. The separation between the slits is reduced to half. As a result the fringe width

(Karnataka NEET 2013)

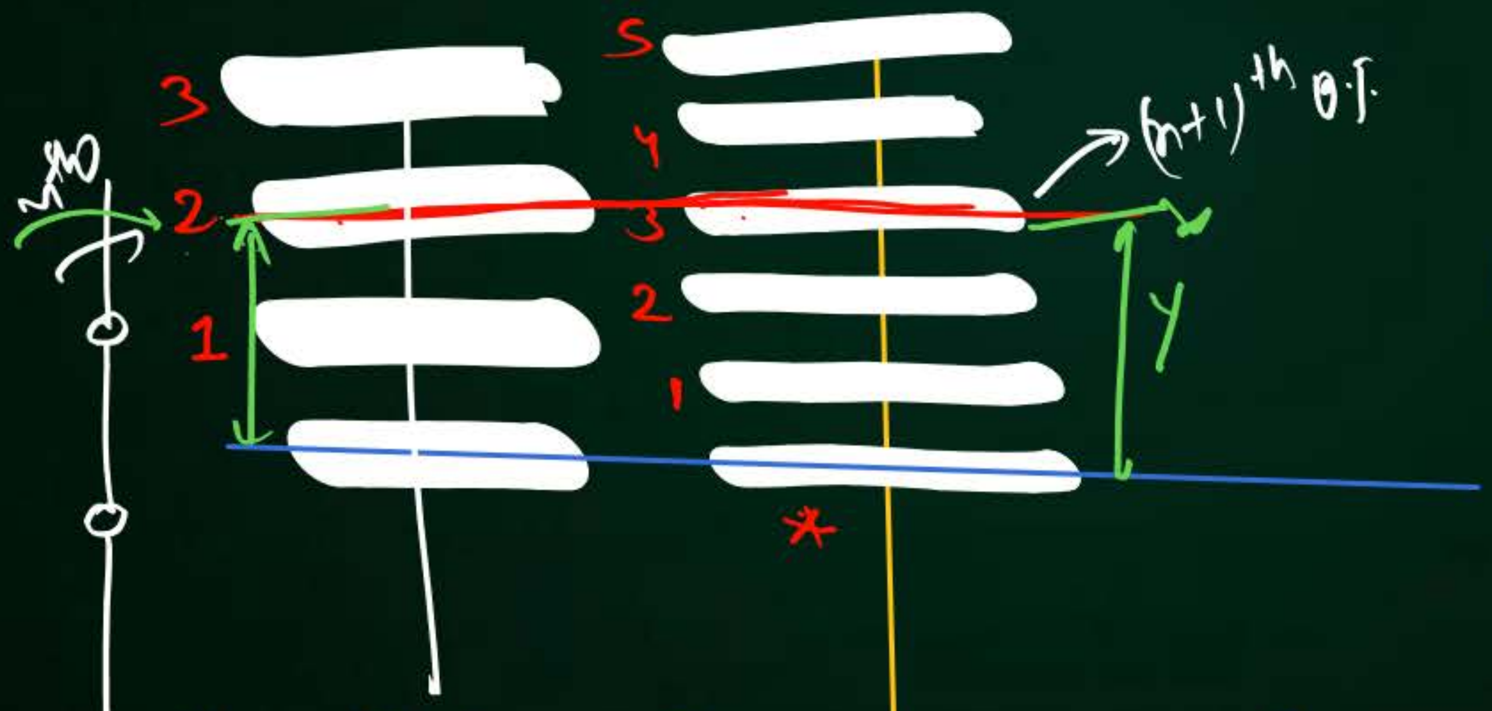
1. is halved
2. becomes four times
3. remains unchanged
4. is doubled.

QUESTION

In Young's double slit experiment, the slits are 2 mm apart and are illuminated by photons of two wavelengths $\lambda_1 = 12000$ Å and $\lambda_2 = 10000$ Å. At what minimum distance from the common central bright fringe on the screen 2 m from the slit will a bright fringe from one interference pattern coincide with a bright fringe from the other?

(NEET 2013)

1. 4 mm
2. 3 mm
3. 8 mm
4. 6 mm



QUESTION

In Young's double slit experiment, the fringes width is found to be 0.4 mm. If the whole apparatus is immersed in water of refractive index 4/3, without disturbing the geometrical arrangement, the new fringe width will be **(1990)**

1. 0.30 mm ✓
2. 0.40 mm
3. 0.53 mm
4. 450 micron.

$$\beta' = \frac{\beta}{\mu} = \frac{0.4\,mm}{4/3} = 0.3\,mm$$

QUESTION

The Young's double slit experiment is performed with blue and with green light of wavelengths 4360 Å and 5460 Å respectively. If x is the distance of 4th maxima from the central one, then (1990)

VIBGYOR

1. $x(\text{blue}) = x(\text{green})$
2. $x(\text{blue}) > x(\text{green})$
3. $x(\text{blue}) < x(\text{green})$
4. $\frac{x\,(\text{blue})}{x\,(\text{green})} = \frac{5460}{4360}$

Conditions for Interference

- The two sources of light should emit continuous waves of same wavelength and same time period *i.e.* the sources should have phase coherence.
- The two sources of light should be very close to each other.
- The waves emitted by two sources should either have zero phase difference or constant phase difference.




THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 04 | Physics

Wave Optics

By- Dr. Manish Raj (MR SIR)



Todays Goal

PhD. on Y.D.S.E



white line

Diffraction *

FRING VISIBILITY

- It is measure of intensity contrast between dark to bright band.

$$\eta = \frac{I_{max} - I_{min}}{I_{max} + I_{min}}$$

fring visibility

$$0 \le \eta \le 1$$

$$\eta = 1 \text{ (Max)}$$

$$I_1 = I_2 = I_0$$

$$I_{min} = 0, \quad I_{max} = 4I_0$$

$$I_{net} = I_1 + I_2 + 2\sqrt{I_1}\sqrt{I_2}\cos\phi$$

$$I_1 = I_2 = I_0$$

$$I_{net} = 2I_0[1 + \cos\phi]$$

$$I_{net} = 4I_0\cos^2(\phi/2)$$

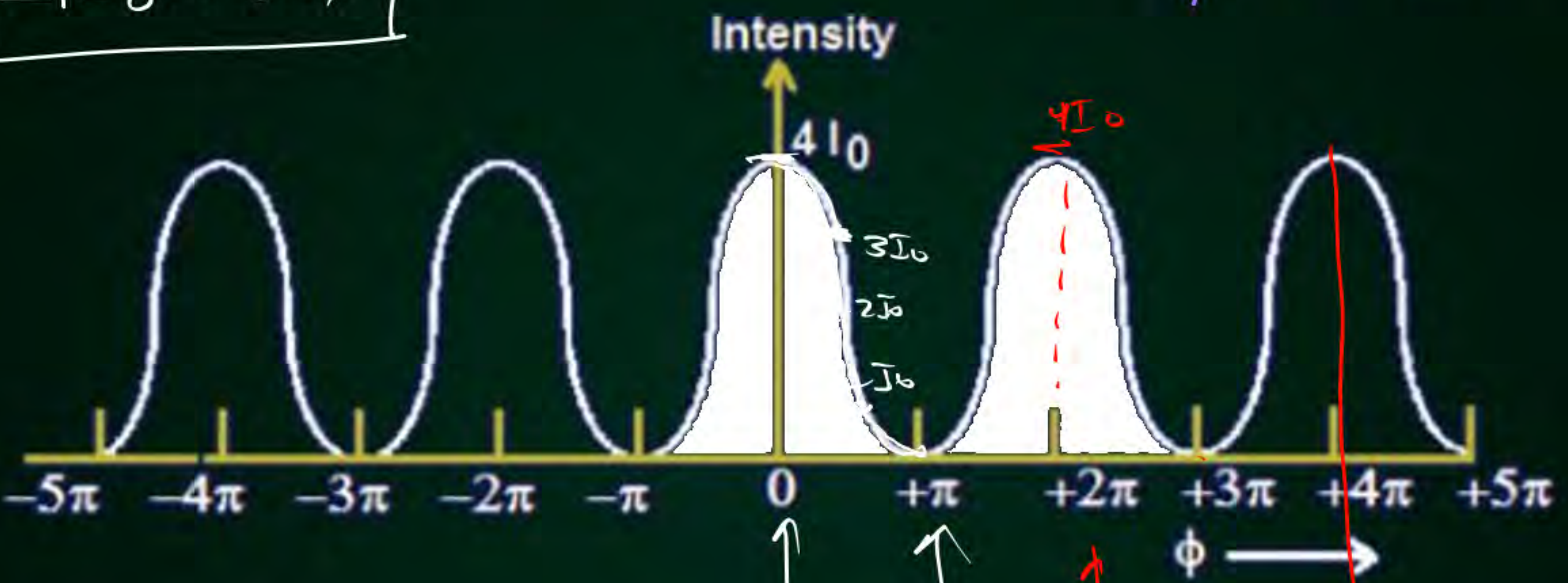
$$\phi = 0 \rightarrow I_{net} = 4I_0$$

$$I_{min} = 0$$

FRINGE-WIDTH

$$I_{net} = 4I_0 \cos^2(\phi/2)$$

I_0 = intens of wave from one



$2\pi \to \lambda$

$\Delta\phi = \pi \to \lambda/2$

$\Delta\phi = 0$

$$\Delta x = \frac{\lambda}{2\pi}\Delta\phi$$

MR*

	C.B	1st D.F	1st B.F	2nd D.F	2nd B.F	3rd D.F
$\Delta x =$	0	$\frac{\lambda}{2}$	λ	$\frac{3\lambda}{2}$	2λ	$\frac{5\lambda}{2}$
$\Delta\phi =$	0	π	2π	3π	4π	5π

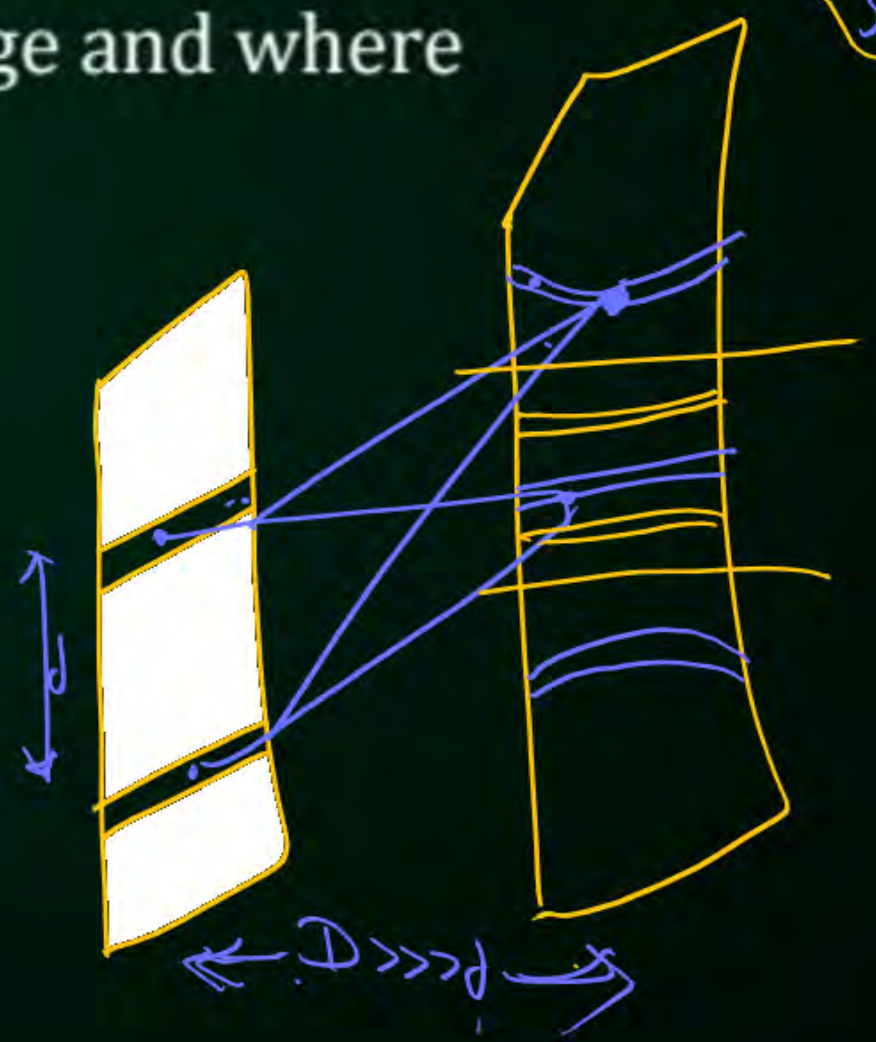
6π 7π

SHAPE OF FRINGES ON SCREEN

- Shape of fringes on the screen is the locus of point with a constant value of $S_2P - S_1P$. $= C \Rightarrow$ hyperbola, but if screen is at very-very large distn or consider small portion of screen then shape of fring will be straight line.
- Whenever $S_2P - S_1P = \lambda$ or $n\lambda$, we obtain bright fringe and where

$S_2P - S_1P = \frac{(2n+1)\lambda}{2}$, we obtain dark fringe. $\rightarrow n = 0, 1, 2, 3, 4$

$S_2P - S_1P = (2n-1)\frac{\lambda}{2}$ $(n = 1, 2, 3, 4)$



QUESTION

Whose fringe width will be more, the one for red light or the one for yellow light, all other things be the same ?

$$\beta = \frac{\lambda D}{d}$$

$$\beta \propto \lambda$$

VIBGYOR

$\longrightarrow \lambda\uparrow \ (\beta\uparrow)$

$$\beta_{Red} > \beta_{yellow}$$

QUESTION

Fringe width in a particular YDSE is measured to be β. What will be the fringe width if wavelength of the light is doubled and separation between the slits is halved? Separation between the screen and slits is tripled.

$\lambda' = 2\lambda$

$d' = d/2$

$D' = 3D$

$\beta = \frac{\lambda D}{d} = \frac{2 \times 3}{d/2} = 12$ time

QUESTION

In a Young's double slit setup using monochromatic light of wavelength λ, the intensity of light at a point where path difference is 2λ is found to be I_0. What will be the intensity at a point where path difference is $\lambda/3$?

C.I. I = Intens of some same

$I_{max} = I_0 = 4I$ — (1)

$\Delta\phi = \frac{2\pi}{\lambda}\Delta x$

$\Delta\phi = \frac{2\pi}{\lambda} \times \frac{\lambda}{3}$

$\Delta\phi = \frac{2\pi}{3}$

$I_{net} = 4I \cos^2\left(\frac{\phi}{2}\right)$

$= I_0 \cos^2\left(\frac{2\pi}{3\times 2}\right)$

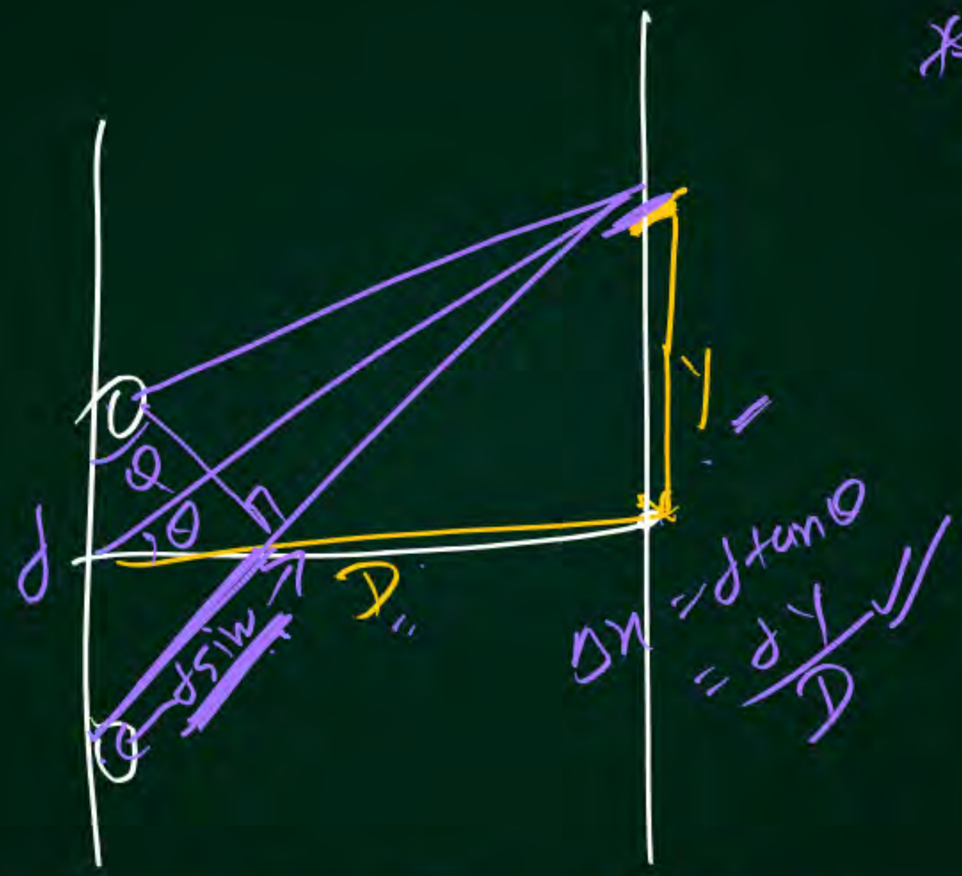
$= I_0 \left(\frac{1}{2}\right)^2$

$= \frac{I_0}{4}$ Ans

QUESTION

In YDSE, $d = 2$ mm, $D = 2$ m and $\lambda = 500$ nm. If intensity of two slits are I_0 and $9I_0$, then find intensity at $y = \frac{1}{6}$ mm.

1. $7I_0$
2. $10I_0$
3. $16I_0$
4. $4I_0$



$\Delta x = \frac{dy}{D} = \frac{2\times10^{-3}}{2\,m}\times\frac{1}{6}10^{-3} = \frac{10^{-6}}{6}$

$\Delta\phi = \frac{2\pi}{\lambda}\times\Delta x = \frac{2\pi}{500\times10^{-9}}\times\frac{10^{-6}}{6} = \frac{2\pi\times10^{-6}}{5\times10^{-7}\times6} = \frac{2\pi\times10}{30} = \frac{2\pi}{3}$

$I_{net} = I_0 + 9I_0 + 2\sqrt{I_0}\sqrt{9I_0}\cos\left(\frac{2\pi}{3}\right)$

$= 10I_0 + 6I_0\times\left(-\frac{1}{2}\right)$

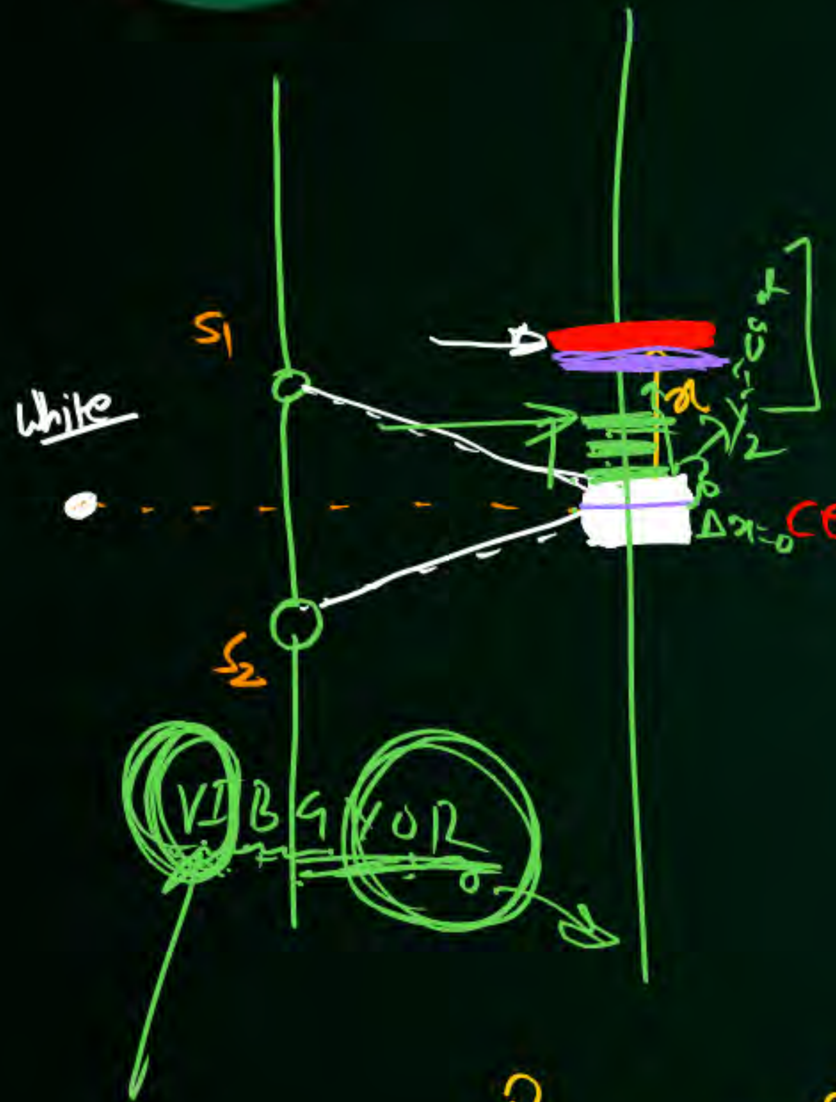
$= 7I_0$

YDSE with White Light

C.I = B.F / D.I = D.F

Coherence light source
↳ $\Delta\phi$ = const

monochromatic
↳ light of single wavelength



central B.F (white)

Y_{1st} D.I (Dark fringe) of Red $= \frac{\lambda_R D}{2d}$

Y_{1st} D.I (Dark fringe) of violet $= \frac{\lambda_v D}{2d}$

Y_{1st} B.F of Red $= x$ (let) $= \left[\frac{1 \times \lambda_R D}{d}\right]$ (C.I)

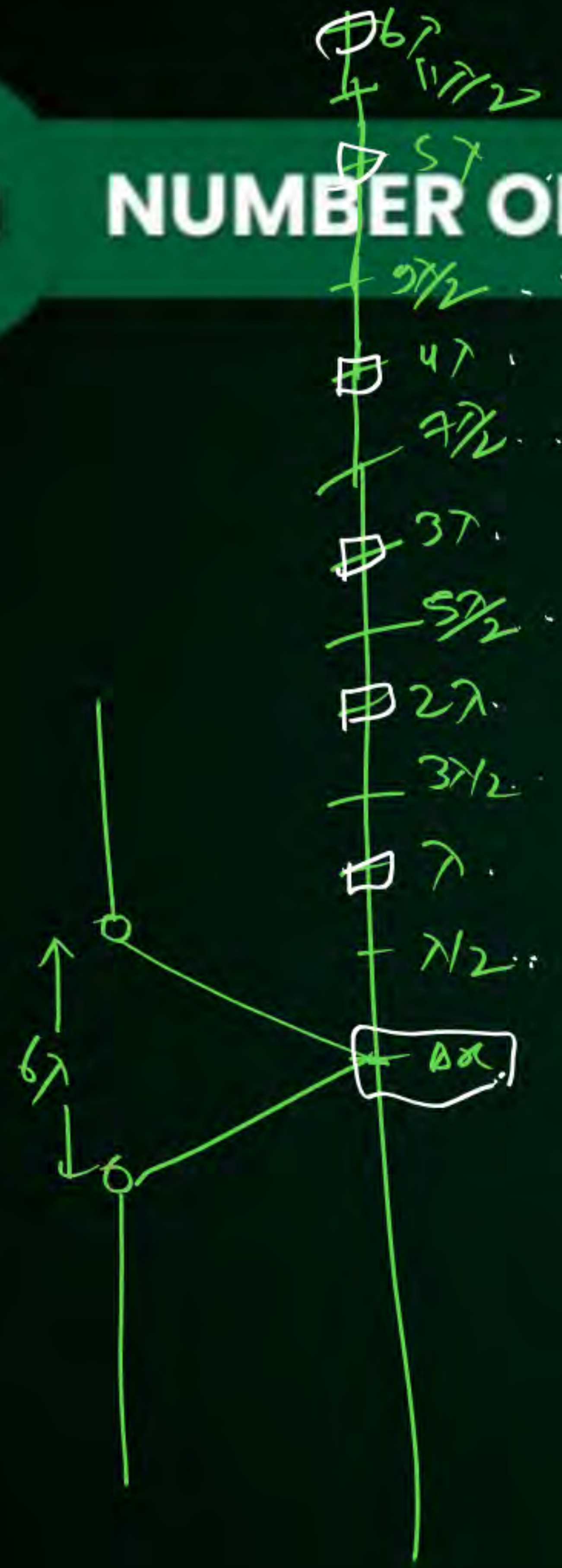
$\beta_{violet} < \beta_{red}$ Y_{1st} B.F of violet $= 0.9x = \frac{\lambda_v D}{d}$

→ 1st C.I. will occur for violet then red from C.B.fringe

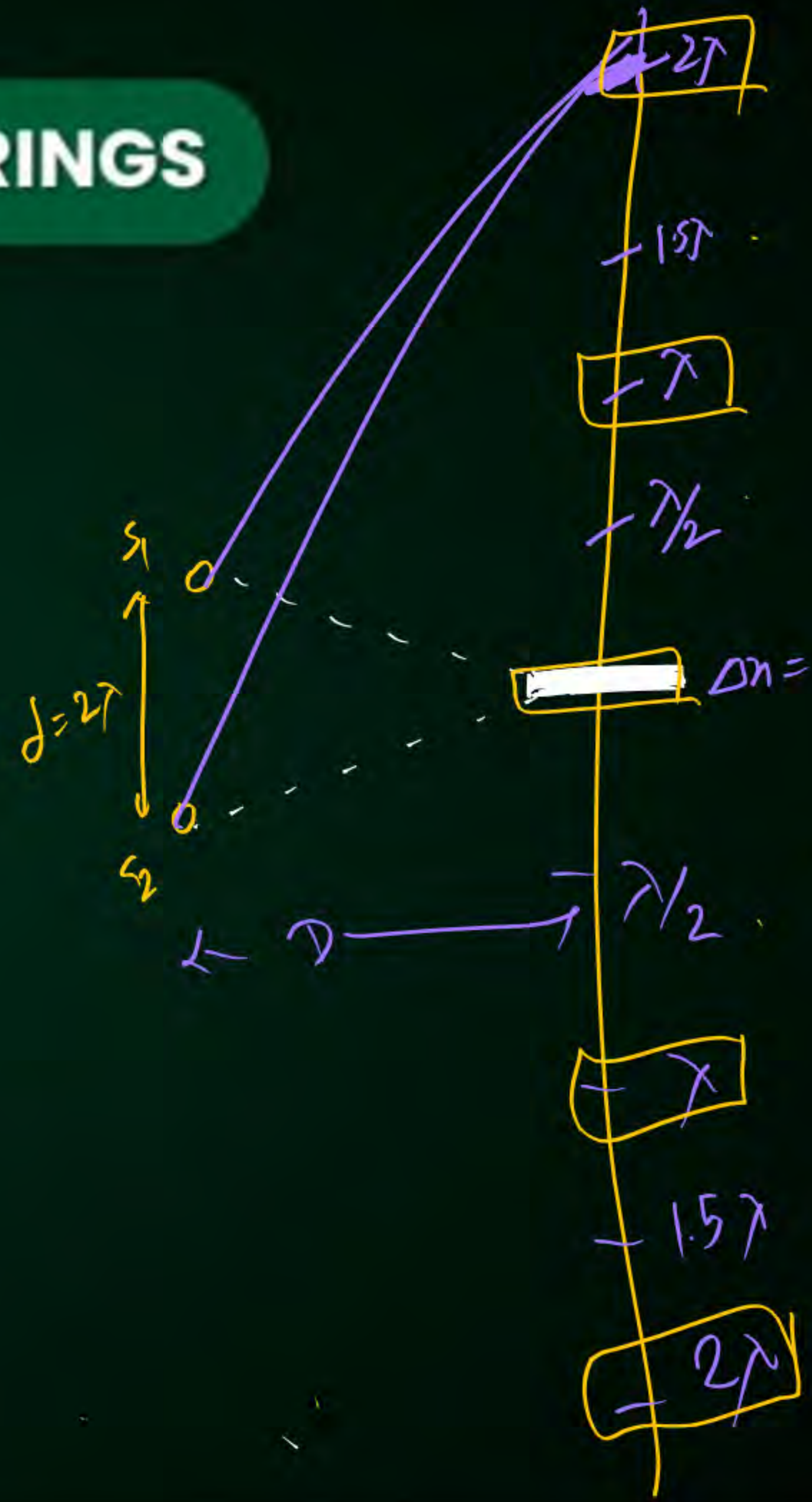
Which colour will appear 1st after central bright fringe

(a) Red ✓
(b) violet
(c) white
(d) green.

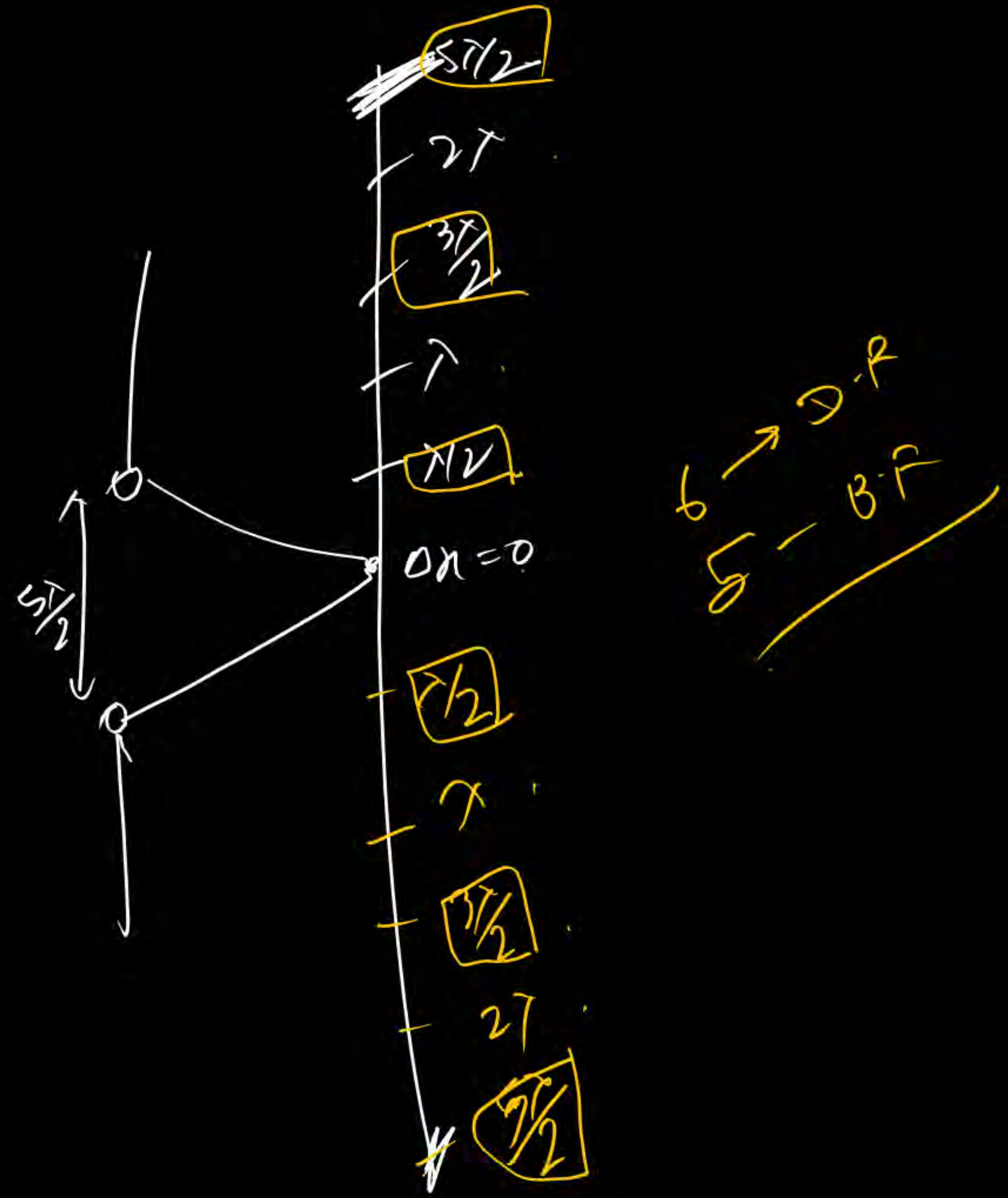
NUMBER OF BRIGHT AND DARK FRINGS



13 B.F
12 D.F

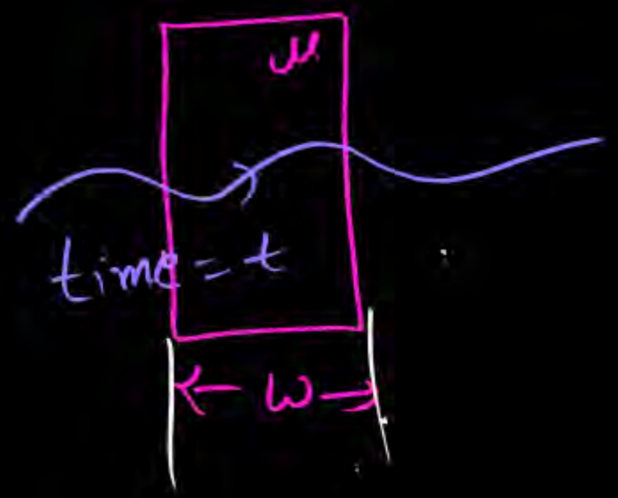


5 B.F
4 D.F


5π/2
2π
3π/2
π
π/2
Ox=0
π/2
π
3π/2
2π
5π/2
5π/2
6 → D·R
5 — B·F

Optical Path = distance travelled by light through air in a same time 't' in which Light cross the medium of width w of refraction Index μ.

→ defined for a medium of width w and refraction Index μ'



$t_{medium} = t_{air}$

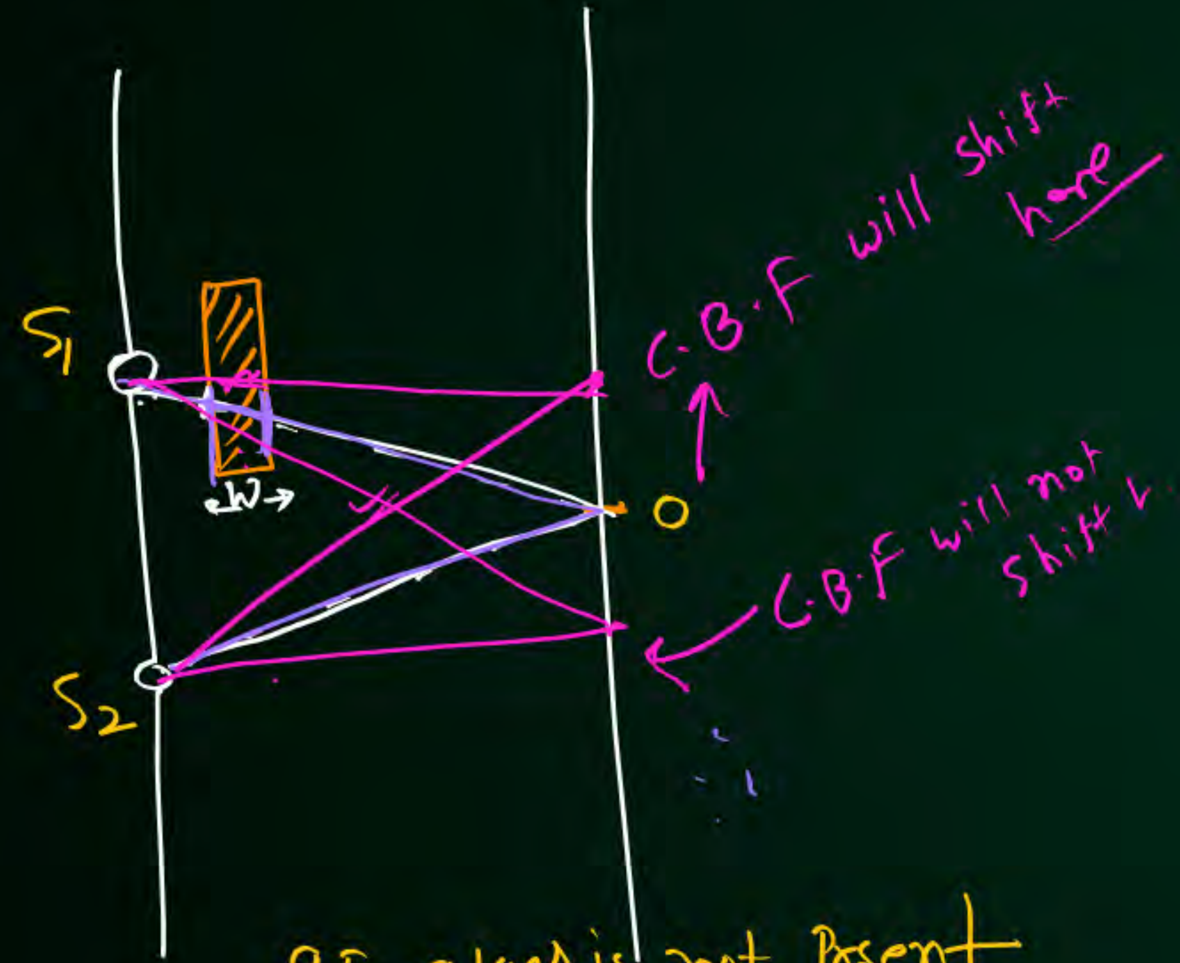
$$\frac{w}{V_m} = \frac{P}{c}$$

$$\frac{\mu w}{c} = \frac{P}{c}$$

$$P = w\mu$$

P → optical path (distⁿ)

Modification in YDSE



If glass is not present

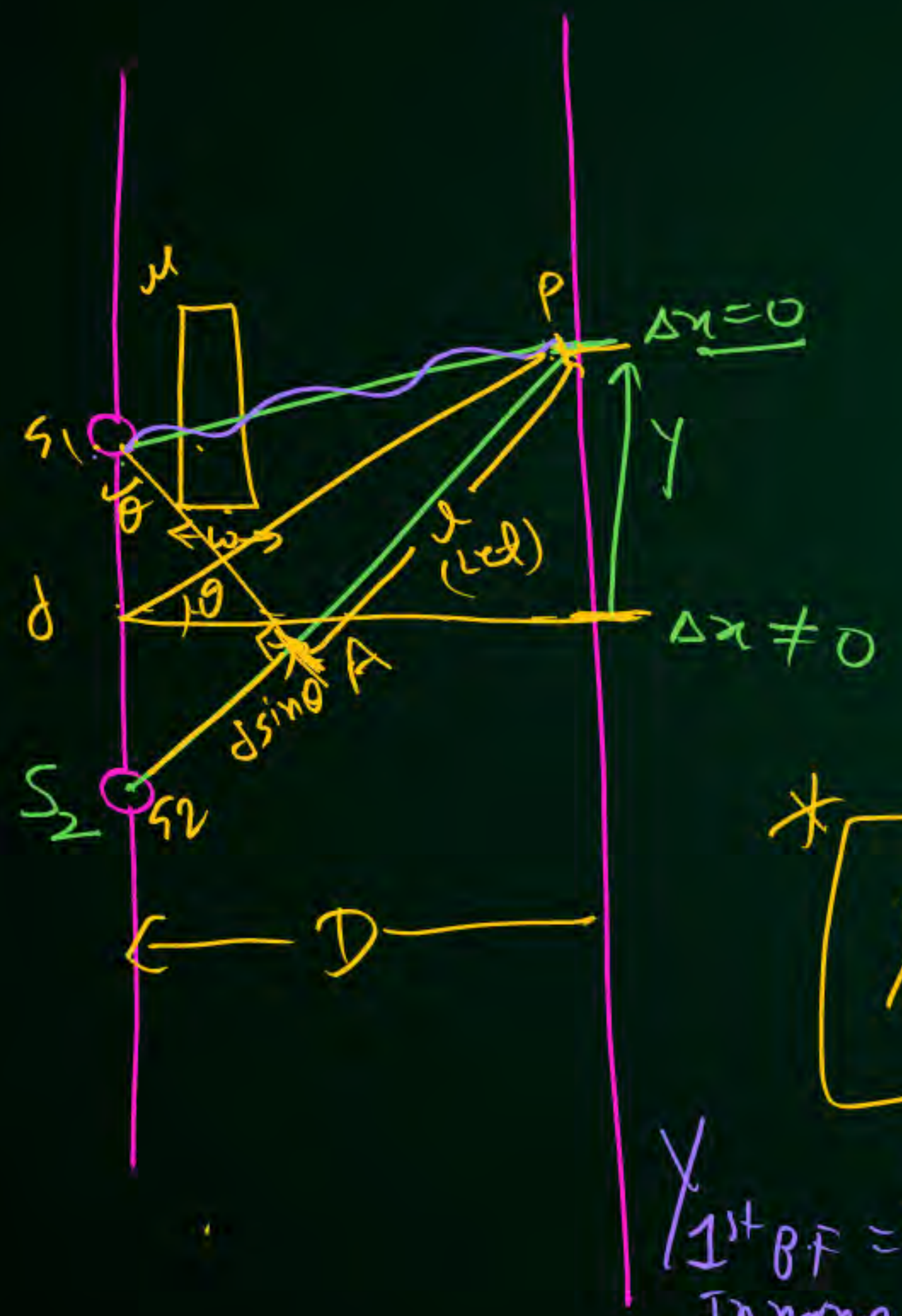
$S_1O = S_2O$

$(\Delta x)_{cent} = 0$

If glass is present then

$S_1O > S_2O$ *

Shift in Central Bright Fringe



$S_1P = ??$

$S_1P = (l-w) + w\mu$ ← due to optical path

$S_2P = l + d\sin\theta = l + d\tan\theta$

at P $\Delta x = 0$ ✓ for C.B.F (central bright fringe)

$$S_1P = S_2P$$

$l - w + w\mu = l + d\tan\theta$

$w(\mu-1) = d\tan\theta$

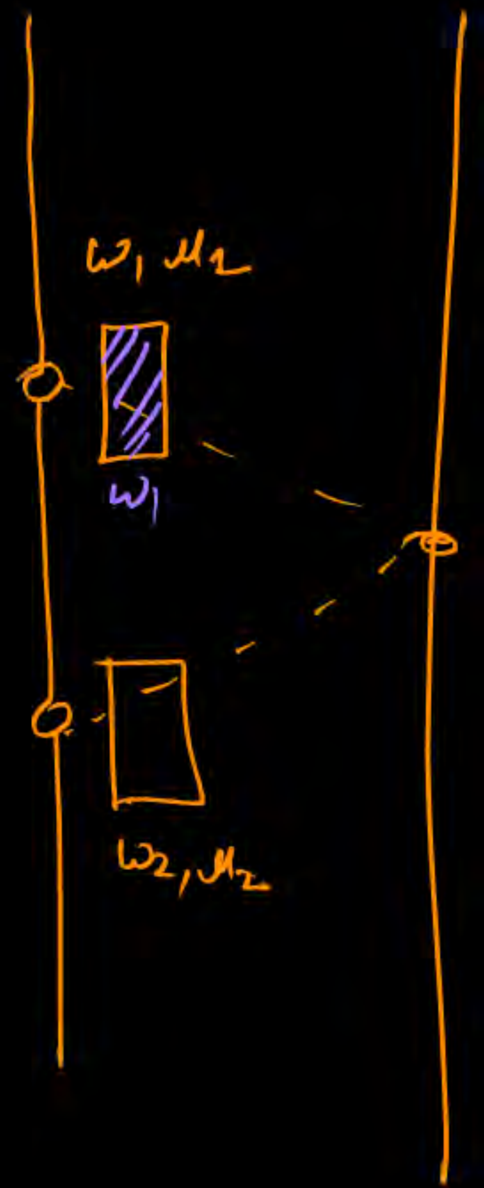
$w(\mu-1) = \frac{dY}{D}$

$$\Rightarrow Y = \frac{w(\mu-1)D}{d}$$

*
$$Y = \frac{w(\mu-1)D}{d}$$

$Y_{1^{st}BF} = \frac{\lambda D}{d}$

In name :



Find rel^n B/W μ_1, ω_1 and $\mu_2\, \omega_2$ So that centroid B.F. remains there

$$* \rightarrow \omega_1(\mu_1 - 1) = \omega_2(\mu_2 - 1)$$

QUESTION

In YDSE, Find the thickness of a glass slab ($1.5 = \mu$) which should be placed at S_1 so the central maxima lies at a point where 5^{th} bright fringes was lying earlier ($\lambda = 5000$ Å)

$$Y_{5^{th}\,BF} = \frac{5\lambda D}{d} = \frac{\omega(\mu-1)D}{d}$$

$$5\lambda = \omega(\mu-1)$$

$$5\times 5000\times 10^{-10} = \omega\,\frac{1}{2}$$

$$50\times 10^{-7} = \omega$$

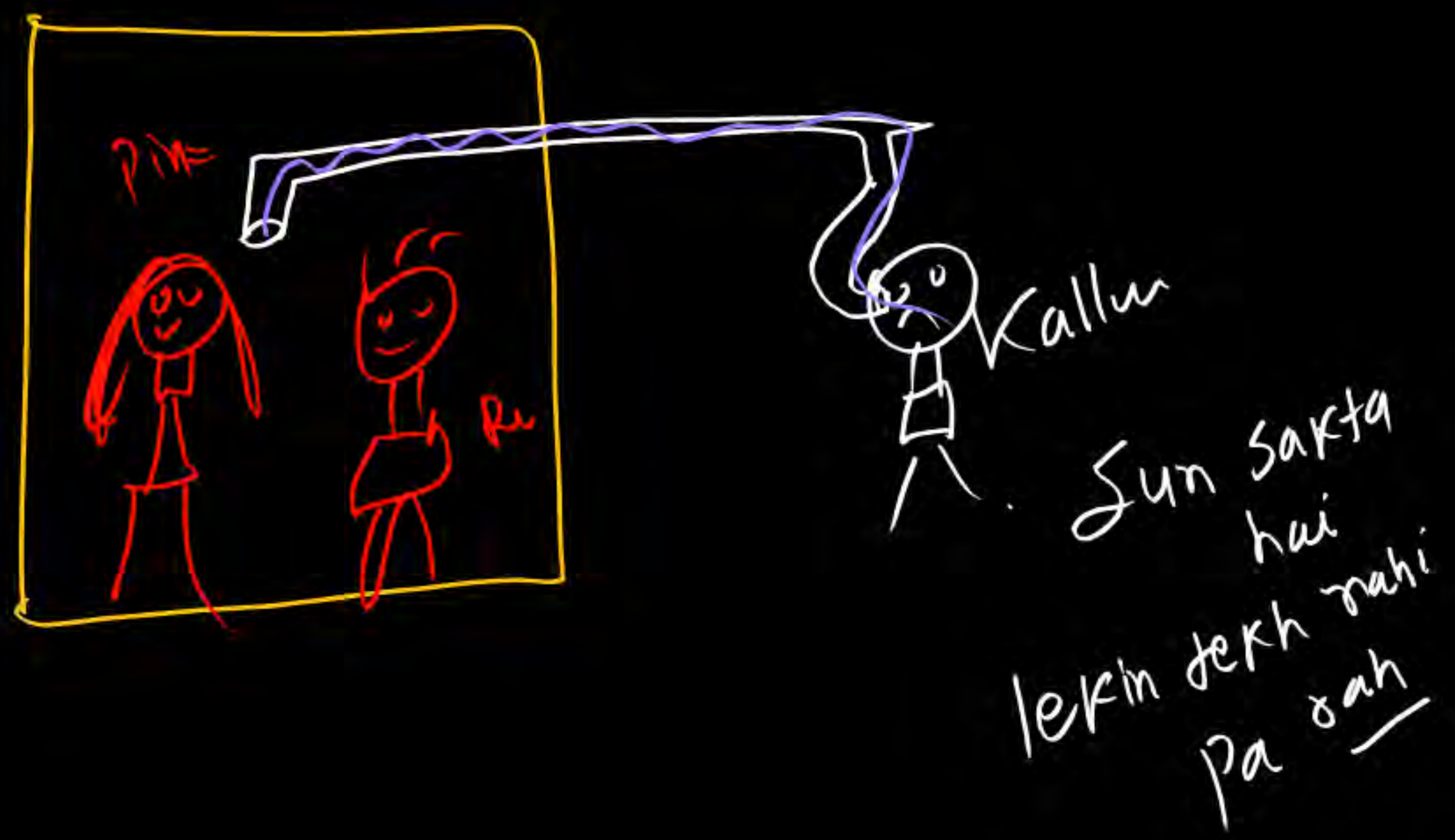
QUESTION

In YDSE, a thin film ($\mu = 1.6$) of thickness 0.01 mm is placed at 1st slit, the central maxima shift to 10th bright fringes earlier, then wavelength of wave is?

$$y_{10} = \frac{10\lambda D}{d} = \frac{w(\mu-1)D}{d}$$

NUMBER OF FRINGES SHIFTED

$$\text{Number of Fringes Shifted} = \frac{\text{Y(shift of C.B)}}{\text{Fringe width}}$$


Kallu
Sun sakta hai
lekin dekh nahi
pa rah


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 05 | Physics

Wave Optics

By- Dr. Manish Raj (MR SIR)



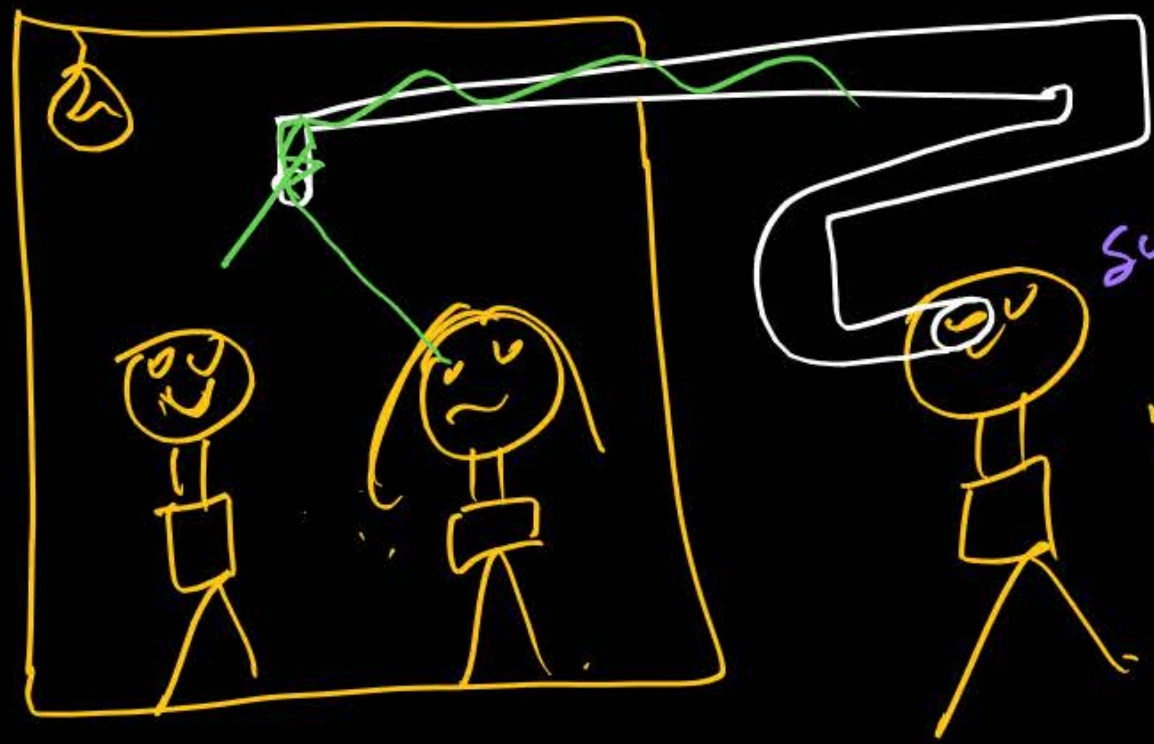
Topics to be covered

Diffraction

Polarisation

1. #
2. #
3. #





sun leta hai but dekh Nahi pata

Kallua.

Sound

$\lambda_{sound} = 1.7m$ to $17m$

wave ← λ_{sound}

$\lambda_{lig} = 400\,nm$

Bending of sound is easier than light

$\lambda_{wave} \approx l_{object}$

→ wave

Condition of diffraction:

- Size of obstacle or aperture should be nearly equal to the wavelength of light

  i.e. $\lambda \simeq a$

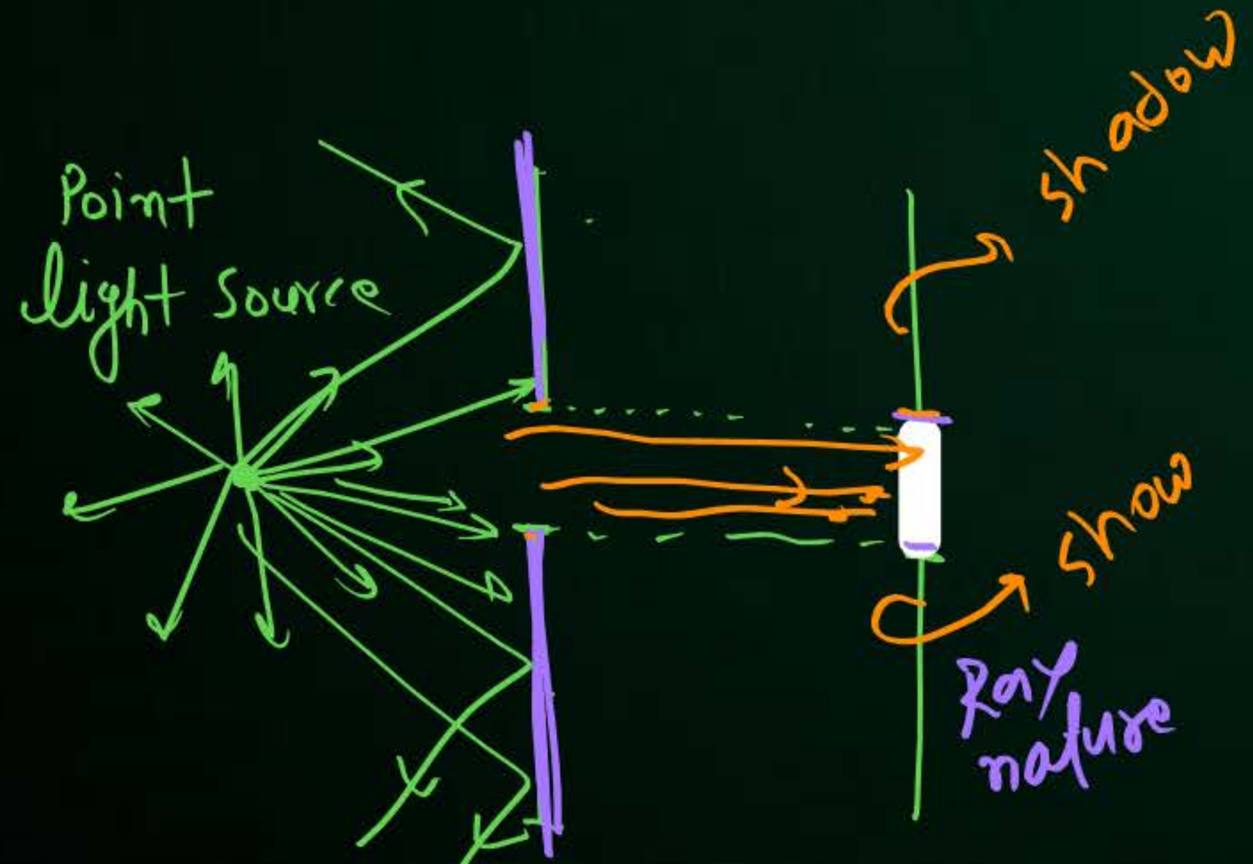
  $a/\lambda \simeq 1$

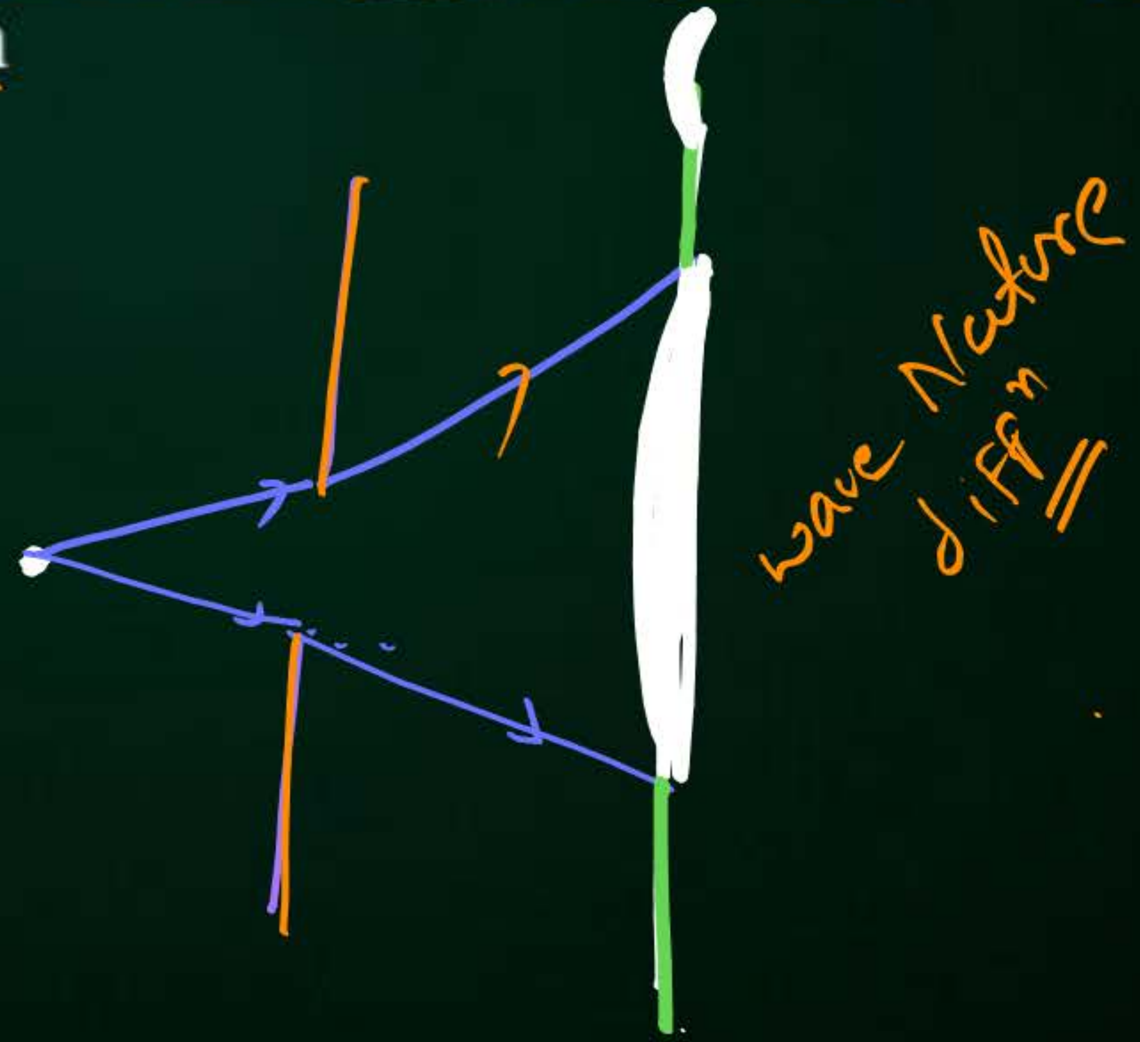
- If size of obstacle is much greater than wavelength of light, then rectilinear motion of light is observed.

DIFFRACTION

Diffraction

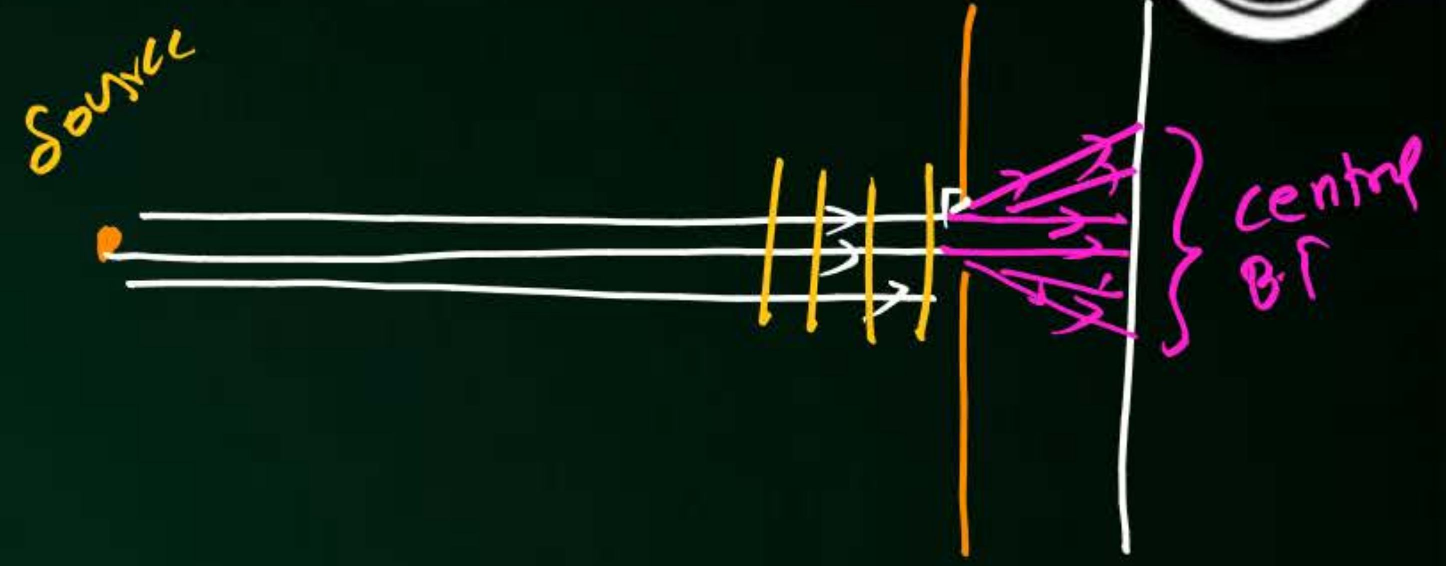
The Bending of light around corners of opaque object and entering into shadow region is called diffraction



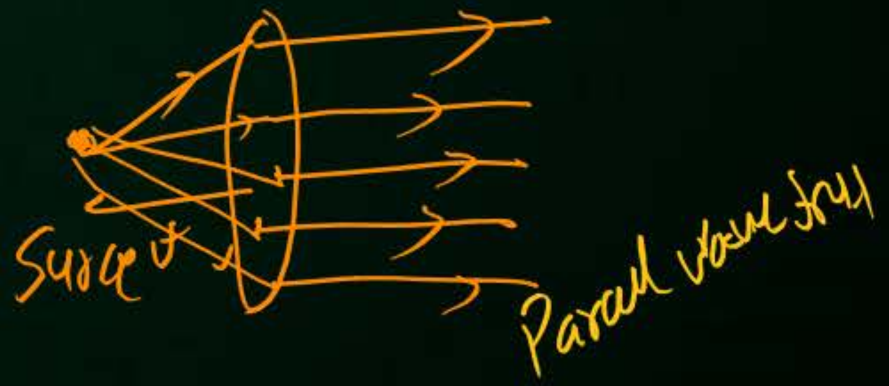


TWO TYPES OF DIFFRACTION:

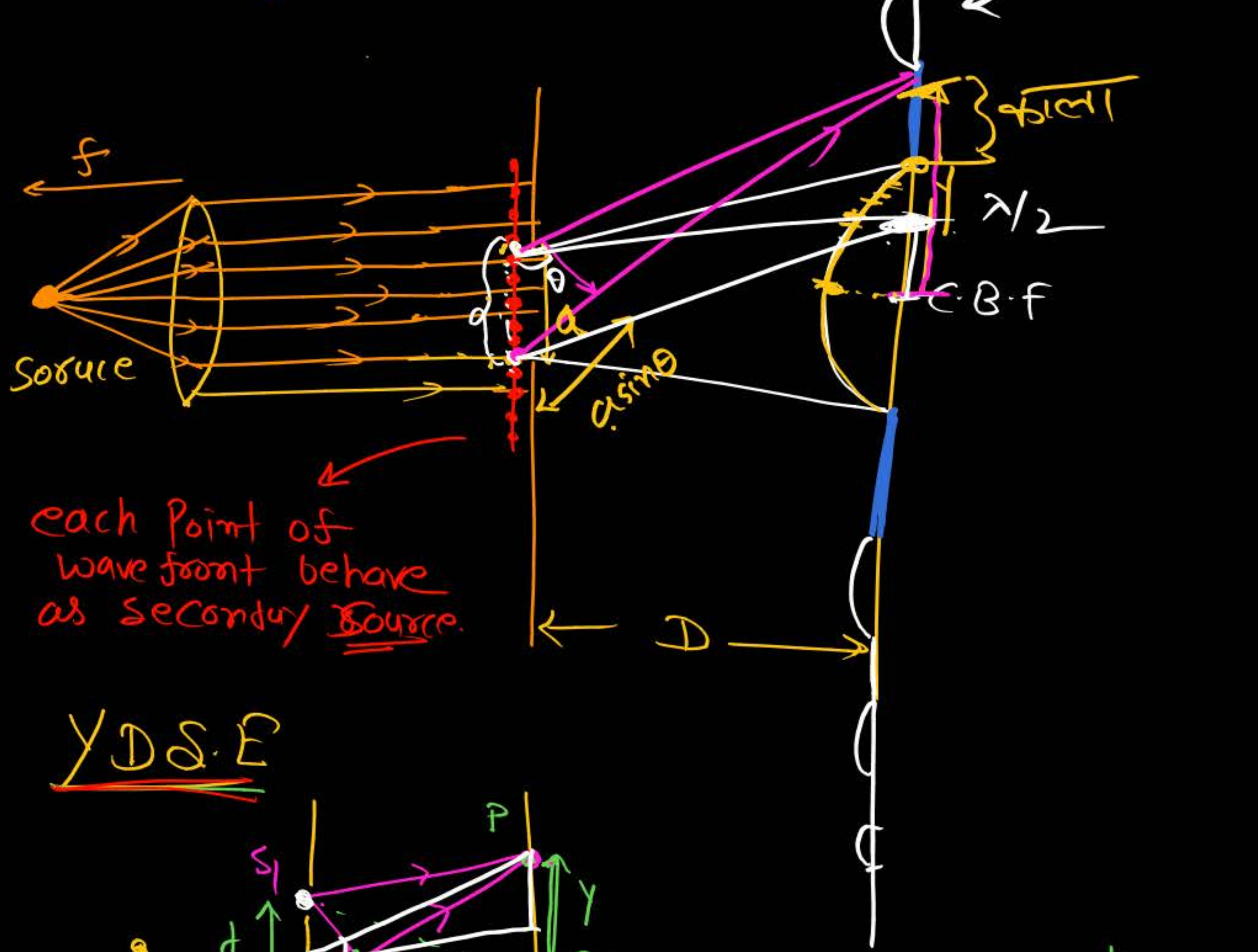
- Fresnel diffraction (Not in syllabus)
  - (i) Source and screen are at finite distance
  - (ii) Spherical wavefront



- Fraunhofer diffraction. (In syllabus)
  - (i) Source and screen are at infinite distance this condition can be achieved by placing convex lens, and source at its focal of lens.
  - (ii) ~~Spherical wave~~ Plane wavefront



Single slit Diffractio

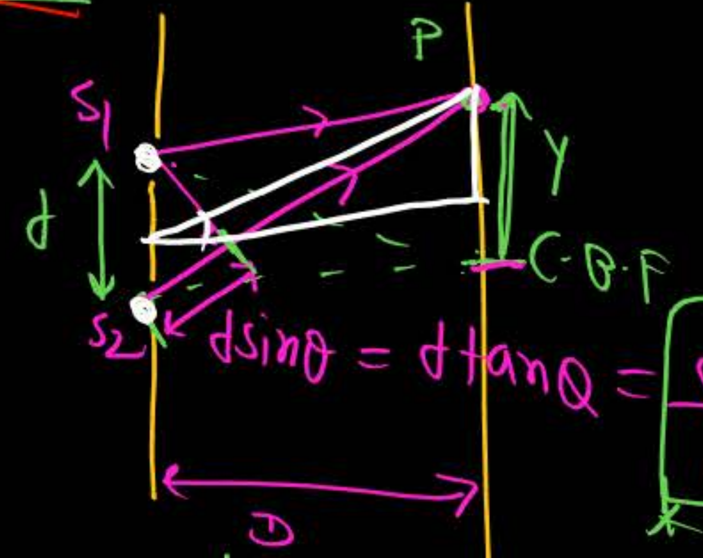


$\Delta x = a\sin\theta = a\tan\theta = \frac{ay}{D}$

↓

Path diffⁿ B/w two source which are at edge of slit

YDSE



$d\sin\theta = d\tan\theta = \frac{dy}{D} = \Delta x$

$\Delta x = \frac{dy}{D} = n\lambda$ (C.I)

$\Delta x = \frac{dy}{D} = (2n-1)\lambda/2$ (D.I)

Y.D.S.E

$\Delta\phi = 0, \pi, 2\pi, 3\pi, 4\pi, 5\pi, 6\pi, 7\pi, 8\pi, 9\pi, 10\pi, 11\pi$

$\Delta x = \frac{dy}{D} = 0, \frac{\lambda}{2}, \lambda, \frac{3\lambda}{2}, 2\lambda, \frac{5\lambda}{2}, 3\lambda, \frac{7\lambda}{2}, 4\lambda, \frac{9\lambda}{2}, 5\lambda, \frac{11\lambda}{2}$

C.B.F, 1st D.F, 1st B.F, 2nd D.F, 2nd B.F, 3rd D.F, 3rd B.F, 4th D.F, 4th B.F, 5th D.F, 5th B.F

* $\Delta\phi = \frac{2\pi}{\lambda}\Delta x$

$\Delta x = \frac{dy}{D} = n\lambda \quad (n = 0, 1, 2, 3, 4)$ Bright fringe

$= (2n-1)\frac{\lambda}{2} \quad (n = 1, 2, 3, 4)$ Dark

Single slit diff^n

$\Delta\phi = 0, \pi, 2\pi, 3\pi, 4\pi, 5\pi, 6\pi, 7\pi, 8\pi, 9\pi, 10\pi, 11\pi$

$\Delta x = a\sin\theta = \frac{ay}{D} = 0, \frac{\lambda}{2}, \lambda, \frac{3\lambda}{2}, 2\lambda, \frac{5\lambda}{2}, 3\lambda, \frac{7\lambda}{2}, 4\lambda, \frac{9\lambda}{2}, 5\lambda, \frac{11\lambda}{2}$

Central Bright fringe, 1st DF, 1st B.F, 2nd D.F, 2nd BF, 3rd DF, 3rd B.F, 4th D.F, 4th B.F, 5th D.

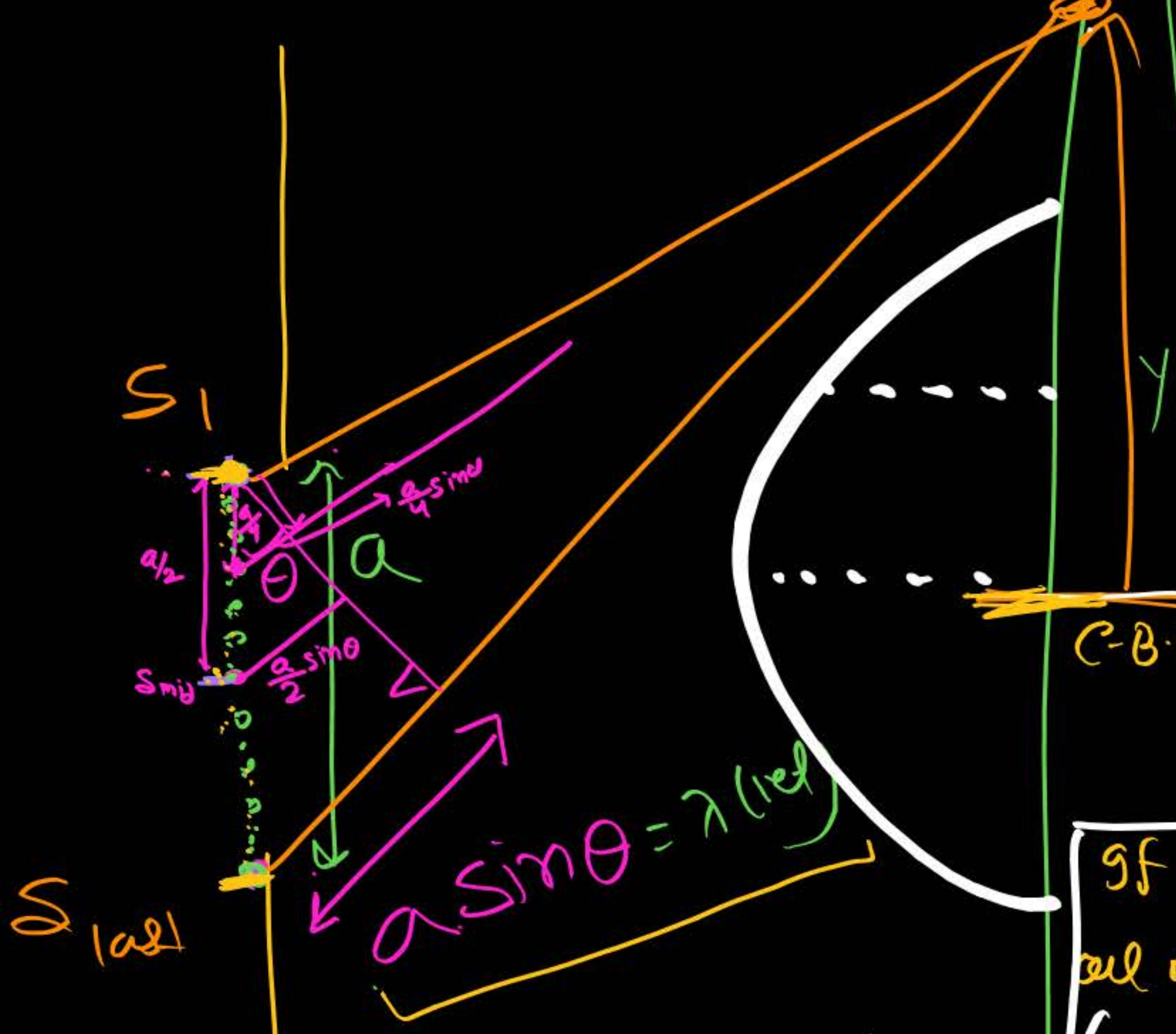
$\Delta x = \frac{ay}{D} = n\lambda$

$n = 1, 2, 3, 4, 5, 6 \ldots$

Destructive Interference *

$\Delta x = \frac{ay}{D} = (2n-1)\frac{\lambda}{2}$ $\quad n = 2, 3, 4, 5, 6, 7$

Secondary D.F.



If $a\sin\theta = \frac{3\lambda}{2}$

1st, 33rd, 66, 100th

$\lambda/2$, $\lambda/2$ → D.I

$\lambda/2$ → C.I

1st C.I

y

C·B·F

If $a\sin\theta = \frac{\lambda}{2}$

1st & mid मानो $\lambda/4$

→ Part of C·B·F

Let there are 100 of source

if Path diffⁿ at y height is λ B/W 1st & last source then Path diffⁿ B/W 1st & mid source will be $\lambda/2$

* $a\sin\theta = \lambda$ — ① (Let) → 1st D.I

1st & 100th ⟶ λ C.I

1st & 50th ⟶ $\lambda/2$

2nd & 51th ⟶ $\lambda/2$

3rd & 52 ⟶ $\lambda/2$

10 & 60 ⟶ $\lambda/2$

20 → 70 ⟶ $\lambda/2$

30 → 80 ⟶ $\lambda/2$

D.I

Dark fring

DIFFERENCE BETWEEN INTERFERENCE AND DIFFRACTION (FOR FRAUNHOFER SINGLE SLIT) :

	Interference		Fraunhofer diffraction
(1)	It is the phenomenon of superposition of two waves coming from two different coherent sources.	(1)	It is the phenomenon of superposition of two waves coming from two different parts of the same wave front.
(2)	In interference pattern, all bright lines are equally bright and equally spaced.	(2)	All bright lines are not equally bright and equally wide. Brightness and width goes on decreasing with the angle of diffraction.
(3)	All dark lines are totally dark	(3)	Dark lines are perfectly dark. Their contrast with bright lines and width goes on decreasing with angle of diffraction.
(4)	In interference bands are large in number	(4)	In diffraction bands are few in number.

DIFFRACTION OF LIGHT

Width of secondary B.F $= \frac{\lambda D}{a}$

- Bending of light rays from sharp edges of an opaque obstacle or aperture and its spreading in the geometrical shadow region is defined as diffraction of light or deviation of light from its rectilinear propagation tendency is defined as diffraction of light.

Width of C.B.F $= \frac{2\lambda D}{a}$

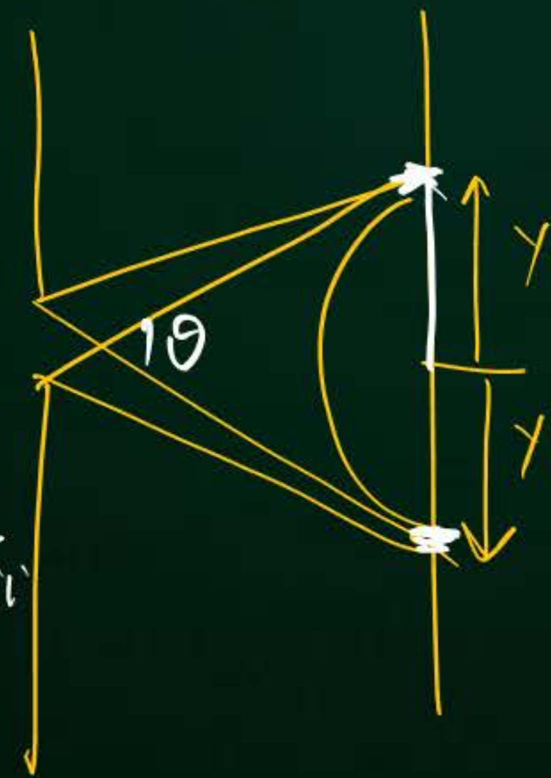
Angular width of C.B.F $= \frac{2\lambda}{a}$

Width of C.B.F.

$a\sin\theta = \frac{ay}{D} = n\lambda$ → Dark

$y = \frac{n\lambda D}{a}$ $(n=1)$

$\left[y_{1^{st}Dr} = \frac{\lambda D}{a}\right]$



QUESTION

Angular width of the central maxima in the Fraunhofer diffraction for $\lambda = 6000$ Å is θ_0. When the same slit is illuminated by another monochromatic light, the angular width decreases by 30%. The wavelength of this light is [NEET Odisha 2019]

1. 420 Å
2. 1800 Å
3. 4200 Å ✓
4. 6000 Å

$$\theta_0 = \frac{2\lambda}{a}$$

$\theta_0 \propto \lambda$

$$\frac{\theta_{01}}{\theta_{02}} = \frac{\lambda_1}{\lambda_2}$$

$$\frac{\theta_0}{70\%\,\theta_0} = \frac{6000}{\lambda}$$

$$\frac{100}{70} = \frac{6000}{\lambda}$$

$\lambda = 4200$ ✓

QUESTION

For a parallel beam of monochromatic light of wavelength 'λ' diffraction is produced by a single slit whose width 'a' is of the wavelength of the light. If 'D' is the distance of the screen from the slit, the width of the central maxima will be **[2015]**

1. $\frac{D\lambda}{a}$
2. $\frac{Da}{\lambda}$
3. $\frac{2Da}{\lambda}$
4. $\frac{2D\lambda}{a}$ ✓

$\Delta x = \frac{ay}{D} = \lambda$ → 1st D.I

$y_{1st\,D} = \left\{\frac{\lambda D}{a}\right\}$



QUESTION

$\Delta x = \lambda$ → $\Delta\phi = 2\pi$

At the first minimum adjacent to the central maximum of a single-slit diffraction pattern, the phase difference between the Huygen's wavelet from the edge of the slit and the wavelet from the midpoint of the slit is: [2015 RS]

1. $\pi/2$ radian
2. π radian ✓
3. $\pi/8$ radian
4. $\pi/4$ radian

QUESTION

In a diffraction pattern due to a single slit of width 'a', the first minimum is observed at an angle 30° when light of wavelength 5000 Å is incident on the slit. The first secondary maximum is observed at an angle of [2016]

1. $\sin^{-1}\left(\frac{1}{4}\right)$
2. $\sin^{-1}\left(\frac{2}{3}\right)$
3. $\sin^{-1}\left(\frac{1}{2}\right)$
4. $\sin^{-1}\left(\frac{3}{4}\right)$

Ans.

$\Delta x = \lambda = \frac{ay}{D}$

$\Delta x = a\sin\theta = n\lambda$ (for Diffn Distance)

$\Delta x = 0, \frac{\lambda}{2}, \lambda, \frac{3\lambda}{2}$

C.W, 1st min., 1st BD

$a\sin\theta_1 = \frac{ay}{D} = \lambda$ — (I)

$a\sin\theta_2 = \frac{3\lambda}{2}$ — (II)

$\frac{\sin 30^\circ}{\sin\theta_2} = \frac{2}{3}$

$\frac{1}{2} \times \frac{3}{2} = \sin\theta_2$

$\theta_2 = \sin^{-1}\left(\frac{3}{4}\right)$

QUESTION

A parallel beam of monochromatic light of wavelength 5000 Å is incident normally on a single narrow slit of width 0.001 mm. The light is focussed by a convex lens on a screen placed in focal plane. The first minimum will be formed for the angle of diffraction equal to **[1993]**

1. 0°
2. 15°
3. 30°
4. 50°

after centre max

$a \sin\theta = \lambda$

$\sin\theta = \frac{\lambda}{a} = \frac{5000 \times 10^{-10}}{1 \times 10^{-3} \times 10^{-3}} = 5 \times 10^{-1} = \frac{5}{10} = \frac{1}{2}$

$\sin\theta = \frac{1}{2}$

$\theta = 30°$

QUESTION

A beam of light of $\lambda = 600$ nm from a distant source falls on a single slit 1 mm wide and the resulting diffraction pattern is observed on a screen 2 m away. The distance between first dark fringes on either side of the central bright fringe is: **[2014]**

1. 1.2 cm
2. 12 mm
3. 2.4 mm
4. 24 mm



β = width of C.B $= \frac{2\lambda D}{a}$

$= \frac{2 \times 600 \times 10^{-9} \times 2}{10^{-3}}$

$= 24 \times 10^{2} \times 10^{-6}$

$= 24 \times 10^{-4}$

$= 24 \times 10^{-2} \times 10^{-2}$ m

$= 0.24$ cm

10 mm = 1 cm

Ummed + utthan = Selection

Paper analysis ✓

Reason

1. syllabus Not complt

2. NO Revision → short Notes ✓ → Ummed easy ✓

3. NO question practice → P.Y.Q / dpp / Notes

4. Silly mistake / calculation

5. exam me ja ke bhul gye

6. Time manage

* Pre Paper solve

→ last PYQ NEET-17/18 22

→ with time limit

Ummed + utthan

Chanell → delete

Light is an E-M wave

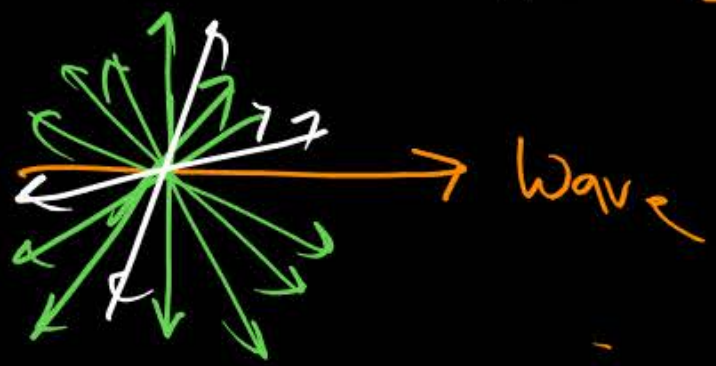
→ electric & magnetic field oscillate $\perp r$ to the dir^n of wave.

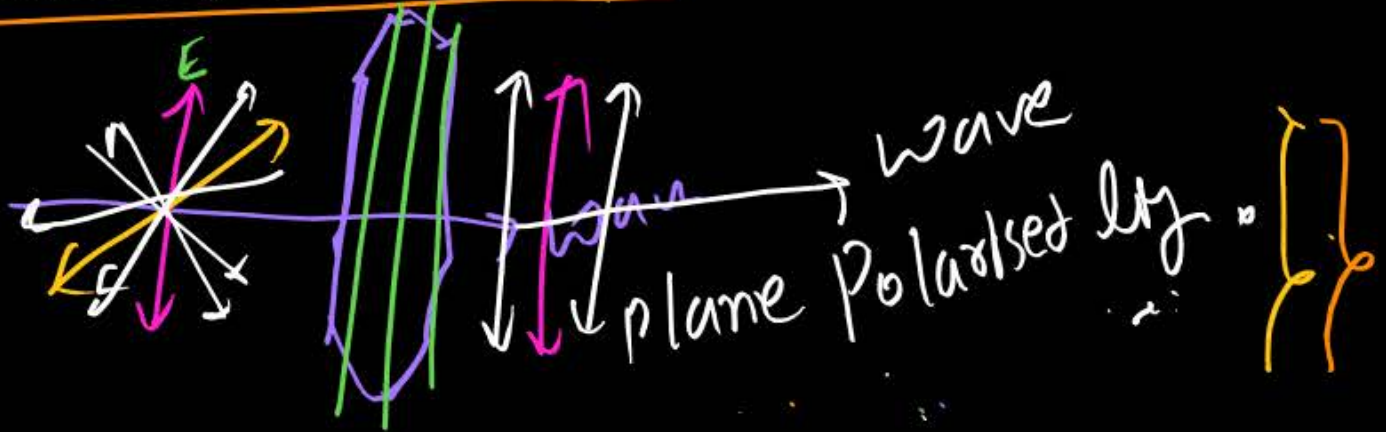
→ $E_0 = C B_0$ or $B_0 = \frac{E_0}{C}$

→ Hence $E_0 >>> B_0$ hence Em wave (light) completly describe by electric field only

Ordinary light

→ electric field oscillate in all diretion Perpendicular the dir^n of wave (light)



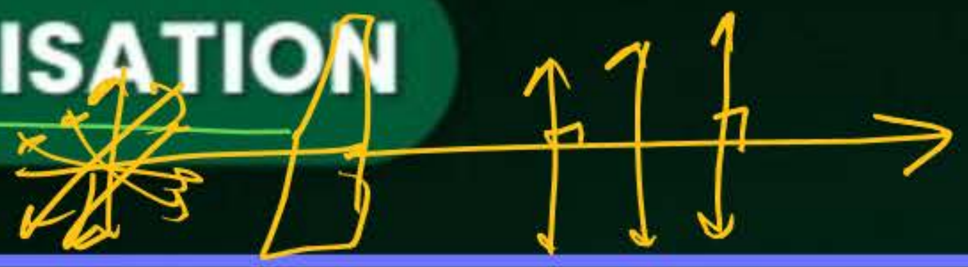


UNPOLARISED LIGHT



- An ordinary beam of light consists of a large number of waves emitted by the atoms of the light source.
- Each atom produces a wave with its own orientation of electric vector $\vec{E}$ so all direction of vibration of $\vec{E}$ are equally probable.

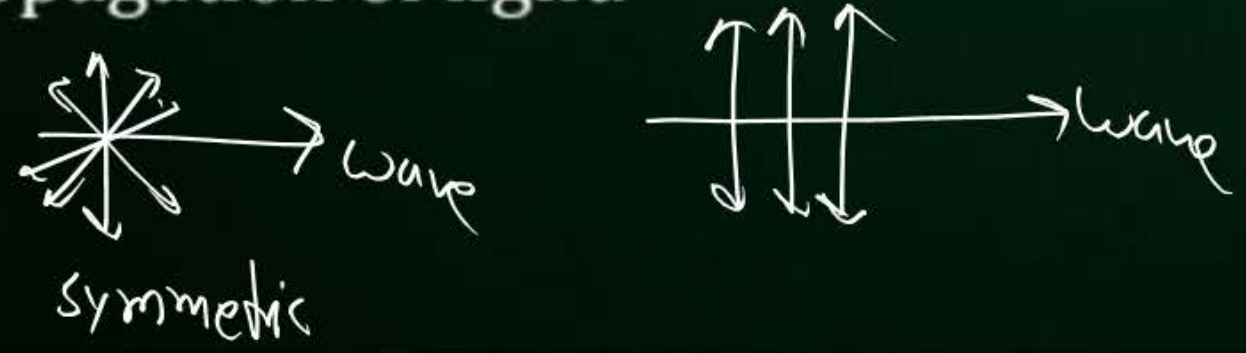
POLARISATION



- The phenomenon of restricting the vibration of light (electric vector) in a particular direction perpendicular to the direction of propagation of wave is called polarisation of light.

- In polarised light, the vibration of the electric vector occur in a plane perpendicular to the direction of propagation of light and are confined to a single direction in the plane (do not occur symmetrically in all possible directions).

- After polarisation the vibrations become asymmetrical about the direction of propagation of light.



POLARISER

Tourmaline crystal:

- When light is passed through a tourmaline crystal cut parallel to its optic axis, the vibrations of the light carrying out of the tourmaline crystal are confined only to one direction in a plane perpendicular to the direction of propagation of light.

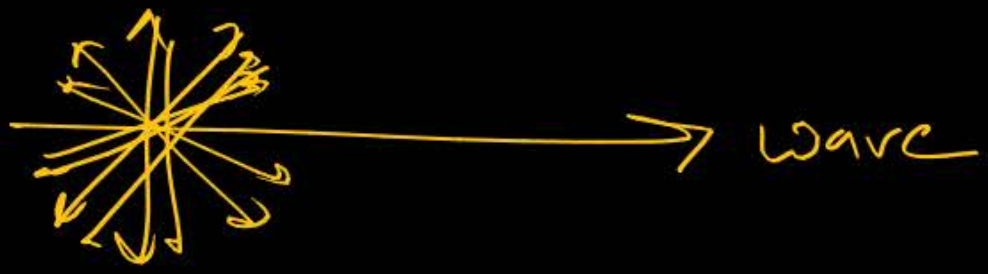
- The emergent light from the crystal is said to be plane polarised light.

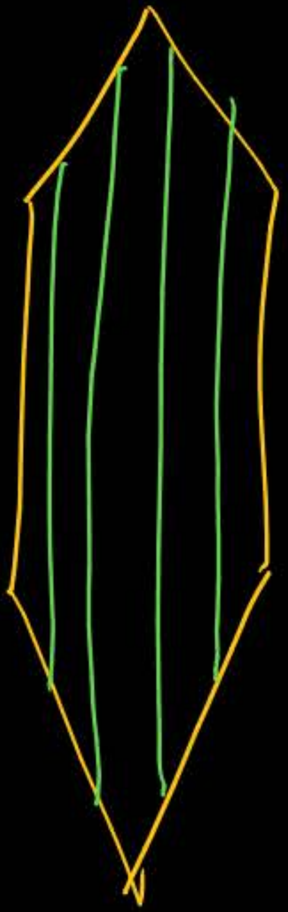
Nicol Prism:

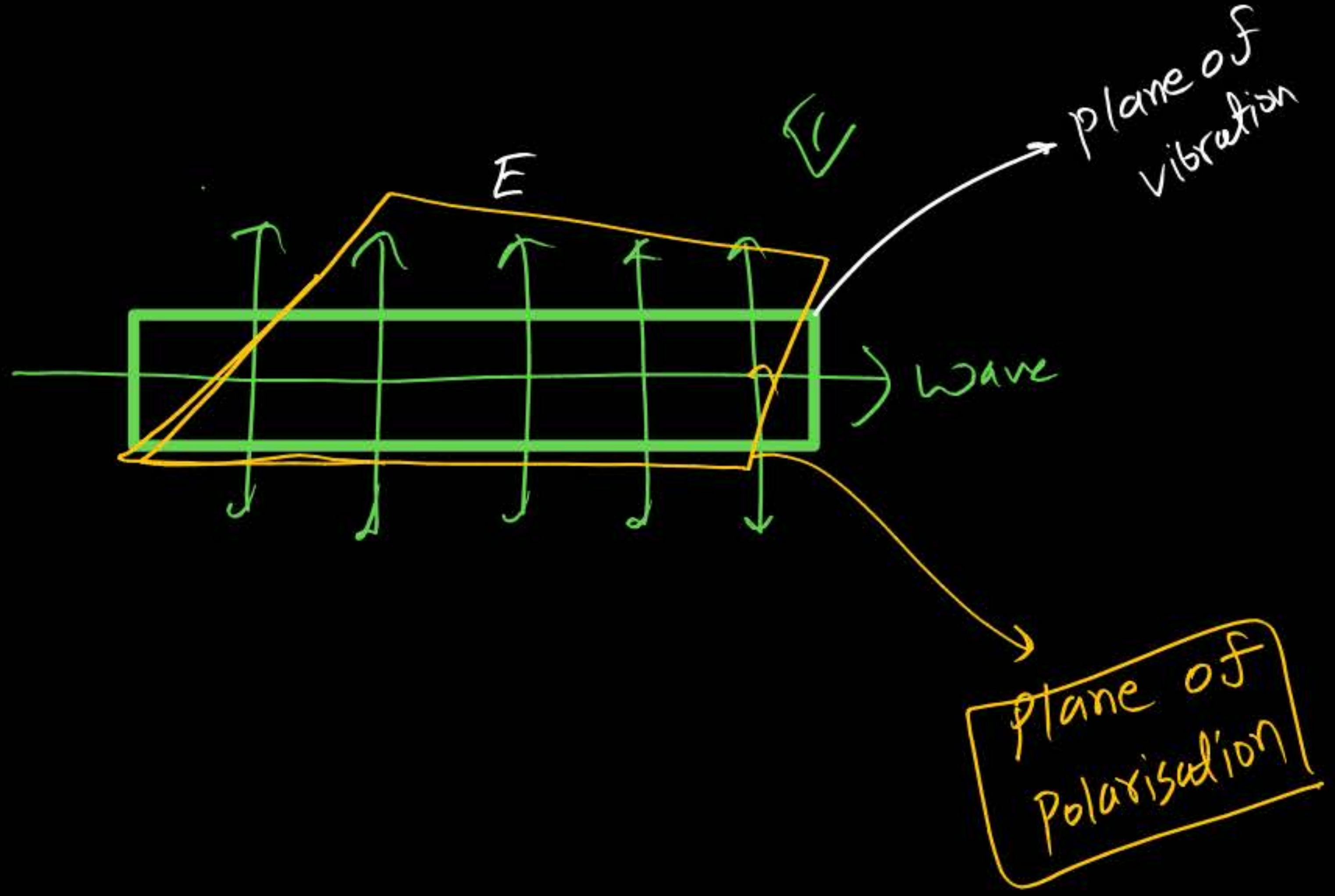
- A nicol prism is an optical device which can be used for the production and detection of plane polarised light.
- It was invented by William Nicol in 1828.

Polaroid:

- A polaroid is a thin commercial sheet in the form of circular disc which makes use of the property of selective absorption to produce an intense beam of plane polarised light.

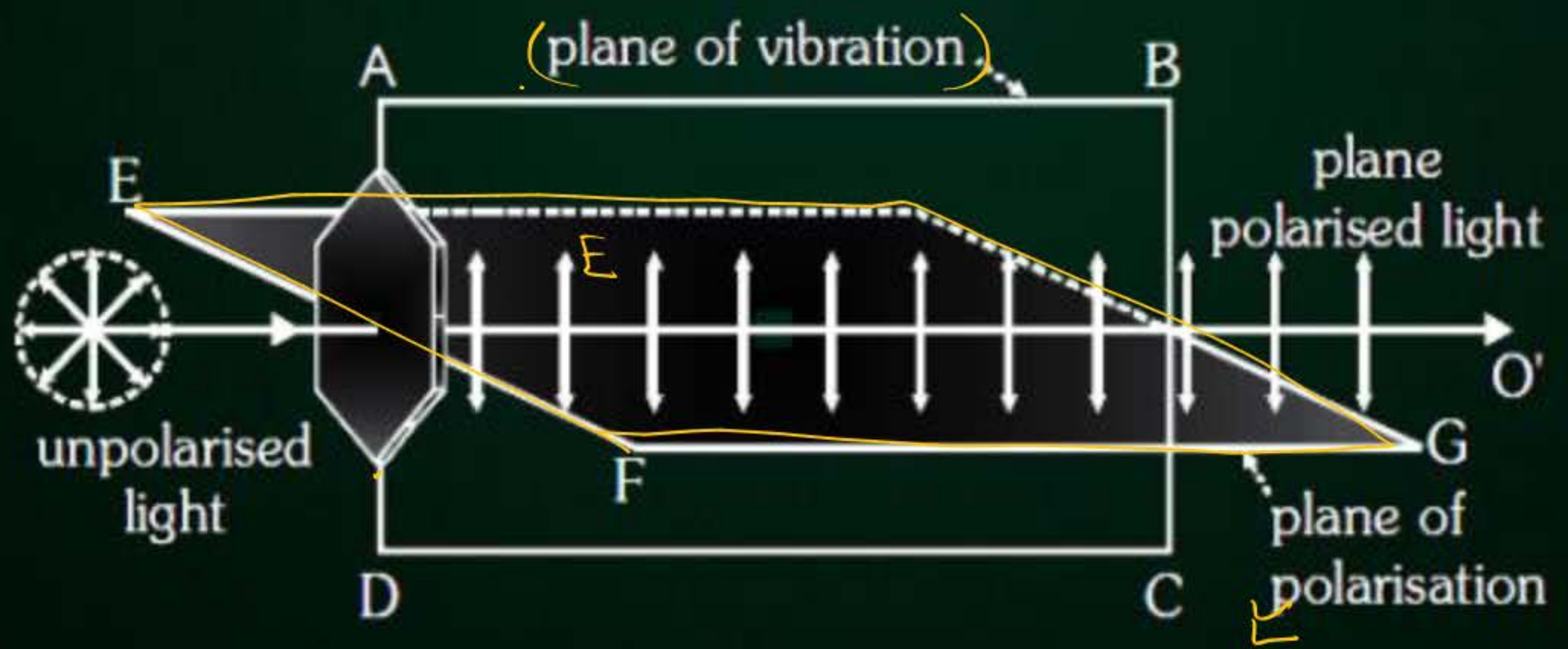

wave



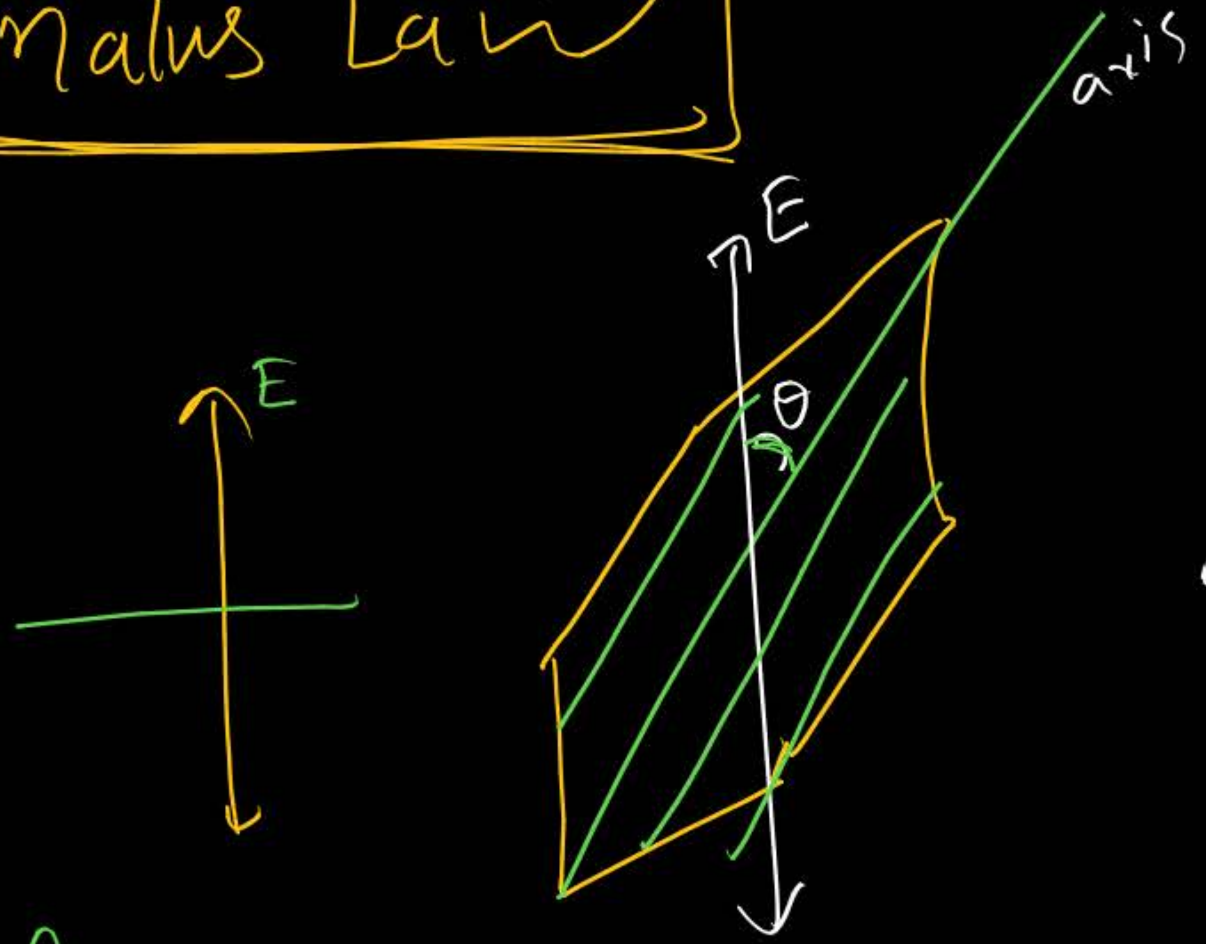

E
plane of vibration
wave
plane of Polarisation

PLANE OF POLARISATION AND PLANE OF VIBRATION

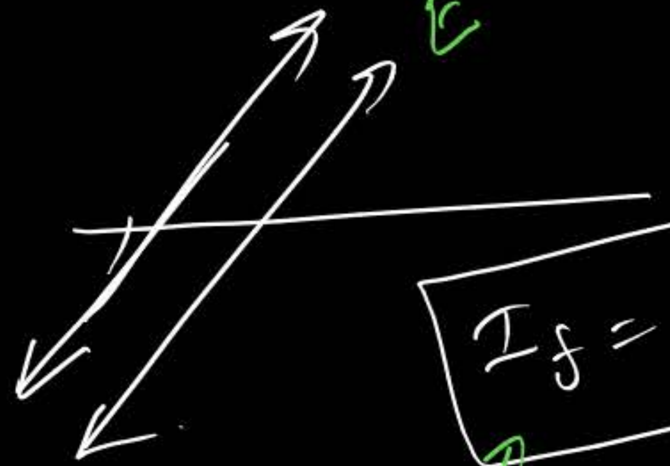
- The plane in which vibrations of light vector and the direction of propogation lie is known as plane of vibration.
- A plane normal to the plane of vibration and in which no vibration takes place is known as plane of polarisation



Malus Law



Initial Intensity = I_i

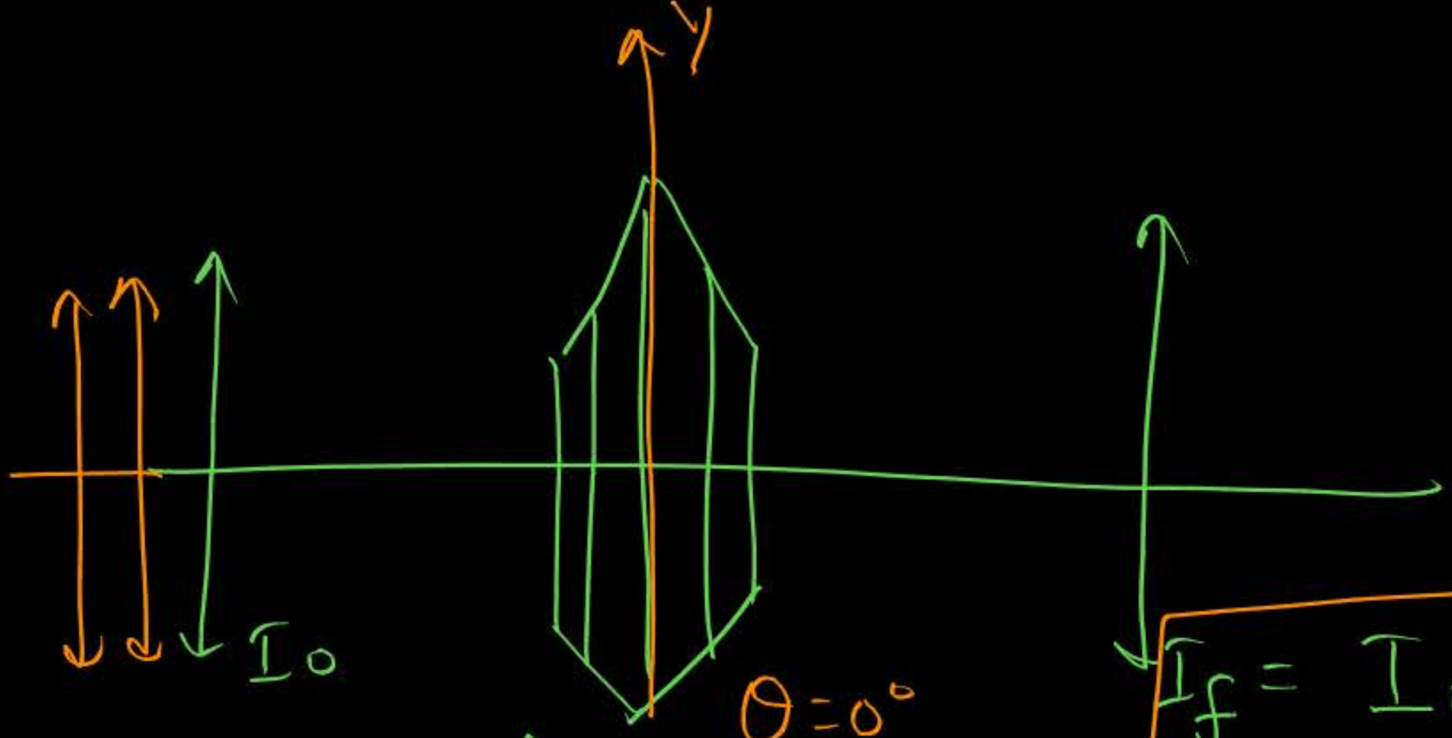


$$I_f = I_0 \cos^2\theta$$ × Malus Law

θ → Angle b/w $\vec{E}$ & optical axis

I_f → Final Intensity of light (Intensity of light after Polariser)

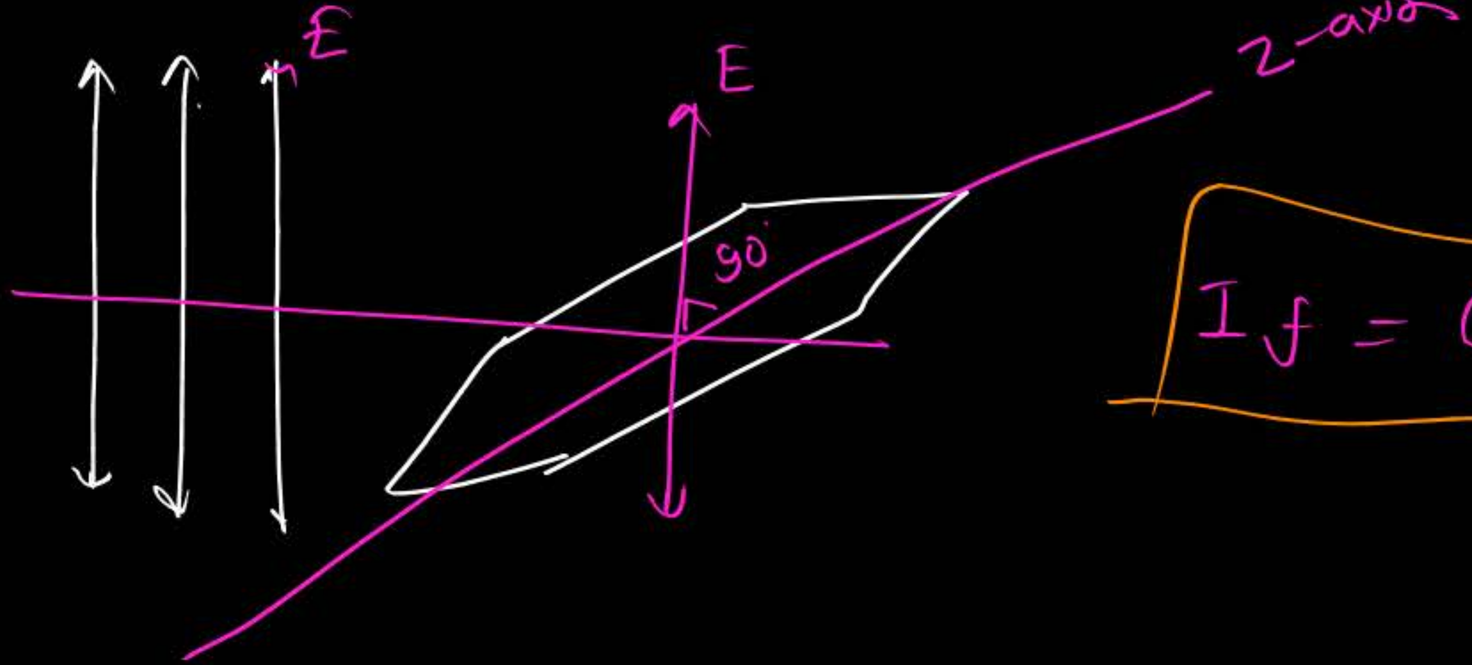
I_0 → Initial Intensity of light [Intensity of light falling on Polariser]



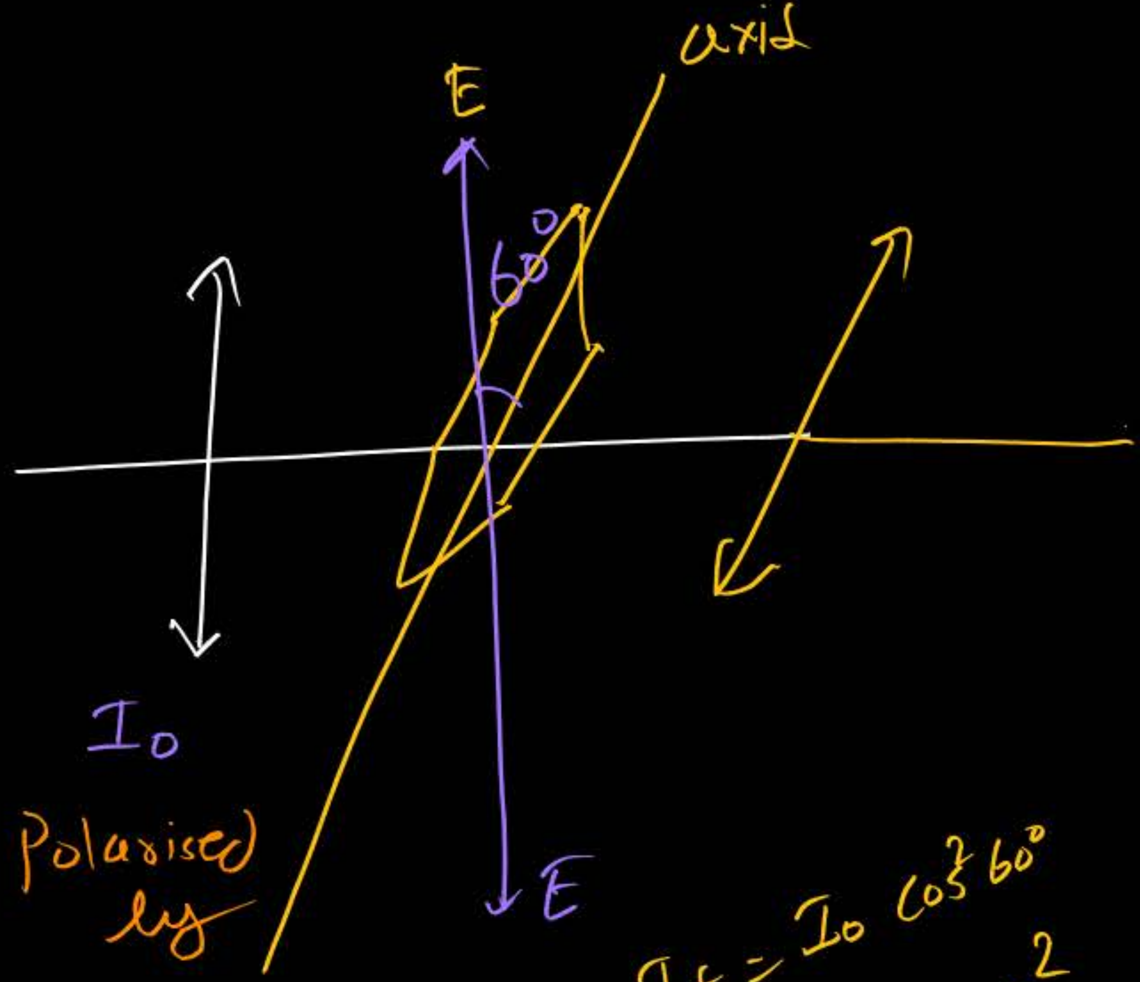
Polarised light

$\theta = 0^\circ$

$$I_f = I_0 \cos^2 0^\circ = I_0$$



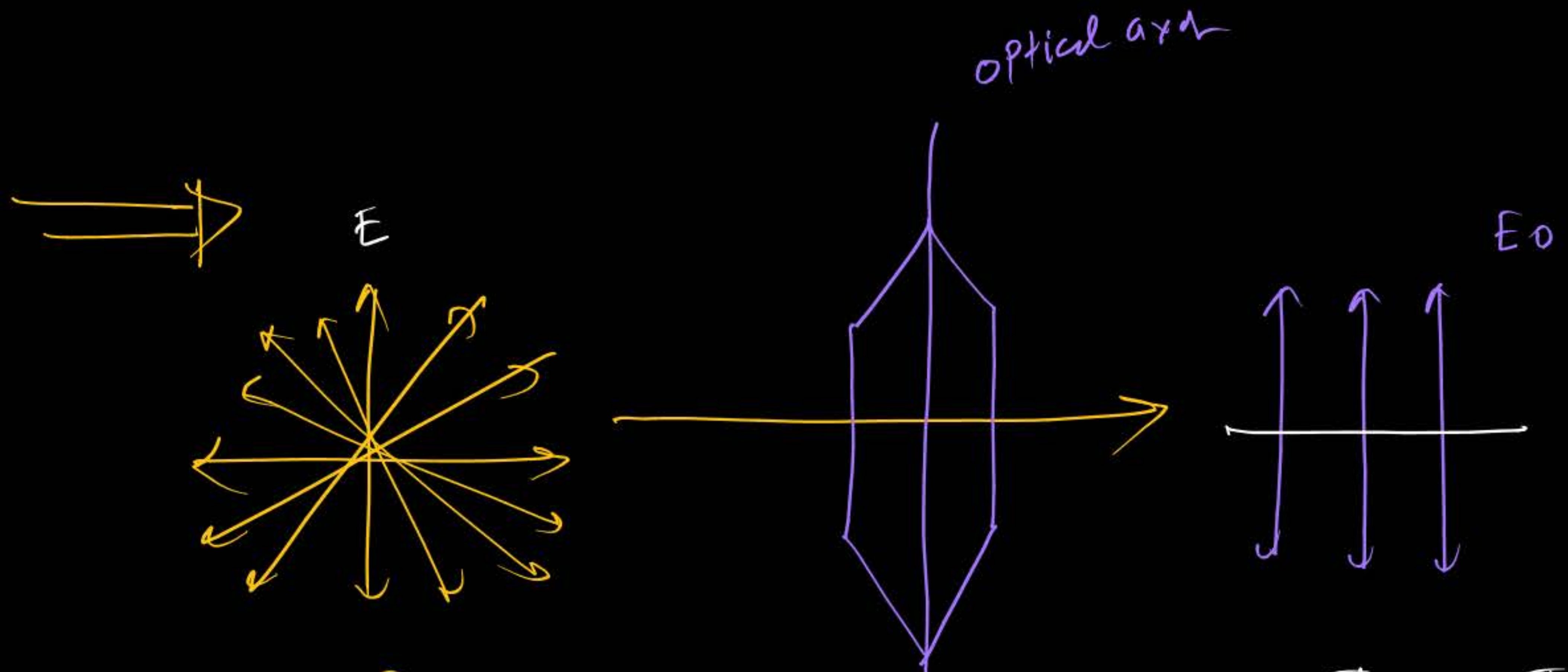
$$I_f = 0$$



$$I_f = I_0 \cos^2 60^\circ$$

$$= I_0 \left[\frac{1}{2}\right]^2$$

$$I_f = \frac{I_0}{4}$$



Intensity = I_0

Unpolarised light

$$I_f = I_0 \cos^2\theta$$

$\theta = 0°$ to $90°$

$$\langle I_f \rangle = I_0 \langle \cos^2\theta \rangle$$

$$I_f = \frac{I_0}{2}$$

QUESTION

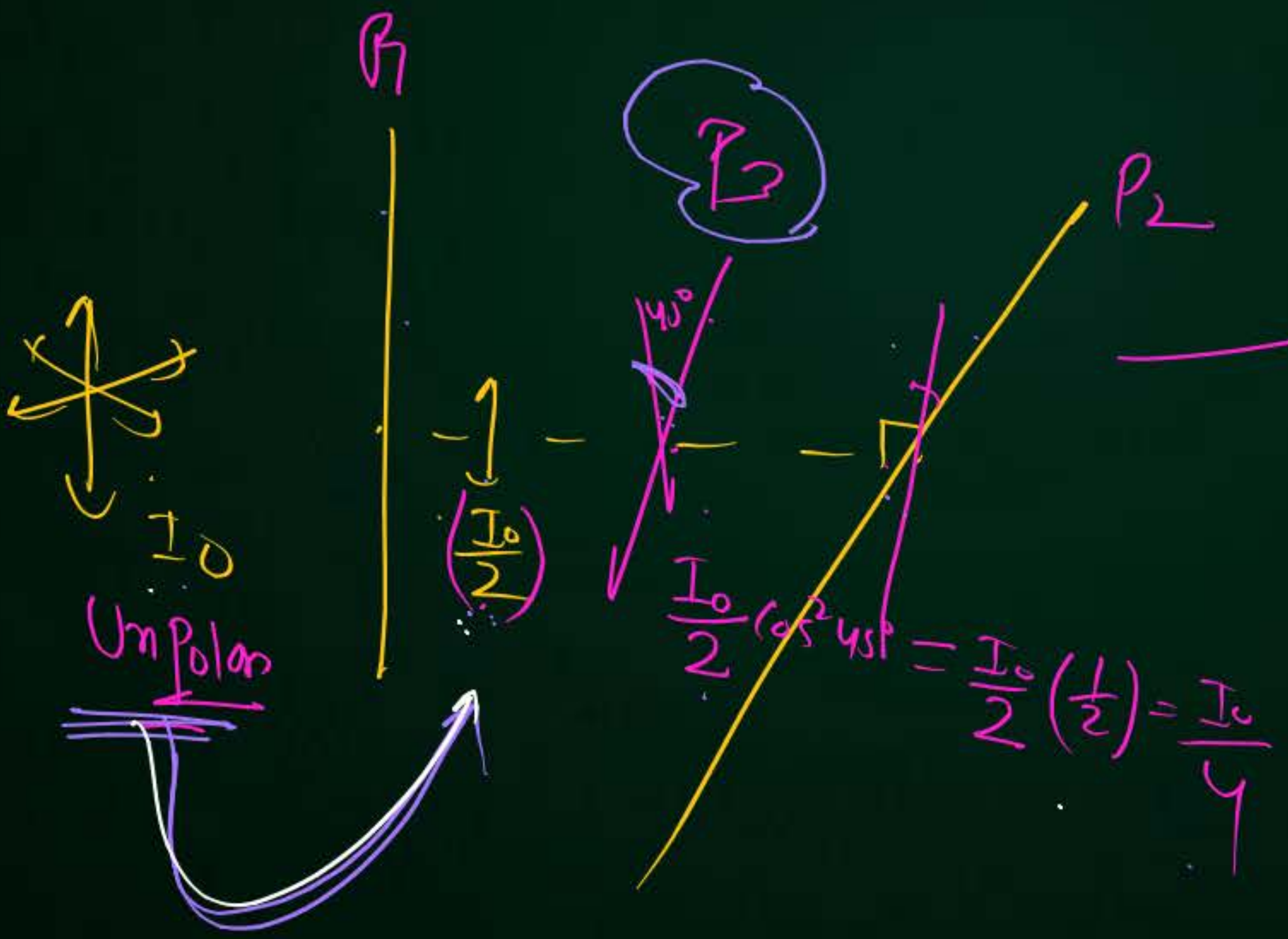
A plane polarized light with intensity I_0 is incident on a polaroid with Electric Field vector making an angle of $60°$ with transmission axis of polaroid. The intensity of the resulting light will be..

1. I_0
2. $I_0/4$ (Ans)
3. $I_0/2$
4. $I_0/8$

QUESTION

Two polaroids P_1 and P_2 are placed with their axis perpendicular to each other. Unpolarised light I_0 is incident on P_1. A third polaroid P_3 is kept in between P_1 and P_2 such that its axis makes an angle 45° with that of P_1. The intensity of transmitted light through P_2 is [NEET 2017]

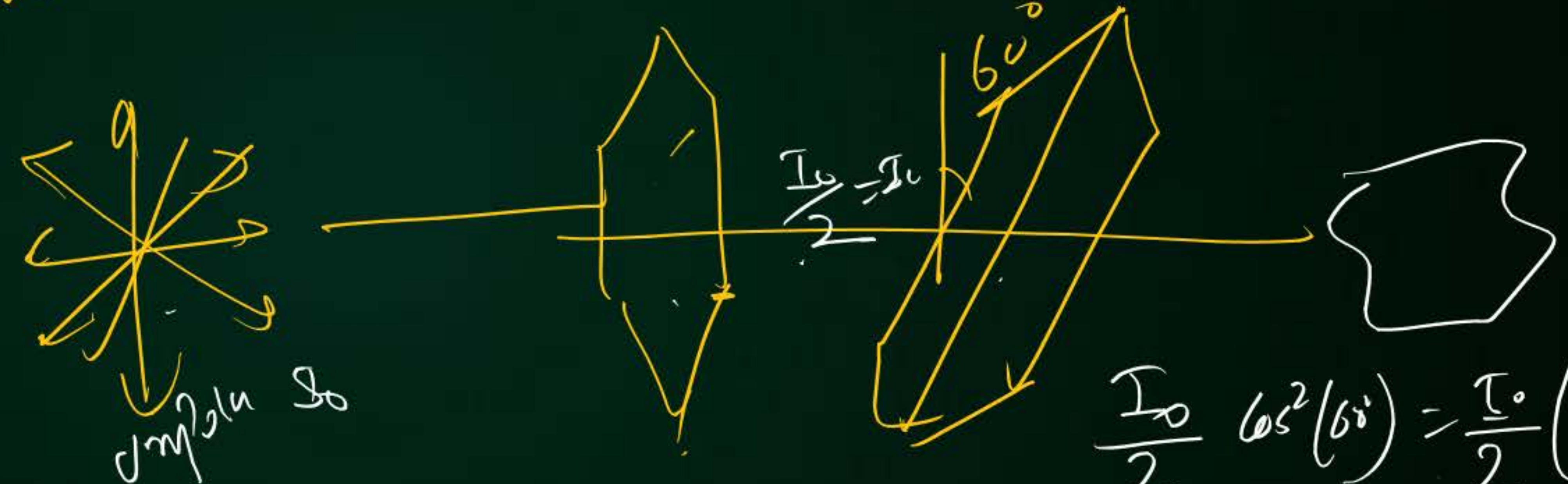
1. $I_0/2$
2. $I_0/4$
3. $I_0/8$
4. $I_0/16$



QUESTION

Two nicols are oriented with, then principal planes making an angle of 60°. The percentage of incident unpolarised light which passes through the system is

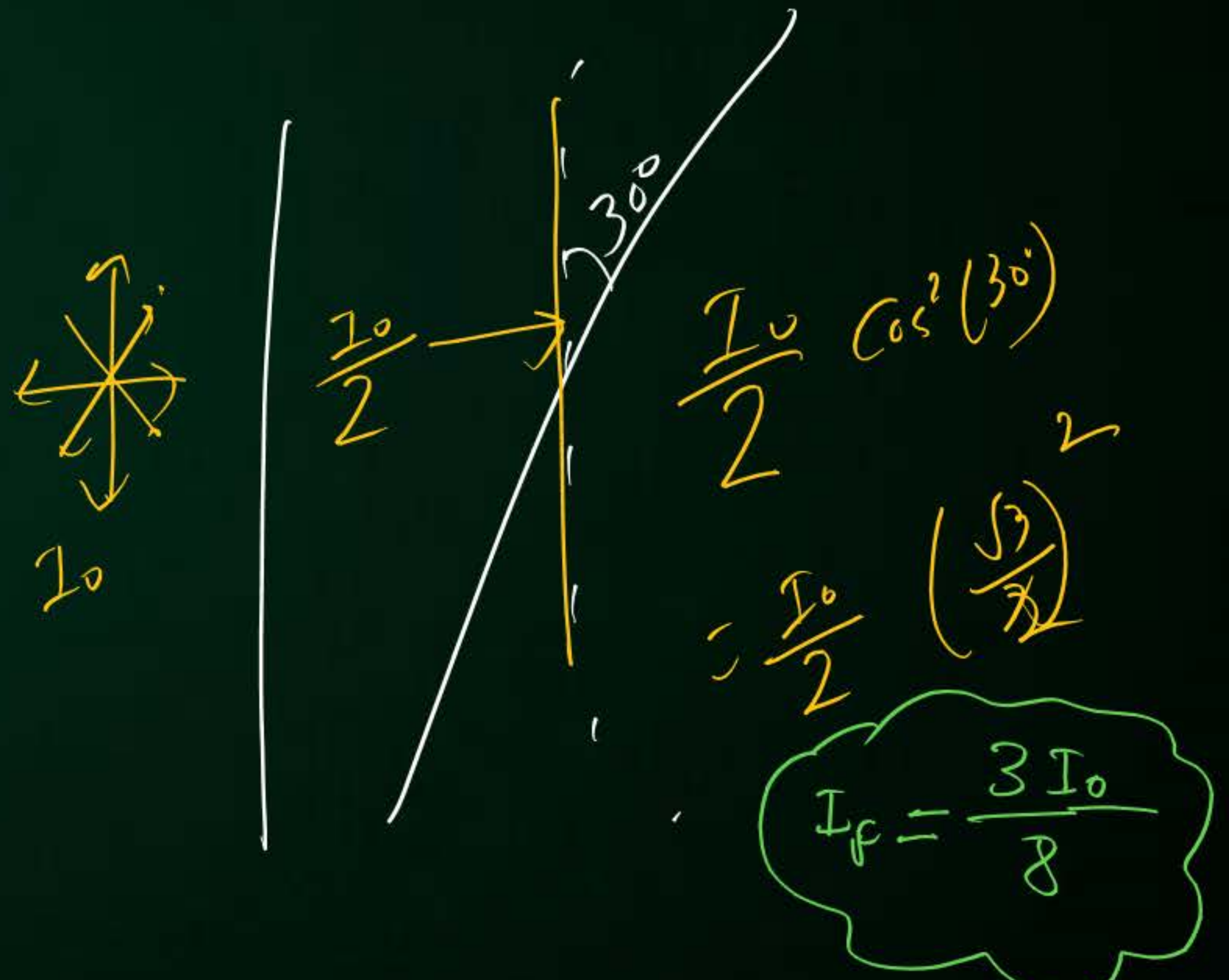
1. 50%
2. 100%
3. 12.5%
4. 37.5%



QUESTION

Two polaroids are oriented with their planes perpendicular to incident light and transmission axis making an angle of 30° with each other. What fraction of incident unpolarised light is transmitted?

1. 1/2
2. 3/4
3. 7/8
4. 3/8



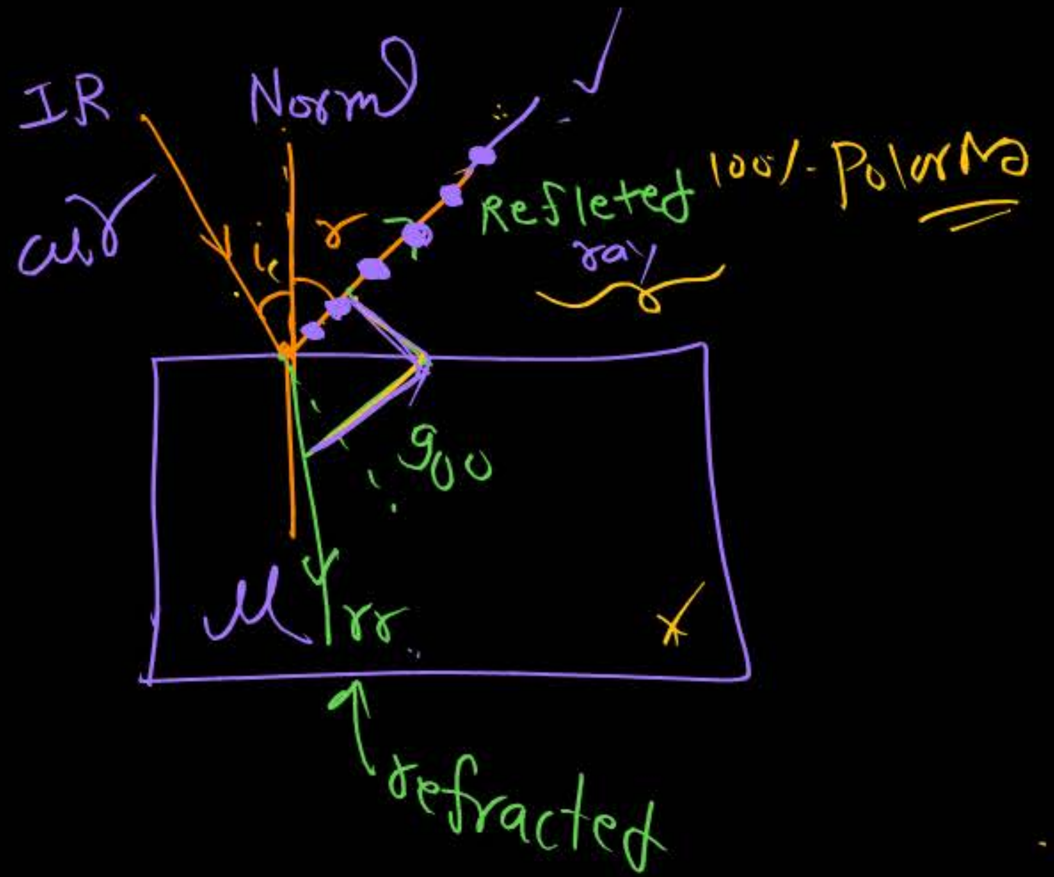
Polarisation By refletion

reflected light is Partially Polarised at any angle of incident; but when reflected and refracted light is perpendicular to each other, then reflected ray is completly (100%) Polarised ⊥r to the plane of Incident, refracted ray is Partially Polarn.

↳ at that case angle of Incident is called Brewester angle

$i_w = \tan^{-1}(\mu)$ *

$\tan i_w = \mu$




THANK YOU

YAKEEN 2.0

FOR NEET 2025

Modern → 3 to 4
atom → 2
nucl → 2 to 3
semicondu → 4

Lecture- 01 | **Physics**

Dual Nature of Radiation and Matter

By- Dr. Manish Raj (MR SIR)



Todays Goal

H/W wave optics

Quantum theory of light

METHODS OF OBTAINING PLANE POLARISED LIGHT

$i_B = \tan^{-1}(\mu)$

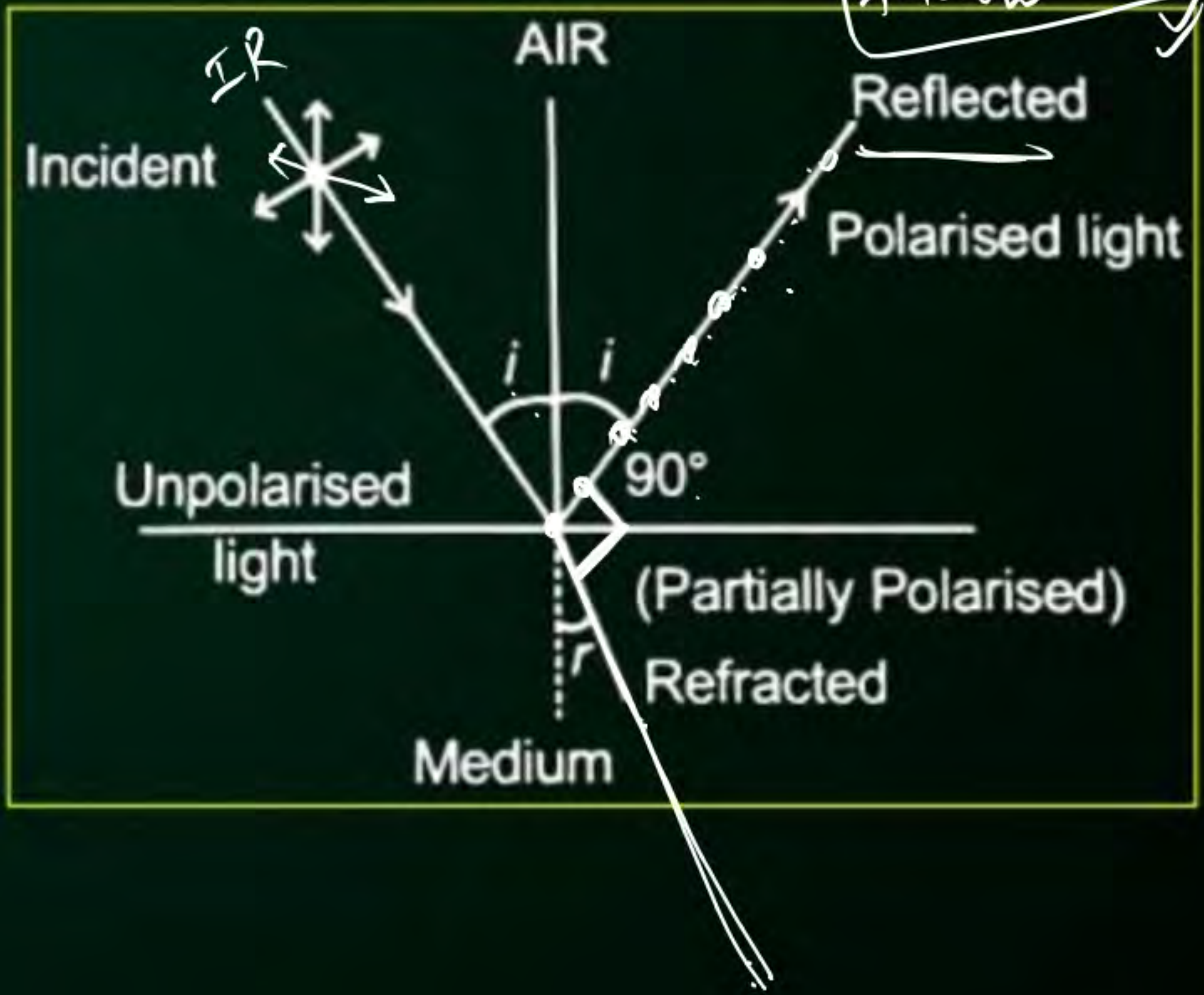
Polarisation by Reflection:

- The simplest method to produce plane polarised light is by reflection. This method was discovered by Malus in 1808.
- When a beam of ordinary light is reflected from a surface, the reflected light is partially polarised.
- (The degree of polarisation of the polarised light in the reflected beam is greatest when it is incident at an angle called polarising angle or Brewster's angle). (100%)

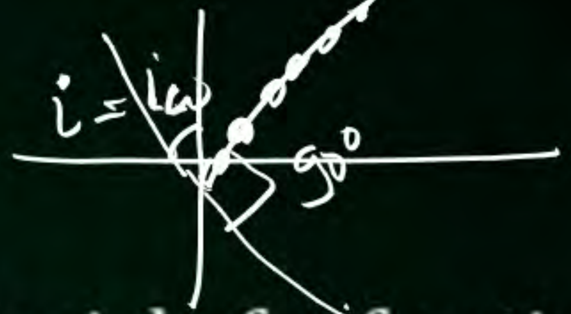
Polarization by Reflection :

- When a light wave is incident on a boundary of a medium, a part of light wave is reflected back into the medium from which it is incident and a part of the wave is refracted into the other medium.

- When unpolarized light is incident on the boundary between two transparent medium, for an angle of incidence in which reflected wave travels at right angle to the refracted wave, the reflected light is polarized while the refracted light is partially polarized

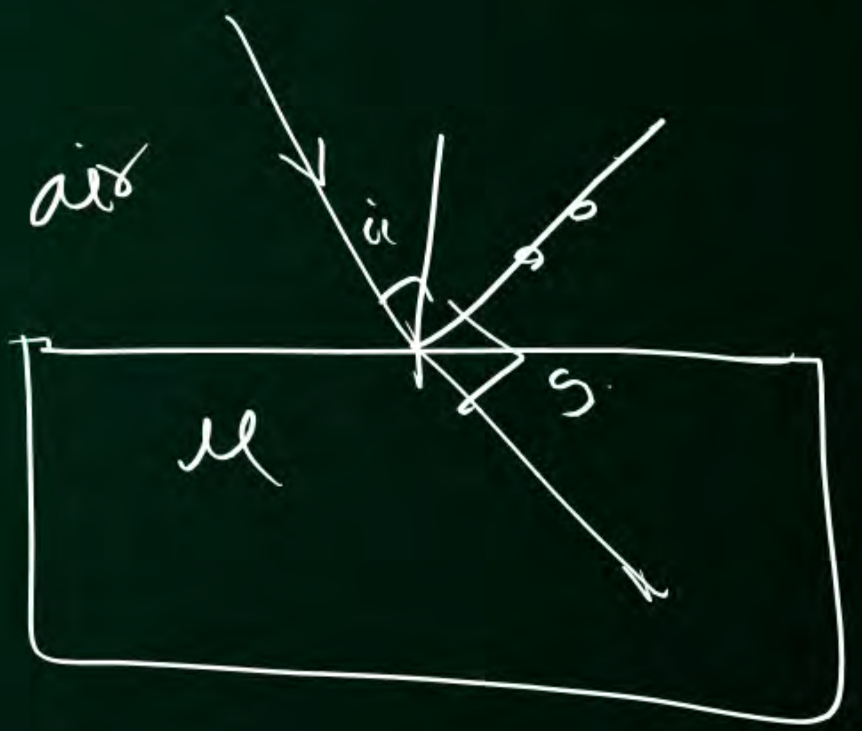


QUESTION



Unpolarised light is incident from air on a plane surface of a material of refractive index 'μ'. At a particular angle of incidence 'i', it is found that the reflected and refracted rays are perpendicular to each other. Which of the following options is correct for this situation?

[NEET - 2018]



1. Reflected light is polarised with its electric vector parallel to the plane of incidence
2. Reflected light is polarised with its electric vector perpendicular to the plane of incidence
3. $i = \tan^{-1}\left(\frac{1}{\mu}\right)$
4. $i = \sin^{-1}\left(\frac{1}{\mu}\right)$

QUESTION

When unpolarised light beam is incident from air onto glass ($n = 1.5$) at the polarising angle

1. reflected beam is polarised 100%
2. reflected and refracted beams are partially polarized
3. the reason for option (a) is that almost all the light is reflected
4. All of the above

QUESTION

* Brewster angle (Polarising angle) from rarer to denser but critical angle defined from denser to rarer.

The critical angle of a certain medium is $\sin^{-1}\left(\frac{3}{5}\right)$. The polarizing angle of the medium is [KCET 2011]

1. $\sin^{-1}\left(\frac{4}{5}\right)$
2. $\tan^{-1}\left(\frac{5}{3}\right)$
3. $\tan^{-1}\left(\frac{3}{4}\right)$
4. $\tan^{-1}\left(\frac{4}{3}\right)$

$\sin i_c = \frac{1}{\mu}$

$\sin i_c = \frac{1}{\mu} = \frac{3}{5}$

$\mu = \frac{5}{3}$

$i_B = \tan^{-1}(\mu)$

$= \tan^{-1}\left(5/3\right)$

$i_c = \sin^{-1}\left(\frac{3}{5}\right)$

$\sin i_c = \frac{3}{5} = \frac{P}{H}$

$B = \sqrt{H^2 - P^2} = \sqrt{5^2 - 3^2} = 4$

$\tan i_c = \frac{P}{B} = \frac{3}{4}$

$i_c = \tan^{-1}$ critical

Revolving Power

QUESTION

Brewster's angle in terms of refractive index (μ) of the medium [AFMC 2007]

1. $\tan^{-1}\sqrt{\mu}$
2. $\sin^{-1}\mu$
3. $\sin^{-1}\sqrt{\mu}$
4. $\tan^{-1}\mu$

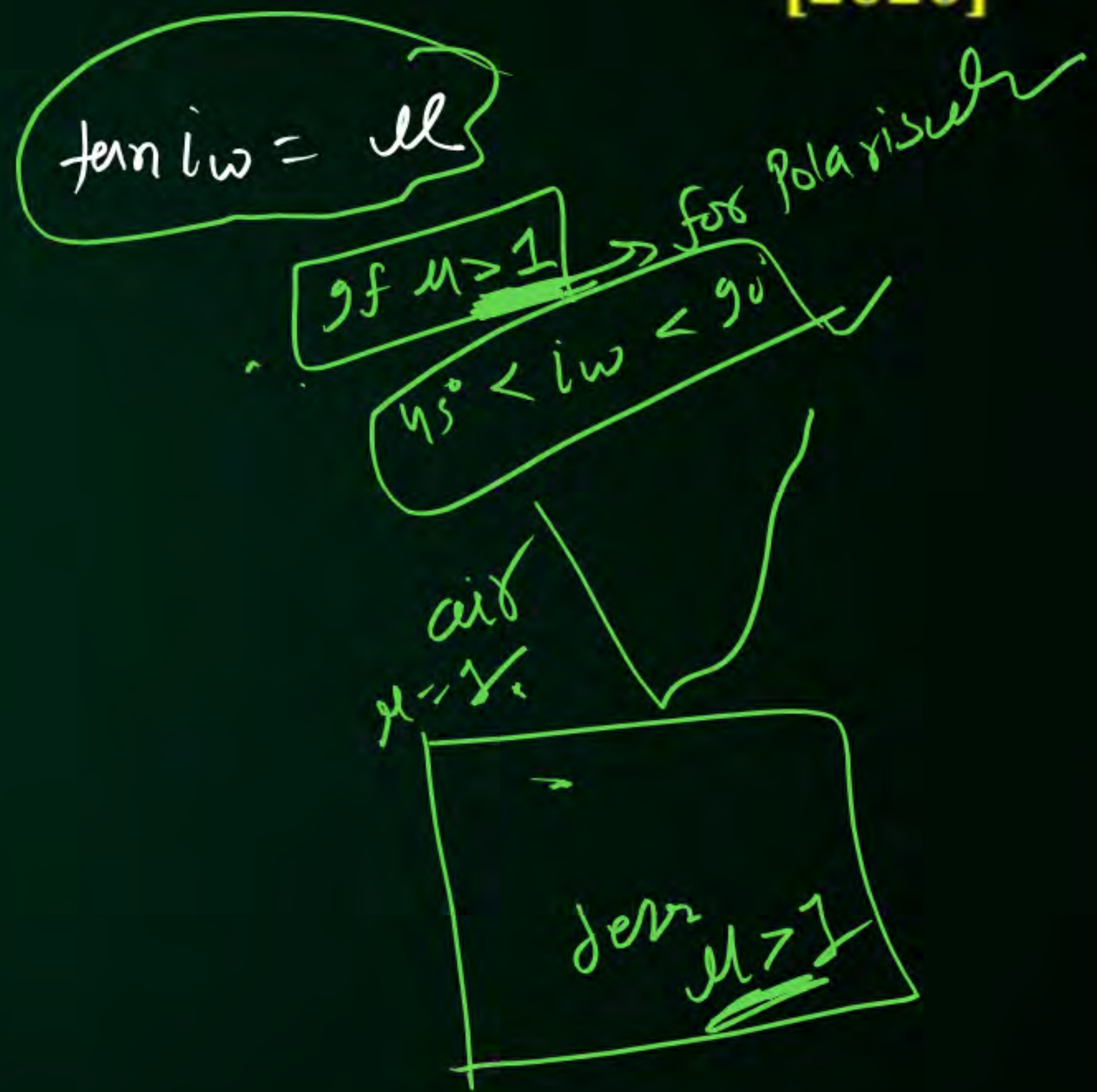
$\tan i_\omega = \mu$

$i_\omega = \tan^{-1}(\mu)$

QUESTION

The Brewsters angle i_b for an interface should be [2020]

1. $30° < i_b < 45°$
2. $45° < i_b < 90°$
3. $i_b = 90°$
4. $0° < i_b < 30°$

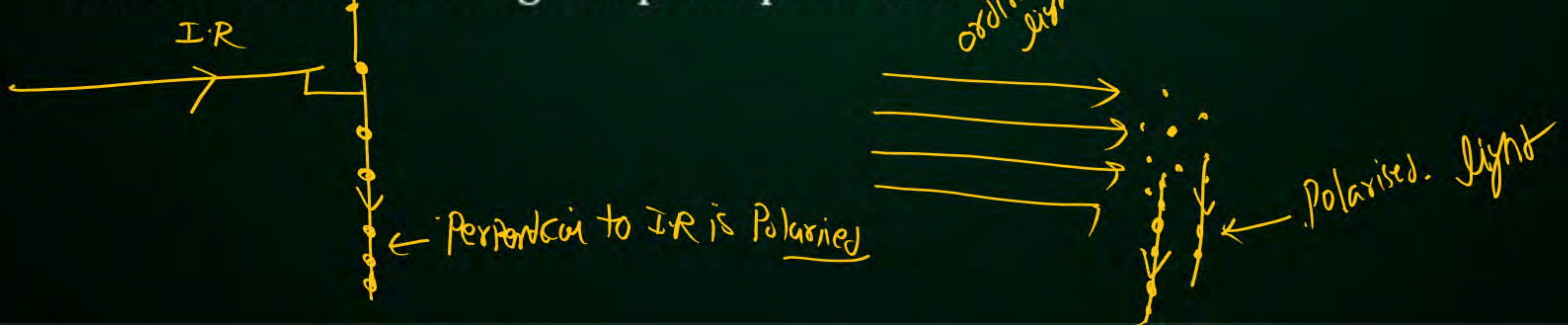


Polarization by Scattering:

- When light is incident on the small particles of atmosphere such as dust, air molecules it is absorbed by the electrons in the molecules, hence electrons start vibrating.

- These vibrating electrons emit radiations in all directions except in its own line of vibration.

- The emitted radiations (light) scattered in a direction perpendicular to direction of incident light is plane polarised.

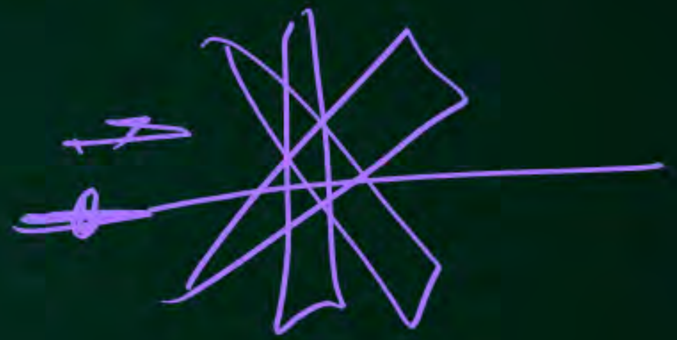


QUESTION

Which of the following phenomena is not common to sound and light waves?

1. Interference (comm)
2. Diffraction (comm)
3. Polarisation ✓
4. Reflection (com)

Not for sound only for light



QUESTION

Pick the wrong answer in the context with rainbow. [NEET 2019]

1. Rainbow is a combined effect of dispersion, refraction and reflection of sunlight.
2. When the light rays undergo two internal reflections in a water drop, a secondary rainbow is formed.
3. The order of colours is reversed in the secondary rainbow.
4. An observer can see a rainbow when his front is towards the sun.

Ans (4)

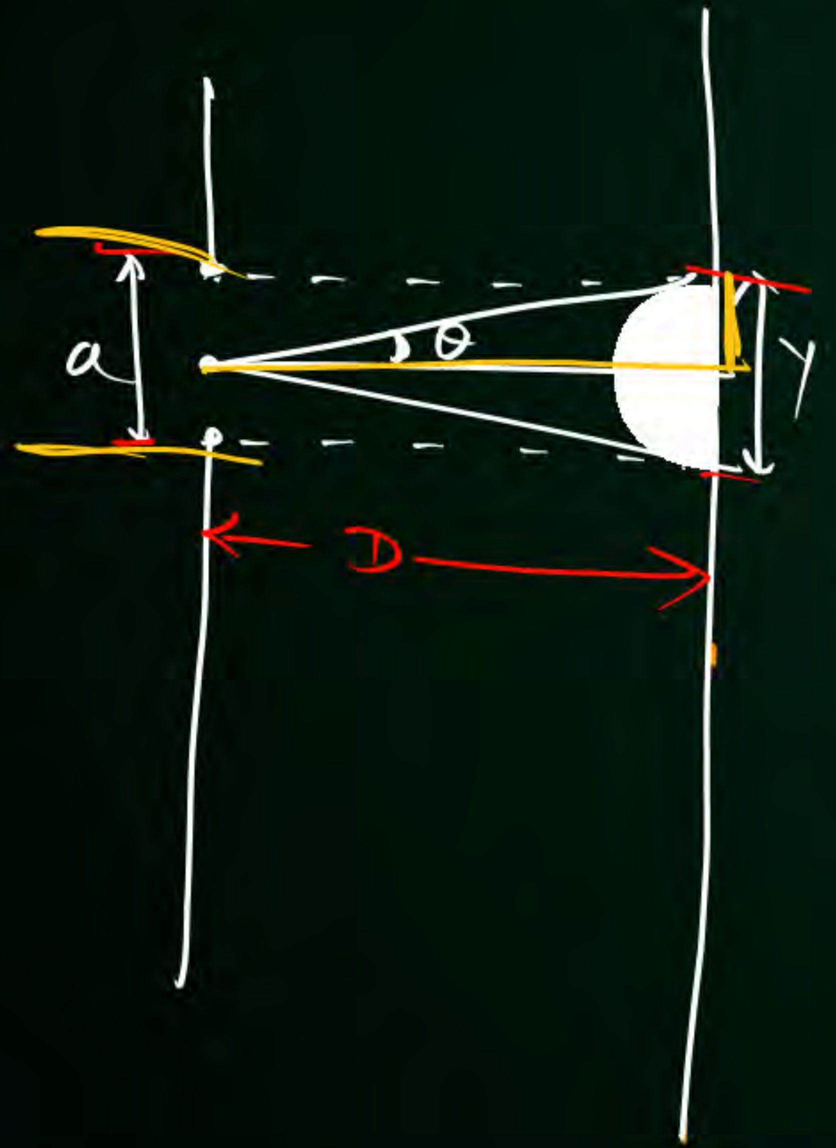
Validity [redacted] of Ray Optics and Wave Optics

If minima is at y height → for minima (1st minima:)

$a \sin\theta = \lambda$

$\sin\theta = \frac{\lambda}{a}$ — (1)

$\tan\theta = \frac{y}{D}$ — (11)



Small small angle

$\frac{\lambda}{a} = \frac{y}{D}$ (for small angle $y \approx a$)

$\frac{\lambda}{a} = \frac{a}{D}$

$* \; D = \left[\frac{a^2}{\lambda}\right]$ → ray ...

↳ fresnel distn

QUESTION

For what distance is ray optics a good approximation when a plane light wave is incident on a circular aperture of width 2 mm having wavelength 600 nm?

1. 6.7 m
2. 3.5 m
3. 2.7 m
4. 5.7 m

$$D = \frac{a^2}{\lambda}$$ ← width of slit

$$D = \frac{a^2}{\lambda} = \frac{(2\times10^{-3})^2}{600\times10^{-9}} = \frac{4\times10^{-6}}{6\times10^{-7}} = \frac{40}{6} = 6.6$$

MODERN Physics

Newton (1670)

- → light is a Particle that Particle is Corpouscular Particle
- → It shows reflection & refraction.

Huygen (1690)

- → light is a logitudinal, mehanical wave.
- → distraction, Interfernce.
- → medium is required for Propagation of light that is ether medium

1927 de-broglie

light is a enegy
↳ which behave as ray, wave, partic

Maxwell (1865)



light is E-M wave

- → Transverse, Non-mechanical wave
- → No medium is required
- → diffraction, Interferenc Polarisation.

1901 (max plank)



- → Light is a particle
- → explain Black Body radiation
- → light is 'Photon'

1920 einstein

Photoelectric effect explain kiya using Particle nature of light.

De-Broglie (1923) :

- Light have dual nature → some time it behave as ray, sometn as a partic
sometn as a wave

Davisson and Germer Expm. (1927) :

- e^- is a wave

G.P. Thomoson – 1927
↳ Proved e^- as a wave

LIGHT

- Light behave as a Ray :-

  $\lambda_{light} << \ell_{object}$

- Light behave as Wave

  $\lambda_{light} \approx \ell_{object}$

- Light behave as a particle (Photon) when it Intracts with e^-, proton, neutron, α-particle.

{Enegy of Light $= hf$ → (a) True (39%) (b) false (58%)

Light → collection of (photons)

→ Enegy of each Photon $= hf$

→ Enegy of light $= nhf$
(n = no. of photon)

$E_{photo} = hf = \frac{hc}{\lambda}$

$h = 6.6 \times 10^{-34}$ JS

$E_{photon} = \frac{2\times10^{-25}}{\lambda(m)}$ J

$E_{photo} = \frac{12400 eV}{\lambda(A^{\circ})}$

→ Rest mass of Photon = 0

→ charge of Photon = 0
(neutral)

"Photon can't be charged"

→ photon does not deviate in electro-magnetic field.

→ Speed of Photon in air/vaccum $= c = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}$

→ Speed of photon in medium ⇒

$$V = \frac{c}{\mu} = \frac{1}{\sqrt{\mu_m \varepsilon_m}} = \frac{1}{\sqrt{\mu_0 \varepsilon_0 \mu_r \varepsilon_r}} = \frac{c}{\sqrt{\mu_r \varepsilon_r}}$$

Relativistic Particle → Small & fast moving

↳ Ex → neutrino, Proton, electron, Photon

Valid for all line e^-, Proton, photon

$$E = \sqrt{(m_0c^2)^2 + (PC)^2}$$

- E → Total energy
- (m_0c^2) → rest mass energy
- (PC) → kinetic energy

↳ for Photon m_0(rest mass) $= 0$

$$E = \sqrt{0 + (PC)^2} = \sqrt{(PC)^2}$$

$$\boxed{E = PC}$$

Rest mass energy

$$\boxed{E = m_0c^2}$$

↳ m_0 = rest mass

energy of Photon

$$E = PC = hf$$

- E → Total energy of photon
- PC → Kinetic energy

P = momentum of Photon.

c = speed of light

$E = PC = hf$

$$P = \frac{E}{C} = \frac{hf}{C} = \frac{hc}{c\lambda} = \frac{h}{\lambda}$$

→ momentum of photon

$Q = 0$
$m_0 = 0$
$v = c$
$E = hf = Pc$

$$P = \frac{h}{\lambda}$$

Moving mass of Photon

$$MC = \frac{E}{C}$$

$$m = \frac{E}{c^2} = \frac{hc}{\lambda c \cdot c} = \frac{h}{\lambda c}$$

→ Moving mass of photon

QUESTION

If radiation of energy E and No. of Photon n then find effective moving mass of photon.

1. $\frac{E}{C}$

2. $\frac{E}{C^2}$

3. $\frac{E}{nC^2}$

4. $\frac{nE}{C^2}$

Energy of radiation = nhf

$E = nhf$

$\left(\frac{E}{n}\right) = hf = pc = mc^2$

$m = \frac{E}{nc^2}$

Photon of Photon is not defined ✓

POWER OF LIGHT

Total energy of light radiation / beam falling per sec. is called power of radiat.

$$P = \frac{E}{t}$$

$$\text{Power} = \frac{E_{light}}{t} = \frac{nhf}{t}$$

$$\text{Power} = \frac{nhf}{t}$$

$\frac{n}{t}$ = no of photon per sec. = $\left(\frac{\text{Power}}{hf}\right)$

MOMENTUM OF PHOTON

$$p = \frac{h}{\lambda} = \frac{E}{c}$$

$$E = pc$$

$$p = \frac{E}{c} = \frac{hc}{\lambda c} = \frac{h}{\lambda}$$

QUESTION

total charge

Total energy, Total momentum are conserved in every e^- – photon interaction but no. of Photon not conserved.

Pair Production

$\gamma + \gamma \longrightarrow e^+ + e^-$

Two photon

$Q_{net} = 0$

☆ Photon (light) does not deviate in E-M field but it deviates in gravitational field. because of effective moving mass

Intensity of radiation = Total energy falling per sec on per unit Area

$$I = \frac{E_{incident}}{At} = \frac{Power}{A}$$

* $Power = IA$

$$I = \frac{nhf}{At}$$

$$I = \frac{n}{t}\frac{hc}{\lambda A}$$

$\frac{n}{t}$ → no. of photon per sec $\frac{n}{t} = \frac{I\lambda A}{hc}$

Is Intensity of light radiation depends on frequency → (a) false (60%) ✗ (b) True (40%) ✓

$$I = \frac{nhf}{At} \propto nf$$

(const)

Intensity depends on frequency $I \propto nf$

Is frequency depends on Intensity → NO

→ because frequency only depends on (source)

#

hf, hf, hf

3- Photon

* $I = \frac{3hf}{At}$

* freq^n const^n
no of double.

hf, hf, hf, hf, hf, hf

$I' = \frac{6hf}{At} = 2I$
double

frequency & no. of Photo both becomes double

* 2hf, 2hf, 2hf, 2hf, 2hf, 2hf

$I' = \frac{12hf}{At} = 4I$

no. of Photon become double

hf, hf, hf, hf, hf, hf

$I' = 2I$

$I \propto nf$

→ if information of frequency is not given.

$I \propto$ no. of Photo

$I \propto$ Photon Flux

→ Counting of Photo passing through per-unit Area

If Intensity and no. of Photon both becomes double then frequency of photon will be ?

Ans remains same

$\cancel{2} I = \cancel{2} n f$ ← remain same

(Q) frequency becomes double & no. of photon becomes half then find Intensity.

$I \propto \frac{n}{2}(f \times 2)$ → remain same

QUESTION

If intensity becomes double then number of Photon will be ?

Ans → $I \propto n$

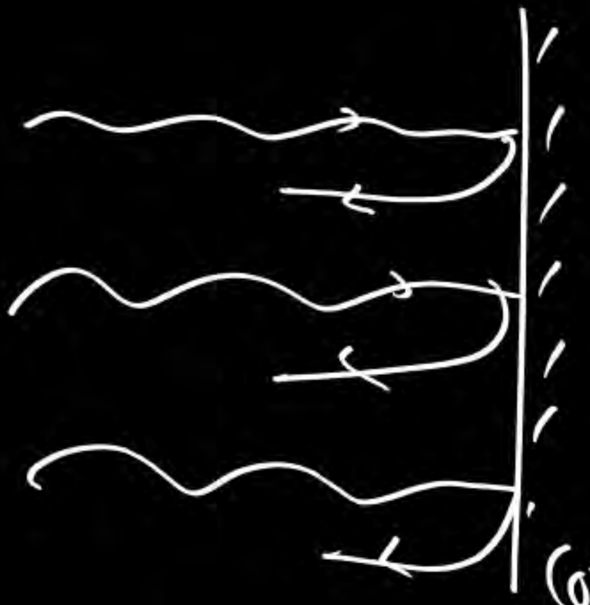
(double)

As

Radiation Pressure

$$\text{Pressure} = \frac{2I}{c} \quad (\text{Compt reflecting body})$$

$$\text{Pressure} = \frac{I}{c} \quad (\text{Compt absorbing body})$$



Compt reflecting



$\rho + \sigma = 1$

ρ → reflection coefficient

σ → absorption coefficient

50% reflecting. $\rho_{\text{reflecting coeffn}} = \frac{1}{2}$

25% reflecting $\rho = 1/4$

100% reflection = $\rho = 1$

0% reflection = $\rho = 0$

$$\text{Pressure} = \frac{I}{c}(\rho + 1)$$

$$\text{Pressure} = \frac{I}{c}(2 - \sigma)$$

σ = absorption coefficient

$(\sigma = 1) \rightarrow$ 100% absorption

QUESTION

If intensity of light is I and 75% radiation is absorbed then find radiation pressure?

$\sigma = 75\% = \frac{75}{100} = \frac{3}{4}$

$\rho = 25\%$ refln $= \frac{1}{4}$

$P = \frac{I}{c}(2-\sigma)$

$= \frac{I}{c}\left(2-\frac{3}{4}\right)$

$= \frac{I}{c}\left(\frac{8-3}{4}\right)$

$= \frac{5I}{4c}$

Press $= \frac{I}{c}(1+\rho)$

$= \frac{I}{c}\left(1+\frac{1}{4}\right)$

$= \frac{I}{c}\left(\frac{5}{4}\right)$

If 30% is absorbed

↳ 70% reflected

$\rho = \frac{70}{100} = \frac{7}{10}$

$P_{rad} = \frac{I}{c}(\rho + 1)$

$= \frac{I}{c}\left(\frac{7}{10} + 1\right)$

$P = \frac{17}{10}\frac{I}{c}$

Ans

QUESTION

If Green light and Red light having same power then which have large no. of Photon.

1. $n_R = n_G$
2. $(n_R > n_G)$
3. $n_R < n_G$
4. Can't say

$P_{Red} = P_{Gn}$

QUESTION

Find frequency of 1 MeV Photon ?

$f = ??$

energy

QUESTION

If power of light 10 kW and wavelength 300 nm then find no. of Photon per sec ?

$\frac{n}{t} = ??$

QUESTION

A plate of Mass 10 g is in equilibrium in air due to light bean on plate then power of beam, if surface area of plates is A and complete reflecting.

QUESTION

The momentum of the photon of wavelength 5000 Å will be

1. 1.3×10^{-27} kg-m/s
2. 1.3×10^{-28} kg-m/s
3. 4×10^{29} kg-m/s
4. 4×10^{-18} kg-m/s

$p = \frac{h}{\lambda}$

QUESTION

A photon in motion has a mass

1. $c/h\nu$
2. h/ν
3. $h\nu$
4. $h\nu/c^2$

QUESTION

Monochromatic light of wavelength 3000 Å is incident on a surface area 4 cm^2. If intensity of light is 150 mW/m^2, find the rate at which photons strike the target.

QUESTION

If a photon has velocity c and frequency ν, which of the following represents its wavelength ?

1. $\frac{h\nu}{c^2}$
2. $h\nu$
3. $\frac{hc}{\nu}$
4. $\frac{c}{\nu}$

QUESTION

The velocity of photons is proportional to (where ν = frequency)

1. $\frac{1}{\sqrt{\nu}}$
2. ν^2
3. ν^0
4. $\sqrt{\nu}$

QUESTION

If the energy of a photon is 10 eV, then its momentum is

1. 3.33×10^{-23} kg-m/s
2. 3.33×10^{-25} kg-m/s
3. 3.33×10^{-29} kg-m/s
4. 3.33×10^{-27} kg-m/s

QUESTION

Two sources of light emit X-rays of wavelength 1 nm and visible light of wavelength 500 nm, respectively. Both the sources emit light of the same power 200 W. The ratio of the number density of photons of X-rays to the number density of photons of the visible light of the given wavelengths is: [JEE Main 2020]

1. 1/500
2. 500
3. 250
4. 1/250

QUESTION

Two streams of photons, possessing energies equal to five and ten times the work function of metal are incident on the metal surface successively. The ratio of maximum velocities of the photoelectron emitted, in the two cases respectively, will be [JEE Main 2022]

1. 1 : 2
2. 1 : 3
3. 2 : 3
4. 3 : 2

QUESTION

If the total energy transferred to a surface in time t is 6.48×10^5 J, then the magnitude of the total momentum delivered to this surface for complete absorption will be: [30 Jan, 2024 (Shift-II)]

1. 2.46×10^{-3} kg m/s
2. 2.16×10^{-3} kg m/s
3. 1.58×10^{-3} kg m/s
4. 4.32×10^{-3} kg m/s

QUESTION

Monochromatic light of frequency 6×10^{14} Hz is produced by a laser. The power emitted is 2×10^{-3} W. How many photons per second on an average, are emitted by source? (Given $h = 6.63 \times 10^{-34}$ Js) [1 Feb, 2024 (Shift-II)]

1. 9×10^{18}
2. 6×10^{15}
3. 5×10^{15}
4. 7×10^{16}

QUESTION

The number of electrons flowing per second in the filament of a 110 W bulb operating at 220 V is: (Given $e = 1.6 \times 10^{-19}$ C) [06 April, 2024 (Shift-II)]

1. 31.25×10^{17}
2. 6.25×10^{18}
3. 6.25×10^{17}
4. 1.25×10^{19}

QUESTION

Energy of a quanta of frequency 10^{15} Hz and $h = 6.6 \times 10^{-34}$ Js will be

1. 6.6×10^{-19} J
2. 6.6×10^{-12} J
3. 6.6×10^{-49} J
4. 6.6×10^{-41} J

QUESTION

Consider a parallel beam of light of wavelength 600 nm and intensity 100 W/m^2. How many photons cross 1 cm^2 area perpendicular to beam in one second?

1. 3×10^{16}
2. 3×10^{14}
3. 3×10^{9}
4. 3×10^{4}

QUESTION

When light of wavelength 300 nm falls on a photoelectric emitter, photoelectrons are just liberated. For another emitter, light of wavelength 600 nm is just sufficient for liberating photoelectrons. The ratio of the work function of the two emitters is:

1. 1 : 2
2. 2 : 1
3. 4 : 1
4. 1 : 4

QUESTION

A 2 mW laser operates at a wavelength of 500 nm. The number of photons that will be emitted per second is

[Given Planck's constant $h = 6.6 \times 10^{-34}$ Js] [10 April, 2019 (Shift-II)]

1. 2×10^{16}
2. 1.5×10^{16}
3. 5×10^{15}
4. 1×10^{16}

QUESTION

If a source of electromagnetic radiation having power 15 kW produces 10^{16} photons per second, the radiation belongs to a part of spectrum is:

(Take Planck constant $h = 6 \times 10^{-34}$ Js) [31 Jan, 2023 (Shift-I)]

1. Micro waves
2. Ultraviolet rays
3. Gamma rays
4. Radio waves

DPP
34 to 53
H/W


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 2 | Physics

Dual Nature of Radiation and Matter



By- Dr. Manish Raj (MR SIR)

Todays Goal

→ M/W

→ Photoelectric effect.

→ full syllabus

→ 1 → Revision

→ 2nd Revision ✓

QUESTION

If Green light and Red light having same power then which have large no. of Photon.

1. $n_R = n_G$
2. $(n_R > n_G)$ ✓ Ans
3. $n_R < n_G$ ✗
4. Can't say

$P_{ow} = \frac{E}{t} = \frac{nhf}{t}$

$P_{Red} = P_{Gn}$

$\frac{E_{radi}}{t} = \frac{n_R h f_R}{t} = \frac{n_G h f_G}{t}$

$= n_R f_R = n_G f_G$

$f_R < f_G$

QUESTION

Find frequency of 1 MeV Photon ?

$f = ??$

energy

$$1\,eV = 1.6\times10^{-19}\,J$$

$$E = hf$$

$$1\,MeV = hf$$

$$10^{6}\times1.6\times10^{-19}\,J = 6.6\times10^{-34}\,f$$

$$10^{-13}$$

$$f = \frac{1.6\times10^{-13}}{6.6\times10^{-34}}\,Hz = 2.4\times10^{10}\,Hz$$

QUESTION

If power of light 10 kW and wavelength 300 nm then find no. of Photon per sec ?

$\frac{n}{t} = ??$

$P = \frac{nE}{t}$

$hc = 2 \times 10^{-25}$ *

$10 kW = \frac{n}{t} \times \frac{hc}{\lambda}$

$\frac{n}{t} = \frac{10 \times 10^3 \times \lambda}{(hc)} = \frac{10 \times 10^3 \times 300 \times 10^{-9}}{2 \times 10^{-25}} = 15 \times 10^2 \times 10^{+19}$

$= 15 \times 10^{21}$ Ans

QUESTION

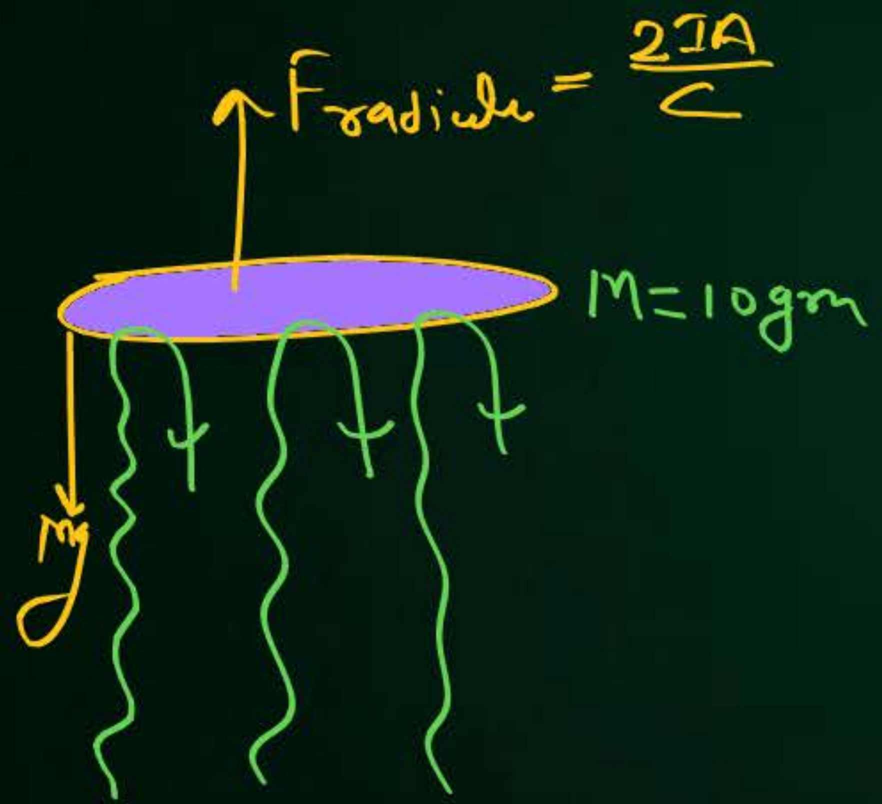
A plate of Mass 10 g is in equilibrium in air due to light bean on plate then power of beam, if surface area of plates is A and complete reflecting.

$I = \frac{E}{At} \rightarrow$ Pow

$IA = $ Power

Pressure $= \frac{2I}{c}$

Force = Press × Area $= \frac{2IA}{c}$



at equilibrium

$mg = \frac{2IA}{c} = \frac{2P}{c}$

$\text{Power} = \frac{mgc}{2}$

$= \frac{10 \times 10^{-3} \times 10 \times 3 \times 10^{8}}{2} = 1.5 \times 10^{7}\ W$

QUESTION

The momentum of the photon of wavelength 5000 Å will be

1. 1.3×10^{-27} kg-m/s
2. 1.3×10^{-28} kg-m/s
3. 4×10^{29} kg-m/s
4. 4×10^{-18} kg-m/s

$p = \frac{h}{\lambda}$

$p = \frac{h}{\lambda} = \frac{6.6 \times 10^{-34}}{5000 \times 10^{-10}}$

$= \frac{6.6 \times 10^{-24}}{5 \times 10^{3}}$

$= \frac{6.6}{5} \times 10^{-27} = 1.3 \times 10^{-27}$

QUESTION

A photon in motion has a mass

1. $c/h\nu$
2. h/ν
3. $h\nu$
4. $h\nu/c^2$ ✓

rest mass of photon = 0

moving mass of photon.

$E = P c$

$E = (m \times c) \times c$

$m = \frac{E}{c^2} = \frac{hf}{c^2}$

QUESTION

Monochromatic light of wavelength 3000 Å is incident on a surface area 4 cm^2. If intensity of light is 150 mW/m^2, find the rate at which photons strike the target.

$$\frac{n}{t} = ??$$

$$I = \frac{nhf}{At}$$

$$\frac{n}{t} = \frac{IA}{hf} = \frac{IA\lambda}{(hc)} = \frac{150\times10^{-3}\times 4\times10^{-4}\times 3000\times 10^{-10}}{2\times10^{-25}}$$

$$= \frac{150\times 2\times 3000\times}{10^{-8}} = 90\times10^{12} = \boxed{9\times10^{13}}$$

QUESTION

If a photon has velocity c and frequency ν, which of the following represents its wavelength ?

(1) $\dfrac{h\nu}{c^2}$

(2) $h\nu$

(3) $\dfrac{hc}{\nu}$

(4) $\dfrac{c}{\nu}$ ✓

$f = \nu = \dfrac{c}{\lambda}$

$\lambda = \dfrac{c}{\nu}$

QUESTION

The velocity of photons is proportional to (where ν = frequency)

Velocity does not depends on frequency

(1) $\frac{1}{\sqrt{\nu}}$

(2) ν^2

(3) ν^0

(4) $\sqrt{\nu}$

QUESTION

If the energy of a photon is 10 eV, then its momentum is

(1) 3.33×10^{-23} kg-m/s

(2) 3.33×10^{-25} kg-m/s

(3) 3.33×10^{-29} kg-m/s

(4) [illegible] 5.3 $\times 10^{-27}$ kg-m/s ✓

$E = pc$

$p = \frac{E}{c} = \frac{10 \times 1.6 \times 10^{-19}}{3 \times 10^{8}}$

$= \frac{16}{3} \times \frac{10^{-19}}{10^{8}}$

$= \frac{16}{3} \times 10^{-27}$ ✓

QUESTION

Two sources of light emit X-rays of wavelength 1 nm and visible light of wavelength 500 nm, respectively. Both the sources emit light of the same power 200 W. The ratio of the number density of photons of X-rays to the number density of photons of the visible light of the given wavelengths is: [JEE Main 2020]

1. 1/500
2. 500
3. 250
4. 1/250

$P = P$

$\frac{n_1 hc}{\lambda_1 t} = \frac{n_2 hc}{\lambda_2 t}$

$\frac{n_1}{\lambda_1} = \frac{n_2}{\lambda_2}$

$\frac{n_1}{n_2} = \frac{\lambda_1}{\lambda_2} = \frac{1\,nm}{500\,nm}$

$= \frac{1}{500}$

QUESTION

If the total energy transferred to a surface in time t is 6.48×10^5 J, then the magnitude of the total momentum delivered to this surface for complete absorption will be:

[30 Jan, 2024 (Shift-II)]

1. 2.46×10^{-3} kg m/s
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4. 4.32×10^{-3} kg m/s





QUESTION

Monochromatic light of frequency 6×10^{14} Hz is produced by a laser. The power emitted is 2×10^{-3} W. How many photons per second on an average, are emitted by source? (Given $h = 6.63 \times 10^{-34}$ Js) [1 Feb, 2024 (Shift-II)]

1. 9×10^{18}
2. 6×10^{15}
3. 5×10^{15}
4. 7×10^{16}

$P = \frac{nhf}{t}$

$\frac{n}{t} = \frac{P}{hf} = \frac{2 \times 10^{-3}}{6.6 \times 10^{-34} \times 6 \times 10^{14}}$

$= \frac{2 \times 10^{17}}{6.6 \times 6 \cdot 3}$

$= \frac{100}{19.8} \times 10^{5}$

QUESTION

The number of electrons flowing per second in the filament of a 110 W bulb operating at 220 V is: (Given $e = 1.6 \times 10^{-19}$ C) [06 April, 2024 (Shift-II)]

1. 31.25×10^{17}
2. 6.25×10^{18}
3. 6.25×10^{17}
4. 1.25×10^{19}

$P = IV$

$P = \frac{q}{t} V$

$P = \frac{n e V}{t}$

$\frac{n}{t} = \frac{P}{eV}$

no. of e^- per sec

QUESTION

Energy of a quanta of frequency 10^{15} Hz and $h = 6.6 \times 10^{-34}$ Js will be

1. 6.6×10^{-19} J
2. 6.6×10^{-12} J
3. 6.6×10^{-49} J
4. 6.6×10^{-41} J

$E = hf = 6.6 \times 10^{-34} \times 10^{15}$

$= 6.6 \times 10^{-19}$ J

QUESTION

Consider a parallel beam of light of wavelength 600 nm and intensity 100 W/m^2. How many photons cross 1 cm^2 area perpendicular to beam in one second?

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2. 3×10^{14}
3. 3×10^{9}
4. 3×10^{4}

$I = \frac{nhc}{\lambda A t}$

$\frac{n}{t} = \frac{I \lambda A}{(hc)}$

$hc = 2 \times 10^{-25}$

QUESTION

A 2 mW laser operates at a wavelength of 500 nm. The number of photons that will be emitted per second is

[Given Planck's constant $h = 6.6 \times 10^{-34}$ Js] [10 April, 2019 (Shift-II)]

done

1. 2×10^{16}
2. 1.5×10^{16}
3. 5×10^{15}
4. 1×10^{16}

QUESTION

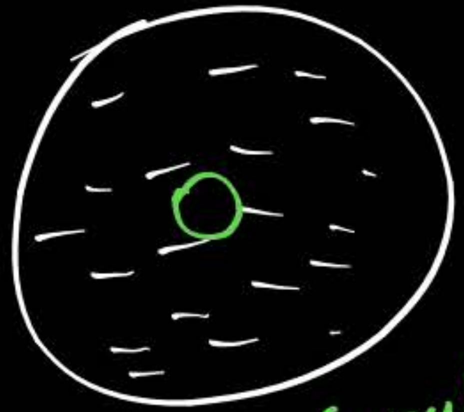
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DPP
34 to 53
H/W

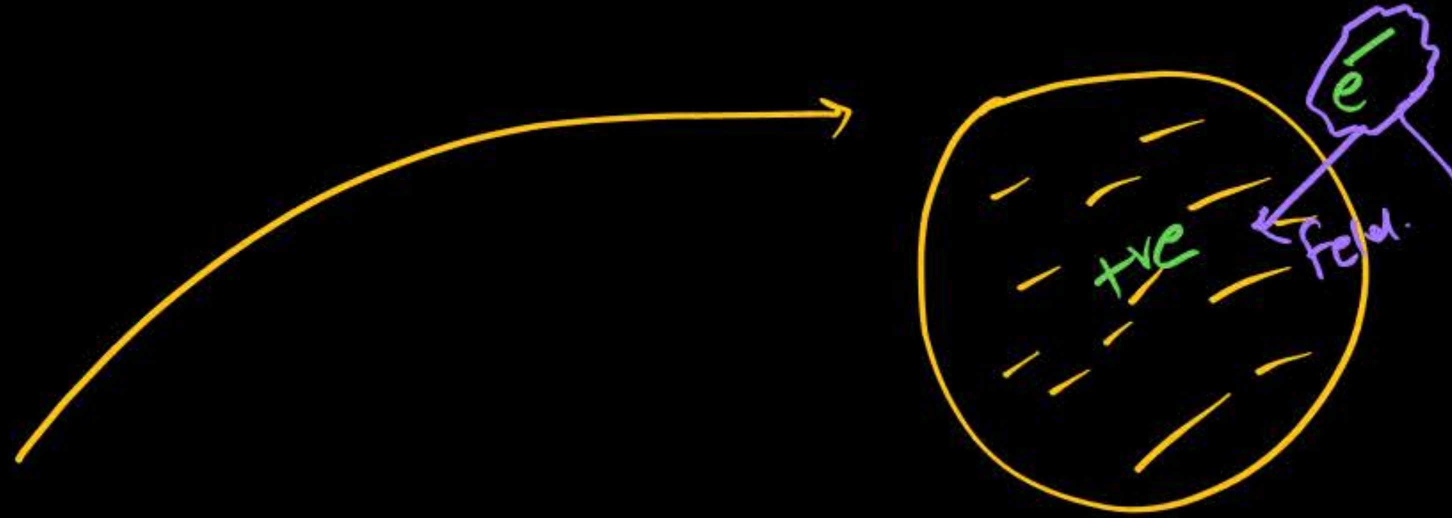
EM wave



Metal (Neutral)

large no. of free e^-s

moving with very high speed.



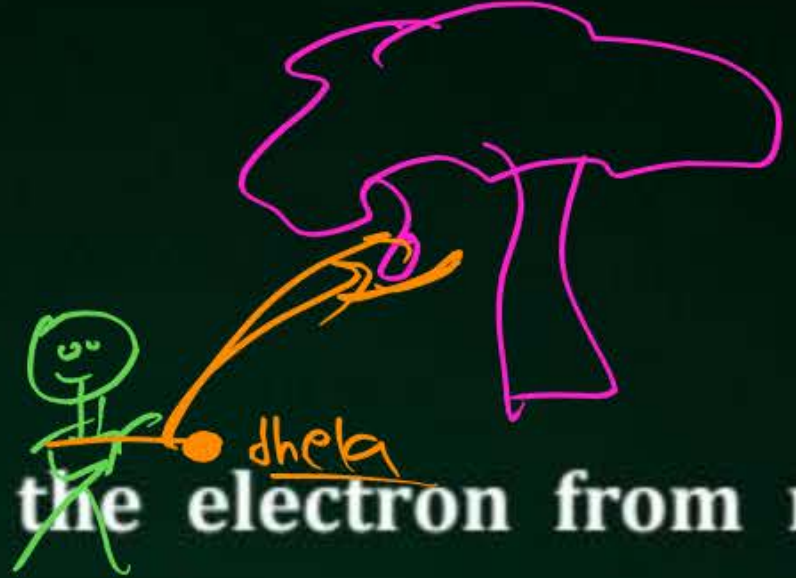
Jaise hi ek bhi e^- bahar nikla then atom becomes +ve charge, electrostatic attractn will pull e^- inside.

Extra energy given to electron so that it overcome that electrostatic attractn & comes outside the metal then that energy is called work function

ϕ = depends on nature of metal.

measure in (Joule) & (eV)

WORK FUNCTION



Minimum energy required to pull the electron from material is called work function.

These energy can be given by :-

(0) Masucle force → मारो e^- को

(1) Thermionic emission → (By heat)

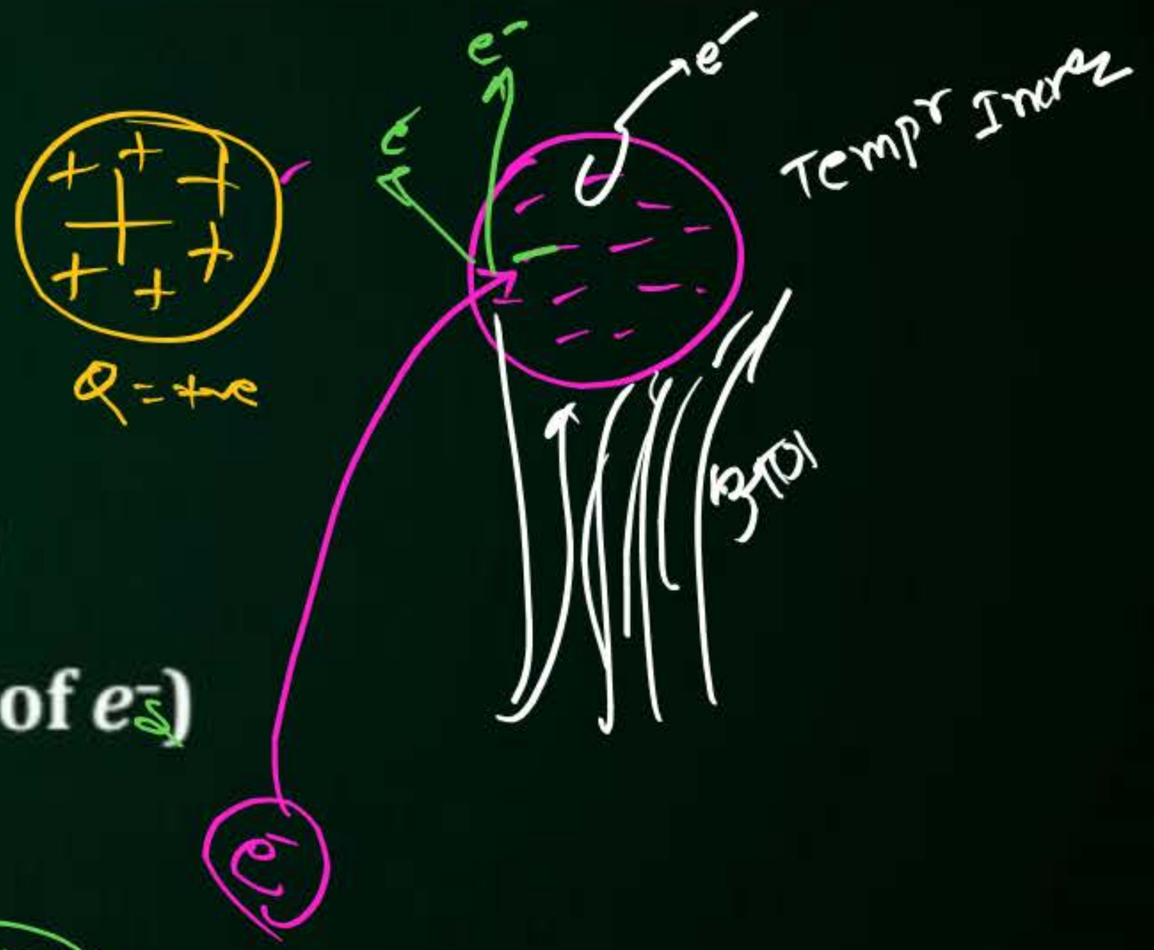
(2) Field emission → (By Electric field)

(3) Secondary emission → (By Collision of e^-s)

(4) Photoelectric effect (By light)

→ light radiation → e^- ka emission.

→ light energy into electrical energy.



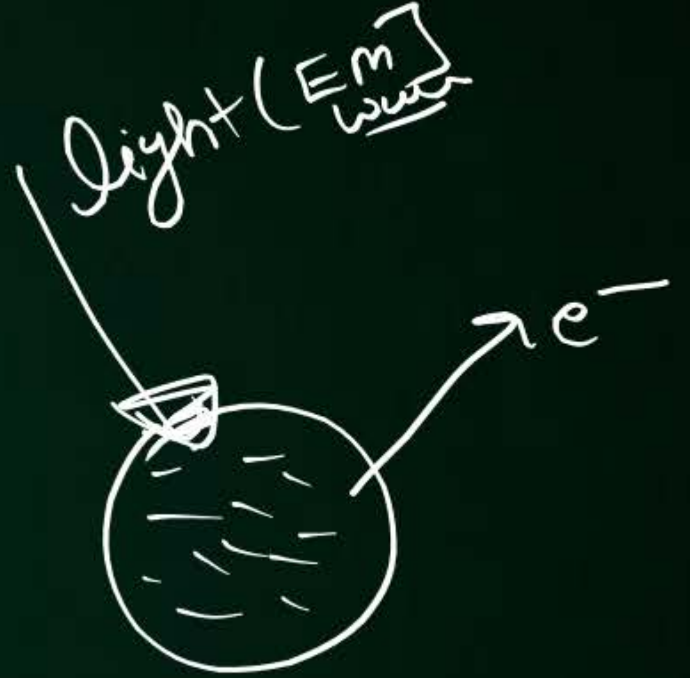


PHOTOELECTRIC EFFECT

Discovered by Hertz and Leanard (1887 & 1892) :

Cant explain by wave theory

Explain by Einstein [Einstein 1920)]



Photoelectric effect is the emission of electron when electromagnetic radiation of suitable energy hits a material & emitted electron is photo electrons

Photon (Light energy) $\Longrightarrow$ Electron (Electric energy)

CONDITION OF PHOTOELECTRIC EFFECT

$E_{light} = \phi_{(\text{work function})}$ → wrong.

$E_{photon} = \phi$ → e^- may eject ✓
e^- must eject ✗



no. of photo = 20
$E_{light} = 10\,eV$

$E_{each\ photo} = \frac{1}{2}\,eV$

$\phi = 2\,eV$ ($\bar{e}$ will not eject)

$E_{photon} \geq \phi$ → $\bar{e}$s may eject

$h f_{photo} \geq \phi$

$f_{pho} \geq \frac{\phi}{h}$

$f_{photo} \geq \frac{h f_0}{h}$ → thereshold frequency

$\frac{hc}{\lambda_{pho}} \geq \frac{hc}{\lambda_0}$ → thereshod wavelength

$\lambda_{phot} \leq \lambda_0$

QUESTION

When light of wavelength 300 nm falls on a photoelectric emitter, photoelectrons are just liberated. For another emitter, light of wavelength 600 nm is just sufficient for liberating photoelectrons. The ratio of the work function of the two emitters is:

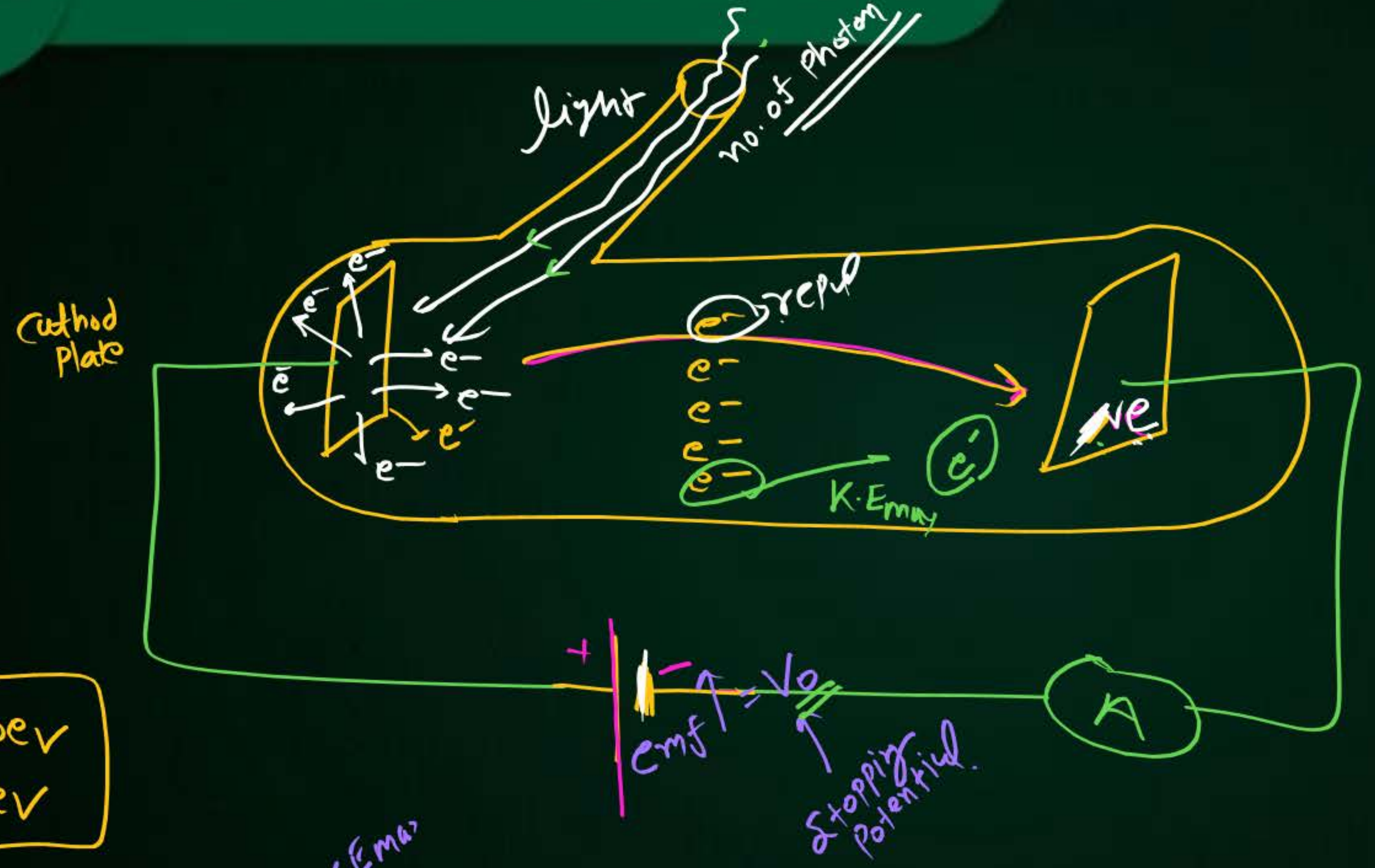
1. 1 : 2
2. 2 : 1
3. 4 : 1
4. 1 : 4

$$\phi_1 = \frac{hc}{\lambda_{01}}$$

$$\phi_2 = \frac{hc}{\lambda_{02}}$$

$$\frac{\phi_1}{\phi_2} = \frac{\lambda_{02}}{\lambda_{01}} = \frac{600}{300} = \frac{2}{1}$$

PHOTOELECTRIC EFFECT



$$E_{photon} = \phi + K.E_{e^-}$$

No collision (Ideal case)

$$E_{photon} = \phi + K.E_{max\ of\ e^-}$$

$$K.E_{max\ e^-} = E_p - \phi$$

Multiple collision

$$K.E_{of\ e^-} = 0$$

$$K.E\ of\ e^- = 0 \text{ to } K.E_{max}$$

$$K.E_{max} = eV_0$$

→ stopping potential at which e⁻ of maxm K.E not able to reach at plate

$$E_p = 10\,eV$$

$$\phi = 4\,eV$$

$K.E_{of\ e} = 0$ to 6ev ← K.Emax

1ev, 2ev, 3ev, 4ev, 5ev

LAWS OF PHOTOELECTRIC EFFECT

experimental finding

1. P.E.E. is an instantaneous process. (time b/w falling of photon & emission of e^-) = 10^{-9} sec.
2. Efficiency of photoelectric = $\frac{\text{no. of electron}}{\text{no. of Photon}} = \frac{\text{output (no. of } e^-)}{\text{Input (no. of Photon)}} = 10^{-3}$ to 10^{-4}

if no of e^- = 1

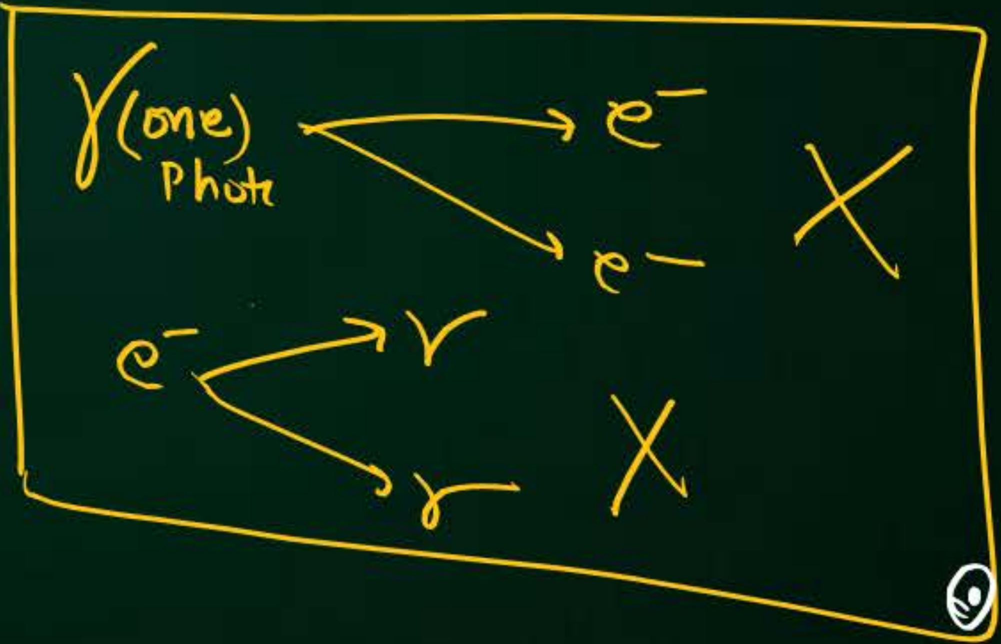
$\frac{1}{\text{no. of pho.}} = 10^{-3}$

$1000 = 10^3$ = no. of Photon

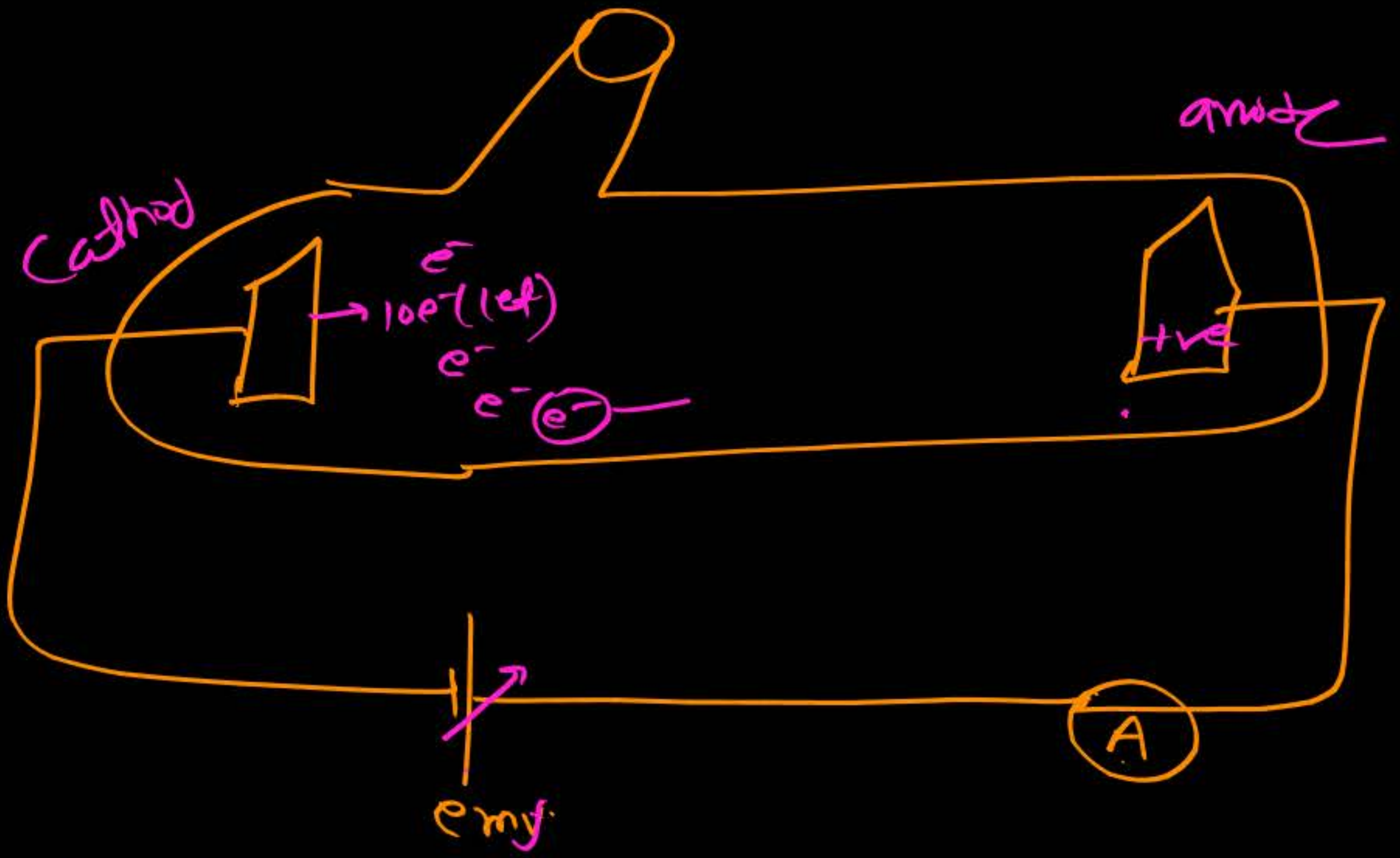
eisten

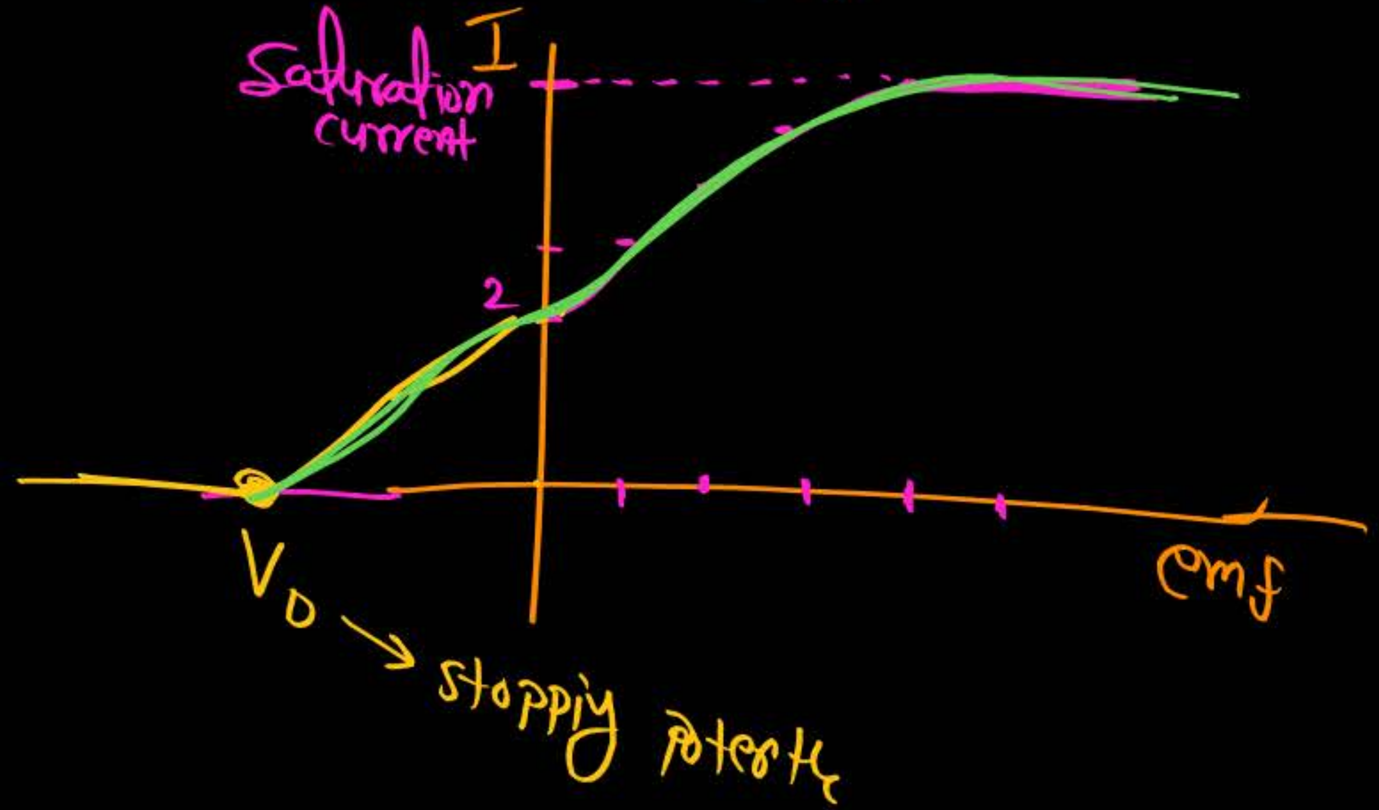
3. One to one interaction

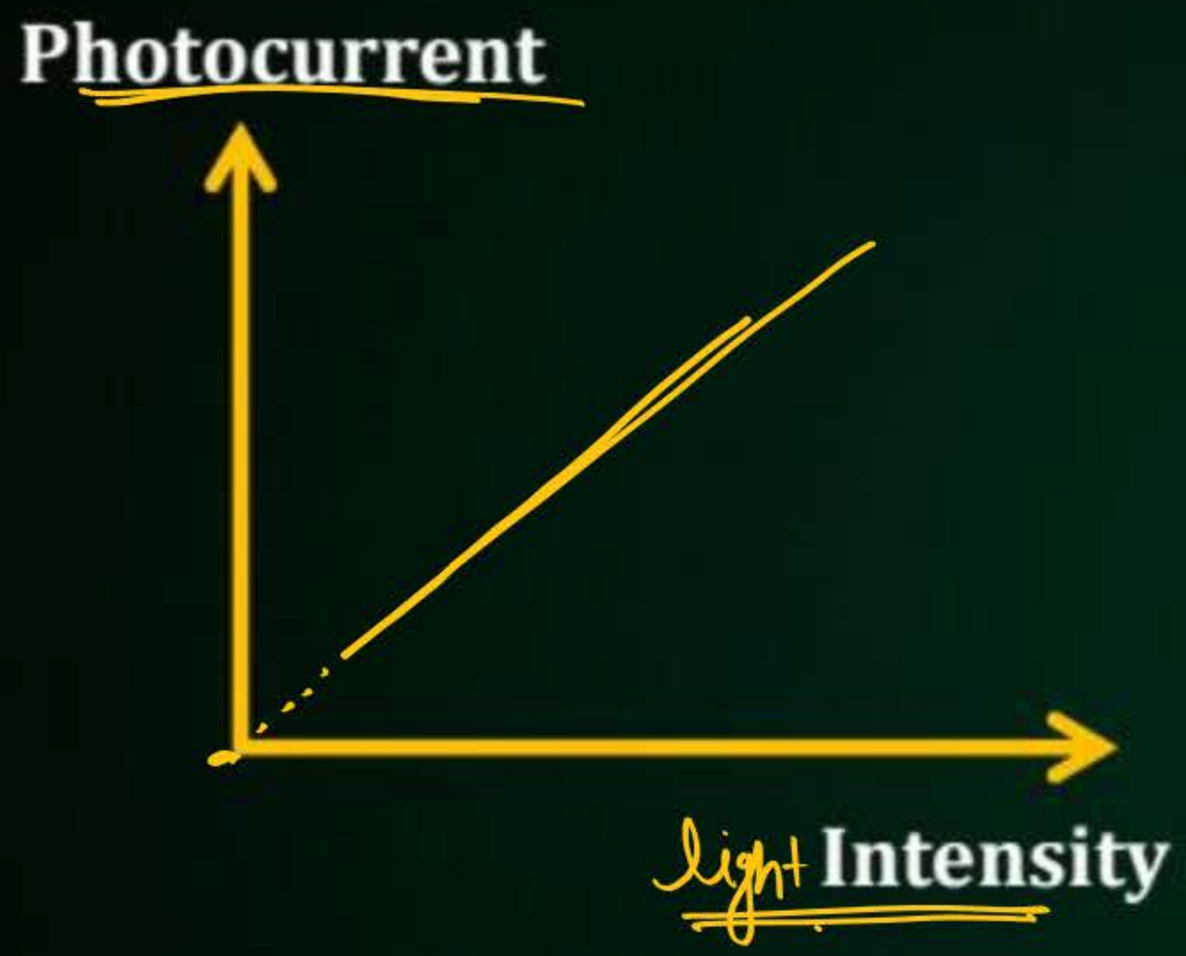
one photon → one electron

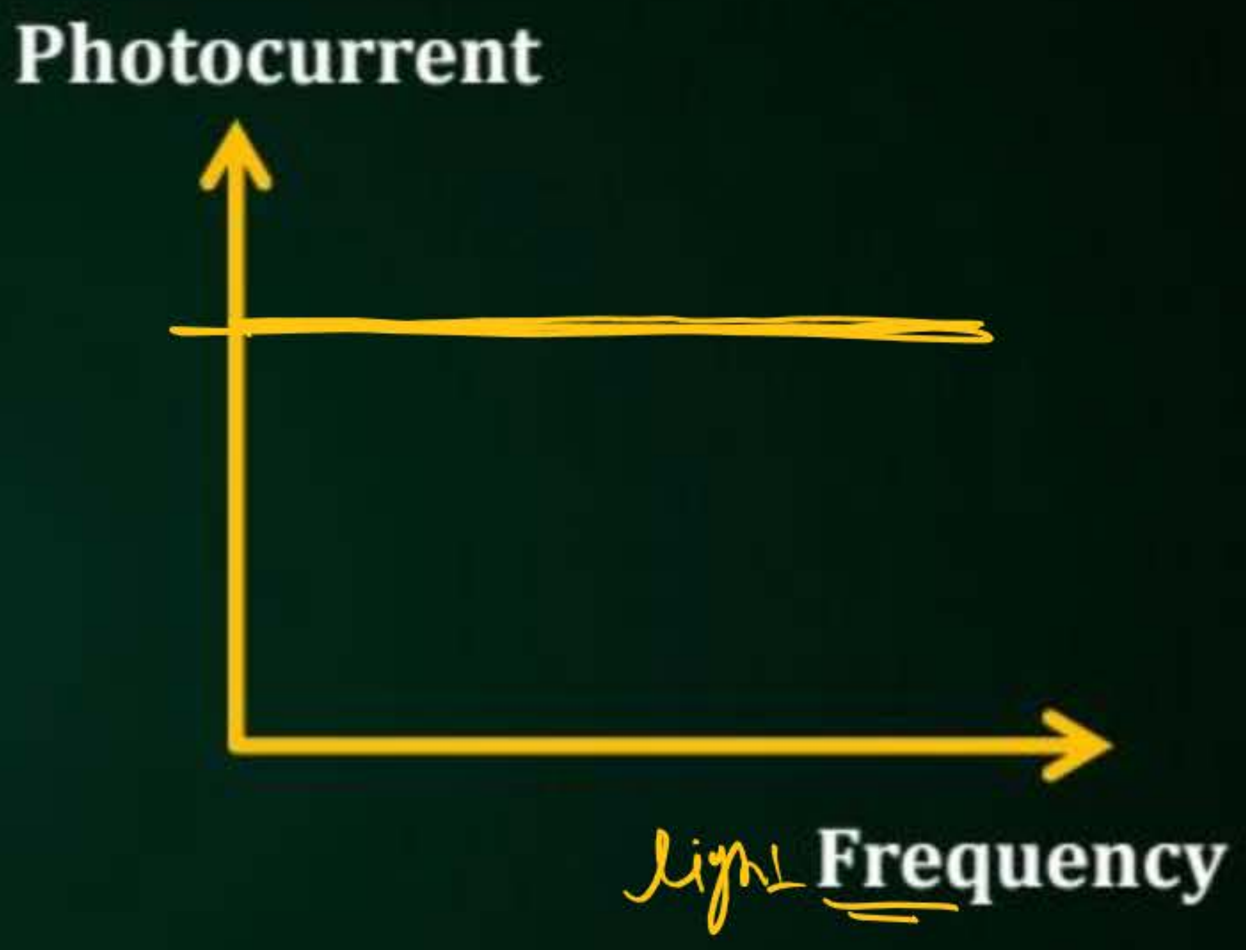


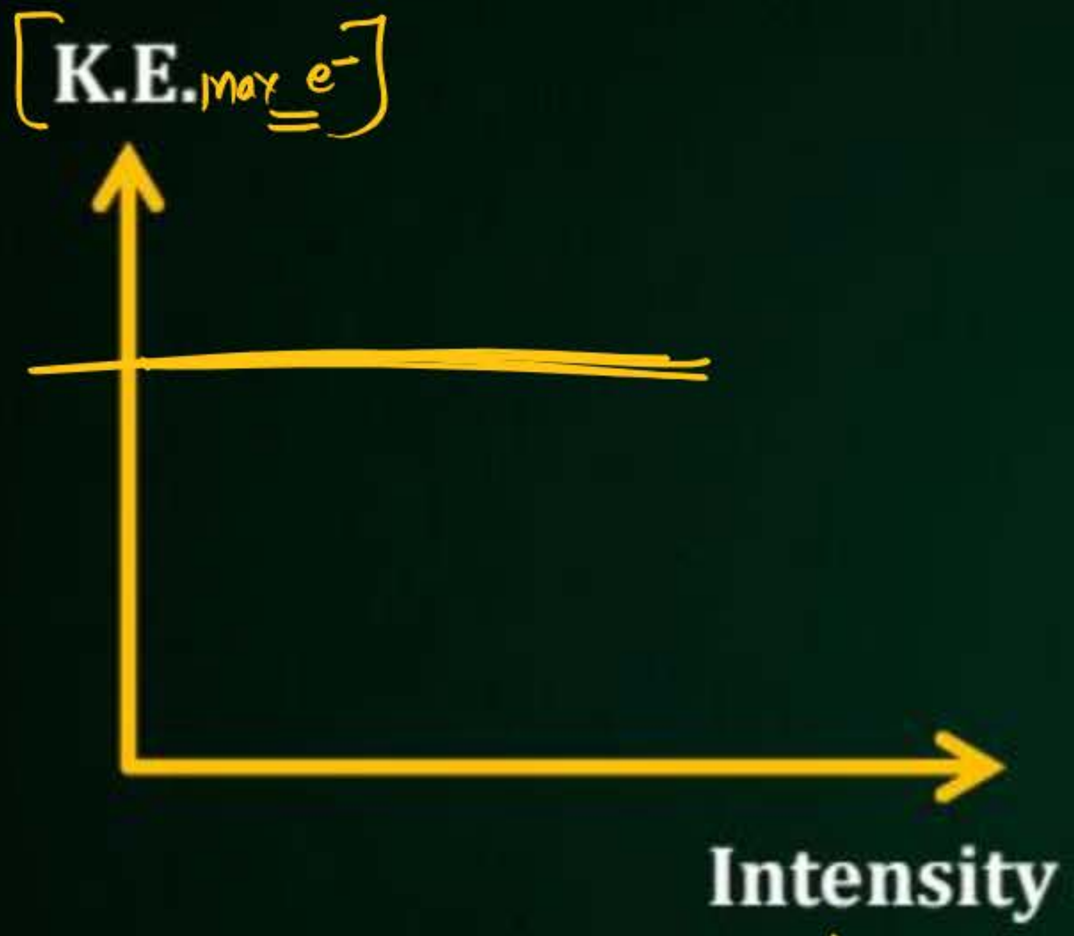
4. E photon ≥ ϕ → {e^- may eject}
5. Max K.E. of emitted electron = $E - \phi$
6. Stopping potential $eV_0 = K.E_{max}$

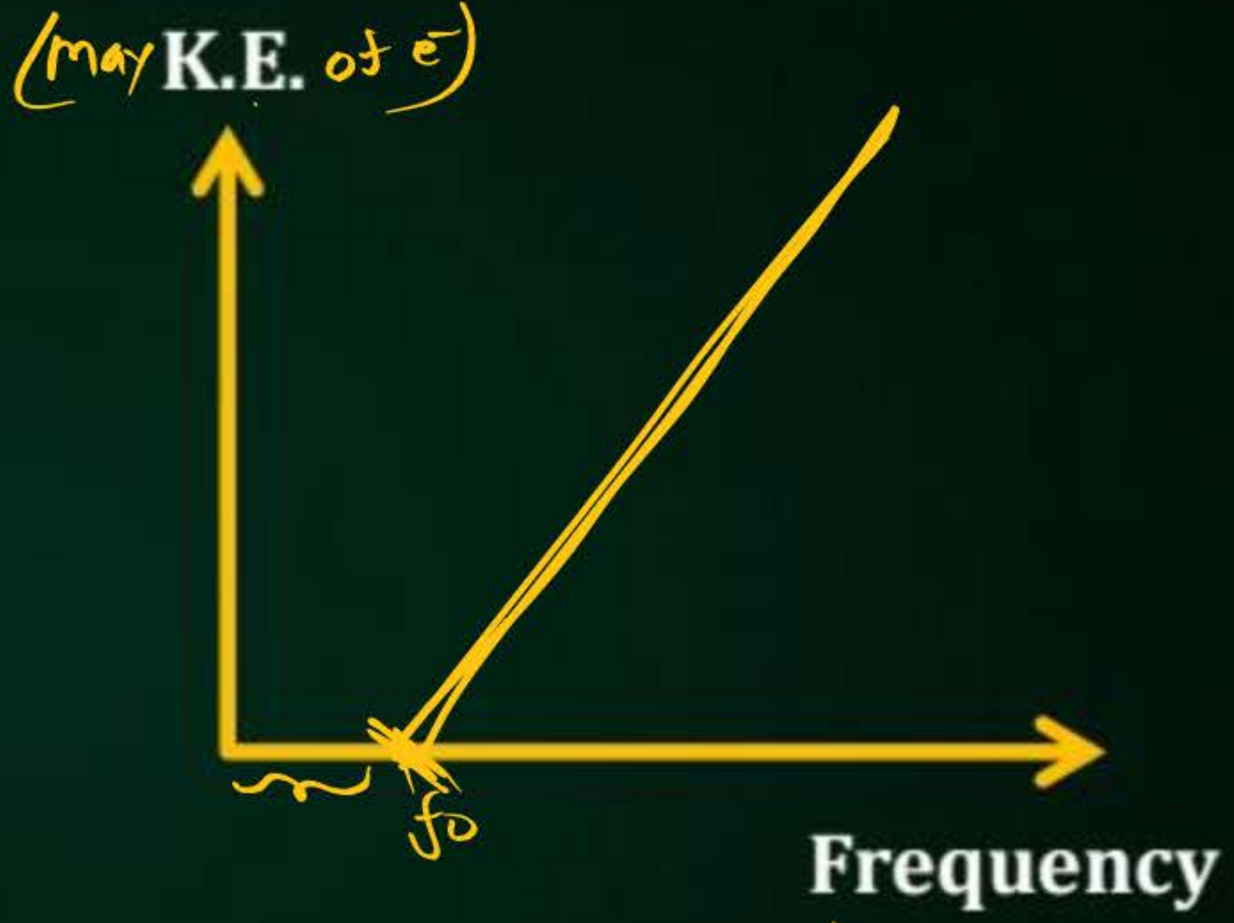

cathod
anode
+ve
emf
A

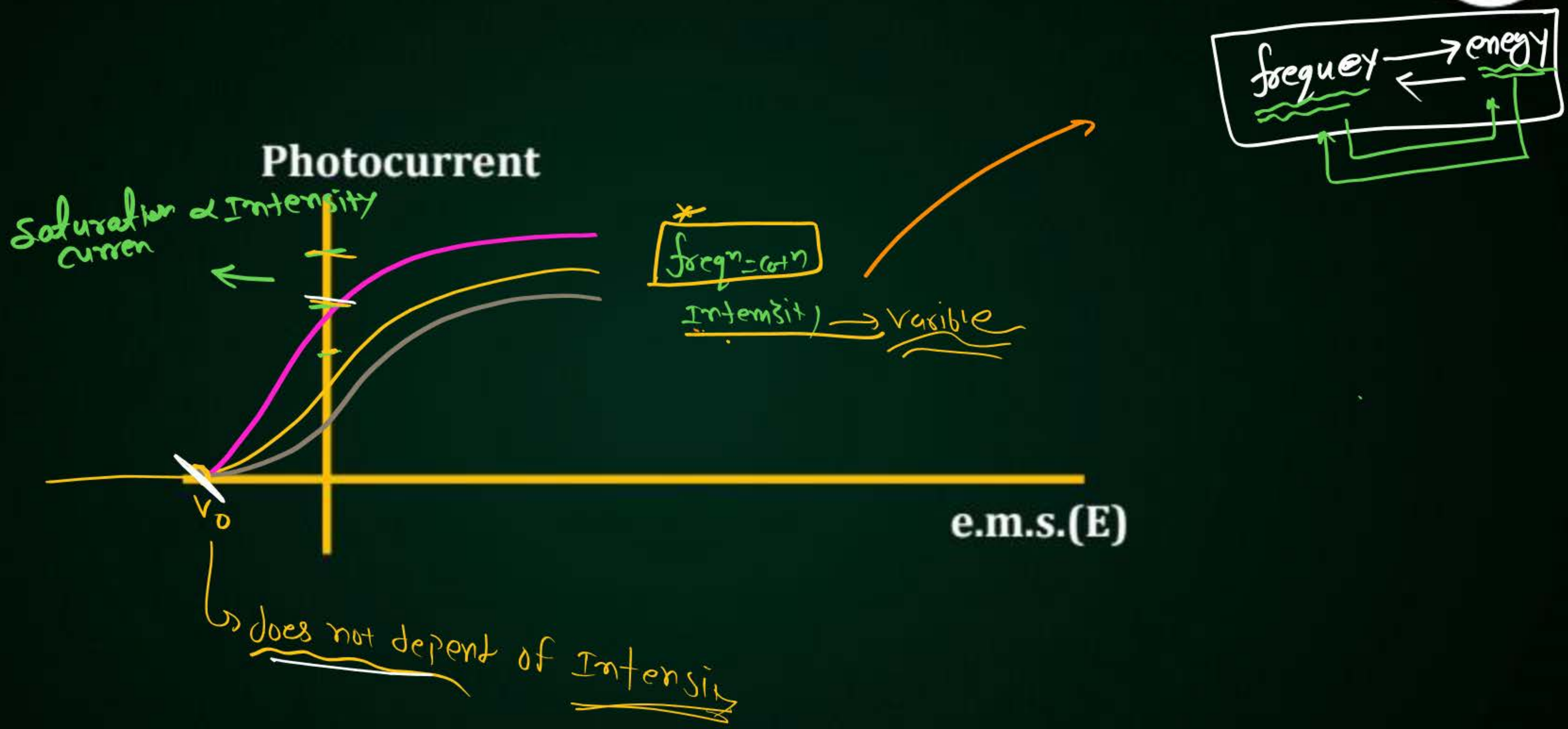

I
Saturation current
2
emf
V_0 → stopping potential


Photocurrent
light Intensity

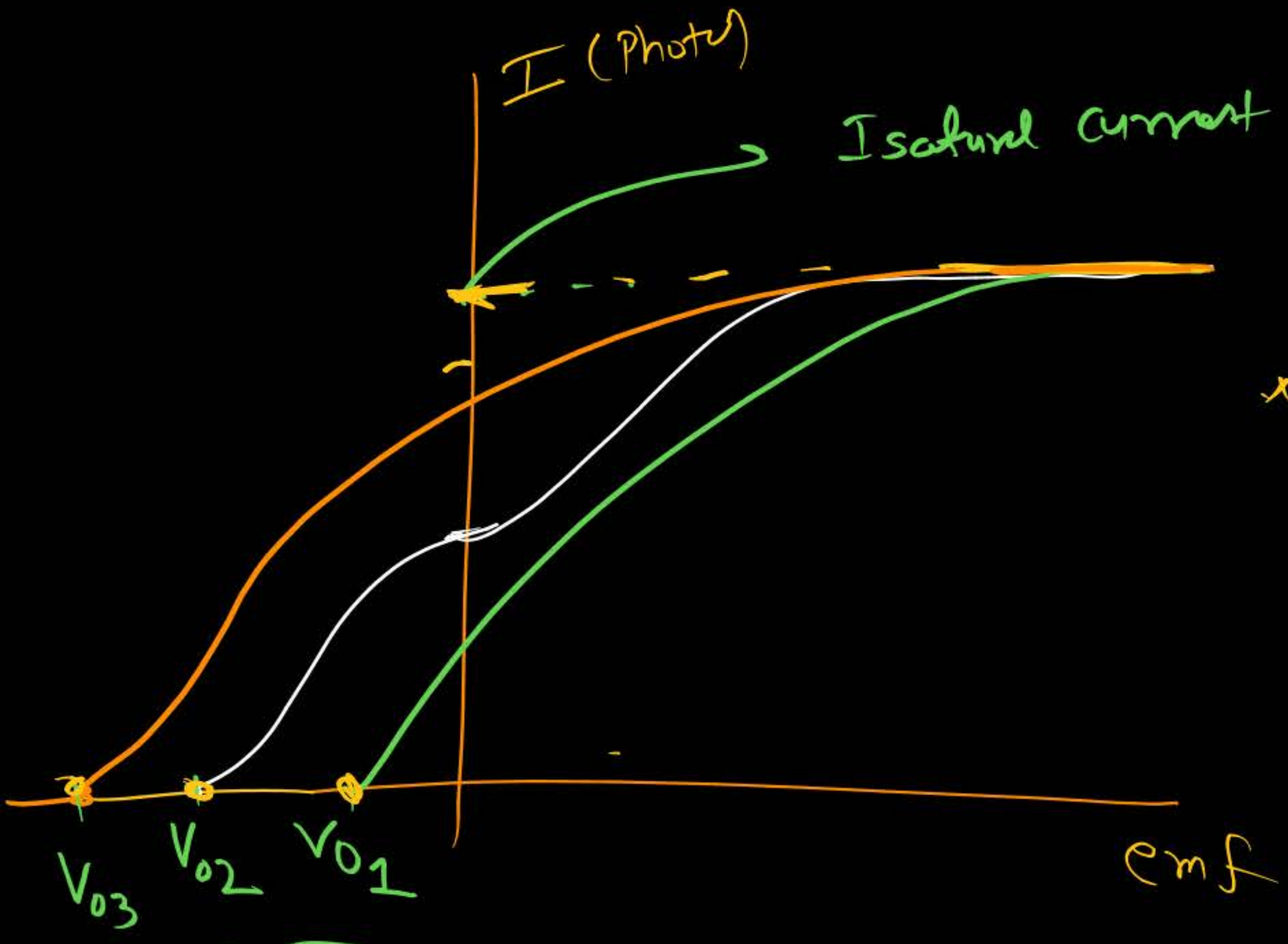

Photocurrent
light Frequency


[K.E.max e⁻]
Intensity


(max K.E. of e⁻)
fo
Frequency


Photocurrent
Saturation current ∝ Intensity
V_0
e.m.s.(E)
does not depend of Intensity
freq^n = const^n
Intensity → variable
frequency → energy

Isaturd current does not depends on frequey.



stopiy potential deper on frequ

no. of photon = cot n

frequcy = Change

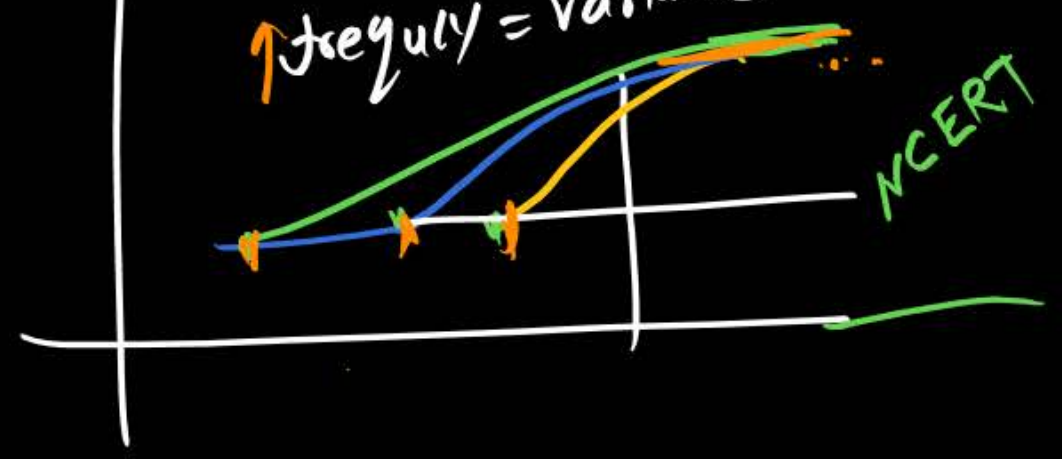


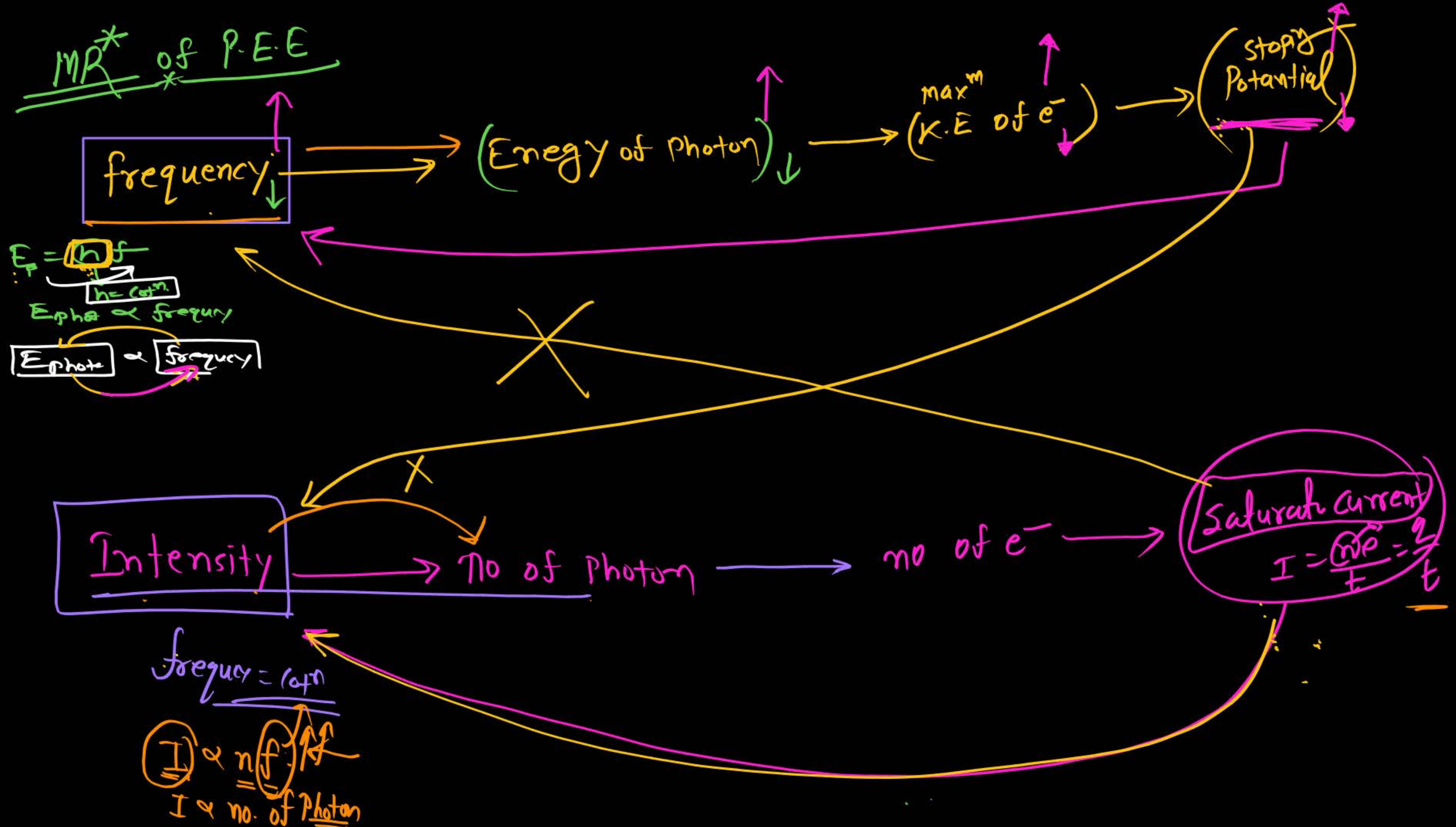
I = n × f

Intensity = lotn

frequly = variable

I = nf





IMR* of P.E.E
frequency
Enegy of Photon
max^m (K.E of e⁻)
Stopig Potantial
E_P = h f
h = cotn
Epho ∝ frequny
Ephote ∝ frequcy
Intensity
no of Photon
no of e⁻
Saturati current
I = ne/t = q/t
frequcy = cotn
I ∝ nf
I ∝ no. of Photon

FREQUENCY : ⟶ energy of photon ⟶ max^m K.E of e^- ⟶ stopping potential

f = const. ⟶ no. of photon ⟶ no of e^- ⟶ current

INTENSITY : ⟶ frequency = variable

$I = nf$

QUESTION

In photo electric effect [JEE Main 2023]

A. The photocurrent is proportional to the intensity of the incident radiation.

B. Maximum kinetic energy with which photoelectrons are emitted depends on the intensity of incident light.

C. Max. K.E. with which photoelectrons are emitted depends on the frequency of incident light.

D. The emission of photoelectrons require a minimum threshold intensity of incident radiation.

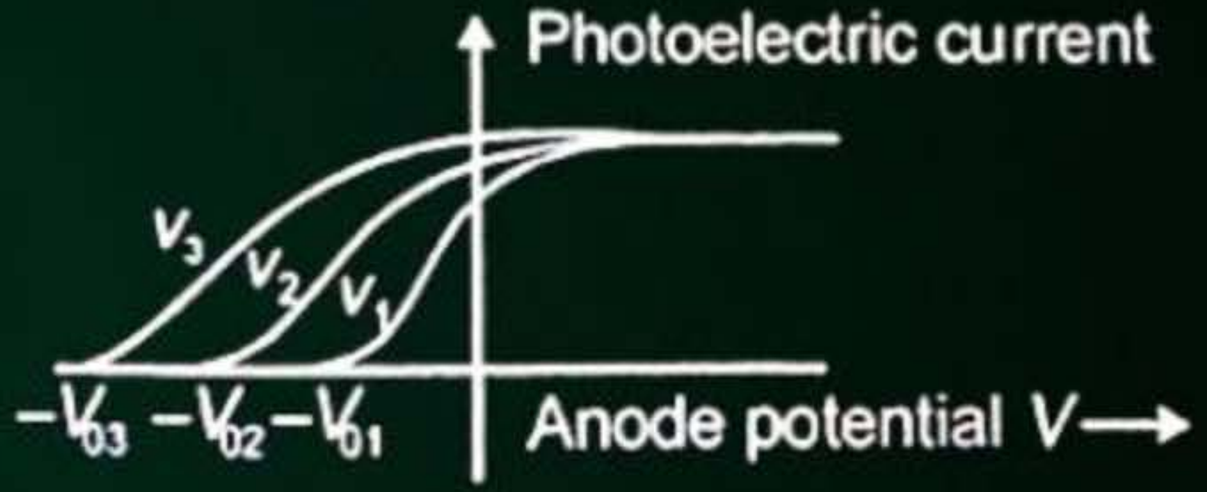
E. Max. K.E. of the photoelectrons is independent of the frequency of the incident light.

Choose the correct answer from the options given below :

1. A and C only
2. A and E only
3. B and C only
4. A and B only

QUESTION

In photoelectric effect, the curve between photoelectric current and anode potential V (for different frequencies) is shown in figure, then



1. $\nu_1 > \nu_2 > \nu_3$
2. $\nu_1 < \nu_2 < \nu_3$
3. $\nu_1 = \nu_2 = \nu_3$
4. $\nu_1 > \nu_2 < \nu_3$

QUESTION

Light of frequency 1.5 times the threshold frequency is incident on photo-sensitive material. If the frequency is halved and intensity is doubled, the photo current becomes

1. Quadrupled
2. Doubled
3. Halved
4. Zero

QUESTION

For a certain metal, ν is five times the ν_0 and the maximum velocity of coming out photo electrons is 8×10^6. If $\nu = 2\nu_0$ the maximum velocity of photo electrons will be

1. 4×10^6 m/s
2. 6×10^6 m/s
3. 8×10^6 m/s
4. 1×10^6 m/s

QUESTION

From the photoelectric effect experiment, following observations are made. Identify which of these are correct

A. The stopping potential depends only on the work function of the metal.

B. The saturation current increases as the intensity of incident light increases.

C. The maximum kinetic energy of a photo electron depends on the intensity of the incident light.

D. Photoelectric effect can be explained using wave theory of light.

Choose the correct answer from the options given below: [JEE Main 2023]

1. B, C only
2. A, C, D only
3. B only
4. A, B, D only

QUESTION

A metallic surface is illuminated with radiation of wavelength λ, the stopping potential is V_0. If the same surface is illuminated with radiation of wavelength 2λ, the stopping potential becomes $V_0/4$. The threshold wavelength for this metallic surface will be -

[JEE Main 2023]

1. $\lambda/4$
2. 4λ
3. $3/2\,\lambda$
4. 3λ

QUESTION

When photon of energy 3.8 eV falls on metallic surface of work function 2.8 eV, then the kinetic energy of emitted electrons are

1. 1 eV
2. 6.6 eV
3. 0 to 1 eV
4. 2.8 eV

QUESTION

Two streams of photons, possessing energies equal to five and ten times the work function of metal are incident on the metal surface successively. The ratio of maximum velocities of the photoelectron emitted, in the two cases respectively, will be [JEE Main 2022]

1. 1 : 2
2. 1 : 3
3. 2 : 3
4. 3 : 2

QUESTION

A monochromatic point source of light is placed at a distance d from a metal surface. Photo electrons are ejected at a rate n per second, and with maximum kinetic energy E. If the source is brought nearer to distance $d/2$, the rate and the maximum kinetic energy per photoelectron become nearly

1. $2n$ and $2E$
2. $4n$ and $4E$
3. $4n$ and E
4. n and $4E$

QUESTION

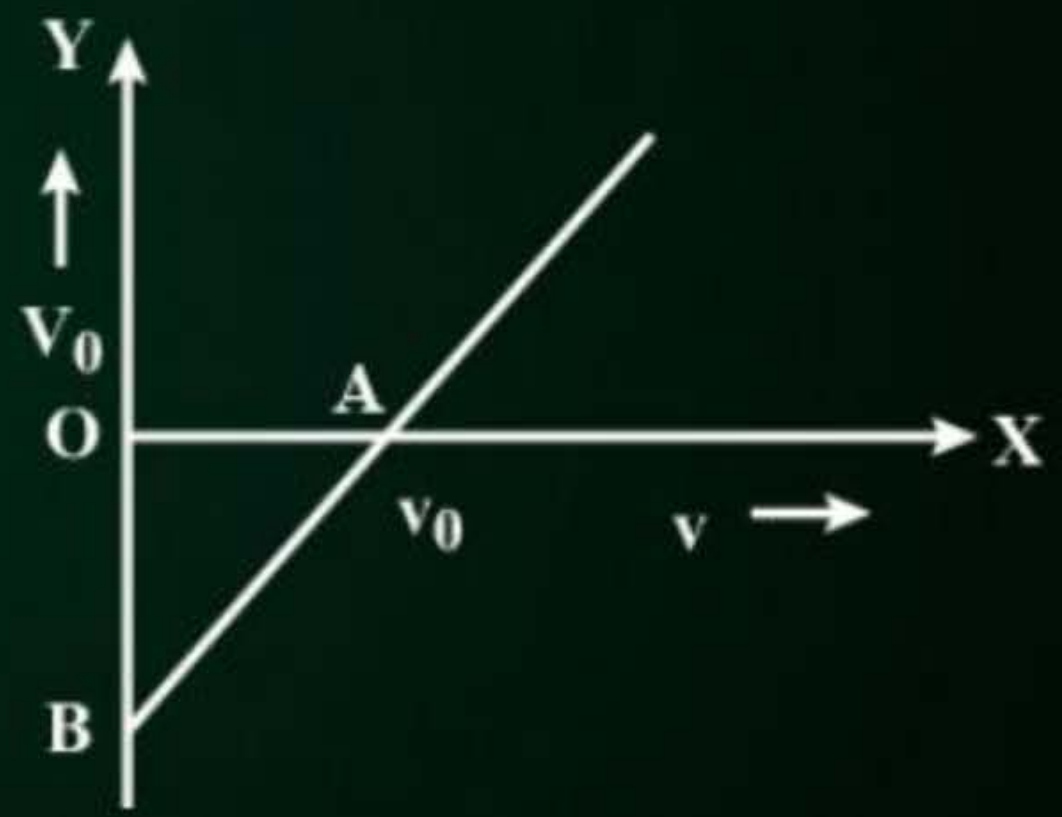
The photoelectric work function

1. Is different for different materials
2. Is same for all metals
3. Depends upon frequency of the incident light
4. Depends upon intensity of the incident light

QUESTION

In an experiment on photoelectric effect the frequency f of the incident light is plotted against the stopping potential V_0. The work function of the photoelectric surface is given by (e is electronic charge)

1. OB × e in eV
2. OB in volt
3. OA in eV
4. The slope of the line AB



QUESTION

If the frequency of light incident on a metallic plate be doubled, how will the maximum kinetic energy of the photoelectrons change?

1. It becomes more than double
2. It becomes less than double
3. It becomes exactly double
4. It does not change

QUESTION

Two streams of photons, possessing energies equal to five and ten times the work function of metal are incident on the metal surface successively. The ratio of maximum velocities of the photoelectron emitted, in the two cases respectively, will be [JEE Main 2022]

1. 1 : 2
2. 1 : 3
3. 2 : 3
4. 3 : 2

QUESTION

In photoelectric effect, the slope of stopping potential versus frequency of incident light for a given surface will be

1. $h e^{-1}$
2. $e h$
3. e
4. h

QUESTION

Wave nature of light cannot explain photoelectric effect because in photoelectric effect, it is seen that

1. For the frequency of light below a certain value, the photoelectric effect does not take place, irrespective of intensity
2. Maximum kinetic energy of ejected electrons is independent of intensity of radiation
3. There is no time lag between the incidence of radiation and emission of electrons
4. All of these

QUESTION

The work function of a substance is 4eV. The longest wavelength of light that can cause the emission of photoelectrons from this substance is approximately

1. 540 nm
2. 400 nm
3. 310 nm
4. 220 nm

QUESTION

Two radiations of photons energies 1 eV and 2.5 eV, successively illuminate a photosensitive metallic surface of work function 0.5 eV. The ratio of the maximum speeds of the emitted electrons is

1. 1 : 4
2. 1 : 2
3. 1 : 1
4. 1 : 5

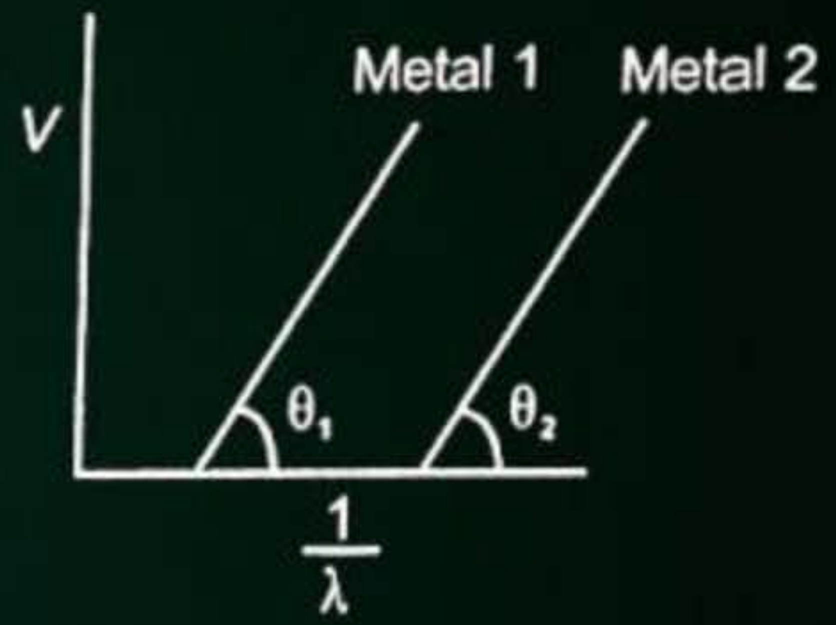
QUESTION

A source S_1 is producing 10^{15} photons per second of wavelength 5000 Å. Another source S_2 is producing 1.02×10^{15} photons per second of wavelength 5100 Å. Then (power of S_2)/(power of S_1) is equal to

1. 0.98
2. 1.00
3. 1.02
4. 1.04

QUESTION

V (stopping potential) is plotted against $1/\lambda$, where λ is wavelength of incident radiations, for two metals



1. Metal 1 may be gold and metal 2 may be cesium
2. $\theta_1 > \theta_2$, if metal-1 is gold and metal-2 is cesium
3. $\theta_1 = \theta_2$, for any two metals
4. $\theta_1 > \theta_2$, if metal-1 and metal-2 are gold and copper respectively

QUESTION

The cathode of a photocell is changed such that the work function changes from w_1 to w_2 ($w_2 > w_1$). If the saturation currents before and after the change are I_1 and I_2 and all other conditions are unchanged, then (assuming $h\nu > w_2$)

1. $I_1 = I_2$
2. $I_1 < I_2$
3. $I_1 > I_2$
4. $I_1 < I_2 > 2I_2$

QUESTION

The work functions of Aluminium and Gold are 4.1 eV and 5.1 eV respectively. The ratio of the slope of the stopping potential versus frequency plot for Gold to that of Aluminium is

[JEE Main 2023]

1. 1.24
2. 2
3. 1
4. 1.5

QUESTION

The different between threshold wavelengths for two metal surfaces A and B having work function $\phi_A = 9$ eV and $\phi_B = 4.5$ eV in nm is

(Given, hc = 1242 eV nm) [JEE Main 2023]

1. 264
2. 138
3. 276
4. 540

QUESTION

If the two metals A and B are exposed to radiation of wavelength 350 nm. The work functions of metals A and B are 4.8 eV and 2.2 eV. Then choose the correct option.

[JEE Main 2023]

1. Metal B will not emit photo-electrons
2. Both metals A and B will emit photo-electrons
3. Both metals A and B will not emit photoelectrons
4. Metal A will not emit photo-electrons

QUESTION

The threshold frequency of metal is f_0. When the light of frequency $2f_0$ is incident on the metal plate, the maximum velocity of photoelectron is v_1. When the frequency of incident radiation is increased to $5f_0$. The maximum velocity of photoelectrons emitted is v_2. The ratio of v_1 to v_2 is : [JEE Main 2023]

1. $\frac{v_1}{v_2} = \frac{1}{2}$

2. $\frac{v_1}{v_2} = \frac{1}{8}$

3. $\frac{v_1}{v_2} = \frac{1}{16}$

4. $\frac{v_1}{v_2} = \frac{1}{4}$

QUESTION

Assertion (A): The photoelectric effect does not takes place, if the energy of the incident radiation is less than the work function of a metal.

Reason (R): Kinetic energy of the photoelectrons is zero, if the energy of the incident radiation is equal to the work function of a metal. [JEE Main 2022]

1. Both A and R are correct and R is the correct explanation of A
2. Both A and R are correct but R is the correct explanation of A
3. A is correct but R is not correct
4. A is not correct but R is correct

QUESTION

The kinetic energy of emitted electron is E when the light incident on the metal has wavelength λ. To double the kinetic energy, the incident light must have wavelength:

[JEE Main 2022]

1. $\frac{hc}{E\lambda - hc}$

2. $\frac{hc\lambda}{E\lambda + hc}$

3. $\frac{h\lambda}{E\lambda + hc}$

4. $\frac{hc\lambda}{E\lambda - hc}$

QUESTION

The light of two different frequencies whose photons have energies 3.8 eV and 1.4 eV respectively, illuminate a metallic surface whose work function is 0.6 eV successively. The ratio of maximum speed of emitted electrons for the two frequencies respectively will be: [JEE Main 2022]

1. 1 : 1
2. 2 : 1
3. 4 : 1
4. 1 : 4

QUESTION

Two identical photocathodes receive the light of frequencies f_1 and f_2 respectively. If the velocities of the photo-electrons coming out are v_1 and v_2 respectively, then

[JEE Main 2021]

1. $v_1^2 - v_2^2 = \frac{2h}{m}[f_1 - f_2]$
2. $v_1^2 + v_2^2 = \frac{2h}{m}[f_1 + f_2]$
3. $v_1 + v_2 = \left[\frac{2h}{m}(f_1 + f_2)\right]^{\frac{1}{2}}$
4. $v_1 - v_2 = \left[\frac{2h}{m}(f_1 - f_2)\right]^{\frac{1}{2}}$

Matter Wave

Matter Wave

QUESTION

Electron beam used in an electron microscope, accelerated by a voltage of 20 kV has a de-Broglie wavelength of λ_0. If the voltage is increased to 40 kV then the de-Broglie wavelength associated with the electron beam would be : [JEE Main 2023]

1. $3\lambda_0$
2. $9\lambda_0$
3. $\lambda_0/2$
4. $\lambda_0/\sqrt{2}$

QUESTION

An α-particle, a proton and an electron have the same kinetic energy. Which one of the following is correct in case of their De-Broglie wavelength : [JEE Main 2023]

1. $\lambda_\alpha > \lambda_p > \lambda_e$
2. $\lambda_\alpha < \lambda_p < \lambda_e$
3. $\lambda_\alpha = \lambda_p = \lambda_e$
4. $\lambda_\alpha > \lambda_p < \lambda_e$

QUESTION

The de-Broglie wavelength of an electron having kinetic energy E is λ. If the kinetic energy of electron becomes $E/4$, then its de-Broglie wavelength will be:

[JEE Main 2023]

1. $\lambda/\sqrt{2}$
2. $\lambda/2$
3. 2λ
4. $\sqrt{2}\,\lambda$

QUESTION

A proton moving with one tenth of velocity of light has a certain de Broglie wavelength of λ. An alpha particle having certain kinetic energy has the same de-Broglie wavelength λ. The ratio of kinetic energy of proton and that of alpha particle is:

[JEE Main 2023]

1. 2 : 1
2. 4 : 1
3. 1 : 2
4. 1 : 4

QUESTION

The kinetic energy of an electron, α-particle and a proton are given as 4K, 2K and K respectively. The de-Broglie wavelength associated with electron (λ_e) α-particle (λ_α) and the proton (λ_p) are as follows : [JEE Main 2023]

1. $\lambda_\alpha = \lambda_p < \lambda_e$
2. $\lambda_\alpha > \lambda_p < \lambda_e$
3. $\lambda_\alpha < \lambda_p < \lambda_e$
4. $\lambda_\alpha = \lambda_p > \lambda_e$

QUESTION

Proton (p) and electron (e) will have same de-Broglie wavelength when the ratio of their momentum is (assume, $m_p = 1849\ m_e$) [JEE Main 2023]

1. $1:43$
2. $43:1$
3. $1:1849$
4. $1:1$

QUESTION

The de Broglie wavelengths for an electron and a photon are λ_e and λ_p respectively. For the same kinetic energy of electron and' photon, which of the following presents the correct relation between the de Broglie wavelengths of [JEE Main 2022]

1. $\lambda_p \propto \lambda_e^2$
2. $\lambda_p \propto \lambda_e$
3. $\lambda_p \propto \sqrt{\lambda_e}$
4. $\lambda_p \propto \sqrt{1/\lambda_e}$

QUESTION

A nucleus of mass M at rest splits into two parts having masses $M'/3$ and $2M'/3$ $(M' < M)$. The ratio of de-Broglie wavelength of two parts will be : [JEE Main 2022]

1. 1 : 2
2. 2 : 1
3. 1 : 1
4. 2 : 3

QUESTION

An α-particle and a carbon 12 atom has same kinetic energy K. The ratio of their de-Broglie wavelengths $(\lambda_{\alpha} : \lambda_{C12})$ is : [JEE Main 2022]

1. $1 : \sqrt{3}$
2. $\sqrt{3} : 1$
3. $3 : 1$
4. $2 : \sqrt{3}$

QUESTION

An electron (mass m) with an initial velocity $\vec{v}=v_0\hat{i}(v_0>0)$ is moving in an electric field $\vec{E}=-E_0\hat{i}(E_0>0)$ where E_0 is constant. If at $t=0$ de Broglie wavelength is $\lambda_0=\frac{h}{mv_0}$, then its de Broglie wavelength after time t is given by

[JEE Main 2022]

1. λ_0
2. $\lambda_0\left(1+\frac{eE_0t}{mv_0}\right)$
3. $\lambda_0 t$
4. $\frac{\lambda_0}{\left(1+\frac{eE_0t}{mv_0}\right)}$

QUESTION

An electron (of mass m) and a-photon have the same energy E in the range of a few eV. The ratio of the de-Broglie wavelength associated with the electron and the wavelength of the photon is (c = speed of light in vacuum) [JEE Main 2021]

1. $\left(\frac{E}{2m}\right)^{1/2}$
2. $\frac{1}{c}\left(\frac{E}{2m}\right)^{1/2}$
3. $c(2mE)^{1/2}$
4. $\frac{1}{c}\left(\frac{2E}{m}\right)^{1/2}$

QUESTION

Consider two separate ideal gases of electrons and protons having same number of particles. The temperatures of both the gases are same. The ratio of the uncertainty in determining the position of an electron to that of a proton is proportional to

[JEE Main 2021]

1. $\sqrt{\frac{m_p}{m_e}}$
2. $\frac{m_p}{m_e}$
3. $\left(\frac{m_p}{m_e}\right)^{3/2}$
4. $\sqrt{\frac{m_e}{m_p}}$

QUESTION

An electron of mass m_e and a proton of mass m_P are accelerated through the same potential difference. The ratio of the de-Broglie wavelength associated with the electron to that with the proton is [JEE Main 2021]

1. $\frac{m_p}{m_e}$
2. 1
3. $\sqrt{\frac{m_p}{m_e}}$
4. $\frac{m_e}{m_p}$

QUESTION

The de-Broglie wavelength associated with an electron and a proton were calculated by accelerating them through same potential of 100 V. What should nearly be the ratio of their wavelengths ? (m_p = 1.00727 u, m_e = 0.00055 u)

[JEE Main 2021]

1. 1860 : 1
2. $(1860)^2 : 1$
3. 41.4 : 1
4. 43 : 1

QUESTION

If the total energy transferred to a surface in time t is 6.48×10^5 J, then the magnitude of the total momentum delivered to this surface for complete absorption will be: [30 Jan, 2024 (Shift-II)]

1. 2.46×10^{-3} kg m/s
2. 2.16×10^{-3} kg m/s
3. 1.58×10^{-3} kg m/s
4. 4.32×10^{-3} kg m/s

QUESTION

Two sources of light emit with a power of 200 W. The ratio of number of photons of visible light emitted by each source having wavelengths 300 nm and 500 nm respectively, will be: [29 Jan, 2024 (Shift-II)]

1. 1 : 5
2. 1 : 3
3. 5 : 3
4. 3 : 5

QUESTION

Monochromatic light of frequency 6×10^{14} Hz is produced by a laser. The power emitted is 2×10^{-3} W. How many photons per second on an average, are emitted by source? (Given $h = 6.63 \times 10^{-34}$ Js) [1 Feb, 2024 (Shift-II)]

1. 9×10^{18}
2. 6×10^{15}
3. 5×10^{15}
4. 7×10^{16}

QUESTION

The number of electrons flowing per second in the filament of a 110 W bulb operating at 220 V is: (Given $e = 1.6 \times 10^{-19}$ C) [06 April, 2024 (Shift-II)]

(1) 31.25×10^{17}

(2) 6.25×10^{18}

(3) 6.25×10^{17}

(4) 1.25×10^{19}

QUESTION

Energy of a quanta of frequency 10^{15} Hz and $h = 6.6 \times 10^{-34}$ Js will be

1. 6.6×10^{-19} J
2. 6.6×10^{-12} J
3. 6.6×10^{-49} J
4. 6.6×10^{-41} J

QUESTION

Consider a parallel beam of light of wavelength 600 nm and intensity 100 W/m^2. How many photons cross 1 cm^2 area perpendicular to beam in one second?

1. 3×10^{16}
2. 3×10^{14}
3. 3×10^{9}
4. 3×10^{4}

QUESTION

When light of wavelength 300 nm falls on a photoelectric emitter, photoelectrons are just liberated. For another emitter, light of wavelength 600 nm is just sufficient for liberating photoelectrons. The ratio of the work function of the two emitters is:

1. 1 : 2
2. 2 : 1
3. 4 : 1
4. 1 : 4

QUESTION

A 2 mW laser operates at a wavelength of 500 nm. The number of photons that will be emitted per second is

[Given Planck's constant $h = 6.6 \times 10^{-34}$ Js] [10 April, 2019 (Shift-II)]

1. 2×10^{16}
2. 1.5×10^{16}
3. 5×10^{15}
4. 1×10^{16}

QUESTION

If a source of electromagnetic radiation having power 15 kW produces 10^{16} photons per second, the radiation belongs to a part of spectrum is:

(Take Planck constant $h = 6 \times 10^{-34}$ Js) [31 Jan, 2023 (Shift-I)]

1. Micro waves
2. Ultraviolet rays
3. Gamma rays
4. Radio waves

QUESTION

Given below are two statements:

Statement-I: Two photons having equal linear momenta have equal wavelengths.

Statement-II: If the wavelength of photon is decreased, then the momentum and energy of a photon will also decrease.


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 2 | Physics

Dual Nature of Radiation and Matter



By- Dr. Manish Raj (MR SIR)

Todays Goal

questions on Photoelectric effec

De-brogliee wavelength

Einstein eq^n of P.E.E.

$$E_p = \phi + K.E_{max}$$

$$E_p = \phi + \frac{1}{2}mv_{max}^2 \quad *$$

$$hf = hf_0 + K.E_{max}$$

$$\frac{hc}{\lambda_{Photo}} = \frac{hc}{\lambda_0} + K.E_{max}$$

$$\frac{hc}{\lambda} = \frac{hc}{\lambda_0} + \frac{1}{2}mv_{max}^2 \quad *$$

$$E_p = \phi + eV_0$$

$$hf = hf_0 + eV_0$$

Graph B/W stopping potential and frequency

$$E_p = \phi + eV_0 \quad \text{—— (1)}$$

$$eV_0 = E_p - \phi$$

$$eV_0 = hf - \phi$$

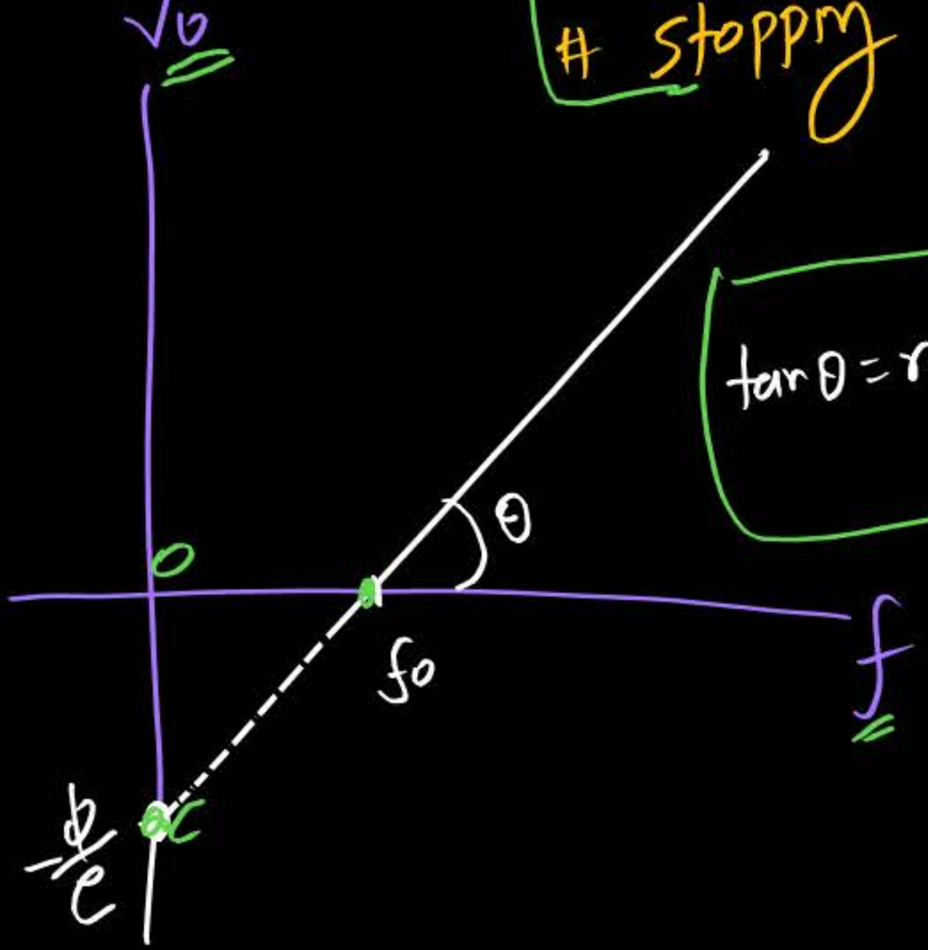
$$V_0 = \frac{hf}{e} - \frac{\phi}{e}$$

$y = mx + c$

Stopping Potential

$PV = nRT$ | $P = \frac{nRT}{V}$ | $y \propto x$

$P \propto T$ | $P \propto V$ | $y = mx + c$



Stopping Potential is directly Proportional to frequency
(a) True (60%)
(b) false (38.1%)

Stopping Potential is linearly dependent on frequency.

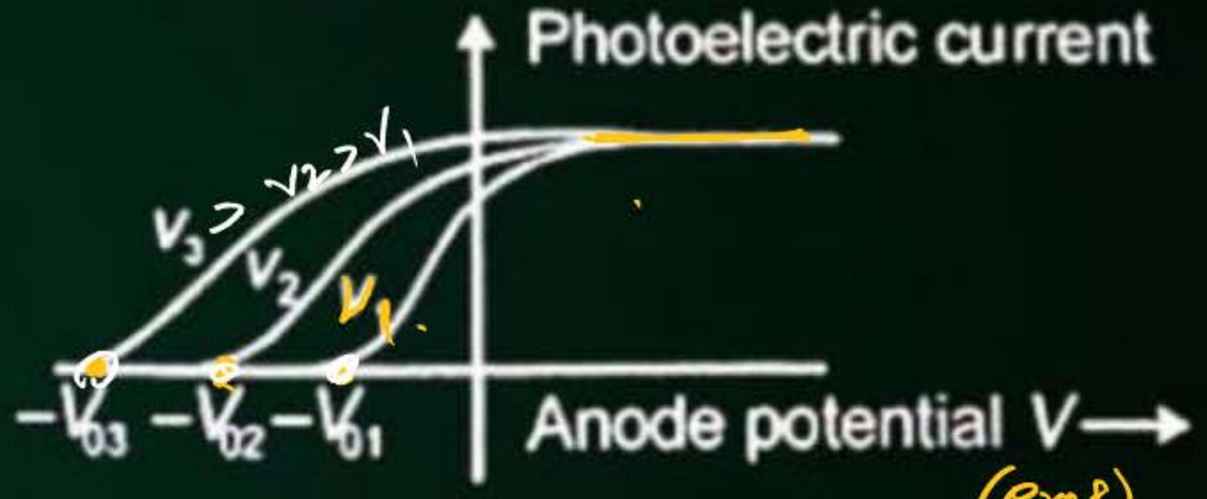
$$\tan\theta = m = \frac{h}{e} = \text{pure const}^n$$

$$y\text{-intercept} = -\frac{\phi}{e}$$

$OC \propto$ work function

QUESTION

In photoelectric effect, the curve between photoelectric current and anode potential V (for different frequencies) is shown in figure, then



1. $v_1 > v_2 > v_3$
2. $v_1 < v_2 < v_3$
3. $v_1 = v_2 = v_3$
4. $v_1 > v_2 < v_3$

QUESTION

The figure shows a plot of photo current versus anode potential for a photosensitive surface for three different radiations. Which one of the following is a correct statement?



1. Curves (b) and (c) represent incident radiations of same frequency having same intensity
2. Curves (a) and (b) represent incident radiations of different frequencies and different intensities
3. Curves (a) and (b) represent incident radiations of same frequency but of different intensities
4. Curves (b) and (c) represent incident radiations of different frequencies and different intensities

QUESTION

Light of frequency 1.5 times the threshold frequency is incident on photo-sensitive material. If the frequency is halved and intensity is doubled, the photo current becomes

1. Quadrupled
2. Doubled
3. Halved
4. Zero

$f' = 1.5 f_0$

$f'' = \frac{1.5 f_0}{2} = 0.75 f_0$

$I'' = 2I$ (Intensity)

$E_p = 3eV$

$\phi = 2eV$

$E_p = 1.5 eV$

$\phi = 2eV$

I

QUESTION

For a certain metal, ν is five times the ν_0 and the maximum velocity of coming out photo electrons is 8×10^6. If $\nu = 2\nu_0$ the maximum velocity of photo electrons will be

1. 4×10^6 m/s
2. 6×10^6 m/s
3. 8×10^6 m/s
4. 1×10^6 m/s

$v_1 =$

$\nu = 5\nu_0$ — (1)

$\nu = 2\nu_0$ — (*)

$h\nu = h\nu_0 + \frac{1}{2}mv_1^2$

$5h\nu_0 - h\nu_0 = \frac{1}{2}mv_1^2$

$2h\nu_0 - h\nu_0 = \frac{1}{2}mv_2^2$

$4h\nu_0 = \frac{1}{2}mv_1^2$

$h\nu_0 = \frac{1}{2}mv_2^2$

$\left(\frac{v_1}{v_2}\right)^2 = 4$

$\frac{v_1}{v_2} = \sqrt{4} = 2$

$v_1 = 2v_2$

$v_2 = \frac{v_1}{2} = \frac{8 \times 10^6}{2} = 4$

(Ans)

QUESTION

A metallic surface is illuminated with radiation of wavelength λ, the stopping potential is V_0. If the same surface is illuminated with radiation of wavelength 2λ, the stopping potential becomes $V_0/4$. The threshold wavelength for this metallic surface will be -

[JEE Main 2023]

1. $\lambda/4$
2. 4λ
3. $3/2\,\lambda$
4. 3λ

$\lambda \longrightarrow (V_0)$

$2\lambda \longrightarrow \left(\frac{V_0}{4}\right)$

λ_0 (??) theresold

case-1

$$\frac{hc}{\lambda} = \frac{hc}{\lambda_0} + eV_0 \quad \text{--- (1)}$$

$$\frac{hc}{2\lambda} = \frac{hc}{\lambda_0} + \frac{eV_0}{4} \quad \text{--- (11)}$$

$$\frac{\frac{hc}{\lambda} - \frac{hc}{\lambda_0}}{\frac{hc}{2\lambda} - \frac{hc}{\lambda_0}} = \frac{eV_0}{\frac{eV_0}{4}}$$

$$\frac{hc}{\lambda} - \frac{hc}{\lambda_0} = 4\left(\frac{hc}{2\lambda} - \frac{hc}{\lambda_0}\right)$$

$$\frac{1}{\lambda} - \frac{1}{\lambda_0} = \frac{4}{2\lambda} - \frac{4}{\lambda_0}$$

$$\frac{4}{\lambda_0} - \frac{1}{\lambda_0} = \frac{2}{\lambda} - \frac{1}{\lambda}$$

$$\frac{4-1}{\lambda_0} = \frac{2-1}{\lambda}$$

$$\frac{3}{\lambda_0} = \frac{1}{\lambda}$$

$$\lambda_0 = 3\lambda$$

QUESTION

When photon of energy 3.8 eV falls on metallic surface of work function 2.8 eV, then the kinetic energy of emitted electrons are

1. 1 eV (30%)
2. 6.6 eV
3. 0 to 1 eV (59%) Bhokwa
4. 2.8 eV

$E_p = \phi + K.E_{max} \text{ of } e^-$

$K.E \text{ of } e_{max} = E_p - \phi$

$= 3.8 - 2.8$

$= 1\,eV$

QUESTION

Two streams of photons, possessing energies equal to five and ten times the work function of metal are incident on the metal surface successively. The ratio of maximum velocities of the photoelectron emitted, in the two cases respectively, will be

[JEE Main 2022]

1. 1 : 2
2. 1 : 3
3. 2 : 3 ✓
4. 3 : 2

$E_{p_1} = 5\phi$

$E_{p_2} = 10\phi$

$E_{p_1} = \phi + \frac{1}{2}mv_1^2$ — (1)

$5\phi - \phi = \frac{1}{2}mv_1^2$

$10\phi - \phi = \frac{1}{2}mv_2^2$

$\frac{4\phi}{9\phi} = \frac{\frac{1}{2}mv_1^2}{\frac{1}{2}mv_2^2}$

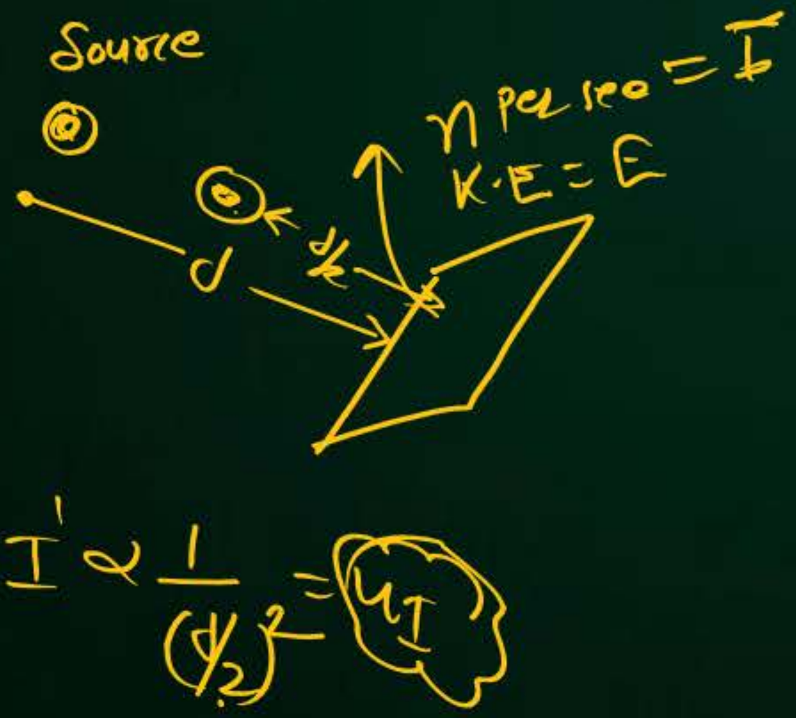
$\sqrt{\frac{4}{9}} = \frac{v_1}{v_2}$

QUESTION

A monochromatic point source of light is placed at a distance d from a metal surface. Photo electrons are ejected at a rate n per second, and with maximum kinetic energy E. If the source is brought nearer to distance $d/2$, the rate and the maximum kinetic energy per photoelectron become nearly

frequency does not depeds on distn
for point sour $I \propto \frac{1}{(d)^2}$

1. $2n$ and $2E$
2. $4n$ and $4E$
3. $4n$ and E
4. n and $4E$



QUESTION

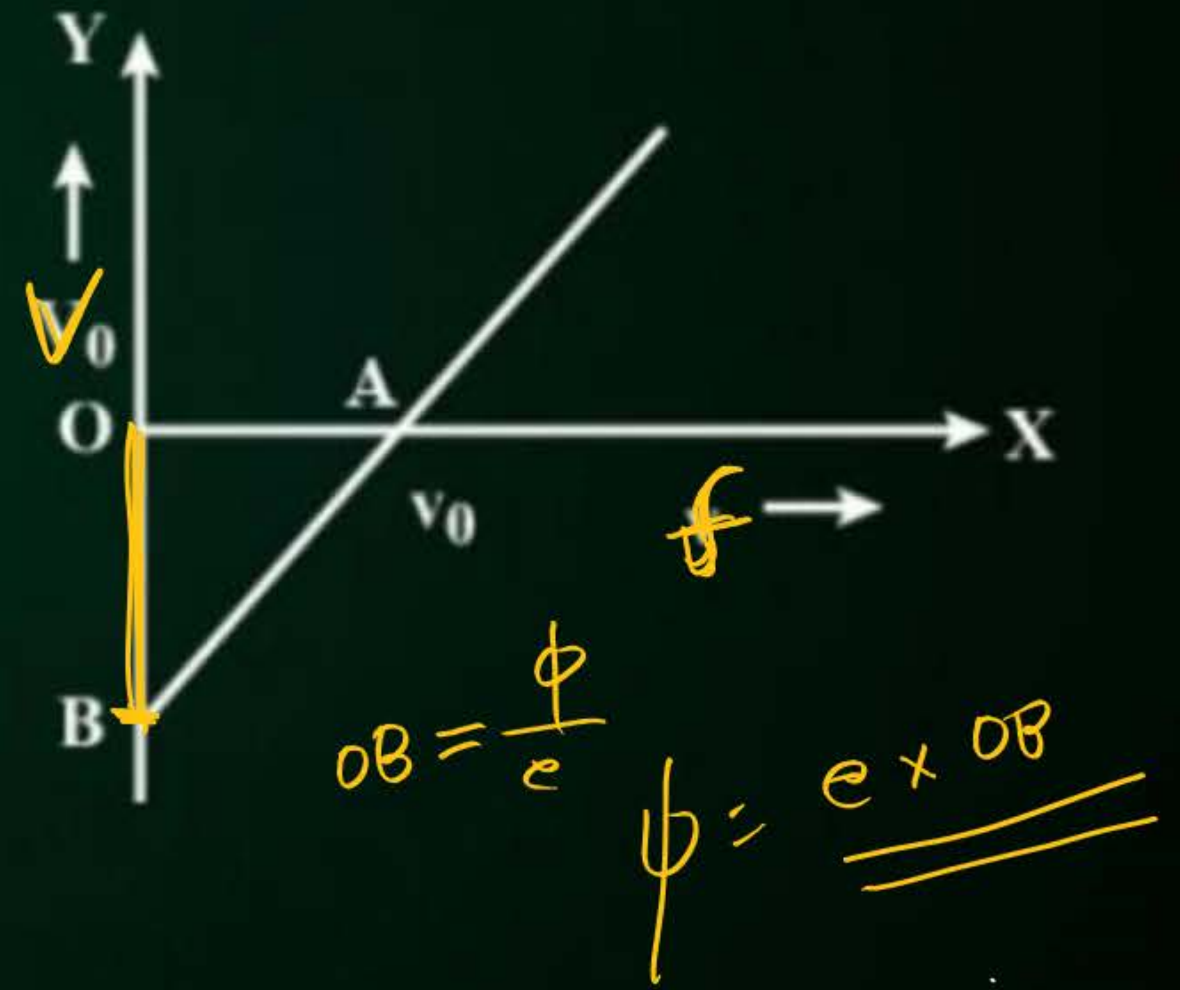
The photoelectric work function

1. Is different for different materials
2. Is same for all metals
3. Depends upon frequency of the incident light
4. Depends upon intensity of the incident light

QUESTION

In an experiment on photoelectric effect the frequency f of the incident light is plotted against the stopping potential V_0. The work function of the photoelectric surface is given by (e is electronic charge)

1. $OB \times e$ in eV
2. OB in volt
3. OA in eV
4. The slope of the line AB



QUESTION

If the frequency of light incident on a metallic plate be doubled, how will the maximum kinetic energy of the photoelectrons change?

1. It becomes more than double
2. It becomes less than double
3. It becomes exactly double
4. It does not change

$E_p = 2\,eV$, $\phi = 1\,eV$, $K.E_m = E_p - \phi = 1\,eV$

$E_p = 4\,eV$, $\phi = 1\,eV$, $K.E_m = 3\,eV$

$frequ = 2 \times f_{initial}$

QUESTION

Two streams of photons, possessing energies equal to five and ten times the work function of metal are incident on the metal surface successively. The ratio of maximum velocities of the photoelectron emitted, in the two cases respectively, will be [JEE Main 2022]

done

1. 1 : 2
2. 1 : 3
3. 2 : 3
4. 3 : 2

QUESTION

In photoelectric effect, the slope of stopping potential versus frequency of incident light for a given surface will be

1. $h e^{-1}$ $= \frac{h}{e}$ ✓
2. $e h$
3. e
4. h

QUESTION

Wave nature of light cannot explain photoelectric effect because in photoelectric effect, it is seen that

1. For the frequency of light below a certain value, the photoelectric effect does not take place, irrespective of intensity

2. Maximum kinetic energy of ejected electrons is independent of intensity of radiation

3. There is no time lag between the incidence of radiation and emission of electrons

4. All of these

Ans (4)

QUESTION

$\phi = 4eV$

The work function of a substance is 4eV. The longest wavelength of light that can cause the emission of photoelectrons from this substance is approximately

1. 540 nm ✗
2. 400 nm ✗
3. 310 nm ✓
4. 220 nm

$\phi = E_{photon}$

$4eV = \frac{hc}{\lambda_0}$

$\lambda_0 = \frac{hc}{4eV} = \frac{12400 eV}{4 eV} = 3100$ Å

$= 3100$ Å

$= 310 nm$

QUESTION

Two radiations of photons energies 1 eV and 2.5 eV, successively illuminate a photosensitive metallic surface of work function 0.5 eV. The ratio of the maximum speeds of the emitted electrons is

1. 1 : 4
2. 1 : 2
3. 1 : 1
4. 1 : 5

E_{p_1} E_{p_2} ϕ

$E_p - \phi = K.E_{e^-}$

$E_p - \phi = \frac{1}{2}mv_1^2$ done

QUESTION

A source S_1 is producing 10^{15} photons per second of wavelength 5000 Å. Another source S_2 is producing 1.02×10^{15} photons per second of wavelength 5100 Å. Then (power of S_2)/(power of S_1) is equal to

(1) 0.98

(2) 1.00

(3) 1.02

(4) 1.04

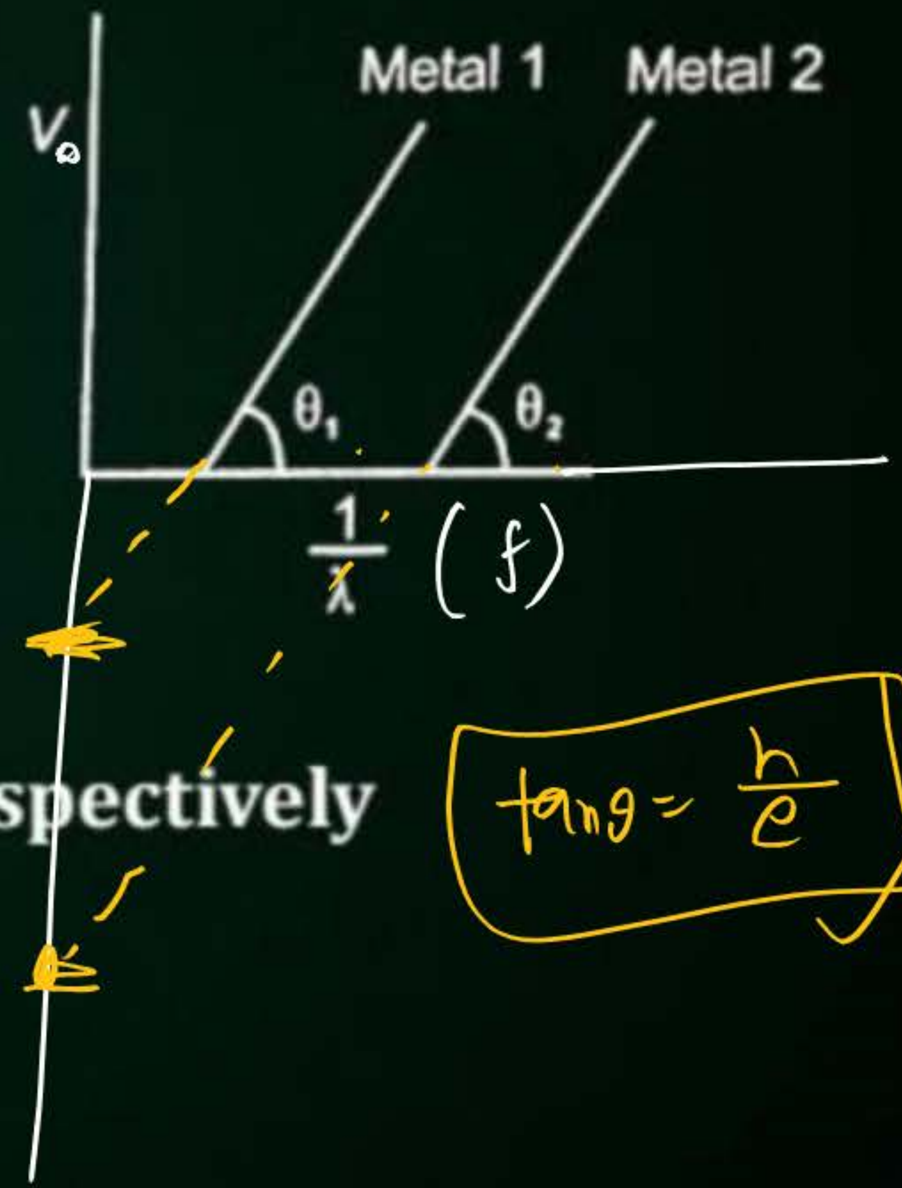
$$P_1 = \frac{n_1 hc}{\lambda_1 t}$$

$$P_2 = \frac{n_2 hc}{\lambda_2 t}$$

QUESTION

V (stopping potential) is plotted against $1/\lambda$, where λ is wavelength of incident radiations, for two metals

1. Metal 1 may be gold and metal 2 may be cesium
2. $\theta_1 > \theta_2$, if metal-1 is gold and metal-2 is cesium
3. $\theta_1 = \theta_2$, for any two metals
4. $\theta_1 > \theta_2$, if metal-1 and metal-2 are gold and copper respectively



QUESTION

The work functions of Aluminium and Gold are 4.1 eV and 5.1 eV respectively. The ratio of the slope of the stopping potential versus frequency plot for Gold to that of Aluminium is

[JEE Main 2023]

1. 1.24
2. 2
3. 1
4. 1.5

slope = $\frac{h}{e}$

QUESTION

The difference between threshold wavelengths for two metal surfaces A and B having work function $\phi_A = 9$ eV and $\phi_B = 4.5$ eV in nm is

(Given, hc = 1242 eV nm) [JEE Main 2023]

1. 264
2. 138 ✓
3. 276
4. 540

$\phi_A = \frac{hc}{\lambda_A}$

$\lambda_A = \frac{hc}{9\,eV} = \frac{1242\,eV}{9\,eV}\,nm$

$\lambda_B = \frac{1242\,eV}{4.5}\,nm$

$\lambda_B - \lambda_1 = 1242\left[\frac{2}{9} - \frac{1}{9}\right]$

$= \frac{1242}{9}$

QUESTION

If the two metals A and B are exposed to radiation of wavelength 350 nm. The work functions of metals A and B are 4.8 eV and 2.2 eV. Then choose the correct option.

[JEE Main 2023]

1. Metal B will not emit photo-electrons
2. Both metals A and B will emit photo-electrons
3. Both metals A and B will not emit photoelectrons
4. Metal A will not emit photo-electrons

QUESTION

The threshold frequency of metal is f_0. When the light of frequency $2f_0$ is incident on the metal plate, the maximum velocity of photoelectron is v_1. When the frequency of incident radiation is increased to $5f_0$. The maximum velocity of photoelectrons emitted is v_2. The ratio of v_1 to v_2 is : [JEE Main 2023]

1. $\frac{v_1}{v_2} = \frac{1}{2}$
2. $\frac{v_1}{v_2} = \frac{1}{8}$
3. $\frac{v_1}{v_2} = \frac{1}{16}$
4. $\frac{v_1}{v_2} = \frac{1}{4}$

$2hf_0 - f_0 = \frac{1}{2}mv_1^2$

$5hf_0 - f_0 = \frac{1}{2}mv_2^2$

done

QUESTION

Assertion (A): The photoelectric effect does not takes place, if the energy of the incident radiation is less than the work function of a metal.

Reason (R): Kinetic energy of the photoelectrons is zero, if the energy of the incident radiation is equal to the work function of a metal.

[JEE Main 2022]

1. Both A and R are correct and R is the correct explanation of A
2. Both A and R are correct but R is the correct explanation of A
3. A is correct but R is not correct
4. A is not correct but R is correct

QUESTION

The kinetic energy of emitted electron is E when the light incident on the metal has wavelength λ. To double the kinetic energy, the incident light must have wavelength:

[JEE Main 2022]

1. $\dfrac{hc}{E\lambda - hc}$
2. $\dfrac{hc\lambda}{E\lambda + hc}$
3. $\dfrac{h\lambda}{E\lambda + hc}$
4. $\dfrac{hc\lambda}{E\lambda - hc}$

$K.E = 2E$

$\lambda' = ??$

$\dfrac{hc}{\lambda} = \phi + E$ — (1)

$\dfrac{hc}{\lambda'} = \phi + 2E$ — (11)

$\dfrac{hc}{\lambda} - E = \dfrac{hc}{\lambda'} - 2E$

$\dfrac{hc}{\lambda} + E = \dfrac{hc}{\lambda'}$

$\dfrac{1}{\lambda'} = \dfrac{hc}{\lambda hc} + \dfrac{E}{hc}$

$\dfrac{1}{\lambda'} = \dfrac{hc + E\lambda}{hc\lambda}$

$\lambda' = \dfrac{hc\lambda}{hc + E\lambda}$

QUESTION

The light of two different frequencies whose photons have energies 3.8 eV and 1.4 eV respectively, illuminate a metallic surface whose work function is 0.6 eV successively. The ratio of maximum speed of emitted electrons for the two frequencies respectively will be: [JEE Main 2022]

1. 1 : 1
2. 2 : 1
3. 4 : 1
4. 1 : 4

$E_p - \phi = \frac{1}{2}mv_1^2$ *

[done]

H/W

QUESTION

Two identical photocathodes receive the light of frequencies f_1 and f_2 respectively. If the velocities of the photo-electrons coming out are v_1 and v_2 respectively, then

[JEE Main 2021]

1. $v_1^2 - v_2^2 = \frac{2h}{m}[f_1 - f_2]$ ✓
2. $v_1^2 + v_2^2 = \frac{2h}{m}[f_1 + f_2]$
3. $v_1 + v_2 = \left[\frac{2h}{m}(f_1 + f_2)\right]^{\frac{1}{2}}$
4. $v_1 - v_2 = \left[\frac{2h}{m}(f_1 - f_2)\right]^{\frac{1}{2}}$

$E_p = \phi + \frac{1}{2}mv_1^2$

$\phi = E_p - \frac{1}{2}mv_1^2$ — (1)

$\phi = hf_1 - \frac{1}{2}mv_1^2 = hf_2 - \frac{1}{2}mv_2^2$

$\phi =$

$hf_1 - hf_2 = \frac{1}{2}m[v_1^2 - v_2^2]$

$v_1^2 - v_2^2 = \frac{2h}{m}(f_1 - f_2)$

Only 6%

QUESTION

The cathode of a photocell is changed such that the work function changes from w_1 to w_2 ($w_2 > w_1$). If the saturation currents before and after the change are I_1 and I_2 and all other conditions are unchanged, then (assuming $h\nu > w_2$)

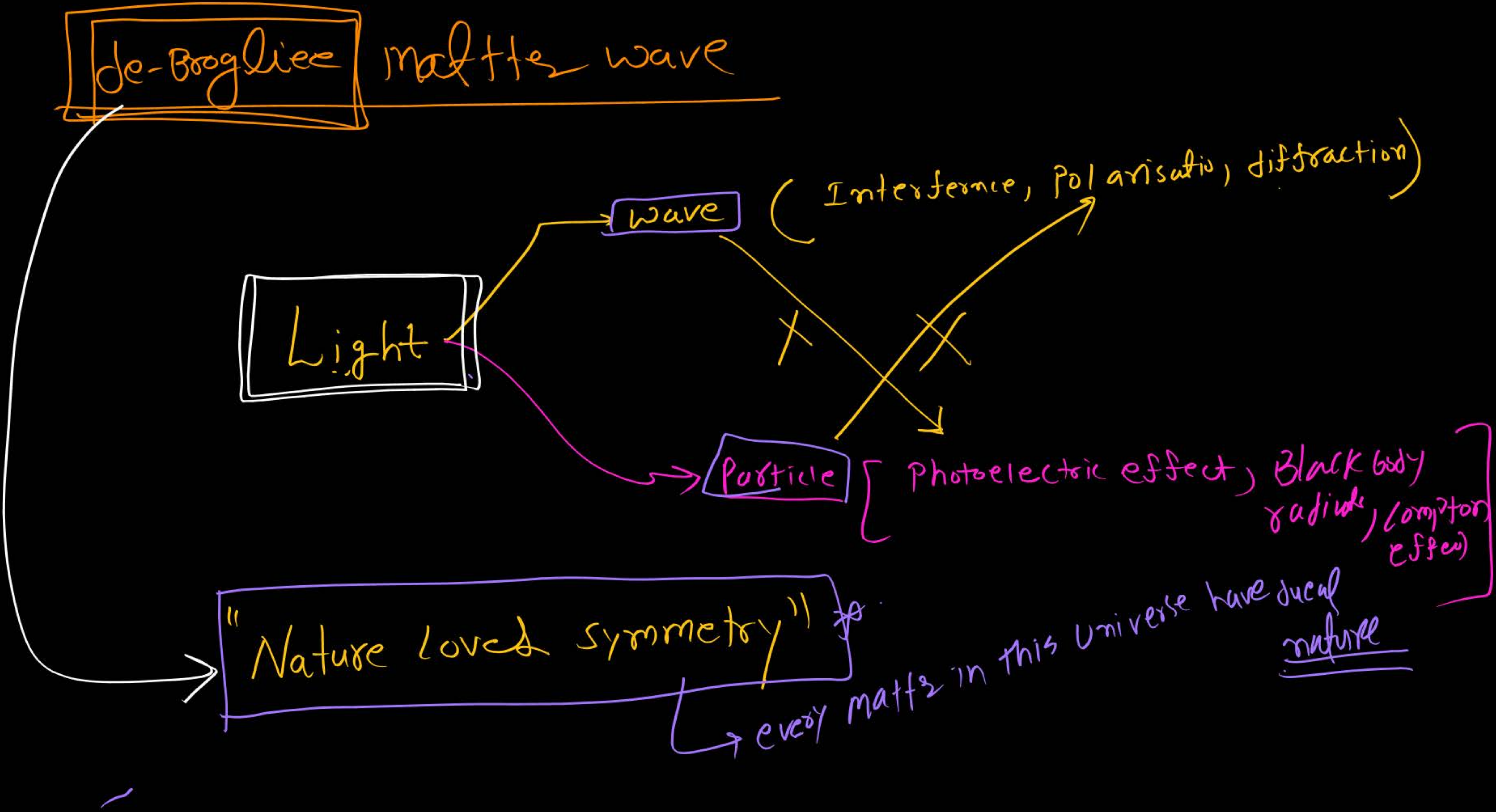
1. $I_1 = I_2$
2. $I_1 < I_2$
3. $I_1 > I_2$
4. $I_1 < I_2 > 2I_2$



$\omega_2 > \omega_1$

2ev > 1ev Exam

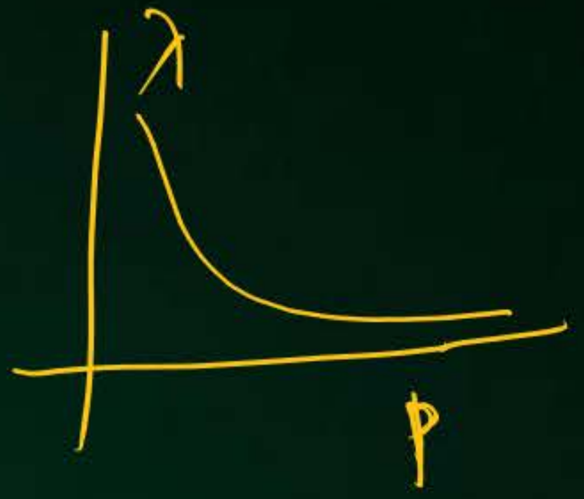
light same $E_{ph} = 3eV$



de-Brogliee mattte wave
Light
wave
(Interference, Polarisation, diffraction)
Particle
[Photoelectric effect, Black body radiation, Compton effect]
"Nature loved symmetry"
every matter in this Universe have ducal nature

Matter Wave

$$\lambda = \frac{h}{p} = \frac{h}{mv}$$





- Matter wave length
- This is not a longitudinal or transverse this matter wave
- It speed $V =$ from zero to infinity
- It can travel through vacuum.

α-Part (2P, 2N)
Deutro (1P+1N)
Proton (P)

$\lambda_\alpha = \frac{0.101 A^\circ}{\sqrt{\Delta V}}$

$\lambda_{Deut} = \frac{0.202 A^\circ}{\sqrt{\Delta V}}$

$\lambda_{prot} = \frac{0.286 A^\circ}{\sqrt{\Delta V}}$

$\lambda_e = \frac{12.27 A^\circ}{\sqrt{\Delta V}}$

$\lambda = \frac{h}{p}$

$\lambda = \frac{h}{mv}$

$\lambda = \frac{h}{\sqrt{2mK.E}}$ *

$\lambda = \frac{h}{\sqrt{2m(q\Delta V)}}$

$K.E = q\Delta V$ *

$\lambda = \frac{h}{qEt}$ → charge is released in electric field

$\lambda = \frac{h}{qBR}$

e^- in n^{th} orbit

$K.E = \frac{13.6 eV}{n^2}$

$\lambda = \frac{h}{\sqrt{2m\left(\frac{13.6 eV}{n^2}\right)}}$

$K.E = \frac{3}{2} K_B T$

$\lambda = \frac{h}{\sqrt{2m \frac{3}{2} K_B T}}$

$\lambda = \frac{h}{\sqrt{3mK_B T}}$ *

$\frac{mv^2}{r} = qvB$

$mv = qBr$

$\Delta p = F.\Delta t = qE\Delta t$

QUESTION

Electron beam used in an electron microscope, accelerated by a voltage of 20 kV has a de-Broglie wavelength of λ_0. If the voltage is increased to 40 kV then the de-Broglie wavelength associated with the electron beam would be : [JEE Main 2023]

1. $3\lambda_0$
2. $9\lambda_0$
3. $\lambda_0/2$
4. $\lambda_0/\sqrt{2}$

$\lambda \propto \frac{1}{\sqrt{\Delta V}} = \frac{1}{\sqrt{2}}$

$\frac{\lambda_0}{\lambda'} = \frac{\sqrt{40\,kV}}{\sqrt{20\,kV}}$

$\frac{\lambda_0}{\lambda'} = \sqrt{2}$

$\lambda' = \frac{\lambda_0}{\sqrt{2}}$

QUESTION

An α-particle, a proton and an electron have the same kinetic energy. Which one of the following is correct in case of their De-Broglie wavelength : [JEE Main 2023]

1. $\lambda_\alpha > \lambda_p > \lambda_e$
2. $\lambda_\alpha < \lambda_p < \lambda_e$
3. $\lambda_\alpha = \lambda_p = \lambda_e$
4. $\lambda_\alpha > \lambda_p < \lambda_e$

$\lambda = \frac{h}{\sqrt{2m(K.E)}}$

QUESTION

The de-Broglie wavelength of an electron having kinetic energy E is λ. If the kinetic energy of electron becomes $E/4$, then its de-Broglie wavelength will be:

[JEE Main 2023]

1. $\lambda/\sqrt{2}$
2. $\lambda/2$
3. 2λ
4. $\sqrt{2}\,\lambda$

QUESTION

A proton moving with one tenth of velocity of light has a certain de Broglie wavelength of λ. An alpha particle having certain kinetic energy has the same de-Broglie wavelength λ. The ratio of kinetic energy of proton and that of alpha particle is:

[JEE Main 2023]

1. 2 : 1
2. 4 : 1 (Ans)
3. 1 : 2
4. 1 : 4

$$\lambda_p = \lambda_{\alpha\text{-particle}}$$

$$\frac{h}{\sqrt{2mK.E_p}} = \frac{h}{\sqrt{2 \cdot 4m\,K.E_\alpha}}$$

$$\frac{1}{K.E_p} = \frac{1}{4K.E_\alpha}$$

$$\frac{K.E_p}{K_\alpha} = \frac{4}{1}$$

QUESTION

The kinetic energy of an electron, α-particle and a proton are given as 4K, 2K and K respectively. The de-Broglie wavelength associated with electron (λ_e) α-particle (λ_α) and the proton (λ_p) are as follows : [JEE Main 2023]

1. $\lambda_\alpha = \lambda_p < \lambda_e$
2. $\lambda_\alpha > \lambda_p < \lambda_e$
3. $\lambda_\alpha < \lambda_p < \lambda_e$
4. $\lambda_\alpha = \lambda_p > \lambda_e$

$(\lambda_e)_{max}$

$$\lambda_p = \frac{h}{\sqrt{2mK}}$$

$$\lambda_\alpha = \frac{h}{\sqrt{2\times(4m)\times 2K}}$$

QUESTION

Proton (p) and electron (e) will have same de-Broglie wavelength when the ratio of their momentum is (assume, $m_p = 1849\ m_e$) **[JEE Main 2023]**

1. $1:43$
2. $43:1$
3. $1:1849$
4. $1:1$

QUESTION

The de Broglie wavelengths for an electron and a photon are λ_e and λ_p respectively. For the same kinetic energy of electron and' photon, which of the following presents the correct relation between the de Broglie wavelengths of [JEE Main 2022]

1. $\lambda_p \propto \lambda_e^2$
2. $\lambda_p \propto \lambda_e$
3. $\lambda_p \propto \sqrt{\lambda_e}$
4. $\lambda_p \propto \sqrt{1/\lambda_e}$

for Photon

$\lambda_{ph} = \frac{1}{E_p} \propto \lambda_e^2$

Photon

→ Photon is Particle but matter Particle.

only for photon

$E = \frac{hc}{\lambda_{photo}}$

$\lambda_{phot} = \frac{hc}{E_p}$ — (1)

Mass → quantity of matter contained in a body.

matter wave for e

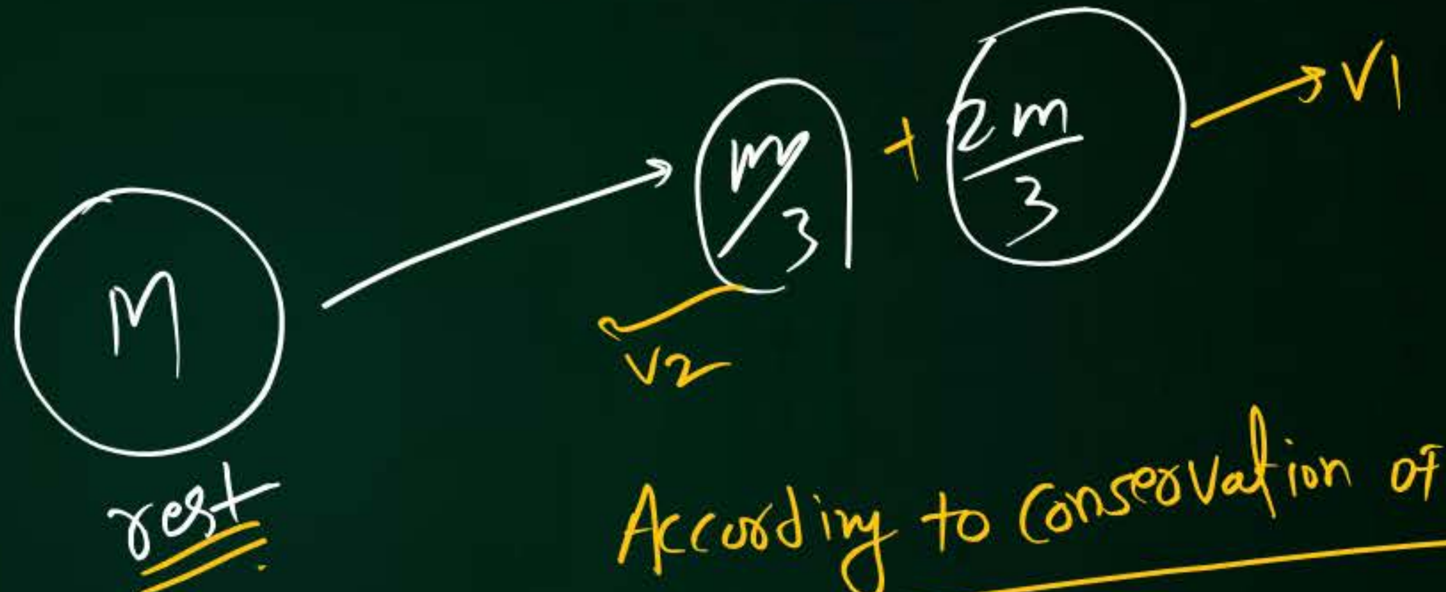
$\lambda_e = \frac{h}{\sqrt{2mE_e}}$

$\lambda_e^2 \propto \frac{1}{E}$

QUESTION

A nucleus of mass M at rest splits into two parts having masses $M'/3$ and $2M'/3$ ($M' < M$). The ratio of de-Broglie wavelength of two parts will be : [JEE Main 2022]

1. 1 : 2
2. 2 : 1
3. 1 : 1
4. 2 : 3



According to conservation of Momentum

$$P_i = P_f$$

$$0 = P_1 + P_2$$

$$P_1 = -P_2$$

QUESTION

An α-particle and a carbon 12 atom has same kinetic energy K. The ratio of their de-Broglie wavelengths ($\lambda_\alpha : \lambda_{C12}$) is : [JEE Main 2022]

(1) $1 : \sqrt{3}$

(2) $\sqrt{3} : 1$

(3) $3 : 1$

(4) $2 : \sqrt{3}$

$\lambda = \frac{h}{\sqrt{2m\,K.E}}$

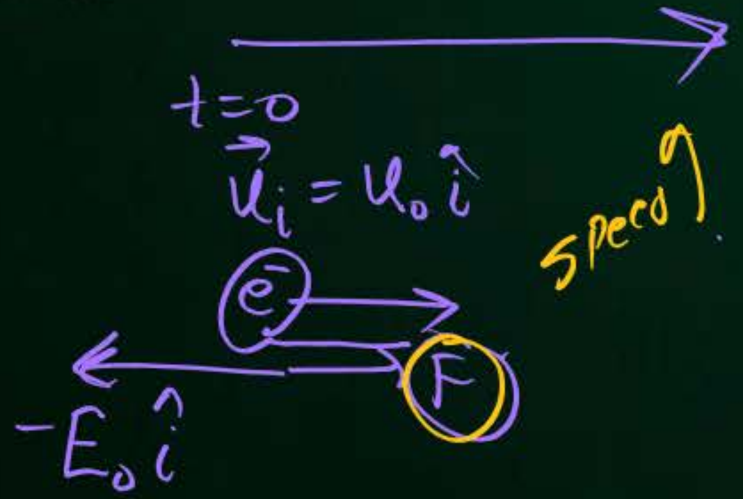
$\lambda \propto \frac{1}{\sqrt{m}}$

QUESTION

An electron (mass m) with an initial velocity $\vec{v} = v_0\hat{i}(v_0 > 0)$ is moving in an electric field $\vec{E} = -E_0\hat{i}(E_0 > 0)$ where E_0 is constant. If at $t = 0$ de Broglie wavelength is $\lambda_0 = \frac{h}{mv_0}$, then its de Broglie wavelength after time t is given by

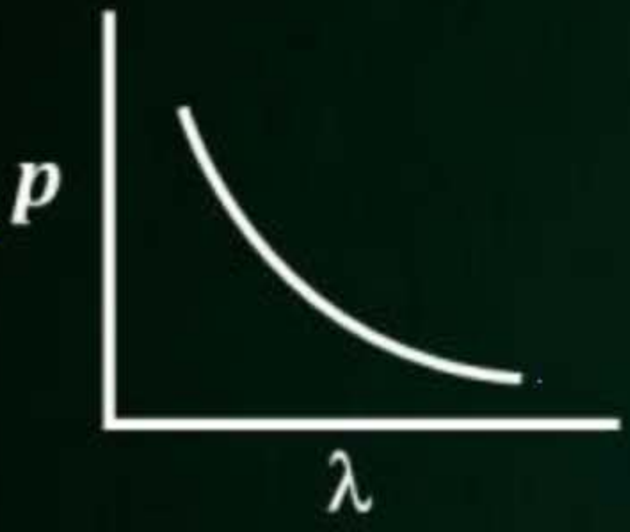
[JEE Main 2022]

1. λ_0
2. $\lambda_0\left(1 + \frac{eE_0t}{mv_0}\right)$
3. $\lambda_0 t$
4. $\frac{\lambda_0}{\left(1+\frac{eE_0t}{mv_0}\right)}$



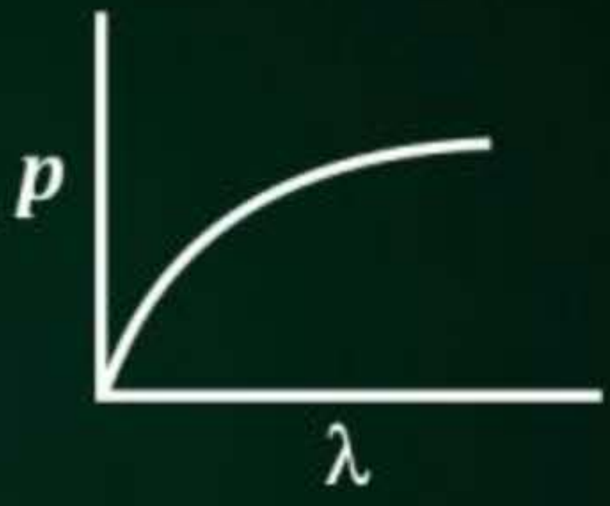
QUESTION

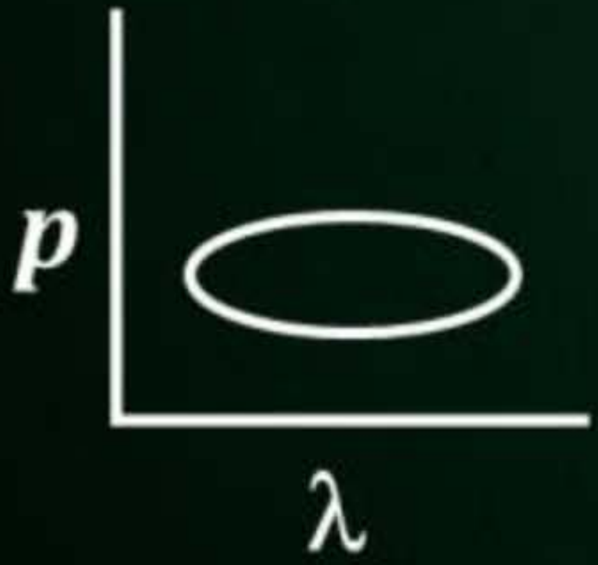
Variation of momentum of particle (p) with associated de-Broglie wavelength (λ) is shown correctly by

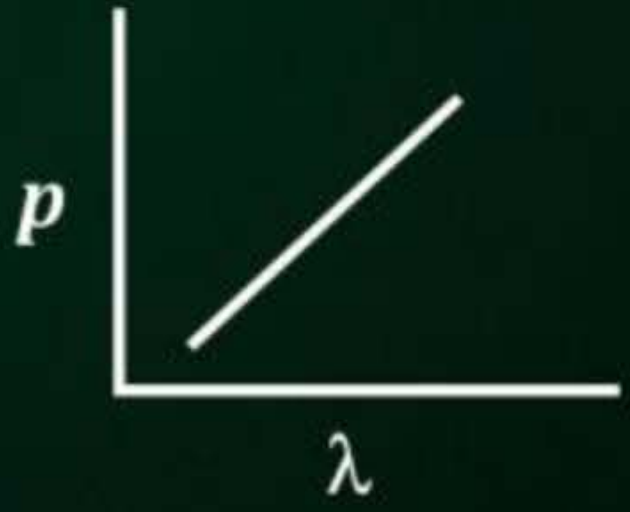
(1) ✓


$\lambda = \frac{h}{p}$

$p \propto \frac{1}{\lambda}$

(2)


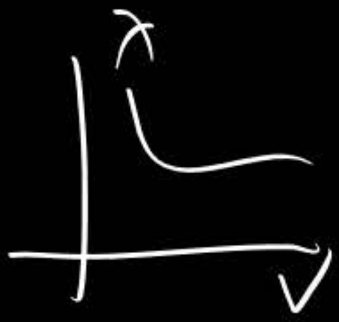
(3)


(4)


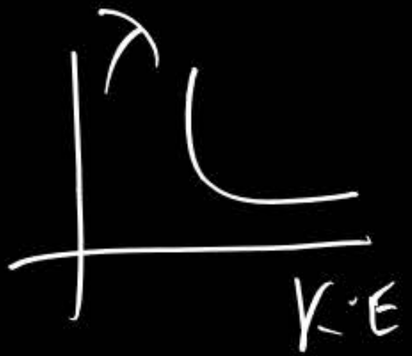
$$\lambda = \frac{h}{p}$$



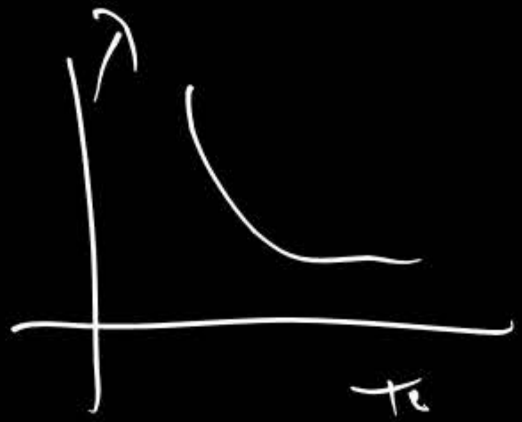
$$\lambda = \frac{h}{mv}$$



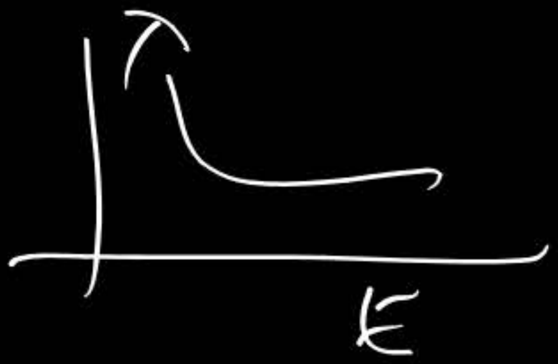
$$\lambda = \frac{h}{\sqrt{2m(K.E)}}$$



$$\lambda = \frac{h}{\sqrt{temp}}$$

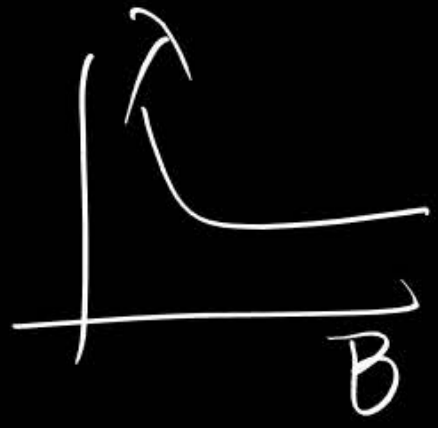


$$\lambda = \frac{h}{qEt}$$

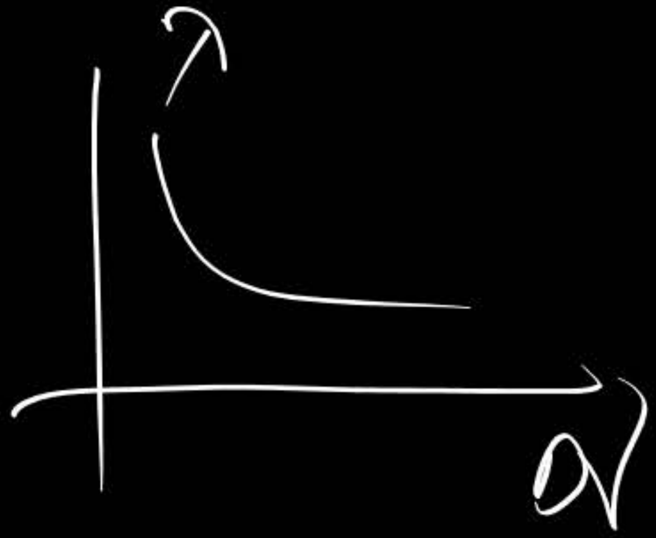


$$\lambda = \frac{h}{qBR}$$





$$\lambda = \frac{h}{\sqrt{2mq\Delta V}}$$



QUESTION

An electron of mass m and a photon have same energy E. The ratio of de-Broglie wavelengths associated with them is [NEET-I 2016]

1. $c(2mE)^{1/2}$
2. $\frac{1}{c}\left(\frac{2m}{E}\right)^{1/2}$
3. $\frac{1}{c}\left(\frac{E}{2m}\right)^{1/2}$
4. $\left(\frac{E}{2m}\right)^{1/2}$

(c being velocity of light)

QUESTION

An electron (of mass m) and a-photon have the same energy E in the range of a few eV. The ratio of the de-Broglie wavelength associated with the electron and the wavelength of the photon is (c = speed of light in vacuum) [JEE Main 2021]

1. $\left(\frac{E}{2m}\right)^{1/2}$

2. $\frac{1}{c}\left(\frac{E}{2m}\right)^{1/2}$

3. $c(2mE)^{1/2}$

4. $\frac{1}{c}\left(\frac{2E}{m}\right)^{1/2}$

QUESTION

Consider two separate ideal gases of electrons and protons having same number of particles. The temperatures of both the gases are same. The ratio of the uncertainty in determining the position of an electron to that of a proton is proportional to

[JEE Main 2021]

1. $\sqrt{\frac{m_p}{m_e}}$
2. $\frac{m_p}{m_e}$
3. $\left(\frac{m_p}{m_e}\right)^{3/2}$
4. $\sqrt{\frac{m_e}{m_p}}$

QUESTION

An electron of mass m_e and a proton of mass m_P are accelerated through the same potential difference. The ratio of the de-Broglie wavelength associated with the electron to that with the proton is

[JEE Main 2021]

1. $\frac{m_p}{m_e}$
2. 1
3. $\sqrt{\frac{m_p}{m_e}}$
4. $\frac{m_e}{m_p}$

$\lambda = \frac{h}{\sqrt{2m(\Delta V)}}$

$\lambda \propto \frac{1}{\sqrt{m}}$

$\frac{\lambda_e}{\lambda_p} = \frac{\sqrt{m_p}}{\sqrt{m_e}}$

QUESTION

The de-Broglie wavelength associated with an electron and a proton were calculated by accelerating them through same potential of 100 V. What should nearly be the ratio of their wavelengths ? (m_p = 1.00727 u, m_e = 0.00055 u)

[JEE Main 2021]

1. 1860 : 1
2. $(1860)^2 : 1$
3. 41.4 : 1
4. 43 : 1

Same as previous

QUESTION

Given below are two statements:

Statement-I: Two photons having equal linear momenta have equal wavelengths.

Statement-II: If the wavelength of photon is decreased, then the momentum and energy of a photon will also decrease.

Statement-I → Two Photons having equal wavelength have equal momentum

I → True

II → false

for photon

$E = \frac{hc}{\lambda} = Pc$

$\lambda = \frac{h}{P}$

λ (wavelength) → Scalar

P (momentum) → vector

QUESTION

Find the ratio of velocities of proton and α-particle if the de Broglie wavelengths of both the particles is same.

$\lambda = \frac{h}{mv}$

$v \propto \frac{1}{m}$

$\frac{v_1}{v_2} = \frac{m_2}{m_1}$

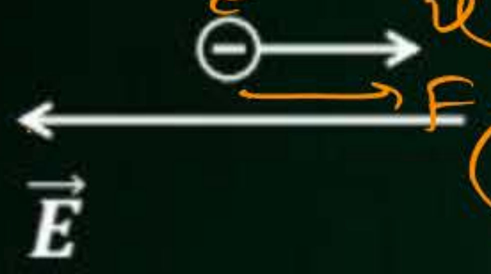
QUESTION

The de-Broglie wavelength of a neutron at 27°C is λ. What will be its wavelength at 927°C ?

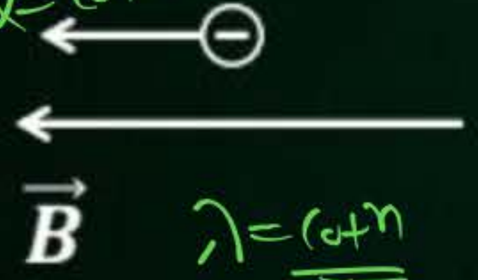
1. $\frac{\lambda}{2}$
2. $\frac{\lambda}{3}$
3. $\frac{\lambda}{4}$
4. $\frac{\lambda}{9}$

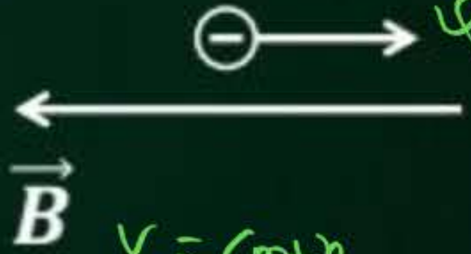
QUESTION

Figure shows four situations in which an electron is moving in electric/ magnetic field. In which case the de Broglie wavelength of electron is increasing?

1 

2 

3 

4 

QUESTION

An electron of mass m when accelerated through a potential difference V has de Broglie wavelength λ. The de Broglie wavelength associated with a proton of mass M accelerated through the same potential difference will be

1. $\lambda \frac{m}{M}$
2. $\lambda \frac{M}{m}$
3. $\lambda \sqrt{\frac{m}{M}}$
4. $\lambda \sqrt{\frac{M}{m}}$

QUESTION

Proton and α-particle are accelerated through the same potential. The ratio of wavelengths is

(1) 2

(2) $\sqrt{2}$

(3) 4

(4) $\frac{1}{2\sqrt{2}}$

QUESTION

When the momentum of a proton is changed by an amount p_0 the corresponding change in the de Broglie wavelength is found to be 0.25%. Find the original momentum of the photon.

QUESTION

If the velocity of an electron is doubled, its de Broglie frequency will

1. Be halved
2. Remain same
3. Be doubled
4. Become four times

QUESTION

A photon and a proton have equal energy E. Ratio of wavelengths $\frac{\lambda_{\text{photon}}}{\lambda_{\text{proton}}}$ is proportional to

1. E
2. $\sqrt{E}$
3. $\frac{1}{\sqrt{E}}$
4. E°

QUESTION

An α-particle moves in a circular path of radius 0.83 cm in the presence of a magnetic field of 0.25 Wb/m^2. The de-Broglie wavelength associated with the particle will be

1. 10 Å
2. 0.01 Å
3. 1 Å
4. 01 Å

QUESTION

A object of mass M is at rest break into two part of ratio 2 : 3 then ratio of their de-Broglie wavelength.

QUESTION

De-Broglie wavelength associated with an electron revolving in the nth state of hydrogen atom is directly proportional to

1. n
2. $1/n$
3. n^2
4. $1/n^2$

QUESTION

A proton is accelerated through 225 V. Its de-Broglie wavelength is

1. 0.1 nm
2. 0.2 nm
3. 0.3 nm
4. 0.4 nm

QUESTION

Of the following having the same kinetic energy, the one which has the largest wavelength is

1. An alpha particle
2. A neutron
3. A proton
4. An electron

QUESTION

The de Broglie wavelength λ associated with a proton increases by 25%, if its momentum is decreased by p_0. The initial momentum was

1. $4\,p_0$
2. $\frac{p_0}{4}$
3. $5\,p_0$
4. $\frac{p_0}{5}$

QUESTION

An electron of mass m with an initial velocity $v = v_0\,\hat{\imath}$ ($v_0 > 0$) enters an electric field $\vec{E} = -\vec{E}_0\,\hat{\imath}$ (E_0 = constant > 0) at t = 0. If λ_0 is its de-Broglie wavelength initially, then its de-Broglie wavelength at time t is [NEET 2018]

1. $\dfrac{\lambda_0}{\left(1+\frac{eE_0}{mv_0}t\right)}$

2. $\lambda_0\left(1+\frac{eE_0}{mv_0}t\right)$

3. $\lambda_0 t$

4. λ_0

QUESTION

The de-Broglie wavelength of a neutron in thermal equilibrium with heavy water at a temperature T (kelvin) and mass m, is [NEET 2017]

1. $\frac{h}{\sqrt{3mkT}}$

2. $\frac{2h}{\sqrt{3mkT}}$

3. $\frac{2h}{\sqrt{mkT}}$

4. $\frac{h}{\sqrt{mkT}}$

QUESTION

The de-Broglie wavelength of neutrons in thermal equilibrium at temperature T is

[Karnataka NEET 2013]

1. $\frac{3.08}{\sqrt{T}}$ Å
2. $\frac{0.308}{\sqrt{T}}$ Å
3. $\frac{0.0308}{\sqrt{T}}$ Å
4. $\frac{30.8}{\sqrt{T}}$ Å

QUESTION

If particles are moving with same velocity, then which has maximum de Broglie wavelength? (2002)

1. proton
2. α-particle
3. neutron
4. β-particle


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 01 | **Physics**

Atoms

By- Dr. Manish Raj (MR SIR)



Todays Goal

- H/W
- Compton / Pair Production /
- atomic physics

QUESTION

Proton and α-particle are accelerated through the same potential. The ratio of wavelengths is

1. 2
2. $\sqrt{2}$
3. 4
4. $\frac{1}{2\sqrt{2}}$

$$\lambda = \frac{h}{p} = \frac{h}{\sqrt{2m K.E}} = \frac{h}{\sqrt{2mq\Delta V}}$$

$$\lambda \propto \frac{1}{\sqrt{mq}}$$

$$\frac{\lambda_p}{\lambda_\alpha} = \frac{\sqrt{4m \times 2e}}{\sqrt{m e}} = 2\sqrt{2}$$

$$\frac{\lambda_\alpha}{\lambda_p} = \frac{1}{2\sqrt{2}}$$

QUESTION

If the velocity of an electron is doubled, its de Broglie frequency will

m = const

1. Be halved
2. Remain same
3. Be doubled (26%) only
4. Become four times

$\lambda = \frac{h}{mv}$

$f \propto \frac{1}{\lambda} = \frac{mv}{h}$

QUESTION

A photon and a proton have equal energy E. Ratio of wavelengths $\frac{\lambda_{photon}}{\lambda_{proton}}$ is proportional to

1. E
2. $\sqrt{E}$
3. $\frac{1}{\sqrt{E}}$
4. E^{0}

$\lambda_{photon} = \frac{hc}{E}$

$\lambda_{proton} = \frac{h}{\sqrt{2mE}}$

$\frac{\lambda_{photon}}{\lambda_{pr}} = \frac{\sqrt{E}}{E}$

QUESTION

An α-particle moves in a circular path of radius 0.83 cm in the presence of a magnetic field of 0.25 Wb/m^2. The de-Broglie wavelength associated with the particle will be

$q = +2e$

1. 10 Å
2. 0.01 Å
3. 1 Å
4. 01 Å

$$\frac{mv^2}{r} = qBv$$

$$mv = qBr$$

$$\lambda = \frac{h}{mv} = \frac{h}{qBr}$$

$$\lambda = \frac{h}{2e \times 0.25 \times 0.83 \times 10^{-2}}$$

QUESTION

A object of mass M is at rest break into two part of ratio 2 : 3 then ratio of their de-Broglie wavelength.

$\lambda_1 : \lambda_2 = 1 : 1$

QUESTION

De-Broglie wavelength associated with an electron revolving in the nth state of hydrogen atom is directly proportional to

1. n ✓
2. $1/n$
3. n^2
4. $1/n^2$

There is n-wave in n^{th} orbit or atom

2nd orbit

1ef = r ardb



* $2\pi r = 2\lambda$

In n^{th} orbit if radius is r

$2\pi r_{n^{th}} = n\lambda$

$2\pi r_0 n^2 = n\lambda$

$\lambda \propto n$

$$\lambda = \frac{h}{\sqrt{2m\left(\frac{13.6}{n^2}\right)}}$$

$$\lambda = \frac{h}{\frac{1}{n}\sqrt{2m \times 13.6}}$$

$$\lambda = \frac{nh}{\sqrt{27.2\,m}}$$

QUESTION

A proton is accelerated through 225 V. Its de-Broglie wavelength is

1. 0.1 nm
2. 0.2 nm
3. 0.3 nm
4. 0.4 nm

$1 A^\circ = 10^{-10} m = 10^{-1} \times 10^{-9} m = 0.1 \times 10^{-9} m$

$\lambda_p = \frac{0.286 A^\circ}{\sqrt{V}}$

$= \frac{0.286 A^\circ}{\sqrt{225}}$

$= \frac{0.286}{15} \times 0.1 nm$

$= 0.02 \times 0.1 nm = 0.002 nm$

$10^{-10} m = 10^{-1} \times 10^{-9} m = 0.1 \times 10^{-9} m$

$\lambda_\alpha = \frac{0.101 A^\circ}{\sqrt{V}}$

$\lambda_{Deut} = \frac{0.202 A^\circ}{\sqrt{V}}$

$\lambda_e = \frac{12.27 A^\circ}{\sqrt{V}}$

QUESTION

Of the following having the same kinetic energy, the one which has the largest wavelength is

1. An alpha particle
2. A neutron
3. A proton
4. An electron

QUESTION

The de Broglie wavelength λ associated with a proton increases by 25%, if its momentum is decreased by p_0. The initial momentum was

1. $4p_0$
2. $\frac{p_0}{4}$
3. $5p_0$ ✓
4. $\frac{p_0}{5}$

Sol^n $\lambda_i = \lambda$ (given)

$\lambda_f = 125\% \cdot \lambda$

$\lambda_f = \frac{125}{100}\lambda$

As $\lambda = \frac{h}{p_i}$ $\quad \lambda_f = \frac{h}{p_f}$

$\lambda_f = \frac{h}{p_i - p_0}$

$\frac{125}{100}\lambda = \frac{h}{p_i - p_0}$

$\frac{5}{4}\lambda = \frac{h}{p_i - p_0}$

$\frac{5}{4} = \frac{p_i}{p_i - p_0}$

$4p_i = 5p_i - 5p_0$

$5p_0 = 5p_i - 4p_i$

$p_i = 5p_0$

QUESTION

The de-Broglie wavelength of a neutron in thermal equilibrium with heavy water at a temperature T (kelvin) and mass m, is [NEET 2017]

1. $\frac{h}{\sqrt{3mkT}}$
2. $\frac{2h}{\sqrt{3mkT}}$
3. $\frac{2h}{\sqrt{mkT}}$
4. $\frac{h}{\sqrt{mkT}}$

$$\lambda = \frac{h}{\sqrt{2m(E)}}$$

$$E = \frac{3}{2} k_B T$$

QUESTION

The de-Broglie wavelength of neutrons in thermal equilibrium at temperature T is

[Karnataka NEET 2013]

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2. $\frac{0.308}{\sqrt{T}}$ Å
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QUESTION

If particles are moving with same velocity, then which has maximum de Broglie wavelength? (2002)

1. proton
2. α-particle
3. neutron
4. β-particle

QUESTION

When the momentum of a proton is changed by an amount p_0 the corresponding change in the de Broglie wavelength is found to be 0.25%. Find the original momentum of the photon.

$\Delta p = p_0$

$p_f - p_i = p_0$

$\frac{\Delta\lambda}{\lambda} = 0.25\%$

$p_i = ??$

Same Qu

$\lambda = \frac{h}{p}$

$100 \times \frac{\Delta\lambda}{\lambda} = -\frac{\Delta p}{p_i} \times 100$

$0.25 = \frac{p_0}{p_i} \times 100$

$p_i = \frac{p_0 \times 100}{0.25}$

$p_i = 400 p_0$

HEISENBERG PRINCIPLE

$$\Delta x \cdot \Delta p \geq \frac{h}{4\pi}$$ ← dim^n correct

$$\Delta \theta \cdot \Delta L \geq \frac{h}{4\pi}$$

Δx = Uncertinity in Position.

→ absolute error in the Measurment of Position.

If $\Delta x = 0$ (You know exact Position)

$$\Delta x \cdot \Delta p = \frac{h}{4\pi}$$

$$0 \, \Delta p = \frac{h}{4\pi}$$

$$\Delta p = \infty$$

IIT-2006

(Q) what is the heisenberg conjugate of energy??

Soln

$$\Delta E \cdot \Delta x \geq \frac{h}{4\pi}$$ (dim less)

$$\Delta x = \frac{h}{\Delta E} = \frac{E \times t}{E}$$

Δx = time

(Q) why electron can't exist inside nuclus??

Soln If I assume e^- is inside nucleus.



$$\Delta x = 10^{-15} m$$

$$\Delta x \cdot \Delta p = \frac{h}{4\pi}$$

$$m \Delta v = \frac{h}{4\pi \times 10^{-15}}$$

$$\Delta v = \frac{h \times 10^{15}}{4\pi \times m}$$

$$\Delta v \simeq 10^{11} \text{ m/s}$$

$\Delta v >>> c$

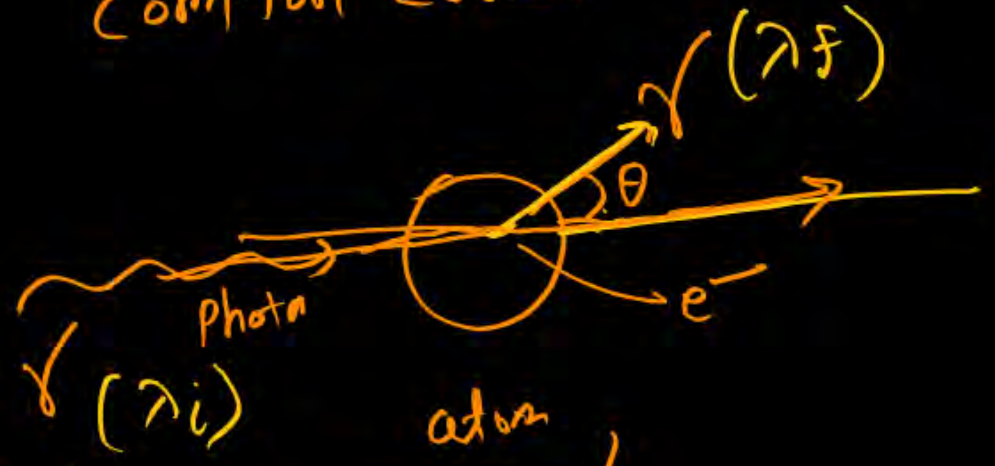
Photoelectric effect



$E \simeq eV$

↳ visible region

Compton effect



↳ $E_{phot} = 1\,keV$

X-ray photon.

(partiall Photoelectric effect)

Compton shift $= \lambda_f - \lambda_i$ $(\lambda f > \lambda_i)$

$$\Delta\lambda = (\lambda f - \lambda_0) = \frac{h}{m_e c}(1 - \cos\theta)$$ *

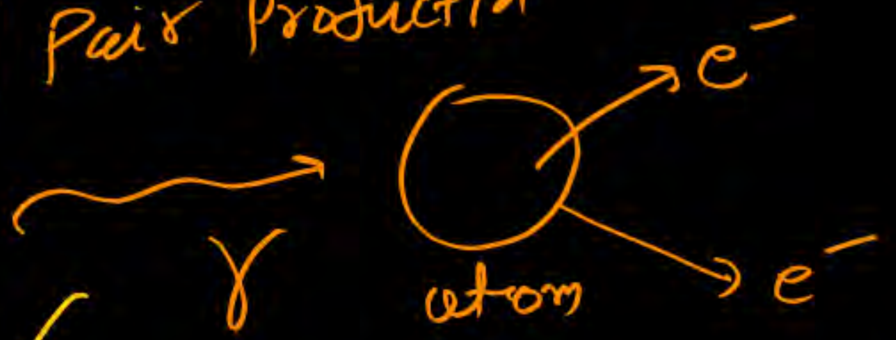
If $\theta = 0$ $\quad \Delta\lambda = 0$ *

If $\theta = 90°$ $\quad \Delta\lambda = \frac{h}{m_e c}$

If $\theta = 180°$ $\quad \Delta\lambda = \frac{2h}{m_e c}$

$\frac{h}{m_e c} = 1.24 \times 10^{-12}\,m$ *

Pair Production



γ-ray Ka photon

$E_{ph} = 1\,meV$

$E_{phot.} = 1.01\,meV$ *

Pair Production

$\gamma + \gamma = e^+ + e^-$

highly enegetic photon of γ-ray

$E = 1.01\,meV$

Pair anihilation

$e^- + e^+ \rightarrow \gamma + \gamma$

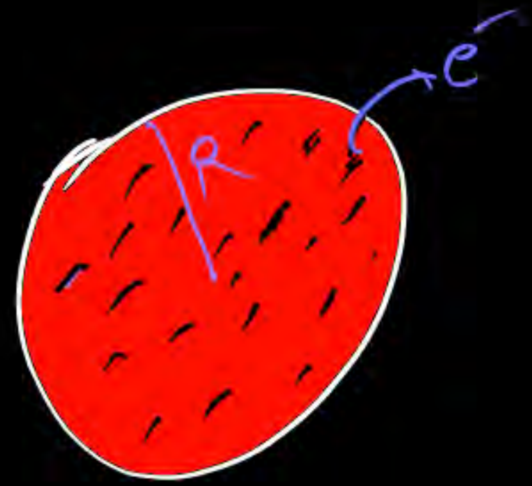
J. J. thomson

- atoms are spherical
- mass of atom uniformally distributed througout the sphere.
- net charge = 0

  $Q_{-ve} = Q_{+ve}$
- +ve charge also uniformally distributed inside sphere.

  _ve charge embeded B/w the Position charge distributi
- $r = 10^{-10} m$

  atom

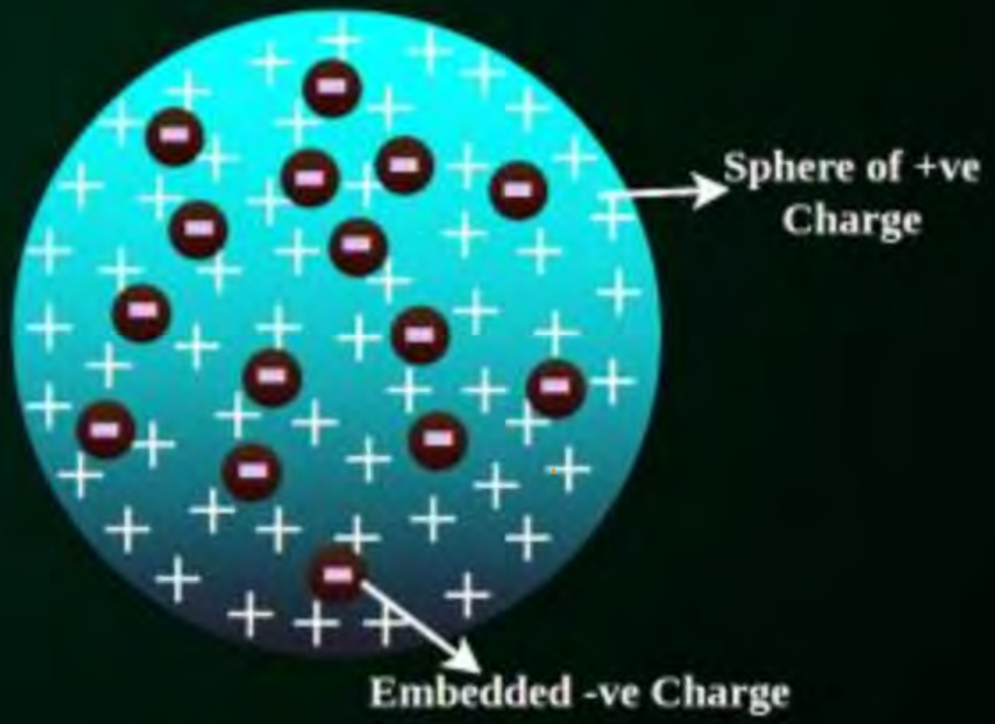


THOMSON'S ATOM MODEL

- The atom as a whole is electrically neutral because the positive charge present on the atom (sphere) is equal to the negative charge of electrons present in the sphere.

- Atom is a positively charged sphere of radius 10^{-10} m in which electrons are embedded in between.

- The positive charge and the whole mass of the atom is uniformly distributed throughout the sphere.



Thomson's Atomic Model

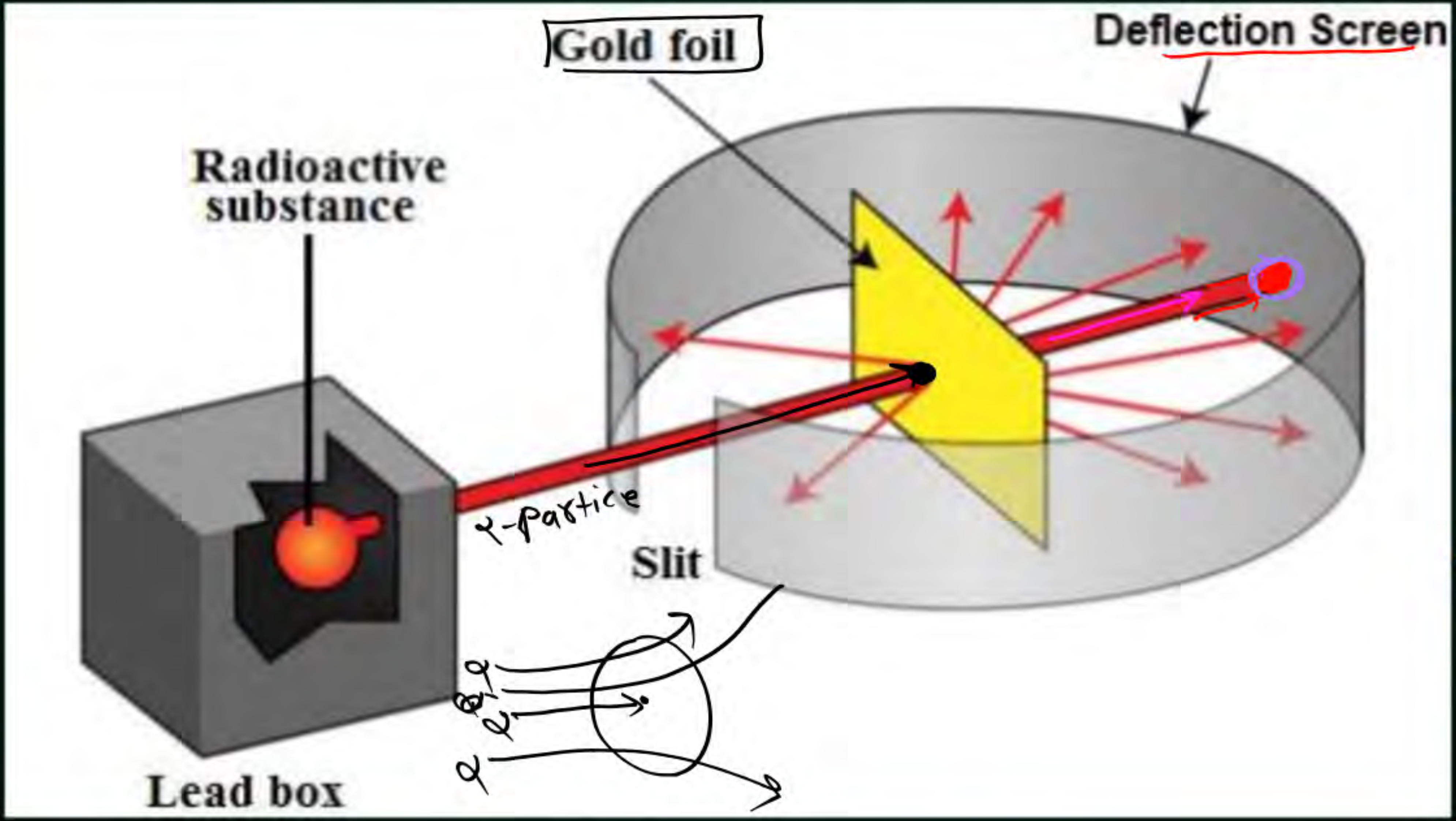
SHORTCOMINGS OF THOMSON'S MODEL

- The spectrum of atoms cannot be explained with the help of this model.
- Scattering of α-particles cannot be explained with the help of this model.

(J. J. thomson)

RUTHERFORD ATOM MODEL

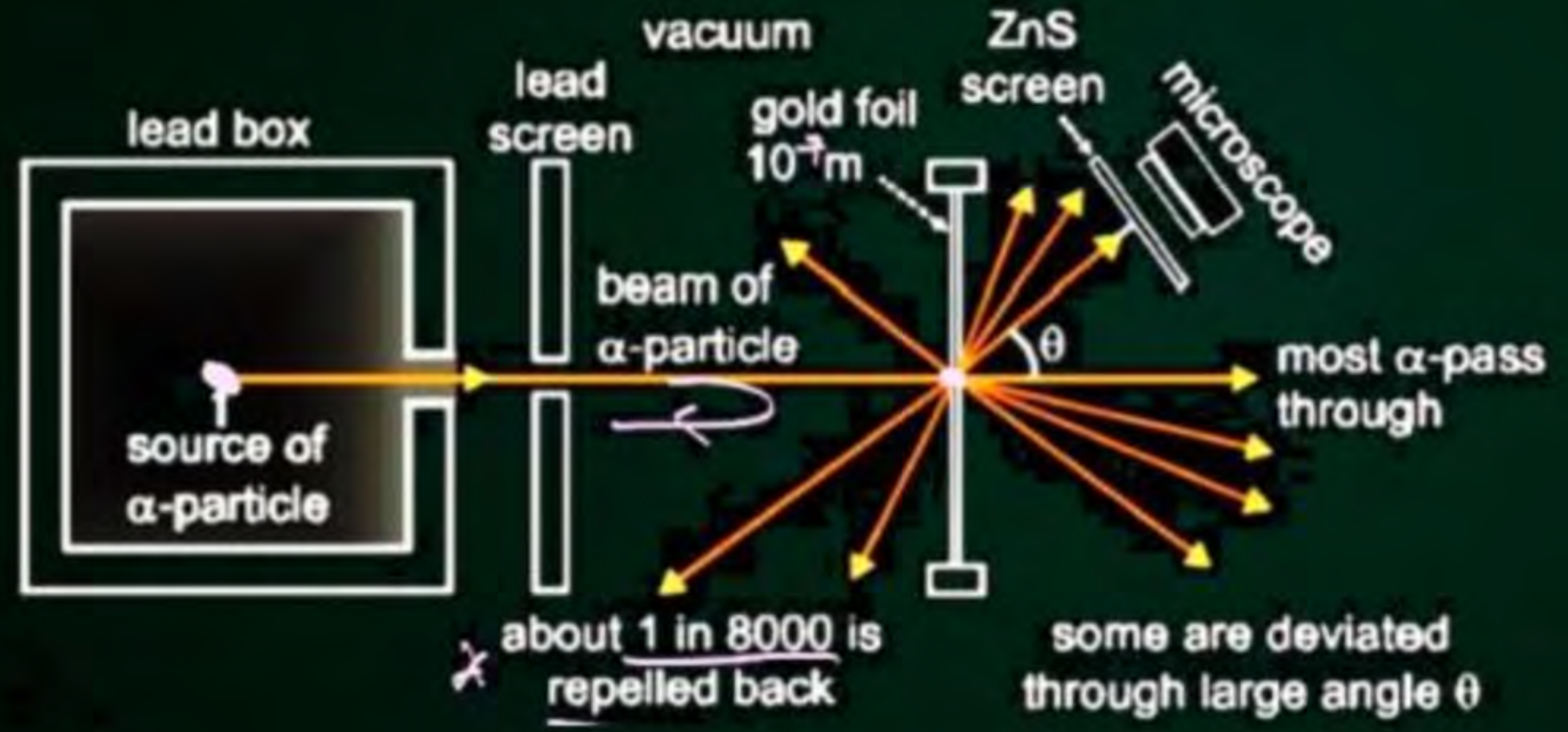
➢ Rutherford experiments on scattering of α-particles by thin gold foil.

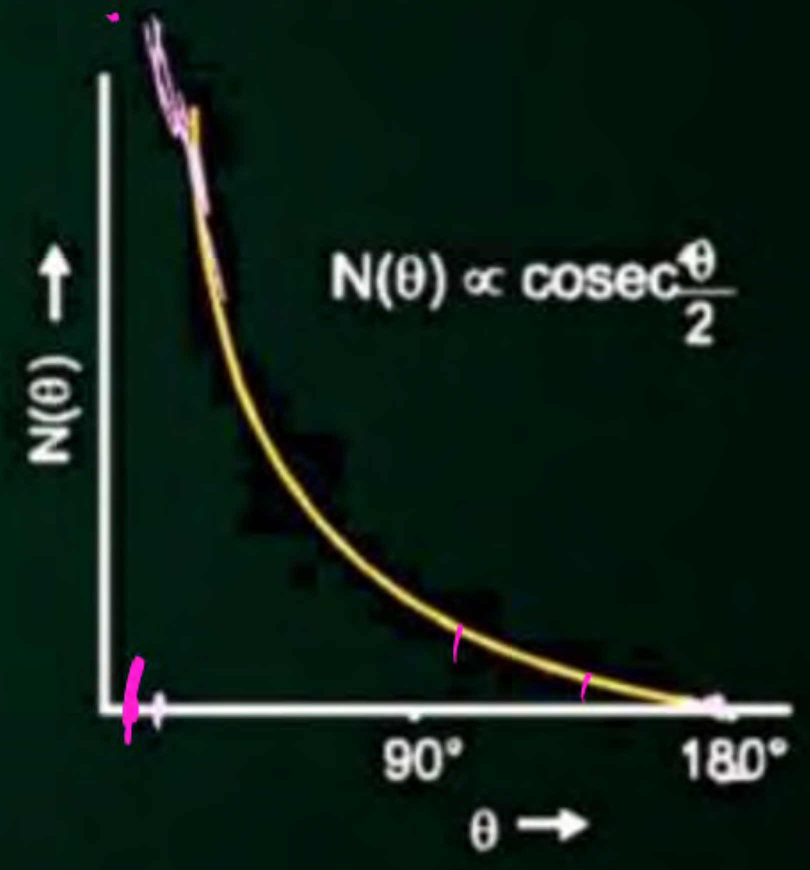


* 99.84% of α-Particle passed without deviation
* 0.16% of α-Particle deviated by some angle
* most of space inside atom is empty/Hollow
* 99.9% of mass of atom concentrated at centre of atom is called nucleus $r = 10^{-15}$ m

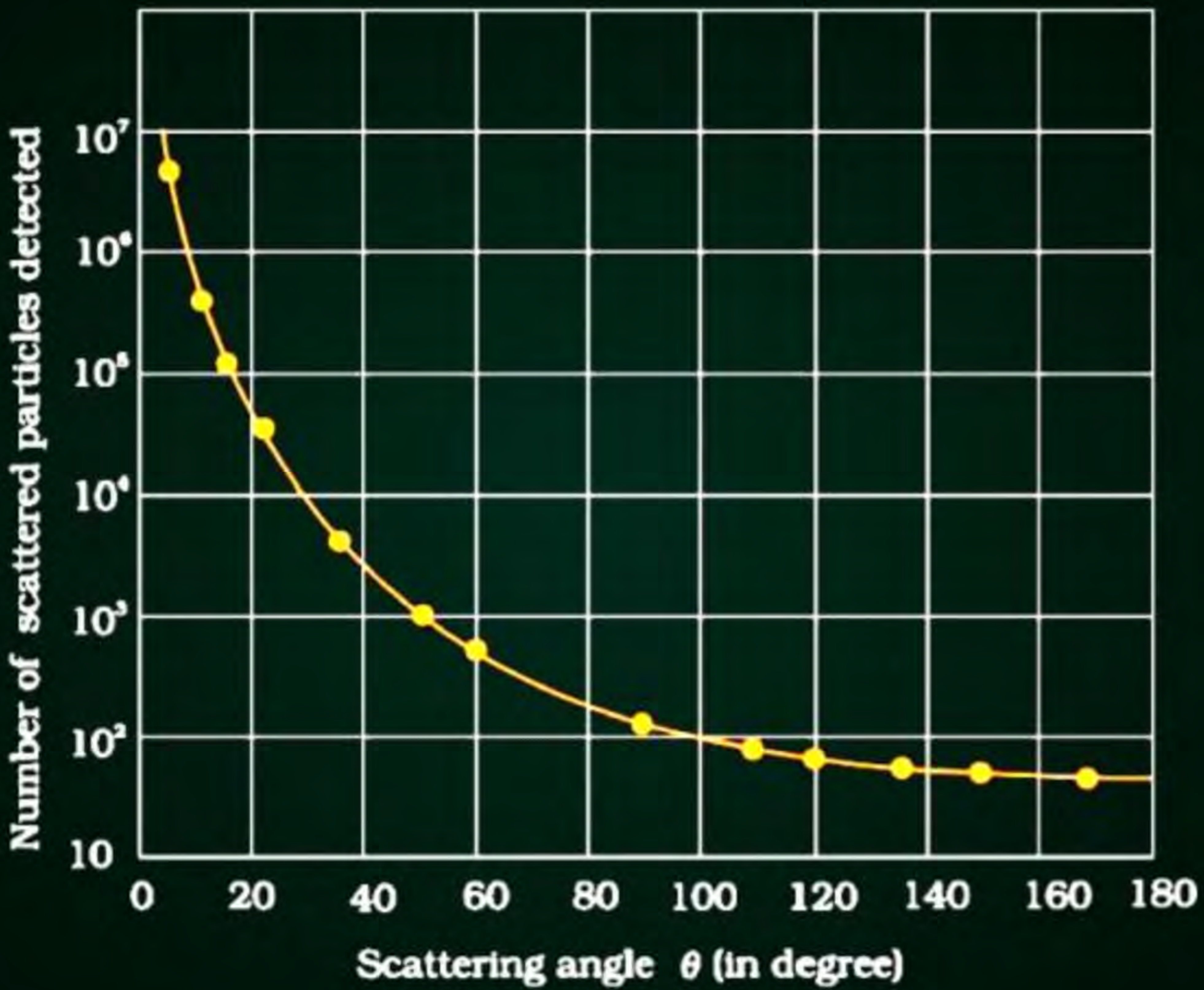
RUTHERFORD ATOM MODEL

➤ Rutherford experiments on scattering of α-particles by thin gold foil.





- Most of the α-particles went straight through the gold foil and produced flashes on the screen as if there were nothing inside gold foil. Thus the atom is hollow.
- Few particles collided with the atoms of the foil which have scattered or deflected through considerable large angles. Few particles even turned back towards source itself.
- The entire positive charge and almost whole mass of the atom is concentrated in small centre called a nucleus.
- The electrons could not deflected the path of a α-particles i.e. electrons are very light.

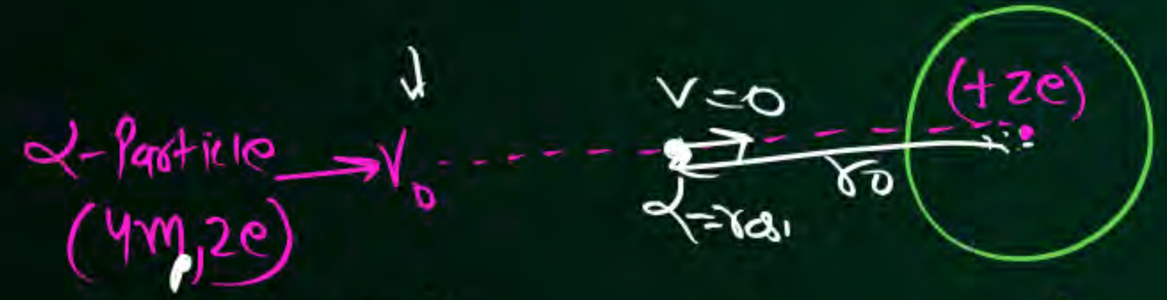


Number of scattered particles detected
10^7
10^6
10^5
10^4
10^3
10^2
10
0
20
40
60
80
100
120
140
160
180
Scattering angle θ (in degree)

DISTANCE OF CLOSEST APPROACH

- b = Impact Parameter = ⊥r dist^n b/w velocity of colliding object

→ 1-D head on collision ke liye ($b = 0°$) then only θ (deviation) = 180° Possible



at large dist^n

atom (Z)

C.O.M.E

P.E + K.E = K.E + P.E

$$0 + \frac{1}{2} m_\alpha v_0^2 = 0 + \frac{K ze \times 2e}{r_0}$$

$$r_0 = \frac{2Kze^2}{\left(\frac{1}{2} m_\alpha v_0^2\right)}$$

$$r_0 = \frac{2Kze^2}{(K.E)_\alpha}$$

$r_{atom} = 10^{-10} m$

$r_{nucleus} = 10^{-15} m$

$$\frac{r_{atom}}{r_{nucleus}} = \frac{10^{-10} m}{10^{-15} m}$$

$$\frac{r_{atom}}{r_{nucleus}} = 10^5 m$$

If M.R made a nucul at his home of size 1m then wat should be size of atom for this nucleus ??

$$\frac{r_{atom}}{r_{nucl}} = \frac{10^{-10}}{10^{-15}} = 10^{+5}$$

$$\frac{r_{atom}}{1m} = 10^{+5}$$

$$r_{atom} = 10^{5} m = 100000 m = 100 KM$$

QUESTION

When an α-particle of mass 'm' moving with velocity 'v' bombards on a heavy nucleus of charge 'Ze' its distance of closest approach from the nucleus depends on m as:

[2016]

1. $1/m$ (Ans)
2. $1/\sqrt{m}$
3. $1/m^2$
4. m

QUESTION

An alpha nucleus of energy $\left(\frac{1}{2}mv^2\right)$ bombards a heavy nuclear target of charge Ze. Then the distance of closest approach for the alpha nucleus will be proportional to

[2010]

1. 1/Ze ✗
2. v^2 ✗
3. 1/m ✓
4. $1/v^4$ ✗

$$\frac{1}{2}mv^2 = \frac{K\,Ze \times 2e}{r_0}$$

$$r_0 \propto \frac{Z}{mv^2}$$

QUESTION

In Rutherford scattering experiment, what will be the correct angle for α-scattering for an impact parameter, $b = 0$? [1994]

deviation

1. 90°
2. 270°
3. 0°
4. 180°

QUESTION

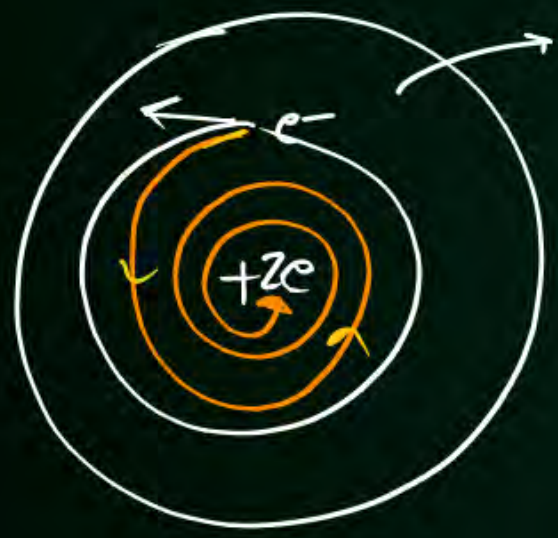
In a Rutherford scattering experiment when a projectile of charge Z_1 and mass M_1 approaches a target nucleus of charge Z_2 and mass M_2 the distance to closest approached is r_0. The energy of the projectile is [2009]

1. directly proportional to $Z_1 Z_2$
2. inversely proportional to Z_1
3. directly proportional to mass M_1
4. directly proportional to $M_1 \times M_2$



DRAWBACK OF RUTHERFORD ATOMIC MODE

→ (1) Stability of atom can't explained by rutherford



atom

→ accelerated e^-

- E-M wave produce → γ
- energy of e^- will decrease
- → Speed ↓
  - → radii ↓

(2) line spectrum can't explained by rutherford

Niles Bhor

$L = \frac{nh}{2\pi}$

$= n(0.5)\frac{h}{\pi}$

$L = \frac{25h}{10\pi}$

(a) Not Possible 30%

(b) Possible 65%

$L = \frac{25h}{10\pi} = n\left[\frac{h}{2\pi}\right]$

$5 = n$ poss.

$$L = \frac{15h}{9\pi}$$

→ Not Possibe

BOHR'S FIRST POSTULATE

- Bohr's first postulate was that an electron in an atom could revolve in certain stable orbits without the emission of radiant energy, contrary to the predictions of electromagnetic theory.
- According to this postulate, each atom has certain definite stable states in which it can exist, and each possible state has definite total energy.
- These are called the stationary states of the atom.

BOHR'S SECOND POSTULATE

- Bohr's second postulate defines these stable orbits. This postulate states that the electron revolves around the nucleus only in those orbits for which the angular momentum is some integral multiple of $h/2\pi$ where h is the Planck's constant ($= 6.6 \times 10^{-34}$ J s).

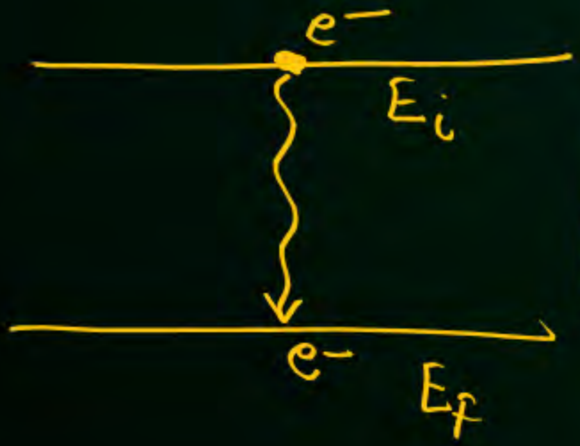
- Thus the angular momentum (L) of the orbiting electron is quantised.

  That is $L = nh/2\pi$

BOHR'S THIRD POSTULATE

[redacted]

- It states that an electron might make a transition from one of its specified non-radiating orbits to another of lower energy.
- When it does so, a photon is emitted having energy equal to the energy difference between the initial and final states.

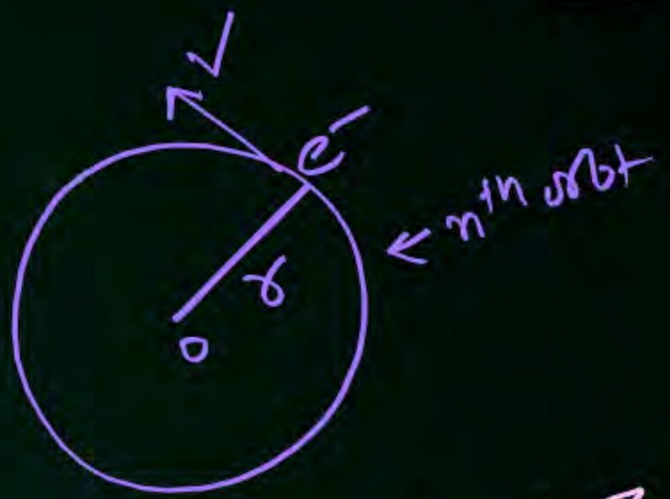


$$E_i - E_f = E_{photon}$$

(1) Velocity of electron in n^{th} orbit:

$$\frac{mv^2}{r} = \frac{K Z e \times e}{r^2} \quad \text{— (i)}$$

$$L = \frac{nh}{2\pi} = mvr \quad \text{— (ii)}$$



$$mv^2 = \frac{KZe^2}{r}$$

$$v(mvr) = KZe^2 \quad \text{— (iii)}$$

using eqn (ii) $mvr = \frac{nh}{2\pi}$

$$v\left[\frac{nh}{2\pi}\right] = KZe^2$$

$$v = \frac{2\pi K Z e^2}{nh}$$

$$v = \frac{\cancel{2\pi} Z e^2}{2\,\cancel{4\pi}\varepsilon_0 nh}$$

$$v = \frac{Ze^2}{2\varepsilon_0 h n}$$

$$v = \left(\frac{e^2}{2\varepsilon_0 h}\right)\frac{Z}{n}$$

$$v = 2.18 \times 10^6\ \text{m/s} \times \frac{Z}{n}$$

$v = 2.2 \times 10^6 \times Z/n$

$$v = \frac{c}{137} \times \frac{Z}{n}$$

$$v \propto \frac{1}{n}$$

$$v \propto Z$$

(2) Radius of the n^{th} orbit:

$$V = \frac{Ze^2}{2\varepsilon_0 nh}$$

$$mvr = \frac{nh}{2\pi} \quad \text{--- (11)}$$

$$r = \frac{nh}{2\pi mv}$$

$$r = \frac{nh}{2\pi m \times \frac{Ze^2}{2\varepsilon_0 (nh)}} = \frac{n^2h^2\varepsilon_0}{\pi m Z e^2}$$

$$r = \frac{\varepsilon_0 h^2}{\pi m e^2} \frac{n^2}{Z}$$

$$r = 0.53\,\text{Å} \times \frac{n^2}{Z}$$

$$r \propto n^2 \qquad r \propto \frac{1}{Z}$$

H-atom $Z = 1$

$n = 1$ (1st orbit)

$$r = 0.53\,\text{Å}$$

$$\text{Time period} = \frac{2\pi r}{v}$$

$$\propto \frac{n^2}{2 \times \frac{Z}{n}}$$

$$T \propto \frac{n^3}{Z^2}$$

$$T = T_0 \frac{n^3}{Z^2}$$

$$T = 1.51 \times 10^{-16} \frac{n^3}{Z^2} \text{ s}$$

$$f \propto \frac{1}{T}$$

due to rotation of e^- magnetic field at centre.

$$B = \frac{\mu_0 I}{2R} = \frac{\mu_0 q}{t\, 2R}$$

$$B \propto \frac{1}{t \times R} \propto \frac{Z^2 \times Z}{n^3 \times n^2}$$

$$B \propto \frac{Z^3}{n^5}$$

$$K.E = \frac{1}{2}(mv^2)$$

$$K.E = \frac{Kze^2}{2r}$$

$$\frac{mv^2}{r} = \frac{Kze^2}{r^2}$$

$$\Rightarrow mv^2 = \frac{Kze^2}{r}$$

Multi. $\frac{1}{2}$ Both Si

$$K.E = \frac{Kze^2}{2r}$$

$$P.E =$$

$$T.E = T.E + P.E$$

gravite | chem

QUESTION

In terms of Bohr radius the radius a_0 the second Bohr orbit of a hydrogen atom is given by

[1992]

1. $4a_0$
2. $8a_0$
3. $\sqrt{2}a_0$
4. $2a_0$

QUESTION

When hydrogen atom is in its first excited level its radius is ______ of the Bohr radius.

[1997]

1. twice
2. 4 times
3. same
4. half

(3) Time period of revolution of electron in n^{th} orbit:

(4) Magnetic field at the centre of n^{th} orbit:

(5) Total energy in n^{th} orbit:

QUESTION

Figure shows electric lines of force due to charges Q_1 and Q_2. Hence



QUESTION

What should be the angular momentum of an electron in Bohr's hydrogen atom whose energy is -0.544eV?

1. $\frac{h}{\pi}$
2. $\frac{3h}{2\pi}$
3. $\frac{5h}{2\pi}$
4. $\frac{2h}{2\pi}$

Energy of each level of H – atom

$n = 1$	Ground state	(1st orbit)	$E = -13.6$ eV
$n = 2$	1st excited state	(2nd orbit)	$E = -3.4$ eV
$n = 3$	2nd excited state	3rd orbit	$E = -1.51$ eV
$n = 4$	3rd excited state		$E = -0.84$ eV
$n = 5$	4th excited state		$E = -0.54$ eV
			$E = -0.36$ eV

H/W


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 02 | Physics

Atoms

By- Dr. Manish Raj (MR SIR)



Todays Goal

H- Spectrum

$$\frac{mv^2}{r} = \frac{Kze \times e}{r^2}$$

$$mv^2 = \frac{Kze^2}{r}$$

multiply by $\frac{1}{2}$ both side

$$L = \frac{nh}{2\pi} = mvr$$

$n = 0, 1, 2, 3, 4$

$$mvr \times v = \frac{Ze^2}{4\pi\varepsilon_0}$$

$$v\frac{nh}{2\pi} = \frac{Ze^2}{4\pi\varepsilon_0 \cdot 2} \Rightarrow v = \frac{Ze^2}{2\varepsilon_0 nh} = 2.2\times10^6 \frac{Z}{n}$$

$$r = 0.53\,A^\circ \frac{n^2}{Z}$$

$$T = 1.51\times10^{-16}\frac{n^3}{Z^2}$$

$$f = \frac{1}{T} = \frac{2}{3}\times10^{+16}\frac{Z^2}{n^3}$$

$$B = \frac{B_0 Z^3}{n^5}$$

$$\frac{1}{2}mv^2 = \frac{1}{2}\frac{Kze^2}{r}$$

$$K.E. = \frac{Kze^2}{2r}$$

$$P.E = \frac{-Kze \times e}{r}$$

$$P.E = -\frac{Kze^2}{r}$$

$$\frac{|P.E|}{2} = K.E$$

$$T.E = P.E + K.E$$

$$= -2K.E + K.E$$

$$T.E = -K.E$$

$$K.E = \frac{1}{2}mv^2 = \frac{1}{2}m\left[\frac{Ze^2}{2\varepsilon_0 nh}\right]^2$$

$$K.E = \frac{1}{2}\frac{m z^2 e^4}{4\varepsilon_0^2 h^2 n^2}$$

$$K.E = \frac{me^4 z^2}{8\varepsilon_0^2 h^2 n^2}$$

$$K.E = 13.6\,eV\frac{z^2}{n^2}$$

H-atom $K.E = \dfrac{13.6\,eV}{n^2}$

$$T.E = \frac{-13.6\,eV}{n^2}$$

$n=1 \rightarrow T.E = -13.6\,eV$

$n=2 \rightarrow T.E = -3.4\,eV$

$n=3 \rightarrow T.E = -1.51\,eV$

$n=4 \rightarrow T.E = -0.85\,eV$

QUESTION

In terms of Bohr radius the radius a_0 the second Bohr orbit of a hydrogen atom is given by [1992]

1. $4a_0$
2. $8a_0$
3. $\sqrt{2}a_0$
4. $2a_0$

QUESTION

When hydrogen atom is in its first excited level its radius is ____ of the Bohr radius.

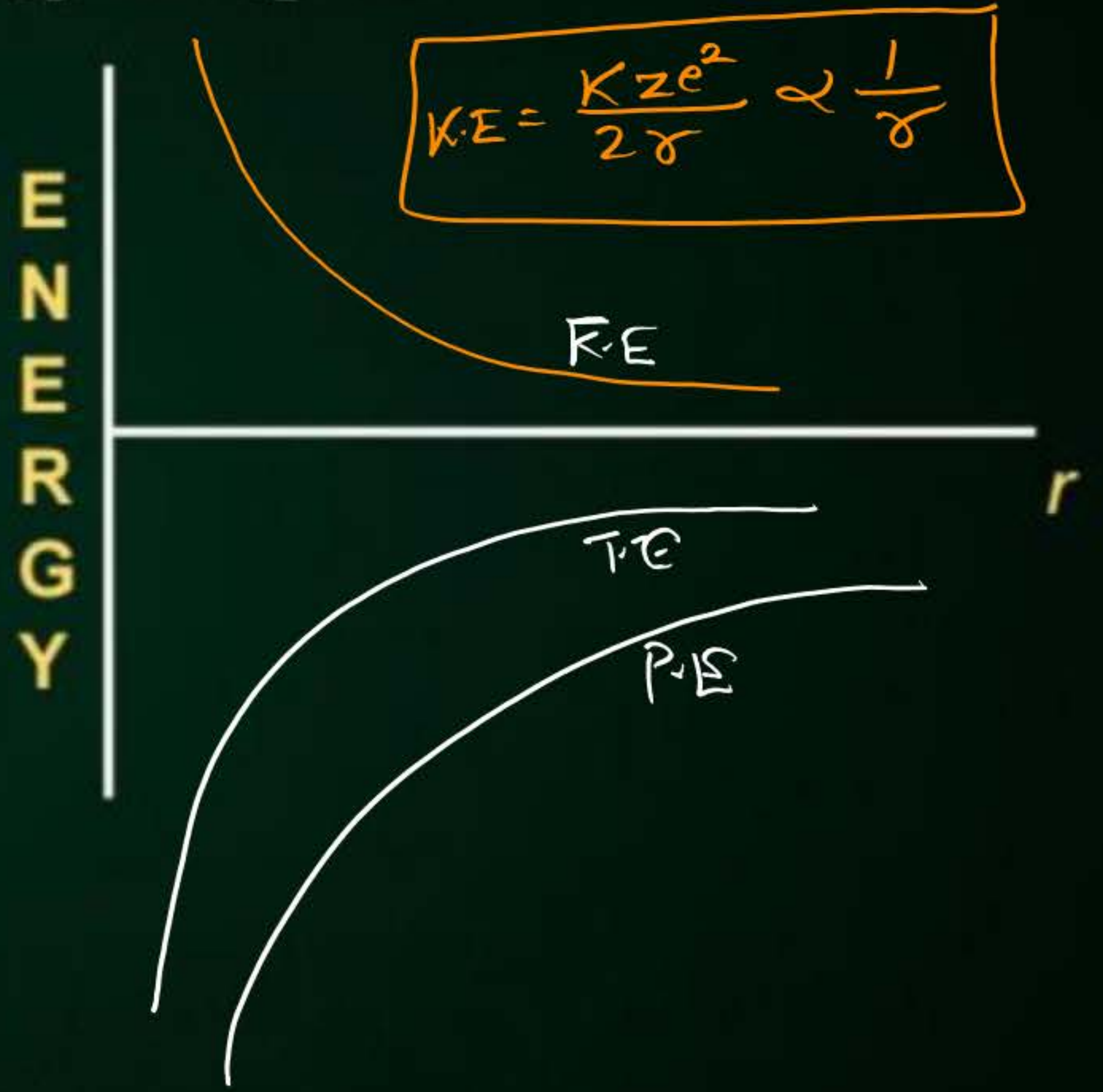
[1997]

1. twice
2. 4 times
3. same
4. half

QUESTION

Figure shows electric lines of force due to charges Q_1 and Q_2. Hence

KaTAPA



QUESTION

What should be the angular momentum of an electron in Bohr's hydrogen atom whose energy is -0.544eV?

1. $\frac{h}{\pi}$

2. $\frac{3h}{2\pi}$

3. $\frac{5h}{2\pi}$

4. $\frac{2h}{2\pi}$

T.E = −0.544 eV

↳ $n = 5$

Ans

4th excited state (5th orbit) n = 5 — 0.54 eV

3rd excited st (4th orbit) n = 4, T.E = − 0.85 eV

2nd excited state (3rd orbit) n = 3, T.E = − 1.51 eV

1st excited state (2nd orbit) n = 2, T.E = − 3.4 eV

Ground state (1st orbit) n = 1, T.E = 13.6 eV

Physics med easy

2025 JEE main Question → Basic math 1st lecture

70 PYQ ke NEET

20 ← # 30 JEE Main — 20%

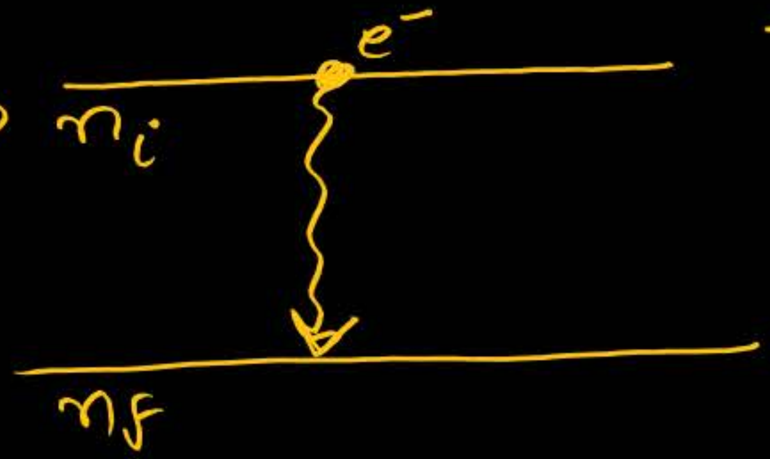
1. 11th walo →
2. 12th walo →
3. 2025 → Syllabus
4. Revision.
5. Backlog.
6. mid-Syllabus
7. Question Practice
8. Sab keliye

$$K.E = \frac{me^4 Z^2}{8\varepsilon_0^2 h^2 n^2}$$

$$T.E = \frac{-me^4 Z^2}{8\varepsilon_0^2 h^2 n^2}$$

→ Total enegy of $\bar{e}$ in n^{th} orbit of H-atom $Z = 1$

$$T.E = \frac{-me^4}{8\varepsilon_0^2 h^2 n^2}$$



$$T.E_i = \frac{-me^4}{8\varepsilon_0^2 h^2 n_i^2}$$

$$T.E_f = \frac{-me^4}{8\varepsilon_0^2 h^2 n_f^2}$$

$$E_{phot.} = T.E_i - T.E_f$$

$$\frac{hc}{\lambda} = \frac{me^4}{8\varepsilon_0^2 h^2}\left[-\frac{1}{n_i^2} + \frac{1}{n_f^2}\right]$$

$$\frac{hc}{\lambda} = \frac{me^4}{8\varepsilon_0^2 h^2}\left[\frac{1}{n_f^2} - \frac{1}{n_i^2}\right]$$

$$\frac{1}{\lambda} = \frac{me^4}{8\varepsilon_0^2 h^3 c}\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right) \ *$$

$$\frac{1}{\lambda} = R\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$$

$$\frac{1}{R} = 912 \, A^\circ$$

$$R = 1.1 \times 10^7 \, m^{-1}$$

$$\frac{1}{\lambda} = R\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$$

$$f = \frac{c}{\lambda}$$

$$f = cR\left[\frac{1}{n_f^2} - \frac{1}{n_i^2}\right]$$

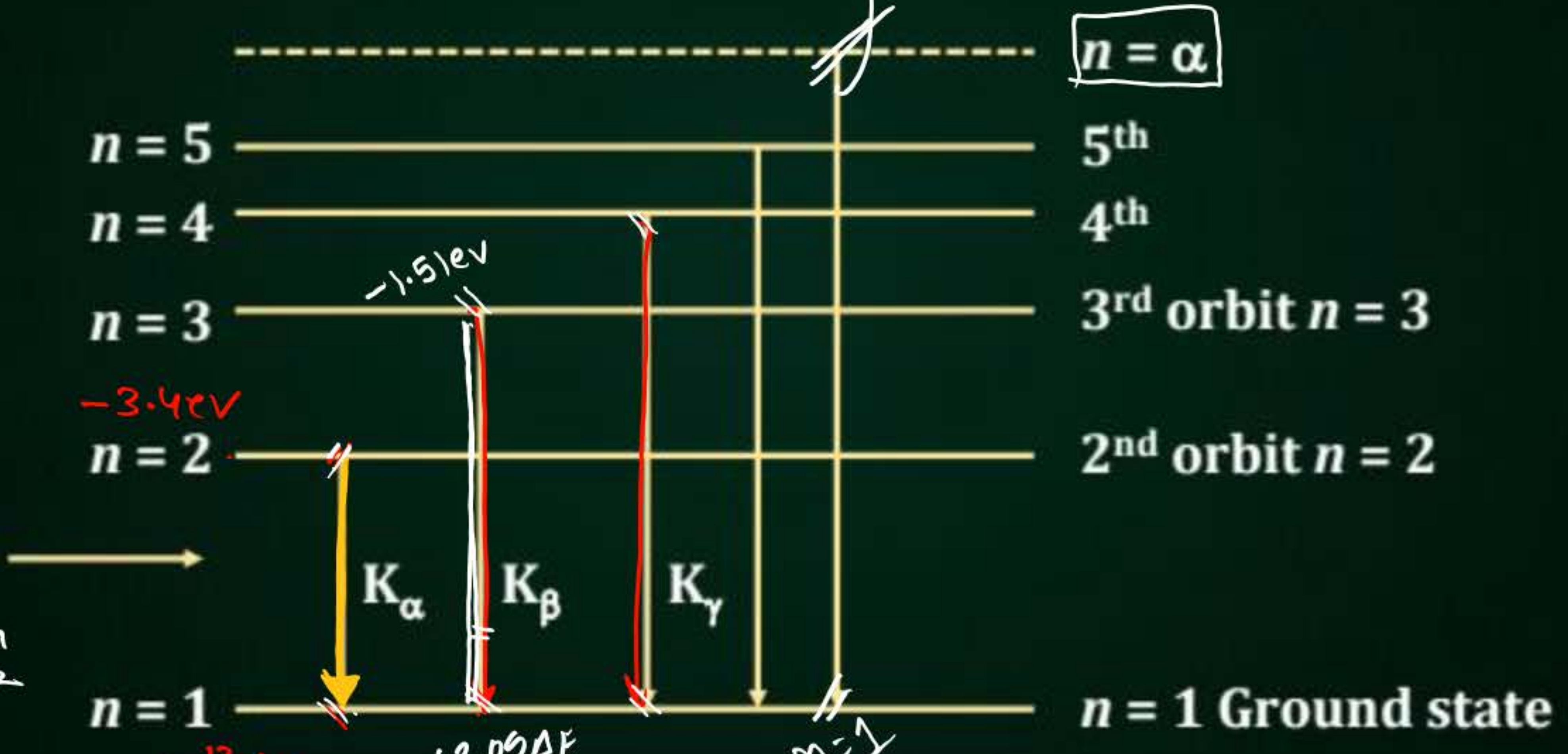
S. No.	Spectral Series	Region	n_f	n_i
1.	Lyman series	Ultra Violet	1	2, 3, 4, ... ∞
2.	Balmer series	Visible	2	3, 4, 5, ... ∞
3.	Paschen series	Infra-red	3	4, 5, 6, ... ∞
4.	Brackett series	Infra-red	4	5, 6, 7, ... ∞
5.	P-fund series	Infra-red	5	6, 7, 8, ... ∞
6.	Humphery series	Far Infra-red	6	7, 8, 9, ... ∞

LYMAN SERIES

$n_f = 1$

$n_i = 2, 3, 4, \ldots \alpha$

- # 1^{st} line
- # α - line
- # λ_{max} of Lyman series
- # f_{min} of Lyman series

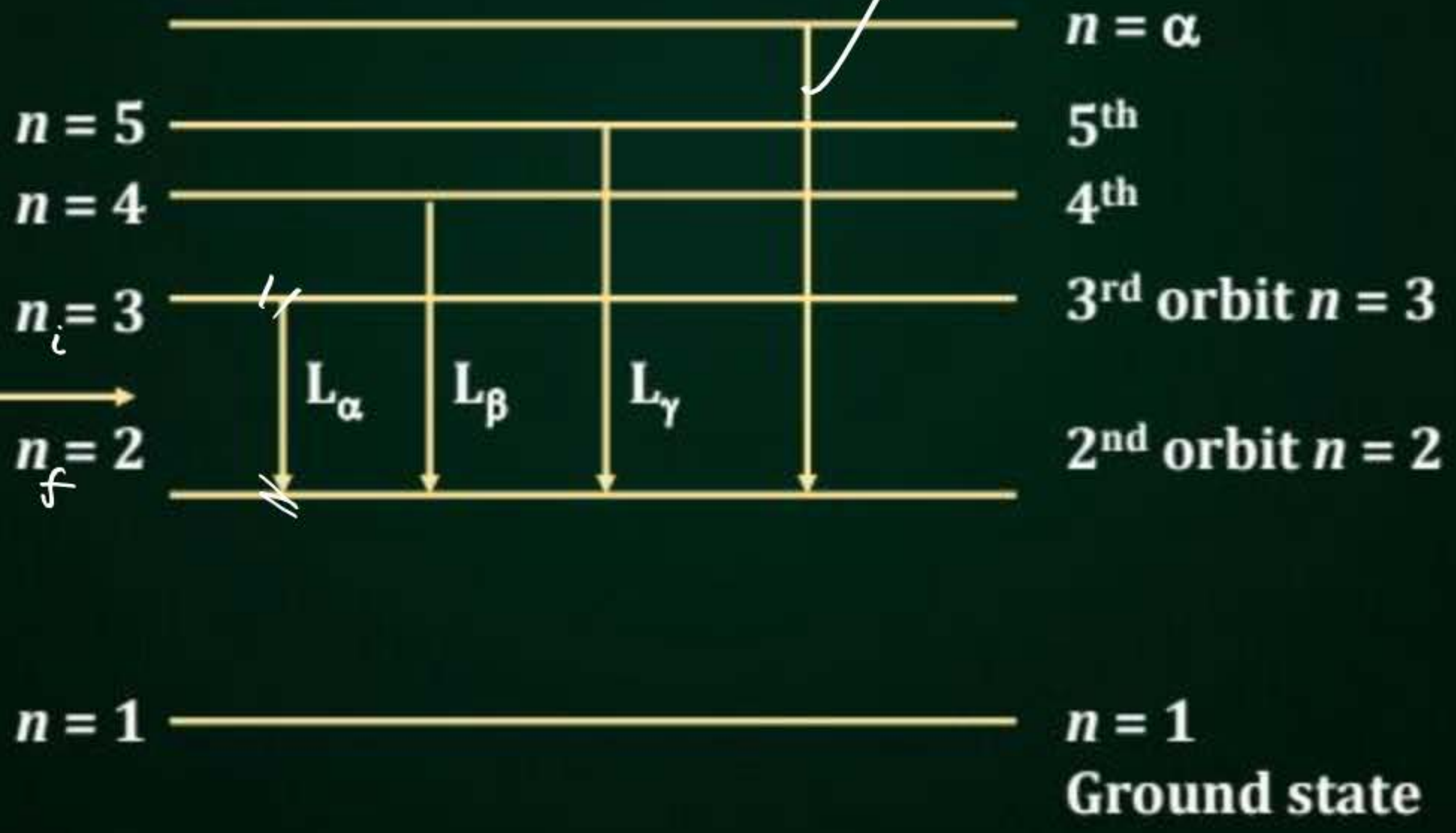


BALMER SERIES (L-series)

$n_f = 2$ $n_i = 3, 4, 5, 6, \ldots \alpha$

last line of Balmer series: $n_i = \infty$, $n_f = 2$ — λ_{min} (f_{max}) of Balmer series

- # 1st line
- # α - line
- # λ_{max} (E_{min})
- # f_{min}



PASCHEN SERIES

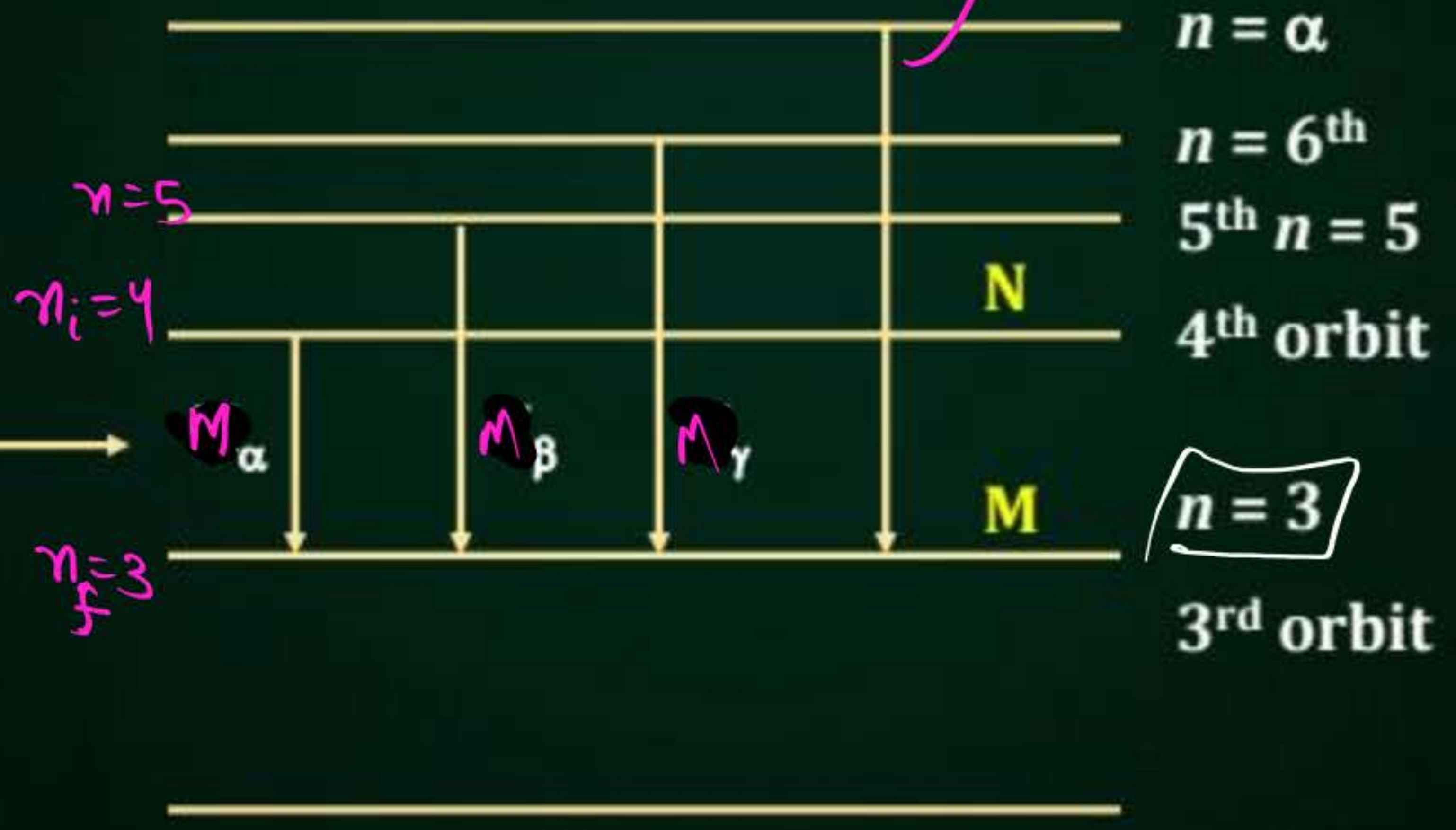
$n_f = 3$ $\quad$ $n_i = 4, 5, 6, 7, \ldots \alpha$

last line of paschen series
λ_{min} (f_{max}) E_{max} of paschen

1st line

α - line

λ_{max}



QUESTION

The ground state energy of H-atom is –13.6 eV. The energy needed to ionize H-atom from its second excited state [1991]

1. 1.51 eV
2. 3.4 eV
3. 13.6 eV
4. 12.1 eV

n = 3

T.E = −1.51 eV

Ionization en = 1.51 eV

Ionization energy = |T.E|

like Binding energy

QUESTION

The angular speed of electron in the nth orbit of hydrogen atom is

1. Directly proportional to n^2
2. Directly proportional to n
3. Inversely proportional to n^3
4. Inversely proportional to n

QUESTION

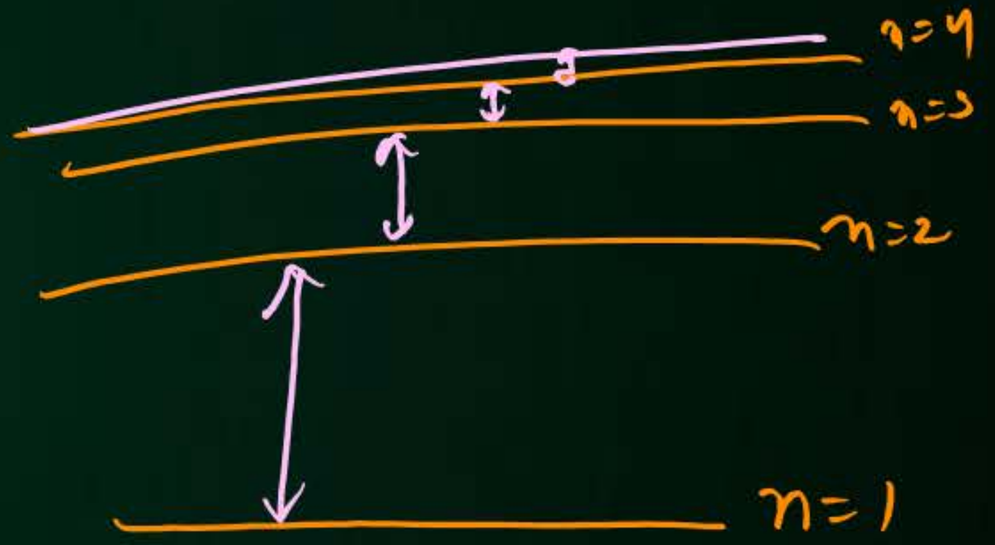
Of the various hydrogen spectrum, the one which lies completely in the ultraviolet region is

1. Lyman series ✓
2. Balmer series ✗
3. Paschen series
4. Brackett series ✗

QUESTION

As the n (number of orbit) increases, the difference of energy between the consecutive energy levels

1. Remains the same
2. Increases
3. Decreases ✓
4. Sometimes increases and sometimes decreases



QUESTION

The ratio of minimum to maximum wavelength of radiation emitted by transition of an electron to ground state of Bohr's hydrogen atom is

1. 3/4 ✓
2. 1/4
3. 1/8
4. 1/5

→ Lyman series.

$$\frac{1}{\lambda_{min}} = R\left[\frac{1}{1} - \frac{1}{\infty}\right] \quad \text{— (1)}$$

$$\frac{1}{\lambda_{min}} = R$$

$$\frac{1}{\lambda_{max}} = R\left[\frac{1}{1} - \frac{1}{2^2}\right] = \frac{3R}{4}$$

$$\frac{1}{\lambda_{max}} = R\left(1 - \frac{1}{4}\right)$$

$$\frac{\lambda_{min}}{\lambda_{max}} = \frac{3R/4}{R}$$

QUESTION

In Bohr's model of the hydrogen atom, the ratio between the period of revolution of an electron in the orbit of $n = 1$ to the period of revolution of the electron in the orbit $n = 2$ is

1. $1 : 2$
2. $2 : 1$
3. $1 : 4$
4. $1 : 8$ ✓ Ans

$T \propto n^3$

$\frac{T_1}{T_2} \propto \left(\frac{n_1}{n_2}\right)^3$

$\frac{T_1}{T_2} = \left(\frac{1}{2}\right)^3 = \frac{1}{8}$

$= 1 : 8$

QUESTION

How many times does the electron go round the first Bohr orbit in a second?

1. 6.57×10^{5} ✗
2. 6.57×10^{10} ✗
3. 6.57×10^{13} ✗
4. 6.57×10^{15}

Ans

$f = \frac{1}{T} = \frac{1}{1.51 \times 10^{-16}}$

$= \frac{2}{3} \times 10^{16}$

$= 0.66 \times 10^{16}$

$= 6.6 \times 10^{15}$

QUESTION

The ratio of the energies of the hydrogen atom in its first excited state to second excited state is

1. 1/4
2. 4/9
3. 9/4
4. 4

2nd orbit 3rd orbit

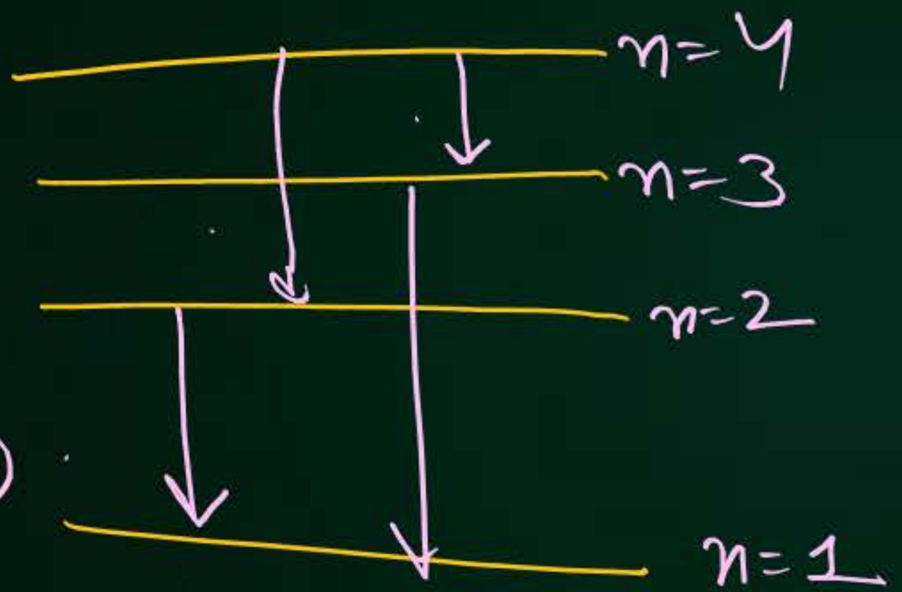
$$E \propto \frac{1}{n^2}$$

$$\frac{E_{2nd}}{E_{3rd}} = \frac{13.6}{(2)^2} \times \frac{(3)^2}{13.6} = \frac{9}{4}$$

QUESTION

Which of the following transitions in a hydrogen atom emit photons of lowest frequency ?

1. $n = 2$ to $n = 1$
2. $n = 4$ to $n = 2$
3. $n = 4$ to $n = 3$
4. $n = 3$ to $n = 1$



QUESTION

The energy of hydrogen atom in its ground state is −13.6 eV. The energy of the level corresponding to $n = 5$ is

1. −0.544 eV
2. −5.40 eV
3. −0.85 eV
4. −2.72 eV

QUESTION

If the electron in hydrogen atom jumps from third orbit to second orbit, the wavelength of the emitted radiation is given by

$n=3$ $\quad$ $n=2$

1. $\lambda = \frac{36}{5R}$ ✓
2. $\lambda = \frac{5R}{36}$
3. $\lambda = \frac{5}{R}$
4. $\lambda = \frac{R}{6}$

$$\frac{1}{\lambda} = R\left[\frac{1}{4} - \frac{1}{9}\right]$$

$$\frac{1}{\lambda} = R\left[\frac{9-4}{36}\right] = \frac{5R}{36}$$

$$\lambda = \frac{36}{5R}$$

QUESTION

The total energy of an electron in the hydrogen atom in the ground state is –13.6 eV. The kinetic energy of this electron is

1. 13.6 eV
2. 0
3. –13.6 eV
4. 6.8 eV

QUESTION

Which state of triply ionised beryllium (Be^{3+}) has the same orbital radius as that of the ground state of hydrogen?

1. 1
2. 2
3. 3
4. 4

$r = \frac{n^2}{Z}$

$\frac{r_{Be}}{r_{H}} = \frac{n^2}{(4)} = \frac{(1)}{\times(1)}$

$n^2 = 4$

$n = \sqrt{4} = 2$

QUESTION

An electron makes a transition from orbit $n = 4$ to the orbit $n = 2$ of a hydrogen atom. What is the wavelength of the emitted radiations?
(R = Rydberg's constant)

1. $\frac{16}{4R}$
2. $\frac{16}{5R}$
3. $\frac{16}{2R}$
4. $\frac{16}{3R}$ ✓

$$\frac{1}{\lambda} = R\left(\frac{1}{4} - \frac{1}{16}\right)$$

$$\frac{1}{\lambda} = R\left(\frac{4-1}{16}\right)$$

$$\frac{1}{\lambda} = \frac{3R}{16}$$

QUESTION

Compton effect supports that

1. X-rays are transverse waves
2. X-rays have high frequency compared to visible light
3. X-rays can easily penetrate matter
4. Photons have momentum

QUESTION

Which is the correct relation between de-Broglie wavelength of an electron in the n^{th} Bohr orbit and radius of the orbit R?

(1) $\lambda = n2\pi R$ ✗

(2) $\lambda = \dfrac{2\pi R}{n}$ ✓

(3) $\lambda = \dfrac{4\pi R}{n}$ ✗

(4) $\lambda = \dfrac{2\pi R}{nh}$ ✗

$n\lambda = 2\pi R$

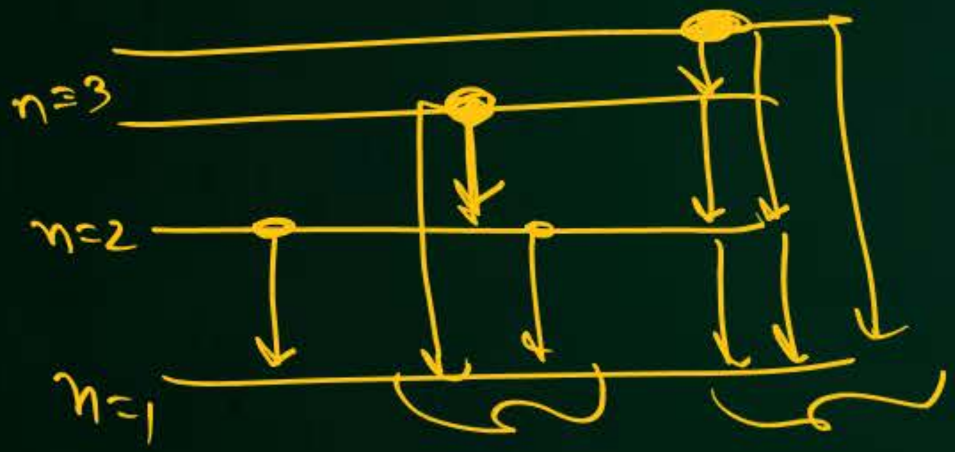
$\lambda = \dfrac{2\pi R}{n}$

QUESTION

Hydrogen atoms are excited from ground state to the principal quantum number 5. Number of spectral lines observed will be

1. 5
2. 4
3. 10
4. 8

$$\frac{n(n-1)}{2} = \text{no of spectral line}$$



$$\frac{5(5-1)}{2} = 10$$

QUESTION

The product of angular speed and tangential speed of electron in n^{th} orbit of hydrogen atom is

1. Directly proportional to n^2
2. Directly proportional to n^3
3. Inversely proportional to n^4 //
4. Independent of n

$$\omega \times v = \frac{1}{n^3 \times n}$$

$$= \frac{1}{n^4}$$

$$\omega \times v \propto \frac{1}{n^3} \times \frac{1}{n} = \frac{1}{n^4} \propto n^{-4}$$

Angular momentum depent on r as.

$L = mvr$

(a) $L \propto r$

(b) $L \propto \frac{1}{r}$

(c) $L \propto r^2$

(d) $L \propto \sqrt{r}$

(e) $L \propto \frac{1}{\sqrt{r}}$

$L = \frac{nh}{2\pi}$

$L \propto n$

Soln

$L = mvr$

$L \propto rv$

$L \propto rv$

$L \propto r \frac{1}{\sqrt{r}} = \sqrt{r}$

$\frac{mv^2}{r} = \frac{K}{r^2}$

$v \propto \frac{1}{\sqrt{r}}$

QUESTION

If a Bohr's atomic model, it is assumed that force between electron and proton varies inversely as r^4, energy of the system will be proportional to

1. n^2
2. n^4
3. n^6 ✓
4. n^8

$$\frac{mv^2}{R} \propto \frac{K}{R^4}$$

$$v^2 \propto \frac{1}{R^3}$$

$$R^3 \propto \frac{1}{v^2}$$

$$R \propto \frac{1}{v^{2/3}}$$

$$L = mvr = \frac{nh}{2\pi}$$

$$vr \propto n$$

$$v \frac{1}{v^{2/3}} \propto n$$

$$v^{1-2/3} \propto n$$

$$v^{1/3} \propto n$$

$$v \propto n^3$$

$$K.E \propto v^2 \propto n^6$$

$$K.E = \frac{1}{2}mv^2$$

$F_{electro} \propto \frac{1}{r^2}$ — only valid

$$v \propto \frac{1}{n}$$

$$r \propto n^2$$

$$K.E \propto \frac{1}{n^2}$$

QUESTION

What should be the ratio of minimum to maximum wavelength of radiation emitted by transition of an electron to ground state of Bohr's hydrogen atom ?

1. 3/4
2. 1/4
3. 1/8
4. 3/8

QUESTION

When an electron do transition from $n = 4$ to $n = 2$, then emitted line in spectrum will be

1. First line of Lyman series
2. Second line of Balmer series
3. First line of Paschen series
4. Second line of Paschen series

QUESTION

The energy of hydrogen atom in n^{th} orbit is E_n then the energy in n^{th} orbit of singly ionised helium atom will be (2001)

1. $4E_n$
2. $E_n/4$
3. $2E_n$
4. $E_n/2$

$E \propto \frac{Z^2}{n^2}$

QUESTION

In which of the following systems will the radius of the first orbit ($n = 1$) be minimum?

(2003)

1. doubly ionized lithium
2. singly ionized helium
3. deuterium atom
4. hydrogen atom

$r = \frac{n^2}{Z}$

$r_{min} = \frac{r_0 n^2}{Z_{max}}$

QUESTION

An electron in a hydrogen atom makes a transition from $n = n_1$ to $n = n_2$. The time period of the electron in the initial state is eight times that in the final state. Find the ratio n_1/n_2 is

1. 2
2. 3
3. 4
4. 8

QUESTION

Assuming Bohr's model for Li^{++} atom, the first excitation energy of ground state of Li^{++} atom is

1. 10.2 eV
2. 91.8 eV
3. 13.6 eV
4. 3.4 eV

QUESTION

The absorption transition between the first and the fourth energy states of hydrogen atom are 3. The emission transition between these states will be

1. 3
2. 4
3. 5
4. 6

QUESTION

When a hydrogen atom emits a photon of energy 12.1 eV, its orbital angular momentum changes by (where h is Planck's constant)

1. $\frac{3h}{\pi}$
2. $\frac{2h}{\pi}$
3. $\frac{h}{\pi}$
4. $\frac{4h}{\pi}$

QUESTION

Which of the following is/are possible values of radius of stable orbit of hydrogen atom?

1. $\frac{\lambda}{2\pi}$

2. $\frac{3\lambda}{4\pi}$

3. $\frac{\lambda}{\pi}$

4. $\frac{5\lambda}{4\pi}$

IONISATION ENERGY

Ionisation Energy: Minimum energy required to remove an e^- from isolated atom.

$$\text{I.E for H-atom} = +13.6 \text{ eV}$$

$$\text{I.E of } He^+ = Z^2 \, \text{I.E}_H = 4 \, (\text{I.E}_H)$$

$$\text{I.E. of } Li^{++} = Z^2 \, \text{I.E}_H = 9 \, (\text{I.E}_H)$$

EXCITATION ENERGY

Ionisation Energy: Minimum energy required to remove an e^- from isolated atom.

I.E for H-atom = +13.6 eV

I.E of $He^+ = Z^2\ I.E_H = 4\ (I.E_H)$

I.E. of $Li^{++} = Z^2\ I.E_H = 9\ (I.E_H)$

QUESTION

The ratio of wavelength of the last line of Balmer series and the last line of Lyman series is

[NEET 2017]

1. 1
2. 4
3. 0.5
4. 2

QUESTION

Given the value of Rydberg constant is $10^7\ m^{-1}$, the wave number of the last line of the Balmer series in hydrogen spectrum will be **(NEET-I 2016)**

1. $0.25 \times 10^7\ m^{-1}$
2. $2.5 \times 10^7\ m^{-1}$
3. $0.025 \times 10^4\ m^{-1}$
4. $0.5 \times 10^7\ m^{-1}$

$\propto$

$K = \frac{2\pi}{\lambda}$ Angul wave no

$\frac{1}{\lambda}$ = wave number ✓

QUESTION

Ratio of longest wavelengths corresponding to Lyman and Balmer series in hydrogen spectrum is [NEET 2013]

1. 7/29
2. 9/31
3. 5/27
4. 5/23

QUESTION

The energy of a hydrogen atom in the ground state is –13.6 eV. The energy of a He^+ ion in the first excited state will be [2010]

1. –13.6 eV
2. –27.2 eV
3. –54.4 eV
4. –6.8 eV

QUESTION

The electron in the hydrogen atom jumps from excited state ($n = 3$) to its ground state ($n = 1$) and the photons thus emitted irradiate a photosensitive material. If the work function of the material is 5.1 eV, the stopping potential is estimated to be (the energy of the electron in nth state $E_n = \frac{-13.6}{n^2}$ eV)

1. 5.1 V
2. 12.1 V
3. 17.2 V
4. 7 V

QUESTION

Consider 3rd orbit of He^+ (Helium), using non-relativistic approach, the speed of electron in this orbit will be [given $K = 9 \times 10^9$ constant, $Z = 2$ and h (Planck's constant) $= 6.6 \times 10^{-34}$ J s]

(2015 Cancelled)

1. 0.73×10^6 m/s
2. 3.0×10^8 m/s
3. 292×10^6 m/s
4. 1.46×10^6 m/s

None
H/W

QUESTION

In which of the following systems will the radius of the first orbit ($n = 1$) be minimum?

(2003)

1. doubly ionized lithium
2. singly ionized helium
3. deuterium atom
4. hydrogen atom

QUESTION

If an electron in a hydrogen atom jumps from the 3^{rd} orbit to the 2^{nd} orbit, it emits a photon of wavelength λ. When it jumps from the 4^{th} orbit to the 3^{rd} orbit, the corresponding wavelength of the photon will be [NEET-II 2016]

1. $\frac{16}{25}\lambda$
2. $\frac{9}{16}\lambda$
3. $\frac{20}{7}\lambda$
4. $\frac{20}{13}\lambda$

QUESTION

Hydrogen atom in ground state is excited by a monochromatic radiation of $\lambda = 975Å$. Number of spectral lines in the resulting spectrum emitted will be (2014)

1. 3
2. 2
3. 6
4. 10

DRAWBACKS OF BOHR'S MODEL

- This model could not explain the fine structure of spectral line.
- There was a splitting of spectral line in presence of magnetic field and electric field, which could not explained by Bohr's model
- This is only valid for single electron atom H, He^{+}, Ki^{++}
- This model is based on circular orbits of electron but in reality there are no circular orbit.
- This model could not explain the intensity of spectral lines.
- This model only considered particle nature of electron.


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 01 | Physics

Nuclei

By- Dr. Manish Raj (MR SIR)



Topics to be covered

absorbtion spectrum / atomic collision

1. NUCLEAR PARTICLE
2. NUCLEAR DENSITY, RADIUS, VOLUME
3. BINDING ENERGY OF NUCLEUS
4. STABILITY OF NUCLEUS



QUESTION

When a hydrogen atom is raised from the ground state to third state

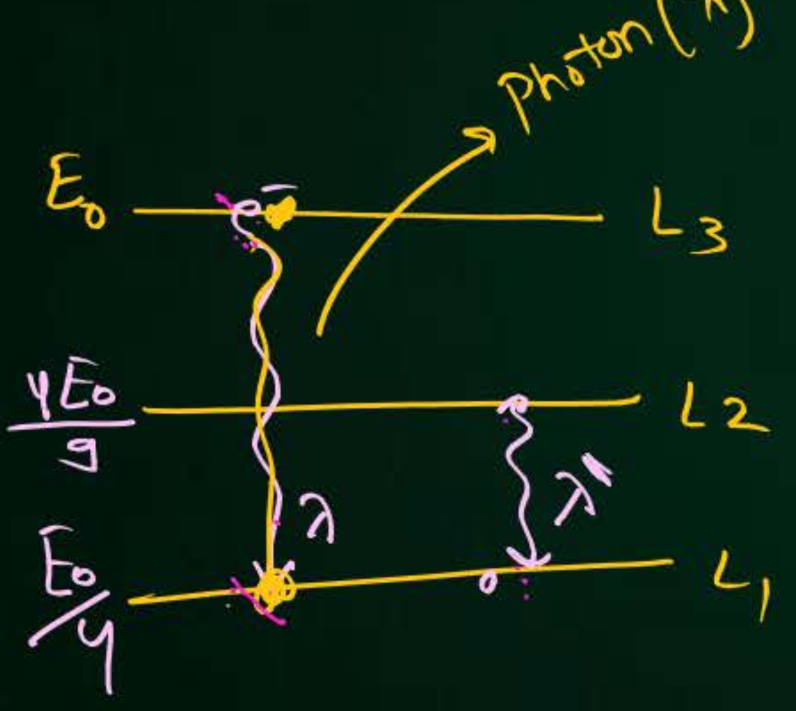
1. Both kinetic energy and potential energy increase
2. Both kinetic energy and potential energy decrease
3. Potential energy increases and kinetic energy decreases
4. Potential energy decreases and kinetic energy increases



QUESTION

The energies of three [redacted] energy levels L_3, L_2 and L_1 of hydrogen atom are E_0, $\frac{4E_0}{9}$ and $\frac{E_0}{4}$ respectively. A photon of wavelength λ is emitted for a transition L_3 to L_1. What will be the wavelength of emission for transition L_2 to L_1?

1. $\frac{16\lambda}{31}$
2. $\frac{27\lambda}{7}$
3. $\frac{19}{20}\lambda$
4. λ

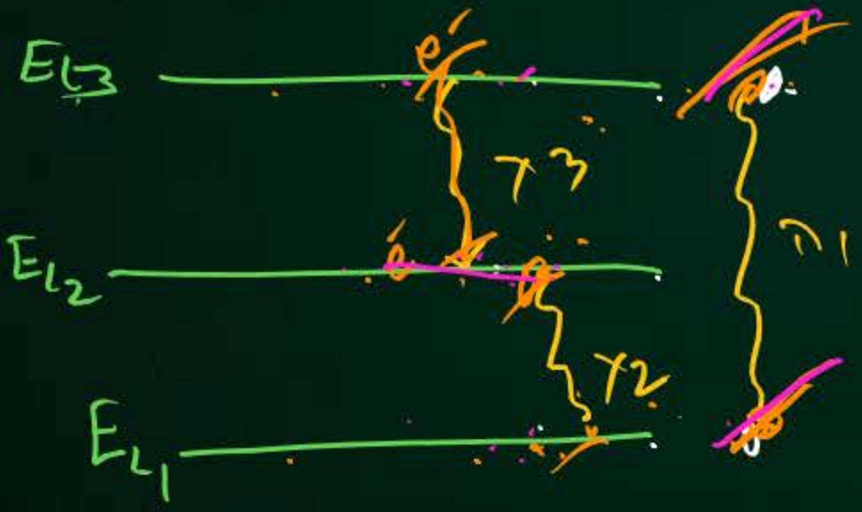




QUESTION

Three energy levels L_1, L_2 and L_3 of a hydrogen atom correspond to increasing values of energy *i.e.*, $E_{L1} < E_{L2} < E_{L3}$. If the wavelength corresponding to the transitions L_3 to L_2, L_2, to L_1, and L_3, to L_1, are λ_3. λ_2 and λ_1 respectively then

1. $\lambda_3 = \lambda_1 + \lambda_2$
2. $\lambda_1 = \dfrac{\lambda_2 \lambda_3}{\lambda_2 + \lambda_3}$
3. $\lambda_1 = \lambda_2 + \lambda_3$
4. $\lambda_3 = \dfrac{\lambda_1 \lambda_2}{\lambda_1 + \lambda_2}$



Sol

$E_{L_3} - E_{L_2} = \dfrac{hc}{\lambda_3}$

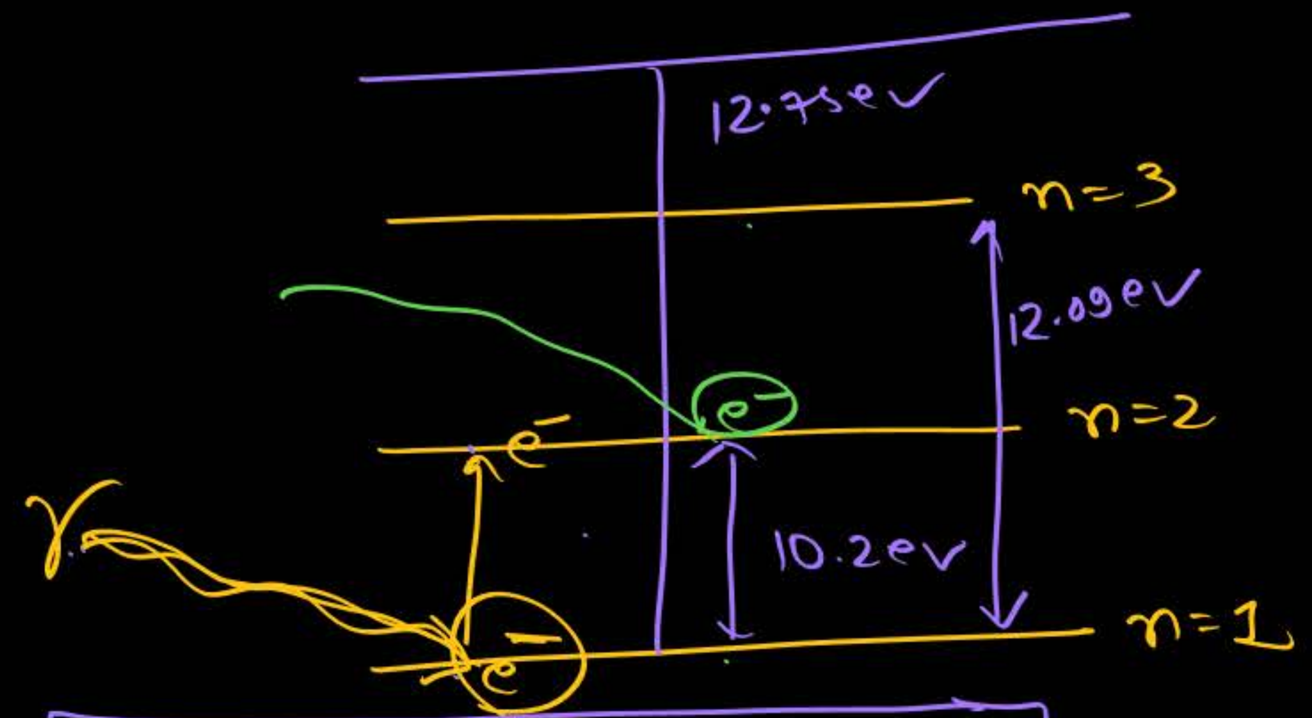
$E_{L_2} - E_{L_1} = \dfrac{hc}{\lambda_2}$

$\dfrac{hc}{\lambda_1} = \dfrac{hc}{\lambda_3} + \dfrac{hc}{\lambda_2}$

$\dfrac{1}{\lambda_1} = \dfrac{\lambda_2 + \lambda_3}{\lambda_2 \lambda_3}$

$\lambda_1 = \dfrac{\lambda_2 \lambda_3}{\lambda_2 + \lambda_3}$

absorbtion specturm — only possible from ground state



$E_\gamma = 12.09\,eV$, $E_p = 12.75\,eV$

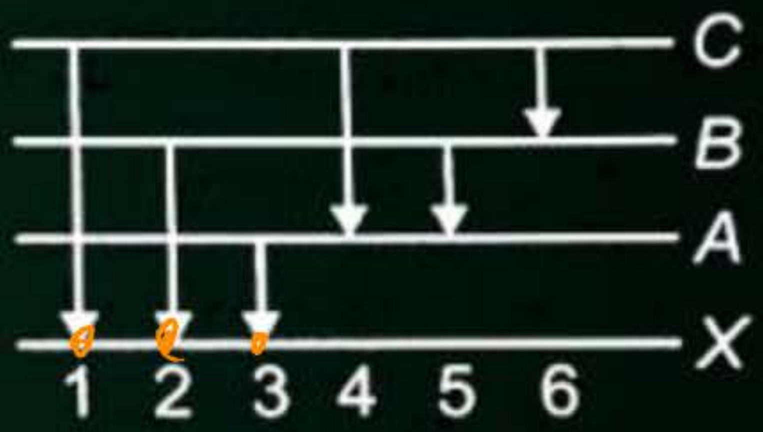
$E_\gamma = 10.2\,eV$ Photon absorbed #

$E_\gamma = 5.8\,eV$ ✗ will not absorb

QUESTION

The figure indicates that energy level diagram of an atom and the origin of six spectral lines in emission (*e.g.* line number 5 arises from the transition from level *B* to *A*). Which of the following spectral lines will also occur in the absorption spectrum?

1. 4, 5, 6
2. 1, 2, 3, 4, 5, 6
3. 1, 2, 3
4. 1, 4, 6

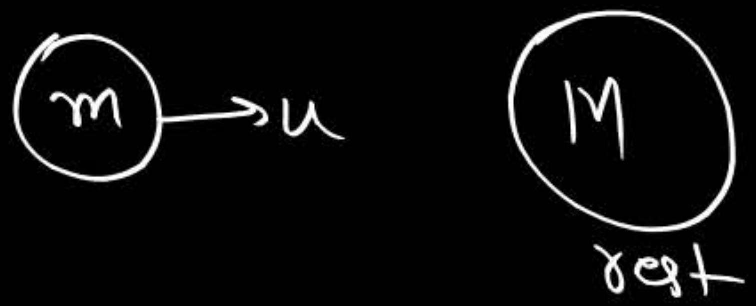


atomic collision

\# In elastic collsion K.E is conserves at all the time → false

$(K.E)_{B/C} = (K.E)_{A/C}$ → in elastic collsion.

Perfectly Inelastic collsion



$$\Delta K.E = \frac{1}{2}\frac{mM}{(m+M)}u^2$$



$$\Delta K.E = \frac{1}{2}\frac{m_\alpha M}{m_\alpha + m}u^2$$

$\Delta K.E = 10.2ev, 12.09ev, 12.7ev$ → collsion Inelastic collsion

$\Delta K.E \neq$ 10.2ev, $\neq$ 12.09ev, $\neq$ 12.75ev → collsion is elastic,

Nuclear Physics

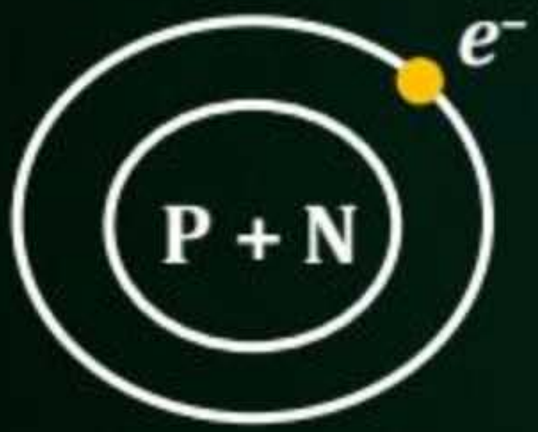
NUCLEI

$${}^{A}_{Z}X$$

A : mass no = no. of P + no. of N

Z : atomic no. = no, of proton

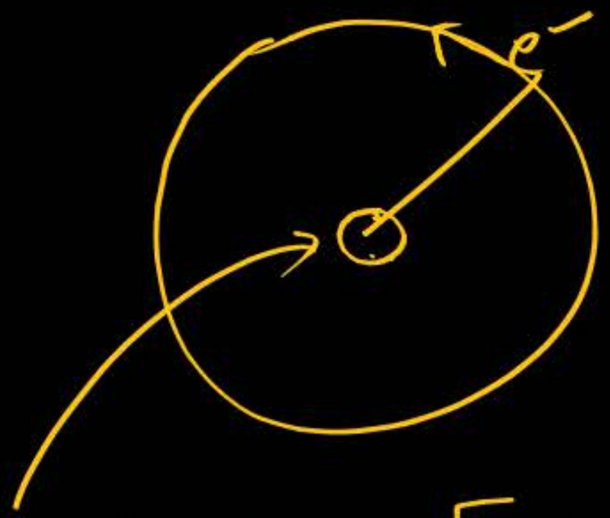
electron	Positron
quarks	
neutrino	Anti-neutrino



Proton + Neutron

- Nucleons
- Hydrons
- Baryons

Nucleus



$_{Z}Y^{A}$ = Nucleus

A = mass no.
A = total no of nucleons
= total no of Proton + Neutron ☆

Z = atomic no. = total no of Proton.

no. of neutron = A - Z *

Nucleus → [Proton + Neutron]
→ [Nucleons, Baryons, Hadrons]

$r_{atom} = 10^{-10}\,m$

$r_{nucleus} = 10^{-15}\,m$

$\frac{r_{atom}}{r_{nuc}} = \frac{10^{-10}\,m}{10^{-15}\,m} = 10^{5}$

Protons & neutrons are not fundamental particles
only electrons are fundamental particle.



Proton Neutron.

up quarks → $+\frac{2}{3}e$
down quarks → $-\frac{1}{3}e$

quarks

up	top	beauty	→ $+\frac{2}{3}e$
down	bottom	charm	→ $-\frac{1}{3}e$

fundamental particle

quarks, electron
neutrino, Positron
Anti-neutrino

- $m_p = 1.67 \times 10^{-27}$ kg = 1.0073 a.m.u.
- $m_n = 1.67 \times 10^{-27}$ kg = 1.0087 a.m.u.
- $m_e = 9.1 \times 10^{-31}$ kg

$$1 \text{ a.m.u.} = 1.66 \times 10^{-27} \text{ kg} = \frac{{}_6C^{12}}{12}$$

one atomic mass unit

REST MASS ENERGY:

$$E = mc^2$$

rest-mass energy



$E = mc^2$

$E_{pinky} = 20 \times (3\times10^8)^2$

$= 20 \times 9 \times 10^{16}$

$= 180 \times 10^{16}$

$E_{pinky} = 1.8 \times 10^{18}$ J

Rest Mass Energy Corresponding 1 a.m.u Mass

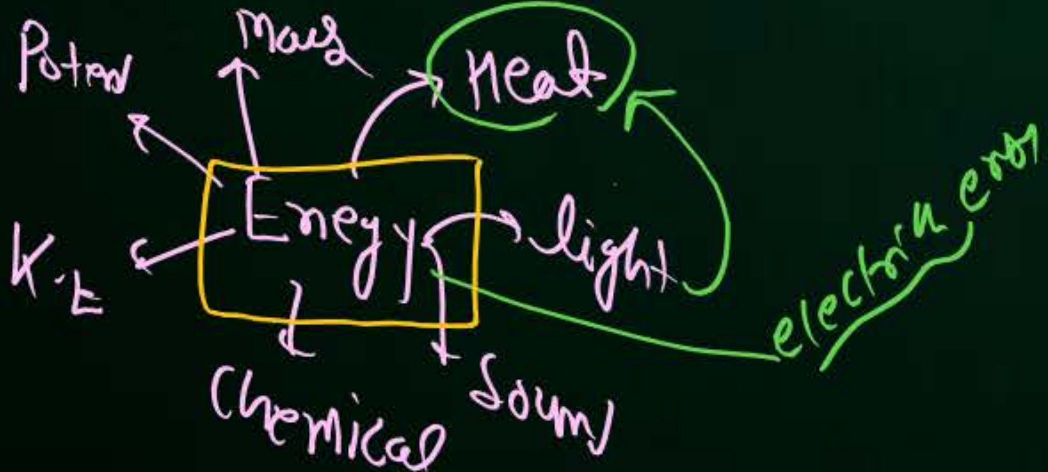
$$E = mc^2$$

$$= 1\,amu\,c^2 = 1.66\times10^{-27}\,kg \times (3\times10^8)^2$$

$$1\,amu \times c^2 = 931.5\,MeV$$

Mass → Mass is nothing but form of energy.

$$1\,amu = 931.5\,MeV/c^2$$

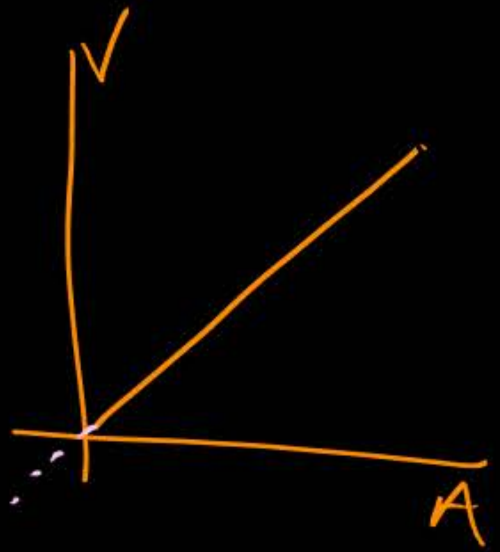


dim^n of mass no = dim^{n}less, unitless

Volume of nucleus

$V \propto A$ (mass no.)

$$V = V_0 A$$



$\frac{4}{3}\pi R^3 \propto A$

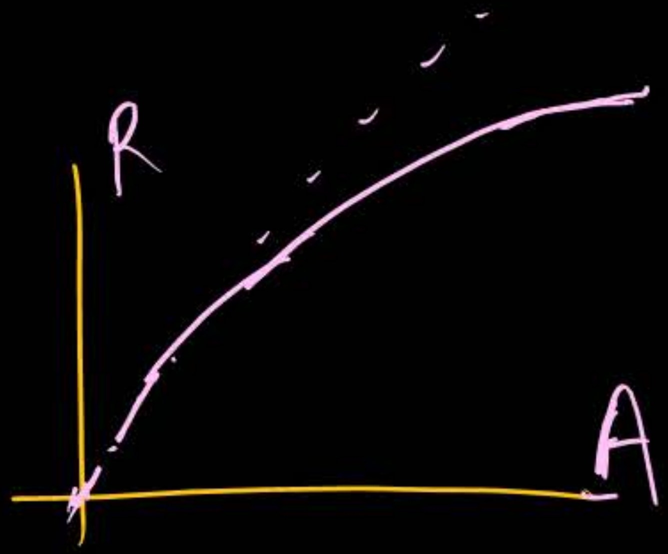
$R^3 \propto A$

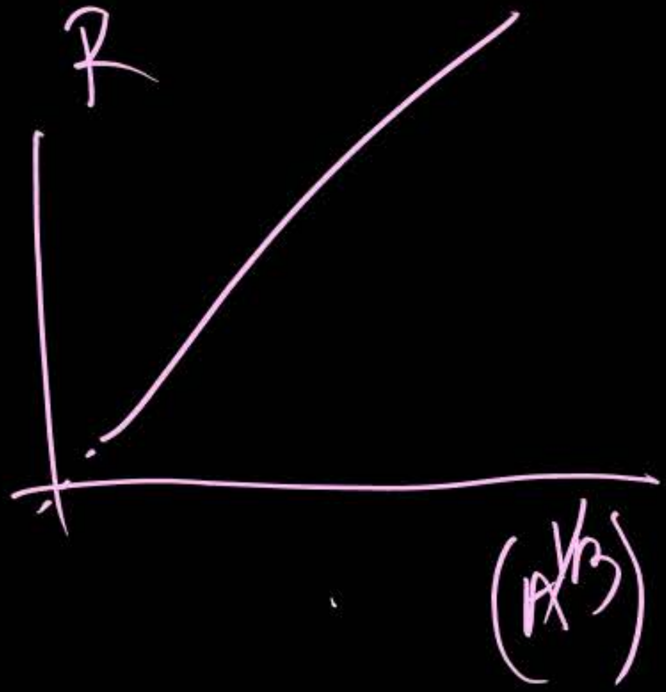
$R \propto A^{1/3}$

$$R = R_0 A^{1/3}$$ *

$R_0 = 1.2$ fm, 1.4 fm

$$\frac{R_1}{R_2} = \left(\frac{A_1}{A_2}\right)^{1/3}$$





density of nucly

$$\rho = \frac{\text{mass}}{\text{Volume}}$$

$$\rho = \frac{m_p A}{V_0 A}$$

$$\rho = \frac{m_p}{V_0} = 10^{17}\ \text{kg/m}^3$$

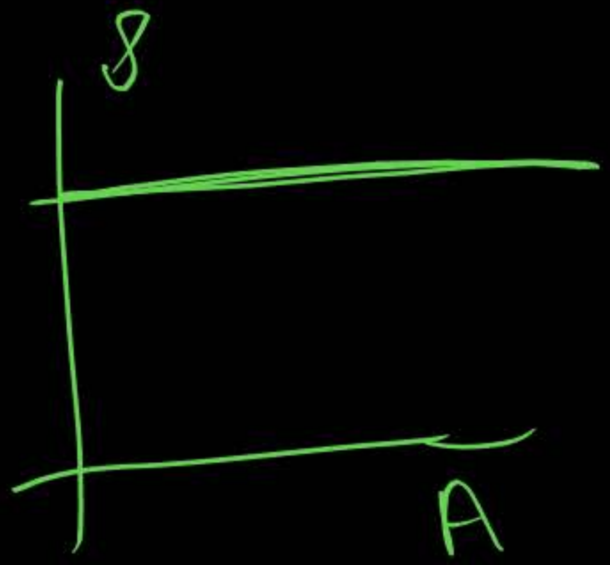
$\forall$ $\boxed{m_p = m_n}$

A = total no of nucly

$\rho = 10^{17}\ \text{kg/m}^3$ = very high densty

ρ = cont for all nucleus

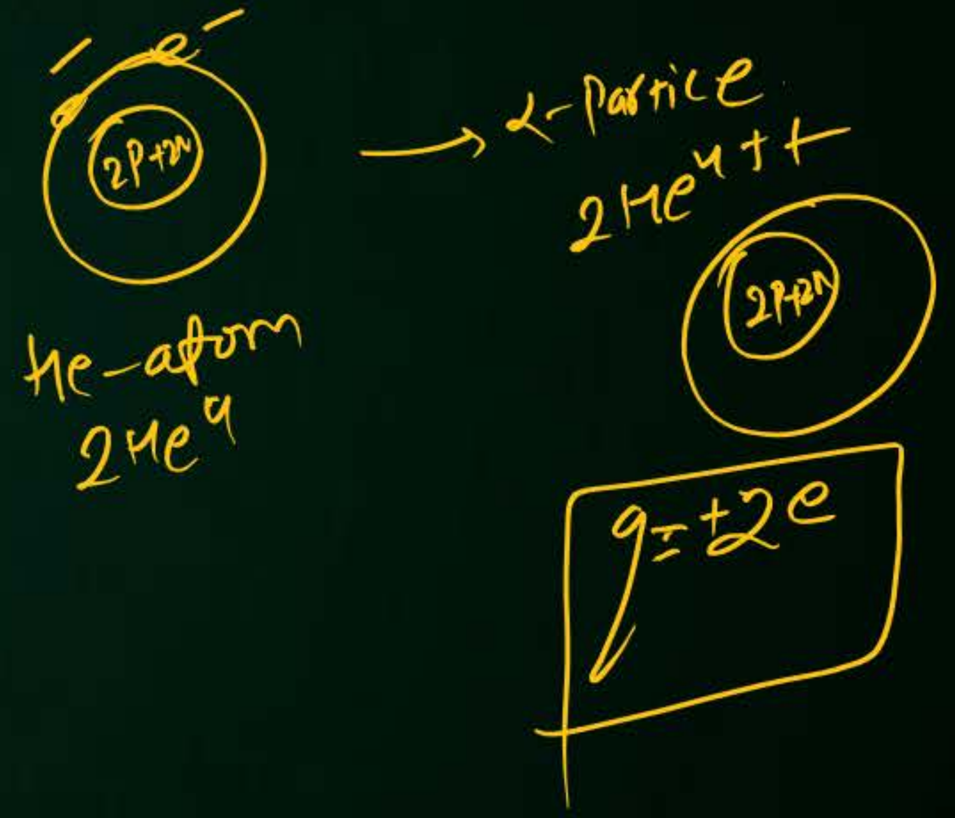
dont depent on mass no.



QUESTION

α-particle consists of **(NEET 2019)**

1. 2 protons only
2. 2 protons and 2 neutrons only
3. 2 electrons, 2 protons and 2 neutrons
4. 2 electrons and protons only



QUESTION

The energy equivalent of one atomic mass unit is (1992)

1. 1.6×10^{-19} J ✗
2. 6.02×10^{23} J ✗
3. 931 MeV ✓ → $E = 1\,amu \times c^2 = 931.5$ MeV
4. 9.31 MeV ✗

QUESTION

The energy equivalent of 0.5 g of a substance is

(NEET 2020)

1. 4.5×10^{16} J
2. 4.5×10^{13} J
3. 1.5×10^{13} J
4. 0.5×10^{13} J

$E = m \times c^2$

$= (0.5 \times 10^{-3}\ kg) \times (3 \times 10^8)^2$

$= 9 \times 10^{16} \times 10^{-3} \times \frac{5}{10}$

$= \frac{45 \times 10^{12} \times 10}{10}$

$= 4.5 \times 10^{13}$

QUESTION

1 atomic mass unit is equal to

1. $\frac{1}{16}$ (mass of O_2 molecules)
2. $\frac{1}{25}$ (mass of F_2 molecules)
3. $\frac{1}{12}$ (mass of one C-atom) ✓
4. $\frac{1}{14}$ (mass of N_2 molecules)

Nuclear Size:

Volume of nucleus $\propto$ mass no.

Nuclear density:

$$\delta = \frac{\text{Mass of nucleus}}{\text{Volume}}$$

QUESTION

What is the nuclear radius of ^{125}Fe if that of ^{27}Al is 3.6 fermi?

^{125}Fe $\quad$ ^{27}Al

R_{Fe} $\quad$ $R_{Al} = 3.6\ fm$

$$R \propto A^{1/3}$$

$$\frac{R_{Fe}}{R_{Al}} = \left(\frac{125}{27}\right)^{1/3}$$

$$R_{Fe} = 3.6 \times \left[\frac{5}{3}\right]$$

(3.6 struck out with 1.2 written above it, 3 struck out)

$\boxed{R_{Fe} = 6\ fm}$

QUESTION

The volume occupied by an atom is greater than the volume of the nucleus by a factor of about

1. 10^1
2. 10^5 (67%)
3. 10^{10}
4. 10^{15} (23%)

$$\frac{V_{atom} = \frac{4}{3}\pi R_{ato}^3}{V_{nucl} = \frac{4}{3}\pi R_{nucl}^3}$$

$$\frac{V_{atom}}{V_{nucl}} = \left(\frac{R_{ato}}{R_{n}}\right)^3 = (10^5)^{\times 3} = 10^{15}$$

QUESTION

Assuming the nuclei to be spherical in shape, how does the surface area of a nucleus of mass number A_1 compare with that of a nucleus of mass number A_2.

Hint : $S = 4\pi R^2 \propto A^{2/3}$

$R \propto A^{1/3}$

$\text{Area} = 4\pi R^2$

$\text{Area} \propto A^{2/3}$

QUESTION

The ratio of the radii of the nuclei ${}_{13}Al^{27}$ and ${}_{52}Te^{125}$ is approximately (1990)

1. $6 : 10$
2. $13 : 52$
3. $40 : 177$
4. $14 : 73$

QUESTION

The mass number of a nucleus is

1. Always less than its atomic number
2. Always more than its atomic number
3. Sometimes equal to its atomic number
4. Sometimes less than and sometimes more than its atomic number

QUESTION

Two nuclei have their mass numbers in the ratio of 1 : 3. The ratio of their nuclear densities would be

1. 1 : 1
2. 1 : 3
3. 3 : 1
4. $(3)^{1/3} : 1$

QUESTION

A nucleus ruptures into two nuclear parts, which have their velocity ratio equal to 2 : 1. What will be the ratio of their nuclear size (nuclear radius)?

1. $3^{1/2} : 1$
2. $1 : 3^{1/2}$
3. $2^{1/3} : 1$
4. $1 : 2^{1/3}$

Conservation of momentum

$$P_1 = P_2$$

$$m_1 v_1 = m_2 v_2$$

$$\frac{m_1}{m_2} = \frac{v_2}{v_1} = \frac{1}{2}$$

$$\frac{\rho \frac{4}{3}\pi R_1^3}{\rho \frac{4}{3}\pi R_2^3} = \frac{m_1}{m_2} = \frac{1}{2}$$

$$\Rightarrow \left(\frac{R_1}{R_2}\right)^3 = \frac{1}{2}$$

QUESTION

M_n and M_p represent the mass of neutron and proton respectively. An element having mass M has N neutrons and Z protons, then the correct relation will be (2001)

1. $M < \{N \cdot M_n + Z \cdot M_p\}$
2. $M > \{N \cdot M_n + Z \cdot M_p\}$
3. $M = \{N \cdot M_n + Z \cdot M_p\}$
4. $M = N\{M_n + M_p\}$

nucleus Mass = M

M = nucleus, $N m_n + Z m_p$ = total mass

2P+2N → Break → (P+P+N+N), $2m_p + 2m_n = M_{total}$

Energy given to break

M < Mass of nucleons

$B.E = \Delta m \times c^2$

Mass defect = (mass of all nucleons) − Mass of nucleus

NUCLEAR BINDING ENERGY/MASS DEFECT

$$\Delta M = [Zm_p + (A - Z)\, m_n - M\ (\text{Nuclear})]$$

mass defect

$_ZX^A$

mass deffect $\Delta m = [Zm_p + (A-Z)m_n - m]$

$B.E. = \Delta m \times c^2$

minimum energy given to Break all the nucleus

QUESTION

The mass of proton is 1.0073u and that of neutron is 1.0087u (u = atomic mass unit). The binding energy of $_2He^4$ is (Given, mass of helium nucleus = 4.0015u)

1. 28.4 MeV
2. 62.4 MeV
3. 42.4 MeV
4. 10.2 MeV

$B.E = \Delta m \times c^2$

$= [Zm_p + (A-Z)m_n - M] \times c^2$

$= [2 \times 1.0073 + 2 \times 1.0087 - 4.0015]\ amu \times c^2$

$= [2.0146 + 2.0174 - 4.0015]\ 931.5\ MeV$

4.0320
4.0015

$\Delta m = 0.0305$

$\Delta m \times c^2 = 0.0305 \times 931.5\ MeV$

QUESTION

Binding energy of $_2HE^4$ and $_3Li^7$ are 27.37 MeV and 39.3 MeV respectively. Which of the two nuclei is more stable?

$B.E(_2He^4) = 27.37\ eV$ → $\left(\frac{B.E}{A}\right) = \frac{27.37}{4} = 6.$ ✓

$B.E(_3Li^7) = 39.3\ eV$

$\left(\frac{B.E}{A}\right)_{Li} = \frac{39.3}{7} = 5.2$

(*) $\left(\frac{B.E}{A}\right) \propto$ stablity

$_2He^4$ is more stable than $_3Li^7$

Ans

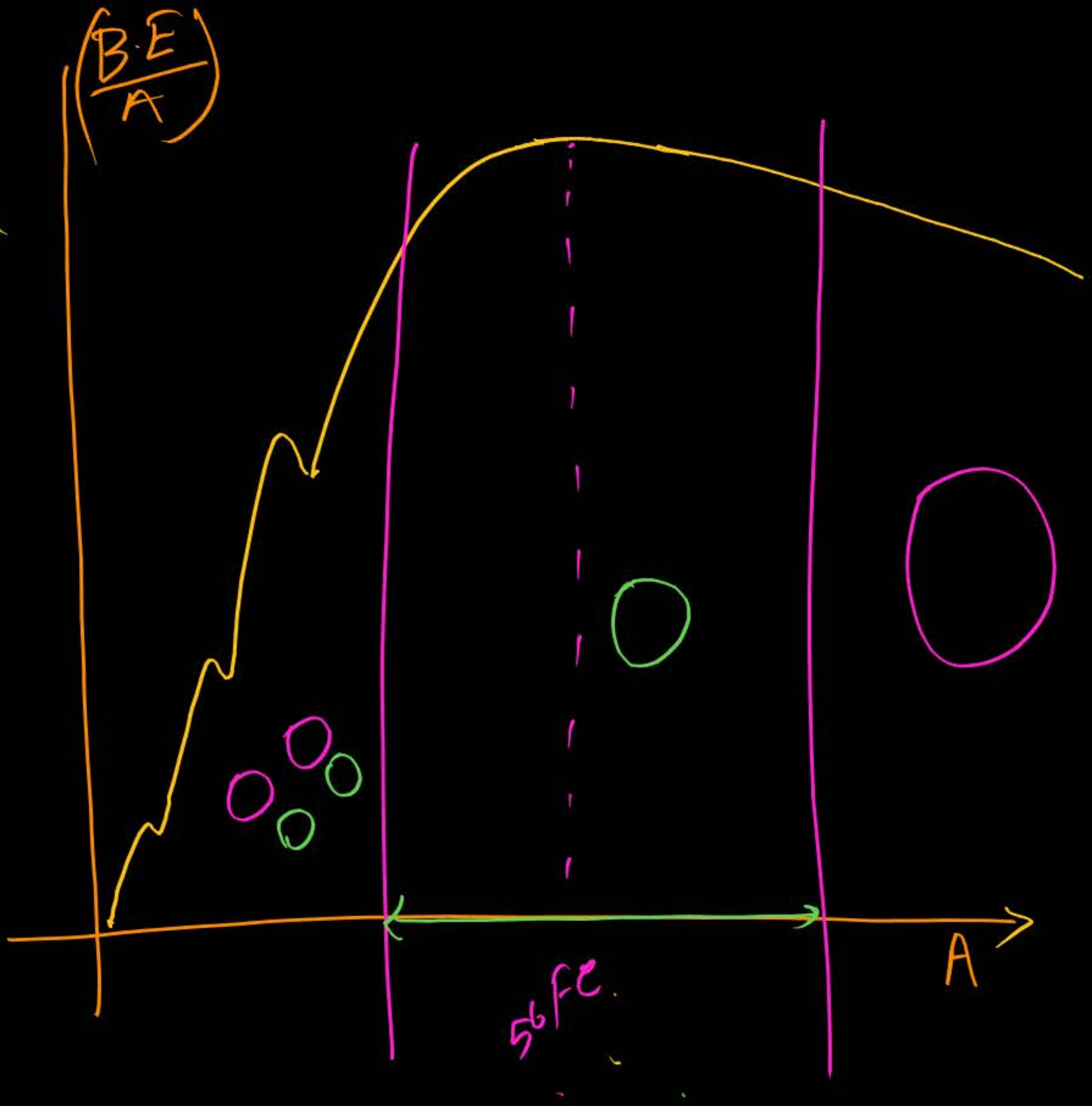
QUESTION

If $M(A; Z)$, M_p and M_n denote the masses of the nucleus ${}^{A}_{Z}X$, proton and neutron respectively in units of u ($1\ u = 931.5\ \text{MeV}/c^2$) and BE represents its binding energy in MeV, then (2008, 2004)

1. $M(A, Z) = ZM_p + (A - Z)M_n - BE$
2. $M(A, Z) = ZM_p + (A - Z)M_n + BE/c^2$
3. $M(A, Z) = ZM_p + (A - Z)M_n - BE/c^2$
4. $M(A, Z) = ZM_p + (A - Z)M_n + BE$

done

as $A \uparrow$ then $\left(\frac{B.E}{A}\right)$ is 1st increase
then decrease



QUESTION

The average binding energy of a nucleon inside an atomic nucleus is about (1989)

1. 8 MeV
2. 8 eV
3. 8 J
4. 8 erg

THANK YOU




YAKEEN 2.0
FOR NEET 2025
Lecture- 02
Physics
Nuclei
70 Days
Revision
By- Dr. Manish Raj (MR SIR)

Todays Goal

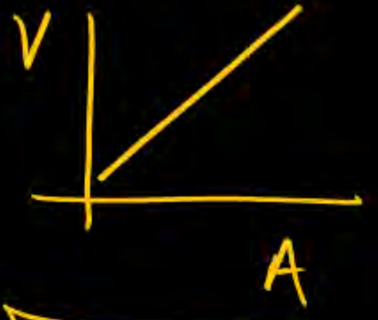
- B.E/A & 'A' Graph
- Q - value of Rctn
- Neutron - Proton Graph

$^{A}_{Z}X$

A → Mass no = Total no of Proton + Neutron.

Z ← atomic no = no of Proton ✓

Volume ∝ A



$R \propto A^{1/3}$





$$\frac{R_1}{R_2} = \left(\frac{A_1}{A_2}\right)^{1/3}$$

density $\propto A^0$
$= 10^{17}\ \text{kg/m}^3$

Δm = mass of all nucleon − $M_{nucleus}$

$$B.E = \Delta m \times c^2$$

B.E → min^n energy given to nuclei to break all the nucleon from nucleus

$$\text{Stability} \propto \left(\frac{B.E}{A}\right)$$

QUESTION

The radius of germanium (Ge) nuclide is measured to be twice the radius of $^{9}_{4}Be$. The number of nucleons in Ge are

1. 72 ✓
2. 73
3. 74
4. 75

$R_{Ge} = 2R_{Be}$ — (1)

$\frac{R_{Ge}}{R_{Be}} = \left(\frac{A}{9}\right)^{1/3}$

$2 = \left(\frac{A}{9}\right)^{1/3}$

$2^3 = \frac{A}{9}$

$8 \times 9 = A$

QUESTION

If $M(A; Z)$, M_p and M_n denote the masses of the nucleus ${}^{A}_{Z}X$, proton and neutron respectively in units of u ($1\ u = 931.5\ \text{MeV}/c^2$) and BE represents its binding energy in MeV, then **(2008, 2004)**

1. $M(A, Z) = ZM_p + (A - Z)M_n - BE$
2. $M(A, Z) = ZM_p + (A - Z)M_n + BE/c^2$
3. $M(A, Z) = ZM_p + (A - Z)M_n - BE/c^2$
4. $M(A, Z) = ZM_p + (A - Z)M_n + BE$

dimension

$B.E = \Delta m \times c^2$

$B.E = (Zm_p + (A-Z)m_n - M) \times c^2$

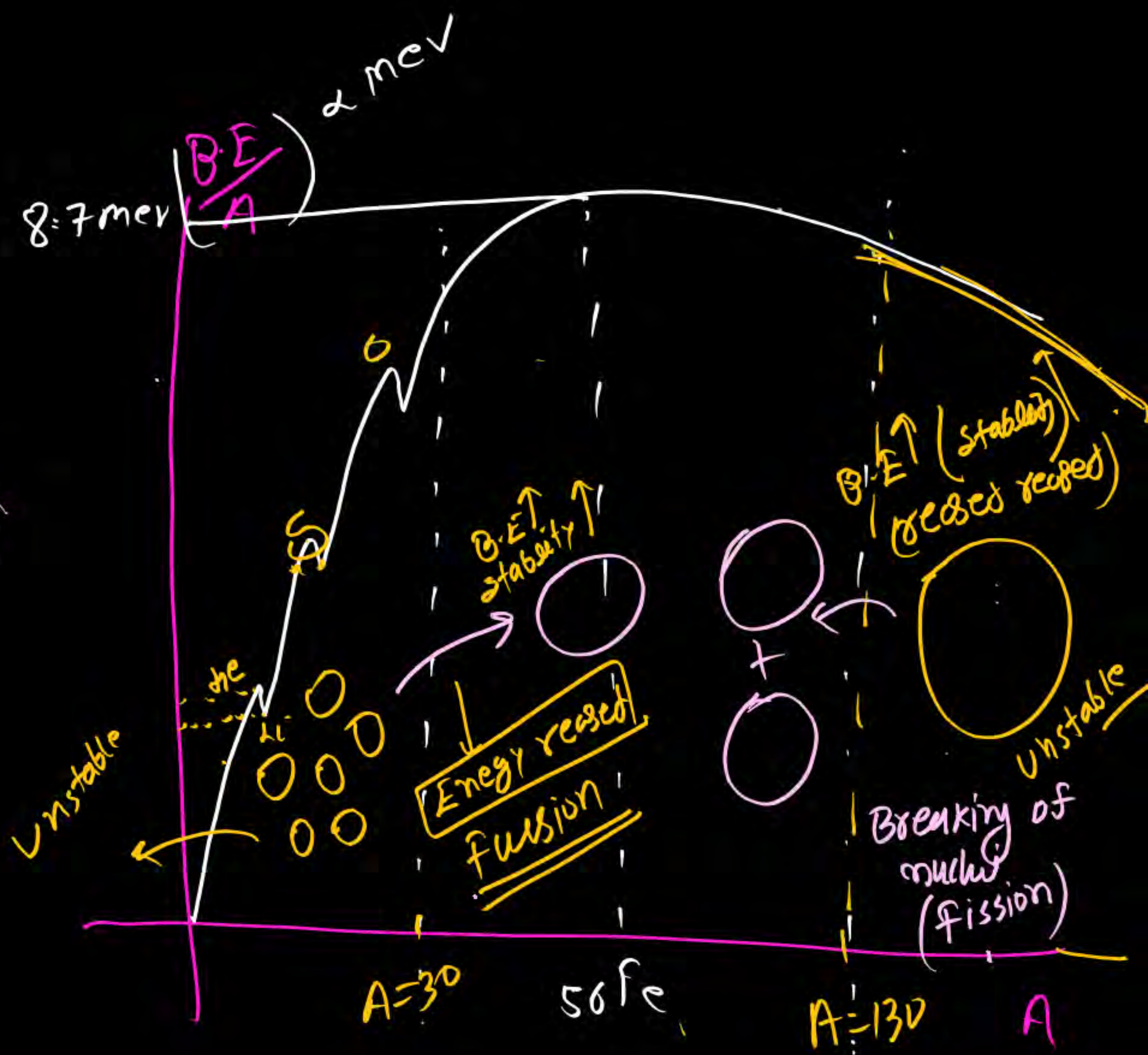
$\frac{B.E}{c^2} = (\quad) - M$



(energy release $\Rightarrow$ stablity Incresed (B.E) $\uparrow$)

$\left(\frac{B.E}{A}\right)_{Avg} = 8\,mev$ ✓

→ $\left(\frac{B.E}{A}\right)$ 1st ↑ then ↓ as mass no (A) ↑



QUESTION

The average binding energy of a nucleon inside an atomic nucleus is about (1989)

1. 8 MeV
2. 8 eV
3. 8 J
4. 8 erg

Q-Value of Nuclear Reaction

$A + B \longrightarrow C + D + Q$

Conservation of enegy

$\Rightarrow m_A c^2 + m_B c^2 = m_C c^2 + m_D c^2 + Q$

$$Q = [(m_A + m_B) - (m_C + m_D)] \times c^2$$

Reactant — Product

If $(m_A + m_B)_{Reactant} > (m_C + m_D)_{product}$

$Q = +ve$ (energy relese) extothermic

C & D More stable

If $(m_A + m_B) < (m_C + m_D)$

Q = absorbed

endothermic reyn

→ C & D less stable → B.E(C) & D ↓

→ Q value of reyn in terms of B.E.

$$Q = B.E(C) + B.E(D) - B.E(A) - B.E(B)$$

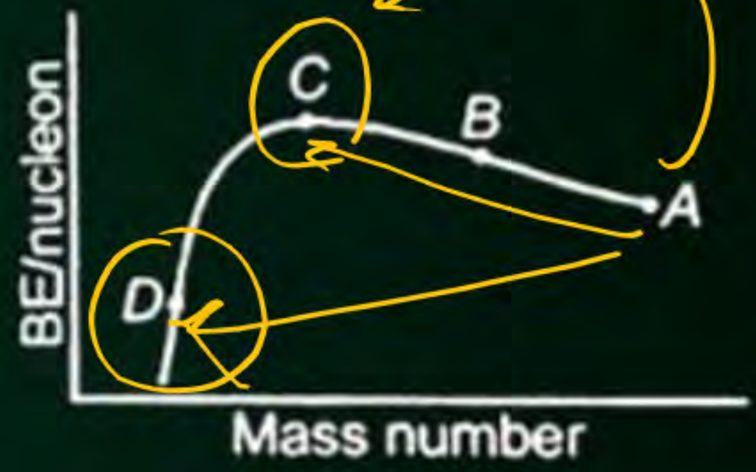
Product — Reactant

If $B.E(C+D) > B.E(A+B)$

Q = realsed

QUESTION

Binding energy per nucleon versus mass number curve for nuclei is shown in the figure. A, B, C and D are four nuclei indicated on the curve. The process that would release energy is



1. $C \rightarrow 2D$
2. $A \rightarrow C + D$
3. $A \rightarrow 2C$
4. $B \rightarrow C + D$

QUESTION

Nucleus A divides into two nuclei B and C in a fission process, their binding energies being E_a, E_b and E_c respectively. Then

1. $E_b + E_c > E_a$
2. $E_b + E_c < E_a$
3. $E_b + E_c = E_a$
4. $E_b - E_c = E_a$

QUESTION

Binding energy per nucleon curve as a function of atomic mass number has a sharp peak for helium nucleus. We can conclude from this that helium nucleus

1. Is very stable
2. Is radioactive
3. Can easily be broken up
4. Can be used as fissionable material

QUESTION

Consider the nuclear reaction

$$X^{200} \rightarrow A^{10} + B^{190}$$

If the binding energy per nucleon for X, A and B is 7.4 MeV, 8.2 MeV and 8.2 MeV respectively, then the amount of the energy released is

1. 200 MeV
2. 160 MeV ✓
3. 110 MeV
4. 90 MeV

$$Q = BE(A+B) - BE(X)$$

$$= 200[8.2] - 200[7.4]$$

$$= 200[8.2 - 7.4]$$

$$= 200 \times 0.8$$

$$= 160$$

QUESTION

The binding energies per nucleon for a deuteron and an α-particle are x_1 and x_2 respectively. The energy Q released in the reaction

$^2H_1 + ^2H_1 \rightarrow ^4He_2 + Q$, is

(1995)

1. $4(x_1 + x_2)$
2. $4(x_2 - x_1)$
3. $2(x_2 + x_1)$
4. $2(x_1 + x_2)$

$Q = 4x_2 - 4x_1$

$= 4[x_2 - x_1]$

QUESTION

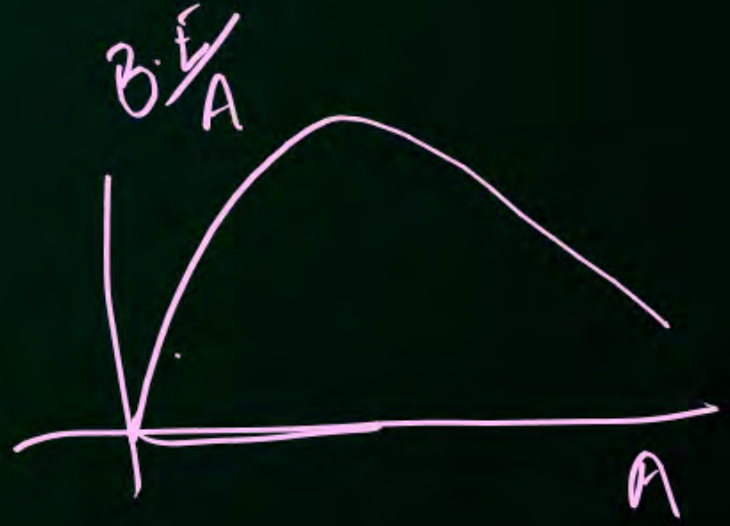
The most penetrating radiation out of the following are

1. β-rays
2. γ-rays
3. X-rays
4. α-rays

QUESTION

How does the Binding Energy per nucleon vary with the increase in the number of nucleons? **(Karnataka NEET 2013)**

1. Decrease continuously with mass number.
2. First decreases and then increases with increase in mass number.
3. First increases and then decreases with increase in mass number.
4. Increases continuously with mass number.



QUESTION

The mass of a $^{7}_{3}Li$ nucleus is 0.042 u less than the sum of the masses of all its nucleons. The binding energy per nucleon of $^{7}_{3}Li$ nucleus is nearly **(2010)**

1. 46 MeV
2. 5.6 MeV
3. 3.9 MeV
4. 23 MeV

Δm

$B.E = \Delta m \times c^2$

$= 0.042\ u \times c^2$

$= 0.042 \times 931.5$ mev

$= \frac{36 \text{ mev}}{A} = 5$

QUESTION

The binding energy per nucleon is maximum in case of (2005)

1. $^{4}_{2}He$
2. $^{56}_{26}Fe$ ✓
3. $^{141}_{56}Ba$
4. $^{235}_{92}U$

- A, B, C → stable Nucli

D → unstable

(N >>> P)

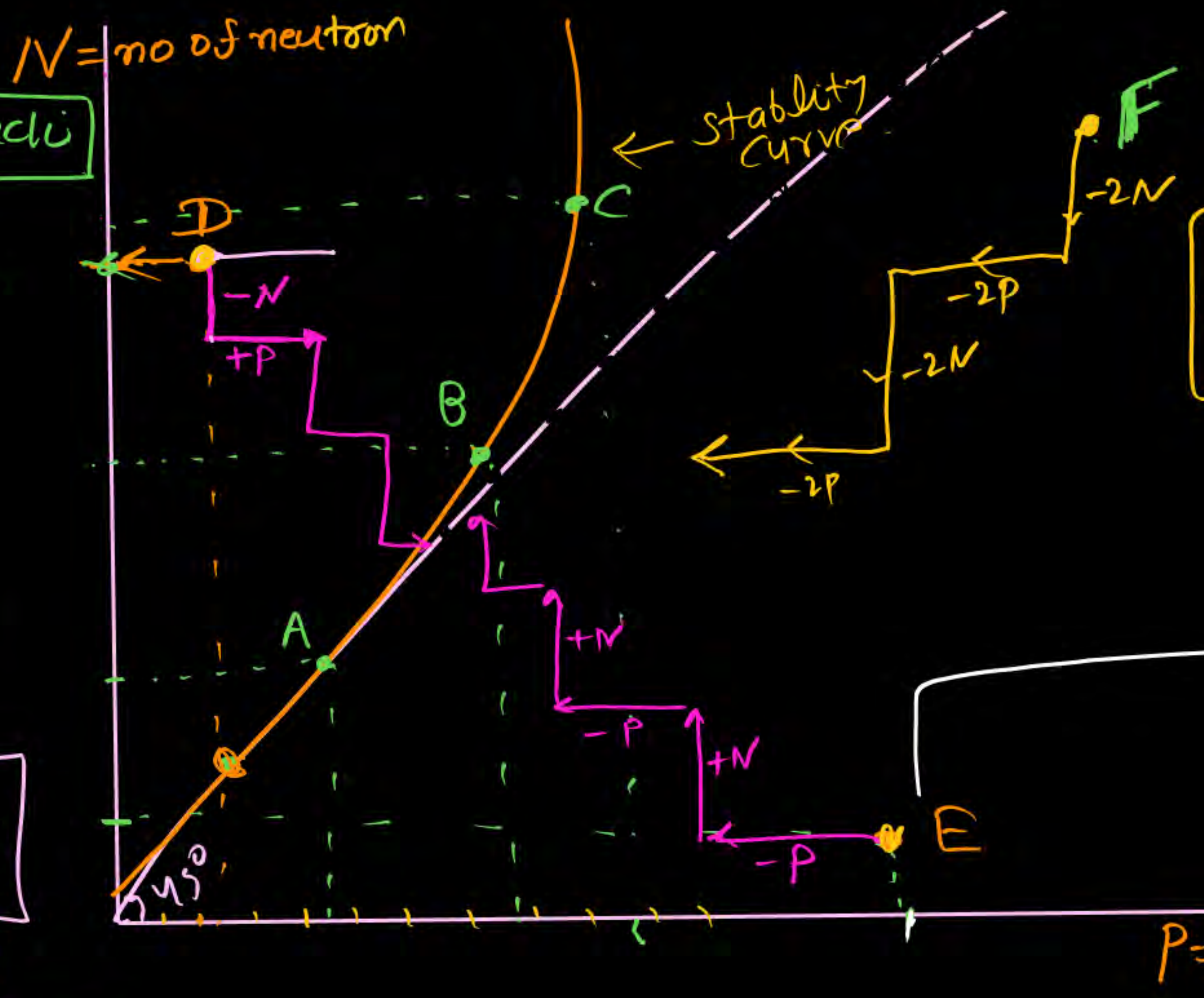
$\left[\frac{N}{P} >>> 1\right]$

$\left[1 >>> \frac{P}{N}\right]$

$N \longrightarrow P + e^- + \bar{\nu}_e$

β⁻ decay (β decay)

$_{Z}X^{A} \longrightarrow {}_{Z+1}Y^{A} + e^-$ → atomic no. Increase by 1, Per β decay A = same



unstable (A >>> 1)

α-decay

$_{Z}X^{A} \longrightarrow {}_{Z-2}Y^{A-4} + {}_{2}He^{4}$

e^- e^+ ν $\bar{\nu}$

β⁺ decay

E → unstable
P >>> N

$\frac{P}{N} >>> 1$

$\frac{N}{P} <<< 1$

Neutrino

$P \longrightarrow N + e^+ + \nu$

β⁺ decay

$_{Z}X^{A} \longrightarrow {}_{Z-1}X^{A} + e^+$

QUESTION

The average binding energy of a nucleon inside an atomic nucleus is about (1989)

1. 8 MeV
2. 8 eV
3. 8 J
4. 8 erg

NUCLEAR STABILITY

Graph between no. of Neutron/no. of Proton.

Stability Curve

QUESTION

Find total number of α and β decay?

QUESTION

α-particles, β-particles and γ-rays are all having same energy. Their penetrating power in a given medium in increasing order will be **(Karnataka NEET 2013)**

1. γ, α, β
2. α, β, γ
3. β, α, γ
4. β, γ, α

QUESTION

A nucleus ${}^{m}_{n}X$ emits one α particle and two β^{-} particles. The resulting nucleus is

(2011, 1998)

1. ${}^{m-6}_{n-4}Z$
2. ${}^{m-6}_{n}Z$
3. ${}^{m-4}_{n}X$
4. ${}^{m-4}_{n-2}Y$



QUESTION

In the nuclear decay given below

$$ {}^{A}_{Z}X \rightarrow {}^{A}_{Z+1}Y \rightarrow {}^{A-4}_{Z-1}B^{*} \rightarrow {}^{A-4}_{Z-1}B, $$

the particles emitted in the sequence are (2009, 1993)

1. γ, β, α
2. β, γ, α
3. α, β, γ
4. β, α, γ

QUESTION

What is the respective number of a and b particles emitted in the following radioactive decay?

$^{200}X_{90} \rightarrow {}^{168}Y_{80}$ (1995)

1. 8 and 8
2. 8 and 6
3. 6 and 8
4. 6 and 6

QUESTION

A deutron is bombarded on $_8O^{16}$ nucleus then α-particle is emitted. The product nucleus is (2002)

(1) $_7N^{13}$

(2) $_5B^{10}$

(3) $_4Be^9$

(4) $_7N^{14}$

QUESTION

Which rays contain (positive) charged particles? (2001)

1. α-rays
2. β-rays
3. γ-rays
4. X-rays

QUESTION

$X(n, \alpha)\ {}_3^7Li$, then X will be [2001]

1. ${}_5^{10}B$
2. ${}_5^{9}B$
3. ${}_4^{11}Be$
4. ${}_2^{4}He$

QUESTION

A nuclear reaction given by

$$_ZX^A \longrightarrow {}_{Z+1}Y^A + {}_{-1}e^0 + \bar{\nu}$$ respectively

(2003)

1. β-decay
2. γ-decay
3. fusion
4. fission

QUESTION

The nucleus $^{115}_{48}Cd$, after two successive β-decay will give (1988)

1. $^{115}_{46}Pa$
2. $^{114}_{49}In$
3. $^{113}_{50}Sn$
4. $^{115}_{50}Sn$

QUESTION

When a uranium isotope $^{235}_{92}U$ is bombarded with a neutron, it generates $^{89}_{36}Kr$, three neutrons and (NEET 2020)

1. $^{144}_{56}Ba$
2. $^{91}_{40}Zr$
3. $^{101}_{36}Kr$
4. $^{103}_{36}Kr$


THANK
YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 03 | Physics

Nuclei



By- Dr. Manish Raj (MR SIR)

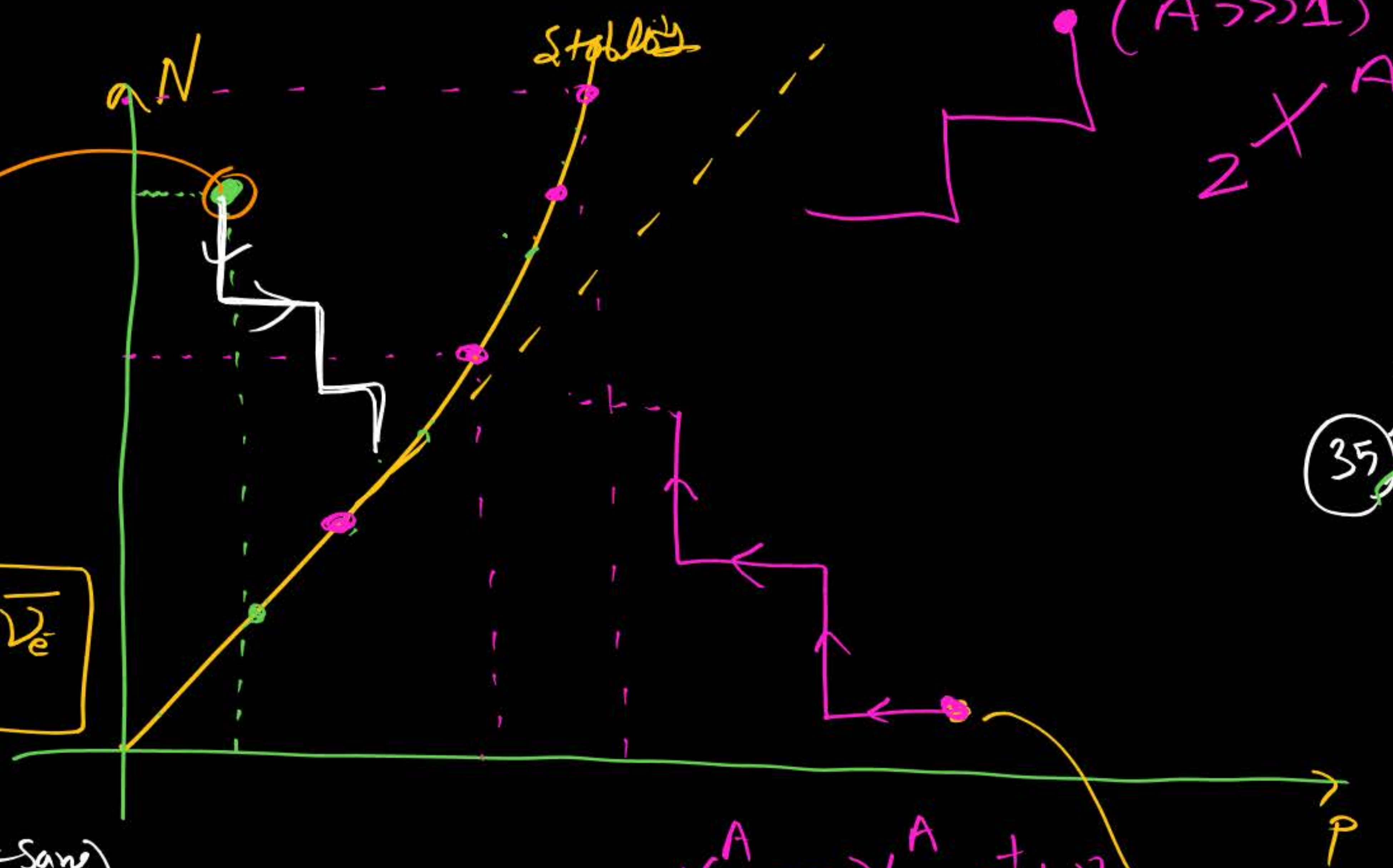
Todays Goal

Revision

α-decay / β / γ

Nucler force

Fission / fusion



Unstable

$N >>> p$

$\frac{N}{p} >>> 1$

$N \to p + e^- + \bar{\nu}_e$

β^- decay

atomic no ↑ (A = same)

$_Z X^A \to Y^A_{Z+1} + e^-$

$_Z X^A \to Y^A_{Z-1} + e^+ + \nu$

unstable

$P >>>> N$

$\frac{P}{N} >>>> 1$

$p \to n + e^+ + \nu_{new}$

β^+ decay (Atomic −1, A = n)

(A >>> 1)

$_Z X^A \to Y^{A-4}_{Z-2} + 2He^4$

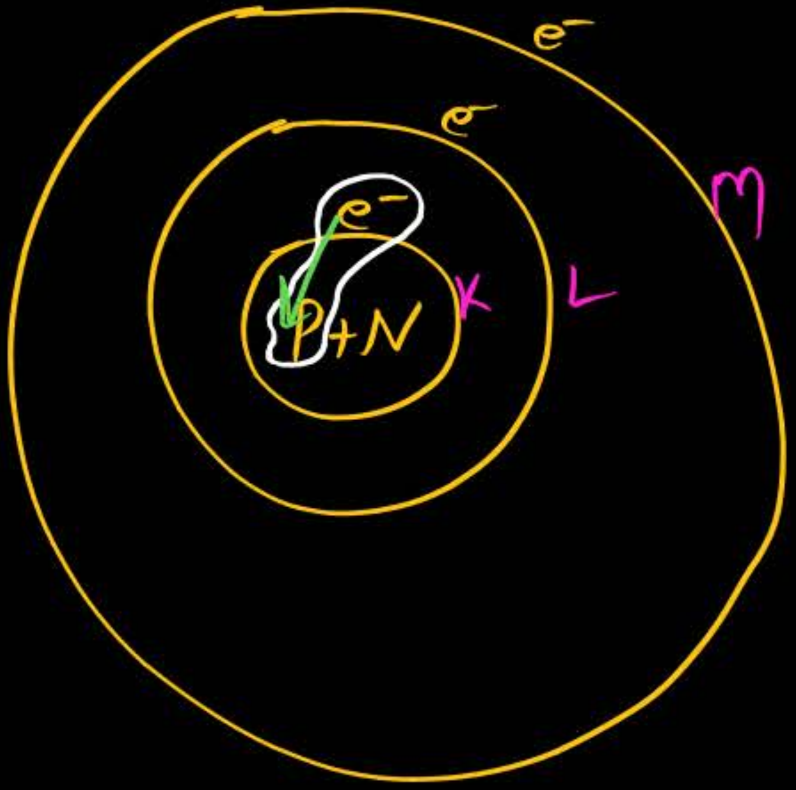
$_{35}X^{72} \to Y^{68}_{37} +$

1 → α-decay

35 − 2 = 33 + 4 = 37

4 β^- decay

e^- capture → {K - capture}



$$p + e^- \longrightarrow N + \nu$$ → neutrino

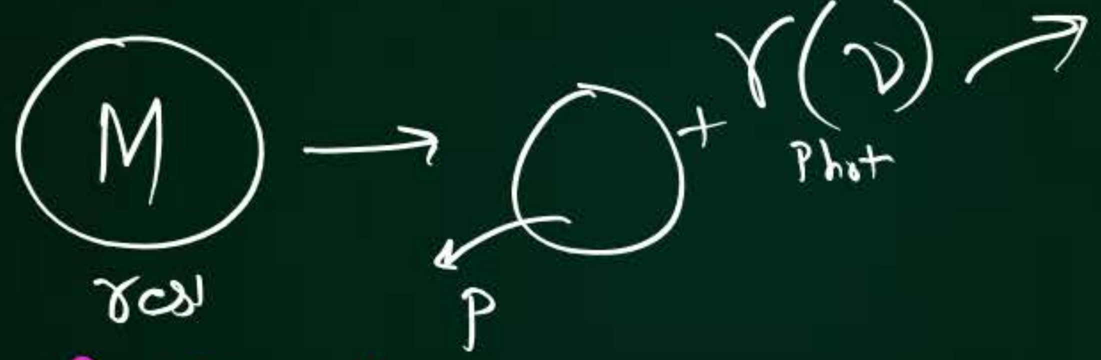
$$e^- + {}_{Z}X^{A} \longrightarrow {}_{Z-1}Y^{A} + \nu$$

QUESTION

A radioactive nucleus of mass M emits a photon of frequency υ and the nucleus recoils. The recoil energy will be **[2011]**

1. $Mc^2 - h\upsilon$
2. $h^2\upsilon^2/2Mc^2$ ✓
3. zero
4. $h\upsilon$

$E = pc$



$p_i = 0 = p_f$

$p_f = \vec{p}_{Nucl} + \vec{p}_{photon} = 0$

$p_{nucle} = -p_{photon}$

$p_{nucle} = \frac{hf}{c}$

$E_{nucle} = \frac{p_{nucle}^2}{2M} = \frac{h^2 f^2}{c^2 2M}$

In any nuclear rexn
- A → same = P + N
- Total energy + mass
- linear & Angular momentum conserved
- Q → conserved

Q - value of α - decay

$$_{Z}X^{A} \longrightarrow {}_{Z-2}Y^{A-4} + {}_{2}He^{4} + Q$$

Parent nuclei (Unstable) → Daughter nuclei + α-Particle

$m_\alpha = 4m_p$

$M_y = m_p(A-4)$

$m_x = m_p A$

$Q = [M_x - m_y - m_\alpha] \times c^2$

$Q = [B.E_y + B.E_\alpha - B.E_x]$

According to conservation of momentum.

$P_i = 0 = P_f = \vec{P}_D + \vec{P}_\alpha$

$\vec{P}_D = -\vec{P}_\alpha$

$|P_D| = |P_\alpha|$

$M_D V_D = M_\alpha V_\alpha$

V_D (Recoil velocity) $= \frac{M_\alpha V_\alpha}{M_D}$

$K.E = \frac{1}{2} m v^2$

$K.E = \frac{p^2}{2m}$

$K.E = \frac{p^2}{2m} \propto \frac{1}{M}$

$K.E_\alpha > K.E_D$

$\frac{K.E_\alpha}{K.E_D} = \frac{(A-4) m_p}{4 m_p} = \frac{A-4}{4}$

$K.E_\alpha + K.E_D = Q$

Putting value of $K.E_D$

$K.E_\alpha + \frac{4\, K.E_\alpha}{A-4} = Q$

$K.E_\alpha \left(1 + \frac{4}{A-4}\right) = Q$

$K.E_\alpha \left[\frac{A-4+4}{(A-4)}\right] = Q$

$K.E_\alpha = \frac{(A-4)Q}{A}$

$A \longrightarrow \alpha$

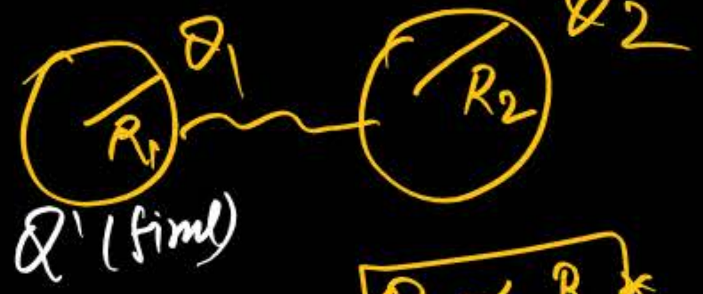
MR*

$K.E \propto \frac{1}{m}$

$$K.E_\alpha = (A-4)\left[\frac{Q}{A}\right]$$

$$K.E_D = 4\left[\frac{Q}{A}\right]$$

$$\frac{K.E_\alpha}{K.E_D} = \frac{A-4}{4}$$



$Q \propto R$

$$Q_{1\,final} = R_1 \frac{Q_{Total\ initial}}{(R_1+R_2)}$$

$$Q_{2\,final} = R_2\left(\frac{Q}{R_1+R_2}\right)$$

$F_{net} = m\,a$ (same)

$F_{net} \propto m$



$$(F_1)_{net} = m_1\left(\frac{F}{m_1+m_2}\right)$$

$$(F_2)_{net} = m_2\left(\frac{F}{m_1+m_2}\right) =$$

Q value of β^- decay

$${}_{Z}X^{A} \longrightarrow {}_{Z+1}Y^{A} + e^{-} + \bar{\nu} + Q$$

Daugh (under Y) · electro (under e^-) · neutrino (under $\bar{\nu}$) · *

$$Q = \left[m(X) - m(Y) \right] \times c^2$$

(under $m(X)$: nucler mass; under $m(Y)$: nucle mass)

→ Q value in terms of (nucler mass)

Nucl + e^- = atom

$$\boxed{K.E_{Daugh} \simeq 0}$$

∵ $K.E_{Daugh} >>>> m_e$

$$Q = \left[\left[m_{Atom}(X) - m_e Z \right] - \left[m_{atom}(Y) - m_e(Z+1) \right] - m_e \right] \times c^2$$

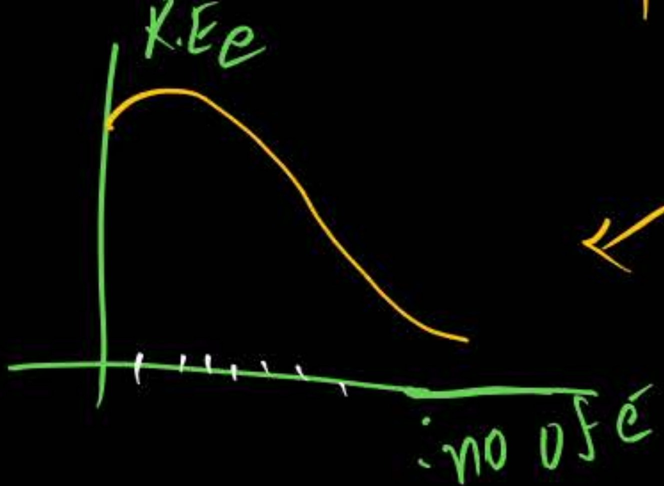
$$Q = \left[m(X) - Z m_e - m_{al}(Y) + Z m_e + m_e - m_e \right]$$

(the m_e terms are struck out)

MR Rafta →

$$\boxed{Q = \left(m(X) - m(Y) \right) \times c^2}$$

(under the brackets: atom)



← MR Rafta

Q - value of β^+ decay

$${}_{Z}X^{A} \longrightarrow {}_{Z-1}Y^{A} + e^{+} + \nu$$

$$Q = [m(X) - m(Y)]c^2$$

nucler mass

(NEET)

$$Q = [m(X) - m(Y) - 2m_e) \times c^2$$

In term of atomic mas

Nuclear - force

strong nuclear force

[b/w nucleons]

$F_{pp} = F_{pN} = F_{NN}$

strong nuclear force

\# $F_{nucl} = 10^{2} F_{electron}$

\# $F_{strong\,nuc} = 10^{38} F_{gravity}$

for stability of nucleus

- always attractive.
- Range $= 10^{-15}$ m
- $F_{strong\,nuc\,force} = 0$ on e^-
- charge Independent
- spin dependent
- Non conservation
- Non-central
- mediated mesons
- Saturation dependent
- medium Independent.

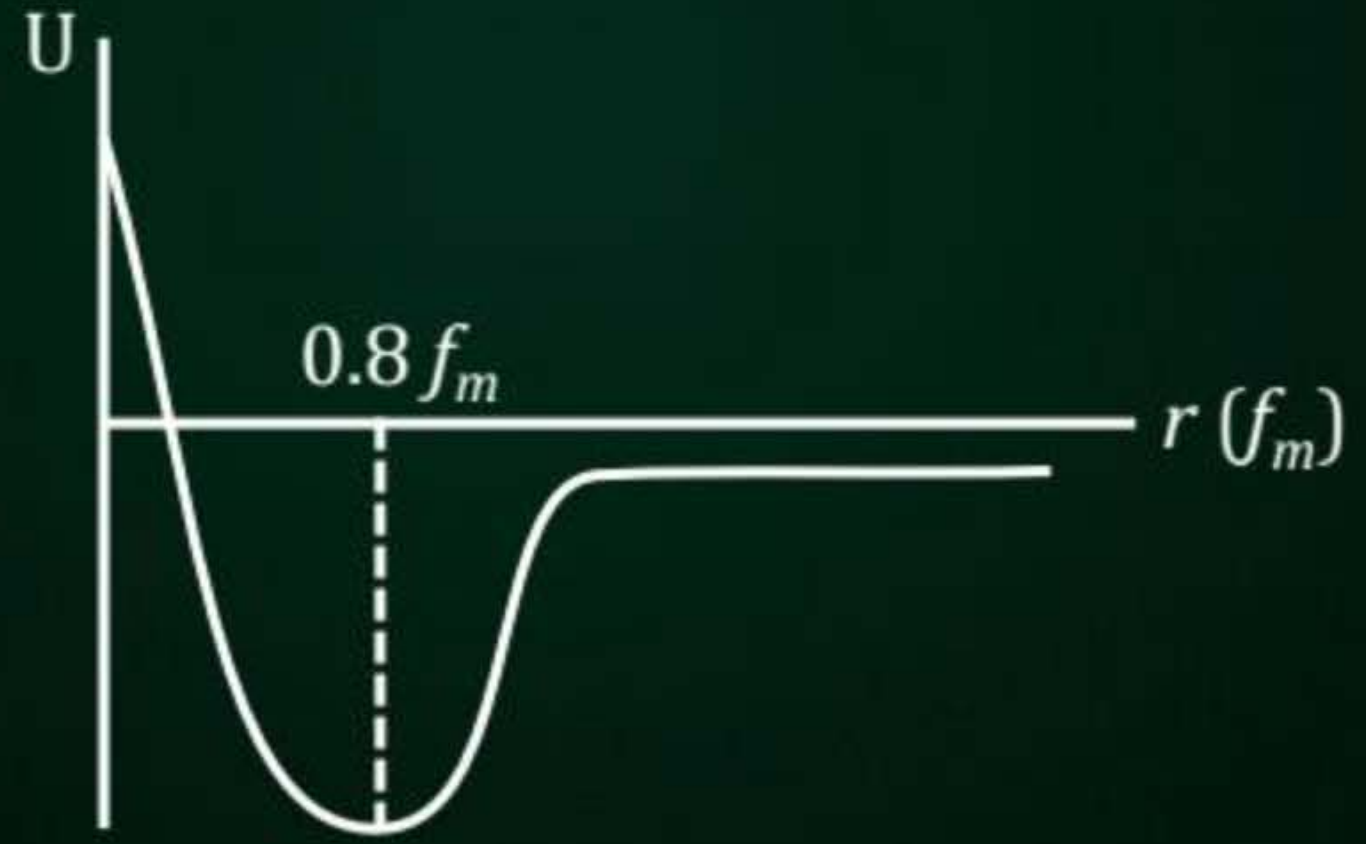
does not follow Inverse square law

- **Strong Nuclear force:**

- **Weak Nuclear force:**

NUCLEAR FORCE

Strongest force, Non-central, Attractive, charge Independent, short range, does not follow inverse square law, saturation in nature. Mediates by meson, spin dependent.



QUESTION

If the nuclear force between two protons, two neutrons and between proton and neutron is denoted by F_{pp}, F_{nn} and F_{pn} respectively, then (1991)

1. $F_{pp} \approx F_{nn} \approx F_{pn}$
2. $F_{pp} \neq F_{nn}$ and $F_{pp} = F_{nn}$
3. $F_{pp} = F_{nn} = F_{pn}$
4. $F_{pp} \neq F_{nn} \neq F_{pn}$

QUESTION

Which of the following statements is true for nuclear forces? (1990)

1. They obey the inverse square law of distance.
2. They obey the inverse third power law of distance.
3. They are short range forces.
4. They are equal in strength to electromagnetic forces.

QUESTION

If net force between proton and proton, neutron and proton, neutron and neutron are F_{PP}, F_{PN} and F_{NN} then which of the following is correct.

1. $F_{PP} = F_{PN} = F_{NN}$
2. $F_{PP} \neq P_{PN} \neq F_{NN}$
3. $F_{PP} < F_{PN} = P_{NN}$
4. $F_{PP} > F_{PN} = P_{NN}$

QUESTION

Force between two proton which are placed at distance 10Å then which of the following correct for nuclear and electrostatic force?

(1) $F_N = F_{elec}$

(2) $F_N > F_{elec}$

(3) $F_N < F_{elec}$

(4) $F_N \geq F_{elec}$

QUESTION

A nucleus $_{n}^{m}X$ emits one α particle and two β^- particles. The resulting nucleus is

(2011, 1998)

1. $_{n-4}^{m-6}Z$
2. $_{n}^{m-6}Z$
3. $_{n}^{m-4}X$
4. $_{n-2}^{m-4}Y$

QUESTION

In the nuclear decay given below

$$ {}^{A}_{Z}X \rightarrow {}^{A}_{Z+1}Y \rightarrow {}^{A-4}_{Z-1}B \rightarrow {}^{A-4}_{Z-1}B, $$

the particles emitted in the sequence are (2009, 1993)

1. γ, β, α
2. β, γ, α
3. α, β, γ
4. β, α, γ

QUESTION

A deutron is bombarded on $_8O^{16}$ nucleus then α-particle is emitted. The product nucleus is (2002)

1. $_7N^{13}$
2. $_5B^{10}$
3. $_4Be^9$
4. $_7N^{14}$ ✓

Charge (may no conserve)

$_1H^2 + {}_8O^{16} \longrightarrow {}_2He^4 + {}_7X^{14}$

Ans

QUESTION

Which rays contain (positive) charged particles? (2001)

1. α-rays ✓
2. β-rays ✗
3. γ-rays ✗
4. X-rays (Photon) ✓

QUESTION

$X(n, \alpha)\ {}_3^7Li$, then X will be [2001]

1. ${}_5^{10}B$
2. ${}_5^{9}B$
3. ${}_4^{11}Be$
4. ${}_2^{4}He$

$X(n, \alpha)\ {}_3Li^7$

$X^{10} + n^1 \xrightarrow{\alpha\text{-ray}} {}_3Li^7 + {}_2He^4$

QUESTION

A nuclear reaction given by

$${}_{Z}X^{A} \longrightarrow {}_{Z+1}Y^{A} + {}_{-1}e^{0} + \bar{\nu} \text{ respectively}$$

(2003)

1. β-decay
2. γ-decay
3. fusion
4. fission

QUESTION

What is the respective number of α and β particles emitted in the following radioactive decay?

$^{200}X_{90} \rightarrow {}^{168}Y_{80}$ (1995)

1. 8 and 8
2. 8 and 6
3. 6 and 8
4. 6 and 6

QUESTION

The nucleus ${}^{115}_{48}Cd$, after two successive β-decay will give (1988)

1. ${}^{115}_{46}Pa$
2. ${}^{114}_{49}In$
3. ${}^{113}_{50}Sn$
4. ${}^{115}_{50}Sn$

QUESTION

When a uranium isotope $^{235}_{92}U$ is bombarded with a neutron, it generates $^{89}_{36}Kr$, three neutrons and

(NEET 2020)

1. $^{144}_{56}Ba$
2. $^{91}_{40}Zr$
3. $^{101}_{36}Kr$
4. $^{103}_{36}Kr$

$$n^1 + {}_{92}U^{235} \longrightarrow {}_{36}Kr^{89} + 3(n^1) + X$$

$$A = 236 - (89+3)$$

$$= 236 - (92)$$

$$= 136 + 8 = 144$$

QUESTION

A nucleus of uranium decays at rest into nuclei of thorium and helium. Then **(2015)**

1. The helium nucleus has more momentum than the thorium nucleus.
2. The helium nucleus has less kinetic energy than the thorium nucleus.
3. The helium nucleus has more kinetic energy than the thorium nucleus.
4. The helium nucleus has less momentum than the thorium nucleus.

(Ans) (C)

QUESTION

The nucleus of element X(A = 220) undergoes α-decay. If Q-value of the reaction is 5.5 MeV, then the kinetic energy of α-particle is:

1. 5.4 MeV
2. None
3. 10.8 MeV
4. 2.7 MeV

$$K.E_\alpha = (A-4)\frac{Q}{A}$$

$$= 216 \times \frac{5.5}{220}$$

QUESTION

In an α-decay, the kinetic energy of α-particle is 48 MeV and Q value of the reaction is 50 MeV. The mass number of the mother nucleus is: (Assume that daughter nucleus is in ground state)

1. 100 ✓ (37%)
2. 96
3. 104
4. None of these

$K.E_{\alpha} = 48 \text{ MeV}$

$Q = 50 \text{ MeV}$

$K.E_{\alpha} = \frac{A-4}{A} \times Q$

$\frac{A-4}{A} = \frac{48}{50} = \frac{24}{25}$

$25A - 100 = 24A$

$A = 100$

QUESTION

In an α-decay, the kinetic energy of α-particle is 48 MeV and Q-value of the reaction is 50 MeV. The mass number of the mother nucleus is X. Find the value of X/25. (Assume that daughter nucleus is in ground state)

1. 2
2. 4
3. 6
4. 8

Nucle Force

always attractive

Weak - nucle force

Rang = 10^{-16} m — Shotest range of force *

Repulsive force

→ non - central

→ $F_{weak\ nucl} < F_{strong\ nucle}$

→ non-centr, non conser.

→ mediated by Bosons

→ charge Independ.

NUCLEAR REACTOR

Controlled chain reaction:

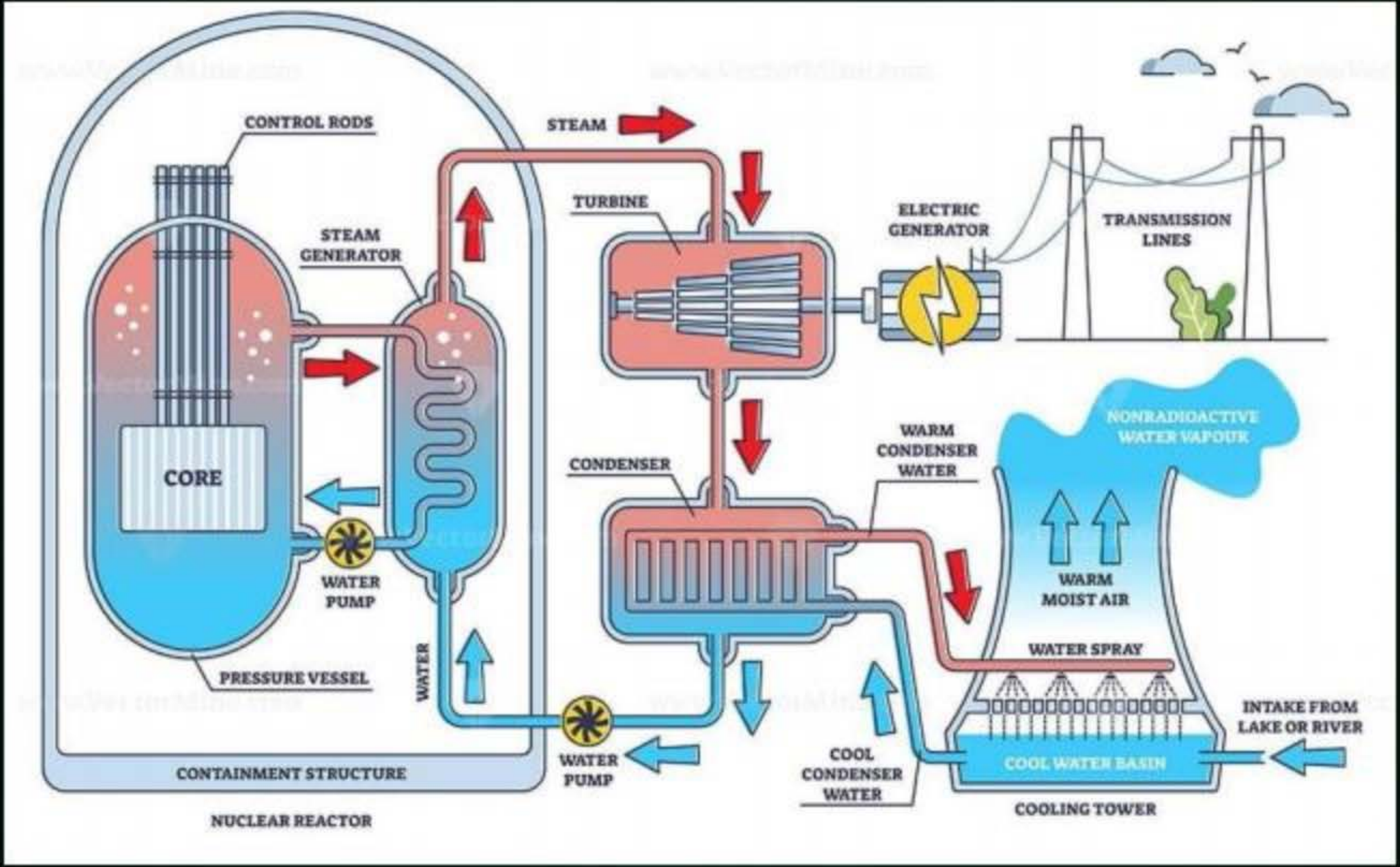
- Avg. 2.5 neutron per fission produced
- It use heavy water (D_2O) and graphite as a moderator to slow down neutron.

$$K = \text{Rate of production of } \frac{\text{nuetron}}{\text{Rate of loss of nuetron}}$$

$K = 1 \Rightarrow$ critical

$K < 1 \Rightarrow$ Controlled

$K > 1 \Rightarrow$ Uncontrolled, explode


CONTROL RODS
STEAM
TURBINE
ELECTRIC GENERATOR
TRANSMISSION LINES
STEAM GENERATOR
CORE
WATER PUMP
CONDENSER
WARM CONDENSER WATER
NONRADIOACTIVE WATER VAPOUR
WARM MOIST AIR
WATER SPRAY
WATER
PRESSURE VESSEL
INTAKE FROM LAKE OR RIVER
WATER PUMP
COOL CONDENSER WATER
COOL WATER BASIN
CONTAINMENT STRUCTURE
NUCLEAR REACTOR
COOLING TOWER

(2) Moderator:

The neutrons produced by fission are fast with kinetic energies of the order of 2 MeV. But, fission is induced most effectively by thermal neutrons with kinetic energies of about 0.04 eV. The substance used to slow down the fast neutrons to thermal neutrons is called moderator. A moderator should have the following properties.

(a) Low molecular weight

(b) It should not absorb neutron

(c) It should undergo elastic collision with neutrons and reduce their speeds.

(3) Control rods:

The rate of reaction is controlled by inserting or withdrawing control rods made of elements cadmium or boron whose nuclei absorb neutrons without undergoing any additional reaction. When control rods are pushed into the reactor, the fission decreases and when they are pulled out the fission grows.

(4) Coolant:

The energy released inside the reactor in the form of heat is removed by coolant. For this purpose air, ice cold water, molten sodium or CO_2 is circulated around the reactor core area which withdraws the heat produced in the core. This heat is utilised for producing steam which is then used to drive turbines for generating electricity.

QUESTION

In any fission process the ratio

$$\frac{\text{mass of fission products}}{\text{mass of parent nucleus}} \text{ is}$$

1. Equal to 1
2. Greater than 1
3. Less than 1
4. Depends on the mass of the parent nucleus

QUESTION

A neutron strikes a $_{92}U^{235}$ nucleus and as a result $_{36}Kr^{93}$ and $^{56}Ba^{140}$ are produced with

1. α-particle
2. 1-neutron
3. 3-neutron
4. 2-β-particle

QUESTION

Control rods used in nuclear reactors are made of

1. Stainless steel
2. Graphite
3. Cadmium
4. Plutonium

QUESTION

Which of the following are suitable for the fusion process?

1. Light nuclei
2. Heavy nuclei
3. Element must be lying in the middle of the periodic table
4. Middle elements, which are lying on binding energy curve


THANK YOU

YAKEEN 2.0

FOR NEET 2025

Lecture- 04 | Physics

Nuclei

By- Dr. Manish Raj (MR SIR)



Todays Goal

Nuclear Fission

NUCLEAR FISSION

↳ Break Hona

- Nuclear fission is a nuclear reaction in which a heavy nuclei breaks into two or more than two lighter nuclei.
- For nuclei stability.

Per fission 200 mev Per fission

Nucler bomb

energy relesed

used in Power reactor

$n + U^{235} \longrightarrow U^{236} \longrightarrow Ba + Kr + 3n^{1}$

unsta

$_1H^1 + _1H^2$

NUCLEAR FUSION

- Process in which two or more than two lighter nuclear combine to form a heavier nucleus.

→ uncontrolled chain rexn {In Sun}

$_1H^1 + _1H^1 \rightarrow _2H^2$

$_1H^1 + _1H^1 + _1H^1 + _1H^1 = _2He^4$

for stability

2 or 4 meV

or 20 MeV per fusion

H-bomb

required Tempr is very high to overcome electrostatic repulsion & combine.

$_1H^1 + _1H^1$

$$U = \frac{Ke \times e}{r_{\rightarrow (r = 1fm)}} = \frac{3}{2} K_B T$$

$T = 10^7 K$ to $10^9 K$ → sun

POWER REACTOR

→ fission

$$\text{Power} = \frac{(\text{Energy})}{t} = \frac{mc^2}{t}$$

$$\text{Power} = \frac{nE}{t}$$

n = no. of fission

E = energy in one fission

t = total time

QUESTION

The power obtained in a reactor using U^{235} disintegration is 1000 kW. The mass decay of U^{235} per hour is (NEET)

1. 1 microgram
2. 10 microgram
3. 20 microgram
4. 40 microgram

Ans

$P = 1000\,kW = 10^3 \times 10^3\,W = 10^6\,W$

$P = \frac{mc^2}{t}$

$10^6 = \frac{m(3\times10^8)^2}{60\times60}$

$m = \frac{3600\times10^6}{9\times10^{16}}$

QUESTION

If 1 gm hydrogen is converted into 0.993 gm of helium in a thermonuclear reaction, the energy released in the reaction is

1. 63×10^{7} J
2. 63×10^{10} J
3. 63×10^{14} J
4. 63×10^{20} J

1 gm
0.993 gm

1.000
0.993
0.007

$E = mc^2$
$= 7 \times 10^{-3} \times 10^{-3} \times (3 \times 10^8)^2$
$= 63 \times 10^{16} \times 10^{-6}$
$= 63 \times 10^{+10}$

QUESTION

In each fission of ${}_{92}U^{235}$ energy of 200 MeV is released. How many acts of fission must occur per second to produce a power of 1kW?

1. 3.1×10^{13} Ans
2. 1.3×10^{16}
3. 1.3×10^{15}
4. 3.1×10^{16}

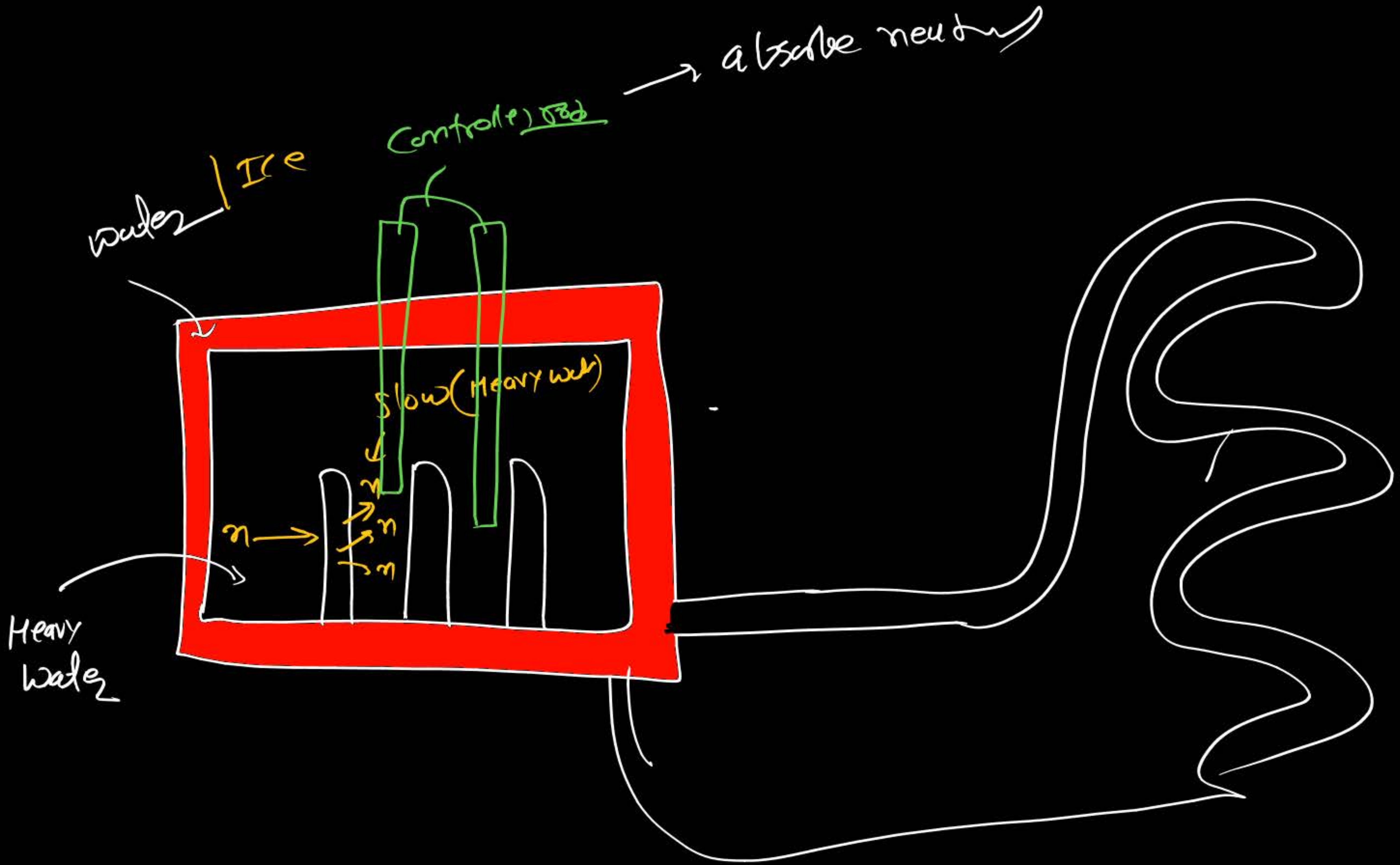
$P = 10^3 W$

$E = 200 MeV = 200 \times 10^6 \times 1.6 \times 10^{-19} J$

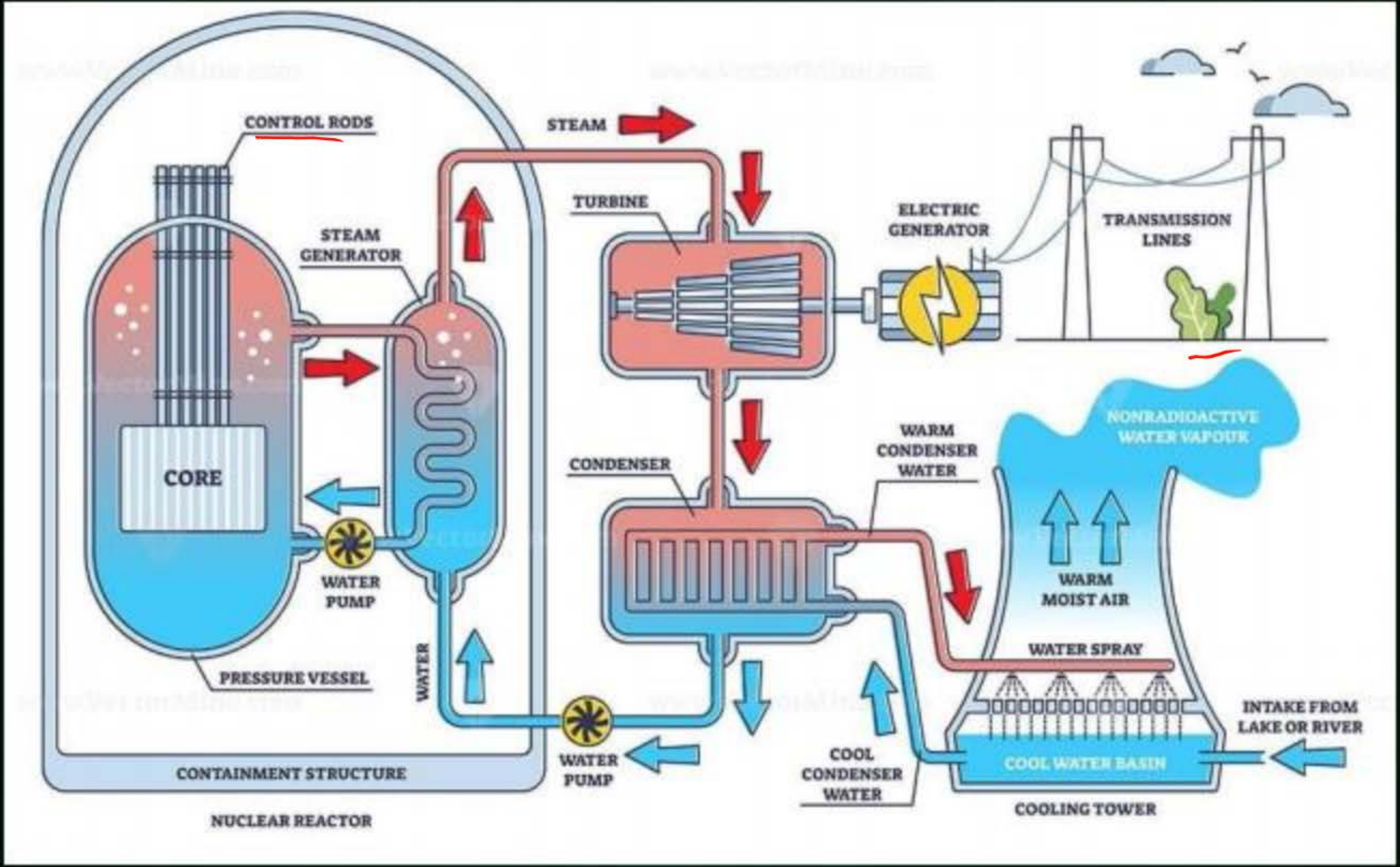
$P = \frac{n}{t} E$

$\frac{n}{t} = \frac{P}{E} = \frac{10^3}{200 \times 10^6 \times 1.6 \times 10^{-19}}$

$= \frac{10^{16}}{3.2 \times 100} = \frac{10^4}{3.2} = \frac{10}{3.2} \times 10^{13}$



absorbe neutron
Controller rod
water | Ice
slow (Heavy water)
n
Heavy water


CONTROL RODS
STEAM
TURBINE
ELECTRIC GENERATOR
TRANSMISSION LINES
STEAM GENERATOR
CORE
CONDENSER
WARM CONDENSER WATER
NONRADIOACTIVE WATER VAPOUR
WARM MOIST AIR
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WATER SPRAY
PRESSURE VESSEL
WATER
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COOL WATER BASIN
CONTAINMENT STRUCTURE
COOLING TOWER
NUCLEAR REACTOR

NUCLEAR REACTOR

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- It use heavy water (D_2O) and graphite as a moderator to slow down neutron.

$$K = \frac{\text{Rate of production of nuetron}}{\text{Rate of loss of nuetron}}$$

$K = 1 \Rightarrow$ critical

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$K > 1 \Rightarrow$ Uncontrolled, explode

QUESTION

Two radioactive isotopes P and Q have half lives 10 minutes and 15 minutes respectively. Freshly prepared samples of each isotope initially contain the same number of atoms. After 30 minutes, the

number of atoms of P ratio $\frac{\text{number of atoms of P}}{\text{number of atoms of Q}}$ will be

1. 0.5
2. 2.0
3. 1.0
4. 3.0

QUESTION

Heavy water instead of ordinary water is used as a moderator in nuclear reactor because ordinary water

1. Cannot slow down neutron
2. Absorbs neutrons
3. Is expensive
4. Accelerates neutron

POWER OF NUCLEAR REACTOR

The necessary requirements for a modern reactor are given below.

(1) Fuel:

Usually, U^{235} or Pu^{239} is used as the fuel in a nuclear reactor.

(2) Moderator:

The neutrons produced by fission are fast with kinetic energies of the order of 2 MeV. But, fission is induced most effectively by thermal neutrons with kinetic energies of about 0.04 eV. The substance used to slow down the fast neutrons to thermal neutrons is called moderator. A moderator should have the following properties.

(a) Low molecular weight

(b) It should not absorb neutron

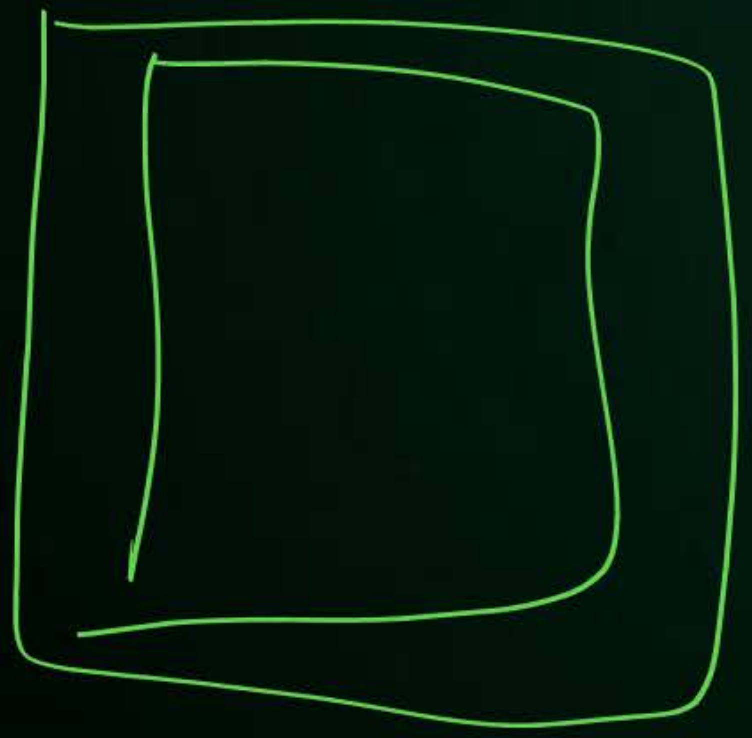
(c) It should undergo elastic collision with neutrons and reduce their speeds.

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The rate of reaction is controlled by inserting or withdrawing control rods made of elements cadmium or boron whose nuclei absorb neutrons without undergoing any additional reaction. When control rods are pushed into the reactor, the fission decreases and when they are pulled out the fission grows.

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QUESTION

In any fission process the ratio $\dfrac{\text{mass of fission products}}{\text{mass of parent nucleus}}$ is

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3. Less than 1
4. Depends on the mass of the parent nucleus

QUESTION

Control rods used in nuclear reactors are made of

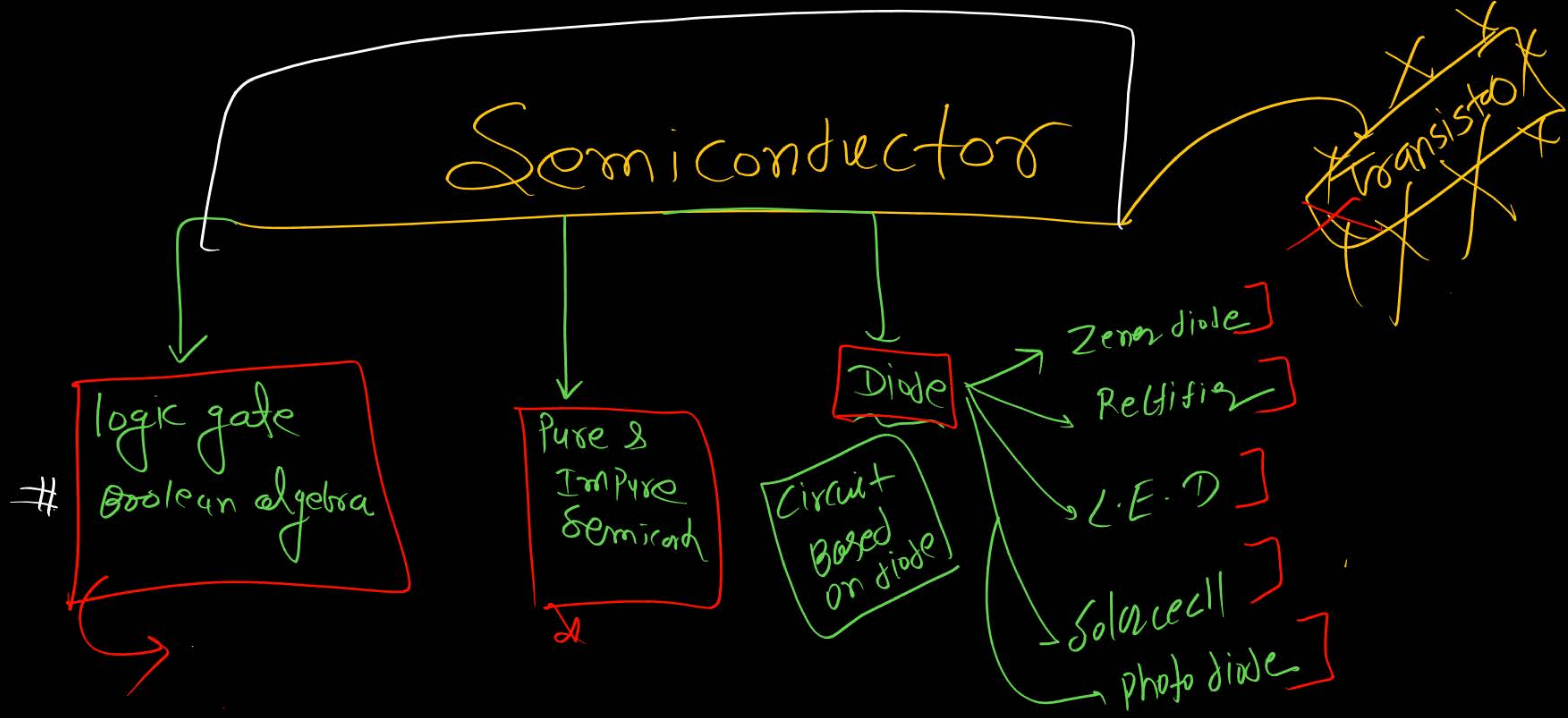
1. Stainless steel
2. Graphite
3. Cadmium
4. Plutonium

QUESTION

Which of the following are suitable for the fusion process?

1. Light nuclei
2. Heavy nuclei
3. Element must be lying in the middle of the periodic table
4. Middle elements, which are lying on binding energy curve

Kinematic of
Radioactive → Half life



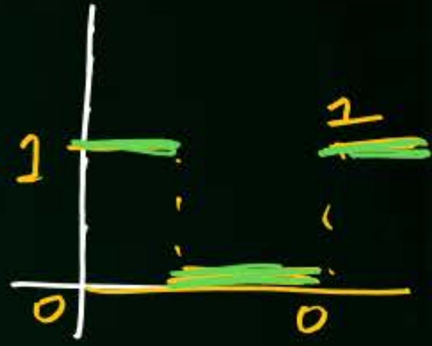
Semiconductor
Transistor
logic gate
Boolean algebra
#
Pure & Impure Semicond
Diode
Circuit Based on diode
Zener diode
Rectifier
L.E.D
Solar cell
photo diode

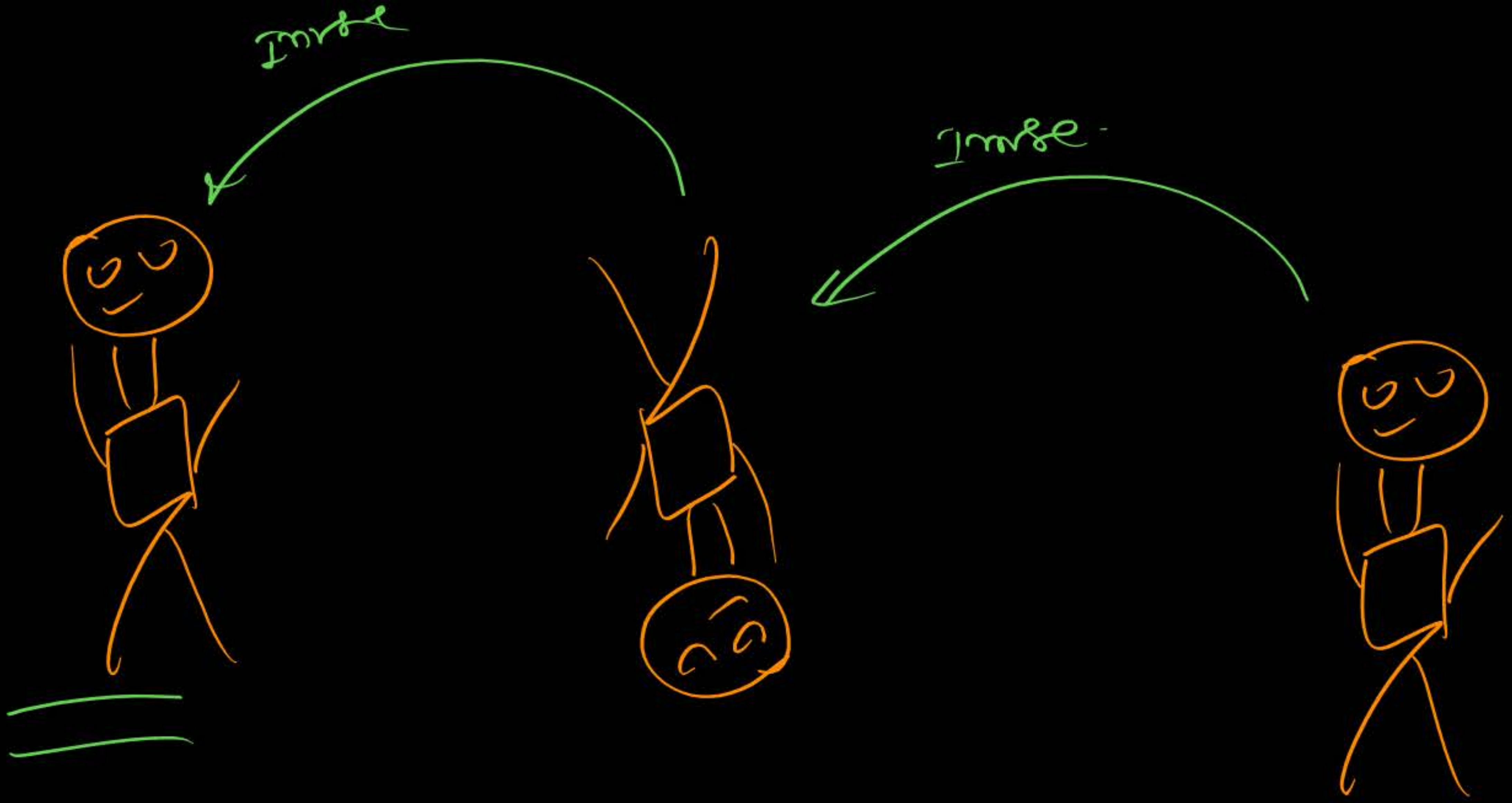
BOOLEAN ALGEBRA and logic gate → only two digit used for Input & output.

Digital Signal

- 0 → 0 volt → Low → off (No)
- 1 → 5 volt → High → on, Yes

Inverse of each other





➢ Boolean Algebra

Subtraction & division नहीं होता है।

Addition	Multiplication	Inverse
$0+0=0$	$0 \cdot 0=0$	$\overline{A} = A$ ka Inverse
$0+1=1$	$0 \cdot 1=0$	$\overline{1}=0$
$1+1=1$	$0 \cdot \overline{1}=0$	$\overline{0}=1$
$1+\overline{1}=1$	$1 \cdot \overline{1}=0$	$\overline{\overline{1}}=1$
$1+1+1=1$	$A \cdot A=A$	$\overline{\overline{0}}=0$
$1+0=1$	$A \cdot \overline{A}=0$ *	
$A+A=A$	$0 \cdot \overline{0}=0$	
$A+\overline{A}=1$ *		

High + High = High *

$A \to 0$, $A \to 1$

QUESTION

Prove that $A + \overline{A} = 1$

Let $A = 1$

$A + \overline{A} = 1$

$1 + \overline{1} = 1$

$1 + 0 = 1$

Prove that $A \cdot \overline{A} = 0$

A is a variable → 0, → 1

$0 \cdot \overline{0} = 0$

$1 \cdot \overline{1} = 1 \cdot 0 = 0$

DE-MORGANS LAW

$$\overline{A+B} = \overline{A} \cdot \overline{B}$$

$$\overline{A \cdot B} = \overline{A} + \overline{B}$$

$$\overline{A} \cdot \overline{B} = \overline{A+B}$$

QUESTION

$AB + \overline{A} + 1 = ?$

$\boxed{1}$ Ans

$1 + AB + \overline{B} + A + A + B + \overline{A} + \overline{A}B$

$AB + \overline{A} + 1 = ??$

- **Commutative Law**

$$A + B = B + A$$

$$A \cdot B = B \cdot A$$

- **Associative Law**

$1 \cdot 0 = 0 \cdot 1$

$$A + (B + C) = (A + B) + C$$

- **Distributive Law**

$$A \cdot (B + C) = AB + A \cdot C$$

$x(y + z) = xy + xz$

➢ **Simplify**

$$\overline{(\bar{A}\cdot B)+(\bar{B}\cdot A)}$$

Break (De morgan)

$$\overline{\bar{A}\cdot B}\cdot\overline{\bar{B}\cdot A}$$

$$(\bar{\bar{A}}+\bar{B})\cdot(\bar{\bar{B}}+\bar{A})$$

$$=(A+\bar{B})\cdot(B+\bar{A})$$

$$=AB+A\bar{A}+\bar{B}B+\bar{B}\bar{A}$$

$$=AB+\bar{A}\bar{B}$$

➢ **Simplify :**

$$\overline{AB+\bar{A}\cdot\bar{B}}$$

$$\overline{AB}\cdot\overline{\bar{A}\cdot\bar{B}}$$

$$(\bar{A}+\bar{B})\cdot(A+B)=$$

QUESTION

If $y = A + AB$ then find value of y.

$$Y = A + AB$$
$$= A(1 + B)$$
$$= A \cdot 1$$
$$\boxed{Y = A}$$

Answer

QUESTION

Find $y = A\overline{B} + AB$, find y?

$$Y = A\overline{B} + AB$$

$$Y = A(\overline{B} + B)$$

$$\boxed{Y = A}$$

Ans

$$Y = A\overline{B} + AB$$

A	B	Y
0	0	0
1	0	1
0	1	0
1	1	1

QUESTION

$y = \overline{A\overline{B} + \overline{A}B}$, simplify ‘$y$’.

OR - Gate → addition

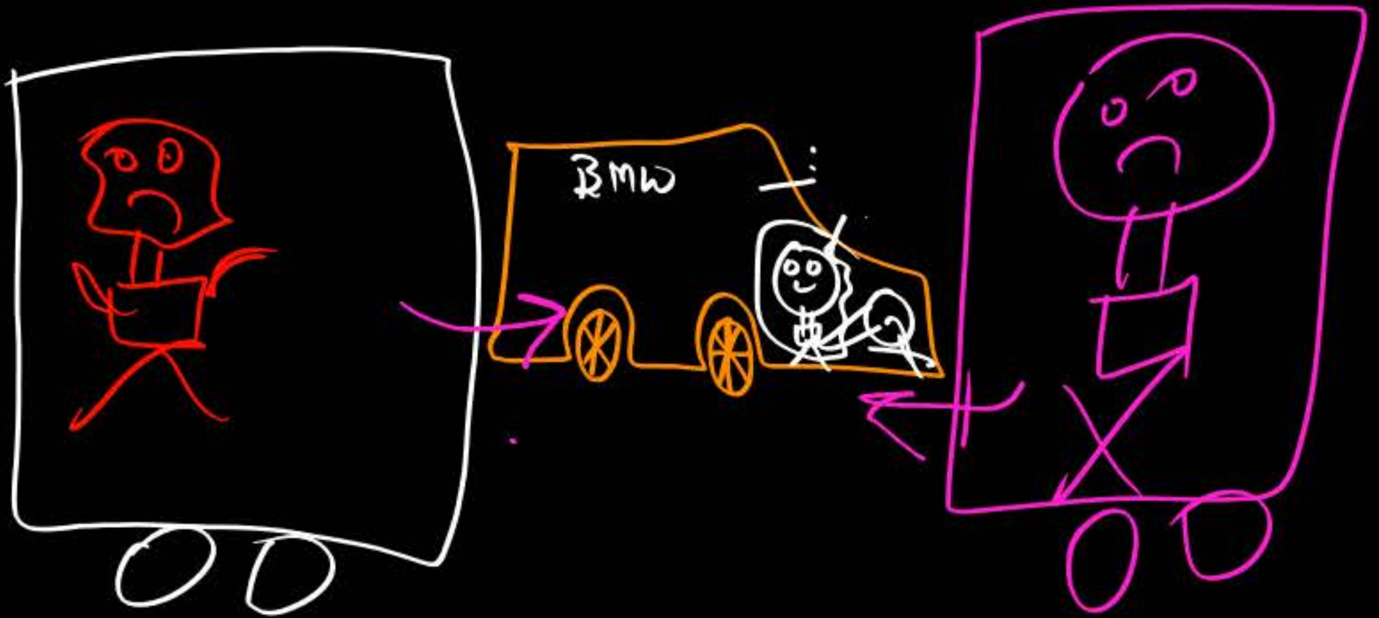
$A + B = Y$

$Y = 1 + 0 = 1$ ✓

$Y = 0 + 1 = 1$ ✓

$Y = 0 + 0 = 0$

$Y = 1 + 1 = 1$ ✓



Joint Bank account

Name — M.R, Ramlal

A   B

$Y = A \cdot B = 1 \cdot 0 = 0$

$0 \cdot 1 = 0$

$0 \cdot 0 = 0$

$1 \cdot 1$

- **Fundamental Gate:** → three fundamental operation

Inverse	Addition	Product
NOT	OR	AND

- **Universal Gate:** → NOR / NAND

- **Special Gate:** X-OR | X-NOR

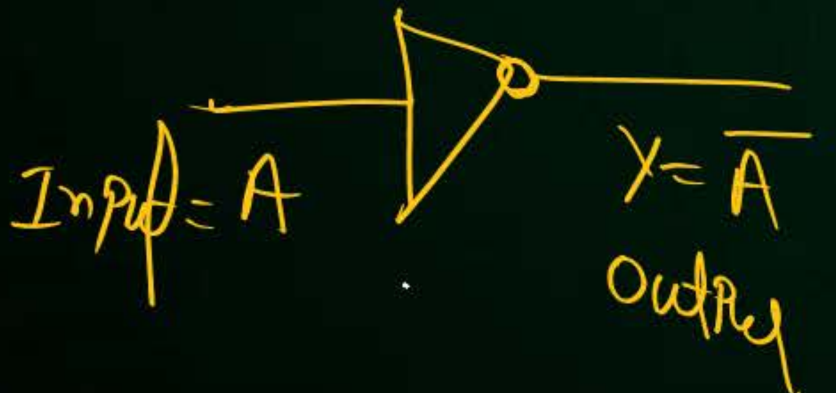
NOT GATE

→ In single Input

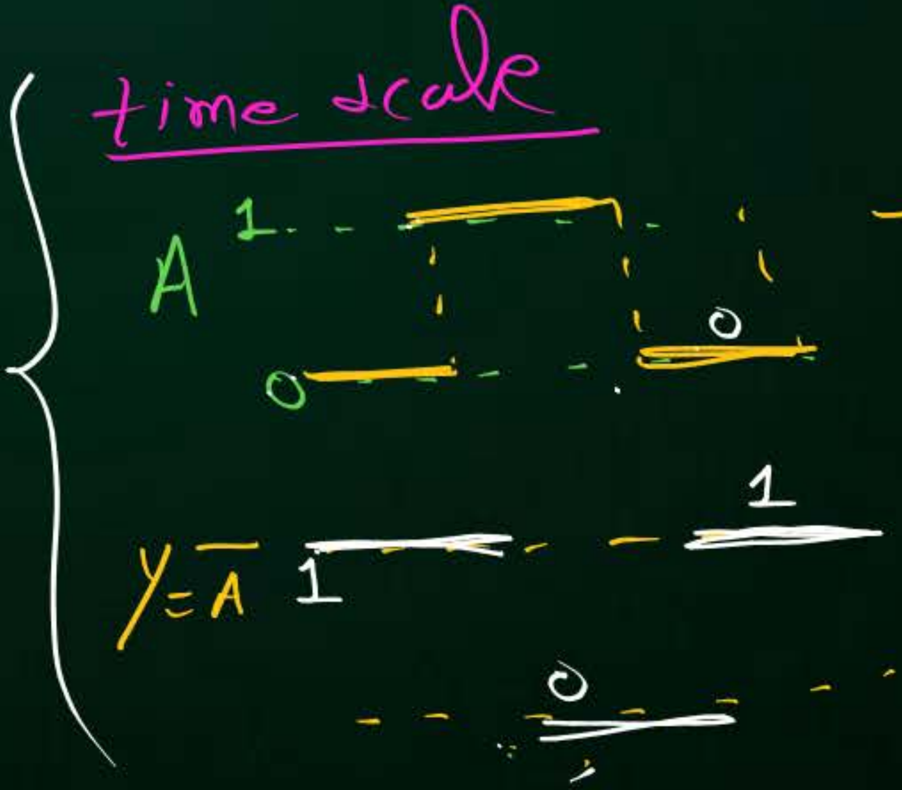
Truth table

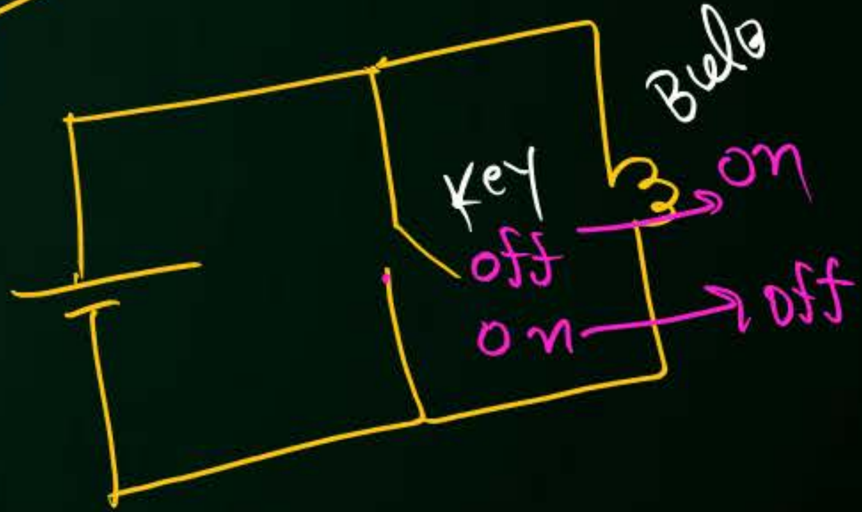
Input	Output
A	$Y = \bar{A}$
1	0
0	1

- Based on inverse operation
- Fundamental Gate
- Formed using Transistor
- Boolean expansion. $Y = \bar{A}$
- Circuit symbol



electrical realisation (Key is in parallel)





ELECTRIC EQUIVALENT CIRCUIT FOR NOT GATE

AND GATE

- Based on Product
- Fundamental Gate
- Formed using diode
- Circuit symbol

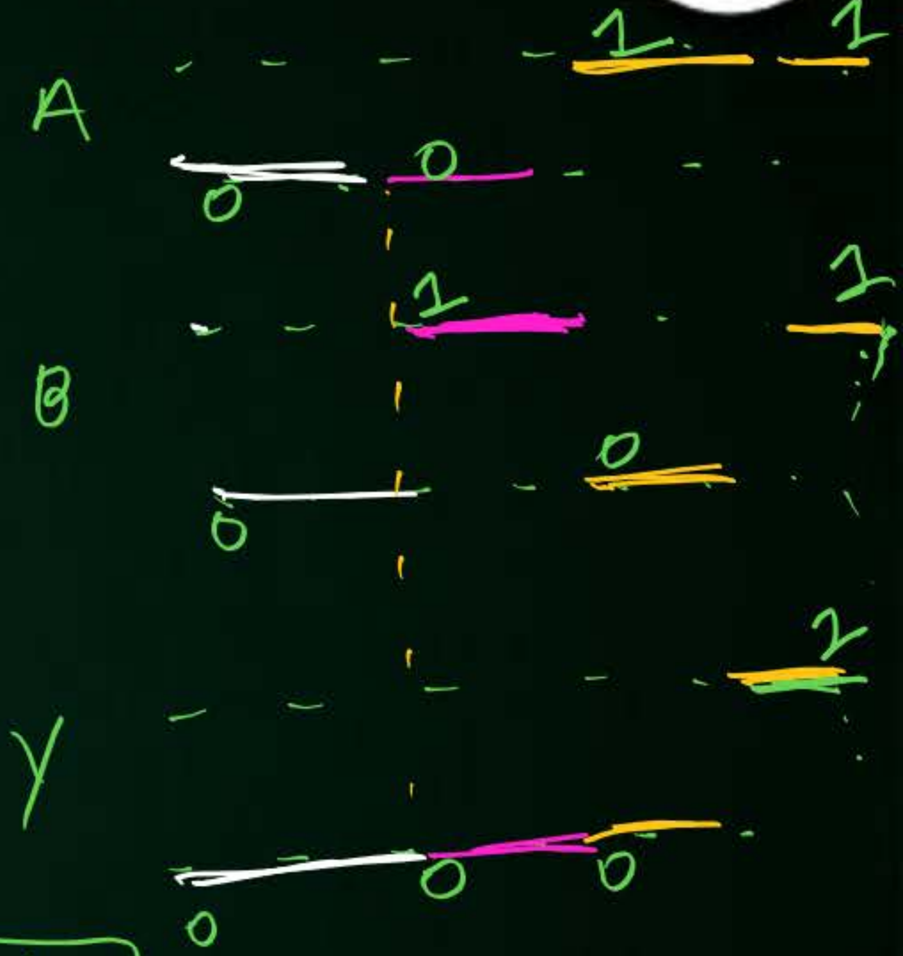


$Y = A \cdot B$ → Boolean exp^n

- * Output is only High when both the Input is high
- Output is Low, if any one Input low.

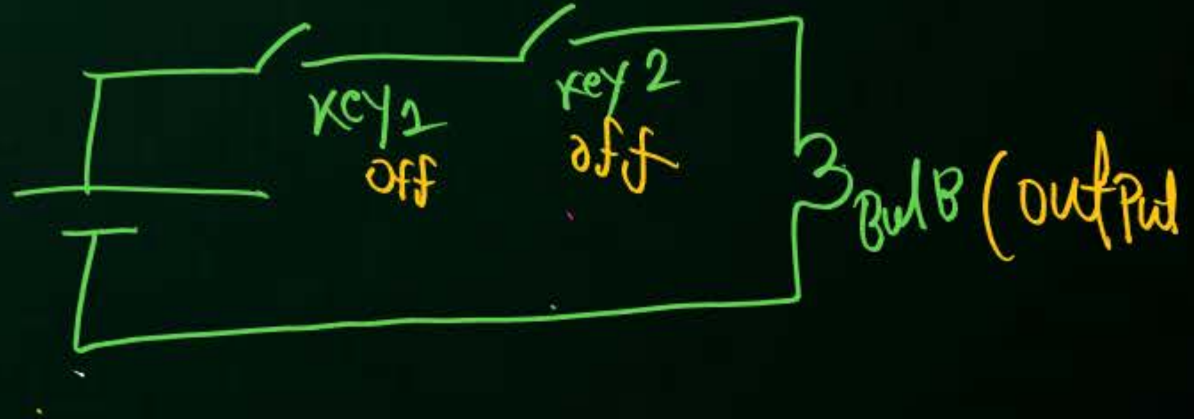
Truth Table

A	B	Y = A·B
0	0	0
0	1	0
1	0	0
1	1	1



electrical realisation

Two Input → Two key



ELECTRIC EQUIVALENT CIRCUIT FOR AND GATE

OR GATE

- Based on addition
- Fundamental Gate
- Formed using diode
- Boolean expansion $y = A + B$
- Circuit symbol

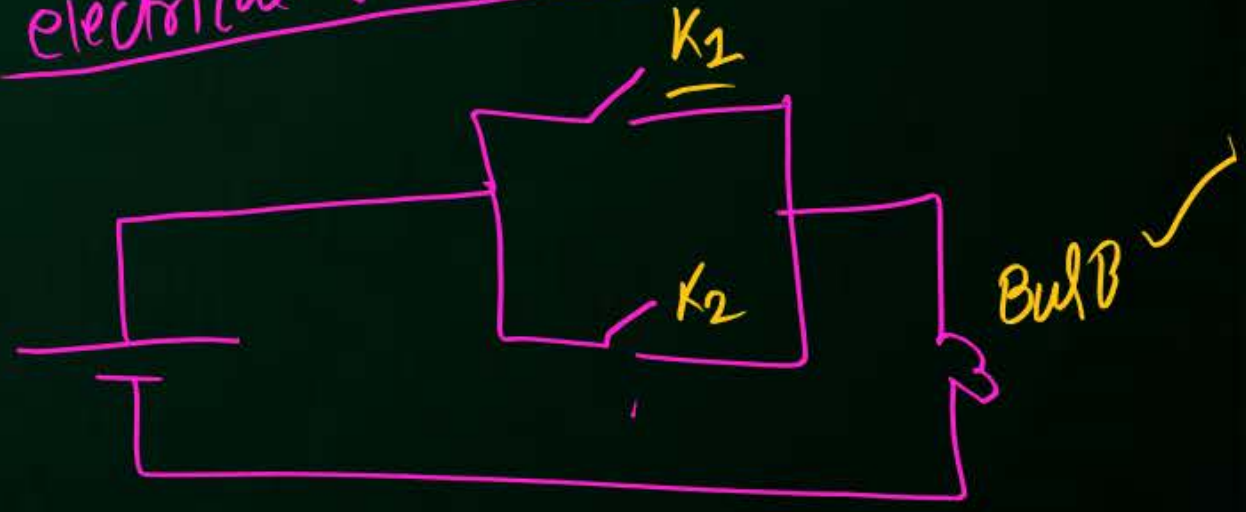


- Output in High, when any one of the input high
- Output is only low, when both the input is low

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1



electrical realisation



ELECTRIC EQUIVALENT CIRCUIT FOR OR GATE

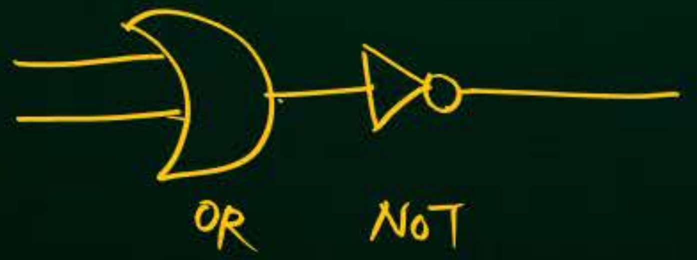
#

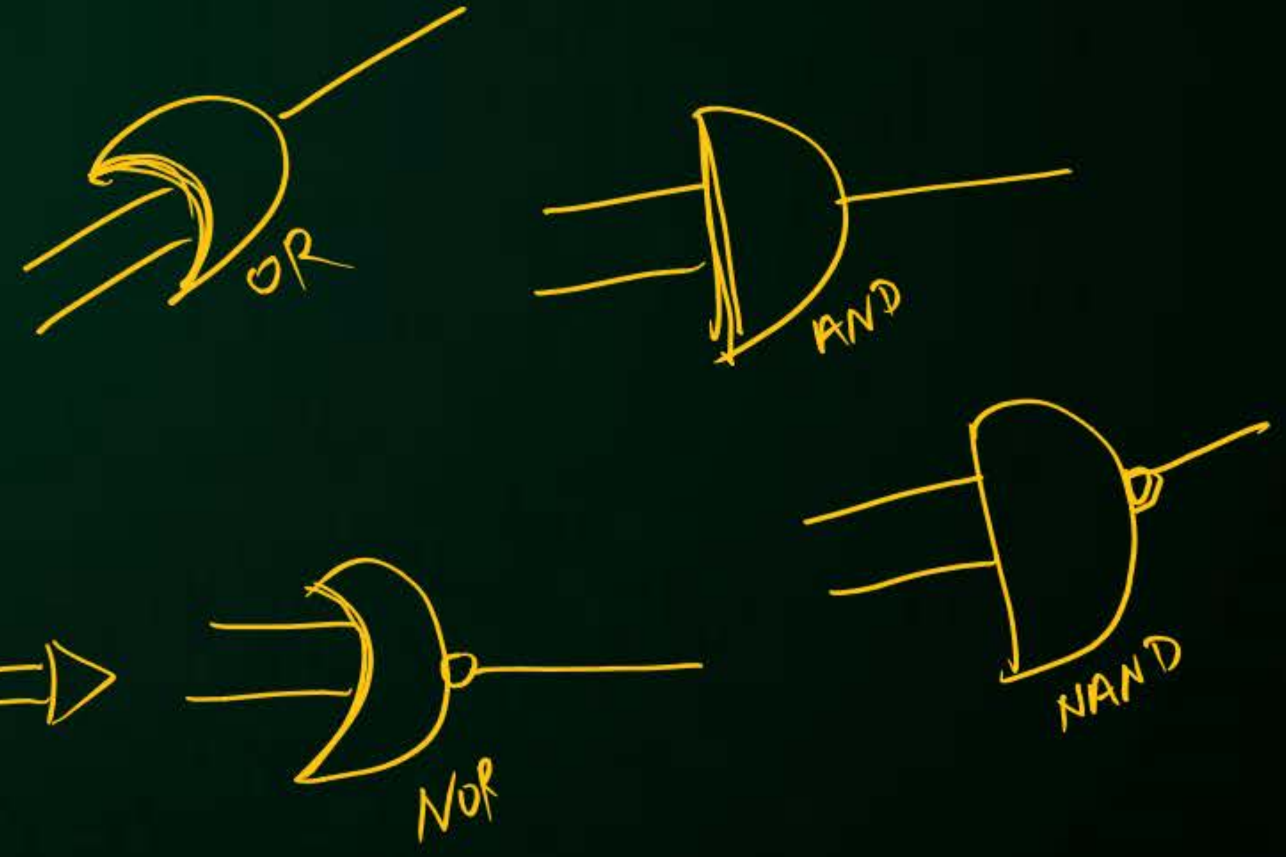
NOR GATE

NOR-GATE → OR + NOT ✓

NOR-GATE → NOT + OR ✗

- Universal gate – all Gate can be formed using this NOR gate
- All Gate can be formed using this
- Boolean expn. $Y = \overline{A+B} = \bar{A} \cdot \bar{B}$
- ~~Formed using~~ diode + Transistor
- Circuit symbol





electricle circuit

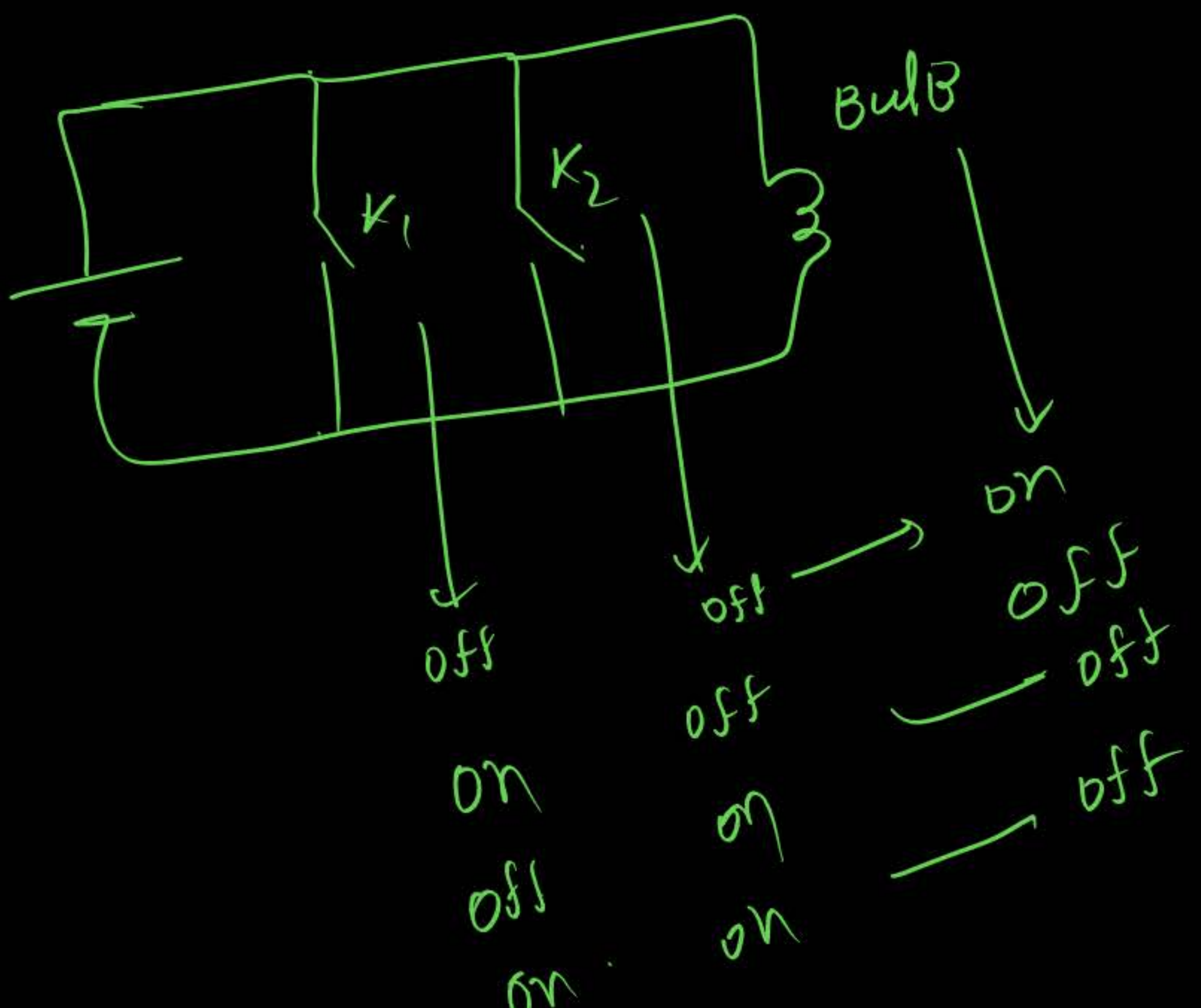
NOR

A	B	Y_{OR} $A+B$	Y_{NOR} $\overline{A+B}$
0	0	0	1
0	1	1	0
1	0	1	0
1	1	1	0

← OR ka Inverse

~~IMP~~

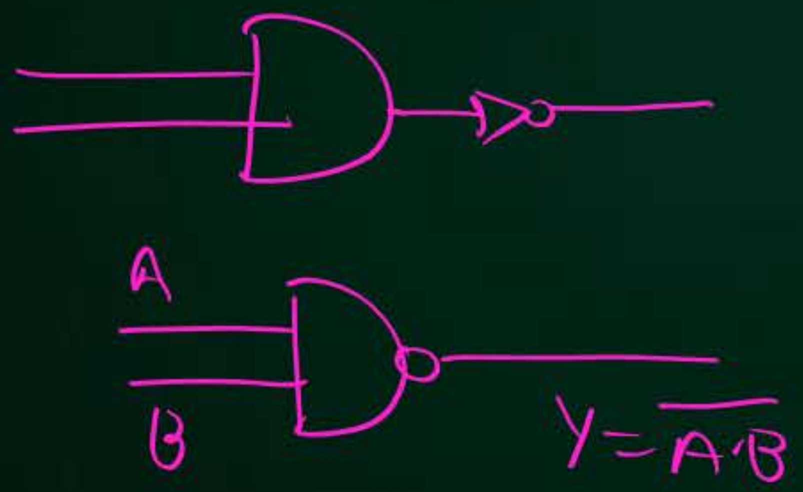
- Inverse → Parallel key to the buble
- OR → Paralle key to each other
- AND → Series key to each other



NAND GATE

AND + NOT

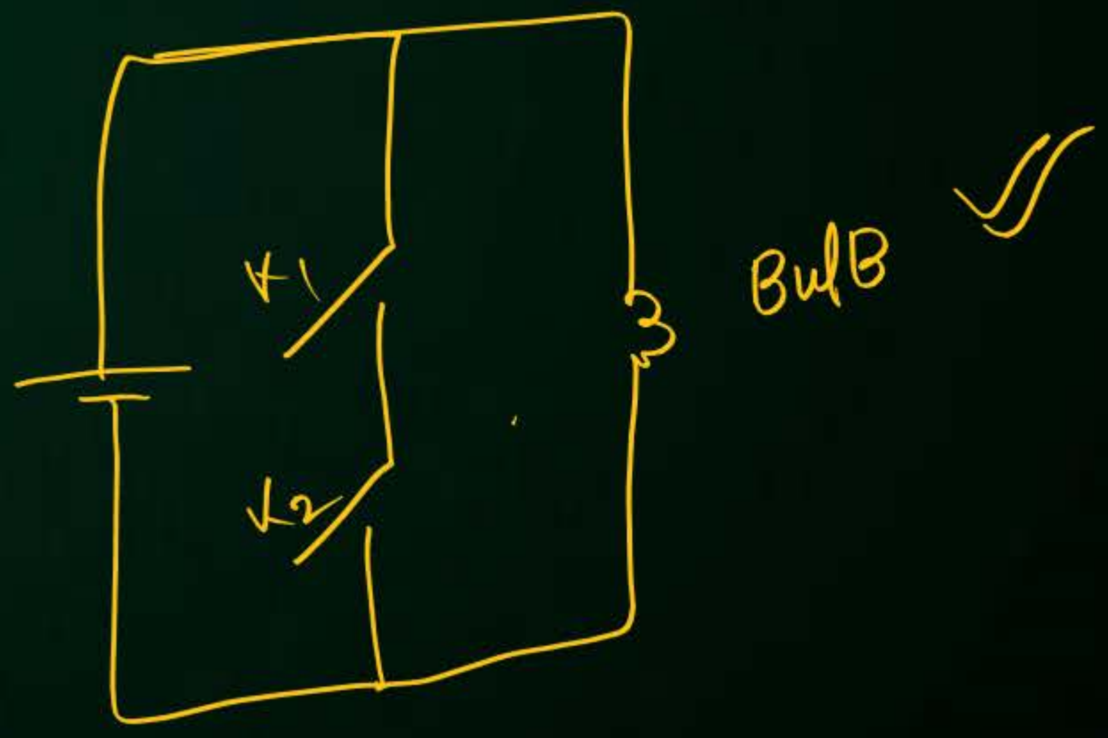
- Universal gate
- All Gate can be formed using this
- Circuit symbol
- Boolean expn.



$$Y = \overline{A \cdot B} = \overline{A} + \overline{B}$$

NAND

A	B	OR	AND	NOR	NAND
0	0	0	0	1	1
1	0	1	0	0	1
0	1	1	0	0	1
1	1	1	1	0	0



QUESTION

The resistivity of a semiconductor depends upon

1. Size of the atom
2. The nature of atoms
3. Type of bonds
4. Size and types of motion

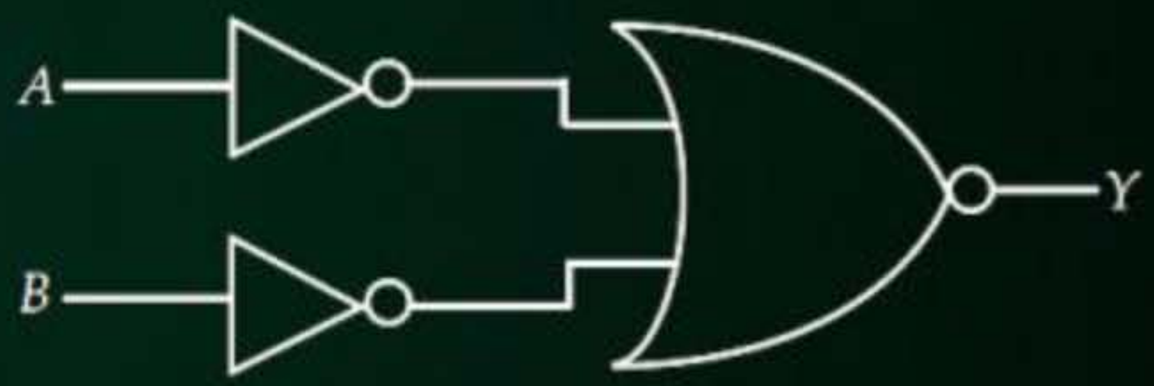
QUESTION

In a semiconductor diode, the reverse biased current is due to drift of free electrons and holes caused by

1. Thermal excitations only
2. Impurity atoms only
3. Both (1) & (2)
4. Neither (1) nor (2)

QUESTION

For the logic circuit shown, the truth table is (NEET 2020)



(1)

A	B	Y
0	0	0
0	1	0
1	0	0
1	1	1

(2)

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

(3)

A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

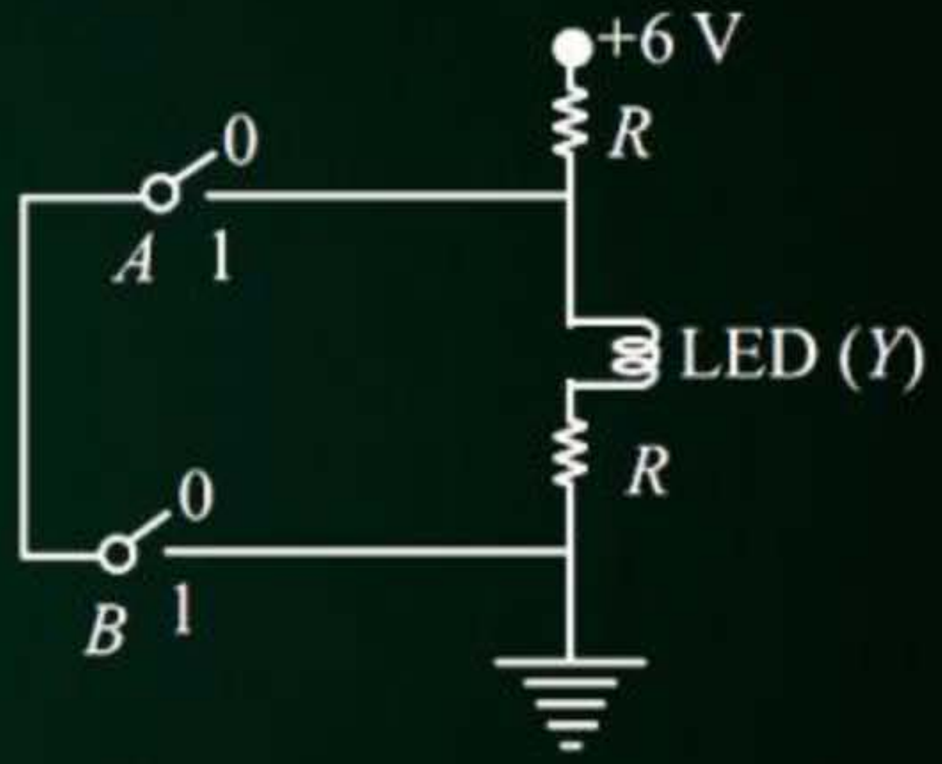
(4)

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

QUESTION

The correct Boolean operation represented by the circuit diagram drawn is

(NEET 2019)



1. NOR
2. AND
3. OR
4. NAND

QUESTION

In the combination of the following gates the output Y can be written in terms of inputs A and B as

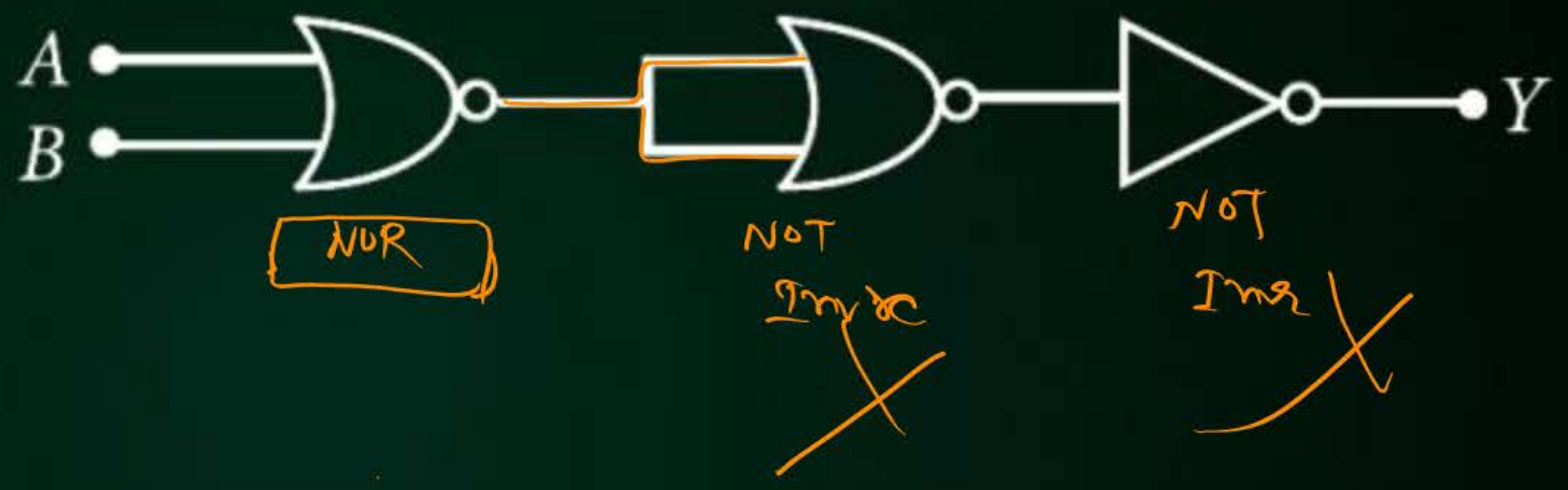
(NEET 2018)



1. $\overline{A.B}$
2. $A.\overline{B} + \overline{A}.B$
3. $\overline{A.B} + A.B$
4. $\overline{A+B}$

QUESTION

The given electrical network is equivalent to (NEET 2017)

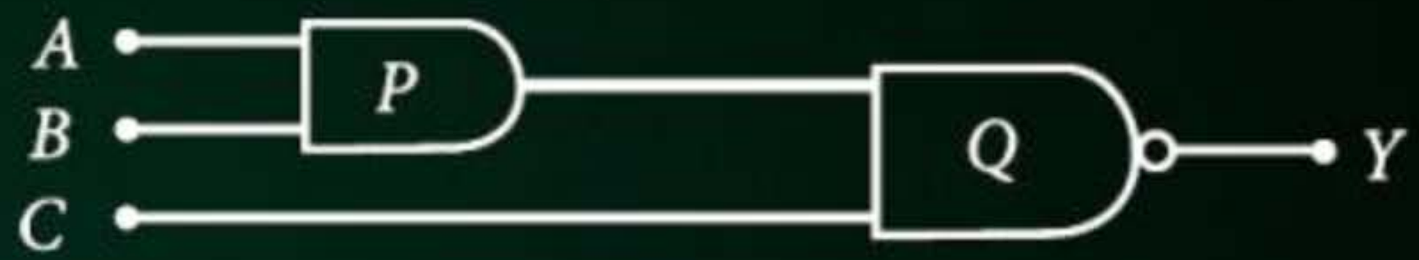


1. OR gate
2. NOR gate
3. NOT gate
4. AND gate

QUESTION

What is the output Y in the following circuit, when all the three inputs A, B, C are first 0 and then 1?

(NEET 2016)

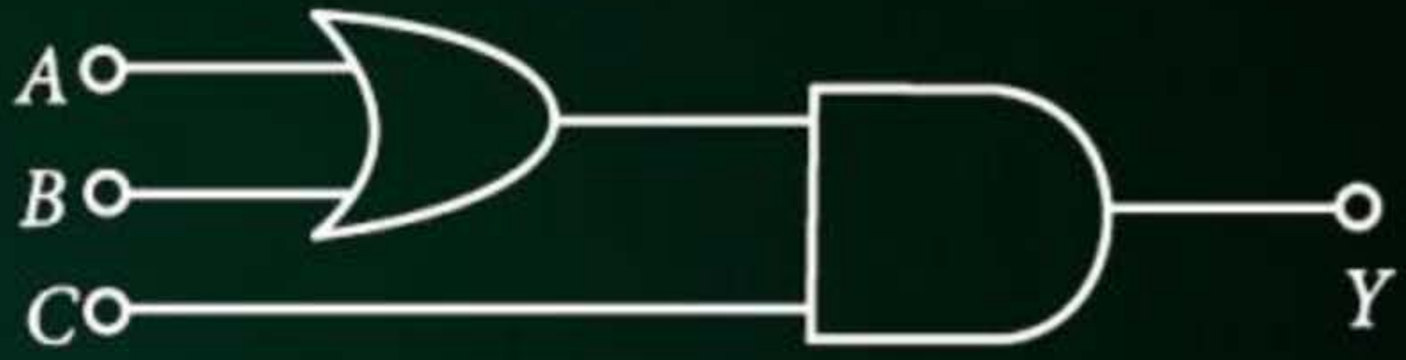


1. 0, 1
2. 0, 0
3. 1, 0
4. 1, 1

QUESTION

To get output 1 for the following circuit, the correct choice for the output is

(NEET 2016, Mains 2012, 2010)



1. $A = 1, B = 1, C = 0$
2. $A = 1, B = 0, C = 1$
3. $A = 0, B = 1, C = 0$
4. $A = 1, B = 0, C = 0$

QUESTION

The Output (X) of the logic circuit shown in figure will be (NEET 2013)

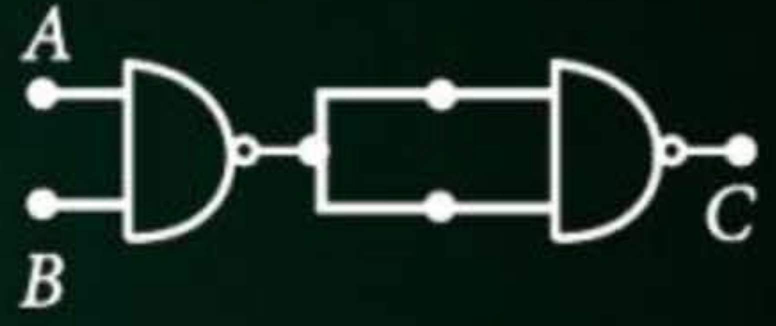


1. $X = A.B$
2. $X = \overline{A + B}$
3. $X = \overline{\overline{A}}.\overline{\overline{B}}$
4. $X = \overline{A.B}$

QUESTION

The Output form of a NAND gate is divided into two in parallel and fed to another NAND gate. The resulting gate is a

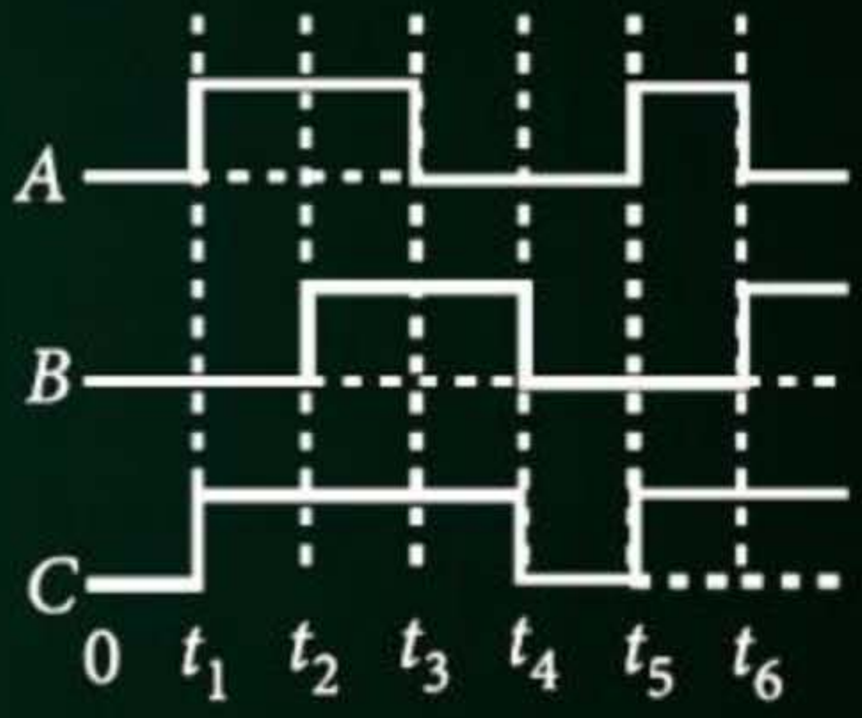
(Karnataka NEET 2013)



1. AND gate
2. NOR gate
3. OR gate
4. NOT gate

QUESTION

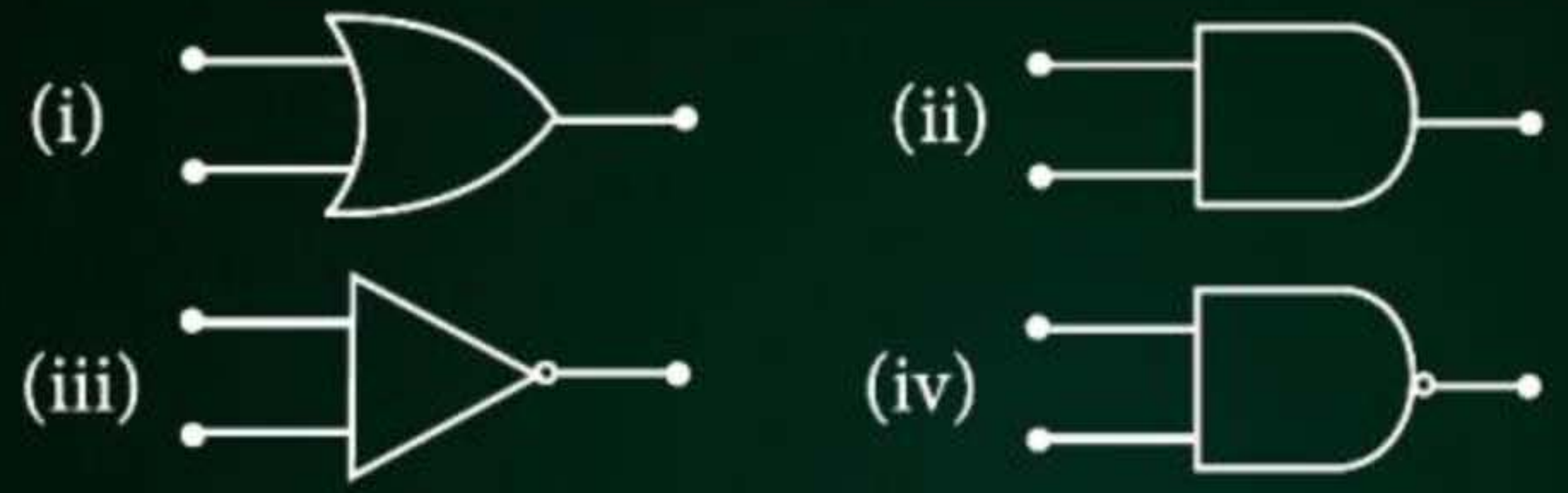
The figure shows a logic circuit with two inputs A and B and the output C. The voltage wave forms across A,B and C are as given. The logic circuit gate is (2012)



1. OR gate
2. NOR gate
3. AND gate
4. NAND gate

QUESTION

Symbolic representation of four logic gates are shown as (2011)



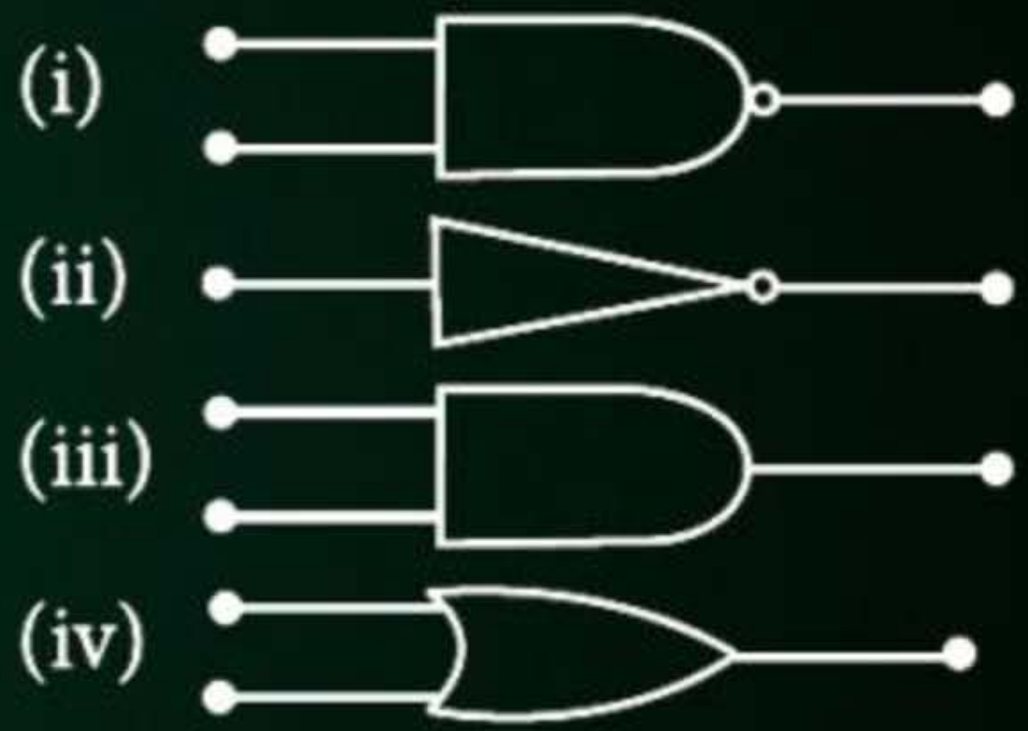
Pick out which ones are for AND, NAND and NOT gates, respectively

1. (ii), (iii) and (iv)
2. (iii), (ii) and (i)
3. (iii), (ii) and (iv)
4. (ii), (iv) and (iii)

QUESTION

The Symbolic representation of four logic gates are shown as

The logic symbols for OR, NOT and NAND gates are respectively (2009)



1. (iv), (i) and (iii)
2. (iv), (ii) and (i)
3. (i), (iii) and (iv)
4. (iii), (iv) and (ii)


THANK YOU

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FOR NEET 2025

Lecture- 01 | **Physics**

Semiconductor Electronics Materials, Devices and Simple Circuits

By- Dr. Manish Raj (MR SIR)



Topics to be covered

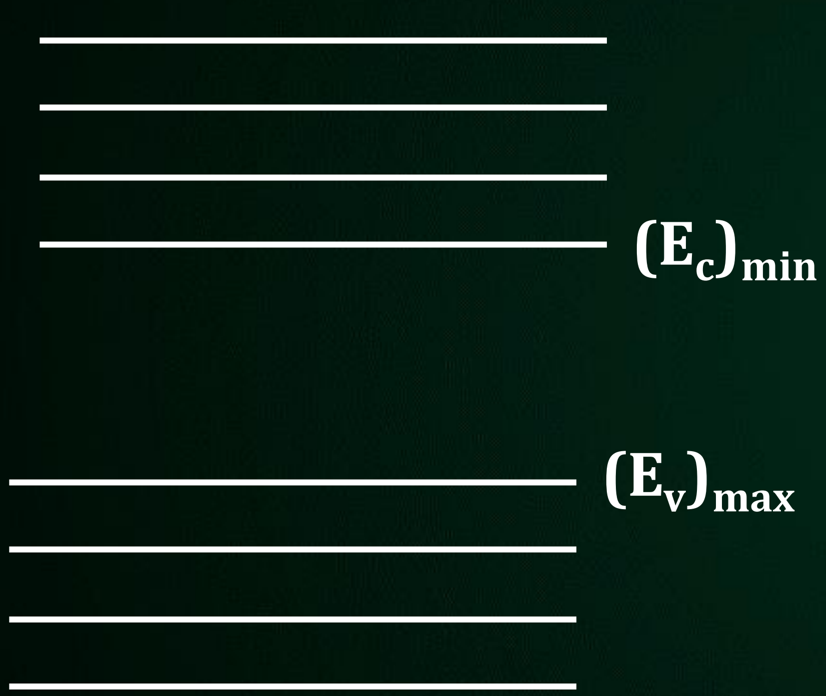
1. Logic Gate
2. #
3. #
4. #



SEMICONDUCTOR

Conductor is conductor, insulator is insulator but semiconductor have dual nature.

BAND THEORY



Conduction Band → Infinite energy level each fixed with two electron.

- These are free e^-
- Current flows due to these e^-

Valance band → Infinite energy level always filled with e^-, these are bonded e^- current do not flow due to these e^-

QUESTION

The semiconductors are generally

1. Monovalent
2. Divalent
3. Trivalent
4. Tetravalent

QUESTION

The resistivity of a semiconductor depends upon

1. Size of the atom
2. The nature of atoms
3. Type of bonds
4. Size and types of motion

METAL

Ey ≈ 0 zero, or vary small

$Ey = (E_c)_{min} - (E_v)_{max}$

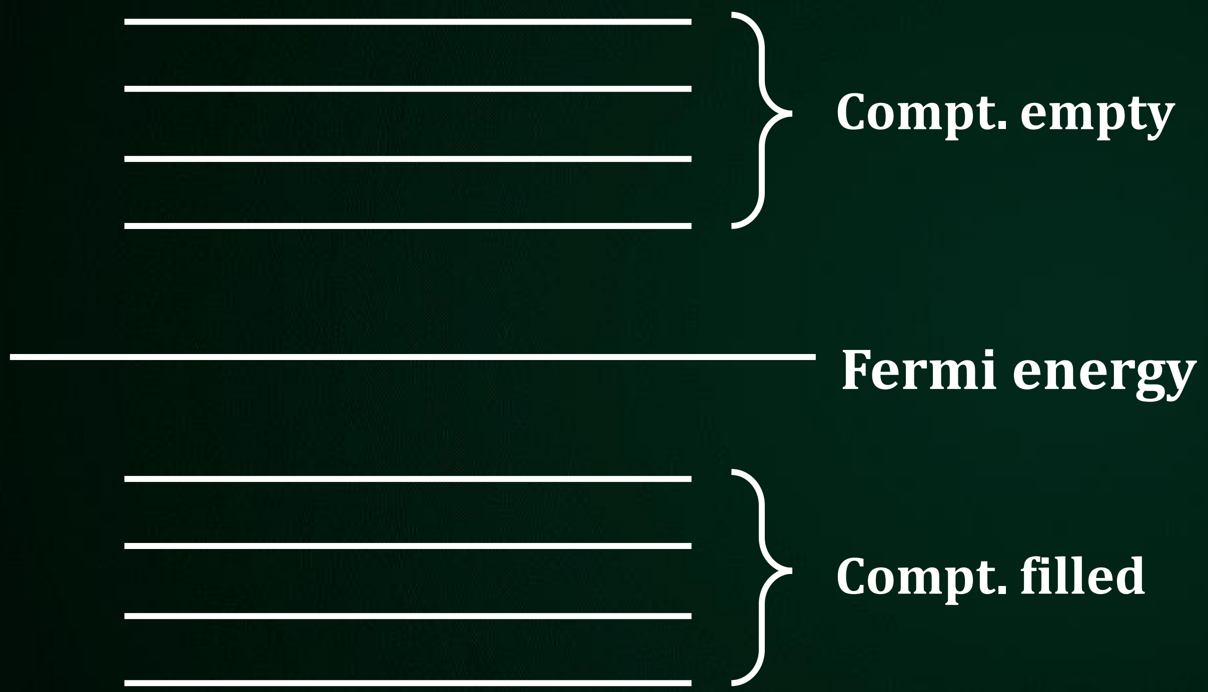
INSULATOR

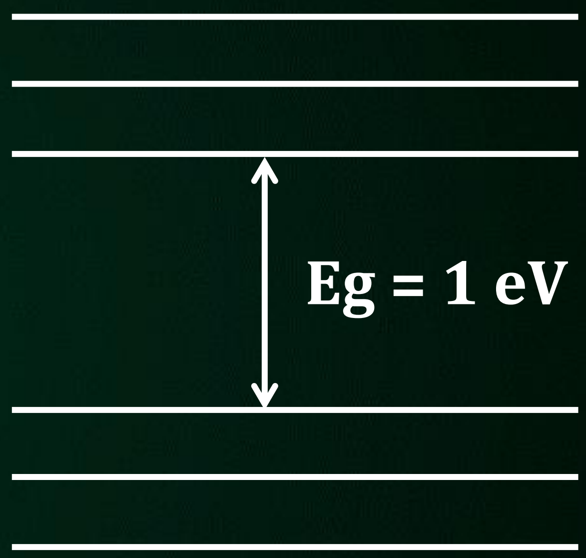
$E_g \geq 3$ eV

- vary large
- no current

SEMICONDUCTOR

At = 300 K (Room temp.)





- Behave as insulator
- No current

$n_i = [n_e] = [n_h]$

At T = 0° K

QUESTION

A pure semiconductor has

1. An infinite resistance at 0°C
2. A finite resistance which does not depend upon temperature
3. A finite resistance which increases with temperature
4. A finite resistance which decreases with temperature

QUESTION

In semiconductors at a room temperature [2006]

1. The valence band is partially empty, and the conduction band is partially filled
2. The valence band is completely filled, and the conduction band is partially filled
3. The valence band is completely filled
4. The conduction band is completely empty

- **Hole** $\rightarrow$
  - charge of hole = $+e$
  - effective mass of hole > effective mass of e^-

- **Recombination** $\rightarrow$ When free e^- collide with hole then free e^- recombine with the hole that decreases the conductivity.

P.Q.	Conductor	Semiconductor	Insulator
Increases			
Decreases			

QUESTION

Choose the only false statement from the following [2005]

1. In conductors the valence and conduction bands overlap

2. Substance with energy gap of the order 10 eV are insulators

3. The resistivity of a semi conductor increases with increase in temperature

4. The conductivity of a semiconductor increases with increasing temperature

EXTRINSIC SEMICONDUCTOR

Doping $\rightarrow$ Process of adding Impurity

N-Type

- Pentavalent Impurity
- Ex- P, As, Sb
- $n_e >> \mathrm{n_h}$
- n_e = majority charge carrier
- n_h = minority charge carrier
- $I_e > I_h$
- $Q_{\mathrm{net}} = 0$
- $N_D \approx n_e$

P – TYPE

- Trivalent Impurity
- Ey- B, In, Al
- $n_e << n_h$

hole current majority

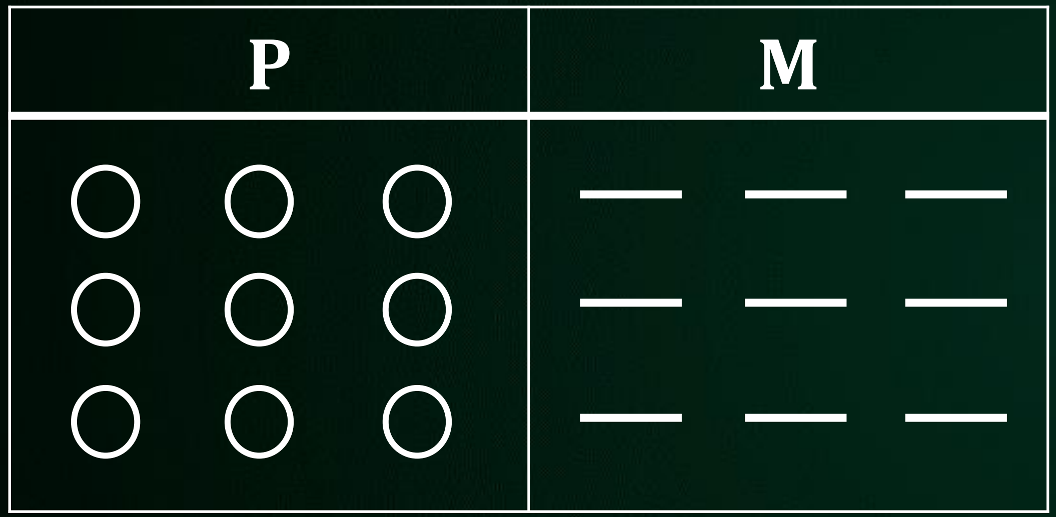
- $Q_{\text{net}} = 0$
- $N_A = n_h$

QUESTION

In semiconductors, which of the following relations is correct at thermal equilibrium?

1. $n_i = n_e = n_h$
2. $n_1{}^2 = n_e n_h$
3. $n_i = n_e / n_h$
4. $n_i = n_e + n_h$

P-N JUNCTION DIODE



QUESTION

What is the use of P-type and N-type?

QUESTION

The impurity atoms with which pure silicon should be doped to make a p-type semiconductor are those of

1. Phosphorus
2. Antimony
3. Boron
4. Copper

QUESTION

The rate of recombination or generation are governed by the law(s) of

1. Mass conservation
2. Electrical neutrality
3. Thermodynamics
4. Chromodynamics

QUESTION

An *n*-type semiconductor is electrically

1. Positive
2. Negative
3. May be positive or negative
4. Neutral

QUESTION

Pure Si at 500K has equal number of electrons (n_e) and holes (n_h) concentrations of $1.5 \times 10^{16} m^{-3}$. Doping by Indium increases (n_h) to $4.5 \times 10^{22} m^{-3}$. The doped semiconductor is of **(Mains 2011)**

1. p-type having electron concentration $(n_e) = 5 \times 10^{9} m^{-3}$
2. n-type with electron concentration $(n_e) = 5 \times 10^{22} m^{-3}$
3. p-type with electron concentration $(n_e) = 2.5 \times 10^{10} m^{-3}$
4. n-type with electron concentration $(n_e) = 2.5 \times 10^{23} m^{-3}$

QUESTION

Pure Si at 300 K has hole and electron densities are $1.5 \times 10^{16}\ m^{-3}$. Doping it by an impurity increases the hole density n_h to $4.5 \times 10^{22}\ m^{-3}$. Electron density in the doped silicon is

1. $1.5 \times 10^{16}\ m^{-3}$
2. $3.0 \times 10^{22}\ m^{-3}$
3. $5 \times 10^{9}\ m^{-3}$
4. $3 \times 10^{6}\ m^{-3}$

QUESTION

In an intrinsic (pure) semiconductor, the number of conduction electrons is 7×10^{19} per cubic metre. Find the total number of current carriers (electrons & holes) in a same semiconductor of size 1 cm × 1 cm × 1 mm.

QUESTION

Pure Si at 300 K has equal electron (n_e) and hole (n_h) concentration of 2×10^{16} per m^3. Doping by indium increases n_h to 4×10^{22} per m^3. Calculate n_e in the doped silicon.

QUESTION

For a p-type semiconductor which of the following statement is true? **(NEET 2019)**

1. Electrons are the majority carriers and pentavalent items are the dopants
2. Electrons are the majority carrier and trivalent atoms are the dopants
3. Holes are the majority carriers and trivalent atoms are the dopants
4. Holes are the majority carriers and pentavalent atoms are the dopants

QUESTION

In a n-type semiconductor which of the following statement is true ? **(NEET 2013)**

1. Holes are minority carriers and pentavalent atoms are dopants
2. Holes are majority carriers and trivalent atoms are dopants
3. Electrons are Majority carriers end trivalent atoms are dopants
4. Electrons are minority carriers and pentavalent atoms are dopants

QUESTION

In a p-type semiconductor, the majority carriers of current are **(1999)**

1. Protons
2. Electrons
3. Holes
4. Neutrons


THANK YOU

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FOR NEET 2025

Lecture- 2 | **Physics**

Semiconductor Electronics Materials, Devices and Simple Circuits

By- Dr. Manish Raj (MR SIR)



Topics to be covered

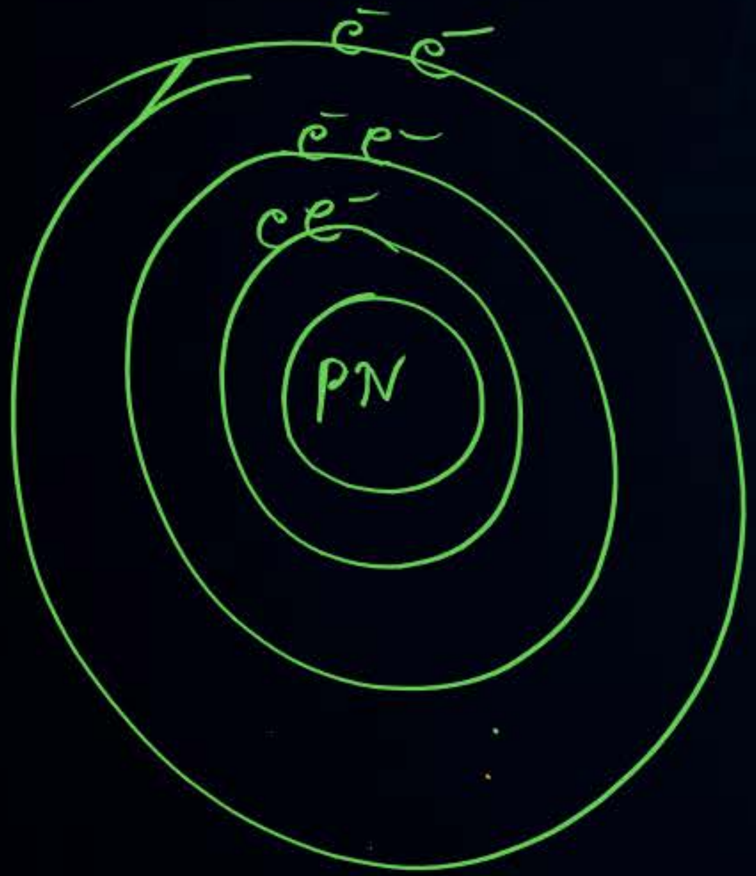
1. # Pure and P-Type & N-Type semiconductor
2. #
3. #
4. #



Conductor is conductor; Insulator is Insulator but semiconductor ... have .. dual nature.

$\sigma_{conductor} > \sigma_{semiconductor} > \sigma_{Insulator}$

Conductivity of semiconductor can be controlled by Tempr and doping

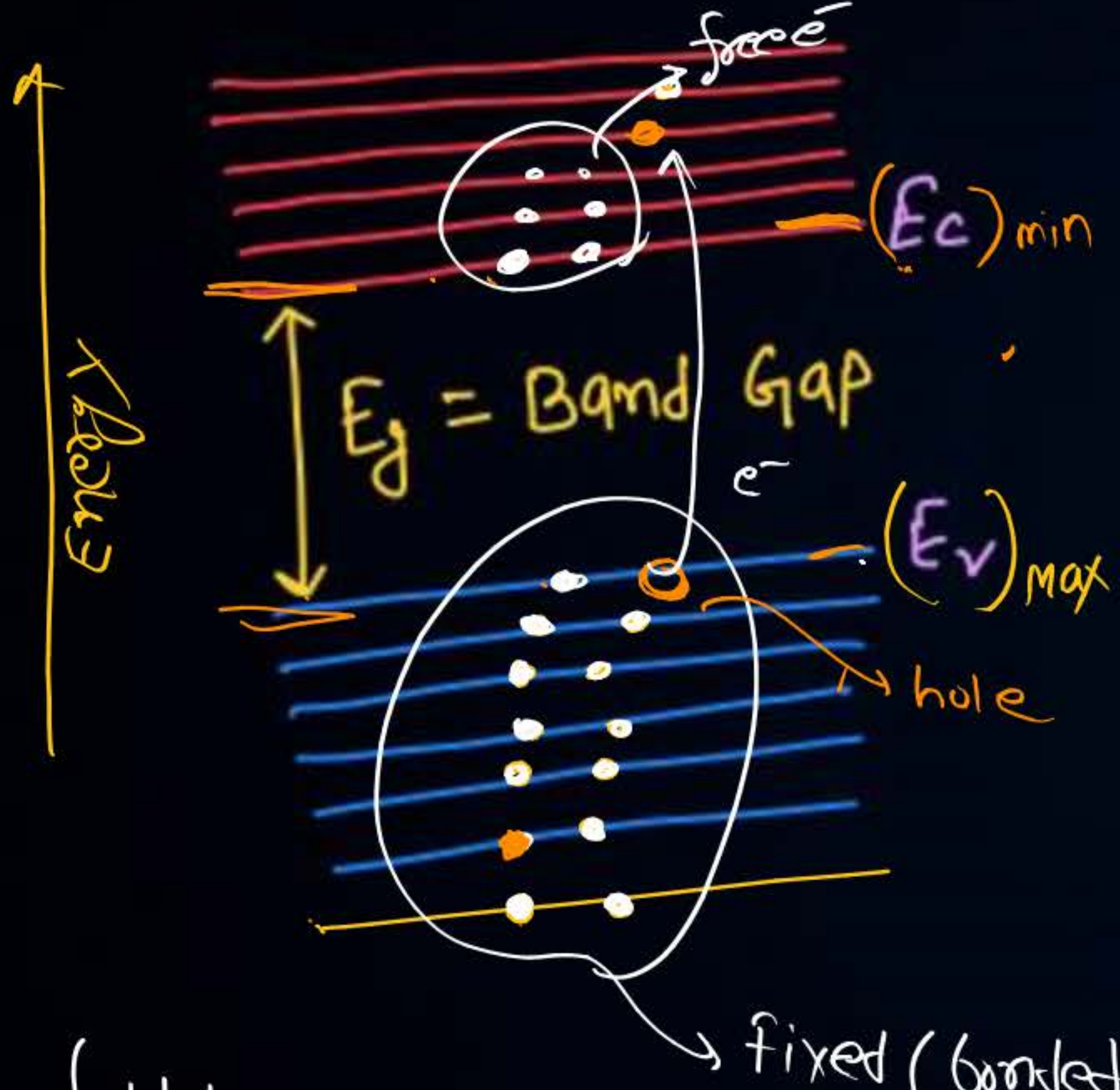


orbit theory

all bonded e⁻s have same energy ⟶ no

Band theory → for all semiconductor, Insulator, & conductor.

↪ on the basis of energy.



Conduction Band → Infinite energy level, empty or may filled with two e^-s

- These are free e^-s.
- current flows due to these e^-'s.

Valance Band → Infinite energy level always filled with e^-s or hole (empty space of e^-)

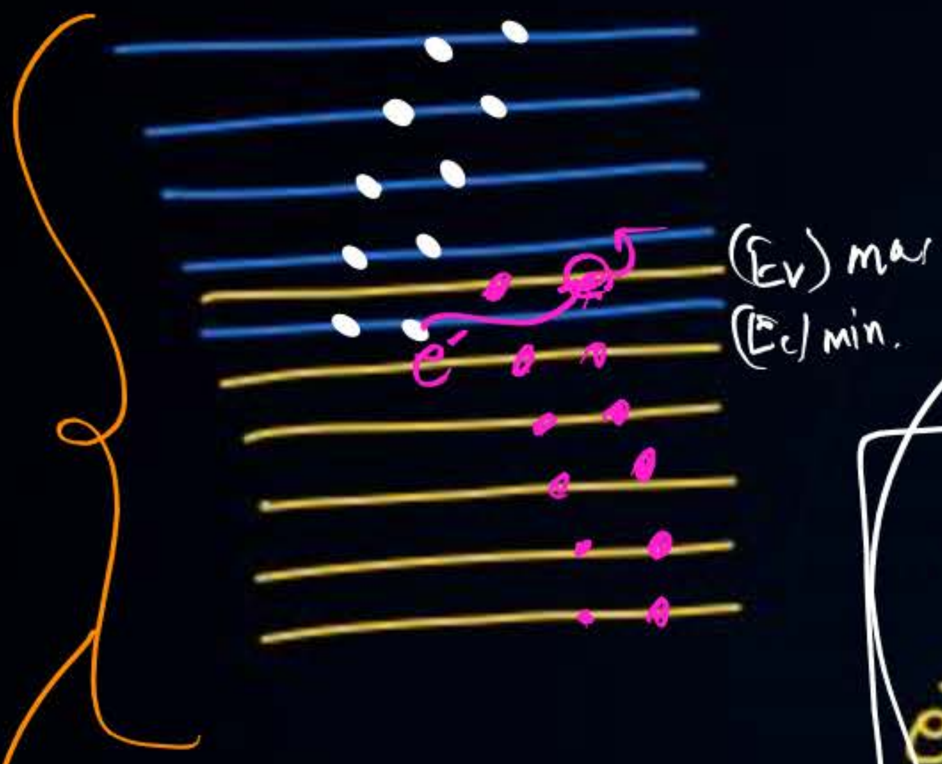
- These are bonded e^-s
- current can't flows due to these e^-s

$$E_g \text{ (Band gap)} = (E_c)_{min} - (E_v)_{max}$$

Hole → Hole is a vacant space of e^-

$Q = +e$

Band theory for metal



$E_g \leq 0.1\,eV$

$E_g \simeq 0$

At T = 0K, conductivity very high.

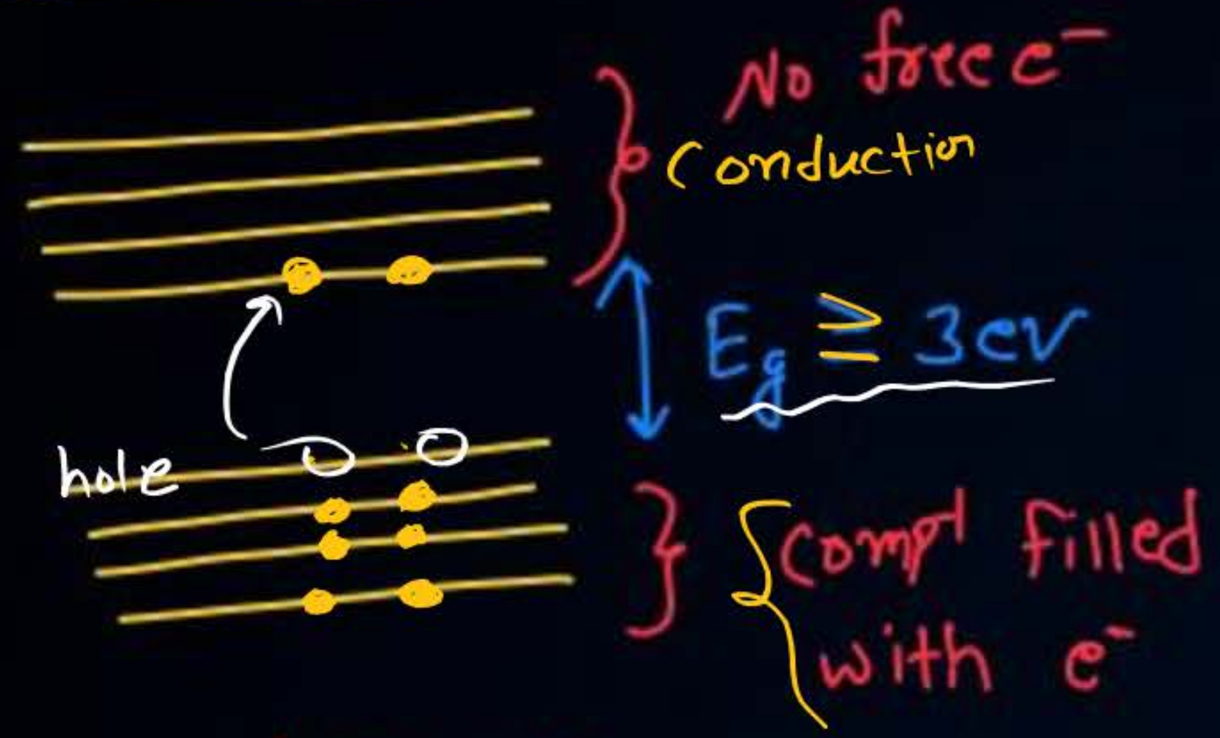
- As Tempr Increase [ē-hole] created but ē-hole pair (re-combination) occurs simultaneously.

→ As Tempr ↑ Increase random motion of ē - Increase → Resistivity ↑ conductivity ↓

Conduction band and valance band overlap to each other.

or Band Gap is very small.

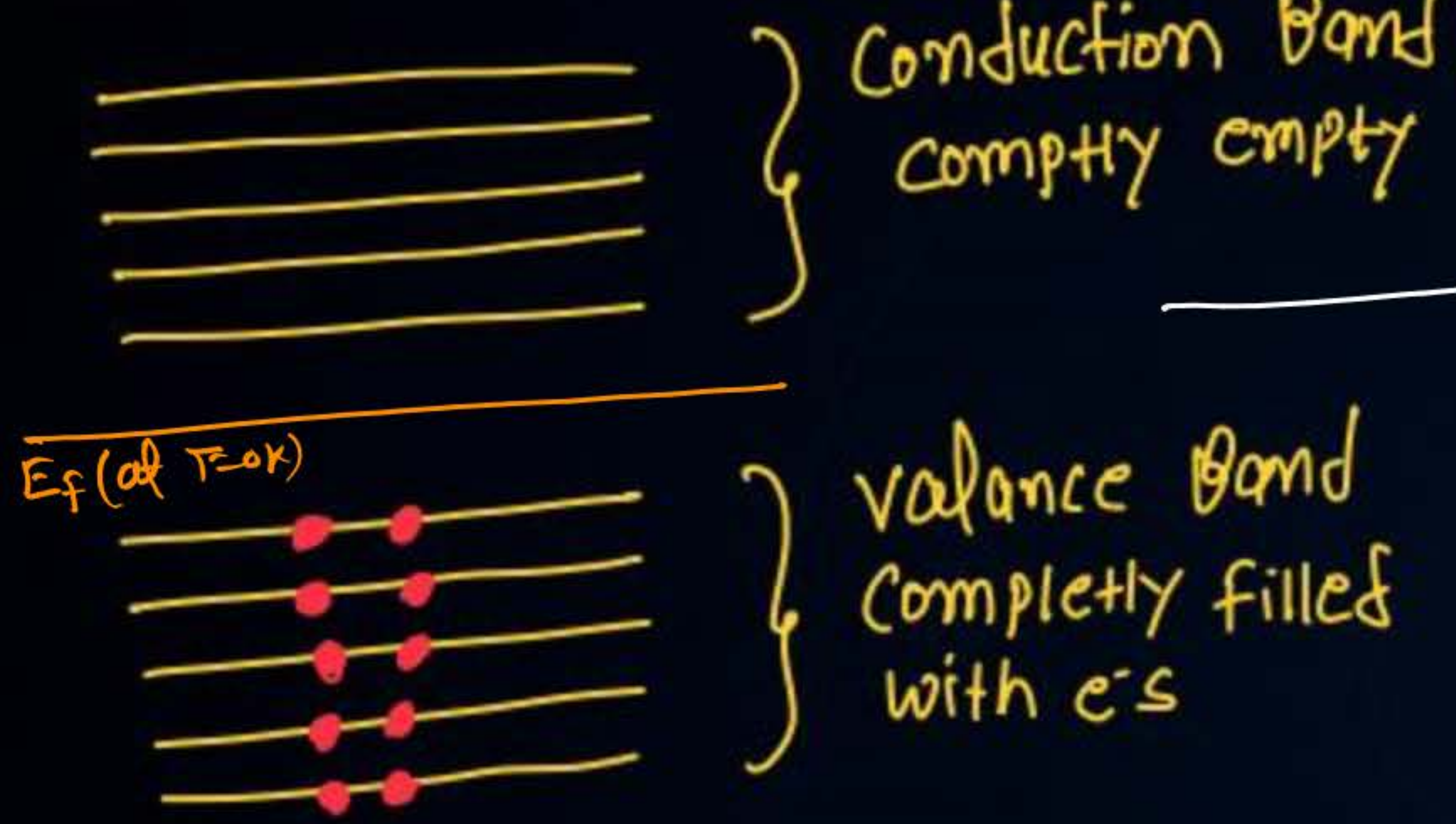
Insulator



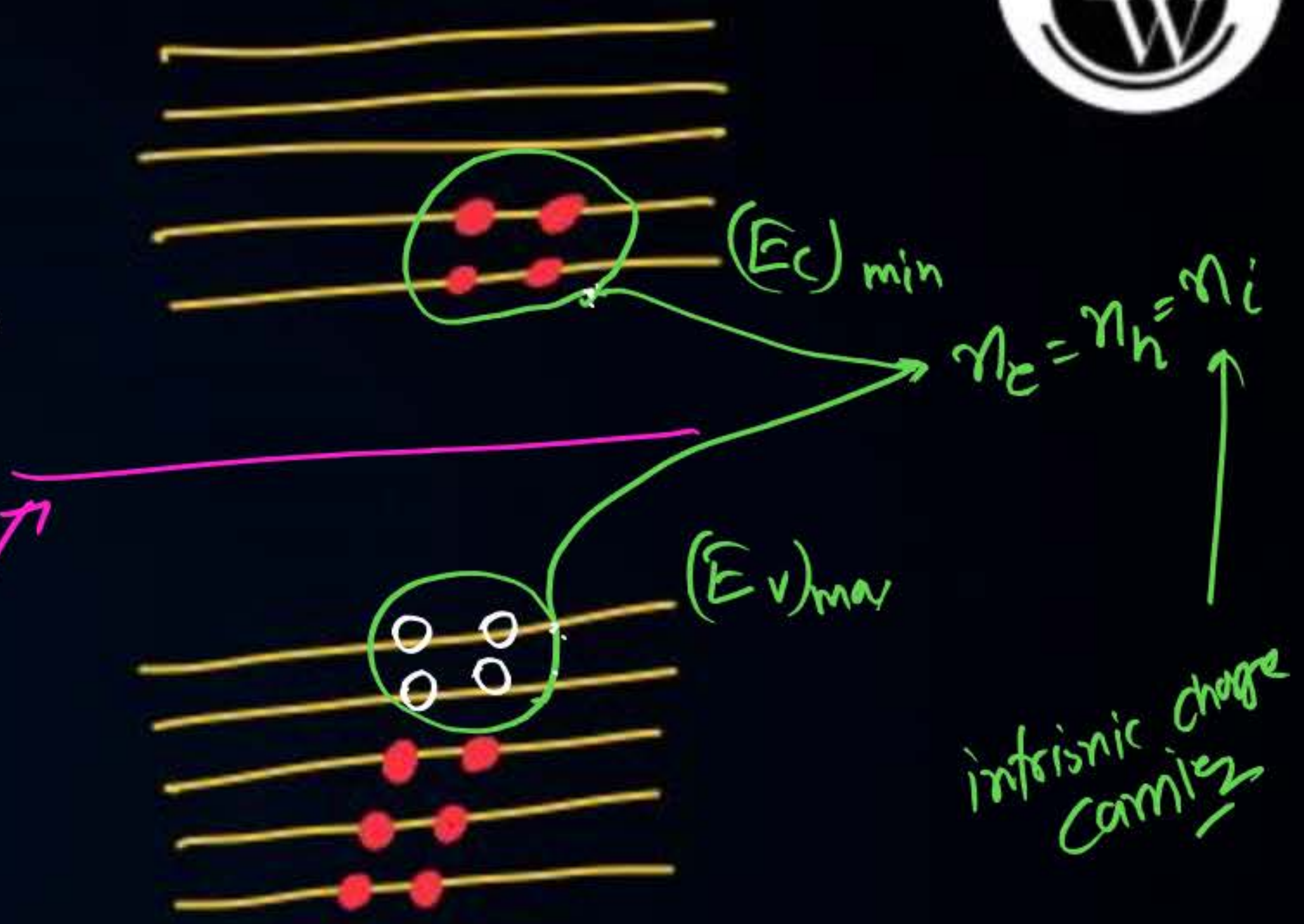
at $T = 0K$

- Due to Increase in Tempr e^- gain energy and Jump into conduction Band and vacant space in valance Band is called hole, but this happen in less amount due to large band gap.
- Hence Tempr ↑ (e^--hole) Pair
  (e^--hole Pair) ↑ Conductivity ↑
  Resistivity ↓

Semiconductor



Temp Increase



\# T = 0K, semiconductor behave as insulator.
because all valace Band is Completly filled but Conduction Band is empty.

→ Fermi energy level → max energy level occupied by e^- at 0K

→ tempr Incre (e^- - hole) Pair Increse

Conductivity ↑ Resistivity ↓

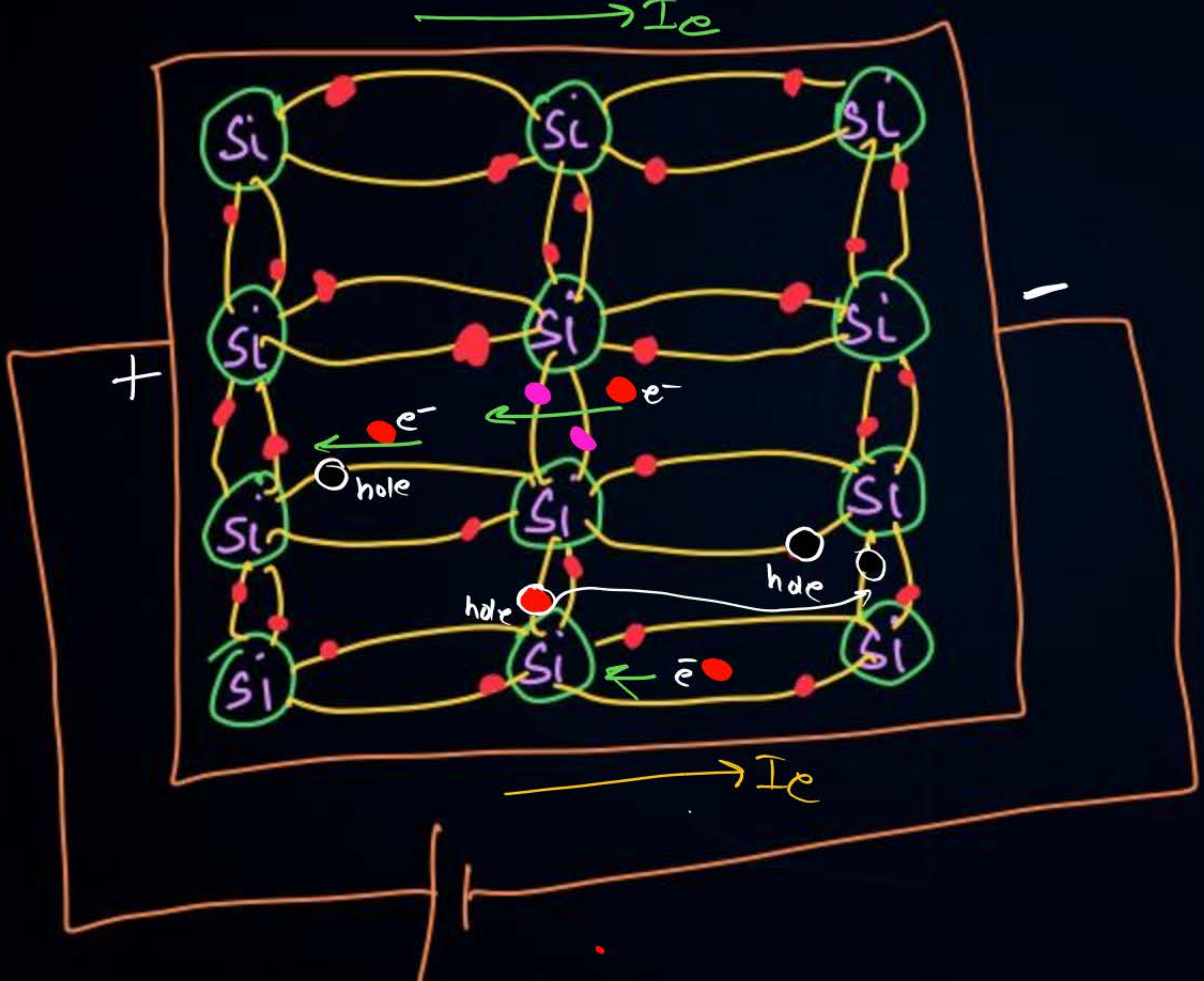
In Pure Semiconductor

n_e = no of free $\bar{e}$ per unit volume ✓

n_h = no of hole per unit volume ✓

$$\boxed{n_i = n_e = n_h}$$

Current in Pure Semiconductor



$I = n_e e A v_d$

effective movement of hole but it is less in number.

hole → $q_{hole} = +e$

Mass of hole >> m_e

$\mu_{hole} << \mu_e$

$\mu = \frac{e\tau}{m}$

$I_{net} = I_e + I_{hole}$

Pure semiconductor

$$I_{net} = I_e + I_h$$

$$v = \mu E$$

$$I_{net} = n_e e A v_{de} + n_h e A v_{dh}$$

Temp

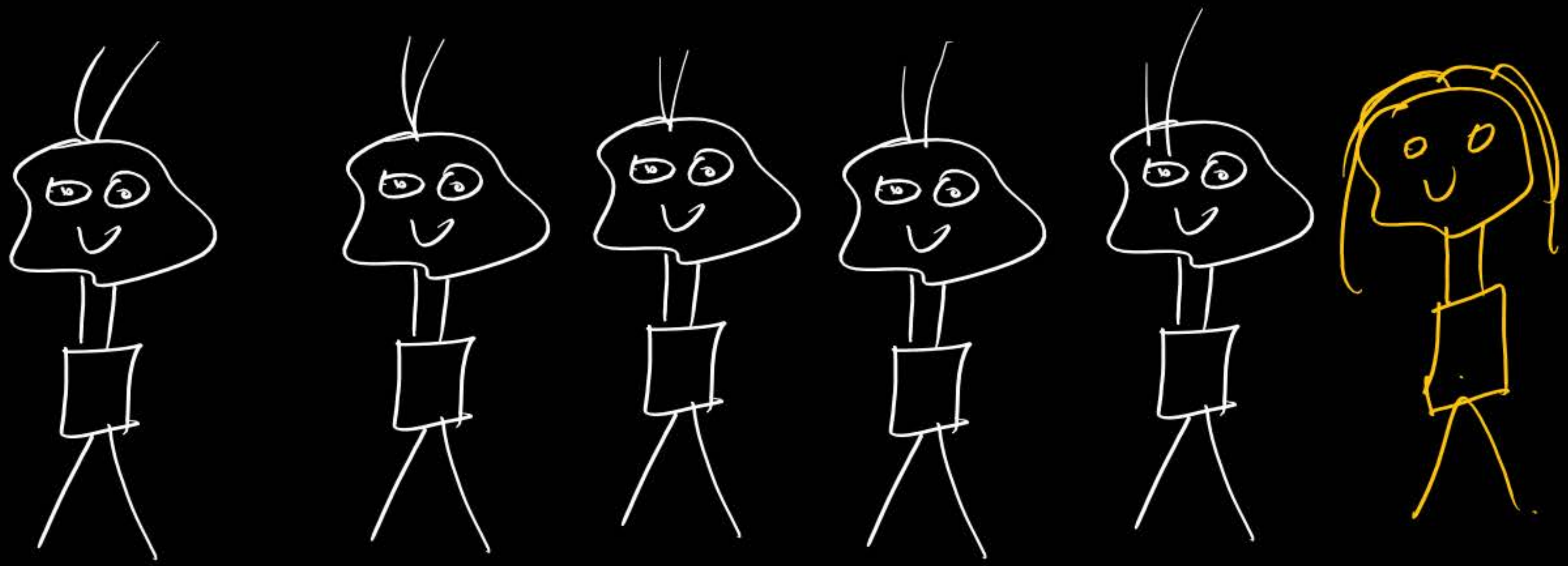
$$n_e = n_h = n_i$$

$$I_{net} = n_i e A [v_{de} + v_{dh}]$$

$$= n_i e A [\mu_e E + \mu_h E]$$

$$= n_i e A E [\mu_e + \mu_h]$$

$$I = n_i e A \frac{V}{l} (\mu_e + \mu_h)$$



Eg- Si Ge GaAs

Eg=1.1ev 0.7ev 1.4ev

N-TYPE [Extrinsic (Impure) Semiconductor]

Pentavalent Impurity

Ex – P, AS, Sb

→ donor Ion → fixed bond me participle.

→ free e^-

$n_e >>> n_{hole}$

$I_e >> I_h$

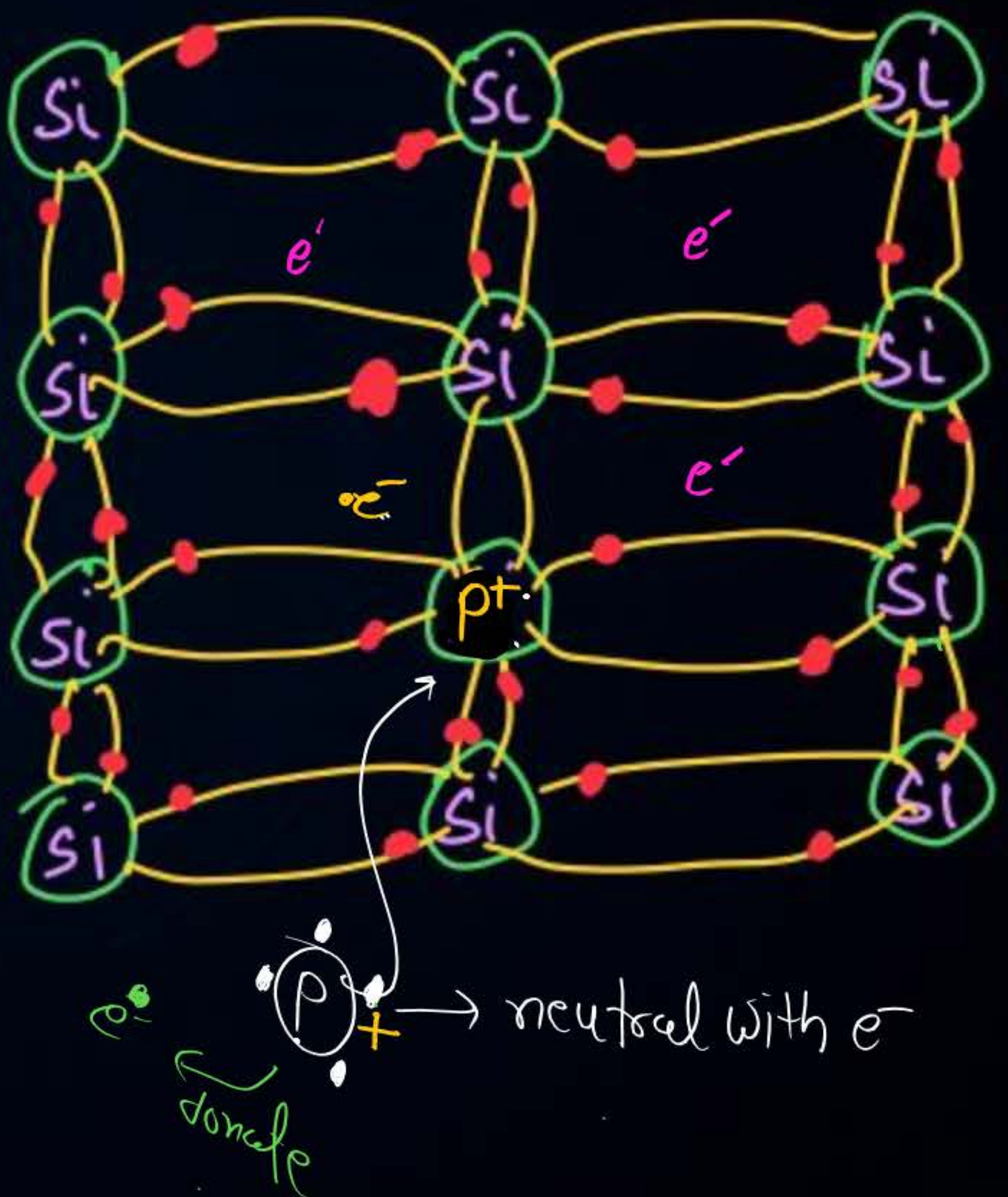
$N_D \approx n_e$

no of donor Ion — no. of free $\bar{e}$

$Q_{net} = 0$

n_e (majority charrier)

n_h (minority charge carrier)



EXTRINSIC SEMICONDUCTOR

\# Doping → Process of adding Impurity

N-Type

- Pentavalent Impurity
- Ex- P, As, Sb
- $n_e >> n_h$
- n_e = majority charge carrier
- n_h = minority charge carrier
- $I_e > I_h$
- $Q_{net} = 0$
- $N_D \approx n_e$

P- Type

Trivalent Impurity

* Ex- B, In, Al

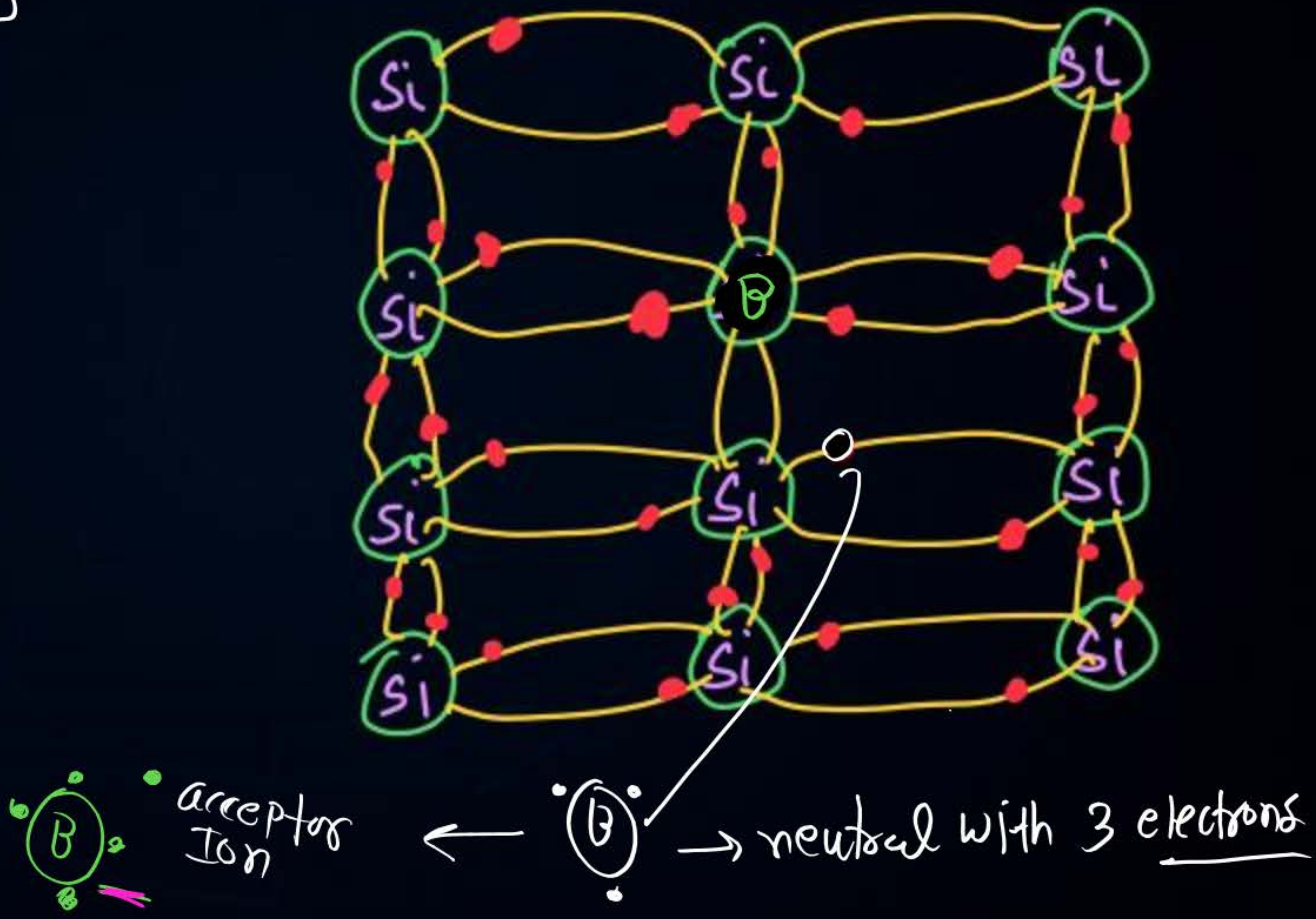
↳ extra free hole

$Q_{net} = 0$

$n_h >>> n_e$

$I_h >>> I_e$

↑ majority   minority



Is N Type Semicondu is useful ?

NO

Mass action law → Based Law of thermal equilibrium

$$n_e \cdot n_h = n_i^2$$

n-Type

$n_e \simeq N_D$

$n_e n_h = n_i^2$

$N_D n_h = n_i^2$

$n_h = \frac{n_i^2}{N_D}$

p-Type

$n_h = N_A$

$n_e n_h = n_i^2$

$n_e = \frac{n_i^2}{N_A}$

n_i = intrinsic charge carrier before doping.

n_e = no of e^- per unit volume

n_h = no of hole per unit volume

→ after doping

QUESTION

The semiconductors are generally

1. Monovalent
2. Divalent
3. Trivalent
4. Tetravalent

QUESTION

The resistivity of a semiconductor depends upon

1. Size of the atom
2. The nature of atoms
3. Type of bonds
4. Size and types of motion

QUESTION

A pure semiconductor has

1. An infinite resistance at $0^{\circ}C$
2. A finite resistance which does not depend upon temperature
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4. A finite resistance which decreases with temperature

QUESTION

In semiconductors at a room temperature [2006]

1. The valence band is partially empty, and the conduction band is partially filled
2. The valence band is completely filled, and the conduction band is partially filled
3. The valence band is completely filled
4. The conduction band is completely empty

- **Hole** →
  - charge of hole = $+e$
  - effective mass of hole > effective mass of e^-

- **Recombination** → When free e^- collide with hole then free e^- recombine with the hole that decreases the conductivity.

P.Q.	Conductor	Semiconductor	Insulator
Increases			
Decreases			

QUESTION

Choose the only false statement from the following [2005]

1. In conductors the valence and conduction bands overlap
2. Substance with energy gap of the order 10 eV are insulators
3. The resistivity of a semi conductor increases with increase in temperature
4. The conductivity of a semiconductor increases with increasing temperature

P – TYPE

- Trivalent Impurity
- Ey- B, In, Al
- $n_e << n_h$

hole current majority

- $Q_{net} = 0$
- $N_A = n_h$

QUESTION

In semiconductors, which of the following relations is correct at thermal equilibrium?

1. $n_i = n_e = n_h$
2. $n_1^2 = n_e n_h$
3. $n_i = n_e / n_h$
4. $n_i = n_e + n_h$

QUESTION

What is the use of P-type and N-type?

QUESTION

The impurity atoms with which pure silicon should be doped to make a p-type semiconductor are those of

1. Phosphorus
2. Antimony
3. Boron
4. Copper

QUESTION

The rate of recombination or generation are governed by the law(s) of

1. Mass conservation
2. Electrical neutrality
3. Thermodynamics
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QUESTION

An n-type semiconductor is electrically

1. Positive
2. Negative
3. May be positive or negative
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QUESTION

Pure Si at 500K has equal number of electrons (n_e) and holes (n_h) concentrations of $1.5 \times 10^{16} m^{-3}$. Doping by Indium increases (n_h) to $4.5 \times 10^{22} m^{-3}$. The doped semiconductor is of

(Mains 2011)

1. p-type having electron concentration $(n_e) = 5 \times 10^9 m^{-3}$
2. n-type with electron concentration $(n_e) = 5 \times 10^{22} m^{-3}$
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QUESTION

Pure Si at 300 K has hole and electron densities are $1.5 \times 10^{16}\ m^{-3}$. Doping it by an impurity increases the hole density n_h to $4.5 \times 10^{22}\ m^{-3}$. Electron density in the doped silicon is

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QUESTION

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QUESTION

For a p-type semiconductor which of the following statement is true? **(NEET 2019)**

1. Electrons are the majority carriers and pentavalent items are the dopants
2. Electrons are the majority carrier and trivalent atoms are the dopants
3. Holes are the majority carriers and trivalent atoms are the dopants
4. Holes are the majority carriers and pentavalent atoms are the dopants

QUESTION

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2. Holes are majority carriers and trivalent atoms are dopants
3. Electrons are Majority carriers end trivalent atoms are dopants
4. Electrons are minority carriers and pentavalent atoms are dopants


THANK YOU

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FOR NEET 2025

Lecture- 3 | Physics

Semiconductor Electronics Materials, Devices and Simple Circuits



By- Dr. Manish Raj (MR SIR)

Todays Goal

- H/W ✓
- PN Junction diode ✓
- circuit with diode ✓
  - zener diode ✓
  - Photo diode ✓
  - LED ✓
  - solar cell ✓
- Half wave & full wave rectifier ✓

QUESTION

The semiconductors are generally

1. Monovalent
2. Divalent
3. Trivalent
4. Tetravalent ✓

Si Ge GaAs

QUESTION

The resistivity of a semiconductor depends upon

1. Size of the atom
2. The nature of atoms
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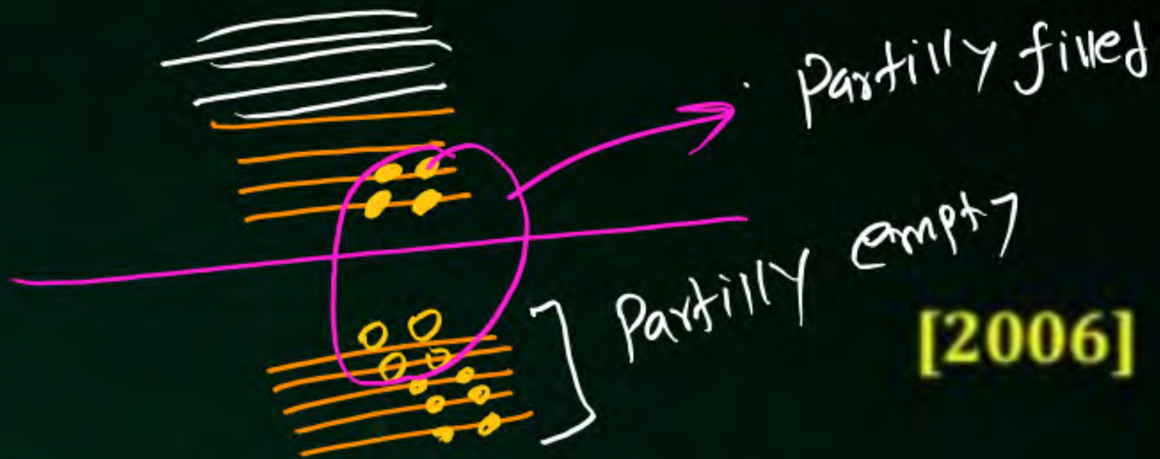
QUESTION

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- **Hole →**
    - charge of hole = $+e$
    - effective mass of hole > effective mass of e^- ✓

$\mu_h << \mu_e$

- **Recombination →** When free e^- collide with hole then free e^- recombine with the hole that decreases the conductivity. and release some enegy.

QUESTION

Choose the only false statement from the following [2005]

1. In conductors the valence and conduction bands overlap
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3. The resistivity of a semi conductor increases with increase in temperature
4. The conductivity of a semiconductor increases with increasing temperature

Ans — (3)

QUESTION

In semiconductors, which of the following relations is correct at thermal equilibrium?

mass - action law is at thermal eqn

1. $n_i = n_e = n_h$
2. $n_i^2 = n_e n_h$
3. $n_i = n_e / n_h$
4. $n_i = n_e + n_h$

QUESTION

The impurity atoms with which pure silicon should be doped to make a p-type semiconductor are those of

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(Mains 2011)

1. p-type having electron concentration $(n_e) = 5 \times 10^9 m^{-3}$
2. n-type with electron concentration $(n_e) = 5 \times 10^{22} m^{-3}$
3. p-type with electron concentration $(n_e) = 2.5 \times 10^{10} m^{-3}$
4. n-type with electron concentration $(n_e) = 2.5 \times 10^{23} m^{-3}$

Ans

$n_i = n_e = n_h = 1.5 \times 10^{16}$

$n_h = 4.5 \times 10^{22}$

P-Type

after doping

$n_e \cdot n_h = n_i^2$

$n_e = \frac{n_i^2}{n_h} = \frac{2.25 \times 10^{32}}{4.5 \times 10^{22}}$

QUESTION

Pure Si at 300 K has hole and electron densities are $1.5 \times 10^{16}\ m^{-3}$. Doping it by an impurity increases the hole density n_h to $4.5 \times 10^{22}\ m^{-3}$. Electron density in the doped silicon is

1. $1.5 \times 10^{16}\ m^{-3}$
2. $3.0 \times 10^{22}\ m^{-3}$
3. $5 \times 10^{9}\ m^{-3}$
4. $3 \times 10^{6}\ m^{-3}$

QUESTION

In an intrinsic (pure) semiconductor, the number of conduction electrons is 7×10^{19} per cubic metre. Find the total number of current carriers (electrons & holes) in a same semiconductor of size 1 cm × 1 cm × 1 mm.

$n_e = 7 \times 10^{19} / m^3$

Total no. of $\bar{e} = \frac{7 \times 10^{19}}{m^3} 10^{-2} m \times 10^{-2} m \times 10^{-3} m$

$= 7 \times 10^{12}$.

Total (hole + $\bar{e}$) $= 14 \times 10^{12}$

QUESTION

Pure Si at 300 K has equal electron (n_e) and hole (n_h) concentration of 2×10^{16} per m^3. Doping by indium increases n_h to 4×10^{22} per m^3. Calculate n_e in the doped silicon.

$n_i = n_e = n_h = 2 \times 10^{16}$ (pure)

final $\begin{cases} n_h = 4 \times 10^{22} \\ n_e = ?? \end{cases}$

$n_e \cdot n_h = n_i^2$

$n_e = \frac{n_i^2}{n_h} = \frac{4 \times 10^{32}}{4 \times 10^{22}} = 10^{10}$

QUESTION

For a p-type semiconductor which of the following statement is true? (NEET 2019)

1. Electrons are the majority carriers and pentavalent items are the dopants
2. Electrons are the majority carrier and trivalent atoms are the dopants
3. Holes are the majority carriers and trivalent atoms are the dopants
4. Holes are the majority carriers and pentavalent atoms are the dopants

Ans (c)

QUESTION

In a n-type semiconductor which of the following statement is true ? (NEET 2013)

1. Holes are minority carriers and pentavalent atoms are dopants
2. Holes are majority carriers and trivalent atoms are dopants
3. Electrons are Majority carriers end trivalent atoms are dopants
4. Electrons are minority carriers and pentavalent atoms are dopants

What is the use of P & N type Semiconductor ??

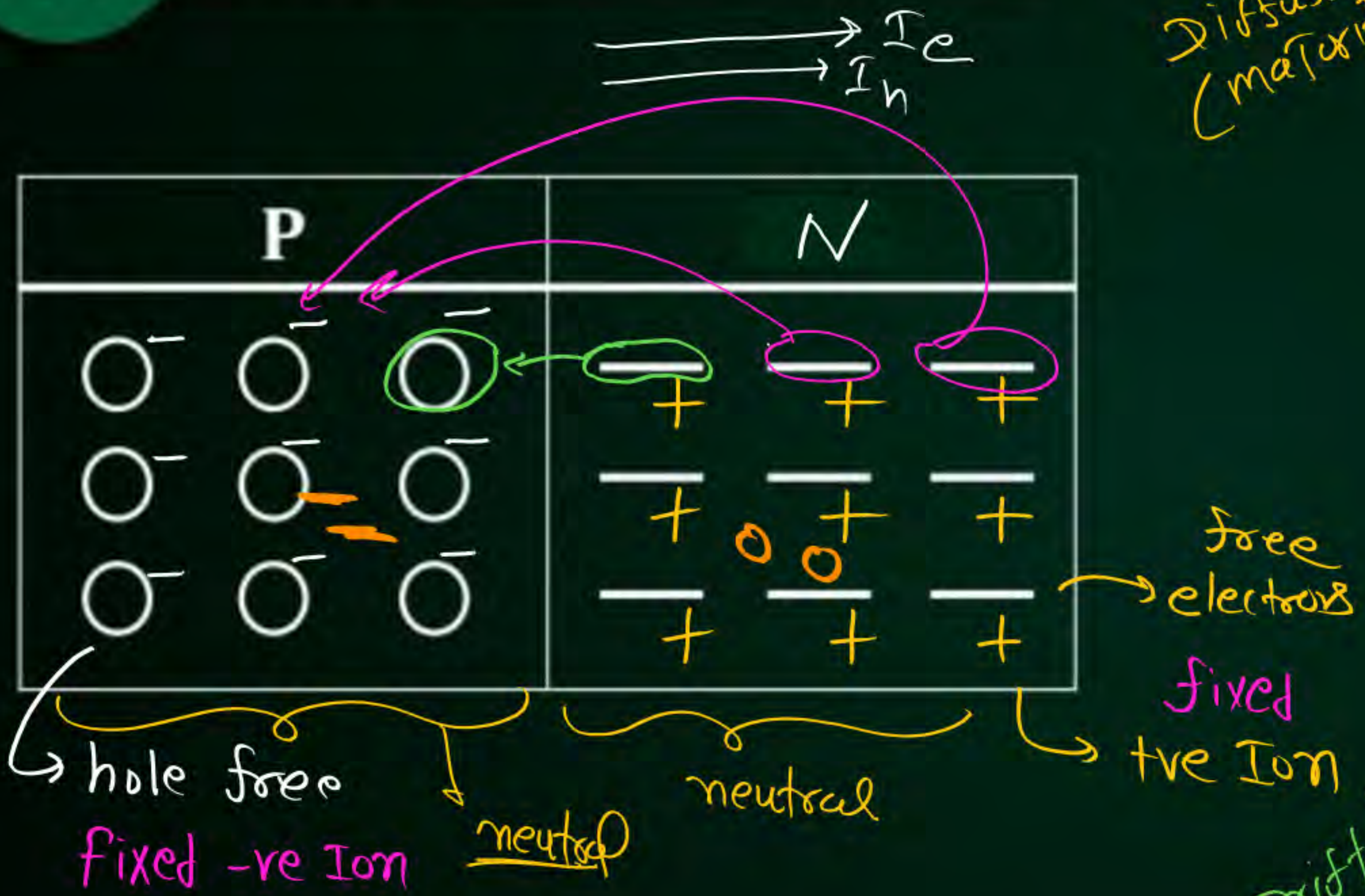
No use

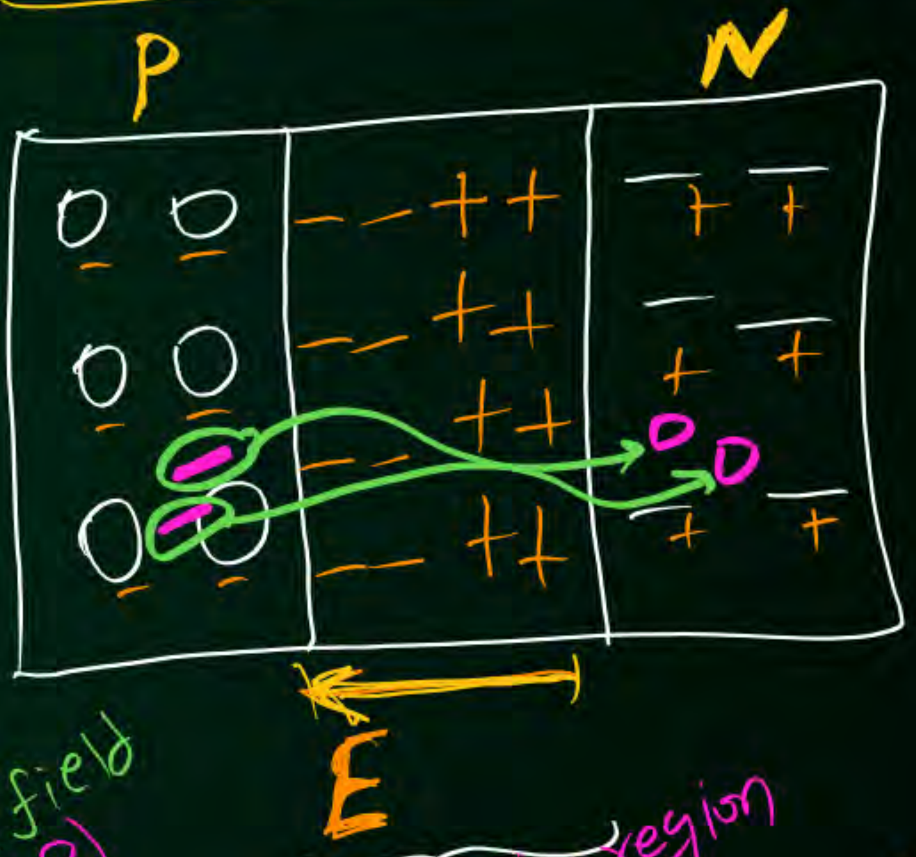
P-N JUNCTION DIODE

Due to concentration → Free e^- will diffuse towards P side from N side & re-combine with hole.

↳ Diffusion (majority)

$I_{(\text{Diffusion current})}$ = P to N *





Drift current due to electric field current (N to P) & Drift current (minority current)

- depletion region
- E → High
- width = 1 μm

ΔV = order of band gap

ΔV = 0.05V, 0.7V

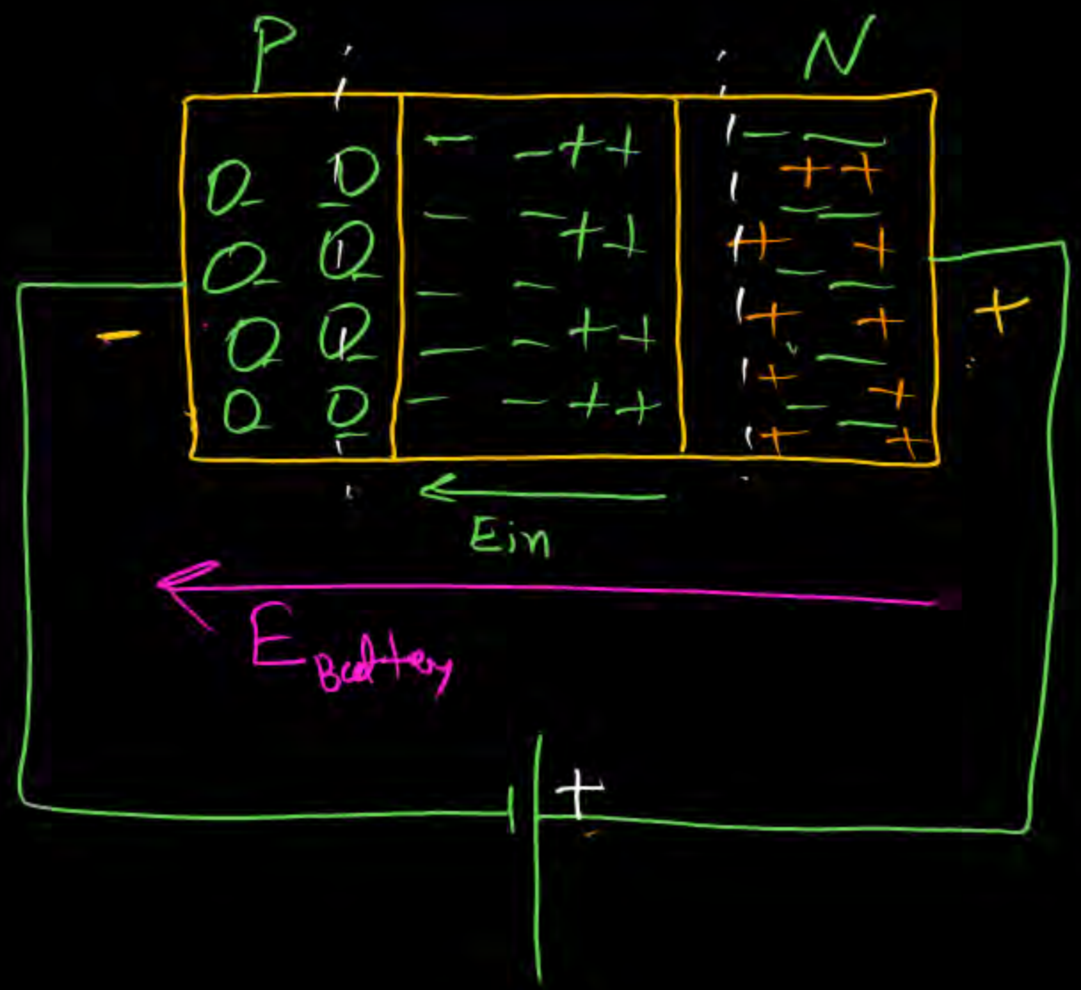
$E = \frac{\Delta V}{d} = \frac{0.05V}{10^{-6}} = 10^{6}$ V/m

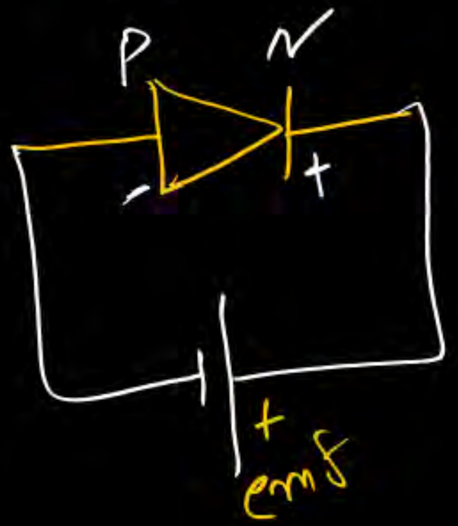
- **Due to e^--hole pair recombination the +ve ion in N-side & -ve ion in P-side reveals, which does not allow the further recombination.**
- **But internal electric field formed in depletion region due to which minority current will move and formed drift current.**
- **Diffusion current → Due to concentration difference of hole and electron.**

Majority Current

Drift current (minority current) = Due to Internal electric field.

Reverse baising





[+ve terminal of Battery connected to 'N' side
-ve terminal of Battery Connected to 'P' side]

$E_{net} = E_{in} + E_{Battery}$ ✓

Increase

$(\Delta V)_{depletion\ region}$ = Potential diff ↑ ✓

width of depletion region ↑

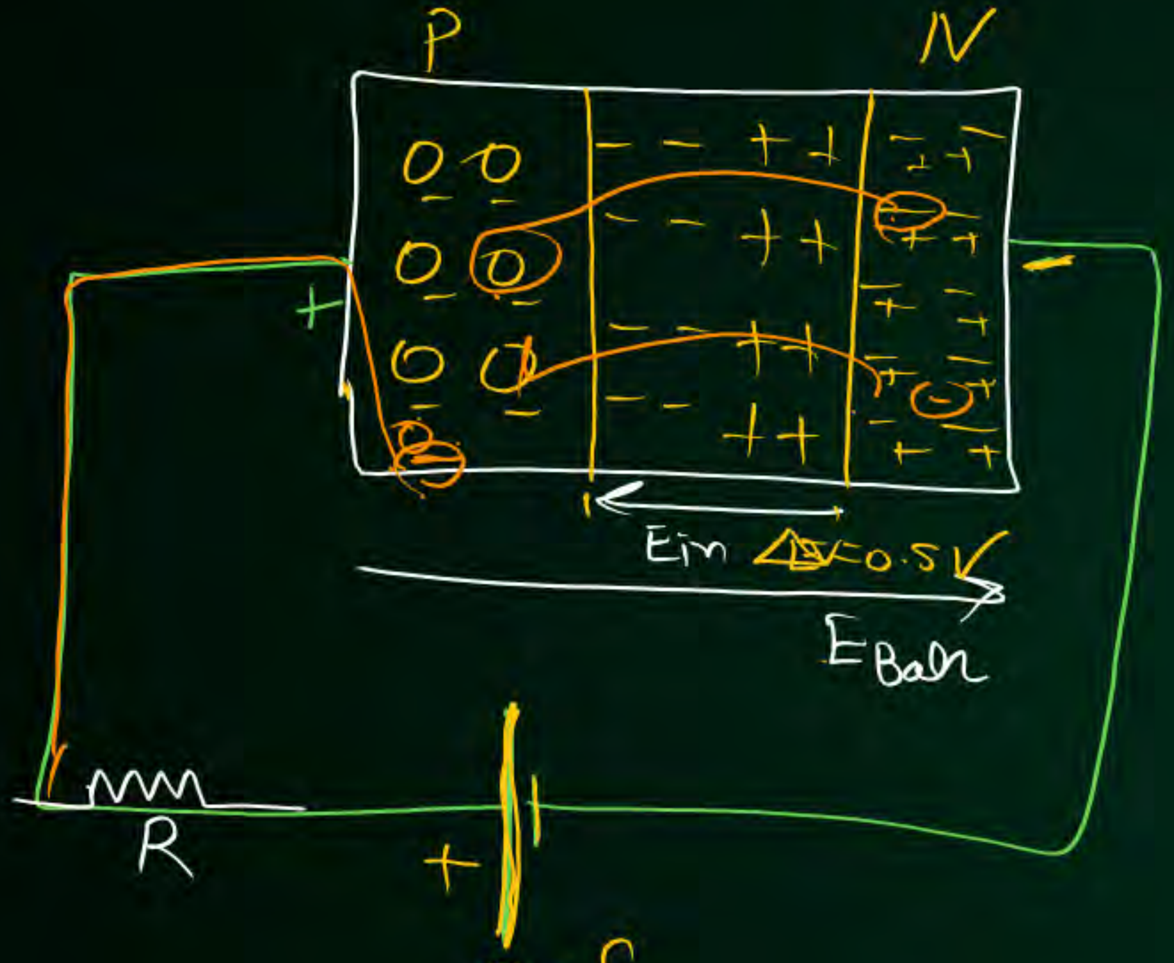
$I_{diffusion} = 0$

(I_{drift}) = minority carrier = μAmp ✓

[Resistance high] Ideal Practically ✓

forward baising

→ If +ve terminal connected to p side & −ve terminal connected to N side





$R_{\text{Ideal diode}} = 0$

($R_{\text{practical diode}}$ = small resistance in F.B)

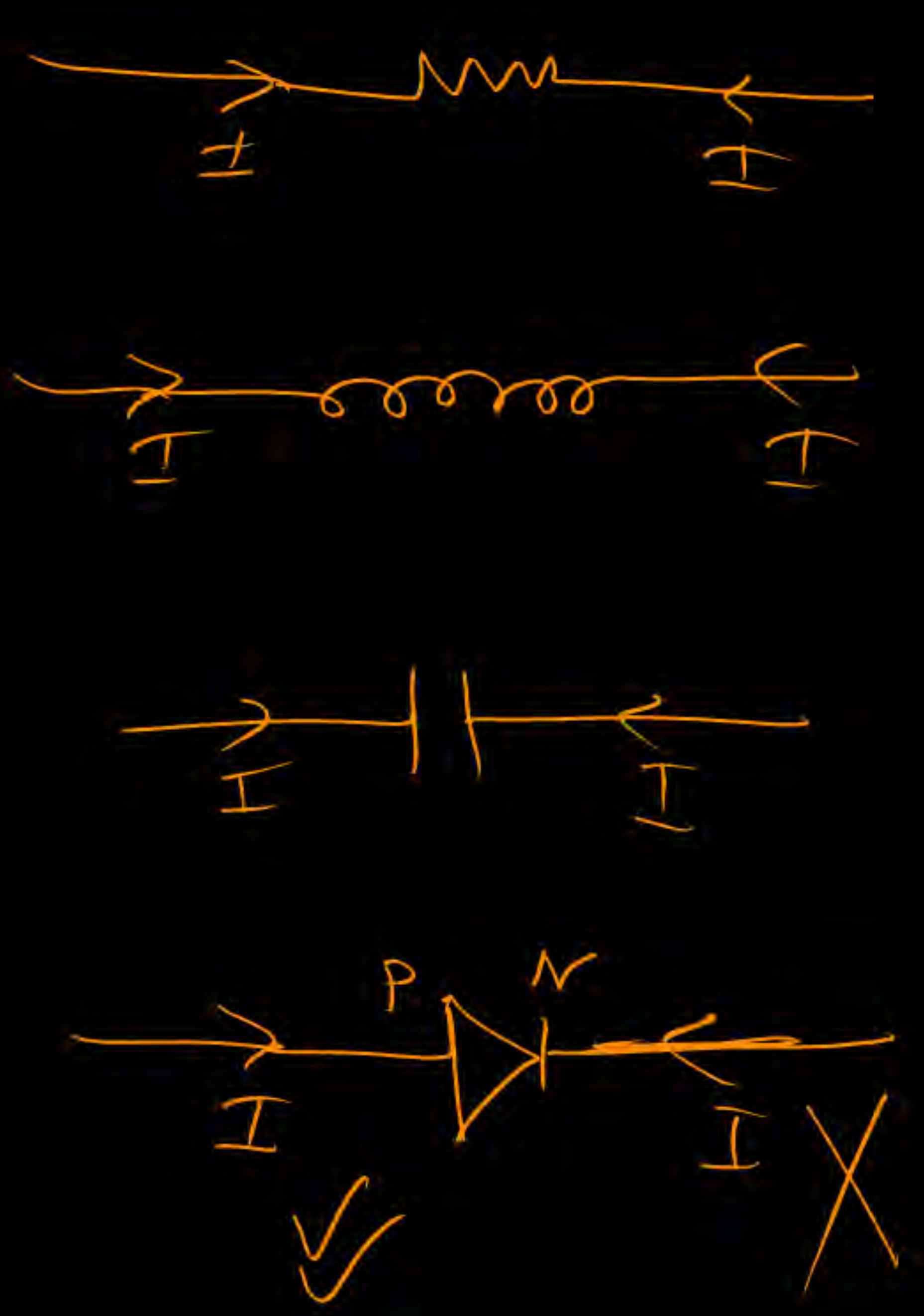


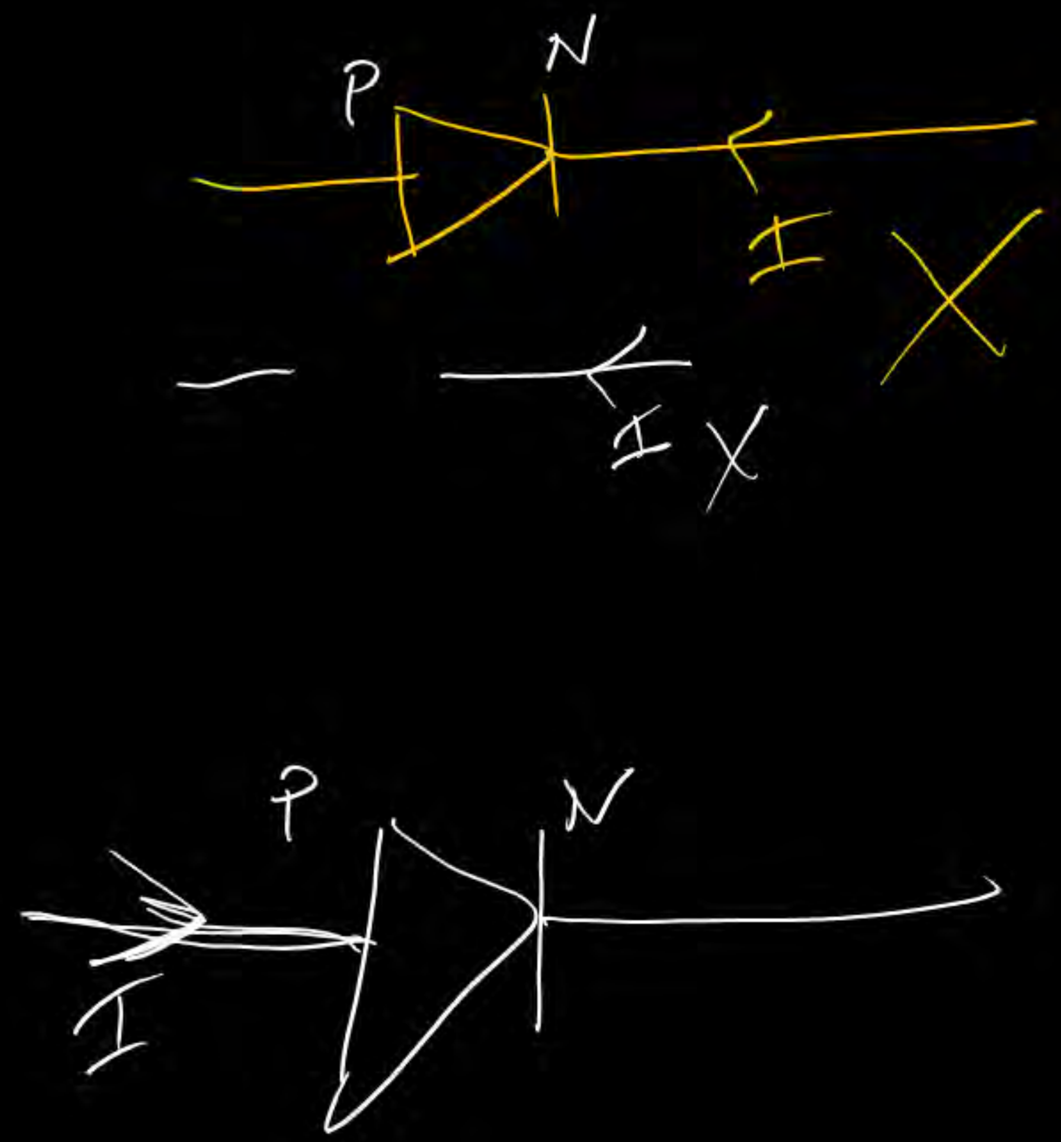
diffusion current will flow

$E_{net} = E_{in} - E_{Bar}$ ↓

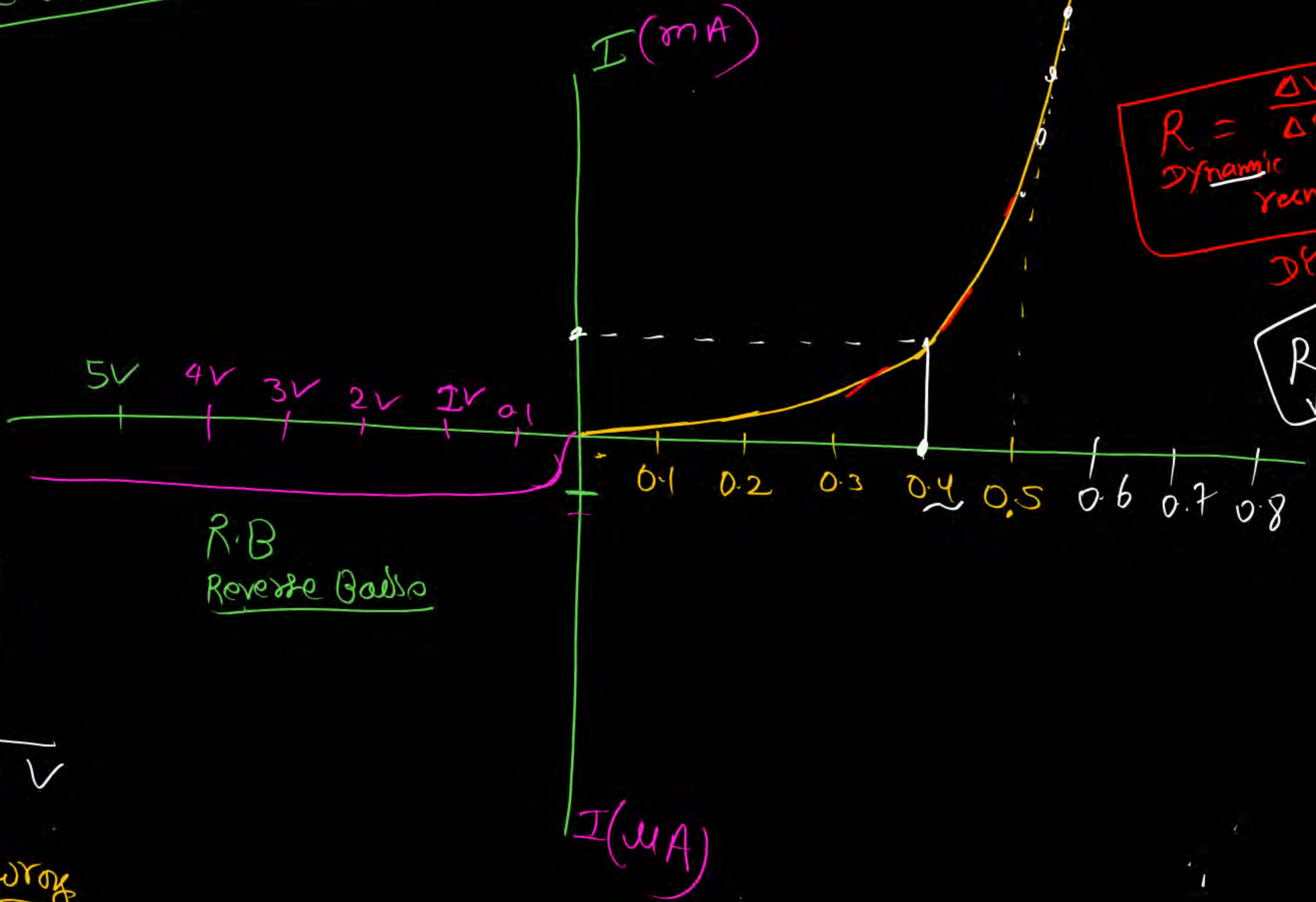
(ΔV) Potential diff ↓

width ↓


I
I
I
I
I
I
P
N
I
I


P
N
I
I
P
N
I

I/V charateristic of Diode → Non-ohmic crystal



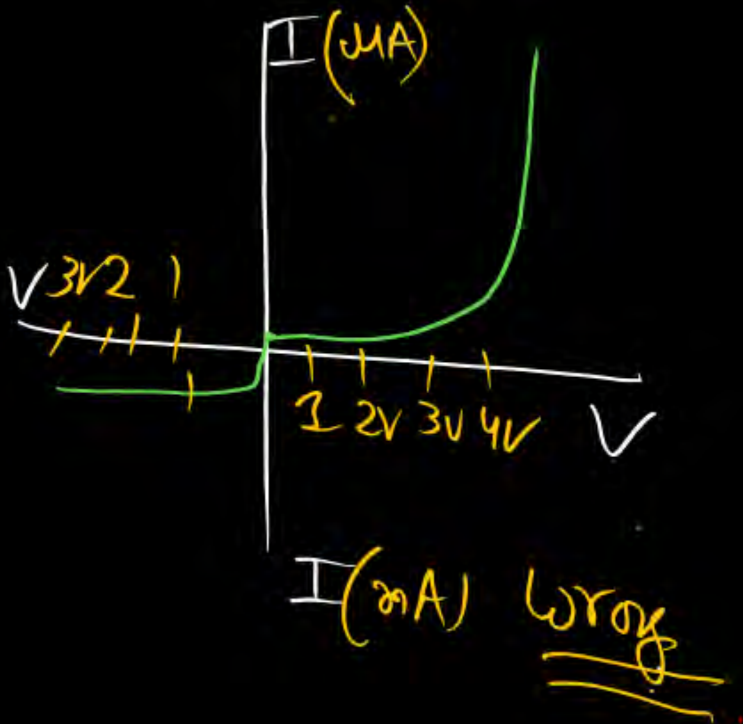
$R = \frac{\Delta V}{\Delta I}$

Dynamic

$R = \frac{V}{I}$

vary

for diode



QUESTION

When n-type semiconductor is heated

1. Number of electrons increases while that of holes decreases.
2. Number of holes increases while that of electrons decreases.
3. Number of electrons and holes remain same.
4. Number of electrons and holes increases equally.

QUESTION

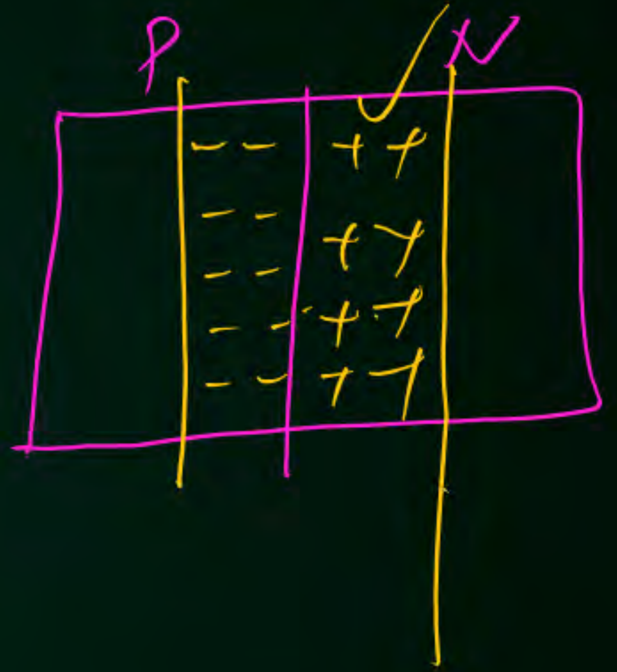
The increase in the width of the depletion region in a p-n junction diode is due to

1. Forward bias only
2. Reverse bias only
3. Both forward bias and reverse bias
4. Increase in forward current

QUESTION

In a p–n junction

1. High potential at n side and low potential at p side
2. High potential at p side and low potential at n side
3. p and n both are at same potential
4. undetermined



QUESTION

Depletion layer consists of

1. mobile ions
2. protons
3. electrons
4. immobile ions

QUESTION

NEET ka favo

Which one of the following represents forward bias diode?

(1)



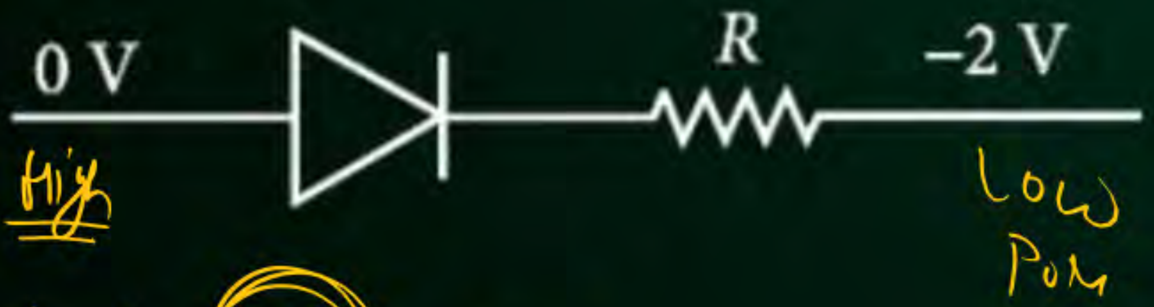
(2)



(3)



(4)

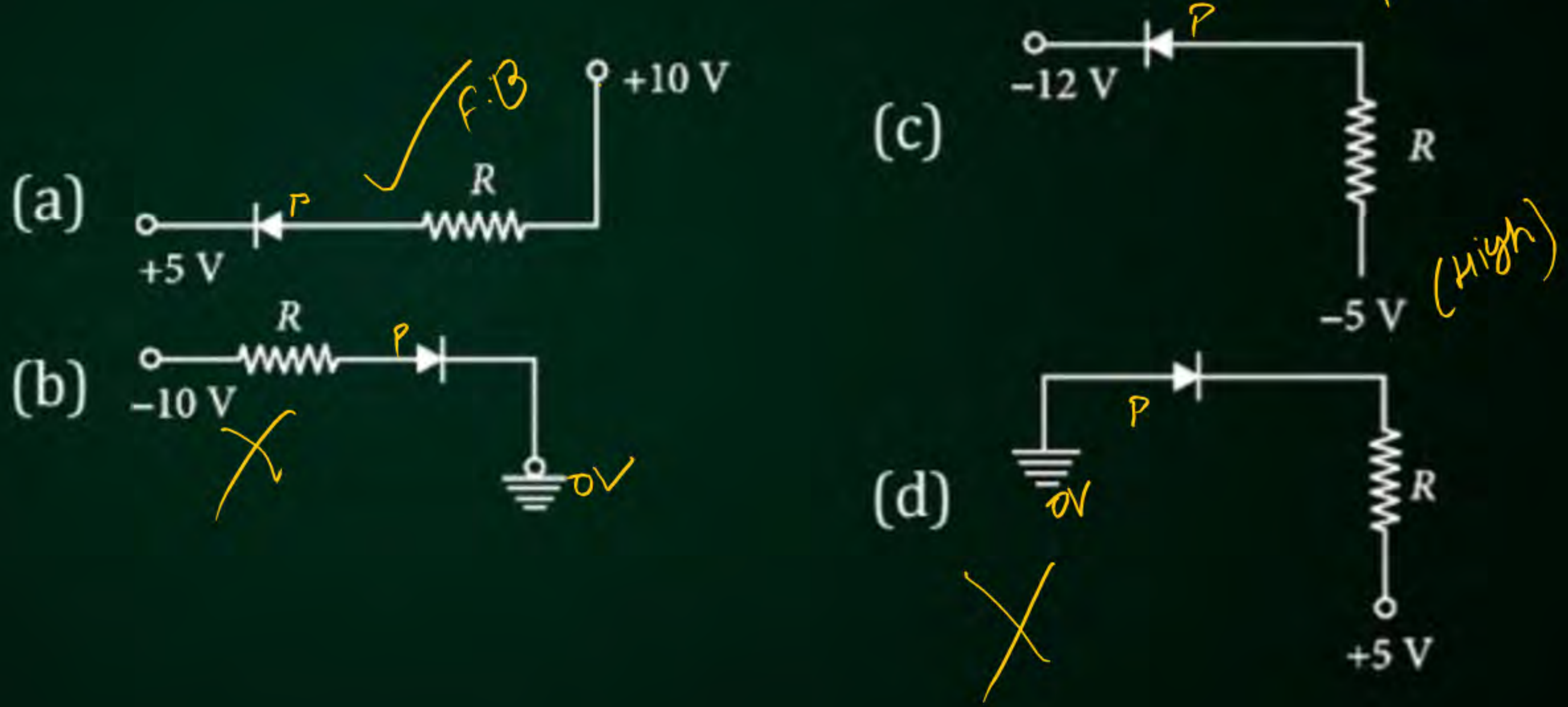


F.B is in 4th option.

QUESTION

In the following figure , the diodes which are forward biased are

1. (a), (b) and (d)
2. (c) only
3. (c) and (a)
4. (b) and (d)

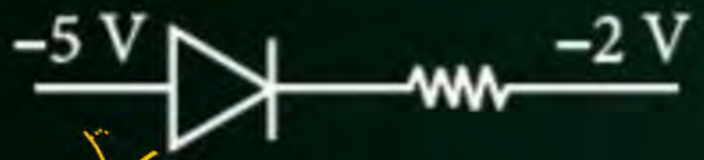


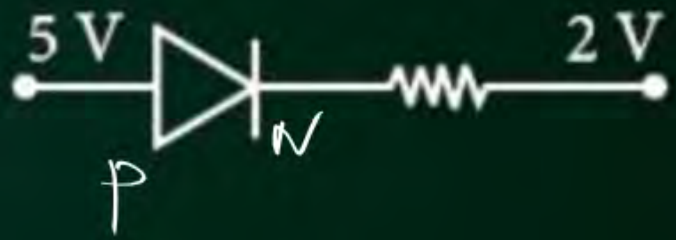
QUESTION

From the following diode circuit, which diode is in forward biased conditions

1. 

2. 

3. 

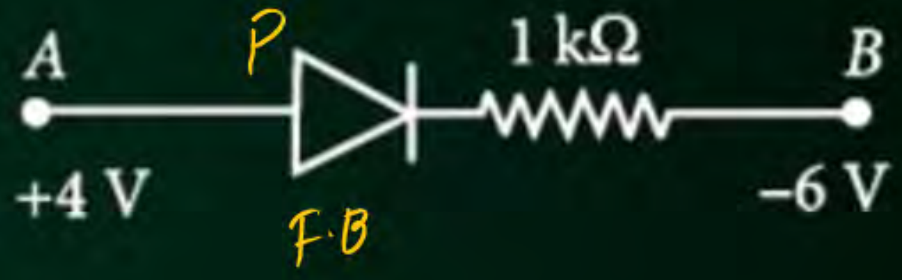
4. 

Ans (1), (4)

QUESTION

Consider the junction diode as ideal. The value of current flowing through AB is

1. $10^{-1}\,A$
2. $10^{-3}\,A$
3. $0\,A$
4. $10^{-2}\,A$ ✓

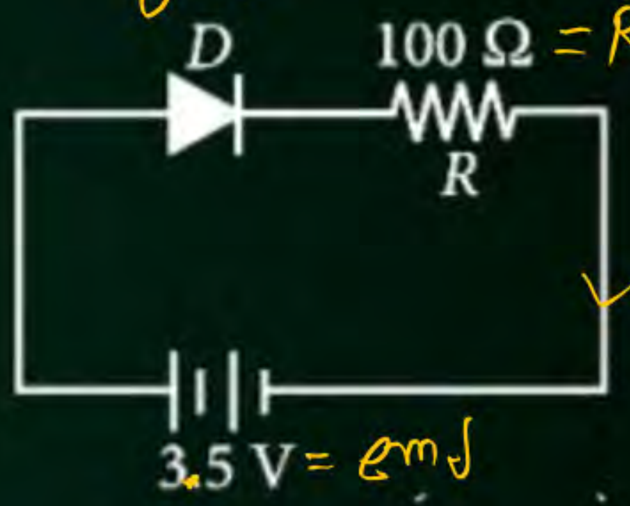




$$I = \frac{10}{10^3} = 10\times10^{-3} = 10^{-2}\,A$$

QUESTION

In the given figure, a diode D is connected to an external resistance $R = 100\ \Omega$ and an e.m.f. of $3.5\ V$. If the barrier potential developed across the diode is $0.5\ V$, the current in the circuit will be



1. $20\ mA$
2. $35\ mA$
3. $30\ mA$
4. $40\ mA$

QUESTION

The given circuit has two ideal diodes connected as shown in figure. The current flowing through the resistance R_1 will be



1. 2.5 A
2. 10.0 A
3. 1.43 A
4. 3.13 A

QUESTION

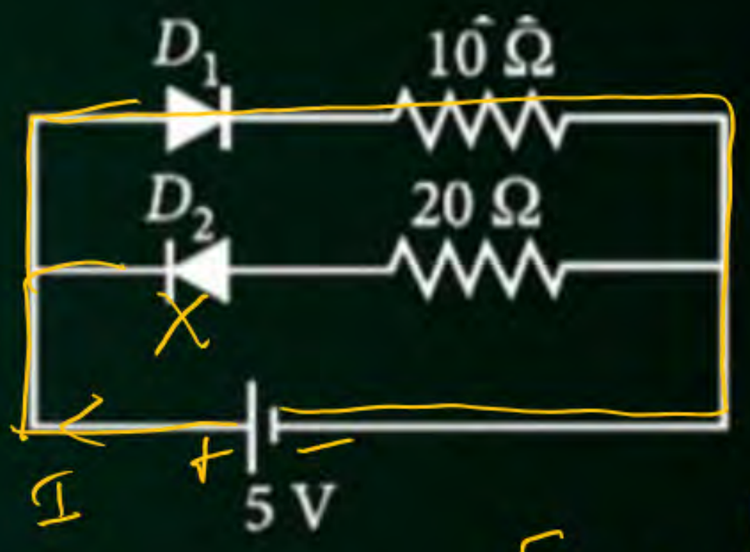
In a $p-n$ junction diode, change in temperature due to heating

1. Affects only reverse resistance
2. Affects only forward resistance
3. Does not affect resistance of $p-n$ junction
4. Affects the overall $V-I$ characteristics of $p-n$ junction

QUESTION

Two ideal diodes are connected to a battery as shown in the circuit. The current supplied by the battery is

1. 0.75 A
2. zero
3. 0.25 A
4. 0.5 A



$I = \frac{5}{10} = \frac{1}{2}$

QUESTION

In forward biasing of the p–n junction

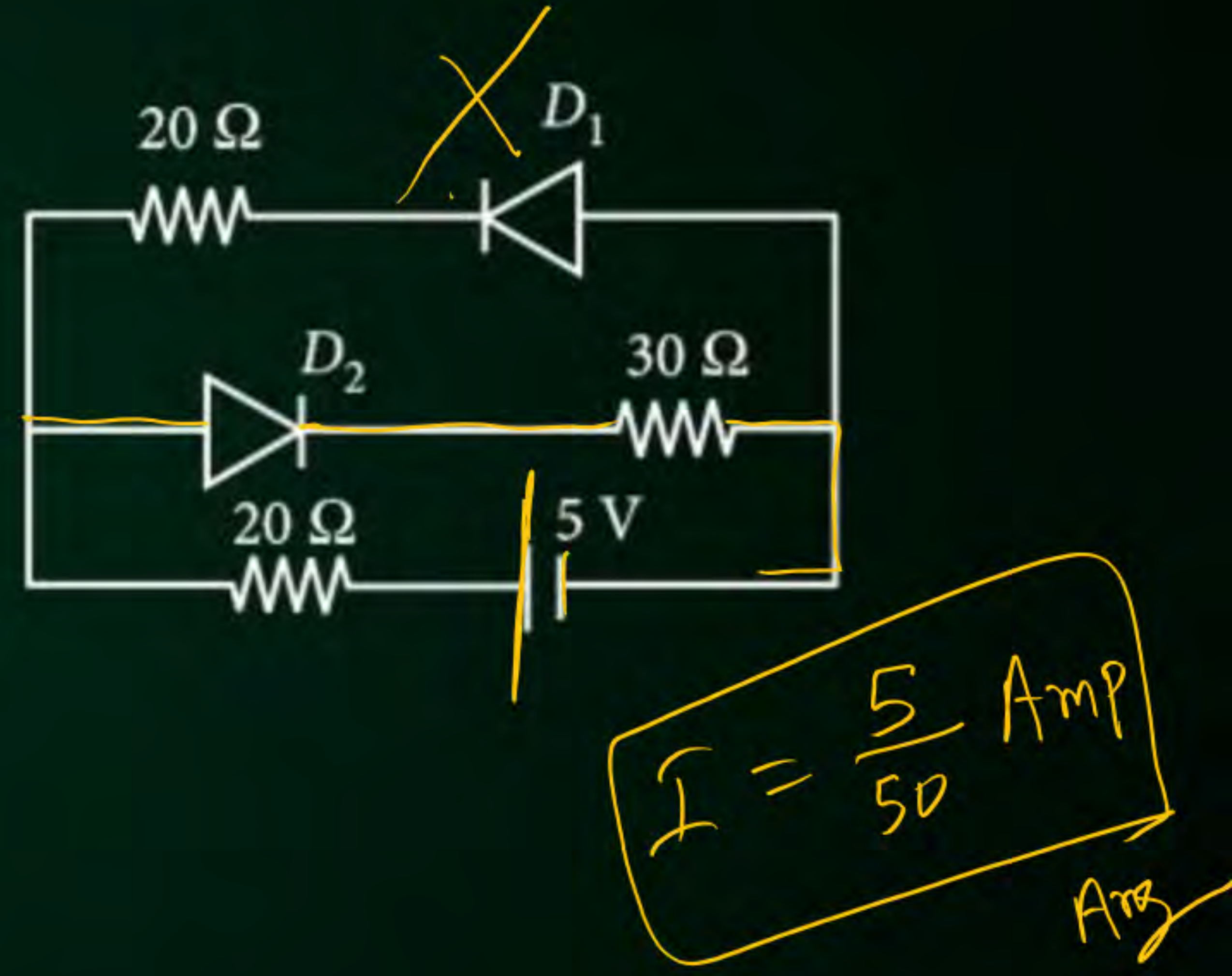
1. The positive terminal of the battery is connected to p–side and the depletion region becomes thick.
2. The positive terminal of the battery is connected to n–side and the depletion region becomes thin.
3. The positive terminal of the battery is connected to n–side and the depletion region becomes thick.
4. The positive terminal of the battery is connected to p-side and the depletion region becomes thin.

Ans (4)

QUESTION

The current in the circuit will be

1. 5/40 A
2. 5/50 A
3. 5/10 A
4. 5/20 A



QUESTION

Application of a forward bias to a p-n junction

1. Widens the depletion zone
2. Increases the potential difference across the depletion zone
3. Increases the number of donors on the n-side
4. Decreases the electric field in the depletion zone

QUESTION

Reverse bias applied to a junction diode

1. Lowers the potential barrier
2. Raises the potential barrier
3. Increases the majority carrier current
4. Increases the minority carrier current

QUESTION

The diode used in the circuit shown in the figure has a constant voltage drop at 0.5 V at all currents and a maximum power rating of 100 milli watts. What should be the value of the resistor R, connected in series with diode for obtaining maximum current?

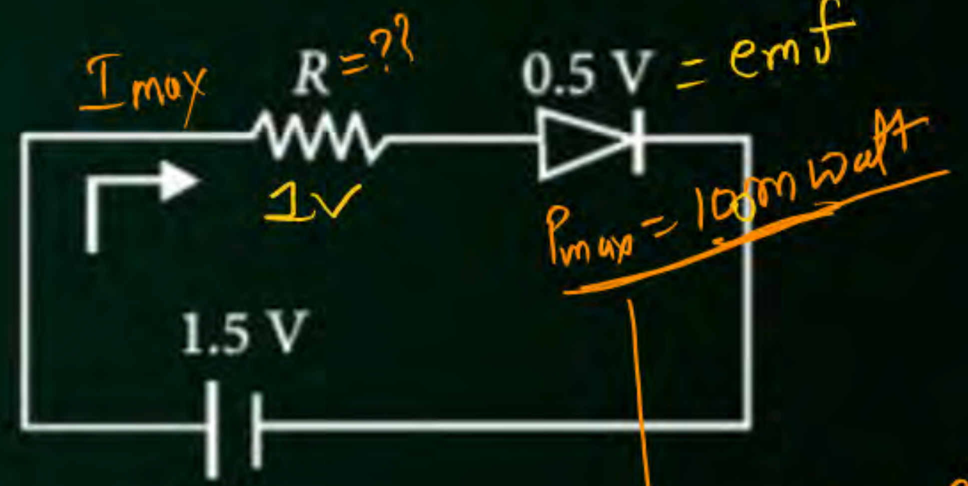
1. 6.76 Ω
2. 20 Ω
3. 5 Ω
4. 5.6 Ω

In Resistance

$V = IR$

$R = \frac{V}{I} = \frac{1}{20 \times 10^{-3}}$

$R = \frac{1000}{200} = 5\,\Omega$

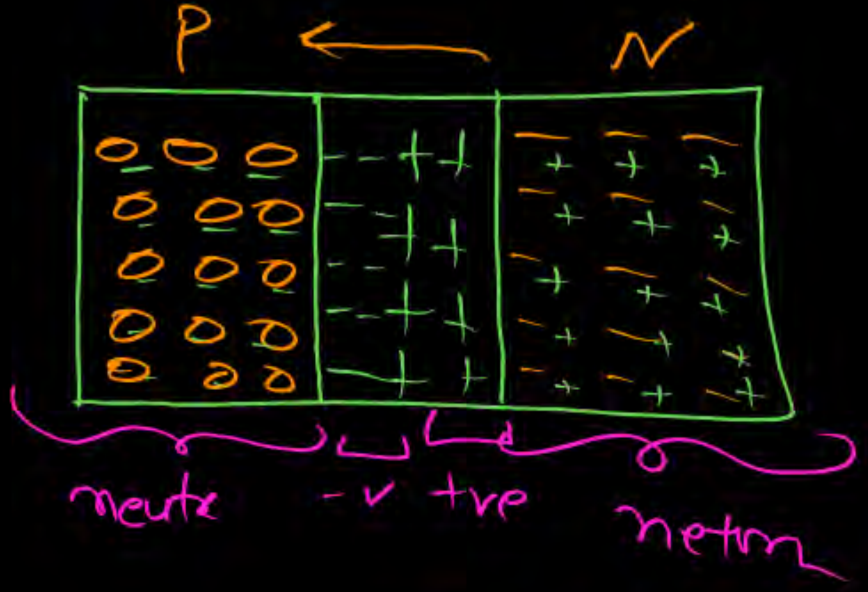


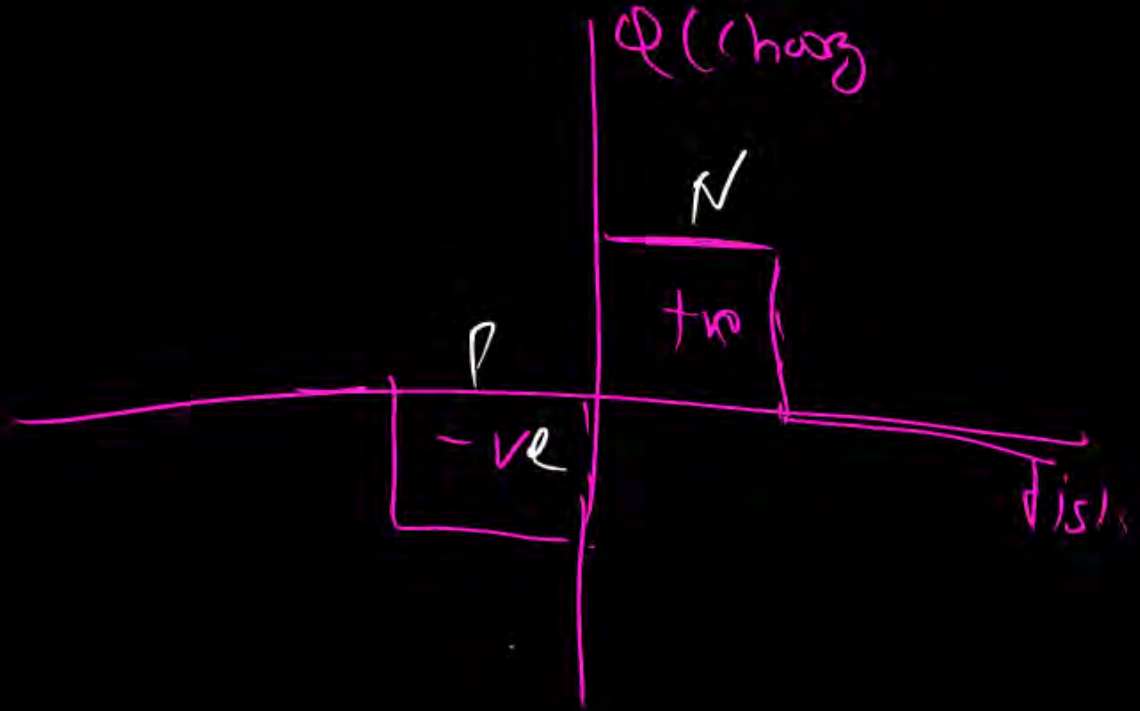
$P = IV$

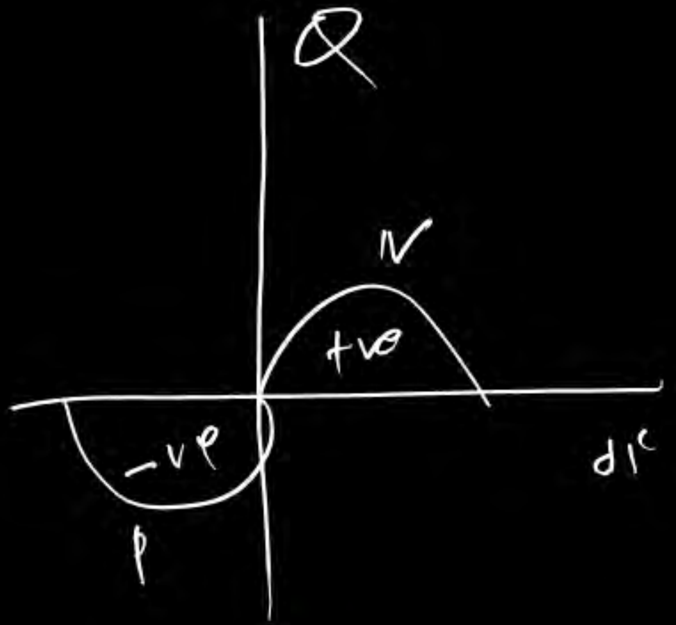
$I = \frac{P}{V} = \frac{100 \times 10^{-3}}{1/2}$

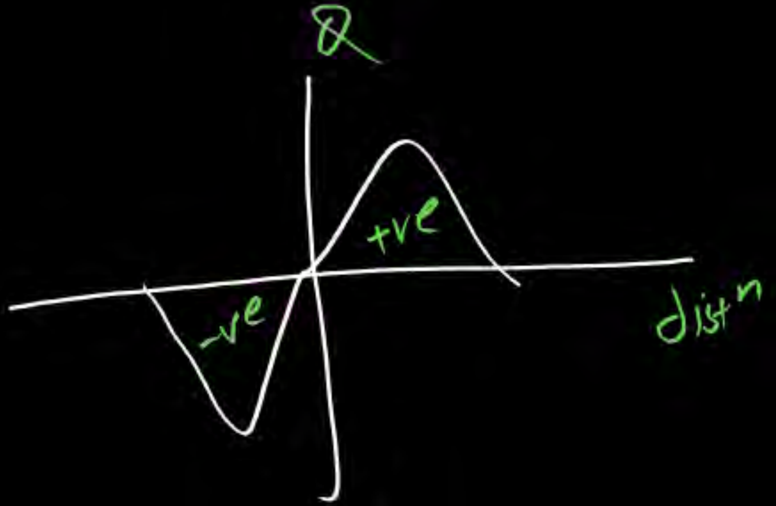
$I = 200 \times 10^{-3}$ A

In depletion region

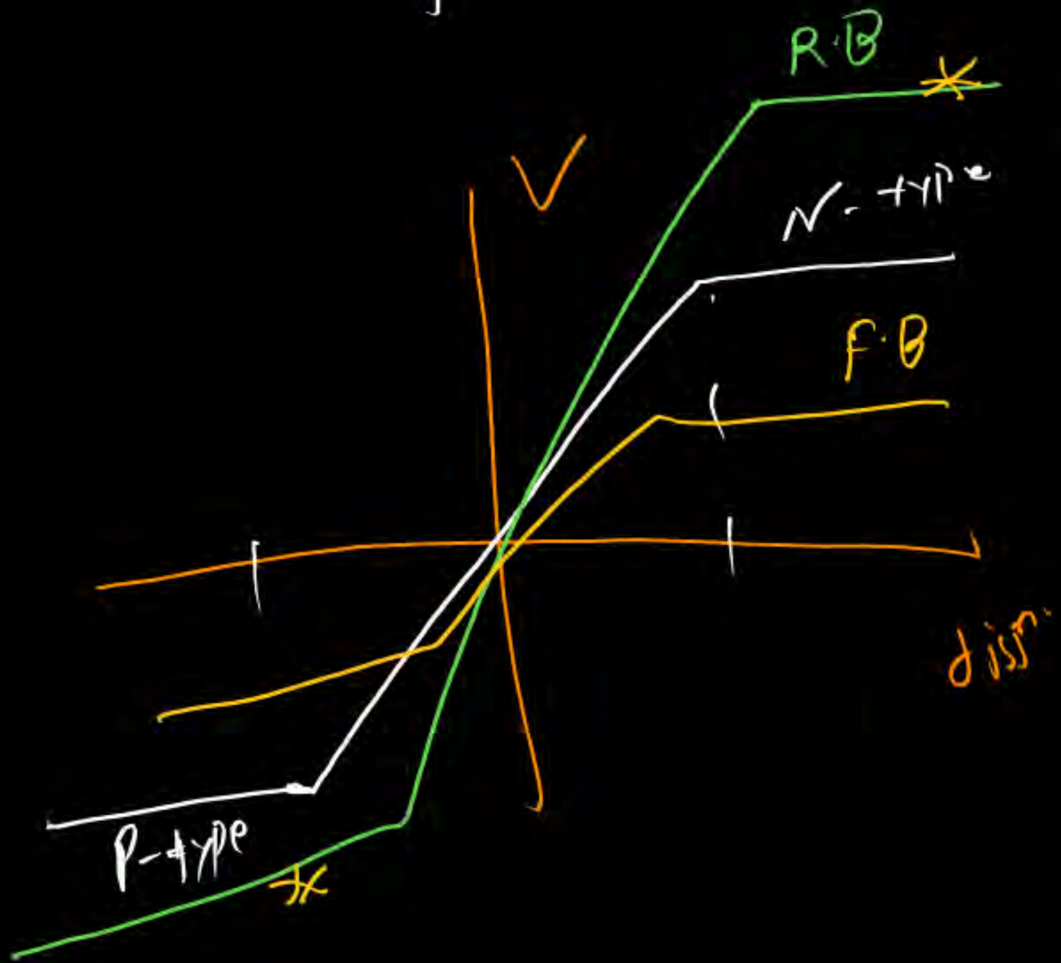






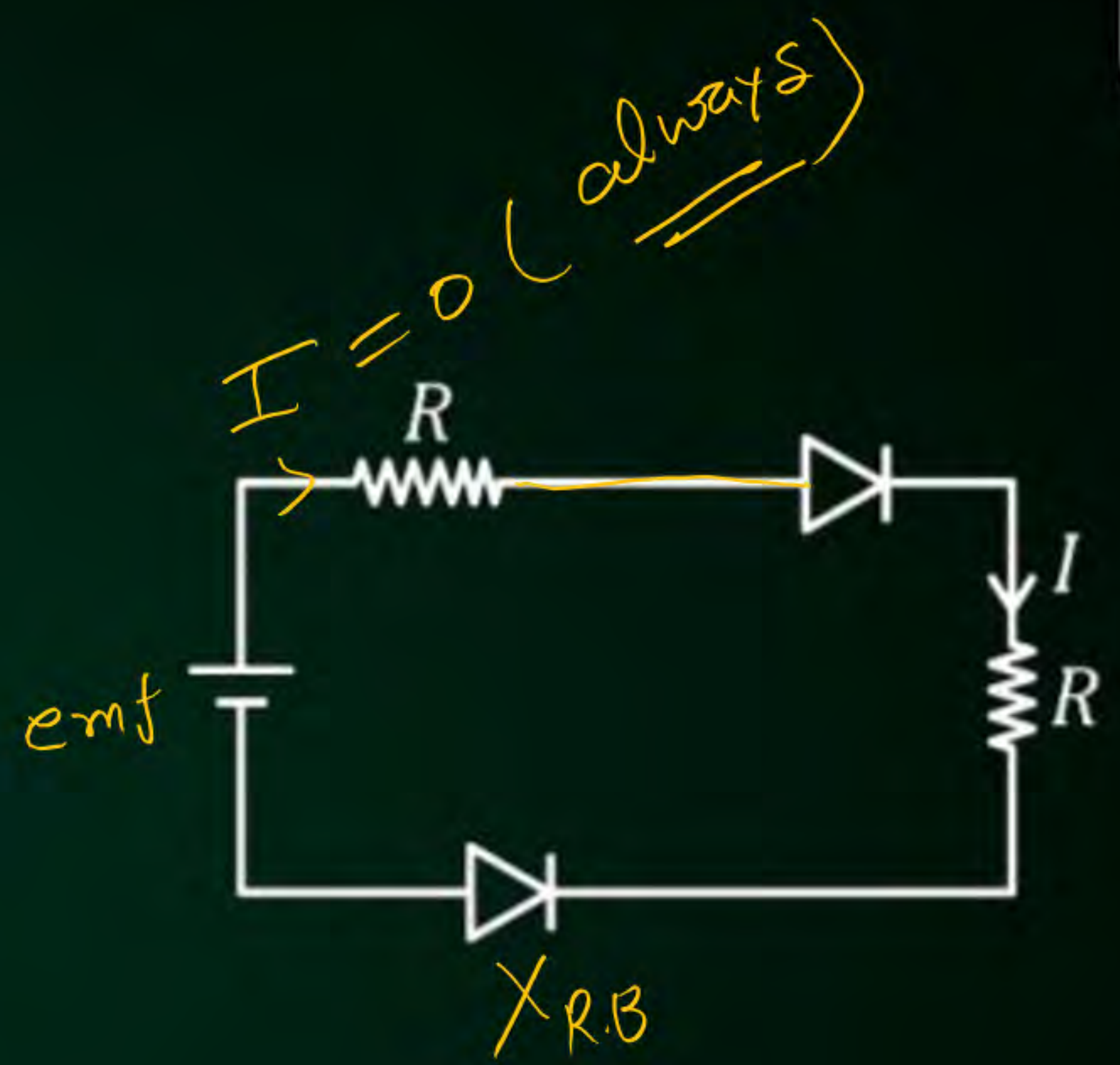






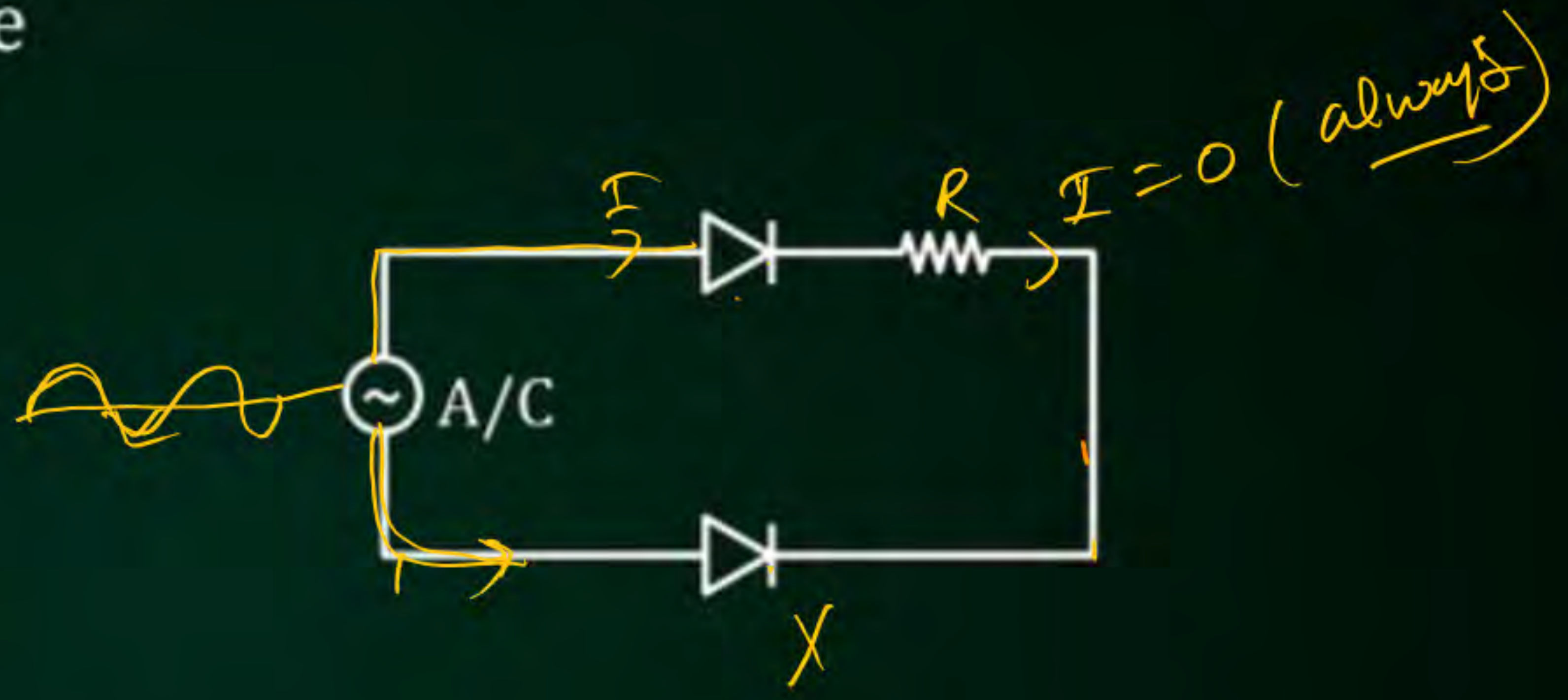
QUESTION

Find current flowing through battery



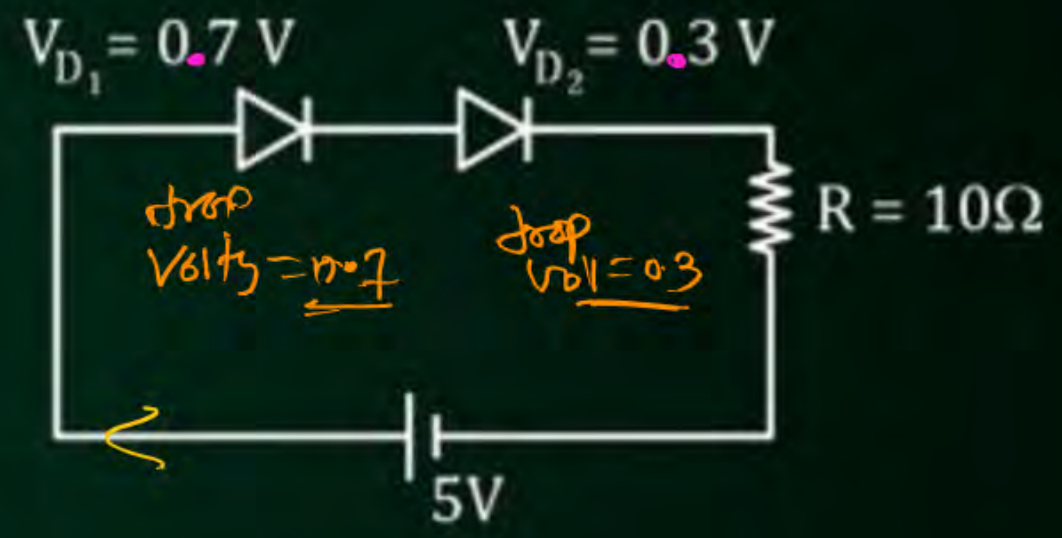
QUESTION

Find current flowing through resistance



QUESTION

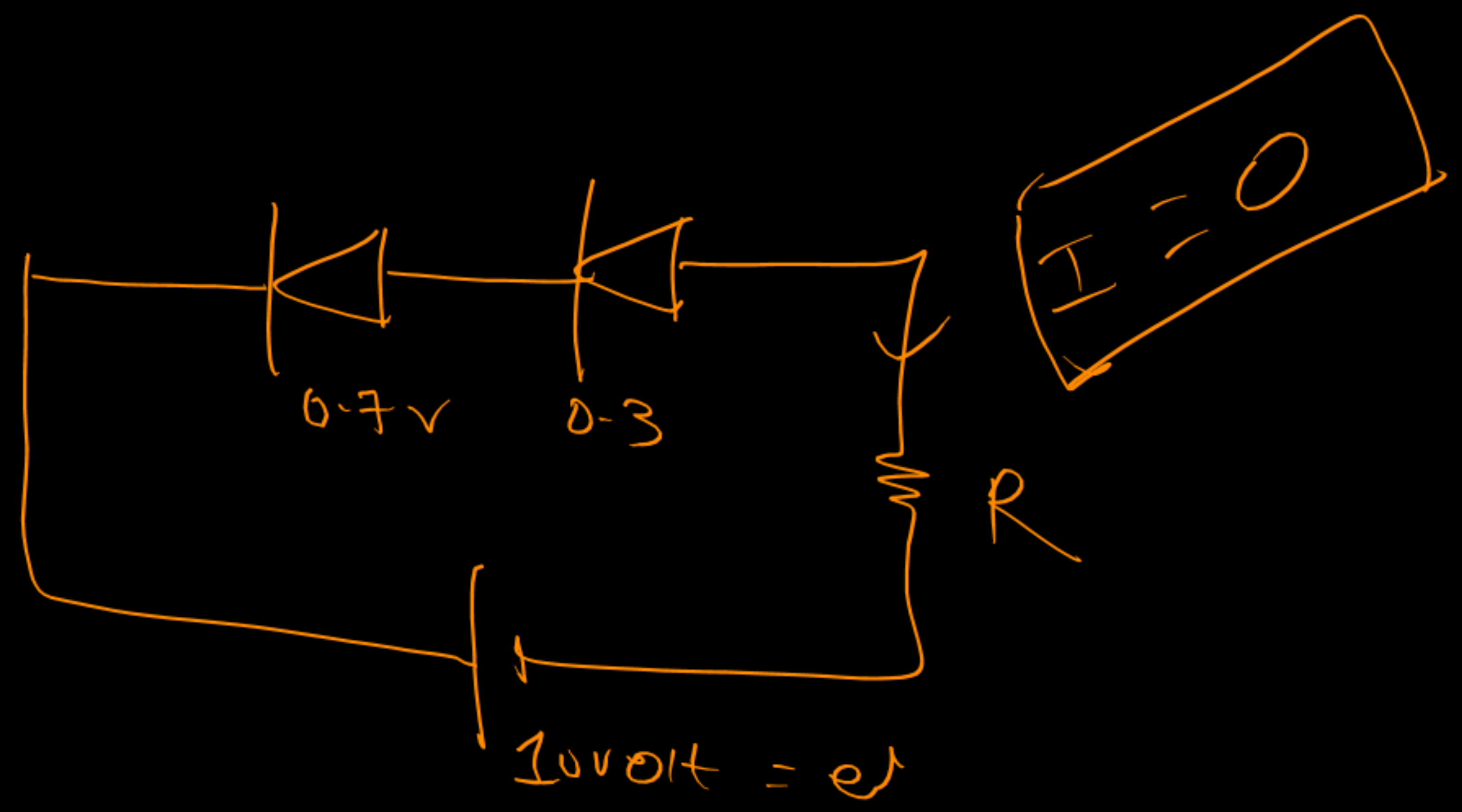
Find



$$I = \frac{5 - 1V}{10}$$

$$= \frac{4}{10}$$

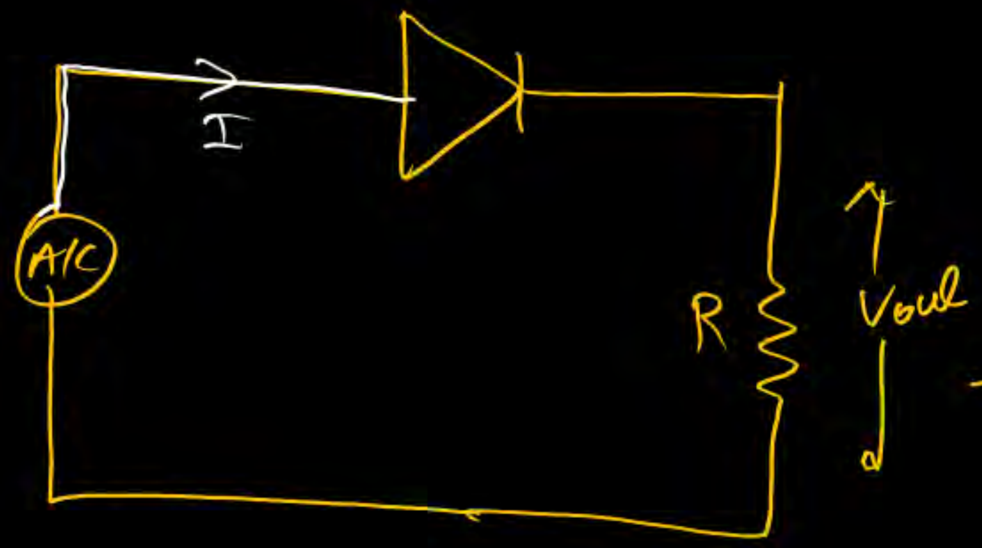
$$= 0.4 \text{ Amp}$$

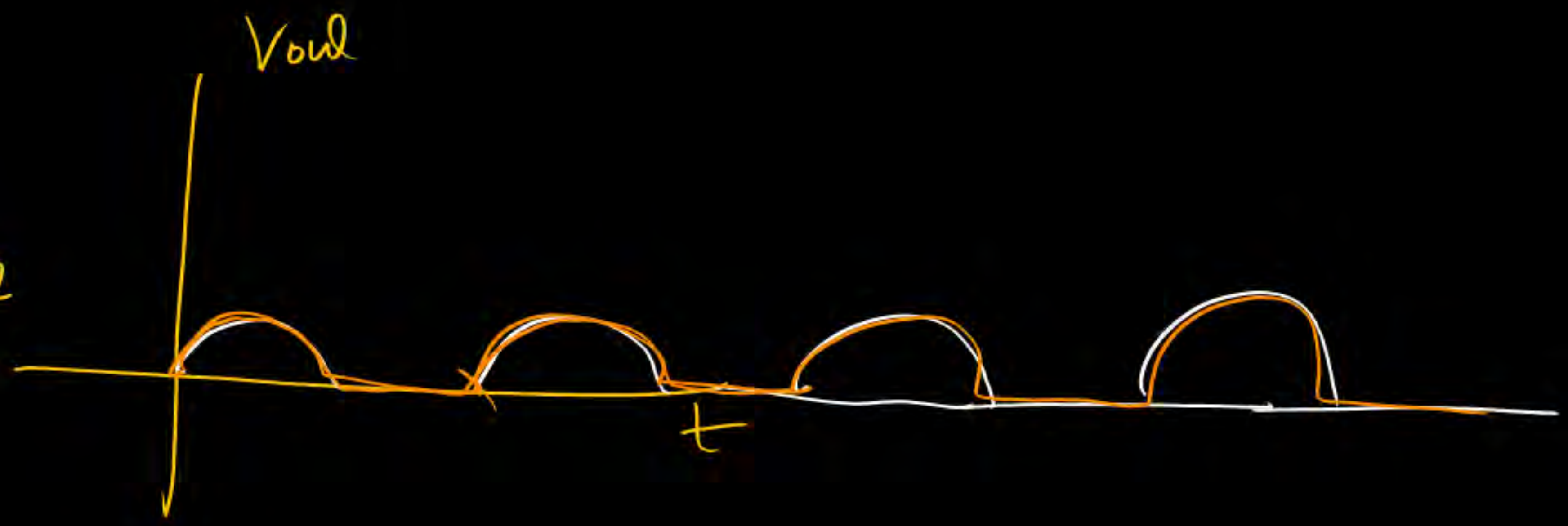


0·7v
0·3
R
I = 0
1v volt = e

Half wave rectifier — convert A/C to लेकर D/C









Output ripple frequency = f input frequency

$I_{(\text{Avg value})_{\text{Half cycle}}} = \left(\frac{2I_0}{\pi}\right)$

$(I_{rms})_{1/2} = \left(I_0/\sqrt{2}\right)$

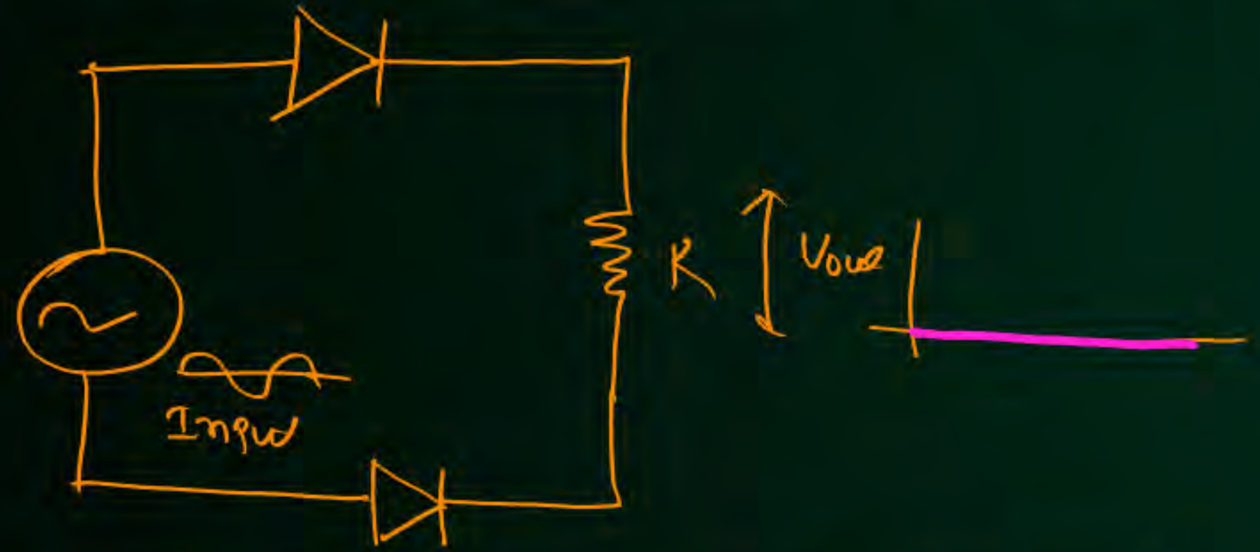
Half $\left(\frac{1}{2}\right)$ → Avg value full cycle $= \frac{I_0}{\;}$

$\left(\frac{1}{\sqrt{2}}\right)$

rms value $= \frac{I_0}{2}$

FULL WAVE RECTFIER

❖ **Converts Alternating Current to Variable Direct Current**



Output always zero → No rectifin

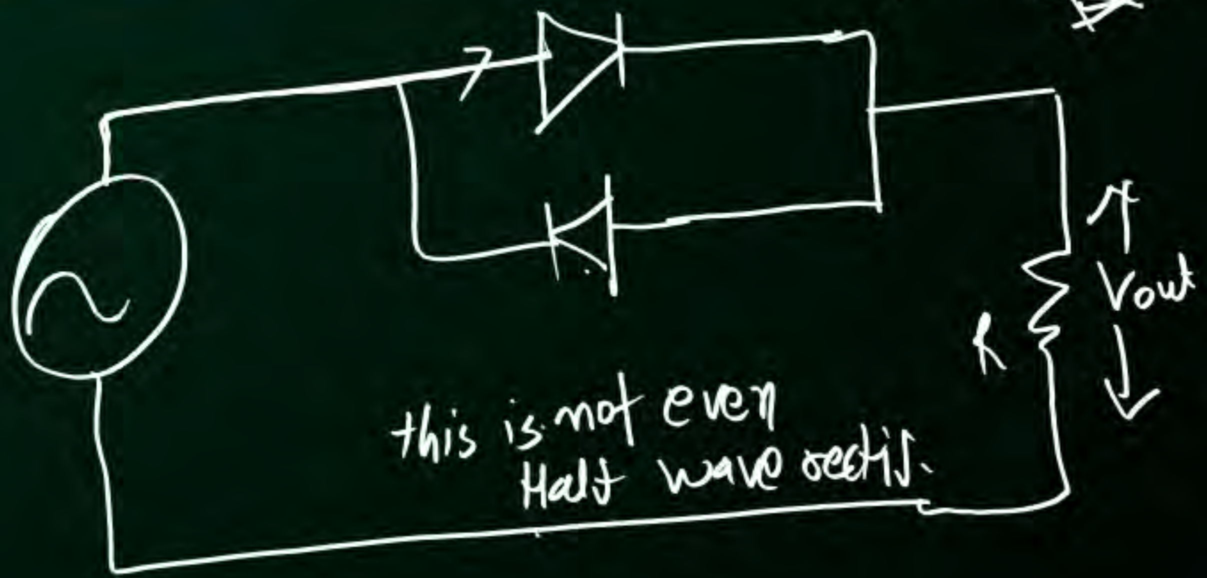


← Half wave rectif.

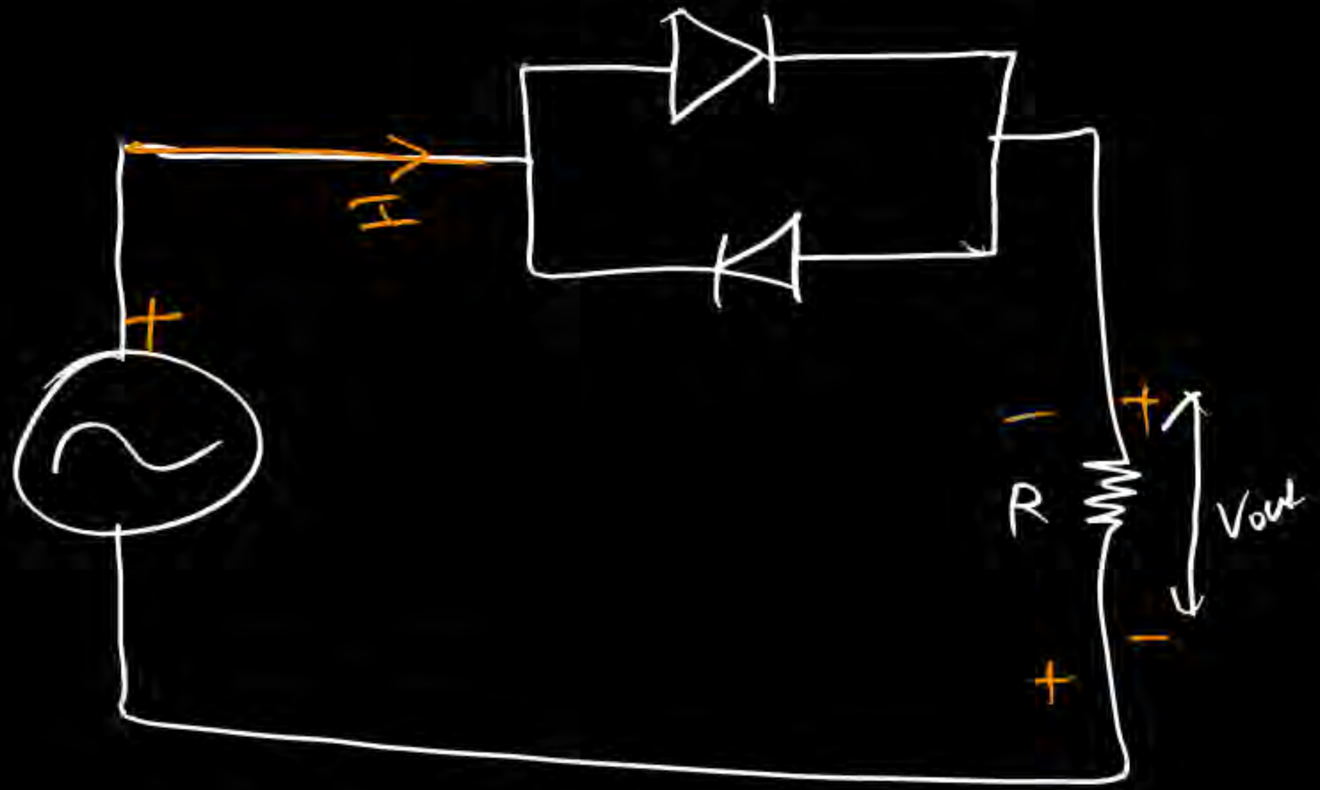


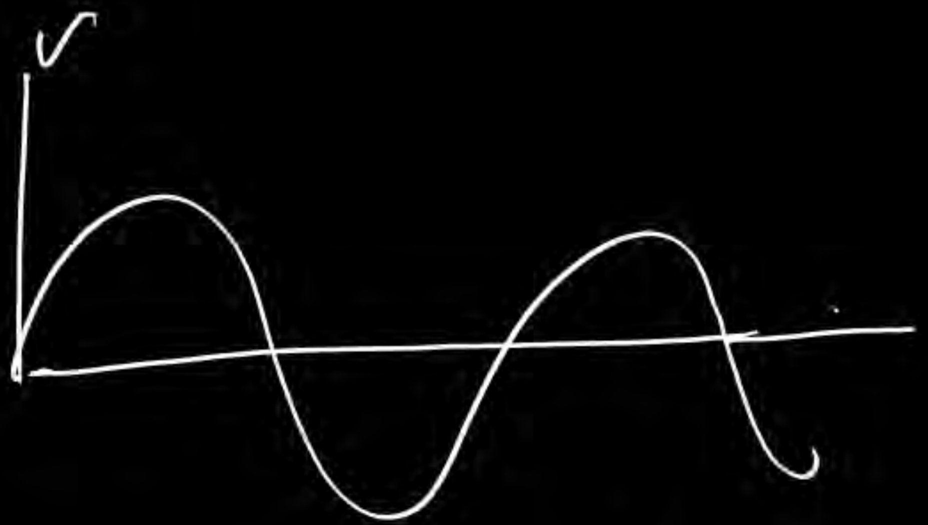
No rectifin ✓

~~yes (a)~~ NO (b)



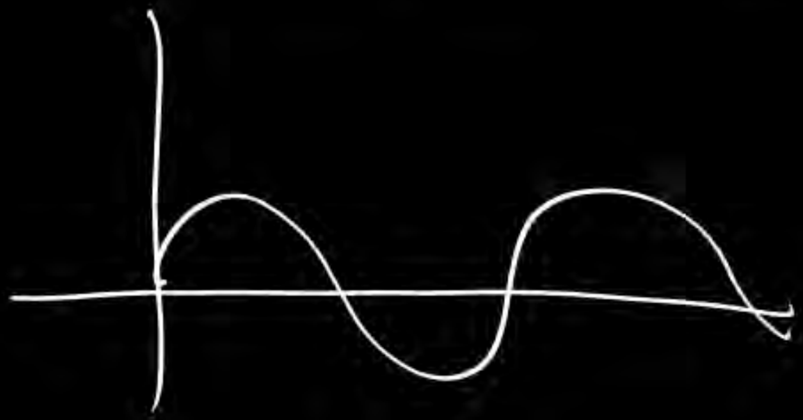
this is not even Half wave rectif.





A/C output



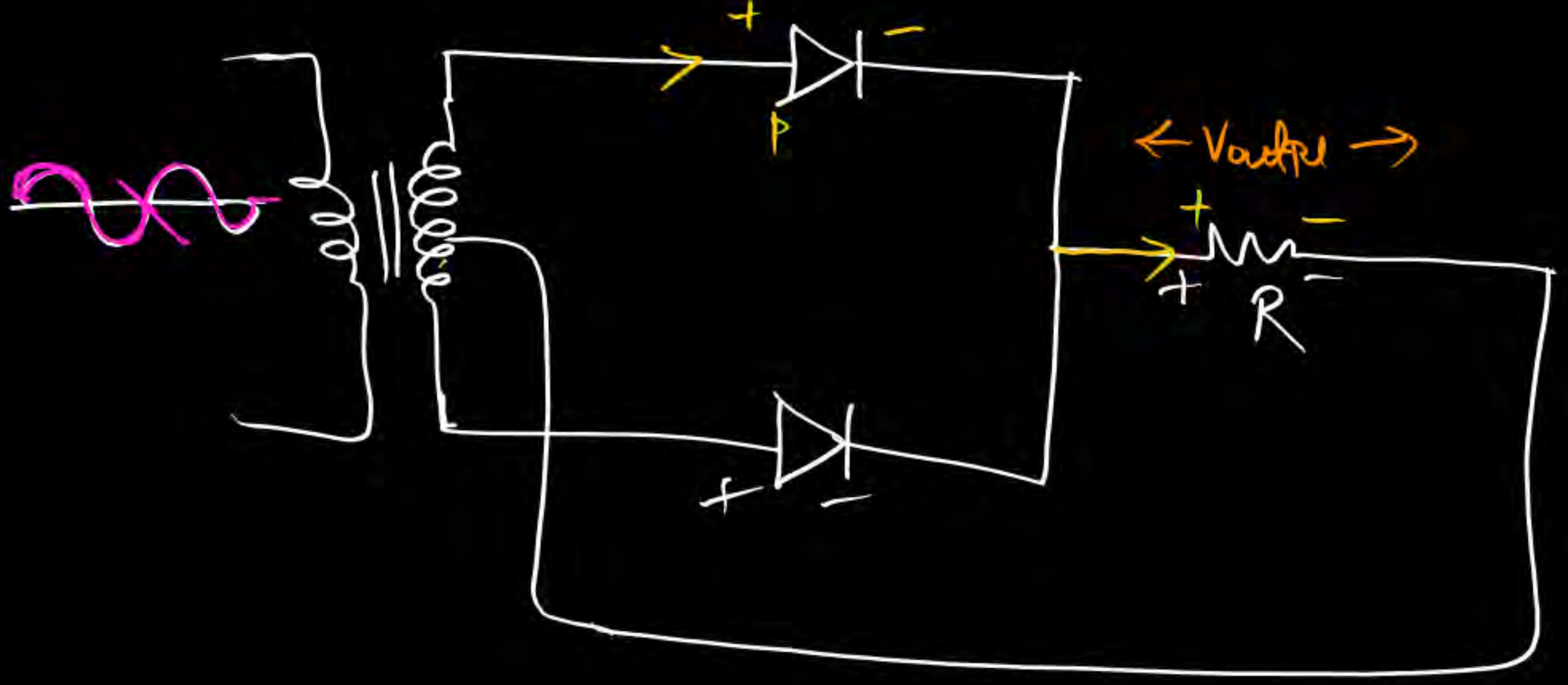


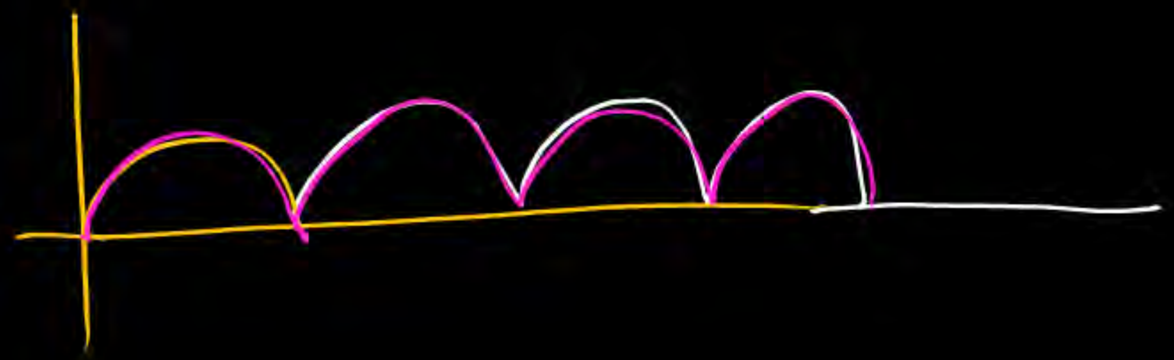
Input

full wave rectifier

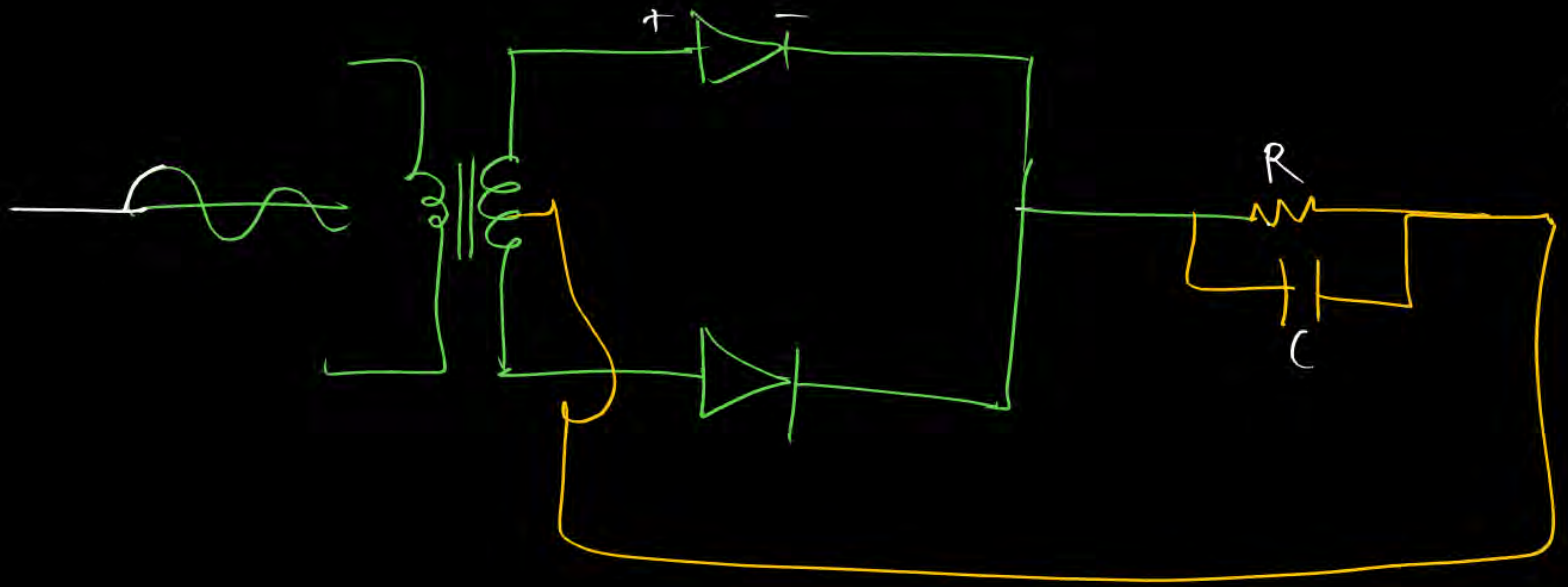
→ Convert A/C into variable D/C

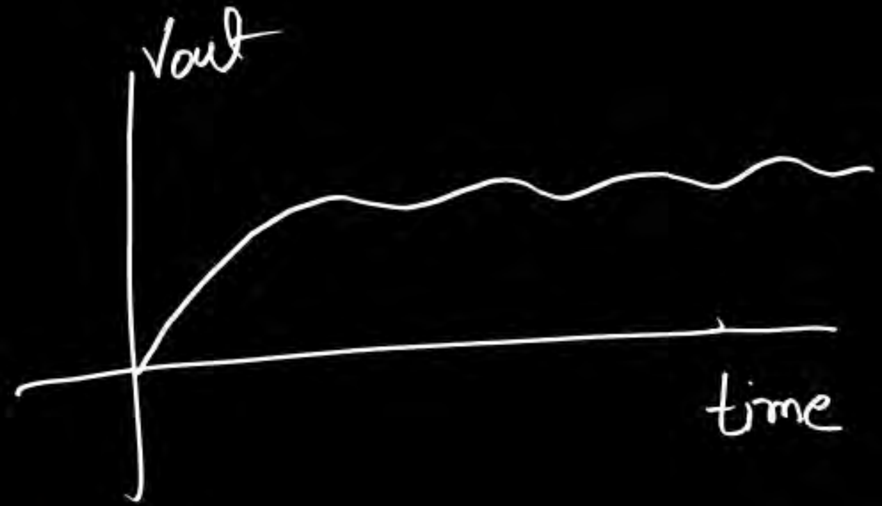
output frequency = 2 x Input frequency





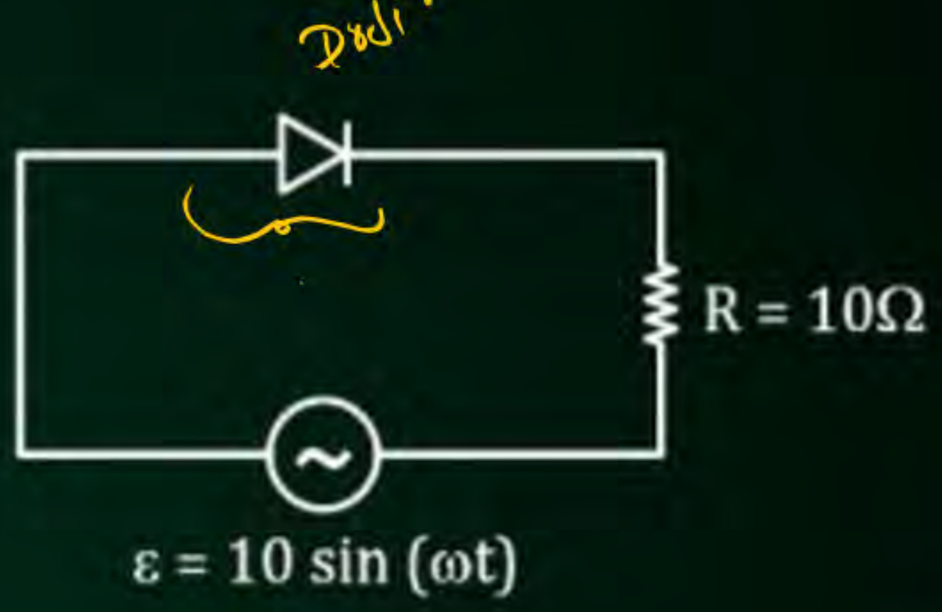
Capacitive filter circuit with full wave rectifier





QUESTION

[redacted]



Power loss across the Resistance in 4-sec if Idode is Ideal ??

$V_0 = 10$

$V_{rms} = \frac{10}{\sqrt{2}}$

$P_{loss} = \frac{V_{rms}^2}{R} = \left(\frac{10}{\sqrt{2}}\right)^2 \times \frac{1}{10}$

$= \frac{100}{2 \times 10}$

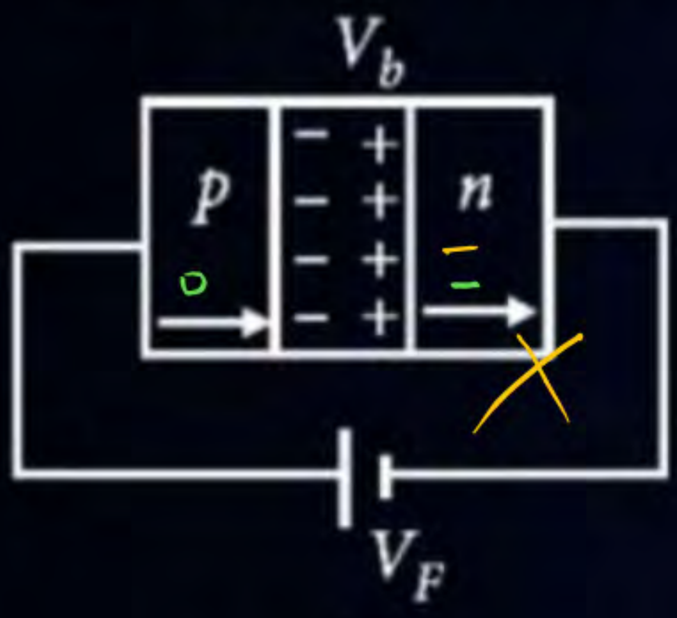
$= \frac{10}{2} = 5W$

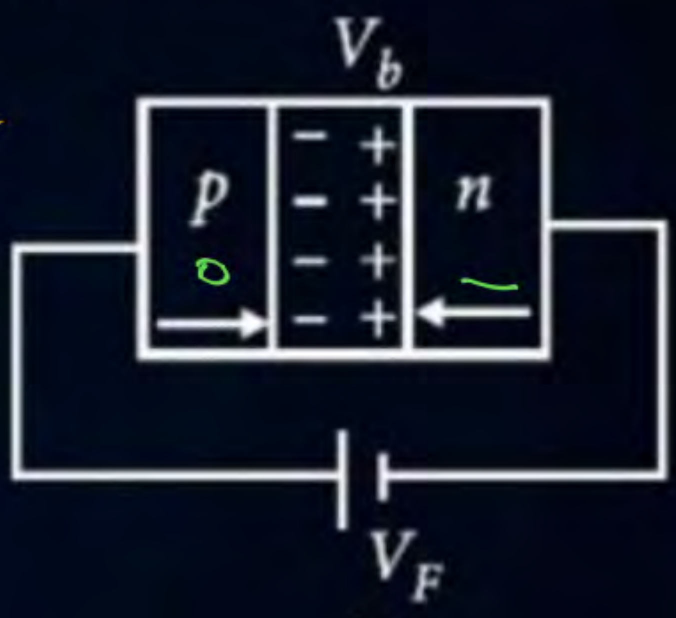
Ans → $P_{loss} = 2.5$ Watt

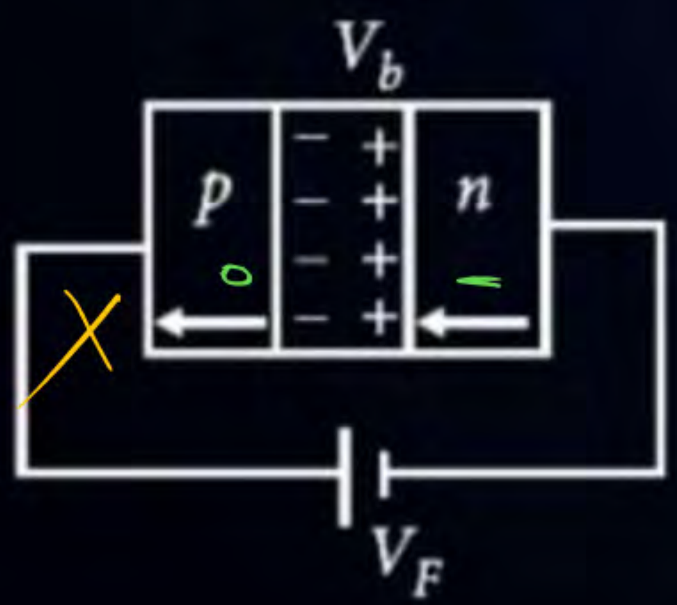
Level up (only Half cycle of A/C current will flow)

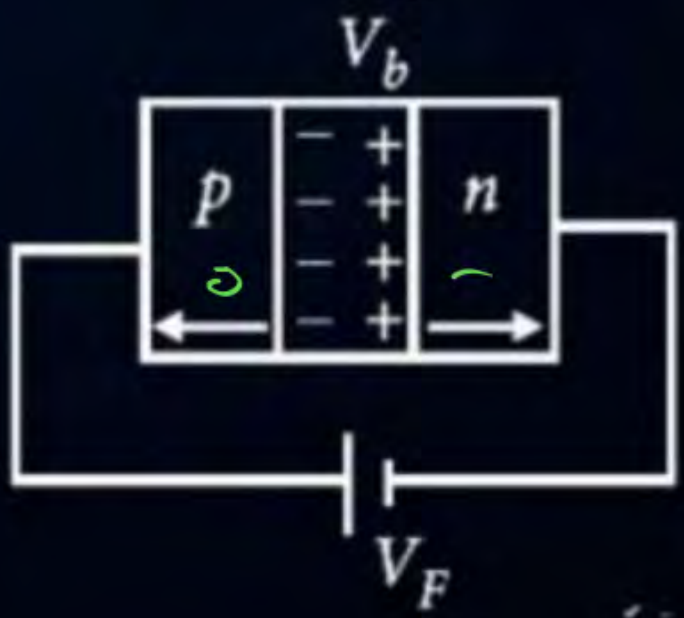
QUESTION

In the case of forward biasing of p–n junction, which one of the following figures correctly depicts the direction of flow of carriers?

(1)


(2)


(3)


(4)




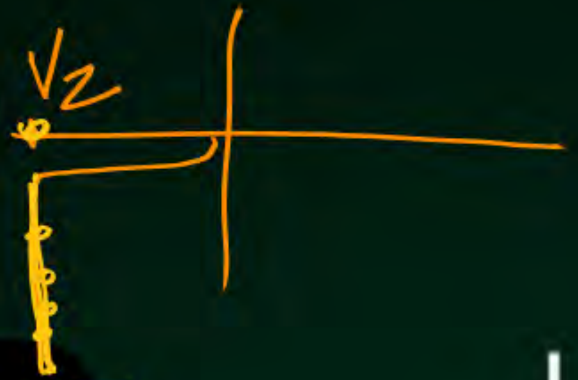
doping less → majority charge carrier ↓

doping large → majority charge carrier large

$$\downarrow \text{width of depletion} \propto \frac{1}{\text{doping level} \uparrow}$$

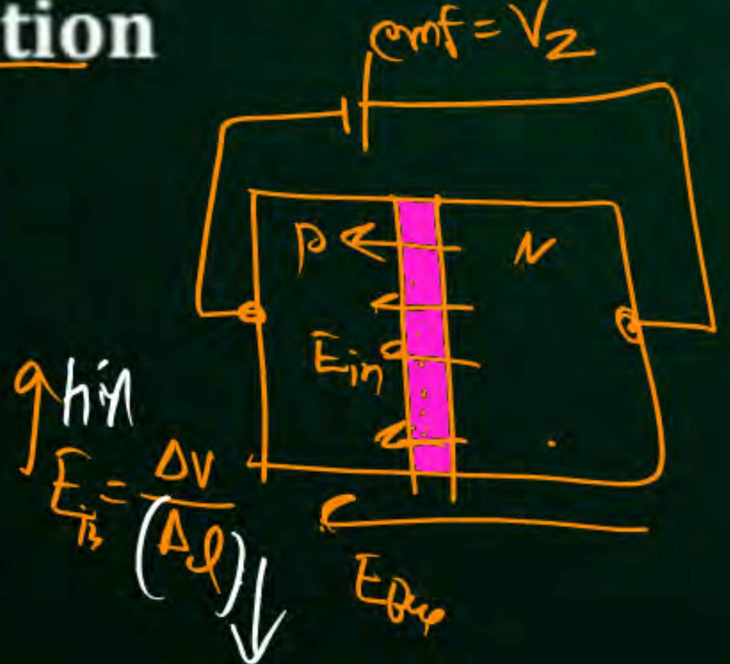
$$\text{width} \uparrow \text{ of depletion} \propto \frac{1}{(\text{doping level}) \downarrow}$$

BREAKDOWN



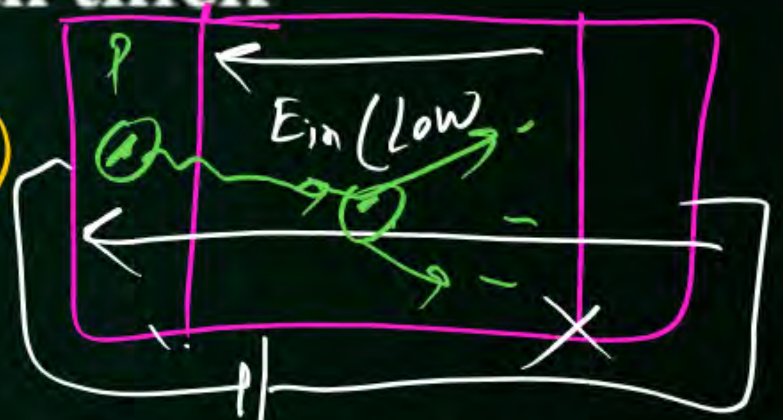
Zener Break down

- High doped semiconductor
- Depletion width thin
- Covalent bond will break due to electric field in reverse biased condition
- Reversible
  ↓ Can be repair



Avalanch Breakdown.

- Low doped semiconductor *
- Depletion width thick
- Not reversible
- Covalent bond will break due to collision. B/w the minority & bonded electron.



Zener Breakdown

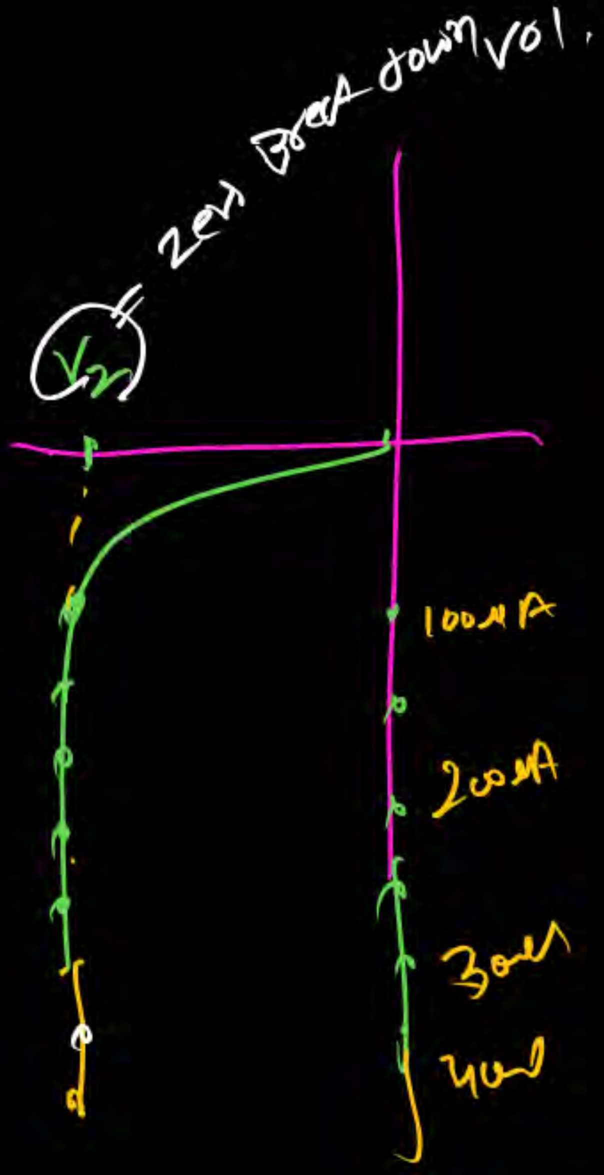
→ High doped Semiconductor ✓

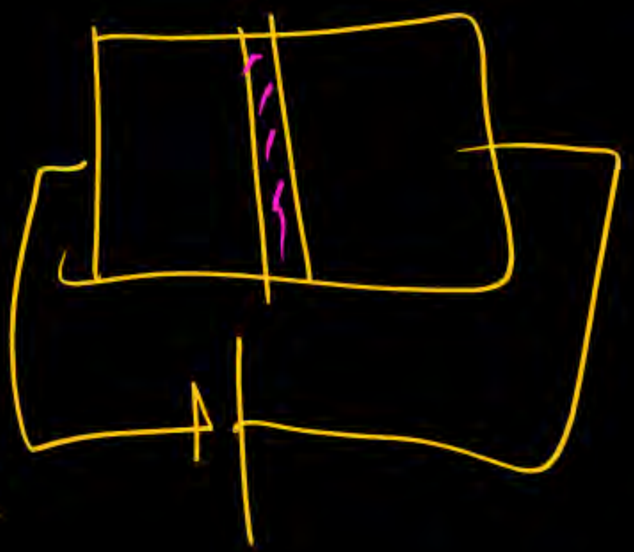
→ depletion width thin (पतला)

→ $\uparrow E_{internal} = \frac{\Delta V}{\Delta l} \downarrow$

High

→ at zener Breakdown Voltage it will break & flow high amount of current





QUESTION

The barrier potential of a p-n junction depends on

1. Type of semiconductor material
2. Amount of doping
3. Temperature

Which one of the following is correct?

1. (1) and (2) only
2. (2) only
3. (2) and (3) only
4. (1), (2) and (3)

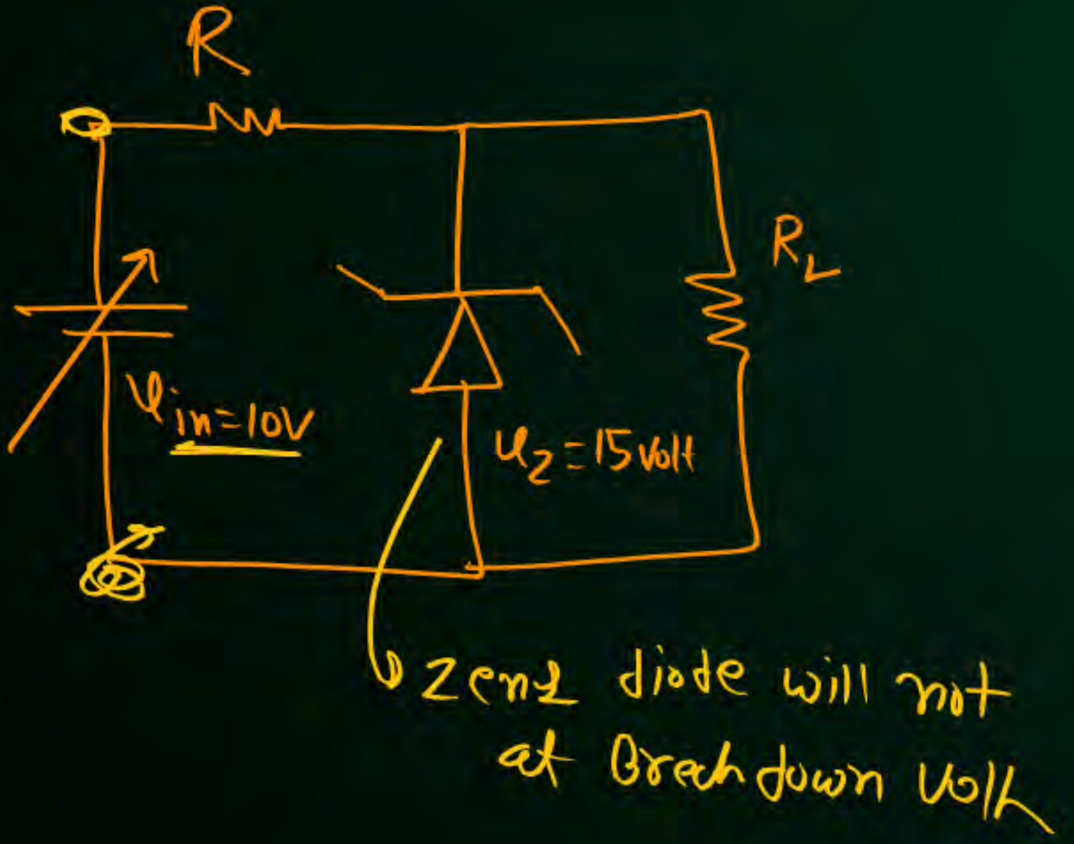
ZENER DIODE

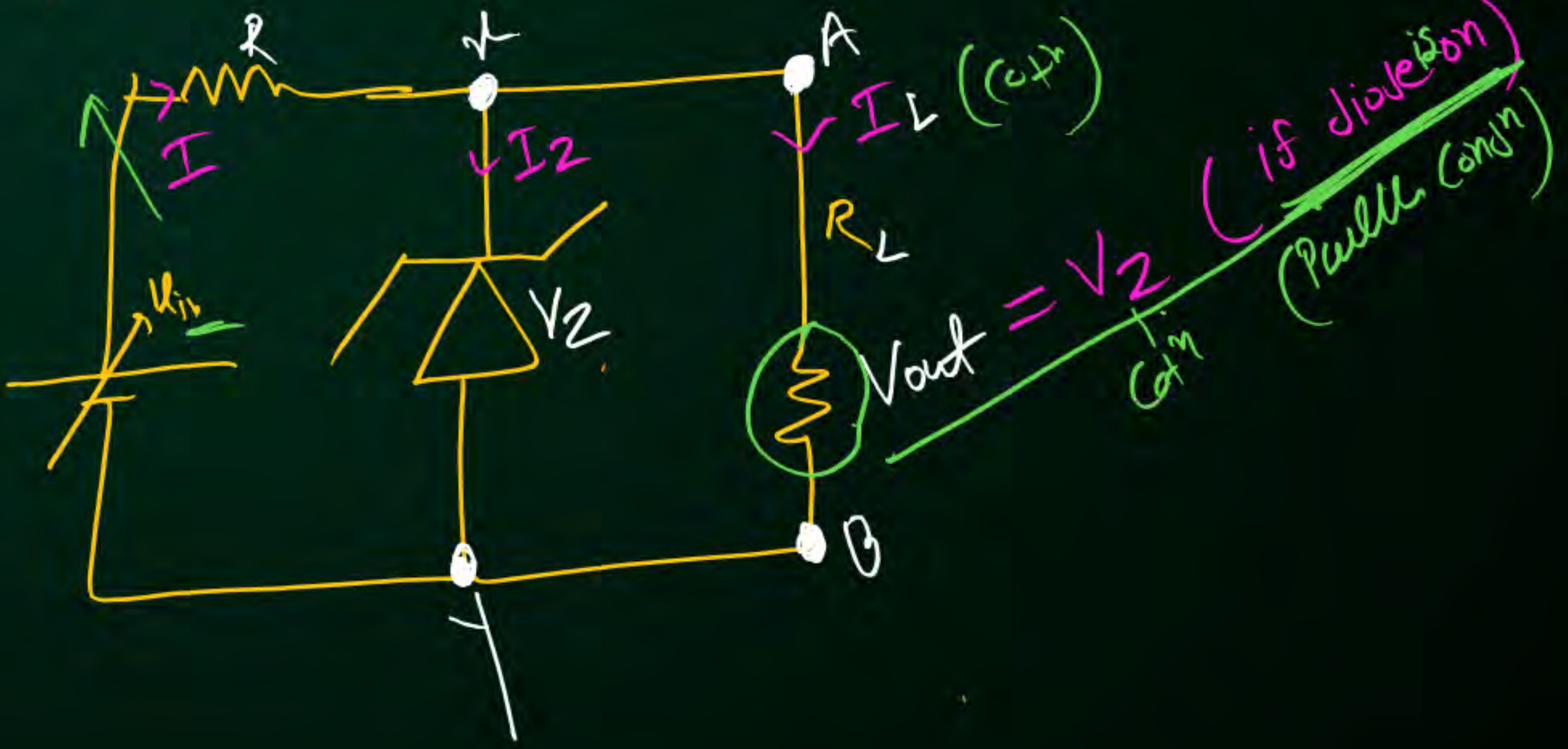
- Voltage regulator.
- Maintain constant voltage
- Works in reverse biased condition at Zener Breakdown voltage.



$I = I_Z + I_L$ —(1)

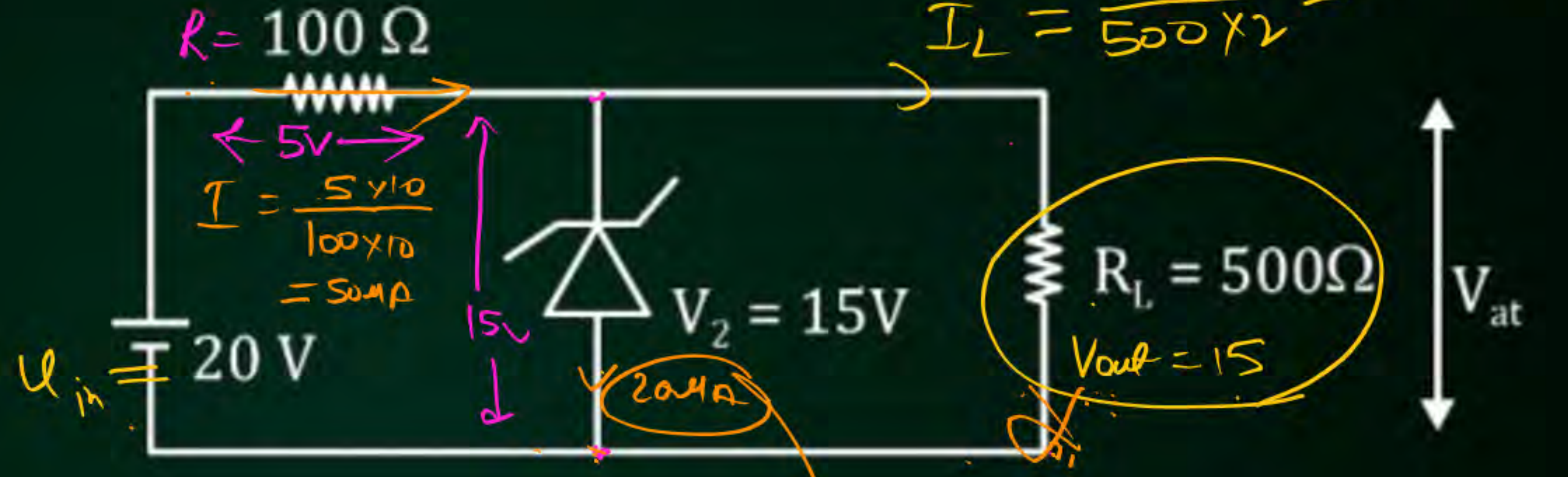
$V_{out} = R_L \cdot I_L$

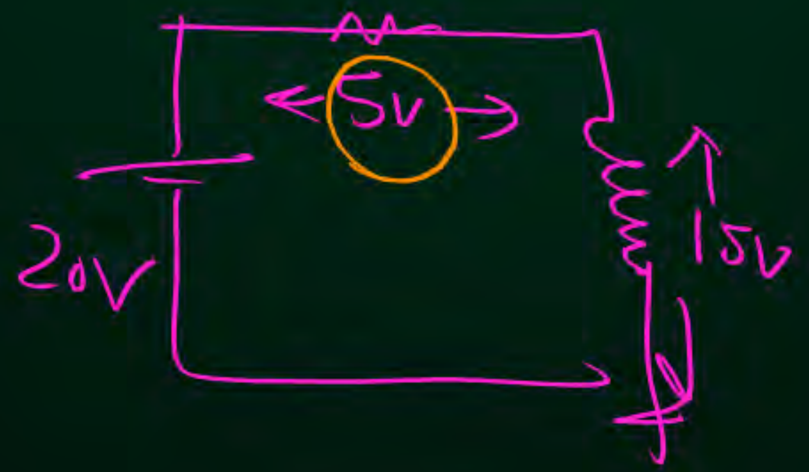




QUESTION

Find current in Zener.

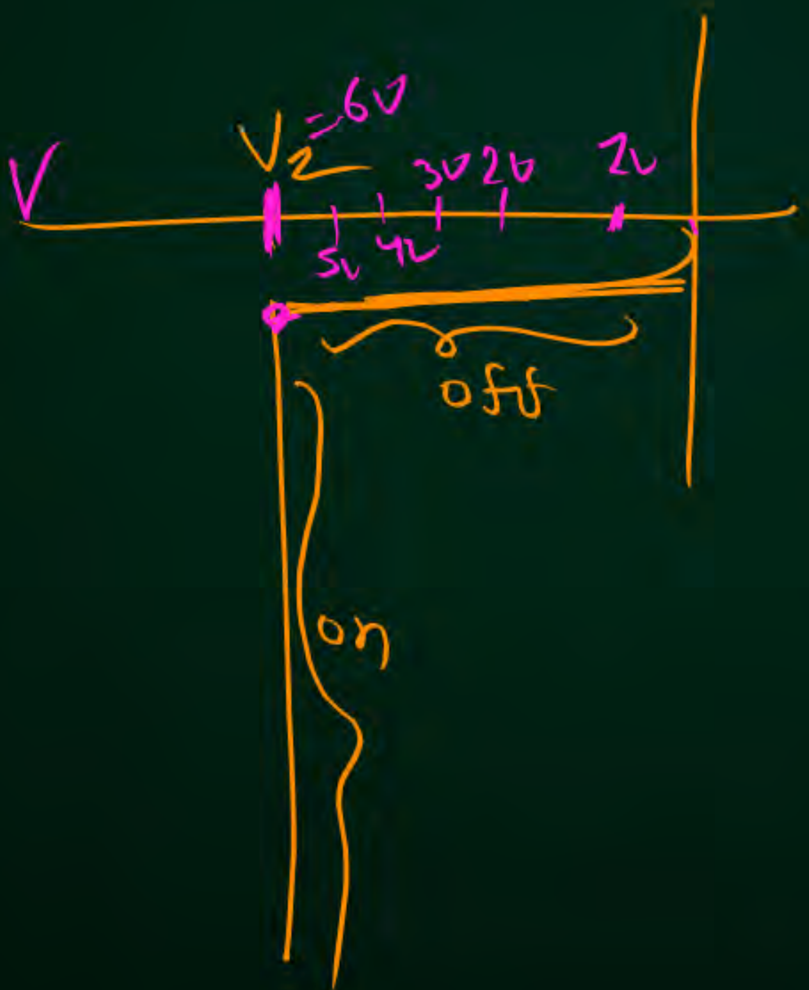




QUESTION

What is the value of output voltage V_0 in the circuit shown in the figure?

1. 6 V
2. 14 V
3. 20 V
4. 26 V



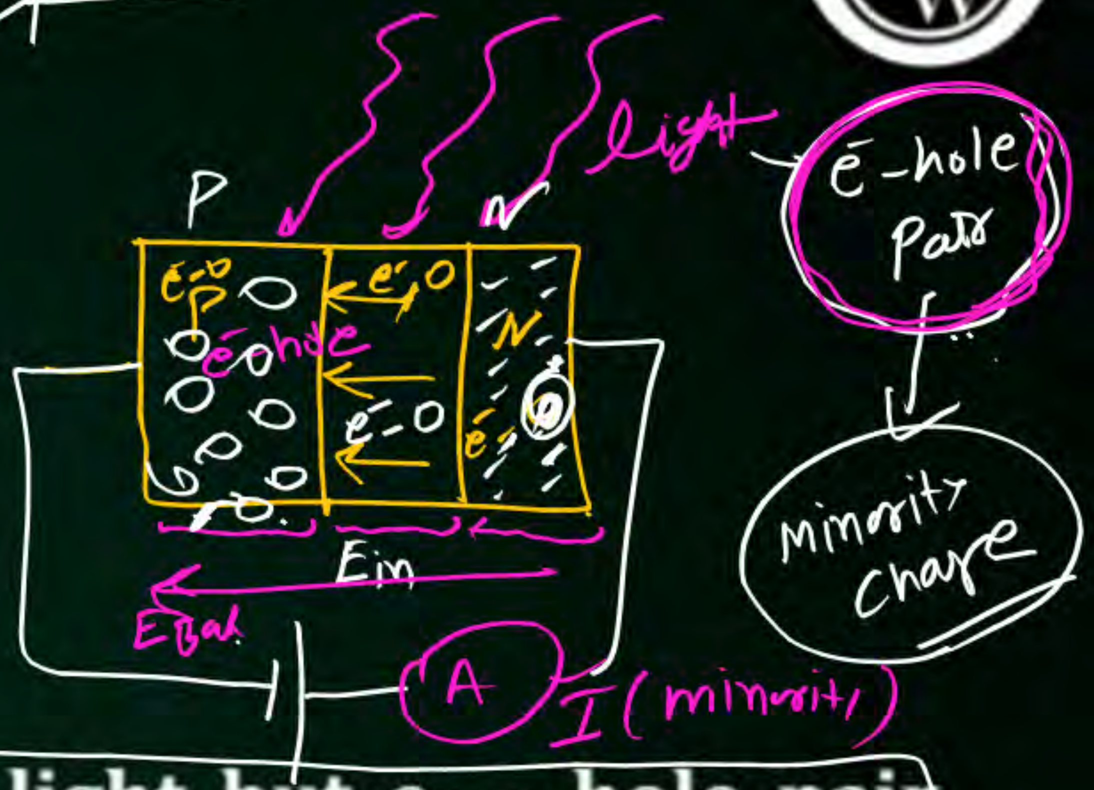


Optoelectronic circuit

- Photo diode
  - Use to detect Intensity of light
- LED
- Solar cell

PHOTO-ELECTRONIC CIRCUIT

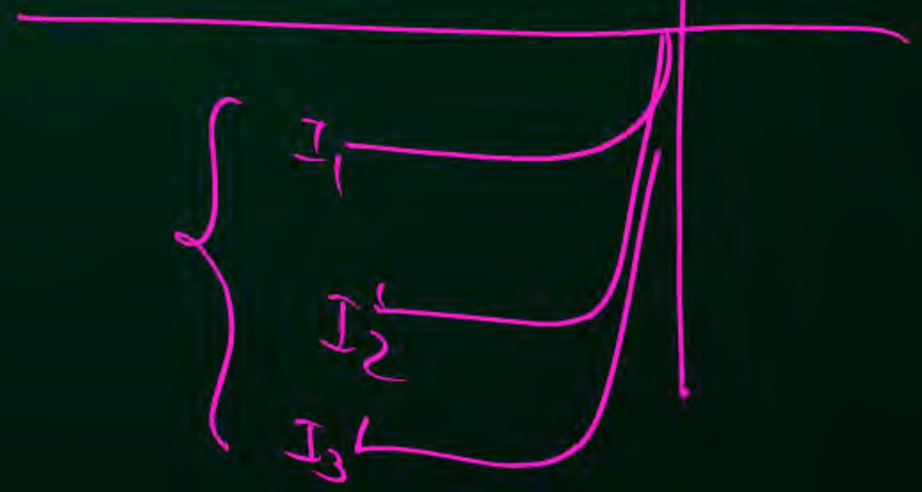




- ❖ Use to detect signal (Intensity of light)
- ❖ **Reverse biased**
- ❖ It measure intensity of signal (Intensity ∝ Current)
- ❖ e- does not comes out of diode due to failing of light but e- - hole pair created.

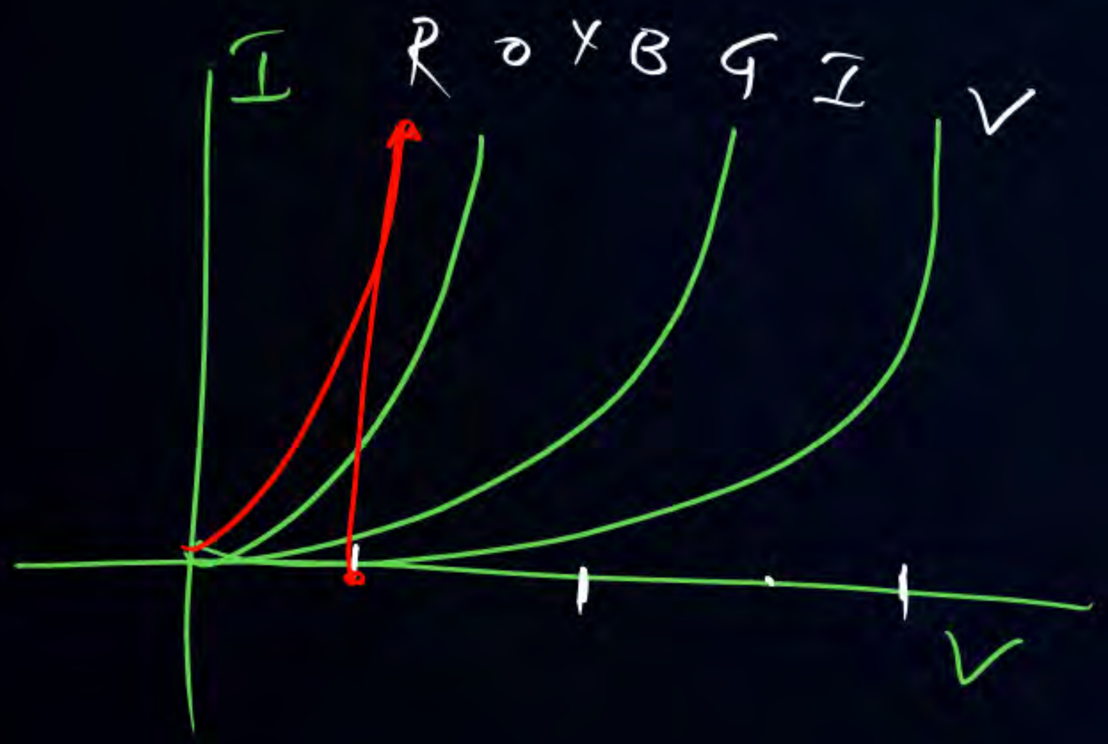
(Intensity ∝ Current)

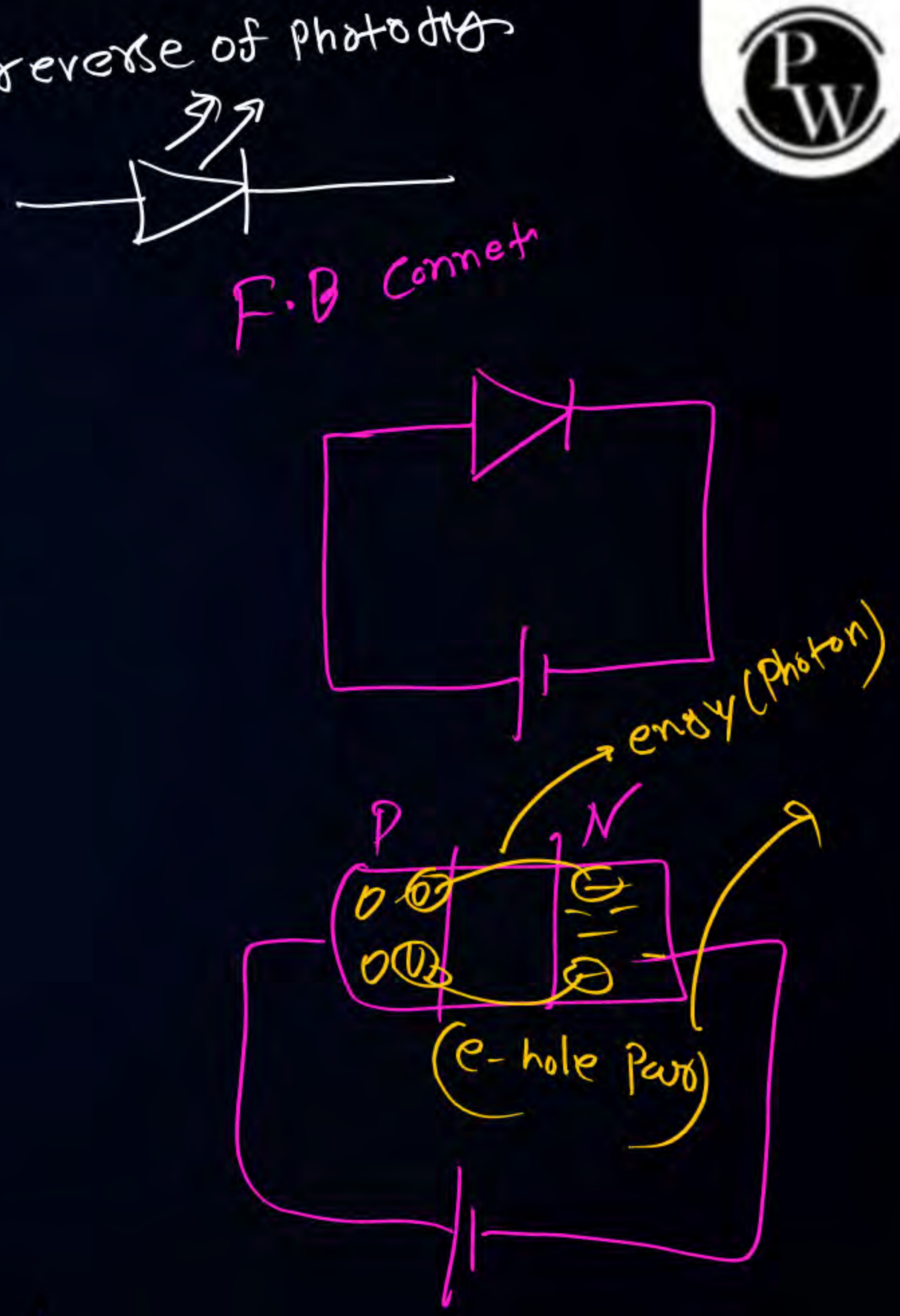
- ❖ Low doped semiconductor.
  - Depletion width layer



LED (LIGHT-EMITTING DIODE)

- Formed using GaAs semiconductor
- Uses in forward condition
- Photon emitted due to e^{-}-hole pair recombination.





QUESTION

An LED is constructed from a p – n junction diode using GaAsP. The energy gap is 1.9 eV. The wavelength of the light emitted will be equal to

1. 10.4×10^{-26} m
2. 654 nm
3. 654 Å
4. 654×10^{-11} m

$$E = \frac{hc}{\lambda}$$

$$1.9\,eV = \frac{12400\,eV}{\lambda(Å)}$$

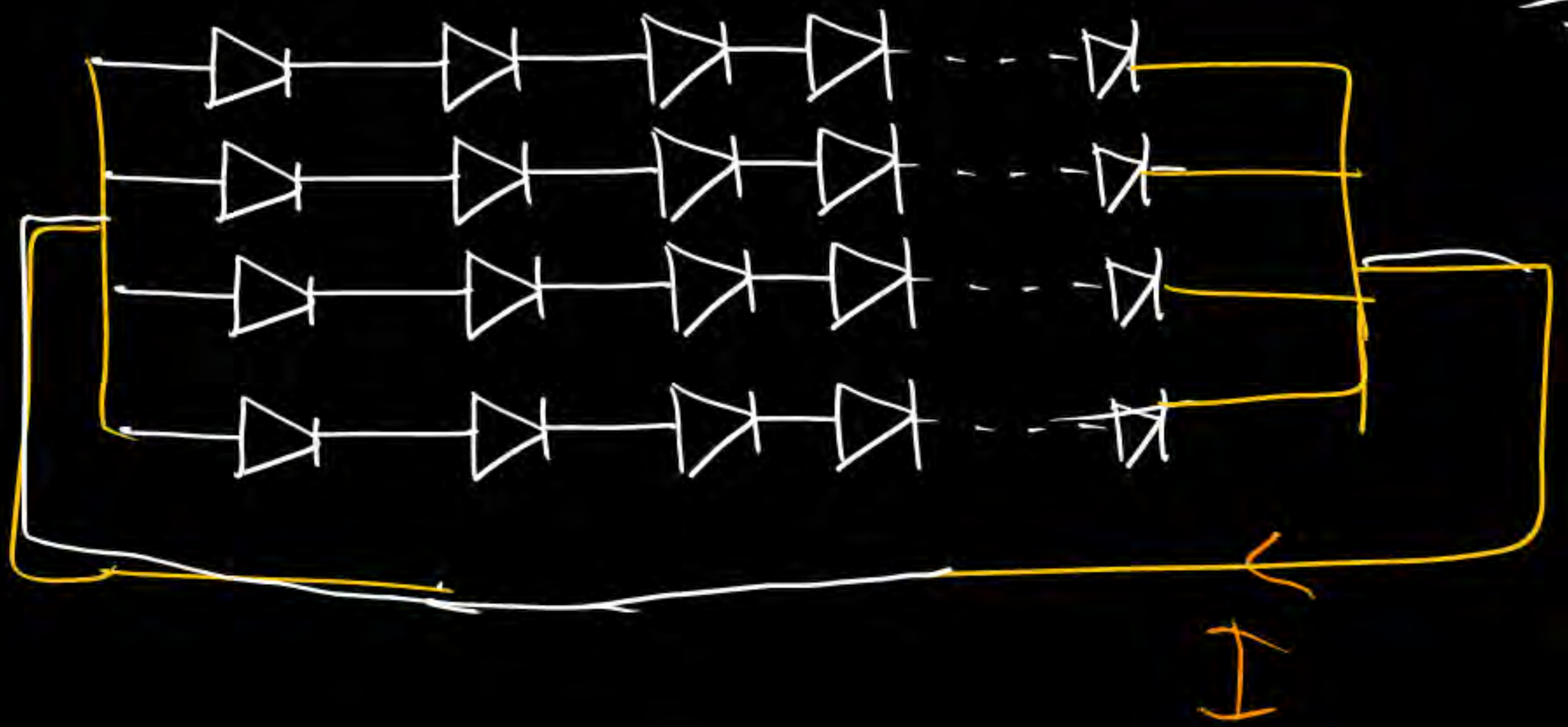
$$\lambda = \frac{12400}{1.9}$$

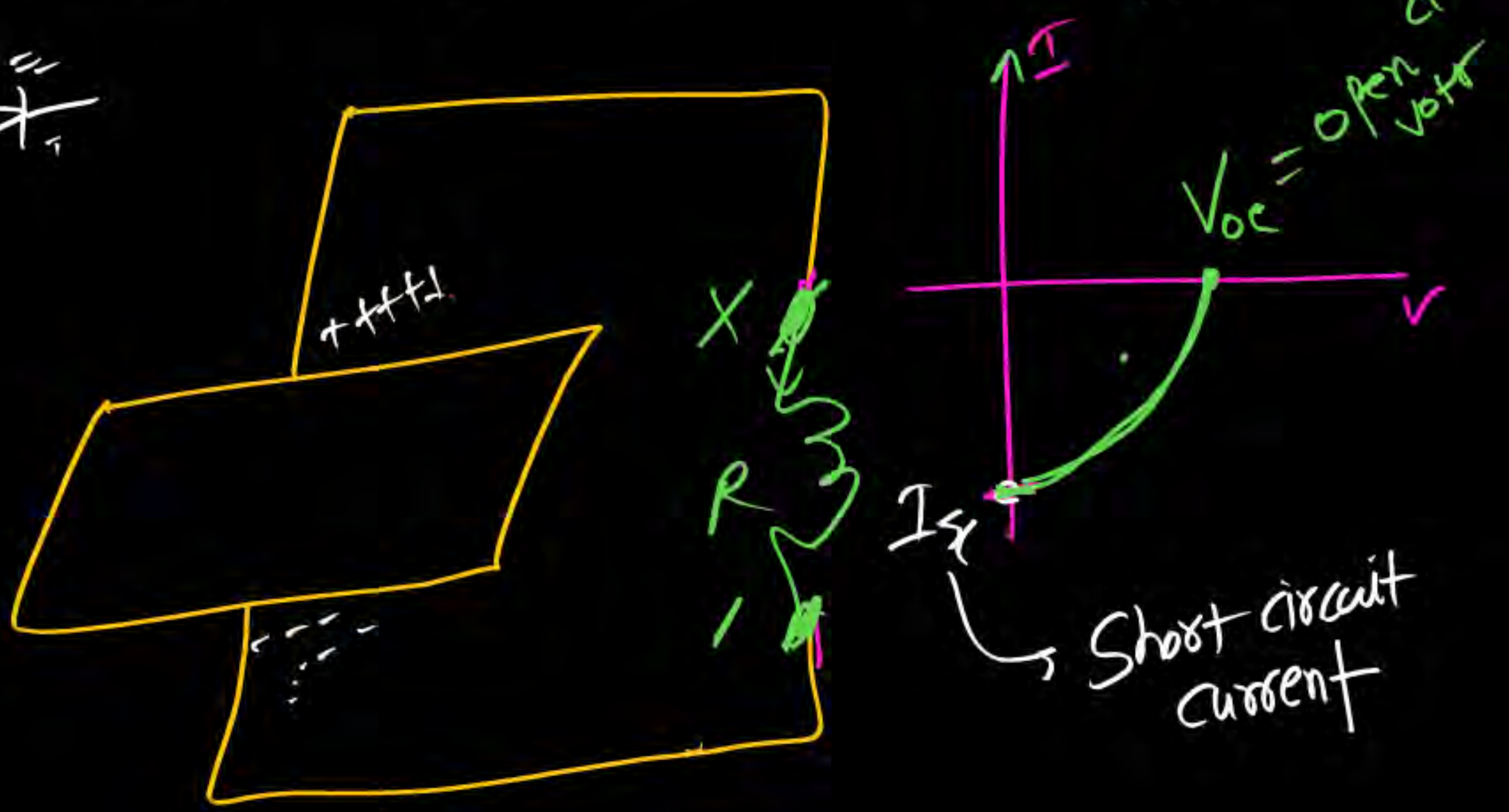
Solar cell

- working same as (photo-diode)
- No baising
- layer of diode connecte in series (To Incre voltage)

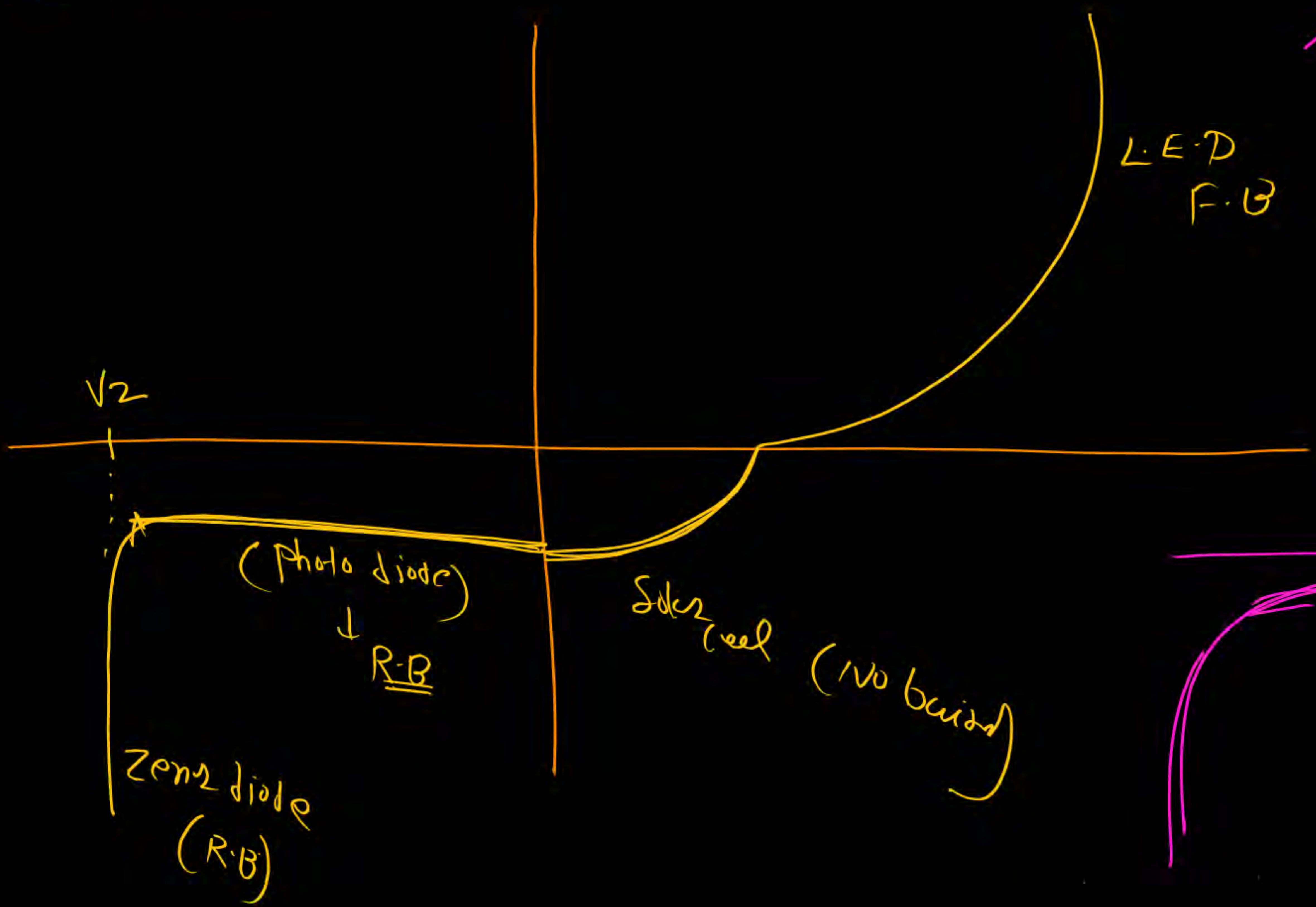


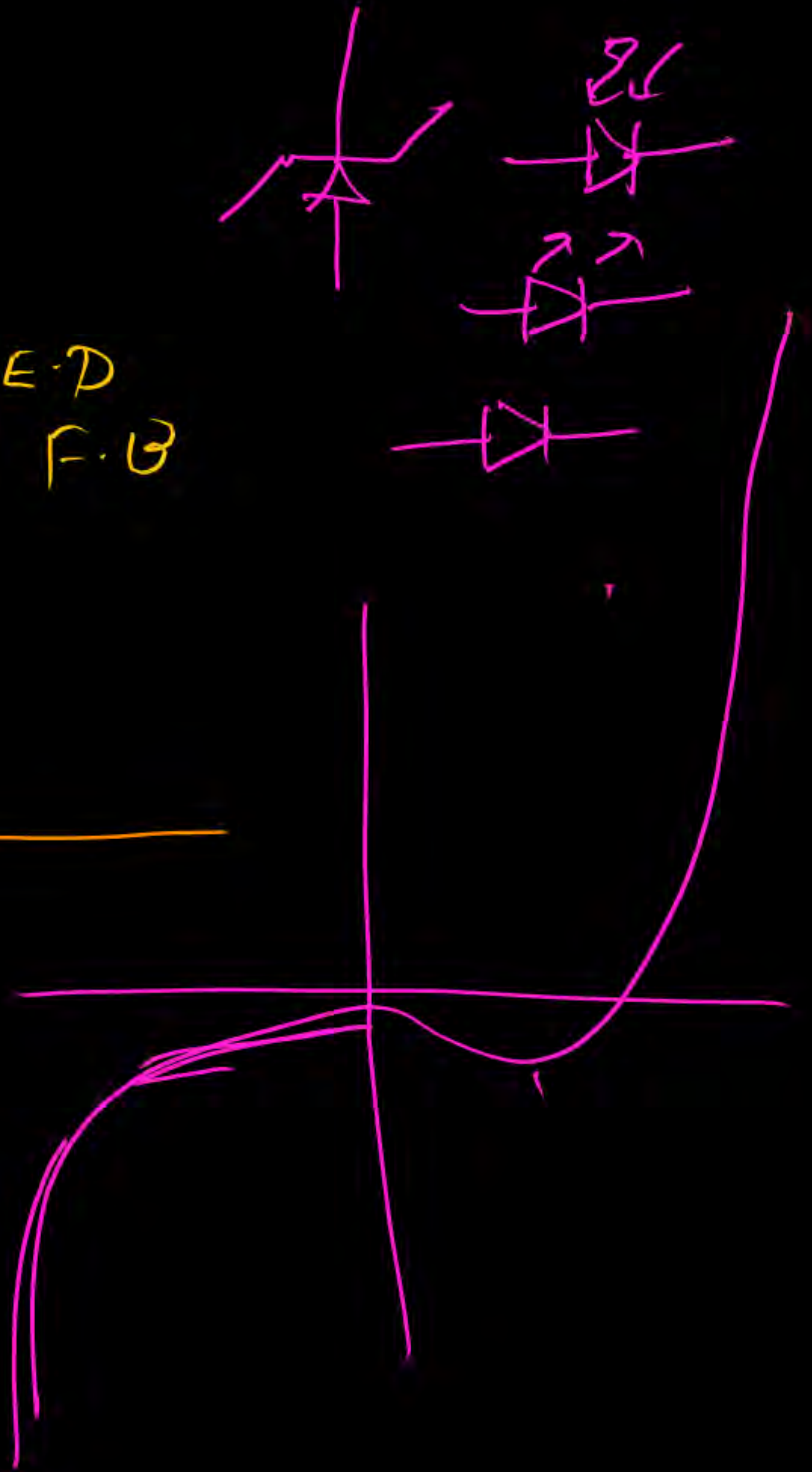






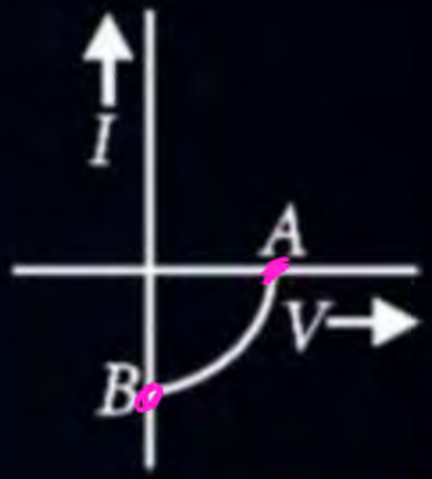
MR* Seal





QUESTION

The given graph represents V − I characteristics for a semiconductor device. Which of the following statement is correct?



1. It is V–I characteristics for solar cell where, point A represents open circuit voltage and point B short circuit current.
2. It is for a solar cell and points A and B represent open circuit voltage and current, respectively.
3. It is for a photodiode and points A and B represent open circuit voltage and current respectively.
4. It is for a LED and points A and B represent open circuit voltage and short circuit current respectively.

QUESTION

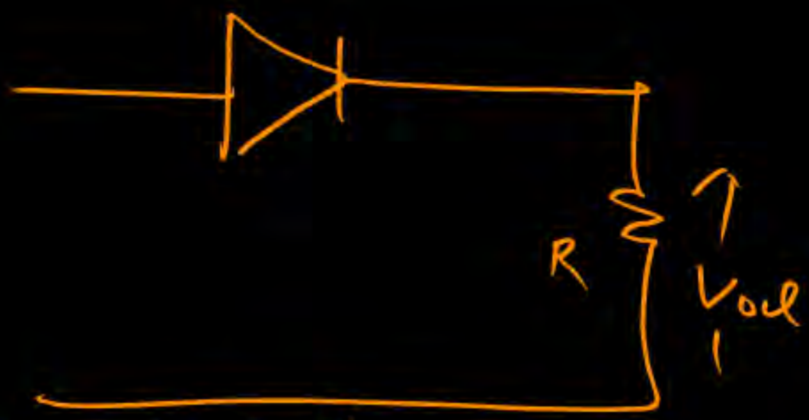
In a p–n junction photo cell, the value of the photo-electromotive force produced by monochromatic light is proportional to

emf (volts)

1. The barrier voltage at the p–n junction
2. The intensity of the light falling on the cell
3. The frequency of the light falling on the cell
4. The voltage applied at the p–n junction

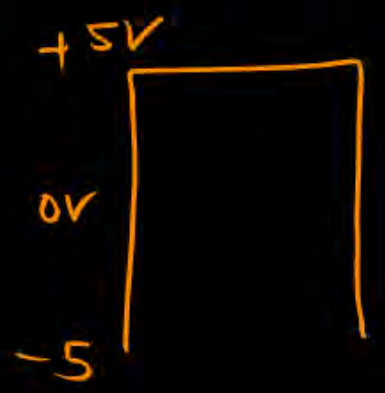


Input

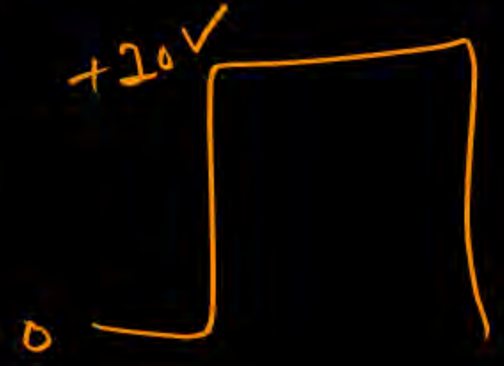


Q) which of the follow correct for output ??

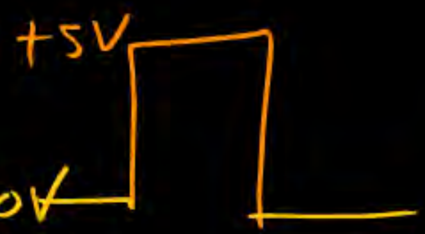
(a) [crossed out]



(c) [crossed out]



(b) [ticked]



correct

(d) [crossed out]



Thank you